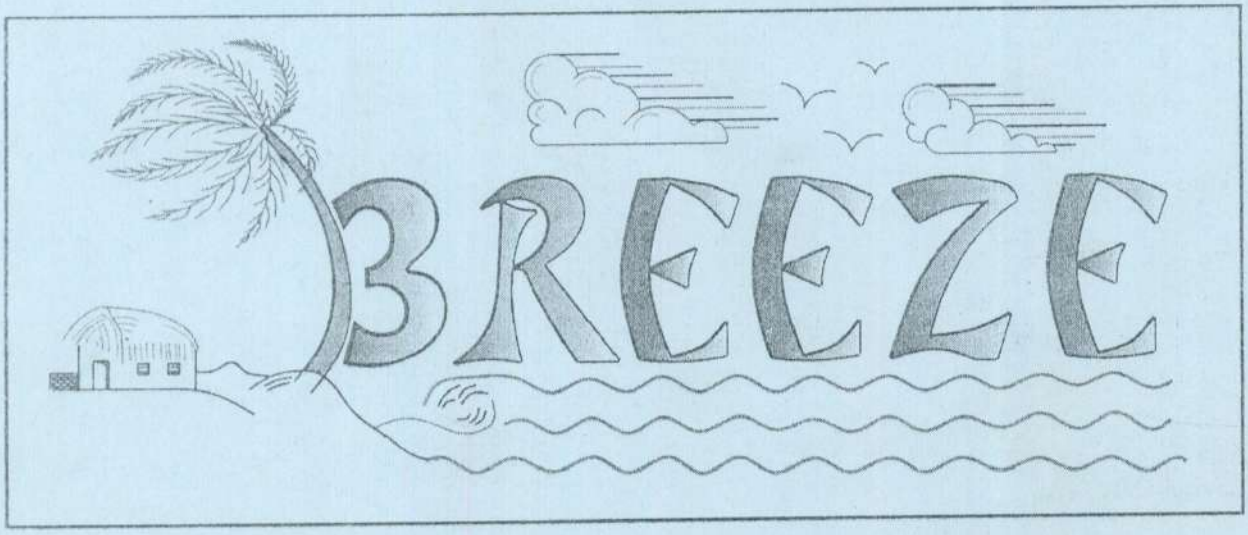

Indian Meteorological Society, Chennai Chapter
Newsletter Vol.13, Issue No.1, June 2011

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EDITORIAL

Dear members,

I have great pleasure in releasing the first issue of Volume 13 of BREEZE. Keeping with the tradition, this year too, the Indian Meteorological Society (IMS) Chennai Chapter has been focused on the key objective of popularising the science of meteorology and actively organised two major events, namely, a seminar on *Indian Northeast Monsoon – Recent Advances and Evolving Concepts, INEMREC – 2011* and two competitions for school students of Std. IX-XII – an English Essay competition on *"Alternate Energy Resources"* and a *"Quiz in Meteorology"*. The Chapter has had a very hectic year since the release of the previous volume of BREEZE in May 2010 in conducting these two events in a grand manner. I am very happy to inform the members that the response has been overwhelming and very encouraging. In fact, INEMREC-2011, though planned on a regional scale, finally culminated into a major event having international flavour in the form of participants from Sri Lanka and USA.

I have presented two separate reports on these two events in this issue. The first prize winning article on *Alternate Energy Resources* is also featuring in this issue. I thank all the members who have contributed articles for this issue. I further request them to offer their continued support and send their articles limited to 3 to 5 pages to the Editor through e-mail to ims.chennai6@gmail.com for the forthcoming issues of BREEZE also. I thank the members of the Editorial Board for their help in the preparation of this volume of BREEZE.

As the term of the existing Local council is coming to an end, I hope that a newly constituted Local Council will take over with great zeal to conduct the activities of the Chapter in a fitting manner. I wish all the best to the incoming team.

With best wishes
S.Balachandran
Editor
June 2011, Chennai

Those who wish to become members of IMS, Chennai Chapter may please mail to
e-mail : ims.chennai6@gmail.com

Membership details of IMS, Chennai Chapter (as on 15 June 2011)
Life Members: 121 Ordinary Members: 26 Total : 147

Disclaimer : The Editor and IMS Chennai Chapter are not responsible for the views expressed by the authors.

Lectures arranged under the auspices of IMS, Chennai Chapter, June 2010 to May 2011

21.6.2010	Modern way of High Performance Computing Shri K.Sarnath, Shri G.Sasidhar and Shri Seshadri, HCL Technologies Ltd., Chennai
17.1.2011	Seminar on "Monsoons 2010". 1. Performance of Northeast Monsoon 2010. Dr.S.R.Ramanan, Sc-E, RMC Chennai 2. Agricultural scenario in Tamil Nadu during the northeast monsoon 2010 Shri S.Santhana Gopalakrishnan, Dy. Director (Agriculture), Govt. of Tamil Nadu
10.3.2011	Northeast monsoon of Sri Lanka, Maldives and surrounding areas. Dr.Lareef Zubair of Columbia University, USA
23.5.2011	Wind energy as an alternate energy resource Dr.A.Bhoopathi, Centre for Wind Energy Technology, Chennai.

PROSPECTS OF SKILFUL SEASONAL FORECASTS OF INDIAN SUMMER MONSOON RAINFALL USING COUPLED ATMOSPHERE-OCEAN MODELS

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The variability in the onset, withdrawal and characteristics of rainfall during the Indian summer monsoon season (June to September) (ISMR) has profound impacts on water resources, power generation, agriculture, economics and ecosystems in the country. The deficient monsoon rainfall during the recent years (2002, 2004) had an adverse impact on India's economy. The most recent drought in 2009 brought to the fore the poor skill of the seasonal forecast models (both statistical and dynamical models) and once again stressed the need for accurate seasonal prediction of rainfall over India.

There are two approaches for seasonal forecasts, one based on statistical methods and the other based on dynamical models. Using dynamical models, we can generate seasonal forecasts in two ways. In the first method, we use an atmospheric general circulation model (AGCM) with the observed sea surface temperatures (SSTs) as boundary conditions. While integrating AGCM, we assume that SST anomalies of April or May month persist during the monsoon season. In the second method, a coupled atmosphere-ocean model is used in which the SSTs are predicted by the ocean model.

Since 1886, the India Meteorological Department (IMD) has been issuing Long range forecasts (LRF) of the southwest monsoon rainfall, mainly based on statistical models. A recent analysis revealed that IMD's operational forecast skill based on statistical methods has not improved over seven decades despite the research efforts and continued changes in the operational models. On the other hand, the analyses of dynamical model (both atmospheric and atmosphere-ocean coupled models) results revealed that there are significant problems in the representation of the mean Indian monsoon climate and its variation on different time scales. At present, statistical models have been performing better than the dynamical models in predicting monsoon rainfall.

The climate prediction centres worldwide are producing global seasonal forecasts using coupled atmosphere-ocean models, thanks to availability of powerful super computing facilities. Systematic research efforts also are being made worldwide to improve the skill of coupled models. In this brief article, we discuss the results of the state-of-art coupled models (ENSEMBLES) in the seasonal forecasts of ISMR. We also compare these results in comparison with the results from the earlier generation of coupled models (DEMETER) to examine whether there is any significant improvement in the prediction skill. The Development of a European Multi-model Ensemble System for seasonal to inter-annual prediction (DEMETER) project

(Palmer et al. 2004) provided an ideal opportunity to examine the simulation characteristics of the Indian summer monsoon. This model experiment consisted of many advanced coupled climate models used in the European climate prediction centers.

ENSEMBLES is an EU-funded integrated project that intends to develop an ensemble prediction system for climate change based on the principal state-of-the-art, high resolution global models developed in Europe. The project has been designated to produce for the first time, an objective probabilistic estimate of uncertainty in future climate at the seasonal to decadal and longer timescales. More details of the project and data sets are available at http://www.ecmwf.int/research/EU_projects/ENSEMBLES/.

