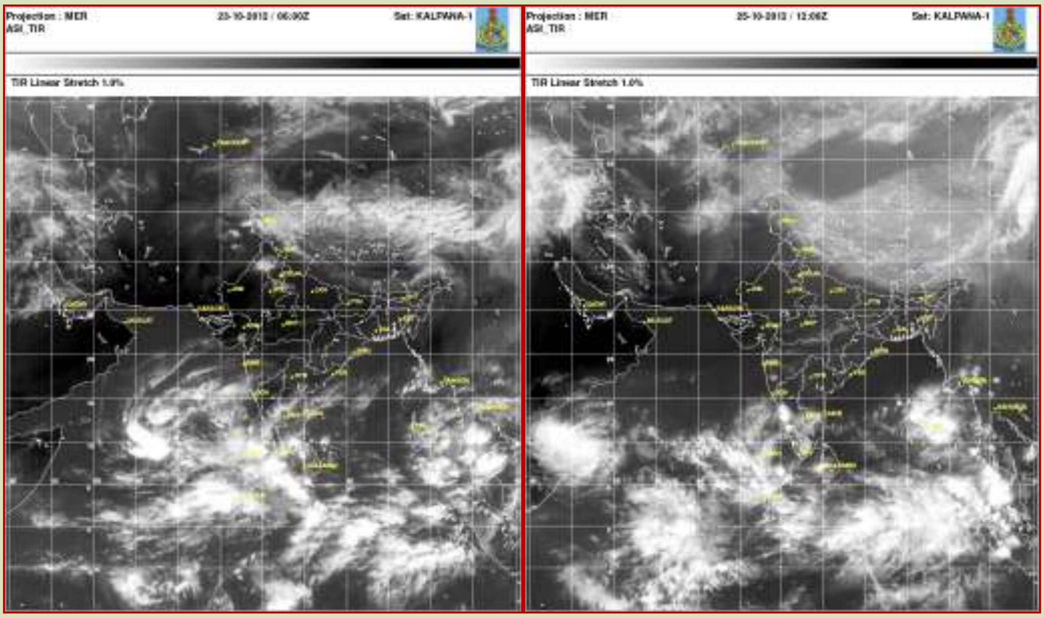
GOVERNMENT OF INDIA

MINISTRY OF EARTH SCIENCES

INDIA METEOROLOGICAL DEPARTMENT

Preliminary Report on Cyclonic Storm MURJAN over the Arabian Sea

(23-26 October 2012)



Satellite imageries during genesis and landfall of CS MURJAN

CYCLONE WARNING DIVISION, NEW DELHI

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Cyclonic Storm 'MURJAN' over Arabian Sea (23-26 October, 2012)

1. Introduction

The cyclonic storm, Murjan formed over the south Arabian Sea in association with an active inter tropical convergence zone during last week of October 2012. It was the first cyclone over the north Indian Ocean during this year. Moving west-southwestwards, it crossed Somalia coast between 1700 and 1800 UTC of 25th October near lat. 9.8^{0}N and 50.8^{0}E. The salient features of this cyclone are given below.

(i) It was the first cyclonic storm to hit Somalia after 1994. A severe cyclonic storm crossed Somalia coast on 19th November 1994 near lat. 8.0^{0}N.

(ii) The cyclonic storm, Murjan caused heavy rainfall and strong wind over Somalia and Ethiopia.

(iii) Though predicted by most of the numerical weather prediction (NWP) models to gradually weaken before landfall, it maintained its cyclonic storm intensity till landfall.

2. Monitoring and prediction

The cyclonic storm was mainly monitored by satellite. The half hourly INSAT/ Kalpana imageries and products were used for monitoring of cyclonic storm. Various numerical weather prediction (NWP) models and dynamical-statistical models including IMD's global and meso-scale models were utilized to predict the track and intensity of the storm. Recently installed Tropical Cyclone Module in the digitized forecasting system of IMD was utilized for analysis and comparison of various NWP models and decision making process.

The brief history of the genesis, intensification and movement of this storm are discussed below

3. Genesis

Under the influence of an active intertropical conv ergence zone, a low pressure area formed over the south Bay of Bengal on 18th October 2012. It moved westwards across Sri Lanka and Palk straight and emerged into southeast Arabian Sea, near Lakshadweep area on 21st October. It continued to move westwards and intensified into a depression over southeast and adjoining southwest and central Arabian Sea near lat. 11.0^{0}N and long. 65.0^{0}E, about 800 km west of Amini Divi at 0300 UTC of 23rd October, 2012.

During the genesis phase, the Madden Julian Oscillation index lay in phase 2 with amplitude greater than one. The phase 2 is favourable for genesis and intensification of the cyclonic disturbances over the Arabian Sea. The sea surface temperature (SST) over the southeast Arabian Sea and adjoining areas was 29-30 degree C. The Ocean heat content (OHC) was 80-100 KJ/cm^2 over the area. The lower level convergence and relative vorticity as well as upper level divergence increased from 22nd to 23rd October. The upper tropospheric ridge lay along 15^{0}N and hence provided the upper level divergence for intensification. The vertical wind shear between 200 and 850 hPa levels was moderate (10-20 knots) around the system centre on 22nd and 23rd October.

4. Intensification and movement

As the depression lay to the south of the upper tropospheric ridge and the steering winds at middle and upper tropospheric levels weresoutheraterly, the system initially moved west northwestwards and intensified into a deep depression at 1500 UTC of 23rd October under the favourable conditions as mentioned in previous section.

Thereafter, the convection increased in the southwest sector with increase in low level relative vorticity in this sector and the steering ridge to the north weakened leading to west-southwestward movement. However, the low to moderate wind shear continued to prevail over the region. Under these circumstances, the deep depression moved west-southwest wards and intensified into a cyclonic storm, 'MURJAN'at 1200 UTC of 24th October. It then continued to move west-southwest wards and crossed Somalia coast near lat. 9.5^0 N between 2230 and 2330 hrs. IST od 25th October, 2012. Though the OHC was less over the southwest Arabian Sea (50-80 KJ/cm^2) and further less near Somalia coast (less than 50 KJ/cm^2) as well as SST (26-28^0C), the system could maintain its intensity of cyclonic storm till landfall, basically due to low to moderate vertical wind shear.

After the landfall, due to land interaction, it weakened into a deep depression over coastal Somalia at 1800 UTC 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 the system is shown in Fig.1. The best track parameters are shown in Table 1.

The typical satellite imagery of cyclone, Murjan at the time of landfall over Somalia coast is shown in Fig.2.

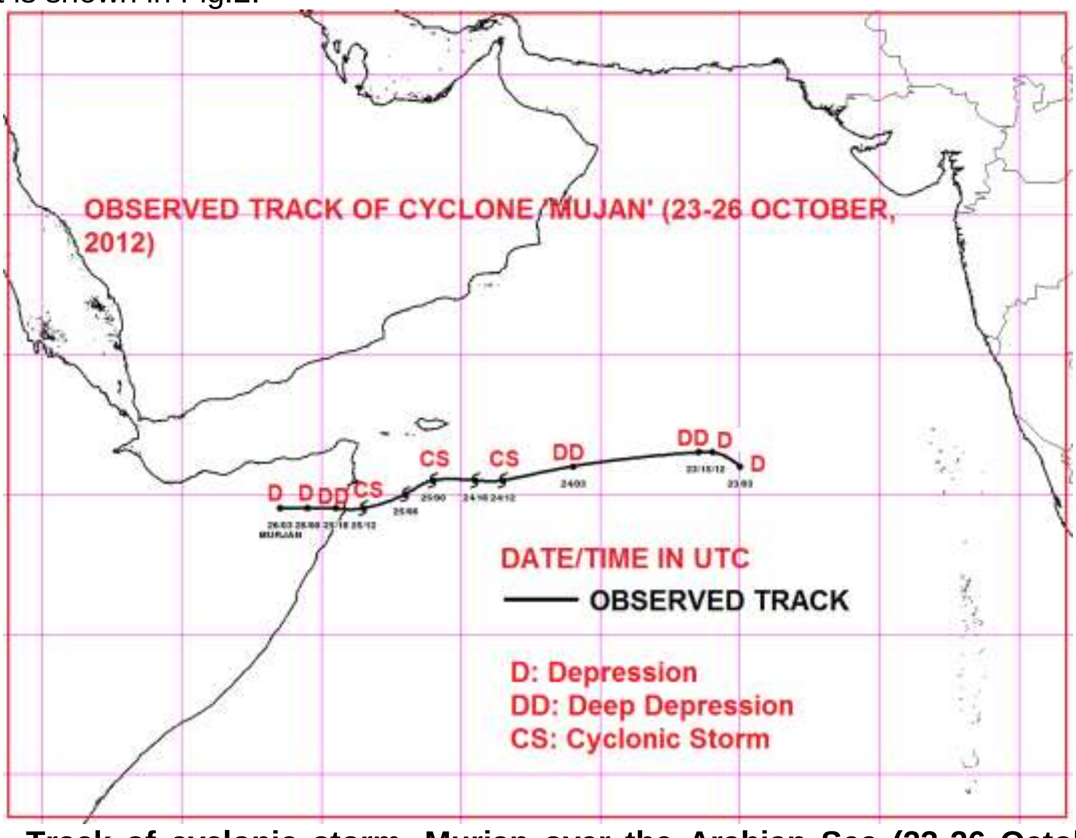

Fig.1. Track of cyclonic storm, Murjan over the Arabian Sea (23-26 October, 2012)

Table: Best track positions and other parameters of the Cyclone 'MURJAN' over the Arabian Sea during 23-26 October, 2012

