Depression over the south coastal Oman and adjoining Yemen (29th May – 01st June, 2020): Summary

1. Brief Life History:

- A cyclonic circulation developed over westcentral and adjoining southwest Arabian Sea (AS) on 27th May. Under it's influence, a low pressure area formed over westcentral AS in the morning (0300 UTC) of 28th May.
- It lay as a Well Marked Low pressure area (WML) over westcentral AS off south Oman-east Yemen coasts in the morning (0300 UTC) of 29th May.
- Under favourable environmental conditions, it concentrated into a depression (D) over south coastal Oman and adjoining Yemen in the afternoon (0900 UTC) of 29th May.
- It moved slightly westwards till the morning (0300 UTC) of 30th May over south coastal Oman and adjoining Yemen.
- Thereafter, it moved southwestwards and weakened into a WML over south coastal Oman and adjoining Yemen in the early morning (0000 UTC) of 1st June 2020.
- The observed track of the system during 29th May to 1st June is presented in **Fig.1**. Best Track parameters associated with the system are presented in **Table1**.

2. Salient Features:

The salient features of the system were as follows:

i. It was the first cyclonic disturbance over the Arabian Sea during the year 2020.
ii. Climatologically, during the period 1891-2018, a total of 17 cyclonic disturbances (including depressions and cyclonic storms) developed over AS during May-June (**Fig. 2a**). Out of these, 13 crossed Oman coast and 4 crossed Yemen coast. Out of the 13 cyclonic disturbances, 4 crossed Oman as depression ((intensity 27-33 kt) and 9 crossed Oman as cyclonic storms (intensity ≥. 34 kt). Out of these 4 cyclonic disturbances, there was only 1 system that maintained the intensity of depression throughout its life period (**Fig. 2b**).
iii. It had an anti-clockwise recurving track as it moved initially westwards till 0300 UTC of 30th over south coastal Oman and adjoining Yemen. Thereafter, it moved southwestwards and weakened into a well marked low pressure area over south coastal Oman and adjoining Yemen in the morning of 1st June.
iv. Constant moisture feed occurred all through the life period of the system owing to the cross equatorial south westerly winds in association with the monsoon

surge. This factor, along with the low to moderate vertical wind shear aided the system to maintain the Depression stage intensity over the coastal belt of Oman and adjoining Yemen for 3 days.

v. The life period (D to D) of the system was 85 hours (3 days & 15 hours).

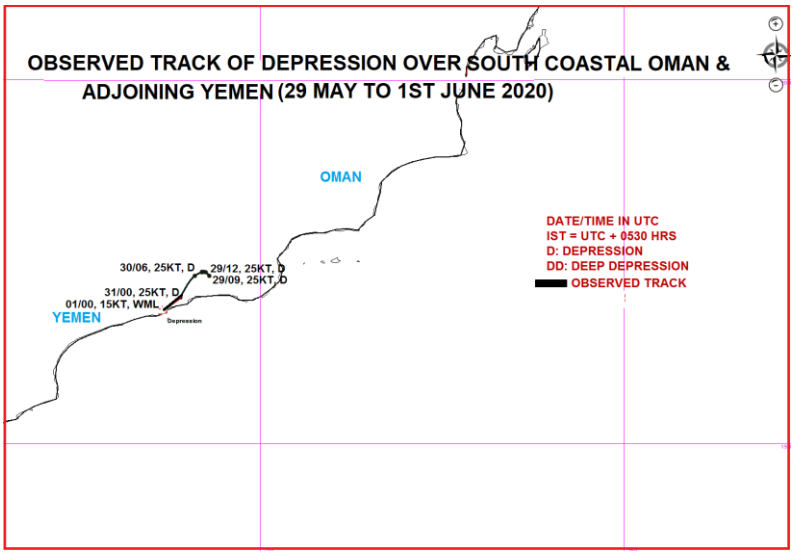

Fig.1: Observed track of depression over the south Oman and east Yemen (29 May-01 June, 2020)

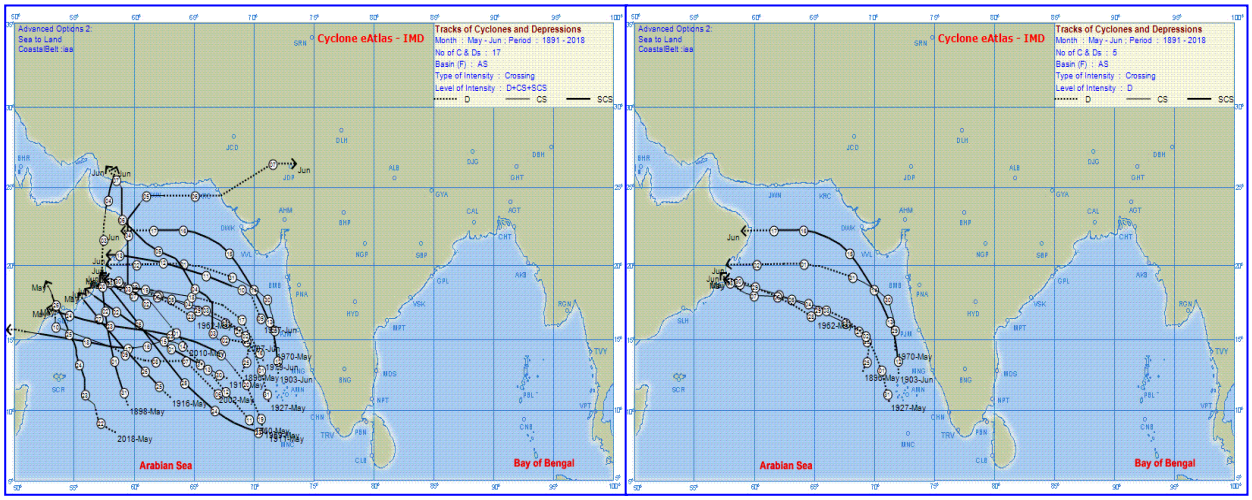

Fig.2: Tracks of (a) cyclonic disturbances (including depression & cyclones) and (b) depressions crossing Oman & Yemen coasts in the months of May & June during 1891-2018

