

Deep Depression over the Arabian sea (06- 10 November 2011)

8.1. Introduction:

A depression formed over southeast Arabian Sea on 6th November 2011, moved initially west-northwestwards and intensified into a depression and further into a deep depression. However, as it moved then northwestwards/northwards towards, westcentral Arabian Sea, it entered into colder sea and gradually dissipated over westcentral Arabian Sea off Oman coast on 10th November, 2011. The salient features of the system are described below.

8.2. Genesis:

Under the influence of active Inter Tropical Convergence zone (ITCZ) running roughly along 10⁰N over the Arabian Sea a low pressure area formed over southeast Arabian Sea on 4th November 2011. It became well marked on 5th with formation of a vortex ($T=1.0$) as seen in Kalpana satellite imagery. The Madden Julian oscillation (MJO) index lay over phase 4 with amplitude more than 1. While phase 4 is favourable, phase 5 and 6 are not favourable for cyclogenesis and intensification over the Arabian Sea. Sea surface temperature was 28⁰-29⁰ C. The ocean heat content was less (60-80 kJ/cm²). The relative vorticity at 850 hPa level and upper level divergence increased on 6th November, 2011. The vertical wind shear of horizontal wind over the region was favourable as it was low to moderate (between 10-20 knots). There was negative (05 knots) 24 hour tendency of vertical wind shear around system centre. The system lay to the south of upper tropospheric ridge, which roughly ran along 17⁰ N in association with an anticyclonic circulation to the northeast of system centre. Considering all these, the well marked low pressure area concentrated into a depression over southeast Arabian Sea and lay centred at 0600 UTC of 06th November 2011 near latitude 10.5⁰N and longitude 65.5⁰E. Satellite imagery indicated gradual increase in convection and organisation of the system. Associated broken intense to very intense convection are seen over Arabian Sea between lat. 8.5⁰N to 15.0⁰N long. 59.0⁰E to 65.5⁰E. The lowest cloud top temperature (CTT) due to convection was around -78⁰c in association with the system. Sustained maximum surface wind speed was estimated to be about 25 knots around system centre. The estimated central pressure is about 1004 hPa. The ship (position near 9.5⁰N and 68⁰E) reported MSLP of 1010.5 hPa with tendency of +1.5 hPa and wind of 210/19 knots. Another ship (position near 13.6⁰n and 62.9⁰e) reported MSLP of 1011.1 hPa with tendency of -1.0 hPa and wind of 010/30 knots.

8.3. Intensification and movement:

All the above mentioned synoptic and environmental condition continued during 6-8th November 2011. It resulted in the west-northwestward movement of the system and gradually intensification. It intensified into a deep depression and lay centred at 0300 UTC of 8th November, 2011 over westcentral Arabian Sea near lat. 13.5⁰N and long.60.0⁰E.

The MJO index moved to phase 6 on 9th November which is not favourable for intensification of the system. Also the system lay over the colder Sea with SST of 26-28⁰ C and Ocean heat content of < 40 KJ/cm². The vertical wind shear of the horizontal wind also increased to 15-25 knots, as the system came under the influence of middle and

upper tropospheric westerly trough to its west along 40⁰E. It also lay closed to the south of upper tropospheric ridge. As a result the deep depression moved north-northwestwards/northwards on 9th and 10th and weakened gradually. It weakened into a depression at 1200 UTC of 9th and into a well marked low pressure area at 1200 UTC. Though the system came under the influence of upper tropospheric westerly trough, it could not recurve northeastwards and rather moved slowly northward, as it was sandwiched between two anticyclonic circulation, one over the eastcentral Arabian Sea and another over Yemen and adjoining Oman in lower and middle levels.

The best track of the system is shown in Fig. 8.1. The typical satellite imageries are shown in Fig. 8.2. The best track and other parameters are shown in Table 8.1. The ECMWF analysis based on 0000 UTC initial condition during 5-10 November 2011 are shown in Fig. 8.3. The crucial observations are given in Table 8.2

Table 8.1 The best track position and other parameters of the deep depression over the Arabian Sea during 06-10 November, 2011.

Date	Time (UTC)	Centre lat. ⁰ N/long ⁰ E	C.I. No.	Estimated centre pressure (hPa)	Estimated maximum sustained surface wind (kts)	Estimated pressure drop at the centre (hPa)	Grade
06-11-2011	0600	10.5/65.5	1.5	1004	25	3	D
	1200	10.6/65.3	1.5	1004	25	3	D
	1800	11.0/64.5	1.5	1004	25	3	D
07-11-2011	0000	11.5/64.0	1.5	1002	25	3	D
	0300	11.5/63.5	1.5	1002	25	3	D
	0600	12.5/62.0	1.5	1002	25	3	D
	1200	13.5/60.5	1.5	1002	25	3	D
	1800	13.5/60.5	1.5	1002	25	3	D
08-11-2011	0000	13.5/60.0	1.5	1002	25	3	D
	0300	13.5/60.0	2.0	1000	30	4	DD
	0600	13.7/59.5	2.0	1000	30	4	DD
	1200	14.0/59.0	2.0	1000	30	4	DD
	1800	14.5/58.5	2.0	1000	30	4	DD
09-11-2011	0000	15.0/58.5	2.0	1000	30	4	DD
	0300	15.0/58.5	2.0	1000	30	4	DD
	0600	15.0/58.5	2.0	1000	30	4	DD
	1200	15.5/58.5	1.5	1002	25	3	D
	1800	15.5/58.5	1.5	1002	25	3	D
10-11-2011	0000	16.0/58.5	1.5	1002	25	3	D
	0300	16.0/58.5	1.5	1002	25	3	D
	1200	The system weakened into a well marked low pressure area over westcentral Arabian Sea off Oman coast.					

