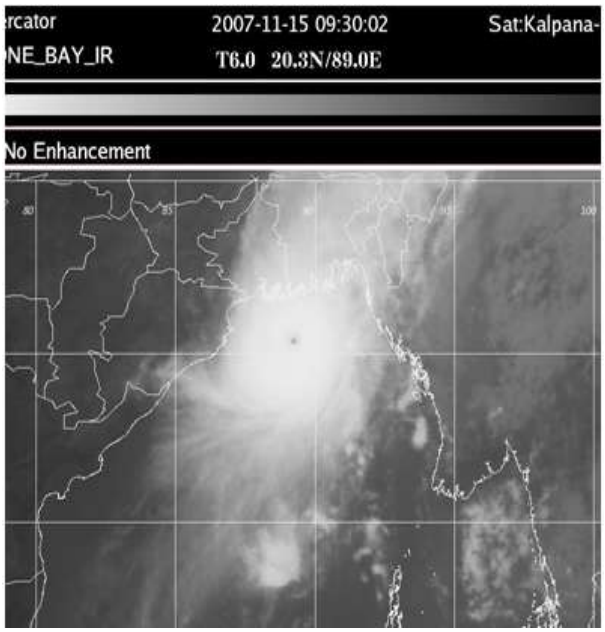
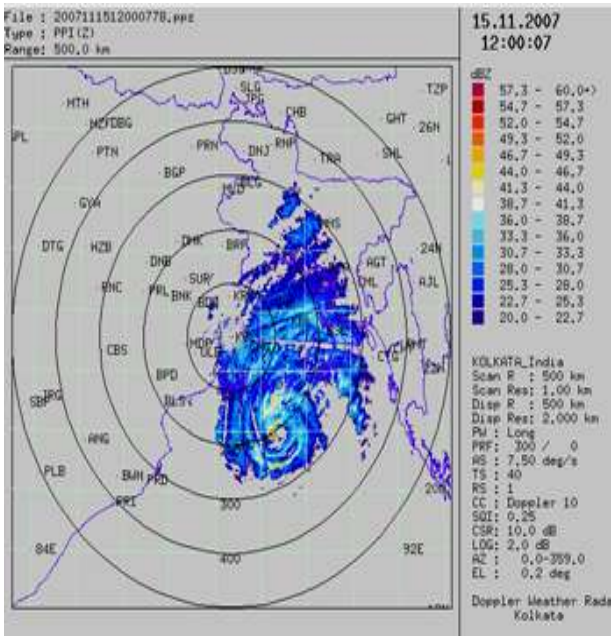
REPORT ON CYCLONIC DISTURBANCES OVER NORTH INDIAN OCEAN

DURING 2007





RSMC-TROPICAL CYCLONES, NEW DELHI

JANUARY 2008

INDIA METEOROLOGICAL DEPARTMENT

RSMC- TROPICAL CYCLONES, NEW DELHI

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INTRODUCTION

Regional Specialized Meteorological Centre (RSMC) - Tropical Cyclones, New Delhi has the responsibility of issuing Tropical Weather Outlook and Tropical Cyclone Advisories for the benefit of the countries in the WMO/ESCAP Panel region bordering the Bay of Bengal and the Arabian Sea, namely, Bangladesh, Pakistan, Maldives, Myanmar, Sultanate of Oman, Sri Lanka and Thailand. It has also the responsibilities as a Tropical Cyclone Advisory Centre (TCAC) to provide Tropical Cyclone Advisories to the designated International Airports as per requirement of International Civil Aviation Organisation (ICAO).

As per the recommendations of the Cyclone Review Committee (CRC) set up by the Government of India, a Cyclone Warning Directorate, co-located with RSMC Tropical Cyclones - New Delhi, was established in 1990 in Northern Hemisphere Analysis Centre (NHAC) of India Meteorological Department (IMD), New Delhi to co-ordinate and supervise the cyclone warning in the country.

The broad functions of RSMC- Tropical Cyclones, New Delhi are as follows:

- Round the clock watch on weather situations over the entire north Indian Ocean.
- Analysis and processing of global meteorological data for diagnostic and prediction purposes.
- Detection, tracking and prediction of cyclonic disturbances in the Bay of Bengal and the Arabian Sea.
- Running of numerical weather prediction models for tropical cyclone track and storm surge predictions.
- Interaction with National Disaster Management Authority and National Disaster Management, Ministry of Home Affairs, Govt. of India to provide timely information and warnings for emergency support services. RSMC-New Delhi also coordinates with national Institute of Disaster Management (NIDM) for sharing the information related to cyclone warning.
- Implementation of the Regional Cyclone Operational Plan of WMO/ESCAP Panel.
- Issue of Tropical Weather Outlook and Tropical Cyclone Advisories to the Panel countries in general.
- Issue of Tropical Cyclone advisories to International airports in the neighbouring countries for International aviation.
- Collection, processing and archival of all data pertaining to cyclonic disturbances viz. wind, storm surge, pressure, rainfall, damage report, satellite and Radar derived information etc. and their exchange with Panel member countries.
- Preparation of comprehensive annual reports on cyclonic disturbances formed over North Indian Ocean every year.
- Preparation of annual review report on various activities including meteorological, hydrological and disaster preparedness and prevention activities of panel member countries.
- Research on storm surge, track and intensity prediction techniques.

CHAPTER- I

ACTIVITIES OF REGIONAL SPECIALIZED METEOROLOGICAL CENTRE – TROPICAL CYCLONES, NEW DELHI

1.1 AREA OF RESPONSIBILITY

The area of responsibility of RSMC Tropical Cyclones, New Delhi (hereafter referred to as RSMC- New Delhi) covers sea areas of north Indian Ocean north of equator between 45^0 E and 100^0 E and includes the member countries of WMO/ESCAP Panel on Tropical Cyclones viz, Bangladesh, India, Maldives, Myanmar, Pakistan, Sri Lanka, Sultanate of Oman and Thailand as shown in Fig. 1.1. The centre issues Tropical Weather Outlook daily at 0600 UTC in normal weather. If a depression forms over north Indian ocean a Special Tropical Weather Outlook is issued additionally at 1700 UTC. The Tropical Cyclone Advisories are issued on tropical cyclones at three hourly intervals when they develop over the north Indian Ocean. RSMC New Delhi has also been issuing Tropical Cyclone Advisories for Aviation as per requirements of ICAO.

RSMC- New Delhi is continuing the naming of Tropical Cyclones formed over North Indian Ocean since October 2004.

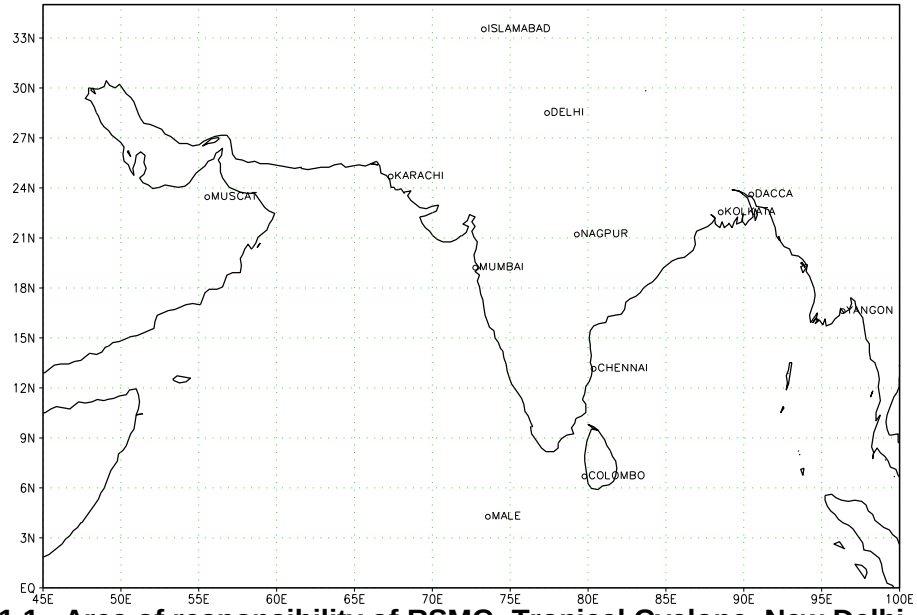


Fig. 1.1 Area of responsibility of RSMC- Tropical Cyclone, New Delhi

1.2 OBSERVATIONAL SYSTEM

A brief description of different types of observational network of IMD and observations collected from networks are given below.

1.2.1 Surface Observatories

IMD has a good network of surface observatories satisfying the requirement of World Meteorological Organization. There are 559 surface observatories in IMD. The data from these stations are used on real time basis for operational forecasting. Recently a number of moored ocean buoys including Meteorological Buoy (MB), Shallow Water (SW), Deep Sea (DS) and Ocean Thermal (OT) buoys have been deployed over the

Indian Sea, under the National Data Buoy Programme (NDBP) of the Department of Ocean Development (DOD), Government of India. The existing buoy network is shown in fig 1.2. A number of Automated Weather Stations (AWS) are also in operation along the coast and provide surface observations on hourly basis which are utilised in cyclone monitoring and forecasting. The AWS network of India is shown in Fig. 1.3

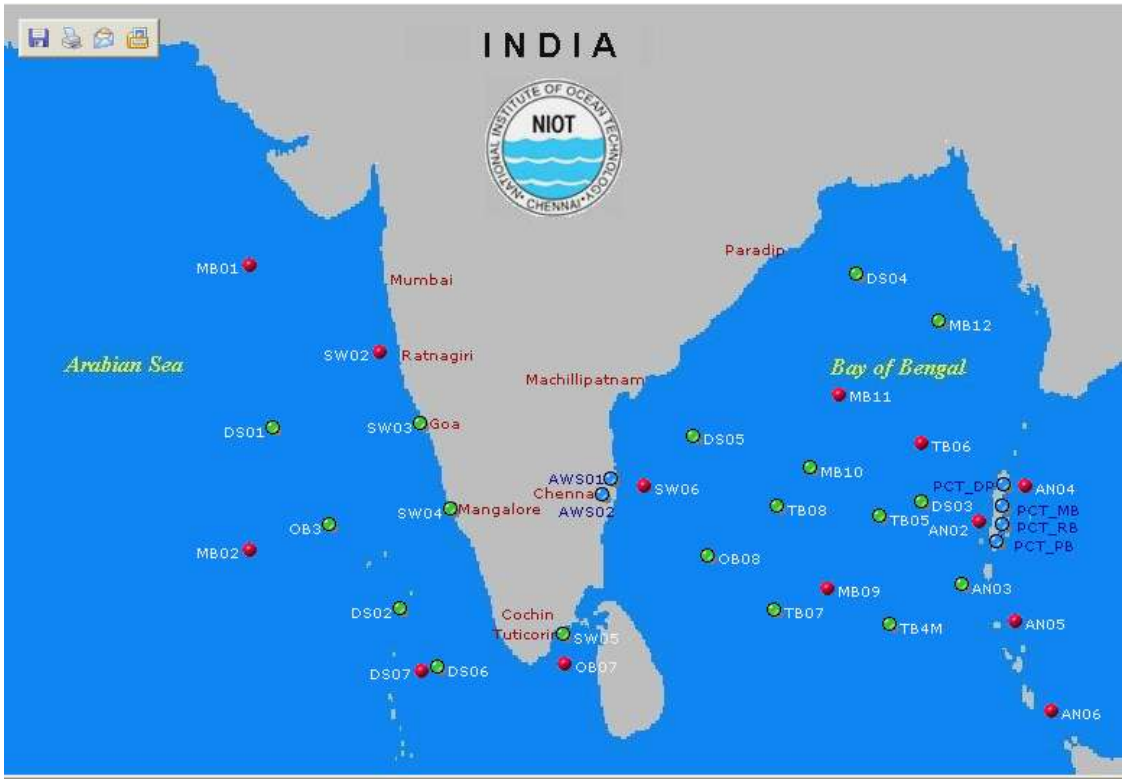


Fig.1.2. Existing buoys network over north Indian Ocean

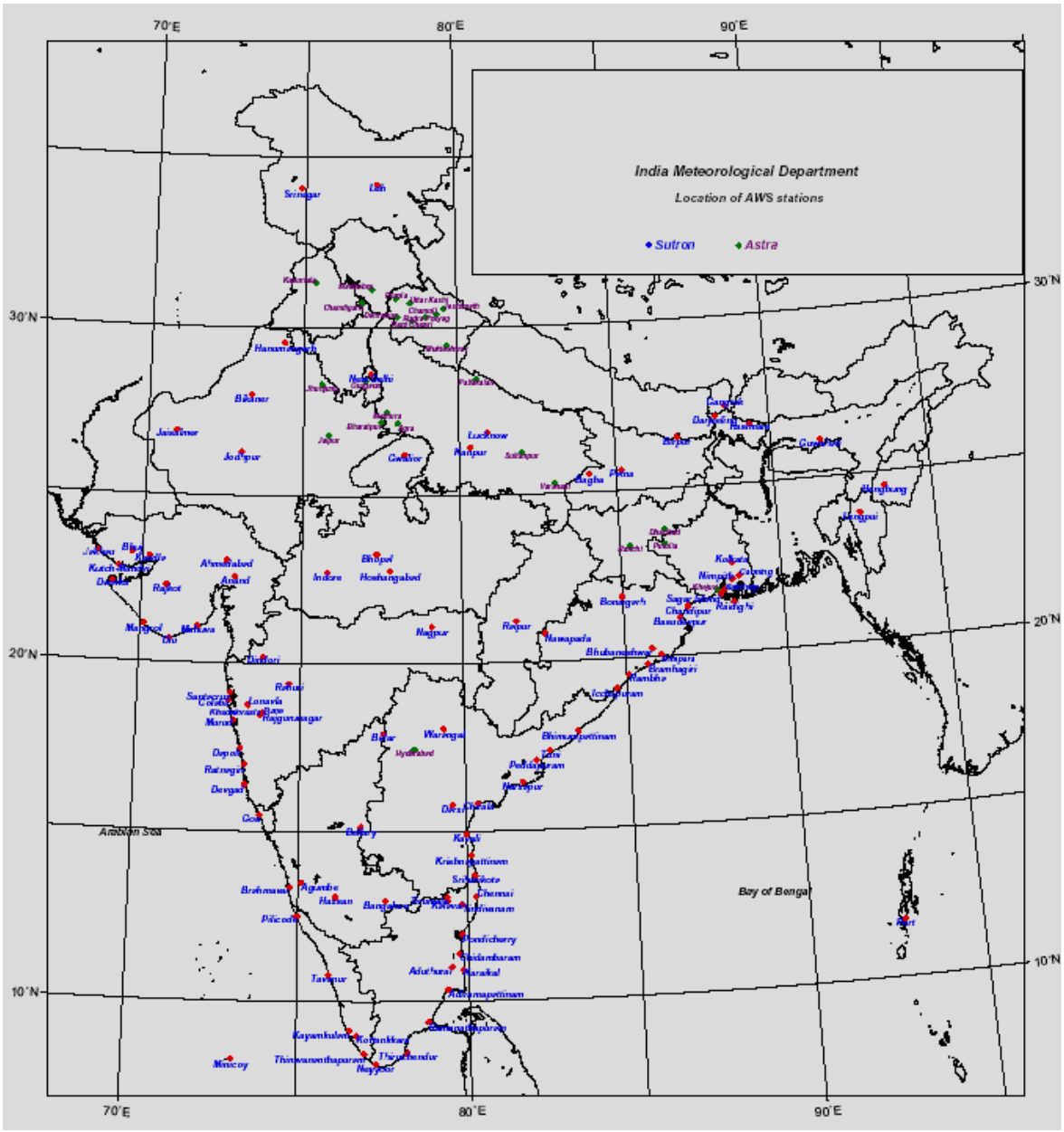


Fig 1.3 Automatic Weather Stations network

1.2.2 Upper Air Observatories

There are at present 62 Pilot Balloon Observatories, 39 Radiosonde/Radiowind observatories and 01 Radiosonde Observatory. The upper air meteorological data thus collected all over the country are used on real time basis for operational forecasting. The short period averages of Radiosonde data and normal of Radiowind data have been published.

A Wind Profiler/Radio Acoustics Sounding System has been installed at DCP Complex, Pashan, Pune in collaboration with M/S SAMEER, Mumbai and IITM, Pune. The instrument is capable of recording upper air temperature up to 3 Km and upper wind up to 9 km above sea level. The performance of the instrument is being monitored.

1.2.3 Radar

(i) Cyclone Detection Radars

There are 11 Nos. of S-band Cyclone Detection Radar (CDR) Stations viz. Kolkata, Paradip, Visakhapatnam, Machilipatnam, Chennai, Sri Harikota, Karaikal, Kochi, Goa, Mumbai and Bhuj (Fig. 1.4). Out of these 11 stations, 6 stations (except Chennai, Kolkata, Sriharikota, Visakhapatnam and Machilipatnam) are using conventional S-band radars. Four number of S-Band Doppler Weather Radars (Meteor 1500S) imported from M/S Gematronik Germany have been installed, commissioned and made operational at Chennai, Kolkata, Machilipatnam and Visakhapatnam respectively with effect from 22.2.2002, 29.1.2003, 8.12.2004 and 27.7.2006 respectively. One indigenous Doppler Weather Radar developed by Indian Space Research Organisation (ISRO) under IMD-ISRO collaboration has been installed and made operational at SHAR Centre, Sri Harikota (Andhra Pradesh) with effect from 9 April, 2004.

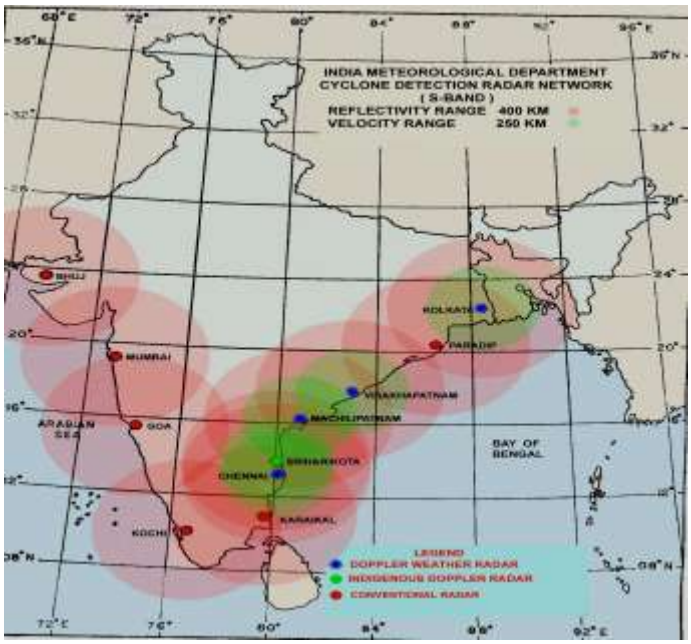


Fig. 1.4 S-band conventional cyclone detection radar and Doppler Weather Radar network

It is also planned to replace the remaining existing old conventional CDRs by the state of Art S-Band Doppler Weather Radar in a phased manner. Doppler Weather Radars (DWR) provide vital information on radial velocity within a tropical cyclone which is not available in conventional radar. A conventional radar provides information on reflectivity and range only, whereas a DWR provides velocity and spectral width data along with various meteorological, hydrological and aviation products which are very useful for forecasters in estimating the storm's center, its intensity and predicting its future movement. The DWR generates these products through a variety of software algorithms. S-band conventional radars and DWR network in India is shown in Fig. 1.4.

(ii) Storm Detection Radars and wind finding Radars

There are at present 9 X-Band radars working on 3 cm. wavelength for the purpose of storm detection. These are located at Kolkata, Chennai, Guwahati, Ranchi, Delhi, Lucknow, Mumbai, Nagpur and Agartala airports (Fig. 1.5). Also, there are two S-Band radars working on 10 cm. wavelength at Sriganganagar and Jaisalmer for warning against convective clouds and

thunder storm formation and one S-Band radar at Mausam Bhawan, Delhi for testing/training purpose.

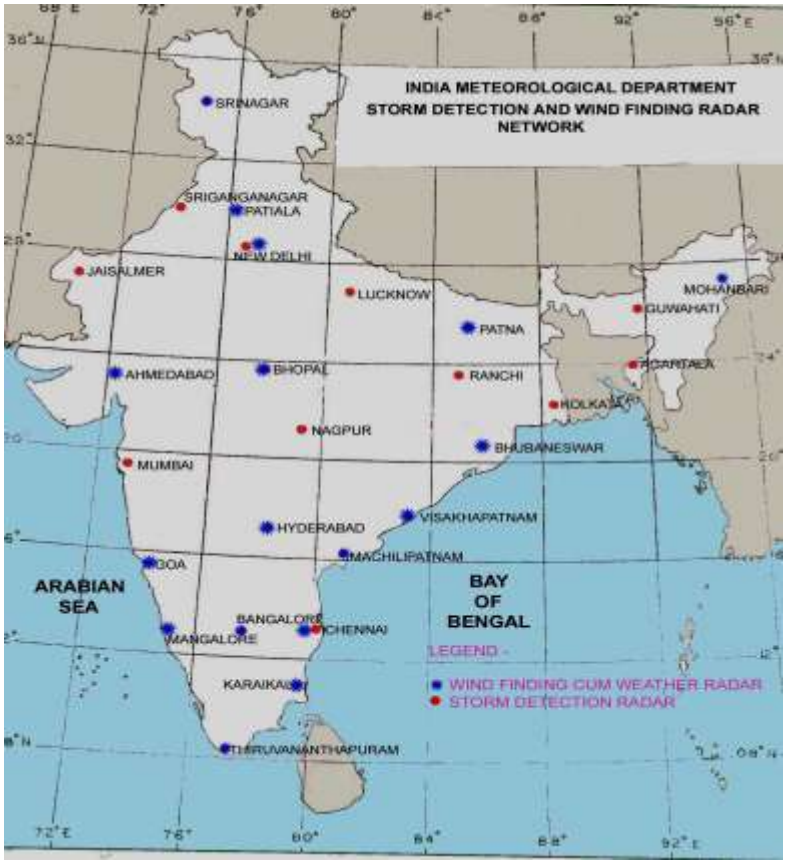


Fig. 1.5 X-band or storm detection radar network

There are 9 X-Band Wind Finding Radars working on 3 cm wavelength at Bhubaneswar, Goa, Mangalore, Visakhapatnam, Bhopal, Karaikal, Machilipatnam, Patna and Thiruvananthapuram.

There are 8 X-Band radars working on 3 cm wavelength which are used for Weather Cum Wind finding purpose. These radars are installed at Ahmedabad, Bangalore, Mohanbari, Chennai, Hyderabad, Delhi (HQ), Patiala and Srinagar.

Ten X-Band radars (at Ahmedabad, Goa, Mangalore, Chennai, Visakhapatnam, Bhubaneshwar, Kolkata, Guwahati, Ranchi & Bangalore) out of 26 X-Band Radars mentioned above have been replaced by latest digital technology based EEC Radars. These radars have the facility of computer controlled operation with presentation of wind profile and display of reflectivity of clouds.

1.2.4 Satellite Monitoring

India has launched Geo-stationary Satellite METSAT, now named KALPANA-I, on September 2002 purely for meteorological applications. It is positioned over the equator at 74^0 E. Another Geostationary satellite under INSAT series (INSAT-3A) was launched in April 2003 with the meteorological payloads identical to those of INSAT-2E which became operational since May 2003. It is positioned over the equator at 93.5^0 E. Both these satellites provide

imageries in visible (VIS), Infrared (IR) and Water Vapour (WV) channels. In addition INSAT-3A is also equipped with Charged Coupled Device (CCD) cameras capable of providing imageries in VIS, Near IR (NIR) and Short-Wave IR (SWIR) channels with greater resolution.

During cyclone situation, data from KALPANA-1 are processed at hourly intervals to assess the location and intensity of cyclonic disturbances out at sea. Similar processing of data from INSAT-3A is done at 3-hourly intervals.

In addition to above, the following products are also generated on operational mode and posted in website of IMD.

- Outgoing Long wave Radiation (OLR)
- Quantitative Precipitation Estimates (QPE)
- Sea Surface Temperatures (SST)
- Cloud Motion Vector (CMV) in 3 levels
- Water Vapour Wind Vector, (WVWV)
- Isotherm analysis on Enhanced infrared images.

1.2.5 Meteorological Data Dissemination

IMD transmits processed imagery, meteorological and facsimile weather charts to field forecasting offices distributed over the country using the Meteorological Data Dissemination (MDD) facility, through INSAT in broadcast mode. The bulletins providing description of the cloud organization and coverage are also sent as advisory to forecasting offices every synoptic hour. When cyclones are detected in satellite imagery, these bulletins are sent every hour. Such advisories are also transmitted to the neighbouring countries.

Processed satellite imagery, analyzed weather charts and conventional synoptic data are up-linked to the satellite in C-band. Satellite broadcasts these data to MDD receiving stations in S-band. MDD receiving stations analyse weather imagery and other data to generate required forecast. The processing system is also being used for generating analogue type of cloud imagery data which are transmitted through INSAT-3C to field stations using S-band broadcast capability of the satellite alongwith other conventional meteorological data and fax charts. There are about 33 MDD receiving stations in the country being operated by different agencies. Two MDD receiving stations are also operating in neighbouring countries at Sri Lanka and Male. In general, the processed images are sent to these stations every hour during cyclone periods. These stations are receiving direct broadcast of cloud imagery, weather facsimile charts and meteorological data on an operational basis. The frequency of transmission from ground to satellite (uplink) is 5899.225 MHz and that of downlink is 2599.225 MHz.

1.3 ANALYSIS

The analysis of synoptic observations is performed four times daily at 00, 06, 12, and 18 UTC. During cyclone period, synoptic charts are prepared and analysed every three hour to monitor the tropical cyclones over the north Indian Ocean.

Cloud imageries from Geostationary Meteorological Satellites INSAT-3A and METSAT (KALPANA-1) are the main sources of information for the analysis of tropical cyclones over the data-sparse region of north Indian Ocean. Data from ocean buoys also provide vital information. Ship observations are also used critically during the cyclonic disturbance period.

The direction and speed of the movement of a tropical cyclone are determined primarily from the three hourly displacement vectors of the centre of the system and by analyzing satellite imageries. When the system comes closer to the coastline, the system location and intensity are determined based on hourly observations from Cyclone Detection Radar and Doppler Weather Radar stations as well as coastal observatories. The AWS stations along

coast are also very useful as they provide hourly observations on real time basis. The water vapour derived wind vector and cloud motion vectors in addition to the conventional wind vectors observed by Radio Wind (RW) instruments are very useful for monitoring and prediction of cyclonic disturbances especially over the sea region.

1.4 PREDICTION SYSTEM IN OPERATIONAL USE DURING THE YEAR 2007

(a) Quasi-Lagrangian Model (QLM)

The QLM, a multilevel fine-mesh primitive equation model with a horizontal resolution of 40 km and 16 sigma levels in the vertical, is being used for tropical cyclone track prediction in IMD. The integration domain consists of 111x111 grid points centred over the initial position of the cyclone. The model includes parameterization of basic physical and dynamical processes associated with the development and movement of a tropical cyclone. The two special attributes of the QLM are: (i) merging of an idealized vortex into the initial analysis to represent a storm in the QLM initial state and (ii) imposition of a steering current over the vortex area with the use of a dipole. The initial fields and lateral boundary conditions are derived based on global model (T-80 and T254) forecasts obtained online from the National Centre for Medium Range Weather Forecasting (NCMRWF), India. The model is run twice a day based on 00 UTC and 12 UTC initial conditions to provide 6 hourly track forecasts valid up to 72 hours. The track forecast products are disseminated as a World Weather Watch (WWW) activity of RSMC, New Delhi.

(b) Limited Area Model (LAM)

The operational forecasting system known as Limited Area Forecast System (LAFS), is a complete system consisting of data decoding and quality control procedures, 3-D multivariate optimum interpolation scheme for objective analysis and a semi-implicit semi-Lagrangian multi-layer primitive equation model. The model is run twice a day based on 00 UTC and 12 UTC observations. The horizontal resolution of the model is 0.75^0x0.75^0 lat. / long. With 16 sigma levels in the vertical. First guess and boundary conditions for running the LAFS are obtained online from global forecast model being operated by the NCMRWF. During cyclone situation, the model is run by including Holland vortex scheme. The forecast products are disseminated as a WWW activity of RSMC, New Delhi.

(c) Non-hydrostatic Meso-scale Model MM-5 (Version 3.6)

The non-hydrostatic model MM-5 is being run on operational basis daily once based on 00 UTC initial conditions for the forecast upto 72 hours. The horizontal resolution of the model is 45 km with 23 sigma levels in the vertical. The domain of integration covers the area between lat. 25.0^o S to 45.0^o N and long. 30^o E to 120.0^o E. National Centre for Environmental Prediction (NCEP) analysis and six hourly forecasts are used as initial and boundary conditions to run the model. During cyclone situations, the model is run by including Holland vortex scheme. The forecast products are disseminated as a WWW activity of RSMC, New Delhi.

(d) Storm Surge Model

For the operational storm surge prediction, IMD uses both nomograms developed by IMD and Dynamical Storm Surge Model developed by Indian Institute of Technology (IIT), Delhi. The nomograms are based on the numerical solution to the hydrodynamical equations governing motion of the Sea. The nomograms are prepared relating peak surge with various parameters such as pressure drop, radius of maximum wind, vector motion of the cyclone and offshore bathymetry. The dynamical model of IIT Delhi is fully non-linear and is forced by wind stress

and quadratic bottom friction following the method of numerical solution to the vertically integrated mass continuity and momentum equations. The updated version of the model currently in operational use covers an analysis area lying between lat. 2.0^0 N and 22.25^0 N and long. 65.0^0 E & 100.0^0 E. The method uses a conditionally stable semi-implicit finite difference stair step scheme with staggered grid for numerical solution of the model equation. The bottom stress is computed from the depth-integrated current using conventional quadratic equation. The bathymetry of the model is derived from Naval Hydrographic charts applying cubic spline technique.

1.5 PRODUCTS GENERATED BY RSMC, NEW DELHI

RSMC, New Delhi prepares and disseminates the following RSMC bulletins.

(I) Tropical Weather Outlook

Tropical Weather Outlook is issued daily at 0600 UTC in normal weather for use of the member countries of WMO/ESCAP Panel. This contains description of synoptic systems over north Indian Ocean along with information on significant cloud systems as seen in satellite imageries and ridge line at 200 hPa level over Indian region. In addition, a special weather outlook is issued at 1700 UTC when a tropical depression lies over north Indian Ocean.

(ii) Tropical Cyclone Advisories

Tropical cyclone advisories are issued at 3 hourly intervals based on 00, 03, 06, 09, 12, 15, 18 and 21 UTC observations. The time of issue is HH+03 hrs. These bulletins contain the current position and intensity, central pressure of the cyclone, description of satellite cloud imagery, expected direction and speed of movement, forecast of winds, squally weather and state of the sea in and around the system. Tropical cyclone advisories are transmitted to panel member Countries through global telecommunication system (GTS) and are also made available on real time basis through internet at IMD's website: http://www.imd.ernet.in and http://www.imd.gov.in. RSMC, New Delhi can also be contacted through e-mail (cwdhq@imdmail.gov.in) for any real time information on cyclonic disturbances over north India Ocean.

(iii) Global Maritime Distress Safety System (GMDSS)

Under Global Maritime Distress Safety System (GMDSS) scheme, India has been designated as one of the 16 services in the world for issuing sea area bulletins for broadcast through GMDSS for MET AREA VIII (N), which covers a large portion of north Indian Ocean. As a routine, two GMDSS bulletins are issued at 0900 and 1800 UTC. During cyclonic situations, additional bulletins (up to 4) are issued for GMDSS broadcast. In addition, coastal weather and warning bulletins are also issued for broadcast through NAVTEX transmitting stations located at Mumbai and Chennai.

(iv) Tropical Cyclone Advisories for Aviation

Tropical Cyclone Advisories for aviation are issued for international aviation as soon as any disturbance over the north Indian Ocean attains or likely to attain the intensity of cyclonic storm (sustained surface wind speed ≥ 34 knots) within next six hours. These bulletins are issued at six hourly intervals based on 00, 06, 12, 18 UTC synoptic charts and the time of issue is HH+03 hrs. These bulletins contains present location of cyclone in lat./long., max sustained

surface wind (in knots), direction of past movement and estimated central pressure, forecast position in Lat./Long and forecast winds in knots valid at HH+12, HH+18 and HH+24 hrs in coded form. The tropical cyclone advisories are transmitted on real time basis through GTS and AFTN channels to designated International Airports of the region prescribed by ICAO.

(V) Bulletin for Indian coasts

These bulletins are issued on every three hourly interval based on the standard 8 synoptic observations at 00, 03, 06, 09, 12, 15, 18 and 21 UTC when the system intensifies into a cyclonic storm over north Indian Ocean. This bulletin contains present status of the cyclone i.e. location, intensity; past movement and forecast intensity & movement, likely landfall point and time and likely adverse weather including heavy rain, gale wind & storm surge. Expected damage and action suggested are also included in the bulletins. This bulletin is completely meant for national users and these are disseminated through various modes of communication including All India Radio, Telephone/Fax, Print and electronic media. It is also posted on cyclone page of IMD website.

1.6 CYCLONE WARNING DISSEMINATION SYSTEM

In addition to the conventional network**,** for quick dissemination of warning against impending disaster from approaching cyclones, IMD has installed specially designed receivers within the vulnerable coastal areas for transmission of warnings to the concerned officials and people using broadcast capacity of INSAT satellite. This is a direct broadcast service of cyclone warning in the regional languages meant for the areas affected or likely to be affected by the cyclone. There are 352 cyclone warning dissemination system (CWDS) stations along the Indian coast; out of these 100 digital CWDS are located along Andhra coast. The IMD's Area Cyclone Warning Centres (ACWCs) at Chennai, Mumbai and Kolkata and Cyclone Warning Centre (CWCs) at Bhubaneswar, Visakhapatnam and Ahmedabad are responsible for originating and disseminating the cyclone warnings through CWDS. The bulletins are generated and transmitted every hour. The cyclone warning bulletin is up-linked to the INSAT in C band. For this service, the frequency of transmission from ground to satellite (uplink) is 5859.225 MHz and downlink is at 2559.225 MHz. The warning is selective and will be received only by the affected or likely to be affected stations. The service is unique in the world and helps the public in general and the administration, in particular, during the cyclone season. It is a very useful system and has saved millions of lives and enormous amount of property from the fury of cyclones. The digital CWDS have shown good results and working satisfactorily.

CHAPTER –II

CYCLONIC ACTIVITIES OVER NORTH INDIAN OCEAN DURING 2007

The year-2007 was a year of near normal cyclonic activity over north Indian Ocean. The basin witnessed the formation of twelve cyclonic disturbances (Table 2.1) against a normal of fifteen. Out of twelve disturbances, five intensified upto the intensity of deep depressions and two into cyclonic storms and one each into very severe cyclonic storm and super cyclonic storm. Tracks of the cyclonic disturbances formed over north Indian Ocean during 2007 are shown in Fig. 2.1.

Two cyclonic storms, including a super cyclonic storm "GONU", and one deep depression formed over the Arabian Sea. However, this deep depression dissipated over the sea itself. The Bay of Bengal witnessed the formation of one very severe cyclonic storm, one cyclonic storm, four deep depressions and three depressions during the year. The brief synopses of the cyclonic storms are given below:

(a) Cyclonic storm "AKASH" over the Bay of Bengal during 13-15 May, 2007

During the onset phase of southwest monsoon, a low pressure area formed over south Andaman Sea on 11 May, 2007. It concentrated into a depression over eastcentral Bay of Bengal on 13 May and into a cyclonic storm **"AKASH"** on 14 May. The cyclonic storm continued to move in a north-northeasterly direction under the influence of upper tropospheric trough in westerlies and crossed south Bangladesh coast, close to south of Cox's Bazar between 2200 and 2300 UTC of 14 May. After crossing the coast, system weakened gradually and continued to move in the same direction. The system caused heavy rainfall over Myanmar, Bangladesh and northeastern states of India.

(b) Super Cyclonic storm "GONU" over the Arabian Sea during 01-07 June, 2007

A low pressure area developed over eastcentral Arabian Sea on 31 May 2007. It concentrated into a depression over the same area and then into a cyclonic storm **"GONU"** at 1200 UTC of 1 June. Thereafter, it moved in a north-northwesterly direction and intensified into a severe cyclonic storm at 0300 UTC of 3 June. It intensified into a very severe cyclonic storm at 1800 UTC of 3 June. The satellite imagery showed open eye at 0600 UTC of 4 June 2007. It intensified into a super cyclonic storm (T6.5) at 1500 UTC of 4 June. Thereafter, it moved in a west-northwesterly direction and started weakening gradually due to relatively colder sea surface temperature and increasing vertical wind shear. It crossed Oman coast as a very severe cyclonic storm around 0300 UTC of 6 June. After crossing Oman coast, it emerged into the Gulf of Oman, weakened gradually and moved in a north-northwesterly direction. It made second landfall over Iran coast near long. 58.5^0 E between 0300 and 0400 UTC of 7 June 2007 as a Cyclonic Storm. The system caused loss of life and property in Oman and Iran due to heavy rainfall, strong winds and storm surge.

