2 Depression over the Arabian Sea (11-12 June 2011)

2.1 Introduction:

During onset phase of monsoon, a depression formed over northeast and adjoining east central Arabian Sea on 11th June 2011. It moved north-northeast wards and crossed Saurashtra coast, about 25 km east of Diu around 2200 UTC of 11 June and weakened into a well marked low pressure area over Saurashtra and adjoining areas at 1200 UTC of 12th June. It caused isolated heavy to very heavy falls and isolated extremely heavy falls over Saurashtra & Diu and Konkan & Goa. It helped in northward advance of monsoon along the west coast of India.

2.2 Genesis:

During onset phase of monsoon a trough of low pressure area ran from south Gujarat coast to Kerala coast on 2nd June with an embedded upper air cyclonic circulation over southeast and adjoining Arabian Sea. It slowly moved northwards and lay over eastcentral Arabian Sea on 5th June. Under its influence, a low pressure area formed over east central Arabian Sea and neighbourhood on 6th June with associated cyclonic circulation extending upto mid-tropospheric levels. It persisted over the same area till 10th June maintaining same intensity.

According to INSAT imagery, a vortex formed over east central Arabian Sea with T1.0 and lay centred at 0000 UTC of 8th June near lat. 17.0^{0}N and long. 70.0^{0}E and near lat. 19.0^{0}N and long. 71.0^{0}E at 0300 UTC of 11th June. The broken intense convection in association with the system become slowly organised. Vertical wind shear over the region on 11th June was low to moderate (10-20 knots). The upper tropospheric ridge at 200 hPa level roughly ran along 24^0 N. Hence the system lay to the south of the upper tropospheric ridge and there was favourable divergence in the upper tropospheric level. In the lower levels, the convergence increased with increased pressure gradient and cross equatorial flow over the Arabian Sea. The sea surface temperature was about 30-32^{0}C over the eastcentral Arabian Sea. The Madden Julian Oscillation (MJO) index was laying in phase 4 which is favourable for genesis of depression.

Due to all the above mentioned favourable factors, the low pressure area over the east central Arabian Sea concentrated into a depression over northeast Arabian Sea off Maharashtra-Gujarat coast and lay centred at 1200 UTC of 11th June near lat. 20.0^{0}N and long. 71.5^{0}E, about 180 km northwest of Mumbai and 150 km southeast of Veraval. The associated maximum sustained wind sped was about 25 knots. However winds were stronger over southern part under the influence of the monsoon surge. The intensity of the system according to Dvorak's classification was T1.5. The associated broken intense to very intense convection (with cloud top temperature of -77^{0}C) lay over Arabian Sea between lat 16.5^{0}N & 21.0^{0}N and to the east of long 65.5^{0}E.

2.3 Intensification and movement:

The ocean heat content, however, was less than 60 KJ/cm^2 on 11th and 12th June which was not favourable for intensification. The amplitude of MJO index was also less than 1. Further, the depression was lying close to the coast. Considering all these, the depression did not intensify further. It moved north-northwestwards and crossed Saurashtra coast, about 25 km east of Diu around 2200 UTC of 11th June and lay centred at 0300 UTC of 12th June over Saurashtra and neighbourhood, about 70 km south-southwest of Amreli (Gujarat) The depression moved further northwestwards and weakened into a well marked low pressure area over Saurashtra and adjoining northeast Arabian Sea at 1200 UTC of 12th June 2011. The best track parameters of the system area given in Table 2.1. The typical satellite imageries of the system are shown in Fig. 2.1. The relative vorticity at 850 hPa level, vertical wind shear between 200 & 850 hPa and upper level wind based on ECMWF analysis are shown in Fig 2.2 based on initial condition of 0000 UTC of 11th and 12th June.

Table 2.1 Best track positions and other parameters of the depression over the Arabian Sea during 11-12 June, 2011

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
11-06-2011	1200	20.0/71.5	1.5	996	25	4	D
	1800	20.0/71.5	1.5	996	25	4	D
	The system crossed Saurashtra (Gujarat) coast near lat. 20.8^{0}N/71.2^{0}E around 2200 UTC 11 June 2011						
12-06-2011	0000	21.0/70.5	-	996	25	4	D
	0300	21.0/70.5	--	998	20	3	D
	0600	21.0/70.5	--	999	20	3	D
	1200	The system weakened into a well marked low pressure area over Saurashtra and adjoining northeast Arabian Sea.					

Realised weather:

Rainfall: Under the influence of the system, widespread rainfall with isolated heavy to very heavy falls occurred over Saurashtra & Kutch and Diu. The significant amount of 24 hours cumulative rainfall (>7 cm) recorded at 0300 UTC of date are follows:

12-6-2011

Saurashtra, Kutch& Diu :

Sutarapada 27, veraval 17, Kodinar 9, Talala and Upleta 8 each.

