



सत्यमेव जयते



वार्षिक प्रतिवेदन ANNUAL REPORT 2020

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
पृथ्वी विज्ञान मंत्रालय, भारत सरकार
Ministry of Earth Sciences, Govt. of India

वार्षिक प्रतिवेदन

ANNUAL REPORT

2020



INDIA METEOROLOGICAL DEPARTMENT

(MINISTRY OF EARTH SCIENCES)

(GOVT. OF INDIA)

MAUSAM BHAWAN, LODI ROAD, NEW DELHI – 110 003, INDIA

TELEFAX : 91-11-24623220

Website : <https://mausamjournal.imd.gov.in/>

e mail : mausamps@gmail.com



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Dr. S.D. Attri, Scientist 'G'
Shri Sunny Chug, Scientist 'C'

Editorial Team

Ram Lal Saxena	Dinesh Khanna
Raj Kumar Verma	Laxmi Pathak
Anu Bhargava	Twinkle Grover
Nitin Yadav	Dal Chand

e mail : mausamps@gmail.com

Dialing Code : 011-43824298, 43824522

Telefax : 91-11-24699216, 91-11-24623220

Toll Free Number : 1800-220-161

Website : [https:// mausamjournal.imd.gov.in/](https://mausamjournal.imd.gov.in/)

IMD ORGANIZATION CHART

INDIA METEOROLOGICAL DEPARTMENT MINISTRY OF EARTH SCIENCES GOVERNMENT OF INDIA



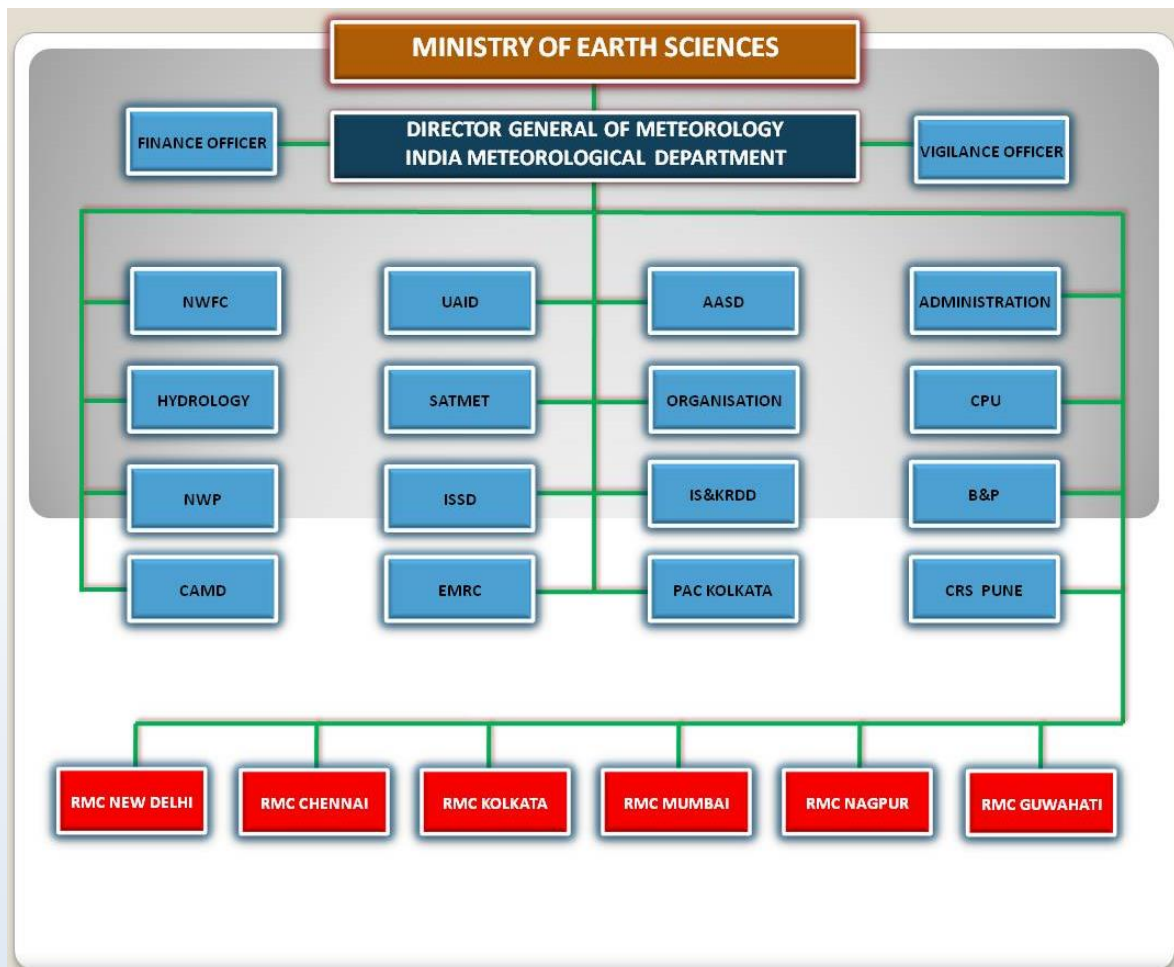
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Hon'ble Union Minister
of Science & Technology,
Minister of Health &
Family Welfare
and Earth Sciences



Dr. Madhavan Nair Rajeevan
Secretary,
Ministry of Earth Sciences,



Dr. Mrutyunjay Mohapatra
Director General of Meteorology
India Meteorological Department



FOREWORD

I have the pleasure to bring out the Annual Report of India Meteorological Department (IMD) for the year 2020 which contains significant activities of the department during the year. The department has providing efficient meteorological services and contributing to safety of life, property and socioeconomic development since its establishment in 1875.

IMD is progressive strides towards modernization of scientific infrastructure in the fields of meteorological observations and information systems have helped to render better services in public and sector areas of agriculture, aviation, shipping, fisheries, energy and transport etc. IMD's services 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 range (monthly and seasonal) and severe weather (cyclones, thunderstorms, extreme rainfall, heat wave, cold wave, fog) forecasts have continuously improved to meet the demands of the user agencies, disaster managers, emergency response groups and other stakeholders.

During 2020, the major achievements have model development activities include: (a) development of an improved genesis potential parameter to predict cyclogenesis in real-time, (b) dynamical downscaling of extended range forecasts to improve the prediction of extreme weather events and (c) development of an early health warning system based on the extended range forecasts. In addition to these, efforts are underway to develop a multi-physics multi-model ensemble prediction system to improve the forecast skill as well as in the observing systems and data assimilation in numerical models. Intense observational campaigns also have been taken up as special atmospheric observations help us to understand model deficiencies and to improve the accuracy of models.

IMD has provided data on parameters 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 and 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.

During 2020, Meteorological Observatory (MO) Leh was upgraded into full-fledged Meteorological Centre (MC) to cater to the needs of the Ladakh region. The new MC was inaugurated by the then Hon'ble Minister of Earth Sciences, Dr. Harsh Vardhan on 29th December, 2020, in august presence of Shri R. K. Mathur, Hon'ble Lieutenant Governor, Ladakh and Shri Jamyang Tsering Namgyal, Hon'ble Member of Parliament also attended the event.

An Integrated Flood Warning System for Mumbai (IFLOWS-Mumbai) jointly developed by NCCR Chennai, IMD, IITM, & NCMRWF for Municipal Corporation of Greater Mumbai (MCGM) launched by Maharashtra Chief Minister Shri Uddhavji Balasaheb Thackeray and the Union Minister Dr. Harsh Vardhan on 12th June, 2020.

During 2020, the then Secretary, Ministry of Earth Sciences dedicated South Asia Flash Flood Guidance System (SAsiaFFGS), first of its kind for South Asian countries namely India, Bangladesh, Bhutan, Nepal and Sri Lanka on 23 October, 2020. The Flash Flood Guidance Services of South Asia is being communicated & updated regularly through social media and received appreciations from National & International stakeholders.

The climate over India was above normal during the year. During the year, annual mean land surface air temperature averaged over the country was +0.29 °C above normal (based on the data of

1981-2010). The year 2020 was the eighth warmest year on record since nation-wide records commenced in 1901. The monsoon and post-monsoon seasons with mean temperature anomalies (Actual temperature-Normal temperature) of +0.43 °C and +0.53 °C respectively mainly contributed to this warming. Mean temperature during the winter was also above normal with anomaly of +0.14 °C. However, during the pre-monsoon season temperature was below normal (-0.03 °C).

During 2020, the anomaly in the maximum, minimum and mean temperature over many parts of the country was generally in the range of $\pm 1.0^{\circ}\text{C}$. Mean temperature over parts of Jammu & Kashmir and Ladakh, Himachal Pradesh, and Andaman & Nicobar Islands was above normal by about 1 °C. Maximum temperature over parts of Jammu & Kashmir and Ladakh, Himachal Pradesh, Assam and Meghalaya, Tripura, Kerala and Mahe was above normal by about 1 °C. However, Maximum temperature over parts of Punjab, Haryana Chandigarh & Delhi, Uttar Pradesh state, Jharkhand, Bihar and Chhattisgarh was below normal by about 1°C. The monsoon season this year (with anomaly +0.43 °C above average) was the sixth warmest since 1901. The Post-monsoon season this year (with anomaly +0.51°C above average) was the fifth warmest since 1901.

The annual rainfall over the country as a whole was 110% of its Long Period Average (LPA) value for the period 1961-2010 during the year. The monsoon season rainfall over the country as a whole was 109% of its LPA. The seasonal rainfall during the Northeast monsoon season (October - December) over the NE Monsoon core region of the south peninsula was 110% of its LPA. All the five subdivisions of the core region except Kerala received excess/normal rainfall.

Five cyclonic storms were formed over the North Indian Ocean; Super cyclonic Storm AMPHAN, Very Severe Cyclonic Storms NIVAR & GATI, Severe Cyclonic Storm NISARG, and Cyclonic Storm 'BUREVI'. Of these, NISARG & GATI formed over Arabian Sea, while the remaining 3 cyclones viz. AMPHAN, NIVAR & BUREVI formed over the Bay of Bengal.

Several users' e - conferences, workshops, seminars and symposia to create awareness about the weather among the people. The implementation of official languages policy in popularizing use of Hindi in day-to-day official works pursued and encouraged. The growth towards publishing research findings in national and International journals has embarked a new high by publishing one hundred twenty five research papers/publications during the year.

Agromet advisories to the farmers were disseminated through different multi-channel system of All India Radio (AIR) and Doordarshan, private TV and radio channels, newspaper and internet, SMS, Whatsapp, Apps and IVR (Interactive Voice Response Technology) etc. is being made on wider scale. Under PPP mode and through Kisan Portal to 42.5 million farmers. A total of present 662 Agromet Advisory Service (AAS) districts bulletins are being prepared and issued to cater to the needs of farmers in the country.

Finally, I take this opportunity to thank all the members of IMD for their dedication and landmark to further enhance the reputation and credibility of the department at national and international level. My special thanks to Dr. S. D. Attri, Sc 'G', Head [Information Science & Knowledge Resource Development Division (IS&KRDD) (Formerly Publication Section)] and his team of publication unit for their sincere efforts in compilation, editing and publication of this Annual Report 2020 & various divisions and offices of IMD for providing requisite inputs.

Dr. Mrutyunjay Mohapatra
Director General of Meteorology

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Ministry of Earth Sciences (MoES)**

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14.	Abstract	<p>This report highlights the progress made by the department during the year 2020. 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 2020 include Sub-basin wise Quantitative Precipitation Forecast (QPF), Location specific forecast for capital cities, New climate and climate change products and reports, New website of IMD entitled MAUSAM (www.mausam.imd.gov.in), development of an improved genesis potential parameter to predict cyclogenesis in real-time, dynamical downscaling of extended range forecasts to improve the prediction of extreme weather events, development of an early health warning system based on the extended range forecasts, improvement in cyclone forecast errors, establishment of Meteorological Centre (MC) Leh, an Integrated Flood Warning System for Mumbai launched by Maharashtra Chief Minister Shri Uddhavji Balasaheb Thackeray and the Union Minister Dr. Harsh Vardhan on 12th June, 2020, launching of mobile app Mausam, implementation of Common Alert Protocol, operationalization of SILAM and ENFUSER for Air Quality Early Warning System for Delhi, establishment of Multi Mission Data Receiving and Processing System, commissioning of Doppler Weather Radars at Kufri and Mukteswar and Sonemarg, J&K</p>
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Contents

Chapter	Topics	Page No.
1.	INDIA METEOROLOGICAL DEPARTMENT–OVERVIEW	1-8
2.	WEATHER SUMMERY DURING 2020	9-31
	1. Winter Season (January-February)	9
	2. Pre-Monsoon Season (March-April-May).....	12
	3. Southwest (SW) Monsoon (June-July-August-September).....	18
	4. Post Monsoon Season (October-November-December).....	25
3.	NUMERICAL WEATHER PREDICTION	33-35
4.	OBSERVATIONAL NETWORK	36-57
	4.1. Upper Air Observational Network.....	36
	4.2. Surface Observational Networks.....	38
	4.3. Environment Monitoring and Research Centre (EMRC)	40
	4.4. Radar Observations.....	44
	4.5. Satellite Observations.....	46
	4.6. SAARC Storm Project - 2020.....	52
5.	WEATHER AND CLIMATE SERVICES OF IMD	58-97
	5.1. Hydromet Services.....	58
	5.2. Agrometeorological Advisories Services.....	65
	5.3. Positional Astronomy Services.....	70
	5.4. Climate Research & Services.....	71
	5.5. Cyclone Monitoring & Prediction.....	79
6.	CAPACITY BUILDING, PUBLIC AWARENESS & OUTREACH PROGRAMME	98-128
	6.1. Conferences & Symposium.....	98
	6.2. Workshop.....	98
	6.3. Meetings.....	100
	6.4. Training.....	109
	6.5. Lectures/Talk.....	112
	6.6. Awareness & Outreach Programme.....	117
	6.7. Visitors.....	118
	6.8 Foreign Deputation.....	120
	6.9. Important Events 2020.	121
7.	RESEARCH PUBLICATIONS	129-135
	7.1. Research contributions Published in 'MAUSAM' during 2019.....	129
	7.2. Research contributions Published in Extra Departmental Journals (Indian & Foreign Journals)	130
	7.3. IMD MET. Monograph.....	133
	7.4. Other publications.....	134
8.	FINANCIAL RESOURCES AND MANAGEMENT PROCESS	136-138
	8.1. Financial Resources and Management.	136
	8.2. Atmospheric & Climate Research – Modelling Observing System & Services (ACROSS)	136
	8.3. Revenue Generated during the Year 2019.....	138
9.	राजभाषा नीति का कार्यान्वयन	139-145
10.	STATUS OF SC/ST/OBC AS ON 01.01.2020	146
11.	MISCELLANEOUS	147-152
	11.1. Honours and Awards.....	147
	11.2. Media Interaction.....	149
	11.3. Addresses of various Met. Centres.....	151

CHAPTER 1

INDIA METEOROLOGICAL DEPARTMENT - OVERVIEW

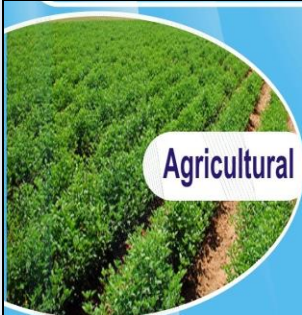
India Meteorological Department, Ministry of Earth Sciences is the National Meteorological Service of the country and the principal Government agency in all matters relating to Meteorology, Seismology and allied discipline and provides weather and climate services to the public and specialized sectors.

Its mandate is:

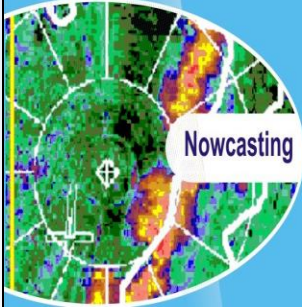
- To take meteorological observations and to provide current and forecast meteorological information for optimum operation of weather-sensitive activities like agriculture, irrigation, shipping, aviation, offshore oil explorations, etc.
- To warn against severe weather phenomena like tropical cyclones, 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 144 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.



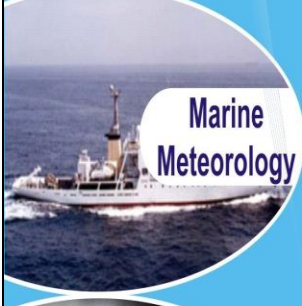
Agricultural



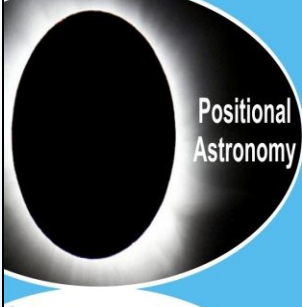
Nowcasting



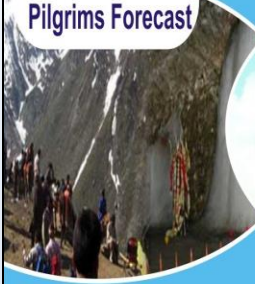
Human Resource Development



Marine Meteorology



Positional Astronomy



Pilgrims Forecast



Forecast and warning Dissemination



India Meteorological Department, Mausam Bhavan New Delhi



IMD, Alipore Observatory, Kolkata founded in 1877

Observed and forecasted track of cyclone Phailin



Monsoon forecasting



Aviation

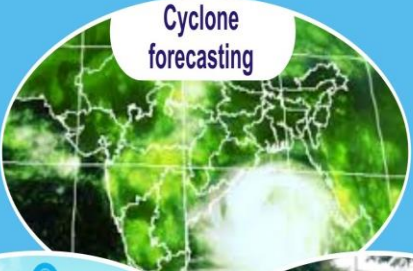


Climate services



Hydro Meteorology

SPECIALIZED SERVICES OF IMD



Cyclone forecasting



Environmental

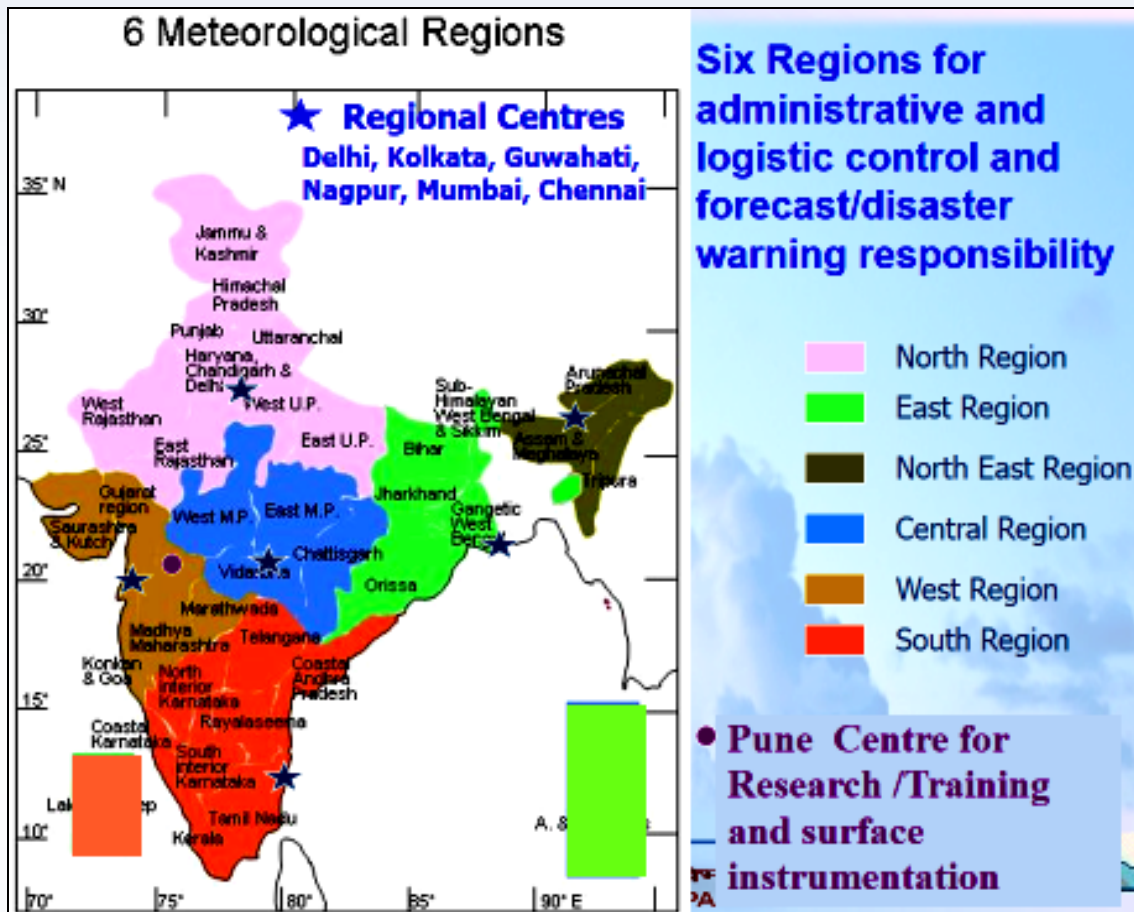


Heavy rainfall warning



Met Observations

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.



In addition, there are separate divisions to deal with specialized subjects, which are:

India Meteorological Department has continued its efforts for the improvement of observing, warning and dissemination mechanism/systems all through 2020. 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 2020. Its short, medium, extended & long range and cyclone forecasts were appreciated all over the world.

Climate over India during 2020 was above normal. During the year, annual mean land surface air temperature averaged over the country was +0.29 °C above normal (based on the data of 1981-2010). The year 2020 was the eighth warmest year on record since nation-wide records commenced in 1901. However, this is substantially lower than the highest warming observed over India during 2016 (+0.71 °C). The monsoon and post-monsoon seasons with mean temperature anomalies (Actual temperature-Normal temperature) of +0.43 °C and +0.53 °C respectively mainly contributed to this warming. Mean temperature during the winter was also above normal with anomaly of +0.14 °C. However, during the pre-monsoon season temperature was below normal (-0.03 °C).

The annual rainfall over the country was 109% of long period average (LPA) of 117.7 cms. Time series of percentage departure of annual rainfall over the country as a whole since 1901. Rainfall over the country as a whole during the SW monsoon season (June-September), which is the principal rainy season of the country, was above normal (109% of LPA of 88 cms). The 2020 Northeast monsoon season (October-December) rainfall over the country as a whole was normal (101% of LPA).

During 2020, 5 cyclones formed over the North Indian Ocean. These are Super cyclonic Storm AMPHAN, Very Severe Cyclonic Storms NIVAR & GATI, Severe Cyclonic Storm NISARGA and Cyclonic Storm 'BUREVI'. Of these, NISARGA & GATI formed over Arabian Sea, while the remaining 3 cyclones viz., AMPHAN, NIVAR & BUREVI formed over the Bay of Bengal. Out of these five most devastating cyclones, the Super Cyclonic Storm AMPHAN formed in the pre-monsoon season and crossed West Bengal coast over Sundarbans on 20th May. The Severe Cyclonic Storm NISARGA, formed in the Monsoon season, crossed Maharashtra coast on 3rd June claimed 4 lives & 2000 livestock in Maharashtra. The remaining three cyclones viz. NIVAR, BUREVI & GATI formed during the post monsoon season.

Among the significant weather events of the year 2020: The country also experienced other high impact weather events like, extremely heavy rainfall, floods, landslide, thunderstorm, lightning, cold waves, etc. Bihar & Uttar Pradesh was the most adversely affected states during the year which reportedly claimed more than 350 deaths from each state mainly due to thunderstorm, lightning & cold wave events. 3 Heavy rainfall & flood related incidents reportedly claimed over 600 lives from different parts of the country during pre-monsoon, monsoon & post-monsoon seasons. Of these, 129 lives were reportedly claimed from Assam, 72 from Kerala [Specifically, 65 persons reportedly claimed dead in a single day from Pettimudi in Munnar, Idukki district of Kerala on 7th August due to landslide.], 61 from Telangana (while, 59 lives reportedly claimed only during the period 1st to 20th October), 54 lives from Bihar, 50 from Maharashtra, 48 Uttar Pradesh, & 38 from Himachal Pradesh. Thunderstorms and lightning reportedly claimed 815 lives from different parts of the country. Among these, 280 from Bihar, 220 from Uttar Pradesh, 122 from Jharkhand, 72 from Madhya Pradesh, 23 from Maharashtra and 20 from Andhra Pradesh were significant. Cold wave conditions mainly prevailed over central parts the country especially in the month of January. It caused deaths of about 150 people. Of these deaths, 88 deaths were reported from Uttar Pradesh alone, 45 from Bihar only on single day on 1st January & 16 from Jharkhand.

Summary of Major achievements in 2020

Observations

- 29 Doppler Weather Radars are operational across the country including one portable DWR at Sonemarg, one X-band Radar each at Kufri and Mukteswar.
- Satellite derived products were augmented with establishment of Multi Mission Data Receiving and Processing System (MMDRPS).
- Current Weather Instrument Systems (CWIS) have been installed in 32 airports and 12 systems have been supplied to IAF for installation in Myanmar.
- Agromet Observatories have been installed at 122 Agro-Meteorological Field Units (AMFUs) and 89 other stations.
- Preparation of real time rainfall statistics was enhanced from 683 to 690 districts.
- 203 new raingauge stations were added in the District-wise Rainfall Monitoring Scheme (DRMS) taking the total number of stations to 4940.
- 190 District Agro-Met. Units have been established in addition to existing 130 units.

Enhancement in Modelling & Weather and Climate Services

- Global Forecast System (GFS) model has been running 4 times a day to generate forecasts twice a day.
- Regional WRF mesoscale model has been running at 3 km resolution to generate forecasts twice a day. Meteograms for 720 locations across the country and for SAARC countries are being prepared daily for location specific forecasts.
- Cyclone specific Hurricane WRF models have been run as coupled model at a resolution of 2 km in collaboration with INCOIS to generate six hourly forecasts.
- New numerical models, SILAM and ENFUSER were made operational for Air Quality Early Warning System for Delhi during 2020.
- NWP Model based gridded rainfall data (WRF & GFS) are provided to Central Water Commission for their flood forecasting model for all 153 river catchments (valid upto 3 days) and Extended Range model products for 10 river basins(valid upto 4 weeks).
- The Flood warning system for Mumbai has been made operational as a part of augmentation of urban meteorological services.
- Generation and issue of Flash flood Guidance for all watersheds of the country and Flash flood Guidance to Nepal, Bhutan, Bangladesh, Sri Lanka every 6 hours commenced with effect from the Monsoon season 2020.
- IMD in collaboration with NCMRWF & IITM implemented Thunderstorm and Lightning Modelling and Warning System with installation of lightning detectors at 82 locations to provide location specific lightning warning.
- Location specific forecast within the capital cities as well as nowcast have been extended to 526 and 894 stations respectively. Also three hourly nowcast warnings are now issued for severe weather for 739 districts.
- Under the flagship programme of Government of India, Integrated Agromet Advisory Services, Gramin Krishi Mausam Sewa (GKMS) is being implemented in the country successfully in collaboration with a number of Central Government Ministries and organizations, state level institutions, private agencies, NGOs, progressive farmers and media. More than 43 million farmers have subscribed for the information through mobile for planning their agricultural activities.

- Increase in issue of District Level agrometeorological advisories from 593 to 698 districts by 2020 and Block level advisories to 2300 Blocks.
- The tourism forecast is being provided in collaboration with Incredible India through integration of information in website and mobile app.
- Impact based forecast was provided for all types of severe weather including cyclone, heat wave, cold wave, fog, heavy rain, thunderstorm at 739 districts and 25 capital cities.
- New normal for onset and withdrawal dates of monsoon was introduced based on the latest data of 1961-2010.
- 169 New names of cyclones over the north Indian Ocean were introduced beginning with cyclone, Nisarga in June 2020.
- Climate of capital cities and smart cities has been prepared along with the trend analysis.
- Climatological Summaries have been published for 22 airports during the year 2020.
- The online Climate Data Portal has been developed for supply of data to various users.
- Long range forecast of temperature and rainfall was issued for all the seasons under South Asia Climate Outlook Forum (SASCOF).
- Health guidance product based on Extended Range (up to Two Weeks) forecast for all meteorological subdivisions and districts.
- Meteorological Centres/Regional Meteorological Centres issued Extended Range Forecasts for their area of responsibility on weekly basis every Thursday.

Outreach

- IMD launched its new mobile App, Mausam. IMD also worked jointly with MEITY for development and dissemination of weather information in Umang Mobile App.
- IMD introduced web-GIS based interactive map for cyclone, heat wave and cold wave warning.
- Social media interaction has been enhanced significantly with the presence in facebook, twitter, instagram, telegram, You Tube and Whats App groups established at IMD HQ and MC/RMC etc.
- Application Programming Interface (API) for weather observed and forecast products Of IMD has been developed and provided to different states, different central Government organizations including NITI Aayog, Tourism, DD News etc. About 10 states have implemented this API for their services.
- Common Alert Protocol (CAP) has been implemented as per WMO standard for severe weather warning. It is being utilized for Global Multi-hazard Alert System (GMAS) of WMO. Google International is also using CAP for Google Alert.
- Crowd Source Platform has been launched through website and mobile app for collecting the weather observations from people.
- The Journal Mausam is being made on line like any other international Journals.
- Meteorological Centre, Leh was established and inaugurated by Hon'ble Minister of Earth Sciences on 29th December, 2020.

Improvement in Forecast Accuracy

- There has been significant improvement in forecast accuracy of severe weather events by 15 to 35% during the last 5 years.
- The probability of detection of 24 hr heavy rainfall has increased to about 80% in 2020. Similarly, the probability of detection of heat wave has increased to 93% in 2019.

- The annual average landfall time forecast errors in 2020 have been 2.4 hrs, 2.8 hrs and 2.0 hrs respectively for 24, 48 and 72 hrs against the past five year average error of been 3.0 hrs, 5.4 hrs and 8.6 hrs based on data of 2015-2019.
- The annual average track forecast errors in 2020 have been 73 km, 85 km and 111 km respectively for 24, 48 and 72 hrs against the past five year average error of 81, 126 and 178 km based on data of 2015-2019.

Awards and Appreciations

- WMO recognized 7 observatories of IMD in 2020; these are Alipore (Kolkata), Gopalpur, Patna, Port Blair, Puri, Ahmedabad and Srinagar as a long-term observing station for more than 100 years.
- IMD earned appreciations from United Nations and Hon'ble President of India, Govt. of West Bengal and Odisha for accurate prediction of Super cyclone Amphan, from Govt of Maharashtra for accurate prediction of cyclone Nisarga and establishment of Mumbai Flood Warning System.
- Appreciation letters were also received from the State Governments of Gujarat, West Bengal, Tripura, Telengana and Uttar Pradesh for exemplary services provided by the IMD.

Chapter 2

Weather Summary during 2020

1. Winter Season (January & February)

Highlights

Rainfall during the season was sixth highest since 2001. Rainfall over the homogeneous region of central India was third highest since 2001. Mean temperature over south peninsular India (26.7 °C) was second highest since 1901 after the year 2016 (26.97 °C). Minimum temperature over south peninsular India (22.15 °C) was third highest since 1901.

Cold Wave conditions

Cold wave conditions prevailed over parts of east and west Rajasthan, Haryana, Chandigarh, Delhi, Jammu & Kashmir, West Uttar Pradesh, Punjab, Himachal Pradesh, Bihar, Odisha Chhattisgarh and Saurashtra & Kutch on isolated days during January.

Cold wave conditions prevailed during the first fortnight (1-13 February) of the month over parts of Haryana, Chandigarh & Delhi and Punjab on many days and over parts of Uttarakhand, Odisha, East and West Madhya Pradesh, Chhattisgarh, Bihar and Jharkhand on few days. During the above period, severe cold wave conditions prevailed on one day each in Punjab and Odisha.

Rainfall Features

Rainfall realized during the season was 98.5% of LPA. It was 162.5% of LPA during January and was 51.5% of LPA during February.

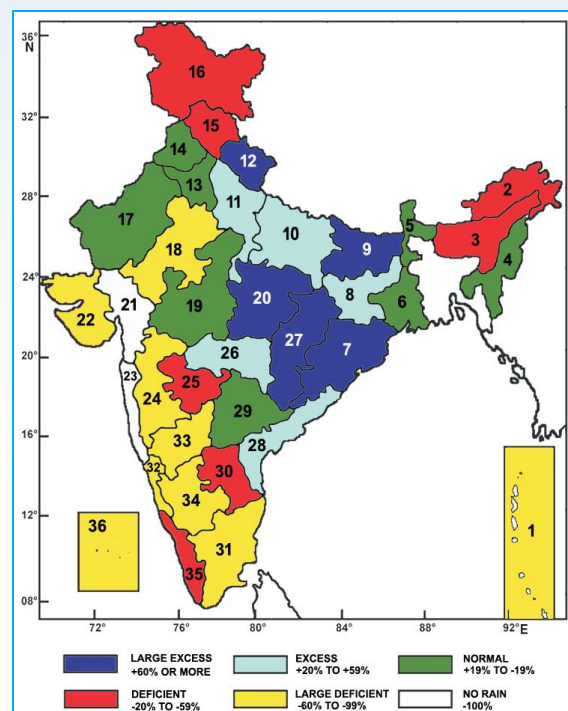
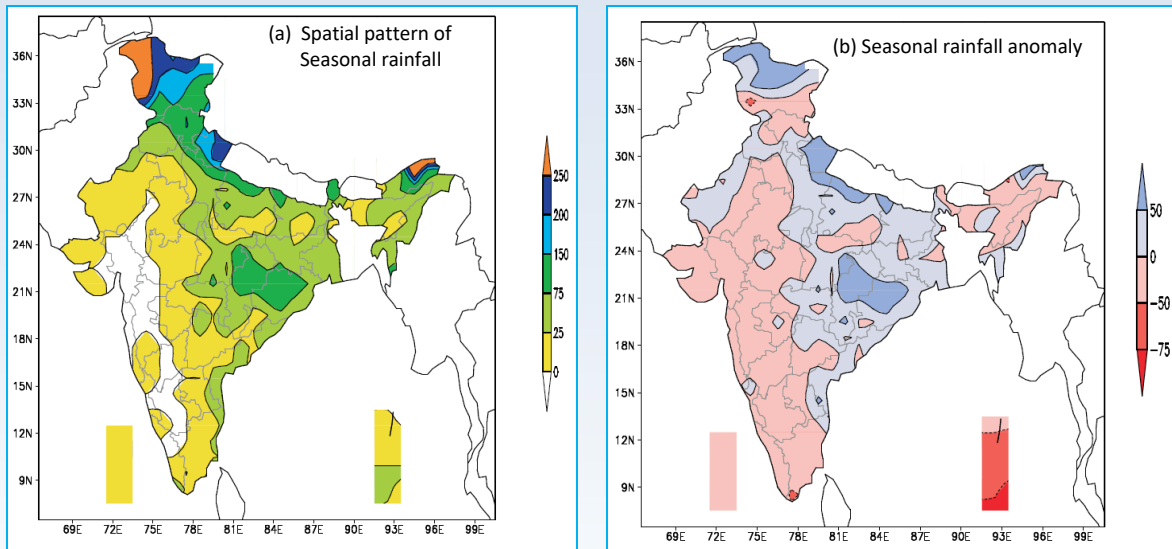


Fig. 1. Sub-divisionwise rainfall percentage departures

During the season, out of 36 meteorological subdivisions, 5 received large excess rainfall, 5 received excess rainfall, 8 received normal rainfall, 7 received deficient rainfall, 9 received large deficient rainfall and two subdivisions received no rain (Fig. 1). Rainfall over Odisha, Jharkhand, Bihar, Uttarakhand, East Madhya Pradesh and Chhattisgarh was more than one and half times of its normal value.

Fig. 2(a) shows the spatial pattern of rainfall (mm) received during the season. Rainfall activity was observed over parts of northwest, east and northeast, central, peninsular India and both the islands except some west central and peninsular parts. Parts of Arunachal Pradesh, Uttarakhand and Jammu & Kashmir received more than 150 mm rainfall. Parts of



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

Arunachal Pradesh and Jammu & Kashmir received more than 250 mm rainfall.

Fig. 2(b) shows the spatial pattern of rainfall anomaly (mm) during the season. Rainfall anomaly was more than 50 mm over parts of Arunachal Pradesh, Odisha, Bihar, Chhattisgarh, East Madhya Pradesh, east and West Uttar Pradesh, Uttarakhand and Jammu & Kashmir. Magnitude of negative rainfall anomaly was more than 50 mm over parts of Tamilnadu, Puducherry & Karaikal, Jammu & Kashmir and Andaman & Nicobar Islands. Magnitude of negative rainfall anomaly was more than 75 mm over parts Andaman & Nicobar Islands.

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. Fig. 3 shows the SPI values for the winter season 2020 (January-February, 2 months cumulative).

Cumulative SPI values of the past two months (January and February) indicate that extremely

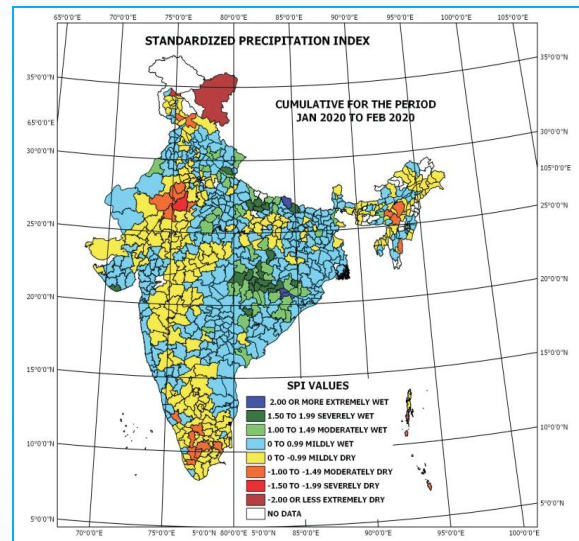
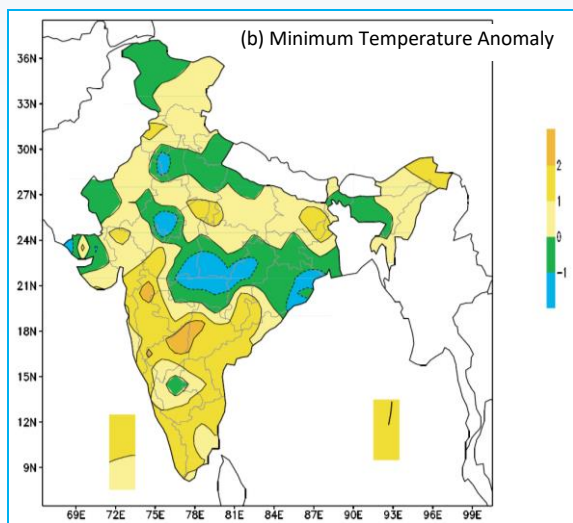
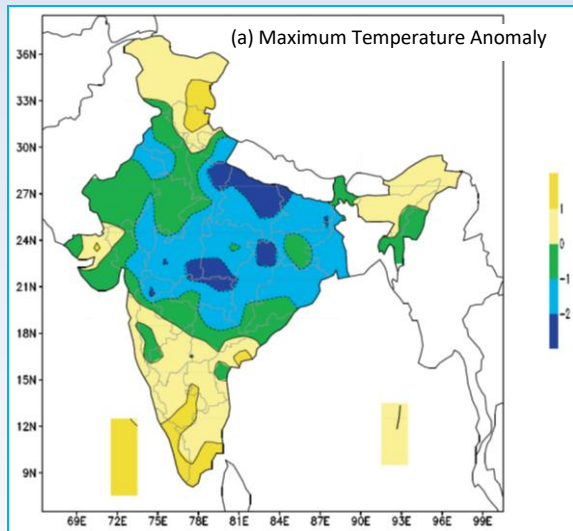


Fig. 3. Standardized Precipitation Index (SPI) cumulative for two months

wet/severely wet conditions were observed over parts of Odisha, Bihar, East Uttar Pradesh, Uttarakhand, East Madhya Pradesh, Saurashtra & Kutch and Chhattisgarh, while extremely dry/severely dry conditions were observed over parts of Jammu & Kashmir and East Rajasthan.

Cumulative past nine months SPI values indicate extremely wet/severely wet conditions over parts of A & N Islands, Odisha, Punjab, Jammu & Kashmir, East Rajasthan, Madhya Pradesh state, Gujarat state, Konkan & Goa,



**Figs. 4(a&b). Mean seasonal temperature anomalies (°C) (a) Maximum (b) Minimum
(Based on 1981-2010 Normals)**

Madhya Maharashtra, Vidarbha, Chhattisgarh and Telangana, Karnataka state, Kerala & Mahe and Lakshadweep while extremely dry/severely dry conditions were observed over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, S. H. West Bengal & Sikkim, Gangetic West Bengal, Jharkhand, Uttar Pradesh state, Haryana, Chandigarh & Delhi, Jammu & Kashmir and Vidarbha.

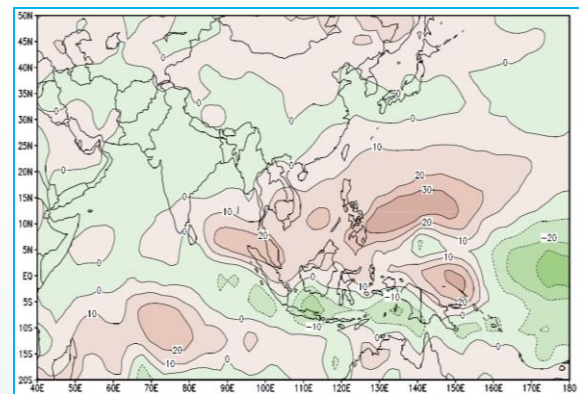
Temperatures

Mean seasonal maximum and minimum temperature anomalies are shown in Figs. 4(a&b) respectively.

Maximum temperature was below normal over most parts of the country except parts of northeast and north India, south peninsular India and both the islands. Maximum temperature anomaly was more than 1 °C over parts of Jammu & Kashmir, Himachal Pradesh, Coastal Andhra Pradesh & Yanam, Tamilnadu, Puducherry & Karaikal, Kerala and Mahe, South Interior Karnataka and Lakshadweep. Maximum temperature anomaly was less than -2 °C over parts of Uttar Pradesh state, Bihar, Chhattisgarh, Madhya Pradesh state and Vidarbha.

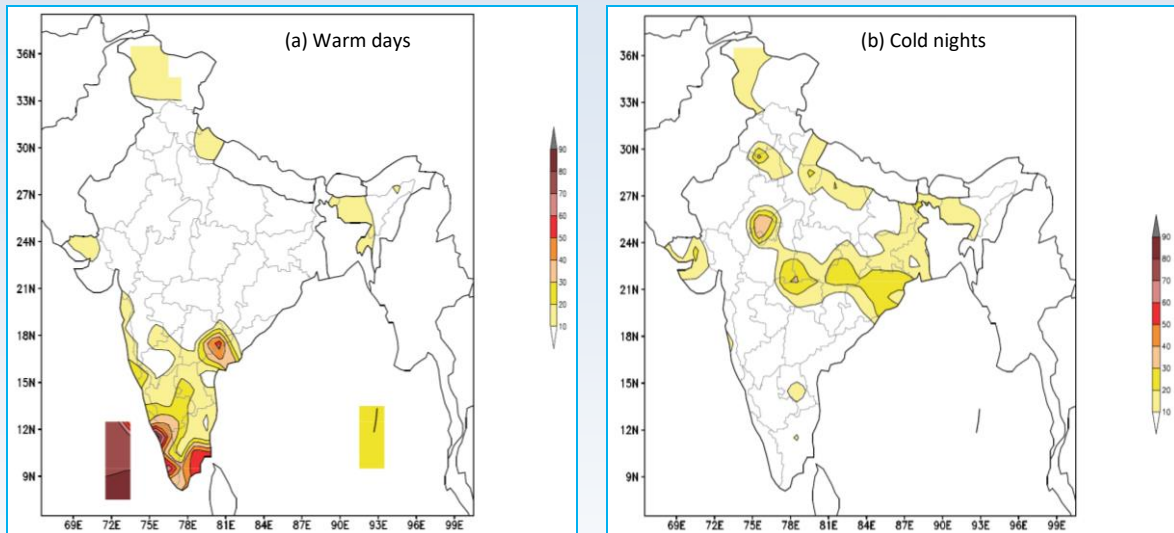
Minimum temperature was above normal over most parts of the country except some parts of northeast, northwest and central India. Minimum temperature anomaly was more than 2 °C over parts of Madhya Maharashtra, North Interior Karnataka and Telangana. Minimum temperature anomaly was less than -1 °C over parts of Haryana, Chandigarh & Delhi, East Rajasthan, Madhya Pradesh state, Chhattisgarh, Vidarbha and Odisha.

Outgoing Longwave Radiation (OLR)



**Fig. 5. OLR anomaly (W/m^2) for the winter season 2018
(Source: CDC / NOAA, USA)
(Based on 1981 - 2010 climatology)**

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig. 5. OLR was normal over entire country & Arabian Sea and was within range -10 to 10 W/m^2 . Positive OLR anomaly exceeding 10 W/m^2 was observed over parts of southeast Bay of Bengal.



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

Warm days/cold nights

Fig. 6(a&b) shows the percentage of days when maximum (minimum) temperature was more (less) than 90th (10th) percentile.

Over parts of coastal Andhra Pradesh & Yanam, Telangana, Tamilnadu, Puducherry & Karaikal, Kerala & Mahe and Lakshadweep, maximum temperature was greater than 90th percentile for more than 50% of the days of the season. For minimum temperature, no significant distribution was observed.

Maximum temperature was below normal over all the homogeneous regions except south peninsular India. Maximum temperature over south peninsular India (31.3 °C) was eighth highest since 1901. Minimum temperature was above or near normal over all the homogeneous regions, except east and northeast India. Minimum temperature over south peninsular India (22.15 °C) was third highest since 1901 after the years 1919 (22.41 °C), 1901 (22.26 °C).

Low Pressure Systems

No intense low pressure systems formed during the season.

2. Pre-Monsoon Season (March-April-May)

Highlights

Rainfall received over the country as a whole (158.5 mm) was third highest since 2001. The minimum temperature (25.42 °C) was fourth highest while the mean temperature (29.9 °C) was the sixth highest over south peninsular India since 1901.

Heat Wave Conditions

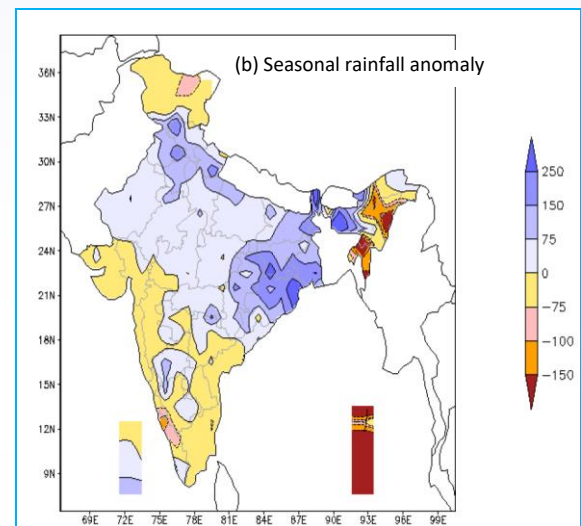
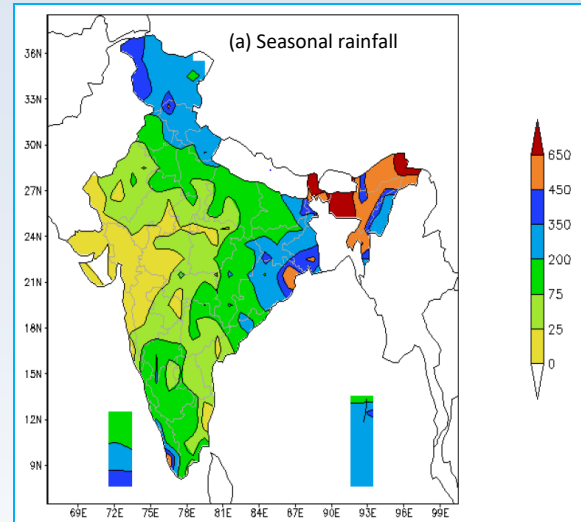
Heat wave/severe heat wave conditions were moderate during the season. These conditions were observed on 13th and 14th in isolated pockets of Gujarat State in the month of April and re-appeared during 21-29 May in some parts of northwest and central India and also over northern parts of south peninsular India. The heat wave conditions were observed over Saurashtra & Kutch and west Rajasthan on 21st May. During 22-29 May, it was observed in some parts, on most of the days in Rajasthan, Vidarbha, Madhya Pradesh, on many days in Haryana, Chandigarh, & Delhi, Telangana, Uttar Pradesh, on a few days in Gujarat, Marathwada and on isolated days in Madhya Maharashtra, Chhattisgarh and coastal Andhra Pradesh. Severe heat wave conditions were

also observed on 25th May in isolated pockets of west Rajasthan, Haryana, Delhi & East Uttar Pradesh and during 27-28 May in some parts of Rajasthan.

Rainfall Features

Rainfall activity during the season was above normal. During the season, out of 36 meteorological subdivisions, 13 received large excess rainfall, 4 received excess rainfall, 11 received normal rainfall, 6 received deficient rainfall and 2 received large deficient rainfall (Fig. 7).

Fig. 8(a) shows the spatial pattern of rainfall (mm) received during the season. Parts of Ladakh, Sub-Himalayan West Bengal & Sikkim, Assam & Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Bihar, Odisha, Lakshadweep and Kerala received more than 350 mm rainfall. Parts of Odisha, Sub-Himalayan West Bengal & Sikkim, Assam & Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram & Tripura received more than 450 mm rainfall. Parts of Sub-Himalayan West Bengal & Sikkim, Assam & Meghalaya



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

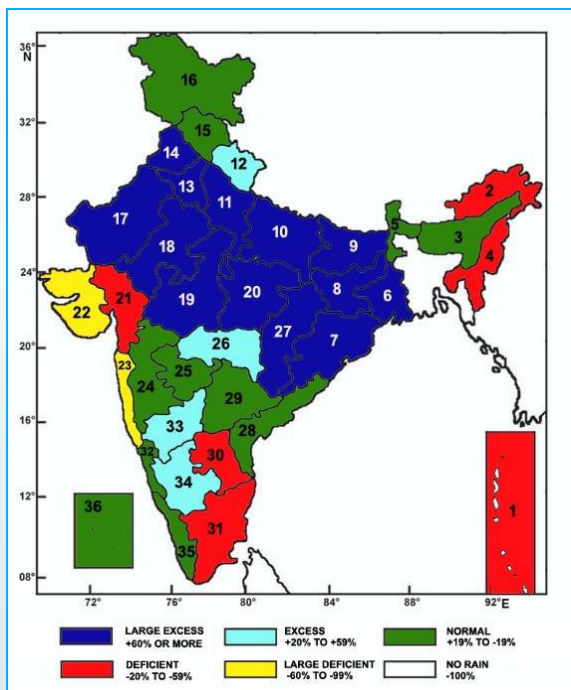


Fig. 7. Sub-divisionwise rainfall percentage departures

and Arunachal Pradesh received more than 650 mm rainfall.

Fig. 8(b) shows the spatial pattern of rainfall anomaly (mm) during the season. Positive rainfall anomaly of more than 150 mm was observed over parts of Gangetic West Bengal, Odisha, Jharkhand, Bihar, Sub-Himalayan West Bengal & Sikkim, Assam & Meghalaya and some isolated places over West Uttar Pradesh, Punjab and Himachal Pradesh. Positive rainfall anomaly of more than 250 mm was observed over parts of Odisha, Sub-Himalayan West Bengal & Sikkim and Assam & Meghalaya. Magnitude of negative rainfall anomaly was more than 75 mm over parts of Ladakh,

Andaman & Nicobar Islands, Arunachal Pradesh, Assam & Meghalaya and Nagaland, Manipur, Mizoram & Tripura and Kerala. Magnitude of negative rainfall anomaly was more than 100 mm over parts of Nagaland, Manipur, Mizoram & Tripura, Assam & Meghalaya, Kerala and Andaman & Nicobar Islands. Magnitude of negative rainfall anomaly was more than 150 mm over parts of Andaman & Nicobar Islands and Nagaland, Manipur, Mizoram & Tripura.

Fig. 9 shows the area weighted cumulative weekly rainfall percentage departure during the season for the country as a whole. Cumulative rainfall departure was positive during all the weeks of the season except first week. For the Pre-monsoon season 2020, rainfall realized was 120% of its LPA value. It was 147 % of LPA during March, 108 % of LPA during April and 114% of LPA during May.

Fig. 10(a) shows the area weighted seasonal rainfall over the country as a whole for the period 1951-2020. Rainfall received over the country as a whole (158.5 mm) was third highest since 2001 after the years 2015 (183.6 mm), 2004 (159.2 mm).

Fig. 10(b) shows the time series of area weighted seasonal rainfall over the four homogeneous regions for the period 1951-2020. During the season this year, rainfall realized over central India was 204% of its LPA, Northwest India (131% of LPA) and East and Northeast India (107% of LPA) and over South peninsular India was (96% of LPA). Rainfall received over homogeneous region of the central India (76.5 mm) was highest since 2001 and rainfall received over northwest India (149.4 mm) was second highest since 2001 after the year 2015 (212.8 mm).

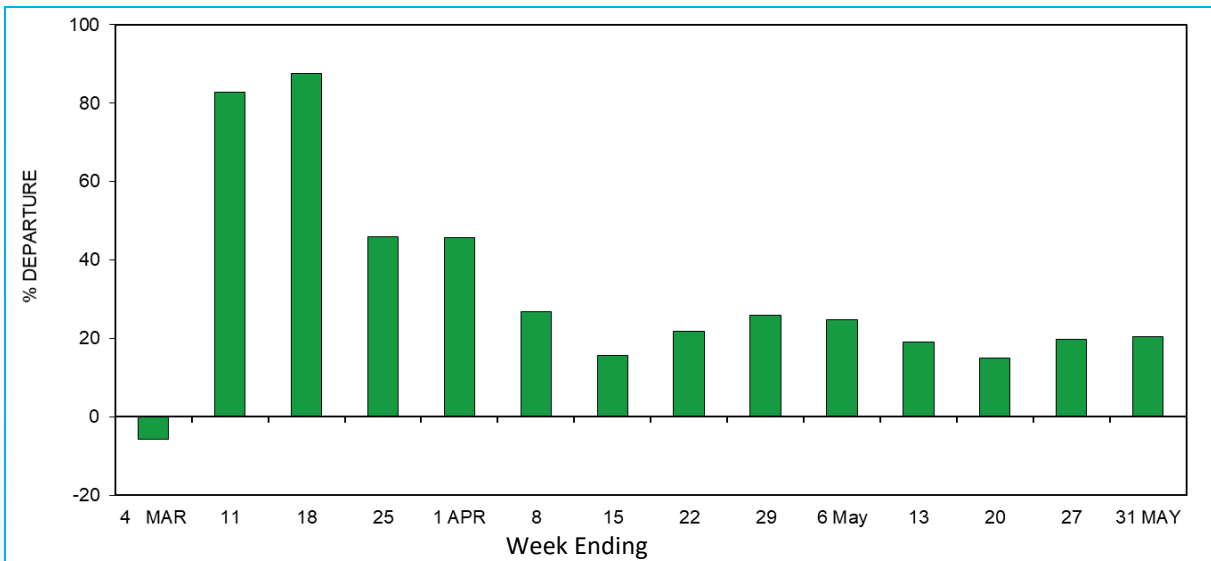


Fig. 9. Accumulated percentage departure of area weighted weekly rainfall over the country as a whole

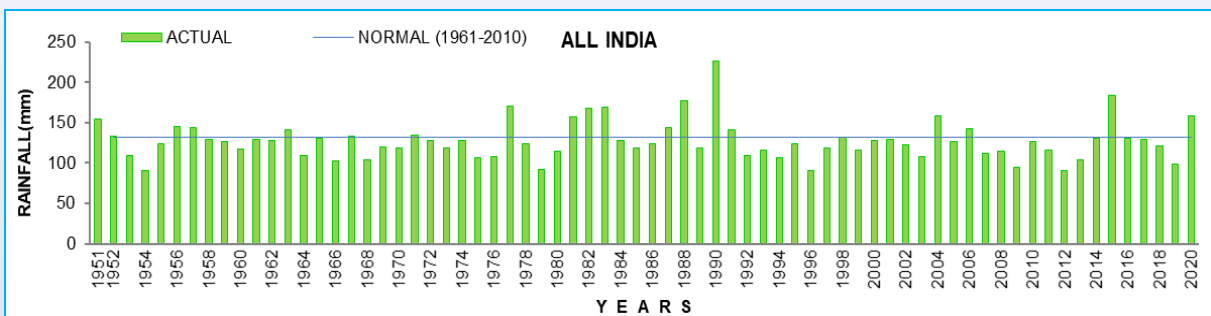


Fig. 10(a). Time series of area weighted rainfall over the country as a whole (1951 - 2020)

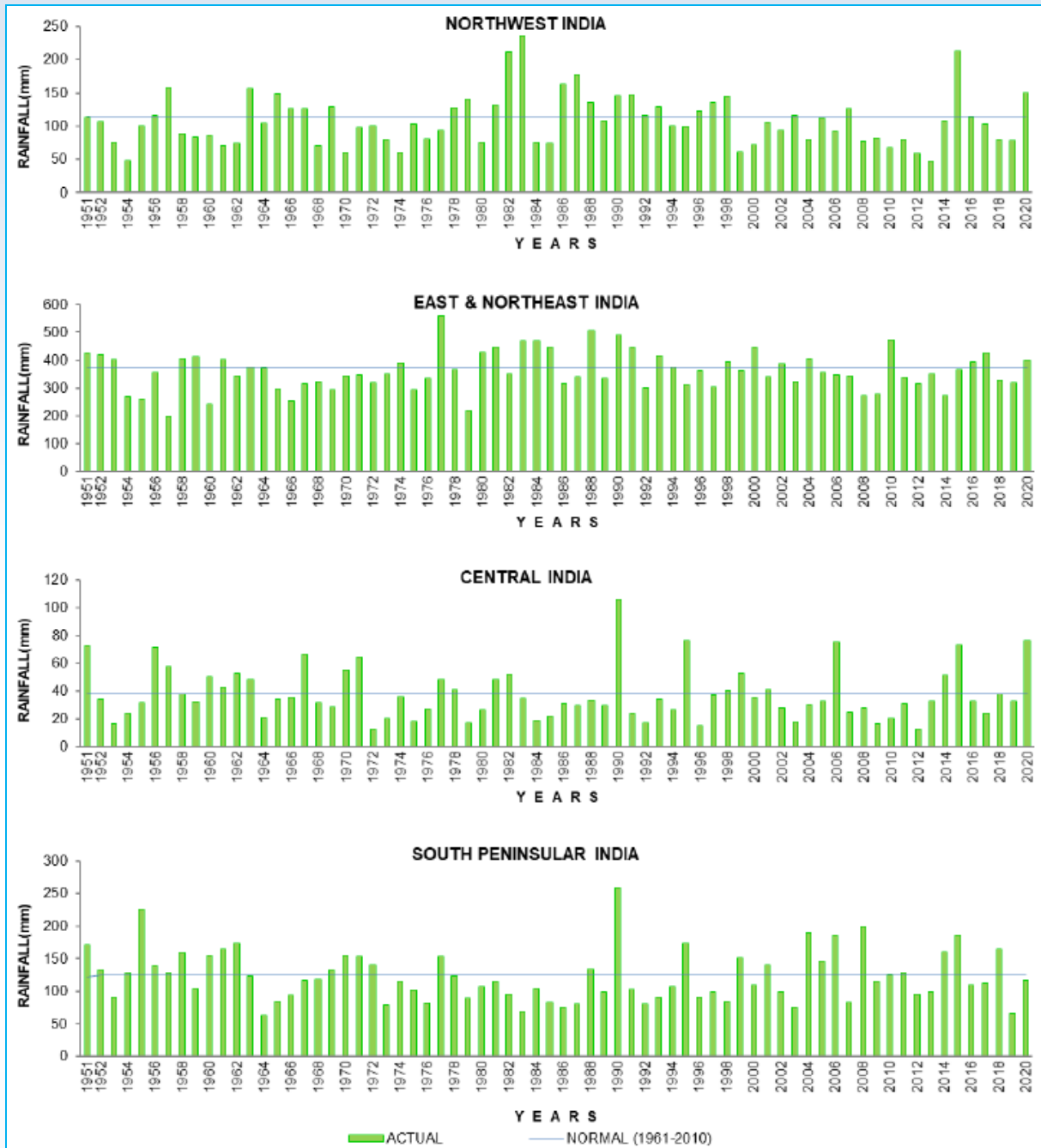


Fig. 10(b). Time series of area weighted rainfall over the four homogeneous regions (1951 - 2020)

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. Fig. 11 gives the SPI values for the pre-monsoon season this year (March-May, 2020).

Cumulative SPI values of the past three months show extremely wet/severely wet conditions over parts of Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Gangetic West Bengal, Odisha, Jharkhand, Bihar, Uttar Pradesh state, Uttarakhand, Haryana, Chandigarh & Delhi, Punjab, Himachal Pradesh, Jammu & Kashmir, Rajasthan state, Madhya Pradesh state, Chhattisgarh and north interior Karnataka while, extremely dry/severely dry conditions

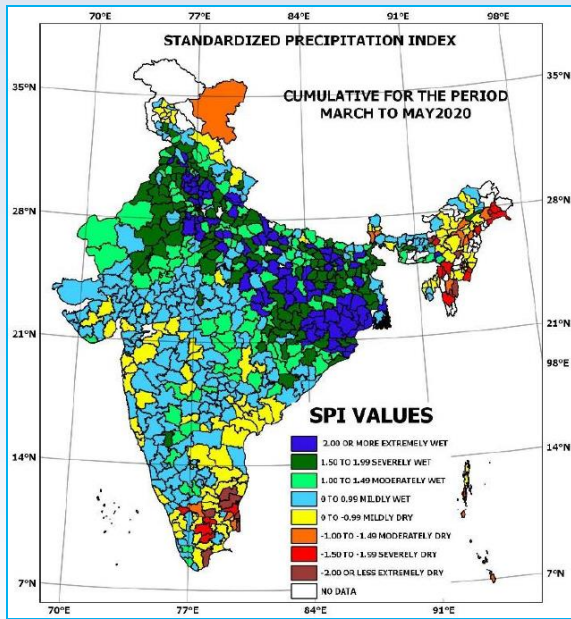


Fig. 11. Standardized precipitation index (SPI) cumulative for pre monsoon season (Mar-May, 2020)

were observed over parts Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura and Tamil Nadu.

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig. 12. It was negative over the entire country, south Indian Ocean, north Arabian Sea, south and central Bay of Bengal except parts of south and central Arabian Sea, east Bay of Bengal and Andaman Sea. Negative OLR anomaly exceeding $10 W/m^2$ was observed over parts of north & central India and southern parts

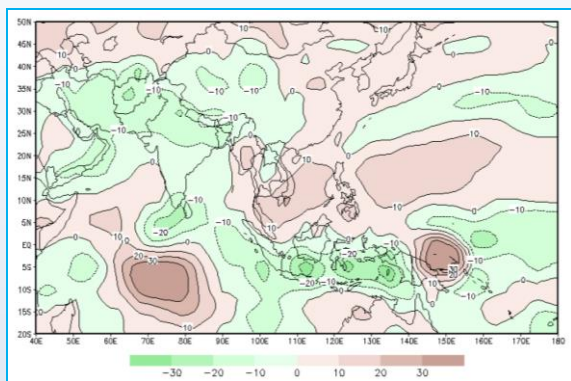
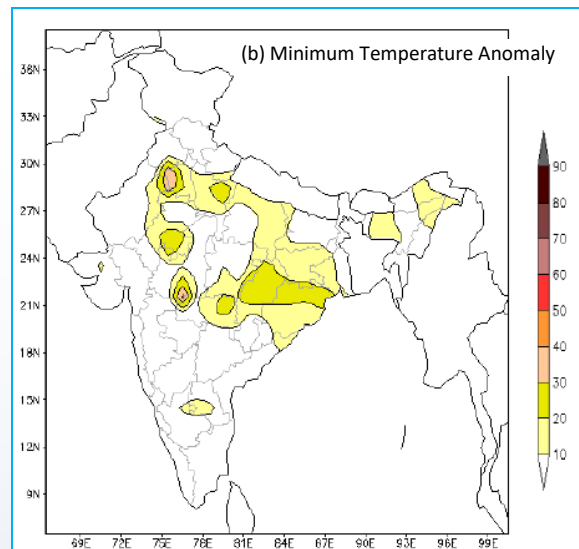
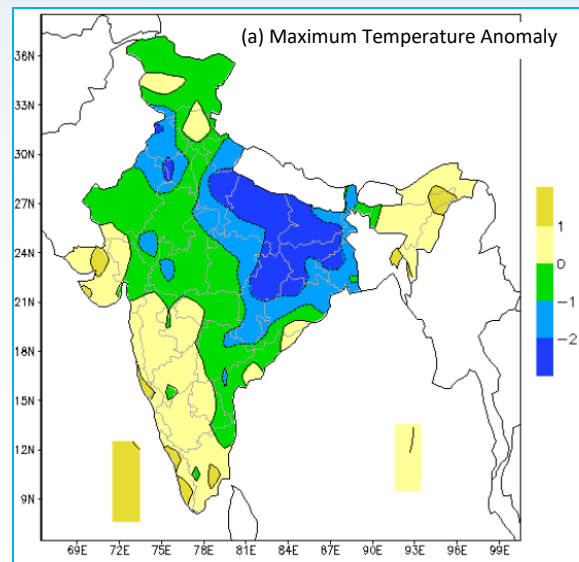


Fig. 12. OLR anomaly (w/m^2) for the season 2018 (Source : CDC / NOAA, USA) (Based on 1981-2010 Climatology)

of south peninsular India and adjoining Indian Ocean and Bay of Bengal.

