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MAXIMISING BENEFIT FROM PUBLIC WEATHER SERVICES[1]

S. Raghavan[2]

> An old joke:
> An army officer went to the Meteorological Office and told the meteorologist that an Army General was coming from Delhi and they wanted to hold a function in his honour in the open air at 4 p.m on 9 March. He was anxious that there should be no rain. He wanted a forecast from the meteorologist. The latter looked at his charts and satellite pictures and told the officer with confidence "The weather that day will be fine. You can go ahead with the party".
> The officer was very pleased and profusely thanked the meteorologist. As an afterthought, he invited the meteorologist to attend the function. The latter, thought for a minute and said "OK, I shall come – if it does not rain".

We have come a long way since then, as people take the weatherperson more seriously. But let us look more systematically at how to make use of weather information.

Ten years ago I had formulated an equation governing the Effectiveness (E) of weather information and the three factors involved in it (Raghavan 1996).

$$E = S \times C \times R \qquad (1)$$

S represents the Science or Skill which leads to the production of meteorological information i.e. the contribution of the meteorologist.

C represents Communication i.e. the timely and proper dissemination of information and its assimilation by the recipients, and

R represents the Response i.e. the action taken by the recipients before, during and after the event.

To maximise E, it is necessary to ensure that all three factors are high. If anyone of them is zero, the product is zero.

Information from S may be

→forecast

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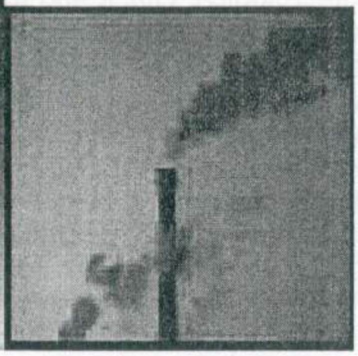
→current weather or past climatological data

You need the current weather data for aviation.

You require wind statistics to select a site for wind power generators.

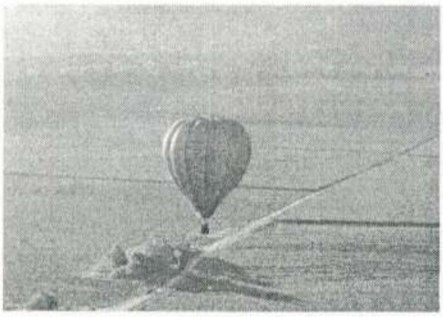


You need meteorological data to study beforehand how industrial pollution will spread.

It is well-known that forecasts may not always be accurate, but less appreciated is the fact even current or past data are often in a form not clearly understood by the recipients. This is why the second factor C is important. This is where the role of the Media is of great importance.

The most important factor R is the action taken before, during and after the event.

Weather information produces a benefit (positive benefit or loss reduction) only when somebody makes use of it. So we have to distinguish between the accuracy of the information and its value.



Information can be accurate but useless.
A balloonist has a problem with his balloon and comes down in a field.
He does not know where he is. He asks a passerby "Where am I"?
The latter replies "You are in a balloon"
100% correct answer but of no use.

Example 1, Agriculture: The National Centre for Medium Range Weather Forecasting (NCMRWF) gave a correct rainfall forecast for two days (31 December 2000 to 1 January 2001) to Punjab Agricultural University, Ludhiana. The university states that Punjab has 3.391 million hectares (Mha) under wheat out of which about 3.221 Mha are irrigated. Assuming that the agromet advisory applied to 20% of the irrigated area, it argues that irrigation of 0.644 Mha was saved. At Rs. 100 per ha, this would mean a saving of Rs. 64.4 million for the state, for the irrigated area alone (in just two days), not to speak of benefits in dry farming areas. This figure looks overoptimistic, but it shows that quite a large saving is possible by the application of the forecast.

Example 2, Aviation: To provide for the possibility that the terminal weather at the landing point may be adverse and a diversion may be necessary, additional fuel for about an hour's flight is usually loaded by airlines. If reliable terminal aerodrome forecast (TAF) is available and it indicates fair weather, the airline can choose not to load additional fuel. Anaman et al., (1998), in a study in Australia, estimate the saving on this account alone for Qantas airlines international flights to Australian airports in 1993 to be Australian $16 million.

The value may be different for different people. To take a simple case, if I forecast a severe weather event you can take action to protect your property of L Rs at a cost C. If I forecast it and it does not occur, your cost C has no benefit and you may curse me. If I fail to forecast it and it occurs, you lose the whole property L. You still curse me.

If the event occurs as forecast and if you have acted on it, your cost is $C + \varepsilon L$ i.e. you lose a small part of your property. If $C + \varepsilon L < L$ your protective action was worthwhile and you should thank me.

		Event Forecast	
		Yes	No
Event Observed	Yes	Cost C + Mitigated Loss ε L	Loss L
	No	Cost C	Normal Loss N = 0

That shows the value of preparedness before the event. Take the case of cyclones affecting Andhra Pradesh.

EXPENDITURE	Rs. Crore
Relief expenditure after the event (including cyclones, floods and droughts), from 1979-80 to 1999-2000.	2781
Damage estimated to have occurred in one single cyclone in 1996	6129
expenditure on preparedness before each event	Not available
World Bank-aided Project in the nineties mostly on infrastructure development	801

This shows that preparedness does not get as much attention as relief after the event. Of course the latter gets political mileage while the former is hard work.

Last season's rains in Tamil Nadu are another example. The relief budget is over Rs. 13000 crore. But much of the damage arose in the first instance by indiscriminate land development blocking drainage paths, destroying water storages and coastal vegetation etc. over the years. If attention had been given to preparedness, damage would have been much less.

Hurricane Katrina which pounded New Orleans in USA caused $38.1 billion, the highest ever, of insured losses. Although it was known that the levees would not stand such a storm and elaborate plans had been made to strengthen them, none was implemented. The Mumbai disaster of July 2005 was yet another, caused by blocking river drainage in the name of development.

It is convenient to say that severe weather events are increasing due to climate change. Many studies show that this is not true (e.g. Raghavan and Rajesh, 2003). But the impact of severe weather is increasing due to societal and economic factors and not the weather events themselves. It is important to distinguish between the two. Instead of considering disasters as "Acts of God", and evading our responsibility we should prepare ourselves better instead of lamenting after the event.

Now let us come to the communication factor C, which has two components
(1) the technical means of dissemination of information and
(2) the correct understanding of this information.

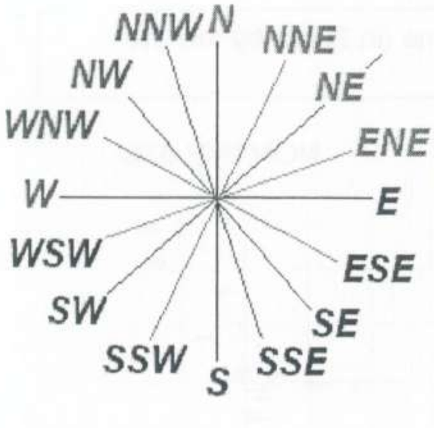
The former has advanced tremendously in the last two decades. We have a very successful satellite-based Cyclone Warning Dissemination System for the past 20 years. We also have the internet. The latest is a project (now in experimental stage) to broadcast warnings to every mobile phone in the language of one's choice.