Konkan & Goa:

Murud 25, Roha 22, Tala 19, Mumbai (Santacruz) 18, Sudhagod 17, Mhasla 15, Thane, Malvan, Alibagh, Uran, Mumbai (Colaba) and Mangaon 11 Each, Kalyan and Dodamarg 10 each; Pen, Khalapur, Kankavli and Sawantwadi 9 each; Khed, Matheran, Ambernath, and Mahad 8 each; Ulhasnagar, Karjat, Kudal, Bhiwandi, Panvel, Canacona, Sangameshwar, Poladpur and Dapoli 7 each.

13-6-2011

Saurashtra, Kutch& Diu:

Mangrol 14, Sutrapada 8,

Konkan & Goa;

Vaibhavwadi 12, Thane Belapur 11, Dabolim, Canacona and Poladpur 9 each; Kankavli and Sangamneshwar 8 each; Guhagar 7.

Maximum sustained wind:

Maximum sustained wind of 40-50 kmph was reported along Saurashtra and Diu coast due to this system.

Damage:

No Damage was reported due to this system.

Warnings:

In connection with the depression, following warnings issued

(i) No. of national bulletins issued to disaster management agencies: 6

(ii) No. of RSMC/Special Tropical Weather Outlook: 2

The verification of heavy rainfall warning issued in connection with the system is given in Table 2.2.

Table 2.2: Forecast verification of heavy rainfall forecast issued during Depression 11-12 June, 2011

Date	Sub-Division	F/C issued Valid for 24 hrs.	F/C Valid for 36/ 48 hrs.	Realized wx during 24 hrs.	Realized wx during 48 hrs
11-06-11	Konkan	SCT H-VH & ISOL Ex H	SCT H-VH	SCT H-VH	SCT H-VH
	Saurashtra	-	SCT H-VH	ISOL VH-EH	ISOL H-VH
	S.Gujarat	-	SCT H-VH	-	-
	Madhya Maharashtra	-	ISOL H	ISOL H	ISOL H
12-06-11	Saurashtra, Kutch& Diu	ISOL H-VH	-	ISOL H-VH	ISOL H-VH
	Gujarat region	ISOL H	-	ISOL H-VH	ISOL H-VH

Legend:

H: Heavy (7-12 cm), VH: Very Heavy (13-24 cm), Ex H: Extremely Heavy (≥ 25 cm)

ISOL: Isolated (25% or less numbers stations reporting heavy rain)

SCT: Scattered (25-50% of stations reporting heavy rain)