The ENSEMBLES seasonal forecast initiative comprises of six global coupled atmosphere-ocean climate models from the UK Met office (UKMO) (HadGEM2 and HadCM3 models), Meteo France (MF), the European Centre for Medium-range weather forecasts (ECMWF), the Leibniz Institute of Marine Sciences at Kiel University (IFM-GEOMAR) and the Euro-Mediterranean Centre for Climate Change (CMCC-INGV) in Bologna. Since DEMETER, the contributing seasonal prediction systems in ENSEMBLES have improved in all aspects with the main advancements including the increase in resolution, the better representation of sub-grid scale physical processes, land, sea-ice and greenhouse gas boundary forcing and the more widespread use of assimilation for ocean initialization.

The common hindcast period of the ENSEMBLES covers the 46 years 1960-2005. For each year, 7-month long seasonal forecasts starting on 1st February, May, August and November have been prepared. For the present study, we have considered the seasonal forecasts starting from 1 May. In order to examine the skill of ENSEMBLES models in predicting the interannual variation of ISMR, we have prepared a time series of ENSEMBLES Multi Model Ensemble (MME) standardized rainfall anomaly averaged over the country (only land points) for the period 1960-2005. The time series of ENSEMBLES MME ISMR is shown in Fig. 1 which also shows the observed ISMR time series derived from the IMD gridded rainfall data for the same period. The DEMETER MME ISMR values for the period 1960-2001 are also shown as red line in the same diagram.

The correlation coefficients between the model and observed rainfall for each of the six ENSEMBLES models and the DEMETER MME are shown in the Table-1. The most significant aspect of this analysis is that the skill of ENSEMBLES MME has improved significantly compared to the DEMETER MME. Compared to DEMETER, the ENSEMBLES MME has improved prediction of ISMR for major drought years like 1972, 1974 and 1982, the excess monsoon year of 1961 and the normal monsoon year of 1976. MME performs better than any individual model at correlating with the observed time series. Among the ENSEMBLES models, The UKMO HadGEM2 model shows the best performance with the highest correlation of 0.39 with the observed rainfall. The model mean and CV are also very close to that of the observed data. For comparison, the correlation between the observed ISMR and IMD's operational seasonal forecasts (based on statistical model) for the period

1988-2010 is also given in Table-1. The skill of IMD's seasonal forecasts for the period 1988-2010 is positive but below the 95% significance level.

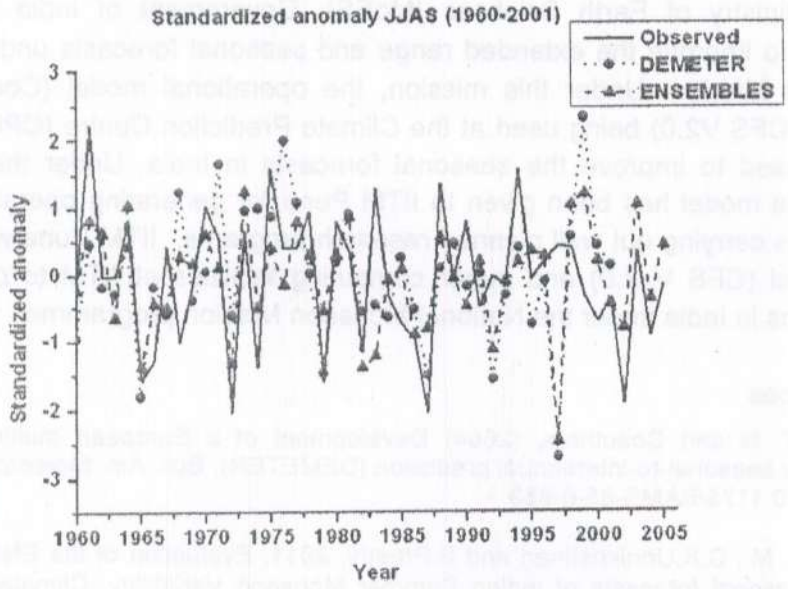

Fig.1 The time series of observed (continuous line), DEMETER (dashed line with circle) and ENSEMBLES (dashed line with triangle) monsoon seasonal rainfall (as standardized anomaly) for the period 1960-2001.

Table 1

Mean and coefficient of variation of monsoon seasonal rainfall (June-September) averaged over the country (land points) for the ENSEMBLES models and ENSEMBLES MME and DEMETER MME. Correlation coefficients of model rainfall with the observed rainfall are also shown. Period: 1960-2005

	Mean rainfall (cm)	Coefficient of Variation CV (%)	Correlation Coefficient (1960-2005)
Observed	82.9	11.9	1
ECMWF	93.2	4.5	0.37
IFM-GEOMAR	79.8	5.7	0.34
MF	45.0	8.2	0.34
HadGEM2	80.0	12.2	0.39
CMCC-INGV	91.0	5.4	0.39
HadCM3	65.6	8.9	0.27
ENSEMBLES MME	75.8	5.7	0.45
DEMETER MME (1960-2001)	76.0	4.3	0.28
IMD's operational Forecasts	---	---	0.29 (1988-2010)

Thus, it is heartening to note that the prediction skill of ISMR in the state-of-art coupled models of European climate centres have improved substantially compared to the previous generation of coupled models. These models have shown the skill, which is comparable with the skill of statistical models. However, there are still many unresolved issues in the coupled models for further improvement. For example, atmosphere-ocean coupling in these models is too unrealistic. In the

models, the atmosphere-ocean coupling is too strong compared to observations. The models have exhibited problems in capturing the impact of Indian ocean variability on Indian summer monsoon. However, we can hope that the systematic research effort being made worldwide will further improve the prediction skill of these coupled models.

Ministry of Earth Sciences (MoES), Government of India has taken the initiative to improve the extended range and seasonal forecasts under the National Monsoon Mission. Under this mission, the operational model (Coupled Forecast System, CFS V2.0) being used at the Climate Prediction Centre (CPC), NCEP USA will be used to improve the seasonal forecasts in India. Under the MoES-NOAA MOU, this model has been given to IITM Pune for generating operational forecasts as well as carrying out well planned research programs. IITM Pune will be providing the model (CFS V 2.0) and super computing facilities at IITM to other academic institutions in India under the National Monsoon Mission programme.

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GLOBAL WARMING, CLIMATE CHANGE AND ALTERNATE ENERGY SOURCES – A FEW RANDOM THOUGHTS AND FACTS

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1. In the last two decades, much has been written and talked about global warming and climate change. Numerous seminars, symposia, workshops et al. have been conducted all over the world on these topics. As is well known, global warming resulted from the addition of greenhouse gases into the atmosphere resulting in climate change. The beginning of the global warming saga which we are talking about now can perhaps be traced back to the Industrial Revolution which originated in England during the middle of the 19th century. Coal mining and burning of coal to generate energy released vast amount of carbon dioxide (CO_2) into the atmosphere. The extraction of crude oil from the earth, refining the same and burning of its various byproducts such as petrol, diesel etc., further aggravated the situation. The 20th century saw petroleum as the major fuel source for propulsion, be it automobile, rail or air travel. The rapid population increase of the world during the 20th century coupled with affluence and ever-increasing living standards ensured that the total energy consumed by the humankind kept on increasing. In fact, the normal per capita energy consumption is frequently taken as one of the indices to measure the prosperity of a country.

2. Today, life of humans in the planet earth is so entwined with energy and its availability. There are two major forms of energy which are in wide use. One is the electrical energy without which life is unimaginable for most of us now. Electrical energy is used by homes, industries, railways and everywhere. Another form of energy is that from hydrocarbons which manifests in many forms such as coal, petrol, diesel, kerosene, natural gas etc. These are the major fuels for propulsion and again life today cannot be imagined without the availability of these fuels.

3. Electrical energy is generated from varied sources like thermal power plants based on burning of coal, hydroelectric plants and wind mills, by using solar energy, from sea waves etc. The hydrocarbons which are mined from the earth will definitely get exhausted some day, be it after 50 / 100 / 200 years or beyond. The hydroelectric plants are a renewable source of power; so are wind mills and solar based plants. Nuclear energy is another major source of power but raises considerable apprehension from the safety point of view.