But the understanding part has not progressed much. Very often there is confusion over the meaning of weather information. Both the meteorological agencies and the media are responsible for this. The former, which are keen to make the messages as scientifically accurate as possible, often use technical jargon, which is confusing to others. The media which wish to present the information to the public in an attractive manner in the quickest possible time, often distort it. Both have the best intentions but the result is not the best.

Matters become worse if translation into, say, Tamil is involved.

Examples:

(1) Met. Office classifies weather systems as low pressure area, depression, cyclonic storm, severe cyclonic storm etc. depending on the wind expected. But the media often report all of them as PUYAL or PUYAL CHINNAM. The latter word is meaningless. By branding any weak weather system as PUYAL we are creating panic.



(2) Met. Office says cyclone will move WESTNORTHWEST. This means a direction 22.5 degrees north of west. But this is often reported as "WEST OR NORTHWEST". It can make a lot of difference to the expected point of landfall.

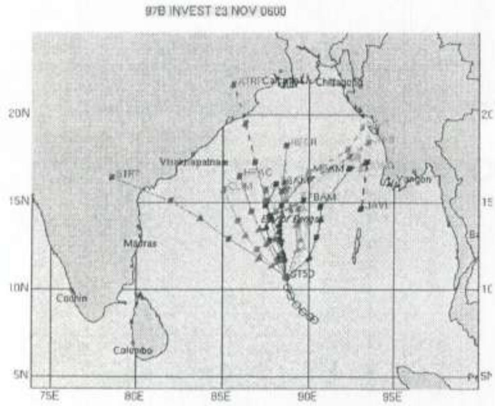
(3) Media often use the same Tamil word PANIPPOZHIVU for, snow in Kashmir, fog in Delhi, ground frost in the Nilgiris, dew in Chennai or even just cold weather. We hope our glossary will help solve this problem. This glossary is only a first attempt and hopefully it will be expanded in due course with feedback from users.

(4) Met. Office describes distribution of rainfall as widespread, scattered, isolated etc. depending on their expectation for each region. It is often broadcast or telecast as "lots and lots of showers", leading the public to think that a lot of rain will occur.

(5) Met. Office forecasts strong westerly winds. The media report says "MERKU NOKKI BALATHA KAATRU VEESUM", which is exactly the opposite.

There are other issues. For example, when a cyclone is in the sea the forecast of its future track is initially made from computer models incorporating available observations (satellite and surface-based) as well as our knowledge of past behaviour of cyclones and the subjective judgement of the meteorologists. There are several limitations to models and they do not always represent reality.

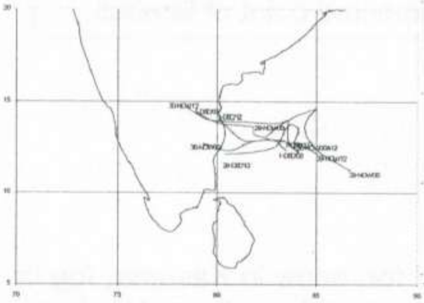
The following figures show this.



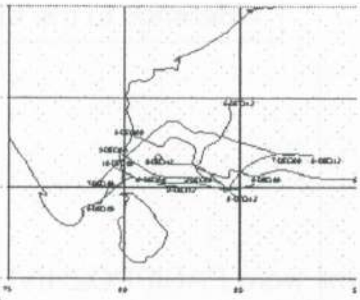
Tracks of a Bay of Bengal cyclone of 2002 predicted by nine different computer models.
--US Naval Research Laboratory picture

Tracks forecast at 12 hourly intervals for the *same* cyclone (in 2005) by the UK Meteorological Office.

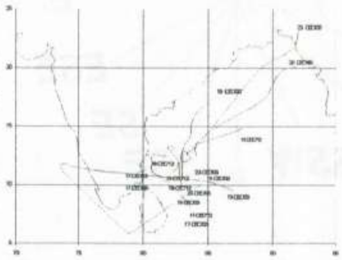
BAAZ 05B



FANOOS 06B

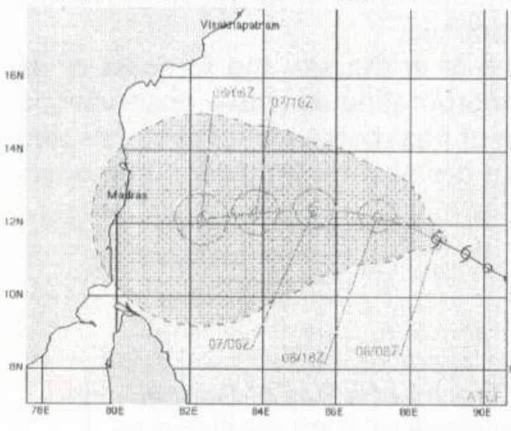


NONAME 07B



Tracks forecast at 12 hourly intervals for the cyclone FANOOS in 2005) by the US Naval Research Laboratory

06B FANOOS 06-12-05 06Z



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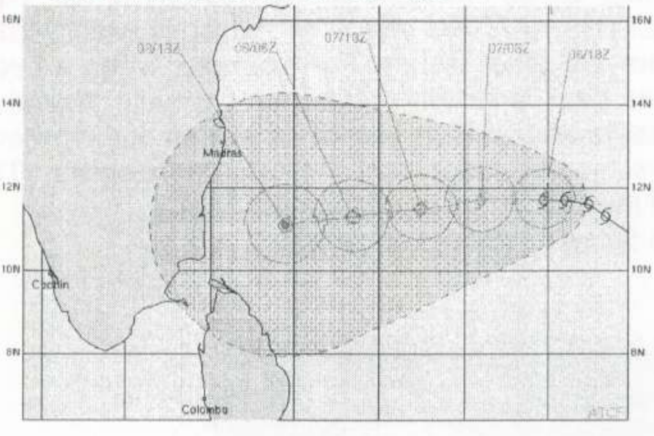

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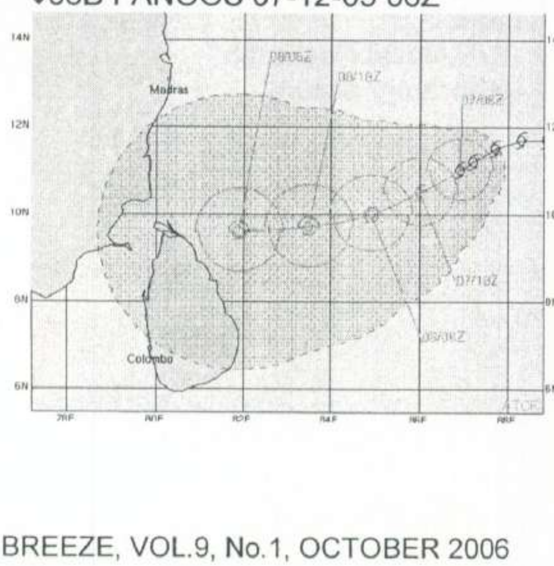

