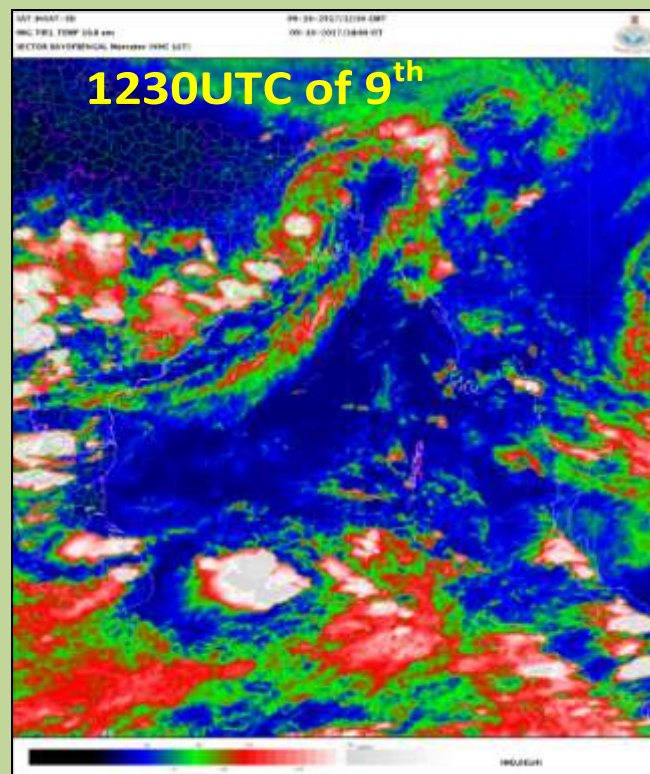




**GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
INDIA METEOROLOGICAL DEPARTMENT**

**Deep Depression over Gangetic West Bengal and
adjoining North Bay of Bengal
(09-10 October, 2017): A Report**



NSAT-3D enhanced coloured IR imagery based on 1230 UTC of 9th October

Cyclone Warning Division

India Meteorological Department

New Delhi

October 2017

Deep Depression over Gangetic West Bengal and adjoining north Bay of Bengal (09-10 October 2017)

1. Introduction

A **low pressure area** formed over North Bay of Bengal (BoB) and adjoining south Bangladesh on 8th October 2017 morning. It lay as a well marked low pressure area (WML) over north BoB and adjoining coastal areas of Bangladesh & West Bengal in the same evening. It concentrated into a depression in the early morning of 9th October over Gangetic West Bengal (GWB) and adjoining north BoB. Moving northwestwards, it intensified into a deep depression (DD) over GWB in the morning of 9th. It moved nearly north-northwestwards and weakened into a depression around noon of 10th October and into a well marked low pressure area over northeast Jharkhand and adjoining West Bengal in the evening of the same day. It became less marked on 11th. The observed track of the system is presented in Fig.1.

The salient features of the system were as follows:

- (i) The total life period of the system was 33 hours against the average life period of deep depression of 90 hours in post monsoon season over the BoB.
- (ii) The system caused heavy to very heavy rainfall at isolated places over GWB and heavy rainfall at isolated places over Bihar on 10th October and heavy rainfall at isolated places over GWB, Jharkhand & Bihar on 11th October 2017.

IMD mobilised all its resources to track the system and regular warnings w.r.t. track, intensity, landfall and associated adverse weather were issued to concerned central and state disaster management agencies, print & electronic media and general public. Regular advisories were also issued to WMO/ESCAP Panel member countries including Bangladesh.

The brief life history, associated weather and forecast performance of IMD/RSMC, New Delhi are presented below.

2. Brief life history

2.1. Genesis, Intensification and Movement:

Under the influence of a cyclonic circulation over North BoB & neighbourhood extending upto 4.5 km above mean sea level, a low pressure area formed over north BoB and adjoining south Bangladesh at 0300 UTC of 8th October. It lay as a well marked low pressure area (WML) over northwest BoB and adjoining coastal areas of Bangladesh & West Bengal at 1200 UTC of same day. It concentrated into a depression at 0000 UTC of 9th October over Gangetic West Bengal and adjoining north BoB with centre near latitude 22.4° N and longitude 88.4 °E.

Considering the environmental conditions, at 0000 UTC of 9th October, the vertical wind shear was low (about 10 knots) around the system centre. The low level relative vorticity was about $100 \times 10^{-6} \text{ s}^{-1}$. The lower level convergence was about $20 \times 10^{-5} \text{ s}^{-1}$. The upper level divergence was about $30 \times 10^{-5} \text{ s}^{-1}$. All these conditions favoured the development of depression over Gangetic West Bengal and adjoining north BoB in the early hours of 9th October. The Madden Julian Oscillation Index lay over phase 4 with amplitude 1. All these conditions helped in maintaining the intensity of the system and associated convection.

At 0000 UTC of 9th October, the upper tropospheric ridge at 200 hPa level ran along 22°N and along 24°N in the middle level. An anticyclonic circulation lay over central India in the middle & upper tropospheric levels. In addition, a trough in mid-latitude westerlies run along longitude 72° E to the north of latitude 32° N. These conditions caused the system to move west-northwestwards slowly and restricted its movement towards west.

