

2017



वार्षिक प्रतिवेदन ANNUAL REPORT

Weather Ready

Climate Smart

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

IMD ORGANIZATION CHART

INDIA METEOROLOGICAL DEPARTMENT MINISTRY OF EARTH SCIENCES GOVERNMENT OF INDIA



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and Earth Sciences



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INDIA METEOROLOGICAL DEPARTMENT
(MINISTRY OF EARTH SCIENCES, GOVT. OF INDIA)

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FOREWORD

It gives me immense pleasure to bring out the Annual Report of India Meteorological Department (IMD) for the year 2017. The report highlights significant activities of the department during the year. The department has been playing a leading role in the field of Earth and Atmospheric Sciences by providing efficient services in meteorology and contributing to safety of life and property. By all means this contribution is a major towards the cause of national development.

The celebration of IMD's Foundation Day on 15th January, has provided ample opportunity to commemorate past glory and a reflection of the future vision. The Department's progressive strides towards modernization of scientific infrastructure in the fields of meteorological observations and information systems has helped to render better services in areas of agriculture, aviation, shipping, fisheries, energy and transport. Numerical Weather Predictions has established its credibility in giving medium and short range forecasting of severe weather phenomenon like cyclones, heavy rains, thundershower, cold and heat waves.

During 2017, IMD achieved some significant milestones like implemented Global Ensemble Forecasting System (GEFS SL) for ensemble forecasts in the medium range time scale. The GEFS SL at semi-Lagrangian resolution T574 in horizontal resolution (~ 25 km) with 64 hybrid sigma-pressure layers was made operational in May, 2017. The operational coupled modelling system for the extended range forecast and the very high resolution global model (GFS T1534) for short to medium range weather forecasts continued in 2017 also. In addition, various new climate products are prepared for providing services to Health Sector, Power Sector, Agriculture sector etc. based on the operational extended range forecast. IMD is in the process of further enhancing the quality of climate services to different users.

IMD has continued its efforts for the improvement of observing, warning and dissemination systems all through 2017. 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, heat wave, cold wave, fog) forecasts have been built to meet the demands of the user agencies, disaster managers, emergency response groups and other stakeholders in an organized manner.

Climate during 2017 over India was substantially warmer. The annual mean temperature for the country this year was +0.71°C above the 1971-2000 average, thus making the year 2017 as the fourth warmest year on record since the nation-wide records commenced in 1901. Higher mean temperatures during the winter season (January-February, with anomaly +0.94 °C, fourth warmest since 1901) and the post-monsoon season (October-December, with anomaly +0.77 °C, third warmest since 1901) mainly accounted for the above normal annual temperature for the year.

Heat wave conditions took a toll of 375 lives throughout the country during the year, which is much less than that during 2016 (480) and (2200) in 2015. This could be attributed to the advance warnings issued in the form of summer temperature outlook (a fresh initiative of IMD this year) and both extended and medium range forecasts with timely updates. Location specific heat index forecasts were also introduced during 2017. I take this opportunity to appreciate the scientists of IMD for their efforts to support the endeavour.

With respect to the cyclone forecasting the annual average track forecast error during 2017 has been 61 km, 108 km and 190 km, respectively for 24, 48 and 72 hrs against the LPA (2012-16) error of 97, 149 and 203 km based on data of 2012-2016.

Doppler Weather Radar (DWR) installed at Kochi and Gopalpur in 2017. The inauguration of S-Band Polarimetric Doppler Weather Radar at Kochi was done in July and Installation of S-Band Polarimetric Doppler Weather Radar at Gopalpur by ISRO - Bharat Electronics Limited (BEL) was done during the year 2017. Augmentation in DWRs network will definitely enhance the accuracy of nowcast of concerned areas.

In 2017, instruments of Dust Storm and Fog Monitoring system have been straightened at airports of north India. In addition, Automated Weather Observing System (AWOS) was developed jointly by NAL and IMD has been successfully commissioned at Mangalore Airport in July, 2017 for measurement of Current Wx and Runway Visual Range (RVR). New Aeronautical Met. Station has been commissioned at Rohini (Delhi), Shirdi (Maharashtra) & Kishangarh (Rajasthan). Three (3) numbers of transmissometers were commissioned at different airports (2 in Kolkata and 1 in Mangalore).

Dissemination of agromet advisories to the farmers through different multi-channel system of All India Radio (AIR) and Doordarshan, private TV and radio channels, newspaper and internet, SMS and IVR (Interactive Voice Response Technology) etc. is being made on wider scale. Agromet Advisories Services (AAS) are disseminated under PPP mode and through Kisan Portal to 21.69 million farmers. In addition to above Crop Specific Weather based Agromet Advisories for the country on daily basis are being telecasted through DD Kisan Channel, on real time in programs like 'Kisan Samachar' and 'Mausam Khabar' in Hindi and in regional languages of Gujarati, Marathi, Malayalam and Tamil.

A large number of Workshops, Symposia and Conferences were organized this year by covering such diverse themes as Sustainable Development, Aviation Meteorology, Heat Wave, Tropical Storm and Local Severe Storm Forecasting, Agriculture meteorology etc. The user community was engaged in dialogue by conducting user's seminars during the year. The Annual Report makes an interesting reading on the plethora of activities pursued in this Department in this vibrant area of science.

Hon'ble Prime Minister of India in his Mann Ki Baat dated the 31st July, 2017 appreciated weather forecasting services of India Meteorological Department and urged the public to use more and more weather forecasts to reduce losses.

In conclusion, I am availing this opportunity to thank all the members of IMD for their true dedication and strive to further enhance the reputation of the department with strong national and international credibility. My special thanks to Dr. D. R. Pattanaik and his team of Publication Unit for their sincere efforts in compilation, editing and publication of this annual report.

Dr. K. J. Ramesh
Director General of Meteorology

CHAPTER 1

INDIA METEOROLOGICAL DEPARTMENT-OVERVIEW

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

It's mandate is:

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

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

From a modest beginning in 1875, IMD has progressively expanded its infrastructure for meteorological observations, communications, forecasting and weather services and it has achieved a parallel scientific growth. IMD has always used contemporary technology. In the telegraph age, it made extensive use of weather telegrams for collecting observational data and sending warnings. Later IMD became the first organization in India to have a message switching computer for supporting its global data exchange. One of the first few electronic computers introduced in the country was provided to IMD for scientific applications in meteorology. India was the first developing country in the world to have its own geostationary satellite, INSAT, for continuous weather monitoring of this part of the globe and particularly for cyclone warning. IMD has continuously ventured into new areas of application and service, and steadily built upon its infra-structure in its history of 143 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

Monsoon forecasting

Aviation

Human Resource Development

Climate services

Marine Meteorology

Hydro Meteorology

Positional Astronomy

Environmental

Pilgrims Forecast

Forecast and warning Dissimination

Cyclone forecasting

Heavy rainfall warning

Met Observations

India Meteorological Department, Mausam Bhavan, New Delhi

IMD, Alipore Observatory, Kolkata founded in 1877

SPECIALIZED SERVICES OF IMD

India had some of the oldest meteorological observatories of the world and the first astronomical and meteorological unit started at Madras in 1793. Thus, meteorological observation in India was taken even prior to the establishment of the department in 1875. Since then IMD has achieved many milestones during the period from 1793 to 2017.

INDIA METEOROLOGICAL DEPARTMENT

Milestones (1793-2017)

1878



Advent of telegraphy enabled centralised data reception and publication of the Indian Daily Weather Report (IDWR) since 1878.
The first weather charts were printed in the IDWR in 1887.

1882



Seismological activity started in India with the establishment of the first observatory at Alipore, Calcutta.
Seismogram of the disastrous Guetta Earthquake, 1935.

1954



Radars were pressed into aviation weather service as early as 1954.
First Cyclone Detection Radar was installed at Vishakhapatnam in 1970.

1973



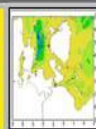
The Telecom ushered in the prospects of global data assimilation and numerical weather forecasting.
View of the Northern Hemisphere Analysis Centre, New Delhi.

2006

Modernization of observing system

The Department took a major initiative to modernize its observational and forecasting infrastructure to deliver a whole range of new services.

2008



New forecast services were introduced in the country addressing specific needs of individual Districts. It has been specifically designed for providing Agricultural advisories.

2010



Integrated Forecasting & Communication System
Setting up of National Weather Forecasting Centre (NWFC) at Delhi
Operational global model
Operational extended range forecast
No-weather

1793



India has some of the oldest Meteorological Observatories of the world.
First Astronomical and Meteorological Unit started at Madras in 1793.

1905



Upper air measurements of winds started in 1905 by the method of tracking balloons with theodolites.
The launching of the Pilot Balloon.

1886



First Long Range Forecast of Monsoon was issued

1964



IMD started receiving satellite images from US Satellites in 1964.
Image received from India's own satellite INSAT.

1982



INSAT provided a Geostationary platform for remote sensing of the atmosphere and automatic data collection.
An unmanned Data Collection Platform.

1875



All meteorological work in the country was brought under a central authority with the establishment of IMD.
First Headquarters-The Alipore Office at Calcutta, started in 1875.

1932



A separate division was created in 1932 for research activities in the field of Agricultural Meteorology.
The first field unit at Pune.

1970



Directorate of Telecommunication was set up in 1970 to rapidly exchange information amongst various centres.
The maze of current communication network.

2003



Launch of Meteorological Data and INSAT imagery through World Space Digital Data Broadcast System.

2017



Implemented Global Ensemble Forecasting System (GEFS- SL) for ensemble forecasts in the medium range time scale at 25 km resolution.
Operationalization of Coupled modeling system for extended range forecast.
High resolution global model (2-12 km) for medium range forecast.

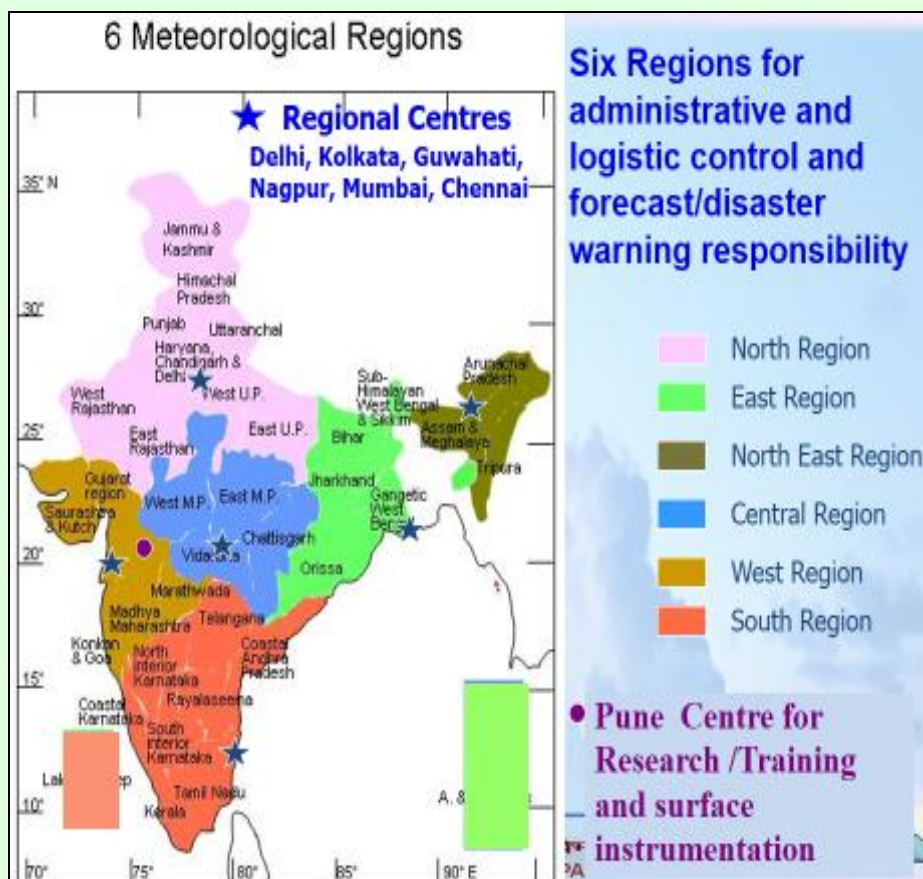
2012



Agromet advisories through SMS to 3.3 million farmers.
Nowcasting of Thunderstorms
ISO 9001:2008 certification to (i) Met services (ii) airport (iii) Met centre Hyderabad, (iv) RSKW Aaya Nagar and (v) Synoptic station at Satterjung, New Delhi

In service of the Nation since 1875

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 2017. 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 2017. Its short, medium and long range and cyclone forecasts were appreciated all over the world.

The year 2017 was one of the world's three warmest years on record. The World Meteorological Organisation (WMO) statement based on a combination of five datasets, three of them using conventional surface observations and two of them reanalyses, shows that global mean temperatures were $0.46\text{ }^{\circ}\text{C} \pm 0.1\text{ }^{\circ}\text{C}$ above the 1981–2010 average and about $1.1\text{ }^{\circ}\text{C} \pm 0.1\text{ }^{\circ}\text{C}$ above pre-industrial levels. By this measure, 2017 and 2015 were effectively indistinguishable as the world's second and third warmest years on record, ranking only behind 2016, which was $0.56\text{ }^{\circ}\text{C}$ above the 1981–2010 average. The years 2015, 2016 and

2017 were clearly warmer than any year prior to 2015, with all pre-2015 years being at least 0.15 °C cooler than 2015, 2016 or 2017. Like over the globe warmer than normal conditions prevailed over India as well in 2017. Climate during 2017 over India was substantially warmer. The annual mean temperature for the country this year was +0.71 °C above the 1971-2000 average, thus making the year 2017 as the fourth warmest year on record since the nation-wide records commenced in 190.1

Rainfall during the southwest monsoon season (June-September) for the country as a whole was normal [(95 % of Long Period average (LPA)]. The Northeast monsoon rainfall activity, over the south peninsula (core region of northeast monsoon rainfall activity comprising of 5 subdivisions viz. Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu & Pondicherry, South Interior Karnataka and Kerala) was below normal [86 % of Long Period Average (LPA)]. Among the significant weather events of the year 2017: Lightning reportedly claimed over 750 lives from different parts of the country (central, northeastern, peninsular & northwestern India) during pre monsoon, monsoon & post monsoon seasons. Of these, 408 deaths were reported from Odisha alone while, 85 deaths were reported from Maharashtra, 68 from Bihar, 51 from Karnataka, 37 from Uttar Pradesh and rest from other parts of the country. Heavy rain & flood related incidents during the monsoon season claimed at least 830 lives from different parts of the country. 142 persons were reported dead from Assam during the period of 13th June to 11th September. 138 persons were reported dead from Uttar Pradesh during 8th July to 10th September, of which 110 persons died due to heavy rain & flood in Ghaghara, Gomati & Rapti rivers during 4th September to 10th September. About 120 persons were reported dead from western industrial state Gujrat during the month of July and 107 from Bihar during 13th August to 23rd August. On 13th August, 46 persons were reported dead due to massive landslide at Kotrupi on the MandiPathankot National Highway near Jogindernagar in Himachal Pradesh, while 15 persons were reported dead in Papum Pare, Arunachal Pradesh on 11th July. Heat wave conditions took a toll of 375 lives throughout the country, of which 236 were reported dead from Andhra Pradesh and 100 from Telangana. With respect to the cyclone forecasting the annual average track forecast error during 2017 has been 61 km, 108 km and 190 km, respectively for 24, 48 and 72 hrs against the LPA (2012-16) error of 97, 149 and 203 km based on data of 2012-2016. Heat wave conditions took a toll of 375 lives throughout the country during the year, which is much less than that during 2016 (480) and (2200) in 2015. This could be attributed to the advance warnings issued in the form of summer temperature outlook (a fresh initiative of IMD this year) and both extended and medium range forecasts with timely updates.

SUMMARY OF MAJOR ACHIEVEMENTS IN 2017

- Two Doppler Weather Radars (DWR) provided by ISRO have been commissioned at Kochi and Gopalpur. Data of ISRO's DWRs at Thiruvananthapuram, Cherrapunji and ITR Chandipur is being utilized by IMD. Data storage of capacity 150 TB have been installed with Radar Central Server at HQ, New Delhi.
- Implementation of Integrated Himalayan Meteorology Project (IHMP) for installation of 10 nos. of X-Band Doppler Weather Radars in the states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand are in process.
- Commissioning of 11 nos. of C-Band Polarimetric Doppler Weather Radars to enhance the observational capacity of the IMD Radar network are also in process.

- Agro-Meteorological Advisory Services are disseminated under PPP mode and through Kisan Portal to 21.69 million farmers.
- IMD (Nowcast Division) created a new web page 'Nowcast Desk' dedicated to Nowcast Services.
- Black Carbon Monitoring Network of 16 stations for measurement of Spectral Aerosol Absorption Coefficient, Equivalent Black Carbon Concentration and bio-mass burning component
- Drishti AWOS installed at Mangalore, Bhubaneshwar and Drishti Transmissometer system installed at Bangaluru and Kolkata airports. These systems are developed indigenously by CSIR-NAL.
- Electronic Sunshine recorder installed during 2017-2018 at Ahmedabad Mumbai, Visakhapatnam and Kolkata.
- Electronic Sunshine recorders were installed at 12 World Radiation Data Centre (WRDC) network stations
- Digital Standard Barometers (200 Nos.) are installed at various departmental observatories across India.
- The production of indigenous GPS based Pilot-sonde has been started in IMD Workshop at New Delhi.
- Total network of upper air radiosounding (RS/RW) of 43 stations has been upgraded with GPS based radiosounding systems.
- 7 DIWE systems at Ludhiana, Imphal, Dimapur, Nagpur, Gaya, Pantnagar & Pondicherry and 4 CWIS systems at Shirdi, Gondhia, Rohini Heliport & Ajmer are installed at various airports across India.
- Sub basin-wise Quantitative Precipitation Estimate for Day-1, Day-2, Day-3, using WRF ARW (9 km x 9 km) based on 0000 UTC & 1200 UTC, MME (0.25°x 0.25°) based on 0000 UTC and Day1 to Day7 using GFS (0.25°x 0.25°) based on 0000 UTC run by IMD are computed and uploaded on IMD website operationally.
- During 2017 IMD implemented Global Ensemble Forecasting System (GEFS SL) for ensemble forecasts in the medium range time scale. The GEFS SL at semi-Lagrangian resolution T574 in horizontal resolution (~ 25 km) with 64 hybrid sigma-pressure layers was made operational in May, 2017. It is run once in a day (0000 UTC) with 20 members (and 1 control) to give ensemble mean and probabilistic forecast in the short to medium range. The initial conditions are generated from the NCEP based Ensemble Kalman Filter (EnKF) component of hybrid Global Data Assimilation System (GDAS).
- The triple nested (18, 6 and 2 km) version (v3.7.1) of Hurricane Weather Research Forecasting (HWRF) model with its various diagnostic products has been run operationally established with 6 hourly intervals for the cyclones over North Indian Ocean.

- National Ozone Centre of IMD is designated as secondary regional ozone centre for Regional Association II (Asia) of World Meteorological Organization.
- High Wind Speed Recorder (HWSR) station installed at Digha, Gopalpur, Paradip and Port Blair in 2017.
- 12 Indian Navy ships were recruited in Indian Voluntary Observing Fleet by Port Meteorological Office Mumbai on 10th February, 2017.
- IMD has set up a countrywide network of 25 nos. Global Navigation Satellite System (GNSS) stations for “Earth and Atmospheric studies”.
- New Aeronautical Met. Station has been commissioned at Rohini (Delhi), Shirdi (Maharashtra) & Kishangarh (Rajasthan).
- Three hundred (300) AWS data logger systems have been provided to RMCs to upgrade with new version of data logger with dual communication-Satellite & GPRS.
- 128 Research Papers/books/Met. monographs published.

Chapter 2

Weather Summary during 2017

1. Winter Season (January & February)

Cold Wave conditions

Cold wave conditions were rather moderate during the season and prevailed only for few days during the mid of January. Mean temperature for the season this year was above normal by about 0.9 °C thus making it the fourth warmest winter season since 1901. The homogeneous region of East & Northeast India was abnormally warmer in respect of maximum temperature during the season and many parts of the country were warmer by about 2 °C in respect of maximum temperature during the month of February. An early start of 'Heat wave conditions' also occurred along the west coast during the last week of the season.

Cold Wave / foggy conditions

Cold wave conditions were moderate during the season. Severe cold wave conditions prevailed only for a shorter duration over parts of northwest and adjoining central India from 10-15 of January. A few stations over the plains even reported sub-zero temperatures during this period. However, cold wave conditions were observed at isolated places for one or two days over the plains of north and east India on many days during January and for a day or two over central parts of the country during last week of February.

Rainfall Features

Rainfall activity over the country during the season as a whole was normal. It was above

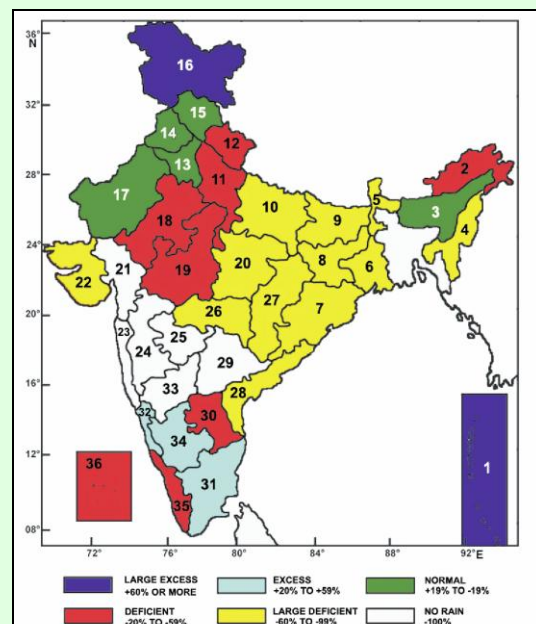
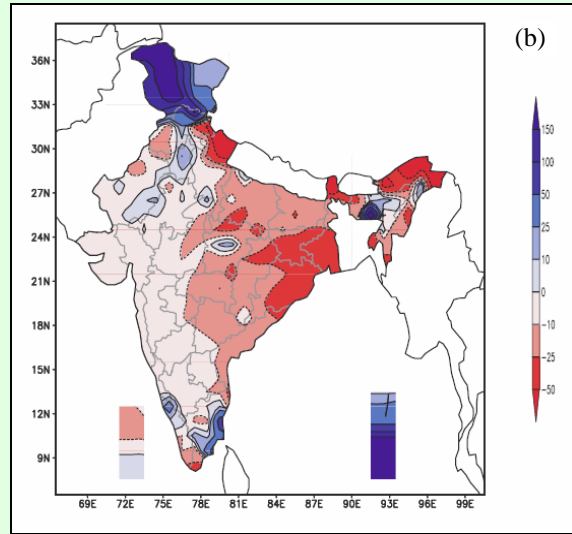
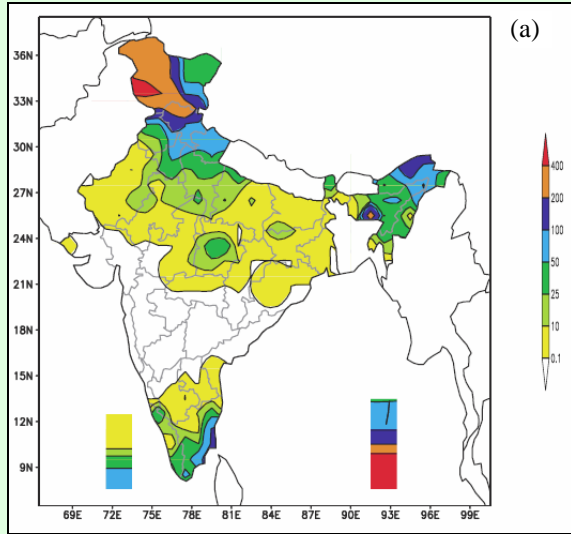


Fig. 1. Sub-divisionwise rainfall percentage departures

normal during January (140% of LPA) & below normal during February (56% of LPA). Rainfall activity was mainly observed over northern/northwestern, south peninsular and extreme northeastern parts of the country. Jammu & Kashmir and Andaman & Nicobar Islands received large excess rainfall. Many subdivisions of north peninsula, central & eastern region received large deficient or no rainfall.

During the season, out of 36 meteorological subdivisions, 2 received large excess rainfall, 3 received excess rainfall, 5 received normal rainfall, 8 received deficient rainfall, 12 received large deficient rainfall. Six subdivisions did not receive any rain (Fig. 1).

Fig. 2(a) shows the spatial pattern of rainfall received during the season. Extreme northern and northeastern parts of the country, parts of extreme south peninsula and



**Figs. 2(a&b). Seasonal (a) rainfall (mm) and (b) rainfall anomaly (mm)
(Based on 1951-2000 Normals)**

the Islands in general received more than 25 mm of rainfall. Parts of Jammu and Kashmir and adjoining Himachal Pradesh, Arunachal Pradesh, Assam & Meghalaya, Coastal Tamil Nadu and Andaman & Nicobar Islands received more than 100 mm of rainfall. Western parts of J&K and southern parts of A&N Islands received more than 400 mm of rainfall.

Fig. 2(b) shows the spatial pattern of rainfall anomaly (mm) during the season. Except for some parts of extreme northern/northwestern and northeastern region and parts of extreme south peninsula, the rainfall anomaly was negative over most parts of the country. Magnitude of negative rainfall anomaly over some eastern parts of the country viz., Gangetic West Bengal, Jharkhand, Odisha, Chattisgarh and many parts of extreme northeastern region was more than 25 mm and over parts of Uttarakhand, Sikkim and Arunachal Pradesh, it was more than 50 mm. Positive rainfall anomaly was more than 100 to 150 mm over parts of Jammu & Kashmir, Meghalaya and Andaman & Nicobar Islands.

Standardized Precipitation Index (SPI)

The Standardized Precipitation Index (SPI) is an index used for measuring drought and is based

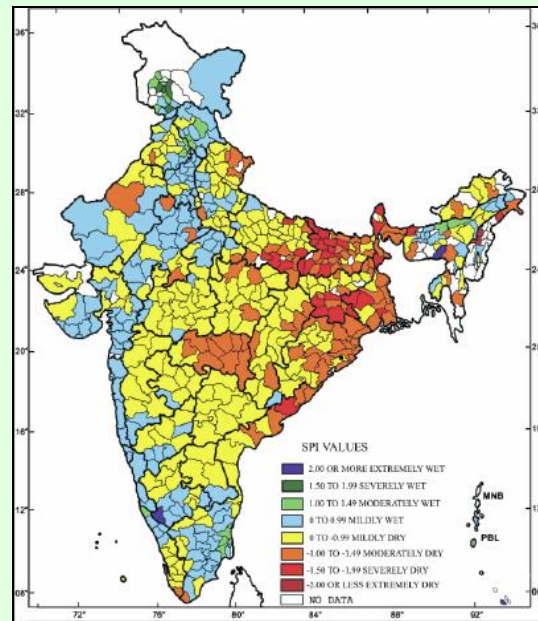


Fig. 3. Standardized Precipitation Index (SPI)

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. Fig. 3 gives the SPI values for the winter season 2017 (January-February, 2 months cumulative). Cumulative SPI values for the winter season indicate extremely wet/severely wet conditions over parts of Andaman & Nicobar Islands, Meghalaya, Jammu & Kashmir and South Interior Karnataka, whereas extremely dry/severely

dry conditions were observed over parts of Arunachal Pradesh, Assam, Nagaland, Sub Himalayan West Bengal & Sikkim, Gangetic West Bengal, Jharkhand, Bihar, East Uttar Pradesh and Coastal Andhra Pradesh.

Temperatures anomaly

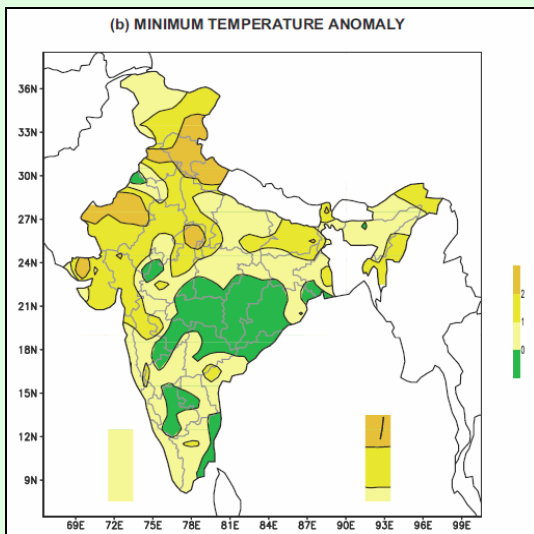
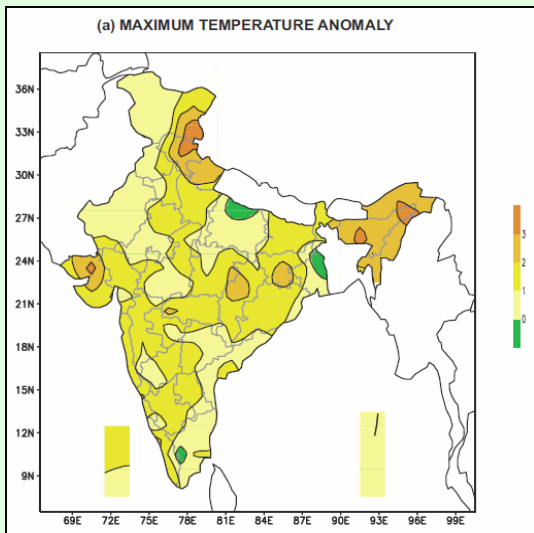
Mean seasonal maximum and minimum temperature anomalies are shown in Figs. 4(a&b) respectively.

Maximum temperature was above normal almost throughout the country. It was above normal by more than 2 °C over parts of Jammu & Kashmir, Himachal Pradesh, Uttarakhand,

Saurashtra & Kutch, Chattisgarh, Jharkhand and most parts of extreme northeastern region.

Minimum temperature was also above normal over most parts of the country except for some parts of peninsula and adjoining eastern region. Over parts of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Punjab, West Rajasthan, Saurashtra & Kutch, West Madhya Pradesh and Andaman & Nicobar islands, it was above normal by about 2 °C.

Outgoing Longwave Radiation (OLR)



Figs. 4(a&b). Mean Seasonal Temperature Anomalies (°C) (a) Maximum (b) Minimum (Based on 1971-2000 Normals)

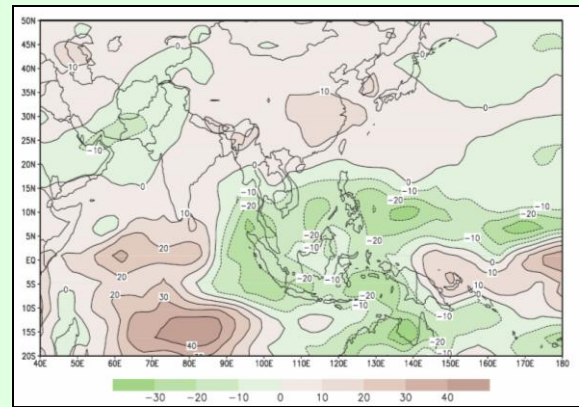
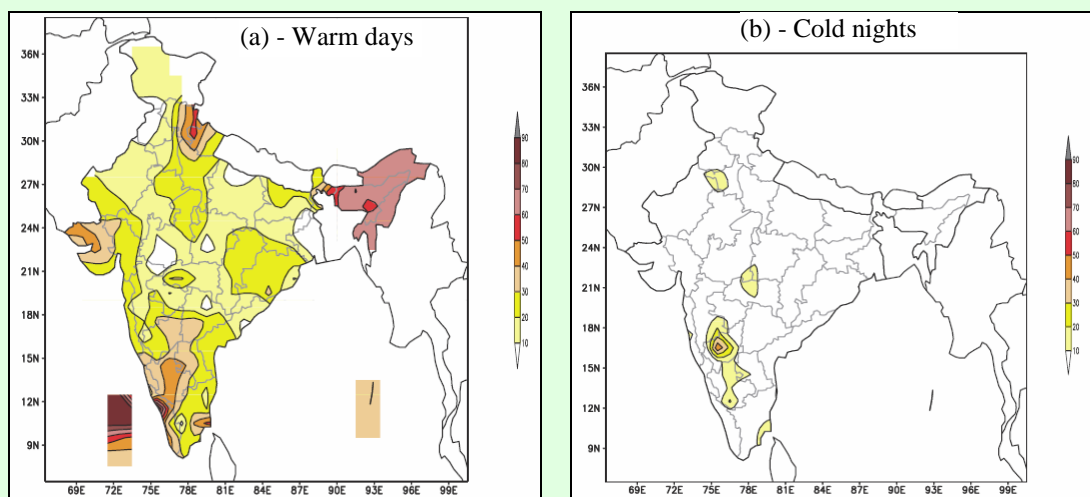


Fig. 5. OLR anomaly (W/m²) for the winter season (Source : CDC / NOAA, USA) (Based on 1981 - 2010 Climatology)

OLR anomaly (W/m²) over the Indian region and neighbourhood is shown in Fig. 5. OLR anomaly was near normal (within ± 10 W/m² range) over most parts of the country and adjoining seas. However, over some extreme northeastern parts of the country and central/western equatorial Indian Ocean region, positive OLR anomaly exceeding 10 to 20 W/m² was observed. Over the eastern equatorial Indian Ocean region and the Andaman seas, negative OLR anomaly exceeding 10 to 20 W/m² was observed.

Warm days/cold nights

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



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

Over parts Himachal Pradesh, Uttarakhand, Kerala and most parts of extreme northeastern region, maximum temperature was greater than 90th percentile for more than 50 to 60% of the days of the season and over parts of Lakshadweep Islands, it exceeded 80%. For minimum temperature, no significant distribution was observed.

Low Pressure Systems

A low pressure area formed over the Bay of Bengal in the month of January. It formed over the south Andaman Sea and neighbourhood on 5th. It remained over the South Andaman Sea and adjoining Tenasserim coast for next few days and became less marked on 12th.

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

Heat Wave Conditions

Heat wave conditions were rather moderate during the season. These conditions were observed over northern, northwestern, central and adjoining eastern parts of the country from the last week of March to the first week of April (26th March to 4rd April) and again from 10th - 21st April. Both maximum and minimum temperature was above normal by more than 5 °C over many stations of these regions during this period. Heat wave

conditions further prevailed over parts of northwest and central India during second week of May. During rest of the season, heat wave conditions were observed only at isolated places over parts of northwestern, central and southeastern India.

Rainfall Features

Rainfall activity over the country during the season as a whole was normal (97.7 % of Long Period Average (LPA) value). It was normal

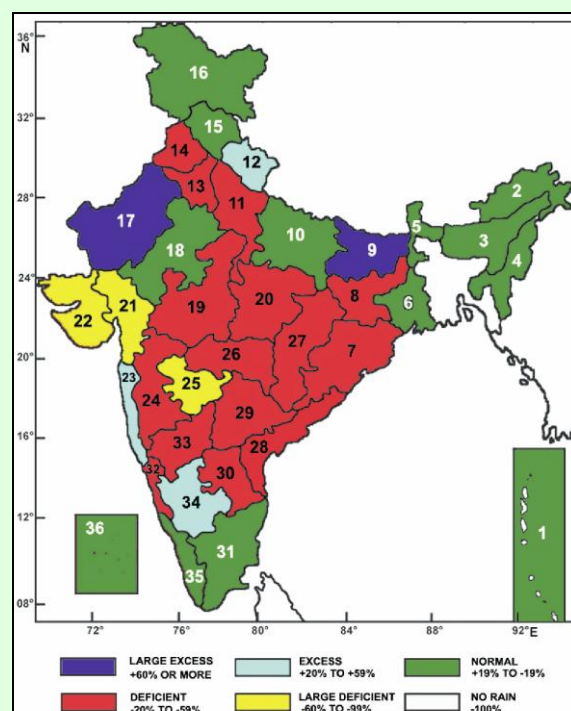
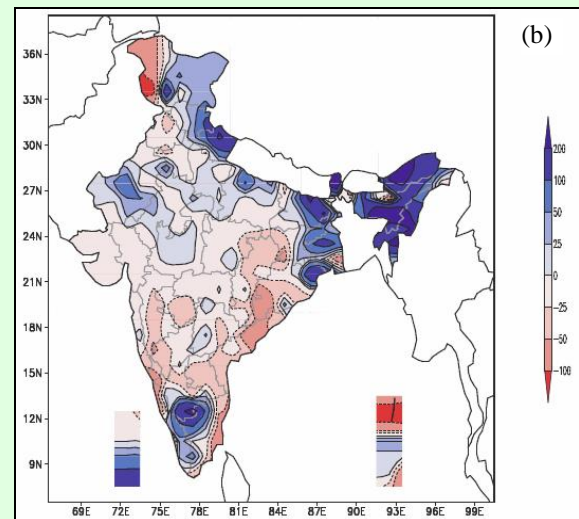
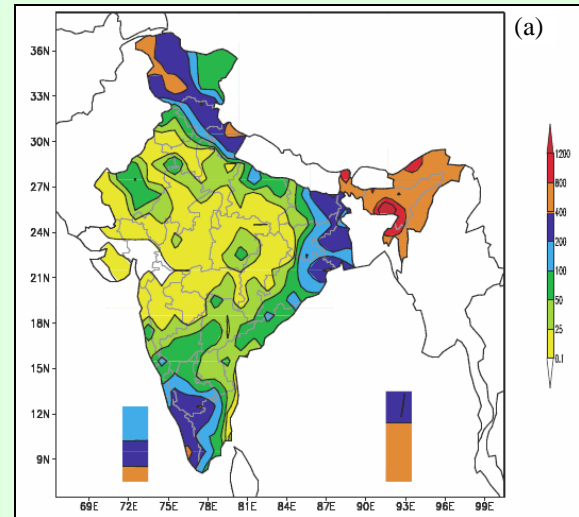


Fig. 7. Sub-divisionwise rainfall percentage Departures for the pre - monsoon season 2017

during March (92.5 % of LPA), above normal during April (116.4% of LPA) and slightly below normal during May (89.2 % of LPA). Sub divisions of north, northeast and south peninsular India in general received large excess/excess/normal rainfall while, sub divisions of central and adjoining north peninsular India received deficient/large deficient rainfall. Bihar and West Rajasthan received about one and half times of their respective normal rainfall. During the season, out of 36 meteorological subdivisions, 2 received large excess rainfall, 3 received excess rainfall, 13 received normal rainfall, 15 received deficient rainfall and 3 received large deficient rainfall (Fig. 7).

Fig. 8(a) shows the spatial pattern of rainfall (mm) received during the season. Northern, eastern/northeastern and south peninsular parts of the country including the Islands received more than 100 mm of rainfall. Parts of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Bihar, Jharkhand, West Bengal and adjoining north Odisha, south interior Karnataka, Kerala and Tamil Nadu received rainfall of the order of 200 to 400 mm. Parts of Jammu & Kashmir, most parts of northeastern region, some parts of Islands received rainfall of the order of 400 to 800 mm. Some parts of extreme northeastern region viz., Sikkim, Arunachal Pradesh and Assam & Meghalaya received rainfall of the order of 800 to 1200 mm.

Fig. 8(b) shows the spatial pattern of rainfall anomaly (mm) during the season. Positive rainfall anomaly of more than 100 mm was observed over parts Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Bihar, Jharkhand, West Bengal, north Odisha, south interior Karnataka, Tamil Nadu and most parts of extreme northeastern region. Over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura and Sub Himalayan West Bengal & Sikkim, positive rainfall anomaly was more than 200 mm.



Figs. 8(a&b). (a) Seasonal rainfall (mm) and (b) Seasonal rainfall anomaly (mm) (Based on 1951-2000 Normals)

Negative rainfall anomaly of the order of 50 to 100 mm was observed over parts of Jammu & Kashmir, south Odisha and adjoining Coastal Andhra Pradesh, coastal Tamil Nadu, coastal Karnataka and Andaman & Nicobar Islands.

Fig. 9(a) shows the area weighted seasonal rainfall over the country as a whole for the period, 1951-2017.

Fig. 9(b) shows the time series of area weighted seasonal rainfall over the four homogeneous regions for the period, 1951-2017. During the season this year East & Northeast India received above normal rainfall (112.8% of LPA), Northwest and South

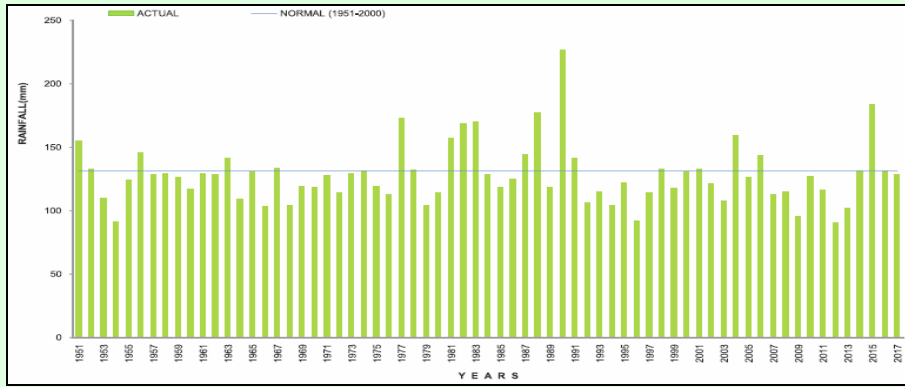


Fig. 9(a). Time series of area weighted rainfall over the country as a whole (1951 - 2017)

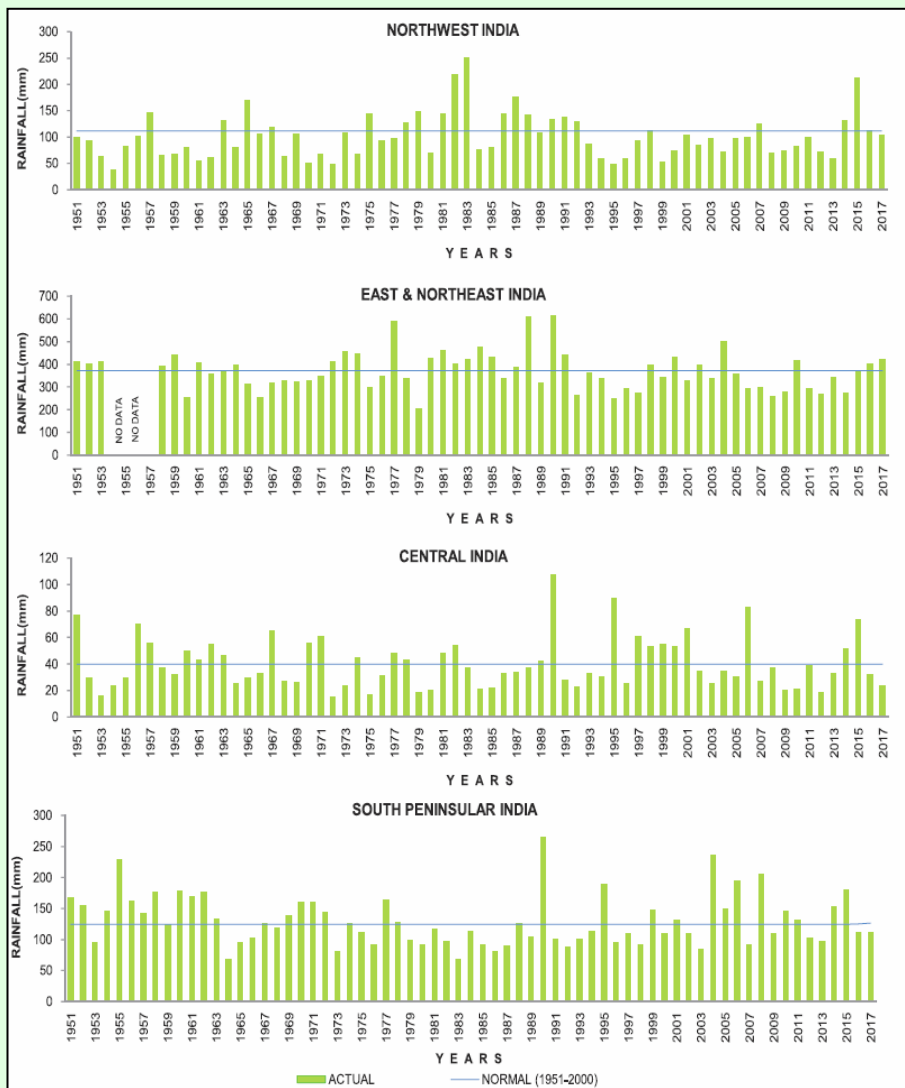
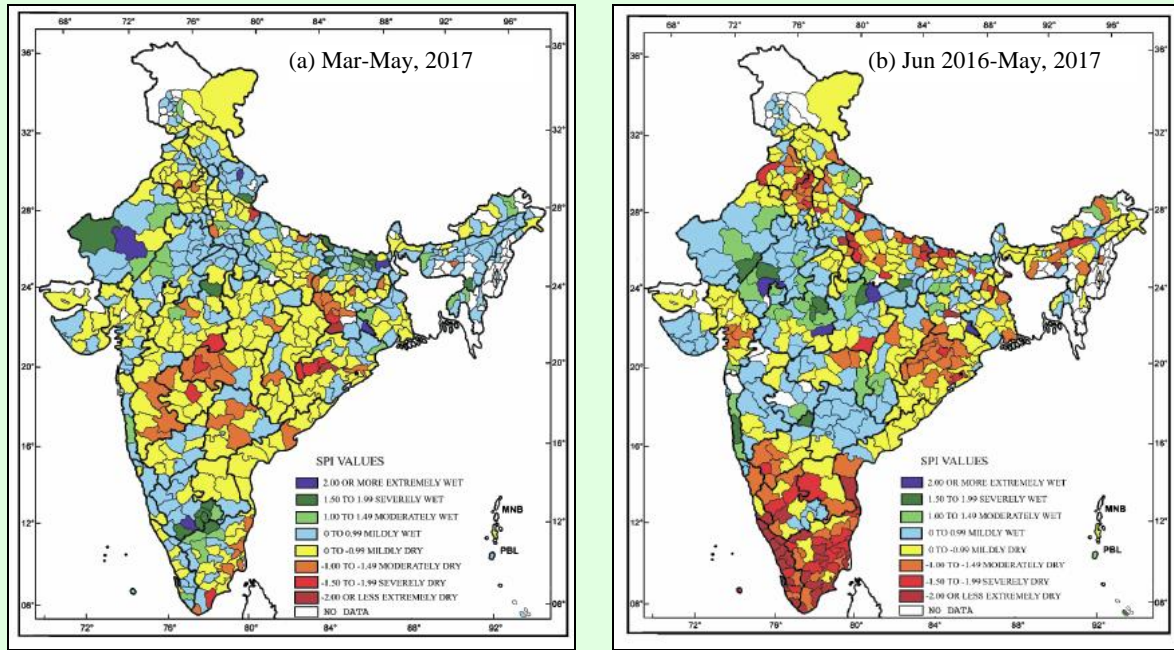


Fig. 9(b). Time series of area weighted rainfall over the four homogeneous regions (1951 - 2017)

peninsular India received normal rainfall (92.4% and 90.4 of their LPA respectively) while, Central India received below normal rainfall (58.5% of its LPA).

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is an index used for monitoring drought and is



Figs. 10(a&b). Standardized Precipitation Index (SPI) for (a) pre-monsoon season (b) since past monsoon season

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. 10 (a&b) give the SPI values for the Pre-monsoon season this year and for the period from past monsoon season, *i.e.*, June 2016-May 2017 (12 months cumulative) respectively.

Cumulative SPI values of the past three months indicate that extremely wet/severely wet conditions were observed over parts of Assam & Meghalaya, Jharkhand, Bihar, Uttarakhand, West Rajasthan, West Madhya Pradesh, Tamil Nadu and South Interior Karnataka, while extremely dry/severely dry conditions were observed over parts of Odisha, Jharkhand, West Uttar Pradesh, West Madhya Pradesh, Marathwada, Vidarbha and Tamil Nadu.

Cumulative SPI values of the past twelve months indicate, extremely wet/severely wet conditions over parts of Andaman & Nicobar Islands, Jharkhand, East Uttar Pradesh, West & East Rajasthan, West & East Madhya Pradesh, Konkan & Goa and North Interior Karnataka, while, extremely dry/severely dry conditions

were observed over parts of Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Odisha, Jharkhand, Bihar, East & West Uttar Pradesh, Uttarakhand, Haryana, Chandigarh & Delhi, Punjab, East Madhya Pradesh, Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu, Karnataka state, Kerala and Lakshadweep Islands.

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig 11. Negative OLR anomaly exceeding $10 W/m^2$ was observed over the extreme south peninsula and the adjoining seas. Elsewhere, the OLR anomaly was near normal (within $\pm 10 W/m^2$).

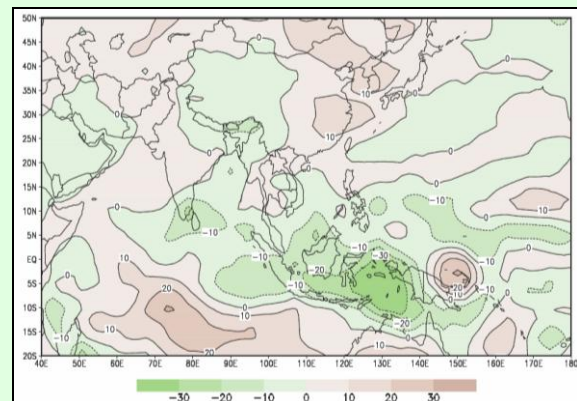


Fig. 11. OLR Anomaly (W/m^2) for the pre-monsoon season 2017 (Source : CDC / NOAA, USA)

Temperature

Mean seasonal maximum and minimum temperature anomalies are shown in Figs. 12(a&b) respectively.

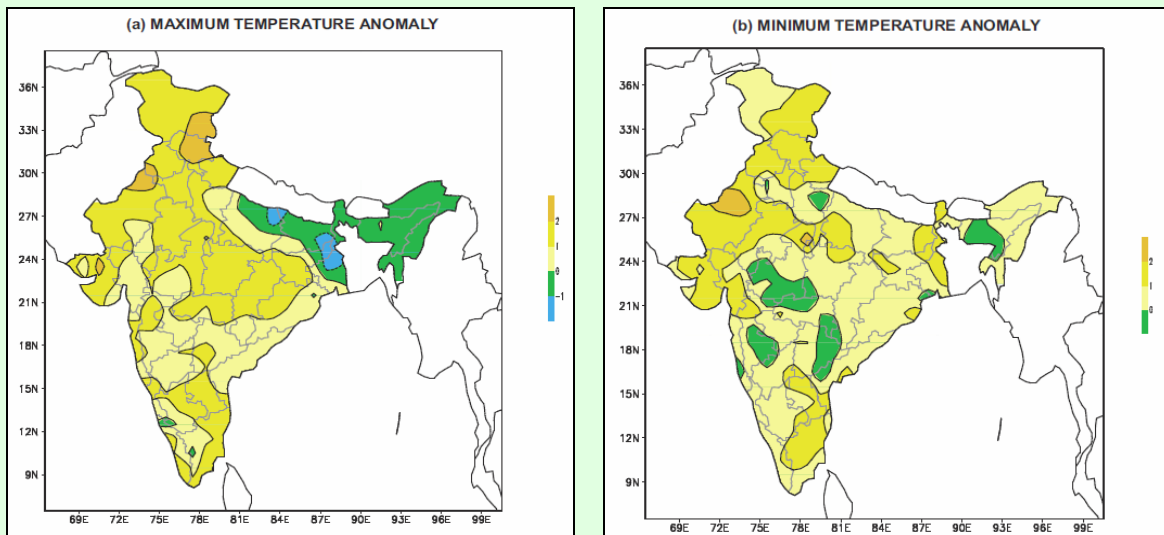
Maximum temperature was above normal over most parts of the country except for the parts of northeastern region. Over many parts of the country it was above normal by more than 1 °C. Over parts of J&K, Himachal Pradesh, Punjab and adjoining West Rajasthan, maximum temperature was above normal by about 2 °C. Over some parts of East Uttar Pradesh and adjoining areas of Bihar,

Jharkhand and Gangetic West Bengal, it was below normal by more than 1 °C.

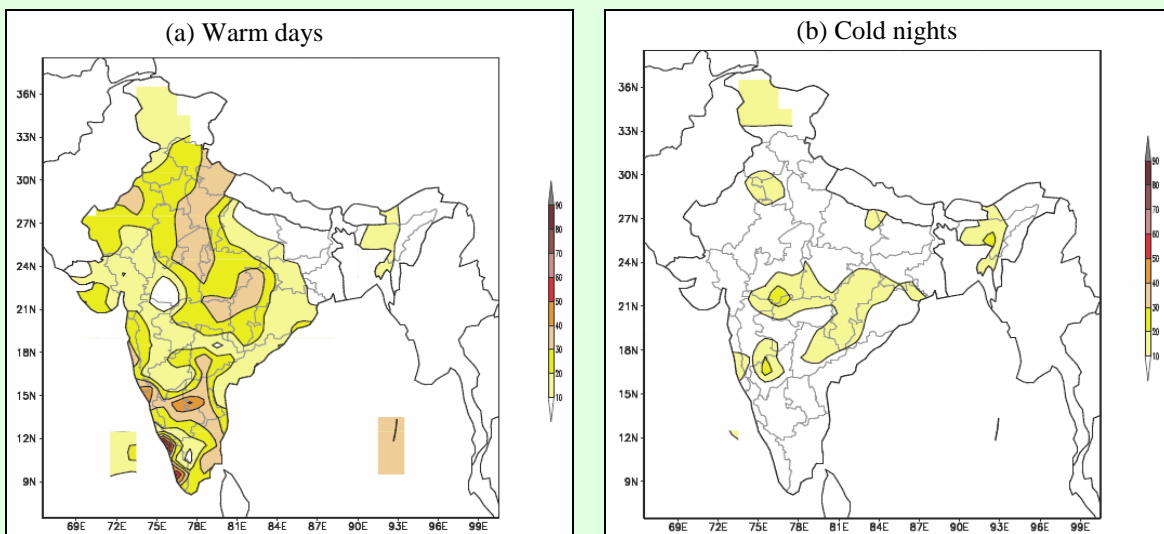
Minimum temperature was also above normal over most parts of the country except for some parts of central, north peninsular and northeastern India.

