Azadi Ka Amrit Mahotsav

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सत्यमेव जयते

भारत मौसम विज्ञान विभाग

INDIA METEOROLOGICAL DEPARTMENT

आदित्यात् जायते वृष्टिः

# वार्षिक प्रतिवेदन

# ANNUAL REPORT

# 2022


भारत मौसम विज्ञान विभाग

INDIA METEOROLOGICAL DEPARTMENT

पृथ्वी विज्ञान मंत्रालय, भारत सरकार

Ministry of Earth Sciences, Govt. of India

# वार्षिक प्रतिवेदन

# ANNUAL REPORT

# 2022


**INDIA METEOROLOGICAL DEPARTMENT**

**(MINISTRY OF EARTH SCIENCES)**

**(GOVT. OF INDIA)**

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# INDIA METEOROLOGICAL DEPARTMENT ORGANIZATION CHART

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Minister of State (Independent Charge) Ministry of Earth Science,
Minister of State for Prime Minister's Office; Personnel, Public Grievances and Pensions; Department of Atomic Energy and Department of Space

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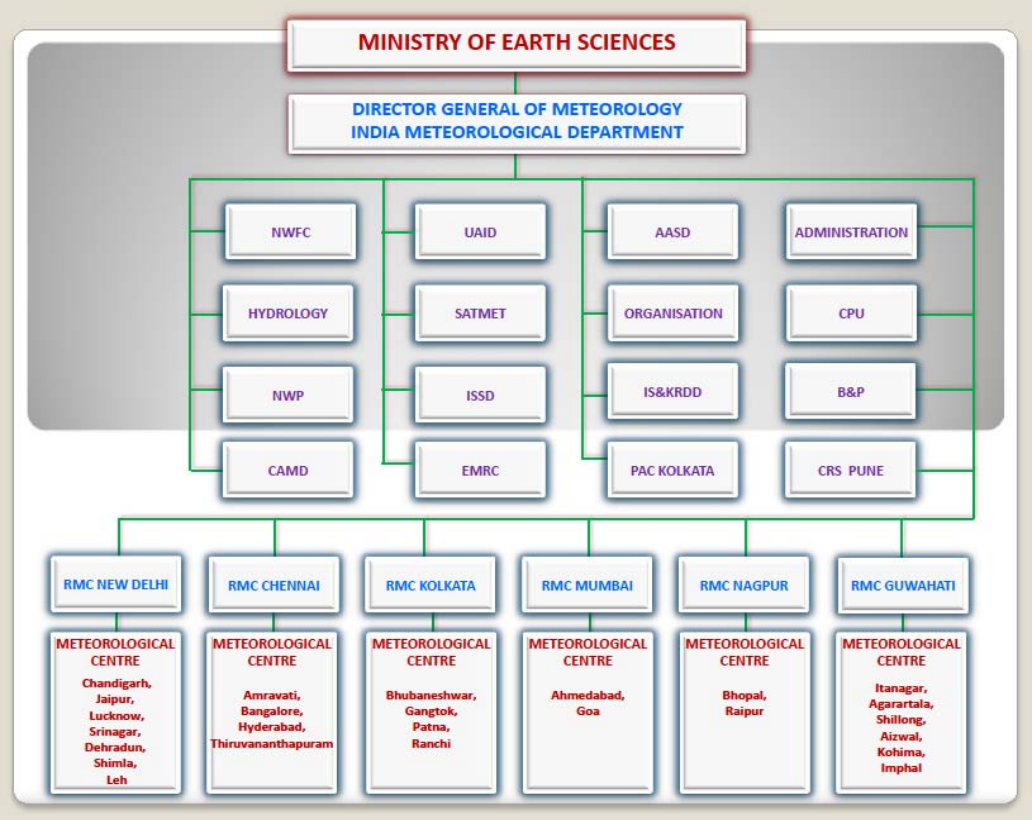
Ministry of Earth Sciences

**Dr. Mrutyunjay Mohapatra**

Director General of Meteorology
India Meteorological Department




| | | | | | |
|---|---|---|---|---|---|
| **NWFC** | **:** | **National Weather Forecasting Centre** | **AASD** | **:** | **Agromet Advisory Services Division** |
| **Hydrology** | **:** | **Hydromet Division** | **Organisation** | **:** | **Organisation** |
| **NWP** | **:** | **Numerical Weather Prediction** | **IS&KRDD** | **:** | **Information Science & Knowledge Resource Development Division** |
| **CAMD** | **:** | **Central Aviation Meteorological Division** | **PAC Kolkata** | **:** | **Positional Astronomy Centre, Kolkata** |
| **UAID** | **:** | **Upper Air Instruments Division** | **Administration** | **:** | **Administration** |
| **SATMET** | **:** | **Satellite Meteorology Division** | **CPU** | **:** | **Central Purchase Unit** |
| **ISSD** | **:** | **Information Systems and Services Division** | **B&P** | **:** | **Budget & Planning** |
| **EMRC** | **:** | **Environment Monitoring & Research Centre** | **CRS Pune** | **:** | **Climate Research & Services, Pune** |

# FOREWORD

It is a great privilege to present the Annual Report of India Meteorological Department (IMD) for the year 2022. The report highlights significant activities of the department during the year. The department has been playing a leading role in the field of Earth and Atmospheric Sciences by providing eminent services in meteorology and allied fields. The safety are critical for protecting life and property, safeguarding the environment and for efficient management of natural resources for sustainable development.

During 2022, the Department's progressive strode towards modernization of scientific infrastructure in the fields of meteorological observations, information systems and numerical modelling. It helped to render better services in areas of disaster management, agriculture, aviation, shipping, fisheries, energy and transport. IMD's services of very short range (up to 6 hrs), short range (up to 3-days in advance), medium range (up to 4-10 days in advance), extended range (up to 4 weeks in advance) and long range (monthly and seasonal) forecast alongwith severe weather (cyclones, thunderstorms, heavy rainfall, heat wave, cold wave, fog, etc.) warnings continuously improved to meet the demands of the user agencies, disaster managers, emergency response groups, other stakeholders and general public.

As a part of R&D, IMD encourages through publication of quarterly journal MAUSAM. The international research journal MAUSAM (formerly Indian Journal of Meteorology, Hydrology & Geophysics) has entered into 73$^{rd}$ year of its publications and has been made online (https://mausamjournal.imd.gov.in/index.php/MAUSAM) since 2021. Since then the journal has been making its way to advancement in the world of scientific journals reaching the Impact Factor of 1.01 in 2021. All the research articles (since the origin of 'MAUSAM', 1950) have been uploaded on the website and the Digital Object Identifiers (DOI's) for all of them have been assigned. The scientists in IMD have published 115 research papers in peer reviewed national and International journals during the year 2022.

IMD monitors the climate parameters and provides annual climate treatment to the country, WMO and IPCC.

The average global temperature in 2022 was about 1.15 (1.02 to 1.27) $^{o}$C above the pre-industrial levels. The 2022 is the 8$^{th}$ consecutive year (2015-2022) that annual global temperatures have reached at least 1 °C above pre-industrial levels, according to all datasets compiled by WMO. The annual mean land surface air temperature averaged over India during 2022 was+0.51 $^{o}$C above the long-term average (1981-2010 period). The year 2022 was the fifth warmest year on record since nationwide records commenced in 1901.

The temperatures were consistently 3 °C-8 °C above normal breaking many decadal and some all-time records in several parts of the country, including the western Himalayas, the plains of Punjab, Haryana, Delhi, Rajasthan and Uttar Pradesh. The states of Odisha, Madhya Pradesh, Gujarat, Chhattisgarh, Telangana and Jharkhand also experienced heatwaves, in some areas severe, with temperatures ranging from 40 °C–44 °C in the last days of March, 2022. The heatwave conditions continued into April, reaching its preliminary peak towards the end of the month. Heatwaves also increase the risk of forest-fires. Around 300 large forest fires occurred in the country on April 28, a third of these in Uttarakhand. By April 29, almost 70 percent of India was affected by the heatwave.

Towards the end of April and in May, the heatwave extended into the coastal areas and eastern parts of India. Anomalously high temperatures during these months adversely affected grain filling and cause early senescence, thus reducing yields.

During 2022, 15 cyclonic disturbances (three cyclonic storms and 12 depressions) formed over the north Indian Ocean against the normal of 11.2 based on data of 1965-2021. It included three cyclones, seven depressions formed over Bay of Bengal and three depressions over Arabian Sea and two land depressions. Overall, the frequency of formation of depressions over the region was above normal and that of cyclones was below normal during 2022. In addition to these, extreme weather events like extremely heavy rainfall, floods, landslide, lightning, thunderstorm, droughts etc were also experienced in various parts of the country. The early warning provided by IMD enabled disaster managers to minimize long lives due to cyclone to 46 in asian region in 2022.

IMD, Ministry of Earth Sciences in active collaboration with ICAR, State Agricultural University and Other Institutes is rendering the weather forecast based Agromet Advisory Services (AAS) to the farmers at district/block level through a network of existing 130 Agro-Met Field Units (AMFUs) and 199 District AgroMet Units (DAMUs). These agromet advisories are being prepared and disseminated by 329 units (AMFUs/DAMU) twice a week (Tuesday and Friday) covering 700 districts and 3100 blocks of the country under Gramin Krishi Mausam Sewa (GKMS). AAS bulletins are also prepared and issued at state levels on every Tuesday & Friday and at National level on every Friday to cater to the needs of users at various levels. The bulletins include past weather, medium-range weather forecast for the next 5 days and specific agromet advisories on field crops, horticultural crops, livestock, etc.

IMD has also provided Climate Services for the water sector for monitoring and prediction of average rainfall over 153 sub basins of India and for health bulletins to give the outlook for suitability for Vector- borne diseases based on extended range weather forecast had been started and is continuously in practice.

Finally, I sincerely thank all the employees of IMD for their support and commitment throughout the last year and I look forward to your continued support in our journey towards setting higher levels of excellence. My special thanks to Dr. V. K. Soni, Scientist ‘F’ and Mr. Sunny Chug, Scientist ‘C’, Information Science & Knowledge Resource Development Division (IS&KRDD) (Formerly Publication Section) and their team in the division for their sincere efforts in compilation, editing and publication of this Annual Report 2022.

**Dr. Mrutyunjay Mohapatra**
**Director General of Meteorology**

## Document Control Sheet

**India Meteorological Department**

**Ministry of Earth Sciences (MoES)**

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| 14. | Abstract | This report highlights the progress made by the India Meteorological Department during the year 2022. The Department has continuously augmenting its observational, forecasting and information systems to render improved services in areas of agriculture, aviation, shipping, fisheries, environment, water, health, energy, transport etc. Some significant achievements during 2022 include 190 new Agro-AWS established at District Agromet Units (DAMUs), Launched “Pune Live Weather App”, installation of 12 new High Wind Speed Recorder (HWSR), installation of 10 Digital Current Weather Instrument System (DCWIS), Commissioning of 3 Doppler Weather Radars at Mukteshwar (Uttarakhand); Kufri (Himachal Pradesh); and Jammu (J&K) in 2021, installation of 200 Agro-AWS at Krishi Vigyan Kendras (KVKs). IMD developed web-GIS based interactive map for cyclone. X-Band Doppler Weather Radar mounted on mobile platform installed at Leh. Integration of Agromet advisories with the mobile apps and websites of various State Department. The Online Web Portal of IMD Journal MAUSAM launched. |
| 15. | Key words | IMD Annual Report 2022, MoES, Publication, Mausam, Weather. |

# CHAPTER 1

# INDIA METEOROLOGICAL DEPARTMENT - OVERVIEW

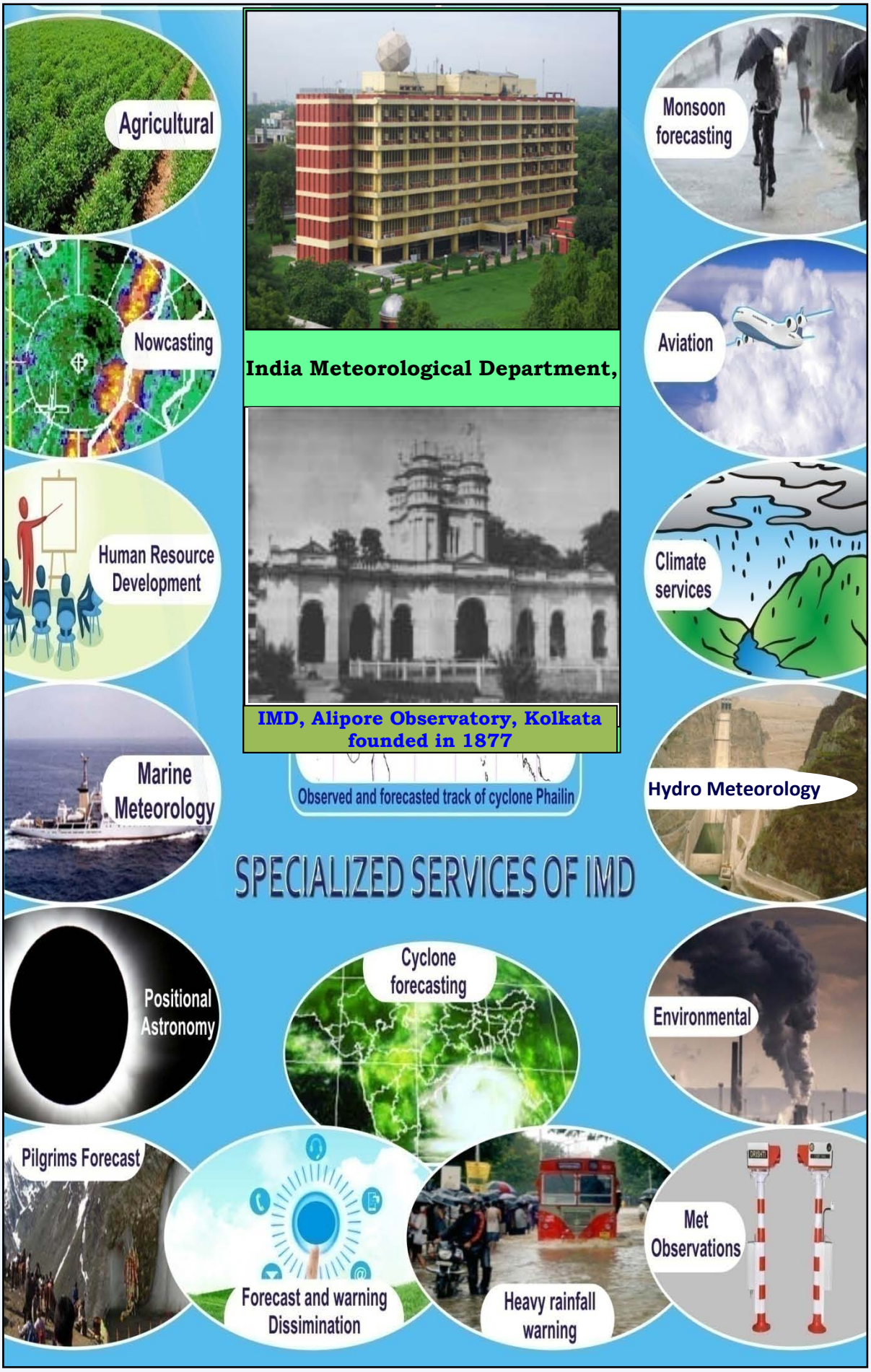
***India Meteorological Department, Ministry of Earth Sciences is the National Meteorological Service of the country and the principal Government agency in all matters relating to Meteorology, Seismology and allied discipline and provides weather and climate services to the public and specialized sectors.***

It's mandate is:

- To take meteorological observations and to provide current and forecast meteorological information for optimum operation of weather-sensitive activities like agriculture, irrigation, shipping, aviation, offshore oil explorations, etc.
- To warn against severe weather phenomena like tropical cyclones, norwesters, duststorms, heavy rains and snow, cold and heat waves, etc., which cause destruction of life and property.
- To provide meteorological statistics required for agriculture, water resource management, industries, oil exploration and other nation-building activities.
- To conduct and promote research in meteorology and allied disciplines.
- To detect and locate earthquakes and to evaluate seismicity in different parts of the country for development projects.

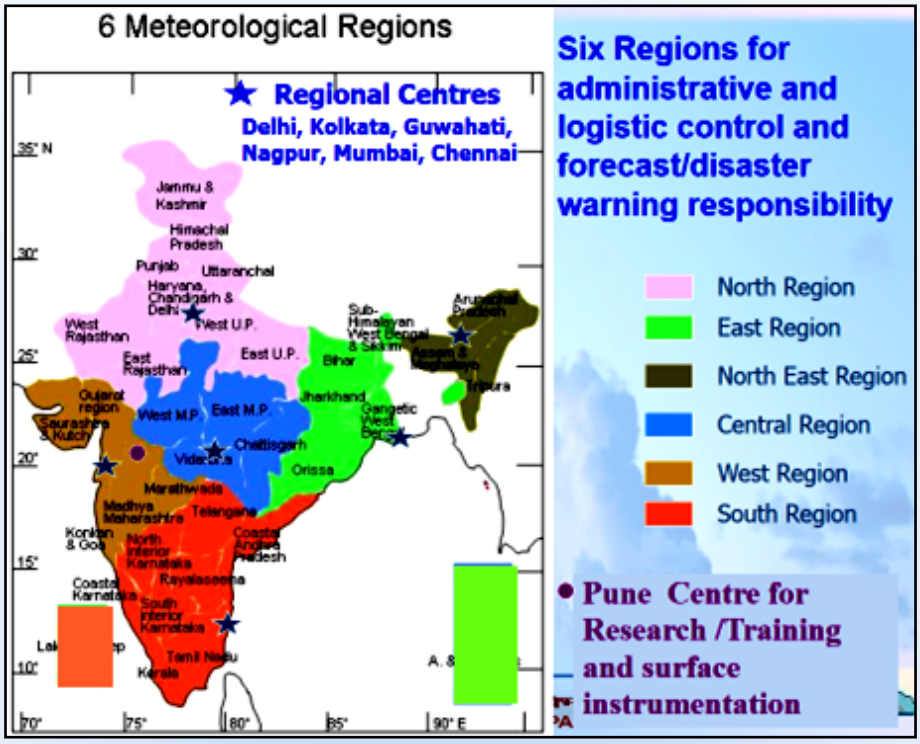
A disastrous tropical cyclone struck Calcutta in 1864 and this was followed by failures of the monsoon rains in 1866 and 1871. In the year 1875, the Government of India established the India Meteorological Department, bringing all meteorological work in the country under a central authority. Mr. H. F. Blanford was appointed Meteorological Reporter to the Government of India.

From a modest beginning in 1875, IMD has progressively expanded its infrastructure for meteorological observations, communications, forecasting and weather services and it has achieved a parallel scientific growth. IMD has always used contemporary technology. In the telegraph age, it made extensive use of weather telegrams for collecting observational data and sending warnings. Later IMD became the first organization in India to have a message switching computer for supporting its global data exchange. One of the first few electronic computers introduced in the country was provided to IMD for scientific applications in meteorology. India was the first developing country in the world to have its own geostationary satellite, INSAT, for continuous weather monitoring of this part of the globe and particularly for cyclone warning. IMD has continuously ventured into new areas of application and service, and steadily built upon its infra-structure in its history of 145 years. It has simultaneously nurtured the growth of meteorology and atmospheric science in India. Today, meteorology in India is poised at the threshold of an exciting future.


Agricultural
Monsoon forecasting
Nowcasting
Aviation
Human Resource Development
Climate services
Marine Meteorology
Hydro Meteorology
Positional Astronomy
Cyclone forecasting
Environmental
Pilgrims Forecast
Forecast and warning Dissimination
Heavy rainfall warning
Met Observations
India Meteorological Department,
IMD, Alipore Observatory, Kolkata founded in 1877
Observed and forecasted track of cyclone Phailin
SPECIALIZED SERVICES OF IMD

India had some of the oldest meteorological observatories of the world and the first astronomical and meteorological unit started at Madras in 1793. Thus, meteorological observation in India was taken even prior to the establishment of the department in 1875. Since then IMD has achieved many milestones during the period from 1793 to 2022.


The Director General of Meteorology is the Head of the India Meteorological Department, with headquarters at New Delhi. For the convenience of administrative and technical control, there are 6 Regional Meteorological Centres, each under a Deputy Director General with headquarters at Mumbai, Chennai, New Delhi, Kolkata, Nagpur and Guwahati. Under the administrative control of Deputy Director General, there are different types of operational units such as Meteorological Centres, Forecasting Offices, Agromet. Advisory Centres, Flood Meteorological Offices and Cyclone Detection Radar Stations.




India Meteorological Department has continued its efforts for the improvement of observing, warning and dissemination mechanism/systems all through 2022. Its improved services rendered in respect of very short (up to 6 hrs), short (up to 3-days in advance), medium (up to 7-10 days in advance), extended (up to 15 to 20 days in advance), long (monthly and seasonal) range and severe weather (cyclones, thunderstorms, extreme rainfall) forecasts have been built to meet the demands of the user agencies, disaster managers, emergency response groups and other stakeholders in an organized manner in 2022. Its short, medium, extended & long range and cyclone forecasts were appreciated all over the world.

The temperatures were consistently 3°C-8°C above normal breaking many decadal and some all-time records in several parts of the country, including the western Himalayas, the plains of Punjab, Haryana, Delhi, Rajasthan and Uttar Pradesh. The states of Odisha, Madhya Pradesh, Gujarat, Chhattisgarh, Telangana and Jharkhand also experienced heatwaves, in some areas severe, with temperatures ranging from 40°C–44°C in the last days of March. The heatwave conditions continued into April, reaching its preliminary peak towards the end of the month. Heatwaves also increase the risk of forest-fires. Around 300 large forest fires occurred in the country on April 28, a third of these in Uttarakhand. By April 29, almost 70 percent of India was affected by the heatwave. Towards the end of April and in May, the heatwave extended into the coastal areas and eastern parts of India.

The rainfall for the country as a whole, for the Annual (Jan-Dec)-2022 has been recorded as 1257.0 mm which is 108% of its Long Period Average (LPA) of 1160.0 mm. In all, category wise, 13 Met sub-divisions in EXCESS, 20 Met sub-divisions in NORMAL, 03 in DEFICIENT and No Met. sub-divisions remained in LARGE EXCESS,LARGE DEFICIENT&NO RAIN category of rainfall.

During 2022, 15 CDs (maximum sustained wind speed (MSW)≥ 17 knots) developed over the NIO against normal (during 1965-2021) of 11.2 per year. Thus, annual activity of formation of CD was above normal during the year 2022.

There were 12 depressions and deep depressions (MSW: 17-33 knots) (Normal: 6.5 per year), 1 cyclonic storm (MSW: 34-47 knots) (Normal: 1.8 per year) and 2 severe cyclonic storms (MSW: 48-63 knots) (Normal: 2.9 per year) during the year 2022.

A total of 3 cyclones (MSW≥ 34 knots) developed over the NIO during 2022 against normal of 4.7 per year. Overall, the frequency of formation of depressions over the region was above normal and that of cyclones was below normal during 2022. There were 3 CDs over Arabian Sea (Normal: 2.3 per year), 10 over Bay of Bengal (Normal: 7.8 per year) and 2 over land (Normal: 1.1 per year) during 2022. Basin-wise activity wrt formation of CDs was above normal over Bay of Bengal, Arabian Sea and Land.

IMD utilized all it's resources for monitoring and prediction of CDs during 2022. We are happy to inform you that all the cyclonic disturbances were monitored and predicted with sufficient lead time and great accuracy. IMD maintained continuous watch over the NIO and monitored all the disturbances with issue of extended range outlook (valid for next 15 days), daily tropical weather outlook (valid for next 5 days), daily detailed prognostic and diagnostic report during October-December (valid for next 7 days) and 6hourly/3hourly/hourly structured bulletins on formation of cyclonic disturbance period.

The CDs were monitored with the help of available satellite observations from INSAT 3D and 3DR, polar orbiting satellites, available ships & buoy observations in the region, Doppler Weather Radars (DWR) and observations from coastal observatories. Various global models and dynamical-statistical models run by Ministry of Earth Sciences (MoES) institutions including IMD, NCMRWF, IITM and INCOIS were utilized to predict the genesis, track, landfall and intensity of the CDs as well as associated severe weather including heavy rainfall, strong winds and storm surge. A digitized forecasting system of IMD was utilized for analysis and comparison of various observations and numerical weather prediction models guidance, decision making process and warning products generation. The forecasts were mainly based on multi-model ensemble techniques developed indigenously by IMD.

Various parts of the country experienced Extreme Weather Events like extremely heavy rainfall, floods, landslide, lightning, thunderstorm, etc. A few of them are mentioned below. The causalities caused by these extreme events mentioned here are based on the media and the government reports from disaster Management Authorities.

Assam was the most adversely affected state during 2022 till date, which reportedly claimed more than 250 deaths mainly due to extremely heavy rainfall, floods, landslide, lightning, thunderstorm events. Bihar was also one of the worst affected state, which claimed more than 180 deaths mainly due to lightning and thunderstorm. While, more than 130 lives were claimed from Maharashtra state due to different weather events.

Heavy rainfall, floods & Landslide incidents claimed over 660 lives from different parts of the country. Of these, 198 lives were from Assam, 73 from Maharashtra, 61 from Himachal Pradesh, 56 from Manipur (due to Massive Landslide in Noney district on 30 June) & 47 from Rajasthan.

Thunderstorms and lightning claimed more than 700 lives from different parts of the country. Among these, the significant number of casualties reported were 186 from Bihar, 64 from Uttar Pradesh, 62 from Jharkhand, 61 from Rajasthan, 58 from Assam, 53 from Chhattisgarh, 50 from Maharashtra, and 48 from Madhya Pradesh and Odisha each.

## SUMMARY OF MAJOR ACHIEVEMENTS IN 2022

### Observations

### Agrometeorological Observatories & Data Management

Observing Systems and Field Campaigns under Gramin Krishi Mausam Seva (GKMS)

- Conventional agromet observatory has been installed at Agromet Field Unit Port Blair, Andaman & Nicobar Islands to enhance weather observations and use in the Agromet Advisories under GKMS scheme.

- 200 Agro-AWS have been established at District Agromet Units (DAMUs) in the premises of Krishi Vigyan Kendras (KVKs).

- In order to enhance outreach, initiatives have been undertaken to integrate the weather forecast and agromet advisories with the mobile applications and websites of various State Governments and Academic Institutions. Integration has already been completed for Bihar, Chhattisgarh, Gujarat, Haryana, Madhya Pradesh, Nagaland, Rajasthan, Tamil Nadu and Uttarakhand states and is in advanced stage for Odisha, Uttar Pradesh, Meghalaya and Maharashtra.

- Impact based forecast (IBF) for Agriculture (Cold Wave/Hailstorm/Heavy Rainfall/ Heat Wave/Thunderstorm with Gusty winds etc.) and Agromet Advisories based on the IBF have been issued for different districts of various States and UTs across the country in co-ordination with National Weather Forecasting Centre (NWFC), New Delhi, Regional Meteorological Centres (RMCs)/ Meteorological Centres (MCs), AMFUs and DAMUs during the year.

**Enhancement in Modelling & Weather and Climate Services**

Integration of Landslide Susceptibility Module into Flash Flood Guidance System for better predictability of landslide associated flash floods in the vulnerable hilly regions of Indian Subcontinent has been completed for Rudraprayag district of Uttarakhand and Wayanad district of Kerala jointly by GSI, NRSC, IMD and HRC.

Integration of Urban Flood Module into Flash Flood Guidance System for real time flood monitoring of urban cities has been taken up. In this context, Delhi has been selected for the pilot study on Urban Flood Modelling. WMO has agreed to fund this project in collaboration with HRC as a development partner. Details of pre-requisite datasets are being collected to facilitate the implementation of this project.

Dissemination of agromet advisories to the farmers through various multi-media channels like All India Radio (AIR) and Doordarshan, private TV and radio channels, newspaper and internet, SMS etc. is being carried out on wider scale. Under Public Private Partnership (PPP) mode, Reliance Foundation, Kisan Sanchar etc. are also disseminating agromet advisories through SMS to the farming community. In addition, number of AMFUs have been sending agromet advisories through SMS in collaboration with Agricultural Technology Management Agency (ATMA). Alerts and warnings have also been issued through SMS by the AMFUs using mKisan portal of Ministry of Agriculture and other social media during the extreme weather events. During deep depression, 756408 SMSs were disseminated to farmers for the States/UT of Andhra Pradesh, Tamil Nadu and Puducherry .

- Development of advanced technology-based tools/techniques for automation of Agromet advisory generation, and feedback collection system.

- Display of Agromet Products in BHUVAN Portal of NRSC, Hyderabad
  Agrimet Division started display of spatial distribution of weather parameters at different temporal scales in BHUVAN Portal developed by National Remote Sensing Centre, Hyderabad on daily basis.

- Space Applications Centre (SAC), Ahmadabad has recently developed ISRO-IMD Vegetation Information System for crop growth monitoring under GKMS scheme. The details have been shared with all AMFUs for their use in advisory preparation

- 115 research papers were published by IMD scientist in national and international journals.
  A total of 38 National bulletins including 2 special messages for national level disaster managers, 7 press releases for print & electronic media, 9 hourly bulletins when system lay close to Andhra Pradesh coast, 38 tropical cyclone advisories for WMO/ESCAP Panel member countries, 17 tropical cyclone advisories for International Civil Aviation, 38 advisories for sea area under Global Maritime Distress Safety System, daily video updates, regular updates on social media (facebook, whatsapp, twitter),

SMS to disaster managers, general public, fishermen and farmers were issued by IMD Headquarter alongwith with similar action by state level offices at Andhra Pradesh, Odisha, West Bengal, Tamilnadu & Puducherry and Andaman & Nicobar Islands.

IMD has started setting up high density meso-network and high-resolution modeling framework for major cities for early weather and air pollution monitoring/forecast/warning under Urban Meteorological services. Currently, dissemination system for Delhi/NCR, Bengaluru, Chennai, Mumbai and Kolkata are available in public domain. The Urban Meteorological services will be augmented to 50 cities by the end of 2022.

1. Installation of indigenous RS/RW System on 10 IMD stations has been completed.

2. 05 Pilot Balloon stations out of 63 PB stations have been upgraded to automatic GPS PB stations and these PB systems are indigenous and manufactured/assembled in IMD Delhi.

3. Installation of indigenous GPS PB system on 18 PB stations out of 20 PB stations has been completed remaining two stations to be installed shortly.

# CHAPTER 2

# Weather Summary during 2022

## 1. Winter Season (January-February)

### Highlights

Seasonal rainfall over sub division of Punjab (127.2 mm) was the second highest since 1901 after the year 1911 (127.2 mm). Seasonal rainfall over the subdivision of Haryana, Chandigarh & Delhi (85.5 mm) was the third highest since 1901 after the years 1954 (117.1 mm) and 2013 (98.8 mm). The mean temperature over South Peninsular India (26.37 °C with an anomaly of 0.51 °C) was the 8$^{th}$ highest since 1901.

### Cold Wave conditions

During 13-19 January, Cold wave conditions were observed at a few places over East Uttar Pradesh, east Rajasthan and East Madhya Pradesh. During 20-26 January cold wave conditions were observed at a few places over Gujarat state, West Madhya Pradesh and east Rajasthan. During the last week of January Severe/Cold wave conditions were observed in East & west Madhya Pradesh, east Rajasthan, Vidarbha and Marathwada.

During 3-9 February, Cold Wave conditions were observed at isolated places over Vidarbha, East Madhya Pradesh, East Uttar Pradesh and Odisha for one day each. During the week of 10-16 February, cold Wave conditions were observed at isolated places over East & West Madhya Pradesh on two days each

### Rainfall Features

Rainfall realized during the season was 144% of its LPA. It was 229% of its LPA during January and 81% of its LPA during February.Except for some subdivisions from the peninsula, west-central India and Lakshadweep all the remaining subdivisions received large excess/excess/normal rainfall.

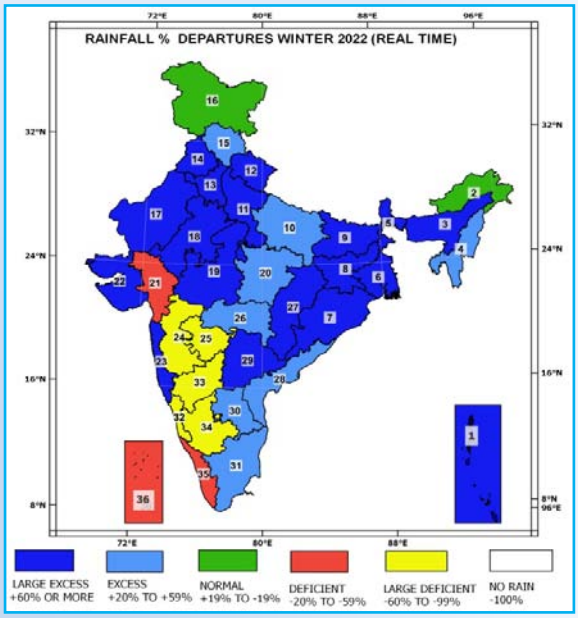
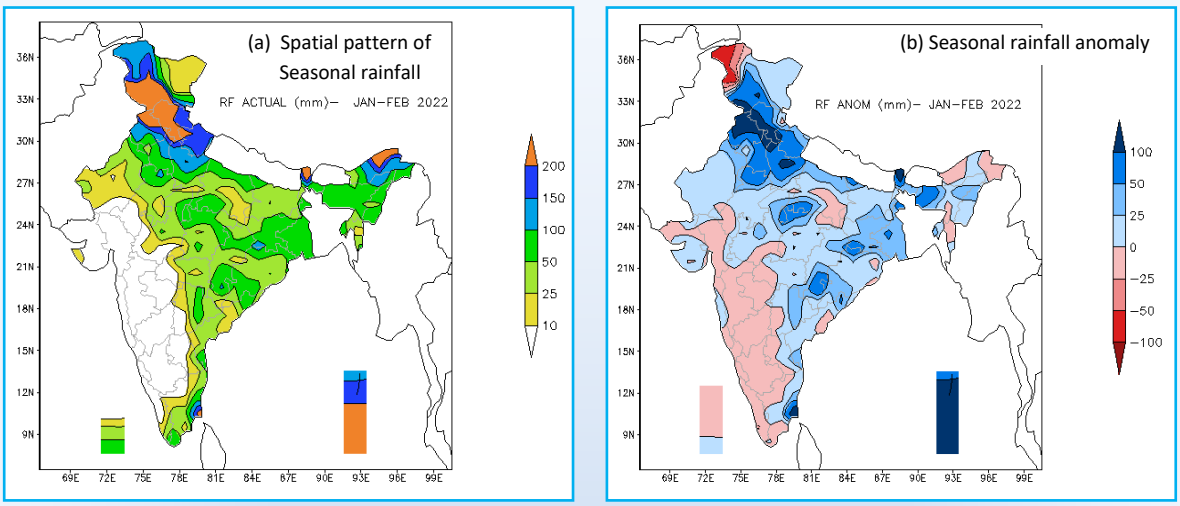



**Fig. 1.** Sub-divisionwise rainfall percentage departures

During the season, out of 36 meteorological subdivisions, 18 received large excess rainfall, 8 received excess rainfall, 2 subdivisions received normal rainfall, 3 received deficient rainfall and 5 received largely deficient rainfall (Fig. 1). Seasonal rainfall over the sub-division of Punjab (127.2 mm) was the second highest since 1901 after the year 1911 (127.2 mm). Seasonal rainfall over the subdivision of Haryana, Chandigarh & Delhi (85.5 mm) was the third highest since 1901 after the years 1954 (117.1 mm) and 2013 (98.8 mm).

Fig. 2(a) shows the spatial pattern of rainfall (mm) received during the season. Rainfall activity was observed over parts of the north, east and northeast, east central, peninsular India and both islands. Parts of Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim, Assam & Meghalaya, West Uttar Pradesh, Uttarakhand, Himachal Pradesh, Haryana, Chandigarh & Delhi, Jammu & Kashmir and Ladakh, Punjab, Tamilnadu, Puducherry & Karaikal and Andaman & Nicobar Islands received more than 100 mm rainfall. The parts of Arunachal Pradesh, Sub-Himalayan West Bengal &




**Figs. 2(a&b).** Spatial pattern of (a) Seasonal rainfall (mm) (b) Seasonal rainfall anomaly (mm) (*Based on 1961-2010 Normals*)

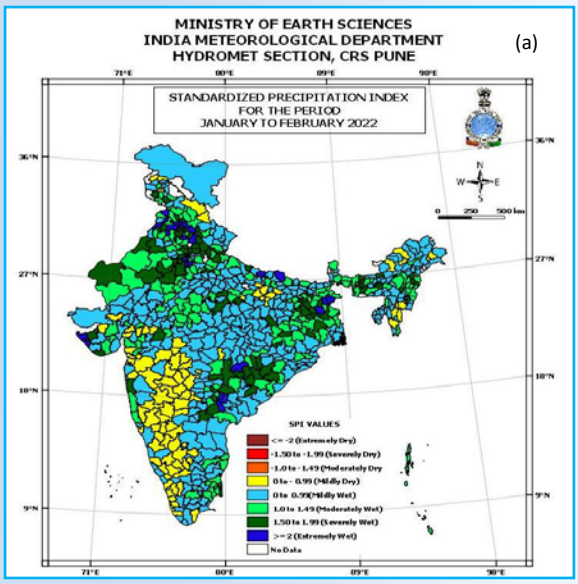
Sikkim, Jammu & Kashmir, Ladakh, Himachal Pradesh, Punjab and Uttarakhand received more than 200 mm rainfall.

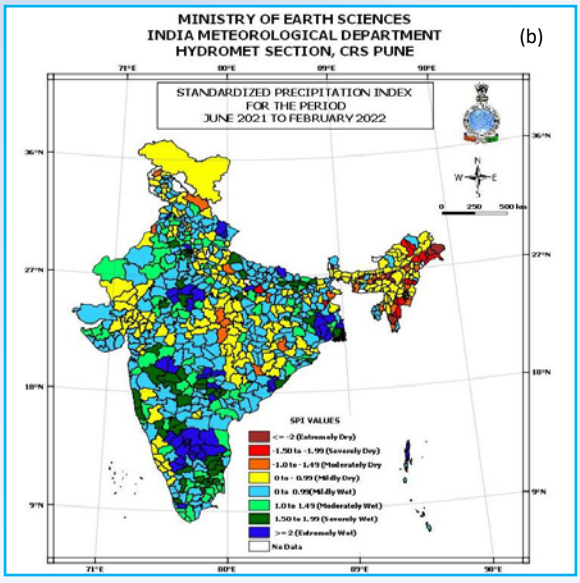
Fig. 2(b) shows the spatial pattern of rainfall anomaly (mm) during the season.Rainfall anomaly was more than 100 mm over parts of Sub-Himalayan West Bengal & Sikkim, Jammu & Kashmir and Ladakh. Punjab, Haryana, Chandigarh & Delhi, Himachal Pradesh, Uttarakhand, West Uttar Pradesh, Tamilnadu, Puducherry &Karaikal and Andaman & Nicobar Islands. The magnitude of the negative rainfall anomaly was more than 50 mm over parts of Jammu & Kashmir and Ladakh.

## Standardized Precipitation Index (SPI)

The Standardized Precipitation Index (SPI) is an index used for measuring drought and is based on only precipitation. This index is negative for drought and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive respectively. Figs. 3(a&b) show the SPI values for the winter season 2022 (January-February, 2 months cumulative) and the period from June 2021-February 2022 (nine months cumulative) respectively.

Cumulative SPI values of the past two months indicate extremely wet/severely wet conditions over parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub Himalayan West Bengal & Sikkim, Gangetic West Bengal, Odisha, Jharkhand, Bihar, Uttar Pradesh state,




**Figs. 3(a&b).** Standardized Precipitation Index (SPI) for (a) Two months (b) Nine months

Uttarakhand, Haryana, Chandigarh & Delhi, Punjab, Himachal Pradesh, Jammu & Kashmir & Ladakh, Rajasthan state, Madhya Pradesh state, Saurashtra & Kutch, Konkan & Goa, Vidarbha, Chhattisgarh, Telangana and Tamil Nadu while, extremely dry/severely dry conditions were not observed over any part of the country.

Cumulative past nine months SPI values indicate extremely wet/severely wet conditions over parts of A & N Islands, Gangetic West Bengal, Odisha, Jharkhand, Bihar, East Uttar Pradesh, Uttarakhand, Haryana, Chandigarh & Delhi, Punjab, East Rajasthan, West Madhya Pradesh, Konkan & Goa, Madhya Maharashtra, Marathawada, Andhra Pradesh state, Telangana, Tamil Nadu, North Interior Karnataka, South Interior Karnataka and Kerala while, extremely dry/severely dry conditions were observed over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub Himalayan West Bengal & Sikkim, Jharkhand and East Uttar Pradesh.

## Outgoing Longwave Radiation (OLR)

OLR anomaly ($W/m^2$) over the Indian region and neighbourhood is shown in Fig. 4. OLR anomaly was within normal range over most parts of the country except Arunachal Pradesh. OLR anomaly was less than -10 $W/m^2$ over central and east central Bay of Bengal.

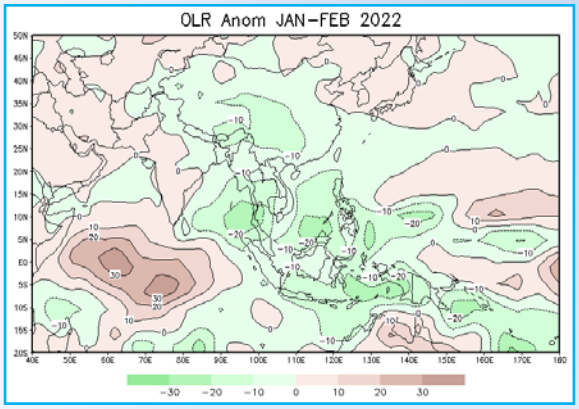
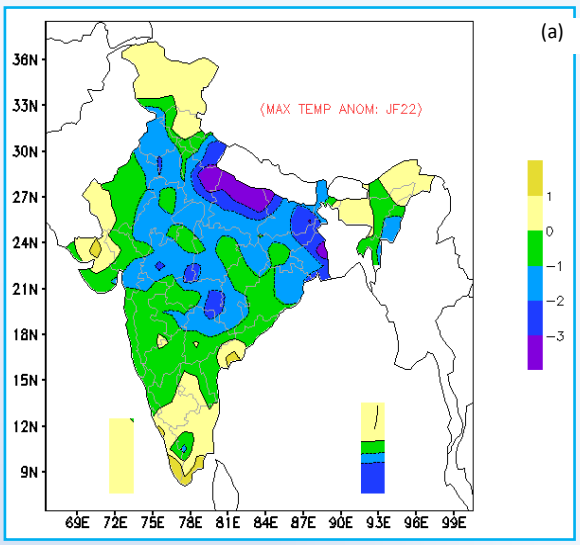
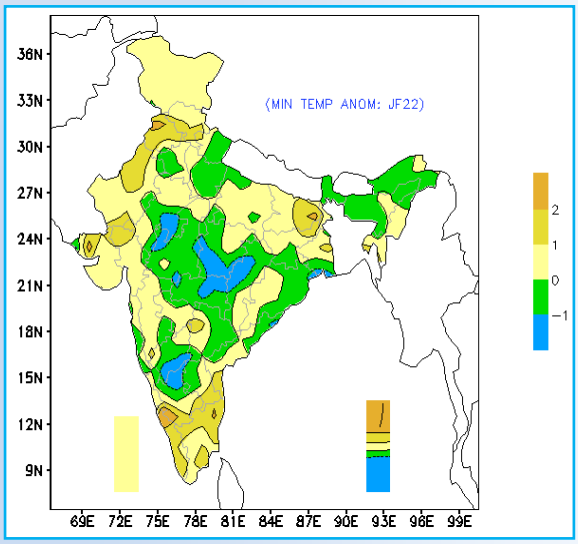



**Fig. 4.** OLR Anomaly ($W/m^2$) for winter (January-February) 2022
(DATA SOURCE: CDC / NOAA, USA)
(Based on 1991 - 2020 Climatology)

## Temperatures

Mean seasonal maximum and minimum temperature anomalies are shown in Figs. 5(a&b) respectively. The maximum temperature was




**Figs. 5(a&b).** Mean seasonal temperature anomalies (°C) (a) Maximum (b) Minimum (Based on 1981-2010 Normals)

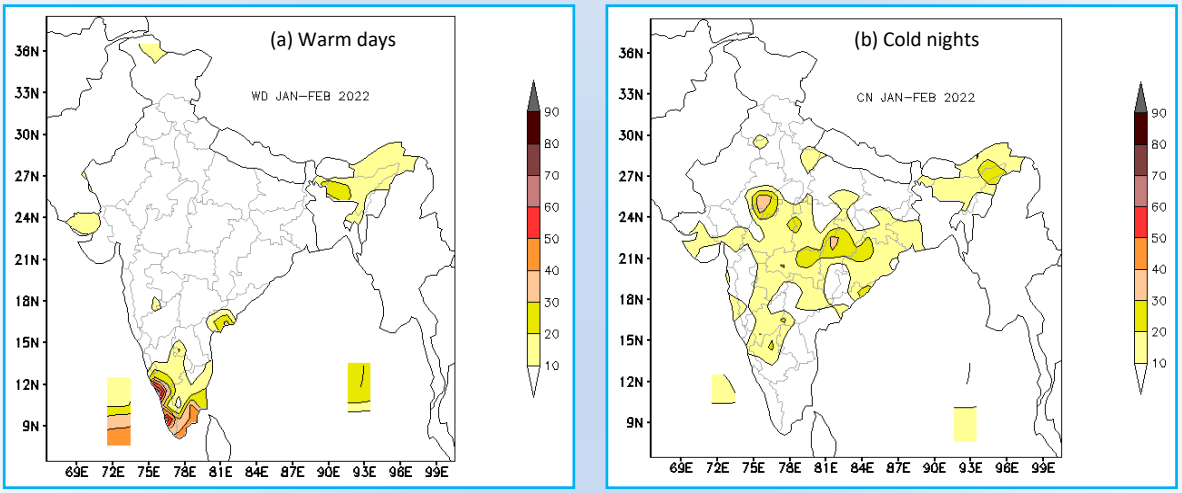
below normal over most parts of thecountry except for some parts of northeast India, central India (Gujarat state), south peninsular India and both islands. The maximum temperature anomaly was more than 1 °C over parts of Saurashtra & Kutch, Coastal Andhra Pradesh & Yanam, Tamil Nadu, Puducherry &Karaikal and Kerala & Mahe. The maximum temperature anomaly was less than -2 °C over parts of Uttarakhand, Uttar Pradesh state, Bihar, Jharkhand, Gangetic West Bengal, Haryana, Chandigarh & Delhi, Madhya Pradesh state, Vidarbha, Telangana and Andaman & Nicobar Islands. The maximum temperature anomaly was less than -3 oC over parts of Uttar Pradesh state, Bihar, Gangetic West Bengal.

some parts of northwest India, central India, south peninsular India and Andaman & Nicobar Islands. The minimum temperature anomaly was more than 2 oC over parts of northern Punjab, Bihar, northern Saurashtra & Kutch, South Interior Karnataka, northern Kerala & Mahe and Andaman & Nicobar Islands. The minimum temperature anomaly was less than -1 oC over parts of West Rajasthan, Madhya Pradesh state, Chhattisgarh, Vidarbha, extreme southern Gangetic West Bengal, Coastal Andhra Pradesh &Yanam, South Interior Karnataka, North Interior Karnataka and Andaman & Nicobar Islands.

## Warm days/cold nights

Figs. 6(a&b) show the percentage of days when the maximum (minimum) temperature was more (less) than the 90$^{th}$ (10$^{th}$) percentile.

Over parts of Tamilnadu, Puducherry & Karaikal, Kerala and Mahe and Lakshadweep maximum temperature was greater than the 90th percentile for more than 40% of the days of the winter season. For minimum temperature, no significant distribution was observed.




**Figs. 6(a&b).** Percentage of days when (a) maximum temperature > 90th percentile (b) minimum temperature < 10$^{th}$ percentile

## Low Pressure Systems

During the winter season one low-pressure system formed over land in the month of February during 3-4 February.

## Significant Weather Events (based on real-time media reports)

The significant weather events during the season (based on real-time media reports). From 1st January to 28$^{th}$ February, a total of 12 persons were reportedly claimed dead, 7 persons injured & 58 livestock perished. The details of causalities are given below, which are based on real-time media reports.

**Lightning:** A total of 4 persons were reportedly claimed dead & 8 livestock perished, from 1$^{st}$ January to 28$^{th}$ February, because of Lightning. Three (3) persons were reportedly claimed dead in Hoshangabad, Morena, Tikamgarh (Madhya Pradesh) and one (1) person reportedly claimed dead in Nagpur (Maharashtra).

**Snowfall:** A total of 7 persons reportedly claimed dead in West Kameng (Arunachal Pradesh), from 1$^{st}$ January to 28$^{th}$ February due to Snowfall.

**Floods & Heavy Rains:** One (1) person reportedly claimed dead in Rajouri, Ramban (Union Territory-Jammu & Kashmir), 1 injured & 50 livestock perished from 1$^{st}$ January to 28$^{th}$ February, because of Floods & Heavy Rains.

**Thunderstorm:** A total of 6 persons were injured in Garhwa (Jharkhand) from 1$^{st}$ January to 28$^{th}$ February, because of the Thunderstorm.

## 2. Pre-monsoon Season (March-May)

### Highlights

Rainfall received over the homogeneous region of southern peninsular India (198.2 mm) was the fifth highest since 1901. The mean temperature for the pre-monsoon season this year was 28.68 °C with an anomaly of 1.06 °C and the second highest after the year 2010 (28.89 °C) since 1901. Mean temperature over Northwest India (26.98 °C) was highest, Central India (30.47 °C) was second highest after the year 2010 (30.59 °C) and East & Northeast India (26.71 °C) was seventh highest since 1901.

### Heat Wave Conditions

During the 2022 pre-monsoon season, heat wave/severe heatwave conditions were observed mostly over parts of central India, northwest India, northern India and northeast India.

### Rainfall Features

Rainfall activity during the 2022 pre-monsoon season was normal. Rainfall realized during the season was 99% of its LPA. During the season, out of 36 meteorological subdivisions, 6 received large excess rainfall, 4 received excess rainfall, 8 received normal rainfall, 10 received deficient rainfall and 8 sub-divisions received largely deficient rainfall (Fig. 7). During the pre-monsoon season rainfall over the homogeneous region of south and north Interior Karnataka (324.5 mm, 162.9 mm respectively) was the highest since 1901. During the pre-monsoon season rainfall over Sub-Himalayan West Bengal & Sikkim (601.4 mm), Assam & Meghalaya (909.3 mm) and Andaman & Nicobar Islands (783.3 mm) was 5th highest since 1901.

Fig. 8(a) shows the spatial pattern of rainfall (mm) received during the season. Parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, Gangetic West Bengal, Bihar, Uttarakhand, Jammu & Kashmir and Ladakh, Coastal Andhra Pradesh & Yanam, Rayalaseema, Tamilnadu, Puducherry & Karaikal, Karnataka state, Kerala & Mahe and both the islands received more than 200 mm rainfall. Parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, Karnataka state, Kerala & Mahe and both the islands received more than 300 mm rainfall.

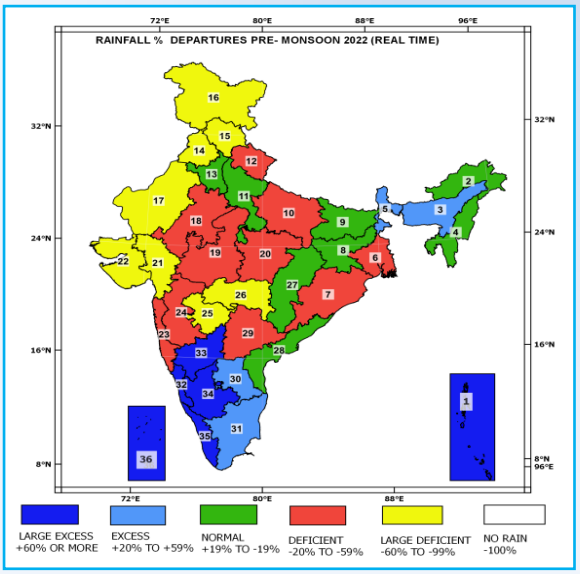
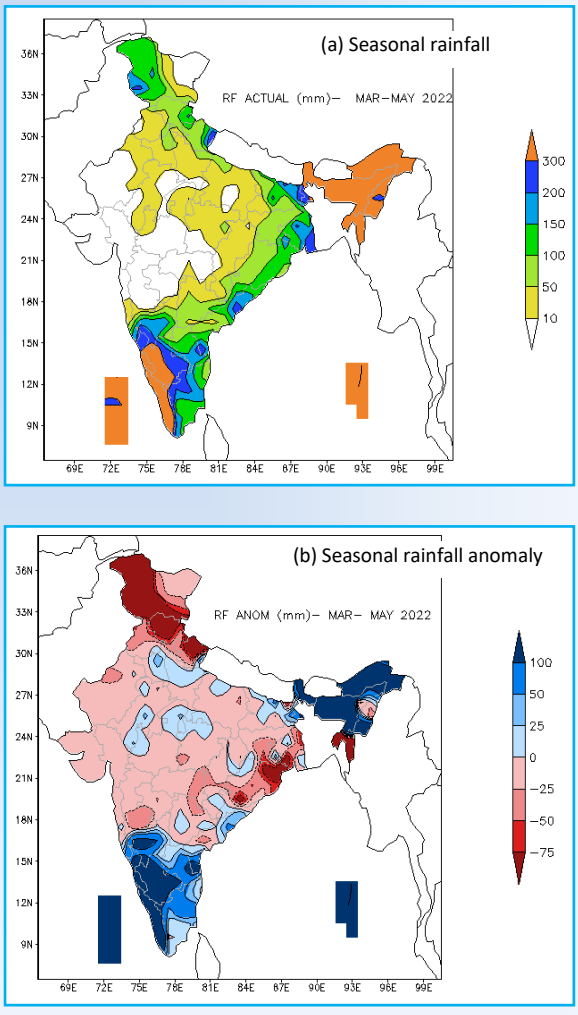



**Fig. 7.** Sub-division-wise rainfall Percentage departure




**Figs. 8(a&b).** (a) Seasonal rainfall (mm) (b) Seasonal rainfall anomaly (mm) (Based on 1961-2010 Normals)

Fig. 8(b) shows the spatial pattern of rainfall anomaly (mm) during the season. Rainfall anomaly was negative over central, northern and northwestern parts, whereas it was positive over northeastern and peninsular parts. A positive rainfall anomaly of more than 100 mm was observed over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, Karnataka state, Andhra Pradesh state, Kerala & Mahe and both the islands. The magnitude of the negative rainfall anomaly was more than 75 mm over parts of Nagaland, Manipur, Mizoram & Tripura, Jammu & Kashmir and Ladakh, Himachal Pradesh, Uttarakhand, Gangetic West Bengal and Odisha.

Fig. 9 shows the area-weighted cumulative weekly rainfall percentage departure during the season for the country as a whole. Cumulative rainfall departure was negative till the 18$^{th}$ of May and turned positive after that.

Fig. 10(a) shows the area-weighted seasonal rainfall over the country as a whole for the period 1951-2022. For the Pre-monsoon season of 2022, rainfall realized was 99% of its LPA value. It was 29 % of its LPA during March, 98 % of its LPA during April and 135% of its LPA during May.

Fig. 10(b) shows the time series of area-weighted seasonal rainfall over the four homogeneous regions for the period 1951-2022. During the season this year, rainfall realized over South peninsular India was 163 %of its LPA, over East and Northeast India 118% of its LPA, central India 61% of its LPA and over Northwest India 37% of its LPA.

**Rainfall received over the homogeneous region of southern peninsular India (198.2 mm) was the fifth highest since 1901** after the years 1990 (239.7 mm), 1943 (220.6 mm), 1955 (214.2 mm) and 1933 (205.1 mm).

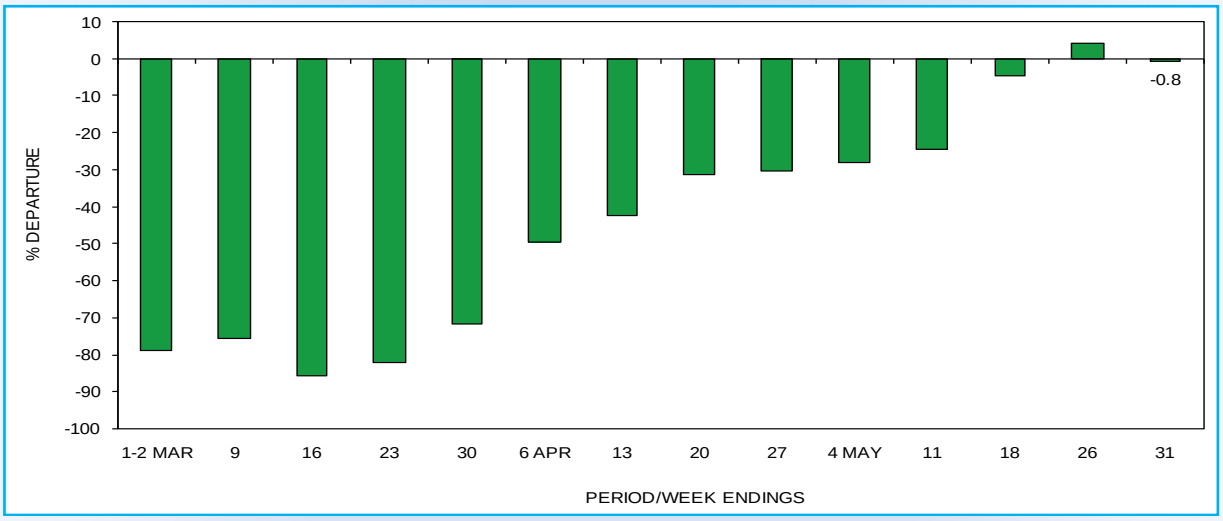



**Fig. 9.** Accumulated percentage departure of area weighted weekly rainfall over the country as a whole

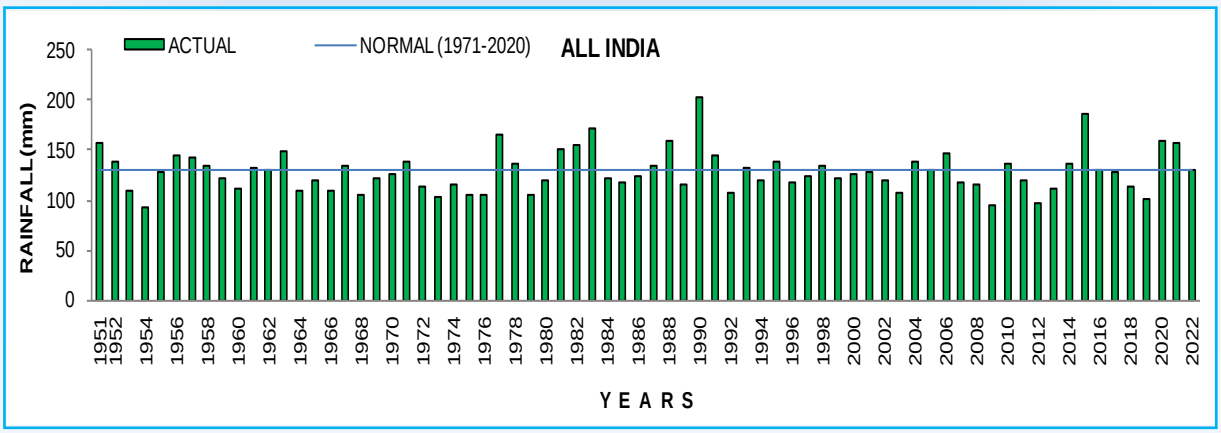



**Fig. 10(a).** Time series of area weighted rainfall over the country as a whole (1951 - 2022)

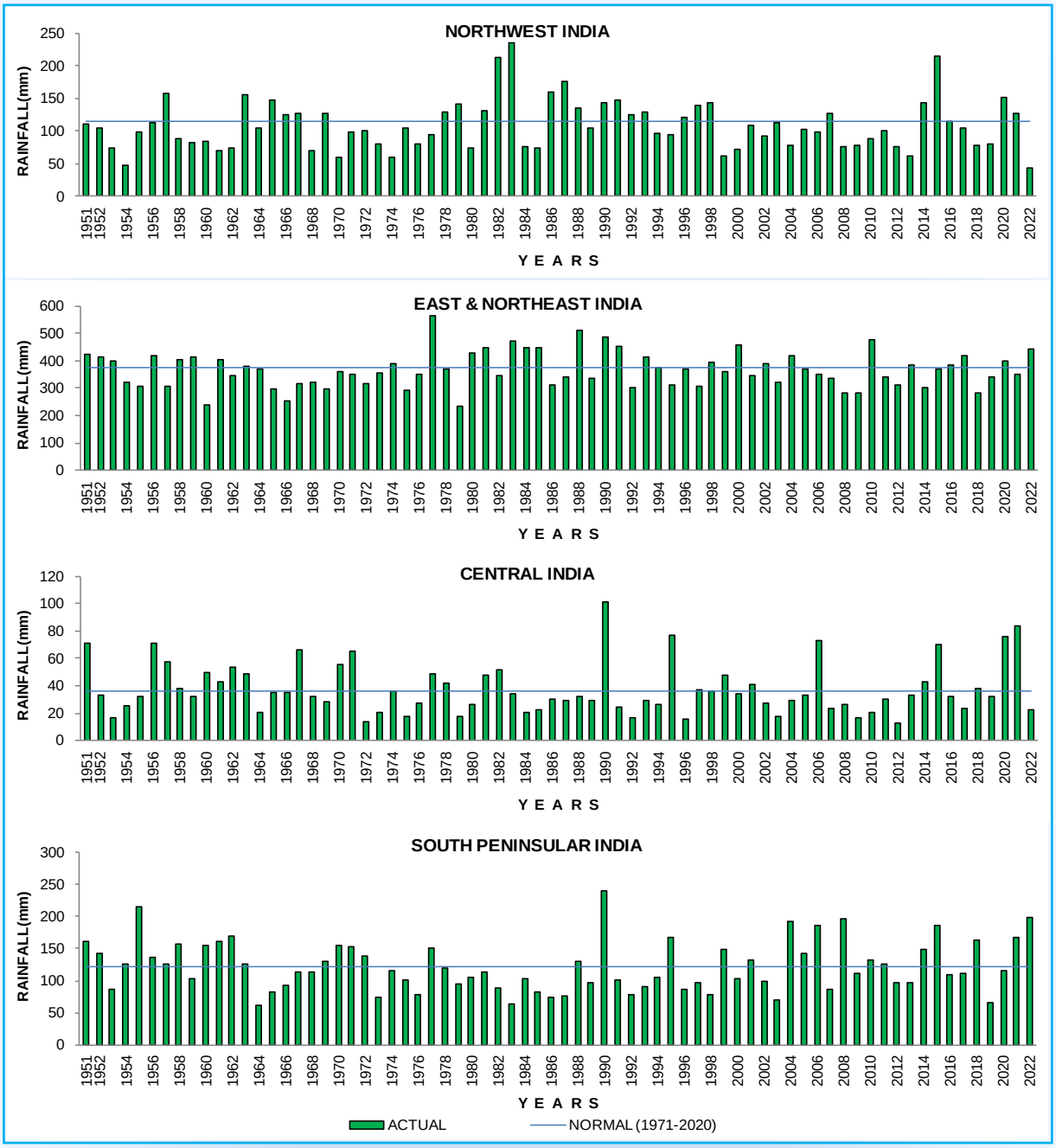


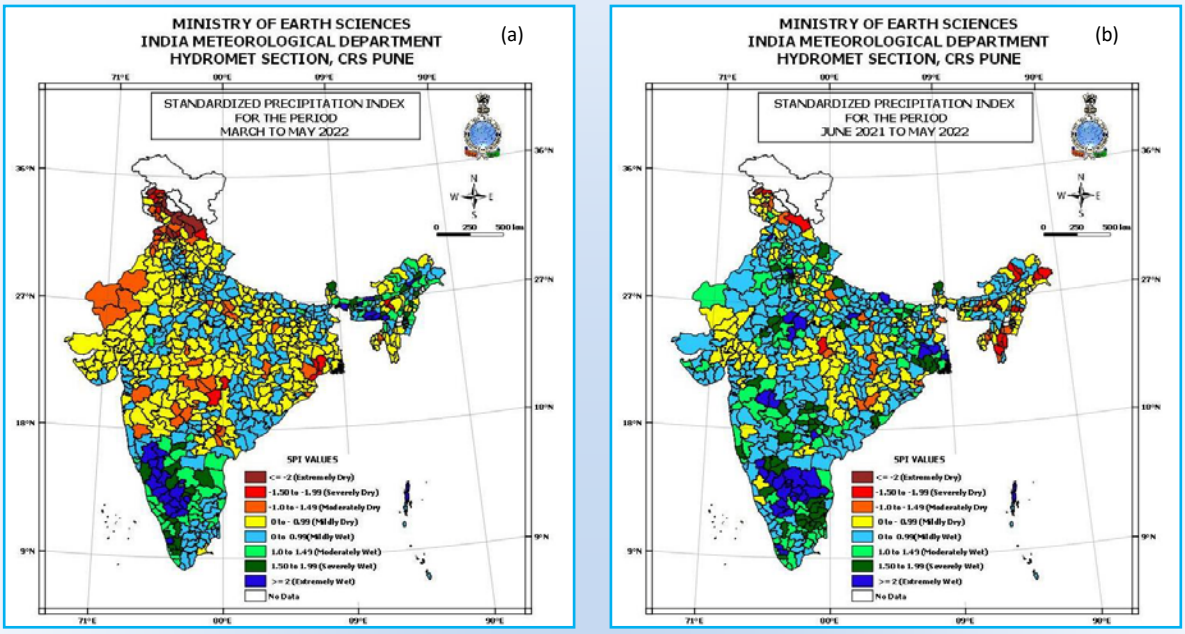

**Fig. 10(b).** Time series of area weighted rainfall over the four homogeneous regions for pre-monsoon (Mar-May) season (1951-2022)

## Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is an index used for monitoring drought and is based on only precipitation. This index is negative for dry, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. Figs. 11(a&b) give the SPI values for the Pre-monsoon season this year and for the period from the past monsoon season, *i.e.*, June 2021-May 2022 (12 months cumulative) respectively.

Cumulative SPI values of the past three months show extremely wet/severely wet conditions over parts of A & N Islands, Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub Himalayan West Bengal & Sikkim, West Uttar Pradesh, Rayalaseema, Tamilnadu, Puducherry & Karaikal, Karnataka state and Kerala & Mahe while extremely dry/severely dry conditions were observed over Assam & Meghalaya, Gangetic West Bengal, Odisha, Punjab, Himachal Pradesh, Jammu & Kashmir, Vidarbha, and Telangana.

Cumulative SPI values of the past twelve months indicate that extremely wet/severely wet conditions were observed over parts of A & N Islands, Sub Himalayan West Bengal & Sikkim, Gangetic West Bengal, Jharkhand, Bihar, East Uttar Pradesh, Uttarakhand, Haryana, Chandigarh & Delhi, Punjab, East Rajasthan, West Madhya Pradesh, Konkan & Goa, Madhya Maharashtra, Marathawada, Andhra Pradesh state, Telangana, Tamilnadu, Puducherry & Karaikal, North Interior Karnataka, South Interior Karnataka and Kerala & Mahe while extremely dry/severely dry conditions were observed over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Himachal Pradesh, Jammu & Kashmir, and East Madhya Pradesh.




**Figs. 11(a&b).** Standardized Precipitation Index (SPI) (a) Three months (b) Twelve months

## Outgoing Longwave Radiation (OLR)

OLR anomaly ($W/m^2$) over the Indian region and neighbourhood is shown in Fig 12. OLR anomaly was positive over most parts of the country except extreme peninsular parts during the 2022 pre-monsoon season. OLR anomaly was within ± 10 $W/m^2$ over the entire country. OLR anomaly was less than -20 $W/m^2$ over southern parts of the Bay of Bengal.

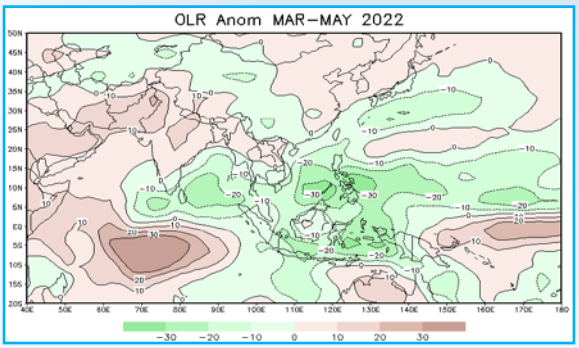


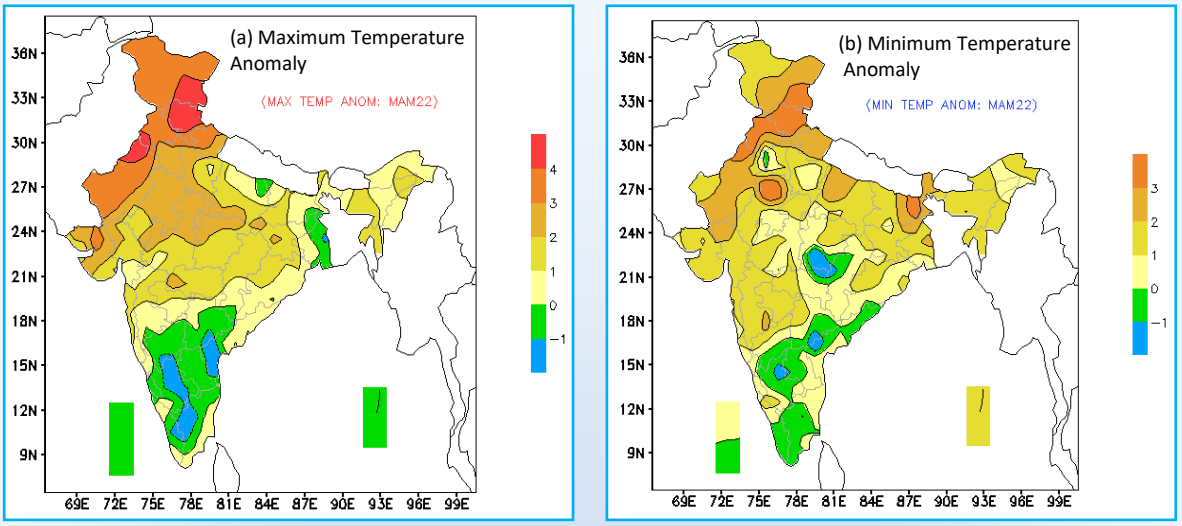

**Fig. 12.** OLR Anomaly ($W/m^2$) For Pre-Monsoon (Mar-May) 2022
(*Source*: CDC/NOAA, USA)(Based on 1991-2020 Climatology)

## Temperature

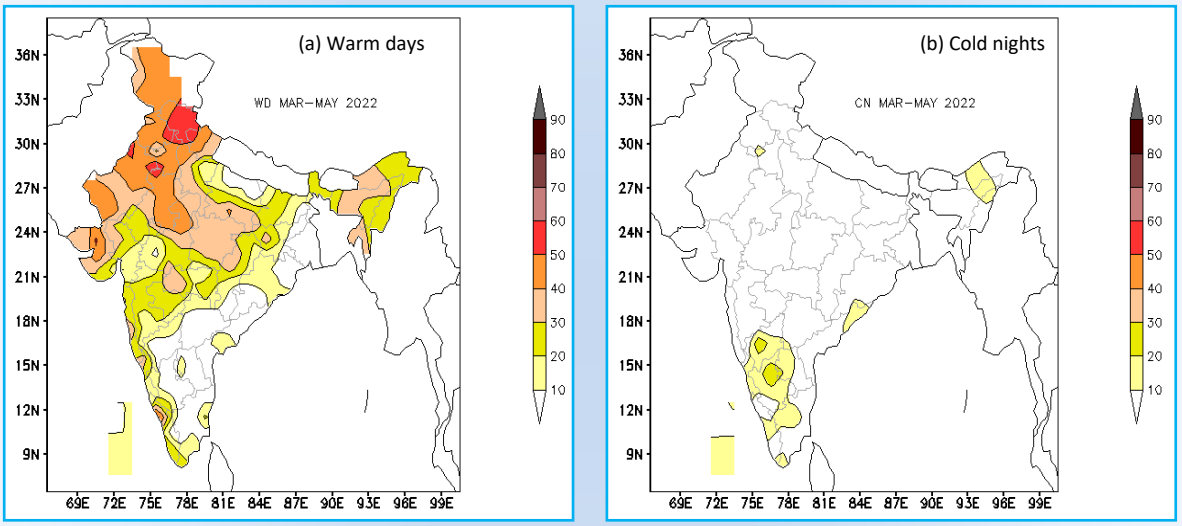
Mean seasonal maximum and minimum temperature anomalies during the season are shown in Figs. 13(a&b) respectively.

The maximum temperature was above normal over most parts of the country except for some parts of east & northeast India, central India, south peninsular India, and both the Islands. The maximum temperature anomaly was more than 4oC over parts of Ladakh, Himachal Pradesh, Punjab, and West Rajasthan. The maximum temperature anomaly was less than -1 °C over parts of Coastal Andhra Pradesh & Yanam, Telangana, South Interior Karnataka, North Interior Karnataka, Kerala & Mahe, Gangetic West Bengal and Tamil Nadu, Puducherry & Karaikal.

The minimum temperature was above normal over most parts of the country except for some parts of central India, south peninsular India, and Lakshadweep. The minimum temperature anomaly was more than 3 °C over parts of Ladakh, Himachal




**Figs. 13(a&b).** Mean seasonal temperature anomalies (°C) (a) maximum (b) minimum (*Based on 1981-2010 normals*)




**Figs. 14(a&b).** Percentage of days when (a) maximum temperature > 90$^{th}$ Percentile
(b) Minimum Temperature < 10$^{th}$ Percentile

Pradesh, Punjab, Rajasthan state, and Bihar. The minimum temperature anomaly was less than -1 °C over parts of East Madhya Pradesh, Chhattisgarh, Vidarbha, Andhra Pradesh state, Telangana, and South Interior Karnataka.

## Percentage of Warm days/Cold nights

Figs. 14(a&b) show the percentage of days when the maximum (minimum) temperature was more (less) than the 90$^{th}$ (10$^{th}$) percentile. Over parts of Uttarakhand, Himachal Pradesh, Haryana, Chandigarh & Delhi, and West Rajasthan maximum temperatures were greater than the 90$^{th}$ percentile for more than 50% of the days of the season. For minimum temperature, no significant distribution was observed.

## Low Pressure Systems

During the 2022 Pre-monsoon season in March two deep depressions formed, one over the Bay of Bengal (3-6 March) and another over the Andaman Sea (20-22). During May, one severe cyclonic storm ("ASANI") formed over the Bay of Bengal (7-12 May), and a depression formed over the Gulf of Martaban and adjoining Myanmar (20-21 May).

| Month/Systems | CS and above | DD | D | WML | LPA |
|---|---|---|---|---|---|
| March | 0 | 2(BOB) | 0 | 0 | 0 |
| April | 0 | 0 | 0 | 0 | 0 |
| May | 1(BOB) | 0 | 1(BOB) | 0 | 0 |
| | (AS: Arabian Sea) | | (BOB: Bay of Bengal) | | |

Fig. 15 shows the track of intense low-pressure systems formed during the season.

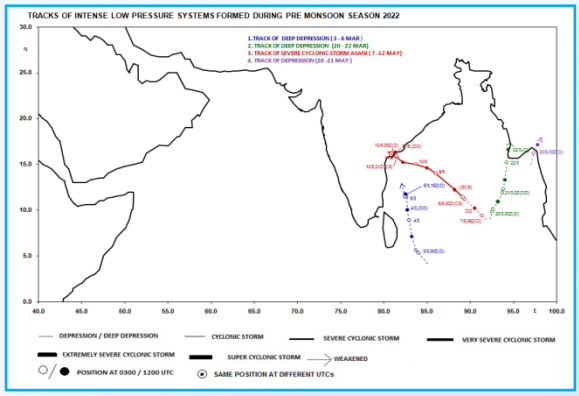



**Fig. 15.** Tracks of intense low-pressure systems formed during Pre-monsoon season (Mar-May) 2022

## Significant Weather events

Fig. 16 shows significant weather events during the season (Based on real-time media reports.

From 1st March to 31st May, a total of 231 persons reportedly claimed dead, 105 persons injured, 11 persons missing & 1234 livestock perished.

**Floods, Heavy Rains & Landslides**: A total of 81 persons reportedly claimed dead, 15 persons injured, 11 persons missing & 1151 livestock perished, from 1st March to 31st May, because of Floods, Heavy Rains & landslides.

**Lightning**: A total of 76 persons reportedly claimed dead, 36 persons injured & 77 livestock perished, from 1st March to 31st May, because of Lightning.

**Thunderstorm**: A total of 35 persons were reportedly claimed dead, 54 people injured & 6 livestock perished, from 1st March to 31st May, because of the Thunderstorm.