At 0300 UTC of 10th, the vertical wind shear was moderate (about 10-20 knots) around the system centre. The low level relative vorticity was about $100 \times 10^{-6} \text{ s}^{-1}$. The lower level convergence decreased and was about $5 \times 10^{-5} \text{ s}^{-1}$ to the southeast of the system centre. The upper level divergence also decreased and was about $10 \times 10^{-5} \text{ s}^{-1}$ around the system centre. The upper tropospheric ridge at 200 hpa level ran along 23^oN. All these conditions led to weakening of system into a depression and lay centred over Gangetic West Bengal and adjoining Jharkhand near latitude 23.8^o N and longitude 86.6 ^oE, at 0600 UTC of 10th Oct. 2017. Under these conditions the system weakened further and into a well marked low pressure area over northeast Jharkhand and adjoining West Bengal at 1200 UTC of same day. It became less marked on 11th. The best track parameters are shown in Table 1. The typical satellite imageries are shown in Fig. 2.

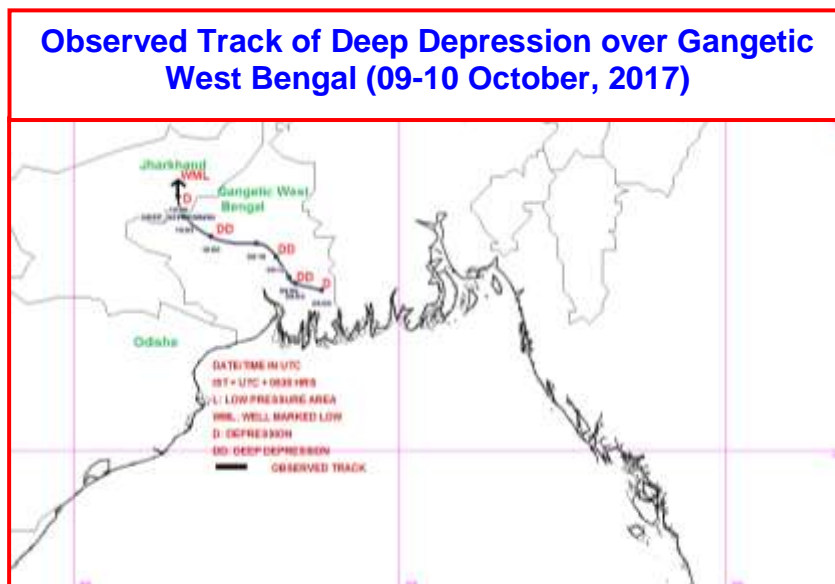


Fig.1.Observed track of Deep Depression over Gangetic west Bengal and adjoining north Bay of Bengal (09-10 October 2017)

Table 1: Best track positions and other parameters of the Deep depression over Gangetic West Bengal and adjoining north Bay of Bengal (09-10 October, 2017)

Date	Time (UTC)	Centre lat. ^o N/ long. ^o E	C.I. NO.	Estimated Central Pressure (hPa)	Estimated Maximum Sustained Surface Wind (kt)	Estimated Pressure drop at the Centre (hPa)	Grade
09/10/2107	0000	22.4/88.4	1.5	996	25	4	D
	0300	22.5/88.4	-	996	30	5	DD
	0600	22.6/88.3	-	996	30	5	DD
	1200	22.9/88.1	-	997	30	5	DD
	1800	23.1/87.8	-	997	30	5	DD
10/10/2017	0000	23.2/87.1	-	998	30	5	DD
	0300	23.5/86.7	-	1000	30	5	DD
	0600	23.8/86.6	-	1000	25	3	D
	1200	Depression weakened into a low pressure area over the Jharkhand & adjoining West Bengal at 1200 UTC of 10 th October					

3. Features observed through satellite and Radar

Satellite monitoring of the system was mainly done by using half hourly INSAT-3D imageries. Satellite imageries from SCATSAT and international geostationary and polar orbiting satellites were also considered for monitoring the system.

3.1 INSAT-3D features

Typical INSAT-3D visible, IR and enhanced colored imageries are presented in Fig.2. At 0000 UTC of 9th October, the intensity of the system was C.I. 1.5. Associated broken low and medium clouds with embedded intense to very intense convection lay over south Bangladesh, Gangetic West Bengal and north BoB. At 0300 UTC of 9th, associated broken low and medium clouds with embedded intense to very intense convection lay over southeast Gangetic West Bengal. At 0300 UTC of 10th, associated broken low and medium clouds with embedded moderate to intense convection lay over east Jharkhand and Gangetic West Bengal. Scattered low and medium clouds with embedded weak to moderate convection lay over south Chattisgarh, Odisha, east Bihar, sub Himalayan West Bengal and adjoining Assam, Sikkim and Bhutan.