Temperature

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



Figs. 13(a&b). Mean seasonal temperature anomalies ($^{\circ}C$) (a) maximum (b) minimum (Based on 1981-2010 normals)

Maximum temperature was below normal over most parts of the country except parts of northeast India, extreme west central India and western & southern parts of south peninsular India and both the Islands.

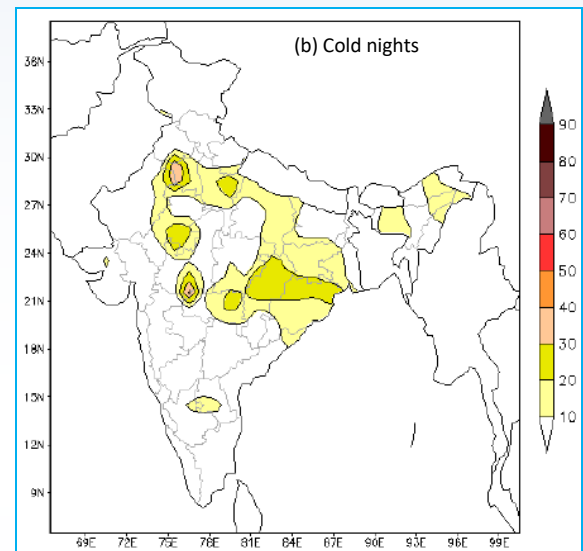
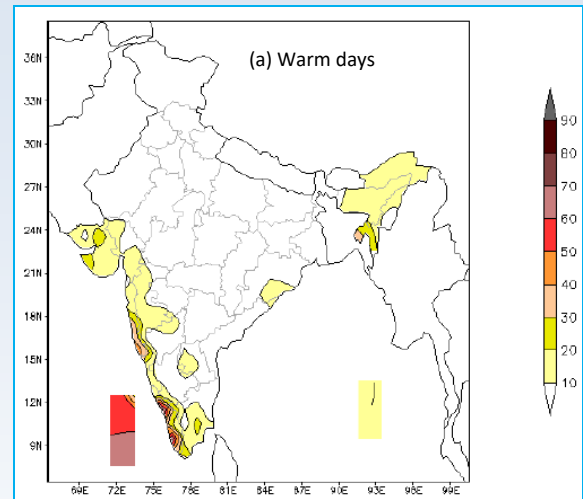
Maximum temperature anomaly was more than 1 °C over parts of Saurashtra & Kutch, Konkan & Goa, Coastal Karnataka, Kerala and Mahe, Tamil Nadu, Puducherry & Karaikal, Assam & Meghalaya, Nagaland, Tripura and Lakshadweep. Maximum temperature anomaly was less than -2 °C over parts of Haryana, Chandigarh & Delhi, Punjab, Uttar Pradesh State, Bihar, Jharkhand, Gangetic West Bengal, Odisha and Chhattisgarh.

Minimum temperature was above normal over most parts of the country except parts of north India, northwest India, east & northeast India and eastern central India. Minimum temperature anomaly was more than 1°C over parts of West Rajasthan, Gujarat state, Madhya Maharashtra, North Interior Karnataka, South Interior Karnataka, Tamil Nadu, Puducherry & Karaikal, Telangana, and both the Islands. Minimum temperature anomaly was less than -1 °C over parts of Haryana, Chandigarh & Delhi, west Uttar Pradesh, east Rajasthan, east Madhya Pradesh, Vidarbha, Chhattisgarh and Odisha.

Percentage of Warm days/Cold nights

Figs. 14(a&b) show the percentage of days when maximum (minimum) temperature was more (less) than 90th (10th) percentile. Over parts of Kerala and Lakshadweep islands, maximum temperature was greater than 90th percentile for more than 50% of the days of the season. For minimum temperature, no significant distribution was observed.

Maximum and minimum temperature was below normal or near normal over all the homogeneous regions except south peninsular India where it was above normal. Maximum temperature over south peninsular India (34.43 °C) was ninth highest since 1901. Minimum temperature over south peninsular India (25.42 °C) was fourth highest since 1901 after the years 2016 (25.86 °C), 2010 (25.65 °C), 1931 (25.45 °C).



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

Low Pressure Systems

During the season, two intense low pressure systems formed, both in the month of May: A Super Cyclonic Storm (SuCS, AMPHAN, 16-21 May) over the Bay of Bengal and a Depression (29-31 May) over the Arabian Sea. Besides these systems a low pressure area formed over south Andaman Sea and adjoining Southeast Bay of Bengal on 1st May and became less marked on 6th May.

Significant Weather events during the season

Cyclonic Storm: Due to Super Cyclonic Storm Amphan, total 90 persons reportedly claimed

dead. Of which, at least 86 people reportedly claimed dead from East Midnapur, North 24 Parganas, South 24 Parganas, Kolkata, Hooghly and Howrah districts of West Bengal. While, 4 persons reportedly claimed dead and nearly 4000 livestock perished from Odisha. Damage to about 88,000 hectares of rice paddies and 2,00,000 hectares of vegetable and sesame crops also reported. Thousands of mud houses damaged. Several trees and electric poles uprooted.

Snowfall (Avalanche): Due to avalanche, 2 persons reportedly claimed dead from Ganderbal district of Jammu & Kashmir on 27th March & 4th May.

Thunderstorm: Due to thunderstorm, 68 persons reportedly claimed dead from north eastern & central parts of the country. Of which, 52 persons reportedly claimed dead from Arwal, Aurangabad, Bhojpur, Bhagalpur, Banka, Darbhanga, Gaya, Jamui, Jehanabad, Kaimur, Katihar, Nalanda, Nawada, Patna, Purnea, Rohtas, Saharsa, Saran, Sheikhpura, Samastipur, Siwan, Sitamarhi districts of Bihar on 13th March, 26th April & 5th, 7th, 19th & 30th May. While more than 900 livestock perished from Aurangabad district of Bihar on 14th March. 14 persons reportedly claimed dead from Chatra, Dhanbad, Deoghar, Giridih, Gumla, Hazaribag, Lohardaga, Palamu, Ranchi, Ranghar districts of Jharkhand on 14th March, 21st, 23rd, 27th & 28th April. Also, one person each reportedly claimed dead from Dhule district of Maharashtra (18th March) & Damoh district of Madhya Pradesh (18th April).

Lightning: Due to Lightning, 31 persons reportedly claimed dead from Madhya Pradesh & Jammu & Kashmir. Of which, 30 persons reportedly claimed dead from Chhindwada, Damoh, Dewas, Dindori, Mandla, Panna, Ratlam, Rewa, Sagar, Satna, Shahdol, Sidhi, Singrouli & Umaria districts of Madhya Pradesh on 13th, 18th, 20th, 25th March and 8th, 18th, 26th April. While one person reportedly claimed dead from the forest

area of Rajouri district of Jammu & Kashmir on 25th April.

Duststorm: Due to Duststorm, 14 persons reportedly claimed dead from Alwar, Churu, Dhaulpur, Jaipur, Karauli, Kota & Tonk districts of Rajasthan on 3rd, 4th & 28th May.

Squall: Due to Squall 6 persons reportedly claimed dead from Dumka and Ramghard districts of Jharkhand on 23rd April. Damage to property and agriculture was reported from Hazaribagh and Ranchi districts on 27th and 29th April.

Gale: Due to Gale, 3 persons reportedly claimed dead from Anantnag & Shopian districts of Jammu & Kashmir on 27th May.

Heat Wave: Due to Heat Wave, 2 persons reportedly claimed dead from Gaya districts of Bihar on 25th May.

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

Chief Features

The southwest monsoon rainfall over the country as a whole, this year, was normal with All India area weighted rainfall 109% of its LPA. The rainfall during the season over the homogeneous region of south peninsular India (939.9 mm) was the highest since 1901. Rainfall distribution was generally fairly well distributed over major parts of the country. Except from one Severe Cyclonic Storm Nisarga which formed during the onset phase of monsoon, no other intense system formed during this season.

Minimum temperature averaged over all India was second highest since 1901.

Onset and advance of SW Monsoon

The Southwest Monsoon advanced into south Bay of Bengal, Nicobar Islands & Andaman Sea

on 17th May. The Northern Limit of Monsoon (NLM) passed through Lat. 5° N/Long. 85° E, Lat. 8° N / Long. 80° E, Car Nicobar Lat. 11° N / Long. 95° E on 17th May. After a hiatus of 9 days, further advance took place on 27th May. During 27-29 May, monsoon covered entire Andaman Sea, Andaman and Nicobar Islands, and advanced into some more parts of south Bay of Bengal, some parts of southwest and southeast Arabian Sea, Maldives-Comorin area. On 29th May, the NLM passed through Lat.7° N / Long. 50° E, Lat.7° N / Long.60° E, Lat.7° N / Long. 70° E, Lat.6° N / Long. 75° E, Lat. 6° N / Long. 79° E, Lat. 8° N / Long. 86° E, Lat. 11° N / Long. 90° E, Lat. 14° N / Long. 93° E and Lat. 16° N / Long. 95° E.

The southwest monsoon advanced into entire south Arabian Sea and Lakshadweep area, remaining parts of Maldives area, most parts of Kerala & Mahe, some parts of Tamil Nadu, Puducherry & Karaikal, some more parts of Comorin area and southwest Bay of Bengal on 1st June. Thus, Southwest Monsoon set in over Kerala on its normal date of 1st June. It covered entire Kerala and Mahe on 4th June, entire southeast Bengal on 6th June, and entire east-central Bay of Bengal on 7th June. During this period, it also covered most parts of Tamil Nadu, Puducherry and Karaikal, some parts of Central Arabian Sea, Karnataka, Rayalaseema, northeast India, west central and north Bay. The Northern Limit of Monsoon (NLM) passed through Lat. 14° N / Long. 60° E, Lat. 14° N / Long. 70° E, Karwar, Shivamogga, Tumakuru, Chittoor, Chennai, Lat. 16° N / Long. 85° E, Lat. 20° N / Long. 90° E and Lat. 22° N / Long. 93° E on 7th June. During 9-16 June there was a steady advance and the monsoon covered entire Tamil Nadu, Puducherry & Karaikal on 10th and entered Northeast India too, entire Karnataka, Rayalaseema & Coastal Andhra Pradesh on 11th, Telangana, Bay of Bengal and northeastern states on 12th Odisha & West Bengal on 13th and covered entire Maharashtra and entered Gujarat and Madhya Pradesh on 14th entire Chhattisgarh, Jharkhand and Bihar and entered

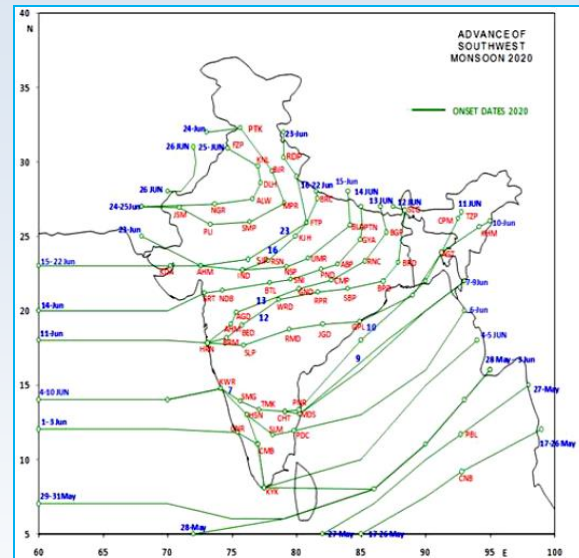


Fig. 15. Advance of southwest monsoon 2020

East Uttar Pradesh on 15th it further advanced into some more parts of West Madhya Pradesh, most parts of East Madhya Pradesh, and some more parts of East Uttar Pradesh on 16th June 2020. The Northern Limit of Monsoon (NLM) passed through Lat. 23° N / Long. 60° E, Kandla, Ahmedabad, Indore, Raisen, Khajuraho, Fatehpur, Bahraich and Lat. 28° N / Long. 81.5° E on 16th June. Then there was a hiatus of 6 days and further advance took place on 23rd June. During 23-25, the monsoon covered entire north Arabian Sea on 23rd Kutch, Gujarat region, Madhya Pradesh, Uttar Pradesh, Uttarakhand and Jammu, Kashmir & Ladakh, Gilgit-Baltistan, Muzaffarabad on 24th, Uttar Pradesh, Himachal Pradesh and Delhi on 25th June. South-West Monsoon further advanced into remaining parts of Rajasthan, Haryana and Punjab and thus covered the entire country on 26th June, 2020.

Fig. 15 depicts the isochrones of advance of southwest monsoon.

Rainfall Features

Most sub-divisions of the country received large excess/excess/normal rainfall except a few from northern region and Nagaland-Manipur-Mizoram-Tripura from the northeast.

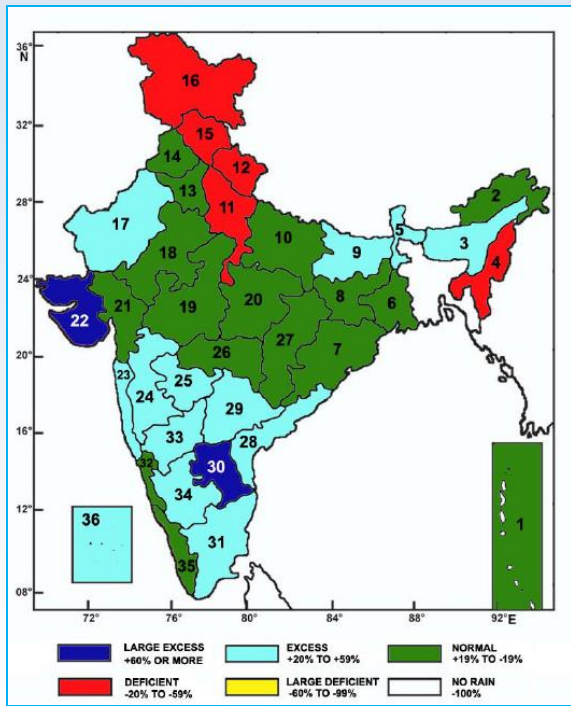


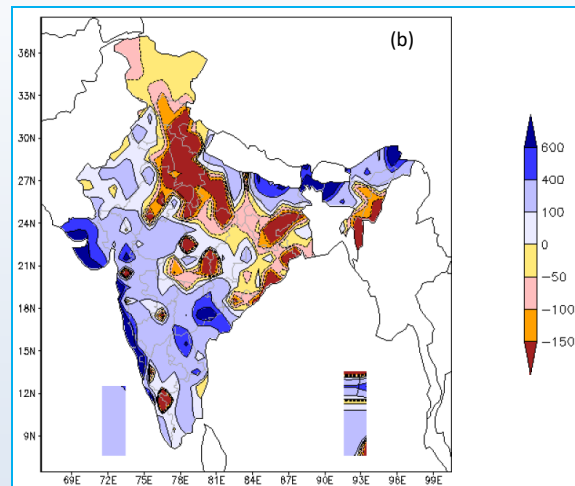
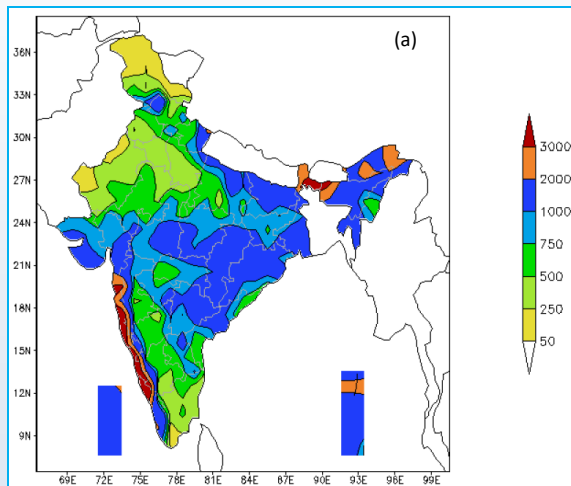
Fig. 16. Sub-divisionwise rainfall percentage departures for the Monsoon 2020

During the season, out of 36 meteorological subdivisions, 2 subdivisions received large excess rainfall, 13 subdivisions received excess rainfall, 16 received normal rainfall and the remaining 5 subdivisions received deficient rainfall (Fig. 16).

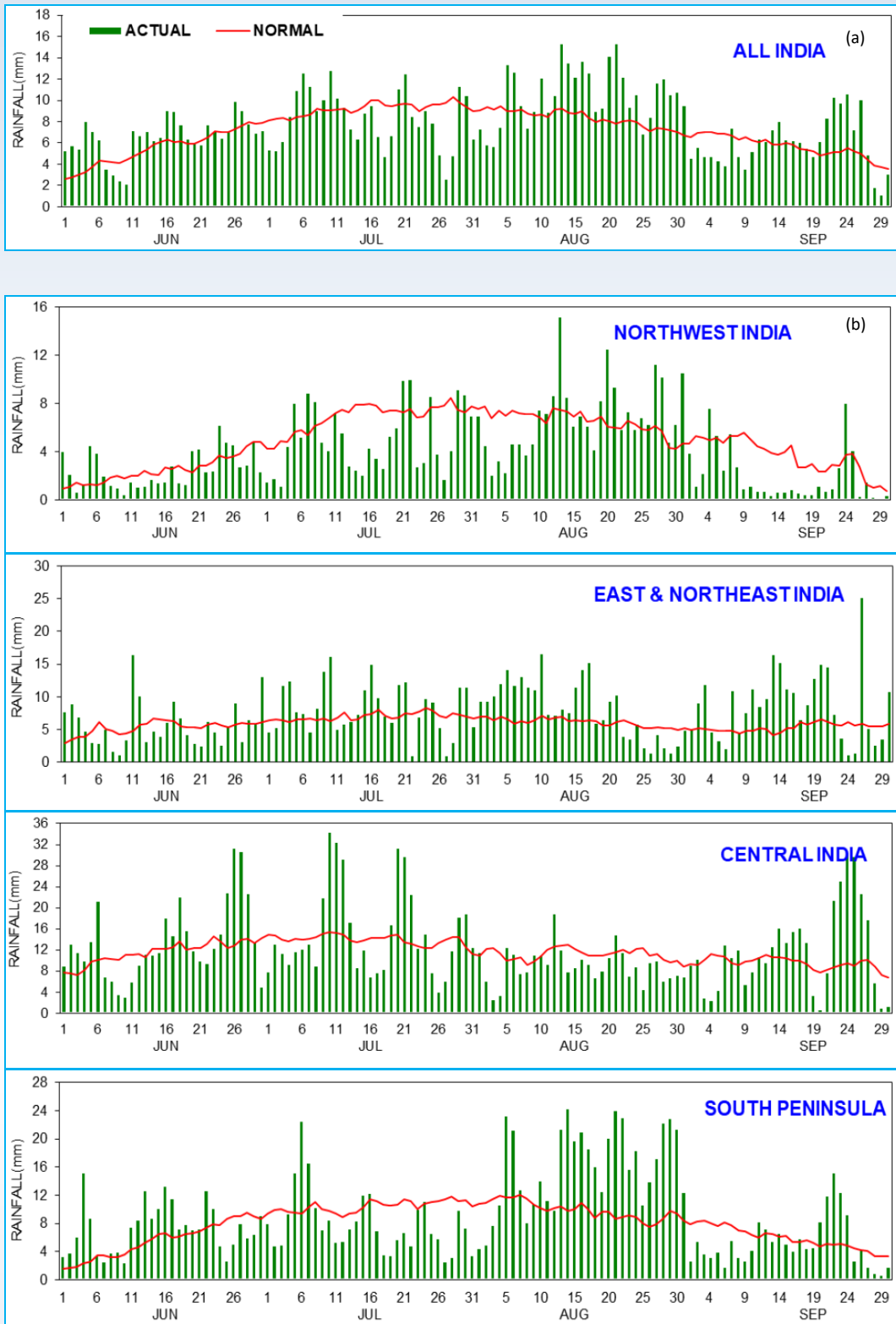
Figs. 17(a&b) show the spatial pattern of rainfall received during the season and its anomaly (mm) respectively.

Most parts of the country including islands received rainfall of the order of 750-2000 mm except some parts of northwestern and peninsular India. Parts of Arunachal Pradesh, Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Konkan & Goa, coastal Karnataka, Kerala & Mahe and Andaman & Nicobar Islands received more than 2000 mm of rainfall. Parts of Konkan & Goa, coastal Karnataka, Kerala and Mahe and Sub-Himalayan West Bengal & Sikkim received more than 3000 mm of rainfall.

Rainfall anomaly was positive over most parts of the country except over some parts of north and adjoining central India, east & northeast India. Positive rainfall anomaly exceeding 400 mm was observed over parts of Arunachal Pradesh, Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Bihar, Coastal Andhra Pradesh & Yanam, Telangana, Rayalaseema, Saurashtra & Kutch, Konkan & Goa, Coastal Karnataka and Kerala. Positive rainfall anomaly exceeding 600 mm was observed over parts of Arunachal Pradesh, Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Telangana, Saurashtra & Kutch, Konkan & Goa, Coastal Karnataka and Kerala. Magnitude of negative rainfall anomaly was more than 150 mm over parts Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Odisha, Jharkhand, east and West Uttar Pradesh,



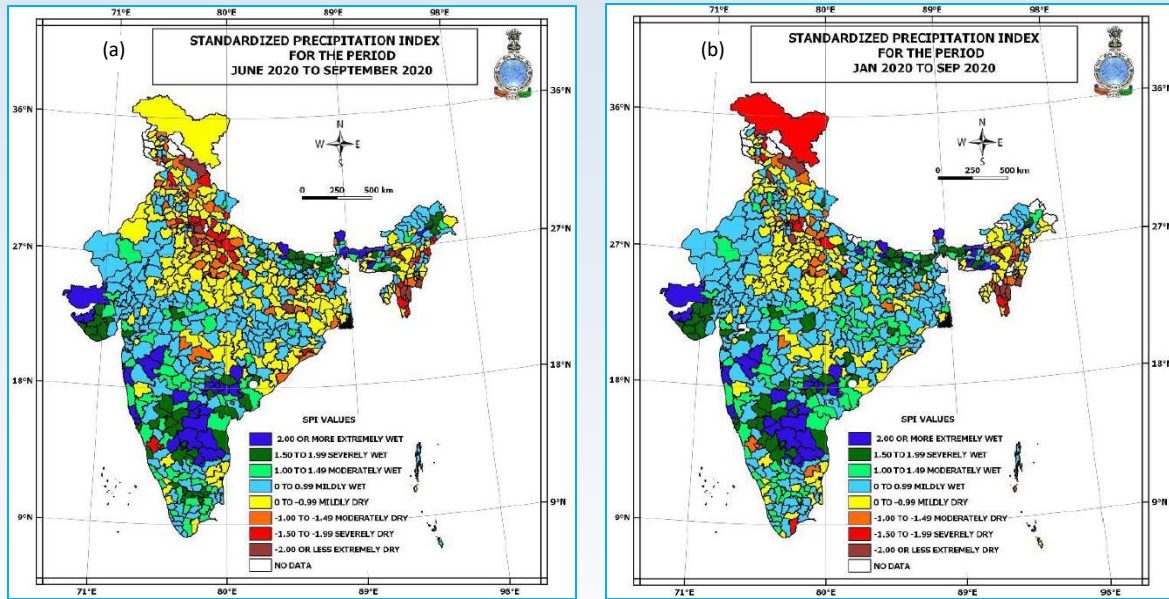
Figs. 17(a&b). (a) Seasonal rainfall (mm) (b) Seasonal rainfall anomaly (mm) (Based on 1961-2010 Normals)



Figs. 18(a&b). Time series of area weighted rainfall over the (a) country as a whole (b) four homogeneous regions, for the monsoon season (1951 - 2018)

Haryana, Chandigarh & Delhi, Uttarakhand, Himachal Pradesh, east Rajasthan, east and West Madhya Pradesh, Kerala and Tamil Nadu, Puducherry & Karaikal.

Figs. 18(a&b) show the daily area weighted rainfall (in mm) and its long term normal over the country as a whole and the four homogeneous regions during the season. For



Figs. 19(a&b). Standardized Precipitation Index (SPI) for (a) Four months (b) Nine months

the country as a whole, rainfall averaged was above or near normal on many days during the season. On almost 20 occasions including the continuous periods of 1-5 June and 21-24 September, it was more than one and half times its normal value. It was below normal at a stretch on 7- 10 June, 29 June - 3 July, 13-15 July, 17-19 July, 25-28 July, 31 July-4 August, 1-6 September and 8-10 September.

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is an index used for monitoring drought and is based only on 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. 19(a&b) give the SPI values for the monsoon season (four months) and the year since January 2020 (nine months) respectively.

Cumulative past four months SPI values indicate, extremely wet/severely wet conditions over parts of Arunachal Pradesh, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, Odisha, Bihar, East Uttar Pradesh, West Madhya Pradesh, Gujarat state, Konkan & Goa, Madhya Maharashtra, Marathwada, Chhattisgarh, Andhra Pradesh state, Telangana, Tamil Nadu & Karaikal,

Karnataka state while, extremely dry/severely dry conditions were observed over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Odisha, Jharkhand, Uttar Pradesh state, Uttarakhand, Haryana, Chandigarh & Delhi, Punjab, Himachal Pradesh, Jammu & Kashmir & Ladakh and South Interior Karnataka.

Cumulative SPI values of the past nine months indicate, extremely wet/severely wet conditions over parts of Arunachal Pradesh, Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, Odisha, Bihar, East Uttar Pradesh, Uttarakhand, Madhya Pradesh state, Gujarat state, Konkan & Goa, Madhya Maharashtra, Marathwada, Chhattisgarh, Andhra Pradesh state, Telangana, North Interior Karnataka and South Interior Karnataka while, extremely dry/severely dry conditions were observed over parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Uttar Pradesh state, Haryana, Chandigarh & Delhi, Punjab, Himachal Pradesh, Jammu & Kashmir & Ladakh and Tamil Nadu & Karaikal.

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig. 20. OLR anomaly was negative throughout the country

except over Uttarakhand, West Uttar Pradesh, Haryana, Chandigarh & Delhi, east Rajasthan and foothills of Himalaya. Magnitude of negative OLR anomaly exceeded 10 W/m^2 over parts of peninsular India and adjoining Bay of Bengal. The positive OLR anomaly was more than 10 W/m^2 over parts of east central Bay of Bengal.

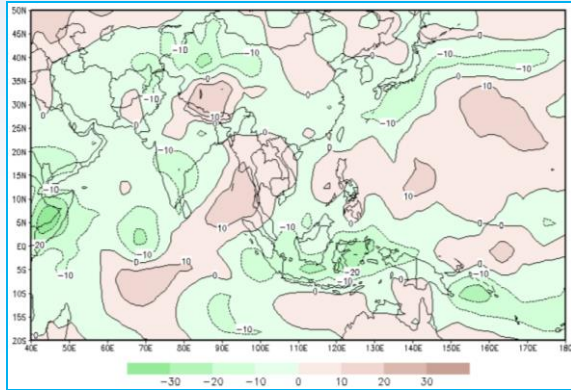


Fig. 20. OLR anomaly (W/m^2) for the monsoon season 2020 (Source: Cdc / NOAA, USA)
(Based On 1981 - 2010 Climatology)

Temperature

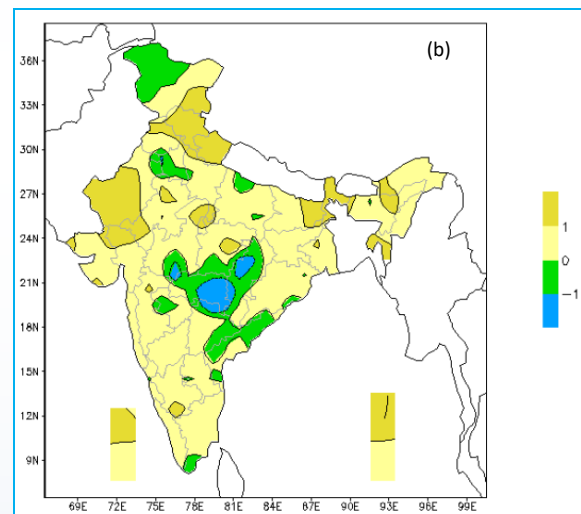
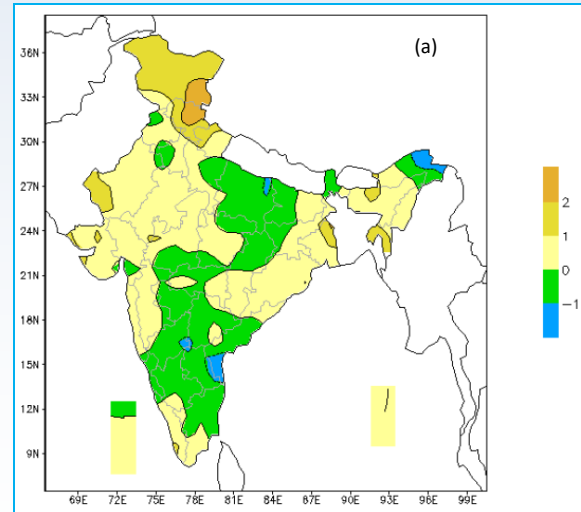
Mean seasonal maximum and minimum temperature anomaly is shown in Fig. 21(a&b).

Maximum temperature was above normal over most parts of the country except over extreme northeastern India, central India, south peninsular India, Sikkim and Lakshadweep. Maximum temperature anomaly was more than 2°C over parts of Ladakh and Himachal Pradesh. Maximum temperature anomaly was less than -1°C over parts of Coastal Andhra Pradesh & Yanam, North Interior Karnataka and Arunachal Pradesh.

Minimum temperature was above normal over most parts of the country except parts of central region of central India and east coastal parts of south peninsular India.

Minimum temperature anomaly was more than 1°C over parts of Ladakh, Himachal Pradesh, Uttarakhand, Punjab, Rajasthan state, Gujarat Region, West Madhya Pradesh,

Bihar, Sub-Himalayan West Bengal & Sikkim, Arunachal Pradesh, Assam and Meghalaya, Mizoram, Tripura, South Interior Karnataka and both the islands. Minimum temperature anomaly was less than -1°C over parts of Chhattisgarh, west Madhya Pradesh and Vidarbha.



Figs. 21(a&b). Mean seasonal temperature anomalies ($^\circ\text{C}$) (a) Maximum (b) Minimum
(Based on 1981-2010 Normals)

Low Pressure Systems

During the season, twelve low pressure systems (1 severe cyclonic storm, 6 well marked low pressure areas & 5 low pressure areas) were formed.

The first intense system of the season formed as a SCS "NISARGA" during 1-4 June over

Arabian Sea. Remaining eleven systems were well marked low pressure areas/low pressure areas. No deep depression/depression formed during the season. Fig. 22 shows the track of intense low pressure system formed during the season.

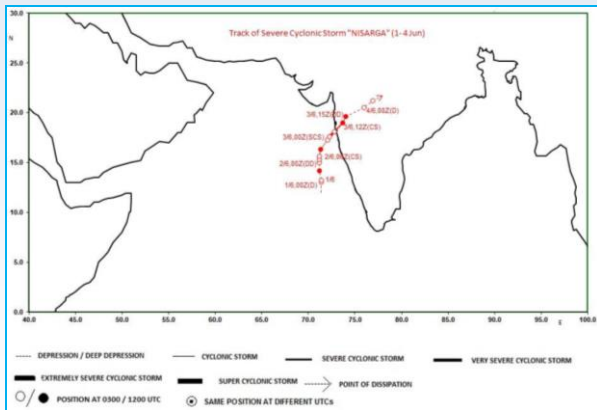


Fig. 22. Tracks of intense low pressure systems formed during the Monsoon season

Significant Weather events

During the season more than 700 persons reportedly claimed dead due to Floods & Heavy Rains, Thunderstorm, Lightning & Cyclonic Storm from different parts of the country. Also, due to Gales, damages to crops, fruits, houses & shops were reported from Jammu Kashmir (Bandipora, Baramullah, Budgam, Kupwara, Srinagar Dist.) on 8th & 23rd June and 5th July while Hailstorm on 6th June damaged crops in Himachal Pradesh (Shimla Distt.).

Cyclonic Storm: Due to Severe Cyclonic Storm 'Nisarga', 5 persons reportedly claimed dead from Alibag, Pune & Raigad districts & 2000 livestock perished from Nasik district of Maharashtra. Damage to crops, houses also reported.

Floods & Heavy Rain: Total 346 persons reportedly claimed dead from different parts of the country during the season. Of these, during the season 119 persons reportedly claimed dead & more than 64 Lakhs animals including poultry birds perished due to the events caused by heavy rains from 32 districts

of Assam. Damage to crops, roads & RCC Bridge/Culvert also reported. Of the remaining casualties, 54 deaths were reported from Bihar (26th July & 1st to 20th August), 48 from Uttar Pradesh (23-26 June, 8th & 18th August), 38 persons & 88 livestock from Himachal Pradesh (24 June-30 September), 18 from Rajasthan (5th, 14th, 16th, 22nd August), 10 from Madhya Pradesh (28-31 August) 8 from Maharashtra (16 July, 4th August, and 19th September), 5 persons & 36 livestock from Jammu & Kashmir (9th, 26th & 27th August) and 4 persons from Uttarakhand (18th, 19th July & 25th August). Landslide claimed 42 lives in Kerala on 7th August. Some other districts with no casualties, from Bihar, Madhya Pradesh, Maharashtra and Jammu & Kashmir were also affected.

Lightning: Due to Lightning, 54 persons reportedly claimed dead during 11th June to 17th September from different parts of the country. Of these, 36 persons reportedly claimed dead from Allahabad, Badaun, Chitrakoot, Chandauli, Gazipur, Jaunpur, Kaushambi, Kushinagar, Mirzapur districts of Uttar Pradesh on 6th July & 15th September. While, 6 from Amarawati, Gondia, Palgarh, Osmanabad districts of Maharashtra on 22nd July, 7th & 17th September. Also, 5 from Anuppur district of Madhya Pradesh (11th June), 4 persons from Poonch & Udhampur districts of Jammu & Kashmir (20th July, 26th August), 3 persons from Rajsmand district of Rajasthan (23rd August).

Thunderstorm: Due to thunderstorm, 310 persons reportedly claimed dead from north & northeast parts of the country. Of these, 217 persons reportedly claimed dead from 35 districts of Bihar on 25th & 30th June, 2- 4, 8th, 19th, 30th & 31st July, 15th September. While, 86 persons reportedly claimed dead 19 districts of Jharkhand during 1st June to 17th September. Also, 5 persons were reported dead from Uttar Pradesh on 12th June and 2 persons from Mandsaur in Madhya Pradesh during 10-11th June.

4. Post Monsoon Season (October-November-December)

Northeast Monsoon Activity

The southwest monsoon withdrew from the entire country on 28th October and northeast monsoon rains subsequently commenced on the same day. Rainfall activity over core region of the South Peninsular India (comprising of 5 subdivisions viz., Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu & Puducherry, South Interior Karnataka and Kerala) during the season as a whole was above normal [110% of Long Period Average (LPA)]. It was below normal during October (87% of LPA) and above normal during November and December (124% of LPA and 166% of LPA respectively).

Rainfall Features

Rainfall realized over the country as a whole during the season was 101% of LPA. It was 103%, 96% and 98% of its LPA during October, November and December months

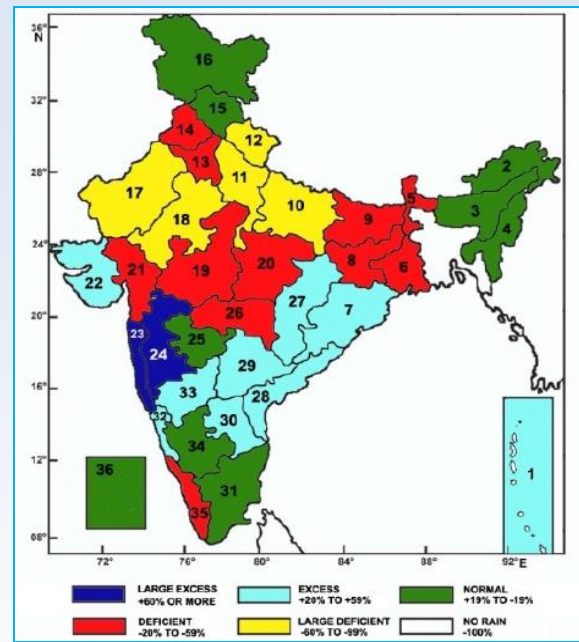
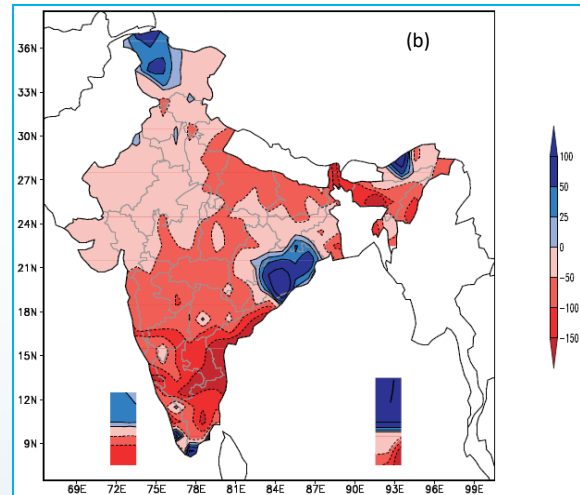
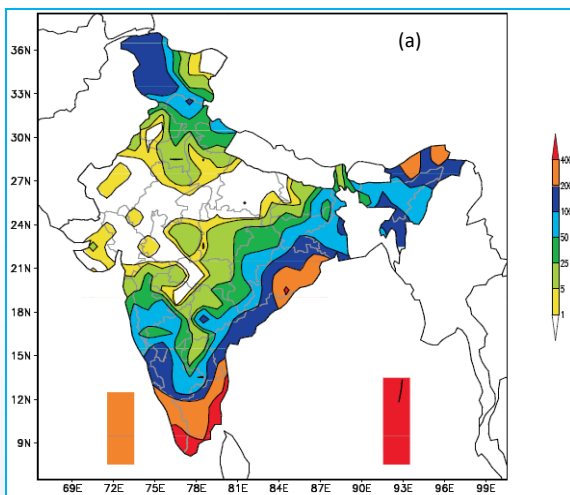


Fig. 23. Sub-divisionwise rainfall percentage departures

respectively. All the subdivisions from south peninsular India except Kerala & Mahe, extreme northeastern, northern subdivisions, both the islands, Konkan & Goa and Madhya Maharashtra remaining subdivisions received large deficient/deficient rainfall.



Figs. 24(a&b). (a) Seasonal rainfall (mm) (b) seasonal rainfall anomaly (mm) (Based on 1951-2000 Normals)

During the season, out of 36 meteorological subdivisions, 2 received large excess rainfall, 9 received excess rainfall, 9 received normal rainfall 11 received deficient and 5 received large deficient rainfall

(Fig. 23). Figs. 24(a&b) show the spatial pattern of rainfall (mm) received during the season and its anomaly respectively. Parts of Jammu & Kashmir and Ladakh, Arunachal

Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, all the subdivisions of south peninsula and both the islands received more than 200 mm rainfall. Parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Odisha, Andhra Pradesh state, Telangana, Madhya Maharashtra, Konkan & Goa, Tamil Nadu, Puducherry & Karaikal, Kerala & Mahe,

Coastal Karnataka and both the islands received more than 300 mm rainfall. Parts of Andaman & Nicobar Islands, Tamil Nadu, Puducherry & Karaikal and Coastal Andhra Pradesh & Yanam, Rayalaseema received more than 600 mm rainfall.

Rainfall anomaly was positive over most parts of south peninsula, extreme northeast region and Jammu & Kashmir and Ladakh. Rainfall anomaly was more than 100 mm over parts of

Jammu & Kashmir, Odisha, Andhra Pradesh state, Rayalaseema, Tamil Nadu, Puducherry & Karaikal, Andaman & Nicobar Islands, Konkan & Goa, Madhya Maharashtra, Coastal Karnataka, North Interior Karnataka. Magnitude of negative rainfall anomaly was more than 100 mm over parts of Andaman & Nicobar Islands, Sub-Himalayan West Bengal & Sikkim, Gangetic West Bengal and Kerala & Mahe.

Fig. 25(a) shows the all India area weighted rainfall series for the season since 1951.

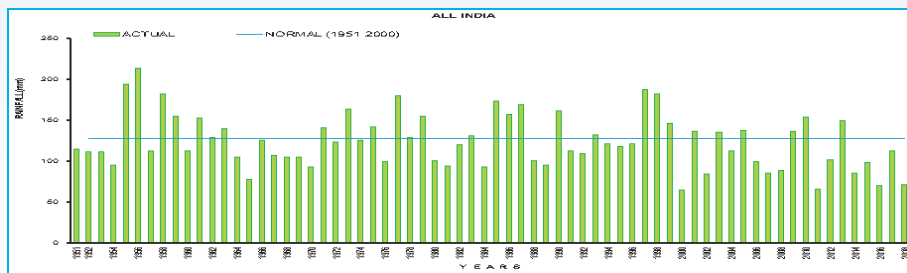


Fig. 25(a). Time series of area weighted rainfall over the country as a whole (1951-2018)

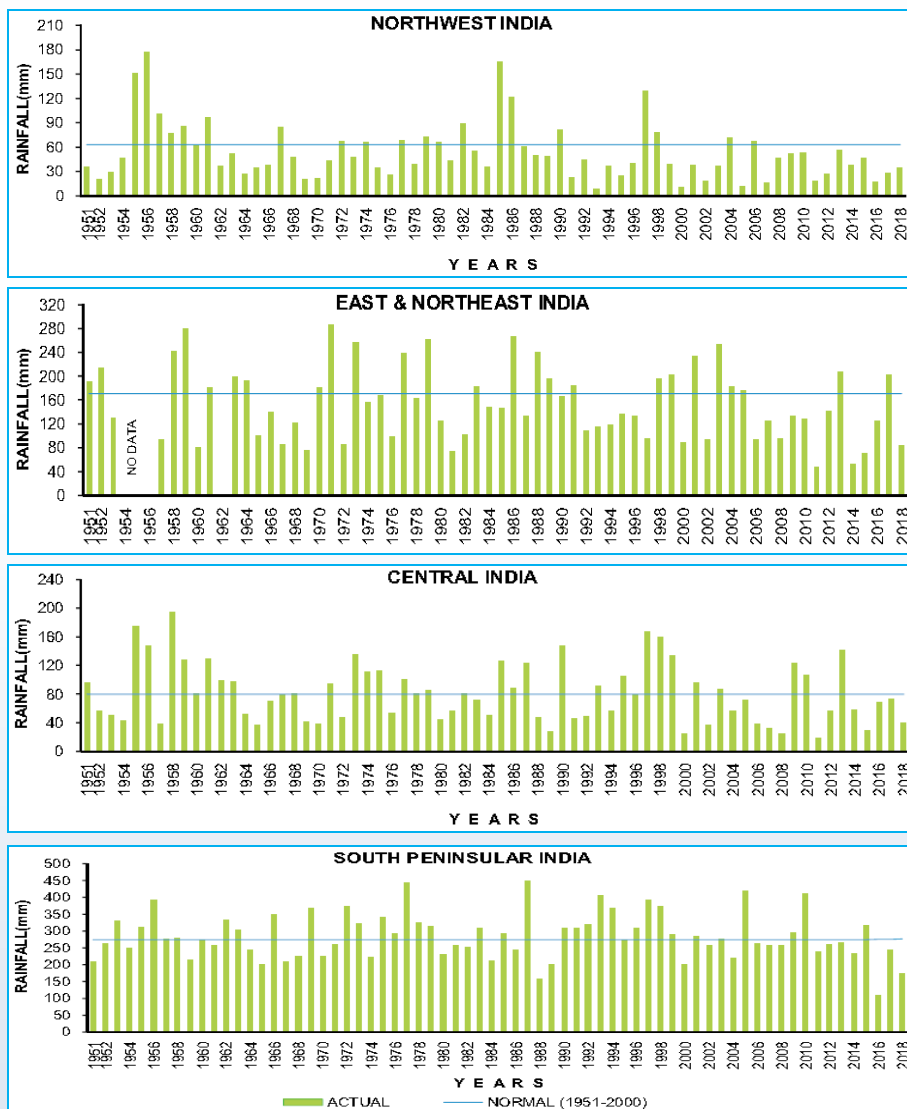


Fig. 25(b). Time series of area weighted rainfall over the four homogeneous regions (1951 - 2018)

Fig. 25(b) shows the area weighted rainfall series for the season over the four homogeneous regions since 1951.

The rainfall for the season was above normal over south peninsular India and central India (115%, 112% of LPA respectively) and was below normal over east & northeast India and northwest India (85%, 61% of LPA respectively). Rainfall over the homogenous region of south peninsula (319.4 mm) was fourth highest since 2001 after the years 2010 (404.9 mm), 2005 (399.8 mm) and 2019 (322.2 mm).

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is an index used for measuring drought and is based only on 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. 26 (a&b) give the SPI values for the northeast monsoon season (October to December 2020 i.e., 3 months cumulative) and the year (January-December 2020, i.e., 12 months cumulative) respectively.

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

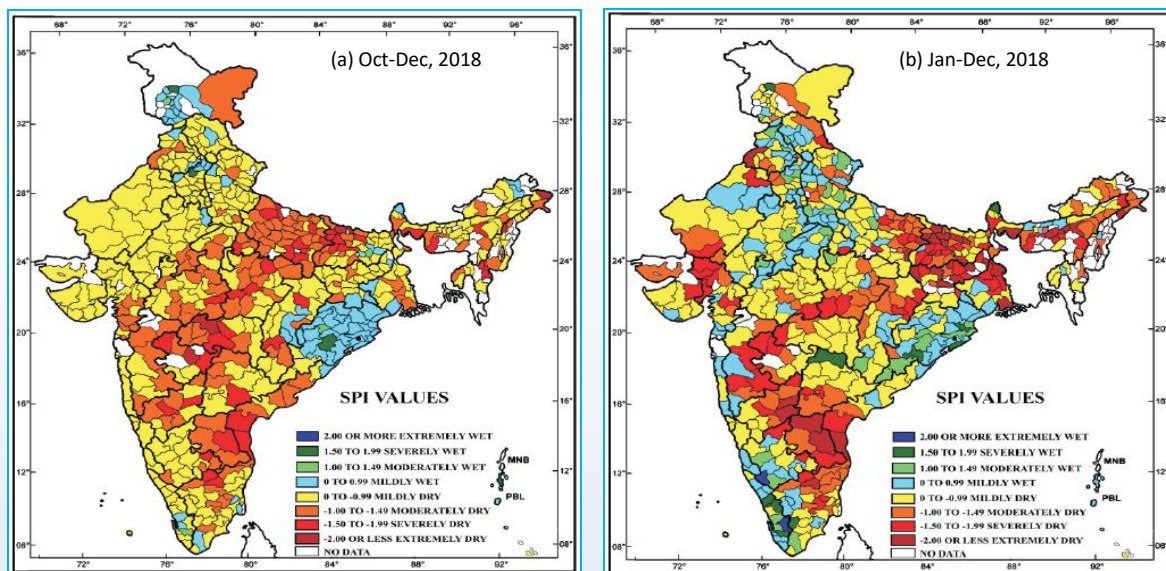


Fig. 26(a&b). Standardized Precipitation Index (SPI) cumulative for (a) Three months (b) Twelve months

Pressure & Wind

Wind anomaly at 850 hPa shows anomalous cyclonic circulation over Arabian Sea. An

anomalous anti cyclonic circulation at 500 hPa level was observed over Central India and adjoining Arabian sea and Bay of Bengal. At 250 hPa level anomalous westerlies prevailed.

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig. 27. OLR anomaly was within range of $+10 W/m^2$ over most parts of the country and Arabian Sea. Negative OLR anomaly exceeding $10 W/m^2$ was observed over most parts of Bay of Bengal.

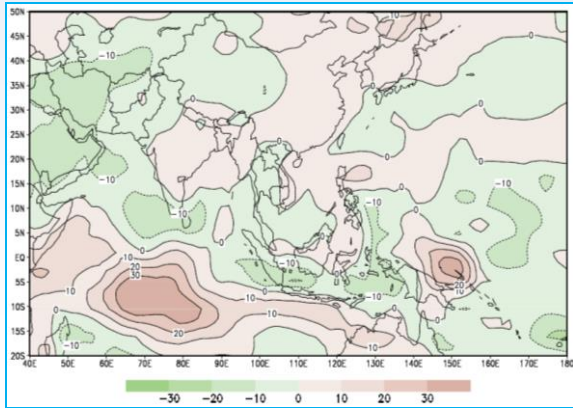


Fig. 27. OLR Anomaly (w/m^2) for the post-monsoon season 2018 (Source : CDC / NOAA, USA) (Based on 1981 - 2010 Climatology)

Temperature

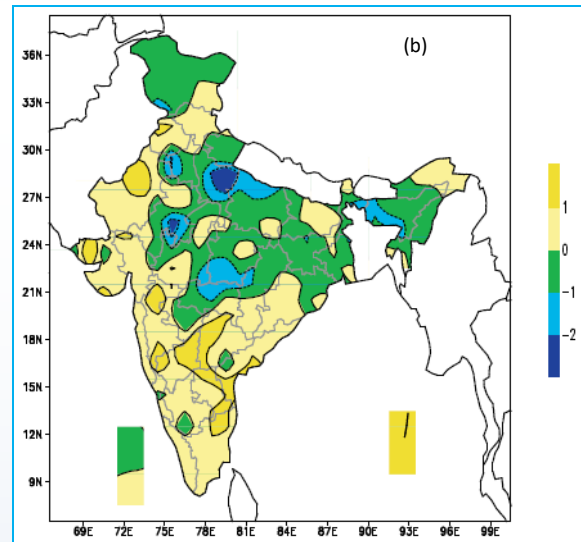
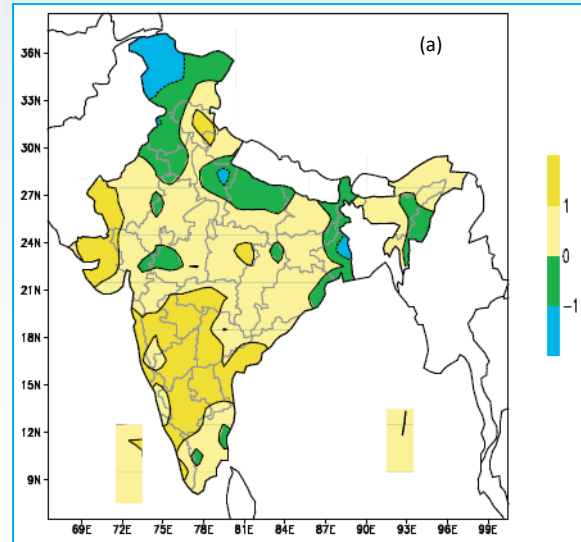
Mean seasonal maximum and minimum temperature anomaly is shown in Figs. 28(a) & 28 (b) respectively.

Maximum temperature was above normal over most parts of the country except some parts of western north India and central India, northeast India and northern south peninsular India. Maximum temperature anomaly was more than $2 ^\circ C$ over parts of Himachal Pradesh and Assam and Meghalaya.

Maximum temperature anomaly was less than $-1 ^\circ C$ over parts of Punjab, Haryana, Chandigarh & Delhi, Uttar Pradesh state, extreme northwestern Saurashtra & Kutch and Madhya Maharashtra.

Minimum temperature was above normal over most parts of the country except for some parts of north and northwest India. Minimum temperature anomaly was more than $2 ^\circ C$ over parts of Madhya Maharashtra, Marathwada, Bihar, South Interior Karnataka and Kerala and

Mahe. Minimum temperature anomaly was less than $-1 ^\circ C$ over parts of Jammu, Kashmir & Ladakh, Haryana, Chandigarh & Delhi, West Uttar Pradesh, East Rajasthan and extreme northwestern Saurashtra & Kutch. Minimum temperature anomaly was less than $-1 ^\circ C$ over parts of Haryana, Chandigarh & Delhi and West Uttar Pradesh.



Figs. 28(a&b). Mean seasonal temperature anomalies ($^\circ C$) (a) Maximum (b) Minimum (Based on 1971-2000 Normals)

Percentage of Warm days/Cold nights

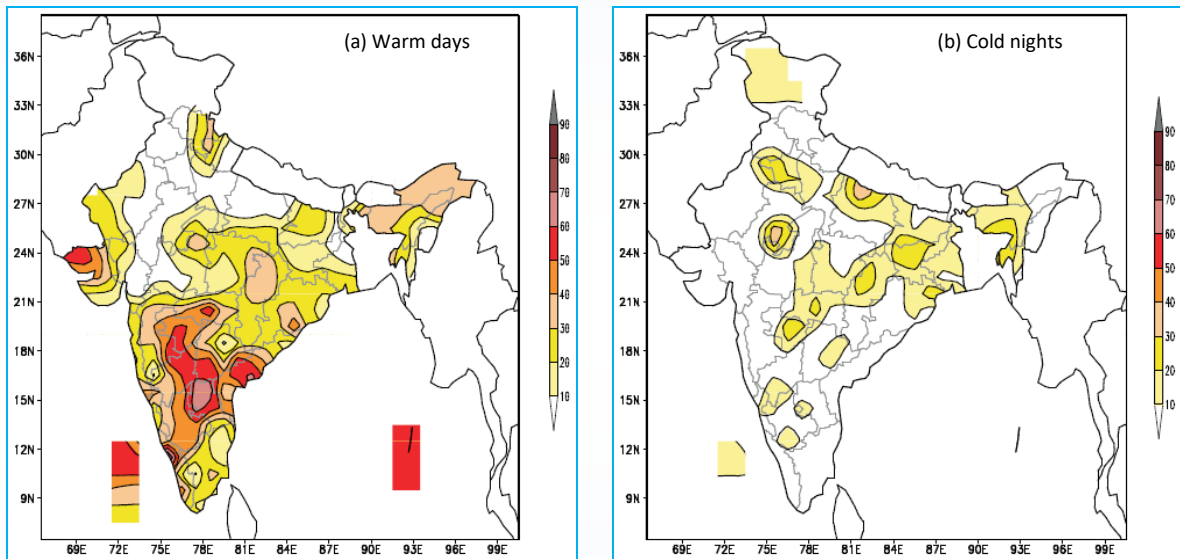
Figs. 29(a&b) show the percentage of days when maximum (minimum) temperature was more (less) than 90^{th} (10^{th}) percentile.

Over parts of Assam & Meghalaya, Uttarakhand, West Uttar Pradesh, Telangana and Kerala & Mahe maximum temperature

was greater than 90th percentile for more than 50% of the days of the season. Over parts of West Uttar Pradesh and Haryana, Chandigarh & Delhi minimum temperature was less than 10th percentile for more than 50% of the days of the season.

Fig. 30 shows the mean temperature for the country as a whole for the season since 1971. Five year moving average values are also shown. The mean temperature for the season this year was 23.8 °C with anomaly 0.51 °C and fifth highest since 1901. Mean temperature over east and northeast India (22.6 °C) was highest, south peninsular India was (27.0 °C) fifth highest since 1901.

Figs. 31(a&b) show, the maximum and minimum temperature series respectively for the country as a whole and the four homogeneous regions during the season since 1971. Both maximum and minimum temperatures were above normal over all the homogeneous regions except northwest India. Maximum temperature over east and northeast India was (28.65 °C) second highest since 1901 after the year 2016 (28.77 °C). Minimum temperature over south peninsular India (23.27 °C) was third highest, all India (18.25 °C) was fourth highest, central India (18.54 °C) was sixth highest and east and northeast India (16.6 °C) was seventh highest since 1901.



Figs. 29(a&b). Percentage of days when (a) maximum temperature > 90th percentile (b) minimum temperature < 10th percentile

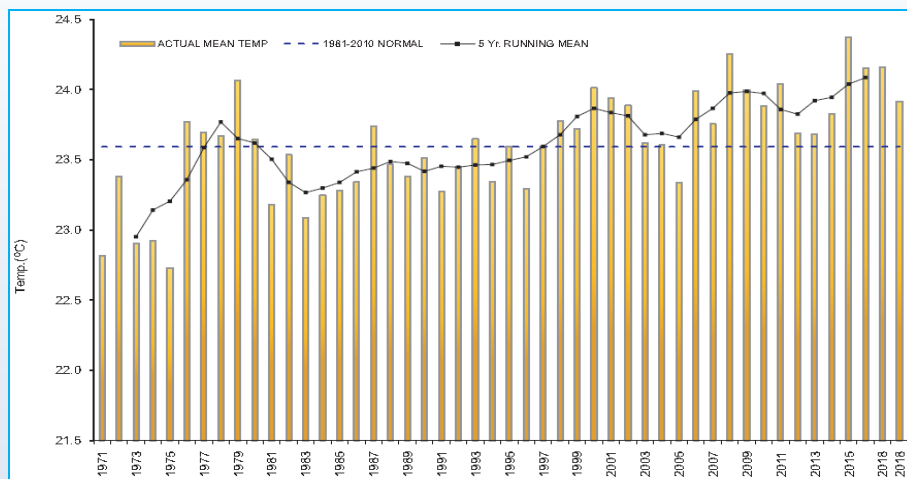
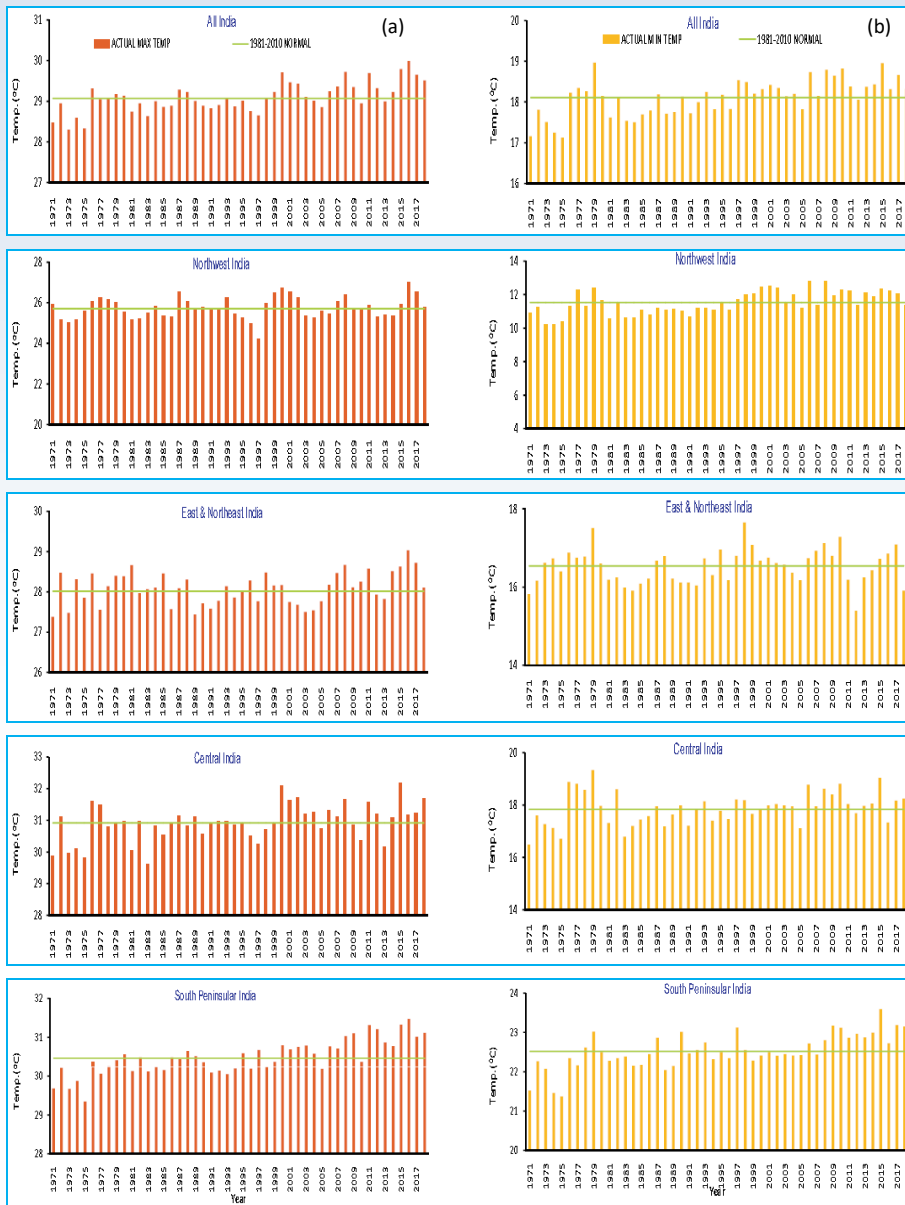


Fig. 30. Time series of mean temperature averaged over India (vertical bars) and five year running mean (continuous line) for the post monsoon season (1971-2018)



Figs. 31(a&b). Time series of temperature for the country as a whole and the four homogeneous regions (1971-2018) (a) Maximum (b) Minimum

Low Pressure Systems

During the season, nine low pressure systems (2 very severe cyclonic storms, 1 cyclonic storm, 1 deep depression, 2 depressions & 3 low pressure area) were formed.

The month of October witnessed three depressions. In the month of November two very severe cyclonic storms “GATI” (over Arabian Sea), “NIVAR” (over Bay of Bengal) and a cyclonic storm “BUREVI “(over Bay of Bengal) formed. Fig. 32 shows track of

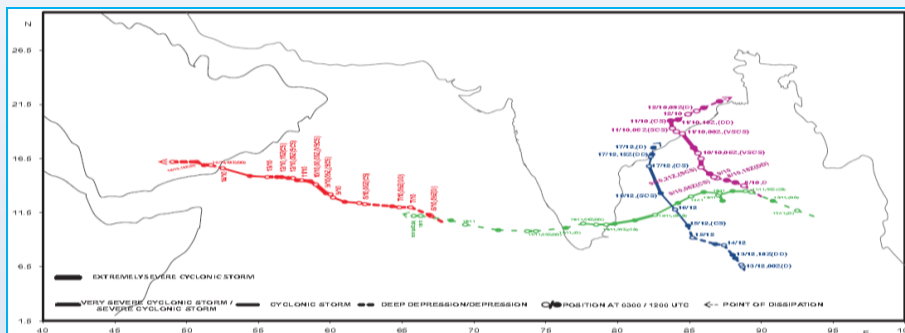


Fig. 32. Tracks of intense low pressure systems formed during the post-monsoon season

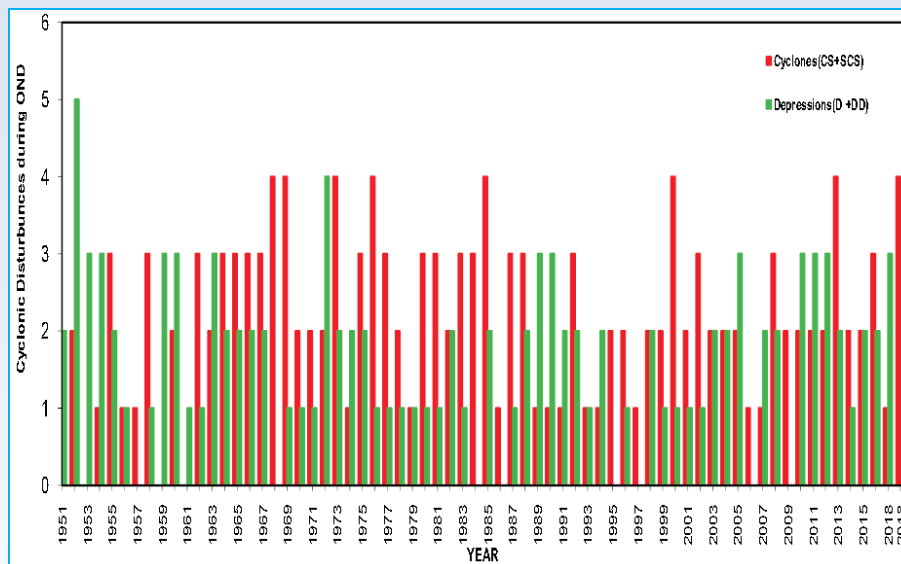


Fig. 33. Frequency of depressions / cyclonic storms formed over the Bay of Bengal during the post-monsoon season (1951-2018)

intense low-pressure systems formed during the season.