**Dust Storm**: A total of 22 persons reportedly claimed dead, from 1st March to 31st May, because of Dust Storm.

**Heat Wave**: A total of 15 people reportedly claimed dead, from 1st March to 31st May, because of Heat Wave.

**Gale**: A total of 1 person was reportedly claimed dead, from 1st March to 31st May, because of Gale.

**Snowfall**: A total of 1 person reportedly claimed dead, from 1st March to 31st May, because of Snowfall.

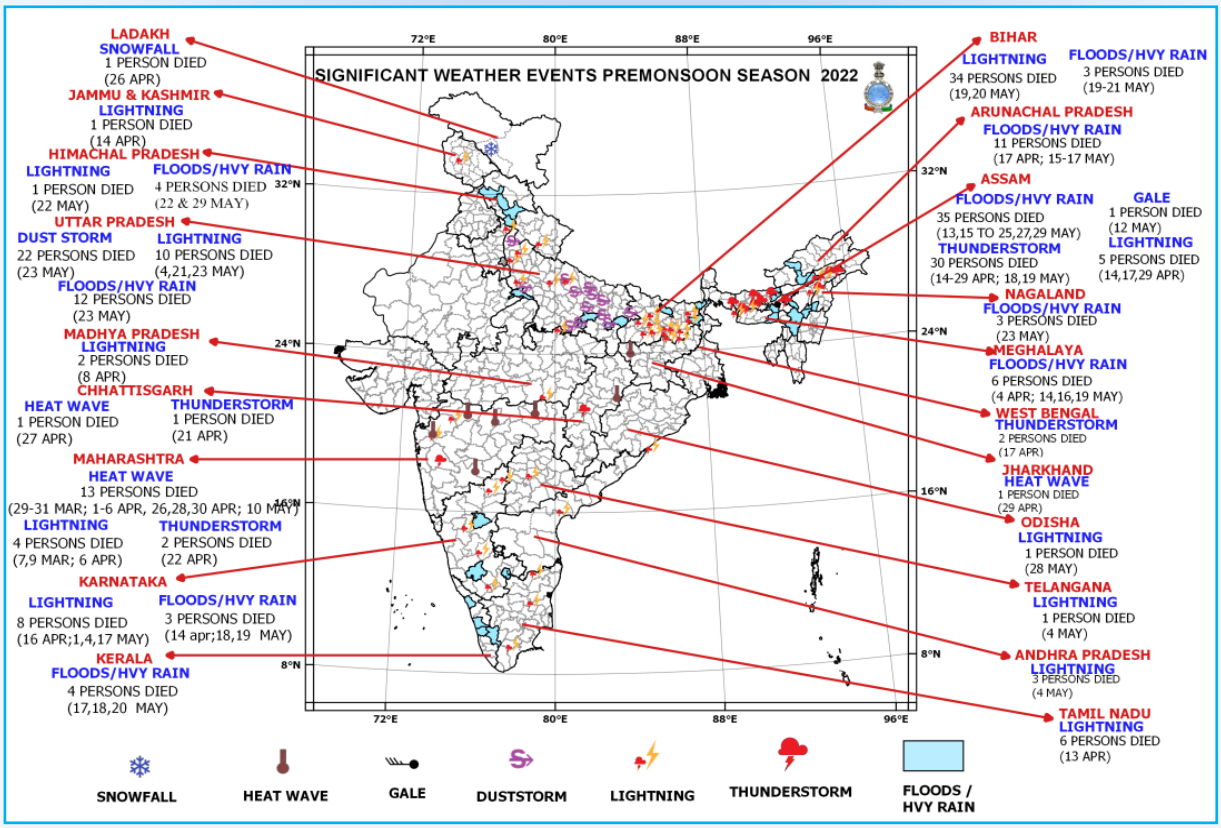



**Fig. 16.** Significant weather events during pre-monsoon (MAR-MAY) season 2022 (Based on real time media report)

## 3. Southwest (SW) Monsoon (June-July-August-September)

### Chief Features

Rainfall during the 2022 Southwest Monsoon Seasonwas above normal. During Southwest Monsoon 2022, All India minimum temperature (24.52 °C with anomaly 0.43 °C) was the fourth highest after the years 2019 (24.66 °C), 2020 (24.60 °C), 2021 (24.53 °C) since 1901. The minimum temperature over East & Northeast India (25.03 °C with anomaly 0.84 °C) was the highestand Northwest India (23.44 °C with anomaly 0.72 °C) was also the highest since 1901. Maximum temperature over East & Northeast India (32.86 °C with anomaly 1.23 °C) was the highest since 1901. The mean temperature over East & Northeast India (28.95 °C with an anomaly of 1.04 °C) was the highest since 1901.

### Onset, Advance and Withdrawal of Southwest Monsoon

Fig. 17(a) depicts the isochrones of Advance of the Southwest Monsoon and Fig. 17(b) depicts the isochrones of Withdrawal of the Southwest Monsoon. Southwest Monsoon set in over Kerala on 29th May, 2022 against the normal date of 1st June, *i.e.*, 3 days ahead of its normal date.

On 3rd June, Southwest Monsoon covered entire northeastern states and some parts of Sub Himalayan West Bengal & Sikkim. By 10th June Southwest Monsoon advanced into some more parts of the central Arabian Sea, the entire Goa, some parts of Konkan, and some more parts of Karnataka. On 10th June the Northern Limit of Monsoon (NLM) passes through Lat. 16° N/ Long. 60° E, Lat. 16° N/Long. 70° E, Vengurla, Chikmagalur, Bengaluru, Puducherry, Lat. 14° N/ Long. 84° E, Lat. 17.0° N/ Long. 87° E, Lat. 20.0° N/ 89.5° E, Lat. 22.0° N/90° E, Lat. 25.0° N/89° E, Siliguri and Lat. 27.50° N/88° E covering further stages over some parts of the Arabian sea and central India and peninsular India and northeast India. By 15th June, it advanced into some more parts of Marathwada, the entire Karnataka and Rayalaseema and Tamil Nadu, some parts of coastal Andhra Pradesh, and northwest & west-central Bay of Bengal. The Northern Limit of Monsoon (NLM) passed through Lat. 21° N/Long. 60° E, Lat. 21° N/Long. 70° E, Diu, Nandurbar,

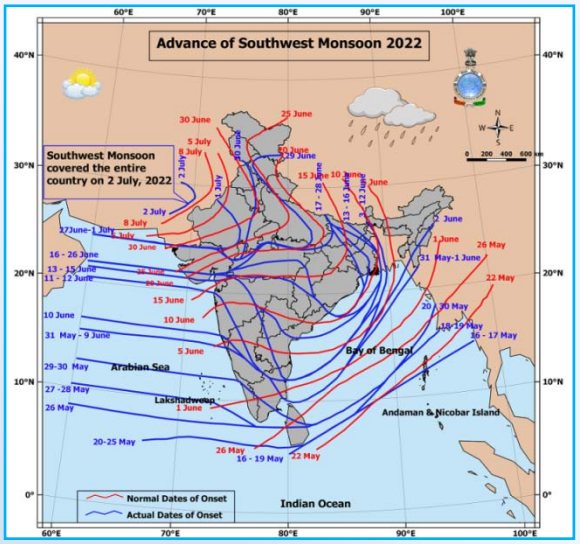



**Fig. 17(a).** Advance of southwest monsoon 2022

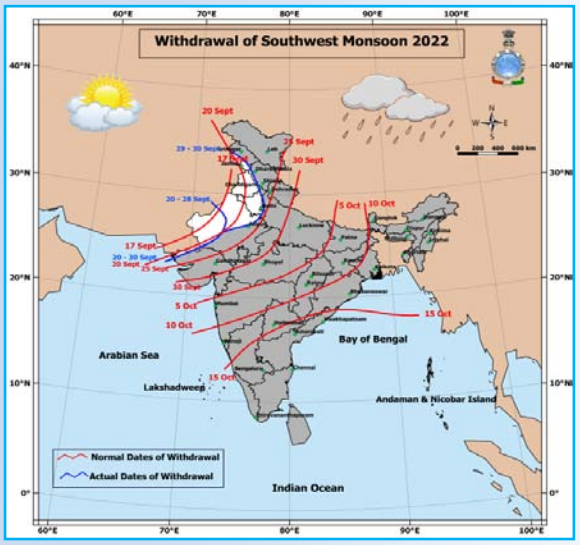



**Fig. 17(b).** Withdrawal of southwest monsoon 2022

Jalgaon, Parbhani, Medak, Rentachintala, Machilipatnam, Lat. 17° N/Long. 84° E, Lat. 18.5° N/Long. 87° E, Lat. 22.0° N/90° E, Lat. 25.0° N/89° E, Balurghat and Supaul, Lat. 26.50° N/86° E. By 19th June, it covered some more parts of the Gujarat region, Madhya Pradesh, the remaining parts of Vidarbha, and some more parts of Chhattisgarh, Gangetic West Bengal, Jharkhand, and Bihar. On 20th June, Southwest Monsoon progressed into most parts of Madhya Pradesh, the remaining parts of Chhattisgarh and Coastal Andhra Pradesh, the remaining parts of northwest Bay of Bengal, entire Odisha and Gangetic West Bengal, most parts of Jharkhand and Bihar, some parts of southeast Uttar Pradesh. After almost a gap of a week by 27th June, Southwest Monsoon further advanced into most parts of the Arabian Sea and most parts of Gujarat state. By 30th June,

Southwest Monsoon advanced into the entire Uttar Pradesh, Himachal Pradesh, and Jammu & Kashmir, some parts of Rajasthan, the entire Delhi, some parts of Punjab and Haryana.The Northern Limit of Monsoon (NLM) passed through Lat. 24° N /Long. 60° E, Lat. 24° N/Long. 65° E, Deesa, Ratlam, Tonk, Sikar, Rohtak, Pathankot. By 30th June, Southwest Monsoon had coveredthe entire Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir, some parts of Rajasthan, the entire Delhi, and some parts of Punjab and Haryana. The Northern Limit of Monsoon (NLM) passed through Lat. 24° N/Long. 60° E, Lat. 24° N/Long. 65° E, Deesa, Ratlam, Tonk, Sikar, Rohtak, Pathankot. Southwest Monsoon further advanced into the entire Punjab and Haryana and more parts of Rajasthan on 1st July, 2022. The SW Monsoon further advanced into the remaining parts of the north Arabian Sea, Gujarat, and Rajasthan on 2nd July, 2022. Thus, the SW Monsoon covered the entire country on 2nd July, 2022, against the normal date of 8th July (6 days before the normal date of covering entire India). Withdrawal of SW monsoon began from southwest Rajasthan and adjoining Kutch on 20th September, 2022 against its normal date of 17th September.

The withdrawal line of Southwest Monsoon passed through Khajuwala, Bikaner, Jodhpur, and Naliya on the 20th and remained there till the 28th of September 2022. It further withdrew from the entire Punjab & Chandigarh, some parts of Jammu & Kashmir, Himachal Pradesh, West Uttar Pradesh and Haryana, the entire Delhi and some more parts of Rajasthan on 29th September, 2022.

## Rainfall Features

Most sub-divisions of the country received excess/ normal rainfall except Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Jharkhand, Bihar, and east & west Uttar Pradesh. During the season, out of 36 meteorological subdivisions, 12 subdivisions received excess rainfall, 18 received normal rainfall and the remaining 6 subdivisions received deficient rainfall (Fig. 18). Table 1 shows the subdivision-wise rainfall statistics (mm) for the southwest monsoon season of 2022.

Figs. 19(a&b) show the spatial pattern of rainfall received during the season and its anomaly (mm) respectively. Most parts of northeast India, central

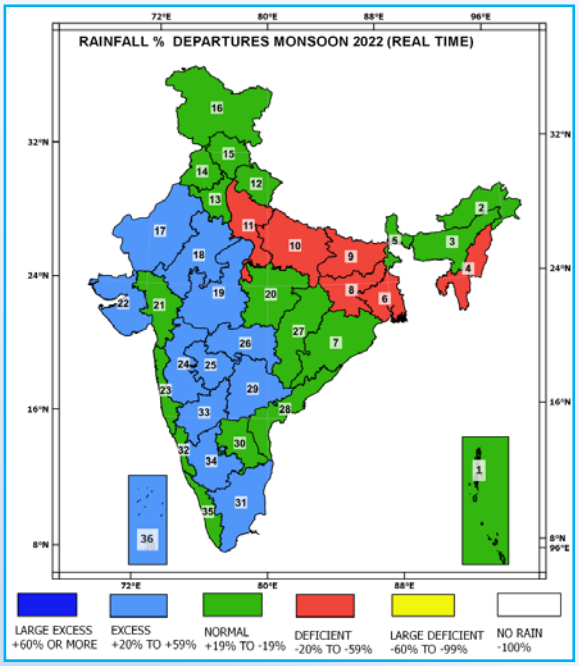
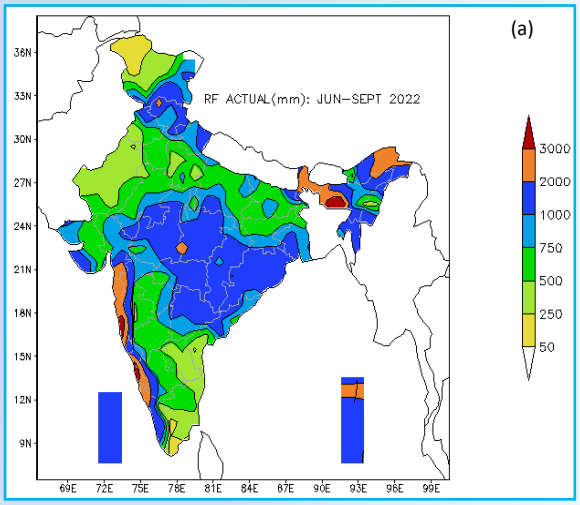
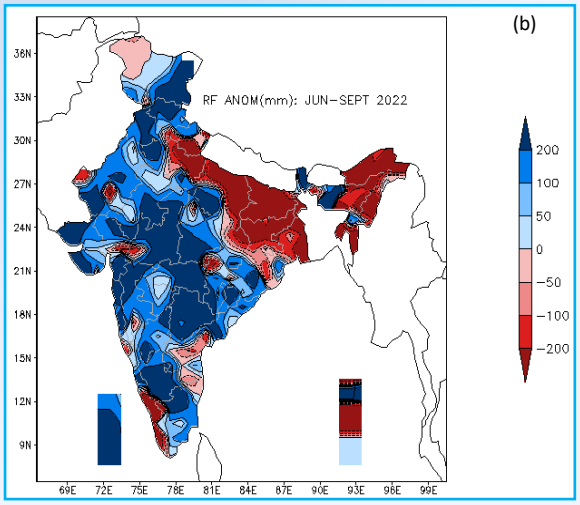



**Fig. 18.** Sub-divisionwise rainfall percentage departures for the Monsoon 2022




**Figs. 19(a&b).** (a) Seasonal rainfall (mm) (b) Seasonal rainfall anomaly (mm) (*Based on 1961-2010 Normals*)

India, north India, west coast, and both the islands received more than 1000 mm of rainfall. Parts of Arunachal Pradesh, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, the entire west coast, East Madhya Pradesh, and Andaman & Nicobar Islands received more than 2000 mm of rainfall. Parts of Assam & Meghalaya and the west coast received more than 3000 mm of rainfall.

Positive Rainfall anomalyof more than 200 mm was observed over most subdivisions of the country and both the islands except a few from the east and northeast India. The magnitude of negative rainfall anomaly was more than 200 mm over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Bihar, East and West Uttar Pradesh, Odisha, Kerala & Mahe and Andaman & Nicobar Islands.

Fig. 20 shows the daily area-weighted averaged rainfall (in mm) and its long-term normal over the country as a whole and the four homogeneous

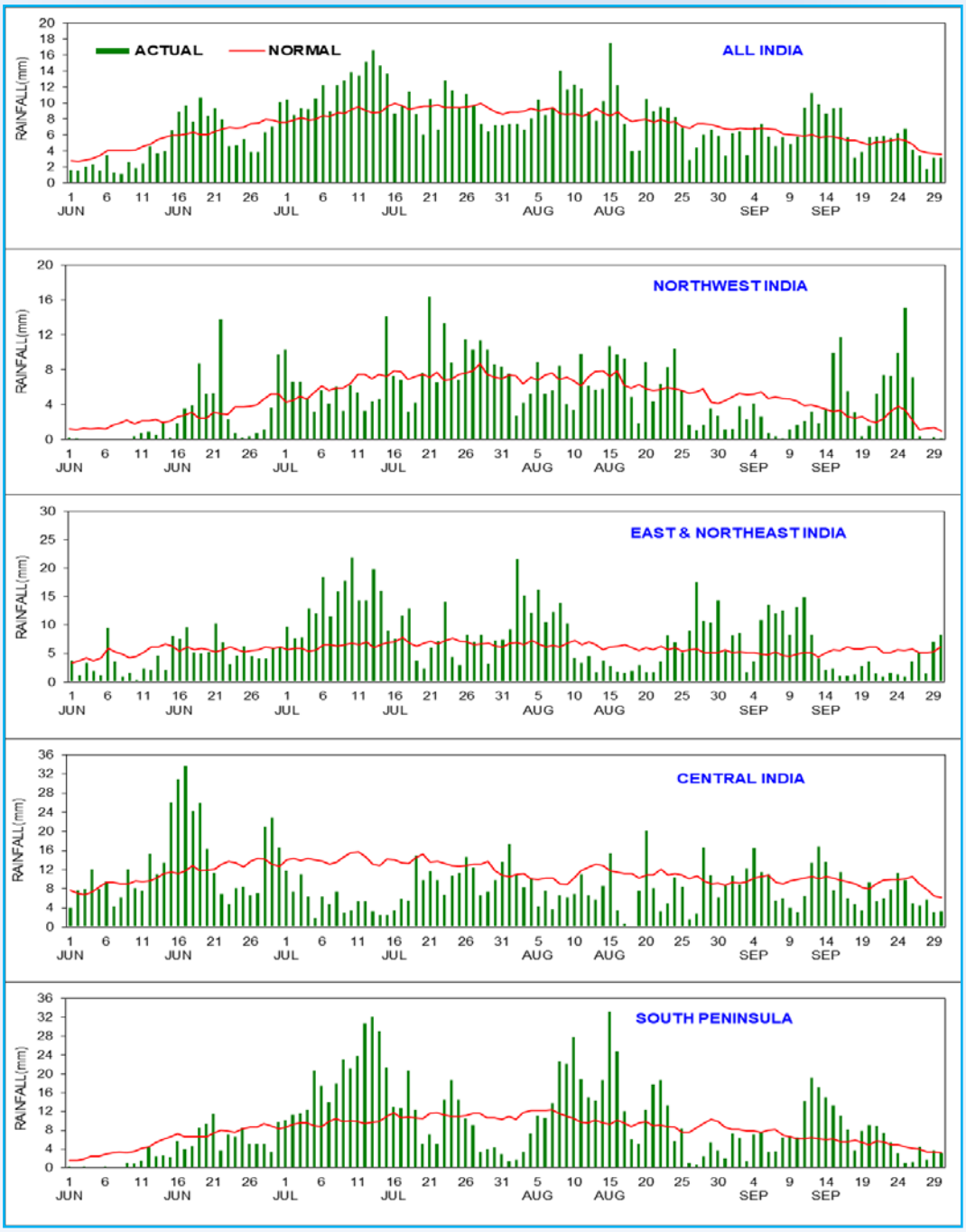



**Fig. 20.** Daily area weighted average rainfall (mm) and its long term normal for the country as a whole and the four homogeneous regions (1 June - 30 September)

regions during the season.The rainfall averaged over the country was above or near normal on 9 days during June, 23 days during July, 15 days during August and 15 days during September.

On almost 15 occasions including the continuous periods of 12-14 July and 11-16 September it was more than one and a half times its normal value.It was below normal at a stretch on 1-14 June, 23-28 June, 28 July - 4 August, 26-31 August (except 29 August) and 26- 29 September.

## Standardized Precipitation Index

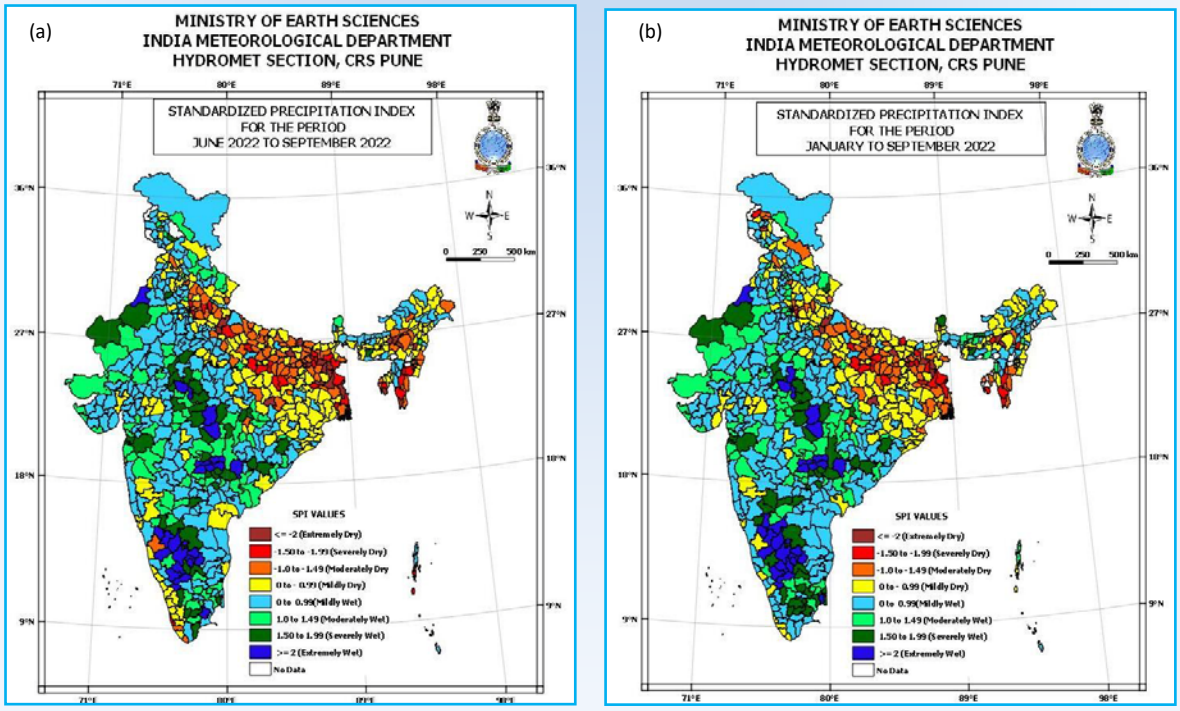
Figs. 21(a&b) give the SPI values for the monsoon season (four months) and the year since January 2022 (nine months) respectively.

Cumulative SPI values of the past four months indicate, extremely wet/severely wet conditions over parts of Assam & Meghalaya, Odisha, Haryana, Chandigarh & Delhi, Jammu & Kashmir & Ladakh, Rajasthan state, Madhya Pradesh state, Gujarat Region, Madhya Maharashtra, Vidarbha, Chhattisgarh, Telangana, Rayalaseema, Tamil Nadu & Karaikal, North Interior Karnataka, South Interior Karnataka, and Lakshadweep while, extremely dry/severely dry conditions were observed over parts of Andaman & Nicobar Islands, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub Himalayan West Bengal & Sikkim, Gangetic West Bengal, Jharkhand, Bihar, Uttar Pradesh state, Haryana, Chandigarh & Delhi, Chhattisgarh, and Kerala & Mahe.

Cumulative past nine months' SPI values indicate, extremely wet/severely wet conditions over parts of Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, Odisha, Uttarakhand, Rajasthan state, Madhya Pradesh state, Gujarat Region, Madhya Maharashtra, Vidarbha, Chhattisgarh, Telangana, Rayalaseema, Tamil Nadu & Karaikal, North Interior Karnataka, South Interior Karnataka, and Lakshadweep while, extremely dry/severely dry conditions were observed over parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Jharkhand, Bihar, Uttar Pradesh state, Haryana, Chandigarh & Delhi, Jammu & Kashmir & Ladakh, and Chhattisgarh.

## Outgoing Longwave Radiation (OLR)

OLR anomaly ($W/m^2$) over the Indian region and neighborhood is shown in Fig. 22. OLR anomaly was negative throughout the country except in extreme northern, east & northeastern, and southwestern parts of the south peninsula. OLR




**Figs. 21(a&b).** Standardized Precipitation Index (SPI) for (a) Four months (b) Nine months

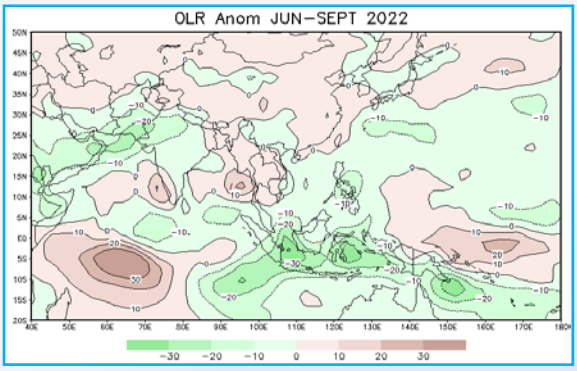
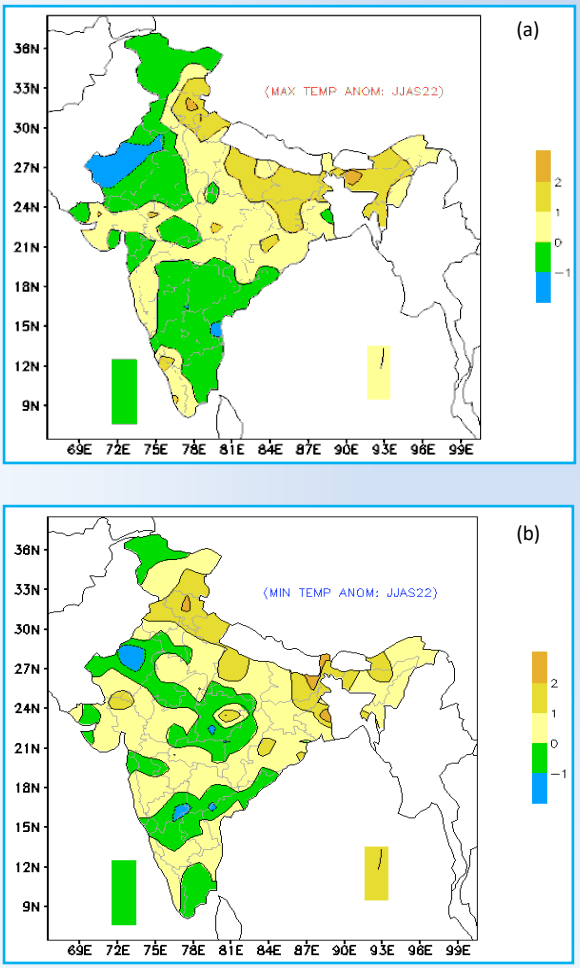



**Fig. 22.** OLR anomaly (W/m$^2$) for the monsoon season 2020 (Source: CDC / NOAA, USA) (*Based On 1981 - 2010 Climatology*)

anomaly was within the normal range ± 10 W/m$^2$. OLR anomaly was less than -20 W/m$^2$ over parts of West Rajasthan.

## Temperature

The mean seasonal maximum and minimum temperature anomaly is shown in Figs. 23(a&b)




**Figs. 23(a&b).** Mean seasonal temperature anomalies (°C) (a) Maximum (b) Minimum (*Based on 1981-2010 Normals*)

respectively. The maximum temperature was above normal over most parts of the country except some parts of northwest India, central India, south peninsular India, and Lakshadweep. Maximum temperature anomaly was more than 2 °C over parts of Himachal Pradesh, Assam & Meghalaya.Maximum temperature anomaly was less than -1 °C over parts of West Rajasthan, Haryana, Chandigarh & Delhi, North Interior Karnataka, and Coastal Andhra Pradesh & Yanam.

The minimum temperature was above normal over most parts of the country except some parts of central India, northwest India, south peninsular India, and Lakshadweep. The minimum temperature anomaly was more than 2 °C over parts of Himachal Pradesh, Bihar, West Bengal state, and Sikkim. The minimum temperature anomaly was less than -1 °C over parts of West Rajasthan, East Madhya Pradesh, North Interior Karnataka, and Coastal Andhra Pradesh & Yanam.

## Low Pressure Systems

During the season, twelve low-pressure systems (1 Deep Depression, 5 Depressions, 2 well-marked low-pressure areas, 2 low-pressure areas and 2 land low-pressure areas) were formed.

Fig. 24 shows the track of the intense low-pressure system formed during the season.

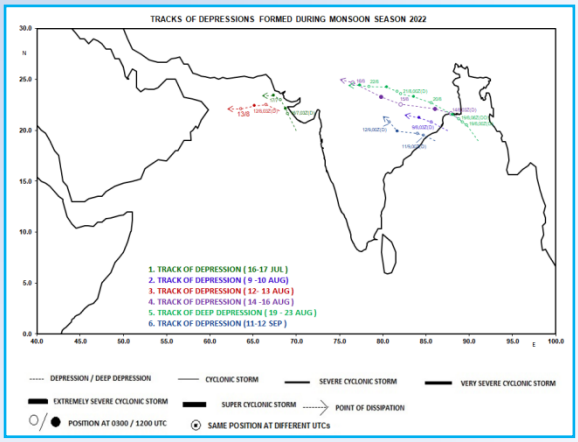



**Fig. 24.** Tracks of intense low pressure systems formed during the southwest monsoon season 2022

Fig. 25 shows the number of depressions and cyclonic storms formed during the Southwest monsoon season inthe last 10-year period (2013-2022).

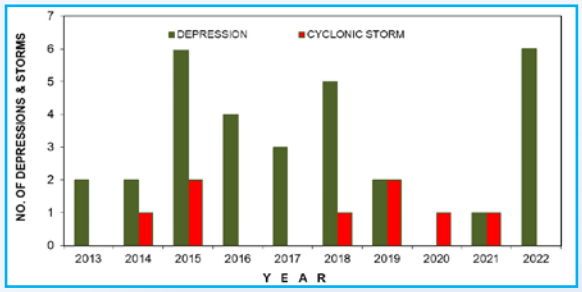



**Fig. 25.** Number of depressions & cyclonic storms formed during the SW monsoon season (2013-2022)

The frequency and place of origin of these low-pressure systems formed over the Indian region during the SW Monsoon season are shown below:

| Month/ Systems | DD | D | WML | LPA | LAND LPA |
|---|---|---|---|---|---|
| June | 0 | 0 | 0 | 1(AS) | 0 |
| July | 0 | 1 (AS) | 1 (BOB), 1 (LAND) | 0 | 1 |
| August | 1(BOB) | 2 (BOB),1 (AS) | 0 | 0 | 0 |
| September | 0 | 1(BOB) | 0 | 1(BOB) | 1 |
| | (AS: Arabian Sea) | | (BOB: Bay of Bengal) | | |

## Significant Weather events

Fig. 26 shows significant weather events during the Southwest season (based on real-time media reports). From 1st June to 30th September, a total of 1323 persons were reportedly claimed dead, more than 430 persons injured, more than 100 persons were missing & more than 1,18,000 livestock perished. The details of causalities on the basis on real-time media reports are given below:

**Floods, Heavy Rains & Landslides**: A total of 619 persons were reportedly claimed dead, more than 160 persons injured, more than 100 persons were missing & more than 1,17,000 livestock perished, during Southwest Monsoon 2022, because of Floods, Heavy Rains & Landslides.

**Lightning** : Total 523 persons reportedly claimed dead, 257 persons injured & 318 livestock perished, during Monsoon 2022, because of Lightning.

**Thunderstorm** : Total 174 persons reportedly claimed dead, 9 person injured & 62 livestock perished, during Monsoon 2022, because of Thunderstorm.

**Heat Wave** : Total 3 person reportedly claimed dead, during Monsoon 2022, because of Heat Wave.

**Gale**: A total of 4 persons were reportedly claimed dead and 8 personswere injured during Monsoon 2022, because of Gale.

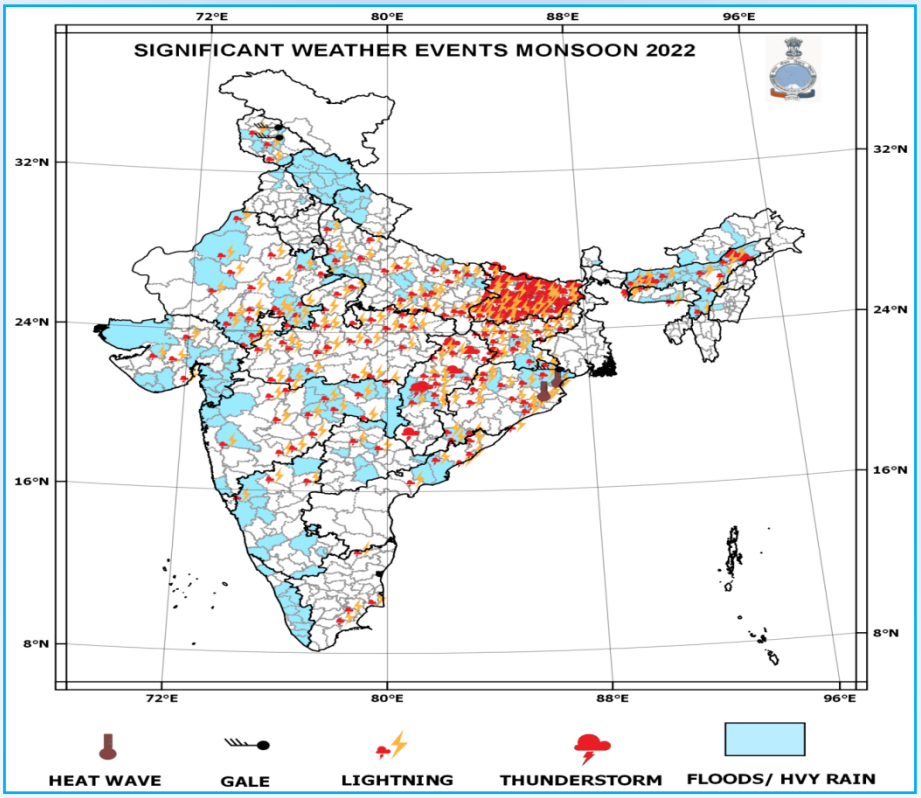



**Fig. 26.** Significant weather events during the southwest monsoon season 2022 (Based on real time media report)

## 4. Post Monsoon Season (Oct-Nov-Dec)

### Highlights

Over the country as a whole the mean temperature for the Post-Monsoon was the 5th highest (23.76 °C with an anomaly of 0.52 °C) since 1901. Over East & Northeast India the maximum temperature was the 2nd highest (28.69 °C with an anomaly of 1.10 °C) after the year 2016 (28.77 °C) and mean temperature (22.65 °C with an anomaly of 0.91 °C) was the highest since 1901.

### Northeast Monsoon Activity

The southwest monsoon withdrew from the entire country on 23rd October and northeast monsoon rains commenced from 29th October. Rainfall activity over core region of the South Peninsular India (comprising of 5 subdivisions viz. Coastal Andhra Pradesh and Yanam, Rayalaseema, Tamil Nadu, Puducherry and Karaikal, South Interior Karnataka and Kerala & Mahe) during the season as a whole was 110% of its LPA. It was 108% of its LPA during October, 85% of its LPA during November and 186% of its LPA during December.

### Rainfall Features

Rainfall realized over the country as a whole during the season was 119% of LPA. Most of the subdivisions received large excess/excess/normal rainfall except Gangetic West Bengal, Punjab, Himachal Pradesh, Coastal Karnataka, West Rajasthan and Saurashtra & Kutch. During the season, out of 36 meteorological subdivisions, 6 received large excess rainfall, 10 received excess rainfall, 14 received normal rainfall, 4 received deficient rainfall and 2 received large deficient rainfall (Fig. 27).

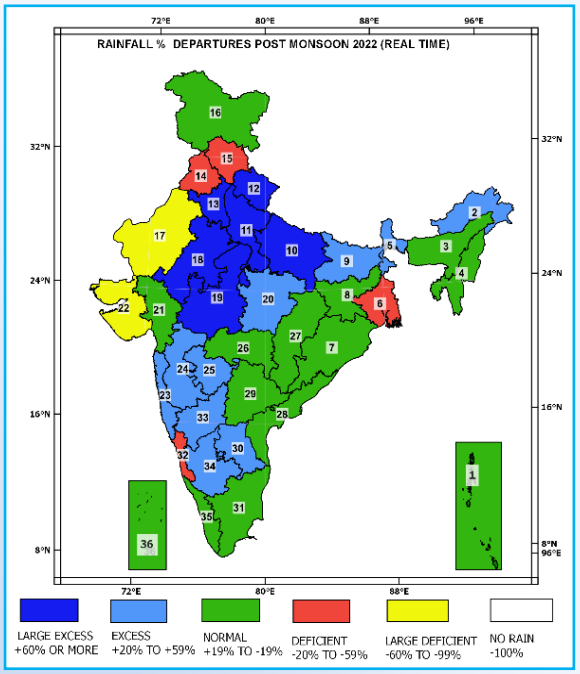
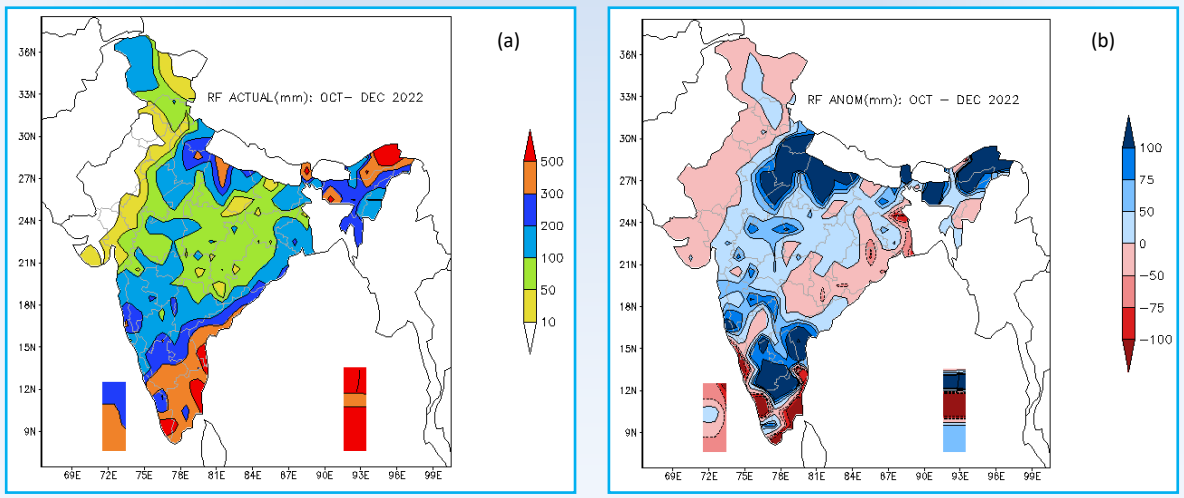



**Fig. 27.** Sub-divisionwise rainfall percentage departures

Figs. 28(a&b) show the spatial pattern of rainfall (mm) received during the season and its anomaly respectively. Parts of Arunachal Pradesh, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, East Uttar Pradesh, Coastal Andhra Pradesh, Rayalaseema, Tamilnadu, Puducherry & Karaikal, South Interior Karnataka, Kerala & Mahe and both the islands received more than 300 mm of rainfall. Parts of Arunachal Pradesh, Coastal Andhra Pradesh, Tamilnadu, Puducherry & Karaikal, Kerala & Mahe and Andaman & Nicobar Islands received more than 500 mm of rainfall.




**Figs. 28(a&b).** (a) Seasonal rainfall (mm) (b) seasonal rainfall anomaly (mm)
(*Based on 1951-2000 Normals*)

Rainfall anomaly was more than 100 mm over parts of Arunachal Pradesh, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, East and west Uttar Pradesh, Uttarakhand, East Rajasthan, West Madhya Pradesh, Coastal Andhra Pradesh, Rayalaseema, Tamilnadu, Puducherry & Karaikal, Konkan & Goa, South Interior Karnataka and Andaman & Nicobar islands. Magnitude of negative rainfall anomaly was more than 100 mm over parts of Tamilnadu, Puducherry & Karaikal, Kerala & Mahe, Coastal Karnataka and Andaman & Nicobar Islands.

All India area weighted rainfall series for the season since 1951 [Fig. 29(a)]. The area weighted rainfall series for the season over the four homogeneous regions since 1951 [Fig. 29(b)]. It was 157% of its LPA over northwest India, 125% of its LPA over central India, 111% if it's LPA over east & northeast India and 109% of its LPA over south peninsula.

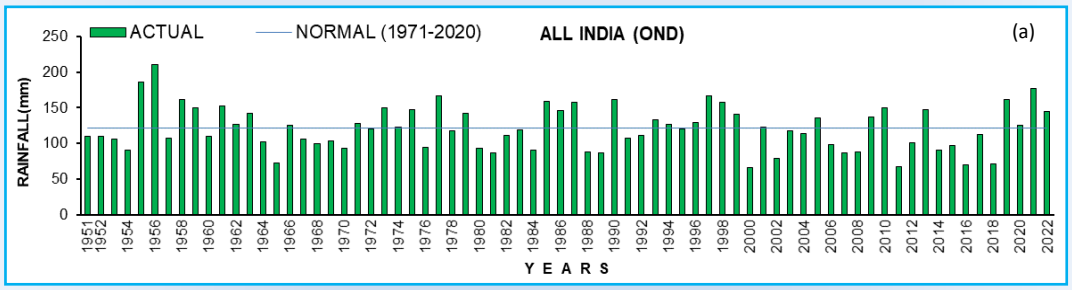



**Fig. 29(a).** Time series of area weighted post monsoon (October-December) (1951-2022) rainfall over the country as a whole

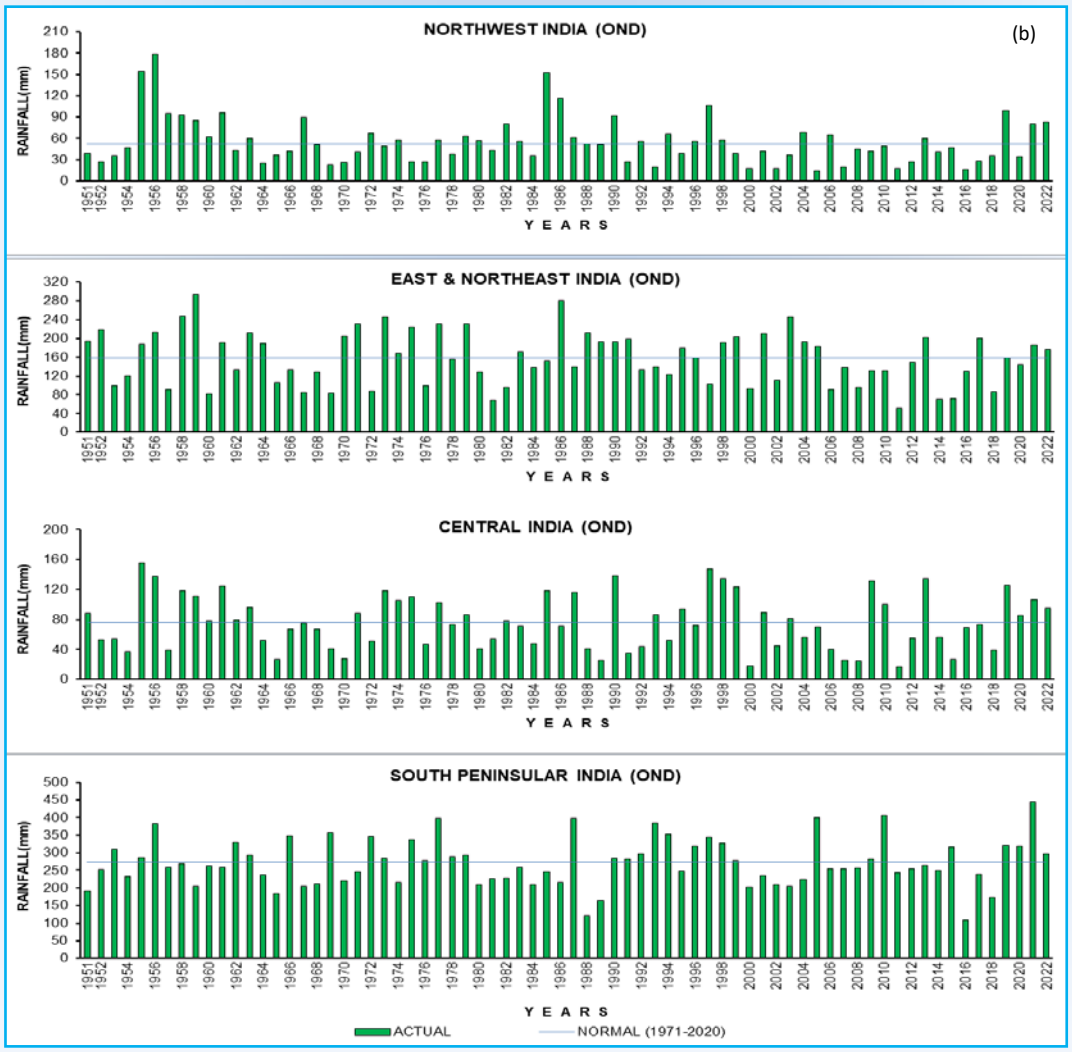



**Fig. 29(b).** Time series of area weighted rainfall over the four homogeneous regions for post monsoon (October-December) (1951 - 2022)

## Standardized Precipitation Index

Figs. 30(a&b) give the SPI values for the northeast monsoon season (October to December 2022, *i.e.*, 3 months cumulative) and the year (January-December 2022, *i.e.*, 12 months cumulative) respectively.

Cumulative SPI values of the past three months indicate extremely wet - severely wet conditions over parts of Arunachal Pradesh, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, Uttar Pradesh state, Uttarakhand, Haryana, Chandigarh & Delhi, East Rajasthan, West Madhya Pradesh and South Interior Karnataka, while extremely dry-severely dry conditions were not observed over any part of the country.

Cumulative SPI values of the past twelve months indicate extremely wet - severely wet conditions over parts of A & N Islands, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, Odisha, Uttar Pradesh state, Rajasthan state, Madhya Pradesh state, Gujarat Region, Konkan & Goa, Madhya Maharashtra, Vidarbha, Chhattisgarh, Telangana, Rayalaseema, Tamil Nadu, North Interior Karnataka, South Interior Karnataka and Lakshadweep, while extremely dry-severely dry conditions were observed over parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Jharkhand, Bihar, Uttar Pradesh state and Chhattisgarh.

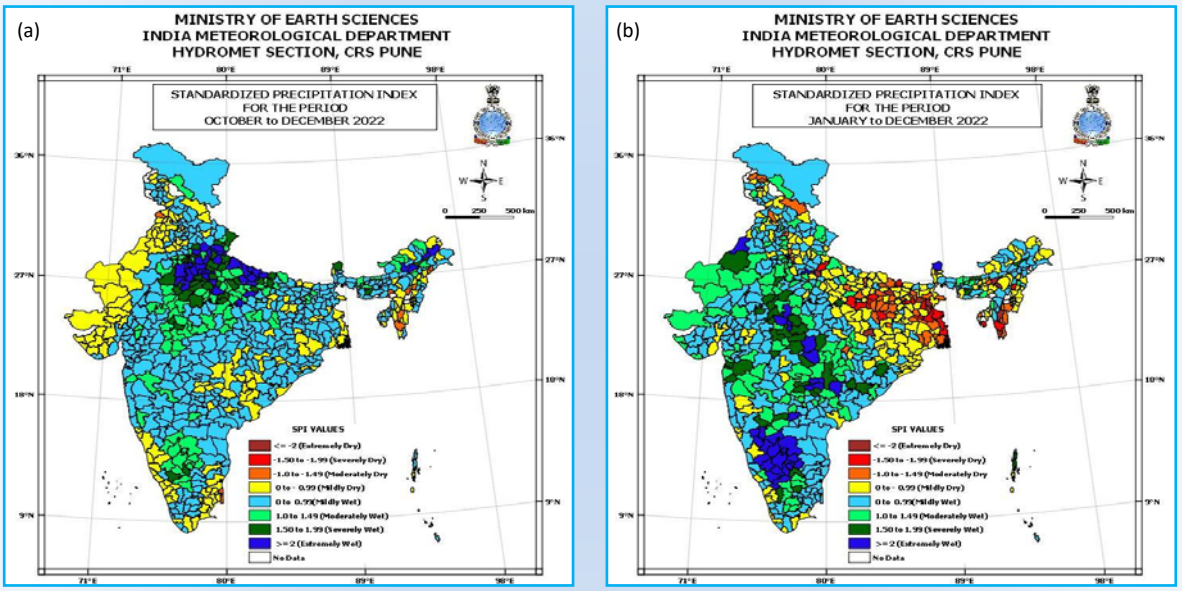



**Fig. 30(a&b).** Standardized Precipitation Index (SPI) cumulative for (a) Three months (b) Twelve months

## Pressure & Wind

The pressure anomaly was negative over most parts of country except some pockets. The negative pressure anomaly was generally less than -0.5 to -1.5 hPa over most parts of the country.

## Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m$^2$) over the Indian region and neighbourhood is shown in Fig. 31. OLR anomaly was within normal range ± 10 W/m$^2$ over most parts of the country except over parts of south east peninsula and adjoining Bay of Bengal where it was less than -10 W/m$^2$.

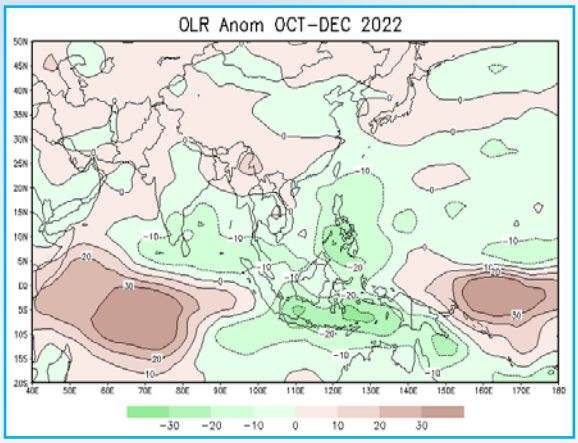
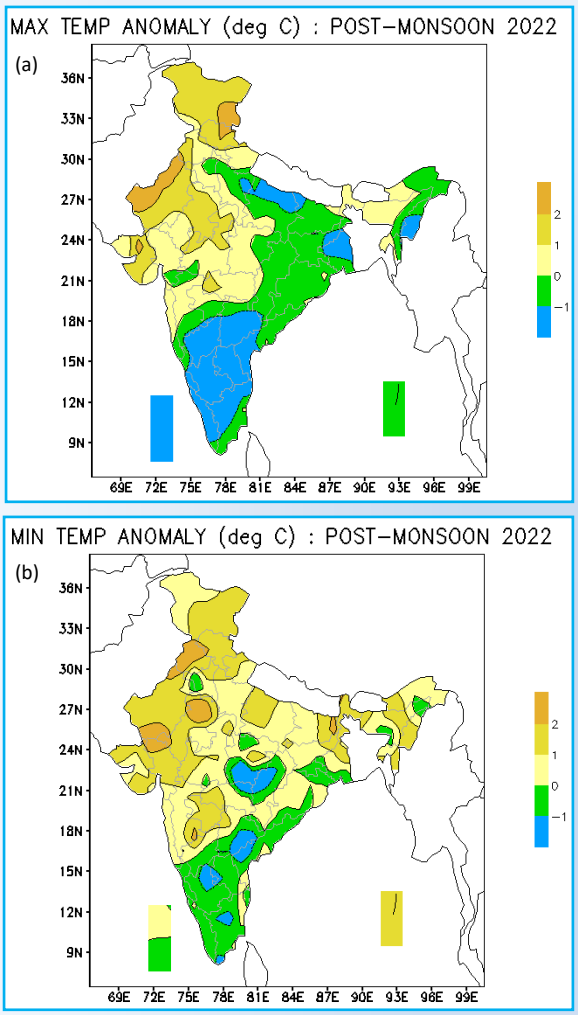



**Fig. 31.** OLR Anomaly (w/m2) for the post-monsoon season 2022 (Source : CDC / NOAA, USA)
(*Based on 1981 - 2010 Climatology*)

## Temperature

Mean seasonal maximum and minimum temperature anomaly is shown in Figs. 32 (a&b) respectively.



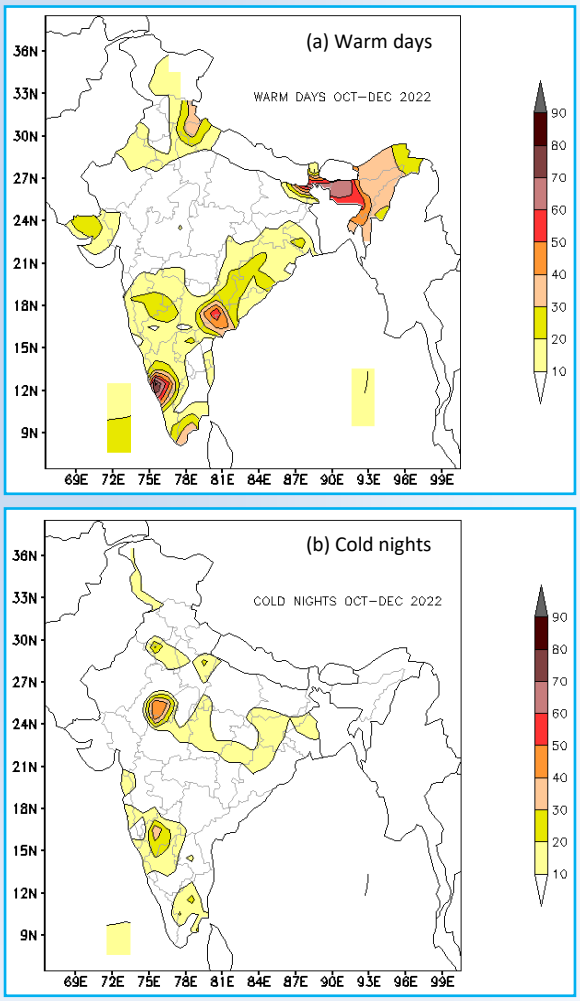

**Figs. 28(a&b).** Mean seasonal temperature anomalies (°C) (a) Maximum (b) Minimum (*Based on 1981-2010 Normals*)

temperature was above normal over most parts of the country except some parts of East & Northeast India, northwest India, eastcentral India, south peninsular India both the islands. Maximum temperature anomaly was more than 2 °C over parts of Ladakh state, Himachal Pradesh, Punjab, West Rajasthan and Saurashtra & Kutch. Maximum temperature anomaly was less than -1 °C over parts of Uttar Pradesh state, Bihar, Gangatic West Bengal, Karnataka state, Telangana, Andhra Pradesh state, Tamil Nadu, Puducherry & Karaikal, Kerala & Mahe and Lakshadweep.

Minimum temperature was above normal over most parts of the country except some parts of northwest India (Haryana, Chandigarh & Delhi), east & northeast India, central India, south peninsular India and Lakshadweep. Minimum temperature anomaly was more than 2 °C over parts of Punjab, Rajasthan state, Bihar, Gujarat region and southern Madhya Maharashtra. Minimum temperature anomaly was less than -1 °C over parts of East Madhya Pradesh, Chhattisgarh, Vidarbha, Telangana, Andhra Pradesh state, South Interior Karnataka and Tamil Nadu, Puducherry & Karaikal.

## Percentage of Warm days/Cold nights

Figs. 33(a&b) show the percentage of days when maximum (minimum) temperature was more (less) than 90$^{th}$ (10$^{th}$) percentile.




**Figs. 33(a&b).** Percentage of days when (a) maximum temperature > 90$^{th}$ percentile (b) minimum temperature < 10$^{th}$ percentile

Over parts of Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, Coastal Andhra Pradesh, Telangana and Kerala & Mahe maximum temperature was greater than 90$^{th}$ percentile for

more than 50% of the days of the season. For minimum temperature no such significant distribution was observed.

Fig. 34 shows the mean temperature time series for the country as a whole for Post-Monsoon season since 1971. Five year moving average values are also shown. The mean temperature for the season this year over the country as a whole was the 5th highest (23.76 °C with an anomaly of 0.52 °C) since 1901. The mean temperature over East & Northeast India (22.65 °C with an anomaly of 0.91 °C) was the highest since 1901.

Figs. 35(a&b) show, the maximum and minimum temperature series respectively for the country as a whole and the four homogeneous regions during Post-Monsoon 2022 since 1971.

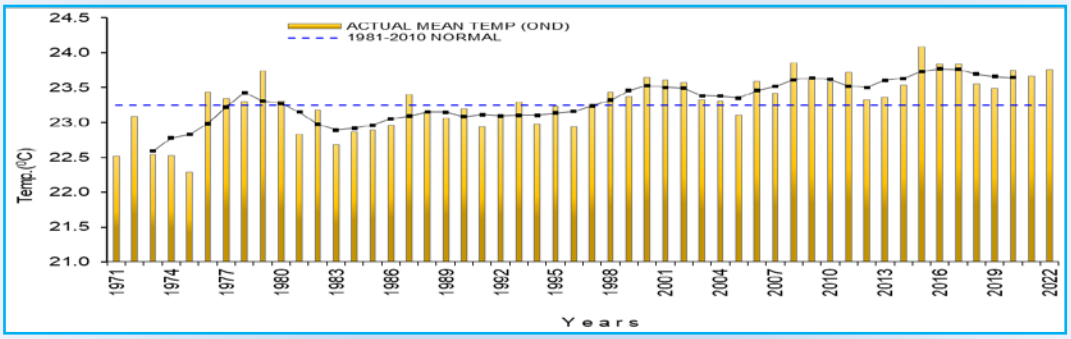
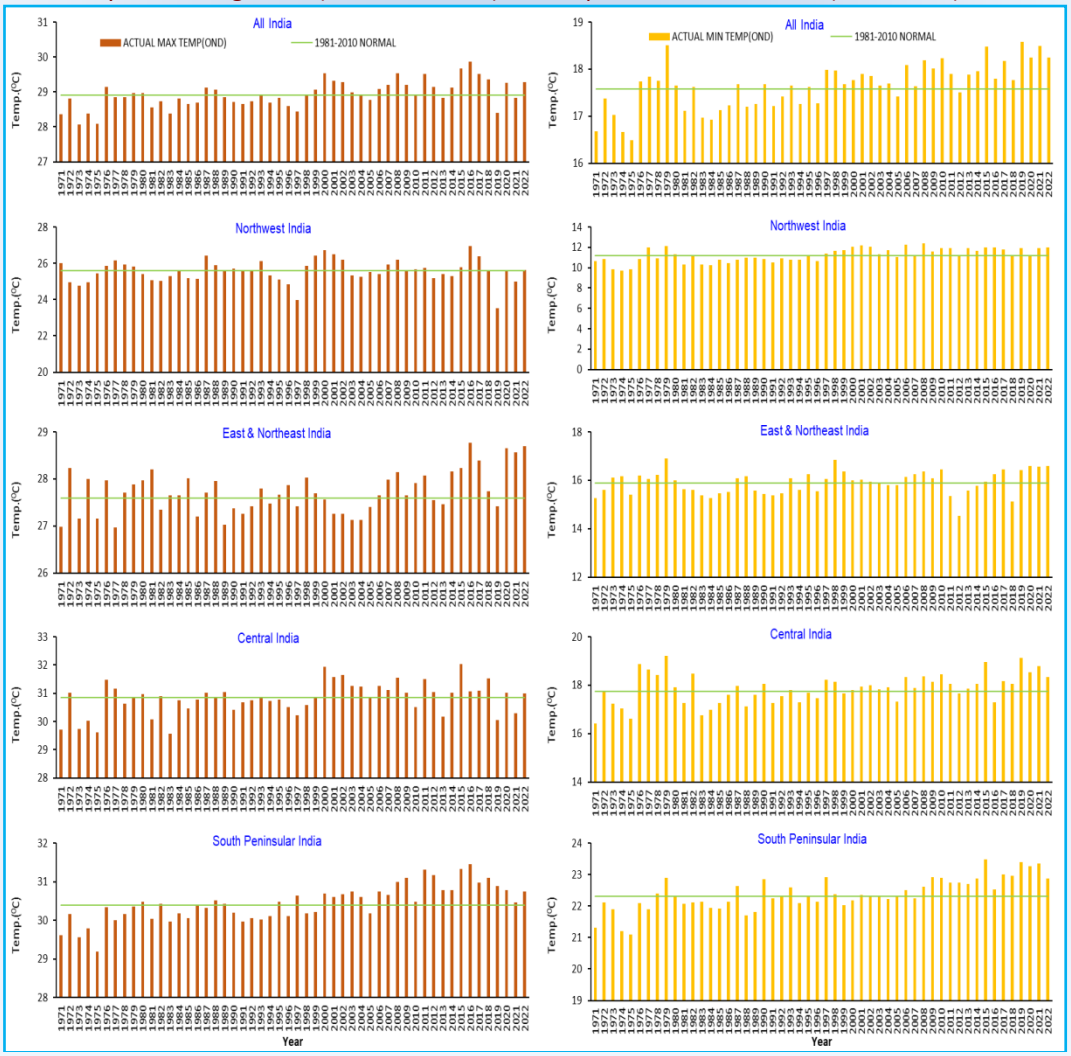



**Fig. 34.** Time series of mean temperature averaged over India (vertical bars) and five year running mean (continuous line) for the post monsoon season (1971-2022)




**Figs. 35(a&b).** Time series of temperature for the country as a whole and the four Homogeneous regions for post monsoon (October-December) (1971- 2022) (a) Maximum (b) Minimum

## Low Pressure Systems

During the season, seven low pressure systems (2 cyclonic storms, 3 depressions, 1 well marked low & 1 low pressure area) were formed. The frequency and place of origin of these low pressure systems formed over the Indian region during the post monsoon season is shown in the table below:

| Month/ Systems | CS and above | DD | D | WML | LPA |
|---|---|---|---|---|---|
| October | 1 (BOB) | | | | 1(BOB) |
| November | | | 1(BOB) | 1 (BOB) | |
| December | 1 (BOB) | 1 (AR SEA) | 1 (BOB) | | |
| | **(AS :** Arabian Sea**)** | | **(BOB :** Bay of Bengal**)** | | |

During October 2022 cyclonic Storm "Sitrang" and a low pressure area formed over Bay of Bengal during the period 22-25 October, 2022. During November 2022 a depression formed during 20-22 November, 2022 over Bay of Bengal. Besides this depression a well marked low pressure area formed over Bay during 9-14 November 2022. During December 2022, severe cyclonic storm "MANDOUS" formed over Bay of Bengal during the period 6-10 December. Besides severe cyclonic storm "MANDOUS", a deep depression formed during 14-17 December over Arabian sea and a depression during 22-25 December over Bay of Bengal. Fig. 36 shows tracks of these systems formed during season.

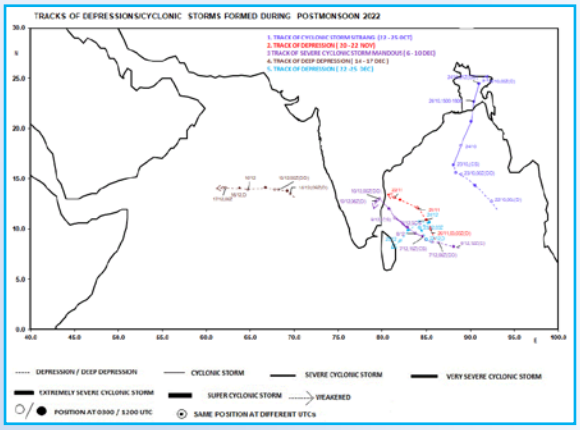



**Fig. 36.** Tracks of intense low pressure system formed during post-monsson season 2022

Fig. 37 shows the number of depressions & storms formed over Bay of Bengal during the post-monsoon season (1951-2022)

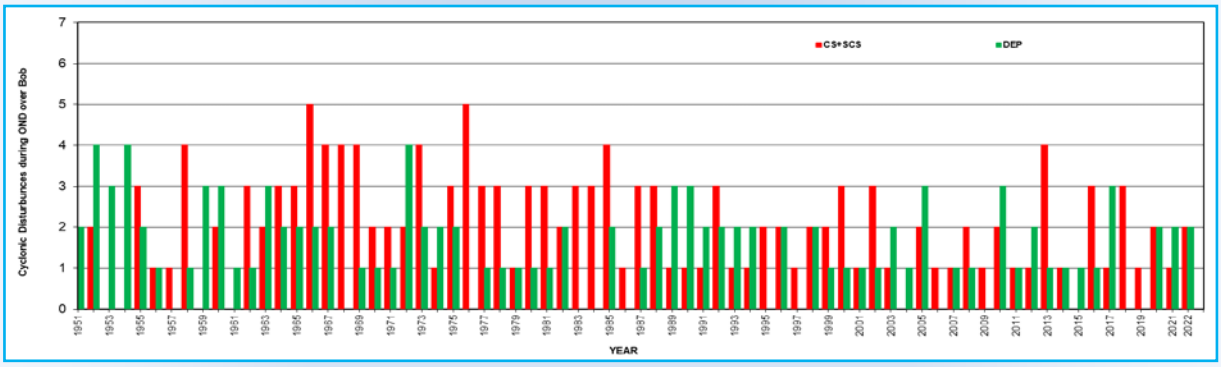



**Fig. 37.** Time series of frequency of depressions/cyclonic storms formed over Bay of Bengal during the post monsoon season Oct-Dec (1951- 2022)
(*Data source*: Cyclone Eatlas RSMC IMD New Delhi) based on real time data

## Significant Weather events

During 1st October to 31st December, 2022, total 157 persons reportedly claimed dead, more than 85 persons injured, more than 15 persons missing & 68 livestock perished. The details of causalities given below, which are based on real time media reports and other state government agencies.

Fig. 38 shows significant weather events during the post monsoon season. (Based on real time media reports)

**Lightning**: Total 60 persons reportedly claimed dead, 58 persons injured & 68 livestock perished, during 1st October to 31st December, because of Lightning.

**Floods, Heavy Rains & Landslide**: Total 55 persons reportedly claimed dead, more than 25 persons injured, & several others missing during 1st October to 31st December, because of Floods, Heavy Rains and Landslide.

**Snowfall**: Total 19 persons reportedly claimed dead & 15 others missing, during 1st October to 31st December, because of Snowfall.

**Thunderstorm**: Total 16 persons reportedly claimed dead & 2 persons injured, during 1st October to 31st December, because of Thunderstorm.

**Cyclonic Storm**: Total 6 persons reportedly claimed dead, because of Severe Cyclonic Storm "MANDOUS". Annamayya, Chittoor, Nellore, Prakasam, Tirupati & Parts of Andhra Pradesh also affected due to Severe Cyclonic Storm "MANDOUS", while Cyclonic Storm "SITRANG" (22 to 25 October) affected the parts of Assam & Mizoram.

**Cold Wave**: One person reportedly claimed dead due to cold wave in Prabhani district of Maharashtra on 21st November.

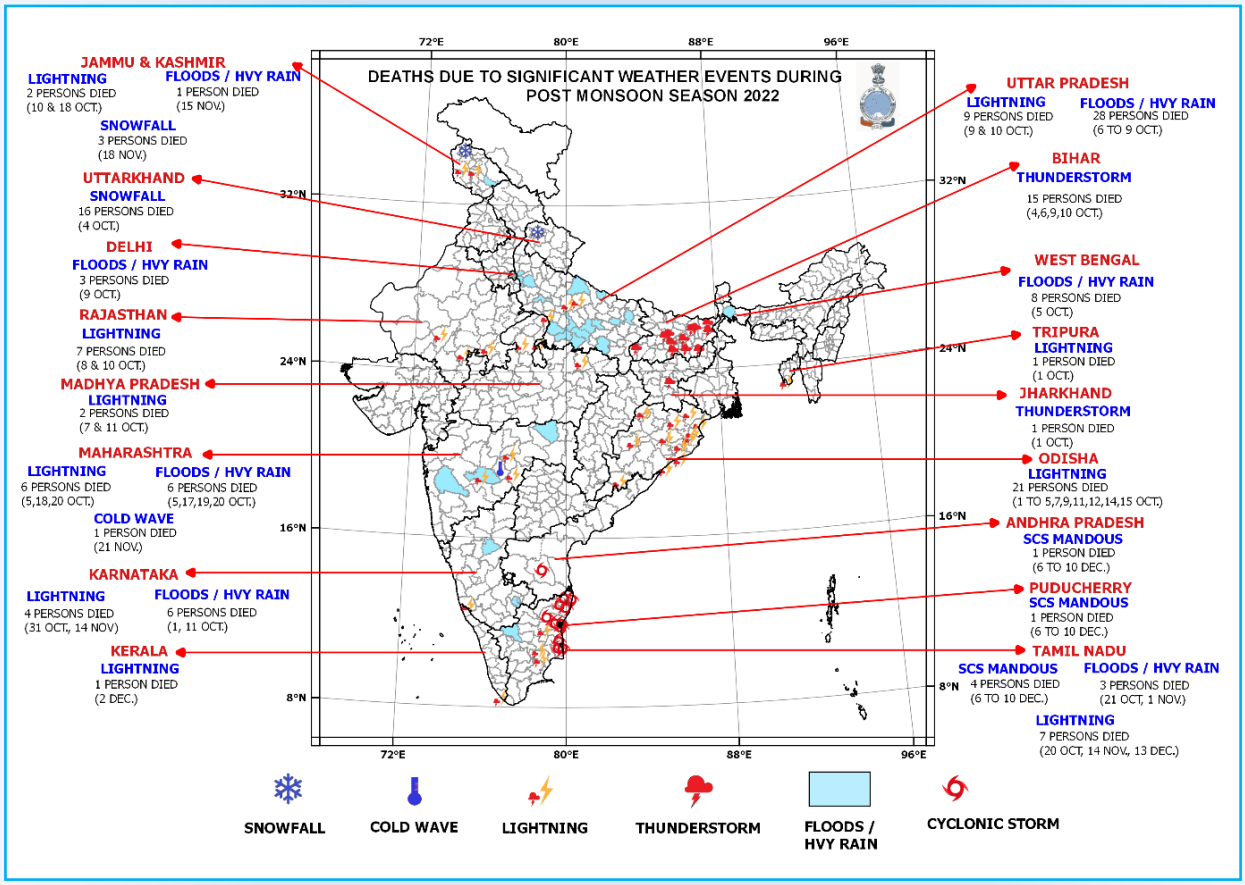



**Fig. 38.** Significant weather events during post monsoon (October-December) 2022 (Based on real time media report)

# CHAPTER 3

# NUMERICAL WEATHER PREDICTION

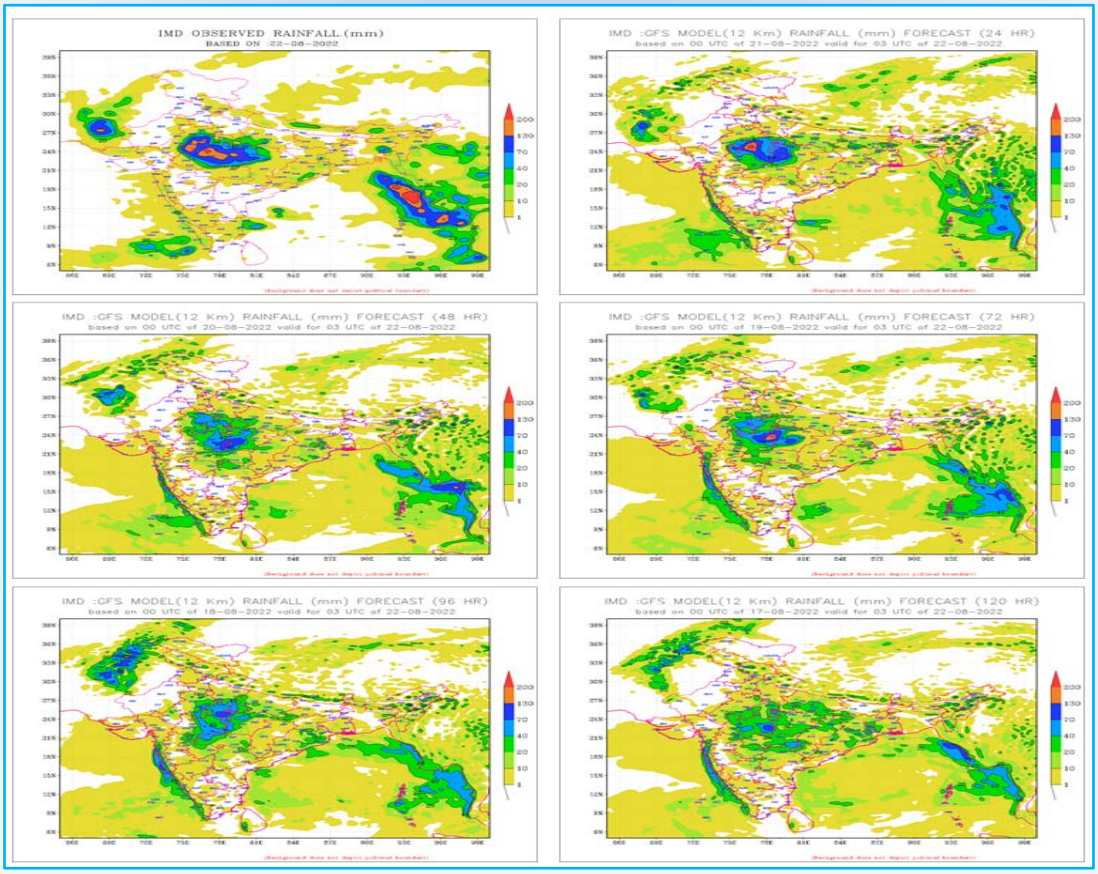
**Global and Regional Modelling (NWP)**

## GFS Model

Global Forecasting System (GFS T1534L64) model is run operationally at India Meteorological Department (IMD) four times in a day (0000, 0600, 1200 & 1800 UTC) to give deterministic forecast in the short to medium range upto 10 days. The forecast model has a resolution of approximately 12 km in horizontal and has 64 levels in the vertical. The initial conditions for this GFS model is generated from the four-dimensional (4D) ensemble-variational data assimilation (DA) system (4DEnsVar) building upon the grid point statistical interpolation (GSI)-based hybrid Global Data Assimilation System (GDAS) run on High Performance Computing Systems (HPCS) at National Center for Medium Range Weather Forecasting (NCMRWF). The real-time GFS T1534L64 model outputs are generated daily at IMD. This 4DEnsVar data assimilation system has capabilities to assimilate various conventional as well as satellite observations including radiances from different polar orbiting and geostationary satellites. The real-time outputs are made available to operational weather forecasters and various users through the national web site of IMD. Fig. 1 shows the forecast and observed heavy rainfall event of 22$^{nd}$ August, 2022 during south west monsoon 2022.

## GEFS Model

Global Ensemble Forecast System (GEFS) GEFS is an operational weather model at IMD to address underlying uncertainties in the input data such limited coverage, instruments or observing systems biases, and the limitations of the model itself. GEFS quantifies these uncertainties by

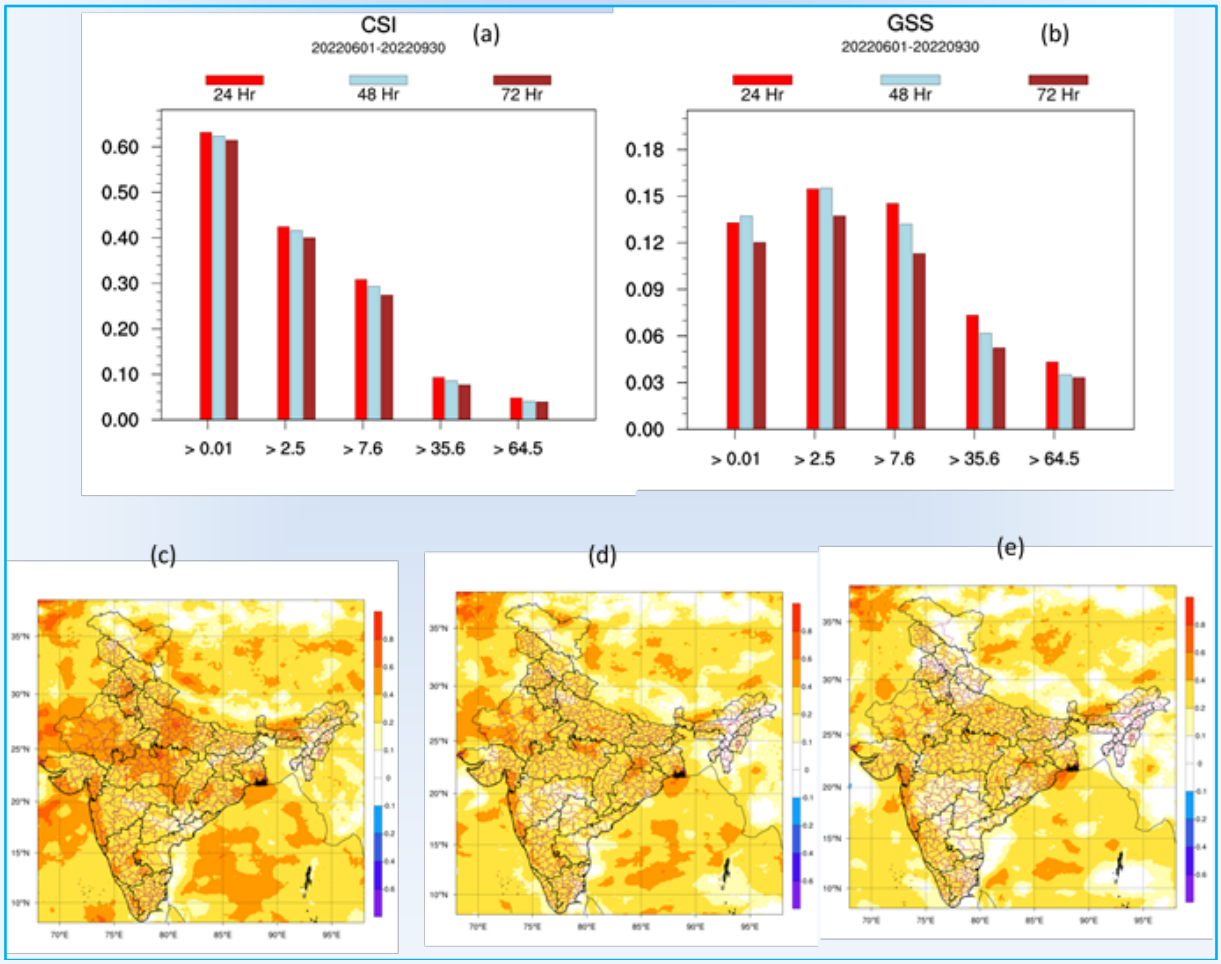



Figs. 1. (a) IMD Observed rainfall for 22nd August, 2022 and IMD-GFS forecast for (b) 24 hours, (c) 48 hours, (d) 72 hours, (e) 96 hours and (f) 120 hours valid for 22nd August, 2022

generating multiple forecasts, which in turn produce a range of potential outcomes based on differences or perturbations applied to the data after it has been incorporated into the model. Global Ensemble Forecast System (GEFS) at IMD is adopted from NCEP and it runs in ~12 km (T1534) resolution. The total number of 21 Ensembles (20 perturbed forecasts + 1 control forecast) constitutes the ensemble system. These 20-ensemble members are generated by Ensemble Kalman Filter (EnKF) method from the forecast perturbation of the previous cycles four times a day (00, 06, 12 and 18 UTC) at all 64 model vertical levels. These analysis perturbations are added to the reconfigured analysis obtained from the hybrid four-dimensional Ensemble variational data assimilation system (GDASHybrid4DEnsVar) as part of the suite. The 243 hours forecast of GEFS is routinely generated based on 0000UTC and 1200 UTC initial conditions which include a control forecast starting from GDAS assimilation and 20 (20 perturbations) ensemble members with each perturbed initial condition (Deshpande *et al*., 2020).