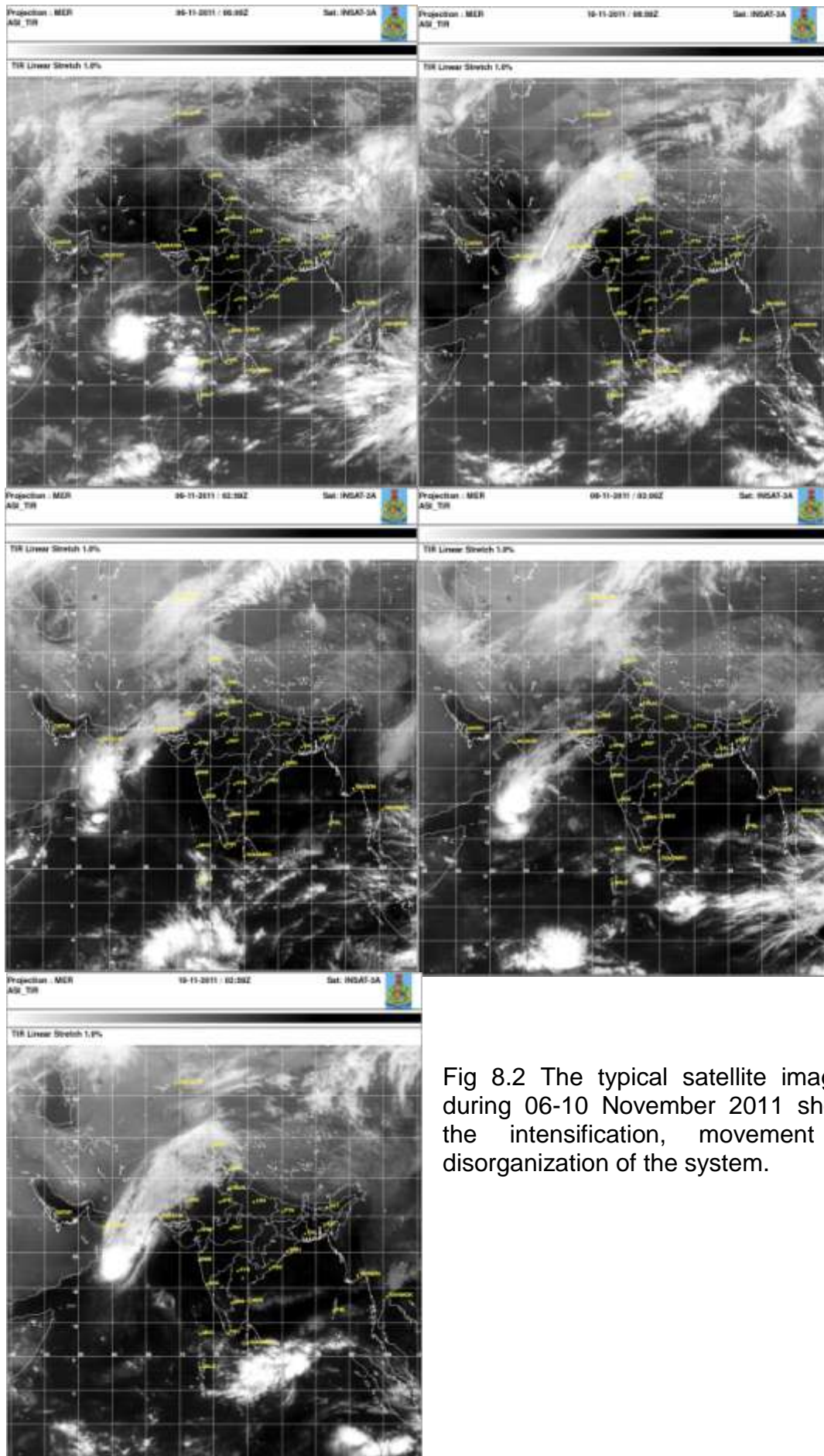
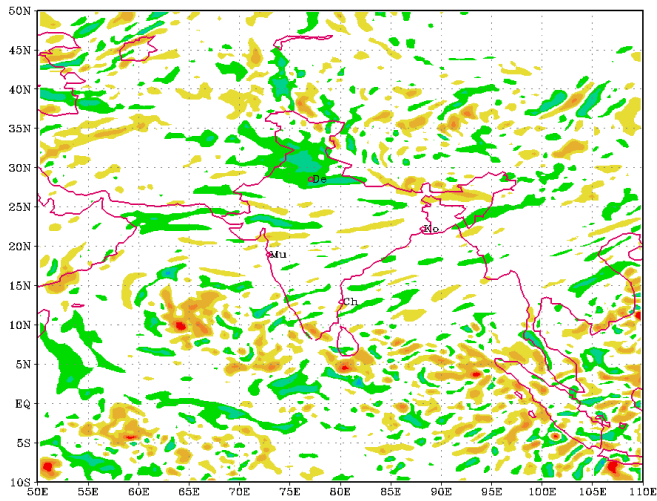
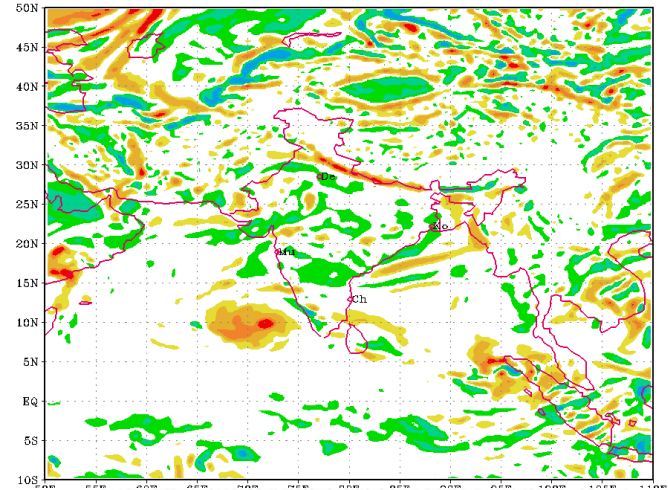