(c) Cyclonic Storm "YEMYIN" over the Arabian Sea during 25-26 June, 2007

The remnant of a deep depression which developed over westcentral Bay of Bengal on 21 June, 2007 and moved west-northwestwards across south India during 22-23 June and emerged into Arabian Sea as a low pressure area, concentrated into a depression over northeast Arabian Sea at 0300 UTC of 25 June. The depression further intensified into a deep depression at 1200 UTC of the same day and into a Cyclonic Storm **"YEMYIN",** at 2100 UTC of the same day. It moved in a northwesterly direction and crossed Pakistan coast near longitude 64.0^0 E between 0200 and 0300 UTC of 26 June. The cyclonic storm **"YEMYIN"** caused extensive damage over south Pakistan due to heavy rain and strong winds.

(d) Very Severe Cyclonic Storm "SIDR" over the Bay of Bengal during 11-16 November, 2007

An upper air cyclonic circulation lay over southeast Bay of Bengal and adjoining area of south Andaman Sea during 8-10 November, 2007. Initially moderate upper-level wind shear inhibited organisation of the system, while strong diffluence aloft aided in developing convection. During this period, easterly wave was also active and vertical wind shear decreased significantly as the circulation became better defined. Under the influence of these factors, a low pressure area formed at 0300 UTC of 11 November over southeast Bay of Bengal and neighbourhood. It concentrated into a depression and subsequently into a deep depression on the same day. Moving in a northwesterly direction, it intensified into cyclonic storm **"SIDR"** and lay centred at 0300 UTC of 12 November, about 220 km southwest of Port Blair. It further concentrated into severe cyclonic storm at 1200 UTC and very severe cyclonic storm at 1800 UTC, while moving in a north-northwesterly direction. It continued to move in north-northwesterly direction till 0000 UTC of 13th. It then moved in a northerly direction and lay centred at 0300 UTC of 15 November near lat 18.0^0 N & long. 89.0^0 E, about 530 km south of Kolkata. The system then moved rapidly and lay centred at 1200 UTC of 15 November near lat. 21.0^0 N and long. 89.0^0 E, about 200 km south-southeast of Kolkata. It then started to move north- northeastwards and crossed west Bangladesh coast around 1700 UTC near longitude 89.8^0 E and lay centred at 1800 UTC near lat. 22.5^0 N and long 90.5^0 E, about 100 km south of Dhaka, Bangladesh. It weakened rapidly into a cyclonic storm, while moving northeastwards. It further weakened into a depression and lay centred at 0300 UTC of 16 November, about 50 km north of Agartala. It lay as well marked low pressure area over northeastern states at 1200 UTC of 16 November and became unimportant at 1500 UTC of the same day.

RSMC, New Delhi mobilized all its resources, both technical and human, to track these tropical disturbances that formed over the north Indian Ocean and issued timely advisories to WMO / ESCAP Panel countries and to the national agencies.

Some of the characteristic features of these cyclonic disturbances are given in (Table 2.2). The statistical data pertaining to the monthly frequencies, total life time (days), frequency distribution (intensity-wise and basin-wise) are given in (Table 2.3). The detailed characteristics of these disturbances are presented and discussed in Sec. 2.1 to 2.12. Comprehensive information on tropical cyclone activity over the north Indian Ocean for last eleven years is given in (Table 2.4).

Salient features:

- Four cyclonic storms including one super cyclonic storm (GONU), one very severe cyclonic storm (SIDR) and two cyclonic storms (AKASH and YEMYIN) formed over north Indian ocean during 2007. However, none of the cyclonic storms had landfall over the Indian coast.
- The first ever super cyclonic storm developed over the Arabian Sea as per recorded history of IMD.
- The super cyclonic storm, GONU made landfall over Iran with cyclonic storm intensity and caused loss of 23 lives and the properties worth $2.5 million. This was the second landfalling cyclonic storm over Iran after 4th June 1898.

Table 2.1

Cyclonic disturbances formed over north Indian Ocean during 2007

1.	Depression over Andaman Sea and adjoining eastcentral Bay of Bengal during 3-5 May, 2007
2.	Cyclonic storm **"AKASH"** over the Bay of Bengal during 13-15 May, 2007
3.	Super cyclonic storm **"GONU"** over the Arabian Sea during 01-07 June, 2007
4.	Deep depression over the Bay of Bengal during 21-23 June, 2007
5.	Cyclonic storm **"YEMYIN"** over the Arabian Sea during 25-26 June, 2007
6.	Deep depression over the Bay of Bengal during 28-30 June, 2007
7.	Deep Depression over the Bay of Bengal during 04-09 July, 2007
8.	Deep depression over the Bay of Bengal during 5-7 August, 2007
9.	Depression over the Bay of Bengal during 21-24 September, 2007
10.	Depression over the Bay of Bengal during 27-29 October, 2007
11.	Deep depression over the Arabian Sea during 27 October to 2 November, 2007
12.	Very severe cyclonic storm **"SIDR"** over the Bay of Bengal during 11-16 November, 2007

Table 2.2

Some Characteristic features of cyclonic disturbances formed over north Indian Ocean and adjoining region during 2007

Cyclonic Storm / Depression	**Date, Time & Lat.(^{0}N)/ Long. (^{0}E) of genesis**	**Date, Time (UTC) place of landfall/ dissipation**	**Estimated lowest central pressure, Date &Time (UTC) & lat.^{o}N / long.^{o}E**	**Estimated Maximum wind speed (kt), Date & Time**	**Max. T. No. Attained**
Depression *over the Bay of Bengal,3-5 May*	*03 May, 1200 UTC near 13.5/93.0*	Crossed Arakan Coast near 16.3^{0}N/94.5^{0}E between 0100 & 0300 UTC of 05 May	*998 hPa at 1200 UTC of 03 May near 13.5/93.0*	*25 kt at 1200 UTC of 05 May*	T 1.5
Cyclonic Storm "AKASH" over the Bay of Bengal 13-15 May	13 May , 0300 UTC near 15.0/90.5	Crossed Bangladesh Coast close to south of Cox's Bazar near 21.2/92.2 between 2200 & 2300 UTC of 14 May	990 hPa at 0300 UTC of 14 May near 16.5/91.0	45 kt at 0600 UTC of 14 May	T 3.0
Super Cyclonic Storm "GONU" over the Arabian sea 01-07 June	01 June, 1800 UTC near 15.0 /68.0	Crossed Makaran Coast as cyclonic storm near long. 58.0^{0}E between 0300 and 0400 UTC of 07June	920 hPa at 1500 UTC of 04 June near 20.0/64.0	127 kt at 1500 UTC of 04 June	T 6.5
Deep Depression over the Bay of Bengal 21-23 June	21June , 0300 UTC near 15.5/86.0	Crossed north Andhra Pradesh coast north of Machilipatnam between 0100 and 0300 UTC of 22 June	988 hPa at 1200 UTC of 21 June near 16.0/84.0	30 kt at 1200 UTC of 21 June	T 2.0
Cyclonic Storm "YEMYIN" over Bay of Bengal 25-26 June	25 June , 0300 UTC near 23.5 /67.5	Crossed Pakistan coast near 25.5/64.0 between 0200-0300 UTC of 26 June	986 hPa at 2100 UTC of 25 June Near 23.5/66.0	35 kt at 2100 UTC of 25 June	2.5

Deep Depression over the Bay of Bengal 28-30 June	28 June , 0000 UTC near 18.5/ 87.0	Crossed Orissa coast near Puri between 0000-0100 UTC of 29 June	986 hPa at 0600 UTC of 28 June Near 18.5/ 87.0	30 kt at 0300 UTC of 28 June.	T 2.0
Deep Depression over the Bay of Bengal, 04-09 July	04 July 0300 UTC near 22.0 / 89.5	*	988 hPa at 0600 UTC of 05 July Near 23.0/88.0	30 kt at 1200 UTC of 05 July.	**
Deep Depression over the Bay of Bengal 05-07 August	05 August , 0000 UTC near 20.0/88.5	Crossed orissa coast between Chandbali and Paradip, between 0100 and 0200 UTC of 06 August.	984 hPa at 2100 UTC of 05 August Near 20.5/87.5	30 kt at 1800 UTC of 05 August	T 2.0
Depression over the Bay of Bengal 21-24 September	21 September 1200 UTC near 18.0/ 86.5	Crossed orissa coast near Puri between 1300-1400 UTC of 22 September.	990 hPa at 0900 UTC of 23 September near 21.0/82.5	25 kt at 1200 UTC of 21 September.	T 1.5
Depression over the Bay of Bengal 27-29 October	27 October, *1800 UTC near 11.5/85.5*	Dissipated over the west central Bay of Bengal.	*1004 hPa at 0300 UTC of* 28 October, *Near 11.5/84.5*	*25 kt at 1800 UTC of* 27 October.	*T 1.5*
Deep Depression over the Arabian sea 27 Oct.-2 Nov.	27 October , 1800 UTC near 10.5/66.5	Dissipated over the west central Arabian Sea.	1000 hPa at 0000 UTC of 31 October, Near 11.5/65.5	30 kt at 0300 UTC of 28 October.	T 2.0
Very Severe Cyclonic Storm *"SIDR"* *over the Bay of Bengal 11-16 N*ovember	11 November *0900 UTC near 10.0/92.0*	Crossed Bangladesh coast around 1700 UTC of 15 November near 89.8. 0E	*944 hPa at 0300 UTC of 15* November, *near 18.0/89.0*	*115 kt at 0300 UTC of 15* November.	*T 6.0*

* : The system formed over Bangladesh coast

** : The system attained the maximum intensity (deep depression) over land area.

Table 2.3

Statistical data relating to cyclonic disturbances over the north Indian Ocean during 2007

A) Monthly frequencies and total lifetime of cyclonic disturbances (CI ≥ 1.5)

S.No	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Life Time in (Days)
1.	D					↔				↔	↔			13.25
2.	DD						↔ ↔	↔	↔		↔			11.88
3.	CS					↔	↔							1.88
4.	SCS													0.88
5.	VSCS											↔		5.75
6.	SuCS						↔							0.25

↔ Peak intensity of the system

B) Frequency distribution of cyclonic disturbances of different intensities based on satellite assessment.

CI No.	**≥1.5**	**≥2.0**	**≥2.5**	**≥3.0**	**≥4.0**	**≥5.0**	**≥6.0**	**≥7.0**
No. of disturbances	**12**	**9**	**4**	**3**	**2**	**2**	**2**	**-**

C) Basin-wise distribution of cyclonic disturbances

Basin	**Number of cyclonic disturbances**
Bay of Bengal	**9**
Arabian Sea	**3**
Land depression	**--**

Table 2.4

Cyclonic disturbances formed over north Indian Ocean and land areas of India during 1997-2007

Year	Basin	D	DD	CS	SCS	VSCS	SuCS	Total
1997	BOB	1	4	1	1	1	--	8
	ARB	1	--	--	--	--	--	1
1998	BOB	--	3	--	1	2	--	6
	ARB	--	1	1	1	1	--	4
1999	BOB	1	3	1	--	1	1	7
	ARB	--	--	--	--	1	--	1
2000	BOB	1	--	3	--	2	--	6
	ARB	--	--	--	--	--	--	-
2001	BOB	2	--	1	--	--	--	3
	ARB	--	--	2	--	1	--	3
2002	BOB	1	1	2	1	--	--	5
	ARB	--	--	1	--	--	--	1
2003	BOB	2	2	--	1	1	--	6
	ARB	--	--	--	1	--	--	1
2004	BOB	2	--	--	--	1	--	3
	ARB	--	2	--	3	--	--	5
	LAND	2	--	--	--	--	--	2
2005	BOB	2	3	4	--	--	--	9
	ARB	2	--	--	--	--	--	2
	LAND	1	--	--	--	--	--	1
2006	BOB	5	2	1	--	1	--	9
	ARB	--	1	--	1	--	--	2
	LAND	1	--	--	--	--	--	1
2007	BOB	3	4	1	--	1	--	9
	ARB	--	1	1	--	--	1	3

D: Depression **DD:** Deep Depression, **CS:** Cyclonic Storm
SCS: Severe Cyclonic Storm **VSCS:** Very Severe Cyclonic Storm
SuCS: super Cyclonic Storm
BOB: Bay of Bengal **ARB:** Arabian Sea

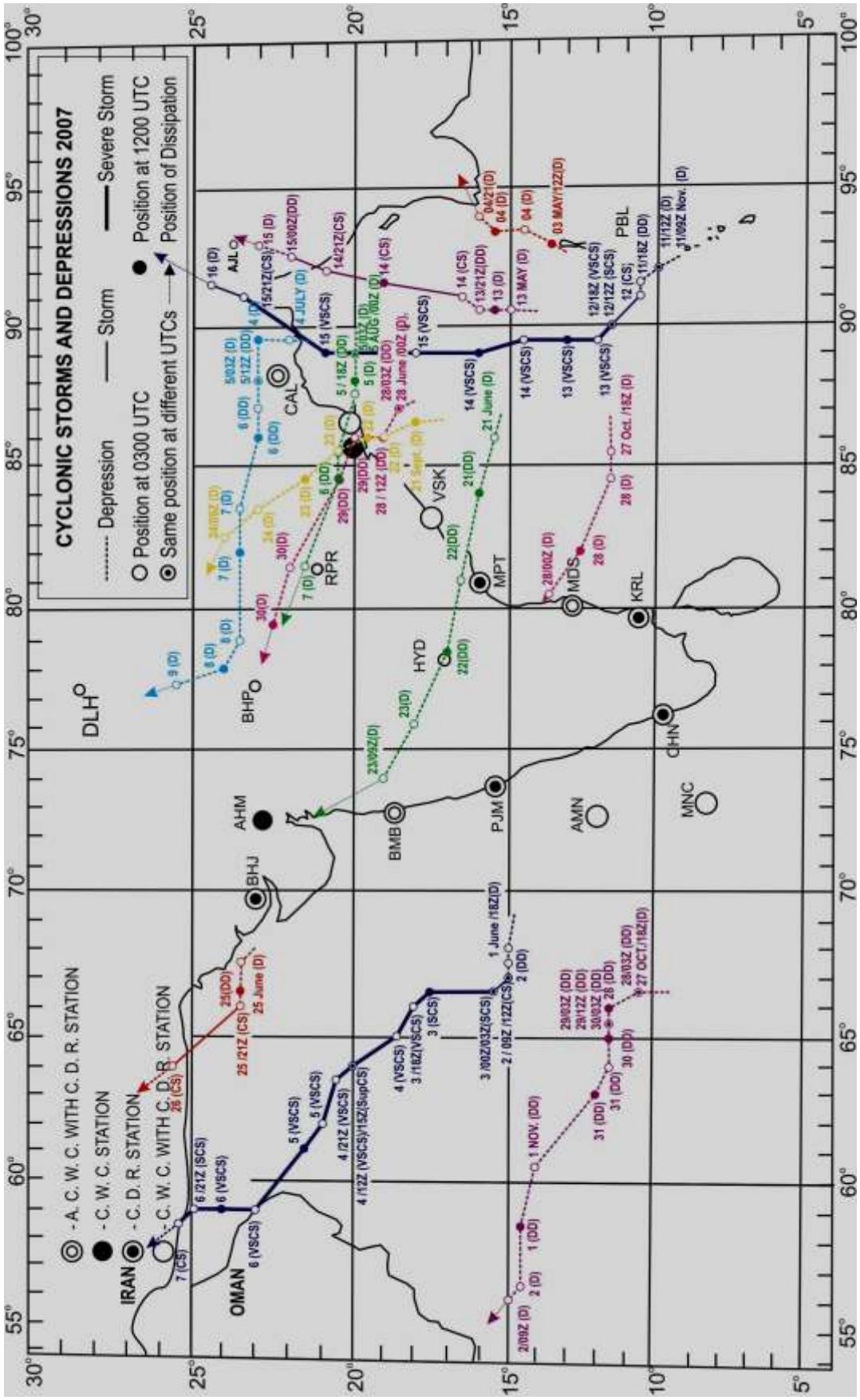


Fig.2.1 Tracks of cyclonic disturbances formed over north Indian Ocean During 2007.

2.1 Depression over Andaman Sea and adjoining east central Bay of Bengal during 3-5 May, 2007

Convective activity during the first week of May increased considerably over south Andaman Sea and south Bay of Bengal. As a result a low pressure area formed over south Andaman Sea on 2 May 2007. It became well marked at 0300 UTC of 3 May and persisted over the same area. It concentrated into a depression and lay centred at 1200 UTC of 3 May over south Andaman near lat 13.5^0 N and Long. 93.0^0 E, about 200 km north of Port Blair (Fig 2.1). Satellite imagery showed weak and curved convective bands around the system. The depression started to move slightly northeastwards till 1800 UTC of 3 May and then moved northwards till 1800 UTC of 4 May. As the system then came under the influence of upper tropospheric westerlies, it moved northeastwards and crossed Arakan coast near lat.16.3 and long. 94.5. Between 0100 & 0300 UTC of 5 May. It was seen over central Myanmar as a low pressure area at 0900 UTC of the same day. During the depression period, wind shear over the Bay of Bengal was about 15-18 m/s, which did not support the system for its intensification. The system throughout its life span moved with an average speed of 7 kmph.

The best track and other parameters are given in Table 2.1.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.1.1 (a-b).

Rainfall Realised:

Fairly widespread rainfall occurred over Andaman and Nicobar island on 4 & 5 May, 2007 with isolated heavy falls on 5^{th}. The chief amount of rainfall (in cm) over these islands is given below:

3 May 2007

Nancowrie, Hut Bay, Port Blair and Long Island -2 each, Mayabander-1.

4 May 2007

Hut Bay-4, Mayabander-3, Nancowrie-2, Carnicobar-1.

5 May 2007

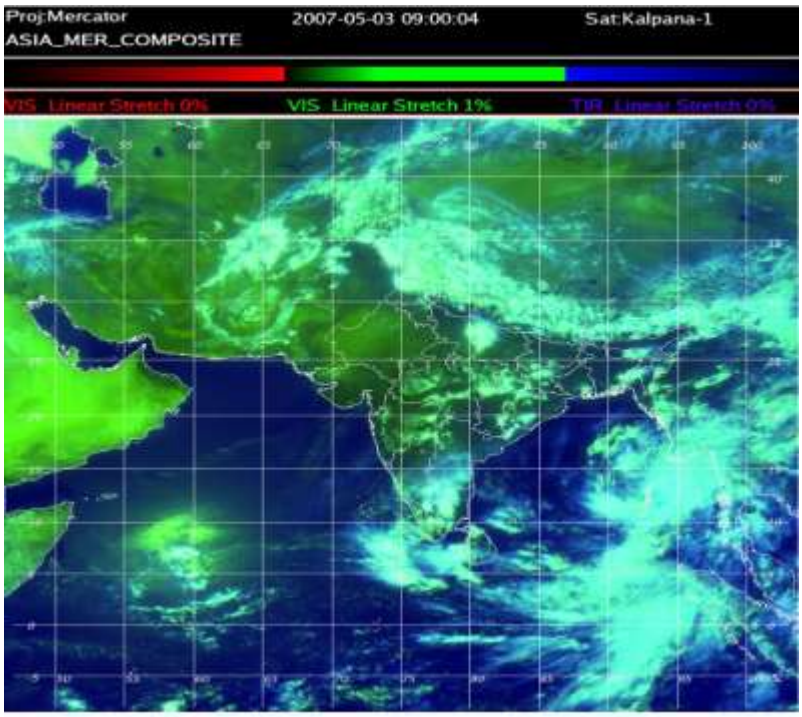
Mayabander-7, Hut Bay-3, Long Island, Port Blair each Nancowrie-2 each.

Damage Reported: Nil

Table 2.1.1
Best track positions and other parameters of the Bay of Bengal Depression during 3-5 May, 2007

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
03-05-2007	1200	13.5/93.0	1.5	998	25	4	D
	1500	13.5/93.0	1.5	998	25	4	D
	1800	13.5/93.5	1.5	998	25	4	D
	2100	14.0/93.5	1.5	1000	25	4	D
04-05-2007	0000	14.0/93.5	1.5	1000	25	4	D
	0300	14.5/93.5	1.5	998	25	4	D
	0600	15.0/93.5	1.5	998	25	4	D
	0900	15.0/93.5	1.5	998	25	4	D
	1200	15.5/93.5	1.5	998	25	4	D
	1500	15.5/93.5	1.5	998	25	4	D
	1800	15.5/93.5	1.5	998	25	4	D
	2100	16.0/94.0	1.5	1000	25	4	D
05-05-2007	System crossed Arakan coast near lat.16.3^0 N/ Long.94.5^0 E between 0100 and 0300 UTC of 5 May, 2007						

(a)



(b)

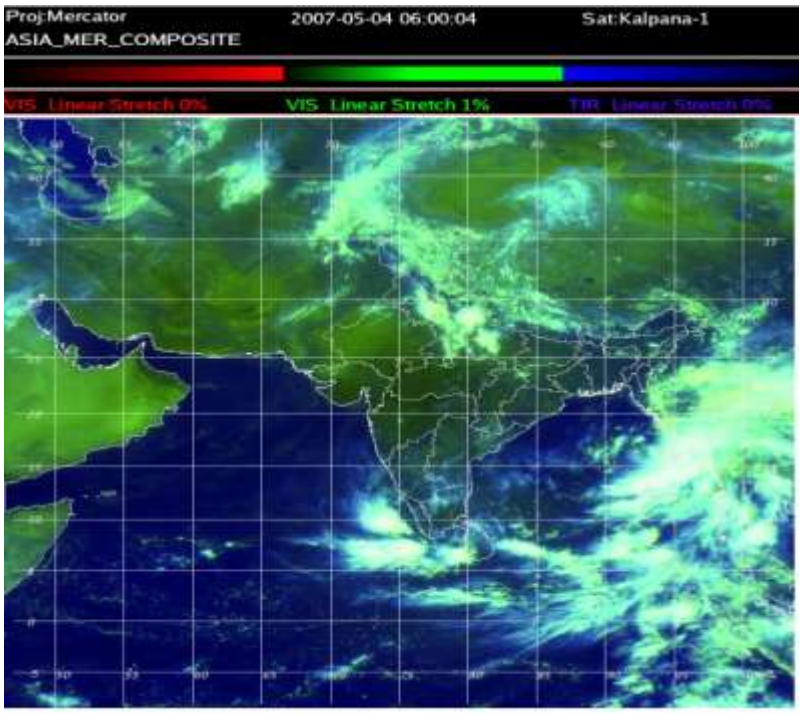


Fig 2.1.1 (a) Satellite KALPANA-1 imagery at 0900 UTC of 3 May, 2007 showing curved band pattern, and (b) Satellite Imagery at 0600 UTC of 4 May showing shear pattern of cloud elongated from southwest to northeast.

2.2 Cyclonic storm "AKASH" over the Bay of Bengal during 13-15 May 2007.

During the onset phase of southwest monsoon, a low pressure area formed over south Andaman Sea at 0300 UTC of 11 May 2007. It became well marked at 1200 UTC of 12 May, while shifting northward. It intensified into a depression over eastcentral Bay of Bengal and lay centred at 0300 UTC of 13 May near lat 15.0^0 N and Long. 90.5^0 E, about 400 km northwest of Port Blair. Moving in a northerly direction, it further intensified into a deep depression at 2100 UTC of same day and lay centred near lat. 16.0^0 N and long 90.5^0 E. On 14 May 2007, the system came under the influence of upper tropospheric westerlies. As a result, system moved in a north-northeasterly direction (Fig.2.2). However the satellite imageries showed a well organized cloud pattern as the system intensified into a cyclonic storm "Akash" and lay centred at 0300 UTC of 14 May near lat. 16.5^0 N and long. 91.0^0 E. Satellite imagery at 0900 UTC of same day showed the associated cloud mass oriented from southwest to northeast with clear out low under the influence of the upper tropospheric westerly trough. Accordingly cyclonic storm continued to moved in a north-northeasterly direction and lay centred at 1200 UTC near lat. 19.0^0 N and long. 91.5^0 E. Moving in the same direction, it crossed south Bangladesh coast close to south of Cox's Bazar between 2200 and 2300 UTC of 14 May. After crossing the coast, the system weakened gradually while moving north-northeast wards. It was seen as a low pressure area over Manipur, Mizoram and adjoining Bangladesh & Myanmar at 1200 UTC of 15 May and become less marked on 16 May, 2007.

The best track and other parameters are given in Table 2.2.1. A few KALPANA-1 cloud imageries of the system showing intensification and north-northeastward movement are shown in Fig. 2.2.1 (a-b). The wind at 850 hPa level over Indian region based on IMD MM5 model at 0000 UTC of 13-15 May 2007 are shown in Fig. 2.2.2. The vertical wind shear between 200 and 850 hPa levels are shown in Fig. 2.2.3.

Rainfall Realised:

Widespread rainfall was realised on 13 May over Andaman & Nicobar Islands and over northeastern states on 15 and 16 May. The chief amount of rainfall (in cm) are as follows.

13 May 2007

Mayabandar, Long Island and Nancowrie-3 each, Carnicobar and Port Blair-2 each, Hut Bay-1.

14 May 2007: Manipur: imphal-5, Lengpui-3, Sabroom-3

15 May 2007: Andaman and Nicobar Islands: Nancowrie-1,
Assam & Meghalaya: Cheerapunji, Shillong- 5 each, Jorhat, Tezpur-3 each

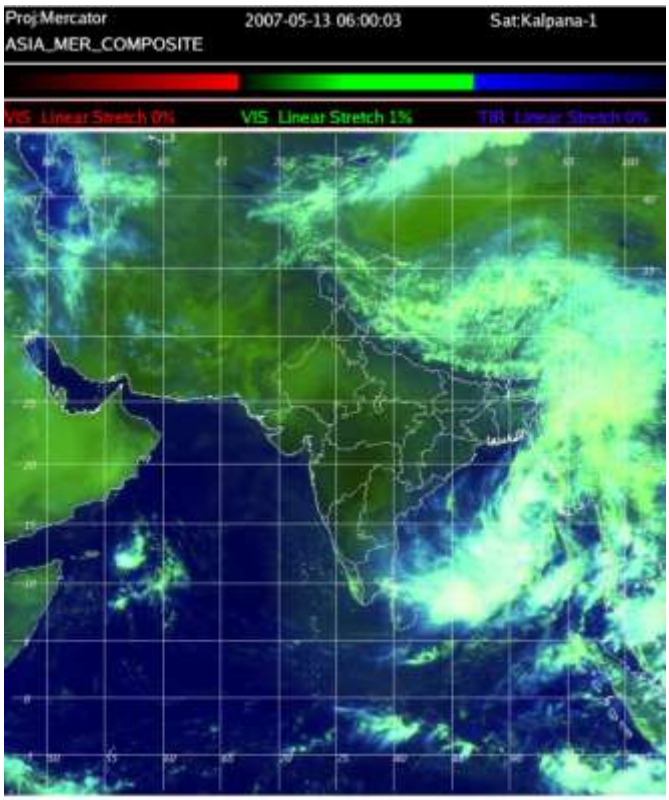
16 May 2007: Arunahal Pradesh: Miao and Passighat- 7 each, Tezu-4, Assam & Meghalaya: Karimganj-5, Khowang-4.

Damage Reported (India):	NIL	
(Myanmar):	People died	8
	Home destroyed	537
	Sittwe Township in Rakhine State	363

Table 2.2.1
Best track positions and other parameters of the cyclonic storm "AKASH" over the Bay of Bengal during 13-15 May, 2007

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
13-05-2007	0300	15.0/90.5	1.5	998	25	4	D
	0600	15.0/90.5	1.5	998	25	4	D
	0900	15.0/90.5	1.5	996	25	4	D
	1200	15.5/90.5	1.5	996	25	4	D
	1500	15.5/90.5	1.5	996	25	4	D
	1800	15.5/90.5	1.5	996	25	4	D
	2100	16.0/90.5	2.0	994	30	6	DD
14-05-2007	0000	16,0/90.5	2.0	994	30	6	DD
	0300	16.5/91.0	2.5	990	35	8	CS
	0600	17.0/91.0	3.0	988	45	10	CS
	0900	18.0/91.5	3.0	988	45	10	CS
	1200	19.0/91.5	3.0	988	45	10	CS
	1500	19.5/91.5	3.0	988	45	10	CS
	1800	20.0/92.0	3.0	988	45	10	CS
	2100	21.0/92.0	3.0	988	45	10	CS
15-05-2007	Cyclonic storm crossed south Bangladesh coast close to south of Cox's Bazar near lat.21.2^{0}N/long.92.2^0 E between 2200-2300 UTC of 14 May. After crossing the coast, the system weakened into a depression at 0000 UTC of 15 May, 2007						

(a)



(b)

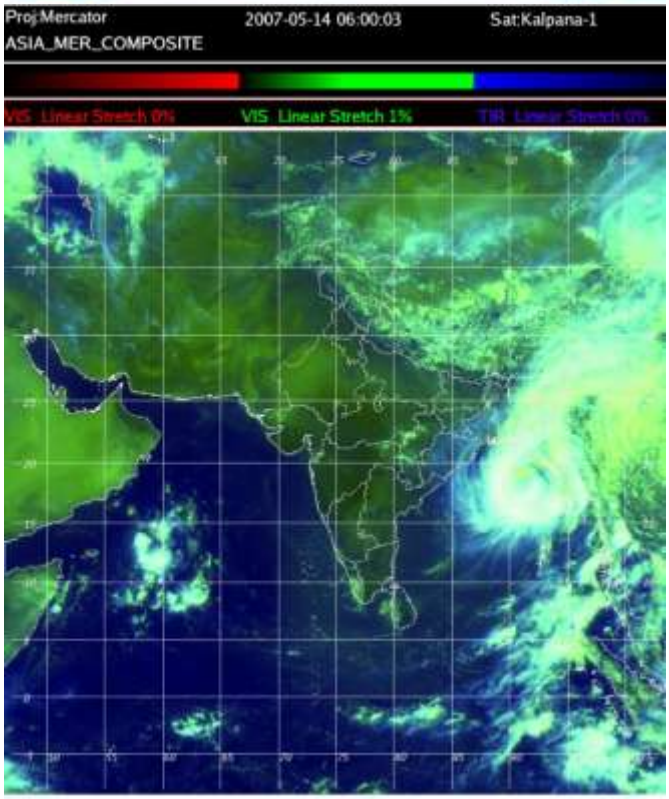
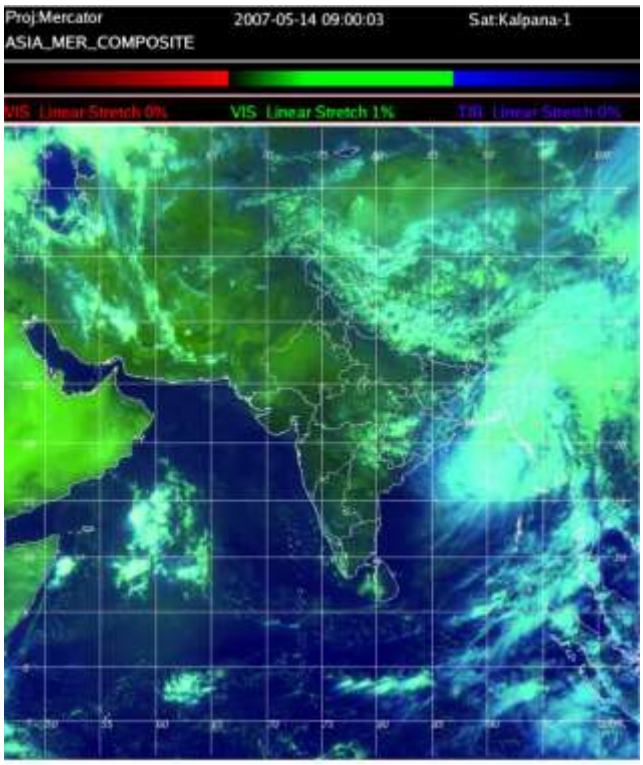


Fig 2.2.1 Satellite KALPANA-1 imageries at (a) 0600 UTC of 13 May, 2007 showing genesis of the cyclonic disturbance over eastcentral Bay of Bengal and (b) at 0600 UTC of 14 May showing well organized clouds in association with the deep depression.

(c)



(d)

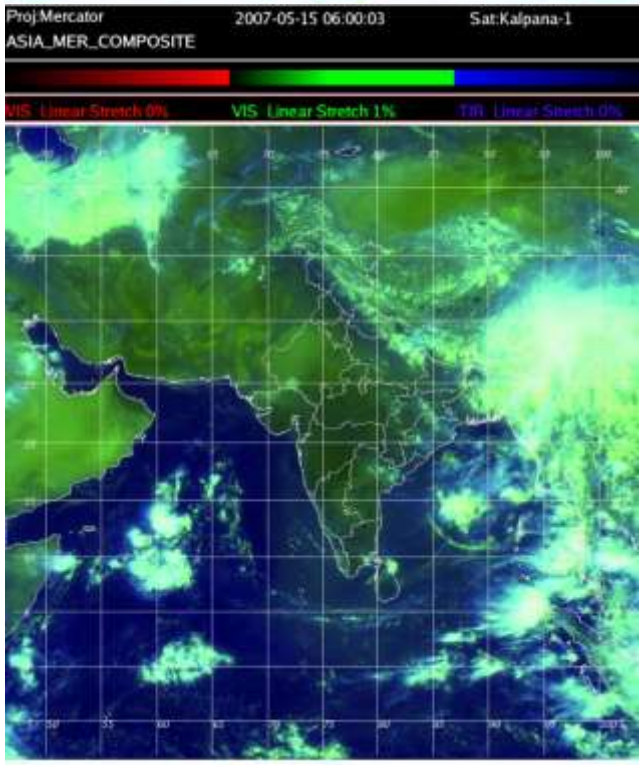


Fig 2.2.1 Satellite KALPANA-1 imageries at (c) 0900 UTC of 14 May, 2007 showing dense cloud mass over southwest Myanmar and adjoining sea areas of Bay of Bengal and (d) 0600 UTC of 15 May showing north-northeastward shifting of dense cloud mass due to movement of the system.