Fig. 33 shows the number of depressions & storms formed over Bay of Bengal during the postmonsoon season (1951-2020).

Significant Weather events

During the season, 182 persons reportedly claimed dead & more than 85,000 livestock perished from different parts of the country.

Floods & Heavy Rains: Total 128 persons reportedly claimed dead & more than 75,000 livestock perished from southern, north eastern & northwest parts of the country during the month of October only. Of these, more than 50 persons reportedly claimed dead from Telangana during 1st to 20th October. Telangana's capital, Hyderabad, is the worst affected district. 40 persons reportedly claimed dead from Kolhapur, Pune, Satara, Sangli, Solapur & Yavatmal districts of Maharashtra during 12th to 16th October and 513 livestock perished from Beed, Kolhapur, Sindhudurg, Solapur, Pune, Satara, Sangli, Solapur districts on 16th October, While, Ahmednagar, Akola, Aurangabad, Buldhana, Hingoli, Jalna, Latur, Nanded, Nashik, Osmanabad, Parbhani, Palghar, Raigad, Ratnagiri, Thane & Washim districts were also

affected during 10th to 20th October. But the worst affected district is Solapur. 13 persons reportedly claimed dead from East Godavari, Krishna, Visakhapatnam, West Godavari districts of Andhra Pradesh on 13th, 14th & 24th October. 5 persons reportedly claimed dead from Bagalkot, Gadag, Gulbarga, Raichur districts of Karnataka during 10th to 13th October & 518 livestock perished from Gulbarga district on 15th October, While, Belgaum, Bidar, Bijapur, Yadgir districts of Karnataka were also affected during the first fortnight of the month. 4 persons reportedly claimed dead & more than 74,000 big & small animals including poultry birds perished due to the events caused by heavy rains from Barpeta, Biswanath, Dhemaji, Goalpara, Hojai, Morigaon, Nagaon, Sonitpur, West Karbi Anglong districts of Assam during the month of October. 2 persons each reportedly claimed dead from Gujarat on 22nd October, East Khasi Hills & West Khasi Hills of Meghalaya on 25th October and West Sikkim on 2nd October. While, One from Kerala on 24th October. Gajapati district of Odisha also affected on 14th October.

Cyclonic Storms: Total 21 persons reportedly claimed dead due to the cyclonic storms in the Bay of Bengal. 12 persons reportedly claimed dead due to Very severe cyclonic storm "NIVAR" which formed during the period 22nd

to 27th November. Of these, 9 persons reportedly claimed dead from Chittoor, Cuddapah, Nellore districts of Andhra Pradesh & 3 from Chennai district of Tamil Nadu. Also, more than 10,000 livestock perished from Andhra Pradesh. While, due to Cyclonic Storm “BUREVI” which formed during the period of 30th November to 5th December, 9 persons reportedly claimed dead & more than 200 livestock perished from Tamil Nadu. The states Tamil Nadu, Kerala & the Union territory Puducherry affected due to CS “BUREVI”. Agricultural, structural, etc. damage reported from the affected states viz. Tamil Nadu, Andhra Pradesh, Kerala & the Union territory Puducherry due to both the cyclones.

Lightning: Due to Lightning, total 17 persons reportedly claimed dead during 4th October to 25th November. Of these, 7 persons reportedly claimed dead from Hingoli, Nashik, Osmanabad, Pune, Ratnagiri, Thane districts of

Maharashtra on 10th, 13th, 14th, 21st & 24th October. 5 persons reportedly claimed dead & more than 70 livestock perished from Bellary, Belgaum, Gulbarga, Yadgir districts of Karnataka on 11th, 12th & 20th October. 4 persons reportedly claimed dead from Jhabua, Morena Districts of Madhya Pradesh on 18th October & 15th November. While one person reportedly claimed dead from Visakhapatnam, Andhra Pradesh on 4th October.

COLD WAVE: Total 11 persons reportedly claimed dead in the 2nd fortnight of December. Of these, 9 persons from Kaimur (Bhabua), Nawada, Saran, Sheohar, Vaishali districts of Bihar and one person from Banda, Uttar Pradesh on 20th December. While one person reportedly claimed dead from Sri Ganganagar, Rajasthan on 17th December.

THUNDERSTORM: 4 persons reportedly claimed dead from Chatra, Giridih, Palamu districts of Jharkhand on 3rd & 5th October.

CHAPTER 3

NUMERICAL WEATHER PREDICTION

Global and Regional Modelling (NWP)

(i) The GFS (GSM. V14) at T1534L64 is ~12 km in horizontal resolution and in the vertical there are 64 hybrid sigma-pressure layers is been run operationally at India Meteorological Department (IMD) four times in a day (0000, 0600, 1200 and 1800 UTC) to give deterministic forecast in the short to medium range. 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). Fig. 1 indicate the Seasonal Mean Error (ME) (mm/day) of GFS T1534 Day-1, Day-3 and Day-5 forecast over Indian region for Southwest Monsoon 2020.

Extended Range Forecast: A coupled model with a suite of models from CFSv2 coupled model has been developed implemented and operationalized in IMD in 2016 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 SST from 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 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). Fig. 2 shows the observed and forecast rainfall valid for four weeks during the 2020 monsoon season from June to September. Observed and forecast maximum temperature for 20-26 Nov 2020 with three week lead time is shown in Fig. 3.

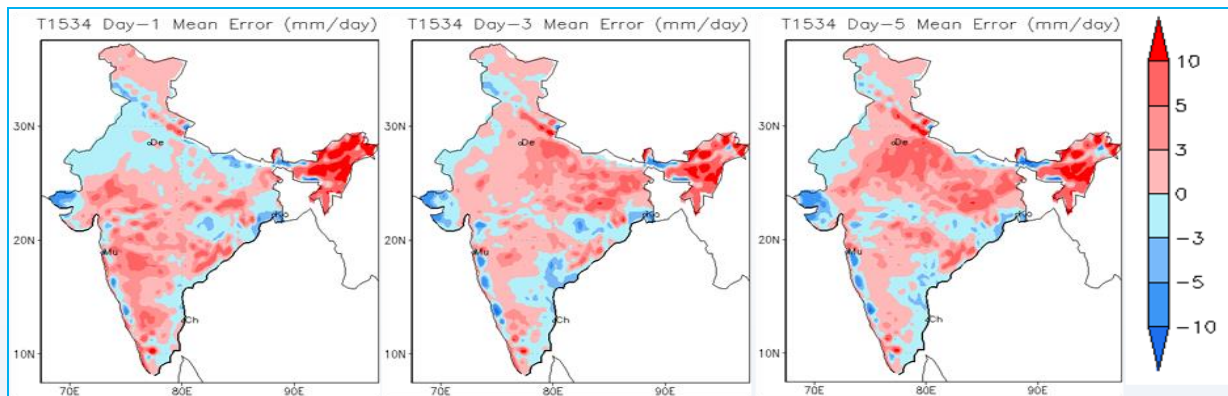


Fig. 1. Seasonal Mean Error (ME) (mm/day) of GFS T1534 Day-1, Day-3 and Day-5 forecast over Indian region for SW monsoon 2020

Regional Mesoscale models

The WRF model (ARW) delivered three days forecasts four times daily at 0000, 0600, 1200 and 1800 UTC. The data assimilation component, is based on regional grid point statistical interpolation (GSI). The model

mother domain has spatial resolution of 03 km and covers spatial area between approximately 05° S to 41° N latitude and 49° E to 103° E longitude. The Root Mean Square Errors (RMSE), Mean Errors (ME) and Pattern Correlation for rainfall forecast during 2020 SW Monsoon season are shown in Fig. 4.

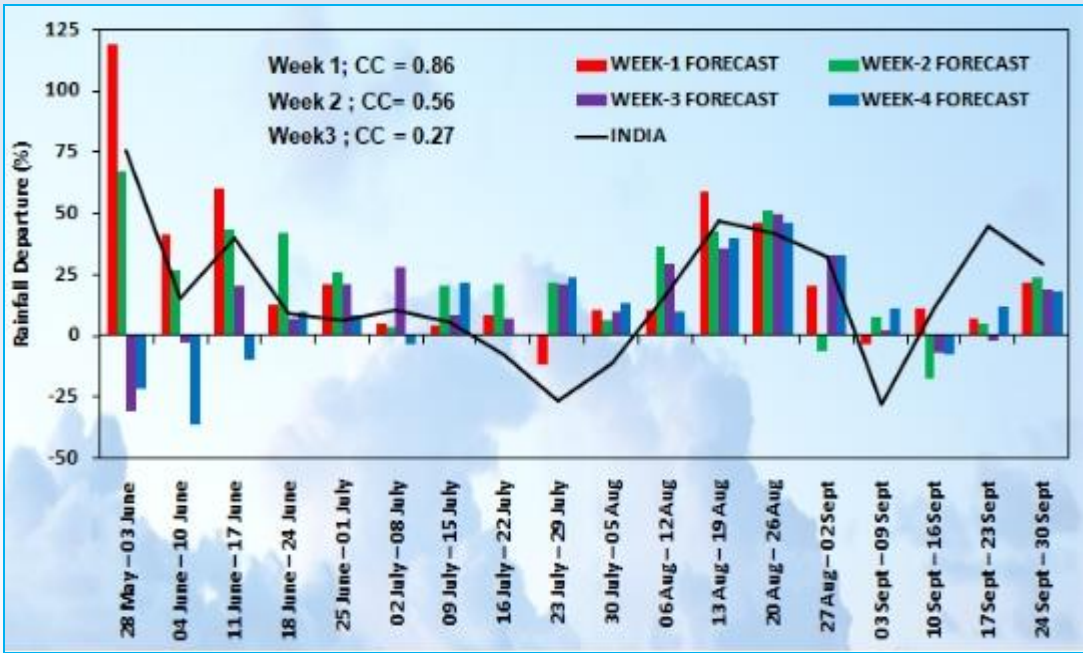


Fig. 2. The observed and forecast rainfall valid for four weeks during the 2020 monsoon season from June to September

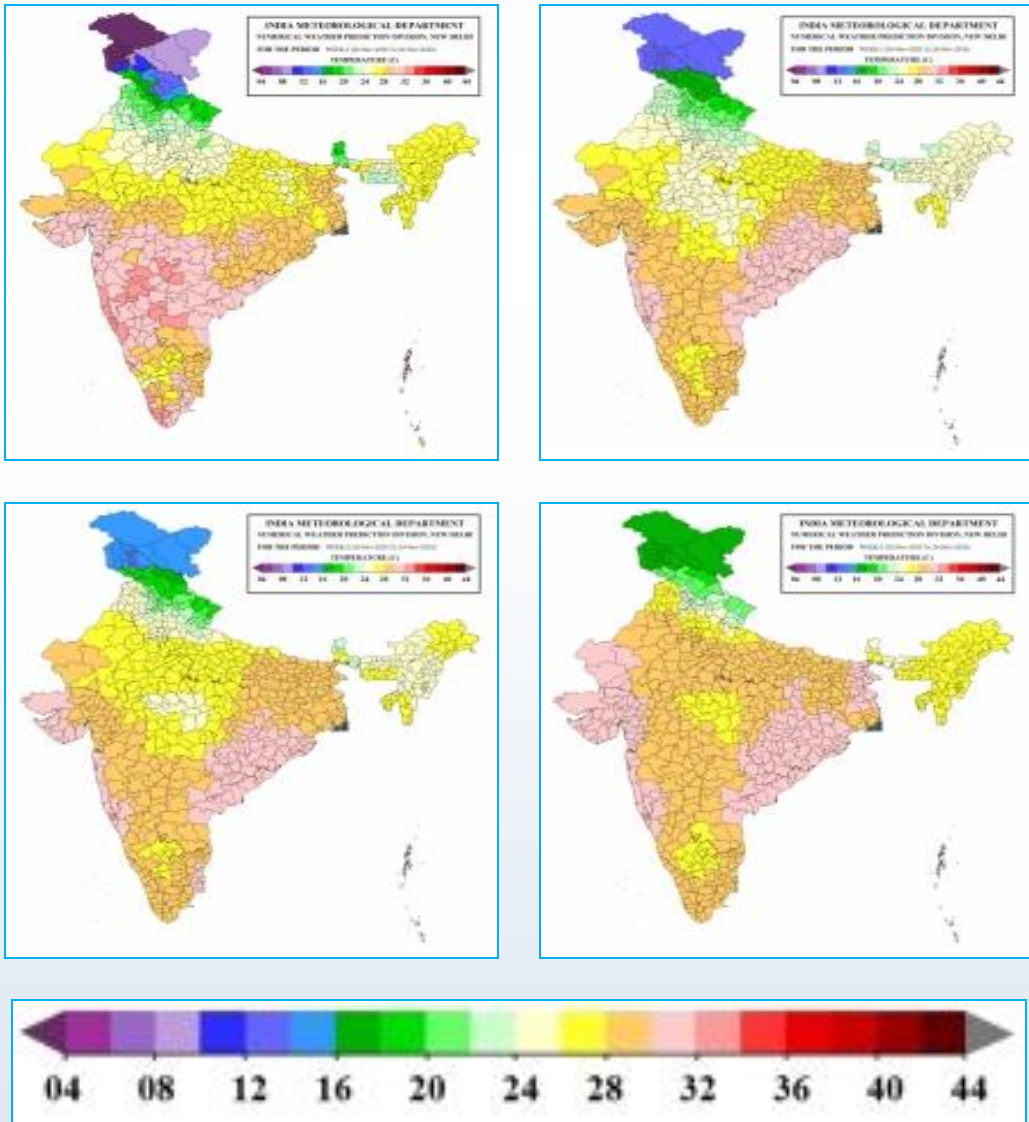
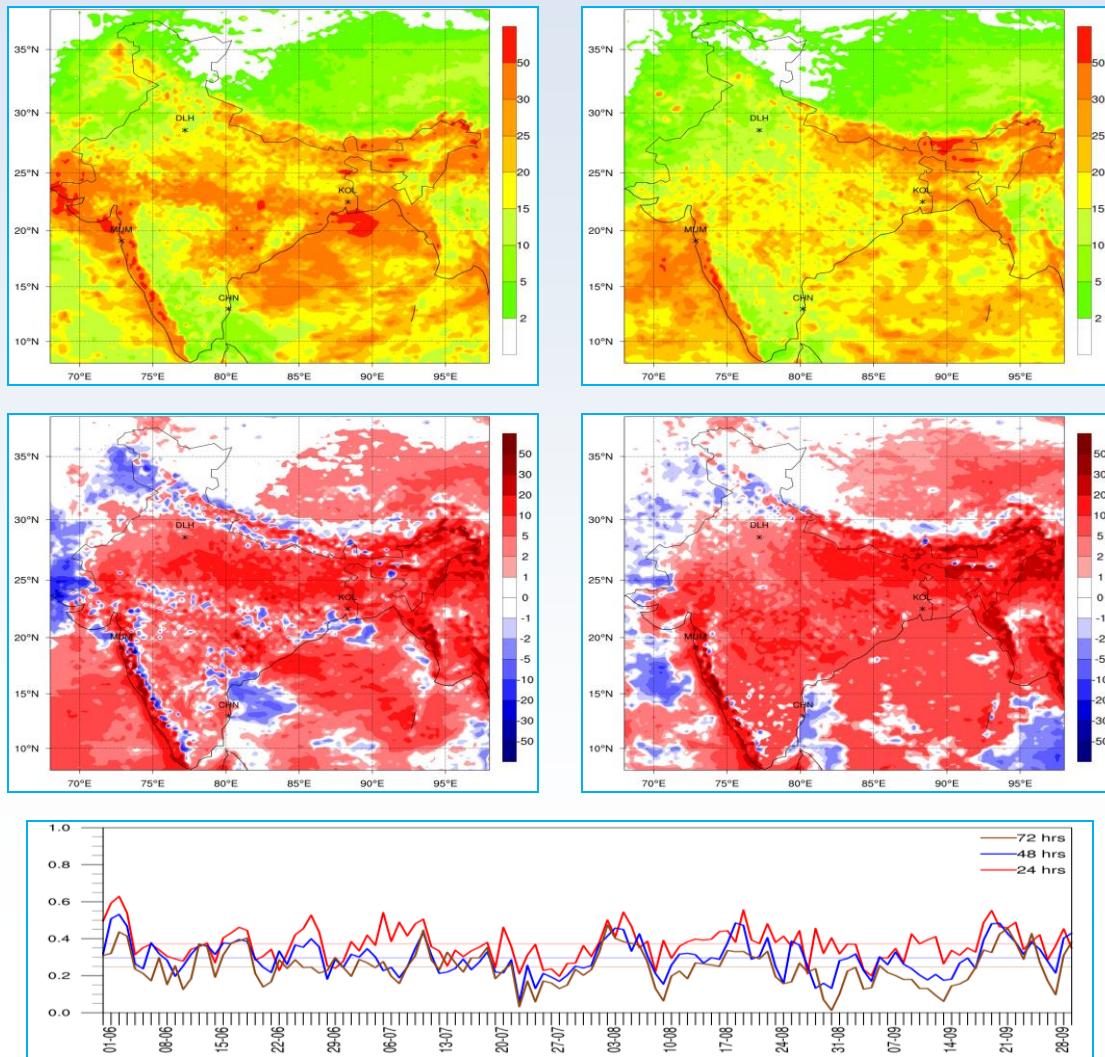


Fig. 3. Observed and forecast maximum temperature for 20-26 Nov 2020 with three week lead time



Figs. 4(a-e). (a) RMSE of rainfall forecast with Low Pressure Area, (b) RMSE of rainfall forecast with no Low Pressure Area, (c) Mean Error (ME) in rainfall forecast with Low Pressure Area, (d) ME in rainfall forecast with no Low Pressure Area and (e) Rainfall Pattern Correlation for all forecast during southwest monsoon 2020

The HWRF version H217 has been ported on the MHIR HPCS with horizontal resolution of 18 km for parent domain and 6 km & 2 km for intermediate and innermost nested domains following the center of cyclonic storm. The model is running with 61 vertical levels with parent domain, intermediate and innermost domain covering area of 80° x 80°, 24° x 24° and 7° x 7° respectively. The special feature modified for tropical cyclone forecasting

includes vortex initialization and correction, GSI based regional data assimilation, coupler for two way coupling between atmosphere and ocean components and fine-tuned physical parameterization schemes. The model was operational for all cyclonic storms (e.g., AMPHAN, NISARGA, GATI, NIVAR & BUREVI) of 2020. The skill of the model for cyclone track and intensity forecasts is given in Table 1.

TABLE 1

HWRF ANNUAL ERRORS - 2020

FORECAST HOURS	12	24	36	48	60	72	84	96	108	120
MEAN TRACK ERROR (KMS)	57	88	112	136	174	207	237	283	321	411
MEAN INTENSITY ERROR(KTS)	9.3	10.4	11.9	13.3	10.7	12.2	15.6	12.9	14.2	11.3
RMSE INTENSITY	11.4	12.1	14.7	17.2	14.4	14.2	17.0	13.7	16.4	12.1
No of F/C VERIFIED	63	61	52	42	33	25	16	11	7	4

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 56 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.

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 six (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).

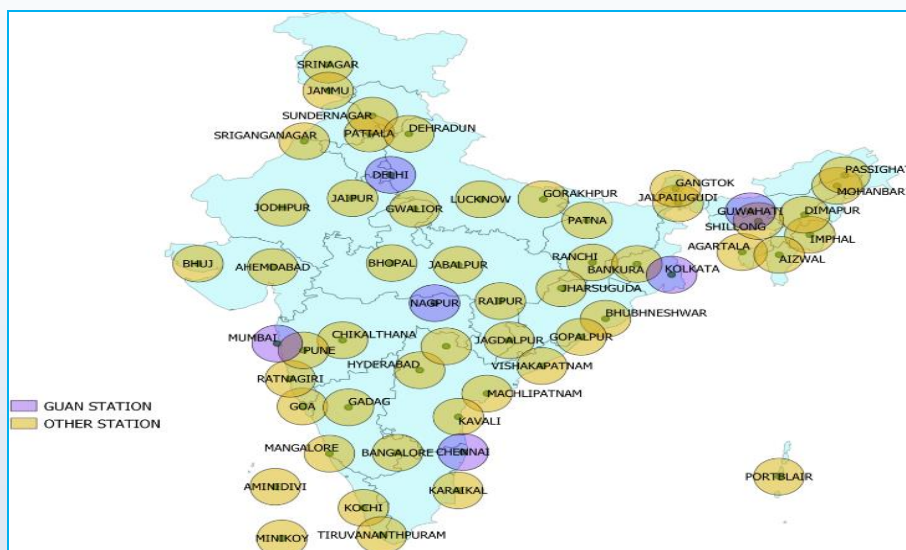


Fig. 1. Existing RS/RW Network of India Meteorological Department

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

IMD is operating 62 PB observatories taking 2 to 4 observations for upper air wind profiles at

0000, 0600, 1200 and 1800 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).

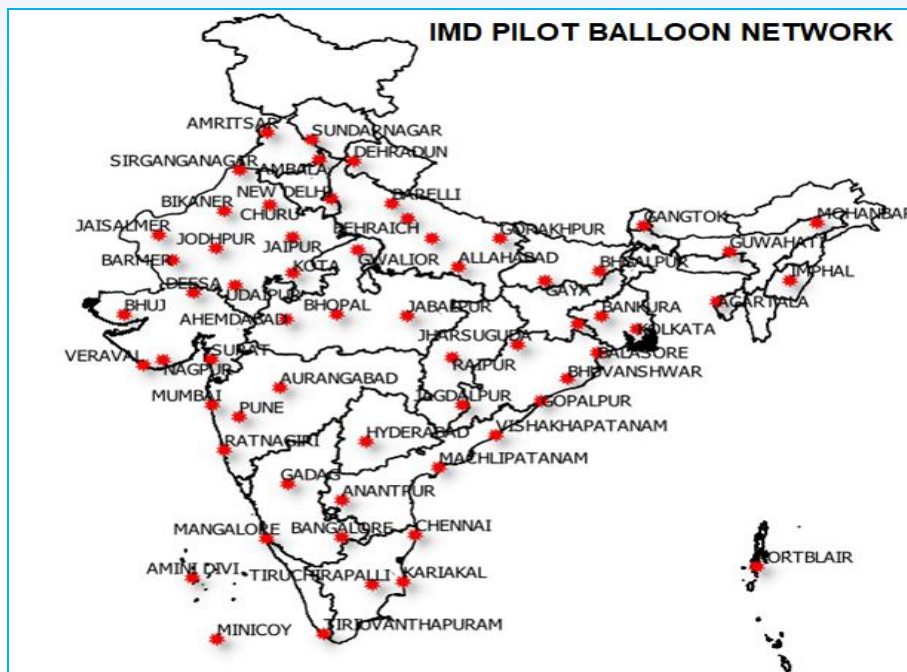


Fig. 2. Upper Air Pilot Balloon (PB) Network of IMD

Major achievements during the year 2019

- (i) Continuation of 06 Nos. of WMO GCOS Upper Air Network (GUAN) standard RS/RW stations at New Delhi, Mumbai, Kolkata, Chennai, Guwhati and Nagpur equipped with GPS based high quality radiosounding systems.
- (ii) Sustenance of total network of upper air radiosounding (RS/RW) of 56 stations with GPS based radiosounding systems.
- (iii) Fabricated PCBs procured from Indian manufacturers for the production of indigenous Pilot-sonde in IMD Workshop at New Delhi, under make in India programme.
- (iv) Procurement of GPS based radiosondes being done from Indian sources, as per make

in India / Atma Nirbhar Bharat initiatives. Testing arranged as per WMO standards and guidelines.

Testing of GPS based radiosondes being procured from Indian sources at RMO Ayanagar utilizing the method of inter-comparison (Fig. 3)



Fig. 3. Testing of GPS based radiosondes being procured from Indian sources at RMO Ayanagar

Testing of GPS based Pilot-sonde manufactured in IMD Workshop New Delhi.



Fig. 4. Testing of GPS based Pilot-sonde manufactured in IMD Workshop New Delhi

4.2. Surface Observational Networks

New Installation and Up-gradation of Airport Instruments

- GPRS based AWS and ARG have introduced IMD Surface Observations. Data transmission is possible at an interval of every 15 minutes. Maximum wind is also generated in it.
- **15 GPRS based AWS** have been installed in Kerala State during 2020 and have used **10 m Tiltable mast**.
- Two AWS have been installed in Ladakh UT - MC Leh and Kargil
- **Installation of 19 AWS for wind measurement for Indian Railway (Ajmer Division area).**

Central Radiation Laboratory, Pune designated as Regional Radiation Centre (RA-II) in WMO is maintaining group of standards including self-calibrating cavity radiometers which are taken to International Pyrhemeter Comparison held by WMO. The new Cavity Radiometers with Solar Trackers and Upgradation of Calibration Hut have been installed at Central Radiation Laboratory, Pashan, Pune.

New Scientific data loggers were installed at Delhi, Jodhpur, Goa, Kolkata, Nagpur, Visakhapatnum, Coimbatore, CAgMO Pune,

Chennai, Mumbai, Shillong, Ahmedabad, Kodaikanal, Thiruvananthapuram for measurement of Solar Radiation (Fig. 5).

New Pyranometers were installed at Delhi, Jodhpur, Goa, Kolkata, Nagpur, Visakhapatnum, Coimbatore, CAgMO Pune, Chennai, Mumbai, Shillong, Ahmedabad, Kodaikanal and Thiruvananthapuram for measurement of Global and Diffuse Solar Radiation [Fig. (6&7)].

New Radiation station has been installed at MO Jammu by the team from Radiation Lab.

The new installation and up-gradation of airport instruments during the year 2020 are shown in following figures.



Fig. 5. Scientific Data Logger



Fig. 6. Secondary Standard Pyranometers for Measurement of Global Solar Radiation



Fig. 7. Pyranometer for measurement of diffuse radiation



Fig. 8. Cavity radiometers with solar trackers and upgradation of calibration

DCWIS system with 10 m frangible mast was installed at the following station during the months :-

- (a) January 2020 - Palam airport and Imphal,
- (b) February 2020 - Varanasi,
- (c) March 2020 - Pakyong and Jabalpur,
- (d) September 2020 - Chennai,
- (e) November 2020 - Indore, Juhu (Mumbai), Nanded,
- (f) December 2020 - Sambra, Guwahati (RWY 02), BIAL Bangalore



Fig. 9. DCWIS system installed at Pakyong

Online DIWE Logger was replaced and DIWE system installed at AMS Dehradun in June, 2020.

HWSR was installed [Figs. (10&11)] at the following station during the months:

- (a) July, 2020 - Vishakapatna, Machilipatnam, Chennai,
- (b) August, 2020 - Goa,
- (c) September 2020 - Cuddalore, Kakinada, Bhubaneshwar, Puri, Ongole,
- (d) October, 2020 - Digha, Kavali, Haldia, Pamban, Gopalpur, Kanyakumari, Veraval, Bhuj,
- (e) November 2020 - Dwarka, Kalingapatnam, Cuddalore, Naliya,
- (f) December 2020 - Salt Lake, PAC Kolkata.

Vishakapatnam



Fig. 10. HWSR installed at Vishakapatnam



Fig. 11. HWSR mast installed at Digha

Installation and configuration of HP server (ftp and http services) for Data Collection and monitoring of AWS and ARG station all over India.

Installation and configuration of HP server (ftp and http services) all for Data Collection and monitoring of HWSR and DCWIS station at airport MET Offices and coastal weather station all over India.

Ceilmeter was installed at Mumbai (Santacruz) on 9th November, 2020.

New Digital Current Weather Information System (DCWIS) has been installed at the 09 number Runways in IGI Airport, Palam, New Delhi.

- 150 numbers of Portable Digital Barometer (PDB) for outstation distribution and 02 number of Digital Pressure Indicator with Controller (DPIC) to be utilized in the surface laboratory have been delivered.
- Audio/Video training compiled by company regarding understanding the operations of Portable Digital Barometer (PDB), this recorded link has uploaded on IMD's metnet portal.
- Workshop division designed 10 numbers of new ARG mast and manufactured in Workshop for Mumbai Urban Project.

4.3. Environment Monitoring and Research Center (EMRC)

Environment Monitoring and Research Center, a division of 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. EMRC 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 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 (Fig. 12) 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.



Fig. 12. IMD Ozone monitoring network

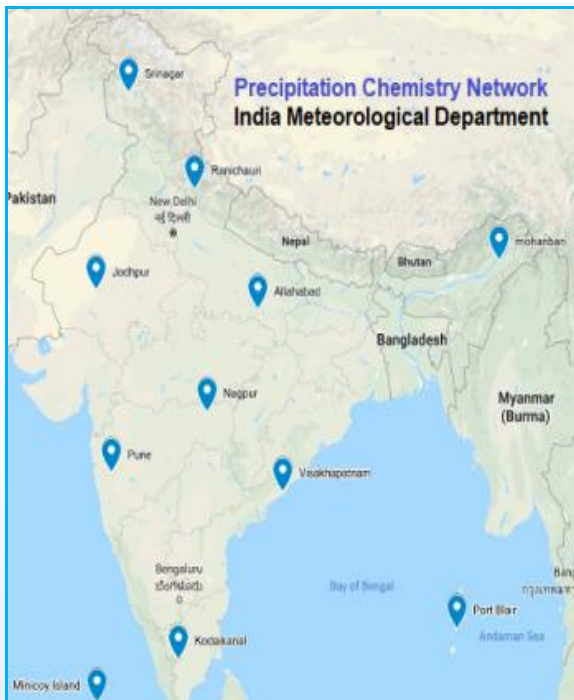


Fig. 13. IMD Precipitation chemistry network

Precipitation and Particulate Matter Chemistry Monitoring

IMD is monitoring Precipitation Chemistry through a network of eleven stations since 1970s (Fig. 13). 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 WMO Laboratory Intercomparison Study 61 and 62 held in the year 2020.

Aerosol Monitoring Network

IMD has established Aerosol Monitoring Network covering different geographic regions of India (Fig. 14). The Aerosol Monitoring Network consists of following sub-networks:



Fig. 14. Aerosol monitoring network of IMD

Sun-Skyradiometer 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.

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.

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.

Chemical Characterization of Aerosols

High Volume Samplers for collecting PM₁₀, PM_{2.5} 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

Under the FMI-IMD cooperation agreement, the latest version of Air Quality forecast model "System for Integrated modelling of Atmospheric composition (SILAM v5.7)" has been operationalized for Indian region. Hourly air quality forecast for 72 hours of all criteria pollutants (PM₁₀, PM_{2.5}, O₃, CO, NO₂, SO₂ and other species) is generated for the domain 60-100°E, 0-40°N. SILAM is coupled with hourly 3-km IMD-WRF meteorological forecasts model. The latest emission inventories CAMS-GLOB v2.1, 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 monoterpene 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, PM_{2.5}, O₃, CO, NO₂, and SO₂) is generated for the domain (28.362N-28.86N, 76.901E-77.56E) 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.

The System for Air quality Forecasting and Research (SAFAR) is operational to monitor and forecast air quality in Delhi. This is a joint project of IITM and IMD. The system is also operational at Pune, Mumbai and Ahmedabad. All major air pollutants (PM_{2.5}, PM₁₀, Ozone, CO, NO_x (NO, NO₂), SO₂, BC, Methane (CH₄), Non-methane hydrocarbons, VOC's, Benzene, Mercury), solar radiation and meteorological parameters are measured at ten air quality station installed in each city.

Performance Verification of Air Quality Model

Fig. 15 shows the comparison for temporal variation between observed and the modeled hourly and daily PM_{2.5} mass concentration from 01 - 28 Feb 2021 over Delhi. Observed (black) surface PM_{2.5} mass concentration are averaged over 43 air quality monitoring stations in Delhi, while simulated SILAM model PM_{2.5} (red) are averaged from the 43 grids containing these observation sites. It can be seen that the SILAM model very well captures the temporal and diurnal variation associated with the synoptic-scale variability during the study period. The forecast verification for other major cities is also completed.

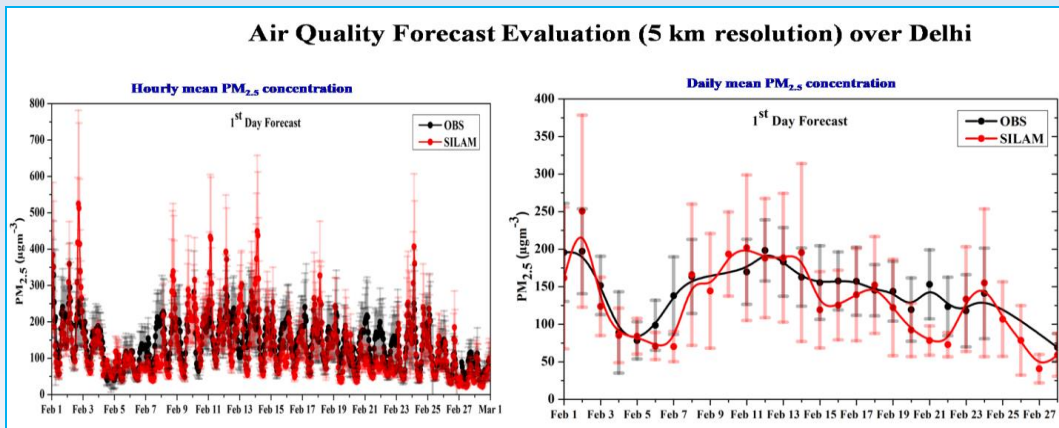


Fig. 15. Comparison between hourly mean PM_{2.5} forecast (red) and hourly mean PM_{2.5} observations (black) with vertical bar showing the standard deviation on day one forecast at 5 km horizontal grid spacing (left) and daily mean PM_{2.5} forecast (red) and observation (black) with vertical bar showing the standard deviation (right) over Delhi during 1st Feb to 28th Feb, 2021

TABLE 1

Performance statistics for mean PM_{2.5} forecast and skill score over Delhi. Mean bias (MB), Pearson's correlation coefficient (r), normalized mean fractional bias (NMFB) and normalized mean fractional error (NMFE)

Variables	Forecast Day	MB	NMFB (%)	NMFE (%)	r
PM _{2.5} _hourly	1 st day	-10.7	-8.0	33.8	0.7
	2 nd day	-15.4	-12.1	38.7	0.6
	3 rd day	-14.5	-11.8	36.3	0.7

The hourly MB statistics shows that the model slightly underestimates the observed PM_{2.5} concentrations by -10.7 µg/m³, -15.4 µg/m³ and -14.5 µg/m³ on the first, second and third day of the forecast respectively. Table 1 reveals that PM_{2.5} forecast performed close to excellent criteria on day 1 as the NMFB and NMFE are within -8.0% and 33.8%, respectively. The model performance is good on day 2 and day 3 with fairly low NMFB (< -12%), and NMFE is within 38%. Performance statistics on daily mean PM_{2.5} time series show excellent performance on all the three days of forecast since NMFB and NMFE were within -12% and 25%, respectively. The correlation coefficient (r) is around 0.7 for the hourly forecast and 0.8 for the daily mean forecast.

Updated Land Use/ Land Cover data at 10 meter resolution

High resolution LULC data over Delhi/NCR region are being developed for to high resolution urban meteorological and air quality forecast. (Fig. 16)

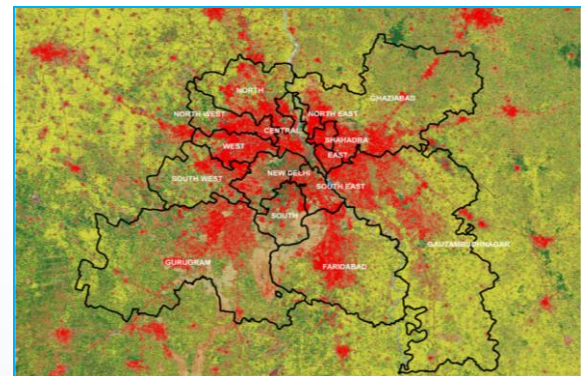


Fig. 16. Spatial distribution of land use/ land cover data of Sentinel satellite at 10 meter resolution over Delhi/NCR regions

High Altitude Background Climate Monitoring Station

IMD maintains a Background Climate Monitoring Station Ranichauri, Uttarakhand (Fig. 17). Skyradiometer, Aethalometer, Differential Mobility Particle Sizer, Nephelometer, Solar Radiation monitoring equipment, Precipitation Chemistry & Surface Ozone Analyzer have been installed at the station. The online GHGs (CO₂, CH₄, N₂O and H₂O) monitoring system has been installed at Ranichauri in 2020.



Fig. 17. IMD Climate Monitoring Station Ranichauri, Uttarakhand

The site is being developed for monitoring aerosol-cloud interaction & GHGs monitoring.

POLAR METEOROLOGICAL RESEARCH DIVISION (PMRD)

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 9th ISEA) and are ongoing till date. A meteorological observatory was commissioned in 2015 by IMD at Bharati, another Indian station in Antarctica (Fig. 18). The observations vertical profile of ozone is also carried out at Bharati regularly (Fig. 19).

Polar WRF model is implemented to provide day-to-day 72 hours weather forecast 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.



Fig. 18. Meteorological Observatory at Bharati



Fig. 19. Launch of Ozonesonde at Bharati

4.4. Radar Observations

(a) Network of Radars

IMD has a network of 26 Doppler Weather Radars all over India. IMD’s DWR network comprises of S-band, C-band and X-band DWRs located at various locations in India as shown in Fig. 20. IMD also utilizes the data input from DWRs of ISRO and IITM located at VSSC, Thiruvananthapuram (C-band), Sohra (S-band), SHAR (Sriharikota:S-band) and Solapur (X-band) respectively.

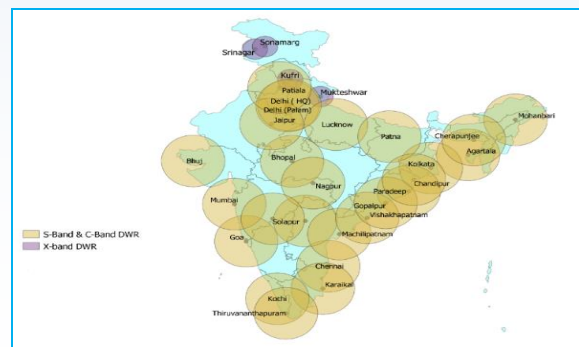


Fig. 20. Existing DWRs Network

(b) Proposed Dual Polarized X- Band DWRs

Dual Polarized X-Band DWRs are proposed to be installed in India under Integrated Himalayan Meteorological Programme (3 DWRs have already been installed at Sonamarg, Kufri and Mukteshwar) (Fig. 21).

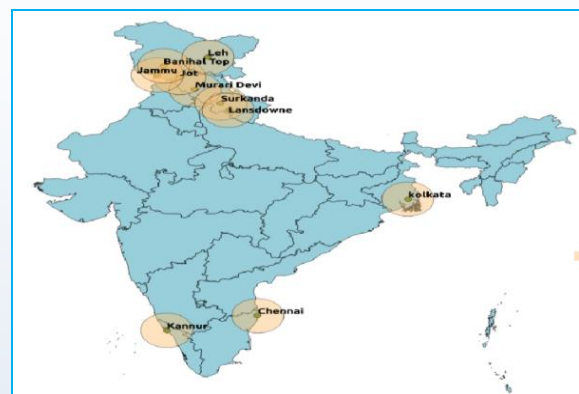


Fig. 21. Proposed X- Band DWR Network

(c) Proposed Dual Polarized 11 C-Band DWRs

11 Dual Polarized C-Band DWRs are proposed to be installed over the mainland of India (Fig. 22).

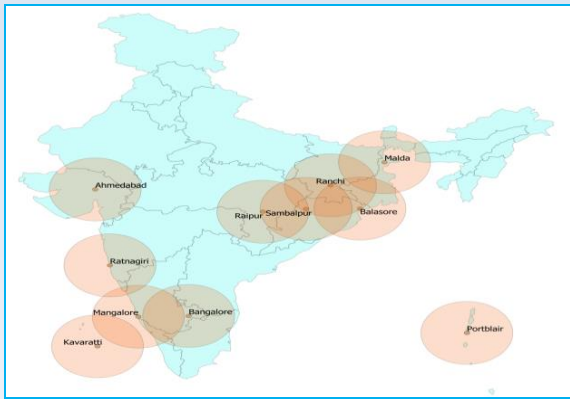


Fig. 22. Proposed C- Band DWR Network

A portable X-Band Doppler Weather Radar mounted on mobile platform received at Sonmarg under Integrated Himalayan Meteorology Programme (IHMP) for Western and Central Himalayas (Fig. 23).



Fig. 23. Portable X-Band Doppler Weather Radar

A tower based X-Band DWR has been installed at Mukteshwar, Uttarakahnd (Fig. 24) and Kufri, HP (Fig. 25) under IHMP



Fig. 24. DWR at Mukteshwar in Uttarakahnd



Fig. 25. DWR at Kufri in HP

IMD has completed the development and implementation of cyclone module (Fig. 26) for real time display of cyclone track, cone of uncertainty and wind speed as layer on Integrated Display system (developed earlier).

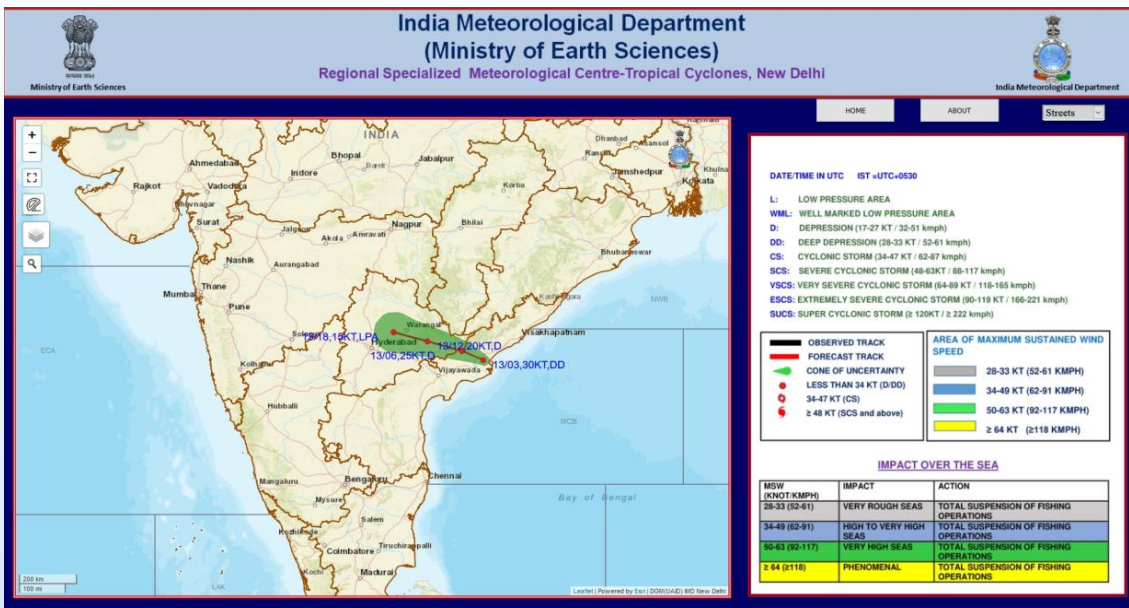


Fig. 26. Cyclone track display over web GIS

4.5. Satellite Observations

Space based observation Network & Services

Recently, IMD has established Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) for INSAT-3D, INSAT-3DR and INSAT-3DS satellites through a MoU with M/s Antrix Corporation Ltd, ISRO and existing IMDPS system is phasing-out. Dedicated New Earth stations have been setup under MMDRPS (Multi-Mission Meteorological Data Reception and Processing System) 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 as per IMD data policy through Web based secured satellite Data Supply System. All available past satellite datasets starting from 1983 will be kept in online mode in due course of time. The meteorological satellite data of INSAT is processed and disseminated by INSAT Meteorological Data Processing System (IMDPS) of India Meteorological Department (IMD) which was installed by M/s Antrix Corporation through an MOU with India Meteorological Department. INSAT-3D and INSAT-3DR are dedicated meteorological geostationary satellites and located at 82-degree and 74-degree East longitude respectively. INSAT-3D & 3DR carries a multi spectral six channel Imager, 19 channels Sounder, Data Relay Transponder and Search & Rescue Transponder. The Site Acceptance Test of Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) is in progress and expected for the commissioning of the system by November 2020 (Fig. 27).



Fig. 27. Block diagram of MMDRPS system

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. Kyarr, Maha, Bulbul, Pawan, Amphan and Nisarga.

RAPID SCAN during cyclone events is shown in Fig. 28.

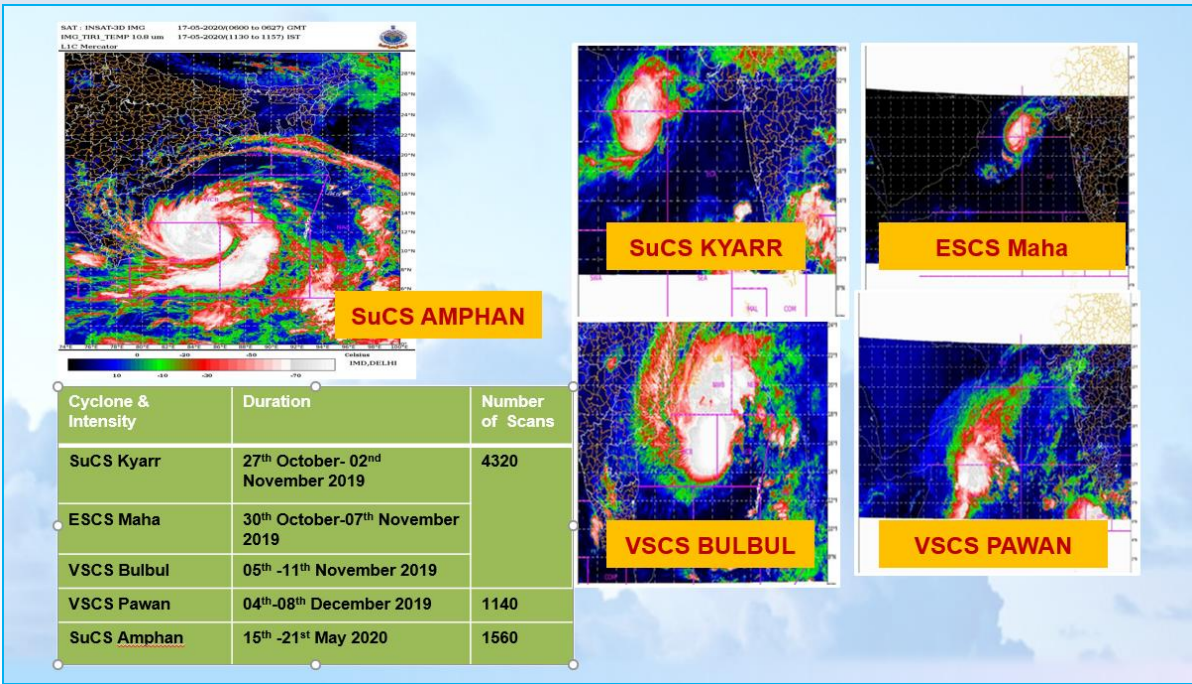


Fig. 28. RAPID SCAN during cyclone events

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) (Fig. 29).

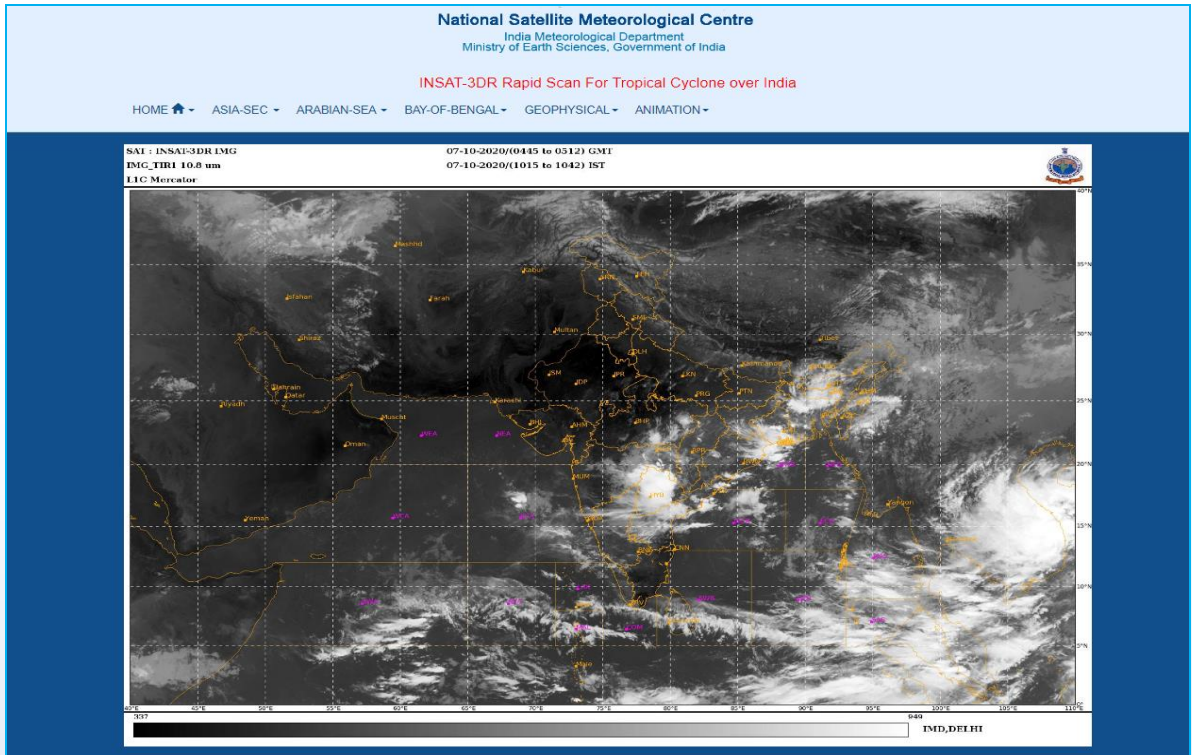


Fig. 29. New webpage of RAPID

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 850 mb, 700 mb, 500 mb, 200 mb 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. Satellite observed radiances and winds are now being assimilated in NWP models to improve their forecast ability. Satellite images are used in monitoring Cyclones. Intensity and position of cyclones is given to forecasters in real time using Dvorak technique. Satellite data and images are also used in monitoring various other significant weather phenomena such as Fog and thunderstorms. Two new types of satellite Imageries IR-1 BT Blended Image & IR-1 BT & Visible Sandwich Image has been made operational which will be very useful for monitoring Thunderstorm events.

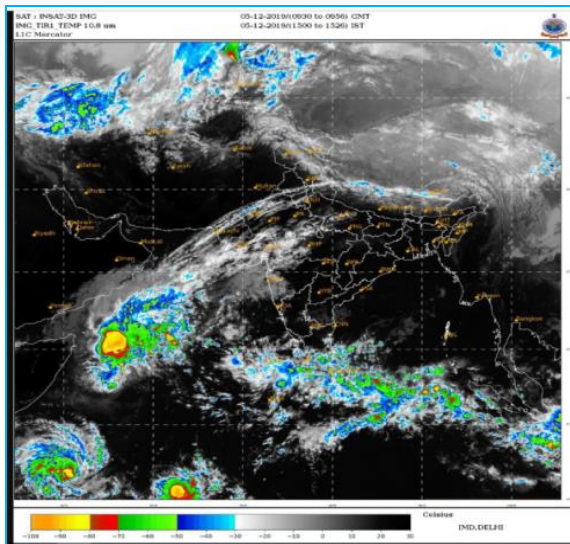


Fig. 30. IR1 BT Blended Image

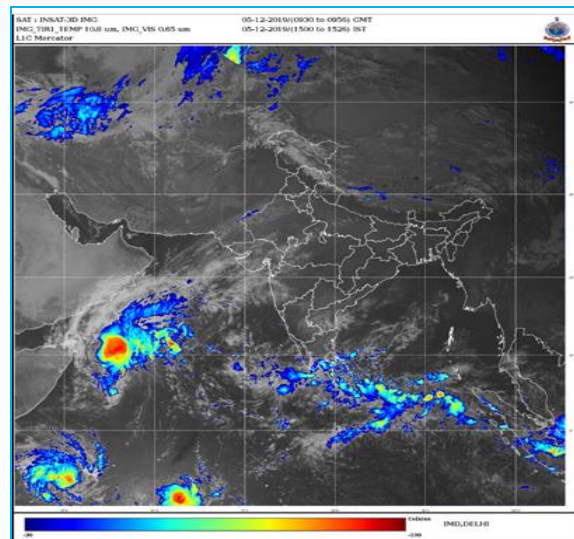


Fig. 31. IR1-BT & Visible Sandwich Image

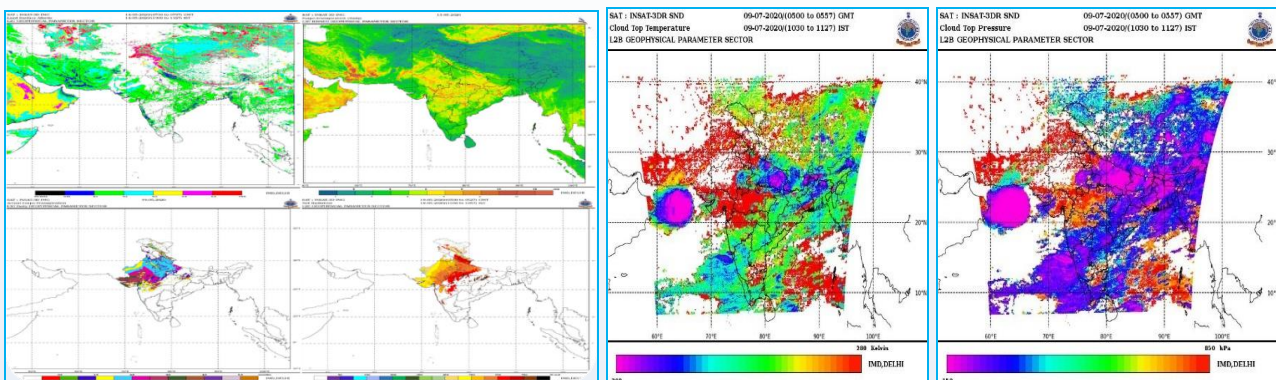


Fig. 32. New products generated from the MMDRPS system (<https://www.satellite.imd.gov.in/agromet/agromet.htm>)

INSAT 3D Sounder has reached its end of life and accordingly a modified scan strategy of INSAT-3DR sounder payload has been implemented with effect from 23rd September 2020. Sounder payloads of INSAT-3DR is

operated in such a way (Fig. 34) that INDIAN land region sector data is covered up twenty times and Indian Ocean region data is covered up four times (0400, 1100, 1600 and 2300 UTC) on hourly basis.

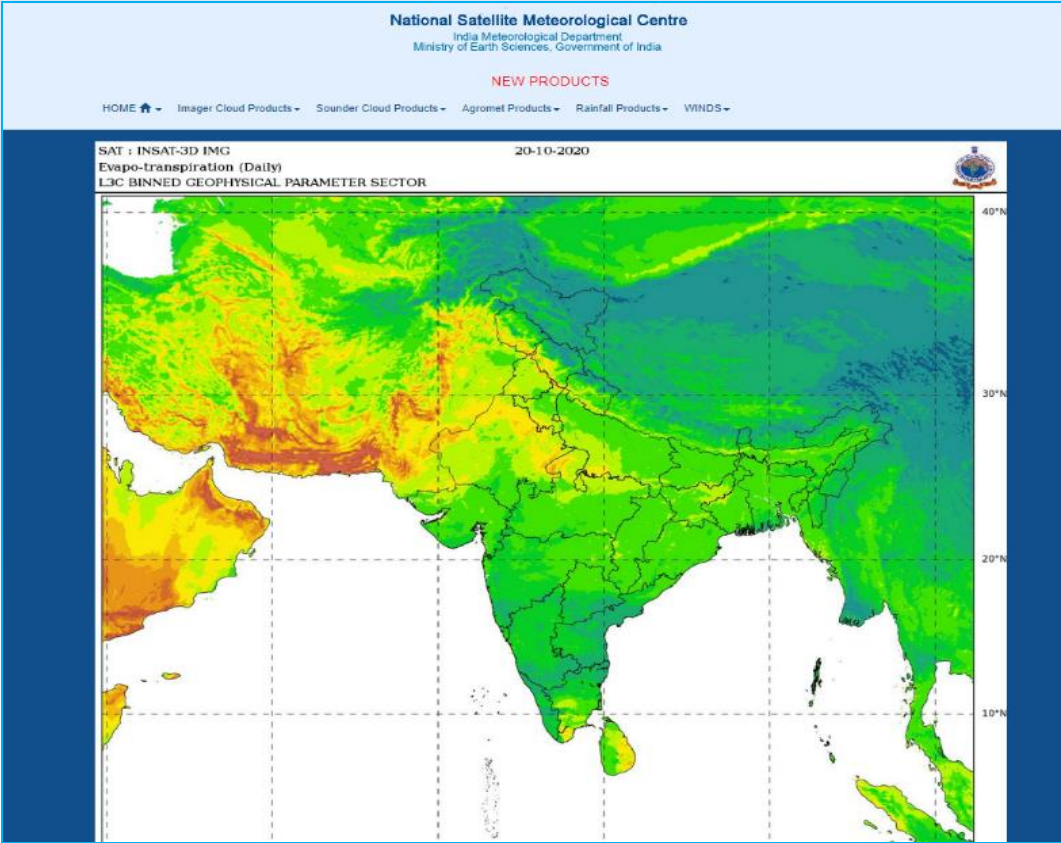


Fig. 33. Dedicated webpage for new products

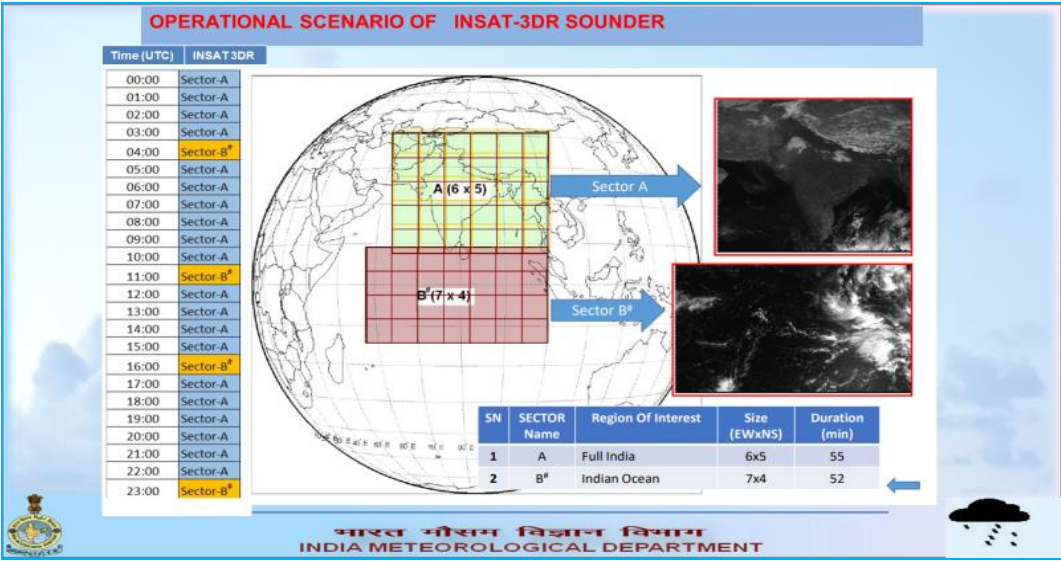


Fig. 34. Operational scenario of INSAT 3DR Sounder

From MMDRPS system, following new products (Net Radiation, Potential Evapo-transpiration, Actual Evapo-Transpiration, Land Surface Albedo, Shortwave Radiation over Ocean, Cloud Particle Effective Radius, Cloud optical Thickness, Improved IMSRA, Total Precipitable water over Ocean, High density visible winds over Ocean, INSAT 3D/3DR Merged winds and 5 day composite winds from Imager and Cloud Top

Temperature and Cloud Top Pressure from Sounder) are also being generated on an operational basis and being disseminated through a dedicated webpage.

The validation of atmospheric Motion Vector (wind products) for the period between August 2019 to June 2020, Land surface temperature (LST) for the period of January to June 2019, vertical Profile of

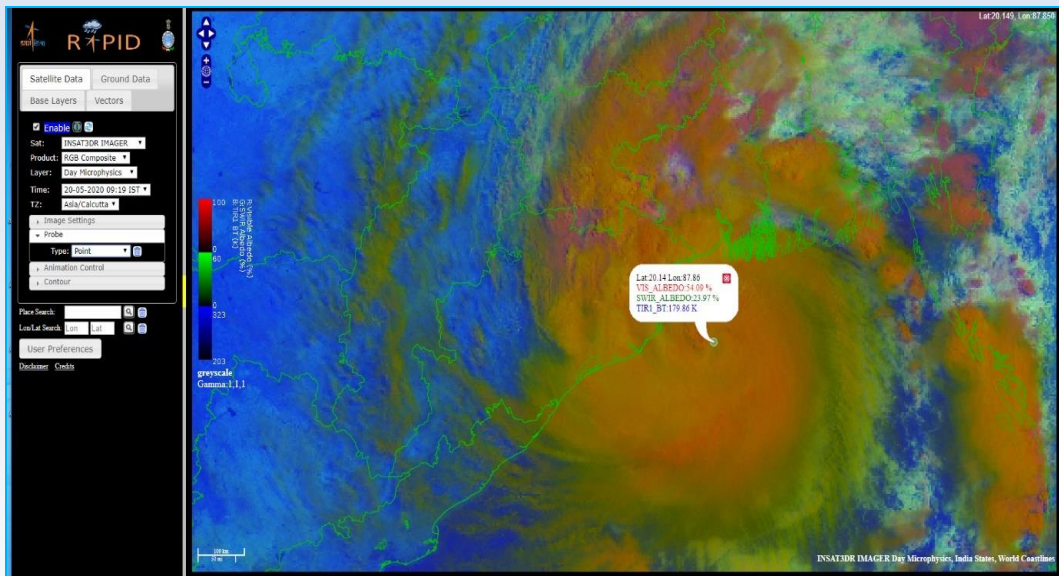


Fig. 35. Utilization of RAPID during a cyclonic event

temperature and humidity has been carried out for the period of and the feedback are used for fine tuning of algorithm of these products and calibration coefficients

IMD has installed 682 Automatic Weather Stations (AWS) and other agencies have installed about 1200 AWS all over the country. IMD has also installed 1350 Automatic Rain Gauge (ARG) Stations. AWS and ARG services are operational by using the Data Relay Transponders (DRT) of INSAT-3D having global receive coverage with a 400 MHz uplink and 4504 MHz downlink frequencies with a data rate of 4.8 kbps for relay of Meteorological, Hydrological, Agro-Meteorological and Oceanographic data from unattended stations. The data collection is mostly carried out in Time Division Multiple Access (TDMA) mode to enhance the output. IMD is in process to upgrade its network using dual communication (Dual GPRS) mode which will ensure frequent data availability in all type weather. A total of 413 Satellite Id's for AWS/ARG were issued to various stakeholders during this period.

IMD's Area Cyclone Warning Centers generate special warning bulletins and transmit them every hour in local languages to the affected areas. During Recent past, in cases of Kyarr, Maha, Bulbul, Pawan, Amphan and Nisarga Cyclones, warnings were disseminated to all

stake holders which resulted in minimum loss to human life. Advanced Dvorak Technique (ADT) software has been customized for INSAT-3D and implemented to determine the intensity of Tropical Cyclones.

To improve navigation accuracy, Fixed Grid Navigation and Automatic Template Based Registration package for INSAT-3D Imager was developed and operationalized at Space Application Centre, Ahmedabad and IMD, New Delhi. The Ancillary Data Products Generation Software (ADPS) capability enhanced to include XRIT products, AWS (Automatic Weather Station) Data Decoding, archival and report generation. Generation of Day Time Microphysics using Visible, SWIR and TIR1 spectral band and Night time Microphysics using MIR, TIR1 and TIR2 RGB composite Images have been started which are being used for cloud classification, operationally.