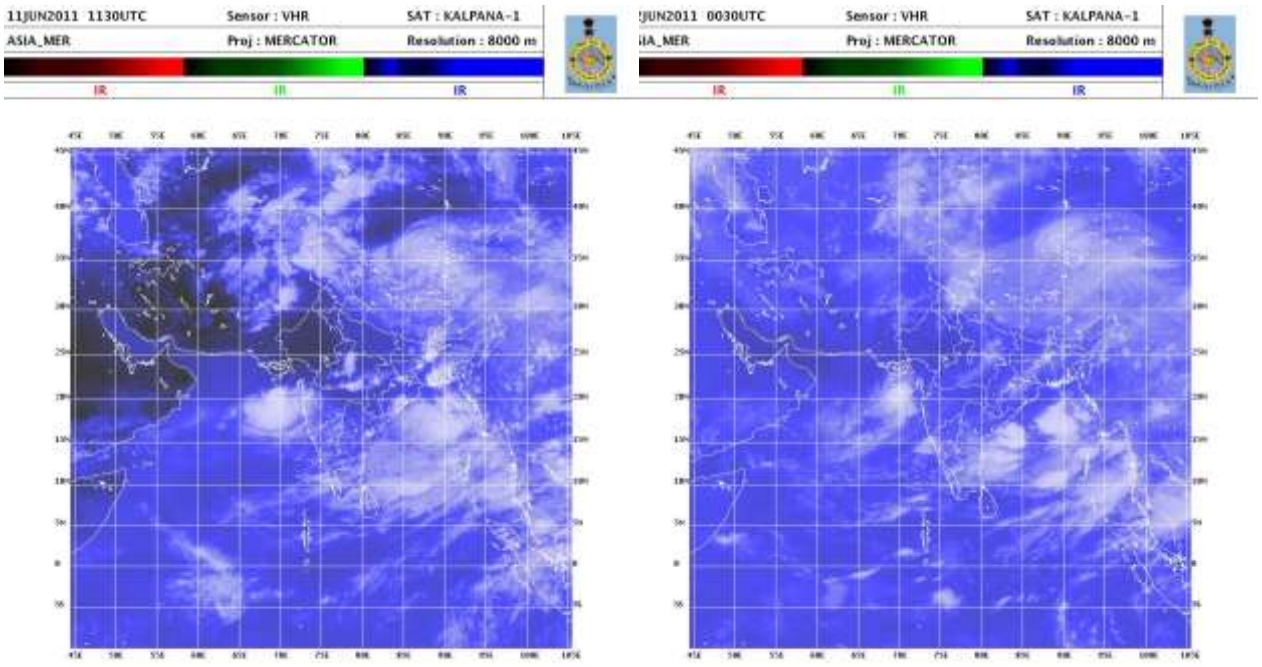

Fig.2.2.1. Typical Satellite imageries of the Depression (11-12 June,2011)

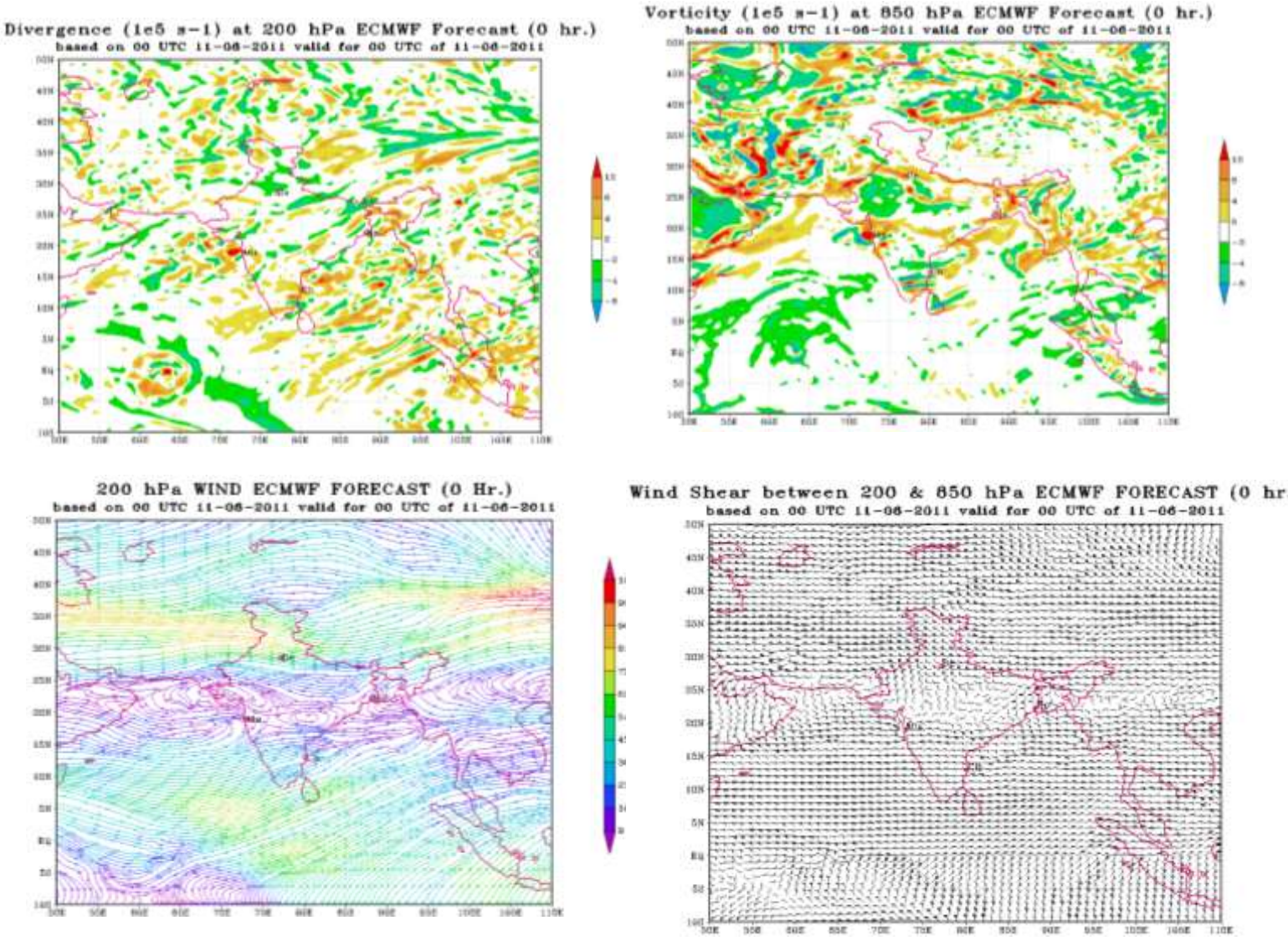

Fig. 2.2(a) (i) upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) wind at 200 hPa level (iv) vertical wind shear of horizontal wind between 200 & 850 hPa level based on the ECMWF model analysis of 0000 UTC of 11th June 2011.