4. The world scientific community has got so much engrossed in the science of global warming and climate change. The quantum of emission of greenhouse gases by various countries into the atmosphere has been meticulously documented. Such statistics are freely available to anybody, thanks to the Internet. According to the latest estimates, USA, China, India, Russia and Japan

are the first five major CO_2 emitters. This type of grading based on absolute emissions has been challenged by a section of climate activists of developed countries who have introduced the concept of per capita emissions. Countries such as India and China by virtue of their huge 100+ crores population will obviously report lower per capita emissions.

5. There has been mutual accusations by different blocks of countries as to which block is responsible for the global warming which has already taken place and if steps are to be taken to retrieve the situation, who will pay for that? We hear statements such as "polluter should pay", being made. In some major international forums constituted to take consensual decisions by various countries to cut emissions, developing countries such as India have refused to accept emission cuts saying that such steps will put brakes on the countries' development. A section of climate scientists have made overprojections of the consequences of climate change by highlighting statistics in a selective way.

6. Apportioning blame for climate change is a very delicate matter as it is almost impossible for anyone – either individual or country or block not to contribute to global warming in some way. For example, when a conference / seminar on climate change is held, the participants all travel by air / train / bus; the proceedings are held in air-conditioned halls – all contributing to release of CO_2 into the atmosphere and further contributing to global warming when the delegates discuss ways and means to reduce global warming! The well known Green peace movement has been campaigning against global warming and setting target to end oil consumption completely. However, the movement owns several ships which sail all over the world to conduct environment campaigns and needless to say, the ships are powered by hydrocarbon-based fuels. These examples show the contradictions and imponderables inherent in global warming / climate change activism.

7. Now, coming to the scenario in India which is the third largest emitter in absolute terms. Despite persisting poverty, our country is leapfrogging into prosperity in several areas. India now has world class 4-6 lane highways criss crossing its length and breadth. Several automobile majors have established shops in India and producing automobiles in lakhs and the prosperous younger generation is lapping up such luxuries wholeheartedly. India is now the producer of more than one crore two-wheelers and more than 30 lakhs cars annually. With rising income levels, air travel has also become affordable to many. Appliances such as washing machines, air-conditioners etc which are power intensive have become so common. The middle class citizens of India who at present have access to such appliances now and are able to afford car, air travel, home air conditioning etc. are unlikely to accept sermons about climate change, global warming and release of CO_2 into the atmosphere.

8. So, what should be the strategy to be adopted by the global community or by a developing country like India in the present scenario of global warming and its projected disastrous consequences? In India, electric power is generated mainly from thermal power plants and hydroelectric plants with only a small contribution

coming from wind farms and nuclear energy. India still has abundant coal reserves to last for perhaps a few hundred years. As for crude oil, India imports more than two-thirds of its requirement. It is very much likely that India will never reach a plateau level for demand for power and petroleum due to the increasing population and increased purchasing power. Increased supply is likely to generate increased usage and consequent increased demand as well. Carbon-based energy generation apart from polluting the atmosphere will not be replenishable and both petroleum and coal especially the former will run out and after a certain time period.

9. This brings us to the adoption of renewable and non-polluting energy, which is also popularly called unconventional energy. Hydrobased, wind and solar power are some of the clean energy sources which are renewable indefinitely. In India, hydrobased power plants have been in existence for more than half century but perhaps the availability of energy from this source may have plateaued. On wind energy, a beginning has been made with the state of Tamil Nadu as the forerunner with maximum number of installations. Generating power from solar energy is still remaining as experimental and demonstrative with conflicting reports about the cost of production.

10. Even if the world / India are able to succeed partially in switching over to renewable energy sources for generation of electricity, the other important area of energy use, viz., fuel for propulsion which is at present the byproducts of petroleum remain unaddressed. In the hauling of trains in corridors with high density traffic switching over from diesel to electric traction is definitely feasible but an alternate fuel for cars / bikes / aeroplanes etc. does not appear to be readily available. Electric powered cars / bikes at best are a novelty. When we take into consideration the various aspects of global warming and climate change, its multifarious causes and effects, the likely remedial solutions etc. into their totality, finding an alternate, renewable and cost-effective non polluting fuel as a replacement for petroleum, would be the all-important goal to be achieved for humankind to continue to maintain its present standard and style of living for generations. The global scientific community instead of harping continuously on climate change will have to focus on and pay more attention to developing of alternate fuel especially replacement for petroleum.

11. According to existing available literature, ethanol which is a fuel derived from plants could partially replace petroleum. Brazil is the pioneer in this field with substantial production of ethanol which is mixed with petrol. In India also, there was talk of using bio-diesel as locomotive fuel by Indian Railways. Whether ethanol could be an alternative fuel for petroleum products is not clear and implementing such a proposal all over the world may have adverse effect on food security of poor countries.

12. Certain other crucial developments in the field of alternate and renewable energy got published but perhaps did not receive the attention they deserved. In 2008, the well-known Honda company of Japan produced a car powered completely by fuel cells, i.e., hydrogen as fuel. Only under 25 cars were produced and sold to

celebrities. The car should have met all the safety norms, produced as it was by such a reputed firm. Then, why there was no effort to manufacture it in large numbers was unclear. Definitely, producing it in large numbers would require specialised refueling stations, service centres etc. But the fact that not much effort was made by the global community in adopting this new technology to unshackle itself from the dependence of petroleum defies logic and reasoning. Overall, this particular technology, i.e., that based on fuel cells looks like the most promising one to replace petroleum as an alternate fuel.

13. More focused research on alternate energy is definitely the need of the hour. Power generation from wind farms and solar energy are based on fluxes of wind and solar radiation. These are meteorological parameters and for India, India Meteorological Department has collected and archived abundant climatological data on these parameters, which would serve as crucial inputs in harvesting wind and solar energy over India.

14. At IMS, Chennai Chapter, the Local Executive Council took a decision to organise a series of lectures on renewable and unconventional energy sources considering their importance in ensuring energy security. One lecture by a Scientist from Centre for Wind Energy and Technology, Chennai was delivered on 23 May 2011. An essay competition on the topic "Alternate energy resources" for students was organised by IMS, Chennai Chapter on 3 Aug 2010 and the first prize-winning essay is published in this issue of Breeze.

15. The following are some of the facts / statistics on global warming / climate change / renewable energy sources:

- During the 20th century, global surface temperature increased by 0.74°C, Temperatures since 1980 have shown sharp rising trend.
- Atmospheric CO_2 (at Hawai, USA) increasd from 315 ppm in 1960 to 382 in 2008. In 1750 it was 280 ppm.
- One litre of petrol when used as fuel produces 2.32 kg (1.3 cubic metres) of CO_2.
- Absolute emissions of CO_2. (in crores tons) – 2009 figures.

World	3040	
China	771	25.3%
USA	542	17.8%
India	160	5.3%
Russia	157	5.2%
Japan	110	3.6%

- In India, temperatures during the last decade have been warmer than the 1961-90 mean by 0.4 to 0.8°C.
- Alternate fuels (potential) : Biofuel, Alcohol (Methanol, ethanol), Ammonia, Hydrogen, Liquid Nitrogen, Compressed air , Nuclear power etc

- Year 2008 – Honda FCX Clarity which is a hydrogen fuel cell automobile launched. There have been a few earlier versions also with hydrogen as fuel.
- In 2008, a solar powered car circumnavigated the world. This car was developed by Swiss scientists.
- Sales of motorcycles in India (112 lakhs, 2009), Car production in India is 7th largest in the world (28 lakhs, 2010). Growth rate 16-18% per annum.
- Population of India (2011): 121 crores , in 2001 : 103 crores.
- Normal per capita power consumption per year by a few countries in watts per person: World – 297; China - 364; USA – 1460 ; Europe -700 ; India – 50.
- Electricity generation in India – Thermal : 65%; Hydro:22%; Nuclear:3%; Others:10%.
- Indian coal reserves : 267 billion tons.
- Consumption of crude oil (thousand barrels per day) : USA – 18810; China - 8324; Japan-4444; India-3110; Russia-2740; World-84213.