(a)

(b)

(c)

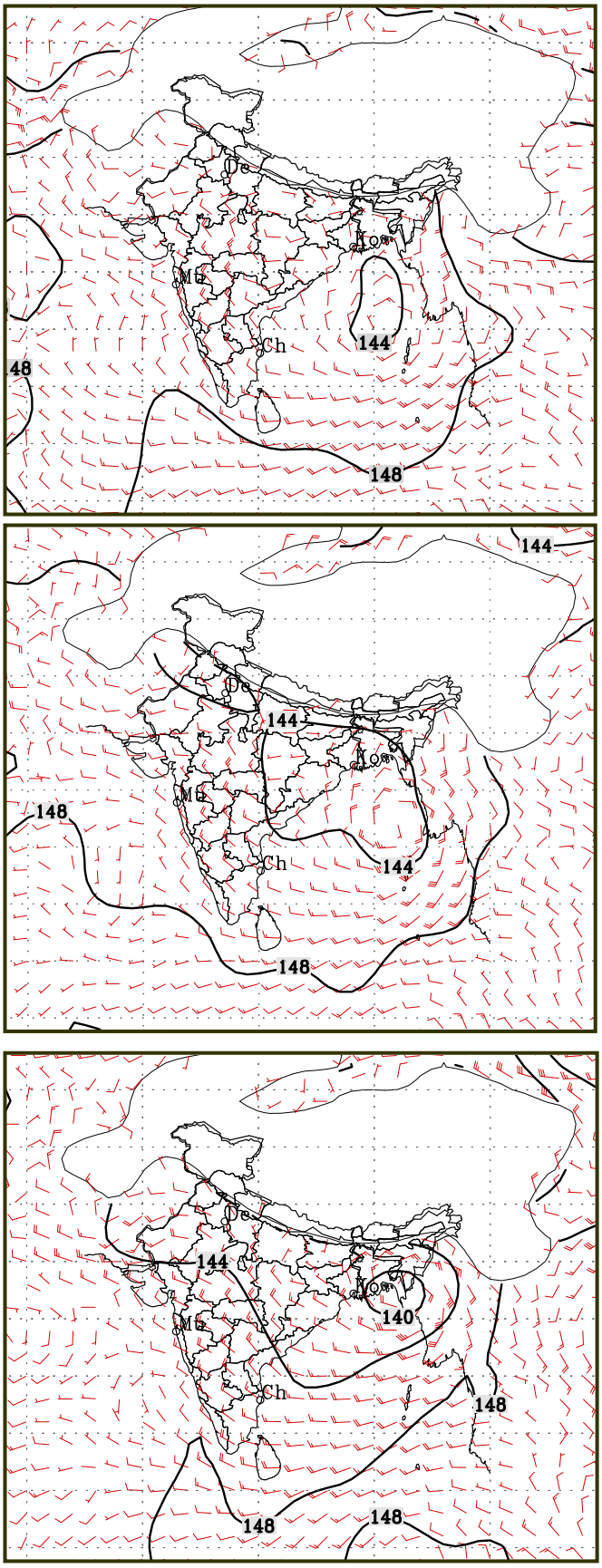


Fig. 2.2.2 850 hPa wind and geopotential at 0000 UTC of (a) 13, (b) 14 and (c) 15 May 2007

(a)

(b)

(c)

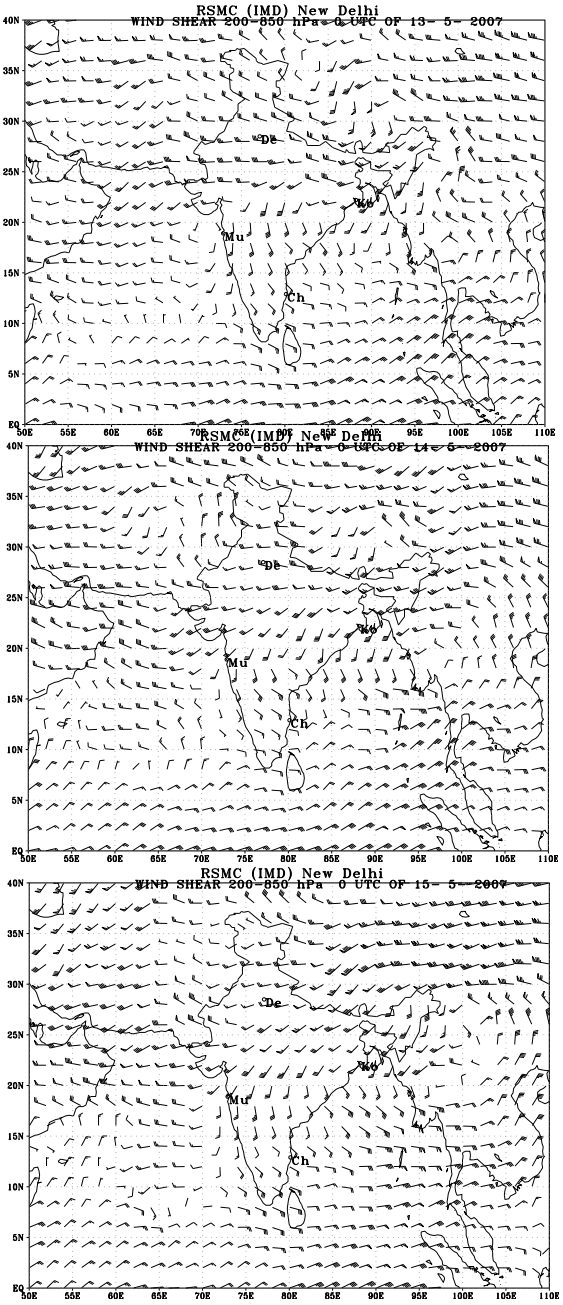


Fig 2.2.3: Vertical Wind shear (kts) of horizontal winds at 00 UTC of (a) 13, (b) 14 and (c) 15 May, 2007

2.3 Super cyclonic storm "GONU" the over Arabian Sea during 01-07 June, 2007

A low pressure area developed over eastcentral Arabian Sea in association with the prevailing surge in monsoon months. During this period there was favourable upper-level environment and warm sea with sea surface temperature of the order of 27-29^{0}C over the Arabian Sea. As a result, the system concentrated into a depression and lay centred at 1800 UTC of 1 June over eastcentral Arabian Sea near lat. 15.0^0 N and long. 68.5^0 E (Fig. 2.1). Initially, the system moved in a westerly direction and concentrated into a deep depression at 0300 UTC of 2 June and into a cyclonic storm **"GONU"** at 0900 UTC and lay centred near lat. 15.0^0 N and long. 67.0^0 E. Moving in a northwesterly direction, it further intensified into a severe cyclonic storm near 0000 UTC of 3 June and lay centred at 15.5^0 N and long. 66.5^0. The eye of the system was first visible at 0600 UTC of 4 June according to KALPANA imagery. At this time, the ridge in upper air was located at about 16.0^0 north over the storm region. Moving in a northwesterly direction it again intensified into a very severe cyclonic storm at 1800 UTC of 3 June. The eye was raged within the central dense overcast (CDO). The system further intensified into a super cyclonic storm and lay centred at 1500 UTC of 4 June near lat 20.0^0 N and long. 64. 0^0 E, with the lowest estimated central pressure 920 hPa and pressure drop of 80 hPa.

The system maintained super cyclonic storm intensity for a short period and weakened into a very severe cyclonic storm at 2100 UTC of 4 June due to entrainment of dry and cold air and colder sea water over the region. Moving in a west-northwesterly direction, it crossed Oman coast as very severe cyclonic storm between 0300 and 0400 UTC of 6 June. The system emerged then into the Gulf of Oman, moved in a north-northwesterly direction and made second landfall over Iran coast near long. 58.5^0 E between 0300 & 0400 UTC 7 June 2007 as a Cyclonic Storm. Moving in the same direction, it weakened gradually and it was seen a well marked low pressure area over Iran and neighbourhood on 8 June 2007. Throughout its life span, the upper air ridge line remained to the north of the system, as system move northward, simultaneously ridge line also shifted towards north.

The best track and other parameters of the system are given in Table 2.3.1. A few KALPANA-1 cloud imageries of the system showing genesis, intensification and decay of the system are given in Fig. 2.3.1 (a-g). The vertical wind shear is shown in Fig. 2.3.2 and upper winds are shown in Fig. 2.3.3.

Weather Realised:

Heavy to very heavy rainfall occurred over eastern coast of Oman, causing flooding and heavy damage. Gale winds with speed of 100 kmph was recorded at Muscat in Oman coast at the time of landfall.

Damage Reported:
Oman:

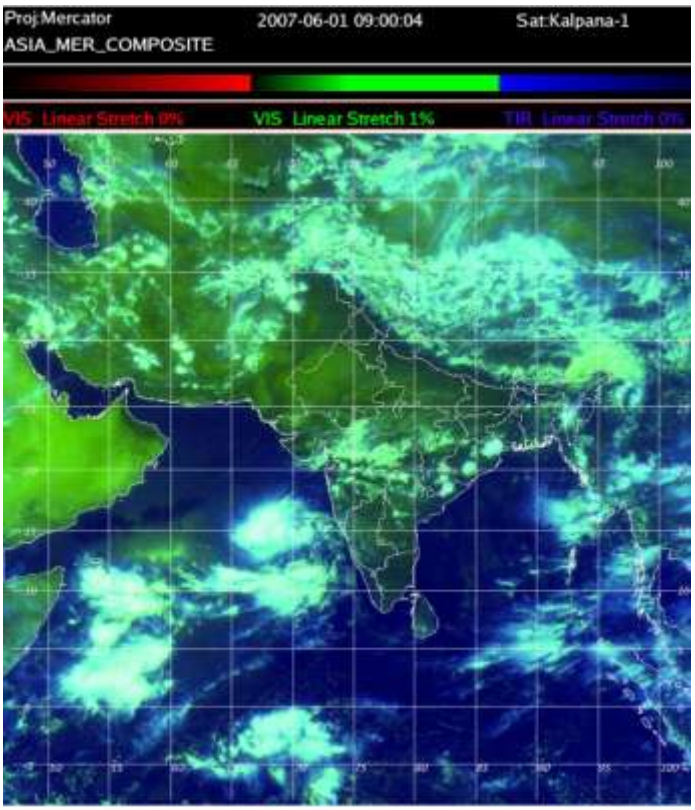
People died	:	50
People missing	:	27
People affected	:	20,000
Estimated Damage to the property	:	$4.2 billion

Iran: Number of human deaths: 28, Loss of property: $ 215 million.

Table-2.3.1
Best track positions and other parameters of Super Cyclonic storm "GONU" over the Arabian Sea during 01-07, June 2007

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
01-06-2007	1800	15.0/68.0	1.5	1002	25	4	D
	2100	15.0/68.0	1.5	1002	25	4	D
02-06-2007	0000	15.0/68.0	1.5	1002	25	4	D
	0300	15.0/67.5	2.0	1000	30	5	DD
	0900	15.0/67.0	2.5	998	35	8	CS
	1200	15.0/67.0	3.0	992	45	10	CS
	1500	15.0/67.0	3.0	992	45	10	CS
	1800	15.0/67.0	3.0	992	45	10	CS
	2100	15.0/66.5	3.0	992	45	10	CS
03-06-2007	0000	15.5/66.5	3.5	988	55	16	SCS
	0300	15.5/66.5	3.5	988	55	16	SCS
	0600	16.0/66.5	3.5	988	55	16	SCS
	0900	16.5/66.5	3.5	988	55	16	SCS
	1200	17.5/66.5	3.5	988	55	16	SCS
	1500	17.5/66.5	3.5	988	55	16	SCS
	1800	18.0/66.0	4.0	980	65	22	VSCS
	2100	18.0/66.0	4.0	980	65	22	VSCS
04-06-2007	0000	18.5/65.0	4.5	974	77	30	VSCS
	0300	18.5/65.0	5.0	960	90	40	VSCS
	0600	19.0/64.5	5.5	952	102	52	VSCS
	0900	19.5/64.5	6.0	934	115	66	VSCS
	1200	20.0/64.0	6.0	934	115	66	VSCS
	1500	20.0/64.0	6.5	920	127	80	SUCS
	1800	20.5/63.5	6.5	920	127	80	SUCS
	2100	20.5/63.5	6.0	935	115	66	VSCS
05-06-2007	0000	20.5/63.0	6.0	936	115	66	VSCS
	0300	21.0/62.0	6.0	936	115	66	VSCS
	0600	21.5/61.5	5.5	950	102	52	VSCS
	0900	21.5/61.0	5.5	950	102	52	VSCS
	1200	21.5/61.0	5.0	960	90	40	VSCS
	1500	22.0/61.0	4.5	970	77	30	VSCS
	1800	22.0/60.5	4.5	970	77	30	VSCS
	2100	22.5/60.5	4.5	970	77	30	VSCS
06-06-2007	0000	22.5/59.5	4.5	970	77	30	VSCS
	VSCS crossed northeast Oman coast near Muscat between 0200-0300 UTC of 6 June.						
	0300	23.0/59.0	4.5	970	77	30	VSCS
	0600	23.5/59.5	4.5	970	77	30	VSCS
	0900	23.5/59.5	4.5	970	77	30	VSCS
	1200	24.0/59.0	4.5	970	77	30	VSCS
	1500	24.0/59.0	4.5	970	77	30	VSCS
	1800	24.5/59.0	4.0	978	65	22	VSCS
	2100	25.0/59.0	3.5	984	55	16	SCS
07-06-2007	0000	25.0/59.0	3.0	988	45	10	CS
	0300	25.5/58.5	3.0	988	45	10	CS
	The cyclonic storm crossed Makaran coast near Lat. 58.0^0 E between 0300 and 0400 UTC of 7 June.						

(a)



(b)

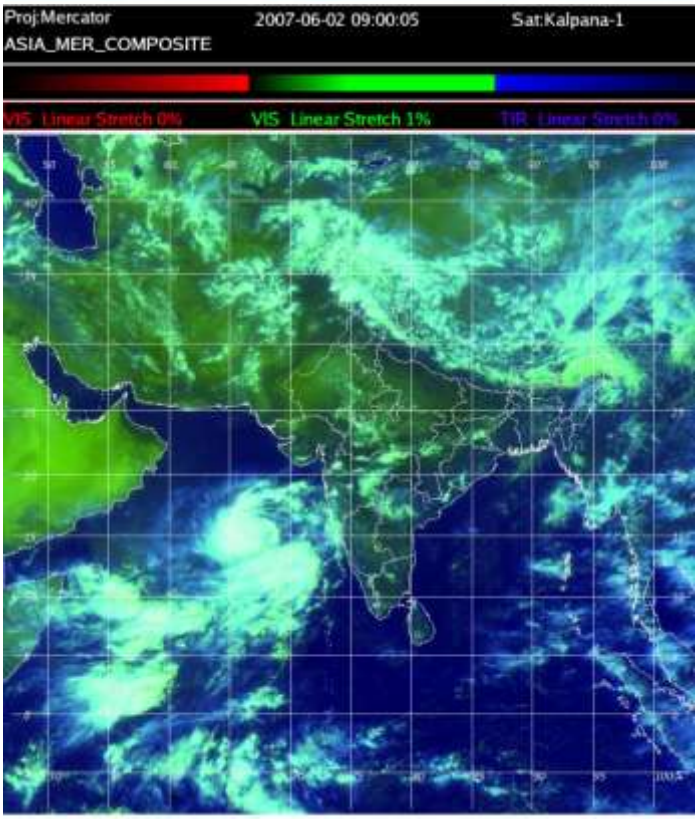
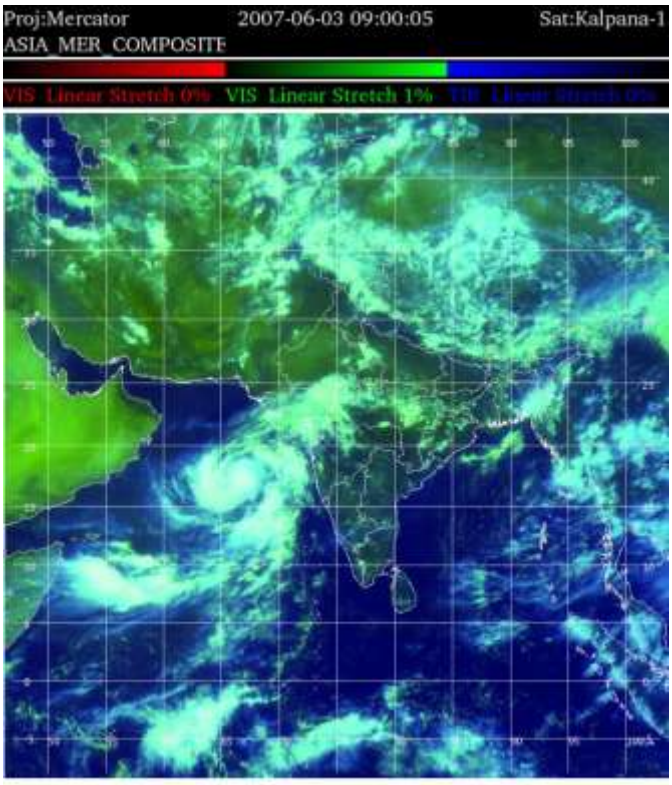


Fig 2.3.1 Satellite KALPANA-1 imagery at 0900 (a) UTC of 1 June, 2007 showing development of two convective cloud clusters and (b) 0900 UTC of 2 June showing organization of convective cloud clusters over the same area, leading to genesis of cyclonic storm.

(c)



(d)

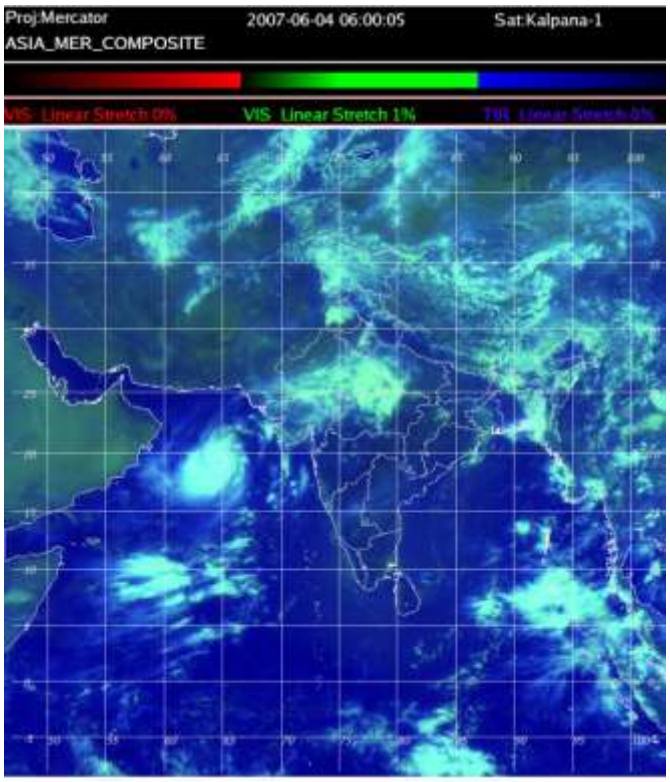
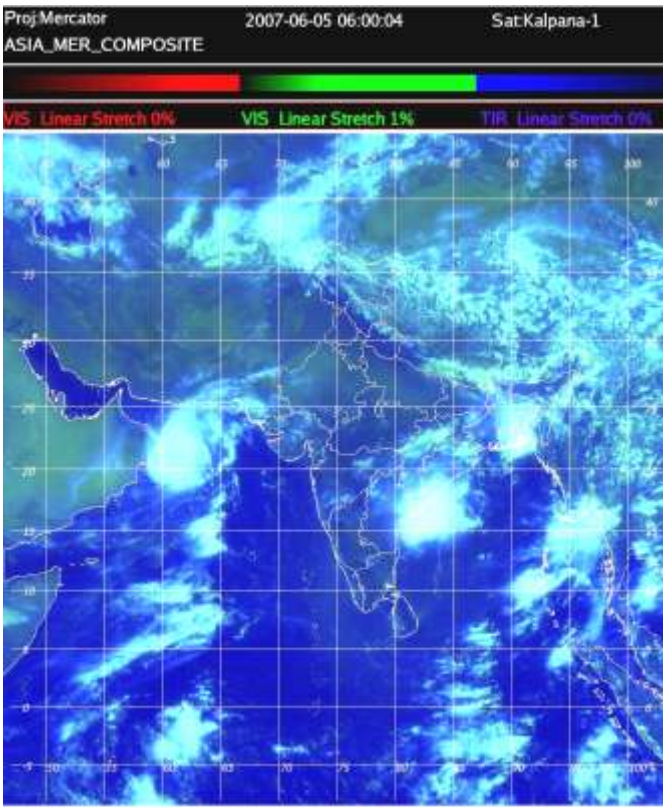


Fig 2.3.1 Satellite KALPANA-1Imagery at (c) 0900 UTC of 3 June, 2007 showing well organized convection with band features in association with Severe Cyclonic Storm and (d) 0600 UTC of 4 June showing well organized CDO in association with the Very Severe Cyclonic Storm.

(e)



(f)

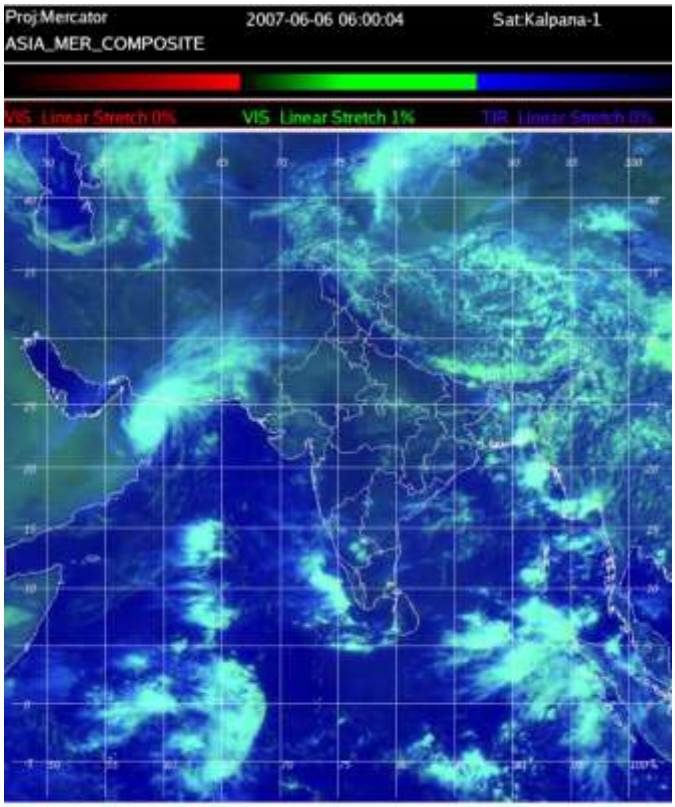


Fig 2.3.1 Satellite KALPANA-1 imagery at (e) 0600 UTC of 5 June, 2007 showing “eye” of the system with the intensity of T6.0, and (f) 0600 UTC of 6 June showing the system entering into Gulf of Oman and spiral clouds oriented towards northeast of the system.

(g)

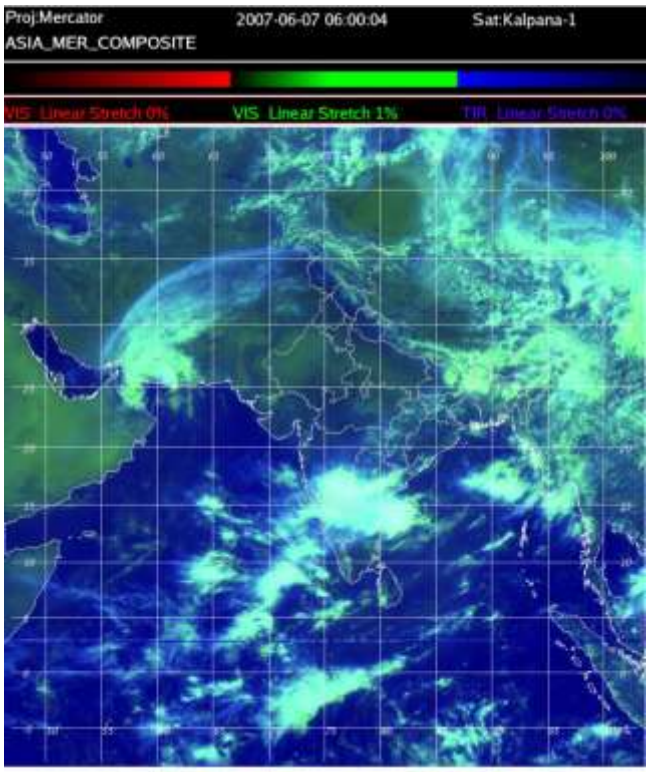
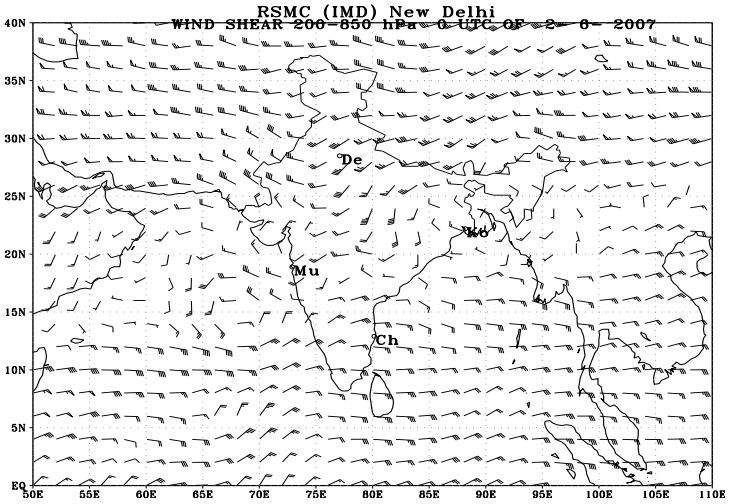
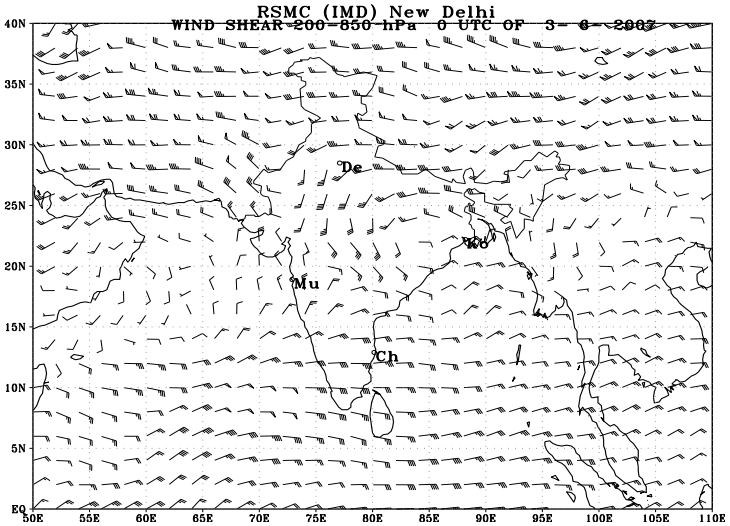


Fig 2.3.1 Satellite KALPANA-1 imagery at (g) 0600 UTC of 7 June, 2007 showing rapid dissipation over Iran and adjoining Gulf of Oman after the landfall over Iran coast.

(a)



(b)



(c)

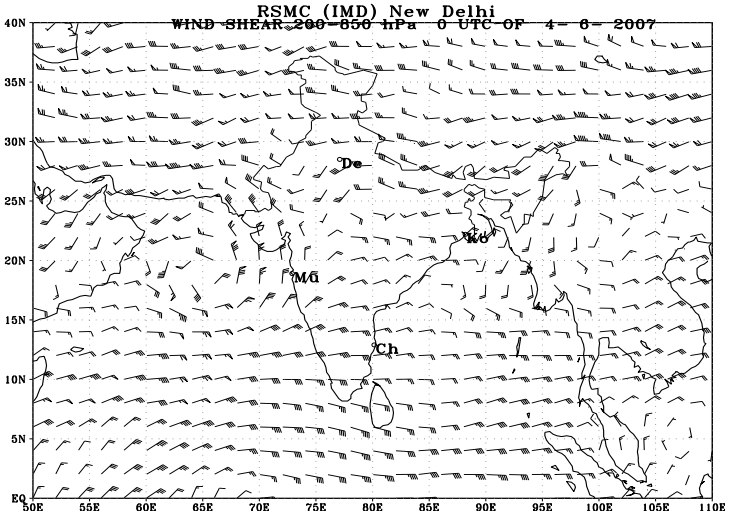


Fig 2.3.2: Vertical wind shear (kts) of horizontal winds (knots) at 00 UTC of (a) 2, (b) 3 and (c) 4 June, 2007 according to Limited Area Model (LAM) analysis of IMD.

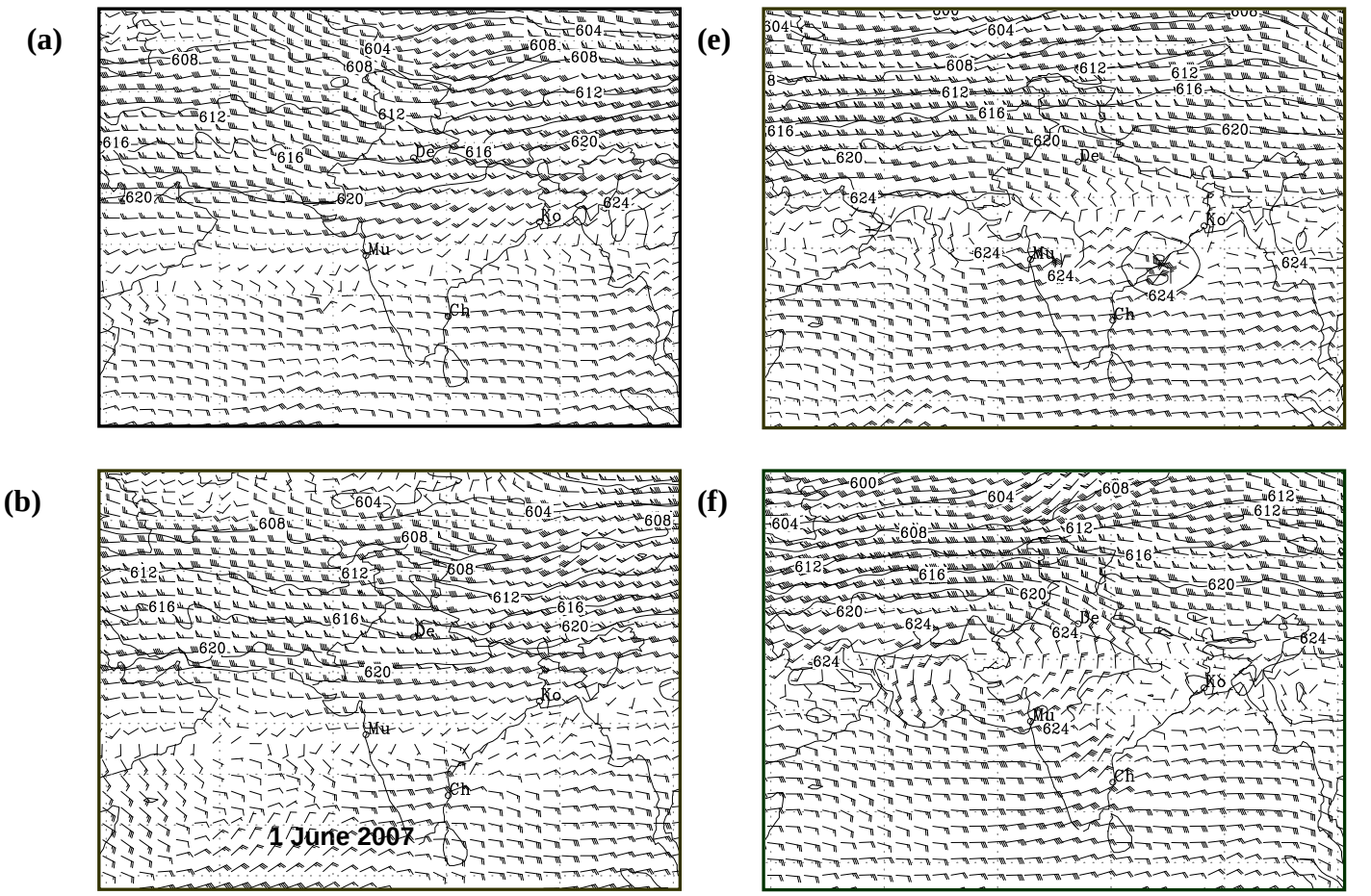


Fig. 2.3.3 (a-g) 200 hPa analysis at 0000 UTC of 1-7 June 2007 according to MM5 model analysis of IMD.

2.4 Deep depression over the Bay of Bengal during 21-23 June, 2007

A low pressure area formed over west central Bay of Bengal at 0300 UTC of 20 June 2007, It intensified into a depression at 0300 UTC of 21 June and lay centred near lat. 15.5^0 N and long. 86.0^0 E, about 450 km east-southeast of Narsapur (43187) of coastal Andhra Pradesh (Fig.2.1). The system moved in a west-northwesterly direction and further intensified into a deep depression, and lay centred at 1200 UTC of 21 June near lat. 16.0^0 N and long. 84.0^0 E. Satellite imageries showed well organized cloud pattern associated with the deep depression. The ridge line at 200 hPa level passed through about 28.0^0 N over Indian region and the wind pattern supported its west-northwestward movement of the system. The deep depression crossed north Andhra Pradesh coast north of Machilipatnam (43185) in the early hours of 22 June 2007 between 0100 and 0300 UTC. The deep depression continued to move west-northwestwards across north Andhra Pradesh, north Karnataka and Madhya Maharashtra and weakened gradually. It lay as a well marked low pressure area over north Konkan and neighborhood at 1200 UTC of 23 June. The well marked low pressure area lay over northeast Arabian sea and adjoining Saurashtra & Kutch at 0300 UTC of 24 June 2007.

The best track and other parameters of the system are given in Table 2.4.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.4.1 and Machilipatnam Doppler Radar Image in Fig. 2.4.2.

Realised Rainfall:

The system caused widespread rainfall with scattered heavy to very heavy rainfall and isolated extremely heavy falls. The chief amount of rainfall (in cm) are given below.

22 JUNE 2007

COASTAL ANDHRA PRADESH: Avanigadda-32, Koduru-32, Nagayalanka-31, Bapatla-25, Martur-23, Chirala-20, Vetapalem-19, Chimakurthy-18, S. N. Padu-18, J. Pagalur-18, Ongole-17, Kothapatnam-16, Darsi-16, Challapalli-15, Tangutur-14, Pammaru-13, Addanki-13, Donakonda-12, Machilipatnam-12, Korisapadu-12, Marrapur-12, Korichedu-11, Guduru-10, Yaddanapudi-10, S. Magulur-10, Gudivada-9, Ballikurava-9, Ghantasala-9, Ibrahimpatnam-9, Nandiwada-9, Unguturu-9, Maripudi-9, Vuyyuru-8, Pedaparupudi-8, Kavali-7, Pedana-7, Gudlavalleru-7, Thotlavalluru-7, Kruttivennu-6, Nellore-6, Mandavalli-5, Bapulapadu-5, Chandarlapadu-5 **ORISSA:** Pottangi-14, Daringibadi-11, Mohana-9, Tikabali-6, R. Udaigiri-5, Aska-5.

23 JUNE 2007

TELANGANA: Almapur-32, Jurala Project -15, Wanaparthy-10, Kalwakurthy-5 **RAYALASEEMA:** Srisailam-40, Kornool-29, Yemmiganur-29, Dhone-25, Mantralayam-24, Atmakur-19, Koilkuntla-15, Porumamilla-15, Allagadda-14, Holagunda-14, Pathikonda-14, Alur-13, Gooty-13, Owk-12, Tadipatri-12, Pamidi-10, Jammalamadugu-9, Proddatur-9, Badvel-8, Kamalapuram-7, Muddanur-7, Cuddapah-5, Dharmavaram-5, Lalyadurg-5, Kanekal-5, Rayadurg-5, Pulivendala-5, Vampalli-5 **NORTH INTERIOR KARNATAKA:** Shahapur-21, Sindhanur-19, Bijapur-18, Balaganur-16, Hanumansagar-15, Taveregere-14, Kushtagi-14, Raichur-14, Deodurg-14, Sindagi-13, Yadgir-12, Nagathan-11, Bagewadi-10, Jamakhandi-10, Shorapur-9, Manvi-9, Rabkavi-9, Athani-8, Biligi-8, Muddebihal-8, Hungund-8, Badami-7, Gangavathy-7, Kuknoor-7, Lingasugur-7, Koppal PTO-6, Koppal-6, Munirabad-6, Yelburga-6, Kalghatgi-6, Khanapur-6, Yedwad-6, Gadag-5, Raibagh-5 **MADHYA MAHARASHTRA:** Gaganbavda-28, Jat-16, Shirol-13, Sangli-13, Vita-13, Atapadi-12, Tasgaon-11, Lohegaon-11, Pune-10, Mahabaleshwar-10, Chandgad-8, Satara-8, Igatpuri-5, Peint-5, Panhala-5, Radhanagari-5, Shahuwadi-5, Shirala-5, **KONKAN & GOA:** Ratnagiri-21, Sanguem-21,

Margaon-20, Quepem-19, Mahad-18, Canacona-17, Mhasala-13, Shrivardhan-13, Murd-13, Valpoi-12, Ponda-11, Mangaon-9, Roha-9, Tala-9, Dabolim-9, Pali-8, Mapusa-8, Harnai-7, Pernem-7, Alibag-6, Bhira-6, Poladpur-6, Panjim-6, Pen-5, Marmugoa-5 **COASTAL KARNATAKA:** Kollur-33, Siddapura (Udupi)-28, Subramanya-24, Dharmasthala-23, Karwar-21, Mani-20, Mudibidre-19, Karkala-18, Shirali-18, Manki-18, Ankola-18, Honavar-15, Puttur-14, Mangalore (AP)-13, Bhatkal-13, Kumta-12, Panambur-11, Kota-10, Kundapur-10, Mulki-9, Yellapura-9, Mangalore-7, Haliyal-7, Sirsi-5, Kiravatti-5, Mundagod-5

24 JUNE 2007

MADHYA MAHARASHTRA: Mahabaleshwar-23, Kolhapur-15, Sangli- **KONKAN & GOA:** Bhira-47, Mhasala-30, Mumbai (Colaba)-28, Koyna-27, Vaibhavwadi-25, Alibag-23, Pali-23, Poladpur-22, Mumbai(SCZ)-21, Thane Belapur-20, Roha-19, Tala-19, Dharavi-18, Matheran-17, Sawantwadi-17, Dodamarg-17, Shrivardhan-16, Panjim-16, Mangaon-15, Pen-15, Murud-15, Thane-14, Bhandup-14, Harnai-14, Kankavli-14, Bhiwandi-13, Devgad-13, Kalyan-12, Khalapur-12, Ratnagiri-12, Margaon-12, Marmugoa-11, Karjat-10, Palghar-9, Vasai-9, Ambernath-9, Sanguem-9, Panvel-8, Sahapur-7, Ulhasnagar-7, Uran-7, Malvan-7, Kudal-7, Dabolim-7, Dahanu-6, Wada-6, Murbad-6, Vengurla-5, Canacona-5 **SAURASHTRA, KUTCH & DIU:** Veraval-10, Mangrol-7, Ranavav-7, Bhanvad-6, Jafrabad-5, Porbandar-5 **NORTH INTERIOR KARNATAKA:** Belgaum-10, Haveri-5, Shiggaon-5 **COASTAL KARNATAKA:** Kollur-25, Sirsi-17, Yellapura-16, Siddapura (Udupi)-13, Bhatkal-13, Mudibidre-11, Shirali-11, Honavar-11, Subramanya-10, Mani-9, Puttur-9, Karkala-9, Dharmasthala-8, Karwar-8, Haliyal-8, Banavasi-8, Kiravatti-8, Kota-7, Udupi-7, Kundapur-7, Mulki-6, Mangalore (AP)-6, Panambur-5, Mundagod-5.