Date	Time (UTC)	Centre lat.^{0} N/ long. ^{0} E	C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
23-10-2012	0300	11.0/65	1.5	1004	25	3	D
	1200	11.5/64.0	1.5	1003	25	3	D
	1500	11.5/63.5	2.0	1002	30	4	DD
24-10-2012	0300	11.0/59.0	2.0	1002	30	5	DD
	1200	10.5/56.5	2.5	1000	35	6	CS
	1800	10.5/55.5	2.5	1000	40	8	CS
25-10-2012	0000	10.5/54.0	2.5	1000	35	6	CS
	0600	10.0/53.0	2.5	1000	35	6	CS
	1200	9.5/51.5	2.5	1000	35	6	CS
	The system crossed Somalia coast near 9.5^{0}N and 50.8^{0}E between 1700-1800 UTC						
	1800	9.5/50.5	2.0	1001	30	4	DD
26-10-2012	0000	9.5/49.5	1.5	1002	25	3	D
	0300	9.5/48.5	1.5	1002	25	3	D

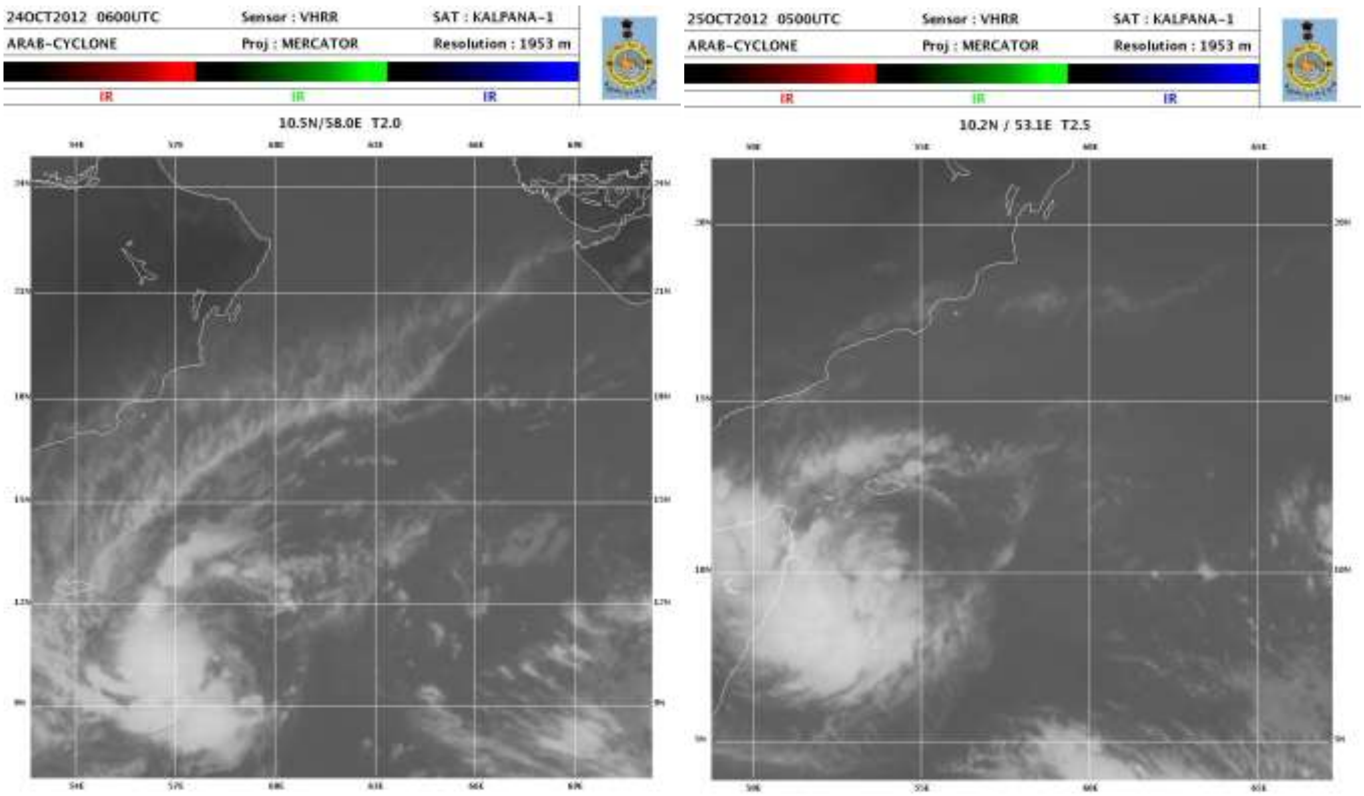

Fig.2(a). Typical satellite imagery of cyclone Murjan 0600 &0500 UTC of 24 & 25 October, 2012.

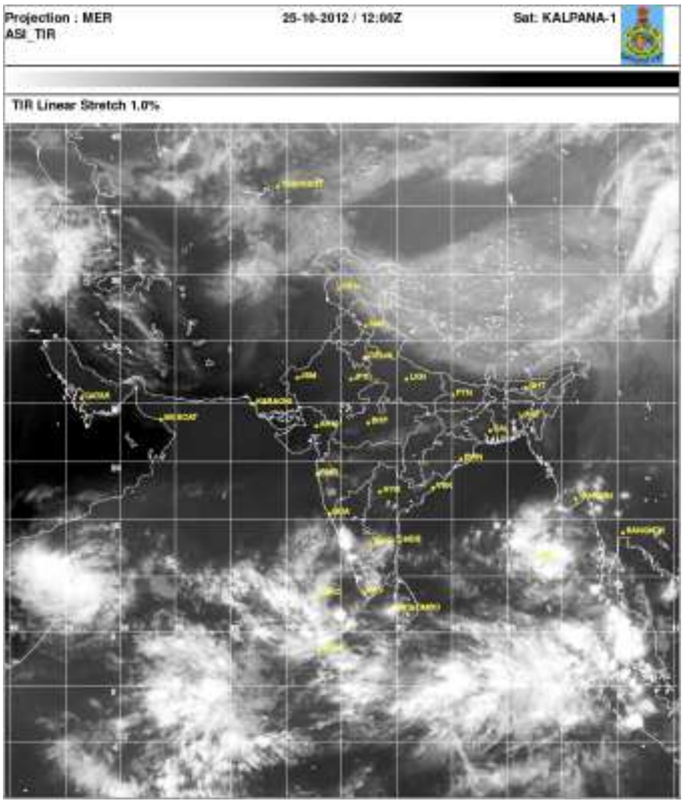

Fig.2(b). Typical satellite imagery of cyclone, Murjan at the time of landfall over Somalia coast.

5. Realised Weather

As estimated by satellite imagery and products, the sustained maximum wind of 65-75 kmph prevailed along and off Somalia coast at the time of landfall. There was no meteorological observation available from Somalia.

6. Forecast and Warning Services

The bulletins were issued by Cyclone Warning Division and Regional Specialised Meteorological Centre (RSMC), New Delhi in regular intervals to WMO/ESCAP Panel countries. As Somalia and Yemen are not members of this Panel, the bulletins were sent to them through the WMO. Following is the statistics of bulletins issued during cyclone, Murjan.

Number of bulletins issued to WMO/ESCAP Panel countries and Somalia and Yemen	: 17
Number of bulletins issued for India coast	: 07
Number of bulletins issued for international civil aviation	: 06

5.1. Forecast Performance

On the first bulletin issued at 1130 hrs IST of 23rd October, 2012 (60 hrs before landfall over Somalia), i.e. sixty hours in advance of landfall, when the system was a depression located at 1200 km east-southeast of Socotra Island, it was predicted that the system would intensify into a cyclonic storm and move towards Somalia and Yemen coast. The average track forecast error is shown in Table 2. It was 61km, 67 km, 92 km and 112 km respectively for 6, 12, 24 and 36 hrs forecast period. This error is significantly less than the average forecast errors in last five years. Considering the landfall forecast error, the landfall near Somalia was predicted well in advance (before 60 hrs). The landfall point forecast errors are about 14 km, 13 km and 23 km and landfall time forecast errors are 1 hr, 5.5 hr and 1.5 hr for 12, 24 and 36 hr lead period respectively (Table 3), which is significantly less than the long period average. The average intensity forecast errors are shown in Table 4. The errors are less than 10 knots for 12-36 hr forecasts, which are comparatively less than the long period average errors.

Table 2: Track Forecast Error:

Lead Period (hr)	Error (km)
12	67 (4)
24	92 (3)
36	112 (1)

(Number in parenthesis indicates number of forecasts verified)

Table 3: Landfall Forecast Error

Lead Period	Position Error (km)	Time Error (hr)
12	14	1 hr Early
24	13	5.5 hrs Early
36	23	1.5 hrs Early

Table 4: Average intensity Forecast Error:

Lead Period (hr)	Absolute error (knots)	Root mean square (RMS) error	Number of forecasts verified
12	6.9	7.8	5
24	6	6.4	3
36	7.4	7.4	1

5. NWP Guidance

The genesis, track and intensity of the cyclone, Murjan was reasonably captured by most of the models. The NWP model analyses of mean sea level pressure, and wind at 850, 500 and 200 hPa levels based on 0000 UTC of 23, 24 and 25 October 2012 for ECMWF, UKMO and IMD GFS models are shown in Fig.4-6.

