



वार्षिक प्रतिवेदन Annual Report 2012

वार्षिक प्रतिवेदन

ANNUAL REPORT

2012



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

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Compiled by

Publication Section, Office of D.G.M.

Design and Formatting

Dinesh Khanna, Publication Section

Printed at

**Office of the Additional Director
General of Meteorological
(Research), Pune**

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FOREWORD

The Annual Report for the year 2012 provides me an opportunity for reflection past one year efforts and achievements made with scope of further advancement. The department has been playing a leading role of providing an excellent weather and hydrological services for benefits of different sector of societies like agriculture productivity, energy generation, efficient aviation, marine and fishery services, disaster management, country planning & more important is an invisible contribution towards growth of GDP of the country. Our scientists continued to strive hard their responsibilities by observing weather & correct disseminating Weather prediction. On the occasion of 137th Foundation Day celebration, the 15th January, then Hon'ble Minister Dr. Ashwani Kumar had reflected the future scenario of the department and envisioned on developments ,use and application of indigenous products. The department progressively strides at various levels towards modernization of scientific infrastructure, commissioning of Doppler Weather RADAR, DMDD System, C band Polarimetric Radar, Automatic Wx station (AWS), Automatic Rain Gauge (ARG,) etc. at various stations during the year.

All operational long range season rainfall forecast for southwest monsoon-2012 were correct. The cumulative rainfall departure was negative throughout the season and monthly rainfall during first two month were below its LPA value whereas rainfall during August & September was higher than LPA value. The NE monsoon rainfall was 96% of LPA and was normal .The performance for track, intensity and landfall prediction for cyclone Murjan & Neelam was better in 12 hrs lead time. In case of hydrological services out of 17092 number of QPF issued for rivers and their sub basins were correct 68% and 26% were out by one stage. Understanding the weather pattern, climate of polar region and their teleconnection with Indian Monsoon is a big challenge for which department continued to shoulder its responsibilities as a member of scientific expedition team to Antarctica. This year highest number of blizzard was reported in May and September month happened to be more gusty. It is not only weather observation but Earthquake and environment monitoring are another thrust area of our responsibility. Environmental Monitoring is used for preparation of environmental impact assessments and risk of harmful effects on natural environment.

The technical & scientific cooperations under various programmes with WMO Geneva, U.K. USA, Southeast Asia and SAARC countries has opened a path ahead for future needs of society. The weather forecasting capabilities, trainee's facility and other modernization programmes were appreciated by Dr. M. Jerraud, Secretary General, WMO, Geneva, Switzerland, deligation led by Dr. Marc Tueller

N. and Dr. Robert Stefanski, chief agromet advisory during their visits. Department has contributed significantly for achieving goal for Global Framework for Climate Services and efficient meteorological services for various sectors at WMO Executive council and WMO congress meet at Geneva. This year India has been recognized as a regional centre for Service Weather Forecast demonstration (SWFP) for south Asia.

In national scenario also keeping in view of national interest various services linked with various stake holder agencies, the department has collaborated with various agencies like State Agricultural universities, Indian Council of Agricultural Research , Watershed organization, Geological Survey of India, IITM, DDA, Centre Water Commission and signed Memorandum of understanding.

The publishing of 16 departmental publications in various disciplines of atmospheric sciences and 92 research papers in various national and International journals by the scientists of the department have taken a new height in raising the strength towards research and development activities. It is also a matter of pride for us that many IMD scientists have received honour and awards for their outstanding performances to take up new responsibilities. In this connections the National Geo Scientists Award to Dr. G. Suresh, Mausam biennial awards to Dr. M. Mohapatra & S. L. Biswas & Award of PhD degree to Dr. R. S. Dattatrayam are worth to mention. It is not possible to flourish any organization without human resources development with time and space.

In order to strengthen human resources the training programmes in field of meteorology, Agro meteorology, Seismology, Instrumentation, Astronomy, Telecommunications, Hydrometeorology, Cyclone, Forecasting etc. were organized during the year. The implementation of officials languages policy in popularizing use of Hindi in day-to-day officials works pursued and encouraged. Besides other activities two publications viz. Mausam Manjusha and Nibandh Sagar were brought out.

In conclusion, I am availing this opportunity to thanks all members of the department for their true dedication and strive to further enhance to reputation of the department with strong national and international credibility. I look forward confidently with the mission to improve our understanding in the subject areas of responsibilities will meet future demand of people of the country.

Dr. Laxman Singh Rathore
Director General of Meteorology

IMD ORGANIZATION CHART

India Meteorological Department

Ministry of Earth Sciences

Govt. of India



Dr. Shailesh Nayak
Secretary, Ministry of
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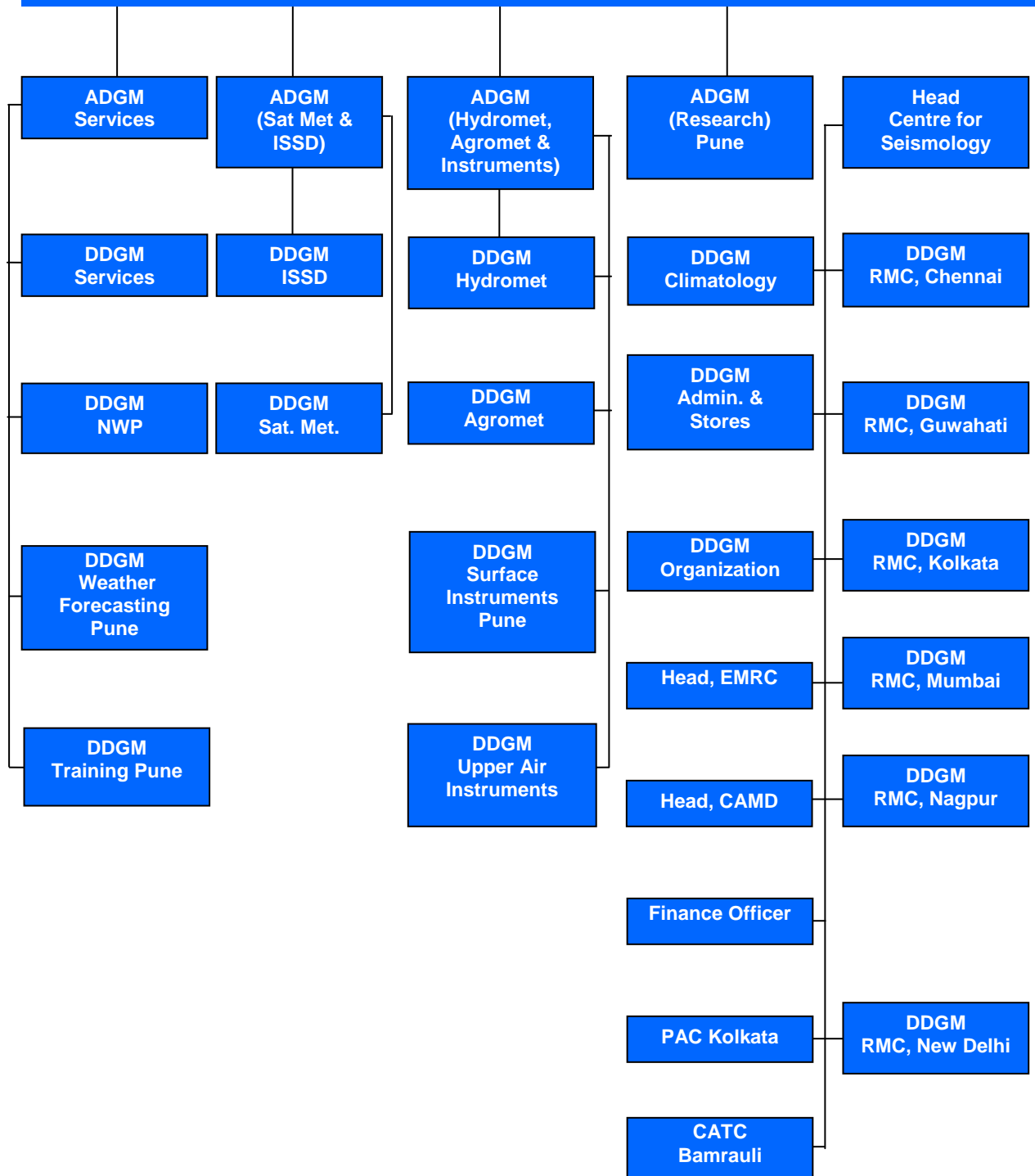
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Dr. (Ms.) Medha Khole, Scientist 'E' / DDGM
(Weather Forecasting)

ORGANISATIONAL STRUCTURE

SECRETARY, MINISTRY OF EARTH SCIENCES

DIRECTOR GENERAL OF METEOROLOGY



1. SEASONAL WEATHER FEATURE

The Indian monsoon is among several geographically distributed observations of global monsoon taking place in the Indian subcontinent. The strength, the variability, the distribution and the general vagaries of the monsoon of the Indian subcontinent, but understanding of the phenomenon and its predictability are still evolving. The unique geographical features of the subcontinent, along with associated atmospheric, oceanic and geophysical components, are extremely influential in ensuring the anticipated behavior for a monsoon in this region. If it rains too much causing floods in several parts of India, in others it rains too little or not at all causing droughts. Such is the variability in the nature of Monsoon rains and weather India is predominantly an agricultural country. A good monsoon resulting in improved agricultural brings down prices of essential food commodities and reduces their imports overall reducing the food inflation. Further improved rains result in increased hydroelectric production. All these factors initiate positive ripple effects throughout the economy of India. Success or failure of crops in any year is always crucial for the development of Indian economy, which in turn controls the economy of the country.

1.1. Winter season

Weather features

Severe cold wave / cold wave conditions prevailed over most parts of the country from the second to fourth week of January. Maximum temperature was also below normal by over 5 °C over most parts of the country during this period. However, minimum temperature was above normal by over 5 °C (indicating warmer night conditions) especially over the eastern parts of the country during first two weeks of January. Cold wave conditions again prevailed over the northwest and west central regions of the country during the first two and last week of February. The peninsular parts of the country also experienced these conditions during the last week of February.

Rainfall features

During the season, out of 36 meteorological subdivisions, 7 received excess rainfall, 3 received normal rainfall, 12 received deficient rainfall and 11 received scanty rainfall.

Remaining 3 subdivisions did not receive any rain. Gangetic West Bengal, Orissa, Chattisgarh, Coastal Andhra Pradesh and Andaman & Nicobar Islands received about one and half to two times of their respective normal rainfall. Meteorological sub-divisions of eastern/northeastern and extreme northern region of the country received excess/normal rainfall. While, rest of the country received deficient/scanty/no rainfall. Cumulative rainfall departure which was high positive during the initial weeks of the season, gradually decreased and became negative during the last week.

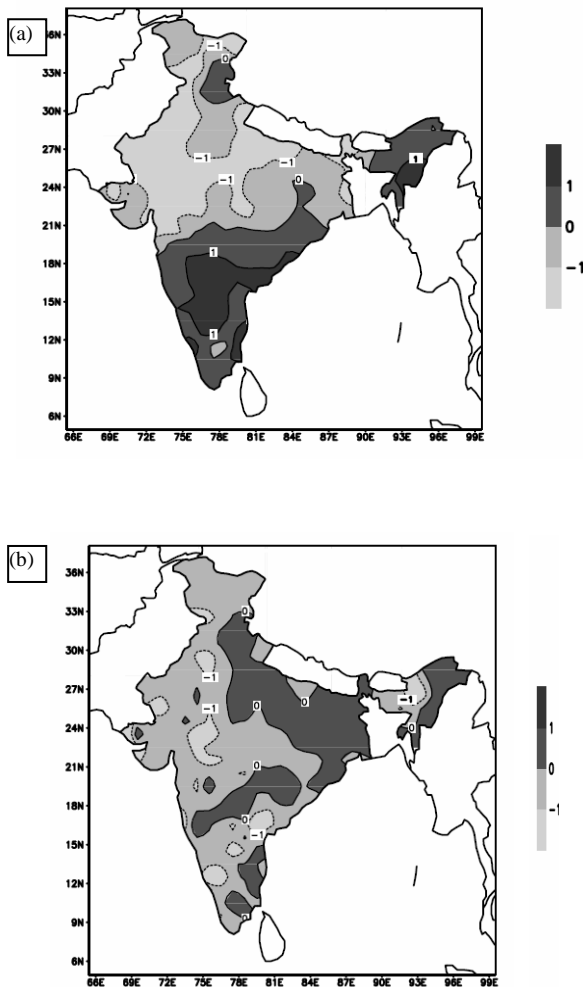
Rainfall activity over the country during the season as a whole was near normal. It was above normal during January (140% of LPA) and subdued during February (58% of LPA). For the winter season 2012, rainfall for the country as a whole was 95% of its Long Period Average (LPA) value.

Temperature

The maximum temperatures were generally below normal over central and northern parts of

the country and above normal over peninsula and extreme northeastern region. These were generally below normal by more than 1 °C over northern/northwestern, western and adjoining central parts of the country. Over parts of central peninsula, coastal Tamil Nadu and Andhra Pradesh and parts of extreme northeastern region, maximum temperatures were above normal by over 1 °C [Fig. 1(a)].

Minimum temperatures were below normal over most parts of the country except parts of northern/northeastern region and some parts of south peninsula. Minimum temperature anomalies were generally within ± 1 °C over most parts of the country [Fig. 1(b)].



Figs. 1(a&b). Mean seasonal temperature anomalies (°C) (a) Maximum (b) Minimum

Pressure & Wind

The pressure anomalies were negative over most parts of the country except some parts of extreme northern region. The negative pressure anomalies were of the order of 0.5 hPa over central and northern parts of country and exceeded 1.0 hPa over parts of south peninsula and eastern / northeastern region.

Outgoing Longwave Radiation (OLR)

Positive OLR anomalies were observed over the peninsula, adjoining central region and most parts of the Indian sea. Over parts of north and south Andaman seas, the negative OLR anomalies exceeded 10 to 20 W/m². Over parts of equatorial region, positive OLR anomalies exceeding 10 to 20 W/m² were observed.

1.2. Pre-monsoon season

Weather feature

Severe cold wave / cold wave conditions continued to prevail over some parts of north, central and adjoining north peninsular India including northern parts of the west coast during first fortnight of March. In the second fortnight of March, severe heat wave / heat wave conditions were observed over western parts of Rajasthan, hilly areas of northeast region and one or two isolated places.

During first fortnight of April, while western and adjoining central parts of the country, *viz.*, parts of Rajasthan and West Madhya Pradesh were under the grip of heat wave, many parts of north east India were relatively cooler as the maximum temperature was below normal by over 50 °C for some days over some stations of this region.

Heat wave conditions prevailed over eastern parts of south peninsula during first week of May and over northeastern parts of the country,

viz., Gangetic West Bengal, Bihar, Jharkhand and Orissa during the second week. During last fortnight of May heat wave / severe heat wave conditions were observed throughout the country on many occasions with highest frequency over the southeast peninsula and northeastern parts of the country.

Rainfall feature

During the season, out of 36 meteorological subdivisions, only one sub-division (Andaman & Nicobar Islands) received excess rainfall, 6 received normal rainfall, 19 received deficient rainfall and 10 received scanty rainfall. Rainfall activity over the country as a whole was below normal during the season. Except for few subdivisions of south peninsula, Rajasthan state and Arunachal Pradesh, entire country received deficient/scanty rainfall.

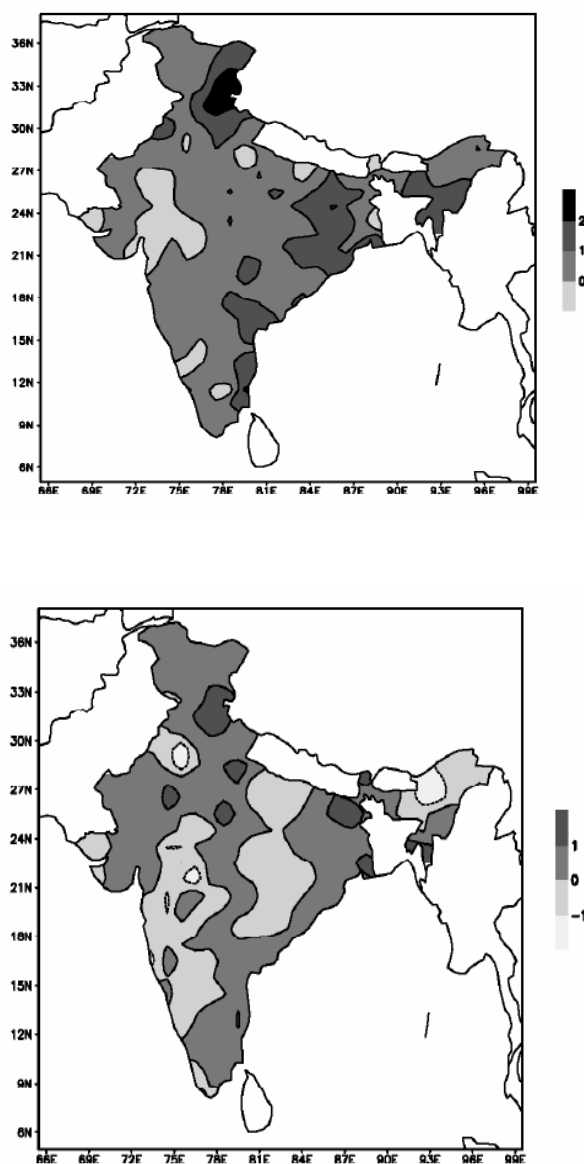
Rainfall anomaly was negative over most parts of the country except some parts of south central peninsula, Rajasthan, Western parts of Jammu & Kashmir and parts of Arunachal Pradesh. Negative rainfall anomaly over the southern parts of west coast, parts of eastern region, *viz.*, Gangetic West Bengal, Orissa, Jharkhand, parts of northern region *viz.*, Jammu & Kashmir, Himachal Pradesh and Uttarakhand and most parts of extreme northeastern region exceeded 5 to 10 cm. Positive rainfall anomaly over parts of South Interior Karnataka exceeded 5 cm.

Out of 36 sub-divisions 1 recorded excess rainfall, 5 recorded normal rainfall, 20 recorded deficient rainfall and remaining 10 sub-divisions recorded scanty rainfall. Cumulative rainfall departure was negative during all the weeks of the season. For the pre-monsoon season 2012, rainfall for the country as a whole was 69% of its Long Period Average (LPA) value. It was 37% of LPA during March, 124% of LPA during April and 50% of LPA during May.

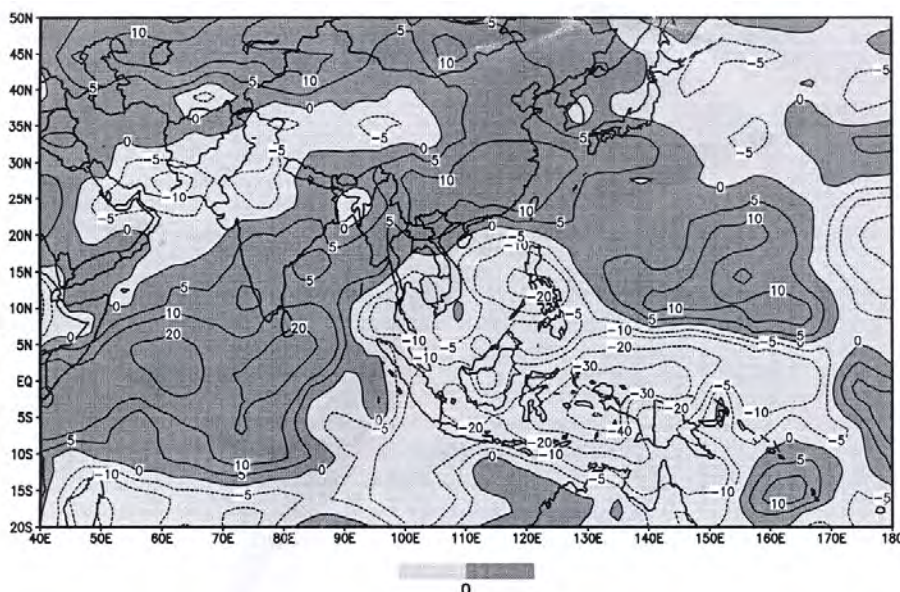
The updated rainfall statistics is, the country as a whole received 31% less rainfall of LPA.

Pressure & Wind

The pressure anomaly was negative over most parts of the country except some parts of southwest peninsula and parts of west central and northern region. The magnitude of negative pressure anomaly over eastern parts of the country was more than 0.5 hPa. At 850 hPa level, an anomalous anticyclonic circulation was observed over the northeast Arabian Sea and adjoining land areas. At 500 hPa level, this anomalous circulation was well marked and more widespread almost throughout the country and adjoining Arabian Sea.



Figs. 2 (a&b). Mean seasonal temperature anomalies ($^{\circ}\text{C}$) (a) maximum and (b) minimum



Figs. 3. OLR anomalies (W/m^2) for pre-monsoon season 2012 (Source : CDC/NOAA, USA)

Temperature

Mean seasonal maximum and minimum temperature anomalies are shown in Figs. 2(a&b) respectively. Both Maximum and minimum temperature anomaly was generally within $+10^\circ\text{C}$ range over most parts of the country. However, over parts of east peninsula viz., Coastal Andhra Pradesh, Telangana and Tamil Nadu, parts of eastern/northeastern region, viz., Orissa, Jharkhand, Bihar, Assam & Meghalaya and Nagaland, Mizoram, Manipur, Tripura and parts of northern region, viz., parts of Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Punjab, maximum temperature was above normal by more than 10°C . Similarly, over parts of Himachal Pradesh and Bihar, minimum temperature was above normal by more than 10°C .

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig. 3. OLR anomaly (W/m^2) over the Indian region and neighbourhood. Positive OLR anomaly exceeding 5 W/m^2 was observed over the peninsula and adjoining central and southern parts of the Indian seas. Over the equatorial

Indian Ocean region, positive OLR anomaly exceeded $10\text{-}20 \text{ W/m}^2$. Negative OLR anomaly exceeding 5 W/m^2 was observed over central and adjoining northern parts of the country and parts of Andaman seas.

1.3. Monsoon season (JJAS)

Onset & Advancement of S W Monsoon

Southwest monsoon set in over Kerala on 5th June (4 days later than its normal date, i.e., 1st June), covering the entire state (Kerala), many parts of south and central Arabian sea, some parts of coastal Karnataka and south Tamil Nadu and some more parts of south & east central Bay of Bengal on the day. It advanced rapidly along the west coast covering Coastal Karnataka, Goa and southern parts of Konkan and Madhya Maharashtra on 6th June. It also covered northeastern states and parts of Sub-Himalayan West Bengal & Sikkim on the same day. The Northern Limit of Monsoon (NLM) as on 6th June, passed through Lat. 18°N / Long. 60°E , Lat. 18°N / Long. 65°E , Lat. 18°N / Long. 70°E , Harnai, Satara, Belgaum, Agumbe, Medikeri, Kodaikanal, Lat. 10°N / Long. 80°E , Lat. 12°N / Long. 86°E , Lat. 18°N / Long. 90°E , Lat. 23°N / Long. 91°E and Gangtok. After a hiatus of six days,

monsoon advanced further in stages on 13, 16 and 17 June and covered most parts of peninsular and eastern India and entire Bay of Bengal. It entered into parts of central India on 19th June and covered most parts of Madhya Maharashtra, remaining parts of Vidarbha, West Bengal & Sikkim, Orissa, most parts of Chattisgarh, Jharkhand, Bihar and some parts of south Madhya Pradesh. It advanced into some more parts of central and northern India on 21st June.

Subsequently, there was a hiatus of about 11 days and monsoon advanced further only on 3rd July, covering some more parts of central India. On the next day, *i.e.*, 4th July, it covered some more parts of north Arabian Sea, Gujarat State, remaining parts of Maharashtra and some more parts of Madhya Pradesh. As on 4th July, the Northern Limit of Monsoon (NLM) passed through Lat. 22° N/Long. 60° E, Lat. 22° N/Long. 65° E, Lat. 22° N / Long. 68° E, Jamnagar, Ahmedabad, Ratlam, Sagar, Satna, Varanasi, Gorakhpur and Lat. 28° N / Long. 83° E. During 5 to 9 July, it advanced rapidly both northwards and westwards and covered most of the northern / northwestern parts of the country. Southwest monsoon covered the remaining parts of north Arabian Sea, Gujarat and Rajasthan States and thus the entire country on 11th July, 4 days ahead of its normal date. The isochrones of advance of southwest monsoon 2012 are shown in Fig. 4.

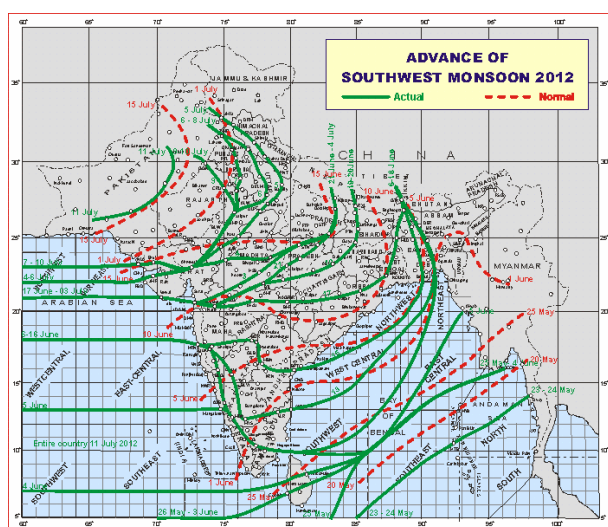


Fig. 4. Isochrones of advance of Southwest monsoon

Withdrawal of SW monsoon

Withdrawal of southwest monsoon started from the extreme northwestern parts of the country, *viz.*, parts of Jammu & Kashmir, Punjab, Haryana, West Rajasthan, Saurashtra & Kutch and north Arabian Sea on 24th September. It withdrew from remaining parts of Punjab, Haryana (including Delhi) and West Rajasthan; some parts of Uttarakhand, Himachal Pradesh, West Uttar Pradesh and Gujarat Region; most parts of East Rajasthan and some more parts of Saurashtra & Kutch on 25th and remaining parts of Jammu & Kashmir, Himachal Pradesh, Uttarakhand and East Rajasthan; some more parts of West Uttar Pradesh, Gujarat State and north Arabian Sea and some parts of East Uttar Pradesh and West Madhya Pradesh on 26th. The withdrawal line passed through Lat. 29° N / Long. 81° E, Kheri, Kanpur, Guna, Ratlam, Vallabh Vidyanagar, Porbandar, Lat. 21° N / Long. 67° E and Lat. 21° N / Long. 60°E on 26th. Monsoon did not withdraw further till the end of the season.

The isochrones of withdrawal of southwest monsoon 2012 are shown in Fig. 5.

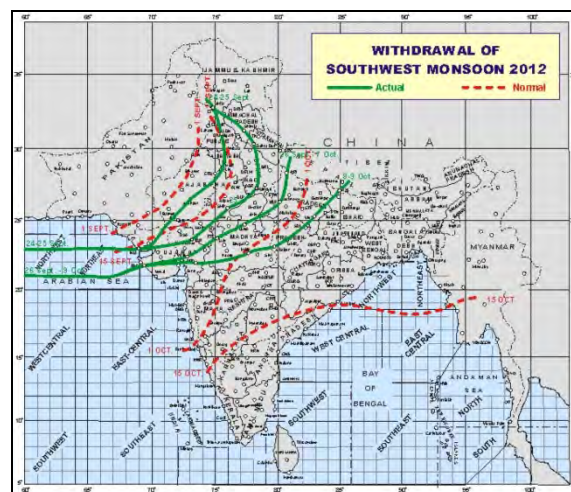


Fig. 5. Isochrones of withdrawal of southwest monsoon

Rainfall features

The southwest monsoon season rainfall over the country as a whole was near normal. However, there was a marked spatial and temporal variability as the central and eastern/northeastern parts of the country

received normal rainfall while parts of south peninsula, western and some northern parts of the country received deficient rainfall.

At the end of season, out of 36 meteorological sub-divisions, only 1 sub-division (Andaman & Nicobar Islands) received excess rainfall, 22 received normal rainfall and remaining 13 subdivisions received deficient rainfall (Fig. 6).

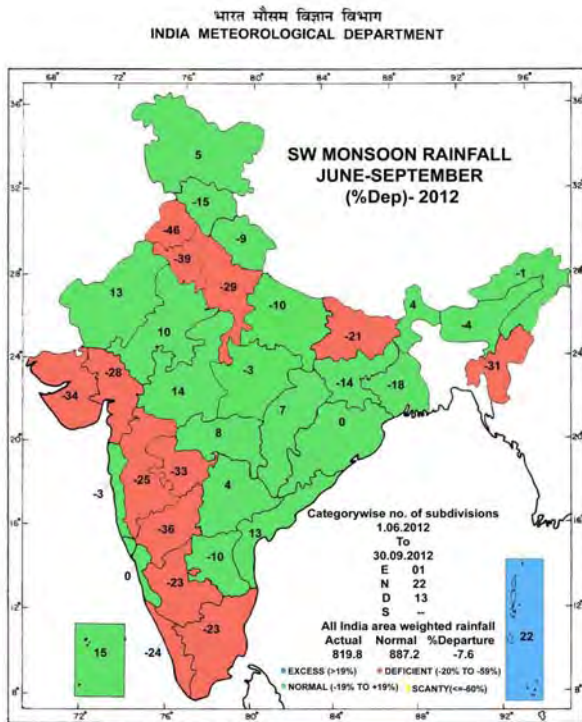


Fig. 6. Sub-division wise rainfall percentage departures for monsoon season 2012

Number of sub-divisions receiving excess, normal, deficient and scanty rainfall during each month of the season and monthly rainfall received as the percentage of Long Period Average (LPA) for each month is given in the Table 1.

TABLE 1

Subdivision wise rainfall statistics (mm)

Month	Jun	Jul	Aug	Sep
Excess	2	2	7	14
Normal	7	19	19	15
Deficient	16	10	9	7
Scanty	11	5	1	0
Rainfall (% of LPA)	72	87	101	113

Seasonal rainfall was above normal over some central, north western and some eastern, extreme northeastern parts of the country and parts of west coast and was below normal elsewhere. Over parts of West Rajasthan, Madhya Pradesh and adjoining north Vidarbha, southern parts of Chattisgarh and adjoining parts of Orissa and Andhra Pradesh, southern parts of Konkan & Goa and adjoining northern parts of Coastal Karnataka and extreme northeastern region, positive rainfall anomaly was of the order of 10 to 30 cm. Negative rainfall anomaly over parts of west peninsula, most parts of Gujarat state, Punjab, Haryana, Chandigarh & Delhi, East Uttar Pradesh, Bihar, Arunachal Pradesh and Nagaland, Mizoram, Manipur and Tripura was of the order of 10 to 30 cm.

Cumulative rainfall departure was negative throughout the season. At the end of season, rainfall was 93% of its LPA over Northwest India, 96% of its LPA over Central India, 90% of its LPA over south Peninsula and 89% of its LPA over East & Northeast India Table 2 (a).

TABLE 2 (a)

Seasonal rainfall

Region	LPA (mm)	Actual Seasonal Rainfall	
		Rainfall (mm)	Rainfall (% of LPA)
All India	887.5	819.8	92
Northwest India	615.0	569.3	93
Central India	975.5	935.5	96
Northeast India	1438.3	1275.3	89
South Peninsula	715.5	643.9	90

TABLE 2 (b)

Monthly rainfall over the country as a whole (All India)

Month	LPA (mm)	Actual monthly Rainfall	
		Rainfall (mm)	Rainfall (% of LPA)
June	163.6	117.8	72
July	289.2	250.4	87
August	261.3	264.7	101
September	173.4	192.0	111

The all India area weighted rainfall percentage departure for the season from 1901-2012. The area weighted rainfall percentage departure for the season this year was -8%.

During the monsoon season the real-time rainfall statistics for the country as a whole received was 8% less than the LPA. East & NE India, Southern peninsula, NW India and, Central India experienced rainfall of 89%, 90%, 93% and 96% of LPA respectively. Out of 36 sub-divisions 1 recorded excess rainfall, 22 recorded normal rainfall and remaining 13 sub-divisions recorded deficient rainfall.

The season rainfall over the country as a whole and four broad geographical regions during the 2012 SW monsoon season are given in the Table 1 along with respective long period average (LPA) values. The rainfall during the monsoon season over the country as whole is also given Table 2 (a&b). The seasonal rainfall over the country as whole and four geographical regions of the country were less than the respective LPAs. Month wise the rainfall during the first two months (June and July) was below its LPA values. However, monthly rainfall for August and September was higher than its LPA values.

The weekly rainfall anomaly from the first week to the week ending 22nd August was negative. However, the rainfall anomalies from week ending 29th August to week ending 19th September were positive and that during the remaining two weeks of the season were again negative (Fig. 7).

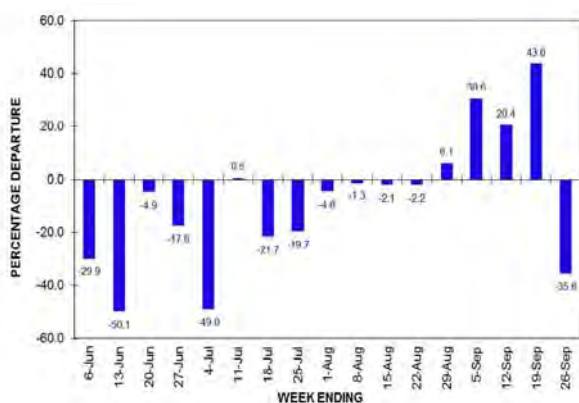


Fig. 7. Week - by - Week Progress of Monsoon Rainfall (anomaly)

Pressure & Wind

The pressure anomaly was negative over most parts of the country except for some parts of south peninsula. Negative pressure anomaly was generally of the order of 0.5 hPa and even exceeded 1 hPa over some parts of northwest and northeast India.

At 850 hPa level, an anomalous east-west ridge was observed over the south peninsula. At 500 hPa level, an anomalous cyclonic circulation was observed over the extreme northwestern parts of the country.

Temperature

The maximum and minimum temperature was near normal and within + 10 °C range over most parts of the country. However, over parts of Himachal Pradesh, Uttarakhand, Punjab, Haryana, Chandigarh & Delhi, East Uttar Pradesh, Bihar, Jharkhand, Gangetic West Bengal and parts of extreme south peninsula, maximum temperature was above normal by about 1 to 2 °C. Similarly, minimum temperature was above normal by about 1 to 2 °C over parts of Himachal Pradesh, Uttarakhand, Punjab, Haryana, Chandigarh & Delhi, East Uttar Pradesh, East Rajasthan, West Madhya Pradesh, Bihar, Jharkhand, Sub-Himalayan West Bengal & Sikkim and Nagaland, Manipur, Mizoram & Tripura.

Outgoing Longwave Radiation (OLR)

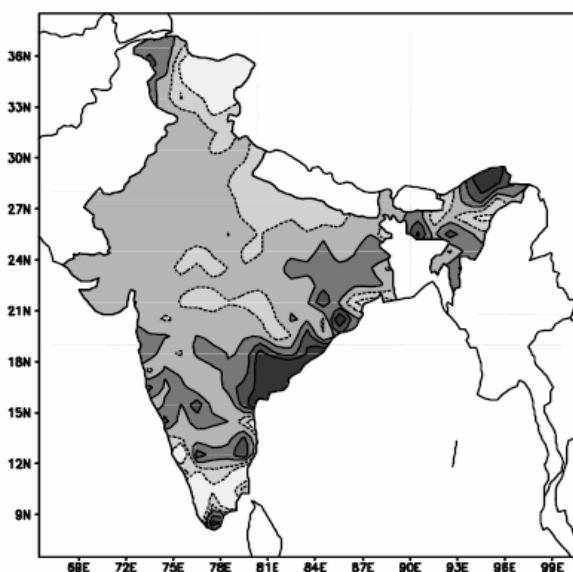
OLR anomaly (W/m^2) over the Indian region and neighbourhood the negative OLR anomaly exceeding $5 W/m^2$ in magnitude was observed over western parts of the country and adjoining northeastern parts of Arabian Sea and also over most parts of extreme northeastern region. Over rest of the country and most parts of adjoining seas, positive anomaly was observed. Positive OLR anomaly over the south peninsula and adjoining southern parts of Indian seas exceeded 5 to $10 W/m^2$.

1.4. Northeast monsoon

Northeast monsoon rains commenced over the south peninsula on 18th October on the same day after the southwest monsoon withdrew from the entire country.

Rainfall features

During the season, rainfall activity over the country as a whole was subdued. Many sub-divisions of the country received deficient/scanty rainfall. However, some Sub-divisions of the peninsula and eastern region received normal to excess rainfall. Rainfall activity over the core region of south peninsula (comprising of 5 sub-divisions, viz., Coastal Andhra Pradesh, Rayalaseema, Tamil Nadu & Puducherry, South Interior Karnataka and Kerala) during the season as a whole was near normal [93% of Long Period Average (LPA)]. It was 92%, 129% and 57% of LPA during October, November and December respectively. Out of the above five sub-divisions, Coastal Andhra Pradesh received excess rainfall, Rayalaseema and Tamil Nadu & Puducherry received normal rainfall, while South Interior Karnataka and Kerala received deficient rainfall. During this season the updated rainfall statistics is, the country as a whole received 4% less rainfall of LPA.



Figs. 10. Seasonal rainfall anomaly (cm)
(Interval : -10, -5, 0, 5, 10) (Based on 1951-2000 Normals)

Out of 36 sub-divisions 8 sub-divisions recorded excess rainfall, 2 recorded normal rainfall, 12 recorded deficient rainfall 11 recorded scanty rainfall and 3 sub-division recorded nil rainfall. Cumulative rainfall departure was negative during all the weeks of the season. At the end of the post-monsoon season 2012, the rainfall for the country as a whole was 79 % of its LPA value.

Pressure & Wind

The pressure anomaly was negative throughout the country and was generally of the order of 0.5 hPa over most parts of the country. At 850 hPa level, anomalous anomalous easterlies prevailed over the south peninsula. An anomalous cyclonic circulation over the south Arabian sea was also observed at the same level. At 500 hPa level, anomalous anticyclonic circulation was observed over the peninsular and central parts of the country.

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood the positive OLR anomaly exceeding $5 W/m^2$ was observed over parts of south peninsula, eastern/northeastern region of the country and most parts of adjoining Bay of Bengal. Over equatorial Indian Ocean region, negative OLR anomaly exceeding $10-20 W/m^2$ was observed.

Temperature

The maximum temperature was above normal over most parts of the country except over the plains of northern/northwestern and eastern India. It was above normal by over $1^\circ C$ over parts of east peninsula, hilly areas of extreme northern region and parts of east Madhya Pradesh, Saurashtra & Kutch and Nagaland, Mizoram, Manipur & Tripura. Over northern parts of east Uttar Pradesh and Bihar, parts of north Rajasthan and adjoining Punjab, maximum temperature was below normal by about 1 to $2^\circ C$.

Minimum temperature was below normal over the Gangetic plains and parts of adjoining central region, extreme northeastern region of the country and some parts of south peninsula, and was above normal elsewhere. It was above normal by over 1 °C over northern parts

Rajasthan. Over northern parts of east Uttar Pradesh and Bihar, parts of Assam & Meghalaya, west Madhya Pradesh and Haryana, Chandigarh & Delhi, minimum temperature was below normal by about 1-2 °C.