### WRF model

During southwest monsoon season 2022, the WRF model (ARW) delivered three days forecasts at 3 km horizontal resolution four times daily at 0000, 0600, 1200 and 1800 UTC with hourly interval. The data assimilation component, regional GSI (Global Statistical Interpolation) takes global GFS analysis and all other conventional quality-controlled observations as its input and generates mesoscale analysis at 3 km resolution. The model produced forecasts over a domain spanning about 5° S to 41° N in north-south and 49° E to 102° E in east-west directions respectively. Fig. 2 portrays skill scores (a) critical success index and (b) Gilbert skill scores for different rainfall thresholds whereas lower row exhibits seasonal averaged spatial correlation coefficient for (c) 24 hours, (d) 48 hours and (e) 72 hours rainfall forecasts with observation.




Figs. 2. (a) Critical Success Index, (b) Gilbert Skill Score & spatial correlation coefficient averaged over whole monsoon season for (c) 24 hours forecast, (d) 48 hours forecast and (e) 72 hours forecast of rainfall

### HWRF-Ocean (HYCOM/POM-TC) coupled model

During pre-monsoon and post-monsoon cyclone seasons of 2022, the movable triple nested HWRF-Ocean (HWRF/POM-TC) coupled model with horizontal resolutions of 18 km, 6 km and 2 km delivered five days forecasts four times a day at 0000 UTC, 0600 UTC, 1200 UTC and 1800 UTC for tropical cyclones formed over north Indian Ocean (NIO). The data assimilation component of HWRF, regional GSI Data Assimilation, generated mesoscale analysis for intermediate and innermost nests which are then merged to generate analysis for all three domains. The model parent domain (18 km horizontal resolution) remained stationary whereas the intermediate domain (6 km horizontal resolution) and the inner most domains (2 km horizontal resolution) moved to track the storm centre. The verification (error) score for SCS ASANI formed during 2022 is presented in Table 1. The Fig. 3 represents the different product generated from operational HWRF-HYCOM coupled model for the Severe Cyclonic Storm (SCS) ASANI during May 2022.

**Table 1**

**Coupled HWRF-HYCOM Track and intensity forecasts Error Statistics for cyclone ASANI**
**(*Number of forecasts verified is given in the parentheses)**

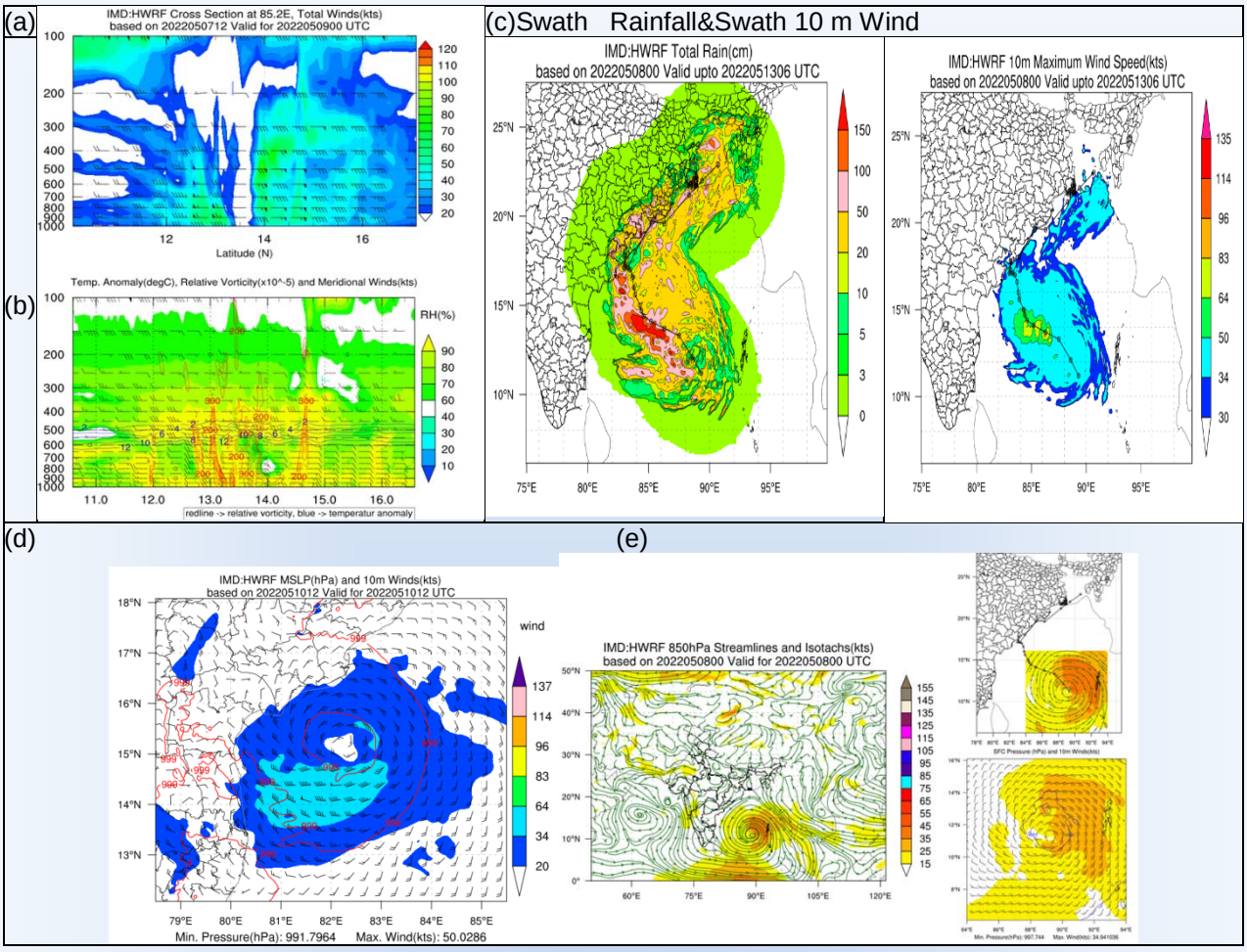
| Errors \ Lead Time | 12 Hr (18) | 24 Hr (16) | 36 Hr (14) | 48 Hr (12) | 60 Hr (10) | 72 Hr (8) | 84 Hr (6) | 96 Hr (4) | 108 Hr (2) |
|---|---|---|---|---|---|---|---|---|---|
| Direct Position Errors (DPE) (km) | 86 | 109 | 125 | 142 | 163 | 149 | 165 | 243 | 247 |
| Along Track Errors (AT) (km) | 53 | 66 | 96 | 106 | 133 | 81 | 116 | 146 | 87 |
| Cross track Errors (CT) (km) | 113 | 129 | 125 | 112 | 108 | 103 | 165 | 143 | 268 |
| Landfall Point Errors (km) | 0 | 110 | 110 | 110 | 112 | 180 | -- | 55 | 741 |
| Landfall Time Errors (hr) | 0 | -12 | -18 | -18 | -18 | -6 | -- | +18 | +12 |
| Average Absolute Intensity Errors (AAE) (kts) | 7.6 | 7.8 | 8.3 | 10.4 | 9.5 | 9.5 | 5.8 | 4.0 | 3.5 |
| Root Mean Square Intensity Errors (RMSE) (kts) | 10.1 | 9.6 | 10.8 | 12.5 | 12.9 | 10.9 | 6.5 | 5.4 | 3.8 |

(*Number of forecasts verified is given in the parentheses)

**Table 2**

**Average track forecast errors (Direct Position Error (DPE)) in km**
**(Number of forecasts verified is given in the parentheses)**

| | 12h | 24h | 36h | 48h | 60h | 72h | 84h | 96h |
|---|---|---|---|---|---|---|---|---|
| Mean MME for 2022 | 67(19) | 75(18) | 115(15) | 144(12) | 203(9) | 285(6) | 349(3) | 395(1) |
| MME(ASANI) | 61.5(8) | 98.5(7) | 167.9(6) | 259.7(5) | 357.3(4) | 443.1(3) | 452.5(2) | 395.4(1) |
| MME (SITRANG) | 66.7(5) | 57.0(5) | 104.6(4) | 99.7(3) | 143.4(2) | 233.6(1) | - | - |
| MME (MANDOUS) | 73.1(6) | 62.5(6) | 59.7(5) | 31.6(4) | 37.8(3) | 72.6(2) | 142.4(1) | - |




**Figs. 3(a-e).** SCS ASANI Zonal Cross-section of (a) Total wind & (b) Humidity and temperature, (c) Swaths of Rainfall & 10 m wind, (d) 10m wind and MSLP of 2 km core domain and (e) Streamlines and Isotachs of combine domain (18x6x2 km)

**Table 3**

**Average absolute errors (AAE) and Root Mean Square (RMSE) errors in knots of SCIP model (Number of forecasts verified is given in the parentheses)**

| Lead time → | 12H | 24H | 36H | 48H | 60H | 72H | 84H | 96H |
|---|---|---|---|---|---|---|---|---|
| IMD-SCIP (AAE) | 5.5 (19) | 4.6 (16) | 3.8 (13) | 3.7(10) | 3.3(7) | 6.3(4) | 10.0(2) | 12.0(1) |
| IMD-SCIP (RMSE) | 7.0 | 5.5 | 4.1 | 4.7 | 3.7 | 6.9 | 10.8 | 12.0 |

## Performance of MME and SCIP for forecasting tropical cyclones over the North Indian Ocean during the year 2022

### (a) Mean track forecast error (km) of MME - 2022

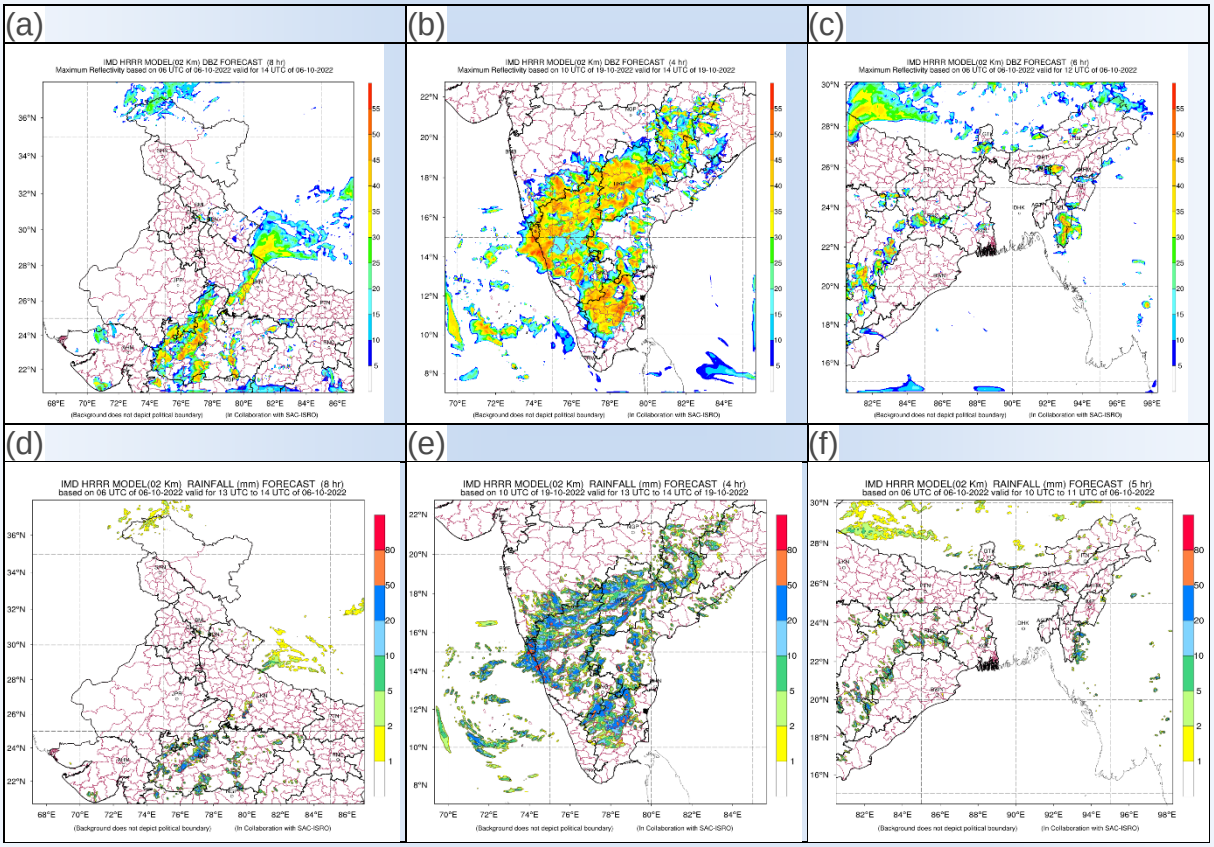
The annual average track forecast errors [Direct position error (DPE)] of multi-model ensemble (MME) during the year 2022 are shown in Table 2. The annual average is computed for the three cyclonic storms ASANI, SITRANG, and MANDOUS formed over the North Indian Ocean (NIO) in 2022. The track forecast errors were 75 km, 144 km, 285 km, and 395 km for MME for the forecast hours 24h, 48h, 72h and 96h respectively.

### (b) Mean Intensity forecast error (kt) of SCIP – 2022

The annual average intensity forecast errors of SCIP model are shown in Table 3. The absolute average error (AAE) was 4.6 kts at 24h, 3.7 kts at 48h, 6.3 kts at 72h, and 12.0 kts at 96 h for all the three cyclonic storms (ASANI, SITRANG, and MANDOUS) over the NIO during the year 2022. The Root Mean Square (RMSE) errors were 5.5 kts at 24h, 4.7 kts at 48h, 6.9 kts at 72h, and 12.0 kts at 96 h.

### High Resolution Rapid Refresh (HRRR) MODEL

The HRRR model is based on Weather Research and Forecasting (WRF) Model's ARW core and takes the initial and boundary condition from the IMD-GFS global model. Utilising the WRF Data Assimilation system (WRF-DA), the RADAR data is assimilated in HRRR model every 10-15 min over a 1-h period. The HRRR is hourly updated, cloud-resolving, convection-allowing atmospheric model, with horizontal resolution of 2 km and provides reflectivity and rainfall forecast for next 12 hours. The HRRR model is run in cyclic mode every hour for three domains covering entire mainland of India viz. North-West Domain, East & North-East Domain and South Peninsular India domain and forecast products are updated on the NWP website after every two hours. The forecast product from HRRR model is shown in Fig. 4.




**Figs. 4(a-f).** The left column figures (a,b,c) shows the Reflectivity forecast product for North West, South and East & North-East India from HRRR model. The right column figures (d,e,f) shoes the rainfall forecast product for North West, South and East & North-East India from HRRR model

### Extended Range Forecasts

A coupled model with a suite of models from CFSv2 coupled model has been developed, implemented, and operationalized in IMD in 2017 for generating operational Extended Range Forecast products for different users. This suite of models are (i) CFSv2 at T382 (≈ 38 km) (ii) CFSv2 at T126 (≈100 km) (iii) GFSbc (bias corrected SSTfrom CFSv2) at T382 and (iv) GFSbc at T126. The Multi-model ensemble (MME) of the above suite is run operationally for 32 days based on every Wednesday initial condition with 4 ensemble members to give forecast for 4 weeks for days 2-8 (week1; Friday to Thursday), days 09-15 (week2; Friday to Thursday), days 16-22 (week3; Friday to

Thursday) and days 23-29 (week4; Friday to Thursday). Due to technical problem with the existing HPCS Aditya, the operational ERF system was migrated to Pratyush HPCS system in June 2022. To see how this break and active phase is predicted in the ERF the weak phase of monsoon during the period from 29 July to 04 August and the active phase during the period from 05-25 August, 2022 is shown in Fig. 5. The weak phase of monsoon during the period 29 July to 04 August is very clearly seen in Fig. 6 based on the initial condition of 20th July, 2022. The forecast weekly rainfall anomalies are also shown in Fig. 7 based on the initial conditions of 27 July and 03 August. Thus, the model could capture these active phases of monsoon for the period from 05 -25 August. On smaller spatial scales (homogeneous regions and met subdivision levels) the forecast shows useful skill up to two weeks. On met subdivision level the category forecasts upto two weeks are being used for agro-advisory purpose.

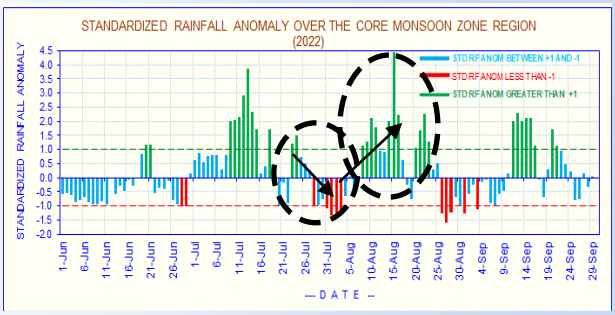



**Fig. 5.** Daily observed rainfall departure during the monsoon season 2022

Agromet applications forecast for 36 met subdivisions of India is prepared for two weeks with categorising the subdivisions as below normal, normal, or above normal category depending on the rainfall departure during the week. The two weeks forecast on met-subdivision level is widely used for application in Agriculture for farmers' advisory. The transition of monsoon from above normal to below normal is well captured in the extended range forecast, which is being used widely for Agromet advisory purpose.

### Districts level extended range forecast

Experimental ERF products are also being prepared for application in other sectors :-

- Agriculture and veterinary sector (The winter frost forecast and extreme low temperature will be used for crop advisory; high temperature for veterinary sector like poultry firm will be used).
- Water sector/Disaster management (The ERF forecast of active and break phases of monsoon, heavy rainfall, severe weather like cyclone etc will be generated for application in hydrological models and reservoirs operations).

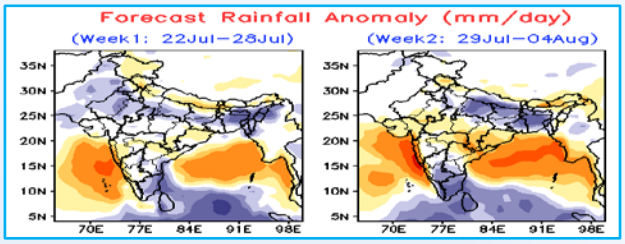
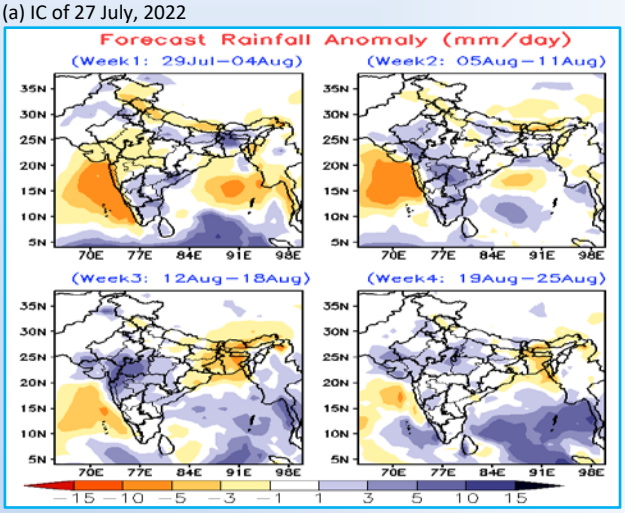



**Fig. 6.** ERF rainfall anomalies for 2 weeks based on initial condition of 20 July, 2022

(a) IC of 27 July, 2022




(b) IC of 03 August, 2022

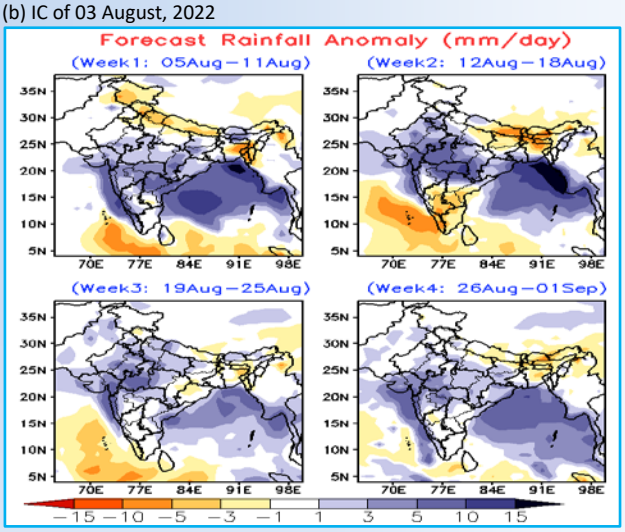



**Fig. 7 .** ERF rainfall anomalies for 4 weeks based on initial condition of 20 July, 2022

- Health sector (indices like heat index, transmission windows for vector borne diseases, cold wave etc will be generated for services in health sector).
- Energy sector (The extreme high and low temperature forecasts products are being generated for potential use in power/energy sector).

### Generation of Multimodel Ensemble (MME) forecast for Indian cities, districts and meteorological sub-divisions

IMD generates location based as well as area averaged forecast from five models and also its MME in real time for decision support. The NWP model forecasts available with IMD is of different spatial resolution (Table 4).

**Table 4**

**Operational Global models**

| | Operation Models | Agency | Resolution (km) |
|---|---|---|---|
| 1. | GFS | IMD | 12 |
| 2. | GEFS | IMD | 12 |
| 3. | GFS | NCEP | 25 |
| 4. | UM | NCMRWF | 12 |
| 5. | GSM | JMA | 25 |
| 6. | IFS | ECMWF | 20 |
| 7. | EPS | NCMRWF | 12 |

Seven days location based forecast of rainfall, maximum temperature, minimum temperature, wind speed, wind direction, relative humidity (at 0300 UTC and 1200 UTC), and cloud cover from each model is generated for Indian cities, followed by MME-mean forecasts have been generated. Currently forecast for 1708 cities are generating. Additionally, meteograms from above models are also generating for these stations.

Area-averaged forecast of rainfall, maximum temperature, minimum temperature, wind speed, wind direction, relative humidity (at 0300 UTC and 1200 UTC) and cloud cover from each model are also generated for Indian districts for next 5 days, followed by MME-mean forecasts. Currently, forecast over 734 districts is being generated in real time. Over these spatial domains, forecast of rainfall distribution also calculated by estimating the percentage of grids reporting a rainfall amount greater than 2.5 mm/day. Similarly, rainfall distribution and intensity forecasts are generating for 36 meteorological sub divisions as a decision support to the forecasters. In addition, a heavy rainfall warning system is developed for districts and meteorological sub-divisions based on MME forecast. These forecasts are disseminated to the operational forecasters at RMCs and MCs as a decision support while issuing forecast. These forecasts (as digital values) and figures are also available at NWP division website. The district rainfall forecast from different NWP model and MME are compared against IMD observation during the south-west monsoon 2022. A case study is presented in this report to evaluate the performance of MME forecast qualitatively over Indian districts. In order to assess the performance of MME forecast, a case study during 16th June, 2022 is shown in the Fig. 8. The extremely heavy rainfall observed over north-eastern region of India (Sub Himalayan West Bengal, Assam & Meghalaya) during 16$^{th}$ June, 2022 was well predicted in MME up to day 5.

Assessment of heavy rainfall warning system is presented (Fig. 9) in terms of probability of detection (POD) of heavy, very heavy and extremely heavy rainfall from seven models. From the Fig. 9, it is clear that MME have good skill in predicting extreme rainfall events than the individual models.

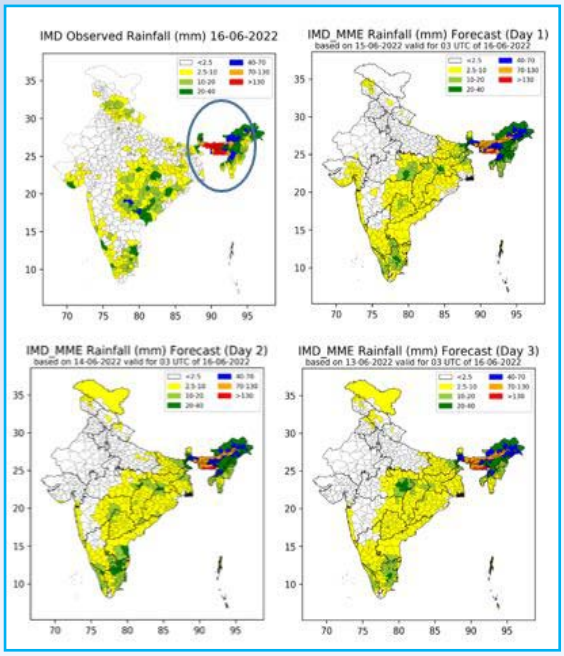



**Fig. 8.** IMD observed rainfall and MME day 1, day 2 and day 3 rainfall forecast for 16$^{th}$ June, 2022

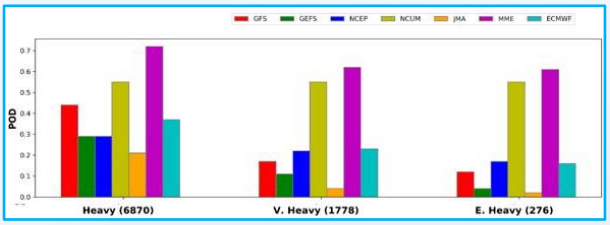



**Fig. 9.** Probability of detection of day 1 rainfall forecast against IMD observations for heavy, very heavy and extremely heavy rainfall categories. No of events in each category is given in the bracket

## Development of MME based operational forecast product for 153 River sub-basin

The summer monsoon rainfall is the major water source for most parts of India and people depend on this water source for their livelihood. The rainfall during this season is highly variable over space and time. The rainfall during the southwest monsoon period is the main source of flow discharge in most of the rivers in India.

The MME forecast product for the 153 river sub-basin is developed and operationalized for the five days forecast. Each day forecast is based on the simple MME of five global models as shown in the Table above. The area average values over each subbasin is computed form the five models and average over the models is represented as MME for that day. Fig. 10 show the two sample plots for day 1 and day 5 operation forecast. These forecasts (as digital values) and figures are also available at NWP division's website.

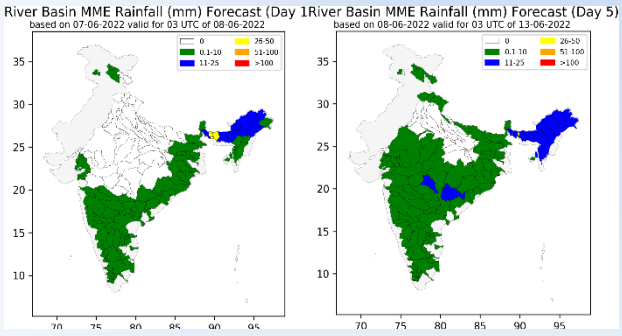



**Fig. 10.** 153 River sub-basin day-1 and day-5 forecast

## Development of MARINE Forecast basd on MME for GMDSS, SeaArea, Fleet and Coastal forecast

The development of the products for the Marine required computation surface wind, visibility, weather, state of sea information. We utilized data from five global operational model's forecasts (IMD-GFS, GEFS, NCUM, NCEP-GFS and NCUM) daily up to five days. Individual models and their MME based graphical products are generated two time a day based on 0000 UTC and 1200 UTC data and updated on the IMD website for the Marine forecast and bulletin preparations. It is pertinent to mention that the role and the area of operations of the India Navy have significantly increased over the past years in tune with the nation's core interests. Therefore, the additional areas covering Longitude 30°E-120°E Latitude 35°S-40°N are considered vital for naval operations and information regarding weather in these areas is critical for planning and safe conduct of operations. In view of the above, an additional area as mentioned in the Fig. 11 is included in the Fleet forecast. Also ships and buoys data are provided for Day1 forecast Fig. 11 shows the Extended Fleet Forecast domain including buoys and ships observation for day 1 forecast.

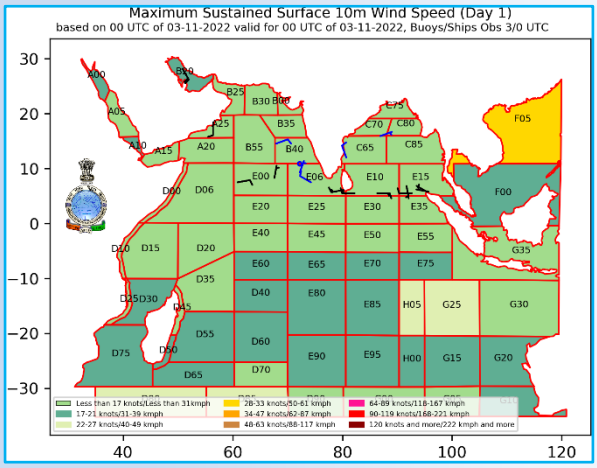



**Fig. 11.** Extended Fleet Forecast domain including buoys and ships observation for day 1 forecast

## E-WRF Operationalization

Recently during March 2022, IMD NWP division has operationally implemented the model EWRF. Presently three different products (Lightning Flash Density, Max Reflectivity and Hourly rainfall) from the Electric-WRF model have been updated in the IMD NWP internal website on the experimental basis for the kind feedback of forecasters. In the E-WRF modelling system, ground-based lightning flash rate has been assimilated for the improvement of the model forecast.

The details of these products available in the NWP website (https://nwp.imd.gov.in/) are depicted below. Presently due to the limitation of the computational resources, we are running the

model at three different times in a day to cover the entire 48 hours of the day. Each run utilizes the latest lightning data assimilation that helps to improve the forecast effectively.

**Early Run** is based on the 0000 UTC IMD-GFS initial conditions with the validity of the forecast being for 24 hours at hourly intervals (0100 UTC to 0000 UTC next day). The Early run products will be available on the website around 0500-0530UTC (10:30 to 11:00 IST).

**Update Run** is also based on the 0000 UTC IMD-GFS initial condition, with the validity of the forecast being for 18 hours at hourly intervals (0700 UTC to 0000 UTC of next day). The Update run's products will be available on the website around 0900 UTC (14:30 IST).

**Third run** is based on the IMD-GFS 1200 UTC initial condition with the validity of the forecast being for 36 hours at hourly intervals (1300 UTC to 2300 UTC of next day). The Third run products will be available on the website around 1730 UTC (11:00 to 1200 IST; midnight).

This Electric WRF model is based on the proper and explicit cloud electrification physics mechanism through which the model generates the electric field over the different grid points of the domain. This electrification mechanism has separate charging and discharging schemes based on different laboratory experiments. In the charging mechanism, Inductive and no-inductive processes have been introduced. Few plots of the products are given below for the understanding of the forecasters (Fig. 12).

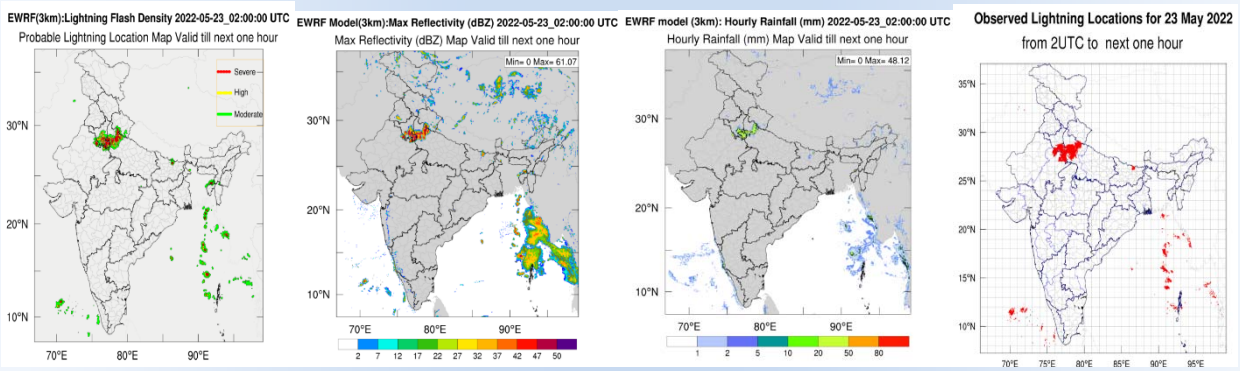



**Fig. 12.** EWRF simulated (left to right) Lightning Flash Origin Density, Max Reflectivity, Rainfall and observed Lightning for 23 May 2022

## Wind Speed Probabilities

The Wind speed is one of the major parameters to identify the intensity of the cyclonic circulation. The IMD-NWP division developed and implemented to monitor the surface (10-meter height) wind speed probabilities exceeding 4 different thresholds which can explain the intensity of the cyclonic circulations using IMDGEFS (21 members) and NEPS (23 members) ensemble models. The four operational wind speed thresholds are ≥ 28 knots (14.4 m/s), ≥ 34 knots (17.5 m/s), ≥ 50 knots (25.7 m/s), ≥ 64 knots (32.9 m/s) and its associated categories are such as Deep Depression, Cyclonic Storm, Severe Cyclonic Storm, and Very Severe Cyclonic Storm, respectively. This wind speed forecast probabilities monitor Fig. 13 are produced at every 6 hourly intervals up to 240 hours. The screenshot of operationalized wind speed probabilities plots using IMDGEFS during the Severe Cyclonic Storm (MANDOUS) during 6-9 Dec, 2022.

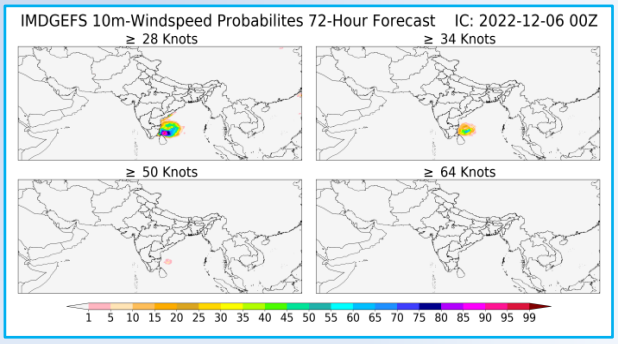



**Fig. 13.** 10-meter wind speed probability at threshold ≥ 28 Knots, ≥ 34 Knots, ≥ 50 Knots, and ≥ 64 Knots using IMDGEFS (20 ensemble members + 1 Control run) based on initial condition as on 2022-12-06-00Z valid for 72 hour forecast (during SCS:MANDOUS)

## Multi Model Ensemble Tropical Cyclone Tracker

ECMWF IFS TC Tracker: The European Centre for Medium-Range Weather Forecasts (ECMWF) developed the Integrated Forecasting System (IFS) model for the global numerical weather prediction

at medium range timescale and developed Tropical Cyclone tracker (IFS-TC-Tracker).

The ECMWF IFS-TC-Tracker source code has been modified by the NWP division of IMD, to feed in multi-model global forecasts outputs and made the individual model TC-tracker lines plot along with multi-model-mean, and the verifications of Tc-Tracker both the visual, and statistical outputs are discussed.

By using these 5 global model outputs including IMDGFS, the IFS-TC-Tracker outputs have been made over north Indian Ocean, operationally at NWP, IMD. All model outputs are being interpolated to T159 Gaussian Grid horizontal resolution before running the IFS-TC-Tracker. For the case study, the 3 cyclonic storms named as 'SCS: ASANI' (2022-05-07-00Z to 2022-05-11-00Z), 'CS: SITRANG' (2022-10-22-12Z to 2022-10-25-00Z) and 'SCS: 'MANDOUS' (2022-12-06-12Z to 2022-12-09-12Z) occurred over the Bay of Bengal (BoB) has been explored. The MME forecast tracks for SCS: MANDOUS along with the Direct Position Error is shown in Fig. 14 and Fig. 15 respectively.

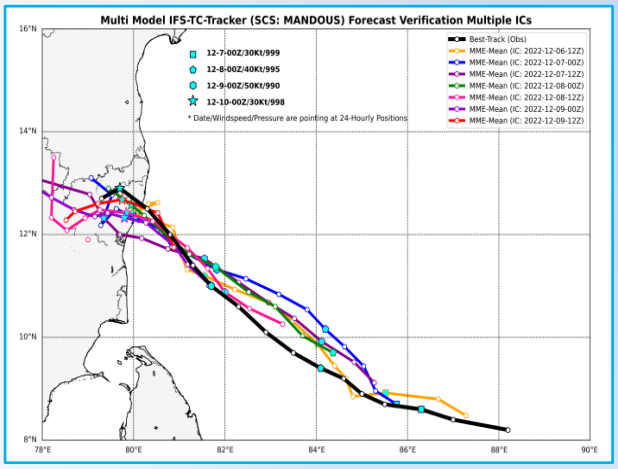



**Fig. 14.** Eyeball Verification of Real-time production of tropical cyclone tracker outputs ('MANDOUS' severe cyclone storm during 2022-12-06-12Z to 2022-12-09-12Z) using ECMWF's IFS-TC-Tracker. The best track (observed) is shown in thick black line. The different initial conditions Multi Model Mean is shown in different colors. The TC tracker outputs are displayed at 12-hourly intervals which are marked in black color dots over individual model-colored lines and white color hollow circles over the MMMean blue dots. The observed position, windspeed, MSLP values are marked with different symbols in the legend (top left of figure), also marked over different initial condition model forecast tracks to compare with best track (black line)

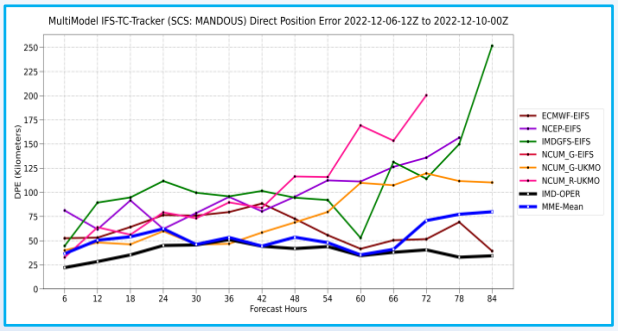



**Fig. 15.** Statistical Verification - Direct Position Error of MANDOUS - severe cyclone storm

The statistical verification – direct position error of cyclonic storm 'MANDOUS' is shown in Fig.15 (c) of the IFS-TC-Tracker outputs of the five models and MMMean, during different initial conditions from 2022-12-06-12Z to 2022-12-10-00Z. The 5 models track errors are within 125 km for lead time upto 54 hours. The Multi Model Mean Track error is consistently below 75 km, 84-hours forecast lead time.

## Madden-Julian Oscillation (MJO) Monitoring and Real-time Verification

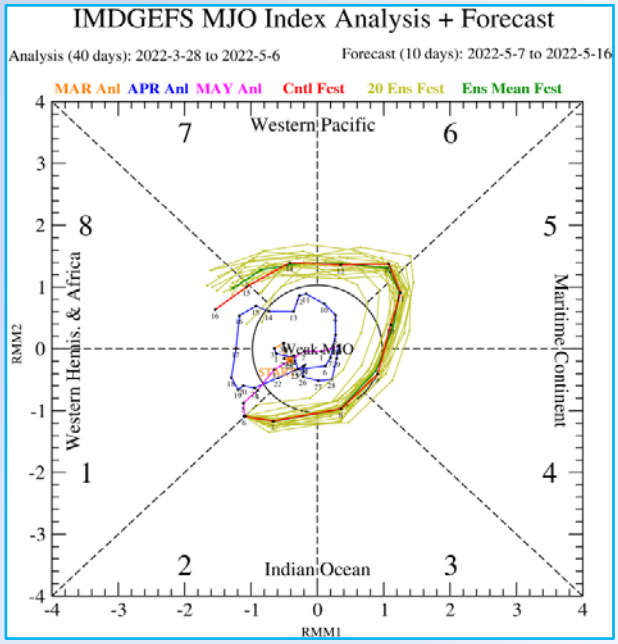



**Fig. 16.** MJO monitor for the last 40 days (2022-03-28 to 2022-05-06) and next 10 days forecasts based on initial condition as on 2022-05-06 (during ASANI severe cyclonic storm)

The Madden-Julian Oscillation (MJO) is the largest element of the intraseasonal (30 to 90 day) variability in the tropical atmosphere. Fig. 16 shows the last 40 days observed + analysis MJO Index monitoring along with next 10 days forecasts

based on initial condition as on 2022-05-06-00Z. The MJO forecast ensemble (IMDGEFS) indices are at phase 3, 4, 5 and 6, and its consequences as expected for the much activity over Bay of Bengal, and it happened as a Severe Cyclonic Storm (ASANI) during during 2022-05-07-0000 UTC to 2022-05-11-1200 UTC. Also, the NWP developed a real-time verification of MJO Index with observed (OLR) + IMD GFS analysis (u-winds) by 11 days lag time.

## Dynamic Meteogram

The NWP division developed jointly with ISSD division, and released the Dynamic Meteogram (Pre-Release) Beta Version 1.0 was on 12-12-2022 to the IMD forecasters on testing mode. http://103.215.208.134/webgis_MME/index.html Screenshot of Dynamic Meteogram Webpage is shown in Fig. 17.

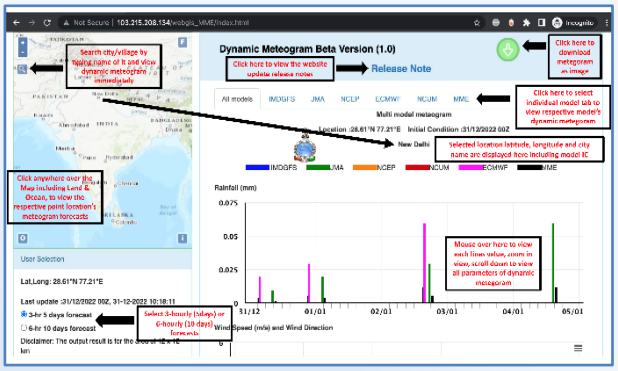



**Fig. 17.** Screenshot of Dynamic Meteogram Webpage, where user can click anywhere on the Map (left side) including Ocean, and the corresponding Meteograms are dynamically generated and displayed as interactive meteograms (on right side) for 5 global models and MME and all models together

All the products available from NWP Division can be accessed in the webpage. https://nwp.imd.gov.in

# CHAPTER 4

# OBSERVATIONAL NETWORK

One of the mandates of IMD is to take meteorological observations for use by different users. Strengthening of atmospheric observational network and its regular maintenance is absolutely required to sustain and improve skill of weather forecasts. IMD has been augmenting its observing system networks over the past years.

## 4.1. Upper Air Observational Network

### Radiosounding Radiowind (RS/RW) network

India Meteorological Department (IMD) has 43 operational Radiosonde radiowind stations in their upper air network, as a part of global observing system (GOS) network of WMO,. These stations take observations for measuring the vertical profile of the Atmosphere, *viz*., Temperature, Pressure, humidity, Wind Speed and Direction, the upper air observations are taken by using balloon borne soundings. These stations are engaged in taking the radiosounding observations twice a day at 0000 UTC and 1200 UTC hours.

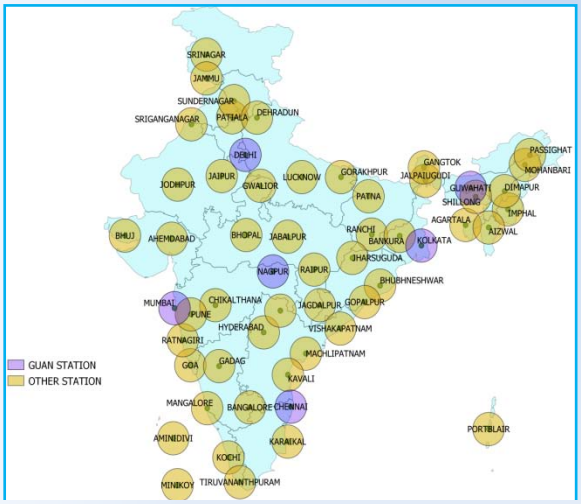



**Fig. 1. Existing RS/RW Network of India Meteorological Department**

As a subset of Global Observing System (GOS) network, World Meteorological Organization (WMO) in collaboration with the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU) established Global Climate Observing system (GCOS) network in 1992, as an outcome of 2nd World Climate Conference. In the upper air domain of GCOS, aiming on further improvement of upper air data quality, IMD established GUAN standard radiosounding observations at its 6 Regional Meteorological Centres (New Delhi, Mumbai, Kolkata, Chennai, Guwahati and Nagpur). The performance of these stations was presented at WMO Technical Conference on Instruments and Methods of Observations (TECO-2016) and a formal claim was made to Secretary General WMO for inclusion of these stations into the GCOS Upper Air Network (GUAN) (Fig.1).

**Based on the sustained performance, these stations have been included in the WMO- GUAN standard network by GCOS Secretariat, and their performance indicators figures in the summary of NOAA's monthly report with effect from June 2017 on regular basis.**

### Pilot Balloon (PB) Network

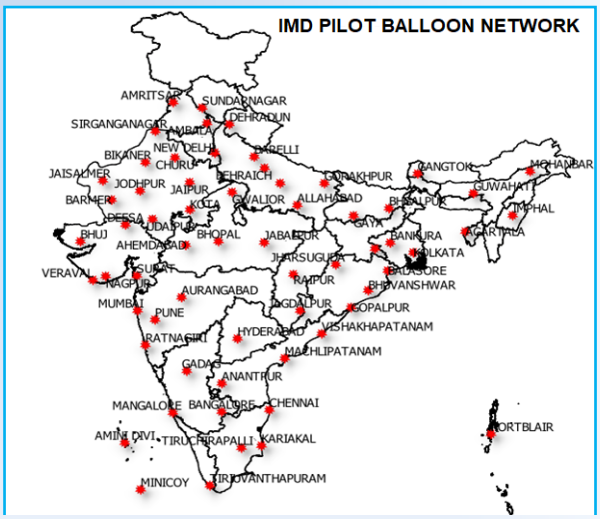



**Fig. 2. Upper Air Pilot Balloon (PB) Network of IMD**

IMD is operating 62 PB observatories taking 2 to 4 observations for upper air wind profiles at 00, 06, 12 and 18 UTC hrs of observations. PB stations are using optical theodolites for balloon tracking

manually. Efforts have been made to switch over to GPS based fully automatic PB systems from conventional optical theodolite based observations. For this, GPS based pilot-sonde has been developed and being manufactured in-house in IMD Workshop. The same has been implemented in the PB network at PB stations of New Delhi, Mumbai and Lucknow (Fig. 2).

**Major Installations during the year:**

1. Installation of indigenous RS/RW System on 10 IMD stations has been completed.

2. 05 Pilot Balloon stations out of 63 PB stations have been upgraded to automatic GPS PB stations and these PB systems are indigenous and manufactured/assembled in IMD Delhi.

3. Installation of indigenous GPS PB system on 18 PB stations out of 20 PB stations has been completed.

### 4.2. Surface Observational Networks

Automated weather stations measure all the important surface weather observations. These weather stations provide accurate and frequent readings, have low power requirements, and can operate practically anywhere. The weather monitoring system able to provide localized information on the weather conditions. These are very useful during severe weather conditions and current weather data made available to all in real time even at 1 minute interval also.

**AAWS/ARG/AWS** can be controlled by electronic devices or computers for automatic weather observation and data collection and transmission. With the utilisation of mobile telemetry, Data acquisition system can be controlled remotely through SMS or FTP Server. AWS/ARG can be installed at remote location and data can be transmitted through satellite communication in real time.

**AGRO Automatic Weather Station (AAWS)**

India Meteorological Department (IMD) has undertaken installation of Agro-AWS at District Agromet Units (DAMUs) located in the Krishi Vigyan Kendras (KVKs) under Indian Council of Agricultural Research (ICAR) network.

200 Agro-AWS installed at DAMUs (Krishi Vigyan Kendras) all over India during 2021-2022.

An agriculture automatic weather station is a meteorological monitoring instrument composed of Data acquisition system with various sensors, which is used in the field of agriculture. It consists of 10 m Tiltable mast and consists of sensors – Temperature and humidly sensors, rainfall sensors Ultrasonic wind sensors at two height 3 m and 10 m height, soil sensors at four depths- 10 cm, 30 cm, 70 cm and 100 cm, sunshine duration sensors. The wind sensors are kept at two heights – one wind sensor for Agriculture purpose and another sensors at forecast purpose. The data transmission through Mobile telemetry (GPRS communication) at an interval of 15 minutes to IMD server by FTP and also by through Email. The power supply to Agro AWS are 12V, 65 AH SMF Battery and charged by 40 W solar panel.

**AGRO AWS SITE**

**Automatic Weather Station (AWS)**

IMD is augmentation is surface observation network with AWS and established network of 806 AWS all over India.

Under 400 AWS Project, 99 AWS have been installed (71 AWS are installed in Kerala state, 21 AWS installed in NE states and 7 AWS installed in Andhra Pradesh) in 2022. It consists of 10 meters Tiltable mast and Data acquisition system with four sensors - Temperature and humidly sensors, rainfall sensors Ultrasonic wind sensors at

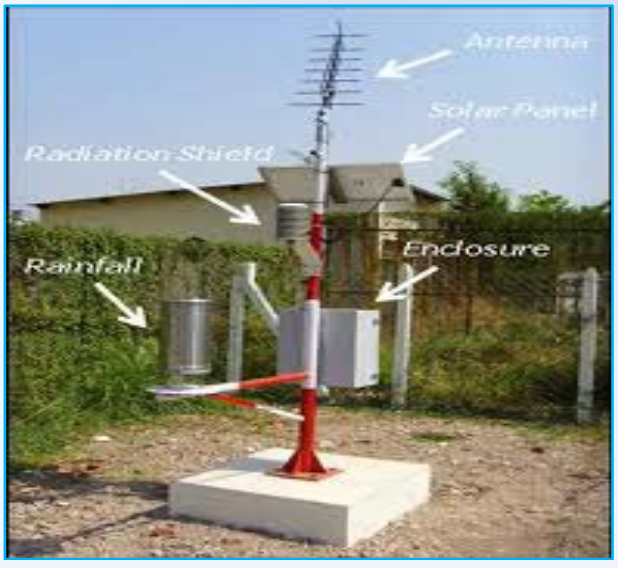
10 m height, pressure sensors. The data transmission through Mobile telemetry (GPRS communication) at an interval of 15 minutes to IMD server by FTP in real time. The power supply to AWS are 12 V, 65 AH SMF Battery and charged by 40 W Solar Panel.


**AWS SITE**

**Automatic Raingauge Station (ARG)**

IMD is augmentation is rainfall observation network with ARGs in Urban areas and established a network of 1382 ARGs all over India.

IMD has augmented 52 ARG network in Mumbai, Kolkata, Chennai, Pune, Guwahati, Agartala and Shillong in 2021-2022 and planning to install more ARGs in other cities also.




**ARG SITE**

It consists of 3 meters fixed mast and Data acquisition system with two sensor – Temperature and humidly sensors and rainfall sensors. The data transmission through Mobile telemetry (GPRS communication) at an interval of 15 minutes to IMD server by FTP in real time and also through satellite communication. The power supply to ARG are 12 V, 42 AH SMF Battery and charged by 40 W Solar Panel.

Conventional agromet observatory has been installed at Agromet Field Unit (AMFU) Port Blair, Andaman & Nicobar Islands to enhance weather observations and use in preparation of Agromet Advisories under GKMS scheme.

Agro-AWS have been installed at 10 more stations till December 2022 in the premises of Krishi Vigyan Kendras (KVKs) under the network of the Indian Council of Agricultural Research (ICAR) to complete installation of a total of 200 Agro-AWSs in the first phase. In addition to conventional weather sensors, these Agro-AWSs are equipped with additional sensors for monitoring soil moisture and soil temperature.

**Solar Radiation Instruments**

India Meteorological Department owns and operates a network of 47 Solar Radiation Stations (SRS) all over India.

IMD started new Solar Radiation Station at MO Agartala.

**Pyrgeometer (Precision Infrared) (Measure Terrestrial Radiation)**

Thermoelectric Pyranometer (Measure Global Solar Radiation)

Thermoelectric Pyranometer with shading ring (Measure Diffuse Solar Radiation)

Sunshine Recorder

Pyradiometer

UV-Radiometers ((UV-A & UV-B Radiation)

HF Cavity radiometer and PMO6 facility (a reference instrument) to measure Direct solar irradiance.
A Calibration Facility for Solar Radiation Instruments at Central Radiation Lab Pune.
IMD have done calibration 125 solar radiation sensors during 2022

## New installations in the year 2022

DCWIS was installed at Shirdi, Jaipur, Shamshabad (RWY 27L), Bajpe (RWY 24), Jamshedpur, Udaipur, Pantnagar, Mopa (Goa), Kadappa, Jalgoan, Kolhapur, Khushinagar, Madurai, Rourkela.

DIWE was installed at INS Garuda (Kochi), Rourkela, INS Shikra (Mumbai), Tirupati.

Present Weather Detector (PWD) integrated with DCWIS was installed at Chennai – 02 nos., Shamshabad (RWY 27 M), Jaipur, Amritsar, Palam, Indore, Chennai, Kochi, Ranchi, Kolkata (RWY 06), Amritsar, Ahmedabad, BIAL Bangalore (PWD – 04 nos., DCWIS – 02 nos.)

PWD at Lucknow

PWD at Bial, Bangalore

High Wind Speed Recorder and Surface Ozone Instrument were installed at Srinagar.

High Wind Speed Recorder and Surface Ozone Instrument at Srinagar

AWS installation during Shree Amarnath Yatra route

## 4.3. Atmospheric Sciences

### Environment Monitoring and Research Center (EMRC)

### Environmental Meteorology Services

IMD conducts monitoring and research related to atmospheric constituents that are capable of forcing change in the climate of the Earth, and may cause depletion of the global ozone layer, and play key roles in air quality from local to global scales. IMD also provides specific services to Ministry of Environment and Forest & Climate Change and other Government Agencies in the assessment of air pollution impacts. IMD contributes in the field of atmospheric environment to the World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) programme. The main objective of GAW is to provide data and other information on the chemical composition & related physical characteristics of the atmosphere and their trends, required to improve understanding of the behaviour of the atmosphere and its interactions with the oceans and the biosphere.

**Ozone Monitoring Network**: National Ozone Centre of EMRC, IMD is designated as secondary regional ozone centre for Regional Association II (Asia) of World Meteorological Organization. The centre maintains a network of ozone monitoring stations including Maitri and Bharati in Antarctica:

- Total Columnar ozone measurement using Dobson spectrophotometer.
- Surface Ozone monitoring network.
- Measurement of Vertical Distribution of Ozone.
- Dobson Spectrophotometer D36 was calibrated and refurbished at Regional Dobson Calibration Center (RDCC) at the Meteorological Observatory Hohenpeissenberg, Germany in 2020. Another Dobson Spectrophotometer D112 was calibrated during WMO International Comparison of Dobson Spectrophotometers (DIC) held at Irene Technical Centre, Pretoria, Gauteng Province, South Africa, 7-18 October, 2019. Two Brewer Spectrophotometers have

been calibrated and refurbished at Canada with the help of WMO.

**Precipitation and Particulate Matter Chemistry Monitoring**: IMD is monitoring Precipitation Chemistry through a network of eleven stations since 1970s. The rainwater and particulate matter samples collected from these stations are analyzed in Air Pollution Chemistry Laboratory at IMD, Pune which is equipped with Ion-chromatograph, UV-VIS Spectrophotometer, Semi-micro Balance, pH & Conductivity Meter, Ultra- pure Deionized Water Purification System. A new Atomic Absorption Spectrophotometer has been installed in the laboratory. The IMD laboratory participated in Laboratory Inter comparison Study 64 and 65 held in the year 2021 and 2022 organized by Quality Assurance/Science Activity Centre – Americas, one of five QA/SACs operating to ensure data quality and support science activities in the WMO GAW.

**Aerosol Monitoring Network**: IMD has established Aerosol Monitoring Network covering different geographic regions of India. The Aerosol Monitoring Network consists of following sub-networks:

(i) **Sun-Sky radiometer Network**: Environment Monitoring and Research Center, India Meteorological Department has established Aerosol Monitoring Network by installing skyradiometer at twenty locations. The network is used to measure optical properties of aerosols such as Aerosol Optical Depth, Single Scattering Albedo, Size Distribution, Phase Function etc.

(ii) **Black Carbon Aerosol Monitoring Network**: Black Carbon Monitoring Network of 25 stations for measurement of Spectral Aerosol Absorption Coefficient, Equivalent Black Carbon Concentration and bio-mass burning component is operational.

(iii) **Multi-wavelength Integrating Nephelometer Network**: IMD has established a network for measurement of aerosol scattering coefficient at twelve locations is operational at New Delhi, Ranichauri, Varanasi, Nagpur, Pune, Port Blair, Visakhapatnam, Guwahati, Kolkata, Jodhpur, Bhuj, Thiruvananthpuram.

(iv) **Chemical Characterization of Aerosols**: High Volume Samplers for collecting PM10, PM2.5 and Total Suspended Particulate Matter have been installed at Delhi, Ranichauri, Pune and Varanasi. The filter papers are being analyzed for chemical characterization of aerosols at Air Pollution Section, O/o CRS, IMD, Pune.

**Air Quality Forecasting and Research**:

The latest version of Air Quality forecast model "System for Integrated modelling of Atmospheric composition (SILAM v5.8)" has been operationalized for Indian region. Hourly air quality forecast for 96 hours of all criteria pollutants ($PM_{10}$, $PM_{2.5}$, $O_3$, CO, $NO_2$, $SO_2$ and other species) is being generated for the domain 60-100oE, 0-40oN. SILAM is coupled with hourly 3-km IMD-WRF meteorological forecasts model. The latest emission inventories CAMS-GLOB v5.3, 0.1-deg supplemented with EDGAR v4.3.2 for coarse and mineral-fine anthropogenic particulate matter, GEIA v1 lightning climatology and MEGAN-MACC biogenic climatology for isoprene and mono-terpene are used in SILAM model. The model is validated with air quality observations available from CPCB. A very high resolution city scale air quality model "**ENvironmental information FUsion SERvice (ENFUSER)**" has been also operationalized for Delhi. Hourly air quality forecast for 72 hours of all criteria pollutants (PM10, PM2.5, O3, CO, NO2, SO2) is generated for the domain (28.362 °N-28.86 °N, 76.901 °E-77.56 °E) at 30m spatial resolution. The model uses and assimilates a large amount of Geographic Information System (GIS) data to describe the modelling area on a high resolution. This includes a detailed description of the road network, buildings, land-use information, high-resolution satellite images, ground elevation, population data, traffic density etc. SILAM and ENFUSER are developed under a collaborative project with Finnish Meteorological Institute. IMD issues AQ Early Warning bulletins based on SILAM and WRF-Chem (IITM) models.

**Performance Verification of Air Quality Model**:

Fig. 1 shows the performance diagram summarizing the Success Ratio, POD, bias, and CSI skill scores for (a) Unhealthy category and (b) Very Unhealthy category of study periods. The labelled dashed lines represent bias scores, while labelled solid contours represent the CSI values. Appropriate symbols for different cities and days of forecast are present in the figure legends.

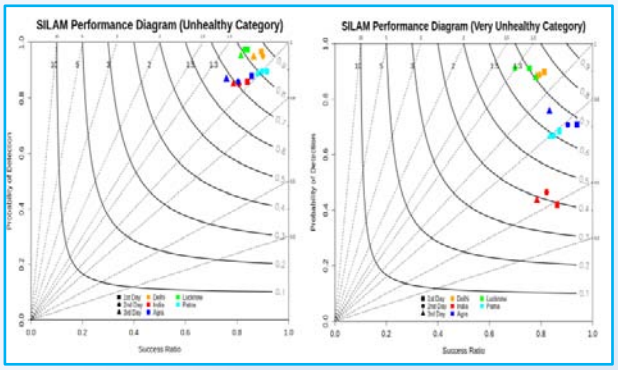



**Fig. 1. Performance diagram summarizing the Success Ratio, POD, bias, and CSI skill scores for (a) Unhealthy category and (b) Very Unhealthy category of study periods. The labelled dashed lines represent bias scores, while labelled solid contours represent the CSI values. Appropriate symbols for different cities and days of forecast are present in the figure legends**

**Urban Meteorological Services**

An exponential growth of urban populations has become a driving force for human development, particularly in developing countries. Although, crowded cities are centres of creativity and economic progress, but face serious challenges on account of polluted air, extreme weather conditions, flooding and other hazards. Increasingly dense, complex and interdependent urban fabrics are rendering cities vulnerable: a single extreme event can lead to a widespread breakdown of a city's infrastructure often through cascading downstream or "domino" effects. Urbanization and the developing cities is the face of the economic growth of India. Urban areas are seats of socioeconomic activities. How climate change will affect cities is currently poorly understood – but is of enormous economic and societal relevance because of the many infrastructural investments and population in the region. Cities, additionally, create their own microclimate due to urban heat islands, and modifying regional hydrology (through rainfall changes), and air quality (urban aerosols).

The World Meteorological Organization (WMO) recognizes that rapid urbanization necessitates on new types of services which make the best use of science and technology and considers the challenge of delivering these as one of the main priorities for the meteorological community. Urban Services, in the traditional sense are related to transportation, housing, water management, waste management, snow clearance, etc. In rapidly changing urban complexion, there is need of Urban Integrated Services containing weather, climate, hydrology and air quality infrastructure (data, observations, predictions) to support traditional (and new) urban services Over the years, specialized services have also been built for state-of-the-art Monitoring, Detection and Early Warning of extreme weather phenomena covering tropical cyclones, thunderstorms, cyclones, coastal inundation, flooding, air quality, health-related stress, dust storms, heavy rains and snowfall events, cold and heat waves, etc. as well as to climate services for building codes, zoning, planning and design.

In pursuit of providing an integrated Early Warning System, India Meteorological Department (IMD) has developed Urban Meteorological Services for 50+ cities in India (https://internal.imd.gov.in/pages/city_weather_main_mausam.php). Urban Integrated Services systems need to consider fine-scale urban data observations for assimilation and model initialization, urban canopy models, urban vegetation, land use and land cover (to assess both exposure and vulnerability but also soil permeability, which might affect the hazard in terms of lag time) ensemble prediction, quantification of uncertainties and processes requiring multi-disciplinary approach. With increasing demand, IMD has already taken Urban Meteorological Services as one of its priority projects to provide location-specific severe weather warnings for capital with the advent of dense observational networks, high-resolution forecasts, multi-hazard early warning systems and climate services promoting the Sustainable Development Goals. However, there are other urban centres like smart cities and other megacities. In view of the expansion of Indian cities, there is an imperative need for strengthening of infrastructure for urban centres and provide integrated environmental /weather services. The integrated urban meteorological services provide seamless observation/forecast for various hydro-meteorological hazards across the scale that includes the prediction of:

- Heat waves and cold wave
- Fog
- Cyclone
- Floods

- Drought
- Strong winds and Squalls
- Hailstorms
- Thunderstorms and lightning
- Impact-based warnings for localized convective activities

The Urban Meteorological Services webpage provides (Fig. 1):

1. Current Weather Observations
2. Current Air quality Observations
3. Weather Forecast
4. Air Quality Forecast
5. District-wise weather warnings
6. Nowcast

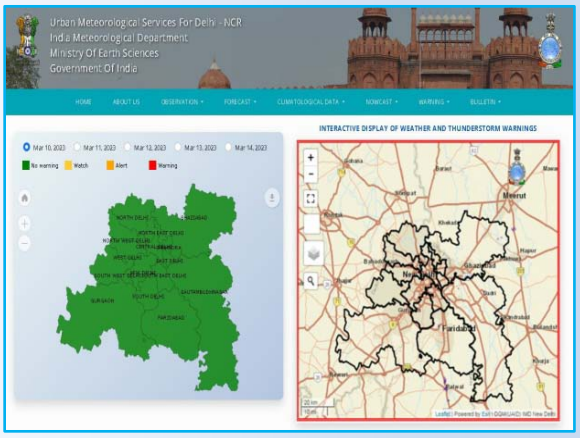



**Fig. 2. Template web page of Urban Meteorological services for Delhi-NCR**

**Weather Observations**

The Ambient Air Temperature, Relative Humidity, Precipitation, Wind Speed and Wind Direction are basic weather observations. Hourly weather parameters observed using Automatic Weather Stations (AWS) from different locations are presented and also displayed in graphical form. An AWS is a meteorological station at which observations are made and transmitted automatically. All the observations are reported in Indian Standard Time (IST) on 24 hour clock time.

**Air Quality Observations**

The air quality observations such as PM2.5, PM10, total Ozone and Dust products from various observational platforms from various sources such as IMD, CPCB, and SPCBs have been included under UMS. The hourly air quality parameters observed using automatic air quality monitoring stations from different locations are presented and also displayed in graphical form.

**Forecast Products**

Weather Forecast Charts: The high-resolution (3km) mesoscale Weather Research and Forecasting (WRF) modeling system with its own assimilation generates 72 hour (3-days) forecasts for wind speed and wind direction (at a height of 10m above sea level), Relative Humidity (at a height of 2m), Temperature (at a height of 2m) and Rainfall. More details of NWP products can be found at: https://mausam.imd.gov.in/imd_latest/contents/faq.php#.

**Weather Forecast Bulletin:** District wise weather forecast for Delhi-NCR for next five days.

**Warnings:** City/ward/zone-wise warnings for severe weather such as Thunderstorm, Heavy Rainfall etc for next 5-days is provided by IMD in colour coded form so that general public can easily understand. Green – No Warning; Yellow – Watch; Orange – Alert; Red – Warning.

**Nowcast:** District wise Nowcast warnings are provided graphically on map with different colours. A weather forecast in which the details about the current weather and forecasts up to a few hours ahead (but less than 24 hours) are given is called Nowcast. Green – No Warning; Yellow – Watch; Orange – Alert; Red – Warning

**Air Quality Forecast**

The air quality forecast for PM10, PM2.5, Ozone and Dust concentration. The forecast is generated based on the FMI-IMD SILAM v5.7 model. System for Integrated modeLling of Atmospheric composition (SILAM) is a global-to-meso-scale dispersion model developed for atmospheric composition, air quality, and emergency decision support applications, as well as for inverse dispersion problem solution. The model utilizes both Eulerian and Lagrangian transport dynamics, 8 chemico-physical transformation modules (basic acid chemistry and secondary aerosol formation, ozone formation in the troposphere and the stratosphere, aerosol dynamics in the air, pollen transformations) and 3D and 4D variational data assimilation.

**R&D efforts in Urban Meteorological Services**

The growth in cities and the concentration of resources being used in the urban region impact the environmental carrying capacity. This leads to unintended consequences such as increasing air pollution, increasing urban heat stress, health impacts, stressed mobility, and energy use. There are also long-term changes that affect the resiliency due to changes in the rainfall patterns and extremes. For example, in a recent study developed over Indian monsoon region, it was shown that the increase in the rainfall extremes that was observed in recent decades is only noted over those regions which have seen increased urbanization. A number of studies have shown this result through different analyses and datasets. There is an ongoing challenge to assess the range of such changes (e.g. heat waves, floods, water shortages, etc.), and develop a good understanding of the cause-effect (attribution/detection) studies. Nadimpalli et al., 2022 demonstrated the effect of urban specific morphological changes in simulating severe convection of Bhubaneswar city. Further studies have also confirmed the realistic representation of dynamic land use land cover changes in the very high resolution cloud permitting models in identifying the rainfall patterns.

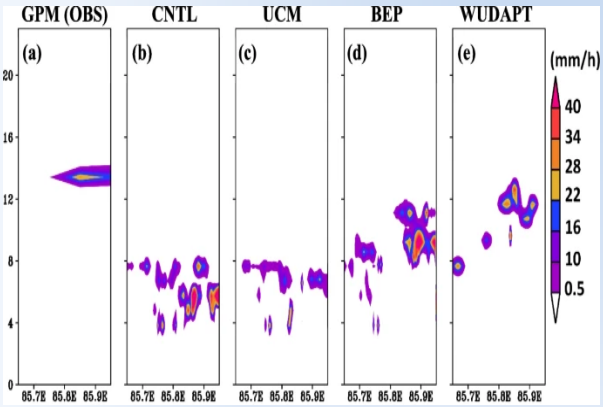



**Fig. 3.** Time-longitude cross section of rain rate (mm/hr) from (a) GPM, (b) CNTL, (c) UCM, (d) BEP and (e) WUDAPT for 30 May 2017 (*Source*: Nadimpalli et al. 2022)

Figs. 3(a-e) shows the temporal-longitudinal evolution of hourly rain rate (mm hr-1) averaged over Bhubaneswar city from Global Precipitation Measurement (GPM), CNTL, UCM, BEP, and WUDAPT, respectively. Reviewing the GPM fields, the rainfall started after 11 UTC around 85.75°–85.95°E and became maximum (28–34 mm hr-1) at 12 UTC. The CNTL simulated rain rate is more than 40 mm hr−1. It is early in the occurrence (Fig. 3b) compared to the observations [Fig. 3(a)]. The peak rainfall around 89°E is not simulated in the CNTL run. In the UCM experiment, the rainfall magnitude is 10-16 mm hr-1 only, with early occurrence [Fig. 3(c)]. The BEP and WUDAPT experiments could reduce the error in the time of occurrence [Fig. 3(d and e)]. Further, both the simulated rainfall's spatial pattern and timing are improved and are closer to observation in the WUDAPT run.

**High Altitude Background Climate Monitoring Station:** IMD maintains a Background Climate Monitoring Station Ranichauri, Uttarakhand. Skyradiometer, Aethalometer, Differential Mobility Particle Sizer, Nephelometer, Solar Radiation monitoring equipment, Precipitation Chemistry and Surface Ozone Analyzer have been installed at the station. The site Online GHGs monitoring System for measurement of CO2, N2O, CH4 and CO concentration has been installed at Ranichauri.

## POLAR METEOROLOGICAL RESEARCH DIVISION (PMRD)

**Polar Meteorological Research**

India Meteorological Department has been an integral part of all the Indian Scientific Expedition to Antarctica (ISEA) since the very first expedition during 1981. IMD started meteorological and ozone observations at Maitri station from January, 1990 (from 9$^{th}$ ISEA) and are ongoing till date. A meteorological observatory was commissioned in 2015 by IMD at Bharati, another Indian station in Antarctica. The observations vertical profile of ozone is also carried out at Bharati regularly.

Latest version of Polar WRF model has been operationalized to provide day-to-day 72 hours weather forecast at 3 km resolution for the Maitri and Bharati region in the Antarctica. The NWP products are routinely made available on the IMD web site to support of Antarctic Expedition. Two IMD officials each at Maitri and Bharati have proceeded as expedition member of 42 ISEA.

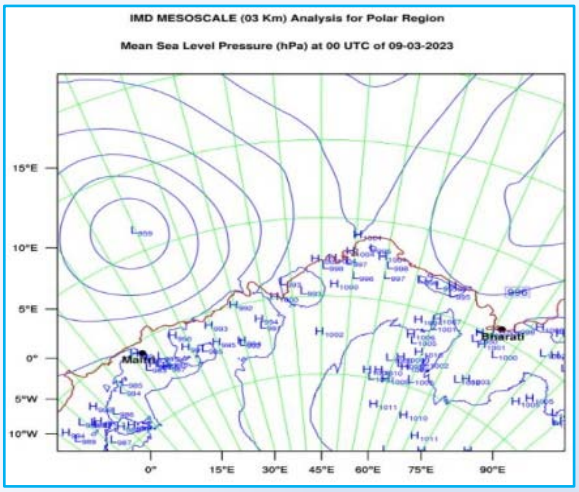
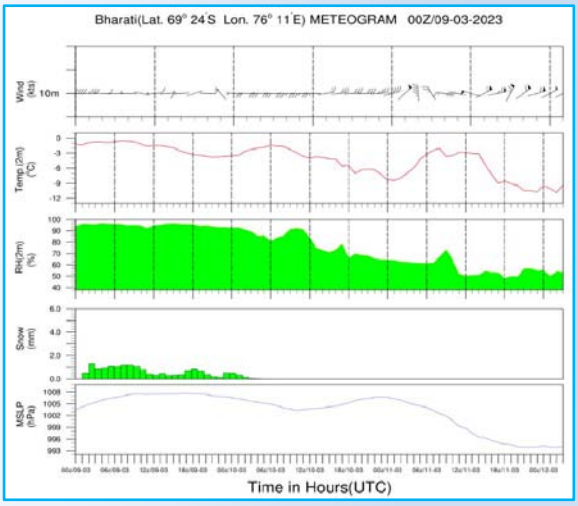



**Fig. 4. Spatial plot of mean sea level pressure (hPa) over polar region**



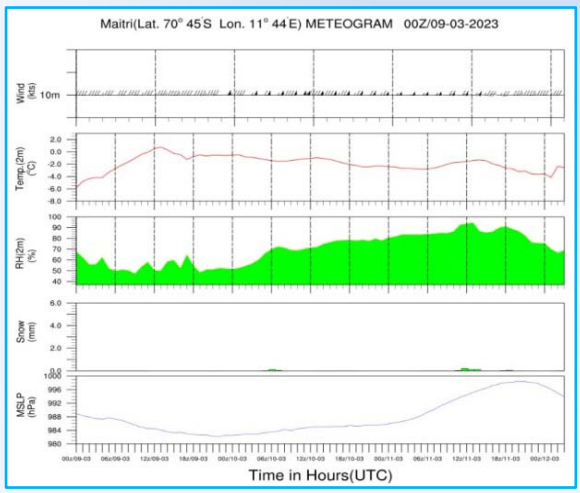
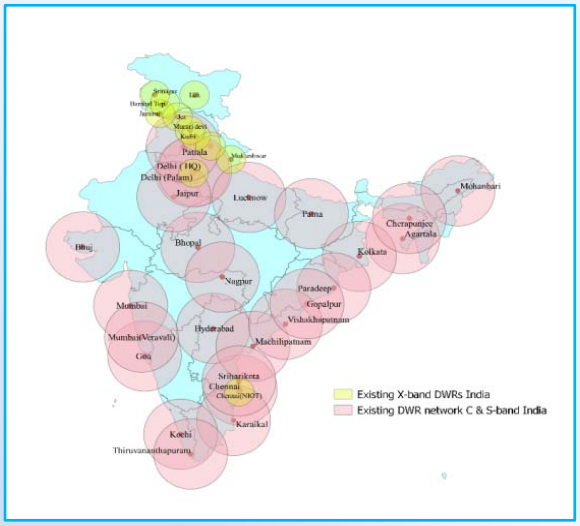




**Fig. 5. Meteogram of T2m (0c), RH at 2m (%), Wind (Kts), MSLP (hPa) and Snow (mm) over Bharati and Maitri stations**

## 4.4. Radar Observations

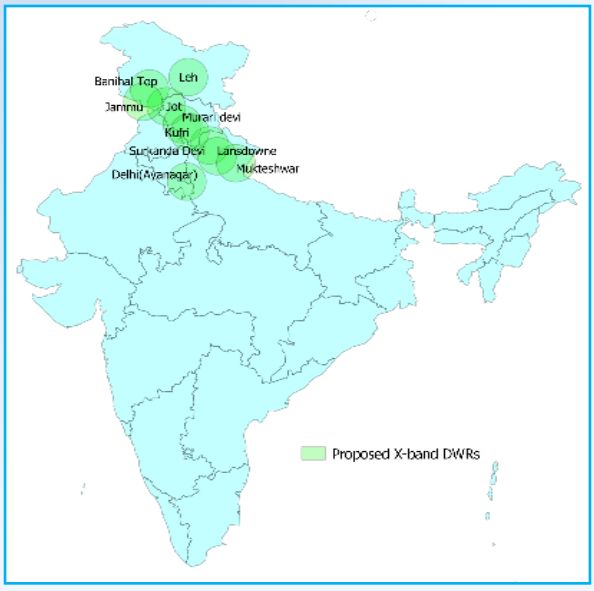
### (a) Network of Radars




**Existing DWRs Network**

IMD operates and maintains Doppler Weather Radar network consisting of a total of 37 S-Band, C-Band and X-band DWRs all over India. It includes 22 S-band, 02 Polarimetric C-band DWRs and 13 X-band DWRs. Two indigenously manufactured X-band polarimetric DWRs have been installed at Veravali (Mumbai) and Pallikarnai. During 2022, four poalrimetric DWRs namely DWR Jot, DWR Murari Devi, DWR Surkanda ji and DWR Banihal have been incorporated in IMD network.In addition to the 34 DWRs, IMD also utilizes the DWRs installed by ISRO at Thiruvananthpuram (C-Band), Cherapunji (S-Band) and Sriharikota (C-Band).

### (b) IHMP Dual Polarized X- Band DWRs

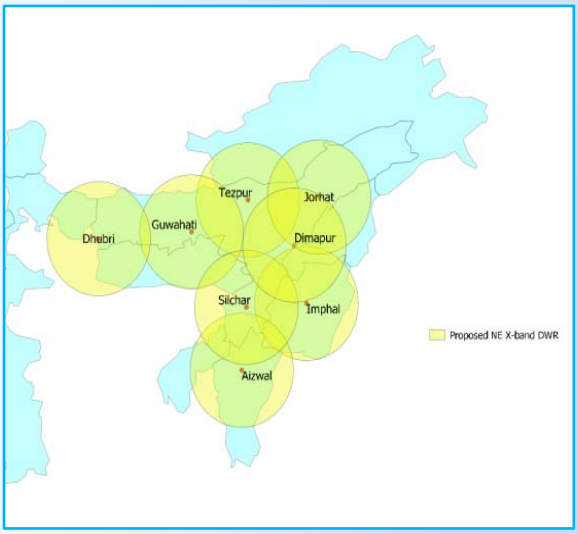



**IHMP X-Band DWR Network**

Dual Polarized 10 X-Band DWRs are being installed in India under IHMP (Integrated Himalayan Meteorological Programme). Out of the 10, 09 DWRs have already been installed at Leh, Kufri, Mukteshwar, Jammu, Ayanagar, Banihal Top, Surkanda Devi, Jot, Murari Devi. All these Radars are an example of achievement of self-reliance goal of "Make in India - Atma Nirbhar Bharat" vision of Hon'ble Prime Minister of India.

### (c) Proposed Dual Polarised X-Band DWRs for North East region

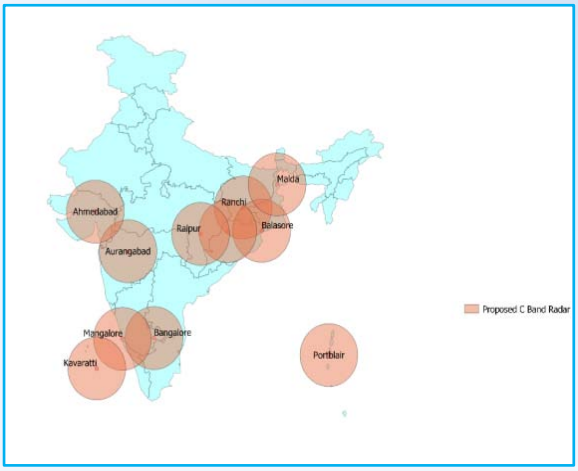
08 Dual Polarised X-Band DWRs are proposed to be installed in North East region of India.




