W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N
T E C H N I C A L D O C U M E N T

WMO/TD No. 84

TROPICAL CYCLONE
PROGRAMME
Report No. TCP-21

TROPICAL CYCLONE OPERATIONAL PLAN FOR THE BAY OF BENGAL AND THE ARABIAN SEA

Edition 2012

SECRETARIAT OF THE WORLD METEOROLOGICAL ORGANIZATION
GENEVA SWITZERLAND

NOTE
The designation employed and the presentation of material in this document does not imply the expression of any opinion what so ever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

CONTENTS

CONTENTS

C H A P T E R I

GENERAL

1.1 Introduction

The loss of life, property and human suffering caused by tropical cyclones in coastal areas in various parts of the globe are well known. These disasters are on occasion, particularly severe in the Bay of Bengal region. The northern part of the Bay of Bengal is known for its potential to generate dangerous high storm tides a major killer when associated with cyclonic storms. In the past, out of 10 recorded cases of very heavy loss of life (ranging from about 40,000 to well over 200,000) in the world due to tropical cyclones, 8 cases were in the Bay of Bengal and the Arabian Sea (5 in Bangladesh and 3 in India). The world's highest recorded storm tide of 45 feet occurred in this region (1876, Bakherganj cyclone near Meghna Estuary, Bangladesh). These facts amply illustrate the importance of an efficient cyclone warning service in this region. Recognizing these facts, the World Meteorological Organization (WMO) and the Economic and Social Commission for Asia and the Pacific (ESCAP) jointly established the Panel on Tropical Cyclones in 1972 as an intergovernmental body. Its membership comprises countries affected by tropical cyclones in the Bay of Bengal and the Arabian Sea. Originally its member countries were Bangladesh, India, Myanmar, Pakistan, Sri Lanka and Thailand. Later Maldives joined this Panel in 1982 followed by Sultanate of Oman in 1997.

The Panel is one of the five regional tropical cyclone bodies established as part of the WMO Tropical Cyclone Programme (TCP) which aims at promoting and coordinating the planning and implementation of measures to mitigate tropical cyclone disasters on a worldwide basis.

The main objective of the WMO/ESCAP Panel on Tropical Cyclones is to promote measures to improve tropical cyclone warning system in the Bay of Bengal and the Arabian Sea.

As part of this endeavour, the Panel at its twelfth session adopted a comprehensive cyclone operational plan for this region. The basic purpose of the operational plan is to facilitate the most effective tropical cyclone warning system for the region with existing facilities. In doing so the plan defines the sharing of responsibilities among Panel countries for the various segments of the system and records the coordination and cooperation achieved. The plan records the agreed arrangements for standardization of operational procedures, efficient exchange of various data related to tropical cyclone warnings, issue of cyclone advisories from a central location having the required facilities for this purpose, archival of data and issue of a tropical weather outlook for the benefit of the region.

The operational plan contains an explicit formulation of the procedures adopted in the Bay of Bengal and Arabian Sea region for the preparation, distribution and exchange of information and warnings pertaining to tropical cyclones. Experience has shown that it is of great advantage to have an explicit statement of the regional procedures to be followed in the event of a cyclone, and this document is designed to serve as a valuable source of information always available for reference by the forecaster and other users, particularly under operational conditions. Relevant information, which is not subject to regional agreement is given in the annexes to the plan.

A technical plan aiming at the development and improvement of the cyclone warning system of the region has been drawn up by the Panel. Implementation of some items under the technical plan would lead to a strengthening of the operational plan.

The operational plan is evolutionary in nature. It is intended that the text of the plan be updated or revised from time to time by the Panel and that each item of information given in the annexes to the plan be kept up to date by the member country concerned.

1.2 Terminology used in the region

1.2.1 General

Panel member countries or member countries
Zone of disturbed weather*

1.2.2 Classification of cyclonic disturbances and tropical cyclones

Cyclonic disturbance (generic term)
(i) Low or low pressure area
(ii) Well marked low pressure area**+**
(iii) Depression or tropical depression
(iv) Deep Depression*

Tropical cyclone (generic term)
(v) Cyclonic storm
(vi) Severe Cyclonic storm
(vii) Very severe cyclonic storm
(viii) Super cyclonic storm

1.2.3 Tropical cyclone characteristics

i) Position or location
ii) Eye
iii) Centre
iv) Centre fix
v) Central pressure
vi) Pressure depth
vii) Direction of movement
viii) Speed of movement
ix) Mean wind speed or sustained wind speed
x) Maximum wind speed
xi) Gust
xii) Storm surge
xiii) Storm tide

1.2.4 Terms related to the warning and warning system

i) Name of the Tropical Cyclone
ii) Tropical cyclone season or cyclone season
iii) Tropical cyclone advisories
iv) Tropical cyclone information bulletin
v) Satellite information
vi) Precyclone watch******
vii) Cyclone Alert*****
viii) Cyclone Warning*****
ix) Post landfall outlook******
x) Visual storm signal
xi) Squally wind
xii) Gale wind
xiii) High sea bulletin
xiv) Coastal weather bulletin
xv) Bulletin or cyclone warning bulletin for Indian coast

****** Term used nationally in India.

***** Term used nationally in Bangladesh, India and Pakistan.

+ Term used nationally in Bangladesh.

1.3 Meaning of terms used for international exchange

Average wind speed: Speed of the wind averaged over the previous 10 minutes (mean surface wind) as read from the anemogram or the 3 minutes mean determined with the non recording anemometer or estimated wind at sea by the mariners using the Beaufort scale.

Bulletin: Cyclone warning bulletin

Central pressure of a tropical cyclone: Surface pressure at the centre of the tropical cyclone as measured or estimated.

Centre fix of the tropical cyclone: The estimated location of the centre of a tropical cyclone (obtained by means other than the aircraft probing of the cyclone i.e. fixation of the centre with the help of land based and other radars, satellite and conventional observations like surface and upper air observations, ships' reports, commercial aircraft observations, etc.)

Centre of the tropical cyclone: The centre of the cloud eye or if not discernible, of the wind / pressure centre.

Confidence in the centre position: Degree of confidence in the centre position of a tropical cyclone expressed as the radius of the smallest circle within which the centre may be located by the analysis.
- "Position good" implies a radius of 30 nautical miles (55 kilometers) or less,
- "Position fair", a radius of 30 to 60 nautical miles (55 to 110 km) and
- "Position poor", a radius of greater than 60 nautical miles (110 km).

Cyclone: Tropical cyclone

Cyclone Alert*: A priority message for the Government officials containing tropical cyclone information and advisories issued generally 48 hours before the commencement of adverse weather.**

A priority message for the Government officials containing information on the formation of a tropical disturbance as soon as it is detected.

Cyclone warning*: A priority message containing tropical cyclone warning and advisories issued generally 24 hours in advance of the commencement of adverse weather.

Cyclone warning bulletin: A priority message for exchange of tropical cyclone information and advisories.

Cyclonic disturbance: A nonfrontal synoptic scale low pressure area originating over tropical waters with organized convection and definite cyclonic wind circulation.

Cyclonic storm: A cyclonic disturbance in which the maximum average surface wind speed is in the range of 34 to 47 knots (62 to 88 km/h).

Depression*: A cyclonic disturbance in which the maximum sustained surface wind speed is between 17 and 27 knots (31 and 51 km/h). If the maximum sustained wind speed lies in the range 28 knots (52 km/h) to 33 knots (61 km/h) the system may be called a "deep depression".

Direction of movement of the tropical cyclone: The direction towards which the centre of the tropical cyclone is moving.

---

* Term used nationally in Bangladesh, India and Pakistan.

** Predefined, based on minimum limit of rainfall during 24 hours or actual wind speed or both.

Eye of the tropical cyclone: The relatively clear and calm area inside the circular wall of convective clouds, the geometric centre of which is the centre of the tropical cyclone.

Gale force wind: Average surface wind speed of 34 to 47 knots (62 to 88 km/h).

GMDSS: Global Maritime Distress and Safety System.

Gust: Instantaneous peak value of surface wind speed recorded or expected.

Hurricane force wind: Average surface wind speed of 64 knots or more.

Low or low pressure area: An area enclosed by a closed isobar with minimum pressure inside when mean surface wind is less than 17 knots (31 km/h).

Maximum sustained wind: Maximum value of the average wind speed at the surface.

Mean wind speed: Average wind speed.

Name of the Tropical Cyclone: Once wind speed in a cyclonic disturbance attains a 34 knots threshold value it will be given an identification name by RSMC tropical cyclones, New Delhi from the consolidated name list.

Panel members countries or member countries : Countries constituting the WMO/ESCAP Panel on Tropical Cyclones viz. Bangladesh, India, Maldives, Myanmar, Oman (Sultanate of), Pakistan, Sri Lanka and Thailand.

Post Landfall Outlook: This bulletin is issued 12 hours before cyclone landfall and contains more specific forecasts about place and time of landfall.

Pre Cyclone Watch: This bulletin contains early warning about likely development of a cyclonic storm and an indication of the coastal belt likely to experience adverse weather.

Severe cyclonic storm: A cyclonic disturbance in which the maximum average surface wind speed is in the range of 48 to 63 knots (89 to 118 km/h).

Severe cyclonic storm with a core of hurricane winds+: A cyclonic disturbance in which the maximum average surface wind speed is 64 knots (119 km/h) or more.

Speed of movement of the tropical cyclone: Speed of movement of the centre of the tropical cyclone.

Squally wind: When sudden increases of wind speed occur in squalls with the increased speed reaching a minimum of 22 knots (40 km/h) and persist for at least one minute.

Storm force wind: Average surface wind speed of 48 to 63 knots.

Storm season: The periods April to May and October to December during which most of the cyclonic storms occur in the Bay of Bengal and Arabian Sea.

Storm surge: The difference between the actual water level under the influence of a meteorological disturbance (storm tide) and the level, which would have been reached in the absence of the meteorological disturbance (i.e. astronomical tide). (Storm surge results mainly from the shoreward movement of water under the action of wind stress. A minor contribution is also made by the hydrostatic rise of water resulting from the lowered barometric pressure.)

Storm tide: The actual water level as influenced by a weather disturbance. The storm tide consists of the normal astronomical tide and the storm surge.

Super cyclone: A cyclonic disturbance in which maximum wind speed is 120 knots and above (222 km/h and above).

Tropical cyclone: Generic term for a non frontal synoptic scale cyclone originating over tropical or subtropical waters with organized convection and definite cyclonic surface wind circulation. The term is also used for a storm in the Southwest Indian Ocean in which the maximum of the sustained wind speed # is estimated to be in the range of 64 to 90 knots and in the South Pacific and Southeast Indian Ocean with the maximum of the sustained wind speed over 33 knots.)
(Note: # Maximum sustained wind speed: Average period of one, three or ten minutes depending upon the regional practices.)

Tropical cyclone advisory: A priority message for exchanging information, internationally, on tropical cyclones in the Bay of Bengal and the Arabian Sea.

Tropical depression: Depression.

Tropical storm: Tropical cyclone.

Tropical Weather Outlook: A priority message for exchange between the Panel countries of synoptic and satellite inferences for the Bay of Bengal and the Arabian Sea region.

Very severe cyclonic storm: A cyclonic disturbance in which maximum wind average is 64 knots to 119 knots (119 to 221 km/h).

Visual storm signals: Visual signals displayed at coastal points of the port to warn ships of squally winds, gales and tropical cyclones.

Weather warning: Meteorological message issued to provide appropriate warnings of hazardous weather conditions.

Zone of disturbed weather: A zone in which the pressure is low relative to the surrounding region and there is convective cloud masses which are not organized.

_____

+ Meaning of term as used nationally in Bangladesh

1.4 Units used

1.4.1 Units used in international exchange

(i) Distance in nautical miles, the unit (nm) being stated.

(ii) Location (position) by degrees and where possible tenths of degrees of latitude and longitude preferably expressed by words.

(iii) Direction to the nearest sixteen points of the compass given in words.

(iv) Speed (wind speed and direction of movement of tropical cyclones) in knots, the unit (kt) being stated.

1.4.2 Units used in national bulletins

(i) Distance in kilometers (km).
(ii) Location in longitude and latitude (degrees and tenths of degrees) or bearing in sixteen points of compass and distance from two or three well known fixed place.
(iii) Direction in sixteen points of compass.
(iv) Speed in km/h.

C H A P T E R II

TROPICAL CYCLONE WARNINGS AND ADVISORIES

2.1 General

The responsibility of warning for the human settlements on land which are threatened by a tropical cyclone rests in all cases with the National Meteorological Services (NMS). These national responsibilities are not subject to regional agreement. Therefore, the cyclone warning systems pertaining to international users and exchanges among the Panel countries are described in this chapter and the cyclone warning systems for Panel countries are described briefly in the annex to this chapter.

2.2 Classification of cyclonic disturbances followed by RSMC, New Delhi

Classifications of cyclonic disturbances for the north Indian Ocean region for the exchange of messages among the Panel countries are given below:

	Weather system	Maximum wind speed
1.	Low pressure area	Wind speed less than 17 kt (31 km/h)
2.	Depression	Wind speed between 17 and 27 kt (31 and 51 km/h)
3.	Deep Depression	Wind speed between 28 and 33 kt (52 and 61 km/h)
4.	Cyclonic storm	Wind speed between 34 and 47 kt (62 and 88 km/h)
5.	Severe cyclonic storm	Wind speed between 48 and 63 kt (89 and 118 km/h)
6.	Very severe cyclonic storm	Wind speed between 64 and 119 kt (119 and 221 km/h)
7.	Super cyclonic storm	Wind speed 120 kt (222 km/h) and above

2.3 Identification of tropical cyclones

As soon as wind speed in a cyclonic disturbance attains a 34 kt threshold value, it will be given an identification name by RSMC tropical cyclones, New Delhi from the consolidated name list **(Table II-1).** The identification system will cover the whole north Indian Ocean.

If the life of a cyclonic disturbance spans two calendar years it will be accounted for in the year in which it has intensified to the stage where the wind speed has attained the 34 kt threshold value.

TABLE II- 1

Table.1 : Table for naming tropical cyclones for the Bay of Bengal and Arabian Sea

Panel Member	Column one		Column two		Column three		Column four	
	Names	Pron'	Names	Pron'	Names	Pron'	Names	Pron'
B'desh	Onil	Onil	Ogni	Og-ni	Nisha	Ni-sha	Giri	Gi-ri
India	Agni	Ag'ni	Akash	Aakaa'sh	Bijli	Bij'li	Jal	Jal
Maldives	Hibaru	--	Gonu	--	Aila	--	Keila	--
Myanmar	Pyarr	Pyarr	Yemyin	Ye-myin	Phyan	Phyan	Thane	Thane
Oman	Baaz	Ba-az	Sidr	Sidr'	Ward	War'd	Murjan	Mur'jaan
Pakistan	Fanoos	Fanoos	Nargis	Nar gis	Laila	Lai la	Nilam	Ni lam
Sri Lanka	Mala	--	Rashmi	Rash'mi	Bandu	--	Mahasen	--
Thailand	Mukda	Muuk-dar	Khai Muk	Ki-muuk	Phet	Pet	Phailin	Pi-lin

Panel Member	Column five		Column six		Column seven		Column eight	
	Names	Pron'	Names	Pron'	Names	Pron'	Names	Pron'
B'desh	Helen	Helen	Chapala	Cho-po-la	Ockhi	Ok-khi	Fani	Foni
India	Lehar	Le'har	Megh	Me'gh	Sagar	Saa'gar	Vayu	Vaa'yu
Maldives	Madi	--	Roanu	--	Mekunu	--	Hikaa	--
Myanmar	Nanauk	Na-nauk	Kyant	Kyant	Daye	Da-ye	Kyarr	Kyarr
Oman	Hudhud	Hud'hud	Nada	N'nada	Luban	L'luban	Maha	M'maha
Pakistan	Nilofar	Ni lofar	Vardah	Var dah	Titli	Titli	Bulbul	Bul bul
Sri Lanka	Priya	--	Asiri	Aa'siri	Gigum	Gi'gum	Soba	--
Thailand	Komen	Goh-men	Mora	Moh-rar	Phethai	Pay-ti	Amphan	Um-pun

2.4 Bulletins issued by RSMC, New Delhi

2.4.1 Tropical weather outlook

The tropical weather outlook will be prepared once daily by RSMC tropical cyclones, New Delhi throughout the year. It will be transmitted on the GTS at 06 UTC every day. The outlook covering the North Indian Ocean indicates possible development of tropical depressions over the sea. An additional Tropical Weather outlook will be transmitted again on the GTS at 1500 UTC based on 1200 UTC observations when a depression is located over the north Indian Ocean region. The additional bulletin will be issued as and when felt necessary by RSMC, New Delhi

2.4.2 Special Tropical weather outlook

The special tropical weather outlook issued in association with the depression will provide brief descriptions of tropical depressions affecting the area. It will give the location, intensity and movement of the system as well as a general statement of land areas coming under threat. It will also contain description of the convective clouds in satellite imageries and diagnostic & prognostic features of the system. It is issued twice a day based on 0300 and 1200 UTC observations. When the depression intensifies into a deep depression, the special tropical weather outlook issued five times a day based on 0000, 0300, 0600, 1200 and 1800 UTC observations will in addition contain the 72 hrs forecast track and intensity of the system in a tabular form. These track and intensity forecasts are issued for +6, +12, +18, +24, +36, +48, 60 and +72 hrs since December 2008.

When a system reaches the cyclonic storm stage (wind speed 34 kt), RSMC tropical cyclones, New Delhi will issue cyclonic storm advisories.

Examples-1 (Special Tropical Weather Outlook in association with a depression)

SPECIAL TROPICAL WEATHER OUTLOOK

DEMS–RSMC TROPICAL CYCLONES NEW DELHI 29-10-2011
TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND ARABIAN SEA) VALID FOR NEXT 24 HOURS ISSUED AT 1500 UTC OF 29 OCTOBER, 2011 BASED ON 1200 UTC OF 29 OCTOBER, 2011 (.)

THE DEPRESSION OVER WEST CENTRAL AND ADJOINING SOUTHWEST ARABIAN SEA MOVED WESTWARD AND LAY CENTRED AT 1200 UTC OF TODAY, THE 29TH OCTOBER 2011 NEAR LATITUDE 13.0^{0}N AND LONGITUDE 61.0^{0}E, ABOUT 1500 KM WEST OF MANGALORE (43284),750 KM EAST OF SOCOTRA ISLAND (41494) AND 850 KM SOUTHEAST OF SALALAH (41316) THE SYSTEM IS LIKELY TO INTENSIFY FURTHER INTO A DEEP DEPRESSION AND MOVE WEST-NORTHWESTWARDS TOWARDS GULF OF ADEN DURING NEXT 72 HRS.

SATELLITE IMAGERY INDICATES GRADUAL INCREASE IN CONVECTION AND ORGANISATION OF THE SYSTEM. THE INTENSITY OF THE SYSTEM IS T1.5. ASSOCIATED BROKEN INTENSE TO VERY INTENSE CONVECTION IS SEEN OVER AREA BETWEEN LAT 10.0^{0}N TO 20.0^{0}N AND LONG 54.0^{0}E TO 70.0^{0}E.THE LOWEST CLOUD TOP TEMPERATURE (CTT) DUE TO CONVECTION IS AROUND -75^{0}C IN ASSOCIATION WITH THE SYSTEM.

SUSTAINED MAXIMUM SURFACE WIND SPEED IS ESTIMATED TO BE ABOUT 25 KNOTS AROUND SYSTEM CENTRE. THE STATE OF THE SEA IS ROUGH TO VERY ROUGH AROUND THE SYSTEM CENTRE. THE ESTIMATED CENTRAL PRESSURE IS ABOUT 1002 HPA.

REMARK:

THE RELATIVE VORTICITY AT 850 HPA LEVEL AND UPPER LEVEL DIVERGENCE HAVE INCREASED DURING PAST 12 HRS. SEA SURFACE TEMPERATURE IS AROUND 28^0-29^{0}C. HOWEVER, OCEAN HEAT CONTENT IS LESS (< 40 KJ/CM^2) AND NOT FAVOURABLE FOR INTENSIFICATION OVER GULF OF ADEN AND ADJOINING ARABIAN SEA. VERTICAL WIND SHEAR OF HORIZONTAL WIND OVER THE REGION IS FAVOURABLE AS IT IS LOW TO MODERATE (BETWEEN 10-20 KNOTS). THERE IS NEGATIVE (05-10 KNOTS) 24 HOUR TENDENCY OF VERTICAL WIND SHEAR AROUND SYSTEM CENTRE. THE SYSTEM LIES TO THE SOUTH OF UPPER TROPOSPHERIC RIDGE, WHICH RUNS ROUGHLY ALONG 18^{0}N IN ASSOCIATION WITH AN ANTICYCLONIC CIRCULATION TO THE NORTHEAST OF SYSTEM CENTRE. CONSIDERING ALL THESE, THE SYSTEM WOULD INTENSIFY FURTHER INTO A DEEP DEPRESSION AND MOVE WEST-NORTHWESTWARDS TOWARDS GULF OF ADEN DURING NEXT 72 HRS. HOWEVER, DUE TO COLDER SEA, THE SYSTEM MAY WEAKEN AGAIN OVER GULF OF ADEN AND ADJOINING ARABIAN SEA.

Examples-2 (Special Tropical Weather Outlook in association with a deep depression)

SPECIAL TROPICAL WEATHER OUTLOOK

DEMS–RSMC TROPICAL CYCLONES NEW DELHI 26-12-2011
TROPICAL WEATHER OUTLOOK FOR NORTH INDIAN OCEAN (THE BAY OF BENGAL AND ARABIAN SEA) VALID FOR NEXT 24 HOURS ISSUED AT 0300 UTC OF 26 DECEMBER, 2011 BASED ON 0000 UTC OF 26 DECEMBER, 2011 (.)

THE DEPRESSION OVER SOUTHEAST BAY OF BENGAL MOVED NORTHWESTWARDS, INTENSIFIED INTO DEEP DEPRESSION, AND LAY CENTRED AT 0000 UTC TODAY, THE 26TH DECEMBER 2011 OVER SOUTHEAST BAY OF BENGAL NEAR LATITUDE 9.5^{0}N AND LONGITUDE 87.5.^{0}E, ABOUT 900 KM SOUTHEAST OF CHENNAI (43279), 700 KM EAST-NORTHEAST OF TRINCOMALEE (43418), 600 KM SOUTHWEST OF PORT BLAIR (43333). THE SYSTEM IS LIKELY TO MOVE NORTHWESTWARDS, INTENSIFY INTO A CYCLONIC STORM DURING NEXT 24 HRS. IT IS LIKELY TO MOVE NORTHWESTWARD INITIALLY, THEN WEST-NORTHWESTWARDS AND CROSS NORTH TAMIL NADU AND SOUTH ANDHRA PRADESH COAST BETWEEN CUDDALORE (43329) AND NELLORE (43245) BY EARLY MORNING OF 29TH DECEMBER 2011.

ACCORDING TO SATELLITE IMAGERIES, THE INTENSITY OF THE SYSTEM IS T2.0. THE LOWEST CLOUD TOP TEMPERATURE (CTT) IS ABOUT -78^{0}C.ASSOCIATED BROKEN LOW/MEDIUM CLOUDS WITH EMBEDDED INTENSE TO VERY INTENSE CONVECTION SEEN OVER BAY OF BENGAL LATITUDE 6.5^{0}N TO 15.0^{0}N EAST OF LONGITUDE 82.0^{0}E, OVER ANDAMAN & NICOBAR ISLANDS AND ADJOINING ANDAMAN SEA THE ASSOCIATED CONVECTION HAS INCREASED GRADUALLY WITH RESPECT TO HEIGHT AND ORGANISATION.. THE POLEWARD OUTFLOW IS DISTINCTLY VISIBLE IN THE SATELLITE IMAGERIES, WHICH FAVOURS INTENSIFICATION.
SUSTAINED MAXIMUM SURFACE WIND SPEED IS ESTIMATED TO BE ABOUT 30 KNOTS AROUND SYSTEM CENTRE. THE STATE OF THE SEA IS ROUGH TO VERY ROUGH AROUND THE SYSTEM CENTRE. THE ESTIMATED CENTRAL PRESSURE IS ABOUT 998 HPA.. BUOY (POSITION NEAR 11.0^{0}N AND 86.5^{0}E) REPORTED MSLP 1000 HPAWIND OF 030/33 KNOTS; BUOY (POSITION NEAR 12.5^{0}N AND 86.0^{0}E) REPORTED MSLP OF 1003.9 HPA.