25 JUNE 2007

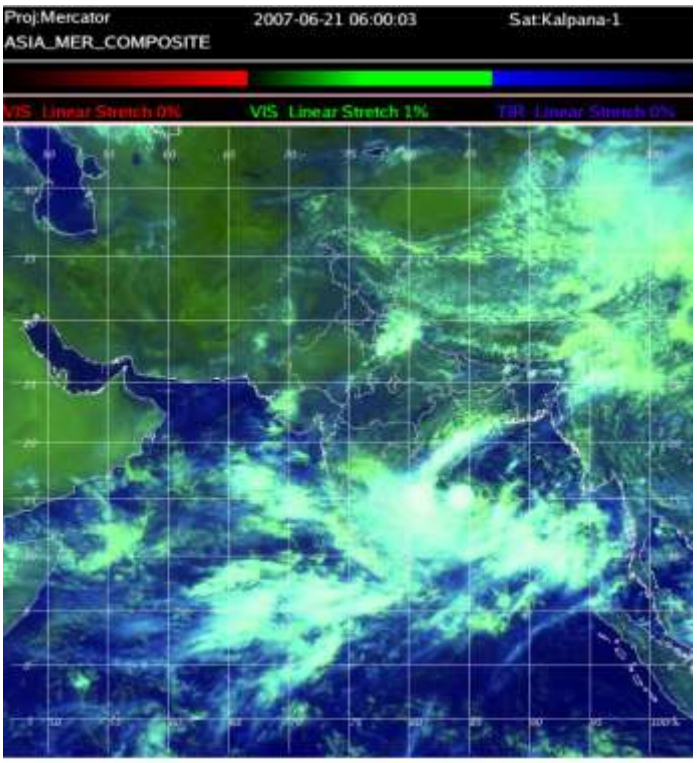
GUJARAT REGION: Umargoan-7, Navsari-7, Olpad-7, Nanipalsan-6, Jalalpur-6, Madhuban-6, Silvasa-6, Palsana-6, Vapi-5, Surat-5, **SAURASHTRA, KUTCH & DIU:** Manavadar-11, Talaja-9, Ranavav-8, Keshod-7, Jafrabad-6, Mahuva-6, Kalyanpur-6, Dhoraji-6, Maliya-5, Kutiana-5, Upleta-5, **KONKAN & GOA:** Alibag-17, Bhandup-12, Mangaon-12, Mhasala-11, Roha-10, Mahad-10, Khalapur-9, Pali-9, Quepem-9, Mumbai(SCZ)-8, Pen-8, Shrivardhan-8, Murud-8, Karjat-7, Poladpur-7, Panvel-7, Matheran-7, Tala-7, Mumbai (Colaba)-6, Uran-6, Ratnagiri-6, Chiplun-5, Sanguem-5, Ponda-5, **MADHYA MAHARASHTRA:** Igatpuri-15, Mahabaleshwar-14, Trimbak-10, Peint-5, Shirala-5.

Damage Reported: 58 people died in Andhra Pradesh due to torrential rain, sea water inundation etc. houses, roads, railway lines and crops were also damaged in this state, especially in Prakasam, kurnool and Guntur districts.

Table-2.4.1
Best track positions and other parameters of deep depression over the Bay of Bengal during 21-23 June, 2007

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
21-06-2007	0300	15.5/86.0	1.5	994	25	4	D
	0600	15.5/85.0	1.5	992	25	4	D
	0900	16.0/84.5	1.5	990	25	4	D
	1200	16.0/84.0	2.0	988	30	5	DD
	1500	16.0/83.5	2.0	988	30	5	DD
	1800	16.0/83.0	2.0	988	30	5	DD
	2100	16.5/82.5	2.0	988	30	5	DD
22-06-2007	0000	16.5/82.0	2.0	988	30	5	DD
	The system crossed north Andhra Pradesh (north of Machilipatanam) between 0100 and 0300 UTC of 22nd June						
	0300	16.5/81.0	-	990	30	5	DD
	0600	16.5/80.0	-	990	30	5	DD
	0900	16.5/79.0	-	988	30	5	DD
	1200	17.0/78.5	-	988	30	5	DD
	1500	17.0/78.0	-	990	30	5	DD
	1800	17.0/77.5	-	992	30	5	DD
	2100	17.5/77.0	-	992	30	5	DD
23-06-2007	0000	17.5/77.0	-	992	30	5	DD
	0300	18.0/76.0	-	992	25	4	D
	0600	18.5/75.0	-	990	25	4	D
	0900	19.0/74.0		990	25	4	D
	1200	Well marked low pressure over north Konkan and neighbourhood.					

(a)



(b)

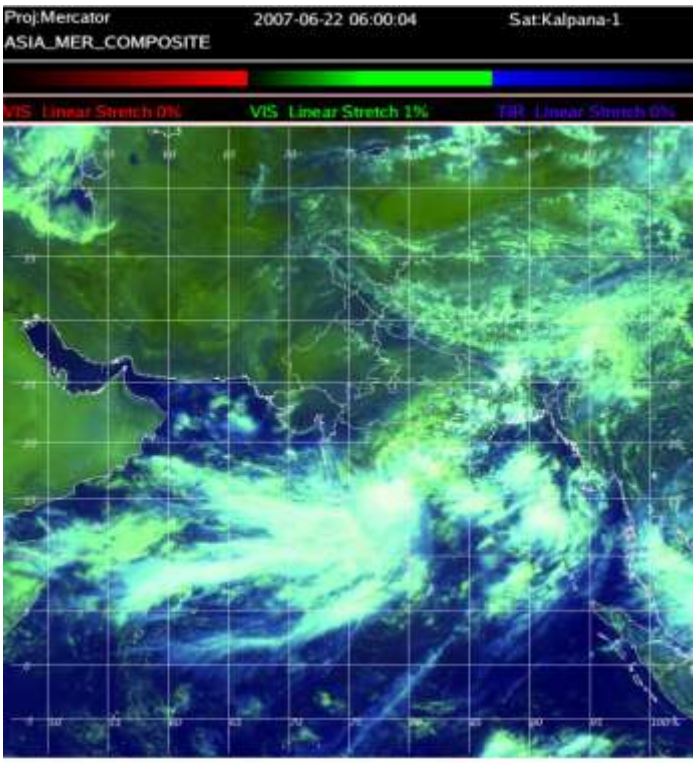
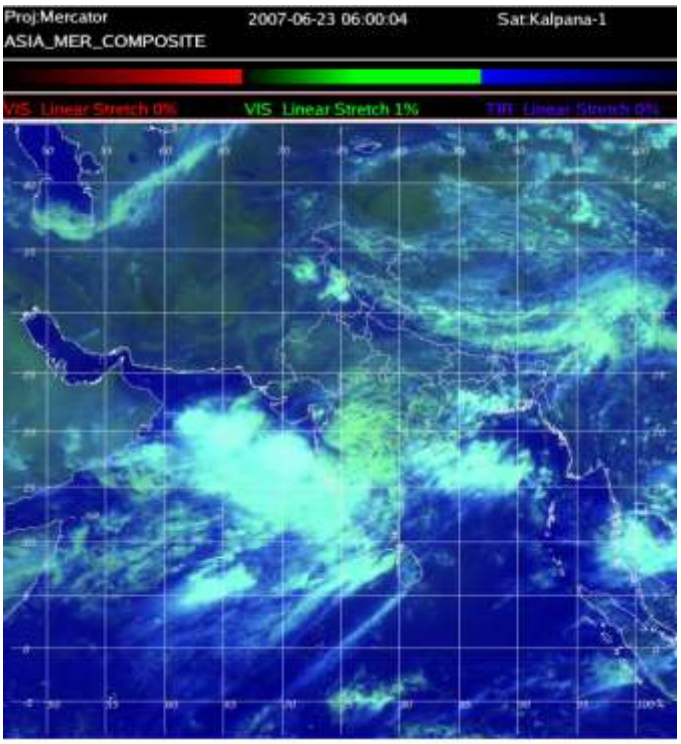


Fig 2.4.1 (a) Satellite KALPANA-1 imagery at 0600 UTC of 21 June, 2007 showing dense convective clouds over westcentral Bay of Bengal and adjoining Andhra Pradesh in association with the depression centered over westcentral Bay of Bengal embedded in active monsoon surge and (b) Satellite Imagery at 0600 UTC of 22 June showing dense convective clouds in southwest sector of deep depression centered over north Andhra Pradesh.

(c)



(d)

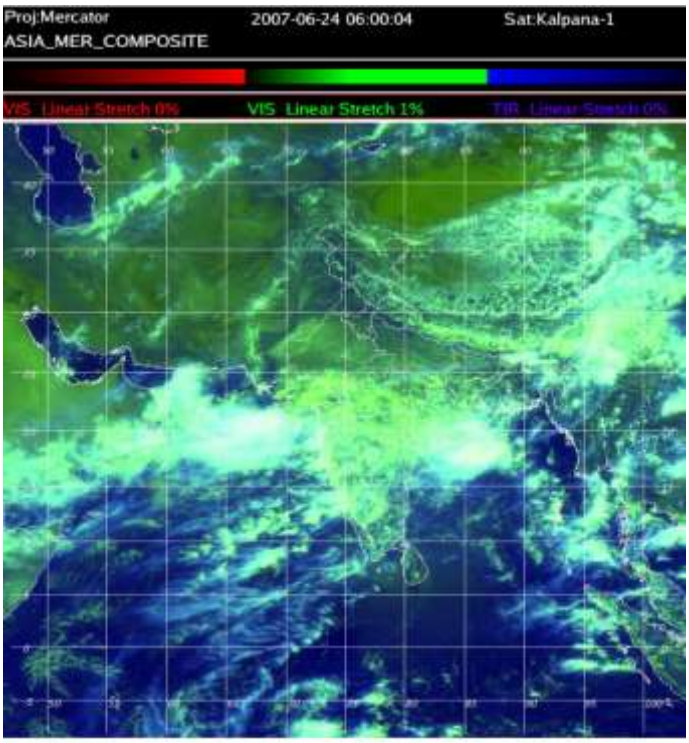


Fig 2.4.1 (c) Satellite KALPANA-1 imagery at 0600 UTC of 23 June, 2007 showing dense convective clouds over coastal and north interior Karnataka and adjoining eastcentral Arabian sea in association with the depression (d) Satellite Imagery at 0600 UTC of 24 June showing intense convective clouds over central and adjoining north Arabian sea in association with the well marked low pressure area over northeast Arabian sea and adjoining Saurashtra and Kutch.

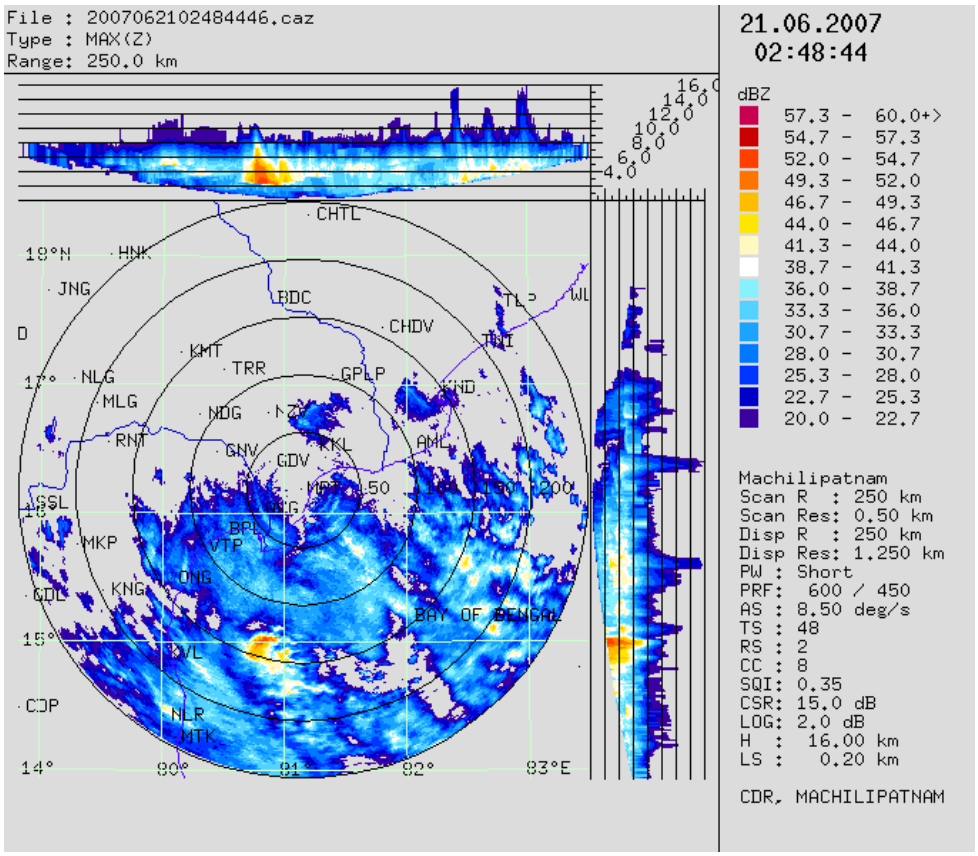


Fig 2.4.2. Machilipatnam Doppler Weather Radar image at (a) 02:48:44 UTC of 21 June, 2007.

2.5 Cyclonic Storm "YEMYIN" over the Arabian Sea during 25-26 June 2007

The remnant of a deep depression which developed over west central Bay of Bengal on 21 June and moved west-northwestwards across south India during 22 and 23 June emerged into northeast Arabian Sea as a well marked low pressure area on 24 June. It concentrated into a depression and lay centred at 0300 UTC of 25 June over northeast Arabian Sea near Lat. 23.5^0 N and Long 67.5^0 E (Fig. 2.1), about 150 kms west-northwest of Naliya (42631). Moving westwards, the system further intensified into a deep depression and lay centred at 1200 UTC of 25 June near Lat 23.5^0 N and Long. 66.5^0 E, about 250 kms west-northwest of Naliya. The satellite imagery showed intense to very intense convective clouds in association with the system. It further intensified into a Cyclonic Storm **"YEMYIN"** and lay centered at 2100 UTC of 25 June near lat. 23.5^0N and long. 66.0^0E. Moving in a northwesterly direction, it crossed Pakistan coast near Long. 64.0^0 E between 0200 and 0300 UTC of 26 June 2007. The system continued to move in a northwesterly direction after landfall and weakened gradually.

The best track and other parameters are given in Table 2.5.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.5.1. The vertical wind shear of horizontal winds at 1200 UTC of 25 and 26 June are shown in Fig. 2.5.2. The vertical wind shear was favorable for intensification the system on 25 June and weakening of the system on 26 June.

Weather Realised:

The system caused fairly widespread rainfall over Saurashtra and kutch. The chief amount of rainfall (≥ 5cm) over Saurashtra and kutch are given below.

25.06.2008

SAURASHTRA, KUTCH & DIU: Kesod, Navsari and Surat-7 each, Nakhtrana-6, Jamnagar, Kutch , Mandvi and Mundra-5 each.

Damage:

The system caused extensive damage over southwest Pakistan due to heavy rains and strong winds.

Pakistan

People died : 420 (205 in Balochistan and 215 in Sindh)

People missing : 109 (80 in Balochistan and 29 in Sindh)

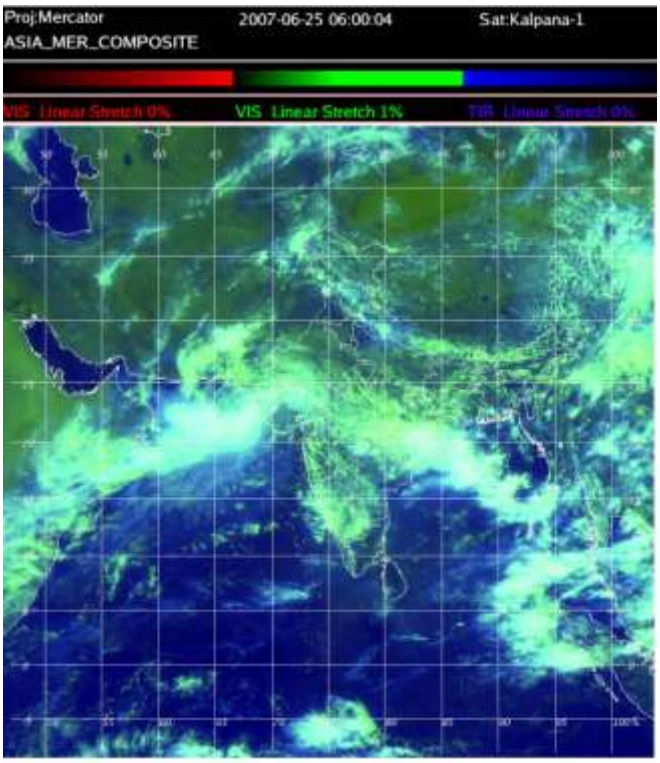
House destroyed : 75,623

As the system moved away from the Indian coast it did not cause any damage in India,

Table-2.5.1
Best track positions and other parameters of the Arabian Sea Cyclonic Storm "Yemyin" During 25-26 June, 2007

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
25-06-2007	0300	23.5/67.5	1.5	992	25	4	D
	0600	23.5/67.5	1.5	992	25	4	D
	0900	23.5/67.0	1.5	990	25	4	D
	1200	23.5/66.5	2.0	988	30	5	DD
	1500	23.5/66.5	2.0	988	30	5	DD
	1800	23.5/66.0	2.0	988	30	5	DD
	2100	23.5/66.0	2.5	986	35	6	CS
26-06-2007	0000	24.0/65.0	2.5	988	35	6	CS
	Crossed the west coast of Pakistan (near long. 64.0 E) between 0200 - 0300 UTC near 64.0^0 E as Cyclonic Storm.						

(a)



(b)

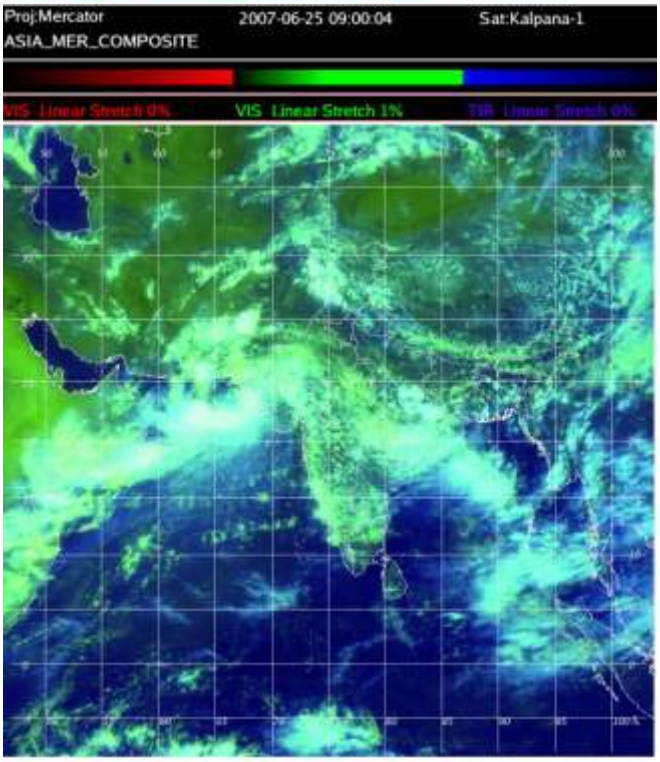
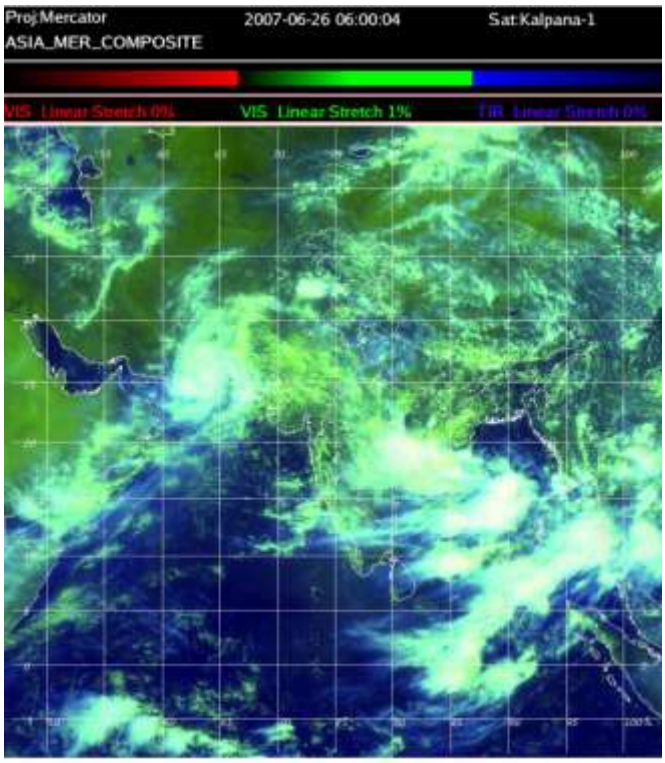


Fig 2.5.1 (a) Satellite KALPANA-1 imagery at 0600 UTC of 25 June, 2007 showing dense convective cloud mass over northeast Arabian sea in association with the depression and (b) Satellite Imagery at 0900 UTC of 25 June showing organized convective cloud mass in association with the deep depression

(c)



(d)

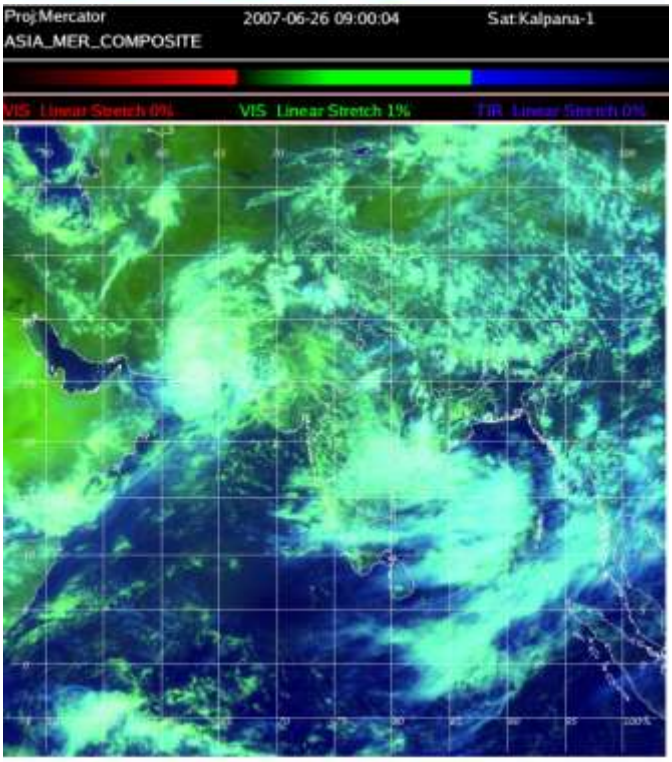
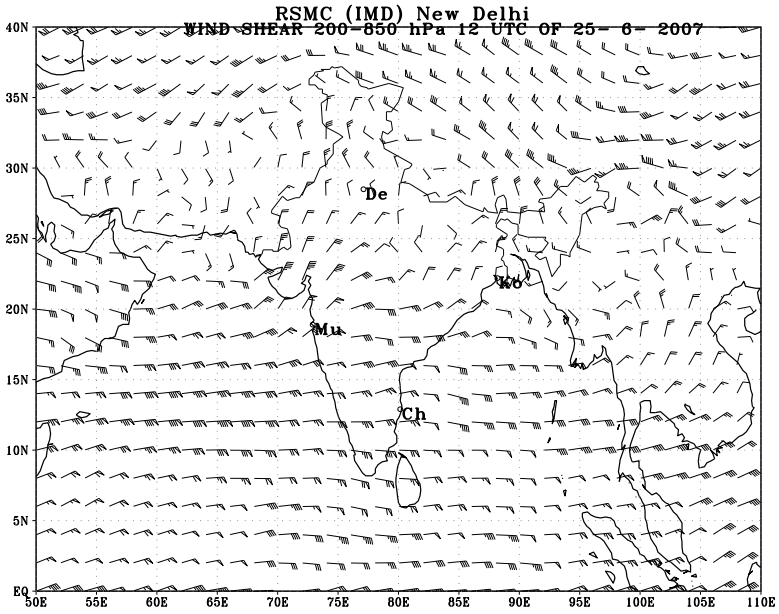


Fig 2.5.1 (c) Satellite KALPANA-1 imagery at 0600 UTC of 26 June, 2007 showing dense cloud mass over Pakistan and adjoining Arabian sea in association with the system and (d) Satellite Imagery of 0900 UTC of 26 June showing weakening of organization of cloud mass in association with the system.

(a)



(b)

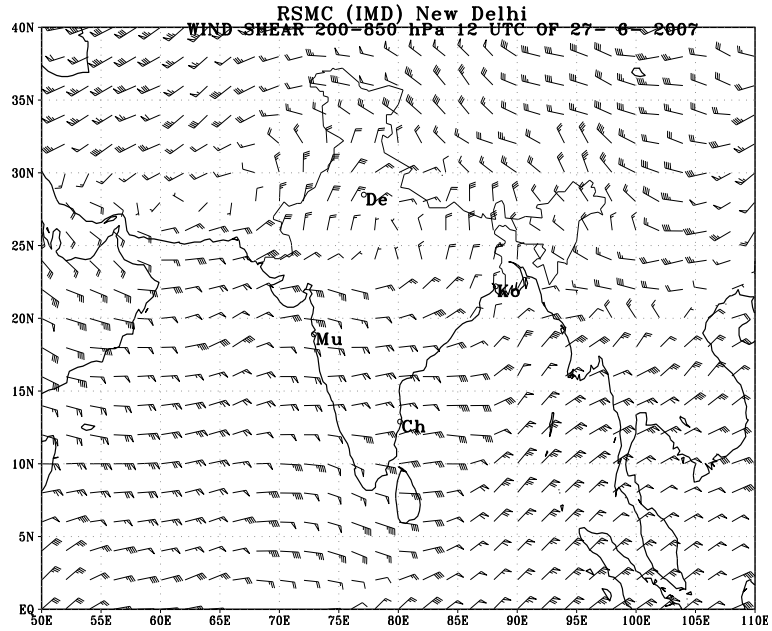


Fig. 2.5.2 Vertical wind shear of horizontal wind (kts) at 12 UTC of (a) 25 and (b) 26 June, 2007

2.6 Deep depression over the Bay of Bengal during 28-30 June 2007

A low pressure area formed over westcentral Bay of Bengal on 27 June 2007. It concentrated into a depression and lay centred at 0000 UTC of 28 June over northwest and adjoining westcentral Bay of Bengal near lat. 18.5^0 N and long. 87.0^0 E (Fig. 2.1), about 200 kms southeast of Puri (43053). It further intensified into a deep depression at 0300 UTC over the same area. The system moved northwestwards and crossed Orissa coast near Puri between 0000 and 0100 UTC of 29 June. After crossing the coast, system moved in a west-northwesterly direction, weakened into a depression and lay centred near lat. 22.0^0 N and long. 81.0^0 E at 0300 UTC of 30 June. The system continued to move in the same direction and weakened into a well marked low pressure area over west Madhya Pradesh and adjoining east Madhya Pradesh & Vidarbha around 1500 UTC of the same day.

The best track and other parameters of the system are given in Table 2.6.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.6.1.

Rainfall Realised:

The system caused widespread rainfall with scattered heavy to very heavy falls and isolated extremely heavy falls. Chief amount of rainfall (in cm) due to the system are given below

28 JUNE, 2007

ORISSA: Jeypore-27, Telkoi-6, Panposh-6, Sundergarh-6, Titilagarh-6, Talcher- 5, Bargarh-5, Mohana-5.

29 JUINE 2007

ORISSA: Koraput-22, Jeypore-21, Nawarangpur-20, Pottangi-19, Umerkote-18, Krishnaprassad-17, Kosagumda-16, Jaleswar-13, Jaipatna-12, Tikabali-11, Ghatagaon-9, Tangi-9, Khandapada-8, R.Udaigiri-8, Banpor-7, Hindol-7, Nayagarh-7, Nilgiri-7, Nimapara-7, Balasore-6, Malkangiri-6, Mohanana-6, Puri-6, Bangiriposhi-5, Baripada-5, Bhawanipatna-5, Bissan Cuttack-5, Chhatrapur-5, Daringibadi-5, Harabhanga-5, Nh5-Govindpur -5,Rajghat- 5, Rayagada-5.

30 JUINE 2007

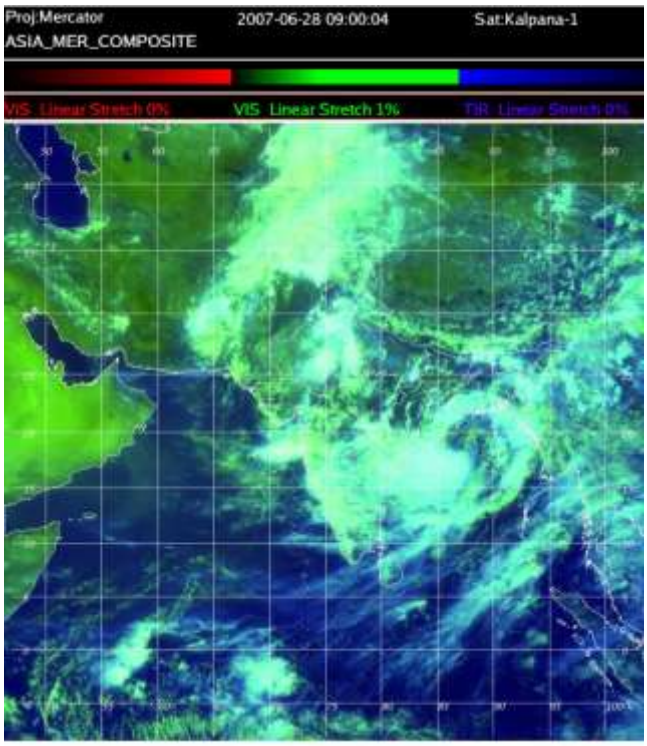
GANGETIC WEST BENGAL: Harinkhola-7, Durgapur-5. **ORISSA:** Paikmal-25 Tikabali-24 Khairamal-21, Kantamal-19, Sonipur-19, Patnagarh-17, Binika-17, Phulbani-17, Narsinghpur-16, Tikarpada-16, Padampur-16, Junagarh-16, Boudhgarh-15, Harabhanga-14, Barmul-14, Bijepur-13, Umerkote-13, Nawapara-12, Baliguda-12, Rairakhol-11, Khariar-11, Belgaon-11, Bolangir-11, Bhanjanagar-10, Lanjigarh-10, Titilagarh-10, Ambabhona-9, Bargarh-9, Dunguripalli-9, Madhabarida-8, Bhawanipatna-8, Khandapada-8, Rajkishore Nagar-7, Madanpur Rampur-7, Nawarangpur-7, Dashpalla-7, Chhendiapada-6, Kosagumda-6, Kotagarh-5, Bissam Cuttack-5. Kotraguda-5. **CHHATTISGARH:** Raipur-30, Mana AP-27, Ba/ada Bazar-22, Simga-18, Charama-18, Durg-17, Gariaband-1S, Dhamdha-13, Pakhanjur-13, Ber/a-12, Kanker-12, Rajim-11, Dhamtari-11, Antagah-11 , Palari-10, Saja-10, Bhanupratppur-10, Jaijpur-9, Sarangarh-9, Keshkal-9, Balad-8, Bemetara-8, Pandaria-8, Dandilahara-7, Nagari-7, Janjgir-7,Champa-7, Akaltata-7, Shivsrinaravan-7, Kandagaan-7, Narayanpur-7.

Damage Report: Nil

Table- 2.6.1
Best track positions and other parameters for deep depression over the Bay of Bengal during 28-30 June, 2007

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
28-06-2007	0000	18.5/87.0	1.5	988	25	4	D
	0300	18.5/87.0	2.0	986	30	5	DD
	0600	18.5/87.0	2.0	986	30	5	DD
	0900	19.0/86.5	2.0	988	30	5	DD
	1200	19.0/86.0	2.0	986	30	5	DD
	1500	19.0/86.0	2.0	986	30	5	DD
	1800	19.0/86.0	2.0	986	30	5	DD
	2100	19.5/86.0	2.0	986	30	5	DD
29-06-2007	0000	19.5/86.0	2.0	986	30	5	DD
	The deep depression crossed the Orissa coast near Puri between 0000 and 0100 UTC.						
	0300	20.0/86.0	-	988	30	5	DD
	0600	20.5/85.5	-	988	30	5	DD
	0900	20.5/85.0	-	988	30	5	DD
	1200	20.5/84.5	-	988	30	5	DD
	1500	20.5/84.0	-	988	30	5	DD
	1800	20.5/83.0	-	988	30	5	DD
	2100	21.0/82.0	-	990	30	5	DD
30-06-2007	0000	21.5/81.5	-	990	30	5	DD
	0300	22.0/81.0	-	992	25	4	D
	0600	22.0/81.0	-	992	25	4	D
	0900	22.5/81.0	-	992	25	4	D
	1200	22.5/80.5	-	992	25	4	D
	The system weakened into a well marked low pressure area over east Madhya Pradesh and adjoining west Madhya Pradesh & Vidarbha at 0300 UTC of 1st July.						

(a)



(b)

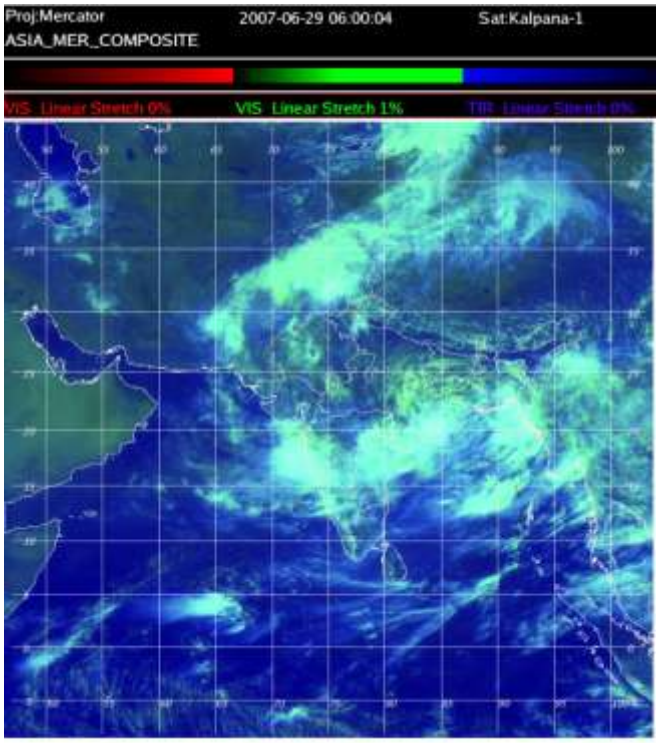


Fig 2.6.1 (a) Satellite Imagery at 0900 UTC of 28 June showing intense convective cloud in the southwest sector and spiral bands in association with the deep depression centred over northwest Bay of Bengal off Orissa coast and (b) Satellite KALPANA-1 imagery at 0600 UTC of 29 June, 2007 showing dense cloud mass over north Andhra-south Orissa due to deep depression over Orissa

(c)

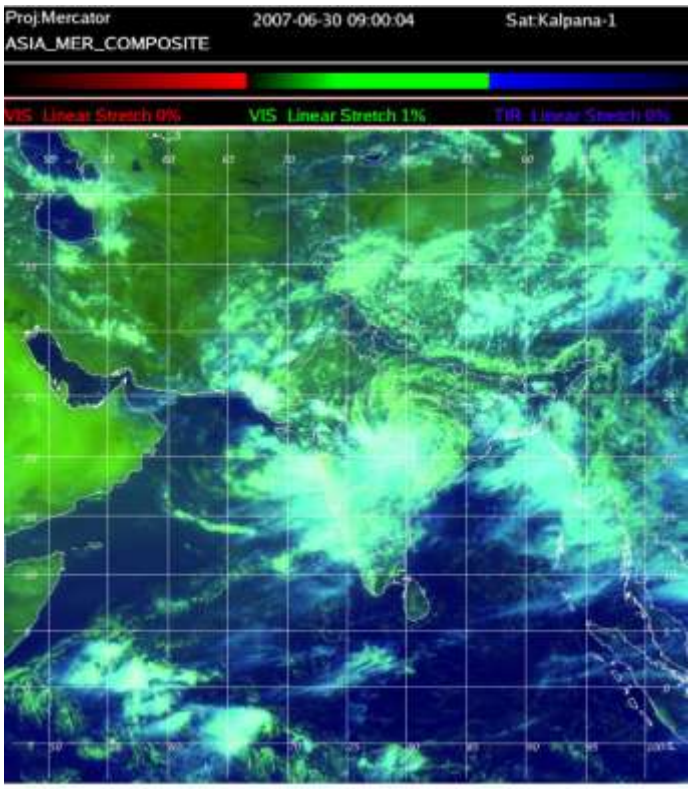


Fig 2.6.1 (c) Satellite Imagery at 0900 UTC of 30 June showing weakening trend in the organization of convective cloud mass in association with the depression over east Madhya Pradesh.