2. CYCLONIC DISTURBANCES DURING THE YEAR

The loss of life and property and human suffering caused by tropical cyclones in coastal areas in various parts of the globe are well known. These disasters are, on occasion, particularly severe in the Bay of Bengal region. The northern part of the Bay of Bengal is known for its potential to generate dangerous high storm tides, a major killer when associated with cyclonic storms. In the past, out of 10 recorded cases of very heavy loss of life (ranging from about 40,000 to well over 200,000) in the world due to tropical cyclones, 9 cases were in the Bay of Bengal and the Arabian Sea (5 in Bangladesh and 3 in India and 1 in Myanmar). The world's highest recorded storm tide of 45 feet occurred in this region (1876, Bakherganj cyclone near Meghna Estuary, Bangladesh). These facts amply illustrate the importance of an efficient cyclone warning service in this region.

The north Indian Ocean witnessed the formation of three cyclonic disturbances during January-October 2012. Out of three disturbances two cyclonic disturbances formed over the Bay of Bengal and one over the Arabian Sea. Out of the two cyclonic disturbances over the Bay of Bengal, one intensified into a cyclonic storm (NILAM) and the other into a deep depression. The cyclonic disturbance over the Arabian Sea intensified

into a cyclonic storm (MURJAN). The systems were continuously monitored and bulletins were issued by Cyclone Warning Division, IMD, and New Delhi in regular intervals to national and international agencies.

(a) Low Pressure Systems

During winter season, no intense low pressure system formed over the North Indian Ocean.

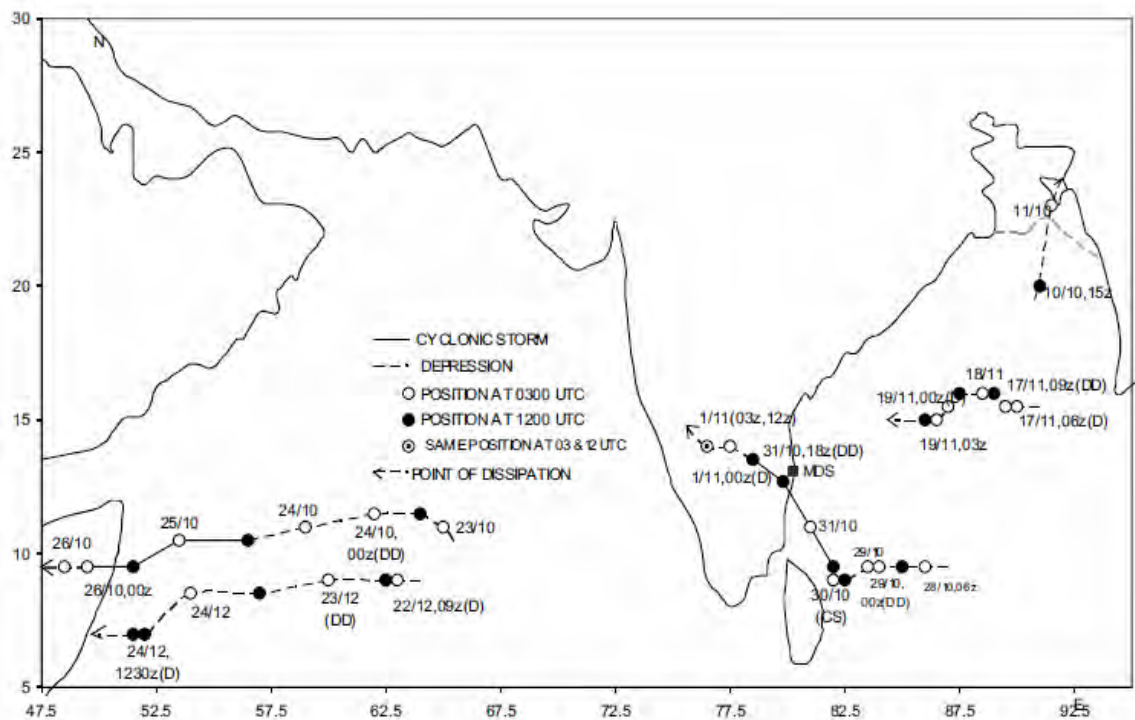


Fig. 1. Tracks of low pressure systems formed during the post-monsoon season (Oct-Dec) 2012

Two cyclonic storms and three depressions formed over the Indian seas during the season. Of these five systems, a depression formed over the northeast Bay of Bengal on 10th October, other formed over the south Bay of Bengal on 17th November dissipated over the sea itself away from the coast. Another deep depression that formed over the south Arabian Sea on 22nd December, moved away from the Indian region. Since these four systems formed away from the Indian region, dissipated over the sea, they did not cause and adverse weather.

During post-monsoon season apart from cyclonic storm, a low pressure area also formed over the Andaman Sea and neighbourhood on 27th November which persisted over the region till 2nd December. Also a well-marked low pressure area which formed over the west central Bay of Bengal at the end of September persisted over coastal Andhra Pradesh Telangana during first two days of October. This system caused heavy rainfall over these regions (Fig. 1).

Deep Depression over the Bay of Bengal (10-11 October, 2012)

A deep depression formed over northeast Bay of Bengal in the evening of 10th October, 2012. It moved northward and crossed Bangladesh coast near Hatia during 11th morning and then moved northeastwards across Bangladesh. It weakened into a well marked low pressure area at 0600 UTC of 11th October, 2012 over Tripura and adjoining Bangladesh and Mizoram. The salient feature of this deep depression was that it intensified into a deep depression before landfall, though it was lying very close to the coast. It was short lived with the life period of about 15 hrs. It caused the death of about 43 persons and left several injured in southeastern part of Bangladesh. The Track of the depression over Bay of Bengal (10-11 October, 2012) is shown in Fig. 2 and the number of depressions & storms formed during the post-monsoon season (1951-2012) is shown in Fig. 3.

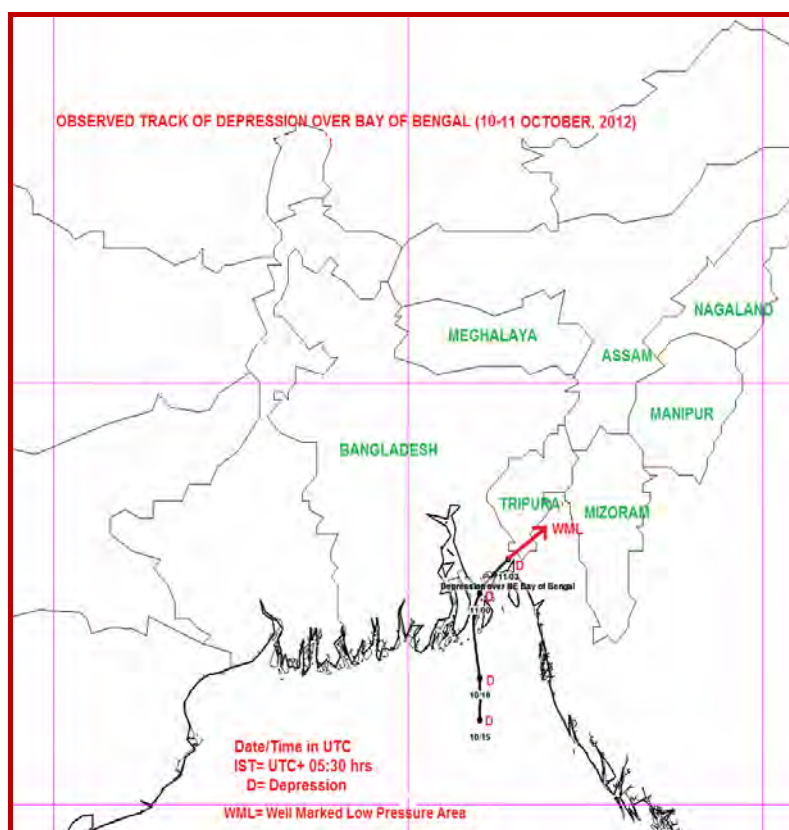


Fig. 2. Track of the depression over Bay of Bengal (10-11 October, 2012)

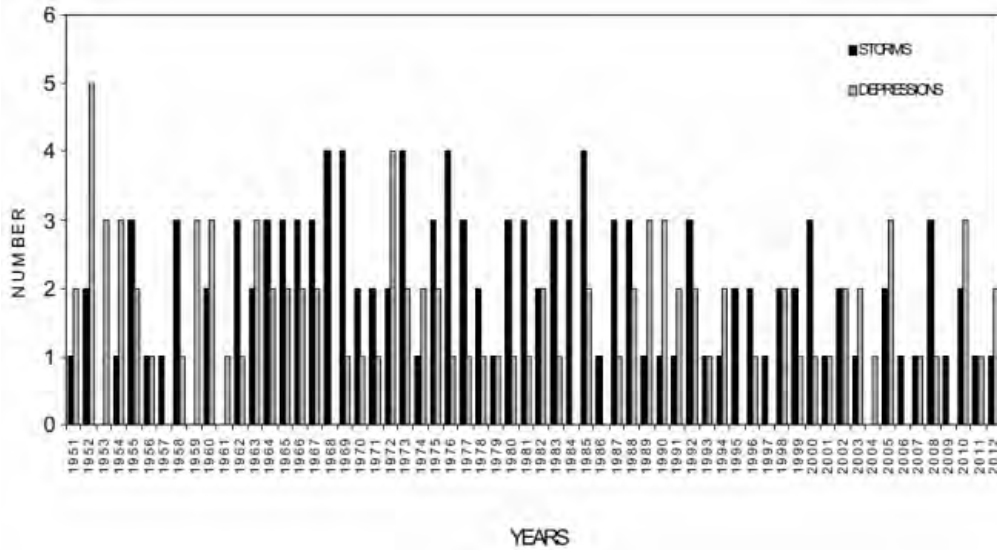


Fig. 3. The number of depressions & storms formed during the post-monsoon season (1951-2012)

(b) Cyclonic storms

(i) Cyclonic Storm, ‘MURJAN’ over Arabian Sea (23-26 October, 2012)

A depression formed over southeast and adjoining southwest and central Arabian Sea near lat. 11.0° N and long. 65.0° E, about 800 km west of Amini Divi in the morning of 23rd October, 2012. It moved initially west-northwest wards and then westwards and intensified into a deep depression in the evening of 23rd October. It then moved west-southwest wards and intensified into a cyclonic storm, ‘MURJAN’ in the evening of 24th October. It then continued to move west-southwest wards and crossed Somalia coast near lat. 9.5° N between 2230 and 2330 hrs (IST) on 25th October, 2012. Due to land interaction it weakened into a deep depression over coastal Somalia at 2330 hrs (IST) of 25th October. It further weakened into a depression over Somalia in the morning of 26th October while moving west-southwest wards. It further weakened into a well marked low pressure area over Somalia and neighbourhood in the evening of 26th October, 2012. The track of cyclonic storm, Murjan over the Arabian Sea (23-26 October, 2012) is shown in Fig. 4.

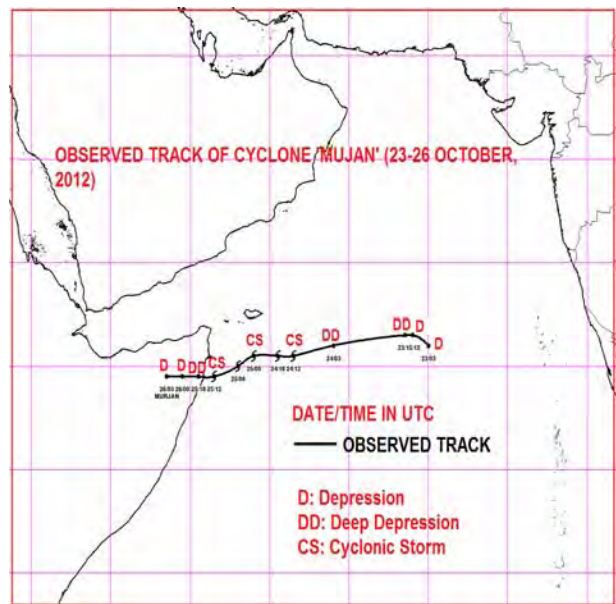


Fig. 4. Track of cyclonic storm, Murjan over the Arabian Sea (23-26 October, 2012)

(ii) Cyclonic Storm, ‘NILAM’ over Bay of Bengal (28 Oct - 1 Nov, 2012)

The cyclonic storm (Nilam) was initially seen as a low pressure area over the southeast Bay of Bengal and neighbourhood on 27th October. It became well marked on 28th and

concentrated into a depression at 0600 hrs UTC of the same day near Lat. 9.5° N / Long. 86.0° E. Moving westwards, it intensified into a deep depression at 0000 hrs UTC of 29th and then into a Cyclonic Storm at 0300 hrs UTC of 30th near Lat. 9.0° N / Long. 82.0° E. It then moved northwards and then north-northwestwards and crossed the north Tamil Nadu coast, south of Chennai, near Mahabalipuram between 1030 & 1130 hrs UTC of 31st and lay centred at 1200 hrs UTC near Lat. 12.7° N / Long. 79.8° E. Moving northwestwards, it weakened into a deep depression over north Tamil Nadu and adjoining areas of Rayalaseema and Karnataka at 1800 hours UTC of the same day and then into a depression over Rayalaseema and adjoining areas of south interior Karnataka at 0000 hours UTC of 1 November. Moving westwards, the system remained practically stationary and lay centred at 0300 & 1200 hours UTC of the same day near Lat. 14.0° N / Long. 76.5° E over South Interior Karnataka close to Chitradurga. It further weakened and lay as a well marked low pressure area over south interior Karnataka and adjoining areas of Rayalaseema in the morning of 2nd, over Telangana and neighbourhood on 3rd and over coastal Andhra Pradesh and neighbourhood on 4th. It become less marked the next day. The track of cyclonic storm, NILAM over Bay of Bengal (28 October - 1 November 2012) is shown in Fig. 5.



Fig. 5. Track of cyclonic storm, NILAM over Bay of Bengal (28 October - 1 November 2012)

(iii) **Track and track prediction error for the cyclone during 2012**

TABLE 1

Average Track Forecast Error of Cyclonic Storm, Nilam

Lead Period (hr)	Error (km)
12	70
24	114
36	145
48	176
60	172
72	236

TABLE 2

Landfall forecast error of cyclonic storm, Nilam

Lead Period (hrs) of forecast from the time of landfall	Landfall Point Forecast Error (km)	Landfall Time Forecast Error (hr)
12	16	1.5
24	11	2.0
36	74	3.0
48	45	1.0
60	11	3.0
72	It was predicted that the system would move towards north Srilanka and Tamil Nadu Coast	

(c) **Trends in forecast performance during 2003-12**

(i) **Landfall**

The landfall forecast errors (landfall point and time errors) are presented in Fig. 6. The landfall point forecast error has reduced significantly in recent years. The 12 and 24 hr landfall point forecast errors have decreased at the rate of about 16 and 34 km per year respectively during 2003-2012. However, the rate of decrease is relatively less in case of landfall time forecast error.

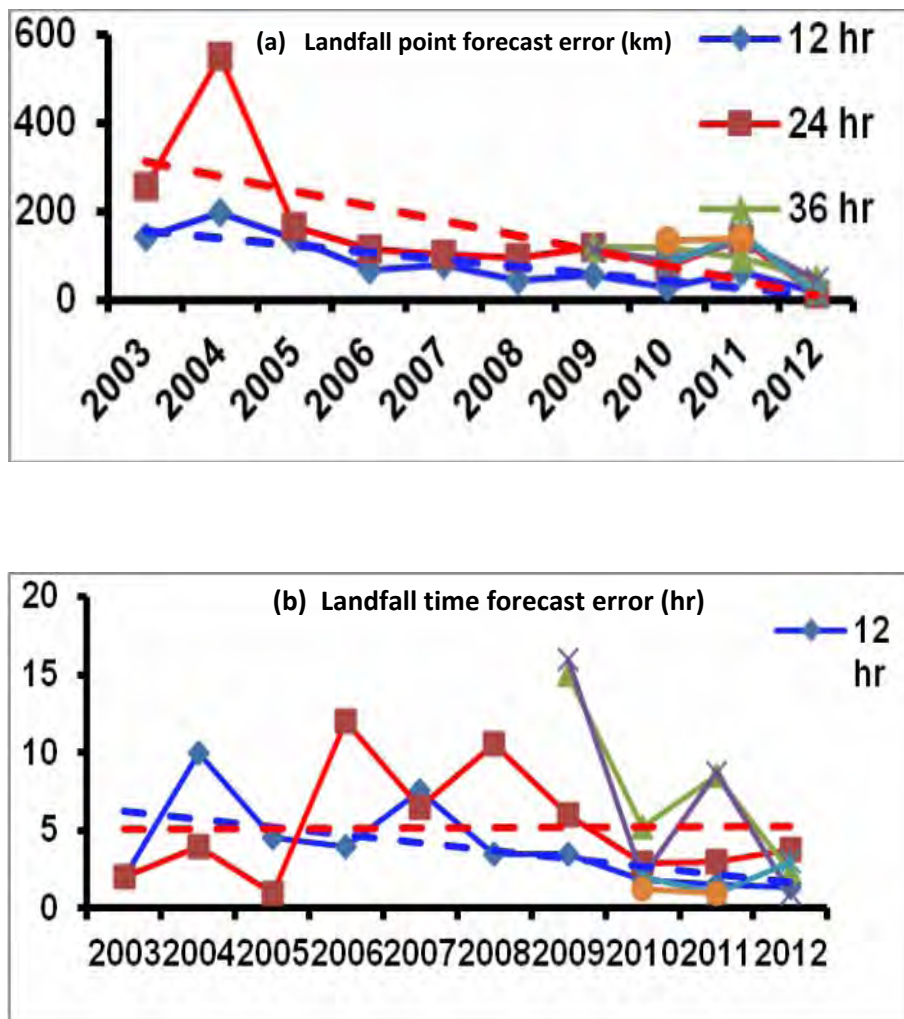
The annual average tropical cyclone track forecast errors and skills during 2003-2012 are presented in Fig. 4.2. The track forecast error has decreased at the rate of about 5.1 km/year and 7.2 km/year during 2003-12 for 12 and 24 hr forecasts respectively. The 36-72 hrs forecast errors also have decreased as shown in Fig. 7. The skill in tropical cyclone track forecast has increased at the rate of 8.2% and 4.1% for 12 and 24 hr forecasts respectively during 2003-2012. There is also significant increase in skill of 36-72 hr track forecasts.

(ii) Intensity

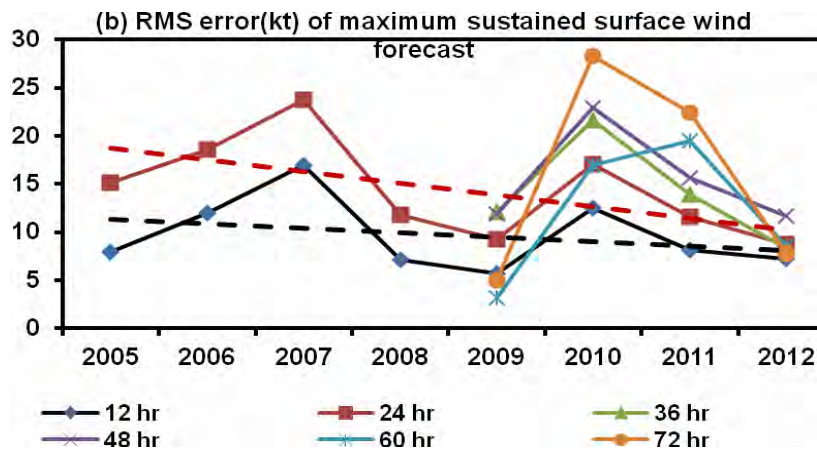
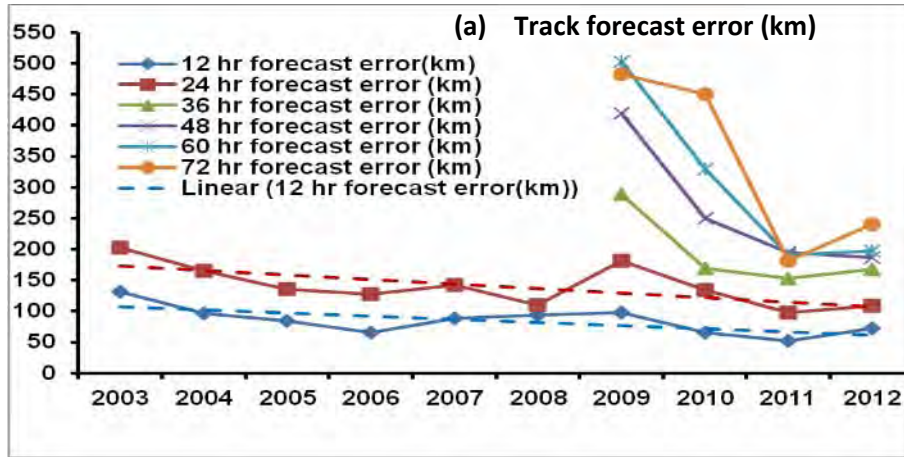
The average absolute error and (b) root mean square (RMS) error in tropical cyclone maximum sustained surface wind forecasts by

IMD during 2005-12 are shown in Figs. 8(a&b). Comparing Figs. 7 (a&b) and Figs. 8 (a&b), it is found that there has been decrease in error in recent years. However, the rate of decrease in intensity error has been less than that of track error. The annual intensity (wind) forecast error has decreased at the rate of 0.3 knots and 1.2 knots in case of absolute error and 0.5 knots and 1.2 knots in case of RMS error for 12 and 24 hr forecasts respectively.

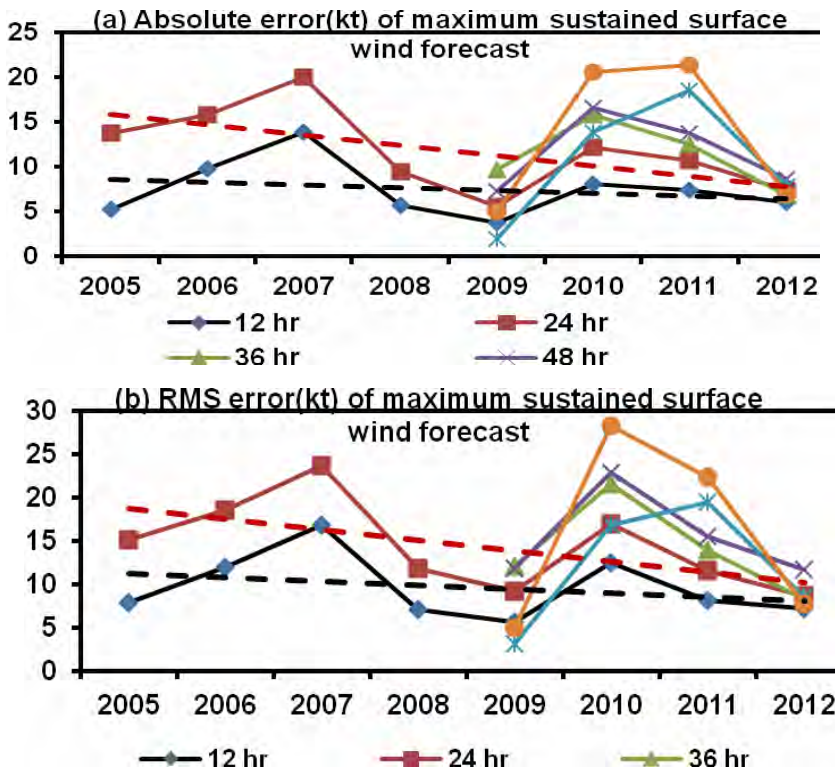
The skill of intensity forecast based on absolute error compared to persistence forecast error during 2005-12 are shown in Fig. 9. It is found that the skill has increased at the rate of 3.3% per year and 8.3% per year for 12 and 24 hr forecasts respectively during 2005-12.



Figs. 6(a&b). Landfall point and time forecast errors of IMD during 2003-12



Figs. 7(a&b). Average tropical cyclone track forecast error and (b) track forecast skill during 2003-2012



Figs. 8(a&b). (a) Absolute error and (b) root mean square (RMS) error in tropical cyclone maximum sustained surface wind forecasts by IMD

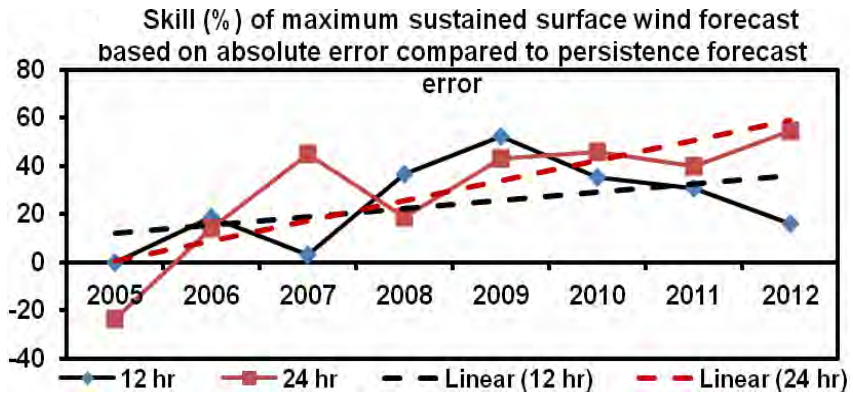


Fig. 9. Skill of intensity forecast based on absolute error compared to persistence forecast error during 2005

3. OPERATIONAL LRF FOR SOUTHWEST MONSOON RAINFALL

The operational long range forecast for the southwest monsoon Season (June to September) rainfall over the country as a whole is issued in two stages; in April and in June. Along with update forecast for the season rainfall over the country as a whole issued in June, forecast for monthly rainfall (for July and August) over the country as a whole and season (June to September) rainfall over the four geographical regions (Northwest India, Central India, Northeast India and South Peninsula) are also issued. Issuing of forecast outlook for the rainfall during second half (August-September) of the monsoon season over the country as a whole was started in 2009. Similarly forecast outlook for September rainfall over the country as a whole was started in 2010. The forecast for Second half of the monsoon season is issued in the end of July and that for the September rainfall is issued in the end of August. In addition to the above long range forecasts for rainfall, an operational forecast for the monsoon onset over Kerala is also issued in the middle of May.

During 2012 the first and second stage (update) operational forecast for southwest monsoon season rainfall over the country as a whole was issued on 26th April and 22nd June respectively. The forecast of rainfall during second half of the monsoon season (August – September) over the country as a whole was issued on 2nd August. No forecast was issued for September rainfall. The forecast for date of monsoon onset over Kerala was issued on 15th May.

Verification of the various operational long range forecasts for monsoon rainfall issued for the 2012 southwest monsoon rainfall and the monsoon onset over Kerala is discussed here. Various statistical models used for generating these forecasts are also described and the experimental forecasts obtained from other climate research institutions in India and abroad are also discussed.

3.1. Empirical models used for operational LRF for rainfall

For the forecasting of season (June to September) rainfall over the country as a

whole, the new ensemble forecasting system using a set of 8 predictors that having stable and strong physical linkage with the Indian south-west monsoon rainfall. Details of the eight predictors used in the ensemble forecasting system is given in the Table 1 along with their signs of impact (Favorable / Unfavorable for normal/excess monsoon) on 2012 SW Monsoon. It may be mentioned that all the SST parameters were computed based on improved version of ERSST Data (ERSST.V3b). For the April forecast, first 5 predictors listed in the table 1 were used.

For the update forecast issued in June, the last 6 predictors were used that include 3 predictors used for April forecast. A parameter having positive (negative) correlation with rainfall is considered to be favorable for good rainfall (more than average rainfall during the training period) if the standardized anomaly of the parameter during the model training period is >0.5 (<-0.5) and unfavorable if the standardized anomaly is <-0.5 (>0.5). When the standardized anomalies are between -0.5 to 0.5 , the parameter is considered to be neutral.

As seen in this Table 1, 3 out of the 5 predictors used for April forecast [Europe land surface air temperature (Jan), Warm water volume anomaly (Feb+Mar) and the East Asia Pressure (Feb+Mar)] were close to their normal values (neutral). Out of the remaining two predictors, the North Atlantic SST (Dec+Jan)

was unfavorable and Equatorial SE Indian Ocean SST (Feb + Mar) was favorable for good rainfall. Out of the 6 predictors used for June forecast, 2 predictors (Nino 3.4 SST anomaly tendency & the North Atlantic SST (Dec+Jan) were unfavourable for normal/above normal monsoon rainfall and 2 predictors

TABLE 1

Details of the 8 predictors used for the ensemble forecast system for the forecasting of 2012 southwest monsoon rainfall over the country as a whole

S. No.	Predictor	Used for forecasts in	Correlation Coefficient (1971-2000)	Favorable / Unfavourable/ Neutral for Normal or Above Normal Rainfall
1.	North West Europe Land Surface Air Temperature Anomaly (Jan)	April	0.58	N
2.	Equatorial Pacific Warm Water Volume Anomaly (Feb + Mar)	April	-0.30	N
3.	North Atlantic Sea Surface Temperature Anomaly (Dec+Jan)	April and June	-0.49	U
4.	Equatorial South East Indian Ocean Sea Surface Temperature Anomaly (Feb+Mar)	April and June	0.45	F
5.	East Asia Mean Sea Level Pressure Anomaly (Feb + Mar)	April and June	0.36	N
6.	Central Pacific (Nino 3.4) Sea Surface Temperature Ano. Tendency (MAM-DJF)	June	-0.49	U
7.	North Atlantic Mean Sea Level Pressure Anomaly (May)	June	-0.52	N
8.	North Central Pacific Zonal Wind Anomaly at 1.5 km above sea level (May)	June	-0.45	N

TABLE 2

The details of the predictors used for forecasting 2012 second half of the monsoon season (August-September) rainfall over the country as a whole

S. No.	Predictor	C.C. (1989-2011)	Favorable/Unfavorable for Normal or Above Normal Rainfall
1.	North Pacific (Region-1) Mean Sea Level Pressure (July)	0.44	U
2.	Central Pacific (Nino 3.4) Sea Surface Temperature Ano. Tendency (AMJ-JFM)	-0.59	U
3.	Bay of Bengal Sea Surface Temperature (June)	0.42	N
4.	North Atlantic Mean Sea Level Pressure (May)	-0.40	F
5.	North Pacific (Region-2) Mean Sea Level Pressure (July)	-0.34	N

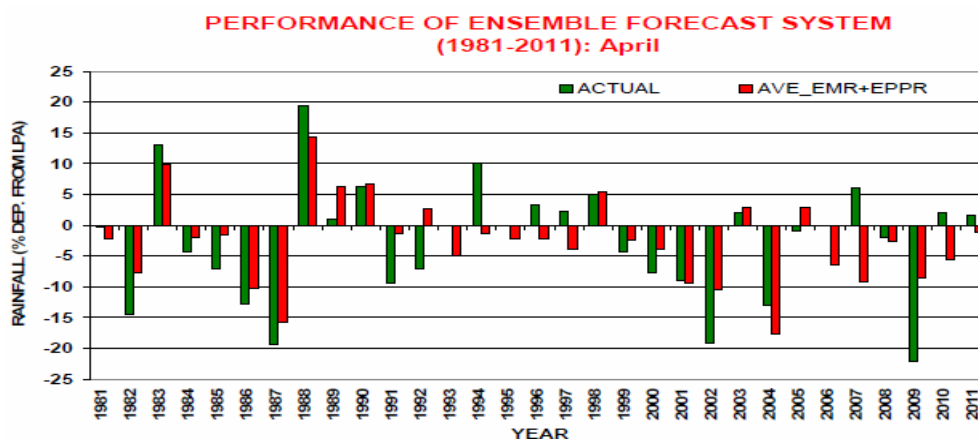


Fig. 1(a). Performance of the ensemble forecast system for the June forecast of the 2012 seasonal monsoon rainfall over the country as a whole

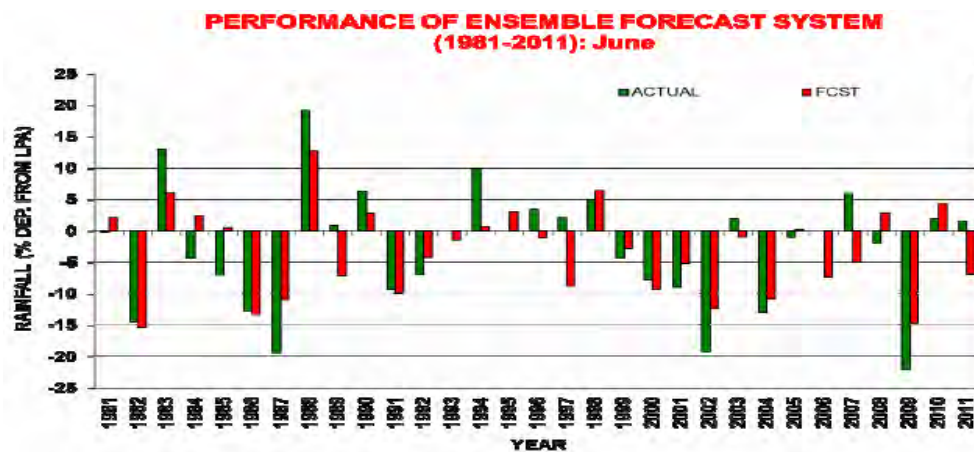


Fig. 1(b). Performance of the ensemble forecast system for the June forecast of the 2012 seasonal monsoon rainfall over the country as a whole

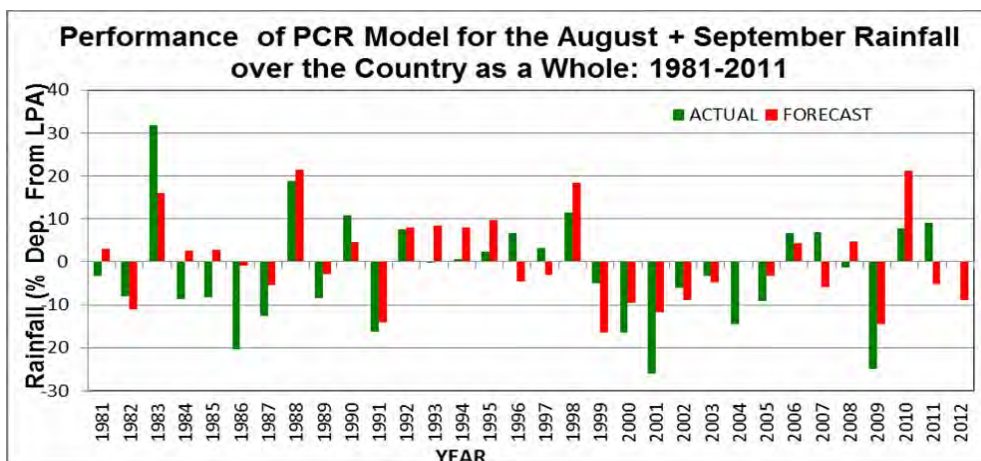


Fig. 2. Performance of the PCR model for the forecast of the rainfall during the second half of the monsoons season (August + September) over the country as a whole

TABLE 3

The details of the predictors used for forecasting 2012 July rainfall over the country as a whole

S. No.	Predictor	Correlation Coefficient (1989-2011)
1.	North Atlantic Sea Surface Temperature (Dec)	-0.15
2.	North Central Pacific Zonal Wind U850 (May)	-0.27
3.	North America Mean Sea Level Pressure (Jan)	0.32
4.	East Asia Mean Sea Level Pressure (Feb)	0.51
5.	North Atlantic Pressure Gradient (Mar)	-0.41
6.	Central Pacific (Nino 3.4) Sea Surface Temperature Anomaly Tendency (MAM-DJF)	-0.25

TABLE 4

The details of the predictors used for forecasting 2012 August rainfall over the country as a whole

S. No.	Parameters	CC (1989-2011)
1.	South Atlantic Mean Sea Level Pressure (Apr)	0.29
2.	South Atlantic Mean Sea Level Pressure (Apr)	-0.35
3.	Central Pacific (Nino 3.4) Sea Surface Temperature Anomaly Tendency (MAM-DJF)	-0.12
4.	South Pacific Zonal Wind at 850 hPa (April)	0.36
5.	Tropical North Atlantic Outgoing Long wave Radiation (Mar)	-0.35

[North central Pacific 850 hPa zonal wind & Equatorial SE Indian Ocean SST (Feb + Mar)] were favourable for normal/above normal monsoon rainfall. The remaining 2 predictors were neutral. The Niño 3.4 SST tendency was noticeably positive associated with the weakening of prevailing moderate to strong La Niña conditions during the period to neutral ENSO conditions. This clearly shows that after March, predictive signals particularly related to the ENSO phenomena had become unfavorable for normal or above normal season rainfall.

In the ensemble forecasting system, the forecast for the seasonal rainfall over the country as a whole was computed as the ensemble average of the forecasts prepared from a set of selected models. Using multiple linear regression (MR) and projection pursuit regression (PPR) techniques, two separate sets of all possible models (based on all possible combinations of models) were constructed first. Based on the performance of these models during some fixed independent test period,

a set of few best models from all possible MR and PPR models were selected for ensemble average. The independent forecasts were used based on moving training method with a fixed window period of 23 years. The standard error of the 6-Parameter ensemble forecasting system is $\pm 4\%$. To prepare the April ensemble average forecast, out of all the total 62 models (32 MR and 32 PPR models), best 16 (10 MR and 6 PPR) models were used. The performance of the April forecasting system for the independent test period (1981-2011) is shown in Fig. 1(a). During the independent forecast period of 1981-2011, the standard error of the 5-parameter ensemble forecast system was 6.4% of LPA.

To prepare the June ensemble average forecast, out of all the total 126 models (63 MR and 63 PPR models), best 5 (4 MR and 1 PPR) models were used. The performance of the June forecasting system for the independent test period (1981-2011) is shown in Fig. 1(b). During the independent forecast period of 1981-2011, the standard error of the 6-

parameter ensemble forecast system was 5.7% of LPA.

3.2. Rainfall during the second half of the monsoon season (August-September)

For this, a new Principal Component Regression (PCR) Model based on 5 predictors was used. Table 2 shows the details of the 5 predictors used for the development of the new PCR model. Data for the period 1958-2011 were used to develop the model. The performance of the model during the independent test period (1981-2011) is given in the Fig. 2. The model RMSE for the independent forecast period is 11.42% of LPA.

As seen in the Table 2, 2 out of 5 predictors were unfavorable for stronger than normal monsoon. Out of the remaining 3 predictors, one predictor was favorable and the other two predictors were neutral. For training the model for 2012, data for the period 1989-2011 was used. The standard error of the model for the training period (1989-2011) is 9.32% of LPA. However, average of model standard errors during the last 10 years (2003-2012) was taken as the model error for issuing the forecast. This is 8% of LPA.

3.3. Forecast of monthly rainfall over the country as a whole

This year, monthly rainfall forecasts were issued for the months of July and August. These forecasts were issued in June along with the update forecast. For the monthly rainfall forecasts over the country as a whole, PCR technique similar to that used for the forecasting of rainfall during the second half of the monsoon was used. For the forecast of July rainfall over the country as a whole, a PCR model with 6 predictors was used. The details of the parameters are given in Table 3. The model was developed using data for the period 1958-2011 and forecast for the independent period of 1981-2011 was generated using moving training period method with a fixed

window period of 23 years. The model training period is 1989-2011 and the model error is $\pm 9\%$.

For the forecast of August rainfall over the country as a whole, a PCR model with 5 predictors was used. The details of the parameters are given in Table 4. The model training period is 1989-2011 and the model error is $\pm 9\%$.

3.4. Forecast of the Seasonal Rainfall over the Four Geographical Regions

Separate PCR models were developed for each of the geographical regions. The method used was similar to the PCR models for July and August rainfall discussed above. However, in the PCR models for the geographical regions, fixed window period of 30 years was used to train the models. The model error for each of the geographical regions was taken as 8% of LPA. The details of forecast issued and realized rainfall for four geographical regions is given in Table 5.