BASED ON LATEST ANALYSIS WITH NWP MODELS AND OTHER CONVENTIONAL TECHNIQUES, ESTIMATED TRACK AND INTENSITY OF THE SYSTEM ARE GIVEN IN THE TABLE BELOW:

DATE/TIME(IUTC)	POSITION (LAT. ^{0}N/ LONG. ^{0}E)	SUSTAINED MAXIMUM SURFACE WIND SPEED (KMPH)	INTENSITY
26-12-2011/0000	9.5/87.5	55-65 GUSTING TO 75	DEEP DEPRESSION
26-12-2011/0600	10.0/87.0	55-65 GUSTING TO 75	DEEP DEPRESSION
26-12-2011/1200	10.5/86.5	65-75 GUSTING TO 85	CYCLONIC STORM
26-12-2011/1800	11.0/86.0	75-85 GUSTING TO 95	CYCLONIC STORM
27-12-2011/0000	11.5/85.5	90-100 GUSTING TO 110	SEVERE CYCLONIC STORM
27-12-2011/1200	12.0/84.5	90-100 GUSTING TO 110	SEVERE CYCLONIC STORM
28-12-2011/0000	12.5/83.5	100-110 GUSTING TO 120	SEVERE CYCLONIC STORM
28-12-2011/1200	13.0/82.0	100-110 GUSTING TO 120	SEVERE CYCLONIC STORM
29-12-2011/0000	13.0/80.5	100-110 GUSTING TO 120	SEVERE CYCLONIC STORM

REMARK:

CONSIDERING THE ENVIRONMENTAL FEATURES, THE SEA SURFACE TEMPERATURE IS ABOUT 27-28 DEG. C. OVER THE REGION. IT IS RELATIVELY LESS TOWARDS TAMIL NADU AND SRILANKA COAST BECOMING 26-27 DEG. C. THE OCEAN THERMAL ENERGY IS 50 - 80 KJ/CM SQUARE AROUND THE SYSTEM CENTRE. IT IS 50-80 KJ/CM SQUARE TO THE WEST AND WEST-NORTHWEST OF SYSTEM AND LESS THAN 50 KJ/CM SQUARE NEAR TAMILNADU AND NORTH SRILANKA COAST. THE MADDEN JULIAN OSCILLATION INDEX CURRENTLY LIES OVER PHASE 5. AS PER STATISTICAL AND NWP MODEL PREDICTIONS, IT IS EXPECTED TO LIE IN PHASE 5 DURING NEXT ONE WEEK. THE PHASE 5 IS FAVOURABLE FOR INTENSIFICATION, AS PER OUR PAST STUDIES. THE UPPER TROPOSPHERIC RIDGE LIES ALONG 10 DEG. N AND HENCE PROVIDES REQUIRED POLEWARD OUTFLOW FOR INTENSIFICATION OF THE SYSTEM. THE

LOW LEVEL CONVERGENCE HAS INCREASED DURING PAST 24 HRS AS WELL AS UPPER LEVEL DIVERGENCE. THE VERTICAL WIND SHEAR BETWEEN 200 AND 850 HPA LEVELS IS MODERATE (15-20 KNOTS) AROUND SYSTEM CENTRE. HOWEVER, IT INCREASES TOWARDS THE COAST OF SRI LANKA AND INDIA, BECOMING 20-30 KNOTS (MODERATE TO HIGH). CONSIDERING THE NWP MODEL GUIDANCE, MOST OF THE MODELS SUGGEST THE INTENSIFICATION OF THE SYSTEM INTO A CYCLONIC STORM BY NEXT 24 HRS. DYNAMICAL- STATISTICAL MODEL OF IMD ALSO SUGGESTS THE SYSTEM TO INTENSIFY INTO A CYCLONIC STORM. WITH RESPECT TO TRACK, MOST OF THE MODELS SUGGEST-NORTHWESTWARD MOVEMENT DURING NEXT 24 HRS AND THEN WESTWARD/WEST-NORTHWESTWARD MOVEMENT CROSS NORTH TAMIL NADU AND SOUTH ANDHRA PRADESH COAST BETWEEN CUDDALORE (43329) AND NELLORE (43245) BY EARLY MORNING OF 29TH DECEMBER 2011. . THE CURRENT FORECAST IS IN AGREEMENT WITH MOST OF THE NWP MODELS GUIDANCE.

2.4.3 Tropical cyclone advisories

When a tropical low pressure system reaches the cyclonic storm stage, or is shortly expected to reach that intensity, RSMC tropical cyclones, New Delhi will issue tropical cyclone advisories. Advisories will be issued at 00, 03, 06, 09, 12, 15, 18 and 21 UTC. The area of responsibility for the issue of tropical cyclone advisories by RSMC Tropical Cyclones, New Delhi cover sea areas of north Indian Ocean between long. 45° E to 100° E. Supplementary advisories may be issued as necessitated by circumstances, e.g., change in intensity or movement.

Tropical cyclone advisories will contain the information of tropical cyclone, name of the cyclone, the present location, intensity and movement (present and past twelve hours) of the storm, and its forecast position, movement, intensity, maximum average surface wind speed with highest gust wind speed and sea conditions (in qualitative terms). These track and intensity forecasts are issued for +6, +12, +18, +24, +36, +48, 60 and +72 hrs. It also contains description of the convection as seen in satellite imageries and brief description of the diagnosis and prognosis of the system. The bulletin will contain the storm surge guidance based on IIT, Delhi Storm Surge prediction model in case of the cyclone landfalling over any member countries. Important information obtained from radar, synoptic, ship observations from the affected areas will also be reported in the advisory bulletin.

Advisories will be exchanged under appropriate headings for regional distribution by RTH, New Delhi on the GTS.

Example

FROM: RSMC – TROPICAL CYCLONES, NEW DELHI
TO: STORM WARNING CENTRE, DHAKA (BANGLADESH)
STORM WARNING CENTRE, YANGAON (MYANMAR)
STORM WARNING CENTRE, BANGKOK (THAILAND)
STORM WARNING CENTRE, COLOMBO (SRILANKA)
STORM WARNING CENTRE, KARACHI (PAKISTAN)
METEOROLOGICAL OFFICE, MALE (MALDIVES)
OMAN METEOROLOGICAL DEPARTMENT, MUSCAT (THROUGH RTH JEDDAH)
TROPICAL CYCLONE ADVISORY
RSMC – TROPICAL CYCLONES, NEW DELHI

TROPICAL STORM **"THANE"** ADVISORY NO. FIFTEEN ISSUED AT 1500 UTC OF 28TH DECEMBER 2011 BASED ON 1200 UTC CHARTS OF 28TH DECEMBER 2011.

THE SEVERE CYCLONIC STORM **'THANE'** OVER SOUTHWEST BAY OF BENGAL MOVED FURTHER WESTWARD, INTENSIFIED INTO A VERY SEVERE CYCLONIC STORM AND LAY CENTERED AT 1200 UTC OF TODAY, THE 28TH DECEMBER 2011 NEAR LATITUDE 12.5^0N AND LONGITUDE 84.5^0E, ABOUT 450 KM EAST-SOUTHEAST OF CHENNAI (43279), 550 KM NORTHEAST OF TRINCOMALEE (43418) AND 900 KM WEST-NORTHWEST OF PORT BLAIR (43333). THE SYSTEM IS LIKELY TO MOVE WEST-WESTWARDS, INTENSIFY FURTHER DURING NEXT 12 HRS AND CROSS NORTH TAMIL NADU COAST BETWEEN NAGAPATTINAM(43347) AND CHENNAI, CLOSE TO PUDUCHERRY(43331) AROUND MORNING OF 30TH DECEMBER 2011. HOWEVER, AS THE CYCLONIC STORM WILL COME FURTHER CLOSE TO COAST AFTER 24 HOURS, THERE IS PROBABILITY OF SLIGHT WEAKENING BEFORE LANDFALL.

ACCORDING TO SATELLITE IMAGERIES, THE INTENSITY OF THE SYSTEM IS T4.0.THE SYSTEM SHOWS REGULAR CDO PATTERN. THE LOWEST CLOUD TOP TEMPERATURE (CTT) IS ABOUT -86^{0}C. ASSOCIATED NTENSE TO VERY INTENSE CONVECTION SEEN OVER BAY OF BENGAL BETWEEN LATITUDE 9.0^{0}N TO 15.0^{0}N AND LONGITUDE 80.5^{0}E TO 87.0^{0}E.

SUSTAINED MAXIMUM SURFACE WIND SPEED IS ESTIMATED TO BE ABOUT 65 KNOTS AROUND SYSTEM CENTRE. THE STATE OF THE SEA IS PHENOMENAL AROUND THE SYSTEM CENTRE. THE ESTIMATED CENTRAL PRESSURE IS ABOUT 980 HPA.

BASED ON LATEST ANALYSIS WITH NWP MODELS AND OTHER CONVENTIONAL TECHNIQUES, ESTIMATED TRACK AND INTENSITY OF THE SYSTEM ARE GIVEN IN THE TABLE BELOW:

Date/Time(UTC)	Position (lat. ^{0}N/ long. ^{0}E)	Sustained maximum surface wind speed (kmph)	Intensity
28-12-2011/1200	12.5/84.5	120-130 gusting to 145	VerySevere Cyclonic Storm
28-12-2011/1800	12.5/83.8	130-140 gusting to 155	VerySevere Cyclonic Storm
29-12-2011/0000	12.5/83.1	130-140 gusting to 155	Very Severe Cyclonic Storm
29-12-2011/0600	12.5/82.4	120-130 gusting to 145	VerySevere Cyclonic Storm
29-12-2011/1200	12.5/81.7	110-120 gusting to 135	Severe Cyclonic Storm
30-12-2011/0000	12.5/80.3	100-110 gusting to 125	Severe Cyclonic Storm
30-12-2011/1200	12.5/78.9	65-75 gusting to 85	Cyclonic Storm
31-12-2011/0000	12.5/77.5	55-65 gusting to 75	Deep Depression
31-12-2011/1200	12.5/76.1	45-55 gusting to 65	Depression

REMARK:

CONSIDERING THE ENVIRONMENTAL FEATURES, THE SEA SURFACE TEMPERATURE IS ABOUT 27-28 DEG. C. OVER THE REGION. IT IS RELATIVELY LESS TOWARDS TAMIL NADU AND SRI LANKA COAST BECOMING 26-27 DEG. C. THE OCEAN THERMAL ENERGY IS LESS THAN 50 KJ/CM SQUARE AROUND THE SYSTEM CENTRE AND NEAR TAMILNADU AND NORTH SRILANKA COAST. THE MADDEN JULIAN OSCILLATION INDEX CURRENTLY LIES OVER PHASE 5. AS PER STATISTICAL AND NWP MODEL PREDICTIONS, IT IS EXPECTED TO REMAIN IN PHASE 5 DURING NEXT FOUR DAYS. THE PHASE 5 IS FAVOURABLE FOR INTENSIFICATION.

THE UPPER TROPOSPHERIC RIDGE LIES ALONG 16.0 DEG. N AND HENCE HELPS IN WESTTWARD MOVEMENT OF THE SYSTEM. THE LOW LEVEL CONVERGENCE AS WELL AS UPPER LEVEL DIVERGENCE HAS INCREASED DURING PAST SIX HOURS. THE VERTICAL WIND SHEAR BETWEEN 200 AND 850 HPA LEVELS IS LOW (5-10 KNOTS) AROUND SYSTEM CENTRE AND ALONG TAMILNADU AND SRI LANKA COAST. HOWEVER, THE VERTICAL WIND SHEAR IS EXPECTED TO INCREASE NEAR THE COAST FROM TOMORROW. CONSIDERING THE NWP MODEL GUIDANCE, MOST OF THE MODELS SUGGEST THE MAINTENANCE OF THE INTENSITY OF THE SYSTEM FOR NEXT 12 HRS. AND SLIGHT WEAKENING BEFORE LANDFALL. WITH RESPECT TO TRACK, MOST OF THE MODELS SUGGEST WESTWARD/ WEST-SOUTHWESTWARD MOVEMENT.THE CURRENT FORECAST IS IN AGREEMENT WITH MAJORITY OF NWP MODELS AND SYNOPTIC GUIDANCE

2.4.4 Tropical cyclone warnings for the high seas

The World Meteorological Organization (WMO) in its Manual on Marine Meteorological Services has recommended the issue of weather and sea bulletins for the high seas in six parts. The first part relates to tropical storm warnings in plain language. Areas of responsibility of each nation for issuing the tropical storm warnings are pre-assigned **(Fig.II-1).**

The cyclone warning centres issuing forecasts and warnings for the benefit of the ships on the high seas in the Panel countries are listed in the **Table II-2.** The area covered by these stations in their bulletins, name of the coastal radio stations with their call signs from where the tropical cyclone warnings are broadcast, are given in **Table II-2.**

AREAS OF RESPONSIBILITY AND DESIGNATED NATIONAL METEOROLOGICAL SERVICES FOR THE ISSUE OF WARNINGS AND WEATHER AND SEA BULLETINS FOR THE GMDSS

Fig. II-1.

TABLE II- 2

Stations issuing cyclone warnings for ships on the high seas

Station	Call sign of Coastal Radio Station	Area covered
Bangladesh, Chittagong	ASC	Bay of Bengal north of 18°N Lat.
India, Mumbai		Arabian Sea north of Lat. 5°N and east of Long. 60°E excluding the area north of Lat. 20°N and west of Long. 68°E. The eastern boundary of the Arabian Sea for which these bulletins are issued by Mumbai is Long. 80°E meridian excluding the Gulf of Mannar.
India, Kolkata		Bay of Bengal north of Lat. 5°N except the area between the coastline on the east and the line drawn through the points 18°N 94.5°E, 18°N 92°E, 13.5°N 92°E, 13.5°N 94°E, 10°N 94°E, 10°N 95°E and 5°N 95°E. The western boundary of the sea area for which bulletins are issued by Kolkata is up to and inclusive of the Gulf of Mannar (i.e., 77.5°E meridian).
***India,** Chennai		Bay of Bengal bulletins issued by ACWC Kolkata are being broadcast through Navtex, Chennai by Narrow Band Direct Printing (NBDP)
Myanmar, Yangon	XYR	Bay of Bengal except area west of Long. 92°E and South of 10°N Lat.
Oman (Sultanate of)	A4M	Muscat Coastal Radio Station
****Pakistan,** Karachi	ASK	Arabian Sea north of 20°N, Gulf of Oman and Persian Gulf.
Sri Lanka, Colombo	4PB	Indian Ocean, Arabian Sea and Bay of Bengal from the equator to 10°N between 60°E and 95°E. The area 5°N to 10°N between 60°E and 95°E is an overlap with India.
Thailand, Bangkok	HSA HSS	Gulf of Thailand, west of southern Thailand. Strait of Malacca and South China Sea.

* Under the new Marine Meteorological Broadcast system, GMDSS (Global Marine Distress Safety System) of IMO/WMO, India issues two bulletins at 0900 and 1800 UTC everyday for broadcast through INMARSAT SAFETY SYSTEM. Additional bulletins are broadcast during Cyclone period.

** To comply IMO/WMO GMDSS and marine Meteorological Broadcast System Pakistan issues the high seas forecast / Marine bulletins for metarea-IX daily at 0700 UTC for broadcast through INMARSAT SAFEYNET SYSTEM. These bulletins are issued at 1900 UTC if so required.

Tropical cyclone warnings for the high seas contains the following informations:

(a) Type of warning and name of the issuing centre

(b) Name of the system and name of the basin

(c) Date and time of reference in UTC

(d) Type of disturbance (depression, cyclonic storm, etc.);

(e) Location in terms of latitude and longitude or with reference to well-known landmarks and ECP

(f) Direction and speed of movement of the disturbance

(g) Extent of affected area in nautical miles

(h) Wind speed or force and direction in the affected areas

(i) Sea and swell condition in affected areas (in qualitative terms)

(j) Other important information such as future position of disturbances

Items (a), (b), (c), (d),(e), (f) ,(g) and (h) listed above should always be included in the warning bulletins.

Example:

VWM 1545 UTC 14 NOVEMBER 2008 CYCLONE WARNING CENTRE KOLKATA WARNING OF TROPICAL STORM. SEVERE CYCLONIC STORM ¶KHAI MUKô IN WEST CENTRAL BAY OF BENGAL CENTRED AT 1200 UTC 14 NOVEMBER 2008 WITHIN HALF A DEGREE OF LATITUDE 14.5 DEGREES NORTH LONGITUDE 83.5 DEGREES EAST REPEAT 14.5° N 83.5° E AAA PRESENT MOVEMENT NORTHWESTWARDS AAA CENTRAL PRESSURE 988 HPA (MAXIMUM SUSTAINED WIND 35 KT GUSTS 45 KT). AREAS 35 KT WIND WITHIN RADIUS 80 NM AND AREAS 30 KT WIND WITHIN 300 NM RADIUS AAA STATE OF SEA VERY ROUGH TO HIGH WITHIN 300 KM OF TROPICAL STORM CENTRE AAA SYSTEM LIKELY TO INTENSIFY AND MOVE IN A NORTHWESTERLY DIRECTION AT 10 KT AAA (NEXT BULLETIN 1845 UTC) AAA

2.4.5 Warnings and advisories for aviation

In accordance with the International Civil Aviation Organization (ICAO) Annex 3 ð *Meteorological Service for International Air Navigation*/ WMO Technical Regulations [C.3.1], tropical cyclone warnings, required for the international air navigation, are issued by designated Meteorological Watch Offices (MWO) as SIGMET messages * , including an outlook, giving information for up to 24 hours ahead concerning the expected positions and maximum surface wind of the centre of the tropical cyclone. Each MWO provides information for one or more specified Flight Information Regions (FIRs) or Upper Information Regions (UIRs). The boundaries of the FIRs/UIRs are defined in ICAO Air Navigation Plans (ANP) for the Asia (ASIA), Middle East (MID) and Pacific (PAC) Regions.

The content and order of elements in a SIGMET message for tropical cyclone shall be in accordance with WMO Technical Regulations [C.3.1]. The data type designator to be included in the WMO abbreviated header of such messages shall be T1T 2 = WC (WMO No. 386, Manual on GTS refers).

The designated Tropical Cyclone Advisory Centre (TCAC), New Delhi shall monitor the development of tropical cyclones in its area of responsibility, in accordance with the ASIA/PAC ANP and issue advisory information concerning the positions of the centre of the cyclone, its direction and speed of movement, central pressure and maximum surface wind near the centre. These advisories are disseminated to the MWOs in the TCAC New Delhi area of responsibility, to be used in the preparation of the OUTLOOK appended to SIGMETs for tropical cyclones. In addition, the tropical cyclone advisories shall be disseminated to the other TCACs, whose areas of responsibility may be affected, to the World Area Forecast Centers (WAFC) London and Washington

and international OPMET data banks and centers operating the satellite distribution systems (SADIS and ISCS). [C.3.1]. The data type designator to be included in the WMO abbreviated header of such messages shall be T1T2 = FK (WMO-No. 386, Manual on GTS, refers).

TCAC New Delhi is issuing Tropical Cyclone Advisories for its area of responsibility, for each tropical cyclone, as necessary, in the format specified by ICAO every six hours along with graphics from 2012.

TC ADVISORY

(i) Text message: A text message is sent through GTS to various users as per the following format

TC ADVISORY

DTG: 20100518/0000Z

TCAC: NEW DELHI

TC: LAILA

NR: 1

PSN: N1130 E08630

MOV: WNW 6 KNOTS

C: 998HPA
MAX WIND: 35KT

FCST PSN+6HR: 18/0600Z N1130 E08600

FCST MAX WIND+6HR: 40 KT

FCST PSN+12HR: 18/1200Z N1200 E08530

FCST MAX WIND+12HR: 45 KT

FCST PSN+18HR: 18/1800Z N1230 E08500

FCST MAX WIND+18HR: 45 KT

FCST PSN+24HR: 19/0000Z N1300 E08430

FCST MAX WIND+24HR: 50 KT

NXT MSG: 20100518/0600Z

(ii) Graphical TC advisory: Now graphical advisory will be sent in graphics in PNG format including text in it through GTS under the header T_PZXE89_C_DEMS

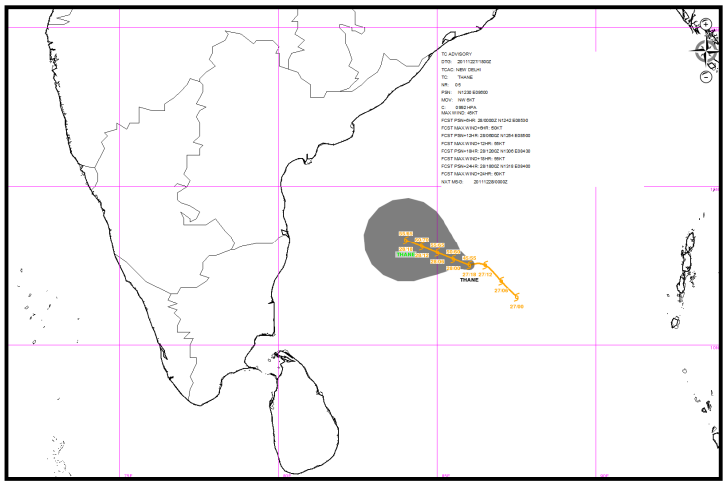

Fig. II-2

(iii) TC advisory to ADRR Hong Kong: TC advisory containing 24 hours forecast is also given to ADRR Hong Kong through FTP based on 00, 06, 12 and 18 UTC observation in the following format.

Example:

#	<comment line>
0005	<TC identifier>
THANE	<TC Name>
2011122706 12.0 087.0 O	<yyyymmddhh Lat. Long. And O stands for observed and F stands for forecast>
2011122712 12.5 086.5 O	
2011122718 12.5 086.0 O	
2011122800 12.5 086.0 O	
2011122806 12.5 085.0 O	
2011122812 12.5 084.3 F	
2011122818 12.7 083.7 F	
2011122900 12.8 083.1 F	
2011122906 12.8 082.5 F	

2.4.6 Tropical cyclone warnings for national purposes

Information on tropical cyclone warnings provided nationally by Panel member countries, including the port warning system, is given in Annex II- A to Annex II- I to this Chapter.

2.4.7 Storm surge guidance

Storm surge warnings will be the responsibility of the National Meteorological Services. However, storm surge guidance will be issued and incorporated in the tropical cyclone advisory bulletin by RSMC- New Delhi based on IIT, Delhi Storm Surge prediction model.

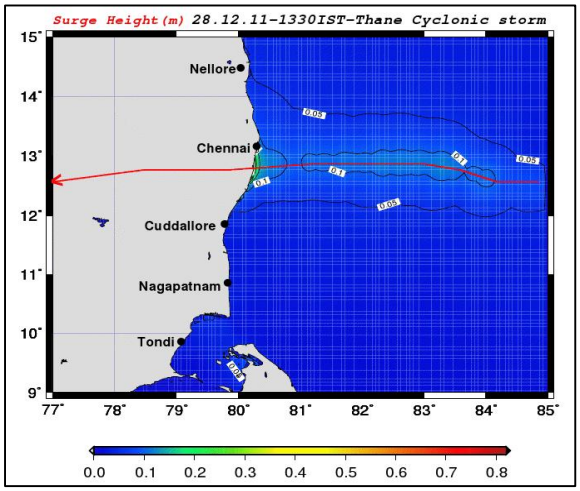

Fig. II-3

2.5 Graphical presentation of track and intensity

The track and intensity of the system will updated and put in cyclone page of IMD website time to time, based on the special tropical weather outlook and tropical cyclone advisory bulletin issued by RSMC, New Delhi from the stage of deep depression and based on 00, 06, 12 and 18 UTC.

2.5.1 **Cone of uncertainty:** The cone of uncertainty in the forecast has been introduced with effect from the cyclone, ÁWARDÔduring December, 2009. It is helpful to the decision makers as it indicates the standard forecast errors in the forecast for different periods like 12, 24, 36, 48, 60 and 72 hrs as given below.

Lead time (hrs)	Standard error (km) used for uncertainty forecast
12	75
24	150
36	200
48	250
60	300
72	350

An example of track forecast with cone of uncertainty is shown in fig. II-2

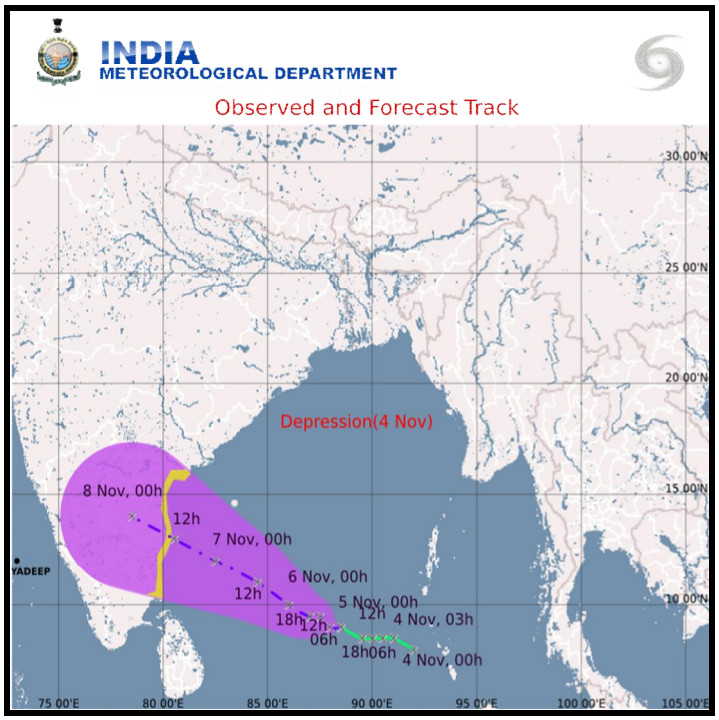

Fig.II-4 A typical example of observed and forecast track with cone of uncertainty.

2.5.2 **Quadrant wind forecast**:

(i) Graphical Product:

The forecast of maximum wind in four quadrants of a cyclone was commenced with effect from cyclone, GIRI during October 2010. In this forecast, the radius of 34, 50 and 64 knot winds are given for various forecast periods like +06, +12, +18, +24, +36, +48, +60 and +72 hrs. A typical graphical presentation of this forecast is shown in Fig.II-3. This bulletin is issued from Deep Depression stage onwards and based on 00, 06, 12 and 18 UTC. It is uploaded in IMD website and sent to focal points of WMO/ESCAP Panel countries by e-mail.

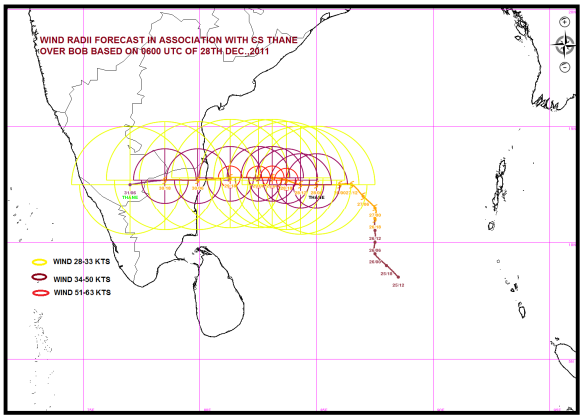

Fig.II-5 An example of Quadrant wind forecast.

(ii) Text Product:

The quadrant wind is also issued in text format and sent to various users through GTS under the header-WTIN31. It is also sent to various NWP modeling groups including NCMRWF, IIT Delhi for vertex relocation. It is provided to storm surge modeling group also for their use.