Fig 8.2 The typical satellite imageries during 06-10 November 2011 showing the intensification, movement and disorganization of the system.

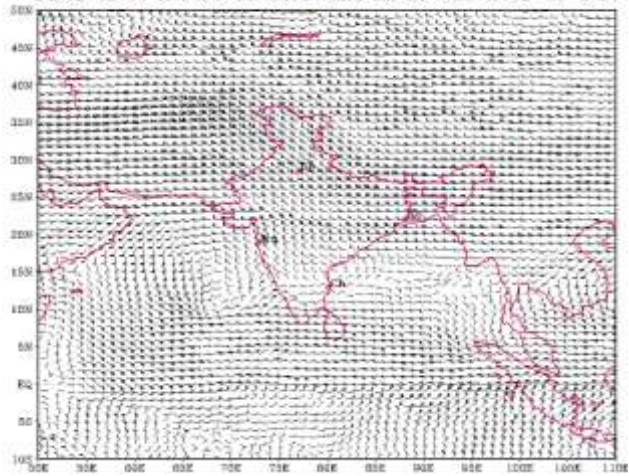
Divergence ($1e5 \text{ s}^{-1}$) at 200 hPa ECMWF Forecast (0 hr.)
 based on 00 UTC 05-11-2011 valid for 00 UTC of 05-11-2011



Vorticity ($1e5 \text{ s}^{-1}$) at 850 hPa ECMWF Forecast (0 hr.)
 based on 00 UTC 05-11-2011 valid for 00 UTC of 05-11-2011



Wind Shear between 200 & 850 hPa ECMWF FORECAST
 based on 00 UTC 05-11-2011 valid for 00 UTC of 05-11-2011



200 hPa WIND ECMWF FORECAST (0 Hr.)
 based on 00 UTC 05-11-2011 valid for 00 UTC of 05-11-2011