3.5. Verification of operational forecasts

a. Onset over Kerala

An indigenously developed statistical model was used for preparing the operational forecast of the onset of monsoon over Kerala. The model based on 6 predictors used the principal component regression (PCR) method for its construction. The model for 2012 was trained using data for the period 1990-2011. For this year, it was forecasted that monsoon will set in over Kerala on 1st June with a model error of ± 4 days. The forecast came correct as the actual monsoon onset over Kerala took place on 5th June, 4 days after the forecasted date. Thus this is the eighth consecutive correct operational forecast for the monsoon onset over Kerala since issuing of operational forecast for the event was started in 2005.

TABLE 5

Details of long range forecasts and actual rainfall

Region	Period	Date of Issue	Forecast (% of LPA)	Actual Rainfall (% of LPA)
All India	June to September	26 th April	99 \pm 5	92
All India	June to September		96 \pm 4	
Northwest India	June to September		93 \pm 8	93
Central India	June to September	22 st June	96 \pm 8	96
Northeast India	June to September		99 \pm 8	89
South Peninsula	June to September		95 \pm 8	90
All India	July		98 \pm 9	87
All India	August		96 \pm 9	101
All India	August to September	2 nd Aug	91 \pm 8	104

b. LRF for SW monsoon rainfall

As per the first stage long range forecast issued on 26th April, the season (June-September) rainfall for the country as a whole was expected to be 99% \pm 5% of LPA. In the updated forecast issued on 22nd June, the forecast for the country as a whole was revised to a lower value of 96% \pm 4% of LPA. The actual season rainfall for the country as a whole (93% of LPA) was less than the forecast and within the lower forecast limit (96% - 4% of LPA) of the second stage forecast. The forecast for the second half of the monsoon season (August - September) for the country as a whole issued in August was 91% with a model error of 8% of LPA. This forecast was an underestimate as the actual rainfall over the country as a whole during the second half of the season was 105% of LPA.

The forecasts for monthly rainfall over the country as a whole for the months of July and August issued in June were 98% & 96% respectively with a model error of $\pm 9\%$. The actual July month forecast was overestimate to the actual rainfall (87% of LPA) and slightly (2% of LPA) less than the lower forecast limit (98% - 9 % of LPA). Whereas the actual rainfall during August was (101% of LPA) well within the upper forecast limit (96% + 9 % of LPA).

Considering the four broad geographical regions of India, the season rainfall was expected to be 93% of its LPA over northwest India, 96% of LPA over Central India, 99% of LPA over northeast India and 95% of LPA over South Peninsula all with a model error of $\pm 8\%$. The actual rainfalls over northwest India, central India, northeast India and south Peninsula were 93%, 96%, 91% and 90% of the LPA respectively. Thus all the forecasts for the 4 geographical regions were within the forecast limits and correct. The forecast and actual rainfall over central India was exactly the same, the actual rainfall over northwest India was just 1% of LPA less than the forecast value, the actual rainfall over south Peninsula was within the lower forecast limit (95% - 8% of LPA) and the actual rainfall over northeast India was exactly at the lower forecast limit (99% - 8% of LPA).

All the operational long range forecasts for season rainfall were correct. The forecast for August rainfall over the country as a whole was also correct. However, the forecast for July rainfall over the country as a whole was an overestimate and that for rainfall during the second half of the monsoon season was an underestimate. The main reason for the

underestimation of the forecast for the second half of the monsoon season was the non-establishment of El Nino conditions in the Pacific as was strongly expected in the beginning of the monsoon season and sudden emergence of basin wide warming of India Ocean during later part of the monsoon season both of which helped increased rainfall activity particularly during later part of August and first half of September.

NE monsoon rainfall

The summary of operational forecast for the 2012 NE monsoon rainfall over South Peninsula was based on statistical models. The Northeast monsoon season rainfall over South Peninsula (Tamil Nadu, Coastal Andhra Pradesh, Rayalaseema, Kerala and South Interior Karnataka) is most likely to be normal (89 - 111% of long period average).

The long period average (LPA) of the North-east monsoon season rainfall over the south Peninsula for the base period 1951-2000 is 332.1 mm. The north-east monsoon seasonal rainfall over Tamil Nadu is most likely to be above normal (>112% of LPA). The long period average (LPA) of the North-east monsoon season rainfall over the Tamil Nadu for the base period 1951-2000 is 438.2 mm. The realized NE monsoon rainfall (Oct-Dec) over South Peninsula was 96% of LPA. IMD's qualitative forecast for NE Monsoon was with high probability to be in the higher side of the normal. The forecast for Tamilnadu was is also likely to be normal with high probability to be in the higher side of the normal and realized rainfall was 122% of LPA.

4. SCIENTIFIC EXPEDITION TO ANTARCTICA - MAITRI

The Indian Antarctic Program is a multi-disciplinary, multi-institutional program under the control of the National Centre for Antarctic and Ocean Research, Ministry of Earth Sciences, Government of India. It was initiated in 1981 with the first Indian expedition to Antarctica. Antarctic holds scientific interest for global research due to a number of reasons: 'Origin of continents, climate change, meteorology and pollution' are among them. The 'ice-ocean and atmospheric interaction causes many ups and down global weather events and climate change. Understanding the weather pattern, climate of polar region and their teleconnection with Indian Monsoon is a big challenge for which department continued to shoulder its responsibilities as a member of scientific expedition team to Antarctica since beginning.

Polar Meteorology Research Division (PMRD) came to existence on May 7, 2012 as decided during the Brain Storming Session held at New Delhi on 24th September 2010. It deals with Antarctic Expedition, Sagar Kanya Cruises and Evaluation of Scientific Project received from Department of Science & Technology (DST). It also intends to undertake research work on Polar Meteorology.

31st ISEA

Two IMD team members of 31st ISEA S/Shri Amalendu Barua, Assistant Meteorologist Gr.I from DGM's Office (PMRD) and R. S. More, Scientific Assistant from DDGM (SI), Pune have completed their expedition at Maitri and returned to India on 16th December, 2012 and 20th January, 2013 respectively.

32nd ISEA

Two IMD team members namely S/Shri Vilas Laxman Jogdand, Scientific Assistant from DDGM(WF), Pune and Subash Chander, Scientific Assistant from MC Srinagar (DDGM, RMC New Delhi) have been deputed for the 32nd Indian Scientific Expedition to

Antarctica (ISEA). They reached at Maitri, Antarctica on 6th December, 2012. They will cover the scientific activities during both summer & winter parts of the expedition till December 2013.

IMD Scientific Programme for 32nd ISEA

Shri V. K. Soni, Director (PMRD) and Shri Sanjay Bist, Met(PMRD) attended two days workshop on "Evaluation of Research Projects for Planning the 32nd Indian Scientific Expedition to Antarctica" held on 27-28, June 2012 at NCAOR, Goa. They gave presentations on Scientific Programme of IMD for 32nd ISEA and review of IMD's earlier work on Antarctica.

Debriefing function at NCAOR, Goa

A debriefing function was held on 25th May 2012 at NCAOR, Goa to felicitate the expedition members of 30th ISEA of summer and winter team (Namely Shri Shankar Prasad, AM-II of DDGM (UI), New Delhi and Shri Ashok D. Khutwad, SA of DDGM (WF), Pune).

Evaluation of project

Besides dealing with Antarctica Expedition and Sagar-Kanya on cruise expedition over Indian Seas, PMRD also conducts evaluation of scientific Project Proposals by IMD Scientists. During 2012, ten numbers of Scientific Research Project (including Annual Progress Reports & Project Completion Reports) have been received for evaluation.



Scene after blizzard, at Maitri, dated 30 July 2012

Weather at Maitri

The forecast is being prepared and validated for Maitri and surrounding region of Antarctica on experimental basis.

Systems/storms in South Indian Ocean are studied. As the southern limits extended up to Antarctica and to develop the connectivity of southern Indian Ocean and Antarctica region and understanding of continuum.

Recently IMD has implemented Polar WRF model for Maitri and Bharati region at the horizontal resolution of 15 km using initial and boundary conditions of the IMD GFS T-382. Daily Forecasts for next 48 hours are produced based on available observations, satellite images of NOAA and synoptic charts provided by Weather Service of South Africa.

<http://www.imd.gov.in/section/nhac/dynamic/polarwrf.htm>

Online hourly meteorological data are available on IMD website. Monthly meteorological report is also available on IMD website. <http://www.imd.gov.in/maitri/index.html>

The Salient features of Meteorological parameters

The following are the salient features of synoptic weather parameters during 2012.

Temperature

During the year 2012 the average temperature was recorded as -0.3°C . The highest Maximum & Lowest Minimum temperatures of the expedition were recorded as $+06.4^{\circ}\text{C}$ (11th January, 2012) and -33.5°C (27th July 2012) respectively. The highest average maximum temperatures and lowest average minimum temperature for the year 2012 were recorded as 2.2°C and -24.1°C respectively.

1.	Lowest Temperature recorded	-33.5°C on 27-07-2012
2.	Highest Temperature recorded	$+06.4$ on 11-01-2012
3.	Maximum gust	93 knots on 27-07-2011 with (Ultrasonic Recorder)
4.	Number of Blizzards	25
5.	Longest Blizzard	53 hours (27 to 29 July 2012)
6.	Total Snowfall	417 mm

Pressure

The monthly average Mean Sea Level Pressure (MSLP) varied from 992.2 hPa in June to 978.2 hPa in January. The highest Maximum MSLP of 1010.8 hPa was recorded during the month of June 2012 and the Lowest Minimum MSLP of 963.5 hPa was recorded during the month of July 2012.



Ozone sonde ascent taken at Maitri, Antarctica

Blizzards

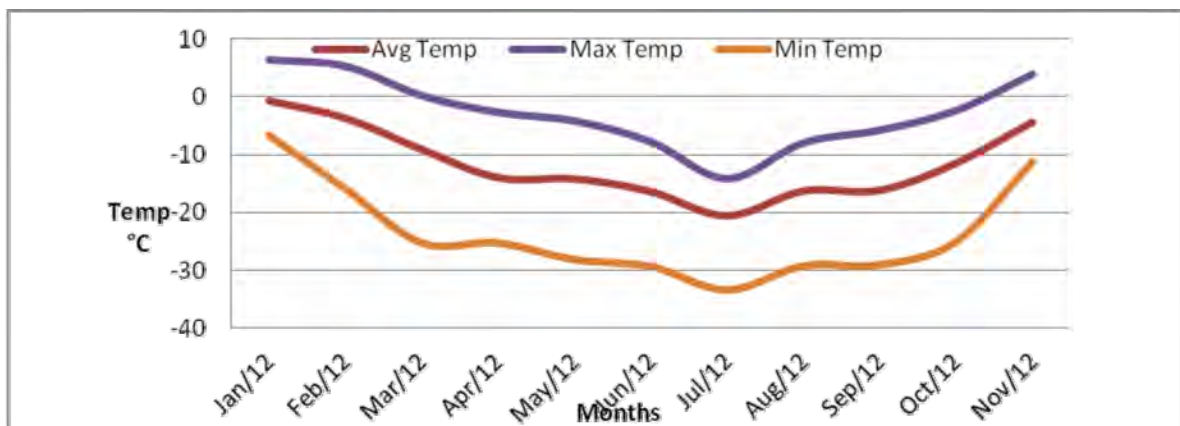
During the year 2012, the maximum No. of blizzards were recorded in the month of May 2012 and 3 each in June, July, August & September 2012; 2 each in February, October, and November 2012; 1 each in January, March & April 2012 and Zero in Dec 2012.

In association with above mentioned Blizzards, the total snowfall throughout the expedition was recorded as 417 mm.

Wind

The month of September was the windiest month of the expedition, Max average wind was of 51 knots with Max Gust of 93 knots. However, the monthly average maximum wind was 19 knots and lowest minimum average wind was recorded at 13 knots. Out of 366 days of the year 226 days recorded wind more than or equal to 23 knots.

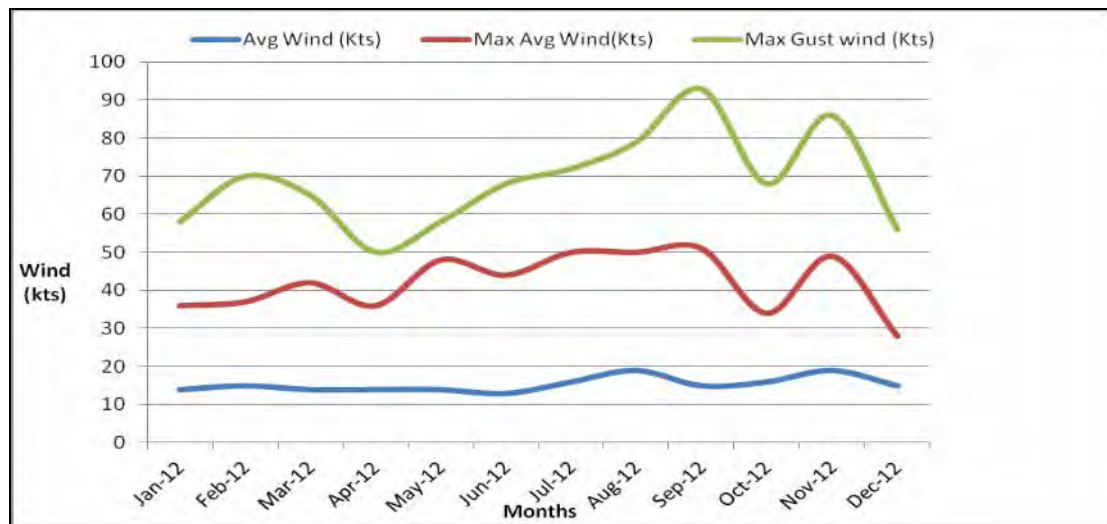
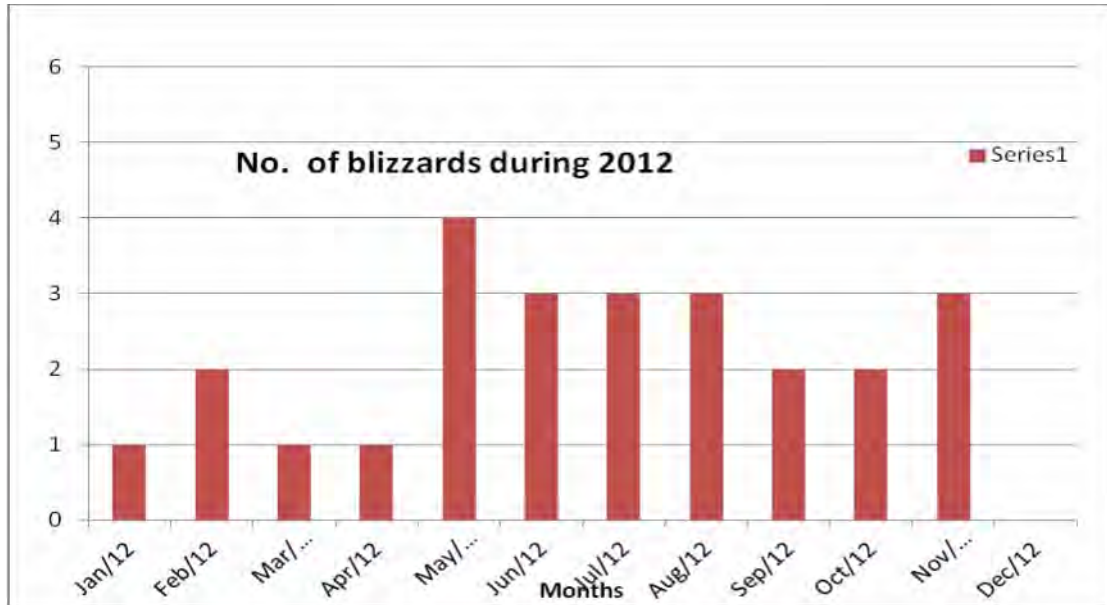
The heaviest snowfall occurred during the month of July 2012, Subsequently, February, May, June, August, September & November 2012 recorded snowfall of 54.0 mm, 26.0 mm, 34.4 mm, 48.1 mm, 50.8 mm and 69.6 mm respectively. The month of January, March, April and Dec. 2012 of the expedition recorded least snowfall of amount 12.3 mm, 2.6 mm 2.8 mm and 0.2 mm respectively. As such throughout the entire expedition 78 days were the precipitation days.



Avg., Max. & Min Temp

Meteorological Parameters Recorded

Month	Jan 12	Feb 12	Mar 12	Apr 12	May 12	Jun 12	Jul 12	Aug 12	Sep 12	Oct 12	Nov 12	Dec 12
Pressure												
Avg. MSLP	978.2	987.0	987.4	984.2	988.0	992.2	981.2	979.9	979.9	981.5	987.7	988.8
Highest MSLP	989.4	999.7	999.5	998.4	997.7	1010.8	1000.9	994.8	994.8	990.3	1007.2	1003.7
Lowest MSLP	969.2	970.9	975.3	965.0	976.2	980.6	963.5	964.8	964.8	967.0	980.1	978.6
Temperature												
Avg. Temp	-00.7	-03.7	-9.1	-14.0	-14.2	-16.4	-20.6	-16.3	-16.2	-11.5	-04.4	-0.3
Max. Temp	06.4	05.3	00.2	-02.7	-04.2	-07.8	-14.2	-08.0	-05.8	-02.4	03.9	5.0
Min. Temp	-06.6	-15.9	-17.4	-25.3	-28.2	-29.4	-33.5	-29.3	-29.1	-25.1	-11.2	-8.0
Avg. Max	02.2	-01.3	-05.7	-11.5	-13.4	-13.4	-20.6	-13.1	-13.3	-08.3	-02.1	-3.3
Avg. Min	-04.0	-07.3	-12.3	-17.0	-16.9	-21.3	-24.1	-18.7	-19.7	-14.7	-06.8	-4.0
Wind												
Avg. kts	14	15	14	14	14	13	16	19	15	16	19	15
Max. Avg kts	36	37	42	44	48	44	50	50	51	34	49	28
Max. Gust	58	70	65	50	58	68	72	79	93	68	86	56
No of day > 23 kts	14	17	26	27	14	12	21	20	15	16	21	23
Blizzards												
No. of Blizzards	1	2	1	1	4	3	3	3	3	2	2	0
No. of Days with pptn	3	8	5	5	13	8	10	7	4	3	7	1
Snowfall	12.3	54.0	2.6	2.8	26.0	34.4	92.2	48.1	50.8	24.0	69.6	0.2



Avg. Wind, Max. Avg. & Max. Gust wind

5. WEATHER PREDICTION USING MATHEMATICAL MODELS

Numerical weather prediction uses mathematical models of the atmosphere and oceans to predict the weather based on current weather conditions it was first attempted in the 1920s, it was not until the advent of computer simulation in the 1950s that numerical weather predictions produced realistic results.

(a) The High Performance Computing System (HPCS)

The HPCS at IMD HQs receives the entire data including manual and automatic devices from across the globe, processes it for the purpose of Generating the initial conditions for feeding NWP models, Generating global and regional forecasts and Generating numerical guidance for operational forecasting offices

At the incoming end of the HPCS is connected to the central message switching computer called "TRANSMET". The products are seamlessly connected to the operational forecasting system of IMD called "SYNERGEE". It directly flows through the manual value addition stages to product generation platforms which create the dissemination products. HPCS server feeds regional servers through automated ftp via VPN circuits.

(b) System run schedule and forecast ranges

Medium Range Forecast System - Implementation of Global Forecast System (GFS)

Global Forecast System (GFS, based on NCEP) at T574L64 resolution has been implemented at NHAC, IMD HQ on IBM based High Power Computing Systems (HPCS). In horizontal, it resolves 574 waves (≈ 25 km in the tropics) in spectral triangular truncation representation (T574). The model has 64 vertical levels (hybrid; sigma and

pressure). This new higher resolution global forecast model and the corresponding assimilation system are adopted from NCEP, USA. The horizontal representation of model variables are in spectral form (spherical harmonic basis functions) with transformation to a Gaussian grid for calculation of nonlinear quantities and physics.

In the operational mode, the Global Data Assimilation (GDAS) cycle runs 4 times a day (0000 UTC, 0600 UTC, 1200 UTC and 1800 UTC). The assimilation system for GFS T574 is a global 3-dimensional variation technique, based on NCEP Grid Point Statistical Interpolation (GSI 3.0.0; Kleist *et al.* 2009) scheme, which is the next generation of Spectral Statistical Interpolation (SSI). The major changes incorporated in T574 GDAS compared to T382 GDAS are: use of variational quality control, flow dependent re-weighting of back ground statistics, use of new version and coefficient for community radiative transfer model, improved tropical cyclone relocation algorithm, changes in the land, snow and ice skill temperature and use of some new observations in the assimilation cycle. The data presently being pre-processed for Global Forecast System at IMD are Upper air sounding – TEMP, GPS & PILOT, Land surface - SYNOP, SYNOP MOBIL & AWS, Marine surface - SHIP, Drifting buoy - BUOY, Sub-surface buoy - BATHY, Aircraft observations - AIREP & AMDAR, Automated Aircraft Observation - BUFR (ACARS), Airport Weather Observations - METAR, Satellite winds - SATOB, High density satellite winds - BUFR (EUMETSAT & Japan), Wind

profiler observations - BUFR (US/Europe), Surface pressure Analysis - PAOB (Australia), Radiance (AMSU-A, AMSU-B, HIRS-3 and HIRS-4, MSU, IASI, SSMI, AIRS, AMSRE, GOES, MHS, GPS Radio occultation, Rain Rate (SSMI and TRMM).

(c) Short Range forecasting system (0 – 72 hours)

(1) Meso-Scale Assimilation System (WRF-VAR)

The regional mesoscale analysis system WRF (ARW) was implemented on the HPCS at HQ of IMD, Delhi with its all components namely, pre-processing programs (WPS and REAL), data assimilation program (WRF-Var), boundary condition updating and forecasting model (WRF) and NCL for display. The pre-processed observational data from GTS and other sources prepared for the Global Forecast System in the BURF format (PREPBUFR of step 2 in GFS) is also used in case of WRF assimilation.

In the WRF-Var assimilation system, all conventional observations over a domain (20°S to 45°N; 40°E to 115°E) which merely cover Regional Specialized Meteorological Centre (RSMC), Delhi region are considered to improve the first guess of GFS analysis. Assimilation is done with 27 km horizontal resolution and 38 vertical eta levels. The boundary conditions from GFS forecasts run at IMD are updated to get a consistency with improved mesoscale analysis. WRF model is then integrated for 75 hours with a nested configuration (27 km mother and 9 km child domain) with physics including cloud microphysics, cumulus, planetary boundary layer and surface layer parameterization. The post-processing programs ARW post and WPP are also installed on HPCS to generate graphical plots and grib2 out for MFI-SYNERGIE system respectively. WRF at 3 km resolution was implemented for National Capital Region of Delhi Region. High resolution WRF has been in operational at other ten regional centres.

(2) Meso-scale model ARPS

The storm scale model ARPS (Advanced Regional Prediction System) was implemented for the Delhi and Kolkata region at the horizontal resolution of 9 km with the assimilation of Doppler Weather Radar observations.

(3) Operational NWP models for Cyclone Forecasting

India Meteorological Department operationally runs three regional models WRF (ARW), WRF (NMM) and Quasi-Lagrangian Model (QLM) for short-range prediction and one Global model (T382L64) (current version T574) for medium range prediction (7 days). The WRF-VAR model is run at the horizontal resolution of 27 km and 9 km with 38 Eta levels in the vertical and the integration is carried up to 72 hours over three domains covering the area between lat. 25° S to 45° N long 40° E to 120° E. Initial and boundary conditions are obtained from the IMD Global Forecast System (IMD GFS) at the resolution of 35 km. The boundary conditions are updated at every six hours interval. The QLM model (resolution 40 km) is used for cyclone track prediction in case of cyclone situation in the north Indian Ocean. IMD also makes use of NWP products prepared by some other operational NWP Centres like, ECMWF (European Centre for Medium Range Weather Forecasting), GFS (NCEP), JMA (Japan Meteorological Agency), UKMO etc. A multimodal ensemble (MME) for predicting the track of tropical cyclones for the Indian Seas is developed. The MME is developed applying multiple linear regression technique using the member models WRF, QLM, GFS (NCEP), ECMWF and JMA. NWP division also provides six hourly intensity forecasts and genesis potential inputs during cyclone conditions. Cyclone track prediction skill of these models are summarized here in Tabular form in the verification section.

(4) Hurricane WRF for Indian Seas

The basic version of the model HWRFV (3.2+) which was operational at EMC, NCEP was ported on IBM P-6/575 machine, IMD, New

Delhi with nested domain of 27 km and 9 km horizontal resolution and 42 vertical levels with outer domain covering the area of 800×800 and inner domain 60×60 with centre of the system adjusted to the centre of the observed cyclonic storm.

The model has special features such as vortex initialization, coupled with Ocean model to take into account the changes in SST during the model integration, tracker and diagnostic software to provide the graphic and text information on track and intensity prediction for real-time operational requirement. HWRF model was tested to run the model in cycling mode at IMD, New Delhi. In this run only the atmospheric model (HWRF) was tested. The Ocean Model (POM-TC) and Ocean coupler requires the customization of Ocean Model for Indian Seas. IMD is expecting to implement the Ocean coupling in collaboration with INCOIS, Hyderabad. The model is presently under testing for experimental operational implementation.

(5) TC Ensemble Forecast for Indian Sea

As per the advice from WMO to provide a guidance of tropical cyclone forecasts in near real-time for the ESCAP/WMO members based on the TIGGE Cyclone XML (CXML) data, under the joint project of World Weather Research Program (WWRP) and Tropical Cyclone Program (TCP). TC homepage was developed by JMA and the same software was transferred to IMD to generate similar page for RSMC, New Delhi. The software was implemented at NWP Division, IMD, New Delhi and ensemble TC products from ECMWF, UKMO, NCEP and JMA will be provided experimentally during the post-monsoon cyclone season 2011 for ESCAP/WMO members of RSMC, New Delhi region.

(d) Polar WRF for the Maitri Region in Antarctica

Polar WRF model (version 3.1.1) is implemented for the forecast up to 48 hours

over the Maitri region. A single static domain with 400×400 grids at the 15 km horizontal spatial resolution and 39 vertical is used. Maitri (lat. $70^\circ 45' S$, long. $11^\circ 44' E$) is kept at the centre of the model domain. The model is run with the initial and six hourly boundary fields from GFS-T574 operational at IMD.

(e) Nowcasting and very short range forecasting systems (0-6 hours)

For nowcasting purposes, application software called "Warning Decision Support System Integrated Information (WDSS-II)", developed by National Severe Storm Lab, USA has been used in experimental mode. For mesoscale forecasting, radar data has been assimilated into the ARPS mesoscale model. With the ingesting of Indian DWR observations, the application software is capable of detecting and removing anomalous propagation echoes.

(f) NWP in operational Agrometeorology

(1) Under Integrated Agromet Advisory Services (IAAS) scheme, district level weather forecast upto 5 days is being issued for seven weather parameters, viz., rainfall, wind speed and direction, maximum temperature, minimum temperature, relative humidity and cloud cover. In addition, weekly cumulative rainfall forecast is also provided. IMD, New Delhi generates these products based on a Multi Model Ensemble (MME) technique using forecast products available from number of models of India and other countries. These include T-799 model of European Centre for Medium Range Weather Forecasting (ECMWF), National Centre for Environmental Prediction (NCEP), USA and Japan Meteorological Agency (JMA), Japan and IMD and NCMRF models. The products are disseminated to Regional Meteorological Centres and Meteorological Centres of IMD located in different states. These offices undertake value addition to these products and communicate to 130 Agromet Field Units (AMFUs) located at State Agricultural Universities (SAUs), institutes of Indian Council of Agricultural Research (ICAR), IIT, etc.

During XIIth Five Year Plan, IMD proposes to generate block level weather forecast for issuing block level agromet advisories using NWP products. For this, pilot studies have been undertaken in collaboration with the following organizations.

(2) IMD has developed crop yield forecasting models based on multiple correlation and regression technique. The crop yield forecasts Agricultural output using Space, Agrometeorology and Land based observations (FASAL) is being provided by IMD at different stages of the growth period, viz., mid-season yield forecast (F2) and pre-harvest yield forecast (F3) using agromet model with crop area estimation by Space Application Centre (SAC). Both these information will be communicated to Department of Agriculture & Cooperation (DAC) for final forecast of crops before harvest. Kharif crop yield forecast during 2012 for 248 districts in 20 states for seven major crops in the country have been prepared and issued.

(g) Performance Results of GFS for rainfall prediction

IMD implemented a Multi-model Ensemble (MME) five days rainfall forecast system, where five models from global leading NWP centres namely, IMD GFS, European Centre for Medium Range Weather Forecasting (ECMWF), Japan Meteorological Agency (JMA), NCEP and United Kingdom Meteorological Office (UKMO) are used as the ensemble member. The weight ($W_{i,j,k}$) for each member model (k) at each grid (i,j) is obtained from the following equation:

$$(a) \quad W_{i,j,k} = \frac{C_{i,j,k}}{\sum_{k=1}^5 C_{i,j,k}}, \quad i = 1, 2, \dots, 161; \\ j = 1, 2, \dots, 161$$

$C_{i,j,k}$ = Correlation co-efficient between rainfall analysis and forecast rainfall for the grid (i,j) of model (k). For the computational consistency, $C_{i,j,k}$ is taken as

0.0001 in case $C_{i,j,k}$ is less than or equal to 0.

The special CC is computed at the grid resolution of 50 km over the country based of daily forecasts during 1 June to 30 September 2011. The result shows that MME is superior to each member model at all the forecasts (day 1 to day 5), in which CC ranges from 0.52 at day-1 forecast to 0.38 at the day- 5 forecast. Among the member models UKMO is found to be superior followed by ECMWF, JMA, IMD GFS T574 (non-member), IMD GFS T382 and NCEP GFS T382. It is interesting to note that over the Indian region, IMD GFS (GFS operated at IMD) performed better compared to NCEP GFS (GFS operated at NCEP). This is because of positive impact of more local observations over India in the data assimilation system of IMD GFS.

Fig. 1 presents seasonal mean PWC (in mm) analysis and mean error of day-1, day-3 and day-5 forecasts from GFS T574 and GFS T382 for the summer monsoon 2011. PWC of higher magnitudes (60 mm to 65 mm) is located over the north Bay of Bengal and adjoining areas of east India and neighboring states. PWC of order 55 mm - 60 mm is found along foot hills, along the monsoon trough region, west coast of India and central Bay of Bengal. Similar pattern is noticed in the corresponding T382 analysis. In the T574, day -1 forecast error shows negative error of order -2 to -3 mm along the region of south of the monsoon trough, some pockets over north west India, north-east India. A pocket of positive error is noticed over western part of the country and along the foot hills of Himalaya, The pattern remains same in the day -3 and day- 5 forecasts, but with increasing magnitude of negative errors. Inter-comparison rainfall prediction skill based on mean spatial Correlation Co-efficient (CC) at the grid resolution of 50 km over the country on the basis of daily forecasts.

The pattern of PWC mean error is found to be broadly matching with the corresponding mean error (under-estimation) pattern of rainfall over India. A significant difference is noticed in

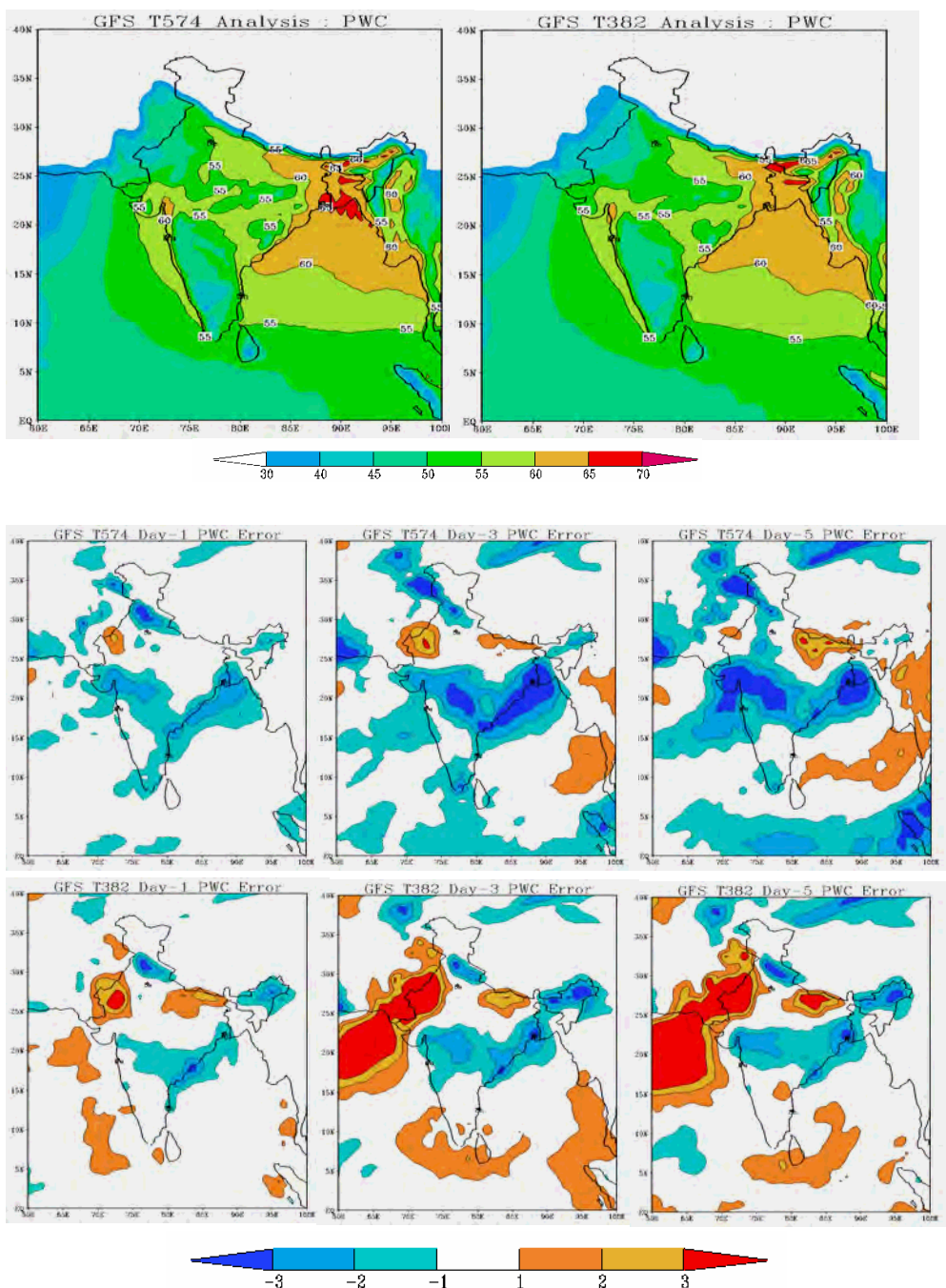


Fig. 1. Seasonal (JJAS) mean precipitable water content (PWC in mm) analysis (top panel) and mean error of 24,72 and 120 hour forecast from GFS T574L64 (middle panel) and GFS T382 (bottom panel) for monsoon 2011

error pattern of PWC forecasts between GFS T574 and GFS T382. In the GFS T382, a belt of positive error is noticed over north east Arabian Sea and adjoin western parts of the country. A pocket of positive error is also noticed along the foot hills of Himalaya. A belt of negative errors are found across the country along 20° N, over north east India and along northern parts of east coast. The pattern

remains same in the day -3 and day -5 forecasts with increasing magnitude of positive errors. The negative mean error of PWC over the central part and over east coast is in well agreement with the responding pattern of mean error of rainfall. But it is difficult to explain the reason for large positive mean error of PWC over the north east Arabian sea extending northward over the land.

6. WEATHER SERVICES

As a service provider designated by the Government, IMD is tasked with providing weather services to As a service provider designated by the Government, IMD is tasked with providing weather services to society in area of Hydrometeorological design, weathrt & flood forecasting, air navigation, farmers communities, fisheries industries, shipping transports mitigation of natural disasters and many more. India is one among the 8 responsible members of the Marine Climatological Summaries Scheme (MCSS) with the responsibility of the Indian Ocean area. Service provision is subject to continuous service quality monitoring and cost management. In addition to weather & forecasting services, IMD has diversified various services in the field of environment monitoring & positional astronomy. Environmental monitoring is used in the preparation of environmental impact assessments, as well as in many circumstances in which human activities carry a risk of harmful effects on the natural environment.

6.1. Hydrometeorological services

The Hydrometeorological Division is providing the necessary technical and operational support to various Central / State Govt. Organisations and other agencies in the field of Hydromet design flood forecasting, water management and agricultural planning purposes. This division carried out compilation of rainfall statistics, hydrometeorological analysis of different river catchments for project authorities and provides meteorological support for flood warning and flood control operations to field units of Central Water Commission. The main annual activities of this division are :

Design storm studies

During the year, 2012, design storm studies of forty two (42) projects were completed; 52 in India and 1 in Nepal. An amount of Rs.16,80,769/- (Rupees Sixteen lacs Eighty Thousand Seven Hundred Sixty Nine only) has been received for carrying out the design storm studies in respect of projects received from private/profit earning agencies. The PMP atlas of Godavari basin is being prepared as a joint contribution from IMD and Central Water Commission.

Rainfall Monitoring

During Monsoon 2012, 1 Subdivision reported Excess rainfall, 22 Sub-divisions reported Normal rainfall and 13 subdivisions reported Deficient rainfall respectively. None of the sub-divisions was in the scanty rainfall category. The rainfall for the country as a whole During Winter-2012 was -4%, Pre-Monsoon was -31%, Monsoon was -7% and Post-Monsoon was -21 % respectively.

During the year fifty two weekly and twelve monthly (updated) districtwise rainfall summaries were prepared. Also, twelve Sub-divisionwise monthly rainfall statistics, based on real-time rainfall data were prepared and sent to ADGM (R) Pune office.

Flood meteorological service

Flood Meteorological Service provided the inputs on rainfall to Central Water Commission (CWC) through 10 Flood Meteorological Offices (FMOs) established in different part of India for operation Flood Forecasting. QPF (Quantitative Precipitation Forecast) were issued by FMOs and supplied to CWC for flood forecasting purposes of 42 rivers and

their 75 sub-basins. During the monsoon season 2012 total 17092 numbers of QPFs were issued by the different FMOs. Out of these 68% of the forecasts were correct, 26 % within + 1 stage out and 5% + 2 stage out.

Strom analysis

Intensity Duration Frequency (IDF) curves for the Station Bangalore in Karnataka, Sanand in Gujarat & Gurgaon in Haryana have been prepared & communicated to the concerned authorities.

A revenue of Rs.97,080/ has been received for supplying IMD curves.

6.2. Agromet. advisories

Agromet advisories are disseminated through various modes of communication including mass and electronic media. In addition to multi-channel dissemination system agromet advisories are being disseminated to the farming community in India through SMS and IVR (Interactive Voice Response Technology) through Public Private Partnership. During 2012, 3.3 million farmers have been benefited directly by this service. IMD has so far tied up with firms like Reuter Market Light (RML), Handygo, State Department of Agriculture (Government of Maharashtra), IFFCO Kisan Sanchar Ltd. (IKSL) and NOKIA Life Tools in this regard.

The following R & D projects are being undertaken through different institutes for use in AAS.

(i) e-Agromet : An IT-based Agrometeorological Advisory System at International Institute of Information Technology, Hyderabad (IIITH) for automated preparation of AAS bulletin for a given weather situation.

(ii) Satellite Data Based Fusion Approach to Develop Soil Moisture Monitoring System in India at Indian Institute of Technology, Roorkee for monitoring soil moisture and its further application in AAS.

(iii) Determination of Soil Moisture over India using Space Borne Passive Microwave Sensors onboard SMOS at International Centre for Radio Science (ICRS), Jodhpur.