Example:

QUADRANT WIND DISTRIBUTION IN ASSOCIATION WITH DEEP DEPRESSION OVER EAST CENTRAL ARABIAN SEA
DATE AND TIME BASED UPON WHICH FORECAST IS PREPARED:
PRESENT DATE AND TIME : 271800 UTC
PRESENT POSITION:12.5^{0}N/ 86.0^0 E
POSITION ACCURATE TO 50 KM
PRESENT MOVEMENT (DDD/FF) PAST SIX HOURS: 260/04KT

PRESENT WIND DISTRIBUTION:
MAX SUSTAINED WINDS: 45 KT, GUSTS 55 KT
RADIUS OF MAXIMUM WIND
WINDS VARY IN EACH QUADRANT
RADII ARE LARGEST RADII EXPECTED ANYWHERE IN THE QUADRANT
WIND RADII VALID OVER OPEN WATER ONLY

FORECASTS:
06 HRS, VALID AT:
280000Z 12.7^{0}N/ 85.5^0 E
MAX SUSTAINED WINDS: 50 KT, GUSTS 60 KT

RADIUS OF 050 KT WINDS:
40 NM NORTHEAST QUADRANT
35 NM SOUTHEAST QUADRANT
35 NM SOUTHWEST QUADRANT
40 NM NORTHWEST QUADRANT
RADIUS OF 034 KT WINDS:
50 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
40 NM SOUTHWEST QUADRANT
50 NM NORTHWEST QUADRANT
RADIUS OF 028 KT WINDS:
120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT
12 HRS, VALID AT:
280600 12.9^{0}N/ 85.0^{0}E
MAX SUSTAINED WINDS : 55 KT, GUSTS 65 KT
RADIUS OF 050 KT WINDS:
40 NM NORTHEAST QUADRANT
35 NM SOUTHEAST QUADRANT
35 NM SOUTHWEST QUADRANT

40 NM NORTHWEST QUADRANT

RADIUS OF 034 KT WINDS:

50 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
40 NM SOUTHWEST QUADRANT
50 NM NORTHWEST QUADRANT

RADIUS OF 028 KT WINDS:

120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT

18 HRS, VALID AT:
281200 13.1^0N/ 84.5^0 E
MAX SUSTAINED WINDS 60 KT, GUSTS 70 KT

RADIUS OF 050 KT WINDS:

40 NM NORTHEAST QUADRANT
35 NM SOUTHEAST QUADRANT
35 NM SOUTHWEST QUADRANT
40 NM NORTHWEST QUADRANT

RADIUS OF 034 KT WINDS:

50 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
40 NM SOUTHWEST QUADRANT
50 NM NORTHWEST QUADRANT

RADIUS OF 028 KT WINDS:

120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT

24 HRS, VALID AT:
281800 13.3^0N/ 84.0^0 E
MAX SUSTAINED WINDS : 55KT, GUSTS 65 KT

RADIUS OF 050 KT WINDS:

30NM NORTHEAST QUADRANT
25 NM SOUTHEAST QUADRANT
25 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT

RADIUS OF 034 KT WINDS:

50 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
40 NM SOUTHWEST QUADRANT
50 NM NORTHWEST QUADRANT

RADIUS OF 028 KT WINDS:

120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT

36HRS, VALID AT:
290600 13.3^0N/ 83.0^0 E
MAX SUSTAINED WINDS : 50KT, GUSTS 60 KT

RADIUS OF 050 KT WINDS:

30NM NORTHEAST QUADRANT
25 NM SOUTHEAST QUADRANT
25 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT

RADIUS OF 034 KT WINDS:

50 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
40 NM SOUTHWEST QUADRANT
50 NM NORTHWEST QUADRANT

RADIUS OF 028 KT WINDS:

120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT

48HRS, VALID AT:
291800 13.3^{0}N/ 81.5^0 E
MAX SUSTAINED WINDS :50 KT, GUSTS 60 KT
RADIUS OF 050 KT WINDS:
30NM NORTHEAST QUADRANT
25 NM SOUTHEAST QUADRANT
25 NM SOUTHWEST QUADRANT
30 NM NORTHWEST QUADRANT
RADIUS OF 034 KT WINDS:
50 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
40 NM SOUTHWEST QUADRANT
50 NM NORTHWEST QUADRANT
RADIUS OF 028 KT WINDS:
120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT
60HRS, VALID AT:
300600 13.2^{0}N/ 79.5^0 E
MAX SUSTAINED WINDS : 35 KT, GUSTS 45 KT
RADIUS OF 034 KT WINDS:
50 NM NORTHEAST QUADRANT
40 NM SOUTHEAST QUADRANT
40 NM SOUTHWEST QUADRANT
50 NM NORTHWEST QUADRANT
RADIUS OF 028 KT WINDS:
120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT
72HRS, VALID AT:
301800 13.0^{0}N/ 78.5^0 E
MAX SUSTAINED WINDS :30 KT, GUSTS 40 KT
RADIUS OF 028 KT WINDS:
120 NM NORTHEAST QUADRANT
100 NM SOUTHEAST QUADRANT
100 NM SOUTHWEST QUADRANT
120 NM NORTHWEST QUADRANT

ANNEX II-A-1

CLASSIFICATION OF TROPICAL CYCLONE WARNING SYSTEMS IN THE PANEL COUNTRIES

Existing classifications of low pressure systems (cyclonic disturbances) in the Panel countries are given below together with the WMO classifications.

Classification of low pressure systems (cyclonic disturbances) presently in use by Panel countries for national purposes)

Country	Type of Disturbance	Corresponding Wind Speed
Bangladesh	Low pressure area	Less than 17 knots (less than 31 km/h)
	Well marked low	17- 21 knots (31-40km/h)
	Depression	22- 27 knots (41-51km/h)
	Deep Depression	28- 33 knots (52-61km/h)
	Cyclonic storm	34 -47 knots (62-88 km/h)
	Severe cyclonic storm	48- 63knots (89-117 km/h)
	Severe cyclonic storm with a core of hurricane wind	64 ï 119 knots (118-221km/h)
	Super cyclonic storm	120 knots and above (222 km/h or more)
India	Low pressure area	Less than 17 knots
	Depression	17 -27 knots
	Deep Depression	28- 33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48 -63 knots
	Very severe cyclonic storm	64 -119 knots
	Super cyclonic storm	120 knots and above
Maldives	Low pressure area	Less than 17 knots
	Depression	17- 27 knots
	Deep Depression	28 -33 knots
	Cyclonic storm	34 -47knots
	Severe cyclonic storm	48 -63knots
	Very severe cyclonic storm	64 -119knots
	Super cyclonic storm	120 knots and above
Myanmar	Low pressure area	Less than 17 knots
	Depression	17- 27 knots
	Deep Depression	28 -33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48 -63 knots
	Very severe cyclonic storm	64 -119 knots
	Super cyclonic storm	120 knots and above
Oman (Sultanate of Oman)	Low	Less than 17 knots
	Depression	17-27 knots
	Deep depression	28-33 knots
	Tropical storm	34-63 knots
	Tropical cyclone	64 knots or more
Pakistan	Depression	22- 27knots
	Deep Depression	28- 33knots
	Cyclonic storm	34 -47knots
	Severe cyclonic storm	48- 63knots
	Very severe cyclonic storm	64- 119 knots
	Super cyclonic storm	120 knots or more

Country	Type of Disturbance	Corresponding Wind Speed
Sri Lanka	Low pressure area	Less than 17 knots
	Depression	17- 27 knots
	Deep Depression	28- 33 knots
	Cyclonic storm	34 -47 knots
	Severe cyclonic storm	48- 63 knots
	Very severe cyclonic storm	64 -119 knots
	Super cyclonic storm	120 knots and above
Thailand	Tropical depression	Up to 33 knots
	Tropical storm or Cyclonic storm	34- 63 knots
	Typhoon or cyclone	64 knots or more
WMO	Tropical depression	Up to 34 knots
Classification	Moderate tropical storm	34- 47 knots
(Vide WMONo.471)	Severe tropical storm	48 -63 knots
	Hurricane (or local synonym) Winds	64 knots and more
	Tropical disturbance of Unknown intensity	Wind speed uncertain

Tropical Cyclone Warning System in Bangladesh

Organization

The Bangladesh Meteorological Department is responsible for providing tropical cyclone warnings to Bangladesh and its coastal areas and for a designated portion of the high seas in the Bay of Bengal. Warnings and forecasts are issued under the authority of the Director, Bangladesh Meteorological Department.

The tropical storm warnings are provided from the Storm Warning Centre, Agargaon, Dhaka1207. This Centre is also responsible for issuing the weather warnings like ñNorôwestersò(severe local storms) warning, etc.

Tracking

The tropical cyclones are tracked with the help of conventional observations, radar, satellite observations and model derived products.

Tropical cyclone warnings

Tropical cyclone warnings are provided to:

(i) The Honourable President
(ii) The Honourable Prime Minister
(iii) Control room, Ministry of Food and Disaster Management (MoFDM)
(iv) All ministries
(v) The Sea Port Authorities at Chittagong, Mongla and Coxôs Bazar
(vi) The Cyclone Preparedness Programme (CPP), Bangladesh Red Crescent Society
(vii) The Armed Forces division, Bangladesh Navy, Bangladesh Air Forece
(viii) Inland river ports authorities
(ix) Airport authorities
(x) Concerned government officials
(xi) The general public (through Betar (Radio) Television, electronic media and mass- media)
(xii) Fishing boats and trawlers in the sea
(xiii) Coast Guard
(xiv) The NGOs

Stages of warnings

Warnings are issued in four stages for the government officials. The first stage called "Alert" is issued to all concerned whenever a disturbance is detected in the Bay as per Standing Orders for Disasters (SOD) of Bangladesh. In the second stage, cyclone warnings are issued in four stages as detailed below:

(i) (a) Distant Cautionary Signal- issued if a ship might run into danger during its voyage after leaving the harbour.
(b) Distant Warning Signal issued when there is no immediate danger of the port but a ship might run into the storm after leaving the port.

(ii) (a) Local Cautionary Signal ï issued when port is threatened by squally weather from tropical disturbances or norôwesters.

(b) Local Warning Signal issued when the port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution. It is issued minimum 24 hours before the landfall.

(iii) Danger Signal issued when the port is likely to experience severe weather from a storm of slight or moderate intensity. The Signal is issued minimum 18 hours before the landfall.

(iv) Great Danger Signal issued when the port is likely to experience severe weather from a storm of great intensity. The signal is issued minimum 10 hours before the landfall.

Format of the cyclone warning bulletin

Cyclone warning bulletins contain the following information:

(i) Name of the storm
(ii) Position of the storm centre
(iii) Direction and speed of movement in knots for international use and km/h for national use.
(iv) Distance of the storm centre from the ports.
(v) Maximum sustained wind within the radius of maximum wind of the disturbance.
(vi) Signals for the maritime ports.
(vii) Areas likely to be affected specifying Police Station (Thana) of subdivision as far as possible.
(vii) Approximate time of commencement of gale winds (speed more than 51 km/ h).
(viii) Storm surge height in meter and areas likely to be inundated.
(ix) Advisory for fishing boats and trawlers over North Bay and Deep Sea.

Tropical cyclone warnings for the high seas

Tropical cyclone warnings for the high seas in Bangladesh are provided from the Storm Warning Centre at Dhaka and are broadcast from the coastal radio station at Chittagong (ASC). Warnings are issued for the Bay of Bengal region north of 18^{o} N latitude.

Warnings to ports

In accordance with international procedure, ports are warned and advised to hoist "Signals" whenever adverse weather is expected over the ports for the oceanic areas, in which it is located due to the tropical cyclone. However, regional difference exists. The warning messages normally contain information on the location, intensity, direction and speed of movement of the tropical cyclone and the expected weather over the port. The tropical cyclone signals used in Bangladesh ports along with their meaning are given in Attachment to **Annex II-b.**

Dissemination

Warnings are disseminated through high priority landline telegrams, telefax, telephone and teleprinter. In addition, warnings are also transmitted to Betar (Radio) Bangladesh, Dhaka, Chittagong, Khulna, Rangpur, Rajshahi and Sylhet for broadcast. Alert messages are broadcast four to five times a day. "Warnings" are broadcast every hour and "Danger" and "Great Danger" messages are broadcast frequently.

Dissemination of tropical cyclone warnings

(i) Telefax
(ii) Telephones
(iii) Automatic Message Switching System (AMSS)
(iv) Bangladesh Betar (Radio)
(v) Television
(vi) Through print & electronic media
(vii) W/T
(viii) Internet, by keeping information on BMD website (http:www.bmd.gov.bd).

Cyclone warning system in India

The India Meteorological Department is responsible for providing tropical cyclone warnings in India. The tropical cyclone warning service is one of the most important functions of the India Meteorological Department and it was the first service undertaken by the Department which is more than 135 years old.

Organization

Tropical cyclone warnings in India are provided through three Area Cyclone Warning Centres (ACWCs) located at Kolkata, Chennai and Mumbai and three Cyclone Warning Centres at Bhubaneswar, Visakhapatnam and Ahmedabad. The entire cyclone warning work is coordinated by the Deputy Director General of Meteorology (Weather Forecasting) at Pune and Deputy Director General of Meteorology (Services) at New Delhi.

Tracking of tropical cyclones

Tracking of the tropical cyclones in India is done with the help of:

(vii) Conventional surface and upper air observations from inland and island stations, coastal Automatic Weather Station (AWS), ships and buoy observations;
(ii) Cyclone detection radar including Doppler Weather Radar;
(iii) Satellite cloud pictures from the Geostationary Satellite (INSAT 3A & Kalpana1).

More details on the observing system are provided in a separate chapter.

Tropical cyclone warnings

The bulletins and warnings issued in connection with tropical cyclones in India may be divided into the following broad categories:

(i) Warning bulletins for shipping on the high seas.
(ii) Warning bulletins for ships plying in the coastal waters.
(iii) Port warnings.
(iv) Fisheries warnings. (Fishermen & Fisheries Officials)
(v) Four stage warnings for the State and Central Government officials.
(vi) Warnings for recipients who are registered with the department (Designated/registered users).
(vii) Aviation.
(viii) Warnings for the general public through All India Radio, Doordarshan and the Press.
(ix) Warning for Indian Navy.
(x) Bulletins for Print / Electronic media.

Format and examples of all these bulletins are shown as Attachment to Annex II-CC

Bulletins for the high seas

These bulletins are for the shipping interests on the high seas. The area covered by these bulletins is the sea area between the Asian Coast and the line joining the points 24^0 N 68^0 E, 20^0 N 68^0 E, 20^0 N 60^0 E, 5^0 N 60^0 E, 5^0 N 95^0 E, 10^0 N 95^0 E, 10^0 N 94^0 E, 13^0 30'N 94^0 E, 13^0 30'N 92^0 E, 18^0 N 92^0 E and 18^0 N 94^0 30'E. The exact area of coverage is shown below (fig.- Annex II-C-I).

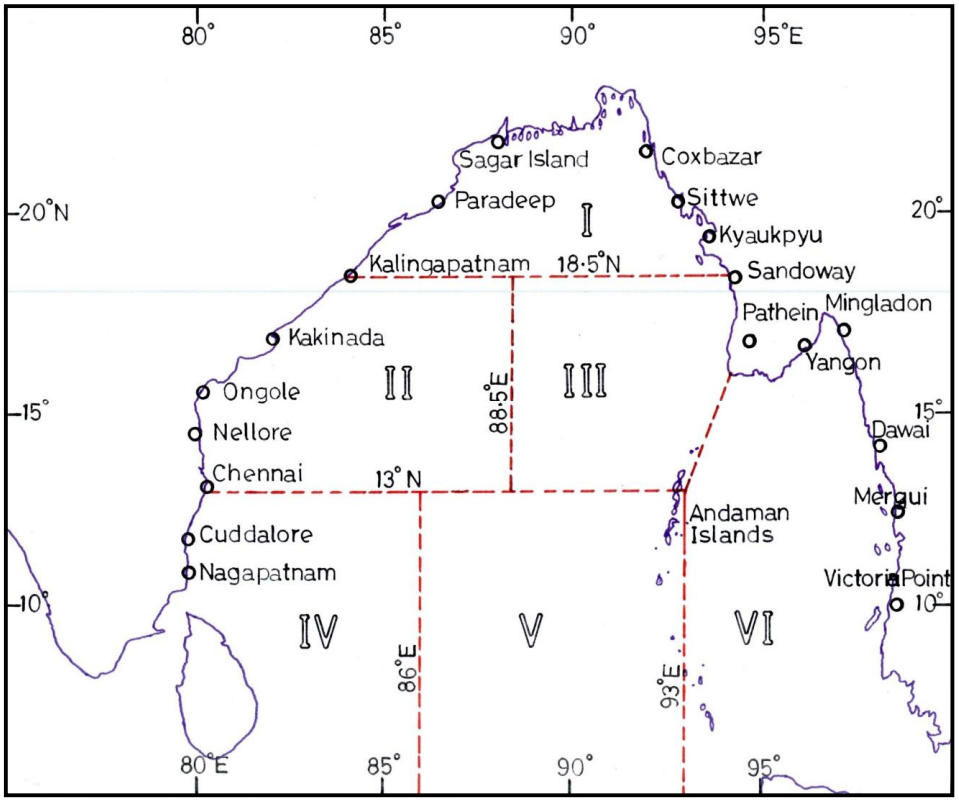

Fig. II-C-I. The exact area of coverage

These bulletins are issued by the Area Cyclone Warning Centres at Kolkata and are broadcast by the Coastal Radio Stations of the Department of Telecommunication (DoT) and ðNAVTEX Chennaiù These bulletins are issued by the Area Cyclone Warning Centres; Mumbai is available to the users through e-mail/fax and uploaded in the website of RMC Mumbai. The bulletins for the Arabian Sea broadcast from Mumbai Radio are issued by the Area Cyclone Warning Centre at Mumbai, whilst those for the Bay of Bengal, broadcast from Kolkata and Chennai Radio, are issued by the Area Cyclone Warning Centre at Kolkata. Under the GMDSS programme of WMO/IMO, India is issuing GMDSS bulletins for met area VIII (N) daily at 0900 UTC and 1800 UTC with additional warning during cyclone period. These bulletins consist of six parts. They are:

Part I : Tropical Cyclone Warning in plain language.

Part II : Synopsis of weather conditions in the forecast area in plain language.

Part III : Forecast in plain language.

Part IV : Analysis of the surface synoptic chart in IAC Fleet Code.

Part V : Data of observations from ships in WMO codes.

Part VI : Data of observations from selected land stations and upper air reports in WMO codes.

In normal undisturbed weather, two bulletins are broadcast at fixed hours known as "Daily" bulletins. In the event of disturbed weather (depression in the Bay of Bengal and the Arabian Sea), a third bulletin known as "Extra" bulletin is broadcast.

When a cyclonic storm has developed, three additional bulletins known as 'Storm' bulletins are broadcast. In addition to these six bulletins, if any unexpected development of weather warrants urgent communication to ships, a "Special" bulletin is issued which may be broadcast at any time. These bulletins are broadcast according to a schedule at fixed hours. Daily bulletins broadcast from Mumbai and Kolkata consist of all the above six parts, while those from Chennai consist only of Parts I, II and III. "Extra", "Storm" and "Special" bulletins contain only Part I.

Coastal Weather Bulletins

These bulletins give weather information in greater detail in the coastal areas for the benefit of ships plying mainly in coastal areas. For the purpose of these bulletins, the coastal area is defined as the sea area up to 75 km off the coastline.

As in the case of sea bulletins for merchant ships, the coastal bulletins are broadcast from Navtex, Chennai. In normal weather coastal bulletins are broadcast twice daily (Daily One at 0630 UTC and Daily Two at 1830 UTC respectively). These are known as "Daily" bulletins. Whenever a depression, tropical cyclone or some other phenomenon influences the weather of the coastal strip concerned "Extra", "Storm" and "Special" bulletins for the coastal strip are also broadcast in addition to "Daily" bulletins.

Each bulletin first gives the name of the coastal strip to which it pertains followed by the details of the weather system, if any, affecting the coastal area. It also includes a forecast of wind, weather, visibility and state of sea for the coastal strip. Information on storm surges/tidal waves and areas likely to be affected are given whenever necessary. The bulletins also give information regarding storm warning signals, if any, hoisted at the ports in the coastal strip concerned.

The coastal bulletins pertaining to Tamil Nadu and Andhra coasts are being sent to Maritime telex (Navtex) at Chennai and they are sending by e-mail/fax to the ships plying in the above coastal waters. It uploaded in the website of RMC Mumbai also. Coastal weather bulletin in respect of Kerala coast is broadcast through Kochi radio and Karnataka coastal weather bulletin is broadcast through the maritime telex (Navtex) Mumbai. These bulletins are also uploaded in the IMD web site (www.imd.ernet.gov.in or www.imd.gov.in).

Under the new GMDSS programme of IMO/WMO, India is issuing NAVTEX bulletins daily from the Area Cyclone Warning Centres at Mumbai and Kolkota for Arabian sea and Bay of Bengal respectively.

Storm warnings to ports

A visual storm warning signal system for the Bay of Bengal ports, chiefly for the port of Kolkata, has been in existence since 1865. A similar system for the ports on the west coast was started in 1880. A uniform system applicable to all Indian ports was introduced in 1898.

The India Meteorological Department issues storm warnings to port officers whose ports are likely to be affected by adverse weather. They are also advised to hoist visual storm warning signals for the benefit of ships at the port and those out at sea. The information is, in most cases, conveyed by very high priority telegrams/fax/e-mail.

The storm warning signals, which are displayed prominently on masts in ports, are in the form of cones and cylinders for day signals and red and white lamps for night signals. In addition to hoisting signals, port officers have, in most cases, arrangements for disseminating the information and warnings received by them to country crafts and sailing vessels in the harbor.

The meaning of the signals used in Indian ports is given in Attachment to Annex II-C2.

Tropical storm warnings to government officials (Four stage warnings)

A **"pre-cyclone watch**ò bulletin is issued by DGM himself soon after the formation of a depression informing senior central government officials including chief secretary of coastal maritime States about likely development of a cyclonic storm, its movements, coastal belt of India likely to experience adverse weather. No fixed format is used.

At the second stage, a "cyclone alert" is issued 48 hours in advance of the expected commencement of adverse weather in association with the cyclonic storm over the coastal area. The third stage of the warning, known as "cyclone warning" is issued 24 hours in advance of commencement of severe weather. The last stage of warning covering the post-landfall scenario is included in the cyclone warnings issued just before landfall and is continued till the cyclonic wind force is maintained in the core area of the cyclonic storm over land.

Post landfall outlook

Post-landfall outlook will be issued as a part of cyclone warning at least 12 hours in advance of the landfall of the system by RSMC New Delhi and the concerned ACWC. On the basis of this outlook, the concerned RMC/MC which are likely to be affected will also issue cyclone warnings for the interior area. This is the regular cyclone warning.

Tropical cyclone bulletins to All India Radio (AIR) for broadcast

In general, weather bulletins are issued by the meteorological offices to the AIR stations for broadcast in the midday transmissions. These are based on 0300 UTC charts. The areas covered by the bulletins are the areas served by the respective AIR stations. These bulletins include:

(i) A summary of the past weather;
(ii) special weather warnings for public services such as the Public Works Department, Irrigation, DoT, Railways, etc. &
(iii) General forecast including warnings.

Points (ii) and (iii) are valid until the morning of the second day. The summary of weather includes information about tropical storms and depressions affecting the area. The centre of the system is included with reference to the nearest well known place and latitude and longitude. Warnings in bulletins once included are repeated in the subsequent daily bulletins also as long as adverse weather is anticipated. In addition, meteorological centres in the maritime states include suitable warnings for fishermen. These general bulletins are broadcast at a fixed time (midday) by the AIR stations and are intended to meet the requirements of the public in general and the needs of various categories of officials in particular.

In addition, special AIR bulletins containing cyclone alert messages issued 48 hours prior to the commencement of the adverse weather and tropical cyclone warning messages issued 24 hours prior to the commencement of the adverse weather in the coastal areas due to an approaching tropical storm are broadcast. These broadcasts are meant to alert the agencies entrusted with the responsibility of carrying out cyclone preparedness works and also the general public.

(For framing the tropical storm warning bulletins to AIR and Doordarshan abbreviated terms like "cyclone" for cyclonic storm, "severe cyclone" for the severe cyclonic storm and "super cyclone" for super cyclonic storm are also used.)

The height of the storm surge is included in the bulletin in meters and it represents height above the normal tide level. The coastal districts likely to be affected by the storm are mentioned in the first sentence of the bulletins. The types of damage likely to be expected from systems of various intensities along with the suggested action are also included. For this purpose the following table is referred.

System Intensity	Damage expected	Action Suggested
Deep Depression (28-33 Kts or 52-61Kmph)	Minor damage to loose and unsecured structures	Fishermen advised not to venture into the open seas.
Cyclonic Storm (34-47kts or 62-87 kmph)	Damage to thatched huts. Breaking of tree branches causing minor damage to power and communication lines	Total suspension of fishing operations
Severe Cyclonic Storm (48-63 kts or 88-117 kmph)	Extensive damage to thatched roofs and huts. Minor damage to power and communication lines due to uprooting of large avenue trees. Flooding of escape routes.	Total suspension of fishing operations. Coastal hutment dwellers to be moved to safer places. People in affected areas to remain indoors.
Very Severe Cyclonic Storm (64-90 kts or 118-167 kmph)	Extensive damage to kutcha houses. Partial disruption of power and communication line. Minor disruption of rail and road traffic. Potential threat from flying debris. Flooding of escape routes.	Total suspension of fishing operations. Mobilise evacuation from coastal areas. Judicious regulation of rail and road traffic. People in affected areas to remain indoors.
Very Severe Cyclonic Storm (91-119 kts or 168- 221 kmph)	Extensive damage to kutcha houses. Some damage to old buildings. Large-scale disruption of power and communication lines. Disruption of rail and road traffic due to extensive flooding. Potential threat from flying debris.	Total suspension of fishing operations. Extensive evacuation from coastal areas. Diversion or suspension of rail and road traffic. People in affected areas to remain indoors.
Super Cyclone (120kts or more or 222 kmph or more)	Extensive structural damage to residential and industrial buildings. Total disruption of communication and power supply. Extensive damage to bridges causing large-scale disruption of rail and road traffic. Large-scale flooding and inundation of sea water. Air full of flying debris.	Total suspension of fishing operations. Large-scale evacuation of coastal population. Total suspension of rail and road traffic in vulnerable areas. People in affected areas to remain indoors.

