



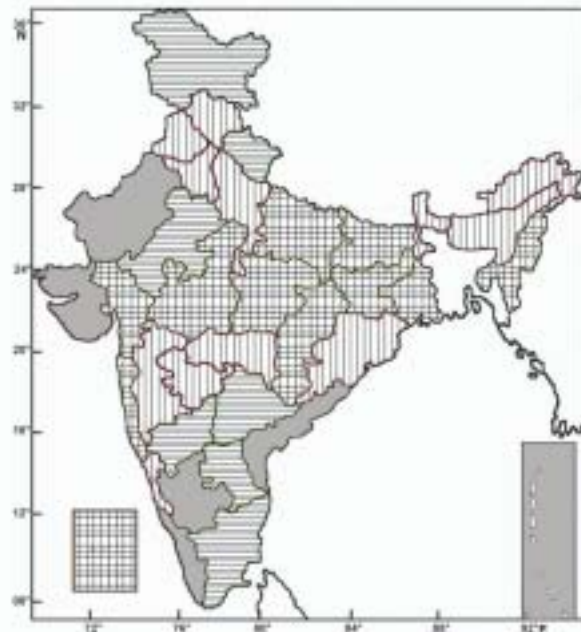
GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT

CLIMATE DIAGNOSTICS BULLETIN OF INDIA

WINTER SEASON

(JANUARY - FEBRUARY) : 2011

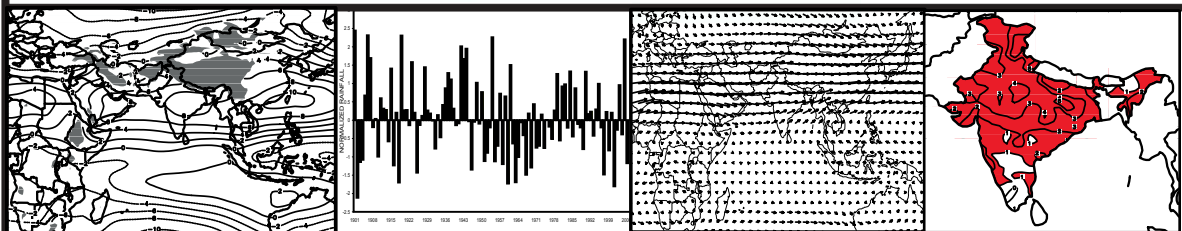
NEAR REAL - TIME ANALYSES



EXCESS +25% OR MORE NORMAL +16% TO 19% DEFICIENT -25% TO -16% SCANTY -62% OR LESS NO DATA



NATIONAL CLIMATE
CENTRE



WINTER SEASON - 2011

MAIN FEATURES OF THE SEASON

Cold Wave Conditions

Severe cold wave / cold wave conditions prevailed over most of the northern and central parts of the country on most of the days during the first three weeks of January. These conditions also prevailed over the peninsular parts of the country during the second and third week of January. Minimum temperatures were below normal by over 5°C on many days over some central and peninsular parts of the country. **However, during February, these conditions prevailed only at isolated places on some occasions over parts of peninsula and eastern parts of the country.**

Rainfall Features

During the season, out of 36 meteorological subdivisions, 6 received excess rainfall, 7 received normal rainfall, 12 received deficient rainfall and remaining 11 subdivisions received scanty rainfall. (Fig.1)

Table 1 shows the subdivision wise rainfall statistics (mm) for the winter season (January-February 2011).

Rainfall activity over the country as a whole was below normal during the season. Subdivisions of central and eastern/northeastern region and some subdivisions of northern region received deficient/scanty rainfall. However, some subdivisions of northwest India and south peninsula received excess rainfall.

Fig. 2(a) shows the spatial pattern of rainfall (cm) received during the season. **Rainfall activity was confined to northern/northwestern and eastern/northeastern parts of the country and parts of south peninsula.** Extreme northern and northeastern parts of the country and parts of Coastal Andhra Pradesh, Tamil Nadu and Kerala received more than 5 cm of rainfall. Rainfall received by parts of Uttaranchal, Himachal Pradesh and Jammu & Kashmir exceeded 10 to 20 cm.

Fig. 2(b) shows the spatial pattern of rainfall anomaly (cm) during the season. Rainfall anomalies were negative over most parts of the country except parts of northern/northwestern region and parts of south peninsula. Negative rainfall anomaly over parts of northern, eastern/northeastern and adjoining central region exceeded 2 cm. Positive rainfall anomaly over parts of Jammu & Kashmir, Coastal Andhra Pradesh, Tamil Nadu and Kerala was of the order of 2 to 5 cm.

Fig. 3 shows the area weighted cumulative weekly rainfall percentage departure during the season for the country as a whole. **Cumulative rainfall departure was negative during all the weeks of the season. However, large rainfall deficiency (exceeding 65 %) till end of January, reduced to some extent due to good rainfall activity in February. For the winter season 2011, rainfall for the country as a whole was 78% of its Long Period Average (LPA) value.**

Fig. 4 shows the percentage departure of area weighted seasonal rainfall over the country as a whole for the period, 1901-2011.

Pressure & Wind

Figs. 5(a) & 5(b) show the mean sea level pressure & its anomalies respectively. **The pressure anomalies were negative throughout the country.** The negative pressure anomalies were of the order of 1 hPa over most parts of country.

Figs. 6(a) & 6(b), 7(a) & 7(b) and 8(a) & 8(b) show the mean circulation patterns and its anomalies at 850, 500 & 200 hPa levels respectively.

At 850 hPa level, an anomalous cyclonic circulation, extending upto 500 hPa level was observed over the northwest Bay of Bengal and adjoining areas. At 250 hPa level, an anomalous northwest to southeast trough in westerlies was observed over the northwestern parts of the country.

Velocity Potential & Stream Function

Figs. 9(a) & 9(b) show the 250 hPa mean Velocity Potential & its anomalies. Similarly, Figs. 10(a) & 10(b) show the mean stream function & its anomalies at 850 hPa level. Negative values are indicated by dashed lines. **Anomalies in the Velocity Potential at 250 hPa level were positive throughout the country, while anomalies in the stream function at 850 hPa level were negative throughout the country.**

Outgoing Longwave Radiation (OLR)

OLR anomaly (W/m^2) over the Indian region and neighbourhood is shown in Fig 11. Negative OLR anomalies were observed over extreme northern and southern parts of country. These anomalies exceeded $10 W/m^2$ over southeast peninsula and adjoining south Bay of Bengal. Positive OLR anomalies exceeding $5 W/m^2$ were observed over central and eastern/northeastern region of the country.

Temperature

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

Maximum temperatures were generally above normal over most parts of the country except over parts of Gangetic plains and adjoining northwestern parts. These were below normal by about $1^\circ C$ over parts of Punjab, West Rajasthan, East & West Uttar Pradesh and parts of Gangetic West Bengal. Over parts of Jammu & Kashmir, Himachal Pradesh, East Madhya Pradesh, Chattisgarh and extreme northeastern region maximum temperatures were above normal by about $1^\circ C$.