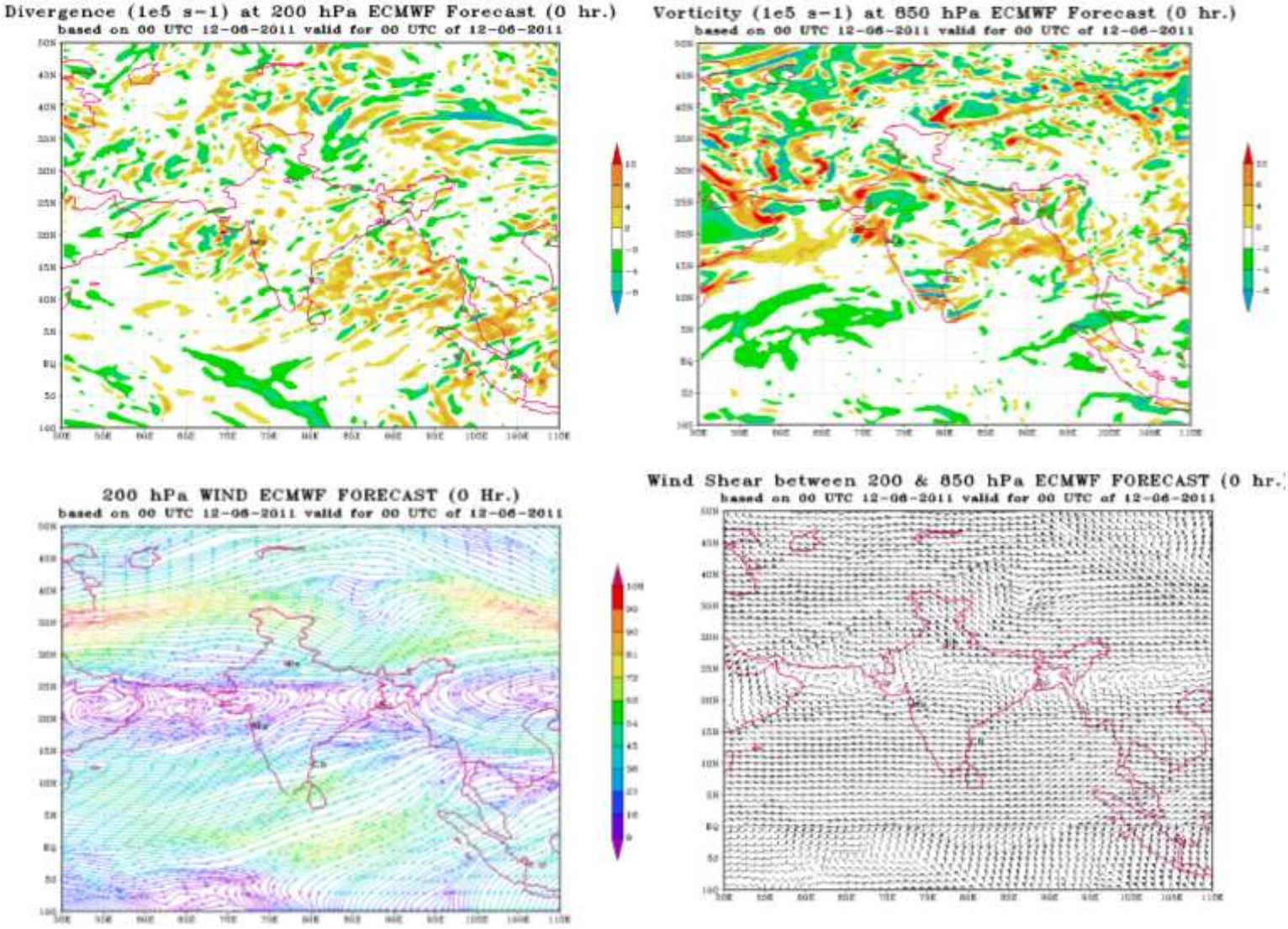

Fig. 2.2(b) (i) upper level divergence at 200 hPa level (ii) low level relative vorticity at 850 hPa level (iii) wind at 200 hPa level (iv) vertical wind shear of horizontal wind between 200 & 850 hPa level based on the ECMWF model analysis of 0000 UTC of 12th June 2011.