Percentage of Warm days/Cold nights

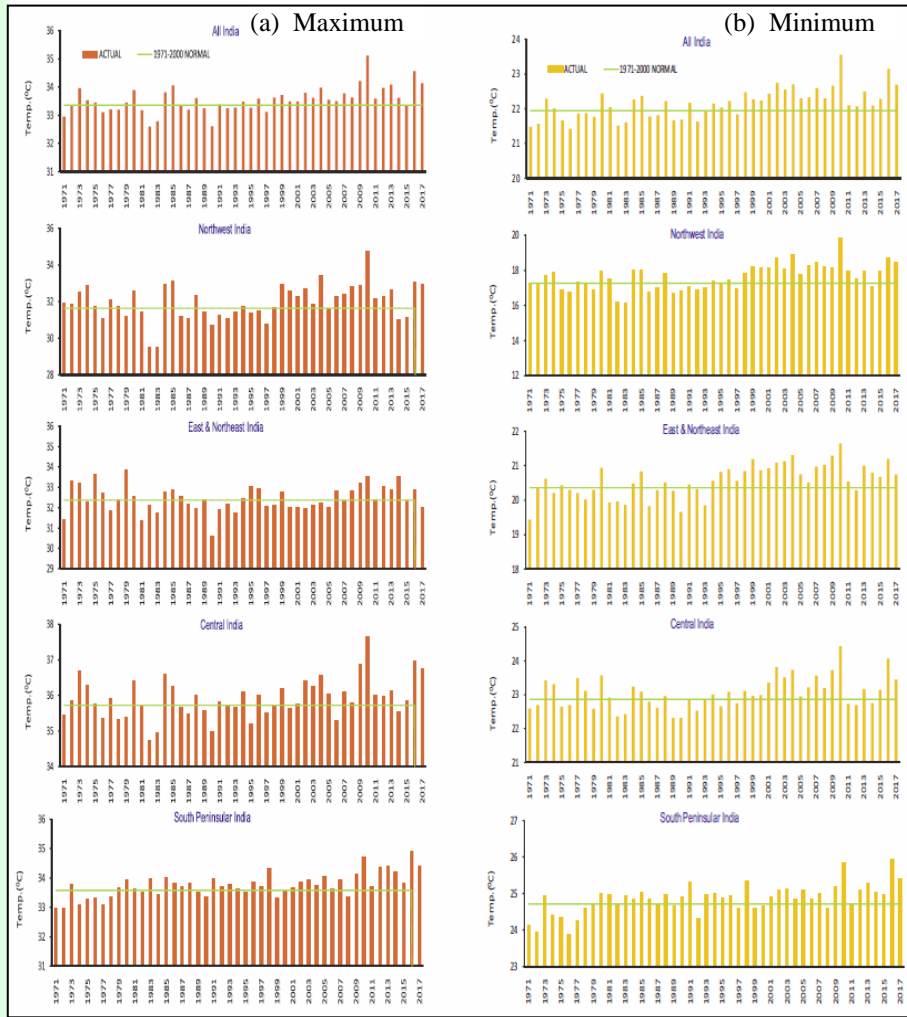
Figs. 13(a&b) show the percentage of days when maximum (minimum) temperature was more (less) than 90th (10th) percentile. Over parts of south Konkan & Goa and adjoining north coastal Karnataka, parts of South



Figs. 12(a&b). Mean seasonal temperature anomaly (°C) (a) Maximum (b) Minimum
(Based on 1971-2000 normals)



Figs. 13(a&b). Percentage of days when maximum temperature > 90th percentile and
(b) Percentage of days when minimum temperature < 10th percentile



Figs. 14(a&b). Time series of temperature for the country as a whole and the four homogeneous regions (1971-2017)

Interior Karnataka and adjoining Rayalaseema and parts of Kerala, maximum temperature was greater than 90th percentile for more than 40 to 50% of the days of the season. For minimum temperature, no significant distribution was observed.

Figs. 14(a&b) show the maximum & minimum temperature series respectively for the country as a whole and the four homogeneous regions during the season since 1971. Both maximum temperature and minimum temp. was normal over the East & Northeast India and above normal over the other three homogeneous regions by about 0.5 to 1 °C.

Low Pressure Systems

During the season, a Cyclonic Storm 'Maarutha' and a Severe Cyclonic Storm

'Mora' formed over the Bay of Bengal in the month of April and May respectively.

The first cyclonic storm of the year 'Maarutha' formed over the east central Bay of Bengal on 15th April. However, it moved away northeastwards away from the Indian region and crossed the Myanmar coast on 16th. Though the system did not cause significant weather over the mainland, it caused light to moderate rain over the Andaman & Nicobar Islands during its formative stage.

The severe cyclonic storm "MORA" formed over the Bay of Bengal during 28-31 May. It made a landfall over the Bangladesh coast on 30th and dissipated over the northeastern parts of the country on 31st. This system caused moderate to Heavy rain over many

parts of the northeastern region of the country after landfall on 30th May.

Significant Weather events during the season

Snowfall (Avalanche): Total 8 persons were reported dead & 7 others injured due to snowfall/ avalanche during 3-6 April from extreme northern states of the country. 3 persons died in Doda district of Jammu & Kashmir (3 Apr). On 4th April, 2 persons were reported dead in Shimla, Himachal Pradesh. 3 Jawans were buried in Ladakh at a post in the Batalik sector on 6-April.

Squall: During the season, 14 deaths were reported from northeastern states of Assam, Bihar & West Bengal. In the month of April & May, 2 persons died & 10 others were injured from Baska, Dhubri, Dhemaji, Majuli, Marigaon, Tinsukia districts of Assam. Huge amount of standing crops was damaged from 15 villages of Dhemaji district of Assam. On 28th May, 5 persons died due to wall collapses in West Champaran district of Bihar. While in the month of March & April, 7 deaths were reported from Birbhum, Burdwan, Malda and North 24 parganas districts of West Bengal.

Gale: Due to gale, 2 deaths were reported from Hassan, Karnataka on 4th April. While one person died in Itanagar, capital of Arunachal Pradesh on 17th May.

Heat wave: During the season, 39 deaths were reported from Maharashtra, Odisha & West Bengal. Total 17 persons died in Aurangabad, Beed, Jalana, Jalgaon, Nanded, Pune, Solapur & Yavatmal districts of Maharashtra during March & April. 20 deaths were reported from Angul, Bargarh, Bhadrak, Bolangir, Sambalpur districts of Odisha during April & May and 2 deaths from West Medinipur, W.B. on 4th April.

Lightning: Lightning reportedly claimed 121 lives from different parts of the country during the season. Of these 36 deaths were reported

from Karnataka, 27 from Bihar, 16 from Maharashtra, 12 from Andhra Pradesh, 8 each from Himachal Pradesh & West Bengal, 6 from Odisha, 4 from Assam and 2 each from Jammu Kashmir & Jharkhand.

Thunderstorm: Thunderstorm activities reportedly claimed 26 lives during the season. Of these, 10 casualties were reported from Karnataka, 9 from Assam and 7 from West Bengal. Huge amount of standing crops & houses were also damaged in Assam and Karnataka.

Hailstorm: Hail storms reportedly claimed 2 lives and damaged more than 1200 houses, disrupted power supply and transport in parts of Tripura, Nagaland and south Assam on 2nd & 3rd April. One death was reported from Catchar district of Assam on 26th April. Huge amount of rabi crop was damaged & many houses were extensively damaged from Barpeta, Bongaigaon, Cachar, Dhemaji, Dibrugarh, Goalpara, Nagaon, Kamrup, Nalbari districts of Assam on 17th March. During the month of March, damage to huge amount of rabi crops was reported from Begusarai, Sasaram, Chapra, Vaishali, Muzaffarpur, East & West Champaran, Sheohar, Sitamarhi, Darbhanga districts of Bihar. On 30th April, horticulture land was damaged & 14 persons were injured in Nashik district of Maharashtra. Also Onion, Mango, Grapes, Pomegranate & vegetable crops was damaged in Ahmednagar, Aurangabad, Nashik, Pune, Satara, Solapur and Osmanabad districts of Maharashtra on 7th May. Damage to vehicles and property was reported on 9th May from Kohima, the state capital of Nagaland.

Heavy Rain: Rain related incidents reportedly claimed 60 lives from western, eastern/northeastern and peninsular parts of the country during the season. 25 persons including 5 children died & 40 others were injured when the wall of a marriage hall collapsed due to heavy rain in Bharatpur, Rajasthan on 10th May. Total 15 deaths were

reported from Araria, Aurangabad, Bugusarai, Lakhisarai, Madhubani, Munger, Nalanda, Patna, Purnia, Supaul districts of Bihar on 9th May. Large amount of rabi crops was also damaged. Landslide due to heavy rain reportedly claimed the lives of 13 Char Dham Pilgrims in Chamoli district of Uttarkhand on 20th May. Also thousands of pilgrims were strained. In different incidences, 4 deaths were reported from Karnataka state during May. Also damage to 10000 areca palm trees, 4000 coconut trees, 2300 papaya plants & 6 acres of mango crops was reported from Kodagu, Tumkur, Mysore districts of the state during the month. 2 persons died in Kistwar, Jammu & Kashmir on 22nd April. One girl was reported washed away in Gauwhati, Assam on 5th May.

Cyclonic storm: Remnants of Severe Cyclonic Storm “Mora”, which crossed the northeastern states of Mizoram & Manipur as a depression, damaged many houses & inundated low lying areas on 30th May.

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

Onset and advance of SW Monsoon

The Southwest Monsoon season rainfall over the country as a whole this year was normal. Rainfall distribution was generally fairly well distributed over major parts of the country. The maximum temperature for the season, for the homogenous region of east and northeast India, was the second warmest since 1901.

Monsoon Onset and withdrawal

The Southwest Monsoon set in and advanced into some parts of Bay of Bengal, Andaman Seas and Andaman & Nicobar Islands in stages during 14 - 18 May. It further advanced after a hiatus of 8 days, on 26th May covering southern parts of Comorin area and some more parts of Bay of Bengal. On 29th, monsoon

advanced into some parts of south Arabian Sea, Maldives - Comorin area and some more parts of southwest, southeast and east central Bay of Bengal. On 30th May, it advanced into some more parts of south Arabian Sea, remaining parts of Maldives-Comorin area, southern parts of Lakshadweep area, Kerala and Tamil Nadu, some more parts of Bay of Bengal and some parts of Nagaland-Manipur-Mizoram and Arunachal Pradesh and the NLM passed through Lat. 10° N / Long. 60° E, Lat. 10° N / Long. 70° E, Kochi, Tondi, Lat. 14° N / Long. 87° E, Lat. 17° N / Long. 90° E, Lat. 20° N / Long. 91° E, Aizwal, Kohima and Deomali. Thus, the Southwest Monsoon set in over Kerala (two days prior to its normal date, *i.e.*, 1 June) and also over the parts of northeastern states on 30th May.

The monsoon further advanced into some more parts of northeastern states and northeast Bay of Bengal on 2nd June. As on 2nd June, the Northern Limit of Monsoon (NLM) passed through Lat. 10°N / Long. 60°E, Lat. 10°N / Long. 70°E, Kochi, Tondi, Lat. 14°N / Long. 87°E, Lat. 17°N / Long. 90°E, Lat. 20°N / Long. 91°E, Agartala, William Nagar, Kokrajhar and Lat. 27°N / Long. 90°E. Monsoon further advanced northwards and covered some more parts of Arabian Sea, south peninsula and southwest and central Bay of Bengal on 6th and 7th. The formation of a Deep depression over North Bay on 11 June and its north-northeastwards movement enabled the further advance of Monsoon in stages over most parts of peninsular India and entire northeast India by 14th. As on 14th June, the NLM passed through Lat. 20.5°N / Long. 60°E, Lat. 20.5°N / Long. 70°E, Valsad, Nashik, Parbhani, Adilabad, Jagdalpur, Bhawanipatna, Chandbali, Digha, Kolkata, Krishnanagar, Darjeeling and Lat. 27.4°N / Long. 87.7°E. During 15-21 June, the advance of southwest monsoon was sluggish and it covered only some parts of north peninsula, central and eastern/northeastern India. As on 21st, the NLM passed through Lat. 20.5°N / Long. 60°E,

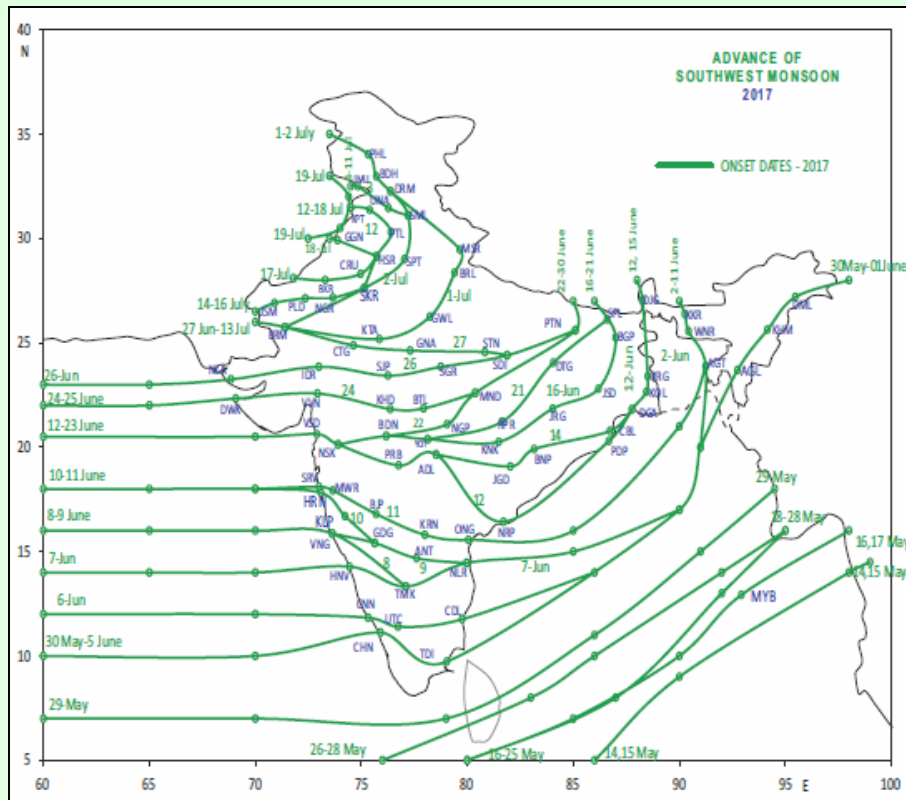


Fig. 15. Advance of southwest monsoon 2017

Lat. 20.5°N / Long. 70°E, Valsad, Nashik, Buldhana, Yeotmal, Raipur, Daltonganj, Supaul and Lat. 27.0°N / Long. 86.0°E. Monsoon further advanced northwards and westwards in stages on 22nd, 24th, 26th and 27th June and covered remaining parts of North Arabian Sea, most parts of western and central India and some parts of eastern India. The NLM passed through Lat. 26°N / Long. 70°E, Barmer, Chittorgarh, Guna, Satna, Siddhi, Patna and Lat. 27°N / Long. 85°E on 27th June. It further advanced over remaining parts of central India and most parts of north India in stages during 1st to 3rd July. As on 3rd July, the Northern Limit of Monsoon (NLM) passed through Lat. 26°N / Long. 70°E, Barmer, Sikar, Sonipat, Shimla, Una, Jammu and Lat. 32.5°N / Long. 74.5°E. After a hiatus of eight days, monsoon further advanced into remaining parts of Himachal Pradesh, Jammu division, some more parts of east Rajasthan, Haryana, Chandigarh & Delhi and some parts of Punjab on 12th. The NLM passed through Lat. 26°N / Long. 70°E, Barmer, Sikar, Hissar, Patiala, Kapurtala & Lat. 31.5°N /

Long. 74.5°E on 12th July. It further advanced in stages into some more parts of Rajasthan, Haryana and Punjab on 14th, 17th and 18th July. The Southwest monsoon advanced into remaining parts of west Rajasthan, Haryana and Punjab on 19th July covering the entire country, four days later than its normal date (15th July). Fig. 15 shows the isochrones of advance of southwest monsoon 2017.

The formation of a well marked low pressure area over northwest Bay of Bengal and its west-northwestward movement during 19-24 September delayed the commencement of withdrawal from west Rajasthan. The withdrawal of southwest monsoon from west Rajasthan commenced on 27th September, over three weeks later than its normal date (1 September). It also withdrew from some parts of Punjab and Haryana, some parts of Kutch and north Arabian Sea on the same day. Southwest Monsoon further withdrew from entire Jammu & Kashmir, Himachal Pradesh, remaining parts of Punjab, Haryana,

Chandigarh & Delhi, west Rajasthan, Kutch, some parts of Uttarakhand, west Uttar Pradesh, Saurashtra and Gujarat and most parts of east Rajasthan and some more parts of west Madhya Pradesh and north Arabian Sea on 30th Sept. As on 30th, the withdrawal line passed through Uttarkashi, Agra, Shivpur Kalyan, Gandhinagar, Dwarka, Lat. 22.0°N / Long. 65.0°E and Lat. 22 0°N / Long. 60.0°E.

Rainfall Features

The southwest monsoon season rainfall over the country as a whole was normal. Most of the subdivisions of the country received excess/ normal rainfall. However, some subdivisions of north and central India viz., Punjab, Haryana, Chandigarh & Delhi, East &

West Uttar Pradesh, East Madhya Pradesh and Vidarbha received deficient rainfall. During the season, out of 36 meteorological subdivisions, 5 subdivisions received excess rainfall, 25 received normal rainfall and the remaining 6 sub-divisions received deficient rainfall.

Fig. 16 shows the subdivisionwise distribution of rainfall percentage departures for the four months of the monsoon season (June to September) 2017.

Figs. 17(a&b) show the spatial pattern of rainfall received during the season and its anomaly (mm) from the LPA respectively. Parts of Central, eastern/northeastern and some northern parts of the country, parts of west coast and the Islands received rainfall of

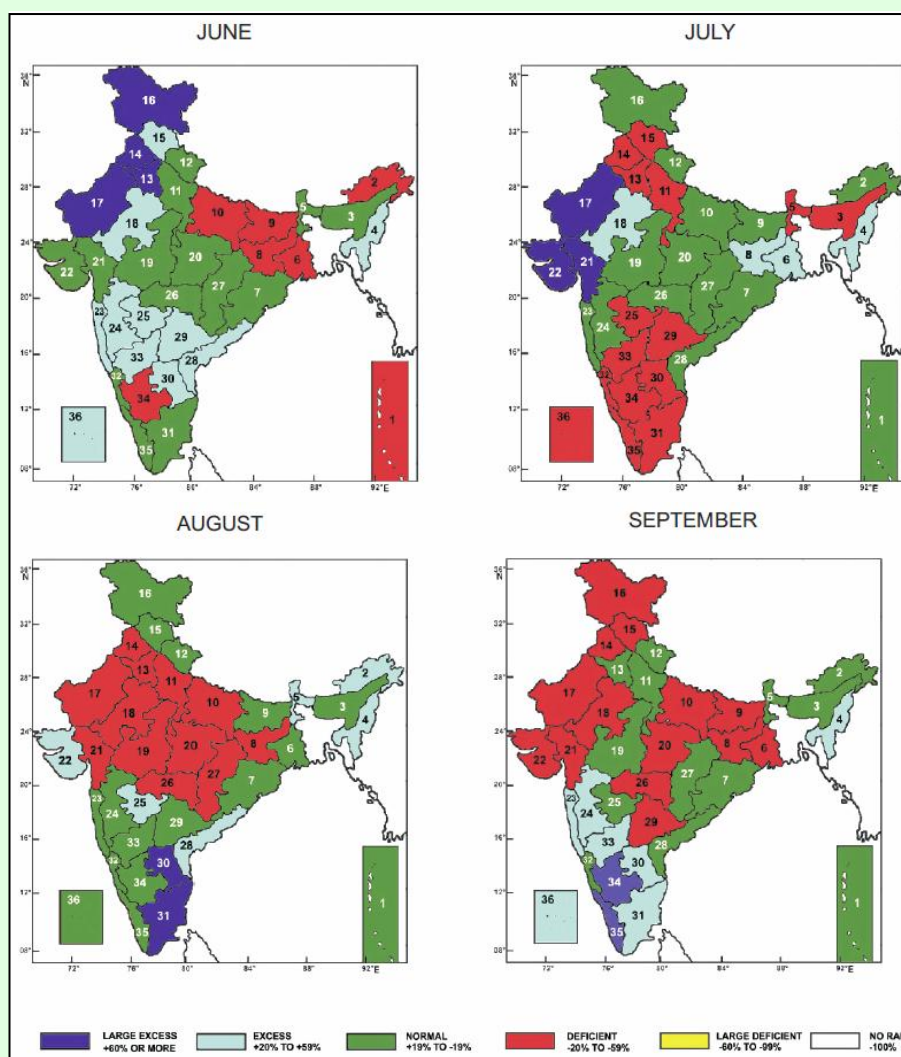
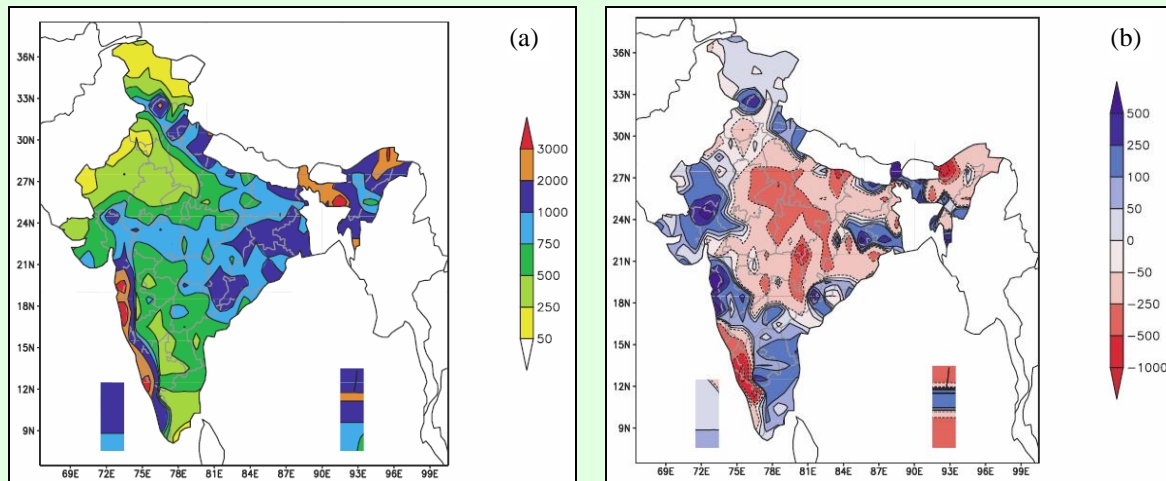


Fig. 16. Monthly sub-divisionwise distribution of rainfall percentage departures



**Figs. 17(a&b). Seasonal (a) rainfall (mm) and (b) Rainfall anomaly (mm)
(Based on 1951-2000 Normals)**

the order of 750-2000 mm. Parts of Konkan & Goa, Coastal Karnataka, Kerala, Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim, Mizoram, Assam & Meghalaya and Andaman & Nicobar Islands received more than 2000 mm of rainfall. Parts of Mizoram, Arunachal Pradesh, Konkan and Kerala received more than 3000 mm of rainfall.

Rainfall anomaly was positive over some parts of east/northeast, extreme north, west, south peninsular India and Lakshadweep and was negative over most parts of central, southern west coast, north, east/northeastern India and Andaman & Nicobar Islands. Positive rainfall anomaly over parts of Himachal Pradesh, Gujarat, Konkan, Gangetic West Bengal, Odisha, Jharkhand, Bihar, Chhattisgarh, Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Tripura, Mizoram, south interior Karnataka, Madhya Maharashtra, Rajasthan was more than 250 mm. The negative rainfall anomaly over parts of Goa, coastal Karnataka, Kerala, east Madhya Pradesh, Chhattisgarh, Vidarbha, east Uttar Pradesh and Arunachal Pradesh generally exceeded 500 mm.

Fig. 18(a) shows the all India area weighted rainfall series for the season since 1951. Fig. 18(b) shows the area weighted rainfall series for the season over the four homogeneous regions since 1951. The rainfall for the season was normal over the Northeast,

Central and South peninsular India (96%, 94% & 100% of LPA respectively) and slightly below normal over the Northwest India (90% of LPA).

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 and the year since January 2017 respectively.

Cumulative past four months SPI values indicate, extremely wet/severely wet conditions over parts of Nagaland, Mizoram, Tripura, Gangetic West Bengal, Odisha, Jharkhand, Bihar, Uttarakhand, Jammu & Kashmir, Rajasthan, Gujarat Region, Konkan & Goa, Madhya Maharashtra, Chhattisgarh, Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu and South Interior Karnataka, while extremely dry/severely dry conditions were observed over parts of Meghalaya, Nagaland, Odisha, Jharkhand, Bihar, Uttar Pradesh state, Punjab, East Rajasthan, East Madhya Pradesh, Vidarbha and Chhattisgarh.

Cumulative SPI values of the past nine months indicate, extremely wet / severely wet

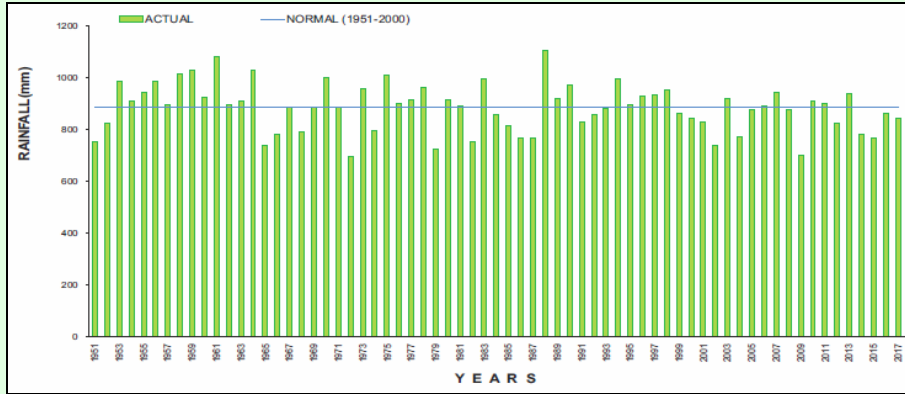


Fig. 18(a). Time series of area weighted rainfall over the country as a whole for the monsoon season (1951-2017)

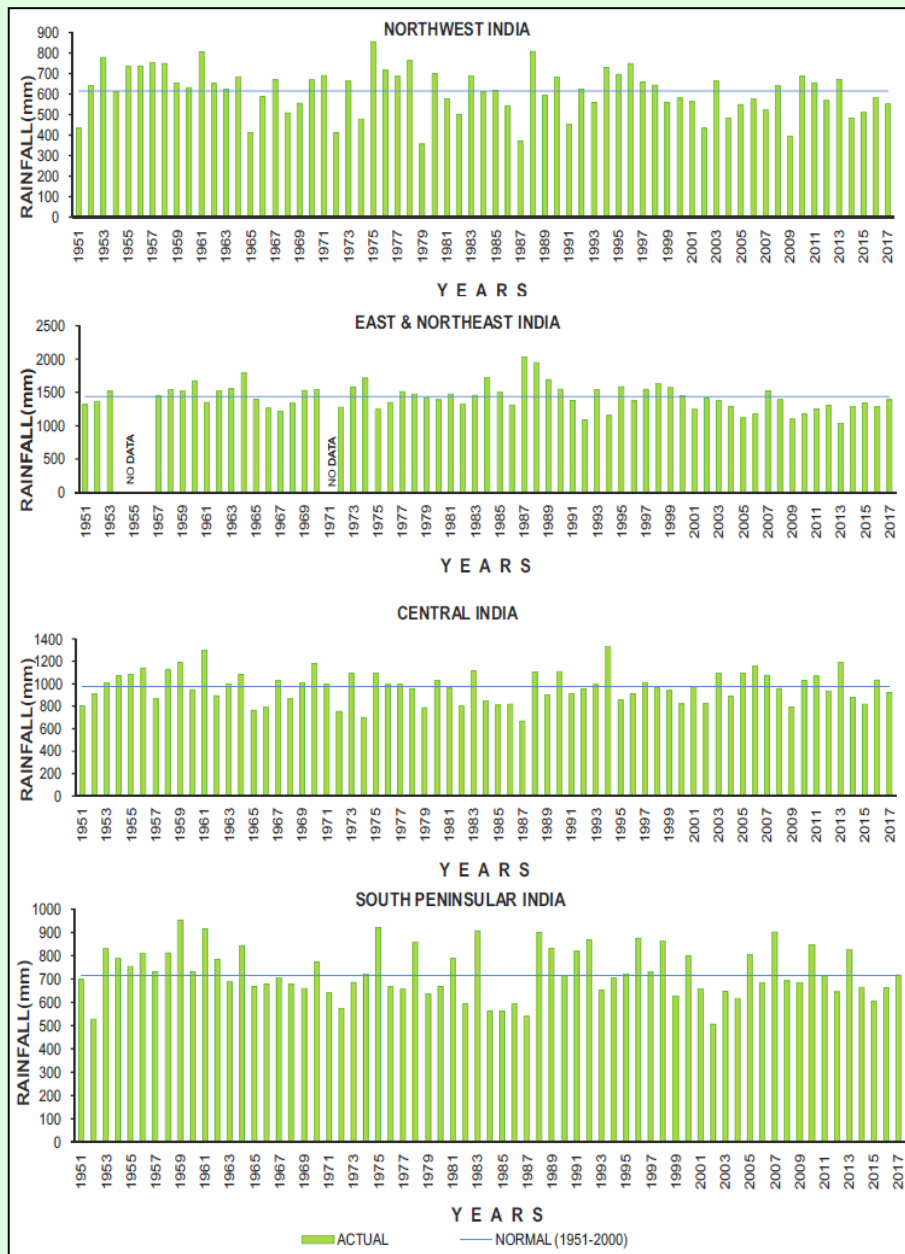
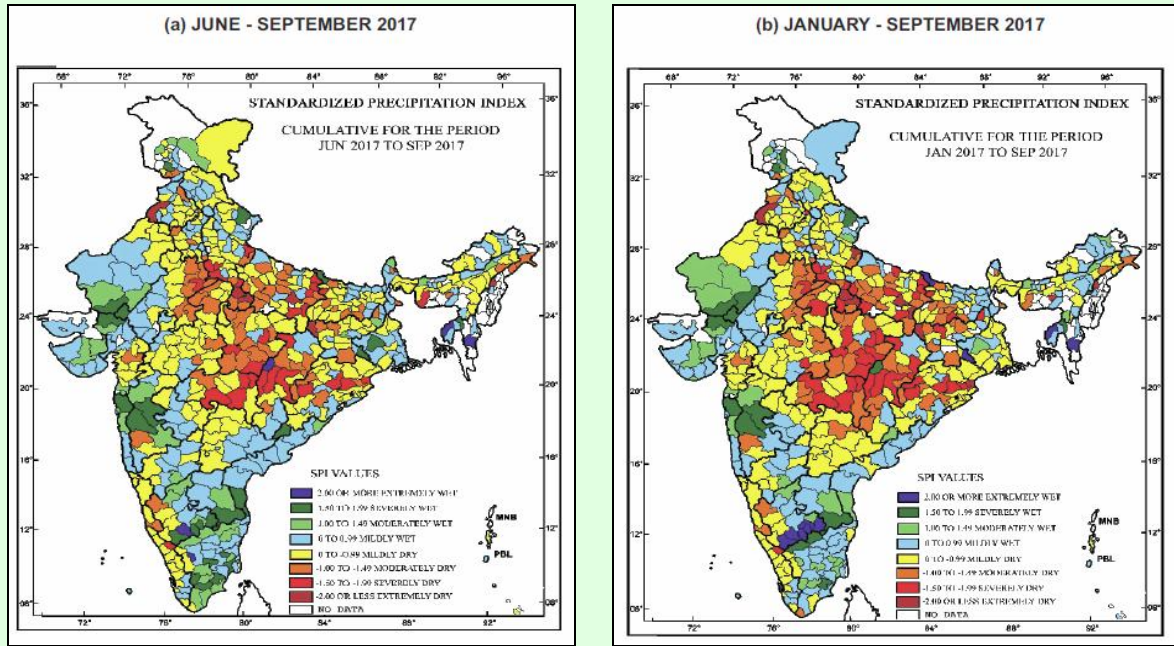


Fig. 18(b). Time series of area weighted rainfall over the four homogeneous regions for the monsoon season (1951 - 2017)



Figs. 19(a&b). Standardized Precipitation Index (SPI) for (a) four months (b) nine months

conditions over parts of Assam, Nagaland, Mizoram, Tripura, Jharkhand, Bihar, Uttarakhand, Jammu & Kashmir, Rajasthan state, Gujarat Region, Konkan, Madhya Maharashtra, Chhattisgarh, Rayalaseema, Tamil Nadu and South Interior Karnataka, while extremely dry/severely dry conditions were observed over parts of Meghalaya, Nagaland, Odisha, Jharkhand, Bihar, Uttar Pradesh state, Haryana, Chandigarh & Delhi, Punjab, East Rajasthan, Madhya Pradesh state, Vidarbha and Chhattisgarh.

Pressure & Wind

The pressure anomaly was near normal (within ± 0.5 hPa) over most parts of the country except for the northern/central region where it was more than 1 hPa.

At 850 hPa level, anomalous easterlies/south easterlies prevailed over the peninsula. An anomalous cyclonic circulation was also observed over the northwest Bay of Bengal and adjoining areas. At 500 hPa level, anomalous westerlies with ridge along coastal peninsula were observed over the Peninsular parts of the country. At 250 hPa level, an anomalous anticyclonic circulation was

observed over the Northeast region and northern parts of the country.

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig. 20. Positive OLR anomaly was observed over northwestern, extreme northern, eastern India and adjoining Bay of Bengal, equatorial Indian Ocean and adjoining southeast Bay and southwest Arabian Sea. It exceeded $10 W/m^2$ (upto $20 W/m^2$) over parts of equatorial Indian Ocean and adjoining southeast Bay and southwest Arabian Sea.

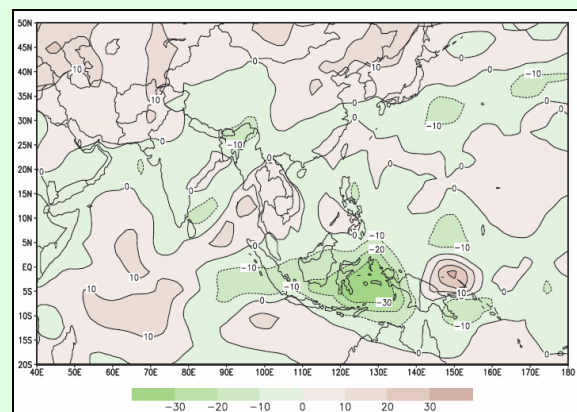


Fig. 20. OLR anomaly (w/m^2) for the monsoon season 2017 (Source : CDC / NOAA, USA) (Based on 1981 - 2010 Climatology)

Low Pressure Systems

During the season, fourteen low pressure systems (1 Deep Depressions, 2 Depressions, 6 well marked low pressure areas & 5 low pressure areas) were formed.

The first intense system of the season formed as a Deep Depression (11-12 June) and the second depression (18-19 July) formed over northwest Bay of Bengal. The third depression was a land depression which formed over northwest Jharkhand and neighbourhood towards the end of July (26-27 July). Most of these depressions and the low pressure areas moved in a westerly/north-westerly direction across eastern and central parts of the country. The month of August and September were devoid of depressions which resulted in below normal rainfall over the country as a whole. However, most of the low pressure systems had a short life span.

Significant Weather events

Heavy rain, lightning and thunderstorm related incidents were the most high impact weather events of the season which reportedly claimed over 980 lives mostly from northern, eastern/north-eastern, central and north peninsular parts of the country.

Thunderstorm: Thunderstorm activities reportedly claimed 61 lives during the season mostly from different parts of the country. Of these, 32 deaths were reported from Jharkhand during the month of June only. 11 persons died in Assam during 5th Jun. to 16th Jul, 9 from West Bengal (19th June), 5 from Jammu & Kashmir (8th June) and 2 each from Telangana (6 June) & U.P. (17th June).

Lightning: As per reports in local newspaper, 353 people were struck & killed by lightning from different parts of the country during the season. During the month of June & July, deaths of 173 persons were reported from 25 districts of Odisha. Death of 52 persons from Bihar and 37 persons from Uttar Pradesh was reported during June-August.

Heavy Rain: During the season heavy rain & flood related incidents claimed at least 569 lives from different parts of the country. Deaths of 143 people were reported from 28 districts of Assam during the period 13th June to 11th September. 138 persons died in Uttar Pradesh during 8th July to 10th September (of which 110 persons due to heavy rain & flood in Ghaghara, Gomati & Rapti rivers during 4-10 September) while 107 persons were reported dead from Bihar. Heavy rains reportedly claimed 54 lives (of which 38 deaths were reported during 29-31 August) from Maharashtra during the period 24th June to 24th September.

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

The mean temperature (24.2 °C) for the country as a whole during the season 2017 was above normal by about 0.76 °C making the season as the third warmest since 1901.

Northeast Monsoon Activity

The southwest monsoon withdrew from the entire country on 25th October and the northeast monsoon rain commenced over the south peninsula on 27th October.

Rainfall activity over core region of the south peninsula (comprising of 5 subdivisions viz., Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu & Puducherry, South Interior Karnataka and Kerala) was below normal (86.1% of Long Period Average (LPA)). It was normal during October and December (96% of LPA, 89% of LPA) and was subdued during November (69% of LPA).

Rainfall Features

Rainfall over the country as a whole during the season was normal (89% of LPA value). It was 101%, 49% and 98% of its LPA during October, November and December months respectively. Eastern/northeastern region, south peninsular region and islands received

large excess/excess/normal rainfall, while remaining parts of the country received deficient / large deficient rainfall.

During the season, out of 36 meteorological subdivisions, 1 subdivision received large excess rainfall, 4 subdivisions received excess rainfall, 14 subdivisions received normal rainfall, 8 subdivisions received deficient rainfall and remaining 9 subdivisions received large deficient rainfall (Fig. 21).

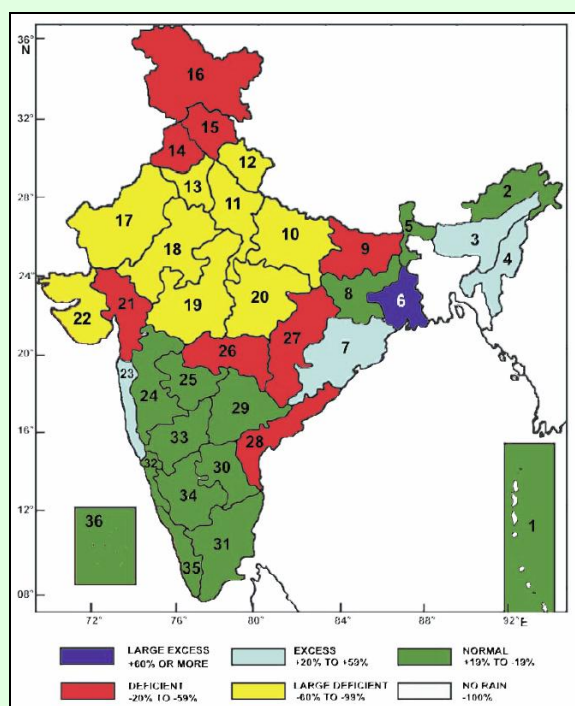


Fig. 21. Sub-divisionwise rainfall percentage departures

Figs. 22(a&b) show the spatial pattern of rainfall (mm) received during the season and its anomaly respectively. Parts of Tamil Nadu, Kerala, south interior Karnataka, Odisha, Gangetic West Bengal, Arunachal Pradesh, Assam & Meghalaya, Manipur, Mizoram & Tripura and Islands received more than 300 mm rainfall. Coastal parts of north Tamil Nadu & Puducherry, southern parts of Kerala and adjoining Tamilnadu, Lakshadweep received more than 600 mm rainfall.

Rainfall anomaly was negative over most parts of the country except for some parts of northeast, central India, peninsular India and Islands. Negative rainfall anomaly exceeded

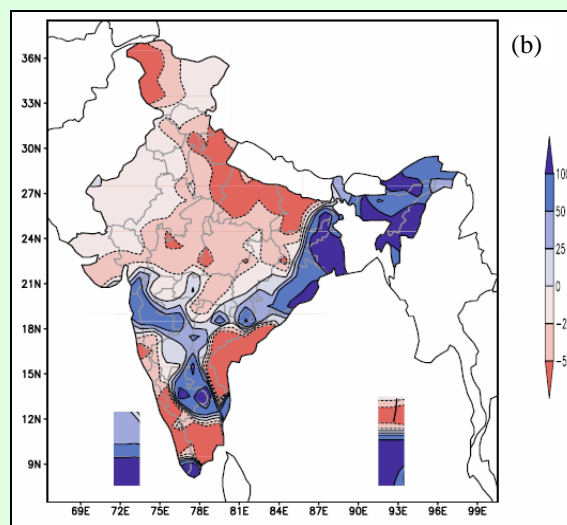
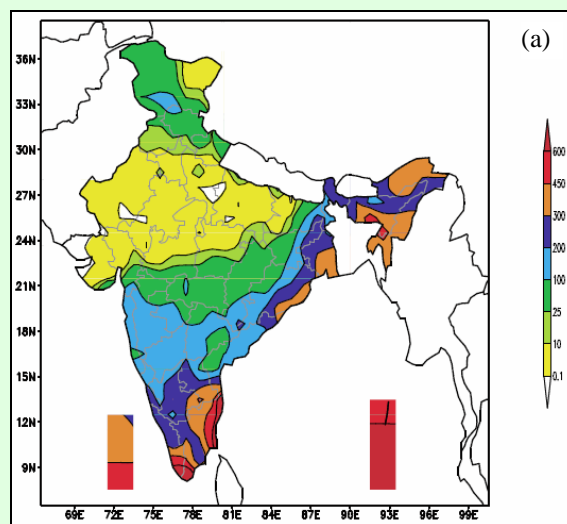


Fig. 22(a&b). (a) Seasonal rainfall (mm) and (b) seasonal rainfall anomaly (mm) (Based on 1951-2000 Normals)

50 mm over most parts of Jammu & Kashmir, Uttarakhand, Uttar Pradesh, Bihar, coastal Andhra Pradesh and adjoining Telangana and Rayalaseema, central parts of Tamilnadu, Kerala, coastal Karnataka and Lakshadweep. While, positive rainfall anomaly more than 100 mm was observed over parts of south Tamil Nadu and adjoining Kerala, south interior Karnataka, Odisha, Gangetic West Bengal and adjoining Jharkhand and Bihar, Arunachal Pradesh, Assam & Meghalaya, Manipur, Mizoram & Tripura and Islands.

Fig. 23(a) shows the all India area weighted rainfall series for the season since 1951.

Fig. 23(b) shows the area weighted rainfall series for the season over the four homogeneous regions since 1951. The rainfall

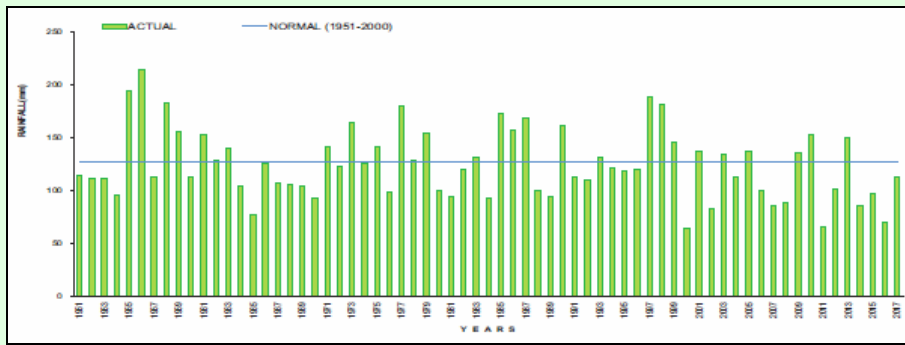


Fig. 23(a). Time series of area weighted rainfall over the country as a whole (1951 - 2017)

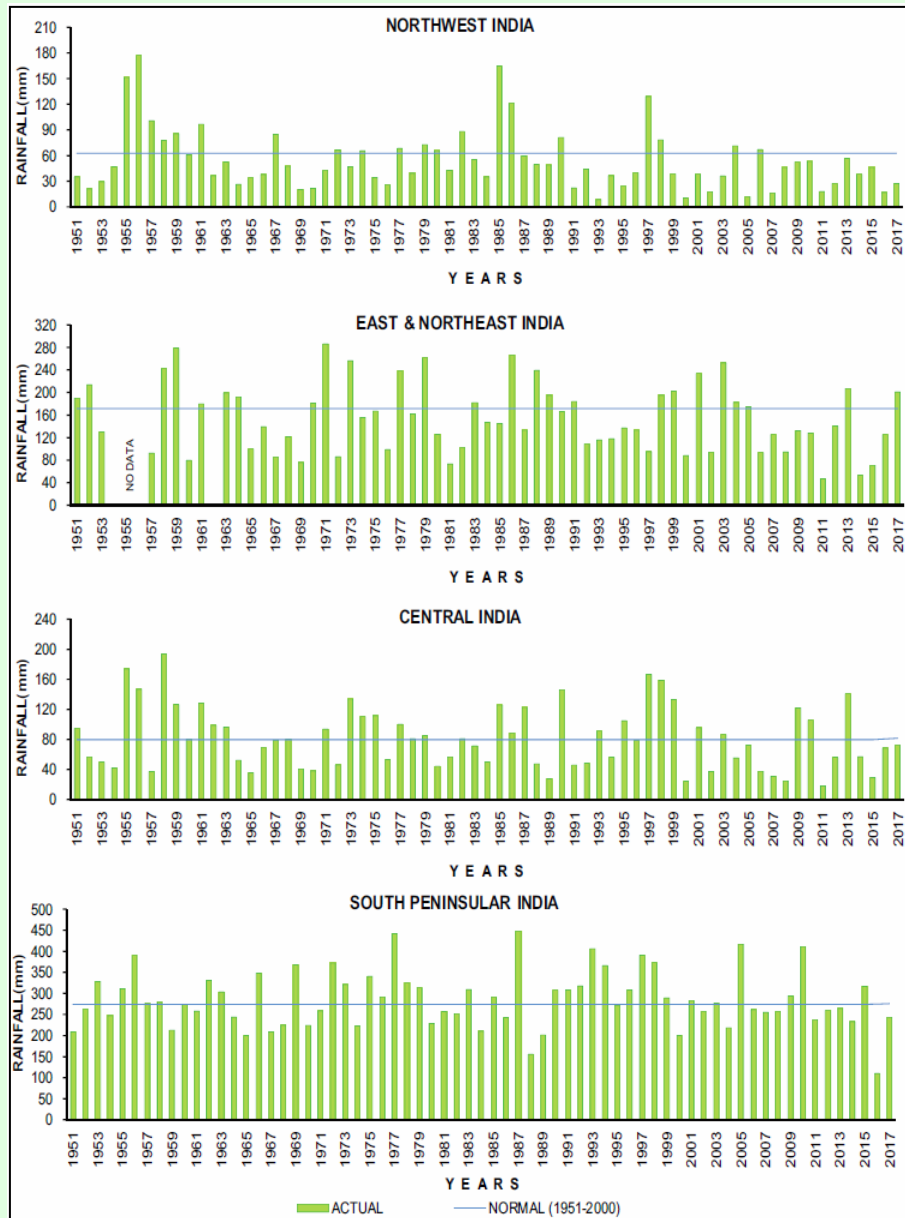


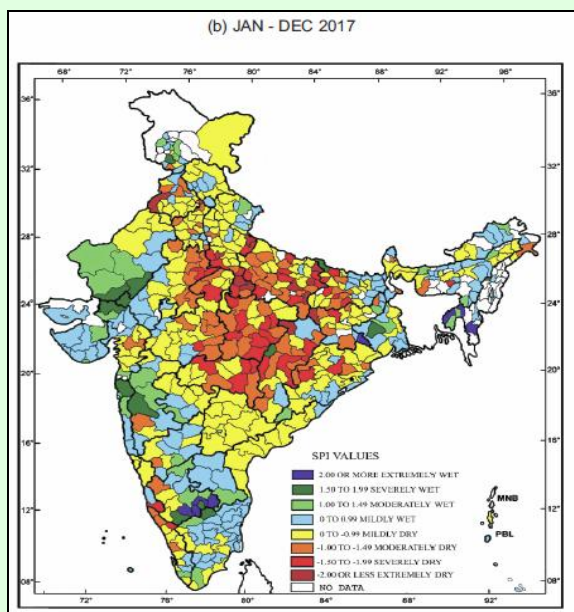
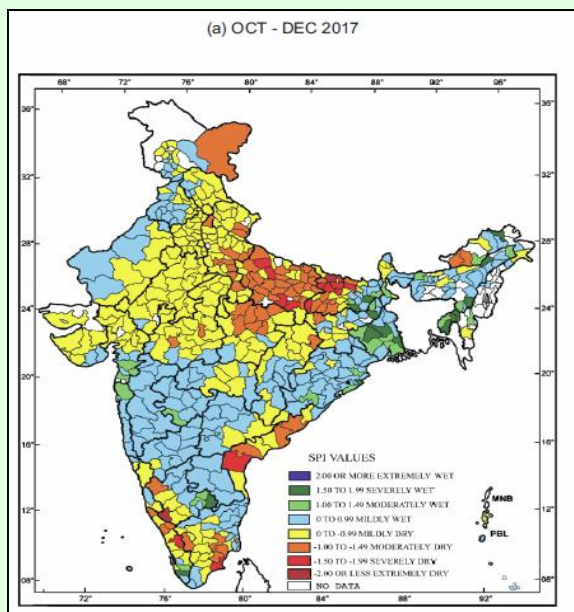
Fig. 23(b). Time series of area weighted rainfall over the four homogeneous regions (1951 - 2017)

for the season was below normal over all the three homogeneous regions except east and northeast India. It was above normal over east and northeast India (117 % of LPA) and below

normal over central and south peninsular India (91% and 89% of LPA respectively), substantially below normal over the northwest India (44 % of LPA).

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. 24(a&b) give the SPI values for the northeast monsoon season (Oct to Dec, 2017 *i.e.*, 3 months cumulative) & the year (Jan-Dec 2017, *i.e.*, 12 months cumulative) respectively.



Figs. 24(a&b). Standardized Precipitation Index (SPI) cumulative for (a) three months (b) twelve months

Cumulative SPI values of the past three months indicate, extremely wet/severely wet

conditions over parts of Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Odisha, Jharkhand, Bihar, South Interior Karnataka and Kerala while extremely dry/severely dry conditions were observed over parts of Bihar, East Uttar Pradesh, Coastal Andhra Pradesh, Tamil Nadu, South Interior Karnataka and Kerala

Cumulative SPI values of the past twelve months indicate, extremely wet/severely wet conditions over parts of Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic WB, Jharkhand, Bihar, Jammu & Kashmir, West Rajasthan, East Rajasthan, Gujarat Region, Konkan & Goa, Madhya Maharashtra, Chhattisgarh, Tamil Nadu and South Interior Karnataka, while extremely dry/severely dry conditions were observed over parts of Assam & Meghalaya, Odisha, Jharkhand, Bihar, East & West U.P., Haryana, Chandigarh & Delhi, Punjab, East Rajasthan, West & East Madhya Pradesh, Vidarbha, Chhattisgarh, Coastal Karnataka & Kerala.

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig. 25. OLR anomaly was positive over north, northwest, extreme northeastern region and some central parts of south peninsula, while it was below normal over most parts of Bay of Bengal and Arabian Sea. It was below normal by $10 W/m^2$ over southern parts of Bay of Bengal.

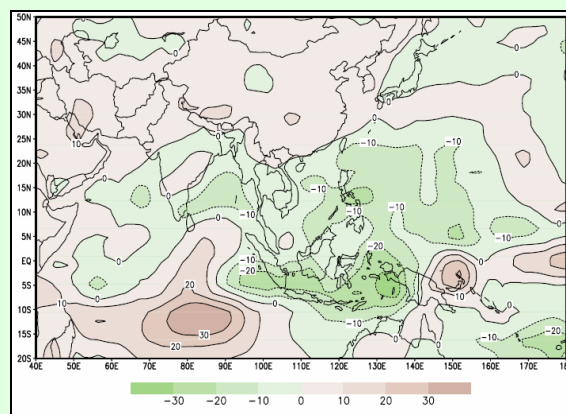
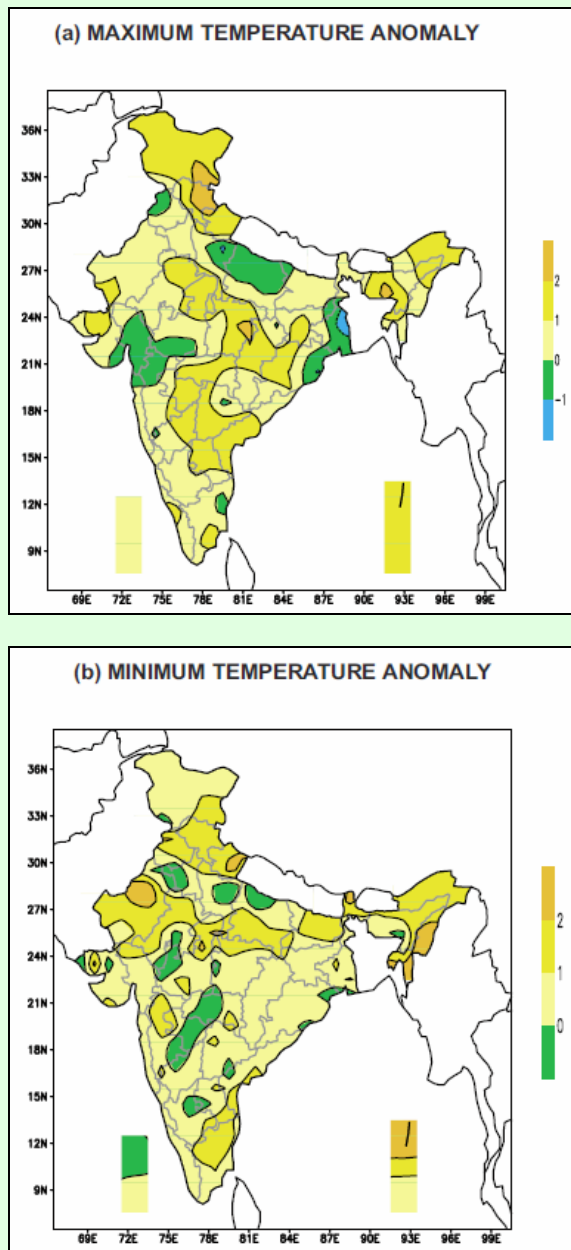


Fig. 25. OLR Anomaly (w/m^2) for the post-monsoon season 2017 (Source : CDC / NOAA, USA) (Based on 1981 - 2010 Climatology)

Temperature

Mean seasonal maximum and minimum temperature anomaly is shown in Figs. 26(a&b) respectively.