Monitoring Agricultural drought

Under the scheme of Monitoring Agricultural drought conditions during Southwest and Northeast monsoons 26 Nos. of fortnightly & 52 Nos. of weekly aridity maps were prepared and supplied to different users.

6.3. Aviation Meteorological Services

IMD provides meteorological support to contribute towards the safety, economy, efficiency and regularity of the aviation services and it is one of the important services provided by IMD. These services are provided through a net work of 4 Meteorological Watch Offices, 18 Aerodrome Meteorological Offices (collocated with the 4 MWOs) and 54 AMSs. An ICAO designated Tropical Cyclone Advisory Center (TCAC) is also functioning from IMD Delhi.

Consequent to the adoption of Amendment 75 to ICAO Annexure 3, in November 2010, implementation of a Quality Management System in the service became mandatory. As part of implementation of QMS, updation and creation of documents related to the service provision are being carried out.

Further, as part of the IMD's safety oversight programme, safety audit of all the four MWOs and majority of the meteorological offices at busy airports have been completed.

In order to promote the indigenous capabilities two instruments for assessing runway visual range developed by National Aeronautical Lab (NAL), Bangalore, in collaboration with IMD were tested and commissioned at IGI Airport, New Delhi.

MoU for provision of aeronautical meteorological support at two newly commissioned airports at Sindhudurg and Durgapaur have been signed.

Instrumentation, communication and product Delivery (OLBS)

Installation of heliport system is in process at Mumbai Juhu Airport and at Vaishno Devi. All the cat-II and cat-III runways are provided with ICAO specified instruments. As additional facilities, one DRISHTI system has been installed at Kolkata Airport and three systems have been installed at IGI Airport, New Delhi. New single on-line briefing system of IMD has been commissioned and is made operational on trial mode. One system is at Delhi and the mirror system is installed and maintained at Chennai Airport. This system is very advanced compared to the old system, like, it can create custom made briefing folders in electronic form. It contains information useful for the low level flights and helicopter operations too. This system also has additional security and accounting features and can be accessed only by the registered users. New state of art AMSS are installed at Nagpur and Guwahati Airports.

6.4. Cyclone warning and advisory services

There are six Regional Specialized Meteorological Centres (RSMC) - Tropical Cyclone (TC) and six Tropical Cyclone Warning Centres (TCWC) for different regions for naming of TCs and the issue of TC advisories and warnings. RSMC, New Delhi which functions in India Meteorological Department (IMD), New Delhi has the official responsibility of monitoring and predicting cyclonic disturbances over the north Indian Ocean (NIO) and issuing Tropical Weather Outlook and TC Advisories for the benefit of the World Meteorological Organisation (WMO) / Economic and Social Cooperation for Asia and the Pacific (ESCAP) Panel member countries including Bangladesh, Pakistan, Maldives, Myanmar, Sultanate of Oman, Sri Lanka and Thailand. It is also responsible for collection, processing and archival of all data pertaining to cyclonic disturbances and preparation of best track data of TCs over the north Indian Ocean. Tropical Cyclone Operational Plan for the north Indian Ocean has been published for the year 2012.

RSMC, New Delhi provides inputs for the development of international best track archives of tropical cyclones which is being developed in World Climate Data Centre (WCDC), located in National Climate Data Centre (NCDC), National Ocean and Atmospheric Administration (NOAA), Asheville, USA.



(i) Cyclone warning/advisory bulletins issued during 2012

Seventeen bulletins during cyclone Murjan were issued to WMO/ESCAP Panel countries, seven bulletins were issued to Somalia and Yemen for India coast guard and six for international civil aviation.

During cyclone, NILAM, 20 bulletins issued to WMO/ESCAP Panel countries, 27 bulletins issued for India coast, 8 bulletins issued for international civil aviation and 4 Bulletin for Disaster Managers of affected coasts.

(ii) Timeliness of cyclone warning bulletins

All the bulletins/warnings have been issued within 2.5 hours of observations, which is an improvement in lead time available to disaster management agencies in recent years. Average time consumed by RSMC, New Delhi to issue cyclone warning bulletin since last three hourly synoptic observations during recent years.

(iii) Change in Format of Cyclone Warning Bulletin

The cyclone warning bulletins include forecast of track and intensity at +6, +12, +18, +24, +36, +48, +60 and +72 hours along with the past observed track and intensity. IMD introduced the forecast upto 72 hrs in December 2008. The cone of uncertainty in the forecast has been introduced with effect from the cyclone, 'WARD' during December, 2009. It is helpful to the decision makers as it indicates the standard forecast errors in the track forecast for different periods like 12, 24, 36, 48, 60 and 72 hrs. The cyclone wind forecast in different quadrants of the cyclone was introduced during 2010 with effect from cyclone 'GIRI' during October 2010. In this forecast apart from maximum winds, winds in each of the four geographical quadrants around the system are predicted. The graphical presentation of these products is also provided on IMD website and also through e-mail. It has been decided to extend forecast upto 120 hrs period as and when situation arises from the year 2012.

(iv) Creation of RSMC website

At present a common website (www.imd.gov.in) exists for both national and international use. However, a dedicated RSMC website with defined static and dynamic pages and link to the websites of WMO ESCAP Panel member countries has been developed.

(v) Web e-Atlas

Best track data and Figures of cyclones and depressions over north Indian Ocean since 1891-2011 in digital form are available on electronic Atlas. The same has been hosted in IMD's website since 2012. Web e-Atlas is now available online at www.mcchennai.eatlas.tn.nic.in with free access to users.

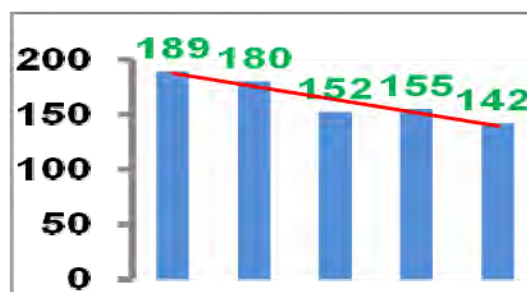
(vi) Forecast Demonstration Project (FDP)

Like previous years several national institutions will participate for joint

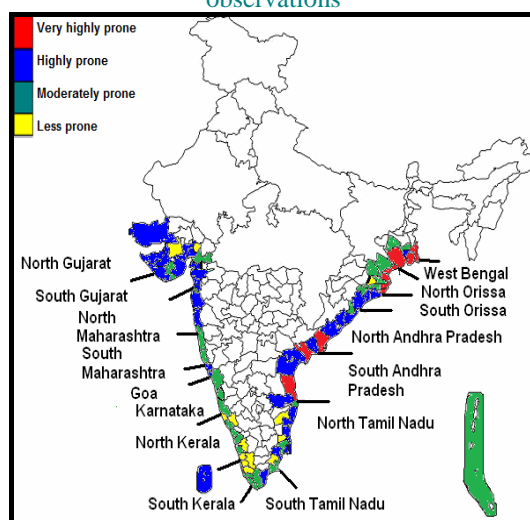
observational, communicational and NWP activities in the final phase of Forecast Demonstration Project on land falling cyclones over Bay of Bengal during 15 October-30 November, 2012.

(vii) Modernisation of cyclone analysis and prediction system

Various strategies were adopted for improvement of analysis and prediction of cyclone. The tropical cyclone analysis, prediction and decision-making process was made by blending scientifically based conceptual models, dynamical & statistical models, meteorological datasets, technology and expertise. Conventional observational network, automatic weather stations (AWS), buoy & ship observations, cyclone detection radars and satellites were used for this purpose. A new weather analysis and forecasting system in a digital environment was used to plot and analyze different weather parameters, satellite, Radar and numerical weather prediction (NWP) model products. An integrated fully automated forecasting environment facility was thus set up for this purpose.



Average time of issue since last three hourly synoptic observations



The manual synoptic weather forecasting was replaced by hybrid systems in which synoptic method could be overlaid on NWP models supported by modern graphical and GIS applications. All the available data and products from various national and international sources were systematically considered for analysis and prediction of cyclones.

(viii) Cyclone Hazard Prone Districts Map of India

The Cyclone Hazard Prone Districts Map of India has been prepared on basis of frequency of cyclones affecting the districts, frequency of severe cyclones affecting the districts, probable maximum precipitation over the districts, maximum wind strength over the districts due to the cyclone and probable maximum storm surge over the districts.

6.5. Services for Indian Ocean and Southern Hemisphere

Indian Ocean and Southern Hemispheric Analysis Center (INOSHAC) has 24 hours operational watch and prepares extended area Synoptic Charts for the region covering 50° S to 45° N and 20° E to 155° E. The bulletins GMDSS, Fleet and sea weather bulletins are issued twice daily based on 0000 and 1200 UTC charts.

For the safety Net. Met. Area VIII (N), IMD issues daily two GMDSS bulletins in fair weather. In disturbed weather (cyclone etc.) extra bulletins are issued every three hours. INOSHAC continuously monitors the weather over India and neighborhood and issue short range forecast for the 36 meteorological subdivisions of India twice daily along with the necessary warnings about severe weather. Apart from the forecast, the bulletins also gives day to day information about synoptic systems affecting the weather, current weather information, day to day rainfall activity, about the onset, advance and the withdrawal of monsoons during monsoon season.

6.6. Service for marine interests

Weather service to marine interests is one of the important responsibilities of the India Meteorological Department; it is also one of its earliest commitments. This service, with many improvements from time to time has continued to be in operation to this day. Organization. India is providing weather services to shipping communities since 1864, much before formal establishment of India Meteorological Department in 1875. The sea bulletins are issued by the Area Cyclone Warning Centres (ACWC) at Mumbai and Kolkata. The coastal bulletins are issued by ACWC, Kolkata for West Bengal coast and Andaman and Nicobar islands; by ACWC, Chennai in respect of Tamil Nadu, Kerala and Karnataka coasts; by Cyclone Warning Centre (CWC), Visakhapatnam for Andhra coast by CWC, Bhubaneswar in respect of Orissa Coast by ACWC, Mumbai in respect of Goa and Maharashtra coasts and by CWC, Ahmadabad in respect of Gujarat coast.

Marine Observations include all meteorological and relate environmental observations at the air-sea-interface, below the sea surface, and in the atmosphere above the sea surface. Observations can be made using fixed or moving platforms, in situ or remote, using surface or space based techniques. In situ measurements are essentially single point observations representative of the surrounding the sea area. Remote Sensing Techniques lead to a large area or volume representation particularly appropriate for observations of sea-ice. The platforms for observations include ships Ocean Weather Stations (OWS), Manned and Unmanned light vessels, Moored buoys, Drifting buoys, Towers, Oil and Gas platforms and Island Automatic Weather Stations. Marine Observations can be made remotely from surface and space based systems. At present, surface based remote sensing systems are available to measure precipitation (Weather Radar), near surface winds (Doppler Radar), Surface Ocean Currents, Surface Wind and Sea State (Microwave Radars). Remote Sensing from space is used for the measurement of

many surface marine variables. It provides bulk of sea state, wind and sea surface temperature data over the World's Oceans.

Major utilization of ship data are as follows:

- To issue Weather and sea bulletins both for shipping on the high seas and those plying in coastal waters (twice daily in undisturbed weather and 6 bulletins per day during storm periods).
- Bulletins for Indian Navy also called Fleet forecasts (twice daily), GMDSS bulletins, Port Warnings (daily once and more often as and when necessary), Fisheries warnings (4 times daily).
- To issue warnings and bulletins to the various interests in the maritime states of India, coastal shipping and ships in the high seas for their specified areas of responsibility. These bulletins include the 4 stage warnings, viz., pre-cyclone watch, cyclone alert, cyclone warning and post land-fall outlook during cyclone situations.
- To issue routine weather forecasts for shipping, fishermen, off-shore oil exploration etc. and issue of special weather warnings for severe weather phenomena like tropical cyclones over the Indian seas.
- To watch over the weather developments in the Indian Seas and advise ships, ports, fishing vessels, the government agencies and other concerned officials, general public etc., in time, regarding adverse weather associated with cyclonic storms and depressions.

6.7. Climate data monitoring & services

National Climate Centre is responsible for Weather data management for India Meteorological Department. This centre has brought out 16 issues of monthly and seasonal

“Climate Diagnostics Bulletin of India” and Annual Summary 2012 during the period. Climate data products viz. daily gridded rainfall and temperature CDs were supplied to different national & international institutes. Total no. of 80 CDs were supplied (35 National institutes & 6 International institutes). Climate products for the South Asia would be generated and put on the website and Regional Climate Centre (RCC) pilot phase would be started.

As a custodian of all meteorological data collected from different stations of the country, National Data Centre (NDC) keyed, processed and archived meteorological data in standard format from time to time. The total holding of meteorological data in the archives as on date is 193.4 million records. During the period under consideration 4,96,25,055 records were retrieved and supplied to different users. This include foreign party one, Indian parties 239 and departmental 160. An amount of Rs.54,02,954/-US \$ 3893 were collected towards the supply of above data 1326 enquiries were answered regarding supply of meteorological data.

Hydrometeorological Section of ADGM (R), Office has computed monthly rainfall data series for districts, states, Met sub-divisions and India as whole based on data from 1901 onwards using uniform methodology. Rainfall data series for the neighboring countries like Nepal, Bangladesh, Pakistan etc. are available for the years from 1875-1950 in the old manuscripts but are not archived so far. The work has been taken up and the following rainfall data has been archived during 2012.

A Pilot project, “A “Rough and Ready” Method of Deducing “Meteors” for Artillery Fire” in association with School of Artillery, Devlali, Nashik, ARDE and IMD, Pune has been successfully completed. The joint project, “A “Rough and Ready” Method of Deducing “Meteors” for Artillery Fire” in association with School of Artillery, Devlali, Nashik, ARDE and IMD, Pune is in progress and preparation of “Upper Air Climatological Atlas of India” is in progress.

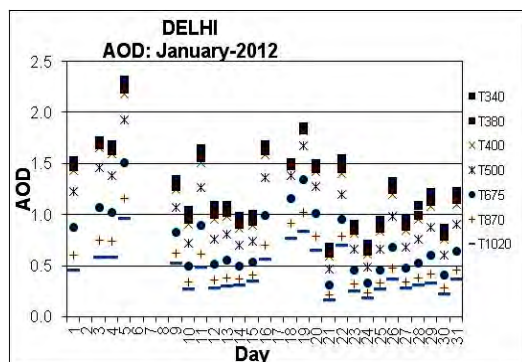
6.8. Environment monitoring

Environment Monitoring Center, India Meteorological Department has established Surface Ozone Monitoring Network by installing Surface UV Absorption Ozone Photometer. UV absorption photometer determines O₃ concentration by measuring the attenuation of UV light due to O₃ in the absorption cell. Monitoring of Columnar Ozone and Vertical distribution is also continued New Delhi, Ranichauri, Varanasi, Nagpur, Pune, Kodaikanal, Thiru'puram, Port Blair, Guwahati and Maitri (Antarctica) stations. One minute average observations are recorded at the stations. Each station is also equipped with the standard Ozone calibrator for onsite calibration. Modernization and Augmentation of Ozonesonde Network by incorporation of latest technology is under process.

Aerosol Monitoring Network

India Meteorological Department has established Aerosol Monitoring Network by installing skyradiometer at twelve locations viz., New Delhi, N. Delhi (Reference Standard), Ranichauri, Varanasi, Nagpur, Pune, Port Blair, Visakhapatnam, Guwahati, Kolkatta, Jodhpur, Rohtak, and Trivandrum Skyradiometer is used to measure optical properties of aerosols such as Aerosol Optical Depth, Single Scattering Albedo, Size Distribution, Phase Function etc. Sky radiometers make measurements in eleven narrow wavebands in the ultraviolet, visible and infrared parts of the solar spectrum.

Quality Monitoring and Forecasting System



The system for air quality forecasting and research that was used to monitor and forecast air quality and weather condition at various venues during the commonwealth games held in October, 2012. This system is now being maintained by IMD. Air Quality Monitoring and Forecasting for other major metro cities will be operationalized by IMD in association with IITM, Pune.

Modernization of Networking

The following instruments for Environment Monitoring and Research have been process for procurement in near future.

(i) Modernization of IMD GAW Precipitation Chemistry Network by installing Automatic Wet Only Collector at 11 stations and further modernizing the air pollution laboratory at IMD, Pune.

(ii) Procurement and Installation of sixteen Equipment for Black Carbon Measurements.

(iii) Procurement and Installation of one Equipment for Baseline GHGs Monitoring System.

(iv) Procurement and Installation of High Volume Air Sampler at 4 locations.

Monitoring of air pollution

Precipitation chemistry - Chemical analysis of precipitation samples received from 11 GAW stations has been carried out.

Aerosol Optical Depth - AOT data from MICROTOPS II Sunphotometer have been received from three GAW stations at IMD, Pune. Ambient Air Quality - Ambient air quality has been monitored using NoX and So₂ gas analyzers for acid precursor gases at Pune and Ranichauri.

6.9. Astronomical Observation and National Calendar

For 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 with a view 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.

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, *i.e.* Indian Astronomical Ephemeris, 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 16 publications annually.

Activities

The Indian Astronomical Ephemeris for the year 2013, 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 on 14th September 2012.

Fourteen language editions of Rashtriya Panchang of 1934 SE (2012-13 AD) and Sunrise-Sunset and Moonrise- Moonset tables for 2013 have been published during the year 2012. These are important regular publications of the centre catering to daily need of users of Almanac, Panchang makers and other users.

A refresher course on Astronomy was organized during 6th to 10th February, 2012 for participants from Gr. A and B officers of RMC, Kolkata.

A pocket-type, card-size calendar containing brief information on important celestial events along with list of holidays during the year 2013 was published.

The centre prepared monthly star charts and astronomical bulletins for 12 months during the year 2012 for giving useful guidance for watching celestial objects in the night sky.

7. Earthquake Monitoring

Center for Seismology is the nodal agency of Government of India responsible for monitoring seismic activity in and around the country. IMD has rendered more than a century of seismological service to the nation with the first seismological observatory of the country having been set up by the department at Kolkata in 1898. Center for Seismology is primarily responsible for monitoring seismic activity in and around the country. The operational task of the Center is to quickly estimate the earthquake source parameters immediately on occurrence of an earthquake and disseminate the information to all the user agencies including the concerned State and Central Government agencies responsible for carrying out relief and rehabilitation measures. The information relating to under-sea earthquakes capable of generating tsunamis on the Indian coastal regions is also disseminated to all concerned user agencies including the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad for issue of tsunami related messages and warnings. The earthquake information is transmitted to various user agencies including public information channels, press, media etc. using different modes of communication, such as SMS, fax, email, IVRS and also posted on IMD's Website (www.imd.gov.in).

India Meteorological Department is maintaining the national seismological network consisting of a total of 82 seismological stations, spread over the entire length and breadth of the country. This includes: (a) 16-station V-SAT based digital seismic telemetry system around National Capital Territory (NCT) of Delhi, (b) 20-station VSAT based real time seismic monitoring network in North East region of the country and (c) 17-station Real Time Seismic Monitoring Network (RTSMN) to monitor and report large magnitude under-sea earthquakes capable of generating tsunamis on the Indian coastal regions and rest are standalone/analog. The information relating to under-sea earthquakes capable of generating tsunamis on the Indian coastal regions is also disseminated to all concerned user agencies including the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad for issue of tsunami related messages and warnings. The earthquake information is transmitted to various user agencies including public

information channels, press, media etc. using different modes of communication, such as SMS, fax, email, IVRS and also posted on IMD's Website (www.imd.gov.in).

Significant earth quake

Two earthquakes of great magnitude 8.5 & 8.1 with their epicenter in Sumatra region were recorded and located by the National Seismological Network (NSN) on 11th April, 2012 which were reported widely felt in parts of main land of the country. The information pertaining to these earthquakes and a brief report on the same was disseminated to various State and Central Government agencies, media press, etc.

Installation of VSAT

A VSAT Hub Antenna (9.0 m) has been installed at NCMRWF Complex, Noida and one 2 Mbps link with redundant facility between IMD and INCOIS, Hyderabad has

been established as part of the project titled “Establishment of an Integrated Seismic & GPS network of stations operated by various National Agencies”.



VSAT Hub Antenna (9.0 m) at NCMRWF Complex, Noida

Portable Digital Seismic Equipments

Eleven sets of state-of-the-art portable digital seismic equipments were procured for monitoring of micro-earthquakes/aftershocks and swarm activity and for site response studies. The system consists of real time transmission of event waveform data from field stations to two Central Receiving Stations through cellular modem facilities offering duplex communication. The auto-location of events is done using an upgraded Local Hydra server/local event processor.

Seismic Microzonation Study of NCT Delhi

Director General of Meteorology (DGM), IMD has constituted a subcommittee comprising the members from Delhi Development Authority (DDA), Central Public Work Department (CPWD), Architecture and City Planner from Ministry of Urban Development (MoUD), Government of India and Dr. D. K. Paul, Professor, Department of Earthquake Engineering, IIT Roorkee, to review the “Proposed Strategy of Implementation of Seismic Microzonation products of NCT Delhi on 1:10K scale in building codes and land use planning of Delhi”, drafted by EREC division.

A meeting of the subcommittee was held on August 1, 2012 in EREC Conference Hall, IMD under the chairmanship of Prof. A. S. Arya, Hon’ble Member Bihar State Disaster Management Authority (BSDMA). Dr. A. K. Shukla made a presentation with emphasis to engineering application of Seismic Hazard Microzonation Products.

Seismic Hazard Microzonation of NCT Delhi on 1:10000 scale, a project of national importance was continued during the year. Under this project, out of planned investigations at 500 sites spread over NCT Delhi, on completion of data generation and analysis at 350 sites, a Preliminary Seismic Hazard Microzonation maps of NCT, Delhi for different themes have been generated for the area covering six districts of NCT, Delhi: namely North-West, district; North, district; North-East, district; East district & West District and part of South-West districts and partly covering remaining part of Delhi.

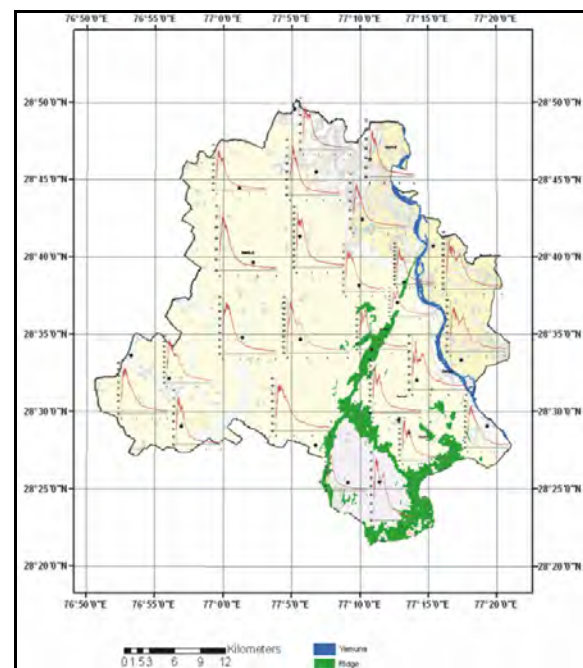


Fig. 1. Acceleration response spectra

A report along with a set of 19 maps of different themes on Seismic Hazard Microzonation and site specific acceleration

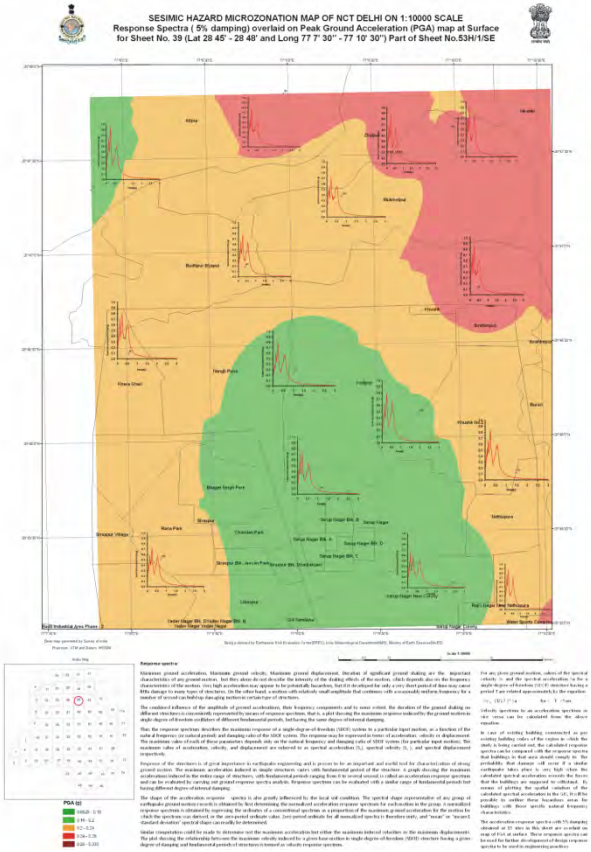


Fig. 2 site specific acceleration response spectra

response spectra had also been generated. This report along with Seismic Hazard Microzonation maps with tentative results were submitted to the Ministry of Urban Development (MoUD) for review and workout strategy/procedure for implementation of the results in building codes and land use planning of NCT Delhi. Fig. 1 shows, acceleration response spectra at 5% damping for 25 selected sites spread over NCT Delhi generated based on Maximum Considered Earthquake (MCE) of return period 2475 years (*i.e.*, 2% probability of exceedance in ground motion in 50 years), overlaid on the Geological Base Map of NCT Delhi on 1:10K scale and ground motion parameters generated under Seismic Hazard Microzonation of NCT Delhi on 1:10,000 scale.

Fig. 2 shows, site specific acceleration response spectra at 5% damping at a few sites, overlaid on the Geological Base Map of NCT Delhi on 1:10K scale, generated in a small area of about 25 sq km represented by one toposheet.

8. Infrastructure Developments - a step further ahead

Atmospheric observation infrastructure forms the backbone of any meteorological service and intensive monitoring of various weather systems through different platform based observing systems provide not only the necessary information about current weather systems, their effective assimilation in numerical models provide important guidance for accurate forecasts. Further augmentation is ongoing for extensive weather observation acquisition and collection platform to supplement the existing infrastructure. Further radiative and thermal balance field is disturbed, causing effect on weather & climate. Hence all these parameters should be monitored at all the radiation stations. Also UV radiation measurement is very important for Health and Agriculture sector.

8.1. Modernization of Radar Network

Radar division is involved in implementation of the work of modernization of the Radar Network by replacing old conventional radars with state of art Doppler Weather Radars, procurement of disdrometers, procurement of spares for effective maintenance, Networking, Archiving data and coordinating in providing data to various user agencies. IMD has a plan to induct total 55 DWRs in its network in phased manners.

(a) Modernization Radar network Under Phase-I continuation from XI to XII Plan

(i) Commissioning of 12 DWRs from M/s Beijing Metstar, China

In first Phase of modernization plan of IMD, 12 Nos DWRs were planned. All the 12 Nos DWRs have already been procured from M/s Beijing Metstar China and reached at respective stations. Out of these 12 Nos DWRs, 8 DWRs have already been commissioned at Delhi (Palam) (22.4.10), Hyderabad (16.7.10), Nagpur (28.2.11), Agartala (13.3.11), Patna

(27.5.11), Lucknow (16.8.11) and Patiala (13.10.11).

DWR at Mohanbari has been installed and commissioned on 02.6.2012. DWRs meant for Goa, Karaikal and Paradip have been kept on hold in view of MOD's advice not to install these radars in coastal locations. DWR at Bhopal is also kept on hold for installation at Kochi. Fresh case for permission is again in process for installation of aforesaid DWRs of coastal locations with some pre conditions.

(ii) Commissioning of 2 DWRs from M/s BEL Bangalore

IMD has procured two nos. of S-band DWRs from M/s BEL, Bangalore under on going scheme for replacement of existing radars at Bhuj and Mumbai (initially Kochi). These radars have been installed at Mumbai and Bhuj. SAT however for DWR Mumbai is still awaited and after commissioning of DWR Mumbai, SAT at Bhuj will be conducted.

(iii) Commissioning of two DWRs from M/s Vaisala, Finland

IMD has procured 2 Nos. C-band dual polarized DWRs for installation in the IMD's radar network one each under Mod phase-I and

Metropolitan Weather-CWG. These C-band DWRs have been installed and commissioned at Delhi (HQ), Mausam Bhawan (19.12.11) and at M.C. Jaipur (28.01.12).

After completion of Phase-I and aforesaid schemes, a total of 21 Nos. Doppler Weather Radars will be in operational network.

(b) Weather parameter observed and their use

DWR gives number of derived products (images) from the three base products *viz.*, Reflectivity, Velocity and Spectrum Width products which can be readily used for nowcasting and more accurate monitoring and warnings for severe weather events like flash floods, thunderstorms, dust storms, heavy rainfall, Gale winds, hail etc. Timely warnings of these severe weather events can save more lives and minimize the damages to properties. Frequency of observations: Doppler Weather Radars which are installed & commissioned operating round the clock (24 × 7) at 10 minutes interval.

(c) Procurement of spares

Radar lab is procuring Doppler Weather Radar spares -72 items on PAC basis from M/s Selex Systemi, Germany for operation and maintenance of Gematronik radars. Supply Order issued & Letter of credit has been established by DGM (CPU) and stores likely to be received in November, 2012.

Radar lab has procured Rainbow software version 5.0 for 4 Nos. for Gematronik DWRs on PAC basis from M/s Selex Systemi, Germany. It is under process of installation in the systems.

DWRs generate various base and derived products including products for hydro meteorological applications like Surface rainfall intensity, Precipitation accumulation. These products require some adaptable parameters which are location and season specific and needs to be evaluated for localized conditions.

8.2. Agro - meteorological Network

Agrimet Division maintains a network of 264 agrometeorological observatories in various agricultural universities/ICAR/Institutes. Beside this network, there are 42 evapotranspiration stations, 214 pan evaporation stations and 43 soil moisture observatories. There are 75 stations recording regular dewfall observations. Under the scheme of desert locust meteorology, 7 micromet cum pilot balloon stations are functioning in north-west India. The data received from these observatories are scrutinized, archived and supplied to scientists, planners etc. through NDC, Pune.

Agrimet Division has developed an “Excel based software using Visual Basics Application (VBA)” for scrutiny and archival of different kinds of Agromet data (CWS, ET, Evapotranspiration, Soil Moisture, Dew etc.). Agro-AWS data are communicated to IMD HQ in prescribed format for onward transmission to Continental Tropical Convergence Zone (CTCZ) on daily basis and uploaded in Division’s website for preparation of agromet advisories by AMFUs.

8.3. Radiation network

The upper-air radiation networks consists of eight stations, conducting fortnightly ascents for monitoring upper-air radiation data including Indian Antarctic station and also maintain surface ozone monitoring network of 5 stations. Fabrication and supply of ozonesondes to the network observatories (4 Nos.) including Indian Antarctic Station. Conducting fortnightly radiometersonde and ozonesonde ascents. Upgradation of hardware and data processing software for Radiometer sonde and ozone sonde is in progress under collaboration with SAMEER.

Also IMD maintains a network of 45 field radiation stations. The radiation is measured by Pyrheliometers and pyranometers with accuracy 1% and 5% respectively. The parameters Global Solar Irradiance, UV-A

radiation and terrestrial radiation at all the 45 stations. Direct (DNI) at 13 stations and diffuse solar radiation are measured at 35 stations. These parameters are recorded at 10 min. time interval.

The sensors for Pyranometers and Pyrhemometers with solar trackers 40 nos each, will be procured under “Augmentation of Radiation network” (12th FYP 2012-17). Till date 22 stations equipped with data loggers, are being interfaced with GPRS modems for real time data transmission on IMD website. Additional 40 GPRS modules are proposed for procurement.

Calibration of all radiation sensors is traceable to World Radiometric Reference (WRR). It is done by their comparison with traveling standards, which have earlier been calibrated against reference standards in radiation lab.

8.4. AWS-Network



AWS at Holy Cave near Shri Amarnath Cave

Installation and maintenance of automatic weather stations (AWS) in remote areas for monitoring the various meteorological parameters are done at Surface instrument division Pune. So far 550 AWS, 878 ARGs systems have been installed & commissioned at various sites. One TDMA type AWS data receiving station has been installed also under the project 550 AWS. Three AWS at Sheshnag, Panchtarni and Holy Cave on the way to Shri Amarnath Yatra have been installed during June 2012. The data recorded by these AWS proved to be very useful to MC

Srinagar in issuing operational weather forecast during Amarnath Yatra. The Certification of AWS ground equipment for Satellite DRT link test is being done at Pune. The Wind profiler with Radio Acoustic Sounding System (WP / RASS) installed at IMD complex, Pashan, Pune, is being used for scientific investigations and data is being supplied regularly to the scientists of different institution.

8.5. Network of HWR Systems

A network of 20 High Wind Speed Recording Systems at cyclone prone observatories at east and west coast of the country is being maintained.

8.6. Network of Aeronautical Instruments

Aeronautical Meteorological Instruments, viz., Transmissometers, Current Weather Instrument Systems (CWIS) and Laser Ceilometer, Distant Indicating Wind Equipment (DIWE) at national and international airports for about 80 airports are being installed. The Installation of integrated airport meteorological system; consisting of transmissometer, digital CWIS and Ceilometer with ATIS and AFTN facilities at three runways of Mumbai airport have been completed. All Analog CWIS / DIWE by a digital system have been replaced.



Fig. 7.1. *Drishti at IGI Airport and Main Sensor (Transmitter & receiver unit)*

An innovative System Installation of Drishti Transmissometer at IGI Airport New Delhi. The Drishti Main Sensor (Transmitter & receiver unit) is given in Fig. Transmissometer is mandatory equipment required to measure visibility at airports as per International Civil Aviation Organization (ICAO) and World meteorological Organization (WMO) recommendations. The unique feature of Drishti is that it has remote accessibility through web enabling for performing health monitoring, online calibration and maintenance of the system.



8.7. Satellite Observations & Network

Satellite Meteorology Division of India Meteorological Department receives and processes meteorological data from the meteorological payloads of INSAT satellites Kalpana-1 and INSAT-3A both have three channel Very High Resolution Radiometer (VHRR) for imaging the Earth in Visible (0.55-0.75 μm), Infra-Red (10.5-12.5 μm) and Water vapour (5.7-7.1 μm) channels having resolution of 2×2 kms in visible and 8×8 kms in WV and IR channels. In addition the INSAT-3A has a three channel Charge Coupled Device (CCD) payload for imaging the earth in Visible (0.62-0.69 μm), Near Infra Red (0.77-0.86 μm) and Short Wave Infra Red (1.55-1.77 μm) bands of Spectrum. The Resolution of CCD payload in all the three channels is $1 \text{ km} \times 1 \text{ km}$. At Present 48 nos. of satellite images are taken daily from Kalpana-1 VHRR which is the main operational satellite and twenty four images are taken from INSAT-3A VHRR. Imaging from CCD is done 6 times during daytime only.

The qualitative products generated after processing the satellite data are transmitted to users for use in Weather forecasting. The list of images & products generated by these satellites are Kalpana-1 VHRR satellite derived imageries, products and INSAT – 3A VHRR satellite derived imageries.

1. Ground receiving and processing systems from Metop/NOAA/MODIS

Three Ground receiving and processing systems for NOAA/METOP and MODIS Polar orbiting satellites were installed at IMD New Delhi, RMC Chennai and at RMC Guwahati. Metop Satellite data receiving & processing systems will enhance the capability of weather forecast by direct interpretation of images as well as by giving input to NWP models. Similarly NOAA/MODIS data shall also be very useful in day to day weather forecasting and input to NWP models as they provide the vertical profile of temperature and humidity in addition to imagery in various channels. The profiles and products are generated and disseminated through website for the use of forecaster on real time basis and validation of various products is in progress.

2. National Satellite Data Center

National Satellite Data Center (NSDC) at IMD New Delhi archives and provides processed imagery data from various INSAT satellites and data of derived products in HDF5 format. The vision of the Centre is to archive all types of Satellite data and derived products. The archival contains new and old data from 1984 onwards and is likely to grow with time with the launch of new satellite like INSAT 3D and archival of satellite data from NOAA/

METOPs/MODIS satellites. Up gradation of NSDC to a state of art New Satellite Data Centre is in progress with new more additional capabilities.

Archival of processed imagery data of all available satellite and its channels and data of all derived quantitative products from a number of operational satellites. The system keeps 2 - 3 months data as on-line storage for current data and products. NSDC has its own web link on IMD website to facilitate data availability and request for retrieval.

3. Global Positioning System (GPS)

Moisture in atmosphere is the main source of all weather related phenomenon. Water content is measured conventionally by upper air soundings and estimated through satellite by Upper Tropospheric Humidity (UTH), Integrated Precipitable Water Vapour measurement which depicts the integrated amount of water vapour vertically over a place is fast being recognized as an important tool for weather forecasting and is being used extensively worldwide. Data are collected at New Delhi from all the five GPS stations at every half hour & processed for integrated precipitable water vapour. The accuracy of IPWV measurement is 5 mm. The assimilation of IPWV data in NWP models has a positive impact on forecasting. Most of the countries have a dense network of GPS stations. In view of this it is felt that a GPS network should be denser in India hence it is proposed to increase the GPS network from five to thirty in order to improve the forecast.

4. Digital Meteorological Data Dissemination (DMDD) Systems

The DMDD System transmits the satellite Cloud imagery, GTS Data and Analyzed Weather Charts round the clock in Digital mode, from New Delhi using INSAT-3C satellite. DMDD receiving Stations installed at IMD offices all over India (in RMCs, MCs,

MOs, FMOs, and CWC etc.). Besides these, there are three nos. of DMDD receiving stations, installed by IMD, in the neighboring countries (Nepal, Sri Lanka and Maldives). Through DMDD System, the cloud pictures are transmitted round the clock in two different formats, viz., JPEG format and Binary format.

In DMDD Receiving System, the received GTS data are stored in separate files, viz., Synop data, Upper air data, Rarep data etc. The receiving system has the capability of storing data in itself for about one month. The received data can be archived in tapes and can be retrieved as and when required.

Three additional stations of DMDD receiving system will be procured and installed at Afghanistan, Bangladesh and Bhutan to enhance international cooperation in SAARC countries.

5. Augmentation programme

The Department of Space (DOS) is in the process of launching an exclusive meteorological satellite INSAT-3D in the first quarter of 2013, which is similar to GOES satellite of USA. This INSAT-3D satellite will have many additional features like, 6-channel imager data payloads in different frequencies and 19 – channel Sounder data payloads with 1 km Resolution imagery in visible band, 4 km in IR band and 8 km in water vapor channel. In addition to satellite imagery in six channels and several new derived products along with the vertical profiles of atmospheric temperature, moisture, total ozone and total Precipitable Water Vapour etc will be available after processing the data from INSAT-3D which will enhance the forecasting capabilities of India Meteorological Department.

To calibrate and validate the data to be received from INSAT-3D a world standard dedicated Calibration and Validation site to be developed near Jaisalmer (Rajasthan) in India and a new CAL/VAL site at Leh, Ladakh have been identified. Climatological & Albedo studies of Ladakh site are in progress.

The existing analog and digital Cyclone Warning Dissemination system will be replaced by DTH based CWDS system through an MOU signed among IMD, ISRO and Doordarshan. DTH based CWDS system will help in disseminating cyclone warnings to the affected coastal areas during the cyclone.

In future, with the launch of INSAT-3D satellite and other satellites the data volume will increase many fold and the present Digital Meteorological Data Dissemination System (DMDD) will not be able to support the full data/images requirements of users due to low rate of data transmission *i.e.*, 128 kbps. A system similar to EUMETcast of Europe which can broadcast the future satellites data and products over the Indian and adjoining areas is proposed to install.

NOAA/ METOP ground receiving system will shortly be upgraded to receive and process the data from recently launched SUMONI-NPP polar orbit Satellite.