**Proposed X- Band DWR Network in North East**

### (d) Proposed Dual Polarized 11 C-Band DWRs

11 Dual Polarized C-Band DWRs are proposed to be installed over the mainland of India

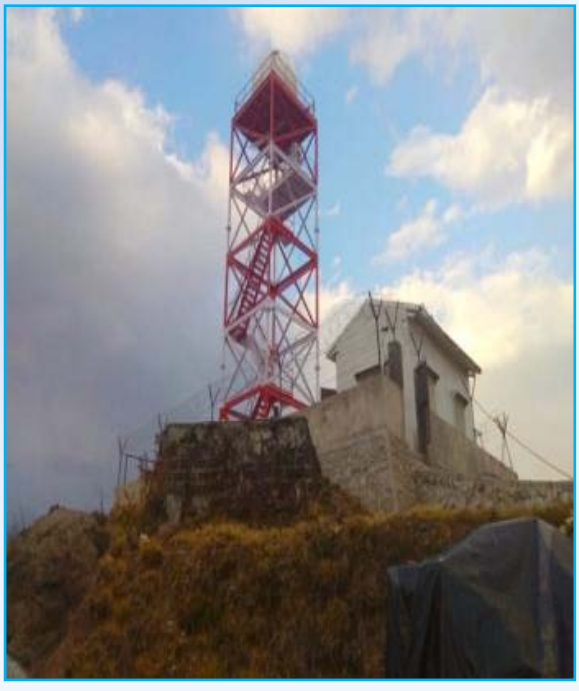



**Proposed C- Band DWR Network**

A transportable X-Band Doppler Weather Radar mounted on mobile platform installed at Leh under Integrated Himalayan Meteorology Programme (IHMP) for Western and Central Himalayas (Fig. 36). This DWR installed by IMD is at the highest altitude in India.

**Portable X-Band Doppler Weather Radar at Leh**

Tower based X-Band DWRs have been installed at Mukteshwar (Uttarakhand), Kufri, (Himachal Pradesh ), Jammu (J&K ), Ayanagar (New Delhi), Banihal Top (Jammu & Kashmir), Surkanda Devi (Uttarakhand), Jot (Himachal Pradesh) and Murari Devi (Himachal Pradesh) under IHMP. Two indigenous DWRs, *i.e.*, X-band DWR at Pallikarnai and C-band at Veravali, Mumbai have also been added in IMD network provided by ISRO.



**DWR at Mukteshwar in Uttarakhand**

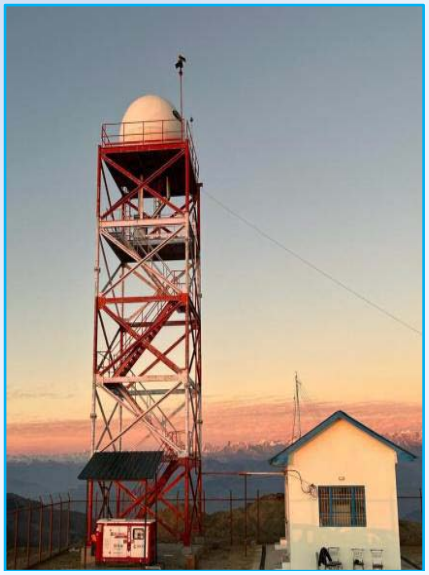
DWR at Kufri in Himachal Pradesh

DWR at Banihal Top in Jammu & Kashmir

DWR at Jammu in Jammu & Kashmir

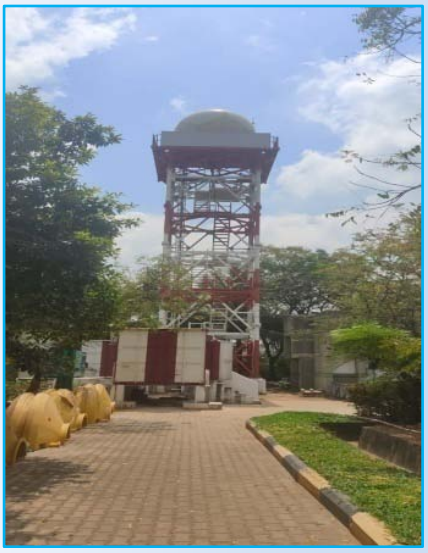
DWR at Surkanda Devi in Uttarakhand

DWR at Ayanagar in New Delhi

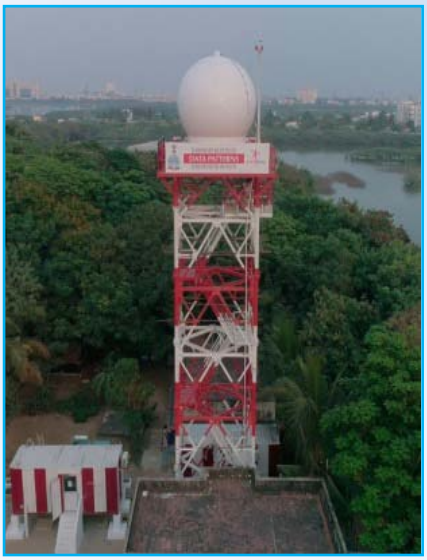


DWR at Jot in Himachal Pradesh

DWR at Murari Devi in Himachal Pradesh



DWR at Pallikarnai, Chennai in Tamil Nadu



DWR at Veravali in Mumbai, Maharashtra

### 4.5. Satellite Observations

IMD has established Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) for INSAT-3D, INSAT-3DR and INSAT-3DS satellites through an MoU with M/s Antrix Corporation Ltd., ISRO. Dedicated New Earth stations have been setup under MMDRPS Project, which have the capability to receive the data from INSAT-3D, INSAT-3DR and upcoming INSAT-3DS satellite. MMDRPS systems consist of advance & latest state of art servers capable to process the complete set of data within 7 minutes after completion of scanning along with the storage capacity of order 2.0/2.0PB (Main/ Mirror) & 324TB SSD which will facilitate online sharing of processed data for all Indian meteorological satellites to the registered users. All available past satellite datasets starting from 1983 will be kept in online mode in due course of time.

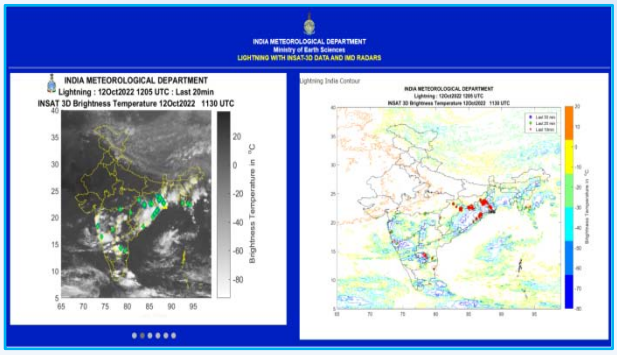
The Imager payload of INSAT-3D and INSAT-3DR is being used in staggered mode so that effectively 15 minutes temporal resolution is achieved. During extreme weather events, INSAT 3DR imager is used for RAPID scanning. Rapid scan has been conducted during major cyclonic events i.e., Tauktae, YAAS, GULAB, SHAHEEN, JAWAD and ASANI. The imageries of rapid scan conducted during cyclonic events are being disseminated through newly developed dedicated web page (http://satellite.imd.gov.in/rapid/rapid_scan.htm).

The products derived from the satellite data include: Cloud images in the Visible, Short wave Infra-red, Mid Infra-red, Thermal Infra-red, Water Vapour Channels and special enhanced images, Atmospheric Motion Vectors (IR Wind, Water Vapour Winds, MIR and Visible Winds), Sea Surface temperature, Outgoing Long-wave radiation, Land

Surface Temperature (LST), Insolation, Quantitative Precipitation Estimates, Night time Fog, Smoke, Fire, Snow Cover, Aerosol Optical Depth, Upper Tropospheric Humidity, Cloud top Temperature, Cloud top Pressure, Temperature & Humidity profiles, Total ozone, Total/Layer Precipitable Water Vapour, Stability Indices. In addition to these, IMD has also started generation of Wind derived products such as Vorticity (at 850mb,700mb,500mb, 200mb levels), Wind Shear, Mid-level Wind Shear, Shear Tendency, Low level Convergence and Upper Level Divergence using Imager Wind product and NCEP forecast file and T-phi gram at all district locations using Sounder data. All these images and products are disseminated in a real time basis through dedicated IMD website.

IMD has set up a countrywide network of 25 nos. Global Navigation Satellite System (GNSS) stations for "Earth and Atmospheric studies" have been Installed and commissioned to drive integrated precipitable water vapor (IPWV). The IPWV data is being used for now casting and assimilated in NWP models to improve the weather forecasting. A dedicated website has been developed to access IPWV data of 25 GNSS site in real time. Graphical user Interface was also provided to visualize 15 min, hourly, daily, weekly and monthly IPW data along with Meteorological data and minimum and maximum value of IPW etc. IPWV data is being shared with NCMRWF in near real time basis for assimilation in NWP model.

The satellite and lighting merged products are also operationalized at IMD website. The merged lightening & satellite cloud top temperature operational product is a joint collaboration of IMD, IITM & IAF. Work is going on to merged (all 3 types of instrument data) Satellite+RADAR and Lightning data for the weather forecast.




**The satellite and lighting merged products**

The processed Satellite data (Digital, image, products) are being used by the operational weather forecasters, IAF, Indian Navy, Indian Coast Guard), Disaster management authorities, international meteorological agencies in a near real time basis for issuing the weather forecasts on a routine basis.

a. The Imager payload of INSAT-3D and INSAT-3DR is being used in staggered mode so that effectively 15 minutes temporal resolution is achieved. During extreme weather events, INSAT 3DR imager is used in RAPID scanning during severe weather/cyclonic. Rapid scan was conducted during major cyclonic events notably during severe cyclonic storm, *i.e.*, Tauktae, YAAS, GULAB, SHAHEEN, JAWAD and ASANI.

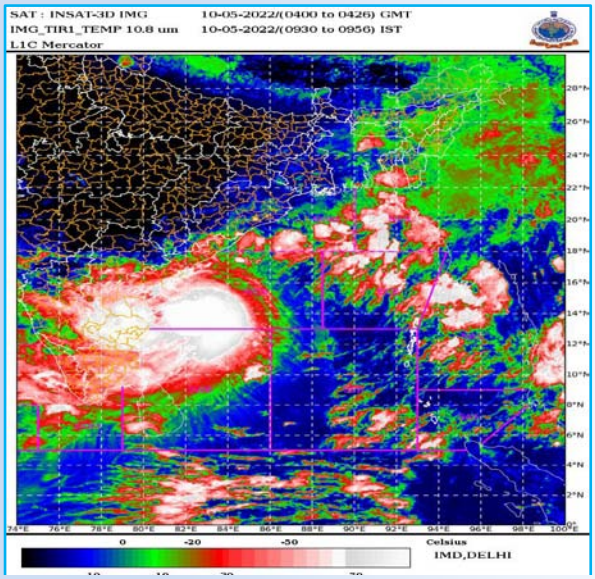



**Fig. 2. RAPID SCAN during cyclone events**

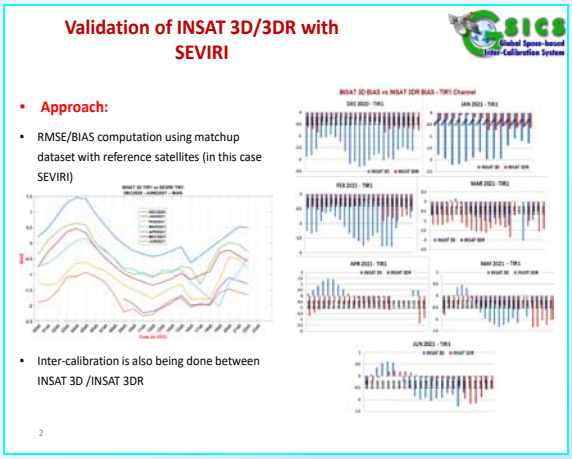
**Calibration and validation activities**

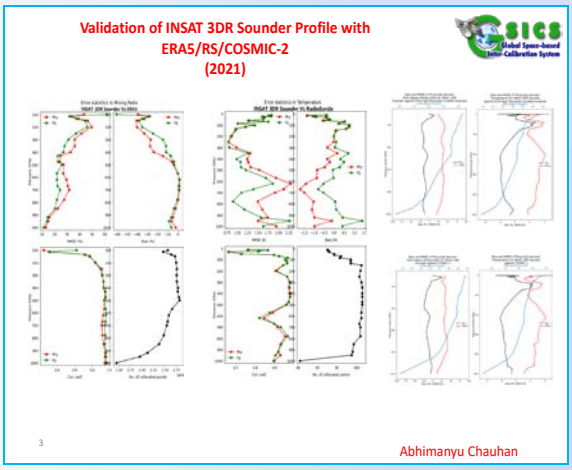
INSAT3D/3DR GSICS correction (TIR1/TIR2/MIR and WV) along with CAl VAL coefficients are being frequently implemented in MMDRPS. Validation of INSAT 3D/3DR IMAGER with SEVIRI and INSAT 3DR Sounder with RS, IRA5, Cosmic-2.

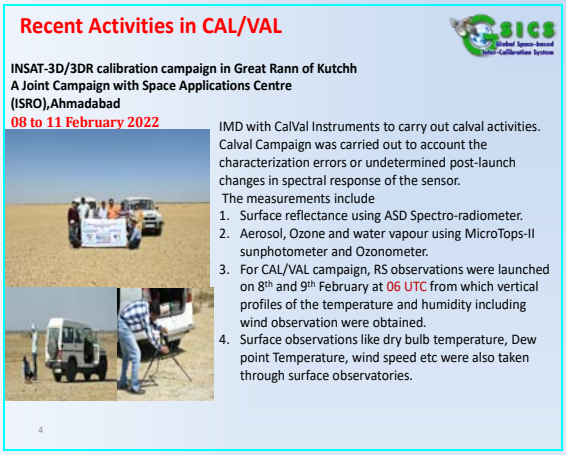
With vicarious calibration report of INSAT-3D and -3DR (CalVal Campaign held in Jan 2020), the coefficients have been successfully updated in MMDRPS operational systems.

INSAT-3D/3DR calibration campaign have been conducted in Great Rann of Kutchh. It was a Joint Campaign with Space Applications Centre (ISRO), Ahmadabad (8 to 11 February 2022).

Photographs and results in slides are given below:




## Tropical Cyclone Monitoring and Prediction 2022

Severe Cyclonic Storm ASANI over the Bay of Bengal (7th - 12th May, 2022): A Report

### Life History of ASANI

• A low pressure area formed over South Andaman Sea and adjoining Southeast Bay of Bengal in the morning (0830 hrs IST) of 6th May, 2022. It lay as a well marked low pressure area over Southeast Bay of Bengal and adjoining south Andaman Sea in the early morning (0530 hours IST) of 7th May.

• Under favourable environmental conditions, it concentrated into a depression over the same region around noon (1130 hrs IST) of same day, the 7th May, 2022.

• It moved northwestwards and intensified into a deep depression over southeast Bay of Bengal in the same evening (1730 hrs IST) of 7th May.

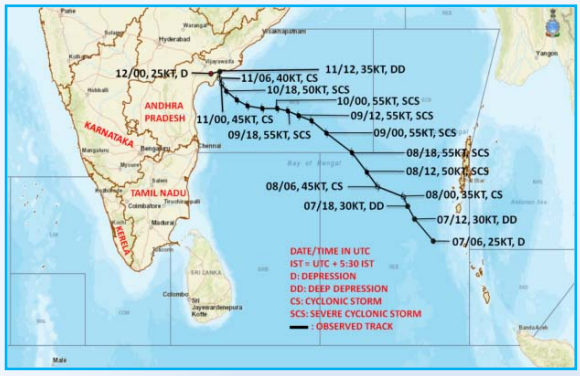
• Continuing to move northwestwards, it intensified into the cyclonic storm "ASANI" in the early morning (0530 hrs IST) of 8th May and into a severe cyclonic storm in the same evening (1730 hrs IST) over southeast Bay of Bengal. Continuing to move northwestwards, it reached peak intensity of 55 knots (100-110 kmph gusting to 120 kmph) on 9th early morning (0530 hrs IST). It maintained it's peak intensity till 10th noon (1130 hrs IST), thus for 30 hrs.

• From 10th evening, it started gradually moving north-northwestwards and weakened into a cyclonic storm over westcentral Bay of Bengal about 60 km south-southeast of Machilipatnam in the early hours (0230 hrs IST) of 11th May.

• Thereafter, it started moving nearly northwards with a very slow speed and weakened into a deep depression over westcentral Bay of Bengal close to Andhra Pradesh coast in the evening (1730 hrs IST) of 11th May.

• It crossed Andhra Pradesh coast near latitude 16.3°N and longitude 81.3°E between Machilipatnam and Narsapur during 1730-1930 hours IST of 11th May, 2022 as a deep depression with maximum sustained wind speed of 55-65 kmph gusting to 75 kmph.

• It then moved slowly west-southwestwards and weakened into a depression in the early morning (0530 hrs IST) and further into a well marked low pressure area in the morning (0830 hrs IST) of 12th May over coastal Andhra Pradesh. The observed track of the system is presented in Fig.




**Observed track of severe cyclonic storm 'ASANI" over the Bay of Bengal during 7-12 May, 2022**

**Salient Features**

(i) Weakening before touching coast

The severe cyclonic storm, "ASANI" weakened into a deep depression before touching the coast mainly due to following reasons:

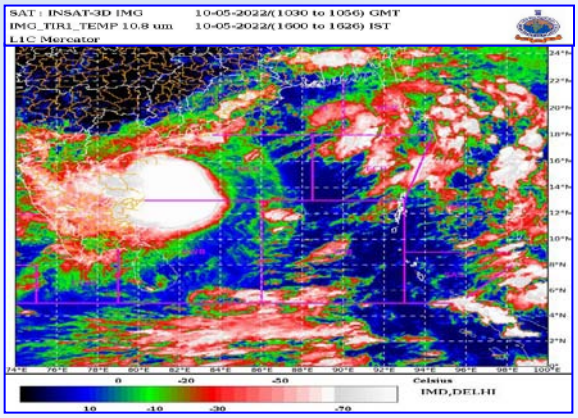
- It entered a region with lower sea surface temperature and lower ocean heat content
- It moved very slow (5-6 kmph against normal speed of 13 kmph) near the coast and remained within 50 km from the coastline from morning to evening of 11th May. The slow movement led to upwelling of sea water and rainfall over the Sea leading to further cooling of sea surface.
- Due to slow movement, there was also land interaction for longer time leading to weakening due to increased friction with land surface.
- There was cold and dry air incursion from Indian landmass in the middle and upper troposphere which are unfavourable for maintaining the intensity of any cyclonic storm.

(ii) Multiple recurvatures

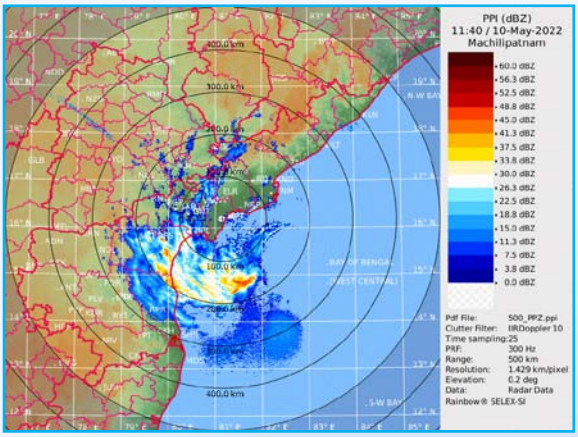
Severe cyclonic storm "Asani" exhibited multiple recurvatures in its track/path. Most of the models suggested change in direction of movement of the system from northwest to northeast near the coast. However, the deep depression (remnant of cyclone Asani) moved slowly northward/ northwestwards on 11$^{th}$ May till evening and slowly west-southwestwards thereafter. It was mainly due to the fact the cyclonic storm was supposed to move northeastwards near the coast under the influence of a short amplitude westerly trough in middle and upper tropospheric levels approaching from the west. However, as the storm weakened while approaching towards coast, the height of the storm decreased being limited to middle tropospheric levels. As a result the steering wind of the storm changed being dominated by southeasterly winds and led to northwestward movement. However, the northwestward movement was restricted/ blocked due to an anticyclone lying over the peninsular India. Thus, the system moved slowly & remained practically stationary near to the coast followed with slow west-southwestward movement till its weakening into a well marked low pressure area in the morning of 12$^{th}$ May over the region.

## Monitoring of Severe Cyclonic Storm, ASANI

India Meteorological Department (IMD) maintained round the clock watch over the north Indian Ocean and the cyclone was monitored since 28$^{th}$ April, about 8 days prior to the formation of low pressure area over south Andaman Sea on 6$^{th}$ May and 9 days prior to the formation of depression over southeast Bay of Bengal. The cyclone was monitored with the help of available satellite observations from INSAT 3D and 3DR, polar orbiting satellites and available ships & buoy observations in the region. The system was also monitored by Doppler Weather RADAR (DWR) Machilipatnam from 10$^{th}$ May morning. Various global models and dynamical-statistical models run by Ministry of Earth Sciences (MoES) institutions, were utilized to predict the genesis, track, landfall and intensity of the cyclone. A digitized forecasting system of IMD was utilized for analysis and comparison of various models' guidance, decision making process and warning products generation. Typical imagery from INSAT 3D (R) and DWR Machilipatnam is presented in Figure given below:




**Typical (a) INSAT 3D (R) imagery at 1600 hrs IST**




**Typical (b) DWR Machilipatnam imagery at 1720**

## Forecast Performance

(i) Genesis Forecast

- First information about likely formation of depression over south Andaman Sea and adjoining Southeast Bay of Bengal was released on 28th April in the Extended Range Outlook (about 9 days prior to formation of depression).

- Subsequent information about the development of low pressure area over south Andaman Sea around 6th May and depression around 7th May was issued in the daily Tropical Weather Outlook and the National Weather Forecast Bulletin issued on 29th April about 7 days prior to the formation of low pressure area over south Andaman Sea on 6th May and 8 days prior to formation of depression over Southeast bay of Bengal.

(ii) Cyclone warnings

- Considering the development of cyclonic storm over southeast Bay of Bengal, IMD issued first Special Message and Press Release at 1300 hours IST of 6th May on formation of low pressure area over South Andaman Sea. It was indicated that the system would intensify into a depression by 7th May evening and into a cyclonic storm by 8th May. The message also indicated that the system would move northwestwards and reach westcentral Bay of Bengal off North Andhra Pradesh-Odisha coasts on 10th May. Heavy rainfall, strong wind and tidal waves warnings were issued alongwith advisories for fishermen. Prior to the formation of depression, pre-genesis track was also issued indicating probable point of genesis and path of expected system.

- The Special Message and Press Release were further updated on 7th May on development of well marked low pressure area.

(iii) Track and intensity forecast

- The first numbered bulletin issued at 1430 hrs IST of 7th May on formation of depression indicated that the system would intensify into a cyclonic storm on 8th May and would reach close to north Andhra Pradesh coast on 11th May. It was also indicated that the system would gradually recurve northeastwards after reaching close to Andhra Pradesh coast and weaken gradually.

- The next bulletin issued at 2120 hrs IST of 7th May further indicated that the system would intensify into a cyclonic storm on 8th May morning and into a severe cyclonic storm in the evening of 8th May. It was also indicated that the system would weaken into a cyclonic storm in the morning of 11th May.

- Actually, the depression formed on 7th May, intensified into a cyclonic storm in the morning and into a severe cyclonic storm in the evening of 8th May. Thereafter it weakened into a cyclonic storm in the early morning of 11th May. Thus, intensification and weakening were correctly predicted from 7th May itself

**Life History of SITRANG**

- A low pressure area formed over North Andaman Sea and adjoining areas of south Andaman Sea & Southeast Bay of Bengal (BoB) in the early morning (0530 hrs IST/0000 UTC) of 20th October, 2022. It lay as a well marked low pressure area over north Andaman Sea and adjoining southeast BoB in the evening (1730 hours IST/1200 UTC) of 21st October.

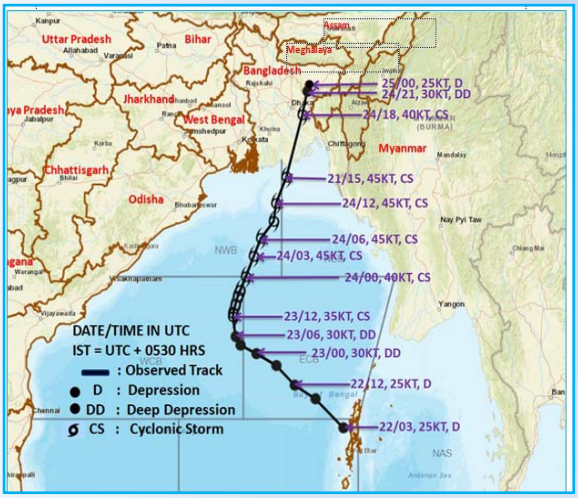
- Under favourable environmental conditions, it concentrated into a depression over southeast and adjoining eastcentral BoB close to Andaman Islands in the forenoon (0830 hrs IST/0300 UTC) of 22nd October, 2022.

- It moved northwestwards and intensified into a deep depression over westcentral BoB in the early morning (0530 hrs IST/0000 UTC) of 23rd October.

• Thereafter, it moved nearly northwards and intensified into the cyclonic storm (CS) "SITRANG" in the evening (1730 hrs IST/1200 UTC) of 23rd October. It then gradually recurved north-northeastwards and crossed Bangladesh coast between Tinkona and Sandwip close to Barisal (near 22.15 °N/90.35 °E) in the night of 24th October during 2130 to 2330 hours IST/1600 to 1800 UTC of 24th October as a cyclonic storm with maximum sustained wind speed of 80-90 kmph gusting to 100 kmph.

• Continuing to move north-northeastwards, it weakened into a deep depression over northeast Bangladesh in the early hours (0230 hours IST of 25th/2100 UTC of 24th), into a depression over interior Bangladesh in the early morning (0530 hours IST/0000 UTC) of 25th October and into a well marked low pressure area over northeast Bangladesh & adjoining Meghalaya in the forenoon (0830 hours IST/0300 UTC) of 25th October, 2022.

The observed track of the system is presented in Fig.

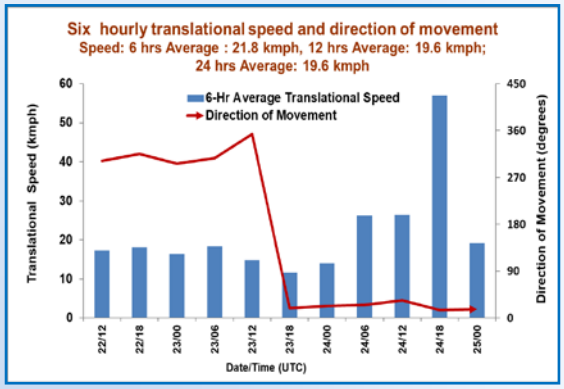



Observed track of cyclonic storm 'SITRANG" over the BoB during 22nd - 25th October, 2022

## 2. Salient Features

I. Recurving track: CS Sitrang initially moved northwestwards under the influence of southeasterly winds in middle and upper tropospheric levels prevailing to the south of ridge near 200N till 23rd morning, thereafter it recuved gradually north-northeastwards from 23rd night under the influence of trough in westerlies and an anticyclone to it's east over Myanmar.

II. Fast movement: CS Sitrang exhibited very fast movement on 24th under the influence of westerly trough, anticyclone over Myanmar and interactions with land.




Past six hourly average translational speed ending at date/time mentioned in the X-axis and direction of movement of cyclonic storm 'SITRANG" over the BoB during 22nd - 25th October, 2022 indicating very high speed of the system during 22/1200 UTC to 22/1800 UTC just before landfall against the average translational speed of 21.8 kmph during the entire life cycle 6 hourly average translational speed of the system was about 21.8 kmph against the normal of 12.9 kmph for CS category over the BoB during post monsoon season. It moved very fast with a speed of about 50 kmph during 1200-1800 UTC of 24th while crossing Bangladesh coast (Fig). Such a high translational speed (about 40 kmph) was last observed during extremely severe cyclonic storm, Sidr (11-16 November, 2007) which crossed Bangladesh coast around 1700 UTC of 15th November, 2007 near 89.8° E.

III. Short life period: The life period of the storm (depression to depression) was about 69 hours (2 days and 21 hours) against the long period average (LPA) (1990-2013) of about 88 hours (3 days & 16 hrs) for CS category over the BoB during post-monsoon season.

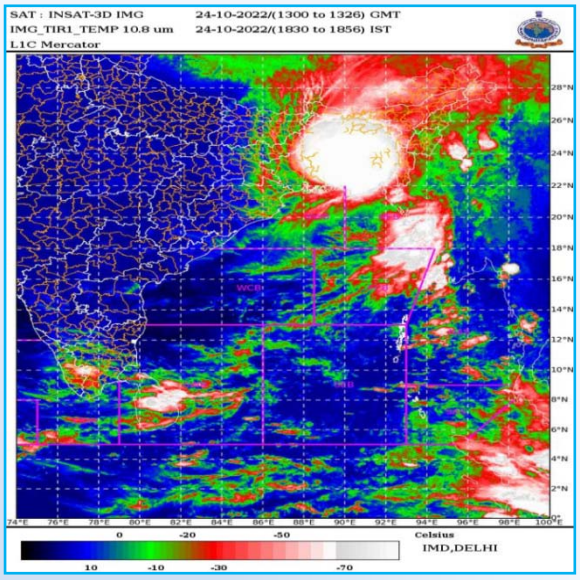
IV. Sheared Storm: The satellite observations detected the sheared nature of the convective clouds in association with the cyclonic storm due to the formation of the system in an environment with moderate vertical wind shear. The clouds

were sheared to the north of the cyclone centre. The environmental vertical wind shear impacted the storm motion and intensification of the system during its short life period.

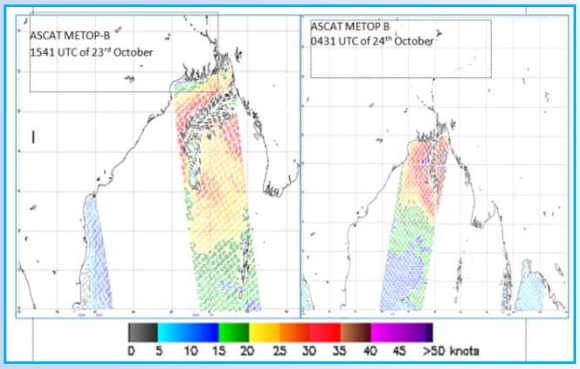
V. Damage Potential and Power Dissipation Index: The Accumulated Cyclone Energy (a measure of damage potential) and Power Dissipation Index (a measure of loss) in association with CS Sitrang were 0.97 × 104 knots 2 and 0.40 × 106 knots 3 respectively against the normal of 1.00 × 104 knots 2 and 0.40 × 106 knots 3 for CS during post monsoon season over the BoB based on the data during 1990-2020.

## 3. Monitoring of Cyclonic Storm, SITRANG

India Meteorological Department (IMD) maintained round the clock watch over the north Indian Ocean and the cyclone was monitored since 6th October, about 11 days prior to the formation of cyclonic circulation over eastcentral BoB and adjoining North Andaman Sea on 17th October, 14 days prior to formation of low pressure area over North Andaman Sea on 20th October and 16 days prior to actual genesis (formation of depression) on 22nd October. The information about the system was first released in the weekly extended range outlook issued by IMD on 6th October. The cyclone was monitored with the help of available satellite observations from INSAT 3D and 3DR, polar orbiting satellites and available ships & buoy observations in the region. On the day of landfall observations from Bangladesh Meteorological Department were utilised for monitoring the system. Various global models and dynamical-statistical models run by Ministry of Earth Sciences (MoES) institutions including IMD, NCMRWF, IITM and INCOIS were utilized to predict the genesis, track, landfall and intensity of the cyclone as well as associated severe weather. A digitized forecasting system of IMD was utilized for analysis and comparison of various numerical weather prediction model guidance, decision making process and warning products generation. Typical satellite based imageries from INSAT 3D (R) and sea surface wind based on Advanced Scatterometer (ASCAT) are presented in the Fig.




Typical INSAT 3D (R) imagery at 1300 UTC OF 24th October




Typical scatterometer winds at 1541 UTC of 23rd October indicating MSW of 35 knots and 0431 UTC of 24th October indicating MSW of 45 knots in association with the system

## Forecast Performance

### (i) Genesis Forecast

- First information about likely formation of cyclonic circulation over eastcentral & adjoining North Andaman Sea during the week 14th-20th October, with low probability (1-33%) of it's intensification into a depression (cyclogenesis) was issued in the extended range outlook issued by IMD on 6th October.

- Subsequent information about likely formation of low pressure area around 20th and its intensification into depression (cyclogenesis) with moderate confidence (34-67%) during beginning of the week 21-27 October was indicated in the extended range outlook issued on 13th October.

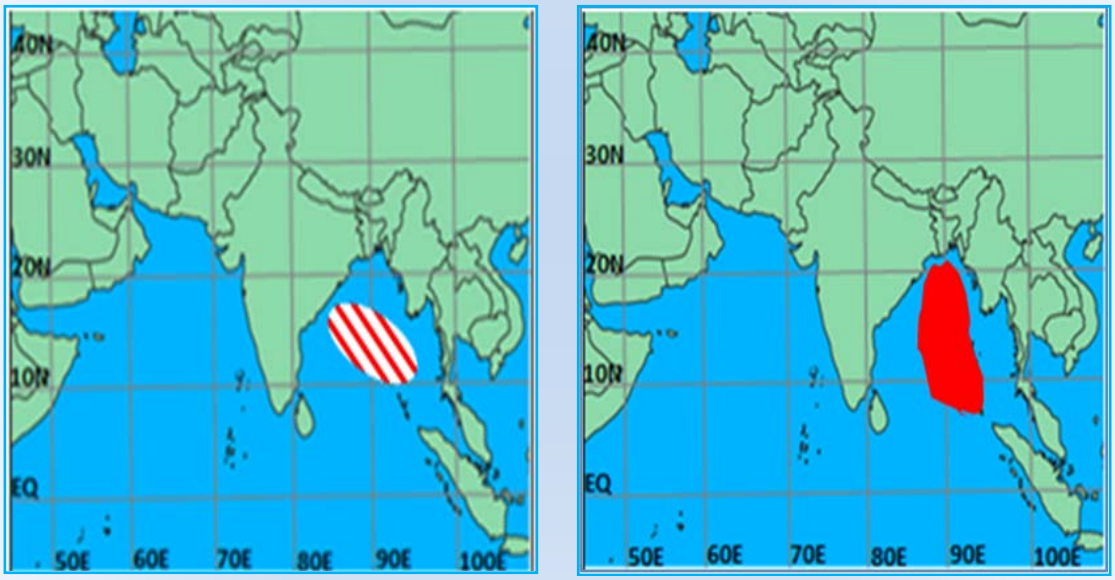
- Further in the extended range outlook issued on 20th October, it was indicated with high confidence (68-100%) that a depression would form over eastcentral & adjoining southeast BoB around 22nd October, intensify into a cyclonic storm over westcentral and adjoining eastcentral BoB by 24th October. It was also indicated that the system would exhibit north-northeastwards recurvature and reach near West Bengal - Bangladesh coasts by 25th October (about 102 hours prior to landfall over Bangladesh).

- The formation of cyclonic circulation on 18th and formation low pressure area on 20th under its influence was predicted on 15th October.

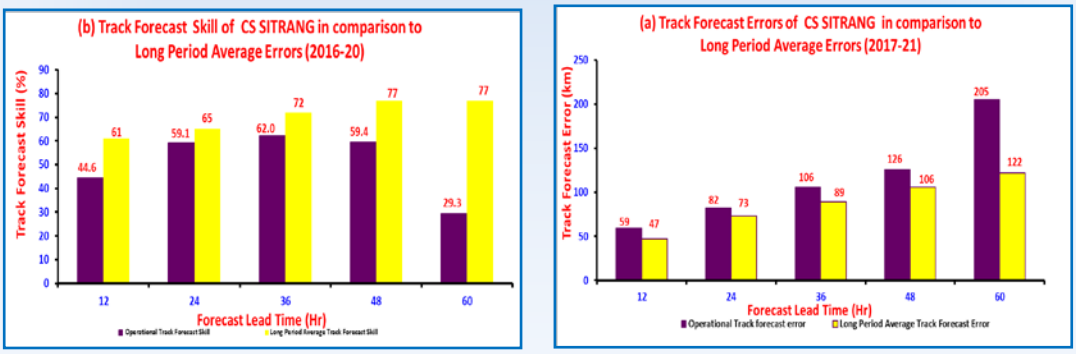
- The daily tropical weather outlook issued at 0700 UTC of 19th October indicated the formation of cyclonic circulation over north Andaman Sea and neighbourhood. It further stated that under its influence, a low pressure area would form over southeast and adjoining eastcentral BoB on 20th which would concentrate into a depression by 22nd morning over central BoB and into a cyclonic storm over westcentral BoB during subsequent 48 hours. Actually, the low pressure area formed on 20th, which became depression on 22nd morning and a cyclonic storm on 23rd evening.

(ii) Operational track, intensity and landfall forecast performance

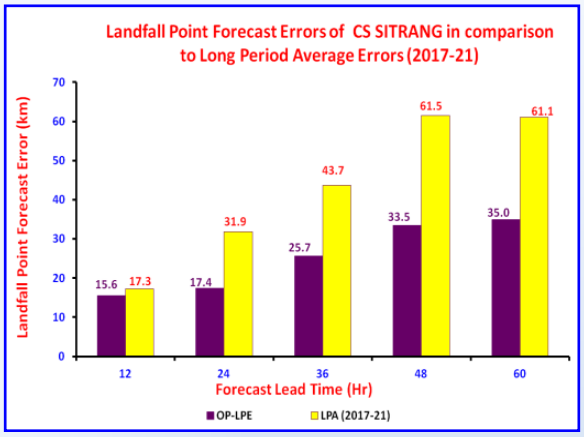
The operational track, intensity and landfall point & time forecast errors are presented in Figures below:

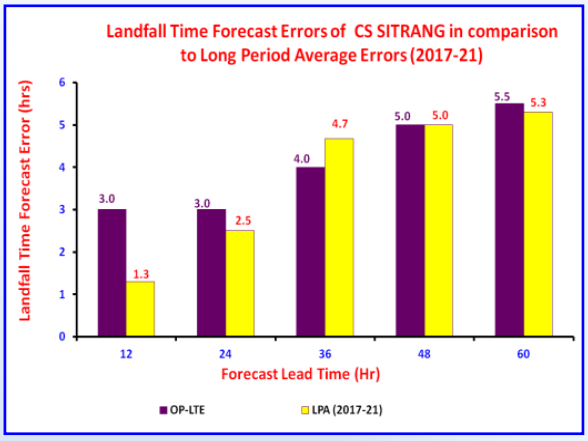



**Extended range outlook issued on 13th October (9 days prior to formation of depression on 22nd) and 20th October (about 4 days prior to landfall indicating movement towards Bangladesh with high confidence)**




**Operational track forecast errors and skill compared to long period average during 2017-21**



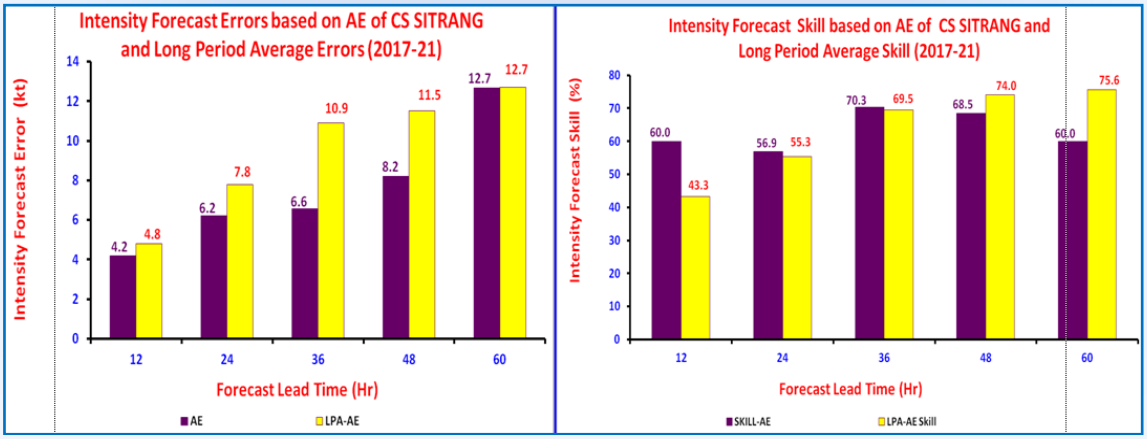

Operational landfall point and time forecast errors and skill compared to long period average during 2017-21

The track forecast errors for 24, 48 and 60 hrs lead period were 82, 126 and 205 km respectively against the long period average (LPA) errors (2017-21) of 73, 106, and 122 km respectively. The relatively higher error in the track forecast for 48 and 60 hrs was mainly due to the fast movement of the cyclone during evening and night of 24th October under the influence of westerly trough to the west of cyclone centre and also the fact that Sitrang had followed a recurving track.

- The landfall point forecast errors for 24, 48 and 60 hrs lead period were 17.4, 33.5, 35.0 km respectively against the LPA errors (2017-21) of 31.9, 61.5 and 61.1 km during 2017-21 respectively. The pre-genesis forecast issued at 0300 UTC of 21st October (about 3.5 days prior to landfall) indicated landfall over Bangladesh coast with an error of about 82.5 km against the LPA error of about 120 km for 84 hours lead period. Though, it was a recurving track, the landfall point errors were appreciably less than the LPA errors for all lead period.

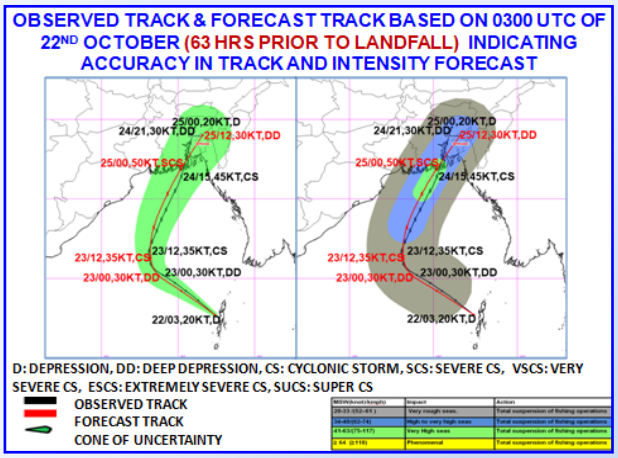
- The landfall time forecast errors for 24, 48 and 60 hrs lead period were 3.0, 5.0 and 5.5 hours respectively against the LPA errors (2017-21) of 2.5, 5.0 and 5.3 hours during 2017-21 respectively. For all lead periods, the landfall time errors were comparable to the LPA errors.

- The absolute error (AE) of intensity (wind) forecast for 24, 48 and 60 hrs lead period were 6.2, 8.2 and 12.7 knots against the LPA errors of 7.8, 11.5 and 12.7 knots during 2017-21 respectively. The error in intensity forecast were appreciably less than the LPA errors for all lead periods.




Operational intensity forecast errors and skill compared to long period average during 2017- 21

- Typical observed and forecast track based on 0830 hours IST/0300 UTC of 22nd October on formation of depression (63 hours prior to landfall) demonstrating accuracy in forecast is presented in Fig.




Observed and forecast track issued at 0830 hours IST of 22nd October (63 hours prior to landfall)

(iii) Forecast and realised severe weather:

(a) Heavy Rainfall

- Warning for isolated heavy rainfall on 24th over coastal districts of Odisha (Puri, Jagatsinghpur, Kendrapara districts) and isolated heavy rainfall over coastal districts (Balasore and Bhadrak districts) on 25th was issued on 21st. It was modified on 24th morning with only light to moderate rainfall forecast over the above areas.

- Warning for isolated heavy rainfall on 24th and isolated heavy to very heavy rainfall on 25th over coastal districts of West Bengal (South and north 24 Parganas, east Medinipur) was issued on 21st.

- Warning for isolated heavy rainfall over Assam, Meghalaya, Nagaland, Manipur, Mizoram, Tripura on 24th and isolated heavy to very heavy rainfall over these areas on 25th was issued on 21st. Further updates were provided regularly till 25th October.

Realised rainfall during past 24 hrs ending at 0830 IST of 25th October, 2022.

Light to moderate rainfall occurred at isolated places over Odisha and at a few places over coastal West Bengal. Rainfall occurred at most places with extremely heavy rainfall at isolated places over Meghalaya; isolated heavy to very heavy rainfall over Arunachal Pradesh and isolated heavy rainfall over Assam and Manipur.

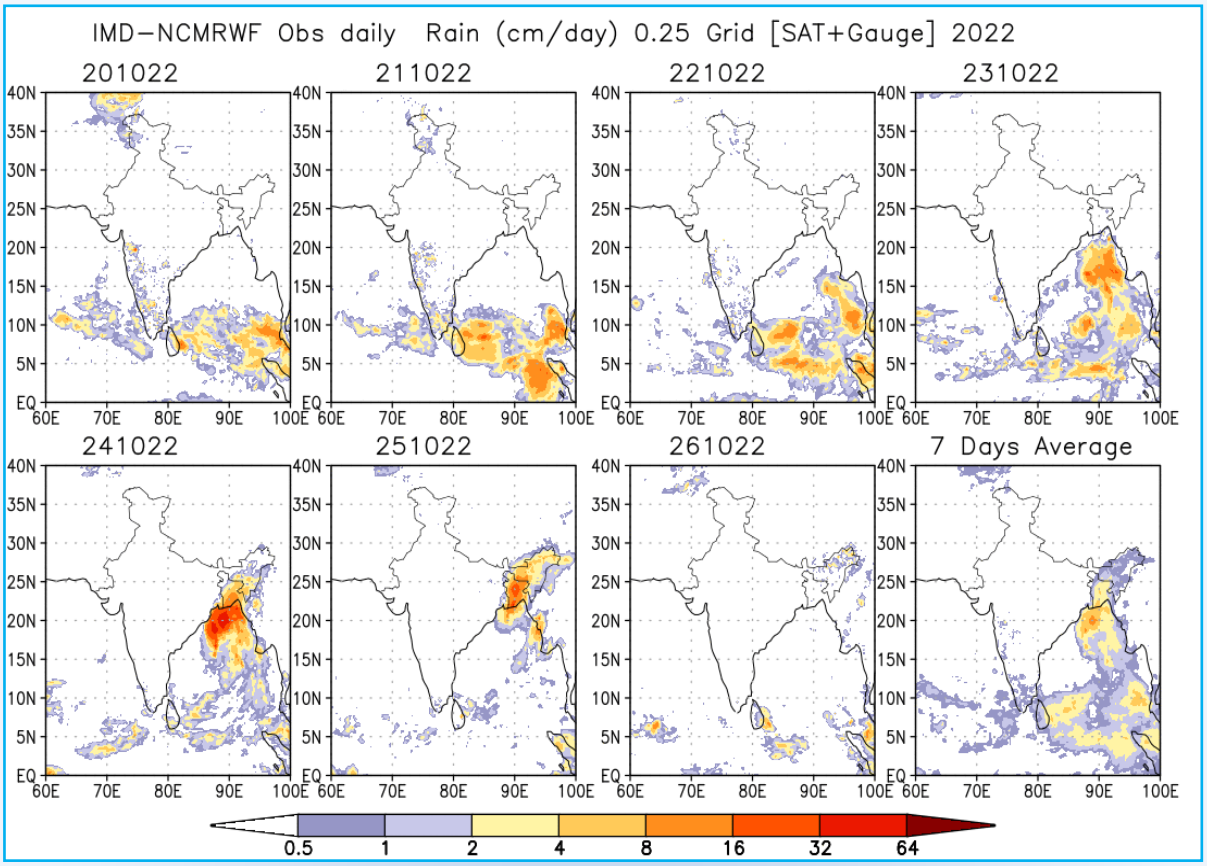
24 hours accumulated heavy rainfall (≥7 cm) ending at 0830 hours IST of 25th Oct is given below:

(i) **Meghalaya**: Mawphlang (Dist East Khasi Hills) 25, Pynursla (Dist East Khasi Hills) 25, Williamnagar (Dist East Garo Hills) 23, Shora (Dist East Garo Hills) 22, Secretariat_Hills(ARG) (Dist East Garo Hills) 21, Shillong (AWS) (Dist East Khasi Hills) 21, Shillong C.S.O. (Dist East Khasi Hills) 20, Mawkyrwat (ARG) (Dist South West Khasi Hills) 18, Barapani (Dist Ribhoi) 18, Nongstoin (Dist West Khasi Hills) 13, Khliehriat (Dist East Jaintia Hills) 12, Baghmara (Dist South Garo Hills) 10;

(ii) **Arunachal Pradesh**: Bomdila (Dist West Kameng) 12, Kalaktang (Dist West Kameng) 10, Kibithu (Dist Anjaw) 9, Basar (Dist West Siang) 8, Ziro (Dist Lower Subansiri) 8, Koloriang (Dist Kurung Kumey) 7, Jung_ARG (Dist Tawang) 7, Kabu Basti (Dist West Siang) 7, Palin(ARG) (Dist Kra Daddi) 7;

(iii) **Assam**: Khanapara (Dist Kamrup Metropolitan) 10, Dudhnoi Kvk(AWS) (Dist Goalpara) 9, Khetri (ARG) & Chandmari (Dist Kamrup Metropolitan) 9, Drf & GoibARGaon (Dist Baksa) 8, Pandu, Nongpoh (Dist Rhibhoi) 8, Goibergaon (Dist Baksa) 8, Udaipur (Dist Tinsukia) 8, Umrangshu (ARG) (Dist West Karbi Anglong) 7, Motunga (Dist Tamulpur) 7, Nalbari (Dist Nalbari) 7, Tamulpur (Dist Baksa) 7, Chandrapur ARG (Dist Kamrup (Rural)) 7, Kheronighat (Dist Karbi Anglong) 7, Guwahati [Dist Kamrup (M)] 7.

(iii) **Manipur**: Ukhrul (Dist Ukhrul) 10, Ukhrul AWS (Dist Ukhrul) 9, Churachandpur (Dist Churachandpur) 7, Senapati (Dist Senapati) 7; The spatial distribution of rainfall based on satellite and raingauge based merged dataset prepared by MoES during 22nd - 25th October is shown in Fig.



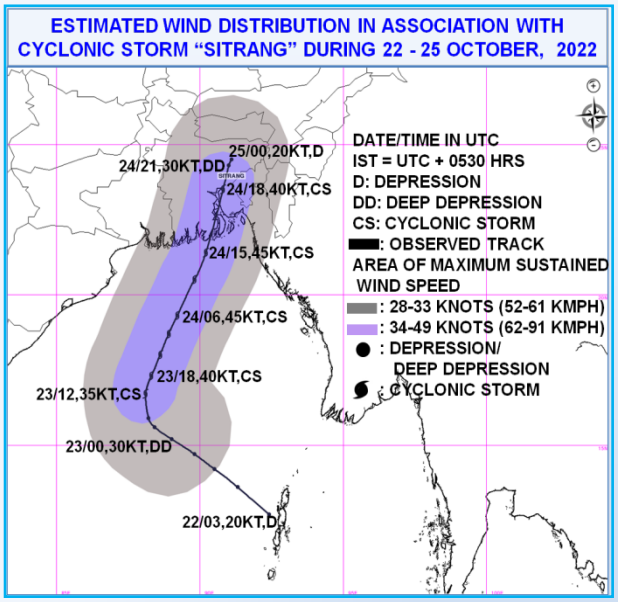

MoES Satellite gauge merged rainfall ending at 0300 UTC of date during 20th - 26th October, 2022

**(b) Wind**

The maximum sustained wind speed of 90-100 gusting to 110 kmph was predicted along & off Bangladesh coast during 24th evening to 25th morning, and 80-90 kmph gusting to 100 kmph along & off 24 Parganas districts and 60-70 gusting to 80 kmph along & off east Medinipur district of West Bengal coast and 50-60 kmph gusting to 70 kmph along & off Balasore district and 45-55 gusting to 65 kmph along & off remaining districts of north coastal Odisha and over Mizoram and Tripura was predicted in the bulletin issued at 1300 hrs IST of 22nd.

- It was modified as 70-90 kmph gusting to 100 kmph along & off 24 Parganas districts and 60-70 gusting to 80 kmph along & off east Medinipur district of West Bengal coast and 45-55 kmph gusting to 65 kmph along & off Balasore district and 40-50 gusting to 60 kmph along & off remaining districts of north coastal Odisha and over Mizoram and Tripura was predicted in the bulletin issued at 1220 hrs IST of 23rd.
- It was modified as 40-50 kmph gusting to 60 kmph along & off Balasore district and 35-45 gusting to 55 kmph along & off remaining districts of north coastal Odisha and 50-60 kmph gusting to 70 kmph over Tripura, 45-55 gusting to 65 kmph over Mizoram, south Assam and adjoining areas of east Meghalaya and Manipur was predicted in the bulletin issued at 1200 hrs IST of 24th.

Estimated maximum sustained wind (MSW) speed of intensity 80-90 kmph gusting to 100 kmph prevailed along & off Bangladesh coast during landfall. MSW of intensity 60-70 kmph gusting 80 kmph prevailed along & off North and South 24 Parganas including Sunderbans forest area during the time of landfall. Kolkata reported MSW of 44 kmph at 1647 IST of 24th October. MSW of 50-60 kmph gusting to 70 kmph prevailed over Tripura and 40-50 kmph gusting to 60 kmph over Meghalaya, South Assam & adjoining Mizoram and along and off north Odisha coast. The estimated wind distribution in association with the system is given in Fig.




Estimated maximum sustained wind speed distribution in association with cyclonic storm Sitrang

**Warnings and advisories issued**

- Considering the development of cyclonic storm over westcentral BoB, IMD issued first Special Message and Press Release at 1400 hours IST of 20th October on formation of low pressure area over North Andaman Sea and neighbourhood. It was also indicated that the system would intensify into a depression and cyclonic storm by 22nd and 24th October respectively. The movement of the system towards West Bengal-Bangladesh coasts was also predicted.

- Special Message and Press Release were further updated on 21st October along with the forecast track, intensity and wind distribution around the system centre upto next 5 days. It was also indicated that the system would cross Bangladesh coast and Bangladesh & adjoining West Bengal coasts would be worst impacted by the storm. Thus, the landfall of the cyclone with a wind speed of 90-100 kmph gusting to 110 kmph was predicted by IMD when the system was a low pressure area over Andaman Sea and three and a half days in advance of landfall time of the cyclone.

- Pre cyclone watch for West Bengal coast was issued at 1300 hours IST of 22nd October with the formation of depression over southeast & adjoining eastcentral BoB (about 60 hours prior to landfall of Sitrang over Bangladesh coast).

- Cyclone Alert for West Bengal coast was issued with intensification of depression into deep depression over eastcentral BoB at 0900 hrs IST of 23rd (about 40 hours prior to landfall of Sitrang).

- It was upgraded as Cyclone Warning for West Bengal coast and was issued at 0230 hours IST of 24th October (about 20 hours prior to landfall of Sitrang).

- A total of 23 National bulletins including 2 special messages for national and state level disaster managers, 6 press releases for print & electronic media, 3 Special Messages from Director General of IMD for high level disaster management officers, 23 tropical cyclone advisories & special tropical weather outlook for WMO/ESCAP Panel member countries including Bangladesh & Myanmar, 9 tropical cyclone advisories for International Civil Aviation, 11 advisories for sea area under Global Maritime Distress Safety System, 17 customised location specific bulletins for offshore/onshore operators, daily video updates, regular updates on social media (Facebook, WhatsApp, Twitter), SMS to disaster managers, general public, fishermen and farmers were issued by IMD Headquarter along with similar action by state level offices at Andhra Pradesh, Odisha, West Bengal and Andaman & Nicobar Islands and INCOIS for fishermen. Regular messages were also sent to Bangladesh & Myanmar through WhatsApp in association with this system

## 4.6. FDP STORM Project – 2022

**STORM Forecast Demonstration Project-2022**

The STORM program was conceived as a multidisciplinary nationally co-ordinated research and development programme and has been carried out as a multi-year observational-cum modelling campaign with an objective to build appropriate operational early warning systems for highly damaging severe thunderstorms over various parts of India. In order to develop methods for improving the accuracy of nowcasting of Severe Thunderstorms, Hailstorms, Squalls & other

associated phenomenon, India Meteorological Department conducts field experiments over entire country under STORM Forecast Demonstration Project (FDP STORM) during March to June every year. The programme was run as SAARC STORM project prior to 2017.

At the end of every FDP programme, an Annual STORM Report is compiled and published. It contains region wise detailed analysis of observed significant weather events, case studies, verification of Intensive Observation Periods (IOPs) issued during the FDP, as well as verification of 3 hourly Nowcasts issued round the clock throughout the season.

This year also STORM Fields Experiments covered the whole India. The monitoring period was uniform for entire country from 1 March to 30 June, 2022.

Under this project, FDP Bulletins were issued on daily basis with updated one in the evening, if required. The FDP Bulletin consists of four sections:

(i) Current Synoptic situations and satellite current & past 24 hrs observations over India,

(ii) NWP model Guidance from IMD GFS, IMD WRF and NCUM (NCMRWF) Models,

(iii) Radar & Realized Thunderstorm reports of the past 24 hours and

(iv) Intensive Observation Period (IOP) for thunderstorm and rainfall occurrence during next 24 hrs and 24-48 hrs for the meteorological subdivision and summary of the weather of the day.

A total of 122 FDP Bulletins were issued during the STORM Period-2022.

**Nowcast Guidance Bulletins**

In addition to FDP Bulletins during March to June - 2022, Nowcast Guidance Bulletins containing current Synoptic features and depicting potential areas for Severe Weather (Heavy Rainfall/Thunderstorm & Associated Phenomenon/Fog) for next 24hours, in text as well as visual form based on 0830 IST observations were issued once a day (updated in the afternoon if needed) throughout the year. These bulletins provide significant guidance to the forecasters working at different RMCs/MCs, in keeping a watch over their areas of responsibility as mentioned in the Guidance Bulletins & issue Nowcast Bulletins accordingly.

**Location Specific three hourly Thunderstorm (TS) Nowcast**

Nowcasting of Severe Weather (thunderstorms, squalls and hailstorms, heavy rainfall etc.) has benefited from the recent improvement in monitoring & forecasting due to introduction of (i) digital and image information at 10 mins interval from a network of 37 Doppler Weather Radars, (ii) half hourly satellite observations from RAPID Satellite imagery, (iii) dense automatic weather station (AWS) network (iv) better analysis tools in synergy system at forecaster's workstation, (v) Ground based lightning network (vi) availability of mesoscale models and (vii) computational & communication capabilities.

TS nowcast of major towns is uploaded every 3 hourly interval utilizing Synoptic Data, Model outputs, Satellite products and finally various Radar outputs by the respective RMCs/MCs/ RWFCs under whose jurisdiction these stations are situated. During the year-2022, 36 new stations were added on All India Nowcast Warning page of IMD website for issuing three hourly thunderstorm nowcast, thereby, increasing the total number of nowcast stations to 1166 (till date) under 25 Nowcast Centers (RMC/RWFC/MC/CWC). Fig.(a) depicts the screen shot of Nowcast Warning Page on IMD website and Fig. (b) indicates the year-wise cumulative number of stations added on Nowcast Warning page for three hourly thunderstorm Nowcast. In addition to stationwise nowcasting, district level nowcasting which was started in July, 2019 was also issued for all the 732 districts of India [Fig. (c)]. Considering the importance and reliability of DWR and satellite based information for nowcast of severe weather, all district headquarters/major towns/ tourist places and specific locations within capital cities (under Urban Meteorology and Climate project) in India are to be included for nowcasting of severe weather.

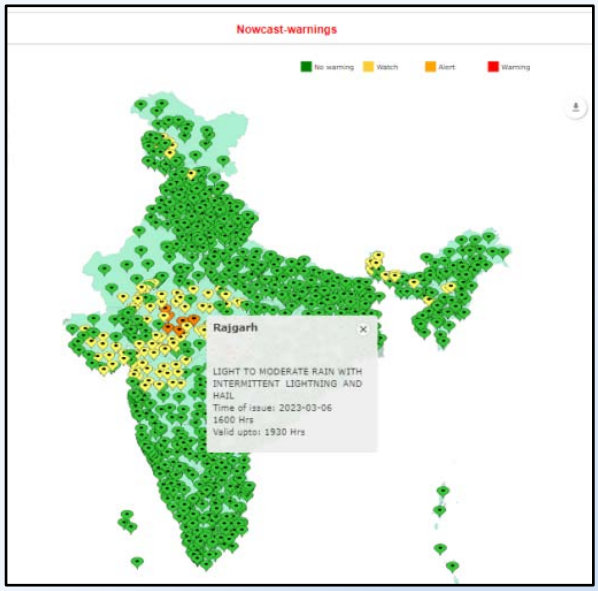



**Fig. (a).** Stationwise Nowcast Warning Page on IMD website
Link:https://mausam.imd.gov.in/imd_latest/contents/stationwise-nowcast-warning.php

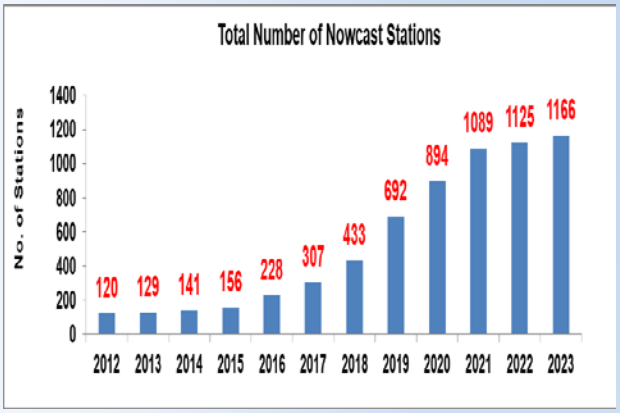



**Fig. (b).** Year-wise cumulative number of stations for three hourly thunderstorm Nowcast

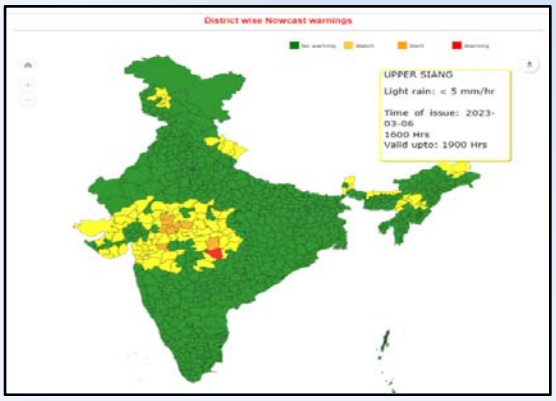



**Fig. (c).** Districtwise Nowcast Warning Web Page on IMD website
Link:https://mausam.imd.gov.in/imd_latest/contents/districtwisewarnings.php

The Stationwise and district wise nowcast is issued for about nineteen categories (Fig. d ) of different kinds based on severity of weather for lightning, thunderstorms, dust storms, hail storms, squalls, rain and snow etc. This nowcast warning page is available on new as well as old IMD websites. Also all other products related to thunderstorm forecasting are available on dedicated thunderstorm web page developed in 2019 (Fig. e).


**Fig. (d).** Different categories of Nowcast Warnings

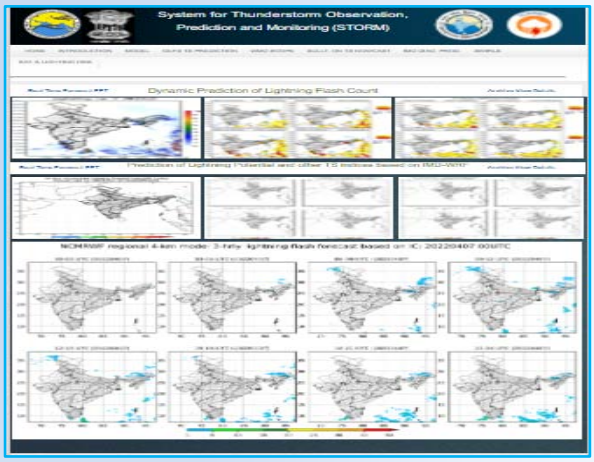



**Fig. (e).** New Web Page for Thunderstorm monitoring and forecasting
Link:https://srf.tropmet.res.in/srf/ts_prediction_system/index.php

This includes products developed by IMD, NCMRWF and IITM scientists under the umbrella of the THUMP project under the chairmanship of Secretary MoES**.** These new products, which provide short range forecast of weather phenomena associated with thunderstorms, have greatly aided in improving the short range forecast of thunderstorms over the Indian region. There has simultaneously been a conscious thrust from all Meteorological centres to provide

| Category/Wind Speed | Structures | Communication & Power | Agriculture | Suggested Actions |
|---|---|---|---|---|
| Light Thunderstorm <41 kmph (21 knots) | Nil | Nil | Nil | Nil |
| Moderate Thunderstorms 41 – 61 kmph (22-33 knots) | Minor damage to loose / unsecured structures | Nil | Minor damage to Banana trees. Damage to ripe paddy crops. | People are advised to keep a watch on the weather for worsening conditions and be ready to move to safer places accordingly. |
| Severe Thunderstorms 62 -87 kmph (34 -47 knots) | Damage to thatched huts. | Minor damage to power and communication lines due to breaking of branches. | Some damage to paddy crops, banana, papaya trees and orchards and Standing crops. | People are advised to take shelter in pukka structures and avoid taking shelter under trees. Farming operations to be temporarily suspended during occurrence of event. Also move away from electric poles and wires. |
| Very Severe Thunderstorms Greater than 87 kmph {(47Kt) in gusts/squall} | Major damage to thatched houses/huts. Rooftops may blow off. Unattached metal sheets may fly. | Minor damage to power and communication lines. | Breaking of tree branches, uprooting of large avenue trees. Moderate damage to banana and papaya trees. Large dead limbs blown from trees. Damage to Standing crops. | People are advised to stay away from weak walls and structures and take shelter in pukka structures. People in affected areas to remain indoors and avoid water bodies and flying projectiles. Farming operations to be temporarily suspended during occurrence of event. |
| Thunderstorm associated with Hailstorm | Major damage to Kutcha structures and tin and asbestos roofed houses, cars | | The fruit, vegetable and field crops at maturity stages are more prone to damage. Damage to Standing crops. | People are advised to stay away from weak walls and structures and take shelter in pukka structures. People in affected areas to remain indoors. |

**Fig. (f).** Impacts associated with various types severe weather events

impact based forecasts for thunderstorms over the Indian region. List of generalized impacts associated with different categories of thunderstorms is also published through a forecast Circular No. 1/2019 (Fig. f).

**Verification of IOPs/TS Nowcast-2022**

**(i) FDP Bulletins**

The thunderstorm forecasts issued for 24hours during FDP STORM-2022 were verified with realised thunderstorm data. The verification results for thunderstorm forecast are shown in Table 2 and graphically by Fig.(g). Fig. (h) indicates verification scores of 24 hr Thunderstorm IOP during 2016 to 2022 which shows a significant improvement in all the scores. Monthwise comparative Probability of Detection (POD) scores during 2016 to 2022

**TABLE**

**Skill sores for Thunderstorm verification for FDP STORM - 2022 (March to June)**

| Month | Ratio Score | POD | FAR | CSI | ETS | BIAS |
|---|---|---|---|---|---|---|
| **March** | 0.88 | 0.73 | 0.66 | 0.30 | 0.25 | 2.16 |
| **April** | 0.79 | 0.84 | 0.37 | 0.56 | 0.38 | 1.32 |
| **May** | 0.71 | 0.91 | 0.39 | 0.58 | 0.27 | 1.49 |
| **June** | 0.68 | 0.92 | 0.38 | 0.59 | 0.22 | 1.48 |
| **FDP-2022** | 0.76 | 0.89 | 0.40 | 0.55 | 0.35 | 1.48 |

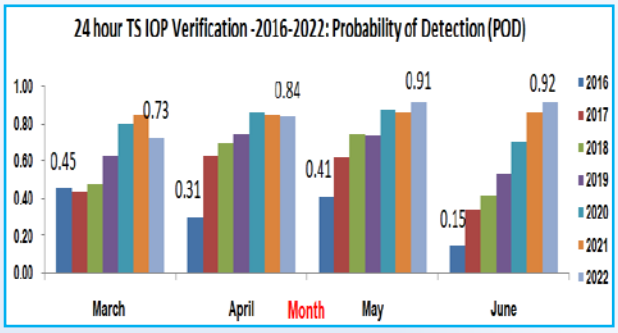



**Fig. (g).** Month wise evolution of the all India POD scores from March to June during the period of 2016 to 2022

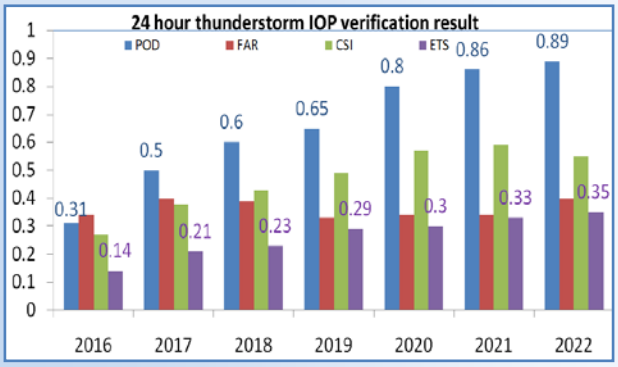



**Fig. (h).** 24 hour thunderstorm forecast verification result for the entire FDP season of 2016 to 2022

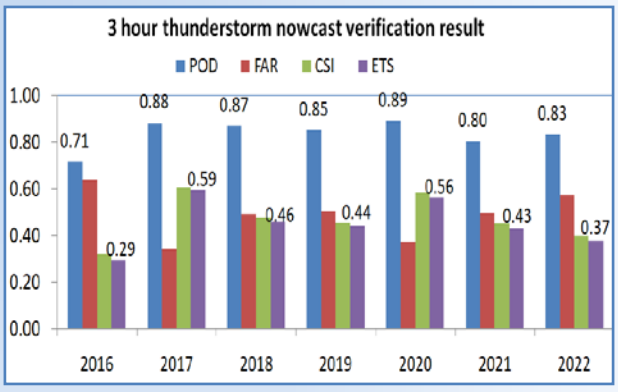



**Fig. (i).** Three hourly thunderstorm nowcast verification result for the entire FDP season of 2016 to 2022

Fig. (i) indicate that this year the thunderstorms were detected more accurately in all the months of the season as compared to similar result for all previous STORM seasons

.

**(ii) Three Hourly TS Nowcast**

Figs(j-n) indicate respectively the Ratio Score, FAR, POD, CSI and ETS scores of three hourly TS Nowcasts issued by various RMCs/MCs during FDP STORM (March to June) for the year-2022 and

Fig. (o) indicates All India Nowcast Verification Scores for the same.

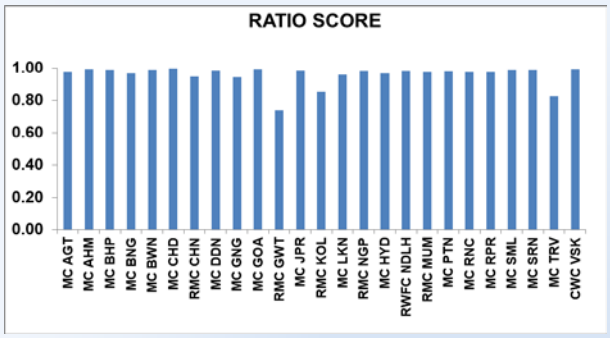



**Fig. (j).** MC-wise Ratio Score of Three Hourly TS Nowcast Verification during FDP STORM-2022

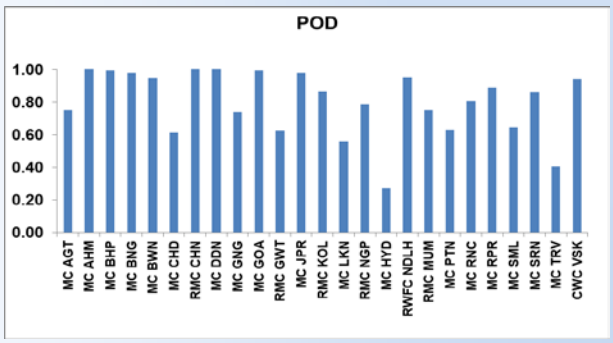



**Fig. (k).** MC-wise Probability of Detection (POD) of Three Hourly TS Nowcast Verification during FDP Periood-2022

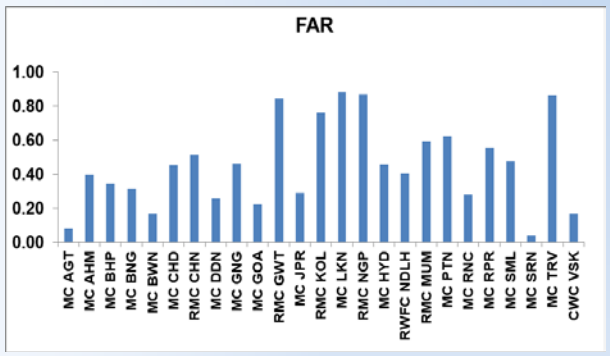



**Fig. (l).** MC-wise False Alarm Ratio (FAR) of Three Hourly TS Nowcast Verification during FDP Period-2022

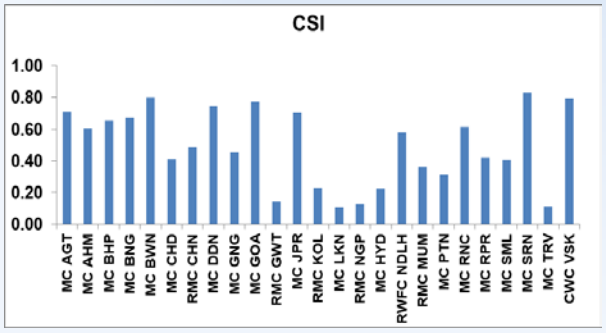



**Fig. (m).** MC-wise Critical Success Index (CSI) of Three Hourly TS Nowcast Verification during FDP Period -2022

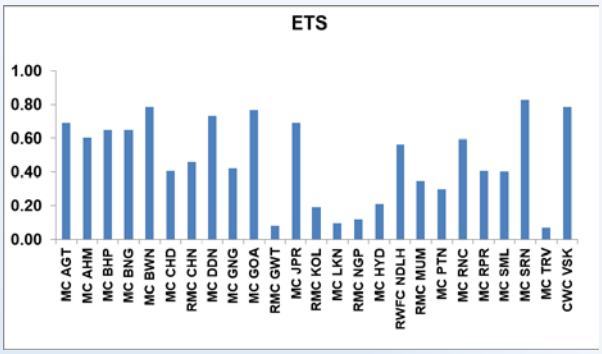



**Fig. (n).** MC-wise of Equitable Threat Score (ETS) of Three Hourly TS Nowcast Verification during FDP Period-2022

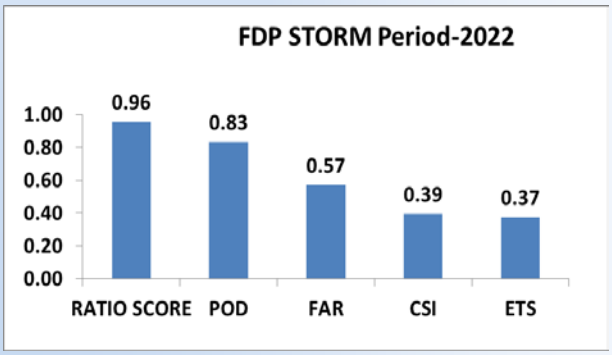



**Fig. (o).** All India 3 hourly TS Nowcast Verification Scores during FDP Period-2022

**FDP STORM Report – 2022**

A detailed STORM Report document, based on thunderstorm activities observed over India during March to June-2022, was prepared by Nowcast Division, NWFC. It contains information on daily weather situation, important weather charts, severe weather events all through the campaign period, case studies and the bulletins issued during the period. The report has been published during IMD foundation Day on 15th January-2023. Figs. (p-v) represent some of the salient features of the FDP STORM Report-2022.