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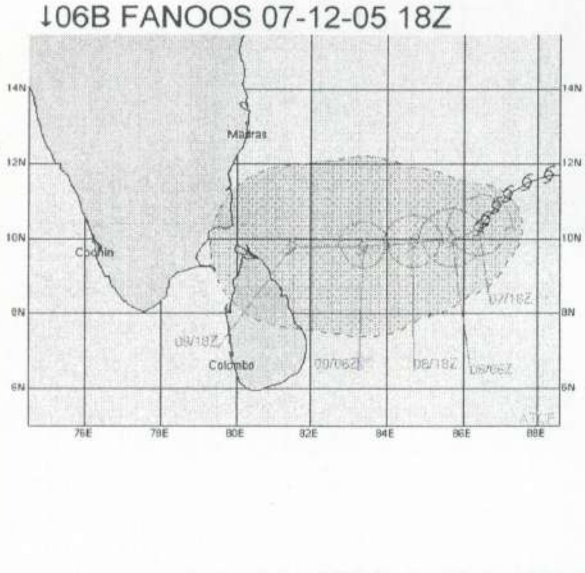

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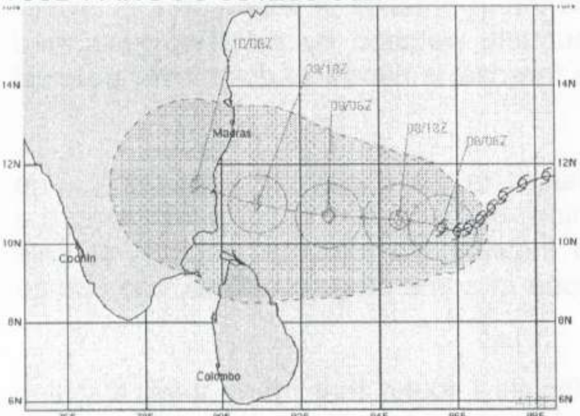

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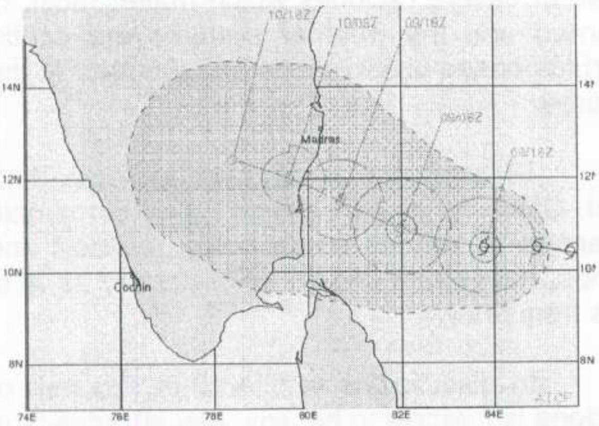

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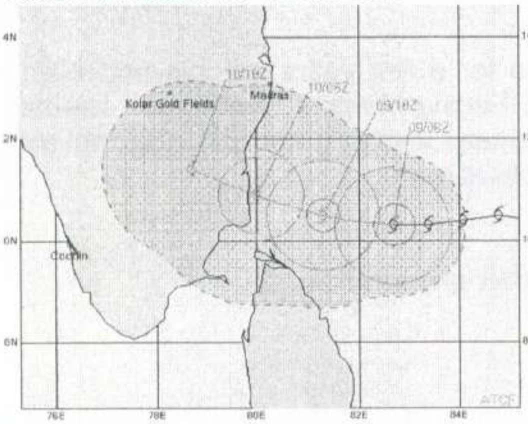

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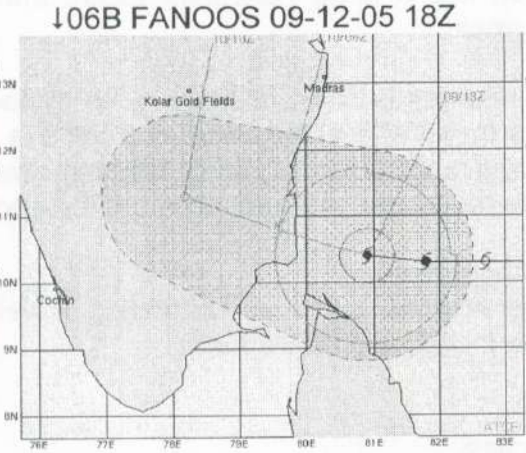

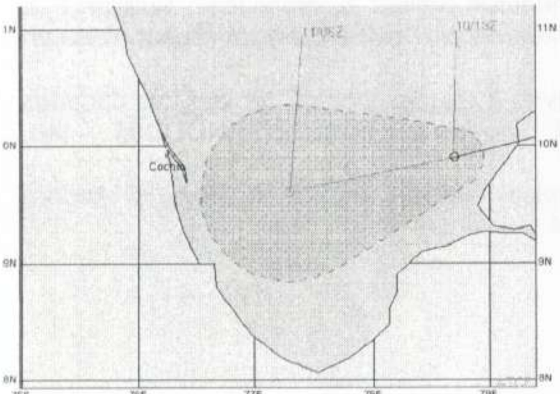

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Note that these forecasts are from the UK and USA. That dispels the myth that they always do better than we do. Some TV channels and newspapers reproduced these but the effect was that the public was presented with conflicting information which caused confusion.

The uncertainty is more in the case of weak cyclones. We do much better in the case of severe cyclones which matter most. Hence in practice, a larger area is initially warned and the weather systems are continuously watched by satellite, radar and surface-based observations and the error in the forecast is narrowed down over a period of time.

Disaster managers have to make decisions in the context of uncertainty. The Met. Office for its part should give (in my opinion) probabilistic forecasts indicating the chances of various areas being affected and indicate the expected regions of gale winds, heavy rain and so on pictorially as is done in some other countries and update this frequently.

In discussions with Andhra Pradesh officials I found that many think that if a cyclone is forecast to hit, say, Machilipatnam, only that district will be affected. A cyclone or depression has a large horizontal extent and various districts can be affected to different degrees.

And memory is short. If there is no cyclone for a few years, people and even governments forget about the problem. I call this a Fading Memory Syndrome. Hence we need a continuous programme of creating awareness involving not only government agencies, the media and the politicians but the people at large.

Let us work together to

(1) increase awareness and understanding of weather phenomena.
(2) organise proactive preparedness.

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Recent Developments in Satellites for Weather Forecasting[1]

B. Manikiam[2]

Introduction

The advent of satellite-based observations, over the past three decades, has added new dimensions to the study of atmosphere and weather systems. The synoptic coverage on a repetitive basis as provided by satellites is ideally suited to study weather related atmospheric processes on different scales. The recent advances in satellite technology in terms of high resolution, multi-spectral bands covering visible, infrared and microwave regions with enhanced radiometry have made space data an inevitable component in weather monitoring and dynamic modeling. The impact of satellite data is phenomenal in certain areas of meteorological applications such as short-range forecasts, cyclone monitoring, aviation forecasts etc. With improving trend in accuracy of satellite retrievals, the initial conditions for models could be defined more precisely leading to improved forecasts, especially in the tropics. The interaction or coupling between the oceans and atmosphere was first appreciated in the context of the El Nino/Southern Oscillation (ENSO) phenomenon expressing as episodic warming and cooling of sea surface in the equatorial central and eastern Pacific (popularly known as El Nino and La Nina events). These events are found to have significant impact on monsoonal systems through teleconnections.