Figs. 26(a&b). Mean seasonal temperature anomalies (°C) (a) Maximum (b) Minimum (Based on 1971-2000 Normals)

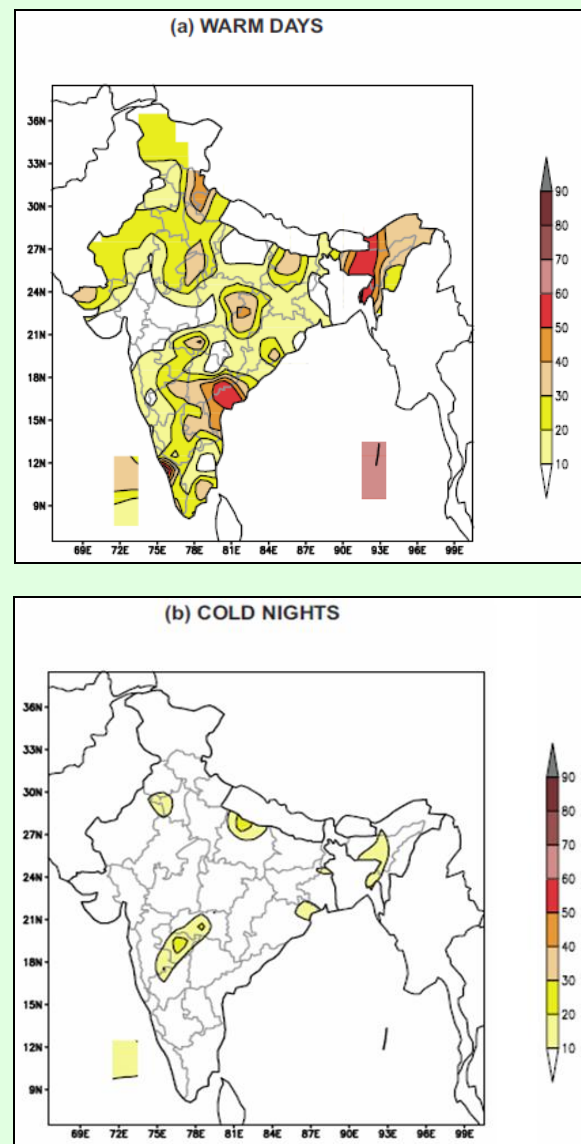
Maximum temperature was above normal over most parts of the country except for parts of East Uttar Pradesh, Gangetic West Bengal, Odisha, Gujarat and adjoining Madhya Maharashtra and West Madhya Pradesh. Over most parts of northern, northeastern, central India and parts of south peninsula it was above normal by 1 °C. Over parts of Jammu &

Kashmir, Himachal Pradesh, Assam & Meghalaya and west Madhya Pradesh it was above normal by more than 2 °C.

Minimum temperature was below normal over some parts of Maharashtra, west Madhya Pradesh, Lakshadweep and at some isolated places. It was above normal by more than 2 °C over parts of Manipur, Mizoram & Tripura, Sub-Himalayan WB & Sikkim, Uttarakhand, West Rajasthan and A&N Islands.

Percentage of Warm days/Cold nights

Figs. 27(a&b) show the percentage of days when maximum (minimum) temperature was more (less) than 90th (10th) percentile.



Figs. 27(a&b). Percentage of days when (a) maximum temperature > 90th percentile (b) minimum temperature < 10th percentile

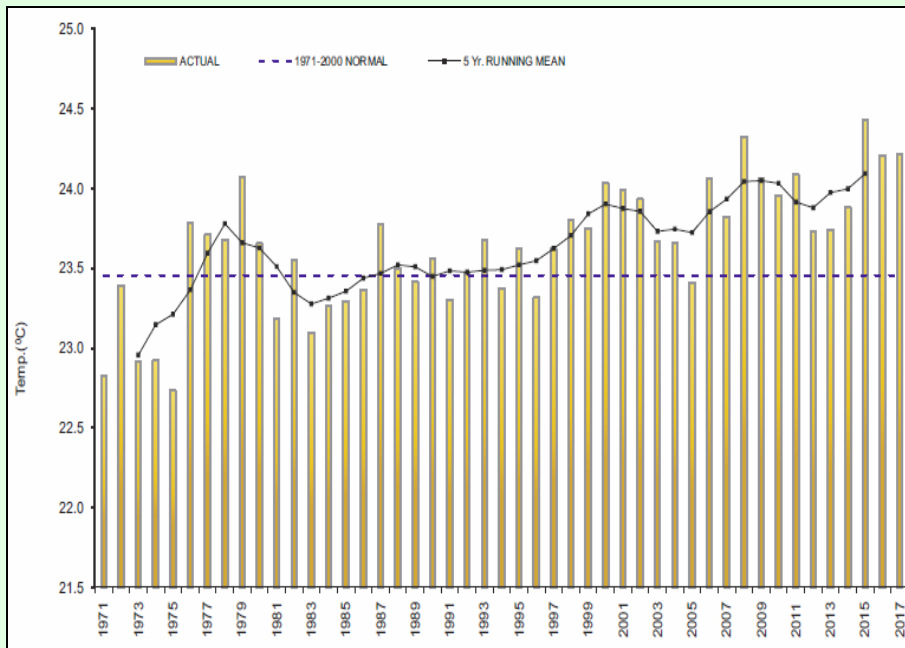
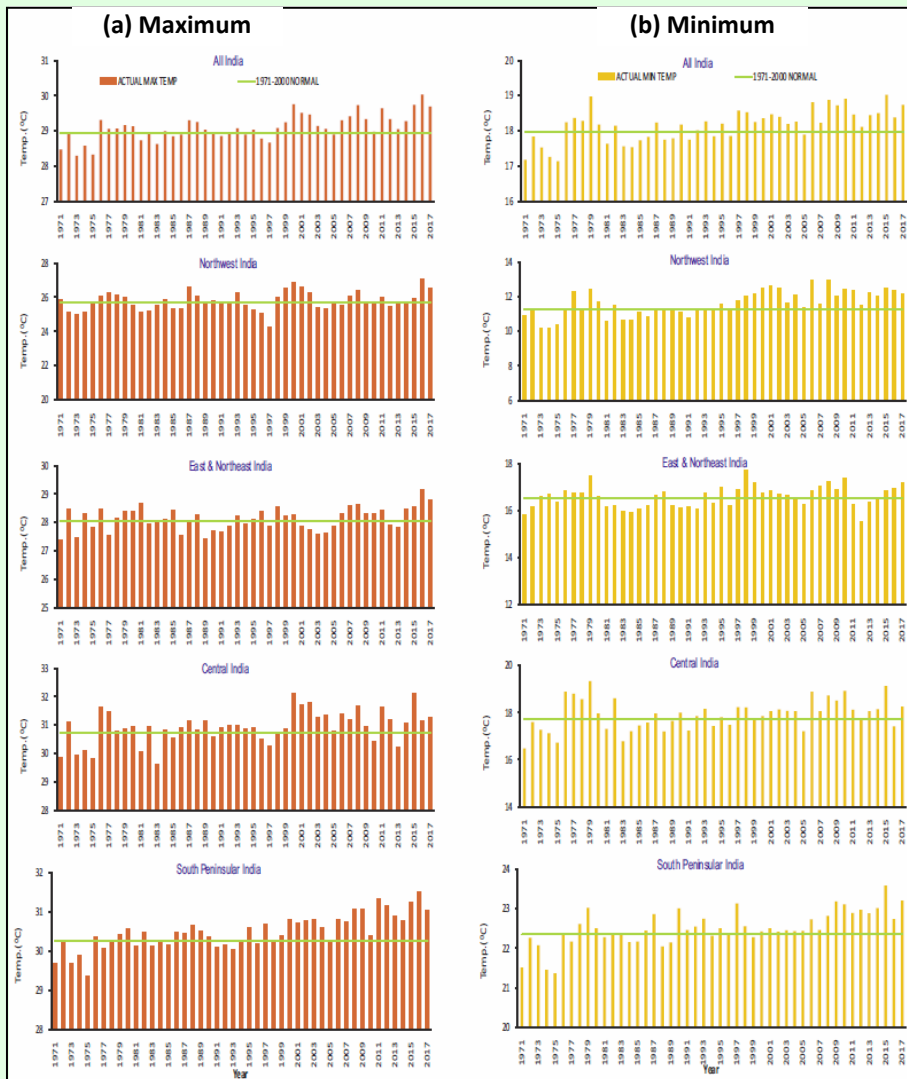


Fig. 28. Time series of mean temperature averaged over India (vertical bars) and five year running mean (continuous line) for the post monsoon season (1971 - 2017)



Figs. 29(a&b). Time series of temperature for the country as a whole and The four homogeneous regions (1971 - 2017) (a) Maximum (b) Minimum

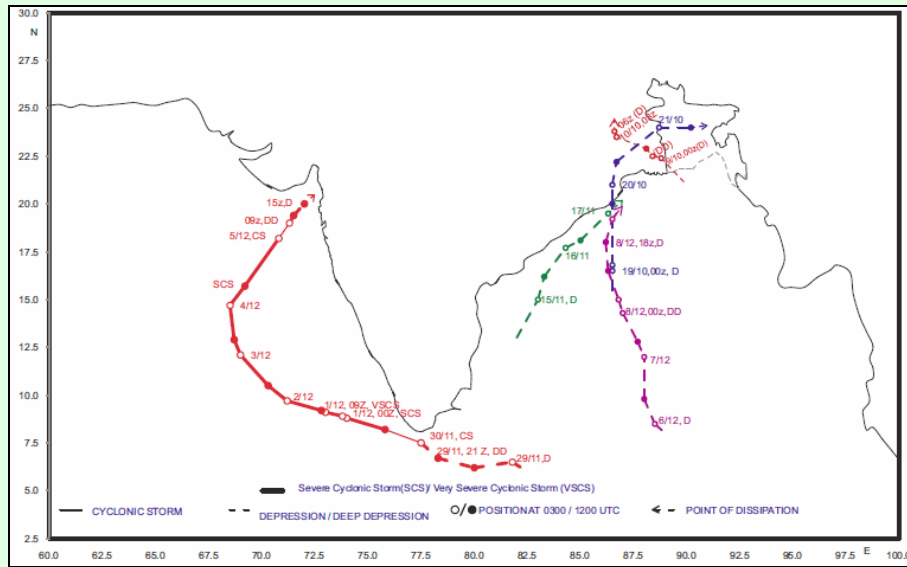


Fig. 30. Tracks of intense low pressure systems formed during the post-monsoon season

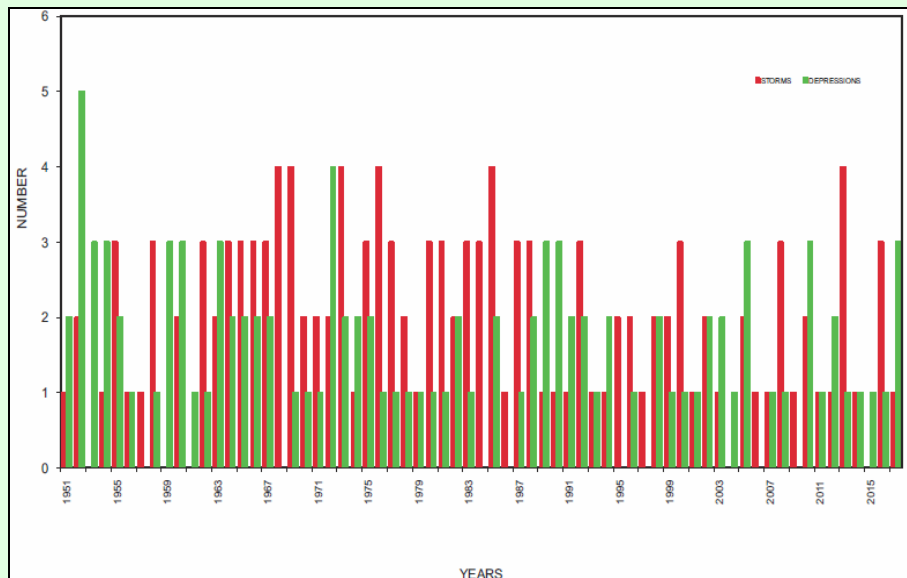


Fig. 31. Frequency of depressions / cyclonic storms formed over the Bay of Bengal During the post-monsoon season (1951 - 2017)

Over parts of Assam and Meghalaya, Tripura, coastal Andhra Pradesh, Telangana, coastal Karnataka and Andaman & Nicobar Islands the maximum temperature was greater than 90th percentile for more than 50% of the days of the season. However, for minimum temperature, no significant distribution was observed.

Fig. 28 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 (24.2 °C) for the season this year was above normal by

about 0.76 °C. It was the third highest since 1901. The highest mean temperature for postmonsoon season since 1901 was recorded during 2015 (24.4 °C) followed by 2008 (24.3 °C).

Figs. 29(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. Maximum and minimum temperature was above normal for all the homogeneous regions by more than 0.5 °C. Maximum temperature over northeast India was the

second highest (28.8 °C) after the year 2016 (29.2 °C). For minimum temperature over south peninsular India, was the third highest (23.2 °C) after the years 2015 (23.6 °C), 1936 (23.3 °C) since 1901.

Low Pressure Systems

A very severe cyclonic storm “Ockhi” over the Bay of Bengal (during November) and four depressions (two in the month of October out of two one land depression and one each in the months of November and December) were formed during the season. The tracks of the systems is shown in Fig. 30.

Legends: L: low pressure area, WML: Well marked low pressure area, ARB: Arabian Sea, BoB: Bay of Bengal, D: Depression, DD : Deep Depression.

The frequency of depressions / cyclonic storms formed over the Bay of Bengal during the post-monsoon season (1951 - 2017) is shown in Fig. 31.

Significant Weather events

Heavy Rain : Total 14 persons reportedly claimed during the season. A sudden downpour wreaked havoc in Hyderabad, Telangana on 2nd October resulting deaths of 2 persons. Also 6 persons reportedly claimed from Tamil Nadu on 3rd November due to

heavy rain. 6 persons reportedly claimed dead from Himachal Pradesh on 11th December due to massive landslide near Rampur district Shimla.

Lightning : Total 75 persons reportedly claimed from Maharashtra, Odisha, Telangana & Tamil Nadu during the month of October & November. Out of which, 39 persons reportedly claimed from Maharashtra, only in 5 days during the period 5th to 9th October. 27 persons reportedly claimed dead from Odisha during 1st to 14th October. Also 4 persons reportedly claimed from Hyderabad, Telangana on 2nd October. 5 persons reportedly claimed from Ariyalur district of Tamil Nadu on 27th November.

Snowfall : Total 9 persons reportedly claimed due to snowfall in the month of December. 3 shepherds died due to snow avalanche on 11th December, while 6 were reportedly claimed from Bandipora, Kupwara districts of Jammu & Kashmir on 12th December.

Cyclonic Storm : The Very Severe Cyclonic Storm “OCKHI”, which moved from the Bay of Bengal to the Arabian sea, caused substantial damage in Kerala, Tamil Nadu & Lakshadweep. Due to which 18 persons reportedly claimed from Tamil Nadu & 74 from Kerala.

CHAPTER 3

NUMERICAL WEATHER PREDICTION

3.1. Global modeling, coupled modeling and Regional Modelling

(i) The GFS (GSM.V13.0.3) at T1534L64 (~ 12 km) in horizontal resolution and 64 hybrid sigma-pressure layers with the top layer centred around 0.27 hPa (approximately 55 km) was made operational on 1 December 2016. During 2017 IMD implemented Global Ensemble Forecasting System (GEFS SL) for ensemble forecasts in the medium range time scale. The GEFS SL at semi-Lagrangian resolution T574 in horizontal resolution (~ 25 km) with 64 hybrid sigma-pressure layers with the top layer centred at 0.27 hPa (approximately 55 km) was made operational on 1 May 2017. It is run once in a day (0000 UTC) with 20 members (and 1 control) to give ensemble mean and probabilistic forecast in the short to medium range. The initial conditions are generated from the NCEP based Ensemble Kalman Filter (EnKF)

component of hybrid Global Data Assimilation System (GDAS). The GFS predicted the rainfall associated with tropical cyclone “OCKHI” reasonably well. The spatial observed and forecast rainfall band associated with TC “OCKHI” is shown in the in Fig. 1. The model forecast with 30 November 2017 initial condition is able to demonstrate the inner core of heavy rainfall and the outer rain bands as seen in the observations.

(ii) A coupled model with a suite of models from CFSv2 coupled model has been developed, implemented and operationalized in July 2016 for generating operational Extended Range Forecast (ERF) 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

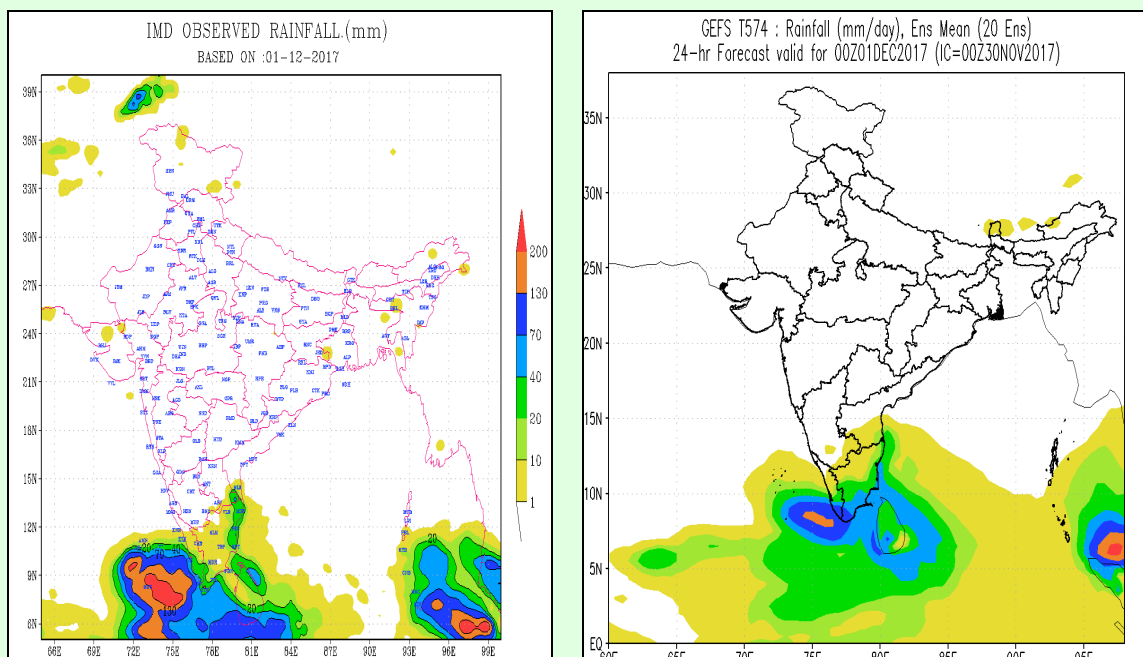


Fig. 1. The observed and 24 hr forecast rainfall associated with tropical cyclone “OCKHI” valid for 1st December, 2017

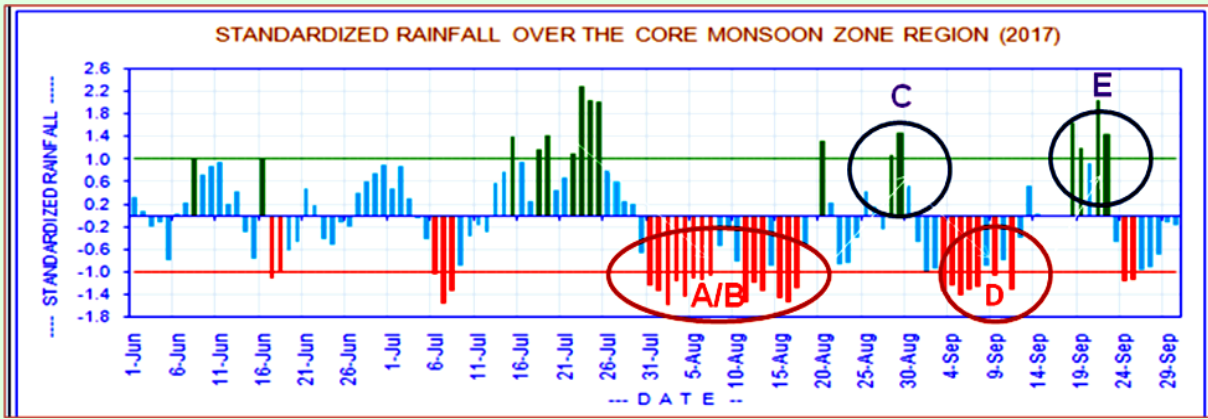


Fig. 2. Standardized rainfall anomalies over the core monsoon region during June to September, 2017

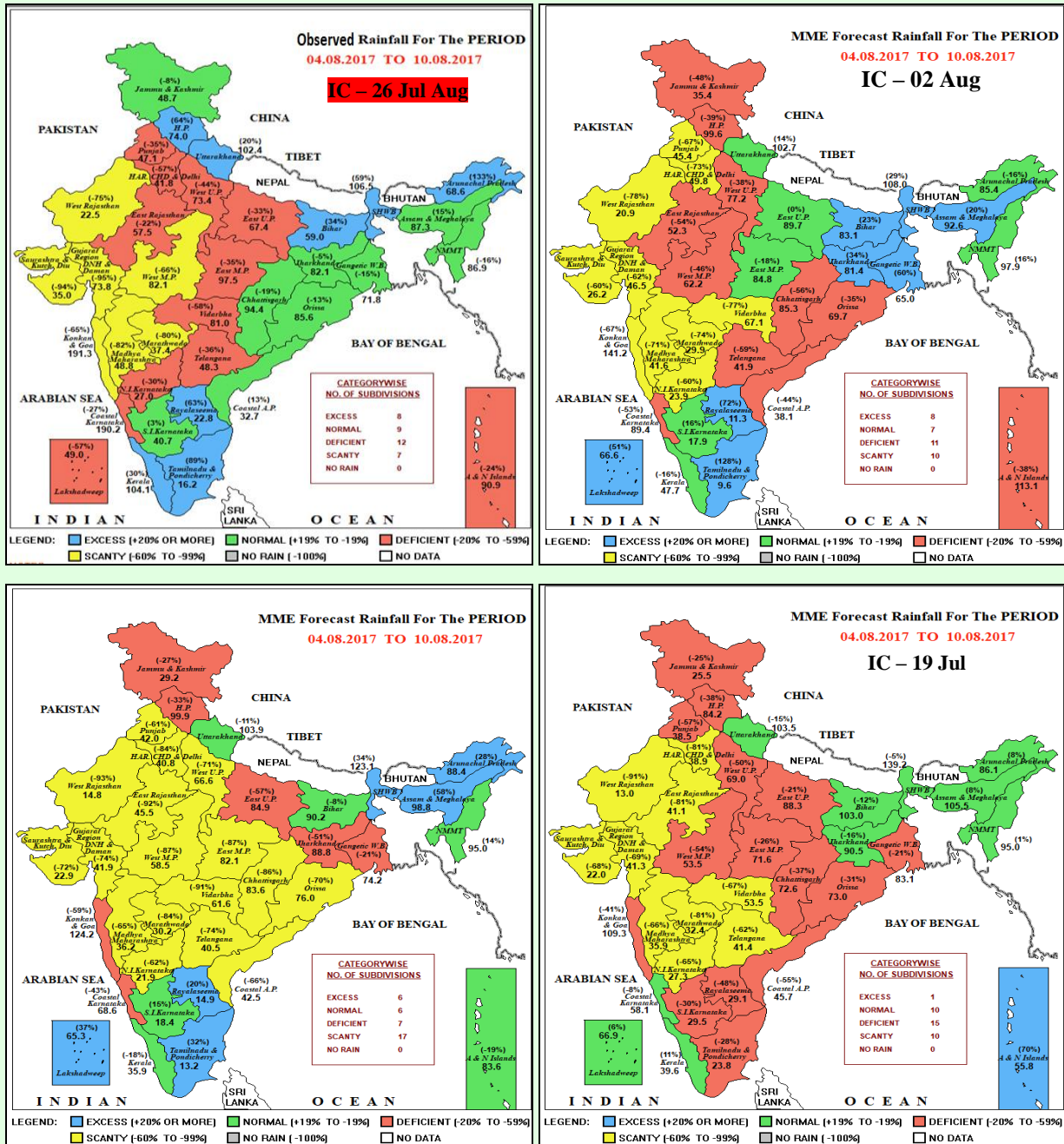


Fig. 3. The observed rainfall anomaly during the period from 4-10 August, 2017 along with the MME based extended range forecast of rainfall anomaly with different lead time valid for the same period

suite is run operationally for 32 days based on every Wednesday initial condition with 4 ensemble members to give forecast for 4 weeks for days 2-8 (week1; Friday to Thursday), days 9-15 (week2; Friday to Thursday), days 16-22 (week3; Friday to Thursday) and days 23-29 (week4; Friday to Thursday). The extended range forecast of monsoon rainfall and extreme temperatures are being used by various user agencies during the year 2017.

During the southwest monsoon season from June to September 2017 there were

many transitions phases (active to weak and weak to active) as shown from the standardized rainfall anomalies over the core monsoon region (Fig. 2). A verification of prediction of transition of active to weak phase of monsoon during the period from 4-10 August, 2017 based on the different lead time is given below. The weak phase of monsoon rainfall during 4-10 August, 2017 is captured well in the extended range forecast with lead time of one week (IC of 2nd August), two week (IC of 26 July) and three week (IC of 19 July) as shown in Fig. 3.

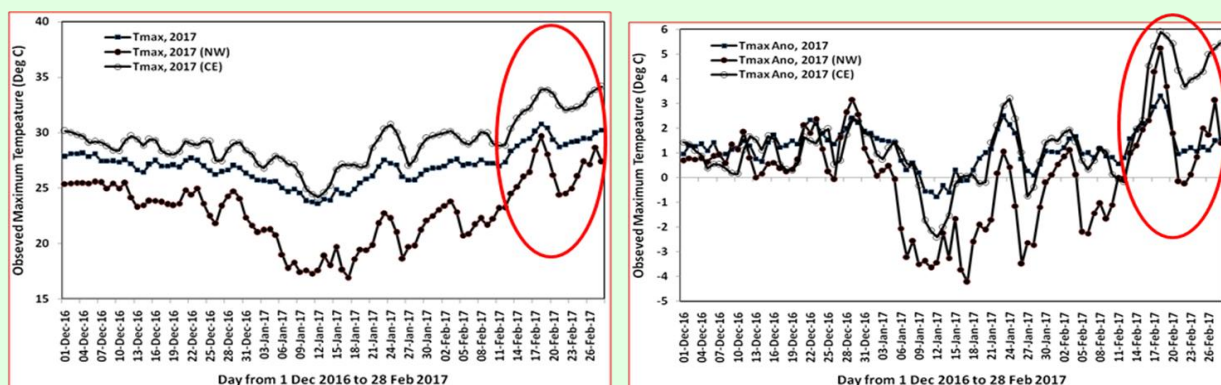


Fig. 4. Maximum temperature (Tmax) and its anomaly averaged over India, Northwest (NW) India and Central (CE) India during 1st December 2016 to 28 February 2017

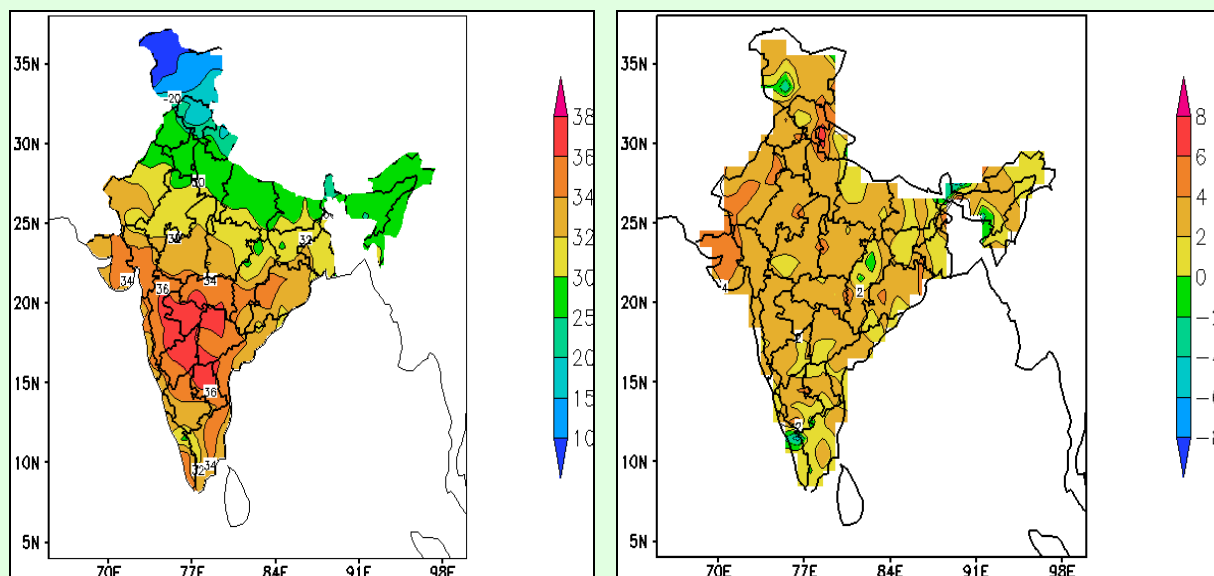


Fig. 5. Observed maximum temperature and its anomaly during the period from 17-23 February, 2017

The extended range forecast is also very useful in giving the appropriate guidance about the extreme temperature forecasting. The sudden warming during the last week of February, 2017 (17-23 February)

as shown in Fig. 4 and also in the spatial plots of maximum temperature and its anomaly in Fig. 5 is very well captured in the MME based ERF forecast with different lead time (Fig. 6).

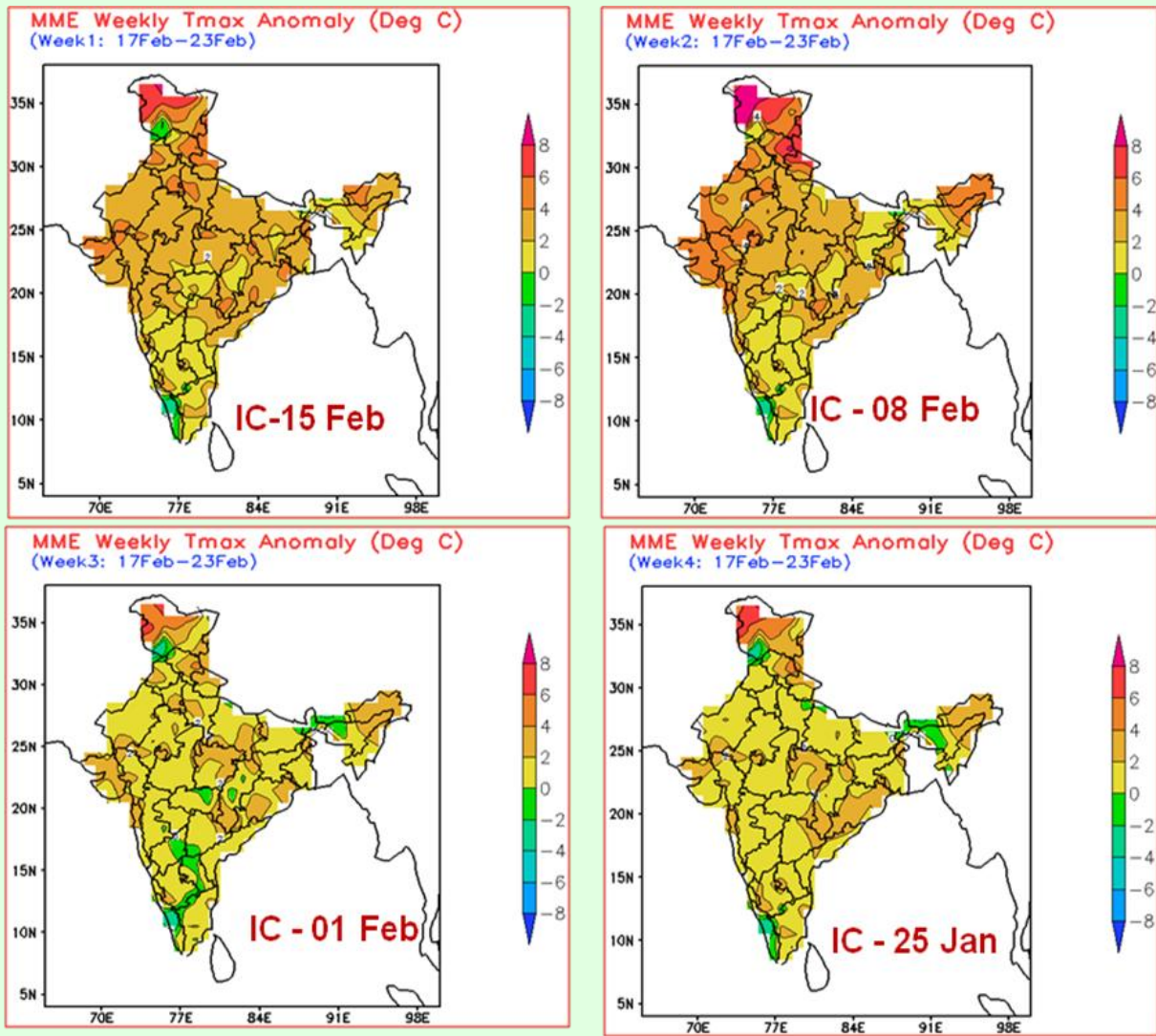


Fig. 6. The MME based ERF forecast of maximum temperature anomaly (T_{max} anomaly) valid for the period from 17-23 February, 2017 with different initial conditions indicating the wide spread warming over the country

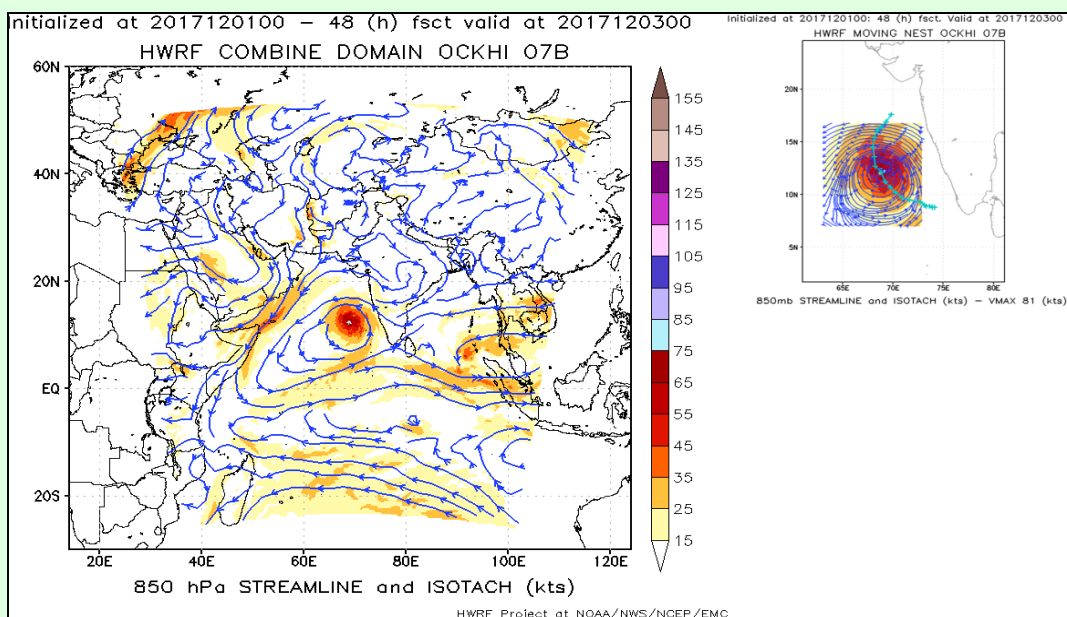


Fig. 7. IMD HWRf combine domain 48 hour forecast valid at 0000 UTC of 3 December initialized at 0000 UTC of 1 December. The inset figure in the picture shows the forecast for inner moving nest.

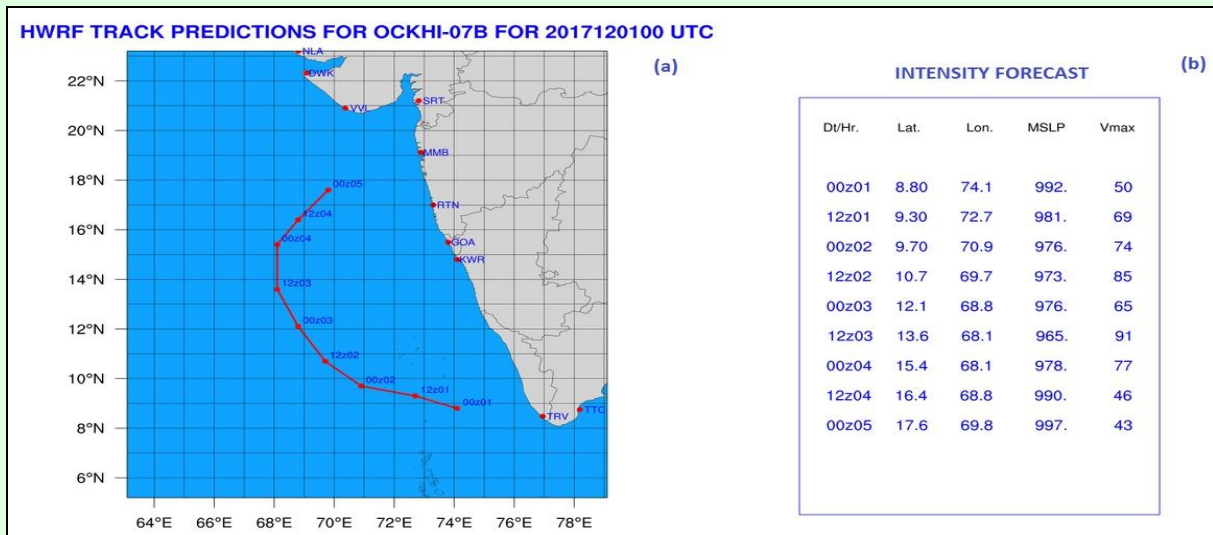


Fig. 8(a&b). IMD HWRf track forecast for 4 days initialized at 0000 UTC of 1 Dec (a) track (b) intensity in knots

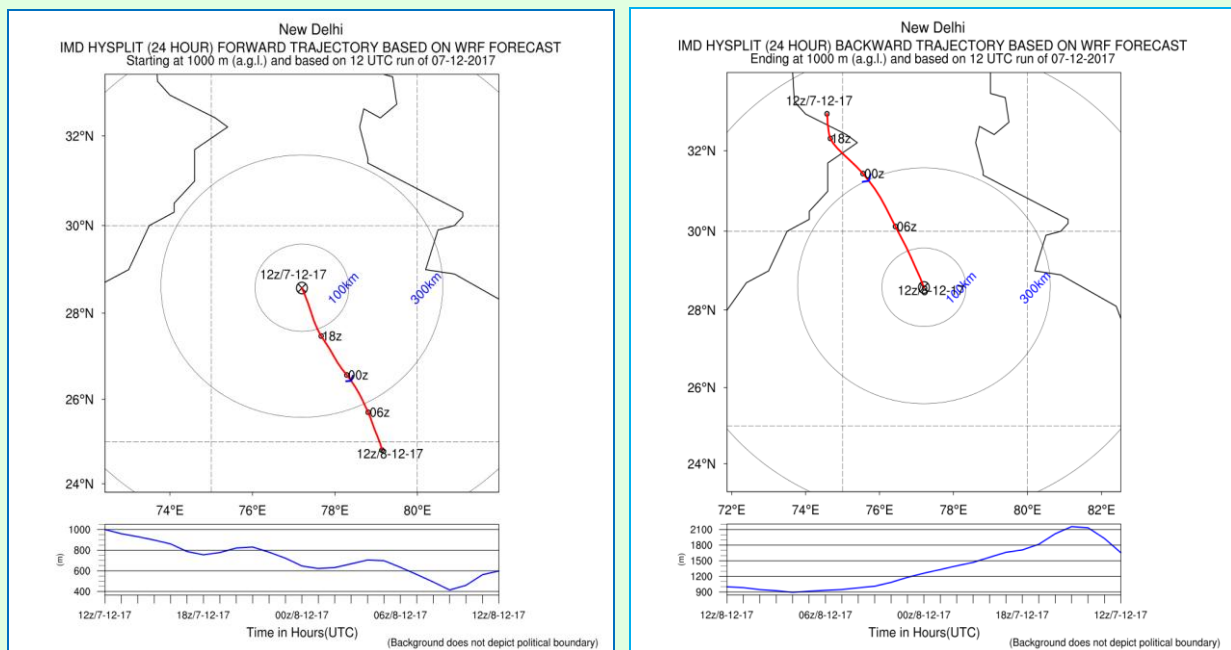


Fig. 9. The forward and backward trajectories respectively over Delhi forcing the model with meteorological input from WRF hourly forecasts based on the initial condition at 0000 UTC of 7 December, 2017

(iii) The triple nested (18, 6 and 2 km) version (v3.8a) of Hurricane WRF (HWRf) model has been run operationally implemented with three dimensional ensemble variational (3D-EnVar) assimilation in 0600 hourly cyclic-mode for the forecasting of cyclone over North Indian Ocean. Recently, the model predicted the track and intensity during the cyclone Ockhi in the Arabian Sea from 30 November to 5 December 2017. The Fig. 7 shows the 48 hours forecast of HWRf based on the initial condition at 0000 UTC of 01 December 2017. Fig. 8(a&b) show the track and intensity

forecast of the cyclone for 4 days respectively based on same initial time.

The HYSPLIT model for the forecasting of trajectories of tracer particle from different cities of India has been operationally implemented during this year before winter. For example, the Fig. 9(a&b) are representing the forward and backward trajectories respectively over Delhi forcing the model with meteorological input from WRF hourly forecasts based on the initial condition at 0000 UTC of 7 December, 2017.

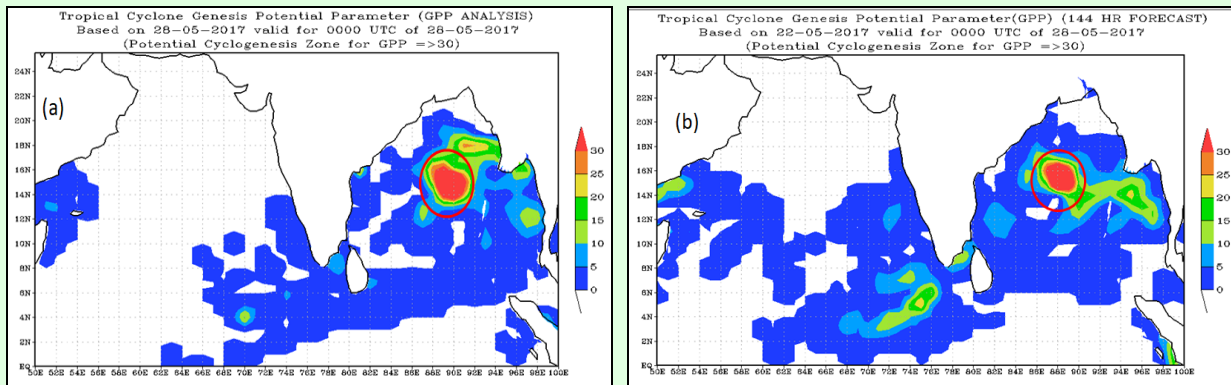


Fig. 10. Analysis and Predicted GPP for the cyclone MORA

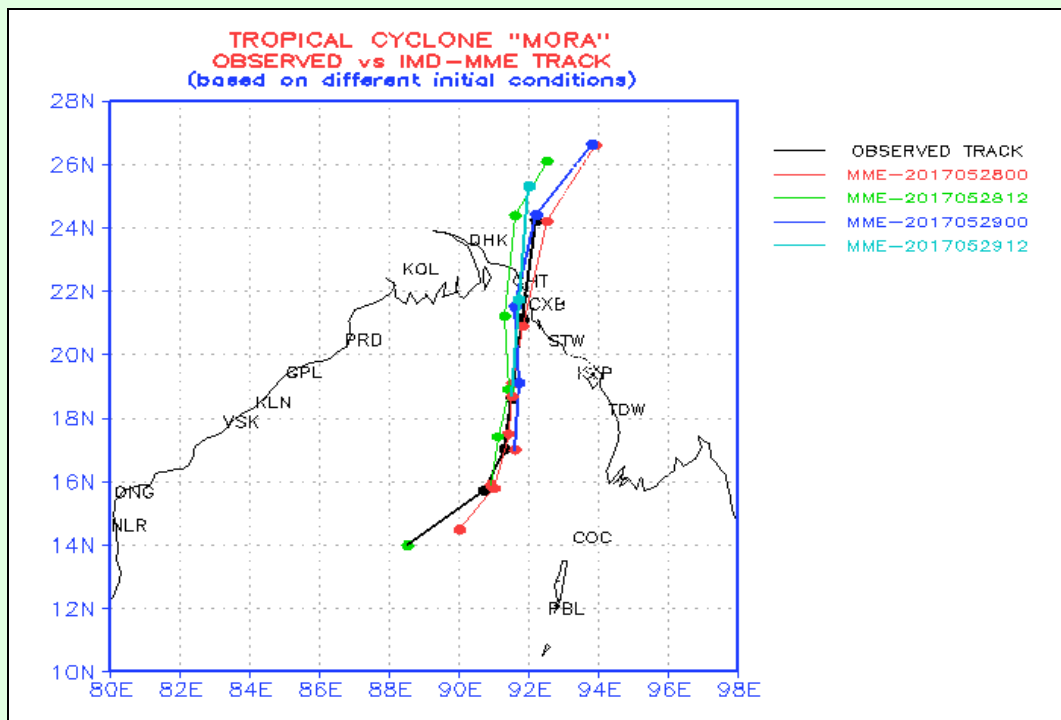


Fig. 11. MME forecast tracks versus Observed track for cyclone MORA

(iv) Genesis and track forecast of tropical cyclone “MORA” using NWP models : Grid point analysis and forecast of GPP is used to identify potential zone of cyclogenesis. For the case of cyclone MORA over the Bay of Bengal during (28-31) May 2017, the analysis Genesis Potential Parameter (GPP) valid for

28th May, 2017 along with the 144 hr forecast GPP based on the initial condition of 22nd May, 2017 indicating the cyclogenesis is shown in the Fig. 10. The corresponding consensus track prediction by MME for cyclone MORA based on different initial conditions along with the observed track is shown in Fig. 11.

CHAPTER 4

OBSERVATIONAL NETWORK

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

4.1. UPPER AIR OBSERVATIONAL NETWORK

Radiosounding Radiowind (RS/RW) network

India Meteorological Department (IMD) has 43 operational Radiosonde radiowind stations in their upper air network (Fig. 1), 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

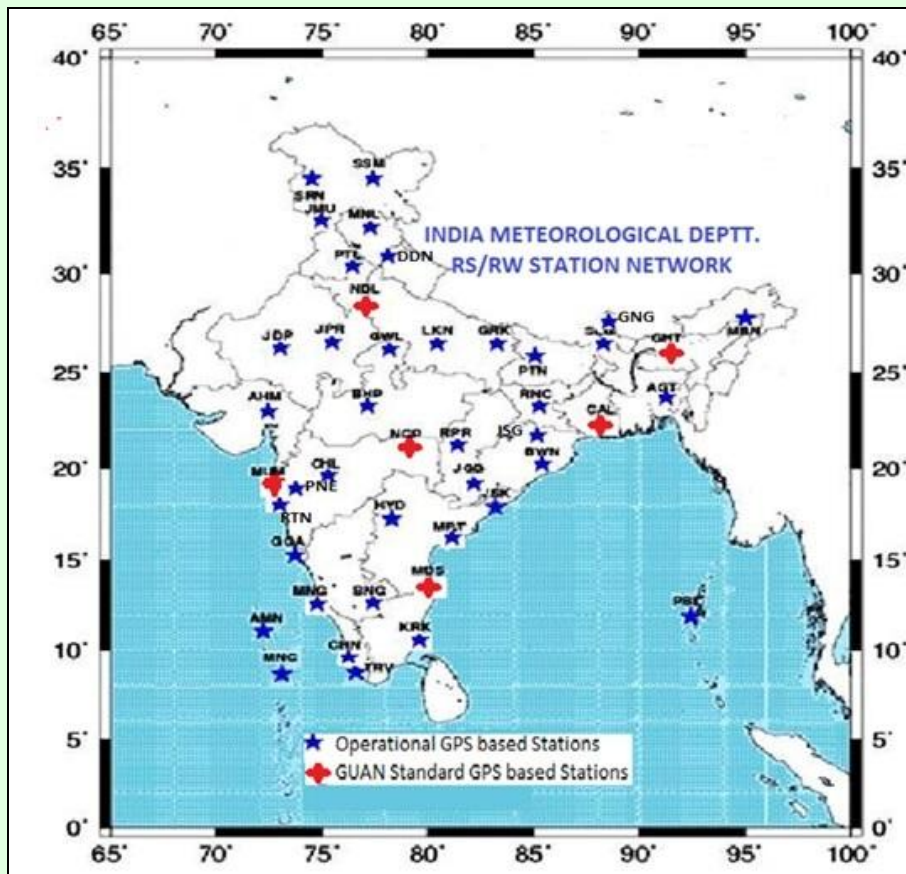
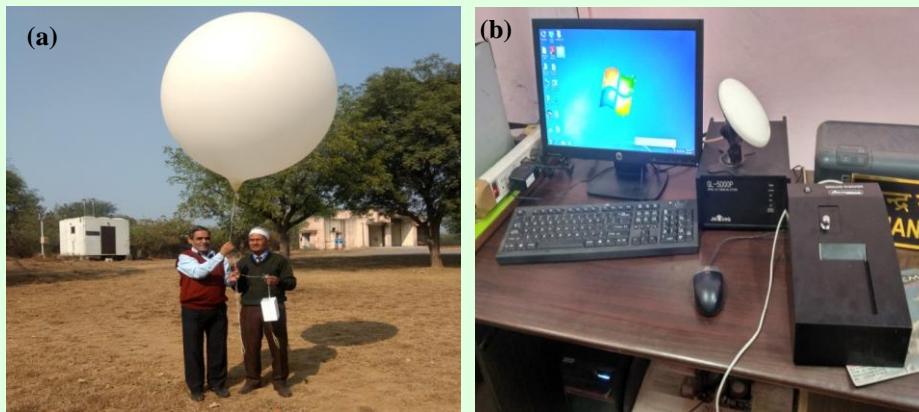


Fig. 1. RS/RW Network of India Meteorological Department



Figs. 2(a&b). (a) Field testing of pilot-sonde at RMO Ayanagar and (b) GPS radiosounding system installation at Patna

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

A. Achievements during the year 2017

(i) 6 Nos. of RS/RW stations namely New Delhi, Mumbai, Kolkata, Chennai, Guwhati and Nagpur equipped with GPS based high quality radiosounding systems (make M/s GRAW Germany) have been inducted into WMO GCOS Upper Air Network (GUAN) network.

(ii) Total network of upper air radiosounding (RS/RW) of 43 stations has been upgraded with GPS based radiosounding systems.

(iii) The production of indigenous GPS based Pilot-sonde has been started in IMD Workshop at New Delhi [Fig. 2(a)] and GPS radiosounding system installation at Patna [Fig. 2(b)].

(iv) Workshop on the *Performance of Upper-air Network of IMD* was held at New Delhi during 4-5 October, 2017. The representatives of all the stations presented the performance of their stations in the workshop. The problems faced by the stations were discussed in details & solutions were also recommended.

(v) Twice a day (0000 and 1200 UTC) radisounding (RS/RW) observations restored at all 43 stations after a long gap.

B. Pilot Balloon (PB) network

62 stations in the upper air network of IMD having pilot balloon observations (Fig. 3). Pilot Balloon Observations are used to measure the upper air profile of wind speed and direction.

Traditionally, the balloon is tracked using Optical Theodolite.

To replace the manual observation with automatic system, the GPS based pilot-sonde system has been developed (Fig. 4). Ground receivers have been obtained from M/s SAMEER, DoIT, GoI. The required pilot-sondes are manufactured in IMD Workshop, New Delhi.

The system has been implemented at RMO Ayanagar on WMO day 2018 and will be

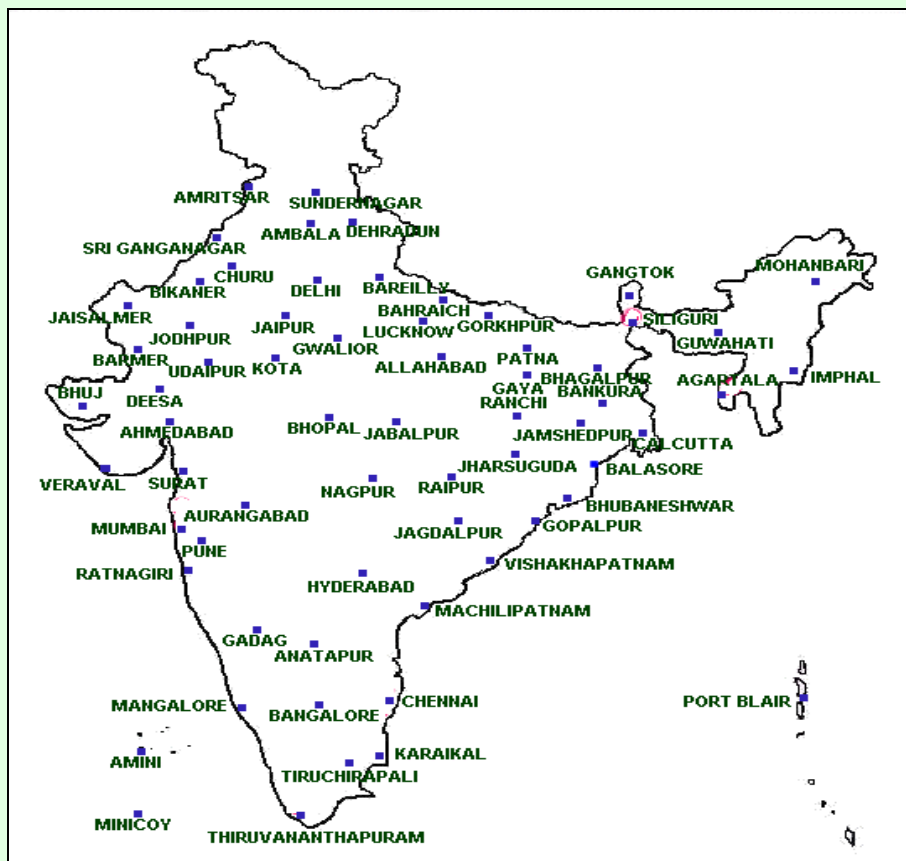


Fig. 3. Upper Air Pilot Balloon (PB) Network of IMD

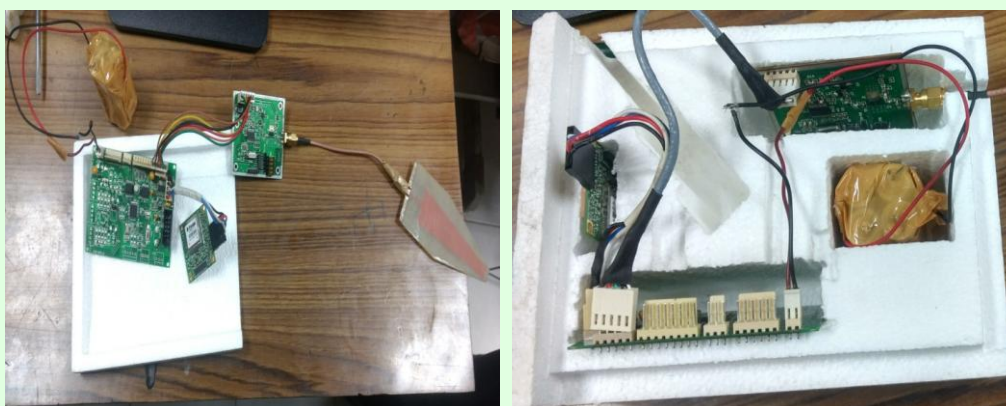


Fig. 4. IMD's Pilot-sonde

introduced at 20 Pilot Balloon (PB) stations in the network during the year.