Table: Best track positions and other parameters of the Depression, over the Arabian Sea during 29 May- 01 June, 2020

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
29/05/2020	0900	17.3	54.3	-	1000	25	3	**D**
	1200	17.3	54.3	-	1000	25	3	D
	1800	17.3	54.3	-	1000	25	3	D
30/05/2020	0000	17.3	54.2	-	1000	25	3	D
	0300	17.3	54.2	-	1000	25	3	D
	0600	17.2	54.0	-	1000	25	3	D
	1200	17.2	54.0	-	1000	25	3	D
	1800	17.2	54.0	-	1000	25	3	D
31/05/2020	0000	17.1	53.8	-	1000	25	3	D
	0300	17.1	53.8	-	1000	25	3	D
	0600	17.0	53.5	-	1000	25	3	D
	1200	16.9	53.1	-	1000	25	3	D
	1800	16.8	52.9	-	1000	25	3	D
01/06/2020	0000	Weakened into well marked low pressure area over south coastal Oman and adjoining Yemen						

3. Monitoring and Prediction:

India Meteorological Department (IMD) maintained round the clock watch over the north Indian Ocean and the system was monitored since 27th May with the development of cyclonic circulation over westcentral and adjoining southwest AS.

The Depression was monitored with the help of available satellite observations from INSAT 3D and 3DR, polar orbiting satellites including SCATSAT, ASCAT etc. and available ships & buoy observations in the region. Various numerical weather prediction models run by the Ministry of Earth Sciences (MoES) institutions, various global models and IMD's dynamical-statistical models developed in-house were utilized to predict the genesis, track, landfall and intensity of the Depression. A digitized forecasting system of IMD was utilized for analysis and comparison of various Numerical models' guidance, decision making process and warning product generation. Typical INSAT-3D imageries are presented in **Fig.3**.

At 0300 UTC of 27th May, scattered low and medium clouds with embedded intense to very intense convection lay over westcentral and adjoining southwest AS. Scattered low and medium clouds with embedded moderate to intense convection lay over southeast AS. At 0300 UTC of 28th May, scattered low and medium clouds with embedded intense to very intense convection lay over southeast and westcentral AS. Scattered low and medium clouds with embedded isolated weak to moderate convection lay over eastcentral AS. At 0300 UTC of 29th May, the cloud mass over westcentral AS further orgnised. The vortex lay over westcentral AS & neighbourhood centered within half a degree of 15.7ºN/54.8ºE. The intensity of the system was T 1.0. Broken low and medium clouds with embedded intense to very intense convection lay over westcentral AS between latitude 13.0ºN to 21.0ºN & longitude 51.0ºE to 57.0ºE and south Oman and adjoining east Yemen. Minimum cloud top temperature (CTT) was minus 93ºC. Scattered low and medium clouds with embedded intense to very intense convection also lay over southeast and westcentral AS. At 0900 UTC of 29th May, broken low and medium clouds with embedded intense to very intense convection lay over westcentral AS between latitude 14.0°N to 17.5°N longitude 51.0°E to 56.0°E and south Oman adjoining north Yemen. Minimum CTT was minus 93°C. At 0300 UTC UTC of 30th May, broken low and medium clouds with embedded intense to very intense convection lay over westcentral AS between latitude 13.5°N to 19.0°N longitude 52.5°E to 57.0°E and south Oman adjoining north Yemen. At 0300 UTC of 31st May, broken low and medium clouds with embedded intense to very intense convection lay over south coastal Oman and adjoining Yemen and westcentral AS between latitude 15.0°N to 19.0°N longitude 52.0°E to 56.0°E. Minimum CTT was minus 93°C.