The weather forecasting capabilities are constrained by several inadequacies, such as (i) initial state of the atmosphere is not well defined due to inadequate observational network over the land and data sparse regions over the oceans, (ii) the boundary layer is not resolved properly, (iii) sub-grid scale processes are not resolved by the models (eg. Mesoscale processes such as thunderstorm), (iv) inadequate parameterisation schemes for moist convection, turbulent mixing etc. and (v) inherent limits to predictability forced by chaotic nature of atmosphere.

Advantages of Space observations

The advantages of Space observations are manifold such as :

- Synoptic view of large areas, bringing out the inter-relations of processes of different spatial scales;
- Frequent observations – geostationary satellites provide continuous monitoring while polar orbiting satellites give typical twice-daily coverage.
- The inherent spatial averaging is more representative than the point in situ observations and readily usable for weather prediction models.
- High level of uniformity of space observations overcomes the problem of inter-calibration needed for ground-based instruments.
- Filling of gaps in observations; Space data covers large oceanic areas and inaccessible and remote land areas, thus giving global coverage.

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[1] Lecture delivered at the Seminar on Public Weather Services and Disaster Management, 9 March 2006, Indian Meteorological Society, Chennai Chapter.

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- New types of data and observation; parameters such as sea surface (skin) temperature, sea surface wind stress, sea level, cloud liquid water content, radiation balance, aerosol are some of the unique parameters provided **only** by satellites.

Indian Meteorological satellites

The launch of the first meteorological satellite TIROS-1 in April 1960 heralded the era of Space observations and gave the first glimpses of the dynamic cloud systems surrounding the Earth. Since then the technology has developed by leaps and bounds in observation capabilities in terms of spatial, spectral and temporal resolutions. Over the past two decades, a global system of Space observations with both geostationary and polar orbiting systems have evolved. Currently several operational meteorological satellite systems are providing global and regional observations. The Indian Space programme initiated in the mid-70's has selected meteorology and weather forecasting as one of the thrust areas. One of the earliest satellites Bhaskara had a microwave payload SAMIR for study of atmosphere and ocean. The INSAT series was conceptualized as multi-purpose systems with meteorology and communications.

Geostationary satellites (INSAT series)

INSAT series of geostationary satellites was conceived to meet the operational needs of meteorology and weather services. The INSAT 1 series launched through the 80's carried a Very High resolution Radiometer (VHRR) payload which operated in two spectral bands – visible [0.55-0.75 μm] and thermal infrared [10.5-12.5 μm]. The INSAT system is designed to provide the following services:

- Round the clock surveillance of weather systems including severe weather events around the Indian region;
- Operational parameters for weather forecasting – cloud cover, cloud top temperature, sea surface temperature, snow cover, cloud motion vectors, out going long wave radiation etc.
- Collection and transmission of meteorological, hydrological and oceanographic data from remote/inaccessible areas through Data Collection Platforms.
- Timely dissemination of warning of impending disasters such as cyclones through Cyclone Warning Dissemination Systems.
- Dissemination of meteorological information including processed images of weather systems through SDUCs(Secondary Data Utilisation Centres).

INSAT 1 series consisted of 4 satellite missions with VHRR payload giving visible images with 2.75 km resolution and thermal data with 11 km resolution, with capability to provide 3 hourly images and half hourly images in sector scan mode. INSAT 1D continues to rate much beyond the mission life. INSAT 2 series that followed was designed based on user feedback and consists of 5 satellites to ensure continuity of services in an enhanced manner. The imaging capability included three modes, viz. full frame, normal mode and sector mode of 5 minutes for rapid coverage of severe weather systems.

INSAT 2E launched in 1999 carried an advanced VHRR payload operating in three channels – visible (2 km resolution), thermal and water vapour (8 kms resolution). The water vapour channel operating in 5.7-7.1 μm is capable of giving water vapour distribution and flow patterns in the lower troposphere. Besides this, INSAT 2E also carries a CCD camera with 3 channels – visible, near infrared and short wave infrared with 1 km resolution to map the vegetation cover.

The first dedicated weather satellite METSAT (renamed as Kalpana 1 in memory of the Indian astronaut) was launched in September 2002 carrying the VHRR and CCD payloads. Along with INSAT 3A launched in 2003, the satellites provide operational data. INSAT 3D planned in future will carry atmospheric sounder for temperature and water vapour profiles and split thermal channels for accurate sea surface temperature retrieval.

Future Indian Satellite Missions

Future missions are planned to meet the requirements of the meteorological community. The Oceansat – 2 proposes to carry a scatterometer for surface wind retrieval. The Megha-Tropiques mission will be a joint effort of ISRO and CNES, France towards study of the water cycle in the tropical region, which is very critical for forecast of monsoon. The unique payloads of the Megha-Tropiques are MADRAS (a multi-frequency microwave radiometer), ScaRab (radiation budget) and SAPHIR (an atmospheric sounder). The mission will operate with an inclined equatorial orbit for repetitive coverage of tropical areas. The mission is expected to give insights into the convective processes in tropics and their characterization (**Table 1**).

Table 1 : Payload characteristics & applications of INSAT 3D & Megha-Tropiques

Satellite	Payload	Bands/Resolution	Resolution (in Km)	Applications
INSAT 3D	6 Channel IMAGER	Spectral Bands (μm)		
		Visible : 0.55 - 0.75	1 km	
		Short Wave IR: 1.55 - 1.70	1km	
		Mid Wave IR : 3.70 - 3.95	4km	Cloud characterization
		Thermal IR – 1: 6.50 - 7.10	4km	
		Thermal IR – 2: 10.30- 11.30	4km	Mesoscale processes
		Water Vapour : 11.30- 12.50	8km	
	19Channel SOUNDER	Spectral Bands (μm) Short Wave Infra Red: Six bands Mid Wave Infra Red : Five Bands Long Wave Infra Red : Seven Bands Visible : One Band	10 X 10 for all bands	Atmospheric water vapour /temperature
Megha-Tropiques	SAPHIR	Six bands around 183 GHz	10 km Horizontal Resolution	Water vapour profile Six atmospheric layers upto 12 km height
	SCARAB	Radiation instrument in short & long wave	40 km Horizontal Resolution	Radiation budget
	MADRAS	89 &157 GHz radiometer 10, 18 &37 GHz radiometer	10 km Horizontal resolution	ice particles in cloud tops cloud liquid water and precipitation; sea surface wind speed 23 GHz : Integrated water vapour

Satellite meteorology applications

The major application of satellite data has been the monitoring of synoptic weather systems ranging from thunderstorms to cyclones and planetary scale phenomena such as monsoon. The dynamic nature of weather systems could be captured through the time series of satellite observations leading to better understanding of the process of genesis, growth and decay. This has led to developing a satellite-based technique (Dvorak technique) to assess the intensity of tropical cyclones accurately and estimate the growth potential. The specific applications include Identification of primary weather systems such as low pressure, depression, troughs/ridges, jet streams, regions of intensive convection, inter-tropical convergence zones etc. and onset and progress of monsoon system.