2.7 Deep Depression over the Bay of Bengal during 04-09 July 2007

A low pressure area formed over the north Bay of Bengal on 3 July, 2007. It concentrated into a depression and lay centred at 0300 UTC of 4 July over Bangladesh coast and adjoining north Bay of Bengal near lat. 22.0^{0}N and long. 89.5 ^{0}E (Fig. 2.1) and at 1200 UTC at was near lat. 23.0^{0}N and long. 89.5^{0}E. The system moved in a westerly direction and lay centred at 0300 UTC of 5 July near lat 23.0^{0}N and long. 88.0^{0}E. It persisted over the same area and intensified into a deep depression at 1200 UTC of the same day. The system continued to move almost in a westerly direction and weakened into a depression and lay centred at 0300 UTC of 7 July near lat. 23.5^{0}N and long. 83.5^{0}E close to Bhopal (west Madhya Pradesh). After reaching 79.0^{0}E, it started to move in a northwesterly direction initially and then it moved in a northerly direction. It lay centred at 0300 UTC of 9 July near lat. 25.0^{0}N and long. 78.0^0 E close to Shivpuri (42459). It weakened then and lay centred as a well marked low pressure area over southeast Rajasthan and adjoining northwest Madhya Pradesh at 1200 UTC of 9 July.

The best track and other parameters of the system are given in Table 2.7.1. A few KALPANA-1 cloud imageries showing the intensification/weakening and the movement of the system are shown in Fig. 2.7.1.

Rainfall Realised:

The system caused widespread rainfall with scattered heavy to very falls and isolated extremely heavy falls over west Bengal, adjoining Orissa, Chhattisgarh, Madhya Pradesh and east Rajasthan on different occasions during its movement. The chief amount of rainfall (≥ 5 cm) are given below

05 July 2007

GANGETIC WEST BENGAL: Phoolberia-28, Kharidwar-24, Bankura-22, Durgapur-22, Purihansa-21, Bankura(CWC)-19, Kalaikunda-19, Dengarparaghat-16, Tantloi-15, Asansol-15, Panagarh-15, Kharagpur (IIT)-15, Harinkhola-13, Suri-12, Mohanpur-12, Gheropara-11, Kansabati Dam-11, Kolkata (Dum Dum)-11, Midnapore-11, Sriniketan-10, Simulia-10, Tusuma-10, Barrackpur-10, Canning-8, Durgachak-8, Haldia-8, Krishnanagar-7, Tilpara Barrage-6, Kolkata(Alipore)-5, Diamond Harbour-5. **ORISSA:** Baripada-14, Rajghat-8, Rairangpur-8, Jaleswar-7, Sukinda-6, Balimundali-6, Jaipur-5, Chandanpur-5, Bangiriposh-5, WEST RAJASTHAN: Sojat-24, Marwar Junction-18, Jatrain-17, Bali-16, Desuri-12, Sumerpur-11, Pali-10, Raipur-9, Sinderi-8, Sayla-7, Ahore-5, Balotra-5.

06 JULY 2007

SUB–HIMALAYAN WEST BENGAL & SIKKIM: Kalimpong-11, Pedong-11, Munsong-10, Diana-9, Khanitar-7, Singlabazar-7, Darjeeling-5, **GANGETIC WEST BENGAL:** Kharagpur -27, Mohanpur-26, Purihansa-23, Midnapore-23, Kalaikunda-23, Phoolberia-17, Simulia-16, Kharidwar-16, Dengarparaghat-16, Diamond Harbour-15, Haldia-14, Tusuma-14, Durgachak-14, Kansabati Dam-13, Contai-12, Bankura (CWC)-10, Uluberia-10, Digha-9, Kolkata (Alipore)-7, Bankura-6, Panagarh-5, Canning-5, **ORISSA:** Jamsolaghat-27, Jhumpura-21, Joshipur-21, Rairangpur-21, Rajghat-20, Tiring-20, Baripada-19, Thakurmunda-18, Ghatagaon-17, Keonjhargarh-16, Champua-15, Swampatna-15, Chandanpur-15, Udala-15, Bangiriposh-14, Bhogari-12, Jaipur-12, Balimundali-11, NH-5 Govindpur-11, Balasore-10, Jaleswar-10, Telkoi-10, Pallahara-10, Karanjia-10, Anandpur-9, Lahunipara-8, Nilgiri-7, Soro-7, Sukinda-7, Panposh-7, Jamankira-6, Barkot-6, Deogarh-6, Rajgangapur-6, Kamakhya Nagar-5, Bonth-5, Deogaon-5, **BIHAR:** Lalganj-5, Patna-5, Sripalpur-5.

07 JULY 2007

ORISSA: Deogarh-22, Jamankira-20, Mandiram Dam-17, Lahunipara-16, Rajgangapur-16, Kuchinda-14, Jharsuguda-14, Laikera-14, Deogaon-13, Baragaon-13, Karanjia-13, Rengali-12, Swampatna-11, Pallahara-11, Bijepur-11, Paikmal-11, Panposh-11, Sundergarh-11, Jhumpura-10, Hirakud-10, Champua-9, Rairakhol-9, Athamalik-9, Barkot-9, Reamal-9, Sonepur-9, Keonjhargarh-8, Khairamal-8, Ambabhona-8, Harabhanga-8, Kantamal-8, Nawarangpur-8, Thakurmunda-8, Binika-8, Dunguripalli-8, Sukinda-7, Ghatagaon-7, Telkoi-7, Sambalpur-7, Rajkishore Nagar-7, Bargarh-7, Padampur-7, Sohela-7, Bolangir-7, Patnagarh-7, Phulbani-7, Anandpur-6, Altuma-6, Kamakhya Nagar-6, Naktideul-6, Chhendiapada-6, Tikarpada-6, Boudhgarh-6, Kosagumda-6, Umerkote-6, Soro-5, NH-5 Govindpur-5, Tikabali-5, **EAST RAJASTHAN:** Atru-9, Choth Ka Barwara-8, Sawai Madhopur (Tehsil)-8, Bundi-7, Manoharthana-7, Sawai Madhopur-7, Baran-6, Dug-6, Talera-6, Arnod-5, Chhotisadri-5, Pratapgarh-5, Salumber-5, **WEST MADHYA PRADESH:** Narsinghgarh-18, Biora-11, Rajgarh-11, Pachmari-9, Khandwa-9, Betul-8, Jhabua-7, Chachora-6, Hosangabad-6, Sendhwa-5, Khilchipur-5, Agar-5, Shajapur-5, Sujalpur-5, Shivpuri-5, Tarana-5, Ganjbasoda-5, **EAST MADHYA PRADESH:** Narsingpur-9, Deori-9, Jabalpur-8, Dindori-6, Katni-6, Sohagpur-6, Umaria-6, Patan-5, **CHHATTISGARH:** Katghora-17, Pali-14, Mahasamund-13, Arang-12, Gharghoda-12, Raigarh-11, Mungeli-10, Saraipali-9, Basna-9, Champa P. T. O.-9, Champa(Oby.)-9, Sakti-9, Bilaspur-8, Korba-8, Kunkuri-8, Janjgir-7, Akaltara-7, Jaijaipur-7, Kondagaon-7, Baloda Bazar-6, Pendra Road-6, Shivarinarayan-6, Jashpurnagar-6, Narayanpur-6, Mana (AP)-5, Balod-5.

08 JULY 2007

ORISSA: Nawarangpur-8, Umarkot-6, **EAST RAJASTHAN:** Ramganjmandi-25, Rawatbhata-21, Bakni-15, Bhainsroadgar-14, Pachpahar-14, Sangod-13, Khanpur-12, Dug-12, Pirawa-9, Aklera-8, Gangdhar-8, Degod-7, Pipalda-7, Atru-7, Sakargarh-7, Kotputli-7, Neemrana-7, Buhana-7, Jhalawar-7, Jalarapatan-7, Sambher-7, Ladpura-6, Kota-6, Kishanganj-5, Nagaur-5, Behror-5, Phulera-5, **WEST MADHYA PRADESH:** Harda-40, Betul-37, Agar-22, Bhasdehi-19, Narsullaganj-19, Multai-17, Bhopal-16, Hosangabad-16, Bareli-16, Begamganj-15, Ashta-15, Udaipura-14, Athner-13, Khirkiya-13, Budhni-11, Shajapur-11, Chanderi-10, Khandwa-10, Sehore-10, Sujalpur-9, Raisen-8, Chachora-7, Ganjbasoda-7, Sironj-7, Ashoknagar-6, Mungaoli-6, Vidisha-6, Guna-5, Ujjain-5, **EAST MADHYA PRADESH:** Amarwara-14, Malajkhand-10, Bichhia-10, Lanjhi-9, Sagar-7, Chhindwara-6, Sausar-5, **MADHYA MAHARASHTRA:** Mahabaleshwar-9, Gaganbavda-7, **VIDARBHA:** Amraoti-11, Nagpur-9, Wardha-6, Yeotmal-6, **CHHATTISGARH:** Pali-9, Katghora-8, Baloda bazar-8, Korba-7, Janjgir-6, Champa P. T. O.-6, Bemetara-6, Kwardha-5, Palari-5, Sigma-5.

09 JULY 2007

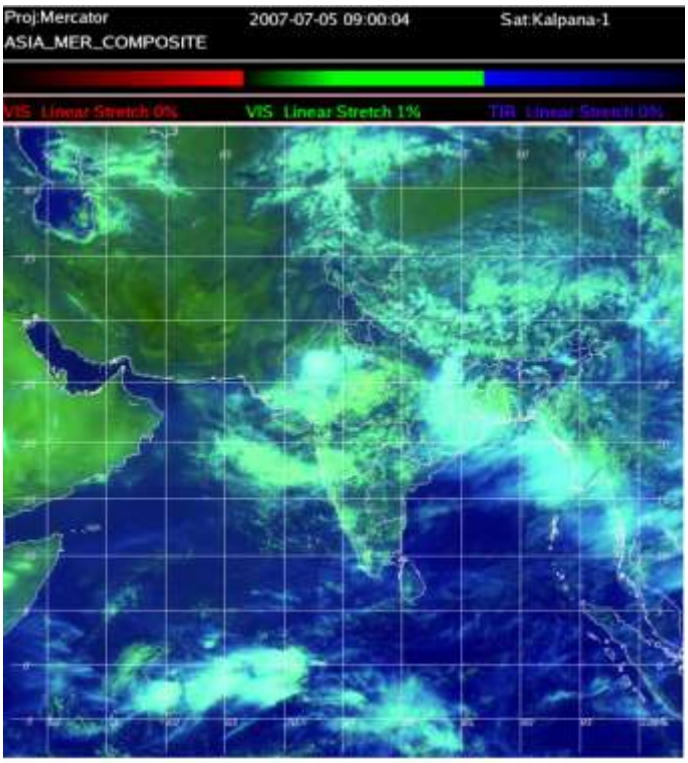
EAST RAJASTHAN: Garhi-49, Danpur-39, Sagwara-35, Kesarpura-33, Banswara-32, Bagidora-31, Ghatol-25, Kushalgarh-25, Arnod-24, Bhungra-24, Sajjangarh-23, Loharia-22, Pipalkhunt-22, Sallopat-22, Galiakot-21, Sabla-21, Arthuna-19, Shergarh-18, Nithuwa-17, Aspur-16, Kotda-15, Dhambola-14, Dariabad-12, Ganeshpur-12, Begu-11, Chikhli-11, Dug-11, Mandalgarh-10, Pirawa-9, Veza-9, Salumber-8, Sirohi-7, Bakani-6, Choth Ka Barwara-6, Degod-6, Kachola-6, Mandana-6, Mount Abu -6, Sawai Madhopur-6, Sunel-6, Abu Road-5, Badisadri-5, Hamirgarh-5, Pardi-5, Pindwara-5, Rain Basera-5, **WEST MADHYA PRADESH:** Ratlam-31, Agar-19, Ujjain-19, Dhar-18, Raisen-17, Susner-15, Indore-14, Mandasaur-12, Vidisha-12, Biora-11, Sarangpur-9, Shajapur-9, Khilchipur-7, Rajgarh-7, Sujalpur-7, Bhopal-6, Jawad-6, Hosangabad-5, Neemuch-5, **GUJARAT REGION:** Bhiloda-24, Kadana-20, Idar-15, Santrampur-9, Modasa-9, Dabhoi-9, Jhalod-8, Lunawada-8, Dhansura-7, Himatnagar-7, Meghraj-7, Fatepura-6, Ukai-6, Dharoi-5, Danta-5, Wanakbori-5, Bayad-5, Khedbrahma-5, **KONKAN & GOA:** Dodamarg-10, Valpoi-10, Sawantwadi-8, Dabolim-8, Pernem-8, Sanguem-8, Ponda-7, Vengurla-6, Quepem-6, Kudal-5, **MADHYA MAHARASHTRA:** Mahabaleshwar-18, Satara-8, Akkalkuwa-5.

10 JULY 2007,
EAST RAJASTHAN: Mount Abu-12, Kushalgarh-12, Sallopat-12, Kotda-10, Bagidora-9, Mavli-9, Pindwara-9, Rajsamand-9, Reodar-9, Sajjangarh-8, Veja-8, Aspur-7, Badnore-7, Kelwara-7, Loharia-7, Nithuwa-7, Sabla-7, Shergarh-7, Jagpura-6, Nathdwara-6, Sheoganj-6, Sirohi-6, Badisadri-5, Danpur-5, Dungla-5, Ladpura-5, Salumber-5, **WEST RAJASTHAN:** Desuri-6, Siwana-6, Sumerpur-6 **WEST MADHYA PRADESH:** Subasera-8, Mandasaur-5, **GUJARAT REGION:** Dhansura-47, Bayad-41, Prantij-37, Vijapur-33, Himatnagar-30, Idar-24, Dantiwada-20, Kheralu-18, Modasa-18, Balasinor-17, Wanakbori-17, Jhalod-16, Palanpur-15, Visnagar-14, Khedbrahma-14, Dharoi-13, Vadnagar-13, Kadana-13, Shehra-13, Santrampur-11, Vadgam-11, Wav-11, Bhiloda-11, Meghraj-11, Fatepura-10, Dahegam-10, Kapadvanj-9, Dohad-8, Limkheda-8, Mansa-8, Tharad-8, Patan-8, Devgadhraria-7, Godhara-7, Danta-7, Dhanera-7, Kathalal-7, Dholka-6, Garbada-6, Sanad-5, Gandhinagar-5, Deesa-5, Thasra-5, Radhanpur-5.

Table- 2.7.1
Best track positions and other parameters for deep depression over Bay of Bengal during 04-09 July, 2007

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
04-07-2007	0300	22.0/89.5	1.5	990	25	4	D
	0600	22.0/89.5	1.5	990	25	4	D
	0900	22.0/89.5	1.5	992	25	4	D
	1200	23.0/89.5	-	990	25	4	D
	1500	23.0/89.5	-	992	25	4	D
	1800	23.0/89.5	-	990	25	4	D
	2100	23.0/89.5	-	992	25	4	D
05-07-2007	0000	23.0/89.5	-	992	25	4	D
	0300	23.0/88.0	-	992	25	4	D
	0600	23.0/88.0	-	988	25	4	D
	0900	23.0/88.0	-	988	25	4	D
	1200	23.0/88.0	-	988	30	5	DD
	1500	23.0/88.0	-	988	30	5	DD
	1800	23.0/88.0	-	990	30	5	DD
	2100	23.0/88.0	-	988	30	5	DD
06-07-2007	0000	23.0/88.0	-	988	30	5	DD
	0300	23.0/87.0	-	988	30	5	DD
	0600	23.0/87.0	-	988	30	5	DD
	0900	23.0/87.0	-	988	30	5	DD
	1200	23.0/86.0	-	988	30	5	DD
	1500	23.0/86.0	-	988	30	5	DD
	1800	23.0/86.0	-	988	30	5	DD
	2100	23.0/86.0	-	988	30	5	DD
07-07-2007	0000	23.0/86.0	-	988	30	5	DD
	0300	23.5/83.5	-	990	25	4	D
	0600	23.5/83.5	-	990	25	4	D
	0900	23.5/83.5	-	990	25	4	D
	1200	23.5/82.0	-	990	25	4	D
	1500	23.5/82.0	-	990	25	4	D
	1800	23.5/82.0	-	990	25	4	D
	2100	23.5/82.0	-	990	25	4	D
08-07-2007	0000	23.5/82.0	-	990	25	4	D
	0300	23.5/79.0	-	990	25	4	D
	0600	23.5/79.0	-	990	25	4	D
	0900	23.5/79.0	-	990	25	4	D
	1200	24.0/78.0	-	990	25	4	D
	1500	24.0/78.0	-	990	25	4	D
	1800	24.0/78.0	-	990	25	4	D
	2100	24.0/78.0	-	990	25	4	D
09-07-2007	0000	24.0/78.0	-	990	25	4	D
	0300	25.0/78.0	-	990	25	4	D
	0600	25.0/78.0	-	990	25	4	D
	0900	25.0/78.0	-	990	25	4	D
	The system weakened into a well marked low pressure area over southeast Rajasthan and adjoining northwest Madhya Pradesh at 1200 UTC of 9 July. **Remark:** This system formed as low pressure area over north Bay of Bengal near coast then intensified into a depression over Bangladesh coast.						

(a)



(b)

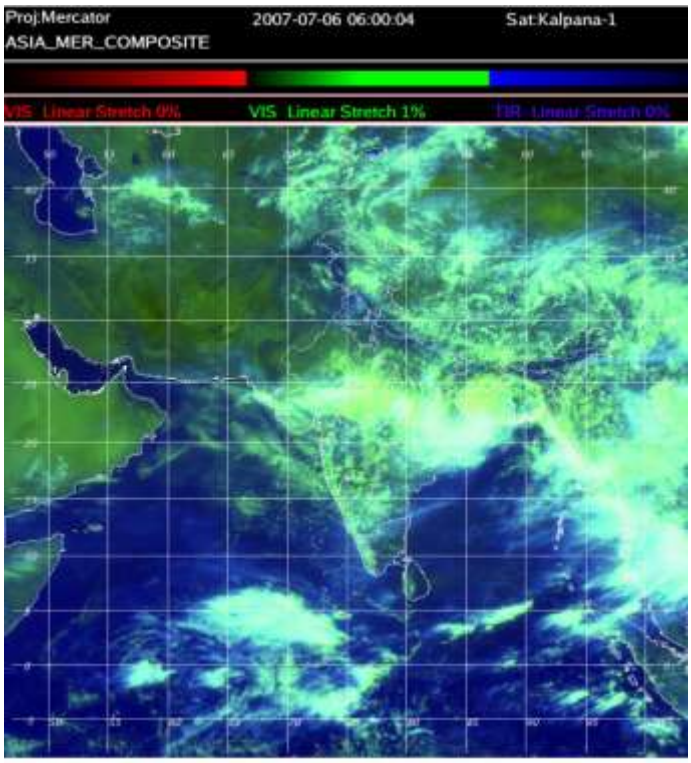


Fig 2.7.1 (a) Satellite KALPANA-1 imagery at 0900 UTC of 5 July, 2007 showing curved features in association with the depression centred over Jharkhand and (b) Satellite Imagery of 0600 UTC at 6July showing dense convective cloud mass to southwest of the deep depression centred over Jharkhand.

(c)

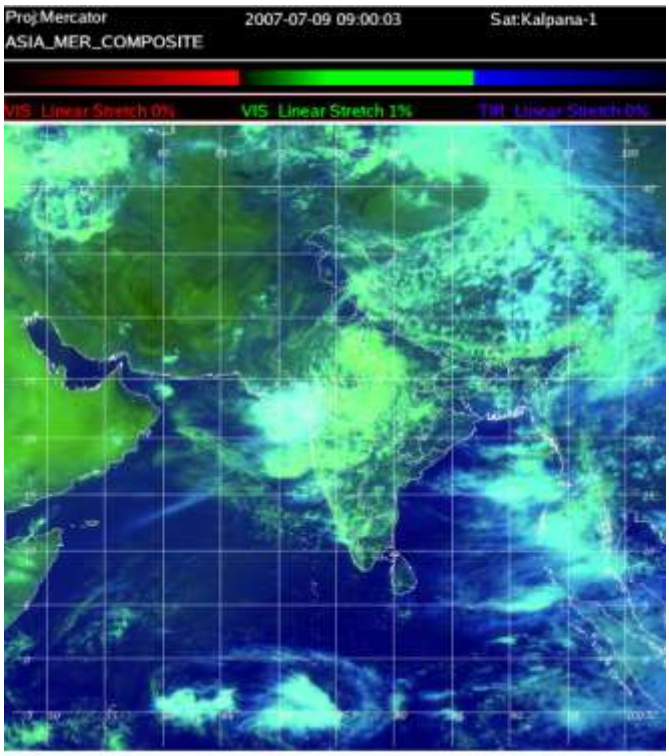


Fig 2.7.1 (c) Satellite KALPANA-1 imagery of 0900 UTC of 9 July, 2007 showing dense cloud mass over western India and adjoining eastcentral & northeast Arabian sea in association with the depression east Madhya Pradesh. It also shows the weakening trend of the depression due to disorganization of the cloud clusters.

2.8 Deep depression over the Bay of Bengal during 5-7 August, 2007

A low pressure area formed over northwest Bay of Bengal on 3 August 2007. It became well marked on 4 August. Subsequently, it concentrated into a depression and lay centred at 0000 UTC of 5 August over northwest Bay of Bengal near lat. 20.0^0 N and long. 88.5^0 E (Fig 2.1). Moving slowly in a westerly direction, it further intensified into a deep depression and lay centred at 1800 UTC near lat. 20.0^0 N and long. 88.5^0 E. It then moved in a west-northwesterly direction and crossed Orissa coast between 0100 – 0200 UTC of 6 August between Chandbali and Paradip and lay centred at 0300 UTC of 6 August 2007 over coastal Orissa near lat. 20.5^0 N and long. 86.0^0 E. The system weakened into a depression and lay centred at 0300 UTC of 7 August near lat. 21.0^0 N and long. 82.0^0 E. The system then moved in a northwesterly direction and weakened further. It lay as well marked low pressure area over central Madhya Pradesh and adjoining areas of southeast Uttar Pradesh at 1200 UTC of 7 August.

The best track and other parameters of the system are given in Table 2.8.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.8.1.

Rainfall Realised:

The system caused widespread rainfall with scattered heavy to very heavy falls and isolated extremely heavy falls along its track especially over the southwest sector of the system. The chief amounts of rainfall (5 cm or more) are given below:

05 AUGUST 2007

ORISSA: Alipingal-35, Cuttack-33, Mundali-27, Naraj-27, Kakatpur-25, Paradeep-18, Bhubaneswar-14, Nimapara-11, Kendrapada-8, Champua-7, Pipili-7, Nilgiri-5, Rajghat-5, Panposh-5.

06 AUGUST 2007

ORISSA: Puri-22, Bhubaneswar-19, Nimapara-18, Pipili-18, Kotagarh-17, Alipingal-16, Kakatpur-16, Paradeep-15, Madanpur Rampur-15, Gop-15, Baliguda-15, Kendrapada-13, Chhatrapur-13, Krishnaprasad-13, Daringibadi-13, Berhampur-12, Junagarh-12, Athagarh-11, Cuttack-11, Patamundai-11, Mandiramdam-11, Rajgangapur-11, Mohana-11, R. Udaigiri-11, Gopalpur-11, Banpur-11, Kotraguda-11, Mundali-10, Purusottampur-10, Bhawanipatna-10, Lanjigarh-10, Khandapada-10, Belgaon-10, Bolangir-10, Champua-9, Naraj-9, Rajkanika-9, Lahunipara-9, Kantamal-9, Mahendragarh-8, Aska-8, Jaipatna-8, Khariar-8, Nawarangpur-8, Tangi-8, Phulbani-8, Tikabali-8, Madhabarida-7, Sorada-7, Umerkote-7, Nayagarh-7, Titilagarh-7, Bissam Cuttack-7, Gudari-7, Nilgiri-6, Jenapur-6, Khairamal-6, Kuchinda-6, Laikera-6, Panposh-6, Komna-6, Kosagumda-6, Bangiriposh-6, Ranpur-6, Binika-6, Chandbali-5, Narsinghpur-5, Jharsuguda-5, Baragaon-5, Jeypore-5, Malkangiri-5, Sonepur-5, Rayagada-5.

Chhattisgarh: Bijapur-9, Pamgarh-8, Dantewada-7, Biliagarh-7, Kharasia-6, Shivarinarayan-6, Jaijaipur-6,Sarangarh-6, Palari-5, Saja-5, Mungeli-5, Janigir-5, Champa PTO-5

07 AUGUST 2007

ORISSA: Umerkote-35, Bhanjanagar-24, Junagarh-23, Nawarangpur-23, Madhabarida-22, Kosagumda-22, Sorada-21, Kotagarh-21, Kotraguda-19, Bhawanipatna-17, Bissam Cuttack-17, Jaipatna-16, Aska-15, Lanjigarh-15, Gudari-15, Mohana-14, Khandapada-13, Ranpur-12, Titilagarh-12, R. Udaigiri-11, Nayagarh-11, Komna-9, Jeypore-9, Koraput-9, Thakurmunda-9, Baliguda-9, Belgaon-8, Tikabali-8, Gunupur-8, Rayagada-8, Khariar-7, Nilgiri-6, Daitari-6, Parlakhemundi-6, Udala-6, Dashpalla-6, Keonjhargarh-5, Kashinagar-5, Purusottampur-5, Malkangiri-5, Patnagarh-5, Phulbani-5.

Vidarbha: Armoori-37, Brahmpuri-35, Arunirorgaon-23, Umrer-20, Deori-18, Saoli-16, Bhiwapur-16, Amgaon-14, Chandrapur-13, Warora-12, Kuchi-12, Hingana-11, Kalmeshwar-11,

Savaner-10, Mul-10, Rajpura-9, Nagpur (city)-9, Wardha-9, Nagpur(AP) -8, Nankhed-8, Warud-8, Selu-7, Kamtee-6, Ashti-6, Katol-6, Mauda-6, Amraoti-5, Sironcha-5, Morsi-5.

Chhattisgarh: Jagdalpur-14, Raipur-9, Mana (AP)-7

08 AUGUST 2007

EAST RAJASTHAN: Kushalgarh-16, Danpur-9, Arnod-8, Dug-7, Kesarpura-6, Pratapgarh-6, Sunel-5, Mokhunda-5, Gangadhar-5, Jhadol-5, Bhopalsagar-5, **WEST MADHYA PRADESH:** Ratlam-13, Betul-12, Indore-5, Ujjain-5, **GUJARAT REGION:** Kadi-23, Becharaji-17, Kalol (Gandhinagar)-14, Gandhinagar-10, Nanipalsan-10, Mehasana-9, Dholka-7, Viramgam-7, Mansa-7, Kapadvanj-7, Bodeli-7, Madhuban-7, Mandvi-7, Sanad-6, Dhanpur-6, Chhotaudepur-6, Mandal-5, Jambugoda-5, Dhansura-5, Rajpipla-5, Umargoan-5, Valsad-5, Vapi-5, Navsari-5, Mahuva-5, **SAURASHTRA, KUTCH & DIU:** Talala-47, Kodinar-31, Maliya-31, Lalpur-29, Veraval-24, Dhoraji-21, Amreli-20, Junagadh-20, Lodhika-20, Mangrol-19, Sutrapada-19, Jamnagar-18, Gondal-15, Lathi-14, Lilia-14, Keshod-14, Dhari-13, Vanthali-13, Upleta-13, Jetpur-12, Rajkot-12, Bagsra-11, Babra-9, Jafrabad-9, Manavadar-9, Bhavnagar-9, Botad-9, Savarkundla-8, Umarala-8, Vallabhipur-8, Khambha-7, Rajula-5, Chotila-5, Mahuva-5, Palitana-5, Sihor-5, Kutiana-5, Porbandar-5, Kalawad-5, Kalyanpur-5, Okha-5, Maliya Miyana-5, **KONKAN & GOA:** Karjat-28, Matheran-21, Jawahar-19, Vasai-19, Khalapur-17, Panvel-16, Wada-13, Murbad-13, Mumbai(SCZ)-12, Palghar-11, Thane-11, Mokhada-10, Uran-10, Canacona-10, Dahanu-9, Kalyan-9, Sahapur-9, Bhiwandi-9, Ulhasnagar-9, Mumbai (Colaba)-9, Bhira-9, Mahad-8, Vaibhavwadi-6, Quepem-6, Ambernath-5, Mangaon-5, Ratnagiri-5, Margaon-5, **MADHYA MAHARASHTRA:** Radhanagari-18, Mahabaleshwar-18, Igatpuri-11, Chandgad-9, Gaganbavda-8, Shahuwadi-8, Peint-7, Trimbak-7, Ajra-7, Panhala-6, **VIDARBHA:** Selu-19, Chandur-15, Brahamapuri-14, Angoan-11, Morshi-11, Ashti-9, Amraoti-9, Tiwasa-9, Warora-7, Saoli-7, Wardha-7, Murtizapur-7, Akot-6, Paratwada-6, Chimur-5, Mul-5, Telhara-5, **CHHATTISGARH:** Dondi-10, Dongargarh-9, Manpur-8, Mohola-6, Kartala-6.

Damage:

The following damages reported

Andhra Pradesh:

Srikakulam District:

1) No. of human lives lost: 3 (missing)
2) Population affected: 14,567
3) Crops damaged: 16,153 hectors
4) Horticulture: 33, 720 hectors
5) Impact on infrastructure: 2, 16,787 lakhs

Vizianagaram District:

Roads breached at Kuneru, Komrada, Mandai.

Orissa:

No. of human deaths: 15

Madhya Pradesh:

No. of human deaths: 3

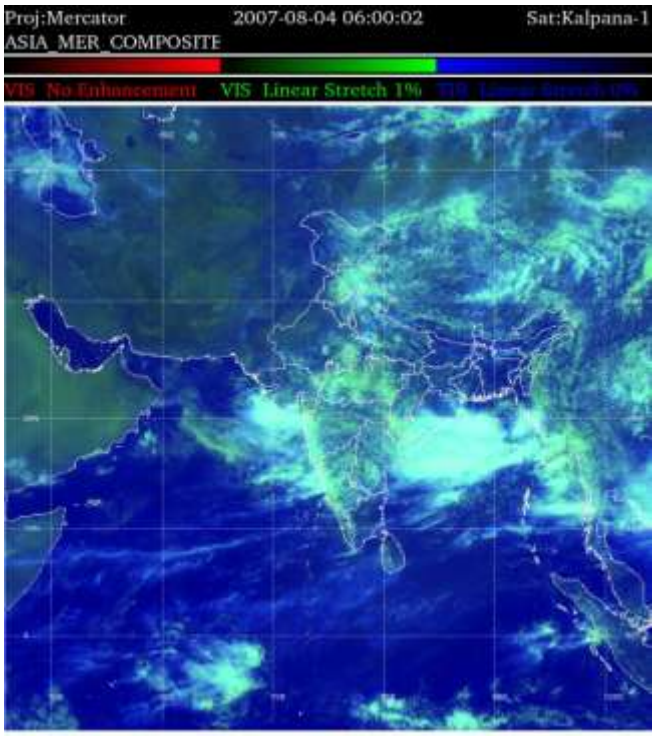
Maharashtra (Vidarbha):

No. of human deaths: 3

Table- 2.8.1
Best track positions and other parameters of deep depression over northwest Bay of Bengal during 05-07, August 2007

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
5-8-2007	0000	20.0/88.5	1.5	992	25	4	D
	0300	20.0/88.5	1.5	992	25	4	D
	0600	20.0/88.5	1.5	992	25	4	D
	0900	20.0/88.5	1.5	990	25	4	D
	1200	20.0/88.0	1.5	990	25	4	D
	1500	20.0/88.5	1.5	990	25	4	D
	1800	20.0/87.5	2.0	988	30	5	DD
	2100	20.5/87.5	2.0	984	30	5	DD
6-8-2007	0000	20.5/87.0	2.0	988	30	5	DD
	Crossed Orissa coast between Chandbali and Paradip between 0100 to 0200 UTC of 6 August, 2007						
	0300	20.5/86.0	-	990	30	5	DD
	0600	20.5/85.0	-	990	30	5	DD
	0900	20.5/84.5	-	990	30	5	DD
	1200	20.5/84.5	-	990	30	5	DD
	1500	20.5/84.5	-	992	30	5	DD
	1800	20.5/84.0	-	992	30	5	DD
	2100	20.5/83.0	-	990	30	5	DD
7-8-2007	0000	21.0/82.5	-	990	30	5	DD
	0300	21.0/82.0	-	992	25	4	D
	0600	22.0/81.0	-	992	25	4	D
	0900	22.5/80.5	-	992	25	4	D
	The system weakened into a well marked low pressure area over Central Madhya Pradesh and adjoining area at 1200 UTC.						

(a)



(b)

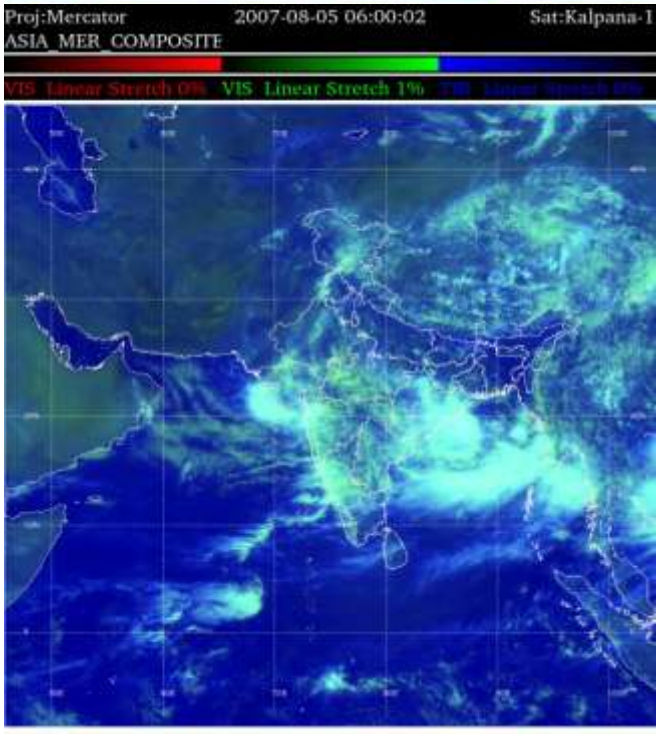
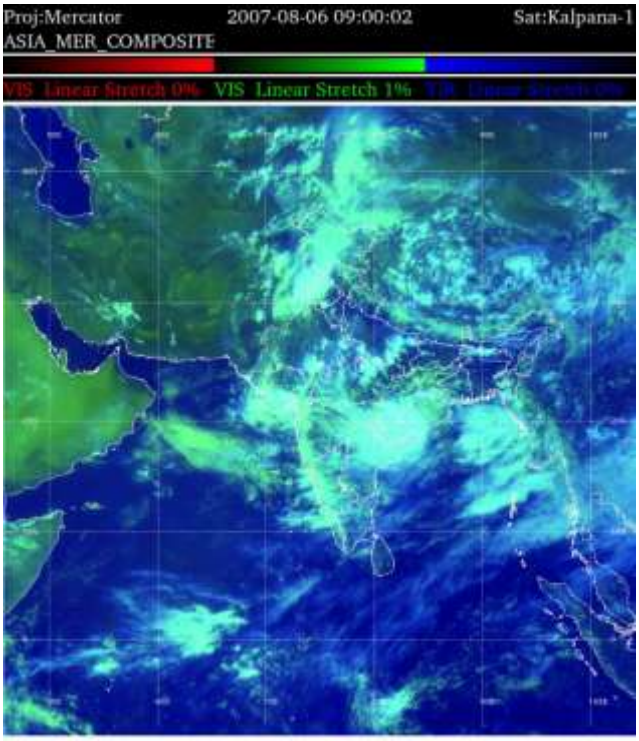


Fig 2.8.1 (a) Satellite KALPANA-1 imagery at 0600 UTC of 4 August, 2007 showing dense cloud mass over northwest Bay of Bengal in association with well marked low pressure area and (b) Satellite Imagery at 0500 UTC of 5 August showing dense cloud mass in association with the depression over northwest Bay of Bengal and adjoining Orissa.