8.8. Calibration of Instruments

Surface instruments, Pune prepares technical specifications, engineering drawings and manuals for installation, operation and maintenance of all surface observatory instruments manufactured in the Division and/or installed at surface observatories. It is a recognized by Bureau of Indian Standards for Certification of indigenously manufactured meteorological instruments. Total No. of BIS standards framed is 14.

Testing, calibration and certification of all surface meteorological instruments - Departmental and non-departmental (Defense establishments, Airlines, scientific and research institutions, private and other user organizations). The pressure standards including RA-II Standard are being calibrated for all at Kolkata and at the various Regional Centers of the Department and those of Indian Airlines, Air India and Hindustan Aeronautics Ltd. The parameters are Temperature, Pressure,

Humidity, Wind Direction / Wind Speed, Precipitation. Thermometers and Barometers calibration are traceable to NPL, New Delhi. 24-hour watch and maintenance of Seismological Observatory at Pune, is equipped with WWSSN and GSN instruments.

Site Acceptance Test of Rainbow 5.0 software upgradation of DWR Chennai has been conducted successfully by M/s. Selex Systems Integration GmbH, Germany during 8 to 10 October, 2012.

8.9. Inauguration

C-Band Polarimetric Radar



Hon'ble Minister inaugurating C-Band Polarimetric Radar

IMD has procured two C-band Doppler Weather Radars. The first C-band Doppler radar was installed and inaugurated in Delhi by Shri Ashwani Kumar, Minister of State of Science & Technology and Earth Sciences, on the occasion of IMD's 137th foundation day on 15th January 2012. This C-band Doppler radar goes a step above the S-band Doppler weather radar and gives additional information. It can identify the type of precipitation-whether it's rain, hail or snow. It can also determine the intensity of winds. This will be useful in detecting storms over the Delhi area. It would imply a real time engagement with the dissemination system directly reaching out to the citizens and user groups. Severe weather warning over very specific locations is the target of nowcasting.

Meteorological Observatory



Meteorological Observatory building at Kannur

The new Meteorological Observatory building at Kannur was inaugurated by Dr. Y.E.A. Raj, DDGM, RMC Chennai on 16th March 2012 in the presence of Shri. K. Santhosh, Director, MC Thiruvananthapuram, Shri A. J. Mathew, Director, CDR Kochi & Shri P.S. Biju, Scientist-C, MC Thiruvananthapuram. A brochure on Met. Observatory, Kannur was brought out at the inaugural function on that day.

a. Auditorium “Vrishti”



Auditorium “VRISHTI”



Shri Vayalar Ravi, Hon'ble Minister of Overseas Indian Affairs, Micro, Small and Medium Enterprises, Science & Technology and Earth Sciences visited IMD at Mausam Bhavan, Lodi Road, New Delhi on 01st October, 2012 and inaugurated the “VRISHTI” Auditorium. Dr. L. S. Rathore, DG, IMD, made presentation on current activities and future plans of IMD.

9. HUMAN RESOURCE DEVELOPMENT

Human Resource Development (HRD) is the framework for helping employees develop their personal and organizational skills, knowledge, and abilities. Human Resource Development includes such opportunities as employee training, employee career development, performance management and development, mentoring, succession planning, key employee identification, and organization development. The focus of all aspects of Human Resource Development is on developing the workforce so that the department and individual employees can accomplish their work goals in service to nation.

9.1. Training

Teaching and training in meteorology are an integral part of the activities of IMD. The Meteorological Training Institute (MTI), Pune is responsible for coordinating these activities for IMD, as it is for a wider audience. It relies both on in-house resources and numerous contacts made in academia. Amateurs, students or professionals, the young and the not so young, all come to gain knowledge, both theoretical and practical, in meteorology, by vocation, but also to optimize their decision-making in operational contexts, for which the weather-climate factor is important - and to some extent predictable.

Training courses in Seismology

Seismology Division organized training programs/ courses in Seismology and allied subjects at various levels to station operators and various departmental officers and non-departmental agencies, such as Snow and Avalanche Study Establishment (SASE) Chandigarh, etc. Officers of Seismology Division also delivered lectures, on request, at various state / central government organizations dealing with earthquake related matters.

A training on operation and maintenance of seismic equipments for conducting micro earthquake surveys and on site response studies was imparted during 12-26 March, 2012 to the scientists and operators of Seismology Division and EREC.

Training courses on 'Agrometeorology

A three day's training programme on crop model simulation was organized during 6-8 February, 2012 at SAMC (State Agromet Centre) Kolkata.

Training course on 'Agrometeorology towards better advisories for serving end-users requirement' for AMFU scientists, was conducted from 31st January to 20th February, 2012 at CTI, Pashan, Pune by the Agricultural Meteorology Division. Seventeen trainees in the rank of Assistant Professor, Associate Professor from different State Agriculture Universities (SAUs) working as Technical officers, Nodal officers & Advisory Board members in different Agrometeorological Field units (AMFUs) located in different agroclimatic zones participated in the course.

Agromet Observers' Course was conducted for two batches during 27 February, 2012 to 16 March, 2012 and 4-22, June 2012.

The Agromet Core course for university Professors, Readers, Scientists from various agricultural / agrometeorological research organizations / ICAR institutions/universities was conducted from 24th April to 14th May, 2012. Total 14 participants (Professors/ Scientists) from various Agricultural Universities throughout the country joined the course. The course content included various aspects of Agricultural Meteorology including climate change impact on crops, crop

simulation modeling, crop yield forecasting, and application of remote sensing in addition to operational Agromet Advisory Service.

Three weeks program for two Agromet Observers' course for grass-root level observers, were conducted from 4 June, 2012 to 22 June, 2012..and from 24th September, 2012 to 12th October, 2012.

Training on 'Crop Yield Forecasting using statistical and crop simulation models' was organized for the newly joined SRFs under FASAL during 4-9 September, 2012.

Operation & Maintenance of Surface Instruments

A training course in maintenance of AWS & ARG stations was conducted for 27 participants from RCs & MCs during 2-13 January, 2012.

Airport Met Training was conducted at Electronic lab for trainees from RCs and MCs from 16-20 April, 2012.

Training was imparted to the members of 32nd Indian Scientific Expedition to Antarctica from 23rd July, 2012 - 6th August 2012 regarding RMS & Ozone sonde flights and operation of UV Absorption Surface Ozone Analysers.

Maintenance & Servicing of Surface Meteorological instruments Training was conducted from 17-28 September, 2012 for ten sailors from Indian Navy.

Radiation instruments and GPRS interfacing training with the data logger was provided to One staff from CSO Shillong during 25-28 September, 2012.

Meteorological Telecommunication Training

During the year 2012 ISSD (Telecom Training Centre) conducted the different Telecom Training Courses in TTC. In total 60 Nos of departmental personnel had undergone training in different Courses from January, 2012 to December, 2012.

Advance Training Course in Meteorological Information Systems (Level-III) was also commenced in 1st week of December, 2012 for six months.

Instrumentations Training

The trainings in Instrumentation are beneficial for the participants of IMD as well as outside officials for upgrading their knowledge specially in the field of Meteorological Instruments being used in various units of India Meteorological Department. The following Trainings in Instrumentation for Intermediate Course (Instrumentation) batch XXXVII during 20th January to 19th May, intermediate Course (Instrumentation) batch XXXVIII during 20th May to 19th September, special Training Batch for Naval Met. Sailors was conducted from 27-31 August and expedition to SK36 and SK29 conducted from 24-29 September, 2012 were conducted during the Year 2012.

Hydrometeorological Training

A training program on 'Vrishti', a Geographical Information System for river basin rainfall data processing was held by Hydromet division, New Delhi in three phases, during 30 May-1 June, 2012 and 4-6 June, 2012 at HQ, New Delhi and during 12-14 June, 2012 at Kolkata. The trainee participants were from the Flood Met. Offices and also from RMCs/MCs.

Another training programme was arranged by Hydromet division on mkRAIN software during 3-4 May, 2012 at training centre, New Delhi. The officers from RMCs, MCs, and FMOs attended the programme arranged.

A Refresher Course on Astronomy



Refresher course at PAC, Kolkata

A refresher course on Astronomy was organized during 6-10 February, 2012 for participants from Gr. A and B officers of RMC, Kolkata. Prof. G. M. Ballabh of Osmania University, Hyderabad; Shri A. K. Bhatnagar, ADGM(Retd.), IMD; Prof U. C. Joshi, PRL Ahmedabad; Prof. Ranjan Gupta, IUCAA, Pune; Prof. Amalendu Bandopadhyaya, Director (Retd.), PAC, Kolkata and Dr. D. P. Duari of Birla Planetarium, Kolkata were the renowned persons who delivered valuable lectures on Astronomy.

A course on Astronomy and night sky observation



Night Sky Observation by School Students

A course on Astronomy and night sky observation for school students was organized in collaboration with Bengal Engineering and Science University, Shibpur, Howrah at the venue Birbhum Institute of Engineering and Technology, Suri, Birbhum during 2-5 January,

2012 under sponsorship of three Science academies. A three member team from PAC, Kolkata conducted the camp, delivered day time lecture and participated in night sky observation. Observation on Transit of Venues on 6th June, 2012, was arranged on the roof top of PAC building for viewing the event through telescope. Electronic and print media have made wide coverage of the event organized by this office. Live telecast of the entire event was made by three different local electronic media from PAC, Kolkata. A large number of people consisting of students, teachers and general public gathered to see the event.

Cyclone forecasters' Training

The annual training of two weeks duration for Cyclone forecasters from WMO/ESCAP panel countries along with the forecasters from Area Cyclone Warning centre/Cyclone Warning Centre of India Meteorological Department was organised during 20th February to 2nd March, 2012. The Cyclone forecasters one each from countries, viz., Srilanka, Maldives and Thailand participated in this training programme.

Course on Satellite Meteorology

Advance Professional Knowledge Course (Satellite Meteorology) was conducted by Satellite Meteorological Division to officials of Air Force Administrative college, Faculty of Meteorology, Coimbatore at New Delhi during 27-28 February, 2012.

Training for implementation of official language

Training of Hindi (Prabodh, Praveen, Pragya) under Hindi Teaching Scheme Shri S.R. Paul, Scientific Assistant of Seismological Section of Headquarter was sent to the full-time training of Praveen course from dated 7th February, 2012 to 6th March, 2012.

Shri Bishvdeep Baruva, UDC of Headquarter was sent to the full time training of Pragya Course from dated 07th March, 2012 to 28th March, 2012.

Smt. Bharti Bhuya, Stenographer of Computer unit of NHAC of Headquarter was sent to the full time training of Hindi Stenography from dated 9th January, 2012 to 4th May, 2012 at Central Hindi Training Institute, 2A, Prithvi Raj Road, New Delhi.

Training on ‘Radar Software’

Two-week training programme on operation, product generation and interpretation, related to the newly upgraded Radar Software Rainbow 5.0 by Dr. Jens Didson of M/s Selex Systems Integration GmbH, Germany commenced at DWR Chennai from 22nd October to 2nd November, 2012. Eight Officers & Staff of other IMD offices (two each from DWRs Kolkata, Visakhapatnam, Machilipatnam and ACWC Chennai) and all officers and staff of DWR Chennai got trained in the programme.

CAPARA Training workshop

World Bank with assistance of National Disaster Management Authority (NDMA) has organized two days training workshop on CAPRA probabilistic – Hazards and Risk Assessment in IMD, New Delhi. In this connection, 6-member delegation from World



Bank and National disaster management imparted above training to IMD officers in Mausam Bhawan, New Delhi during 22- 23 March, 2012. Senior scientists from IMD and NDMA attended the training.

Forecasting Training Programme

A one day training programme imparted in National Weather Forecasting Centre (NWFC), New Delhi on 14th May, 2012. This training

programme contained description of rainfall, temperature distribution, heat/ cold wave conditions, interpretation of Radar images, low/medium clouds from satellite inferences. Dr. M. Mohapatra, Scientist-E, Cyclone Warning Division gave a lecture on cyclone warnings and its forecast. All officers and staff members of NWFC attended the same.

Seasonal Prediction of SW Monsoon Rainfall

A three days (16-18 April, 2012) capacity building training workshop on “Seasonal Prediction of Southwest Monsoon Rainfall” for participants from the South Asian countries and which was conducted at the India Meteorological Department (IMD), Pune. The training workshop was attended by representatives from ten South Asian countries, namely Bangladesh, Bhutan, India, Japan, Korea, Maldives, Myanmar, Nepal and Sri Lanka, SMRC, Dhaka and U.K. M.O, London. Experts from the IMD and the Indian Institute of Tropical Meteorology (IITM), Pune and international experts from United Kingdom Meteorological Office, UK, and World Meteorological Organization, Geneva participated in the training workshop as the resource persons.

Programme on Transit of Venus



Officers during the Observational programme of Transit of Venus

Observation on Transit of Venus of 6 June, 2012 a public outreach programme, was arranged by PAC, Kolkata for viewing of the

event by projection method through telescope and direct viewing through telescope. Large number of people consisting of students, teachers and general public, gathered to see the event. Electronic and print media have made wide coverage of the event organised by this office. Live telecast of the entire event was made by electronic media.

9.2. Sports Meet

The 12 All India IMD Sports Meet 2012-13 was organized under the chairmanship of Dr. L. R. Meena, Sc. 'F' & President, IMD Recreation Club, New Delhi to promote the spirit of competition, harmony and brotherhood among the participants. It was hosted by M. C., Bhopal at Sports Authority of India Campus, Bhopal during 7 to 10 March, 2013. The officers and staff of IMD and other Earth System Science Organization presented their skills in various Sports events, *i.e.*, Cricket, Volley Ball / Shooting Ball, Carrom, Chess, Table Tennis, etc. Dr. L. S. Rathore, DG, IMD has inaugurated the Sports Meet on 7 March, 2013 in the presence of Chief Guest Shri Ishwar Das Lohani, Hon'ble Speaker, Vidhan Sabha, Madhya Pradesh and Special Guest Shri R. K. Naidu, Regional Director, SAI, Bhopal. The

vote of thanks to all the guests was given by Shri Arvind Kumar Singh, Honorary Secretary, NOC. Dr. L. R. Meena, Sc. 'F' & Chairman, NOC presented the prizes to the winners & runners-up of different sports events including Team Trophies during closing ceremony held at SAI campus.



IMD Cricket team players

IMD Cricket team participated in Cricket tournament conducted by Survey of India, Dehradun during 5-10 November, 2012. Shri Nayyar was declared best bowler of the tournament.

10. NATIONAL & INTERNATIONAL COLLABORATION

10.1. International Co-Operation

Visit of Secretary General, WMO Geneva



DG, IMD alongwith Secretary General, WMO at IMD, Pune

Dr. M. Jerraud, Secretary General, WMO Geneva, Switzerland visited New Delhi on 21st February, 2012 and had discussion on various issues with Secretary, MoES and DGM IMD. During this visit he also visited IMD, Pune and was briefed about the activities of IMD, Pune. Dr. Medha Khole, DDGM (WF), participated in the meeting of Secretary General, WMO with IMD officers and made a presentation on Activities of Offices of the DDGM (WF). The Secretary General also visited the Weather Central and INOSHAC Division. Dr. Medha Khole, DDGM (WF) briefed him about the operational activities related to Weather Forecasting, SYNERGIE Workstations and Video Conferencing facility.

International Reinsurers Visitors

A team of international reinsurers visited Agrimet Division, Pune on 5th March 2012. The delegates were Mr. Marc Tueller Novae, Switzerland, Mr. Dominic Oldridge, U. K. Mr. Salaheddine Dhouib Liberty France, Ms. Olena Sosenko Scor Re, France, Mr. Ellis Simon Guy Carpenter, U. K., Mr. Timothy Gregory Guy

Carpenter, U. K., Mr. P. P. Rao, J. B. Boda India, Mr. Rohit A. Boda, Mr. Ajay Singhal, Mr. D. G. Halve, Mr. Deepak Patil, Agriculture Ins. Company, India. The visitors were explained the various activities of IMD including the present status and future programme on Monthly.

International Seismological Centre, U.K.



Executive Committee (EC) members at ISC at UK

National Seismological Bulletins containing the phase data and the processed information on source parameters of all earthquakes located by the Seismological Network of IMD are being prepared regularly. India is a permanent Member of the International Seismological Centre (ISC), UK. Seismological Bulletins of IMD are regularly supplied to International Seismological Centre (ISC), UK for incorporation in the ISC's Monthly Seismological Bulletins, which contain information on earthquakes occurring all across the globe. Dr. R.S.Dattatrayam, Scientist-F & Head (Seismology), IMD who is one of the members of the Executive Committee (EC) attended the annual meeting of the EC held during 17-18th June, 2012 at Thatcham, Berkshire, UK to discuss and review the working of ISC towards suggesting improvements in the preparation and exchange of seismological bulletin data.

Visit of Dr. Robert Stefanski

Dr. Robert Stefanski, Chief, Agricultural Meteorology Division, WMO, Geneva visited IMD, Pune Office. On 22nd April 2012, Dr. Medha Khole Scientist 'E' briefed him the weather forecasting services currently being provided and the utilization of SYNERGIE workstation in day-to-day weather forecast generation.



Dr. Medha Khole briefing to WMO EC Panel

WMO Executive Council Meet

The annual meeting of Executive Council of the World Meteorological Organization (WMO) was held from 25 June, 2003 July to review progress in the provision of critical weather, climate and water services to meet the growing needs of society. The 64th session of the Executive Council considered WMO priorities, including: the Global Framework for Climate Services; enhanced disaster risk reduction (DRR); improved observation and information systems; more efficient meteorological services for the aviation sector; and capacity-strengthening of National Meteorological and Hydrological Services (NMHSs) in developing countries. Dr. L. S. Rathore, DG, IMD represented India in this Council meet at Geneva.

International Geological Congress Meet

Dr. R. S. Dattatrayam, Scientist-F & Head (Seismology), IMD visited Brisbane, Australia, as part of a 4-member delegation led by Secretary, MoES, for attending the 34th

meeting of the International Geological Congress (IGC), during 5-10 August, 2012.



Secretary, MoES and Dr. Dattatrayam at IGC, U.K.

As a part of this meeting, India, represented jointly by the Ministry of Mines/Geological Survey of India, the Ministry of Earth Sciences and the Indian National Science Academy (INSA), presented a south Asian bid, on behalf of five countries viz., India, Bangladesh, Nepal, Pakistan and Sri Lanka, for holding the 36th meeting of IGC in India in 2020. India won the bid, with overwhelming response of 128 votes in its favor as against 51 votes for Canada, the only other contender.

WMO Congress, Geneva



Dr. L. S. Rathore, DGM, AVM(Dr.) Ajit Tyagi PRO of WMO and others at Geneva

Indian delegation led by Dr. Shailesh Naik, Secretary and Chairman Earth Sciences, comprising of Dr. L. S. Rathore, DGM &

Dr. Ajit Tyagi, P. R. of India, Shri A.S. Khati, Joint Secretary, MoES, Dr. S.D. Attri visited WMO Geneva, Switzerland 29 to 31 October, 2012 to participate in Extraordinary Session of WMO Congress. The Congress was Chaired by Mr. D. Grimes, President of WMO. The opening session started at 0930 on 29th October, 2012.

The president welcomed to all participants to congress. During this congress emphasize was given towards the success of the GFCS which require the commitment of Nations and other institutions to advance the collective capacities to monitor, understand and forecast weather phenomena for benefit to all. Dr. L.S. Rathore, DGM and Dr. Ajit Tyagi also attended Technical Conferences on GFCS during 26-27 October, 2012.

SWFDP for Southeast Asia

IMD has agreed to be a regional centre for Severe Weather Forecasting Demonstration Project (SWFDP) for southeast Asia and will provide cyclone related forecast and advisory services to southeast Asian countries including Thailand, Vietnam, Laos and Cambodia.

Collaboration with IRIS Washington, USA

Transmission of continuous seismic waveform data of three IMD stations, viz., Portblair, Minicoy and Shillong to the Server at Incorporated Research Institutions of Seismology (IRIS), Washington, USA has been implemented successfully, to enable availability of continuous seismic waveform data to global community for early warning of tsunamis.

10.2. National Collaboration

Collaboration with ICAR

Agricultural Meteorology Division in collaboration with State Agricultural Universities, Indian Council of Agricultural Research, Indian Institute of Technology

published Agromet Brochure (multi-lingual) highlighting the activities of the Division particularly different areas of Integrated Agromet Advisory Services launched by IMD/MoES for the benefit of the farmers. The brochures were circulated to the concerned organizations/institutes and all other organization directly and indirectly related to the agricultural services in the country. In this financial year agromet brochures were prepared in six languages namely Kannada, Telugu, Malayalam, Oriya, Tamil and Bengali.

Collaboration with W.O. Trust

IMD and Watershed organization Trust (WOTR) started collaborative project for the generation of short range weather forecast using the inputs from Automated Weather Stations (AWS) and block level advisories. Initially block level forecast and agromet advisories are issued for 2 specified clusters of 25 villages in Sangamner and Akole Talukas of Ahmednagar District, Maharashtra.

Pilot project is initiated jointly by IMD and the Consultative Group on International Agricultural Research (CGIAR) under the Research Program on Climate Change, Agriculture and Food Security (CCAFS) to develop block level advisories for the selected districts in Punjab and Bihar.

Collaboration with GSI

Facility has been extended to Geological Survey of India (GSI), Lucknow for data analysis and interpretation for site response study of the city of Jalandhar, Punjab on data collected by GSI, during March 13-20, 2012.

Collaboration with IITM

A MoU between India Meteorological Department and Indian Institute of Tropical Meteorology, Pune on implementing Dynamical Coupled Model Forecasting System for Long Range Forecasting seasonal mean and extended range forecasting of Active-Break spells was signed on 10th July 2012.

Seismic Experts and Delhi Development Authority

Delhi Development Authority (DDA) is in process of setting up separate division for retrofitting of buildings in NCT Delhi and formulated an Expert group, under the Chairmanship of Engineer Member, DDA. The EREC is extending available expertise, as member of the group, to develop suitable infrastructure and technical capability to take up the job in holistic manner.

Collaboration with AFCL



Dr. N. Chattopadhyay and Shri S. J. Thote – exchange of MoU

Memorandum of Understanding (MoU) between India Meteorological Department (IMD) and Agricultural Finance Corporation Limited (AFCL) was signed by Dr. N. Chattopadhyay, Deputy Director General of Meteorology (Agrimet) & Scientist E, Pune and Shri S. J. Thote, Deputy General Manager, AFCL. AFCL is in the field of design and development of framework of technology and resource support for providing right, accurate, timely and agro-geographical relevant information to farming community for realisation of individual and nation prosperity through improved agricultural practices, capacity building and de-risking from weather anomalies.

Collaboration with CWC

A Memorandum of Understanding (MoU) was signed by Dr. L.S. Rathore, Director General of Meteorology, India Meteorological Department and Sh. Rajesh Kumar, Chairman, Central

Water Commission, on 26th November, 2012 for collaboration on the work of “Preparation of Probable Maximum Precipitation (PMP) Atlas for Brahmaputra Basin and Updation of old PMP Atlases”. Dr. Surinder Kaur, DDGM(H), Hydromet Division, New Delhi was also present.



Dr. L.S. Rathore, DG, IMD and Shri Rajesh Kumar, Chairman, CWC

10.3. International Assignment

Shri G. Suresh, Sc. ‘E’, Seismology Division, attended the workshop on “Managing Waveform Data and Metadata for Seismic Networks” organized by Incorporated Research Institutions of Seismology (IRIS), USA during 8-13 January, 2012 at Thai Meteorological Department, Bangkok, and made presentation on “Real time monitoring of Indian Seismicity” and acquainted with the PDCC software application.

Dr. Rajesh Prakesh, Sc. ‘E’, Shri R. K. Singh, Sc. ‘D’ and Shri A. C. Lyndoh, Sc. ‘D’ were deputed for training in operation, maintenance and software in seismic equipments from 1-15 February, 2012 at M/s. GEMPA, Germany and M/s. Reftek Inc. USA under the project “Establishment of seismic telemetry network in North East India”.

Dr. K. K. Singh, Sc. ‘F’ was on tour to Canada during 16-20 February, 2012 to participate in the Special Symposium on Enhancing Information flow for Global food security & climate change at Annual Meeting of the American Society for advancement of Services (AAAS).



Dr. S. K. Roy Bhowmik, Sc. 'F' at Geneva

Dr. S. K. Roy Bhowmik, Sc. 'F' attended WMO Steering Group Meeting of Severe Weather Forecast Demonstration Project (SWFDP) at Geneva during 28 February to 2 March 2012. The meeting reviewed progress in the implementation of the SWFDP in Southern Africa, South Pacific, Eastern Africa, Southeast Asia and Bay of Bengal (South Asia) and identified issues, including sustainability & training aspects.

Shri B. K. Bandyopadhyay, Sc. 'F' was on tour to Myanmar to attend 39th Session of WMO/ESCAP Panel Meeting on Tropical Cyclones from 5 to 9 March, 2012.

Shri M. K. Bhatnagar, Sc. 'F' was on tour to Colombo, Sri Lanka from 19 to 22 March, 2012 to participate in the Quality Management System Implementation Workshop.

Dr. (Mrs.) Surinder Kaur, Sc. 'F' visited Japan to attend the 9th meeting of the GEOSS Asia water Cyclone Initiative International Coordination Group and 5th GEOSS AP symposium from 2-4 April, 2012.

Shri A. K. Jaswal, Sc. 'E' participated in the "Eighth session of the Forum on the Regional Climate Monitoring Assessment and Prediction for Asia" from 5- 7 April, 2012 held at Beijing, China.

Dr. S. D. Attri, Sc. 'E' visited Bangkok, Thailand during 11-12 April 2012 to participate in the regional planning workshop in climate change.

Shri Vivek Sinha, Sc. 'E' visited Bangkok, Thailand from 17 - 20 April, 2012 to attend OPMET/MTP/10 and METWARN/ITF/2.

Dr. A. K. Srivastava, Sc. 'E' attended 'SAARC Climate Risk' meeting on, Climate Risk in the Region, "Ways to Comprehensively address the related social, economic and environmental challenges" from 16 to 17 May, 2012 held at Male, Maldives.

Shri R. K. Giri, Sc. 'D' visited Kathmandu, Nepal during 23 to 25 May, 2012 to attend the HCOS project 4th regional steering committee meeting.

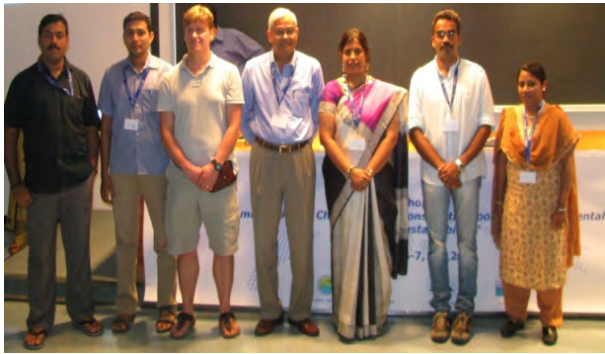
Dr. S. K. Roy Bhowmik, Sc. 'F' was on deputation to SAARC Meteorological Research Centre, Dhaka to attend Meeting of the Focal Points on "Formulation of Inter-Governmental Monsoon Initiative Programme" held in SAARC Meteorological Research Centre, Dhaka, Bangladesh during 30 to 31 May, 2012.

Shri N. K. Pangasa, Sc. 'F' visited Cairo, Egypt during 29 to 31 May, 2012 to attend Seventeenth Meeting SADISOPGS (Satellite Distribution operator group system) organized by ICAO Montreal.

Dr. R. S. Dattatrayam, Scientist 'F' attended the annual meeting of the Executive Committee International Seismological Centre, U. K. held during 17-18 June, 2012 at Thatcham, Berkshire, UK to discuss and review the working of ISC towards suggesting improvements in the preparation and exchange of seismological bulletin data.

Shri Suresh Ram, Sc. 'D' CAMD, New Delhi attended 16th Meeting of Communication/ Navigation/ Surveillance and Meteorology Sub-Group at Bangkok, Thailand from 23-27 July, 2012.

Ms. Latha Sridhar, S.A. participated the "Targeted Training Activity on El Nino Southern Oscillation Monsoon in the Current and Future Climate" at ICTP, Trieste, Italy from 30th July to 10th August, 2012.



Ms. Latha Sridhar, at ICTP, Trieste, Italy

Shri Hirendra Ashwin Kumar Singh, Director along with three other officials was on deputation for four weeks from 20th August to 14th September, 2012 for technical training in Hardware and software of Automatic Message Switching System at France, Paris.

Dr. L. R. Meena, Sc., 'F' attended 15th Session of WMO Commission for Basic System (CBS) held at Jakarta, Indonesia from 10-15 September, 2012.



Dr. L.S. Rathore, DG, IMD at SMRC, Dhaka

Dr. L. S. Rathore, Director General of Meteorology attended and chaired the meeting of Governing Board of SMRC from 12-13 September, 2012 followed by the Selection Committee meeting on 14th September at Dhaka, Bangladesh.

Shri A. D. Tathe, Director as a member of Indian delegation attended 2nd Bilateral meeting with KMA, Korea from 20-21 September, 2012.



WMO EUMETSAT participants

Shri Virendra Singh, Sc. 'D' and Six Delegates from Natural Resources Defense Council & Mount Sinai School of Medicine, New York (Hardware & Operations) attended the WMO/EUMETSAT workshop on RGB satellite products hosted by EUMETSAT at Seeheim, Germany during 17-19 September, 2012.



A. K. Sharma, Sc. 'F' (Sat. Met.) and Smt. Suman Goyal, Sc. 'E'

Shri A. K. Sharma, Sc. 'F. and Smt. Suman Goyal, Sc. 'E' attended High profile Lab training, meeting of the coordination Group of the RA-II Pilot project to Develop Support for NMHSs in Satellite Data, Products and 3rd Asiana/ Oceania conference on the use of Satellite Data at Jincheon and Jeju Island, Republic of Korea from 4 to 12 October, 2012.

Dr. K. K. Singh, Sc. 'F' visited Fairfax, UA, USA, 16-19 October, 2012 to participate in the International Symposium on Synergistic Applications to Food and Water Society and informal discussions on various users with CAGM Management Group.

Shri A. K. Sharma, Sc. 'F', Smt. Suman Goyal, Sc. 'E', Sh. Virendra Singh, Director and Dr. N. Puviarasan, Met. I attended discussion meeting with Prof. T. Nakajima and Dr. K. Aoki and Presentation by Prof. Nakajima, Director, and Center for Earth Surface System Dynamics, Ocean Research Institute, University of Tokyo On 24th October, 2012 at India Meteorological Department, New Delhi.

Shri A. K. Sharma, Sc. 'F' attended Plenary Session and Working Group Meeting of coordination Group for Meteorological Satellites (CGMS-40) from 5 to 8 November, 2012 at Lugano, Switzerland. He co-chaired the Working Group-II on Satellite Data products and training.

Dr. M. Mohapatra, Sc. 'E' visited Haikou, China from 5 to 9 November, 2012 to attend International Workshop on Rapid Change Phenomena in Tropical Cyclones.

Shri B. K. Bandyopadhyay, Sc. 'F' visited Citko, Indonesia from 12 to 15 November, 2012 to attend 7th Tropical Cyclone (TC) Coordination Meeting (TCM-VIII).

Dr. L. S. Rathore, DGM visited SMRC Dhaka, Bangladesh on 15th November, 2012 to attend Selection Committee Meeting.



Dr. N. Chattopadhyay and other during visit of Senegal

Dr. N. Chattopadhyay, Head, Agrimet Division, IMD, Pune participated in the International Workshop on 'Scaling Up

Climate Services for Farmers in Africa and South Asia" held during 10-12 December, 2012 in Saly Portudal, Senegal.

Shri B. P. Yadav, Sc. 'E', visited Kuala Lumpur, Malaysia from 10 to 12 December, 2012 to attend 2nd Monsoon Heavy Rainfall Workshop.

Dr. N. Chattopadhyay, Sc. 'E', visited Senegal from 10 to 12 December, 2012 to attend the International Workshop on Scaling up Climate Services for Farmers in Africa and South Asia.

Dr. M. Mohapatra, Sc. 'E', visited Muscat, Oman from 17th to 19th December, 2012 to attend Workshop on Tropical Cyclone and Forecasting in PTC-Region.



Dr. S. D. Attri, DDGM (O) represented India as Principal Delegate in 15th Session of RAII and Management Board Meeting and delivered Scientific Lecturer on "Challenges and Opportunities of Weather and Climate Services In RAII" during 13-19 December, 2012. He also participated in WMO Regional Seminar on "Strategic Capacity Development of National Meteorological and Hydrological Services (NMHSs) in Regional Association II (Asia) during 11-12 December 2012, delivered a Lead talk on "Climate Services in India: Challenges and Plans" and served as Rapporteur for Session on Climate Services".

10.4. Distinguished visitors

Dr. M. Rajeevan, Advisor to Secretary, MOES on 27th November visited IMD, Pune in connection with progress on the project of National Climate Data Centre (NCDC) at Pune and discussed other issues with senior officers of IMD, Pune.

Shri Vilasrao Deshmukh, Honorable Minister MoES, visited IMD Pune on 7th April, 2012 and had a meeting with Heads of the Departments and senior officers & was briefed about the activities of IMD, Pune. On arrival of honorable Minister in the IMD campus, he was received by Shri S. Krishnaiah, LACD, ADGM (R). All divisional head of the offices and senior officers were also present.

The honorable minister expressed desire to know (a) effect of climate change on weather pattern over India and Maharashtra (b) what are the deficiencies experienced in the way of weather forecast in India (c) condition of observational network compared with the world standard (d) any methodology about detection and tracking of lightening. Most of his questions were explained by Shri Krishnaiah, ADGM (R) and senior officers. He was informed that services, rendered about the weather and climate, are of the world standard.

The activities and functioning of weather central was briefly explained to him. The data reception from all over India and neighbouring countries, the plotting of weather data, analysis of weather chart and prediction.. He also talked to weather section of Regional Meteorological Centre Mumbai via video conferencing facility.



Honourable minister at IMD Pune

The all modular and sample field instruments were shown to him displayed. It was informed to him that the surface instruments are manufactured, calibrated and tested in the laboratories and after undergoing tests, the equipment are sent to field stations for use. These instruments are supplied all over India and it was informed that Surface instruments lab has been credited with achieved the ISO 9001:2008 certification. IMD workshop staff members also welcomed the honorable Minister on his visit by offering a bouquet.



Hon'ble Minister visiting Library

There is lot of demand of climatological data in various sectors such as aviation, agriculture, and industry. There is huge demand of historical data of all the weather elements. This data demand is being catered by National Data Centre Pune. The archival and supply of data to the users and data management have become more fast with the introduction of CLYSIS. It was also informed that data supply will be made online very soon.

The working of High Performance Computing System (HPCS) was also shown to him which have been installed recently and capable of running different models and will be used in weather forecasting purposes. The Honorable Minister expressed much satisfaction over the work of IMD and appreciated the progress made during last so many years in the fields of meteorology.

11. ACTIVITIES AND EVENTS

11.1. Awards

MoES – 2012 Annual Awards



On the occasion of celebration of MoES Foundation day on 27th July, 2012, a Certificate of Merit is given to the Scientists / Engineers in Oceanic Science and Atmospheric Science working under the administrative control of the Ministry. The award consists of Rs. 30,000/- in addition to trophy and a citation. Dr. Kripan Ghosh and Dr. Ashok Kumar Das of this department have been conferred upon certificate for their outstanding contribution in the field of Atmospheric Science & Technology. Shri Debajyoti Bhattacharya, Smt. Bharti Jha, Shri J. M. Sinha have been conferred best employees award in their respective cadre. The award and certificates for the year was given by the Honorable Minister of Earth Sciences, Shri Vilasrao Deshmukh on this occasion at Vigyan Bhavan, New Delhi.

Slogan Competition

A slogan competition on topic 'Fighting corruption in the country or civil society' was organized during Vigilance awareness week. Shri Sanjeev Sharma, A.M. II, Shri R.H. Sharma, S. A. and Smt. M. Anuradha, Hindi Translator was adjudged 1st, 2nd and 3rd prize

winners respectively. A certificate and cash prize was given to them on IMD Foundation day.

Best Employees Award

On the occasion of IMD's Foundation day, Dr. D.P. Dubey, Sc. 'E', Shri V. R. Durai, Sc. 'C' - Gr. A, Shri M. A. Sunder Singh, Asst. Met. I, Shri S. K. Singh, Asstt. Met. II - Gr. B (Gaz.), Shri H. S. Sisodia S. A., Shri Dinesh Khanna, S. A. - Gr. B (Non-Gaz.), and Ms. V. Joglekar



Shri Dinesh Khanna receiving Award from Hon'ble Minister

Junior Translator, Shri K. Gopal, Mech. Grade-I - Group 'C', Shri K. K. Sikdar, Driver and Shri Ramesh Chand, Met Attendant - MTS have been conferred best employees award in their respective cadres.

Appreciation letter

Shri Sonam Lotus, Sc. 'C' was awarded a letter of appreciation by the Chairman of SASB, H.E The Governor of J&K Shri N. N. Vohra, for issuing accurate weather forecast during Amarnath Yatra 2012 in a function attended by galaxy of state dignitaries on 8th August 2012 at Raj Bhavan, Srinagar.

Mausam Biennial Awards



Dr. M. Mohapatra, Sc. 'E' receiving Biennial Mausam Award

On the occasion of IMD Foundation day, Dr. M. Mohapatra, Sc. 'E', Shri H. R. Biswas, Met. Gr. I, Shri G. K. Sawaisarje, Met. Gr. I, were conferred 25th Biennial Mausam Award (2008-09) for their research paper entitled 'Daily summer monsoon rainfall over northeast India due to synoptic scale system', published in MAUSAM in January 2008 (Vol. 59, No.1). This award consists of Rs.50,000/- (Rs. Fifty Thousand) only to be shared by the authors and a citation to each author.

Music Competition

Smt. Suma Eldho, S. A. got 2nd consolation prize in Music (female) competition organised by the Town Official Language Implementation Committee, Thiruvananthapuram during the observance of Joint Hindi Fortnight Celebrations.

A viva-voice examination for Ph.D degree

A viva-voice examination for Smt. B. Geetha, S.A, RMC Chennai for awarding Ph.D degree in Atmospheric Science for her thesis entitled "Indian NE Monsoon as a component of Asian Winter Monsoon and its relationship with large scale global and regional circulation features" under the guidance of Dr. Y. E. A. Raj, DDGM, RMC Chennai was held on 26th July 2012 at RMC Chennai. The research was carried out at RMC Chennai which is a

recognised research institute for pursuing Ph. D degree in Atmospheric Science under University of Madras. Dr. T. R. Sivaramakrishnan, Professor, Sastra University, Thanjavur was the external examiner.

Uttarakhand Gaurav award



Shri Anand Sharma, Sc. 'E' M.C. Dehra Dun was awarded "Uttarakhand Gaurav award" by Shri Dev Vimal Herbal Heritage and Educational Society, Dehra Dun on 9th September 2012. The function was presided by Shri M. M. Ghildyal, Lokayukt, Uttarakhand Government and former- Justice, High court, Nanital.

Dr. V. Vizaya Bhaskar, Director was nominated as external expert in the committee to evaluate Technical and financial aspects to procure "Well Logging Equipment" for Central Water and Power Research Station, Pune. He attended a meeting at CWPRS to formulate specifications for well logging unit during February, 2012.

National Geoscience Award – 2010

Sh G. Suresh, Sc. 'E' has been conferred with National Geoscience Award – 2010 by the Ministry of Mines on 16th February 2012, in recognition of significant contribution in the field of Disaster Management related to the establishment of Tsunami Warning System.