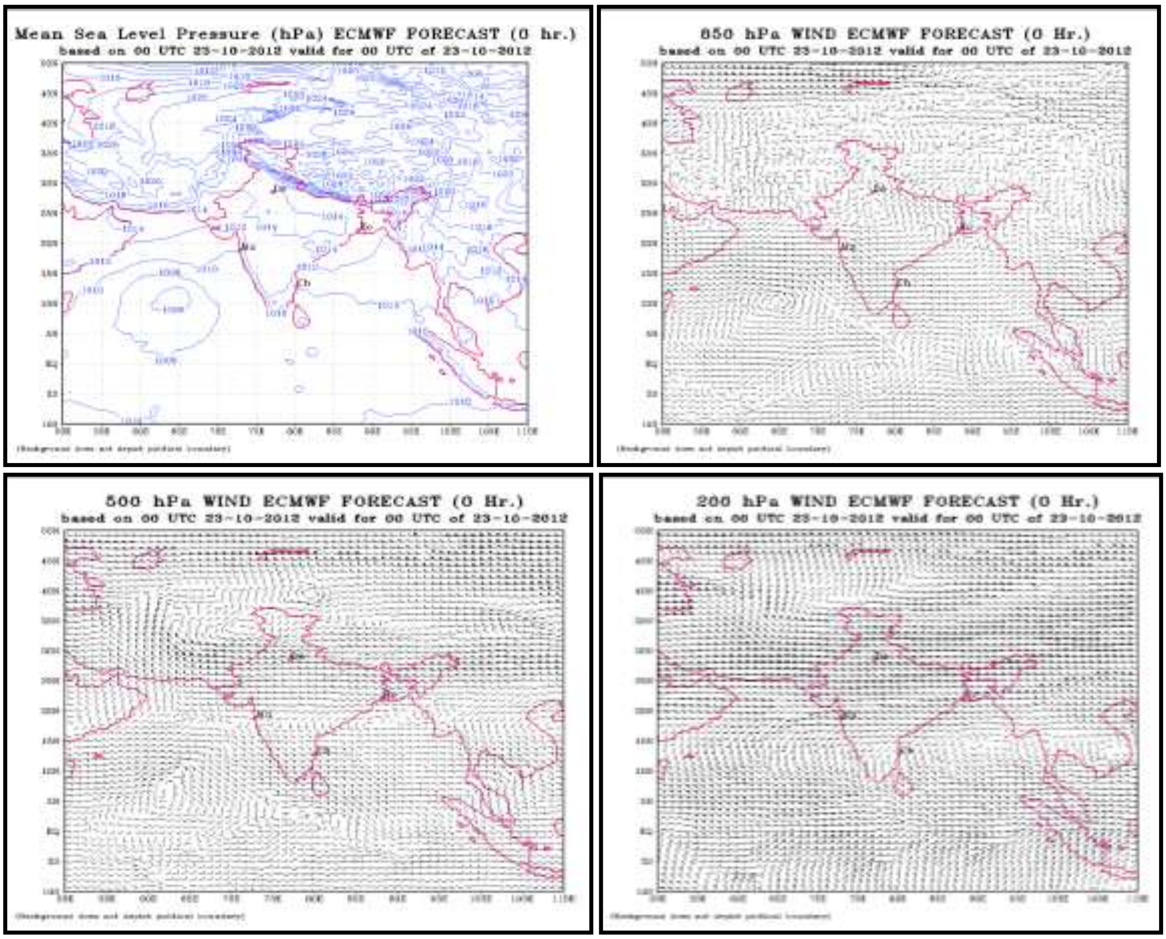

Fig.4 (a). ECMWF ANALYSIS of MSLP and Winds at 850, 500 and 200, 500 and 200 hPa based on 0000 UTC of 23rd October, 2012

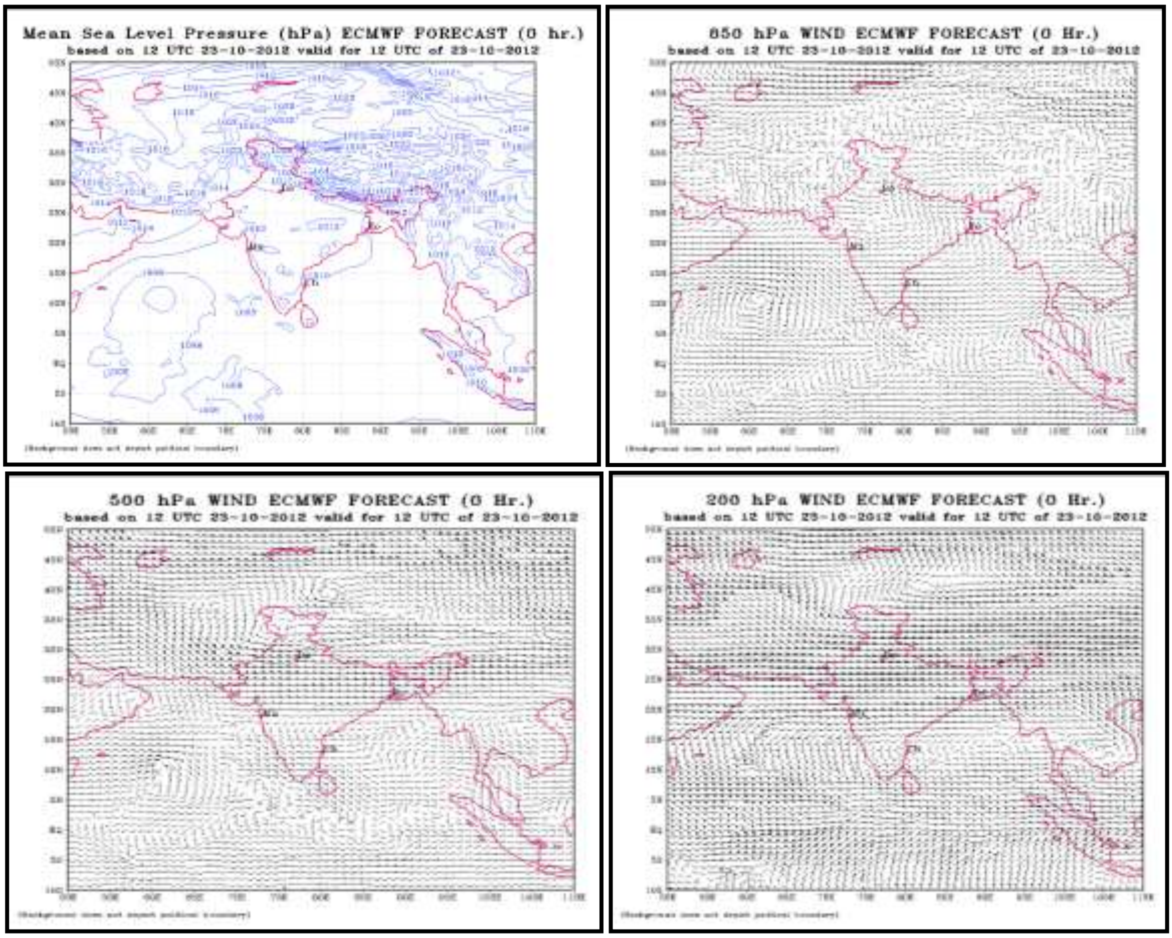

Fig.4 (b). ECMWF ANALYSIS of MSLP and Winds at 850, 500 and 200 hPa based on 1200 UTC of 23rd October, 2012

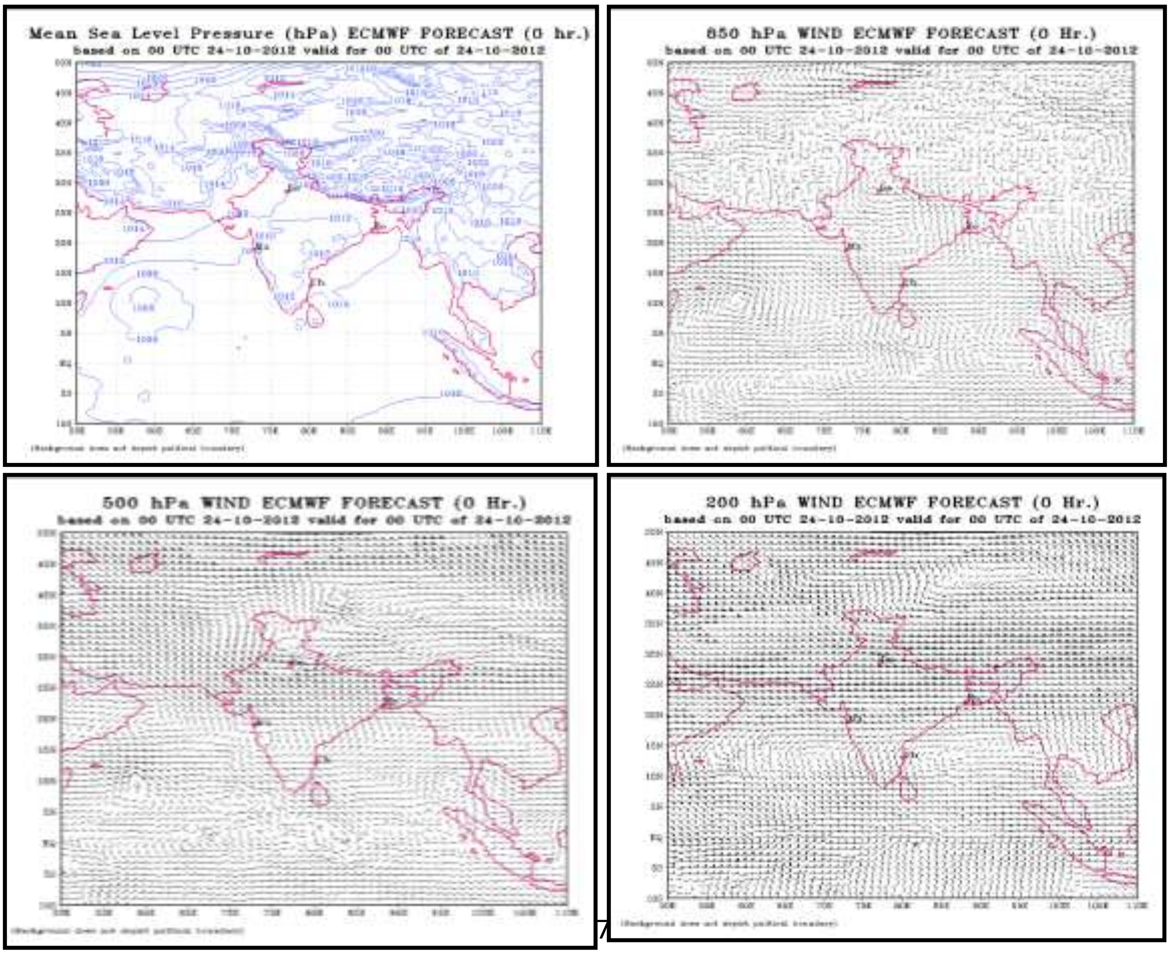

Fig4. (c) ECMWF ANALYSIS of MSLP and Winds at 850, 500 and 200 hPa based on 0000 UTC of 24th October, 2012