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AVIATION METEOROLOGICAL SERVICES PROVIDED BY INDIA METEOROLOGICAL DEPARTMENT – PAST, PRESENT AND FUTURE

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Early air navigation in India

Ever since the first flight in India from Allahabad to Naini in 1911 was made successfully, the need for current weather information and forecast was felt very much by the aviators. As weather has been proven to have a major influence on every phase of aircraft operations, the demand for reliable forecast started arising since then. To meet this requirement, *upper air wind observations* were commenced from Agra in 1913 and from Lahore in 1918. Based on these upper air observations, the first known aviation forecast was issued from Simla in the year 1921 for the Royal Air Force (RAF) operations in Waziristan which was part of the then northwest India. Daily summary of upper wind was sent telegraphically during 1921-22 to the RAF HQ for deciding the aircraft operations and then to the regional military operations at Waziristan and Dardoni during 1923-24. The services rendered by India Meteorological Department (IMD) were well appreciated by the War Department, Washington, United States.

Establishment of aviation meteorological forecasting offices

Subsequently, forecasting offices at Peshawar and Quetta were opened during 1925 and at Karachi during December 1926. The responsibility of issuing weather forecast for a portion of Imperial route from England to India, viz., Basrah – Karachi was given to Karachi forecasting office. The first air mail service to India commenced during 1929 and Delhi and Karachi meteorological forecasting offices were empowered with the responsibility of issuing adverse weather warnings for the air mail service flights.

Kolkata forecasting office catered to the aviation meteorological needs of Eastern India and Burma sectors. Flying boat service for the route Singapore – Kolkata commenced during 1929. During early 1930, the Tata and Sons' flights Karachi – Chennai and air taxi service between Chennai and Kolkata were catered to by Pune weather office. Wireless communication system for the quick dissemination of current weather information and forecast was set up during early 1930s.

Aviation services - aftermath of the second World War

Rapid growth of aviation activities were seen during 1941 when a number of air fields were opened during the 2nd World War. As the aircrafts, mostly for war – bombers, were flying at altitudes 5000-6000 m a.m.s.l and at times above these heights as well, the need for temperature and winds upto 10 km was felt for flight planning and payload / cargo load computation requirements. Hence a number of *radio sonde* stations were set up in India by the United States Air Force. With the introduction of jet flights passing over India during 1952, a network of *radio-wind observatories* and *(thunder)storm detecting radar stations* were established by IMD to cater to the requirements of high altitude flying jet aircrafts.

Non-stop flights from India to destinations like Hongkong, Cairo etc were commenced thanks to the establishment of *extended chart analysis and prognostication centres* established at Mumbai and Kolkata by IMD which issued *chart form of documentation (CFD)* from 1st January 1964. As per ICAO recommendations, *Area Forecast Centres* were opened at New Delhi, Tokyo, Cairo, Melbourne and Moscow during late 1960s to prepare and transmit the actual and prognostic charts.

Ushering aeronautical meteorological instrumentation, telecommunication and forecasting services

Transmissometer to assess the runway visual range (RVR) was installed at Dum Dum airport in 1966. *Remote sensing instruments* were installed at runways during late 1960s and *Ceilometer* to estimate the height of the base of the low clouds during 1974 at Mumbai. *Dedicated teleprinter links* between Mumbai, Kolkata, Delhi and Chennai were established for quick exchange of aeronautical meteorological information and SIGMET warnings. As many as 19 aerodrome meteorological offices (AMO) to issue route and terminal forecasts for their own aerodromes as well as to the 57 attached aerodrome meteorological stations (AMS) were functioning during mid 1970s.

Current weather instrumentation with Wi-Fi communication link in Runway 25 of Chennai airport.

As the current weather information and adverse weather warnings need to be disseminated through fastest mode of telecommunication system, *the teleprinter, telex and facsimile form of communication* were considered inadequate and hence *automatic message switching system (AMSS)* have been installed at Delhi, Mumbai, Kolkata and Chennai during mid 1980s. These systems have been used for meteorological data exchange, ROBEX (Regional OPMET Bulletin Exchange), SIGMET warning dissemination within and neighbouring FIRs.

Economic benefits of meteorology in aviation

It has been estimated that weather hazards are the cause for about 200 deaths and about $15 billion monetary loss every year in the United States. Similar statistics may be available in each country albeit somewhat of lower order than those estimated by the United States. The causes of aircraft accidents such as wind shear, micro bursts, thunderstorms and associated weather hazards to aircrafts, volcanic ash clouds etc were studied in depth by the meteorological communities throughout the world with the improved

(a) observation techniques such as remote sensing instrumentation (Radar, Doppler weather radar, Wind profilers, satellite sounders and imagers, Lidars, lightning detectors etc),

(b) analysis capabilities such as numerical weather prediction models (NWP) through super computers

(c) method of insitu surface and upper air observations such as sophisticated electronic sensors for temperature, humidity measurements, transmissometers and laser ceilometers

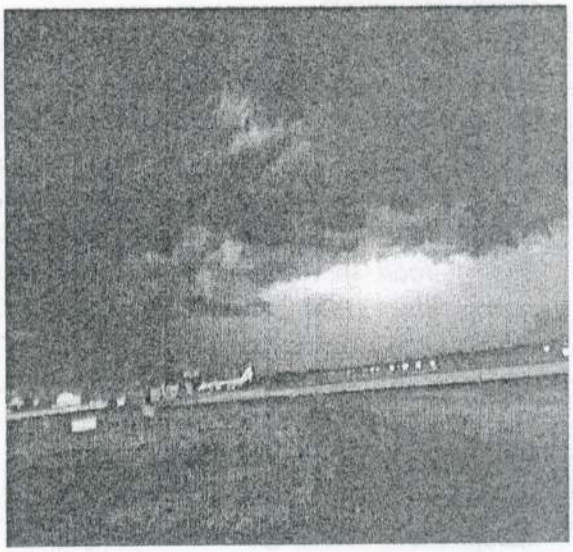
(d) air-borne weather detection and warning systems.

The above developments from 1970s to 1990s made it possible for the Pilots to avert the

- hazardous icing,
- turbulence and wind shear areas,
- dangerous thunderstorm areas,
- cyclonic storms,
- volcanic ash cloud regions etc

and for the operations people to

- ✓ do proper flight planning,
- ✓ make diversion strategies,
- ✓ device optimal payload calculations etc.

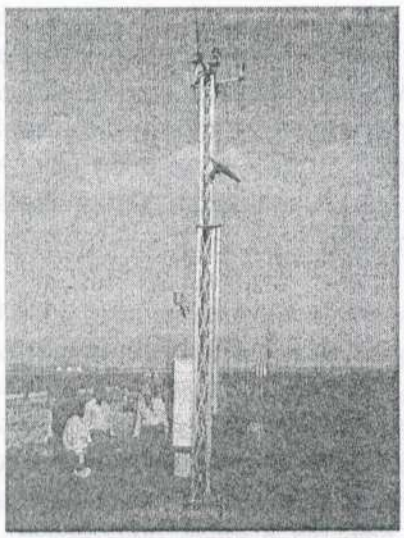


It has been estimated and documented by the U.S weather bureau that advance information and warning about the hazardous weather and accurate enroute forecast result in billions of US $ saving every year. Similar statistics, perhaps with lesser monetary gain figures, may be available elsewhere in the world provided such

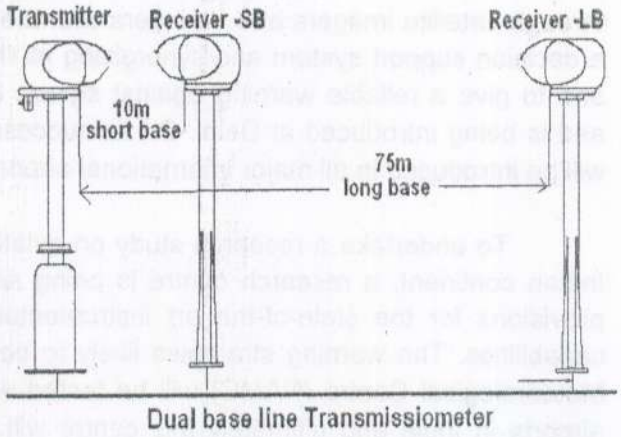
a study is undertaken. In India, such a study needs to be undertaken. Thus the economic benefits of meteorological information and forecasting services have been well recognized and documented the world wide.