These bulletins are generally issued at the time of each sea area bulletin. The frequency of the bulletin can be raised when the tropical storm is tracked with the help of radar and previous warnings issued needs modification.

A third set of bulletins issued to AIR is the coastal weather bulletins. Whenever a cyclonic storm is likely to affect the Indian coastal areas, coastal weather bulletins issued by the India Meteorological Department are broadcast in the All India News Cycles of All India Radio from New Delhi in English, Hindi and in the regional language of the area affected. These bulletins contain information on the following:

1) Time of issue of bulletin in IST
2) Coastal strip for which bulletin issued and period of validity
3) Position, intensity and movement of cyclonic storm
4) Forecast point and time of landfall
5) Signals hoisted at the ports in the coastal strip
6) Information of storm surges/tidal waves

Dissemination of tropical cyclone warnings

The modes of telecommunication used for the dissemination of tropical cyclone warnings in India are:

(i) Telefax
(ii) Telephones
(iii) Automatic Message Switching System (AMSS)
(iv) All India Radio
(v) Television
(vi) Cyclone Warning Dissemination System (CWDS), Digital Cyclone Warning Dissemination System (DCWDS) one way communication system
(vii) W/T (especially police W/T)
(viii) Internet, by keeping information on IMD website (http://:www.imd.gov.in).
(ix) Microwave link of the railways
(x) IVRS
(xi) e-mail
(xii) SMS
(xiii) GMDSS

The following warnings/advisory products are given in the dynamic page of cyclone page of IMDÕs website. When one type of communication channel fails, the alternate channel is used

RSMC, New Delhi website

Static Page in IMD website
(www.imd.gov.in/section/nhac/dynamic/cyclone.htm)

Home
RSMC
About RSMC
FDP ï Cyclone

Publications
- TROPICAL CYCLONE PROGRAMME Report No. TCP21(2010)
- TROPICAL CYCLONE PROGRAMME Report No. TCP21(2011)
- Report on Cyclonic Disturbances over North Indian Ocean
- Annual Cyclone Review

Implementation Report of FDP-2010
Preliminary Report-2011
Cyclone Warning Division
About Cyclone Warning Division
Bulletins
Cyclone Warning Organisation

Frequency of Cyclonic Disturbances over North Indian Ocean

Frequency of Cyclonic Disturbances during Monsoon season

Tropical Cyclone Awareness

Frequently Asked Questions

Damage Potential of Tropical Cyclone

Port Warnings

Names Of Tropical Cyclones Over North Indian Ocean

Terminology on Cyclonic disturbances over the North Indian Ocean

Archives
Best Tracks Data (1990-2011)
Cyclone E-Atlas IMD

.

Dynamic Page in IMD website
(www.imd.gov.in/section/nhac/dynamic/cyclone.htm)

CYCLONE WARNINGS

Cyclone Warning For Indian Coast
R S M C Bulletin
T C A C Bulletin
Observed & Forecast Track
Cyclone Wind Forecast
Storm Surge Prediction Model
Latest Satellite Imagery of Cyclone
NWP Guidance

Cyclone warning system in Maldives

The Department of Meteorology Maldives (DMM) issue tropical cyclone and severe weather warning to the public and travellers across the country. Apart from severe weather and tropical cyclone warning, tsunami warnings received through GTS were also despatched. The National Meteorological Centre has established the following means of communication for the dissemination of the warning.

(i) Hotlines (dedicated telephone)
(ii) Local TV (Television Maldives)
(iii) Local Radio (Voice of Maldives)
(iv) Coast Guard Service
(v) Internet (http://www.meteorology.gov.mv)
(vi) Facsimile

Cyclone warning system in Myanmar

2.5. Cyclone warning system in Myanmar

2.5.1 Organization

Tropical cyclone warnings in Myanmar are provided by the Department of Meteorology and Hydrology (DMH), Myanmar. Tropical cyclone warnings are provided from the Multi-Hazard Early Warning Center of DMH in Nay Pyi Taw.

2.5.2 Tracking of Tropical Cyclone

Conventional observations, such as surface and upper air observations, ships' reports, and radar and satellite observations are utilized for observing, detecting and tracking tropical cyclones.

2.5.3 Dissemination of Storm Warning

Collection and dissemination of meteorological data and warnings are done with the coordination of Myanmar Posts and Telecommunications and Department of Civil Aviation point-to-point circuit. The modes of telecommunication used for the dissemination of tropical cyclone warnings in Myanmar are:

1. Telephone
2. Facsimile
3. Local TV (3 Channel)
4. Myanmar Radio
5. FM Radio
6. DMH website- www.moezala.gov.mm
7. Single Side Band Transceiver

2.5.3 Tropical cyclone warnings

The Multi-Hazard Early Warning Center of DMH in Nay Pyi Taw is responsible for providing tropical cyclone and storm surge warnings to its coastal population, the ports along the Myanmar coast and for the designated area of the high seas in the Bay of Bengal. 24x7 Storm Watch Centers: Nay Pyi Taw Multi Hazard Early Warning Centre, Yangon Forecasting office, Mingaladon International Airport Aviation Forecasting office and all coastline observatories watch the storms whenever cyclones develop in the Bay of Bengal.

Storm news and warnings are issued at frequent intervals for national and international users in various sectors. Special storm warnings accompanied with color code and possible storm affected specific areas are issued hourly to all news media. National televisions televised all hourly news continuously in footnote rolling format frequently.

The area designated for Myanmar for providing warnings is the area of the Bay of Bengal east of 92ęE and north of 10ęN. Warnings are broadcast through the coastal radio station at Yangon (call sign XYR).

Port warning signals and their meanings used in the ports of Myanmar are given in AnnexII-E.

Tropical Cyclone Warning System in Oman

Organization

Tropical cyclone warnings in Oman are provided by the Department of Meteorology under the Directorate General of Meteorology and Air Navigation (DGMAN) which falls under the Ministry of Transport and Communication in cooperation with the National Committee for Civil Defense (NCCD).

Tracking

The Oman Regional Model as well as other international numerical weather prediction products are used for early warning. The Tropical Cyclones are tracked with the help of surface and upper air observation, satellite imagery and aircraft observations.
The tropical cyclones are tracked with the help of conventional surface and upper air observations, satellite images particularly the Kalpana-1 INSAT 3A.

Tropical Cyclone Warning

Tropical cyclone warnings are provided for:

(i) The high seas
(ii) Coastal waters
(iii) Ports
(iv) Civilian and military aviation
(v) Governmental officials
(vi) General public including fishermen
(vii) Recipients registered with the DGMAN

Warning Procedures

The Central Forecasting Office will issue tropical storm report, advisory, warnings and amendments every 12 hours or more frequently if required by changing conditions. The Advisory or warning will contain the following information

(i) Number
(ii) Date and time
(iii) Name of Storm
(iv) Classification
(v) Position of the Tropical storm
(vi) Intensity
(vii) Central pressure
(viii) Movement the direction and speed
(ix) Wind direction and speed around the centre
(x) Destination from a coastal point
(xi) Outlook

In the event the storm is expected to approach the coast of Oman, the following bulletins will be issued according to the stage:

Reports

When it is expected that a depression, storm, severe storm or cyclone may approach Oman coast within 72 hours, a report will be issued and it will be renewed every other 24 hours.

Advisory

When it is expected that a depression, storm, severe storm or cyclone May approach Oman coast within 48 hours an advisory will be issued and it will be renewed every other 6 hours.

Warning

When it is expected that a depression, storm, severe storm or cyclone may approach Oman coast within 24 hours a warning will be issued and it will be renewed every other 3 hours.

Last Report

When it is expected that a depression, storm, severe storm or cyclone is dissipating a report will be issued clearing the event.

Bulletins for high sea

Tropical cyclones warnings for the high seas in Oman are provided by the Central Forecasting Office located at Muscat International Airport and broadcasted from the Muscat coastal radio station at Muscat whose call sign is A4M.

Warnings for Ports

The Central Forecasting Office of the Meteorology Department issues warnings to ports whenever adverse weather is expected to affect them
The main ports are:
1- Mina Sultan Qaboos in Muscat
2- Mina Salalah
3- Mina Sohar
4- Wudam Naval Base

Dissemination of the Tropical Cyclone Warnings

The modes of telecommunication used for the dissemination of tropical cyclone warnings and advisories to different categories of recipients are:

1- Telephones
2- Telefax
3- Internet (E-mail, & web site)
4- Short Massages Service (SMS)
5- Wireless Application protocol WAP
6- Voice Mail Pager System
7- Oman Radio
8- Oman Television
9- Muscat Radio Coastal Station

Bulletins for the High Seas

Tropical cyclone warnings for the high seas in Oman are provided by the Central Forecasting Office located at Seeb International Airport and are broadcast from the Muscat Coastal Radio Station at Muscat, whose call sign is A4M.

Warnings to Ports

The Central Forecasting Office of the Meteorological Department issues storm warnings to ports whenever adverse weather is expected to affect them.

The main Ports are:

(i) Mina Sultan Qaboos in Muscat
(ii) Mina Salalah
(iii) Wudam Naval Base
(iv) Khasab
(v) Sohar
(vi) Qalhat

Dissemination of Tropical Cyclone Warnings

The modes of telecommunication used for the dissemination of tropical cyclone warnings and advisories to different categories of recipients are:

(i) Telephones
(ii) Telefax
(iii) Voice Mail Pager System
(iv) Oman Radio
(v) Oman Television
(vi) Muscat Radio Coastal Station
(vii) Web site: www.met.gov.om
(viii) Email

ANNEX II-G-1

Tropical cyclone warning system in Pakistan

Pakistan Meteorological Department is responsible for the preparation and issuance of tropical cyclone warnings in Pakistan. The tropical cyclone warnings are issued by Marine Meteorology & Tropical Cyclone Warning Centre of PMD.

Tracking of the tropical cyclones

Tracking of the tropical cyclone in Pakistan is done with the help of following:

(i) Conventional surface and upper air observations from inland stations and ships' observations
(ii) Model outputs and guidance from the global tropical cyclones warning centres
(iii) The NWP products of High resolution Regional Model (implemented at PMD)
(iv) Cyclone detection radar
(v) Meteorological satellites data products.
(vi) AWSs installed at coast along Sindh and Makran (Balochistan)

Tropical cyclone Watch, Alert and Warning

Tropical cyclone Watch, Alert and Warning are issued by PMDøs Marine Meteorology & Tropical Cyclone Warning Centre as per following criteria:

Tropical cyclone Watch is issued when a tropical cyclone gets formed or enters the Arabian Sea north of Lat. 10^{o}N. Tropical cyclone Watch is issued irrespective of cycloneøs threat to affect Pakistanøs coastal areas. The issuance of tropical cyclone Watch requires the concerned authorities to be watchful.

Tropical cyclone Alert is issued when there is likelihood that tropical cyclone may affect Pakistanøs coastal areas.

Tropical cyclone Warning is issued when there is very likelihood that tropical cyclone may affect Pakistan coast. Tropical cyclone warnings are issued every three (3) or six (6) hours and/or whenever necessary and imperative.

Tropical cyclone warnings

The bulletins and warnings issued in connection with tropical cyclones in Pakistan are divided into the following broad categories:

i. Warning bulletins for shipping on the high seas
ii. Warning bulletins for ships plying in the coastal waters
iii. Port warnings
iv. Fisheries warnings
v. Warnings for Government officials and functionaries including National Disaster Management Authority (NDMA) and Provincial Disaster Management Authorities (PDMAs) and District Management Authorities (DDMAs)
vi. Warnings for recipients who are registered with PMD
vii. Warnings for aviation
viii. Warnings for the general public through electronic and print media
ix. Warnings to CBOs, NGOs and INGOs
x. Warning to Search and Rescue (SAR) Operations

Types of warnings

Bulletins for the high seas

These bulletins are for the shipping interests on the high seas. The area covered includes the North Arabian Sea (north of 20^{o} N).

These bulletins are issued by the PMDôs Marine Meteorology -Tropical Cyclone Warning Centre, Karachi and are broadcast by the Coastal Radio Stations. These bulletins consist of three parts.

Part I : Tropical Cyclone Warning in plain language.
Part II : Synopsis of weather conditions in the forecast area in plain language.
Part III : Forecast in plain language (for weather, wind, visibility and sea state etc.).

During normal undisturbed weather, two bulletins are broadcast at fixed hours known as "Daily" bulletins. In the event of disturbed weather additional bulletins are issued.

Storm warnings to ports

PMDôs Marine Meteorology &Tropical Cyclone Warning Centre issues warnings to port officers whose parts are likely to be affected by adverse weather. They are also advised to hoist visual storm warning signals for the benefit of ships at the port and those out at sea. The information is, in most cases, conveyed by facsimile, SMS and telephone. The meaning of the port warning signals used in Pakistan ports is given in Annex-II-G.

Dissemination of tropical cyclone warnings

The modes of telecommunication used for the dissemination of tropical cyclone warnings in Pakistan are:

i. Coastal Radio (ASK)
ii. Telephones
iii. Electronic and print media
iv. Radio Pakistan
v. Pakistan television
vi. Telex/Telefax
vii. Internet, PMDôs website: www.pmd.gov.pk
viii. SMS and
ix. FM radios

The mode of telecommunication differs for different types of messages. When one type of communication channel fails, the alternate channel is used.

ANNEX II-H-1

Cyclone warning system in Sri Lanka

Organization

The responsibility of the cyclone warning in Sri Lanka rests with the Department of Meteorology, Sri Lanka. Tropical cyclone warnings are provided from the National Meteorological Centre (NMC) Colombo.

Tracking

Tropical cyclones are tracked with the help of conventional observations, radar, satellite observations and aircraft reports. These are dealt with in more detail in a separate chapter.

Tropical cyclone warnings

Tropical cyclone advisories/ alerts/ warnings are issued under two criteria, viz., Distance from the Coast and Intensity of the System, each criterion having key stages.

(a). Distance Criterion

(i) **When a depression or a cyclonic storm is about 550 km off the coast**.

In addition to distance of storm centre from coast, this bulletin indicates forecast conditions on the (a) speed and direction of movement and (b) maximum surface wind speed likely. This bulletin is issued every twelve (12) hours and wherever imperative.

(ii) When the cyclonic storm is 300 km off the coast.

In addition to above contents, information on areas likely to be affected are provided. This bulletin is issued every six (6) hours and wherever imperative. and

(iii) When the cyclonic storm is 200 km off the coast.

If landfall is indicated, a bulletin is issued every three (3) hour and wherever imperative. This bulletin includes additional information on point of landfall, storm surges and areas likely to be inundated.

Signal No.	Colour	Description	Action required
1	White	Potential area of development	Information only, vessels at sea to be vigilant.
2	White	Cyclone has fomed	Information only, vessels to avoid the area, listen to media.
3	Yellow	Weather experienced in coastal region, sea getting rough	Vessels to avoid the area, people to stay away from sea/ beach.
4	Yellow	Raining with windy (~40 knots), sea rough	Stay away from beach, vessels in danger, be inside building.
5	Yellow	Heavy rain with very strong wind (>40 knots)	Be ready to leave buildings with weak structures (in relevant areas only) and low lying (flood prone) areas, secure your home/valuables.
6	Red	Heavy rain with very strong wind >40 kts, cyclone expected to cross land	Evacuate to pre-designated safe places
7	Red	Severe weather very strong wind (>50 knots), severe cyclone expected to cross land	Evacuate to pre-designated safe places
8	Green	Cyclone warning cancellation/withdrawal bulletin	

(b). Intensity Criterion (Signal levels)

(i) When the cyclonic storm is 300 km off the coast.

In addition to above contents, information on areas likely to be affected are provided. This bulletin is issued every six (6) hours and wherever imperative and

(ii) When the cyclonic storm is 200 km off the coast and if landfall is indicated, a bulletin is issued every three (3) hour and wherever imperative. This bulletin includes additional information on point of landfall, storm surges and areas likely to be inundated.

Tropical cyclone warning

Tropical cyclone warnings for different users

- Relevant Government Officials including HE President & Prime Minister
- Disaster Management Centre (DMC)
- General Public
- Media
- The Armed Services & Police
- Local Administrations of relevant districts and
- Irrigation, Highways etc.

Specific users

- Coastal fishing
- Shipping and
- Aviation

Tropical cyclonic warnings for the high seas

For the high seas, the tropical cyclone warnings are provided from NMC Colombo and broadcast through the coastal radio station Colombo Radio (4PB). The area covered by the warnings is the Indian Ocean, Arabian Sea and the Bay of Bengal from the equator to 10^0 N between 60^0 E and 95^0 E.

Dissemination of tropical cyclone warnings

The warnings/bulletins for the high seas are disseminated through Colombo (4PB). Other general modes are:

- State and Private Radio
- State and Private Television
- Press/Print Media
- Telephones/Pager/ SMS
- Police Communication
- Teleprinter
- Telefax
- Internet SLMD website (http://www.meteo.gov.lk)
- Through warning towers of Disaster Management Centre

Tropical cyclone warnings in Thailand

Organization

Tropical cyclone warnings in Thailand are provided by the Meteorological Department, Thailand, from the Meteorological Office at Bangkok.

Tracking

Tropical cyclones are tracked with the help of conventional observations, radar, satellite observations and aircraft reports. These are dealt with in more detail in a separate chapter.

Tropical cyclone warning system

Tropical cyclone warnings for the high seas are issued from the Meteorological Office at Bangkok through the Bangkok coastal radio stations (HSA, HSS) for the areas covered by the Gulf of Thailand, west of Southern Thailand, Straight of Malacca and the South China Sea.

Port warnings issued in Thailand have been simplified. Three signals are used to indicate different stages of tropical storms, viz., tropical depression with wind speed up to 33 kts, tropical storm with wind speed 34 to 63 kts and typhoon or cyclone or storm with wind speed 64 kts or more. Four signals are used for the four different areas of responsibility. Port warning signals used in Thailand Port are given in Attachment AnnexII-I.

Day Signals*		Specifications	Night Signals*	Remarks

Bangladesh (8.XI.1976)

Signals Meant for Maritime Ports

16a	I.	Distant Cautionary Signal Number One	3b	
		There is a region of squally weather in which a storm may be forming (well marked low or depression with surface winds up to 61 km/h. (33 knots))		These signals indicate that ships may be exposed to danger after leaving the harbour
10a	II.	Distant Warning Signal Number Two	2b	
		A storm has formed (cyclonic storm with surface winds 62-88 kmph. (34-47 knots)		
3a	III.	Local Cautionary Signal Number Three	5b	
		The port is threatened by squally weather (cyclonic circulation with surface winds 40-50 km/h. (22-27 knots)) or squalls due Nor'Westers)		These signals indicate that the port itself and the ships in it are in danger
2a	IV.	Local Warning Signal Number Four	4b	
		The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution (cyclonic circulation with surface winds 51-61 km/h. (28-33 knots))		
17a	V.	Danger Signal Number Five	16b	
		The port will experience severe weather that the port itself and the ship in it and in coast to the south of the port (to the east of the port in the case of Mangla) cyclonic storm with surface winds 62-88 km/h. (34-47 knots)		These signals indicate that the port itself and the ships in it are in danger

* The national systems of visual storm warning signals (day signals and night signals) are reproduced in WMO Publication - WMO-No. 9, TD. 4, Volume D, Part D - Visual Storm Warning Signals Annexes II and III respectively.

Day Signals*	Specifications	Night Signals*	Remarks

Bangladesh - continued

18a	VI. Danger Signal Number Six The port will experience severe weather from a storm, of slight or moderate intensity that is expected to cross the coast to the north of the port (to the west of the port in the case of Mangla) (wind speed same as in Signal No. V)	17b	)	
19a	VII. Danger Signal Number Seven The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross over or near to the port (wind speed as in Signal No. V)	18b	)	
20a	VIII. Great Danger Signal Number Eight The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port (to the east of the port in the case of Mangla) (severe cyclonic storm with surface winds 89-118 km/h. (48-63 knots) or severe cyclonic storm of hurricane intensity with winds 119 km/h. (64 knots) or above)	19b	)	These signals indicate that the port itself and the ships in it are in danger
21a	IX. Great Danger Signal Number Nine The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port (to the east of the port in the case of Mangla) (wind speed same as in Signal No. VIII)	20b	)	

* See footnote on page 1 of Attachment to Annex II-B

Day Signals*	Specifications	Night Signals*	Remarks

Bangladesh - continued

22a	X. Great Danger Signal Number Ten The port will experience severe weather from a storm of great intensity that is expected to cross the coast over or near to the port (wind speed same as in Signal No. VIII)	21b	these signals indicate that the port itself and the ships in it are in danger
23a	XI. Failure of Communications Communications with the Meteorological Warning Centre have broken down and the local officer considers that there is danger of bad weather	7b	
	Signals Meant for River Ports		
24a	(I) Cautionary Signal Number One Your area is threatened by squally winds of transient nature (Nor'Wester squalls) of wind speed not exceeding 60 km/h. (32 knots). Look out for further development	5b	these signals are used for the river ports, river and police stations in Bangladesh
1a	(II) Warning Signal Number Two ñA storm (of depression intensity, associated sustained winds not more than 61 km/h. (33 knots) or Nor'Wester squall (of wind speed 61 km/h. (33 knots) or high is likely to strike you (vessels of 65 feet and under in length are to seek shelter immediately) .	7b	these signals are used for the river ports, river and police stations in Bangladesh
2a	(III) Danger Signal Number Three A storm (of gale force, associated sustained winds 62-88 km/h. (34-47 knots)) will soon strike you. All vessels are to seek shelter immediately	2b	

*See footnote on page 1 of Attachment to Annex II-B

Day Signals*	Specifications	Night Signals*	Remarks

Bangladesh - continued

10a	(IV) Great Danger Signal Number Four A violent storm (of whole gale) force and above, associated sustained wind speed exceeding 88 km/h. (47 knots)) will soon strike you. All vessels continue taking shelter immediately	31b	)))))))

In the existing Tropical Cyclone Signal System in Bangladesh, two different types of Signal Numbers, one for maritime and one for river ports are being used for the same cyclone in the sea and its adjoining river ports. This often leads to create confusion among the general public and those who are related with disaster management activities. This confusion has also been observed during the recent cyclone SIDR. Therefore, to avoid any further confusion, unification and standardization of the signals has been made by the Government of the People's Republic of Bangladesh, which is yet to be implemented. Prior to the execution of the new signals, sufficient awareness needs to be raised for the general public, maritime and river port authorities and for the disaster management sector. Once this is done and the Government feels that it is appropriate to implement the new signals, the Panel will be informed accordingly.

Bulletins issued by India for Indian coast

1. State/Central Govt. Officials/Vital installations / Registered User Cyclone Alert/ Cyclone Warning Bulletin No.

FORMAT:

Date and Time of Issue:

(i) Information on cyclone : The cyclonic storm lay over..... Bay of Bengal/Arabian Sea Center ..... kms. ..... (Direction) of ..... place.

(ii) Forecast
Further intensification:
Direction of Movement:
Expected landfall area:
Expected time of landfall:

(iii) Weather Warning

(a) Rainfall ..... in ..... Districts (Names)

(b) Gales reaching ..... in ..... Districts (Names)

(c) Gale force winds reaching 35 knots in ..... Districts

(d) Tidal waves ..... in coastal areas of ..... Districts (Names)

(e) Sea condition:
(f) Damage (As per IMD instruction) ..... Districts (Names)

(g) Likely impacts as per IMD Monograph on ñDamage Potential of Tropical [Depending on Intensity of Storm (T-No)]

(a) Fishermen not to venture into open sea.
(b) Evacuation of people from low lying areas to safer places/Cyclone Shelters.
(c) General public in the threat area advised to be indoors.
(d) Rail & road transport to be regulated.

2. Port Warning

FORMAT:

Port Warning No. Date and Time for Issue

(i) Information on cyclone: The cyclonic storm lay over Bay of Bengal/Arabian Sea near Lat.__/Long. ____ at a distance _____ km. from _____ at _____ IST _____ Estimated Central Pressure _____ hPa.
(ii) Forecast :
Further intensification:
Direction of Movement:
Expected Landfall Area :
Expected Time of Landfall :

(iii) Advice for hoisting Storm Warning Signals:
(iv) Likely impacts and actions: Depending on intensity of the storm as per IMD Monograph on ñDamage Potential of Tropical Cyclonesò

3. **Cyclone Warning Bulletin for AIR/Press / Public:**

FORMAT:

Cyclone Alert / Warning Bulletin No. _____ issued by _____ at _____ Hrs. IST on _____ (Date) for repeated broadcast at hourly / half hourly intervals. Cyclone Alert / Warning for _____ Districts. Cyclone centred at _____ hrs. IST of _____ (date) about _____ kms. _____ of (direction) _____(Place). Expected to intensify further and move in a _____ direction and cross _____ coast near / between _____ (Place)_____ (day/time). Under its influence heavy to very heavy rain likely cause floods in _____ districts commencing from _____ (time/day). Gales speed reaching _____ kmph causing _____ damage _____in districts commencing from _____ (Date/Time) Gale force winds reaching 70 kmph likely extend into _____ Districts, causing damage _____ in _____ districts. Tidal wave of _____ m likely inundate low lying area of _____ Districts at the time of crossing coast.
Fishermen advised not to venture out. Public advised to cooperate with the State authorities in disaster management efforts.