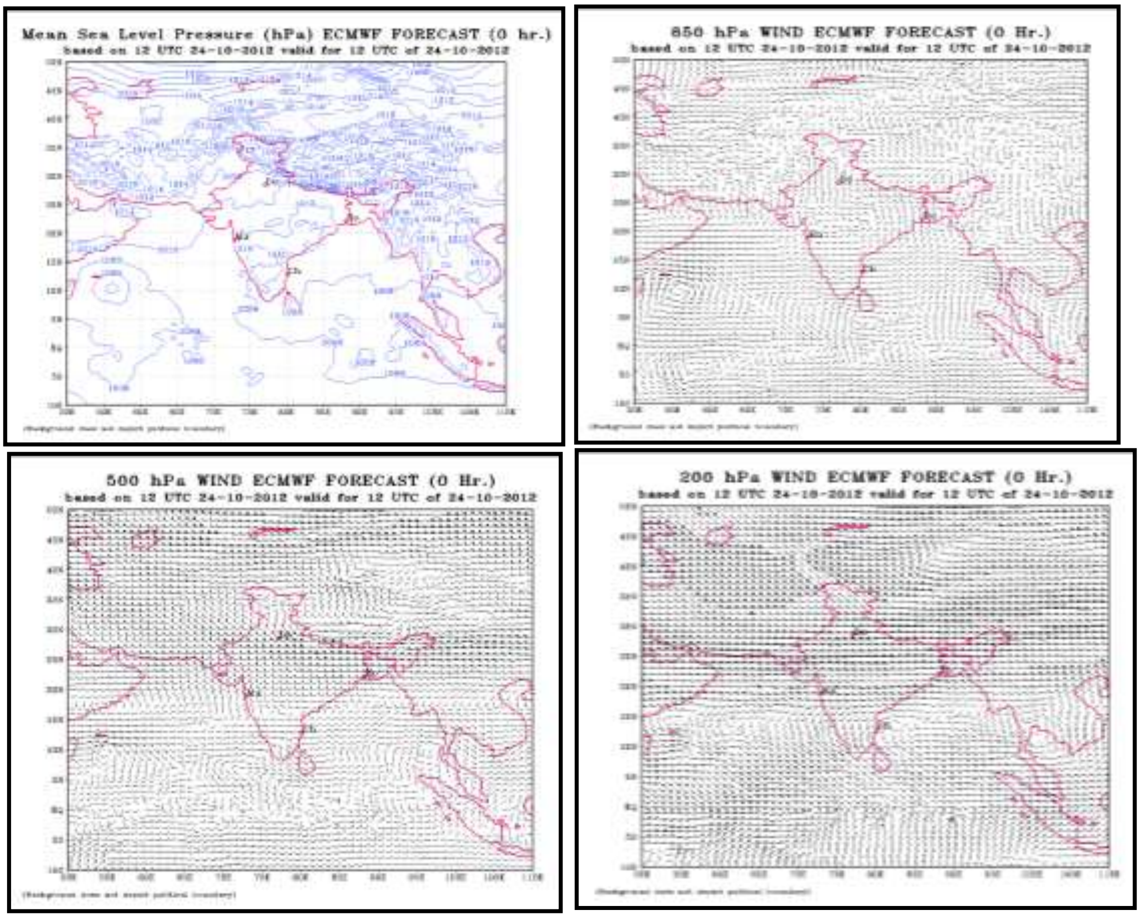

Fig. 4(d). ECMWF analysis of MSLP and Winds at 850, 500 and 200 hPa based on 1200 UTC of 24th October, 2012

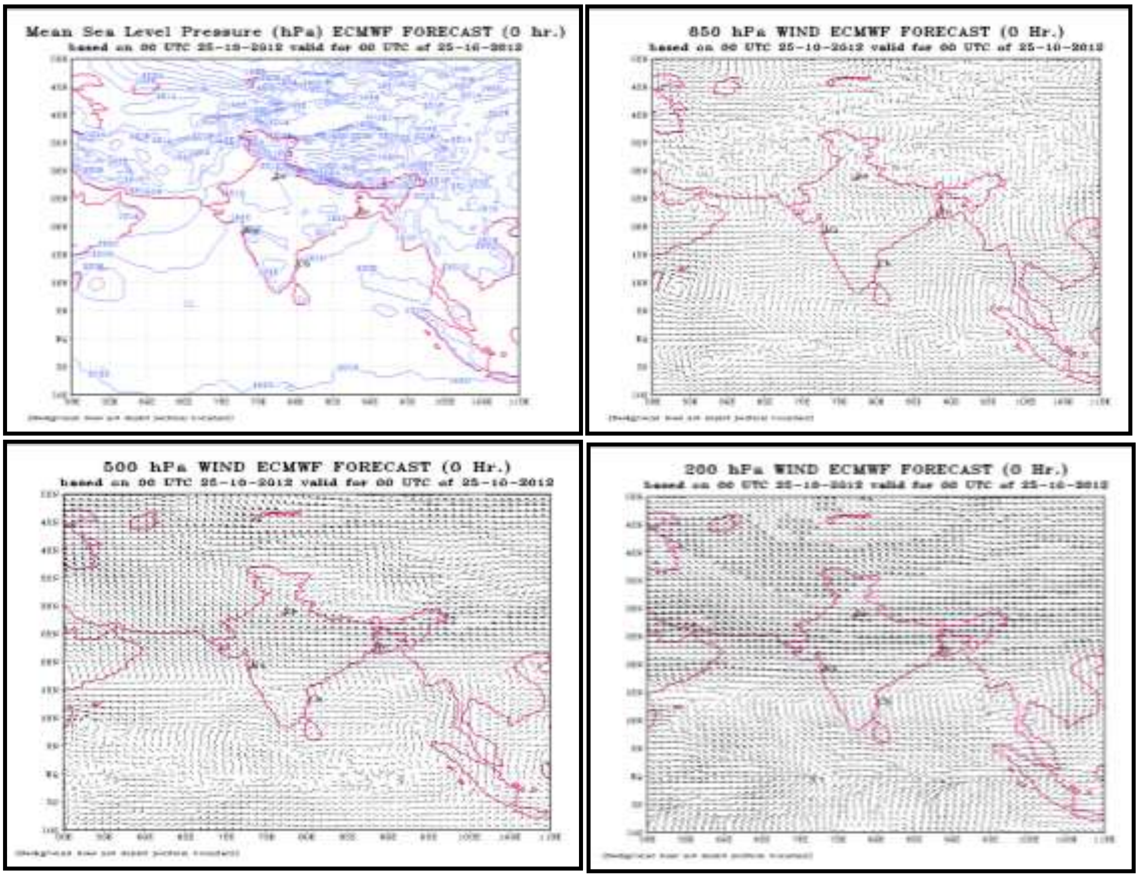

Fig. 4(e). ECMWF ANALYSIS of MSLP and Winds at 850, 500 and 200 hPa based on 0000 UTC of 25th October, 2012

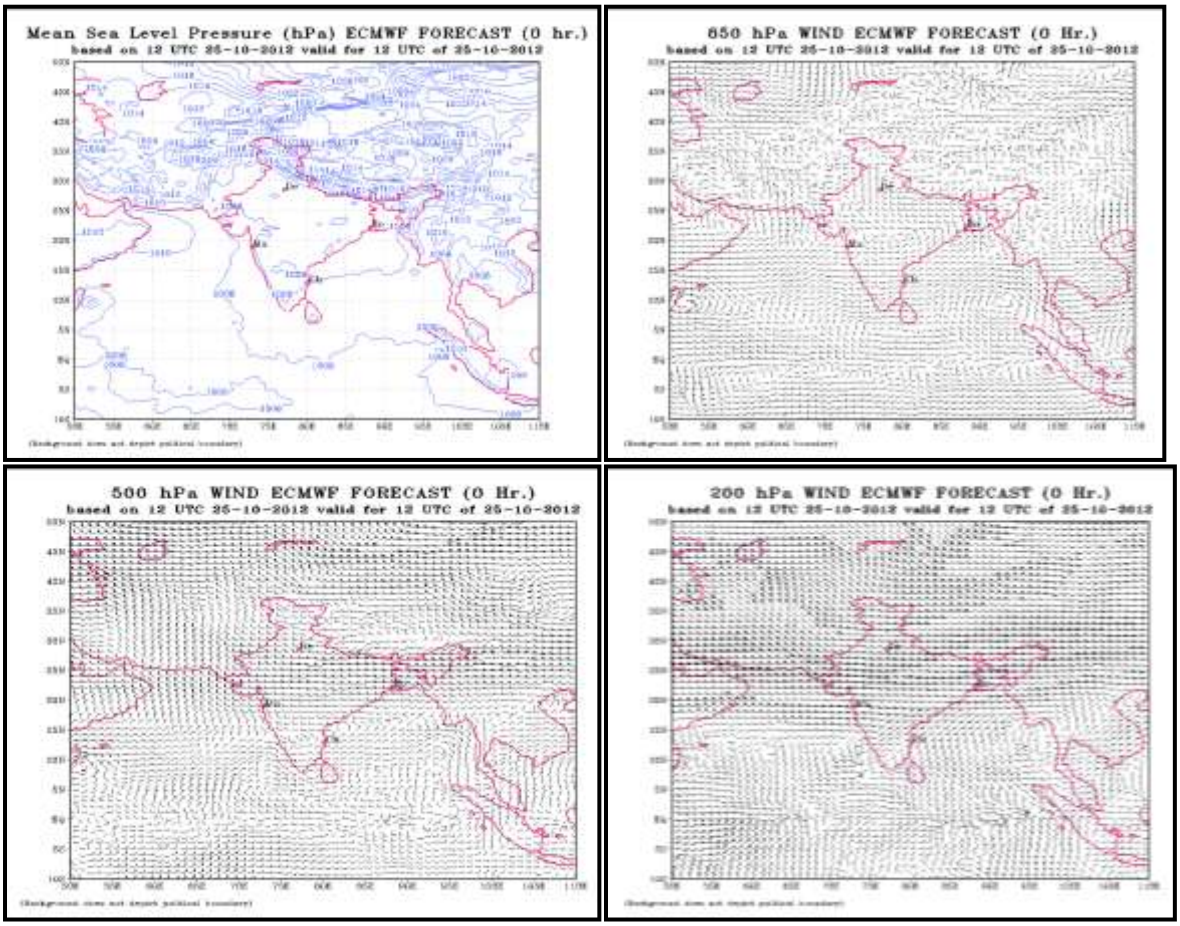

Fig.4(f). ECMWF ANALYSIS of MSLP and Winds at 850, 500 and 200 hPa based on 1200 UTC of 25th October, 2012