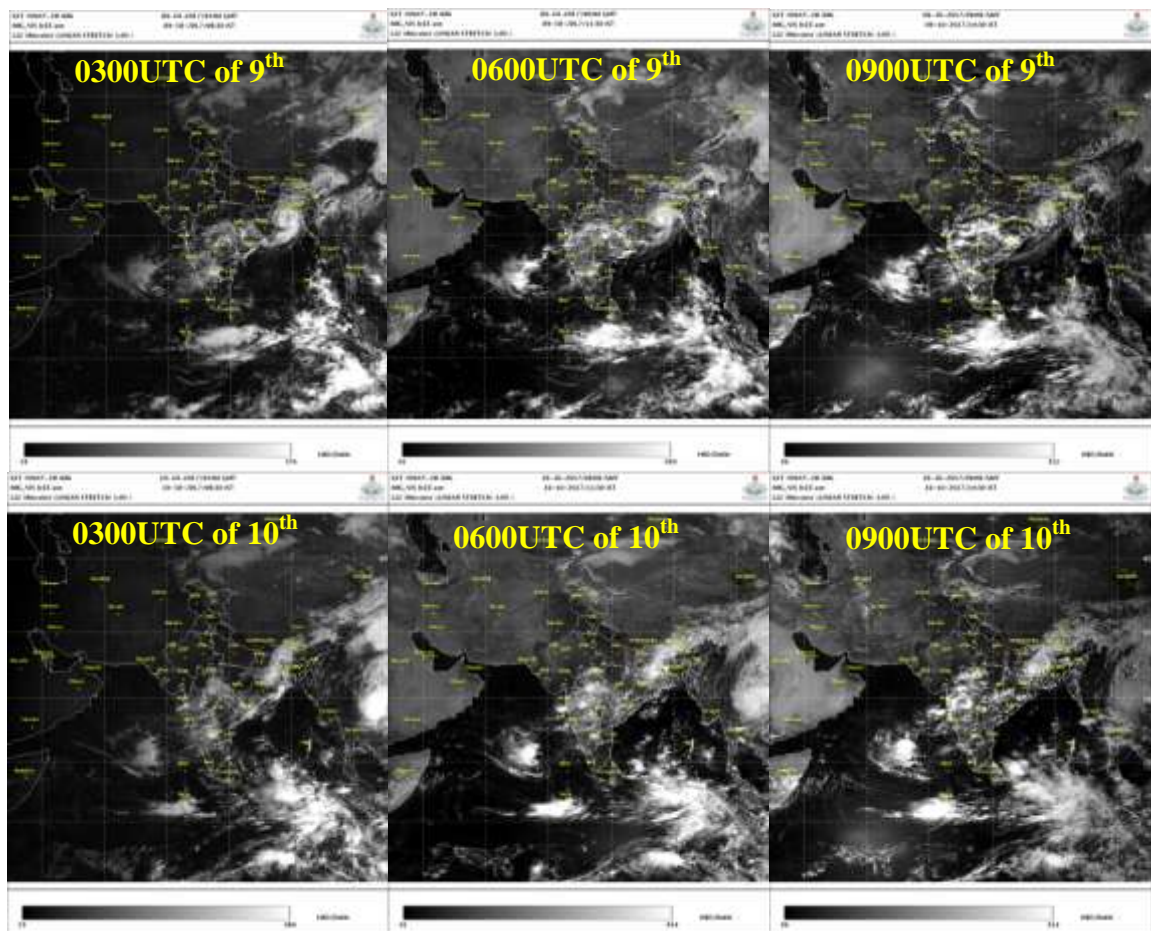


Fig. 2(i): INSAT-3D visible imageries of Depression (09-10 October, 2017)

Satellite imageries indicated that at the time of genesis, there was warm and moist air advection from the sea reaching upto northeast sector of depression. The convection was well organised with distinct spiral banding till 0000 UTC of 10th. The structure started disorganising from 0300 UTC onwards, with shearing of convection far away from the

system centre over south Chattisgarh, Odisha, east Bihar, sub Himalayan West Bengal and adjoining Assam, Sikkim and Bhutan. Gradually, the depression weakened into a well marked low pressure area at 1200 UTC of 10th October.