The foremost applications of meteorological satellite data are towards the following operational services :

i. Watch and monitor growth of weather phenomena like cumulonimbus cells, thunderstorm, fog etc. and their decay;
ii. Track movements of migrating systems such as tropical cyclones, monsoon depressions, western disturbances etc.;
iii. Identify and locate primary synoptic systems like surface lows, troughs/ridges, jet streams, regions of intensive convection, inter tropical convergence zones etc.;
iv. Monitor onset and progress of monsoon systems;
v. Detect genesis and growth of tropical cyclones and monitor their intensification and movement till landfall.

Satellite applications for disaster management

Satellite based weather forecasts and advance warnings of severe weather will minimise the loss of life and damage and facilitates timely and effective rescue, relief and rehabilitation of the affected population. Clearly the most vital application of satellite data is in detecting, providing and delivering early warnings using earth observations and communication capabilities offered by satellites. Satellites are particularly suited to deliver local-specific disaster warning communications to those entities/groups/persons who are located in remote rural and under-developed areas and in providing communication support for administrative actions for emergency preparedness.

The earth observation satellites provide comprehensive, synoptic and multi-temporal coverage of large areas in real time and at frequent intervals. The most important application of satellites is in detecting, providing and delivering early warning of impending disasters such as floods, droughts, cyclones and even forest fires. Continuous monitoring by both geo-stationary and low earth orbiting weather satellites like GOES, INSAT, METEOSAT and NOAA is capable of providing early warning on cyclones and floods.

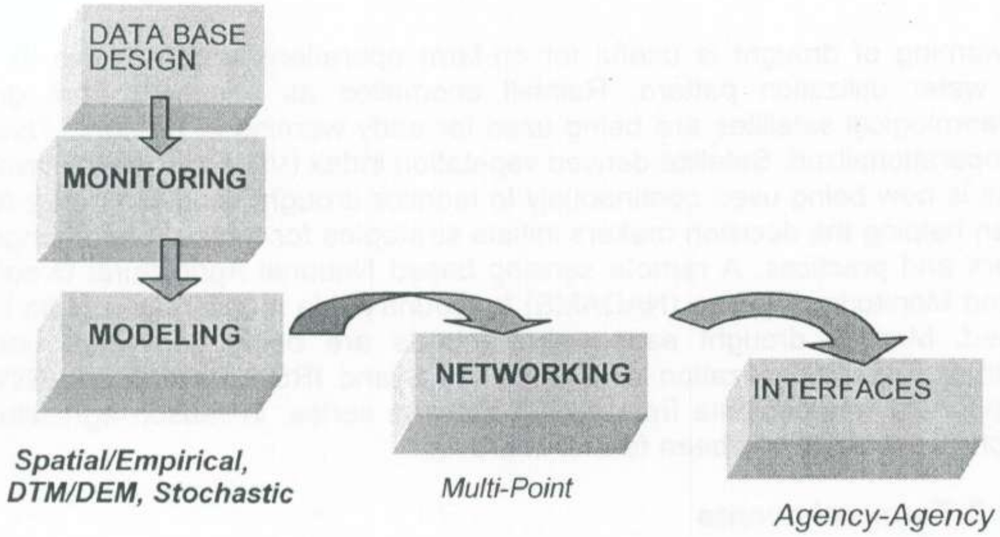

Fig. 1 : Disaster Management – Basic elements

The following sections give a brief summary of various applications of satellite data for operational disaster management:

Cyclone monitoring and warning

Meteorological satellites are valuable for monitoring and forecasting of cyclones. INSAT/VHRR images are being used to identify cloud systems over the oceans, where no observational data are available, as well as for cyclone tracking, intensity assessment and prediction of storm surges, etc. They need to be supplemented by ground meteorological observations and radar data for accurate assessment of rainfall intensity. An innovative use of INSAT has been in the implementation of the unique, unattended, locale - specific Cyclone Warning Dissemination System (CWDS) consisting of over 250 disaster warning receivers installed in cyclone prone areas of the country, designed to provide warning to coastal villages about an impending cyclone. Since commissioning and first operational use for disaster warning in 1987, CWDS has become a vital disaster mitigation mechanism. Current research around the globe is concentrating on use of meso-scale models with satellite data inputs to improve the prediction of cyclone intensity and track.

Flood Management

Despite limitations of cloud cover and long revisit period, satellites have been providing vital information towards (i) precipitation forecast and warning (ii) inundation mapping and damage assessment and (iii) flood plain management. Recent advances in using microwave data, especially to address the persistently cloud affected areas have enhanced the potential use of remote sensing by virtue of its all weather capability. Besides providing inputs for quantitative estimation of precipitation, geo-stationary satellites have become increasingly helpful in collection of data on rainfall, river stages, etc., for remote, uninhabited locations over the land using DCPs.

Drought management

Early warning of drought is useful for on-farm operations and to arrive at an optimal local water utilization pattern. Rainfall anomalies as observed from geo-stationary/meteorological satellites are being used for early warning of drought. This is yet to be fully operationalized. Satellite derived vegetation index (VI) which is sensitive to moisture stress is now being used continuously to monitor drought conditions on a real time basis often helping the decision makers initiate strategies for recovery by changing cropping patters and practices. A remote sensing based National Agricultural Drought Assessment and Monitoring System (NADAMS) for countrywide monitoring in India has been developed. Monthly drought assessment reports are being generated under NADAMS. With the operationalization of IRS-1C WiFS and IRS-P3 WiFS and SWIR bands and supporting weather data from INSAT/Kalpana series, in-season agricultural drought monitoring capability has been further improved.

Storm surge & Tsunami events

The large ocean waves associated with storm surge and Tsunami need to be detected and proper warning given to the coastal population. While storm surge models exist with inputs on intensity of cyclone, speed, track of the cyclone and coastal aspects to give forecast of surge heights, with respect to tsunami much needs to be done for an operational system. We need to put together a monitoring system with deep ocean measuring instruments linked to INSAT, wave propagation models, coastal inundation simulation and warning dissemination systems for tackling the tsunami events and their adverse impacts

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Global features associated with Indian Southwest and Northeast Monsoons - 2005[1]

Y.E.A.RAJ[2]

I Southwest monsoon 2005

The overall performance of southwest monsoon 2005 over India was just normal. The June-September southwest monsoon rainfall over India realised during the years 1999-2005 and the monthly and seasonal rainfall figures of India for the above season along with the normal values are presented below in Tables 1 & 2 respectively.

TABLE 1

Year	1999	2000	2001	2002	2003	2004	2005
Indian Monsoon Rainfall (ie., all India rainfall for the monsoon season) as % anomaly	-5	-8	-8	-19	2	-13	-1

TABLE 2

Month	June	July	August	September	JJAS
Rainfall 2005 as % anomaly	-11.9	13.9	-27.3	18.4	-1.2
Normal Rainfall (mm)	157	286	258	169	869

As seen from the above tables the performance of southwest monsoon during 1999-2005 was subnormal with only one positive departure(2003). There was a severe drought in 2002 when the realised monsoon rainfall over India was deficient by 19 % from normal followed by a good monsoon of 2003 with 2% excess and again a highly deficient (13%) monsoon of 2004 followed by a just normal monsoon of 2005 (1% deficient).