4. Fisheries Warning

FORMAT:

Fisheries warning No. _____
Date and Time of Issue _____

(i) Information on Cyclone: Cyclonic Storm lay over _____ Bay of Bengal / Arabian Sea at a distance _____ kms. _____ from _____ at _____ time (IST) on _____ (date)
(ii) Forecast: Further intensification Direction of Movement

Expected landfall area Expected time of landfall
(iii) Warnings: Wind Sea Condition Tidal Waves
(iv) Storm Warning Signals at ports
Advice and Action: i) Fishermen not to venture into open seas ii) Fishermen at Sea not to come to the ports (names) _____ in coast.

5. Post Landfall Outlook

FORMAT:

EVEN AFTER LANDFALL, THE SYSTEM IS LIKELY TO MAINTAIN ITS INTENSITY FOR é é é é é é é . HOURS AND WEAKEN GRADUALLY AAA UNDER ITS INFLUENCE RAINS AT MOST/MANY PLACES WITH HEAVY TO VERY HEAVY FALLS AT é é é é é é é é é é é é é LIKELY COMMENCE/CONTINUE IN é é é é é é é é é é (COASTAL DISTRICTS) FROM é é é é é (TIME)é é é é é é é é . (DAY) é é é é é é é é é (DATES) CAUSING INUNDATION OF LOW-LYING AREAS AAA GALE WINDS/SQUALLY WINDS SPEED REACHING é é é é é . KMPH LIKELY COMMENCE/CONTINUE IN é é é é é é é é é é é é é ..(COASTAL DISTRICTS) FROM é é é (TIME)ONé é é é é é é é (DAY)é é é é é (DATE) CAUSING DAMAGES TO é é é é é é é é é é é . (PROPERTY AS INDICATED IN IMD MONOGRAPH ON ñDAMAGE POTENTIAL OF TROPICAL CYCLONEò) AND é é é é é é é é é (VEGETATION) AND GENERAL DISRUPTION OF COMMUNICATION AND POWER SUPPLY FOR é é é é é é é é é é é

2. AS THE CYCLONE MOVES INLAND é é é é é é é é .. INTERIOR DISTRICTS MAY ALSO EXPERIENCE HEAVY/VERY HEAVY RAIN ACCOMPANIED WITH GALE WITH SPEEDREACHING é é é é é . KMPH COMMENCING FROM é é é é é é (TIME) ON é é é é é é . (DAY) é é é é é é é . (DATE) FOR é é é é .. HRS, CAUSING FLOODING OF LOW LYING AREAS AND DAMAGE TO PROPERTY AS INDICATED IN IMD MONOGRAPH ON ñDAMAGE POTENTIAL OF TROPICAL CYCLONEò

(AS PER IMD INSTRUCTION)
PEOPLE ARE ADVISED TO REMAIN INDOORS/IN SAFE PLACES AND COOPERATE WITH STATE GOVERNMENT OFFICIALS AND DISASTER MANAGEMENT AGENCIES.

Example: (CYCLONE WARNING FOR INDIAN COAST)

Cyclone warning for West Bengal and north Orissa coasts. "Orange Message"

The cyclonic storm ñ**AILA"** over west central & adjoining east central and north west Bay of Bengal moved further northwards and lay centred at 2030 hours IST of today, the 24th May 2009 over northwest & adjoining central Bay of Bengal near lat. 19.0^0 N and long. 88.5^0 E, about 250 km east-southeast of Paradip, 300 km south-southeast of Sagar Island and 380 km southwest of Khepupara (Bangladesh). The system is likely to intensify further and move in a near northerly direction and cross West Bengal-Bangladesh coast near long. 88.5^0 E (about 50 km east of Sagar Island) around 25th May 2009 afternoon/evening.

Based on latest analysis with Numerical Weather Prediction (NWP) models and other conventional techniques, estimated track and intensity of the system are given in the Table below:

Date/Time(IST)	Position (lat. ^{0}N/long. ^{0}E)	Sustained maximum surface wind speed (kmph)
24.05.2009/2030	19.0/88.5	65 gusting to 75
24.05.2009/2330	19.5/88.5	75 gusting to 85
25.05.2009/0530	20.5/88.5	85 gusting to 95
25.05.2009/1130	21.5/88.5	95 gusting to 105
25.05.2009/1730	22.5/88.5(over land)	85 gusting to 95
26.05.2009/0530	24.5/89.0(over land)	55 gusting to 65

Under its influence, rainfall at most places with heavy to very heavy falls at a few places and isolated extremely heavy falls (Ó25 cm) is likely over Gangetic West Bengal and north coastal Orissa during next 48 hours.

Gale winds speed reaching 60-70 kmph gusting to 80 kmph are likely along and off north Orissa coast. Gale wind speed reaching 60-70 kmph gusting 80 kmph also likely along and off West Bengal coast which may increase to 85-95 kmph gusting to 105 kmph along and off West Bengal coast during landfall period. Sea condition will be very high along and off West Bengal coast and very rough to high along and off Orissa coast.

Storm surge of about 2-3 meters above astronomical tide is likely over coastal areas of south 24-Pargana and Midnapur districts of West Bengal at the time of landfall.

.

Damage expected: Damage to thatched huts, breaking of tree branches causing minor damage to power and communication lines over coastal districts of West Bengal and north Orissa

Advice and Action suggested: Total suspension of fishing operations. Fishermen are advised not to venture into the sea along and off these coasts.

India Radio warnings largely used

Day Signals*		Specifications	Night Signals*	Remarks
16a	I.	Distant Cautionary Signal Number One There is a region of squally weather in which a storm may be forming (well marked low or depression with surface winds up to 61 km/h. (33 knots))	3b	These signals indicate that ships may be exposed to danger after leaving the harbour
10a	II.	Distant Warning Signal Number Two A storm has formed (cyclonic storm with surface winds 63-87 km/h. (34-47 knots))	2b	
3a*	III.	Local Cautionary Signal Number Three The port is threatened by squally weather (cyclonic circulation with surface winds 40-50 km/h. (22-27 knots)) or squalls due Nor'Westers)	5b	These signals indicate that the port itself and the ships in it are in danger
2a*	IV.	Local Warning Signal Number Four The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution (cyclonic circulation with surface winds 52-61 km/h. (28-33 knots))	4b	
17a	V.	Danger Signal Number Five The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast keeping the port to the left of its course (to the east of the port in the case of Mangla) (cyclonic storm with surface winds 63-87 km/h. (34-47 knots))	16b	These signals indicate that the port itself and the ships in it are in danger
8a	VI.	Danger signal number Six Port will experience severe weather from a cyclone expected to move keeping the port to the right of its track	17b	These signals indicate that the port itself and the ships in it are in danger
19a*	VII.	Danger signal number Seven Port will experience severe weather from a cyclone expected to move over or close to the port	18b	This signal is also hoisted when a storm is expected to skirt the coast without (actually) crossing it
20a	VIII.	Great Danger Signal number Eight Port will experience severe weather from a severe cyclone expected to move keeping the port to the left of its track	19b	These signals indicate that the port itself and the ships in it are in danger

21a IX. Great Danger Signal number Nine

Port will experience severe weather from a severe cyclone expected to move keeping the port to the right of its track

20b) These signals indicate) that the port itself) and the ships in it are) in danger

22a* X. Great Danger Signal number Ten

Port will experience severe weather from a severe cyclone expected to move over or close to the port

21b) This signal is also hoisted) when a storm is expected) to skirt the coast without) (actually) crossing it

23a* XI. Failure of Communication

Communications with the meteorological warning centre have broken down, and the local office considers there is a danger of bad weather

7b))))

Brief System

* In the brief system only one of the five signals marked by an asterisk of the general system is hoisted, and the Port Officers are kept informed of the prospects of local bad weather associated with any disturbance in the sea, for the general information of shipping.

Extended System

Special section signals, in addition to those of the general system, are exhibited at certain ports in the Bay of Bengal belonging to the extended system.

If the port itself is threatened, the appropriate local signals of the general system are hoisted. But, if there is an area of squally weather or a storm that does not threaten the port, the distant cautionary or distant warning signal of the general system is hoisted, and one or more of the locality signals (described in the next paragraph) are hoisted under the distant signals, to indicate the position of the disturbance in the Bay.

The following shapes, when hung below a distant cautionary or warning signal, become locality signals, indicating the six divisions into which the Bay of Bengal has been divided for this purpose 1) . If, however, the centre of the storm is near the boundary of a division, the hoisting of two locality signals is requested, the first indicating the division in which the centre is thought to be situated and the second the division nearest to the first.

In the event of a storm centre being near the corner where three divisions meet, the hoisting of three locality signals is requested, the first indicating the division in which the storm is estimated to be centred, the second the nearest adjoining division, and the third the remaining division.

Signal	3a	10a	24a	16a	2a	23a
Section	I	II	III	IV	V	VI

---

* See footnote on page 1 of Attachment to Annex II-B

1) The divisions are as indicated on the chart given on page II A6. Thus, if there is squally weather in Section I of the Bay, the signal 25a would be hoisted at the various ports, and if a storm has formed in Section II, the signal 11a would be hoisted at all ports which were not directly threatened. As already stated, the ports directly threatened would hoist one or other of the local signals. The Meteorological Department endeavours to keep the number of locality signals on each hoist as small as possible, and generally the number of only that section in which the centre of the storm is situated is given in the Warning bulletin.

Day Signals*	Specifications	Night Signals*	Remarks
Myanmar (21.II.1977)			
	General System		
16a	There is a region of squally weather in which a storm may be forming	3b	Distant cautionary signal
10a	A storm has formed	2b	Distant warning signal
3a	The port is threatened by squally weather	5b*	Local cautionary signal
2a*	The port is threatened by a storm, but it does not appear that the danger is as yet sufficiently great to justify extreme measures of precaution	4b*	Local warning signal. The existence of a storm can often be determined before its direction of motion can be fixed. In this case all those ports which the storm could possibly strike are warned by this signal
17a	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross the coast to the south of the port (or to the east in the case of Yangon, Pathein and Diamond Island)	16b	Local danger signal
18a	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross the coast to the north of the port (or to the west in the case of Yangon and Moulmein)	17b	Local danger signal
19a*	The port will experience severe weather from a storm, of slight or moderate intensity, that is expected to cross over or near to the port	18b*	Local danger signal
20a	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port (or to the east in the case of Yangon, Pathein and Diamond Island)	19b	Local great danger signal

* See footnote on page 1 of Attachment to Annex II-B

Day Signals*	Specifications	Night Signals*	Remarks

Myanmar - continued

21a	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the north of the port (or to the west in the case of Yangon and Moulmein)	20b	Local great danger signal
22a*	The port will experience severe weather from a storm of great intensity that is expected to cross over or near to the port	21b*	Local great danger signal
23a*	Communications with the meteorological warning centre have broken down, and the local officer considers that there is a danger of bad weather	7b*	Local failure of communications signal

Brief System

In the brief system only one of the five signals marked by an asterisk of the general system is hoisted, and the Port Officers are kept informed of the prospects of local bad weather associated with any disturbance in the sea, for the general information of shipping.

Extended System

Special signals, in addition to those of the general system, are exhibited at certain ports in the Bay of Bengal belonging to the extended system.

If the port itself is threatened, the appropriate local signals of the general system are hoisted. But, if there is an area of squally weather or a storm that does not threaten the port, the distant cautionary or distant warning signal of the general system is hoisted, and one or more of the locality signals (described in the next paragraph) are hoisted under the distant signals, to indicate the position of the disturbance in the Bay.

The following shapes, when hung below a distant cautionary or warning signal, become locality signals, indicating the six divisions into which the Bay of Bengal has been divided for this purpose 1) . If, however, the centre of the storm is near the boundary of a division, the hoisting of two locality signals is requested, the first indicating the division in which the centre is thought to be situated and the second the division nearest to the first.

In the event of a storm centre being near the corner where three divisions meet, the hoisting of three locality signals is requested, the first indicating the division in which the storm is estimated to be centred, the second

the nearest adjoining division, and the third the remaining division.

Signal	3a	10a	24a	16a	2a	23a
Section	I	II	III	IV	V	VI

* See footnote on page 1 of Attachment to Annex II-B

1) The divisions are as indicated on the chart given on page 26 Thus, if there is squally weather in Section I of the Bay, the signal 25a would be hoisted at the various ports, and if a storm has formed in Section II, the signal 11a would be hoisted at all ports which were not directly threatened. As already stated, the ports directly threatened would hoist one or other of the local signals. The Department of Meteorology and Hydrology endeavours to keep the number of locality signals on each hoist as small as possible, and generally the number of only that section in which the centre of the storm is situated is given in the Warning bulletin.

Day Signals*	Specifications	Night Signals*	Remarks

Pakistan - (10.VI.1984) Radio **warnings largely used**

16a	There is a region of squally weather in which a storm may be forming	3b	These signals indicate that ships may be exposed to danger after leaving the harbour
10a	A storm has formed	2b	
3a	Port is threatened by squally weather	5b	These signals indicate that the port itself and the ships in it are in danger
2a	Port is threatened by a storm, but it does not appear that danger justifies extreme measures of precaution	4b	
17a	Severe weather from a storm of slight or moderate intensity, expected to cross the coast to south or east of port	16b	
18a	Severe weather from a storm of slight or moderate intensity, expected to cross the coast to north or west of port	17b	These signals indicate that the port itself and the ships in it are in danger
19a	Severe weather from a storm of slight or moderate intensity, expected to cross over or near to the port	18b	
20a	Severe weather from a storm of great intensity, expected to cross the coast to south or east of port	19b	

_____

See footnote on page 1 of Attachment to Annex II-B

Day Signals*	Specifications	Night Signals*	Remarks
Pakistan - continued			
21a	Severe weather from a storm of great intensity, expected to cross the coast to north or west of port	20b	These signals indicate that the port itself and the ships in it are in danger
22a	Severe weather from a storm of great intensity, expected to cross over or near to the port	21b	
23a	Communications with the meteo-rological warning centre have broken down, and the local office considers there is a danger of bad weather	7b	These signals indicate that the port itself and the ships in it are in danger

Thailand (11.IV.1984)

Signals indicating the intensity of storms

35a Tropical depression or storm with wind speeds near centre not exceeding 33 kt

36a Tropical storm or storm with wind speeds near centre from 34 kt and over but not exceeding 63 kt

56a Typhoon or cyclone or storm with wind speeds near centre 64 kt or more

1. Signals indicating the occurrence of storms in the Gulf of Thailand and adjacent seas to be displayed at Port Area (Bangkok) and at Bangkok Harbour Limit I (Pong Pachjamit Fort, Pagklongsarn, Dhonburi)

2 Signals indicating the intensity and locality of storms will be hoisted on the same yard-arm with the pennant indicating the intensity and the flag indicating the locality of the storm. The flag is always hoisted below the pennant

_____

* See footnote on page 1 of Attachment to Annex II-B

Day Signals*	Specifications	Night Signals*	Remarks

Thailand - continued

Signals indicating the locality of storms

37a Area 1 : Gulf of Thailand east coast to Lat. 5°N and Long. 105°E

38a Area 2 : Gulf of Thailand west coast to Lat. 5°N

43a Area 3 : Andaman Sea bounded by west coast of southern Burma, west coast of southern Thailand, Long. 97°E, Lat. 5°N and Lat. 14°N

51a Area 4 : South China Sea bounded by southern Viet Nam coast, Lat. 12°N, Lat. 5°N, Long. 105°E and Long. 112°E

Note: In normal weather conditions (no tropical depression, storm or typhoon) the white pennant with red circle (52a) will be displayed at the upper yard-arm at Bangkok Harbour Limit I (Pong Pachjamit Fort, Pagklongsarn, Dhonburi).

_____

* See footnote on page 1 of Attachment to Annex II-B

C H A P T E R III

THE OBSERVING SYSTEM AND OBSERVING PROGRAMME

3.1 Networks of surface and upper air stations

3.1.1 Observations from basic network

The list of implemented regional basic synoptic networks of surface and upper air stations of the Panel countries is given in **Table III-1.** The network of stations adopted for regional exchange by the World Weather Watch is considered adequate for routine tracking of weather systems. However, in the cyclone season, particularly when a tropical depression or storm exists in the region, special efforts will be made by the national meteorological services to improve the collection and distribution of surface synoptic reports from the coastal stations.

3.1.2 Special observations from the WWW network

National meteorological services will endeavor to arrange for additional observations in areas coming within the circulation of a tropical cyclone. These stations will make round the clock three hourly or hourly observations when the system is of tropical storm intensity and close to the coast and the observations will be passed on real time to the Panel countries.

3.1.3 Special observations from stations other than those of the regional basic synoptic network

National Meteorological Services (NMS) have established a large number of meteorological observing stations, in addition to those in the regional basic synoptic network, observations from which are received by the NMS. When there is a tropical cyclone in the Bay of Bengal or in the Arabian Sea, observations from these stations, particularly from coastal stations, will be exchanged on real time basis on priority. If the observations are not received during a tropical cyclone situation a request for them could be sent to the NMC concerned. A list of these stations is given in **Table III-2.**

TABLE III-1: List of implemented regional basic synoptic network stations

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
41240	KHASAB		X	X	X	X	X	X							
242	DIBA*	X	X	X	X	X	X	X	X						
244	BURAIMI	X	X	X	X	X	X	X	X						
246	SOHAR MAJIS		X	X	X	X	X	X	X	X					
253	RUSTAQ	X	X	X	X	X	X	X	X						
254	SAIQ	.	X	X	X	X									
255	NIZWA*			X	X	X									
256	SEEB INT. AIRPORT	X	X	X	X	X	X	X	X	X					
257	SAMAIL	X	X	X	X	X	X	X	X						
258	MINA SULTAN QABOOS	X	X	X	X	X	X	X	X						
262	FAHUD	X	X	X	X	X	X	X	X						
263	BAHLA	X	X	X	X	X	X	X	X						
264	ADAM	X	X	X	X	X	X	X	X						
265	IBRA	X	X	X	X	X	X	X	X						
267	QALHAT	X	X	X	X	X	X	X	X						
268	SUR	X	X	X	X	X	X	X	X						
275	QARN ALAM	X	X	X	X	X	X	X	X						
288	MASIRAH	X	X	X	X	X	X	X	X						
304	MARMUL	X	X	X	X	X	X	X	X						
312	MINA SALALAH	X	X	X	X	X	X	X	X						
314	THUMRAIT	X	X	X	X	X	X	X	X						
315	QAIROON HAIRITI		X	X	X	X	X	X	X	X					
316	SALALAH	X	X	X	X	X	X	X	X	X					
515	DROSH		X	X	X	X	X	X	X	X					
530	PESHAWAR	X	X	X	X	X	X	X	X	X	X	X	X		X
560	PARACHINAR	X	X	X	X	X	X	X	X						
571	ISLAMABAD AIRPORT	X	X	X	X	X	X	X	X						
594	SARGODHA	X	X	X	X	X	X	X	X	X	X	X	X		X
598	JHELUM	X	X	X	X	X	X	X	X	X	X	X	X		
620	ZHOB	X	X	X	X	X	X	X	X						
624	DERA ISMAIL KHAN	X	X	X	X	X	X	X	X	X	X	X	X		
641	LAHORE CITY		X	X	X	X	X	X	X	X	X	X	X		X
660	QUETTA AIRPORT		X	X	X	X	X	X	X	X					
675	MULTAN	X	X	X	X	X	X	X	X	X	X	X	X		X
685	BAR KHAN	X	X	X	X	X	X	X	X	X	X	X			
710	NOKKUNDI		X	X	X	X	X	X	X	X					
712	DAL BANDIN	X	X	X	X	X	X	X	X	X	X	X	X		
715	JACOBABAD	X	X	X	X	X	X	X	X	X	X	X	X		
718	KHANPUR	X	X	X	X	X	X	X	X						
739	PANJGUR	X	X	X	X	X	X	X	X						X
744	KHUZDAR	X	X	X	X	X	X	X	X	X	X	X			
749	NAWABSHAH	X	X	X	X	X	X	X	X	X	X	X			
756	JIWANI	X	X	X	X	X	X	X	X	X	X	X			
764	HYDERABAD	X	X	X	X	X	X	X	X	X	X	X	X		
768	CHHOR		X	X	X	X	X	X	X	X	X	X	X		X
780	KARACHI AIRPORT	X	X	X	X	X	X	X	X	X	X	X	X		X

* During the period of tropical cyclone

Name of station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
41859	RANGPUR	X	X	X	X	X	X	X	X	X	X	X	X		
41883	BOGRA	X	X	X	X	X	X	X	X	X	X	X	X	X	
41886	MYMENSINGH	X	X	X	X	X	X	X	X						
41891	SYLHET	X	X	X	X	X	X	X	X	X	X	X	X		
41907	ISHURDI	X	X	X	X	X	X	X	X	X	X	X	X		
41923	DHAKA	X	X	X	X	X	X	X	X	X	X	X	X	X	
41936	JESSORE	X	X	X	X	X	X	X	X	X	X	X	X		
41943	FENI	X	X	X	X	X	X	X	X	X	X	X	X		
41950	BARISAL	X	X	X	X	X	X	X	X	X	X	X	X		
41953	MAIJDI COURT	X	X	X	X	X	X	X	X						
41963	HATIYA	X	X	X	X	X	X	X	X						
41964	SANDWIP	X	X	X	X	X	X	X	X						
41977	CHITTAGONG (AMBAGAN)		.	.	.	.	.	.	.	X	X	X	X	X	
41978	CHITTAGONG (PATENGA)	X	X	X	X	X	X	X	X						
41984	KHEPUPARA	X	X	X	X	X	X	X	X						
41989	KUTUBDIA	X	X	X	X	X	X	X	X						
41992	COX'S BAZAR	X	X	X	X	X	X	X	X	X	X	X	X		

Name of station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
42027	SRINAGAR	X	X	X	X	X	X	X	X	X	X		X	X	X
42071	AMRITSAR	X	X	X	X	X	X	X	X	X	X				
42101	PATIALA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42111	DEHRADUN	X	X	X	X	X	X	X	X						
42131	HISSAR	X	X	X	X	X	X	X	X						
42165	BIKANER	X	X	X	X	X	X	X	X						
42182	NEW DELHI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42189	BAREILLY	X	X	X	X	X	X	X	X						
42260	AGRA	X	X	X	X	X	X	X	X						
42309	NORTH LAKHIMPUR		X	X	X	X	X								
42314	DIBRUGARH/MOHANBARI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42328	JAISALMER	X	X	X	X	X	X	X	X						
42339	JODHPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42348	JAIPUR/SANGANER	X	X	X	X	X	X	X	X	X		X			
42361	GWALIOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42369	LUCKNOW/AMAUSI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42379	GORAKHPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42397	SILIGURI	X	X	X	X	X	X	X	X						
42410	GUWAHATI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42415	TEZPUR	X	X	X	X	X	X	X	X						
42452	KOTA AERODROME	X	X	X	X	X	X	X	X						
42475	ALLAHABAD/ BAMHRAULI	X	X	X	X	X	X	X	X						
42492	PATNA	X	X	X	X	X	X	X	X					X	X
42559	GUNA	X	X	X	X	X	X	X	X						
42571	SATNA	X	X	X	X	X	X	X	X						
42587	DALTONGANJ		X	X	X	X									
42591	GAYA	X	X	X	X	X	X	X	X	X		X	X		
42623	IMPHAL TULIHAL	X	X	X	X	X	X	X	X	X	X	X	X		
42634	BHUJ-RUDRAMATA	X	X	X	X	X	X	X	X						
42779	PENDRA	X	X	X	X	X	X	X	X						
42798	JAMSHEDPUR	X	X	X	X	X	X	X	X	X		X			
42809	KOLKATA / DUMDUM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42840	SURAT	X	X	X	X	X	X	X	X						
42867	NAGPUR /SONEGAON	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42875	RAIPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42886	JHARSUGUDA	X	X	X	X	X	X	X	X	X					
42895	BALASORE	X	X	X	X	X	X	X	X						
42909	VERAVAL	X	X	X	X	X	X	X	X						
42921	NASIK CITY	X	X	X	X	X	X	X	X						
42933	AKOLA	X	X	X	X	X	X	X	X						
42971	BHUBANESWAR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42977	SANDHEADS		X			X									

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
43003	MUMBAI (SANTACRUZ)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43014	AURANGABAD	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	CHIKALTHANA														
43041	JAGDALPUR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43063	PUNE	X	X	X	X	X	X	X	X						
43086	RAMGUNDAM	X	X	X	X	X	X	X	X						
43110	RATNAGIRI	X	X	X	X	X	X	X	X						
43117	SHOLAPUR	X	X	X	X	X	X	X	X						
43128	HYDERABAD AIRPORT	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43150	VISHAKHAPATNAM/	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	WALTAIR														
43185	MACHILIPATNAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	(FRANCHPET)														
43189	KAKINADA	X	X	X	X	X	X	X	X						
43192	GOA/PANJIM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43198	BELGAUM/SAMBRE	X	X	X	X	X	X	X	X						
43201	GADAG	X	X	X	X	X	X	X	X						
43213	KURNOOL	X	X	X	X	X	X	X	X						
43226	HONAVAR	X	X	X	X	X	X	X	X						
43233	CHITRADURGA	X	X	X	X	X	X	X	X						
43237	ANANTAPUR	X	X	X	X	X	X	X	X						
43245	NELLORE	X	X	X	X	X	X	X	X						
43279	CHENNAI/MEENAMBAKKAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43284	MANGALORE/BAJPE	X	X	X	X	X	X	X	X						
43285	MANGALORE/PANAMBUR	X	X	X	X		X	X							
43295	BANGALORE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42830	PORBANDAR	X	X	X	X	X	X	X	X						
43049	GOPALPUR	X	X	X	X	X	X	X	X	X		X	X		
43221	ONGOLE	X	X	X	X	X	X	X	X						
43348	ADIRAMPATTINAM	X			X										