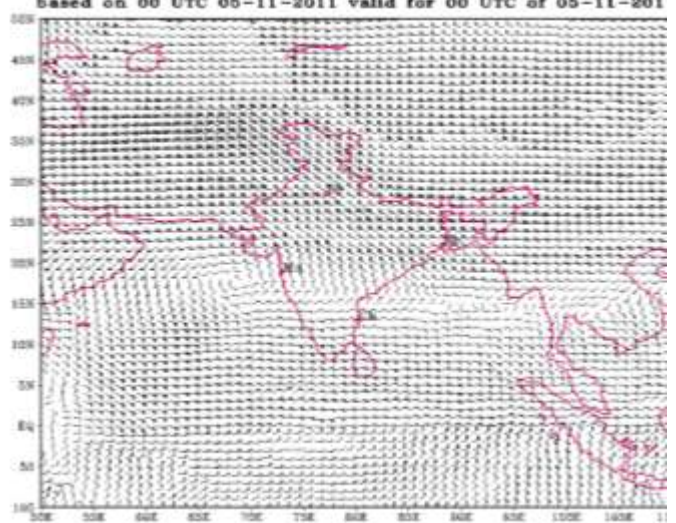
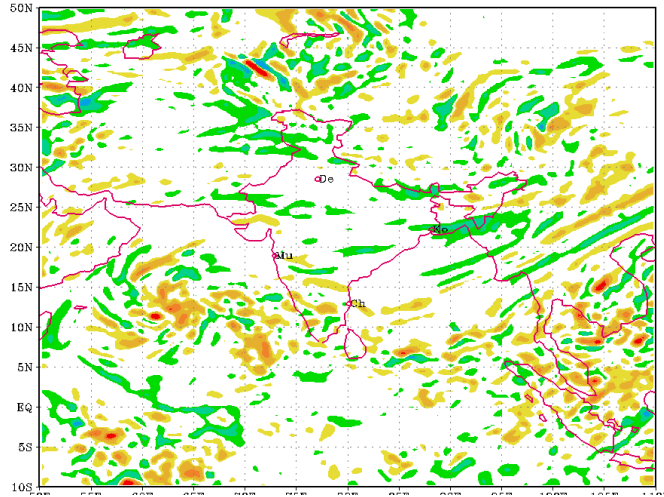
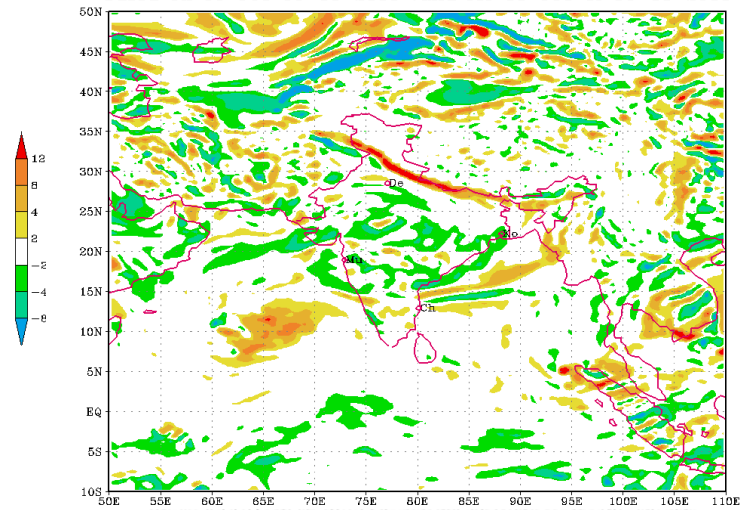


Fig. 8.3 (a) (i) Upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) vertical wind shear of horizontal wind between 200 and 850 hPa level (iv) wind at 200 hPa level based on the ECMWF model analysis of 0000 UTC of 5th November, 2011.

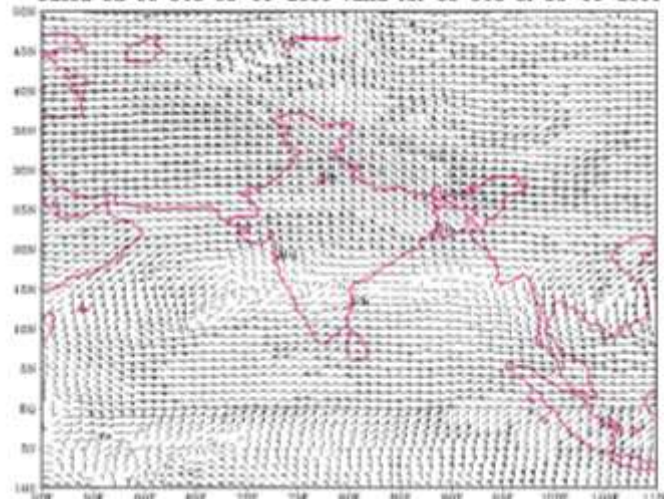
Divergence ($1e5 \text{ s}^{-1}$) at 200 hPa ECMWF Forecast (0 hr.)
based on 00 UTC 06-11-2011 valid for 00 UTC of 06-11-2011



Vorticity ($1e5 \text{ s}^{-1}$) at 850 hPa ECMWF Forecast (0 hr.)
based on 00 UTC 06-11-2011 valid for 00 UTC of 06-11-2011



Wind Shear between 200 & 850 hPa ECMWF FORECAST
based on 00 UTC 06-11-2011 valid for 00 UTC of 06-11-2011



200 hPa WIND ECMWF FORECAST (0 Hr.)
based on 00 UTC 06-11-2011 valid for 00 UTC of 06-11-2011