2. Inferences from global teleconnections / parameters

2.1.ENSO

El Nino refers to the warming of the sea surface temperature (SST) off the Peru coast of South America. Abnormal sea surface temperature anomalies in the eastern equatorial pacific influence major meteorological events all over the globe. Southern oscillation is another global scale phenomenon. It refers to the see-saw-like pressure oscillation between Eastern equatorial Pacific (represented by Tahiti) and South Indian ocean (represented by Darwin). The pressure difference between Tahiti and Darwin is referred to as southern oscillation index (SOI). The above two parameters are strongly

[1] Synopsis of the lecture delivered at the Monsoon Seminar, IMS Chennai Chapter on 28 Feb 2006

[2]Director, Regional Meteorological Centre, Chennai

inter related (negative correlation of 0.85) and are together studied as ENSO parameter worldwide.

It has been established that positive SOI is associated with good southwest (poor northeast) monsoon and negative SOI is associated with poor southwest (good northeast) monsoon. But the relation is not one to one. Above normal SST over the Nino region especially Nino 3.4 is taken as El Nino event and it affects the Indian monsoon unfavourably.

Monthly variation of SOI during 2005 is given in table 3.

TABLE 3

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1.8	-29.1	0.2	-11.2	-14.5	2.6	0.9	-6.9	3.9	10.9	-2.7	0.6

During 2005, SOI during April and May was significantly negative. However, all the El nino indices reported near normal values. By and large, the ENSO conditions were reported as neutral by most of the international climate monitoring agencies before and during the monsoon.

Below normal performance of monsoon in June could perhaps be associated with the negative SOI values in April and May. But the intra seasonal rainfall variation of southwest monsoon during 2005 was not well related to the variation of ENSO parameters.

2.2. SST, OLR, Storm tracks over Pacific

SST anomalies over the north Indian Ocean were normal to above normal in June and normal in July, Aug and Sep. No strong anomaly pattern was noticed in the Pacific.

Outgoing Long wave Radiation (OLR) anomalies over the Indian region were either nil or positive during June and August; they were negative during July and September, consistent with the monsoon performance.

During June-Sep of 2005, frequency of typhoons in Pacific was 16, which is an almost normal figure. Generally, west moving typhoons over Pacific favour good southwest monsoon and north moving typhoons are unfavourable. Of the 16 typhoons that formed in the Pacific during JJAS, 5 recurved N/NE. By and large, others moved WNW.

3. Indian Ocean dipole and Equinoo

The above two parameters have emerged in the late 1990s as Indian Ocean features modulating the southwest monsoon.

3.1 Indian ocean dipole :

To explain the concept of Indian ocean dipole, two boxes over the Indian ocean are defined.

1. Western Equatorial Indian Ocean box (WEIO) : 50 to70ºE / 10ºS to 10ºN.
2. Eastern Equatorial Indian Ocean box (EEIO) : 90 to110ºE / 10ºS to Equator.

SST anomalies are computed for each box individually.

SST_a of WEIO – SST_a of EEIO = DMI called the *Dipole Mode Index.*

It has been shown that the anomalies over the above two regions tend to bear opposite signs. Positive DMI results in easterlies and stronger cross-equatorial flow. Severe drought of 2002 has been partially explained by invoking the concept of DMI since ENSO conditions were neutral during 2002. SST anomalies showed positive DMI during 2003 which could explain the good monsoon of 2003.

3.2 Equinoo

The index of Equinoo is based on the anomaly of the zonal component of the surface wind over equator in the box 60-90ºE and 2.5ºS to 2.5ºN. If the zonal wind anomaly over this region is positive, it favours a below par Indian southwest monsoon. The developers of Equinoo claim that the correlation between Indian Monsoon Rainfall(IMR) and Equinoo index is better than the correlation between IMR and DMI and that the Equinoo index also provided some pre-indication of the severe drought of 2002. More investigations are required with longer series before DMI and Equinoo indices could be used as predictors for southwest monsoon.

II. Northeast monsoon 2005

1. Northeast monsoon activity is confined to the four southern sub divisions of Tamil Nadu, Kerala, Coastal Andhra Pradesh and Rayalaseema. However the NE Monsoon is the principal rainy season for Tamil Nadu. For the four southern subdivisions where the October-December northeast monsoon rainfall is significant, the rainfall realised for the year 2005 is given in table 4. Northeast monsoon rainfall realised during the last 10 years in the sub division of Tamil Nadu and expressed as percentage anomaly is given in table 5.

TABLE 4

Subdivision	Actual mm	Normal mm	% anomaly
TN	765	415.2	84
Kerala	501	493	2
CAP	523.8	323.2	62
R/seema	421.5	208.5	102

TABLE 5

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
NRT as % anomaly	20	52	12	-6	-22	-15	-12	-25	1	84*

North East Monson Rainfall of Tamilnadu(NRT) : October – December Rainfall of Tamil Nadu.(* : tentative figure, may be updated)

As seen from Tables 4 and 5 the northeast monsoon rainfall for the year 2005 was one of the heaviest since 1901 – both for Tamil Nadu and the Southern region. After several years of negative departures and deficient rainfall, this year monsoon rainfall with its large excess has contributed substantially towards maintaining the stationary character of the northeast monsoon rainfall series. After 1997 (52% excess), excess rainfall during OND occurred only after 8 years i.e., during 2005.

2. Northeast monsoon outlook for 2005

The following are the precursors for a good northeast monsoon:

(i) Westerly wind anomalies at 200 hPa in April over India
(ii) Negative temperature anomalies over parts of India during June-Sep.
(iii) Weak easterly jet over extreme south Indian peninsula during Aug and Sep
(iv) Negative SOI and El Nino event during June-Sep.

During the northeast monsoon season of 2005, (i) and (iii) were favourable. Data for(ii) are not readily available and there has not been any signal from (iv).

Based on the above 4 pre-cursors a normal to above normal rainfall during northeast monsoon season could have been arrived at as an outlook in the first week of October. However, large excess rainfall could not have been anticipated.

3. Global features associated with the northeast monsoon of 2005

3.1 SST, OLR, 850 hPa winds and water vapour over Indian region

Substantially negative OLR anomalies and negative OLR anomalies prevailed over Bay of Bengal and the Indian peninsula in Oct and Nov respectively. Negative OLR anomalies prevailed over Bay of Bengal, western Pacific and parts of Indian ocean adjoining Australia during OND.

SST over the north Indian ocean was generally between 28-29ºC. No significant anomaly pattern was seen.

850 hPa winds were stronger over the north Indian ocean south of 15ºN in OND. December anomalies were exceptionally strong.

Water vapour over the Bay of Bengal, west Pacific and northern parts of south Indian ocean were very high in the range of 40-60 mm and anomalies were in the range 3-6 mm in Oct and Nov and 6-9 mm in Dec.