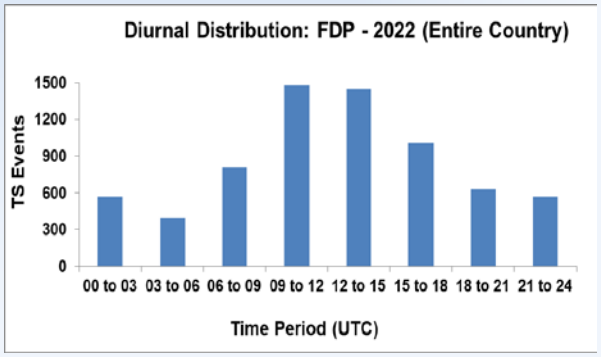



**Fig. (p).** Diurnal distribution of TS events over the country during FDP STORM -2022

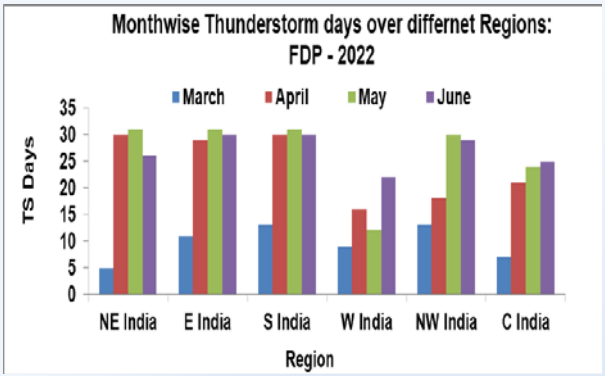



**Fig. (q).** Monthwise distribution of TS Days over different regions of India during FDP STORM-2022

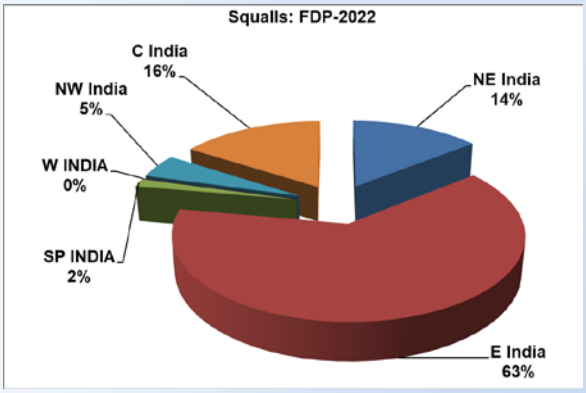



**Fig. (r).** Regionwise Distribution of squall events over the country during entire FDP STORM-2022

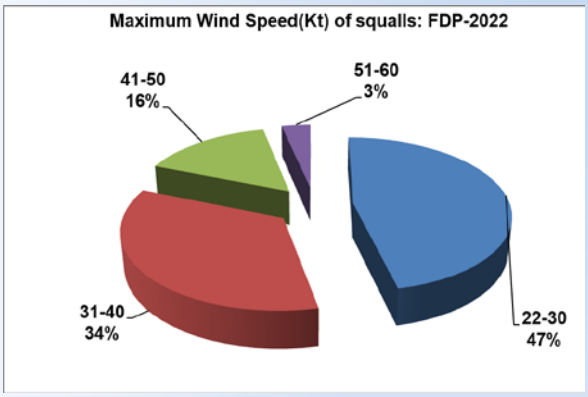



**Fig. (s).** Distribution of squalls over the country based upon max wind speed (Kt) during FDP STORM -2022

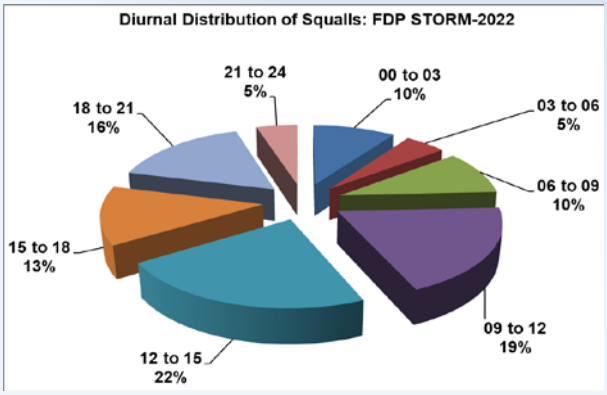



**Fig. (t).** Diurnal (time in UTC) distribution of thundersqualls during FDP STORM-2022

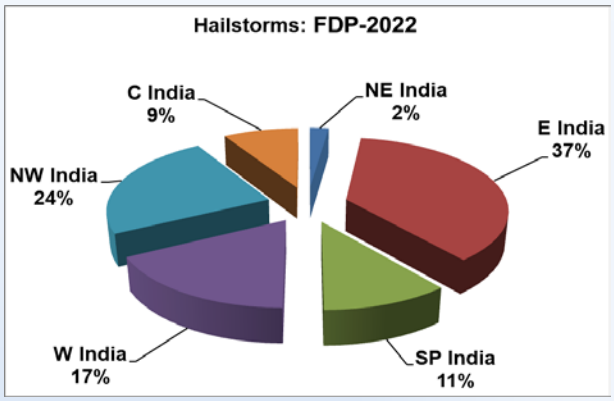



**Fig. (u).** Regionwise distribution of hailstorm events during FDP STORM-2022

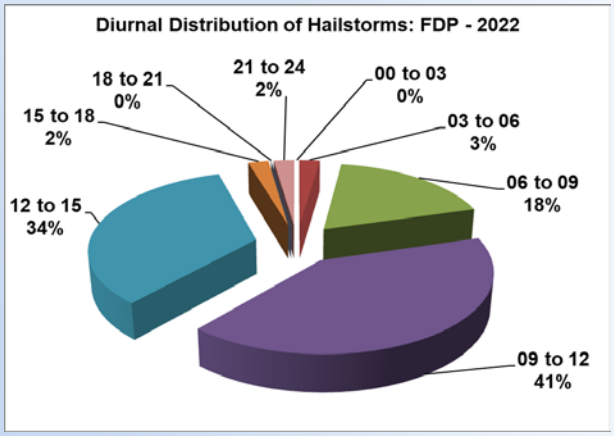



**Fig. (v).** Diurnal Distribution of Hailstorm Events over the Country during entire FDP STORM-2022

**Short-range Warning of Intense Rainstorms in Localised Systems (SWIRLS)**

SWIRLS is based on the extrapolation of radar echoes using the TREC (Tracking Radar Echoes by Correlation) technique. With a suitable choice of pixel array size on the radar reflectivity maps, the TREC vectors derived can be used to monitor and extrapolate echo motion right across the mesoscale spectrum, from individual convective cells, to supercells and clusters, and to groups of rain bands or squall lines.

On the basis of TREC, quantitative precipitation forecast (QPF) algorithms have been developed to produce high resolution forecast rainfall distribution maps over the local area. These maps provide useful objective guidance for forecasters to assess the likely rain scenario in the next 30, 60 & 120 minutes along with analysis and to facilitate decision-making in operating the Rainstorm

Warning System. The first SWIRLS was installed and made operational at Delhi in October, 2018. At present the SWIRLS software is operational at Delhi. Fig. (w) shows IMD SWIRLS forecast for Delhi.

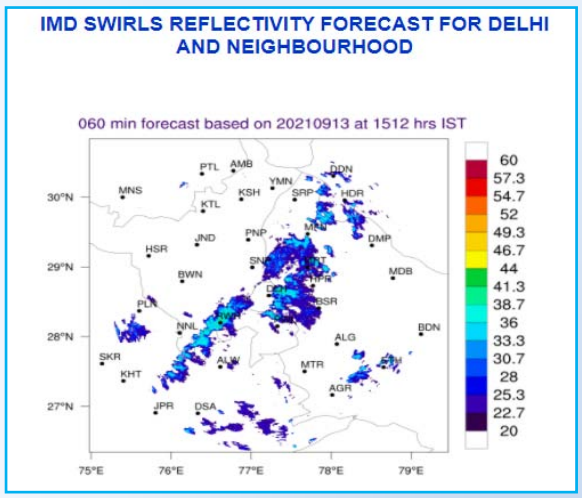



**Fig. (w).** SWIRLS Reflectivity Delhi
Link: https://nwp.imd.gov.in/swirls.php

**New Initiatives undertaken by Nowcast Unit**

(i) Automation of district nowcast verification
IMD operationally issues district level nowcasts for severe weather for all districts of India round the clock at three hourly intervals since 2018. The phenomena for which nowcasts are issued include: (a) Thunderstorms and associated weather and (b) rainfall. All these nowcasts are updated every three hours on the IMD website (https ://mausam.imd.gov.in/imd_latest/contents/district twisewarnings.php). The data from the ground based lightning array network of the Indian Institute of Tropical Meteorology and Indian Air Force has been used for verification of the District level Nowcasts. This network currently has 83 sensors and provides spatial accuracy of about 500 m. The point data for lightning with lat-long coordinates is provided from the network in near realtime mode to IMD at 15 minute intervals for operational use. The point data is geolocated up to the district level using open source "Nominatim Server" software. For verification purposes, a yes-no criterion (2x2 configuration table) is applied for occurrence-non-occurrence of thunderstorms in each district. All the eleven categories of nowcasts for thunderstorms and associated weather are considered for verification. A minimum of 2 (two) incidences of lightning occurrence in a district within the validity period of a nowcast is considered occurrence of thunderstorm over that district. The two flashes may occur concurrently or subsequently in time in any part of the district within a period of three hours, i.e., during the validity time of the nowcast for the district. Based on both observation and nowcast for thunderstorms (any one of the eleven categories), the forecast skill scores have been calculated. Fig. (x-z, xx) represent the district wise POD, FAR, CST and ETS scores of 3hourly district nowcast verification for the FDP STORM Period-2022 (March to June).

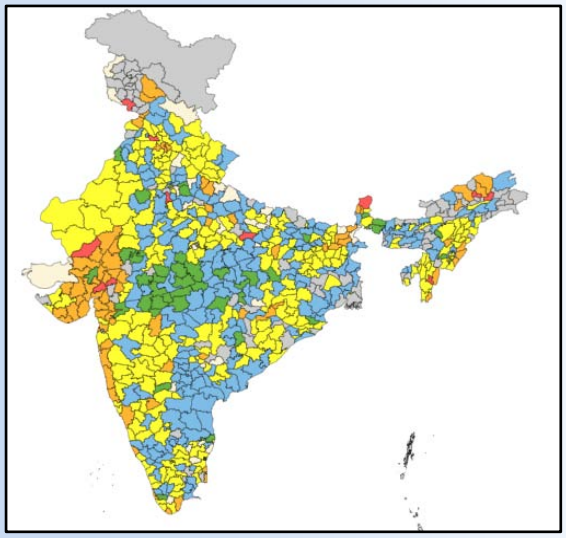


**Fig. (x).** Districtwise POD of 3 hourly district nowcast verification for FDP STORM Period -2022

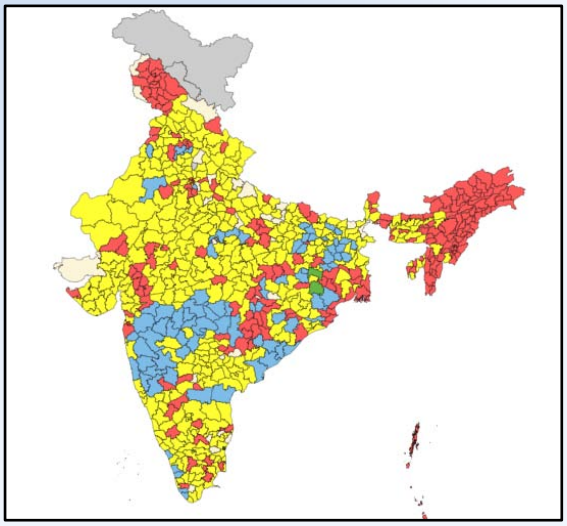


**Fig. (y).** Districtwise FAR of 3 hourly district nowcast verification for FDP STORM Period-2022

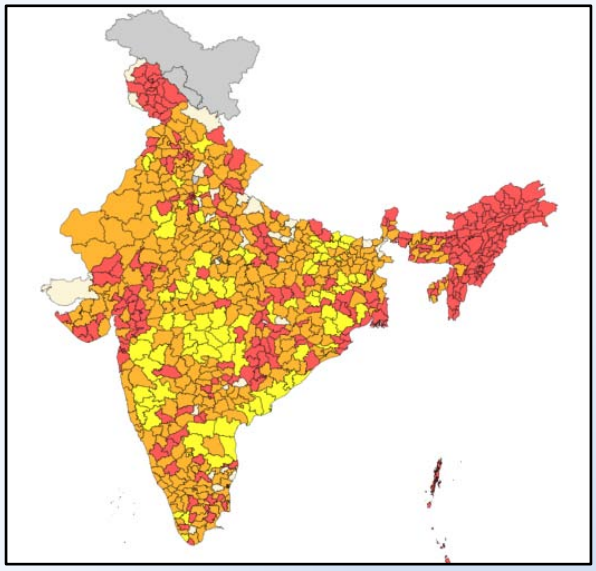


**Fig. (z).** Districtwise CSI of 3 hourly district nowcast verification for FDP STORM Period -2022

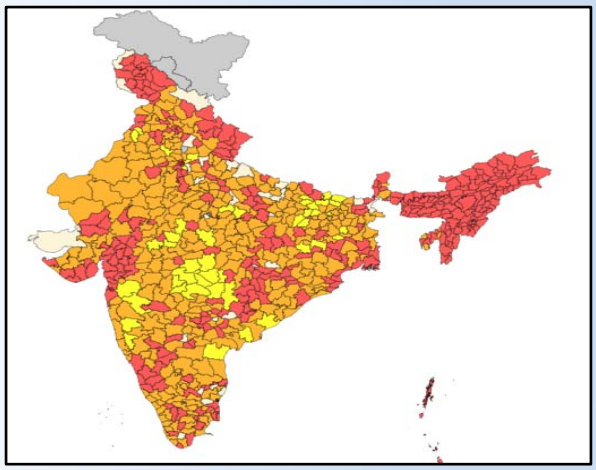


**Fig. (xx).** Districtwise ETS of 3 hourly district nowcast for FDP STORM Period -2022

**(ii) Crowdsourcing**

The term "crowdsourcing" was first coined in 2006 by American journalist Jeff Howe who defined it as "the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and general large) network of people in the form of an open call.

In recent years, with the improved understanding of the mesoscale nature of weather systems over Indian region, the constraints of the existing observatory network are sought to be supplemented by other sources of observations. This requirement has been partly met by remote sensed observations of weather by radar and satellite based instruments and the lightning detection network. However, in the absence of validation with ground data, the limitations of each instrument hamper the process of forming a clear picture of the weather occurred and its intensity and impact. The lack of clarity in observations causes uncertainty in forecasts of subsequent weather and its associated impact. With the widespread availability of smart phones, information regarding the state of the atmosphere can now be obtained from many non-traditional sources in text, audio and video form from sources such as citizen scientists (Wiggins and Crowston, 2011), amateur weather stations and sensors, smart devices and social-media/web 2.0 (Muller et al.).

Since 2021, IMD has started an online interface (Fig (yy) to collect the information of the weather that has occurred as well as the associated impact information for six weather events initially, viz., Rain. Hail, Duststorm, Wind Speed, Thunderstorm/Lightning & Fog. The target weather reporters are (a) Class II, Class III observatories (any observatory not covered under MMR) (b) AMFU, KVK observatories (c) Railways Station Masters (d) Power discom maintenance staff & (e) General Public. Further, the interface has following features: (i) The reporting interface is without login requirement. (ii) The time of submission will be automatically recorded. (iii) The user machine address and time is automatically recorded. (iv) The user has the facility to record the Location, State, District of observation. There is also the facility to add photo or video proof of the event.

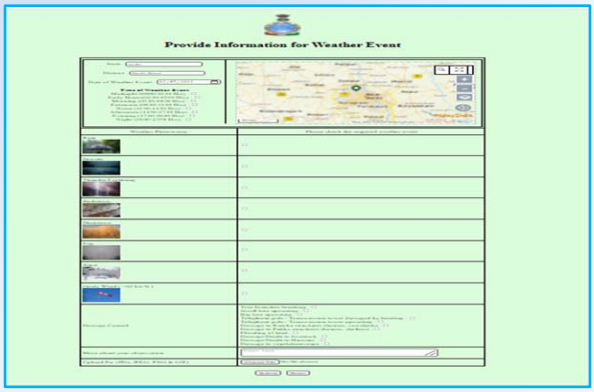



**Fig. (yy).** Crowdsourcing weather reporting Interface
Link:
https://city.imd.gov.in/citywx/crowd/enter_th_datag.php

# CHAPTER 5

# WEATHER AND CLIMATE SERVICES OF IMD

## 5.1. Hydromet Services

During 2022, IMD achieved some significant improvement in Flood Meteorological Services by improving Quantitative Precipitation Forecasts (QPF) skill by 1%, Increased the lead period of River Sub Basin wise QPF and Probabilistic QPF inDay-2 and Day-4, Increased DRMS Network from5204 to 5611 rainfall stations and full operations of the flash flood guidance services for South Asia.

### Major achievements

Successful operations of SASIAFFGS for providing flash flood gudiance services to India, Nepal, Bhutan, Bangladesh and Sri lanka for the flood season 2022.

HydroSoS - A WMO Project for Hydrological Status and Outlook System (HydroSOS) for GBM basin in collaboration with Nepal, Bhutan, Bangladesh and India initiated.

407 Rain gauge stations were included in CRIS and station code provided to RMCs/MCs in the year of 2022

No of district increased from 695 to 703 in preparation of rainfall summary/statistics.

New Rainfall Normal based on the period of 1971-2020 was implemented in Customised Rainfall information system for All India Rainfall summary 2022.

Changing of the Names of Districts and Stations on the demands of RMC/MC as per the state government policy.

Non-Representation of Districts in rainfall summary in the monsoon season amongst 703 districts has been tends to 0. (No districts remained in NOT DATA AVILABLE CATEGORY).

### Mandate of Hydromet Division

Hydro-meteorological Division is established to fulfill the following mandates with various services being provided to support all stakeholders, Central/State Govt. organizations and other agencies in sector specific applications. (Fig. 1)

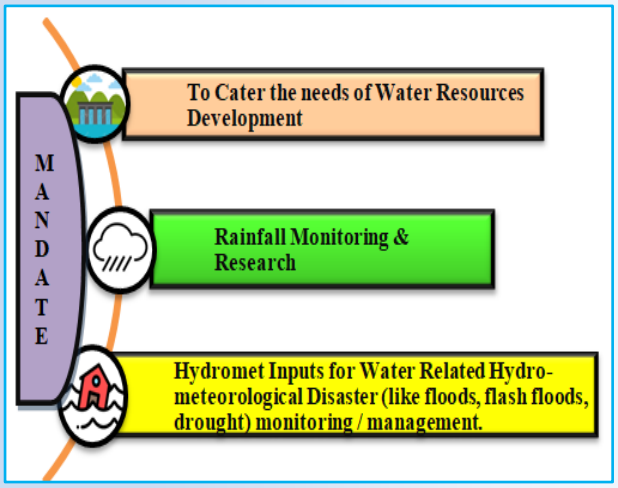



**Fig. 1.** Mandate of Hydromet Division

### Overview of Hydro-meteorological Services of IMD

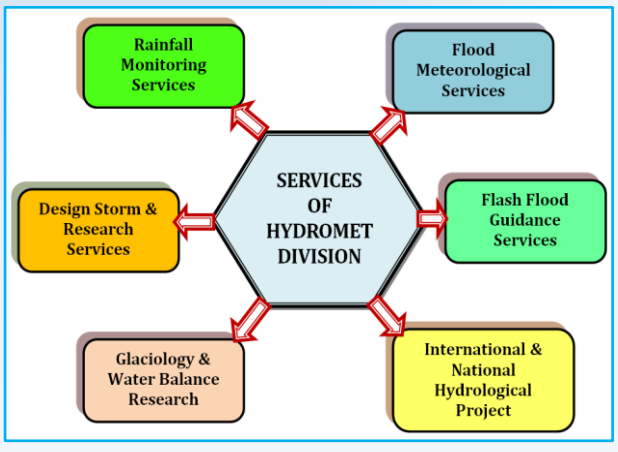


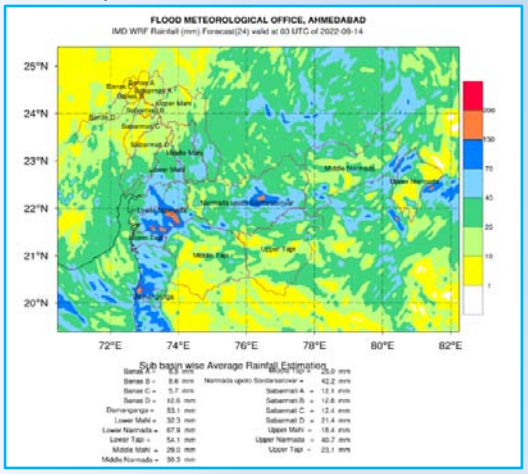

**Fig. 2.** Services of Hydromet Division

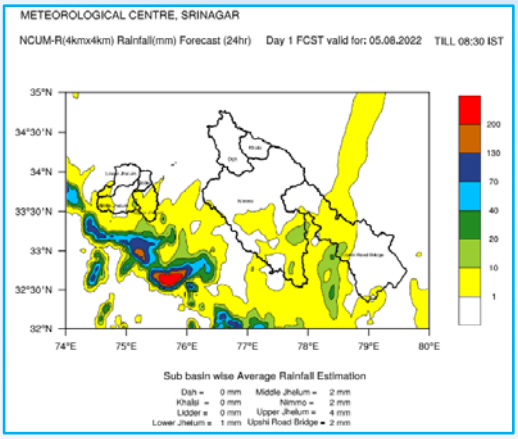
## Flood Meteorological Services

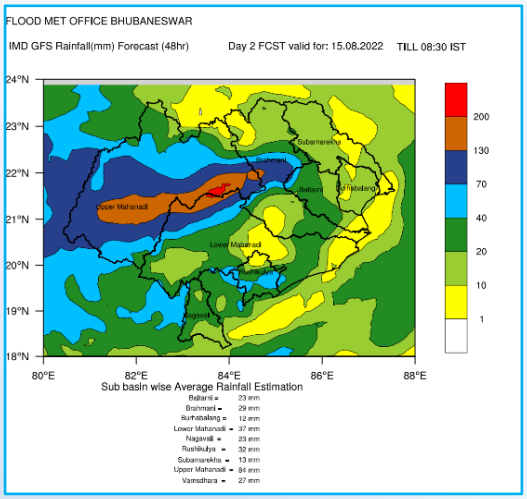
The sub-basin wise Quantitative Precipitation Forecasts (QPFs) were issued (daily on operational basis) by FMOs Agra, New Delhi, Asansol, Ahmedabad, Bhubaneswar, Guwahati, Jalpaiguri, Hyderabad, Lucknow, Patna, DVC Met Unit Kolkata, MC Srinagar, Chennai, Thiruvananthapuram and Bengaluru during the monsoon season 2022 for their area of jurisdiction from 1st June to October 2022. FMO Chennai, Thiruvananthapuram and Bengaluru continued to issue QPFs upto 31st December 2022. These operational QPF were provided to the field offices of Central Water Commission for the use in their Flood Forecast Model.

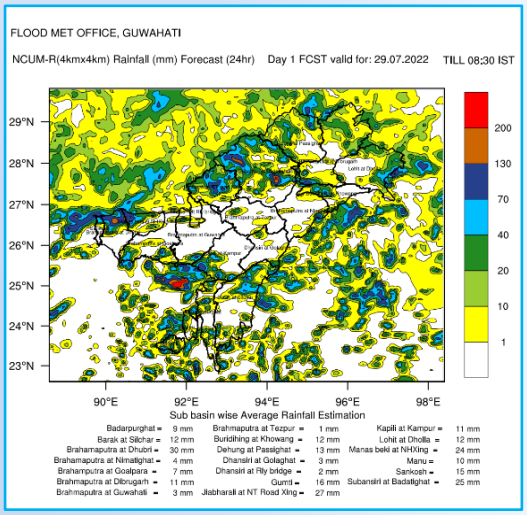
During this year, the accuracy within same category of river sub-basin-wise QPF has improved by1% in Day-2 and Day-4 as compared to 2021.

River Sub basin-wise Quantitative Precipitation Estimate for Day-1, Day-2, Day-3 using WRF ARW (3km x 3km) & NCUM-R (4km x 4km), for Day-1 to Day-7 using GFS (12km x 12km) & NCUM-G (12km x 12km) were uploaded in IMD website operationally for 153 river sub-basins.



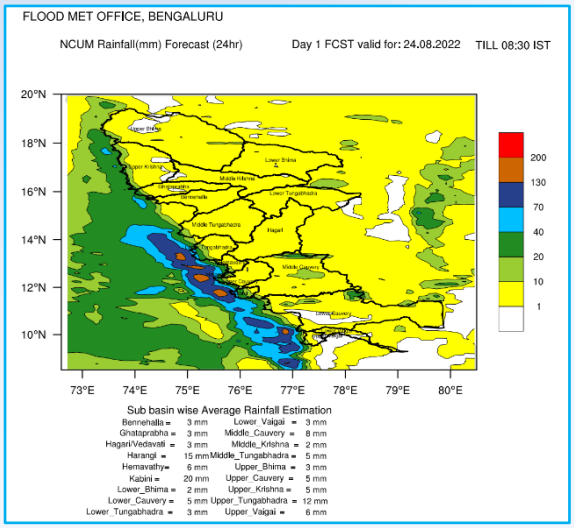



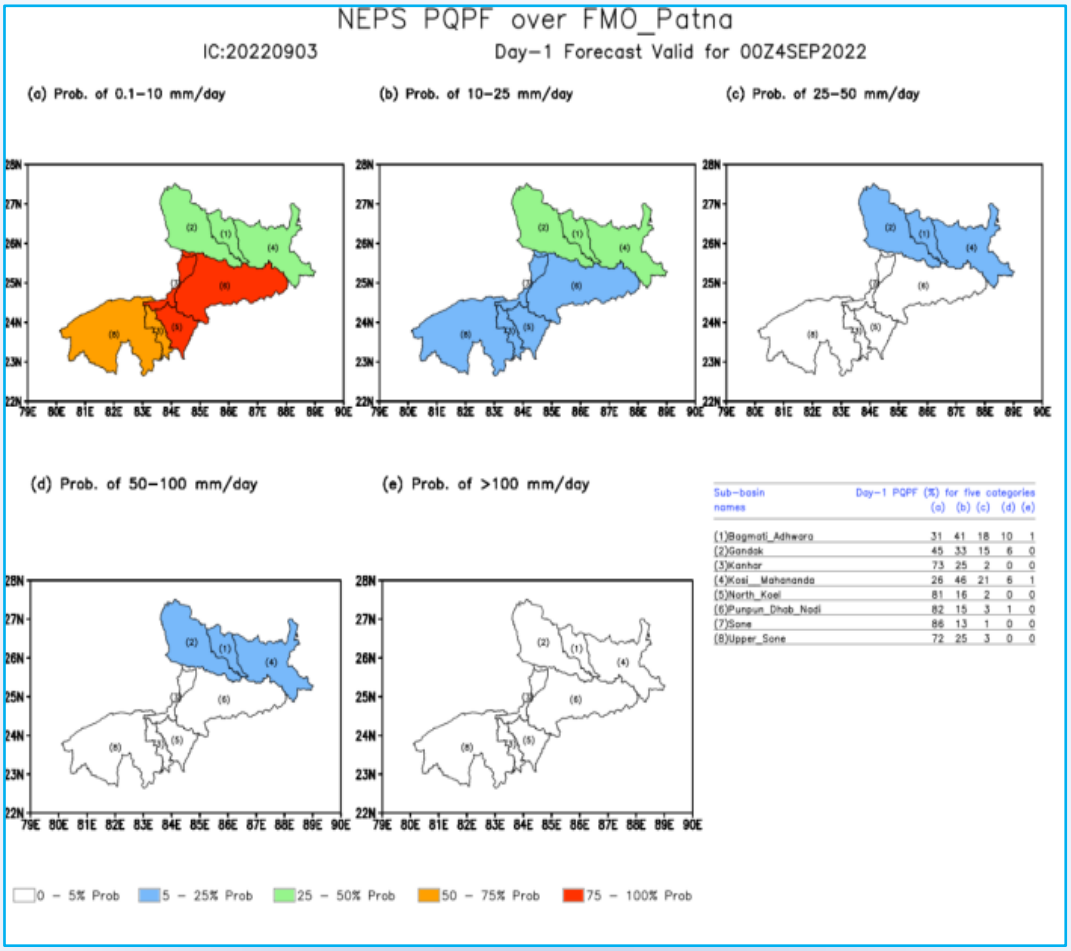



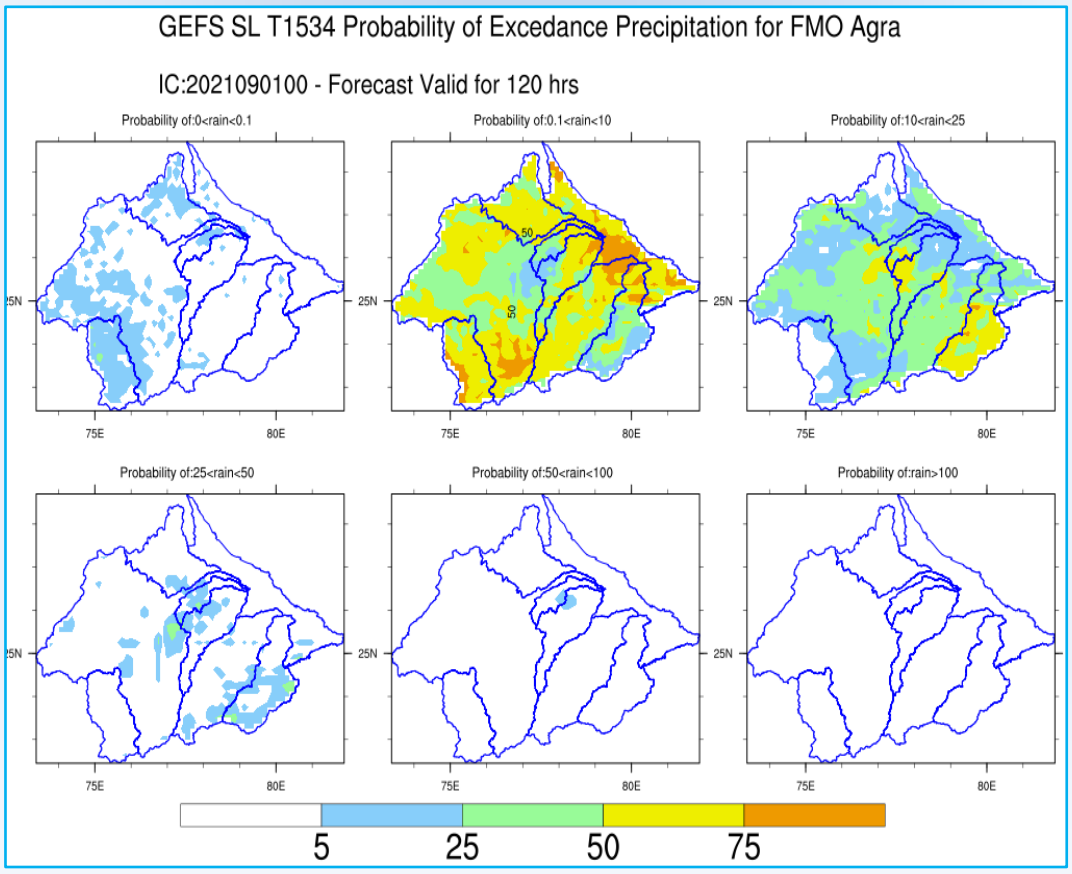




IMD provided grided rainfall forecast data of the dynamical model operationally vizGFS (12km x 12km) and WRF (3km x 3km) to Central Water Commission for the use in Hydrological modelling.

River sub basin wise Probabilistic QPF based on dynamical model GEFS & NEPS were uploaded in the IMD website operationally.




NEPS PQPF over FMO_Patna
IC:20220903
Day-1 Forecast Valid for 00Z4SEP2022
(a) Prob. of 0.1-10 mm/day
(b) Prob. of 10-25 mm/day
(c) Prob. of 25-50 mm/day
(d) Prob. of 50-100 mm/day
(e) Prob. of >100 mm/day
Sub-basin names
Day-1 PQPF (%) for five categories
(a) (b) (c) (d) (e)
(1)Bagmati_Adhwara 31 41 18 10 1
(2)Gandak 45 33 15 6 0
(3)Kanhar 73 25 2 0 0
(4)Kosi_Mahananda 26 46 21 6 1
(5)North_Koel 81 16 2 0 0
(6)Punpun_Dhab_Nadi 82 15 3 1 0
(7)Sone 86 13 1 0 0
(8)Upper_Sone 72 25 3 0 0
0 - 5% Prob
5 - 25% Prob
25 - 50% Prob
50 - 75% Prob
75 - 100% Prob


GEFS SL T1534 Probability of Excedance Precipitation for FMO Agra
IC:2021090100 - Forecast Valid for 120 hrs
Probability of:0<rain<0.1
Probability of:0.1<rain<10
Probability of:10<rain<25
Probability of:25<rain<50
Probability of:50<rain<100
Probability of:rain>100
75E
80E
25N
5
25
50
75

**Issuing joint advisories on Flood Status of the country by IMD, CWC and NDRF as suggested by MHA**

| Fl. No. | River/Sub-Basin/Basin | State | District | Rainfall Situation | | | | | Remarks/ Advisories |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | |
| 1 | Penganga/Middle Godavari/Godavari | Maharashtra | Yavatmal | | | | | | |
| 2 | Wardha/Middle Godavari/Godavari | Maharashtra | Chandrapur | | | | | | |
| 3 | Godavari/Middle Godavari/Godavari | Telangana | Adilabad Bhupalpally | | | | | | |
| 4 | Sabari/Lower Godavari/Godavari | Andra Pradesh | Alluri Sitharama Raju | | | | | | |
| 5 | Goadavari/Lower Godavari/Godavari | Andra Pradesh | Alluri Sitharama Raju | | | | | | |
| 6 | Kosi/Kosi/Ganga | Bihar | Supaul | | | | | | |
| 7 | Sabari/Lower Godavari/Godavari | Chhattisgarh | Sukma | | | | | | |
| 8 | Indravathi /Lower Godavari/Godavari | Chhattisgarh | Bijapur | | | | | | |
| 9 | Damanganga/Damanganga/West Flowing Rivers from Tapi to Tadri | Dadra and Nagar Haveli | Dadra and Nagar Haveli | | | | | | |
| 10 | Purna/Purna/West Flowing Rivers from Tapi to Tadri | Gujarat | Surat | | | | | | |
| 11 | Cauvery/Upper Cauvery/Cauvery | Karnataka | Chamarajanagar | | | | | | |
| 12 | Tungabhadra /Upper Krishna/Krishna | Karnataka | Shimoga | | | | | | |
| 13 | Kumudvati/Upper Krishna/Krishna | Karnataka | Haveri | | | | | | |
| 14 | Varadha/Upper Krishna/Krishna | Karnataka | Haveri | | | | | | |
| 15 | Bhavani/Middle Cauvery/Cauvery | Kerala | Palaghat | | | | | | |
| 16 | Tapi/Middle Tapi/Tapi | Madhya Pradesh | Burhanpur | | | | | | |
| 17 | Noyyal/Middle Cauvery/Cauvery | Tamil Nadu | Coimbatore | | | | | | |
| 18 | Godavari/Middle Godavari/Godavari | Telangana | Mulugu Badradri | | | | | | |
| 19 | Sarda/Ghaghara/Ganga | Uttar Pradesh | Kheri | | | | | | |

## Daily monitoring of river sub basin wise Severe Flood Situation & high QPF provided to Central Agencies

| Flood Monitoring Offices | | | | Flood Level (CWC) | | Quantitative Precipitation Forecast (QPF) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Day-1 (13-05-2022)* | | | Day-2 (14-05-2022)* | | | Day-3 (15-05-2022)* | | | Day-4 (16-05-2022)* | | | Day-5 (17-05-2022)* | | |
| SNo | FMO | Basin | Sub-Basin | Severe Flood | Extreme Flood | 26-50mm | 51-100mm | >100mm | 26-50mm | 51-100mm | >100mm | 26-50mm | 51-100mm | >100mm | 26-50mm | 51-100mm | >100mm | 26-50mm | 51-100mm | >100mm |
| 1 | FMO Jalpaiguri | Brahmaputra | Jaldhaka | | | √ | | | √ | | | √ | | | √ | | | √ | | |
| 2 | FMO Jalpaiguri | Brahmaputra | Torsa | | | √ | | | | √ | | | √ | | | √ | | √ | | |
| 3 | FMO Jalpaiguri | Brahmaputra | Raidak | | | √ | | | | √ | | | √ | | | √ | | √ | | |
| 4 | FMO Guwahati | Barak | Barak at Silchar | | | √ | | | | | | | | | | | | √ | | |
| 5 | FMO Guwahati | Barak | Badarpurghat | | | √ | | | √ | | | | | | | | | √ | | |
| 6 | FMO Guwahati | Gumti | Gumti | | | √ | | | | | | | | | | | | | | |
| 7 | FMO Guwahati | Brahmaputra | Lohit at Dholla | | | √ | | | | | | | | | | | | | | |
| 8 | FMO Guwahati | Brahmaputra | Brahmaputra at Dibrugarh | | | √ | | | | | | | | | | | | | | |
| 9 | FMO Guwahati | Brahmaputra | Buridihing at Khowang | | | √ | | | | | | | | | | | | | | |
| 10 | FMO Guwahati | Brahmaputra | Jiabharali at NT road Xing | | | √ | | | | | | | | | | | | | | |
| 11 | FMO Guwahati | Brahmaputra | Manas/ Beki at N H Xing | | | √ | | | √ | | | | | | | | | | | |
| 12 | FMO Guwahati | Brahmaputra | Brahmaputra at Goalpara | | | √ | | | √ | | | | | | | | | | | |
| 13 | FMO Guwahati | Brahmaputra | Brahmaputra at Dhubri | | | √ | | | √ | | | √ | | | | | | | | |
| 14 | FMO Guwahati | Brahmaputra | Sankosh | | | √ | | | √ | | | √ | | | | | | | | |

**Design Storm Studies/Storm Analysis**

1. Design Storm Studies are being conducted to evaluate design storm estimates (rainfall magnitude and time distribution) for various river catchments/ projects in the country, for use as main input for design engineers in estimating design flood for hydraulic structures, irrigation projects, dams etc. on various rivers. This estimation of design values is required for safe and optimum design of storage and spillway capacity. On the request of Central Govt./ State Govt., Private Agencies, design storm values (Standard Project Storm, Probable Maximum Precipitation along with Time Distribution, IDF Curve etc.) are being provided for users as main input. These studies are being carried out on payment basis. The detailed project reports aresent to the project authorities

2. During the year 2022, design storm studies of Eleven (11) projects have been completed. Revenue of Rs.30,87,951/- (Rupees Thirty Lakh Eighty Seven Thousand Nine Hundred and Fifty One only) was generated.

3. Published the Technical Report entitled "Design Storm Studies undertaken during 2021" and uploaded in IMD website

**Rainfall Monitoring Services**

1. Major Services includes Real-time rainfall monitoring and summary day throughout the year. Brings out updated monthly, seasonal & annual rainfall statistics and publishes Annual Rainfall Report.

2. Hydromet Division brings out real-time rainfall summary every week from Thursday to Wednesday and also for months. During Monsoon season, the same is prepared on daily basis for 703 Districts, 36 Met. Sub-divisions, 36 States including UTs, 4 Regions and for the country as a whole. Besides this, rainfall statistics is also prepared for 61 selected River basins of India and the maps are uploaded on IMD website. The Unit also brings out updated monthly, seasonal and annual rainfall statistics after incorporating the late receipt data. Rainfall Monitoring Unit also publishes Annual Rainfall Report.

3. The rainfall summary is used by various stake holders for multiple purposes like Agricultural planning and advisories, Crop yield forecast, Agricultural pricing, Estimation of irrigation requirements, Relief measures, Hydro-power Planning and many other economical and research activities. Recipients of rainfall statistics include higher authorities like Office of Hon. Prime minister, Secretary MoES etc.

4. Rainfall statistics for the Annual (Jan-Dec) - 2022 prepared with an all India network of about 5611 DRMS stations.

5. The rainfall statistics was prepared for the Annual (Jan-Dec)-2022. The rainfall for the country as a whole, for the Annual (Jan-Dec)-2022 has been recorded as 1257.0 mm which is 108% of its Long Period Average (LPA) of 1160.0 mm. In all, category wise, 13 Met sub-divisions in EXCESS, 20 Met sub-divisions in NORMAL, 03 in DEFICIENT and No Met. sub-divisions remained in LARGE EXCESS, LARGE DEFICIENT & NO RAIN category of rainfall.

## SUBDIVISION-WISE RAINFALL (MM) DISTRIBUTION

| S. NO. | METEOROLOGICAL SUBDIVISIONS | PERIOD: ANNUAL (JAN-DEC) -2022 | | | |
|---|---|---|---|---|---|
| | | ACTUAL | NORMAL | % DEP. | CAT. |
| EAST & NORTH EAST INDIA | | 1815.6 | 1946.5 | -7% | |
| 1 | ARUNACHAL PRADESH | 2810.6 | 2807.0 | 0% | N |
| 2 | ASSAM & MEGHALAYA | 2752.3 | 2577.0 | 7% | N |
| 3 | N M M T | 1564.6 | 2009.7 | -22% | D |
| 4 | SHWB & SIKKIM | 2764.1 | 2539.8 | 9% | N |
| 5 | GANGETIC WEST BENGAL | 1222.0 | 1559.0 | -22% | D |
| 6 | JHARKHAND | 1044.5 | 1220.7 | -14% | N |
| 7 | BIHAR | 894.5 | 1164.4 | -23% | D |
| NORTH WEST INDIA | | 827.6 | 833.3 | -1% | |
| 1 | EAST U.P. | 767.3 | 900.3 | -15% | N |
| 2 | WEST U.P. | 749.9 | 765.3 | -2% | N |
| 3 | UTTARAKHAND | 1517.3 | 1477.6 | 3% | N |
| 4 | HAR. CHD & DELHI | 623.6 | 527.1 | 18% | N |
| 5 | PUNJAB | 573.2 | 565.5 | 1% | N |
| 6 | HIMACHAL PRADESH | 1086.4 | 1245.1 | -13% | N |
| 7 | J & K AND LADAKH | 1040.4 | 1232.3 | -16% | N |
| 8 | WEST RAJASTHAN | 483.2 | 328.9 | 47% | E |
| 9 | EAST RAJASTHAN | 886.8 | 684.6 | 30% | E |
| CENTRAL INDIA | | 1304.5 | 1105.0 | 18% | |
| 1 | ODISHA | 1466.7 | 1444.7 | 2% | N |
| 2 | WEST MADHYA PRADESH | 1321.3 | 951.3 | 39% | E |
| 3 | EAST MADHYA PRADESH | 1293.4 | 1156.2 | 12% | N |
| 4 | GUJARAT REGION | 1143.0 | 967.3 | 18% | N |
| 5 | SAURASHTRA & KUTCH | 761.9 | 572.4 | 33% | E |
| 6 | KONKAN & GOA | 3337.4 | 3041.5 | 10% | N |
| 7 | MADHYA MAHARASHTRA | 1121.3 | 880.1 | 27% | E |
| 8 | MARATHWADA | 932.9 | 771.5 | 21% | E |
| 9 | VIDARBHA | 1347.3 | 1057.4 | 27% | E |
| 10 | CHHATTISGARH | 1438.1 | 1266.6 | 14% | N |
| SOUTH PENINSULA | | 1394.4 | 1127.2 | 24% | |
| 1 | A & N ISLAND | 3238.7 | 2838.2 | 14% | N |
| 2 | COASTAL A. P.& YANAM | 1128.1 | 1042.7 | 8% | N |
| 3 | TELANGANA | 1270.6 | 938.7 | 35% | E |
| 4 | RAYALASEEMA | 911.8 | 733.3 | 24% | E |
| 5 | TAMIL., PUDU. & KARAIKAL | 1131.0 | 921.4 | 23% | E |
| 6 | COASTAL KARNATAKA | 3763.2 | 3516.1 | 7% | N |
| 7 | N. I. KARNATAKA | 979.3 | 696.3 | 41% | E |
| 8 | S. I. KARNATAKA | 1628.3 | 1025.9 | 59% | E |
| 9 | KERALA & MAHE | 2897.0 | 2890.7 | 0% | N |
| 10 | LAKSHADWEEP | 2095.9 | 1584.3 | 32% | E |
| COUNTRY AS A WHOLE | | 1257.0 | 1160.0 | 8% | |

## CATEGORYWISE NO. OF SUBDIVISIONS & % AREA (SUBDIVISIONAL) OF THE COUNTRY

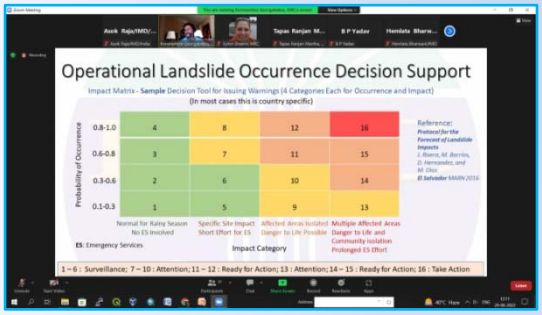
| CATEGORY | | PERIOD: ANNUAL (JAN-DEC) -2022 | |
|---|---|---|---|
| | | NO. OF SUBDIVISIONS | SUBDIVISIONAL % AREA OF COUNTRY |
| LARGE EXCESS | | 0 | 0% |
| EXCESS | | 13 | 42% |
| NORMAL | | 20 | 51% |
| DEFICIENT | | 3 | 7% |
| LARGE DEFICIENT | | 0 | 0% |
| NO RAIN | | 0 | 0% |

**South Asia Flash Flood Guidance Services**

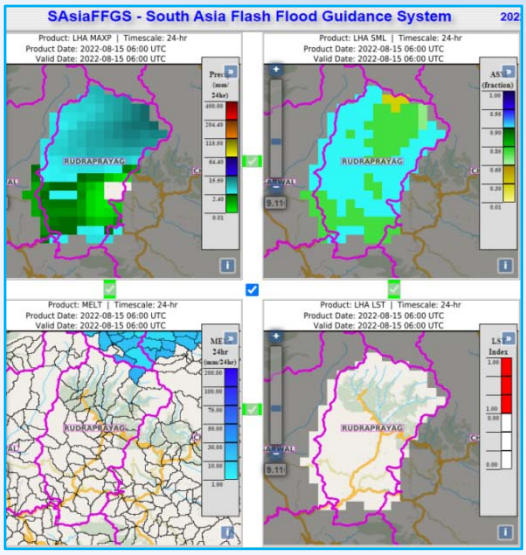
Recent initiatives under the flagship Flash Flood Guidance Services for South Asia programme

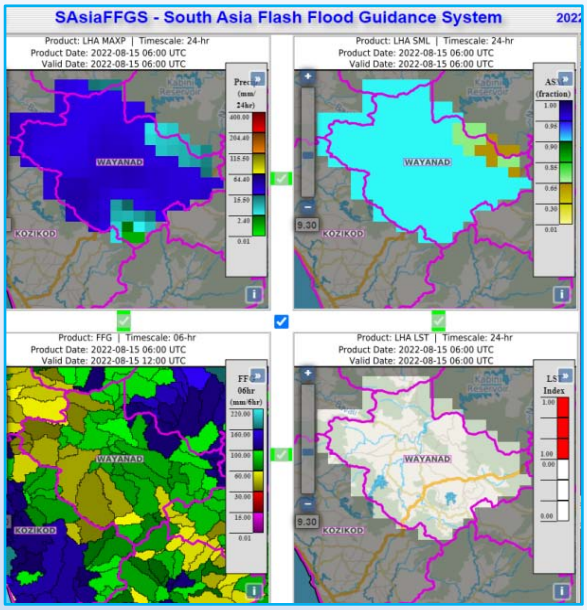
1. Flash Flood Guidance Services : Recent initiatives under the flagship Flash Flood Guidance Services for South Asia programme:

(I) Integration of Landslide Susceptibility Module into Flash Flood Guidance System for better predictability of landslide associated flash floods in the vulnerable hilly regions of Indian Subcontinent. Landslides are a major hydro-geological hazard that is invariably triggered due to incessant rains in conjunction with human intervention impacting the topographical features of the area. During the past few flood seasons, these events are increasingly witnessed in the Rudraprayag district of Uttarakhand and Wayanad district of Kerala. In collaboration with GSI, NRSC, IMD and HRC, a virtual training was conducted on 29th June, 2022 and the Landslide Susceptibility Module of Rudraprayag and Wayandwas integrated successfully into FFGS for operations.




1-Day Training by HRC on Landslide Susceptibility Module (29 June 2022)




Landslide Susceptibility Module of Rudraprayag & Wayanad

Integration of Urban Flood Module into Flash Flood Guidance System for real time flood monitoring of urban cities. In this context, Delhi has been selected for the pilot study on Urban Flood Modelling based on the increasing growth potential, vulnerability of sudden floods/ water logging. WMO has agreed to fund this project in collaboration with HRC as a development partner. Details of pre-requisite datasets are being collected to facilitate the implementation of this project.

In house development of automation of Flash Flood alerts in the form of graphical bulletins for providing Flash Flood Guidance Services was tested and commissioned for operations since December 2022.

## 5.2. Agrometeorological Advisories Services

Agrometeorological Observatories & Data Management:

(i) Agromet Division maintains a network of conventional agromet observatories of 191. The observations are uploaded in the website of Agromet Division (https://www.imdagrimet.gov.in/).

(ii) 200 Agro-AWS have been established at District Agromet Units (DAMUs) in the premises of KrishiVigyanKendras (KVKs)

(iii) Weather data have been integrated with KisanSuvidha app and Umang app.

(iv) Agromet data received from various stations are scrutinized and are being archived at National Data Centre Pune (NDC).

Weather Services under Gramin Krishi Mausam Sewa (GKMS)

a. Preparation of Agromet Advisory Service (AAS) bulletins

India Meteorological Department (IMD), Ministry of Earth Sciences in active collaboration with ICAR, State Agricultural University and Other Institutes is rendering the weather forecast based Agromet Advisory Services (AAS) to the farmers at district/block level through a network of existing 130 Agro-Met Field Units (AMFUs) and 199 District AgroMet Units (DAMUs). These agromet advisories are being prepared and disseminated by 329 units (AMFUs/DAMU) twice a week (Tuesday and Friday) covering 700 districts and 3100 blocks of the country under GraminKrishiMausamSewa (GKMS). AAS bulletins are also prepared and issued at state levels on every Tuesday & Friday and at National level on every Friday to cater to the needs of users at various levels. The bulletins include past weather, medium-range weather forecast for the next 5 days and specific agromet advisories on field crops, horticultural crops, livestock, etc.

b. Dissemination of agromet advisories

(i) Dissemination of agromet advisories to the farmers through different multi-channels like All India Radio (AIR) and Door Darshan, private TV and radio channels, newspaper and internet, SMS and IVR (Interactive Voice Response Technology) etc. is being carried out. Under Public Private Partnership (PPP) mode, Reliance Foundation, IFFCO Kisan Sanchar Limited (IKSL), Kisan Sanchar etc. are disseminating agromet advisories in SMS and IVR format to the farming community.

(ii) In addition to that, numbers of AMFUs are sending agromet advisories through SMS in collaboration with Agricultural Technology Management Agency (ATMA)/KVKs. Presently, the dissemination of special bulletin for extreme weather events is facilitated by mKisan portal of DAC&FW.

(iii) Apart from SMS, Agromet advisories are directly disseminated by AMFUs and DAMUs to the farming community with the help of social media like WhatsApp. Agromet Advisories have been disseminated to 13,75,330 farmers in 1,21,443 villages in 3,645 blocks through 16,377 WhatsApp groups till December 2022 (Fig.1).

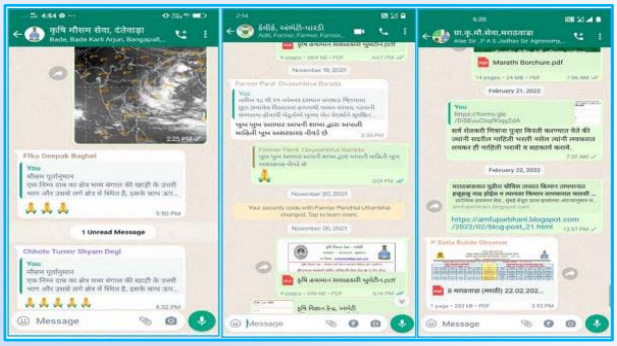


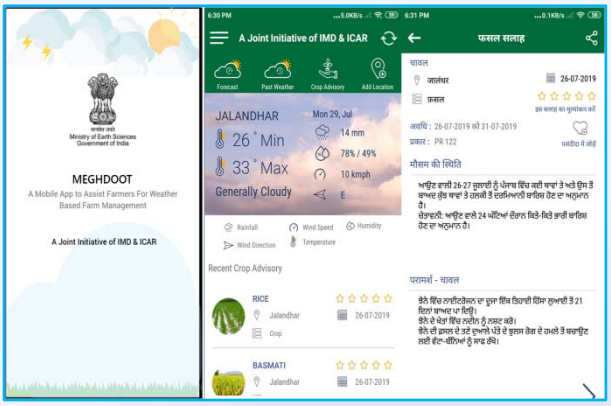
**Fig. 1.** Dissemination of Agromet Advisories in regional languages through WhatsApp

(iv) Integration of Agromet advisories with the mobile apps and websites of various State Department (Chhattisgarh, Tamil Nadu, Haryana, Madhya Pradesh, Gujarat, Rajasthan, Bihar, Nagaland, Uttarakhand, Meghalaya, Uttar Pradesh (Integration with Panchayat Raj website) and Odisha (Integration with SATARK App of OSDMA) (Fig. 2).


**Fig. 2.** Integration of Advisories with mobile State Govts.apps and Agril. Universities

**(iv) Meghdoot Mobile app**

The mobile App, Meghdoot, a joint initiative of India Meteorological Department (IMD), Indian Institute of Tropical Meteorology (IITM) and ICAR aims to deliver critical information to farmers through a simple and easy to use mobile application. Weather information and Agromet advisories are being disseminated through various other apps also.




**(v) Geospatial Agromet Advisory service**

Recently, IMD started displaying weather forecast at district level (12 Km resolution) for next 5 days on rainfall, cloud cover, maximum and minimum temperature, wind speed and direction, relative humidity morning and afternoon, warnings and nowcast using WebGIS on Mausam website. The district level agromet advisories are also available in vernacular language for 700 districts of the country (Fig. 3).

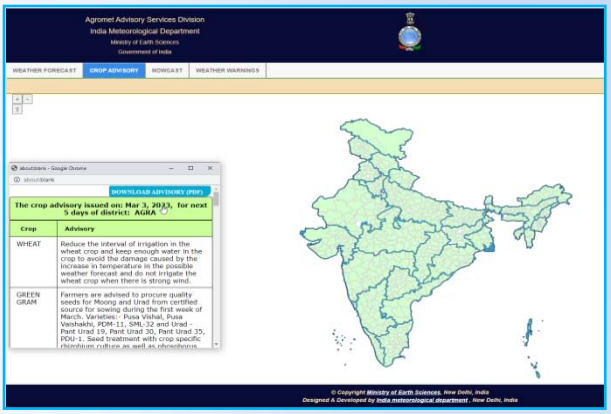



**Fig. 3.** Geospatial Agromet Advisory service

c. Agromet Products

Agrimet Division has continued generation of following agromet products like Spatial variation of weather parameters at different temporal scales, Soil Moisture (SM): Estimated SM based on Realized information (Daily) and Forecast (twice a week on Tuesday & Friday), Soil temperature and evaporation. In addition to this Satellite products like Normalized Difference Vegetation Index (NDVI), Reference Evapotranspiration and Insolation maps, Vegetation Condition Index (VCI), Vegetation Health Index (VHI) and Temperature Condition Index (TCI) Fig. 4.

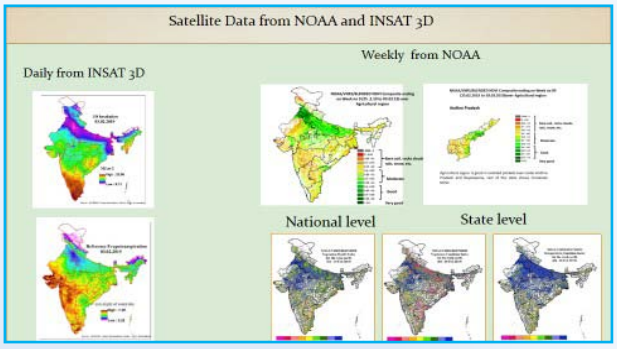



**Fig.4. Satellite Data Products**

**d. Display of Agromet Products in BHUVAN Portal of NRSC, Hyderabad**

Agrimet Division started display of spatial distribution of weather parameters at different temporal scales in BHUVAN Portal developed by National Remote Sensing Centre, Hyderabad on daily basis.

e. Space Applications Centre (SAC), Ahmadabad has recently developed ISRO-IMD Vegetation Information System for crop growth monitoring under GKMS scheme. The details have been shared with all AMFUs for their use in advisory preparation (Fig. 5).

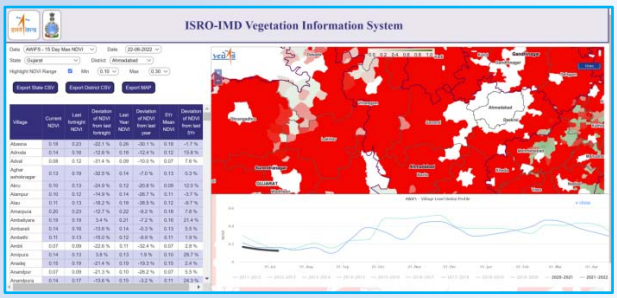



**Fig.5.ISRO-IMD Vegetation Information System**

**f. Dynamic Crop weather calendar (DCWC)**

IMD in collaboration with ICAR-CRIDA developed the Dynamic Crop Weather calendar; a designated standalone module to address the real-time crop phenological stage and their normal weather requirement. This module also helps in addressing the irrigation requirement of the crop based on the water balance approach. The DCWC intends to atomize agromet advisories using prevailing and forecasted weather. Modules have been validated for 303 locations covering all the Agro-climatic Zones.

**g. Support for management of Extreme weather events**

During the year, Impact based forecast (IBF) as well as related SMS have been issued to the farming community by the respective Agromet Field Units (AMFUs) of the States to safeguard the crops from cyclonic storms and other extreme weather events in the form of Alerts and warnings along with Agromet Advisories.Number of farmers receiving the SMS during various extreme events are furnished below:

(i) Special Agromet Bulletins and heavy rainfall warning were issued for cyclonic storm Asani (7-11 May) 2022, Sitrang (23-24 October), and Mandoug (8-9 December).

(ii) Impact based forecast (IBF) for Agriculture (Heavy Rainfall), (Heavy Rainfall/Thunderstorm with Gusty winds/Cold Wave/Hailstorm)and Agromet advisories based on the IBF have been issued for different districts of various States and UTs across the country in co-ordination with NWFC, New Delhi, RMCs/MCs, AMFUs and DAMUs.

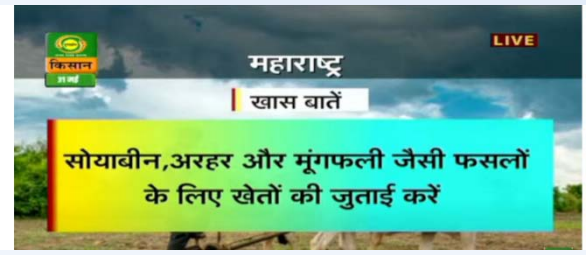
**(h) New Initiative under Gramin Krishi Mausam Sewa (GKMS)**

Expansion of District Agromet network from 130 to 329 to provide block-level Agromet advisories.

Issuance of Block level weather forecast and Advisory is targeted to reach maximum no. of farmer's household.

Development of advanced technology-based tools/techniques for automation of advisory generation, and feedback collection system.

Improvement in quality AAS using surface observations, Geo-spatial products and crop simulation models.




Dessimination of Agromet Advisories through National channel DD Kisan


Dessimination of Agromet Advisories through Regional DD News Channel of Bihar & Jharkhand

## 5.3. Positional Astronomy Services

At the time of Independence, India had a large number of different calendars with divergent methods of reckoning the time. These calendars reflected the rich and varied political, cultural and historical traditions of India. Each calendar system had its advantages and disadvantages. Therefore, there was a need to adopt a scientific approach and evolve a uniform calendar for the entire country.

It was felt desirable by the Government of India to have uniformity in the calendar throughout the country for civic, social and other purposes. The Government appointed a Calendar Reform Committee in November, 1952, under CSIR with Prof. MeghnadSaha as Chairman with a view to develop a unified National Calendar on the basis of most accurate modern astronomical data for the interest of national integrity. The committee recommended preparation of the Indian Ephemeris and Nautical Almanac calculated with most modern astronomical formulae, the National Calendar of India with timings of tithis, nakshatras, yoga etc, and also festival dates. The era chosen for this calendar was the Saka Era. The work of the Committee was taken up by the India Meteorological Department from 1st December, 1955. The work was entrusted to a unit named Positional Astronomy Centre at Kolkata. The unit undertook the preparation of 'The Indian Astronomical Ephemeris' for 1958, the first issue was published in 1957. Simultaneously the first issue of RashtriyaPanchang (containing data of National calendar along with usual panchang parameters to serve as a standard panchang for whole of the country) was started from 1879 Saka Era (1957-58 AD).

Positional Astronomy Centre, Kolkata under IMD, is the only national agency dealing with work on

publication of Ephemeris containing data on positional coordinates of celestial objects. The centre is also responsible to prepare the National Calendar for civil and religious purposes through publication of RashtriyaPanchang in 14 languages which serves as a standard panchang of the country and acts as a source of correct panchang data. The centre also fixes dates of all India festivals for all communities for declaration of holidays by the Central and State Governments Thus, the job performed by the centre is unique and no other organization in the country is performing this kind of work.

**Present Activities**

Publication of Indian Astronomical Ephemeris

Tables of Sunrise- Sunset, Moonrise-Moonset

Preparation of Indian National calendar

Publication of RashtriyaPanchang in 14 languages namely, Hindi, English, Sanskrit, Urdu, Assamese, Bengali, Gujarati, Marathi, Punjabi, Tamil, Telugu, Kannada, Malayalam and Odia.

Supply data to meets up data requirements of a large number of users including Government organizations, non-Government organizations, astronomers, various panchang makers, general public etc.

Taking observation on special astronomical events from time to time with the help of its portable telescopes.

**Activities during the Year 2022**

The Indian Astronomical Ephemeris for the year 2023, an annual publication of Positional Astronomy Centre, has been published both in hard copy and soft copy format. The publication contains mainly the positional data of the Sun, Moon and planets in different astronomical co-ordinate system; rising and setting time of the Sun and Moon; mean and apparent places of bright stars; diary of celestial events; eclipses and occultation data; calendric data; explanatory text and other useful information on astronomy.

RashtriyaPanchang of 1944 Saka Era (2022-23 AD) in 14 languages have been published both in hard copy and soft copy format. These are important regular publications of the centre catering to daily need of users of almanac, Panchang makers and other users. This publication contains Tithi, Nakshatra, Yoga and Karana in IST calculated for central point (82°30̀ E, 23°11′ N); Lunar months commences from the ending moment of New Moon-traditional luni-solar arrangement; Tables of longitudes, beginning of lagnas, transits of the Sun, Moon and planets in different rasis and nakshatras; All India fairs and festivals for all communities; Tables of Sunrise-Sunset and Moonrise-Moonset.

Tables of Sunrise- Sunset, Moonrise-Moonset for 2023 have been published during the year 2022.

Web based service has been continued by the centre by creation of electronic versions of 14 language editions of RashtriyaPanchang and Indian Astronomical Ephemeris which can be accessed by the users through the PAC Kolkata website.

The monthly star charts and astronomical bulletins for all 12 months of 2022 has been prepared by the centre with the aim to provide helpful guidance on observing celestial objects in the night sky. The bulletins comprise concise explanations of object positions in the sky, along with celestial diagrams, which can be used for practical demonstrations.

All India festivals for all communities have been fixed for the year 2023 in advance for declaration of holidays by the Government of India and other State Governments. Calendar data of Indian National Calendar along with Gregorian calendar data for the year 2023-24 has been prepared in advance for various stakeholders.

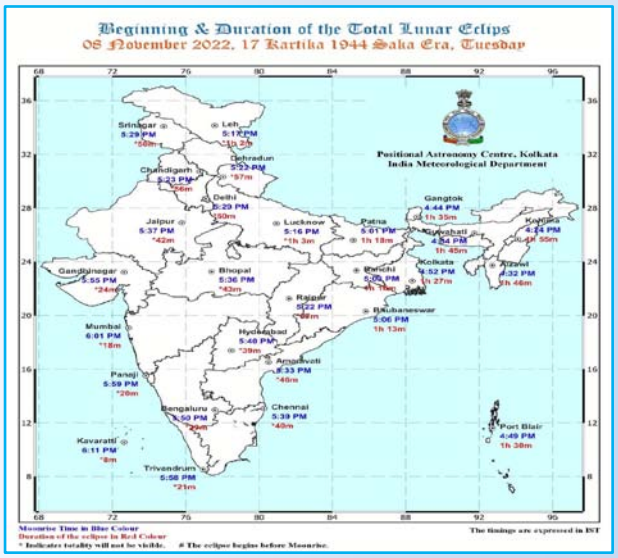
Advance panchang data has been prepared and supplied to different stakeholders.

Press bulletin has been issued in advance for media for eclipse event in 2022 visible in India.

**Observation**

The total lunar eclipse on 8$^{th}$ November, 2022 (17$^{th}$ Kartika, 1944 Saka Era) was observed from the terrace of the PAC, Kolkata building with the help of 14-inch, 12-inch and 6-inch telescopes. The beginning of the partial (Umbral) phase (at 1439

IST) and total phase (at 1546 IST) of the eclipse were not visible as the phenomena happened before the Moonrise (at 1652 IST). The phenomenon of rise of the eclipsed moon could not be observed through the telescope of the PAC due to cloudiness. However, the ending of both the total phase (at 1712 IST) and the partial (Umbral) phase (at 1819 IST) were successfully observed from the PAC rooftop and timings of occurrence of both the phenomena matched with the mathematically computed timings at this centre.




## 5.4. Climate Research & Services

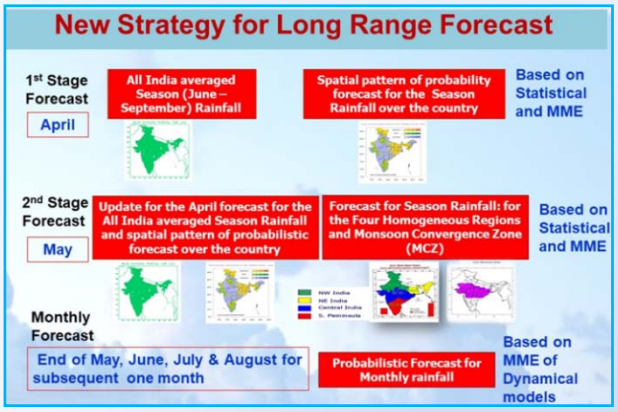
### (i) Operational Long Range Forecast and its Verification

### Operational LRF System

India Meteorological Department (IMD) issues operational monthly and seasonal forecasts for the southwest monsoon rainfall using models based on the latest statistical techniques with useful skill (Rajeevan et al., 2007, Pai et al., 2011). Since 2021, IMD has adopted a new strategy for issuing monthly and seasonal operational forecasts for the southwest monsoon rainfall over the country by modifying the existing two stage forecasting strategy. Schematic diagram (Fig. 1) showing various operational forecasts for the southwest monsoon rainfall issued by IMD. The new strategy is based on the existing statistical forecasting system and the newly developed Multi-Model Ensemble (MME) based forecasting system. The MME approach uses the coupled global climate models (CGCMs) from different global climate prediction and research centers including IMD's Monsoon Mission Climate Forecasting System (MMCFS) model. The spatial distribution of probabilistic forecasts for tercile categories (above normal, normal and below normal) for the seasonal rainfall (June to September) over the country was also issued at the end of the previous month based on MME approach for the first time in the history of the operational seasonal forecasting in the country. In addition to that, IMD has also been making efforts to develop a separate forecast for the Monsoon Core Zone (MCZ), which represents most of the rainfed agriculture region in

the country. A separate forecast for the MCZ will be more useful for agricultural planning and crop yield estimation etc. IMD will issue a separate probabilistic forecast for the MCZ, based on MME system and a new statistical model.

Details of the various long range forecasts issued by IMD and their verification are discussed in thisreport. Various operational forecasts issued by IMD as shown in table 1 and the Performance operational forecast (1988-2022) is shown in Fig. 2.



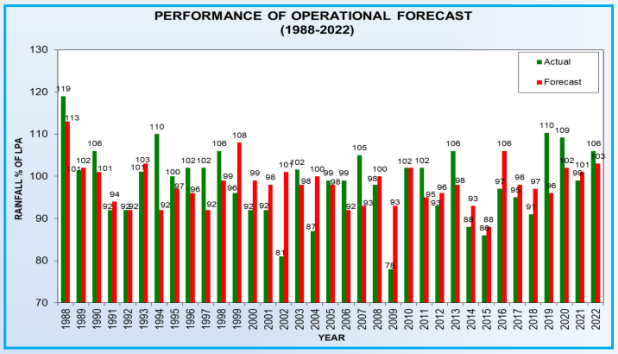




**Fig. 2.** Performance operational forecast (1988-2022)

**TABLE 1**

**Details of the various long range forecasts issued by IMD**

| S.No. | Forecast for | Region for which forecast issued | Method/Model |
|---|---|---|---|
| 1 | Monthly outlook for rainfall and temperatures during February 2022 | North India consisting of seven meteorological subdivisions (East Uttar Pradesh, West Uttar Pradesh, Uttarakhand, Haryana, Chandigarh & Delhi, Punjab, Himachal Pradesh, Jammu Kashmir & Ladakh) and spatial rainfall probability forecast | MME |
| 2 | Seasonal (March-May) and Monthly (March) 2022 Outlook for the Rainfall and Temperatures | Country as a Whole | MME |
| 3 | Long Range Forecast for the 2022 Southwest Monsoon Season Rainfall | Country as a Whole | Statistical & MME |
| 4 | Monthly Outlook for the Temperature and Rainfall during May 2022 | Country as a Whole | MME |
| 5 | Forecast of the Onset Date of Southwest Monsoon - 2022 over Kerala | Over Kerala | MME |
| 6 | Updated Long Range Forecast of Rainfall during Southwest Monsoon Season (June - September), 2022 and Monthly Outlook for Rainfall and Temperature during June 2022 | Country as a Whole, | Statistical & MME |
| 7 | Forecast outlook for rainfall and temperatures during the month of July 2022 of Southwest monsoon season | Country as a Whole | MME |
| 8 | Forecast outlook for rainfall and temperatures during the month of August and August-September 2022 of Southwest monsoon season. | Country as a Whole | MME |
| 9 | Forecast outlook for rainfall and temperatures for the Month of September 2022 | Country as a Whole | MME |
| 10 | Forecast outlook for rainfall and temperatures for Post-monsoon Season (OCT-DEC) 2022 | South Peninsular India | MME |
| 11 | Salient Features of Monsoon 2022 | Country as a Whole | .... |
| 12 | Long Range Forecast for rainfall and temperature for November 2022 | Country as a Whole | MME |
| 13 | Seasonal Outlook for Winter Temperatures and Rainfall and Temperature Forecast for December 2022 | Country as a Whole | MME |

Verification of Operational Long Range Forecasts:

Southwest Monsoon Season (June to September, 2022) Rainfall

Table 1. gives the summary of the various operational long range forecasts issued for the 2022 Southwest monsoon rainfall along with the realized rainfalls.

The first stage forecast for the season (June-September) rainfall over the country as a whole issued in April was 99% of LPA with a model error of ± 5% of LPA. The update issued in May for this forecast was (103% of LPA) with a model error of ± 4% of LPA. The actual season rainfall for the country as a whole was 106% of LPA, which is 7% & 3% of LPA more than the April and June forecasts respectively. Thus, the April forecasts was not within upper forecast limit but the updated forecast was within upper limit and were underestimated the actual rainfall value. The spatial distribution of probabilistic forecasts for tercile categories (above normal, normal and below normal) for the seasonal rainfall (June to September) is shown in Fig. 1(a) and observed rainfall category is given in Fig. 1(b).

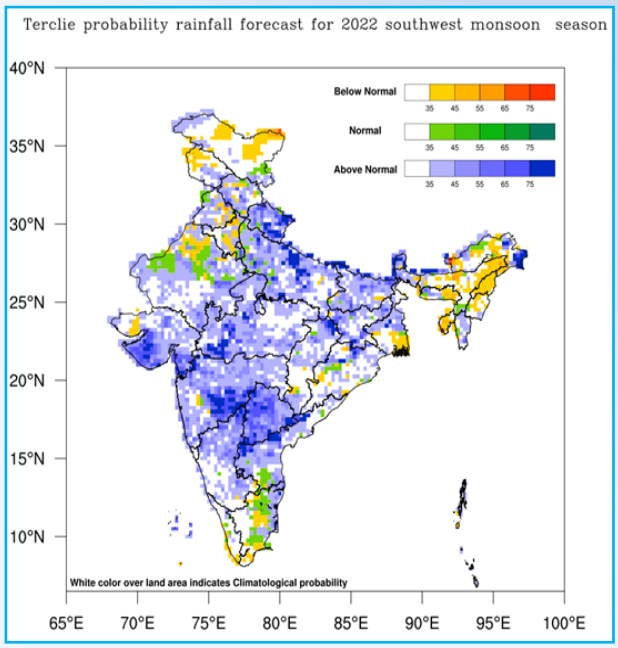



**Fig. 1(a).** The spatial distribution of probabilistic rainfall forecasts for tercile categories for JJAS 2022

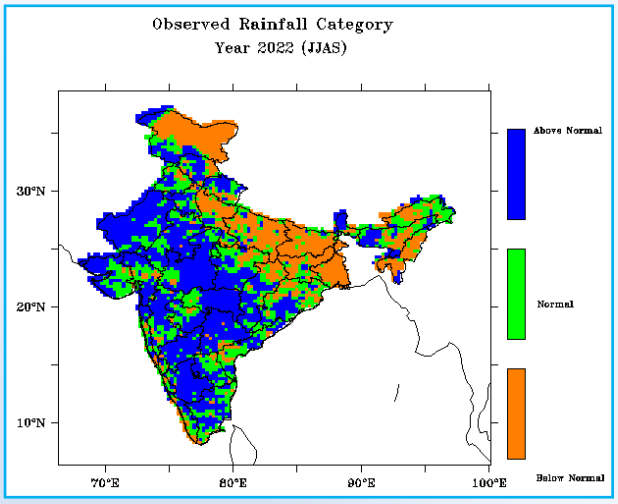



**Fig. 1(b).** The spatial distribution of observed rainfall category for 2022 monsoon season

Considering the four broad geographical regions of India, the forecasts issued in 31st May for the season rainfall over Northwest India, Central India, Northeast India and South Peninsula were Normal (92-108% of LPA), Above Normal (>106% of LPA), Normal [96-106% of LPA)] & Above Normal (>106% of LPA) respectively. The newly introduced seasonal rainfall over Monsoon Core Zone (MCZ) was forecast as Above Normal (>106% of LPA). The actual rainfall over Northwest India, Central India, Northeast India, South Peninsula and Monsoon Core Zone were 101%, 119%, 82%, 122% and 120 % of the LPA respectively. The monthly forecast issued for June, July, August & September were Normal [92-108% of Long Period Average (LPA)], normal [94 to 106 % of Long Period Average (LPA)], Normal [94-106% of Long Period Average (LPA)] & Above Normal [>91-109% of Long Period Average (LPA)] respectively. The actual rainfall for the country as a whole for June was 92% of LPA, July was 117% of LPA, August was 103% of LPA whereas for September was 108% of LPA. The forecast for the second half of the monsoon season (August - September) for the country as a whole was normal [94 to 106% of Long Period Average (LPA)] whereas actual rainfall was 105% of LPA. The monthly forecast issued for July was underestimated and August was within the range of the forecast whereas for September was slightly below the range of the forecast. The forecast for the second half of the monsoon season (August -September) for the country as a whole was within the forecast limit.

**Table 2**

**Verification of the operational forecast issued for the 2022 southwest monsoon rainfall**

| Region | Period | Forecast (% of LPA) | Actual Rainfall (% of LPA) |
|---|---|---|---|
| | | **(Issued on 14th April)** | |
| **All India** | June to September | Normal (96-104% of LPA)<br>99± 5 of LPA | 106.5 |
| | | **(Issued on 31st May)** | |
| All India | June to September | Normal (96-104% of LPA)<br>103± 4 of LPA | 106.5 |
| Northwest India | June to September | Normal (92-108% of LPA) | 101 |
| Central India | June to September | Above Normal (>106% of LPA) | 119 |
| Northeast India | June to September | Normal (96-106% of LPA) | 83 |
| South Peninsula | June to September | Above Normal (>106% of LPA) | 122 |
| Monsoon Core Zone | June to September | Above Normal (>106% of LPA) | 120 |
| All India | June | Normal (92-108% of LPA) | 92 |
| All India | July (issued on 1st July) | July: Normal (94-106% of LPA | 116.8 |
| All India | August & Aug-Sept (issued on 1st Aug) | August: Normal (94-106% of LPA | 103.5 |
| | | Aug+Sept: Normal (94-106% of LPA) | 105 |
| All India | September (issued on 1st Sept) | Above Normal (>91-109% of LPA) | 108 |

(II) Regional Climate Centre (RCC) Activities:

The CRS office of IMD, Pune is also recognized as the WMO Regional Climate Center (RCC) for south Asia. Presently the MMCFS is used for the following the RCC long range forecasting activities.

(a) Generate global monthly and seasonal (anomaly and probability) forecasts for the temperature and rainfall. This is updated every month.

(b) Prepare Seasonal Climate Outlook for rainfall and temperatures over south Asia for the next 2 moving 3-month seasons (total 4 months) with monthly update.

(c) Prepare ENSO & IOD bulletin every month providing statement on the global SST anomalies and probabilities forecast with emphasis on the ENSO and IOD conditions for the next 9 months prepared based with monthly update.

(d) Take lead role in preparing consensus forecast outlook for the monsoon season rainfall, northeast monsoon rainfall and winter rainfall over south Asia.

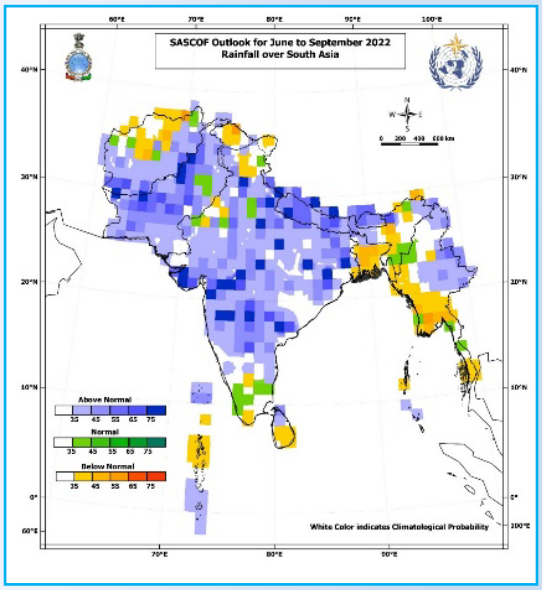
(e) Acting as Lead Centre in conducting South Asia Climate Forum Activities for RA II Region and Conducting SASCOF for generating consensus outlook for South Asian region for Summer Monsoon, Northeast Monsoon and December to February (DJF) Season. During the year 2022, three such SASCOF events were organized (SASCOF 22, SASCOF 23, and SASCOF 24).

Summary of SASCOF 22:

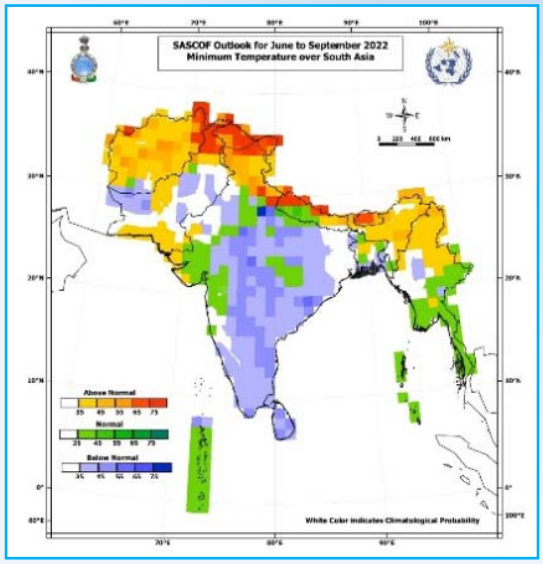
Normal to above normal rainfall is most likely during the 2022 southwest monsoon season (June – September) over most parts of the South Asia. Geographically, above normal rainfall is most likely along the foot hills of Himalayas, many areas of northwestern and central parts of the region, and some areas of east and southern parts of the region. However, below normal rainfall is most likely over some areas of extreme north, northwest, and south, and southeastern parts of the region. The seasonal rainfall is most likely to be normal or of climatological probabilities over the remaining areas of the region.