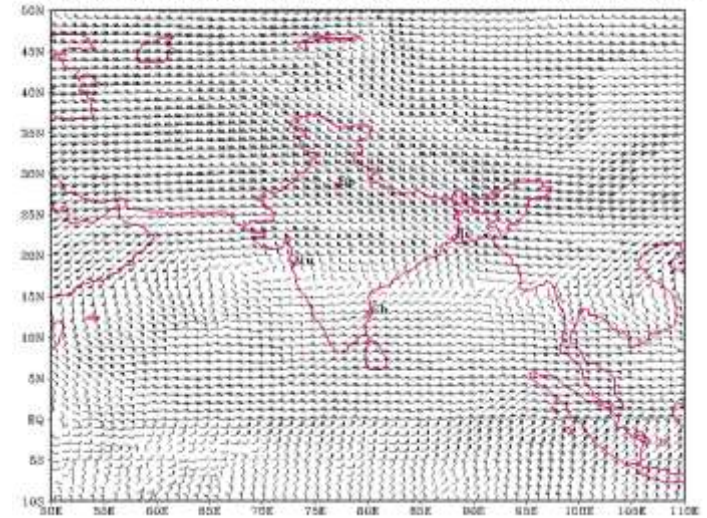
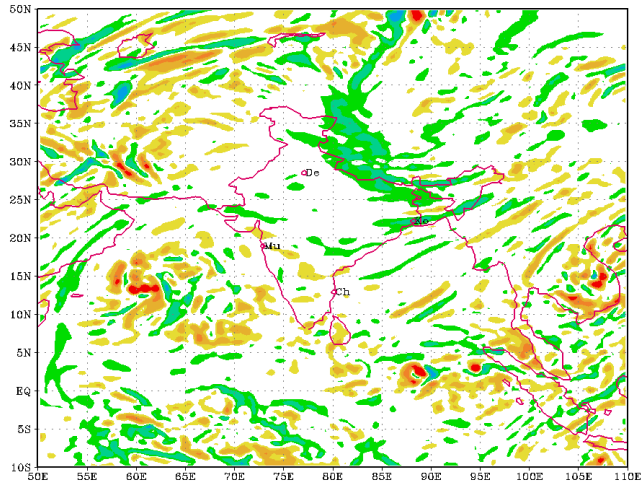
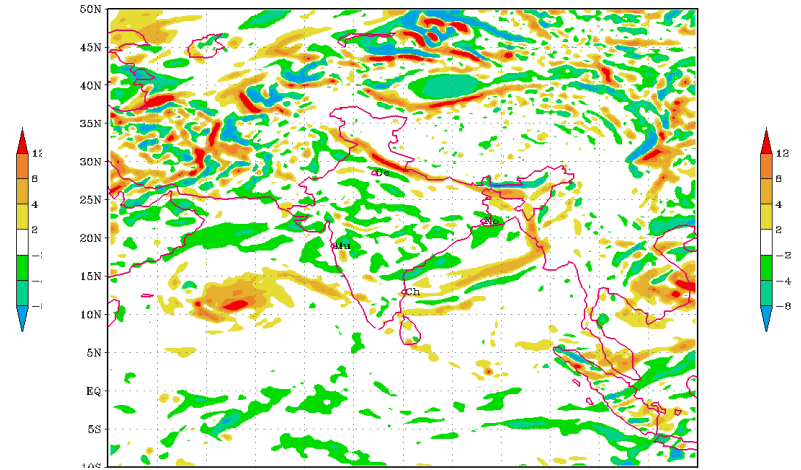


Fig. 8.3 (b) (i) Upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) vertical wind shear of horizontal wind between 200 and 850 hPa level (iv) wind at 200 hPa level based on the ECMWF model analysis of 0000 UTC of 6th November, 2011.

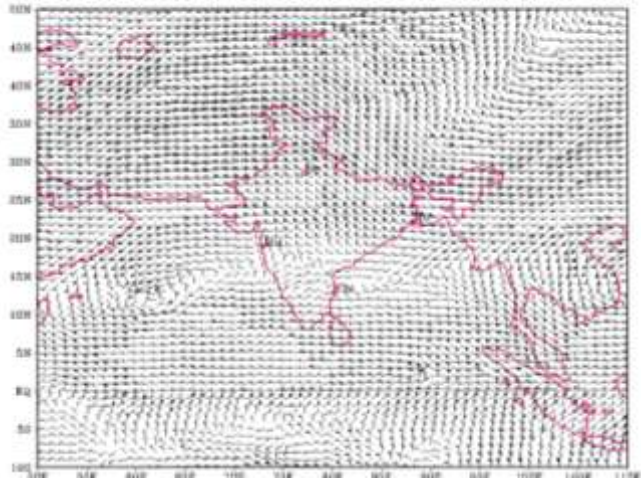
Divergence ($1e5 \text{ s}^{-1}$) at 200 hPa ECMWF Forecast (0 hr.)
based on 00 UTC 07-11-2011 valid for 00 UTC of 07-11-2011



Vorticity ($1e5 \text{ s}^{-1}$) at 850 hPa ECMWF Forecast (0 hr.)
based on 00 UTC 07-11-2011 valid for 00 UTC of 07-11-2011



Wind Shear between 200 & 850 hPa ECMWF FORECAST (0 hr.)
based on 00 UTC 07-11-2011 valid for 00 UTC of 07-11-2011



200 hPa WIND ECMWF FORECAST (0 Hr.)
based on 00 UTC 07-11-2011 valid for 00 UTC of 07-11-2011