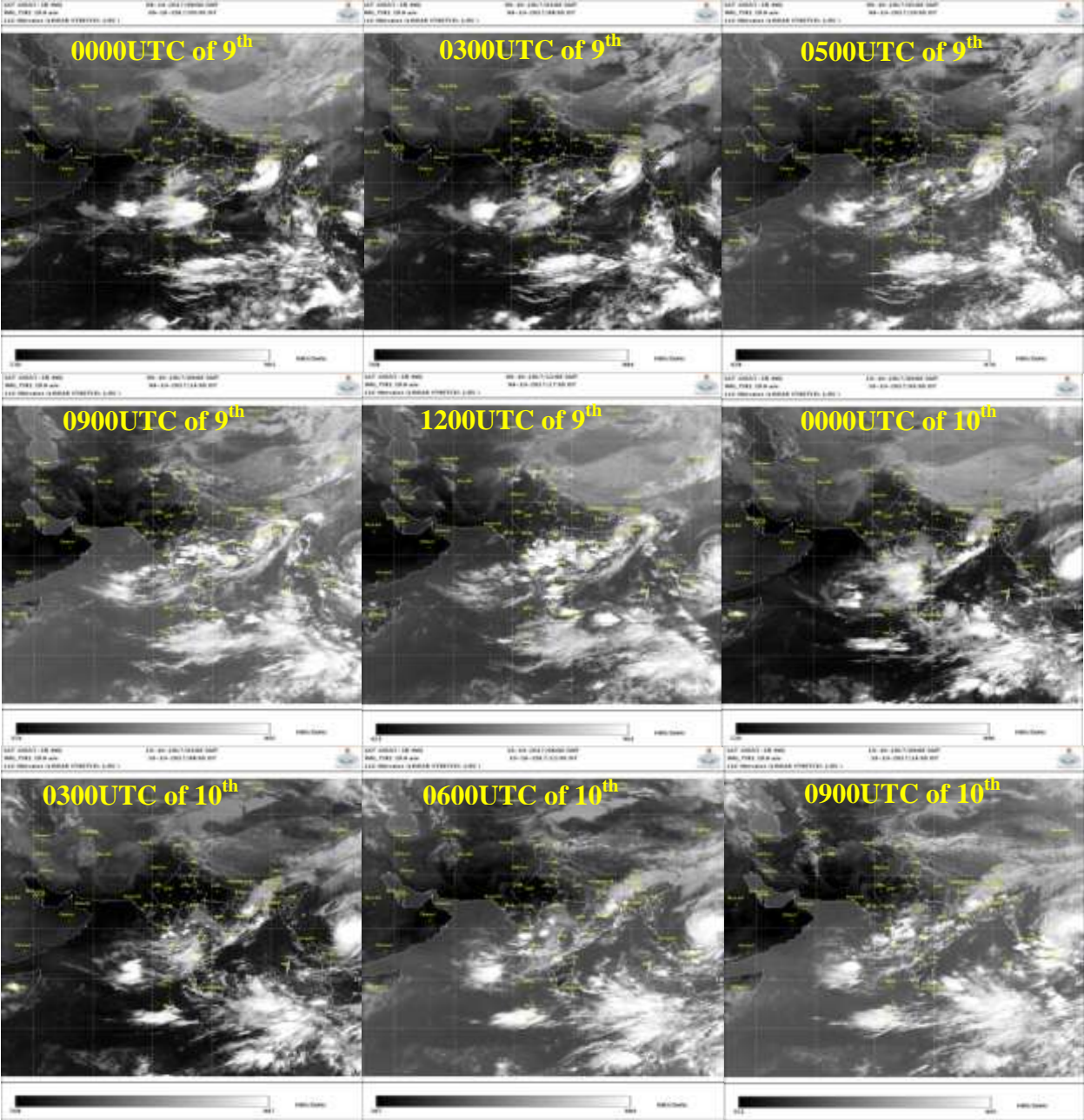


Fig. 2(ii): INSAT-3D IR imageries of Depression (09-10 October, 2017)

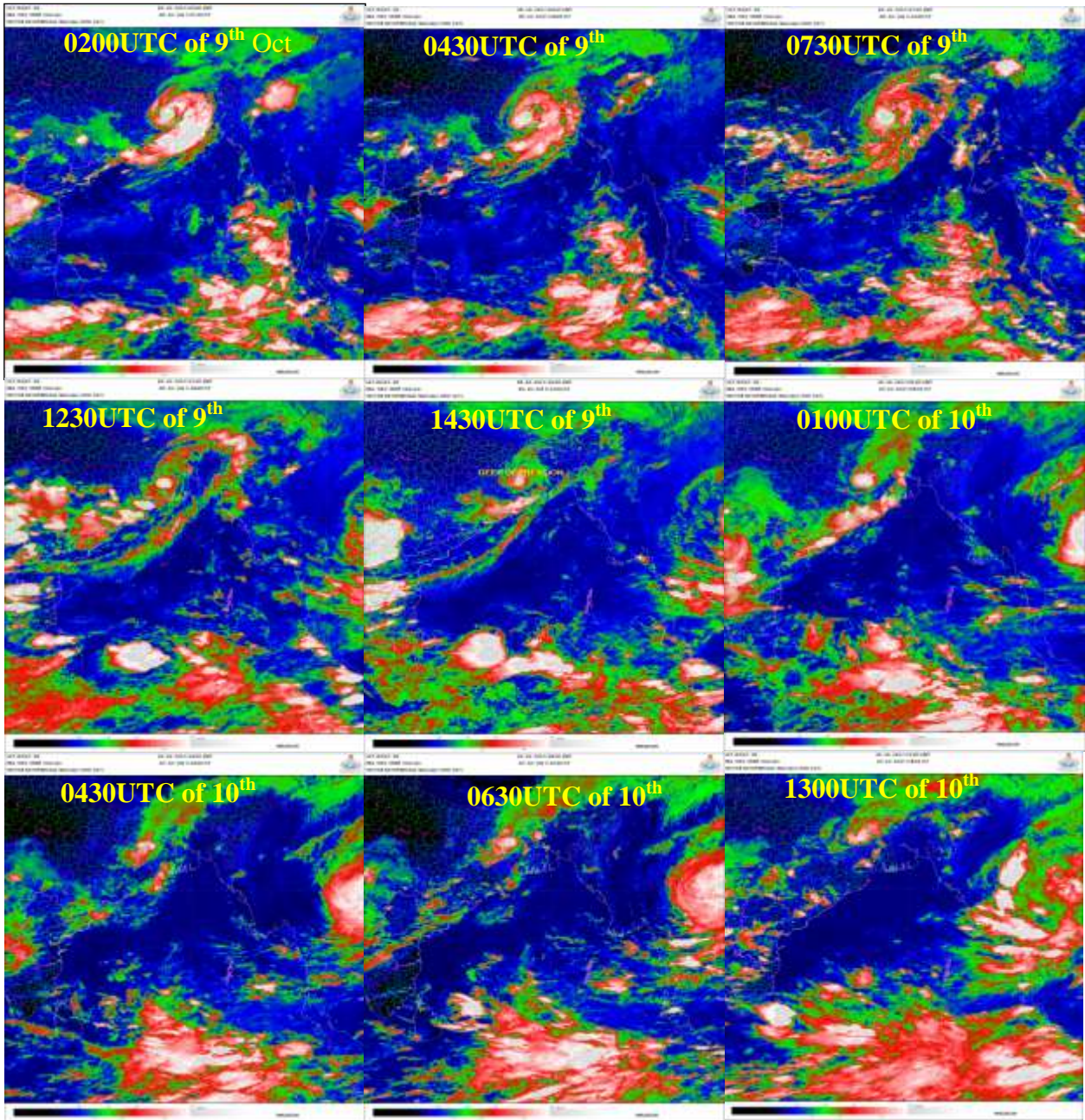


Fig. 2(iii): INSAT-3D enhanced coloured imageries of Depression (09-10 October, 2017)