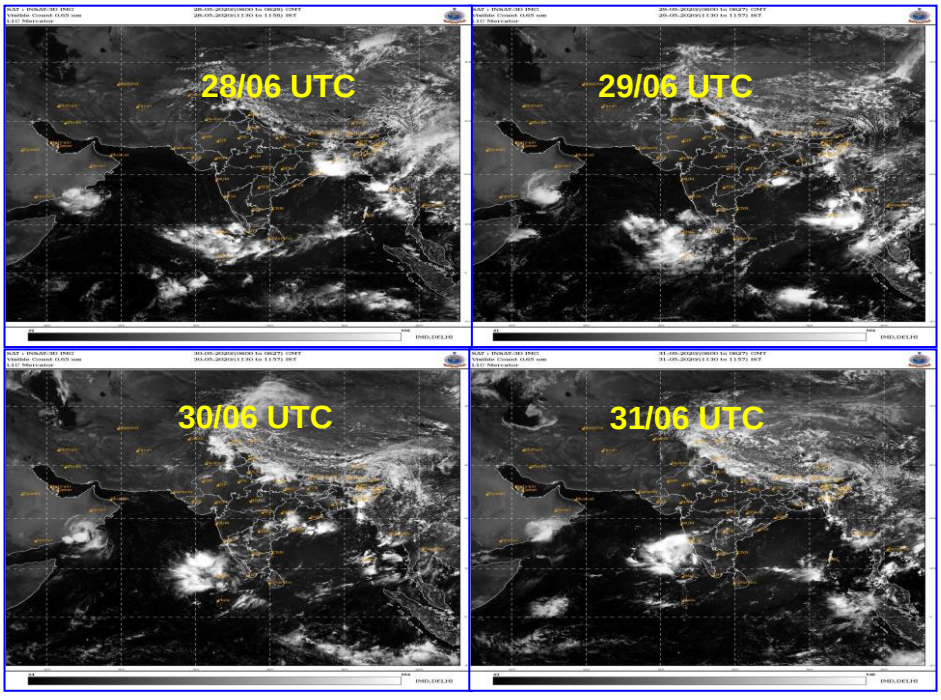

Fig. 3 (a): INSAT-3D visible imageries during 28th-31st May, 2020

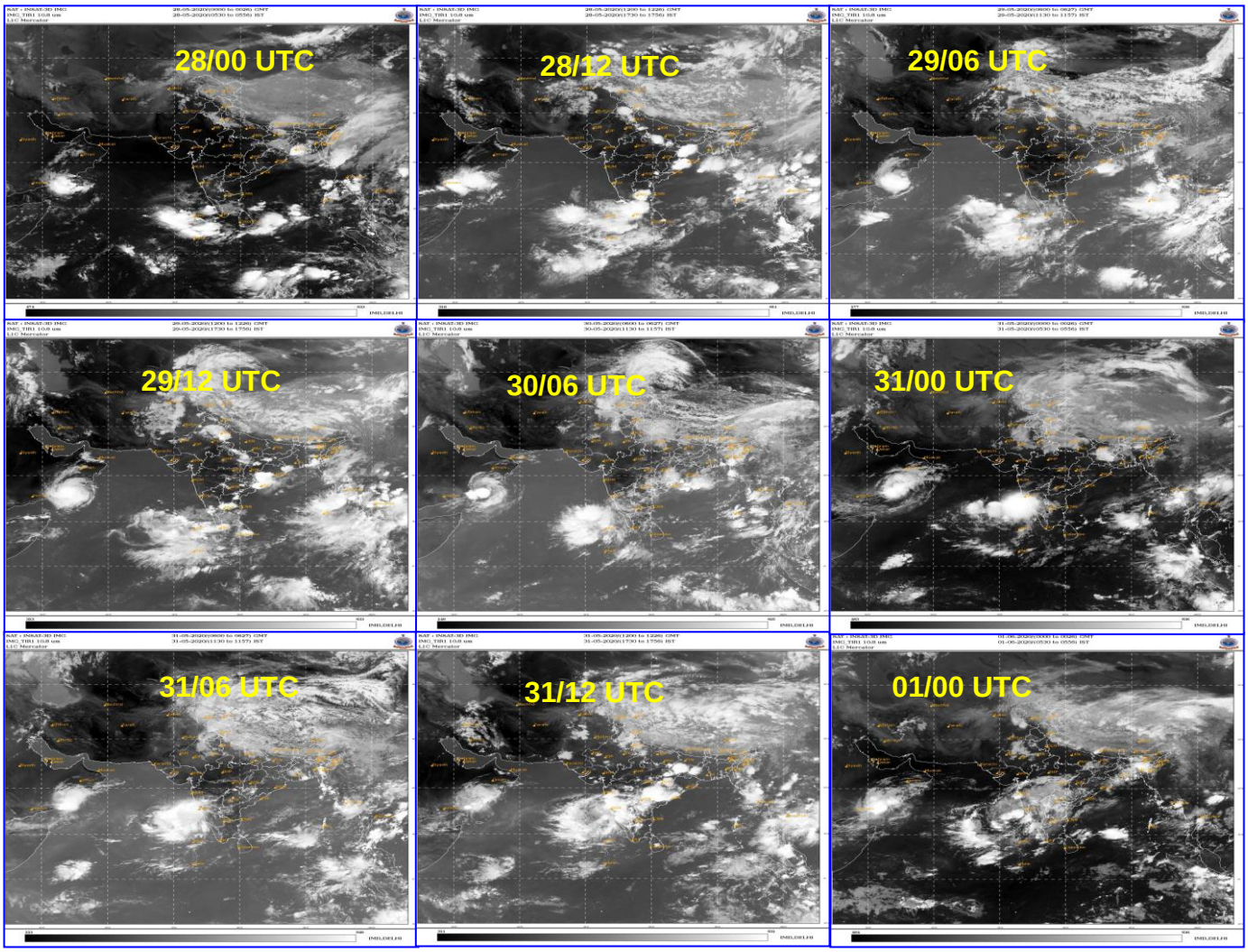

Fig. 3 (b): INSAT-3D IR imageries during 28th May – 1st June, 2020

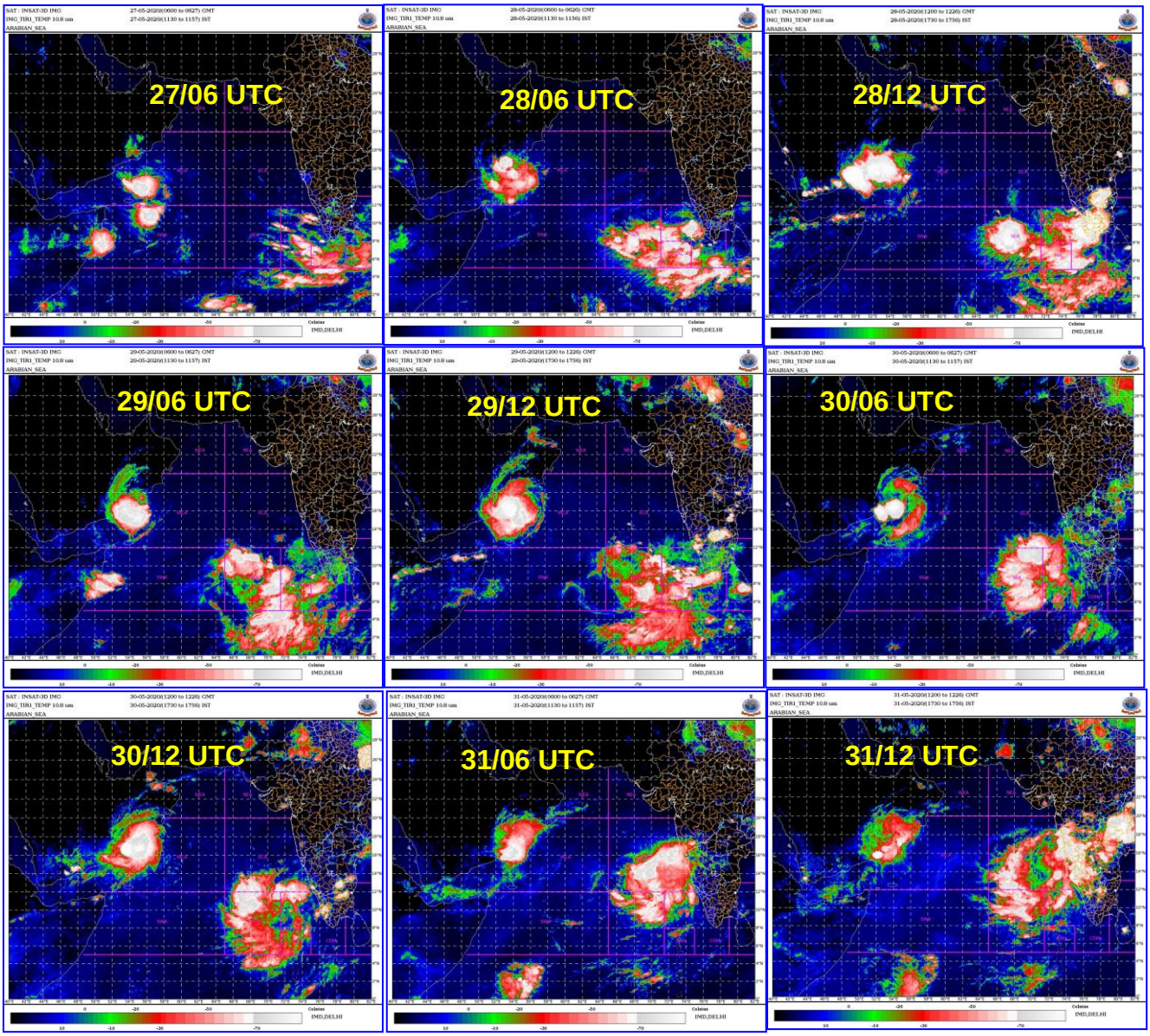

Fig. 3 (c): INSAT-3D enhanced colour imageries during 27th May – 31st May, 2020

4. NWP Model forecast

IMD GFS analysis of mean sea level pressure, 10m wind, winds at 850, 500 and 200 hPa levels based on 0000 UTC during 29th May to 1st June is presented in Fig.4. On 29th May, IMD GFS predicted a cyclonic circulation over westcentral AS off south coastal Oman and adjoining Yemen coasts. The circulation extended upto 500 hPa level.