Minimum temperatures were below normal over many parts of the country except parts of northern/northwestern and northeastern region and parts of extreme south peninsula. Over north peninsula and adjoining central and eastern parts of the country, minimum temperatures were below normal by 1 to $2^\circ C$. Over parts of Jammu & Kashmir, West and East Rajasthan and Saurashtra & Kutch, these were above normal by about $1^\circ C$.

Low Pressure Systems

A depression formed over the southwest Bay of Bengal during the season in the month of February. However, it was short lived and weakened in situ.

The depression was first seen as a low pressure area over the southwest Bay of Bengal on 2nd. It concentrated into a **depression** and lay centred at 0900 hrs UTC of 2nd, near Lat. $6.5^\circ N$ /Long. $82.5^\circ E$ (about 550 km southeast of Kanya Kumari). It remained practically stationary over there till 1200 UTC of the same day. It weakened into a well marked low pressure area at 00 UTC of 3rd and lay over the southwest Bay of Bengal and adjoining Sri Lanka. It weakened into a low pressure area over the same region and persisted there from 4th to 8th morning and became less marked on 8th evening.

Apart from this depression, a short lived low pressure area also formed over the southwest Bay of Bengal during 11 to 13 January.

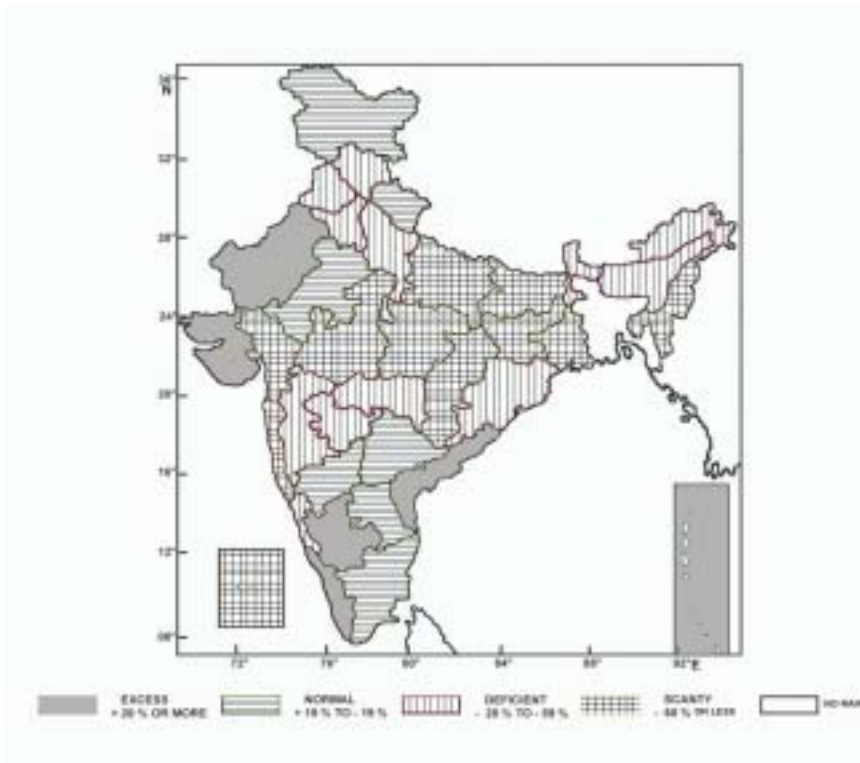


FIG. 1 : SUB-DIVISIONWISE RAINFALL PERCENTAGE DEPARTURES FOR THE WINTER SEASON 2011

RAINFALL

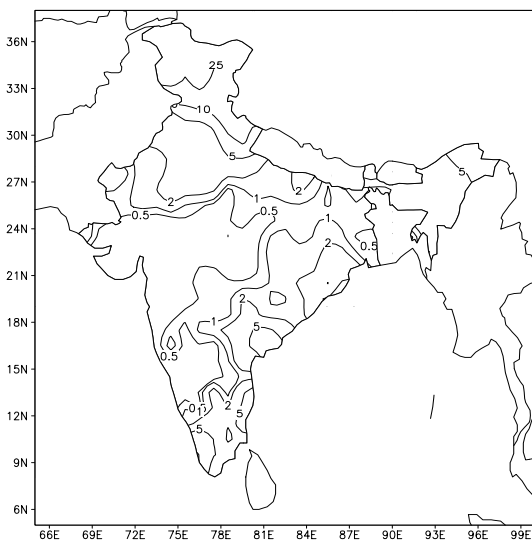


FIG. 2(a) : SEASONAL RAINFALL (cm)
(INTERVAL : 0.5, 1, 2, 5, 10, 25)

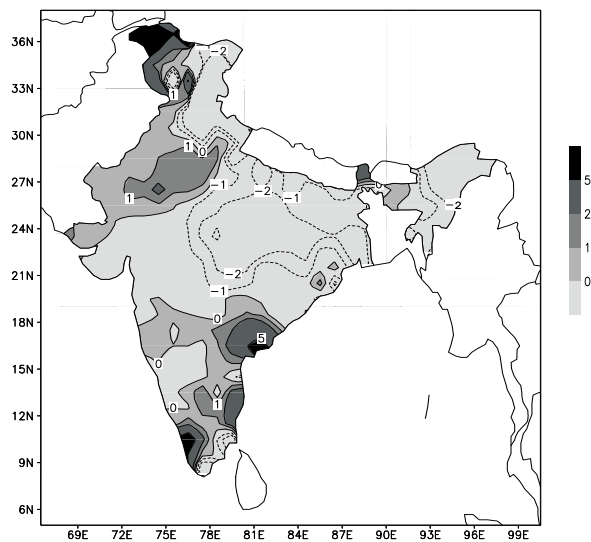


FIG. 2(b) : SEASONAL RAINFALL ANOMALY (cm)
(INTERVAL : -2,-1, 0,1, 2,5)
(BASED ON 1951-2000 NORMALS)