(c)



(d)

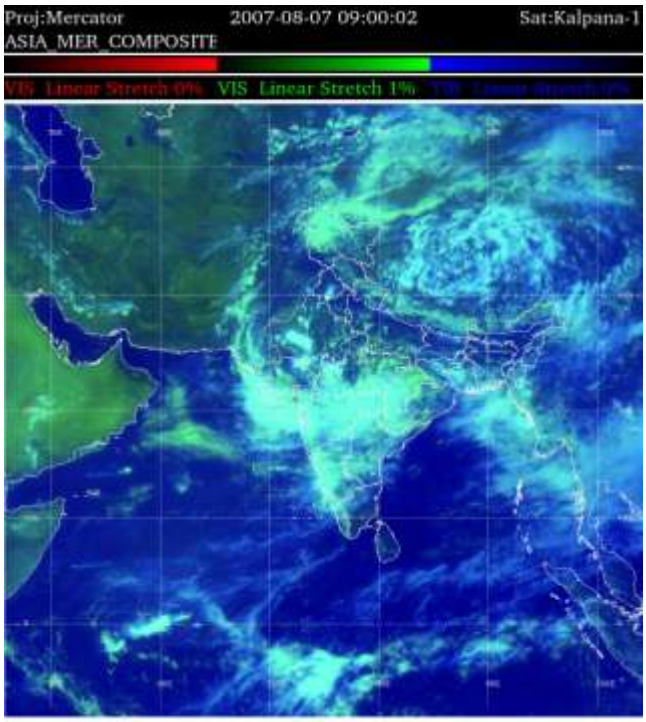


Fig 2.8.1 (c) Satellite KALPANA-1 imagery at 0900 UTC of 6 August, 2007 showing dense cloud mass over south Orissa and neighbourhood in association with deep depression over Orissa and (d) Satellite Imagery at 0900 UTC of 7 August showing dense cloud mass in association with the depression over Chhattisgarh and neighbourhood.

2.9 Depression over the Bay of the Bengal during 21-24 September 2007

A low pressure area developed over west central Bay of Bengal on 19 September, 2007. It persisted over the same area upto morning of 21st September. It concentrated into a depression over west central Bay of Bengal on 21 September and lay centred at 1200 UTC near Lat. 18.0^0 N and Long. 86.5^0 E (Fig.2.1). The depression moved north-northwestwards and crossed Orissa coast near Puri between 1300 and 1400 UTC of 22 Sept. After crossing the coast, system moved in a northwesterly direction and lay centred at 0300 UTC of 23 Sept. and near Lat.20.5^0 N and Long. 85.5^0 E and near Lat.23.0^0 N and Long.83.5^0 E at 0300 UTC of 24 September. It weakened then and lay as a well marked low pressure area over northeast Madhya Pradesh and adjoining southeast Uttar Pradesh at 1200 UTC of 24 September 2007.

The best track and other parameters of the system are given in Table 2.9.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.9.1.

Rainfall Realised:

The system caused widespread rainfall with scattered heavy to very heavy falls. The chief amounts of rainfall (in cm) are given below:

21 SEPTEMBER 2007
ORISSA:
Mundali-11, Cuttack-8, Naraj-7, Athagarh-6, Kendrapada and Patamundai-6 each, Kakatpur, Khand apada, Kosagumda, Nimapara, Pipili, Pottangi, Umerkote and NH-5 Govindpur-5 each. **CHHATTISGARH:** Konta-5.

COASTAL ANDHRA PRADESH:
Tekkali-7, Sompeta – 6, Ichapuram, Kakinada, Mandasa, Palasa and Tuni 5 each.

22 SEPTEMBER 2007
GANGETIC WEST BENGAL: Digha and Durgachak-11 each, Diamond Harbour, Kalaikunda and Mohanpur-5 each. **ORISSA:** Chand bali-19, Alipingal-18, Patamundai-15, Akhuapada-14, Kendrapada and Kakatpur-13, Balasore, Soro, Jenapur, Mundali, Udala, Nilgiri, Paradeep, Athagarh and Rajkanika-11, Bhogari, Jajpur and Dhenkanal-10 each, Rajghat, Bonth, Naraj and Bhubaneswar-9 each, Sukinda, Hindol, Nimapara, Khand apada and Tikabali-8 each, Jaipur and Baripada-7 each, Jaleswar, Gop and Pipili- 6 each, Kamakhya Nagar, Narsinghpur, Balimundali, Krishnaprasad, Puri, Barmul, Dashpalla, Nayagarh, Ranpur-5 each. **CHHATTISGARH:** Konta-7, Dantewada-5.

23 SEPTEMBER 2007
GANGETIC WEST BENGAL: Canning-16, Kolkata(Dum Dum)-13, Barrackpur, Kolkata(Alipore) and Digha-10 each,Diamond Harbour, Durgachak and Kalaikunda-9 each, Midnapore-8, Kansabati Dam, Tusuma and Mohanpur-7 each, Purihansa, Kharidwar, Harinkhola and Phoolberia-6 each, Burdwan, Contai and Dengraparaghat-5.**ORISSA:** Athagarh-27, Nilgiri-24, Ghatagaon-22, NH-5 Govindpur-17 and Soro-17 each, Boudhgarh-15 and Tikabali-15 each, Balasore-14 and Naraj-14 each, Harabhanga-13, Jenapur, Baripada and Phulbani-12 each, Rajghat, Anand pur, Angul, Bangiriposhi, Thakurmunda and Bolangir-11 each, Cuttack, Chhendiapada and Rajkishore Nagar-10 each, Jhumpura, Swampatna, Dhenkanal, Mundali, Narsinghpur, Rengali, Kosagumda, Barmul, Bhubaneswar and Baliguda-9 each, Bhograi, Jaleswar, Paradeep, Keonjhargarh, Khairamal, Kantamal, Rairangpur and Khand apada-8 each, Bonth, Chand bali, Mohana, Sorada and Tiring-7 each, Akhuapada, Bargarh, Kakatpur, Tangi and Nayagarh-6 each. **CHHATTISGARH:** Mahasamund-5.

24 SEPTEMBER 2007

GANGETIC WEST BENGAL: Bankura(CWC)-20, Canning-19, Bankura and Basirhat-18 each, Durgapur-16 and Kolkata(Dum Dum)-16 each, Mohanpur and Dengraparaghat-15 each, Kalaikunda-13, Kansabati Dam and Harinkhola-12 each, Suri,Tantloi and Midnapore-11 each, Gheropara, Tilpara Barrage, Asansol and Kharagpur (IIT)-10 each, Sriniketan, Purihansa, Panagarh- and Kolkata(Alipore)-9 each, Krishnanagar-8, Berhampur-7, Rampurhat, Purullia, Tusuma, Kharidwar, Diamond Harbour and Durgachak-6 each, Contai and Digha-5 each. **ORISSA:** Jamankira-19, Sambalpur-18, Binika-17, Hirakud and Rajkishore Nagar-15 each, Rairakhol-14, Rajghat, Chhendiapada, Ambabhona and Boudhgarh-13 each, Harabhanga-12, Kantamal-10, Jaleswar, Ghatagaon, Kuchinda, Naktideul, Athamalik, Deogarh, Bargarh, Baripada and Jamsolaghat-9 each, Balasore, Nilgiri, Soro and Thakurmunda-8 each, Pallahara, Talcher, Tikarpada, Reamal, Panposh, Bangiriposhi, Chand anpur, Sonepur-7 each, Champua, Telkoi, Angul, Sohela, Balimundali, Baliguda, Phulbani and Tikabali-6 each, Bhograi, Keonjhargarh, Altuma, Kamakhya Nagar, Khairamal, Narsinghpur, Bijepur, Komna, Nawarangpur and Dunguripalli-5 each. **JHARKHAND :** Putki-15, Panchet-14, Messanjore-13, Mython-12, Barkisurya-10 and Ranchi-10 each, Jamtara, Maharo and Nand adih-9 each, Sikadia-8, Khesiary, Konner and Tilaiya-7, Tenughat-6, Hindigir, Jamshedpur, Pupunki and Ramgarh-5 each. **CHHATTISGARH:** Anthnagarh-9, Arang-5.

25 SEPTEMBER 2007

GANGETIC WEST BENGAL: Gheropara-22, Barrackpur-19, Sriniketan-18, Kolkata(Alipore)-17, Berhampur-16, Krishnanagar, Kolkata (Dum Dum), Diamond Harbour and Durgachak-15 each, Uluberia-14, Tilpara Barrage-13, Harinkhola-12, Suri-11 and Asansol-11 each, Rampurhat-10, Contai-9, Canning-8, Narayanpur and Midnapore-7, Tantloi, Simulia, Tusuma and Mohanpur-5 each. **ORISSA:** Champua-7, Jhumpura and Tiring-6 each, Laikera-5. **JHARKHAND:** Pupunki-11 and Tilaiya-11 each, Messanjore, Mython and Sikadia-9 each, Barkisurya, Jamshedpur(AP) and Nand adih-8 each, Jamshedpur(City), Konner and Putki-6 each, Maharo-5. **BIHAR:** Munger-17, Sikand arpur-15, Hayaghat-14, Baltara-13, Bhagalpur, Colgaon, Darauli and, Patna-12 each, Sripalpur-11, Khagaria-10 and Rewaghat-10 each, Basua, Hatidah and Samastipur-9 each, Jhanjharpur, Kursela and Lalgang-7 each, Chopan and Palmerganj-6 each, Benibad, Lalbegiaghat and Saulighat-5 each. **CHHATTISGARH:** Sukma-12, Arang-5 and Dondi-5.

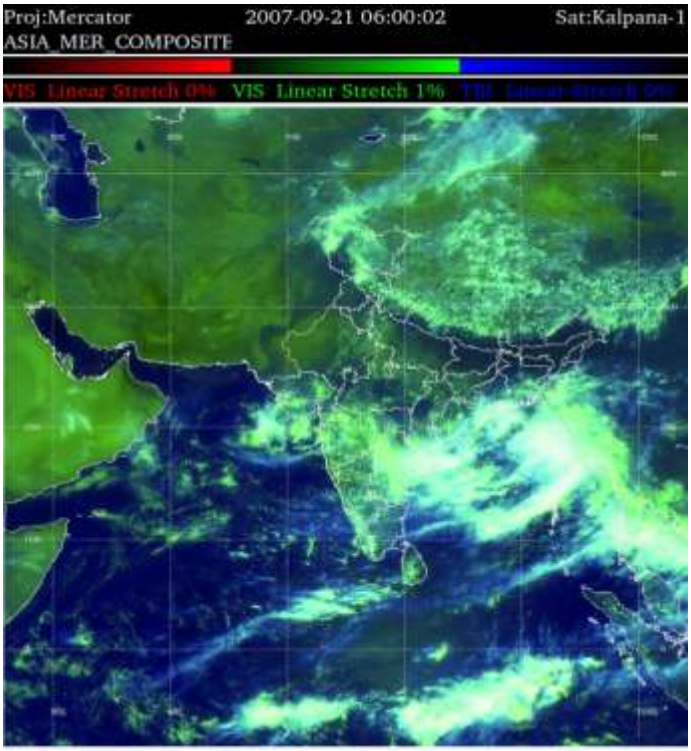
Damage:

About 75 people died (39 in Orissa, 17 in West Bengal, 16 in Bihar, 3 in Andhra Pradesh). Lakhs of people were affected due to floods. Crops over thousands of acres affected and many houses were damaged.

Table-2.9.1
Best track positions and other parameters of depression over northwest Bay of Bengal during 21-24 September, 2007

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
21-09-2007	1200	18.0/86.5	1.5	994	25	4	D
	1500	18.5/86.0	1.5	996	25	4	D
	1800	18.5/86.0	1.5	996	25	4	D
	2100	18.5/86.0	1.5	994	25	4	D
22-09-2007	0000	19.0/86.0	1.5	994	25	4	D
	0300	19.0/86.0	1.5	994	25	4	D
	0600	19.5/86.0	1.5	994	25	4	D
	0900	19.5/86.0	1.5	992	25	4	D
	1200	19.5/86.0	1.5	992	25	4	D
	Depression crossed Orissa coast near Puri between 1300-1400 UTC of 22 September.						
	1500	20.0/86.0	-	992	25	4	D
	1800	20.0/86.0	-	992	25	4	D
	2100	20.5/86.0	-	992	25	4	D
23-09-2007	0000	20.5/86.0	-	990	25	4	D
	0300	20.5/85.5	-	992	25	4	D
	0600	20.5/85.0	-	992	25	4	D
	0900	20.5/85.0	-	990	25	4	D
	1200	21.5/84.5	-	990	25	4	D
	1500	21.5/84.5	-	990	25	4	D
	1800	22.0/84.0	-	992	25	4	D
	2100	22.5/84.0	-	994	25	4	D
24-09-2007	0000	23.0/83.5	-	994	25	4	D
	0300	23.0/83.5	-	998	25	4	D
	0600	23.5/83.0	-	998	25	4	D
	0900	24.0/82.5	-	998	25	4	D
	The system weakened into a well Marked Low pressure area over northeast Madhya Pradesh and adjoining southeast Uttar Pradesh at 1200 UTC.						

(a)



(b)

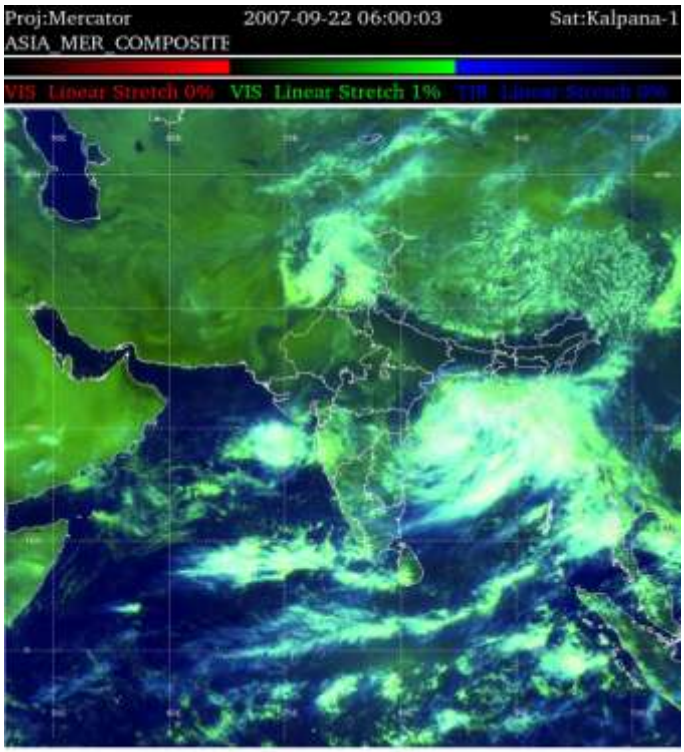
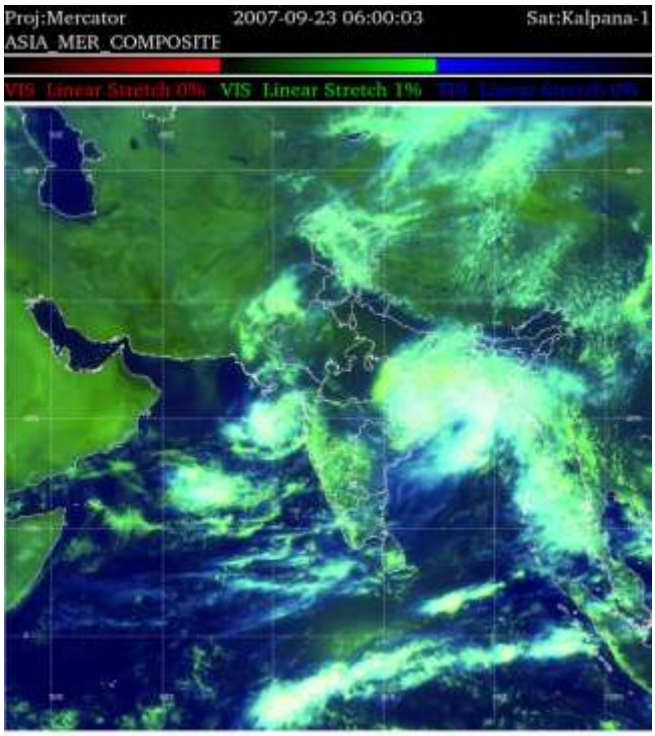


Fig 2.9.1 (a) Satellite KALPANA-1 imagery at 0600 UTC of 21 September, 2007 showing dense cloud mass over northwest Bay of Bengal, Orissa and north Andhra Pradesh in association with the well marked low pressure area over west central Bay of Bengal and (b) Satellite Imagery at 0600 UTC of 22 September showing dense cloud mass with spiral bands in association with the depression centred over northwest Bay of Bengal.

(c)



(d)

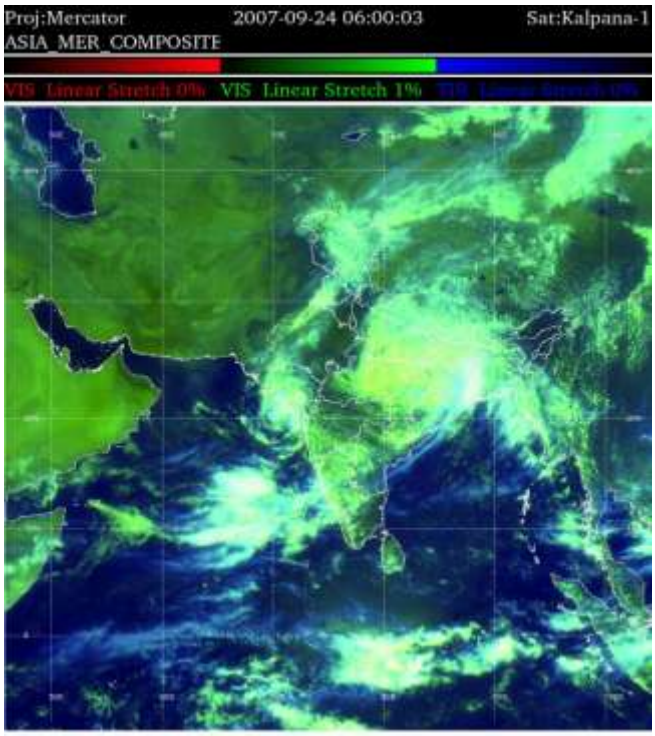


Fig 2.9.1 (c) Satellite KALPANA-1 imagery at 0600 UTC of 23 September, 2007 showing dense cloud mass over Orissa and Chhattisgarh in association with the depression centred over north Orissa and neighbourhood and (d) Satellite Imagery at 0600 UTC of 24 September showing disorganization of cloud mass. The depression weakened into a well marked low pressure area at 1200 UTC of 24 September.

2.10 Depression over the Bay of Bengal during 27-29 October 2007

A low pressure area formed over the westcentral and adjoining southwest Bay of Bengal, under the influence of an active east west shear zone on 25 Oct, 2007. It concentrated into a depression and lay centred at 1800 UTC 27 October over southwest Bay of Bengal near Lat. 11.5^0 N and Long. 85.5^0 E (Fig. 2.1). Moving in a westerly direction it lay centred at 0300 UTC of 28 October near lat. 11.5^0 N long. 84.5^0E. Strong easterly winds in the upper troposphere influenced the system to move in a westerly direction. The system then moved in a west-northwesterly direction and lay centred at 1200 UTC of same day near Lat. 12.5^0 N and 82.0^0 E and at 0000 UTC of 29 October 2007 near Lat. 13.5^0 N and Long. 80.5^0 E, close to Andhra Pradesh coast south of Nellore. At this time, convective cloud mass persisted over the coastal areas of north Tamilnadu and south coastal Andhra Pradesh, where as the centre of the system still lay over sea. Due to rising wind shear, it weakened and lay as a well marked low pressure area over westcentral and adjoining southwest Bay of Bengal, north coastal Tamilnadu and south coastal Andhra Pradesh at 0300 UTC of 29 October 2007.

The best track and other parameters of the system are given in Table 2.10.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.10.1 and Chennai Doppler Weather Radar imageries are shown in Fig. 2.10.2.

Rainfall Realised:

The system caused widespread rainfall with scattered heavy falls. The chief amounts of rainfall (in cm) are given below:

27 October 2007

TAMIL NADU and PUDUCHERRY: Karaikal-7, Nagapttinam-5, Vedaranniyam-3, Puducherry, Chennai (City), Atiramapattinam, Tiruchchirapalli and Coimbatore-2 each, Cuddalore, Vellore and Tuticorin-1 each. **COASTAL ANDHRA PRADESH**: Kavali-7, Nellore-6.

28 October 2007

COASTAL ANDHRA PRADESH: Nellore-2. **RAYALASEEMA:** Tirupathi-3.**TAMIL NADU & PUDUCHERRY:** adurai-6, Karaikal-5, Nagapttinam-3, Chennai (City), Salem and Cuddalore-3 each, Kodaikanal and Tondi-2 each, Puducherry and Vedaranniyam-1 each.

29 October 2007

.**COASTAL ANDHRA PRADESH:** Nellore-22, Kavali-20, RAYALASEEMA: Tirupathi-18, Anantapur-1. **TAMIL NADU & PUDUCHERRY:** Chennai (City)-14, Vellore-9, Puducherry-6, Cuddalore-2, Tondi-1, Atiramapattinam-1, Coimbatore-1.

30 October 2007

COASTAL ANDHRA PRADESH: Kavali-35, Nellore-17, Ongole-5, Bapatla-4, Waltair-2, Narsapur, Machilipattinam and Visakhapatnam-1 each. **RAYALASEEMA**: Tirupathi-4, Anantapur-1.**TAMIL NADU and PUDUCHERRY:** Atiramapattinam, Kannyakumari and Chennai (City)-1 each.

Damage Reported:

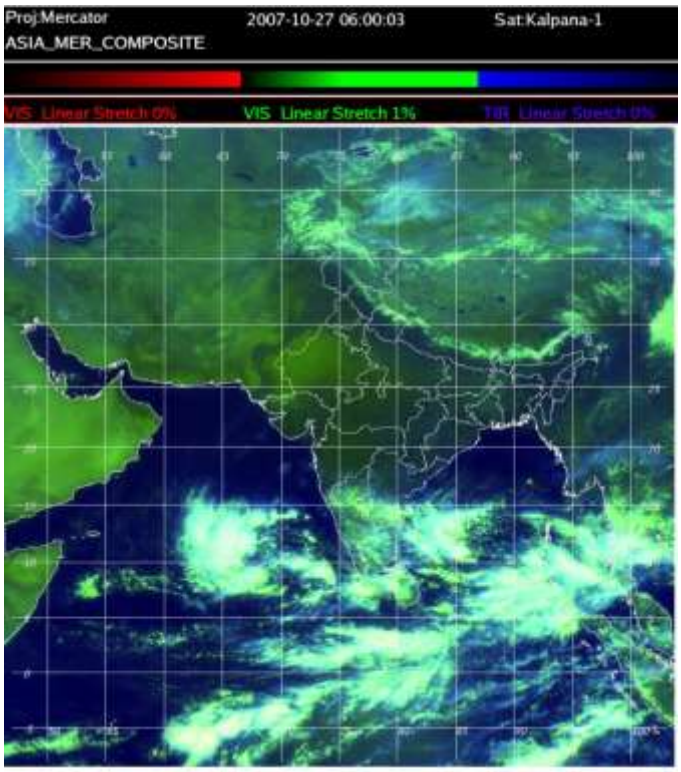
Andhra Pradesh: 18 people lost their lives in Nellore district of coastal Andhra Pradesh. Paddy and other crops over thousands of archers of land were affected. Thousands of houses were either fully / severely damaged. Lakhs of population were affected. Several irrigation projects were overflowed. Roads were washed away. Traffic and transport were disrupted.

Tamilnadu: 8 persons died due to heavy rain and electrocution. Paddy field in 1500 acres were submerged.

Table-2.10.1
Best track positions and other parameters of depression over the southwest Bay of Bengal during 27-29 October, 2007

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
27-10-2007	1800	11.5/85.5	1.5	1006	25	4	D
	2100	11.5/85.5	1.5	1006	25	4	D
28-10-2007	0000	11.5/85.0	1.5	1006	25	4	D
	0300	11.5/84.5	1.5	1004	25	4	D
	0900	12.0/83.5	1.5	1004	25	4	D
	1200	12.5/82.0	1.5	1004	25	4	D
	1500	13.0/82.0	1.5	1004	25	4	D
	1800	13.5/81.5	1.5	1004	25	4	D
	2100	13.5/81.0	1.5	1006	25	4	D
29-10-2007	0000	13.5/80.5	1.5	1006	25	4	D
	The system weakened into a well marked low pressure area over westcentral and adjoining southwest Bay of Bengal, north coastal Tamilnadu and south coastal Andhra Pradesh at 0300 UTC.						

(a)



(b)

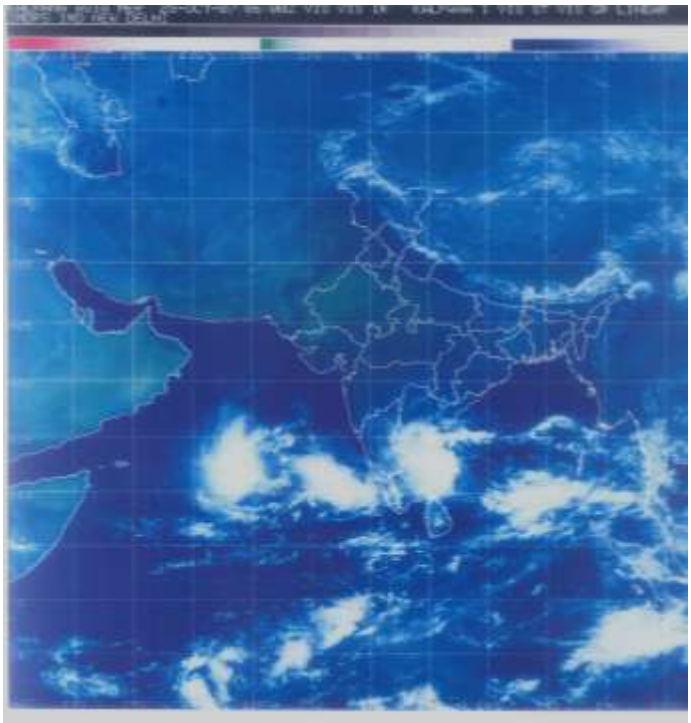
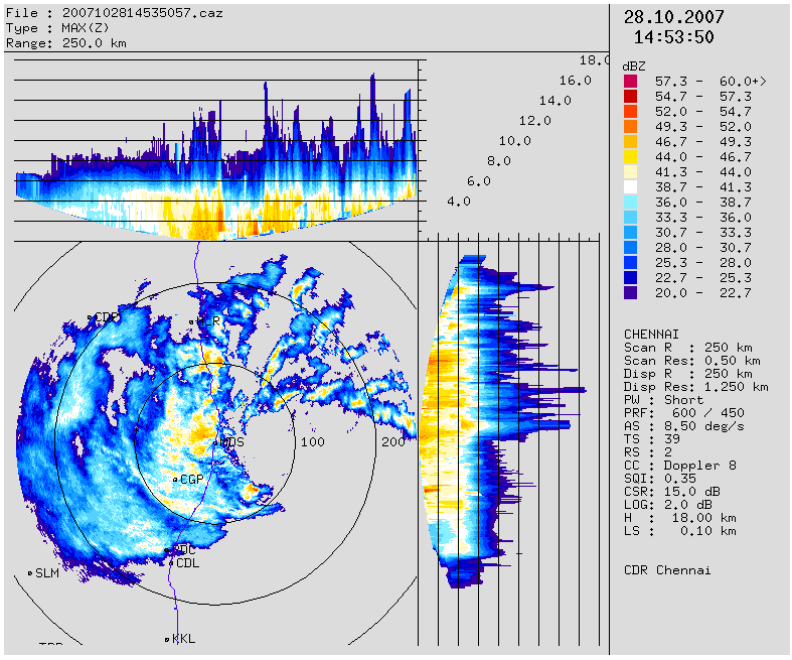


Fig 2.10.1(a) Satellite KALPANA-1 imagery at 0900 UTC of 27 October, 2007 showing organization of convective cloud clusters over southeast Bay of Bengal in association with the persisting low pressure area over southwest Bay of Bengal and (b) Satellite Imagery at 0600 UTC of 28 October showing dense convective clouds in association with the depression over southwest Bay of Bengal.

(a)



(b)

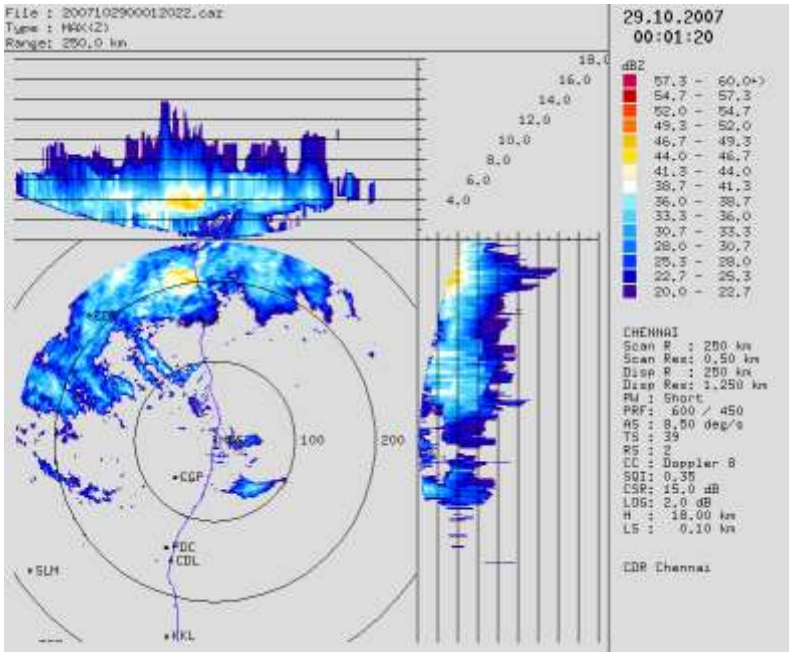


Fig 2.10.2. Chennai Doppler Weather Radar imageries at (a) 14:53:50 UTC of 28 October, 2007 and (b) 00:01:20 UTC of 29 October, 2007.

2.11 Deep depression over the Arabian sea during 27 October to 2 November 2007

A cloud cluster persisted 3 to 4 days prior to development of a low pressure area on 26 October 2007 over southeast Arabian Sea. This low pressure area concentrated into a depression at 1800 UTC of 27 October 2007 over southeast Arabian Sea near lat. 10.5^0 N and long. 66.5^0 E (Fig. 2.1) about 600 kms west of Agati (Lakshadip). The genesis took place at the same time over the same latitudinal belt where the depression developed over southwest Bay of Bengal. Remaining practically stationary, the depression over the southeast Arabian sea intensified into deep depression at 0300 UTC of 28 October 2007. Initially the deep depression moved in a northwesterly direction and lay centred near lat. 11.5^0 N and long. 66.0^0E at 1200 UTC of 28 October. Then, it moved in a westerly direction till 0900 UTC of 31 October 2007. It moved then in west-northwesterly direction. As the system entered into the area of colder sea surface temperature and higher vertical wind shear, it weakened into a depression and lay centred at 0300 UTC of 2nd November over westcentral and adjoining southwest Arabian Sea. It further weakened and lay as a well marked low pressure area over westcentral and adjoining southwest Arabian Sea at 1200 UTC of 2 November 2007.

The best track and other parameters are given in Table 2.11.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.11.1 and Chennai Doppler Radar Images Fig. 2-11.2 (a&b).

Rainfall Realised:

The system caused widespread rainfall with scattered heavy falls. The chief amounts of rainfall (in cm) are given below:

27 October 2007:
KERALA : Kozhikode-6, Kannur -1 **LAKSHADWEEP:** Minicoy-1

28 October 2007:
COASTAL KARNATAKA: Honavar-2, **KERALA:** Karipur-8, Kozhikode-5, Nedumbassery-3,Alappuzha-1. **LAKSHADWEEP:** Minicoy-2, Amini Divi-1, Agathi-1.

29 October 2007:
KERALA: Nedumbassery-6, Alappuzha-3 and Kochi-3 each, Kannur, Karipur and Kozhikode-2 each. **LAKSHADWEEP:** Agathi-7, Minicoy-4, Amini Divi-3.

30 October 2007: .
KERALA: Nedumbassery-6, Kochi-4, Thiruvananathapuram (City)-3, Thiruvananathapuram (AP), Alappuzha and Karipur-2 each, Kozhikode-1, **LAKSHADWEEP:** Agathi-7, Minicoy-4, Amini Divi-3.

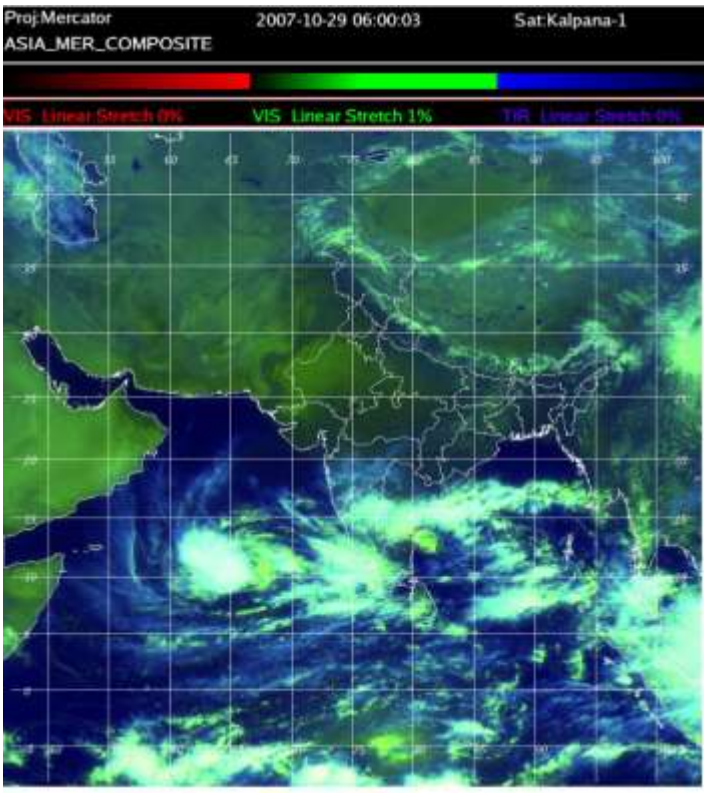
Damage Reported: Nil

Table-2.11.1

Best track positions and other parameters of deep depression over southwest Arabian Sea 27 October to 2 November, 2007

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
27-10-2007	1800	10.5/66.5	1.5	1006	25	4	D
	2100	10.5/66.5	1.5	1006	25	4	D
28-10-2007	0000	10.5/66.5	1.5	1006	25	4	D
	0300	10.5/66.5	2.0	1004	30	5	DD
	0900	11.0/66.5	2.0	1004	30	5	DD
	1200	11.5/66.0	2.0	1004	30	5	DD
	1500	11.5/66.0	2.0	1004	30	5	DD
	1800	11.5/66.0	2.0	1004	30	5	DD
	2100	11.5/66.0	2.0	1004	30	5	DD
29-10-007	0000	11.5/66.0	2.0	1004	30	5	DD
	0300	11.5/65.5	2.0	1002	30	5	DD
	0600	11.5/65.5	2.0	1002	30	5	DD
	0900	11.5/65.5	2.0	1002	30	5	DD
	1200	11.5/65.5	2.0	1002	30	5	DD
	1500	11.5/65.5	2.0	1002	30	5	DD
	1800	11.5/65.5	2.0	1002	30	5	DD
	2100	11.5/65.5	2.0	1002	30	5	DD
30-10-2007	0000	11.5/65.5	2.0	1002	30	5	DD
	0300	11.5/65.5	2.0	1002	30	5	DD
	0600	11.5/65.5	2.0	1002	30	5	DD
	0900	11.5/65.5	2.0	1002	30	5	DD
	1200	11.5/65.0	2.0	1002	30	5	DD
	1500	11.5/64.5	2.0	1002	30	5	DD
	1800	11.5/64.5	2.0	1002	30	5	DD
	2100	11.5/64.5	2.0	1002	30	5	DD
31-10-2007	0000	11.5/64.5	2.0	1000	30	5	DD
	0300	11.5/64.0	2.0	1000	30	5	DD
	0600	11.5/64.0	2.0	1000	30	5	DD
	0900	11.5/63.5	2.0	1002	30	5	DD
	1200	12.0/63.0	2.0	1002	30	5	DD
	1500	12.0/63.0	2.0	1002	30	5	DD
	1800	12.5/62.5	2.0	1002	30	5	DD
	2100	12.0/62.0	2.0	1002	30	5	DD
01-11-2007	0000	13.5/61.5	2.0	1002	30	5	DD
	0300	14.0/60.5	2.0	1002	30	5	DD
	0600	14.0/60.0	2.0	1002	30	5	DD
	0900	14.0/59.5	2.0	1002	30	5	DD
	1200	14.5/58.5	2.0	1002	30	5	DD
	1500	14.5/58.0	2.0	1002	30	5	DD
	1800	14.5/57.5	2.0	1002	30	5	DD
	2100	14.5/57.0	2.0	1002	30	5	DD
02-11-2007	0000	14.5/57.0	2.0	1002	30	5	DD
	0300	14.5/56.5	1.5	1004	25	4	D
	0600	14.5/56.5	1.5	1004	25	4	D
	0900	15.0/56.0	1.5	1004	25	4	D
	The depression weakened into a well marked low pressure area over westcentral and adjoining southwest Arabian sea at 1200 UTC.						