GPS based pilot-sondes are being procured for 20 stations through rate contract.

C. Future Projects:

- Sustenance of 6 high quality GUAN standard RS/RW stations.
- Expansion of GUAN standard network from 6 to 12 stations.

- Continuation of all 43 RS/RW stations with twice a day ascents.

- Implementation of GPS based pilot-sonde system in the upper air pilot (PB) network.

- 20 PB stations to be up-graded by employing IMD manufactured GPS based PB-sonde.

- 20 PB stations to be up-graded by procuring other GPS based PB-sonde.

4.2. SURFACE OBSERVATIONAL NETWORKS

4.2.1. Improvements and Augmentation of Observational Network

(a) New Installations, sustenance & modernization of surface observatories:

Digital Standard Barometers (200 Nos.) are delivered and installation completed at departmental observatories including major airports across India [Figs. 5(a&b)]. Performances of DSB are satisfactory. All Part Time Observatories will also be equipped with DSB.



Fig. 5(a). Digital station barometer

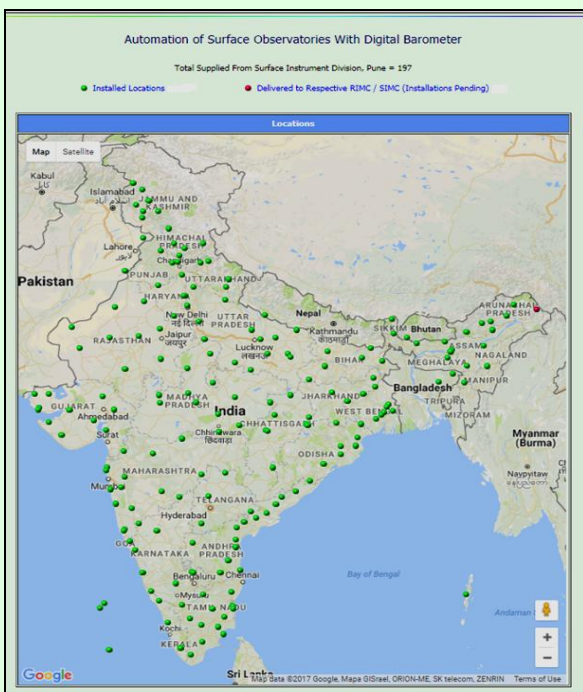


Fig. 5(b). Network of DSB installed in India

Electronic Sunshine recorder

Electronic Sunshine recorder installed during 2017-2018 at Ahmedabad Mumbai, Visakhapatnam and Kolkata [Figs. 6(a&b)].



Fig. 6(a&b). Installation of electronic sunshine recorder at (a) Kolkata (b) Vishakhapatnam

New Installation and Up-gradation of Airport Instruments

The new installation and up-gradation of airport instruments during April 2017 to March 2018 are shown in Table 1.

TABLE 1

List of New installation and upgradation of airport instruments

S. No.	Station	System Installed
1	Shirdi	CWIS
2	Ludhiana	DIWE
3	Gondhia	CWIS
4	Digha, Gopalpur, Paradip	HWSR
5	Imphal	DIWE
6	Dimapur	DIWE
7	Mangalore	AWOS
8	Rohini Heliport	CWIS
9	AMO Kolkata	DRISHTI-2NOS.
10	Begumpet, Hyderabad	CWIS upgradation
11	Port Blair	HWSR
12	Nagpur	DIWE
13	Gaya	DIWE
14	Ajmer	CWIS
15	Pantnagar	DIWE
16	Bangalore	DRISHTI-2NOS.
17	Jalgaon	Portable kit (PRESSURE +ATRH)
18	Kolhapur	PORTABLE KIT (Pressure +ATRH)
19	IGI Delhi	DRISHTI upgradation
20	EMRC, Delhi	Surface OZONE upgradation
21	RMC Nagpur	Surface OZONE system upgradation
22	Antartica	Supplied new instruments
23	Pondicherry	DIWE

The CWIS data logger at filed site is based on open architecture (real time Linux) and is modular in design (Fig. 7). It is scalable in terms of input and output channels and measurement and sampling requirements of end users. Third party GPRS modem can be interfaced with the logger. The data logger configuration can be done Over The Air (OTA). The data are stored in accordance with ICAO regulations. Dew Point temperature, QNH and QFE are also derived and stored. The data transmitted from multiple field systems installed along the runway are received in a desktop computer (Data Acquisition PC) in MBR/ATC via wireless or cable communication mode. DIWE System shown in Fig. 8.



Fig. 7. CWIS data logger



Fig. 8. DIWE System

Drishiti System

Drishiti AWOS installed at Mangalore, Bhubaneswar and Drishiti Transmissometer system installed at Bangaluru and Kolkata airports (Fig. 9). These systems are developed indigenously by CSIR-NAL.



Fig. 9. DRISHTI system installed at Kolkata airport

Laser Ceilometers

Repaired and refurbished Laser Ceilometers – 8 Nos. have been received and tested at Surface Instruments Division, Climate Research and Services, IMD, Pune (Fig. 10). These systems will be installed at 8 airports.



Fig. 10. Laser ceilometers

Portable Travelling Standard Kit

The demonstration of travelling standard kit by Microstep co. pvt. Ltd. is shown in Fig. 11(a) & travelling standard kit is shown in Fig. 11(b).



Fig. 11(a). Demonstration of travelling standard kit by Microstep co. pvt. Ltd.



Fig. 11(b). Travelling standard kit

Data logger supplied and Installed to all RMC

The data logger supplied and installed to all RMC are shown in Table 2.

TABLE 2

List of Data loggers supplied to various RMC

RMC	Data logger supplied	Data logger installed
RMC Mumbai	40	11
RMC Nagpur	27	26
RMC Kolkata	50	47
RMC Guwahati	25	24
RMC Chennai	60	60
RMC Delhi	95	73
CRS Pune	3	1
Total	300	242

Installation of AWS and training in maintenance of AWS at MC Raipur

Installation of AWS and training in maintenance of AWS was organized at MC, Raipur (Fig. 12)



Figs. 12. AWS site Installation and AWS data logger

4.3. SATELLITE OBSERVATIONS

Atmospheric Observations and Services

The meteorological satellite data of INSAT series of satellites (Kalpana-1, INSAT-3D, & INSAT-3DR), is received, processed and disseminated by INSAT Meteorological Data Processing System (IMDPS) at India Meteorological Department (IMD) which was dedicated to the nation by the Hon'ble Minister of Science and Technology, Ministry of Earth Sciences on 15 January 2014. The performance of the system during the current year has been maintained to the level of 98.5% operation efficiency (24x365 bases). The output generated by the system is used for efficient and successful forecasting the major weather events such as Fog, Thunder Storm and cyclones. The satellite data is assimilated in Numerical Weather Prediction Models, the output which further used to issue short range and medium range weather forecast.

At present, there are three operational satellites *i.e.*, Kalpana-1 (VHRR, DRT), and INSAT-3D (Imager, Sounder, DRT) and INSAT-3DR (Imager, Sounder, DRT) carrying meteorological payloads are supporting weather forecasting services. INSAT-3DR was launched successfully on 8th September 2016 by GSLV - F05 and placed at 74 degree east in place of Kalpana-1 which has been shifted at 73.2 degree east. INSAT-3DR similar to INSAT-3D, is an advanced meteorological satellite of India configured with an imaging System and an Atmospheric Sounder. INSAT-3DR carries a multi spectral Imager, 19 channel Sounder, Data Relay Transponder and Search and Rescue Transponder payloads.

IMD is in action to establish Multi-Mission Meteorological Data Receiving and Processing System (MMDRPS) for INSAT-3D, INSAT-3DR and INSAT-3DS in collaboration with M/s Antrix Corporation Ltd, ISRO for which an MOU has been signed between IMD and ISRO on 6th March 2017. The project is being monitored closely for implementation. At

present the processed data of INSAT-3DR Imager and Sounder is being obtained from SAC, Ahmedabad through dedicated NKN connectivity and images generated at IMDPS and are disseminated on IMD website on real time basis.

Modified scan strategy of INSAT-3D and INSAT-3DR sounder payload has been implemented with effect from 12.08.2017. INDIAN region sector data is now available on hourly basis and Ocean region data is available on one and half hourly basis. Finalization and successful testing of rapid/Super-rapid Scan Scenario of Imager of INSAT-3DR in operational chain. Finalization of BUFR format of MT-ROSA Profile data and its dissemination on GTS since last week of September 2017.

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), wind derived products (vorticity, convergence, divergence wind shear and shear tendency), Sea Surface temperature, Outgoing Long-wave radiation, Land Surface Temperature (LST), Insolation, Quantitative Precipitation Estimates (Three hourly accumulated Global precipitation index, INSAT multispectral rain fall and Hydro estimator), Night time Fog, Smoke, Fire, Snow Cover, Aerosol Optical Depth, Upper Tropospheric Humidity, cloud top pressure and temperature using Imager data, Temperature & Humidity profiles, Total ozone, Total/Layer Precipitable Water Vapour, Stability Indices 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. Generation of special sector images like Mata Vaishnodevi Shrine, Amarnathji Yatra, Cyclone (BD and NHC Cyclone Enhancement Imagery), Fog, special sector for Nepal etc during Cyclone, Monsoon, squall, launch of new satellites by ISRO. Successful implement of generation of new high-resolution Aviation Sector images, new high-resolution images with district boundaries for Char Dham yatra routes.

The validation of atmospheric Motion Vector (wind products), sea surface temperature, Outgoing Long wave Radiations (OLR) vertical Profile of temperature and humidity has been carried out for the period of November 2016 to December 2017 and the feedback are used for fine tuning of algorithm of these products and calibration coefficients.

A joint calibration/validation (Cal/Val) campaign 7-9 February 2017 was carried out successfully at Runn of Kutch, Gujarat by IMD and SAC (ISRO). A joint report of Cal/Val campaign results has been prepared and site has been accepted for conducting regular Cal/Val campaign for INSAT-3D/3DR Cal/Val.

Satellite Application unit has successfully monitored the cyclones Marutha April 2017 Mora May 2017 and Ockhi December 2017 and special bulletins provided to the forecasters regarding center and intensity of cyclone using Advanced Dwork Technique (ADT) software customized for INSAT-3D satellite data.

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 HRIT/LRIT 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. 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.

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.

Software for forecasting and tracking of evaluation of cloud cluster acquired from National Institute for Space Research/ Centre for Weather Forecast and Climate Studies (INPE//CPTEC), Brazil has been customized for INSAT-3D and operationalized.

It is stated that satellite technology is of great use in meteorology and plays a very significant role in the improvement of weather forecasting and dissemination. In fact the improvement in weather forecasting is mainly attributed to increasing use of satellite data.

4.4. 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 and related physical characteristics of the atmosphere and their trends, required to improve understanding of the behavior 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 including Maitri and Bharati in Antarctica.

- Total Columnar ozone measurement using Brewer and Dobson spectrometer at five locations.
- Surface Ozone monitoring through a network of ten stations (Fig. 13).
- Measurement of Vertical Distribution of Ozone using IMD Ozonesonde.



Fig. 13. Ozone monitoring network

Precipitation and Particulate Matter Chemistry Monitoring

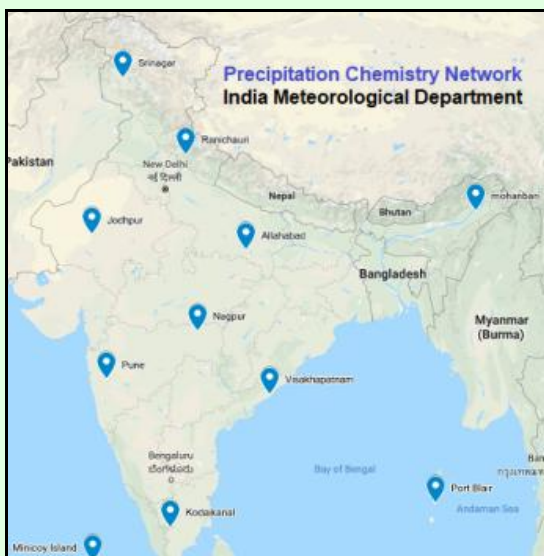


Fig. 14. Precipitation chemistry network

IMD is monitoring Precipitation Chemistry through a network of eleven stations since 1970s (Fig. 14). The rainwater samples collected from these stations are analyzed in Precipitation Chemistry Laboratory at IMD, Pune which is equipped with Ion-chromatograph, UV-VIS Spectrophotometer, Atomic Absorption Spectrophotometer, Semi-micro Balance, pH and Conductivity Meter. High Volume Samplers for collecting PM₁₀, PM_{2.5} and Total Suspended Particulate Matter (TSP) have been installed at Delhi, Ranichauri, Pune and Varanasi. The filter papers are being analyzed for chemical characterization of aerosols.

Aerosol Monitoring Network

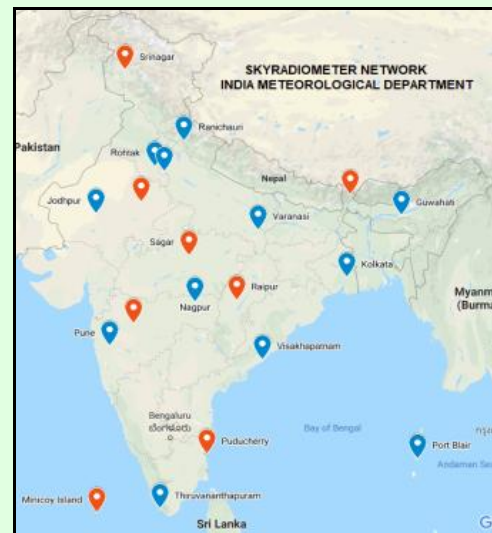


Fig. 15. Skyradiometer network of IMD

Environment Monitoring and Research Center, India Meteorological Department has established Aerosol Monitoring Network by installing skyradiometer at twelve locations (Fig. 15). The network is used to measure optical properties of aerosols such as Aerosol Optical Depth, Single Scattering Albedo, Size Distribution, Phase Function etc. The Network has been expanded during 2017-18 by adding 8 more stations.

Black Carbon Monitoring Network

Black Carbon Monitoring Network of 16 stations for measurement of Spectral Aerosol Absorption Coefficient, Equivalent Black

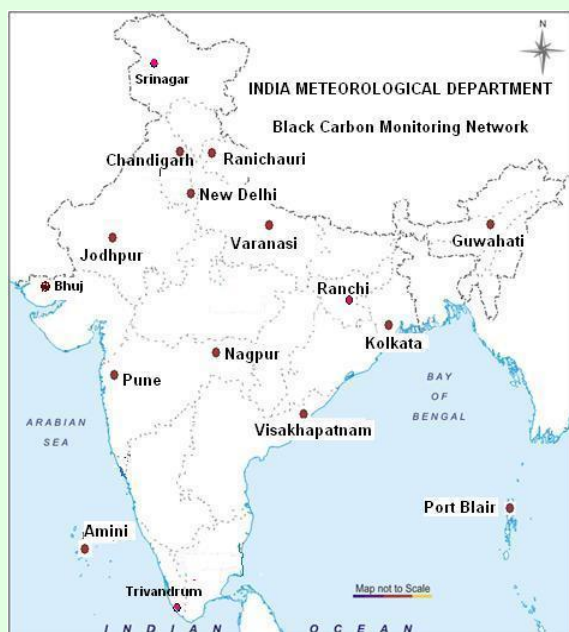


Fig. 16. Black carbon monitoring network

Carbon Concentration and bio-mass burning component has been established during 2016. The network is being expanded during 2018 by including nine more stations (Fig. 16).

Multi-wavelength Integrating Nephelometer Network

IMD has established a network for measurement of aerosol scattering coefficient at twelve locations is under installation. The network stations are: New Delhi, Ranichauri, Varanasi, Nagpur, Pune, Port Blair, Visakhapatnam, Guwahati, Kolkata, Jodhpur, Bhuj, Thiruvananthpuram.

System for Air quality Forecasting And Research (SAFAR)

The System for Air quality Forecasting And Research (SAFAR) has been operationalized by IMD 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 ($PM_{2.5}$, PM_{10} , Ozone, CO, NO_x (NO, NO₂), SO₂, BC, Methane (CH₄), Non-methane hydrocarbons (NMHC), VOC's, Benzene, Mercury), solar radiation and meteorological parameters are measured at ten air quality station installed in each city. SAFAR provides

location specific information on air quality in near real time and its forecast 1-3 days in advance.

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 this 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. 17). The observations vertical profile of ozone is also carried out at Bharati regularly (Fig. 18). Polar WRF model is implemented to provide day-to-day short range (48 hours) weather forecast for the Maitri and Bharati region in the Antarctica. The NWP products are routinely made available on the IMD web site in support of Antarctic Expedition.



Fig. 17. Meteorological Observatory at Bharati



Fig. 18. Launch of Ozonesonde at Bharati

minutes ahead at 30 minute intervals, was additionally installed at MC Srinagar. With this a total of ten stations (including the above and RMC Chennai, RMC Delhi and MC Hyderabad) have automatic nowcasting of Thunderstorm occurrence and movement for a 250 km domain around the respective Doppler radar location. This information is uploaded at ten minute intervals at the various MC websites on real time basis. Fig. 23 shows IMD WDSS-II reflectivity forecast for Chandigarh and Jaipur.

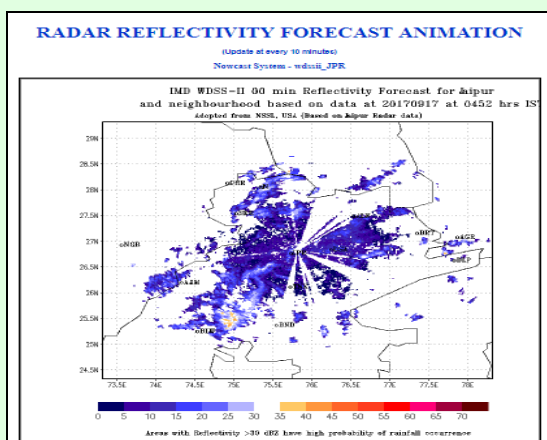
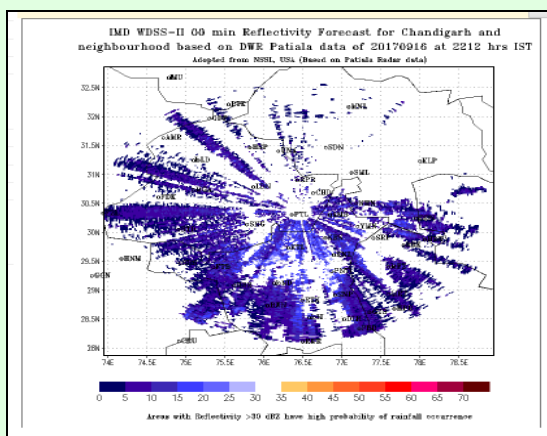


Fig. 23. IMD WDSS-II reflectivity forecast for Chandigarh and Jaipur

C. STORM Forecast Demonstration Project-2017

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.

Broad objectives of the FDP STORM can be put forward as follows:

To understand the genesis, development and propagation of severe thunderstorms.

To enhance the knowledge of dynamical and thermo-dynamical structure and the role of micro-physical processes on intensification of these severe storms.

To study the behaviours of atmospheric electrification during intensification of these storms and their interaction with cloud microphysical processes.

Development/customization of mesoscale prediction systems with improved forecast skill for prediction of these severe thunderstorms.

The programme was started in 2009 & STORM Field Experiments were conducted jointly in Bangladesh, Bhutan, east and northeast India and Nepal under the name SAARC STORM Programme. In 2012, Afghanistan, Northwest India and Pakistan were also included under this programme to focus on deep convective moist and dry storms over these areas and in 2013 STORM field experiments were also conducted in Southern Peninsular India, Maldives and Sri Lanka to study maritime and continental convective storms during pre-monsoon season and thus whole India was covered under FDP STORM. Since then, the project is being conducted successfully every year during pre-monsoon season. 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 6 March to 30 June, 2017.

Under this project, FDP Bulletins were issued twice a day, *i.e.*, normal bulletin based on 0300 UTC observations by 1330 hrs IST and updated one in the evening. The FDP Bulletin consists of four sections:

1. Current Synoptic situations and cloud description over India,
2. NWP model Guidance from IMD GFS, IMD WRF and NCUM (NCMRWF) Models,
3. Summary of 1 & 2 above and
4. Intensive Observation Period 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 117 FDP Bulletins were issued during the STORM Period-2017.

D. Nowcast Guidance Bulletins

In addition to FDP Bulletins during March to June-2017, Nowcast Guidance Bulletin containing current Synoptic features, Radar and Satellite (RAPID) inferences and depicting potential areas for Severe Weather (Heavy Rainfall/Thunderstorm & Associated Phenomenon/Fog) for next 24 hours, in text as well as visual form are issued once/twice (if needed) a day which 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 and issue Nowcast Bulletins if necessary.

E. All India Thunderstorm Nowcast

Nowcasting of Severe Weather (thunderstorms, squalls and hailstorms, heavy

rainfall etc.) has benefited from the recent improvement in monitoring and 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 and (v) availability of mesoscale models, (vi) computational and 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 under whose jurisdiction these stations are situated. This year, with the operationalization of DWR Goa & Thiruvananthapuram, four new domains were created under MC Thiruvananthapuram, MC Bengaluru, MC Goa and CWC Visakhapatnam for issuing three hourly Nowcast for Severe Weather for selected places in Kerala, Karnataka, Goa & Coastal Andhra Pradesh respectively. Also nowcast for some additional district headquarters under some existing nowcast domains was started and 177 new stations were added on All India Nowcast Warning page of IMD website till March, 2018, thereby, increasing the total number of nowcast stations to 378. At present there are 20 Nowcast Domains/Centres (RMC/ RWFC/ MC/ CWC). Considering the importance and reliability of DWR based information for

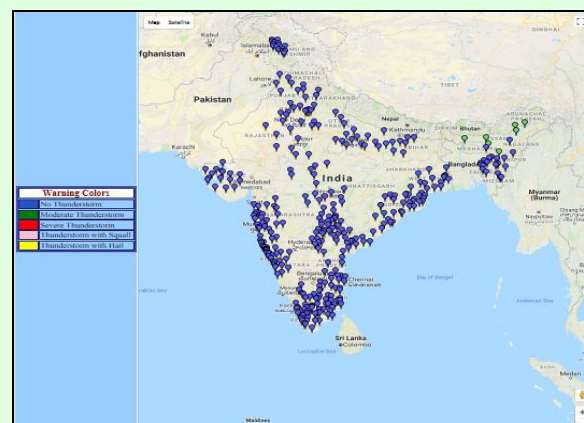


Fig. 24. Screenshot of Three hourly Thunderstorm Nowcast Warning Page on IMD website

nowcast of severe weather it is planned to included all district headquarters/major towns/tourist places which come under the coverage of any DWR (with in approx. 250 km) for nowcasting of severe weather by the end of this year. Fig. 24 depicts the screen shot of Nowcast Warning Page on IMD website.

F. Verification of IOPs/TS Nowcast-2017

(i) FDP Bulletins

The thunderstorm and rainfall forecast issued for 24 hours in FDP bulletins were verified with realised thunderstorm and rainfall data. The verification results for thunderstorm forecast are shown in Table 3 and graphically by Fig. 25, while verification results for various forecasted rainfall categories are given in Table 4 and graphically by Fig. 26.

TABLE 3

Skill Scores for Thunderstorm Verification for STORM Period - 2017

Skill Scores	March	April	May	June	Season
RATIO SCORE	0.81	0.80	0.73	0.57	0.73
POD	0.33	0.66	0.67	0.39	0.53
FAR	0.30	0.21	0.14	0.07	0.15
CSI	0.29	0.57	0.61	0.38	0.49
ETS	0.21	0.40	0.30	0.14	0.29

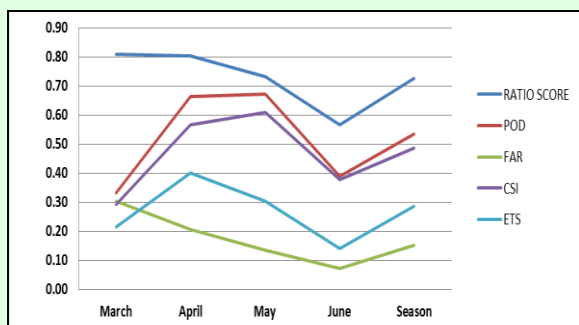


Fig. 25. TS Verification Scores for March to June & entire season during STORM Period-2017

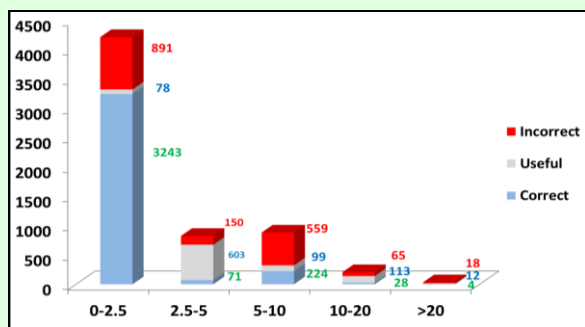


Fig. 26. Category-wise Rainfall Verification for STORM Period-2017 (March to June)

TABLE 4

Category wise rainfall verification for STORM Period-2017 (March to June)

Rainfall Category (cm)	Out by one range		Out by two or more range
	Correct	Useful	Incorrect
0-2.5	3243	78	891
2.5-5	71	603	150
5-10	224	99	559
10-20	28	113	65
>20	4	12	18
Total	3570	905	1683

(ii) Three Hourly Thunderstorm Nowcast:

Figs. (27-31) indicate respectively the Ratio Score, FAR, POD, ETS and CSI of Nowcast issued by various RMCs/ MCs during year-2017 and Fig. 32 indicates All India Scores of the same.

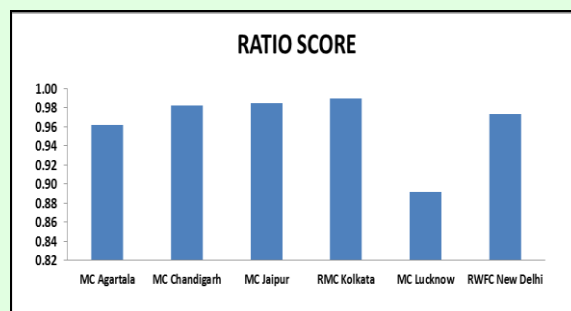


Fig. 27. MC-wise Ratio Score of Three Hourly Nowcast Verification-2017

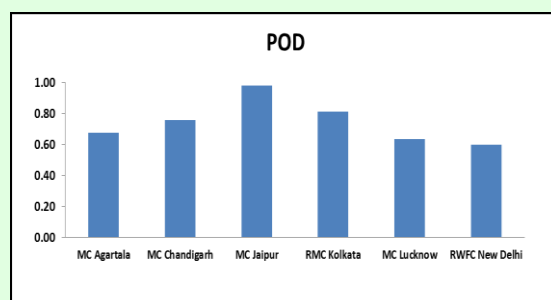


Fig. 28. MC-wise Probability of Detection score of Three Hourly Nowcast Verification-2017

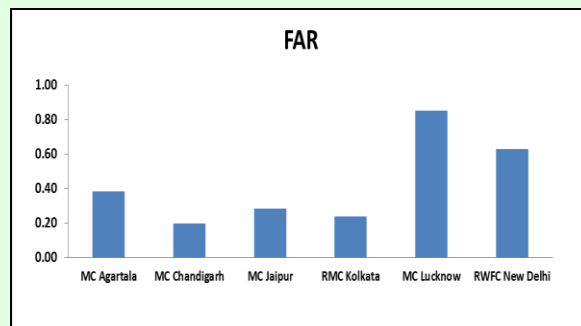


Fig. 29. MC-wise False Alarm Ratio of Three Hourly Nowcast Verification-2017

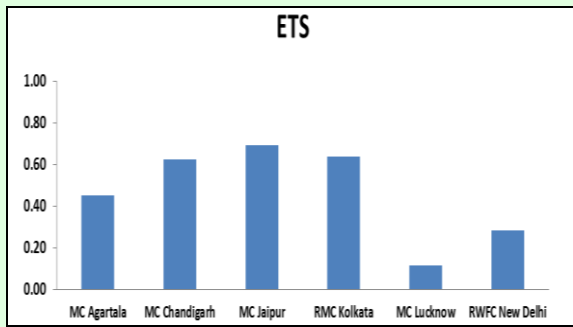


Fig. 30. MC-wise Equitable Threat Score of Three Hourly Nowcast Verification-2017

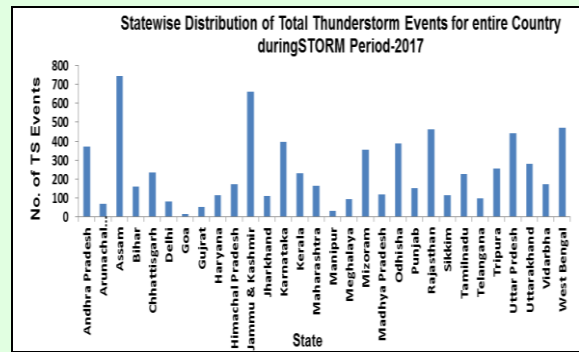


Fig. 34. Statewise distribution of thunderstorm events over the country during Storm Period-2017

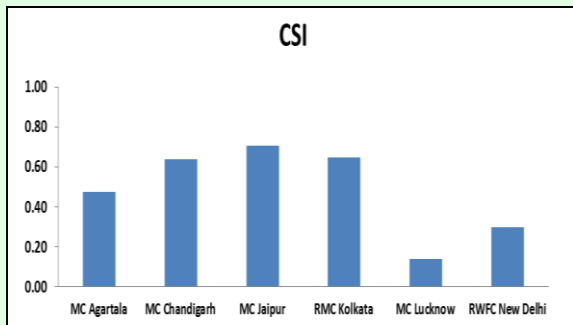


Fig. 31. MC-wise Critical Success Index in respect of various RMCs/MCs

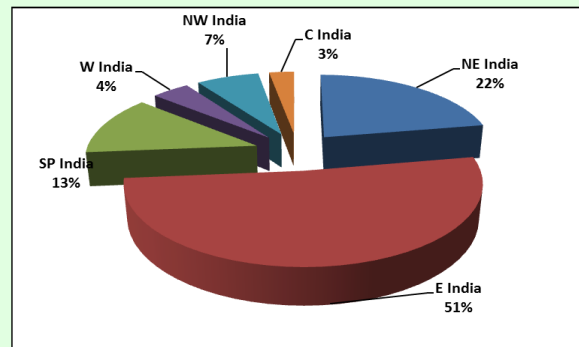


Fig. 35. Regionwise distribution of thundersquall events over the country during entire Storm Period-2017

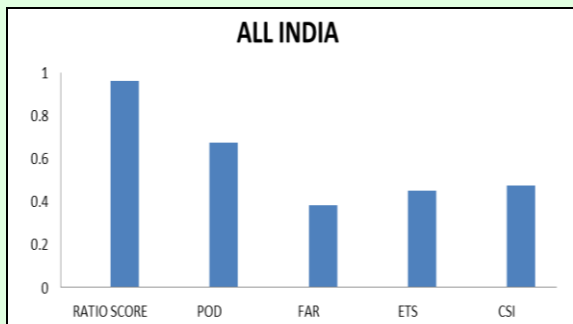


Fig. 32. All India Nowcast Verification Scores-2017

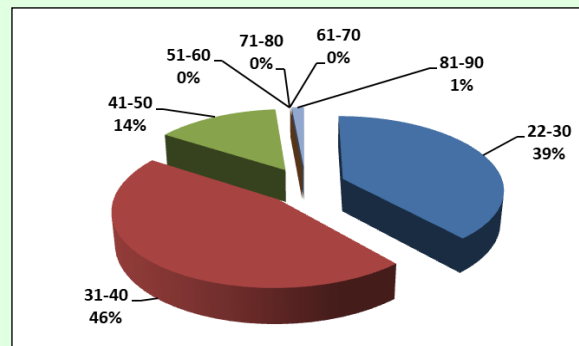


Fig. 36. Distribution of thunder squalls over the country based upon max wind speed (Kt) during Storm Period-2017

G. STORM Report-2017

This year also, a detailed Storm Report document is being prepared by Nowcast Division. It contains information on daily weather situation, important weather charts,

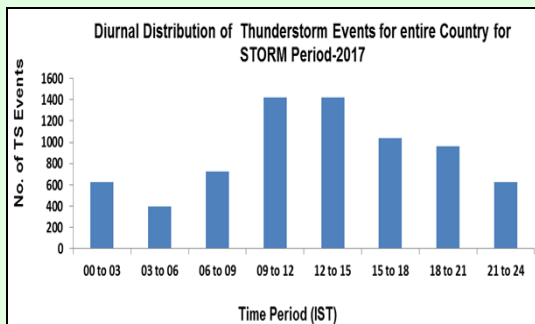


Fig. 33. Diurnal distribution of TS events over the country during Storm Period-2017

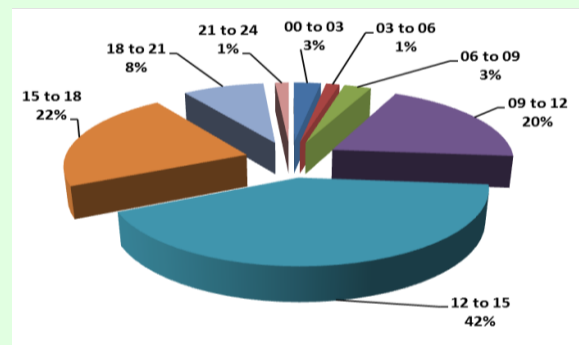


Fig. 37. Diurnal distribution of thunder squalls during Storm Period-2017

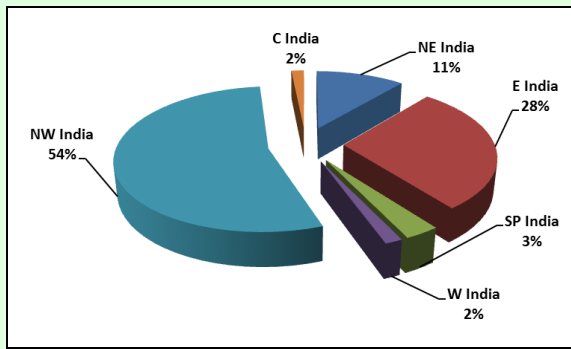


Fig. 38. Regionwise distribution of hailstorm events during Storm Period-2017

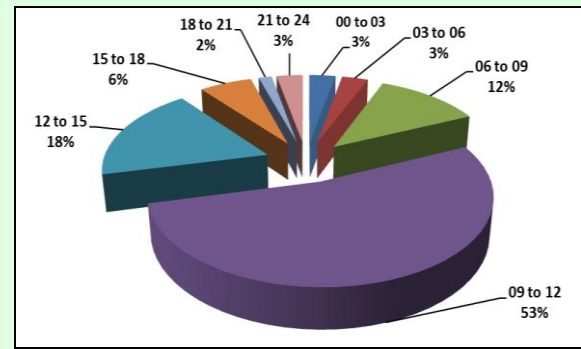


Fig. 39. Diurnal Distribution of Hailstorm Events over the Country during entire Storm Period-2017

severe weather events all through the campaign period, case studies and the bulletins issued during the period. The report

is expected to be completed and published soon. Figs. (33-39) represent some of the important results of the Storm Report-2017.

CHAPTER 5

WEATHER AND CLIMATE SERVICES OF IMD

5.1. HYDROMET SERVICES

The Hydro-meteorological Division is providing the necessary technical and operational support to various Central/State Govt. organization and other agencies in the field of hydro met design, flood forecasting, rainfall monitoring for water management and agricultural planning purposes etc.

Major Services

Design storm Estimates

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. For Govt. agencies, these studies are being carried out and supplied free of cost where as for private / profit earning agencies on payment basis. The project reports containing the design storm studies are being sent in respect of the projects on payment basis.

During the year 2017, design storm studies of thirty seven (37) projects have been completed and results communicated to the concerned project authorities. An amount of Rs.10,43,623/- (Rupees ten lakh forty three thousand six hundred twenty three only) has been deposited in IMD's A/c for carrying out

the design storm studies in respect of projects received from private/profit earning agencies. The Probable Maximum Precipitation (PMP) Atlas for Krishna Basin has been published by the division which is a very important input for design engineers for any construction of hydraulic structures in this basin area.

Rainfall Monitoring

Hydromet Division brings out real-time rainfall summary every week from Thursday to Wednesday and also for months. During Monsoon season, the same is prepared on daily basis for 660 Districts, 36 Met. Sub Divisions, 36 States including UTs, 4 Regions and for the country as a whole. Besides this, rainfall statistics is also prepared for **61 selected River basins** of India and the maps are uploaded on IMD website. The Unit also brings out updated monthly, seasonal and annual rainfall statistics after incorporating the late receipt data. Rainfall Monitoring Unit also publishes Annual Rainfall Report.

The rainfall summary is used by various stake holders for multiple purposes like Agricultural planning and advisories, Crop yield forecast, Agricultural pricing, Estimation of irrigation requirements, Relief measures, Hydro-power Planning and many other economical and research activities.

Recipients of rainfall statistics include higher authorities like Office of Hon. Prime minister, Secretary MoES etc.

Updated rainfall statistics for the Annual rainfall - 2017 was prepared. The rainfall for the country as a whole for the annual rainfall has been recorded as 1127.1 mm against the normal rainfall for the annual as 1187.6 mm (departure -05%). In all, 3 met sub-divisions

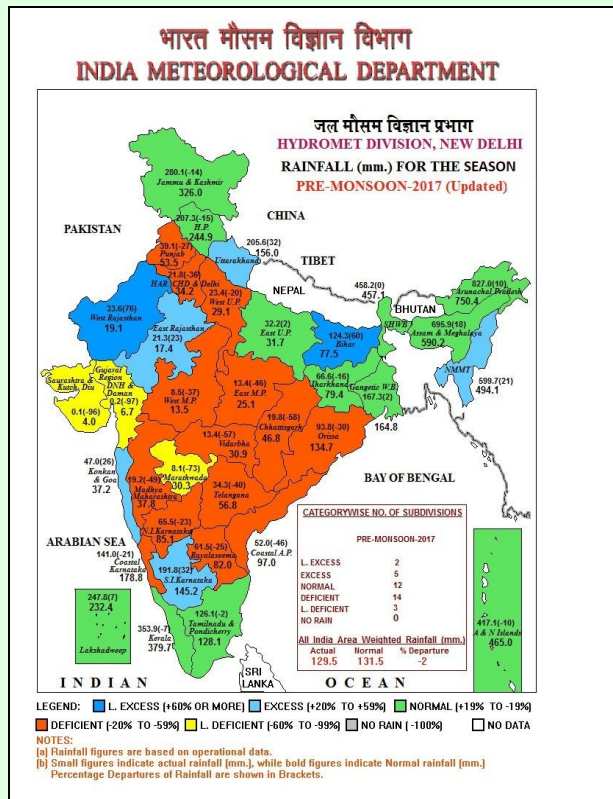
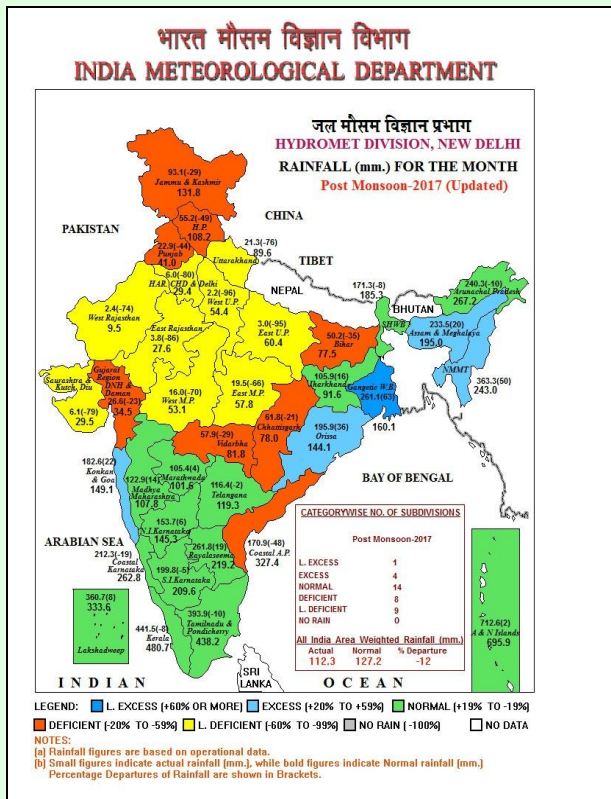
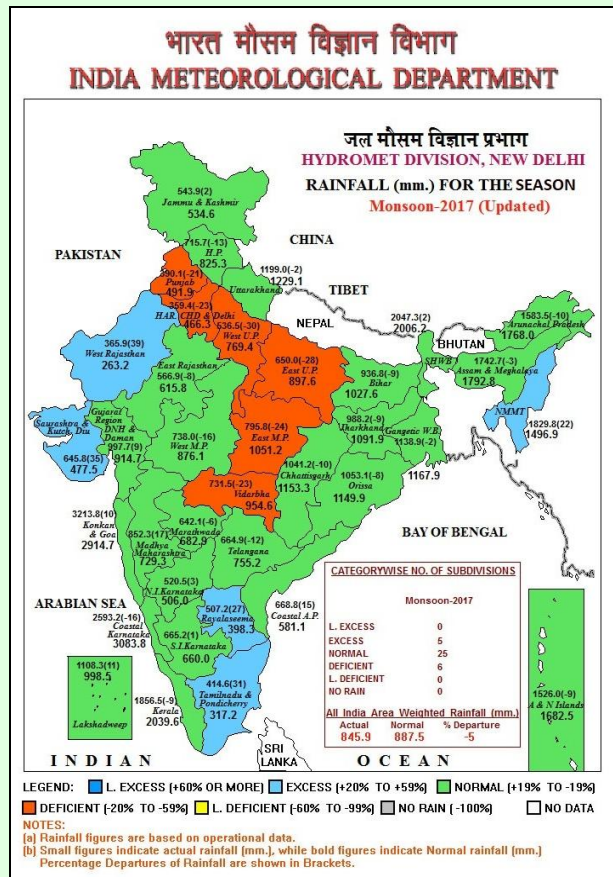
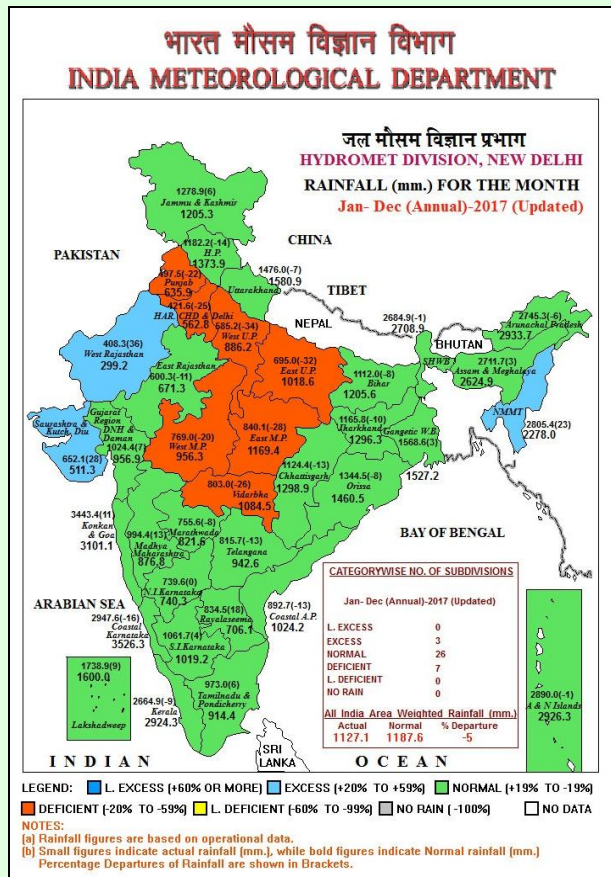


Fig. 1. Subdivision-wise rainfall map of India during 2017

remained in category of Excess rainfall, 26 in Normal and 7 in Deficient rainfall. The

subdivision-wise real-time rainfall map for the annual, 2017 is shown in Fig. 1 & Table 1.

TABLE 1

Subdivision-wise rainfall (mm) distribution

S. No.	Meteorological Sub-divisions	Annual Actual	Jan-Dec, 2017		
			Normal	% Dep.	Cat.
EAST & NORTH EAST INDIA		2061.2	2037.8	1%	
1.	Arunachal Pradesh	2745.3	2933.7	-6%	N
2.	Assam & Meghalaya	2711.7	2624.9	3%	N
3.	N M M T	2805.4	2278.0	23%	E
4.	SHWB & Sikkim	2684.9	2708.9	-1%	N
5.	Gangetic West Bengal	1568.6	1527.2	3%	N
6.	Jharkhand	1165.8	1296.3	-10%	N
7.	Bihar	1112.0	1205.6	-8%	N
NORTH WEST INDIA		787.9	866.9	-9%	
1.	East U.P.	695.0	1018.6	-32%	D
2.	West U.P.	585.2	886.2	-34%	D
3.	Uttarakhand	1476.0	1580.9	-7%	N
4.	Haryana, Chandigarh & Delhi	421.6	562.8	-25%	D
5.	Punjab	497.5	635.9	-22%	D
6.	Himachal Pradesh	1182.2	1373.9	-14%	N
7.	Jammu & Kashmir	1278.9	1205.3	6%	N
8.	West Rajasthan	408.3	299.2	36%	E
9.	East Rajasthan	600.3	671.3	-11%	N
CENTRAL INDIA		1018.5	1111.0	-8%	
1.	Odisha	1344.5	1460.5	-8%	N
2.	West Madhya Pradesh	769.0	956.3	-20%	D
3.	East Madhya Pradesh	840.1	1169.4	-28%	D
4.	Gujarat Region	1024.4	956.9	7%	N
5.	Saurashtra & Kutch	652.1	511.3	28%	E
6.	Konkan & Goa	3443.4	3101.1	11%	N
7.	Madhya Maharashtra	994.4	876.8	13%	N
8.	Marathwada	755.6	821.6	-8%	N
9.	Vidarbha	803.0	1084.5	-26%	D
10.	Chhattisgarh	1124.4	1298.9	-13%	N
SOUTH PENINSULA		1086.3	1128.3	-4%	
1.	A & N Island	2890.0	2926.3	-1%	N
2.	Coastal Andhra Pradesh	892.7	1024.2	-13%	N
3.	Telangana	815.7	942.6	-13%	N
4.	Rayalaseema	834.5	706.1	18%	N
5.	Tamilnadu & Puducherry	973.0	914.4	6%	N
6.	Coastal Karnataka	2947.6	3526.3	-16%	N
7.	N. I. Karnataka	739.6	740.3	0%	N
8.	S. I. Karnataka	1061.7	1019.2	4%	N
9.	Kerala	2664.9	2924.3	-9%	N
10.	Lakshadweep	1738.9	1600.0	9%	N
Country as a whole		1127.1	1187.6	-5%	

Flood Meteorological Service

(i) Sub basin-wise Quantitative Precipitation Estimate for Day-1, Day-2, Day-3, using WRF ARW (9 km x 9 km) based on 0000 UTC & 1200 UTC, MME (0.25° x 0.25°) based on 0000 UTC and Day1 to Day7 using GFS (0.25° x 0.25°) based on 0000 UTC run by IMD are computed

and uploaded on IMD website operationally.

(ii) Hydromet division, New Delhi has customized sub Basin-wise QPF using NWP Model WRF ARW at 0000 & 1200 UTC, MME at 0000 UTC and GFS at 0000 UTC for 21 river sub-basin area (Total 146) which is to be used by FMOs as additional input for formulation of Hydromet/QPF bulletin (Fig. 2).

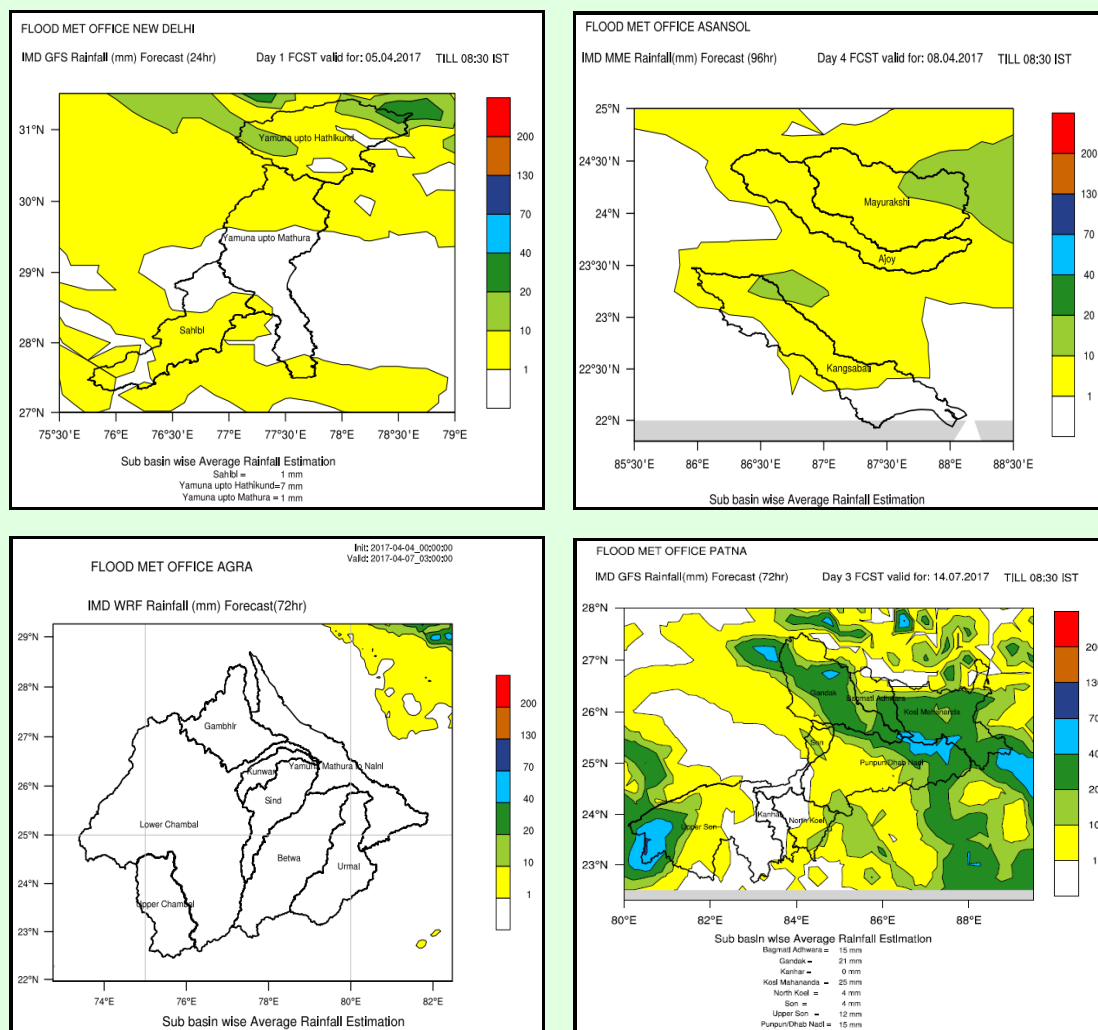


Fig. 2. IMD GFS/WRF Rainfall (mm) forecast

5.2. AGROMETEOROLOGICAL ADVISORIES SERVICES

Dissemination of agromet advisories

Agromet Advisory Services (AAS) under Gramin Krishi MausamSeva (GKMS) scheme:

At present, AAS bulletins are being prepared and issued at district, state and national levels to cater to the needs of users at various levels. 636 district level AAS bulletins are prepared and issued by Agromet Field Units (AMFUs) located in State Agricultural Universities, ICAR institutes, IITs etc. State level AAS bulletins are prepared and issued by 23 State Agromet Centres of IMD and National AAS bulletin is prepared by Agrimet Division. Also, CRIDA, Hyderabad in

collaboration with IMD issues Operational AAS Bulletin based on Extended Range Weather Forecast during monsoon to help farmers to cope with climate risks and uncertainties and effectively use seasonal to inter-annual climate forecasts. During Rabi 2017-18, IMD and CRIDA have started AAS bulletin based on temperature forecast using ERFS.

Dissemination of Agromet Advisories to the farmers through different multi-channel system like All India Radio (AIR) and Doordarshan, private TV and radio channels, newspaper and internet, SMS and IVR (Interactive Voice Response Technology) etc. is being made on wider scale. At present agromet advisories are disseminated through Kisan Portal and private companies PPP mode and to 22.7 million farmers. Also,

weather forecast and advisories under alerts and warnings through SMS enable farmers in planning farming operations effectively to minimise/control damage of crops under adverse weather conditions. In addition to above Crop Specific Weather based Agromet Advisories for the country on daily basis are being telecasted through DD Kisan Channel, on real time in programs like 'Kisan Samachar' and 'Mausam Khabar' in Hindi and Marathi.

Other Activities carried out during the year

1. Farmers Awareness Programme (FAP)

Farmers' awareness programmes were organised at 43 AMFUs across the country during the year. Besides, the Nodal Officers/Technical Officers participated in number of awareness programme and taken active initiatives in popularizing the GKMS. AMFUs also arranged field visits, field

demonstration, farmers' interaction and also participated in Kisan Mela. A graphical representation of the total number of farmers attended the Farmer Awareness Programme at different AMFUs is represented (Fig. 3).