RAINFALL

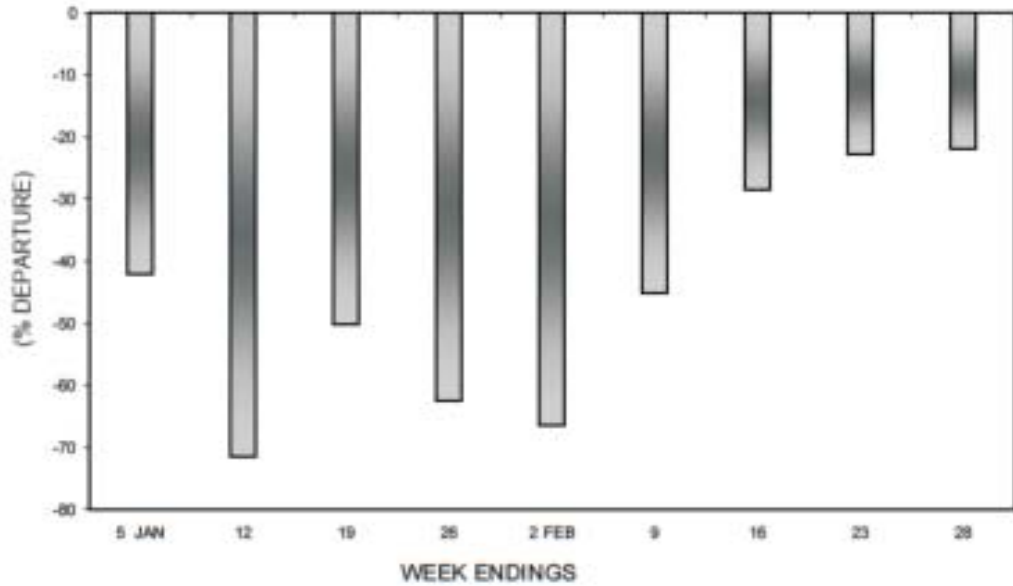


FIG. 3 : ACCUMULATED PERCENTAGE DEPARTURE OF AREA WEIGHTED WEEKLY RAINFALL OVER THE COUNTRY AS A WHOLE FOR THE WINTER SEASON

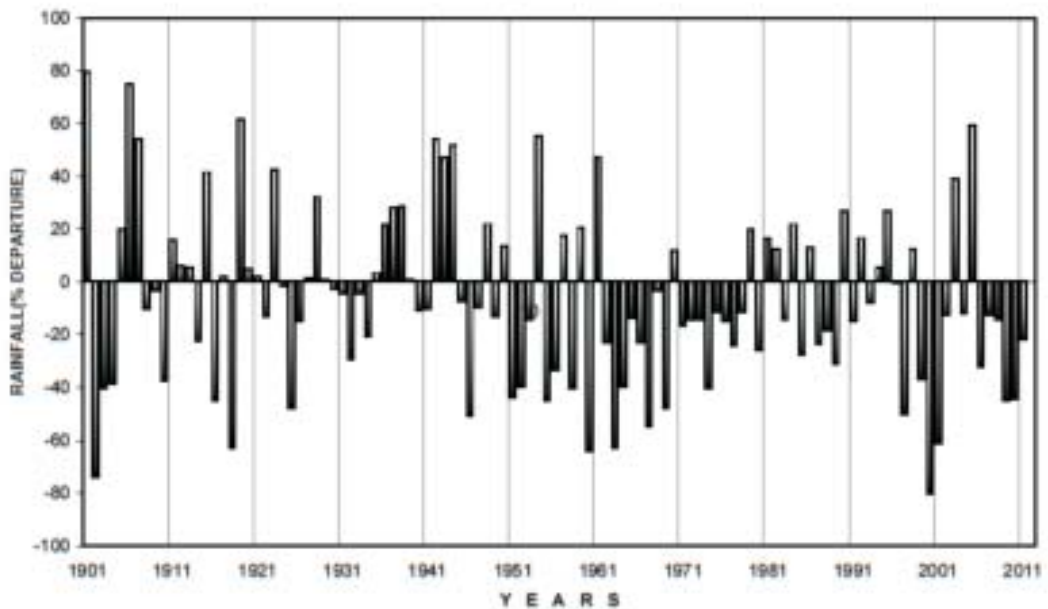
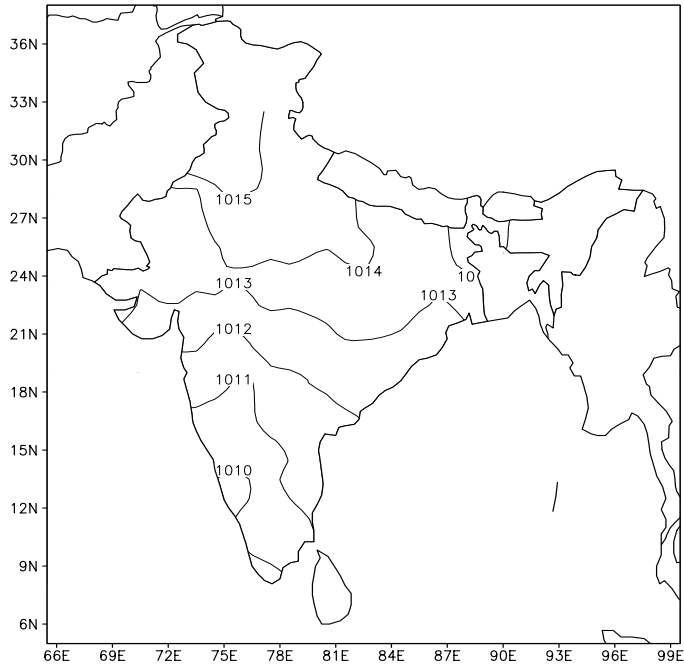
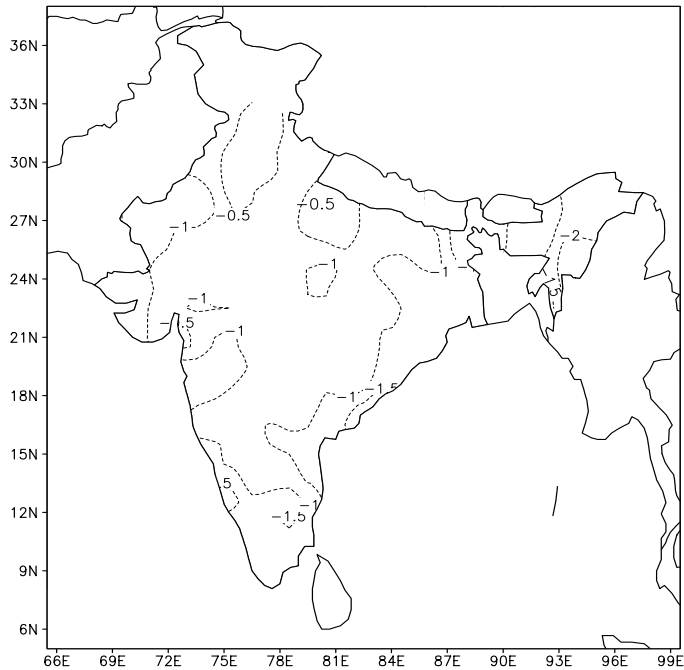


FIG. 4 : PERCENTAGE DEPARTURE OF AREA WEIGHTED RAINFALL OVER THE COUNTRY AS A WHOLE FOR WINTER SEASON (1901 - 2011) (NORMAL IS BASED ON THE DATA FOR THE PERIOD 1941-1990)

(a) MEAN SEA LEVEL PRESSURE (MSLP)