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
43311	AMINI DIVI	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43314	KOZHIKODE	X	X	X	X	X	X	X	X						
43321	COIMBATORE/PEELAMEDU	X	X	X	X	X	X	X	X						
43329	CUDDALORE	X	X	X	X	X	X	X	X						
43333	PORT BLAIR	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43344	TIRUCHIRAPALLI	X	X	X	X	X	X	X	X						
43346	KARAIKAL	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43353	KOCHI WILLINGTON	X	X	X	X	X	X	X	X					X	X
43369	MINICOY	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43371	THIRUVANANTHAPURAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43418	TRINCOMALEE	X	X	X	X	X	X	X	X						
43421	ANURADHAPURA		X	X	X	X	X	X	X	X					
43424	PUTTALAM		X	X	X	X	X	X	X	X					
43436	BATTICALOA	X	X	X	X	X	X	X	X						
43450	KATUNAYAKE		X	X	X	X	X	X	X	X					
43466	COLOMBO	X	X	X	X	X	X	X	X		X	X		X	X
43473	NUWARA ELIYA	X	X	X	X	X	X	X	X						
43486	RATNAPURA	X	X	X	X	X	X	X	X						
43495	GALLE	X	X	X	X	X	X	X	X						
43497	HAMBANTOTA		X	X	X	X	X	X	X	X					
43533	HANIMADHOO		X	X	X	X	X	X	X	X					
43555	MALE	X	X	X	X	X	X	X	X		X				
43577	KADHDHOO	X	X	X	X	X	.	.	.						
43588	KADEHDHOO	X	X	X	X	X	X								
43599	GAN	X	X	X	X	X	X	X	X		X				X
48001	PUTAO	X	X	X	X	X	X	X	X						
48004	HKAMTI	X	X	X	X	X	X	X	X						
48008	HYITKYINA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
48010	HOMALIN	X	X	X	X	X	X	X	X						
48018	KATHA	X	X	X	X	X	X	X	X						
48019	BHAMO		X	X	X	X	X	X	X	X					
48020	MAWLAIK	X	X	X	X	X	X	X	X						
48025	KALEWA	X	X	X	X	X	X	X	X						
48035	LASHIO		X	X	X	X	X	X	X	X					
48037	MONYWA	X	X	X	X	X	X	X	X						
48042	MANDALAY	X	X	X	X	X	X	X	X	X	X	X	X	X	X
48045	MINDAT	X	X	X	X	X	X	X	X						
48048	NYUNG-U	X	X	X	X	X	X	X	X						
48053	MEIKTILA	X	X	X	X	X	X	X	X						
48057	TAUNGGYI		X	X	X	X	X	X	X	X					
48060	KENGTUNG		X	X	X	X	X	X	X	X					
48062	SITTWE	X	X	X	X	X	X	X	X	X	X	X	X	X	X
48071	KYAUKPYU		X	X	X	X	X	X	X	X					

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
48077	PROME		X	X	X	X	X	X	X	X					
48078	TOUNGOO	X	X	X	X	X	X	X	X						
48080	SANDOWAY	X	X	X	X	X	X	X	X						
48094	PATHEIN	X	X	X	X	X	X	X	X	X	X	X	X		
48097	YANGON	X	X	X	X	X	X	X	X	X	X	X	X	X	X
48108	DAWEI	X	X	X	X	X	X	X	X						
48109	COCO ISLAND		X	X	X	X	X	X	X	X					
48110	MERGUI	X	X	X	X	X	X	X	X						
48112	KAWTHAUNG	X	X	X	X	X	X	X	X						
48300	MAE HONG SON	X	X	X	X	X	X	X	X						
48303	CHIANG RAI	X	X	X	X	X	X	X	X						
48327	CHIANG MAI	X	X	X	X	X	X	X	X		X	X		X	
48328	LAMPANG	X	X	X	X	X	X	X	X						
48330	PHRAE	X	X	X	X	X	X	X	X						
48331	NAN	X	X	X	X	X	X	X	X						
48351	UTTARADIT	X	X	X	X	X	X	X	X						
48353	LOEI	X	X	X	X	X	X	X	X						
48354	UDON THANI	X	X	X	X	X	X	X	X						
48356	SAKON NAKHON	X	X	X	X	X	X	X	X						
48375	MAE SOT	X	X	X	X	X	X	X	X						
48376	TAK	X	X	X	X	X	X	X	X						
48377	BHUMIBOL DAM	X	X	X	X	X	X	X	X						
48378	PHITSANULOK	X	X	X	X	X	X	X	X						
48379	PHETCHABUN		X	X	X	X	X	X	X						
48381	KHON KAEN	X	X	X	X	X	X	X	X						
48400	NAKHON SAWAN	X	X	X	X	X	X	X	X						
48407	UBON RATCHATHANI	X	X	X	X	X	X	X	X		X	X		X	
48431	NAKHON RATCHASIMA	X	X	X	X	X	X	X	X						
48432	SURIN	X	X	X	X	X	X	X	X						
48455	BANGKOK	X	X	X	X	X	X	X	X		X	X		X	
48456	DON MUANG	X	X	X	X	X	X	X	X						
48462	ARANYAPRATHET	X	X	X	X	X	X	X	X						
48475	HUA HIN	X	X	X	X	X	X	X	X						
48477	SATTAHIP	X	X	X	X	X	X	X	X						
48480	CHANTHABURI	X	X	X	X	X	X	X	X	X		X			
48500	PRACHUAP KHIRIKHAN	X	X	X	X	X	X	X	X	X		X			
48517	CHUMPHON	X	X	X	X	X	X	X	X						
48532	RANONG	X	X	X	X	X	X	X	X						
48551	SURAT THANI	X	X	X	X	X	X	X	X	X	X	X	X		
48565	PHUKET AIRPORT	X	X	X	X	X	X	X	X					X	
48567	TRANG	X	X	X	X	X	X	X	X						
48568	SONGKHLA	X	X	X	X	X	X	X	X		X	X		X	
48569	HAT YAI	X	X	X	X	X	X	X	X						
48583	NARATHIWAT	X	X	X	X	X	X	X	X	X					

TABLE III-2: List of stations other than those in the WWW network from which special observations are available in cyclone situations

Country: Bangladesh

Name of Station		Surface								Radiowind				Radiosonde	
1		2								3				4	
		00	03	06	09	12	15	18	21	00	06	12	18	00	12
41858	SAYEDPUR	X	X	X	X	X	X	X	X						
41859	RANGPUR	X	X	X	X	X	X	X	X	X	X	X	X		
41863	DINAJPUR	X	X	X	X	X	X	X	X						
41883	BOGRA	X	X	X	X	X	X	X	X	X	X	X	X	X	
41886	MYMENSINGH	X	X	X	X	X	X	X	X						
41891	SYLHET	X	X	X	X	X	X	X	X	X	X	X	X		
41895	RAJSHAHI	X	X	X	X	X	X	X							
41909	TANGAIL	X	X	X	X	X	X	X							
41907	ISHURDI	X	X	X	X	X	X	X	X	X	X	X	X		
41915	SRIMONGAL	X	X	X	X	X	X	X	X						
41923	DHAKA	X	X	X	X	X	X	X	X	X	X	X	X	X	
41926	CHUADANGA	X	X	X	X	X	X	X	X						
41929	FARIDPUR	X	X	X	X	X	X	X	X						
41933	COMILLA	X	X	X	X	X	X	X							
41936	JESSORE	X	X	X	X	X	X	X	X	X	X	X	X		
41939	MADARIPUR	X	X	X	X	X	X	X	X						
41941	CHANDPUR	X	X	X	X	X	X	X	X						
41943	FENI	X	X	X	X	X	X	X	X	X	X	X	X		
41946	SATKHIRA	X	X	X	X	X	X	X	X						
41947	KHULNA	X	X	X	X	X	X	X	X						
41950	BARISAL	X	X	X	X	X	X	X	X	X	X	X	X		
41951	BHOLA	X	X	X	X	X	X	X	X						
41953	MAIJDI COURT	X	X	X	X	X	X	X	X						
41958	MONGLA	X	X	X	X	X	X	X	X						
41960	PATUAKHALI	X	X	X	X	X	X	X	X						
41963	HATIYA	X	X	X	X	X	X	X	X						
41964	SANDWIP	X	X	X	X	X	X	X	X						
41965	SITAKUNDA	X	X	X	X	X	X	X	X						
41966	RANGAMATI	X	X	X	X	X	X	X	X						
41977	CHITTAGONG (AMBAGAN)		.	.	.	.	.	.	.	X	X	X	X	X	
41978	CHITTAGONG (PATENGA)	X	X	X	X	X	X	X	X						
41984	KHEPUPARA	X	X	X	X	X	X	X	X						
41989	KUTUBDIA	X	X	X	X	X	X	X	X						
41992	COX'S BAZAR	X	X	X	X	X	X	X	X	X	X	X	X		
41998	TEKNAF	X	X	X	X	X	X	X	X						
43413	MANNAR	X	X	X	X	X	X	X							
43475	POTTUVIL	X	X	X	X	X	X	X							

Buoy's ID	Surface								Radiowind				Radiosonde	
1	2								3				4	
	00	03	06	09	12	15	18	21	00	06	12	18	00	12
Indian Buoys														
AD02 (ARB)	X	X	X	X	X			X						
AD03 (ARB)	X	X		X	X	X	X	X						
AD04 (ARB)	X	X		X	X	X	X	X						
AD05 (ARB)	X	X	X	X	X	X	X	X						
CB02 (ARB)	X	X		X	X		X	X						
CB03 (ARB)	X	X		X	X		X	X						
SW02 (ARB)	X	X		X	X		X	X						
BD02 (BOB)	X	X	X	X	X	X	X	X						
BD07 (BOB)	X	X	X	X	X	X	X	X						
BD08 (BOB)	X	X	X	X	X	X	X	X						
BD10 (BOB)	X	X		X	X	X	X	X						
BD11 (BOB)	X	X	X	X	X	X	X	X						
BD12 (BOB)	X	X		X	X	X	X	X						
BD13 (BOB)	X	X		X	X		X	X						
CB01 (BOB)	X	X		X	X		X	X						
Oman Buoys														
23051 Buoy (MINA SULTAN QABOOS)	X	X	X	X	X	X	X	X						
052 Buoy (SUR)[1]	X	X	X	X	X	X	X	X						
053 Buoy (MINA SALALA)[1]	X	X	X	X	X	X	X	X						
055 Buoy (SOHAR)	X	X	X	X	X	X	X	X						

[1] Temporarily discontinued

3.1.4 Upper air stations

Additional upper wind observations will be made as appropriate whenever a tropical cyclone is centered within 500 nautical miles of the station. The minimum required is two observations per day, but for a better understanding of the ambient wind field three or even four flights on some days will be made when possible. All these additional upper air observations will be distributed among the Panel countries.

3.2 Observations from mobile ships

Efforts will be made to obtain the maximum number of ships' observations from the cyclone field by the NMSs and to pass on these observations to RSMC New Delhi. Whenever there is a tropical cyclone in the Bay of Bengal or in the Arabian Sea, additional ships' reports at frequent intervals will be requested by the storm warning centre/meteorological office concerned.

3.3 Aircraft reports

All reports from aircraft in flight in the area will be passed on real time to RSMC, New Delhi and to other Panel countries. In case the national meteorological service collecting the report deems it to be of interest in the analysis or forecasting of a tropical cyclone situation, it will be prefixed with an agreed high priority symbol.

3.4 Radar observations

As long as a tropical cyclone remains within range of one of the cyclone detection radars in the region, the meteorological centre concerned will keep the system under continuous surveillance and will transmit the radar observations through GTS to RSMC New Delhi and other Panel countries. These reports will be made in accordance with a reestablished schedule, preferably on a regular three hourly basis.

The report will be in the RADOB code (FM20VRADOB) or the code given in **Annex IIIA** and will be transmitted twice to ensure reception of the complete message.

In case the report is in plain language, the full range of information available at the radar station will be given. The message will therefore include, where available, the confirmation of the determination of the centre; the shape, definition, size and character tendency of the eye, the distance between the end of the outermost band and the centre of the cyclone and the direction and speed of movement with a statement of the interval of time over which the movement was calculated.

A list of the cyclone detection radar stations in the Panel area is given in **Table III-3**.

TABLE III-3
WEATHER RADAR STATIONS KEEPING WATCH
OVER THE ARABIAN SEA AND THE BAY OF BENGAL

Country	Station	N	E	Type	Op. since
Bangladesh	41992 Cox's Bazar	21°20'	92°17'	Doppler	1970
	41984 Khepupara	21°59'	90°14'	Doppler	1982
	41923 Dhaka	23°46'	90°23'	10 cm	1970
	41859 Rangpur	25°44'	89°14'	10 cm	1999
India	42807 Kolkata	22°34'	88°21'	10 cm / DWR	1973 2002
	42976 Paradip	20°16'	86°39'	10 cm	1973
	43149 Visakhapatnam	17°45'	83°21'	10 cm	1970
				DWR	2006
	43185 Machilipatnam	16°11'	81°09'	10 cm/	1981
				DWR	2004
	-- Sriharikota	13°40'	80°14'	DWR	2004
	43278 Chennai	12°59'	80°15'	10 cm	1973
				DWR	2002
	43346 Karaikal	10°54'	79°50'	10 cm	1989
	43353 Kochi	09°56'	76°16'	10 cm	1987
	43192 Goa (Not operational)	15°29'	73°49'	10 cm	2002
	43057 Mumbai	18°54'	72°49'	10 cm	1989
	42634 Bhuj (Not operational)	23°15'	69°48'	10 cm	1987
Myanmar	48071 Kyaukpyu	19°23'	93°33'	10 cm	1979
Pakistan	41780 Karachi	24°54'	67°08'	5.6 cm	1991
Sri Lanka	43418 Trincomalee (Not operational)	08° 35ô	81°15ô	10 cm	1982
Thailand	48455 Bangkok	13° 55'	100°36'	10 cm Doppler	1992
	48475 Hau Hin	12°35'	99°57'	10 cm Doppler	1995
	48517 Chumphon	10°29'	99°11'	5.6 cm Doppler	2008
	48551 Surat Thani	09°08'	99°9ô	10 cm Doppler	1993
	48565 Phuket	08°08'	98°19'	5.6 cm Doppler	2006
	48569 HAT Yai	06°56'	100°23ô	5.6 cm Doppler	2004
	48563 Krabi	08°06'	98°58ô	5.6 cm Doppler	2006
	48568 Songkhla	07°26'	100°27ô	5.6 cm Doppler	2011

3.5 Satellite observations

Although the same images are obtained at all cyclone warning centres, it is essential that meteorological authorities compare with each other the conclusions reached on the intensity, position and development characteristics shown by the images.

When a depression or tropical cyclone is in existence in the Panel region, meteorological services will transmit to RSMC tropical cyclones, New Delhi, as soon as is feasible, bulletins of satellite observations. RSMC New Delhi is incorporating the satellite derived information in their bulletins which are disseminated for use in the Panel countries.

As soon as a tropical cyclone is observed over the Panel region, RSMC tropical cyclones, New Delhi will receive a satellite bulletin based on INSAT / Kalpana-1 pictures every hour to the extent possible. Information from this bulletin will be included in the tropical cyclone advisories which will be issued from RSMC tropical cyclones, New Delhi eight times a day when a tropical cyclone is in the Panel region.

Satellite bulletins generally contain the following information in plain language:

1. Identification of issuing station, date and time of origin.
2. Time of picture, identification of satellite.
3. Position of centre and whether eye discernible.
4. Intensity: T number, maximum sustained wind and central pressure estimated.
5. Other characteristics deduced from picture, e.g., organization, size of CDO, diameter and definition of eye and estimated extent of winds of specified speeds.
6. Past movement.
7. Development characteristics.

Satellite cloud imagery monitoring facilities in the Panel countries is given in Annex III-B

CODE FOR REPORTING RADAR OBSERVATIONS RELATING TO CYCLONIC DISTURBANCES

Part "A" (to be reported when centre of the storm can be determined).

CYREP FFAA STATION IIiii YYGGg 4R wLaLaLa 1LoLoLoLo EYE or SPIRAL
6CSDT Pdsdsfsfs

Explanatory Notes

CYREP FFAA : Radar Report giving centre of a cyclone
STATION : Name of station in plain language
Iiiii : Station Index Number
YY : UTC date
GGg : Time of observation in hours and tens of minutes UTC
4 : Indicator figure
1 : Quadrant of globe '1' for our area as per WMO definition
Rw : Wavelength of radar
3 for 3 cm radar, 5 for 5.6 cm radar, 8 for 10 cm radar
LaLaLa : Latitude } In tenths of a degree.
Tenths are
} obtained by dividing the number of minutes
LoLoLoLo : Longitude } by six and discarding the remainder.
EYE or SPIRAL : Either the word "EYE" or the word "SPIRAL" will be reported, but not both.
The word "EYE" will be reported if a partial or complete eye is seen by the radar.
If a double walled eye is seen "DOUBLE EYE" will be reported instead of "EYE".
If the storm centre is estimated using only spiral bands the word "SPIRAL" will be reported.
6 : Indicator figure to show that eye characteristics and/or confidence of fix follow.
C : Confidence of fix (Vide Table 1).
S : Shape of eye and length of arc of eyewall seen (Vide Table 2).
D : Diameter or length of major axis of the eye (Vide Table 3).
T : Tendency of the eye determined over the period since the last observation (Vide Table 4).

NOTE: S, D and T will be reported as solidus (/) if the storm centre is fixed from spiral bands only.

P: Period over which the movement of the storm centre has been determined (Vide Table 5).
dsds: Direction in tens of degree towards which the storm centre is moving.
fsfs: Speed of movement of storm centre in kilometres per hour.

If movement over a period of 3 hours or more cannot be estimated, the group pdsdsfsfs will be dropped.

NOTE: The radar meteorologist may at his discretion add any other operationally useful information not covered above, in plain language at the end of Part A of the message.

TABLE 1

Confidence of Fix (C)

Code Figure	Category	Radar echo pattern	Likely accuracy about
1.	Very poor	Spiral bands, ill defined or too few or too short	100 km
2.	Poor	Centre estimated from well defined spiral bands --------- eye not visible	50 km
3.	Fair	Partial eye wall seen	30 km
4.	Good	Closed or nearly closed eye whose geometric centres can be located with confidence	10 km

NOTE: The accuracy and criteria as given above are only illustrative and not definitive.

TABLE 2

Shape of eye and length of arc of eyewall seen (S)

Code Figure	Length of arc	Shape
0	-------	Ill-defined
1	Less than 180^0	{ Shape other than
2	More than 180^0	{ circular or elliptical
3	Closed	{
4	Less than 180^0	{
5	More than 180^0	{ Elliptical
6	Closed	{
7	Less than 180^0	{
8	More than 180^0	{ Circular
9	Closed	{

TABLE 3

D- Diameter or length of major axis of the eye of the tropical cyclone

Code Figure		Code Figure	
0	less than 10 km	6	60 to 69 km
1	10 to 19 km	7	70 to 79 km
2	20 to 29 km	8	80 to 89 km
3	30 to 39 km	9	90 km and greater
4	40 to 49 km	/	undetermined
5	50 to 59 km		

TABLE 4

T- Tendency of the eye, determined over the period since the last observation

Code Figure	
0	Eye has first become visible since the last observation.
1	No significant change in the characteristics or size of the eye.
2	Eye has become smaller with no other significant change in characteristics.
3	Eye has become larger with no other significant change in characteristics.
4	Eye has become less distinct with no significant change in size.
5	Eye has become less distinct and decreased in size.
6	Eye has become less distinct and increased in size.
7	Eye has become more distinct with no significant change in size.
8	Eye has become more distinct and decreased in size.
9	Eye has become more distinct and increased in size.
/	Change in character and size of eye cannot be determined.

TABLE 5

P- Period over which the movement of the storm centre has been determined

Code Figure	Period
7	During the preceding 3 hours
8	During the preceding 6 hours
9	During a period of more than 6 hours

(to be reported whenever any radar echo is seen)

RAREP FFBB IIiii YYGGg CHARACTER (b1b1b1/r1r1r1 ----------bnbnbn/rnrnrn) INTENSITY TENDENCY dsdsfsfs ALTD (bbb/HtHt/rrr)

NOTE: 1. Part B will normally be reported only at synoptic hours. In the case of any break in observations or rapid development, additional Part B messages may be transmitted as necessary.

2. Part A messages are to be prepared and transmitted as close to the observation time as possible. Part B can be transmitted separately, after Part A has been sent. When Part A and Part B are transmitted together, the code groups RAREP, IIiii, YYGGg need not be included in Part B.

Character:

EYE : An echo identified definitely as the eyewall of a tropical cyclone.

SPRL BND : A continuous or broken curved line of echoes recognizable as a spiral band associated with a cyclonic system.

SQL LN : This pattern should normally have a length to width ratio of about 10 to 1 and length about 60 km or more.

BRKN LN : A broken line of echoes.

SLD : An area fully covered with echoes.

BRKN : An area 4/8 to 7/8 covered with echoes.

SCT : An area 1/8 to 4/8 covered with echoes.

WDLY SCT : An area less than 1/8 covered with echoes.

ISLTD : Isolated solid mass of echo.

ECHO ALDFT : Echo seen only at elevations higher than half the beam width.

bbb : Azimuth in three digits (degrees) of points on the periphery of an echo area.

rrr : Range (three digits) in units of kilometres.

NOTE:

(1) The groups within the brackets ( ) may be reported as many times as necessary.

(2) In the case of line echoes, in spiral bands and eye wall, as many bbb/rrr points along the line as necessary may be given to define the shape of the line. The points should preferably be given along the line in the anticlockwise direction.

(3) In the case of areas, as many bbb/rrr points as necessary to define the shape may preferably be given in the anticlockwise order starting from the northernmost point. The first point should be repeated as the last point to indicate that it is a closed area.

(4) In any one RAREP message, the character of echoes ..... will be reported in the order given in the group description above.

(5) If an echo system with a distinct characteristic is partly or wholly embedded in another, the two systems should be reported in separate groups. For example, a SPRL BND, or BRKNLN (which may be distinguished as such by using the attenuator or isoecho system) embedded in a larger area of echoes will be reported as SPRL BND or BRKN LN in addition to the area reported separately.

(6) The number of features or groups should be as few as possible, and should be just sufficient to convey an overall picture of the system.

Intensity:

		For radars having facility for quantitative measurement	
Code	**dBZ**	**Approximate rainfall rate mm/hr**	**Other radars**
WK	23 to 32	less than 4	Qualitatively
MDT	33 to 42	4 to 15	determined as in
STG	43 to 52	16 to 63	Weather Radar
VRY STG	53 or more	64 and above	Manual

NOTE: (1) The intensity of the strongest echo in the group is to be reported.
(2) The rainfall rates indicated are based on the relationship Z = 200R 1.6 and may be taken only as a rough guide.
(3) Intensity is to be reported only of echoes within 200 km range

Tendency:

INCG : Increasing
DCG : Decreasing
NO CHG : No change

In view of the difficulties in finding out the tendency of echoes of large areal extent as in a depression or cyclone, tendency should be reported only in case of isolated cells or groups of cells or a line mainly for aviation purposes. The radar meteorologist will take into consideration the change in height, area, length and intensity of echoes over a period of time in judging the tendency.

dsds : Direction in tens of degrees towards which the echo or group of echoes is moving.
fsfs : Speed in kmph of the echo or group of echoes.

Doppler Weather Radar (DWR):

There are 11 S-band Radars for Cyclone Detection located at Kolkata, Paradip, Visakhapatnam, Machilipatnam, Chennai, Sriharikota, Karaikal, Kochi, Goa, Mumbai, and Bhuj. Out of these 11 stations, 5 stations (except Chennai, Kolkata, Sriharikota, Visakhapatnam and Machilipatnam) are using conventional S-band radars. However, the conventional S-band radars are not operational at Bhuj & Goa. Four number of S-Band Doppler Weather Radars (Meteor 1500S) imported from MIS 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 Organization (ISRO) under IMD-ISRO collaboration has been installed and made operational at SHAR Centre, Sriharikota (Andhra Pradesh) with effect from 9 April, 2004. A Bharat Electronics Limited made indigenous S-band radar has been installed and commissioned in Mumbai recently.

Doppler Weather Radars provide vital information on radial velocity within tropical cyclone which is not available in conventional radars. 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.

NOTE: (1) In case of a group of echoes or of a line, only the overall movement of the group of echoes will be reported.
(2) The movement will be observed over a period of, say 30 to 60 minutes.

ALTD: Indicator for echo height information.

HtHt : Height of top of echo above mean sea level in kilometers.

NOTE: (1) Reports of heights should be restricted to a maximum range of 200 km from the station.
(2) In the case of echoes of large areas, the height group may be repeated as necessary for including a number of prominent echoes.

The radar meteorologist will have discretion to report any other special phenomena such as Bright Band and Anomalous Propagation in plain language at the end of the message.

Parts A and B both shall be used whenever the echo pattern observed is recognized as relating to tropical cyclone. Part B only will be used for reporting echoes other than connected with tropical cyclone.

———————————

Satellite cloud imagery monitoring facilities in the Panel countries

Bangladesh

Bangladesh Meteorological Department (BMD) has the facilities of NOAA HRPT and MTSAT LRIT & HRIT cloud imageries from NOAA and MTSAT satellites respectively. The satellite imageries of all channels are updated on BMD website (http://www.bmd.gov.bd) regularly.

India

An exclusive meteorological satellite KALPANA-I was launched on 12 September, 2002. It gives satellite Imagery in three channels, i.e. Visible, Infrared and Water Vapour. The VHRR resolution of this satellite is 2X2 Km in Visible and 8X8 Km in Infrared and Water Vapour channels. Data from this satellite are being received and processed at IMD, New Delhi. KALPANA-I is located at 74.0° E longitude.

Another Satellite INSAT-3A was launched on 10 April, 2003. It is also utilised operationally at IMD. It has three VHRR channels identical to KALPANA-I VHRR and in addition has three channels of CCD. It is located at 93.5 deg E .The three channels of CCD give Imagery in three channels namely visible, Near Infrared and Short wave Infrared. The resolution of CCD payload in all three channels is 1 Km.

The satellite imageries of all channels are updated every half hourly on IMD website. The images displayed are full frame, Asia Mercator Sector and Northwest sector. Animation of last 24 hours/ 72 hours/ Infrared images are also put on IMD website (www.imd.ernet.in and www.imd.gov.in) for users and public.