2. On-line reception of Agromet Data

The data received from agromet observatories are scrutinized, archived and supplied to scientists, planners etc. through NDC, Pune. To use the agromet data for operational purpose, Agricultural Meteorology Division, IMD, Pune has developed web (php) based software in collaboration with NIC, Pune for online transmission of agromet data, which is hosted in the website of Agrimet Division. Around 90 AMFU and 60 CWS Agromet observatories have started uploading agromet data on web portal of Agrimet Division (Fig. 4).

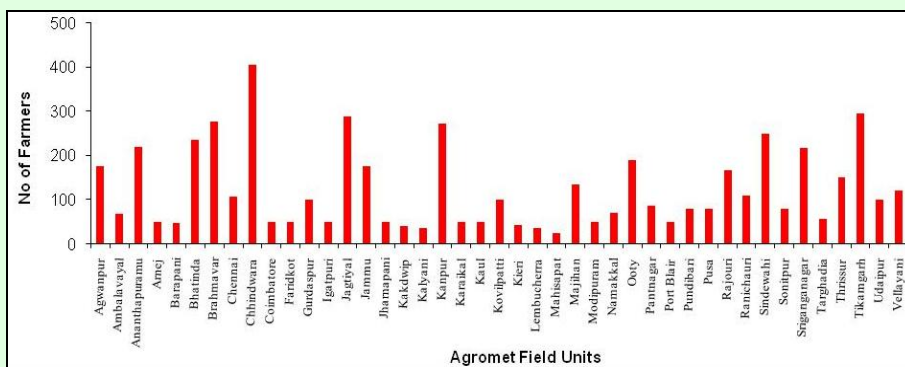


Fig. 3. Numbers of farmers attended Farmers awareness programme at different centers

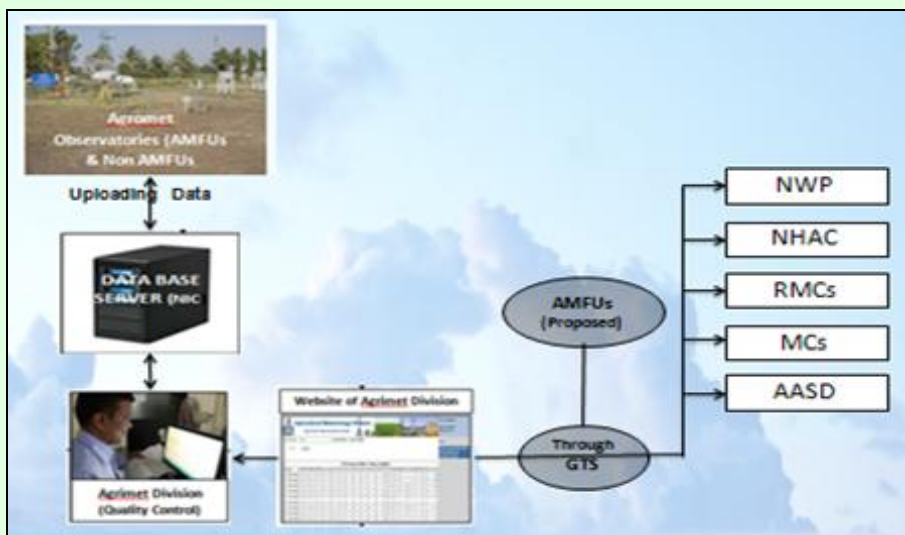


Fig. 4. On-line reception of Agromet Data

3. On line Verification of Value Added Forecast

Agrimet Division, IMD Pune in collaboration with NIC, Pune developed software for online verification of value added forecast. Presently gridded rainfall (0.25 × 0.25) and Temperature (0.5 × 0.5) is used for verification (Fig. 5).

4. Establishment of DAMUs

As a part of GKMS, it is proposed to establish 200 District Agromet Units (DAMUs) in existing KrishiVigyanKendras (Ministry of Agriculture) in the Phase-I and all districts in Phase-II. IMD has started establishing District Agromet Units (DAMUs) at KrishiVigyanKendras (KVKs) under Indian Council of Agriculture Research (ICAR) network. To assess the existing infrastructure, manpower etc. of KVKs for setting up DAMUs under GKMS Scheme, 100 KVKs have been visited by IMD and AMFU officials.

Research & Excellence in Agrometeorology

Agrimet Division has started generation of the following agromet products for operational use in AAS. All these products are generated under PAN India mode on 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.

1. Soil Moisture : Realized (Daily) and Forecast (Twice a week on Tuesday and Friday)
2. Growing Degree days : Weekly and Seasonal (Kharif and Rabi seasons)
3. Spatial Variation of weather parameters at different temporal scales
4. Soil temperature and evaporation on different temporal scales.
5. Satellite products: Normalized Differential Vegetation Index and Reference Evapotranspiration and Insolation maps in collaboration with SAC Ahmedabad are generated.
6. Agrimet Division will shortly generate the following products like Temperature Humidity Index (THI) using weather data, Satellite products like Land Surface Temperature (LST), Soil Moisture Index (SMI), Soil Wetness Index (SWI), Fog, Vegetation condition Index (VCI), Temperature Condition Index (TCI) and Vegetation Health (VHI).

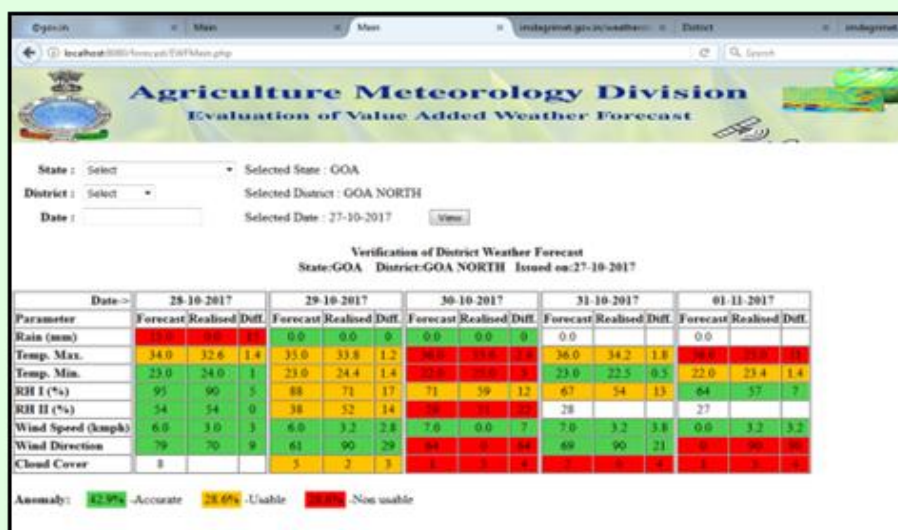


Fig. 5. Online verification of value added forecast

New Initiative under “Gramin Krishi Mausam Sewa”

1. IMD in collaboration with WOTR, Pune is developing a software for Automation on preparation of Agromet Advisories to generate locale and crop specific dynamic advisories, advisories generated based on crop growth, water requirement, water availability and weather conditions.

2. Initiatives have been taken to display the agromet products generated through MOSDAC and VEDAS website of SAC, Ahmedabad and Bhuvan portal of NRSC, Hyderabad.

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 today farm operations like sowing, irrigation scheduling, fertilizer and pesticide applications etc. Also special advisories, alerts and warnings issued during extreme weather events like heavy rain, cold wave, heat wave, hail storms etc. helped them in minimizing the loss.

5.3. ENVIRONMENTAL MONITORING

IMD is expanding the skyradiometer network SKYNET-India by installing eight more skyradiometer in different geographic regions. Installation at Gangtok, Jaipur, Raipur, Puducherry, Aurangabad and Sagar has been completed.

High Volume Samplers for collecting PM₁₀, PM_{2.5} and Total Suspended Particulate Matter have been installed at Delhi, Ranichauri, Pune and Varanasi (Fig. 6). The filter papers will be analyzed for chemical characterization of aerosols.

Ion-chromatograph, UV-VIS Spectrophotometer and Semi-micro Balance have been installed in Air Pollution Laboratory,



Fig. 6. High volume sampler for collecting PM₁₀, PM_{2.5} and Total Suspended Particulate Matter



Fig. 7(a). Ion-chromatograph



Fig. 7(b). UV-VIS Spectrophotometer



Fig. 7(c). Semi-micro Balance

O/o ADGM (R), IMD, Pune for chemical analysis of precipitation samples and particulate matter Figs. 7(a-c).

EMRC has evaluated more than 1500 Environmental Impact Assessment Reports of

Thermal Power, Industrial, Coal Mine and Non-coal Mine projects referred to IMD by Ministry of Environment & Forests during 2017.

Further expansion of Black Carbon Monitoring Network of IMD will be completed during 2017-18 by installing nine more instruments. The augmentation of IMD Ozone network will be completed during 2017-18 by installing two Total Column Ozone Instruments and three Ozonesonde systems.

5.4. 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 then Prime Minister, Late Pt. Jawaharlal Nehru 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, Malayalam, Marathi, Oriya, Punjabi, 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 2017

1. The Indian Astronomical Ephemeris for the year 2018, 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.

2. Fourteen language editions of Rashtriya Panchang of 1939 SE (2017-18 AD) and Sunrise-Sunset and Moonrise- Moonset tables for 2018 have been published during the year 2017. These are important regular publications of the centre catering to daily need of users of almanac, Panchang makers and other users.

3. Web based service has been started by the centre by creation of electronic versions of 14 language editions of Rashtriya Panchang which can be accessed by the users through the PAC Kolkata website.

4. A pocket-type, card-size calendar containing brief information on important

celestial events during the year 2017 has been published in for benefit of users.

5. The centre has prepared monthly star charts and astronomical bulletins for 12 months during the year 2017 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.

5.5. FOG FORECASTING SERVICES

Winter Fog Field Campaign at New Delhi (December 2016- February 2017)

Fog season 2016-17 and performances of Airport (Location) based Fog monitoring and Forecasting/Nowcasting system with special emphasis on performance of IGI Airport Fog Information System and Joint IITM-IMD WIFEX : During Nov to Feb each year, North India is the most vulnerable area in frequent fog/smog formation area among all region of India. For accurate time to time Fog Monitoring and Forecasting and disseminating major fog information including fog warnings for aviation users communities, across major airport of north India, IMD has deployed real time fog information system at IGI Airports (IGIA) in winter of 2016-2017.

In January, 2017, at IGIA, the total fog hours of visibility <1000 m was total of 31 days of 364 hours against the normal of 25 days and 243 hour. However, in terms of its impact on aviation, when we consider dense fog events of $V < 200$ m, it shows Jan 2017 had some higher than normal dense fog occurrences as it had 13 days of 63 hours (normal is 10 days and 52 hours) and was comparable to December 2016 occurrences when its total was also higher than its normal as 13 days with 62 hours. On day to day basis, there were three major dense fog spells formed in Jan 2017 covering 2 to 5 days period during 1-3, 16-20 and 27-31 Jan with occurrence of one an unusual case of day

period fog intensified into dense fog events as late as during 0830-1130 IST on 9 January. In January 2017, the accuracy (percentage correct) of daily forecast of occurrences and non occurrences of dense fog, have been verified to be 81% which include 11 hits, 14 correct rejections with 4 False Alarm and 2 missed. When compared to since 2010 for the January [Figs. 8(a&b)].

During November to February each year, North India is the most vulnerable area in frequent for fog/smog formation area among all region of India. For accurate time to time Fog Monitoring and Forecasting and disseminating major fog information including fog warnings for aviation users communities, across major airport of north India, IMD has deployed following real time real time fog information system at IGI Airports (IGIA) in winter of 2016-2017.

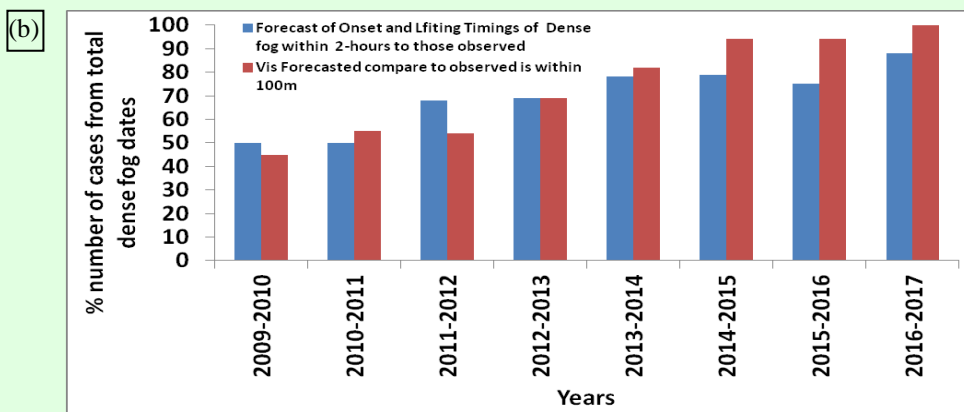
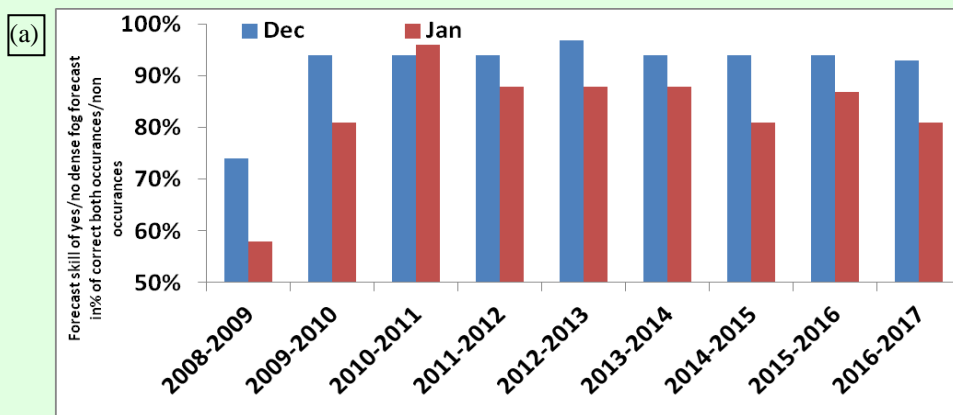
Fog Monitoring

- Airport AWS/RVR, Synop

- Live RVR
- RAPID-INSAT 3-D of IMD and Radiometer from joint IITM-IMD WIFES
- Instruments under Fog campaign (Radiometer, Sodar and other fog-Microphysics and pollution measuring equipments).

Fog forecast /Early warning system

- Routinely 6- hourly gap forecast - Intensity and duration based fog forecast updates with 18-hours validity (AWS-Synop-RAPID trend, Synop and climatological threshold method, Empirical fog model, IITM, NCMRWF fog models and GFS model and forecast Products).
- RVR nowcast in case CAT-III dense fog likely affect any RWY
- Fog Forecasts for AMT, LKN, JPR, VNS at 6-hourly intervals.



Figs. 8(a&b). Skill of dense fog forecast 2008-2017. (a) % correct (b) Onset/lifting skill and minimum Visibility forecast skill

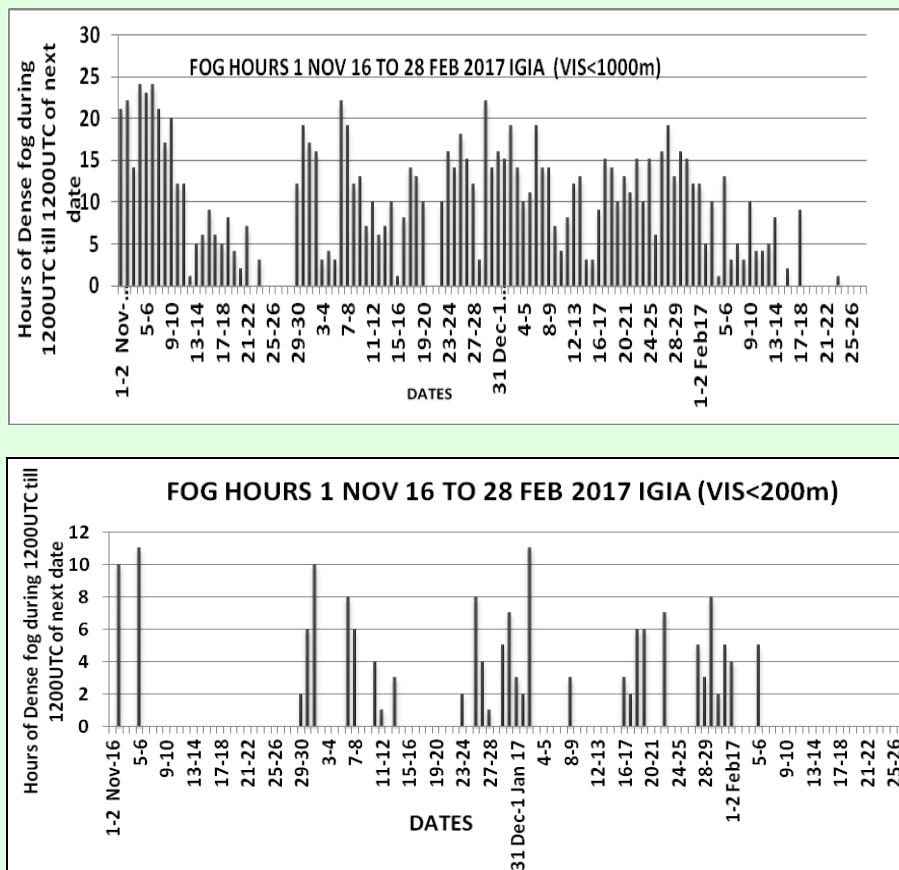


Fig. 9. Day to day fog duration at IGIA for 1 Nov to 28 Feb 2016-17

Fog information dissemination

- OLBS/IMD main website
- SMS

Met office IGIA has used at real time a total of eighteen number of RVR and six AWS at its three RWY to monitor the fog formation at surface, at very high resolution at few meters to kms gap just around areas of 7×10 km area at IGIA, what is called the world's highest RVR/AWS based fog monitoring system amongst all airports in the world.

Fig. 9 shows day to day occurrences of all fog hours at visibility <1000 m and dense fog hours at visibility <200 m. In day to day occurrences, the 1st spell was a severe spell smog/Fog days of 29 October - 7 November 2016.

Serviceability status of all Sixteen RVR systems in winter 2016-17: IGIA has been equipped with total of 16 RVR systems with

two types of RVR systems *i.e.*, thirteen RVR instruments of Drishti type manufactured and commissioned indigenously and three are of Telvent RVR systems. All these 16 RVRs were functional at three RWY at 24x7 for managing this fog season. These are most crucial for ATC to make landing/take off/taxing in different low visibility/CAT-ILS Systems as fog events routinely intensify/dissipates. All these RVR had provided data un-interruptedly to ATC through display and to other users like airlines, DIAL, etc. *via* Live RVR in the website at 24x7, at each 10-15 second gap updates. This is the 1st fog season when, Indigenous Drishti RVR systems were independently used in an integrated manner via single display to all ATC seats for all RWYs operations, for all landings/take offs during all fog period and there was not a single case when RVR values of any RWY ends were not made available to ATC in integrated display system during any CAT-ILS period and hence there was not a single diversion at IGIA attributed in this season due to any such RVR un-serviceability.

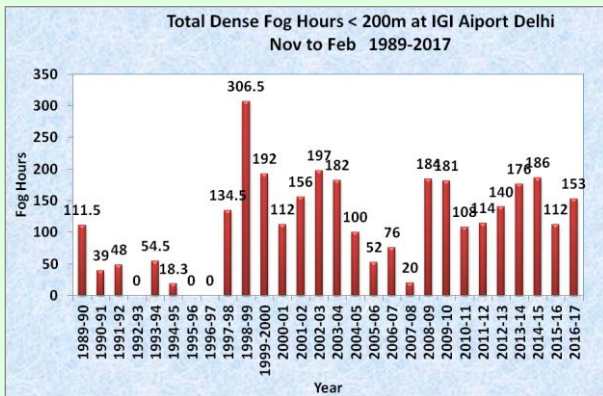


Fig. 10. Variation of Nov-Feb for whole fog seasonal dense fog hours of operational interest during 1989-2017

The variation of Nov-Feb for whole fog seasonal dense fog hours of operational interest during 1989-2017 is shown in Fig. 10.

On success of this winter joint IITM-IMD(MoES) fog campaign Phase 2 conducted at IGIA in Dec-Jan 2016-17: In contrast to last winter fog campaign pashe-1, this year the fog campaign phase 2, has been more successful in view the formation of number of dense fog cases were much higher *i.e.*, of 23 dates and 135 hours in Dec-Jan 2016-17, when all participated scientists got opportunity to collect very high number of sample in comparison to last year 2015-16 Dec-Jan, when it was only 16 cases of dense fog events of total 86 hours were captured. The other reason also, the fog campaign in this season was started in time by 1st week of Dec 2016 and hence it has almost captured all initial events while in last year, it was started late in 3rd week of Dec, by when few initial dense fog events were already missed. Though, in this season the Tethered balloons observation was not taken due to non permission from authority, but collection of huge special fog samples with due care by IISER Mohali and data from around 31 equipments for studding fog micro-physics with fully functional of scanning mobility particle sizer (SMPS) and Tower (ATC) based temp and RH profiling, all new for this season and day to day running and validation of a real time dynamic fog model at the very high resolution, all by IITM, remained special major achievements for this season fog campaign.

Description of IMD Delhi Fog forecast/nowcast system 2016-2017 :

Following series of methods were deployed for real time fog forecasting & nowcasting at IGIA.

- **Process based Fog forecast system**
- **Climatological, synoptic pattern based, Threshold and checklist based**
 - Threshold table using surface & upper air
 - Climatological and Synop Checklist/Pattern method using min temp, RH, ridge line and winds, etc., GFS products
 - Trends from real time data
 - New Rapid online analysis system for Satellite based nowcast system using Reflectivity/BTD/RGB and night time channel subtraction method
 - Nowcast of fog based on trends and spatial shift of satellite-RAPID fog areas and Reflectivity/BTD/RGB values and trends of parameters from DWR/RVR/AWS/Synop network of Delhi
 - Fog FDP products and Objective based fog forecast using fog Models
- **Objective based fog forecast using fog Models**
 - IMD Empirical Fog model of intensity and duration based fog forecast System-Oct 2008
 - WRF-based fog model (CMMACS and IAF Fog Models -Oct 2008-2011
 - Experimental spatial intensity based UCEM spatial fog forecast map from NCMRWF for 24, 48, 72 hours and further validity-October 2014
 - IITM WRF chem. Products in 2016-17 which was run in two BC GFS and NCUM-UKMO – December, 2016

5.6. CYCLONE MONITORING & PREDICTION

Cyclonic disturbances during 2017

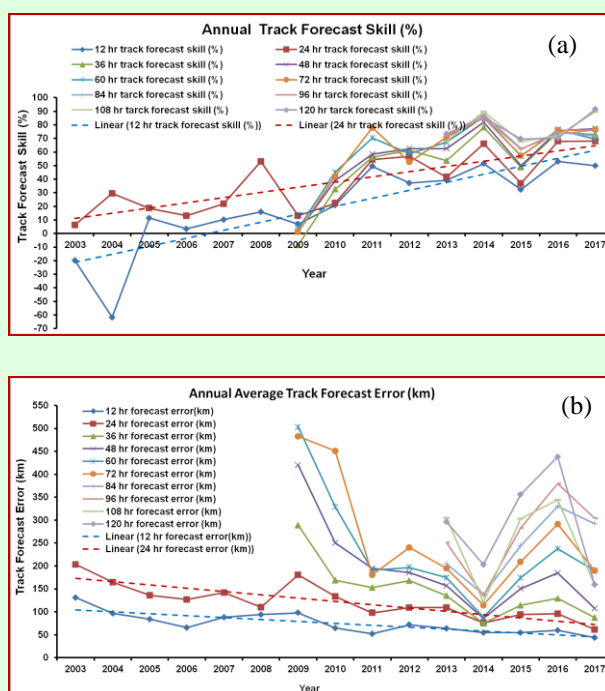
There were 10 cyclonic disturbances (depressions and cyclones) over the north Indian Ocean (NIO) and adjoining land regions during 2017 against the long period average (LPA) of 12 disturbances per year based on data of 1961-2015. Out of 10 CDs, 3 intensified into tropical cyclones against the normal frequency of 4.5 cyclones per year over north Indian Ocean (NIO) based on LPA. It included 1 cyclonic storms (CS), Maarutha, one severe cyclonic storm (SCS), Mora & one very severe cyclonic storm, Ockhi. These cyclones are:

- *Cyclonic storm, Maarutha over Bay of Bengal (15-17 April)*
- *Cyclonic storm, Mora over Bay of Bengal (28-31 May)*
- *Very Severe Cyclonic Storm, Ockhi over Bay of Bengal (29 November to 6 December, 2017)*

The cyclonic activity over the NIO was near normal during pre-monsoon season, 2017 with formation of two cyclones. The activity during the post-monsoon was below normal with formation of one cyclone at the end of November. No cyclone crossed Indian coast during 2017 against the normal of about 2 such cyclones per year.

5.6.1. Cyclone Forecast Verification

The annual average track forecast errors in 2017 have been 61 km, 108 km and 190 km, respectively for 24, 48 and 72hrs against the past five year average error of 97, 149 and 183 km based on data of 2012-2016. The errors have been significantly lower during this year as compared to long period average (2012-16). The track forest skills compared to climatology and persistence forecast are 68%, 77% and 76% respectively for the 24, 48 and



Figs. 11(a&b). Annual (a) Track Forecast Skill (%) and (b) Average Track Forecast Error (km) of RSMC, New Delhi over North Indian Ocean

72 hrs lead period which is much higher than long period average of 2012-2016 (54%, 67% & 69% respectively). The annual average landfall forecast errors for the year 2017 have been 19 km, 50 km and 59 km for 12, 24 and 48 hrs lead period during 2017 against the average of past five years of 37 km, 56 km and 94 km during 2012-2016. The landfall time forecast errors have been 1, 0.5 and 3.5 hrs for 12, 24 and 48 hrs lead period during 2017 against the average of past five years of 2.5, 4.2 and 4.7 hrs during 2012-2016. It can be seen from Figs. 11(a&b) that there has been continuous improvement in forecast accuracy with decrease in landfall and track forecast errors and increase in skill over the years.

The annual average track forecast error during 2017 has been 61 km, 108 km and 190 km, respectively for 24, 48 and 72 hrs against the LPA (2012-16) error of 97, 149 and 203 km based on data of 2012-2016.

Also the track forecast skills compared to CLIPER forecast during 2015 are 37%, 50% and 57% respectively for the 24, 48 and 72 hrs lead period which is lower than LPA of 2010-2014

(46%, 62% & 68% respectively) by about 10%. Official track forecast errors during 2015 were 7-13% less as compared to 2010-14 upto 72 hours lead period and 17-30 % more beyond that. There has been reduction in track forecast error by about 12%, 8% and 9% for 24, 48, 72 hr lead period respectively relative to the LPA based on 2010-14.

5.6.2. Severe Cyclonic Storm, Mora

A severe cyclonic storm Mora developed over the Bay of Bengal during last week of May. It moved nearly north-northeastwards and crossed Bangladesh coast close to south of Chittagong in the forenoon (between 0400 and 0500 UTC) of 30th May 2017. The observed track of the SCS Mora is shown in Fig. 12. The peak maximum sustained surface wind speed (MSW) of the cyclone was 110-120 kmph gusting to 130 kmph (60 knots) and the system crossed Bangladesh coast with this peak wind speed. After landfall, it moved across north-eastern states of India and caused rainfall. It caused heavy rainfall over northeastern states and squally winds over Mizoram and Tripura.

Forecast Performance

- The first information regarding formation of a low pressure area over southeast & adjoining central Bay of Bengal was issued in the morning of 25th May.
- The first information regarding formation of depression over southeast BOB during next 48 hours (i.e., 28th May) was issued on 26th May and depression formed over southeast BOB in the morning of 28th (48 hours in advance of formation of depression).
- In it's first bulletin based on 0000 UTC of 28th May, RSMC New Delhi indicated the nearly north-northeastward movement of system towards Bangladesh coast with landfall in the forenoon of 30th (52 hours prior to landfall).
- The landfall point forecast error is about 35, 59 and 00 km respectively for 12, 24 and

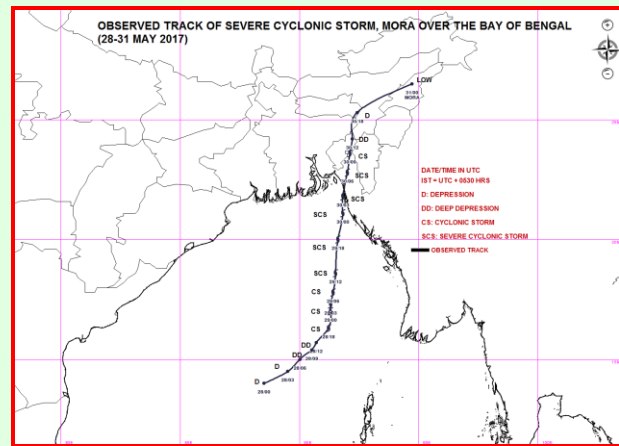


Fig. 12. Observed track of SCS, 'Mora' over BoB during 28-31 May 2017

36 hrs lead period of forecast and landfall time forecast error was almost NIL for all the above forecast times.

- The track forecast error for 12, 24 and 48 hrs lead period are 27, 22 and 73 km respectively against the last five years (2012-2016) average track forecast error of 60, 97 and 149 km. The track forecast skill was about 64%, 87% and 86% for 12, 24 and 48 hrs lead period respectively against the last five years (2012-2016) average track forecast skill of 44%, 54% and 67%. All forecast tracks along-with observed tracks are shown in Fig. 13.
- The absolute intensity (wind) forecast error for 12, 24 and 48 hrs lead period are 2.1, 3.0 and 3.4 knots against the LPA of 6.5, 10.7 and 13.8 knots respectively.
- Typical graphical products displaying observed and forecast track with cone of uncertainty and wind distribution forecast are presented in Figs. 14(a&b).
- Regular bulletins were issued to disaster management agencies of central level and states of West Bengal, Tripura, Manipur, Mizoram, Nagaland, Assam, Meghalaya, Arunachal Pradesh and Andaman & Nicobar Islands during the period.

Every three hourly TC Advisories were issued to central & state level disaster managers, media general public and WMO/ESCAP member countries including Bangladesh.

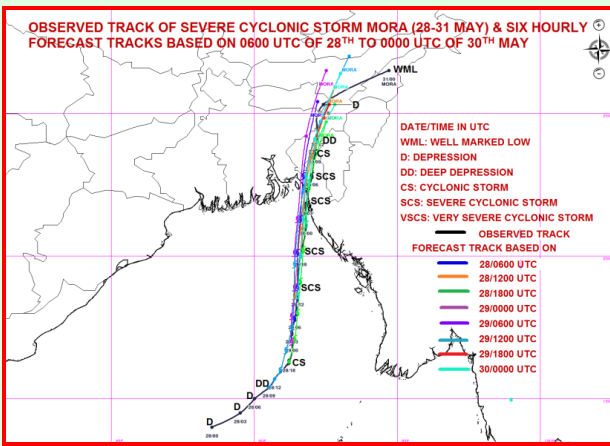
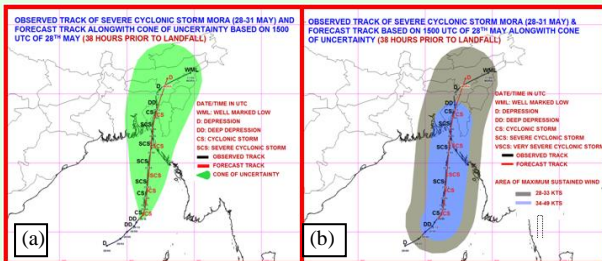


Fig. 13. Observed and forecast tracks of SCS, MORA



Figs. 14(a&b). Observed track of SCS Mora (28-31 May, 2017) and forecast track based on 1500 UTC of 18th May along with (a) Cone of uncertainty and (b) Quadrant wind distribution

5.6.3. Very Severe Cyclonic Storm Ockhi

➤ Very Severe Cyclonic Storm (VSCS) Ockhi originated from a low pressure area over southwest Bay of Bengal. Under favourable environmental conditions, it concentrated into a Depression over southwest Bay of Bengal off southeast Sri Lanka coast in the morning of 29th Nov. Moving westwards, it crossed Sri Lanka coast after some time. Continuing its westward movement, it emerged in Comorin Area in the evening of 29th and intensified into a Deep Depression (DD) in the early hrs of 30th. It further moved northwestwards intensified into Cyclonic Storm (CS) in the morning of 30th Nov., into a Severe Cyclonic Storm (SCS) over Lakshadweep area in the early morning of 1st Dec. and VSCS over SE Arabian Sea to the west of Lakshadweep in the afternoon of 1st Dec. It then moved northwards and reached its peak intensity of 85 knots (150-160 kmph) in the morning of 4th Dec. It then moved north-northeastwards and weakened gradually into an SCS in the evening of 4th Dec., into a CS in the morning of 5th, into DD in the evening of

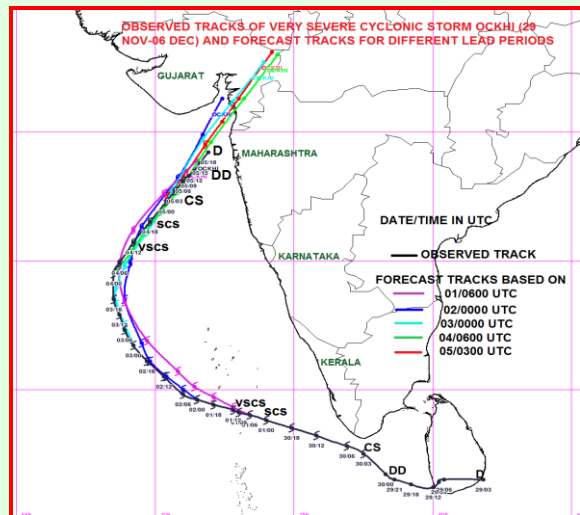


Fig. 15. Observed track of VSCS OKCHI and forecast track for different lead period

5th, into D in the same late evening and into well marked low (WML) in the early hrs of 6th Dec over northeast Arabian Sea and adjoining south coastal Gujarat and north coastal Maharashtra. It crossed South coast of Gujarat between Surat and Dahanu as a WML around early morning of 6th December. Observed track of VSCS OKCHI and forecast tracks for different lead periods is shown in Fig. 15.

- Ockhi was the most intense tropical cyclone in the Arabian Sea since Cyclone Megh in 2015.
- It was the third and the strongest storm over north Indian Ocean during 2017.
- Cyclone Ockhi is noted for its very unusual track. It originated from a low pressure area over southwest Bay of Bengal and ended over south coastal Gujarat and neighbourhood. It had a track length of about 2540 km.
- The first information regarding formation of depression over BOB during next 48-72 hours (i.e., 30th onwards) was issued on 28th November in the Tropical Weather Outlook issued at 1200 hrs IST and depression formed over southeast BOB in the morning of 28th.
- In its first bulletin based on 0300 UTC of 29th Nov, RSMC New Delhi indicated the west-northwestward movement of system and its emergence into Comorin area by 30th. It was

also mentioned that the system would intensify into DD during next 24 hours. The system emerged into Comorin Area during night of 29th and intensified into DD in the morning of 30th.

- First information about intensification of system into cyclone was given in the bulletin issued at 0530 IST of 30th.

- Cyclone Alert for Lakshadweep area was given in the bulletin issued on 0830 IST of 30th.

- Cyclone Warning for south Kerala, adjoining districts of south Tamilnadu and Lakshadweep Islands was issued on 1200 hrs IST of 30th Nov.

- First information about north/northeastwards recurvature of system was issued on 0830 hours IST of 1st December.

- First information about north/northeastwards recurvature of system and weakening of system thereafter was issued on 0830 hours IST of 3rd December.

- Regular warnings were issued for fishermen along and off Tamilnadu, Kerala, Lakshadweep Islands, Goa, Maharashtra, Karnataka & Gujarat, Dadra Nagar Haveli, Daman and Diu coasts. Every three hourly TC Advisories were issued to central & state level disaster managers, media general public and WMO/ESCAP member countries including Bangladesh.

- The track forecast error for 12, 24, 48 and 72 hrs lead period are 52, 77, 112 and 190 km respectively against the last five years (2012-2016) average track forecast error of 60, 97, 149 and 203 km. The track forecast skill was about 61%, 76% and 76% for 24, 48 and 72 hrs lead period respectively against the last five years (2012-2016) average track forecast skill of 54%, 67% and 71%. The observed and forecast tracks of Ockhi are shown in Fig. 16.

- The absolute intensity (wind) forecast error for 24, 48 and 72 hrs lead period are 7.0,

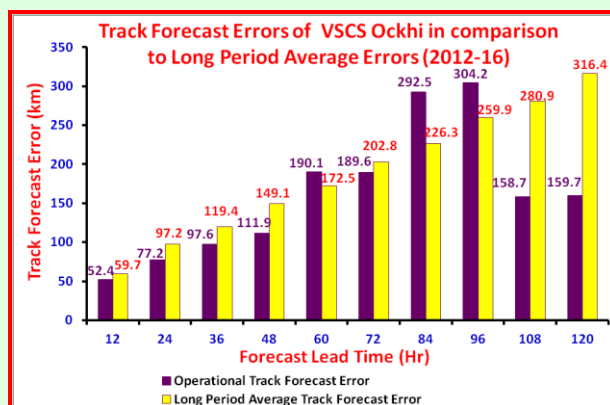


Fig. 16. Track forecast errors of VSCS OKCHI

- 13.5 and 16.4 knots against the LPA of 10.7, 15.5 and 16.3 knots respectively. The skill in absolute intensity (wind) forecast for 24, 48 and 72 hrs lead period are 48.4%, 61% and 75.7% against the LPA of 35.2%, 55.7% and 66.8% respectively.

5.7. CLIMATE RESEARCH & SERVICES

The Climate Centre at IMD Pune has been now recognized as the Regional Climate Centre for providing regional climate services. In 2017, Climate Research and Services (CRS) division is created by combining different IMD offices at Pune. The major services provided by this division are given below :

(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

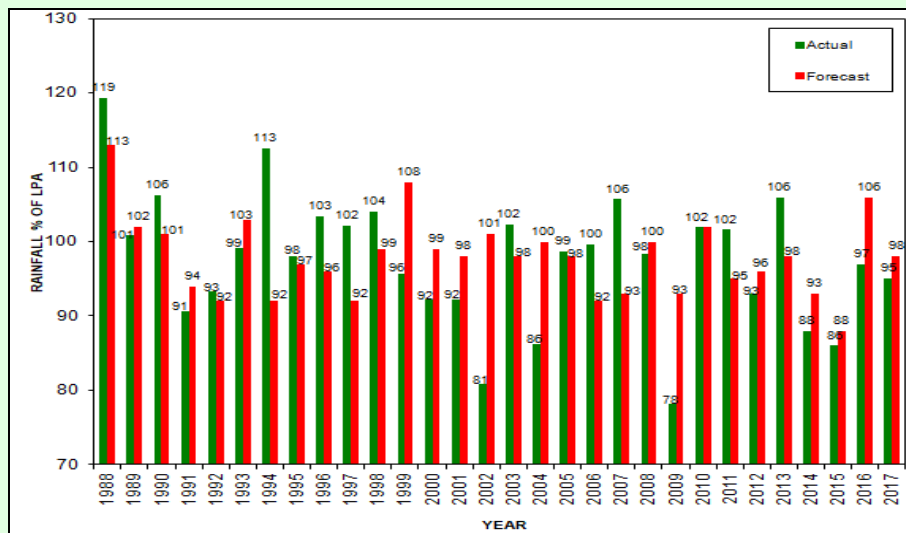


Fig. 17. Performance operational forecast (1988-2017)

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	MMCFS
3	SW Monsoon Season (June to September) Rainfall	Country as a whole	April	Statistical
4	SW Monsoon Season (June to September) Rainfall	Country as a whole	June	Statistical
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 and 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	MMCFS

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 updated 15th of every month is now available through IMD, Pune (www.imd.pune.gov.in) and IITM (www.tropmet.res.in) websites. In 2017, 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).

The Performance operational forecast (1988-2017) is shown in Fig. 17.

Verification of Operational Long Range Forecasts

(i) Winter Season (January to March, 2017) Precipitation over North India

The LRF for the 2017 winter season (January to March) rainfall over north India was issued in the last week of December 2016. North India consisting of seven subdivisions (East U.P., West U.P. Uttaranchal, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir) receives about 17% of its annual rainfall during the winter season (January to March). The Jammu & Kashmir in particular receives about 30% of its annual rainfall during this period. The winter rainfall is very crucial for Rabi crops over the region. It is also crucial for the water management of the region. In view of these reasons, India Meteorological Department (IMD) has been issuing long range forecast outlook for the winter rainfall over north India. IMD also continuously works to improve the skill of the forecasting models. This year, for preparing the quantitative and probabilistic forecasts for winter season rainfall over the North India, a 4-parameter Principle Component Regression (PCR) has been used.

The Table 3 below shows the summary of the verification of the long range forecasts issued for the 2017 winter season.

(ii) 2017 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. The year 2016 was the warmest year ever recorded since 1901 with country averaged annual mean land surface air temperature of 0.91 °C above the 1961-1990 average. The country also experienced significantly above normal mean temperature during the 2016 pre-monsoon season (March-May) with anomaly of +1.36 °C, second warmest ever since 1901. Significantly above normal mean temperatures continued in January, 2017 (0.67 °C). During the 2017 Pre-monsoon season (March to May) and Hot Weather Season (April to June), the forecast suggested warmer than normal temperatures in all meteorological subdivisions of the country. Seasonal (April - June) average temperatures over most of the subdivisions from north and central India are likely to be above normal by more than 1.0 °C. In view of its social relevance, India Meteorological Department, Ministry of Earth Sciences issued a seasonal outlook for summer temperatures over the country based on the predictions from MMCFS. The model climatology was prepared using retrospective forecasts generated for 28 years (1982-2010). The model showed moderate skill for summer temperatures over many subdivisions over northwest and central India during the period 1982-2008.

The sub-division wise maximum, minimum and mean temperatures forecast issued by IMD for

TABLE 3

Verification of Long Range Forecast for 2017 Winter Season

Forecast	Actual
The 2017 winter season (Jan to March) rainfall over north India is most likely to be normal (≥ 85 to ≤ 115 of the Long Period Average (LPA)).	Winter rainfall in North India during the period January to March 2017 was normal (≥ 85 to ≤ 115 of the LPA).
The Long Period Average of the winter rainfall over North India for the period 1951-2000 is 183.1 mm.	

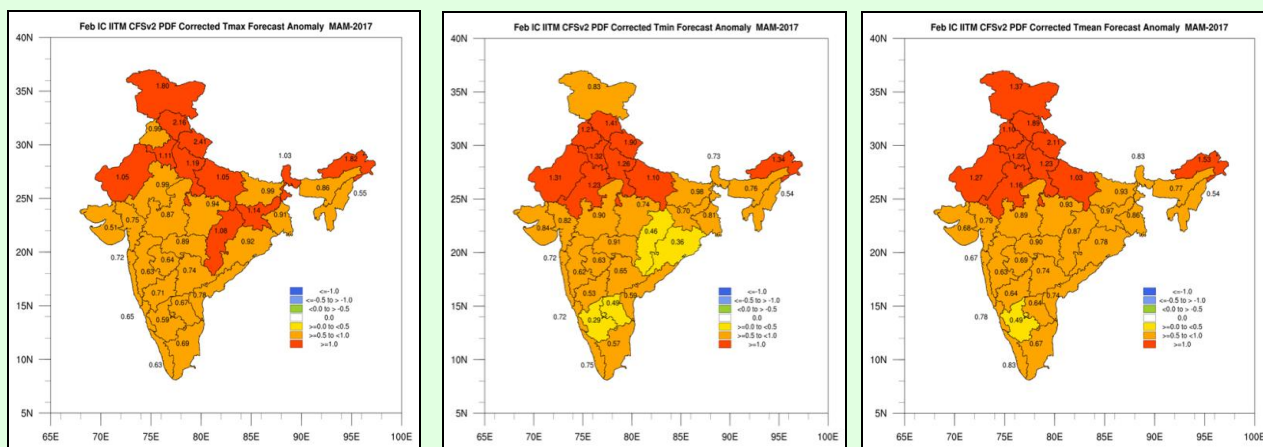


Fig. 18. Subdivision wise maximum, minimum and mean temperatures forecast issued by IMD for the 2017 Pre monsoon season (March to May) along with actual subdivision wise temperature anomalies

the 2017 Pre monsoon season (March to May) along with actual subdivision wise temperature anomalies are shown in Fig. 18.

The forecast for 2017 hot weather season (April to June) was prepared using 47 ensemble member forecasts, based on the 2017 March initial conditions.

(iii) Southwest Monsoon Season (June to September, 2017) 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 (Fig. 19).

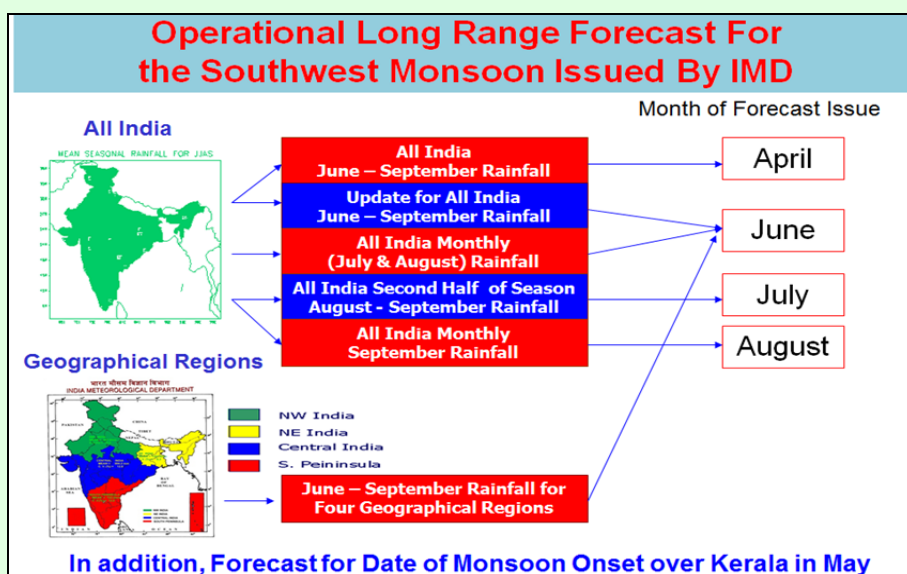


Fig. 19. Schematic diagram showing various operational forecasts for the southwest monsoon rainfall issued by IMD

TABLE 4

Verification of the operational forecast issued for the 2017 southwest monsoon rainfall

Region	Period	Forecast (% of LPA)		Actual Rainfall (% of LPA)
		18 April	6 June (Update)	
All India	June to September	96 ± 5	98 ± 4	95
Northwest India	June to September		96 ± 8	90
Central India	June to September		100 ± 8	94
Northeast India	June to September		96 ± 8	96
South Peninsula	June to September		99 ± 8	100
All India	July		96 ± 9	102
All India	August		99 ± 9	87
All India	August to September		100 ± 8	87

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 30th May, on the same day as forecasted on 30th May ± 4 days. Thus the operational forecast for the monsoon onset over Kerala has been correct (within the forecast limits) during 12 of the 13 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 ± 4 days against the forecast of 30th May.

The Table 4 gives the summary of the verification of the long range forecasts issued for the 2017 Southwest Monsoon. In 2017, the forecasts for the seasonal rainfalls over country as whole and the four broad geographical regions as well as forecast for the July rainfall over the country as whole are correct. However, the forecasts for the rainfall during the second half of the monsoon season and the August rainfall are overestimates to the actual rainfall and are not correct.

(iv) Northeast Monsoon Rainfall over South Peninsula (October to December, 2017)

The long range forecast for the 2017 NE monsoon season (October to December) rainfall over South Peninsula and Tamil Nadu was issued in the last week of September 2017. The south Peninsula consisting of five

subdivisions (Tamil Nadu, Coastal Andhra Pradesh, Rayalseema, 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. This year, 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. Similarly a 4-Parameter PCR model has been used for the forecasting season Rainfall over Tamil Nadu.

Forecast Area

South Peninsula consisting of Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu, South Interior Karnataka and Kerala is the forecast area for the purpose of this forecast. Over this area, the Long Period Average rainfall and Coefficient of variation are 332.1mm and 25.3% and that for Tamilnadu are 438.2 mm and 31.5% respectively.

Verification

Actual rainfall (based on real time data) over South Peninsula during the season (Oct-Dec) was 285.8 mm & actual rainfall over Tamilnadu during the season (Oct-Dec) was 394.0 mm.

Normal rainfall for the season (Oct-Dec) over South Peninsula and Tamilnadu are 332.1mm and 438.2mm respectively.

Thus, the seasonal rainfall (Oct-Dec) was 86% of its long period average (LPA) over South Peninsula and 90% of its long period average (LPA) over Tamilnadu.

Future Plans

- Improve the skill of existing operational statistical long range forecasting system.
- Operationalization of the coupled dynamical forecasting system for monthly and seasonal forecasts.
- Develop tools for sector specific climate prediction products.
- Generate regional and sub-regional tailored climate prediction products.
- Develop tools for verification of quantitative and probabilistic climate hindcasts and forecast products.
- Generate regional and sub-regional tailored products, relevant to RCC User needs, including seasonal outlooks etc.
- Provide on-line access to products/services to different users.
- Assess use of climate prediction products and services through feedback from users.
- Coordinate with stake holders to generate 'consensus' statement on regional or sub-regional forecasts.
- Development of tools for LRF at various spatial scales using statistical recalibration of the dynamical model outputs.
- Development of tools for drought prediction.
- Perform verification of RCC quantitative LRF products, including the exchange of basic forecasts and hindcast data.

(ii) Climate Monitoring & Annual Climate Statement

In line with the warmer than normal observed global temperatures during 2017, mean temperature over India was significantly higher during the year. During 2017, the annual mean land surface air temperature, averaged over the country, was +0.71 °C above the 1971-2000 average, thus making the year 2017 as the fourth warmest year on record since nation-wide records commenced in 1901. The winter and post monsoon seasons (January-February, with anomaly of +0.94 °C, fourth highest and October-December, with anomaly +0.77 °C, third highest, since 1901) mainly accounted for the above normal annual temperature for the year.

The 2017 annual rainfall over the country as a whole was 94.6% of Long Period Average (LPA) value for the period 1951-2000.

Temperatures

The 2017 annual mean land surface air temperature for the country was +0.71 °C above the 1971-2000 average, thus making the year 2017 as the fourth warmest year on record since 1901 (Fig. 20). The five warmest years on record in order were: 2016 (+0.87 °C), 2009 (+0.85 °C), 2010 (+0.82 °C), 2017 (+0.71 °C), 2015 (+0.59 °C). It may be mentioned that 12 out of 15 warmest years were during the recent past fifteen years (2003-2017). Past decade (2001-2010/ 2008-2017) was also the warmest decade on record with anomalies of 0.46 °C /0.54 °C. The annual mean temperature during 1901-2017 showed an increasing trend of 0.66 °C/100 years (Fig. 20) with significant increasing trend in maximum temperature (1.06 °C/100 years), and relatively lower increasing trend (0.26 °C/100 years) in minimum temperature. The country averaged season mean temperatures were also above the average during all the four seasons with the post-monsoon season (October-December, +0.77 °C) being the 3rd warmest and the winter season (January- February, +0.94 °C) being the

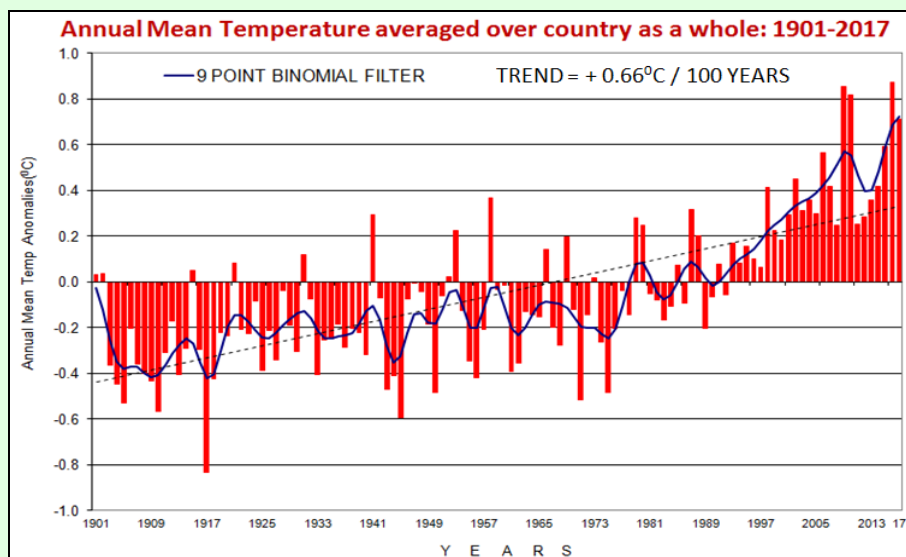


Fig. 20. Annual mean land surface air temperatures anomalies averaged over India for the period 1901-2017. The anomalies were computed with respect to base period of 1971-2000. The dotted line indicates the linear trend in the time series. The solid blue curve represents the sub-decadal time scale variation smoothed with a binomial filter

4th warmest since 1901. Monsoon season (June-Sept) this year with anomaly +0.51 °C was the 5th warmest since 1901 and the pre monsoon season (March-May, with anomaly +0.77 °C above average) being the 6th warmest ever since 1901. The country averaged mean monthly temperatures were warmer than the normal during all the months of the year with mean temperatures exceeding more than 1 °C above average recorded during the three months (February (1.29 °C), April (1.04 °C) and October (1.11 °C)). Also, September (0.82 °C) & October (1.11 °C) were the warmest since 1901.

Rainfall

The annual rainfall over the country was 94.6 % of Long Period (1951-2000) Average (LPA). Rainfall over the country as a whole during the SW monsoon season, which is the principal rainy season was normal (94.8 % of LPA). During this season, among the four large geographical regions of the country, South Peninsula received highest rainfall (100.3% of LPA) and Northwest India received lowest rainfall (89.9% of LPA). East & Northeast India and Central India received seasonal rainfall of 96.4% of LPA and 94.1% of LPA respectively.