During the season, above normal minimum temperatures are likely over many areas along

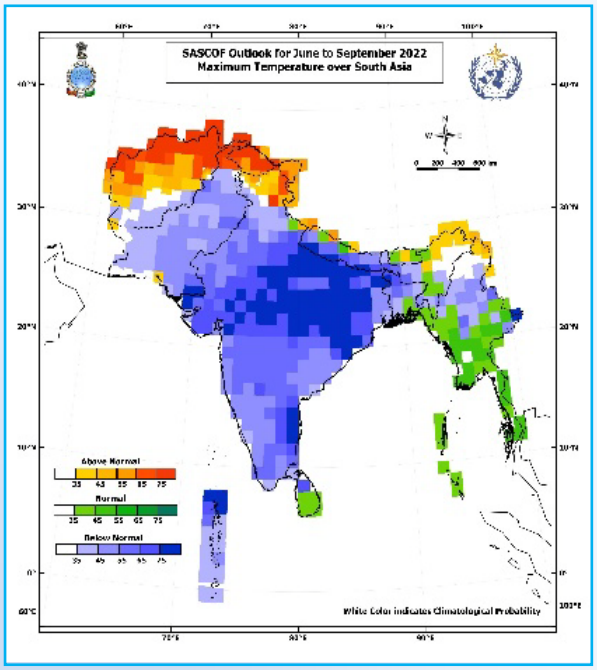
foothills of Himalayas, northern, northwestern and northeastern parts of the South Asia. Below normal to normal minimum temperatures are most likely over most areas of central, southern and southeastern part of South Asia. The seasonal minimum temperatures have climatological probabilities over remaining parts of the region. The seasonal maximum temperatures are most likely to be normal to below normal over most parts of the region except over extreme northwest and some areas of northern and northeastern parts of the region. Maximum temperatures have climatological probabilities over remaining parts of the region.




Probability of the most likely category for the 2022 southwest monsoon rainfall over South Asia




Consensus outlook for the monsoon season (June to September 2022) Minimum Temperature and over South Asia

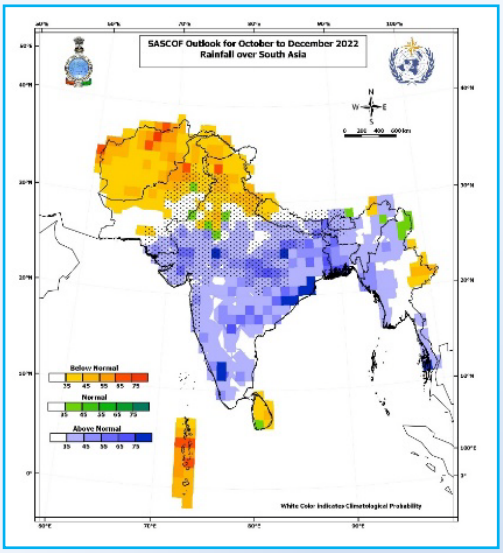



Consensus outlook for the monsoon season (June to September 2022) Maximum Temperature and over South Asia

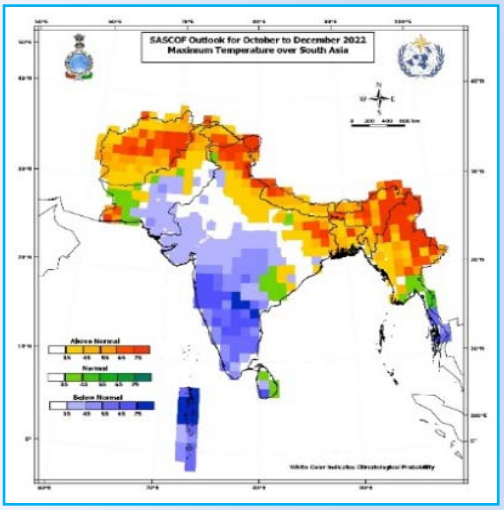
**Summary of SASCOF 23**

Below-normal rainfall is likely during October - December (OND) season 2022 over the extreme southern parts of the South Asia including the islands where climatologically we receive good amount of rainfall during the season. Below normal rainfall is also likely over the northwestern parts of South Asia as well as extreme eastern parts of South Asia which normally receive very low rainfall during OND season. Above normal rainfall is likely over most parts of west, central and northeast regions and remaining area of southern parts of South Asia. Remaining part of the region is likely to experience normal or climatological probability for the seasonal rainfall.

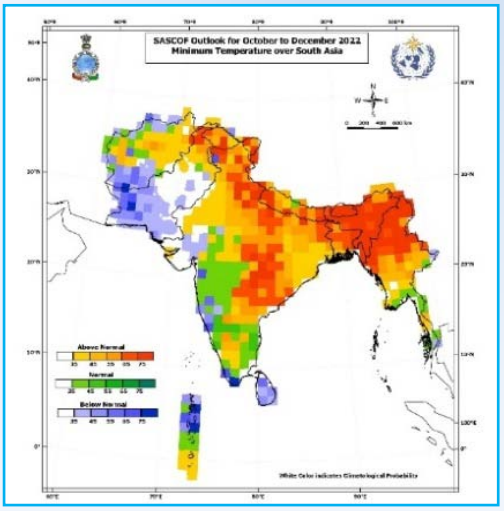
During the season, normal to above normal maximum temperatures are likely over northwest, northeast parts of South Asia including foothills of Himalaya. The maximum temperature is likely to be below normal over the west, central and southern parts of South Asia. The minimum temperature is likely to be above normal over most part of the region except parts of west, northwest and southern parts of South Asia.




Outlook for 2022 October to December season Rainfall over South Asia. The dotted area showed in the map climatologically receives very low rainfall and experience dry weather during OND season




Outlook for October to December season 2022 maximum temperature over South Asia



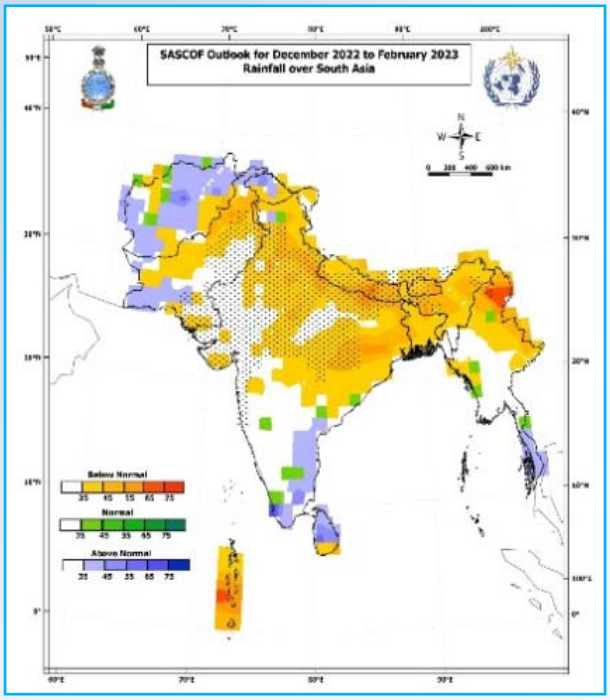

Outlook for October to December season 2022 minimum temperature over South Asia

**Summary of SASCOF 24**

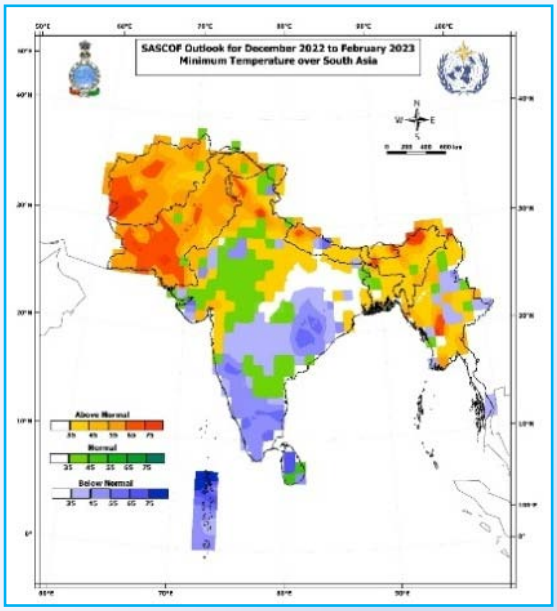
Below-normal precipitation is likely during the winter season (December 2022 to February 2023) over many regions of South Asia like parts of the north, northwest, along the foothills of the Himalayas, and the northeastern part of South Asia. Above normal precipitation is likely over the extreme northwest region and some regions of the southern part of South Asia.

During the season, above normal minimum temperatures are likely over many areas of the north, northwestern, northeast, and along the plains of the Himalayas. However, below normal minimum temperatures are likely over some areas of central and southern parts of the region.

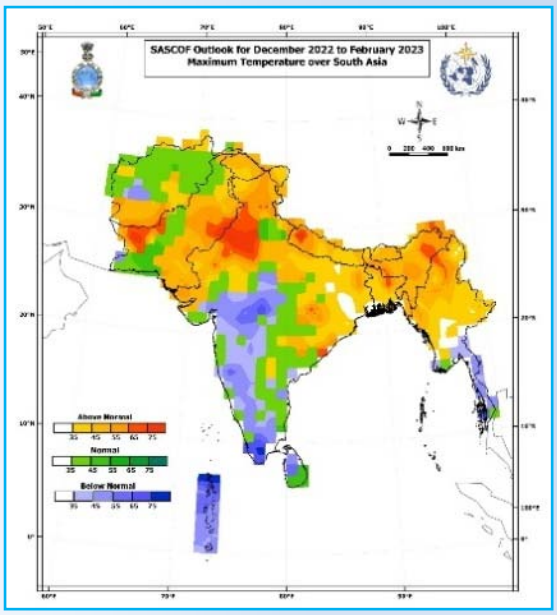
Normal to Above normal maximum temperatures are most likely over north, northwest, northeast regions and along the Himalayas. Below normal maximum temperatures are likely over parts of the central and southern regions.




Consensus outlook for the winter season (December 2022 to February 2023) precipitation over South Asia. The dotted area shown in the map climatologically receives very low rainfall and experiences dry weather during the DJF season




Consensus outlook for the winter season (December 2022 to February 2023) Minimum Temperature over South Asia




Consensus outlook for the winter season (December 2022 to February 2023) Maximum Temperature over South Asia

## 5.5. Cyclone Monitoring & Prediction

### 5.5.1. Salient features of the cyclonic disturbances over the North Indian Ocean during 2022

The salient features of the cyclonic disturbances (CDs) over the north Indian Ocean (NIO) during the year 2022, the operational forecast performance of India Meteorological Department (IMD) and new initiatives during the year are presented below:

**1. Salient features of CDs over the NIO.**

Following CDs developed over the NIO during 2022:

(i) Deep depression over Bay of Bengal during 03-06 March, 2022
(ii) Deep depression over North Andaman Sea during 20-23 March, 2022
(iii) Severe cyclonic storm Asani over Bay of Bengal during 07-12 May, 2022
(iv) Depression over Bay of Bengal during 20-21 May, 2022
(v) Depression over Arabian Sea during 16-18 July, 2022
(vi) Depression over coastal Odisha during 09-10 August, 2022
(vii) Depression over Arabian Sea during 12-13 August, 2022
(viii) Depression over Bay of Bengal during 14-16 August, 2022
(ix) Deep depression over Bay of Bengal during 19-23 August, 2022
(x) Depression over South Odisha during 11-12 September, 2022
(xi) Cyclonic Storm Sitrang over Bay of Bengal during 22-25 October, 2022
(xii) Depression over Bay of Bengal during 20-22 November, 2022
(xiii) Severe Cyclonic Storm Mandous over Bay of Bengal during 06-10 December, 2022
(xiv) Deep Depression over Arabian Sea during 14-17 December, 2022
(xv) Depression over Bay of Bengal during 22-25 December, 2022

Observed tracks of the CDs during 2022 are presented in Fig. 1.

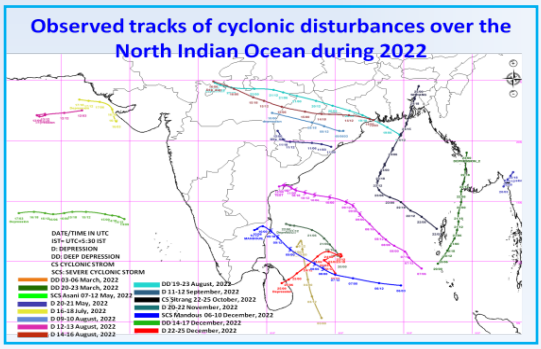



**Fig. 1.** Tracks of cyclonic disturbances over the North Indian Ocean during 2022

- Annual Frequency of CDs: During 2022, 15 CDs (maximum sustained wind speed (MSW) ≥ 17 knots) developed over the NIO against normal (during 1965-2021) of 11.2 per year. Thus, annual activity of formation of CD was above normal during the year 2022.

- Frequency of different categories of CDs: There were 12 depressions and deep depressions (MSW: 17-33 knots) (Normal: 6.5 per year), 1 cyclonic storm (MSW: 34-47 knots) (Normal: 1.8 per year) and 2 severe cyclonic storms (MSW: 48-63 knots) (Normal: 2.9 per year) during the year 2022. A total of 3 cyclones (MSW ≥ 34 knots) developed over the NIO during 2022 against normal of 4.7 per year. Overall, the frequency of formation of depressions over the region was above normal and that of cyclones was below normal during 2022.

- Frequency of CDs over Bay of Bengal and Arabian Sea: There were 3 CDs over Arabian Sea (Normal: 2.3 per year), 10 over Bay of Bengal (Normal: 7.8 per year) and 2 over land (Normal: 1.1 per year) during 2022. Basin-wise activity wrt formation of CDs was above normal over Bay of Bengal, Arabian Sea and Land.

- Frequency of cyclones over Bay of Bengal (BoB) and Arabian Sea(AS): 3 cyclones developed over the BoB and zero over the AS against normal of 3.5 per year and 1.2 per year over the BoB and AS respectively. Thus, frequency of formation of CS over both the basins was below average.

- Unique features wrt frequency of cyclones: During 2022, no cyclone developed over the AS against normal (1965-2020) of 1.2 per year. In past, no cyclone over the AS was observed in 1990, 1991, 1997, 2000, 2005, 2008, 2013, 2016, 2017.

- Unique feature wrt intensity of cyclones: There was no very severe cyclonic storm during 2022. Last such activity was observed 10 years ago in 2012 followed by 2009, 2005, 2002, 1986 (during the period 1982-2021).

- Frequency of CDs in different seasons: There were 4 CDs during pre-monsoon season (March-May) (Normal: 1.4 per year), 6 CDs during monsoon season (June-September) (Normal: 4.9 per year) and 5 during post-monsoon season (October-December) (Normal: 4.8 per year). Season-wise activity was above normal during pre-monsoon season.

- Movement: Asani exhibited multiple recurvatures (significant change in direction of movement), very slow movement and weakening before landfall. Sitrang followed recurving track, very fast movement prior to landfall and very short life period. Mandous also followed recurving path and slow movement. Thus, all the 3 TCs during 2022 had recurving tracks and either slow or fast movement before and during landfall and two out of three cyclones had weakening trend before landfall.

- Landfall: All the 3 cyclones were landfalling systems (Normal: 3.2 per year). However, hileAsani crossed coast a deep depression, Sitrang and Mandous crossed coast as cyclonic storms.

- Annual Accumulated Cyclone Energy: The Annual Accumulated Cyclone Energy (a measure of damage potential) in association with cyclones during 2022 was 6.37 × 104 knots 2 against the long period average (LPA) based on data of (1982-2020) of (a) 14.41 × 104 knots 2 for cyclones over the BoB, (b) 6.77 × 104 knots 2 over the AS and (c) 21.18 × 104 knots2 over the NIO. Thus, the damage potential of cyclones during 2022 was less as compared to annual average over the BoB, AS and NIO.

- Power Dissipation Index: The Annual Power Dissipation Index (a measure of loss) in association with cyclones during 2022 was 3.04 × 106 knots3 against the LPA based on data of (1982-2020) of (a) 9.51 × 106 knots3 for cyclones over the BoB, (b) 4.57 × 106 knots3 over the AS and (c) 14.08 × 106 knots 3 over the NIO. Thus, the measure of loss due tocyclones during 2022 was less as compared to annual average over the BoB, AS and NIO.

- Total life period: Total number of CD days over the NIO during 2022 was 39 days and 9 hours during 2022 against the LPA (based on data during 1990-2020) of 29 days and 20 hours. It was mainly due to increased frequency of depressions/ deep depressions instead of longer life period of any CDs.

- Average translational speed: Six hourly average translational speed of cyclones during

2022 was 15.5 kmph against LPA (based on data during 1990-2020) translational speed of 13.9 kmph for cyclones over BoB. This it was near normal.

- In spite of the recurving tracks and increased difficulty level in forecasting, all the parameters including genesis, track, landfall point, landfall time & intensity and associated adverse weather including heavy rainfall, wind and storm surge were predicted accurately with sufficient lead period. It enabled disaster managers, stakeholders and general public to take response actions which resulted in significant reduction in death toll and management of cyclonic disturbances over the region.

- Operational Forecast Performance: The average track forecast errors during 2018-22 have been 75 km, 113 km and 154 km respectively for 24, 48 and 72 hrs against the average errors of 93, 144 and 201 km during 2012-21. The average errors in intensity forecast during 2018-22 have been 7.4 knots, 10.5 knots and 14.0 knots respectively for 24, 48 and 72 hrs lead period of forecast against the average errors of 10.4, 15.5 and 15.7 knots during 2012-21. The annual average landfall point forecast errors for the year 2022 have been 14.8 km, 24.5 km and 4.5 km for 24, 48 and 72 hrs lead period against the past five years average errors of 30.7 km, 43.9 km and 85.7 km during 2012-2021.

- The accuracy in both track and intensity prediction registered an overall improvement of 20-30% upto 72 hours lead period during 2018-22 as compared to that of 2013-17. The accuracy in landfall point prediction registered an overall improvement of 40-70% upto 72 hours lead period during 2018-22 as compared to that of 2013-17.

- Death toll: The cyclones during 2022 caused total number of 5 deaths in India and 38 deaths in WMO/ESCAP panel member countries (viz. Bangladesh and Sri Lanka).

## 2. Monitoring and forecasting

IMD utilized all it's resources for monitoring and prediction of CDs during 2022. We are happy to inform you that all the cyclonic disturbances were monitored and predicted with sufficient lead time and great accuracy. IMD maintained continuous watch over the NIO and monitored all the disturbances with issue of extended range outlook (valid for next 15 days), daily tropical weather outlook (valid for next 5 days), daily detailed prognostic and diagnostic report during October-December (valid for next 7 days) and 6hourly/3hourly/hourly structured bulletins on formation of cyclonic disturbance period. The CDs were monitored with the help of available satellite observations from INSAT 3D and 3DR, polar orbiting satellites, available ships & buoy observations in the region, Doppler Weather Radars (DWR) and observations from coastal observatories. Various global models and dynamical-statistical models run by Ministry of Earth Sciences (MoES) institutions including IMD, NCMRWF, IITM and INCOIS were utilized to predict the genesis, track, landfall and intensity of the CDs as well as associated severe weather including heavy rainfall, strong winds and storm surge. A digitized forecasting system of IMD was utilized for analysis and comparison of various observations and numerical weather prediction models guidance, decision making process and warning products generation. The forecasts were mainly based on multi-model ensemble techniques developed indigenously by IMD.

## 3. Forecast performance of RSMC New Delhi

### 3.1 . Annual Performance during 2022

(a) Genesis Forecast performance: All the CDs developed over the region were predicted in the extended range outlook (ERO) issued every Thursday. Cyclone Asani was predicted in the ERO guidance issued on 28th April, about 9 days ahead of formation of depression over BoB on 7th May. Sitrang was predicted in the ERO guidance issued on 6th October, about 16 days ahead of formation of depression over BoB on 16th October. Mandous was predicted in the ERO guidance issued on 24th November, about 12 days ahead of formation of depression over BoB on 6$^{th}$ December.

(b) Pregenesis track and intensity forecast performance: IMD issued pre-genesis forecast of track, intensity and landfall iro the cyclones from low pressure area stage with reasonable accuracy. The pre-genesis track forecast of cyclone, Mandous had almost zero landfall point & time as well as landall intensity forecast errors.

(c) Track forecast performance: Annual average track forecast errors in 2022 have been 42.3 km, 77.5 km and 108.0 km, respectively for 12, 24 and 36 hrs against the long period average (LPA) errors of 51.7, 82.4 and 100.3 km based on data of 2012-2021. The forecast accuracy since 2003 indicates an improvement at the rate of 5.8 km/year (58 km in 10 years) for 24 hrs lead period.

(d) Intensity forecast performance: The annual average absolute error (AE) in intensity forecast error has been 3.8 knots, 4.0 knots and 5.0 knots against the LPA (2012-21) errors of 8.9, 13.0 and 14.9 knots for 24, 48 and 72 hrs lead period respectively. The intensity forecast accuracy since 2005 indicates an improvement at the rate of 0.52 knots/year (5.2 knots in 10 years) for 24 hrs lead period.

(e) Landfall point forecast performance: The annual average landfall point forecast errors for the year 2022 have been 14.8 km, 24.5 km and 4.5 km against the LPA (2012-21) errors of 32.5 km, 62.9 km and 103.9 km for 24, 48 and 72 hrs lead period respectively. The landfall point forecast accuracy since 2003 indicates an improvement at the rate of 14.4 km/year (144 km in 10 years) for 24 hrs lead period since 2003.

(f) Landfall time forecast performance: The landfall time forecast errors for the year have been 5.0, 7.5 and zero hrs against the LPA (2012-21) errors of 3.1, 4.9 and 6.6 hrs for 24, 48 and 72 hrs lead period respectively. The landfall time forecast accuracy since 2003 indicates an improvement at the rate of 0.18 hours/year (1.8 hours in 10 years) for 24 hrs lead period since 2003.


**Fig. 2.** Annual average track, intensity, landfall point and landfall time forecast accuracy during 2022

The annual average track, intensity, landfall point and landfall time forecast accuracy during 2022 compared to LPA (2012-2021) accuracy are presented in Fig. 2. Typical observed and forecast tracks with cones of uncertainty and quadrant wind distributions during cyclone Sitrang and Mandous are presented in Fig. 3 and Fig.4 respectively.

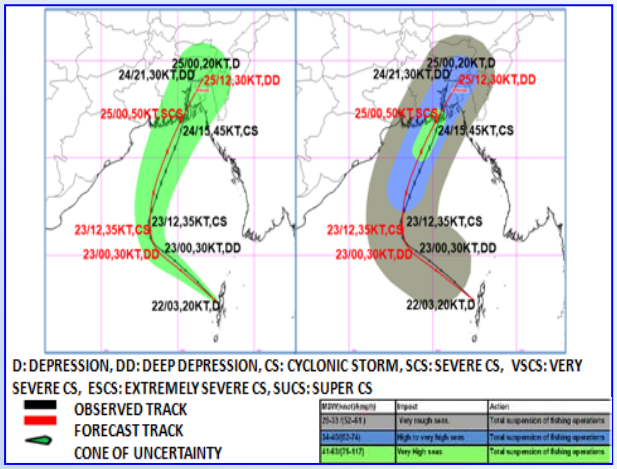



**Fig. 3.** Observed and forecast track issued at 0830 hours IST of 22nd October (63 hours prior to landfall) indicating accuracy in track, landfall and intensity

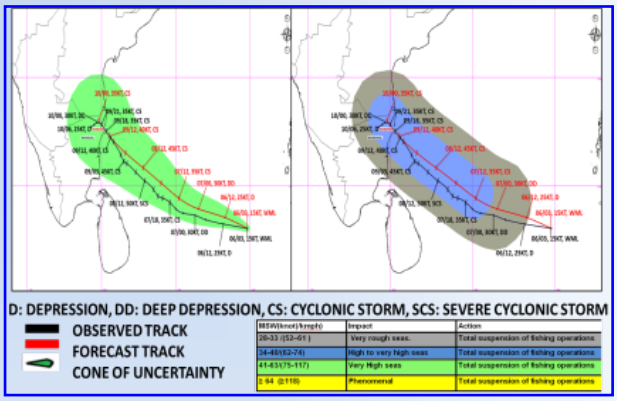



**Fig. 4.** Observed and forecast track issued at 0830 hours IST of 6th December (90 hours prior to landfall) indicating accuracy in track, landfall and intensity

### 3.2. Forecast Performance during 2018-22 vis-a-vis 2013-17

a. The average track forecast errors during 2018-22 have been 74 km, 112 km and 153 km respectively for 24, 48 and 72 hrs against the average errors of 93, 144 and 201 km during 2013-17. The accuracy in track prediction registered an overall improvement of 20-25% upto 120 hours lead period during 2018-22.

b. The average errors in intensity forecast during 2018-22 have been 7.4 knots, 10.5 knots and 14.0 knots respectively for 24, 48 and 72 hrs lead period of forecast against the average errors of 10.4, 15.5 and 15.7 knots during 2013-17. The accuracy in intensity prediction registered an overall improvement of 20-30% upto 72 hours lead period during 2018-22.

c. The annual average landfall point forecast errors during 2018-22 have been 26.2 km, 39.9 km & 75.6 km for 24, 48 & 72 hrs lead period against the average errors of 42.3 km, 94.8 & 122.1 km during 2013-17. Thus, the accuracy in landfall point prediction registered an overall improvement of 40-70% upto 72 hours lead period during 2018-22.

d. The landfall time forecast errors during 2018-22 have been 2.8, 4.5 & 3.8 hrs for 24, 48 & 72 hrs lead period against the average errors of 3.6, 5.4 & 8.0 hrs respectively during 2013-17. Thus, the accuracy in landfall time prediction registered an overall improvement of 15-25% upto 48 hours lead period during 2018-22.

The comparative analysis of track, landfall and intensity errors during 2018-22 vis-à-vis the errors during 2013-17 are presented in Fig. 5.

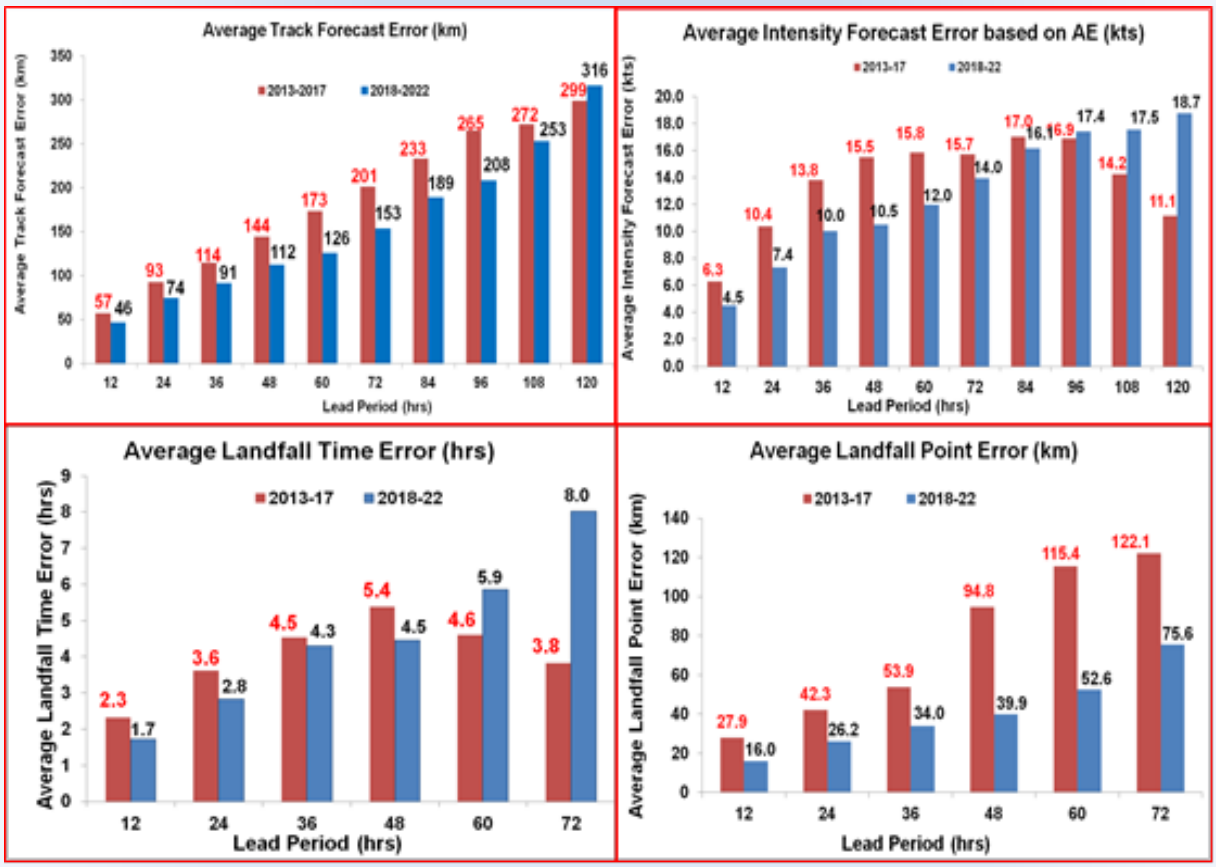



**Fig. 5.** Comparative analysis of track, intensity, landfall point and landfall time errors during 2018-22 vis-à-vis the errors during 2013-17

### 3.3. Five year moving average errors

Considering the fact that NIO region experiences, an average of about 5 cyclones in a year, the forecast performance in track, landfall and intensity prediction has been presented as 5 year moving average errors in Fig. 6. Despite the fact that NIO region is a data sparse region with poor socio-economic conditions, it is clearly seen that over the years there has been significant improvement in track, intensity and landfall point & time prediction over the region.

**Five year moving average errors**

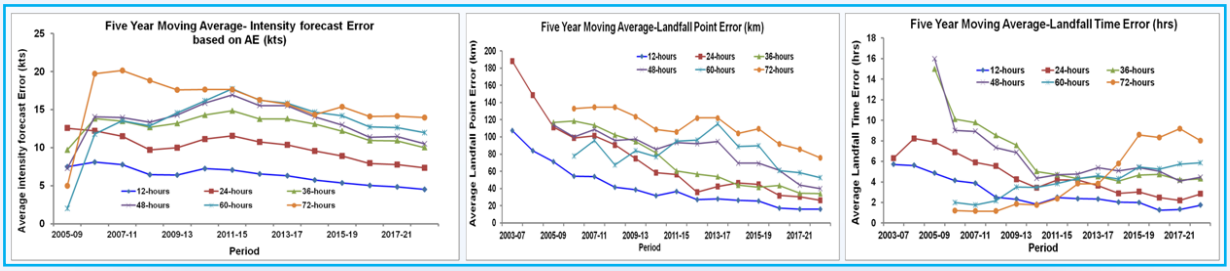



**Fig. 6.** Five year moving average track, intensity, landfall point and landfall time errors

## 4. Death toll due to cyclones

The cyclones during 2022 caused 5 deaths in India and 38 deaths in WMO/ESCAP panel member countries (viz. Bangladesh and Sri Lanka). The comparative figures indicating death toll over the Indian region and WMO/ESCAP panel member countries since 2010 is presented in Fig. 7. It indicates that there has been significant reduction in loss of human lives due to cyclones hitting India as well as WMO/ESCAP Panel countries in North Indian Ocean region.

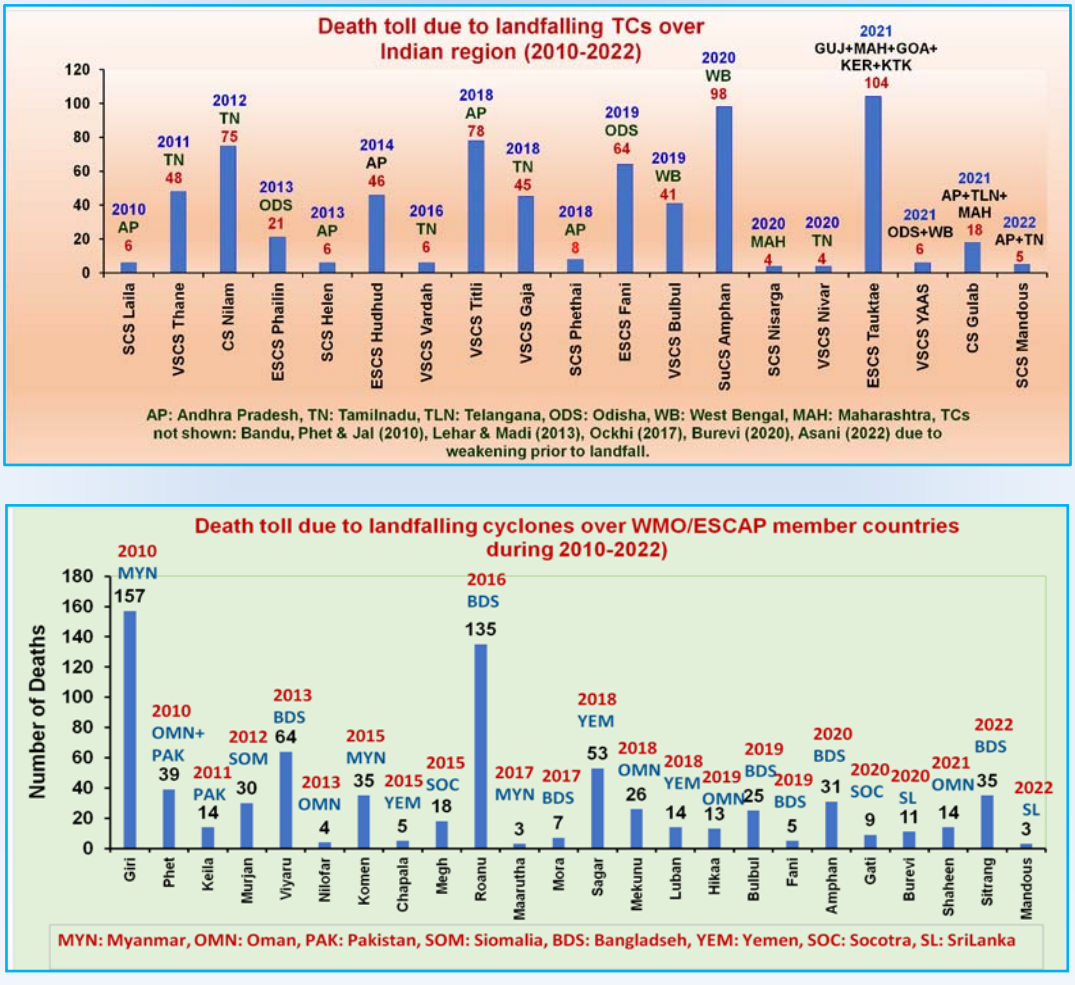






**Fig. 7.** Death toll due to cyclones during 2022 over Indian region and WMO/ESCAP member countries

**5. Bulletins issued by IMD during 2022**

IMD maintained round the clock watch over the NIO region and issued extended range outlooks (ERO) every Thursday with probabilistic cyclogenesis forecast valid for next 2 weeks.

It was followed by daily tropical weather outlook (TWO) with probabilistic cyclogenesis forecast for next 5 days.

On the likely formation of depression, IMD issued pre-genesis track and intensity forecast once in a day at the stage of low pressure area.

On the formation of depression, IMD issued regular bulletins 6hrly followed by 3 hrly bulletins from the stage of cyclonic storm and hrly bulletin in case of a landfalling cyclone, about 12 hrs prior to landfall.

Special daily prognostic and diagnostic bulletin under Tropical Cyclone Forecasting Programme (TCFP) was issued during October-December.

Statistics of bulletins issued during the year is given below:

Extended Range Outlook: 52

Tropical Weather Outlook: 326

RSMC Bulletin: 163

National Bulletin: 188

Hourly Bulletins: 20

Bulletins for International Civil Aviation: 37

Press Release: 42

**6. Major initiatives in various components of early warning system of TCs during 2022 included**

a. Observations: i) Augmentation of high wind speed recorders along the east and west coast of India with current no. across country reaching 36 HWSRs, ii) augmentation of radar network to 36countrywide, iii) New Rapid tool (Version-2)(available at https://rapid.imd.gov.in/rapid/) for better analysis of satellite, radar and model products, iv) availability of Meteosat-9 products at the link: http://foreignsat.imd.gov.in/, (web GIS based decision support system to compare, comprehend and analyse the observation and models products and arrive at the decision on current status and forecast, v) During cyclone Mandous, Doppler Weather Chennai released 3D analysis of precipitation during landfall of SCS Mandous (https://youtu.be/1S2BeFLVVfE).

b. Modeling: i) Introduction of High Resolution Rapid Refresh Model (https://nwp.imd.gov.in/wrf_HRRR_nwp_sp.php) with continuous assimilation of radar data alongwith other conventional observations. ii) Introduction of new multi model ensemble technique for cyclone track, intensity and landfall prediction , iii) Generation of single panel plots of IMD GFS, NCEP GFS, JMA, NEPS, GEFS, NCUM, WRF, NCUM-R, ECMWF, iv) All in one Meteograms for better visualization and decision making (IMD WRF, IMDGFS, GEFS, NEPS), (v) EWRF model for cloud to ground lightning provides forecast for lightning density, reflectivity and hourly rainfall for next 12 hours.

c. Forecasting Services: (i) Web based Dynamic Composite Risk Atlas (Web-DCRA) Tool for generating dynamic impact based forecast, (ii) development of decision support system for rainfall & winds on GIS platform indigenously for forecasters, (iii) development of fishermen warning graphics based on multi model guidance, (iv) introduction of probabilistic guidance for area of maximum sustained wind speed exceeding 20 knots and 35 knots, (v) introduction of pre-genesis forecast of track, intensity & structure, (vi) introduction of distance from forecast track and nearest time of arrival since March, 2022, (vii) introduction of customized location specific bulletins for offshore industries, (viii) availability of marine bulletins in textual, graphical and interactive GIS platform for users for easy decision making

d. Warning Dissemination: RSMC utilises all means of communication for transmission including email, FAX, websites, social networking platforms (facebook, tweeter, whatsapp), SMS etc. During 2022, new initiatives included (i) development of Application Programming Interface being utilised by Global Multi-hazard Alert System (GMAS) of WMO, Google, Apple, Windy and various central and state governments agencies, press &

electronic media including DD News etc., (iii) crowd sourcing, (iv) common alert protocol (CAP) implementation and (v) dissemination of cyclone bulletins to WMO/ESCAP member countries through whatsapp.

e. Forecast Verification: Introduction of verification of forecast to determine accuracy of (i) genesis forecast in extended and medium range and (ii) pre-genesis track & intensity forecast apart from earlier introduced forecast verification methods for track, intensity, landfall of cyclonic disturbances and associated adverse weather forecasts.

**7. Capacity Building Measures**

IMD conducted pre-cyclone exercise meetings with national and state level disaster managers in first week of April & October, 2022.

Two weeks Cyclone forecasters training for 13 member countries of WMO/ESCAP Panel in April.

Training about basics of cyclones for off-shore operators, coast guards, Directorate General of Hydrocarbons and related Ministries officials in May, 2022

**8. Major publications**

During 2022 IMD released following publications wrt cyclones.

Report on cyclonic disturbances over North Indian Ocean during 2021.

Tropical Cyclone Operation Plan (TCP-21) including explicit formulation of the procedures adopted in the Bay of Bengal and Arabian Sea region for the preparation, distribution and exchange of information and warnings pertaining to tropical cyclones by 13 member countries and their respective contact details. The report is prepared by IMD and published by WMO.

Forecast Demonstration Project during 2021: A Report.

Preliminary Reports on cyclonic disturbances during 2022.

Best track data of all cyclonic disturbances during 2022.

Updation of various datasets on climatology of cyclones on RSMC website.

Archival of all bulletins on RSMC website since 2011.

All these measures enabled the disaster managers and general public in reducing the loss of human life to double digit during the year. It also helped in building confidence among disaster managers, stakeholders, media & general public for successful management of cyclonic disturbances and hence minimisation of losses.

For regular updates kindly visit www.rsmcnewdelhi.imd.gov.in and www.mausam.imd.gov.in

## 5.6. Drought Monitoring & Prediction

Drought Monitoring and Prediction is being done using different indices like SPI (Standardized Precipitation Index), AAI (Aridity Anomaly Index) and SPEI Drought monitoring using Aridity Anomaly Index (AAI). The SPI maps are being generated every week as well as every month to identify the regions with prevailing or beginning/ ending of the extremely/ severely/ moderately dry/ wet conditions. The detailed statistics of the SPI computed for the entire SW monsoon period helps the various state government agencies for initiating drought management. Weekly SPI maps and values is being sent to all the state authorities as demanded by them according to new Drought manual of Ministry of Agriculture.

Weekly Drought monitoring using Standardized Precipitation Evaporation Index (SPEI) has been done in the year 2020. Prediction of one-week advance SPI and AAI maps is being done during SW monsoon and NE monsoon using IMD GFS district rainfall forecast. SPI Forecast maps for one week to four weeks are also being generated using ERFS data.

**Climate services for water sector**

Weekly monitoring and prediction of basin averaged rainfall and volume of water for 101 river sub basins of India based on ERF has been started in the year 2019 and are being regularly uploaded in IMD Pune website.

**Climate services for Health sector**

Climate information for Health bulletin viz., temporal evolution of spatial distribution of transmission window for Vector borne disease and probabilistic outlook about prevalence of climatic suitability for VBD occurrence based on extended range weather forecast on weekly basis started in May 2$^{nd}$ week 2017 is continued on every Friday. The regions which are likely to get maximum/ minimum temperature within threshold maximum / minimum temperature of above VBD transmission windows during succeeding two weeks are indicated.

# CHAPTER 6

# CAPACITY BUILDING, PUBLIC AWARENESS & OUTREACH PROGRAMME

IMD's major initiative in 2022 was to provide capacity building for its officers and staff, personnel from the other organizations in the country as well as from foreign countries particularly personnel from Asia pacific regions through organised training programmes, user workshops, conferences etc. Salient details are as under.

## 6.1. CONFERENCES, SEMINAR & SYMPOSIUM

**Dr. Pulak Guhatakurta,** Sc. 'F', **Dr. Rajib Chattopadhyay,** Sc. 'E', and **Dr. Divya Surendran,** Sc. 'C', had participated in the **National Programme on Climate Change and Human Health (NPCCHH)** webinar series conducted by **National Centre for Disease Control (NCDC)** and had an online interaction on Climate Hazards and Vulnerability Atlas of India with state health department officers on 11th February, 2022.

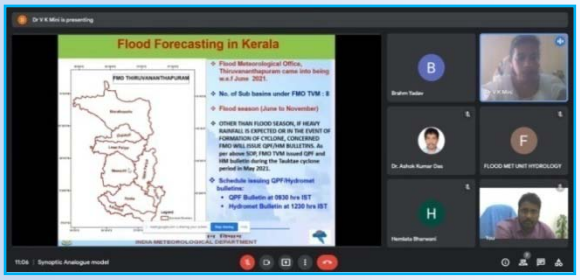
**Shri Raja Acharya**, Met. 'A', Participated in the "**International Ocean Data Conference 2022**", organized online by the International Oceanographic and Data Exchange (Intergovernmental Oceanographic Commission) during 14-16 February, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the inaugural session of the 3 days Annual Monsoon Workshop (AMW-2021) and National E-symposium on "**Changing Climate and extreme events Impacts , Mitigation & Role of Oceans**" organized by IMS Pune Chapter on 21st February, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**Bharat Bharti Bhasha Mahotsav-2022 : A Curtain raiser**" on 22nd February, 2022.

**Dr. Ashutosh Kumar Misra,** Sc. 'D', attended the online webinar on "**Recent advances in the application and utility of sub seasonal-to-seasonal predictions**" by Christopher White, University of Strathclyde, Glasgow, UK on 9th March, 2022.

**Shri B. P. Yadav**, Sc. 'F', **Dr. Ashok Kumar Das**, Sc. 'E', **Shri S. K. Manik**, Sc. 'C', **Shri Asok Raja**, Sc. 'C' and **Ms. Hemlata Bharwani**, Sc. 'C' attended the presentation made by **Dr. V. K. Mini**, Sc. 'E' on 11th March, 2022 through VC for the Showcasing of the '**Synoptic Analogue Model**' for FMO Trivandrum.



Flood Forecasting using Synoptic Analogue Model

**Dr. M. Mohapatra**, DG, IMD participated as Guest of Honour during the National Webinar Series on "**Environmental Sustainability for Self Reliant India**" on 12th March, 2022 by Prabasi Odia Samiti, New Delhi.

**Dr. M. Mohapatra**, DG, IMD participated as a Lead Speaker during the International Conference on "**Climate Resilient Farming through Multifaceted Production Strategies**" organized by Tamil Nadu Agricultural University, Coimbatore on 17th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting of "**National Crisis management Committee**" at cabinet Secretariat on 17th March, 2022 and made a presentation on status of low pressure area over Andaman Sea.

**Dr. M. Mohapatra**, DG, IMD participated in the "**International Indian Ocean Science Conference (IIOSC-2022)**" at Goa and chaired the Session on "**Marine weather hazards 14-Extreme Events and their Impacts**" on 18th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**TNAU-Directorate of Crop Management - Golden Jubilee Year International Conference, 2022**" as Lead speaker on 18th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated as the Guest of Honor at the Conference on "**Building Climate Resilience and Transition to Circular Economy**" on 24th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**CII conference on Climate Change & Water Connect : moving from Risks to Resilience for a water secure future**" on 25th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the Annual Conference on Capacity Building for Disaster Response - 2022 organized by NDRF, New Delhi on 7th April, 2022. DGM, IMD also participated in the Valedictory Session on 8th April, 2022.

**Shri K. S. Hosalikar**, Sc. 'G', **Dr. O. P. Sreejith**, Sc. 'E' and **Dr. Rajib Chattopadhyay**, Sc. 'E', participated in "**Quad Climate Information Services Taskforce Experts Group**" on 19-20 April, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**15th Civil Services Day"** at Vigyan Bhawan, New Delhi on 20-21 April, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the Virtual Conference Call on the "**Monsoon Season**" with Systematix Shares and Stocks (India) Ltd. on 22nd April, 2022.

**Dr. S. D. Attri**, Sc. 'G' participated in the **Panchayati Raj Day celebrations** at Alli Village, Samba, J&K on 23rd April, 2022 which was inaugurated by the Hon'ble Prime Minister of India.

**Dr. M. Mohapatra**, DG, IMD participated in the Inaugural Session of "**22nd South Asian Climate Outlook forum**" on 26th April, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "WMO Secretary General Briefing Session" on 4th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated as Chief Guest in the **National Technology Day, 2022** celebrations organised by National Council for Cement and Building Materials (NCCBM), Ballabgarh, Haryana on 11th May, 2022.

**Dr. M. Mohapatra**, DG, IMD and **Dr. K. Sathi Devi**, Sc. 'F' participated in the meeting to review the preparedness and other arrangements for '**Shri Amar Nath ji Yatra 2022**' under Chairmanship of Union Home Secretary through video conference on 13th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the annual conference of Relief Commissioners/ Secretaries, Department of Disaster Management of States/UTs to **review the Status of Preparedness for South-West Monsoon 2022** at New Delhi on 18-19 May, 2022 and made a presentation.

**Dr. M. Mohapatra**, DG, IMD addressed the Valedictory Session of the Face-to-Face Training program on "**Climate Information for Disaster resilient Agriculture**" organized at ICAR-IISS, Bhopal on 20th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the Inaugural Session of the training on "**Seasonal Prediction of Operational Services in south Asia**" on 23rd May, 2022.

**Dr. S. D. Attri**, Sc. 'G' attended "**Industrial Decarbonisation Summit 2022**" in New Delhi which was inaugurated by Hon'ble Union Minister, **Shri Nitin Gagkari** 16th June 2022.

Hon'ble Union Minister, Shri Nitin Gagkari, Dr. S. D. Attri and others during the Summit

**Shri Raja Acharya**, Met. 'A' participated in the "**WMO Third High-Level Virtual Session of the OCP**" and Launch of "**White Paper #2 on Future of National Meteorological or Hydrometeorological Services-Evolving Roles and Responsibilities**" on 20th June, 2022.

**Dr. S. D. Attri,** Sc. 'G' participated in a seminar on "**Modern Pollution Abatement Techniques to achieve Sustainability in Industries**" organised by the Institution of Engineers during 5-6 August, 2022.

Dr. S. D. Attri during the inauguration of the Seminar

**Shri Raja Acharya**, Met. 'A', attended the virtual conference on 1st International Geodiversity Day and & 6th International Geo ethics Day organised by the Ministry of Earth Sciences, Govt of India, Society of Earth Scientists and INSA (Indian National Science Academy) New Delhi on 10th and 11th October, 2022.

**Shri S. K. Manik**, Sc. 'C' attended the 6th International Dam Safety Conference from 10-12 October, 2022 at Jaipur, Rajasthan, organized by Indian Committee on Large Dams (INCOLD) in association with Central Board of Irrigation & Power (CBIP), Central Water Commission and DRIP.

**Dr. H. R. Biswas**, Sc. 'F', **Sri U. Das**, Sc. 'C' and **Dr. S. Dwivedi**, Sc. 'C' attended the video conference between India Meteorological Department and Odisha Space Application Centre on 13th October, 2022 regarding Geospatial data sharing for Urban Met Services and Impact Based Forecasting.

**Shri Raja Acharya**, Met. 'A', attended the online mode the WMO Technical hybrid conference on "**The UN Global Early Warning Initiative for Climate Adaptation : Early Warnings for All**" on 22nd October, 2022.

**Dr. G. N. Raha**, Head M. C. Gangtok has attended virtual Press Conference on Monthly Outlook of Rainfall and Temperature for November 2022, on 1st November, 2022. The Meeting was headed by Director General of Meteorology, New Delhi.

**Shri Bikram Singh**, Sc. 'F' and **Shri Rohit Thapliyal**, Sc. 'C' attended the National Conference and exhibition on "**Akash for Life**" organized from 4th November to 7th November, 2022 by IIRS, Dehradun at Uttaranchal University, Dehradun.

**Dr. M. Mohapatra**, DG, IMD attended Round Table Conference on "**Building Resilience to Heat Extremes : Opportunities and Way Forward**" during the meeting organized by Coalition for Disaster Resilient Infrastructure (CDRI), New Delhi on 8th December, 2022.

**Ms. R. B. Gayary**, Met. 'B' and **Ms. Doli Haloi**, Met. 'B', attended international, Conference on "**Sustainable Technology or River erosion Alleviation and Management-2O22 (STREM-2022)**" on 14-15 December, 2022.

**Dr. S. D. Attri**, Sc. 'G', addressed the delegates as Panelist in International conference organised by CRIDA Hyderabad during 22-24 December, 2022.


Dr. S. D. Attri, Sc. 'G' and others during the conference

**Shri Raja Acharya**, Met. 'A', Attended the virtual conference "**Indian Ocean Tsunami Ready Hybrid Workshop**" held at Bali Indonesia through hybrid mode during 22-26 November, 2022 organised by the Intergovernmental Oceanographic Commission (UN).

**Dr. Kripan Ghosh**, Sc. 'F' attended a symposium on "**Building an Environment Conducive to Growth**" organised by Government of Maharashtra (GoM) under the Project on Climate Resilient Agriculture (PoCRA) in Maharashtra at Sahyadri State Guest House, Mumbai on 1st December, 2022.

**Dr. Rajib Chattopadhyay**, Sc. 'E', **Dr. Ananya Karmakar,** Sc. 'C', **Ms. Lekshmi** S, JRF and **Mr. Nilesh Wagh**, Project Sc. 'C' participated in the National symposium TROPMET-2022 held at IISER Bhopal from 29th November to 2nd December, 2022.

## 6.2. WORKSHOP

**Dr. M. Mohapatra**, DG, IMD participated as Guest of Honour at the 3 days workshop cum training programme on "**Climate Modelling and Remote Sensing Applications for Environmental Systems**" organized by Amity University on 6th January, 2022. **Dr. Mohapatra** was presented a memento by the University.

**Dr. M. Mohapatra**, DG, IMD participated in the Workshop for Disaster Management Nodal Officers of the Ministries / Department of Govt. of India on 2nd March and made presentation on "**Early warning system**".

**Dr. M. Mohapatra**, DG, IMD participated in the "**3rd WCSSP India Annual Workshop**" during 7-11 March and chaired a session.

**Dr. Kuldeep Srivastava**, Sc. 'E' attended the Digital India Dialogues Capacity Building workshop for Government Leaders: titled '**Using AI and Blockchain to Solve Supply Chain Problems**' on 25th March, 2022 conducted by National e-Governance Division (NeGD), Ministry of Electronics and Information Technology.

**INTERNATIONAL WORKSHOP ON MONSOONS - 7 (IWM-7)**

Participants of International Workshop on Monsoons

7th International Workshop on Monsoons (IWM-7) was jointly organized by India Meteorological Department, Ministry of Earth Sciences, Government of India and WGTMR, in cooperation with the WCRP CLIVAR/GEWEX Monsoons Panel, the International Monsoons Project Office (IMPO) hosted by the Indian Institute of Tropical Meteorology (IITM) and Indian Meteorological Society (IMS) at New Delhi, India during 22-26 March, 2022. A booklet "Abstracts Volume : IWM-7" is the compilation of all the abstracts that will be presented during IWM-7.

**Dr. M. Mohapatra**, DG, IMD participated in the inaugural ceremony of the "**WMO's International Monsoon Workshop-7"** and chaired a session on 26th March, 2021.

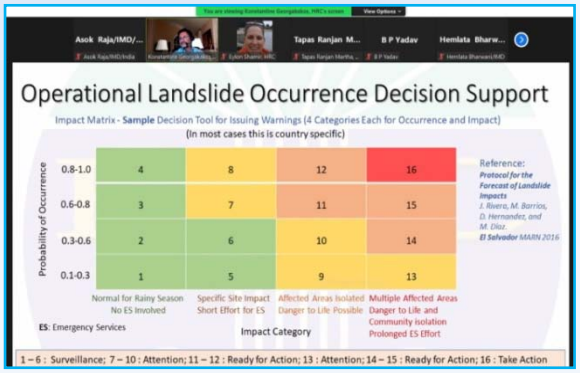
**Shri B. P. Yadav**, Sc. 'F' participated in online consultative workshop on data availability and requirement for the development of River Basin Management Plan including E-Flows assessment in Ramganga River Basin on 6th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated as Chief Guest in the **National Technology Day, 2022** celebrations organised by National Council for Cement and Building Materials (NCCBM), Ballabgarh, Haryana on 11th May, 2022.

**Dr. M. Mohapatra**, DG, IMD along with other senior officers of IMD participated in One Day National Workshop on "**Dam Safety Act, 2021 for Dam Safety Governance in India**" at Dr. Ambedkar International Centre, 15, Janpath, New Delhi on 16th June, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E' attended workshop on "**WIS 2.0 meeting**" conducted by World Meteorological Organization (WMO) on 22nd June, 2022 in virtual mode regarding its **implementation plan**, and "**WIS2 in a box**", to the industry to prepare for **the transition from WIS and GTS to WIS 2.0** and to explore opportunities for synergies to foster WIS-2.0.

**Shri B. P. Yadav**, Sc. 'F', **Shri Rahul Saxena**, Sc. 'F', **Dr. A. K. Das**, Sc. 'E', **Shri S. K. Manik**, Sc. 'C', **Shri Asok Raja**, Sc. 'C' and **Ms. Hemlata Bharwani**, Sc. 'C' along with representatives of NRSC, GSI participated in the 1-Day Technical Workshop on "**Landslide Hazard Assessment Capability**"- Training of Forecasters with special emphasis on Rudraprayag (Uttarakhand) and Wayanad (Kerala), Indian Region on 29th June, 2022.




Workshop on "Landslide Hazard Assessment Capability"

**Shri S. K. Manik**, Sc. 'C' attended 1 Day workshop on 10th August, 2022 to demonstrate the functionality of the "**NDR Geo portal for data monetization, EoDB and data integration at NSDI**".

**Dr. M. Mohapatra**, DG, IMD and **Dr. D. R. Pattanaik**, Sc. 'F' participated in the **first Kerala State Climate Change Stakeholders Consultation Workshop (KCCSCW-for Identifying Weather and Climate Information requirements of user Sectors)** during 1-2 August, 2022.

**Shri Raja Acharya**, Met. 'A' participated in the online workshop "**From Global to Coastal : Cultivating New Solutions and Partnerships for an Enhanced Ocean Observing System in a Decade of Accelerating Change**" during 15-17 August, 2022 organised by the International Centre for Theoretical Physics, Italy (UN/IAEA), GOOS and CLIVAR (WMO).

**Dr. Soma Senroy**, Sc. 'F' and **Shri Umasankar Das**, Sc. 'C', attended workshop and stakeholders' meeting on "**Lightning-North Odisha Tribal Lightning Resilience Programme-2022**" during 25-26 August, 2022 at Fakir Mohan University (FMU), Balasore, organised jointly by P. G. Department of Geography, FMU and Climate Resilient Observing Systems Promotion Council (CROPC) and India Meteorological Department.

**Shri M. I. Ansari**, Sc. E was participated in "**WMO 2022 Upper-Air Instrument Intercomparison**", from 5-9 September, 2022 in Lindenberg, Germany.

**Dr. Sankar Nath**, Sc. E participated in **WMO Common Alerting Protocol (CAP) implementation Workshop and Training Course**, during 19-21 September, 2022 at Amsterdam, Neitherland.

**Dr. Somenath Dutta**, Sc. 'F', MTI Pune, participated in the "**5th Meeting of the EC Capacity Development Panel (CDP)**" from 19-23 September in Geneva, Switzerland.

**Shri Raja Acharya**, Met. 'A', attended the "**Ocean Best Practices Virtual Workshop (OBPS VI)**" on 5th and 19th October, 2022 organised by the Inter-governmental Oceanographic Commission (UN).

**Dr. Kuldeep Srivastava**, Sc. 'E' participated in "**Second United Nations World Geospatial Information Congress (UNWGIC 2022)**" during 10-14 October, 2022 at Hyderabad.

**Dr. Satyaban B. Ratna**, Sc. 'E', attended "**CLIVAR CDP annual workshop : External versus internal variability on decadal and longer time scales**" organized by CLIVAR on 12th and 19th October, 2022.

**Dr. Kripan Ghosh**, Sc. 'F', attended the online workshop on "**Agrometeorological Services**" from 12 and 13 October, 2022 organised by World Meteorological Organization (WMO) in conjunction with the 4th Meeting of the "**Standing Committee on Services to Agriculture**".

**Dr. Kripan Ghosh**, Sc. 'F' and **Dr. Ashutosh Kumar Misra**, Sc. 'D' attended an online consultation workshop on "**Climate Change Vulnerability Assessment at Block Level for Districts in the States of Sikkim (West Sikkim) and Uttarakhand (Uttarkashi)**" under JSB project organized by UNDP on 17th October, 2022.

**Shri Bikram Singh**, Sc. 'F', MC Dehradun was invited for a two-day National workshop on "**Reducing Risk & Building Resilience: Capacity Building in the Mountain States**" from 20-21 October, 2022 organized by Dr. R. S. Tolia Uttarakhand Academy of Administration, Nainital and National Institute of Disaster Management, Ministry of Home Affairs, Govt. of India, Delhi. Shri Bikram Singh, Head/Scientist-'F', MC Dehradun attended the two day national workshop as a panelist to contribute the session on "Disaster Risk in the Mountains: Climate Changes".

**Dr. Kuldeep Srivastava**, Sc. 'E' participated in brainstorming on "**Strategies for Adoption of Geospatial Information Standards for data sharing**" in hybrid mode on 31st October, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the workshop on "**People-centred impact based warnings**" organized by World Meteorological Organisation (WMO) on 1st November, 2022 through VC.

**Dr. Kripan Ghosh**, Sc. 'F' and **Dr. Ashutosh Kumar Misra**, Sc. 'D' attended the online second workshop of the WMO WWRP HIWeather impact-based warnings workshop series on "**People-centred impact-based forecast and warnings**" on 1st November, 2022.

**Shri Raja Acharya**, Met. 'A', attended the virtually in the "**38th session of Data Buoy Cooperation Panel (DBCP-38)**" held at Geneva Switzerland through hybrid mode during 1-4 November, 2022 organised by the WMO and Intergovernmental Oceanographic Commission (UN).

**Shri B. P. Yadav**, Sc. 'G' and **Shri Asok Raja S. K.**, Sc. 'C' attended India Water Week 2022 on Water Security for Sustainable Development with Equity organised by NWDA from 1-5 November, 2022. Shri B. P. Yadav, Sc. 'G' also Co-Chaired the session on Impact of Climate Change and Adaptation Strategies on 2 November, 2022.

**Shri B. P. Yadav**, Sc. 'G' attended "**Hydromet and Early Warning Joint Learning Exercise Partnership Building**" on 3 November, 2022 organised by World Bank.

**Dr. M. Mohapatra**, DG, IMD participated virtually in the workshop on "**Multi-hazard based warnings**" organized by WMO on 10th November, 2022.

**Shri Raja Acharya**, Met. 'A', attended the virtual workshop "**Tenth International Workshop on Tropical Cyclones (IWTC-10)**" held at Bali Indonesia through hybrid mode during 5-9 December, 2022 organised by the WMO.

**Dr. M. Mohapatra**, DG, IMD, **Dr. O. P. Sreejith**, Sc. 'E', **Dr. Satyaban B. Ratna**, Sc. 'E' and other senior officers of IMD attended Scoping workshop on the "**WMO recognized entity supporting El Nino/La Nina information**" during 6-8 December, 2022. Dr. M. Mohapatra, DGM IMD delivered opening and welcome address during the workshop.

**Dr. M. Mohapatra**, DG, IMD attended Online workshop on "**Fog Monitoring and Forecasting for Aviation Services**" organized at Meteorological Watch Office, New Delhi on 10th December, 2022.

**Dr. M. Mohapatra**, DG, IMD and **Shri B. P. Yadav**, Sc. 'G' attended "**5th RA-II Hydrological Advisors Forum**" organized by WMO on 15th December, 2022.

**Dr. Satyaban B. Ratna**, Sc. 'E' attended an online Workshop on the "**NFCS South Africa Funding Model Options**" on 7th December, 2022.

## 6.3. MEETINGS

**Shri Shivinder Singh,** Sc. 'C' and **Shri Bhavish Gemini,** S.A. participated in a meeting regarding **'Smart Cities Open Data Portal (SCODP)'** held under the chairmanship of Commissioner, Municipal Corporation Chandigarh on January 03, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**Inaugural ceremony of the building of School of Earth Sciences**", IIT Bhubaneswar on 4th January, 2022.

**Shri Gajendra Kumar**, Sc. 'F' attended the meetings on 09-01-2022, 18-01-2022, and 08-03-2022 of Committee constituted under the chairmanship of Secretary, Ministry of Civil Aviation (MoCA) to oversee the implementation of recommendations made in the "**Kozhikode aircraft accident investigation report**".

**Dr. S. D. Attri**, Sc. 'G' attended High Powered Committee (PRC) meeting of "**Climate Change & Health"** organised by ICMR on 11th January, 2022.

**Dr. S. D. Attri**, Sc. 'G' participated in the meeting under Chairmanship of Member and Secretary I/C, NDMA with TERI and Assam State Disaster Management Authority and other Stakeholders to discuss the 2nd and final deliverable of the project "**Development of Flood Warning System for Guwahati Town**" on 12th January, 2021.

**Dr. (Smt.) K. Naga Ratna**, Sc. 'E' attended a meeting convened by Chief Secretary of Government of Telangana on 10th February, 2022 in connection with the visit of "**VVIP - Hon'ble President of India**" to Telangana on 13-14 January, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the first SRMC meeting under MM-III Programme on 19th January, 2021.

**Dr. S. D. Attri**, Sc. 'G' attended Seminar on "**Participatory Integrated Climate Services for Agriculture (PICSA)**" organised jointly by UN World Food Programme (WFP) and Department of Agriculture, Govt. of Odisha on 19th January, 2022.

**Dr. Kripan Ghosh,** Sc. 'F', attended the online meeting on "**Status of Procurement activities in**

**IMD"** under the Chairmanship of the Secretary, MoES, on 19th January, 2022.

**Dr. Kripan Ghosh,** Sc. 'F', attended the online meeting with the officials of World Food Programme, India on "**National Consultation on WFP India's new Country Strategic Plan 2023-27**" on 20th January, 2022.

**Dr. S. D. Attri**, Sc. 'G' chaired Meeting on "**Adaptation Fund Proposal Development**" organised by World Food Progarmme, UN on 20th January, 2022.

**M.C. Chandigarh** and **Shri Manmohan Singh,** Sc. 'F', participated in the 53rd meeting of Haryana State Drought Relief & Flood Control Board held under the chairmanship of Hon'ble Chief Minister Haryana at Haryana Niwas, Sector-3, Chandigarh on24th January, 2022.

**Dr. Kripan Ghosh,** Sc. 'F', **Dr. Ashutosh Kumar Misra,** Sc. 'D', and **Dr. Asha Latwal,** Sc. 'C', attended the online meeting to discuss project components for collaborative project proposal "**Development of mobile app 'Grape Advisory' for dissemination of weather forecast, alerts and advisory to grape growers**" among ICAR-NRCG, Pune, IMD, Pune and NIC Mumbai on 27th January, 2022.

**Shri B. P. Yadav,** Sc. 'F', **Shri Rahul Saxena,** Sc. 'F', **Dr. Ashok Kumar Das,** Sc. 'E', **Shri Asok Raja,** Sc. 'C', **Shri S. K. Manik,** Sc. 'C' and **Ms. Hemlata Bharwani,** Sc. 'C' attended the online meeting with HRC, GSI & NRSC for collaborative pilot phase work on SASIAFFGS Landslide Enhancements for two identified locations in India on 28th January, 2022.

**Shri U. K. Shende,** Sc. 'E', has attended an online meeting regarding "**Review of Aviation Weather Decision Support System**" on dated 28th January, 2022.

**Dr. O. P. Sreejith,** Sc. 'E', attended "**MoES NWP HPCS**" meeting on 31st January 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**Raising Day ceremony of Indian Coast Guard**" on 1st February, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**24th Foundation Day ceremony of INCOIS"** on 3rd February, 2022.

**Dr. M. Mohapatra**, DG, IMD and **Dr. S. D. Attri**, Sc. 'G' with senior officials of IMD Ministry of Earth Sciences, IITM Pune, NCMRWF Noida, SEBI, National Commodity & Derivatives Exchange Limited and Ministry of Finance participated in meeting held under the chairmanship of Addl. Secretary, Ministry of Finance on "**Inclusion of 'Weather"** in the list of notified goods for Commodities Derivatives trading under Section 2 (bc) of the Securities Contracts (Regulation) Act, 1956 on 3rd February, 2022.

**Dr. (Smt.) K. Naga Ratna**, Sc. 'E' attended a Co-ordination Meeting convened by Chief Secretary of Government of Telangana on 3rd February, 2022 to tie-up arrangements for the **"visit of VVIP – Hon'ble Prime Minister of India"** to Hyderabad.

**Dr. Pulak Guhathakurta,** Sc. 'F', Dr. Divya Surendran', Sc. 'C', and colleagues from RCC IMD, Pune, UK MET Office and RIMES had participated in the Pre-preparatory meeting for upcoming **Summer Monsoon SASCOF22** conducted online by Regional Climate Centre (RCC), Pune on 8th February 2022.

**Shri U. K. Shende,** Sc. 'E', has attended an online meeting on "Discussions and pending issues of DRISHTI, RVR, instrument spares etc. with Airport authority of India (AAI)" under the chairmanship of DGM, IMD on 8th February, 2022.

**Dr. Kripan Ghosh,** Sc. 'F', **Dr. Ashutosh Kumar Misra,** Sc. 'D' and **Dr. Asha Latwal,** Sc. 'C', **Brainstorming meeting regarding vision 2047** chaired by DGM, IMD, New Delhi with Senior Scientists and officials from IMD, New Delhi, IMD, Pune and RMCs and MCs of IMD on 9th February, 2022.

**Shri U. K. Shende,** Sc. 'E', has attended an online meeting on "**Functional group of indigenous development of met. Instruments**" under chairmanship of Hon. DGM, HQ, New Delhi and presentation given on Digital Snow Guage installation on 11th February, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting with Shri Alok Prem Nagar, JS, Ministry of Panchayati Raj regarding "**CORS network for utilization of weather forecasting**" on 15thFebruary, 2022.

**Shri U. K. Shende,** Sc. 'E', has attended an online meeting on "**Aviation Weather Decision Support System (AWDSS)**" under the chairmanship of hon. DGM, HQ, New Delhi on 18th February, 2022.

**Dr. S. D. Attri**, Sc. 'G' participated in meeting on '**Adaptation**' chaired by Secretary, MoEF&CC on 18th February, 2022.

**Shri Gajendra Kumar,** Sc. 'F', attended **Joint Coordination Meeting between AAI-IMD-GGIAL** through VC on **upcoming Goa airport** on 22nd February, 2022.

**Dr. S. D. Attri**, Sc. 'G' participated in meeting of '**Expert Team on Agromet Risk Management**', SERCOM, WMO on 23rd February, 2022.

**Dr. M. Mohapatra**, DG, IMD delivered keynote address at the "**High Performance Computing (HPC): Driving India Digital Transformation**" organized by American Chamber of Commerce in India on 24th February, 2022.

**Dr. Kripan Ghosh,** Sc. 'F' and **Dr. Asha Latwal,** Sc. 'C', attended an online meeting to "**Discuss integration of advisory module between IMD and DoA applications**" organised by Maharashtra Agriculture Department on 24th February, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the podcast interview for Microsoft Series for the episode dedicated to weather prediction and how it has evolved over many years on 24th February, 2022.

**Shri Raja Acharya**, Met. 'A', attended as an Observer, the fifteenth Meeting of the "**Working Group on Tsunamis and Other Hazards related to Sea Level Warning and Mitigation Systems (TOWS-WG-XV)**" conducted by the Intergovernmental Oceanographic Commission of UNESCO (UNESCO-IOC) through online on 24-25 February, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the inaugural ceremony of the year long program Azadi Ka Amrit Mahotsav as Key Note Speaker on 26th February, 2022.

**Dr. S. D. Attri**, Sc. 'G' attended meeting on '**National War Book**' on 28thFebruary, 2022 held under the chairmanship of Security (Security) at north Block, New Delhi.

A meeting / discussion with **Dr. Sanjay Sharma**, NDMA on "**API related matter w.r.t. SMS and whatsApp features in the mobile app related to Web-DCRA**" was organized at IMD on 3rdMarch, 2022 under the chairmanship of **Dr. M. Mohapatra**, DG, IMD.

**Sh. B.P. Yadav**, Head Hydromet, **Shri Rahul Saxena**, Sc.-'F', **Dr. Ashok Kumar Das**, Sc-'E', Shri. Asok Raja S K, Sh. S K Manik Sc.-'C' attended a virtual meeting regarding **"Expansion of Hydromet Services"** with FMO Patna officials and Bihar Government officials on 4th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated as Guest of Honour in the "**Forecasting Healthy Futures Conclave**" at Mayfair Lagoon, Bhubaneswar organized by Institute for Malaria & Climate Solutions, Bhubaneswar, Govt. of Odisha and IMD on 8thMarch, 2022. The joint initiative aims at minimizing the mortality and morbidity due to Malaria in the state of Odisha.

**Dr. M. Mohapatra**, DG, IMD participated in the "**1st Regional Conclave of SDMAs**" in collaboration with the Government of Tamil Nadu involving 11 coastal and island states of Tamil Nadu, Karnataka, Kerala, Andhra Pradesh, Odisha, West Bengal, Goa, Andaman & Nicobar Island, Dadra and Nagar Haveli and Daman & Diu during 8-9 March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**Session II-Scientific and Technological Innovations**" by Different Institutions / Agencies on 8th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the Special Session at International Conference on "**Agriculture for Sustainable Future (Agri-Vision 2022)**" held in Cuttack on 8th March, 2022.

**Dr. S. D. Attri**, Sc. 'G' attended Dialogue towards "**Clean Air**" oragnised by Commission for Air Quality Management in National Capital Region and Adjoining Areas (CAQM) at Gurugram on 8th March, 2022.

**Dr. S. D. Attri**, Sc. 'G' chaired meeting between GMDA, Gurgaon and IMD officials for finalising sites for '**establishment of AWS and Air Quality Monitoring systems**' in Gururam and Faridabad districts on 11th March, 2022 at IMD New Delhi.

**Dr. M. Mohapatra**, DG, IMD participated in the virtual meeting with Officials of Nuclear Power Corporation of India (NPCIL) on 14th March, 2022 for '**provision of weather forecast**' for Nuclear Power generation centres.

**Shri Gajendra Kumar**, Sc. 'F', attended meeting through VC with **KIAL Kannur** on 15th March, 2022 to discuss the issues on renewing the **MoU between IMD and Kannur International Airport Ltd (KIAL).**

**Shri A. K. Singh,** Sc. 'E', attended the TCE meeting on March 16, 2022 & March 17, 2022 organized by DGRE Chandigarh to procure X-Band DWR by DGRE for NIT Sikkim.

**Dr. M. Mohapatra**, DG, IMD participated in the VC on "**Weather Services for power sector preparedness**" on 16th March, 2022 with POSOCO.

**M.C. Chandigarh** organized an online interaction meeting with all the AMFUs and DAMUs of Haryana and Punjab states to discuss the progress under GKMS Scheme on 17th March, 2022.

**Dr. S. D. Attri**, Sc.'G' inaugurated '**Annual Hindi Vaigyanik Sanghosti**' participated of NCMRWF as Chief Guest on 21st March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting to overview the preparations for Workshop on "**Interpretation and Application of Products for Nowcasting**" during 21-25 March, 2022.

**Dr. Kripan Ghosh,** Sc. 'F', attended the online meeting to review the progress and status of feedback received from various organisations / departments of GoI for the development of an IT-based Decision Support system, viz. "**Integrated Water and Crop Information & Management System (IWCIMS)**" by Secretary DoWR RD & GR on 23rd March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting to discuss the **various measures need to be taken to reduce the death caused by lightning in the country** under the chairmanship of Shri Krishna S. Vatsa on 24th March, 2022.

**Shri Gajendra Kumar**, Sc. 'F' and **C. S. Tomar**, Sc. 'E', participated in "**ICAO MET/IE WG/20: Twentieth Meeting of the Meteorological Information Exchange Working Group**" from 28-30 March, 2022 through VC.

**Dr. S. D. Attri**, Sc. 'G' attended "**CED 59 Smart Cities Sectional Committee of the Bureau of Indian Standards**" on 30th March, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**SOFF peer advisors kick off meeting**" on 31st March, 2022.

**Dr. P. Guhathakurta**, Sc. 'F', **Dr. O. P. Sreejith**, Sc. 'E', **Dr. Satyabhan Bishoy Ratna**, Sc. 'E', **Dr. Divya Surendran**, Sc. 'C', **Dr. S. D. Sanap**, Sc. 'C', **Ms. Arti Bandgar**, Sc. 'C', **Ms. Smita Nair**, Met. 'A' and **Mr. Prasad Bhor**, Met. 'A' participated in the online Pre-COF meeting from 5-7 April & 19-21 April, 2022 and for **SASCOF-22 CSUF** from 26-28 April, 2022.

**Dr. Geeta Agnihotri**, Sc. 'F' and **Dr. Rajavel Manickam**, Sc. 'E', **Dr. Kuldeep Srivastava**, Sc. 'E', **Dr. Sankar Nath**, Sc. 'E' and **Shri Parmod Kumar**, Sc. 'C', have attended "**AMR/ACR 2022 Meeting**" held on 8-9 April, 2022.

**Dr. S. D. Attri**, Sc. 'G' participated in the "**2nd Meeting of the Steering Committee**" held under the Chairmanship of Addl. Secretary, MoEF&CC on 11th April, 2022 regarding **India's Adaptation Communication**.

**Dr K K Singh,** Sc G and Head, AASD **and Dr. S. D. Attri**, Sc. 'G' attended the Meeting **to discuss the development of the dissemination system with Ministry of information Technology for use of Agromet information by farmers** on 12th April, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the discussion Meeting with team from UNDP regarding "**Climate services in Uttarakhand and Sikkim states**" on 13th April, 2022.

**Dr. M. Ravichandran**, Secretary, MoES and **Dr. M. Mohapatra**, DG, IMD attended the Department related Parliamentary Standing Committee on Science and Technology, Environment, Forests and Climate Change regarding "**Monsoon prospects - projections for 2022**" on 18th April, 2022.

**Dr. S. D. Attri**, Sc. 'G', **Dr. Kuldeep Srivastava**, Sc. 'E' and **Dr. Sankar Nath**, Sc. 'E' participated in the

discussion meeting regarding the **Tamil Nadu Disaster Agency and Management** on 22nd April, 2022.

**Dr. M. Mohapatra**, DG, IMD and other experts in IMD participated in the Virtual Meeting on "**Vulnerability Analysis and downscaling of Global Climate Model in Odisha context**" organized by Forest Environment & Climate Change Deptt., Govt. of Odisha on 25th April, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E' attended Eighth Meeting of "**Geospatial Information Sectional Committee, LITD-22**" held on 26th April, 2022 through WebEx.

**Dr. M. Mohapatra**, DG, IMD participated as Panelist in the Recording of the Panel discussion "**Aapda Ka Samna**" on the topic "**Cyclone Warning and Rescue**" at DD National on 27th April, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the **Research advisory Committee Meeting** of IITM on 28-29 April, 2022 and virtually in **Governing Council meeting** on 30th April, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the VC meeting on "**Heat Wave & Monsoon Preparedness**" on 2nd and 5th May, 2022 under the chairmanship of Principal Secretary to Prime Minister and made a presentation on 5th May, 2022.

**Dr. Kripan Ghosh**, Sc. 'F' attended the meeting regarding "**Organization Details Document for developing Integrated Water and Crop Information Management System (IWCIMS)**" by Ministry of Jal Shakti, New Delhi on 5th May,2022.

**Dr. K. K. Singh**, Sc. 'G', chaired the "**9th meeting of Project Monitoring and Advisory Committee (PMAC)**" of IMD on 2nd May, 2022 to monitor the progress of the **projects under ACROSS-IMD** and to suggest suitable remedial measures for successful implementation of the activities.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting with Director, INCOIS under the chairmanship of Secretary, MoES to **finalise proposal for enhancement of observations, modeling and data reception system for generation and dissemination of customized bulletins for safe offshore operations** on 10th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting of the National Executive Committee to **review preparedness for Severe Cyclonic Storm 'ASANI' over westcentral Bay of Bengal** on 10th May, 2022.

**Dr. Pulak Guhathakurta**, Sc. 'F' attended the "**TEG Meeting of Vector Borne Disease I- NIMR- Sharing of Vector Borne Disease Deliverables (HAP) to TEG VBD**" under the National Programme on Climate Change and Human Health (NPCCHH) on 10th May, 2022.