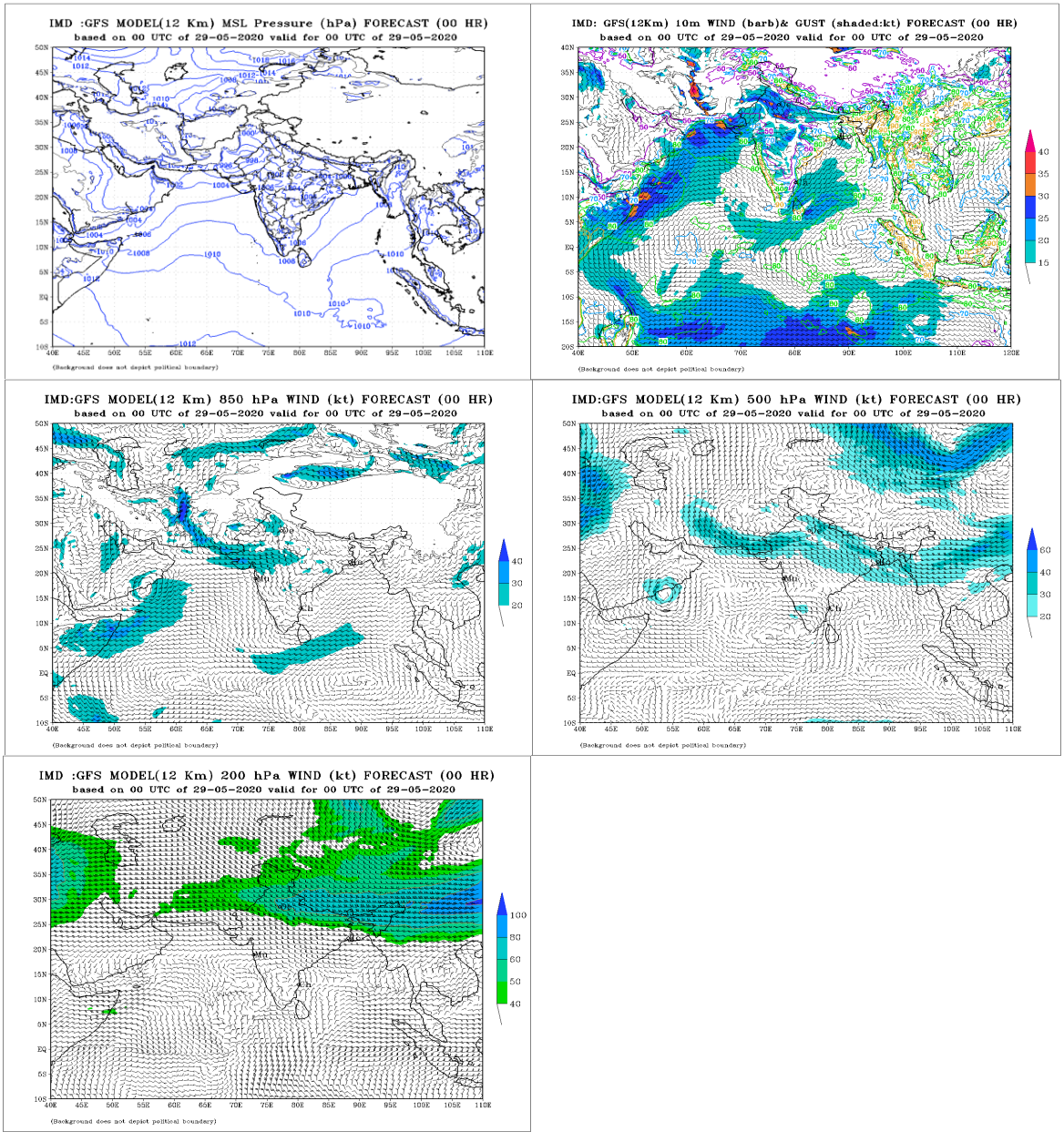

Fig. 4a: IMD GFS analysis of mean sea level pressure (hPa), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 29th May.

On 30th May, IMD GFS predicted a depression over south coastal Oman and adjoining Yemen coasts. The circulation extended upto 200 hPa level.