Shri G. Suresh, Scientist-E receiving National Geoscience Award

Dr. R. S. Dattatrayam, Sc. 'F' has been declared qualified for the award of the Degree of Doctor of Philosophy (Ph.D) of the University of Delhi, for his thesis entitled "Analysis of Broadband seismological Data – Application to few significant Indian earthquake".

Dr. S. C. Sahu, Scientist-'E' has been awarded "Chinta O Chetana National Award-2012" for his commendable service in the field of Science by 32nd National Baishakhi Festival Bhubaneswar on 17 April 2012.

Dr. N. Chattopadhyay, Dr. S. Chandras, Dr. B. Das and Dr. L. S. Rathore was awarded First Prize for Poster presentation on "Evaluating the Potential of Kalpana-1 Rainfall Product for Operational Agromet Advisory Services in India" in the workshop on "Meteorological Satellite Kalpana: A Decade Service to the Nation organized by Space Application Centre, Ahmedabad on 9th October, 2012.

11.2. Events

IMD Foundation Day

India Meteorological Department established in 1875 has charted an eventful and cherished journey to its 137th year. The relevance of its services has remained as poignant as it was at its inception. It has spread and enlarged in applicability with increasing sophistication of means of production in society-Weather and Climate, being major factors influencing them

IMD foundation day was celebrated with great enthusiasm at H. Q. New Delhi and also at Regional Centres all over India. The function was attended by a large number of distinguished eminent scientists. An exhibition displaying the recent developments & achievements in the modernization programme of the department was also arranged. During celebration at H.Q New Delhi, Dr. Ashwani Kumar, Hon'ble Minister for MoES was the Chief Guest and the function was presided over by Dr. Shailesh Nayak, Secretary, MoES. Prof. Yashpal, Eminent scientist & Educationist graced the occasion as a special guest.



Dr. Ashwani Kumar, Hon'ble Minister, MoES felicitating Dr. P. V. Joseph

AVM (Dr.) Ajit Tyagi, the then DGM, briefed about achievements made by the department during past year. Prof. Yashpal shared his experiences. On this occasion Dr. P. V. Joseph was felicitated in recognition of his valuable services rendered to the department and contributing towards its developments, growth and image in a significant manner.

World Meteorological Day

Every year, on 23rd of March, World Meteorological Organization (WMO) and the international meteorological community celebrate the World Meteorological Day traditionally focused on a selected key subject. The theme for World Meteorological Day 2012 is "Powering our future with weather, climate and water" in particular to illustrate the benefits provided by weather, climate and water. The international meteorological

community stressed upon the four Sectors- disaster risk reduction, water, health and food security-as priority sector to be addressed. In this context, the emphasis were also given upon other emerging societal problems like Farming, Transport, Trade and Tourism, Energy and Sustainable Cities. On this occasion, India Meteorological Department, (H. Q.), New Delhi, and all regional/sub-offices of RMCs, MCs, MOs and AMOs remained open for the public and students.



Dr. Y. E. A. Raj, DDGM Chennai delivering talk on theme

With reference to main theme exhibitions were arranged and posters depicting the tectonic structure of the earth, earth quake zones, Tsunamis, Cyclonic storms, Thunderstorms, AWS, DWR etc. were also displayed. It was celebrated with overwhelming response of students and public.

A talk in English and in Tamil on the theme of World Meteorological Day-2012 “Powering our future with weather, climate and water” by Dr. Y. E. A. Raj, DDGM, RMC Chennai was broadcasted in AIR Chennai on 22nd March 2012.

National Science Day

National Science Day was celebrated in IMD Pune office premises on 28th February. Dr. A. L. Koppa, DDGM (C) inaugurated the exhibition. It was well attended by students, scientists, journalists & scholars and large number of general public.



World Meteorological Day celebration at M. C., Thiruvananthapuram

Annular Eclipse of The Sun

An Annular eclipse of the Sun occurred on 21 May, 2012 (31 Vaisakha, 1934 Saka Era). The annular eclipse of the Sun was visible within a narrow corridor that traverses Earth's Northern Hemisphere. The annular path of the Moon's shadow began in eastern Asia at the Chinese coast, passes through south of Japan, then crosses the North Pacific Ocean ended in the western United States. The ending of the partial phase of the eclipse was visible for a very short duration from the northeast India after the sunrise. The partial phase of this eclipse began at 2 h 26 m IST. The annular phase began at 3 h 39 m IST and ended at 7 h 7m IST. The partial phase ended at 8h 19m IST.

11.3. Exhibitions



M. C., Thiruvananthapuram represented IMD under the Ministry of Earth Sciences in the “SURAKSHAAYANAM – 2012” an

international workshop & exhibition on “Disaster Risk Reduction and Contingency Planning” inaugurated by Shri Oommen Chandy, the Chief Minister of Kerala, at Kanakakkunnu Palace grounds, Thiruvananthapuram and organized by Kerala State Disaster Management Authority (SDMA), Kerala during 4 to 10 March, 2012.



Exhibition stall of IMD at Thiruvananthapuram

The exhibition stall was arranged by depicting the pictures and charts specially prepared for the different warnings issued by IMD, Seismological Network and Earth quakes, extreme climatological events and Natural hazards, Doppler effects, Weather Radars to track cyclones, Tsunami, AWS/ARG net work and the upper air wind patterns were also described in the permanent posters.

11.4. Media Interaction

Shri Manmohan Singh, Director, MC Shimla, delivered a radio talk on “Comparative Study of precipitation of current year with the precipitation of previous year “on All India Radio Shimla on 27th February, 2012.

Shri B. Puttanna, Sc. ‘D’ has participated in a discussion on “Public TV” channel for one hour on effect of cyclone “NILAM” on Karnataka on 31st October, 12. Also participated in live News on TV-9 (News Kannada and English) Public TV on cyclone “NILAM” alert on 31st October, 2012.

Dr. R. S. Dattatrayam, Sc. ‘F’ participated in a video recording of Lok Sabha Television (LSTV) channel on the subject “Coping with natural disasters – Earthquakes” on 7th December, 2012 along with Prof. Harsh K Gupta, Member, NDMA and Dr. Deep Shikha Sharma, R. G. College, Meerut, U. P. The program was telecast on 15th and 22nd December, 2012 at 18.00 hours on LSTV channel.

Dr. N. Chattopadhyay, Head Agrimet division, Pune gave an interview on topic “Many countries to learn from IMD’s services” in Sakal Times on 28th December, 2012.

12. CONFERENCES, WORKSHOPS & SEMINARS

Workshop/Seminar

WMO Technical Planning Workshop



Participant of workshop on Technical planning

A WMO Workshop on Technical Planning Workshop on the Severe Weather Forecasting Demonstration Project (SWFDP) for South Asia was held in New Delhi from 23rd to 27th January, 2012. Delegates from WMO and representatives from other countries like Sri Lanka, Bangladesh, Maldives, Thailand, Myanmar, Japan, USA and India participated in the workshop. The Workshop was inaugurated by Dr. Shailesh Nayak, Secretary, MoES. Senior scientists of the department including Shri B. K. Bandyopadhyay DDGM(S), Shri B. P. Yadav, Sc. 'E' and Dr. M. Mohapatra, Sc. 'E' attended this workshop.

Workshop on “Challenges, Developments and Opportunities in Nowcasting”

A three day Training Workshop on “Challenges, Developments and Opportunities in Nowcasting” (CDO-NOW-2012) was organized by National Weather Forecasting Centre, India Meteorological Department (IMD), New Delhi from 27- 29 January, 2012. The aim of the Training Workshop was to give

a thrust for development and implementation of a 24 × 7 Monitoring and Nowcasting system in IMD with particular reference to high impact weather events. The structure of Training Workshop was designed to focus on the application of Observations, Synoptic, DWR, NWP, Satellite techniques in Nowcasting.

In the forenoon sessions, lectures were given on various themes by the experts/ renowned scientists from IMD, NCMRWF, and Indian Air force, Indian Navy, SAC Ahmedabad, IIT Delhi, IITM, Pune, SHAR and Coast Guard. In the afternoon sessions, Hands on Training/ Practicals were arranged to demonstrate the application of various tools/techniques in Nowcasting.



Release of book on Nowcast Techniques

The workshop was attended by 33 Departmental candidates and 16 participants from various other Institutes/Departments across the country. A Guide Book on Nowcast Techniques was prepared and given to the participants as ready reference material.

National Seminar on Nowcasting

A two day National Seminar on “Challenges, Developments and Opportunities in Nowcasting” (CDO-NOW-2012)” was organized by NWFC during 30-31 January 2012. The inauguration of National Seminar

was held at India Islamic Centre, Lodi Road on 30th January, 2012. Shri PP Shrivastav, IAS (Retd), Hon'ble Member "Northeast Council" was the Chief Guest and Shri T. Nanda Kumar, Hon,ble Member, NDMA was the Guest of Honour.



Lighting of lamp by Secretary MoES

The Inaugural session was presided over by Dr. Shailesh Nayak, Chairman, Earth System Science Organisation & Secretary Ministry of Earth Sciences. There were six scientific sessions viz. Plenary Session, Satellite Applications, NWP Aspects, Radar Applications, Application and Observational Aspects and Roadmap of Nowcasting.

During these sessions there were Invited/Lead Talks and contributed papers. The lead talks were given by experts/reowned scientists from IMD, NCMRWF, Indian Air force, Indian Navy, SAC Ahmedabad, IIT Delhi, IITM, Pune, SHAR and Coast Guard. A Special session for Interaction with User Organisations and Media was also organized. The Concluding and recommendation session was chaired by Shailesh Nayak, Chairman, Earth System Science Organisation & Secretary, Ministry of Earth Sciences. The seminar was attended by about 150 participants from different organisations/ institutes/Departments across the country.

International Conference on IOTCCC

The second WMO International Conference on Indian Ocean Tropical Cyclones and Climate Change (IOTCCC) was held at New Delhi

during 14-17 February, 2012. The conference was inaugurated by Hon'ble Vice Chairman Shri M. Shashidhar Reddy on 14th February, 2012 and Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences presided over the inaugural function.

About 150 delegates including 32 foreign delegates participated in the conference. There were four plenary sessions, 14 parallel technical sessions, two panel discussions and a concluding session.



Hon'ble V. C. Shri M. Shashidhar Reddy & Dr. Shailesh Nayak, Secretary, MoES

There were invited talks by the eminent scientists in the field of cyclone and climate change impact on cyclones over the Indian Ocean in the plenary sessions and beginning of each parallel, technical session. The several recommendations have been adopted at the end of the conference for further action. During the inaugural function, two books, *i.e.*, 'Abstracts of Proceedings of Second WMO International Conference on Indian Ocean Tropical Cyclones and Climate Change' and 'Cyclone Warning in India: Standard Operation Procedure' was released.

Workshop on pre-monsoon weather activity

One day workshop on "Pre-Monsoon Weather activity over Eastern Region" was jointly organized by RMC, Kolkata and IMS, Kolkata Chapter on 21st February, 2012. The objective of the workshop was to have interaction and

exchange of knowledge and experience amongst the experts, young scientists and members of IMS. At the beginning, Secretary of IMS Kolkata, Shri D. Pradhan, DDGM guests, dignitaries and participants and offered thanks for joining the workshop.

Seasonal Prediction of SW Monsoon Rainfall

A 3 days capacity building training workshop on “Seasonal Prediction of Southwest Monsoon Rainfall” conducted at the India Meteorological Department Pune during 16-18 April, 2012. The training workshop was attended by representatives from 7 South Asian countries, namely, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, and Sri Lanka. An expert from (SAARC Meteorological Research Centre, Dhaka Bangladesh), also participated. Experts from the IMD and the Indian Institute of Tropical Meteorology, Pune and international experts from UK Met. Office and Japan Meteorological Agency participated in the training workshop as resource persons.

Variability of Monsoon in Kerala



Dr. Y. E. A. Raj, Dy Director General of Meteorology, Regional Meteorological Centre, Chennai inaugurating the Seminar

A seminar on “Variability of Monsoons in Kerala” was conducted on 21st August 2012 in the conference hall of M.C. Thiruvananthapuram jointly organized by M.C. Thiruvananthapuram & IMS Thiruvananthapuram Chapter. Dr. Y. E. A.

Raj, DDGM inaugurated the seminar and many scientists from various organizations attended. Shri K. Santhosh, Scientist – E, Smt. V.K. Mini, Scientist-C and Smt. G. Geetha, S.A. of M.C. Thiruvananthapuram attended and presented papers on this occasion.

IMD Support for Helicopter Operation

A workshop on Meteorological support for helicopter operation was conducted by CAMD on 23rd August, 2012. During inauguration] Shri Arun Mishra, DG, Civil Aviation, appreciated IMD’s services provided to aviation sector. Dr. L. S. Rathore, DG, IMD emphasized on commitment of Department to provide the Meteorological support to helicopter operations.



Dr. L.S. Rathore, DG, IMD, Shri Arun Mishra, DG, Civil

He emphasized that IMD’s ongoing project on Himalayan Meteorology like DWR and AWS will be very useful for aviation sector. Shri M. K. Bhatnagar, DDGM presented the organizational setup of IMD, products available on IMD’s website for low level flight operation and future plan of IMD for helicopter operations. About 20 helicopter operators attended the workshop.

Individual Participants

Dr. A. K. Das, Met. - I attended the training Workshop cum National Seminar on Nowcasting during 27-29, January, 2012 at New Delhi.

Dr. A. K. Srivastava, Sc. 'E' attended two days seminar on, "Identification and Prioritization of Statistical Indicators on Climate Change" from 3rd to 4th February, 2012 at Hyderabad. of Maharashtra in connection with "Real time Decision Support System (RTDSS) for Krishna and Bhima basins."

Dr. G. Krishnakumar, Sc. 'E' participated in the workshop on 27th March, 2012 organised by Government

Lalit Shripad, A. M. II and Shri R. G. Patil, S.A. attended "Garuda Grid Workshop for Scientific and Engineering Applications" organized by Centre for Development of Advanced Computing (C-DAC) on 7- 8 August, 2012 at CDAC, Pune.

Dr. (Mrs.) Surinder Kaur, Sc. 'F' attended the workshop organized by Govt. of Odisha and MoWR to finalise and harmonize Integrated Water Resources Management Plan during 5-6 October, 2012 at Bhubaneshwar.

Dr. N. Chattopadhyay, Head, Agrimet Division, Pune participated in the 8th Convention of Grameen Gyan Abhiyan held at M.S. Swaminathan Research Foundation, Chennai, during 28-30 October,

Dr. D. S. Pai, Sc. 'E', Shri S. D. Raskar, S.A. and Shri R.G. Patil, SA attended "NKN Annual

Workshop 2012" at IIT, Bombay jointly organized by NIC and IIT Bombay from 31st October to 3rd November, 2012.

Dr. N. Puviarasan, Met. I attended 11th Biennial conference of Pan Ocean Remote Sensing Conference (PORSEC-2012) from 5-9 November, 2012 organized by INCOIS Kerala.

Dr A. K. Shukla, Sc. 'F', attendended an international workshop on "EAS-INDIA workshop 2012: Building Regional Framework for Earthquake Risk Management" on 8-9 November, 2012 at Ashoka Hotel, New Delhi, Organized by Ministry of Home Affairs.

Shri K. Santhosh, Sc. 'E' attended City Consultation Workshop regarding implementation of the project "Climate Risk Management in Urban Areas through Disaster Preparedness and Mitigation" convened by Disaster Management (Revenue K) Department, Govt. of Kerala on 14th December, 2012.

Shri K. Santhosh, Sc. 'E' attended City Consultation Workshop regarding implementation of the project "Climate Risk Management in Urban Areas through Disaster Preparedness and Mitigation" convened by Disaster Management (Revenue K) Department, Govt. of Kerala on 14th December, 2012.

13. MEETINGS

ACR/AMR/ATR Meeting



Secretary MoES, DG IMD and Dr. Medha Khole

Annual Cyclone Review / Monsoon Review / Technical Review (ACR/AMR/ATR-2012) was organised by National Weather Forecasting Centre during 4-6 January 2012 at India International Centre, Lodi Road, New Delhi. AVM (Dr.) Ajit Tyagi, DG, IMD, Divisional Heads & other Scientists of IMD and Senior Scientists from Ministry of Earth Sciences and NCMRWF participated in the deliberations. The meetings reviewed the activities of the department during the past year and future plans to improve the weather services provided by various users.

Meeting for Regional Integrated Multi Hazard Early Warning System

A WMO – RIMES (Regional Integrated Multi Hazard Early Warning System) project working group meeting on ‘Integrating IMD Forecast Information products into planning and programmes of climate sensitive sectors’ was convened on 21st February, 2012 at RMC Chennai. 18 delegates from Tamil Nadu State Govt. departments of agriculture, fisheries, public works and disaster management and two experts from RIMES working group, Bangkok participated in the meet. The project involves integrating IMD’s forecast information products into planning and programmes of climate sensitive sectors such as agriculture,

fisheries, public works and disaster management.

Annual Review Meeting on Agromet Advisory Service

RMC Guwahati conducted a state level Annual Review Meeting on Agromet Advisory Service at Guwahati for the state of Assam on 21 March, 2012. Hon’ble Shri Kabindra Barkakati, Director of Agriculture, Govt. of Assam inaugurated the meeting. Shri Awadhesh Kumar, DDGM RMC Guwahati presided over the meeting. In his key note address, Shri Barkakati mainly emphasized on the extensive use of AAS for better and effective agricultural practices existing in the state. Shri Awadhesh Kumar stressed on development of fruitful feedback mechanism involving all the stake holders in the state for further improving the services. In the meeting participants from the state Agriculture Department, Nodal officers of AMFUs, Programme Coordinators of KVKs, Agriculture Scientists from Horticulture Department, representatives of AIR, DDK and Progressive farmers were present.

South Asian Climate Outlook Forum (SASCOF-3)

Third meet of South Asian Climate Outlook Forum (SASCOF-3) was organized during 19-20 April, 2012. In SASCOF-3 the above experts as well as experts from Korea Meteorological Administration (KMA), representatives from the WMO and scientists from different research institutes from the host country (India) including the India Meteorological Department (IMD), Indian Institute of Tropical Meteorology (IITM), Pune, Centre for Development for Advance Computing (C-DAC), Pune, and Centre for Mathematical Modelling and Computer Simulation (CMMACS), Bangalore, took

active part in deliberations for finalizing the consensus outlook for the summer monsoon rainfall over South Asia.



Forecasts from National Centers for Environmental Prediction (NCEP), USA, Meteo France, France, International Research Institute for Climate and Society (IRI), USA, World Meteorological Organization's Lead Centre for Long Range Forecasting - Multi-Model Ensemble, Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and APEC Climate Center etc. were also considered for preparing the consensus forecast. There were 42 participants from 9 countries. In addition, around 20 experts from the national agro meteorological services of the SAARC nations and an expert from the WMO also joined the forum in afternoon session (IV session) of the last day. A "consensus" statement regarding outlook of the Summer Monsoon Season for the south Asia was issued.

'Mausam' Editorial Committee Meeting

The Editorial Committee Meeting of departmental journal MAUSAM was held on 30th January 2012 at DGM Conference Hall. The Editor of MAUSAM AVM (Dr.) Ajit Tyagi, chaired the Meeting. Dr. S.M. Kulshrestha, Shri D. R. Sikka, Prof. S. K. Dube, Shri R. C. Bhatia and Dr. B. Padmanabhamurty, all committee members-attended the meeting along with Editorial Office team. After welcome address by DGM, Shri U. P. Singh, Secretary, MAUSAM, briefed the achievements made during the past four years.



On this occasion a CD containing bibliography of MAUSAM since 1950 prepared by Editorial office was presented to Committee Members. The Committee members appreciated the efforts made by Editorial office. They gave their valuable suggestions for further improvement of Journal MAUSAM.

Meeting on "Operational Agromet. Services



Agricultural Meteorology Division, India Meteorological Department, Pune, World Meteorological Organisation, Geneva and SAARC Agriculture Centre, Bangladesh jointly organized the Consultation Meeting on "Operational Agrometeorological Services in SAARC and other countries in RA II region" at National Meteorological Training Institute, Pune from 20-21 April 2012. A number of high level dignitaries such as Dr. A. K. Azad, Director, SAARC Agriculture Centre, Mr. Robert Stefanski, Chief Agricultural Meteorology Division, WMO, Geneva, Prof. R. R. Kelkar, Former DGM, AVM (Dr.) Ajit Tyagi, Former DGM, Dr. K. J. Ramesh, Sc.

'G', DST, Dr. S. Sardesai, Sc. 'G', NIC have participated in the meeting. The objective of the meeting was to share the ideas and understanding of agromet advisories services among the agrometeorologist from SAARC and non-SAARC countries in the RA-II which will ultimate boost the agriculturist activities and also benefit both the group of countries.

Media Briefing for Long Range Rainfall Forecast – 2012



The first stage forecast for the 2012 Southwest Monsoon Rainfall for the country as a whole was issued in press release at PIB Shastri Bhawan, New Delhi on 26th April 2012. Dr. D. S. Pai gave a presentation on Long range Forecasts for SW Monsoon. Followed by press release and media briefing by the Hon'ble ministers, Secretary MoES and DG, IMD.

Meeting on Seismic Microzonation



Eighth meeting of the extended group of Advisory and Monitoring Committee on Seismic Microzonation of NCT Delhi on 1: 10K scale was held on July 6, 2012 at EREC

conference Hall, IMD under the chairmanship of Prof. A.S. Arya, Former National Seismic Advisor and presently, Hon'ble Member, Bihar State Disaster Management Authority (BSDMA), to review of Seismic Microzonation results/products before finalization. In this meeting reputed structural engineers, Architecture, City Planner and officials involved in disaster management from Delhi Development Authority (DDA), Central Public Work Department (CPWD), Ministry of Urban Development (MoUD), Government of India, Government of Delhi, Survey of India, etc were specially invited to apprise with the Seismic Microzonation products generated for part of NCT Delhi and to further discuss strategy of implementation of seismic microzonation products in land use planning and design of building codes for NCT Delhi.

User Meet on "Weather Services

Bridging the gap with user communities/ stakeholders" was organised by R.M.C, Chennai on 5th September, 2012 at I. I. T. (Madras), Campus, Chennai. The programme was sponsored by Govt. of Tamil Nadu under UNDP, Chennai.



Dr. L. S. Rathore, DG, IMD, presided over the meet. Shri Jaindra Nath Swain, I.A.S., Principal Secretary, Govt. of Tamil Nadu, the Chief Guest delivered the inaugural address. Dr. Y. E. A. Raj, DDGM, RMC Chennai, Dr. S. R. Ramanan, Scientist 'E' and several other officers participated in the meet. Around 47 delegates participated in this User meet from 45 organizations including representatives from the State and Central Government offices.

International Consultancy Meet

Ministry of Earth Sciences Govt. of India is launching 'National Monsoon Mission' (NMM) with a vision to develop a state-of-the-art dynamical prediction system for monsoon rainfall on different time scales, which is being co-ordinated by IITM. The National Monsoon Mission International Consultancy Meeting was held in IITM, Pune during 11-12 September to discuss the proposals received from national and international scientists/organizations. Dr. S. K. Roy Bhowmik, Scientist 'F' and Dr. D. R. Pattanaik, Scientist 'D' participated in this meeting and delivered talks on Operational Challenges of Short & Medium Range Weather Prediction and Operational Challenges of Extended Range Weather Prediction respectively.

Standing Advisory Committee Meeting



Members of SAC

23rd Standing Advisory Committee meeting of Positional Astronomy Centre, Kolkata was held on 10th October, 2012 at Salt Lake office of PAC under chairmanship of Dr. G. M. Ballabh, Professor, Osmania University, Hyderabad. Dr. L. S. Rathore, DGM, Shri S. Sen, Sc. 'E', Shri U. P. Singh, Director and other members of Advisory Committee were present in the meeting. The committee took some important recommendations for overall improvement in the functioning of the centre in future.

Sixth ARM on IAAS



Dr. L.S. Rathore, DG, IMD addressing

IMD and Banaras Hindu University jointly organized the Sixth Annual Review Meeting (ARM) of Integrated Agromet Advisory Service at Varanasi from 21-23 November, 2012. A number of high level dignitaries, Scientists/Officers from IMD, Principal Nodal Officers, Nodal Officers and Technical Officers from Agro meteorological Field Units (AMFUs), NGOs and private firms have participated in the meeting. In total there were 315 participants.

The main objectives of the annual review meeting was to review the implementation of the IAAS scheme in respect of the quality of the Agromet advisories prepared, its dissemination to the farmers, performance of District Level Weather Forecast (DLWF) and ultimately working out the future course of actions for the improvements of the advisory system. Important recommendations like accuracy of weather forecast, establishing strong linkages with dissemination agencies for wider outreach, use of state-of-the-art technology in AAS etc. were made at the end of the meeting for strengthening the service.

FMO officers and users interaction

Two days annual meet of FMO officers and Users interaction was organized by Hydromet Division, New Delhi during 6th & 7th December, 2012 at FMO Patna.

TROPMET 2012



The Conference was organized by India Meteorological Society and held from 20-22 November, 2012 at Dehradun which was sponsored by MoES, ISRO, ICRA, Ministry of Agriculture and Department of Science & Technology. Meteorology with special emphasis on mountains" is the theme of the TROPMET - 2012 conference, chosen taking into consideration of large mountain resources of India and its important role in economic development.

“Chief Guest was Shri Surinder Singh Negi, Hon’ble Ministry of Uttarakhand State. The presidential address was delivered by Dr. Shelish Nayak, IMS president, Secretary & Chairman Earth Science Organisation whereas Dr. Y. V. N. Krishnamurthy Director, IIRS welcomed the distinguished delegates. Shri Anand Sharma, Sc. ‘E’ Meteorological Centre and Secretary, IMS – Dehra Dun Chapter was Convener of the organizing committee. A book on ‘Climate of Dehradun’ by S/Shri Anand Sharma, O. P. Singh and M. M. Saklani was released during this occasion. During this conference Shri D. R. Sikka, Retd. Director (IITM) was honoured by Sir Gilbert Thomas Walker Award consisting of a Medal and cash award of Rs.1 Lakh.

Setting of Seismic Network

State Government of Bihar was intended to set up a Local Seismic Network in the State of Bihar, and constituted a Committee under the Chairmanship of Prof. A. S. Arya, Hon’ble member of Bihar State Disaster Management Authority (BSDMA). Dr. A. K. Shukla, Head

EREC was nominated as a member of the committee by the Government of Bihar. On request of BSDMA, third meeting of the committee was organized in EREC on 15 February, 2012 to apprise the members about the Facility of IMD. In absence of Prof A S Arya, the meeting was chaired by Dr A. K. Shukla, Head EREC. Shri P.R.Baidya, Scientists E also participated in the meeting and provided feedback on proposed IMD network and Seismicity of Bihar. Dr. A. K. Shukla also drafted a report on behalfs of the committee.

Review Meeting of Pilot Project

Review meeting of pilot project between NABARD and IMD was held on 28th December, 2012 at NABARD’s Regional Office, Pune. Dr. N. Chattopadhyay, Head, Agrimet Division, Pune and others officers of IMD, Nodal Officers of KVKs & District Correspondents of NABARD under this project participated in this meeting.

Individuals Meetings

Shri S. B. Tyagi, Sc. ‘E’ attended the Indian side of Joint Working Group on 27th January, 2012, Room No. 411, Shram shakti Bhawan, Rafi Marg, New Delhi to assess the progress made on the action plan for signed by the Indo-Australia Joint Working Group.

Dr. A. K. Srivastava, Sc. ‘E’ attended the First Meeting of the Project Monitoring and Review Committee” of Watershed Organization Trust (WOTR) at National Bank for Agriculture and Rural Development (NABARD) Pune on 2nd February 2012.

Shri K. Santhosh, Director, IMD, attended the State Level Review Meeting of Agromet Advisory Services was conducted on 09/02/2012 in the Banquet Hall of Govt. Guest House, Thycaud, Thiruvananthapuram.

Shri A. K. Sharma, Sc. ‘F’ attended the 132nd meeting of Technical Advisory Group, INSAT Coordination Committee (TAG-ICC) at ISRO

(HQ), New BEL Road, Bangalore on 15th February, 2012.

Shri O. P. Sreejith, Met.I attended meeting called “Kick up meeting” for one multi-institutional joint project between MoES and U. K on 20th February, 2012 at IITM, Pune.

Dr. (Mrs.) Surinder Kaur, Sc. ‘F’ and Shri S. B. Tyagi, Sc.‘E’ attended the Indian Side of Joint Working Group under the Chairmanship of Shri Pradeep Kumar, Commissioner (Project), MoWR, on 24 February, 2012 in Shram Shakti Bhawan, Rafi Marg, New Delhi.

Dr. (Mrs.) Surinder Kaur, Sc. ‘F’ attended the Indo-Australia Joint Working Group on Water on 11th April, 2012 in MoWR, Shram Shakti Bhawan, New Delhi.

Dr. A. K. Shukla, Head (EREC) attended a meeting as a member of the expert committee constituted by Bihar Government, on 17th April, 2012 at Bihar State Disaster Management Authority (BSDMA) regarding setting up of Patna Seismic Observatories in Bihar state by Govt. of Bihar.

Mr. I. J. Verma, Director attended meeting at School of Artillery, Devlali, Nashik from 11th to 12th June on “Rough and Ready” Method of Deducing “Meteors” for Artillery Fire.

Dr. G. Krishnakumar, Sc. ‘E’ and Dr. Pulak Guhathakurta, Scientist ‘E’ attended a meeting on review of ‘National Data Sharing and Accessibility’ policy under the Chairmanship of Dr. Surinder Kaur, Scientist ‘F’ from 12th to 13th July at New Delhi.

Shri O. P. Sreejith, Met. I and Shri. S.D.Raskar, S.A. attended GARUDA-NKN partners Meet organized by Centre for Development of Advanced Computing, Bangalore held from 20th to 21st July at NIAS Auditorium, Bangalore.

Shri B. Puttanna, Director-in-charge, MC Bangalore attended the GARUDA-NKN Partners Meet 2012 on 20th and 21st July 2012 at NIAS Auditorium, Bangalore. He was

nominated as the chair person for the session 4 on 21st July 2012 for the session on Climate and Bio-Diversity.

Shri B. Mukhopadhyay, DDGM(C) and Shri A.K. Jaswal, Sc.’E’ attended the meeting on ‘Joint Research and Development of Atmospheric Instrumentation for Operational Meteorology’ held on 24th July at Society for Applied Microwave Electronic Engineering and Research (SAMEER), Powai, Mumbai.

Shri S. B. Tyagi, Sc. ‘E’ attended the Scoping Meeting for” Integrated Programme on Gangotri glacier-Implementation Plan”, during 14-15 September 2012 at SASE, Chandigarh.

Dr. (Mrs.) Surinder Kaur, Sc. ‘F’ attended the Internal meeting of Indian side Indo-Australia Joint Working Group with three nodal officers nominated by State Govt. on 28, September 2012 in Shram Shakti Bhawan, Rafi Marg, New Delhi to assess the progress made on (i) Action Plan (ii) Development of a Project Plan for Integrated Water Resources Management of Brahmani-Baitarni river basin and proposed workshop.

Dr. G. Krishnakumar, Sc. ‘E’ and member of Advisory Group Committee for Real time Decision System under Hydrology Project attended the one-day workshop and meeting on 11th October, 2012 at Pune, organized by Government of Maharashtra.

Dr. Jayanta Sarkar, Sc. ‘E’ attended a meeting of State level Co-ordination Committee on Crop Insurance (SLCCCI) at Krishi Bhavan, Gandhinagar on 30th October, 2012.

Shri P. R. Baidya, Sc. ‘E’ attended a meeting of Technical Committee held on 15th November, 2012 at Thiruvananthapuram, organized by Kerala State Electricity Board, Kerala in connection with setting up seismic network in and around Idduki Dam, Kerala.

Shri B. Puttanna, Director, attended a meeting called by Principal Secretary to Govt. of India, Planning, Programme Monitoring and Statistics

Deptt pertaining to the hosting of Weekly Rainfall data in the website by Directorate of Economic and Statistics on 17th November, 2012.

Shri A. K. Sharma, Sc. 'F' attended Annual Agro Met. Review meeting and delivered presentation on Satellite Meteorology in Agro Met Advisory service on 23rd November, 2012 at Banaras Hindu University, Varanasi, U.P.

Dr. (Mrs.) Surinder Kaur, Sc. 'F' and **Shri S. B. Tyagi**, Sc. 'E' attended the Third meeting of Mountain Meteorology Executive Board of

the project "PARWAT CENTRAL" on 30th November, 2012 at Mausam Bhawan, Lodhi Road, New Delhi.

Dr. R. S. Dattatrayam, Sc. 'F' attended the meetings of the Project Management Team (PMT) at INCOIS, Hyderabad on 4th December, 2012 and Project Steering Committee (PSC), Chaired by Secretary, MoES at Prithvi Bhawan on 5th December, 2012, in connection with the implementation of the project "Establishment of an integrated Seismic and GPS Network of stations operated by various national agencies".

14. LECTURE

Dr. M. Mohapatra, Sc. 'E' delivered a lecture on "Early warning on Cyclone" at NIDM on 10th January, 2012 to senior Govt. officials.

Shri G. K. Das, Met-I delivered a lecture on "A Climatological feature of temperature & heavy rainfall events over Kolkata and its impact on human being" at a seminar on "Geographical Appraisal of the city of Joy's environmental well being" organized by Sursana College in collaboration with Jadavpur University at Town Hall, Kolkata on 17th January, 2012.

Dr. Medha Khole, Sc. 'E' delivered a lecture on "Extreme Weather Phenomena" at NFAI Auditorium, Law College Road, Pune organized by Vishwa Scientific and National Film Archive of India in association with Vigyan Prasar, Govt. of India on 20-22 January, 2012.

Dr. Medha Khole, Sc. 'E' DDGM (WF), delivered a lecture on "Services rendered by IMD : An Overview" at a seminar hosted by C-DAC on Interdisciplinary application of Weather and Climate-Computational perspective on 25th January, 2012.

Dr. M. Mohapatra, Sc. 'E' delivered an invited talk on "Synthesis of information and products for nowcasting of severe weather events" in the 3 day National Training cum workshop on Challenges, Development and Opportunity for Nowcasting held at New Delhi during 27-29 January, 2012.

Dr. M. Mohapatra, Sc. 'E' delivered a lead talk on 'Nowcasting for management of severe weather events affecting India' in the National Seminar on Challenges, Development and Opportunity; Nowcasting organized by IMD at New Delhi during 30-31 January, 2012.

Dr. Jayanta Sarkar, Sc. 'E' delivered two lectures for the participants of training course on "Agro meteorology towards better advisories for serving end users requirement" held from 31st January to 20th February, 2012.

Dr. Jayanta Sarkar, Sc. 'E' delivered two lectures for the participants of training course on "Agro meteorology towards better advisories for serving end users requirement" held from 31st January to 20th February.

Dr. R. Suresh, Sc. 'E' delivered lectures in the 'Met Officers' course at School of Naval Oceanography (SNOM), Naval Base, Kochi on 2-3 February, 2012.

Dr. S. D. Attri, Sc. 'E' (EMRC), delivered a lecture on "Soil, Water and Nitrogen Dynamics simulated in cropping system models" on 6th February, 2012 in the training course on "Agro meteorology towards better advisories for serving end users requirement" organized by Agrimet, Division at Pune.

Dr. Y. E. A. Raj, DDGM delivered a key note address at the programme on "Disaster Management" convened by University of Madras on 6th February, 2012.

Shri S. B. Thampi, Sc. 'E', DWR Chennai delivered an invited-talk on the topic "Radar for Agriculture meteorology" in the training course on 'Agro meteorology' to the members of "Integrated Agromet Advisory Service Units", at Pune on 7th February, 2012.

Smt. Suman Goyal, Sc. 'E' delivered lecture on Utilization of Satellite Imagery and Products for operational weather forecasting applications in IMD Satellite Imagery Interpretation and Cyclone intensity analyses technique at school of Naval Oceanography & Meteorology during 8th February, 2012 at Kochi.

Dr. Medha Khole, Sc. 'E' delivered two lectures on the topics, "The monsoon and its forecasting" and "Variability of Indian Monsoons and Western Disturbances", on 8th February, 2012 during training course on, "Agrometeorology towards better advisories for serving end users requirements", organized by Agrimet division, Pune .

Dr. A. K. Srivastava, Sc. 'E' delivered a lecture on, "Climate change scenario with reference to IMD data" in the training course on, 'Agrometeorology towards better advisories for serving end users requirements' at Pune on 9th February, 2012.

Smt. Sarita Joshi, Senior Translator, delivered a PPT presentation on "Use of Computer Technology in Hindi" in the forenoon of 13th February, 2012 for staff members and afternoon for officers of MoES.

Shri Anand Kumar Sharma, Sc. 'E' and Head, Meteorological Centre, Dehra Dun invited and delivered lecture on UNFCCC, Kyoto Protocol, CDM and Carbon credits to post graduate students of Natural resource management, Forest Research Institute University, Dehra Dun on 15, 16 and 22 February, 2012.

Shri B. S. Bagde, AM-II participated in "Farmers Awareness Programme" at ZARS, Sindewahi, Chandrapur on 22nd February, 2012 and delivered a lecture on "Agrometeorology and its application to Farmers and society".

Shri Manmohan Singh, Director, MC Shimla, delivered lecture in Brain Storming Session on "Precession Farming Technologies for mitigating effect of climate change" at Solan on 24th February, 2012.

Shri A. K. Mitra, Sc.- 'C', has delivered lectures for Indian Air-Force officers on (i) NOAA polar orbiting satellite and HRPT data reception and processing, (ii) Products generated from AVHRR and Sounder data and (iii) Rainfall estimation using Microwave data during 27-28 February, 2012.

Dr. Medha Khole, Sc. 'E' delivered a lecture on the topics, "Science of Weather Forecasting" on 28th February, 2012 on the occasion of National Science Day at Armament Research and Development Establishment (ARDE), Pashan, Pune.

Dr. P. K. Nandankar, Sc. 'E', DDGM, RMC Nagpur participated in Agro Seminar "Assessment of Kharif 2011 and planning for Rabi 2011-12" held on 1-2 March, 2012 at Varanasi jointly organized by BHU, Varanasi and IMD.

Shri Surender Paul, Director delivered a lecture on over view of meteorological Services in Punjab and Haryana on 6th March, 2012 organized by Indian Institute of Science Education and Research (ISSER), Mohali on a workshop on atmosphere chemistry during 5-6 March, 2012.

Shri D. Pradhan, DDGM delivered a lecture on 9th March, 2012 at "NBSS & LUP (ICAR)," Salt Lake, Kolkata on "Application of Remote sensing devices in Weather forecasting".



Shri B. K. Piush receiving bouquet from Dr. (Mrs.) S. Kaur, Sc. 'F'

Shri B. K. Piush, delivered the lecture on Women Empowerment through spirituality by Brahma Kumaris Ishwariya Vishwa Vidyalaya was held on 15th March, 2012 at Conference Hall, Mausam Bhawan, Lodi Road, New Delhi. In addition to the lecture audience interaction and guided meditation was also organised.

Shri A. K. Mitra, Sc. 'C', has delivered a lecture on delivered on "State level Annual Review Meeting on Integrated Agromet Advisory Services" at MC Bhubaneswar, IMD on 14th March 2012. In the lecture, MODIS and INSAT derived NDVI products have been detailed.

Smt. V. K. Mini, Sc. 'C' gave a lecture on "Cyclone Risk Mitigation & Management" on 15th March, 2012 for a training programme for high level officials organized by the Institute of Land and Disaster Management, Thiruvananthapuram.

Dr. P. K. Nandankar, Sc. 'E', DDGM, RMC Nagpur delivered a lecture on the topic "Weather information through knowledge network" on 20th March, 2012 held at Vasant Rao Naik state Agro extension, Management and Training Institute.