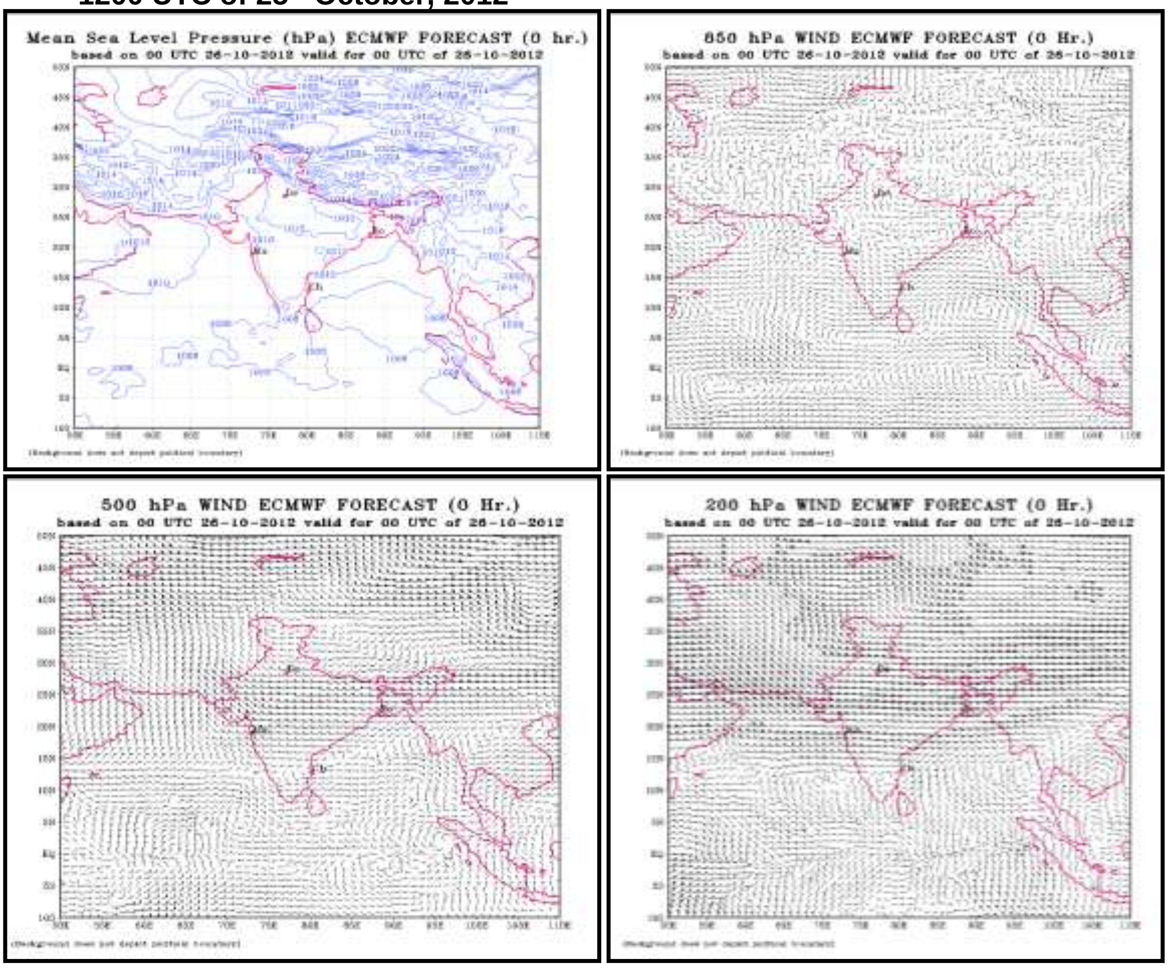

Fig. 4(g). ECMWF ANALYSIS OF MSLP and Winds at 850, 500 and 200 hPa based on 0000 UTC of 26th October, 2012

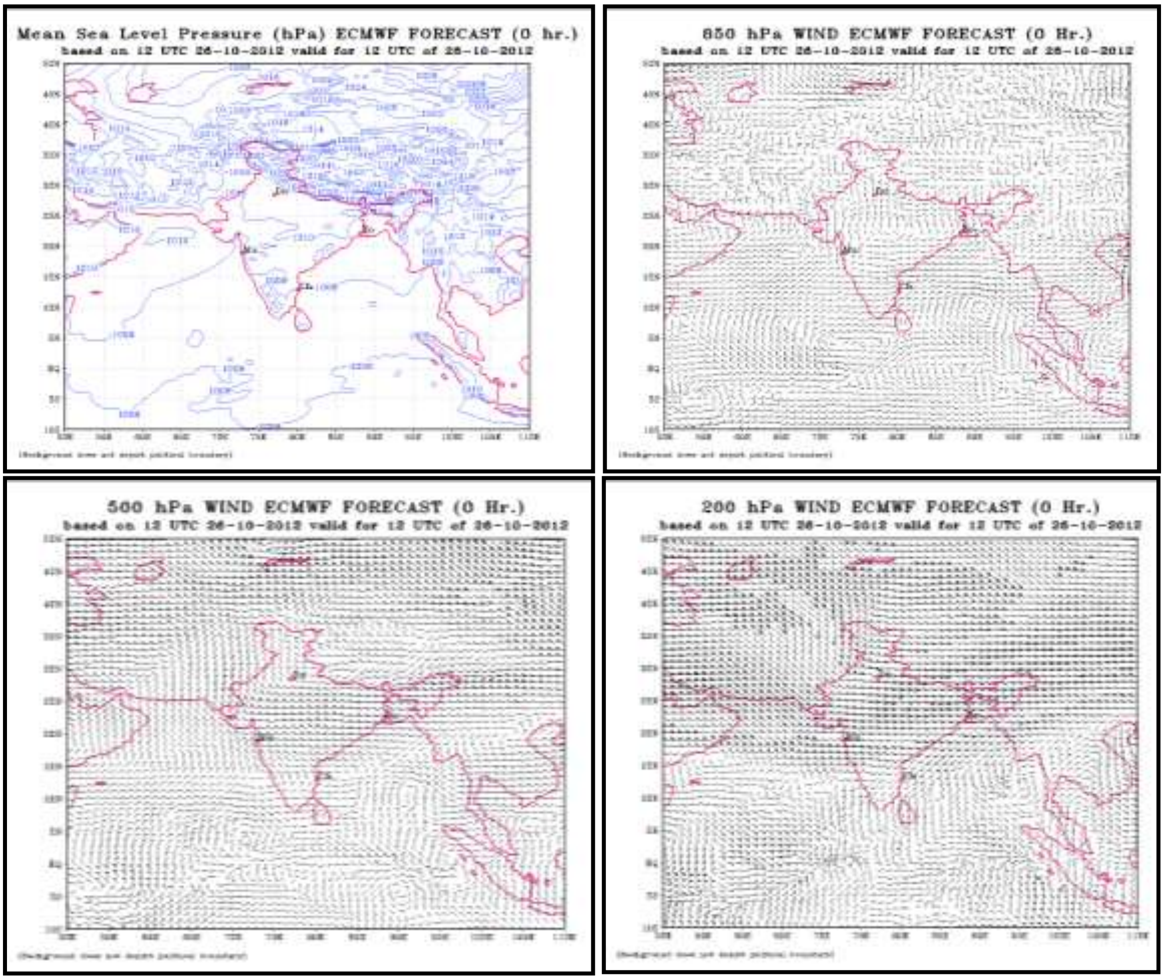

Fig. 4(h). ECMWF analysis of MSLP and Winds at 850, 500 and 200 hPa based on 1200 UTC of 26th October, 2012