The northeast monsoon season rainfall over the country as a whole was below normal (88.6% of LPA). The seasonal rainfall over northeast monsoon region of the south peninsula (comprising of 5 subdivisions viz. Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu & Puducherry, South Interior Karnataka and Kerala), was also below average (86.1% of LPA), except Coastal Andhra Pradesh, which received deficient rainfall, all other four subdivisions received normal rainfall.

High Impact Weather Events

During 2017, 3 cyclonic storms formed over the north Indian Ocean. Out 3 systems, 2 formed during the pre-monsoon season and did not have any landfall over the Indian region. The first one "Maarutha" forming in the east central bay of Bengal on 15th April, crossed the Myanmar coast next day i.e. on 15 April, the other one forming over the central Bay on 28 May, crossed Bangladesh on 30th. The last system Okhi, which moved from the Bay of Bengal to the Arabian Sea, caused substantial damage in Kerala, Tamil Nadu and Lakshadweep. The country also experienced other high impact weather events like, extreme heavy rainfall, heat and cold waves, snow cover, thunderstorm, dust storm,

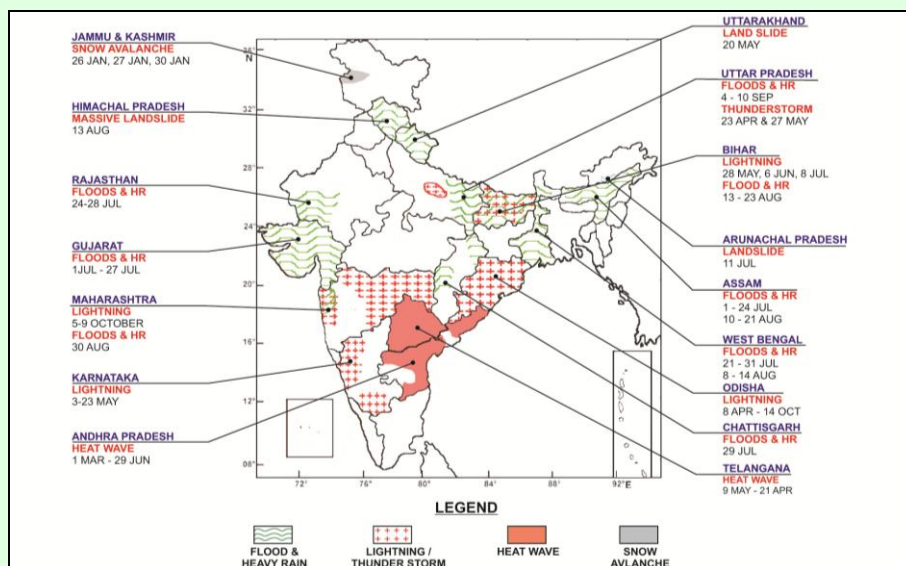


Fig. 21. Major extreme weather events occurred during 2017

lightening, floods etc. (Fig. 21). The casualties mentioned here are based on the media and government reports.

Lightning reportedly claimed over significant number of lives from different parts of the (central, northeastern, peninsular & northwestern parts of the) country during pre-monsoon, monsoon & post-monsoon seasons. Of these deaths, maximum deaths were reported from Odisha.

Heavy rain & flood related incidents during the monsoon season claimed many lives from different parts of the country. Several persons were reportedly died from Assam during the period of 13th June to 11th September in two spells of floods and in Uttar Pradesh during 8th July to 10th September, of which some people reportedly died due to heavy rain & flood in Ghaghara, Gomati & Rapti Rivers during 4th September to 10th September. There were several reported deaths from western industrial state Gujrat during the month of July and from Bihar during 13-23 August, 2017.

On 13th August, many persons were reportedly dead due to massive landslide at Kotrupi on the Mandi-Pathankot National Highway near Jogindernagar in Himachal Pradesh and remaining deaths were reported from the other parts of the country. Similarly, a few people also died in Papum Pare, Arunachal Pradesh on 11th July due to landslides.

Heat wave conditions prevailed mainly over peninsular parts of the country during the period 1st March to 29th June. It took a many lives from Andhra Pradesh & from Telangana.

(iii) Supply of Meteorological Data

As a custodian of all meteorological data collected different stations of the country, National Data Centre (NDC) keyed, processed and archived them in standard format from time to time. The total holding of meteorological data at the data centre as of date is **32.02 million** records of which around **5.82 million** records have been updated to the archives in the year 2017.

During the year 2017, NDC received **1853** queries and requests for data supply from various parties that include Government, private institutions, industries, research and operational users. On receipt of requests, the required data were retrieved from the computer archives, within short time and supplied to the users on CDs, in the desired formats, following the usual formalities as per department policy. During the period **10,50,12,028** records were retrieved and supplied to different users. In the current year, **61** educational/research institutes have registered with IMD for supply of data for academic & research purposes. An amount of **₹ 64,33,950/-** has been earned by sale of data.

Development of Climate Data Services Portal

Towards implementation of the “**Climate Data Services Portal**”, the draft Request for Proposal (RFP) has been prepared which accomplishes integration of the following components.

- (a) A seamless dedicated web portal for providing all climate data services;
- (b) Facilities with fully-automated tools for data management activities that include (i) fast data acquisition, (ii) real-time monitoring / reporting & QA/QC procedures, (iii) archival and retrieval, (iv) net-centric / web based utilities for data, products and analytics with GIS, Table, text enabled formats;
- (c) On-line data supply management;
- (d) Services of all climate related details / data products prepared from IMD and those institutions under MoES

Cataloguing the Digitally Photographed and archived Charts

The project was taken up **subsequent to implementation** of the project “**Digital Photography of Analysed Weather Charts**” thereby accomplishing the archival of **around 8 lakhs** analysed weather charts and making available for remote access through a web portal. This project achieved cataloguing of all the **8 lakhs** archived charts based on their synoptic events and use them as referral charts in the operational forecasting. The portal thus developed with the data bases of analysed charts as well as the synoptic events and features of IDWRs, helps viewing past charts for referencing and analogy based on Synoptic parameters as tools. The activity has enabled digitisation of the important synoptic details from the old IDWRs. The project has been successfully implemented in September 2017.

Data Extraction from Autographic Charts

Data Extraction of around 80 million old autographic charts available at RC/MCs has been proposed through development of software on the scanned autographic charts and to archive the high resolution data (up to 10 minutes interval). As a pilot project around 16000 charts of 3 elements (viz., Temperature, Pressure and Humidity) were extracted thereby archiving around 4 millions of high resolution (lower than hourly) data. In order to operationalise the data extraction works, a hands on training on the software was successfully conducted at RMC Mumbai for the IMD personnel of Technical sections from different RMC/MCs. It has been since decided to take up the works at regional levels procurement activities and data extraction works were proposed to be taken up at respective RMCs and Pune. However, in addition to the 3 elements, wind and rainfall elements need to be extracted by developing suitable extraction software. The procurement process is in progress.

Data Rescue of MMR Sheets

In 2009-11, the data rescue project - Phase I for scanning the old manuscripts / Monthly Meteorological Register (MMR) sheets was taken up by which data prior to 1969 were digitized. The list of data disgitised is shown in the Table 5.

TABLE 5
Digitization of data prior to 1969

Data	Period
8 AM observation registers	1890 – 1931
Monthly Meteorological registers	1931 – 1968
Radiation Data	1968 – 1990
Current Weather of select stations	1960 – 2000

Subsequently, the remaining 70% of historical data from different manuscripts / records are proposed Data Rescue Phase II as Plan Project which has been initiated in 2017.

CHAPTER 6

CAPACITY BUILDING, PUBLIC AWARENESS & OUTREACH PROGRAMME

IMD's major initiative in 2017 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 & WORKSHOP

Dr. M. Mohapatra, Scientist 'G' participated as Panellist in the discussion on "Climate Change: Adaptations & Mitigation" in the 8th Indian Youth Science Congress organised by M. S. Swaminathan Research Foundation on 16th February, 2017 at Mumbai.

Dr. S. D. Attri, Scientist 'F', AASD participated and addressed as Chief Guest on the Valedictory Function of International Conference on "Emerging Areas in Environmental Science and Engineering" organized by GJU Hisar during 16-18 February, 2017.

Shri A. K. Baxla, Scientist 'E' has attended 6th International Communication and Information Technology Conference (CICON)-2016-17, titled "Emerging Trends in Science, Technology, Engineering and Management: Research and Development" with the theme "Doubling Farmers' income by 2022 - Smart Farming and Smart Village" organized by Shobhit University Meerut on 17th February, 2017.

Shri Rahul Saxena, Scientist 'E' participated in the workshop at The Energy and Resources Institute (TERI) organised an International Conference on Urban Geo Informatics (ICUG) at TERI University, New Delhi on 22-23 February, 2017.

Dr. M. Mohapatra, Scientist 'G' participated as Chief Speaker in the Valedictory function of 9th National Seminar on "Water Resources Management in the context of Climate Change for growing India" jointly organised by SCET and OUAT at Bhubaneswar during 27 February - 1 March, 2017. **Dr. S. C. Sahu**, Scientist 'F', also participated in the seminar as Chairman on 27-28 February, 2017.

Shri Anand Sharma, Sc. 'F' and Dr. Ranjit Singh, Sc. 'F' participated in the National Conference on Agriculture for Kharif Campaign 2017 at Vigyan Bhavan, New Delhi on 25-26 April, 2017 and were one of the panellists for the group discussion on Pradhan Mantri Fasal Bima Yojana. The meeting was chaired by Hon. Minister for Agriculture, Govt. of India Shri Radha Mohan Singh.

Dr. D. S. Pai, Scientist 'F' participated in the "International Conference on Climate Change and Adaptation Empowering small holders and ensuring food security" and delivered a lecture on "Improvement over Seasonal Rainfall Prediction: Indian Experience" at Chennai, Tamil Nadu from 11-12 May, 2017.

Dr. K. J. Ramesh, DG, IMD, Dr. K. K. Singh, Scientist 'F' and Shri K. Santosh, Scientist 'E' participated in one day workshop on "Delivery of Agromet Advisory through SMS" workshop was jointly organized by IMD and govt of Karnataka at Vikas Soudha Bangalore on 29th May, 2017 Workshop was inaugurated by Agriculture minister of Karnataka and D.G. I.M.D. gave the keynote address.

Dr. (Mrs.) Surinder Kaur, DDGM (H) attended France-South Asia Regional Meteorological Conference during 6-7 June, 2017 at Taj Mahal Hotel, Conference Room, New Delhi.

Shri Anand Sharma, Scientist 'F' participated in the 2nd User Conference at Shimla on 15th June, 2017 and made a presentation on "Agro Advisory Services for Western Himalayan Region". The conference was chaired by, Additional Chief Secretary, Himachal Government, Shri Tarun Sridhar.

Dr. N. Chattopadhyay, Scientist 'F' (Agrimet), attended the National Conference on "Developing Climate Services along with wx forecast for Building Climate Smart Farmers" organized by National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) in cooperation of Govt. of Gujarat and Anand Agriculture University (AAU) on 30th June, 2017 at AAU Anand.



Dr. N. Chattopadhyay, Sc. 'F' during the conference

Dr. M. Mohapatra, Scientist 'G' participated in the "The South Asian Conference on Early Warning for Disaster Risk Reduction in Agriculture" during 25-26 October, 2017 at Palampur, Himachal as distinguished Guest of Honour and delivered a lead talk on the "Wx Forecast and Warning Services for Mountain Regions of India-Problems & Prospects".

Dr. K. J. Ramesh, D. G., IMD participated in Enviro-Health Conference 2017 on "Air pollution and future strategies with a focus on the NCT of Delhi" on 2nd November, 2017 at MoES, Prithvi Bhavan, Lodhi Road, New Delhi".



Dr. M. Rajeevan, Secretary, MoES, Dr. K. J. Ramesh, DG, IMD and other senior officers during the conference

Workshop

Dr. K. K Singh, Sc. 'F' and Shri A. K. Baxla, Sc. 'E' attended and gave presentation on "Latest Technology development in use of Agromet model & Implementation status of Agromet component of FASAL Scheme" in the National Workshop on Improvement of Agricultural Statistics during 4-5 January, 2017 at NASC Complex, New Delhi.

Shri Anand Sharma, Sc. 'F' was one of the panellists in the National Biodiversity conference organised by Wild Life Institute of India at Dehradun on 14th February, 2017 and spoke about climate variability / change and agro ecosystem in relation to Biodiversity Conservation.

Dr. Kamaljit Ray, Sc. 'F', Shri Anand Sharma, Sc. 'F' and Dr. Ranjit Singh, Sc. 'F' Regional Coordinators provided inputs from IMD for the training workshop on Drought Manual 2016 organized on 16th February, 2017 in MNCFC, Pusa Campus, New Delhi-110012.

Dr. S. D. Attri, Sc. 'F' and Dr. Ranjeet Singh, Sc. 'F' attended Workshop on "Pilot studies on use of technology for crop insurance" organized by Ministry of Agriculture at NASC, Complex, New Delhi on 28th February, 2017.

Dr. V. K. Soni, Sc. 'E' participated in the workshop on 'Raising Risk Awareness' organised by The Energy and Resources Institute (TERI) on 28th February, 2017 at India Habitat Centre, New Delhi.

Pre-monsoon Convective Wx Systems

A training workshop on "Pre-monsoon convective weather systems" for thunderstorm nowcast was organised for the forecasters of IMD at New Delhi during 1-4 March, 2017. In this workshop Dr. M. Mohapatra, Sc. 'G', Dr. Sathi Devi, Sc. 'F', Shri Charan Singh, Sc. 'E', Dr. D. R. Pattanaik, Sc. 'E', Dr. Soma Sen Roy, Sc. 'E', Dr. S. D. Kotal, Sc. 'E', Dr. A. K. Das, Sc. 'D', Dr. V. R. Durai, Sc. 'D' etc. delivered lectures and conducted

practicals to the trainees. Shri Bikram Sen, Met. 'A' and Shri Pradeep Sharma, Met. 'A' also participated in the said workshop.



Discussion during workshop

Dr. D. R. Pattanaik, Scientist 'E' participated in the Annual Monsoon-2016 workshop organised by India Meteorological Society, IMS Pune Chapter on 15th March, 2017 at IITM, Pune. During the event Dr. Pattanaik delivered an invited talk on "New Operational Extended Range Forecast System of IMD and its Application in Different Sectors".



Dr. D. R. Pattanaik, Scientist 'E' delivering talk at IITM

Dr. K. K. Singh, Sc. 'F', Head, AASD, **Dr. S. D. Attri**, Sc. 'F' and **Shri A. K. Baxla**, Sc. 'E' participated in National Workshop on "Doubling Farmer's Income through Scaling-up" organised by ICRISAT during 15-16 March, 2017 at VIF, New Delhi. **Dr. S. D. Attri** delivered lead talk on "Role of Agromet Advisory Services in Managing Risk under Changing Climate" on this occasion.



Dr. S. D. Attri, at ICRISAT Workshop, New Delhi,

Heat Wave Forecasts for State Level Preparedness

Workshop on **Heat Wave Forecasts** for State Level Preparedness held on 28-29 March 2017,

at New Delhi Jointly organised by IMD and IMS. The workshop was inaugurated by lightening a lamp by **Dr. M. Rajeevan**, Secretary, MoES, **Dr. K. J. Ramesh**, DG, IMD, **Dr. Akhilesh Gupta**, Adviser, DST and AVM (Dr.) **Ajit Tyagi**, President, IMS. The workshop was attended by the forecasters/researchers from MoES, disaster management agencies from various states, NDMA, concerned senior officers of state level and NGOs.



The Inauguration of the workshop on Heat Wave Forecast



Group photograph of dignitaries during the Workshop

"Heavy rainfall prediction and its impact assessment"

A national workshop inaugurated by **Dr. K. J. Ramesh**, DG, IMD was held on 31st March, 2017 at IMD to discuss the R&D activity on heavy rainfall prediction and its impact assessment. Representatives from IITM, IMD, NCMRWF, IIT Bhubaneshwar, IIT Madras, Andhra University, Amity Centre for Atmospheric & Science Technology, Centre for Development of Advanced Computing, Pune and Space Applications Center, Ahmadabad attended the meeting. Special



Discussion during the workshop

invitee Prof. Dev Niyogi, Purdue University, USA also attended the meeting. In his opening remarks, DGM explained the difficulties of prediction of heavy rainfall and emphasized about the needs of multi-organizational collaboration for prediction of heavy rainfall.



Dr. K. J. Ramesh, DG, IMD and other officers during the workshop

After the inaugural session the technical session was conducted under the chairmanship of Prof. U. C. Mohanty. Dr. M. Mohapatra, Sc. 'G' outlined the scope of discussion and expected outcome of the meeting. Participants from the research organization presented their R&D activities. Prof. Niyogi also presented the R&D activities of Prof. Subimal Ghosh (IIT Bombay).

Shri S. B. Thampi, Sc. 'F', Dr. S. Balachandran, Sc. 'F' and Ms. B. Amudha, Sc. 'D' participated in the main programme organised by NIOT to commemorate the completion of 20 years of service in ocean observation on 22nd April, 2017 at NIOT, Chennai. Ms. Amudha delivered a talk on "Validation of Quikscat wind data over Bay of Bengal using ocean surface winds from moored buoys during the phases of Indian northeast monsoon, 1999-2008" in the workshop held at NIOT, Chennai.

Weather forecasting for effective Disaster Management

A workshop on "Weather forecasting for effective Disaster Management" organized by Department of Disaster Management, Govt. of Uttarakhand and IMD on 16th May, 2017 at Dehradun, which was inaugurated by Hon'ble Chief Secretary Shri S. Ramaswamy, Govt. of Uttarakhand in presence of Shri Amit Singh Negi, Secretary, Department of Disaster Management, Govt. of Uttarakhand, Dr. D.

Pradhan, Sc. 'G', Dr. Sai Krishnan, Sc. 'F', Dr. G. Suresh, Sc. 'F' & others senior officers of IMD.



IMD Officers in the workshop

Dr. K. J. Ramesh, DG, IMD presided over a joint User's Workshop organised by IMD and Govt. of Maharashtra on 'Weather Forecasting Services in the State and Emerging New Sectors' at Pune on 26th May, 2017.

AGRO-METEOROLOGICAL ADVISORY SERVICES



Workshop on Agro-meteorological Advisory Services

As a joint venture with State Government to reach maximum farming households of Karnataka in presence of Hon'ble Minister of Agriculture, Govt. of Karnataka, Additional Chief Secretary & Development commissioner, DG, IMD, Senior officials of Agriculture of districts in Karnataka and Senior officials of IMD at Vikas Soudha, Bengaluru. A one day workshop on 29th May, 2017 delivery of Agromet Advisory Services based on crop through SMS to Farmers of Karnataka was conducted as a joint venture with State Govt. to reach maximum farming households of Karnataka.

DISASTER PREPAREDNESS WORKSHOP



Shri Bikram Singh gave a presentation on "Thunderstorm and its socio economic impacts"

Shri Bikram Singh, Sc. 'E' attended "Disaster Preparedness Workshop" and gave a presentation on "Thunderstorm and its socio economic impacts" on 16th June, 2017 organized by Disaster Management Department, Govt. of Uttarakhand. The event was inaugurated by Shri S. Ramaswamy, Chief Secretary, Govt. of Uttarakhand.

Dr. N. Chattopadhyay, Sc. 'F' attended the workshop on "Emerging Applications of Space Technology in Agriculture and Allied Sectors" organized by Space Application Centre, ISRO, Ahmedabad from 28-29 June, 2017 at SAC Ahmedabad and delivered a presentation on "Global Scenario and issues of operational ; Agromet Services".



Group photograph of Members

Dr. Sanjib Bandyopadhyay, Sc. 'F' Attended workshop cum interactive session on weather information for power sector on 7th July, 2017 organised by Power System Operation Corporation Limited (A Govt. of India Enterprise) at Golf Club Road, Kolkata.

Dr. S. Balachandran, Sc. 'F' RMC Chennai attended Workshop on Climate Information Services for the Health Sector of Tamil Nadu on 17th July, 2017 conducted by RIMES at Public Health Deptt. Training Centre, Chennai.

Dr. S. Balachandran, Sc. 'F' and Shri B. Arul Malar Kannan, Sc. 'D' participated as IMD representatives in the Command Control Centre Collaborative (CCC) Workshop/Meet for Chennai Smart City for Disaster Management System on 7th August, 2017 at Chennai.

Dr. A. K. Srivastava, Sc. 'F' attended workshop from 22-23 August, 2017 on "Implementation of Climate Smart Village (CSV) Approach in

Maharashtra and delivered a lecture on "Understanding Climate Variation and Factors in Maharashtra".

Urban Climate: Science, Impacts & adaptation



Dr. K. J. Ramesh, DG, IMD during the workshop

Dr. K. J. Ramesh, DG, IMD, Dr. D.R. Pattanaik, Sc. 'E' and other officers of IMD participated in the DST's National Workshop on "Urban Climate : Science, Impacts and adaptation" on 21-22 September, 2017 at Hisar, Haryana

Dr. K. J. Ramesh, DG, IMD was guest of honour at the workshop on "Delivering of Agro Meteorological Advisory Services at Block/ Village level through SMS to farmers of Odisha" organized by Department of Agriculture and Farmer's Empowerment, Govt. of Odisha at IMAGE, Bhubaneswar on 10th October, 2017. Dr. (Mrs.) Kamaljit Ray, Sc. 'G', Dr. K. K. Singh, Sc. 'F', Dr. S. C. Sahu, Sc. 'F' and from Agromet Division, IMD, New Delhi also participated in the workshop.

Shri Anand Sharma, Sc. 'F' organized and participated in the UNESCO, IMS and IMD International workshop on "Strengthening Early Warning for Disaster Risk Reduction for Himalayan Agriculture" at Palampur Agricultural University on 25-26 October, 2017. He delivered lead talk on "Extreme Weather events with respect to Himalayas" and "Agromet Services and its Outreach".

INTROMET-2017

Dr. K. J. Ramesh, D. G., IMD participated in International Tropical Meteorology Symposium (INTROMET-2017) on 7-10 November, 2017 at Ahmedabad Under the auspices of IMS, New Delhi Organised by IMS -

Ahmedabad Chapter and Space Applications Centre, ISRO. On this occasion Dr. K. J. Ramesh, D. G., IMD was awarded with IMS fellowship. On this occasion, **Dr. M. Mohapatra**, Scientist 'G' delivered lead Talk on 9th November, 2017 on “Satellite Observations for Nowcasting and Short Range Weather Prediction in International Conference, INTROMET-2017”.



Dr. M. Rajeevan, Secretary, MoES, Dr. K. J. Ramesh, DG, IMD & other officers during the lighting of lamp

Dr. K. K. Singh, Sc. 'F' attended workshop on “Climate Smart Agriculture in Asia: Beyond Pilot Evaluation and Models” held at Hanoi, Vietnam from 21-23, November, 2017.

6.2. MEETINGS

Dr. S. D. Attri, Sc. 'F', visited Ahmedabad (Gujarat) to discuss with Principle Secretary, other senior officer of Agriculture Department, Government of Gujarat and officials of MC, Ahmedabad regarding augmentation of Agromet Advisory to block level, improvement in observation and forecast increase in number of farmers for SMS dissemination during 23-24 January, 2017.

The Annual Cyclone Review and Annual Monsoon Review (ACR and AMR) Meetings were held during 19-20 January, 2017 at Nagpur. Scientists from IMD, MoES, IITM, Pune, NCMRWF, INCOIS and NIOT participated in the meeting for planning operational services strategy improvements for 2017-18.

Dr. Kamaljit Ray, Sc. 'F' attended a meeting under the chairmanship of Dr. Ashish Kumar Bhutani, Joint Secretary, MOAg & FW to

discuss the issues related to implementation of Restructured Weather Based Crop Insurance Scheme (RWBCIS) in Telangana on 19th January, 2017 at Krishi Bhavan, New Delhi.

Dr. K. K. Singh, Sc. 'F', Shri S. C. Bhan, Sc. 'F' and Dr. Nagrale from MC Jaipur, IMD attended the meeting with Director of Agriculture, Govt. of Rajasthan regarding Strengthening of Agro Advisory Services on 7th February, 2017.

Dr. Kamaljit Ray, Sc. 'F', Regional Coordinator, Dr. Y. K. Reddy, Director M.C., Hyderabad and Dr. Balasuramanium, Sc. 'D', Pune attended the State level stakeholders meeting for the state of Telangana on Agromet advisory services held at Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad on 8th February, 2017 to discuss on creation of State level Consortium on Agromet Advisory Services involving institutes of State Agricultural University, State Department of Agriculture, KVK, ATMA, NGO, Panchayat and other Stake holders. Dr. M. Jagan Mohan, IAS, Commissioner, Dept. of Agriculture, Govt. of Telangana was the chief Guest of the meet.



Dr. Kamaljit Ray during the meeting at Hyderabad

Dr. N. Chattopadhyay, Sc. 'F' attended the meeting of Selection Committee for the teachers posts in the discipline of Agricultural Meteorology held at Anand Agricultural University (AAU), Anand on 8th February, 2017 and also attended the XIII Agricultural Science Congress at University of Agricultural Sciences (UAS), Bengaluru on 21st February, 2017 and delivered a lecture on ‘Combating Effect of Climate Change and Climate Variability on Indian Agriculture through Smart Weather Forecasting and ICT Applications’.



Dr. N. Chattopadhyay, Sc. 'F' during the meeting

Dr. M. Mohapatra, Sc. 'G' participated as member in the 11th Meeting of Technical Advisory Committee constituted by Director General of Lighthouse and Light Ships (DGLL) held in **February, 2017** at NOIDA, UP. All the Area Cyclone Warning Centres (ACWCs) and Cyclone Warning Centres (CWCs) of IMD were provided the procedure to upload the coastal weather bulletins on real time in the uploading system of DGLL through remote log in.

Shri R. Balasubramanian, Scientist 'D' participated in Stakeholders Meeting under Gramin Krishi Mausam Sewa (GKMS) scheme held at Agro Climate Research centre (ACRC), Rajendranagar, Hyderabad on 8th February, 2017 and made presentation on "Establishment of District Agromet Units (DAMUs) and Block level forecast based advisory" in the meeting and also attended Stakeholders Meeting under Gramin Krishi Mausam Sewa (GKMS) scheme held on 27th February, 2017 at Tirupati.

Dr. S. D. Attri, Sc. F, visited Mumbai to discuss with Principal Secretary and other senior officers of Agriculture Department, Govt. of Maharashtra and officials of Regional MC, Mumbai, Agrimet Pune and Commissioner, Agriculture Pune regarding augmentation of Agromet advisory to block level, improvement in observations & forecast, increase in numbers of farmers for SMS dissemination etc. during 12-15 February, 2017.

Shri Anand Sharma, Sc. 'F', Shri Bikram Singh, Sc. 'E' and Shri Rohit Thapliyal, Sc. 'B' attended a meeting with Additional Secretary, Government of Uttarakhand regarding Block level agriculture forecast and sharing the

farmer data base of Uttarakhand on 14th February, 2017.

Dr. K. K. Singh, Scientist 'F', attended a meeting on 15th February, 2017 at Patna called for "Improving the outreach of Agro Meteorological Advisories to farmers in Bihar" between the IMD officials, Director of Agriculture, Govt. of Bihar and other state agriculture officers from Bihar.

Dr. K. J. Ramesh, DG, IMD and Shri K. N. Mohan, Head MTI and officers of NAL had a meeting with Director National Aerospace Laboratories for further deployment of Aviation weather observing systems and new Drishti Transmissometers, from 10th to 12th March at Bengaluru.

Shri Anand Sharma, Sc. 'F', attended a meeting with Addl. Chief Secretary (Agriculture) Shri Ranbir Singh, Govt. of Uttarakhand, regarding nomination of Nodal Officer for GKMS project by the state government and for providing data base of farmers for dissemination of Wx based agro advisories through SMS on 14th March, 2017.

Dr. K. K. Singh, Sc. 'F' attended meeting with Financial Commissioner Shri P. K. Jain, Government of Jammu and Kashmir at New Delhi regarding AWS requirement for crop insurance on 24th March, 2017.

Dr. K. J. Ramesh, DG, IMD attended 64th Meeting of Governing Body of National Water Development Agency (NWDA) on 27th March, 2017 in Vigyan Bhawan, New Delhi.



Meeting with officers of Bihar AMFU & MC, Patna

Shri Anand Sharma, Sc. 'F', attended and participated in the Wheat Procurement

meeting held at Krishi Bhavan on 15th February, 2017 and provided inputs. The meeting was chaired by Shri Utpal Kumar Singh, Additional Secretary, Ministry of Agriculture and Farmers Welfare.

Shri S. C. Bhan, Sc. 'F' attended inaugural event of Stakeholders Meet under GKMS on 20th February, 2017 at IARI, Delhi.

Dr. K. J. Ramesh, DG, IMD and Dr. M Mohapatra, Sc. G held a meeting with Secretary, DRDO, Ministry of Defence on 21st February, 2017 for joint collaborative campaign for observations from the field of cyclonic disturbances over the North Indian Ocean using the Unmanned Aerial Vehicle (UAV) available with DRDO.

डा. एस. एल. सिंह, वैज्ञानिक, 'एफ' ने 23 फरवरी, 2017 को National Navtex Centre, Mumbai में आयोजित 12 वीं TAC (Technical Advisory Committee) की मीटिंग में भाग लिया।

Dr. Kamaljit Ray, Regional Coordinator, Dr. Y. K. Reddy, Director M.C. Hyderabad and Dr. Balasuramanium, Sc. 'D', Pune attended the State level stakeholders meeting for the state of Andhra Pradesh on Agromet advisory services held at G.H. Sankara Reddi Conference Hall, IFT on 27th February, 2017. The Chief Guest was Dr. K. Dhananjaya Reddy, IAS, Commissioner of Agriculture, Department of Agriculture, and Govt. of Andhra Pradesh.

Shri Anand Sharma, Sc. 'F', attended and participated in the Crisis Management Plan (Drought) meeting held at Krishi Bhavan on 28th February, 2017 and provided inputs for the plan. The meeting was chaired by Shri Utpal Kumar Singh, Additional Secretary, Ministry of Agriculture and Farmers Welfare.

Dr. K. K. Singh, Sc. 'F', attended a meeting on 28th February, 2017 at Raipur called for "Improving the outreach of Agro Meteorological Advisories to farmers in Chattisgarh", between the IMD officials, Director of Agriculture, Govt. of Chattisgarh and other state agriculture officers.

Dr. M. Mohapatra, Sc. 'G' participated in the 2nd Meeting of MoES-ISRO sub-committee on Atmospheric Applications & Research at Space Application Centre (SAC), Ahmedabad on 10th March, 2017.

Marine Section of Climate Research and Services (CRS) organized a meeting on 4th April, 2017 at IMD, Pune with Cmde, Manoj Kumar Singh, Principal Director, Naval Oceanology and Meteorology, New Delhi, Capt. C. S. Panda from Eastern Naval Command, Vizag, Captain, Abhinav D. Barve from Western Naval Command & Senior Vice President Captain S. K. Yadav of Shipping Corporation of India, Mumbai, Captain Som Raj. The meeting was chaired by **Dr. K. J. Ramesh**, DGM, (New Delhi) presented the mementos and certificates for the selected ships of Indian Navy.

Dr. Sanjib Bandyopadhyay, Sc. 'F' attended the 35th meeting of the State Level Coordination Committee on Crop Insurance (SLCCCI) held on 7th April, 2017 at Conference room Agriculture Department, Howrah.

Dr. N. Chattopadhyay, Sc. 'F' attended the meeting on "Irrigation Scheduling and mapping for real time implementation for preparation of Agromet advisories" under GKMS projects on 11th April, 2017 at Indian Institute of Tropical Meteorology, Pune.

Dr. Jayanta Sarkar, Sc. 'F' and other officers attended a meeting with Director, Airport Authority of India Ahmedabad regarding relocation/construction of Met Centre and DWR building on 11th April, 2017.

Dr. Kamaljit Ray, Sc. 'F' attended a meeting on strengthening of outreach of districtwise Agromet advisory by dissemination of the message directly through SMS with Principal Secretary to Govt., Dept. of Agriculture & Farmer's Empowerment, Govt. of Odisha on 15th April, 2017 at Bhubaneswar.

Dr. A. K. Srivastava, Sc. 'F' attended a briefing meeting on "United Nations Framework

Convention on Climate Change Conference (UNFCCC)” on 17th April, 2017 at MoEF, New Delhi.

Pre-cyclone Exercise to share the latest advances in Cyclone Warning Services of IMD for the ensuing cyclone season was held at IMD, New Delhi on 17th April, 2017. Experts from Ministry of Home Affairs (MHA), NDMA, National Institute of Disaster Management, Central Water Commission, Indian Air Force, Indian Navy, IIT Delhi, NCMRWFC and various divisions of India Meteorological Department (IMD) participated in the meeting.

Shri K. Santosh, Sc. ‘E’ attended a meeting under the chairmanship of Addl. Chief Secretary, Govt. of Karnataka at Bangalore on 17th April, 2017 regarding sharing of database of farmers to IMD and utilising meteorological data under Karnataka State network of observatories and raingauge stations for issue of block level Agromet Advisories.

Pre-monsoon Meeting was presided by Dr. Sanjib Bandyopadhyay, Sc. ‘F’ at RMC Kolkata on 19th April, 2017 regarding Cyclone Warning Preparedness and Dissemination. Officers from different organizations of Govt. of WB & Govt. of India along with Public Sector like CESC, BSNL etc. attended the meeting.



Pre-monsoon Meeting at Kolkata

USER MEET ON “WEATHER SERVICES: EMERGING NEEDS AND WAY FORWARD”

Dr. K. J. Ramesh, DG, IMD presided a User Meet on “Weather Services: Emerging Needs and Way Forward” meet organized by RMC, IMD Chennai on 19th April, 2017. 61 delegates

from around 45 organizations including representatives from the State & Central Govt. offices. A booklet on Wx Forecast Terminologies in Tamil was released during the meet.



Shri S. B. Thampi, DDGM participated in the IITM/IMD “Lightning and Extreme Weather Events Workshop”

Review meeting of the programme and plan of activities during 2017-18 was held at NIOT, Pallikaranai, Chennai during 20-21 April, 2017. Dr. M. Rajeevan, Secretary to Government of India, MoES, Dr. K. J. Ramesh, DG, IMD New Delhi and Shri S. B. Thampi, Scientist ‘F’ attended the meeting.

Shri S. B. Thampi, Sc. ‘F’ participated as an Expert Committee Member in the meeting convened by the Addl. Chief Secretary and Development Commissioner, Govt. of Karnataka on 24th April, 2017 to discuss about providing technical assistance for taking up of Cloud Seeding Operation in Karnataka during Monsoon 2017.

Meeting of the Task Group constituted by MoES and ISRO to prepare a proposal for inclusion of meteorological payloads in the 4th generation INSAT satellites and continuation of program beyond 2024 was held at SAC, ISRO, Ahmedabad under the chairmanship of Dr. M. Mohapatra, Sc. ‘G’ and Head Services on 25th April, 2017. Dr. A. K. Mitra, Sc. ‘D’, NWFC also participated in the meeting.

Dr. K. J. Ramesh, DG, IMD, Dr. M. Mohapatra, Sc. ‘G’ participated in preparedness meeting organised by NDMA on the ensuing Monsoon season on 28th April, 2017.

“Thunderstorms: Socio-Economic Impacts, Early Warning and Risk Management”

IMD and Indian Meteorological Society, Kolkata Chapter jointly organized the National

Seminar on “Thunderstorms: Socio-Economic Impacts, Early Warning and Risk Management” under the auspices of Department of Disaster Management & Civil Defense, Govt. of West Bengal in association with CESC Ltd., RP-Sanjib Goenka Group at International Management Institute, Kolkata on 29th April, 2017.



Dr. Ajit Tyagi, Ex. DGM and others during the seminar

SAFAR Ahmedabad was inaugurated on 12th May, 2017 by **Honourable minister of earth sciences Dr. Harsh Vardhan** at AMC Community hall, Bodakdev, Ahmedabad. Director I/C, many officers and staff of this office attended the function. Dr. Jayanta Sarkar, Sc. ‘D’ proposed vote of thanks on the occasion. Dr. Manorama Mohanty, Sc. ‘D’ was honoured for her contribution in implementation of the SAFAR project.



Hon'ble Minister, Dr. Harsh Vardhan & officers of IMD

Dr. D. Pradhan, Sc. ‘G’, Sh. K. C. Sai Krishnan, Sc. ‘F’ and Sh. Bikram Singh, Sc. ‘E’ attended a meeting with Shri S. Ramaswamy, Chief Secretary, Govt. of Uttarakhand & Shri Amit Negi, Secretary, Department of Disaster Management, Govt. of Uttarakhand in connection with Installation of Radars and the Chardham Weather forecast on 15th May, 2017 at Secretariat, Uttarakhand.

Dr. Ranjit Singh, Sc. ‘F’ participated in the GKMS meeting with Director, Agriculture Dr. Gyan Singh, Uttar Pradesh government on 18th May, 2017.

Shri Anand Sharma, Sc. ‘F’ participated in the meeting at Krishi Bhavan on 24th May, 2017 for Drought management / Monitoring. The meeting was chaired by Shri Srinivas, Joint Secretary, Agriculture, Cooperation and Farmers Welfare Ministry of Agriculture.

Joint Agresco-2017

Dr. N. Chattopadhyay, Sc. ‘F’ attended Joint Agricultural Research and Development Meeting (Joint Agresco-2017) from 29-31 May, 2017 at Vasantrya Naik Maharashtra Krishi Vidyapeeth, Parbhani & gave presentation on Monsoon 2017 & Agriculture in Maharashtra.



Dr. N. Chattopadhyay gave presentation

Dr. S. D. Attri, Sc. ‘F’ participated in the meeting at Krishi Bhavan on 7th June, 2017 for Drought management / Monitoring chaired by, Addl. Secretary, Agriculture, Cooperation and Farmers Welfare Ministry of Agriculture.

Dr. K. K. Singh, Sc. ‘F’ and Dr. S. D. Attri, Sc. ‘F’ attended the Meeting on Implementation of GAMES for dissemination of weather forecast and crop advisory to farmers organized on 13th June, 2017 at Rajiv Bhawan, New Delhi.

Shri Bikram Singh, Sc. ‘E’ attended a meeting under the chairmanship of Chief Secretary, Uttarakhand on “Monsoon Preparation” at Secretariat, Uttarakhand on 30th June, 2017 and brief them regarding Advance of Monsoon in Uttarakhand.



Shri Bikram Singh during briefing advance of monsoon

A discussion meeting on 'State Level Climate Services -Forecasting Kerala State' was hosted at Thiruvananthapuram by M. C. Thiruvananthapuram on 2nd July, 2017. Shri A. S. Kati, Joint Secretary, MoES, Dr. K. J. Ramesh, DG, IMD, Dr. A. K. Sahai, Sc. 'G', Dr. D. S. Pai, Sc. 'F', Dr. A. K. Srivastava, Sc. 'F' Shri S. B. Thampi, Sc. 'F', Dr. S. Balachandran, Sc. 'F', Shri S. Sudevan, Sc. 'E', along with other dignitaries from IMD and other scientific institutions participated in the meeting.

Shri S. M. Metri, Sc. 'E', Dr Geeta Agnihotri, Sc. 'E', Shri G. Raja Ramesh, Met. 'B' attended meeting at Southern Regional Load Despatch Centre (SRLDC), Bengaluru Familiarization of web portal exclusively created by IMD, New Delhi for Power System Operation Co-operation (POSOCO) use and interpretation of weather data on 12th July, 2017

Presentation on Disaster Preparedness



Shri Bikram Singh, Sc. 'E' during the presentation

Shri Bikram Singh, Sc. 'E' attended a meeting on 14th July, 2017 on Disaster Preparedness and gave a presentation on "Monsoon-2017 forecast & Performance of Monsoon-2017 till date and operational products being generated by M. C. Dehradun" in the meeting chaired by the Chief Minister, Govt. of Uttarakhand and attended by other ministers, the Chief Secretary and the Secretaries/Heads of various departments of Government of Uttarakhand.

Dr. S. Balachandran, Sc. 'F', attended three Executive Committee meetings at NIOT on 15th July, 1st August and 7th September, 2017 regarding conducting Indian International Science Festival held at Chennai during 13-16 October, 2017.

1st Meeting of Expert Committee for development of Decision Support System (DSS) on Cyclones was held at Indian National Centre for Ocean Information Service (INCOIS), Hyderabad on 19th July to develop DSS on cyclones in line with Tsunami Warning System. **Dr. M. Mohapatra**, Sc. 'G' gave a presentation on Cyclone Warning Services of IMD.

Dr K. K. Singh, Sc. 'F' and Shri Anand Sharma, Sc. 'F', attended the meeting for Drought manual revision based on the observations from National Disaster Management Center, Government of Karnataka, Meeting was organized by MNCFC, Department of Agriculture & Cooperation on 25th July, 2017.

Shri Surender Paul, Sc. 'E' attended a meeting organized by Disaster Management Revenue Rehabilitation, Govt. of Haryana regarding forecast for the remaining part of monsoon season. Meeting was chaired by Shri M. S. Marwa, Member, NDA, Govt. of India at Mini Secretariat, Chandigarh on 27th July, 2017.

Dr. K. J. Ramesh, DG, IMD had meeting with Ms. Rita Sharma of United Kingdom Met. Office on 9th August, 2017 at British High Commission, New Delhi.

Dr. M. Mohapatra, Sc. 'G' participated in the 1st meeting of Working Group 5, NITI Aayog on "Data/Information for Informed Decision Making by Multiple Stake holders" to discuss the current progress of working task force and decide roadmap to progress ahead at Indian National Science Academy, New Delhi on 18th August, 2017.

Shri S. Sengupta, Sc. 'E' accompanied by Shri Anand Shankar, Sc. 'B' attended Bihar State Disaster Management Authority annual meeting under chairmanship of Hon'ble Chief Minister of the state on 6 September, 2017.

Dr. S. C. Sahu, Sc. 'F' attended Meeting on Vector Borne Diseases at Directorate of Public Health, Bhubaneswar on 12th September, 2017.

Dr. S. Balachandran, Sc. 'F' attended a meeting on "Achievements of the previous Plan Schemes and Future strategy for the schemes approved for implementation during 2017-20 and beyond" convened by Secretary, MoES at New Delhi in 15th September, 2017. S/Shri Y. K. Reddy, Sc. 'F', S. M. Metri, Sc. 'E' and S. Sudevan, Sc. 'E' participated in the meeting.

Shri Surender Paul, Sc. 'E' attended a meeting with Secretary MoES, New Delhi to discuss the achievement of previous schemes and future strategy for schemes approved for implementation during 2017-20 at New Delhi on 15th September, 2017.

Dr. S. Balachandran, Sc. 'F' participated in the meeting to "Kick-off" the project, "A Platform for Integrated Governance in Metropolitan Chennai : Developing Resilience Scenarios and Strategies through Participatory Simulations" under the Chairmanship of the Principal Secretary/Commissioner, Revenue Administration and Disaster Management and Mitigation Department, Chennai at Chennai on 18th September, 2017.

Dr. S. Balachandran, Sc. 'F' participated in the meeting on preparedness of North East Monsoon, convened by the Chief Secretary, Government of Tamil Nadu at Secretariat on 22nd September, 2017.

Shri Bikram Singh, Sc. 'E' attended a meeting on 25th September, 2017 at ITM, DRDO, Mussoorie in connection with installation of DWR at ITM campus, Mussoorie.

Dr. K. K. Singh, Sc. 'F' and Dr. Ranjit Singh participated in State level Rabi Productivity meeting - 2017 cum workshop "On delivery of Agro-Meteorological Advisories Services (AAS) at block/village level through SMS to farmers of U.P." held at Krishi Bhavan, Lucknow on 4th October, 2017.

Dr. Somenath Dutta, Sc. 'F' attended a meeting on 5th October, 2017 in Remote Sensing Application Centre (MHRAC), Mumbai in connection with the "UNICEF sponsored project on monitoring four major diseases in Maharashtra".

Dr. K. J. Ramesh, DG, IMD, Dr. K. K. Singh, Sc. 'F' and Dr. S. D. Attri, Sc. 'F' participated in the meeting chaired by DG, ICAR and Secretary, DARE along with DDG (Agric. Ext.), ADG (Agric Ext.) and other officers of ICAR for discussion of "MoU between both the organizations, establishment of DAMUs at KVKs of ICAR and augmentation of Agromet Advisory Service in the country" on 6th Oct., 2017.

Dr. G. C. Debnath, Sc. 'F' attended a meeting regarding "Construction of New ATC Tower and Technical Block" at NSCBI Airport organized by RED AAI, Kolkata on 9th October, 2017 and in this regard a joint Inspection was also made on 12th October, 2017.

Shri K. S. Hosalikar, Sc. 'F', Smt. Dr. Manorama Mohanty, Sc. 'D' and Shri K. G. Kacha, Met. 'A' attended a meeting, with Director, S.V.P.I. Airport, Ahmedabad to discuss the matter regarding "Relocation/ construction of new Met. Centre building and installation of DWR at SVPI Airport" on 10th October, 2017.

Shri Bikram Singh, Sc. 'E' attended meetings on 10th October, 16th October, 18th October and 23rd October, 2017 at Secretariat, Govt. of Uttarakhand in connection with Hon'ble Prime Minister visit to Dehradun and Mussoorie on 26-27 October, 2017 and Shri Kedarnath ji on 20th October, 2017 and provided weather briefing. The meeting was chaired by Chief Secretary, Govt. of Uttarakhand.

Dr. K. J. Ramesh, DG, IMD and Shri L. Ramesh Babu, Sc. 'D' AMO Bengaluru participated in a meeting with Shri Arunachalam, General Manager, KIAL and Smt. Pushpa Pandey, Asst. Manager, KIAL regarding the provision of "Drishti RVR instruments" at KIA airport on 16th October, 2017.

Dr. S. D. Attri, Sc. 'F' participated in the meeting chaired by Principle Secretary, Agriculture, Government of Gujarat along with Head, MC Ahmedabad, Director Agriculture and Nodal Officer, Gujarat on 26th October, 2017 for “augmentation of Agromet Services and holding of District Level Stakeholders”.

Dr. M. Mohapatra, Sc. 'G' participated in the 3rd Meeting of the Peer Group of Building Materials and Technology Promotion Council (BMTPC) for updation and revision of Vulnerability Atlas of India with respect of earthquakes, wind/ cyclones and floods on 1st November, 2017.

11th Arm of GKMS and FASAL at Raipur

Dr. K. J. Ramesh, DG, IMD, Shri R. R. Mali, Scientist 'F' and Dr. P. Guhathakurta, Scientist 'F' were attended the 11th Annual Review Meeting (ARM) of “Gramin Krishi Mausam Seva (GKMS)” and 7th ARM of “FASAL, Scheme” held at Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh, from 15-18 November, 2017 to review the progress on content of weather forecast for agriculture, agromet advisory, dissemination and feedback mechanism.



Dr. K. J. Ramesh, DG, IMD and other officers during the meeting

Dr. S. K. Peshin, Scientist 'F' attended the meeting on “Present air pollution situation in Delhi” under the chairmanship of Hon'ble Lt. Governor, Delhi on 17th November, 2017 in the conference room, Raj Niwas, Delhi.

User Meet

Dr. K. J. Ramesh, DG, IMD and other officials of IMD attended “User Meet” organized by MC Hyderabad on 23rd November, 2017. Meeting

was organized by MC Hyderabad in the presence of Agriculture Commissioner of Telangana, State Agriculture officers, Scientists from CRIDA and local farmers.



Dr. K. J. Ramesh, DG, IMD other officers of other departments during the user meet at Hyderabad

RFP meeting in connection with procurement of 11 nos. of C-Band Dual Polarimetric DWRs was arranged through V.C. at MC Bengaluru on 28th November, 2017. The following delegates attended the meeting, Dr. P. Radhakishan, Sc. 'H', LRDE, Bangalore, Chairman, Dr. V. K. Anandan, Sc. 'G', RDR, ISTRAC, ISRO Bangalore.

Shri Virendra Singh, Sc. 'E', Dr. R. K. Giri, Sc. 'E', Dr. A. K. Mitra, Sc. 'D', Shri Amit Kumar, Sc. 'B' and Shri S. K. Mukherjee, Met. 'A' attended the “Incremental Preliminary Design Review (PDR) meeting of Multi Mission Data Reception and Processing System (MMDRPS)” at Antrix Corporation Limited ISRO Bengaluru during 29 November to 1 December, 2017.

Dr. A. K. Sahai, Head, CR&S attended a discussion meeting on “Improving the use of extended range forecast for Risk Management in Agriculture and also to Refine Known Crop Weather Data to improve Crop Advisory Quality” and delivered a lecture on the “Role of MJO etc. in Extended Range Forecast” for the benefit to Scientist, Research Fellows and Staff of Agromet Division of IMD New Delhi on 13-14 December, 2017.

Dr. Sanjib Bandyopadhyay, Sc. 'F', attended “10th Meeting of the Standing committee of Eastern Zonal Council” held at Kolkata on 21st December, 2017 organized by Inter State Council Secretariat, Ministry of Home Affairs, Govt. of India. Dr. Bandyopadhyay informed the Council in connection with installation of Radar at MC Ranchi.

6.3. TRAINING

Thirteen Students (CSSTEAP) from seven countries of the **Asia-Pacific region**, who are undergoing training on 'Satellite Meteorology & Global climate' of SATMET-9 course at Space Applications centre (ISRO), Ahmedabad, visited DWR Chennai, along with the course director, as part of their South India study tour on 27th January and were explained about the functions of DWR and utility of its products.

Shri S. B. Thampi, Sc. 'F' & First Appellate Authority and Ms. B. Amudha, Sc. D' & Central Public Information Officer participated in the 42nd Training Programme on the Right to Information Act 2005 conducted by Institute of Public Administration held at Bengaluru during 3-4 February, 2017.

Dr. K. K. Singh, Sc. 'F' attended inaugural event of training on "New-Dimensions in Agrometeorology for improvement of Agromet Advisories: Capacity building" to the AMFU scientists organized at Rajasthan Agricultural Research Institute, Jaipur during 6-15 February, 2017 and also delivered a talk on Strengthening outreach of Agro Advisory Services to farmers.

An on-site training programme for **Aviation Weather Forecasters** was conducted at Meteorological Office, Indira Gandhi International Airport on 8th February, 2017. The experts from satellite, Radar, environment meteorology, numerical wx prediction modeling & forecasting divisions of IMD, New Delhi participated and presented lectures in the training programme.

Training programme in operation and maintenance of **Airport Meteorological Instruments (AMI)** was conducted at E Lab from 20th to 24th February, 2017.

Shri S. B. Thampi, Sc. 'F' attended training programme on Public Procurement at National Institute of Finance Management at Delhi during 5-6 June, 2017.

Shri Surender Paul, Sc. 'E' attended training programme on Public Procurement for Government Officers at National Institute of Financial Management, Faridabad during 3-8 July, 2017.

Dr. Jayanta Sarkar, Scientist 'F' attended "Training programme on Public Procurement for Government Officers" at National Institute of Financial Management, Pali, Faridabad, Haryana, during 10-15 July, 2017.

Dr. M. Mohapatra, Scientist 'G' participated in the training workshop on "Review and Updation of Disaster Management Plan of Central Ministries" organised by National Institute of Disaster Management (NIDM), Ministry of Home Affairs (MHA) at New Delhi on 17th July, 2017.

"Introductory Crop Micrometeorology"



Dr. N. Chattopadhyay, Sc. 'F' & others during training

Dr. N. Chattopadhyay, Sc. 'F' as Chief guest inaugurated the Training programme on "Introductory Crop Micro - meteorology" organized by Mahatma Phule Krishi Vidyapeeth, Department of Agriculture Meteorology, Pune held on 7th September, 2017 at Pune.

RIMC, Kolkata conducted "Instrument Maintenance Training Program" from 23-25 October, 2017 for Maintenance of Observatories all over the region attended by officials of ZIMC, RMC, Kolkata. Dr. Sanjib Bandyopadhyay, Scientist 'F', delivered a talk on new DFPR and Procurement through GeM on this occasion.

Dr. A. K. Sahai, Sc. 'G' visited Ahmedabad from 5-7 December, 2017 to attend a training workshop on "Seasonal Climate Forecasting for

SOUTH ASIA” organized by SAARC Disaster Management Centre (JU) Gandhinagar, Gujrat and delivered a talk on “Regional Climate Centre - Climate Monitoring and Prediction Products and Services for South Asia”. Dr. D. S. Pai, Sc. ‘F’ and Dr. Somanath Dutta, Sc. ‘F’ also attended the workshop and delivered lectures.

25 trainees from SAARC visited M. C. Ahmedabad on 7th December, 2017 and Dr. Jayanta Sarkar, Scientist 'F' delivered lecture to them regarding weather forecasting.

WMO's Tropical Cyclones Forecasters Training 2017



Dr. K. J. Ramesh, DG, IMD, Dr. M. Mohapatra, Sc. ‘G’, and participants of RSMC Training 2017

The WMO's Tropical Cyclones Forecasters Training 2017 was conducted by Regional Specialised Meteorological Centre (RSMC), New Delhi during 11-22 December, 2017 at India Meteorological Department (IMD), New Delhi. The training aimed at capacity building of the tropical cyclones (TCs) forecasters in the region by understanding the latest developments in observations, monitoring, modeling, prediction and warning services of TCs over the region and carrying out the practical examples in these aspects. There were 19 participants including 3 from WMO/ESCAP Panel member countries viz., Myanmar, Oman and Sri Lanka, 6 from Area Cyclone Warning Centres (ACWCs) and Cyclone Warning Centres (CWCs) of IMD and 9 from National Weather Forecasting Centre & RSMC New Delhi. The training programme was inaugurated by Dr. K. J. Ramesh, D. G., IMD on 11th December. The resource persons for this training programme included experts from IMD, National Centre for Medium Range

Weather Forecasting (NCMRWF) and Indian Institute of Technology (IIT), Delhi.

6.4. LECTURES

Dr. S. C. Sahu, Sc. ‘F’, delivered lecture on Understanding Heat Island Effect and urban agriculture and Global warming vs Heat Island Effect at MI & WU, Barmunda, Bhubaneswar on 3rd January, 2017.

Dr. K. K. Singh, Scientist ‘F’ and Mrs Priyanka Singh, Sc. ‘B’ attended and delivered lecture in the training on “Climate Resilient Technologies for sustainable agriculture production under Rain-fed situation” organized by Directorate of Extension RVSKVV, Gwalior on 12-14 January, 2017 at College of Agriculture, Indore.

Dr. M. Mohapatra, Sc. ‘G’ participated as an invited speaker in the 3- day residential training programme on Global Warming, Climate Change and Disaster Management - Future Perspective organised by the School of Public Health, PGIMER, Chandigarh in collaboration with Punjab University, Chandigarh and delivered a lecture on Early Warning Systems & Weather Extremes on 23rd February, 2017.