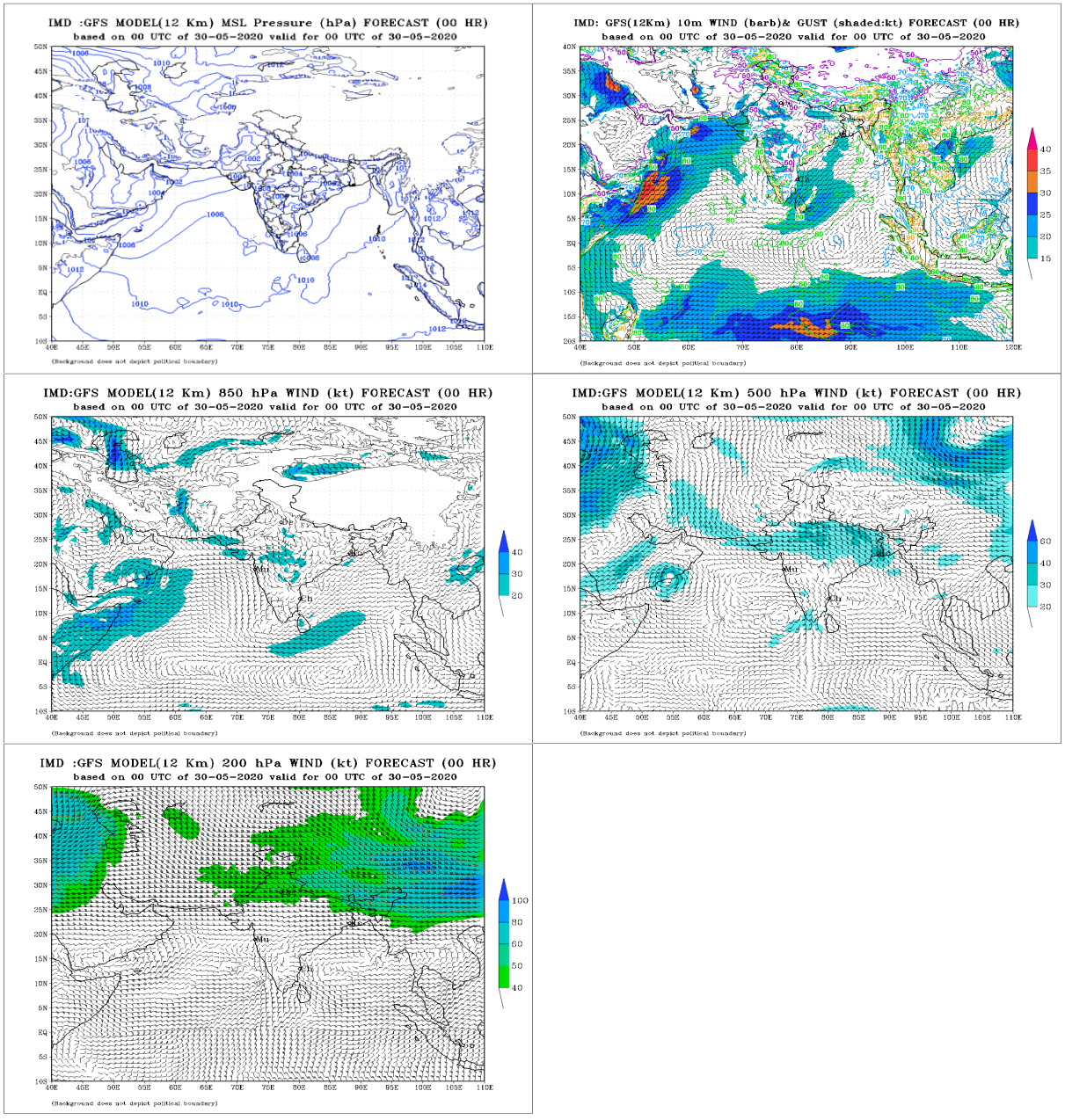

Fig. 4b: IMD GFS analysis of mean sea level pressure (hPa), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 30th May.

On 31st May, IMD GFS predicted a cyclonic circulation over south coastal Oman and adjoining Yemen coasts. The circulation extended upto 200 hPa level.

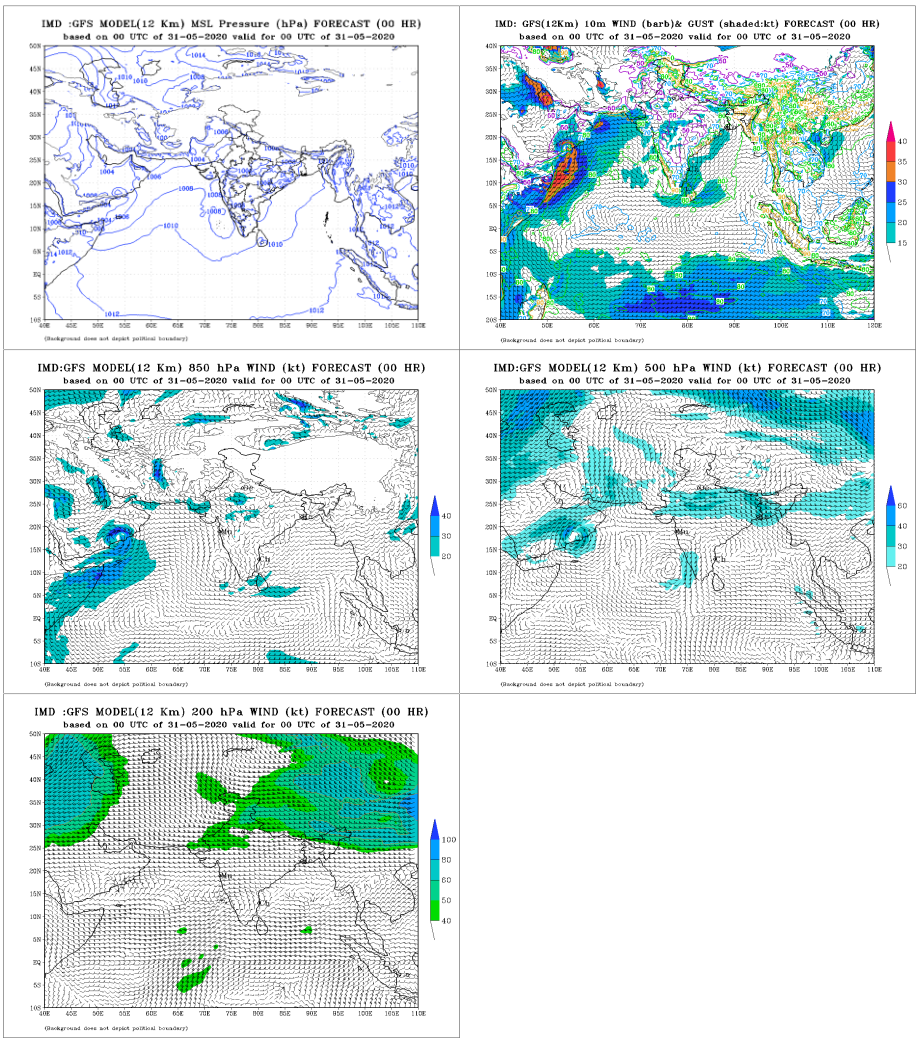

Fig. 4c: IMD GFS analysis of mean sea level pressure (hPa), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 31st May.

On 1st June, IMD GFS predicted a well marked low pressure area over south coastal Oman and adjoining Yemen coasts with west-southwestwards movement. The circulation extended upto 500 hPa level.