Satellite Derived Products

The computer system (IMDPS) commissioned in year 2000, is used for processing data from INSAT series of satellite. Apart from generating cloud imagery, the following products are derived from satellite data; and the same are also archived.

(i) Cloud Motion Vector (CMVs) and water vapour winds based on three consecutive KALPANA-I images at 00, 06 ,12 &15 UTC are being disseminated over the GTS and website.

(ii) Sea Surface Temperature (SSTs) eight times a day as well as, daily mean for each 1^0 x 1^0 latitude/ longitude grid (free from cloud contamination) using KALPANA-I data.

(iii) Outgoing Long wave Radiation (OLR) on daily / weekly / monthly basis over 0.25^0x0.25^0 latitude/longitude grid

(iv) Quantitative Precipitation Estimates (QPE) on daily / weekly / monthly basis over l^0 x 1^0 attitude/ longitude grid, using the standard temperature threshold technique of Arkin.

(iv) The cloud motion vectors derived from INSAT satellites are displayed on IMD website daily. In addition to this QPE, OLR and SST are also displayed on IMD website daily.

In recent years India has launched the following Satellite which will be useful in the monitoring and prediction of tropical cyclone.

(a) Oceansat-2

Oceansat-2 satellite mainframe systems derive their heritage from previous IRS missions and launched by PSLV-C14 from Satish Dhawan Space Centre, Sriharikota on Sept. 23, 2009. It carries three payloads:

- Ocean Colour Monitor (OCM)
- Ku-band Pencil Beam scatterometer (SCAT) developed by ISRO
- Radio Occultation Sounder for Atmosphere (ROSA) developed by the Italian Space Agency.

The satellite wind available from Oceansat-2 are being used in tropical cyclone monitoring and prediction

(b) Megha-Tropiques

In a joint collaboration with France, India has launched Megha-Tropiques Satellite on 12 October, 2011. The scientific objective of this satellite is as follows:

- to improve the knowledge of the water cycle in the intertropical region, to evaluate its consequences on the energy budget,
- to study the life cycle of tropical convective systems over ocean and continents, the environmental conditions for their appearance and evolution, their water budget, and the associated transports of water vapor.
- to provide data about the processes leading to dramatic weather events affecting the Tropical countries, as cyclones, systems producing heavy rainfalls, processes governing monsoons variability or droughts.

The main payloads instruments are:

- A microwave imager (MADRAS) aimed mainly to study precipitation and cloud properties, including ice at the top of clouds (SSM/I type, with an additional channel at 157 GHz).
- A microwave sounding instrument for the atmospheric water vapor (SAPHIR - 6 channels in the 183 GHz band).
- A radiometer devoted to the measurement of outgoing radiative fluxes at the top of the atmosphere (ScaRaB).

The data from this satellite are under validation and the same will be available for use soon.

(c) RISAT-1:

Radar Satellite-1 (RISAT-1) is a state of the art Microwave Remote Sensing Satellite carrying a Synthetic Aperture Radar (SAR) Payload operating in C-band (5.35 GHz), which enables imaging of the surface features during both day and night under all weather conditions. Active Microwave Remote Sensing provides cloud penetration and day-night imaging capability. These unique characteristics of C-band (5.35GHz) Synthetic Aperture Radar enable applications in management of natural disasters like flood and cyclone. The data from this satellite will be available for operation use in later part of 2012

Cyclone Warning Dissemination System (CWDS) through INSAT

Cyclone Warning Dissemination System (CWDS) is a dependable scheme for transmission of cyclone alert/warning message directly to the area likely to be affected by the cyclone using the S-band broadcast capabilities on board the Indian National Satellite (INSAT) .The system enables the cyclone warning center of IMD to directly and selectively address a particular area likely to be affected by cyclones. 251 Analogue CWDS receiver and 101 Digital CWDS receivers have already been installed in the coastal areas on India. The effectiveness and performance of the CWDS system has been monitored during the past cyclones and it has been found to be good. The network of 101 Digital CWDS receivers is installed in the Andhra Pradesh coast during 2003 and it has been working satisfactorily. There is a plan to increase present network to 500 receivers of Digital technology by shortly.

Digital Meteorological Data Dissemination (DMDD)

Under this scheme, processed satellite imagery analysed weather charts, synoptic meteorological data from GTS are being at difficult field stations of IMD up linked to INSAT in the C-band for reception at ground stations in the S-band. 37 DMDD stations have been installed at difficult field stations of IMD and they are operational, including one in the Maldives and one in Colombo, Sri Lanka. PC-based image processing workstations are available at 37 DMDD stations. The present MDD stations are replaced by Digital MDD receivers. HRIT/LRIT data format is used in transmitting. Three DMDD receiving stations are also operating in neighbouring SAARC countries at Srilanka, Nepal and Maldives.

Automatic Weather Stations (AWS)

Data from the AWS is being received round the clock at the Receiving Earth Station, Pune through the geostationary satellite KALPANA-I, and utilizing Pseudo-Random burst Sequence (PRBS) technique of transmission.

The raw data received from all AWS is processed at the Earth Station and the synoptic data in WMO synop Mobile FM-14 Ext format is transmitted to Global Telecommunication system (GTS) by AMSS Mumbai every hour. The processed data is archived at earth station, Pune. Synoptic charts plotted at NHAC, New Delhi using data from AWS are available for forecasters in the site ftp://nhac@202.141.140.210. Procedures for quality checking and archival of AWS data at National Data Centre (NDC), Pune have also commenced. Current AWS data is available in IMD Pune website **www.imdpune.gov.in.**

Network expansion programmes:

As part of the network expansion programme, installation and commissioning of 550 more AWS which includes 127 Agro-AWS in Agricultural Meteorological field units (AMFUS) for the Agro Climatic Zones of India is expected. Similarly 1350 Automatic rain Gauge Stations are also expected to be commissioned in the IMD network. 550 AWS and 1350 ARGs will utilize Time Division Multiple Access (TDMA) technique for AWS data transmission.

Future plans

(I) INSAT-3D is scheduled to be launched by the end of 2012, which will have 6 ï channel imager as well as 19 channels sounder as Meteorological payloads.

(II) A network of 50 GPS stations will be set up for estimation of Integrated Perceptible Water Vapour (IPWV).

Two No. of NOAA/MODIS data receiving and processing systems have been installed in India at Delhi and Chennai.

Maldives

The Department of Meteorology receives imagery from INSAT/KALPANA and METEOSAT satellites through internet.

Myanmar

The Department of Meteorology and Hydrology in Myanmar is receiving satellite imageries from MTSAT ground receiver, Feng Yun Cast ground receiver and also from US polar-orbiting satellites (NOAA series of the USA).

Oman (Sultanate of Oman)

The Meteorological Department has the following satellite ground receiving stations:

(i) APT and WEFAX system based at Seeb International Airport.

(ii) APT and WEFAX system based at Salalah Airport.

(iii) HRPT system at Seeb International Airport.

(iv) PDUS at Seeb International Airport.

(v) S-VISSR at Seeb International Airport.

All the above mentioned systems receive their data from the EUMETSAT Geostationary Satellite and NOAA Polar Orbiting Satellites.

Apart from generating cloud imagery, several products are derived from the satellite data. Some of these products are:

(i) Sounding based on TOVS [on experimental basis]

(ii) Sea surface temperature

(iii) Precipitation estimates

(iv) Cloud tops

(v) Fire detection [on experimental basis]

(vi) Pollution [on experimental basis]

(vii) Vegetation Index - NDVI [on experimental basis]

Pakistan

Pakistan Meteorological Department (PMD) operates a network of nine APT stations at Islamabad, Karachi, Lahore, Multan, Gilgit, and Skardu, besides HRPT stations at Quetta and Islamabad. APT pictures are regularly received from US polar-orbiting satellites (NOAA Series) amid other geo-stationary satellites in the region. One SADIS equipment has been installed at the Met. Office Karachi Airport recently which is functioning since December 2000.

Sri Lanka

METEOSAT-7/ MTSAT/ INSAT imageries are accessed through Internet regularly

Thailand

The Meteorological Department in Thailand is receiving satellite imagery from NOAA, MTSAT FY-1, FY-2, FY-3 & MODIS satellites.

_____

C H A P T E R IV

TROPICAL CYCLONE FORECASTING

4.1 Forecasting development and movement of tropical cyclones

The final responsibility for analysis and forecasting development and movement of tropical cyclones in the region will be with the National Meteorological Service of each of the Members. However, in addition to the exchange of observational data needed for analysis and forecasting, the following special arrangements for the exchange of processed products and advisories have been made.

(i) (a) Processed products will be provided by RSMC tropical cyclones, New Delhi. A list of output products broadcast from RSMC tropical cyclones, New Delhi for international purposes is given inTable IV1. A list of other products broadcast through facsimile from RSMC tropical cyclones, New Delhi for national purposes is given in Annex IV-A.
(b) RSMC tropical cyclones, New Delhi will issue a tropical weather outlook once daily throughout the year for the benefit of the Member countries. It is being transmitted on the GTS at 06 UTC. The outlook covering the Bay of Bengal and the Arabian Sea indicates possible development of tropical depressions over the sea. An additional outlook will be transmitted again over the GTS at 1700 UTC when a Depression is located and expected to intensify into a cyclonic storm.

(ii) In case there is a tropical cyclone in the Panel region, RSMC tropical cyclones, New Delhi will also issue the following:
(a) Tropical cyclone advisories, details of which have been given in earlier chapters.
(b) Tropical Cyclone Advisory Centre (TCAC) New Delhi will issue Tropical Cyclone Advisory bulletins for the international air navigation to Meteorological Watch Offices (MWOs) in area of responsibility at least for every six hours.

(iii) The satellite tropical disturbance summary issued from Washington will be exchanged through the GTS.
(National Meteorological Services may like to use climatological charts of average vector motions for the track prediction. The track prediction based on climatological charts are usually most useful (minimum error) when tropical storms are to the south of subtropical anticyclones. Such charts for the region for each month and for each season are available**.**

4.2 Prediction Models in operational use during the year 2009

1.5.1. Global Forecast System

The Global Forecast System (GFS), adopted from National Centre for Environmental Prediction (NCEP), at T382L64 (~ 35 km in horizontal) resolution (incorporating Global Statistical Interpolation (GSI) scheme as the global data assimilation for the forecast up to 7 days) was implemented at India Meteorological Department (IMD), New Delhi on IBM based High Power Computing Systems (HPCS) in May 2010. Currently, it runs twice in a day (00 UTC and 12 UTC). The upgraded version of the GFS (*GSI 3.0.0 and GSM 9.1.0*) model at T574L64 (~ 25 km) resolution has been also operated in the experimental mode since 1 June 2011 and real-time outputs are made available to the national web site of IMD (www.imd.gov.in).

1.5.2. 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 taken from the IMD GFS-382. 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.

1.5.3. Regional Forecast System

IMD operationally runs three regional models WRFDA-WRFARW(v3.2), WRF(NMM) for short-range prediction during cyclone condition.

1.5.3.1. Non-hydrostatic mesoscale modeling system WRFDA-WRF-ARW

The mesoscale forecast system Weather Research and Forecast WRFDA (version 3.2) with 3DVAR data assimilation is being operated daily twice to generate mesoscale analysis at 27 km and 9 km horizontal resolutions using IMD GFS-T382L64 analysis/forecast as first guess. Using initial and boundary conditions from the WRFDA, the WRF (ARW) is run for the forecast up to 3 days with double nested configuration with horizontal resolution of 27 km and 9 km and 38 Eta levels in the vertical. The model mother domain covers the area between lat. 25º S to 45º N long 40º E to 120º E and child covers whole India. The performance of the model is found to be reasonably skilful for cyclone genesis and track prediction. At ten other regional centres, very high resolution mesoscale models (WRF at 3 km resolution) are also operational with their respective regional setup/configurations. The latest version of NCEP HWRF is also implemented at IMD for the Indian basins with the assimilation of local observations. The model has the provision for vortex re-location and moving nesting procedure. In this direction action has been already initiated and the model is exceeded to be available in the operational mode by the end of 2011.

1.5.4. Genesis Potential Parameter (GPP)

A cyclone genesis parameter, termed the genesis potential parameter (GPP), for the North Indian Sea is developed (Kotal et al, 2009). The parameter is deýned as the product of four variables, namely vorticity at 850 hPa, middle tropospheric relative humidity, middle tropospheric instability, and the inverse of vertical wind shear. The parameter is operationally used for distinction between non-developing and developing systems at their early development stages. The composite GPP value is found to be around three to ýve times greater for developing systems than for non-developing systems. The analysis of the parameter at early development stage of a cyclonic storm found to provide a useful predictive signal for intensiýcation of the system.

The grid point analysis and forecast of the genesis parameter up to seven days is also generated on real time (available at http://www.imd.gov.in/section/nhac/dynamic/Analysis.htm). Higher value of the GPP over a region indicates higher potential of genesis over the region. Region with GPP value equal or greater than 30 is found to be high potential zone for cyclogenesis. The analysis of the parameter and its effectiveness during cyclonic disturbances in 2010 affirm its usefulness as a predictive signal (4-5 days in advance) for cyclogenesis over the North Indian Ocean.

1.5.5. Statistical Dynamical model for Cyclone Intensity Prediction (SCIP)

A statistical-dynamical model (SCIP) (Kotal et al, 2008) has been implemented for real time forecasting of 12 hourly intensity up to 72 hours. The model parameters are derived based on model analysis fields of past cyclones. The parameters selected as predictors are: Initial storm intensity, Intensity changes during past 12 hours, Storm motion speed, Initial storm latitude position, Vertical wind shear averaged along the storm track, Vorticity at 850 hPa, Divergence at 200 hPa and Sea Surface Temperature (SST). For the real-time forecasting, model parameters are derived based on the forecast fields of ECMWF model. The method is found to be promising for the operational use.

1.5.6. Multi-model ensemble (MME) technique

The multi model ensemble (MME) technique (Kotal and Roy Bhowmik, 2011) is based on a statistical linear regression approach. The predictors selected for the ensemble technique are forecasts latitude and longitude positions at 12-hour interval up to 72-hour of five operational NWP models. In the MME method, forecast latitude and longitude position of the member models are linearly regressed against the observed (track) latitude and longitude position for each forecast time at 12-hours intervals for the forecast up to 72-hour. The outputs at 12 hours forecast intervals of these models are first post-processed using GRIB decoder. The 12 hourly predicted cyclone tracks are then determined from the respective mean sea level pressure fields using a cyclone tracking software. Multiple linear regression technique is used to generate weights (regression coefficients) for each model for each forecast hour (12hr, 24hr, 36 hr, 48hr, 60hr, 72hr) based on the past data.

These coefficients are then used as weights for the ensemble forecasts. 12-hourly forecast latitude (LAT^f) and longitude (LON^f) positions are defined by multiple linear regression technique. In the updated version, MM5 model in the ensemble member is replaced by IMD WRF model. IMD also makes use of NWP products prepared by some other operational NWP Centres like, ECMWF (European Centre for Medium Range Weather Forecasting), GFS (NCEP), JMA (Japan Meteorological Agency), UKMO etc. The MME is developed applying multiple linear regression technique using the member models WRF(ARW), QLM, GFS (NCEP), ECMWF and JMA. All these NWP products are routinely made available on the IMD web site www.imd.gov.in. The MME technique has been implemented from 2009 for real time forecasting of tropical cyclones.

1.5.7. Hurricane WRF Model

Recently under Indo-US joint collaborative program, IMD adapted Hurricane-WRF model for Tropical Cyclone track and intensity forecast for North Indian Ocean (NIO) region for its operational requirements. The basic version of the model HWRFV (3.2+) which was operational at EMC, NCEP, USA was ported on IMD IBM P-6/575 machine with nested domain of 27 km and 9 km horizontal resolution and 42 vertical levels with outer domain covering the area of 80^0x80^0 and inner domain 6^0x6^0 with centre of the system adjusted to the centre of the observed cyclonic storm. The outer domain covers most of the North Indian Ocean including the Arabian Sea and Bay of Bengal and the inner domain mainly covering the cyclonic vortex with moving along the movement of the system. The model has special features such as vortex initialization, coupled with Ocean model to take into account the changes in SST during the model integration, tracker and diagnostic software to provide the graphic and text information on track and intensity prediction for real-time operational requirement.

As part of model validation, case studies were undertaken to test the ability of the model for the Cyclonic storms formed during the year 2010 and model forecasts are produced upto 5 days during the 2011 cyclone season as an experimental forecast in real-time. In these runs only the atmospheric model (HWRF) was tested. The Ocean Model (POM-TC) and Ocean coupler requires the customization of Ocean Model for Indian Seas. In this regards, IMD is expecting to work in collaboration with INCOIS, Hyderabad which is running the Ocean Models (POM)/Hybrid co-ordinate ocean model (HYCOM) to support in porting the Ocean Model with Indian Ocean climatology and real time data of SST over Indian Seas. Few more experiments for the Tropical Cyclones formed during the last 5 years are to be taken up for further validation of the model to customize the model for Indian Ocean region ultimately to make Tropical WRF model (T-WRF).

1.5.8. Tropical Cyclone Ensemble Forecast based on Global Models Ensemble (TIGGE) Data

As part of WMO Program to provide a guidance of tropical cyclone (TC) forecasts in near real-time for the ESCAP/WMO Member Countries based on the TIGGE Cyclone XML (CXML) data, IMD implemented JMA supported software for real-time TC forecast over North Indian Ocean (NIO) during 2011.

The Ensemble and deterministic forecast products from ECMWF (50+1 Members), NCEP (20+1 Members), UKMO (23+1 Members) are available near real-time for NIO region for named TCs. These Products includes: Deterministic and Ensemble TC track forecasts, Strike Probability Maps, Strike probability of cities within the range of 120 kms 4 days in advance. The JMA provided software to prepare Web page to provide guidance of tropical cyclone forecasts in near real-time for the ESCAP/WMO committee Members is under preparation. For verification purposes, the best track data of IMD has to be embedded on the forecast track and strike probability maps. Presently the data and products are to be validated using the IMD best track data.

Table 1.1: Model Parameters

S.No.	Member models	Symbol of Predictors	
		Latitude position	Longitude position
1.	European Centre for Medium-Range Weather Forecasts (ECMWF),	$ECMWF^{lat}$	$ECMWF^{lon}$
2.	GFS of National Centers for Environmental Prediction (NCEP)	$NCEP^{lat}$	$NCEP^{lon}$
3.	Japan Meteorological Agency (JMA)	JMA^{lat}	JMA^{lon}
4.	MM5 Model	$MM5^{lat}$	$MM5^{lon}$
5.	Quasi-Langrangian model (QLM)	QLM^{lat}	QLM^{lon}

Table 1.2: Regression coefficients for latitude position for different forecast hours

Forecast hours	a_0	a_1	a_2	a_3	a_4	a_5
12 hr	1.46633	0.4837	0.08762	0.0474	-0.06954	0.34208
24 hr	0.75662	0.7622	-.08543	-.17727	-0.02354	0.45521
36 hr	1.28923	0.6177	-.05394	0.0407	0.12614	0.17496
48 hr	0.60173	1.3521	0.30361	-0.3094	-0.00463	-0.27553
60 hr	0.36611	1.1298	-.15616	0.1433	-0.11323	0.03574
72 hr	2.49751	0.3766	-.37158	0.9005	-0.21182	0.14239

Table 1.3: Regression coefficients for longitude position for different forecasts hour

Forecast hours	a'_0	$a^{\hat{0}}_1$	$a^{\hat{0}}_2$	$a^{\hat{0}}_3$	$a^{\hat{0}}_4$	a'_5
12 hr	2.1269	0.3363	0.07031	0.1089	-0.04351	0.4990
24 hr	1.04316	0.85076	-0.14555	-.07929	0.16159	0.19624
36 hr	5.82346	0.32571	-0.10423	0.34342	-0.05668	0.42152
48 hr	0.29452	0.36666	-0.04239	0.08226	0.18461	0.40281
60 hr	1.63954	0.24631	0.03642	0.23184	-0.12901	0.59908
72 hr	6.21043	0.28419	0.04475	0.48297	-0.01591	0.13165

The MME technique has been implemented from 2009 for real time forecasting of tropical cyclones.

4.3 Storm surge forecasting

Storm surge forecasting will be the responsibility of the National Meteorological Services. However, storm surge guidance will be issued and incorporated in the Tropical Cyclone Advisory bulletin by RSMC- New Delhi based on IIT, Delhi Storm Surge prediction model.

Processed products updated and uploaded on IMD's website (www.imd.gov.in) on real time bases by RSMC –Tropical Cyclones New for national/international purposes.

(A) WEATHER CHARTS

Model	**Products**
GFS	Analysis and forecast up to 168 hrs
WRF-VAR (AWR) Analysis 27 km	Analysis and forecast up to 72 hrs
WRF-VAR (AWR) Analysis 9 km	Analysis and forecast up to 72 hrs
MM5	Analysis and forecast up to 72 hrs
Extended Range Forecast	Temperature anomaly and mean rainfall forecast up to one month
Other products	Weekly Upper Level Mean Winds
	Weekly Upper Level Wind Anomalies
	Monthly Upper Level Mean Winds
	Monthly Upper Level Wind Anomalies

(B) DOPPLER RADAR PRODUCTS

- MAX(Z) Product
- Plan Position Indicator(Z)
- Volume Velocity processing(2)
- Plan Position Indicator(V)
- Surface Rainfall Intensity
- Precipitation Accumulation (PAC) 24 hrs at 0300 UTC

(C) INSAT IMAGES & INSAT PRODUCTS

(i) INSAT IMAGES

(a)FULL DISC

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel

(b) SECTOR

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel
- Enhanced IR Channel
- Enhanced Visible Channel

(c) NORTH WEST SECTOR

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel

(d) NORTH EAST SECTOR

- Visible Channel
- Infra-red Channel
- Colour Composite
- Water Vapour Channel

(ii) PRODUCTS

- Daily Average WV image from Kalpana-1
- Daily Average IR image from Kalpana-1
- Cloud Motion Vectors (CMV)
- Water Vapour Winds (WVW)
- Cloud Top Temperature Image
- Cloud Top Temperature Image (Below -40^{o}C)
- G.P.S. Precipitable Water Data
- Insat - 3A CCD Image
- Normalised Difference Vegetative Index
- Upper Tropospheric Humidity (UTH)
- Map of Daily UTH
- Map of Weekly UTH
- Sea Surface Temperature (SST)
- Map of Weekly SST
- Map of Daily SST

- Outgoing Long wave Radiation (OLR)
- Latitude-Time Diagram of daily OLR from 1 January 2010
- Latitude-Time Diagram of daily OLR from 1 January 2009
- Latitude-Time Diagram of daily OLR for the Year 2009
- Latitude-Time Diagram of daily OLR (Monsoon season 2009
- Latitude-Time Diagram of daily OLR(Monsoon Season 2008)
- Map of Daily Mean OLR
- Map of Weekly Mean OLR
- Map of Monthly Mean OLR
- Map of Seasonal Mean OLR
- Quantitative Precipitation Estimate (QPE)
- Map of Daily QPE
- Map of Weekly QPE
- Map of Monthly QPE
- Map of Seasonal QPE

NOAA APT IMAGES

Visible Channel
IR Channel

CHAPTER V

COMMUNICATIONS

5.1 General

The basic communication network for the exchange of data, forecast, warnings and observations will be the Global Telecommunication System (GTS). Tropical cyclone advisories and warnings (SIGMETs) for aviation shall be transmitted by means of the Aeronautical Fixed Service (AFS), according to the provision of ICAO Annex 3/WMONo. 49, Technical Regulations [C.3.1], and ICAO ASIA/PAC and MID ANP FASIDs.

Processed products of RSMC tropical cyclones, New Delhi are distributed in chart form through Satellite broadcast as well as through ftp server on Internet.

In the GTS a regional arrangement exists for the exchange of raw and processed data, forecasts, warnings and addressed messages. Normally message-switching computers in GTS transmit the data on a first in-first out basis. However, priority can be assigned to certain messages on the basis of abbreviated headings. Such messages are given preference over other messages in transmission on the circuits.

The messages for which high priorities are to be assigned are:

(i) all radar observations in cyclonic storm situations;

(ii) composite ships' surface and upper-air observations from the tropical cyclone field:

(iii) tropical cyclone warnings;

(iv) tropical weather outlook;

(v) tropical cyclone advisories; and

(vi) satellite bulletins from RSMC tropical cyclones, New Delhi.

To exchange these messages on priority basis among the Panel countries the abbreviated headings as decided in consultation with RTH New Delhi will be used.

5.2 Procedures to be followed

WMO headings.
Station location indicators.
International block and station index numbers will be used to send surface and upper-air observations.

5.2.1 Tropical cyclone warning headings

The headings used for the exchange of tropical cyclone warnings by the Panel countries are given in Table V1. Member countries will request RTH New Delhi to assign priority to these headings if not already provided.

5.2.2 Telecommunication headings for the exchange of radar observations

The telecommunication headings used for the exchange of radar observations are listed in Table V2.

5.2.3 Telecommunication headings for the exchange of other messages

The telecommunication headings (which will be the priority headings) for the exchange of tropical weather outlook, tropical storm advisories and satellite bulletins as decided in consultation with the RTH New Delhi are listed in Table V3.

5.2.4 Telecommunication headings for the exchange of tropical cyclone advisories and warnings for aviation

The telecommunication headings for the exchange of tropical cyclone advisories and warnings for aviation are given in Table V4.

5.3 Existing GTS circuits among the Panel countries

1. New Delhi -Bangkok	Upgraded to 64 Kbps TCP/IP WMO FTP circuit.
2. New Delhi- Colombo (Sri Lanka)	Upgraded to internet.
3. New Delhi Dhaka(Bangladesh)	64 kbps TCP/IP WMO Socket circuit, satellite (since March 2007)
4. New Delhi- Karachi(Pakistan)	Upgraded to 64 kbps.
5. New Delhi -Malé(Maldives)	Upgraded to Internet w.e.f. February,2004.
6. New Delhi -Yangon(Myanmar)	Upgraded to internet.
7. New Delhi -Bangkok	Upgraded to internet.
8. New Delhi -Muscat	Upgraded to 64 kbps TCP/IP WMO Socket circuit.
9. New Delhi.-Jeddah	Upgraded to internet.