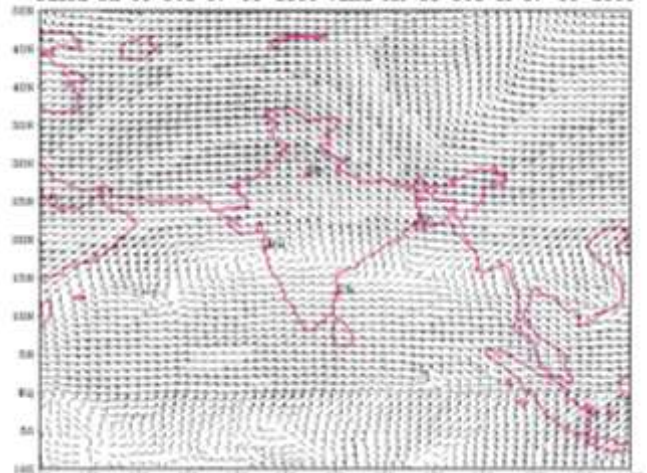
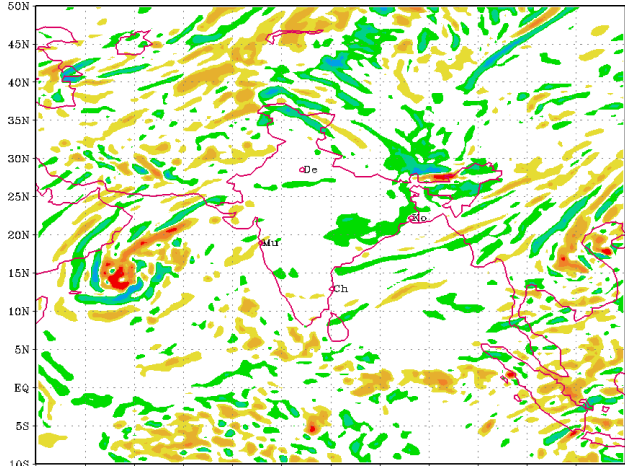
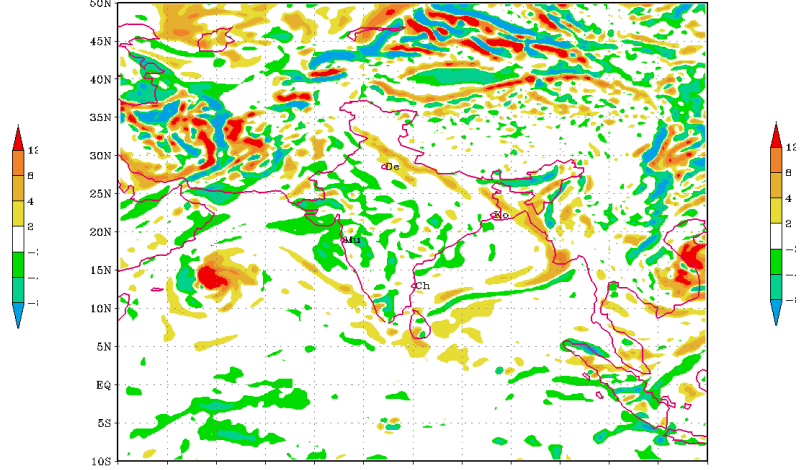


Fig. 8.3 (c) (i) Upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) vertical wind shear of horizontal wind between 200 and 850 hPa level (iv) wind at 200 hPa level based on the ECMWF model analysis of 0000 UTC of 7th November, 2011.

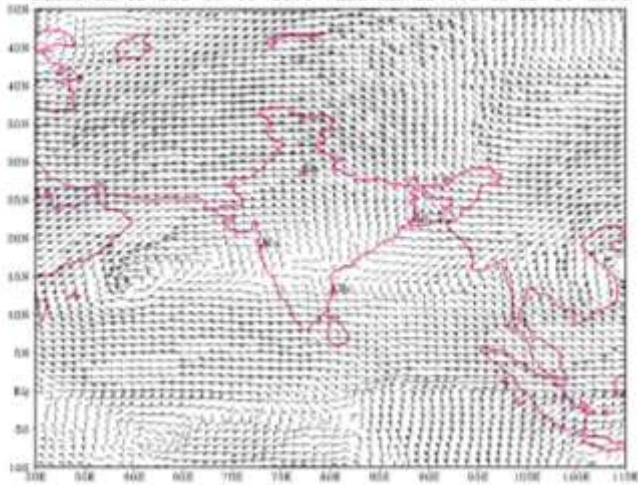
Divergence ($1e5 \text{ s}^{-1}$) at 200 hPa ECMWF Forecast (0 hr.)
 based on 00 UTC 08-11-2011 valid for 00 UTC of 08-11-2011



Vorticity ($1e5 \text{ s}^{-1}$) at 850 hPa ECMWF Forecast (0 hr.)
 based on 00 UTC 08-11-2011 valid for 00 UTC of 08-11-2011



Wind Shear between 200 & 850 hPa ECMWF FORECAST (0 hr.)
 based on 00 UTC 08-11-2011 valid for 00 UTC of 08-11-2011



200 hPa WIND ECMWF FORECAST (0 Hr.)
 based on 00 UTC 08-11-2011 valid for 00 UTC of 08-11-2011

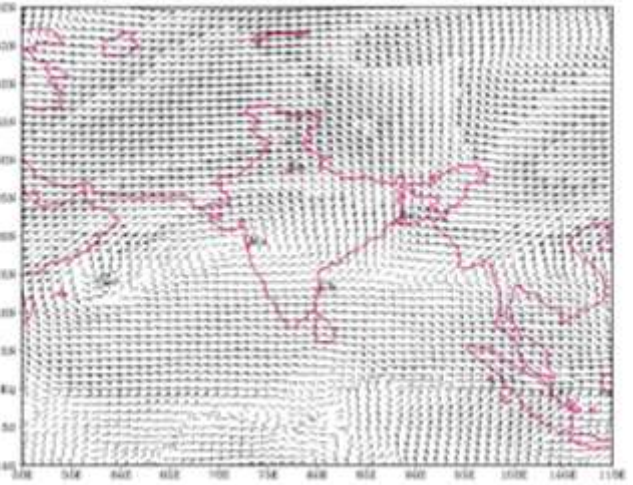


Fig. 8.3 (d) (i) Upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) vertical wind shear of horizontal wind between 200 and 850 hPa level (iv) wind at 200 hPa level based on the ECMWF model analysis of 0000 UTC of 8th November, 2011.