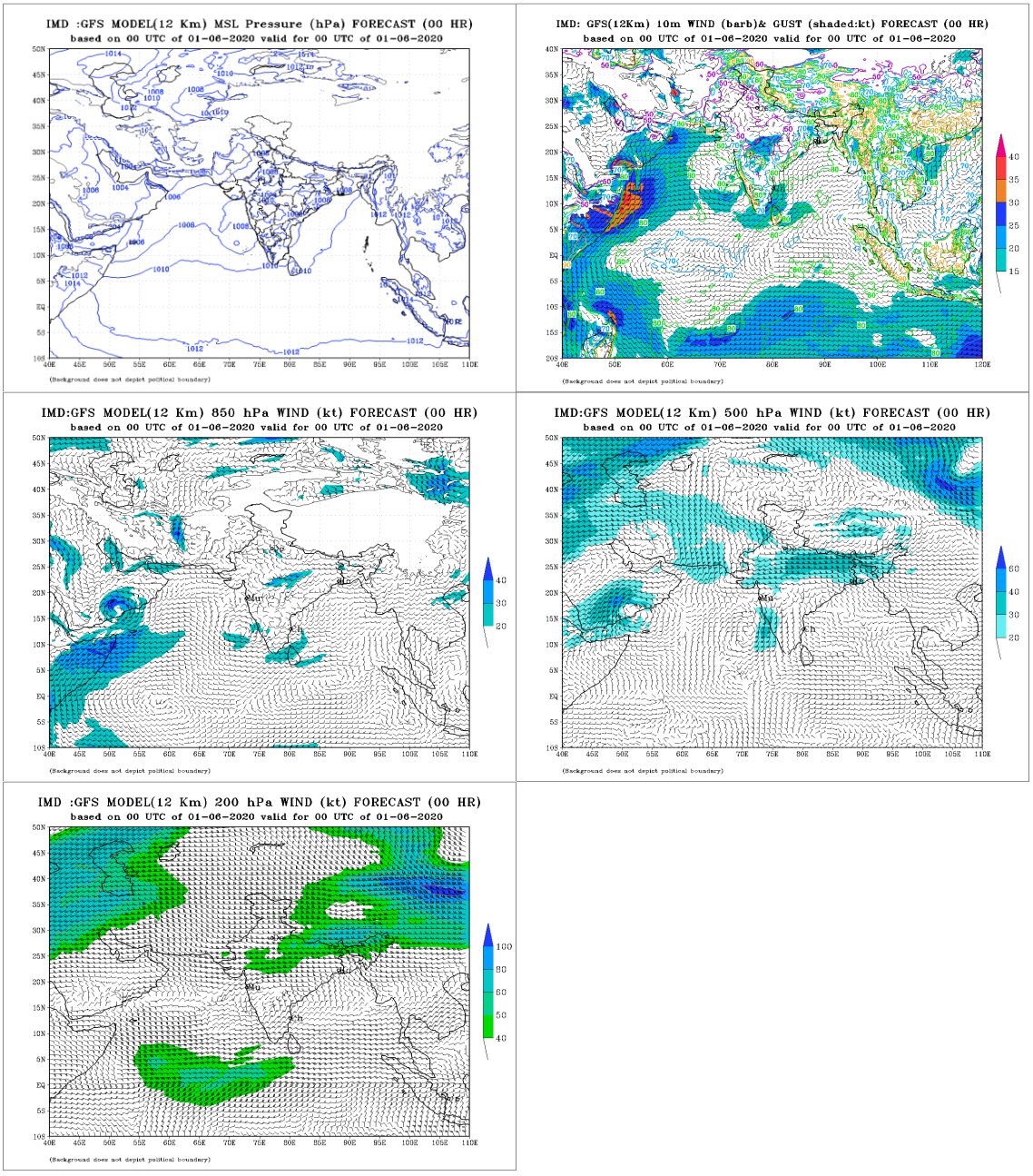

Fig. 4d: IMD GFS analysis of mean sea level pressure (hPa), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 1st June.

5. Realized Weather:

5.1. Realised rainfall

Rainfall associated with depression over coastal Oman and Yemen based on IMD-NCMRWF GPM merged gauge 24 hours cumulative rainfall ending at 0300 UTC of date is depicted in **Fig 5**.

It indicates occurrence of heavy to very heavy rainfall at few places with extremely heavy falls at isolated places during 29th-31st May and heavy to very heavy rainfall at isolated places on 1st June over south coastal Oman and adjoining Yemen.

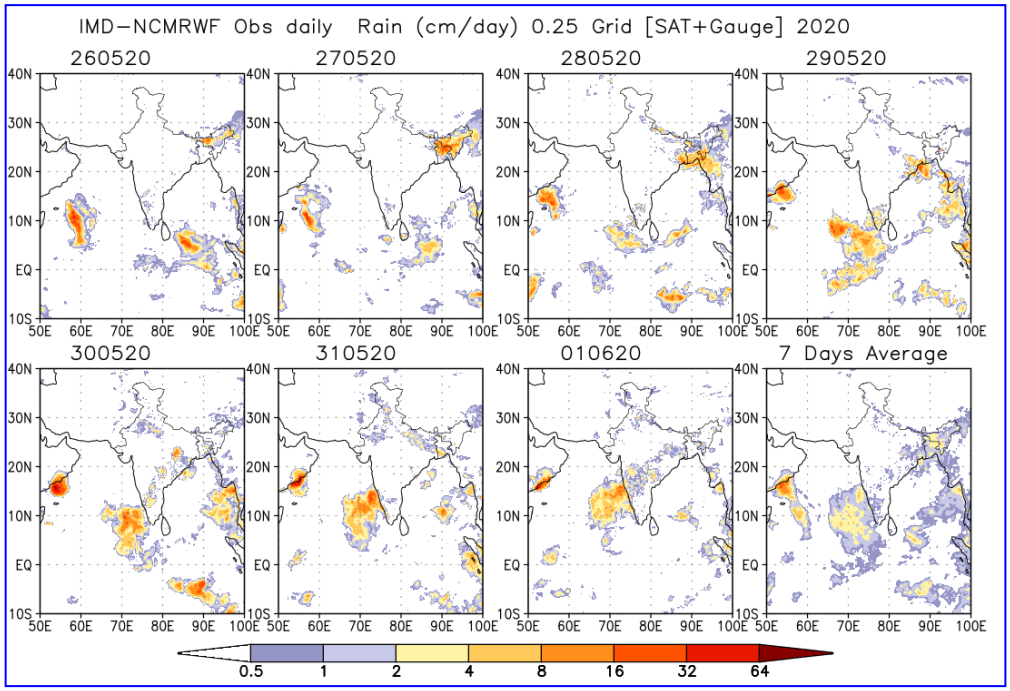

Fig.5: IMD-NCMRWF GPM merged gauge 24 hr cumulative rainfall (cm) ending at 0830 IST of date during 16th May – 22nd May and 7 days average rainfall (cm/day)

5.2. Realised wind:

As per satellite data maximum sustained winds of the order of 20 – 25 kts prevailed over south coastal Oman and adjoining Yemen during 29th-31st May.