Currently available meteorological instrumentation, telecommunication and forecasting services in India

As the airline operators and agencies recognised the role of meteorological information and forecasts for the safety and economy of aircraft operations, the meteorological requirements from the users were ever increasing in terms of precision, accuracy and demand. A number of digital current weather observing systems, integrated automatic current weather instrumentation system have been installed in many airports in India. Transmissometers at both ends of runways for CAT II operations and at both ends and also at mid runway for CAT III operations have been installed wherever necessary.



Integrated Automatic Current Weather Instrumentation System, Shamshabad



Dual base line Transmissiometer

A sudden spurt in aviation activities were noticed during early 1990s with a number of private operators catering to the aviation services across the lengths and breadths of the country. However, due to high operational cost and competition many of the operators have ceased their existence. The payment of salary and perks for the operational people was also stated to be a cause for the loss these operators have faced. In a similar way, exponential growth in aviation activities have been seen during early 2000s. However, with the Government's liberalisation and globalisation policies, these operators have made it possible for the common man to avail air travel. Basically, these agencies – some of them are known as low cost carriers – have offered a cheap air fare by cutting operational costs. The air crews were given tight schedules and have minimum transit time at any airport. In the absence of authorized flight despatchers, the air crews found it difficult to come from Apron to the Met. office to avail meteorological briefing personally during the minimum transit

duration at an airport. Having recognised and understood the need for providing meteorological briefing services to the aircrews of low cost civil air carriers, online aviation meteorological briefing system (OLBS) has been introduced w.e.f 1st June 2007 after successful trial run from 22nd March 2006 from AMO, Chennai for flights originating from Chennai FIR. The OLBS has been extended to other FIRs subsequently during 2007 itself. Online meteorological briefing services for the short haul low level flights (upto 500 n.m and below FL100) have been introduced from AMO Chennai w.e.f 15th March 2010 on trial basis with an ultimate view of extending this facility on operational basis throughout India.

Future Aviation Meteorological Services in India

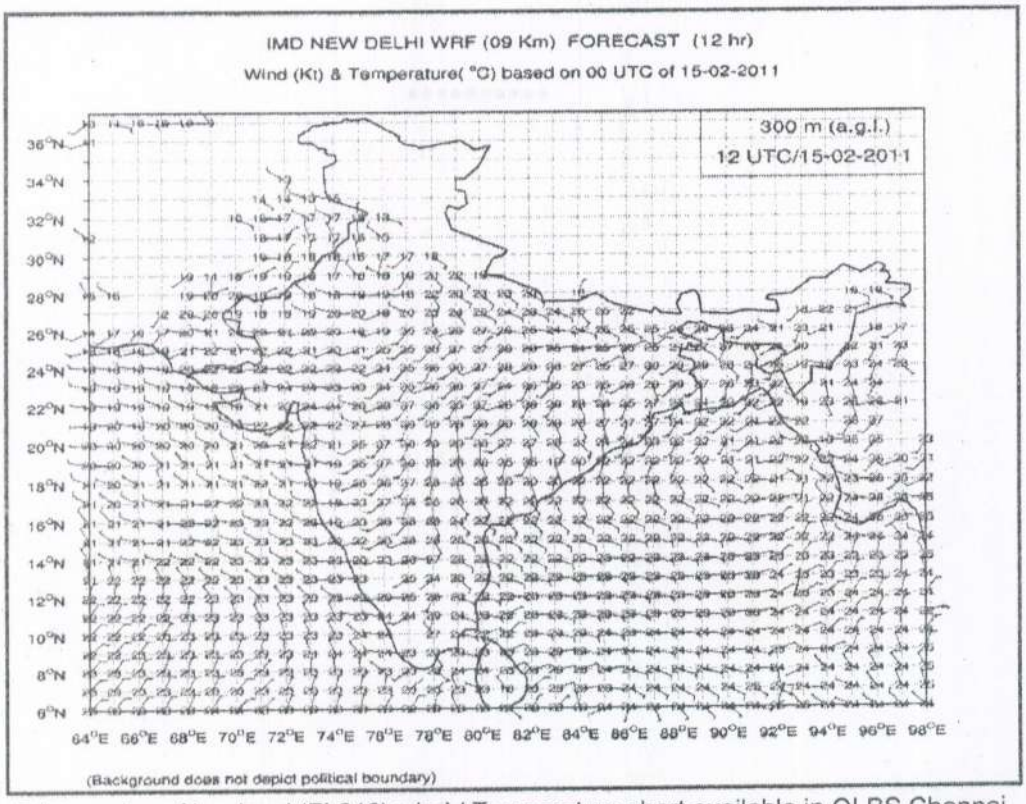
In order to meet the growing requirements of aviation current weather information at all airport in India, IMD has planned for installing automatic weather observing system (AWOS) at 42 airports in replacement of existing analogue instrumentation during 2011-12. The AWOS consists of integrated digital sensors for temperature, humidity, wind, pressure measurements and RVR assessment, ceiling height estimation (i.e. height of the base of low clouds) at runway.

Combining the observed meteorological data of crucial meteorological parameters from runway, products from Doppler weather radars, data obtained through satellite imagers and sounders with the NWP model outputs and developing a decision support system and synergizing all the information for improved forecasts and to give a reliable warning against severe aviation hazards have been planned and is being introduced at Delhi. On its successful launch and usage, similar facility will be introduced in all major international airports in India.

To undertake a research study on aviation weather hazards as applicable to Indian continent, a research centre is being set up at New Delhi which may have provisions for the state-of-the art instrumentation, computing power and analysis capabilities. The warning strategies likely to be developed by this National Aviation Meteorological Centre (NAMC) will be tested at Delhi and also at few other major airports in India and ultimately this centre will be guiding the AMOs and attached AMSs throughout the country to extend the best possible aviation meteorological services.

It is proposed to introduce a chart form of documentation (CFD) for low level flights through OLBS. NWP model based forecast charts having validity 6, 12, 18 and 24 hours from the scheduled upper air observation timings (00 and 12 UTC) for the flight levels (FL) 010, 020, 030, 040, 060 and 070 are being tested. These charts are similar to the wind / temperature forecast charts provided for international air navigation by the World Area Forecast Centres (WAFC) located at London and Washington for flight levels, FL050, 100,140, 185, 230, 300, 340, 390, FL450 and FL530. It is hoped that the low level flight operators will have the CFD before the end of 2010.

The icing information provided in the domestic significant weather charts issued by IMD has been appreciated and well acknowledged by the Pilots, especially the foreign Pilots flying in Indian FIRs. The introduction of OLBS and the contemplated introduction of OLBS for low level flights (below FL070 specifically) have been acknowledged not only by the Pilots but also by the Operational group as these save time and give much more additional information than that could have been obtained through personal / oral briefing in the limited time period when they visit the local meteorological office. Traditionally IMD has always been understanding the needs of the aviators and meet their requirements and at times provide vital information much more than the user expected to have.



Trial version of low level (FL010) wind / Temperature chart available in OLBS Chennai.

The necessity of feedback / in-flight reports / de-briefing

The feed back from the user community, especially from the flight crews, is very much needed to improve our services specifically in the areas of low level wind shear (LLWS) and turbulence observation and reporting. It may not be out of place to mention here that as per provisions of ICAO Annex 3 (Chapter 5, paras 5.5 and 5.6,; Appendix 4, paras 2.6 and 4.1), the information on LLWS observation and reporting and clear air turbulence (CAT) based on aircraft measured eddy dissipation rate (EDR) and conversion into turbulence index (TI) shall be reported by the Pilots [Quote: "*icing, turbulence, and to a large extent wind shear are elements which for the time being can not be satisfactorily observed from the ground and for which in most cases aircraft observations represent the only available evidence*"]. These information will be vital for validating the algorithms used for warning the air crews

against LLWS and /or for devising new warning strategies on LLWS / CAT or to validate the NWP products. These points have been discussed in-depth at various forums such as Regional Operations Committee (ROC) meetings etc in Chennai with a request to pass on in-flight / post flight reports so that a good data base can be generated to devise a suitable wind shear alert / warning strategy exploiting the data likely to be obtained from Doppler weather radars being introduced by IMD in major cities.