(b) MSLP ANOMALY

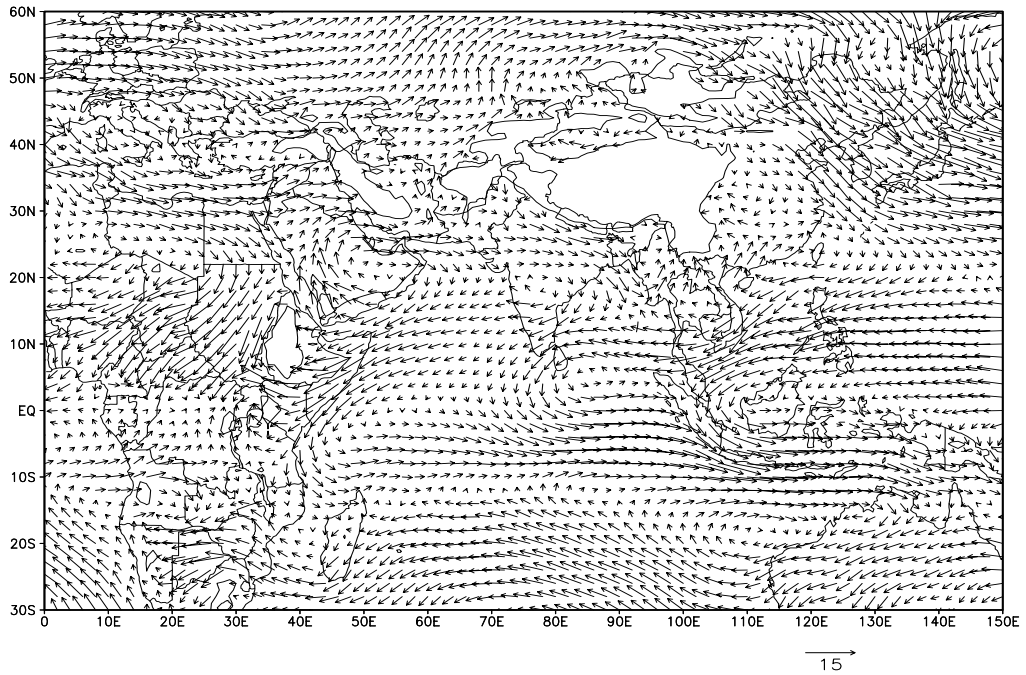


PRESSURE

FIG. 5 : SEASONAL (JAN - FEB) MEAN SEA LEVEL PRESSURE (hPa)
(a) MEAN (b) ANOMALY
(BASED ON 1971 - 2000 NORMALS)

WIND AT 850 hPa

(a) MEAN WIND : 850 hPa



(b) WIND ANOMALY : 850 hPa

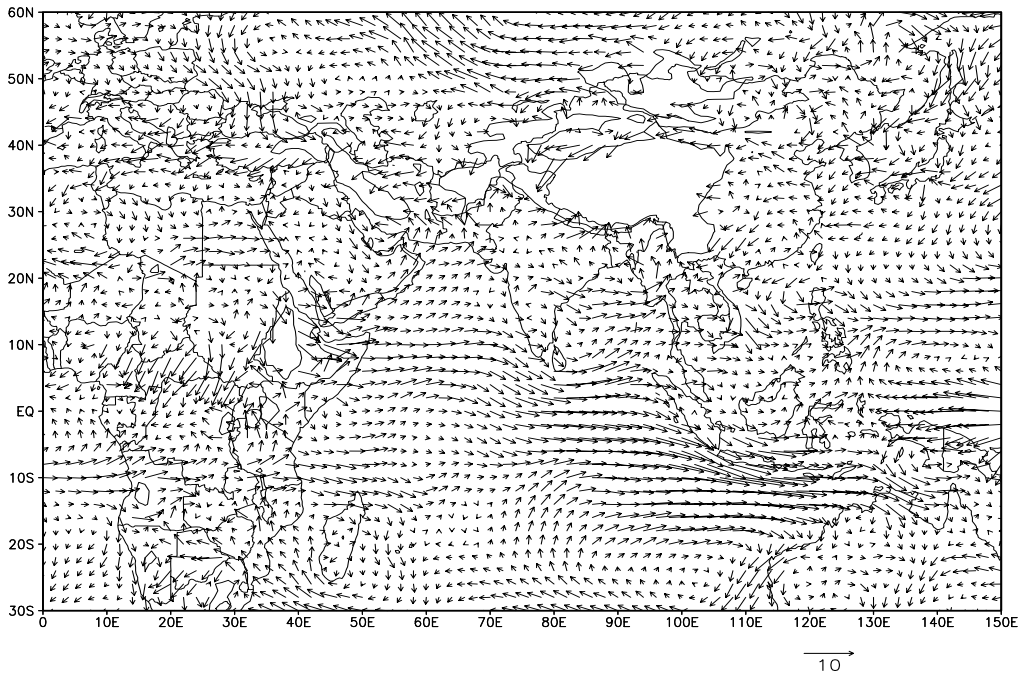
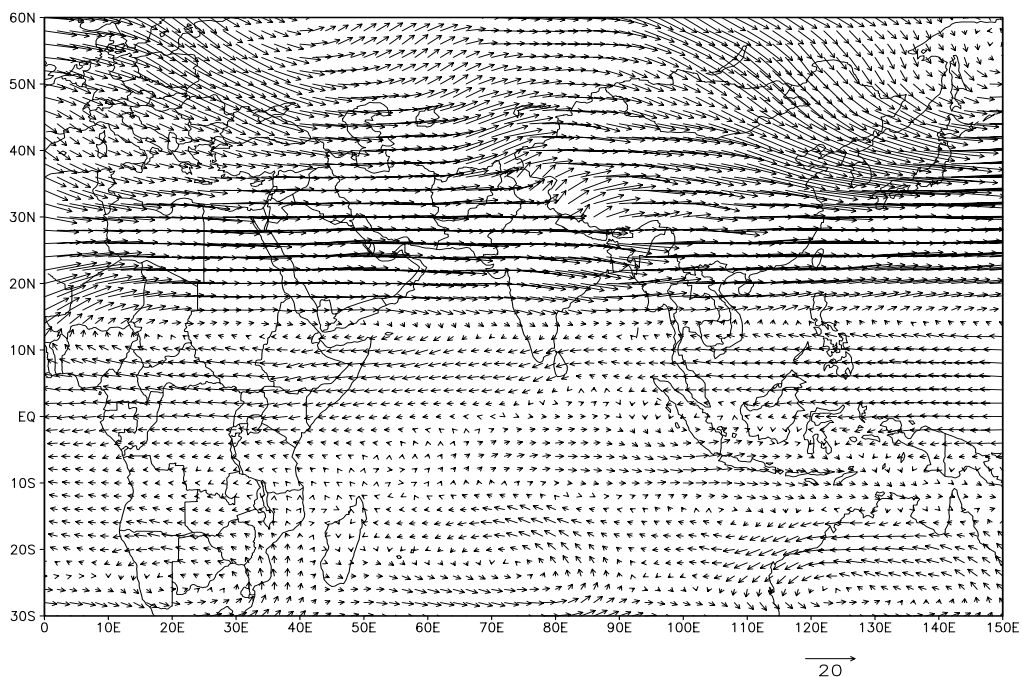