4. Summary

Overall, the bountiful Indian northeast monsoon of 2005 appears to have been triggered by / associated with (a) active equatorial trough (b) active southeast Asian winter monsoon especially during December. This is revealed by both OLR and water vapour distribution. Wind anomalies support the above features.

However, SST anomalies over the Bay of Bengal do not appear to have played any significant role in causing the excess northeast monsoon of 2005.

This appears to be in concordance with the absence of any significant relation between the north Indian ocean SST and southwest monsoon rainfall during June-September.

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Integrated Weather Forecast System – The need of the hour[1]

T.N. Balasubramanian[2]

1.Genesis

Integration means bringing together different components of a system for effective synergistic operation and impact. This is mostly required for Indian weather forecast system being given by different organizations under different spatial and temporal modes.

An examination of the sources of different weather forecasts, especially for rainfall, which is important for crop production, reveals that now–casting (an hour lead time forecast), short range forecast (a lead time of one day with an out look for one more day), and long range forecast (a lead time of more than 10 days to a season) are given by the India Meteorological Department (IMD), while medium range forecast (a lead time of 3 to 10 days) is given by the National Centre For Medium Range Weather Forecasting (NCMRWF), New Delhi and seasonal climate forecast(SCF) with a lead time of a season is given by Department of Agricultural Meteorology, Tamil Nadu Agricultural University(TNAU). In addition, a few more organizations also provide long range forecast information for south west monsoon season.

Among the three organizations indicated above, both NCMRWF and TNAU have their own channel of communicating weather information systematically to the users especially farmers. This brings to highlight that three major organizations do this assignment of rainfall forecasting with different modes of communication to the users/clients. Each organization has its own way of providing information to the users independently. Hence addressing seasonal rainfall for effective farm decision is thus absent in India.

2. What should be done?

Four activities must be carried out for efficient weather forecast system and they are :

1. Single window must be identified to disseminate nowcast, short range, medium range forecasts and seasonal climate information to the farmers. This may be done either by IMD or NCMRWF or concerned State Agricultural University,
2. For carrying out this exercise all the three organizations must work together with close understanding and co-operation,
3. Educating farmers on weather consciousness and using valuable information effectively, and

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[1] Synopsis of lecture delivered at IMS Chennai Chapter

[2] Rtd. Professor in Agricultural Meteorology, Tamil Nadu Agricultural University, Coimbatore and consultant (Agro-climatology) M.S.Swaminathan Research Foundation, Chennai-113.

4. Identification of selected mass media for communication.

3. Procedure for communicating weather information

For each agro-climatic zone, a separate agency may be identified and all forecast information must be given to the farmers through this single window as indicated hereunder. The existing window in India is NCMRWF, which has strong communication channel and this mode may be used for this purpose.

Through this window, first the weather information from long range and seasonal climate forecast must be given to the farmers. This will help the farmers to take farm decision on crops to be selected, area to be brought under crops during the season and best bet technology to be selected and it's tailoring. Further, this will help the farmer to procure required input for the ensuing season and also to facilitate him/her to arrange for a loan. Comprehensively the National Government can decide the policy of export and import based on the seasonal forecast cropping programme.

Secondly, after giving long range forecast information, the information from medium range weather forecast must be given to farmers through the same window continuously to take farm decision on preparing the field for sowing, organizing labourers, pest and disease management, preparing contingency plan to meet both benevolent and malevolent weather situations and farm operations which require 3 to 4 days advance time for pro-active planning.

Thirdly, the information from short range may be given to take farm decision on sowing, irrigation scheduling, weeding, fertilizer application, plant protection, harvesting etc,

Fourthly the farmers may use the now-casting information for mid term correction of their farm operations proposed.

In this way all the forecast information must reach through single window to the farmers one by one with in an agricultural season.

4.Benefits of this integrated weather forecast system

1. Aids for comprehensive farm decisions
2. Macro and micro level decisions with in time and avoiding belated farm operations.
3. Opportunity for enhancing input efficiency
4. Chance for reducing cost of cultivation
5. Sustainable agriculture and negligible yield loss
6. Introduction of weather based agriculture, which is mostly required for countries with monsoon rainfall like India.

5.Accuracy of weather forecast

Presently rainfall forecast is prepared based on Numerical Weather Prediction model, and hence it requires smoothening for local condition so as to develop confidence with the farmer. For this purpose the information on local climatology, indigenous knowledge that prevails in the region may be blended with the model input.

6.Conclusion

There is a scope for integrated weather forecast in India in the coming years and let us hope for that. This concept of integration must be introduced with due participation of the farmers/clients. Farmers must be trained for weather consciousness and its application in agriculture.

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TROPICAL CYCLONE NAMES IN THE NORTH INDIAN OCEAN BASIN

S. Raghavan[1]

The naming of tropical cyclones in the Bay of Bengal in the cyclone season of 2005, created considerable positive interest among the media and the public. Assignment of names to tropical storms and hurricanes has long been a practice in the Atlantic basin. A set of names in English alphabetical order are decided for each year in advance and when the system attains *tropical storm intensity*, the first available name in the list is assigned to it. As there is often more than one cyclone in the Atlantic at the same time, the naming avoids confusion in public bulletins. Originally the lists consisted only of feminine names (generally Christian names common in the West), but feminist groups intervened saying that women are supposed to be gentle and cyclones are anything but. The practice of having masculine and feminine names alternately was then started.

In the Northwest Pacific the practice was to identify cyclones by serial numbers. In the 20th century a four-figure number was usually used, the first two digits representing the year and the next two the serial number in that year. E.g. 8007 would mean the 7th typhoon (or tropical storm) of the year 1980. Later the WMO-ESCAP Typhoon Committee decided to have lists of names characteristic of the typhoon region countries. Examples of names in 2005 were KAI-TAK and BOLAVEN. These names are not in alphabetical order but they are in the alphabetical order of the countries nominating these names. The naming of any particular cyclone (according to the previously determined list) is done by the Japan Meteorological Agency. In addition, the Philippines uses its own names in the area around that country.

Similar naming schemes have been in existence for several years in the other ocean basins except the North Indian Ocean (NIO) basin consisting of the Bay of Bengal and Arabian Sea.

Besides the names, the Joint Typhoon Warning Center (JTWC), Hawaii and the National Hurricane Center, Miami assign a two-digit serial number (starting with 01) to every storm from the "tropical depression" stage followed by a letter indicating the basin. For example 01A means the first system of the year in the Arabian Sea and 05B the 5th system of the year in the Bay of Bengal.

The India Meteorological Department has traditionally been naming cyclones after the town nearest to the point of landfall. E.g. Paradip cyclone, or Nagappattinam cyclone but obviously this could be done only after landfall. When the storm is in the sea it used to be referred as the "cyclonic storm in the southwest Bay" or "severe cyclonic

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storm in the northeast Arabian Sea" and so on. Usually this caused no confusion, as it is very rare for more than one storm to exist at the same time in the Bay of Bengal or the Arabian Sea. The idea of naming cyclones has been discussed within the IMD in the past and it was felt that introduction of names may generate unnecessary controversies in the choice of names.

However as all the littoral countries are involved, the WMO-ESCAP Panel on Tropical Cyclones drew up a list of names contributed by the Member-countries. These are in the alphabetical order of the names of the countries. The table is reproduced below.