Shri Bikram Singh, Scientist ‘E’, was invited to deliver a lecture on ‘Thunderstorms & its Socio Economic Impacts’ at IIRS, Dehradun by Indian Meteorological Society (I.M.S.) and welcomed by President, IMS on 27th March, 2017.



Shri Bikram Singh, Sc. ‘E’ during the lecture

Sanjib Bandyopadhyay, Scientist ‘F’ delivered a lecture on Genesis Evolution, Tracking and Intensity Prediction & Warning dissemination mechanism for Tropical Cyclone at Administrative Training Institute, Salt Lake City, Kolkata on 6th April, 2017.

Shri Anand Sharma, Sc. 'F' and Priyanka Singh Sc. 'B' Participated and Shri Anand Sharma delivered a talk on "Gramin Krishi Mausam Seva: Current Status and Future Plans" at the Stakeholders meeting of Agriculture Officers of Bihar Government at Patna on 15th April, 2017. The Principal Secretary, Agriculture Bihar Government appreciated the presentation and assured support for the project

Dr. Jayanta Sarkar, Scientist 'F' delivered a lecture on Hazard detection, Monitoring, Forecasting and Information Dissemination Mechanism in the state at GIDM on 26th April, 2017, at Gandhinagar.

Shri Bikram Singh, Sc. 'E', MC, Dehradun delivered a lecture on 'Weather forecasting for effective disaster management with special reference of Uttara-khand state' at Uttarakhand Administrative Academy, Nainital on 9th June, 2017.

Dr. S. Balachandran, Sc. 'F' delivered a lecture on "Disaster Management and Mitigation Measures" to State Government Disaster Management officials on 20th June, 2017 at Anna Institute of Management, Chennai.

Dr. M. Mohapatra, Sc. 'G' delivered a lecture on 'Overview for hazards and determining the possibility for establishing early warning system and institutional mechanism for regional early warning system' in Training Workshop on Short Range Early Warning System for SAARC Member Countries organised by SAARC Disaster Management Centre at Ahmedabad on 21st June, 2017. Dr. M. Mohapatra also participated as a panelist in the panel discussion held in the same evening. Dr. S. K. Roy Bhowmik, Scientist 'F', NWP delivered a lecture on "Severe Weather and Early Warning System for SAARC region" in the workshop.

Dr. D. R. Pattanaik, Sc. 'E' delivered an invited talk on "Extended range forecast and its use during monsoon season" on 23rd June, 2017 in the Department of Agro-meteorology, Indira Gandhi Krishi Vishwavidyalaya, Raipur.



Dr. Pattanaik with officials of IGKV, Raipur

Dr. D. S. Pai, Sc. 'F' delivered a special talk on the "Seasonal Prediction Activities of MoES" in the colloquium organized jointly by IMS Cochin Chapter and Department of Atmospheric Sciences' CUSAT, Cochin on 5th July, 2017.

Shri Surender Paul, Scientist 'E' attended lecture on advances in climate change delivered by Dr. Akhilesh Gupta, Adviser, Head Climate Change, Department of Science & Technology, Chandigarh at Mahatma Gandhi State Institute of Public Administration, Chandigarh on 17th August, 2017.

Dr. K. J. Ramesh, DG, IMD, was guest of honour at the DST's National Workshop on 'Urban Climate: Science, Impacts and Adaptation' organized by School of Earth Ocean and Climate Sciences of IIT, Bhubaneswar on 21st September, 2017.

Dr. K. K. Singh Sc. 'F' and Dr. S. D. Attri, Sc. 'E' participated in "2017 Asia Pacific Agriculture Insurance Forum" held in New Delhi during 26-27 September, 2017. Dr S. D Attri delivered lead talk on "Advances in Meteorological Observations and Services".

Shri J. R. Prasad, Scientist 'E', RMC Nagpur delivered a lecture on the topic "Weather and Climate variability in and around Nagpur" in WHO Workshop to be held during 31 October to 3rd November, 2017 at CSIR-NEERI Nagpur.

Dr. N. Chattopadhyay, Scientist 'F' delivered lecture on "Genesis and future strategies of Agromet Advisory Services" in the country in the "National Training Programme on Fundamentals of Agricultural Meteorology" organized by Mahatma Phule Krishi

Vidyapeeth, Department of Agricultural Meteorology, Centre of Advance Faculty Training (CAFT) in Meteorology, Pune on 8th November, 2017.

Dr. Anupam Kashyapi, Sc. 'F' visited as Guest Faculty for delivering lecture for "PGDDM 1st Semester at Disaster Management Institute, (DMI), Govt. of Madhya Pradesh" on 27th November, 2017 at DMI Hostel, Bhopal.

Shri S. C. Bhan, Sc. 'F', delivered two invited lectures on "Agro Meteorological data Collection Analysis and Management" for ICAR Technical staff held at ICAR-CRIDA, Hyderabad during 11-23 December, 2017.

Shri Anand Sharma, Sc. 'F', AASD, delivered invited lecture on "Early Warning System and Weather Forecasting" at Uttarakhand Academy of Administration, Nainital on 21st December, 2017.

Dr. Jayanta Sarkar, Sc.'F' delivered lecture on "Weather forecasting in Gujarat state at KVK, Vadodara" on 22nd December, 2017 with regards to Farmers awareness program (FAP).

Dr. S. D. Attri, Sc. 'F' participated and addressed the farming community in FAP organised by KVK Vadodara on 22nd December, 2017 which was also attended by Director (Ext), Dean (Ag.), Senior officers of AAU Anand, KVK, Director MC Ahmedabad & 300 farmers.



Dr. S. D. Attri, Sc. 'F' addressing the farmer

Dr. K. K. Singh, Scientist 'F' and Dr. Kripan Ghosh, Scientist 'E', AASD delivered lecture in Training programme cum workshop on "Use of

Extended Range Forecast For Development of CRM Tool in Agriculture" during 23-30 Dec., 2017 at University of Agriculture & Horticultural Sciences, Shivmogga, Karnataka.

6.5. AWARENESS & OUTREACH PROGRAMME

Farmers' awareness programmes were organised at 41 Agromet Field Units across the country in Namakkal, Kovipatti, Ooty, Modipuram, Ranichouri, Adhurai, Bhatinda, Brahmawar, Chennai, Chhindwara, Delhi, Diphu, Hyderabad, Jagtiyal, Kalyani, Kanpur, Kharagpur, Navile, Pantnagar, Solan, Sonitpur, Thrissur, Tikamgarh, Vellayani, Majihan, Pundibari, Lembuchera, Jahnapani, Rajouri, Portblair, Kakdwip, Faridkot, Igatpuri, Sindewahi, Pusa, Agwanpur, Sriganganagar, Kaul, Barapani, Coimbatore and Jammu.

India International Science Festival (IISF-2017)



Outreach programme on 26th Sept., 2017 at Chennai

RMC, Chennai organized jointly by Ministry of Science and Technology, Ministry of Earth Sciences, Vijnana Bharati and National Institute of Ocean Technology in connection with Third India International Science Festival (IISF) a outreach programme on 26th September, 2017 to popularize the event amongst school and college students. About 35 UG/PG Physics students from Women's Christian College Chennai and about 45 school students from KRM Public School, Chennai attended the programme. Officers, Staff, retired officers of RMC Chennai and members of IMS Chennai Chapter also attended the programme. Dr. N. P. Rajive, Vijnana Bharathi (VIBHA), New Delhi emphasized the need on National Meet on Social Organisation and

Institutions and delivered lecture extemporarily on the subject. Dr. Sekar Raghavan, Director, Rain Centre, Chennai delivered key note address on "Rain Water Harvesting" and Shri N. S. Chidambaram, a retired science teacher and Editor of Ariviyal Oli - A science magazine in Tamil - spoke on the importance of popularizing science and technology in the society.

The three hourly Nowcast warnings for Severe Weather events for any area issued by IMD are automatically disseminated through mKisan portal of Govt. of India to all the registered farmers of that area in the form of local language SMS. This mKisan Portal link was successfully shifted from old window based Platform to Linux based Platform with the help of NWP Division of IMD & officers from Ministry of Agriculture.

Visitors

Dr. R. Rajeevan, Secretary MoES, Dr. Gopal Iyenger, Programme Advisor and Dr. K. J. Ramesh, DGM to discuss about the present and future activities under GKMS scheme of the division on 12th January, 2017 at AASD New Delhi.

Shri Anil Patinge, Met. 'B' and Shri M. A. Pachankar, SA participated and explained various activities of Agrimet Division to the visitors in the Krushik, India's biggest 'Live Demo and Agri. Expo' held at KVK, Baramati during 19-22 January, 2017.



Krushik at KVK, Baramati

Team from UK Meteorological Office headed by its Chief Executive Officer visited India Meteorological Department (IMD) on 7th

February. Dr. M. Mohapatra, Scientist 'G' made a presentation on Activities of India Meteorological Department (Present and immediate future).

Dr. Zaid S. Hadpad, Asstt. Section Manager Group Supervisor Jet Propulsion Lab, California Institute of Technology, NASA visited IMD office on 15th February, 2017.



Dr. K. J. Ramesh, DGM with delegation of UK

A delegation of UK Ocean experts visited IMD and held meeting with Dr. K. J. Ramesh, DGM and Dr. M Mohapatra, Scientist 'G' on 20th February, 2017 to build cooperation between IMD and UK Met. Office.

A team from United Nations Development Programme (UNDP) visited various units of IMD, New Delhi on 17th April, 2017 in connection with the preparation of a documentary film on Weather Events and their forecast.

Team from **United Nations Development Programme** visited various work stations of IMD for the documentary film on weather events on 17th April, 2017.

Approximately 38 students from GIDM, Gandhinagar visited Met. Centre on 19th April, 2017. They visited observatory upper air section and were familiarized with the procedure of weather forecasting.

Hon'ble Minister Visit at Agartala

Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology & Earth Sciences visited Meteorological Centre and Doppler Weather Radar, Agartala on 3rd June, 2017.



Hon'ble Minister during his visit Agartala

Visit of J.S., MoES to RMC Kolkata



Shri A.S. Khati, J.S., MoES during his visit at Kolkata

Shri A. S. Khati, Joint Secretary MoES had visited RMC Kolkata (Alipore) for the meeting with DDGM, RMC Kolkata & all officers & staffs, regarding administrative issues and services, on 24th June, 2017.

Ms. Dilshanie Perera, Ph. D. scholar, from Stanford University, USA visited India Meteorological Department during 7-15 August, 2017. During her visit, Dr. M. Mohapatra, Scientist 'G' explained to her various aspects of forecasting services and role of IMD in disaster management within the country and among various WMO/ESCAP Panel member countries. She was also briefed about various observational aspects including satellite, radar, telecommunication and numerical weather prediction models for cyclone monitoring.

Three Japanese researchers, Dr. Yusuke Yamane from Tokoha University, Dr. Azusa Fukushima from Kobe Gakuin University and Dr. Toru Terraio from Kagawa University visited IMD, Pune on 21st August, 2017 to discuss about the data rescue of old observational data.

IAF officer trainees visited **Electronic Lab, O/o CRS, Pune** on 11th September, 2017.

30 JCO/NCO from College of Military Engineering, Dapodi visited **MTI, Pashan** on 11th September, 2017.

140 students from D. Y. Patil Engineering, Warle, Talegaon visited **MTI, Pashan** on 22nd September, 2017.

72 Students from Kamalnayan Bajaj Engineering College, Baramati visited **MTI, Pashan** on 30th September, 2017.

43 students and 3 faculties from **D. Y. Patil college** of Engineering, Ambi visited **MTI, Pashan, Pune** on 4th October, 2017. Dr. Anupam Kashyapi, Scientist 'F', Dr. D. M. Rase, Meteorologist 'B', Shantanu Waykar, Met. 'A', Shri A. B. Bhole, Met. 'A', explained the different activities of MTI such as Mandate of IMD, observatory, instruments etc.

32 Students from Siddhant college of Engineering visited **MTI, Pune** on 12th October. Dr Anupam Kashyapi, Scientist 'F', Dr. D. M. Rase, Met. 'B', Shantanu Waykar, Met. 'A', Shri A. B. Bhole, Met. 'A', explained the different activities of MTI such as Mandate of IMD, observatory, instruments etc.

30 students from New Horizon Public School, visited Sat. Met Division on 25th October, 2017 and 25 students of Northcap University, Gurugram visited "Sat. Met. Division" on 31st October, 2017.



Students at M.C. Dehradun

A group of 155 Students alongwith 4 faculty member from Saint Kabeer Academy, Dehradun visited "M.C. Dehradun" on 16th November, 2017. Student's along with faculty members were briefed about different

instruments of Meteorological observatory and a general lecture on weather and climate was given by the staff members of M.C. Dehradun.

197 students from DLF public school, Ghaziabad visited "Satellite Meteorology Division" during the period from 20-23 November, 2017.

Prof. (Dr.) Nitin Raghunath Karmalkar, Hon'ble Vice Chancellor, Savitri bai Phule Pune University visited this office on 21st November and had discussion with all the Heads of Division and delivered a lecture on "Koyana Seismicity".

30 students from Shiv Nanda School, Delhi; 35 students from DPMI India, and 15 Scientists from ICAR visited "Sat. Met Division" on 21st, 28th and 29th November, 2017 respectively.

Prof. Adam H. Sobel, Professor of Applied Physics and Applied Mathematics and of Earth and Environmental Sciences, Department of Applied Physics and Applied Mathematics, Department of Earth and Environmental Sciences, Columbia University, New York, USA visited "CR&S, Pune" office on 7th December, 2017 and had meeting with senior officers of IMD, Pune.

Shri Navin Bhan from UNDP, Fiji attended the meeting regarding Training for Meteorologists of seven pacific island countries on 11th December, 2017.

A group of 40 Students alongwith 2 faculty member from Sri Sai Baba International Public School, Rishikesh visited "M.C. Dehradun" on 12th December, 2017.



Students at M.C. Dehradun

Twenty (20) students from Naval College, Cochin visited "IMD, Pune" on 4th December, 2017.

Twenty One (21) trainees from Naval base Kochi visited "IMD, Pune" on 6th December, 2017 for familiarization training.

Total 250 students from Arunodya Public school New Delhi, DPS R. K. Puram New Delhi and Tagor International School visited "Sat. Met. Division" at H.Q. during December, 2017.

Shri M. A. Pachankar, Met. 'A' and Shri S. Y. Wagmare, S. A. participated in the 9th AGROVISION - 2017 held during 10-13 November, 2017 at Nagpur, Maharashtra.



Officials of IMD during 9th AGROVISION - 2017

Foreign Deputation of IMD Scientists

Dr K. J. Ramesh, DG, IMD, was on foreign deputation to Abu Dhabi, United Arab Emirates to attend Sixteenth Session of Regional Association-II of WMO during 12-16 February, 2017.

Dr. R. K. Giri, Sc. 'E', was on foreign deputation to Abu Dhabi, United Arab Emirates to attend Seventh Regional Conference on Management of Meteorological and Hydrological Services in Regional Association-II (RECO-7) during 10-11 February 2017 & Sixteenth session of Regional Association-II during 12-16 February 2017.

Dr. N. Chattopadhyay, Sc. 'F' attended the Expert Team Meeting of Commission for Agricultural Meteorology (CAgM), World Meteorological Organization, Geneva viz., ET 1.1-'Expert Team on Live stock, Poultry and

Inland Fisheries : Agromet Services and Products' and ET 1.2-'Expert Team on crops: Agromet Services, and Products' during 15 to 17 March, 2017 in Pousada Candongas da Serra, Tiradentes, Brazil.



CAGM Meeting at Tiradentes, Brazil

Shri S. B. Thampi, Sc. 'F' was on foreign deputation to Neuss, Germany during 15-17 March, 2017 for Factory Acceptance Test (FAT) of C-Band Doppler Weather Radar (DWR) being purchase by IITM, MoES.

Dr. R. Suresh, Sc. 'F', was on foreign deputation to Bangkok, Thailand during 20-22 March, 2017 to participate in the 15th meeting of the Asia/Pacific Meteorological Information Exchange Working Group (MET/IE WG/15).

Dr. Ashim Kumar Mitra, Sc. 'D' was on foreign deputation to Madison (U.S.A.) during 20-24 March, 2017 to attend joint meeting on Research & Data Working Group on Global Space based inter-Calibration System (GSICS).

Dr. M. Mohapatra, Sc. 'G' was on foreign deputation to Ushuaia, Argentina during 21-24 March, 2017 to participate in the 7th Session of the Executive Council Panel of Experts on Polar and High Mountain Observations, Research and Services (EC-PHORS-7).

Dr. D. S. Pai, Sc. 'F' was on foreign deputation to Nanjing, China during 21-24 March, 2017 to participate in WMO's International Workshop on Climate Services Information System (CSIS) Operations and Co-ordination.

Dr. Sunil Kumar Peshin, Scientist 'G' was on foreign deputation to Geneva(Switzerland) during 28-30 March, 2017 to participate in the

10th meeting of the Ozone Research Managers of the Parties of the Vienna Convention.

Dr. Arvind Kumar Srivastava, Sc. 'F' was on foreign deputation to Beijing, China during 17-28 April, 2017 to attend International Training Course on Global Framework for Climate Services (GFCS) & 13th Session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia (FOCRAll).

Dr. A. K. Sahai, Sc. 'G', Dr. D. S. Pai, Sc. 'F', Dr. O. P. Sreejith, Sc. 'D' and Ms. A. B. Bandgar, Sc. 'B' were on deputation in 10th Session of the South Asian Climate Outlook Forum (SASCOF-10) from 24-26 April, 2017 at Thimpu Bhutan.

Shri Vijaya Kumar Valluri, Met. 'B', was on deputation to Alanya, Antalya, Turkey during 24-28 April, 2017 to attend International Training Course on Metcap Plus Visualization Package and TAC2BUFR Software.

Dr. K. J. Ramesh, DG, IMD and Dr. R. K. Giri, Sc. 'E' were on deputation to Geneva during 13-17 May, 2017 to participate in 69th Session of Executive Council Meeting of World Meteorological Organisation (WMO).

Shri Sankar Nath, Sc. 'D' was on deputation to Offenbach, Germany during 23-24 May, 2017 to participate in the OSCAR/ Surface Training Course in RA VI.

Dr. Mrutyunjay Mohapatra, Sc. 'G' was on deputation to Suva, Fiji during 25-26 May, 2017 as a member of Indian Delegation to participate in Sustainable Development Conference for the Pacific Islands.

Dr. S. K. Peshin, Sc. 'G' was on deputation to Jeju Island (Republic of Korea) during 11-16 June, 2017 to attend 45th Session of Co-ordination Group for Meteorological Satellites (CGMS-45) and CGMS Working Group.

Shri Sonam Lotus, Sc. 'D' was on deputation to Seoul, Republic of Korea during 13-23 June, 2017 to participate in the International Training Course on Weather Radar Operation.

Dr A. K. Das, Sc. 'D' was on foreign deputation to Japan during 2-29 July, 2017 to attend the knowledge co-creation program on 'Capacity Development for Flood Risk Management with Integrated Flood Analysis System (IFAS)' organized by Japan International Cooperation Agency (JICA) under the International Co-operation Program of the Govt. of Japan.

Dr. K. J. Ramesh, DG, IMD was on foreign deputation to Papua New Guinea during 22-25 August, 2017 to attend 9th meeting of Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES).

Shri G. K. Sawaisarje, Sc. 'D', was on deputation to participate in the Training Development Workshop for Regional Training Institutions in WMO Regional Associations II and V (RA-II & RA-V) held at Melbourne, Australia from 28th August to 1st September, 2017.

Dr Siddharth Singh, Sc. 'D' was on foreign deputation to Melbourne (Australia) during 28 August, 2017 to 1 September, 2017 to participate in the 16th WMO-GAW Brewer Operator Course-Asia/Pacific.

Dr. D. S. Pai, Sc. 'F' was on foreign deputation to Guayaquil, Ecuador to participate in WMO International Workshop on Global Review of Regional Climate Outlook Forums (RCOF) during 5-7 September, 2017.

Dr. Mrutyunjay Mohapatra, Sc. 'G' was on foreign deputation to Bahrain to participate in the Forty-fourth Session of WMO/ ESCAP Panel on Tropical Cyclones (PTC-44) held during 10-14 September, 2017.

Shri Narendra Nigam, Sc. 'F' was on foreign deputation to Beijing, China to participate in the International Training Course on Aeronautical Meteorology Services organised by WMO Regional Training Centre (RTC) during 11-22 September, 2017.

Dr. K. K. Singh, Scientist 'F' and **Dr. N. Chattopadhyay**, Sc. 'F' was on foreign

deputation to Dhaka, Bangladesh to participate in the Workshop on Participatory Development and Delivery of Agricultural Climate Services during 17-19 September, 2017.

Dr. A. K. Sahai, Sc. 'G' was on foreign deputation to Entebbe (Uganda) to participate in the Initial Planning Meeting on WMO Global Hydrological Status and Outlook Systems (HYDROSoS) during 25- 30 September, 2017.

Dr. D. S. Pai, Sc. 'F' was on deputation to Male, Maldives to attend the 11th Session of South Asian Climate Outlook Forum (SASCOF-11) from 25- 27 September, 2017.



Dr. D. S. Pai, Scientist 'F' and other participants

Shri B. P. Yadav, Sc. 'F', was on foreign deputation to Bangkok (Thailand) to participate in the Expert Group Meeting on "Regional Co-operation in Early Warning for Trans boundary River Basin Floods, Flash Floods and Land-slides in Asia and Pacific" during 9-11 October, 2017.

Shri Virendra Singh, Sc. 'F', was on foreign deputation to Vladivostok City (Russia) to participate in the "Eighth Asia/Oceania Meteorological Satellite Users Conference (AOMSUC-VIII) and Associated" during 16-21 October, 2017.

Shri K. N. Mohan, Sc. 'F', was on foreign deputation to Bridgetown (Barbados) to participate in the "13th WMO Symposium on Education and Training (SYMET-XII) and Quadrennial Meeting of Directors of WMO Regional Training Centres (RTCs)" during 30 October to 2 November, 2017.

Shri Asok Raja, Sc. 'B', participated in Knowledge Co-Creation Program on “Promotion of Mainstreaming Disaster Risk Reduction” in Japan from 5-18 November, 2017.

Dr. R. K. Jenamani, Sc. 'F', **Shri Vivek Sinha**, Sc. 'F', **Shri Manish Ranalkar**, Sc. 'D', and **Dr. A. K. Mitra**, Sc. 'D', participated in “WMO Aeronautical Meteorological Conference 2017, Aero Meteorological Science 2017 and AVRDP” from 6-10 November, 2017 at Météo-France, Toulouse, France.

Shri R. Bibraj, Sc. 'B' participated in the “Advanced Workshop on “Meteorological Warnings” held at RTC Bet-Dagan, Shefayim, Israel from 6-16 November, 2017.

Dr. A. K. Srivastava, Sc. 'F', participated in the 23rd meeting of “Conference of Parties (COP 23)” held at Bonn, Germany from 6-17 November, 2017.

Shri V. P. Singh, Sc. 'B', **Ms. Hemlata Motiram Bharwani**, Sc. 'B', **Shri Thangjala Lhouvum**, Sc. 'B', **Shri S. Prayek**, Sc. 'B', **Dr. A. Dharma Raju**, Sc. 'B', participated in Knowledge Co-Creation Program for Young leaders on “Disaster Reduction” in Japan during 6-25 November, 2017.

Dr. Somenath Dutta, Sc. 'F' participated in KMA/WMO Regional Workshop on “Impact based Forecasts in RA-II” at Seoul, Republic of Korea during 7-9, November, 2017.

Dr. (Mrs.) Suman Goyal, Sc. 'E', participated in the “RGB Experts and Developers Workshop” in Tokyo, Japan during 7-9 November, 2017.

Dr. S. D. Attri, Sc. 'F', attended “WMO Stakeholders Workshop on Climate Services for Agriculture” held at Thimphu, Bhutan during 7-9 November, 2017 and gave a presentations on various topic on weather, climate and agromet services, served as Chairman of Sessions including “Recommendations and Concluding”.



Dr. S. D. Attri, Sc. 'F' at Thimphu, Bhutan

Dr. P. Guhathakurta, Sc. 'F', attended the “4th Bilateral Meeting of KMA and MoES” held in Seoul, S. Korea from 9-10 November, 2017.

Dr A. K. Sahai, Sc. 'G' and **Dr. D. R. Pattanaik**, Sc. 'E' participate in the Sixth International Workshop on “Monsoon (IWM-VI)” during 13-17 November, 2017 at Singapore.



Dr. D. R. Pattanaik, Sc. 'E' during the workshop

Dr. S. L. Singh, Sc. 'F', participated in Joint Meeting of the Expert Team on “WIS Centers (ET-WISC) Communications Techniques and systems (ET-CTS) and the Task Team on Global Information Systems Centers (TT-GISC)”, at WMO HQs, Geneva, Switzerland during 13-17 November, 2017.

Dr. M. Mohapatra, Sc. 'G' participated in International workshop on “Cataloguing and managing information on extreme weather, water and climate events” at Geneva, Switzerland during 20-22 November, 2017.

Dr. K. Sathi Devi, Sc. 'F', attended the “Severe weather forecasting demonstration project

(SWFDP)” held at Hanoi, Vietnam from 20-23 November, 2017.

Dr. K. K. Singh, Sc. 'F' attended workshop on “Climate Smart Agriculture in Asia: Beyond pilot evaluation and models” at Hanoi during the period 21-23 November, 2017.



Dr. K. K. Singh and participants

Dr. S. Balachandran, Sc. 'F', attended the “Regional Capacity Development Workshop for multi-hazard risk assessment and early warning systems” at the World Bosai Forum 2017 Sendai, Japan on 27 November, 2017.

Dr. N. Chattopadhyay, Sc. 'F' attended the meeting of “Implementation and Coordination Team (ICT) and Management Group of WMO Commission for Agricultural Meteorology” held in Geneva, Switzerland, during 28-30 November, 2017.



ICT & Management group of WMO Commission

Dr. Ashim Kumar Mitra, Sc. 'D' participated in “International TOVS Study Conference (ITSC)” organised by the EUMETSAT-ITSC-XXI at Darmstadt, Germany during 29 November to 5 December, 2017.

Shri Anand Sharma, Sc. 'F' participated in the International Seminar on “Resilient Hindu Kush Himalaya” at Kathmandu, Nepal during 3-6 December, 2017.

Shri R. Balasubramanian, Sc. 'D' attended the regional workshop on “Moving from Drought

monitoring system to management and training programme on Earth observation based Tools for Drought monitoring” held at GISTDA (Geo-Informatics and Space Technology Development Agency, Bangkok, Thailand from 4-8 December, 2018.

Mrs. Suman Goyal, Sc. 'F' participated in 4th International workshop on “Tropical Cyclone Landfall Processes” at Macau, China during 5-7 December, 2017.

Dr. K. K. Singh, Sc. 'F' attended WMO’s RA II Region Working Group Chairs’ Meeting at Abu Dhabi, United Arab Emirates during 12-14 December, 2017. He is Coordinator for Expert Group on Agriculture Meteorology (EG-AgM) under Working Group on Climate Services for RA II region. He made two presentations on - (i) EG-AgM Work Plan for 2017-2020 for RA-II and (ii) Review of the regional activities in Asia and Implementation of RA II Operating Plan 2016-2019.

6.6. IMPORTANT EVENTS 2017

IMD Foundation Day, 2017

India Meteorological Department (IMD) celebrated **142nd Foundation Day**, 2017 at National Cooperative Union of India (NCUI) Auditorium, 3 Siri Fort Institutional Area, August Kranti Marg, New Delhi on 15th January, 2017. **Dr. S. Christopher**, Chairman DRDO and Secretary Department of Defence R & D was the Chief Guest of the function and **Dr. M. Rajeevan**, Secretary, Ministry of Earth Sciences presided over the function. **Dr. K. J. Ramesh**, DG, IMD welcomed the chief guest and addressed the gathering about the achievements of IMD during the previous year. The Chief Guest addressed the audience about the weather services of IMD and also highlighted how the services provided by IMD are useful to DRDO in many respects.

Dr. L. S. Rathore, Former DGM, IMD was felicitated by the Chief Guest on this occasion. **Shri A. K. Sharma, Met. 'B'** was also felicitated by the Chief Guest for winning a Gold Medal in



Lightening of Lamp and Release of Books during IMD Foundation day, 2017



Felicitation of Dr. L. S. Rathore Former DGM, IMD



Felicitation of Shri A. K. Sharma, Met. 'B'

Benchpress Championship held at Tashkent Uzbekistan during 14-20 October, 2016.

RMC New Delhi, MC Srinagar, MOs: Lucknow, Chitradurga, Baroda, Jalpaigudi, Dhubri and Indore, RS/RW Aminidevi and AMFU Tirupati were awarded as best RMC, best MC, Best MOs, best RS/RW and best AMFU respectively.

Chief Guest released the new addition of Mausam Manjusha (Hindi Patrika) and Met. Monograph entitled "Assessment of total Columnar Ozone over Indian Stations" by Siddhartha Singh, V. K. Soni, R. K. Giri, Priyanka Sinha and S. K. Peshin EMRC New Delhi.

On this occasion the prizes were distributed to the winners of an Art and Debate Competition, which was conducted by IMD among the School Children as a part of the IMD Foundation Day celebration.

Science Exhibition - 2017

Dr. A. K. Sahai, Sc. 'G' assumed charge on 1st January, 2017 as Head, Office of Climate Research & Services, IMD Pune after

superannuation of Shri B. Mukhopadhyay, Sc. 'G' on 31st December, 2016.



Science Day at GMRT, Khodad, Junnar

Shri A. K. Dhotre, Met. 'B' and Shri Anil Patinge, Met. 'B' participated in the Science Exhibition - 2017 on the occasion of "Science Day" at Giant Metre wave Radio Telescope, National Centre for Radio Astrophysics, Khodad, Near Narayangaon, Taluka-Junnar, Distt.- Pune during 28th February and 1st March, 2017.

The National Science Day was celebrated on 28th February, 2017. On this occasion an exhibition was arranged in the main building. Dr. A. K. Sahai, Sc. 'G' inaugurated the exhibition. It was well attended by large number of students, scientists, journalist and general public.

Basantotsav-2017 on 4-5 March, 2017 at Rajbhavan Uttarakhand



Hon'ble Governor, Uttarakhand, Dr. K. K. Paul at MC Dehradun

Honourable Governor, Uttarakhand, Dr. K. K. Paul (centre) inspecting stall of M. C. Dehradun at Rajbhavan, Dehradun. Shri Bikram Singh, Director, MC Dehradun (rightmost) briefed him about Weather instruments and services provided by IMD.

World Meteorological Day

World Meteorological Day was celebrated on 23rd March, 2017 on the theme "Understanding Clouds" at IMD HQ and most of its sub-offices all over India. On this occasion, exhibitions were arranged in different offices of IMD highlighting the theme of World Meteorological Day. Special lectures/talks/ media coverage/ interviews were also organised during this occasion. Dr. R. R. Kelkar, Former DGM delivered a talk "Poetry of Clouds" on this occasion at IMD HQ, New Delhi.

BRAINSTORMING MEETING ON MODERNISATION OF WX & CLIMATE SERVICES



Brainstorming Meeting on Modernisation of Climate & Weather Services held at Prithvi Bhawan on 13th April, 2017

Brainstorming meeting on the project "Modernisation of Weather and Climate Services during the period 2017-2024" was held at Ministry of Earth Sciences (MoES) on 13th April, 2017. The meeting aimed at preparation of detailed Science Plan and

Project Report. Experts and Scientists in the field from all over the country participated in the meeting.

VISIT OF PARLIAMENTARY STANDING COMMITTEE

Parliamentary Standing Committee on Science and Technology, Environment & Forests headed by Shrimati Renuka Chowdhury, MP visited IMD on 24th April, 2017 to have on-the-spot assessment of the functioning of the Weather Forecasting System. Twelve members of this Parliamentary Standing Committee visited Satellite Meteorology Division, National Weather Forecasting Centre and Radar facility in IMD, New Delhi and held detailed discussions with the senior officers of IMD. Dr. M. Mohapatra, Sc. 'G' gave a presentation on "Weather Forecasting Services of IMD" with a real time demonstration of forecasting activities of IMD. The members of the Parliamentary Standing Committee appreciated the functioning of IMD specially the weather forecast and warning services.



Dr. M. Mohapatra, Sc. 'G' giving a real time demonstration to Hon'ble Members of Parliamentary Standing Committee

IMD & Himachal State Disaster Management Authority jointly organized Second user's conference on Awareness Program and Challenges in weather forecasting over Western Himalayan Region at Shimla on 15th June, 2017.

POSOCO-IMD weather portal

Shri Piyush Goyal, Hon'ble Minister for Power inaugurated POSOCO-IMD weather portal on 23rd June, 2017 for utilization of weather information for power management. This is

the joint project of Power System Operation Corporation Limited (POSOCO) and IMD.



POSOCO-IMD weather portal

BULLETIN ON HEAT WAVE

Dr. Harsh Vardhan, Hon'ble Union Minister of Ministry of Science & Technology and Ministry of Earth Sciences wrote to Hon'ble Chief Ministers of Heat Wave prone states to implement Heat Wave Action Plan. A special daily Bulletin on prevailing Heat Wave conditions and its forecast/warning for next 5 days in different meteorological subdivisions and districts are being issued from the month of April. A special web page has been created in IMD website (http://imd.gov.in/pages/heat_wave.php).

SWACHHTHA PAKHWADA



The team of officials which did the cleaning of a part of the green space opposite RMC Chennai main building

Swachhta Pakhwara : Swachhta Pakhwada was celebrated during 16-30 June, 2017 at HQ and other offices of IMD. Cleaning of office premises and campus, weeding out of files and condemnation of old/obsolete/unserviceable items were undertaken.

INTERNATIONAL YOGA DAY

Yoga Day - The 3rd International Yoga day was celebrated on 21st June, 2017 at various offices

of India Meteorological Department. A yoga class on this occasion was undertaken by a yoga guru from 'Ministry of AYUSH' in Vrishti Sabhagaar at H.Q. in which officers and members of staff were participated.



International Yoga day at Kolkata

INAUGURATION OF DOPPLER WEATHER RADAR (DWR)



Dr. Harsh Vardhan, Hon'ble Union Cabinet Minister for S&T, MoES, MoFE&CC, Shri A. S. Kiran Kumar, Secretary, DoS and Chairman ISRO and Dr. K. J. Ramesh, DG, IMD during the inauguration of DWR Kochi.



DWR Kochi building

The S band weather radar at Kochi is replaced by dual polarized Doppler Weather Radar provided by ISRO and manufactured by M/s Bharat Electronics Limited, Bangalore. Radar is inaugurated on 12th July, 2017 by Dr. Harsh Vardhan, Hon'ble Union Cabinet Minister for Science & Technology,

Ministry of Earth Sciences, Ministry of Forest, Environment and Climate Change in the presence of Shri A. S. Kiran Kumar, Secretary, Department of Space and Chairman ISRO and Dr. K. J. Ramesh, DG, IMD.

हिंदी पखवाड़ा, 2017



दीप प्रज्ज्वलित एवं मौसम मंजूषा के 25^{वें} संस्करण का विमोचन

भारत मौसम विज्ञान विभाग मुख्यालय में दिनांक 1 सितंबर, 2017 से 14 सितंबर, 2017 तक हिंदी पखवाड़ा तथा दिनांक 14 सितंबर, 2017 को हिंदी दिवस समारोह मनाया गया। समारोह की अध्यक्षता क्षेत्रीय मौसम विज्ञान के अपर महानिदेशक महोदय डॉ. डी. प्रधान ने की। इस समारोह के विशिष्ट अतिथि प्रख्यात साहित्यकार व कवि डॉ. दिविक रमेश जी रहे। इस दौरान विभिन्न हिंदी प्रतियोगिताओं जैसे हिंदी रूपांतरण, टाइपिंग, आशुभाषण, श्रुतलेखन, स्वरचित कविता पाठ, हिंदी लेखन एवं वाद-विवाद का आयोजन किया गया। समारोह का शुभारंभ अपर महानिदेशक महोदय डॉ. डी. प्रधान, डॉ. एस. के. पेशिन, वैज्ञानिक 'जी', डॉ. एस. के. राँय भौमिक, वैज्ञानिक 'एफ' तथा मुख्य अतिथि प्रसिद्ध कवि श्री डॉ. दिविक रमेश जी ने संयुक्त रूप से दीप प्रज्ज्वलित करके किया। इस अवसर पर माननीय गृह मंत्री श्री राजनाथ सिंह द्वारा भेजे गए संदेश को सुश्री रेवा शर्मा, वरिष्ठ हिन्दी अधिकारी ने समारोह में पढ़कर सुनाया। हिन्दी पत्रिका मौसम मंजूषा के 25^{वें} अंक का विमोचन भी इस अवसर पर किया गया तथा हिंदी दिवस के अवसर पर वर्ष 2016-17 के दौरान हिंदी में सर्वाधिक कार्य करने के लिए कल्याण अनुभाग को राजभाषा चलशील्ड प्रदान की गई। समारोह में हिंदी पखवाड़ा के दौरान आयोजित हुई हिन्दी प्रतियोगिताओं के विजेताओं को नकद पुरस्कार और प्रमाण पत्र प्रदान किए गए। समारोह में कार्मिकों एवं बच्चों द्वारा सांस्कृतिक कार्यक्रम प्रस्तुत किए गए।

The officials of Agromet Advisory Services Division (AASD) Participated in MoES exhibition during 28 July to 11 August, 2017 at Parliament House, New Delhi.



The officials of AASD in MoES exhibition at parliament house

Indo-UK meeting to develop Weather and Climate Science for Service Partnership – India



Dr. M. Mohapatra, Sc. 'G' explaining the forecasting services to team UK-Met at NWFC

Dr. M. Mohapatra, Sc. 'G' participated in the Indo-UK meeting held on 8th August, 2017 at Prithvi Bhawan to develop Weather and Climate Science for Service Partnership-India (WCSSP India) program and discuss the possible areas of collaboration. Dr. Mohapatra gave a presentation on 'Prediction of Extreme Weather Events - India Efforts'. UK Met. Office Team visited various workstations of India Meteorological Department (IMD) including NWFC, Satellite and Radar divisions on 10th August. Dr. Mohapatra explained various forecasting modules at NWFC and the warning services of IMD to the visiting team. Similarly, Dr. D. Pradhan, Sc. 'G' explained about the Radar and Shri Virender Singh, Sc. 'E' explained about the satellite related activities.

Meteorological Science Festival, METFEST 'MUGIL' at RMC Chennai – August 2017



Meteorological Science Festival "(METFEST) MUGIL"

Under the joint auspices of Indian Meteorological Society, Chennai Chapter and Regional Meteorological Centre Chennai a Meteorological Science Festival “(METFEST) MUGIL” was organised for school and college students in August 2017 at RMC Chennai on the theme of World Meteorological Day 2017-“Understanding Clouds”. Seven events-Painting, Quiz, Presentation of models / exhibits, Oral presentation, Weather photography and Presentation of working models / schematic animations spread over two days - 19th August, 2017 and 28th August, 2017. Fifty (50) students from various schools and colleges in and around Chennai participated in the seven events held on 19th August, 2017 and 28th August, 2017. Prizes were awarded to the winners and certificates were given to all participants.

Dr. Sanjib Bandyopadhyay, Sc. 'F' attended 21st National Exhibition at Agradut Krirangan, New Barrackpore, Kolkata organized by Central Calcutta Science & Culture Organisation for Youth on 24th August, 2017. He mentored the volunteers of 'MoES stall' ways to make the presentations livelier and to in still scientific temperament amongst visitors.

WMO ESCAP Panel on Tropical Cyclones

A document on Tropical Cyclone Forecasters Competency for WMO/ESCAP Panel member countries has been prepared by RSMC, New Delhi and the same has been sent to WMO as per the decision of 66th Executive Council meeting of WMO. It will be presented in 44th Session of Panel on Tropical Cyclones at Bahrain during 10 -14 September, 2017.



Dr. M. Mohapatra, Scientist 'G' chairing the 44th Session of WMO ESCAP Panel on Tropical Cyclones at Bahrain

Dr. M. Mohapatra, Sc. 'G' Chaired the above 44th Session of WMO ESCAP Panel on Tropical Cyclones and elected as Chairman of the WMO/ESCAP Panel on Tropical Cyclones for the year 2017-18. During the meeting Dr. M. Mohapatra gave presentations on Activities of RSMC New Delhi, Tropical Cyclone Activity during 2016 and Tropical cyclone Forecasting Competency. WMO in particular appreciated efforts by Dr. M. Mohapatra in updating the Tropical Cyclone Operational Plan (TCP-21). The deputation report for the visit was submitted to Ministry of Earth Sciences on 20th September, 2017.

Post-Monsoon Pre-Cyclone Exercise



Dr. Sanjib Bandyopadhyay, Sc. 'F' and officers of other departments during the seminar

Post-Monsoon Pre-Cyclone Exercise was conducted on 21st September, 2016 at Seminar Hall, MSO Building, Alipore under the chairmanship of Dr. Sanjib Bandyopadhyay, Sc. 'F', RMC Kolkata. High level Central and State Government concerned authorities Like Coast Guard, All India Radio, Doordarshan, Eastern and South-eastern railways, Disaster Management Department, Govt. of West Bengal, DVC, representatives from office of the DMs and SPs of coastal districts, several NGOs and others took part in the exercise. Shri G. K. Das, Sc. 'D' presented “Cyclone Warning Preparedness and Dissemination”. Shri H. R. Biswas, Sc. 'D' presented “Monitoring of Cyclone through Satellite” and Shri A. Chanda, Sc. 'E' presented “Application of DWR in Cyclone Monitoring” at the seminar.

IMD hosted an International seminar on 'WMO/UKMO Aviation Seminar' under Voluntary Co-operation Programme (VCP) of WMO in New Delhi during 13-17 November,

2017. Nineteen trainees from 14 countries participated in the seminar.

Hon'ble Member of Parliament (Rajya Sabha) Shri Amar Shankar Sable visited IMD, Pune on 5th December, 2017 and had meeting with senior officials.

Secretary's visit at RMC, Kolkata



Dr. M. Rajeevan, Secretary, MoES with officials of IMD

Dr. M Rajeevan, Secretary, MoES visited RMC Kolkata on 27th November, 2017. He had meetings with officials of RMC, Kolkata and was apprised of work of different units. He explained the vision of the Ministry for the future.

Shri Bikram Singh, Sc. 'E' was one of the panellists in technical session of the workshop on "Rejuvenation of Naini Lake" organized by Government of Uttarakhand and UNDP and Inaugurated by Hon'ble Governor, Govt. of Uttarakhand on 27th November, 2017.

Dr. V. Vizaya Bhaskar, Sc. 'E' acted as a member of the Techno-Commercial committee for services of five years comprehensive maintenance contract for Online SO₂ analyzers installed at IITM, Pune.

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 2016 it has an IMPACT FACTOR (IF): 0.467 and 5-year Impact factor 0.395 calculated by Thomson Reuter U.S.A. The rating score given by National Academy of Agricultural Sciences (NAAS) for the year 2016 is 6.31. IMD Scientists published 128 research paper/books in Mausam/Met. Monograph/Met Reports and National & International Journal during 2017.

7.1. RESEARCH CONTRIBUTIONS PUBLISHED IN 'MAUSAM'

Manoj Gundalia and Mrugen Dholakia, **"Modeling daily reference evapotranspiration in middle south Saurashtra region of India for monsoon season using most dominant meteorological variables and the FAO-56 Penman-Monteith method"**, *Mausam*, 68, 1, 1-8.

Younes Khosravi, Hasan Lashkari and Hosein Asakereh, **"Spatial variability of water vapor in south and southwest of Iran"**, *Mausam*, 68, 1, 9-22.

Ashok Kumar, Nabansu Chattopadhyay, Y. V. Ramarao, K. K. Singh, V. R. Durai, Ananda K. Das, Mahesh Rathi, Pradeep Mishra, K. Malathi, Anil Soni and Sridevi, **"Block level weather forecast using direct model output from NWP models during monsoon season in India"**, *Mausam*, 68, 1, 23-40.

Madhurima Das, Arnab Hazra, Aditi Sarkar, Sabyasachi Bhattacharya and Pabitra Banik, **"Comparison of spatial interpolation methods for estimation of weekly rainfall in West Bengal, India"** *Mausam*, 68, 1, 41-50.

K. Naga Ratna and Manorama Mohanty, **"Some characteristics of southwest monsoon rainfall over urban centres in Andhra Pradesh and Telangana"**, *Mausam*, 68, 1, 51-66.

Mujahid Khan, R. C. Hasija and Nitin Tanwar, **"Optimum size and shape of plots based on data from a uniformity trial on Indian Mustard in Haryana"**, *Mausam*, 68, 1, 67-74.

N. Chattopadhyay, S. Sunitha Devi, Gracy John and V. R. Choudhari, **"Occurrence of hail storms and strategies to minimize its effect on crops"**, *Mausam*, 68, 1, 75-92.

S. B. Yadav, H. R. Patel, S. K. Mishra, P. K. Parmar, B. I. Karandey and V. Pandey, **"Impact assessment of climate change on groundnut yield of middle Gujarat region"**, *Mausam*, 68, 1, 93-98.

N. S. Abeysingha, J. M. N. S. Jayasekara and T. J. Meegastenna, **"Stream flow trends in up and midstream of Kirindi Oya river basin in Sri Lanka and its linkages to rainfall"**, *Mausam*, 68, 1, 99-110.

Sunil Kumar Peshin, Priyanka Sinha and Amit Bisht, **"Impact of Diwali firework emissions on air quality of New Delhi, India during 2013-2015"**, *Mausam*, 68, 1, 111-118.

V. Vizaya Bhaskar, V. K. Soni and A. S. Panicker, **"Long term characteristics of aerosols over Pune, central India - Effect on radiative forcing"**, *Mausam*, 68, 1, 119-130.

S. Pasupalak, G. Panigrahi, T. Panigrahi, S. Mohanty and K. K. Singh, **"Extreme rainfall events over Odisha state, India "**, *Mausam*, 68, 1, 131-138.

Prabhjyot Kaur, Navneet Kaur and Harpreet Singh, **"PRECIS-model simulated changes in climatic parameters under various scenarios in different agro-climatic zones of Punjab"**, *Mausam*, **68**, 1, 139-148.

C. S. Tomar, D. Saha, S. Das, Sanjay Shaw, Sanjay Bist and M. K. Gupta, **"Analysis of temperature variability and trends over Tripura"**, *Mausam*, **68**, 1, 149-160.

Vivekanand Singh and Anshuman Singh, **"Variation of temperature and rainfall at Patna"**, *Mausam*, **68**, 1, 161-168.

R. P. Kane, **"Antarctic ozone hole, latest 2015 situation about recovery"**, *Mausam*, **68**, 1, 169-170.

Bidyut Bikash Deori, Bhabesh Gogoi, Kushal Sarmah, S. K. Paul, B. Kalita and D. Doley, **"Rainfall probability analysis of Kokrajhar district of lower Brahmaputra valley zone of Assam"**, *Mausam*, **68**, 1, 171-174.

E. T. Ozdemir, A. Deniz, I. Sezen, Z. Aslan and V. Yavuz, **"Investigation of thunderstorms over Ataturk international airport (LTBA), Istanbul"**, *Mausam*, **68**, 1, 175-180.

Prasanta Das, Somenath Dutta and Shyamal Kumar Mondal, **"A mathematical model for the 3-D dynamics of lee wave across a meso-scale mountain corner"**, *Mausam*, **68**, 2, 195-204.

Neeraj kumar, C. C. Panchal, S. K. Chandrawanshi and J. D. Thanki, **"Analysis of rainfall by using Mann-Kendall trend, Sen's slope and variability at five districts of south Gujarat, India"**, *Mausam*, **68**, 2, 205-222.

A. P. Ramaraj, V. Geethalakshmi and K. Bhuvanewari, **"Understanding the uncertainty cascaded in climate change projections for agricultural decision making"**, *Mausam*, **68**, 2, 223-234.

A. K. Jaswal, P. A. Kore and Virendra Singh, **"Variability and trends in low cloud cover over India during 1961-2010"**, *Mausam*, **68**, 2, 235-252.

Li Lei, P.W. Chan and S. M. Tse, **"Observation and simulation of mountain wave trains in a tropical cyclone situation"**, *Mausam*, **68**, 2, 253-260.

B. Amudha, Y. E. A. Raj and S. B. Thampi, **"A statistical analysis of the differences between rainfall estimated by Chennai DWR and conventional rainfall data on monthly and seasonal scales during the Indian northeast monsoon season"**, *Mausam*, **68**, 2, 261-278.

N. Chattopadhyay, S. S. Vyas, B. K. Bhattacharya, N. S. Tidke and N. G. Dhangar, **"Validation of soil moisture derived from water balance method and satellite observation,"** *Mausam*, **68**, 2, 279-286.

P. K. Singh, L. S. Rathore, D. V. Bhaskar rao, K. K. Singh, A. K. Baxla, S. C. Bhan, Akhiesh Gupta and Sompal Singh. **"Spatial analysis of rainfall variability and rainfed rice crop using GIS Technique in West Bengal (India),"** *Mausam*, **68**, 2, 287-298.

Utpal Dey, D. N. Dhutraj, Digangana Talukdar and Anup Das, **"Role of weather factors in development of late leaf spot (Phaeoisariopsis personata) on groundnut (Arachis hypogaea)"**, *Mausam*, **68**, 2, 299-308.

M. Jayakumar and M. Rajavel, **"Coffee yield forecasting using climate indices based agrometeorological model in Kerala"**, *Mausam*, **68**, 2, 308-316

Ranjit Kumar Paul, **"Modelling long memory in maximum and minimum temperature series in India,"** *Mausam*, **68**, 2, 317-326.

G. C. Debnath and G. K. Das, **"Verification of operational rainfall forecast over eastern India during southwest monsoon season"**, *Mausam*, **68**, 2, 327-334.

Younes Khosravi, Hasan Lashkari and Hosein Asakereh, **"Water vapor pressure trends in south and southwest Iran"**, *Mausam*, **68**, 2, 335-348.

J. Hazarika, B. Pathak and A. N. Patowary, **"Studying monthly rainfall over Dibrugarh, Assam: Use of SARIMA approach"**, *Mausam*, **68**, 2, 349-356.

Pijush Basak, **"Southwest monsoon rainfall in Assam: An application of principal component analysis for understanding of variability"**, *Mausam*, **68**, 2, 357-366.

Prasoon Kumar Singh and Shonam Sharma, **"Statistical analysis of seasonal and annual rainfall trends over Dhanbad, Jharkhand India,"** *Mausam*, **68**, 2, 367-368.

Sangita Sharma, Manmohan Singh and S. C. Bhan, **"A study on pre-harvest forecast of maize yield using statistical model for Himachal Pradesh"**, *Mausam*, **68**, 2, 369-374.

S. Pradhan, V. K. Sehgal, K. K. Bandyopadhyay, J. Mukherjee, D. K. Das and R. K. Dhakar, **"Trend analysis of weather parameters and climatic water balance at New Delhi"**, *Mausam*, **68**, 2, 375-382.

Janak Lal Nayava, Sunil Adhikary and Om Ratna Bajrachary, **"Spatial and temporal variation of surface air temperature at different altitude zone in recent 30 years over Nepal"**, *Mausam*, **68**, 3, 417-428.

R. K. Mall, Nidhi Singh, R. Prasad, A. Tompkins and Akhilesh Gupta, **"Impact of climate variability on human health: A pilot study in tertiary care hospital of Eastern Uttar Pradesh, India"**, *Mausam*, **68**, 3, 429-438.

Surinder Kaur, Sumant Kumar Diwakar and Ashok Kumar Das, **"Long term rainfall trend over meteorological sub divisions and districts of India"**, *Mausam*, **68**, 3, 439-450.

Dhruba Jyoti Bora, Munindra Borah and Abhijit Bhuyan, **"Regional analysis of maximum rainfall using L-moment and LH-moment: A comparative case study for the northeast India"**, *Mausam*, **68**, 3, 451-462.

Y. Wang, Z. W. Shilenje, P. O. Sagero, A. M. Nyongesa and N. Banda, **"Rainfall variability and meteorological drought in the Horn of Africa"**, *Mausam*, **68**, 3, 463-474.

Rajesh Prakash and H. N. Srivastava, **"Diurnal variations of outgoing long wave radiation (OLR) vis a vis 4 January, 2016 Manipur earthquake (Mw: 6.7) : An earthquake precursor?"**, *Mausam*, **68**, 3, 475-486.

Krishanu Manna and Sanjay Sen, **"Interacting inclined strike-slip faults in a layered medium"**, *Mausam*, **68**, 3, 487-498.

Ved Prakash, S. K. Dwivedi, Santosh Kumar, J. S. Mishra, K. K. Rao, S. S. Singh and B. P. Bhatt, **"Effect of elevated CO₂ and temperature on growth and yield of wheat grown in sub-humid climate of eastern Indo-Gangetic Plain (IGP)"**, *Mausam*, **68**, 3, 499-506.

He Zhiming, Deng Shiru, Li Lei and Pak Wai Chan, **"An analysis on the effects of urbanization on the local climate of three inland developing cities in East China"**, *Mausam*, **68**, 3, 507-518.

G. K. Sawaisarje, Somenath Dutta and S. Jagtap, **"Role of Hamiltonian energy in thunderstorms"**, *Mausam*, **68**, 3, 519-528.

Sukumar Roy, (Smt.) Snigdha Pal and Nabajit Chakravarty, **"Estimation of solar radiation using two step method in West Bengal"**, *Mausam*, **68**, 3, 529-536.

Girish K. Jha, Gajab Singh, S. Vennila, M. Hegde, M. S. Rao and H. Panwar, **"Multi-layer perceptron based neural network model predicting maximum severity of Spodoptera litura (Fabricius) on groundnut in relation to climate for Dharwad region of Karnataka (India)"**, *Mausam*, **68**, 3, 537-542.

Ranbir Singh Rana, Vaibhav Kalia, R. M. Bhagat and Sharda Singh, **"Extreme snowfall event analysis and its impacts on agriculture and horticultural crops in western Himalaya, India"**, *Mausam*, **68**, 3, 543-550.

S. L. Singh, Sankar Nath and M. K. Bhatnagar, **"The WMO information system at IMD Pune: A global meteorological information system"**, *Mausam*, **68**, 3, 550-555.

Neha Sharma, N. S. Murty and A. S. Nain, **“Analysing the effect of temperature variation on rice yield and crop characteristics using oryza model in tarai region of Uttarakhand”**, *Mausam*, **68**, 3, 556-560.