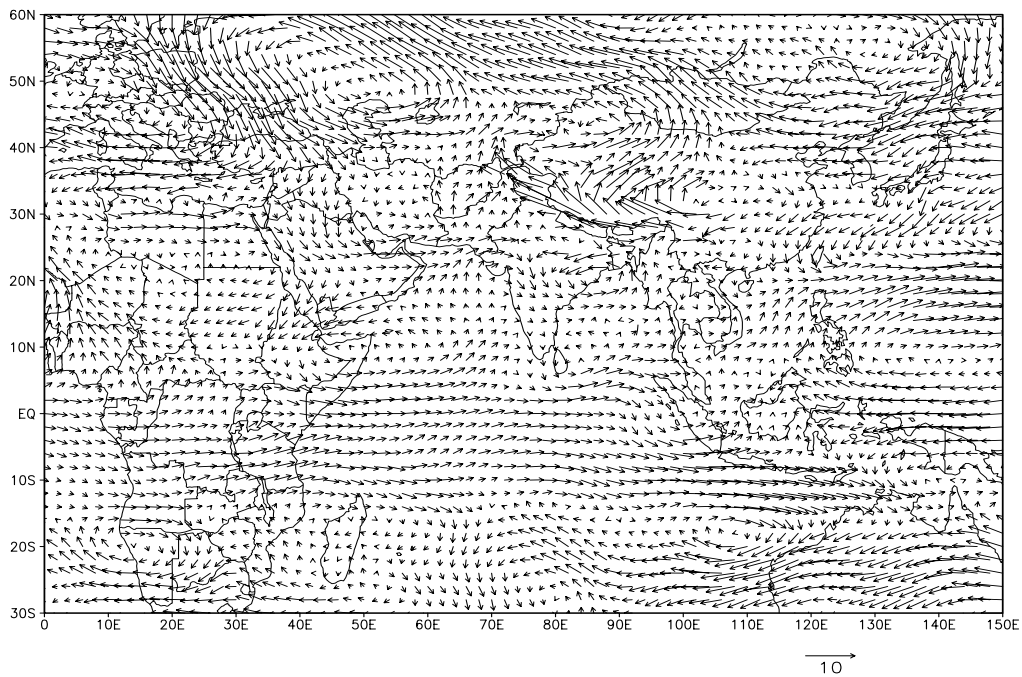
FIG. 6 : SEASONAL (JAN - FEB) WIND (m/s) (a) MEAN (b) ANOMALY AT 850 hPa

(SOURCE : OPERATIONAL NWP ANALYSIS OF IMD GFS T-382)
(ANOMALY IS BASED ON 1959-88 CLIMATOLOGY)

(a) MEAN WIND : 500 hPa



(b) WIND ANOMALY : 500 hPa



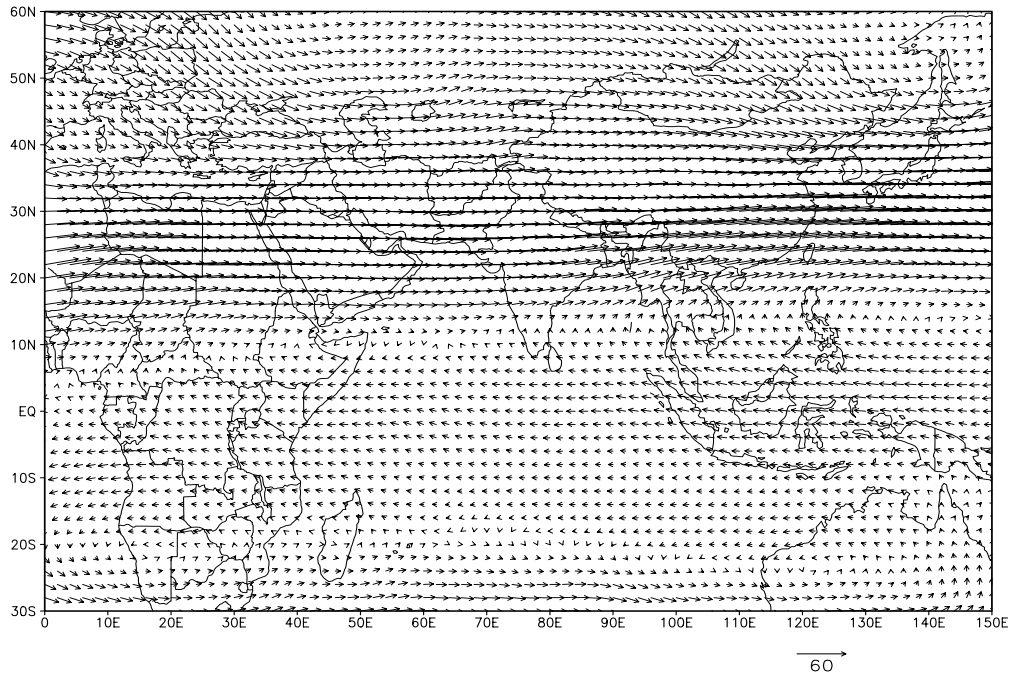
WIND AT 500 hPa

FIG. 7 : SEASONAL (JAN - FEB) WIND (m/s) (a) MEAN (b) ANOMALY AT 500 hPa

(SOURCE : OPERATIONAL NWP ANALYSIS OF IMD GFS T-382)
(ANOMALY IS BASED ON 1959-88 CLIMATOLOGY)