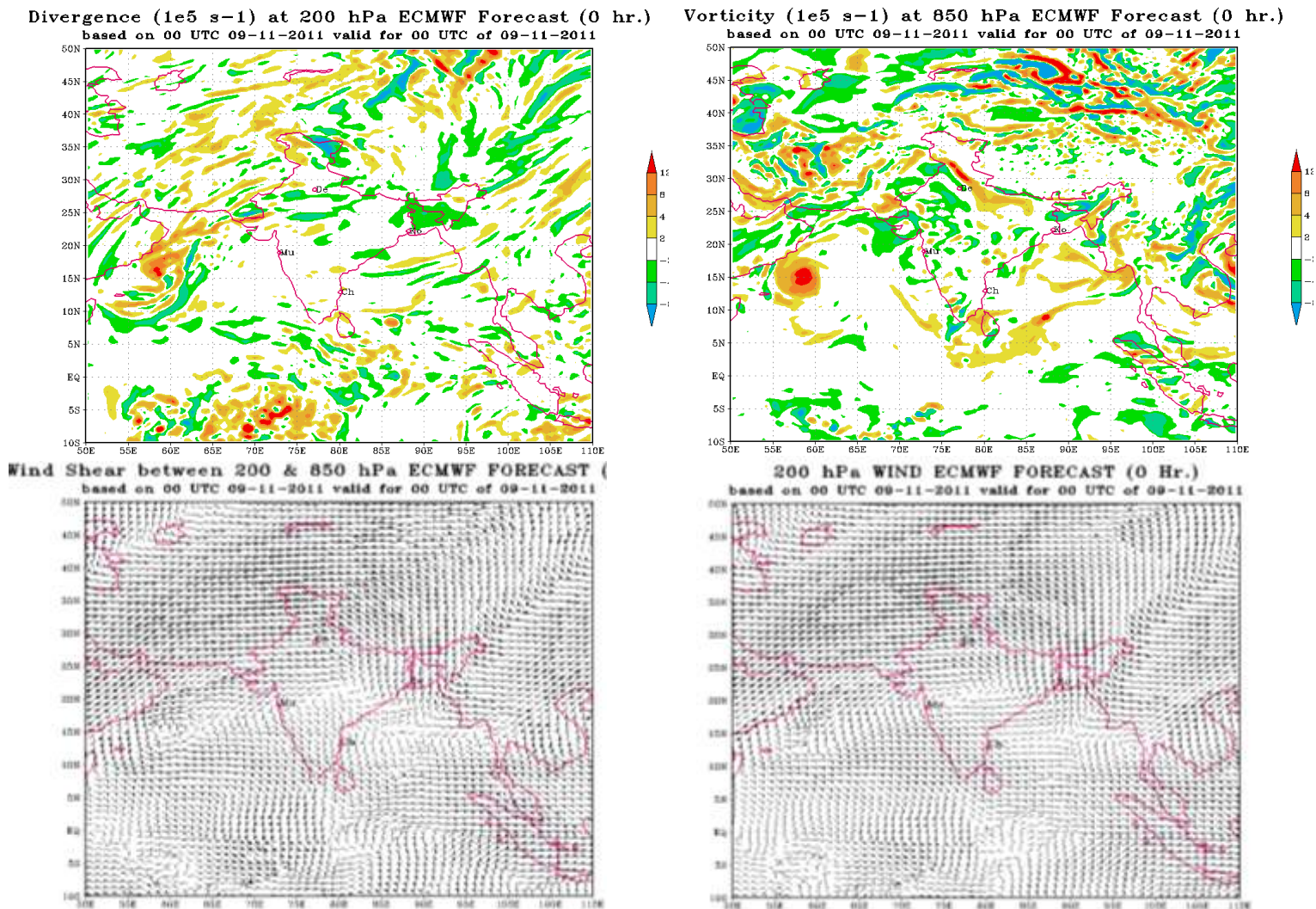


Fig. 8.3 (e) (i) Upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) vertical wind shear of horizontal wind between 200 and 850 hPa level (iv) wind at 200 hPa level based on the ECMWF model analysis of 0000 UTC of 9th November, 2011.