Jayanta Sarkar and J. R. Chicholikar, **“Future climate change scenario in hot semi-arid climate of Saurashtra, Gujarat by using statistical downscaling by LARS-WG model”**, *Mausam*, **68**, 4, 589-596.

B. P. Yadav, Naresh Kumar and Sonum Lotus, **“Synoptic & climatological aspects of extreme rainfall over western Himalayas towards end of 2014 southwest monsoon season”**, *Mausam*, **68**, 4, 597-606.

R. K. S. Maurya, G. P. Singh, U. K. Choudhary and S. C. Bhan, **“Regional climate simulation of present day temperature over India using RegCM3: Evaluation and analysis of model performance”**, *Mausam*, **68**, 4, 607-620.

Mehran Behjati, Jit Singh Mandeep, Mahamod Ismail and Rosdiadee Nordin, **“Investigation of accuracy of rain-rate and rain-attenuation prediction models in satellite communications based on meteorological skills”**, *Mausam*, **68**, 4, 621-632.

Surinder Kaur and P. K. Gupta, **“The devastating rainstorm of June-2013 in Uttarakhand, India”**, *Mausam*, **68**, 4, 633-642.

Noor Ahmed Kalhor, Zhiguo He, Dongfeng Xu, Asif Inam, Faiz Muhammad and Naimatullah Sohoo, **“Seasonal variation of oceanographic processes in Indus river estuary”**, *Mausam*, **68**, 4, 643-654.

Ranbir Singh Rana, Manmohan Singh, Ranu Pathania, S. K. Upadhyay and Vaibhav Kalia, **“Impact of changes in climatic conditions on temperate fruit production of Himachal Pradesh”**, *Mausam*, **68**, 4, 655-662.

L. N. Sun, J. Y. Wang and B. Zhang, **“Wavelet analysis for seasonal precipitation variations**

of Yuanmou dry-hot valley in recent 50 years”, *Mausam*, **68**, 4, 663-672.

Kanika Taneja, S. D. Attri, Shamsad Ahmad, Kafeel Ahmad, V. K. Soni, Vikram Mor and Rajesh Dhankhar, **“Comparative assessment of aerosol optical properties over a mega city and an adjacent urban area in India”**, *MAUSAM*, **68**, 4, 673-688.

Suman Goyal, M. Mohapatra, Priyanka Kumari, S. K. Dube and Kushagra Rajendra, **“Validation of Advanced Dvorak Technique (ADT) over north Indian Ocean”**, *Mausam*, **68**, 4, 689-698.

Kuldeep Sharma, Raghavendra Ashrit, R. Bhatla, R. Rakhi, Gopal Iyengar and E. N. Rajagopal, **“Verification of heavy rainfall in NWP models : A case study”**, *Mausam*, **68**, 4, 699-712.

S. G. Patil and A. Majumder, **“Annual and seasonal variability of wet day frequency in West Bengal, India”**, *Mausam*, **68**, 4, 713-722.

Moutusi Tahashildar, Pradip K. Bora, Lala I. P. Ray and Vishram Ram, **“Crop-coefficients of tomato as derived using monolithic weighing type lysimeter in mid hill region of Meghalaya”**, *Mausam*, **68**, 4, 723-732.

K. K. Gill and S. S. Kukal, **“Long term and recent variability in rainfall amount and distribution in different agroclimatic regions of Punjab”**, *Mausam*, **68**, 4, 733-737.

V. Vizaya Bhaskar and S. M. Lahogaonkar, **“Long term aerosol characterization over Kodaikanal, a high altitude station in South India”**, *Mausam*, **68**, 4, 738-744.

Mohan Singh, Ram Niwas, A. K. Godara, Rajeev and M. L. Khichar, **“Pheno-thermal response of pears in Western Indo Gangetic Plain”**, *Mausam*, **68**, 4, 745-750.

7.2. RESEARCH CONTRIBUTIONS PUBLISHED IN EXTRA DEPARTMENTAL JOURNALS (INDIAN & FOREIGN JOURNALS)

- A. Hazra, H. S. Chaudhari, M. Ranalkar and J. P. Chen, 2017, "**Role of interactions between cloud microphysics, dynamics and aerosol in the heavy rainfall event of June 2013 over Uttarakhand, India**", *Q. J. R. Meteorol. Soc.*, **143**, 986-998. doi:10.1002/qj.2983.
- A. Madhulata, M. Rajeevan, S. K. Roy Bhowmik and A. K. Das, 2017, "**Impact of Assimilation of Conventional and Satellite Radiance GTS Observations on Simulation of Mesoscale Convective System Over Southeast India Using WRF-3DVar**", *Pure Appl. Geophys.*, DOI 10.1007/s00024-017-1689-5.
- A. P. Dimri, A. Chevuturi, D. Niyogi, R. J. Thayyen, Kamaljit Ray, S. N. Tripathi, A. K. Pandey and U. C. Mohanty, 2017 "**Cloudbursts in Indian Himalayas: A review**", *Earth- Science Reviews*, **168**, 1-23.
- B. Geetha and S. Balachandran, 2016, "**Diabatic heating and convective asymmetries during rapid intensity changes of tropical cyclones over North Indian Ocean**", *Tropical Cyclone Research and Review*, **5**, 1-2, 32-44.
- D. R. Pattanaik and M. Mohapatra, 2017, "**Active Northeast Monsoon over India during 2015 - An Assessment of Real-Time Extended Range Forecast**", *Current Science*, **112**, 11, 2253-2262.
- D. R. Pattanaik, 2017, "**Hybrid (dynamical-empirical) forecast of Indian monsoon rainfall during 2016**", *Current Science*, **112**, 12, 2367-2369.
- H. R. Biswas and P. K. Kundu, 2017, "**A principle component analysis based model to predict post-monsoon tropical cyclone activity in the Bay of Bengal using oceanic Niño index and dipole mode index**", *Int. J. Climatol.*, doi:10.1002/joc.5344.
- Hiren Dave, M. E. James and Kamaljit Ray, 2017, "**Trends in intense rainfall events over Gujarat State (India) in the warming environment using gridded and conventional data**", *International Journal of Applied Environmental Sciences*, **12**, 5, 977-998.
- M. S. Shekhar, Usha Devi, Surender Paul, G. P. Singh and Amreek Singh, 2017, "**Analysis of trends in extreme precipitation events over western Himalaya Region intensity and duration wise**", *Ind. Geophys. Union*, **21**, 3, 225-231.
- M. Mohapatra, B. Geetha, and Monica Sharma, 2017, "**Reduction in uncertainty in tropical cyclone track forecasts over the North Indian Ocean**", *Current Science*, **112**, 9, 1826-1830.
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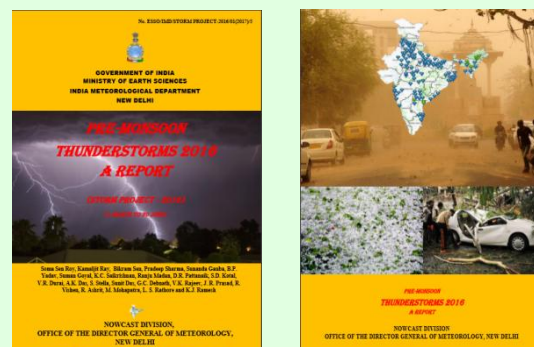


Fig. 1. STORM Report-2016

CHAPTER 8

FINANCIAL RESOURCES AND MANAGEMENT PROCESS

8.1. FINANCIAL RESOURCES AND MANAGEMENT

Budget Estimates/ Revised Estimates

Budget provisions for the department during the financial year 2017-18 were as follows:

Central Sector schemes :

B.E. : Rs. 188.75 crores

R.E. : Rs. 149.75 crores

Establishment :

B.E. : Rs. 383.34 crores

R.E. : Rs. 372.61 crores

8.2. CENTRAL SECTOR SCHEMES

To upgrade and sustain the forecasting capabilities of the Department, various activities, as mentioned below, are being undertaken under ACROSS-IMD during 2017-24 with budgetary provision upto 2020 :

1. Atmospheric Observations Network (AON)

AON primarily encompassing ongoing programs in an integrated manner aimed at sustenance of observational network. Current status of various programs under AON is as follows :

- DWR commissioned at Gopalpur. At present, there are 24 DWRs in the IMD Radar Network.
- Site selection work is almost over for commissioning of 11 C-Band DWRs.
- Existing Data Storage archival capacity enhanced to 150 TB. The DWR data is being

archived at IMD New Delhi, and efforts are being made for simultaneous archival at MC Hyderabad.

- Complying with the long-standing demand of WMO, 6 RS/RW stations namely New Delhi, Mumbai, Kolkata, Chennai, Guwahati and Nagpur, equipped with GPS based high quality radiosounding systems (Make M/s GRAW Germany), have been inducted into WMO GCOS Upper Air Network (GUAN). This network to be expanded from 6 to 12 in near future.

- RS/RW network is to be expanded from 43 to 55 in future.

- 20 stations to be up-graded with IMD make pilotsondes; procurement of Pilotsondes for 20 other stations under process; to be operational by August 2018. Remaining stations would be upgraded by December 2018.

- Steps are being taken to modernize IMD Class-I observatories so that these observatories may conform to International standards. Prototype E-Stevenson screen instruments have been developed and installed at RMC Mumbai for trials.

- A central AWS data receiving Hub is being planned at Pashan, Pune to cater to reception of all types AWS/ARG system and a new upgraded website for AWS/ARG network has been developed. RFP is prepared for data reception facility to receive data of more than 10,000 AWS/ARG stations.

- Mobile app to be developed for local forecasts and city weather information.

- Raingauge network would be enhanced for preparation of Block/Taluka- wise rainfall statistics.
- Installation of Multi-Mission Meteorological Data Receiving & Processing System (MMDRPS) viz., expected to be completed by December 2018/ January 2019.
- Sustenance and maintenance of all existing and proposed satellite systems on CAMC basis.
- Establishment and operationalization of in-situ calibration and validation site for INSAT series satellites.
- Inter-calibration of VHRR/ Imager observations from time series of geostationary satellites (IOGEO).
- Upgradation of three existing (Delhi, Chennai and Guwahati) Polar Orbit Direct Receiving and Processing systems.
- Development of Products and Satellite based Expert systems for forecasting and calibration & research with National and International collaboration : Finalization of Development Methodology for cloud classification and product related to aviation meteorology, Integration of all images related to tropical cyclones at one platform in collaboration with SAC, ISRO.

2. Upgradation of Forecast System

Current status of this activity, primarily aimed at upgradation and sustenance of the forecast system to an optimum level coupled with data integration, product generation & dissemination of Weather Forecast & Warning information, is as follows :

- Replacement of Automatic Message Switching Systems (AMSS) at AMO Palam, Kolkata, Mumbai and Chennai to be initiated.
- Extension of Video conferencing at all important stations (RMC/ MCs/ ACWCs/ CWCs

etc.) is under process for instant discussion and information exchange.

- NKN connectivity to be utilized for data exchange between major centres. NIC has approved NKN connectivity at 37 more locations (AMO/ CWC/ ACWC/ DWR).
- Under Integrated Himalayan Meteorology Programme (IHMP), initiated process for procurement of 10 X-Band DWRs. Four (04) X-Band DWRs to be installed in J&K, three (03) X-Band DWRs are proposed to be installed in Himanchal Pradesh and three (03) X-Band DWRs are proposed to be installed in Uttarakhand.
- Initiated the case for procurement of three Portable (mobile) X-Band Radars for covering Amarnath Ji Yatra.

3. Weather & Climate Services (WCS)

WCS is a continuing activity primarily encompassing ongoing programs in an integrated manner aimed at providing efficient weather and climate services across the country in various sectors. Current status of various components under WCS is as follows:

Gramin Krishi Mausam Sewa (GKMS) :

To increase the number of farmers benefiting from advisories, it is planned to upgrade the existing district level agro-meteorological advisory services to block level jointly by IMD and ICAR. This will be done by setting up District Agromet Unit (DAMUs) in 530 districts in the premises of Krishi Vigyan Kendra (KVK) and ICAR will administrate the establishment of DAMU. This will be complementary to existing 130 AMFUs in each district, thus a total network of 660 units will be established in each district. These DAMUs will be established in three phases-

1.	2017-18	200 DAMU + 130 AMFU
2.	2018-19	200 DAMU
3.	2019-20	130 DAMU

IMD will provide sub-district level forecast and warning on extreme events as to each DAMU for advisory preparation. Expert panel at DAMU (KVK) will generate advisory at sub-district level for field and horticultural crops, livestock, poultry etc. on every Tuesday and Friday (Bi-Weekly). Joint Director (Ag)/District Agriculture Officer from State Department of Agriculture will also be part of expert panel.

These advisories will be disseminated through Mass Media, website, extension wing of SDA, KVK, NGOs, Growers Association, Farmers Field Clubs, Panchayati Raj, SHG etc. Appropriate mechanism will be established to send the advisories through SMS to all the farmers at village level across the country. Efforts will be made by DAMUs to conduct Farmer Awareness Programmes at micro-level for increasing awareness among the farmers on impact of weather and climate on agriculture. Coordination with the State Department has also been established to incorporate the farmers' database available with the State Department in existing farmers receiving the SMS.

Augmentation of Aviation Meteorological Services:

- Major upgradation of Meteorological facility at all airports. Indigenous 10 metre frangible mast with sliding mechanism has been developed and theoretical, simulation testing completed at NAL Bengaluru. First mast has been received at Bhubaneswar and would be commissioned soon. After three months of observation, twenty such masts will be deployed at major International airports to commission totally indigenous Integrated AWOS with Transmissometer.
- IMD make basic AWOS would be deployed at domestic Airports and Air strips. Sensors required *i.e.* T/RH, Pressure, Wind speed/Direction have already been procured. Mast & Data acquisition and Display system are to be procured. AWOS likely to be deployed at 15 stations by 2018.

- 8 Laser Ceilometers have been received from M/s Eliasson, Sweden to be installed at Major airports. Apart from that a prototype Ceilometer has been developed by LASTEC under joint IMD-LASTEC partnership programme, its production is expected to start by December 2018.

- RFP for Heliport AWOS finalized and approved for following Airports and Heliports:

Safdarjung Airport, Rohini Heliport, Agati Airport, Aizwal Airport, Naharlougun, Tawang Heliport, Passighat Airport, Barapani Airport, State Helipad, Lerie-Kohima, Diu Airport. (Total-10).

- Establishing new Aerodrome MET Office at Greenfield airports.

Climate Services:

- A draft RFP has been prepared for development of Climate Data Web Portal.
- Implementation of Data digitization from autographic charts available at IMD to be done.
- Climate of 69 smart cities is being uploaded on official website.
- Climate information for health based on ERF products being prepared weekly on experimental basis.
- Validation of Climate information for Health based on ERF products is under process.

Training in operational Meteorology:

- Procurement of required NWP computers is under process for establishment of NWP laboratory.
- EOI is under review for setting up video class rooms at Pune & Delhi.

- Expert faculties from MoES institutes, Pune University, Retired IMD & IITM officials are called for imparting training to AMTC, FTC and IMTC and refresher courses.

4. Commissioning Of Polarimetric Doppler Weather Radars (DWRs)

The activity “Commissioning of Polarimetric Doppler Weather Radars (DWRs)” is aimed at augmenting the DWR network over the country to facilitate plugging the existing gaps in the meteorological observational network of radars for most parts of the country except Himalayas and Northeastern states, through installation of eleven C-Band dual polarized DWRs at the various locations across the country, for providing adequate warning in the event of approach of Cyclonic Storms, Monsoon Depressions, etc. along with the vital information for nowcasting purposes on mesoscale convective weather developments. The locations have been identified as per the existing & planned network of IMD, Indian Air Force (IAF) and Indian Space Research Organization (ISRO) to ensure the optimum utilization of the national resources, thereby avoiding any duplicity and wastefulness. The availability of countrywide weather radar coverage and its integration, including overlapping regions of the proposed network would also help to stimulate research on the

dynamics and microphysics of convective weather phenomena.

The programme consists of three major parts, i.e., development of infrastructure for installation of Radar, procurement of Radar and induction of manpower for its operation and maintenance. Infrastructure development includes erecting at least 15-20 metres height metallic tower for mounting the antenna and radome over it and a mini-building / prefabricated structure for housing the DWR monitoring unit.

8.3. DELEGATION OF ENHANCED FINANCIAL POWERS

In order to achieve timely realization of goals and to avoid procedural delays in procurements; enhanced Financial Powers has been delegated to Heads of CRS Pune, RMCs, MCs and CDRs/DWRs etc. & stand-alone Offices headed by Group ‘A’ Offices and Remote Offices in IMD.

8.4. TRAINING IN PUBLIC PROCUREMENT

Around 90 officers from all sub-offices of IMD participated in the Training programme on Public Procurement for Government officers at National Institute of Financial Management, Faridabad during financial year 2017-18.

8.5. REVENUE GENERATED DURING THE YEAR 2017

(i). 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	-	-	-	-	55055	-	-	-	-	131360	-	-
DGM NHAC	-	-	-	-	-	-	-	-	-	-	-	-
DGM (Publication)	48150	85475	-	46365	8675	16490	14325	12225	8000	2575	22625	10050
RMC, New Delhi												
New Delhi	102930	46309	30161	12901	15089	42216	7745	-	-	-	57616	61091
Jaipur	4254	14100	34348	2959	10016	18884	6387	3500	-	-	29579	5344
Lucknow	3509	8672	3566	12249	16090	1783	-	-	-	-	-	4088
Srinagar	12095	-	14062	11135	25458	12162	1700	-	-	-	4480	11310
Chandigarh	11736	26387	-	3515	14316	20254	-	-	-	-	-	-
Shimla	3814	11185	-	-	-	-	-	-	-	-	3997	6570
Dehredun	-	-	-	-	-	-	-	-	-	-	-	-
RMC, Mumbai												
Mumbai	-	-	-	4564	33025	77961	55976	58601	36352	36479	56148	26747
Ahemdabad	-	12407	-	-	5429	6227	83642	38879	-	10186	-	-
RMC, Nagpur												
Nagpur	14188	38207	39365	14815	24551	86153	63956	64606	62169	10913	33932	59754
Bhopal	2294	-	1674	1191	40395	-	-	-	-	-	46953	-
RMC, Kolkata												
Kolkata	17501	-	3829	18723	32290	6267	1386	-	-	1750	-	-
Patna	-	-	-	-	-	-	-	-	-	-	-	-
Bhubneshwar	4407	31323	10810	75101	12573	10229	-	-	8160	-	-	-
Gangtok	-	4700	2759	-	-	92120	1832	-	-	-	-	15883
RMC, Guwahati												
Guwahati	28027	106223	104787	74586	70093	61977	28438	92325	227184	115104	48593	15081
Agartala	7331	2885	2450	1459	2458	22771	-	8618	2618	5899	11039	11039
RMC, Chennai												
Chennai	145370	69433	77343	299357	46771	246993	601036	51353	115889	500567	84927	70150
Thiruvananthapuram	23146	30647	129938	43514	67427	34049	70871	7446	3772	14141	65928	29870
Hyderabad	22935	25060	154648	15331	21469	37645	49786	38555	11910	61898	72160	15175
Bangalore	58768	33495	67295	16340	93120	74680	39345	42295	65717	84532	87195	55630
ACWC Chennai	24030	4806	-	4806	31469	2403	10368	50497	10796	5398	8099	-
CWC Visakhapatnam	1238	3450	8301	4204	10223	8389	23043	-	5470	9938	2596	1437
CRS, Pune												
Pune	969365	311784	677968	361540	353500	191631	1515618	323397	146827	1337425	797585	66940

CHAPTER 9

STATUS OF SC/ST/OBC AS ON 01.01.2017

(i) Status of SC/ST/OBC as on 01.01.2017 (Group wise)

Groups	Representation of SCs / STs / OBCs as on 1.1.2016				Appointments by Promotion during the calendar year		
	No. of Employees	SCs	STs	OBCs	SCs	STs	Total
Group A	217	33	14	42	3	2	18
Group B (Gaz.)	1286	219	101	0	38	25	388
Group B (Non- Gaz.)	1247	204	67	339	9	4	37
Group C	1542	485	160	172	23	5	79
TOTAL	4292	941	342	553	73	36	522

(ii) Status of SC/ST/OBC as on 01.01.2017 (Pay Scale Wise)

Pay Scale in Rs.	Representation of SCs / STs / OBCs as on 01.01.2016				Appointments by promotion during the calendar year		
	No. of Employees	SCs	STs	OBCs	SCs	STs	Total
PB-3 + GP 5400	61	9	4	15	0	0	0
PB-3 + GP 6600	3	0	0	2	0	0	0
PB-3 + GP 7600	57	11	5	20	0	0	1
PB-4 + GP 8700	57	13	4	5	2	1	9
PB-4 + GP 8900	35	0	1	0	1	1	8
PB-4 + GP 10000	3	0	0	0	0	0	0
75500-80000	1	0	0	0	0	0	0
TOTAL	217	33	14	42	3	2	18

CHAPTER 10

राजभाषा नीति का कार्यान्वयन

राजभाषा गौरव पुरस्कार



महामहिम राष्ट्रपति श्री रामनाथ कोविन्द जी के द्वारा 'मौसम-मंजूषा' में प्रकाशित लेख के लिए श्री आर. बी. एस. नारायण, मौसम विज्ञानी 'बी' को पुरस्कार प्रदान करते हुए

भारत के महामहिम राष्ट्रपति श्री रामनाथ कोविन्द जी के करकमलों से 'मौसम-मंजूषा' में प्रकाशित लेख के लिए श्री आर. बी. एस. नारायण, मौसम विज्ञानी 'बी' को दिनांक 14 सितम्बर, 2017 को राष्ट्रपति भवन में आयोजित हिंदी दिवस समारोह के दौरान मौसम कार्यालय सांताक्रुज (मुंबई) में कार्यरत हिंदीतर भाषी वर्ग में राजभाषा गौरव सम्मान (प्रथम) मिला।

सातवाँ विश्व हिंदी दिवस एवं सांस्कृतिक समारोह 2017

परिवर्तन जन कल्याण समिति द्वारा आयोजित 'सातवाँ विश्व हिंदी दिवस एवं सांस्कृतिक समारोह 2017' के अवसर पर दिनांक 10 जनवरी, 2017 को माननीय संसद सदस्य लोकसभा एवं संयोजक संसदीय राजभाषा

समिति की दूसरी उपसमिति डॉ. प्रसन्न कुमार पाटसाणी द्वारा उपनिदेशक (राजभाषा) सुश्री रेवा शर्मा को 'राजभाषा हिंदी कार्यान्वयन रत्न' से सम्मानित किया गया।



डॉ. प्रसन्न कुमार पाटसाणी, माननीय संसद सदस्य द्वारा उपनिदेशक (राजभाषा) सुश्री रेवा शर्मा को 'राजभाषा हिंदी कार्यान्वयन रत्न' से सम्मानित किया गया

राष्ट्रभाषा स्वाभिमान न्यास द्वारा आयोजित 23^{वें} अखिल भारतीय राजभाषा विकास एवं सम्मान समारोह में श्री रामहरि शर्मा, वैज्ञानिक सहायक को राजभाषा हिंदी के विकास में योगदान देने के लिए दिनांक 13 जनवरी 2017 को गाँधी शांति प्रतिष्ठान सभागार, नई दिल्ली में 'राजभाषा गौरव सम्मान-2017' से सम्मानित किया गया।

संसदीय राजभाषा समिति द्वारा निरीक्षण

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 14 जनवरी, 2017 को मौसम केंद्र, बंगलुरु का राजभाषायी निरीक्षण किया गया। यह निरीक्षण डॉ. प्रसन्न

कुमार पाटसाणी जी की अध्यक्षता में हुआ जिसमें मुख्यालय के प्रतिनिधि के रूप में डॉ. एस. के. पेशिन वैज्ञानिक 'जी', सुश्री रेवा शर्मा उप निदेशक (राज भाषा) और श्रीमती सरिता जोशी सहायक निदेशक (रा. भा.) ने भाग लिया।



डॉ. प्रसन्न कुमार पाटसाणी, माननीय संसद सदस्य का डॉ. एस. के. पेशिन, वैज्ञानिक 'जी' मौसम केंद्र बंगलुरु के राजभाषायी निरीक्षण के दौरान

माननीय संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 16 जनवरी, 2017 को मौसम केंद्र गोवा का राजभाषायी निरीक्षण किया गया यह निरीक्षण डॉ. सुनील बलीराम गायकवाड जी की अध्यक्षता में हुआ जिसमें मुख्यालय के प्रतिनिधि के रूप में डॉ एस. के. पेशिन, वैज्ञानिक जी और मुख्यालय की सुश्री रेवा शर्मा उप. निदे. (रा. भा.) और श्रीमती सरिता जोशी सहा. निदे. (रा. भा.) ने भाग लिया।



संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 20 मई, 2017 को मौसम

कार्यालय - इम्फाल का राजभाषायी निरीक्षण किया गया। यह निरीक्षण डॉ प्रसन्न कुमार पाटसाणी जी की अध्यक्षता में हुआ जिसमें मुख्यालय के प्रतिनिधि के रूप में डॉ. देवेंद्र प्रधान, वैज्ञानिक 'जी' और हिंदी अनुभाग से सुश्री रेवा शर्मा उप. निदे. (रा.भा.) तथा श्रीमती सरिता जोशी, सहा.निदे. (रा.भा) ने भाग लिया।



संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 22 मई, 2017 को मौसम केंद्र अगरतला का राजभाषायी निरीक्षण किया गया। यह निरीक्षण डॉ. प्रसन्न कुमार पाटसाणी जी की अध्यक्षता में हुआ जिसमें मुख्यालय के प्रतिनिधि के रूप में डॉ. देवेंद्र प्रधान, वैज्ञानिक जी डॉ. संजय ओनील शॉ और हिंदी अनुभाग से सुश्री रेवा शर्मा उप. निदे. (रा. भा.) तथा श्रीमती सरिता जोशी सहा.निदे. (रा. भा.) ने भाग लिया।



डॉ. प्रसन्न कुमार पाटसाणी, माननीय संसद सदस्य, डॉ. देवेंद्र प्रधान, 'जी', सुश्री रेवा शर्मा व अन्य मौसम केंद्र अगरतला के राजभाषायी निरीक्षण के दौरान

अखिल भारतीय हिंदी संगोष्ठी



डॉ. के. जे. रमेश, डी जी, आई एम डी द्वारा छठवीं अखिल भारतीय विभागीय हिंदी संगोष्ठी का शुभारम्भ

भारत मौसम विज्ञान विभाग (मुख्यालय) द्वारा दिनांक 1-2 जून, 2017 तक दो दिवसीय छठवीं अखिल भारतीय विभागीय हिंदी संगोष्ठी आयोजन मौसम केंद्र तिरुवनंतपुरम में समारोहपूर्वक किया गया। दो दिवसीय छठवीं अखिल भारतीय विभागीय हिंदी संगोष्ठी में देश भर के कार्यालयों से 35 कार्मिकों ने भाग लिया और वैज्ञानिक एवं तकनीकी विषयों पर पॉवर प्वाइंट प्रेजेंटेशन दिए।

पूर्वोत्तर भारत में अंतर मंत्रालय / अंतर विभागीय हिंदी संगोष्ठी

वैज्ञानिक एवं तकनीकी तथा राजभाषा हिंदी से जुड़े विभिन्न विषयों पर पूर्वोत्तर भारत में अंतर मंत्रालय/ अंतर विभागीय हिंदी संगोष्ठी का आयोजन किया गया। 4-5 दिसम्बर, 2017 को शिलांग में संगोष्ठी का सफल आयोजन किया गया जिसमें विभाग के और विभागेतर कुल 36 कार्मिकों ने भाग लिया। 4 दिसम्बर, 2017 की प्रातः उद्घाटन समारोह की अध्यक्षता महानिदेशक महोदय डॉ. के. जे. रमेश ने की। इस समारोह के मुख्य अतिथि पूर्वोत्तर पर्वतीय विश्व विद्यालय शिलांग के कुलपति प्रोफेसर एस. के. श्रीवास्तव थे।



डॉ. के. जे. रमेश, डी जी, आई एम डी, डॉ. एस. के. पेशिन, वैज्ञानिक 'जी' व अन्य अधिकारीगण



डॉ. के. जे. रमेश, डी जी, आई एम डी, डॉ. एस. के. पेशिन, वैज्ञानिक 'जी' व अन्य अधिकारीगण

अंतरिक्ष अनुप्रयोग केंद्र शिलांग के निदेशक श्री पी. एल. एन. राजू और केंद्रीय हिंदी निदेशालय शिलांग के क्षेत्रीय निदेशक डॉ. ब्रजेन्द्र सिंह विशिष्ट अतिथि के रूप में आमंत्रित थे।

संगोष्ठी / कार्यशाला / व्याख्यान

दिनांक 24 जनवरी, 2017 को कृषि मौसम प्रभाग में मुख्यालय की सहायक निदेशक (राजभाषा) श्रीमती सरिता जोशी द्वारा कम्प्यूटर पर हिंदी में कार्य करने से संबंधित 'कम्प्यूटर और हिंदी-सुविधाएँ एवं उपयोग' विषय पर प्रेजेंटेशन दिया गया और यूनिकोड में कार्य करने की जानकारी दी गई।

पृथ्वी विज्ञान मंत्रालय द्वारा दिनांक 16 मार्च, 2017 को आयोजित हिंदी कार्यशाला में प्रवक्ता के रूप में सहायक निदेशक (राजभाषा) श्रीमती सरिता जोशी को आमंत्रित किया गया। उन्होंने

‘कम्प्यूटर और हिंदी सुविधाएँ एवं उपयोग’ विषय पर व्याख्यान दिया।

मुख्यालय में दिनांक 30 मार्च, 2017 को हिंदी कार्यशाला का आयोजन किया गया जिसमें श्री बीरेन्द्र कुमार, वरिष्ठ अनुवादक तथा श्री प्रमोद कुमार, सहायक ने व्याख्यान दिए और राजभाषा हिंदी के प्रगामी प्रयोग से संबंधित तिमाही प्रगति रिपोर्ट भरने के बारे में विस्तार से चर्चा की।

सुश्री रेवा शर्मा, उप.निदे. (रा.भा.) एवं श्रीमती सरिता जोशी सहा. निदे. (रा. भा.) ने 4-6 अप्रैल 2017 के दौरान मौसम केंद्र - गंगटोक में हिंदी कार्यशाला का आयोजन किया।

दिनांक 5 जून, 2017 को मौसम केंद्र तिरुवनंतपुरम में कार्यशाला का आयोजन किया गया जिसमें हिंदी वॉयस टापींग, यूनिकोड फॉट अपलोड करना एवं उस पर हिंदी में कार्य करने का प्रशिक्षण दिया गया एवं राजभाषा संबंधी नियमों एवं अधिनियमों की जानकारी दी गई।

केंद्रीय अनुवाद ब्यूरो, राजभाषा विभाग, गृह मंत्रालय के तत्वावधान में दिनांक 7 जुलाई, 2017 को अनुवाद प्रशिक्षण ई-लर्निंग प्लेटफॉर्म का लोकार्पण समारोह का आयोजन किया गया। इस समारोह में भारत मौसम विज्ञान विभाग की तरफ से डॉ. एस. के. पेशिन वैज्ञानिक ‘जी’, सुश्री रेवा शर्मा, उपनिदेशक (रा.भा.), श्रीमती सरिता जोशी, सहायक निदेशक (रा.भा.) तथा श्री बीरेन्द्र कुमार, वरिष्ठ अनुवादक ने भाग लिया।

श्री रामहरि शर्मा, मौसम विज्ञानी-‘ए’ एवं श्री बीरेन्द्र कुमार, वरिष्ठ अनुवादक ने दिनांक 12 से 14 अक्टूबर, 2017 तक पुरी में

परिवर्तन जन कल्याण समिति द्वारा आयोजित अखिल भारतीय हिंदी सम्मेलन एवं कार्यशाला में भाग लिया। इस कार्यालय में श्री रामहरि शर्मा, मौसम विज्ञानी - ‘ए’ ने भारत मौसम विज्ञान विभाग में हिंदी भाषा का विकास’ पर पाँवर प्वाइंट प्रेजेंटेशन प्रस्तुत किया।

मौसम केंद्र भुवनेश्वर में 9 से 10 अक्टूबर तक हिंदी कार्यशाला का आयोजन किया तथा श्री रामहरि शर्मा, मौसम विज्ञानी-‘ए’ द्वारा वॉइस टाइपिंग और श्री बीरेन्द्र कुमार, वरिष्ठ अनुवादक द्वारा राजभाषा हिंदी के प्रगामी प्रयोग से संबंधित तिमाही प्रगति रिपोर्ट भरने तथा कार्यालयीन दैनिक कार्य हिंदी में सहजतापूर्वक करने का प्रशिक्षण दिया गया।

मुख्यालय के हिंदी अनुभाग द्वारा दिनांक 6 दिसम्बर, 2017 को केंद्रीय भूकंप वेधशाला शिलांग में हिंदी कार्यशाला का आयोजन किया गया। इस हिंदी कार्यशाला में उपनिदेशक सुश्री रेवा शर्मा, सहायक निदेशक श्रीमती सरिता जोशी, वरिष्ठ अनुवादक श्रीमती शांता उन्नीकृष्णन, श्रीमती कल्पना श्रीवास्तव, श्री बीरेन्द्र कुमार, और श्रीमती वल्सला जोगलेकर तथा कनिष्ठ अनुवादक श्रीमती अपर्णा खेड़कर द्वारा राजभाषा हिंदी के कार्यान्वयन संबंधी भिन्न-भिन्न विषयों पर व्याख्यान दिए।

मुख्यालय के हिंदी अनुभाग द्वारा दिनांक 8 दिसम्बर, 2017 को प्रादेशिक मौसम केंद्र गुवाहाटी में हिंदी कार्यशाला का आयोजन किया गया जिसमें उपनिदेशक सुश्री रेवा शर्मा, सहायक निदेशक श्रीमती सरिता जोशी तथा वरिष्ठ अनुवादक बीरेन्द्र कुमार द्वारा राजभाषा हिंदी के कार्यान्वयन संबंधी भिन्न भिन्न विषयों पर व्याख्यान दिए गए।

उपकार्यालयों का राजभाषायी निरीक्षण

मुख्यालय की उपनिदेशक (राजभाषा), सहायक निदेशक (राजभाषा) तथा वरिष्ठ अनुवादक द्वारा दिनांक 24 जनवरी, 2017 को कृषि मौसम प्रभाग का राजभाषायी निरीक्षण किया गया तथा राजभाषा हिंदी के सफल कार्यान्वयन की दिशा में प्रयास करने के लिए आवश्यक मार्गदर्शन किया गया।

मुख्यालय की उपनिदेशक (राजभाषा), सहायक निदेशक (राजभाषा) तथा वरिष्ठ अनुवादक एवं सहायक द्वारा दिनांक 28 फरवरी, 2017 को मुख्यालय के आयोजना अनुभाग तथा बजट अनुभाग का राजभाषायी निरीक्षण किया गया जिसमें राजभाषा हिंदी के सफल कार्यान्वयन की दिशा में प्रयास करने के लिए आवश्यक मार्गदर्शन किया गया।

पृथ्वी विज्ञान मंत्रालय के अधिकारियों द्वारा 17 मार्च, 2017 को मौसम विज्ञान के महानिदेशक के कार्यालय, नई दिल्ली का राजभाषायी निरीक्षण किया गया।

सुश्री रेवा शर्मा, उप. निदे. (रा. भा.) एवं श्रीमती सरिता जोशी सहा. निदे. (रा.भा.) ने 4-6 अप्रैल, 2017 तक मौसम केंद्र-गंगटोक का राजभाषायी निरीक्षण किया। इस दौरान हिंदी कार्यशाला का भी आयोजन किया।

दिनांक 12-13 अप्रैल, 2017 को मुख्यालय के उपग्रह मौसम प्रभाग तथा केंद्रीय विमानन मौसम प्रभाग का राजभाषायी निरीक्षण किया।

दिनांक 22 मई, 2017 को मौसम केंद्र अगरतला में कार्यशाला का आयोजन किया

गया जिसमें सुश्री रेवा शर्मा उप. निदे. (रा. भा.) एवं श्रीमती सरिता जोशी सहा. निदे. (रा.भा.) द्वारा हिंदी वॉयस टाइपिंग यूनिकोड फॉट अपलोड करना एवं उस पर हिंदी में कार्य करने का प्रशिक्षण दिया गया एवं राजभाषा संबंधी नियमों एवं अधिनियमों की जानकारी दी गई।

मुख्यालय की उपनिदेशक (राजभाषा), सहायक निदेशक (राजभाषा) द्वारा दिनांक 5 जून, 2017 को मौसम केंद्र तिरुवनंतपुरम कार्यालय का राजभाषायी निरीक्षण किया गया।

मौसम केंद्र तिरुवनंतपुरम कार्यालय का दिनांक 5 जून, 2017 को राजभाषायी निरीक्षण किया गया तथा हिंदी कार्यशाला का आयोजन किया गया जिसमें हिंदी वॉयस टाइपिंग एवं राजभाषा संबंधी नियमों एवं अधिनियमों की जानकारी दी गई।

श्री रामहरि शर्मा, मौसम विज्ञानी-‘ए’ एवं श्री बीरेन्द्र कुमार, वरिष्ठ अनुवादक ने दिनांक 11 अक्टूबर, 2017 को मौसम कार्यालय पुरी का राजभाषायी निरीक्षण किया गया।

समारोह

भारत मौसम विज्ञान विभाग के मुख्यालय में हिंदी दिवस समारोह 14 सितम्बर, 2017 को आयोजित किया गया। रंग बिरंगे फूलों से सजे और संगीतमय वृष्टि सभागार में इस कार्यक्रम का आयोजन किया गया। हिंदी दिवस समारोह की अध्यक्षता वैज्ञानिक ‘जी’ डॉ. सुनील कुमार पेशिन, ‘जी’ ने की। इस समारोह की खास बात यह थी कि हमारे देश के कवि श्री दिविक रमेश जी इस समारोह के मुख्य अतिथि थे। वृष्टि

सभागार में उपस्थित सभी लोगों का सुश्री रेवा शर्मा ने स्वागत, अभिवादन और अभिनन्दन किया।



डॉ. डी. प्रधान व अन्य अधिकारीगण हिंदी



डॉ. डी. प्रधान व अन्य अधिकारीगण

प्रकाशन

विभागीय हिंदी गृह पत्रिका मौसम मंजूषा के 24^{वें} संस्करण का विमोचन दिनांक 15 जनवरी, 2017 को भारत मौसम विज्ञान विभाग के स्थापना दिवस के अवसर पर किया गया।

दिनांक 1 जून, 2017 को छठवीं अखिल भारतीय विभागीय हिंदी संगोष्ठी के उद्घाटन सत्र में महानिदेशक महोदय डॉ. के. जे. रमेश, मुख्य अतिथि डॉ. तंकमणि अम्मा, श्री एस. बी.

तंपी उपमहानिदेशक प्रादेशिक मौसम केंद्र चेन्नै, डॉ. देवेन्द्र प्रधान, उपमहानिदेशक प्रादेशिक मौसम केंद्र नई दिल्ली, श्री सुदवेन, निदेशक, मौसम केंद्र तिरुवनंतपुरम और सुश्री रेवा शर्मा उपनिदेशक (राजभाषा) द्वारा पाँचवीं अखिल भारतीय विभागीय हिंदी संगोष्ठी की पुस्तक 'मौसम विज्ञान के बढ़ते चरण' का विमोचन किया गया।



डॉ. के. जे. रमेश, डॉ. डी प्रधान व अन्य अधिकारीगण हिंदी पुस्तक 'मौसम विज्ञान के बढ़ते चरण' का विमोचन करते हुए

हिंदी दिवस 14 सितम्बर, 2017 के अवसर पर मौसम मंजूषा के रजत (25^{वें}) संस्करण का विमोचन किया गया।



डॉ. डी. प्रधान, वैज्ञानिक 'जी' डॉ. एस. के. पेशिन, वैज्ञानिक 'जी' व अन्य अधिकारीगण मौसम मंजूषा के रजत (25^{वें}) संस्करण का विमोचन करते हुए

CHAPTER 11

MISCELLANEOUS

11.1. HONOURS AND AWARDS

IMD Awards

Best RMC/MC/MOs Awards and Awards to IMD Scientists/employees were given on 142nd IMD Foundation Day celebrations.

Best RMC : RMC New Delhi;

Best MC : MC Srinagar;

Best MO : M.O. Dhubri, RMC Guwahati; M.O. Jalpaigudi, RMC Kolkata; M.O. Indore, RMC Nagpur; M.O. Chitradurga, RMC Chennai; M.O. Baroda, RMC Mumbai; M.O. Lucknow, RMC New Delhi.

Best RS/RW : RS/RW Aminidevi

Best AMFU : AMFU Tirupati

MoES AWARD 2016-2017

Ministry of Earth Sciences celebrated its foundation day on 27th July 2017 at Vigyan Bhawan, New Delhi. Various award were presented to officials from different organisations of MoES.

Certificate of Merit

1. Dr. R. R. Mali, Scientist 'F', DGM, New Delhi.
2. S. I. Laskar, Scientist 'D' ADGM (R), Pune.



Dr. R. R. Mali, Sc. 'F' receiving the award from Dr. Harsh Vardhan, Hon'ble Minister of Earth Sciences



Dr. S. I. Laskar, Sc. 'D' receiving the award from Dr. Harsh Vardhan, Hon'ble Minister of Earth Sciences

Best Employee Award for the year 2016-17

1. Dr. Sumit Kumar Bhattacharya, Met. 'A', DGM's Office (NWP), New Delhi.
2. Shri Roshan Kumar Chhetri, S.A., M.C. Gangtok, RMC Kolkata.
3. Ms. T. Amudha, UDC, RMC, Chennai.
4. Shri Banwari Singh, MTS, ISSD, DGM's Office, New Delhi.
5. Shri Aditya Kumar Das, MTS, M.O. Tezpur, RMC Guwahati.

Indian Science Congress

RMC Chennai represented MoES for the 104th Indian Science Congress held at SV University Tirupathi during 3-7 January and **Shri P. S.Biju, Sc. 'D'** received the Best Informative Stall.



Shri. P. S. Biju, Sc. 'D' receiving the Best Informative Stall award

The certificates of achievement of the three best essays on “**Space based Observations for Weather, Environment, Climate and Societal Benefits**” were awarded to the winner of the contest by Shri J. R. Prasad, Sc. 'E', Chairman of IMS, Nagpur Chapter in view of student's event for INTROMET-2017'.



Winners of the essay contest in INTROMET-2017'

Dr. O. P. Sreejith received **B. N. Desai Award** on Monsoon Research during the opening ceremony of the INTROMET Symposium on 7th November, 2017 at Space Application Center, Ahmedabad. In this conference lead author of the paper published in “Nature” in which Dr. A. K. Srivastava is also a co-author was awarded Young Scientist Award.

मौसम केंद्र हैदराबाद में कार्यरत 22 कर्मिकों को हिंदी शिक्षण योजना के अंतर्गत प्रबोध व प्राज्ञ परीक्षा अच्छे अंको से उत्तीर्ण करने पर कुल ₹ 48,000/-, प्रादेशिक मौसम केंद्र मुंबई, मौसम कार्यालय सांताक्रुज, कोलाबा में कार्यरत 20 कर्मिकों को प्राज्ञ परीक्षा अच्छे अंको से उत्तीर्ण करने पर कुल ₹ 34,400/- तथा प्रादेशिक मौसम केंद्र, कोलकाता में कार्यरत 16 कर्मिकों को हिंदी प्रवीण परीक्षा अच्छे अंको से उत्तीर्ण करने पर कुल राशि ₹ 21,600/- की नकद पुरस्कार राशि के स्वीकृति पत्र जारी किए गए।

Appreciation Received

Special Weather forecast for legislative assembly elections and counting held in Uttarakhand was issued to district authorities which was duly recognized and appreciated by District authorities.

The President, 104th Indian Science Congress appreciated cyclone warning services of IMD “Among our many-sided advances in meteorology, important outcomes during the recent cyclones in Odisha, Andhra Pradesh and Tamilnadu, when we received accurate forecasts of landfall points that were more accurate than the forecasts of international agencies.



The **Parliamentary Standing Committee** on Science and Technology and Earth Sciences in it's 294th Report appreciated the cyclone warning services of IMD. The excerpt of the report appreciating the cyclone warning is given below:

“The track record of the Ministry has been above par in the case of cyclone predictions which has been seen in the case of Hudhud and Vardah.” The committee also appreciated the achievements of Ministry in the area of accuracy in weather forecasting.

डा. एस. एल. सिंह, वैज्ञानिक-एफ को 23 मार्च, 2017 “WMO दिवस” के अवसर पर 2012-2016 की अवधि के दौरान (1) थीम लीडर के रूप में प्रारंभिक चेतावनी प्रणालियों सहित WIS-GTS संचालन में (WIS-GTS operations including Early Warning Systems as a theme leader, RA II of WMO) तथा

(2) संचार बुनियादी ढांचा और आरएमटीएन स्थिति का उन्नयन डब्ल्यूएमओ के आरए II में (Communication infrastructure and RMTN status up gradation in RA II of WMO) की उत्कृष्ट सेवाओं के विषय में दो प्रमाण पत्र प्रदान किये गये।

Hon'ble Prime Minister in his Maan Ki Baat dated the 31st July, 2017 appreciated “**weather forecasting services of India Meteorological Department**” and urged the public to use more and more weather forecasts to reduce losses. Excerpt of his address is “**Weather forecasts are available these days and the concerned technology has become so advanced these days, and space science also plays a very big role that these weather forecasts turn out to be mostly accurate now. We should also gradually make it our nature to set our work patterns according to the weather predictions, which could safeguard us against losses**”.

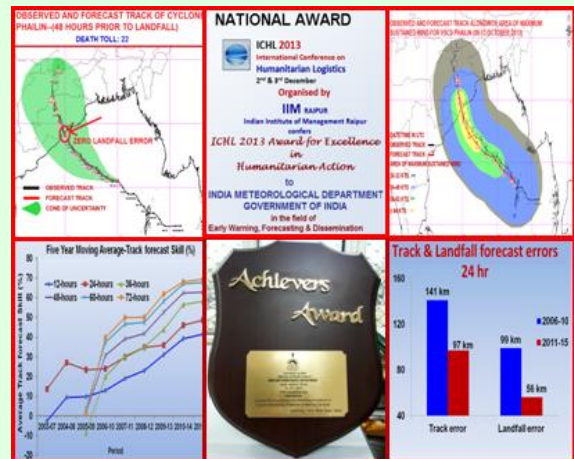
The Chief Secretary, Government of Uttarakhand, appreciated the weather forecast issued by M. C. Dehradun towards Hourly Weather forecast and Warnings during VVIP-1 visit to Haridwar, Sri Badrinath ji and Sri Kedarnath ji on 22nd and 23rd September, 2017 to the Chief Secretary, Government of Uttarakhand, Secretary, Protocol and other Senior Officers of Govt. of Uttarakhand.

The Hourly Weather forecast and Warnings issued by MC Dehradun was appreciated by the Chief Secretary, Govt. of Uttarakhand during VVIP visit to Dehradun, Sri Kedarnath ji and Mussoorie on 20, 26 and 27 October, 2017 to Chief Secretary, Secretary, Protocol and other senior officers of Govt. of Uttarakhand for smooth management of the visit.

11.2. MEDIA INTERACTION

Documentary film showcasing Early Warning System of Cyclones highlighting accurate predictions of VSCS Phailin (2013) and VSCS

Hudhud (2014) was telecast on the occasion of 142nd Foundation Day ceremony of IMD on 15th January. The documentary film was telecast by DD India and Lok Sabha TV on 23rd March-the WMO Day with repeat telecast by DD India on 24th March, 2017. The film has been uploaded on YouTube: <https://www.youtube.com/watch?v=3ODXUlcYims&feature=youtu.be>



Rajya Sabha TV telecast an episode of "Eureka in conversation with Dr. M. Mohapatra, Scientist-G (Services)" highlighting achievements of IMD in early warning system of cyclones on 28th January with repeat telecast on 29th January and 2nd February. The same is available on YouTube at <https://www.youtube.com/watch?v=WOBjsw2YTNg>



Vigyan Prasar under its India Science News and Feature Services published a feature entitled “**Cyclone Man of India: Dr. M. Mohapatra**”. The article is available at http://www.vigyanprasar.gov.in/whats_new/isn/Dr-Mrutyunjay-Mohapatra.pdf

Dr. S. D. Attri, Scientist 'F' participated in one-hour programme on "Climate Change and agriculture" at DD Kisan, New Delhi on 11th March, 2017.

The documentary film on "**Early Warning System of Tropical Cyclones over north Indian Ocean**" was telecast by DD India and Lok Sabha TV on 23rd March-the WMO Day with repeat telecast by DD India on 24th March, 2017.

Doordarshan Ahmedabad telecasted a programme of **Dr. Jayanta Sarkar, Sc. 'F'** on environment on 25-26 March, 2017 on the event of WMO day celebration 2017.

TV programme was recorded by Door Darshan Ahmedabad team and it was telecasted in its programme "**Paryavarn Darshan**" on 25 and 26 March, 2017. Electronic and print media have been routinely briefed regarding **weather scenario over the state**.

Dr. S. C. Sahu, Scientist 'F' delivered lecture on "Meteorological Information for Timely Awareness" Prasar Bharati, Bhubaneswar on 27th March, 2017.

Dr. K. J. Ramesh, DGM, and Dr. K. K. Singh, Sc. 'F', participated in the talk on 'Mausam Vigyan and Kisan' in Hindi under the programme Vad-Samvad of DD-Kisan on 29th March, 2017.

Shri Anand Kumar Sharma, Scientist F was interview by WION (International coverage) TV on "Weather and Agriculture" on 31st March, 2017.

NDMA published an interview entitled "**Dr. M. Mohapatra on Tropical Cyclones**" in their quaterly magazine Samvad.

Vigyan Prasar under its India Science News and Feature Services published a feature entitled "**Cyclone Man of India: Dr. M. Mohapatra**".

An article "**Pollution turning country's rainfall acidic, shows study**" was published in Times of India.

Dr. S. C. Sahu, Scientist 'F', M. C. Bhubaneswar Record lecture on World Meteorological day was broadcasted by All India Radio, Cuttack at 7:25am on 23rd March, 2017 and telecasted by Prasar Bharati, Doordarshan, Bhubaneswar at 4:30 pm and 11:00 pm on 23rd March, 2017.

IMD arranged a Press Conference on "**First Stage Forecast of Southwest Monsoon Season-2017 Rainfall**" on 18th April, 2017. All print and electronic media persons were invited to participate in the meeting. The long range forecast issued is as below:

(a) Quantitatively, the monsoon seasonal rainfall is likely to be 96% of the Long Period Average (LPA) with an error of $\pm 5\%$.

(b) Forecast assessment suggests 38% of probability for near normal monsoon rainfall.

Dr. M. Mohapatra, Scientist 'G' and Head (Services) had an interactive talk in Hindi on the theme "गर्मी की लहर: पूर्वानुमान और सावधानियाँ" highlighting the formation, development, prediction, precautions, etc. related to Heat Wave in India. The programme was broadcast by All India Radio on 20th April, 2017.

Panel discussion "Sustainable development: Life must go on"

Dr. K. J. Ramesh, DG, IMD and Shri Anand Sharma, Scientist 'F' was invited and participated in the panel discussion on "Sustainable development: Life must go on" by All India Radio on 27th May, 2017. The programme was recorded both in Hindi and English and will be broadcast on 4th June, 2017.

Shri Anand Sharma, Scientist 'F' was interviewed by Lok Sabha TV on weather based agro advisories on 6th June, 2017 and by DD Kisan TV on weather and weather based agro advisories on 12th June, 2017.



Shri Anand Sharma, was interviewed by DD Kisan TV on weather and weather based agro advisories on 12th June, 2017

Shri Anand Sharma, Scientist 'F' was interviewed by Doordarshan TV and AIR Shimla on weather based agro advisories on 15th June, 2017.

Dr. S. D. Attri, Scientist 'F' participated in one-hour programme on "Monsoon and Agriculture" at Doordarshan, New Delhi on 1st June, 2017.



Dr. S. D. Attri, delivered talk on "Monsoon and Agriculture"

Shri S. M. Metri, Scientist 'E' attended Mass Media Meeting on 2nd June, 2017 at Doordarshan Kendra, Bengaluru.

Shri S. M. Metri, Scientist 'E' answered about 126 Weather Enquiries by Electronic and Print Media during the period.

Shri Bikram Singh, Scientist 'E', Meteorological Centre, Dehra Dun was interviewed by Aaj Tak, India news, ETV, Sahara TV, Samachar Plus, Network 10, Mandakini ki Awaz, etc.

Dr. S. C. Sahu, Scientist 'F', M. C. Bhubaneswar, participated in panel discussion in Kalinga TV live telecast for creating massive public awareness campaign on the safety awareness on lightning on 29th July, 2017.

Dr. M. Mohapatra, Scientist 'G' participated as a Panelist in the live Panel Discussion Programme in Hindi organized by Lok Sabha TV during 1900-2000 hrs IST of 30th July, 2017 on the theme, "Rain, Flood and Disaster"

Forecast was issued on 8th August, 2017 for moderate to rather heavy rain with moderate to severe thunderstorm at a few places over Ariyalur district. As per press reports, a bridge built across a river broke due to flash floods caused by heavy rains near Sendurai in Ariyalur district on 9th August, 2017.

Forecast was issued on 16th August 2017 for moderate to heavy rain with moderate to severe thunderstorm at a many places over Namakkal district. As per press reports, a woman was burnt to death due to severe thunderstorm and lightning near Kolli Hills in Namakkal district on 17th August, 2017.

Shri S. S. Mairal, Met 'B' attended quarterly meeting on "Gramin Sallagar Karyakrem" of All India Radio (AIR) on 25th September, 2017 Symbiosis International University, Hinjewadi, Pune. He discussed the mechanism of preparation composite Agromet Advisory Bulletins for Maharashtra state and assured the officers of AIR for forwarding of bulletin within time *i.e.*, 1700 hours for its editing in order to broadcast early morning on next day.

Dr. S. C. Sahu, Scientist 'F' M.C. Bhubaneswar delivered lecture in the "Training cum Workshop" at NABM (P), All India Radio and Doordarshan, Bhubaneswar on "Meteorological Information & Disaster Management" on 24th October, 2017.



Shri Anand Sharma, Sc. 'F' talk on Lok Sabha TV

Shri Anand Sharma, Scientist 'F' was interviewed by Lok Sabha TV on 28th November, 2017 on the topic Disaster Risk Reduction in Himalayan Agriculture.

Shri Anand Sharma, Scientist 'F' was interviewed by DD Kisan TV for weather forecast on daily basis on 28 and 18 occasions during November and December, 2017 respectively.

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

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