5.4 List of important telephone numbers and addresses connected with tropical cyclone warnings in the Panel countries

A list containing addresses of the tropical cyclone warning centres of the Panel countries, together with their telephone numbers, is given in Annex V-A.

5.5 Global Maritime disturbances Safety System (GMDSS)

GMDSS is a satellite based broadcast system intended for the benefit of ships at high seas. EGC (Enhanced Group Call) Safety Net System of the INMARSAT (International Maritime Satellite Organization) together with NAVTEX and MSI (Maritime Safety Information) broadcast form integral parts of the GMDSS. Under this ocean going vessels would receive:

a) Meteorological forecasts and warnings;
b) Navigational aid and warnings; and
c) Helps in search and rescue operations. WMO has suggested date of full implementation of the system as 1st February, 1999. IMD is broadcasting two GMDSS bulletins at 0900 and 1800 UTC everyday with effect from 1st October, 1998 and additional warnings during the cyclone season.

5.6 India Meteorological Department started Digital Data Broadcast service via Satellite using World Space ñ**Asia Star**ò Satellite. This is replacement of the HF Broadcast System. The Meteorological data presently being broadcast are:

(i) Indian Satellite images such as three hourly Visible, Infrared, Colour and Water Vapour images.
(ii) GTS data (SYNOP, PILOT, TEMP, METAR, TAF etc) of India and its neighbouring countries.
(iii) Weather Charts and Model outputs.

The Broadcast covers large areas of Middle ï East and South East Asia at a downlink frequency of 14671492 MHZ. at a speed of 128 Kbps.

5.7 India Meteorological Department is hosting its own website www.imd.ernet.in and www.imd.gov.in which also provides information pertaining to WX Charts, Forecasts, Warnings, Satellite Imageries, Hydrological and Seismological and other weather related topics are updated on regular basis.

5.8 Regional Meteorological Centres located at Delhi, Chennai, Nagpur and Mumbai are hosting their own websites.

TABLE V-1
ABBREVIATED HEADINGS FOR EXCHANGE OF
TROPICAL CYCLONE WARNINGS FOR THE HIGH SEAS

	Country	GTS Abbreviated Headings	Priority
1.	Bangladesh	WTBW20 VGDC	Highest
2.	India	WTIN20 DEMS	Highest
3.	Maldives	WTMV20 VRMM	Highest
4.	Myanmar	WTBM20 and WOBM20 VBRR	Highest
5	Oman (Sultanate of Oman)	WTOM20 and WSOM20 OOMS	Highest
6.	Pakistan	WWPK20 OPKC	Highest
7.	Sri Lanka	WTSB40 VCCC	Highest
8.	Thailand	WTTH20 VTBB	Highest

TABLE V-2

Communication headings for the exchange of radar observations

	Country	Abbreviated heading	
1.	Bangladesh	SDBW20 VGDC	
2.	India	SDIN90 VABB	(Mumbai-Karachi)
		SDIN90 VECC	(Kolkata-Dhaka and Bangkok)
		SDIN90 VOMM	(Chennai-Bangkok, Dhaka and Colombo)
3.	Maldives	SDMV20 VRMM	
4.	Myanmar	SDBM20 VBRR	
5.	Pakistan	SDPK20 OPKC	
		SDPK40 OPKC	
6.	Thailand	SDTH20 VTBB	
7.	Sri Lanka	SDSB20 VCCC	

TABLE V-3

GTS headings for the exchange of tropical weather outlook, tropical storm advisory and satellite bulletin

Country	Abbreviated heading	
	Tropical weather outlook	Tropical storm advisory
		BMAA01 VGDC
Bangladesh	WWBW20 VGDC,	BMAA01 VBRR
India	WTIN20 DEMS	BMAA01 OPKC
Pakistan	WWPK20 OPKC	BMAA01 VCCC
		BMAA01 VTBB
		BMAA01 VRMM
		BMAA01 OOMS

Satellite bulletins generated by RTH, New Delhi

TCIN20 DEMS (Sat bulletins based on INSAT pictures)- For International
TCIN50 DEMS (Sat bulletins based on INSAT pictures
TCIN51 DEMS (Intense precipitation advisory bulletins | For National
ATIN50 DEMS (For all CDRs during cyclone period)

INSAT Satellite bulletins generated by RTH, New Delhi

TWIO01 DEMS	TWIO06 DEMS
TWIO02 DEMS	TWIO07 DEMS
TWIO03 DEMS	TWIO08 DEMS
TWIO04 DEMS	TWIO09 DEMS

TABLE V-4

WMO headings for the exchange of Tropical cyclone advisories for aviation and SIGMETS

I. TC Advisories

	Country	Abbrevaited heading	Area
1.	India	FKIN21 VIDP FKIN20 VIDP	Bay of Bengal Arabian Sea

II. SIGMETs for tropical cylcones

	Country	Abbrevaited heading	Area
1.	Bangladesh	WCBWxx VGDC	Dhaka
2.	India	WCINxx VECC WCINxx VOMM WCINxx VABB	Kolkata Chennai Mumbai
3.	Maldives	WCMV31 VRMM	Malé
4.	Myanmar	WCBMxx VYYY	Yangon
5.	Oman (Sultanate of Oman)	WCOMxx OOMS	Muscat
6.	Pakistan	WCPKxx OPKC	Karachi
7.	Sri Lanka	WCSB31 VCCC	Colombo
8.	Thailand	WCTH31 VTBB	Bangkok

Notes:

1. *TCAC New Delhi shall send the TC advisories to the MWOs through AFTN. In addition to the MWOs listed above, the advisories have been sent to all MWOs in the area of responsibility of TCAC New Delhi according to ICAO ASIA/PAC and MID Regions FASIDs.*
2. *TCAC New Delhi have send the TC advisories to Singapore OPMET Data Bank – AFTN address WSSSYMYX.*
3. *The MWOs listed above have send their SIGMETs for tropical cyclones through AFTN to the MWOs responsible for the adjacent FIRs and to Singapore OPMET Data Bank – AFTN address WSSSYMYX.*

ANNEX V-A-1

LIST OF IMPORTANT ADDRESSES AND TELEPHONE NUMBERS CONNECTED WITH TROPICAL CYCLONE WARNINGS IN THE PANEL COUNTRIES

Bangladesh

Director
Bangladesh Meteorological Department
Meteorological Complex
Agargaon
Dhaka-120

Phone:Off: (880) 2-8116634,
(880) 2-8144968(direct)
Res: (880) 2-8900202
Fax: (880) 2-8118230
E-mail: info@bmd.gov.bd
Home page: http://www.bmd.gov.bd

Deputy Director
Storm Warning Centre
Dhaka

Phone: Off: (880) 2-9114388
Res: (880) 2-9127767
Fax: (880) 2-8118230
swc@bmd.gov.bd

Duty Forecasting Officer
Storm Warning Centre
Dhaka

Phone: (880) 2-8113071
(880) 2-9135742
(880) 2-9111015
(880) 2-9112439
Fax: (880) 2-8118230
swc@bmd.gov.bd

India

Director General of Meteorology
India Meteorological Department (IMD)
Regional Telecommunication Hub
Mausam Bhavan, Lodi Road

Phone: Off: (91) 11-24611842
Fax (91) 11-24611792
Res: (91) 11-24122236

E-mail: lsrathore@gmail.com
Home page: http://www.imd.gov.in

Deputy Director General
RSMC, New Delhi

Phone:

Off: (91) 11-24611068
(91) 11-24635664
Res: (91) 11-24618053
E-mail: cwdhq2008@gmail.com
bkbando1705@yahoo.co.in

Duty Officer

Phone: (91) 11-24631913 (24 hrs)

Maldives

Deputy Director General,
Maldives Meteorological Service,
Hulhuleô22000,
Maldives.

Phone:

Off: (960) 332 6200
Fax: (960) 332 0021 , 334 1797
Res: (960) 332 2829
Mobile: (960) 7771828
Email: shareef@meteorology.gov.mv

Duty Forecaster,
National Meteorological Centre

Phone: Off: (960) 3323084
Fax: (960) 3315509
Email: metmdv@gmail.com

Myanmar

Director-General
Department of Meteorology
and Hydrology
Building No. 5
Nay Pyi Taw

Phone: Off: (9567) 411031
(9567) 411032
(9567) 411422
(9567) 411446
(9567) 411251
Res: (9567) 403404
Fax: (9567) 411449
(9567) 411250
Email: dg.dmh@mptmail.net.mm
Home page:www.moezala.gov.mm

Oman

Oman Meteorological Department
(Directororate General of Meteorology and Air Navigation DGMAN),
Muscat Intl Airport
P.O. Box 1, P.C. 111
Muscat

Phone: 0096824518303(24 hours)
Fax: 00968519363 (24 hours)
Home page: http://www.met.gov.om

Mr Badr Alrumhi
Director of Main Forecasting Center

Phone: 0096824519610 (office)
Mobile: 0096899327811
Email: b.alrumhi@met.gov.om

Mr Khalid Aljahwari
Assistant Director
Main Forecasting Center

Phone: 0096824518272 (office)
Mobile:0096899355368
Email: k.aljahwari@met.gov.om

Pakistan

Mr. Arif Mahmood
Director General
Pakistan Meteorological Department
Headquarters Office, Sector H-8/2,
Islamabad ï 44000, Pakistan

Tel: + (92) 51-9250367, Fax: +(92) 51-9250368
Email: dgpakmet@yahoo.com
pmd@pakmet.com.pk
Pakmet_islamabad@yahoo.com
Website: http:// www.pmd.gov.pk

Mr. Abdul Qayoom Bhutto
Acting Director
Marine Meteorology ï
Tropical Cyclone Warning Centre (TCWC),
Meteorological Complex, University Road,
Karachi ï 75270, Pakistan

Tel: + (92) 21-9261434, Fax.: +(92) 21-9261405
Cell: +(92) 333-7271894
Email: aq_1961@yahool.com
Website: http://www.pakmet.com.pk

Duty Forecasting Officer / Meteorologist,
Main Analysis Centre
Meteorological Complex, University Road
Karachi ï 75270, Pakistan

Tel: + (92) 21-99261417
+(92) 21 99238958 (24 Hours)
Fax. +(92) 21-99261405
Website: http:// www.pmd.gov.pk

Sri Lanka

Director-General of Meteorology Department of Meteorology Bauddhaloka Mawatha Colombo-7	Phone: Off: (94) 11-2694104 Fax (94) 11-2698311 E-mail: meteo1@sltnet.lk Home page: http://www.meteo.gov.lk E-mail: meteo@sltnet.lk Private: khsunila@gmail.com
Director, Operations	Phone/Fax (94) 11-2692756 E-mail: ajithweer@yahoo.com
Deputy Director, NMC, Colombo	Phone/Fax (94) 11-2691443 E-mail: siriranjith1957@gmail.com
Duty Meteorologist, NMC, Colombo	Phone (94) 11-2684746 E-mail: meteo2@sltnet.lk
Duty Meteorologist, Met office International Airport, Katunayake	Phone (94) 11-2252721 E-mail: meteo3@sltnet.lk Fax: (94) 11-2252319

Thailand

Director-General Thai Meteorological Department 4353 Sukumvit Road Bang-Na, Bangkok 10260	Phone : (66) 2-399 1425 Fax : (66) 2-399 1426 E-mail : tmd_inter@tmd.go.th Home page: http://www.tmd.go.th

Focal Points of the Forecast Center (in accordance to Para. 9.5 of PTC -36th final report)

Bangladesh Mr. Samsuddin Ahmed

Asstt. Director Storm Warning Centre Bangladesh Meteorological Department Meteorological Complex Agargaon Dhaka-1207	Phone: Off: (880) 2-9135742, +880 01713434488 Fax: (880) 2-8118230 E-mail: shamsbmd@yahoo.com swc@bmd.gov.bd

India :

1. B.K. Bandyopadhyay
Deputy Director General of Meteorology
India Meteorological Department
Lodi Road, New Delhi -110003
Phone: +011 -24635664
Fax: +011-24626815
email:bkbando1705@yahoo.co.in
bkban@imdmail.gov.in

2 Dr. M. Mohapatra
Scientist ôEö(Cyclone Warning)ô
India Meteorological Department
Lodi Road, New Delhi -110003
Phone. +011 -24611068
+011 -24652484
Fax: +011 -24626815
email: mohapatra_imd@yahoo.com
mohapatraimd@gmail.com

Maldives

Ali SHAREEF
Deputy Director General,
Maldives Meteorological Service,
Hulhuleô22000,
Maldives.
Phone: Off: (960) 332 6200
Fax: (960) 332 0021 , 334 1797
Res: (960) 332 2829
Mobile: (960) 7771828
Email: shareef@meteorology.gov.mv

Duty Forecaster,
National Meteorological Centre
Phone: Off: (960) 3323084
Fax: (960) 3315509
Email: metmdv@gmail.com
Website: www.met.gov.mv

Myanmar

Dr. Thein Tun
Department of Meteorology
and Hydrology
Office No. (5) Ministry of Transport
Nay Pyi Taw, Myanmar
Phone: Off: (+9567) 411031
Fax: (+9567) 411449/411250
Email: dg.dmh@mptmail.net.mm
theintun500@gmail.com

Sultanate of Oman

Khalid Khasim saif AL-Jahwari
Assistant Director of forecasting and observing practices
Director General of Meteorology and Air Navigation (DGMAN)
Muscat International Airport
P.O.BOX 1, P. C. 111
Sultanate of Oman
Tel (00968) 24519610
Fax (00968) 24519363
khalid.aljahwari13@gmail.com

PAKISTAN

(1) Mr. Abdul Qayoom Bhutto
Acting Director,
Tropical Cyclone Warning Centre
Meteorological Complex, University Road
Karanchi-75270, Pakistan
Tel : +(92) 21-9261434
Fax: + (92)-21-9261405
Cell: +(92) 333-7271894
Email: aq_1961@yahool.com

(2) **Mr. Muhammad Hanif**
Director,
National Weather Forecasting Centre,
Pakistan Meteorological Department,
Head quarters Office, Sector H-8/2,
Islamabad- 44000, Pakistan
Tel : +92-51-9250595
+92-51-9250363-4 (Ext-803) (24 Hours)
Fax: +92-51-9250368, 9250362
Cell: +92-333-5128132
Email: hanifwxc@hotmail.com
pmd@pakmet.com.pk
PMD website: www.pakmet.com.pk

SRI LANKA

(1) Mr. M.D Dayananda
Deputy Director
National Meteorological Centre
Department of Meteorology
COLOMBO 7,
SRI LANKA
Phone/Fax NO. (94)11-2691443
Email: daya_md7@hotmail.com

(2) Duty Meteorologist
National Meteorological Centre
Department of Meteorology
COLOMBO 7, SRI LANKA
Phone No. (94)11-2682661
Fax No. (94)11-2691443
E-mail: meteo2@sltnet.lk

(3) Mr. D.A.Jayasinghe Arachchi
Meteorologist in charge
National Meteorological
Centre Department of Meteorology
COLOMBO 7, SRI LANKA
Phone No. (94)11-2682661
Fax No. (94)11-2691443
Email: dananda52@yahoo.com

THAILAND

(1). Mrs. Watcharee Virapun
Director, Weather Forecast Bureau
Thai Meteorological Department
4353 Sukumvit Road
Bang-Na
Bangkok 10260
THAILAND

Phone: (66) 2-398 9801
Fax : (66) 2-399 4001
(24 hours)
E-mail: W_virapun@tmd.go.th, tmd_inter@tmd.go.th
Home page: http://www.tmd.go.th

(2) Mr. Prawit Jampanya
Director, Central Weather Forecast Division
Weather Forecast Bureau
Thai Meteorological Department
4353 Sukumvit Road
Bang-Na
Bangkok 10260
THAILAND

Phone: (66) 2-398 9830
Fax: (66) 2-398 9836
(66) 2-398 9816
(24 hours)
E-mail: jampanya@tmd.go.th, tmd_inter@tmd.go.th
Home page: http://www.tmd.go.th

PTC Secretariat

WMO/ESCAP Panel on Tropical Cyclones (PTC) Secretariat,
Meteorological Complex,
Pitras Bukhari Road, Sector H-8/2,
Islamabad -44000, Pakistan

Tel: +(92) 51-9250365, 9250593
Fax:+(92) 51-9250368
E-mail: PTC.Sectt@yahoo.com
PTC Website:http://www.tsuptc-wmo.org

C H A P T E R VI

MONITORING AND QUALITY CONTROL OF DATA

6.1 Monitoring of data

It will be the responsibility of the National Meteorological Services to monitor the data, advisories and forecasts received by them in accordance with the specified arrangements. Each tropical cyclone warning centre will review from time to time the inflow of data to the centre and also the transmission to neighbouring services of the messages they are responsible for sending out.

To be sure of reception of important data in the case of cyclonic storm situations, cyclone warning centres of the Member countries will transmit addressed messages to RSMC tropical cyclones, New Delhi four times a day which will include important surface, upper-air and ships' observations.

The National Meteorological Services will inform RSMC tropical cyclones, New Delhi of any shortcomings in the flow of data (raw and processed) and also indicate any requirements over and above those already agreed upon for tropical cyclone warning purposes.

6.2 Quality control

National Meteorological Services will make extra efforts to make sure that all observational data passed on GTS, particularly during disturbed weather, have been checked for errors and that corrections are made if needed. They will impress upon their observing stations the need for accuracy of data, particularly in tropical cyclone situations and the difficulties that may be caused in the decision process by an incorrectly recorded or transmitted observation.

In case of doubt as to the correctness of any observation or part thereof, an addressed message will be sent to the national service and to RSMC tropical cyclones, New Delhi requesting confirmation.

C H A P T E R VII

ARCHIVAL OF DATA

7.1 Necessity for data archival

In view of the development of computer facilities in the region, it is expected that the research efforts on tropical cyclones will substantially increase. In addition to dynamic modeling of tropical cyclones on the new generation computer being acquired by national authorities, it is expected that the synoptic oriented investigations and research as well as verification programmes will be undertaken in the region.

It is, therefore, necessary to create data sets as detailed and as complete as possible for all the future cyclones.

7.2 Tropical cyclone data on landfall

There is a dearth of information on actual conditions of tropical cyclones and an endeavor is therefore required to be made to utilize whatever information is obtained to the maximum extent possible. In particular, the Panel countries are interested in verifying forecast and estimated conditions against the actual.

Panel countries will take appropriate steps to ensure that after a tropical cyclone makes a landfall all the available data pertaining to that tropical cyclone are collected and archived. Data on the actual condition of winds, storm surge, surface pressure and rainfall from stations near the point of landfall will be sent to RSMC tropical cyclones, New Delhi. If the landfall is in a country other than India, its meteorological service will send a brief summary of information to RSMC tropical cyclones, New Delhi for inclusion in the RSMC New Delhi tropical cyclone report.

In the case of a tropical cyclone making a landfall on the coast of a country, which is not a member of the Panel, RSMC Tropical Cyclones, New Delhi will collect the information for inclusion in the RSMC, New Delhi tropical cyclones report.

7.3 Role of RSMC-tropical cyclones, New Delhi in data archiving

For each tropical cyclone occurrence in the area, initially RSMC tropical cyclones New Delhi will compile the following data sets:

(i) Daily synoptic charts covering the area 45^0 N to 30^0 S and 30^0 E to 120^0 E for the surface and upper-air charts for the levels 700, 500 and 200 hPa for 00 UTC and 12 UTC.

(ii) All upper-air data from stations within 15 degrees of the tropical cyclone field.

(iii) The tracks of tropical cyclones for the Panel regions prepared by the India Meteorological Department.

(iv) An e-Atlas on Cyclones and Depressions (C&Dõs) having many salient features as generation of Tracks, several types of C&Dõs statistics have been developed and also circulated to Panel Member countries for their use.

(v) The online version of e-Atlas is available at IMD Website at Cyclone Page under the URL: www.rmcchennaieatlas.tn.nic.in.

For the purpose of making these archives the National Meteorological Services will supply New Delhi with relevant information requested by RSMC tropical cyclones, New Delhi. On request by a Panel country, the RSMC tropical cyclones, New Delhi will make arrangements to supply these data sets to the Panel Member concerned on a copying cost basis.

In accordance with the directive of the WMO Executive Council (ECXLV), Geneva, July 1993) an international format for the archiving of tropical cyclone data is to be used by all RSMCs with activity specialization in tropical cyclones.

The Tropical Cyclone Programme (TCP) office of the WMO Secretariat has the responsibility for the maintenance of the format, including assignment of the source codes to appropriate organizations, and authorizing additions and changes.

In the international format given below, the Dvorak T number (Position 3536) and Dvorak CI number (position 3738) will be the ones determined at the centre submitting the data, in the case of the Panel on Tropical Cyclones, by RSMC New Delhi.

Complete historic data in the format given in Annex VII-A will be made available for research applications. RSMC New Delhi will provide such data, to the Director of the National Climatic Data Centre (NCDC), USA in this format through WMO.

GLOBAL TROPICAL CYCLONE TRACK AND INTENSITY DATA SET REPORT FORMAT

Position Content

1-9

Cyclone identification code composed by 2 digit numbers in order within the cyclone season, area code and year code. 01 SWI2000 shows the 1st system observed in Southwest Indian Ocean basin during the 2000/2001 season. Area codes are as follows:

ARB = Arabian Sea
ATL = Atlantic Ocean
AUB = Australian Region (Brisbane)
AUD = Australian Region (Darwin)
AUP = Australian Region (Perth)
BOB = Bay of Bengal
CNP = Central North Pacific Ocean
ENP = Eastern North Pacific Ocean
ZEA = New Zealand Region
SWI = Southwest Indian Ocean
SWP = Southwest Pacific Ocean
WNP = Western North Pacific Ocean and South China Sea

10-19 Storm Name
20-23 Year
24-25 Month (0112)
26-27 Day (0131)
28-29 Hour-universal times (at least every 6 hourly position 00Z, 06Z, 12Z and 18Z)
30 Latitude indicator:
1 =North latitude;
2=South latitude
31-33 Latitude (degrees and tenths)
34-35 Check sum (sum of all digits in the latitude)
36 Longitude indicator:
1 =West longitude;
2=East longitude
37-40 Longitude (degrees and tenths)
41-42 Check sum (sum of all digits in the longitude)
43 position confidence*
1 = good (<30nm; <55km)
2 = fair (3060nm; 55-110km)
3 = poor (>60nm; >110km)
9 = unknown

Note* Confidence in the center position: Degree of confidence in the center position of a tropical cyclone expressed as the radius of the smallest circle within which the center may be located by the analysis. "position good" implies a radius of less than 30 nm, 55 km; "position fair", a radius of 30 to 60 nm, 55 to 110km; and "position poor", radius of greater than 60 nm, 110km.

44-45 Dvorak T number (99 for no report)
46-47 Dvorak CI number (99 for no report)
48-50 Maximum average wind speed (whole values) (999 for no report).
51 Units 1 =kt, 2=m/s, 3=km per hour.
52-53 Time interval for averaging wind speed (minutes for measured or derived wind speed, 99 if unknown or estimated).
54-56 Maximum Wind Gust (999 for no report)
57 Gust Period (seconds, 9 for unknown)
58 Quality code for wind reports:
1 =Aircraft or Dropsonde observation
2=Over water observation (e.g. buoy)
3=Over land observation
4=Dvorak estimate
5=Other
59-62 Central pressure (nearest hectopascal) (9999 if unknown or unavailable)
63 Quality code for pressure report (same code as for winds)

64 Units of length: 1 =nm, 2=km
65-67 Radius of maximum winds (999 for no report)
68 Quality code for RMW:
1 =Aircraft observation
2=Radar with well defined eye
3=Satellite with well defined eye
4=Radar or satellite, poorly defined eye
5=Other estimate
69-71 Threshold value for wind speed (gale force preferred, 999 for no report)
72-75 Radius in Sector 1: 315 45
76-79 Radius in Sector 2: 45 135
80-83 Radius in Sector 3: 135 225
84-87 Radius in Sector 4: 225 315
88 Quality code for wind threshold
1=Aircraft observations
2=Surface observations
3=Estimate from outer closed isobar
4=Other estimate
89-91 Second threshold value for wind speed (999 for no report)
92-95 Radius in Sector 1: 315 45
96-99 Radius in Sector 2: 45 135
100-103 Radius in Sector 3: 135 225
104-107 Radius in Sector 4: 225 315
108 Quality code for wind threshold (code as for row 88)
10910 Cyclone type:
01 = tropics; disturbance (no closed isobars)
02= <34 knot winds, <17m/s winds and at least one closed isobar
03= 34-63 knots, 17 32m/s
04= >63 knots, >32m/s
05= extra tropical
06= dissipating
07= subtropical cyclone (non frontal, low pressure system that comprises I initially baroclinic circulation developing over subtropical water)
08= overland
09= unknown
111-112 Source code (2 digit code to represent the country or organization that provided the data to NCDC USA. WMO Secretariat is authorized to assign number to additional participating centers, organizations)
01 RSMC Miami Hurricane Center
02 RSMC Tokyo Typhoon Center
03 RSMC tropical cyclones New Delhi
04 RSMC La Reunion Tropical Cyclone Centre
05 Australian Bureau of Meteorology
06 Meteorological Service of New Zealand Ltd.
07 RSMC Nadi Tropical Cyclone Centre
08** Joint Typhoon Warning Center, Honolulu
09** Madagascar Meteorological Service
10 ** Mauritius Meteorological Service
11 ** Meteorological Service, New Caledonia
12 Central Pacific Hurricane Center, Honolulu

Note**: no longer used

Headings 1-19 Cyclone identification code and name;
20-29 Date time group;
30-43 Best track positions;
44-110 Intensity, Size and Type;
111-112 Source code.