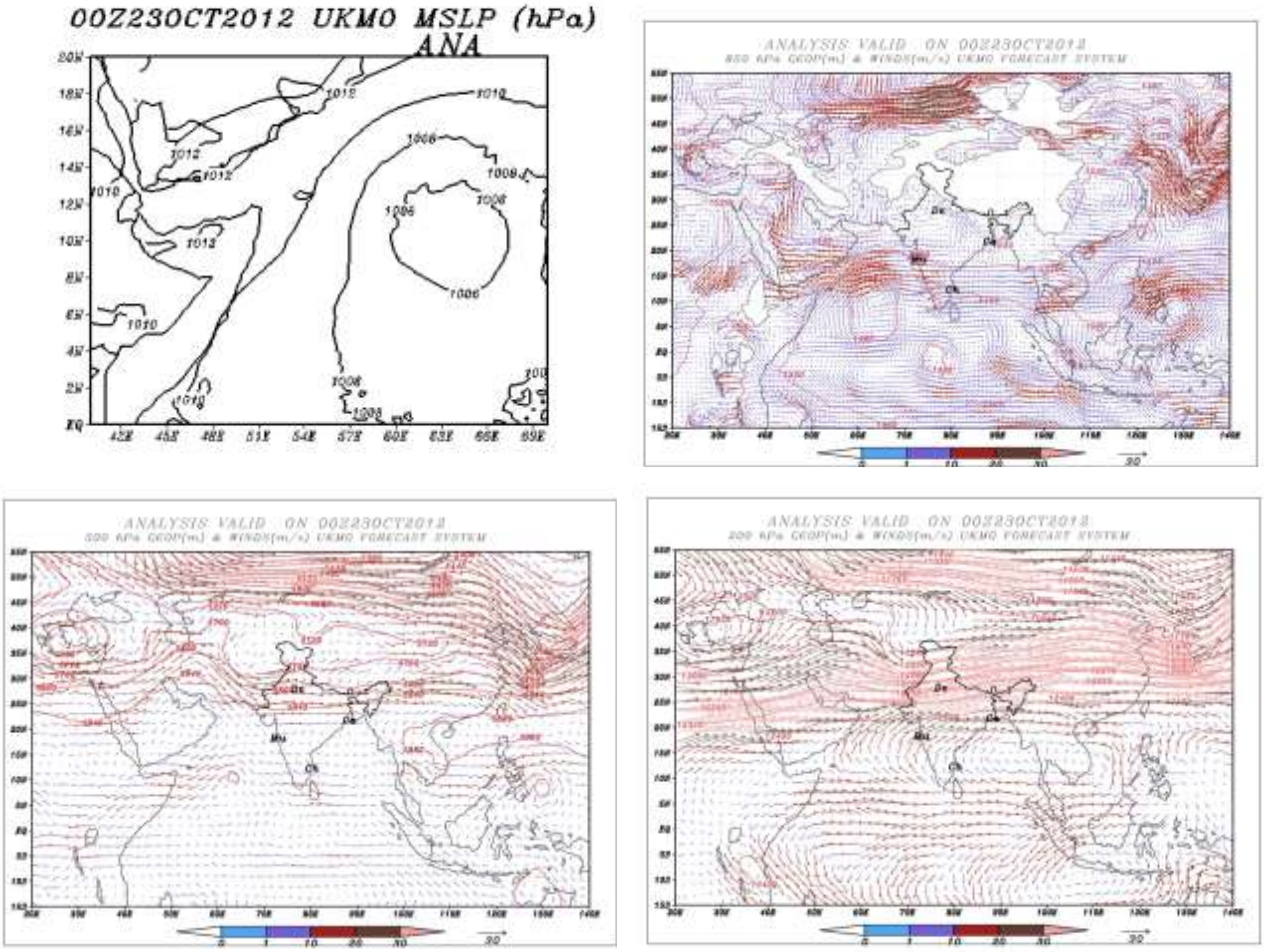

Fig. 5(a)UKMO analysis MSLP and wind at 850,500 & 200 hPa based on 0000 UTC of 23 October, 2012

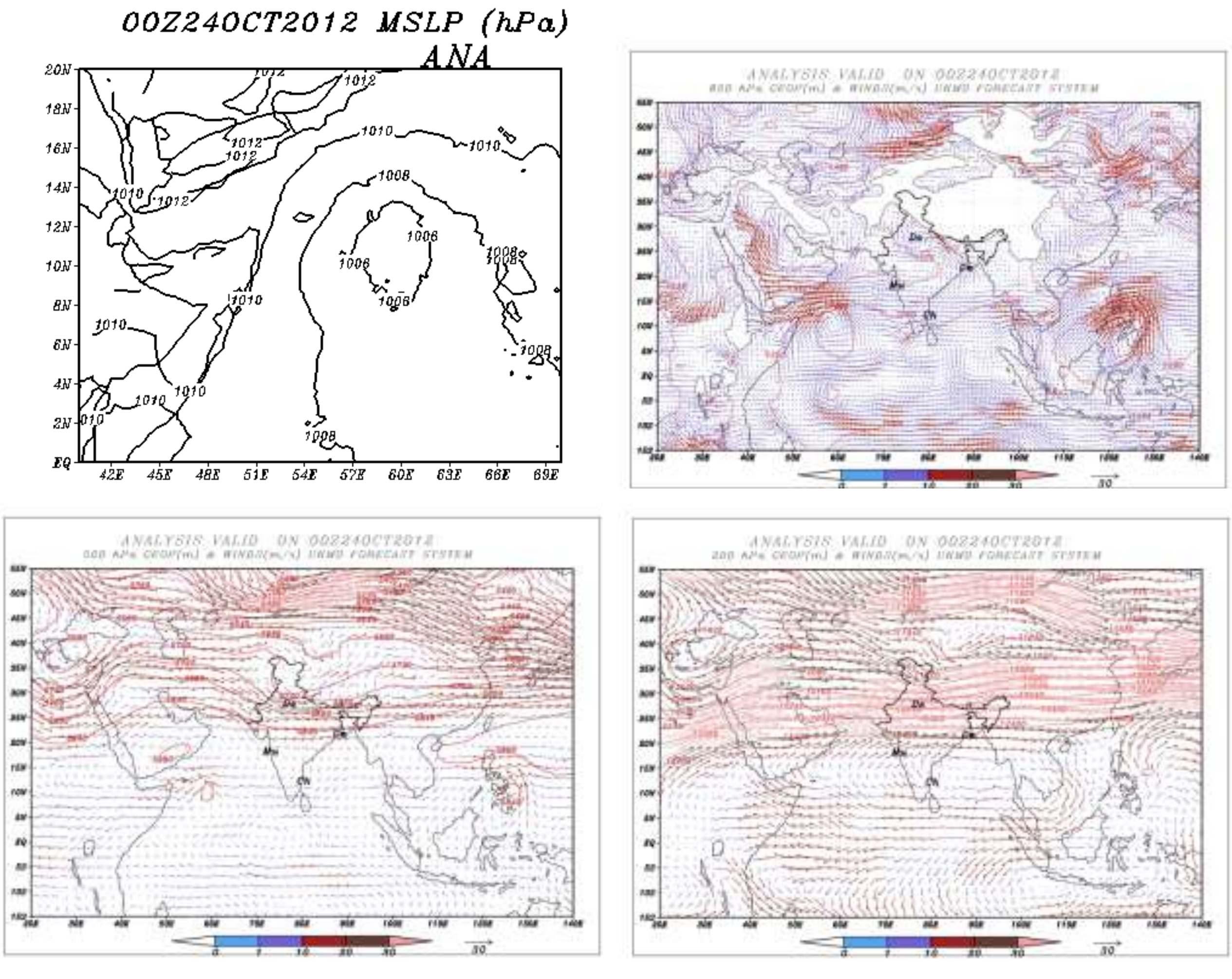

Fig. 5(b) UKMO analysis of MSLP and wind 850, 500 & 200 hPa based on 0000 UTC of 24 October, 2012

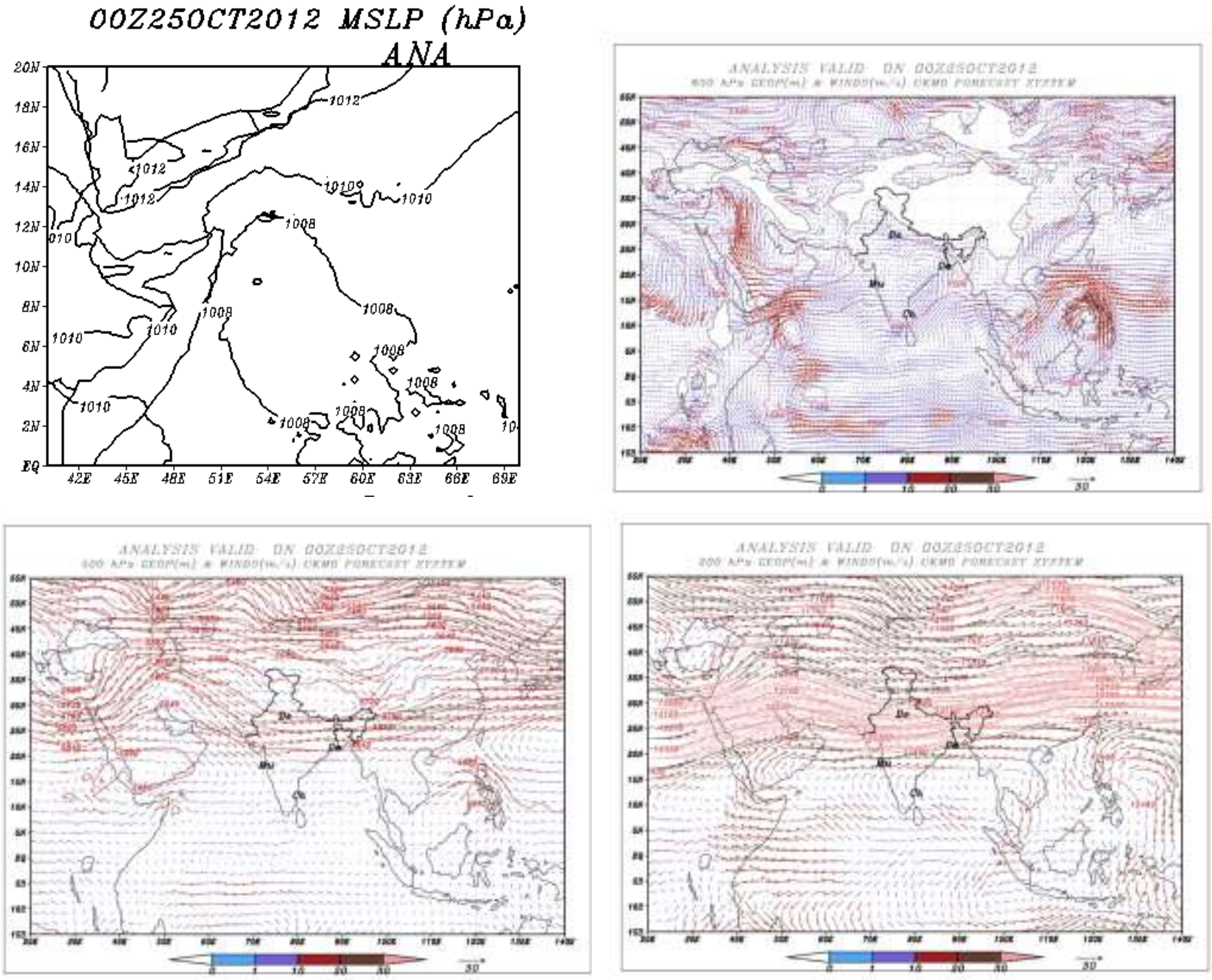

Fig.5 (c) UKMO analysis of MSLP and wind at 850, 500 & 200 hPa. based on 0000 UTC of 25 October. 2012