Space Application Centre, Ahmedabad has developed the Real Time Analysis Product & Information Dissemination (RAPID) which is a web based quick visualization and analysis tool for satellite data on a real-time basis and IMD has hosted it operationally since January 2015. (Fig. 35). This introduces Next Generation Weather Data Access & Advanced Visualization Application that touch the life of common man in one or other way ranging from weather events to atmospheric

phenomenon. This has capability to visualize the Fog presence over railway track and highways & a pilot can see the position of clouds and fog of the entire route in real time basis interactively. This also have capability to generate, time series plot of different products derived from satellites along with measuring capability of distance, area of any cloud system and to display the digital value of different parameters over different types of maps. The following additional features have been added in RAPID such as Taluk boundaries, India Sub-Basins and FMO Basin and the following enhancement (Aviation colour enhancement (AVN), Funktop enhancement-to highlight intense areas of precipitation, Rainbow i.e. colourful enhancement for a pretty image, new variation on the Rainbow enhancement curve – Colourful enhancement (RBtop) are integrated in RAPID.

The rapid scans data and INSAT 3DR data has been integrated in RAPID since October 2019 for real time visualization and analysis of weather events. Integration of NWP model and radar data in RAPID is in progress.

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 lightning merged products are also operationalized at IMD website. The merged lightning & 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 (Fig. 36).

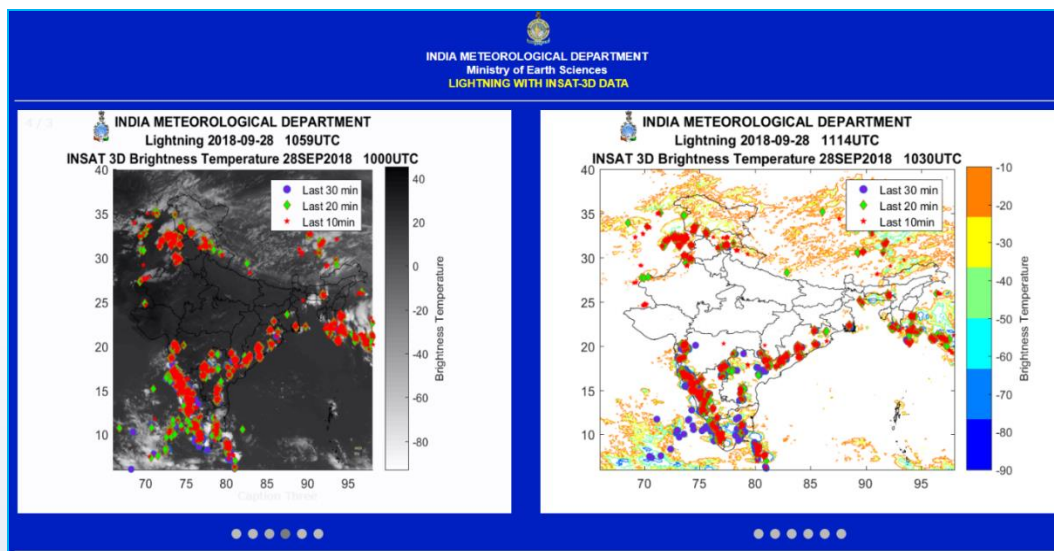


Fig. 36. Satellite and lightning merged products

Site Acceptance Test (SAT) of **MMDRPS** has been completed by SAT committee on dated 12th November, 2020 and MMDRPS system declared commissioned w.e.f. 12-11-2020 by SAT committee.

Security audit of all the satellite web pages has been conducted from agency name and all vulnerability pointed out by the security audit team has been resolved successfully and security audit certificate obtained.

4.6. SAARC Storm Project - 2020

STORM Forecast Demonstration Project-2020

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 thunder storms 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, STORM Reports containing region wise detailed analysis of observed significant weather events, case studies and verification of Intensive Observation Periods (IOPs) issued during the FDP, are prepared and published.

This year also STORM Fields Experiments covered the whole India. The monitoring period was uniform for entire country from 1 March to 30 June, 2020.

Under this project, FDP Bulletins were issued on daily basis with updated one, 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 (NCOMRWF) Models,
- (iii) Summary of 1 & 2 above and
- (iv) Intensive Observation Period (IOP) for thunderstorm and rainfall occurrence during

next 24 hrs and 24-48 hrs for meteorological subdivision and image display of the same. The bulletin also contains satellite imageries, Radar and Thunderstorm Reports.

A total of 122 FDP Bulletins were issued during the STORM Period-2020.

Nowcast Guidance Bulletins

In addition to FDP Bulletins during March to June - 2020, Nowcast Guidance Bulletin 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/twice (if needed) a day throughout the year. This bulletin provides significant guidance to the forecasters working at different RMCs/MCs, in keeping a watch over their areas of responsibility as mentioned in the Guidance Bulletin & 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 18 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) availability of mesoscale models and (vi) 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-2020, 202 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 894 under 25 Nowcast Centres (RMC/RWFC/MC/CWC). Fig. 37 depicts the screen shot of Nowcast Warning Page on IMD website and Fig. 38 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 districts of India (Fig. 39). 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.

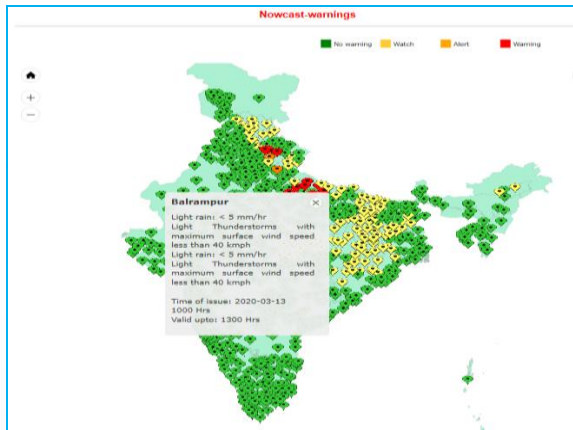


Fig. 37. Stationwise Nowcast Warning Page on IMD website

Link:https://mausam.imd.gov.in/imd_latest/contents/stationwise-nowcast-warning.php

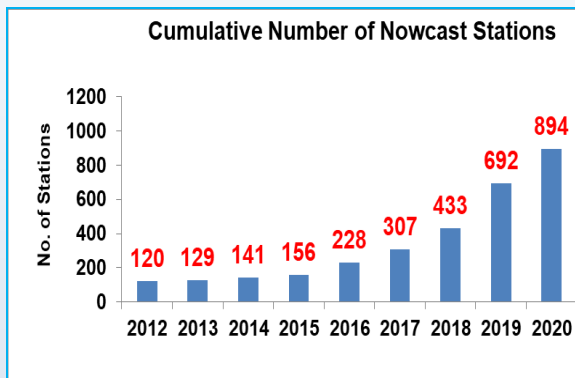


Fig. 38. Year-wise cumulative number of stations for three hourly thunderstorm Nowcast

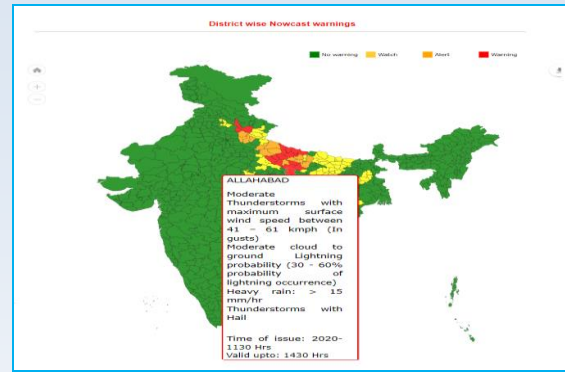


Fig. 39. Districtwise Nowcast Warning Web Page on IMD website

Link:https://mausam.imd.gov.in/imd_latest/contents/districtwisewarnings.php

The Stationwise and district wise nowcast is issued for about nineteen categories (Fig. 40) 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. 41).

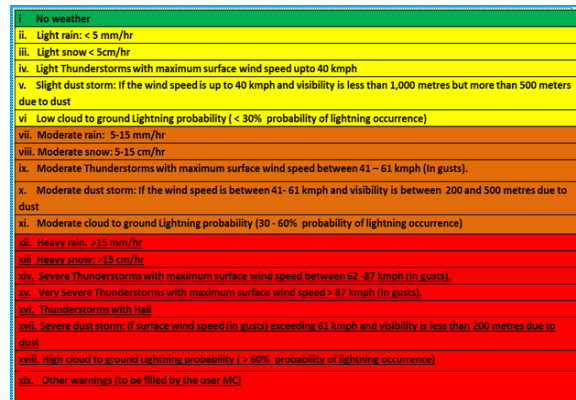


Fig. 40. Different categories of Nowcast Warnings

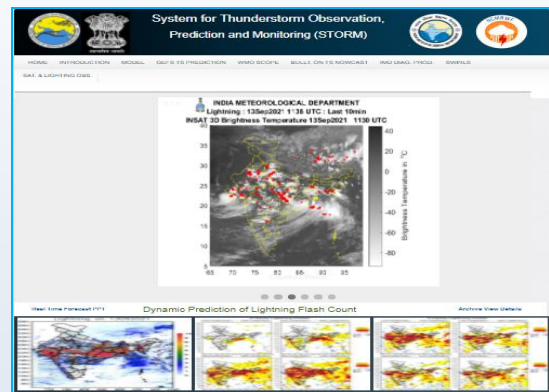


Fig. 41. New Web Page for Thunderstorm monitoring and forecasting

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. Roof tops 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. 42. Impacts associated with various types severe weather events

impact based forecasts for thunderstorms over the Indian region. Generalized impacts associated with different categories of thunderstorms is also published through a forecast Circular No. 1/2019 (Fig. 42).

Verification of IOPs/TS Nowcast-2020

(i) FDP Bulletins

The thunderstorm and rainfall forecast issued for 24hours during **FDP STORM-2020** were verified with realised thunderstorm and rainfall data. The verification results for thunderstorm forecast are shown in Table 2 and graphically by Fig. 43. Fig. 44 indicates verification scores of 24 hr Thunderstorm IOP during 2016 to 2020 which shows a significant improvement in all the scores. Monthwise comparative Probability of Detection (POD).

TABLE 2

Skill scores for Thunderstorm verification for FDP STORM - 2020 (March to June)

Month	Ratio Score	POD	FAR	CSI	ETS	BIAS
March	0.78	0.80	0.43	0.50	0.35	1.40
April	0.74	0.86	0.36	0.58	0.32	1.34
May	0.74	0.88	0.31	0.63	0.32	1.27
June	0.64	0.70	0.29	0.55	0.15	1.00
FDP-2020	0.73	0.80	0.34	0.57	0.30	1.22

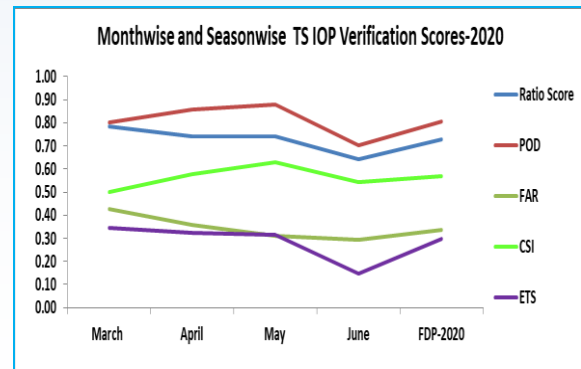


Fig. 43. Monthly and seasonal 24 hr Thunderstorm IOP verification scores during FDP STORM - 2020

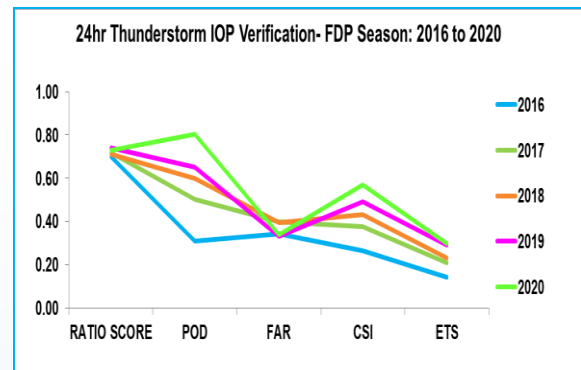


Fig. 44. Comparative 24 hr Thunderstorm IOP verification scores during FDP STORM - 2016 to 2020

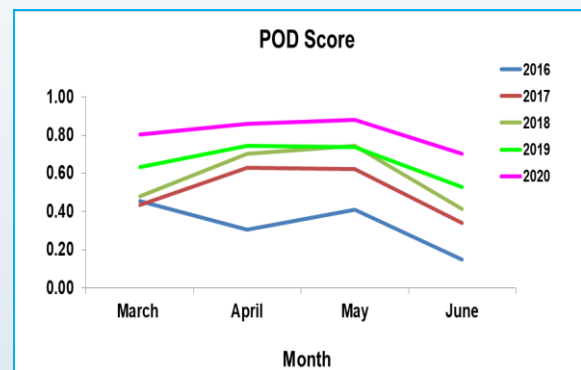


Fig. 45. Comparative POD Scores of 24 hr Thunderstorm IOP verification during FDP STORM - 2016 to 2020

TABLE 3

Category wise Rainfall Verification FDP STORM - 2020 (March to June)

Rainfall Category	Within Range	Out by one Range	Out by two or more Range	Total RF Forecasts issued
	Correct	Useful	Incorrect	
≤2.5	2565	530	357	3452
>2.5-5.0	39	56	8	103
5.1-10.0	254	241	74	569
10.1-20.0	52	69	17	138
>20.0	12	13	5	30
Total	2922	909	461	4292

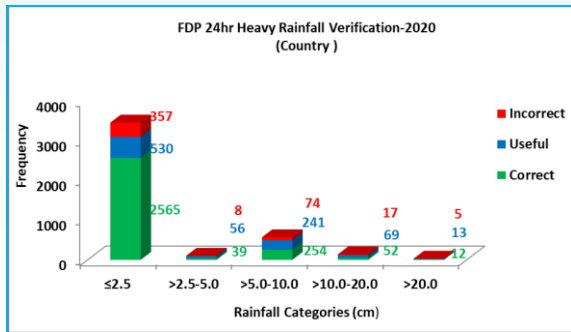


Fig. 46. Category-wise Rainfall Verification for FDP STORM - 2020 (March to June)

scores during 2016 to 2020 (Fig. 45) indicates 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. The verification results for various forecasted rainfall categories are given in Table 3 and graphically by Fig. 46.

(ii) Three Hourly TS Nowcast

Figs. 47-51 indicate respectively the Ratio Score, FAR, POD, ETS and CSI of three hourly TS Nowcast issued by various RMCs/MCs during FDP STORM (March to June) for the year-2020 and Fig. 52 indicates All India Scores.

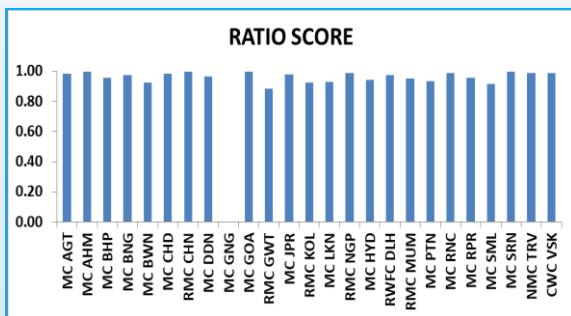


Fig. 47. MC-wise Ratio Score of Three Hourly TS Nowcast Verification during FDP STORM-2020

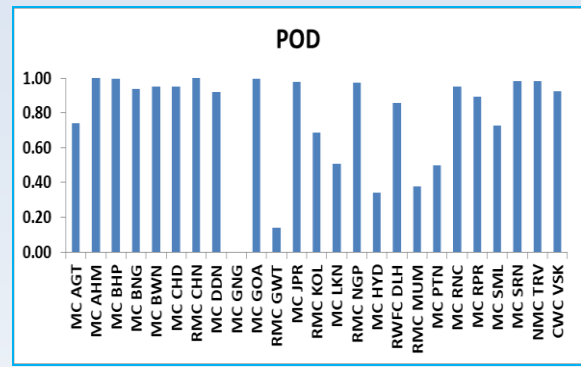


Fig. 48. MC-wise Probability of Detection (POD) of Three Hourly TS Nowcast Verification during FDP Period-2020

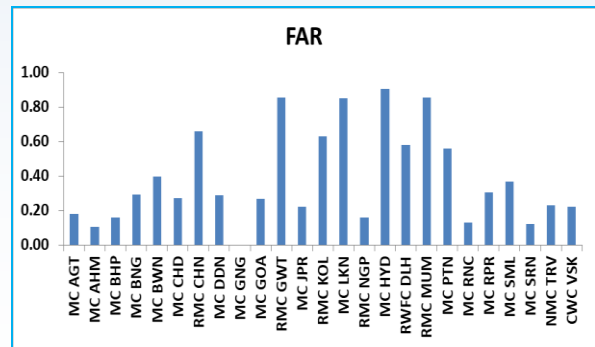


Fig. 49. MC-wise False Alarm Ratio (FAR) of Three Hourly TS Nowcast Verification during FDP Period-2020

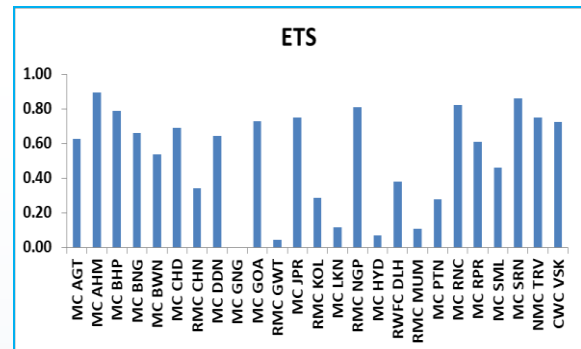


Fig. 50. MC-wise Equitable Threat Score (ETS) of Three Hourly TS Nowcast Verification during FDP Period -2020

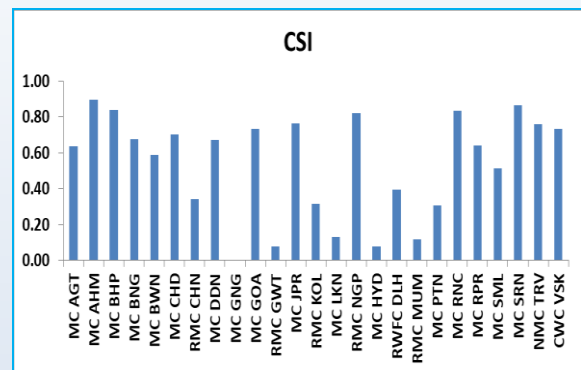


Fig. 51. MC-wise Critical Success Index (CSI) of Three Hourly TS Nowcast Verification during FDP Period-2020

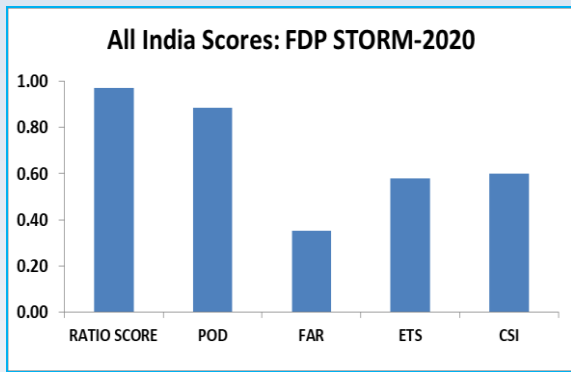


Fig. 52. All India TS Nowcast Verification Scores during FDP Period-2020

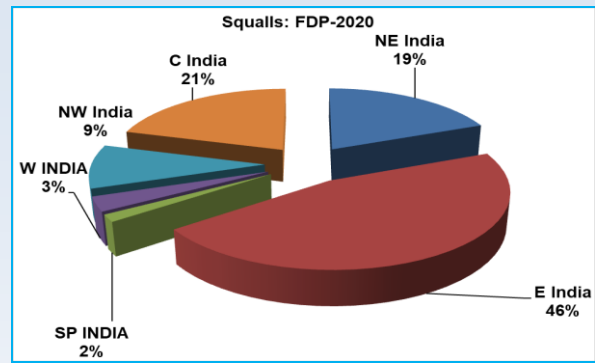


Fig. 55. Regionwise Distribution of squall events over the country during entire FDP STORM-2020

FDP STORM Report – 2020

A detailed STORM Report document, based on thunderstorm activities observed over India during March to June-2020, was prepared by Nowcast Division. 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 is expected to be published soon. Figs. 53-59 represent some of the salient features of the FDP STORM Report-2020.

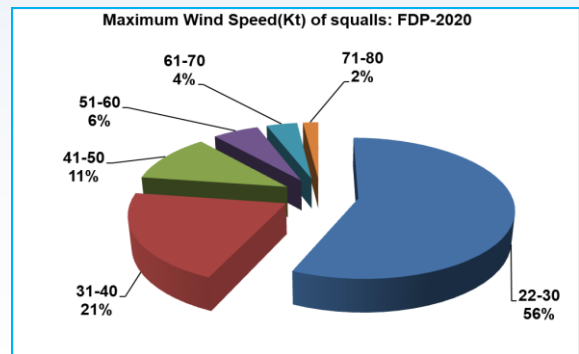


Fig. 56. Distribution of squalls over the country based upon max wind speed (Kt) during FDP STORM -2020

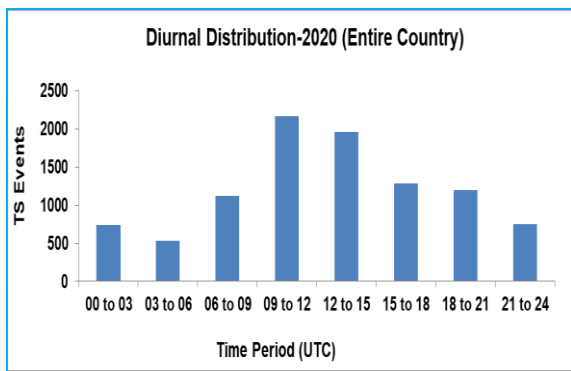


Fig. 53. Diurnal distribution of TS events over the country during FDP STORM -2020

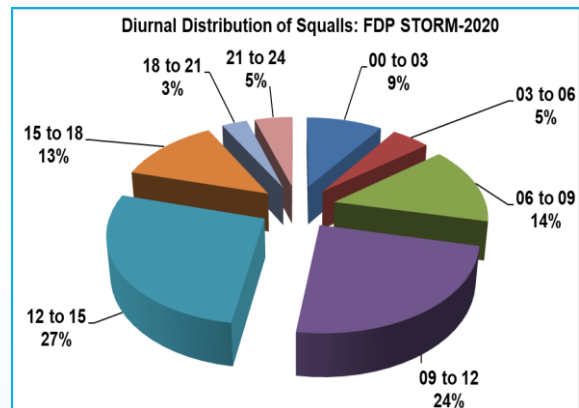


Fig. 57. Diurnal (time in UTC) distribution of thundersqualls during FDP STORM-2020

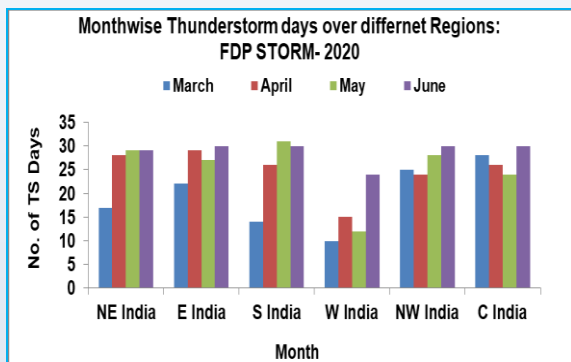


Fig. 54. Monthwise distribution of TS Days over different regions of India during FDP STORM-2020

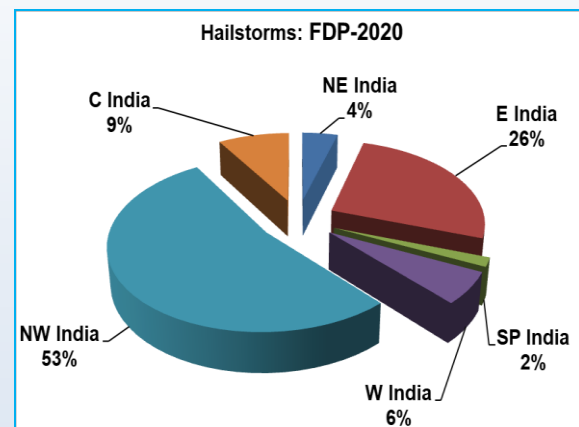


Fig. 58. Regionwise distribution of hailstorm events during FDP STORM-2020

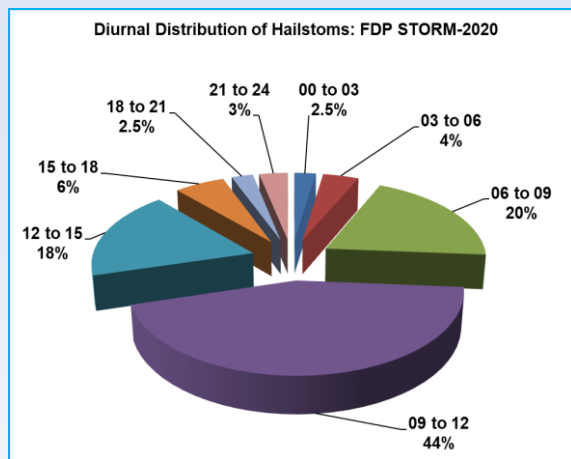


Fig. 59. Diurnal Distribution of Hailstorm Events over the Country during entire FDP STORM-2020

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 installed at 12 stations, viz; Delhi, Mumbai, Goa, Machilipatnam, Patna, Agartala, Mohanbari, Visakhapatnam, Patiala, Hyderabad, Lucknow and Kolkata. Fig. 60 shows IMD SWIRLS forecast for Delhi.

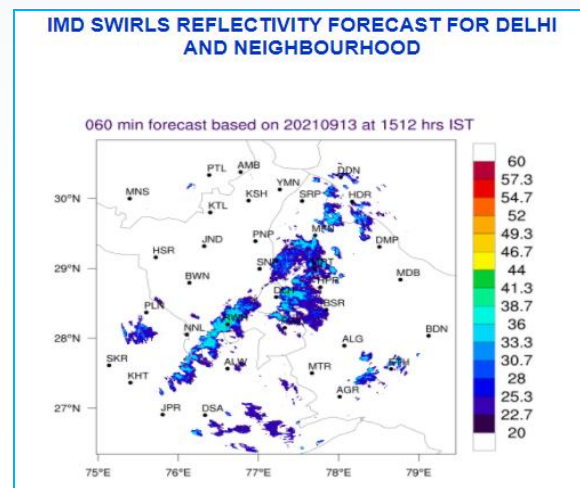


Fig. 60. SWIRLS Reflectivity Delhi
 Link: <https://nwp.imd.gov.in/swirls.php>

CHAPTER 5

WEATHER AND CLIMATE SERVICES OF IMD

5.1. Hydromet Services

During 2020, IMD achieved some significant improvement in Flood Meteorological Services by improving Quantitative Precipitation Forecasts skill, operationalising Probabilistic Quantitative Precipitation Forecasts, increased rainfall observations from 4359 to 4737 rainfall stations and operationalisation of the flash flood guidance services for South Asia.

Major achievements

Number of districts increased from 683 to 690 in preparation of rainfall summary/statistics.

Improvement of operational QPF over NWP guidance by 11% in Day1 and 9% in Day2.

Improvement of operational QPF for 2020 over QPF 2019 guidance by 3-10% in Day1 for many river basins.

328 New Rain gauge stations were included in CRIS.

The Flash Flood Guidance Services introduced in South Asia for providing impact based flash flood guidance bulletins every 6 hours to all stakeholders (Fig. 1). This new service is now operationally implemented through regional and national collaborations. Regular Bulletins are being sent to all stakeholders via email, social media.

Real-time monitoring of QPF & Flood situation and shared with CWC and other central agencies (Fig. 2).

Prepared Standard Operations Procedures (SOP) & Checklists for Hydromet Services including Rainfall Monitoring, Design Storm Studies, Flood Meteorological and Flash Flood Guidance Services and updated brochure of Hydromet activities.

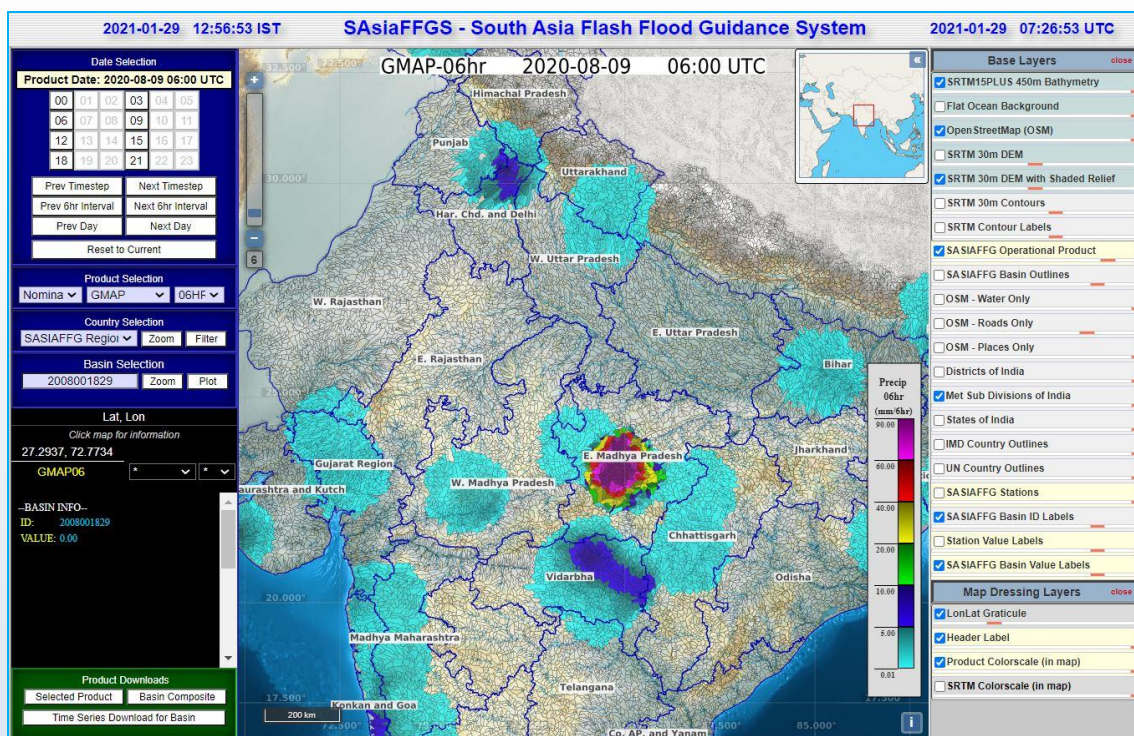


Fig. 1. Real-time Portal of Flash Flood Guidance System

Real Time Monitoring of Flood and Hydrometeorological Forecasting by IMD														
Date: 05.12.2020														
Flood Monitoring Offices				Flood Level (CWC)		Quantitative Precipitation Forecast (QPF) (IMD)								
SNO	FMO	Basin	Sub-Basin	Severe Flood	Extreme Flood	Day-1			Day-2			Day-3		
						26-50mm	51-100mm	>100mm	26-50mm	51-100mm	>100mm	26-50mm	51-100mm	>100mm
1	FMO Bengaluru	Cauvery	Lower Cauvery	√										
2	FMO Bengaluru	Cauvery	Kabini						√					
3	FMO Bengaluru	West Flowing Rivers	Bharathapuzha						√					
4	FMO Bengaluru	West Flowing Rivers	Lower Periyar						√					
5	FMO Bengaluru	West Flowing Rivers	Chalakudi						√					
6	FMO Chennai	East Flowing Rivers	Korttalaiyar			√			√					
7	FMO Chennai	East Flowing Rivers	Vellar			√								
8	FMO Chennai	East Flowing Rivers	Lower South Pennar			√			√					
9	FMO Chennai	Pennar	Lower Pennar			√			√			√		

Highest Flood Level =HFL

Severe Flood : when the river water level is at or above Danger Level and below HFL.

Extreme Flood : when the river water level is at or above HFL

Fig. 2. Real-time Monitoring of QPF & Floods

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. 3).

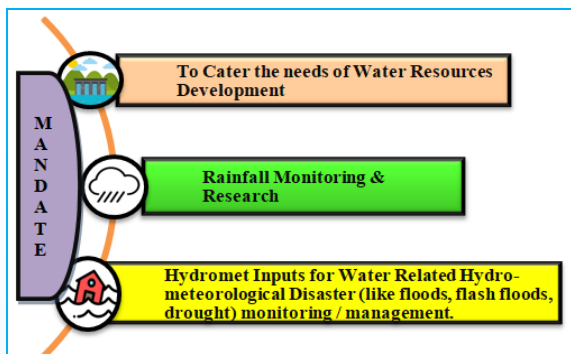


Fig. 3. Mandate of Hydromet Division

Overview of Hydro-meteorological Services of IMD

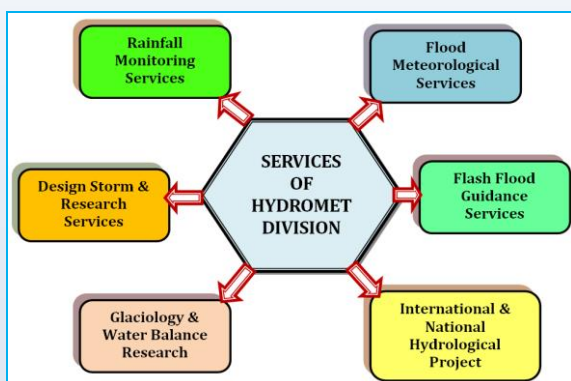


Fig. 4. Services of Hydromet Division

Flood Meteorological Services

Sub basin-wise Quantitative Precipitation Estimate for Day-1, Day-2, Day-3 using WRF ARW (9 km x 9 km), for Day-1 to Day-5 using MME (0.25° x 0.25°) and Day-1 to Day-7 using GFS (12 km x 12 km) & NCUM (12 km x 12 km) are computed and uploaded in IMD website operationally.

Operationalization of sub basin wise Probabilistic QPF based on dynamical model GEFS & NEPS used in river basin rainfall forecast.

Operational Grid Point Dynamical Rainfall Forecast based on GFS (12 km x 12 km) and WRF (3 km x 3 km) regularly provided to Central Water Commission for the use in Hydrological modelling.

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, RMC Chennai and MC Bengaluru during 2020 for their area of jurisdiction.

Regular issuance of QPF and Hydromet Bulletin for 10 major river basins (18 sub basins) for a pilot study on flood management

activities under the guidance of MHA sent to Secretary, MoES, CWC and others.

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

Monitoring the Issuance of Hydromet bulletin with QPF & heavy rainfall warnings with lead time of 72 hours for CWC by Hydromet Division & 14 flood Meteorological Offices.

Special Quantitative Precipitation Forecast (QPF) is issued during Cyclone or Heavy Rainfall Spells during non-flood season.

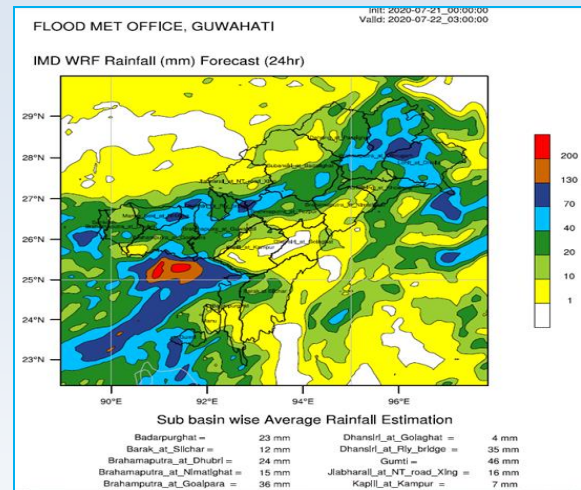


Fig. 5. IMD WRF Sub basin wise Rainfall Forecast – FMO Guwahati

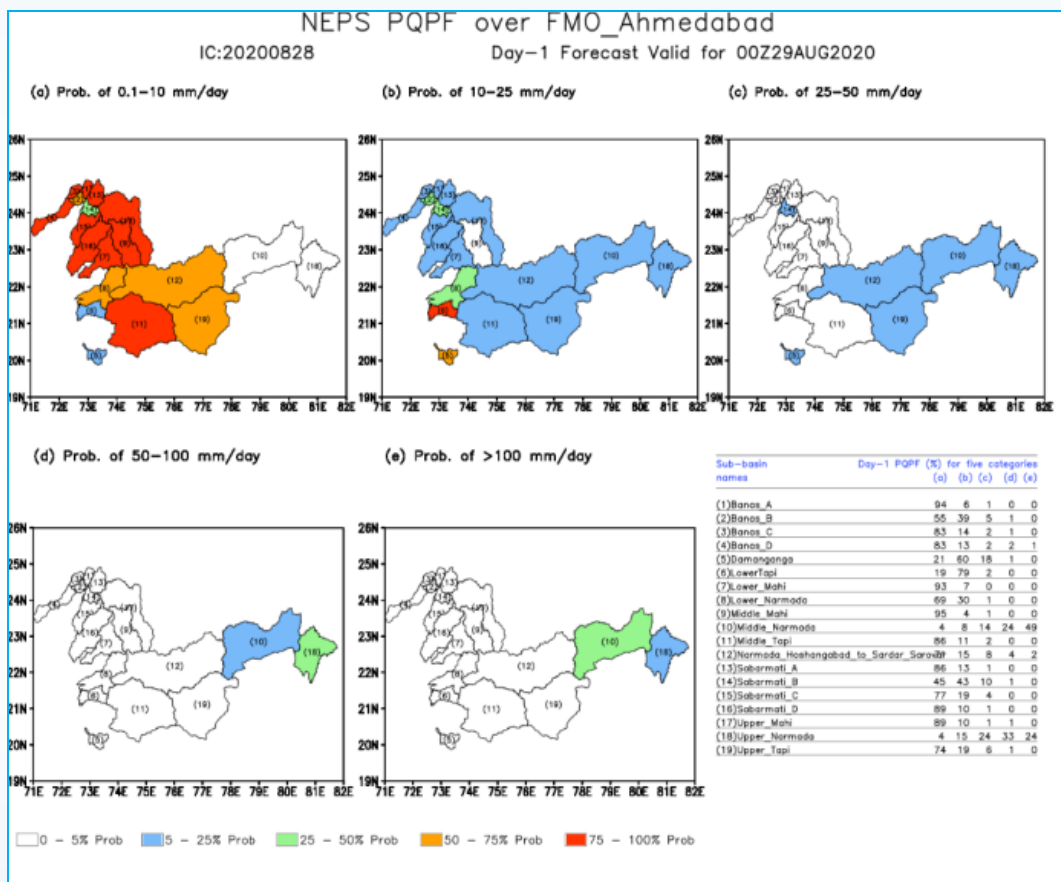


Fig. 6. Sub Basin Wise Probabilistic NEPF QPF– FMO Ahmedabad

Design Storm Studies/Storm Analysis

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) are being provided for users as main input.

During the year 2020, design storm studies of thirteen (13) projects were completed and results communicated to the concerned project authorities. An amount of Rs.31,93,152/- deposited in IMD's A/c for carrying out the design storm studies in respect of projects received from private/profit earning agencies.

Rainfall Monitoring Services

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.

During Monsoon season, the summary prepared on daily basis for 690 Districts, 36 Met. Subdivisions, 37 States including UTs, 4 homogenous 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. This rainfall summary is being 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.

Rainfall statistics for the SW-Monsoon - 2020 prepared with an all India network of about 4940 DRMS stations. The rainfall for the country as a whole has been recorded as 961.4 mm against the normal rainfall for the annual as 880.6 mm (departure 9%). In all, 02 met subdivisions remained in category of Large Excess rainfall, 13 met subdivisions in category of Excess rainfall, 16 in Normal, 05 in Deficient rainfall and no any met subdivisions in Large Deficient and No Rain category. The subdivision-wise updated rainfall map for the Monsoon and pre-monsoon season, 2020 is given. (See Fig. 7)

Subdivision-wise rainfall (mm) distribution and categorywise no. of subdivisions & % area (subdivisional) of the country are given in Table 1.

328 Rain gauge stations were included in CRIS and station codes provided to RMCs/MCs in the year of 2020 for inclusion in MK Rain.

No of district increased from 683 to 690 in preparation of rainfall summary/statistics.

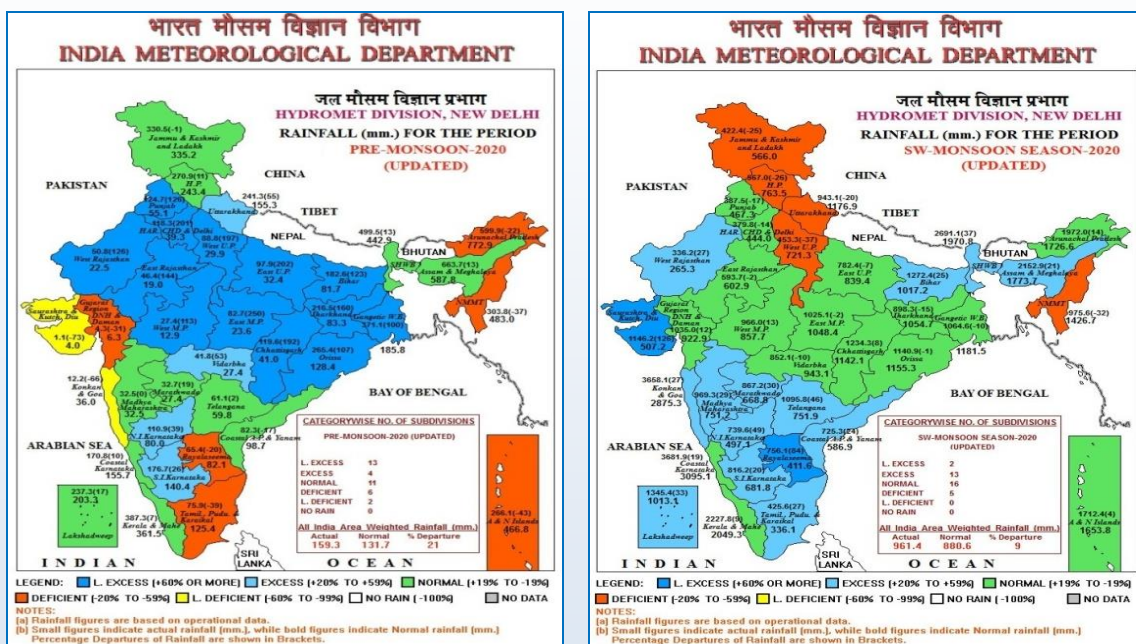


Fig. 7 Subdivision-wise rainfall map of India – 2020

Table 1

SUBDIVISION-WISE RAINFALL (MM) DISTRIBUTION

S. NO.	METEOROLOGICAL SUBDIVISIONS	PERIOD:		SW-MONSOON SEASON-2020	
		ACTUAL	NORMAL	% DEP.	CAT.
EAST & NORTH EAST INDIA		1509.0	1410.4	7%	
1	ARUNACHAL PRADESH	1972.0	1726.6	14%	N
2	ASSAM & MEGHALAYA	2152.9	1773.7	21%	E
3	N M M T	975.6	1426.7	-32%	D
4	SHWB & SIKKIM	2691.1	1970.8	37%	E
5	GANGETIC WEST BENGAL	1064.6	1181.5	-10%	N
6	JHARKHAND	898.3	1054.7	-15%	N
7	BIHAR	1272.4	1017.2	25%	E
NORTH WEST INDIA		516.5	599.5	-14%	
1	EAST U.P.	782.4	839.4	-7%	N
2	WEST U.P.	453.3	721.3	-37%	D
3	UTTARAKHAND	943.1	1176.9	-20%	D
4	HAR. CHD & DELHI	379.8	444.0	-14%	N
5	PUNJAB	387.5	467.3	-17%	N
6	HIMACHAL PRADESH	567.0	763.5	-26%	D
7	J & K AND LADAKH	422.4	566.0	-25%	D
8	WEST RAJASTHAN	336.2	265.3	27%	E
9	EAST RAJASTHAN	593.7	602.9	-2%	N
CENTRAL INDIA		1122.4	976.6	15%	
1	ODISHA	1140.9	1155.3	-1%	N
2	WEST MADHYA PRADESH	966.0	857.7	13%	N
3	EAST MADHYA PRADESH	1025.1	1048.4	-2%	N
4	GUJARAT REGION	1035.0	922.9	12%	N
5	SAURASHTRA & KUTCH	1146.2	507.2	126%	LE
6	KONKAN & GOA	3658.1	2875.3	27%	E
7	MADHYA MAHARASHTRA	969.3	751.2	29%	E
8	MARATHWADA	867.2	668.8	30%	E
9	VIDARBHA	852.1	943.1	-10%	N
10	CHHATTISGARH	1234.3	1142.1	8%	N
SOUTH PENINSULA		937.4	726.2	29%	
1	A & N ISLAND	1712.4	1653.8	4%	N
2	COASTAL A. P. & YANAM	725.3	586.9	24%	E
3	TELANGANA	1095.8	751.9	46%	E
4	RAYALASEEMA	756.1	411.6	84%	LE
5	TAMIL., PUDU. & KARAIKAL	425.6	336.1	27%	E
6	COASTAL KARNATAKA	3681.9	3095.1	19%	N
7	N. I. KARNATAKA	739.6	497.1	49%	E
8	S. I. KARNATAKA	816.2	681.8	20%	E
9	KERALA & MAHE	2227.8	2049.3	9%	N
10	LAKSHADWEEP	1345.4	1013.1	33%	E
COUNTRY AS A WHOLE		961.4	880.6	9%	

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

CATEGORY	PERIOD:	
	NO. OF SUBDIVISIONS	% AREA OF COUNTRY
LARGE EXCESS	2	5%
EXCESS	13	35%
NORMAL	16	45%
DEFICIENT	5	15%
LARGE DEFICIENT	0	0%
NO RAIN	0	0%

Central Hydromet Observatory

During 2020, inspite of COVID 19 pandemic situation a total of 1055 visitors/ students visited Central Hydromet Observatory (CHO), India Meteorological Department from different schools, colleges and other official agency for familiarization of Meteorological instruments & Observations procedures in IMD (Fig. 8).

South Asia Flash Flood Guidance Services

Development & Evolution of SASIAFFGS was successfully completed as illustrated in the event diagram (Fig. 9).

Presently, Regional (South Asia) Flash Flood Guidance Bulletins up to district level based on 0000, 0600, 1200 and 1800 UTC are being issued by Hydromet Division at HQ to respective National Meteorological & Hydrological Service of Srilanka, Bhutan, Nepal & Bangladesh (Fig. 10).

National Flash Flood Guidance Bulletins up to district level based on 0000, 0600, 1200, 1800 UTC are being issued by Hydromet Division at HQ to CWC Flood Directorate, NDMA, FMO's/RMC's/MC's.



Fig. 8. Central Hydromet Observatory



Fig. 9 Evolution of SASIAFFGS



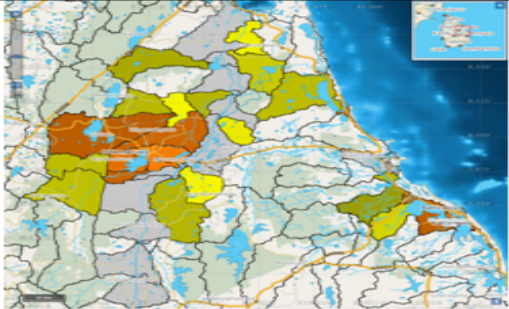
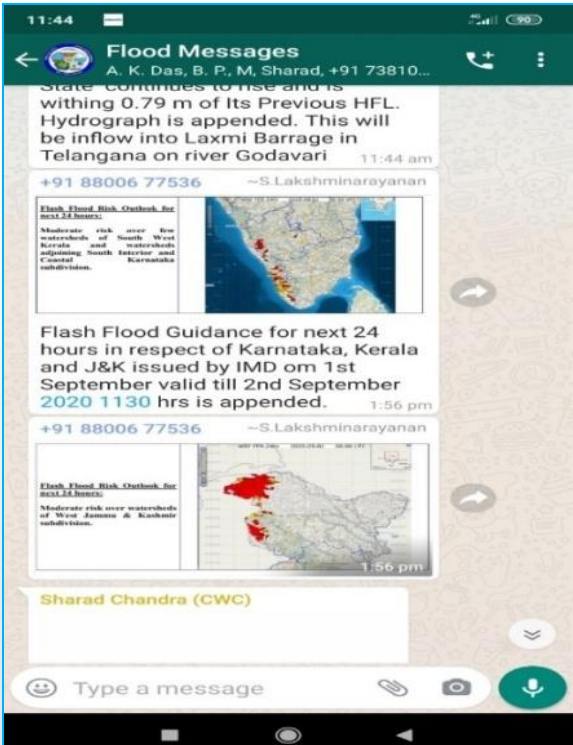
 Ministry of Earth Sciences	GOVERNMENT OF INDIA MINISTRY OF EARTH SCIENCES INDIA METEOROLOGICAL DEPARTMENT HYDROMET DIVISION FLASH FLOOD GUIDANCE CELL	
<u>South Asia Flash Flood Guidance Bulletin</u>		
DATED: 22.12.2020 TIME OF ISSUE: 0700 UTC VALID TILL 1200 UTC		
From: India Meteorological Department, New Delhi (Email Id: sasiaffgimd@gmail.com)		
To: National Meteorological and Hydrological Services, Sri Lanka		
Copy To: National Meteorological and Hydrological Services, Nepal National Meteorological and Hydrological Services, Bhutan National Meteorological and Hydrological Services, Bangladesh		
<u>Area of Concern (AoC): Some watersheds & neighbourhoods of Sri Lanka.</u>		
<u>Diagnostic Guidance:</u> Based on Merged Mean Areal Precipitation (Gauge and Satellite) of 0600 UTC, recorded rainfall is 1.5 - 148.93 mm during last 6 hours & up to 240.58 mm in last 24 hours over AoC. Real-time Satellite indicates HIGH convective activity with INSAT 3D CTBT value of -80 Deg C over North Eastern & Central parts of Sri Lanka and NIL convective activity over Nepal, Bhutan & Bangladesh. Land Surface Model shows some partially saturated watersheds up to 65% and few nearly saturated watersheds up to 95% over North & Central parts & coastal neighbourhoods of AoC.		
<u>Prognostic Guidance:</u> Dynamic Global (GFS) & Mesoscale Model (WRF & NCUM) forecasts Moderate rainfall up to 240 mm over AoC in next 24 hours.		
<u>Observed Flash Flood Threat (IFFT) Till 0700 UTC of 22.12.2020:</u> Based on 0600Z Real-time conditions some watersheds & neighbourhoods of North Eastern & Eastern parts of Sri Lanka indicates surface runoff conditions with Imminent Moderate Threat Perceived with continuous rainfall due to extended trough moving towards westwards into interior parts of Central Sri Lanka.		
This Regional Guidance Bulletin should be modified by the respective NMHS as per latest meteorological and hydrological conditions. Disclaimer: This is only a guidance bulletin and not a warning for flash floods.		

Fig. 10. Regional Flash Flood Guidance Bulletin issued to NMHS, Sri Lanka



State continues to maintain with 0.79 m of its Previous HFL. Hydrograph is appended. This will be inflow into Laxmi Barrage in Telangana on river Godavari 11:44 am

+91 88006 77536 --S.Lakshminarayanan

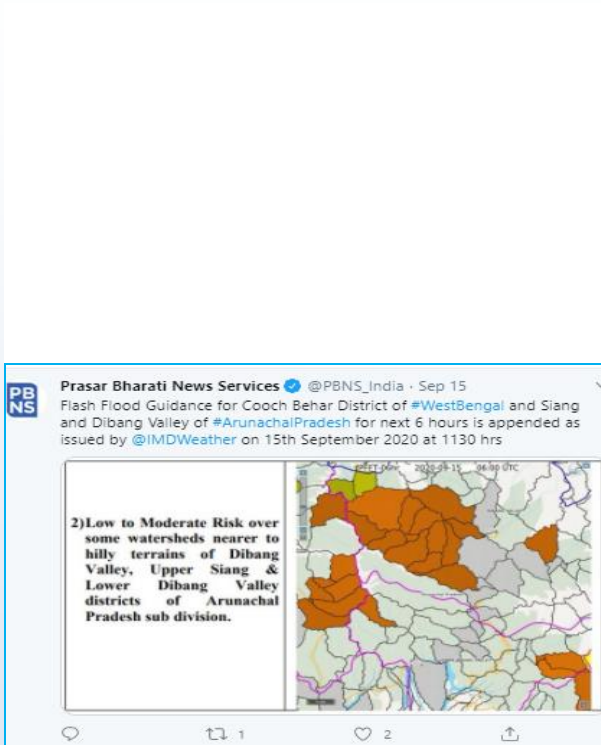
Flash Flood Risk Outlook for next 24 hours:
Moderate risk over the watersheds of South West Kerala and watersheds adjoining South Interior and Coastal Karnataka sub-division.

Flash Flood Guidance for next 24 hours in respect of Karnataka, Kerala and J&K issued by IMD on 1st September valid till 2nd September 2020 1130 hrs is appended. 1:56 pm

+91 88006 77536 --S.Lakshminarayanan

Flash Flood Risk Outlook for next 24 hours:
Moderate risk over watersheds of West Assam & Kamete sub-division.

Sharad Chandra (CWC)



PB NS Prasar Bharati News Services @PBNS_India · Sep 15
Flash Flood Guidance for Cooch Behar District of #WestBengal and Siang and Dibang Valley of #ArunachalPradesh for next 6 hours is appended as issued by @IMDWeather on 15th September 2020 at 1130 hrs

2) Low to Moderate Risk over some watersheds nearer to hilly terrains of Dibang Valley, Upper Siang & Lower Dibang Valley districts of Arunachal Pradesh sub-division.

Fig. 11: Flash Flood Guidance Bulletins

Flash Flood Guidance alerts are being issued based on 0000, 0600, 1200, 1800 UTC model runs as per Standard Operating Procedure and check list.

Regular Flash Flood guidance's in the form of Risks with 24 hour lead time and in the form of threats with 6 hour lead time based on near real-time meteorological & hydrological conditions is being operationally issued to all user agencies and stakeholders through Email/Social Media platforms (Fig. 11).

5.2. Agrometeorological Advisories Services

Agrometeorological Observatories & Data Management

(i) Agrimet Division maintains a network of agrometeorological observatories, dewfall and soil moisture stations. The data received through online and offline mode from these observatories are scrutinized, archived and supplied to scientists, planners etc. through NDC, Pune. Around 191 Agromet observatories are uploading on web portal of Agrimet Division.

(ii) Conventional Agromet Observatories at 5 AMFUs, *i.e.*, Agwanpur, G. Udaigiri, Pusa (RAU), Bhubaneswar, Roorkee (IIT) have been installed during the year.

(iii) Weather data is provided to Ministry of Agriculture for use in Kisan Suvidha app and also to NGOs and Agromet Field Units for generation of block level AAS bulletin through web services on real time.

Weather Services under Gramin Krishi Mausam Sewa (GKMS)

a. Preparation of Agromet Advisory Service (AAS) bulletins

(i) AAS bulletins have been prepared and issued at district and state levels on every Tuesday & Friday and at National level on every Friday to cater to the needs of users at various levels. The district level AAS bulletins

are prepared and issued by 130 Agromet Field Units (AMFUs) located in State Agricultural Universities, ICAR institutes, IITs etc. The bulletins include past weather, medium range weather forecast for next 5 days and specific agromet advisories on field crops, horticultural crops, livestock etc. At present these bulletins are issued for 662 districts in the country.

(ii) IMD in collaboration with CRIDA, Hyderabad issues Operational AAS bulletin based on Extended Range Weather Forecast on every Friday to help farmers to take decision on agricultural operations and also to the planners to take policy decision.

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. Agromet Advisories are being disseminated in both Regional and English languages through "Kisan SMS", a portal (<http://farmer.gov.in/adv/login.aspx>) launched by the Ministry of Agriculture, Government of India. In addition to that, number of AMFUs have been sending agromet advisories through SMS in collaboration with Agricultural Technology Management Agency (ATMA)/KVKs. At present 42.5 million farmers are receiving SMS and benefitted by this service directly. Weather forecast and advisories under alerts and warnings during extreme weather events are also issued through SMS which enable the farmers in planning appropriate farming operations to minimize damage of crops under adverse weather conditions.

(ii) In addition to above, Agromet Advisories are being telecast on Tuesday and Friday through DD Kisan Channel in programs like

'Kisan Samachar' and 'Mausam Khabar' in Hindi and Marathi.

(iii) Disaster Support: Alerts and warning messages for the cyclones like Fani: 5937365 (Andhra Pradesh : 849809, Assam: 962312, Arunachal Pradesh: 1389, Karnataka: 66599, Odisha: 2523248, Puducherry : 10694, Tamilnadu : 646570, West Bengal: 876744), Vayu: 1767494 (Gujarat: 704279, Karnataka: 117016, Kerala: 655544, Maharashtra: 290655), Bulbul: 1819501 (Odisha: 1469608, West Bengal: 349893) and for Hailstorm: Maharashtra: 5052314 during 2019 have been issued to the farming community in the respective Agromet Field Units of the States to safeguard the crops.

c. Agromet Products

Agrimet Division has continued generation of following agromet products for operational use in AAS. All these products are being generated under PAN India mode using geospatial technology and are uploaded in the Division's website and communicated to the AMFUs for preparation of more accurate agromet advisories at district level.

(i) Soil Moisture: Realized (Daily) and Forecast (twice a week on Tuesday & Friday)

(ii) Spatial variation of weather parameters at different temporal scales

(iii) Soil temperature and evaporation on daily and weekly scale

d. Satellite products

(i) Normalized Difference Vegetation Index (NDVI)

(ii) Reference Evapotranspiration & Insolation maps in collaboration with SAC Ahmedabad

(iii) Vegetation Condition Index (VCI)

(iv) Vegetation Health Index (VHI)

(v) Temperature Condition Index (TCI) (Fig. 12)

e. 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 (Fig. 13).

f. Research & Development Project on AAS

(i) Agrimet Division, IMD, Pune in collaboration with NIC, Pune is redesigning Division's website using PHP which is user friendly and with additional features.

(ii) A web based Agromet-DSS-software has been developed by Agrimet Advisory Services Division (AASD) of IMD in collaboration with RIMES (The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia) (Fig. 14) for online generation of District and block level AAS bulletins by the scientists of AMFUs located at State Agricultural Universities, institutes of ICAR and IITs etc. Presently 25 AAS Units and 128 Agromet Field Units, 188 DAMUs Are utilizing the portal for value addition of forecast and generation of district and block level weather bulletins respectively through the portal the bulletins are also being pushed to recently launched megdoot app.

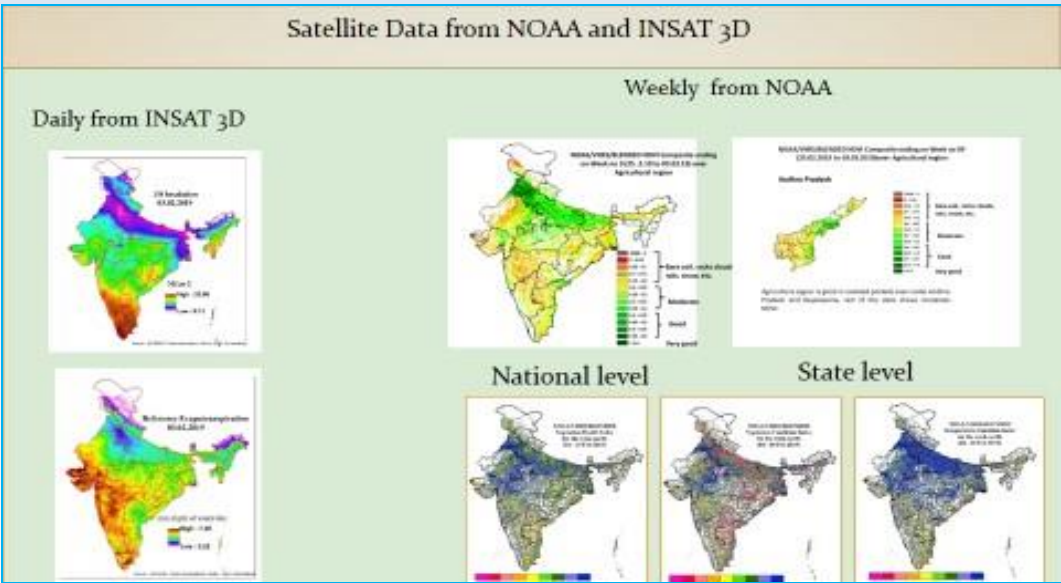


Fig. 12. Satellite Data Products



Fig. 13. Display of Spatial Weather parameters in Bhuvan Portal



Fig. 14. Agromet Decision Support System

g. New Initiative under Gramin Krishi Mausam Sewa (GKMS)

(i) India Meteorological Department (IMD) and Indian Institute of Tropical meteorology (IITM) and the Indian Council of Agricultural Research (ICAR) developed a mobile application “Meghdoot” for the dissemination of Agromet Advisories to the farmers (Fig. 15). It provides weather data and forecast relating to temperature, rainfall, humidity

and wind speed and direction, which play critical role in agricultural operations and advisories to the farmers on how to take care of their crops and livestock. The information would be updated twice a week on every Tuesday and Friday. The app would provide information in the form of images, maps and pictures to help the farmers for decision making based on weather information and agromet advisories.



Fig. 15. Meghdoot Mobile App

(ii) IMD in collaboration with WOTR, Pune is developing Decision Support System software for automated preparation of agromet advisories to generate locale and crop specific dynamic agromet advisories.

Implantation of District level Agromet Advisory Services through District Agro-Met Units (DAMUs) at KVKs in the Country

In order to empower the farmers with weather based agromet advisory customized at block level, IMD and ICAR are jointly extending the network to District level by setting up of District Agro-Met Units (DAMUs) at Krishi Vigyan Kendras (KVKs) in 530 districts in addition to existing 130 AMFUs. Each DAMU at

KVK will be facilitated with (i) one Automatic Weather Station (AWS) to record changes in weather, (ii) Two manpower: one Subject Matter Specialist-Agrometeorology (SMS-Agrometeorology) and one Observer, (iii) Expert Panel consisting of Subject Matter Specialists at KVK and District Level Head of State Department of Agriculture to prepare agromet advisory at block level and (iv) dissemination platforms including mKisan portal for sending Agromet SMS to farmers. IMD and ICAR are jointly implementing the setting up of DAMUs at KVKs in phased manner. Till December 2020, recruitment of manpower at 196 DAMUs are completed and 171 DAMUs started to prepare block level agromet advisory bulletins in experimental

mode for around 2000 blocks and disseminating through state extension services and social media (whatsapp) to selected villages and farmers.

Crop Yield Forecasting Under FASAL Scheme

Under the FASAL (Forecasting of Agricultural Output using Space Agrometeorology and Land based observation) project of Ministry of Agriculture & Farmers Welfare, IMD in coordination with 47 Agromet Field Units of FASAL network forecasted crop yield of 14 major mandate crops. These forecast are based on statistical models and crop simulation model based and forecasting has been carried out at 3 phenological phases in advance & provided to Ministry of Agriculture.

Economic Impacts of the Agrometeorological Services

It has been reported by the farmers under different AMFUs that the weather forecast and agromet advisories are helping them in day to day farm operations like sowing, irrigation scheduling, fertilizer and pesticide applications etc. Special advisories, alerts and warnings issued during extreme weather events like heavy rain, cold wave, heat wave, hail storms etc. also helped them in minimizing the loss.

New Initiative under Gramin Krishi Mausam Sewa (GKMS)

Agrimet Division has taken special initiative under the GKMS to make agromet advisories more precise and accurate and reach maximum number of agriculture dependent farming households like:

(i) *Implementation of Block level AAS in the country:* After successful implementation of district level AAS, IMD in collaboration with Indian Council of Agricultural Research (ICAR) is venturing into implementation of block level weather forecast and Agromet Advisories. District Agromet Units (DAMUs) are being established in Krishi Vigyan Kendras (KVKs) under ICAR network in a phase-wise manner

for rendering block level AAS. Short term training programmes were conducted on “Preparation and Dissemination of Agromet Advisories at Block level under Gramin Krishi Mausam Seva (GKMS) scheme” for Subject Matter Specialists (SMS) and Observers of Krishi Vigyan Kendras (KVKs) under various ATARI zones of ICAR at New Delhi (29 July-3 August), Kolkata (6-11 August), Jorhat (26-31 August), Solapur (19-24 August), Hyderabad (14-19 October) and Jabalpur (20-25 November).

(ii) *Experimental Block Level Agro Advisories:* A total 2624 Experimental Block level advisories have been issued by both Agromet Field Units and District Agromet Units.

(iii) Agrimet Division, IMD, Pune in coordination with State Department of Agriculture, Government of Maharashtra and Agromet Field Units (AMFUs) in Maharashtra organised Video Conference to discuss southwest monsoon status and decision of *kharif* sowing and further crop management based on weather during SW monsoon 2019.