WIND AT 250 hPa

(a) MEAN WIND : 250 hPa



(b) WIND ANOMALY : 250 hPa

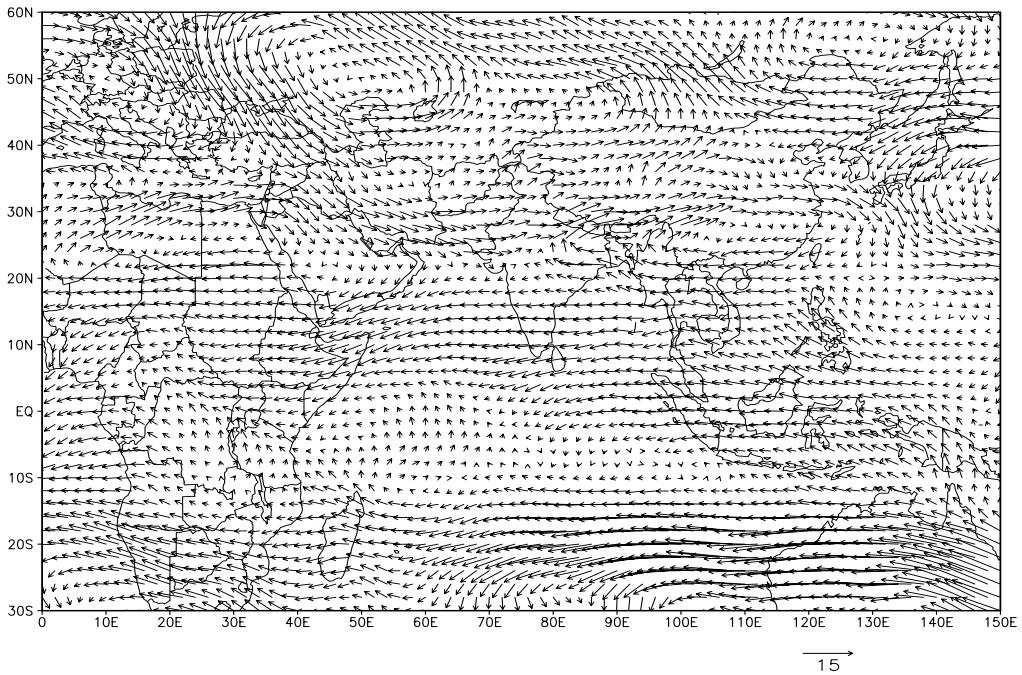
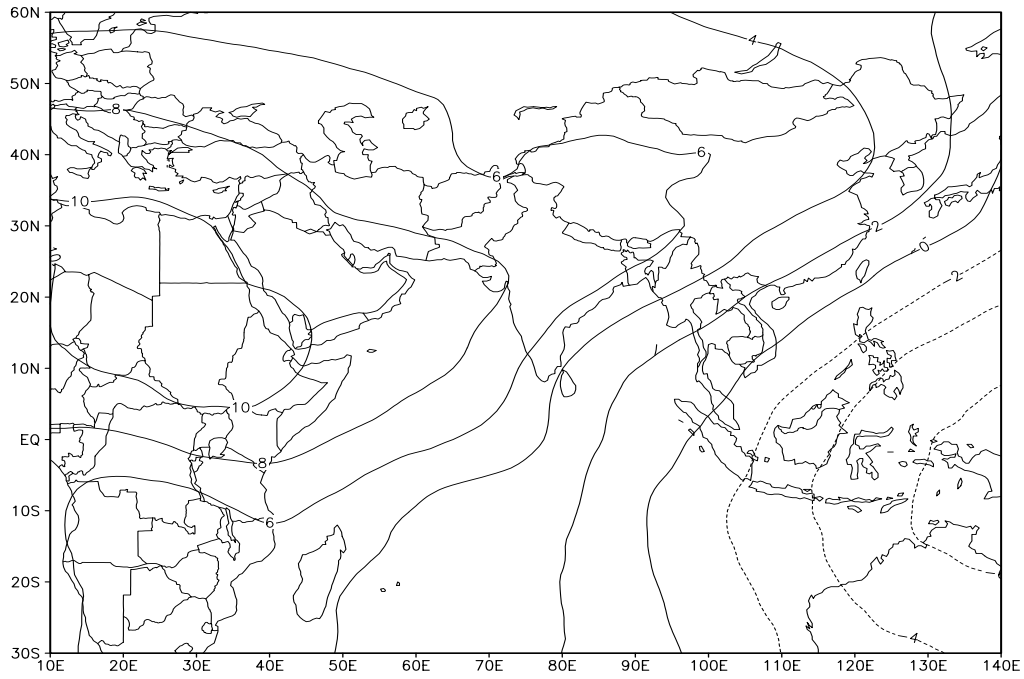


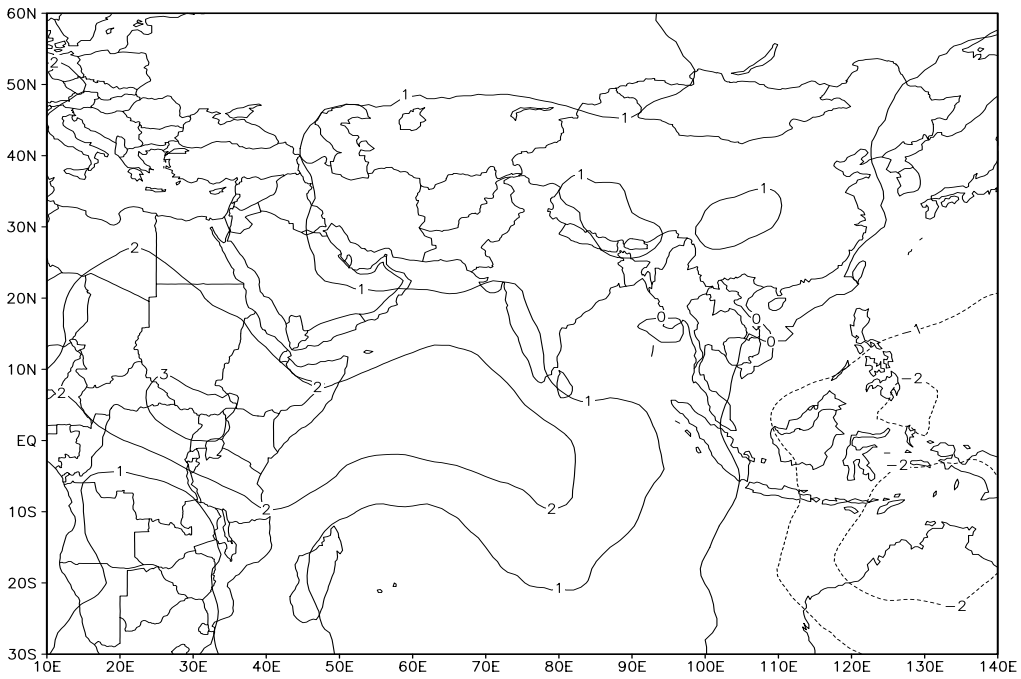
FIG. 8 : SEASONAL (JAN - FEB) WIND (m/s) (a) MEAN (b) ANOMALY AT 250 hPa

(SOURCE : OPERATIONAL NWP ANALYSIS OF IMD GFS T-382)
(ANOMALY IS BASED ON 1959-88 CLIMATOLOGY)