**Dr. D. R Pattanaik**, Sc. 'F' has participated in first Meeting of the "**Bay of Bengal Initiative of the Multi-Sectoral Technical and Economic Co-operation (BIMSTEC)**", at NDMA Bhawan, on 12th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting with **Dr. Kaushik Sarkar**, Director, Institute for Malaria & Climate Solutions (IMACS), regarding "**Standardizing climate-based actions for vector borne diseases**" on 17th May, 2022.

**Dr. Geeta Agnihotri**, Sc. 'F' and **Shri A. Prasad**, Sc. 'D' attended "**Stake Holders Meeting on Flood Forecasting**" by CWC, Bengaluru held on 17th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**WCSSP India Executive Committee Meeting**" on 23rd May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**Systematic Observations and Financing Facilities**" Second Meeting of WMO on 24th May, 2022.

**Dr. Rajavel Manickam**, Sc. 'E' attended meeting on "**Implementation plan of IMD with regard to integration**" with Project Director, FRUITS on 25th May, 2022.

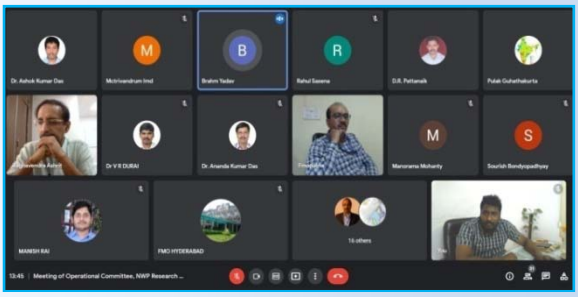
**Dr. M. Mohapatra**, DG, IMD participated in the meeting with **Dr. Kapil Kumar Narula**, CEO & Executive Director, CII Water Institute regarding Hydrological Evaluations and Meteorological Data on 25th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting with **Shri Abhinav Saxena,** Adani Power on 26th May, 2022 for **weather services to renewable energy sector**.

**Dr. Kuldeep Srivastava**, Sc. 'E' attended VC meeting on "**NSDI Nodal Officers and State SDI PIs**" meeting on 26th May, 2022 regarding **technical progress, upcoming action plan** for 2022-23, and NSDI/SSDI activities in the next phase of the initiative.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting with Shri A. R. Subbiah, Director, RIMES Program Unit regarding **Protocol & Procedures** on IMD Rimes Unit, IRU on 27th May, 2022.

**Shri B. P. Yadav**, Sc. 'F', **Shri Rahul Saxena**, Sc. 'F', **Dr. A. K. Das**, Sc. 'E', **Shri S. K. Manik**, Sc. 'C', **Shri Asok Raja**, Sc. 'C' and **Ms. Hemlata Bharwani**, Sc. 'C'along with officials of NWP, NCMRWF, IITM and all RMC's, MC's, FMO'S attended the Meeting on 'Operational Committee on NWP Research' on 30th May, 2022.



NWP Meeting on 30 May 2022

**Dr. M. Mohapatra**, DG, IMD, **Sh B.P. Yadav**, Sc. 'F' & DDGM (H), **Sh. Rahul Saxena**, Sc.-'F' participated in the meeting under the Chairmanship of Hon'ble Home Minister to **review the flood preparedness in the country** at New Delhi on 2nd June, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting under the Chairmanship of Hon'ble Union Home Minister to **review the progress of arrangements for Shri Amarnath ji Yatra** at North Block, New Delhi on 3rd June, 2022.

**Dr. Kripan Ghosh**, Sc. 'F' attended the Brainstorming session on "**Agroclimatic Atlas of India: A revisit**" organized by ICAR-CRIDA under AICRPAM project on 3rd June, 2022.

**Shri S. C. Bhan**, Sc. 'F' and **Shri H. S. Sawhney**, Sc. 'E' attended a Meeting held under the Chairmanship of **Shri Lav Aggarwal**, Joint Secretary (PH), Ministry of Health & Family Welfare to discuss the Inter-Ministerial declaration between Stakeholders and proposed action for "**One Health**" activity on 7th June, 2022 at Nirman Bhawan, New Delhi.

**Dr. M. Mohapatra**, DG, IMD participated in the Virtual meeting with DG, Hydrocarbon to **discuss the project proposal for augmentation of observations for generating customized forecast for offshore exploration & production operators** on 8th June, 2022.

**Dr. Kripan Ghosh**, Sc. 'F' attended the Pradhanmantri Fasal Bima Yojana (PMFBY) "**State Level Crop Insurance Coordination Committee meeting**" organized by Commissionerate of Agriculture, Pune, Maharashtra on 8th June, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the 1st meeting of Indian Ocean Rim Association (IORA) Working Group on "**Disaster Risk Management**" at NDMA Bhavan, New Delhi on 9th June, 2022 along with other senior officers of IMD.

**Dr. S. D. Attri**, Sc. 'G' participated through VC in WMO/GAW Implementation plan meeting on 13th June, 2022.

**Dr. S. D. Attri**, Sc. 'G' participated in meeting regarding **formulation of plan for organisation of an International Conference cum Exhibition on Akash Tattva** chaired by the Hon'ble Minister, MoES on 16th June, 2022

**Shri Manmohan Singh**, Sc. 'F' participated in the meeting regarding ensuing "**South West Monsoon 2022**" organized by Haryana State Disaster Management Authority (SDMA) held at Mini Secretariat Haryana, Chandigarh on 15th June, 2022.

**Dr. Kripan Ghosh**, Sc. 'F' attended the online meeting to discuss "**Development & deployment of Speech based system of mandi & weather information**" with officials from IMD, New Delhi and IIT, Madras on 15th June, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in "**WMO's Cordination Group for Meteorological satellites (CGMS)-50**" meeting on 15th June, 2022 and special event on 21st June, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E' attended "**TT GISC Meeting**" conducted by World

Meteorological Organization (WMO) on 16th June, 2022 in virtual mode regarding annual status report.

**Dr. Kripan Ghosh**, Sc. 'F' attended the online meeting to discuss about "**Water management and crop health project**" with officials from CRS, IMD, Pune and IIT, Bombay on 16th June, 2022.

**Shri Shivinder Singh**, Sc. 'C' participated in the "**53rd meeting of Haryana State Drought Relief & Flood Control Board**" held under the chairmanship of Chief Secretary, Haryana held through Video Conferencing on 23rd June, 2022.

**Dr. Kripan Ghosh**, Sc. 'F', **Dr. Ashutosh Kumar Misra**, Sc. 'D' and **Dr. Asha Latwal**, Sc. 'C' attended a meeting regarding "**Integration of IMD Weather Forecast and Agromet Advisories at MahaAgritech Portal**" with the officials from Dept of Agriculture, Govt of Maharashtra, Maharashtra Remote Sensing Applications Center (MRSAC) Nagpur and AASD, New Delhi on 28th June, 2022

**Dr. H. R. Biswas**, Sc. 'E' attended the "**Crop Weather Watch Group Committee Meeting on Drought Management for Kharif – 2022"** under the chairmanship of AC & CDRC, DAFE, Govt. of Odisha, on virtual mode through Webex Links on 4th and 25th July, 2022 and under the chairmanship of Agriculture Production Commissioner, Govt. of Odisha, on virtual mode through Microsoft Teams on 1st, 8th and 16th August, 2022.

**Shri Ashish Kumar**, Sc. 'C' participated in a meeting organised by Bihar State Disaster Management Authority, Patna on 15th July, 2022 regarding **Protocol for Dissemination of Information for Disaster Management during ongoing Monsoon Season.**

**Dr. D. R. Pattanaik**, Sc. 'F' has participated (online) the first Meeting of the **Research Council (RC**) of Institute for Climate Change Studies (ICCS), Kottayam held on 16th July, 2022**.**

Sr. officials of Directorate General of Hydrocarbons, IMD and INCOIS participated in meeting on 19th July, 2022 to **finalise the proposal for augmentation of observational network to generate customized location specific forecast for offshore industries**.

**Dr. M. Rajavel**, Sc. 'E' participated in meeting involving MC Bengaluru and NKAFC Dharwad regarding **continuation of activities of NKAFC, Dharwad** on 19th July, 2022.

**Shri Vivek Sinha**, Sc. 'F' has participated in an online meeting organised by Nagar Rajbhasha Karyavanyan Samiti, Patna on 21st July, 2022.

**Dr. Ashutosh Kumar Misra**, Sc. 'D' and **Dr. Asha Latwal,** Sc. 'C' attended the online meeting to "**review the current status of activities under GKMS**" chaired by **Dr. K. K. Singh**, Sc. 'G' with Director/Head from RMCs and MCs of IMD, Scientists from AASD, IMD, New Delhi and Agrimet Division, IMD, Pune, Nodal Officers and Technical Officers from AMFUs on 25th July, 2022.

**Dr. Sathi Devi**, Sc. 'F' attended the BRICS Expert level workshop (along with **Dr. A. K. Das**, Sc. 'E' and **Smt. Monica Sharma**, Sc. 'D') on 26th July, 2022 at NDMA Bhawan and gave a presentation on 'Early Warning Services of IMD'.

**Shri Abhishek Anand**, Sc. 'C' participated in "**Table Top Exercise**" by NDMA regarding flood preparedness on 27th July, 2022.

**Shri J. P. Gupta**, Sc. 'F' attended meeting regarding **present status of rainfall and prediction over Uttar Pradesh in view of less rainfall** under the chairmanship of honorable Chief Minister, Govt. of Uttar Pradesh on 1st August, 2022 at Lucknow.

**Shri Raja Sekhar Shivraju**, Sc. 'C' attended the **Coastal Security Co-ordination Committee meeting** under the Chairmanship of Commissioner, Vasai-Virar, Maharashtra on 1st August, 2022.

**Shri Rahul M.**, Sc. 'C' attended meeting on "**Implementation of AI based Nowcasting**" involving IMD and MIS Google on 3rd August, 2022.

**Dr. A. Bhattacharya**, Sc. 'C' and **Shri Debdeep Chakraborty**, Met. 'A', attended the **Co-Ordination Meeting** held at NSCBI Airport, PS on 3rd August, 2022, on the visit of Hon'ble Chief Minister of West Bengal.

**Dr. Pulak Guhathakurta**, Sc. 'F' has attended the Project Review Committee (PRC) meeting online on "**Impact of Climate Change on Vector-Borne Disease (VBD)**" held on 5th August, 2022 at

ICMR-National Institute of Malaria Research (NIMR), New Delhi.

**Dr. Ranjeet Singh**, Sc. 'F', attended meeting of **Crop Weather Watch Group for Drought Management (CWWGDM)** with State Government to monitor drought parameter on 5th, 10th, 17th and 23rd August, 2022.

**Dr. Sheshakumar Goroshi**, Sc. 'E' attended **TNAU-ACRC-IMD-GKMS-Capacity building meeting** and presented use of **ISRO-IMD Vegetation Information System platform** for crop growth monitoring under Gramin Krishi Mausam Sewa (GKMS), 11th August, 2022.

**Dr. K. K. Singh**, Sc. 'G', **Dr. Sheshakumar Goroshi**, Sc. 'E' and **Ms. Priyanka Singh**, Sc. 'C' attended the launch of the project, "**Leveraging Nationally Determined Contributions (NDCs) to achieve net-zero emissions and climate-resilient development, in response to the climate emergency**" funded by Japan on 11th August, 2022 jointly organized by UNDP and IMD.

**Dr. M. Mohapatra**, DG, IMD participated in the Meeting under Chairmanship of Principal Secretary to Hon'ble Prime Minister on "**Kharif Crops Sowing Position for current Season (2022) and the Weather Forecast**" through VC on 12th August, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the launch of the Project "**Leveraging nationally Determined contributions (NDCs) to achieve net-zero emissions and climate-resilient development, in response to the climate emergency**" organized by UNDP.

**Shri K. S. Hosalikar**, Sc. 'G', **Dr. A. Kashyapi**, Sc. 'F', **Dr. Kripan Ghosh**, Sc. 'F', **Shri U. K. Shende**, Sc. 'E' and **Dr. Ashutosh Kumar Mishra**, Sc. 'D' attended online meeting on "**NFCS presentation**" on 12th August, 2022.

**Shri. N. T. Niyas**, Sc. 'D' attended online discussion regarding **preparation of State Action Plan on Climate Change** conducted by Directorate of Environment and Climate change , Kerala held on 16th August, 2022.

**Shri Kuldeep Srivastava**, Sc. 'E' participated in 15th meeting of "**National Spatial Data Infrastructure (NSDI) Executive Committee**" held in physical mode on 18th August, 2022 to review the progress of NSDI.

**Shri Sonam Lotus**, Sc. 'E' participated in a meeting regarding **strengthening of observational network of AWS** in Ladakh chaired by **Shri Suagat Biswas**, IAS, Secretary Disaster Management, Ladakh on 18th August, 2022.

**Dr. M. Mohapatra**, DG, IMD participated as a Resource Person in the informational interview on "**State of Art Practices in Meteorological Forecasting and Role of Engineers**" conducted by School of Electrical and Electronics Engineering, REVA University, Karnataka on 19th August, 2022.

**Shri Bikram Singh,** Sc. 'F' attended a meeting under the chairmanship of Secretary, Uttarakhand Disaster Management Authority, Government of Uttarakhand on 22nd August, 2022 in connection with the weather forecast issued for 19th August heavy rainfall event. **Shri Bikram Singh,** Sc. 'F' gave a presentation on "**Observed weather and forecast & warnings**" issued by M. C. Dehradun for 19th August heavy rainfall event. They also inquired about the **operations of DWR at Surkanda Ji** and installation of more DWR in Uttarakhand to make weather forecasting more effective.

**Shri S. M. Metri**, Sc. 'E' and **Shri B. S. Muralidhara**, Met. 'B' attended the **Seventh Technical Evaluation Committee (TEC) Meeting** called by Water Resources Department, GoK at Vikas Soudha on 19th August, 2022.

**Dr. K. Naga Ratna**, Sc. 'E' attended the meeting conducted by the Hon'ble Minister of Culture, Tourism & DoNER, Govt. of India, with Heads of Offices at Hyderabad on 26th August, 2022.

**Dr. O. P. Sreejith**, Sc. 'E', **Dr. Satyabhan Bishoy Ratna**, Sc. 'E', **Ms. Arti Bandgar**, Sc. 'C' and **Mr. Prasad Bhor**, Met 'A' participated and attended the online pre-preparatory meeting on 26th August, 2022 regarding the **conduction of SASCOF-23**.

**Dr. Rajib Chattopadhyay**, Sc. 'E' given an online lecture on "**Climate Change and Sustainable Development Goals: Forecasting and Risk Management**" at IISBWM Kolkata and CII sponsored course work on 26th August, 2022.

**Dr. S. Balachandran**, Sc. 'F' had meeting with **Shri S. K. Prabakar**, IAS, Commissioner of Revenue Administration, Government of Tamilnadu to discuss forecasting requirements on 29th August, 2022.

**Dr. G. N. Raha,** Sc. 'E', **Shri U. Das**, Sc. 'C' and **Shri Manoj Biswa**l, S.A. attended a meeting to discuss the **progress on the Urban Meteorological Services program** on 29th August, 2022, under the chairmanship of DGM.

**Shri J. P. Gupta**, Sc. 'F' participated in "**State level committee meeting ground water estimation 2022**"on 30th August, 2022 Chaired by Pramukh Sachiv (Namami Gange Govt. of U.P).

**Dr. K. K. Singh**, Sc. 'G' and **Dr. Sathi Devi**, Sc. 'F' participated in the meeting under Chairmanship of Secretary, Department of Food & Public distribution, to **discuss the arrangements for procurement of Paddy/Fortified Rice and Coarse grains during the ensuring KMS 2022-2023 (Kharif Crop only)** at New Delhi on 30th August, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the meeting under chairmanship of Principal Secretary to Hon'ble Prime Minister to review situation in states affected by flood in 2022 at South Block, PMO, New Delhi on 31st August, 2022.

**Dr. M. Mohapatra**, DG, IMD had meeting with **Dr. Ranjit Kumar Sinha**, Secretary, Disaster Management Department, Uttarakhand Government on 1st September, 2022 regarding **strengthening of early warning services** in Uttarakhand.

**Dr. R. K. Giri**, Sc. 'F', IMD participated in the "**Systematic Observations Financing Facility Workshop**" with Implementing Entities and peer advisors through Zoom on 1st September, 2022.

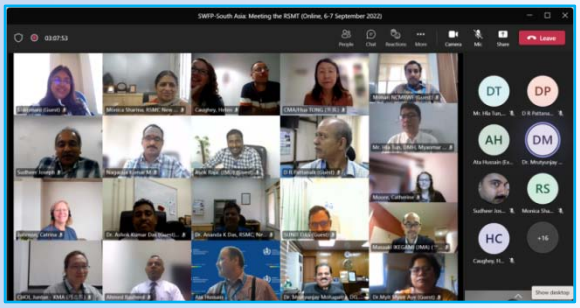
**Dr. M. Ravichandran**, Secretary, MoES, **Dr. M. Mohapatra**, DG, IMD and **Dr. Sankar Nath**, Sc. 'E' and participated in the meeting on "**Weather Forecasting for using aircraft**" as observation point under the Chairmanship of **Shri Tarun Kapoor**, Advisor to PM through VC on 1st September, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E' participated in the 18th Meeting of "**Central Geological Programming Board (CGPB) - XI on Geoinformatics and Data Management**" on 2nd September, 2022.

A meeting was organised with HRC for discussion on the topic **"Flash floods events in July 2022 in the Hilly areas of India"** on 02 September 2022. The meeting was attended by Shri B.P. Yadav, Sc.'F' & DDGM(H), Shri Rahul Saxena, Sc. 'F', Dr. A.K.Das, Sc. 'E', Ms. Hemlata, Sc. 'C', Shri Asok Raja, Sc. 'C' and Shri S.K. Manik, Sc. 'C' from Hydromet Division along with team members of HRC.

**Dr. K. K. Singh**, Sc. 'G', **Dr. S. D. Attri**, Sc. 'G', **Dr. Kripan Ghosh**, Sc. 'F' attended meeting for "**Development of the pull system for use of Agromet information by farmers**" chaired by DGM, MoES on 5th September, 2022.

**Sh. B.P. Yadav, Sc. 'F' & DDGM (H), Shri Rahul Saxena, Sc. 'F' and Dr. A. K. Das, Sc. 'E' Ms. Hemlata, Sc. 'C', Shri Asok Raja, Sc. 'C'** attended meeting of **Regional Sub programme Management Team (RSMT)for SWFP-South Asia** held on 6th -7th September 2022 .



Regional Sub programme Management Team (RSMT) for SWFP-South Asia Dated 7th September, 2022

**Dr. S. Dwivedi**, Sc. 'C', **Shri R. K. Mohapatra**, Met. 'B' and **Shri S. Patra**, S. A. attended an online training organized by WFP under DAFP, Govt. of Odisha on Master Trainers and Extension Workers using PICSA Tools from 5-9 September, 2022.

**Shri K. N. Mohan**, Sc. 'G' and **Dr. S. O. Shaw**, Sc. 'F' were invited to RAJBHAWAN Guwahati (Assam) on 11th September, 2022, to attend Seminar on "**Climate Change**".

**Dr. Kuldeep Srivastava** , Sc. 'E' & Dr. Sankar Nath, Sc. 'E' attended **Regional Association II (RA II) Infrastructure Working Group (WG-I) Expert Team meeting** held on 12th September, 2022 through online mode.

**Shri Surender Paul**, Sc. 'F' and **Shri Harminder Dutta**, Met. 'A' attended on Meeting regarding general discussions on the modalities for the

implementation of PMFBY & R-WBCIS under the Chairmanship of the Director of Agriculture, H.P. in the Directorate of Agriculture, H.P., Shimla on 13th September, 2022.

**Shri P. S. Kannan**, Sc. 'E' attended "**North-East Monsoon preparatory meeting**" chaired by Chief Secretary to Govt. of Tamilnadu at Secretariate on 13th September, 2022.

**Dr. Kripan Ghosh**, Sc. 'F' attended the "**Expert Team meeting of Working Group on Services**", WMO, **Regional Association II** on 14th September, 2022.

**Dr. S. Balachandran**, Sc. 'F' attended online meeting conducted by NDMA **in connection with disaster management plan for Tirumala Tirupati Devasthanam temple complex** on 15th September, 2022.

**Shri Harmeet Singh Sawhney**, Sc. 'E' attended a meeting related to "**Climate Change and Human Health**" held on 15th September 2022 at National Centre for Disease Control.

**Dr. S. Dwivedi**, Sc. 'C' attended the Meeting on "**User Acceptance Testing for Operational Systems for Integrated Disaster Risk Management for Odisha (SATARK) application**" by RIMES, Thailand at OSDMA, Bhubaneswar on 17th September, 2022.

**Dr. Jayanta Sarkar**, Sc. 'F' and **Shri S. G. Kamble**, Sc. 'F' attended the event '**Swacch Saagar Surakshit Saagar**' with **Dr. M. Ravichandran,** Secretary, MOES and **Shri Gopal Iyengar**, Sc. 'G', MOES on 17th September, 2022, organized by the Ministry of Earth Sciences.

**Dr. D. R. Pattanaik**, Sc. 'F' and **Dr. Kuldeep Srivastava**, Sc. 'E' had meeting with Baron Weather Inc., USA at Hotel Imperial, Janpath on 19th September, 2022.

**Dr. K. K. Singh**, Sc. 'G' and **Dr. S. D. Attri**, Sc. 'G' attended meeting on "Agriculture Satellites" chaired by Hon'ble Union Minister of Agriculture on 22nd September, 2022.

**Dr. S. O. Shaw**, Sc.'F' attended meeting of **Project Review & Steering Group** in respect of the project **"Data processing of ST Radar Data and development of software for NKN upload"** on 23rd September, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the **6th Steering Committee Meeting or Common Alerting Protocol (CAP)** based Integrated Alert System through VC organized by NDMA on 29th September, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E' attended 18th Meeting of Committee XII - '**Geoscience for Sustainable Development**' of the CGPB on 4th October, 2022.

**Shri P. R. Naskar**, Sc. 'C' and **Dr. Anwesa Bhattacharya** Sc. 'C' from AMO Kolkata, attended the SSEA SIGMET coordination platform meeting on 7th October, 2022.

**Shri B. P. Yadav**, Sc. 'F', **Shri Rahul Saxena**, Sc. 'F', **Shri Asok Raja S. K.**, Sc. 'C' and **Ms. Hemlatha Bharwani**, Sc. 'C' attended the WMO meeting on Hydrological Status and Outlook System (HydroSOS) over Ganga-Brahmaputra and Meghna Basins (GBM) on 13th October, 2022.

**Dr. S. Bandyopadhyay**, Sc. 'F' attended Co-Ordination meeting for Cyclonic Circulation over Bay of Bengal called by Chief Secretary, Government of West Bengal on 17th October, 2022.

**Dr. S. D. Attri,** Sc. 'G' attended meeting held under the Chairmanship of Hon'ble Minister for MoEF&CC for discussing India's strategy in COP 27 17 October, 2022.

**Dr. Satyaban B. Ratna**, Sc. 'E' attended the annual review meeting of MoES Research Fellowship Program (MRFP) organised by IITM, Pune on 20th October, 2022.

**Shri U. Das**, Sc. 'C' and **Dr. S. Dwivedi**, Sc. 'C', attended a meeting in B.P.I. Airport Campus under the chairmanship of Director, B.P.I. Airport on 21st October, 2022 related to Cyclone-SITRANG.

**Dr. S. D. Attri**, Sc. 'G' attended "**Standing Advisory Committee meeting of Positional Astronomy Centre**", Kolkata, IMD, held on 27th October, 2022.

**Dr. H. R. Biswas**, Sc. 'F' has attended in the flag-off Ceremony at BPI Airport, Bhubaneswar for the 1st flight services to Jeypore from Bhubaneswar, on 31st October, 2022 and also Meteorological services at Jeypore for this flight operation has been started.

**Dr. Kripan Ghosh**, Sc. 'F', attended the meeting with the delegation from World Bank and officials from IMD, Pune in connection with joint Hydromet Training program for delegates from Bangladesh on 31st October, 2022. He also delivered a presentation on "**Agromet Advisory Services of IMD**".

**Dr. M. Mohapatra**, DGM IMD participated as Chief Guest during the inaugural ceremony of the Scientific Advisory Committee Meeting at NCMRWF, Noida on 2nd November, 2022.

Scientific Advisory Committee Meeting at NCMRWF, Noida

**Dr. M. Mohapatra**, DG, IMD and **Dr. Kuldeep Srivastava**, Sc. 'E', participated in the Inception meeting of the "**National and sub-national Disaster Risk and Resilience Assessment and Roadmap for Telecommunication Sector Project**" organized by Coalition for Disaster Resilient Infrastructure on 3rd Nov, 2022.

**Dr. M. Mohapatra**, DG, IMD and **Dr. R. K Jenamani**, Sc. 'F' participated in the "**Weather and Climate Science for Service Partnership India (WCSSP-India)**" Executive Committee Meeting through virtual mode on 3rd November, 2022.

**Dr. S. Bandyopadhyay**, Sc. 'F' chaired Hindi Inspection meeting in presence of **Shri Manoj Abusaria**, Jt. Director (MoES) at RMC Kolkata On 3rd November, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E' attended meeting regarding DRRAF for Telecommunications Sector from Coalition of Disaster Resilient Infrastructure, New Delhi on 3rd November, 2022 at the CDRI secretariat, New Delhi. The purpose of the meeting was to enhance the disaster resilience of the telecommunication sector.

**Dr. Pulak Guhathakurta**, Sc. 'F', has attended the First face-to-face WMO RA II CP-Hydrology Meeting from 31st October to 1st November, 2022 and First RA II Global Hydrological Status and Outlook System (HydroSOS) Implementation Workshop from 1st to 3rd November, 2022 held at Vientiane, Lao PDR online.

**Dr. Rajib Chattopadhya, Dr. Divya Surendran and Dr. Ananya Karmakar** attended the meeting at NDC, IMD Pune on 3rd November, 2022 discussing a joint study on "**Seasonal energy efficiency ratio of Pune city for air conditioning systems**" by O/o CRS, Pune, YASHADA and COEP.

**Shri B. P. Yadav**, Sc. 'G', **Shri Rahul Saxena**, Sc. 'F', **Dr. A. K. Das**, Sc. 'E', **Shri S. K. Manik**, Sc. 'C', **Shri Asok Raj S. K.**, Sc. 'C', **Ms. Hemlata Bharwani**, Sc. 'C' attended the virtual meeting for Enhancement of the SASIAFFGS with Landslide Warning Module on 4th November, 2022 organised by HRC, USA.

**Dr. Kripan Ghosh,** Sc. 'F' attended the online meeting to discuss "**Inputs for WG-Services Annual Report on Agriculture Services for 2022-23 and planned activities for 2023-24**" on 9th November, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the Courtesy meeting with "**SAC-IMD team for Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS)**" on 11th November, 2022.

**Dr. M. Mohapatra**, DG, IMD attended the meeting on Committee of Parliament on Official Language inspected Meteorological Centre, Raipur 14th November, 2022.

**Shri D. Senthil Pandiyan**, Jt. Secretary (MoES) visited RMC, Kolkata. **Dr. S. Bandyopadhyay**, RMC Kolkata briefed him about the activities of RMC Kolkata, on 16th November, 2022.

**Dr. H. R. Biswas**, Sc. 'F' attended the virtual meeting with Chief Secretary ,Odisha and Odisha State Disaster Management Authority (OSDMA) Team on the implementation of SATARK in collaboration with RIMES, Thailand on 16th November, 2022.

**Dr. M. Mohapatra**, DG, IMD attended Meeting with Major General (Dr.) R. K. Marwaha, Former Addl. Director, INMAS, DRDO and presently Scientific Advisor of International Life Sciences

Institute-India (ILSI-India) regarding Project on Climate Change impact on Health on 18th Nov., 2022.

**Dr. O. P. Sreejith**, Sc. 'E', **Dr. Satyabhan Bishoy Ratna**, Sc. 'E', **Dr. Sabeerali C. T.**, Sc. 'C', **Mr. Prasad Bhor**, Met. 'A' participated in the online meeting on 24th November for SASCOF-24.

**Dr. S. D. Attri**, Sc. 'G', IMD attended 32nd meeting of the Joint Hindi Advisory Committee of the MoES and DST on 26th December.

**Dr. M. Mohapatra**, DGM IMD attended 2nd Meeting of IPSTRA Programme Interphase Committee on 30th December, 2022.

### Inter-agency meeting

**Shri B. P. Yadav**, Sc. 'F' and Dr. Ashok Kumar Das, Sc. 'E' attended the Sixty Ninth (69th) Meeting of "**Governing Body of the National Water Development Agency (NWDA)**" under the Chairmanship of Secretary, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti which was held on 19th January, 2022.

**Shri B. P. Yadav**, Sc. 'F' attended 4th Meeting of the National Level Steering Committee for implementation of the "**National Hydrology Project**" on 5th July, 2022 organized by Ministry of Jal Shakti, Department of Water Resources.

**Dr. M. Mohapatra**, DG, IMD attended meeting with **Ms. Corinne Demenge**, Head Swiss Corporation Office India and Counsellor, Switzerland Embassy regarding interaction on **"Cloudburst and thematic Swiss experience and technical"** presentation by Swiss Meteo on 9th December, 2022.

**Dr. M. Mohapatra**, DG, IMD attended the inaugural Session of the One day Meeting and brainstorming session under Chairmanship of Secretary, MoES to discuss the on-going MoES-NOAA international agreement on "**Tropical cyclones and the way forward"** on 12th December, 2022.

**Dr. M. Mohapatra**, DG, IMD attended meeting under the chairmanship of Member Secretary, NDMA with concerned Ministries and States prone to Cold Wave to review the **preparedness and mitigation measures for cold Wave season** 2022-23 through VC on 12th December, 2022.

**Dr. M. Mohapatra**, DG, IMD and **Dr. Sankar Nath**, Sc. 'F' attended the meeting for implementation of Common Alerting Protocol by the WMO Members of RAII on 14th December, 2022.

**Dr. S. Bandyopadhyay**, Sc. 'F' attended Consultation meeting on "**Implementation of Emergency Action Plan for Maithon & Panchet Dam**" of Damodar Valley Corporation at Maithon Dam, Dhanbad, Jharkhand on 14th December, 2022

**Shri U. Das**, Sc. 'C' attended 2nd meeting on progress of the pilot project & Improving food security for small holder farmers in Odisha using Climate Resilient Practices at Krushi Bhawan, Bhubaneswar under the Chairmanship of the Director of Agriculture and Food Production, Odisha on 23rd December, 2022.

**Shri Harmeet Singh Sawhney**, Sc. 'E' attended a meeting to discuss various aspects of new CERC DSM Regulations related to RE generators/RE Rich states held under the chairmanship of Chairperson, Central Electricity Authority on 26th December, 2022 at Sewa Bhawan, New Delhi.

**Dr. M. Mohapatra**, DG, IMD attended meeting under the Chairmanship of Secretary, Ministry of Panchayati Raj regarding installation of met sensors for weather related predictions on Continuous Operating Reference Station (CORS) infrastructure established by Survey of India across the country on 29th December, 2022.

**Dr. H. R. Biswas**, M. C. Bhubaneswar attended the meeting under the chairmanship of Additional Chief Secretary, Govt. of Odisha to review the status of preparedness for the impending Cyclone in the Bay of Bengal on 21st October, 2022.

**Dr. S. Dwivedi**, Sc. 'C', attended 58th State Level Co-ordination Committee meeting on Crop Insurance (SLCCI) on 28th October, 2022 under the chairmanship of Chief Secretary, Odisha on virtual mode.

**Dr. K. K. Singh**, chaired the 11th meeting of "**Project Monitoring and Advisory Committee (PMAC)"** of IMD on 1st November, 2022 to monitor the progress of the projects under ACROSS-IMD.

**Shri B. P. Yadav**, Sc. 'G' attended 17th Meeting of Governing body of the National Water Development Agency on 15th November, 2022.

**Dr. M. Mohapatra**, DG, IMD attended the **70th Meeting of Governing Body of the National Water Development Agency (NWDA)** under Chairmanship of Secretary, Department of Water Resources, River Development and Ganga rejuvenation, Ministry of Jal Shakti, New Delhi in hybrid mode on 15th November, 2022

**Dr. M. Mohapatra**, DG, IMD attended 1st High Level Meeting of Co-ordination Group for Meteorological Satellites (CGMS): Future Direction 2022 on 21st November, 2022.

**Dr. H. R. Biswas**, Sc. 'F' attended Crop Weather Watch Group Committee Meeting (CWWGCM) of Kharif Crop through video conferencing via micro soft team's link under the Chairmanship of Agriculture Production Commissioner on 10th October, 2022 and 21st November, 2022.

**Dr. M. Mohapatra**, DG, IMD attended Meeting with **Shri Gaurav Gupta**, IAS, Addl. Chief Secretary, Infrastructure, Development, Ports and Inland Water Transport Department, Govt. of Karnataka and **Dr. M. R. Ravi**, IAS, Managing Director, KSIIDC and Brig. (Retd.) **D. M. Purvimath**, Technical Advisor, KSIIDC regarding operationalization of Shivamogga Airport on 24th November, 2022.

**Dr. H. R. Biswas**, Sc. 'F' attended the meeting under the chairmanship of Hon'ble Chief Minister of Odisha, on 25th November, 2022 to review the preparation of Cold Wave in the state.

**Dr. S. Dwivedi**, Sc. 'C', attended a meeting on Crop Contingency Plan 2023-24 under the chairmanship of Director of Agriculture of Food Production, Odisha in Krushi Bhawan, Odisha on 29 November, 2022.

**Dr. S. D. Attri**, Sc. 'G' attended Meeting on "**Global Climate Change & Health**" held on 30 November, 2022 at ICMR, New Delhi.

**Dr. K. Sathi Devi**, Sc. 'G' attended Internal stakeholders meeting hosted by Ministry of External Affairs regarding **Quad HADR TTX** on 7th December, 2022.

**Dr. M. Mohapatra**, DGM IMD attended Recording of the special program '**Aapda Ka Samna**' on Cold Wave organized by NDMA on 30th December to be telecast on Doordarshan.

## 6.4. TRAININGS

**Dr. M. Mohapatra**, DG, IMD delivered Inaugural Address at the Short-Term Refresher Course on "**Satellite Applications for Cyclone Monitoring and forecasting**" on 14th March, 2022.

**Sh. S K Manik, Sc.** 'C' attended the training from WMO on **"Interoperable of Data exchange in Hydrology"** from 21st March to 29th April, 2022.

**Shri Asok Raja S. K.,** Sc. 'C' attended the Short Term Course on "**Open Source GIS and Geoweb Services"** conducted by CSSTEAP, affiliated to UN, during 25 April to 6 May, 2022.

Short Term Course on "Open Source GIS and Geoweb Services"

**Dr. M. Mohapatra**, DG, IMD inaugurated the "**Aviation Forecasting Refresher Course**" at MWO, Palam on 30th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the "**19th Research Advisory Committee (RAC) of SAMEER**" through hybrid mode on 30th May, 2022.

### 18th Tropical Cyclones Forecasters Training 2022

**18th Tropical Cyclones Forecasters Training 2022** was conducted by Regional Specialised Meteorological Centre (RSMC), New Delhi during 4-14 April through online mode. There were 65 participants including 15 from WMO/ESCAP Panel member countries and 51 from ACWCs, CWCs & coastal MCs & MOs, National Weather Forecasting Centre and RSMC New Delhi. WMO appreciated IMD for successful organisation of the training programme.

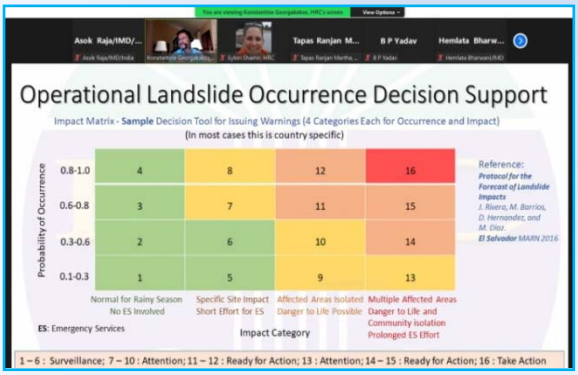
**IMD** organised Familiarization training (online mode) for Exploration and Production Operators on 2nd May with about 150 participants from Directorate General of Hydrocarbons, Indian Coast Guard, Office of Health, Safety & Environment, Oil Industry Safety Directorate, Indian Navy and operators including Oil & Natural Gas Corporation, Shell, Sun Petro, Invenire, Reliance, Adani etc. During the training lectures were arranged about basics of cyclones, various bulletins issued by IMD for marine community and customised products developed for safe offshore operation.

## Web of Science training

MoES has subscribed to **Web of Science** for its institutes as part of Digital Earth Consortium. To best utilize this source, five sessions of training on different topics were held during the quarter on 18th May, 24th May, 31st May, 8th June and 14th June, 2022.

International Technical Discussion on "**SAsiaFFGS Enhanced with Landslide Hazard Assessment Capability - Training of Forecasters**" was held on 3rd June, 2022.

**Shri B. P. Yadav**, Sc. 'F', Sh Rahul Saxena, Sc. 'F', Dr. A. K. Das, Sc. 'E', Shri S. K. Manik, Sc. 'C', Shri Asok Raja, Sc. 'C' and Ms. Hemlata Bharwani, Sc. 'C' along with representatives of NRSC, GSI participated in the 1-Day Technical Workshop on "**Landslide Hazard Assessment Capability - Training of Forecasters with special emphasis on Rudraprayag (Uttarakhand) and Wayanad (Kerala), Indian Region**" on 29 June, 2022.




**Technical Workshop on "Landslide Hazard Assessment Capability"**

**Shri Rakesh Kumar**, Sc. 'C', **Shri A. C. Roy**, Met. 'A', **Shri R. Saikia**, Met. 'A', **Shri A. J. Bhuyan**, Met. 'A', **Shri S. Mohadikar**, S. A., **Shri M. Kumar**, S. A., **Shri K. Patgiri**, R. M., **Shri P. Dutta**, Mech. Asstt. Proceeded to IngenTechonology, Kanpur for training of satellite transmitter along with other sensors of AWS/ARG w.e.f. 22nd July, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E', **Shri Sunny Chug**, Sc. 'C' and**Smt. Komal Srivastava**, S. A. participated in an interactive session-cum-training program on "**Cyber Hygiene**" in Ministry of Earth Sciences (MoES) on 15th September, 2022 through online mode to sensitize the officers about the digital and cyber risks, rapidly growing cyber-crimes and preventive measures, conducted by MHA.

**Dr. Kripan Ghosh**, Sc. 'F', attended the familiarization programme for officials of many national and international insurance companies and meeting with them for discussion on "**the requirement of weather/climate data useful for the insurance sector and data availability about the loss and damage with insurance companies**" under the Chairmanship of Head, CR&S, IMD, Pune on 10th November, 2022.

24 officials from Sashastra Seema Bal (SSB) visited Sat. Met. division on 19th October, 2022 as a part of two weeks course on "**Advanced Satellite Communication**" organized by ALTTC. These officials attended the talk entitled "**Meteorological Satellites and their Applications**" delivered by Shri S. C. Bhan, Sc. 'F' and were given a tour of MMDRPS system.

**Sri U. Das**, Sc. 'C' and **Dr. S. Dwivedi**, Sc. 'C', M. C. Bhubaneswar attended the Cyclone Web based Dynamic Composite Risk Atlas and Decision Support System (WEB-DCRA & DSS) Application training - online on 28th October, 2022 and 29th October, 2022.

**Shri S. C. Bhan**, Sc. 'G', **Shri Shibin Balakrishnan**, Sc. 'C', Dr. (Ms.) **Neeti Singh**, Sc. 'C', **Shri Atul Kumar Verma**, Met. 'A', **Shri Vimal Srivastava**, S.A. and **Shri Yogesh Kumar Jha**, S.A. visited Space Application Centre (SAC), Ahmedabad from 1st November, 2022 to 3rd November, 2022 for training on MMDRPS system to be handed over to IMD.

**Dr. O. P. Sreejith**, Sc. 'E' attended online Mediterranean Climate Outlook Forum (MEdCOF's) training session on 10th November 2022 and gave presentation on "**The experience of SASCOF Objective Forecast**".

**Shri Kunal Kaushik**, Met. 'A' & **Shri Pritam Chakraborty**, S.A. MC Gangtok has attended online training workshop program on Environment Instruments during 14th to 17th November, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E' and **Dr. Sankar Nath**, Sc. 'E' attended 1-week training programme on Big Data Management & Comprehensive Analysis conducted by Centre for Development of Advanced Computing, Mohali during 14 November to 18 November, 2022 through online mode.

**Mrs. Divya Kumari**, S.A, ISSD, HQ New Delhi imparted two days (on 24-11-2022 & 25-11-2022) eOffice training to the officials of RMC Guwahati and other offices under its region in physical mode at RMC Guwahati.

**Shri Asok Raj S. K.**, Sc. 'C', **Ms. Hemlata Bharwani**, Sc. 'C' attended the "**WMO FFGS Training Plan Virtual Meet**" at 2000 Hours IST on 8 December, 2022 organised by WMO. About 30 trained hydro meteorologists from different regional centres across the globe attended this meeting for enhancing the outreach and capacity building activities.

**Shri Bikram Singh**, Sc. 'F' addressing the trainee participants of Surface Field Observatories of Govt. of Uttarakhand at M. C. Dehradun on 14th December, 2022.

**Shri S. K. Manik**, Sc. 'C' and **Shri Asok Raja S. K.**, Sc. 'C' attended a Refresher Course on "**Interpretation and Application of NWP Products in Weather Forecasting Services**" during 19-23 December, 2022, organized by NWP Division, IMD.

**Ms. Komal Srivastava**, S.A. successfully completed Online Short term Refresher Course on Met Telecommunication which was held from 19th December to 23rd December, 2022.

**Shri Parmod Kumar**, Sc. 'C' and METNET Team imparted training to IMD CeASS users & Monitoring Officers regarding Online Leave A A training programme was conducted office wise for 8 Main Offices (DGM New Delhi, CRS Pune, RMC Chennai, RMC Guwahati, RMC Kolkata, RMC Mumbai, RMC Nagpur and RMC New Delhi) through Webex meeting from 21st November to 30th November, 2022 for Management, Promotion, Transfer, Sub-Office/Section update and other updates realted to Service Book and also to download various reports required by establishment section.

5 No's officers/ Scientist from Centre for Earth Sciences & Himalayan Studies Dept. of Science & Technology, Govt. of Arunachal Pradesh, visited RMC Guwahati for training for installation / introduction of ARG/AWS instruments, w.e.f 6-7/12/2022.

## WEBINAR

**Dr. Kuldeep Srivastava**, Sc. 'E', attended 3-day webinar-based "**Bhuvan Overview**" Training course conducted by TEOG and Bhuvan Web Services of NRSC during 15-17 March, 2022.

**Raja Acharya**, Met. 'A', attended the webinar "**Seafloor Fiber Optic Sensing**" organized by the Distributed Acoustic Systems Research Coordination Network (DAS RCN) Marine Geophysics Working Group & IRIS (Incorporated Research Institutions for Seismology) on 30th March, 2022.

**Dr. Kuldeep Srivastava**, Sc. 'E', Shri Parmod Kumar, Sc. 'C' and **Ms. Komal Srivastava**, S. A. attended webinar on - "**METAVERSE- The future of Internet**" on 25th April, 2022 organized by Bureau of Indian standards.

**Shri Raja Acharya**, Met. 'A' attended webinar on "**WMO CAP Implementation**" workshop during 19-20 September, 2022 organized by the WMO, ITU, IFRC and OASIS.

**Shri Raja Acharya**, Met. 'A', Attended the webinar "**The Use of Autonomous Vehicles and High Technology for Ocean Observation**" organised by the GOOS Office, Intergovernmental Oceanographic Commission (UN) on 29th Nov., 2022.

**Dr. Satyaban B Ratna**, Sc. 'E' attended the webinar on "**MSCA Staff Exchanges Call 2022 - How to collaborate with Europe**" organized by EURAXESS India on 18th October, 2022.

**Dr. Satyaban B. Ratna**, Sc. 'E', attended a webinar on "**The Climate Classroom @ COP27 : Climate Change Communication**" organized by WMO on 11th November, 2022.

**Shri Raja Acharya**, Met. 'A' attended the webinar "**The Use of Autonomous Vehicles and High Technology for Ocean Observation**" organised by the GOOS Office, Intergovernmental Oceanographic Commission (UN) on 29th November, 2022.

## PRESENTATION

**Shri B. P. Yadav,** Sc. 'F' & DDGM (H) made a presentation in the meeting to review the "**Flood preparedness**" organised by MHA. Govt. of India at NDCC building on 27 May, 2022.

**Dr. S. Bandyopadhyay**, Sc. 'F' attended as an Expert and delivered a presentation during an online training program on "**Resilience Measures of Buildings with Special Reference to Floods and Cyclones**" on 21st July, 2022 organized by the National Institute of Disaster Management (NIDM), MHA, Govt. of India, in collaboration with the Department of Geography, the University of Burdwan.

**Shri Arulalan T.**, Sc. 'C', participated in the workshop and presented a poster titled "***Prediction of Western Disturbance Tracks using NCUM-ERP: A Month Ahead***" in **Subseasonal to Seasonal Science and Applications Workshop – 2022** held at Boulder, Colorado, USA.

**Shikha Verma**, S. A. Presented Paper titled "**Analysis of urban area extracted from NDBI and classification approach by using satellite data**" at the 8th International Conference on Engineering and Emerging Technologies - ICEET 2022, scheduled, during 27-28 October, 2022 at Kuala Lumpur, Malaysia.

**Dr. Iyyappan M.**, Sc. 'D' presented paper tiled on Heavy Rainfall Vulnerability Assessment and participated as a Co-Chair National Conference on "**Landslide Risk Assessment and Mitigation in India**" organized by Department of Geography, Jamia Millia Islamia on 2nd November, 2022.

**Dr. (Smt.) Manorama Mohanty**, Sc. 'E', M. C. Ahmedabad participated and give Power Point Presentation on Early Warning System in 20th National Maritime Search and Rescue (NMSAR) scheduled on 18th November, 2022 at Tent City-2, Ekta Nagar (Kevadia), Gujarat.

**Dr. Sabeerali C. T.**, Sc. 'C' delivered the "**Country forecast**" presentation during the 24-SASCOF meeting held online on 24th November, 2022.

**Shri Shubhendu Karmakar**, Met. 'A' presented a paper titled "**Glacier Mass Budget and Associated influence of the Climate during 20002020 in Alaknanda Basin, Uttarakhand**" and presented a poster on 1st December, 2022 at TROPMET-2022 Conference held from 29 Nov - 2 Dec, 2022 at IISER, Bhopal.

**Ms. Laxmi Pathak**, S. A. presented a paper titled "**Nowcasting of Thunderstorm events using Indian GNSS IPWV and Insat 3D and 3DR DATA**" and presented a poster on 30th November, 2022 at TROPMET-2022 Conference held from 29 November - 2 December, 2022 at IISER, Bhopal.

**Dr. Satyaban B Ratna**, Sc. 'E', presented a talk on "**Study of Indian Summer Monsoon Variability over Gujarat (West Coast India) and Associated Large Scale Dynamics**" and **Ms. Tanu Sharma**, JRF, presented a talk on "**Reinvestigating the changing relationship between the Indian Summer Monsoon and ENSO in the recent decades**" at TROPMET-2022 in IISER, Bhopal from 29th November to 2nd December, 2022.

**Dr. Ananya Karmakar**, Sc. 'C' had given Oral presentation on the topic "**Modulation of Climate Zones of Subdivisions of India in The Historical Records**", **Mr. Nilesh Wagh**, Project Scientist 'C' had given Oral presentation on the topic "**Analysis of Drought in Southwest Indian Ocean Countries Using SPI and SPEI and their Relationship with Global SST**" and **Lekshmi S.**, Research Fellow (MRFP) presented a lightning talk (a short talk + poster presentation) on the topic "**Intraseasonal Modes of Summer Temperature Variability and Long-term trends of Heatwaves over India**" in TROPMET-2022 held at IISER Bhopal from 29th November to 2nd December, 2022.

**Dr. O. P. Sreejith**, Sc. 'E', participated and gave presentation for the SAMA & SAFOAM Workshop "**Monsoon 2022: Impact of Monsoon Variability on Agriculture**" organized by South Asia Meteorological Association (SAMA) & South Asia Forum on Agricultural Meteorology (SAFOAM) on 3rd December, 2022.

**Shri K. C. Sai Krishnan**, Sc. 'G' attended INFCOM-2 from 24th October, 2022 to 28th October, 2022 at Switzerland to present India's development and progress on various action points and future plan services in India and over various member countries in this region.

**Mr. Mohd. Imran Ansari**, Sc. 'E' & **Mr. Rohit Shukla**, Sc. 'C', IMD, New Delhi to conduct "**Factory acceptance test (FAT)**" at the factory site of original equipment manufacturer (OEM) to be held at WEATEHEX Co. Ltd. 1-4 10, 25, Obongsandan 3-ro UIwang-si, Gyeonggi-Do, 16079, in Republic of Korea from 24-26 November, 2022.

**Dr. M. Mohapatra**, DG, IMD and **Dr. K. S. Hosalikar**, Sc. 'G', IMD attended Eighteenth Session of the RA II Management Group, at Abu Dhabi, UAE 28 to 29 November, 2022.

**Dr. M. Mohapatra**, DG, IMD has been on Ex-India deputation to United Arab Emirates to participate in the Eighteenth Session of the RA II Management Group during 28th - 29th November.

## 6.5. LECTURES/TALK

**Dr. M. Mohapatra**, DG, IMD participated as distinguished expert in the "**Technical Session on Opportunities for Implementation of STIP**" organized by NIDM on 6th January, 2022.

**Dr. M. Mohapatra**, DG, IMD delivered lecture on Early Warning Systems in India during the Technical Session on "**Overview of Disaster Management in India**" in the workshop for the Nodal Officers of Disaster Management in all Ministries/Departments of Government of India on 12th January, 2022.

**Dr. S. D. Attri**, Sc. 'G', delivered talk on "**Climate Change Mitigation: Role of Science, Technology, Economics and Policy**" on 8th February, 2022 in Training program on "**Role of Technology in Community Level Disaster Mitigation for Scientists & Technologists**" organised by LBSNAA, Mussoorie during 7 - 11 February, 2022.

**Dr. S. D. Attri**, Sc. 'G' delivered talk in Hindi on '**Advances in Weather and Climate Services**' on the occasion of '**Vigyan Sarvtra Pujayte**' on 25th February, 2022.

Dr. S. D. Attri, Sc. 'G' during talk

**Dr. M. Mohapatra**, DG, IMD delivered a Lecture at NIAS Bengaluru on 14th March, 2022 on "**Weather forecasting with reference to Science, Technology and Innovation Programme (STIP)**".

**Dr. Kripan Ghosh**, Sc. 'F' delivered lecture on the topic "**Strategies for Climatic Risk Assessment and its Management for Agriculture**" on 6th April, 2022 through online mode in ICAR sponsored 21 days' Winter School on "**Climate Smart Agriculture for Sustainable Production**", conducted by the Centre for Advance Studies on Climate Change (CASCC), Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, from 28th March-17th April, 2022.

**Dr. Ashutosh Kumar Misra,** Sc. 'D' delivered a lecture on "**Role of Agrimet Division and GKMS services for the farming community**" to the faculty members and B.Sc. Agriculture students from Main Campus, University of Agricultural Sciences, Dharwad, Karnataka on 12th April, 2022 and Agriculture College, Bijapur, Karnataka on 22nd April, 2022 during their visit to CR&S, Pune.

**Dr. M. Mohapatra**, DG, IMD delivered a lecture as a distinguished speaker in the webinar on "**Building Climate Resilience for the Most Heat Vulnerable: Strengthening Preparedness and Response**" organized by NRDC on 6th April, 2022 and on 6th May, 2022.

**Sh. B. P. Yadav,** Sc. 'F' delivered a talk **"Real time Early Warning & Forecasting of IMD for Hydro-Meteorological Disasters"** in the National Workshop on "Application of Science and Technology in Flood Management on 1st June, 2022 organized by Bihar State Disaster Management Authority, Government of Bihar.

**Dr. M. Mohapatra**, DG, IMD delivered an invited talk on "**Climate Change and Extreme Weather**" on the occasion of the World Environment Day at CSIR-NISC PR, New Delhi on 6th June, 2022.

Dr. M. Mohapatra, DG, IMD on the occasion of the World Environment Day

**Dr. M. Mohapatra**, DG, IMD delivered an online invited talk on "**Monsoon 2022-what to expect**" organized by Kerala State Disaster Management Authority on 10th June, 2022.


**Dr. M. Mohapatra**, DG, IMD participated and delivered Keynote address on "**How Can we Make Uttarakhand Climate Resilient**" organized by Uttarakhand Disaster Management Authority and Council on Energy, Environment and Water, Vasant Kunj, New Delhi on 15th June, 2022.

**Shri B.P. Yadav,** Sc.-'F' (Head Hydromet), Shri Rahul Saxena, Sc.-'F', Dr. A.K. Das, Sc.-'E' & Shri S. K. Manik, Sc.-'C' attended a National Workshop on **"Dam Safety Act 2021 for Dam Safety Governance in India",** organised by the Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti on 16th June, 2022 at New Delhi.

**Dr. S. D. Attri**, Sc. 'G' delivered invited talk (VC) on "**Climate change and Management Strategies**" organised by Geological Society of India on 1st July, 2022.

**Dr. Satyaban Bishoyi Ratna**, Sc. 'E' delivered an online invited talk on "**Indian Summer Monsoon Variability: Teleconnections and Prediction**" at the Institute of Marine Sciences, National Research Council (CNR-ISMAR), Italy on 15th July, 2022.

**Dr. Divya Surendran**, Sc. 'C' delivered couple of online lectures on 20- 21 July, 2022 and conducted hands on practical sessions for the staffs of National Center for Hydrology & Meteorology (NCHM), Bhutan, on the topic "**Climapact tool**" which is part of WMO Bhutan CST training program conducted by RIMES, Thailand and NCHM, Bhutan.

**Dr. D. R. Pattanaik**, Sc. 'F' delivered a talk in National Workshop and Brainstorming meeting on **"Space based Information Support for Climate and Environment Studies : Road to the Future"** on 18-19 July, 2022 at ISRO, New Delhi


Dr. D. R. Pattanaik, Sc. 'F' during the workshop

**Shri Nahush Kulkarni,** Sc. 'C' was invited to deliver lecture on "**Early Warning importance and Meteorological services of MC Agartala**", at Central Training Institute (CTI) on 29th July, 2022.

**Dr. O. P. Sreejith**, Sc. 'E' and **Dr. Rajib Chattopadhyay**, Sc. 'E' delivered lecture respectively on "**Climate Services for the State of Kerala**" and "**A study of Malaria and Dengue outbreaks over Kerala based on Climate Indicators**" during First "**Kerala State Climate Change Stakeholders Consultation Workshop**" at Trivandum, Kerala on 1-2 August 2022.

**Dr. Ashutosh Kumar Misra**, Sc. 'D' delivered a lecture on "**Mandates and Activities of Agricultural Meteorology Division**" to the officers from School of Naval Oceanology & Meteorology, Kochi, Kerala on 3rd August, 2022.

**Dr. (Smt.) Manorama Mohanty**, Sc. 'E' delivered lecture on "**Forecasting and Warning System for**

**Cyclone, Flood and Weather in Short Term Training Program-Disaster management & Resilience Building**" organized by L. D. Engineering College, Ahmedabadon 3rd August, 2022.

**Dr. S. D. Attri**, Sc. 'G' addressed the participants as Chief Guest during **Valedictory function of Faculty Development Training Programme on Disaster Risk Reduction** organised by Jamia Milia Islamia, New Delhi on 5th August, 2022.

**Dr. M. Mohapatra**, DG, IMD delivered an Invited talk on "**Weather Forecasting and Indian Climate Changes**" during the programme organized by National Science Centre under Azadi Ka Amrit Mahotsav on 10th August, 2022.

**Dr. M. Mohapatra**, DG, IMD Chaired & delivered Keynote address on "**partnership & collaborations for Multi-Hazard Early Warning system in South Asia**" on 12th August, 2022 during the International Conference on "S**ystems Analysis for Enabling Integrated Policy Making**" at Scope Convention Centre, Lodi Road, New Delhi during 10-12 August, 2022.

**Shri B. P. Yadav**, Sc. 'F' delivered a lead talk on "**Early Warning & Forecasting Services of IMD for Management of Hydro-Meteorological Disasters**" in the International Conference on Systems Analysis for Enabling Integrated Policy Making on 10-12 August, 2022 organised by TIFAC.

**Dr. Divya Surendran**, Sc. 'C' delivered an online lecture on "**Importance of Sector Specific Climate Indices for the better understanding of Climate Change**" on 11th August, 2022 as a part of webinar series conducted by Institute for climate change Studies (ICCS), Kerala.

**Shri A. K. Singh**, Sc. 'E' delivered a lecture at **VINBAX-2022 (a joint exercise of Vietnam & Indian Army for Humanitarian assistance & disaster relief exercise)** on 13th August, 2022 at Army Office Panchkula.

**Dr. A. Kashyapi**, Sc. 'F' was invited to deliver lecture on the topic "**Role of Weather Forecasting and Prediction of Extreme Events**" on 30th August, 2022, at the Annual Grape Seminar, 2022 held at Wakad.

**Dr. (Smt.) Manorama Mohanty,** Sc. 'E' delivered an expert lecture on "**Meteorology and Forecasting**" at IIPH, Gandhinagar on 1st September, 2022.

**Dr. D. R. Pattanaik**, Sc. 'F' delivered talk on "**SWFP Global Centre IMD"** during **Severe Weather Forecast Project -South Asia (SWFP-SA) Meeting of the Regional Subprogramme Management Team (RSMT**), organised by WMO was held online during 6-7 September, 2022. **Dr. M. Mohapatra**, DG, IMD, chaired the meeting.

**Shri Raja Acharya**, Met. 'A' attended the **WMO SOT Metadata webinar** on 12th September, 2022 organised by the WMO SOT (Ship Observations Team).

**Shri Dhan Singh**, Met. 'A', **Shri Raja Acharya**, Met. 'A', **Ms. Laxmi Pathak**, S. A. and **Ms. Twinkle Grover**, S. A. attended the webinar "**Navigating the pathways of research publishing in high-quality journals with Scopus and Science Direct**" on 16-17 September, 2022 organized by DGM Publication, MoES, KCRNet and Elsevier.

**Dr. S. D. Attri**, Sc. 'G' delivered invited talk on "**Climate, Ozone and Sustainable living**" organized by IGN Open University, New Delhi on 16th September, 2022

**Dr. S. O. Shaw**, Sc. 'F' and **Shri Sunit Das**, Sc. 'E' were invited by Assam Don bosco University Azara, Guwahati to deliver lecture on the topic "**Hydro meteorological Instruments and Weather Forecast and Early Waming System**" on 19th September, 2022.

**Dr. M. Mohapatra**, DG, IMD participated as Panelist in the Webinar "**2047 – Disaster Risk Reduction**" organized by NIDM on 23rd September, 2022.

**Dr. M. Mohapatra**, DG, IMD delivered Distinguished Keynote address on the topic "**In the Eye of the Storm : Tackling Natural Calamities through Precise Projections**" in the 3rd Edition of the Economic Times Best Tech Brands organized by The Economic Times at Tango Room, Taj Vivanta, Bengaluru, Bangalore on 23rd September, 2022.

**Dr. S. Balachandran**, Sc. 'F' delivered talk on "**Role of Weather and Climate services for Blue Economy**" in the conclave organized by South Indian Chamber of Commerce on 23rd September, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the **Twenty-Third Session of South Asian Climate Outlook Forum (SASCOF-23)** and **Climate Services User Forum (CSUF)** during 26-30 September, 2022.

**Dr. Sabeer Ali**, Sc. 'C' talk on the topic "**Experimental Tropical Cyclone Seasonal Forecast over North Indian Ocean (NIO)**" in the Twenty-third Session of South Asian Climate Outlook Forum (SASCOF-23) held from 26-29 September, 2022.

**Shri S. K. Manik**, Sc. 'C' delivered a talk on Early Warning System on Flash Flood Causing to Landslide in the National conference on Landslide Risk Assessment and Mitigation in India, during 01-02 November 2022, organized by Jamia Millia Islamia University, New Delhi. He also Co-Chaired the Technical Session on "**Landslide Impact on Society and Preparedness**".

**Shri U. K. Shende**, Sc. 'E' has delivered lectures on the subject entitled "**Aviation instrumentation refresher course**" to various trainees commencing from 17th to 21st October, 2022. This training was arranged by ICI Training Centre (ICITC), New Delhi.

**Dr. S. D. Attri,** Sc. 'G' delivered talk on "**Vigilance Aspects**" on 31st October, 2022 in Vigilance awareness Week organised by MoES.

**Dr. Sabeerali**, C. T., Sc. 'C' delivered a talk on "**MMCFS verification**" in the Third Pole Regional Climate Centre (TPRCC) meeting held online on 2nd November, 2022.

**Shri U. K. Shende**, Sc. 'E' has delivered lecture on practical of Airport Meteorological Instrument (AMI) for FTC Batch No.194 on 4th November, 2022.

**Dr. O. P. Sreejith**, Sc. 'E' "**IITM Monsoon Discussing seminar on 10th November 2022**" at IITM and delivered talk on "**Seasonal forecast 2022 Southwest Monsoon**".

**Dr. M. Mohapatra**, DG, IMD delivered Plenary Lecture on Climate change and extreme weather at the 3rd Federation of Indian Geoscience Association (FIGA) at Wadia Institute of Himalayan Geology (WIHG), Dehradun on "**Floods: Past and Present**" on 16th November, 2022.

**Shri Nahush Kulkarni**, Sc. 'C', M. C. Agartala invited to deliver lecture on "**Early Warning importance and Meteorological Service of M. C. Agartala**" at Central Training Institute (CTI) on 16th November, 2022.

**Dr. M. Mohapatra**, DG, IMD attended the IITM Diamond Jubilee Foundation Day at IITM, Pune on 17th November, 2022.

**Shri U. K. Shende**, Sc. 'E' has delivered lectures to fifteen Airforce officers on Surface Instruments who were on training at SID, Pune from 19th to 23rd December, 2022.

**Dr. Satyaban B. Ratna**, Sc. 'E', attended a webinar "**Explaining and Predicting Earth System Change Webinar series - The Triple La Niña**" organized by WMO, WCRP on 22nd November, 2022.

**Shri Sukumar Roy**, Met. 'A', gave lecture on Agromet instruments to the students of SAMETI, Narendrapur Ramkrshna Mission on 23rd November, 2022.

**Dr. S. Bandyopadhyay**, RMC Kolkata delivered a lecture on "**Weather and Disaster Management**" to the newly recruited officers of Block Disaster management, Government of West Bengal at RMC Kolkata on 29th November, 2022.

**Dr. M. Mohapatra**, DG, IMD delivered a lecture on "**Meteorological Science: Recent Advances**" in the DST-NIAS Training programme on 1st December, 2022.

**Dr. Divya Surendran**, Sc. 'C', delivered a lecture on "**Meteorological Instruments and measurements for climate stations**" on 12th December, 2022 as a part of Induction Training Program for newly recruited Junior Engineers of Central Water Commission, Central Water Commission National Water Academy, Pune.

**Dr. Kripan Ghosh**, Sc. 'F', delivered an Invited Lecture on "**Recent advances in Agromet Advisory Services in India**" in National Training Programme on "**Recent Advances in Agricultural Meteorology**" organised by Centre of Advanced Faculty Training in Agril. Meteorology (CAFT), College of Agriculture, Pune on 15th December, 2022.

**Dr. Ashutosh Kumar Misra**, Sc. 'D' delivered a lecture on "**IMD services for the farming community of the country**" to the B.Tech. (Agri. Engg.) students and faculty members of Navsari Agricultural University, Gujarat on 15th December, 2022.

**Shri Rahul Saxena**, Sc. 'F' and **Dr. Ashok Kumar Das**, Sc. 'E' delivered several resourceful lectures on the Use of NWP Modelling in Hydromet Services and FFGS Application in the NWP Refresher Course on "**Interpretation and Application of NWP Products in Weather Forecasting Services**" during 19-23 December, 2022, organized by NWP Division, IMD.

**Dr. H. R. Biswas**, Sc. 'F', M. C. Bhubaneswar delivered lecture on Heavy Rainfall on 23rd December, 2022 for the refresher course on "**Interpretation and Application of NWP Products in Weather Forecasting services**" conducted by NWP Division, IMD, New Delhi held during 19-23 December, 2022.

**Dr. M. Mohapatra**, DG, IMD delivered a lecture on "**Monitoring and Forecasting of cyclone mandous : A case study**" during the NWP Refresher Course on 20th December, 2022.

**Ms. Monica Sharma**, Sc. 'D' delivered a lecture on "**SOP for Monitoring and Forecasting of cyclone mandous : A case study**" during the NWP Refresher Course on 20th December, 2022.

## 6.6. AWARENESS & OUTREACH PROGRAMME

Dr. M. Mohapatra, DG, IMD during inaugural ceremony

**Dr. M. Mohapatra**, DG, IMD participated in the inaugural ceremony of **Hologram Statue of Netaji Subhas Chandra Bose** at India Gate on 23rd January, 2022. Hon'ble Prime Minister of India appreciated the **end to end cyclone response system in India** that has reduced death toll in recent years.

**Shri Asok Raja SK**, Sc. 'C' participated in a hybrid programme on General Administration and Financial Issues by HRDC, CSIR during 9-15 March 2022 at Prithvi Bhawan, Lodi road, New Delhi.

**Dr. S. D. Attri**, Sc. 'G' delivered Chief Guest Address in valedictory function of Short Term Training Program on "**Recent Advances in Technology for Environment Sustainability (RATES)**" from March 7-12, 2022 organized by J.C. Bose University of Science & Technology, YMCA, Faridabad on 12th March, 2022.

NWP division in IMD New Delhi organised a training workshop for the field forecasters of IMD about the "**Interpretation of NWP products for the Sectoral Applications**" during 19-23 December, 2022 in hybrid mode. About 50 scientists from various offices of IMD participated physically along with about equal number of scientists participated through online mode. The inauguration of the event was arranged on 19th December, 2022, chaired by **Dr. M. Mohapatra**, Director General of Meteorology. **Dr. D. R. Pattanaik**, Head NWP, IMD New Delhi delivered the welcome address and also delivered the inaugural talk on the "**Historical Perspective of Numerical Weather Prediction in India Meteorological Department**". **Dr. M. Mohapatra**, DGM IMD in his address, encouraged the participants to take this opportunity seriously and learn many new things during this refresher course. He also emphasized that they should be involved actively in the deliberations. He further emphasized that after the training they should do lot of work in their work place by using NWP data for applications in forecasting.

Scientists from various offices of IMD

A two day Meteorological Observation Training for Surface Field Observers of Govt. of Uttarakhand was conducted by MC Dehradun, IMD,

Government of India and Uttarakhand State Disaster Management Authority, Govt. Of Uttarakhand and organized by Astra Microwave Products Ltd., Hyderabad at Meteorological Centre, Dehradun from 14 December to 15 December, 2022. **Shri Bikram Singh**, Scientist-'F', **Sh. Rohit Thapliyal**, Scientist-'C' and **Shri Ankit Sharma**, S.A. gave lecture to the trainees. **Shri Bhaumik Indrawal,** Met-'A' and **Shri Ankit Sharma**, S.A. demonstrated and trained the trainees about meteorological observations.

Shri Bikram Singh, Sc. 'F' and others

**Shri Dhaneesh K.**, Sc. 'C', M. O. Paradeep participated in the training on "**Skill Upgradation & Awareness Programme**" as a speaker to deliver lecture to the trainees (Sagar Mitras), organised by Brackish Water Training Centre, Paradeep under Directorate of Fisheries, Odisha, Cuttack on 6 October, 2022 on Airport Meteorological instruments from 18 October, 2021 to 21 October, 2022.

## NATIONAL / INTERNATIONAL COLLABORATION

Agrimet Division, IMD, Pune organised a five-day workshop on "**Operational procedures for preparation of agromet advisories: knowledge and experiences sharing workshop**" in collaboration with Regional Integrated Multi-Hazard Early Warning System (RIMES) and UK Met Office (UKMO) for the officials of Bangladesh and Nepal during 30th May-3rd June, 2022. **Dr. S. D. Attri**, Sc. 'G' inaugurated the workshop.

Agrimet Division, IMD, Pune organised a five-day workshop on "Operational procedures for preparation of agromet advisories"

## ONLINE INTERVIEW
## PANEL DISCUSSION/ INTERVIEW

**Shri Sunny Chug**, Sc. 'C' participated as a member of the interview panel for selecting logistics team for **42nd Indian Scientific expedition to Antarctica** at Mahika hall, MoES during 19 - 22 July 2022.

**Shri Himanshu Gupta**, S.A. from M. C. Gangtok attended "**Second Regional Conclave of State Disaster Management Authorities**" on 14th October, 2022 & 15th October, 2022. He participated on "**Moderated panel discussion on setting up early warning systems for cascading disasters in mountains**".

**Dr. O. P Sreejith**, Sc. 'E' and **Dr. Satyaban B.**, Sc. 'E' Ratna attended the "**Hydromet Joint Learning Exercise**" with the teams from World Bank and Bangladesh on 31st October, 2022.

**Dr. M. Mohapatra**, DG, IMD participated as Panellist for the episode on "**Aapdaka Samna**" for Doordarshan on "**Urban Flood**" to be hosted by NDMA on 3rd December, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in a Panel discussion on India-2047 organised by South Asian Institute for Advanced Research and Development (SAIARD), Academic cum Research Institute, Kolkata on 16th October, 2022. The SAIARD conferred Pride of India Award to Dr. M. Mohapatra on this occasion.


The SAIARD conferred Pride of India Award to Dr. M. Mohapatra

## 6.7. VISITORS

Fifteen (15) students from Nagaon College (Assam) visited **RMC Guwahati** on 4th January, 2022. They were given demonstration on surface observatory, AWs & ARG.

**M.C. Chandigarh** organized visit of students and research scholars of Punjab Agriculture University, Ludhiana and briefed them about the services being provided by Meteorological Centre Chandigarh on February 14, 2022. Shri Manmohan Singh, Sc. 'F' delivered a lecture to visitors.

Visit of students and research scholars of Punjab Agriculture University, Ludhiana at M.C. Chandigarh

About nineteen (19) students from Zakir Husain Delhi College visited the "**Central Hydromet Observatory**" on 15th March, 2022.

**Students from Zakir Husain Delhi College visited the "Central Hydromet Observatory"**

Sixty one (61) students from R. C. Technical, Ahmedabad visited **Met. Centre, Ahmedabad** on 25th March, 2022 and briefed them about the functioning of IMD by the Scientist, M.C. Ahmedabad.

**Shri K. S. Kandasamy**, IAS, Director, and **Shri M. S. Vaidyanathan**, Watershed Management Expert Disaster Management, Tamil Nadu Disaster Risk Reduction Agency visited IMD on 22nd April, 2022 to seek cooperation from IMD in establishing automatic weather stations and radars in Tamilnadu state for effective management of various hydrometeorological disasters. The team visited various technical divisions of IMD.

About 121 visitors including students from Delhi NCR visited the Central Hydromet Observatory during January-March.

Students from Delhi NCR to the Central Hydromet Observatory

Dr. M. Mohapatra, DG, IMD had a meeting with Commodore G. Rambabu

**Dr. M. Mohapatra**, DG, IMD had a meeting with Commodore G. Rambabu, Commodore (Naval and Meteorology), Directorate of Naval Oceanology and Meteorology, Indian Navy to **improve co-ordination between the two organizations** on 14th June, 2022.

FMI Officials visited IMD for project mode co-operation in environmental Monitoring and forecasting

FMI Officials visited IMD for project mode co-operation in environmental Monitoring and forecasting.

About 68 visitors including a Group of Senior Residents Doctors from AIIMS New Delhi, Officers from INDIAN NAVY and Students from DPS RN SCHOOL Ghaziabad visited the Central Hydromet Observatory from July 2022 to September 2022.

Hands on Interaction with the officers of Indian Navy visited Central Hydromet Observatory during September 2022

**Dr. M. Ravichandran**, Secretary, Ministry of Earth Sciences (MoES) visited Met Watch Office, IGI Airport, Palam on 5th July, 2022 to review met services facilities including functionality of Drishti RVR systems and interacted with officials of IMD at ATC-AAI, DIAL (Air side)

**Delegation from Nigeria visited IMD on 20th July, 2022**

**Shri D. S. Mishra**, Chief Secretary, UP visited IMD to discuss about the **improvements in observational network in Uttar Pradesh and technical support from IMD** with **Dr. M. Mohapatra**, DG, IMD and scientists on 8th August, 2022

The students of Hiralal Majumder Memorial College for Women, Konnagar, Hooghly, visited RMC Kolkata on 26th August, 2022.

Middle level officers of three-day training programme on '**Coastal Hazard Management**' conducted by the Anna Institute of Management, Chennai, visited RMC Chennai on 18th Aug., 2022.

**State disaster Management Authority (SDMA)** officials visited MC Agartala to understand the working of Meteorological Services on 28th July, 2022.

**Dr. Vijay Tallapragada**, Senior Scientist, Environment Modelling Center, NOAA USA visited IMD on 29th December and held discussion with Dr. M. Mohapatra, DGM IMD and other officers on various modeling developments that can be shared with IMD under international agreement with India.

The delegation from defence department of **United Arab Emirates** visited IMD, New Delhi on 13th December to have an overview of cyclone warning services and weather forecasting services of Regional Specialised Meteorological Centre (RSMC), New Delhi/ IMD.

143 students of B.Sc (Agriculture) of B.A College of Agriculture, Anand Agricultural University, Anand visited MC Ahmedabad on 10 and 11 November, 2022.

**Shri Ashok Chandra Panda**, Hon'ble Minister of Science & Technology, Govt. of Odisha visited IMD on 12th November.

30 students of class 7th standard from Jamaaly English Medium School have visited on our weather department to have knowledge regarding weather forecast on 26/11/2022.

6 visitors from Public Health Foundation of India (PHFI) visited on 29th December, 2022 at M.C. Ahmedabad.

36 MBBS Students from Himalayan Institute of Medical Sciences, Dehradun with 2 faculties, visited Meteorological Centre Dehradun premises on 28 October, 2022 and 18 October, 2022 and 16 MBBS Students from Govt. Doon Medical College, Dehradun with 02 faculties on 28th October, 2022.

Students of various colleges visiting MC Dehradun

300 Nos. of students along with teachers from Delhi Public School, Joka visited RMC Kolkata in three phases during November'22 as their educational tour.

The students and teachers from Delhi Public School, Joka visiting RMC Kolkata as their educational tour

27 Nos. of Geography Honors students and professors from Prasanta Chandra Mahalanobis Mahavidyalaya, Kolkata visited RMC Kolkata as their educational tour on 7th December, 2022.

Geography honors students of P.C. Mhalonabish Mahavidyalaya, Kolkata visiting Alipore Observatory on 07.12.22 as an educational tour

45 Nos. of B.Sc. Students and professors from Berhampore Girls' College, Murshidabad came to RMC Kolkata as educational visit on 15th December, 2022.


B.Sc. Students and professor from Berhampore Girls College, Murshidabad visiting ACWC Kolkata as their Educational Tour

RMC Kolkata participated in "17th Science Exhibition cum Environmental Awareness Fair" at Netaji Subhas Maidan, Madhyamgram Chowmatha, 24 Parganas (N), WB, from 23rd December, 22 to 27 December, 22. The exhibition team from RMC Kolkata had displayed various display-items and Met. Instruments and made familiar about its implications and importance of use in weather forecasting to the visitors. **Dr. S. Bandyopadhyay**, DDGM, RMC Kolkata delivered lecture before the visitors in the exhibition.

Students with their parents visiting IMD Stall, arranged by the officials of RMC Kolkata at Science Exhibition, Madhyamgram during 23rd-27th December 2022

About 267 visitors including member of IIT Delhi, Namai Gange Project from Jal Shakti Mantralaya, Govt of India, Kirorimal College, Delhi University, Greater Noida Institute of Technology, Laxman Public School, DPS Mathura Road, Cambridge School Srinivaspuri visited the Central Hydromet Observatory from October to December, 2022.

Students of Kirorimal College, Delhi University

Eighteen numbers of 1st & 3rd semester of Master Students of Sikkim Government College, Namchi along with their teachers have visited M. O. Gangtok on 17th December, 2022 Shri Abhishek Patel, S.A. attended the visitors.

160 Students of Mothers Public school, Bhubaneswar in two groups-one on 20 October, 2022 and the other on 21 October, 2022 - along with their teachers visited M.C. Bhubaneswar on study tour.

105 numbers of Students of Modern Seniority Secondary School, Gangtok along with their teachers / staff visited at M.O. Gangtok as educational tour, on 14th October, 2022.

Student interaction and lab visit were conducted for the students and faculties of Somaiya College of science and commerce, Mumbai on 23rd November 2022.

Approx. 1318 visitors visited this office were briefed on various activities of the Climate, Agrimet and Instruments division which includes 33 teachers and 133 Cadets visited CAgMo, Pune during the period.

30 numbers of "**Foreign delegates from International Reinsurers**" visited O/o Head CRS, Pune on 10th November, 2022.

## 6.8. IMPORTANT EVENTS 2022

### IMD FOUNDATION DAY, 2022

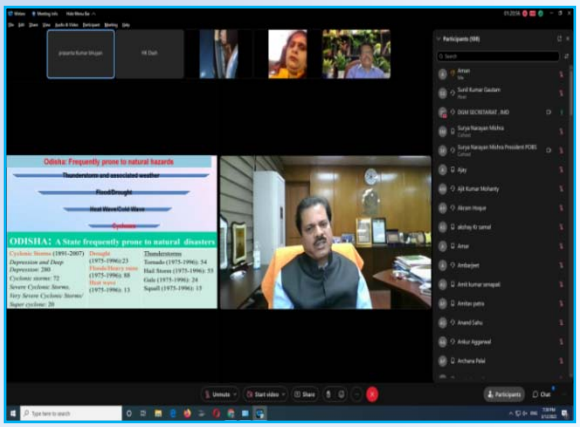
IMD Foundation Day, 2022 Inaugurated by Dr. Jitendra Singh, Hon'ble Minister

Dr. Jitendra Singh, Hon'ble Minister of state, Dr. M. Ravichandran, Secretary, MoES, Dr. M. Mohapatra, DG, IMD and Dr. S. D. Attri, Sc. 'G' during IMD Foundation day

IMD celebrated its 147th Foundation Day on 14th January, 2022 in hybrid mode. The Event was inaugurated by Chief Guest **Dr. Jitendra Singh**, Hon'ble Minister of state (Independent Charge) Ministry of Science & Technology & Earth Sciences, Minister of State, Prime Minister's Office, Ministry of Personnel, Public Grievances and Pensions, Department of Atomic Energy and Department of Space, Government of India. The Hon'ble Minister appreciated the initiatives and contribution of IMD in safeguarding the life and property with its accurate prediction and timely dissemination of forecast and warnings. He also assured all support in further augmentation of its observational and modeling capabilities. The occasion was marked with welcome address by **Dr. M. Mohapatra**, DG, IMD highlighting initiatives taken by IMD in augmenting observational, modeling, forecasting and early warning capabilities of IMD to provide sector specific and timely forecast, Presidential Address by **Dr. M. Ravichandran**, Secretary, MoES, Special Address by Guests of Honour **Shri R. K. Mathur**, Hon'ble Lt. Governor of Ladakh, **Shri Jamyang Tsering Namgyal**, Hon'ble Member of Parliament, Ladakh, **Dr. K. Sivan**, Chairman, ISRO and Vote of Thanks by **Dr. S. D. Attri**, Sc. 'G' and Chairman of Organizing Committee for the celebrations.