(iv) *Farmers’ Awareness Programme (FAP)* is one day programme organised by IMD, AMFU and DAMU. The major objectives of this activity is creating awareness about usefulness of AAS and weather/climate information among the farming community and also to help to increase the interaction between the local farming communities and the MCs, AMFUs and KVK. 1123 FAPs were conducted in year 2020 which were attended by around 63,125 farmers.





Fig. 16. Farmers' Awareness Programme (FAPs) at AMFU, Navasari, Valsad, Gujarat and DAMU, Chattarpur, Madhya Pradesh

5.3. Positional Astronomy Services

With a view to developing astronomical and astrophysical studies in India as envisaged by the planning committee constituted by the Govt. of India in 1945, a small unit, known as Nautical Almanac Unit, was set up under CSIR at Calcutta. Although the Govt. of India used Gregorian calendar for official use, divergent practices of calendar keeping were in vogue during the period of post independence of the country. A need was felt by the Government to develop a unified National Calendar on the basis of the most accurate modern astronomical data in the interest of national integrity. Keeping these in view, a Calendar Reform Committee was formed in 1952 under the CSIR with Late Prof. Meghnad Saha as the Chairman. The Committee recommended preparation of the Indian Ephemeris and Nautical almanac (renamed as Indian Astronomical Ephemeris from 1979 issue) incorporating therein usual astronomical data calculated with most modern astronomical formula, to publish the National Calendar of India (using Saka Era) in the form of Rashtriya Panchang with Solar Calendar system for civil use and Luni solar Calendar system for religious use. It was decided that these works should be done by the Nautical Almanac Unit. This Unit was taken over by the India Meteorological Department from CSIR on 1st December, 1955 and put under Regional Meteorological Centre, Calcutta. On 1st

December 1979, following the recommendations of Dr. Ramanna Committee, the centre was made an independent centre and renamed as Positional Astronomy Centre. It was then brought under the direct administrative control of DGM. A standing advisory committee consisting of eminent experts in the field of astronomy advises DGM on technical matters and future scientific programs of the centre.

Positional Astronomy Centre is the nodal office of the Govt. of India to generate data on Positional Astronomy and to publish the same in the form of annual publications viz., The Indian Astronomical Ephemeris. It is also performing pivotal role in implementing the recommendations of two committees, one already mentioned earlier as Calendar Reform Committee and other one constituted later on and named as Peer Review Committee, through publication of Rashtriya Panchang in 14 languages. India is one of the 7 countries in the world having an ephemeride office like this centre and publishing the Indian Astronomical Ephemeris. The centre issues the following 16 publications annually.

- (i) The Indian Astronomical Ephemeris
- (ii) Tables of Sunrise- Sunset, Moonrise- Moonset
- (iii) Rashtriya Panchang in 14 languages namely - English, Hindi, Urdu, Sanskrit, Assamese, Bengali, Gujrati, Kannada, Punjabi, Malayalam, Marathi, Oriya, Tamil & Telegu.

The centre also fixes up dates of all India festivals for all communities for declaration of holiday by Central & State Govt.

The centre also meets specific data requirements of a large number of users including Govt. organizations, non Govt. organizations, professional astronomers, research scholars, various panchang makers, general public etc.

This centre also provides five years advance accurate calendric data to many leading panchang makers of the country for preparation of their own Panchangs.

The centre also contributes to a great extent in popularizing astronomy through publication of monthly astronomical bulletin and star charts (presently star charts are being prepared on computer), issuing press release on different astronomical events through various print media, attending live discussions on various electronic media etc.

This centre also takes observation on special astronomical events from time to time with the help of its portable telescopes at different places of the country.

ACTIVITIES DURING THE YEAR 2020

- The Indian Astronomical Ephemeris for the year 2021, an annual publication of Positional Astronomy Centre, which mainly contains positional data of the Sun, Moon and planets, basic data on yearly positions of fundamental stars, diary of celestial events, calendric data, eclipse data, explanatory text and other useful information on astronomy has been published both in hard copy and soft copy format.
- Fourteen language editions of Rashtriya Panchang of 1942 SE (2020-21 AD) and Sunrise-Sunset and Moonrise -Moonset tables for 2021 have been published during the year 2020. These are important regular publications of the centre catering to daily need of users of almanac, Panchang makers and other users.
- Web based service has been continued by the centre by creation of electronic versions of 14 language editions of Rashtriya Panchang and Indian Astronomical Ephemeris which can be accessed by the users through the PAC Kolkata website.
- The centre has prepared monthly star charts and astronomical bulletins for 12 months during the year 2020 for giving useful guidance for watching celestial objects in the night sky. The bulletins contain brief texts

explaining positions of objects in the sky and celestial diagrams showing positions for practical demonstrations.

- All India festivals for all communities for the year 2021 have been prepared in advance for declaration of holidays by the Govt. of India and other State Governments. Calendar data of Indian National Calendar along with Gregorian calendar data for the year 2021-22 has been prepared in advance for different stake holders.
- Five year advance panchang data has been prepared and supplied to different enlisted panchang makers.
- Press bulletin has been issued in advance for media for eclipse event in 2020 visible in India

5.4. Climate Research & Services

(i) Operational Long Range Forecast and its Verification

Operational LRF System

The present operational Long-Range Forecasting (LRF) system for generating the rainfall/precipitation forecast is essentially based on the statistical methods and that for generating temperature forecasts is based on the coupled forecasting system (CFS). The operational LRF system based on statistical models was developed through in-house research activities and regular review. IMD issues operational long-range forecasts for rainfall/ precipitation during Winter (January-March), Southwest Monsoon (Jun to Sept) and Northeast Monsoon (October-December) seasons. Among these, forecast for monsoon season is most important as the rainfall received during this season accounts for 70-90% of the annual rainfall over most parts of the country and due strong positive association of monsoon season rainfall with both Kharif and Rabi crop production in the country. Table 2 shows various forecasts. Since 2012, as additional forecast guidance, IMD started to use the experimental forecasts for the monsoon rainfall generated by the

dynamical model approach developed by Indian Institute of Tropical Meteorology (IITM), Pune. The present dynamical model forecasting system is based on the global climate forecasting system (CFS) version 2. The CFS is a fully coupled general circulation model (CGCM) implemented by IITM under Monsoon Mission project launched by the Ministry of Earth Sciences (MoES) (Saha et al, 2014). The

global monthly and season forecasts for rainfall and temperature prepared using Monsoon Mission CFS (MMCFS) is available through IMD, Pune (www.imdpune.gov.in) website. In 2018, CFS was used for issuing an outlook for seasonal temperatures over India during the hot weather seasons (March to May & April to June) and cold weather season (December to February).

Table 2

Various operational forecasts issued by IMD

S. No.	Forecast for	Region for which forecast issued	Issued in	Method/Model
1	Winter Season (Jan- March) Precipitation	Northwest India	December	Statistical
2	Hot Weather Season Temperature for (March- May) & (April-June) seasons	Subdivision wise	March	Dynamical
3	SW Monsoon Season (June to September) Rainfall	Country as a whole	April	Statistical & Dynamical
4	SW Monsoon Season (June to September) Rainfall	Country as a whole	June	Statistical & Dynamical
5	South-West Monsoon Onset	Kerala	May	Statistical
6	SW Monsoon Season (June to September) Rainfall	Four broad geographical regions: Northwest India, Northeast India, Central India & South Peninsula	June	Statistical
7	SW Monsoon Monthly Rainfall for July and August	Country as a whole	June	Statistical
8	SW Monsoon Second half of the Season (August-September) Rainfall	Country as a whole	July	Statistical
9	September Rainfall	Country as a whole	August	Statistical
10	NE Monsoon Season (October to December) Rainfall	South Peninsula	September	Statistical
11	Cold Weather Season (December - February) Temperature	Subdivision wise	November	Dynamical

Details of the various long-range forecasts issued by IMD & their verification are discussed

in this report. The Performance operational forecast (1988-2020) is shown in Fig. 17.

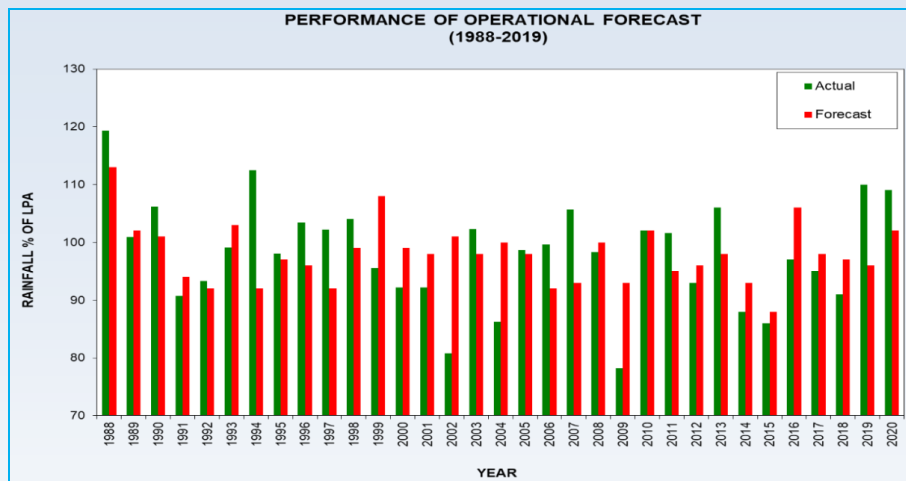


Fig. 17. Performance operational forecast (1988-2020)

(ii) 2020 Hot Weather Season Temperature Forecast for Hot Weather (March- May & April - June) Seasons

The country experiences hot weather primarily during March to July. March to May season is known as the pre-monsoon season and April to June is known as Hot weather season. During these seasons, many parts of the country experience heat wave conditions (days with abnormally warmer temperatures) with many adverse consequences. Abnormally above normal temperatures can have devastating effects on human health, water resources and power generation and outage. There is a marked relationship between human mortality and thermal stress.

India Meteorological Department (IMD), Ministry of Earth Sciences (MoES) has been issuing seasonal forecast outlooks for subdivision scale temperatures over the country for both hot and cold weather seasons based on predictions from the Monsoon Mission Coupled Forecasting System (MMCFS) Model developed under MoES's monsoon mission project. The model hindcasts and forecasts were bias corrected using the probability distribution function (pdf) method. The forecast for 2020 pre-monsoon season (March to May) was prepared using 30 ensemble member forecasts, based on the 2020 February initial conditions. IMD had issued the following seasonal forecast for March to May (MAM) 2020. The season

average temperatures are likely to be warmer than normal over most of the meteorological subdivisions of northwest, west and central India and some subdivisions from north and south India. Near normal temperatures are likely in the remaining subdivisions. Above normal heat wave conditions are likely in the core heat wave (HW) zone during the season (March-May).

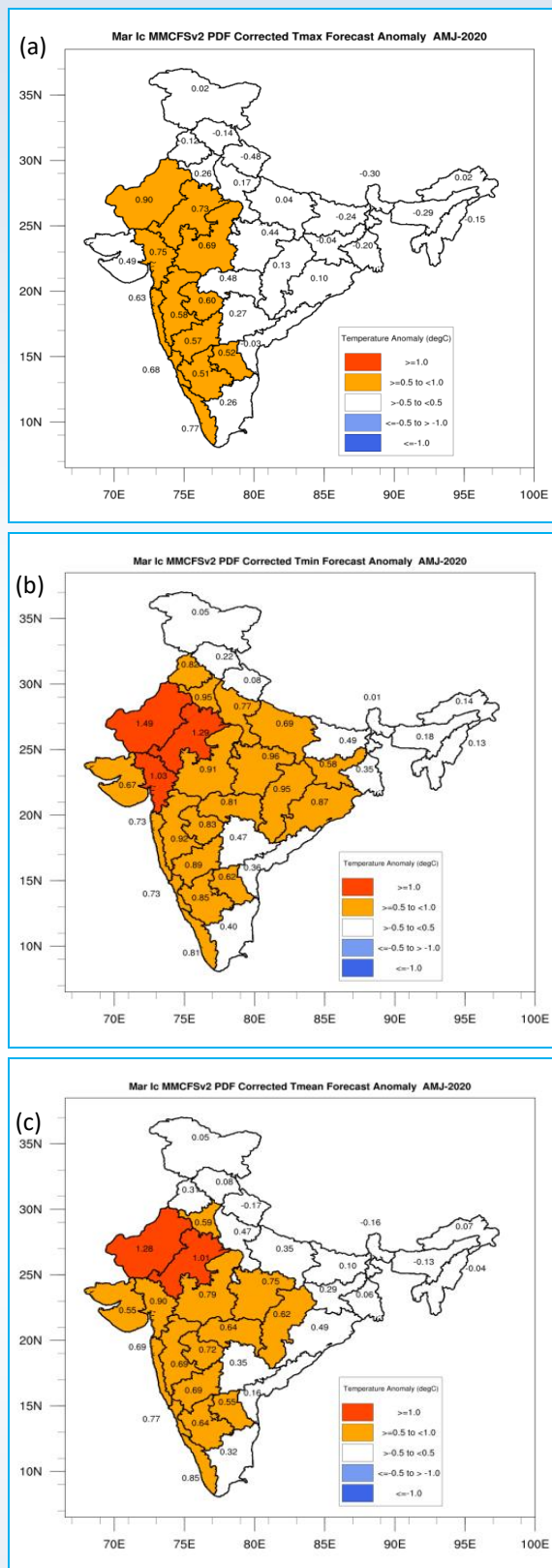
IMD had issued seasonal forecast for Hot Weather Season (April to June) using 43 ensemble member forecasts from MMCFS based on the 2020 March initial conditions. The summary of outlook was as follows:

The April-May-June (AMJ) season average maximum temperatures are likely to warmer than normal by 0.5°C to 1°C over some of the meteorological subdivisions of northwest, west and western peninsular India.

The April-May-June (AMJ) season average minimum temperatures are also likely to be warmer than normal by 0.5°C to 1°C over most of the subdivisions of northwest, west, central, east and western peninsular India.

Frequency of heat waves in the core heat wave zone is likely to be slightly above normal during the season.

The sub-division wise maximum, minimum and mean temperatures forecast issued by IMD for the 2020 Hot weather season (April to June) is shown in [Figs. 18(a-c)] respectively.



Figs. 18 (a-c). Subdivision wise maximum, minimum and mean temperatures forecast issued by IMD for the 2020 hot weather season (April to June 2020)

(iii) Southwest Monsoon Season (June to September, 2020) Rainfall

Long range forecasts were issued for monthly (for July, August), second half (August +

September) and seasonal rainfall over the country as a whole and for seasonal rainfall over four geographical regions (Northwest India, Central India, Northeast India and South Peninsula) with useful skill. In addition to the above long-range forecasts, an operational forecast for the monsoon onset over Kerala was issued in May. For the forecasting of the south-west monsoon season (June – September) rainfall over the country as a whole, the newly introduced statistical ensemble forecasting system based on 8 parameters were used. Multiple Regression models based on separate parameters sets were used for the forecast of the monsoon season rainfall over four geographical regions (NW India, NE India, Central India and South Peninsula) of the country and forecast for the rainfall over the second half of the monsoon Season over the country as a whole. Principal Component Regression Models were used for the forecast of monthly rainfall for the months of Jul & August over the country as a whole.

The operational forecast for the onset of monsoon over Kerala was prepared using a 6 - Parameter principal component regression (PCR) method. The forecast for monsoon onset over Kerala for this year was correct, as the monsoon onset over Kerala took place on 1st June against the forecast of 5th June \pm 4days. Thus, the operational forecast for the monsoon onset over Kerala has been correct (within the forecast limits) during 15 of the 16 years since issuing of operational forecast for the event started in 2005. Only in 2015, the forecast for monsoon onset over Kerala was not correct, as the monsoon set over Kerala on 5th June \pm 4 days against the forecast of 30th May (Fig. 19).

The forecasts for the rainfall over the country as whole during the season and forecasts for the seasonal rainfalls over three broad geographical regions (Central India, Northeast India and South Peninsula) and that for August and second half of the monsoon season rainfall over the country as a whole were found to be underestimated to the actual rainfall. Also, the forecasts for the rainfall over

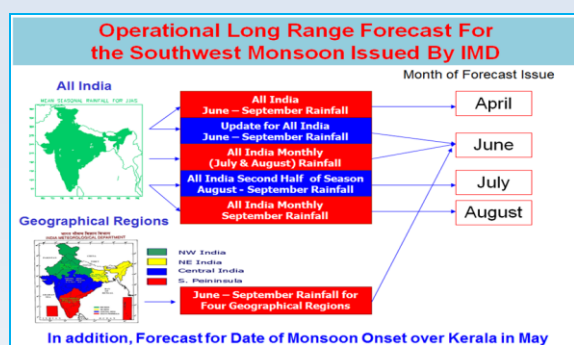


Fig. 19. Schematic diagram showing various operational forecasts for the Southwest monsoon rainfall issued by IMD

the country as whole during July and forecast for the Northwest India were found to be overestimated to the actual rainfall and were not correct. Verification of all the forecasts is given below in Table 3.

Table 3

Verification of the operational forecast issued for the 2020 southwest monsoon rainfall

Region	Period	Forecast (% of LPA)		Actual Rainfall (% of LPA)
		15 th April	1st June	
All India	June to Sept	100 ± 5	102 ± 4	109
Northwest India	June to Sept		107 ± 8	84
Central India	June to Sept		103 ± 8	115
Northeast India	June to Sept		96 ± 8	106
South Peninsula	June to Sept		102 ± 8	130
All India	July		103 ± 9	90
All India	August		97 ± 9	127
All India	August to Sept (issued on 31 st July)		104 ± 8	118

(iv) Northeast Monsoon Rainfall over South Peninsula (October to December, 2020)

The long range forecast for the 2020 NE monsoon season (October to December) rainfall over South Peninsula and Tamil Nadu was issued in the last week of September 2020. The south Peninsula consisting of five subdivisions (Tamil Nadu, Coastal Andhra Pradesh, Rayalaseema, Kerala and south

interior Karnataka) receives about 30% of its annual rainfall during the NE monsoon season (October to December). Tamil Nadu in particular receives about 48% of its annual rainfall during this season. Due to this important fact, IMD has been preparing experimental forecasts for NE monsoon season rainfall over south Peninsula since 1998 using statistical models. IMD also continuously works to improve the skill of the forecasting models. For preparing the quantitative and probabilistic forecasts for NE monsoon season rainfall over the south Peninsula, a 5-parameter Principle Component Regression (PCR) has been used. The forecast for NE Monsoon communicated to concerned State Government Authorities.

(v) 2020 Cold weather Season (December to February) Temperatures

IMD had issued Seasonal outlook for the subdivision averaged temperatures for the last cold weather season (December 2020 to February 2021 or (DJF 2020-2021)) on 30th November 2020, based on IMD's Monsoon Mission Coupled Forecasting System (MMCFS) Model developed under MoES's monsoon mission project.

The summary of forecast for the winter season (DJF) was as follows:

During the upcoming winter season (December to February), below normal minimum temperatures are likely over most subdivisions of north, northwest, central and few subdivisions over east India.

The probability forecast for minimum temperature indicates that below normal minimum temperatures are likely over most subdivisions of north, northwest, central and a few subdivisions of east India. Most of the subdivisions of northeast India, few subdivisions of west coast and south peninsular India are likely to experience above normal minimum temperatures. The probability forecast for maximum temperature

indicates that above normal maximum temperatures are likely over most subdivisions of northwest, north, east and northeast India and a few subdivisions of central and

peninsular India. Most of the subdivisions of south peninsular India are likely to experience below normal maximum temperatures [Fig. 20 (a&b)].

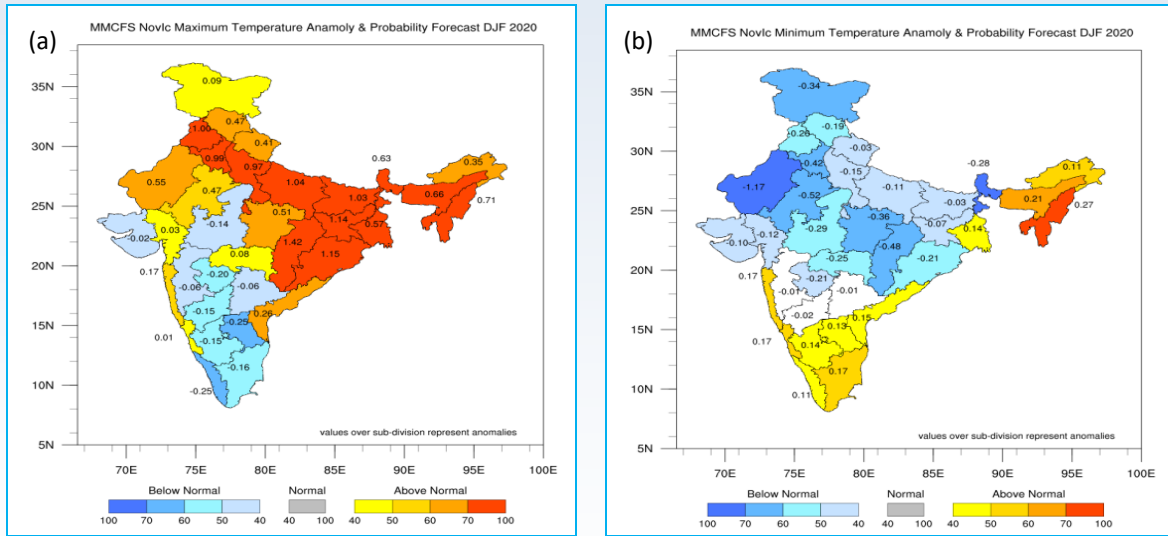


Fig. 20 (a&b). Probability forecast & sub-division averaged (a) Maximum Temperature Anomaly forecast for Dec 2020 to Feb 2021 and (b) Minimum Temperature Anomaly forecast for Dec 2020 to Feb 2021

(vi) Climate Monitoring & Annual Climate Statement

Climate over India during 2020 was above average with respect to temperature. The annual mean temperature for the country this year was +0.29 °C above the 1981-2010 average. Higher mean temperatures during the monsoon season (Jun-Sep, with anomaly 0.43 °C) and post monsoon season (Oct-Dec, with anomaly 0.53 °C) mainly accounted for the above normal annual temperature for the year.

Rainfall during the principal rainy season [Southwest (summer) monsoon season (June-

September)] for the country as a whole was normal [109% of Long Period average (LPA)]. The seasonal rainfall during the Northeast monsoon season (October - December) over the NE Monsoon core region of the south peninsula was 110% of its LPA.

Temperatures

The annual mean temperature for the country was +0.29 °C above the 1981-2010 average, thus making the year 2020 as the eighth warmest year on record since 1901 (Fig. 21).

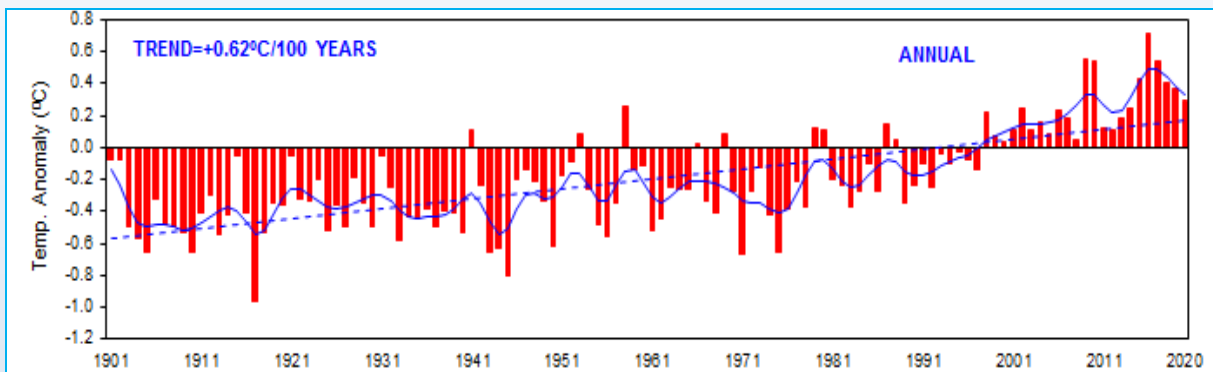


Fig. 21. Annual mean land surface air temperatures anomalies averaged over India for the period 1901-2020. The anomalies were computed with respect to base period of 1981-2010. The solid blue curve represents the sub-decadal time scale variation smoothed with a binomial filter

The other 7 warmest years on record in order were: 2016 (anomaly +0.71 °C), 2009 (0.55 °C), 2017 (0.541 °C), 2010 (0.539 °C), 2015 (0.42 °C), 2018 (0.40 °C) and 2019 (0.36 °C).

It may be mentioned that 12 out of the 15 warmest years were from the recent past fifteen years (2006-2020). In addition, the past decade (2001-2010/2011-2020) was the warmest decade on record with anomalies of 0.23 °C / 0.34 °C above average. During 1901-2020, the annual mean temperature showed an increasing trend of 0.62 °C/100 years with significant increasing trend in the maximum temperature (0.99 °C /100 years), and relatively lower increasing trend (0.24 °C/100 years) in the minimum temperature.

Rainfall

Rainfall activity over the country as a whole was normal (109 % of LPA) during the year. Out of 36 meteorological subdivisions, two sub-division Saurashtra & Kutch and Rayalaseema received large excess rainfall, 10 received excess rainfall, 21 received normal rainfall and remaining 3 subdivisions received deficient rainfall. At the end of year, of the four homogeneous regions, south peninsular India received 122%, central India received 119%, East & Northeast India received 105 % while Northwest India received 90 % of their respective LPA rainfall.

High Impact Weather Events

During 2020, 5 cyclonic storms formed over the North Indian Ocean; Super cyclonic Storm **AMPHAN**, Very Severe Cyclonic Storms **NIVAR & GATI**, Severe Cyclonic Storm **NISARG**, and Cyclonic Storm '**BUREVI**'. Of these, **NISARG & GATI** formed over Arabian Sea, while the remaining 3 cyclones viz. **AMPHAN, NIVAR & BUREVI** formed over the Bay of Bengal. Out of these five most devastating cyclonic storms, the Super Cyclonic Storm **AMPHAN** formed in the pre-monsoon season and crossed West Bengal coast over Sundarbans on 20th May. It claimed 90 lives & about 4,000 livestock

mainly from West Bengal. The Severe Cyclonic Storm **NISARG** formed in the Monsoon season and crossed Maharashtra coast on 3rd June claimed 4 lives & 2000 livestock from Maharashtra. The remaining three **NIVAR, BUREVI & GATI** formed during the post monsoon season.

The country also experienced other high impact weather events like, extremely heavy rainfall, floods, landslide, thunderstorm, lightning, cold waves, etc. A few are listed below. The casualties mentioned here are based on the media and government reports.

Bihar & Uttar Pradesh were the most adversely affected states during the year which reportedly claimed more than 350 deaths from each state mainly due to thunderstorm, lightning & cold wave events.

Heavy rainfall & flood related incidents reportedly claimed over 600 lives from different parts of the country during pre-monsoon, monsoon & post-monsoon seasons. Of these, 129 lives were reportedly claimed from Assam, 72 from Kerala [Specifically, 65 persons reportedly claimed dead in a single day from Pettimudi in Munnar, Idukki district of Kerala on 7th August due to landslide.], 61 from Telangana (while, 59 lives reportedly claimed only during the period 1st to 20th October), 54 lives from Bihar, 50 from Maharashtra, 48 Uttar Pradesh, & 38 from Himachal Pradesh.

Thunderstorms reportedly claimed 578 lives from different parts of the country. Of these deaths, 280 were claimed from Bihar, 167 from Uttar Pradesh & 122 from Jharkhand. Lightning events reportedly claimed 237 lives from central, northwestern, northeastern and peninsular parts of the country. Of these, 72 lives were from Madhya Pradesh, 53 from Uttar Pradesh, 26 from Bihar, 23 from Maharashtra and 20 from Andhra Pradesh.

Cold wave conditions mainly prevailed over central parts the country especially in the month of January. It caused deaths of about 150 people. Of these deaths, 88 deaths were reported from Uttar

Pradesh alone, 45 from Bihar only on single day 1st January & 16 from Jharkhand. Major Extreme Weather Events Occurred during 2020 & associated loss of life are shown in Fig. 22.

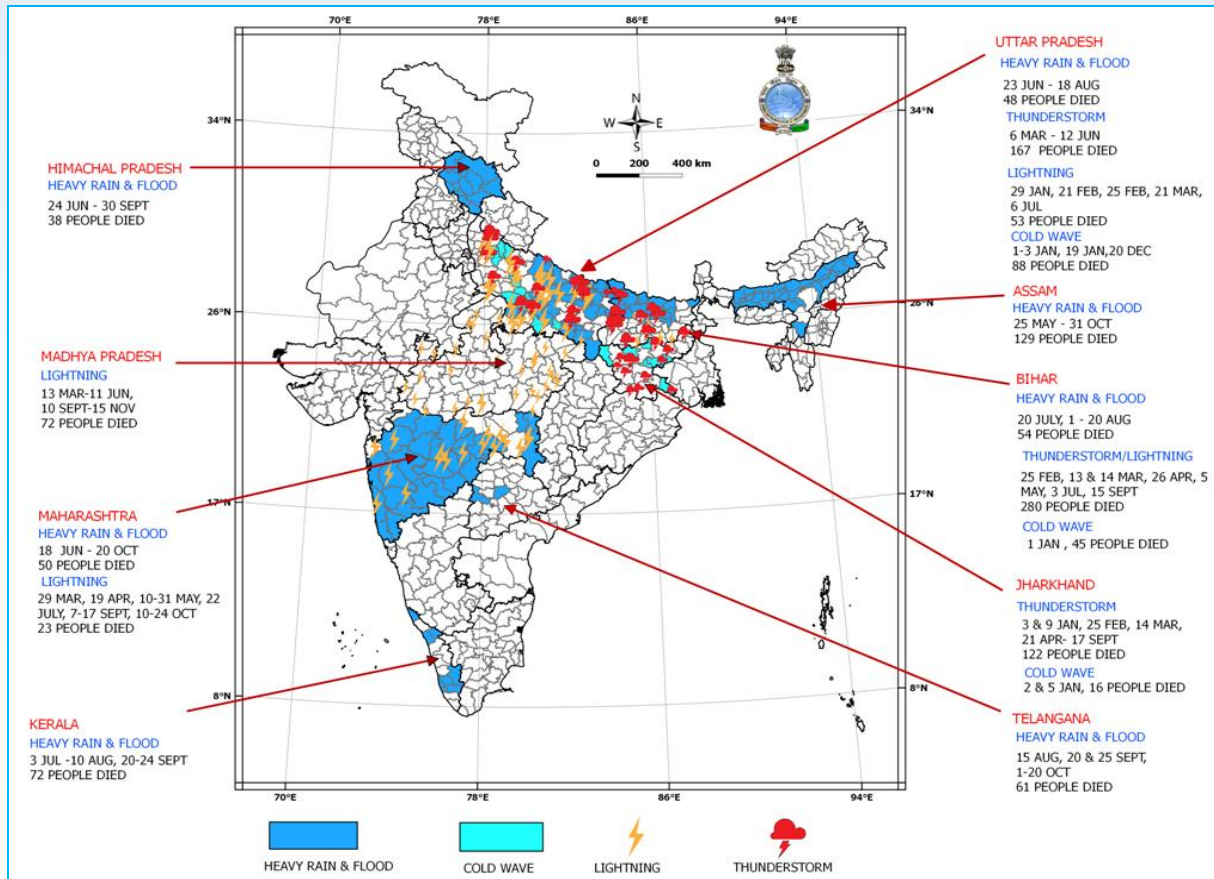


Fig. 22. Major extreme weather events occurred during 2020

Disaster Support: During the year SMS has been issued to the farming community by the respective Agromet Field Units of the States to safeguard the crops from cyclonic storms in the form of Alerts and warnings along with Agromet Advisories. Number of farmers receiving the SMS during various extreme events are furnished below:

- **Super Cyclonic Storm AMPHAN over Bay of Bengal (16-22 May):** 2878069 farmers in the states of Andhra Pradesh, Odisha, West Bengal, Assam and Meghalaya.
- **Severe Cyclonic Storm "NISARGA" over Arabian Sea (1-4 June):** 2037075 farmers in the states of Maharashtra, Gujarat and Goa.
- **Deep Depression over Bay of Bengal (11-14 October):** 1971886 farmers in the states of Andhra Pradesh, Telangana, Karnataka & Odisha.
- **Depression over Arabian Sea (17-19 October):** 1855378 farmers in the states of Gujarat and Maharashtra.
- **Severe Cyclonic Storm "NIVAR" over Bay of Bengal (24-26 November):** 3322543 farmers in the states of Tamilnadu, Puducherry, Andhra Pradesh, Telangana and Karnataka.
- **Cyclonic Storm 'BUREVI' over Bay of Bengal (1 December):** 2414675 farmers in the states of Tamilnadu, Puducherry, Kerala and South Coastal Andhra Pradesh.

5.5. Cyclone Monitoring & Prediction

5.5.1. Annual Characteristics of Cyclonic disturbances during 2020

Nine cyclonic disturbances (CDs) including depressions and cyclones developed over the north Indian Ocean (NIO) including 5 over the Bay of Bengal (BoB) and 4 over the Arabian Sea (AS) during the year 2020 against the normal of 12 CDs per year over the NIO.

The year 2020 witnessed 5 cyclones (3 over BoB and 2 over AS) and 4 depressions/deep depressions (2 over BoB and 2 over AS). Both the cyclones over the AS were severe & above intensity cyclones and out of 3 cyclones over BoB, 2 were severe & above intensity cyclones and 1 was a cyclonic storm.

Details of these CDs over the north Indian Ocean in 2020 are listed below:

- **Super cyclonic storm AMPHAN over Bay of Bengal (16-21 May)**
- **Severe cyclonic storm NISARGA over the Arabian Sea (01-04 June)**
- **Very severe cyclonic storm GATI over the Arabian Sea (21-24 November)**
- **Very Severe Cyclonic Storm NIVAR over Bay of Bengal (22-27 November)**
- **Cyclonic Storm BUREVI over the Bay of Bengal (30 November-05 December)**

Arabian Sea witnessed above normal activity during 2020 with the formation of 4 CDs including 2 cyclones (Nisarga & Gati) against the normal of 1.7 CDs and 1 cyclone per year. The activity over the BoB was subdued this year with the formation of only 3 cyclones during 2020 against the normal of 4 per year. However, the frequency of severe category of cyclones was normal over BoB with the formation of 2 severe category storms (Amphan & Nivar) against the normal of 2 per year. Considering seasonal distribution, while one cyclone (super cyclonic storm Amphan) and another (severe cyclonic storm Nisarga) formed during pre-monsoon and monsoon

season respectively, three cyclones (very severe cyclonic storm, Gati and Nivar and cyclonic storm Burevi) formed during post-monsoon season. No CDs formed over BoB during monsoon season.

All the cyclones during 2020 exhibited unique characteristics w.r.t track, intensity and landfall. SuCS Amphan in May, 2020 was the first super cyclone over BoB after the Odisha super cyclone of 1999. Nisarga in June, 2020 was the first severe cyclonic storm (SCS) which crossed Maharashtra coast as a severe category storm after the SCS that crossed Maharashtra coast on 24th May, 1961. It was also the 4th cyclone crossing Maharashtra coast during the period 1961-2020. GATI in November, 2020 was the first very severe cyclonic storm crossing Somalia coast during satellite era. Gati was the 5th cyclone crossing Somalia coast after a cyclonic storm in November, 1994, Murjan in 2012, Sagar in 2018 and Pawan in 2019. Nivar was the first cyclonic storm over BoB during post monsoon season. It caused intense rainfall over activity over north Tamil Nadu & Puducherry, Rayalaseema and south coastal Andhra Pradesh during 24-26 November. Nivar over BoB and Gati over AS occurred simultaneously during 21-26 November. Such simultaneous occurrence was last observed in 2019 during 5-7 November with ESCS Maha over AS and Bulbul over BoB. Burevi was the 14th cyclone that crossed Sri Lanka coast during the period 1891-2019. A system analogous to that of CS 'BUREVI' occurred during 15-17 January 1906 which crossed the east coast of Sri Lanka, close to north of Trincomalee, moved across Pamban area and weakened near Ramanathapuram district coast. Burevi had the similar track & intensity characteristic as the cyclonic storm in January, 1906. Burevi also exhibited strange behaviour w.r.t. movement. It remained practically stationary for nearly 36 hours over the Pamban area and became less marked over the same area. Last such stationary characteristic was observed during 1999 Super Cyclone over Odisha which remained stationary for 33 hours.

All the five cyclones over the NIO during 2020 were **landfalling cyclones**. Amphan crossed West Bengal – Bangladesh coasts as a very severe cyclonic storm on 20th May. Nisarga crossed Maharashtra coast as a severe cyclonic storm on 03rd June. Gati crossed Somalia coast on 22nd November as a very severe cyclonic storm. Nivar crossed Tamil Nadu & Puducherry coasts near Puducherry on 25th November midnight as a very severe cyclonic storm. Burevi crossed Sri Lanka in the midnight of 2nd December and second landfall over Pamban area in the afternoon of 3rd December.

During 2020, two cyclones (Nisarga and Nivar) out of five had a northeastward **recurving track**. While Nisarga recurved northeastward over the Sea before landfall, Nivar recurved northeastward after the landfall over Tamil Nadu coast. All others including Amphan, Gati and Burevi had almost straight track. While Gati had fastest moving track, Burevi had a slow moving track especially over Gulf of Mannar.

Regular bulletins were issued to disaster management agencies of central level and concerned states during the life period of various cyclonic disturbances with frequent updates by SMSs and social networking sites. Every three hourly Tropical Cyclone Advisories were also issued to central & state level disaster managers, media, general public and WMO/ESCAP member countries, WMO and the United Nations.

5.5.2. Characteristics of Cyclonic Storms during 2020

5.5.2.1. Super cyclonic storm AMPHAN over the Bay of Bengal (16-21 May)

- The Super Cyclonic Storm (SuCS) “AMPHAN” originated from the remnant of a Low Pressure Area which occurred in the near Equatorial Easterly wave over south Andaman Sea and adjoining southeast Bay of Bengal (BoB) during 1st - 5th May. Though the Low Pressure Area became less marked on 6th May,

its remnant circulation meandered over south Andaman Sea and adjoining southeast BoB during 6-12 May. Under its influence, a fresh Low Pressure Area formed over southeast BoB and adjoining south Andaman Sea in the morning (0300 UTC) of 13th May.

- It lay as a well marked low pressure area (WML) over southeast BoB & neighbourhood in the morning (0300 UTC) of 14th May. Under favourable environmental conditions, it concentrated into a depression (D) over southeast BoB in the early morning (0000 UTC) of 16th May and further intensified into a deep depression (DD) in the same afternoon (0900 UTC). It moved north- northwestwards and intensified into Cyclonic Storm “AMPHAN” (pronounced as UM-PUN) over southeast BoB in the evening (1200 UTC) of 16th May, 2020. Moving nearly northwards, it further intensified into a Severe Cyclonic Storm (SCS) over southeast BoB in the morning (0300 UTC) of 17th May. It underwent rapid intensification during subsequent 24 hours and accordingly intensified into a Very Severe Cyclonic Storm (VSCS) by the afternoon (0900 UTC) of 17th, Extremely Severe Cyclonic Storm (ESCS) in the early hours of 18th (2100 UTC of 17th May) and into a Super Cyclonic Storm (SuCS) around noon (0600 UTC) of 18th May, 2020.

- It maintained the intensity of SuCS over westcentral BoB for nearly 24 hours, before weakening into an ESCS over westcentral BoB around noon (0600 UTC) of 19th May.

- Thereafter, it weakened slightly and crossed West Bengal - Bangladesh coasts as a VSCS, across Sundarbans, near latitude 21.65° N and longitude 88.3° E during 1530-1730 hrs IST (1000-1200 UTC) of 20th May, with maximum sustained wind speed of 155-165 kmph gusting to 185 kmph. It lay over West Bengal as a VSCS, gradually moving north-northeastwards during late evening to night (1200 – 1500 UTC) of 20th May. It moved very close to Kolkata during this period.

- Moving further north-northeastwards, it weakened into an SCS over Bangladesh & adjoining West Bengal around mid-night (1800 UTC) of 20th May, weakened further into a CS over Bangladesh in the early hours (2100 UTC of 20th) of 21st May, into DD over Bangladesh around noon of 21st May and into a D over north Bangladesh in the evening (1200 UTC) of the same day. It further weakened and lay as a well marked low pressure area over north Bangladesh and neighbourhood around mid-night (1800 UTC) of 21st May (Fig. 23).

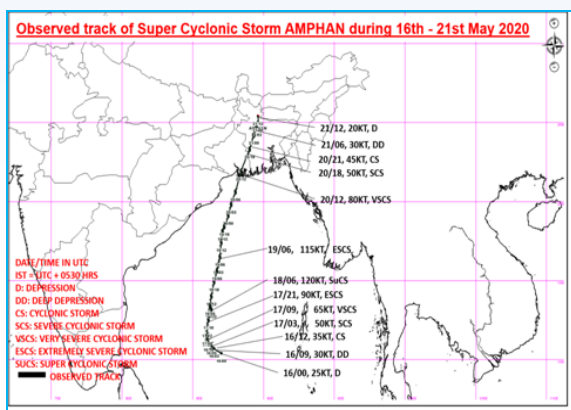


Fig. 23. Observed track of SuCS 'AMPHAN' over the southeast Bay of Bengal (16-21 May, 2020)

Forecast Performance

- First information was provided in the extended range outlook on 7th May (about 6 days prior to formation of LPA, 9 days prior to formation of depression and 13 days prior to Landfall) indicated that the system would intensify into a Cyclonic storm and move initially northwestwards and recurve north-northeastwards towards north BoB.
- Tropical Weather Outlook in the Press Release and informatory message to the Government of India issued on 13th April (on the day of development of LPA, 3 days prior to formation of depression and 7 days prior to Landfall), it was indicated that the system would intensify into a cyclonic storm by 16th evening and would move initially northwestwards till 17th and then recurve north-northeastwards towards north BoB.
- Actually, the depression formed in the morning (0000 UTC) of 16th and the system moved north-northwestwards till 17th evening (1200 UTC) followed by north-northeastward recurvature thereafter and crossed West Bengal coast on 20th Afternoon.
- In the first bulletin issued at 0845 IST of 16th May (104 hrs prior to landfall) with the formation of Depression, it was indicated that the system would intensify into a cyclonic storm and will move north-northwestwards till 17th May followed by north-northeastward recurvature towards West Bengal coast during 18th-20th May and cross West Bengal coast with maximum sustained wind speed of 155-165 kmph gusting to 180 kmph.
- In the bulletin issued at 1645 hrs IST of 16th May (24 hrs prior to rapid intensification), rapid intensification of the system was predicted and the system rapidly intensified from 17th afternoon onwards.
- In the bulletin issued at 0845 hrs IST of 17th May (80 hrs prior to landfall), it was precisely mentioned that the system would cross West Bengal-Bangladesh coasts between Sagar Island (West Bengal) and Hatiya Islands (Bangladesh coast) during afternoon to evening of 20th May with maximum sustained wind speed of 155-165 kmph gusting to 185 kmph. The predicted track indicated Landfall across Sunderbans on 20th Afternoon.
- IMD continuously predicted since 16th May that Amphan will cross West Bengal coast as a very severe cyclonic storm (VSCS) with wind speed of 155-165 kmph gusting to 180 kmph on 20th May.
- The observed and forecast track along with cone of uncertainty and wind distributions around the centre for various lead periods are presented in [Figs. 31 (a-c)]. About 84 hours prior to landfall, IMD could correctly forecast track, landfall point, time and intensity correctly.

- The landfall point forecast errors for 24, 48 and 72 hrs lead period were 5.5, 11.0, and 35.2 km respectively against the LPA errors of 44.7, 69.4 and 109.3 km during 2015-19 respectively.

- The landfall time forecast errors for 24, 48 and 72 hrs lead period were 0.5, 0, and 2.0 hours respectively against the LPA errors of 3.0, 5.4 and 8.6 hours during 2015-19 respectively.

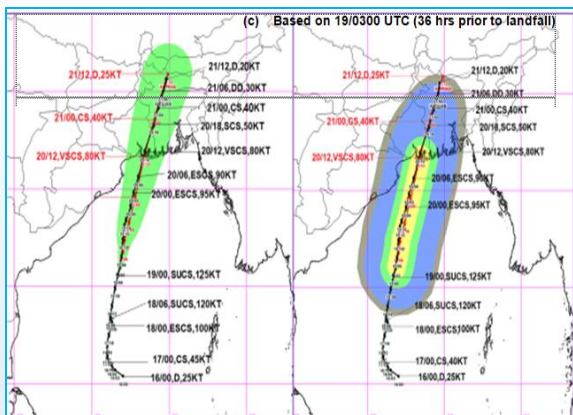
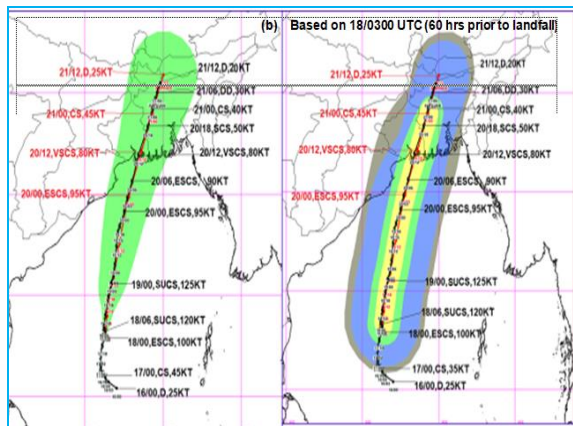
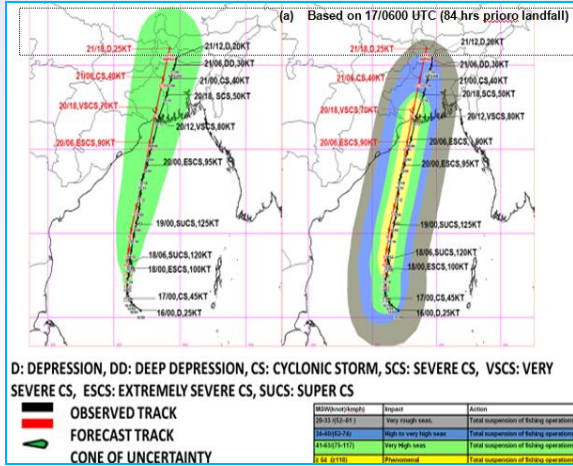


Fig. 24 (a-c). Observed and forecast track along with cone of uncertainty and quadrant wind distribution based on (b) 0300 UTC of 18th May (60 hours prior to landfall) and (c) 0300 UTC of 19th May (36 hours prior to landfall) of SuCS AMPHAN indicating accuracy in landfall, track & intensity predictions

- For all lead periods, the landfall errors were exceptionally less than the LPA errors during 2015-19. Considering the Eye (Centre) Diameter of Cyclone ‘Amphan’ as 15 km at the time of landfall, there was almost zero error in landfall time and point forecast upto 48 hrs lead period.

- The track forecast errors for 24, 48 and 72 hrs lead period were 59.4, 59.9, and 61.0 km respectively against the LPA errors of 80.6, 125.5, and 171.2 km respectively.

- The track forecast skill was about 60%, 78%, and 88% against the LPA skill of 61%, 73%, and 74% for 24, 48 and 72 hrs lead period respectively.

- Track forecast errors were exceptionally less than the past five years average errors for all lead periods. Similarly, track forecast skill was higher than the past five years average skill for all lead periods beyond 24 hours.

- The absolute error (AE) of intensity (wind) forecast for 24, 48 and 72 hrs lead period were 13.4, 15.0 and 9.0 knots against the LPA errors of 8.9, 13.0, and 15.4 knots during 2015-19 respectively.

- The root mean square error (RMSE) of intensity (wind) forecast for 24, 48 and 72 hrs lead period were 18.8, 22.1 and 12.2 knots against the LPA errors of 11.5, 16.7, and 19.2 knots respectively.

- The skill (%) in intensity forecast as compared to persistence forecast based on AE for 24, 48 and 72 hrs lead period was 56%, 80% and 94% against the LPA of 45%, 69% and 72% respectively.

- The skill (%) in intensity forecast based on RMSE for 24, 48 and 72 hrs lead period was 50%, 76% and 93% against the LPA of 49%, 63% and 72% respectively.
- Thus even being a Super cyclone, the intensity forecast was skill full and better than the Long Period Average.

5.4.2.2. Severe Cyclonic Storm “NISARGA” over the Arabian Sea (1-4 June)

A Low-pressure area formed over southeast & adjoining eastcentral Arabian Sea and Lakshadweep area in the early morning (0000 UTC) of 31st May 2020. Under favorable environmental conditions, it concentrated into a depression over eastcentral and adjoining southeast Arabian Sea in the early morning (0000 UTC) of 1st June 2020. It intensified into deep depression over eastcentral Arabian Sea in the early morning (0000 UTC) and into cyclonic storm “NISARGA” in the noon (0600 UTC) of 2nd June. It moved northwards till evening (1200 UTC) of 2nd June. Thereafter, it gradually recurved northeastwards and intensified into a severe cyclonic storm in the early morning (0000 UTC) of 3rd June 2020. Further moving northeastwards, it crossed Maharashtra coast close to south of Alibag as a severe cyclonic storm with a maximum sustained wind speed of 110-120 kmph gusting to 130 kmph during 0700-0900 UTC of 03rd June. Continuing to move northeastwards after landfall, it weakened into a cyclonic storm in the evening (1200 UTC) over north Madhya Maharashtra and into a deep depression in the mid-night (1800 UTC) of 3rd June 2020 over the same region. It further weakened into a depression over western parts of Vidarbha and neighbourhood in the early morning (0000 UTC) and into a well-marked low-pressure area in the evening (1200 UTC) of 4th June over central parts of Madhya Pradesh. It lay as a low-pressure area over southeast Uttar Pradesh and adjoining Bihar in the afternoon (0900 UTC) of 5th June (Fig. 25).

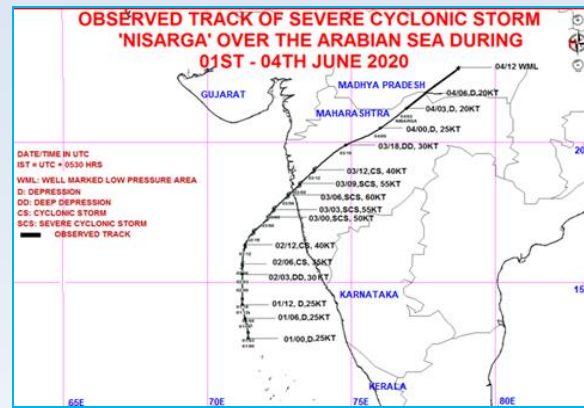


Fig. 25. Observed track of SCS ‘NISARGA’ over the eastcentral and adjoining southeast Arabian Sea (1st - 4th June, 2020)

Forecast Performance

- First information about development of low pressure area over southeast Arabian Sea was given in the extended range outlook issued on 21st May about 10 days prior to the formation of low pressure area over the southeast & adjoining eastcentral Arabian Sea and Lakshadweep area on 31st May.
- First information about development of depression over southeast Arabian Sea was issued in the tropical weather outlook and national weather forecast bulletin issued at 1200 noon of 29th May about 3 days prior to the formation of depression over southeast & adjoining eastcentral Arabian Sea on 1st June morning.
- With the formation of low pressure area over southeast & adjoining eastcentral Arabian Sea on 31st May morning, IMD issued first bulletin at 0630 UTC of 31st May and indicated that the system would intensify into a cyclonic storm and reach north Maharashtra and Gujarat coasts by 3rd June, (about 77 hours prior to landfall of SCS NISARGA).
- In the bulletin issued at 0400 UTC of 1st June, it was indicated that the system would intensify upto severe cyclonic storm stage with maximum sustained wind speed of 105-115 kmph gusting to 125 kmph and cross north Maharashtra and south Gujarat coasts between Harihareshwar (Raigad), Maharashtra and Daman during evening/ night of 3rd June

(about 52 hours prior to landfall of SCS NISARGA).

- In the bulletin issued at 0600 UTC of 2nd June, it was indicated that the system would cross close to Alibag (Raigad District, Maharashtra) during the afternoon of 03rd June as a Severe Cyclonic Storm with a maximum sustained wind speed of 100-110 kmph gusting to 120 kmph (about 28 hours prior to landfall of SCS NISARGA).

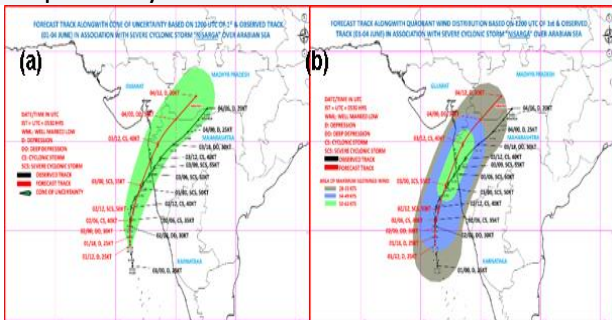
- Actually, the severe cyclonic storm Nisarga crossed north Maharashtra coast close to south of Alibag with a maximum sustained wind speed of 110-120 kmph gusting to 130 kmph between 0700 & 0900 UTC of 3rd June.

- Actually, the severe cyclonic storm Nisarga crossed north Maharashtra coast close to south of Alibag with a maximum sustained wind speed of 110-120 kmph gusting to 130 kmph between 0700 & 0900 UTC of 3rd June.

- Thus, the track, landfall point & time, intensity and associated adverse weather like heavy rainfall, gale wind and storm surge were predicted well in advance by IMD.

- Typical observed & forecast track along with cone of uncertainty and quadrant wind distribution based on 1200 UTC of 1st June about 45 hours prior to landfall is presented in Fig. 26.

- The landfall point forecast errors for 12, 24 and 48 hrs lead period were 7.8, 33.1 and 80.1 km respectively against the LPA errors of 25.4, 44.7 and 69.4 km during 2015-19 respectively.



Figs. 26(a&b). Typical observed and forecast track along with cone of uncertainty and quadrant wind distribution based on 1200 UTC of 1st June (45 hrs prior to landfall) of SCS NISARGA

- The landfall time forecast errors for 12, 24 and 48 & 72 hrs lead period were 0, 0.5, 0 & 1.0 hours respectively against the LPA errors of 2.0, 3.0 & 5.4 hours during 2015-19 respectively.

- The track forecast errors for 12, 24 & 48 hrs lead period were 59.7, 111.6, and 212.0 km respectively against the LPA errors of 49.6, 80.6 & 125.5 km respectively. The relatively higher forecast error was due to recurving nature of the track.

- The track forecast skill was about 67%, 73%, and 78% against the LPA skill of 58%, 61% & 73% for 12, 24 & 48 hrs lead period respectively. Thus, the track forecast skill was higher than the past five years average skill during 2015-19 for all lead periods.

- The absolute error (AE) of intensity (wind) forecast for 12, 24 & 48 hrs lead period were 2.9, 3.3 and 7.5 knots against the LPA errors of 5.4, 8.9 & 13.0 knots during 2015-19 respectively.

- The root mean square error (RMSE) of intensity (wind) forecast for 12, 24 & 48 hrs lead period were 4.6, 5.8 & 7.9 knots against the LPA errors of 7.1, 11.5 & 16.7 knots respectively.

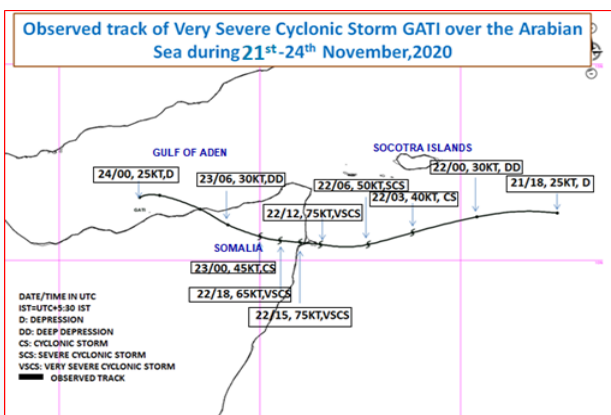
- The skill (%) in intensity forecast based on AE for 12, 24 & 48 hrs lead period was 80%, 89% and 81% against the LPA of 28%, 45% & 69% respectively.

- The skill (%) in intensity forecast based on RMSE for 12, 24 & 48 hrs lead period was 78%, 85% and 82% against the LPA of 36%, 49% & 63% respectively.

5.4.2.3 Very Severe Cyclonic Storm “GATI” over the Arabian Sea (21st – 24th November 2020)

- Very Severe Cyclonic Storm (VSCS) “GATI” originated from a low pressure area formed over central parts of south Arabian Sea (AS) in the morning (0300 UTC) 19th November. It lay

as a well marked low pressure area over southwest AS & neighborhood in the early morning (0000 UTC) 21st. It concentrated into a depression over the same region in the midnight (1800 UTC) of 21st. Moving west-southwestwards, it explosively intensified into a deep depression in the early morning (0000 UTC) of 22nd further into the cyclonic storm "GATI" in the same morning (0300 UTC), into a severe cyclonic storm in the noon (0600 UTC) and into very severe cyclonic storm in the afternoon (0900 UTC) over southwest AS. It reached its peak intensity of 75 knots in the same evening (1200 UTC) over the southwest AS. Continuing to move westwards, it crossed Somalia coast near latitude 10.45°N and longitude 51.10°E between 1400 and 1500 UTC of 22nd as a very severe cyclonic storm with estimated wind speed of 130-140 kmph gusting to 155 kmph. Continuing to move nearly westwards, it weakened into a severe cyclonic storm in the early hours (2100 UTC of 22nd) of 23rd into a cyclonic storm in the early morning (0000 UTC) and into a deep depression in the same noon (0600 UTC) over north Somalia.



Figs. 27. Observed track of VSCS GATI (21-24 November, 2020) over the Arabian Sea

- Thereafter, it moved west-northwestwards and emerged into Gulf of Aden in the evening (1200 UTC) of 23rd. Continuing to move west-northwestwards, it weakened into a depression in the early morning (0000 UTC) of 24th over Gulf of Aden and adjoining north Somalia and into a well marked low pressure area in the noon (0600 UTC) of 24th over the same region. As per

media reports, intense rainfall activity occurred over north Somalia. More than 20 cm rainfall occurred during the period of a day against about 10 cm of annual rainfall over this region (Fig. 27).

Forecast Performance

- The extended range outlook issued on 12th November indicated that a depression would form over southwest AS during the week (20-26 November) (about 9 days prior to formation of depression). Actually, depression formed over southwest AS on 21st November.

- The tropical weather outlook issued on 17th November, indicated that a low pressure area would form over south Arabian Sea around 19th with moderate probability of its intensification into depression (51-75%) around 21st. It was also indicated that the system would move gradually west-northwestwards towards Gulf of Aden by 24th November.

- The first press release issued in association with this system at 1730 hrs IST of 18th November indicated that a depression would form over southwest AS around 21st. It also indicated that, it would move west-northwestwards away from Indian coast (about 3 days and 6 hours prior to formation of depression). Wind warnings for deep sea areas of Arabian Sea were issued in the Press Release along with the advisories for fishermen.

- On 18th November, the detailed daily Report with prognosis and diagnosis issued by IMD under the Forecast Demonstration Project (FDP) indicated that a low pressure area would form over south Arabian Sea around 19th with moderate probability of its intensification into depression around 21st. It was also indicated that the system would move gradually west-northwestwards towards Gulf of Aden by 24th November. Intense observation period was declared for Lakshadweep on 18th November and for South Oman and Yemen during 22nd to 25th November. This bulletin is uploaded every

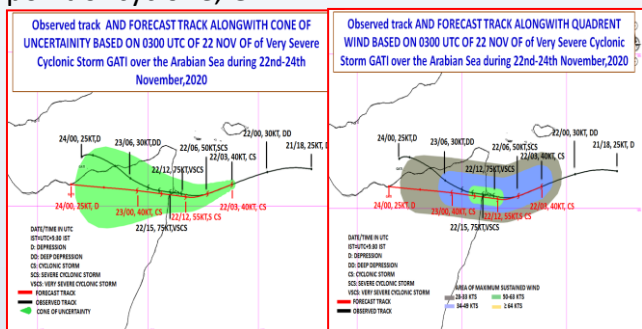
day on RSMC website and sent by email to all the beneficiaries of RSMC advisories everyday during FDP Phase (October-December).

- First information that the system would cross north Somalia coast around 10.5° N during early morning hours of 23rd was issued at 0900 hrs IST of 22nd November as a severe cyclonic storm with wind speed of 100-110 kmph gusting to 120 kmph. Warnings were further upgraded afterwards. Actually, the system crossed north Somalia coast near 10.5° N/ 51.1° E around 1500 UTC with maximum sustained wind speed of 130-140 kmph gusting to 155 kmph.

- Since 18th November onwards, regular updates about the state of Arabian Sea and advisories for fishermen were issued for the states along the west coast of India and Lakshadweep Islands.

- Thus, track and landfall could be predicted well. However, majority of models could not capture the fast movement and rapid intensification of the system over the southwest Arabian Sea leading to higher intensity forecast errors operationally.

- The observed and forecast track based on 0300 UTC of 22nd about 12 hrs prior to landfall demonstrating accuracy in track and landfall prediction is presented in Fig. 6. The black and red lines indicate the observed (actual) track and forecast track respectively. The closeness of these two lines indicate very accurate forecast of track (movement) and landfall point of cyclone, GATI.



Figs. 28. Observed and forecast track of VSCS GATI based on 0830 hours IST of 22nd November (12hrs in advance of landfall) demonstrating accuracy in track, landfall and intensity forecast

- The 12 hr landfall point forecast error was 7.7km against the long period average (LPA) error of 45 km during 2015-19 respectively. The landfall time forecast error for 12 hrs lead period was 1.5 hours against the LPA (2015-19) error of 2.0 hrs.

- The track forecast errors for 12, 24 and 48 hrs lead period were 61.2, 100.6, and 113.3 km respectively against the LPA errors (2015-19) of 49.6, 80.6 and 125.5 km respectively. The track forecast skill was about 63%, 67% and 78% against the LPA skill of 58%, 61%, and 73% for 12, 24 and 48 hrs lead period respectively.

- The absolute error (AE) of intensity (wind) forecast for 12, 24 and 48 hrs lead period were 6.4, 5.1 and 0.7 knots against the LPA errors of 5.4, 8.9 and 13.0 knots during 2015-19 respectively. The root mean square error (RMSE) of intensity (wind) forecast for 12, 24 and 48 hrs lead period were 8.5, 5.1 and 0.7 knots against the LPA errors of 7.1, 11.5 and 16.7 knots respectively.

- The skill (%) in intensity forecast as compared to persistence forecast based on AE for 12, 24 and 48 hrs lead period was 78%, 94% and 99% against the LPA of 29%, 45% and 69% respectively. The skill (%) in intensity forecast based on RMSE for 12, 24 and 48 hrs lead period was 78%, 94% and 99% against the LPA of 36%, 49% and 63% respectively.

5.4.2.4. Very Severe Cyclonic Storm “NIVAR” over the Bay of Bengal (22nd -27th November 2020)

A Low Pressure Area (LPA) formed over Equatorial Indian Ocean (EIO) and adjoining central parts of south Bay of Bengal (BoB) on 21st November.

It lay as a Well Marked Low Pressure Area (WML) over southwest & adjoining southeast Bay of Bengal on 22nd November. It concentrated into a depression over the same region in the early hours (0230 hrs IST / 2100 UTC of 22nd) of 23rd November.