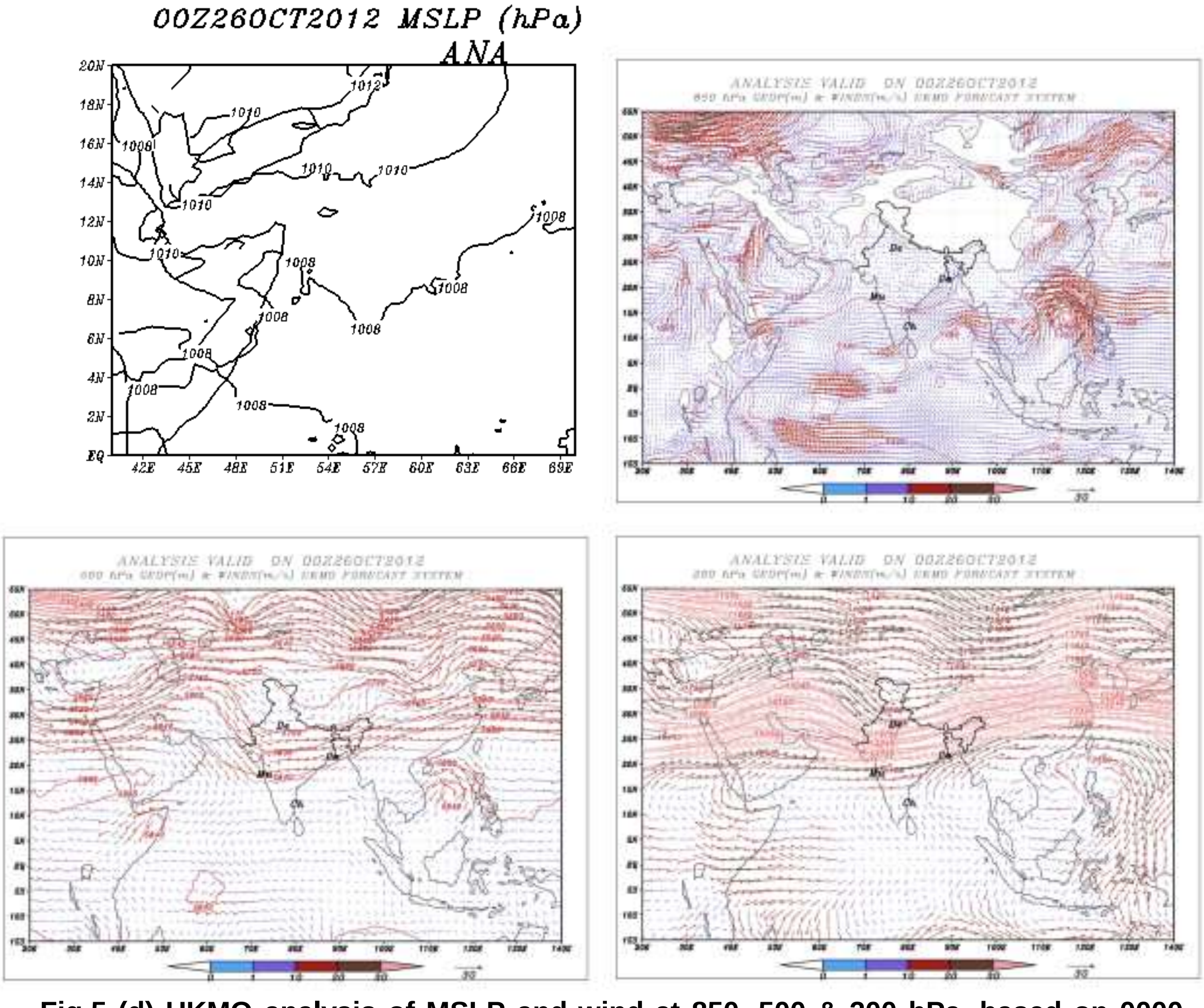

Fig.5 (d) UKMO analysis of MSLP and wind at 850, 500 & 200 hPa. based on 0000 UTC of 26 October. 2012

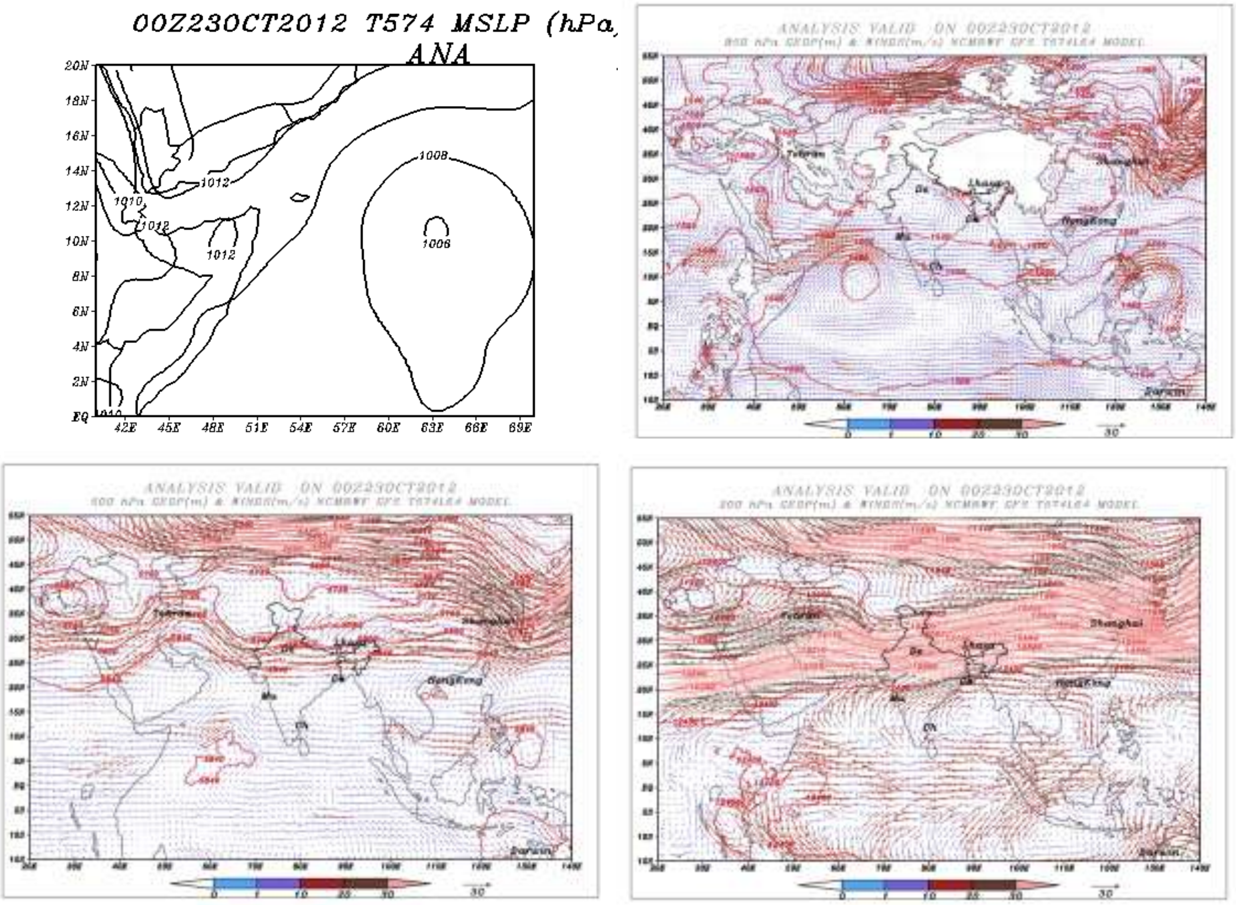

Fig.7(a) NCMRWF GFS 574L64 analysis of MSLP and wind at 850, 500 & 200 hPa based on 0000 UTC of 23 October, 2012