(a)



(b)

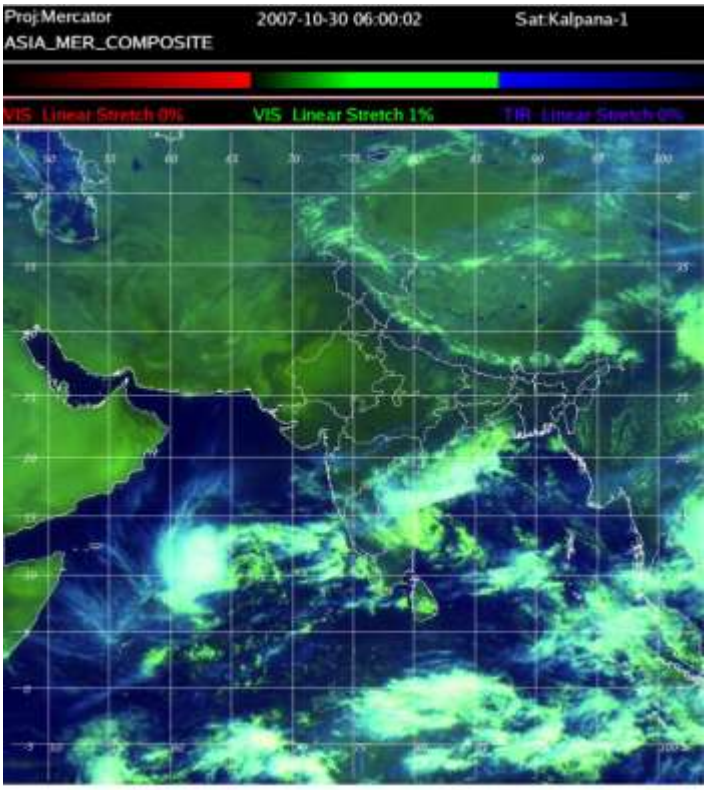
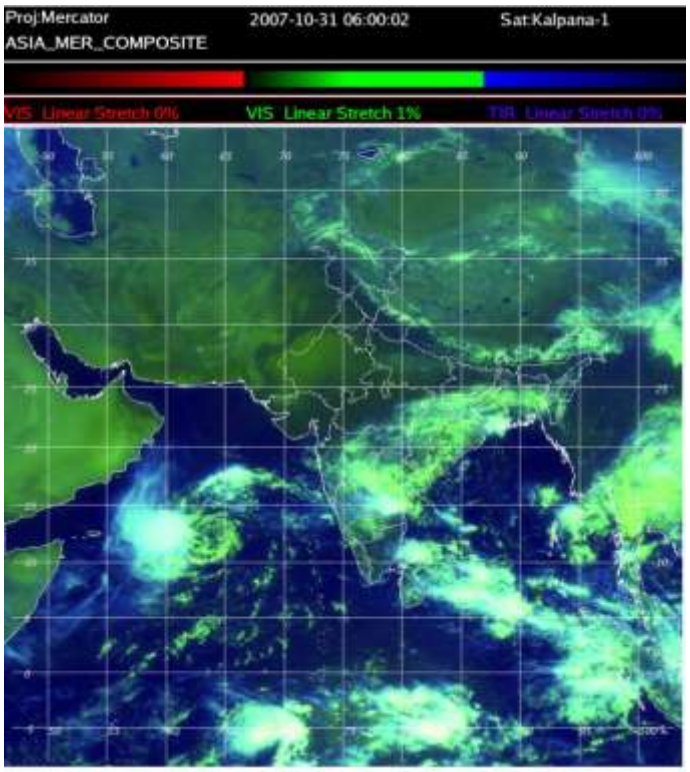


Fig 2.11.1 (a) Satellite KALPANA-1 imagery at 0900 UTC of 29 October, 2007 showing dense convective cloud over southwest Arabian Sea in association with the deep depression and (b) Satellite Imagery of 0600 UTC of 30 October showing dense cloud mass ahead of the system centre.

(c)



(d)

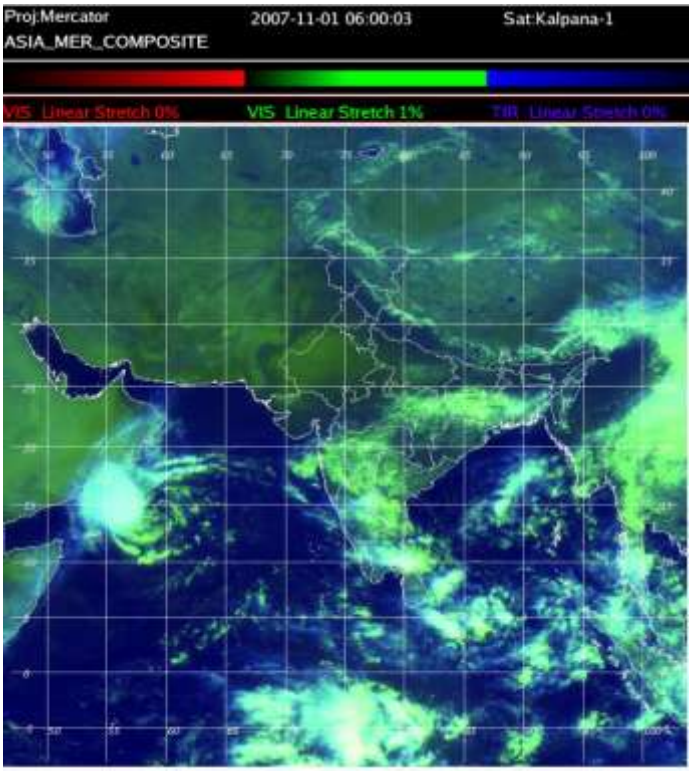
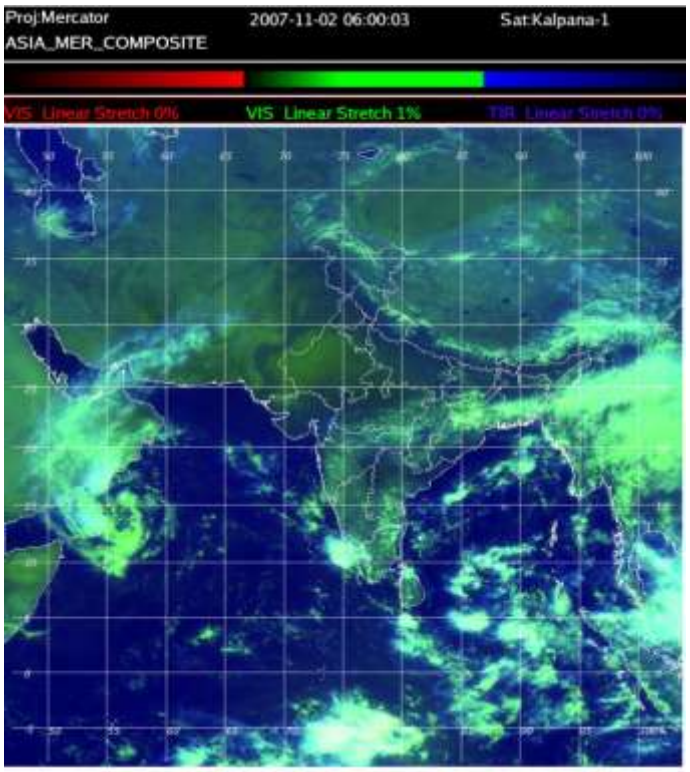


Fig 2.11.1 (c) Satellite KALPANA-1 imagery at 0600 UTC of 31 October, 2007 showing dense convective cloud mass west of the deep depression and (d) Satellite Imagery at 0600 UTC of 1 November showing dense convective cloud over Oman coast ahead of the centre of the deep depression.

(e)



(f)

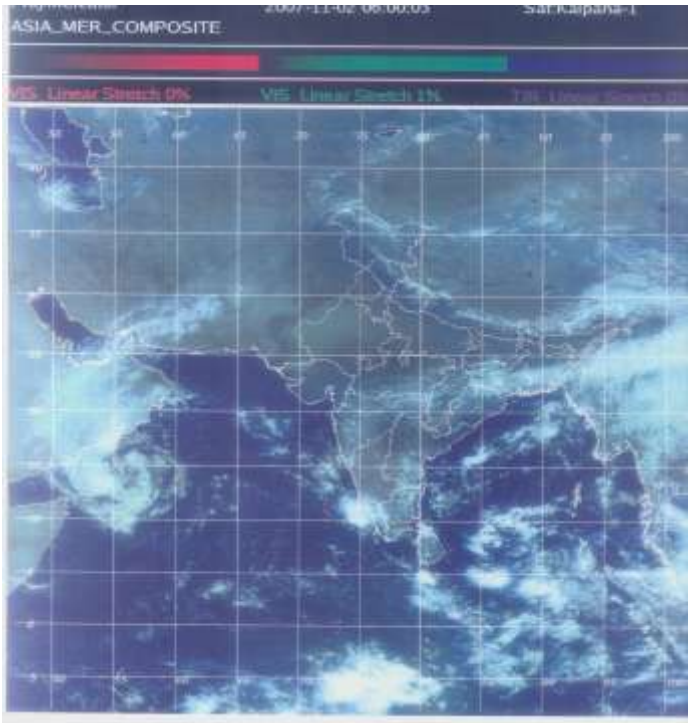


Fig 2.11.1 (e) Satellite KALPANA-1 imagery at 0600 UTC of 2 November, 2007 showing weakening of the system due to shearing and convection with cloud mass and (f) Satellite Imagery at 0900 UTC of 2 November showing further weakening of the system over sea near southeast coast of Oman.

2.12.1 Very severe cyclonic storm 'SIDR' over the Bay of Bengal during 11-16 November 2007

An upper air cyclonic circulation lay over southeast Bay of Bengal and adjoining area of south Andaman sea during 8-10 November 2007. Initially moderate to high vertical wind shear inhibited organisation, while strong diffluence aloft aided in developing convection. During this period easterly wave was also active. The vertical wind shear over the region decreased gradually and the circulation became more defined. Under the influence of these scenarios, a low pressure area formed at 0300 UTC of 11 November over southeast Bay of Bengal and neighbourhood. It concentrated into a depression and lay centred at 0900 UTC of the same day over southeast Bay of Bengal near lat. 10.0^0 N and long. 92^0E, about 200 km south-southwest of Port Blair (Fig. 2.1). Moving slightly northwestwards it intensified into a deep depression and lay centred at 1800 UTC of 11 November near lat. 10.5^0 N and 91.5^0 E. It intensified into a cyclonic storm, **"SIDR"** and lay centred at 0300 UTC of 12 November near lat. 10.5^0 N & 91.0^0 E, about 220 km southwest of Port Blair. It moved in the northwesterly direction, further intensified into severe cyclonic storm and lay centred at 1200 UTC of the same day near lat. 11.5^0 N and long. 90.0^0 E. It remained practically stationary then and intensified into a very severe cyclonic storm at 1800 UTC of 12 November. The system moved slightly northwestwards thereafter till 0000 UTC of 13th. Afterwards, the system moved in a near northerly direction upto 1200 UTC of 15 November. From 1200 UTC of 15 November, the system recurved and moved in a north-northeasterly direction, under the influence of the upper tropospheric trough to the west of the system centre as the system lay to the north of upper tropospheric ridge. It crossed west Bangladesh coast around 1700 UTC near longitude 89.8^0 E as a very severe cyclonic storm and lay centred at 1800 UTC near lat. 22.5^0 N and long 90.5^0 E, about 100 km south of Dhaka (Bangladesh). The system then weakened rapidly into a cyclonic storm while moving northeastwards and lay centred at 2100 UTC of 15 November near lat 23.5^0 N and long. 91.0^0 E, about 70 km southwest of Agartala (42724). It further weakened into a depression and lay centred at 0300 UTC of 16 November near lat. 24.5^0 N and long. 91.5^0 E, about 50 km north of Agartala. It lay as a well marked low pressure area over northeastern states of India at 1200 UTC of 16 November. The best track and other parameters of the system are given in Table 2.12.1. A few KALPANA-1 cloud imageries of the system are shown in Fig. 2.12.1.

The system could be tracked with Radar from 0300 UTC of 15 November. CDR Paradip observations of the system are given in Table-2.12.2.

Doppler weather radar at Kolkata also tracked the system. The DWR Kolkata observations of the system are given in Table 2.12.3. A few DWR imageries of DWR Kolkata are shown in Fig.. 2.12.2

The vertical wind shears of horizontal winds at 0000 UTC of 11-16 November 2007 according to LAM analyses are shown in Fig. 2.12.3.

Table-2.12.1

Best track positions and other parameters for Very Severe Cyclonic Storm "SIDR" over the Bay of Bengal during 11-16 November, 2007

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
11-11-2007	0900	10.0/92.0	1.5	1004	25	4	D
	1200	10.0/92.0	1.5	1004	25	4	D
	1500	10.0/92.0	1.5	1004	25	4	D
	1800	10.5/91.5	2.0	1002	30	5	DD
	2100	10.5/91.5	2.0	1002	30	5	DD
12-11-07	0000	10.5/91.5	2.0	1002	30	5	DD
	0300	10.5/91.0	2.5	1002	35	6	CS
	0600	11.0/90.5	3.0	998	40	10	CS
	0900	11.0/90.5	3.0	996	45	12	CS
	1200	11.5/90.0	3.5	992	55	16	SCS
	1500	11.5/90.0	3.5	992	55	16	SCS
	1800	11.5/90.0	4.0	986	65	20	VSCS
	2100	11.5/90.0	4.5	980	80	29	VSCS
13-11-07	0000	12.0/89.5	5.0	968	90	40	VSCS
	0300	12.0/89.5	5.0	968	90	40	VSCS
	0600	12.0/89.5	5.0	968	90	40	VSCS
	0900	13.0/89.5	5.0	964	90	40	VSCS
	1200	13.0/89.5	5.0	964	90	40	VSCS
	1500	13.0/89.5	5.0	964	90	40	VSCS
	1800	13.5/89.5	5.0	964	90	40	VSCS
	2100	14.0/89.5	5.0	964	90	40	VSCS
14-11-07	0000	14.5/89.5	5.0	964	90	40	VSCS
	0300	14.5/89.5	5.0	964	90	40	VSCS
	0600	15.0/89.5	5.0	964	90	40	VSCS
	0900	15.5/89.5	5.0	964	90	40	VSCS
	1200	16.0/89.0	5.0	964	90	40	VSCS
	1500	16.0/89.0	5.0	964	90	40	VSCS
	1800	16.5/89.0	5.5	956	105	55	VSCS
	2100	17.0/89.0	5.5	956	105	55	VSCS
15-11-07	0000	17.5/89.0	5.5	956	105	55	VSCS
	0300	18.0/89.0	6.0	944	115	66	VSCS
	0600	19.5/89.0	6.0	944	115	66	VSCS
	0900	20.0/89.0	6.0	944	115	66	VSCS
	1200	21.0/89.0	6.0	944	115	66	VSCS
	1500	21.5/89.5	6.0	944	115	66	VSCS
	VSCS crossed Bangladesh coast near long. 89.8^0 E around 1700 UTC of 15 November, 2007						
	1800	22.5/90.5	-	-	-	-	VSCS
	2100	23.5/91.0	-	-	-	-	CS
16-11-2007	0000	23.5/91.0	-	-	-	-	CS
	0300	24.5/91.5	-	-	-	-	D

Table-2.12.2

Radar observations by CDR, Paradip

Date/Time(UTC) Of observations	Lat.N/Long. E	Character	Radius of eye Kms.	Azimuth of the storm centre/ Range from Station
15/0300	19.0/89.3	Spiral	--	115deg/300km
15/0600	19.7/89.3	Eye	18	103deg/265km
15/0700	19.8/89.3	Eye	18	097deg/260km
15/0900	20.3/89.6	Eye	20	087deg/280km
15/1100	21.3/89.6	Eye	14	072deg/315km
15/1200	21.5/89.6	Eye	18	065deg/315km
15/1400	21.8/89.5	Spiral	--	058deg/330km
15/1500	22.0/89.5	spiral	--	054deg/340km

Table 2.12.3

Radar observations of Doppler Weather Radar, Kolkata on 15 November 2007

Date Time (UTC) of observations	Centre Lat.^{0} N/Long.^{0} E	Diameter of EYE (Kms)	Thickness of Eye wall(Kms)	Estimated Wind speed m/s
5:34:00	19.16/89.1	33	14	-
6:10:00	19.27/89.2	29	19	-
7:04:00	19.43/89.31	29	11	-
8:00:00	19.56/89.5	26	14	39
9:00:00	20.12/89.1	21	18	39
10:00:00	20.26/89.15	24	21	43
11:00:00	20.43/89.21	20	24	45
12:00:00	20.59/89.27	26	25	45
12:58:00	21.16/89.31	24	27	51
13:58:00	21.31/89.38	21	34	51
14:58:00	21.44/89.43	24-	32	51
15:58:00	21.55/89.48	-	-	51
16:58:00	22.30/89.97	-	-	-

Weather Realised:

Andaman & Nicobar Island received significant amount of rainfall during 11-14 November 2007. The system caused heavy to very heavy rainfall over northeastern states of India. It caused heavy to very heavy rainfall over Bangladesh. The chief amount of rainfall (in cm) are given below:

11 NOVEMBER

ANDAMAN & NICOBAR ISLANDS: Carnicobar-18, Port Blair-11, Hut Bay-8, Long Island -3, Nancowry-1,

12 NOVEMBER

ANDAMAN & NICOBAR ISLANDS: Long Island -7, Carnicobar-6, Port Blair-4, Mayaband ar-3, Hut Bay-2 and Nancowry-2 each.

13 NOVEMBER
ANDAMAN & NICOBAR ISLANDS: Hut Bay-1.

14 NOVEMBER
ANDAMAN & NICOBAR ISLANDS: Mayabandar, Port Blair and Carnicobar-2 each, Hut Bay-1.

15 NOVEMBER
NAGALAND, MANIPUR, MIZORAM & TRIPURA: Imphal and Lengpui-3 each, Kailashahar and Agartala-2 each

16 NOVEMBER
ASSAM and MEGHALAYA: Cherrapunji-15, Shillong-14, Silchar-3, Guwahati-2, Lumding and Jorhat-1 each. **NAGALAND , MANIPUR, MIZORAM & TRIPURA:** Agartala-10, Kailashahar-6, Kohima-5, Imphal and Lengpui-1. **GANGETIC WEST BENGAL:** Canning-5, Haldia-1, Kolkata(Dum Dum)-1.

17 NOVEMBER

ARUNACHAL PRADESH: Ziro, Bhalukpong and Bomdila-1 each. **ASSAM & MEGHALAYA:** Cherrapunji-6, Silchar-4,Lumding-3, Shillong-2, Golaghat and Margherita-2 each, Dibrugarh, Tezpur, North Lakhimpur, Jorhat, Khowang, Numaligarh, Neamatighat, Bokajan,Badatighat, Chouldhoaghat, Dharamtul, Kampur,Sibsagar and Dhollabazar-1 each. **NAGALAND, MANIPUR, MIZORAM & TRIPURA:** Kohima and Kailashahar-1 each.

STRONG WIND: A station in coastal Bangaladesh reported 80 knots at 1800 UTC of 15 November 2007. According to media report, the wind speed of about 200 kmph prevailed over Bangladesh coast at the time of landfall.

STORM SURGE: According to media report Tidal wave of about 6 meters inundated low lying areas of Bangladesh
.

DAMAGE REPORTED:

INDIA :

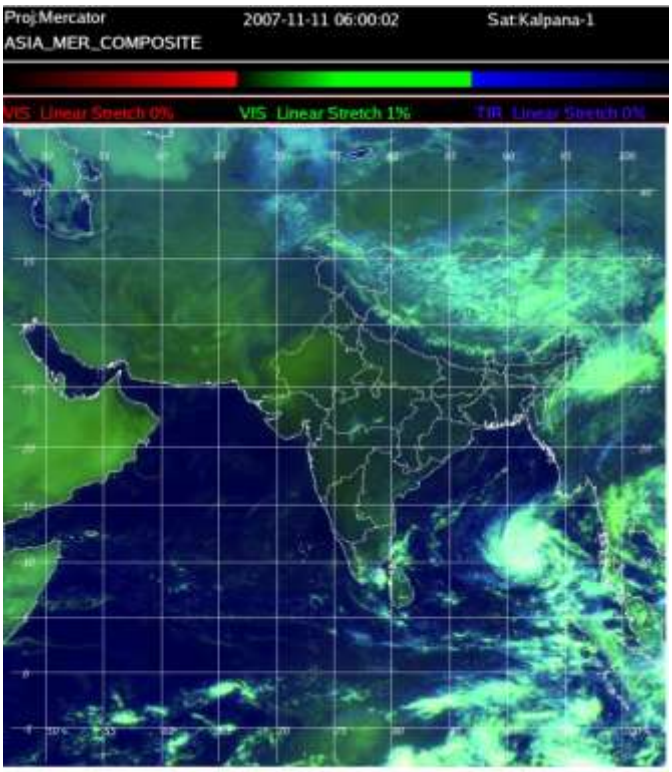
One person died, 46 villages and thousands of people affected in West Bengal. Crops were damaged in thousands of hectares of land. There was disruption of electricity supply in the costal belt of West Bengal due to breaking of dam over Bidyadhari river. Extensive areas were flooded near Gajikhali and Kheaghat. Some houses were partially / totally damaged in Mizoram. Guwahati-Shillong road was also affected at several places.

BANGLADESH :

According to media reports, the following damages occurred over Bangladesh.

No. of human deaths : 3363
People missed :871
No. of people affected : 8923259
Family affected : 2064026
House damaged :1522077
Crops damaged : 2473639 acre
Trees destroyed : 4065316

(a)



(b)

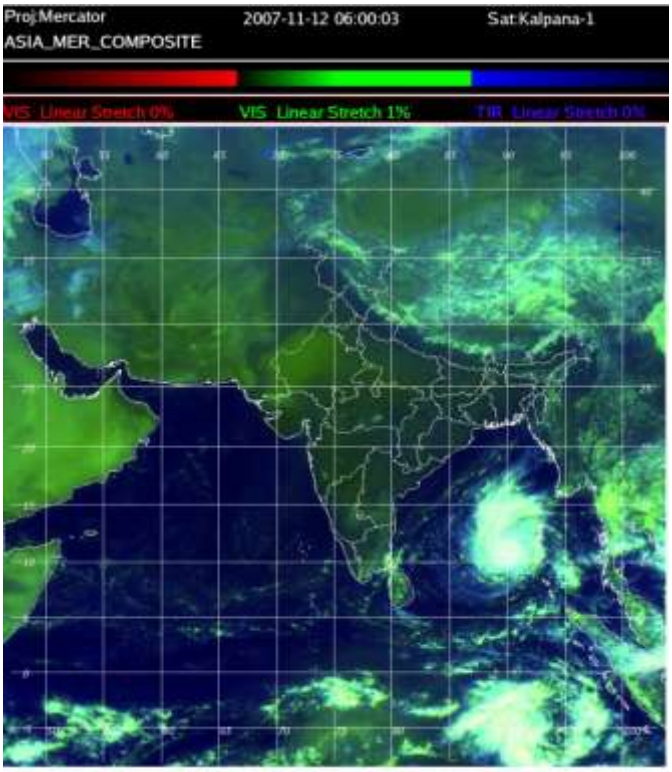
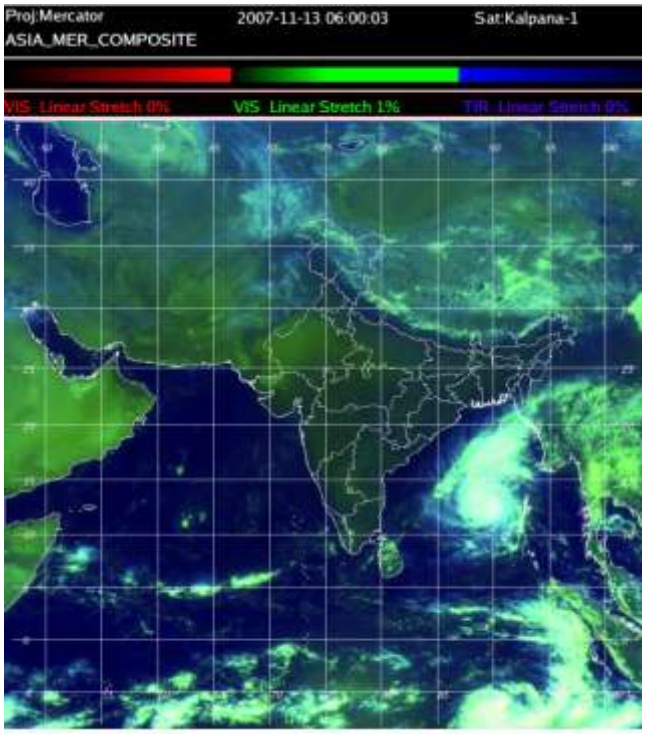


Fig 2.12.1 (a) Satellite KALPANA-1 imagery at 0600 UTC of 11 November, 2007 showing the development of convective clouds over southeast Andaman sea in association with the low pressure are (b) Satellite Imagery at 0600 UTC of 12 November showing well organized convective clouds over east central and adjoining southeast Bay of Bengal in association with the cyclonic storm over southeast Bay of Bengal.

(c)



(d)

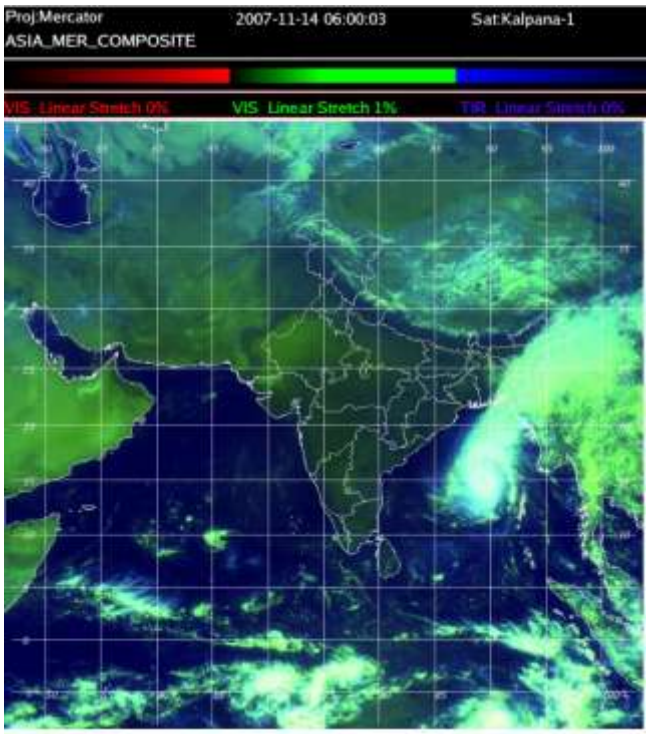
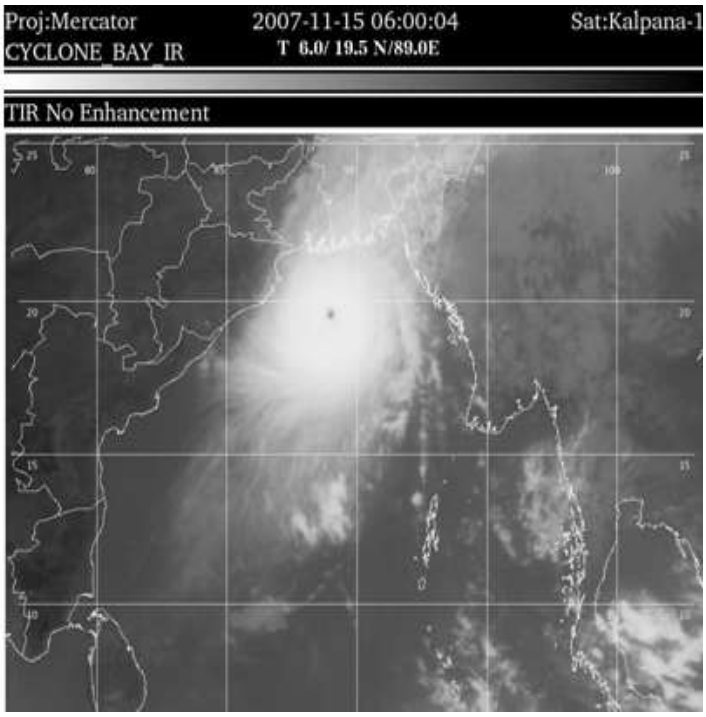


Fig 2.12.1 (c) Satellite KALPANA-1 imagery at 0600 UTC of 13 November 2007 showing CDO pattern over east central Bay Of Bengal and (d) Satellite Imagery at 0600 UTC of 14 November showing CDO pattern with banding features over eastcentral and adjoining westcentral Bay of Bengal.

(e)



(f)

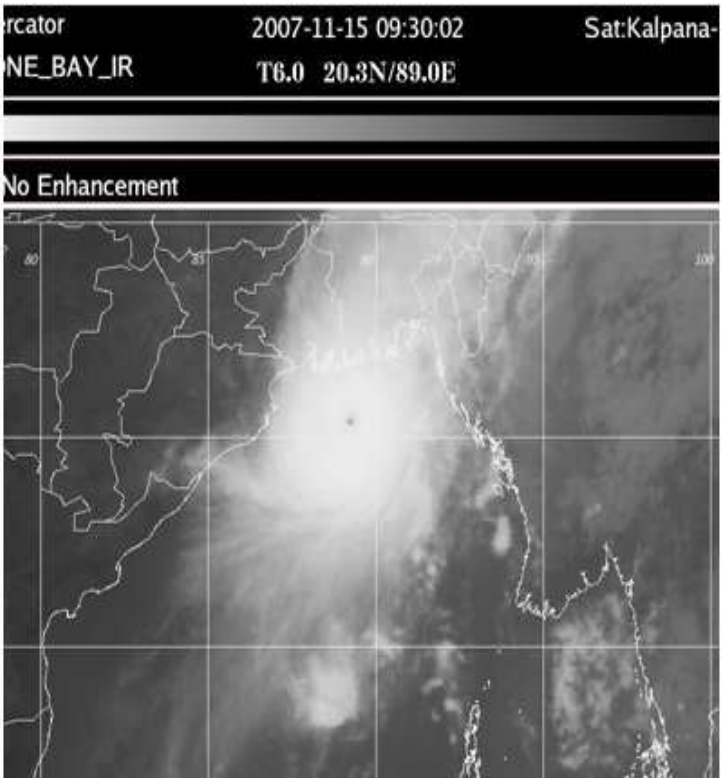
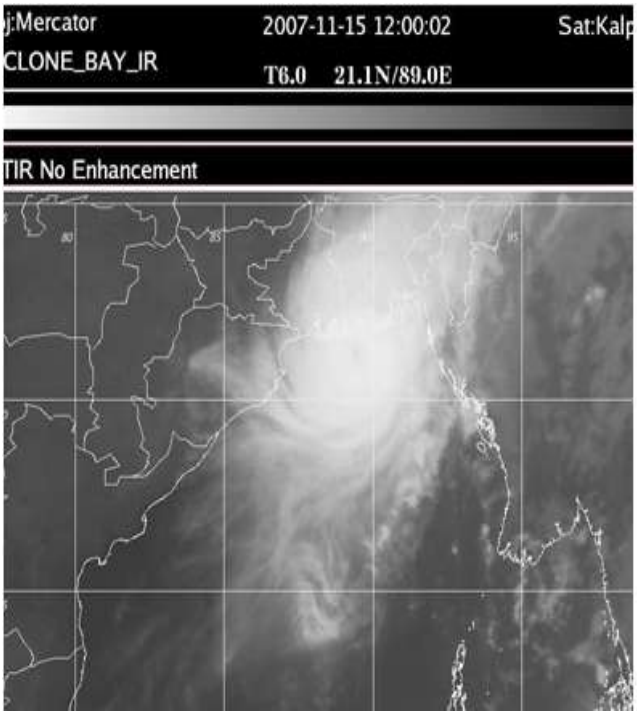


Fig 2.12.1 Satellite KALPANA-1 imagery (e) at 0600 UTC and (f) at 0900 UTC of 15 November showing open EYE and feeding bands and of 15 November 2007 showing “EYE” of very severe cyclonic storm.

(g)



(h)

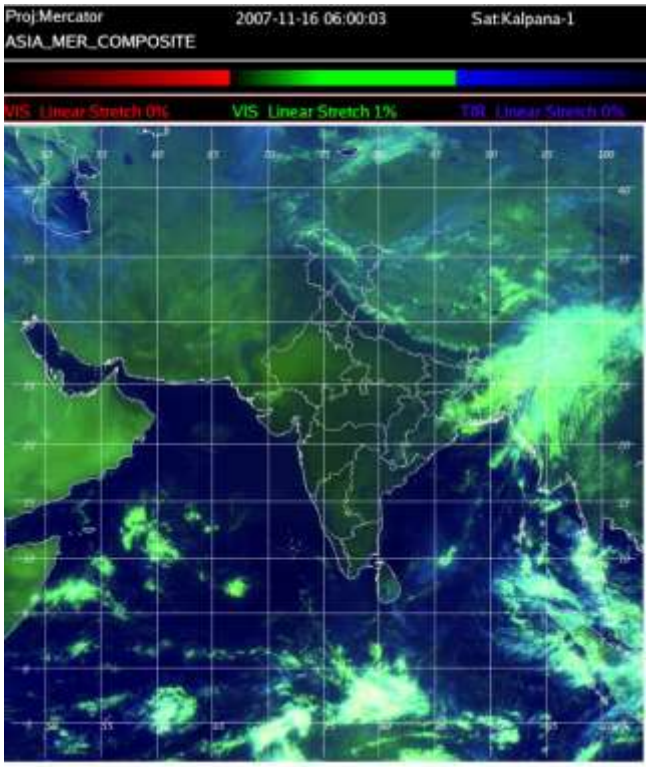


Fig 2.12.1 (g) Satellite KALPANA-1 at 1200 UTC of 15 November showing system centre over the sea and half of the convective cloud mass lying over the land areas and (h) Satellite KALPANA-1 imagery at 0600 UTC of 16 November showing weakening of the system as the convective cloud mass lay oriented from northeast to southwest.

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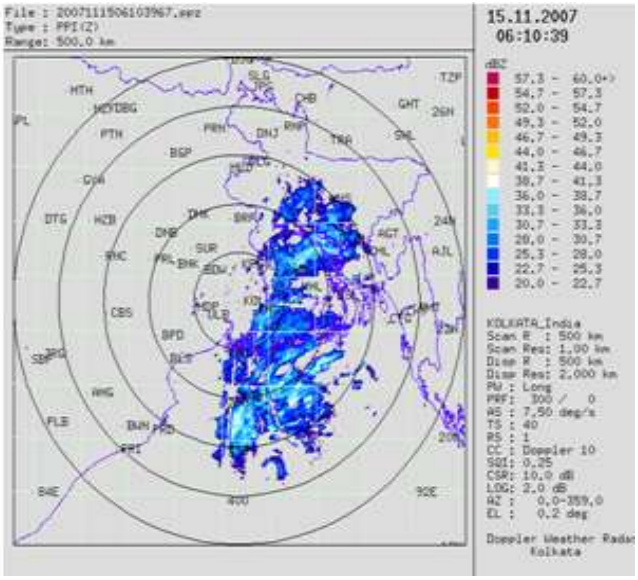
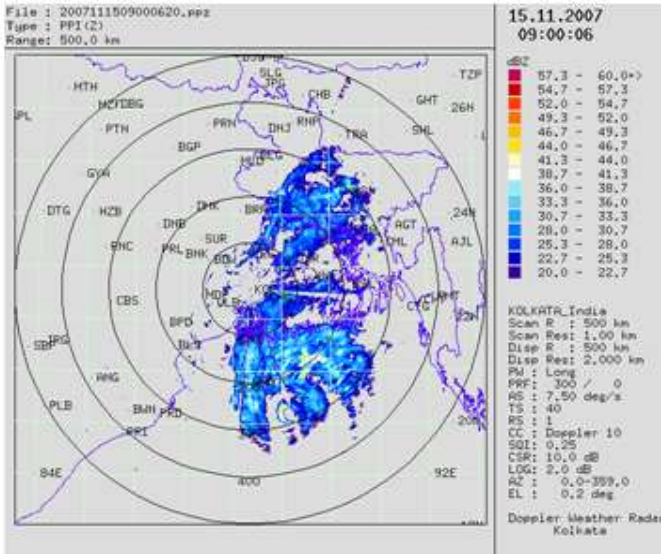
(a)



(b)



(c)

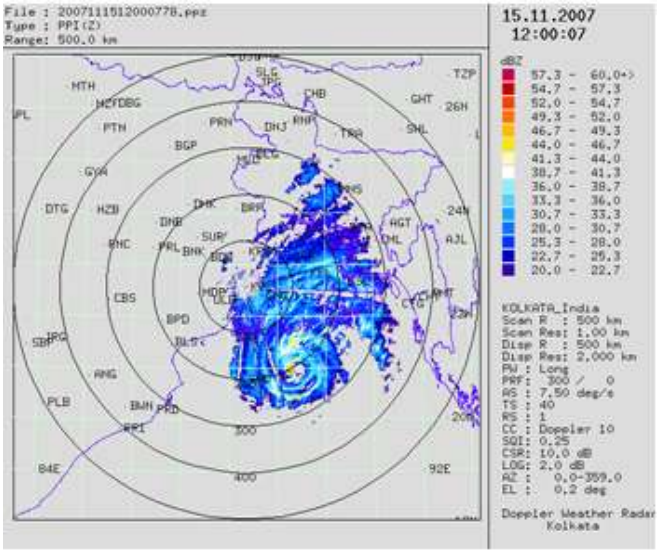
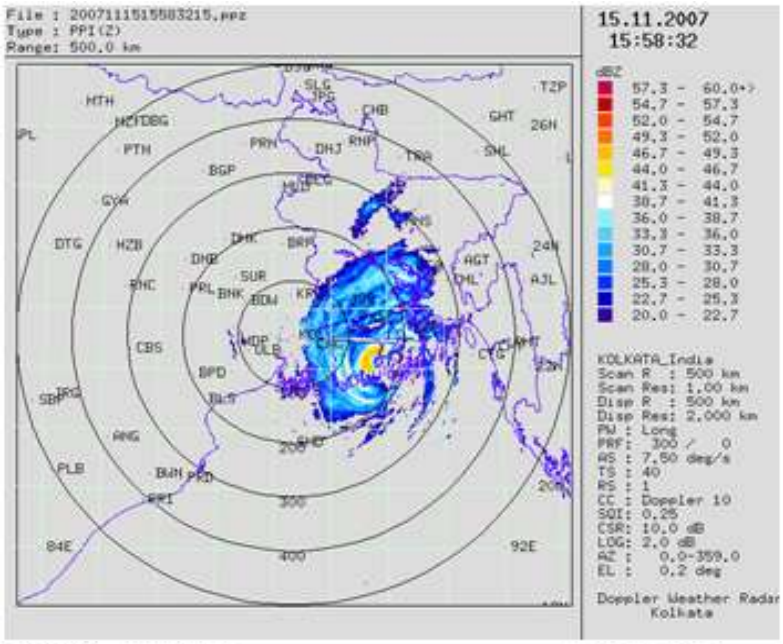


Fig 2.12.2 Kolkata Doppler Weather Radar imageries at (a) 06:10:39 UTC (b) 09:00:06 UTC and (c) at 12:00:07 UTC of 15 November 2007.