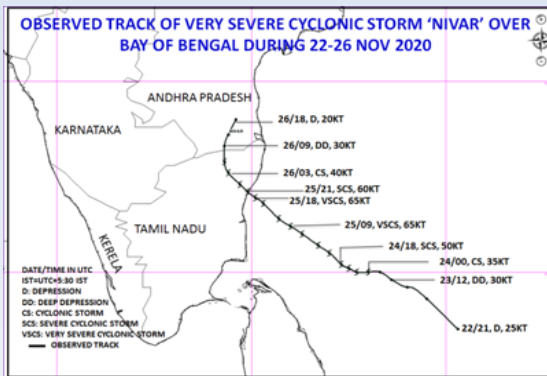


Fig. 29. Observed track of very severe cyclonic storm "NIVAR" over Bay of Bengal

Moving west-northwestwards, it intensified into a deep depression in the evening of 23rd and further into the cyclonic storm "NIVAR" in the early morning (0530 hrs IST / 0000 UTC) of 24th over southwest BoB. Continuing to move west-northwestwards, it further intensified into a severe cyclonic storm in the midnight (2330 hrs IST / 1800 UTC) of 24th and into a very severe cyclonic storm in the afternoon (1430 hrs IST / 0900 UTC) of 25th. Moving further northwestwards, it crossed Tamilnadu & Puducherry coasts near Puducherry (near lat. 12.1°N and long. 79.9°E) during 2330 IST of 25th to 0230 IST of 26th as a very severe cyclonic storm with estimated wind speed of 120 kmph gusting to 135 kmph. Continuing to move northwestwards, it weakened into a severe cyclonic storm in the early morning hours (0230 hrs IST) of 26th. Thereafter, it moved north-northwestwards and weakened into a cyclonic storm in the morning (0830 hrs IST / 0300 UTC) of 26th November, 2020 over north coastal Tamilnadu. Thereafter, it started re-curving north-northeastwards and weakened into a deep depression in the afternoon (1430 hrs IST) of 26th over south Rayalaseema, into a depression in the same midnight (2330 hrs IST) over south coastal Andhra Pradesh. Thereafter, it weakened into a well marked low pressure area over south coastal Andhra Pradesh and adjoining westcentral BoB in the early morning (0000 UTC) of 27th November. Under the influence of this system, intense rainfall activity occurred over north Tamil Nadu & Puducherry, Rayalaseema and south coastal Andhra

Pradesh. Heavy to very heavy rainfall occurred at a few places and isolated extremely heavy rainfall (≥ 20 cm) occurred over north Tamilnadu, Puducherry on 24th, 25th & 26th and over Rayalaseema & south coastal AP on 25th and 26th (Fig. 29).

Forecast Performance

- The extended range outlook issued on 12th November, indicated that a low pressure area would form over BoB during first half of week (20-26 November) and depression would form over south Bay of Bengal later half of the week. Actually, low pressure area formed over EIO and adjoining central parts of south BoB on 21st November and depression formed over central parts south BoB in on 23rd November. Thus, the genesis of "NIVAR" was predicted by IMD about 12 days in advance.
- The daily national bulletin issued at 1210 hrs IST of 20th November indicated that a low pressure area would form over central parts of south Bay of Bengal around 23rd November, 2020. It was also indicated that it would concentrate into a depression over southwest Bay of Bengal and move west-northwestwards towards Tamilnadu coast by 25th. Actually, the system moved northwestwards towards Tamilnadu coast and crossed the coast in the late night of 25th. Thus, track of "NIVAR" was predicted correctly by IMD about 5 days in advance.
- The first special bulletin and press release issued at 1500 hrs IST of 21st November indicated that a depression would form over southwest BoB around 23rd. It was also indicated that, it would intensify further and move west-northwestwards towards Sri Lanka-south Tamil Nadu coast and reach near Tamil Nadu & Puducherry coast on 25th November, 2020 (about 4 days and 8 hours prior to landfall near Puducherry).
- In the bulletin issued at 1130 hrs IST of 22nd November. It was indicated that the cyclone would cross Tamilnadu and

South Andaman Sea and Equatorial Indian Ocean on 29th. Under favourable environmental conditions, it concentrated into a Depression in the early morning (0530 hrs IST / 0000 UTC) of 30th November 2020 over Southeast Bay of Bengal. Moving nearly westwards, it intensified into a Deep Depression in the early morning of 1st December 2020 over Southwest and adjoining Southeast Bay of Bengal. Subsequently it moved west-northwestwards and intensified into Cyclonic Storm 'Burevi' over Southwest Bay of Bengal in the evening (1730 hrs IST / 1200 UTC) of 1st December 2020. Continuing the west-northwestward movement, it crossed Sri Lanka coast close to north of Trincomalee near Lat. 8.85°N and Long. 81.0°E between 2230 and 2330 hrs IST (1700 & 1800 UTC) of 2nd December 2020 as a Cyclonic Storm with a maximum sustained wind speed of 80-90 kmph gusting to 100 kmph. Moving across northern parts of Sri Lanka, it emerged into Gulf of Mannar in the morning and lay centred close to Pamban around noon (1130 hrs IST / 0600 UTC) of 3rd December. It crossed Pamban area around 0800 UTC of 3rd. Continuing to move west-northwestwards, it weakened into a Deep Depression over the same region in the evening (1200 UTC) of 3rd December. Thereafter the movement slowed down significantly and it remained practically stationary over Gulf of Mannar close to Ramanathapuram district coast for nearly 18 hours and further weakened into a Depression in the evening of 4th December over the same region. Further remaining stationary at the same place for subsequent 18 hours, it gradually weakened into a well marked Low pressure area around noon (1130 hrs IST / 0600 UTC) of 5th December Fig. 31. This system during its initial stage as a Low pressure area had caused fairly widespread rainfall with isolated very heavy falls over Andaman & Nicobar Islands on 29th November. Under the influence of this system, widespread rainfall with heavy to very heavy falls at a few places & extremely heavy (≥ 20 cm) falls at isolated places occurred over Tamil Nadu during 2-4 December.

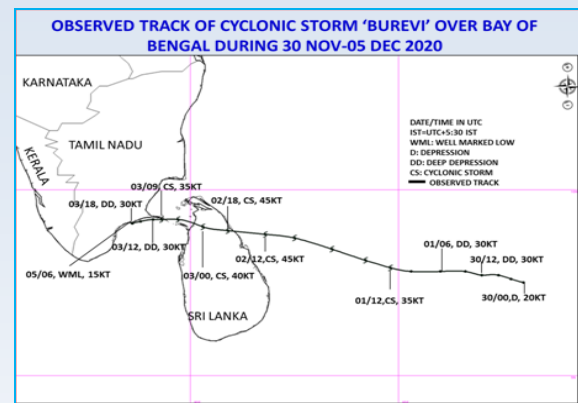


Fig. 31. Observed track of cyclonic storm "BUREVI" over Bay of Bengal

Forecast Performance

- The extended range outlook issued on 26th November indicated that there is a 'High' (68–100 %) probability for cyclogenesis over southwest Bay of Bengal during the second half of week (27th November - 03rd December). Actually, the Depression formed over southeast BoB on 30th November.
- First information that a low pressure area would form over southeast Bay of Bengal around 28th November with high (76-100%) probability of its intensification into depression around 30th was issued in the Tropical Weather Outlook at 1130 hrs IST of 27th November. Actually low pressure area formed over south Andaman Sea on 28th November (0830 hrs IST) and it concentrated into a depression over southwest Bay of Bengal on 30th (0530 hrs IST).
- The information that a low pressure area would form over southeast Bay of Bengal around 29th November was also provided in the Press Release issued at 1600 hrs IST of 27th November. All warnings w.r.t. heavy rainfall, strong wind, state of Sea and advisory for fishermen was issued in the Press Release. Extremely heavy rainfall warning over Tamil Nadu & Puducherry on 2nd & 3rd December was also indicated in the Press Release. Special bulletins were issued by Area Cyclone Warning Centre, Chennai and Cyclone Warning Centre, Thiruvananthapuram also.

- In the first Press Release issued on 27th November, it was also indicated that the system would intensify further and move towards Tamil Nadu-Puducherry coasts.
- The bulletin issued at 0930 hrs IST of 30th Fig. 32, indicated that the system would intensify upto cyclonic storm stage, cross Sri Lanka coast between 7.5-9.0 degree N around evening of 2nd December. It was also indicated that the system would emerge into Gulf of Mannar and Comorin area on 3rd December morning. Actually, the system crossed Sri Lanka coast as a cyclonic storm near 08.85 N and Log 81.0 °E during 2230 – 2330 UTC of 2nd December 2020. It emerged into Gulf of Mannar during forenoon of 3rd December.
- The warnings were further updated and at 0210 hrs IST of 1st December, it was indicated that the system would emerge into Gulf of Mannar- Comorin area on 3rd December morning and move towards south Tamil Nadu coast.
- The warnings were further updated and at 1430 hrs IST of 1st December, it was indicated that the system would emerge into Gulf of Mannar and adjoining Comorin area on 3rd December morning and cross south Tamil Nadu coast between Kanniyakumai and Pamban around early morning of 4th December.

- At 1130 hrs IST of 2nd December, it was further indicated that the system would be centered very close to Pamban around noon of 3rd December and it's impact over Ramanathapuram district will commence from 3rd December forenoon.

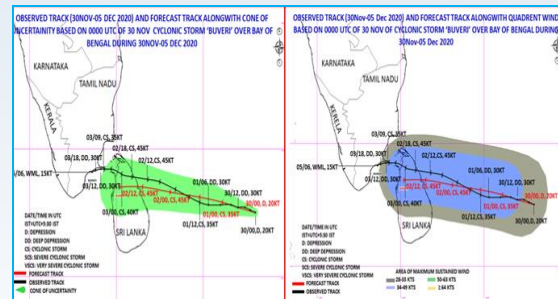


Fig. 32. The observed and forecast track of cyclonic storm “BUREVI” based on 0000 UTC of 30th November demonstrating accuracy in landfall, track and intensity prediction (about 60 hrs prior to landfall over Sri Lanka)

The salient features of the five cyclones during 2020 are presented in Table 3 and their composite tracks are presented in Fig. 33.

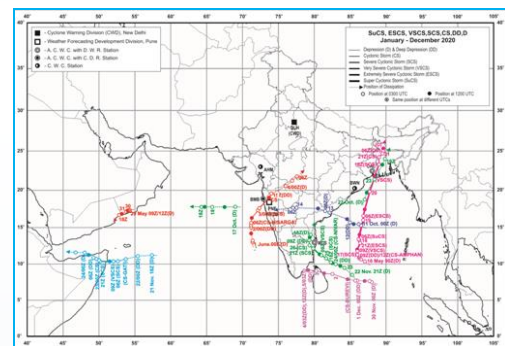


Fig. 33. Composite tracks of cyclones during 2020

TABLE 3

Characteristics of cyclones during 2020

S. No.	Cyclonic storm/Depression	Date, Time & Place of genesis (Lat. N/long E)	Date, Time (UTC) Place (Lat./Long.) of Landfall	Estimated lowest central pressure, Time & Date (UTC) & Lat.N/Long.E	Estimated Maximum wind speed (kt), Date & Time	Max T. No. Attained
1	Super Cyclonic Storm (SuCS) AMPHAN over Southeast Bay of Bengal during 16-21 May	16 th May 2020, 0000 UTC over Southeast Bay of Bengal near (10.4N/87.0E)	Crossed West Bengal – Bangladesh coasts as a very severe cyclonic storm across Sundarbans, near lat.21.65°N/long. 88.3°E during 1000-1200 UTC	920 hPa at 1800 UTC 18 th May 2020 near (14.9N/86.5E)	130 knots at 1800 UTC 18 th May 2020 near (14.9N/86.5E)	T 6.5
2	Severe Cyclonic Storm NISARGA over eastcentral and adjoining southeast Arabian Sea during 01-04 June	1 st June 2020, 0000 UTC over eastcentral and adjoining southeast Arabian Sea (13.0N/71.4E)	Crossed Maharashtra coast close to south of Alibag near 18.35°N/72.95°E, as Severe Cyclonic Storm between 0700-0900 UTC of 03 rd June	984 hPa at 0600 UTC 3 rd June 2020 near (18.1N/72.8E)	60 knots at 0600 UTC 3 rd June 2020 near (18.1N/72.8E)	T 4.0
3	Very Severe Cyclonic Storm GATI over Arabian Sea during 21-24 November	21 st November 2020 at 1800 UTC over Arabian Sea near (11.2N/57.4E)	Crossed Somalia Coast near lat 10.450 N and long 51.10 E between 1400 and 1500 UTC of 22nd Nov.	976 hPa at 1200 UTC on 22 nd November 2020 near (10.4N/51.5E)	75 knots at 1200 UTC on 22 nd November 2020 near (10.4N/51.5E)	T 4.5
4	Very Severe Cyclonic Storm Nivar over Bay of Bengal during 22-26 November	22 nd November 2020, 2100 UTC over Bay of Bengal near (8.5N/85.3E)	Crossed Tamilnadu and Puducherry coasts near Puducherry (near Lat 12.10N and Log 79.90 E) during 1800 – 2100 UTC of 25th	982 hPa at 0900 UTC on 25 th November 2020 near (11.2N/81.0E)	65 knots at 0900 UTC on 25 th November 2020 near (11.2N/81.0E)	T 4.0
5	Cyclonic Storm Burevi over Bay of Bengal during 30 Nov-05 December (November)	30 th Nov 2020, 0000 UTC over Bay of Bengal near (7.5N/88.0E)	1) Crossed Sri Lanka coast close to north of Trincomalee (near Lat 08.850N and Log 81.00 E) during 1700 – 1800 UTC of 02nd December 2020 2) Crossed Pamban area (near Lat 09.20N and Log 79.350 E) during 0800 UTC of 03rd December 2020	996 hPa at 0600 UTC 02 nd December 2020 near (8.8N/82.2E)	45 knots at 0600 UTC 02 nd December 2020 near (8.8N/82.2E)	T 3.0

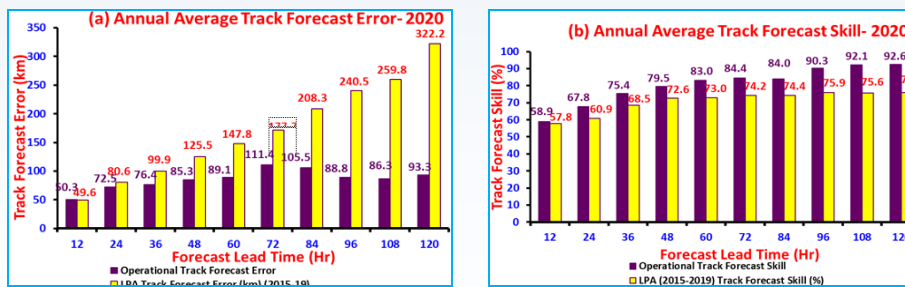
5.5.3. Annual Average Cyclone Forecast error and skill during 2020

5.5.3.1. Annual Track, landfall and intensity forecast error

- Track forecast

The annual average track forecast errors in 2020 have been 72 km, 85 km and 111 km, respectively for 24, 48 and 72hrs against the past five year average error of 80, 125 and

177 km based on data of 2015-2020. The errors have been significantly lower during this year as compared to long period average (2015-19) for all lead periods upto 120 hours. The track forecast skills compared to climatology and persistence forecast are 68%, 79% and 84% respectively for the 24, 48 and 72 hrs lead period which is comparatively higher than long period average of 2015-2020 (58%, 80% & 84% respectively). The track forecast errors and skill during 2020 are presented in Fig. 34.



Figs. 34(a&b). Annual average (a) track forecast error (km) and (b) track forecast skill against the climatology and persistence forecast during 2020 as compared to that during 2015-2020

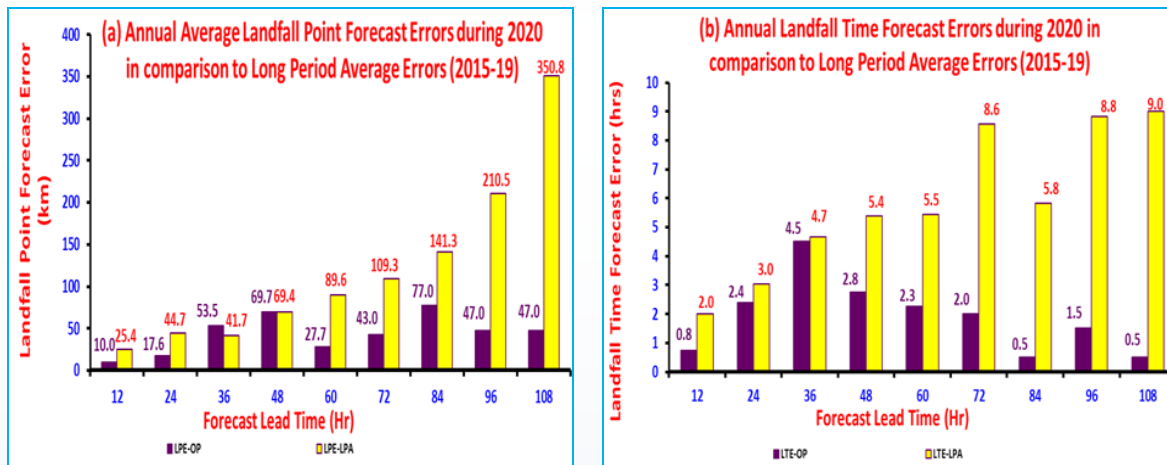


Fig. 35(a&b). Annual average (a) landfall point forecast error (km) and (b) landfall time (hrs) during 2020 as compared to that during 2015-2020

- Landfall forecast

The annual average landfall point forecast errors for the year 2020 have been 18 km, 70 km and 43 km for 24, 48 and 72 hrs lead period against the long period average of past five years during 2015-19 of 47 km, 70 km and 110 km [Figs. 35(a&b)].

The landfall time forecast errors have been 2.4, 2.8 and 2.0 hrs for 24, 48 and 72 hrs lead period during 2020 against the average of past

five years of 3.0, 5.4 and 8.6 hrs during 2015-2019.

- Intensity forecast

The average absolute errors during 2020 have been 7.1 knots, 8.8 knots and 9.3 knots respectively for 24, 48 and 72 hrs lead period of forecast against the long period average errors of 8.9, 13.0 and 15.4 knots during 2015-19 [Figs. 36 (a&b) and 37 (a&b)].

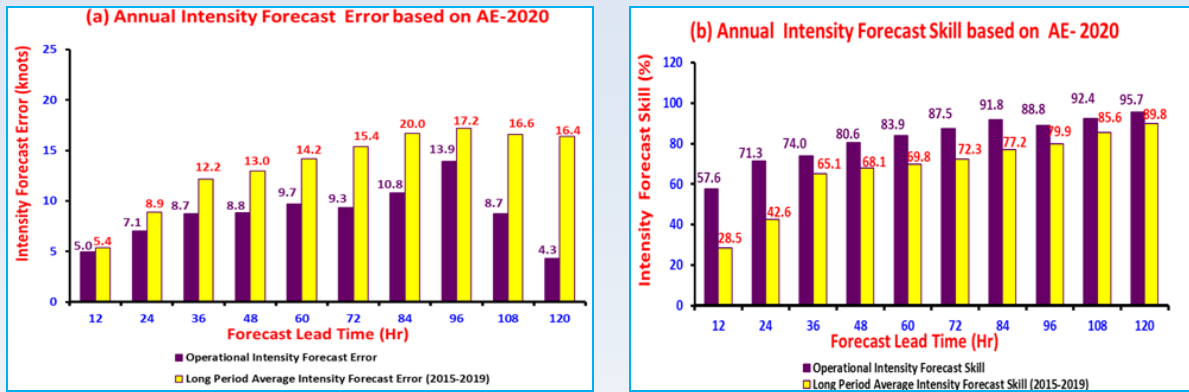


Fig. 36. Annual average intensity forecast error (knots) based on absolute errors and root mean square errors during 2020 as compared to LPA (2015-2020)

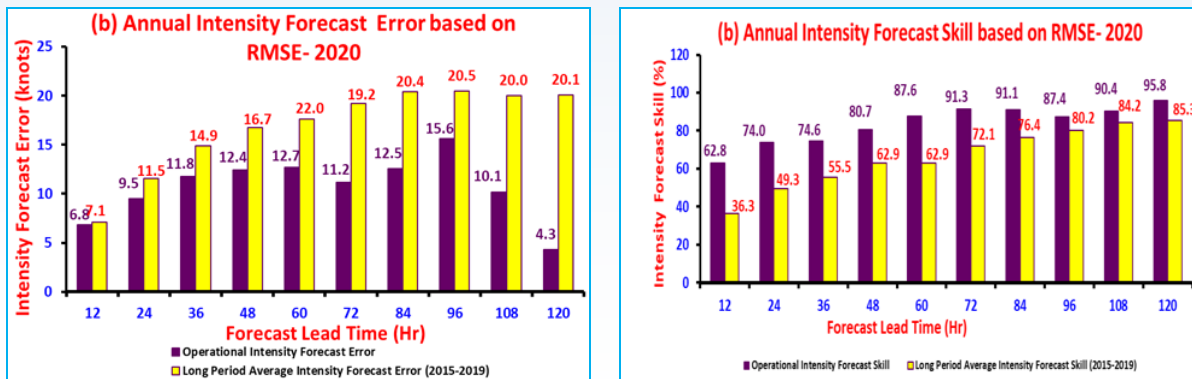


Fig. 37. Annual average intensity forecast skill (%) based on absolute errors and root mean square errors during 2020 as compared to that during 2015-2019

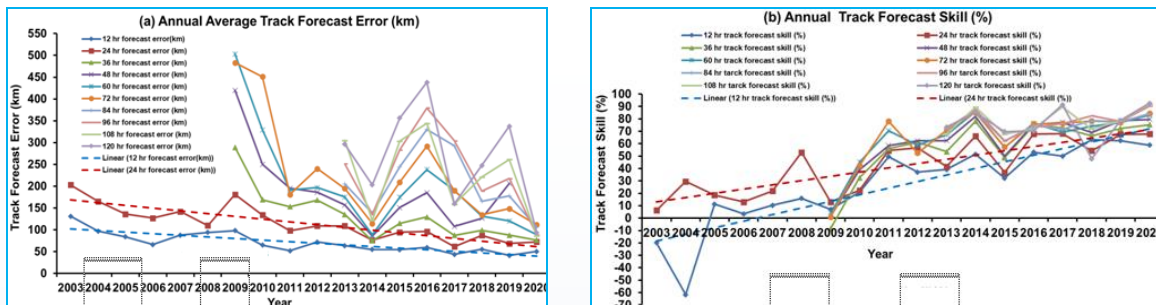


Fig. 38. Inter-annual average track forecast (a) errors and (b) skill during 2020

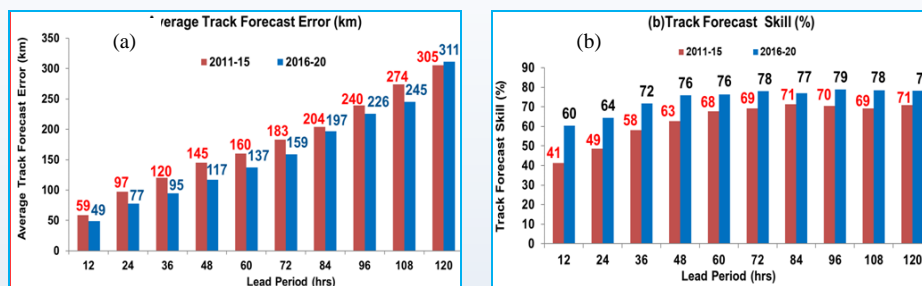


Fig. 39. Comparative Average track forecast (a) error and (b) skill during 2015-19 vis-à-vis 2010-14

The annual average skill based on AE and RMSE are presented in [Figs. 44(a&b)]. The average skill based on AE during 2020 have been 46.8, 63.5 & 69.6 % respectively for 24,

48 and 72 hrs lead period of forecast against the past five year average of 35.2, 55.7& 66.8%. The average skill based on RMSE during 2020 have been 51.3, 67.6 & 74.3 %

respectively for 24, 48 and 72 hrs lead period of forecast against the past five year average of 39, 59.6 & 72.2%.

5.5.3.2. Trend in errors and skill

• **Track forecast error and skill**

Inter-annual errors and skill in track forecast since 2003 are presented in [Figs. 38(a&b)]. There has been significant improvement in annual average track forecast errors and skill due to modernisation programme of IMD in 2009 with respect to observation, analysis and prediction tools & techniques which has been further augmented through improvement in observations, mainly from DWR and satellite and in terms of improved numerical modelling including enhanced data assimilation, higher resolution, improved physics etc.

There has been continuous improvement in track forecast accuracy with decrease in track forecast errors at the rate of 6.3 km/year (63 km in 10 years) for 24 hrs lead period and increase in skill at the rate of 3.4% per year

(34% in 10 years) since 2003. Similarly, for 12 hrs lead period, there has been improvement in track forecast accuracy with decrease in track forecast errors at the rate of 3.7 km/year (37 km in 10 years) and increase in skill at the rate of 5.3% per year (53% in 10 years) since 2003.

The comparative analysis of average track forecast error and skill during 2016-20 and 2011-15 is presented in (Fig. 39).

• **Landfall point and time forecast errors**

There has been an improvement in landfall point forecast accuracy at the rate of 16.4 km/year (164 km in 10 years) for 24 hrs lead period since 2003. Similarly, for 12 hrs lead period, there has been improvement in landfall point forecast error at the rate of 8.2km/year (82 km in 10 years) since 2003. Considering the landfall time errors, there has been an improvement at the rate of 0.21 hrs/year (2.1 hrs in 10 years) for 24 hrs lead period since 2003 is presented in (Fig. 40).

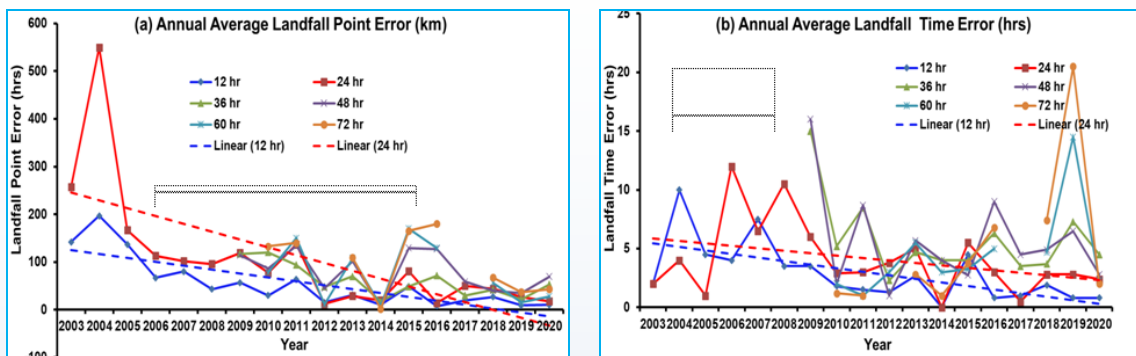


Fig. 40. Annual average (a) Landfall Point errors (b) Landfall Time errors

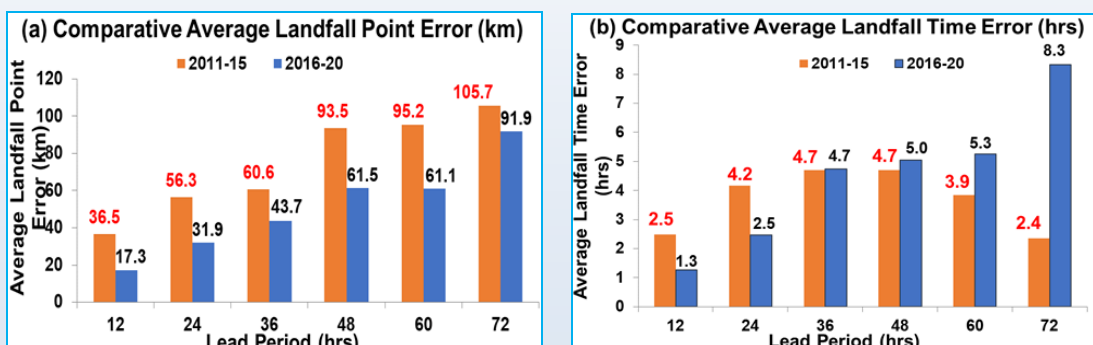


Fig. 41(a&b). Comparative Average landfall (a) point and (b) time forecast errors during 2016-20 vis-à-Vis 2011-15

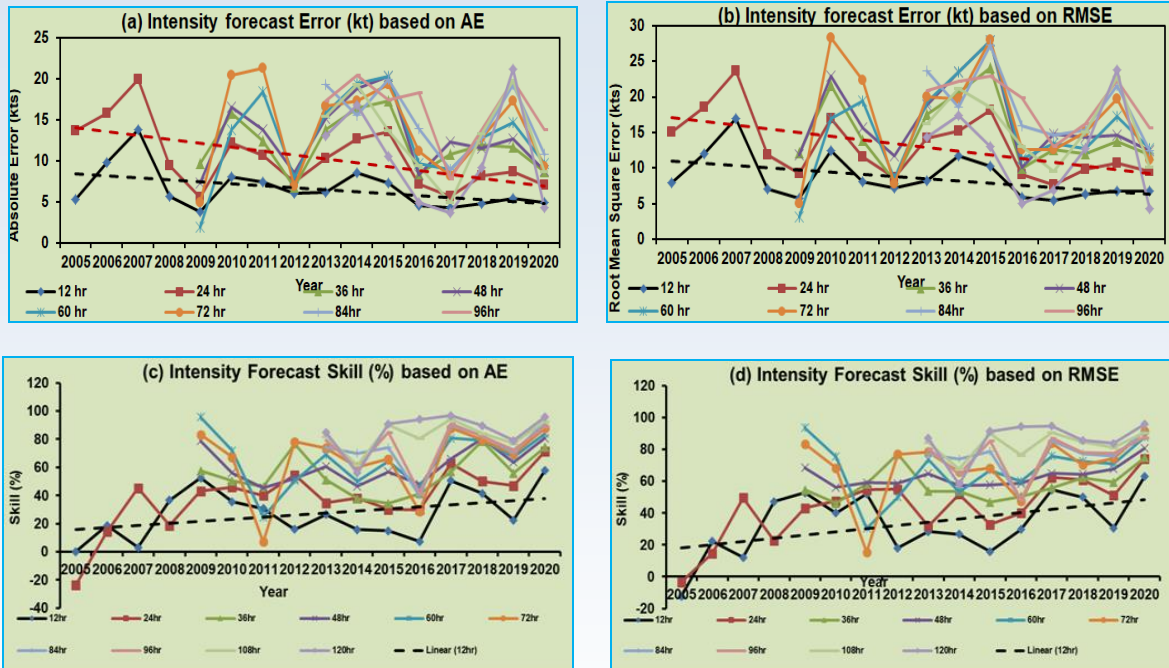


Fig.42(a-d). Annual average Intensity forecast(kts) errors based on (a) AE (b) RMSE and Annual average Intensity forecast skill (%) based on (c) AE (d) RMSE

Similarly, for 12 hrs lead period, there has been an improvement at the rate of 0.3 hrs/year (3.0 hrs in 10 years) for 12 hrs lead period since 2003.

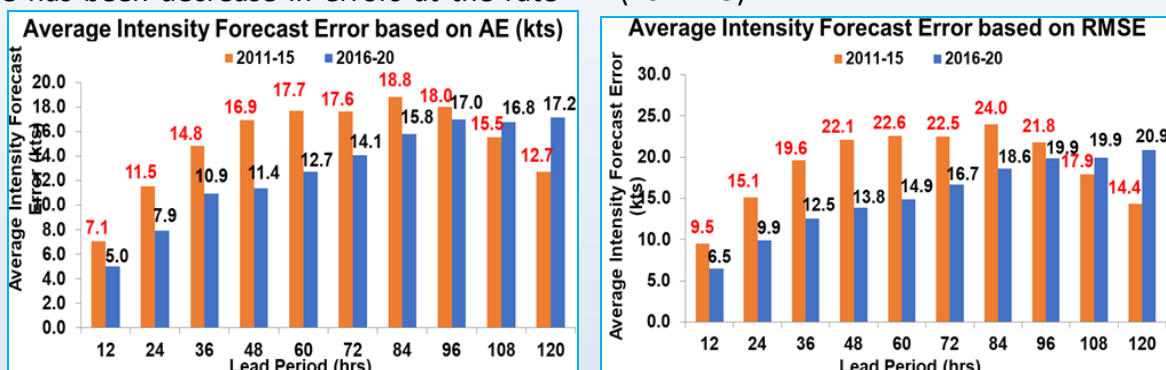
Comparative analysis of LPE and LTE during 2016-20 vis-à-vis 2011-15 is presented in Fig. 41. The 12 and 24 hr LPEs during 2016-20 were 17.3 km and 31.9 km against 36.5 km and 56.3 km respectively during 2011-15.

• **Intensity forecast error and skill**

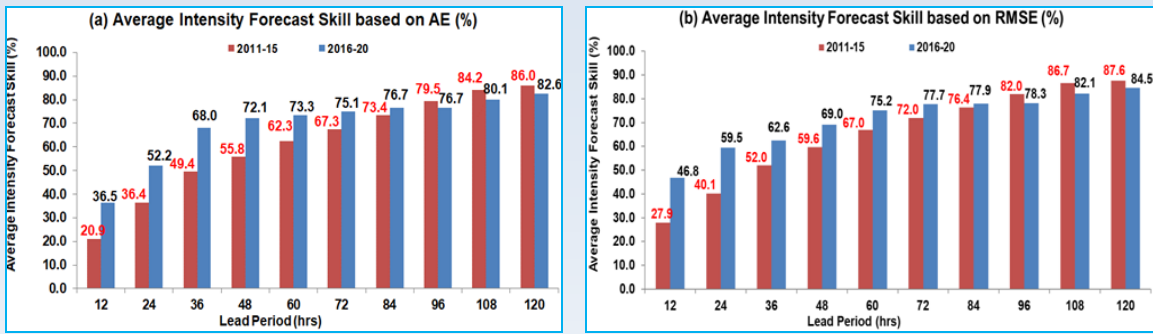
Inter-annual errors in intensity forecast since 2005 are presented in in Figs. 42(a-d) for skill in intensity forecast based on based on RSME. As regards improvement in intensity forecast, there has been decrease in errors at the rate

of 0.48 knots/year (4.8 knots in 10 years) for 24 hrs lead period and increase in skill at the rate of 3.1% per year (31% in 10 years) since 2005. Similarly, for 12 hrs lead period, there has been decrease in intensity forecast errors at the rate of 0.25 knots/year (2.5 knots in 10 years) and increase in skill at the rate of 1.5% per year (15% in 10 years) since 2003.

The comparative analysis of average intensity forecast error and skill based on AE and RMSE during 2016-20 and 2011-15 are presented in Fig. 43 and 44 respectively. It can be seen that there has been marginal improvement in intensity forecast during recent five years (2016-20) as compared to previous five years (2011-15).



Figs. 43(a&b).Comparative Average Intensity forecast errors (kts) based on (a) absolute error and (b) root mean square errors during 2016-20 vis-à-vis 2011-15

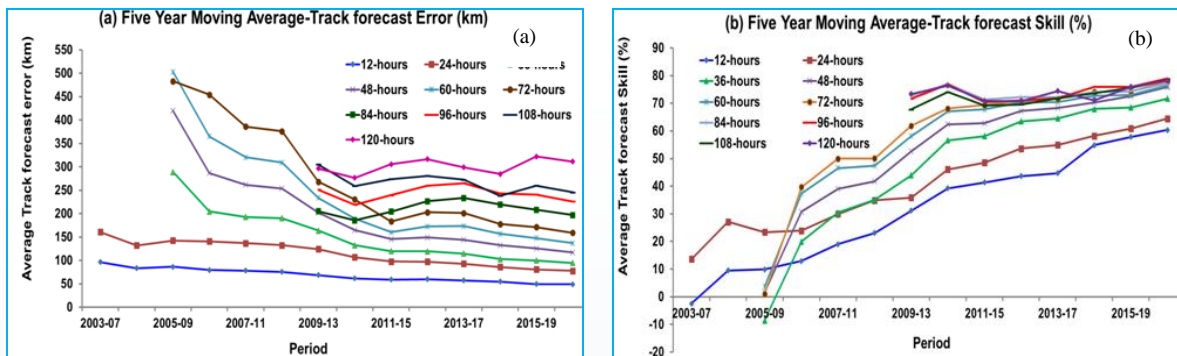


Figs. 44(a&b). Comparative Average Intensity forecast skill(%) based on (a) absolute error and (b) root mean square errors during 2016-20 vis-à-vis 2011-15

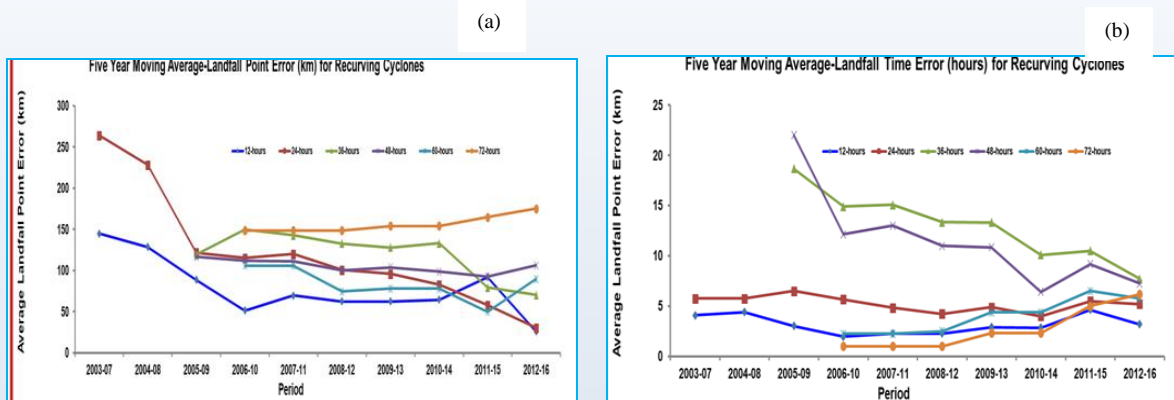
Five Year Moving Average errors and skill over north Indian Ocean

It can be seen from Figs. 45-47 that there has been continuous improvement in forecast accuracy with decrease in landfall and track forecast errors and increase in skill over the years. Due to modernization programme of

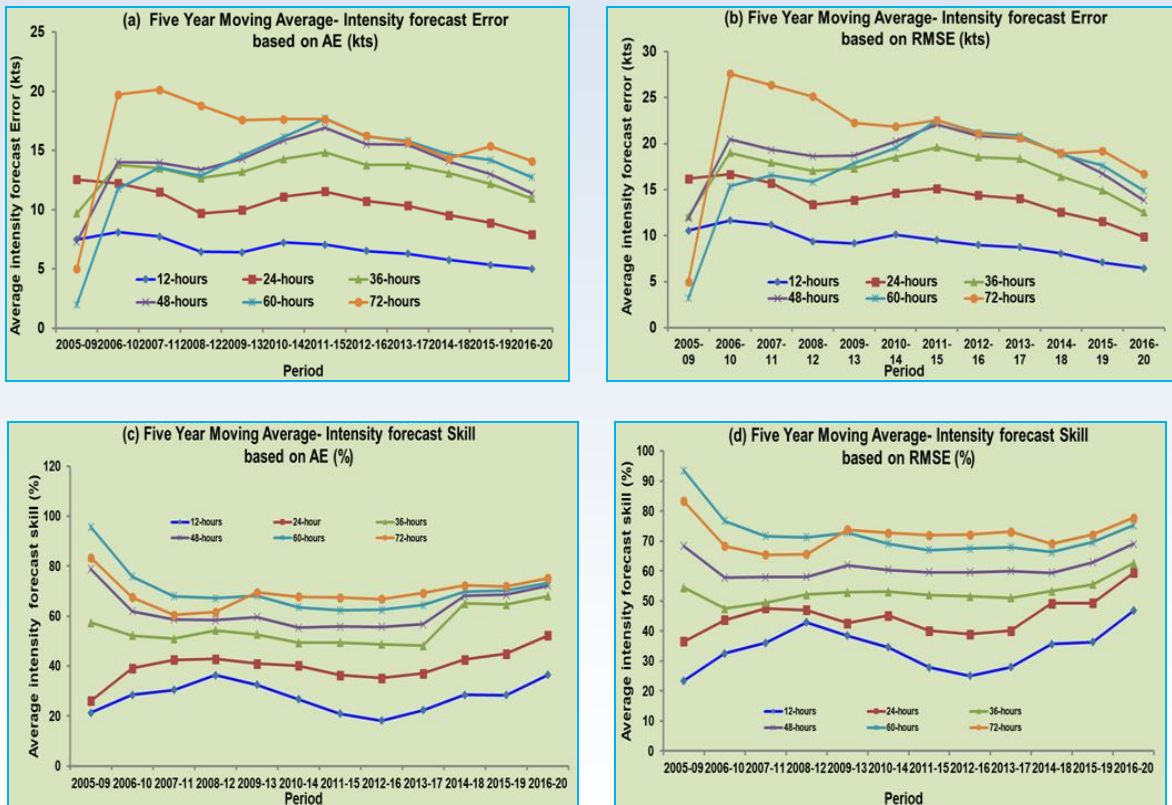
IMD and other initiatives of MoES, the improvement has been more significant since 2009. However, the rate of improvement in intensity forecast over the years has been marginal as can be seen from Fig. 47. The 36-72 hours forecasts commenced from 2009 and it was further extended to 120 hrs from 2013 onwards.



Figs. 45(a&b) . Five Year Moving Average (a) Track Forecast Error (km) and (b) Track Forecast Skill (%) of RSMC, New Delhi over North Indian Ocean



Figs. 46(a&b). Five Year Moving Average Errors in (a) Landfall Point (km) and (b) Landfall Time (hrs) of RSMC, New Delhi over north Indian Ocean



Figs. 47(a-d). Five Year Moving Average Intensity Forecast (a) Absolute Error (kts) and (b) Root Mean Square Error (kts) of RSMC, New Delhi over the NIO and Five Year Moving Average Intensity Forecast skill based on (c) AE and (d) RMSE of RSMC, New Delhi over North Indian Ocean

5.5.5. New initiatives

(i) Commencing from cyclone Amphan the cyclone warning bulletins and graphics were made available to public through Umang Mobile App of Govt. of India.

(ii) Cyclone warning graphics were also made available through Google Network.

(iii) Cyclone warning track with cone of uncertainty and wind warning distribution in four geographical quadrants around the centre of system on GIS platform was made live on RSMC, New Delhi website.

CHAPTER 6

CAPACITY BUILDING, PUBLIC AWARENESS & OUTREACH PROGRAMME

IMD's major initiative in 2020 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 & SYMPOSIUM

Shri H. R. Biswas, Sc. 'E' attended the International Conference on "**Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) Disaster Management Exercise - 2020**" held at Puri and Bhubaneswar during 11-13 February, 2020 and delivered a lecture on Early Warning System.

Dr. M. Mohapatra, DG, IMD attended the National Conference on "**Coastal Ocean-Atmosphere Science and Technology (COAST 2020)**" at Berhampur University and National Science Day at Institute of Physics, Department of Atomic Energy, Govt. of India as Chief Speaker on 28th February, 2020. He was also felicitated for accurate cyclone warning services in the region.



Dr. M. Mohapatra, DG, IMD during the Conference

6.2. WORKSHOP

Dr. S. O. Shaw, Sc. 'E' Guwahati participated in the workshop on "**Interim Report of SSAP for water sector Assam**" on 18th January, 2020 at IIT Guwahati.

Shri S. K. Manik, Sc. 'C' attended the International Workshop on "**Advanced spatial Analytics and Deep Learning for Geospatial Applications**" during 20-31 January, 2020 at Bengaluru.

Dr. K. K. Singh, Sc. 'G' and **Dr. S. D. Attri**, Sc. 'F' participated in "**Peer Exchange Round-table on Drought Resilient Agriculture**" organised by NIDM, New Delhi on 30th January, 2020.

Dr. S. D. Attri, Sc. 'F' participated in the workshop on "**Assessment and management of ground water resources under changing climatic conditions**" held at PAU Ludhiana on 6th February, 2020.



Dr. S. D. Attri, Sc. 'F' during the workshop

Shri Kuldeep Srivastava, Sc. 'E' attended a National Workshop on "**e-office**" on 12th February, 2020 at Pravasi Bhartiya Kendra, New Delhi.

Dr. Sanjib Bandyopadhyay, Sc. 'F' attended a workshop and delivered a lecture on "**Weather & Climate: Data Analysis and Application**" on 17th February, 2020 at University of Calcutta, Kolkata 700019 Organized by Department of Atmospheric Sciences, University of Calcutta.

Dr. G. K. Das, Sc. 'E' attended National Workshop on "**Weather & Climate: Data analysis and application**" at the Deptt. of Atmospheric Science, University of Calcutta on 18th February, 2020.

Shri H. R. Biswas, Sc. 'E' attended the Workshop on Implementation of Project on "**Urban Integrated Environmental Modeling and Services for Indian Cities**" at OSDMA, Rajiv Bhawan, Bhubaneswar on 19th February, 2020.

Dr. Sanjib Bandyopadhyay, Sc. 'F' inaugurated and participated in the Hindi workshop. **Shri Ramesh Chandra Mishra**, Hindi instructor from Department of Official Languages imparted the training on 5th March, 2020.



Dr. Sanjib Bandyopadhyay, Sc. 'F' during the Hindi workshop

Shri B. P. Yadav, Sc. 'F' and **Shri Asok Raja** Sc. 'C' attended the half Day Workshop on "**Water Security and Sustainable Development Hub**" on 13th March, 2020 at IIT, Delhi.

Shri Sukumar Roy, Met. 'A' co-ordinated and attended an online workshop of "**DAMUs of West Bengal and Odisha**" which was organized by ATARI Kolkata on 21st July, 2020.

Shri Raja Acharya, Met. 'A' attended a virtual workshop on "**Ocean Best Practices System (OBPS) Workshop IV**" organised by the IOC

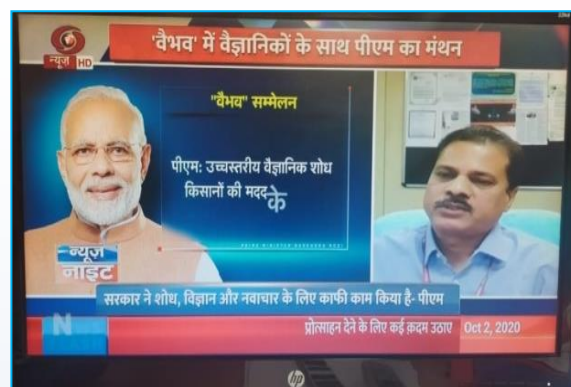
(Intergovernmental Oceanographic Commission) on 18, 21-25, 30 September, 2020.

Shri K. Raja, Met. 'B' RMC Chennai attended Annual Review workshop of "**DAMU, KVKS**" conducted online by ATARI, Hyderabad on 23rd September, 2020.

Shri B. P. Yadav, Sc. 'F' participated in Common Alert Protocol (CAP) Implementation Workshop 2020 for "**Emergency alerting mechanism**" of disasters on 28th September, 2020.

Dr. G. N. Raha, Sc. 'E', attended Stakeholders' workshop online through Zoom on 30th September, 2020 conducted by IRADe with support from Ministry of Environment, Forests & Climate Change (MoEFCC) under National Mission on Himalayan Studies aims to "**Develop Disaster Resilience Action Plan for Gangtok city**".

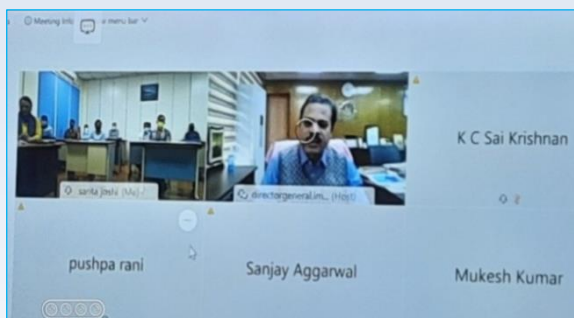
Dr. M. Mohapatra, DG, IMD attended **Vaibhav Summit** on 2nd October, 2020 and gave Interview at AIR, New Delhi.



Dr. M. Mohapatra, DG, IMD during Vaibhav Summit

मुख्यालय द्वारा दिनांक 11 नवंबर, 2020 को ई-हिंदी कार्यशाला का आयोजन किया गया। जिसका शुभारंभ डॉ. मृत्युंजय महापात्र, महानिदेशक महोदय द्वारा किया गया। महानिदेशक महोदय ने सभी प्रतिभा ग्यों को हिंदी कार्यशाला में प्रतिभा गता के लाभ के बारे में बताया। श्रीमती सरिता जोशी, सहायक निदेशक (रा.भा.), श्रीमती कल्पना

श्रीवास्तव, वरिष्ठ अनुवाद अधिकारी तथा श्री बीरेन्द्र कुमार, वरिष्ठ अनुवाद अधिकारी ने इस कार्यशाला में व्याख्यान दिए।



डॉ. मृत्युंजय महापात्र, महानिदेशक तथा अन्य
ई-हिंदी कार्यशाला के दौरान

Shri B. P. Yadav, Sc. 'F', **Shri Rahul Saxena**, Sc. 'F' and **Dr. Ashok Kumar Das**, Sc. 'E' attended the online Session of **"Regional cooperation workshop for enhancing forecasting, monitoring and preparedness for Floods and Droughts in South Asia"** during 8-10 December, 2020 organised by RIMES .

Shri Abhishek Anand, Sc. 'B' and **Shri Ravi Raushan**, S. A. attended the workshop on 18th December, 2020 organized by Birsa Agriculture University, Kanke (Ranchi) on the topic **"Sensitization of DAMUs in Jharkhand"**.

6.3. MEETINGS

Dr. (Ms.) Sathi Devi, Sc. 'F' and **Smt. Sunitha Devi S.**, Sc. 'E' attended a Meeting of the **"Expert Committee constituted for vetting of Terms of Reference of Expression of Interest (Eoi)/ Request for Proposal (RFP)"** for selection of an agency for conducting a pilot study on 'Multi Hazard Vulnerability Risk Assessment' at NDMA on 7th January, 2020 and provided inputs for modification of the RFP.

Dr. R. K. Jenamani, Sc. 'F' represented IMD and participated in **"23rd Cauvery Water Regulation Committee (CWRC)"** meeting held during 9-10 January, 2020 at Puducherry and presented the rainfall status of NE monsoon of 2019-20. He also visited the river delta and canal areas of Karikal-Tamil Nadu border areas

with expert team for hydro-meteorological assessment.

Shri H. R. Biswas, Sc. 'E' attended **"Crop Weather Watch Group Committee Meeting"** at Krushi Bhawan, Deptt. of Agriculture & Farmer's Empowerment, Govt. of Odisha on 13th January, 2020.

Dr. A. K. Das, Sc. 'E' attended the **"Inter-Ministerial Committee meeting on Water Conservation"** on 16th January, 2020 organized by DoWR, RD&GR (National Water Mission) at Sharm Shakti Bhawan, New Delhi.

Dr. S. D. Attri, Sc. 'F' participated in Project monitoring committee meeting for NSM project **"Urban Modelling: Development of multi-sectorial simulation lab and science based decision support framework to address urban environment issues"** on 17th January, 2020 chaired by Secretary, MoES in New Delhi.

Shri U. K. Shende, Sc. 'E' attended the meeting with AAI-DIAL (Delhi International Airport Limited) on 17th January, 2020 regarding **"Meteorological site selection for newly constructed runway number 29L to 11L"** at IGI Airport, New Delhi.

Dr. S. O. Shaw, Sc. 'E' participated in **"Airfield Environment Management Committee meeting"** at AAI Guwahati on 24th January, 2020.

Shri Vivek Sinha, Sc. 'F' along with **Shri A. Shankar**, Sc. 'B' attended a meeting with Vice Chairman and members of Bihar State Disaster Management Authority regarding **"Services provided by IMD"** on 24th January, 2020.

Dr. Ranjeet Singh, Sc. 'F' attended **"Crop Weather Watch Group meeting"** at Krishi Bhawan on 31st January, 2020.

Shri H. R. Biswas, Sc. 'E' attended a meeting on **"Implementation of Comprehensive Mass Messaging System for dissemination Disaster Early Warning"** at O/o SRC, Rajiv Bhawan, Bhubaneswar on 1st February, 2020.

Shri Virendra Singh, Sc. 'F', **Dr. R. K. Giri**, Sc. 'E' and **Dr. A. K. Mitra**, Sc. 'E' attended the meeting with "**Meteo France International (MFI)**" on 4th February, 2020 at H.Q., New Delhi.

Dr. Kuldeep Srivastava, Sc. 'E' attended a meeting to discuss and finalize technicalities pertaining to hosting of "**Web-DCRA & DSS Tool at IMD, HQ**" on 6th February, 2020 at NDMA, New Delhi.

Dr. S. L. Singh, Sc. 'F', **Dr. Kuldeep Srivastava**, Sc. 'E', **Shri Sankar Nath**, Sc. 'E' and **Shri Sunny Chug**, Sc. 'C' attended a meeting regarding "**UMANG App**" on 7th February, 2020 at H.Q., IMD, New Delhi.

Shri H. R. Biswas, Sc. 'E' attended the Brainstorming Session on "**Climate Change**" at the Centre for Excellence in Environment, Climate Change and Public Health (CoE-ECCPH), Utkal University, Bhubaneswar on 10th February, 2020 .

Dr. D. S. Pai, Sc. 'F', **Dr. Pulak Guhathakurta**, Sc. 'F', **Dr. Kripan Ghosh**, Sc. 'E', **Shri R. Balasubramanian**, Sc. 'E' and Senior Scientists attended the "**ICCS-6 and South Asia Heat Health Summit (SAHHS) meeting**" at IITM Pune from 11-15 February, 2020.

Dr. S. O. Shaw, Sc. 'E' participated in DAMU review meeting "**ICAR-ATARI Zone VI**" for newly recruited SMS and Observers held at Guwahati, during 14th & 15th February, 2020.

Shri A. K. Baxla, Sc. 'E', attended Review meeting of "**Pilot Studies for GP level Yield Estimation using Technology of MoAg&FW, DAC&FW under Pradhan Mantri Fasal Bima Yojna scheme**" on 18th March 2020 at MNCFC Pusa Road, New Delhi.

Dr. Mrutyunjay Mohapatra, DG, IMD participated in preparatory meeting for "**Shri Amarnath Yatra, 2020**" held by Home Secretary, Govt. of India on 19th March, 2020.

भारत मौसम वज्ञान वभाग, मुख्यालय की राजभाषा कार्यान्वयन समिति की 150^{वीं} वशेष बैठक दिनांक 19 मार्च, 2020 को डॉक्टर देवेन्द्र प्रधान वैज्ञानिक 'जी' की अध्यक्षता में आयोजित की गई।



भारत मौसम वज्ञान वभाग, मुख्यालय की राजभाषा कार्यान्वयन समिति की 150^{वीं} वशेष बैठक

Dr. Mrutyunjay Mohapatra, DG IMD participated in the preparatory meeting for ensuing **Shri Amarnath Yatra** under the chairmanship of Home Secretary, Govt of India on 19th April, 2020 and briefed about the "**Preparedness of IMD for providing weather observation and forecast for Shri Amarnath Yatra**".

Dr. M. Mohapatra, DGM, **Dr. S. D. Attri**, Sc. 'F' and **Dr. R. K. Giri**, Sc. 'E' attended "**RA II Management Group Meeting**" of World Meteorological Organisation through video conferencing on 24th April, 2020.

Dr. S. D. Attri, Sc. 'F' attended Online Meeting on "**Long Term Ecological Observatories**" organised by Ministry of Environment, Forests and Climate Change on 2nd May, 2020.

Shri Abhishek Anand, Sc. 'B' and **Shri Saurabh Kumar**, S.A. from M. C. Ranchi attended a meeting on 11th May, 2020 with the Director of Dept. of Agriculture, Govt. of Jharkhand for "**Technical discussion on the project of installation of 260 Nos. of AWS**" in Jharkhand.

Dr. Smt. Manorama Mohanty, Sc. 'E' attended Inter-state meeting through Video Conferencing on "**Flood Management & preparedness for Monsoon 2020 for Mahi, Sabarmati and Banas basins**" under the chairmanship of Chief

Engineer, Mahi and Tapi basin organisations at CWC, Gandhinagar on 12th May, 2020.

Shri H. R. Biswas, Sc. 'E' attended the meeting under the chairmanship of **Chief Secretary, Govt. of Odisha** to review the status of **"Preparedness for the impending Super Cyclone in the Bay of Bengal"** on 15th May, 2020 at Secretariat (Lok seva Bhawan), Bhubaneswar and briefed Time to time to Chief Minister's Office, Chief Secretary's Office, Special Relief Commissioner and other State Govt. Officials of Govt. of Odisha during the period.

Dr. Jayanta Sarkar, Sc. 'F' attended a meeting chaired by the Chief Secretary, Govt. of Gujarat, at Gandhinagar regarding **"Monsoon 2020 preparedness"** on 15th May, 2020 and made a presentation.

Dr. M. Mohapatra, DG, IMD participated in the **National Crisis Management Committee meetings** held on 16th, 18th, 19th and 21st May, 2020 under the chairmanship of **Hon'ble Cabinet Secretary** and presented the current status and forecast of super cyclone **AMPHAN**.

Shri H. R. Biswas, Sc. 'E' attended the meeting to **"Review the status of preparedness for the impending Cyclone in the Bay of Bengal"** on 16th May, 2020 (1700 Hours IST) at Secretariat (Lok seva Bhawan), Bhubaneswar chaired by **Hon'ble Chief Minister, Odisha** and gave a presentation on Forecast, Warning and Impact on Odisha due to this system.



Shri H. R. Biswas, Sc. 'E' briefed about the Super Cyclone AMPHAN

Dr. M. Mohapatra, DG, IMD presented the current status and forecast of **"Super cyclone AMPHAN"** in the review meeting chaired by Hon'ble Home Minister on 18th May, 2020.

Dr. S. D. Attri, Sc. 'F' and **Dr. R. K. Giri**, Sc. 'E' attended **"Executive Council Meeting of World Meteorological Organisation"** through video-conferencing on 19th May, 2020.

Dr. Kripan Ghosh, Sc. 'E', **Dr. O. P. Sreejith**, Sc. 'E', **Shri R. Balasubramanian**, Sc. 'E', **Ms. A. B. Bandgar** and Sc. 'C' attended the meeting on **"Kharif Campaign and Southwest monsoon 2020"** for Maharashtra organized by State Department of Agriculture, Government of Maharashtra on 21st May, 2020 through Video Conferencing.



Kharif Campaign and SW monsoon 2020 with Govt. of Maharashtra

Dr. M. Mohapatra, DG, IMD chaired the **"WMO Severe Weather Forecasting Programme-South Asia Meeting"** on 25th May, 2020 through video conference.

Dr. M. Mohapatra, DGM, IMD chaired the **"Annual Monsoon Review & Annual Cyclone Review Meetings 2020"** through Video conference on 29th May, 2020.

Dr. M. Mohapatra, DG, IMD attended and made presentation on the **"Cyclone over the Arabian Sea"** at Ministry of Home Affairs in a meeting chaired by Hon'ble Home Minister on 1st June, 2020.

Dr. Jayanta Sarkar, Sc. 'F' attended a meeting with Honorable Chief Minister of Gujarat **Shri Vijaybhai Rupani** at Gandhinagar regarding **"Anticipated cyclone in Arabian Sea"** on 1st June, 2020.

Dr. M. Mohapatra, DG, IMD attended meetings of the National Crisis Management Committee on the “**Preparedness for the cyclone NISARGA in the Arabian Sea**” convened at Rashtrapati Bhawan, New Delhi on 1st and 2nd June, 2020.

Dr. M. Mohapatra, DG, IMD attended telepresence at MoES to discuss “**India’s Ensemble Prediction System**” on 4th June, 2020.

Shri Surender Paul, Sc. ‘F’ attended a video conference to review “**Flood preparedness in State Haryana - 2020**” on 4th June, 2020 under the Chairmanship of Hon’ble Chief Minister, Haryana at Civil Secretariat, Chandigarh.

Dr. M. Mohapatra, DG, IMD attended telepresence meeting of “**Regional Integrated Multi-Hazard Early Warning System (RIMES)**” on 8th June, 2020.

Dr. O. P. Sreeiith, Sc. ‘E’, **Dr. D. E. Surendran**, Sc. ‘C’, **Ms. A. B. Bandgar**, Sc. ‘C’ and **Dr. S. D. Sanap**, Sc. ‘C’, participated in “**SASCOF-17 Update Meeting**” on 8th June for “**Update of Consensus forecast for South Asia Region**”.

Shri H. R. Biswas, Sc. ‘E’ attended the “**Crop Weather Watch Group Committee Meeting (CWWGCM) of Kharif Crop**” at Krishi Bhawan, Bhubaneswar under the Chairmanship of Agriculture Production on 8th June 2020, 22nd June, 2020 and 29th June, 2020.

Shri Vivek Sinha, Sc. ‘F’, **Shri Anand Shankar**, Sc. ‘B’, **Shri Sandeep Kumar**, Met. ‘A’ and **Shri Sanjay Kumar**, Met. ‘A’ attended the “**Flood preparedness**” meeting on 9th June, 2020, chaired by the chief Secretary, Bihar through Video Conference.

Shri H. R. Biswas, Sc. ‘E’ attended the meeting on the proposal for transfer of State Drought Monitoring Cell (SDMC) from OSDMA to Agriculture and F.E. Department and on “**Procurement and installation of AWS and ARG covering all Gram Panchayats in Odisha**” chaired by Addl. Chief Secretary-cum-

Development Commissioner and Agriculture Production Commissioner at Lok seva Bhawan on 12th June, 2020.

Dr. Sanjib Bandyopadhyay, Sc. ‘F’ attended a web based video conference on 12th June, 2020 with **Hon’ble Minister-in-Charge, Irrigation & Waterways Department, Govt. of West Bengal** to review the status of “**Flood preparedness and related inter-departmental issues for the ensuing Monsoon 2020**”.

Shri Vivek Sinha, Sc. ‘F’ and **Shri Anand Shankar**, Sc. ‘B’ attended the meeting on 13th June, 2020 chaired by **Hon’ble Chief Minister of Bihar** to review the “**Flood preparedness for the state**”.

Shri Sukumar Roy, Met. ‘A’ attended the “**41st SLCCCI**” meeting organized by Agricultural Deptt., West Bengal at Nabanna on 16th June, 2020.

Dr. Sanjib Bandyopadhyay, Sc. ‘F’, **Dr. Kripan Ghosh**, Sc. ‘E’, **Shri R. Balasubramanian**, Sc. ‘E’ and **Shri Sukumar Roy**, Met. ‘A’ attended the online meeting on “**ARM, FASAL**” on 17th June, 2020.

Dr. M. Mohapatra, DG, IMD Chaired meeting on the “**Aviation Weather Decision Support System (AWDSS)**” on 19th June, 2020.

Dr. M. Mohapatra, DG, IMD attended meeting under Chairmanship of Secretary, MoES to discuss about the “**Development of Data Centres**” at MoES Institutes on 19th June, 2020.

Dr. S. D. Attri, Sc. ‘F’ participated through VC in High Level Monitoring Committee Meeting of ICAR Flagship programme on “**National Innovations in Climate Resilient Agriculture**” chaired by Secretary, DARE and DG, ICAR on 23rd, June, 2020.

Shri Vivek Sinha, Sc. ‘F’, **Shri Anand Shankar**, Sc. ‘B’, **Shri Sandeep Kumar**, Met. ‘A’, **Shri Sanjay Kumar**, Met. ‘A’ and **Ms. Aarti Gupta**,

S.A. attended a Video Conference meeting on 23rd June, 2020, with State Agriculture Department regarding “**Value added F/C & advisory at Block level**”.

Shri G. N. Raha, Sc. ‘E’ attended “**Monsoon Preparedness Meeting**” on 24th June, 2020 organized by Sikkim State Disaster Management Authority (SSDMA), Gangtok, Sikkim.

Dr. Kripan Ghosh, Sc. ‘E’, **Shri R. Balasubramanian**, Sc. ‘E’ and AASD officials attended the Web Conference on “**Use of Agromet DSS for Automated Generation of Agromet Advisories**” organized by Watershed Organisation Trust (WOTR) on 26th June, 2020.

Dr. S. D. Attri, Sc. ‘F’ attended National Supercomputing Mission Project Review Meeting on “**Urban Meteorology**” organised by CDAC, Pune on 27th June, 2020.

Dr. M. Mohapatra, DG, IMD, **Dr. D. S. Pai**, Sc. ‘F’ and **Dr. Pulak Guhathakurta**, Sc. ‘F’ and other senior officers of IMD attended “**Monsoon Mission Review meeting**” (online) held by MoES on 29th June, 2020.

Dr. S. D. Attri, Sc. ‘F’ and **Dr. D. R. Pattanaik**, Sc. ‘F’ attending through VC the meeting of “**FAO Rome Desert Locust Information System**” on 29th June, 2020.

Dr. M. Mohapatra, DG, IMD attended meeting under Chairmanship of Secretary, MoES on “**NWP Model Development Roadmap**” through VC on 2nd July, 2020.

Dr. M. Mohapatra, DG, IMD and **Dr. Soma Sen Roy**, Sc. ‘F’ attended a meeting at NDMA to review the “**Preparedness for Thunderstorm and lightning with the state’s most affected by Thunderstorms and Lightning**” under chairmanship of **Lt. Gen, Ata Hasnain** on 3rd July 2020.

Dr. H. R. Biswas, Sc. ‘E’ attended the Meeting through Web Based Video Conferencing with State Government to monitor “**Drought Parameter**” on 3rd July, 2020.