It is hoped that user interactions on de-briefing about the weather forecast provided to the air crews and timely dissemination of aircraft observations and in-flight reports to the Meteorological office through ATC or as de-briefing report, as per procedures laid out by ICAO, will enhance the services being provided by IMD and ultimately beneficial to the airlines for the safe, economic, effective and efficient conduct of flights.

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REPORT ON THE SEMINAR – INEMREC-2011

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Monsoon provides life-giving rain and shapes the lives of millions of human population and livestock in India. The performance of the monsoon has extraordinary implications on the economy of tropical countries. The monsoon processes are subtle and interactive involving many components of the climate system, so much so that understanding the underlying physical processes, monitoring and predicting the behavior of monsoons continue to be challenging areas for atmospheric scientists. In the southeast peninsular India, the regions of Tamil Nadu, Kerala, Rayalaseema and south coastal Andhra Pradesh are the major beneficiaries of Northeast (NE) monsoon. The NE monsoon is well defined over Coastal Tamil Nadu with some stations receiving more than 100 cm of normal seasonal rainfall. The NE monsoon also extends to parts of Sri Lanka especially over the eastern coast. The rainfall during NE monsoon is of immense societal significance to the human population of 15 crores as it supports the main cultivation season known as *Rabi* in southern India and *Maha* in Sri Lanka. Plenty of scope exists in research on NE monsoon especially with the availability of large amount of data from modern observing systems such as satellites, Doppler Weather Radar, Scatterometer etc. and the availability of Numerical Weather Prediction models to the research community.

With this background, the Indian Meteorological Society (IMS) Chennai Chapter and Regional Meteorological Centre, Chennai conducted a seminar '**INDIAN NORTHEAST MONSOON – RECENT ADVANCES AND EVOLVING CONCEPTS (INEMREC-2011)' during February 24-25, 2011** at Anna Institute of Management, Greenways Road, Chennai. The seminar was aimed to assimilate the present as well as the evolving concepts related to the Indian Northeast Monsoon. INEMREC-2011 provided a common platform for researchers, planners, hydrologists, agriculturists, and disaster managers who are involved in some way with Indian NE monsoon.

The Inaugural Function of the seminar was held on 24 Feb 2011, 0930 hrs IST. AVM.(Dr.) Ajit Tyagi, Director General of Meteorology, India Meteorological Department (IMD), New Delhi and Chairman, Scientific Advisory Committee (SAC), INEMREC-2011 was the Chief Guest. Dr.J.Radhakrishnan, IAS, Country Director, United Nations Development Programme (UNDP), New Delhi was the Guest of Honour. Dr.L.S. Rathore, Head (Agromet), IMD and President, Indian Meteorological Society (IMS), New Delhi presided over the function. Dr.Y.E.A.Raj, Deputy Director General of Meteorology, Regional Meteorological Centre (RMC) Chennai and Chairman, Local Organising Committee (LOC), INEMREC-2011 welcomed the dignitaries and guests. He also briefed the audience about the background for holding INEMREC-2011 and on the significance of choosing northeast monsoon as the focal theme of the seminar.

The Book of Abstracts of INEMREC-2011 was released during this occasion by AVM.(Dr.) Ajit Tyagi, Director General of Meteorology, IMD, New Delhi and the first copy was received by Dr.J.Radhakrishnan, IAS, Country Director, UNDP, New Delhi.

Dr. L.S. Rathore, Head (Agromet), IMD and President, Indian Meteorological Society, New Delhi presided over the function and delivered the Presidential Address. He appreciated IMS Chennai Chapter and RMC Chennai for their research works on northeast monsoon and also for conducting the seminar on northeast monsoon which is the chief rainy season for the southeastern parts of India. He recommended conducting more intense scientific programmes such as MONEX to facilitate further studies on northeast monsoon.

Dr.J.Radhakrishnan, Country Director, UNDP, New Delhi recalled his interactions with IMD Chennai during incidences of drought, floods and Tsunami when he was the District Collector, Nagapattinam. He also pointed out the need for close interaction between IMD and civil administrators at times of impending disasters which would be highly beneficial to the farming and fishing communities.

AVM.(Dr.) Ajit Tyagi, Director General of Meteorology, IMD New Delhi in his inaugural address complimented the organisers on the choice of focal theme of the seminar which is very important from the regional perspective and briefed about the recent initiatives taken towards modernisation of IMD services. He encouraged further studies on northeast monsoon using new observational and forecasting tools.

Dr.S.Balachandran, Scientist-E, RMC Chennai and Convener, INEMREC–2011 proposed the Vote of Thanks.

After the Inaugural function, a press briefing on activities of IMD with special reference to significance of organising seminars like INEMREC–2011 was held by AVM.(Dr.) Ajit Tyagi, Director General of Meteorology, IMD New Delhi.

Press briefs in English and Tamil giving salient features of the seminar were prepared and circulated to media persons. 'The Hindu' published a report on 22 Feb 2011 as a curtain raiser to the seminar. 'The Hindu' also published information about the seminar in its 'Chennai Today' column on 24 Feb 2011 .'The Times of India' published a report on the inaugural function. 'Deccan Chronicle' dated 25 Feb 2011 published a capsule on the seminar and challenges in northeast monsoon studies. The Inaugural function was covered by the visual media also.

In all about 160 delegates participated. Some of the organisations from which delegates had participated are given below:

1. Andhra University, Vishakhapatnam
2. Annamalai University, Chidambaram
3. Centre for Atmospheric Sciences(CAS), IIT New Delhi
4. Centre for Earth, Atmosphere and Weather Modification Technologies (CEA&WMT), Jawaharlal Nehru Technological University, Hyderabad

5. Cochin University of Science and Technology, Kochi
6. IIT, Mumbai
7. India Meteorological Department
8. Indian Institute of Tropical Meteorology (IITM), Pune
9. Indian Space Research Organisation , SHAR, Sriharikota
10. Indian Space Research Organisation, Bangalore
11. Institute of Remote Sensing (IRS), Anna University, Chennai
12. National Atmospheric Research Laboratory (NARL), Gadanki
13. National Institute of Oceanography, Chennai
14. National Institute of Oceanography, Goa
15. S.V University, Tirupati
16. SASTRA University, Tanjavur
17. SRM University, Chennai
18. Tamil Nadu Agricultural University, Coimbatore

In addition to above, four foreign delegates from Sri Lanka and USA also participated in the seminar, which gave an international flavour to the seminar which was initially planned for a regional scale.

During the technical sessions, 12 invited talks by eminent experts and 62 contributory papers covering all the sub-themes of the seminar, viz., Climatology, Variability and Seasonal Prediction (CVS), Dynamical Modelling and Application of Modern Observing Systems (DMO), Synoptic aspects, Ocean and Atmospheric Processes (SOA), Tropical Cyclones, Floods, Droughts and Natural Disaster Management (TCD), Agricultural and Hydrological aspects (AHA), Public education and Outreach (PEO) and Northeast monsoon of Sri Lanka and Southeast Asia (NSL) were presented.

The session on disaster management, held during the forenoon of 25 Feb 2011, was an extensive one and was well attended by officials from Govt. of Tamil Nadu and UNDP. There were three invited talks, three guest lectures by officials dealing with disaster management and a lead presentation during the session. Prof.S.Sethuraman, North Caronina University, USA shared his wisdom, expertise and experiences regarding interaction of landfalling tropical cyclones with environment. Collectors from two coastal districts of Tamil Nadu, viz., Shri P.Seetharaman, IAS, District Collector, Cuddalore, Govt. of Tamil Nadu and Shri Rajendra Ratnoo, IAS, District Collector, Kanyakumari, Govt. of Tamil Nadu delivered talks on importance of weather related warnings in disaster management and shared their experiences in effective handling of mitigation measures during natural disasters using weather warnings. Both the District Collectors complimented on the utility of IMD's warnings in disaster management aspects. Shri C.John David, Project Officer, EWS&RM, UNDP, Chennai, delivered a talk on role of UNDP on disaster management and briefed on disaster risk management programme and community based disaster preparedness.

As an important outcome of the seminar the following recommendations were drafted. Some of the recommendations have been suggested by eminent scientists who participated in the seminar.