(d)



(e)

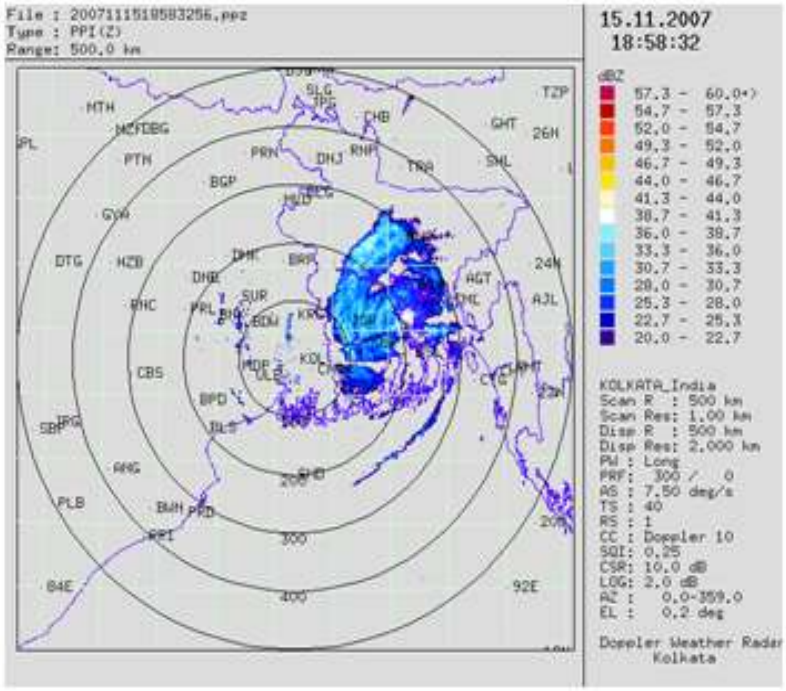
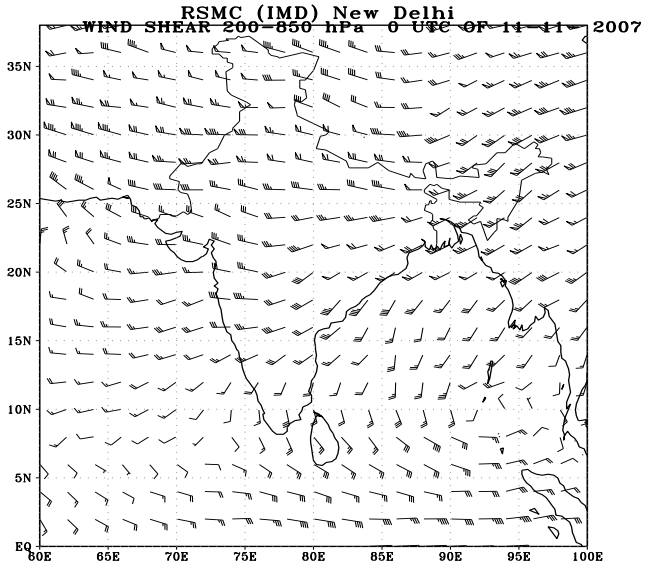
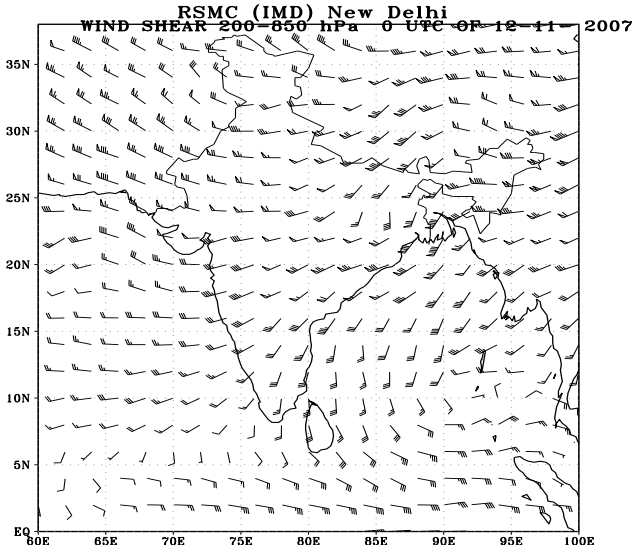


Fig 2.12.2 Kolkata Doppler Weather Radar imageries at (d) 15:58:32 UTC and (e) 18:58:32 UTC of 15 November 2007.

(a)



(b)



(c)

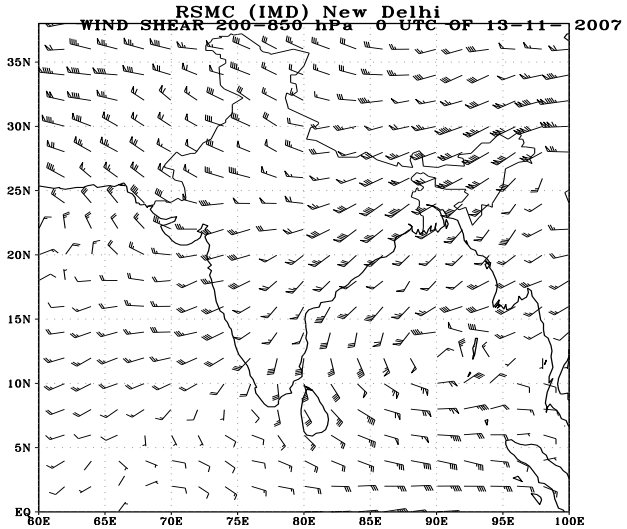
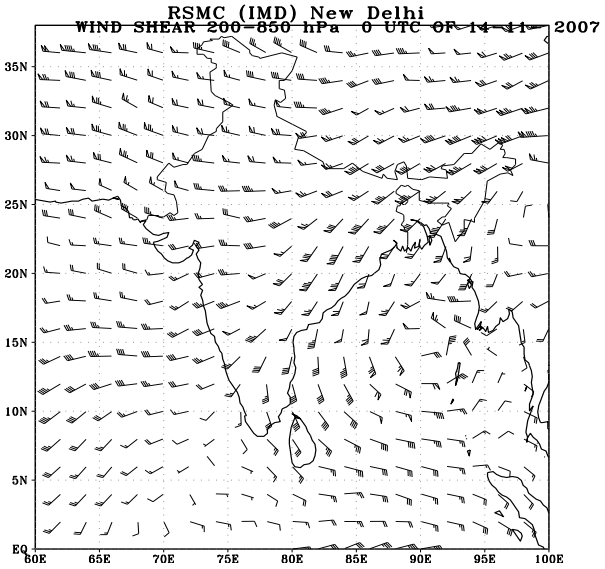
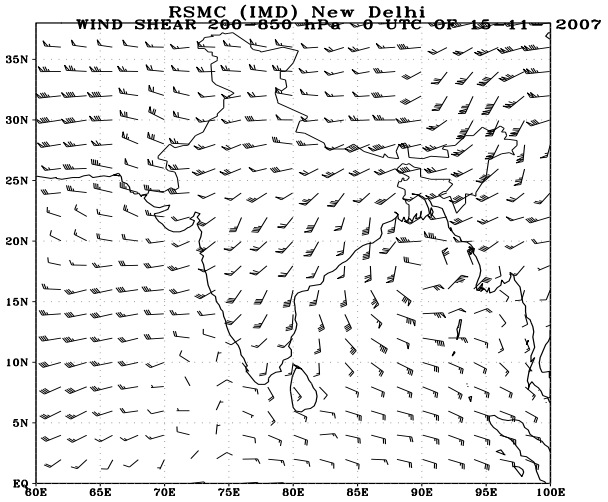


Fig. 2.12.3 Vertical wind shear of horizontal wind (kt) at 00 UTC of (a) 11, (b) 12 and (c) 13 November 2007

(d)



(e)



(f)

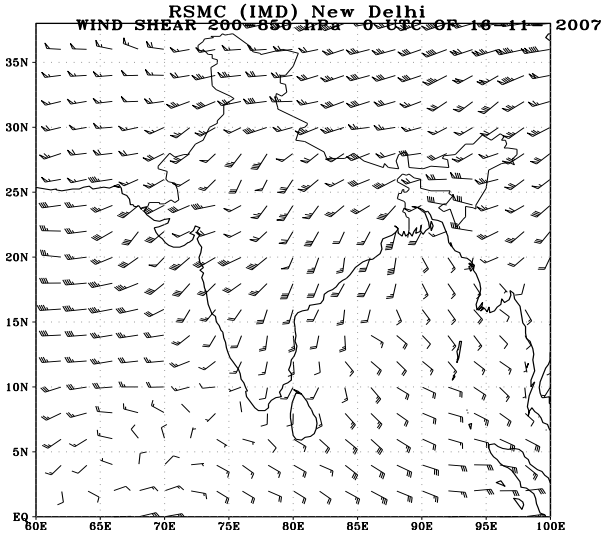


Fig. 2.12.3 (contd) Vertical wind shear of horizontal wind (kt) at 00 UTC of (a) 14, (b) 15 and (c) 16 November 2007

Chapter – III

Track prediction by Numerical Weather prediction (NWP)

3.1 Introduction

IMD operationally runs three regional models, Limited Area Model (LAM), MM5 model and Quasi-Lagrangian Model (QLM) for short range prediction. The MM5 model is run at the horizontal resolution of 45 km with 23 sigma levels in the vertical and the integration is carried upto 72 hours over a single domain covering the area between lat. 30 ^{o} S to 45 ^{o} N long 25 ^{o} E to 125 ^{o} E. Initial and boundary conditions are obtained from the NCEP Global Forecast System (NCEP GFS) readily available on the Internet at the resolution of 1 ^{o} x1 ^{o} lat./long. The boundary conditions are updated at every six hourly interval. The LAM is integrated up to 48 hours at the horizontal resolution of 0.75 ^{o}x 0.75^{o} lat/long with 16 sigma levels in the vertical over the same domain using the initial and boundary conditions provided by T-80 Global operational model run at NCMRWF. The model is also made flexible to run with NCEP GFS outputs as initial and boundary conditions. During cyclone situation, the model is run by including 'Holland vortex' scheme for generating synoptic vortex in the initial condition. The QLM is used for cyclone track prediction in case of cyclone situation in the Arabian Sea or Bay of Bengal. QLM is a multilevel fine-mesh primitive equation model with a horizontal resolution of 40 km and 16 sigma levels in the vertical. The integration domain consists of 111x111 grid points in a 4440x4440 km^2 domain that is centred on the initial position of the cyclone. The model includes parameterization of basic physical and dynamical processes associated with the development and movement of a tropical cyclone. The two special attributes of the QLM are: (i) merging of an idealized vortex into the initial analysis to represent a storm in the QLM initial state; and (ii) imposition of a steering current over the vortex area with the use of a dipole. The centre of a cyclone is determined on the basis of 850 hPa model output of wind fields. IMD also makes use of NWP products prepared by a few other operational NWP Centers like, National Centre for Medium Range Weather Forecasting (NCMRWF) T-254 model, European Centre for Medium Range Weather Forecasting (ECMWF), United Kingdom Met Office (UKMO) model etc for prediction of tracks of cyclonic disturbances. The performance of all these models has been discussed in the following sections.

3.2 Performance of Cyclone Track Prediction Models

In this section the performance of QLM for cyclone track prediction during 2007 is examined along with other operational NWP models.

(i) Bay of Bengal cyclonic storm "AKASH" of May 2007

The forecast tracks of the system on the basis of operational NWP models namely, ECMWF, NCMRWF (T-254) and IMD QLM against the observed track are shown in Fig. 3.1. In this case, QLM was found to be the only operational model to indicate north-easterly movement of the system before the landfall. Landfall errors of this model are shown in Table 3.1. IMD QLM shows landfall position error of 140 km with 12 hours early landfall in the 48 hours forecast. The NCMRWF T-254 shows landfall position error of 175 km with 6 hours early landfall in the 72 hours forecast. ECMWF shows landfall position errors of 330 km and 370 km at the 72 hours and 48 hours forecasts respectively. Landfall time was very close to the observed landfall time.

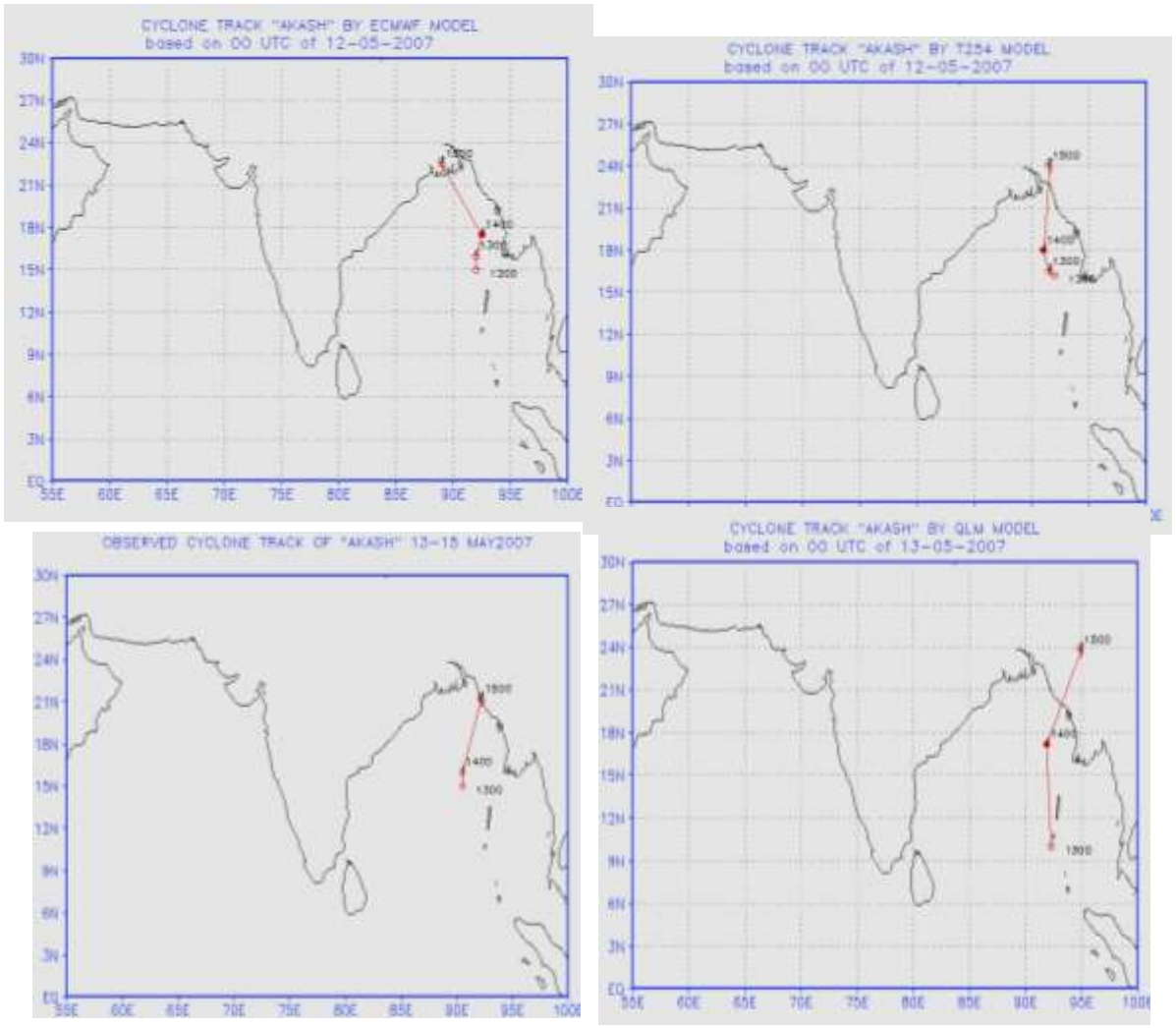


Fig. 3.1: Predicted and observed tracks of Bay of Bengal Cyclonic Storm **AKASH** of May 2007

(ii) Arabian Sea super cyclonic storm "GONU" of June 2007

Fig. 3.2 presents the forecast tracks of the system based on initial condition of 00 UTC of 4 June by operational NWP models along with the observed track. In this case, the T254 forecast track showed southwesterly movement when the system moved north northwestwards. QLM and ECMWF both could capture the northwesterly movement of the system relatively better than T-254. In this case (Table 3.2), T-254 showed landfall position error of 930 km in the 72 hours forecast. ECMWF showed landfall position errors of 400 to 500 km in the 24 hours to 72 hours forecast period. QLM showed landfall position errors of 395 km in the 72 hours forecast and 505 km in the 24 hours forecast.

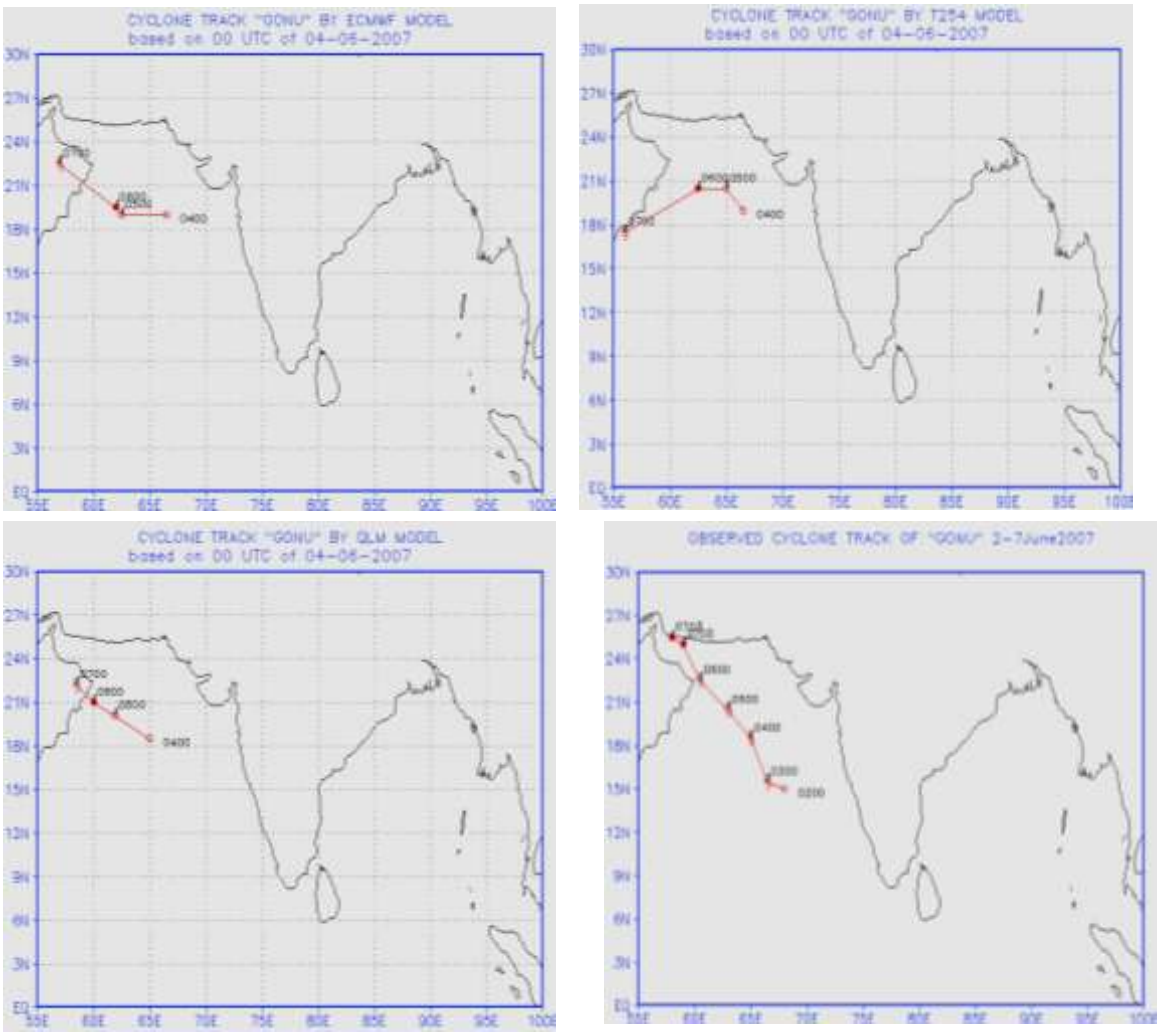


Fig. 3.2: Predicted and observed tracks of Arabian Sea Super Cyclone **GONU** of June 2007

(iii) ***Bay of Bengal very severe cyclonic storm "SIDR" of November 2007***

Fig. 3.3 displays the forecast track positions of **SIDR** by the operational models at 72 hours, 48 hours and 24 hours time scale along with the observed track. The corresponding landfall errors are summarized in Table 3.3. The 72 hours forecasts based on 00 UTC initial conditions of 13 November depicted large landfall error by all the models except the ECMWF. Similar error with less magnitude persisted in the 48 hours forecasts based on 00 UTC initial conditions of 14 November. All the models showed reasonably good performance in the 24 hours forecasts based on the initial conditions of 00 UTC of 15 November, when some convergence in the forecasts by these models are noted. Forecasts produced by ECMWF model are found to be superior both in terms of landfall point and landfall time. All the forecasts (72 hours, 48 hours, and 24 hours) by ECMWF were found to be consistent. Landfall position errors were around 55 to 25 km at the 72 hours to 24 hours forecast period. The landfall time error was within 2 hours of observed landfall time. QLM showed landfall position errors of 650 km, 270 km and 45 km respectively in the 72 hours, 48 hours and 24 hours forecasts. The landfall time was close to the observed landfall time. T-254 landfall position errors of 720 km in the 72 hours forecast and 115 -120 km in the 48 hours and 24 hours forecasts. The landfall time was delayed by 25 hours and 12 hours in the 72 hours and 48 hours forecasts respectively.

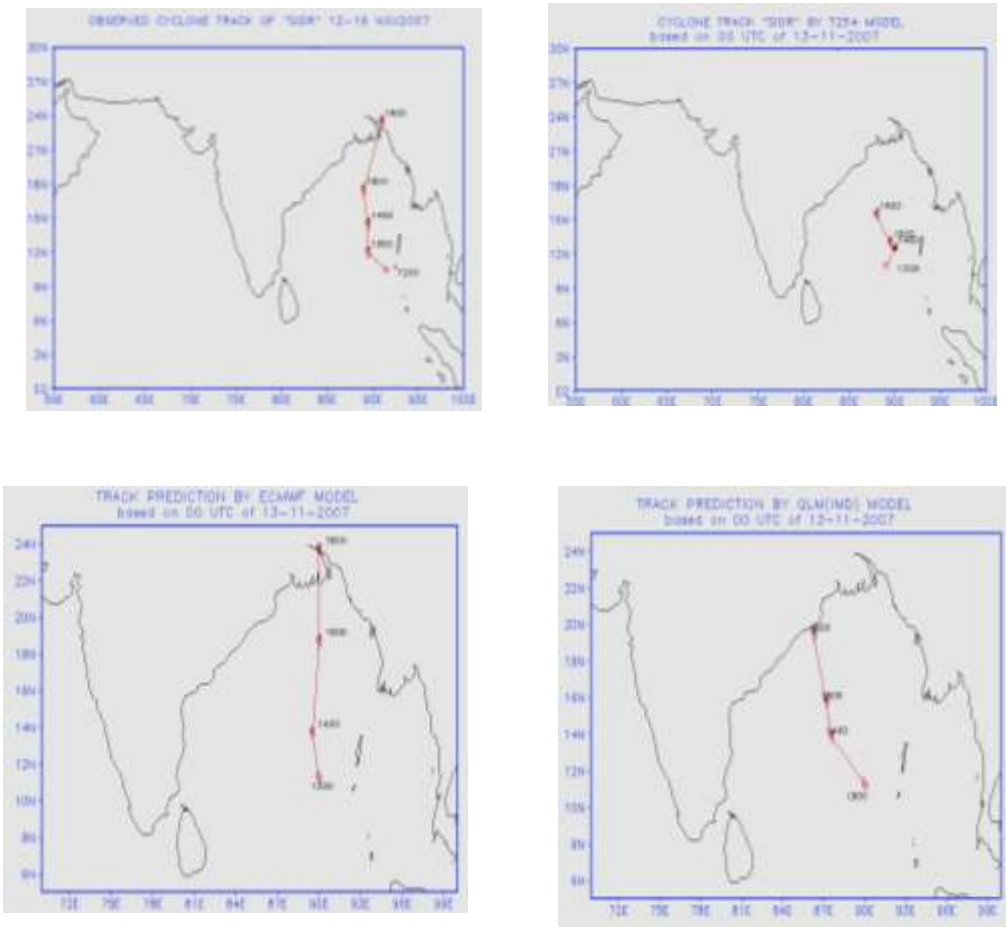


Fig. 3.3 (a) Bay of Bengal very severe cyclonic storm **SIDR** of November 2007 (72 hrs forecasts)

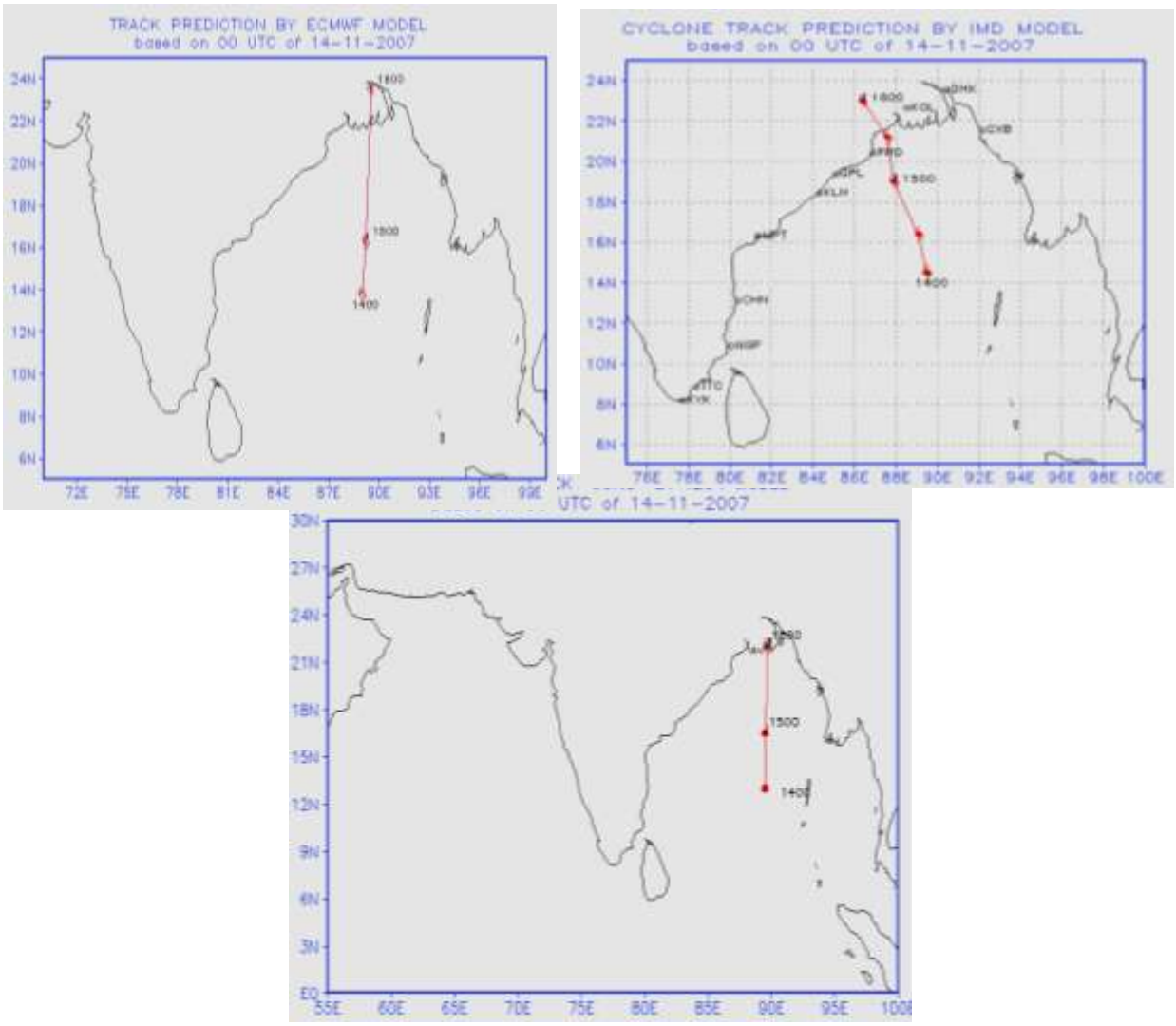
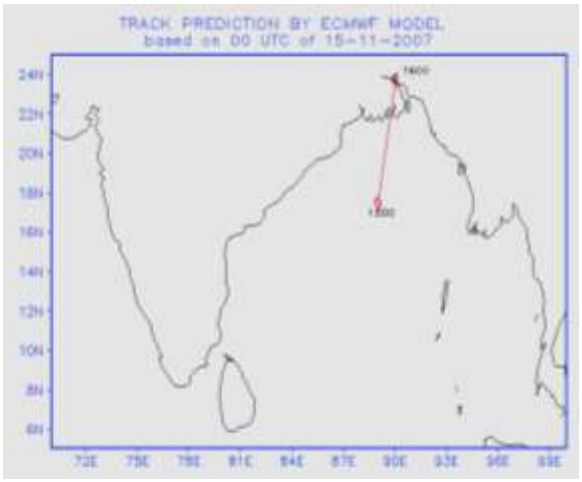
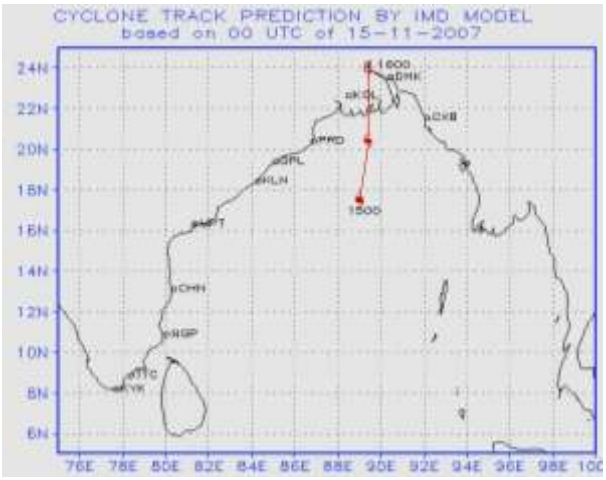


Fig. 3.3 (b) Bay of Bengal very severe cyclonic storm **SIDR** of November 2007
(48 hrs forecasts)





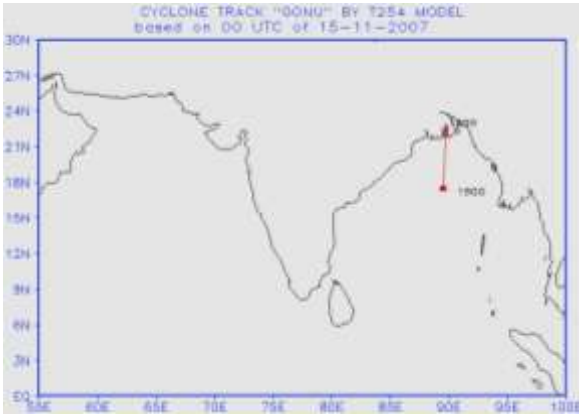


Fig. 3.3 (c) Bay of Bengal very severe cyclonic storm **SIDR** of November 2007 (24 hrs forecasts)

Table 1: Bay of Bengal Cyclonic Storm **AKASH** of May 2007

Models	**Initial Date/time MAY 2007**	**Landfall Fcst. point (^{0}N/^{0}E)**	**Landfall Fc Date/time (UTC)**	**Landfall Error(km)**	**Landfall time error**
T254	120000	22.5/91.0	14/1200	175	6 hrs early
ECMWF	120000 130000	22.0/89.0 21.5/88.5	15/2200 15/0000	330 370	3 hrs early nil
QLM	130000	20.0.0/93.0	14/1200	140	12 hrs early

Table 2: Arabian Sea Super Cyclone **GONU** of June 2007

Models	**Initial Date/time**	**Landfall/Fcst. point (^{0}N/^{0}E)**	**Landfall Fcst. Date/time (UTC)**	**Landfall Error(km)**	**Landfall time error**
T254	030000 040000 050000	17.5/56.0 ---- ----	07/0000	930	3 hrs delay
ECMWF	040000 050000 060000	21.0/58.5 22.0/60.0 22.2/60.0	06/1200 06/1700 06/1500	500 425 410	15 hrs early 4 hrs early 6 hrs early
QLM	040000 050000 060000	21.8/60.1 24.0/58.9 21.1/59.8	06/1200 ---- 06/1730	395 ---- 505	18 hrs early no landfall 4 hr early

Table 3: Bay of Bengal very severe cyclonic storm **SIDR** of November 2007

Models	**Initial Date/time**	**Landfall/Fcst. point (^{0}N/^{0}E)**	**Landfall Fcst. Date/time (UTC)**	**Landfall Error(km)**	**Landfall time error**
T254	130000 140000 150000	18.2/84.0 21.8/88.7 22.0/88.7	17/1900 16/0600 15/1800	720 115 120	25 hrs delay 12 hrs delay 1 hr delay
ECMWF	130000 140000 150000	22.4/89.4 22.1/89.5 21.9/89.7	16/1900 15/1600 15/1500	55 55 25	2 hrs delay 7 hrs delay 2 hrs early
QLM	130000 140000 150000	19.5/86.3 21.4/87.2 21.9/89.4	- 15/1300 15/1600	650 270 45	No land fall 4 hrs early 1 hr early

(iv) Track Error Statistics of QLM

Table 4 contains the verification statistics of the mean position errors (km) of the redicted track from the observed track. The position errors for 12 hours forecast by QLM rangebetween 15 km to 212 km with an average of 92 km for these cyclones. For the 24 hours forecast, the position errors range between 45 km to 291 km with an average of 136 km. For the 36 hours forecast, the position errors range between 83 km to 314 km with an average of 165 km. For the 48 hours forecast, the position errors range between 89 km to 408 km with an average of 252 km. For the 60 hours and 72 hours forecasts, the mean position error remains as 320 km.

Table 4: QLM track prediction Errors (in km) for the year 2007

Date	Month	12 H	24 H	36 H	48 H	60 H	72 H
13	5	79.2	184.7	199.2	373.2		
14	5	212.1	291.9				
2	6	74	49.3	91.4	217.4	347.3	385.7
3	6	131.3	126.3	220.3	206.6	354.2	517.3
4	6	108.9	91.8	102.9	176.1	261.2	322.8
5	6	15.2	46.7	83.9	89.7		
13	11	44.7	215.4	314	408.5		
14	11	96.2	45.7	147.8	293.8		
15	11	69.4	172.1				
MEAN		92	136	165	252	320	320

3.3 Storm Surge Prediction:

The real time storm surge prediction made on the basis of IIT Delhi Storm Surge model for this system has indicated a peak storm surge of height 6 m at the landfall point, which was found to be consistent with the peak surge estimated based on IMD Nomograms as well as the peak surge reported in the print media. However, the IIT-Delhi model indicated some over-estimation of surge height along the West Bengal and north Orissa coasts.

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