Dr. M. Mohapatra, DG, IMD and **Shri B. P. Yadav**, Sc. ‘F’ attended meeting chaired by **Hon’ble Home Minister** regarding Review of “**Preparedness measure to deal with flood situation in major flood prone river basin in the country**” at MHA, North Block, New Delhi on 3rd July, 2020.

Shri B. P. Yadav, Sc. ‘F’ attended a High level Meeting called by **Hon’ble Home Minister** to discuss “**Rainfall forecast over major river basins for flood management**” on 3rd July, 2020.

Dr. M. Mohapatra, DG, IMD alongwith other senior officers of IMD attended meeting chaired by **Shri G. V. V. Sarma**, Member Secretary, NDMA through VC to review the “**Progress of project on Urban Flood Early Warning in Guwahati Town and proposed actions by TERI**” on 7th July, 2020.

Dr. M. Mohapatra, DG, IMD chaired the meeting on “**Development of roadmap for implementation of Decision Support System for Early Warning of Severe Weather**” in collaboration with RIMES on 8th July, 2020.

Dr. M. Mohapatra, DG, IMD assumed the Charge of “**President of New National Council of Indian Meteorological Society**” on 10th July, 2020.

Dr. M. Mohapatra, DG, IMD alongwith other senior officers attended meeting under chairmanship of **Dr. M. Rajeevan**, Secretary, MoES to discuss about “**Establishment of a Centre in Dharwad**” on 13th July, 2020.

Dr. M. Mohapatra, DG, IMD attended the meeting of Expert Committee on “**Heat Wave to review Heat Wave Season 2020**” through VC on 13th July, 2020.

Shri C. S. Patil, Sc. ‘D’ attended the meeting of “**Weather watch Committee**” through Video Conference on 14th July, 2020 under the Chairmanship of Additional Chief Secretary Cum development Commissioner, Govt. of Karnataka, Vidhan Soudha Bangalore.

Dr. S. Balachandran, Sc. 'F' participated in the **"Pre - NE Monsoon Preparedness meeting 2020"** convened by Special Officer / Commissioner, Greater Chennai Corporation, on 15th July, 2020 at Chennai Corporation.

Dr. M. Mohapatra, DG, IMD and **Dr. S. D. Attri**, Sc. 'G' attended meeting on **"Measures to be taken to deal with possible global catastrophe"** organized by NDMA on 16th July, 2020.

Dr. Ashok Kumar Das, Sc. 'E' and **Shri Asok Raja**, Sc. 'C' participated through video conferencing in the 4th quarterly inter ministerial meeting on **"BRTMS"** on 17th July, 2020.

Dr. M. Mohapatra, DG, IMD and **Dr. Soma Sen Roy**, Sc. 'F' attended First Meeting of the Expert Group organized by NDMA to implement the Action Plan on **"Thunderstorm & Lightning"** on 20th July, 2020.

Dr. H. R. Biswas, Sc. 'E' attended the **"Crop Weather Watch Group Committee Meeting"** through Microsoft Teams by Video Conferencing under the Chairmanship of Agriculture Production Commissioner, Odisha on 20th July, 2020.

Dr. Sanjib Bandyopadhyay, Sc. 'F' attended review meeting of **"GKMS Project and delivered Remarks on Technical Session"** through video conference on 21st July, 2020.

Dr. Sanjib Bandyopadhyay, Sc. 'F' attended the **"Monsoon Preparedness Review Meeting - 2020"** at the Department of Disaster Management & Civil Defence, Government of West Bengal on 21st July, 2020.

Dr. M. Mohapatra, DG, IMD chaired Meeting with Regional Integrated Multi-Hazard Early Warning System (RIMES) to discuss about **"Development of DSS for the State with the help of RIMES and IMD"** on 3rd August, 2020.

Dr. Geeta Agnihotri, Sc. 'E' attended through VC meeting with RIMES team regarding

"Establishment of DSS in different states" on 3rd August, 2020.

Dr. H. R. Biswas, Sc. 'E', attended the **"Crop Weather Watch Group Committee Meeting"** at Krushi Bhawan, Department of Agriculture and Farmer's Empowerment, Government of Odisha on 4th August, 2020.

Dr. M. Mohapatra, DG, IMD chaired meeting to discuss Research/Project Problem on **"AI-ML (Artificial Intelligence-Machine Learning)"** in collaboration with IIIT, Vadodara on 6th August, 2020.

Dr. M. Mohapatra, DG, IMD alongwith other senior officers chaired a meeting with IIT, Delhi and Central water Commission to discuss about **"Brahmaputra River Monitoring in Tibet Autonomous Region"** on 7th August, 2020.

Dr. Geeta Agnihotri, Sc. 'E' and **Dr. Rajavel Manickam**, Sc. 'E', meeting with Head Agromet, IMD, New Delhi regarding **"Functioning of North Karnataka Agrometeorological Research and Forecasting Centre Dharwad"** on 8th August, 2020.

Dr. M. Mohapatra, DG, IMD attended a review meeting through VC on the **"Situation of flood and flood management in the country"** under Chairmanship of Hon'ble Prime Minister of India on 10th August, 2020. Hon'ble PM appreciated the joint effort of IMD and CWC in providing the warning for floods.

Dr. M. Mohapatra, DG, IMD chaired meeting with Regional Integrated Multi-Hazard Early Warning System (RIMES) to discuss about **"Development of DSS"** for the states with the help of RIMES and IMD on 13th August, 2020.

Dr. M. Mohapatra, DG, IMD attended meeting through VC on **"Outcome Document"** with Niti Aayog on 21st August, 2020.

Dr. M. Mohapatra, DG, IMD co-chaired Skype meeting on **"Weather and Climate Science for Service Partnership (WCSSP)"** India Executive Committee on 24th August, 2020.

Shri B. P. Yadav, Sc. 'F', **Dr. Ashok Kr. Das**, Sc. 'E' and **Shri Asok Raja**, Sc. 'C' attended "Quarterly Inter-ministerial meeting on Brahmaputra Real-time Monitoring System (BRTMS) project" with Member (RM), CWC on 24th August, 2020.

Dr. M. Mohapatra, DG, IMD, **Shri Virendra Singh**, Sc. 'F', **Dr. Suman Goyal**, Sc. 'F' and **Dr. A. K. Mitra**, Sc. 'E' attended the "48th Plenary Session of Coordination Group for Meteorological Satellites (CGMS)" on 25-26 August, 2020.

Dr. Rajavel Manickam, Sc. 'E' attended through VC in Member of Selection committee for conducting interview for subject matter specialist and Agromet observer under "DAMU project in KVK Gadag" on 28th August, 2020.

Dr. Jayanta Sarkar, Sc. 'F' had a meeting with Chief Secretary, Government of Gujarat on 31st August, 2020 at Gandhinagar and made presentation on "Active wet spell over Gujarat".

Shri B. P. Yadav, Sc. 'F', **Shri Rahul Saxena**, Sc. 'F' and **Dr. Ashok Kr. Das**, Sc. 'E' attended ACROSS Project Coordinators Meeting with Secretary, MoES for "Implementation of project activities in pipeline" on 2nd September, 2020.

Hydromet Division organized a video conference with SAsiaFFGS member countries and WMO on 3rd September, 2020 for discussing the recent "FFGS activities and FFGS Sustainability Strategy".

Dr. M. Mohapatra, DG, IMD, senior officers of IMD attended meeting with Chief Managing Director of Power System Operation Corporation Limited (POSOCO) through VC on 4th September, 2020 regarding "Augmentation of weather services to power sector".

Dr. S. D. Attri, Sc. 'G' attended meeting of "Recruitment Committee for selection of SMS (Agromet) and Agromet. observer for Professor Jayashankar Telangana State

Agricultural University, Hyderabad" on 5th September, 2020.

Dr. M. Mohapatra, DG, IMD and **Shri B. P. Yadav**, Sc. 'F' attended 6th meeting of the expert Committee of Ministry of Water Resources for "Scientific Assessment of Flood Prone Area in India" through VC on 8th September, 2020.

Dr. M. Mohapatra, DG, IMD attended "8th Scientific Review and Monitoring Committee meeting of Monsoon Mission - II" organized by IITM, Pune through Video Conference on 9th September, 2020.

Dr. M. Mohapatra, DG, IMD attended Review Meeting under the Chairmanship of Member Secretary, NDMA on "Web-DCRA & DSS Tool" on 15th September, 2020.

Shri B. P. Yadav, Sc. 'F' attended 1st Technical Subcommittee meeting on Revamped Guidelines of Pradhan Mantri Fasal Bima Yojana (PMFBY) for "Implementation of two step Crop Yield Estimation process for Rabi 2020-21" on 17th September, 2020.

Dr. M. Mohapatra, DG, IMD attended meeting through VC under the chairmanship of **Shri Kamal Kishore**, Member, NDMA to discuss about way forward on the decision taken in the meeting of Expert Committee on "Heat Wave regarding hazard analysis by including night temperature and wind direction" on 21st September, 2020.

Ms. Jyoti Arora, Spl. Secretary & Financial Advisor, **Shri Nalin Kumar Srivastava**, Director Finance, IMD and **Dr. S. I. Laskar**, FO, IMD attended "Virtual meeting of the Financial Advisory Committee (FINAC-39)" on 24-25 September, 2020.

Dr. S. D. Attri, Sc. 'G' attended meeting on "Flood Forecasting and Early Warning System of Kolkata" on 25th September, 2020.

Dr. G. K. Das, Sc. 'E' attended a meeting with Principal Disaster Secretary, Disaster

Management, and Government of West Bengal on 26th September, 2020 regarding **“Monsoon rainfall status in West Bengal”**.

Dr. M. Mohapatra, DG, IMD, **Dr. S. D. Attri**, Sc. ‘G’, **Dr. Pulakguthakurta**, Sc. ‘F’, **Shri B. P. Yadav**, Sc. ‘F’, **Dr. D. R. Pattaniak**, Sc. ‘F’ and **Dr. R. K. Giri**, Sc. ‘E’ attended the **“Seventy-second (72th) Session (Virtual) of the Executive Council (EC-72)”** during 28 September - 2 October, 2020.

Dr. H. R. Biswas, Sc. ‘E’ attended the **Crop Weather Watch Group Committee Meeting** through Video Conferencing under the Chairmanship of **Agriculture Production Commissioner, Odisha** on 5th October, 19th October, 2nd November and 7th December, 2020.

India Meteorological Department (IMD) organized the on-line pre-cyclone exercise meeting on 6th October, 2020 under the chairmanship of **Dr. Mrutyunjay Mohapatra**, DG, IMD to review the preparedness, take stock of requirements, plan for the cyclone season October-December, 2020 and share new initiatives by IMD with stake holders. The meeting was participated by experts from **IMD, National Centre for Medium Range Weather Forecasting (NCMRWF), Indian Air Force (IAF), Indian Navy (IN), Central Water Commission (CWC), India Institute of Technology (IIT) Delhi, Indian National Centre for Ocean Information Services (INCOIS), National Disaster Management Agency (NDMA), National Disaster Response Force (NDRF), Deptt. of Fisheries, Punctuality Cell, Indian Railways and Central Water Commission (CWC)**.

Shri B. P. Yadav, Sc. ‘F’ and **Dr. A. K. Das**, Sc. ‘E’ attended **“Project Monitoring & Advisory Committee (PMAC)”** on 9th October, 2020 regarding Upgradation of Hydro-meteorological Services. **Dr. A. K. Das**, Sc. ‘E’ made the presentation for the project.

Dr. Sanjib Bandyopadhyay, Sc. ‘F’ held a meeting on 9th October, 2020 to initiate

campaign on **“Jan Andolan Campaign”** and administrated the pledge to the employees of RMC Kolkata on this occasion social distancing and wearing of Mask was observed.

Dr. M. Mohapatra, DG, IMD attended 2nd Steering Committee meeting on **“Common Alert Protocol”** organized by **NDMA** on 13th October, 2020.

Dr. S. D. Attri, Sc. ‘G’ attended Video Conferencing on 14th October, 2020 regarding **“Automation of Agromet Advisory Services”** and a link with this model template has been sent to all DAMU, AMFU and State Agricultural Authorities. **Shri Surender Paul**, Sc. ‘F’ also attended this meeting.

Dr. H. R. Biswas, Sc. ‘E’ attended the Meeting through Video Conferencing on **Setting up new AWS and ARG stations in Odisha state** on 15th October, 2020.

Dr. M. Mohapatra, DG, IMD along with **Dr. Sankar Nath**, Sc. ‘E’ attended E-Meeting with Google organized by **NDMA** for **“Dissemination of Common Alert Protocol Alerts”** on 16th October, 2020.

Dr. K. Naga Ratna, Sc. ‘E’ participated in a web Conference organized by Telangana State Centre of the Institution of Engineers (India) on **“Unprecedented Floods in GHMC Area”** on 16th October, 2020.

The Work Progress Review Meeting of UK MET. OFFICE (UKMO)-MoES (IMD, NCMRWF, IITM, IMD) Weather and Climate Science for Service Partnership India Executive Committee - WCSSP India was held virtually on 19th October, 2020. **Dr. R. K. Jenamani**, Sc. ‘F’ as the coordinator of the WP3 (IBF) Sub-project for IMD presented the present status and progress in the VC.

Dr. R. K. Giri, Sc. ‘E’ and **Dr. A. K. Mitra**, Sc. ‘E’, participated in the **GSICS Data Working Group (GDWG)** organized by **CGMS** on a virtual mode on dated 20th October, 2020.

Shri Virendra Singh, Sc. 'F' and **Dr. A. K. Mitra**, Sc. 'E' participated in "**4th DB-Net Coordination Group**" meeting organised by WMO on virtual mode during 20-22 October, 2020.

Dr. Geeta Agnihotri, Sc. 'E' and **Shri C. S. Patil**, Sc. 'D', M. C. Bengaluru participated a meeting convened by DG, IMD on "**Impact based forecast**" through video conferencing on 2nd & 20th November, 2020.

Dr. M. Mohapatra, DG, IMD attended Conference on "**Moving from Risks to Resilience for a water secure future**" organized by **Confederation of Indian Industry (CII)** on 3rd November, 2020.

Dr. M. Mohapatra, DG, IMD attended meeting of the "**National Coordination Committee for Polar Science**" via Google Meet/Webex organized by NCPOR, Goa on 4th November, 2020.

Dr. S. D. Attri, Sc. 'G' participated in Meeting on "**Vigilance Mechanism**" organised by MoES on 5th November, 2020.

Dr. S. D. Attri, Sc. 'G' and **Smt. Priyanka Singh**, Sc. 'B', participated in meeting on "**Automation of Agromet Advisory Services**" organised by IMD and WoTR on 5th November, 2020.

Shri S. Mishra, Met. 'B' and **Shri P. K. Nath**, Met. 'A' attended the "**Table Top Exercise Meeting**" (Preparatory Meeting for Full Scale Emergency Exercise - 2020) at B.P.I. Airport, Bhubaneswar on 5th November, 2020.

Dr. H. R. Biswas, Sc. 'E', attended the Meeting of State Level Steering Committee (SLSC) for "**Implementation of World Bank Assisted National Hydrology Project**" through Video Conferencing on 9th November, 2020.

Dr. S. D. Attri, Sc. 'G' participated in Task Force Meeting on "**Climate change and Vector Borne Diseases**" organised by ICMR on 12th November, 2020.

Shri Umasankar Das, Sc. 'C' attended the "**Crop Weather Watch Group Committee Meeting**" through Video Conferencing under the Chairmanship of **Agriculture Production Commissioner**, Odisha on 16th November, 2020 and 21st December, 2020.

Dr. S. D. Attri, Sc. 'G' and **Shri Raja Acharya**, Met. 'A' participated in virtual "**WMO Data Conference**" held under the chairmanship of SG, WMO during 16-19 November, 2020.

Dr. M. Mohapatra, DG, IMD participated in the Panel discussion on the topic "**Severe Weather Preparedness Amid the Pandemic**" organized by Open Gov TV on 17th November, 2020.

Dr. M. Mohapatra, DGM attended virtual meeting of the National Crisis Management Committee on 22nd and 23rd November, 2020 in connection with cyclone "**NIVAR**". **Dr. K. K. Singh**, Sc. 'G' attended the stakeholders meet on "**Implementation of block level Agromet Advisories for Telangana state**" under GKMS under chairmanship of Pr. Secretary & Commissioner (Agriculture) organized by M. C., Hyderabad on 23rd November, 2020.

Dr. M. Mohapatra, DG, IMD, **Mrs. Sunitha Devi**, Sc. 'E' and **Mrs. Monica Sharma**, Met. 'A' participated through Video Conference in **WMO/ESCAP Panel on Tropical Cyclones (PTC-47) Meeting** during 23-26 November, 2020. **Mrs. Sunitha Devi** presented the "**Annual Report on Cyclonic Disturbances over north Indian Ocean during 2019, Country Report of India and Tropical Cyclone Operational Plan (TCP-21)**" during the meeting.

Dr. S. D. Attri, Sc. 'G' addressed the delegates as "**Guest of Honour**" in Inaugural function of International Conference on "**Building Resilient and Sustainable Societies: Emerging Social and Economic Challenges**" organised by Jamia Milia Islamia during 25-26 November, 2020.

Dr. Kuldeep Srivastava, Sc. 'E' and **Shri Sankar Nath**, Sc. 'E' attended a meeting on **"Organisational Resilience 2.0: Managing Multiple Threats Proactively, efficiently and effectively"** on 25th November, 2020 organised by Open Gov C10 Network Pvt. Ltd.

Shri Shivinder Singh, Sc. 'C' attended meeting of **"Official Language Implementation"** through online platform Microsoft Teams Platform on 25th November, 2020.

Dr. M. Mohapatra, DG, IMD attended Inaugural Function of the Conference on **"Climate Change, Disasters & Sustainable Livelihood"** as Guest of Honour, organized by Department of Geography, University of Allahabad, Prayagraj on 26th November, 2020.

Dr. K. K. Singh, Sc. 'G' attended 5th National Conference on **"Review of implementation of Pradhan Mantri Fasal Bima Yojana/ Restructured Weather Based Crop Insurance Scheme (PMFBY/ RWBCIS)"** on 27-28 November, 2020 organized by DAC&FW.

Dr. M. Mohapatra, DG, IMD attended **"Cabinet Secretariat National Crisis Management Committee Meeting"** on 1st December, 2020 for discussion on cyclonic storm **"Burevi"**.

Dr. Sanjib Bandyopadhyay, Sc. 'F', attended a meeting with Chairman of WBHIDCO for **Installation of Automatic Rain Gauge in New Town, Kolkata** on 7th December, 2020.

A meeting was attended by **Shri Virendra Singh**, Sc. 'F' and **Dr. A. K. Mitra**, Sc. 'E' on dated 16th December, 2020 with ISRO (HQ), NSIL and NRC regarding up gradation of **NOAA/Metop ground receiving & processing system** under the chairmanship of **Dr. Gopal Iyenger**, Advisor, MoES.

Smt. Deepa R. V., S. A. and **Shri Pankaj Kumar**, S. A. attended Review meeting on **"Ongoing works of Geospatial Group"** through Video Conferencing with H.Q., New Delhi on 19 & 26 December, 2020.

Dr. M. Mohapatra, DG, IMD and **Dr. Naresh Kumar**, Sc. 'E' attended meeting under Chairmanship of Member, NDMA regarding **"Hazard analysis by including night temperature and wind direction"** on 21st December, 2020 and delivered an invited talk on **"Self-resilient early warning services"**.

Shri P.S. Kannan, Sc. 'E' attended the meeting on **"Review of Quarterly Progress Reports"** held by HQ, Rajbhasha cell through video conference on 23rd December, 2020. **Smt. O. M. Malathi Nandakumar**, Hindi Co-ord. Officer and **Smt. Beulah Abel**, steno, Rajbhasha cell attended.

मुख्यालय की राजभाषा कार्यान्वयन समिति की वर्ष 2020 की चौथी तिमाही बैठक) 153^{वीं} बैठक (दिनांक 23 दिसंबर, 2020 को डॉ. एस. डी. अत्री, वैज्ञानिक 'जी' की अध्यक्षता में आयोजित की गई। इस बैठक में मुख्यालय के साथ-साथ वभाग के अन्य आठ उपकार्यालयों की तिमाही प्रगति रिपोर्ट की भी समीक्षा की गई। सभी उपकार्यालयों के प्रमुख / हिंदी संपर्क अधिकारी वी. सी. के माध्यम से इस समीक्षा बैठक में उपस्थित रहे।

Dr. M. Mohapatra, DG, IMD attended as Guest of Honour, the valedictory function of **Students Engineering Model Competition 2020** organized by **CSIR - Central Electronics Engineering Research Institute**, Pilani, Rajasthan on 24th December, 2020.

ANNUAL CYCLONE/MONSOON REVIEW MEETING

Dr. M. Mohapatra, DGM, IMD chaired the **"Annual Monsoon Review & Annual Cyclone Review Meetings 2020"** through Video conference on 29th May, 2020.

6.4. TRAINING

Dr. Sanjib Bandyopadhyay, Sc. 'F' and **Shri H. R. Biswas**, Sc. 'E' convened a two days Training Programme for all Officer In-charges of MCs under RMC Kolkata on **"Block Level Forecast**

and Administrative & other Technical issues" on 20-21 January, 2020 at RMC, Kolkata.

A two days 'Training-Cum-Familiarization Workshop on Precipitation and Aerosol Chemistry' was held from 25-26 February, 2020 in the office of CR&S, Pune.

A two-days "AWS training programme" for officials from different observatories in Odisha for installation and maintenance of Cellcomm instruments was held at **M. C., Bhubaneswar** under the guidance of **Shri P. S. Biju**, Sc. 'E' from O/o CRS, Pune from 2-3 March, 2020.

Shri U. V. Singh, Sc. 'E', **Dr. A. K. Mitra**, Sc. 'E', **Shri Shibin**, Sc. 'C' and **Shri Ramashray Yadav**, Sc. 'C' imparted on the "Job training on activity of Satellite Meteorology Division" to the trainees of Meteorological Instrumentation and Information System during 12-13 March, 2020.

Dr. Sanjib Bandyopadhyay, Sc., 'F' inaugurated "Cellcomm Training on AWS data logger system" to IMD Participants from all over the region, on 13th March 2020. **Shri Sanjoy Bhowal**, S. A. from FMO Jalpaiguri, **Shri Shyam Sagar Yadav**, S. A. from MC Ranchi and **Shri Rakesh Kumar**, S.A. from FMO Asansol were on training on Cellcomm Data Logger at RMC Kolkata.



Dr. Sanjib Bandyopadhyay, Sc. 'F' during Cellcomm Training

Shri Anand Shankar, Sc. 'B' participated in "The International Distance Training Course on Short-term Climate Monitoring and Prediction in Disaster Prevention and Mitigation" by China Meteorological Administration Training Centre during the Period from 18-31 May, 2020.

Online Information Technology (IT) Training on System Administration for the "South Asia Flash Flood Guidance System", from 17th June to 10th July, 2020. Overview of SAFFGS by regional trainer was held at 1500-1530 hrs on 18th June, 2020 through VC and 1st online session was held on 26th June, 2020 with Hydrologic Research Centre (HRC) and World Meteorological Centre (WMO). Sixteen (16) participants from different RMCs / MCs and Hydromet. division participated in the training.

Dr. M. Mohapatra, DG, IMD chaired the online inaugural session for **IT Training of "South Asia Flash Flood Guidance (SAsiaFFG)" System** on 26th June, 2020. The Session was attended by senior scientists of IMD, HRC USA and WMO.

Dr. Manish R. Ranalkar, Sc. 'E' and **Shri U. K. Shende**, Sc. 'E' attended online training conducted by Integrated training and Policy Research (ITPR), New Delhi for the purpose of "Public-procurement, e-procurement and GeM Portal" from 26-27 June, 2020.

AMTC Batch No. 180 phase II is being continued with 10 trainees (6 from Indian Navy, 2 from Indian Coast Guard & 2 from Mauritius Met. Services).

Forecaster's Training Course Batch No. 189 Post mid term commenced w.e.f. 15th June, 2020 online through skype.



Inaugural Training Session of SAsiaFFGS

Online IT and Administration training under the **South Asia Flash Flood Guidance system**

(SAsiaFFGS) imparted by WMO and HRC to 15 participants at **Regional Centre, IMD Pune** during 17th June - 10th July, 2020.

Hydromet Division, India Meteorological Department organized an online training workshop on **“Operational Activities of Flood Meteorological Services”** with all RMCs, MCs, FMOs, CRS Pune and NWFC during 1-2 July, 2020. **Dr. M. Mohapatra**, DG, IMD Chaired inaugural session of online training programme for FMOs on 1st July, 2020. Distinguished scientists from various organizations presented about their role in flood monitoring related aspects. The training ended with discussion session on issuance of Hydromet Bulletin. The training recorded wide participation of 75 officers/staff from 40 offices of IMD across India.

SOUTH ASIA FLASH FLOOD GUIDANCE SERVICES

IMD, Regional Centre of **South Asia Flash Flood Guidance System (SAFFGS)**, conducted an online training on flash flood guidance system from 8-10 July, 2020 for 150 forecasters from India, Bhutan, Bangladesh, Nepal, Sri Lanka, WMO and HRC, USA. **Dr. M. Mohapatra**, DG, IMD chaired the concluding session of operational SAFFGS on 10th July, 2020.

WMO appreciated Regional Centre (SASIAFFGS) & Hydromet Division for organising **International Operational SAsiaFFGS training** for forecasters of about 150 trainees across the region from India, Bangladesh, Nepal, Bhutan, Sri Lanka, WMO and HRC, USA held during 8-10 July, 2020. The event gathered a wide publicity on WMO's official website, social media platforms, etc and gave awareness in the region.

A short term online Training Course on **“Preparation and Dissemination of Agromet Advisories at Block level under Gramin Krishi Mausam Seva (GKMS) scheme”** was organized during 27 July - 1 August, 2020 for Subject

Matter Specialists (Agromet) & Observers of 25 District Agro. Met Units (DAMU).

Dr. Geeta Agnihotri, Sc. 'E' and **Shri S. M. Metri**, Sc. 'E', VC in **“Maintenance of AWS ARG in Karnataka”** on line training 28th August, 2020.

Dr. (Smt.) V. K. Mini, Sc. 'E' and **Shri Arun Kumar VH**, Sc. 'C', attended **“Govt. Official Training Programme”** in Big Data Technologies by CDAC, Noida during the period 19 October - 3 November, 2020.

Ms. Neeru Barak, S. A. attended virtual training on **“Application of Geographic Information on System in Disaster Risk Management”** from 26-30 October, 2020 organized by India Institute of Remote Sensing, Dehradun.

Dr. Kuldeep Srivastava, Sc. 'E' attended, participated and completed Five days Online Faculty Development Programme on **“Cyber Security Analytics and Cyber Forensics”** organised by the Department of Computer Applications, Saintgits College of Engineering, Kottayam from 16-20 November, 2020.

Online Training programme on **“Preparation and Dissemination of Agromet Advisories at Block level under Gramin Krishi Mausam Seva(GKMS) Scheme (18.11.2020 - 21.11.2020)”** for Subject Matter Specialists (Agromet) of OUAT DAMUs has been attended by **Shri Umasankar Das**, Sc. 'C' on 19th November, 2020.

Dr. G. K. Das, Sc. 'E' and **Dr. V.K. Mini**, Sc. 'E' attended 5 days virtual training programme on **“Role of Technology in Community level Disaster Mitigation”** organized by Lal Bahadur Shastri National Academy of Administration, Mussoorie during 23-27 November, 2020.

Shri Uma Borah, Met. 'A' attended the **“Advance Refresher course in Aviation Meteorology”** online training conducted by

MTI Pune during the period 23-27 November, 2020.

Dr. G. N. Raha, Sc. 'E' attended an online training programme conducted by NDMA & SSDMA on **"Incident Response System (IRS) and Table Top Exercise for Earthquake for State and Districts of Sikkim"** held on 25th November, 2020.

In House training for forecaster held on 23rd December, 2020. **Shri Vivek Sinha, Sc. 'F'**, **Shri Anand Shankar, Sc. 'C'** and **Dr. T. N. Jha, Retd. Sc. 'E'** gave their presentation as resource person.

IMTC Training in Batch No. 9 *via* distance learning was completed at M.C. Bhubaneswar during December, 2020. IMTC Training in Batch No. 10 *via* distance learning started on 28th December, 2020.

6.5. LECTURES/TALK

Dr. S. D. Attri, Sc., 'F' delivered a talk on **"Agromet-DSS to enhance climate services to agriculture for risk management"** in Inaugural Session of Asia Regional workshop on **"Digital Solutions to Accelerate Adaptation to Climate Change in Agriculture"** held during 13-14 January, 2020 at Divecha Centre for Climate Change, Indian Institute of Science, Bengaluru.



Dr. S. D. Attri, Sc. 'F' during the talk at IISc

Shri S. K. Manik, Sc. 'C' attended 11th Seminar of **"Water Talk"** organized by DoWR, RD&GR (National Water Mission) on 17th January, 2020 at Dr. Ambedkar International Centre, New Delhi.

Shri Virendra Singh, Sc. 'F' delivered lecture to the trainees of **"Forecasters Training course Batch-188"** on 22-23 January, 2020 at MTI Pune.

Dr. S. D. Attri, Sc. 'F' delivered lecture on **"Effect of urbanization on extreme events"** in Advanced Refresher course on **"Extreme weather events"** at IMD Pune on 23rd January, 2020.

Shri Umasankar Das, Sc. 'C', delivered a lecture on **"A Tale of two spices: Indian Monsoon and Its variability"** at Department of Applied Geography, Ravenshaw University, Cuttack on 25th January, 2020.



Shri Umasankar Das, Sc. 'C', during delivering lecture

Shri H. R. Biswas, Sc. 'E' delivered a lecture on **"Climate Change, Regional Scenario and Weather Forecasting"** on the occasion of celebrating the Golden Jubilee of Geography Department, Utkal University, Vani Vihar, Bhubaneswar on 18th February, 2020.

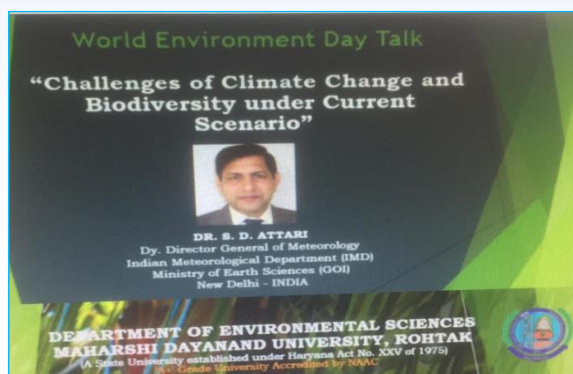
Dr. S. D. Attri, Sc. 'F' delivered talk on **"Operationalizing District Agromet Units (DAMU) for Effective Weather Based Services"** at ICAR-KVK Workshop 28th February, 2020 at NASC, New Delhi.

Shri Amit Kumar, Sc. 'C', delivered lecture in Familiarization Training on **"Interpretation of Radar, Satellite and NWP Products for Nowcasting"** held at M.C., Chandigarh during 4-5 March, 2020.

Dr. S. D. Attri, Sc. 'F' delivered invited talk on **"Operationalising District Agromet Units (DAMUs) For Effective Weather Based Services"** in Regional User Meet on 7th March, 2020 at Nagpur.

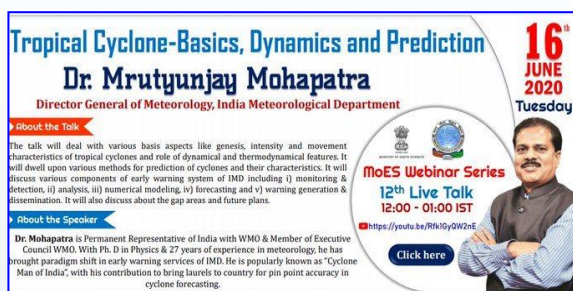
Dr. Kripan Ghosh, Sc. 'E' delivered a lecture on **"Impact based Agromet Advisory Services in India"** in online training on **"Recent Advances and Instrumentation in Agricultural Meteorology"** organized by Vasant Dada Naik Marathwada Agricultural University (VNMAV) Parbhani on 29th May, 2020.

Dr. S. D. Attri, Sc. 'F' delivered inaugural talk through VC on **"Challenges of Climate Change and Biodiversity under Current Scenario"** on the occasion of World Environment Day on 5th June, 2020 organised by MDU Rohtak.



Dr. S. D. Attri, Sc. 'F' during inaugural talk

12th Live Talk of MoES Webinar Series was given by **Dr. Mrutyunjay Mohapatra, DG, IMD** on Tropical Cyclone Basics, Dynamics and Prediction on 16th June, 2020. The discussion is available at the link: <https://youtu.be/Rfk1GyQW2nE>.



Dr. S. D. Attri, Sc. 'F' delivered invited talk in International webinar on **"Climate Change implications and management strategies"** on 23rd June, 2020 organised by Central University of Haryana and RPS College, Mahendergarh.

Dr. Sanjib Bandyopadhyay, Sc. 'F' delivered a special online lecture on 26th June, 2020 for the **M.Sc. Students, Research Scholars and**

faculties of Department of Environmental Science and Department of Geography of The University of Burdwan on the topic **"Role of IMD in forecasting and dissemination of warning towards planning for an effective disaster Management"**.

Shri B. P. Yadav, Sc. 'F' delivered a lecture on **"Cloudburst and Floods"** on 21st July, 2020 organized by NIDM.

Dr. D. R. Pattanaik, Sc. 'F' delivered an invited talk on **"Climate Change and Extreme Weather Events"** to the trainees during the webinar series jointly organised by National Institute of Disaster Management (NIDM) and India meteorological Department (IMD) on 4th August, 2020.



Dr. D. R. Pattanaik, Sc. 'F' during an invited talk

Dr. Sanjib Bandyopadhyay, Sc. 'F' inaugurated and delivered a lecture in a training programme to the officers of GSI Kolkata on **"Early Warning System in vogue in IMD forecast procedure, heavy rainfall warning particularly in North Bengal leading to landslides"** held on 24th and 25th August, 2020 at RMC Kolkata. The training programme was held on a request by GSI Kolkata as on a pilot mode. **Dr. G. K. Das, Sc. 'E'** also delivered lecture on **"Technique for weather forecasting and its limitations"**.

Shri Debapriya Roy, Sc. 'C' and **Shri Sukumar Roy, Met. 'A'** gave talks/lectures related to **"Weather forecasting procedures and Usefulness of Damini App. & Impact of lightning and thunderstorm"** to farmers respectively in an online Farmer's Awareness Programme in **Google Meet** which was organized by AMFU Kalyani on 5th September, 2020.

Dr. S. D. Attri, Sc. 'G' delivered invited talk on **"Climate Change and Technological Interventions under Current Scenario"** in FDP on 8th September, 2020 organised by J. C. Bose University of Science & Technology, YMCA.

Dr. M. Mohapatra, DG, IMD delivered a talk on **"Cyclone warning services in a Teachers' Training programme"** organized by NIDM through VC on 22nd September, 2020.



Dr. M. Mohapatra, DG, IMD and senior officers of IMD

Shri Ranjan Phukan, Sc. 'C' presented a talk on **"IMD's role in Disaster Management"** in a webinar organized by Govt. of Tripura on 5th October, 2020.

Dr. M. Mohapatra, DG, IMD delivered lecture on **"Chasing the Cyclone"** during **World Space Week** celebrated by Indian Society of Remote Sensing (ISRS), Delhi Chapter via Google Meet on 6th October, 2020.

Dr. S. D. Attri, Sc. 'G' delivered invited talk in Webinar on **"Climate Change and Sustainable Development under current scenario"** on 7th October, 2020 organized by GJU Hisar.

Dr. S. D. Attri, Sc. 'G' delivered invited talk on **"Climate services for agriculture and other sectors"** in webinar on 8th October, 2020 organised by Ministry of Electronics and Information Technology, New Delhi.

Dr. S. D. Attri, Sc. 'G' delivered address in **"Symposium cum Farmers and planners Interaction"** on 9th October, 2020 organised by P. K. University, Shivpuri (MP).

Dr. M. Mohapatra, DG, IMD delivered a talk on the topic **"Climate Change & Cyclones"** in

the Online Training Programme on **"Climate Change: Challenges and response"** (for Women Scientists) organized by Lal Bahadur Shastri National Academy of Administration, Mussorie, Uttarakhand on 9th October, 2020.

Shri Surender Paul, Sc. 'F' attended a meeting with **Shri Sanjeev Kaushal**, IAS, Additional Chief Secretary and FCR, Haryana regarding development of **"Decision Support System (DSs)"** to manage potential hazards associated severe weather events in Haryana on 14th October, 2020.

Dr. M. Mohapatra, DG, IMD attended National Webinar on **"Cold Wave Risk Reduction"** organized by NDMA and delivered talk in the Technical Session - I on **"Early warning dissemination and sector specific measures"** on 14th October, 2020.

Dr. M. Mohapatra, DG, IMD delivered Annual Monsoon Talk on **"Monsoon-2020: Scientific issues and challenges"** organized by IMS, Ahmedabad Chapter on 16th October, 2020.

Dr. S. D. Attri, Sc. 'G' delivered invited talk in Webinar on **"Role of Meteorology in better Air Quality Management"** organised by Indian Association for Air Pollution Control (D) on 17th October, 2020.



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

Dr. M. Mohapatra, DG, IMD attended as a Panellist for Webinar on **"V13H2; S9: Multi Hazard Vulnerability and Mitigation in the coastal areas towards Impact based Multi Hazard Warning System"** organized by INCOIS, Hyderabad on 20th October, 2020 under the objective of Vaibhav Summit.

Shri Surender Paul, Sc. 'F' attended a webinar on **"Weather Perspectives in Modern Era"** and organized by K. V. K. Jalandhar and gave talk on **"Agromet Advisories in India Currents Status and Future Plan"** on 20th October, 2020.

Shri Virendra Singh, Sc. 'F', delivered lecture on **"Overview of Satellite Meteorology in RSMC Cyclone"** Training Programme on dated 20th October, 2020.

Dr. M. Mohapatra, DG, IMD attended meeting under Chairmanship of Secretary, DoWR, RD & GR regarding follow-up of decisions taken in meeting taken by Hon'ble Home Minister to review the **"Preparedness measures to deal with flood situation in major flood prone river basin in the country"** on 21st October, 2020.

Dr. S. D. Attri, Sc. 'G' delivered address as Chief Guest in **"Valedictory function of Refresher Course in Environmental Science/ Education"** on 21st October, 2020 by JMI, New Delhi.

Dr. (Smt.) K. Naga Ratna, Sc. 'E' participated in a Webinar on **"Agromet Advisories Forecast and IT Based Future Market"** organized by MANAGE, Hyderabad, on 22nd October, 2020.

Dr. N. Puviarasan, Sc. 'E' attended a selection committee meeting as a nominated member for the selection of one **"Agromet Observer"** on contract basis through online interview on 27th October, 2020 under GKMS Scheme.

Dr. S. D. Attri, Sc. 'G' participated in CBI National Conference on **"Vigilance and Anti-Corruption"** during 27-29 October, 2020, inaugurated by Hon'ble Prime Minister of India.

Dr. S. D. Attri, Sc. 'G', Sc. 'G' participated in Meeting on **"Preparation/Updation of Hazard Zonation Maps/Atlas"** organised by MNCFC, New Delhi on 28th October, 2020.

Dr. Sanjib Bandyopadhyay, Sc. 'F' attended Webinar on **"Enhancing Preparedness for**

Response to COVID-19 & Extreme Weather Events" held on 4th November, 2020.

Dr. Sanjib Bandyopadhyay, Sc. 'F' was invited to attend as Chief Guest in inaugural session of **"Web based seminar on Weather Resilience Agricultural Technologist for farmers of Cuttack District"** by DAMU, KVK Cuttack on 11th November, 2020.

Dr. S. Balachandran, Sc. 'F' attended webinar and delivered lecture on **"Climate Change - Issues and adaptation"** conducted by Indian Red Cross Society, Vellore District Branch, on **International Day for Risk Reduction 2020**, on 18th November, 2020.

Dr. S. D. Attri, Sc. 'G' participated in Brainstorming session on **"Development of NextGen Agro-Advisory Services"** on 19th November, 2020 organised by ICRISAT, Hyderabad.

Dr. S. Balachandran, Sc. 'F' gave a lecture on **"Climate Change - IMD Early Warning System- An Overview"** in the AICTE sponsored programme on **"Disaster Mitigation: Shift from Disaster Management towards preparedness"** organized by Department of Civil Engineering, School of Infrastructure, Crescent Institute of Science and Technology, on 19th November, 2020.

Dr. Geeta Agnihotri, Sc. 'E' attended a Lecture by **Shri T. P. Sharma**, Officer on Special Duty, CVC on 19th November, 2020 by video conference.

Dr. S. D. Attri, Sc. 'G' delivered talk on **"Block Level Agro Meteorological Services in India"** in webinar on **"Implementation of block level Agromet Advisories under GKMS"** held under the chairmanship of Secretary and Commissioner, Telangana on 23rd November, 2020 which was participated by officers of State Agriculture Department, M.C. Hyderabad, SMS of DAMUs and TOs of AMFUs.

Dr. H. R. Biswas, Sc. 'E', delivered lecture on the subject **"TAF writing using recently developed NWP Products for Aviation**

Application through online mode in Advanced Refresher Course on Aviation Meteorology conducted by MTI, Pune on dated 24th November, 2020.

Dr. M. Mohapatra, DG, IMD presided over Webinar on **“Winter Weather System and its Impact on Different Sectors”** organized by Indian Meteorological Society and IMD on 27th November, 2020.

Dr. Ashok Kr. Das, Sc. ‘E’ participated and delivered an online lecture on **“Hydromet Services”** in the India International Science Festival - 2020 on 28th November, 2020.

Dr. S. D. Attri, Sc. ‘G’ delivered talk on **“Role of Climate Advisory for food security”** in Building



Dr. S. D. Attri, Sc. ‘G’ delivering talk

Self-reliant Farmers in the arena of **Climate Change for Food Security: The Indian Perspective, Climate Dialogues special side events - UNFCCC**, November on 30th November, 2020.

Shri B. P. Yadav, Sc. ‘F’, delivered lecture on **“Real time Meteorological data for Flood Forecasting”** on 2nd December, 2020 in an International Workshop organized by RMSI.

Dr. M. Mohapatra, DG, IMD delivered invited talk in **INGARSS 2020** organized by Space Applications Centre, ISRO, Ahmedabad on 4th December, 2020.

Shri Surender Paul, Sc. ‘F’ delivered invited talk for the training session titled **“Training of Community Volunteers of District Moga in Disaster Response (Aapda Mitra)”** 9th November to 4th December, 2020 organized by

Mahatma Gandhi State Institute of Public Administration (MGSIPA).

Shri Shivinder Singh, Sc. ‘C’ delivered online lecture to the **“Students of B.Sc (Hons.) Agriculture”** of Rayat Bahra University” on 4th December, 2020.

Shri Raja Acharya, Met. ‘A’ attended a webinar on **“Co-designing the science we need for the Ocean Decade - Part 2”**, convened by the Intergovernmental Oceanographic Commission of UNESCO in partnership with the International Science Council, on 8th December, 2020.

Dr. S. D. Attri, Sc. ‘G’ participated in Stakeholders’ Workshop on **“India-Drought Monitor”** on 10th December, 2020 organised by CRIDA Hyderabad.

Dr. M. Mohapatra, DG, IMD, delivered a plenary talk on **“Impact based forecasting”** in Virtual Symposium on **“Tropical Meteorology (TROPMET-2020)”** under the theme **“Weather and Climate Services over Mountainous Regions”** organized by Indian Meteorological Society (IMS) in collaboration with North Eastern Space Applications Centre (NESAC), Shillong during 14 -17 December, 2020.

Dr. B. Geetha, Met. ‘A’ delivered lectures on **“Northeast monsoon”**, to the AMTC-batch 181 trainees during 16-18th December, 2020 conducted by MTI, IMD Pune.

Dr. M. Mohapatra, DG, IMD attended webinar on **“Developing a self-reliant DRM Framework”** in the series of **“Atmanirbhar Bharat in DRM”** organized by NIDM on 21st December, 2020.

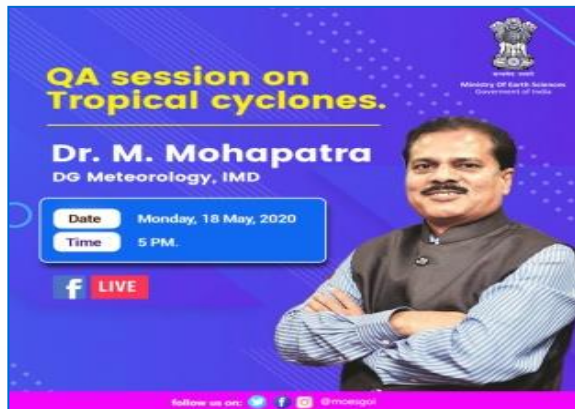
Dr. B. Geetha, Met. ‘A’ delivered lecture on **“Cyclone Disaster Management”** to the visiting trainees (state govt officials) of Anna Institute of Management in the training programme on **“Coastal Hazard Management”** on 22nd December, 2020.

Dr. K. K. Singh, Sc. ‘G’ delivered a talk as Chief Guest on 25th December, 2020 on the occasion

of valedictory function of training on “**Crop weather modelling: Tool for climate smart agriculture**” to agriculture scientists organised during 2-25 December, 2020 under NAHEP by CAAST-CSAWIM, Mahatma Phule Krishi Vidyapeeth, Rahuri.

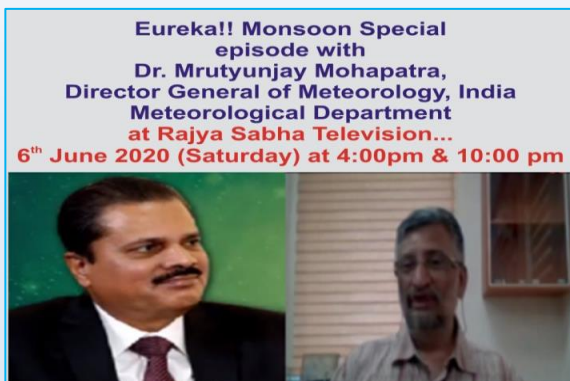
6.6. AWARENESS & OUTREACH PROGRAMME

MoES started a new live event series on Facebook. In the first event, **Dr. M. Mohapatra**, DG, IMD appeared live on Facebook account of MoES (<https://www.facebook.com/moesgoi>) on 18th May, 2020 at 5.00 PM to share his insights and answer the queries of the viewers on Tropical Cyclones. A large number of visitors (around 900) participated in the discussion.



Dr. M. Mohapatra, DG, IMD live on Facebook account of MoES

Rajya Sabha Television aired Monsoon Special Episode with Dr. Mrutyunjay Mohapatra on 6th June, 2020. The programme is available at the link: <https://www.youtube.com/watch?v=BH5i1Q6i8Qk&fbclid=IwAR2dV8HJkGSFz0VLiaPdpistlfs50OFWtltB1qVpVbLqN-iMAQqWfXVYXoU>



An article entitled “**Keeping a Weather Eye on Cyclones with IMD Chief**” was published by e-magazine My City Links on 8th June. In the interview **Dr. Mohapatra**, DG, IMD explained the intricacies involved in weather prediction particularly the cyclones. The article is available at the link: <https://www.mycitylinks.in/keeping-a-weather-eye-on-cyclones-with-imd-chief?fbclid=IwAR1P5cIQVhjTONy8HUKQGpm4dhSdHvoU8qlqD3KiV37Fxy2ZmB2OFqfWnDI>



The Week Magazine published an interview entitled “**Urban Meteorology is the next big thing**” with **Dr. Mrutyunjay Mohapatra**, DG, IMD on 18th June, 2020. The detailed interview is available at the link: https://www.theweek.in/news/sci-tech/2020/06/18/urban-meteorology-is-the-next-big-thing.html?fbclid=IwAR3Q3isH9q79ChxoINphGaizHNhvfOzt-KA5VR0rHZfyFV1_kYZqBA99jms



Shri S. Balamourougane, S.A. presented a poster titled “**Photovoltaic application alternate source of load energy**” at VICARE, organized by Association of Global Academicians and Researchers & Association of Indian Biologists (AIB), TN on 18th July, 2020 and awarded with Best Poster Presentation Award.

Dr. G. N. Raha, Sc. 'E' attended State Disaster Risk Reduction Day (DDR) on an online platform, "Google meet" on 18th September, 2020 organised by Sikkim State Disaster Management Authority.

Dr. M. Mohapatra, DG, IMD along with **Dr. K. K. Singh**, Sc. 'G' and Head, Agromet Division attended 4th India Agricultural Outlook Forum 2020 organized by Department of Agriculture, Cooperation & Farmers Welfare on 15-16 October, 2020.

Dr. M. Mohapatra, DG, IMD attended the online fireside chat organized by Google with Principal Scientific Advisor to Prime Minister on 30th October, 2020 on "Utility of Artificial Intelligence and Machine Learning (AI & ML)" in India.

K. S. Hosalikar, Sc. 'G' participated in the first virtual session of the "World Meteorological Organisation (WMO) Infrastructure Commission (INFCOM) Part II" from 9-13 November, 2020.

Dr. M. Mohapatra, DG, IMD attended "38th Prof. R. Ananthkrishnan colloquium" by **Dr. Nils P. Wedi**, Head Earth System Modelling, ECMWF on 11th November, 2020.

6.7. VISITORS

Forty (40) students of ITI Arab Ki Sarai, Delhi visited **Satellite Meteorology Division, IMD H.Q.** on 6th January, 2020 for familiarization with the activity of Satellite Meteorology Division.

Two (2) students from Deptt. of Atmospheric Science, School of Earth Science, Central University of Rajasthan visited **M.C. Bhubaneswar** on 6th January, 2020 for exposure to Met. Observatory and Operational Forecasting Methods.



Students at M.C. Bhubaneswar

Twenty Four (24) students along with 12 teachers of major mining and industrial regions of the state participating in the event visited **M.C., Bhubaneswar** on 11th January, 2020 as part of the State level Environment cum Mineral Awareness Programme (EMAP).



Students & teachers of during visit of M.C., Bhubaneswar

A delegation led by **Director of Meteorological Department of Qatar and Permanent Representative of Qatar with WMO** visited IMD, H.Q. on 13th January, 2020 and held a meeting with **Secretary, MoES and Director General of Meteorology** and a team of senior scientists. The delegation was briefed about various activities of IMD and the meteorological support in terms of observation, model & forecast products and trainings being provided by IMD to Qatar.

Twenty (20) Students along with two teachers of Surendranath Centenary School, Ranchi visited M.C., Ranchi on 17th January, 2020. They were briefed about modern weather forecast procedure of IMD and Climate Condition of Ranchi.

One hundred Sixty (160) students of Vosco Public School of class Fifth, Delhi visited **Satellite Meteorology Division, IMD H.Q.** during 20-23 January, 2020 for familiarization.

One hundred five (105) students of Krishna Engineering College visited **Satellite Meteorology Division, IMD H.Q.** during 29th and 30th January, for familiarization.

World Meteorological Organization (WMO) Evaluation Team inspected **IMD's training centre at Delhi and Pune** during 10-14 February, 2020 to review **WMO's Regional Training Centre (RTC)**. The delegation from WMO had a live demonstration of teaching & training facilities at Regional Training Centre (RTC), hostel facilities and also visited various work-stations/divisions of IMD at Delhi and Pune.



WMO Evaluation Team at IMD

Sixty eight (68) students and teachers of Akra Krishnanagar alika Vidyalaya on 13th February, 2020 and to 85 students and teachers of Belgharia Jatindas Vidyamandir for Girls, Kolkata on 20th February visited **RMC, Kolkata** and they were briefed details of weather forecast by RMC Kolkata officials.

Eighty (80) students and 8 teachers of Aerodrome Colony, U.G. U. P. School, Bhubaneswar visited **M. C., Bhubaneswar** to get familiarized with different observation instruments, operational activities and weather forecasting on the occasion of National Science Day on 28th February, 2020.



Students and teachers at M.C. Bhubaneswar

Sixty (60) students and 6 teachers of degree college and engineering students were visited **RMC, Nagpur**. They were briefed by IMD officials about basics of surface observatory sites, instruments, AWS and upper air observation (RS/RW observation) and radiation unit. A Film on cyclone and working of various sections was explained to them.



Students and officers posing in RSRW during visit at RMC, Nagpur

One thousand fifty five (1055) visitors/ students visited **Central Hydromet Observatory (CHO), IMD, H.Q.** during the month of January (495), February (510) and March (50), 2020 from different schools, colleges and other official agency for the familiarization of the Meteorological instruments using in CHO.



Visitors/students visited Central Hydromet Observatory, IMD, H.Q.

Nine (9) Scientists from IMD participated virtually in **Web-Ex CGMS-48 Working Group meeting** commenced during 25-29 May, 2020 at Eumetsat Office Darmstadt, Germany.

Secenty Six (76) students of Suchitra Academy, Hyderabad, participated in virtual tour on **"Weather and Climate changes"** at Meteorological Centre, Hyderabad on 22nd July, 2020.

One Hundred Sixteen (116) students of Pallavi Engineering College, Ranga Reddy District, Hyderabad participated in virtual tour on **"Instruments and Weather Forecasting"** at

M. C., Hyderabad in Cisco Webex, on 30th July, 2020.

Hon'ble Speaker of Legislative Assembly **Shri Vishweshwar Hegde Kageri, Govt of Karnataka** visited **M.C. Bangalore** on 2nd November, 2020.

Six newly joined SMS (Subject Matter Specialist) of KVK DAMU accompanying with Joint Director Extension (DE&M) and I/C OUAT DAMUs, Directorate of Extension Education, OUAT Bhubaneswar visited IMD Bhubaneswar on dated 27th November, 2020 to get familiarized with different Observation Instruments, Operational Activities and Operational Forecasting Methods. **Dr. H. R. Biswas**, Sc. 'E' and Head, M. C. Bhubaneswar briefed them on the importance and role of DAMU in GKMS Project and Agromet Services in Odisha.

10 Nos. of farmers from Krishi Vigyan Kendra, Darang Assam visited RMC Guwahati on 21st December, 2020 for familiarization to functioning of Met. Observatory.

6.8. FOREIGN DEPUTATION

Indian delegation lead by **Dr. M. Rajeevan, Secretary**, MoES, **Dr. Gopal Iyengar**, Sc. 'G', MoES and **Dr. M. Mohapatra**, DG, IMD was on ex-India deputation to Bangkok, Thailand during 20-22 January, 2020 to participate "**11th Council Meeting of Regional Integrated Multi-Hazard Early Warning System (RIMES)**". During the meeting, DG, IMD made a presentation on the "**Success story of cyclone warning services of IMD for the region**" in the RIMES Council meeting held at Asian Institute of Technology, Bangkok on 21st January, 2020.

Shri S. C. Bhan, Sc. 'F' was on foreign deputation to Geneva, Switzerland during 21-23 January, 2020 to participate in "**Expert team meeting: Implementation of WHO/WMO Joint Work plan and Integrated Health Science and Services**".

Dr. (Mrs.) Suman Goyal, Sc. 'F' was on foreign deputation to California, USA during 23-28 January, 2020 to participate the Workshop on "**Merging geostationary infra-red with Low-earth-orbit microwave observations to improve the now casting of severe convection**" under the Jet Propulsion Laboratory's Science Visitor and Colloquium Program (SVCP) in Pasadena.

Ms. Soma Sen Roy, Sc. 'E' was on foreign deputation to USA during 28-31 January, 2020 to participate in the "**4th Convective Scale Modeling Workshop at National Centre for Atmospheric Research (NCAR) Boulder**".

Dr. Sunit Das, Sc. 'E' was on ex-India deputation to Japan from 19th January to 15th February, 2020 to participate in the knowledge Co-creation Program on "**Practical Methodology for Flood Control Planning and River Basin Management in Asia Region**".

Shri Shanker Pal, Sc. 'B' National Centre for Seismology (NCS), was on ex-India deputation to Japan during 13th January to 7th March, 2020 to participate in the "**Group and Region Focused Program – Global Seismological Observation**" at Building Research Institute (BRI) Tsukuba, Japan.

Mrs. Sunitha Devi Santhamma, Sc. 'E' was on foreign deputation to Geneva, Switzerland during 6-7 February, 2020 to participate in "**Tropical Cyclone Impact Estimation for Humanitarian Preparedness and Response: Joining the Dots**" was held in conjunction with the Humanitarian Network & Partnerships Week (HNPW) 2020 during the period.

Dr. N. Puviarasan, Sc. 'E' was on foreign deputation to European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), Germany during 19-21 February, 2020 to participate in "**2nd Risk assessment workshop of The Coordination Group for Meteorological Satellites (CGMS) Working Group III**".

Dr. Kuldeep Srivastava, Sc. 'E' was on Ex-India deputation during 3-6 March, 2020 to participate in "**CI/CD (Continuous Integration/Continuous Delivery) Training/Workshop and Publish/Subscribe Workshop**" in Toulouse, France.

6.9. IMPORTANT EVENTS 2020

IMD FOUNDATION DAY, 2020

India Meteorological Department (IMD) celebrated its 145th Foundation Day at Dr. Ambedkar International Centre, New Delhi on 15th January, 2020. **Dr. Ashutosh Sharma**, Secretary, Department of Science & Technology graced the occasion as the Chief Guest. **Dr. M. Rajeevan**, Secretary, Ministry of Earth Sciences presided over the Function. **Dr. Mrutyunjay Mohapatra**, Director General of Meteorology highlighted the achievements of IMD during the year 2019 in serving various sectors of society.

Dr. Mohapatra informed about upgradation of observational network, improvements in forecast accuracy and improvements in warning dissemination mechanism through launching of **new website: www.mausam.imd.gov.in** for general public. The winner students from various schools in Delhi were also awarded cash prize and mementoes for their participations in various competitions like quiz, debates, poster making etc. organized by IMD. The programme is available at the link: <https://youtu.be/2qYaCBhhKHQ>.



Dr. Ashutosh Sharma, Secretary, DST, Dr. M. Rajeevan, Secretary, MoES, Dr. Mrutyunjay Mohapatra, DG, IMD and Dr. D. Pradhan, Sc. 'G', IMD Foundation Day 2020, New Delhi

NATIONAL VOTERS' DAY

A Pledge on National Voters Day on 25 January, 2020 was administered at H.Q., IMD and all sub-offices of IMD spread all over India.

71st REPUBLIC DAY

71st Republic Day was celebrated and National Flag was hoisted at H.Q., IMD and all sub-offices of IMD on 26th January, 2020 followed by National Anthem and other patriotic songs. On this occasion, all heads of the offices hoisted National Flag and sang National Anthem and other patriotic songs along with officers and staff members.



Officials during Flag hoisting on Republic Day 2020 at RMC Kolkata

NATIONAL SCIENCE DAY, 2020

National Science Day was celebrated on 28th February, 2020 at H.Q., IMD and all sub-offices of IMD spread all over India. On this occasion, an exhibition was arranged in the main building of of IMD, Pune. **Dr. D. S. Pai**, Scientist 'F' inaugurated the exhibition. It was well attended by large number of students, scientists, journalist and general public.

National Science Day was celebrated in Regional Meteorological Centre, Guwahati on the theme of this year '**Women In Science**'. **Dr. Rousy K. Baruah**, State Project Manager, Assam State Rural Livelihood Mission, Guwahati was the Chief Guest of the function. Shri Ajay Narayan, PGT, Geography, Kendriya Vidyalaya, Borjhar, Guwahati was the Guest-of-Honour. On this occasion, **Dr. Sanjay O'Neill**

Shaw, DDGM, RMC Guwahati delivered a lecture on the contribution of women in the field of science and technology. Dr. Rousy K. Baruah, in her presentation, stressed on giving opportunities to females in their families to expand their wings. The programme was anchored by Ms Sandipa Bhattacharya. Vote of thanks was given by Ms. Anamika Sarma, Scientific Assistant.



Shri Ajay Narayan, Dr. Sanjay O'Neill Shaw, Dr. Rousy K. Baruah and Ms. Sandipa Bhattacharya during National Science Day

AMS Ludhiana celebrated National Science Day in fond memory of Sir C.V. Raman. On this day a group of students from Govt. Boys Sr. Sec. School, Sahnewal (Ludhiana) visited our Office premises and learnt about the "Role of Aviation and Meteorology in Nation Building". Officials at AMS Ludhiana gave a short talk on Basics of Meteorology and also held Practical demonstrations.



Officials of AMS Ludhiana giving a short talk to the students

User's Workshop on "Weather Forecast and Associated Services"

Shri Nitin Gadkari, Hon'ble Cabinet Minister of Road Transport and Highway, Micro, Small and Medium Enterprises, Govt. of India inaugurated as **Chief Guest** the User's Workshop on "Weather Forecast & Associated Services" at Regional Meteorological Centre, Nagpur on 7th March, 2020 in the august presence of **Dr. M. Mohapatra** DG, IMD. **Shri Ashish Bijawal**, Dy. Collector, Nagpur and **Dr.**

P. K. Jain, Regional Director, C.G.W.B. were Guests of Honours of the programme. **Shri M. L. Sahu**, Sc. 'F' was organizing secretary & about 150 persons participated in the event.



Shri Nitin Gadkari, Hon'ble Minister, Dr. M. Mohapatra, DG, IMD and others during lighting of lamp at Users meet

WORLD METEOROLOGICAL DAY 2020

World Meteorological Day (WM DAY) - 2020 was celebrated on 23rd March, 2020 at IMD HQ and its sub-offices all over India on the theme "**Climate, Water & Agriculture**".

On the occasion, several special programmes were aired on its theme **Climate, Water & Agriculture** and other meteorological topics at different channels of TV and radio including DD National (DD Science) & regional channels in which many IMD scientists were invited as experts to participate.

A special programme entitled "**Samjhein Mausam Ke Vigyan Ko**" on the theme "Climate and Water" was aired on DD National (DD Science) at 5:00 PM on 21st March, 2020 with experts as **Dr. Mrutyunjay Mohapatra**, Director General of Meteorology, India Meteorological Department and **Prof. S. K. Dube**, Vice Chancellor, Amity University.



Dr. M. Mohapatra, DG, IMD and Prof. S. K. Dube, Vice Chancellor, Amity University on DD National

Sixteenth session of South Asia Climate Outlook Forum (SASCOF-16)

Sixteenth session of South Asia Climate Outlook Forum (SASCOF-16) and Climate Service Users Forum (CSUF) was conducted online from 20 to 22 April, 2020 and released consensus statement for South West Monsoon 2020 for South Asia. The summary of the climate statement is given below:

(i) The Sixteenth Session of South Asia Outlook Forum (SASCOF-16) online was conducted through video conference.

(ii) Normal rainfall is most likely during the 2020 southwest monsoon season (June - September) as a whole over most parts of South Asia. Geographically, above normal rainfall is most likely over the southern part and some areas of north-western parts of the



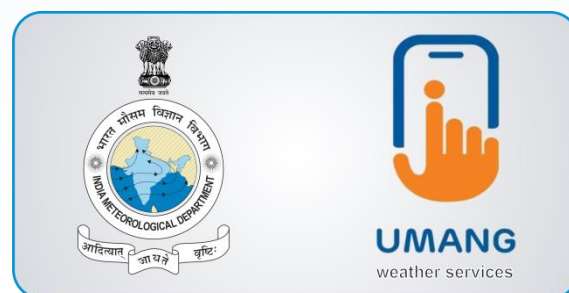
SASCOF-16 online was conducted through video conference

region. However, below-normal rainfall is most likely over land areas around North Bay of Bengal and northern most parts of the region. Normal rainfall is most likely over the remaining areas.

Unified Mobile Application for New-age Governance (UMANG) App

Dr. M. Rajeevan, Secretary, MoES launched IMD's Mobile App-UMANG (Unified Mobile Application for New-age Governance) on 22nd May, 2020 in presence of Dr. M. Mohapatra, DG, IMD and Shri Abhishek Singh, President and CEO of NeGD and other many scientists.

(The App is available at Web: <https://web.umang.gov.in/web/#/>, Android: <https://play.google.com/store/apps/details...>, iOS: <https://apps.apple.com/in/app/umang/id1236448>).



Dr. M. Rajeevan, Secretary, MoES and Shri Abhishek Singh, President and CEO of NeGD during launching of Mobile App-UMANG

Seven (7) services, like, current weather, nowcast, city forecast, tourism forecast, rainfall information, warnings and cyclones are updated features of UMANG APP hosted on <http://mausam.imd.gov.in> web site of IMD have been on-boarded on UMANG Mobile application.