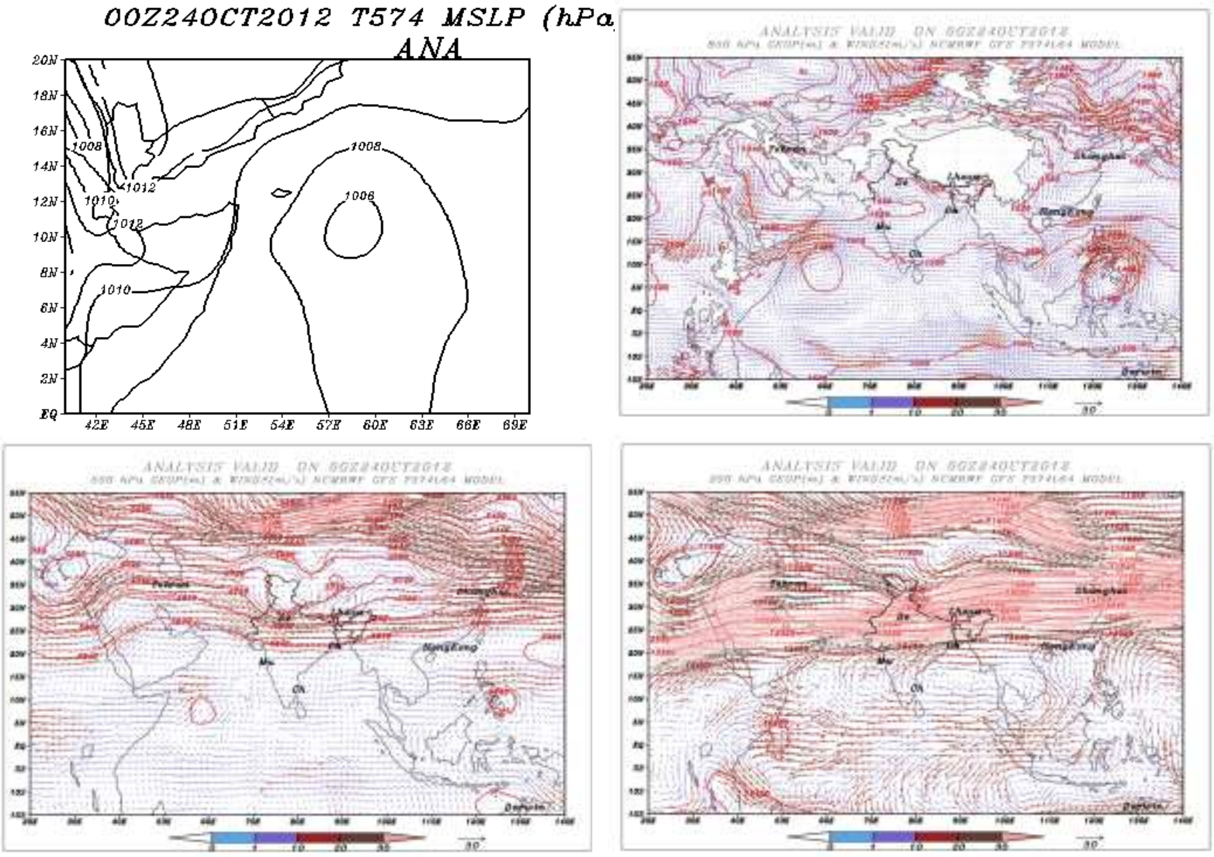

Fig.7(b) NCMRWF GFS 574L64 analysis of MSLP and wind at 850, 500 & 200 hPa based on 0000 UTC of 24 October, 2012

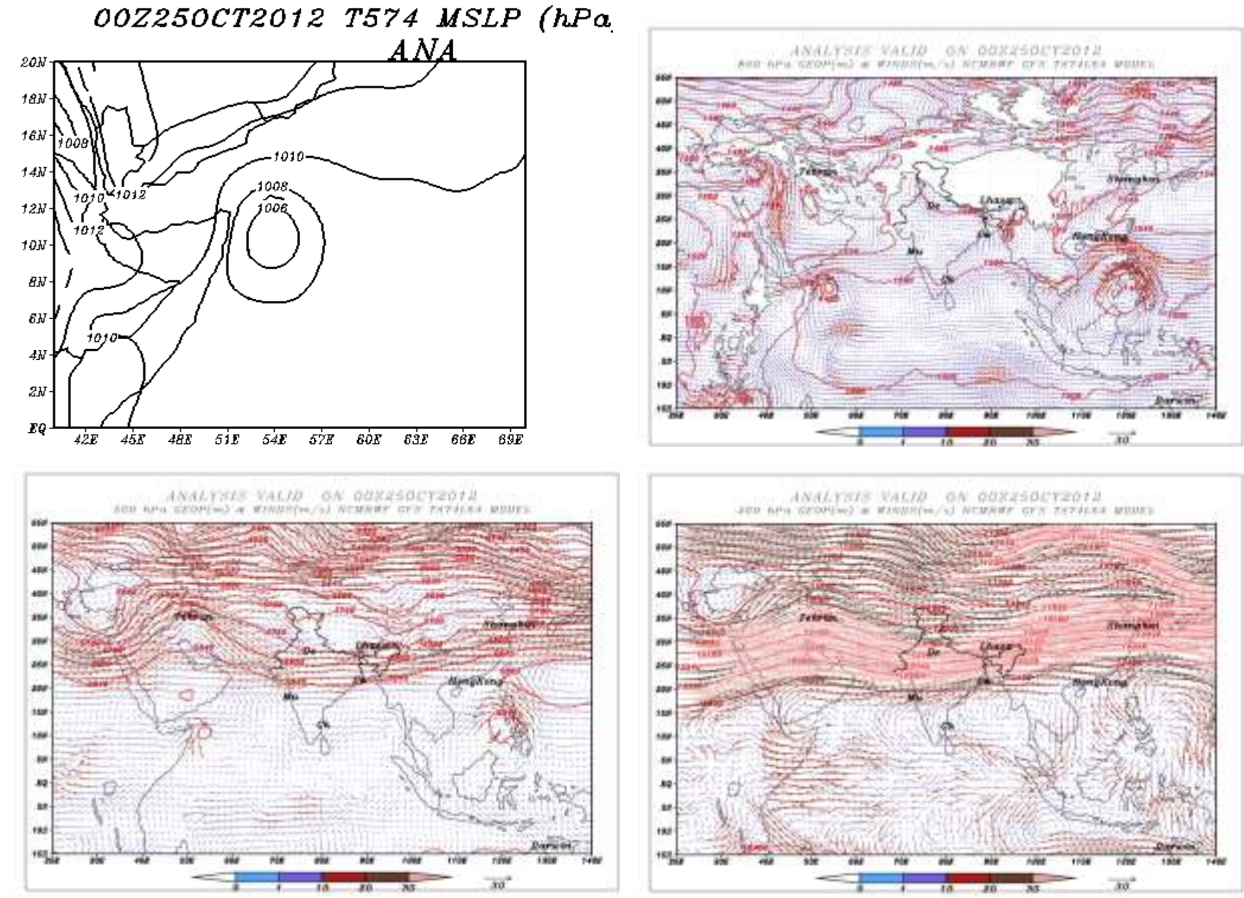

Fig.7(c) NCMRWF GFS 574L64 analysis of MSLP and wind at 850, 500 & 200 hPa based on 0000 UTC of 25 October, 2012

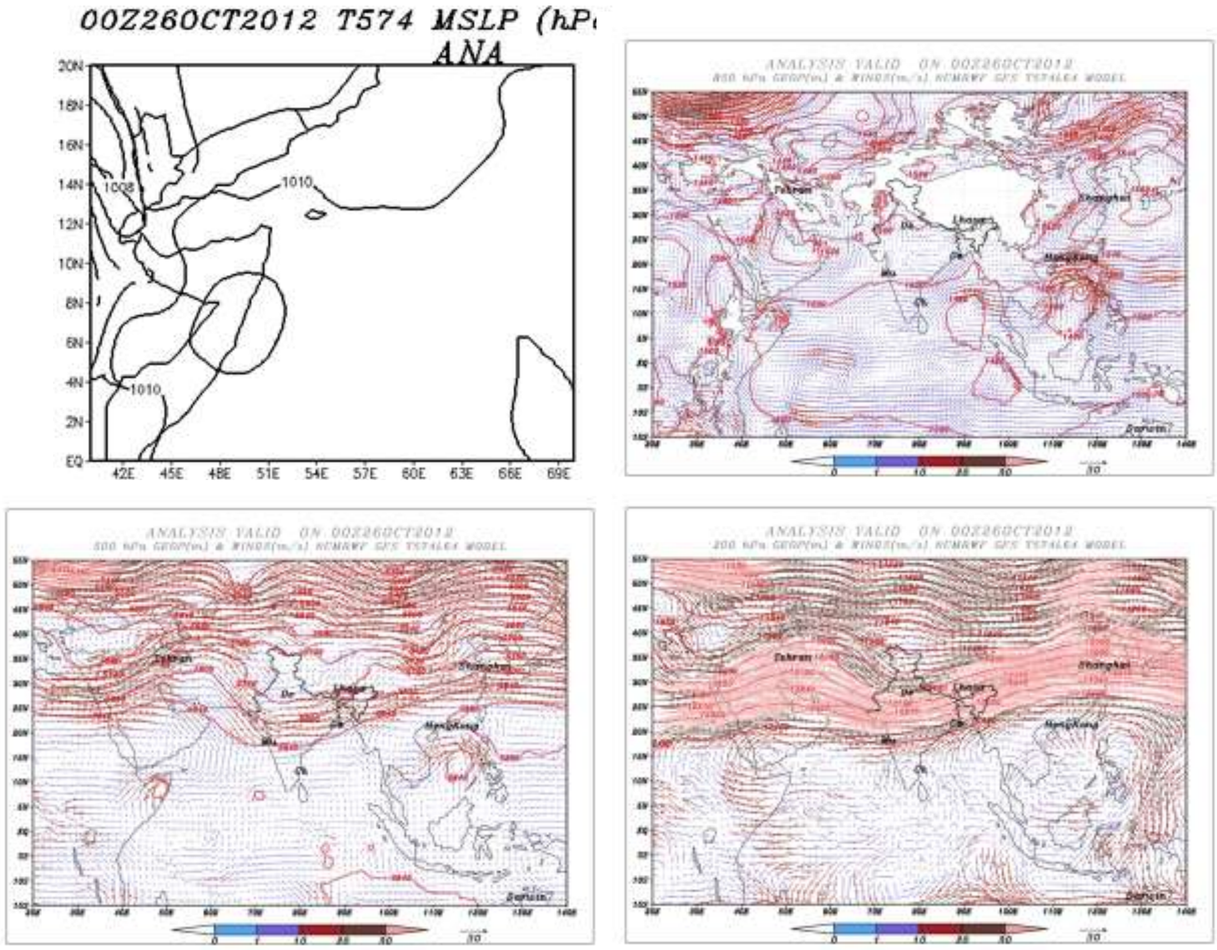

Fig.7(d) NCMRWF GFS 574L64 analysis of MSLP and wind at 850, 500 & 200 hPa based on 0000 UTC of 26 October, 2012

7. Damage

There were reports of large scale flooding in Bosaso city in Somalia. The storm brought strong winds and heavy but beneficial rains within the areas of Bari region (Bossasso, Ishkushban and Bandar Beyla) according to the Somalia Water and Land Information Management, as reported in the media.