North Indian Ocean names (courtesy UK Met. Office website)

Names available for use from 2004 onwards				
	I	**II**	**III**	**IV**
Contributed by	**Name**	**Name**	**Name**	**Name**
Bangladesh	Onil	Ogni	Nisha	Giri
India	Agni (2004)	Akash	Bijli	Jal
Maldives	Hibaru	Gonu	Aila	Keila
Myanmar	Pyarr	Yemyin	Phyan	Thane
Oman	Baaz	Sidr	Ward	Mujan
Pakistan	Fanoos	Nargis	Laila	Nilam
Sri Lanka	Mala	Abe	Bandu	Mahasen
Thailand	Mukda	Khai-Muk	Phet	Phailin
Bangladesh	Helen	Chapala	Ockhi	Fani
India	Lehar	Megh	Sagar	Vayu
Maldives	Madi	Vaali	Baazu	Hikaa
Myanmar	Na-nauk	Kyant	Daye	Kyarr
Oman	Hudhud	Nada	Luban	Maha
Pakistan	Nilofar	Vardah	Titli	Bulbul
Sri Lanka	Priya	Sama	Das	Soba
Thailand	Komen	Mora	Phethai	Amphan

These lists will be used sequentially. The first name in any given year is the one immediately following the last name from the previous year. The year is included in parentheses after the last name to be used in that season

Thus tropical cyclone 05B in the Bay in November-December 2005 was named BAAZ and 06B (December) was named FANOOS. These names were aired in on the

TV and in the Press. When the next system formed in December itself it was assigned the number 07B but it did not qualify for naming. Though no meteorological agency named it, some sections of the media which took a fancy for the new naming game called it "Mala" that being the name next on the list. But this was unauthorised and is likely to create confusion as that name will be assigned to the first cyclone in 2006.

The public interest in the naming led to another bizarre situation. Some people could not make out why peculiar names like BAAZ or FANOOS were assigned. They did not realise that these were contributed by other Basin countries (Oman and Pakistan in this case). One politician in Tamil Nadu is reported to have said that cyclones affecting Tamil Nadu should be given Tamil names! By that logic the cyclone's name should be changed once the forecast landfall point changes to another state or country. One should not be surprised if a political agitation starts on this issue in the future. Perhaps IMD was right in its earlier thinking that christening of cyclones may create problems!

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Raining Cats and Dogs

K.V.Balasubramanian[1]

In meteorology, precipitation is indicated by several terms viz. – Rain (light, moderate, heavy, intermittent, continuous), drizzle, hail, rain with thunder, sleet, snow. However, in common or literary parlance the following are the expressions that we often hear connected with the rain: *downpour*, *spitting rain*, "*rained cats and dogs*". Of these, the last one is a very interesting. In my school days, my English Teacher told me that rain with thunder and lightening is something like a fight between a cat and a dog hence, the expression. But, while going through an old meteorological magazine I found an interesting explanation for "raining cats and dogs".

- Dr. Brewer's "Dictionary of Phrase and Fable" gives the following meaning for the expression – "A perversion of the word '*cata dupe*' (a waterfall). It is raining catadupes or cataracts".
- Another explanation is – "the phrase 'raining cats and dogs' has its origin in the Greek word 'cata doxas' (contrary to the experience) i.e., in an unusual manner.
- If the rain overflowed the kennels, then it is 'raining cats and dogs' is one more explanation.

"Dead puppies, stinking sprats,
All drenched in mud;
Drowned cats and turnip tops,
Come tumbling down the flood"

– from ' A City Shower' (probably by Dean Swift).

But most interesting and convincing explanation may be this:

"In Western mythology the cat is supposed to have a great influence on the weather and English sailors used to say "the cat has a gale of wind in her tail", when she is unusually frisky. Witches that rode upon the storms were said to assume the form of cats; and the stormy northwest wind is called the 'cat's-nose' in the Harz (England) even by 1900s.

The dog is a signal of wind, like the wolf, both animals were attendants of Odin, the storm God. In old German pictures the wind is figured as the 'head of a dog or wolf' from which the blast issue.

The 'cat' therefore symbolizes the down-pouring rain and the dog the strong gusts of wind, which accompany a rainstorm; and a "rain of cats and dogs" is a heavy rain with wind.

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CHAPTER NEWS

IMS Chennai Chapter organised a seminar on "Public Weather Services and Disaster Management" at Chennai on 09.03.2006 in collaboration with Regional Meteorological Centre, Chennai and ISRO, Bangalore, sponsored by ISRO with the support from 'The Hindu, Chennai' and the Corporation of Chennai.

The seminar had inaugural and technical sessions. The technical session had 3 invited talks and an interactive session. 49 delegates from 24 organisations including the media (both print and electronic) participated.

'A Glossary of Meteorological terms in Tamil' was brought out and distributed to delegates and users during the seminar and is available for price of Rs.20.

Scientific Talks / Lectures

1. Recent Trends in Telecommunication and Information Technology- Smt.S.Geetha, Sub-divisional Engineer, Rajiv Gandhi Memorial Telecom Training Centre, BSNL Chennai on 21.07.2005.

2. A brief on New Zealand Met.Services, Ms.Jasmine Kennedy, public weather forecaster, New Zealand on 27.01.2006.

3. Mini Seminar on the performance of Monsoon 2005 in connection with National Science Day on 28.02.2006. The following talks were delivered.

    a) "Review of Performance of SW monsoon" By Shri.S.Balachandran, Dir, RMC Chennai.
    b) "Review of performance of NE Monsoon 2005" by Shri.S.R.Ramanan, Dir, RMC Chennai.
    c) "Global features associated with SW and NE Monsoon 2005" by Dr.Y.E.A.Raj, Dir, RMC Chennai.
    d) "Cyclone Disturbances over Bay of Bengal during NE Monsoon 2005- Radar perspective" by Shri.S.B.Thampi, Dir, CDR Chennai.
    e) Scientific talk by Shri.Thangavelu, Chairman, Metro Water, Chennai.

4. Two Scientific Presentations connected with the World Meteorological Day theme "Preventing and Mitigating Natural Disasters" were arranged. Shri.K.Suresh, IAS, Chairman, Chennai Port Trust and Prof.P.C.Kesavan, Dr.M.S.Swaminathan Research Foundation, Chennai delivered the talks on 23.03.2006.

5. Dr.T.N.Balasubramanian, Tamilnadu Agricultural University, Coimabatore delivered a talk on Integrated Weather Forecasting System-The need of the hour.

6. Dr.D.N.Ramachandran, Telecommunication Consultant, Chennai delivered a talk on "Automatic Weather Data Collection from rural areas and its utilisation" on 20.09.2006.

7. The Annual General Body meeting was held on 29.06.2006.Shri.R.Nallaswamy of IMD, Joint Secretary was authorised to be the Secretary in place of Dr.P.V.Revi Kumar, who left IMD.

8. The circulars, brochures of TROPMET-2006 to be held at Pune, 21-23 November 2006 were circulated among the members.

INDIAN METEOROLOGICAL SOCIETY, CHENNAI CHAPTER

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