(a) VELOCITY POTENTIAL : 250 hPa



(b) VELOCITY POTENTIAL ANOMALY : 250 hPa



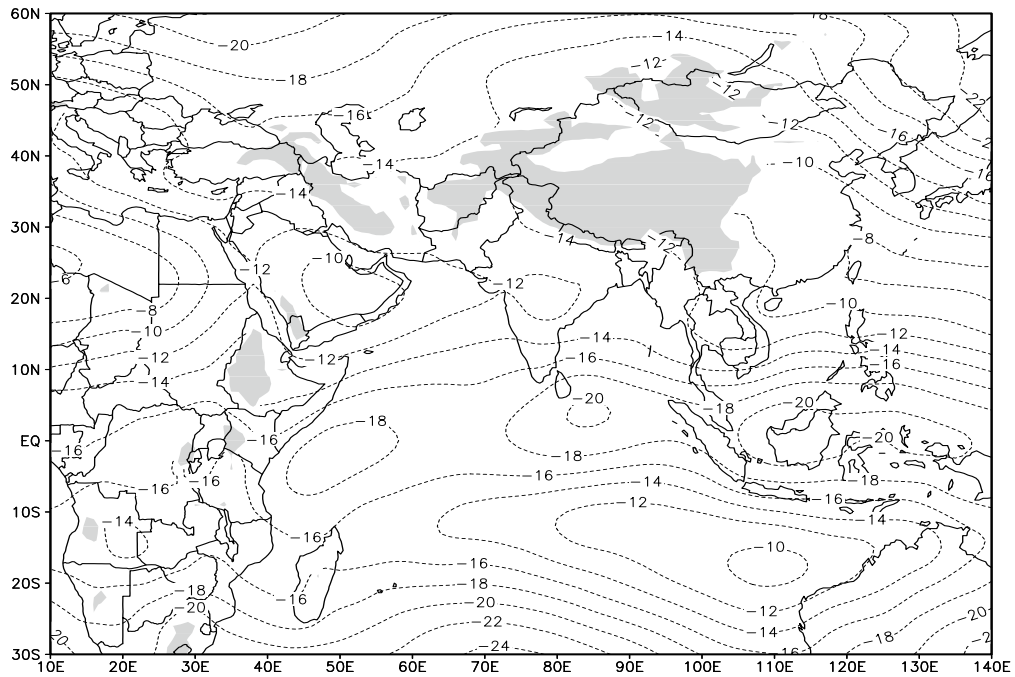
VELOCITY POTENTIAL

**FIG. 9: SEASONAL (JAN - FEB) VELOCITY POTENTIAL ($10^6 \text{m}^2/\text{s}$)
(a) MEAN (b) ANOMALY AT 250 hPa**

*(SOURCE : OPERATIONAL NWP ANALYSIS OF IMD GFS T-382)
(ANOMALY IS BASED ON 1959-88 CLIMATOLOGY)*

STREAM FUNCTION

(a) STREAM FUNCTION : 850 hPa



(b) STREAM FUNCTION ANOMALY : 850 hPa

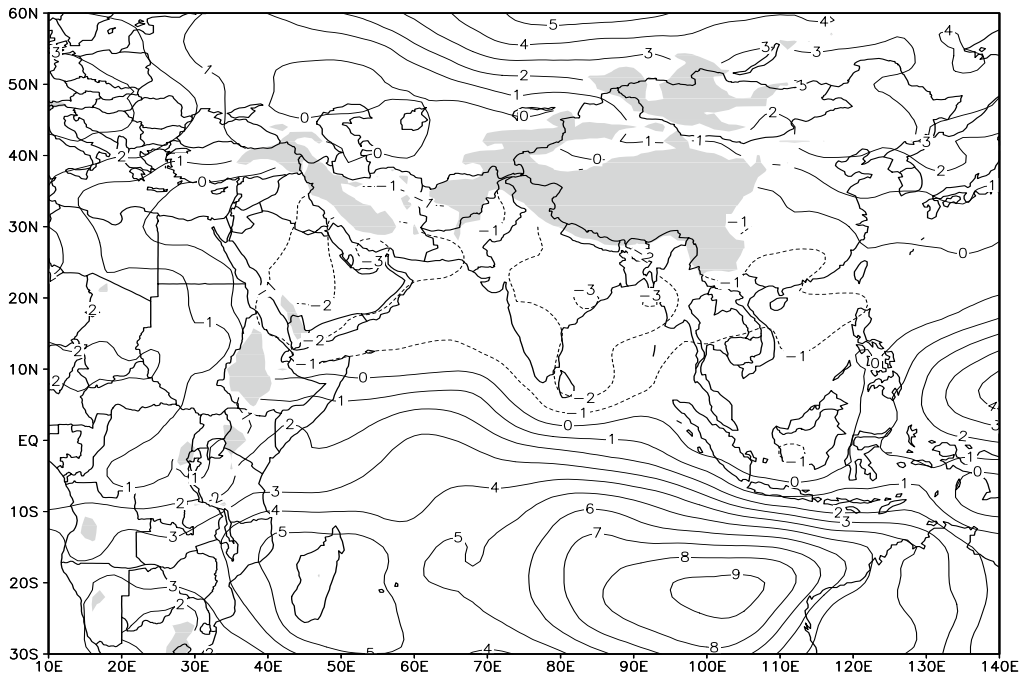


FIG. 10 : SEASONAL (JAN - FEB) STREAM FUNCTION ($10^6 m^2/s$)

(a) MEAN (b) ANOMALY AT 850 hPa

*(SOURCE : OPERATIONAL NWP ANALYSIS OF IMD GFS T-382)
(ANOMALY IS BASED ON 1959-88 CLIMATOLOGY)*

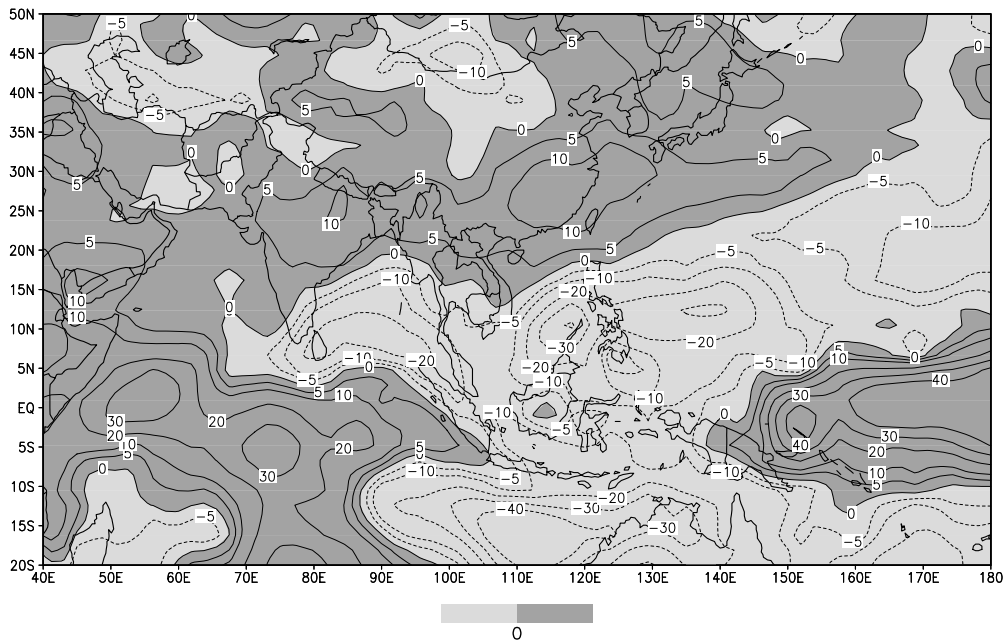


FIG. 11 : OLR ANOMALIES (W/m^2) FOR WINTER SEASON 2011
 (SOURCE : CDC / NOAA, USA)
 (ANOMALY IS BASED ON 1968-96 CLIMATOLOGY)