5.3. Realised storm surge:

No storm surge was reported in association with the system.

6. Forecast performance:

6.1. Genesis, track, intensity and adverse weather forecast

- The system was monitored since 27th May on formation of cyclonic circulation over westcentral and adjoining southwest AS. In the tropical weather outlook

issued at 0600 UTC of 27th, it was indicated that the cyclonic circulation would organise into a low pressure area around 29th and into a depression around 31st May.

- In the bulletin issued in the evening (1200 UTC) of 29th May, it was indicated that the system would move initially northwestwards for some time and southwestwards thereafter. It was forecast that the system would intensify upto deep depression stage. Actually, the system moved slightly northwestwards till midnight (1800 UTC) of 30th and southwestwards thereafter and it maintained it's intensity of depression only.
- Since first bulletin issued in the evening (1230 UTC), it was mentioned that the system would not cause any adverse weather over the west coast of India. However, state of Sea over the westcentral Arabian Sea and corresponding fishermen warnings were issued since the development of depression over south coastal Oman and adjoining Yemen.

7. Warning Services

Bulletins issued by Cyclone Warning Division, New Delhi

- **Track, intensity and landfall forecast:** IMD continuously monitored, predicted and issued bulletins containing track, intensity, and landfall forecast for +06, +12, +18, +24, +36 and +48 hrs lead period till the system weakened into a low pressure area. The above forecasts were issued from the stage of depression onwards along with the cone of uncertainty in the track forecast five times a day.
- **Wind structure forecast for shipping and coastal hazard management** The radius of maximum wind and radii of MSW ≥28 knots wind in four quadrants of cyclone was issued every six hourly giving forecast for +06, +12, +18, +24, +36 and +48 hrs lead period.
- **Adverse weather warning bulletins:** State of Sea over westcentral AS and fishermen warnings were issued to central, state and district level disaster management agencies including MHA NDRF, NDMA for all concerned states along the west coast of India including Kerala, Karnataka, Lakshadweep, Goa and Maharashtra. These bulletins were also issued to Defence including Indian Navy & Indian Air Force.
- **Warning graphics:** The graphical display of the observed and forecast track with cone of uncertainty and the wind forecast for different quadrants were disseminated by email and uploaded in the RSMC, New Delhi website (http://rsmcnewdelhi.imd.gov.in/) regularly.
- **Warning and advisory for marine community:** The three/six hourly Global Maritime Distress Safety System (GMDSS) bulletins were issued by the Marine Weather Services division at New Delhi and bulletins for maritime interest were issued by Area cyclone warning centres of IMD at Chennai, and

Cyclone warning centres at Thiruvananthapuram to ports, fishermen, coastal and high Sea shipping community.

- **Diagnostic and prognostic features of the Depression:** The prognostics and diagnostics of the systems were described in the RSMC bulletins.

Statistics of bulletins issued by RSMC New Delhi in association with the depression over south coastal Oman and adjoining Yemen are given in **Table 2.**

Table 2: Bulletins issued by RSMC New Delhi

S.N	Bulletin type	No. of Bulletins	Issued to
1	National Bulletin	13	1. IMD website, RSMC New Delhi website and Mausam website 2. FAX and e-mail to Control Room Ministry of Home Affairs & National Disaster Management Authority, Cabinet Secretariat, Minister of Science & Technology, Headquarter Integrated Defence Staff, Director General Doordarshan, All India Radio, National Disaster Response Force, Press Information Bureau, Chief Secretary to Government of Kerala, Karnataka, Lakshadweep, Goa and Maharashtra.
2	RSMC Bulletin	13	1. IMD's website, RSMC website and Mausam website 2. WMO/ESCAP member countries including Oman and Yemen through GTS and E-mail.

8. Acknowledgement:

India Meteorological Department (IMD) and RSMC New Delhi duly acknowledge the contribution from WMO and all the stake holders and disaster management agencies who contributed to the successful monitoring, prediction and early warning service of depression over south coastal Oman and adjoining Yemen. We acknowledge the contribution of all sister organisations of Ministry of Earth Sciences including National Centre for Medium Range Weather Forecasting Centre (NCMRWF), Indian National Centre for Ocean Information Services (INCOIS), National Institute of Ocean Technology (NIOT), Indian Institute of Tropical Meteorology (IITM) Pune, research institutes including IIT Bhubaneswar, IIT Delhi and Space Application Centre, Indian Space Research Organisation (SAC-ISRO) for their valuable support. The support from various Divisions/Sections of IMD including Area Cyclone Warning Centre (ACWC) Chennai and Mumbai Cyclone Warning Centre (CWC) Thiruvananthapuram, Ahmedabad and Meteorological Centre (MC) Goa. The contribution from Numerical Weather Prediction Division, Satellite and Radar Division, Surface & Upper air instruments Divisions, New Delhi and Information System and Services Division at IMD is also duly acknowledged.