4. Dynamical features

IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10 m, 850, 500 and 200 hPa levels are presented in Fig.3. IMD GFS (T1534) could not simulate the genesis and intensification of the system. However, it picked up the associated cyclonic circulation extending upto mid-tropospheric level. It also predicted presence of anticyclone over central India in middle and upper tropospheric levels and trough in mid-latitude westerlies based on initial conditions of 0000 UTC of 9th October 2017.

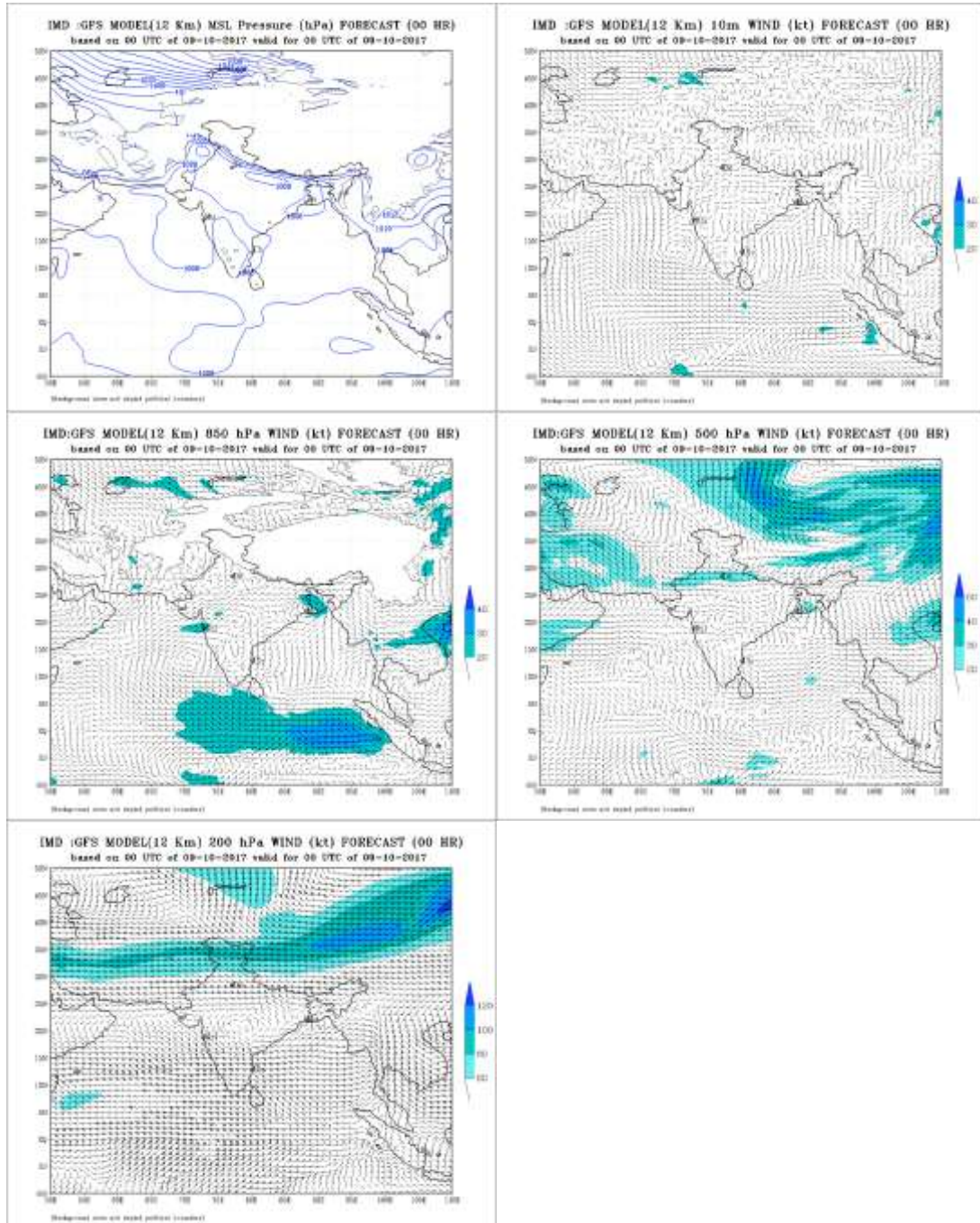


Fig3 (i): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 09th October 2017

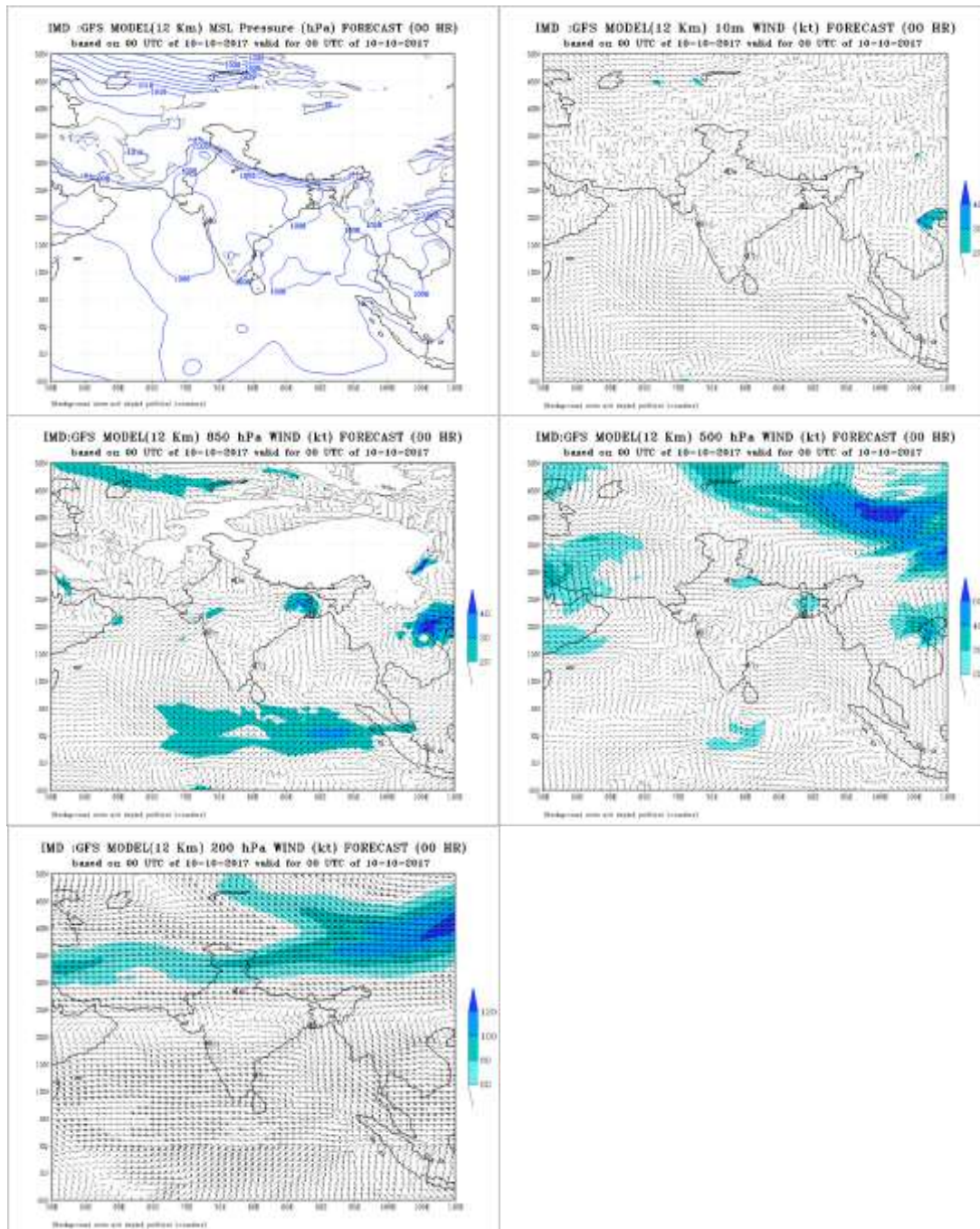


Fig3 (ii): IMD GFS (T1534) mean sea level pressure (MSLP), winds at 10m, 850, 500 and 200 hPa levels based on 0000 UTC of 10th October 2017

5. Realized Weather:

5.1 Rainfall:

The system caused heavy to very heavy rainfall at isolated places over Gangetic West Bengal and heavy rainfall at isolated places over Bihar on 10th October and heavy rainfall at

isolated places over Gangetic West Bengal, Jharkhand and Bihar on 11th October 2017. The daily rainfall distribution based on merged gridded rainfall data of IMD/NCMRWF during depression period is shown in Fig.4. It depicts that the system caused heavy to very heavy rainfall over north BoB and adjoining Gangetic West Bengal on 7th and 8th. On 9th, it caused heavy to very heavy rainfall at isolated places over Gangetic West Bengal. On 10th, it caused heavy to very heavy falls at isolated places over Gangetic West Bengal and Bihar.