Inauguration of IFLOWS-Mumbai

Integrated Flood Warning System for Mumbai (IFLOWS-Mumbai) was launched on 12th June, 2020 by Hon'ble Minister of Science & Technology, Minister of Health & Family Welfare and Minister of Earth Sciences, Dr. Harshvardhan and Hon'ble Chief Minister of Maharashtra, Shri Uddhav Thackeray, Dr. M Rajeevan, Secretary, Ministry of Earth Sciences through video conference (VC) which was also attended by Dr. M. Mohapatra, DG, IMD,

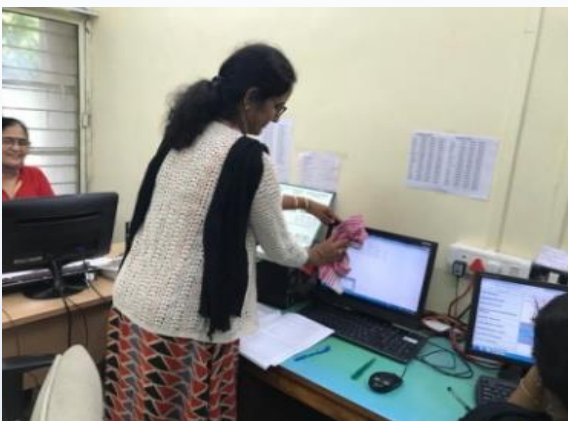
Senior Officers of Government of Maharashtra & Ministry of Earth Sciences, Directors of IITM, NCCR and NCMRWF, Dr. S. D. Attri, Sc. 'F' and Shri K. S. Hosalikar, Sc. 'F'.

INTERNATIONAL YOGA DAY

International Yoga Day was celebrated at IMD, H.Q. and sub-offices of IMD on 21st June, 2020 as per guidelines issued by the government.

SWACHHTHA PAKHWADA

Swachhta Pakhwada was observed at IMD, H. Q. and various sub-offices of IMD **during 1-15 July, 2020**. **Dr. Mrutyunjay Mohapatra**, DG, IMD administered the pledge on 1st July. A large number of officers and staff members of IMD made shramdaan to maintain cleanliness during the period.



Swachhata Pakhwada at M. C. Bengaluru

MAUSAM MOBILE APP

India Meteorological Department has taken various initiatives in recent years for

improvement in dissemination of weather forecast and warning services based on latest tools and technologies. To further enhance this initiative, **IMD's weather app MAUSAM** was launched by Hon'ble Minister of Earth Sciences, **Dr. Harsh Vardhan** on 27th July, 2020 at the eve of Foundation Day Function of MoES. This Mobile App is dedicated to the general public and designed to communicate the weather information and forecasts in a lucid manner without technical jargons. Users can access observed weather, forecasts, radar images & be proactively warned of impending weather events.



Hon'ble Minister of Earth Sciences, **Dr. Harsh Vardhan**, **Dr. M. Rajeevan**, Secretary, MoES, **Shri Vipin Chandra**, Jt. Secretary, MoES during launching of Mobile APP MAUSAM

The MAUSAM mobile app will be an important tool for dissemination of weather information and warnings in an attractive and user friendly manner which will meet the requirements of public.



The **MAUSAM mobile App** has the following 5 services:

Current Weather: Current temperature, humidity, wind speed, direction for 200 cities updated 8 times a day. Information on Sunrise/ sunset and moonrise/ moonset is also given.

Nowcast: Three hourly warnings of localized weather phenomena and their intensity issued for about 800 stations, and districts of India by State Meteorological Centres of IMD.

City Forecast: Past 24 hours and 7 day forecast of weather conditions around 450 cities in India.

Warnings: Alerts issued twice a day for all districts for the next five days in colour code (Red, Orange and Yellow) to warn citizens of approaching dangerous weather.

Radar products: Latest Station wise radar products.

INDEPENDENCE DAY

Independence Day celebrated on 15th August, 2020 at IMD, H.Q. and sub offices under protective measures like social distancing etc. have been followed during hoisting of flag and its celebration.



Independence Day celebration at M. C. Ranchi

हिंदी पखवाड़ा / हिंदी दिवस 2020

भारत मौसम वज्ञान वभाग के मुख्यालय नई दिल्ली में 14 सतम्बर, 2020 को को वड - 19

की परिस्थितियों के मद्देनजर सामाजिक दूरी को ध्यान में रखते हुए हिंदी दिवस समारोह आयोजित किया गया। रंग बिरंगे फूलों से सजे और संगीतमय वृष्टि सभागार में इस कार्यक्रम का आयोजन किया गया। हिंदी दिवस समारोह की अध्यक्षता मौसम वभाग के महानिदेशक महोदय डॉ. मृत्युंजय महापात्र ने की।



डॉ. मृत्युंजय महापात्र, मौसम वभाग के महानिदेशक हिंदी दिवस समारोह के दौरान संबोधित करते हुए

समारोह का शुभारंभ दीप प्रज्ज्वलन से हुआ। इसके पश्चात माँ सरस्वती का आशीर्वाद लेते हुए सरस्वती वंदना की गई। श्रीमती सरिता जोशी, सहायक निदेशक (राजभाषा) ने माननीय गृह मंत्री श्री अमर शाह द्वारा देशवासियों को भेजे गए संदेश को सभी को पढ़ कर सुनाया। इस समारोह के व शष्ट अतिथि श्री बी. एल. गौड़ जी का महानिदेशक महोदय द्वारा शॉल और स्मृति चन्ह से सम्मान किया गया।



व शष्ट अतिथि श्री बी. एल. गौड़ जी का महानिदेशक महोदय डॉ. महापात्र शॉल द्वारा सम्मान करते हुए

इस अवसर पर वभागीय हिंदी गृह पत्रिका 'मौसम-मंजूषा' के 31^{वें} संस्करण का द्वारा वमोचन किया

गया। इसके बाद हिंदी पखवाड़ा 2020 के दौरान आयोजित की गई प्रतियोगिताओं के विजेताओं को नकद पुरस्कार और प्रमाण-पत्र प्रदान किए गए।

भारत मौसम विज्ञान विभाग के विभिन्न उप कार्यालयों में भी हिंदी दिवस का आयोजन किया गया जिसमें कार्यालयों के लोगों ने बढ़-चढ़ के भाग लिया। यह कार्यक्रम निबंध, कविता और भाषण प्रतियोगिता जैसे विषयों पर आधारित रही।



एम. सी., भुवनेश्वर में हिंदी दिवस का आयोजन

WMO's Tropical Cyclones Forecaster Training

WMO's Tropical Cyclones Forecaster training was held during 7-17 October, 2020 through VC mode aimed at building capacity of the TC forecasters in the region by understanding the latest developments in observations, monitoring, modeling, prediction and warning services of TCs with practical examples. The training included resource persons from **IMD, NCMRWF and INCOIS and SMC Tokyo**. There were 54 participants including 19 from WMO/ESCAP Panel member countries and 35 from ACWCs, CWCs & coastal MCs & MOs, NWFC and RSMC New Delhi. **Dr. M. Mohapatra**, DG, IMD also delivered lectures including a special one on “**Chasing the Cyclones: Countdown with Disaster Managers**”.



Dr. M. Mohapatra, DG, IMD and other officers during WMO's TC Forecaster training

INDIA INTERNATIONAL SCIENCE FESTIVAL-2020

Dr. M. Mohapatra, DG, IMD attended virtual **Curtain Raiser Ceremony of the IISF-2020** by **Dr. Harsh Vardhan**, Hon'ble Minister of Science & Technology and Earth Sciences organised by Indian Institute of Tropical Meteorology (IITM) on 18th December, 2020.

Dr. Mohapatra, DG, IMD attended Inauguration of the IISF 2020 Mega Science EXPO by **Dr. Harsh Vardhan**, Hon'ble Minister for Health & Family Welfare, Science & Technology and Earth Sciences, Govt. of India on 22nd December, 2020.

Shri Raja Acharya, Met. 'A' participated in a Virtual Conference on “**India International Science Festival (IISF) 2020**” and participated in “**Clean Air event**” of MoES held during 23-24 December, 2020.

New MC at Leh

India Meteorological Department established a dedicated **Meteorological Centre** at Leh for the Union Territory of Ladakh on 29th December, 2020. Meteorological Centre, Leh was virtually inaugurated by **Dr. Harsh Vardhan**, Hon'ble Union Minister for Health & Family Welfare, Science & Technology, Earth Sciences in the presence of **Shri R. K. Mathur**, Hon'ble Lt. Governor (Ladakh), **Shri Jamyang Tsering Namgyal**, Hon'ble Member of Parliament from Ladakh, **Dr. M. Rajeevan**, Secretary, Ministry of Earth Sciences, **Shri Suagat Biswas**, IAS, Divisional Commissioner / Secretary Disaster Management (Ladakh), **Dr. M. Mohapatra**, DG, IMD, **Shri Anand Kumar Sharma**, Sc. 'G' and **Shri Sonam Lotus**, Sc. 'E'. The establishment of this office is a shining example of the concern of the GOI for the people of Ladakh. The Webcast Video Link is available: <http://webcast.gov.in/moes/imd/>



Dr. Harsh Vardhan, Hon'ble Union Minister for Health and Family Welfare, Science & Technology, Earth Sciences, Dr. M. Rajeevan, Secretary, MoES, Dr. M. Mohapatra, DG, IMD and other officers during inauguration of Meteorological Centre at Leh



Meteorological Centre at Leh



Observatory at Leh

Important Events

IMD launched video capsule of current weather status and weather forecast for next two weeks on 12th June, 2020. The first video capsule was presented by **Dr. Mrutyunjay Mohapatra, DG, IMD**. The video capsule is uploaded on face book page of Weather India and Mausam NWFC every Friday in both English and Hindi languages.

M. C. Ranchi is the first office in IMD which initiated online feedback mechanism from all stakeholders (Press, Electronics Media, and State Govt. Departments etc.) through Google form. The Report of this Feedback was widely appreciated throughout IMD.

IMD as **Regional Center of SAsiaFFGS** attended 1st FFGS Regional Centers' Teleconference organized by WMO for discussing the recent FFGS activities, FFGS Sustainability Strategy and steps forward on 5th August, 2020.

Honourable Ministry of Earth Sciences tweeted about the **New Flash Flood Guidance Services** provided to South Asian countries on 27th August, 2020 and appreciated the Pre-Operational stage activities. South Asia Regional Guidance bulletins are being issued regularly Since June 2020.



Dr. Harsh Vardhan, Union Minister for Health and Family Welfare, Science and Technology, Earth Sciences and others

Dr. M. Mohapatra, DG, IMD, Dr. S. D. Attri, Sc. 'G' and **Dr. R. K. Giri, Sc. 'E'** participated in "Executive Council Meeting" on 2nd October, 2020.

Dr. M. Rajeevan, Secretary, Ministry of Earth Sciences dedicated **Flash Flood Guidance Services**, first of its kind for South Asian countries namely India, Bangladesh, Bhutan, Nepal and Sri Lanka on 23rd October, 2020. The system was launched virtually in the presence of distinguished guests **Shri G. V. V. Sarma, IAS** (Member Secretary NDMA, India), **Dr. Rajendra Kumar Jain** (Chairman, Central Water Commission, India), **Dr. M. Mohapatra, DG, IMD** and DG's & PR's of all member countries, delegates from WMO, HRC, NDMA, CWC, IIT and other dignitaries from National & International institutions.

Vigilance Awareness Week was observed at IMD, HQ at New Delhi and its sub-offices spread all over India from 27th October 2020 to 2nd November, 2020 and the "Integrity Pledge" was administered to the employees. On the occasion lectures were also delivered on the theme सतर्क भारत, समृद्ध भारत - **Satark Bharat, Samridh Bharat (Vigilant India, Prosperous India)**.



Dr. M. Rajeevan, Secretary, MoES, Dr. M. Mohapatra, DG, IMD and others during launching of FFGS

Rashtriya Ekta Diwas was observed at **IMD, HQ New Delhi** and its sub-offices spread all over India on 31st October, 2020 and the Pledge was administered to the employees.

Dr. M. Mohapatra, DG, IMD attended online release of NCAER Report on “**Estimating the Economic Benefits of Investments in Monsoon Mission and High-Performance Computing facilities**” by **Dr. Harsh Vardhan**,

Hon’ble Minister of Science & Technology and Earth Sciences, Govt. of India on 3rd November, 2020.

Dr. M. Mohapatra, DG, IMD attended **AIML** project with IIT, Vadodara on 10th November, 2020.

“**Samvidhan Divas (Indian Constitution Day)**” pledge was administered in IMD on 26th November, 2020.

Dissemination of Agromet. advisories to the users’ community through SMS and IVR technology is being continued in the country through Kisan Portal and under **PPP mode**. At present Agromet. Advisories are reaching to **36.61 million farmers** in the country through SMS directly.

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. For the year 2020 it has an IMPACT FACTOR (IF): 0.636 and 5-year Impact factor 0.499 calculated by Thomson Reuter U.S.A. The rating score given by National Academy of Agricultural Sciences (NAAS) for the year 2020 is 6.24. IMD Scientists published 113 research paper/books in Mausam/Met. Monograph/Met Reports and National & International Journal during 2020.

7.1. RESEARCH CONTRIBUTIONS PUBLISHED IN 'MAUSAM'

Ramashray Yadav, N. Puviarasan, R. K. Giri, C. S. Tomar and Virendra Singh, **"Comparison of GNSS and INSAT-3D sounder retrieved precipitable water vapour and validation with the GPS Sonde data over Indian Subcontinent"**, *Mausam*, **71**, 1, 1-10.

R. Bibraj, B. Arul Malar Kannan, K. Ramachandra Rao and K. C. Saikrishnan, **"An analysis of anomalous propagation parameters and its effect on the intensity of clutter in weather radars"**, *Mausam*, **71**, 1, 11-20.

S. D. Attri, Sudheer Kumar, N. Chattopadhyay, S. Tiwari and Anita Kashyap, **"The study of frost occurrence and risk analysis in Indo-Gangetic Plains of India during recent decades"**, *Mausam*, **71**, 1, 95-102.

G. N. Raha, S. Bandyopadhyay and S. Das **"Heavy rainfall analysis over Teesta catchment and adjoining areas of Sub-Himalayan West Bengal and Sikkim"**, *Mausam*, **71**, 1, 133-144.

J. K. S. Yadav, **"An integrated approach in design, installation and commissioning of mirror RTH and Global Information System Center (GISC) at, Pune"**, *Mausam*, **71**, 1, 149-158.

N. Puviarasan, Ramashray Yadav, R. K. Giri and Virendra Singh, **"GPS Meteorology : Error in the estimation of precipitable water by ground based GPS system in some meso-scale thunderstorms - A case study"**, *Mausam*, **71**, 2, 175-186.

Arti Bandgar, Pallavi Prabhu, O. P. Sreejith and D. S. Pai, **"An analysis of monthly rainfall and the meteorological conditions associated with the deficient rainfall towards the end of 2017 southwest monsoon season"**, *Mausam*, **71**, 3, 391-404.

Suman Samanta, Saon Banerjee, Pulak Kumar Patra, Sudhansu Sekhar Maiti and Nabansu Chattopadhyay, **"Choice of ideal Sunshine Hour based model to predict global solar radiation in India"**, *Mausam*, **71**, 3, 451-466.

R. S. Sharma, B. K. Mandal and G. K. Das, **"Diagnostic analysis of catastrophic flood over eastern India in July 2017 - A case study"**, *Mausam*, **71**, 3, 513-522.

D. S. Pai, Arti Bandgar, Sunitha Devi, Madhuri Musale, M. R. Badwaik, A. P. Kundale, Sulochana Gadgil, M. Mohapatra and M. Rajeevan, **"Normal dates of onset/progress and withdrawal of southwest monsoon over India"**, *Mausam*, **71**, 4, 553-570.

R. R. Kelkar and O. P. Sreejith, **"Meteorological sub-divisions of India and their geopolitical evolution from 1875 to 2020"**, *Mausam*, **71**, 4, 571-584.

Ashwini Kulkarni, Pulak Guhathakurta, Savita Patwradhan and Sulochana Gadgil, **“Meteorological sub-divisions of India : Assessment of coherence, homogeneity and recommended redelineation”**, *Mausam*, **71**, 4, 585-604.

Mukhtar Ahmed, Sonam Lotus, Rajalakshmi D., Shivinder Singh and Subha Rao, A.V.M., **“Analysis of rainfall and drought climatology for crop planning in subtropical plains of Chatha, Jammu”**, *Mausam*, **71**, 4, 749-756.

7.2. RESEARCH CONTRIBUTIONS PUBLISHED IN EXTRA DEPARTMENTAL JOURNALS (INDIAN & FOREIGN JOURNALS)

Acharya, Raja, 2020, **“Ocean Energy and related Technological Advances”**, *Earth Science India*, **13**, 2, 13-17.

Agnihotri, Geeta, Gouda, K. C. and Das, Someshwar, 2020, **“Characteristics of pre-monsoon convective systems over south peninsular India and neighborhood using Tropical Rainfall Measuring Mission's Precipitation Radar”**, *Meteorology and Atmospheric Physics*, <https://doi.org/10.1007/s00703-020-00740-7>.

Arora, Charu, Kumar, Vivek, Shashi Kant and Bhomick, Suman, 2020, **“A Delayed Prey–Predator System with Migration and Disease Infection”**, *Int. J. of Applied and Computational Mathematics*, (Springer), **6**, Art. No. : 132.

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Attri, S. D., 2020, **“Climate Services for Managing Climate Change Impacts on Agriculture”**, Chapter in book : *Global Climate Change: Resilient and Smart Agriculture*, V. Venkatramanan et al. (eds.), Springer Nature Singapore Pte Ltd., 301-314.

Baburaj, P. P., Abhilash, S., Mohankumar, K., Sahai, A. K., 2020, **“On the Epochal variability in the frequency of cyclones during the pre-onset and onset phases of the monsoon over the North Indian Ocean”**, *Advances in atmospheric sciences*, **37**, 634-651.

Bhan, S. C., Shankar, Anand, Mishra, Ragini and Shilpashree, G. S., 2020, **“Meteorological conditions Associated with AES/JE Outbreak 2019 in Bihar”**, *Indian Journal of Public Health Research and Development*, **11**, 7, 765-771.

Das, S. S., Ramkumar, G., Koushik, N., Murphy, D. J., Girach, I. A., Suneeth, K. V., Subrahmanyam, K. V., Soni, V. K., Kumar, V. and Nazeer, M., 2020, **“Multiplatform observations of stratosphere-troposphere exchange over the Bharati (69.41° S, 76° E), Antarctica during ISEA-35”**, *Journal of Atmospheric and Solar-Terrestrial Physics*, **211**, Art. ID 105455.

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Geetha, B. and Balachandran, S., 2020, **“Development and Rapid Intensification of Tropical Cyclone OCKHI (2017) over the North Indian Ocean”**, *Journal of Atmospheric Science Research*, **3**, 3, 13-22.

Ghude, S. D., Kumar, Rajesh, Jena, Chinmay, Debnath, Sreyashi, Kulkarni, Rachana G., Alessandrini, Stefano, Biswas, Mrinal, Kulkrani, Santosh, Pithani, Prakash, Kelkar, Saurab, Sajjan, Veeresh, Chate, D. M., Soni, V. K., Singh, Siddhartha, Nanjundiah, Ravi S. and Rajeevan, M., 2020, **“Evaluation of PM2.5 forecast using chemical data assimilation in the WRF-Chem model: a new initiative under the Ministry of Earth Sciences (MoES) air quality early warning system (AQEWS) for Delhi”**, *Current Science*, **118**, 11, 1803-1815.

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- Hulswar, S., Soni, V. K., Sapate, J. P., More, R. S. and Mahajan, A. S., 2020, "**Validation of satellite retrieved ozone profiles using in-situ ozonesonde observations over the Indian Antarctic station, Bharati**", *Polar Science*, **25**, Art. ID 100547.
- Jena, C., Ghude, S., Kumar, R., Debnath, S., Soni, V. K., Nanjundiah, R. S. and Rajeevan, M., 2020, "**High-resolution (400 m) operational air quality early warning system for Delhi, India**", *IGAC News*, **66**, 25-26.
- Kanawade, V. P., Srivastava, A. K., Ram, K., Asmi, E., Vakkari, V., Soni, V. K., Varaprasad, V. and Sarangi, C., 2020, "**What caused severe air pollution episode of November 2016 in New Delhi?**", *Atmospheric Environment*, **222**, 117-125.
- Kotal, S. D. and Bhattacharya, S. K., 2020, "**Improvement of wind field forecast for tropical cyclones over North Indian Ocean**", *Tropical Cyclones Research & Review*, **9**, 53-66.
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RSMC released **“Tropical Cyclone Operational Plan (TCP-21) Edition 2019”**, The same is available at <http://www.rsmcnewdelhi.imd.gov.in/images/pdf/publications/tcp-21/tcp-21-2019.pdf>.

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RR No. 1/2020 CRS Research Report, **“Development of a New (1degx 1deg) (1981-2019) Monthly Gridded Rainfall Data Set Over South Asian Region”**, Latha Sridhar, Divya Surendran, Aradhana Kumari, Md. Bazlur Rashid, Azeema Ahmed, O. P. Sreejith and D. S. Pai.

CHAPTER 8

FINANCIAL RESOURCES AND MANAGEMENT PROCESS

8.1. FINANCIAL RESOURCES AND MANAGEMENT

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.) during Financial Year 2020-21 are given in Table 1.

TABLE 1

Budget Estimates (B.E.) during Financial Year 2020-21

Central Sector Schemes	Establishment	Total
249.22	443.44	692.66

Atmospheric & Climate Research – Modelling Observing Systems & Services (ACROSS)

To upgrade the forecasting capabilities, various programs were implemented in IMD during 2017-20 (14th Finance Commission period) under the umbrella scheme “Atmosphere & Climate Research-Modelling Observing Systems & Services (ACROSS)” of the MoES is given in Table 2.

The projects under ACROSS-IMD are continuing programs from previous Plan periods encompassing various activities in an integrated manner to ensure the sustenance & augmentation of observations & enhancement of facilities required for the weather forecasting services. The programs are being implemented by various Offices/Divisions across the country having long and requisite experience in the required fields. Various scientists have been assigned for implementation of the activities. With the Delegation of Enhanced Financial Powers to Heads of RMCs, MCs and CDRs/DWRs etc. & stand-alone offices headed by Group ‘A’ officers and Remote Offices in India Meteorological Department, execution of the scheme is being done at all offices across the country and expenditure is incurred by RMCs, MCs and other offices of the Department for successful implementation of the scheme. The implementation of the activities is under the overall guidance of the Director General of Meteorology and other senior scientists.

As per the directive of the Department of Expenditure OM No: 66(59)/PFC-II/2018 dated 17 September 2018, Ministry of Earth Sciences constituted an Independent Review

TABLE 2

Budget Estimates (B.E.) during Financial Year 2020-21

S. No.	Name of the Scheme/Project	Budget Outlays (Rs. in Crores)
1.	Atmospheric observations Network (AON)	222.0
2.	Upgradation of Forecast System (UFS)	158.0
3.	Weather & Climate Services (WCS)	241.0
4.	Commissioning of Polarimetric DWRs	42.0
Total		663.0

committee (IRC) to evaluate all nine sub-schemes under the umbrella scheme “Atmosphere and Climate Research: Modelling, Observing Systems and Services (ACROSS)” in qualitative and quantitative terms for continuation from 14th Finance commission (2017-20) to next Finance Commission Cycle. The committee evaluated the sub-schemes in terms of importance of the schemes in the context of national development, mechanism of implementation, achievements corresponding to the objectives of the scheme, key bottlenecks/issues & challenges surfaced during the implementation, assets created/ services provided to the beneficiaries and Direct/indirect employment generation. Financial review on allocation and expenditure of the scheme was also made.

The committee appreciated the work being done under the ACROSS scheme and commented that that the activities under the nine sub-schemes of ACROSS are immensely contributing towards the delivery of a reliable and skillful weather and climate services. In view of the importance of the umbrella scheme ACROSS in the national context, the committee recommended the continuation of all the nine-schemes under ACROSS from the 14th Finance commission (2017-20) to the 15th Finance Commission.

Furthermore, in accordance with MoES Administrative Order dated 30th March 2020, all the activities/ sub-schemes under ACROSS-IMD have been continued/ extended during Financial Year 2020-21 at an estimated cost of Rs. 249.57 Crore. IMD programme-wise budget during FY 2020-21 is given in Table 3.

TABLE 3

IMD programme-wise Budget under ACROSS (Rs. in crore)

Programme	Type	Allocation
AON (including MAQWS)	Revenue	53.71
	Capital	39.00
WCS	Revenue	47.33
	Capital	35.50
UFS (including Monsoon Mission-II)	Revenue	27.15
	Capital	33.50
PDWRs	Revenue	1.88
	Capital	11.50
Total	Revenue	130.07
	Capital	119.50

AON - Atmospheric Observations Network

WCS - Weather & Climate Services

UFS – Upgradation of Forecast System

PDWRs – Commissioning of Polarimetric Doppler Weather Radars

8.4. REVENUE GENERATED DURING THE YEAR 2018

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	64965	Nil	Nil	Nil	64965	Nil	Nil	22131	Nil	Nil	Nil
DGM (Publication)	18700	25125	23375	Nil 0	675	Nil	450	28225	17575	4000	24000	33825
RMC, New Delhi												
New Delhi	88555	59054	Nil	Nil	Nil	65386	26328	41258	59147	81546	27245	10306
Jaipur	19616	12269	16036	Nil	Nil	16279	42957	39080	68883	12757	4571	40480
Lucknow	8498	13845	9670	4914	2591	6412	35548	5066	15048	5076	7855	72917
Srinagar	13487	16048	6927	Nil	Nil	7399	3457	4012	1770	8826	2124	19252
Chandigarh	5074	Nil	40651	Nil	Nil	5064	15190	21346	31892	2714	Nil	Nil
Shimla	26748	23954	11512	Nil	Nil	4079	32873	4850	1615	8117	22542	12158
Dehredun	40571	180079	2301	Nil	9771	35539	86770	43798	54466	16502	33433	9538
RMC, Mumbai												
Mumbai	27292	57670	14080	2548	18252	17005	59464	66153	39841	28595	45814	31557
RMC, Nagpur												
Nagpur	40572	62741	15526	Nil	23322	23835	49000	55529	33011	24532	29458	25096
Bhopal	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
RMC, Kolkata												
RMC Kolkata	130593	9110	19017	Nil	4219	22500	41189	63446	6984	8737	34826	5389
PAC Kolkata	Nil	Nil	2953	Nil	5352	14135	35132	2268	5502	20162	Nil	Nil
Patna	69368	3785	2420	Nil	Nil	4156	Nil	1139	2596	10726	8682	4379
Bhubneshwar	7260	32479	2648	Nil	9239	7670	30444	15340	34565	71567	54257	2122
Gangtok	4874	2393	11077	Nil	Nil	27991	5122	7766	Nil	22191	10078	7434
Ranchi	7435	18641	Nil	Nil	Nil	2596	20988	2596	2596	11679	1347	7258
RMC, Guwahati												
Guwahati	82589	67894	145919	Nil	10017	26956	25077	45381	55813	53992	38388	61913
Agartala	2288	Nil	Nil	9624	7410	1141	3433	23684	15564	1167	9786	2904
RMC, Chennai												
Chennai	57282	37879	48074	30309	102252	46545	12375	99697	48686	182466	40824	30579
Thiruvananthapuram	103316	31474	10110	7932	161600	16519	8668	16374	35752	20590	5460	20056
Hyderabad	33634	22093	45730	Nil	42624	74680	17155	83837	11261	105453	132692	80542
Bangalore	29011	15964	99519	Nil	43520	85325	57238	70010	79615	52892	61397	23622
ACWC Chennai	Nil	Nil	Nil	Nil	Nil	Nil	10718	Nil	12514	25605	Nil	10259
CWC Visakhapatnam	1861	3189	Nil	Nil	5675	2122	Nil	Nil	Nil	6490	10524	11918
CRS, Pune												
Pune	560816	595482	544295	13235	47968	4742709 \$196	205519	1011150	926111	544833 \$171	192595	464811 \$21

CHAPTER 9

राजभाषा नीति का कार्यान्वयन

संसदीय राजभाषा समिति द्वारा निरीक्षण

प्रादेशिक मौसम केंद्र, चेन्नै - संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 15.01.2020 को प्रादेशिक मौसम केंद्र, चेन्नै कार्यालय का राजभाषायी निरीक्षण किया गया। इस निरीक्षण कार्यक्रम में मुख्यालय से डॉ. के. के. सिंह, वैज्ञानिक 'जी' तथा सुश्री रेवा शर्मा, उपनिदेशक (राजभाषा) ने भाग लिया। इसके अलावा मुख्यालय के राजभाषा अनुभाग से श्रीमती सरिता जोशी, सहायक निदेशक (रा.भा.) और श्रीमती कल्पना श्रीवास्तव, वरिष्ठ अनुवादक भी इस निरीक्षण के दौरान उपस्थित रहे।



मौसम केंद्र, अहमदाबाद - संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 27.02.2020 को मौसम केंद्र अहमदाबाद कार्यालय का बडोदरा में राजभाषायी निरीक्षण किया गया। इस निरीक्षण कार्यक्रम में मुख्यालय से डॉ. देवेन्द्र प्रधान, वैज्ञानिक 'जी', सुश्री रेवा शर्मा, उपनिदेशक (रा.भा.) तथा श्रीमती सरिता जोशी, सहायक निदेशक (रा.भा.) ने भाग लिया। इसके अलावा मुख्यालय के राजभाषा अनुभाग से श्रीमती कल्पना श्रीवास्तव,

वरिष्ठ अनुवादक तथा श्री बीरेन्द्र कुमार, वरिष्ठ अनुवादक भी उपस्थित रहे।



प्रादेशिक मौसम केंद्र, नई दिल्ली - माननीय संसदीय राजभाषा समिति दूसरी उपसमिति द्वारा दिनांक 07.12.2020 को प्रादेशिक मौसम केंद्र, नई दिल्ली का राजभाषायी निरीक्षण किया गया जिसमें महानिदेशक डॉ. मृत्युंजय महापात्र, श्री आनंद कुमार शर्मा, वैज्ञानिक 'जी', सहायक निदेशक (रा.भा.) श्रीमती सरिता जोशी तथा श्रीमती पूनम सिंह हिंदी संपर्क अधिकारी ने भाग लिया।



भारत मौसम विज्ञान विभाग (मुख्यालय) - माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 08.12.2020 को भारत मौसम विज्ञान विभाग (मुख्यालय) का राजभाषायी निरीक्षण किया गया जिसमें महानिदेशक डॉ. मृत्युंजय महापात्र, डॉ. शिवदेव अत्री वैज्ञानिक 'जी' तथा सहायक निदेशक (रा.भा.) श्रीमती सरिता जोशी ने भाग लिया।



माननीय संसदीय राजभाषा समिति द्वारा इस अवसर पर प्रादेशिक मौसम केंद्र- गुवाहाटी की हिंदी गृह पत्रिका 'नीलाचल' के पहले संस्करण का विमोचन किया गया।



राजभाषा अनुभाग द्वारा निरीक्षण

मुख्यालय की उपनिदेशक (रा.भा.) सुश्री रेवा शर्मा तथा वरिष्ठ अनुवादक श्रीमती कल्पना श्रीवास्तव द्वारा दिनांक 03.02.2020 से 04.02.2020 तक **मौसम केंद्र, अहमदाबाद** का राजभाषायी निरीक्षण किया गया।

मुख्यालय के राजभाषा अनुभाग की उपनिदेशक (रा.भा.) सुश्री रेवा शर्मा, सहायक निदेशक (रा.भा.) श्रीमती सरिता जोशी, तथा वरिष्ठ अनुवादक श्रीमती कल्पना श्रीवास्तव एवं वरिष्ठ श्री बीरेन्द्र कुमार द्वारा दिनांक 28.02.2020 को **विमानन मौसम केंद्र (ए एम एस) बडोदरा** का राजभाषायी निरीक्षण किया गया।



राजभाषायी ई-निरीक्षण

राजभाषा अनुभाग द्वारा

- दिनांक 22.07.2020 को प्रादेशिक मौसम केंद्र-नई दिल्ली, मौसम केंद्र- देहरादून तथा मौसम केंद्र- जयपुर का राजभाषायी ई-निरीक्षण किया गया जिसमें उपमहानिदेशक (प्रशा.) श्री वाई. के. रेड्डी उपस्थित रहे।

डॉ. के. के. सिंह, वैज्ञानिक 'जी' तथा श्रीमती सरिता जोशी सहायक निदेशक (रा.भा.) द्वारा

- दिनांक 14.08.2020 को प्रादेशिक मौसम केंद्र-मुंबई, मौसम केंद्र- अहमदाबाद तथा मौसम केंद्र- गोवा

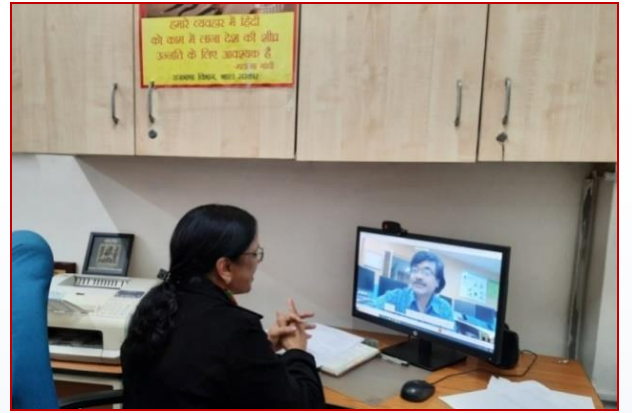


- दिनांक 28.09.2020 को जलवायु अनुसंधान एवं सेवाएँ पुणे, मौसम केंद्र- गंगटोक, मौसम केंद्र- भुवनेश्वर तथा प्रादेशिक मौसम केंद्र- कोलकाता

- दिनांक 20.10.2020 को प्रादेशिक मौसम केंद्र- चेन्नै, मौसम केंद्र- बंगलुरु, मौसम केंद्र- हैदराबाद तथा मौसम केंद्र- अमरावती

- दिनांक 18.11.2020 को प्रादेशिक मौसम केंद्र- नागपुर, मौसम केंद्र- रायपुर, मौसम केंद्र- भोपाल तथा मौसम केंद्र- तिरुवनंतपुरम का राजभाषायी ई-निरीक्षण किया गया तथा आवश्यक दिशानिर्देश दिए गए।

श्रीमती सरिता जोशी सहायक निदेशक (रा.भा.) द्वारा दिनांक 16.12.2020 को प्रादेशिक मौसम केंद्र गुवाहाटी, मौसम केंद्र- अगरतला, मौसम केंद्र- शिलाँग तथा मौसम केंद्र- ईटानगर का राजभाषायी ई-निरीक्षण किया गया।



- दिनांक 16.11.2020 को पृथ्वी विज्ञान मंत्रालय के संयुक्त निदेशक(रा.भा.) श्री मनोज आबूसरिया द्वारा मुख्यालय का राजभाषायी निरीक्षण किया गया। इस निरीक्षण में महानिदेशक महोदय तथा उपमहानिदेशक-(प्रशा.) भी उपस्थित रहे।

हिंदी दिवस/हिंदी पखवाड़ा

मुख्यालय में दिनांक 14.09.2020 को कोविड-19 की परिस्थितियों को ध्यान में रखते हुए हिंदी दिवस समारोह का सफल आयोजन किया गया। हिंदी

दिवस समारोह की अध्यक्षता डॉ. मृत्युंजय महापात्र, महानिदेशक ने की तथा इस समारोह के मुख्य अतिथि श्री बी. एल. गौड़, संस्कृति मंत्रालय की हिंदी सलाहकार समिति के पूर्व सदस्य एवं सुप्रसिद्ध साहित्यकार एवं लेखक रहे ।



हिंदी दिवस/हिंदी पखवाड़ा 2020 के दौरान आयोजित की गई 06 प्रतियोगिताओं के 30 विजेताओं को महानिदेशक महोदय डॉ. मृत्युंजय महापात्र एवं मुख्य अतिथि श्री बी. एल. गौड़ तथा हिंदी दिवस समारोह समिति के अध्यक्ष डॉ. के. के. सिंह वैज्ञानिक 'जी' के हाथों से पुरस्कार एवं प्रमाण-पत्र प्रदान किए गए।



राजभाषा चलशील्ड

वर्ष 2019-20 के दौरान हिंदी में उत्कृष्ट कार्य के लिए मुख्यालय के 'कल्याण अनुभाग' को हिंदी दिवस 2020 के अवसर पर राजभाषा चलशील्ड प्रदान की गई। कल्याण अनुभाग के प्रभारी

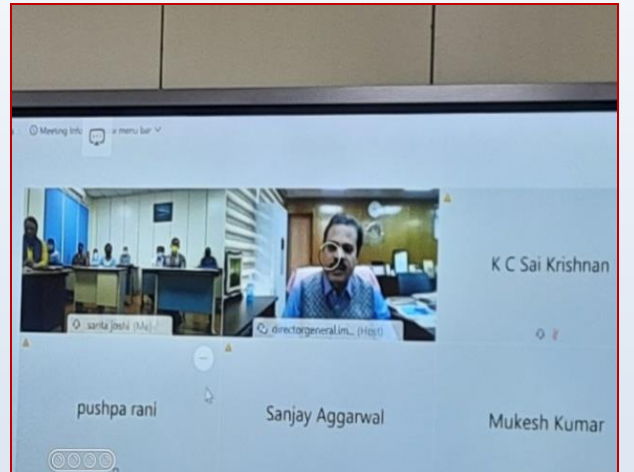
अधिकारी मो. इमरान अंसारी ने राजभाषा चलशील्ड ग्रहण की।



हिंदी कार्यशाला/ ई हिंदी कार्यशाला

एकीकृत मौसम विज्ञान प्रशिक्षण पाठ्यक्रम के प्रशिक्षणार्थियों को दिनांक 03.01.2020 को श्रीमती कल्पना श्रीवास्तव, वरिष्ठ अनुवादक ने 'राजभाषा हिंदी की संवैधानिक स्थिति', सुश्री रेवा शर्मा, उपनिदेशक (रा.भा.) ने दिनांक 21.01.2020 को 'राजभाषा नीति' तथा श्रीमती सरिता जोशी, सहायक निदेशक (रा.भा.) ने दिनांक 21.01.2020 को 'कम्प्यूटर और सूचना प्रौद्योगिकी' विषय पर व्याख्यान दिए।

मुख्यालय द्वारा दिनांक 11.11. 2020 को ई-हिंदी कार्यशाला का आयोजन किया गया जिसका शुभारंभ महानिदेशक महोदय द्वारा किया गया। महानिदेशक महोदय ने सभी प्रतिभागियों को हिंदी कार्यशाला में प्रतिभागिता के लाभ के बारे में बताया।



श्रीमती सरिता जोशी, सहायक निदेशक (रा.भा.), श्रीमती कल्पना श्रीवास्तव, वरिष्ठ अनुवाद अधिकारी तथा श्री बीरेन्द्र कुमार, वरिष्ठ अनुवाद अधिकारी ने इस कार्यशाला में व्याख्यान दिए।



मौसम मंजूषा के 30^{वें} संस्करण का विमोचन विभाग के 145^{वें} स्थापना दिवस के अवसर पर दिनांक 15.01.2020 को सचिव-विज्ञान एवं प्रौद्योगिकी मंत्रालय, सचिव-पृथ्वी विज्ञान मंत्रालय, तथा महानिदेशक, भारत मौसम विज्ञान विभाग द्वारा किया गया।

प्रकाशन

भारत मौसम विज्ञान विभाग (मुख्यालय) की राजभाषा कार्यान्वयन समिति की 150^{वीं} विशेष बैठक के अवसर पर दिनांक 19.03.2020 को विभाग की राजभाषा से जुड़ी उपलब्धियों को दर्शाती हुई राजभाषा स्मारिका का विमोचन डॉ. देवेन्द्र प्रधान, वैज्ञानिक 'जी' द्वारा किया गया।



विभागीय हिंदी गृह पत्रिका 'मौसम-मंजूषा' के 31^{वें} संस्करण का विमोचन डॉ. मृत्युंजय महापात्र, महानिदेशक, मुख्य अतिथि श्री बी. एल. गौड, डॉ. के. के. सिंह, वैज्ञानिक 'जी' तथा श्रीमती सरिता जोशी सहायक निदेशक (रा.भा.) द्वारा किया गया।

राजभाषा स्मारिका

राजभाषा कार्यान्वयन समिति की 150^{वीं} बैठक
19 मार्च 2020















भारत मौसम विज्ञान विभाग
पृथ्वी विज्ञान मंत्रालय
मौसम भवन, लोदी रोड
नई दिल्ली -110003



बैठक

भारत मौसम विज्ञान विभाग, मुख्यालय की राजभाषा कार्यान्वयन समिति की

- 150^{वीं} विशेष तिमाही बैठक दिनांक 19.03.2020 को डॉ. देवेन्द्र प्रधान, वैज्ञानिक 'जी'
- 151^{वीं} बैठक दिनांक 26.06.2020 को डॉ. मृत्युंजय महापात्र, महानिदेशक
- 152^{वीं} बैठक दिनांक 29.09.2020 को डॉ. मृत्युंजय महापात्र, महानिदेशक
- तथा दिनांक 23.12.2020 को 153^{वीं} बैठक डॉ. एस.डी अत्री, वैज्ञानिक 'जी' की अध्यक्षता में आयोजित की गई ।

152^{वीं} तथा 153^{वीं} बैठकों में उपकार्यालय के प्रमुखों को भी वी सी के माध्यम से जोड़ा गया तथा उनकी तिमाही प्रगति रिपोर्टों की भी समीक्षा की गई ।

अनुवाद कार्य

नेमी अनुवाद कार्य के अलावा पृथ्वी विज्ञान मंत्रालय की वार्षिक रिपोर्ट के अध्याय-8, भारत मौसम विज्ञान विभाग के स्थापना दिवस समारोह के निमंत्रण, वैज्ञानिक 'जी' पद पर सीधी भर्ती तथा प्रतिनियुक्ति के आधार पर भर्ती से संबंधित 02

विज्ञापन, मार्च से मई 2020 के दौरान तापमान का ऋतुनिष्ठ आउटलुक से संबंधित प्रेस विज्ञप्ति, विभागीय शोध पत्रिका 'मौसम' में प्रकाशित किए जाने वाले सार, भारत मौसम विज्ञान विभाग की नई वेबसाइट के होम पेज के पृष्ठों, प्रशासनिक अधिकारी, समूह 'ख' तथा उच्च श्रेणी लिपिक, समूह 'ग' के भर्ती नियम 2020 की अधिसूचना तथा अनुसूची, कोविड-19 से संबंधित आदेश के नोटिस, भारतीय उष्ण कटिबंधीय मौसम विज्ञान संस्थान द्वारा आवंटित महानिदेशक महोदय के पावर प्वाइंट प्रेजेंटेशन के सार, उच्च श्रेणी लिपिक के भर्ती नियम की संशोधित प्रति, कोविड से संबंधित मेटनेट पर डाले जाने वाले महानिदेशक महोदय के पॉप अप संदेश, दिनांक 29.12.2020 को मौसम केंद्र-लेह की स्थापना से संबंधित प्रेस विज्ञप्ति, मंत्रालय द्वारा मंत्रिमंडल के समक्ष प्रस्तुत किए जाने वाले समझौता ज्ञापन के गोपनीय कैबिनेट नोट का हिंदी पाठ तैयार किया गया।

प्रोत्साहन योजना

भारत मौसम विज्ञान विभाग के स्थापना दिवस 15 जनवरी 2020 के अवसर पर राजभाषा हिंदी में उत्कृष्ट प्रदर्शन के लिए "राजभाषा शील्ड" मौसम केंद्र, गंगटोक के प्रमुख डॉ जी. एन. राहा, वैज्ञानिक "ई" को प्रदान की गई।



मुख्यालय में कार्यरत 07 कार्मिकों को सरकारी कामकाज मूलरूप से हिंदी में करने की प्रोत्साहन

योजना के अंतर्गत कुल 23000₹. (तेईस हजार रूपये केवल) तथा उपकार्यालयों में कार्यरत 10 कार्मिकों को सरकारी कामकाज मूलरूप से हिंदी में करने की प्रोत्साहन योजना के अंतर्गत कुल 29000₹. (उन्तीस हजार रूपये केवल) के पुरस्कार तथा प्रमाण पत्र प्रदान किए गए ।

विभागीय गृह पत्रिका मौसम मंजूषा के 30^{वें} संस्करण के 18 रचयिताओं को कुल 27,000₹.

(सत्ताइस हजार रूपये मात्र) तथा 31^{वें} संस्करण के 23 रचयिताओं को कुल 34,500₹. की प्रोत्साहन राशि की प्रदान की गई।

विभाग में कार्यरत कुल 36 कार्मिकों को हिंदी शिक्षण योजना के अंतर्गत हिंदी प्रबोध, प्रवीण ,प्राज्ञ परीक्षा उत्तीर्ण करने पर कुल 75,400 ₹. की नकद पुरस्कार राशि प्रदान की गई।

CHAPTER 10**STATUS OF SC/ST/OBC AS ON 01.01.2020****(i) Status of SC/ST/OBC as on 01.01.2020 (Group wise)**

Groups	Representation of SCs / STs / OBCs as on 1.1.2020				Appointments by Promotion during the calendar year		
	No. of Employees	SCs	STs	OBCs	SCs	STs	Total
Group A	185	32	14	40	7	3	37
Group B (Gaz.)	1120	207	111	89	Nil	Nil	Nil
Group B (Non- Gaz.)	1771	264	130	606	Nil	Nil	Nil
Group C	1303	394	143	176	Nil	Nil	Nil
TOTAL	4379	897	398	911	7	3	37

(ii) Status of SC/ST/OBC as on 01.01.2020 (Pay Scale Wise)

Pay Scale in Rs.	Representation of SCs / STs / OBCs as on 01.01.2019				Appointments by promotion during the calendar year		
	No. of Employees	SCs	STs	OBCs	SCs	STs	Total
PB-3 + GP 5400	23	4	3	7	0	0	0
PB-3 + GP 6600	44	4	2	10	3	2	17
PB-3 + GP 7600	7	1	1	4	0	0	0
PB-4 + GP 8700	66	18	6	18	0	1	6
PB-4 + GP 8900	43	5	2	1	4	0	8
PB-4 + GP 10000	1	0	0	0	0	0	6
75500-80000	1	0	0	0	0	0	0
TOTAL	185	32	14	40	7	3	37

CHAPTER 11

MISCELLANEOUS

11.1. HONOURS AND AWARDS

IMD Awards

Best RMC/MC/MOs Awards and Awards to IMD Scientists/employees were given on the occasion of 145th IMD Foundation Day celebrations.

Most Performed RMC : RMC, Mumbai;

Most Performed MC : MC, Bhubaneswar;

Most Performed MO : (i) M.O. Puri, (ii) M.O. Kolhapur, (iii) M.O. Ramagundam;

Best RS/RW : RS/RW Jodhpur;

Best DWR - DWR, Vishakhapatnam;

Best AMO/AMS: (i) AMO Kolkata, (ii) AMO Thiruvananthapuram, (iii) AMO Nagpur;

Rajbhasha Shield : MC, Gangtok;

Best Group 'A' Officers : (i) Shri J. P. Gupta, Sc. 'F', MC, Lucknow, (ii) Shri Sandeep Kumar Sharma, Sc. 'B', MWO Palam;



Shri J. P. Gupta receiving best group 'A' officer award-2019

Best Group 'B' Officials : (i) Shri S. N. R. Gopal, Met. 'B', MC, Bangalore, (ii) Shri Arun Sharma, Met. 'A', DGM's Office (HQ), (iii) Sh. Rajiv Chawla, A.O.-III, DGM's Office, (iv) Shri Ashwin

Raju D. K., S.A., RMC, Chennai, (v) Mrs. Priya Dinesh, Assistant, MC, Hyderabad;

Best Group 'C' Officials : (i) Shri Naveen Prajapati, Steno Gr.II, RMC, Kolkata, (ii) Shri Manoj Kumar Paul, UDC, RMC, Guwahati, (iii) Shri D. V. Bhinge, MTS, CRS, Pune (iv) Shri S. S. Tike, MTS, M.O. Satara

MoES AWARD 2019-2020

Ministry of Earth Sciences celebrated its foundation day on 27th July 2020 at Vigyan Bhawan, New Delhi. Various award were presented to officials from different organisations of MoES.

Certificate of Merit

1. Dr. P. Guhathakurta, Sc. 'F', CRS Pune,
2. Shri Sanjib Sen, Sc. 'F', PAC Kolkata and
3. Dr. H. R. Biswas, Sc. 'E', MC Bhubaneswar

Best Employee Award for the year 2019-20

- (i) Shri Dinesh Kumar, Met. 'A', ISSD, DGM's Office
- (ii) Shri Kailash Mangain, AO-III, DDO, DGM's Office
- (iii) Shri Pradeep Sharma, Met. 'A', NWFC, DGM's Office
- (iv) Smt. Sheela Abraham, SA, RMC Mumbai
- (v) Ms. Madhuri M. Musale, SA, CRS Pune
- (vi) Shri Jawaharlal Das, UDC, RMC, Mumbai
- (vii) Shri Putul Dutta, Mech. Gr.'I', RMC, Guwahati
- (viii) Shri VDVR Prasad, MTS, M.C. Hyderabad
- (ix) Shri S. B. Singh, MTS, M.C. Jaipur.

29th Biennial MAUSAM Award

The 29th Biennial MAUSAM Award consists of a Citation and cash prize of Rs.50,000/- (Rs. Fifty Thousand only) were also conferred upon Dr. S. P. Ghanekar, Dr. S. G. Narkhedkar and Late Prof. D. R. Sikka for their research paper entitled, “**Progress of Indian summer monsoon onset and convective episodes over Indo-Pacific region observed during 2009-2014**” published in the October 2016 (Vol. 67, No. 4) issue of MAUSAM.

Appreciation Received

Odisha Govt. thanked IMD Chief for accurate predictions of AMPHAN. The detailed article published by Hindustan Times on 21st May, 2020 is available at :

<https://www.hindustantimes.com/india-news/odisha-govtthanks-imd-chief-for-accurate-forecast-of-cyclone-amphan/story-afbVMgt8fh1eLnfXMFNZGM.html>



The Chief Disaster Risk Reduction Centre, United Nations Development Programme, Chief Minister of Odisha & West Bengal, Director General, National Disaster Response Force, media and general public appreciated cyclone forecasting services of IMD. Life profile of DG, IMD was published in various leading newspapers of the country.

Prameya News, Odisha appreciated DGM IMD for accurate cyclone warning services during AMPHAN.

Indian Air Force appreciated IMD for precise and accurate predictions during AMPHAN.

Government of West Bengal appreciated the role of IMD in providing accurate and frequent updates on super cyclone AMPHAN that helped minimize loss of lives.

DG, NDRF appreciated accurate forecast of super cyclone AMPHAN that helped disaster managers effectively mitigate the disaster associated with super cyclone AMPHAN.

Ommcomm News, Odisha published article “The story of Cyclone Man of India whose efforts saved lives” on 24th May. The same is available at the link:

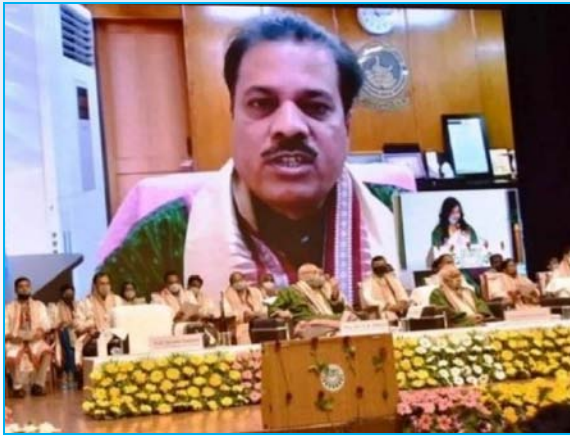
https://ommcomnews.com/odisha-news/the-story-of-india-s-cyclone-man-whose-efforts-saved-millions-of-lives/odia?fbclid=IwAR3DMLYLWAKznNVLLnRIslybaUJEXh8y7rxH6m94BGMbNyxVX5_KzKwduA

Hon’ble Chief Minister Shri Uddhavaji B. Thackeray, Govt. of Maharashtra appreciated the Weather Services provided by RMC, Mumbai during the Period of 3-6 August, 2020, When entire Konkan (Mah) received Extremely Heavy Rainfall including Mumbai, Thane.

Director, Directorate of Fire & Emergency Services issued a D.O. letter appreciating Meteorological Centre, Goa for proactive steps being taken to enhance its forecasting capabilities and also conveyed that the short term, long term warnings have helped Fire & Emergency department immensely in preparing for emerging situations and being optimum in their response towards the situations.

Chief Secretary, Telangana appreciated the services rendered by Meteorological Centre, Hyderabad during monsoon season and Hyderabad Floods during October, 2020.

Dr. Mrutyunjay Mohapatra, DG, IMD was conferred the “**Doctor of Science (D.Sc.) Honoris Causa**” by **Kalinga Institute of Industrial Technology (KIIT)**, Bhubaneswar through virtual platform on 21st November, 2020 during the 16th Annual Convocation.

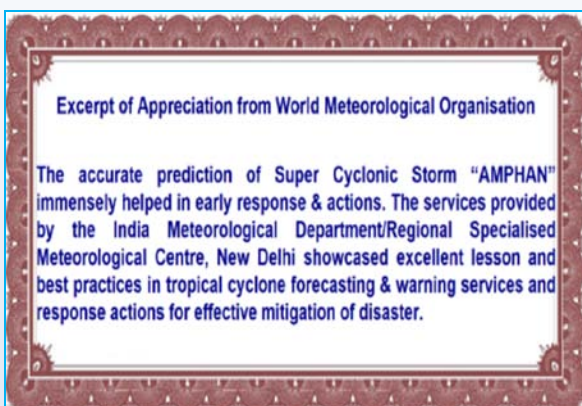


Dr. Mrutyunjay Mohapatra, DG, IMD during convocation

Dr. S. D. Attri, Sc. ‘G’ has been nominated as **Member, Expert Team on Agromet. Risk Management of Standing Committee on Services for Agriculture of SERCOM, WMO**.

Appreciation from WMO

WMO sent appreciation letter to **Dr. Mrutyunjay Mohapatra**, DG, IMD on 2nd June, 2020 for accurate prediction of Super Cyclonic Storm “**AMPHAN**” that immensely helped in early response and actions. WMO wrote that the services provided by IMD/RSMC New Delhi, showcased excellent lesson and best



practices in tropical cyclone forecasting & warning services and response actions for effective mitigation of disaster. The news was

aired in various leading national TV channels & newspapers.

WMO appreciated the efforts and activities taken up by **India Meteorological Department** to improve its **Flood Meteorological Services** during this unusual Heavy Monsoon Rainfall in many parts of India and its services to South Asia under the leadership of **Dr. M. Mohapatra**, DG, IMD amid Covid19 Pandemic crisis. IMD organised an on line training on flash flood guidance system during 8-10 Jul for forecasters of south Asia.

Raja Acharya, Met. ‘A’, nominated as “**Ocean Expert Data Base of the Inter-Governmental Oceanographic Commission (IOC) a specialized agency of the UN**”. Ocean Expert is a Global directory of marine professionals. The Ocean Expert portal contains information about research materials, online conferences, webinars related to ocean science. It is the main address database of the Intergovernmental Oceanographic Commission of UNESCO.

<https://oceanexpert.org/expert/20814>.

11.2. MEDIA INTERACTION

Dr. S. O. Shaw, Sc. ‘E’, **Shri Sunit Das**, Sc. ‘E’ and **Shri Atul Kumar Singh**, Sc.‘C’ attended Media Workshop on “**Weather and Climate information**” on 7th January, 2020 at RMC Guwahati. **Dr. Sanjay O’Neill Shaw**, Sc. ‘E’ in his inaugural speech welcomed the media persons and thanked them for giving wide coverage of weather forecasts and warnings provided by Regional Meteorological Centre, Guwahati. **S/Shri S.N. Deka** and **H.G. Pathak** were invited as special guest. The workshop was attended by media persons of various houses like:- Doordarshan, Aaj Tak, Times of India, G Plus, DY365, Pratidin Time, News18, News Live, E TV, Time 8, News Time, Prag News etc. During interaction session with media persons, answers were given to their queries. The media persons were highly satisfied with the presentations given to them. They liked the facilities available at RMC,

Guwahati and appreciated the services provided to media.



Dr. S. O. Shaw, Sc. 'E' and others during media workshop

Shri S. S. Mairal, Met. 'B' visited Doordarshan Kendra, Pune and participated in talk on 'Effects of Cyclones on Agriculture and its management' in Krishi darshan programme on 28th February.

M.C. Bhubaneswar issued Special Weather Bulletins (Informatory Messages) and Press Release on "**Wet spell, Intense Rainfall and Thunderstorm Activity**" to State Govt. Offices, Media and General Public and all concerned users during 5-8 and 21-25 February, 2020. Frequent print and electronic media briefings about the system and its intensification have been done during the period.

Dr. Sanjib Bandyopadhyay, Sc. 'F' delivered his talk in All India Radio on the occasion of "**WMO day**" on 17th and 20th March, 2020.

Dr. S. D. Attri, Sc. 'F' participated in telephonic All India Radio programme on "Climate Change and Agriculture" on 3rd May, 2020.

Dr. M. Mohapatra, DG, IMD and **Shri S. N. Pradhan**, DG, NDRF addressed joint press conference on 19th, 20th and 21st May, 2020 for briefing media and general public about the impact of super cyclone AMPHAN.

Dr. Sanjib Bandyopadhyay, Sc. 'F' on Press Meet at RMC, Kolkata on 20th May, 2020 about the Super Cyclonic Storm "AMPHAN" over the South East Bay of Bengal during 16-21 May, 2020.



Dr. Sanjib Bandyopadhyay, Sc. 'F' during the Press Meet

Shri C. S. Patil, Sc. 'D' delivered live talk on "**Cyclone**" over Radio city 93.3 Hubballi Live talk on 22nd May, 2020.

Kalinga News, Odisha telecast a story "AMPHAN predictions came true" on 27th May, 2020. The same is available at the link

<https://youtu.be/nL3zhHQpnwl>.

Kanak News, Odisha telecast a story "**Know about Cyclone Man Mrutyunjay Mohapatra childhood story**" on 28th May, 2020. The same is available at the link

https://youtu.be/YamkvLVy_84.

Interviews of **Dr. M. Mohapatra**, DG, IMD were telecast on RSTV, Republic TV, Odisha TV, Zee TV, NDTV, RSTV, K News, O TV, Kanak TV, India Science etc.

Dr. Geeta Agnihotri, Sc. 'E' and **Shri S. C. Patil**, Sc. 'D' briefed on All India Radio on Depression/Cyclone (Nisarga) over Arabian Sea and its influence over Karnataka State on 1st June, 2020.

Dr. M. Mohapatra, DG, IMD attended Skype interview with Economic Times on 4th June, 2020.

Dr. S. D. Attri, Sc. 'F' participated in programme through VC on "**Monsoon and Agriculture**" at DD Kisan, New Delhi on 11th June, 2020.

Dr. M. Mohapatra, DG, IMD delivered Talk on “**Tropical Cyclones - Basics, Dynamics and Prediction**” during MoES webinar series 12th Live Talk on 16th June, 2020.

Dr. Geeta Agnihotri, Sc. ‘E’, **Shri S. M. Metri**, Sc. ‘E’ and **Shri C. S. Patil**, Sc. ‘D’ answered about Weather Enquiries by Electronic and Print Media during the period.

Dr. M. Mohapatra, DG, IMD participated in the discussion on floods in North-Eastern states in the face of disaster on 30th August 2020. Other panelist included L. Gen. (Retired) Syed Ata Hasnain, Member, NDMA and Dr. P. L. N. Raju, Director, NESAC. The discussion was broadcast on DD News on Sunday, the 30th August, 2020. The programme is available at the link: <https://www.youtube.com/watch?v=fS6oM1ZBybs&feature=youtu.be>



On 25th September, 2020, **Dr. Sanjib Bandyopadhyay**, Sc. ‘F’, RMC Kolkata participated in a **Door Darshan program on Aapda Ka Saamna an episode on Cyclones**, through web.

Dr. Geeta Agnihotri, Sc. ‘E’ and **Shri C. S. Patil**, Sc. ‘D’, answered about 460 weather Enquiries by Electronic and Print Media during the period.

Joint Press Briefing was done by **Dr. M. Mohapatra**, DG, IMD and **Shri S. N. Pradhan**, DG, NDRF on Cyclone “**Nivar**” on 24th November, 2020.



Joint Press Briefing by IMD and NDRF

Shri C. S. Patil, Sc. ‘D’, M. C. Bengaluru, gave a talk on cyclone “**Nivar**” in All India Radio, Bengaluru on 24th November, 2020.

Dr. Geeta Agnihotri, Sc. ‘E’ & Head, M. C. Bangalore gave a live talk in Hindi to All India Radio Kalaburgi on “**Weather Forecast**” due to deep depression that crossed NAP coast and caused heavy rainfall over Karnataka.

Shri C. S. Patil, Sc. ‘D’ and **Dr. Rajveel Manickam**, Sc. ‘D’, M. C. Bangalore gave a live talk in Hindi to All India Radio Kalaburga on “**Weather forecast due to deep depression**” that crossed North Andhra Pradesh coast and caused heavy rainfall over Karnataka.

11.3. ADDRESSES OF VARIOUS MET. CENTRES

Delhi Region**Director**

Meteorological Centre,
SCO-2455-56, (First Floor),
Sector 22 C, CHANDIGARH - 160 022.
e-mail: chandimet@yahoo.com

Director

Meteorological Centre,
Mausam Bhawan, Budhsinghpura,
Sanganer, JAIPUR – 302 01.
e-mail: mcjpr@imd.gov.in
mcjaipur2007@yahoo.com

Director

Meteorological Centre,
Civil Aerodrome,
Amausi, LUCKNOW - 226 009.
e-mail: amo.lkn@imd.gov.in

Director

Meteorological Centre,
Ram Bagh Complex,
SRINAGAR – 190 015.
e-mail: lotusladakh@gmail.com

Director

Meteorological Centre,
Survey of India Compound,
17, E.C. Road, Karanpur,
DEHRADUN-248 001.
e-mail: mcdehradun@yahoo.co.in

Director

Meteorological Centre,
Bibra House, Cliffend Estate,
SHIMLA – 171 001.
e-mail: mc.sml@imd.gov.in

Chennai Region**Director**

Meteorological Centre,
Central Observatory, Palace Road,
BANGALORE – 560 001.
e-mail: mcbng@imd.gov.in
amo.bng@imd.gov.in

Director

Meteorological Centre,
Hyderabad Airport,
HYDERABAD – 500 016.
e-mail: mchyd@imd.gov.in
amo.hyd@imd.gov.in

Director

Meteorological Centre, Observatory,
THIRUVANANTHAPURAM – 695 033.
e-mail: mc.trv@imd.gov.in
mctrivandrum@gmail.com

Mumbai Region**Director**

Meteorological Centre,
Civil Aerodrome,
AHMEDABAD - 380 012.
e-mail: mc.ahm@imd.gov.in
mchm@rediffmail.com

Director

Meteorological Centre,
Altinho, Panaji
GOA – 403 001.
e-mail: mc.goa@imd.gov.in

Kolkata Region**Director**

Meteorological Centre,
Civil Aerodrome,
BHUBANESHWAR - 751 009.
e-mail: mc.bwn@imd.gov.in
imdbbsr@ori.nic.in

Director

Meteorological Centre,
Ladaki Mansion, Baluwakhan,
GANGTOK – 737 101.
e-mail: mc.gtk@imd.gov.in
gangtokmet@gmail.com

Director

Meteorological Centre,
Civil Aerodrome,
PATNA – 800 014.
e-mail: mc.ptn@imd.gov.in
aviationmcpatna@gmail.com

Director

Meteorological Centre,
Civil Aerodrome,
RANCHI – 834 002.
e-mail: mc.rnc@imd.gov.in
metranchi@gmail.com

Nagpur Region**Director**

Meteorological Centre,
Mausam Vigyan Kendra,
Arera Hills,
Satpura Post Office,
BHOPAL - 462 004.
e-mail: mc.bhp@imd.gov.in
mcbhopal@rediffmail.com

Director

Meteorological Centre,
Lalpur, RAIPUR
e-mail: mc.rpr@imd.gov.in
rsrw.rpr@gmail.com

Guwahati Region**Director**

Meteorological Centre,
Naharlagun Helipad complex,
ITANAGAR – 791 110.
e-mail: mc.itn@imd.gov.in
weqaatheritn@sancharnet.in

Director

Meteorological Centre,
P.O. Agartala Aerodrome,
AGARTALA – 791 110.
e-mail: mc.agt@imd.gov.in
amo.agt@imd.gov.in



भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

पृथ्वी विज्ञान मंत्रालय, भारत सरकार
Ministry of Earth Sciences, Govt. of India