### WORLD METEOROLOGICAL DAY 2022

India Meteorological Department celebrated World Meteorological Day on 23rd March, 2022. On this occasion, various activities were organized in IMD HQ and various sub-offices of IMD highlighting the services rendered by various divisions and offices of IMD.




Dr. M. Mohapatra, DG, IMD highlighting the services of IMD

On this occasion, RMC Chennai celebrated WM Day with the theme – "Early Warning and Early Action – Hydrometeorological and Climate Information for Disaster Risk Reduction". Open house, meteorological exhibition and scientific talks on the theme were arranged.

Dr. S. Balachandran welcomed Chief Guest Dr. Balaji Narasimhan, Professor, IIT Madras

Visitors on WMO day at Meenambakkam Observatory, Chennai

**CRS, Pune** celebrated World Meteorological Day in hybrid mode by arranging a Meteorological exhibition and Webinar on 23rd March, 2022. Live demonstration of meteorological and seismological instruments, 'Be a weather observer' segment for students to take their own weather observation, a short documentary film on 'Expedition to Antarctica' was shown in the exhibition. About 1300 people including students, scientists, scholars, journalists and general public visited the exhibition. All visitors marked their comments with great enthusiasm.

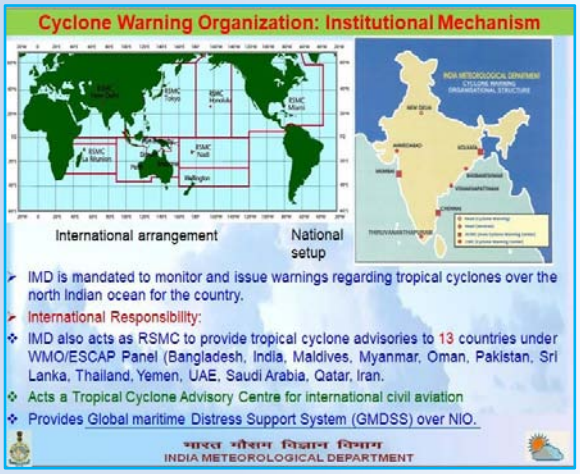
Visitors on WM day at CRS, Pune

## LETTER OF AGREEMENT

IMD and Manikaran Analytics Limited signed Letter of Agreementon 4th March, 2022 under the chairmanship of **Dr. M. Mohapatra**, DG, IMD for R&D on weather services for power sector.

**Pre-cyclone exercise Meeting on 5th April, 2022**

IMD organized the on-line pre-cyclone exercise meeting on 5th April, 2022 under the chairmanship of **Dr. Mrutyunjay Mohapatra**, DG, IMD to review the preparedness, take stock of requirements, plan for the cyclone season April-June, 2022 and share new initiatives by IMD with stake holders. **Dr. Mohapatra**, DG, IMD in his opening address touched upon various issues from forecasting to last mile connectivity and discussed the areas that require improvement in particular customized sector specific advisories as per user's need. He informed the participants that IMD has achieved significant improvements in observational network, modeling capabilities and forecasting techniques. As a result, there has been a paradigm shift in the cyclone forecasts in terms of track, landfall, intensity and adverse weather including heavy rainfall, strong wind and storm surge warnings. He also briefed the participants on the new developments in cyclone warning services during 2022.




Institutional Mechanism of Cyclone Warning Division of IMD

## SOUTH ASIAN CLIMATE OUTLOOK FORUM

22nd Session of South Asian Climate Outlook Forum (SASCOF-22) and Climate Services User Forum (CSUF) have been conducted online from 26-28 April, 2022.

## Count Down Event to International Yoga Day 2022

Count down event to **International Yoga Day 2022** was organised in the compound of India Meteorological Department on 27th May, 2022. Honourable Union Minister **Dr. Jitender Singh**

made his great presence in the event and performed the yoga activities. He encouraged people to exercise the yoga routine in their daily life. **Dr. Mrutyunjay Mohapatra**, DG, IMD, **Dr. S. D. Attri**, Sc. 'G' and **Dr. Gopal Ayenger**, Sc. 'G', Ministry of earth Sciences also attended the event and practiced the Yoga activities. Many other officials of IMD and Ministry of Earth Sciences participated in the event. The theme of the International Yoga Day-2022 was "**Yoga for humanity**".


Dr. Jitender Singh, Honourable minister,
Dr. Mrutyunjay Mohapatra, DG, IMD & others

## WMO Executive Council Meeting

**Dr. M. Mohapatra**, DG, IMD participated in **75th** session of the Executive Council (EC-75) of "**WMO** held during 20 to 24 June 2022 in Geneva, Switzerland.

The WMO's Executive Council has given the green light to major strategic proposals to **ensure that early warning services reach everyone in the next five years and to establish a Greenhouse Gas monitoring system**.

Dr. M. Mohapatra, DG, IMD during "WMO Executive Council Meeting"

## MEMORANDUM OF UNDERSTANDING

Memorandum of Understanding was signed between IIT Bombay, Mumbai and IMD (CR&S Pune) for joint studies and Projects related to climate on 2nd May, 2022.


## MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding signed between India Meteorological Department and Power System Operation Corporation Ltd. (POSOCO) on 3rd June, 2022 regarding "**Use of Weather Information provided by India Meteorological Department by Power System Operators across the India for better management of Indian Power System and for the purpose of analysis**".


Dr. M. Mohapatra, DG, IMD and Mr. S. R. Narasimhan; CMD, POSOCO during the Signing event

**MOU** was signed between **IMD and Punjabi University, Patiala, Punjab** to strengthen the future research endeavours at both the organizations on 8th September, 2022.


Dr. Mrutyunjay Mohapatra, DGM with Vice Chancellor and other Officials of Punjabi University

Signing of MoU between IMD and SAIARD, Kolkata

MOU was signed between IMD and SAIARD, Kolkata for **collaborative research on meteorology on** 22nd September, 2022 at IMD New Delhi.

## Celebration of 76th Independence Day, 2022

**Dr. Jitendra Singh** Hon'ble Minister of State (Independent Charge) for the Ministry of Science and Technology and Ministry of Earth Sciences, Minister of State for Prime Minister's Office; Ministry of Personnel, Public Grievances and Pensions; Department of Atomic Energy and Department of Space, **Dr. M. Ravichandran**, Secretary, Ministry of Earth Sciences, **Dr. Rajesh S. Gokhale,** Secretary, Department of Biotechnology, **Dr. Srivari Chandrasekhar**, Secretary, Department of Science & Technology, **Dr. N. Kalaiselvi**, Secretary, Department of Scientific & Industrial Research& DG CSIR visited IMD on 15th August, 2022. **Dr. M. Mohapatra**, DG, IMD welcomed Hon'ble Minister, Secretaries and Officials from MoES, DBT, DST, DSIR, IMD and NCMRWF, School children and media and highlighted the significant activities of IMD. Hon'ble Minister hoisted the **National Flag** on the auspicious occasion of **76th Independence Day** at IMD premises and addressed the gathering.

Dr. Jitendra Singh Hon'ble Minister hoisting the National Flag

Participants in 76th Independence Day event in IMD

## Independence Day, 2022

**Dr. Geeta Agnihotri,** Sc.'F' hoisted the National Flag on the occasion of Independence Day, 2022 at MC Bengaluru.

Dr. Geeta Agnihotri after hoisting the National Flag

**Dr. S. Bandyopadhyay,** Sc. 'F' hoisted National Flag on the 76th Indian Independence Day. A cultural programme had also been organized by RMC Kolkata.

Dr. S. Bandyopadhyay holding miniature of the National flag

**On 10th August, 2022, Dr. S. Bandyopadhyay, Sc. 'F'**delivered a lecture on the occasion of 75 years of India's Independence, celebration of "Azadi ka Amrit Mahotsav" an awareness program on Weather, Climate and Climate Change.

The students from schools and colleges had participated in various competitions on Essay writing, Photography, Drawing and Quiz contest organised on the occasion. Prizes were awarded to the participants of the schools and colleges and certificates for the participation were issued.

Dr. S. Bandyopadhyay, Sc. 'F' with the winners of events

**Dr. M. Mohapatra**, DG, IMD participated in the celebration programme on the occasion of '**World Ocean Day**' under Azadi Ka Amrut Mahotsav on 8th June, 2022.

Signing of MoU between IMD & Amity University, Gurgaon

MoU was signed between IMD and Amity University Gurugram for **cooperation in the area of Climate and Environmental Monitoring and Research**on 19th July, 2022.

## South Asian Climate Outlook Forum (SASCOF-23)

Twenty-third Session of **South Asian Climate Outlook Forum (SASCOF-23)** and **Climate Services User Forum (CSUF)** were held during 26-29 September, 2022. The aim of the workshop was to prepare the Consensus Outlook for OND 2022 Season. The Climate Services User Forum (CSUF) which was conducted on the 29th was aimed to understand the Interpretation of the Consensus Outlook for OND 2022 and study the Application/New Products for Climate Service for South Asia.

SASCOF 23 and CSUF - Online Session

## Second South Asia Hydromet Forum (SAHF) Executive Council Meeting

**Dr. M. Mohapatra**, DG, IMD attended the "**Second South Asia Hydromet Forum (SAHF) Executive Council Meeting**" from 19-20 September, 2022 held in Bangkok, Thailand to review progress, agree on strategies and actions identified in the SAHF Regional Approach, establish a mechanism to sustain SAHF beyond the current phase and decide on the way forward. The SAHF EC is constituted by DG/Directors of NMHSs as a managerial council that develops strategic plans for the implementation of the SAHF.


Dr. M. Mohapatra, DG, IMD during "Second South Asia Hydromet Forum (SAHF) Executive Council Meeting"

## Inauguration of New Building of Meteorological Centre Lucknow

Smt. Anandi Ben Patel, Hon'ble Governor of Uttar Pradesh Inaugurated New Building of Meteorological Centre Lucknow on 31st October, 2022 in the gracious presence of Dr. M. Ravichandran, Secretary, MoES, Dr. M. Mohapatra, DG, IMD and Shri Khushveer Singh, Head RMC New Delhi.

Smt. Anandi Ben Patel, Hon'ble Governor of Uttar Pradesh with of Dr. M. Ravichandran, Secretary, MoES, Dr. M. Mohapatra, DG, IMD

## National Conference and exhibition on "Akash for Life"

A National Conference and exhibition on "**Akash for Life**" was organized from on 4th November to 7th November, 2022 by IIRS, Dehradun at Uttaranchal University, Dehradun and the Meteorological Centre Dehradun also participated in this exhibition. MC Dehradun displayed its surface and upper air observation instruments and gave demonstration of 02 RS/ RW observation. The Honourable Governor Lt. General (Retd.) Gurmit Singh, Govt. of Uttarakhand released the RS/ RW flight on the occasion of inauguration of exhibition on 4th November, 2022 in presence of dignitaries and visitors.

The Hon'ble Governor of Uttarakhand Lt. General (Retd.) it Singh, releasing the RS/ RW flight in "Akash for Life" exhibition

The Secretary, MoES, Govt. of India, visiting stall of IMD, MC Dehradun

IMD signed a MoU with Fakir Mohan University, Balasore

India Meteorological Department signed a Memorandum of understanding with Fakir Mohan University, Balasore to enhance research & development activities between the two organizations on 17th October, 2022.

IMD signed a MoU with Sambalpur University on 26th Nov, 2022 to enhance research & development activities between the two organizations. Dr. M. Mohapatra, DG, IMD delivered Keynote address on "Science & Technology in combating climate Change during the 23rd Odisha Bigyan 'O' Paribesh Congress (OBPC) to be organized by Sambalpur University on 26th November, 2022.


IMD signed a MoU with Sambalpur University on 26th Nov, 2022

The Officials of Meteorological Centre Bengaluru attended live telecast of the event on 20th October, 2022 and took pledge for the same for "**MISSION LIFE**". School/students were on observatory visit to attend the live telecast.

Officials of M. C. Bengaluru during live telecast

The Secretary, MoES, Govt. of India briefing about the RS/RW flight in "**Akash for Life**" National conference and exhibition at Uttaranchal University, Dehradun on 6th November, 2022.

National conference and exhibition at Uttaranchal University, Dehradun

**Dr. S. D. Attri**, Sc. 'G' attended COP-27 held in Egypt during 10-18 November, 2022. He also addressed gathering on the release of State of Asia Climate 2021.


Dr. S. D. Attri, Sc. 'G' attended COP-27 held in Egypt during 10-18 Nov, 2022

# CHAPTER 7

# RESEARCH PUBLICATIONS

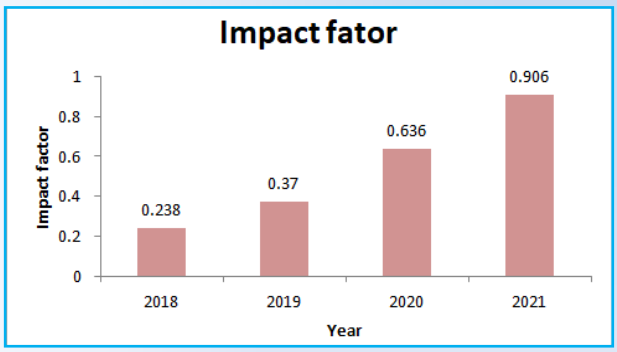
***MAUSAM (Formerly Indian Journal of Meteorology, Hydrology & Geophysics), established in January 1950, is the quarterly research journal brought out by the department. It is a premier scientific research journal in the field of Meteorology, hydrology & Geophysics for publication of original scientific research work. MAUSAM is being indexed and abstracted by Thomson Reuter U.S.A.***

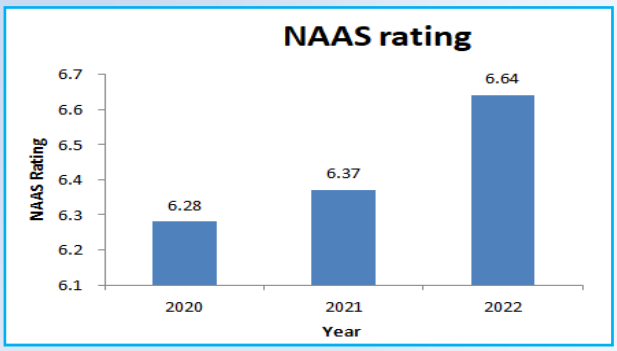
***Achievements of International Research Journal 'MAUSAM'***

***India Meteorological Department's Quarterly International Research Journal 'MAUSAM' has been made online (https://mausamjournal.imd.gov.in/index.php/MAUSAM) since 2021. Since then the journal has been making its way to advancement in the world of Scientific Journals. A few breakthrough points are:***

***•All the research articles (since the origin of 'MAUSAM', 1950) have been uploaded on the website and the Digital Object Identifiers (DOI's) for all of them have been activated and are working successfully.***

***•The impact factor the journal rated by several agencies has been increased and at the maximum for the past three years.***
***The journal is rated by:***
***Journal Citation Rankings (JCR): 0.636 to 0.906 (Web of science)/1.01 (Scopus) in 2021,***
***National Academy of Agricultural Sciences: 6.37 to 6.64 in 2022.***




## 7.1. RESEARCH CONTRIBUTIONS PUBLISHED IN 'MAUSAM'

**Y. E. A. Raj** and **B. Amudha**, 2022, "**Extent of diurnal cycle of rainfall and its intra seasonal variation over coastal Tamil Nadu during north east monsoon season**", *MAUSAM*, **73**, 1, 1-18, https://doi.org/10.54302/mausam.v73i1.4984.

**Ranjan Phukan** and **D. Saha**, 2022, "**Analysis of rainfall trends over Tripura**", *MAUSAM*, **73**, 1, 27-36, https://doi.org/10.54302/mausam.v73i1.5078.

**Bikram Singh** and **RohitThapliyal**, 2022, "**Cloudburst events observed over Uttarakhand during monsoon season 2017 and their analysis**", *MAUSAM*, **73**, 1, 91-104, https://doi.org/10.54302/mausam.v73i1.5084.

**Singh, V. P., Mathew, J.** and **Verma, I. J.,** 2022, "**Inter-spatial heat vulnerability assessment of Summer-2018 over Madhya Pradesh using discomfort (wind & Thermal) indices**", *MAUSAM*, **73**, 1, 105-114, https://doi.org/10.54302/ mausam.v73i1.5085.

**Sandip Nivdange, Chinmay Jena, Pooja V. Pawar, Gaurav Govardhan, SreyashiDebnath, Santosh Kulkarni, PrasannaLonkar, Akash Vispute, Narendra Dhangar, Avinash Parde, Prodip Acharja, Vinod Kumar, Prafull Yadav, Rachana Kulkarni, Manoj Khare** and **N. R. Karmalkar**, 2022, "**Nationwide CoViD-19 lockdown impact on air quality in India**", *MAUSAM*, **73**, 1, 115-128, https://doi.org/10.54302/mausam. v73i1.1475.

**Prasanta Das** and **Somenath Dutta**, 2022, "**A mathematical model for fluxes associated with internal gravity waves excited by a corner mountain**", *MAUSAM*, **73**, 1, 181-188, https://doi.org/10.54302/mausam.v73i1.5091.

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**Ch. Sridevi**, **P. Suneetha**, **K. K. Singh**, **V. R. Durai**, **D. R. Pattanaik** and **A. K. Das**, 2022, "**Evaluation of forecast skill of GFS T1534 for heavy rainfall events of Monsoon 2017 at district level across India**", *MAUSAM*, **73**, 2, 217-228, https://doi.org/10.54302/mausam.v73i2.5473.

**Mukhtar Ahmed**, **Bappa Das**, **Sonam Lotus** and **Mahboob Ali**, 2022, "**A study on frequency of western disturbances and precipitation trends over Jammu & Kashmir, India: 1980-2019**", *MAUSAM*, **73**, 2, 283-294, https://doi.org/10.54302/ mausam.v73i2.698.

**Priyanka Singh** and **Naresh Kumar**, 2022, "**Analysis of trend and temporal variability in rainfall over Northeast India**", *MAUSAM*, **73**, 2, 307-314, https://doi.org/10.54302/ mausam.v73i2.5479.

**Ashok Kumar Das**, **B. P. Yadav**, **Charu** and **Jyotsana Dhingra**, 2022, "**Evaluation of performance of WRF (ARW) and GFS for Quantitative Precipitation Forecast and its value addition over India river sub-basins during recent years**", *MAUSAM,* **73**, 2, 315-340, https://doi.org/ 10.54302/ mausam.v73i2.5480.

Sahu, Rajesh Kumar, BhishmaTyagi, Naresh Krishna Vissa and **Mrutyunjay Mohapatra**, 2022, "**Pre-Monsoon Thunderstorm Season Climatology of Convective Available Potential Energy (CAPE) and Convective Inhibition (CIN) over Eastern India**", *MAUSAM*, **73**, 3, 565-86. https://doi.org/ 10.54302/mausam.v73i3.1247.

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**Pai, D. S.** and **Smitha Nair**, 2022, "**Impact of El-Niño-Southern Oscillation (ENSO) on Extreme Temperature Events over India**", *MAUSAM,* **73**, 3, 597-606, doi: https://doi.org/ 10.54302/mausam.v 73i3.5932.

**Ansari, M. I.** and **Ranju Madan,** 2022, "**Sustenance of Global Climate Observation System Upper Air Network (GUAN) of IndiaMeteorological Department**", *MAUSAM,* **73**, 3, 637-650. https://doi.org/ 10.54302/mausam.v73i3.2197.

**Tomar, C. S.** 2022. "**Unprecedented Weather Activity Over Northwest India on 23rd May, 2016**", *MAUSAM,* **73,** 3, 705-709. https://doi.org/10.54302/mausam.v73i3.5938.

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N. Dhangar, A. NPARDE, **R. AHMED,** D. SVVDPRASAD and D. MANILAL, **"Fog nowcasting over the IGI airport, New Delhi, India using decision tree"**, *MAUSAM*, 73, 4, 785-794, https://doi.org/10.54302/mausam.v73i4.3441.

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# CHAPTER 8

# FINANCIAL RESOURCES AND MANAGEMENT PROCESS

## 8.1. Budget Outlay of approved schemes of IMD

IMD receives its budget allocation under two categories namely, budget for implementation of Central Sector schemes and budget for Establishment related expenditure. Budget Estimates (B.E.)/ Revised Estimates (R.E.) during Financial Year 2022-23 are as follows:

| Budget Estimates 2022-23 (Rs. in Crores) | | | |
|---|---|---|---|
| | **Central Sector Schemes** | **Establishment** | **Total** |
| **BE** | **216.71** | **514.03** | **730.74** |
| **RE** | 211.40 | 481.47 | 692.87 |

**Atmospheric & Climate Research - Modelling Observing Systems & Services (ACROSS)**

To upgrade the forecasting capabilities throughout the country, various programs are being implemented in IMD under the umbrella scheme "Atmosphere & Climate Research-Modelling Observing Systems & Services (ACROSS)" of the Ministry of Earth Sciences (MoES) namely, Atmospheric Observation Network (AON), Upgradation of Forecast System (UFS), Weather & Climate Services (WCS) and Commissioning of Polarimetric Doppler Weather Radars (PDWR).

**Main activities being undertaken during 2021-26 under these four sub-schemes are listed below:**

**Atmospheric Observations Network (AON)**

- Integrated Meteorological Services for the North-East (NE) region through commissioning of DWRs, AWOS/ HAWOS, AWSs/ARGs/ SGs, Microwave Radiometers, Wind LiDARs etc, and establishment/ upgradation of Meteorological Centres aimed at improving weather and climate services over the region.
- Sustenance and Augmentation of observational networks comprising of Doppler Weather Radars (DWRs), Automatic Rain Gauges (ARGs), Automatic Weather systems (AWSs), Upper Air (RS/RW and PB), Surface, Environmental and Polar Observatories etc.
- Establishment/ upgradation and maintenance of Multi processing, computing and communication facilities for Satellite Meteorological Applications comprising of Multi Mission Data Reception and Processing System (MMDRPS), Polar Orbit Direct Receiving systems etc.

**Upgradation of Forecast System (UFS)**

- Upgradation and sustenance of Communication Systems for observations data and forecast products transmission.
- Development of an advanced Operational Forecast System, Delivery System for Forecast, Automation of Nowcast, Thunderstorm research Test bed, Urban Meteorological Services and Positional Astronomy services.

- Upgradation of Hydrometeorological Services

- Integrated Himalayan Meteorological Programme for Western & Central Himalayas (IHMP).

- Capacity building, Outreach, R&D, Publication etc.

**Weather & Climate Services (WCS)**

- Setting up of District Agro-Met Units (DAMUs) at all the districts complimentarily with existing AMFUs in the country for extension of Agromet Advisory Services (AAS).

- To expand the outreach of weather based Agromet advisories to the farmers through multiple means of communication, collection of feedback and impact assessment of AAS.

- Major upgradation of Meteorological facilities at all airports through commissioning of State-of-art Integrated Aviation Weather Observing Systems (AWOS), Microwave Radiometers, Doppler LIDARs, Wind Profilers etc. to support Aeronautical MET Services.

- Setting up of automated Heliport Weather Observing & Transmitting System (HAWOS) at Heliports, Landing ground, and other strategic locations to support the helicopter and low level flight operation of IAF, Indian Army and CPMF and also at important tourist and pilgrimage locations.

- Sustenance & maintenance of Aviation Meteorological instruments and facilities through repairs, procurement of sensors, spares, CAMC/AMC etc.

- Establishment of a state-of the-art Climate Data Centre with integrated advanced Climate Data Services portal for rendering national and regional climate services.

- To provide a comprehensive set of improved and specialized climate services for the country through upgradation of the existing operational activities of climate monitoring, climate prediction, climate data management and climate applications.

- Providing upgraded climate services to south Asia as WMO recognized Regional Climate Centre (RCC) for the region.

- To upgrade the training infrastructure and facilities to enhance the capacity of the training establishment. To support in the building & development capacity in the field of operational weather & Climate services to the countries in RA-II region as a WMO recognized Regional Training Centre (RTC) for the region. To sign MoU with different universities for accreditation of it's different training courses.

- Contributions among WMO/RIMES/ESCAP/ Global Framework for Climate Services (GFCS) in South Asia etc.

**Commissioning of Polarimetric Doppler Weather Radars (PDWR)**

The scheme "Commissioning of Polarimetric Doppler Weather Radars (DWRs)"is aimed at augmenting the DWR network over the country to facilitate plugging the existing gaps in the meteorological observational network of radars for most parts of the country, through installation of eleven C-Band dual polarized DWRs.

## 8.2. REVENUE GENERATED DURING THE YEAR 2022

### Sale of Meteorological Data

| RCs/MCs | Total revenue received by sale of meteorological data during the month (Amount in Rupees) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| DGM, New Delhi | | | | | | | | | | | | |
| DGM SATMET | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL |
| DGM HYDROLOGY | 326672 | 165248 | 675113 | NIL | 582627 | NIL | 425820 | 564022 | NIL | NIL | 348449 | NIL |
| DGM (Publication) | 24550 | 67206 | 45800 | 11225 | 8225 | 8225 | 16675 | 4000 | 8225 | 2200 | 24000 | NIL |
| RMC, New Delhi | | | | | | | | | | | | |
| New Delhi | 30134 | 30874 | 46862 | 26552 | 75035 | 78490 | 10457 | 13283 | 8575 | 66757 | 29539 | 2656 |
| Jaipur | NIL | 2596 | 26865 | NIL | 31806 | 29964 | 34535 | 32284 | 28708 | 12323 | 6027 | 13100 |
| Lucknow | 63872 | 13851 | 7316 | 17408 | 7627 | 9147 | 18749 | 11255 | 32697 | 9230 | 17525 | 6702 |
| Srinagar | 16499 | 26529 | 11758 | 2655 | NIL | 54165 | 5015 | NIL | 20060 | 29696 | 8875 | 7375 |
| Chandigarh | 2714 | 10101 | 21592 | 5711 | 11769 | 19291 | 14922 | 24518 | 22503 | 15525 | 10968 | 11362 |
| Shimla | 12278 | NIL | 6416 | 3102 | 5074 | 8674 | 5074 | 12055 | 14592 | 9908 | 10644 | 3321 |
| Dehradun | 35576 | 6666 | 3717 | NIL | 6367 | 2537 | NIL | 7434 | 4897 | NIL | 30038 | NIL |
| RMC, Mumbai | | | | | | | | | | | | |
| Mumbai | 37147 | 36168 | 25177 | 23376 | 23653 | 23094 | 42943 | 2706 | 12351 | 43792 | 25367 | 7658 |
| RMC, Nagpur | | | | | | | | | | | | |
| Nagpur | 50170 | 2823 | 34388 | NIL | 13320 | 13802 | 21830 | 39648 | 40608 | 7198 | 41798 | 7316 |
| Bhopal | 2737 | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL |
| RMC, Kolkata | | | | | | | | | | | | |
| RMC Kolkata | NIL | NIL | NIL | NIL | 7931 | NIL | 3995 | 5811 | 16539 | NIL | 114728 | 160933 |
| PAC Kolkata | NIL | NIL | NIL | NIL | NIL | NIL | NIL | 13158 | 13071 | NIL | 17071 | 6904 |
| Patna | NIL | NIL | 11807 | 4446 | NIL | NIL | NIL | NIL | 17354 | 43626 | NIL | 4140 |
| Bhubaneswar | NIL | NIL | NIL | 6845 | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL |
| Gangtok | NIL | NIL | NIL | 2926 | NIL | NIL | NIL | 32888 | 9974 | 22875 | 56524 | 159728 |
| Ranchi | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | 24490 | 3417 | 5049 | 25314 |
| RMC, Guwahati | | | | | | | | | | | | |
| Guwahati | 32204 | 35153 | 38066 | 111321 | 29999 | 125172 | 150767 | 216080 | 61976 | 36044 | 59503 | 24970 |
| Agartala | 19094 | 12977 | NIL | 4620 | 8849 | 6564 | 1782 | 17443 | NIL | 3564 | NIL | 11428 |
| RMC, Chennai | | | | | | | | | | | | |
| Chennai | 131591 | 114275 | 69893 | 65196 | 47507 | 30302 | 48458 | 56473 | 142898 | 83325 | 97644 | 34009 |
| Thiruvananthapuram | 7080 | 28320 | 22713 | 13339 | 154971 | 18352 | 3540 | 42480 | 10620 | 15930 | 26502 | 3540 |
| Hyderabad | 13689 | 48944 | 13050 | 11333 | 37866 | 42066 | 22555 | 17054 | 14139 | 9857 | 39691 | 15042 |
| Bangalore | 110229 | 102722 | 105876 | 129426 | 119276 | 218991 | 120931 | 115705 | 198627 | 244819 | 681918 | 123237 |
| ACWC Chennai | NIL | NIL | 7080 | NIL | 7080 | NIL | NIL | 28320 | NIL | 7080 | NIL | NIL |
| CWC Visakhapatnam | NIL | NIL | NIL | NIL | 4962 | 33971 | NIL | 5226 | 4961 | 1300 | NIL | 7201 |
| CRS, Pune | | | | | | | | | | | | |
| Pune | 970278 US $1534 | 261553 | 169727 US $360 | 171537 US $374 | 81653 | 504098 US $5417 | 1101976 | 695151 | 417471 | 710313 | 339512 US $337 | 314640 |

# CHAPTER 9

# राजभाषा नीति का कार्यांवयन

## संसदीय राजभाषा समिति द्वारा निरीक्षण

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 12.02.2022 को मौसम केंद्र पटना का पटना में राजभाषायी निरीक्षण किया गया। इस निरीक्षण कार्यक्रम में मुख्यालय से डॉ के.के. सिंह, वैज्ञानिक 'जी' तथा श्रीमती सरिता जोशी उपनिदेशक (राजभाषा) ने भाग लिया। प्रादेशिक मौसम केंद्र, कोलकाता से डॉ सजीब बंदोपाध्याय - वैज्ञानिक 'एफ' तथा मौसम केंद्र, पटना से श्री विवेक सिन्हा- वैज्ञानिक 'एफ' उपस्थित रहे।

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 07.03.2022 को मौसम केंद्र अगरतला का निरीक्षण किया गया। इस निरीक्षण में मंत्रालय की श्रीमती इंदिरा मूर्ति- संयुक्त सचिव, श्री मनोज आबूसरिया- संयुक्त निदेशक (रा.भा.) और मुख्यालय से डॉ. शिवदेव अत्री- वैज्ञानिक 'जी', श्रीमती सरिता जोशी, उप निदेशक (रा.भा.) ने भाग लिया। प्रादेशिक मौसम केंद्र, गुवाहाटी से डॉ. के. एन. मोहन, वैज्ञानिक 'जी' तथा मौसम केंद्र, अगरतला से श्री नहुष कुलकर्णी, वैज्ञानिक 'सी' उपस्थित रहे। निरीक्षण सफल एवं संतोषजनक रहा।


संसदीय राजभाषा समिति द्वारा मौसम केंद्र- अगरतला का निरीक्षण

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 29.04.2022 को मौसम केंद्र- चंडीगढ का निरीक्षण किया गया। इस निरीक्षण में मंत्रालय की तरफ से श्रीमती इंदिरा मूर्ति- संयुक्तफ सचिव और श्री मनोज आबूसरिया- संयुक्तण निदेशक (रा.भा.) तथा मुख्यामलय की तरफ से डॉ. शिव देव अत्री- वैज्ञानिक 'जी' और श्रीमती सरिता जोशी-उप निदेशक (रा.भा.) ने भाग लिया। प्रादेशिक मौसम केंद्र- नई दिल्ली से श्री चरण सिंह- वैज्ञानिक 'एफ' और मौसम केंद्र- चंडीगढ़ से डॉ. मनमोहन सिंह- वैज्ञानिक 'एफ'उपस्थिसत रहे। निरीक्षण सफल एवं संतोषजनक रहा।


संसदीय राजभाषा समिति द्वारा मौसम केंद्र – चंडीगढ का निरीक्षण

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 04.05.2022 को हाइड्रोजन फैक्ट्री आगरा का निरीक्षण किया गया। इस

संसदीय राजभाषा समिति की दूसरी उपसमिति द्वाराहाइड्रोजन फैक्ट्री आगरा का निरीक्षण

निरीक्षण में मंत्रालय से श्रीमती इंदिरा मूर्ति, संयुक्त सचिव और श्री मनोज आबूसरिया, संयुक्त निदेशक (रा.भा) और मुख्या0लय से डॉ. के. के. सिंह , वैज्ञानिक 'जी' और श्रीमती सरिता जोशी, उपनिदेशक (रा.भा.) ने भाग लिया। हाइड्रोजन फैक्ट्री , आगरा के प्रमुख श्री पप्पूय सिंह, मौसम विज्ञानी 'ए' उपस्थित रहे। निरीक्षण सफल एवं संतोषजनक रहा।

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 26.08.2022 को मौसम केंद्र - बेंगलुरू तथा हवाई अड्डा मौसम स्टेरशन - कोयंबटूर का निरीक्षण किया गया। इस निरीक्षण में मुख्यालय की तरफ से महानिदेशक डॉ. मृत्युंजय महापात्र तथा उपनिदेशक (राजभाषा) श्रीमती सरिता जोशी ने भाग लिया। प्रोदशिक मौसम केंद्र - चेन्नै से डॉ. एस. बालचंद्रन, वैज्ञानिक 'एफ', मौसम केंद्र-बेंगलुरू की प्रमुख डॉ. गीता अग्निहोत्री, वैज्ञानिक 'एफ' तथा हवाई अड्डा मौसम स्टेशन कोयम्बिटूर के प्रमुख श्री के. आर. दास, मौसम विज्ञानी 'बी' उपस्थित रहे। दोनों कार्यालयों का निरीक्षण सफल रहा।

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 26.09.2022 को मौसम केंद्र - तिरूवनंतपुरम का निरीक्षण किया गया। इस निरीक्षण में मुख्यालय की ओर से डॉ. के. के. सिंह, वैज्ञानिक 'जी' तथा श्रीमती सरिता जोशी, उपनिदेशक (राजभाषा) ने भाग लिया। प्रोदशिक मौसम केंद्र - चेन्नै से डॉ. एस. बालचंद्रन , वैज्ञानिक 'एफ' तथा मौसम केंद्र - तिरूवनंतपुरम के प्रमुख डॉ. के. संतोष, वैज्ञानिक 'एफ' उपस्थित रहे ।

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 14.11.2022 को मौसम केंद्र - रायपुर का निरीक्षण किया गया। निरीक्षण में मुख्यालय से महानिदेशक महोदय डॉ. मृत्युंजय महापात्र और उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी ने भाग लिया। यह निरीक्षण सफल रहा ।

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 16.11.2022 को प्रादेशिक मौसम केंद्र - कोलकाता का निरीक्षण किया गया। निरीक्षण में मुख्यालय से डॉ. के. के. सिंह, वैज्ञानिक 'जी' और उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी ने भाग लिया। यह निरीक्षण सफल रहा।

## राजभाषायी ई-निरीक्षण

दिनांक 11.01.2022 को प्रादेशिक मौसम केंद्र - नागपुर द्वारा मौसम कार्यालय- अकोला, मौसम कार्यालय - इंदौर तथा मौसम कार्यालय - सागर का ई निरीक्षण किया गया जिसमें सहायक निदेशक (रा.भा.) श्रीमती सरिता जोशी उपस्थीत रहीं और आवश्याक दिशा निर्देश दिए।

दिनांक 12.01.2022 को मौसम केंद्र - चंडीगढ़, मौसम केंद्र - लखनऊ तथा खगोल विज्ञान केंद्र - कोलकाता का राजभाषायी ई निरीक्षण श्रीमती सरिता जोशी, सहायक निदेशक (रा.भा.) द्वारा किया गया जिसमें पृथ्वी विज्ञान मंत्रालय के संयुक्त निदेशक (रा.भा.) श्री मनोज आबूसरिया भी उपस्थित रहे।

दिनांक 18.02.2022 को मौसम केंद्र - शिमला, मौसम केंद्र - देहरादून, मौसम केंद्र- श्रीनगर और मौसम केंद्र- लेह का राजभाषायी ई-निरीक्षण उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी द्वारा किया गया व आवश्य-क दिशानिर्देश दिए गए। निरीक्षण में डॉ. के. के. सिंह , वैज्ञानिक 'जी' तथा श्री मनोज आबूसरिया, संयुक्तग निदेशक (रा.भा.) पृथ्वी विज्ञान मंत्रालय भी शामिल रहे।

दिनांक 21.2.2022 को प्रादेशिक मौसम केंद्र - नागपुर द्वारा मौसम कार्यालय - बिलासपुर और मौसमकार्यालय -अम्बितकापुर का राजभाषायी ई निरीक्षण किया गया जिसमें उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी उपस्थितत रहीं और आवश्ययक दिशा निर्देश दिए।

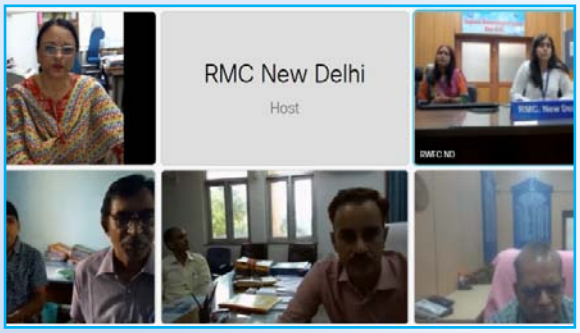
दिनांक 21.04.2022 को प्रादेशिक मौसम केंद्र- चेन्नै, मौसम केंद्र - हैदराबाद तथा मौसम केंद्र-तिरूवनतंपुरम का राजभाषायी ई-निरीक्षण श्रीमती सरिता जोशी, उप निदेशक (रा.भा.) द्वारा किया गया जिसमें पृथ्वी विज्ञान मंत्रालय से श्री मनोज आबूसरिया, संयुक्त निदेशक (रा.भा.) तथा मुख्यालय से डॉ. एस. डी. अत्री , वैज्ञानिक 'जी' भी शामिल रहे।

**प्रादेशिक मौसम केंद्र - चेन्नै, मौसम केंद्र - हैदराबाद तथा मौसम केंद्र - तिरूवनतंपुरम का राजभाषायी ई-निरीक्षण**

दिनांक 31.05.2022 को खगोल विज्ञान केंद्र-कोलकाता, मौसम केंद्र-बेंगलुरू और मौसम केंद्र- अमरावती का श्रीमती सरिता जोशी, उपनिदेशक (रा.भा.) द्वारा राजभाषायी ई निरीक्षण किया गया जिसमें पृथ्वी विज्ञान मंत्रालय से श्री मनोजआबूसरिया, संयुक्त निदेशक (रा.भा.) तथा मुख्यालय से श्रीमती रंजू मदान उपमहानिदेशक (प्रशा.) भी शामिल रहे।

**खगोल विज्ञान केंद्र-कोलकाता, मौसम केंद्र - बेंगलुरू और मौसम केंद्र - अमरावती काराजभाषायीई - निरीक्षण**

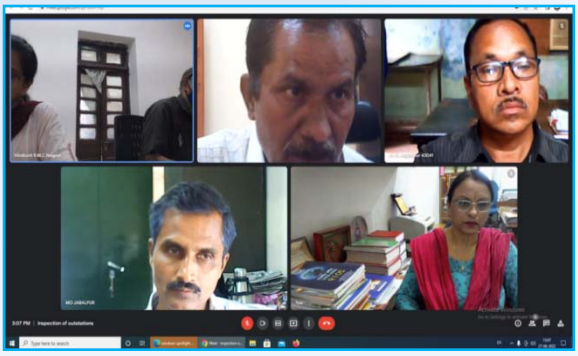
दिनांक 08.06.2022 को प्रादेशिक मौसम केंद्र - नई दिल्ली द्वारा मौसम कार्यालय एवं पवन सूचक गुब्बारा वेधशाला - कोटा और दिनांक 15.06.2022 को मौसम रेडार स्टेशन एवं पवन सूचक गुब्बारा वेधशाला - जैसलमेर, मौसम रेडार स्टेशन- श्रीगंगानगर और पवन सूचक गुब्बारा वेधशाला- चुरू का राजभाषायी ई-निरीक्षण किया गया जिसमें उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी उपस्थित रहीं और आवश्यक दिशा निर्देश दिए।




**प्रादेशिक मौसम केंद्र - नई दिल्ली द्वाराराजभाषायीई-निरीक्षण**

दिनांक 06.06.2022 को प्रादेशिक मौसम केंद्र - कोलकाता द्वारा मौसम कार्यालय - पुरी , विमानन मौसम कार्यालय - आसनसोल और विमानन मौसम कार्यालय- जलपाईगुडी का राजभाषायी ई-निरीक्षण किया गया जिसमें उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी उपस्थिवत रहीं और आवश्याक दिशा निर्देश दिए।

दिनांक 28.06.2022 को प्रादेशिक मौसम केंद्र - नागपुर द्वारा मौसम कार्यालय - ग्वालियर , मौसम कार्यालय - जबलपुर और मौसम कार्यालय- जगदलपुर का राजभाषायी ई-निरीक्षण किया गया जिसमें उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी उपस्थित रहीं और आवश्यक दिशा निर्देश दिए।



**प्रादेशिक मौसम केंद्र- नागपुर द्वाराराजभाषायीई-निरीक्षण**

दिनांक 28.07.2022 को प्रादेशिक मौसम केंद्र - मुंबई, मौसम केंद्र - गोवा, मौसम केंद्र - श्रीनगर और मौसम केंद्र - शिमला का श्रीमती सरिता जोशी, उपनिदेशक (रा.भा.) द्वारा राजभाषायी ई-निरीक्षण किया गया जिसमें पृथ्वी विज्ञान मंत्रालय के श्री मनोज आबूसरिया, संयुक्त निदेशक (रा.भा.) शामिल रहे।

दिनांक 15.11.2022 को मौसम केंद्र - रायपुर, दिनांक 17.11.2022 को मौसम कार्यालय - कोलकाता और खगोल विज्ञान केंद्र - कोलकाता तथा दिनांक 18.11.2022 को प्रादेशिक मौसम केंद्र - कोलकाता का राजभाषायी निरीक्षण उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी द्वारा किया गया।

## हिंदी दिवस समारोह

मुख्यालय में हिंदी दिवस समारोह 2022 का दिनांक 29.09.2022 को सफल आयोजन किया गया। हिंदी दिवस समारोह की अध्यदक्षता डॉ. मृत्युंजय महापात्र, महानिदेशक महोदय ने की तथा इस समारोह की मुख्य अतिथि श्रीमती प्रमिला भारती, सुप्रसिद्ध गीत गज़लकार व साहित्यकार रही।

मुख्यालय में हिंदी दिवस/हिंदी पखवाड़ा 2022 के दौरान आयोजित की गई 6 प्रतियोगिताओं के 30 विजेताओं को महानिदेशक महोदय डॉ. मृत्युंजय महापात्र एवं मुख्य अतिथि श्रीमती प्रमिला भारती तथा हिंदी दिवस समारोह समिति के अध्यक्ष डॉ. के. के. सिंह, वैज्ञानिक 'जी' के हाथों से पुरस्कार एवं प्रमाण पत्र प्रदान किए गए ।

मुख्यालय में हिंदी दिवस/हिंदी पखवाड़ा 2022 के दौरान आयोजित की गई प्रतियोगिताएँ

मुख्यालय के हिंदी दिवस/पखवाड़ा 2022 के समापन समारोह में सरकारी कामकाज मूलरूप से हिंदी में करने की प्रोत्सांहन योजना 2021-2022 के

हिंदी दिवस/ पखवाड़ा 2022

मुख्यालय तथा प्रादेशिक मौसम केंद्र, नई दिल्ली के विजेताओं को महानिदेशक महोदय, मुख्य अतिथि विजेताओं को महानिदेशक महोदय, मुख्य अतिथि तथा समारोह समिति के अध्यक्ष द्वारा प्रमाण पत्र प्रदान किए गए।

हिंदी दिवस समारोह 29.09.2022 के अवसर पर राजभाषा हिंदी में सर्वश्रेष्ठ कार्य करने हेतु वर्ष 2021-2022 के लिए राजभाषा चलशील्ड सूचना का अधिकार प्रकोष्ठ को प्रदान की गई ।

राजभाषा हिंदी में सर्वश्रेष्ठ कार्य करने हेतु वर्ष 2021-2022 के लिए राजभाषा चलशील्ड

## प्रकाशन

'मौसम मंजूषा' के 34$^{वें}$ संस्करण का विमोचन विभाग के स्थापना दिवस के अवसर पर दिनांक 14.01.2022 को माननीय मंत्री महोदय डॉ.जितेन्द्र सिंह जी द्वारा किया गया। पत्रिका की प्रतियाँ मुख्यालय के अनुभागों, राजभाषा कार्यान्वनसमिति कोसदस्यों / उपकार्यालयों को वितरित की गई।

'मौसम मंजूषा' के 34वें संस्करण का विमोचन

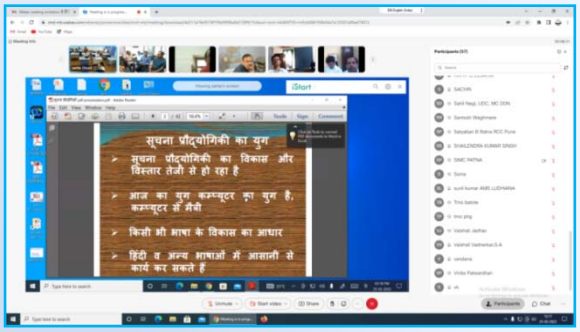
विभागीय हिंदी गृह पत्रिका 'मौसम मंजूषा'का 34वाँ संस्करण राजभाषा विभाग, गृह मंत्रालय की वेबसाइट में 'ई-पत्रिका पुस्तकालय' के अंतर्गत अपलोड किया गया।

माननीय महानिदेशक महोदय डॉ. मृत्युंजय महापात्र जी द्वारा विभागीय गृह पत्रिका 'मौसम मंजूषा' के 35वें संस्करण का विमोचन हिंदी दिवस/हिंदी पखवाड़ा 2022 के अवसर पर दिनांक 29.09.2022 को किया गया।


माननीय महानिदेशक महोदय डॉ. मृत्युंजय महापात्र जी द्वारा 'मौसम मंजूषा' के 35वें संस्करण का विमोचन

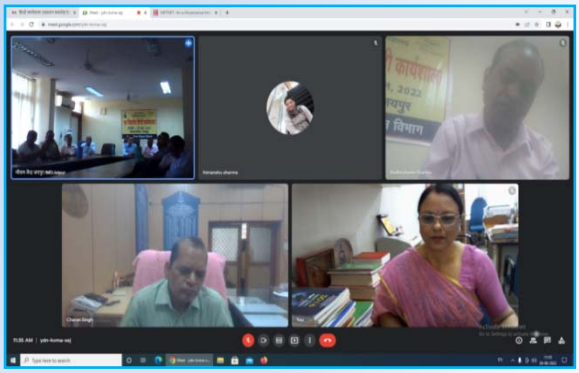
## कार्यशाला/व्याख्यान

मुख्यालय द्वारा दिनांक 25.03.22 को ई-हिंदी कार्यशाला का आयोजन किया गया जिसमें दिल्ली सहित विभिन्न कार्यालयों के लगभग 124 कार्मिकों ने भाग लिया। ई-हिंदी कार्यशाला का शुभारंभ महानिदेशक महोदय डॉ मृत्युंजय महापात्र के संबोधन से हुआ। इस कार्यशाला में पृथ्वी विज्ञान मंत्रालय के संयुक्त निदेशक (राजभाषा) श्री मनोज आबूसरिया, सेवानिवृत्तप उप निदेशक (रा.भा.) सुश्री रेवा शर्मा, श्रीमती सरिता जोशी, उप निदेशक (राजभाषा) एवं वरिष्ठ अनुवाद अधिकारी श्री बीरेन्द्र कुमार ने व्याख्यान दिए।




ई-हिंदी कार्यशाला

मौसम केंद्र - जयपुर द्वारा दिनांक 28.06.2022 को आयोजित हिंदी कार्यशाला में श्रीमती सरिता जोशी उपनिदेशक (रा.भा.) ने स्वागत भाषण दिया।



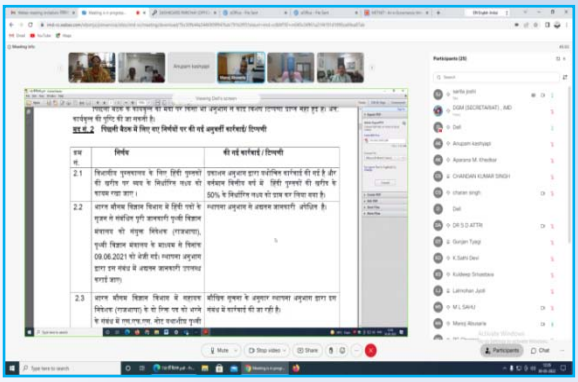
मौसम केंद्र- जयपुर द्वारा आयोजित हिंदी कार्यशाला

भारत मौसम विज्ञान विभाग के 'सहायक' पद के कार्मिकों के प्रशिक्षण कार्यक्रम में श्रीमती सरिता जोशी, उपनिदेशक ने 'राजभाषा हिंदी' पर व्याख्यान दिया। उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी ने दिनांक 25.11.2022 को बेसिक/ मॉड्यूलर प्रशिक्षण पाठ्यक्रम के प्रशिक्षार्थियों को 'राजभाषा हिंदी- आवश्यक जानकारियाँ' विषय पर व्याख्यान दिया।

मुख्यालय द्वारा दिनांक 15.12.2022 को ई-हिंदी कार्यशाला का आयोजन किया गया जिसमें दिल्ली सहित विभिन्न कार्यालयों के लगभग 200 कार्मिकों ने भाग लिया। ई-हिंदी कार्यशाला का शुभारंभ महानिदेशक महोदय डॉ मृत्युंजय महापात्र के संबोधन से हुआ। इस कार्यशाला में सेवानिवृत्त उप निदेशक (रा.भा.) सुश्री रेवा शर्मा, श्रीमती सरिता जोशी, उप निदेशक (राजभाषा) एवं वरिष्ठ अनुवाद अधिकारी श्री बीरेन्द्र कुमार ने व्याख्यान दिए।

## बैठकें

मुख्यालय की राजभाषा कार्यान्वयन समिति की वर्ष 2022 की पहली तिमाही बैठक (158वीं तिमाही बैठक) महानिदेशक महोदय की अनुमति से डॉ. शिवदेव अत्री वैज्ञानिक 'जी' की अध्यक्षता में दिनांक 30.03.2022 को वर्चुअल माध्यम से आयोजित की गई। इस बैठक में पृथ्वी विज्ञान मंत्रालय के संयुक्त निदेशक (राजभाषा) श्री मनोज आबूसरिया, मुख्यालय के अधिकारी तथा उपकार्यालयों के प्रमुख/ प्रतिनिधि वर्चुअल माध्यम से उपस्थित रहे। अंत में महानिदेशक महोदय ने भी आवश्यक दिशानिर्देश दिए ।



मुख्यालय की राजभाषा कार्यान्वयन समिति की वर्ष 2022 की 158वीं तिमाही बैठक

डॉ. एस. डी. अत्री , वैज्ञानिक 'जी' की अध्यक्षता में विभाग की पुस्तकालय समिति की दिनांक 25.03.2022 को आयोजित 119वीं बैठक में श्रीमती सरिता जोशी, उपनिदेशक (राजभाषा) ने सदस्यों के रूप में भाग लिया।

विज्ञान और प्रौद्योगिकी मंत्रालय तथा पृथ्वी विज्ञान मंत्रालय की संयुक्त हिंदी सलाहकार समिति की दिनांक 06.06.2022 को आयोजित की जाने वाली 31वीं बैठक के लिए पिछली बैठक (30वीं) के कार्यवृत्ति पर की गई कार्रवाई की रिपोर्ट, 31 मार्च 2022 की तिमाही प्रगति रिपोर्ट, राजभाषा नीति के कार्यान्वयन संबंधी संवैधानिक प्रावधानों के अनुपालन की स्थिति (31 दिसंबर, 2021 की तिमाही और 31 मार्च, 2022 की तिमाही रिपोर्ट के अनुसार) तथा हिंदी पखवाड़े के आयोजन संबंधी रिपोर्ट विज्ञान और प्रौद्योगिकी मंत्रालय और पृथ्वी विज्ञान मंत्रालय को भेजी गई।

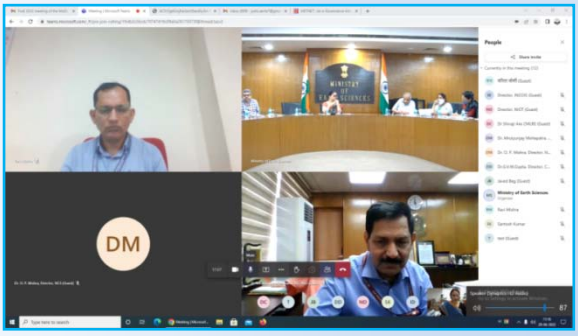
पृथ्वी विज्ञान मंत्रालय तथा विज्ञान और प्रौद्योगिकी मंत्रालय की संयुक्त हिंदी सलाहकार समिति की 31वीं बैठक का आयोजन माननीय मंत्री महोदय की अध्यक्षता में दिनांक 6.06.2022 को पृथ्वी विज्ञान मंत्रालय में किया गया। इस बैठक में डॉ मृत्युंजय महापात्र, महानिदेशक महोदय ने सदस्य के रूप में भाग लिया। महानिदेशक महोदय द्वारा माननीय मंत्री महोदय तथा समिति के सभी सदस्यों का शॉल पहनाकर स्वागत किया गया। मुख्यालय से उपनिदेशक (रा.भा.), श्रीमती सरिता जोशी, वरिष्ठ अनुवाद अधिकारी तथा कनिष्ठ अनुवाद अधिकारी भी इस बैठक में उपस्थित रहे।

महानिदेशक महोदय द्वारा माननीय मंत्री महोदय तथा समिति के सभी सदस्यों का शॉल पहनाकर स्वागत किया गया

मुख्यालय की राजभाषा कार्यान्वयन समिति की वर्ष 2022 की दूसरी तिमाही बैठक (158वीं तिमाही बैठक) महानिदेशक महोदय की अनुमति से डॉ. शिवदेव अत्री वैज्ञानिक 'जी' की अध्यक्षता में दिनांक 29.06.2022 को वर्चुअल माध्यम से आयोजित की गई। इस बैठक में

मुख्यालय के अधिकारी तथा उपकार्यालयों के प्रमुख/प्रतिनिधि वर्चुअल माध्यम से उपस्थित रहे।

पृथ्वी विज्ञान मंत्रालय द्वारा दिनांक 29.06.2022 को श्रीमती इंदिरा मूर्ति-संयुक्त सचिव महोदया की अध्यक्षता में आयोजित राजभाषा कार्यान्वयन समिति की बैठक में डॉ. एस. डी. अत्री वैज्ञानिक 'जी' / कार्यकारी महानिदेशक तथा श्रीमती सरिता जोशी, उपनिदेशक (रा.भा.) ने भारत मौसम विज्ञान विभाग का प्रतिनिधित्व किया।




**श्रीमती इंदिरा मूर्ति-संयुक्त सचिव महोदया की अध्यक्षता में आयोजित राजभाषा कार्यान्वयन समिति की बैठक**

डॉ. एस. डी. अत्री , वैज्ञानिक 'जी' की अध्यक्षता में पुस्तकालय सलाहकार समिति की दिनांक 20.07.2022 आयोजित 120वीं बैठक में श्रीमती सरिता जोशी, उपनिदेशक (रा.भा.) ने सदस्य के रूप में भाग लिया।

भारत मौसम विज्ञान विभाग के 148वें स्थापना दिवस के आयोजन से संबंधित विर्द्यार्थियों हेतु प्रतियोगिताएँ आयोजित करने से संबंधित उपसमिति में सदस्य के रूप में उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी को नामित किया गया। महानिदेशक महोदय की अध्यक्षता में दिनांक 22.11.2022 को हुई संबंधित बैठक में उपनिदेशक (रा.भा.) ने भाग लिया ।

विज्ञान और प्रौद्योगिकी मंत्रालय तथा पृथ्वी विज्ञान मंत्रालय की संयुक्त हिंदी सलाहकार समिति की 32वीं बैठक का आयोजन दिनांक 26.12.2022 को माननीय मंत्री डॉ. जितेन्द्र सिंह, विज्ञान और प्रौद्योगिकी मंत्रालय तथा पृथ्वी विज्ञान मंत्रालय की अध्यक्षता में पृथ्वी भवन के अर्णव हॉल लोदी रोड, नई दिल्ली में संपन्न हुआ। इस बैठक में कार्यभारी महानिदेशक डॉ. शिवदेव अत्री वैज्ञानिक 'जी' तथा उपनिदेशक (रा.भा.) श्रीमती सरिता जोशी ने भाग लिया।

# CHAPTER 10

# STATUS OF SC/ST/OBC AS ON 01.01.2022

### (i) Status of SC/ST/OBC as on 01.01.2022 (Group wise)

| | Representation of SCs / STs/ OBCs as on 1.1.2022 | | | | Appointments by Promotion during the calendar year | | |
|---|---|---|---|---|---|---|---|
| Groups | No. of Employees | SCs | STs | OBCs | SCs | STs | Total |
| Group A | 204 | 30 | 13 | 55 | 0 | 1 | 16 |
| Group B (Gaz.) | 892 | 182 | 109 | 89 | 166 | 34 | 1082 |
| Group B (Non- Gaz.) | 1819 | 284 | 137 | 650 | NA | NA | NA |
| Group C | 1157 | 342 | 121 | 189 | NA | NA | NA |
| TOTAL | 1096 | 212 | 122 | 144 | 166 | 35 | 1098 |

### (ii) Status of SC/ST/OBC as on 01.01.2022 (Pay Scale Wise)

| | Representation of SCs / STs / OBCs as on 01.01.2022 | | | | Appointments by promotion during the calendar year | | |
|---|---|---|---|---|---|---|---|
| Pay Scale in Rs. | No. of Employees | SCs | STs | OBCs | SCs | STs | Total |
| PB-3 + GP 5400 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| PB-3 + GP 6600 | 81 | 10 | 5 | 26 | 0 | 0 | 1 |
| PB-3 + GP 7600 | 17 | 1 | 1 | 6 | 0 | 0 | 0 |
| PB-4 + GP 8700 | 59 | 11 | 5 | 19 | 0 | 0 | 2 |
| PB-4 + GP 8900 | 40 | 8 | 2 | 4 | 0 | 1 | 3 |
| PB-4 + GP 10000 | 5 | 0 | 0 | 0 | 0 | 0 | 10 |
| 75500-80000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 204 | 30 | 13 | 55 | 0 | 1 | 16 |

# CHAPTER 11

# MISCELLANEOUS

## 11.1. HONOURS AND AWARDS

### IMD Awards

India Meteorological Department (IMD) presented following awards on 147th IMD foundation day on 14th January, 2022 for the year 2021-22:

**Best MC** – MC, Jaipur;

**Best MWO/AMO/AMS** - AMO, Indore;

**Best MO** - Bilaspur;

**Best DWR** - DWR, Goa ;

**Rajbhasha Shield** – PAC, Kolkata

**Best Employee awards**

**Best Group 'A' Officers** - (i) Dr. V. P. Singh, Sc. 'C', M.C. Bhopal

**Best Group 'B' Officials** - (i) Shri S. K. Sharma, Met. 'A', DGM Office, New Delhi, (ii) Shri P. S. Chinchole, Met. 'A', RMC Nagpur, (iii) Shri Gagan Deep, A.O. II, DGM Office, New Delhi, (iv) Shri Gagan Deep, A.O. II, DGM Office, New Delhi, (v) Shri Sanjay Damodar Raskar, S.A., CRS Pune, (vi) Ms. R. V. Deepa, S.A., RMC Chennai
(vii) Shri Anuj Sinha, Assistant, RMC Mumbai

**Best Group 'C' Officials** : (i) Shri Tapas Hazra, UDC, RMC Kolkata,, (ii) Shri K. Y. Potkule, MTS, RMC Mumbai

**PAC Kolkata** has been awarded 'Rajbhasha Shield Trophy' 2021 and a '**Certificate of Merit**' by DGM, New Delhi on the occasion of 147$^{th}$ India Meteorological Department Foundation Day 14$^{th}$ January, 2022 for excellent performance in implementation of Official Language Policy during the year 2021.

### Appreciation Received

The following officials received Appreciation Letter towards their research contribution for the year 2021.

| S. No. | Name | Designation | Posted at |
|---|---|---|---|
| 1. | Shri Rizwan Ahmed | Met. 'A' | IMD, New Delhi |
| 2. | Shri Raja Acharya | Met. 'A' | RMC, Kolkata |
| 3. | Ms. Kavita Navria | SA | IMD, New Delhi |
| 4. | Shri Vikram Parashar | Met. 'A' | IMD, New Delhi |
| 5. | Shri AshishTyagi | SA | IMD, New Delhi |
| 6. | Shri Atul KumarVerma | SA | IMD, New Delhi |
| 7. | Shri P. P. Baburaj | SA | RMC, Chennai |
| 8. | Shri Samudrala Venkata Jagannadha Kumar | Met. 'A' | CWC, Visakhapatnam |
| 9. | Shri Arun Sharma | Met. 'A' | IMD, New Delhi |

Performance of India Meteorological Department in Inter Ministry Tournaments 2021-22 organized by Central Civil Services Cultural &Sports Board (CCSCSB) (DoPT).

| S. No. | Name of Event | Name of winners | Position acquired |
|---|---|---|---|
| 1. | Power lifting (Best Physique) | Shri Rohit Vashisht | Silver |
| 2. | Athletics (10000 m Race) | Samundra Singh | Silver |
| 3. | Carrom | Shri Syed Md. Ali | Bronze |
| 4. | Badminton (Doubles) | Shri Praveen Ghildiyal<br>Shri Anoop Kandari | Bronze |
| 5. | Badminton Veteran (Singles) | Ms. Renu Verma | Bronze |
| 6. | Badminton Veteran (Doubles) | Ms. Renu Verma<br>Ms. Sunita Rani | Bronze |
| 7. | Group Folk Dance | Ms. Rhythm Naswa<br>Ms. Shivali<br>Ms. Devrakshanjali Srivastava<br>Ms. Shikha Verma<br>Ms. Divya Kumari<br>Ms. Rashmi Kumari<br>Ms. Laxmi Pathak<br>Ms. Twinkle Grover | Bronze |
| 8. | All India Chess Tournament 2021-22 | Ms. Komal Srivastava | First Prize in 5$^{th}$ Board in Women Team Chess Event |
| 9. | Azadi ka Amrit Mahotsav | **Badminton Silver**<br>(Women's Singles)<br>Ms. Malini Thakur<br>**Basketball**<br>Ms. Rhythm Naswa<br>**Badminton**<br>**(Women's Double)**<br>Ms. Rhythm Naswa and Ms. Nisha | Silver<br><br><br><br>Silver<br><br><br>Bronze |

**Shri Praveen K. Ghildiyal**, Met-A participated in Inter Ministerial Badminton Tournament-2021-22 and won Bronze Medal in Men Doubles event.


**Shri Praveen K. Ghildiyal, Met. 'A' won Bronze Medal**

**Dr. M. Mohapatra, DG, IMD with the winners and IMD Recreation Club, Delhi Executive Body**

**IMD and MoES personnel on the inauguration of 'Vigyan Sarvtra Pujayte' on 22nd February, 2022**

**Dr. Mrutyunjay Mohapatra**, DG, IMD was conferred upon "**Shrikshetra Samman - 2022**" for bringing **paradigm shift in Cyclone Warning Services** and for his laudable contribution to society by voluntary service organization- Shree Shrikshetra Soochana, Puri during the 20th Folk Fair and 13th Krishi Fair-2022 at Puri, Odisha.

## Shrikshetra Samman-2022

**Shrikshetra Samman-2022 conferred upon DG, IMD**

## WCDM-DRR AWARD

India Meteorological Department was conferred "World Congress Disaster Management- Disaster Risk Reduction Award" for outstanding contribution in weather forecasting and early warning services for cyclones and extreme weather events on 22nd June, 2022. Dr. S. D. Attri, Sc. 'G' received this award.

**Dr. S. D. Attri receiving the award**

Ministry of Earth Sciences nominated **Shri S. C. Bhan**, Sc. 'F' as Nodal Person from MoES to coordinate for finalization of One Health Inter-Ministerial Declaration and planning of proposed "**One Health Conclave**" agenda.

**Certificate of Merit** was awarded to **Shri P. S. Biju**, Sc. 'E' (IMD) on the occasion of Foundation day of MoES on 27th July, 2022.

**Dr. Mrutyunjay Mohapatra**, DG, IMD has been nominated as Expert Member of Board of Governors of IIIT Vadodara in August, 2022 under the category "**Eminent person out of research laboratories**".

The Hon'ble Governor of Odisha and Chancellor of the FM University, **Dr. Ganeshi Lal** conferred **Vyasa Gourab Samman** upon **Dr. Mrutyunjay Mohapatra**, DG, IMD for his contribution to the field of Science (Meteorology) that has led to paradigm shift in cyclone warning services in India and enabled minimising death toll to double digit.

**Dr. Mrutyunjay Mohapatra**, DG, IMD was conferred the Most Inspirational Personality Award by the Interview Times, Bhubaneswar on 2nd October, 2022. He participated in the rapid fire round interview programme conducted by the Interview Times (https://youtu.be/l1CNx4t7VP8).

**Dr. Mrutyunjay Mohapatra**, DG, IMD participated as Guest of Honour in the World Environment Summit 2022 at Vallabhbhai Patel Chest Institute, Delhi University on 15th October. He was conferred the Environment & Societal Development Association (ESDA) environmental Excellence award-2022 during the event.


**Shri Raja Acharya**, Met. 'A' received appreciation from WMO in connection with participation through online mode as an observer in the 25th annual Ocean Observation Physics and Climate Panel (OOPC) meeting organised by the WMO on 20-21 October, 2022 in hybrid mode.

**Shri Mohit**, S.A., a recognized sportsman in IMD won the Inter Ministry Tournament and got selected for 41st National Shooting Ball Championship held on 25 to 27 December, 2022.

**Dr. Saniay O"Neill Shaw**, Sc. 'F', awarded Certificate of excellence for working as Official Nodal Officer for official language during the year 2021-22 on I7.I0.22 by the Ministry of Earth Sciences.

## 11.2. MEDIA INTERACTION

**Dr. S. D. Attri**, Sc. 'G', participated in programme on "**Weather and Agriculture**" at AIR New Delhi on 21st January, 2022.

**Dr. M. Mohapatra**, DG, IMD discussed the "**Ancient Indian Knowledge of Weather Forecasting**" in the 21st episode of the programme "Power of Listening" on the theme "Megh Vidya" broadcast by All India Radio on 18th February, 2022. The broadcast programme is also available at https://youtu.be/a07Lv8j2iX8.

**Dr. M. Mohapatra**, DG, IMD participated in the "**CSE's Annual Media Conclave**" on 2nd March, 2022 and delivered a talk on "**climate change impact on extreme weather events**".

**Dr. M. Mohapatra**, DG, IMD participated in the Virtual Panel discussion show organized by Doordarshan on 11th March, 2022 on "**cyclone management**".

**Shri Manmohan Singh**, Sc. 'F', delivered an online talk on the topic "**Services provided by IMD for the state of Punjab**" on the occasion of "**World Meteorological Day 2022**" on Doordarshan Chandigarh on 23rd March, 2022.

Radio and TV talk on the theme of WM day 2022: "**A talk on Early Warning and Early Action - Hydro-meteorological and Climate Information for Disaster Risk Reduction**", by **Dr. S. Balachandran**, Sc. 'F' was broadcast by FM Rainbow 101.4 MHz on 23March, 20.22 at 10:02 IST.

**Shri Manmohan Singh**, Sc. 'F' participated in a live online talk on "**Heat Wave and Food Security**" in a current affairs programme aired on Doordarshan Jalandhar on 30th April, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the Discussion on "**Heat Waves and Climate Change**" during Prime Time English Show at Sansad TV - Perspective on 2nd May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the recording by All India Radio on "**Monsoon Preparedness, Cyclone and Heat Wave**" on 9th May, 2022.

**Dr. M. Mohapatra**, DG, IMD participated in the recording for the Special Prime Time Hindi Show on the topic "**Extreme Weather condition and Global Warming**" of Sansad TV on 19th May, 2022.

**Dr. Geeta Agnihotri**, Sc. 'E' answered about 135 Weather Enquiries by Electronic and Print Media during the quarter.

**Dr. M. Mohapatra**, DG, IMD participated in the Recording of the virtual discussion about "**Southwest monsoon**" by Doordarshan on 26th May, 2022.

**Shri Tamal Mukherjee**, Senior Producer, Current Affairs, CAN Mediacorp, Singapore shot a brief interview of **Dr. Mrutyunjay Mohapatra**, DG, IMD for a documentary on "**Heat wave, climate change and impact on food security**" on 3rd June, 2022.

Special Interviews on "**Prevailing weather and monsoon**" were given by Shri K. S. Hosalikar, Sc. 'G' to media and stake holders.


**Dr. M. Mohapatra**, DG, IMD and chair, South Asia Hydromet Forum (SAHF) participated in the Podcast recording with Shri Karma Duphu, Co-Chair, SAHF on 26th May, 2022 organised by RIMES.

**Mr. HyeRyeon Chung**, Reporter from TBS News Station, South Korea interviewed **Dr. M. Mohapatra**, DG, IMD regarding monsoon on 4th June, 2022.

**Shri Manmohan Singh**, Sc. 'F' participated in a live online talk show on the occasion of '**World Environment Day 2022**' on Doordarshan Chandigarh on 5th June, 2022.

**Dr. M. Mohapatra**, DG, IMD joined live Interview for the show '**Bloomberg Markets Asia**' with anchors Rishaad Salamat and Haslinda Amin of Bloomberg TV on 16th June, 2022.

A special interview with **Dr. M. Mohapatra**, DG, IMD on the subject "**Khush Haal Jiwan Ke Liye Avashyak Hai Mausam Ka Purvanuman**" was published in CSIR July Monthly Issue.

IMD issued daily weather forecasting video of about 5 minutes duration in English & Hindi through YouTube, Facebook, Twitter and IMD website. Bulletins and Warnings along with graphics were also communicated through Social Media including Facebook, Twitter, Instagram, YouTube and IMD Blog page.

Weekly Videos on extended range forecast were issued every Thursday through website and social media (Facebook, Twitter, YouTube etc.). The forecast videos in regional language were issued by regional offices of IMD regularly.

**Dr. M. Mohapatra**, DG, IMD participated as Chief Speaker during the Prime Time English Show "**Perspective**" discussing on "**Monsoon Changing Patterns**" organized by Sansad TV through Zoom on 22nd August, 2022.

**Dr. Geeta Agnihotri**, Sc. 'F' answered 45 Weather Enquiries by Electronic and Print Media during July to September 2022.

IMD issued daily weather forecasting video of about 5 minutes duration in English & Hindi through YouTube, Facebook, Twitter and IMD website.

Weekly Video on extended range forecast (upto two weeks) were issued every Thursday through website and socialmedia (Facebook, Twitter, YouTube etc.).

Bulletins and Warnings along with graphics were communicated through Social Media including Facebook, Twitter, Instagram, YouTube and IMD Blog page.

India Meteorological Department (IMD) organized Press Conference on "**Outlook for rainfall and temperature for the month of November, 2022**" on 1st November, 2022. **Dr. M. Mohapatra**, DG, IMD addressed the press conference online.

**Dr. M. Mohapatra**, DG, IMD attended Recording of the special program '**Aapda Ka Samna**' on Cold Wave organized by NDMA on 30th December to be telecast on Doordarshan.

**Dr. Mrutyunjay Mohapatra**, DGM IMD addressed Press Conference regarding Seasonal Outlook for Winter Temperatures and Rainfall Forecast for December, 2022 on 1st December, 2022.

Special Interviews on prevailing weather and monsoon were given by **Shri K. S. Hosalikar**, Sc. 'G', CR&S Pune and Head SID Pune to different media and stake holders.

During the quarter 184 Farmers awareness programmes (FAPs) were organized by AMFUs and DAMUs across the country by Agromet Division.

24 Success stories regarding agromet advisory services rendered under GKMS were collected from AMFUs and DAMUs during the quarter.

## 11.3. NEW PROJECTS/SCHEMES/PROGRAMMES APPROVED/ INITIATED

**Recent initiatives under the Flash Flood Guidance Services for South Asia programme**

Integration of **Landslide Susceptibility Module into Flash Flood Guidance System** for better predictability of landslide associated flash floods in the vulnerable hilly regions of Indian Subcontinent. During the past few flood seasons, these events are increasingly witnessed in the **Rudraprayag district of Uttarakhand** and **Wayanad district of Kerala**. Hence, it is imperative for the pilot study on landslide susceptibility zoning in two locations in collaboration with GSI, NRSC, IMD & HRC.

Integration of **Urban Flood Module into Flash Flood Guidance System** for real time flood monitoring of urban cities. In this context, **Delhi has been selected for the pilot study on Urban Flood Modeling** based on the increasing growth potential, vulnerability of sudden floods/ water logging, available requisite datasets, Doppler Weather Radar Data, etc.

Under the flagship Flash Flood Guidance Services for South Asia programme, Integration of Landslide Susceptibility Module into Flash Flood Guidance System for better predictability of landslide associated flash floods in the vulnerable hilly regions of Indian Subcontinent. Integration of Urban Flood Module into Flash Flood Guidance System for real time flood monitoring of urban cities.

**Dr. S. Balachandran**, Sc. 'F', participated in the "**Drone based calibration activities of X Band Radar**" installed at NIOT Chennai campus, Pallikaranai on 6th January, 2022.

**Shri Himadri Baishya**, Sc. 'C' and **Shri P. Dutta**, Mech-I, along with installation party from CRS Pune proceeded to Tawang & Bomdila (Arunachal Pradesh) for installation of "Cellcomm AWS & snow gauge sensors" w.e.f. 17-26 January, 2022.

**Two Design storm studies** for (i) Yammeng Hydro Project, Arunachal Pradesh and (ii) Katapati Barrage, Maharashtra got completed and the values sent to the concerned project authority.

A Detailed Report on Project **Nalganga Dam**, Maharashtra have been prepared and sent to concerned Project authority.

On request of **Gp Capt., Command Met. Officer** in connection with the **conduct of Air Display operating over River front, Ahmedabad** as a part of Defence Expo 0600 UTC & 0800 UTC special P.B. ascents w.e.f. 23/02/2022 to 04/03/2022 taken and data supplied to IAF.

**Two nos. of High End Servers** with 28 TB NAS storage was commissioned during March, 2022 as Hardware Support for Customized Rainfall Information System & Hydrological Services.

Implementation of Revised procedure for flow of funds under Central Sector Scheme was held at MoES on 12th April, 2022.

In the month of June, 2022 - Four AWS was installed in Pune District, Maharashtra by IMD, Pune.

Map display, subdivision-wise option, registered page and login page in Nowcast Verification Portal have been added on IMD's website. Also Web-page for Past- year's monsoon data has been created for M. C. Jaipur.

**IMD Stores Dashboard** has been launched to show the **live status of the entries** of all fixed assets including (Desktop, Printer, Scanner, UPS, Photocopiers, and Air Conditioners etc.), Obsolete Items and Historic/Artistic Value items. Entries are being done by all sections of IMD Offices in STORE INVENTORY after visiting **LOGIN BY SECTION in METNET**.

A crowd-source app named "**Public Observation**" developed by **Shri Vikas Meena**, S. A. under the guidance of **Dr. Sankar Nath**, Sc. 'E' was launched on the occasion of Foundation Day of IMD.

Completed computation of cumulative rainfall (mm) and volume of water (TMC). Since June, 2021. Corresponding maps are being generated every week for river sub basin of India.

The websites of CWC Vishakhapatnam, M.C. Agartala, M.C. Ahmedabad, M.C. Amaravati, M.C. Chandigarh, M.C. Itanagar, M.C. Jaipur, M.C. Leh, M.C. Lucknow, M.C. Patna, M.C. Shillong have been converted into hindi language.

**New airports** started at Kushinagar (Uttar Pradesh), Sindhudurg (Maharashtra).
**Installation** of 77 frangible mast and Current Weather.

**Instrument System** (CWIS) completed at 60 airports.

**Present Weather** & Visibility Sensor installed at Delhi, Hyderabad, Kozhikode, Pakyong, Patna and Shirdi airports.

**CEL (Central Electronics Limited)** produced **Drishti** prototype is installed at IGI Airport, Delhi and is under observation.

Scatterometer RVR has been installed at Agartala and Lengpui in July, 2022 and DIWE installed at Tirupati Airport in August, 2022.

DCWIS was installed at Gannavaram Airport, along with DCWIS & PWD at Bhubaneswar Airport and at Kolhapur Airport in September, 2022.

PWD was installed at Jaipur & Amritsar Airport from in September 2022.

AWS at NIT Rourkela has been commissioned on 23rd December, 2022.

03 AWS is installed in Kerala, Manipur and Meghalaya State under 400 AWS Project.

DCWIS system was installed at Khushinagar, Madurai and Rourkela airport (SAIL) in October, November and December 2022 respectively.

## 11.4. ADDRESSES OF VARIOUS REGIONAL METEOROLOGICAL CENTRES & METEOROLOGICAL CENTRES

**RMC New Delhi**
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**RMC Guwahati**
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भारत मौसम विज्ञान विभाग

**INDIA METEOROLOGICAL DEPARTMENT**

पृथ्वी विज्ञान मंत्रालय, भारत सरकार

**Ministry of Earth Sciences, Govt. of India**