OLR / TEMPERATURE

(a) MAXIMUM TEMPERATURE ANOMALY

(b) MINIMUM TEMPERATURE ANOMALY

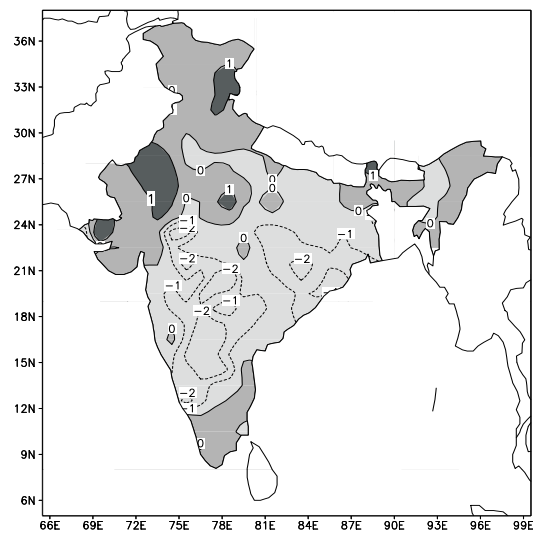
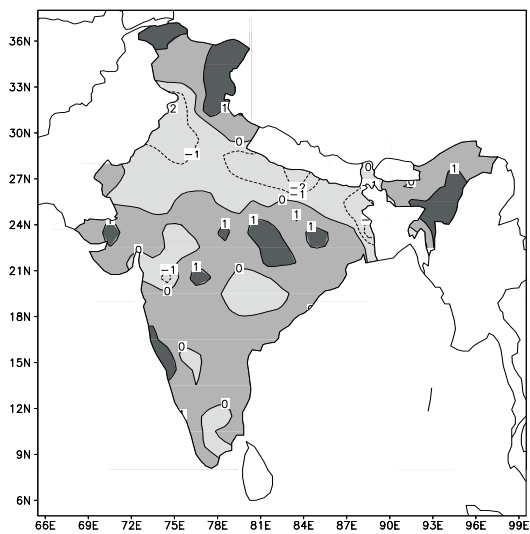


FIG. 12: MEAN SEASONAL TEMPERATURE ANOMALIES ($^{\circ}C$)
(a) MAXIMUM (b) MINIMUM
 (BASED ON 1971 - 2000 NORMALS)

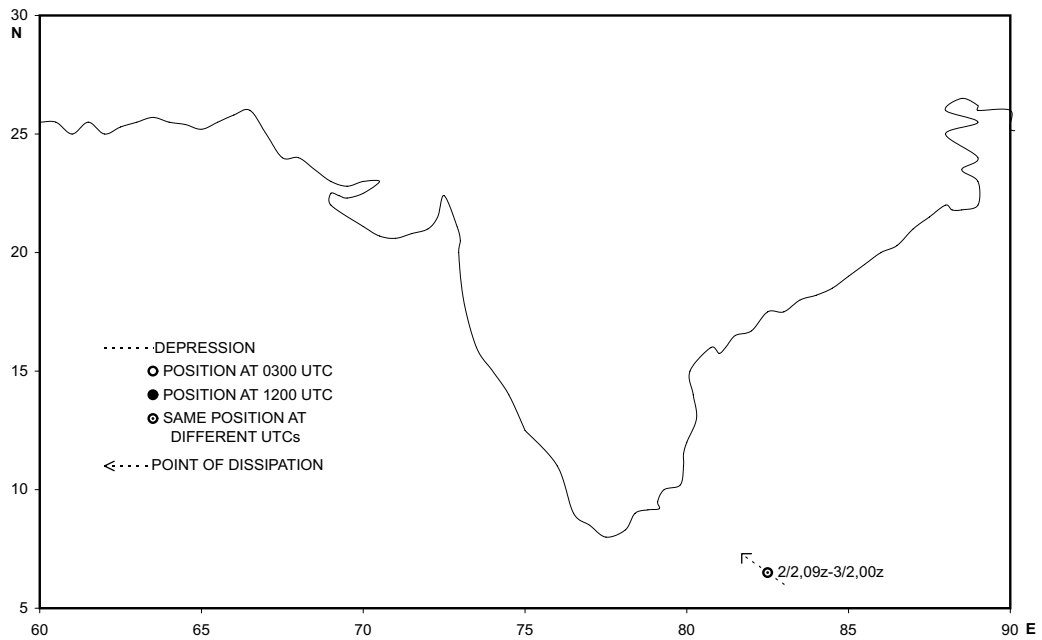


FIG.13 : TRACK OF DEPRESSION FORMED DURING THE WINTER SEASON

TABLE 1
METEOROLOGICAL SUB-DIVISIONWISE RAINFALL STATISTICS
FOR THE WINTER SEASON (JAN-FEB) 2011 BASED ON
OPERATIONAL DATA

SUBDIVISION				ACTUAL (mm)	NORMAL (mm)	% DEP.	SUBDIVISION				ACTUAL (mm)	NORMAL (mm)	% DEP.
1.	Andaman & Nicobar Islands	304.4	82.9	267	19.	West Madhya Pradesh	1.6	13.6	-89				
2.	Arunachal Pradesh	66.5	148.1	-55	20.	East Madhya Pradesh	2.1	35.3	-94				
3.	Assam & Meghalaya	20.6	46.9	-56	21.	Gujarat region	0.2	1.1	-86				
4.	Naga, Mani, Mizo. & Trip.	11.2	44.0	-75	22.	Saurashtra & Kutch	1.9	0.6	221				
5.	Sub-Himalayan W. B. & Sik.	25.3	60.3	-58	23.	Konkan & Goa	**	0.3	-99				
6.	Gangetic West Bengal	6.2	34.4	-82	24.	Madhya Maharashtra	1.5	1.9	-23				
7.	Orissa	21.1	31.8	-34	25.	Marathwada	5.3	6.8	-22				
8.	Jharkhand	7.9	33.4	-76	26.	Vidarbha	9.2	17.2	-46				
9.	Bihar	7.6	23.0	-67	27.	Chattisgarh	5.3	21.3	-75				
10.	East Uttar Pradesh	10.1	28.9	-65	28.	Coastal Andhra Pradesh	22.7	18.7	21				
11.	West Uttar Pradesh	16.1	33.3	-52	29.	Telangana	9.7	11.3	-14				
12.	Uttarakhand	93.6	106.2	-12	30.	Rayalaseema	7.2	6.6	10				
13.	Haryana Chnd. & Delhi	21.4	32.9	-35	31.	Tamil Nadu & Pondicherry	35.3	30.9	14				
14.	Punjab	36.7	49.5	-26	32.	Coastal Karnataka	0.5	0.9	-40				
15.	Himachal Pradesh	133.5	195.5	-32	33.	North Interior Karnataka	4.2	3.9	8				
16.	Jammu & Kashmir	228.4	212.9	7	34.	South Interior Karnataka	9.0	4.4	104				
17.	West Rajasthan	12.7	7.4	71	35.	Kerala	66.7	23.4	185				
18.	East Rajasthan	12.4	10.5	18	36.	Lakshadweep	7.8	35.5	-78				

(** : RAINFALL AMOUNT OF 0.01 TO 0.4 mm)