- Northeast monsoon features are complex in nature and it is worthwhile to attempt micro scale analysis of northeast monsoon rainfall.

- Application & utilisation of observational data from AWS & ARG networks, satellite based data like TRMM, MODIS data etc. are essential for understanding of weather systems during Northeast monsoon season.

- Assimilation of data from above modern observing systems into NWP models to create better initial conditions and simulation of features of northeast monsoon could be attempted.

- Studies related to synoptic features other than cyclones and depressions, such as easterly waves, during northeast monsoon have to be encouraged. Climatological aspects of such features have to be brought out.

- Intense observational experiments similar to MONEX conducted for southwest monsoon should be conducted for northeast monsoon also and data collected during these experiments should be used for advanced research activities.

- The Cauvery delta region of Tamil Nadu which is known as the rice bowl of the state, depends on rain water from northeast monsoon in addition to the water from the Cauvery river and irrigation dams / tanks for agricultural activities. However, owing to the unstable nature of northeast monsoon, the farmers undergo considerable hardship if the northeast monsoon fails. Cloud seeding studies to evaluate the feasibility and efficacy of carrying out cloud seeing over the Cauvery delta region could be initiated. Such studies could be carried out with the radar data already generated at Karaikal radar, satellite pictures and also when Doppler Weather Radar is installed in Karaikal in the near future.

- Users of weather information such as public administrators, NGOs etc. should be educated and encouraged to distinguish between normal weather events and very extreme events associated with impending dangers which should facilitate responses based on sound decisions.

- Weather related challenges faced by public administrators during Northeast monsoon with specific reference to coastal parts of southern peninsular India have to be addressed through an integrated approach involving various stakeholders like UNDP, NGOs connected to diasaster management.

- In order that all mitigation activities have to be undertaken within a very short lead time between time of issue of forecast and occurrence of disastrous weather events, it is important to pool in all local volunteers and keep them in readiness for very quick responsive actions to the damages caused by the disastrous weather event instead of bringing in trained personnel from elsewhere. But, such local volunteers have to be pre-trained so as to act quickly, correctly and precisely. A pilot project involving administrators, local disaster managers (NGOs and volunteers) and weather forecasters can be taken up with the help of UNDP for a small sub-region and the outcome can be studied.

- Improvement and upgradation of last mile connectivity for information related to impending disastrous weather events like tropical cyclone, floods and droughts etc. during northeast monsoon season has to be brought out through real time interactions between scientific community and society.

- Dissemination channels used for last mile connectivity should be such that these are used commonly during normal periods also. Dedicated channels used during exigencies only will not be as effective as the routine methods.

- Vulnerability mapping is an important aspect of disaster management. Adaptation of knowledge which has been gained for regional generalisation has limitations while addressing local situations. There is a need for sub-regional understanding of monsoon and consequential vulnerability mapping using AWS, microwave mapping and Advanced Laser Terrain Mapping (ALTM).

- There is a need for combined efforts of scientific community and the press (print and visual media) for taking the weather information to the public in the right perspective.

- There is considerable scope for carrying out research in the various aspects of Indian northeast monsoon. A dedicated research centre for this could be set up in any University / Institution / Department with Chennai as the preferred location.

The Chairman informed the delegates that the above recommendations of the seminar would be communicated to the scientific / administrative / user community for consideration.

Dr.Y.E.A. Raj, DDGM, RMC Chennai and Chairman, IMS Chennai Chapter Chaired the Concluding Session held on 25th Feb 2010 . He provided a gist of proceedings of the seminar and thanked all participants for their contributions towards achieving the intended goal of the seminar. The seminar concluded on a happy note with the Convener Dr.S.Balachandran's Vote of Thanks to all the delegates and to all those who were instrumental in the success of the seminar.

The IMS Chennai chapter thanks all the organising committee members for their support and cooperation and members of the Scientific Advisory Committee for their guidance and encouragement. We thank all the invited speakers for their contributions and the chairpersons of the various sessions for conducting the sessions efficiently. Thanks are also due to several eminent personalities for their participation, comments and feedback. Financial supports rendered by the Donor, the Government of Tamil Nadu through the UNDP, Sponsor, ISRO, Bangalore, Co-sponsors, Chennai Port Trust, Chennai, NIOT, Chennai, Tamil Nadu State Apex Co-operative Bank Ltd., Chennai and Science City, Govt. of Tamil Nadu, Chennai and BEL, Bangalore are sincerely acknowledged.

A few photographs covering the inaugural function and the technical sessions are given in the Annexure.

Annexure

Photographs covering the seminar

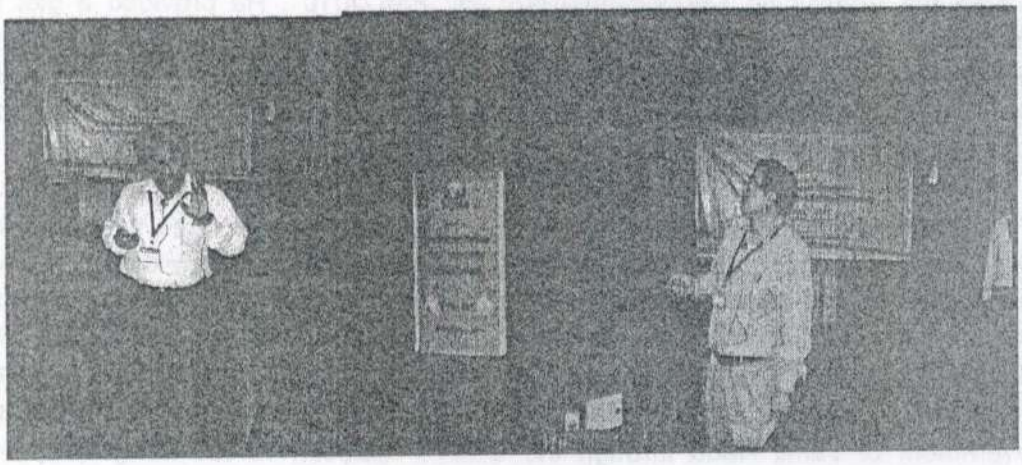
Inaugural function

Traditional lighting of lamp

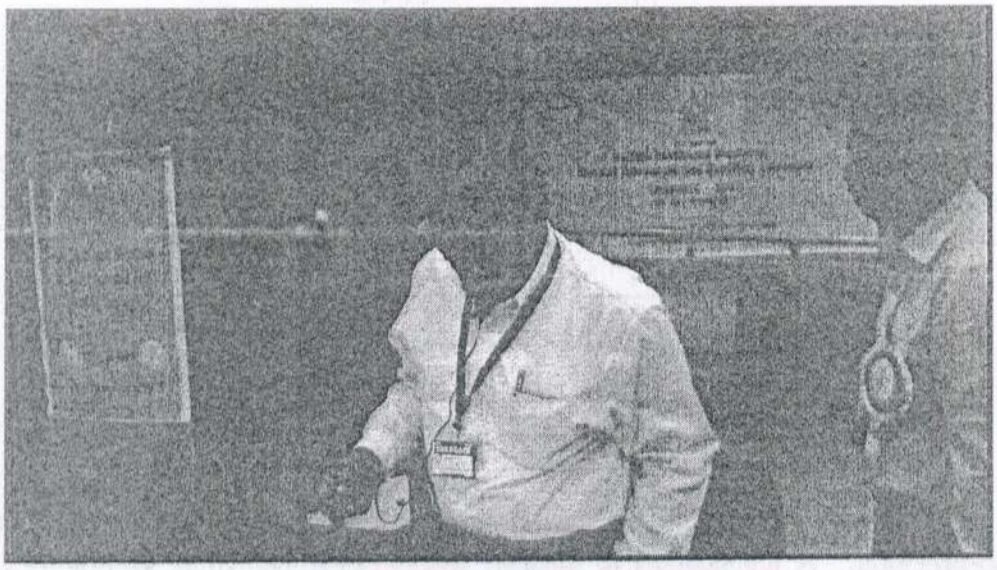
Release of book of abstracts by the Chief Guest