Dr. S. C. Sahu, Director, M. C. Bhubaneswar delivered lecture in training course on "Drought Management" organised by Gopabandhu Academy of Administration, Bhubaneswar on 20-22 March, 2012.

Shri P. S. Biju, Sc. 'C' gave a lecture on "Meteorological Observations" in the National Seminar on recent trends in physics organized by Deptt. of Physics, University College, Thiruvananthapuram on 22nd March, 2012.

Dr. Medha Khole, Sc. 'E' delivered a radio talk on the occasion of WMO day, based on the theme for WMO day 2012, entitled, "Powering our future with Weather, Climate and Water". It was broadcast through All India Radio, Pune across the State of Maharashtra, at 7.30 pm on 23rd March, 2012.

Shri Manmohan Singh, Sc. 'D', attended the "Earth Day" function organized by the 'Organization of Social Environment & Rural Development' (SERD) Sponsored by MoES, and delivered a lecture on the topic "Every Day is 2 Earth Day" on 22nd April, 2012.

Dr. G. Krishnakumar, Sc. 'E' delivered lecture on the topic "Ingredients of Agromet

Database" on 3rd May, 2012 at the Agromet trainee's course conducted by O/o DDGM (Agrimet) Pune.

Dr. V. Vizaya Bhaskar, Sc.'E' delivered lecture on "Air Pollution Impacts on Plants" in Agromet Core Course on 4th May, 2012.

Dr. Medha Khole, Sc. 'E', delivered a lecture on the topic, "Early warning systems of IMD pertaining to Cyclones" at YASHADA, Pune on 8th May, 2012 at the Maharashtra State Government's one day workshop on Monsoon Preparation and Hydro Meteorological Hazards.

Mrs. Manorama Mohanty, Sc. 'C' delivered lecture on "Role of IMD in Forecasting & early warning to the delegates of Gujarat institute of Disaster Management, Ahmedabad on 10th & 24th May, 2012.

Shri N. T. Niyas, Sc. 'C' was on tour to Malappuram, Kerala to deliver a guest lecture on, 'Experiences of Antarctica : Climate Change, Weather and Climate Monitoring' during 21-23 May, 2012.

Shri B. Puttanna, Sc. 'E', - gave lecture on "Early Warning System in Disaster Management – Karnataka State Experience" to Group A & B level Officers of Government of Karnataka at Administrative Training Institute, Mysore on 22 May, 2012.

Shri Anand Kumar Sharma, Sc. 'E', Meteorological Centre, Dehradun delivered a talk on Understanding Weather and Climate on World Environment Day, *i.e.*, 5th June, 2012 at the Wild Institute of India.

Dr. Sachin Parar and **Dr. Sandhya** from Rajyoga Education and Research Foundation delivered the talk on Art of positive thinking and anger management which was organized by DDGM (UI), New Delhi at workshop hall on 6th June, 2012.

Dr. A. K. Shukla, Sc. 'F', Head (EREC) attended the meeting at Ministry of Urban Development under the chairmanship of Secretary on 11th June, 2012 and delivered a

brief presentation about the recent product generation of Seismic Hazard Microzonation Maps of NCT Delhi on 1:10,000 scales.

Shri A. K. Sharma, Sc. 'F', delivered a lecture at International Centre for Radio Sciences, Jodhpur on "Application of Satellite images/products in Agro Meteorology" on 24th June, 2012.

Dr. N. Chattopadhyay, Head, Agrimet Division, Pune attended and presented a paper in the workshop on "Micro level Action Plan at District Level for Climate Resilient Agriculture" held during 29-30 June, 2012 at Anand Agricultural University, Anand, Gujarat.

Shri B. Puttanna, Sc. 'E', gave a presentation on "Early Warning System in Disaster Management – Karnataka State Experience" to Group A & B level Officers of Government of Karnataka at Administrative Training Institute, Mysore on 3rd July, 2012.

Dr. P. Khare, Sc. 'D' delivered lecture regarding "Technical aspects of Meteorology in Hindi" on HINDI KARYASHALA in the O/o ADGM (R), Pune on 4th July, 2012.

Dr. Ashok Kumar Das, Sc. 'C' delivered a lecture on 'QPF and Rainfall Monitoring' on 6th July, 2012 at Central Training Institute, Pashan, Pune for Advance Met. Training course.

Dr. M. Mohapatra, Sc. 'E' delivered lecture on the Indo-US training workshop and colloquium on modeling and data assimilation for tropical cyclone prediction during 9-14 July, 2012 at IIT Bhubaneshwar.

Shri Anand Sharma, Sc. 'E', M.C, Dehra Dun delivered lectures on General Circulation, Radiation balance, Stability and instability of atmosphere etc. to M. Sc. students of Forest Research Institute University from 16 to 20 July, 2012.

Shri Manmohan Singh, Sc. 'D' M. C. Shimla, attended a Training Program for the

public relation officers of State on "Media Role in disaster Management" and delivered a lecture on the topic "Early warning for Hydro-Meteorological Disasters & Earthquakes" at Mashobra on 30th July, 2012.

Shri Manmohan Singh, Director M. C. Shimla, attended a Training Program for the Sub Divisional Magistrate from all district of the state on "Media Role in disaster Management" and delivered a lecture on the topic "Early warning for Hydro-Meteorological Disasters & Earthquakes" at Mashobra on 3rd August, 2012 and 8th August 2012.

Shri Surender Paul, Sc. 'D' delivered a lecture on application of weather in Mountain Meteorology as a part of Field training course in Glaciology organized by Geological Survey of India, in Manali on 8th August, 2012.

Dr. Medha Khole, Sc. 'E' and DDGM(WF), Pune delivered an invited lecture on the topic 'Science of Weather Forecasting' at the meeting of Rotary Club of Poona Midtown on 22nd August, 2012.

Shri S. C. Bhan, Sc. 'E' delivered lecture on "Modern Techniques in Agrometeorological Forecast" in the training programme on "CROP – Weather Dynamics" on 27th August, 2012 at CRIDA, Hyderabad.

Shri M. L. Sahu, Sc. 'E' delivered a lecture in a training of Chhattisgarh administrative academy at Secretariat, Raipur on 3rd September, 2012 on "Rainfall and monsoon weather forecast".

Dr. Jayanta Sarkar, Sc. 'E' attended State Level Consultation Meeting on "Towards Urban Climate Change Resilience" at Surat on 12th September, 2012 arranged by Surat Municipal Corporation & delivered a talk on "Climate Change Scenario over India."

Dr. R. Suresh, Sc. 'E' participated as Chief Guest in the 45th Engineers day celebrated by Institution of Engineers (India), Chennai chapter on 15th September, 2012 and delivered a thematic address on 'Appropriate climate

Responsive Technologies for inclusive Growth and sustainable Development.

Dr. Jayanta Sarkar, Sc. 'E' delivered lecture on "Understanding Climate, Atmosphere & Climate Change" on 26th September, 2012 in the training conducted by Gujarat Institute of Disaster Management (GIDM) at Gandhinagar.

Dr. L. R. Meena, DDGM (ISSD) and **Dr. M. Mohapatra**, Sc. 'E', CWD attended the 8th Foundation Day of National Disaster Management Authority (NDMA) at Vigyan Bhavan, New Delhi on 28th September, 2012. Dr. L. R. Meena participated in Panel Discussion on the subject "Cyclone Management".



Dr. J. Vivekanandan, delivering lecture at ARNAV hall MoES

Dr. J. Vivekanandan, Earth Observing Laboratory, National Centre for Atmospheric Research (NCAR), Boulder, CO, USA, delivered a lecture on, "Remote sensing of precipitation, Cloud, Aerosol and water vapour using radar, Lidar and Micro wave radio meter" on 1st October, 2012 at ARNAV Hall, MoES Building, Prithvi Bhavan, New Delhi.

Shri Virendra Singh, Sc. 'D' delivered a invited lecture on "Kalpana-Application Operational Meteorology in a workshop Meteorological Satellite KALPANA, "A decade of service to the nation", organized by SAC Ahmadabad on 9th October, 2012.

Shri B. Puttanna, Sc. 'E' delivered a lecture on Early Warning System in Disaster Management, to State Govt. officials at District Training Institute Banashankari, Bangalore on 6th November, 2012.

Sadguru Jaggi Vasudev, Isha Foundation, delivered a lecture on "Inner Engineering" on 6th November, 2012 IMD at "VRISHTI" Auditorium Mausam Bhavan, Lodi Road New Delhi.

Dr. Rajesh Prakash, Sc. 'E' delivered a lecture on "Introduction to Seismology and Earthquake" to the executive Trainees of NTPC on 14th November, 2012 at CBIP, New Delhi.

Dr. Andrew Turner, Department of Meteorology, University of Reading U.K. delivered a lecture on, "Climate Change: The south Asian monsoon and model mean states Biases" on 12th December, 2012 at ARNAV Hall, MoES Building, Prithvi Bhavan, New Delhi.



Dr. Andrew Turner during the lecture

Dr. Y. E. A. Raj, DDGM, RMC Chennai delivered an invited talk on "Precise observation and weather prediction and protection against adverse climatic changes" on 17th December, 2012 in a special programme on "Science for Shaping the future of India" organised by Indian Science Congress Chennai.

Shri A. K. Mitra, Sc. 'C' Satmet Division, has delivered the lecture on Atmospheric Sounding to the Forecaster Training Course Batch No. 176, MTI, Pune during 18-20 December, 2012 as a visiting faculty.

Dr. S. D. Attri, Scientist 'delivered inaugural address as a chief guest in a National Seminar

on “Population, Environment and Sustainable Development In India: Issues and Challenges” during 22-23 December, 2012 at Meerut College, Meerut, Uttar Pradesh.

Shri G. K. Sawaisarje, Scientist ‘C’ delivered lecture on Computer Programming and applications to Advance Met Training Course; Batch No. 173 at Meteorology Training Institute, Pashan.

15. RESEARCH PUBLICATIONS

For 2012, the journal 'MAUSAM' has an Impact Factor (IF) : 0.140 and 5-year Impact Factor : 0.254 by Thomson Reuters, U.S.A.

15.1. Mausam, Vol. 63, No.1

Kuldeep Srivastava, Sharan S. Y. Iau, H. Y. Yeung, T. L. Cheng, Rashmi Bhardwaj, A. M. Kannan, S. K. Roy Bhowmik and Hari Singh, "Use of SWIRLS nowcasting system for quantitative precipitation forecast using Indian DWR data".

S. Balachandran and B. Geetha, "Statistical prediction of seasonal cyclonic activity over North Indian Ocean".

Ajit Tyagi, D. R. Sikka, Suman Goyal and Mansi Bhowmick, "A satellite based study of pre-monsoon thunderstorms (Nor'westers) over eastern India and their organization into mesoscale convective complexes".

Vartika Singh and Pramendra Dev, "50 year rainfall data analysis and future trend in Saharanpur region".

M. S. Tomar, "An insight into the severe floods in India during 2005, 2006 & 2007".

O. P. Singh, "Satellite derived sea surface temperature variability in the Bay of Bengal".

J. K. S. Yadav, R. K. Giri and L. R. Meena, "IPWV estimation and data quality analysis from different GNSS antenna".

Rajendra Kumar Jenamani, "Development of intensity based fog climatological information system (daily and hourly) at IGI airport, New Delhi for use in fog forecasting and aviation".

L. M. Jyoti and Sanjib Sen, "On the transit of Venus 2012: Method of computation for prediction of contact timings".

M. Abdel- Wahab, Khaled S.M. Essa, M. Embaby and Sawsan E.M. Elsaid, "Some characteristic parameters of Gaussian plume model".

I. J. Verma, A. L. Koppa, R. Balasubramanian, V.N. Jadhav and R. S. Erande, "Monthly climatic water balance at selected locations in India".

P. N. Mahajan, R. M. Khaladkar, S. G. Narkhedkar, Sathy Nair, Amita Prabhu and M. Mahakur, "Investigation of features of May, 2001 tropical cyclone over the Arabian Sea through IRS-P4 and other satellite data".

Kushal Pal Singh Vatsa, Ranju Madan, Rupa Jaggi and K. C. Sai Krishnan, "Indigenous carbon humidity sensor for radiosondes".

बद्रीनारायण विश्णोई, आनन्द नागर, विनीत अग्रवाल एवं कालूराम शर्मा, "जैसलमेर के तापमान में परिवर्तन की प्रवृत्ति का अध्ययन".

R. S. Akre and G. S. Nagrale, "A study of drought situation in El-Nino years over central India homogeneous region".

E. Kulandaivelu and M. V. Guhan, "Record rainfall over Ketty valley, Nilgiri, Tamil Nadu".

I. J. Verma, H.P. Das, R. Balasubramanian and V. N. Jadhav, "Comparative study on water and heat unit requirement of finger millet (*Eleusine coracana* G.) in different agroclimatic".

15.2. Mausam, Vol. 63, No. 2

Charan Singh, Sunit Das, R. B. Verma, B. L. Verma and B. K. Bandyopadhyay, "Rainfall estimation of landfalling tropical cyclones over Indian coasts through satellite imagery".

Rajendra Kumar Jenamani, “Micro-climatic study and trend analysis of fog characteristics at IGI airport New Delhi using hourly data (1981-2005)”.

S. K. Midya, H. Sarkar, S. Sarkar, D. K. Maiti and M. Ghosh, “Sharp decrease of attenuation of 183.31 GHz water molecule absorption line associated with Nor’wester over Kolkata – may be one important experimental set-up to forecast Nor’wester”.

B. Puttanna and Geeta Agnihotri, “Floods in Karnataka during 2009 : A synoptic study”.

M. Rajavel, R. P. Samui and K. G. Kanade, “Assessment of water requirement of tobacco at Rajamundry (Andhra Pradesh)”.

A. Kashyapi and A. S. Bahot, “Phenophase wise study of parameters controlling water requirement of soyabean crop [Glycine max (L.) Merr.] at various agroclimatic zones”.

K. S. Hosalikar, K. N. Mohan, R.D. Vashishta and Ajit Tyagi, “An integrated automatic aviation meteorological instrument system at C.S.I. airport, Mumbai”.

H. P. Shukla, R. S. Dattatrayam and A. K. Bhatnagar, “Seismicity of region around dams in North West India”.

K. V. S. Namboodiri, P. K. Dileep and Koshy Mammen, “Wind steadiness up to 35 km and its variability before the southwest monsoon onset and the withdrawal”.

Piyush Joshi and A. Ganju, “Maximum and minimum temperature prediction over western Himalaya using artificial neural network”.

S. M. Metri, “Study of GPS Radiosonde observation system in Goa”.

Devendra Pradhan, U. K. De and U. V. Singh, “Development of nowcasting technique and evaluation of convective indices for thunderstorm prediction in Gangetic West Bengal (India) using Doppler Weather Radar and upper air data”.

Bimal Krishna Biswas and P B. Dukare, “A climatological study of thunderstorm activity over Aurangabad (Chikalhana) Airport with special relevance to aviation in flight planning”.

R. D. Ram, R. B. Verma, U. P. Singh and G. N. Raha, “Threshold values of various indices of thunder storms during pre monsoon over Mohanbari”.

P. K. Chakraborty and A. K. Sen, “A synoptic analogue model for quantitative precipitation forecast over Damodar valley area”.

M. S. Tomar, “Measurement and analysis of Radio refractive index over Patiala during monsoon season with respect to its diurnal and monthly characteristics”.

15.3. Mausam, Vol. 63, No. 3

A. K. Jaswal, S. R. Bhambak, M. K. Gujar, S. H. Mohite, “S. Anantharaman and S. Bhagyalakshmy Development of 1961-1990 monthly surface climatology of India and patterns of differences of some meteorological parameters with respect to the 1951-1980 climatology”.

Mehfooz Ali, Surinder Kaur, S. B. Tyagi and U. P. Singh, “Modeling of short duration extreme rainfall events over Lower Yamuna Catchment”.

Rajendra Kumar Jenamani, “Analysis of Ocean-Atmospheric features associated with extreme temperature variation over east coast of India – A special emphasis to Orissa heat waves of 1998 and 2005”.

P. Basak, “Convective development at Kolkata (22.53° N, 88.33° E), India during pre-monsoon season using linear discriminant analysis technique”.

D. R. Pattanaik, Ajit Tyagi and Arun Kumar, “Dynamical-Empirical forecast for the Indian monsoon rainfall using the NCEP Coupled Modeling System – Application for real time monsoon forecast”.

Mohan Singh and H.S. Bhatia, “Thermal indices in relation to crop phenology and fruit yield of apple”.

Ranjana Agrawal, Chandrahas and Kaustav Aditya, “Use of discriminant function analysis for forecasting crop yield”.

D. Pradhan and U. K. De, “Doppler Weather Radar analysis of short term cyclonic storm”.

G. K. Das, S. K. Midya, G. C. Debnath and S. N. Roy, “The relationship between geopotential height and movement & landfall of tropical cyclone in the Bay of Bengal region”.

एस. शेखर, अजय ए दृ कुमार और अश्वाघोष गन्जु, “स्थान विशेष के मौसम का पूर्वानुमानएम”

Soumendu Sengupta, B. K. Mandal and D. Pradhan, “Exceptional heavy rainfall over Ajoy, Mayurakshi and Kansabati catchments and QPF verification during flood season of September 2009”.

बद्रीनारायण विश्णोई, आनन्द नागर और कालूराम शर्मा, “जैसलमेर क्षेत्र में संवहनी मेघों की रेडार प्रतिध्वनियों का अध्ययन”

J. P. Gupta, Mannu Ram and Moti Lal, “Semi – quantitative precipitation forecast for river Sai catchment by synoptic analogue method”.

Ashok Kumar Das and L. A. Siddique, “A case study of heavy downpour over NE India”.

V. K. Mini and S. R. Prabhakaran Nayar, “An analysis of monthly and synoptic scale variation of radio refractive index during pre-monsoon and monsoon onset phase”.

15.4. Mausam, Vol. 63, No. 4

G. K. Sawaisarje and M. R. Ranalkar, “Cumulonimbus cloud with anvil over India : Synoptic cloud type observations 1970-2000”.

Mohan Singh and S. S. Bhardwaj, “Verification and usability of location specific medium range weather forecast for Kullu valley”.

Carmen Maftai and Alina Barbulescu, “Statistical analysis of precipitation time series in the Dobrudja region”.

Kamaljit Ray, B. N. Joshi, I. M. Vasoya, N. S. Darji and L. A. Gandhi, “QPF model for Sabarnati basin based on Synoptic analogue method”.

D. T. Meshram, S. D. Gorantiwar and A. S. Lohakare, “ARIMA model for forecasting of evaporation of Solapur station of Maharashtra, India”.

I. J. Verma, V. K. Soni, N. D. Sabale and A. L. Koppa, “Spatial variability of annual and monthly Potential Evapotranspiration (PET) over India”.

M. R. Ranalkar, R. P. Mishra, Anjit Anjan and S. Krishnaiah, “Network of Automatic Weather Stations : Pseudo random burst sequence type”.

P. S. Biju, Anjit Anjan, R. D. Vashistha and K. Santhosh, “An indigenous state-of-the-art Digital Automatic Recording System (DARS) for surface meteorological observatories”.

G. K. Das, S. N. Roy and S. K. Midya, “A climatological feature with forecasting aspect of heavy rainfall events over Kolkata”.

Suresh Ram and M. Mohapatra, “Some aspect of squall over Indira Gandhi International airport, New Delhi”.

K. K. Agrawal and P. K. Singh, “Characteristics of rainfall pattern for crop planning at Jabalpur region (Madhya Pradesh) of India”.

M. S. Tomar, “Rainfall pattern over Patiala during monsoon season”.

J. P. Gupta, Mannu Ram and Moti Lal, “Semi – quantitative precipitation forecast for middle Ganga sub-catchment by synoptic analogue method”.

15.5. Extra Departmental Research Publication

A. J. Litta, U. C. Mohanty, S. Kiran Prasad, M. Mohapatra, Ajit Tyagi and S. C. Sahu, “Simulation of Tornado over Orissa (India) on 31 March 2009 using WRF-NMM model” 2012. *Natural Hazards* 61, 1219-1242, DOI:10.1007/s11069-011-9979-1, IF 1.398.

A. K. Mitra, Sc-C, “An atmospheric instability derived with MODIS profile using real-time direct broadcast data over the Indian region” *Journal Natural Hazards*, Springer Publications.

A. K. Mitra, A. K. Sharma, V. K. Soni and P. K. Kundu, “Characteristics of recent dust storms over the Indian region using real time multi-satellite observations from the direct broadcast receiving system at IMD”, *Advances in Space Research* doi:10.1016/j.asr.2012.11.017.

Bhan, S. C., “Southwest monsoon in India and its Forecasting System in Yozana (July, 2012)”.

Dushmanta R. Pattanaik, Biswajit Mukhopadhyay, Arun Kumar, “Monthly Forecast of Indian Southwest Monsoon Rainfall Based on NCEP’s Coupled Forecast System Atmospheric and Climate Sciences”, 2012, 2, 479-491 doi:10.4236/acs.2012.24042.

Giri, R. K, Rani, Pooja, Prakash Satish and Singh Jagadish, 2012, “Satellite viewed duststorms – An Overview” *International Journal of Physics and Mathematica I Sciences* 2 (1), 1-12, 38-45.

Gupta, S., Mohanty, W. K., Prakash R. and Shukla, A. K. (2012), “Crustal Heterogeneity and Seismotectonics of the National Capital Region, Delhi, India” *Journal of Pure and Applied Geophysics* [(Impact Factor 1.787 as on (2011)].

Geeta Agnihotri and M Mohapatra, “Prediction of occurrence of daily summer monsoon precipitation over Karnataka,” *Meteorological Applications*, 19, 130-139 17, DOI 10.1002

J. Panda and R. K. Giri, “A comprehensive study of surface and upper air characteristics over two stations on the west coast of India during the occurrence of a cyclonic storm” *Natural hazards*, online published. DOI10.1007/s11069-012-0282-6 NAAS rating =7.5).

K. Osuri Krishna, U. C. Mohanty, A. Routray, “Customization of WRF-ARW model with physical parameterization schemes for met246”, IF 1.402

Kayal J. R., Arefiev S.S., Baruah Saurabh, Hazarika D., Gogoi N., Gautam J. L., Baruah Santanu, Dorbath C., Tatevossian R. (2012), “Large and great earthquakes in the Shillong plateau - Assam valley area of Northeast India Region:Pop-up and transverse tectonics,” *Tectonophysics*, 532-535, pp186-192.

Kumar Anupam, Roy Bhowmik S. K. and Das Ananda K, “Implementation of Polar WRF for short range prediction of weather over Maitri region in Antarctica”, *Journal of Earth system*.

Krishna K. Osuri, U. C. Mohanty, A. Routray and M. Mohapatra, “The impact of satellite-derived winddata assimilation on track, intensity and structure of tropical cyclones over the North Indian Ocean”, *International Journal of Remote Sensing*, 33, 1627-1652 DOI:10.1080/01431161.2011.596849, IF 1.117.

M. Mohapatra, G. S. Mandal, B. K. Bandyopadhyay, Ajit Tyagi and U. C. Mohanty, “Classification of cyclone hazard prone districts of India”, 2012,*Natural Hazards* ,63, 1601-1620,DOI 10.1007/s11069-011-9891-8, IF 1.398.

M. Mohapatra, B. K. Bandyopadhyay and Ajit Tyagi, “Best Track parameters of tropical cyclones over the North Indian Ocean: a review”, 2012, *Natural Hazards*, 63, 1285-1317, DOI10.1007/s11069-011-9935-0, IF1.398.

Makarand A. Kulkarni and M. Mohapatra, “The simulation of tropical cyclones over North Indian Ocean”, *Natural Hazards*, 63, 1337-1359, DOI 10.1007/s11069-011-9862-0, IF 1.398.

Mandal, H. S., Khan, P. K., Shukla, A. K. (2012), “Soil responses near Delhi Ridge and adjacent region in Greater Delhi during incidence of a local earthquake”. *Journal of Natural Hazards*, DOI 10.1007/s11069-012-0098-4. [(Impact Factor 1.529) No pp 41-53.

Manmohan Singh, et al., “Analysis of snowfall pattern over catchment of Satluj River, Himachal Pradesh” ‘Vayu Mandal’.

Prakash Satish, R. K. Giri and Adesh, 2012, “An Episode Of Convective Heavy Rainfall Over Tamilnadu And Kerala: Observational Study”, *International Journal of Physics and Mathematical Sciences* 2 (1), 1-12, 86-96.

Prakash Satish Giri, R. K. Giri and Adesh, 2012, “Disastrous squalls at Delhi”, *International Journal of Physics and Mathematical Sciences* 2 (1), 1-12, 131-147.

Prakash Satish, Giri, R. K. and Agarwal, Satish Chand, 2012, “ARPS Model Simulation Of Synoptic Scale Weather” *International Journal of Physics and Mathematical Sciences* 2 (1), 1-12.

R. Suresh, “Forecasting and nowcasting convective weather phenomena over southern peninsular India : Part I : Thunderstorm and Part II : Severe Local Storms”, *Indian Journal of Radio and Space*.

R. K. Giri, Prakash Satish, Ravindra Kumar and Panda Jagabandhu, 2012, “Significance Of Scatterometer Winds Data In Weak Vortices Diagnosis In Indian Seas”, *International Journal of Physics and Mathematical Sciences*, 2 (1), 1-12, 19-26.

Roy Bhowmik S. K. and Durai V. R., “Development of multi-model ensemble based district level medium range rainfall forecast system for Indian region”, *Journal of Earth system Science*, 121(2), 273-285.

S. C. Sahu, “Impact of AWS observations in WRF-3DVAR data assimilation system: a case study on abnormal warming condition in Odisha” *Natural Hazards* DOI 10.1007/s11069-012-0393.

Sen Roy Soma, Saha, S. B., Hashmi, F., Roy Bhowmik, S. K. and Kundu, P. K., “Evaluation of short-period rainfall estimates from Kalpana-1 satellite using MET software”, *Journal of Earth system Science*, 121.

Singh, S. K., J. F. Pacheco, M. Ordaz, R. S. Dattatrayam, G. Suresh and P. R. Baidya, (2012), “Estimating tsunami potential of earthquakes in the Sumatra – Andaman Region based on broadband seismograms in India”, *Natural Hazards*, Vol. 52.

Sonam Lotus, “Forecast of Rice(*Oryza Sativa* L.) yield based on the climatic parameter in Srinagar, J&K”, *Journal of Agrometeorology, India*.

Srivastava Kuldeep, Gao Jidong, Brewster K Roy Bhowmik S. K. Xue Ming and Gadi Ranu, “Assimilation of Indian radar data with ADAS and 3DVAR techniques for simulation of a small scale tropical cyclone using ARPS mode”, *Natural Hazards*, 58, 15-29.

Surender Paul, “Cotton yield prediction using weather based statistical model” *Journal of Agro meteorology Association of Agro meteorologist Gujarat*

Virendra Singh, “Relationship between sea surface temperature and surface temperature over Arabian Sea, Bengal and Indian Ocean”, *I.Ind Geophye Union* (April 2012).

Virendra Singh, “Unusual severe weather events over western Himalyan region during 2012”, *Geomatics National Hazards and Risk*.

15.6. Papers Published during Proceeding/Seminar

Dr. R. S. Dattatrayam, G. Suresh, P. R. Baidya, Rajesh Prakash, J. L. Gautam, H. P. Shukla and Dal Singh. A., “Standards and Methodologies on seismic data generation, processing and archival and guidelines for data sharing and supply”, Proceedings of the Indian National Science Academy (INSA), New Delhi

Dr. N. Puviarasan, Met-I submitted a paper, “South-West monsoon Onset, Advance and Withdrawal over Indian Subcontinent – A study from PW measurements from ground based GPS System.” On 11th Biennial conference of Pan Ocean Remote Sensing Conference (PORSEC-2012) from 5th - 9th November 2012 organized by INCOIS at Kochi, Kerala.

Medha Khole and Sunitha Devi, S., “Spatial variation of trends in the frequency and intensity of tropical cyclones over the north Indian Ocean” at WMO conference on Indian Ocean Tropical Cyclones and Climate Change (IOTCCC) -2012.

Medha Khole and Sunitha Devi. S., “Cyclones making land fall over Indian coastline and associated damage- The Indian scenario” at WMO conference on Indian Ocean Tropical Cyclones and Climate Change (IOTCCC) -2012.

P. Chandrashekar Rao and A. S. Shinde, “MJO and Cyclogenesis in the Tropical South Indian ocean” at WMO conference on Indian Ocean Tropical Cyclones and Climate Change (IOTCCC) -2012.

Dr. P. C. S. Rao, Director, S. B. Gaonkar, Director, K. R. Lokhande, A.M. I and V. B. Kadam, S. A., “A climatological study of storms of South Indian Ocean in the bygone century by at WMO conference on Indian Ocean Tropical Cyclones and Climate Change (IOTCCC) -2012.

15.7. Miscellaneous Publications

Dr. L. S. Rathore, N. Chattopadhyay and K. K. Singh, “Dissemination of Agromet Advisory Services on Mobile Phone through Public Private Partnership Programme” and “Reaching Farming community in India through Farmer Awareness Programmes” and “Climate Exchange”, A joint publication of Tudor Rose, U. K and World Meteorological Organisation, Geneva.

“Climatological Table 1971-2000

Climate Diagnostics Bulletins of India Monthly, Seasonal, and annual summary

Disastrous Weather Events year 2009, 2010

Met. Monograph, “**Monsoon 2011- A Report**” Synoptic Meteorology No.2/2012 by Ajit Tyagi and D. S. Pai.

Met Monograph “Drought Scenario Over India – Analyses based on Standardized Precipitation Index”, “Climatology No. – 24/2012 by Jayanta Sarkar, Ajit Tyagi and B. Mukhopadhyay .

‘**Atlas of Wind Roses**’ of departmental observatories based upon 1971-2000 surface observations for 0300 UTC.

NCC Research Report No. 1/2012 entitled “Trends and variability of monthly, seasonal and annual rainfall for the districts of Maharashtra and spatial analysis of Seasonality Index in identifying the changes in rainfall regime” by P. Guhathakurta and Elizabeth Saji.

Rainfall data products in CD ROM’s for “100 Years (1901-2000), Monthly Rainfall Data Series for Districts, States, Met. Sub-Divisional and all India”

“**Rainfall Atlas of India -2012**” based on the Normal for the period 1952-2000 in CD ROM’s.

Monthly Normals of Radiosonde and Radiowind for Indian Stations (1971- 2000) - 1730 IST, for 35 Indian stations for 0000 UTC (1730 IST).

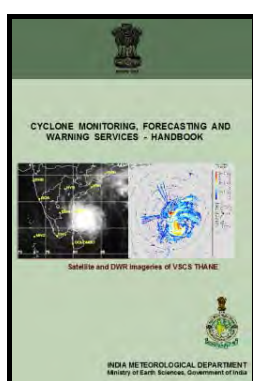
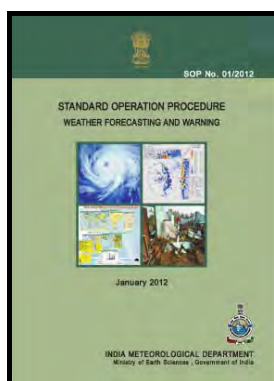
Weekly Drought Outlook maps, Weekly and Biweekly Aridity Anomaly maps and reports for Southwest monsoon season and Northeast monsoon season for 2012.

Monthly and Cumulative maps for the Standardized Precipitation Index(SPI) for southwest monsoon season

Meteorological services for aviation in India, 4th edition 2012

Climate of Jharkhand, Climate of Bihar and Climate of Dehra Dun,

Standard Operation Procedure (SOP) manuals.



In order to maintain uniform methodology in monitoring and forecasting disastrous weather events IMD has prepared Standard Operation Procedure (SOP) manuals which will be very helpful for operational forecasters and researchers in Meteorology. IMD has prepared SOP on Weather Forecasting & Warning Services, SOP on cyclone and Handbook on Cyclone Monitoring & Services during the year 2012.

(i) SOP on Weather Forecasting & Warning Services.

(ii) SOP on Cyclone Warning in India includes various aspects of cyclone monitoring, prediction and warning services.

(iii) Handbook on Cyclone Monitoring, Forecasting and Services includes all the steps required for cyclone monitoring, forecasting and dissemination services and will serve as a ready reference for cyclone forecasters during cyclone period.

16. IMPLEMENTATION OF POLICY OF THE OFFICIAL LANGUAGE

Hindi Section of India Meteorological Department is mainly engaged in the translation work along with the implementation of policy of the official language to promote the progressive use of Hindi. A Quarterly official Language Implementation Committee meetings were organized under the Chairmanship of Director General of Meteorology were organized on during the year.

16.1. Reports

Quarterly Progress Reports of quarter ending, i.e., 31 December 2011, 31 March 2012, 30 June 2012 and 30 September 2012 regarding the progressive use of official Language Hindi of Headquarter were sent to Department of Official Language and Ministry of Earth Sciences.

Half Yearly Reports as on 31st March 2012 and 30th September 2012 regarding Hindi Teaching Scheme of Headquarter were sent to the Office of Hindi Teaching Scheme.

Annual Assessment Report (10th April 2012 to 31st March 2012) regarding the use of official Language Hindi was sent to Regional Implementation Office (North Region), Department of Official Language, Ministry of Home Affairs.

16.2. Publications

Mausam Manjusha

The 17th Edition of the departmental house magazine "Mausam Manjusha" was published during the year and copies of the edition of Mausam Manjusha were sent to the writers, members of official language implementation committee, Ministry, Department of official

language and retired officers of different ministries / Departments, Heads of all sub-offices of Delhi and outside of Delhi.

Nibandh Sagar

A collection of first three awarded essays of IMD all India Departmental Hindi Essay writing competition organized during 2004 to 2010 were compiled in NIBANDH SAGAR 2012 and published during the years. Copies of Nibandh Sagar 2012 were sent to the members of 8 officials language implementation committee.

The presentation made in the fourth All India Departmental Hindi Sanghosthi on the subject "Mausam Sewaon Ki Upyogita" were printed and released on 137th Foundation day of IMD.

16.3. Departmental schemes

Official language rolling trophy for the year 2011-2012 was awarded to the Deputy Director General of Meteorology, Regional Meteorologica Centre, New Delhi for writing maximum letter in Hindi. Dr. Laxman Singh Rathore, DGM presented the O. L. Rolling trophy to Dr. O. P. Singh, Scientist F, of RMC New Delhi on the occasion Hindi Diwas Samaroh dated 21st September.

All India Departmental Hindi Essay competition was organized.

Aaj Ka Hindi Shabd are being displayed on display board of the department at main gate and the display board of the Satellite Meteorological building. Templates of these words are being prepared by the Hindi section.

A Cash award of Rs.4500/- was awarded to the 9 officials of H.Q. and sub offices under the above scheme.

Hindi Pakhwara and Hindi Divas were celebrated at India Meteorological Department and its sub offices. Normally Hindi Pakhwara is organized from 1-15 September, 2012 every year. During this Pakhwara, the main events were essays, notes and draft writing, typing, self composed poems, debate competitions etc. Hindi Divas was celebrated on 21st. September, 2012.

Unicode was activated in the 235 computers of different sections of H.Q.

The second sub-committee of parliament on official language inspected IMD Observatory, Okha, Gujarat on 26 September. The follow up action on the assurances given to the parliament committee during the inspection of meteorological observatory, Okha was carried out and was sent to the committee of parliament on official language through Ministry of earth sciences.

16.4. हिंदी पखवाड़ा एवं हिंदी दिवस का आयोजन

मौसम विज्ञान विभाग के मुख्यालय एवं सभी उप कार्यालयों में हिन्दी दिवस एवं हिन्दी पखवाड़ा का आयोजन पूरे हर्षोल्लास से मनाया गया। मुख्यतः हिन्दी पखवाड़ा का आयोजन दिनांक 1-15 सितम्बर 2012 तक किया गया। इस दौरान विभिन्न प्रतिगताएँ जैसे हिंदी निबंध, टिप्पण एवं मसौदा लेखन, टंकणयो, स्वरचित काव्य पाठ, वाद-विवाद प्रतियोगिता, राष्ट्रीय एकता और राजभाषा हिन्दी विषय पर स्लोगन और मोबाईल का दैनिक जीवन में उपयोग विषय पर कार्टून आदि मुख्य आकर्षण रहे।



डॉ. एल. एस. राठौर, महानिदेशक डॉ. ओ. पी. सिंह को राजभाषा चलशील्ड प्रदान करते हुए

मुख्यालय में हिन्दी दिवस समारोह दिनांक 21 सितम्बर 2012 को मनाया गया, जिसकी अध्यक्षता मौसम विज्ञान के महानिदेशक डॉ. लक्ष्मण सिंह राठौर ने की। जहाँ महानिदेशक महोदय ने हिन्दी में अधिकाधिक कार्य करने की प्रेरणा दी वहीं डॉ. एल. आर. मीना, अध्यक्ष, हिन्दी पखवाड़ा/दिवस आयोजन समिति ने इतिहास के पन्नों से हिन्दी में किए गए कुछ अहिन्दी भाषी विद्वानों द्वारा राजभाषा के उत्थान के लिए किए गए कार्यों का उदाहरण प्रस्तुत किया।

इस समारोह में हिंदी पखवाड़ा के दौरान आयोजित विभिन्न हिंदी प्रतियोगिताओं के विजेताओं को नकद पुरस्कार और प्रमाण पत्र प्रदान किए गए। हिंदी में सर्वाधिक पत्र भेजने के लिए राजभाषा चलशील्ड वर्ष 2011-2012, डॉ. ओ. पी. सिंह, उपमहानिदेशक, प्रादेशिक मौसम केंद्र, नई दिल्ली को प्रदान की गई। इस अवसर पर हिंदी गृह पत्रिका "मौसम मंजूषा" के 17वें अंक तथा "निबंध सागर" का भी विमोचन किया गया। इस दौरान कार्यालय के कर्मियों द्वारा विभिन्न प्रकार के सांस्कृतिक कार्यक्रम एवं हास्य नाटिका की प्रस्तुति के साथ मुंशी प्रेमचन्द की कहानी "पंच परमेश्वर" के नाट्य रूपांतरण का सफल मंचन किया गया।



सांस्कृतिक कार्यक्रम

अखिल भारतीय विभागीय हिंदी निबंध प्रतियोगिता 2012 का आयोजन किया गया जिसमें श्री एम. आर. कालवे, (मुख्यालय), नई दिल्ली ने प्रथम, श्री संजय ओनील, प्रा. मौ. केन्द्र, गुवाहाटी ने द्वितीय, श्री रामहरि शर्मा, मौ.वि.म.नि. (उ.वा.उ.), नई दिल्ली ने तृतीय, श्री ललित कुमार शर्मा, (मुख्यालय), नई दिल्ली, श्री जयकुमार शर्मा, निदेशक, मौसम केंद्र,

अगरतला व श्री मौ. इमरान अंसारी, मौ. वि.-I, मौ. वि.म.नि.(उ.वा.उ.), नई दिल्ली ने प्रोत्साहन पुरस्कार प्राप्त किए । अखिल भारतीय विभागीय हिंदी निबंध

प्रतियोगिता 2012 के दिल्ली स्थित कार्यालयों के विजेताओं को महानिदेशक महोदय द्वारा प्रमाण-पत्र प्रदान किए गए ।

17. REVENUES AND EXPENDITURES

The budget of a department is a summary or plan of the intended revenues and expenditures. It is a quantitative expression of a plan for a defined period of time. It may include planned sales volumes and revenues, resource quantities, costs and expenses, assets, liabilities and cash flows.