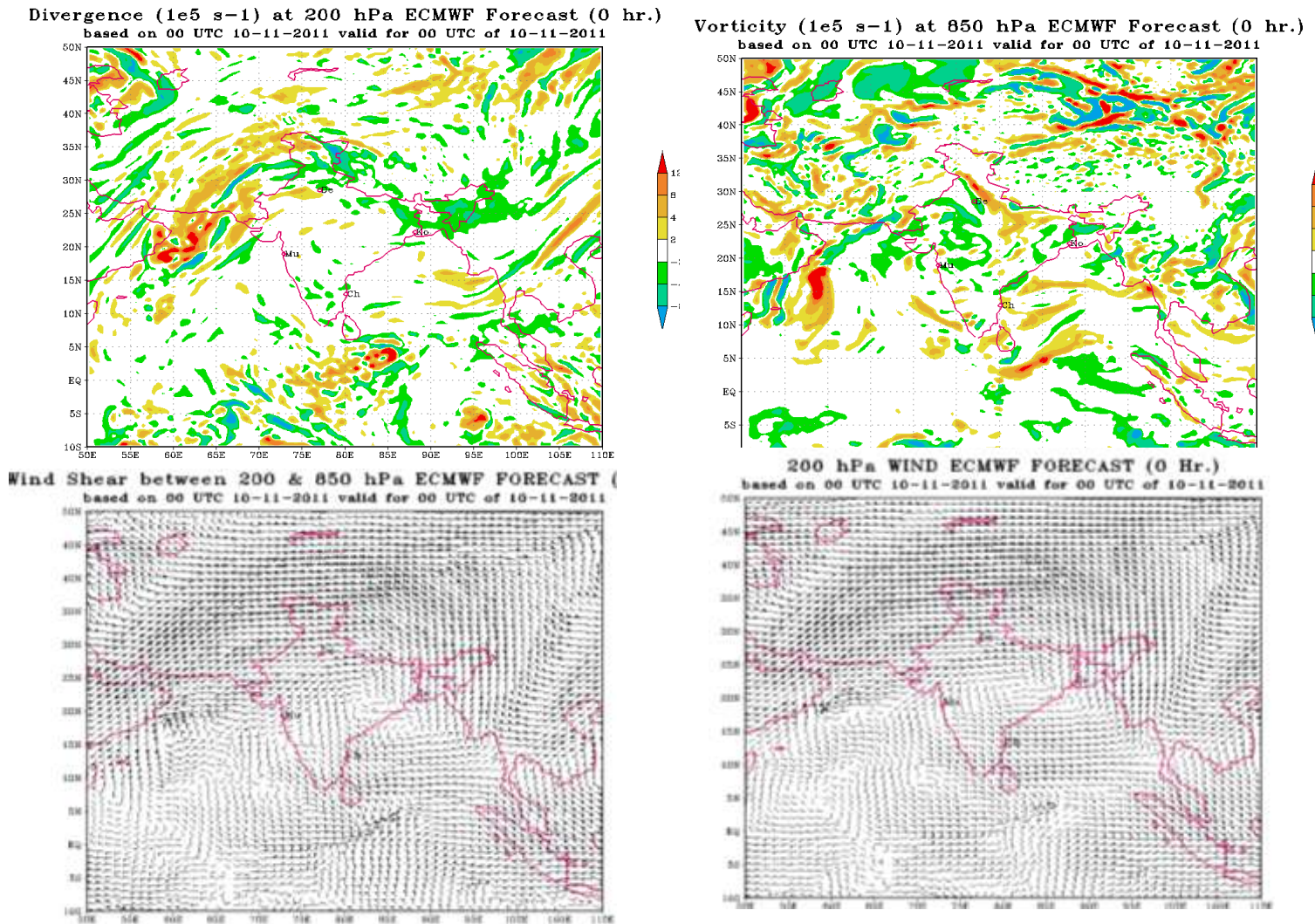


Fig. 8.3 (f) (i) Upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) vertical wind shear of horizontal wind between 200 and 850 hPa level (iv) wind at 200 hPa level based on the ECMWF model analysis of 0000 UTC of 10th November, 2011.

8.4 Realised weather:

No significant weather has been reported from Oman due to this system.

8.5 Damage;

No damage has been reported in Oman due to this system.

8.6 Performance of CWD/RSMC New Delhi

The system was continuously monitored and predicted since 4th November 2011. Once daily bulletin was issued to Oman through e-mail in addition to the Tropical Weather Outlook during 01-06 November 2011. The Special Weather Outlook was issued to Oman based on 03 & 12 UTC of 06-10 November 2011 giving details of the deep depression and its forecasts. The bulletin was also issued to control room, National Disaster Management (NDM), MHA Govt. of India and Other high officials.

The statistics of the number of bulletins issued by IMD are given below.
for national disaster management agencies : 07
Bulletin issued to WMO/ESCAP panel countries: 10

8.6.1. Verification of track & intensity forecast of DD over Bay of Bengal (06-10) Nov.2011

Average Track & Intensity Forecast Error of Deep Depression
(6-10 November 2011)

Lead period (hrs)	Average track forecast error (kms)	Average intensity Forecast error (kts)
12	69 (3)	7 (3)
24	111 (3)	8 (3)
36	238 (2)	10 (2)
48	349 (1)	10 (1)

The figure in bracket is the number of forecasts verified.