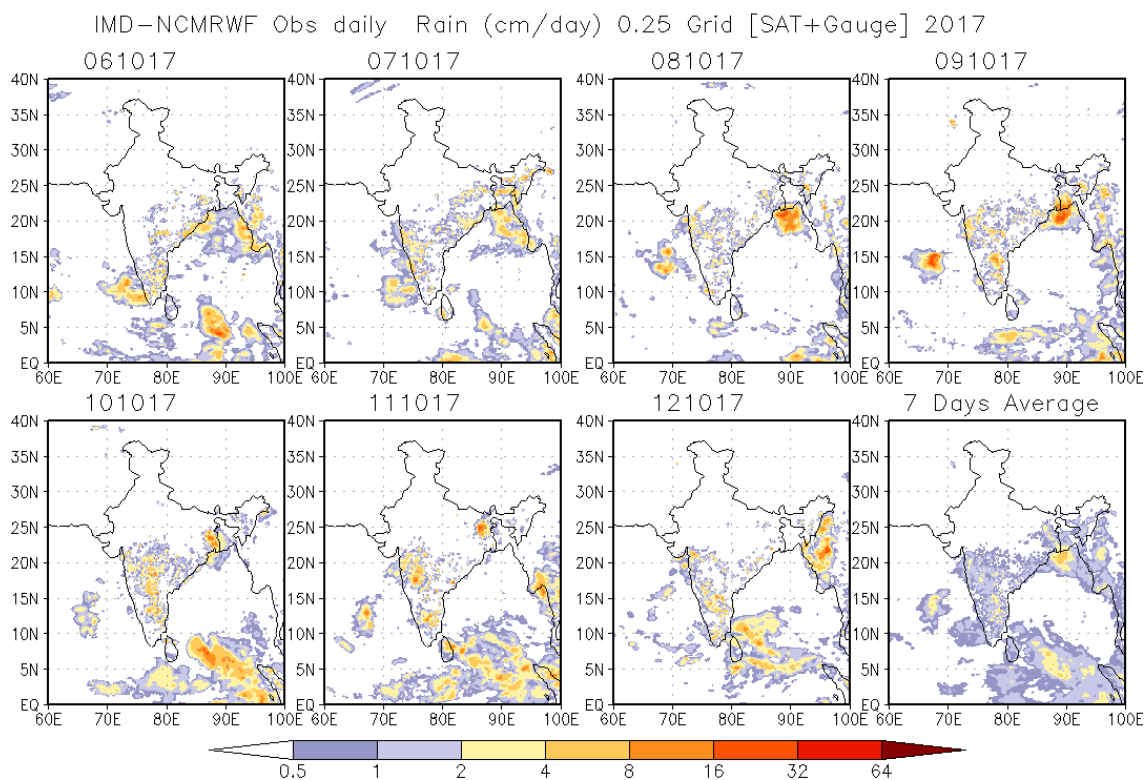


Fig.4: Daily rainfall distribution based on merged gridded rainfall data of IMD/NCMRWF during 09-10 October 2017 ending at 0300 UTC of day.

Realized 24 hrs accumulated rainfall (≥ 7 cm) ending at 0830 hrs IST of date during the life cycle of the system are presented below:

9TH OCTOBER:

GANGETIC WEST BENGAL: Canning-14, Baruipur & Manmothnagar-12 each, Diamond Harbour-7

Odisha: Talcher-9.

10 OCTOBER 2017:

GANGETIC WEST BENGAL: Durgapur-19, Burdawan (STATE)-17, Panagarh & Asansol-16 each, Asansol-15, Gheropara-14, Bolpur & Burdwan-13 each, Sri Niketan-12, Narayanpur & Kanksa-11 each, Barrackpur-10, Uluberia-9, Bagati, Chinsura Mangalkote & Bongaon-8 each, Hetampur, Uluberia, Dum Dum, Alipore, Amta & Bankura-7 each

ODISHA: Niali-7

JHARKHAND: Dumka-11, Maithon-11, Gobindpur-8, Mohanpur-7

CHHATTISGARH: Sukma-8, Rajim-7

11 OCTOBER 2017:**GANGETIC WEST BENGAL:** Asansol-9, Narayanpur-7**ODISHA:** Bhograi-7,**JHARKHAND:** Jamtara-14, Giridih-10, Pathargama & Moharo- 9 each, Madhupur & Dumka-8 each,**BIHAR:** Jamui-19, Sono-18, Suryagadha-17, Bhagalpur-15, Jhajha-14, Parbatta-13, Lakhisaral, Banka & Bihpur-11 each, Monghyr & Sabour-10 each, Cheria B.Puri & Katoria-8 each, Gogri-7**6. Bulletins issued by Cyclone Warning Division, New Delhi**

IMD continuously monitored, predicted and issued bulletins containing track and intensity of the system till weakened into a low pressure area to the concerned central and state disaster management authorities and press & media.

- The prognostics and diagnostics of the systems were described in the RSMC bulletins.
- Warnings bulletins for adverse weather like heavy rain were issued with every three hourly update during life cycle of system to the central, state and district level disaster management agencies including MHA, NDRF, NDMA, chief secretaries Odisha, West Bengal, Chattisgarh, Jharkhand, Bihar and Sikkim. These bulletins were also issued to Railways, Surface Transport, Defence including Indian Navy & Indian Air Force, Ministry of Agriculture, Ministry of Information and Broadcasting etc.
- The graphical display of the observed track was disseminated by email and uploaded in the RSMC, New Delhi website (<http://www.rsmcnewdelhi.imd.gov.in>) regularly.
- Press and electronic media were given daily updates since inception of system through press release, e-mail, website and SMS.
- The six hourly bulletins were issued by the cyclone warning division at New Delhi and cyclone warning centres of IMD at Kolkata, Visakhapatnam and Bhubaneswar to ports, fishermen, coastal and high sea shipping community

Statistics of bulletins issued by Cyclone Warning services of IMD in association with the system are given in Table 2.