17.1. Budget Estimate (Non-Plan)

For the FY 2012-13 (Rs./In Thousands)

Budget Grant (2012-13) B.E. (Revenue)

Rs. 2751000, B.E. Capital Rs. 3400

Expenditure (2011-12) Revenue

Rs. 2500292 Capital Rs. 568

17.2. Budget Estimate (Plan)

For the FY 2012-13 (Rs./In Thousands)

Budget Grant (2012-13)

Expenditure (2011-12)

B.E. (Revenue) Rs. 71000

Rs. 519342

B.E. (Capital) Rs. 135000 Rs. 929413

Budget Schemes & their implementation under XII Five Year (2007-2012) Plan

Schemes Details of the various Plan Schemes have been initiated under XII FYP. The details are as follows:

Atmospheric Observations Systems Network (Rs.700 Crores) & Satellite meteorology (Rs. 70 Crore)

Installation of Doppler Weather Radar (DWR) completed at Mohanbari and ready for inauguration.

ISRO commenced the installation process of DWR at Chirapunjee.

Site Acceptance Test (SAT) of indigenous DWR conducted at Mumbai, suggested modifications being carried out by M/s BEL for final SAT.

5 Nos. of GPS based Upper Air Systems commissioned at Kolkata, Bhopal, Nagpur, Ahmadabad and Bhubaneswar.

Automatic Message Switching Systems (AMSS) commissioned at Nagpur and Guwahati.

Mirror RTH (AMSS) installation at Pune in progress, likely to be commissioned by end of May 2013.

Web Based Pilot Briefing system (On Line Briefing System) implemented at Chennai and Delhi airports.

Current weather display systems (METAR Display Systems) installed at Nagpur, Raipur, Bhopal, Guwahati, Agartala and Mohanbari Airports.

National Knowledge Network (NKN) 1 Gbps connectivity extended for data exchange With NCMRWF, SAC Ahmedabad and RMC Kolkata through CUG.

In compliance to ICAO requirements, Secured SADIS FTP service implemented for using aviation data and products.

Commissioning of 550 Automatic Weather Stations (AWS) completed.

Network of Automatic Rain Gauges (ARGs) increased to 1026 numbers. Installation of AWS

en-route to Amarnath Yatra at 3 locations completed.

Oceansat-II satellite scatterometer data of Ocean winds disseminated to the International community through WMO GTS.

A model site of cyclone warning messages dissemination installed at Regional Meteorological Centre, Chennai.

Nilam and Murjan Cyclones tracked successfully.

Gramin Krishi Mausam Sewa (Agrometeorology) (Rs. 165 Crores)

Agromet Advisory Service Bulletins issued in 12 languages.

Disseminated Agromet Advisory to 3.4 million farmers through PPP mode (Reuter Market Light, Handygo, IFFCO Kisan Sanchar Limited (IKSL), Nokia and State Govt. of Maharashtra

The agromet advisory services provided by IMD through various channels have resulted in significant increase in farm productivity, resulting in increased availability of food and higher income generation.

At present only 10 to 15 percent of the farmers are benefitting from the SMS services and about 24% farmers are aware about Agromet services.

The economic benefit of these services which has been estimated by NCAER at Rs.50,000 Crores per year is extrapolated to rise to Rs.211,000 crores if the entire farming community in the country were to apply Agromet information to their agricultural activity.

Aviation Services (Rs. 115 Crores)

Airport Meteorological Instruments (AMIs) will be upgraded at runway locations for the major airports by commissioning of Airport Weather Observing Systems, Transmissometers, Aviation Weather Decision

Support Systems & implementation of Aircraft Meteorological Data Relay (AMDAR).

New airports are likely to be commissioned/operationalised in future, additional Aerodrome Meteorological Offices shall be opened at these airports and support for helicopters operations in mountainous region will also be taken up.

Metropolitan Air Quality and Weather Service : Rs 90 crores (Atmos. Processes and Modeling Services)

Scheme will be taken up jointly with IITM to provide near real time and 1-2 day advance forecast for weather and air quality information for several Metropolitan cities and to forecast weather in now-cast and short range scales over different sections of the Metropolitan cities including severe weather warnings.

To provide detailed customized meteorological products on-demand basis and to study the impact of air pollution on Health and Agriculture.

To develop a System of Air Quality Forecasting and Research (SAFAR) in major metropolitan cities of India under the studies of Atmospheric Chemistry and Climate.

Metropolitan air quality and weather service providing real-time weather as well as nowcasting of weather and air quality in all metro cities as well be initiated.

Seismological Research

Observational Network and Data Centre.

Sustenance of existing observational systems and data centre facilities.

Upgradation and setting of a total 38 stations.

Integration of seismological observatories operated by other agencies.

Setting up of "Decision Support and Information Dissemination (DSID) system" and seismic Hazard Microzonation of 30 targeted cities of the country.

17.3. Revenue Generated by sale of Meteorological Data

RCs/MCs	Total revenue received by sale of meteorological data during the month (Amount in Rupees)												
	April 2012	May	June	July	August	Sep	Oct	Nov	Dec	Jan 2013	Feb	Mar	Total
DGM													
New Delhi													
DGM Satmet	Nil	Nil	44989	45484	Nil	Nil	50484	Nil	Nil	39600	Nil	Nil	180557
DGM NHAC	Nil	190900	Nil	227937	Nil	Nil	Nil	Nil	Nil	Nil	Nil	626892	1045729
DGM EREC	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil		
DGM (Pub.)	27910	21500	38610	29895	2450	25255	19500	9150	7910	38309	38600	66570	325659
RMC New Delhi													
Delhi	98541	21256	49398	48059	60137	12326	113663	31502	20301				455183
Jaipur	148078	28822	31214	33483	22251	25530	204029	67206	17171	14857		13394	606035
Lucknow		6910	15487	10444	25731	1910	63628	13020		21020	6910	9382	174442
Srinagar	24685	11750	15000	10800	15900	9600	21300	3900		22100	8700		143735
Chandigarh	9791	76329	14040	27620	5535	732	13420	Nil	8924	92652	17527		266570
Shimla	1792	8558	3459	59018	1966	9650	1021	Nil	3519	9338	5504		103825
Dehredun	7734	1572	17246	4594	5964	36314	4363	6619	21720	4008	5217	27213	142564
RMC Mumbai													
Mumbai	53204	56639	45679	22024	44363	211198	56207	24061	45327		126726		685428
Ahemdabad	55727	5021	52386	54032	39084	10344	18608	23444	11382	12145	169227	16242	467642
RMC Nagpur													
Nagpur	18113	75411	65920	151920	34581	84404	86177	118851	4346	99374	32474	19326	790897
Bhopal	Nil	Nil	21654	4496	2871	1192	872	999	5706	4974	837	1429	45030
Raipur	*No climatological unit hence Met. Data supplied by RMC, Nagpur												
RMC Kolkata													
Kolkata	77946	67791	69466	47076	16035	15224	28785	31404	16380	79977	121032	14734	585850
Patna	86270	89525	25284	8766	15704	4041	14337	3934	Nil	79276	161920	16635	505692
Bhubneshwar	47138	148553	88046	304230	39681	74495	26437	14807	117878	260174	446172	400880	1968491
Agartala					3960	1121			11211		4062	2323	22677
Ranchi	No revenue as no data supply is made by their office.												
Gangtok	14947	1291	85511	1185	3971	3494	1074	7416				Nil	118889
RMC Guwahati													
Guwahati	14292	180980	115390	82433	111249	188363	128954	24240	24305	63264	31718	55926	1021114
Itanagar	No revenue as no technical section.												
RMC Chennai													
Chennai	41428	89016	203706	111822	71051	144761	153399	49657	72698	87251	100855	178476	1304120
Thiruvananthapuram	24684	49208	86731	64125	56279	15251	25365	17255	97732	69722	56908	109111	672371
Hyderabad	70059	63944	21749	49605	114160	47924	197124	21004	66579	17284	125699	32969	828100
Bangalore	53955	61420	108686	37119	45200	43010	21705	60500	20127	64295	22235	13370	551622
ACWC Chennai	7280	Nil	23512	9574	9049	3075	13846	3956	13846	3956	Nil	1978	90072
CWC Visakhapatnam	3000	25302	16250	7995	7089	5873	22448	7461	23941	15165	10197	5055	149776
O/o ADGM (R)	659358	758843	568715	660342	384800	857782	1298590	1371022	371892	156259	301341	275625	7664569
	US\$1499												US\$114
O/o DDGM (SI)	No sale of data hence no revenue.												
O/o DDGM (Agr)													
O/o DDGM (WF)	Nil	21689	3941	Nil	2250	2038	Nil	Nil	103403	23252			156573
Grand Total													21073212

18. ANNUAL STATEMENT OF RESERVATION OF SCs, STs and OBCs IN THE DEPARTMENT

A. Number of appointment made during the calendar year 2012 as on 1st January 2013

REPORT – I

Representation of SCs / STs / OBCs as on (01.01.2013)					Number of appointment made durint the calendar year 2012									
Groups	Total No. of Employees	SCs	STs	OBCs	By Direct Recruitment				By Promotion			By Deputation		
					Total	SCs	STs	OBCs	Total	SCs	STs	Total	SCs	STs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Group A	217	29	13	25	-	-	-	-	24	*	*	2	-	-
Group B	809	157	58	-	-	-	-	-	24	2	3	-	-	-
Group B (Non- Gaz.)	1934	286	107	254	-	-	-	-	61	11	10	-	-	-
Group C	1955	627	188	179	4	2	-	1	74	18	5	-	-	-
TOTAL	4915	1099	366	458	4	2	-	1	183	31	18	2	-	-

B. Number of appointment during the calendar year 2012 in group 'A' service as on 1st January 2013

REPORT – II

Representation of SCs / STs / OBCs as on (01.01.2013)					Number of appointment made durint the calendar year 2012									
Pay Scale (in rupees)	No. of Employees	SCs	STs	OBCs	By Direct Recruitment				By Promotion			By Deputation		
					Total	SCs	STs	OBCs	Total	SCs	STs	Total	SCs	STs
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PB-3 + GP 5400	-	-	-	-	-	-	-	-	1	*	*	-	-	-
PB-3 + GP 6600	46	7	3	18	-	-	-	-	1	*	*	2	-	-
PB-3 + GP 7600	68	11	6	6	-	-	-	-	5	*	*	-	-	-
PB-4 + GP 8700	79	10	2	1	-	-	-	-	14	*	*	2	-	-
PB-4 + GP 8900	19	1	1	-	-	-	-	-	4	*	*	-	-	-
PB-4 + GP 10000	--	-	-	-	-	-	-	-	-	*	*	-	-	-
75500-80000	1	-	-	-	-	-	-	-	-	*	*	-	-	-
Total	213	29	12	25					25	*	*	4	-	-

19. IMPORTANT TELEPHONE LINKS

NAME	DESIGNATION/OFFICE	EPABX New OFFICE TELEPHONE NO. /	
		Delhi	FAX
Dr. L. S. Rathore	DGM	4201	011-24611842
Shri Jagmohan Sharma	PS to DGM, New Delhi	4225	011-24611842
Shri J. P. Sharma	Senior PS to DGM	4253	011-24611842
Shri D. K. Nim	Finance Officer, IMD	4502	011-24623210
Shri Rajiv Sharma	DDGM (A&S), New Delhi	4210	011-24621472
Smt. Mamta Negi	PA to DDGM(A&S), New Delhi	4302	011-24621472
Shri L. R. Meena	Scientist 'F' (ISSD), New Delhi	4314	011-24616051
Shri A. K. Sharma	Scientist 'F' (Sat. Met.), New Delhi	4415	011-24626021
Dr. R. S. Dattatrayan	Scientist 'F' (Seismo), New Delhi	4405	011-24611305
Dr. S. K. Roy Bhowmik	Scientist 'F' (NWP), New Delhi	4482	011-24615815
Dr. (Smt.) S. Kaur	Scientist 'F' (Hydro.), New Delhi	4223	011-24619167
Dr. S. K. Peshin	Scientist 'F', (EMRC), New Delhi	4235	011-24635797
Shri S. K. Kundu	Scientist 'F', (UI), New Delhi	4245	011-24611451
Shri Surya Bali Jaiswar	DDGM, New Delhi	4227	011-24624486
Shri B. K. Bandyopadhyay	Scientist 'F', (S), New Delhi	4334	011-24635664
Shri S. Krishnaiah	Scientist 'F', LACD ADGM (R), Pune		020-25535411
Dr. (Ms.) Medha Khole	DDGM (WF), Pune		020-25532875
Dr. N. Chattopadhyay	Scientist 'E', (Agrimet.), Pune		020-25513102
Dr. Somenath Dutta	Scientist 'E', DDGM (Training), Pune		020-25665530
Shri B. Mukhopadhyay	DDGM (Climatology), NDC, Pune		020 - 25535797
Dr. K. K. Singh	Scientist 'E', (Head Agrimet.)	4240	011-24619844
Dr. O. P. Singh	DDGM, RMC, New Delhi	4213	011-24690279
Shri N. Y. Apte	DDGM, RMC, Mumbai		022-22150517
Dr. Y.E.A. Raj	DDGM, RMC, Chennai		044-28276752
Shri Devendra Pradhan	DDGM, RMC, Kolkata		033-24793782
Dr. P. K. Nandankar	DDGM, RMC, Nagpur	4460	0712-2284266
Shri Awadhesh Kumar	DDGM, RMC, Guwahati		0361-2840206

NAME	DESIGNATION/OFFICE	EPABX New Delhi	OFFICE TELEPHONE NO. / FAX
Shri M.K. Bhatnagar	Scientist 'F', (CAMD), New Delhi	4301	011-24615371
Shri Satish Bhatia	Scientist 'F', (DGM Sectt.), New Delhi	4513	011-24611710
Dr. A.K. Shukla	Scientist 'F', (EREC), New Delhi	4576	011-24616309
Dr. Mrs. Suman Goyal	Scientist 'E', (Sat. Met.), New Delhi	4408	011-24626019
Dr. S. D. Attri	DDGM (Organisation), New Delhi	4309	011-24640701
Shri B. P. Yadav	Scientist 'E', (NWFC), New Delhi	4398	011-24629798
Dr. M. Mohpatara	Scientist 'E', (CWD), New Delhi	4385	011-24652484
Shri D. P. Mishra	Scientist 'E', (Radar Lab.), New Delhi	4224	011-24632234
Dr. G. Krishna Kumar	Scientist 'E', (NDC), Pune		020-25530992
Dr. J. Rajendra Kumar	Scientist 'E', (AMO), Palam, New Delhi		011-25654335
Shri S. C. Bhan	Scientist 'E', (DGM Sectt.), New Delhi	4513	011-24611710
Shri Suresh Chand	Scientist 'E', (CPU), New Delhi	4236	011-24698247
Shri Y. P. Singh	Scientist 'E', (Finance), New Delhi	4487	011-24697640
Shri Shiv Ganesh	Scientist 'E' (IT), New Delhi	4549	
Shri Vivek Sinha	Director (Establishment), New Delhi	4442	011-24625547
Shri A. K. Bansal	Director (Vigilance), New Delhi	4254	011-24652318
Shri R. P. Lal	Director (Planning), New Delhi	4260	011-24625917
Shri U. P. Singh	Director (Publication), New Delhi	4262	011-24651287
Dr. A. P. Pandey	Met. (Admn.), New Delhi	4204	011-24602480
Caretaker, Mausam Bhawan	-	4372	
Guest House (H.Q.)	-	4472	

New Exchange – Airtel Telephone

Dialing from Delhi : 4382XXXX

Dialing from outside Delhi : 011 4382XXXX

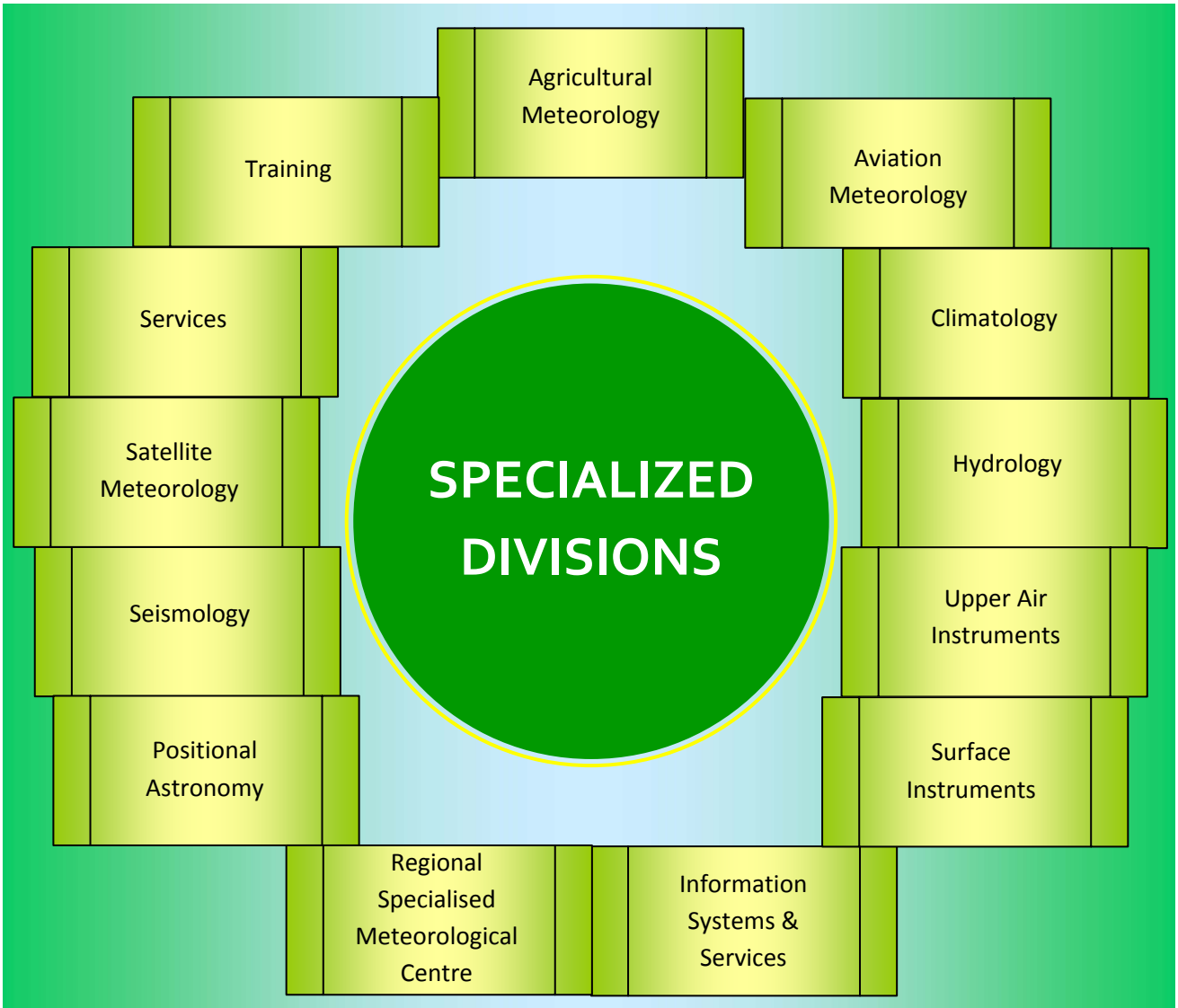
Where XXXX stands for 4 digit EPABX number

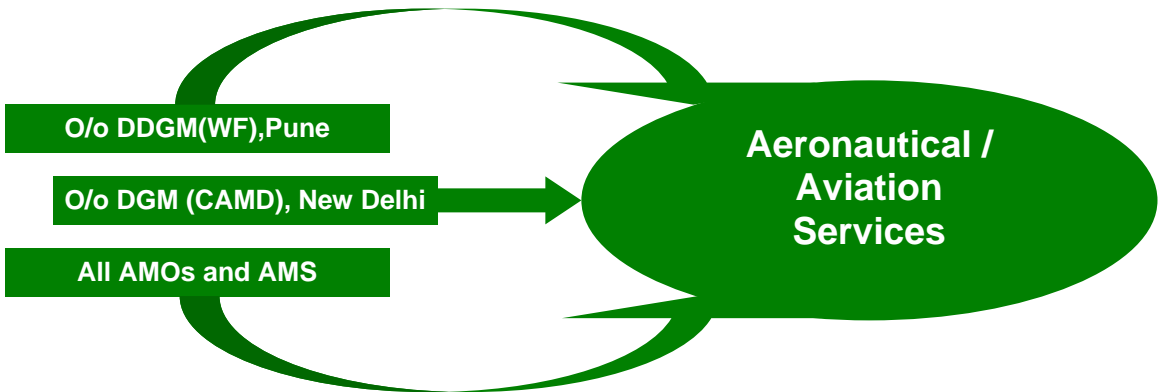
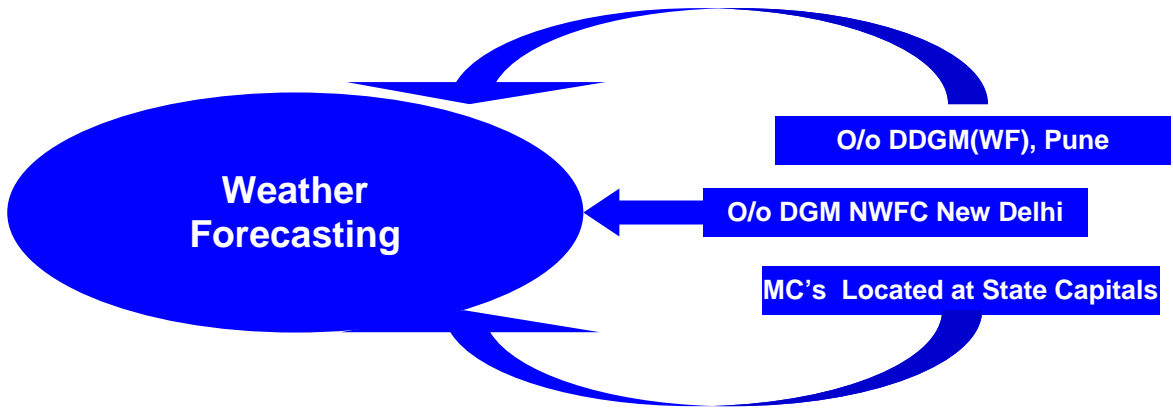
Telefax : 91-11-24699216, 91-11-24623220

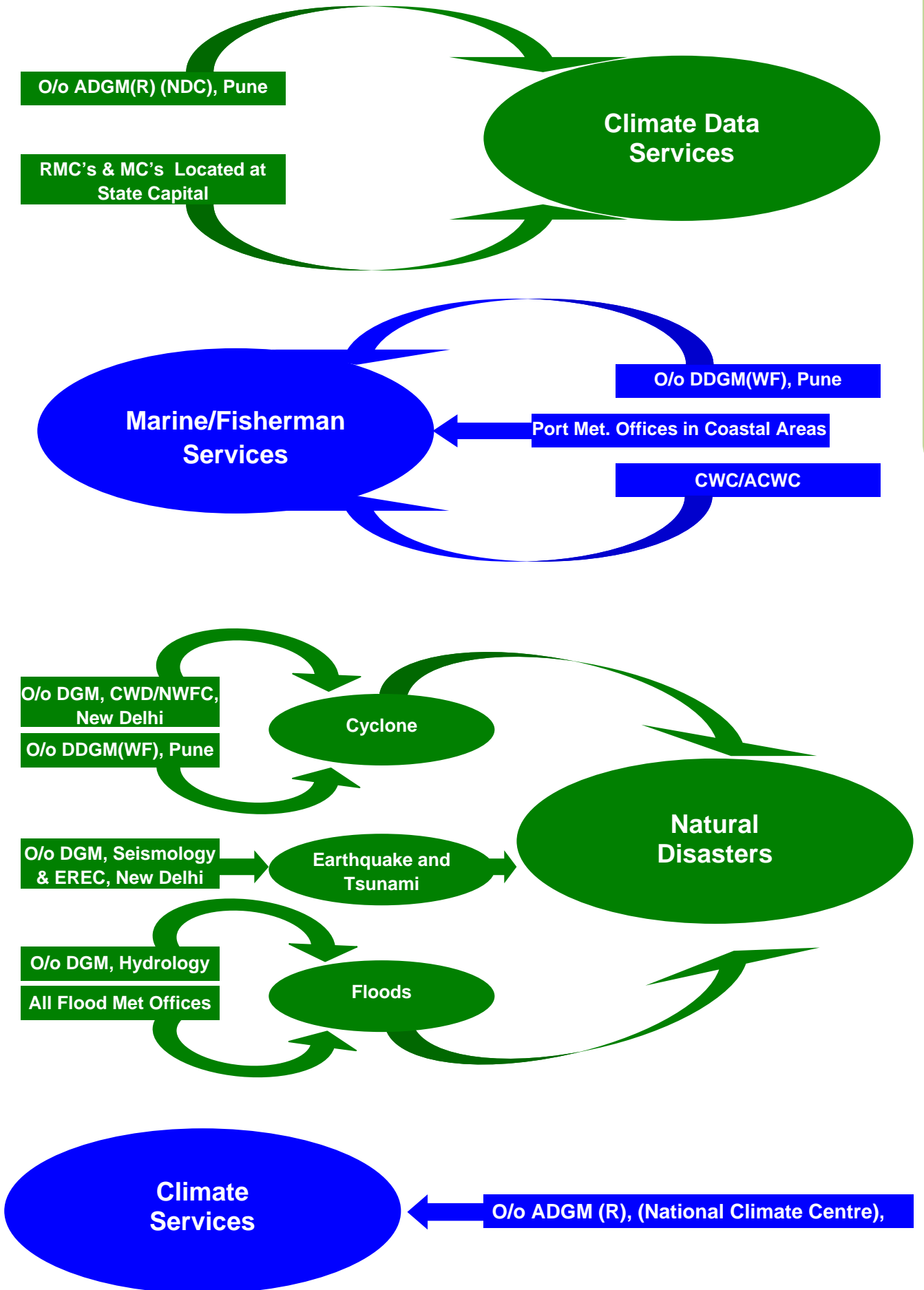
Website : www.mausam.gov.in

www.imd.gov.in

20. IMD's SERVICES







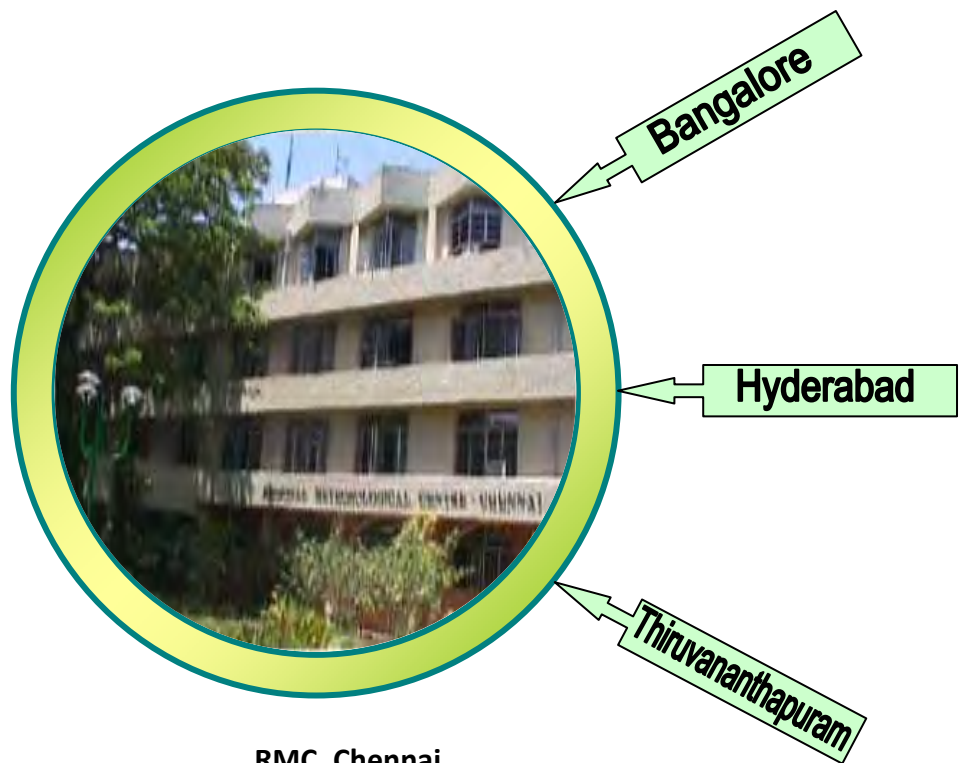
Regional Meteorological Centres



RMC, New Delhi

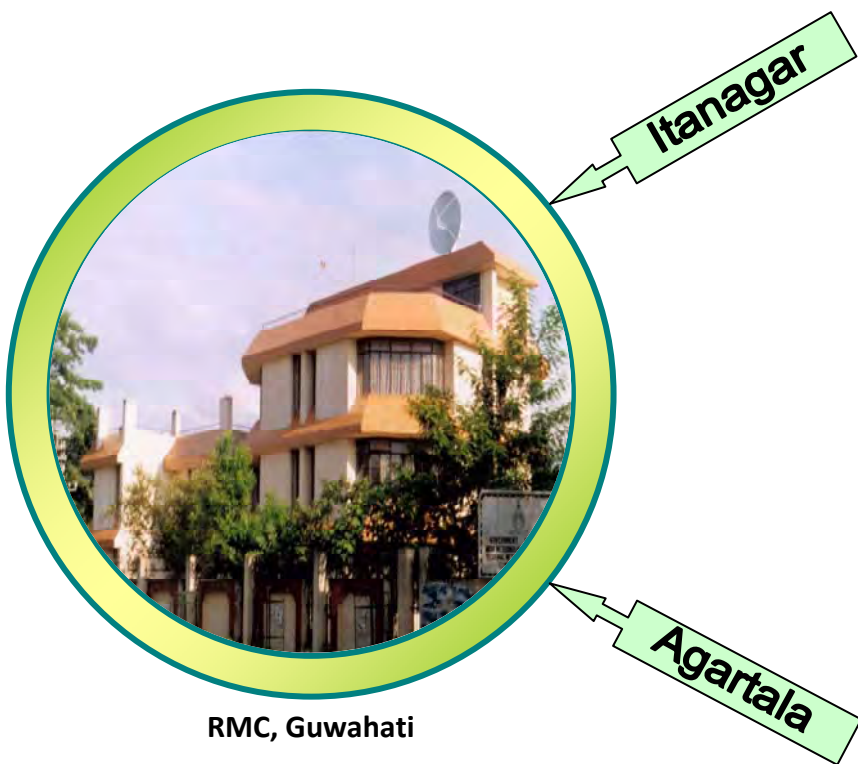
Under the administrative control of RMC, New Delhi, there are operational units such as Met. Centres at state capitals of U.P., H. P., Punjab, Haryana, J&K and Uttarakhand, Forecasting Offices, Agrometeorological Advisory Service Centres and Flood Meteorological Offices.

Regional Meteorological Centre at Chennai was started on 1 April 1945 to supervise and coordinate meteorological services in the Southern Region, which now covers the states of Tamilnadu, Andhra Pradesh, Karnataka, Kerala and Union Territories of Pondicherry and Lakshadweep.



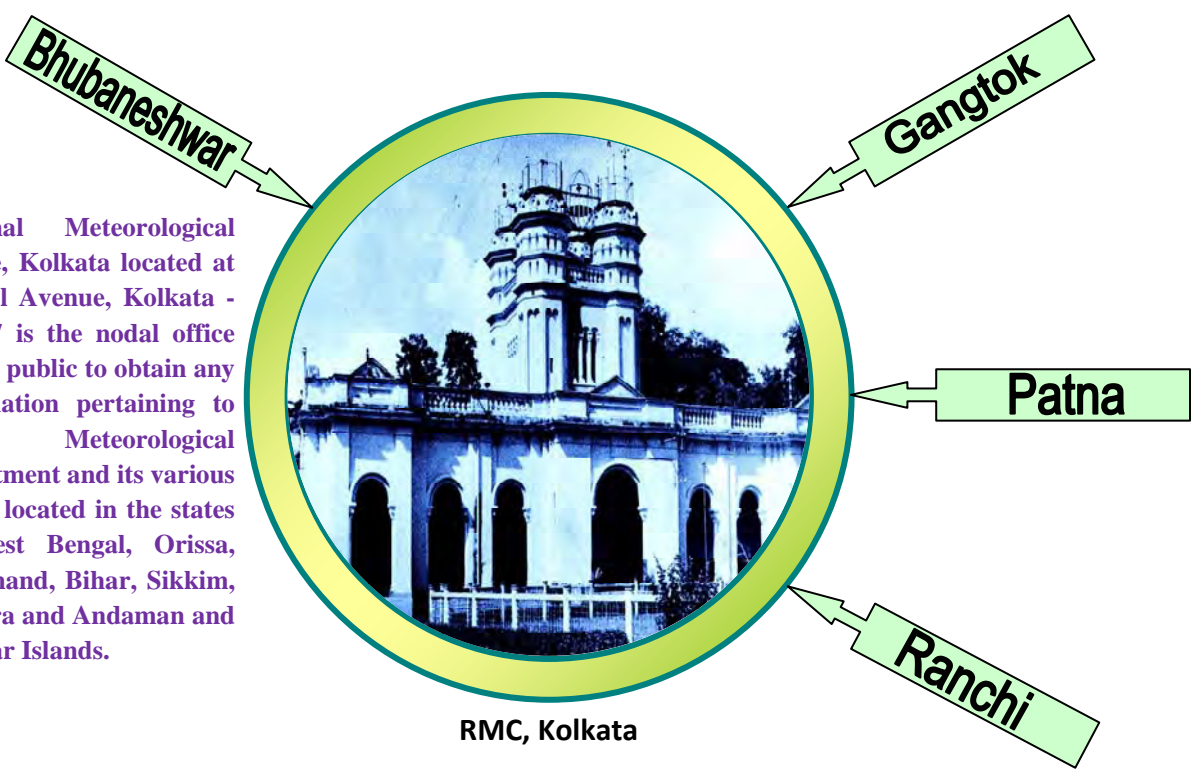
RMC, Chennai

The Regional Meteorological Centre Guwahati was started at Guwahati Airport on 23 July 1949. It was upgraded to Met. Centre on 25 March 1974 and further upgraded to RMC on 01 April 1997. All Met Offices of North-East region except that in Tripura are under administrative & technical control of RMC Guwahati.



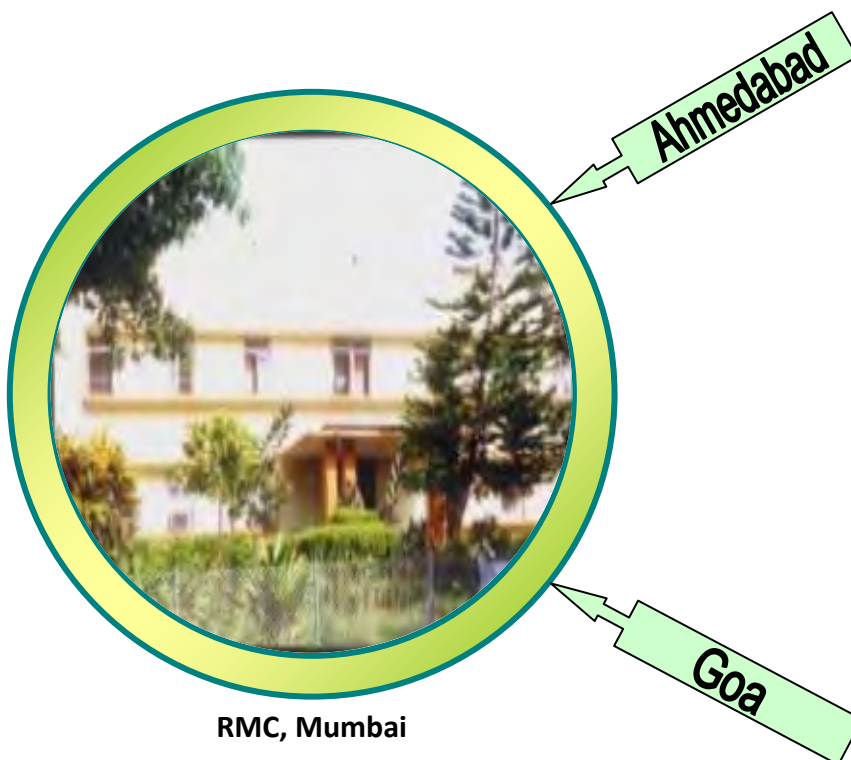
RMC, Guwahati

Regional Meteorological Centre, Kolkata located at 4, Daul Avenue, Kolkata - 700027 is the nodal office for the public to obtain any information pertaining to India Meteorological Department and its various offices located in the states of West Bengal, Orissa, Jharkhand, Bihar, Sikkim, Tripura and Andaman and Nicobar Islands.



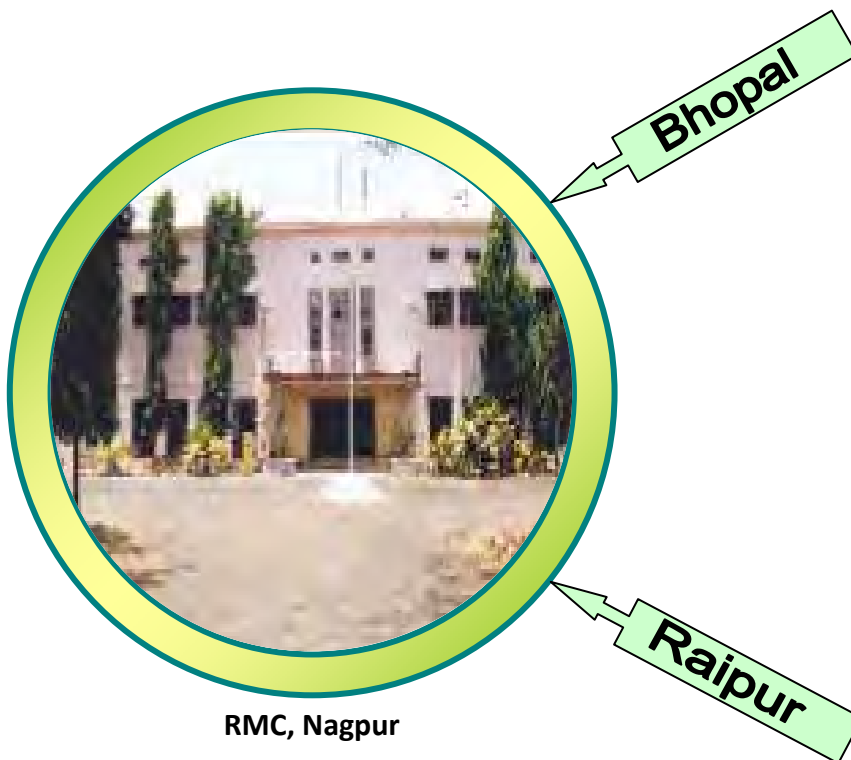
RMC, Kolkata

The R.M.C., Mumbai was established in April 1945 for providing weather Forecasting and related services to the states of Maharashtra, Goa and Gujarat excluding Vidarbha region of Maharashtra State. The centre is also responsible for the monitoring of tropical cyclone formation in Arabian Sea and cyclone warning work, which is carried out by Area C.W.C. Mumbai and C.W.C. Ahmedabad.



RMC, Mumbai

R.M.C., Nagpur was established in the year 1945 at Nagpur Airport. It controls M.C. Bhopal, M.C. Raipur and M.O. Nagpur. There are 16 departmental, 48 non-departmental observatories, 6 Agrimet observatories and 3 Seismological observatories functioning under RMC Nagpur. RMC Nagpur covers Madhya Pradesh, Chhattisgarh and Vidarbha region.



RMC, Nagpur

Meteorological Centres

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KOLKATA REGION

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INDIA METEOROLOGICAL DEPARTMENT

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Ministry of Earth Sciences, Govt. of India

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