Table 2a: Bulletins issued by Cyclone Warning Division, India Meteorological Department

S.No.	Bulletin	No. of Bulletins	Issued to
1	National Bulletin	9	1. IMD's website 2. FAX and e-mail to Control Room NDM, Ministry of Home Affairs, Control Room NDMA, Cabinet Secretariat, Minister of Sc. & Tech, Secretary MoES, DST, HQ Integrated Defence Staff, DG Doordarshan, All India Radio, DG-NDRF, Director Indian Railways, Indian Navy, IAF, Chief Secretary: Odisha, West Bengal, Chattisgarh, Jharkhand, Bihar, Sikkim.
2	RSMC Bulletin	3	1. IMD's website 2. WMO/ESCAP member countries through GTS and E-mail 3. Indian Navy, IAF by E-mail
3	Press Release	1	Disaster Managers, Media persons by email and uploaded on website

4	SMS	3711	SMS through (i) IMD network for disaster managers at national level and concerned states-119 (ii) Department of Electronics and Information Technology-3692
---	-----	------	--

Table 2b: Bulletins issued by Area Cyclone Warning Centre (ACWC) Kolkata/Cyclone Warning Centre (CWC) Bhubaneswar/Meteorological Centre (MC) Patna

S.No.	Type of Bulletin	ACWC Kolkata	CWC Bhubaneswar	MC Patna
1.	Sea Area Bulletins	4	NIL	NA
2.	Coastal Weather Bulletins for WB Coast-	4	05	NA
3.	Fishermen Warnings issued for WB Coast fishermen	8	10	NA
4.	Port Warnings for WB ports	3	04	NA
5.	Heavy Rainfall Warning	4	03	02
6.	Information & Warning issued to West Bengal Government and other Agencies	8	07	01
7.	SMS/ Whatsapp (message in group)	4 times	NIL	NIL

NA: Not applicable

7. Verification of Heavy Rainfall Warning

The verification of heavy rainfall warnings issued by IMD for the deep depression during 9-10th October is presented in Table 3. It can be found that the occurrence of heavy rainfall in association with the system could be predicted accurately and well in advance.

Table 3: Verification of heavy rainfall warning issued by IMD for Deep Depression over Gangetic West Bengal and adjoining north Bay of Bengal (09-10 October, 2017)

Date/Time of issue	Heavy rainfall warning	Realised heavy rainfall (7cm or more) ending at 0830 hrs IST of date
0300 UTC of 9 th Oct. 2017	<ul style="list-style-type: none"> ❖ Heavy to very heavy rainfall at a few places and extremely heavy rainfall at isolated places over Gangetic West Bengal during next 24 hours and isolated heavy to very heavy rainfall during subsequent 24 hours. ❖ Heavy to very heavy rainfall at isolated places over north Odisha and Jharkhand during next 48 hours. ❖ Heavy rainfall at isolated places over Chhattisgarh & south Odisha on 10th and over Bihar on 10th & 11th October. 	<p>9TH OCTOBER: GANGETIC WEST BENGAL: Canning-14, Baruipur & Manmothnagar-12 each, Diamond Harbour-7 Odisha: Talcher-9. 10 OCTOBER 2017: GANGETIC WEST BENGAL: Durgapur-19, Burdawan (STATE)-17, Panagarh & Asansol-16 each, Asansol-15, Gheropara-14, Bolpur & Burdwan-13 each, Sri Niketan-12, Narayanpur & Kanksa-11 each, Barrackpur-10, Uluberia-9, Bagati, Chinsura Mangalkote & Bongaon-8 each, Hetampur, Uluberia, Dum Dum, Alipore, Amta & Bankura-7 each ODISHA: Niali-7 JHARKHAND: Dumka-11, Maithon-11, Gobindpur-8, Mohanpur-7</p>

0300 UTC of 10 th Oct. 2017	<ul style="list-style-type: none"> ❖ Heavy to very heavy rainfall at isolated places over Sub-Himalayan West Bengal, northern parts of Gangetic West Bengal, northeast Jharkhand and east and central Bihar during next 24 hours. ❖ Heavy rainfall at isolated places over Sikkim during the same period. 	CHHATTISGARH: Sukma-8, Rajim-7 <u>11 OCTOBER 2017:</u> GANGETIC WEST BENGAL: Asansol-9, Narayanpur-7 ODISHA: Bhograi-7, JHARKHAND: Jamtara-14, Giridih-10, Pathargama & Moharo- 9 each, Madhupur & Dumka-8 each, BIHAR: Jamui-19, Sono-18, Suryagadha-17, Bhagalpur-15, Jhajha-14, Parbatta-13, Lakhisaral, Banka & Bihpur-11 each, Monghyr & Sabour-10 each, Cheria B.Puri & Katoria-8 each, Gogri-7.
--	---	---

8. Summary and Conclusion:

A **low pressure area** formed over North Bay of Bengal and adjoining south Bangladesh on 8th October morning. It concentrated into a depression in the early morning of 9th over Gangetic West Bengal and adjoining north BoB. Moving northwestwards, it intensified into a deep depression (DD) in the morning of 9th. It moved nearly north-northwestwards and weakened into a depression around noon of 10th and into a well marked low pressure area over northeast Jharkhand and adjoining West Bengal in the evening of the same day. It became less marked on 11th.

9. Acknowledgements:

India Meteorological Department (IMD) duly acknowledges the contribution of all sister organizations of Ministry of Earth Sciences including National Centre for Medium Range Weather Forecasting Centre (NCMRWF), Indian National Centre for Ocean Information Services (INCOIS) and National Institute of Ocean Technology (NIOT). The support from various Divisions/Sections of IMD including ACWC Kolkata, CWC Bhubaneswar, Regional Meteorological Centre (RMC) Guwahati, Numerical Weather Prediction (NWP) Division, Information System & Services Division (ISSD) and Satellite Division at IMD HQ New Delhi is also acknowledged.