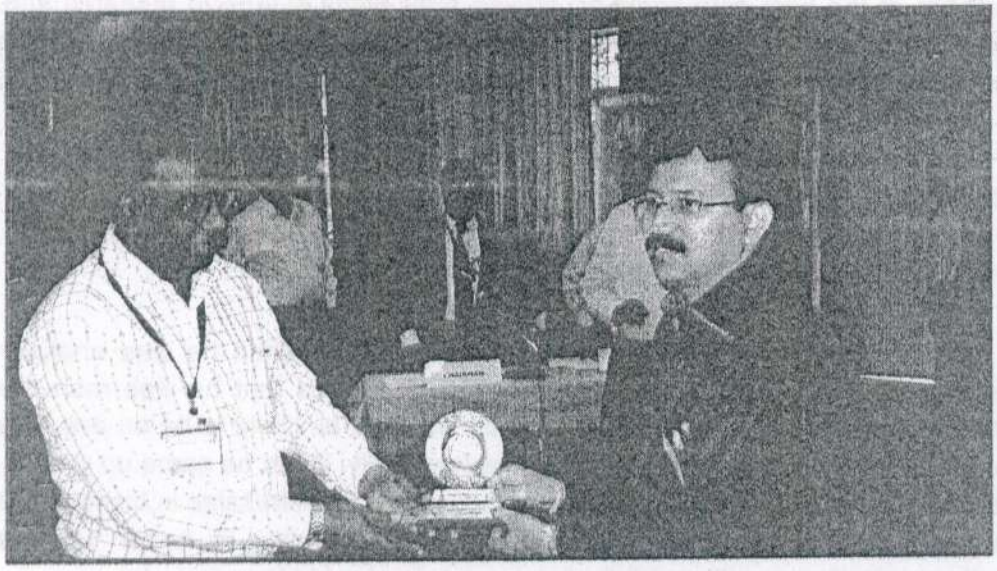
Address by the Chief Guest

Technical sessions



Delegates from Sri Lanka and USA





Participation of District Collectors of Cuddalore and Kanyakumari

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A SCIENTIFIC EXPLANATION FOR USING DIFFERENT CATEGORIES IN RAINFALL SUMMARIES FOR ALL THE METEOROLOGICAL SUBDIVISIONS

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India Meteorological Department in its rainfall summary for sub-divisions is using the categories listed in Table 1 below:

Table 1

Category	% Departure from mean
Excess	> 19%
Normal	Between – 19% to 19 %
Deficient	Between -20% to -59%
Scanty	<-59%

The above categories are being used uniformly for all the 36 meteorological sub-divisions. A justification to support above classification is attempted in the following. Though the attempts to get official documentary evidence from IMD to justify above criteria were not fruitful, some scientific explanation based on the statistics of the past data could be arrived after some extensive research and deep thinking. Of course these are author's personal explanation which might be the reasons behind adopting the above criterion.

It is assumed that sub division rainfall is normally distributed. Let us see some properties of normal distribution.

The Gaussian or Normal Distribution

Karl Friedrich Gauss invented this distribution when he was analyzing the errors he made observing star positions. He reasoned that he was more likely to make small errors than large ones, that he was just as likely to be on one side than the other, and that the larger the error, the less likely. What he came up with, is often called the *normal* distribution, but sometimes called the *Gaussian* in his honor. It would be preferable to call it as Gaussian because, not only to honor him but, the implication that every other distribution is *abnormal* could be avoided.

Gaussian PDF

The PDF for the Gaussian is very similar to the exponential, the major differences being that the exponent is squared (which gets us symmetry around zero) and some constants:

$$f(x) = \frac{e^{-x^2/2}}{\sqrt{2\pi}}$$

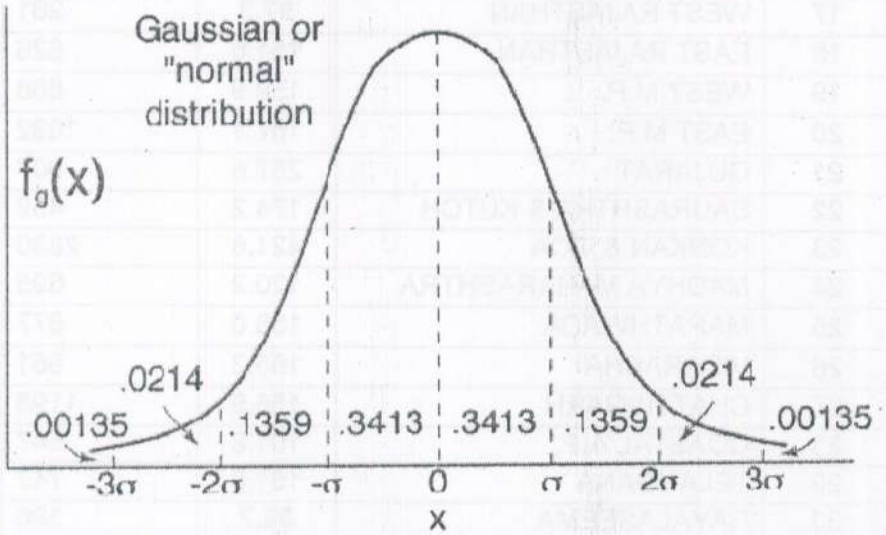
The preceding is called the *standard normal* and has a mean of 0.

1. A more general form is allows a mean of μ (mu) and a standard deviation of σ (sigma):

$$f(x) = \frac{e^{-(x-\mu)^2/(2\sigma^2)}}{\sigma\sqrt{2\pi}}$$

Some convenient properties

- It's symmetric around the mean, so mean=median
- The mean is the mode
- 68 percent of the population is within 1 sd of the mean
- 95 percent of the population is within 2 sd of the mean
- 99 percent of the population is within 3 sd of the mean



The main thrust in rainfall summary is to identify the regions experiencing significant less rainfall. As seen in the above 68% of the population is within 1 sd of the mean. Thus the category normal in rainfall summary is used when rainfall is within 1 sd of the mean. Since we are more concern about the less rainfall than more rainfall, therefore all the value greater than 1 sd of the mean is categorized as excess rainfall and the category deficient is used if the actual rainfall is less than -1σ but greater than -3σ . The category scanty is used when the sample value is even less than -3σ. That is the category which is in the extreme left region of the above distribution function (0.135% of the population). The range between -σ to -3σ is categorized as deficient rainfall. Then how Table 1 above is obtained from these is explained below.

Table 2

S.No.	Name of Sub-division	SD(mm)	Mean (mm)
1	ANDAMAN & NICOBAR ISLANDS	509.0	1818
2	ARUNACHAL PRADESH	204.6	1719
3	ASSAM & MEGHALAYA	131.3	1582
4	N. M. M. T.	152.8	1528
5	WEST BENGAL & SIKKIM	304.5	2175
6	GANGETIC WEST BENGAL	149.8	1135
7	ORISSA	136.0	1172
8	JHARKHAND	133.5	1094
9	BIHAR	148.5	1046
10	EAST U.P.	158.3	894
11	WEST U.P.	150.7	746
12	UTTARANCHAL	193.3	1124
13	HARYANA	123.5	446
14	PUNJAB	138.9	479
15	HIMACHAL PRADESH	171.8	830
16	JAMMU & KASHMIR	92.6	477
17	WEST RAJASTHAN	97.3	261
18	EAST RAJASTHAN	151.6	626
19	WEST M.P.	158.9	868
20	EAST M.P.	167.1	1092
21	GUJARAT	257.6	907
22	SAURASHTRA & KUTCH	174.2	452
23	KONKAN & GOA	421.6	2830
24	MADHYA MAHARASHTRA	120.2	695
25	MARATHWADA	168.0	677
26	VIDARABHA	165.3	961
27	CHATTISGARH	156.9	1198
28	COASTAL A.P.	101.8	547
29	TELANGANA	151.6	747
30	RAYALASEEMA	96.7	396
31	TAMIL NADU	58.5	320
32	COASTAL KARANATAKA	433.9	2992
33	NORTH INTERIOR KARNATAKA	103.5	523
34	SOUTH INTERIOR KARNATAKA	112.4	685
35	KERALA	381.6	2132
36	LAKSHADWEEP	186.8	988

Let us see the statistical properties of the subdivision rainfall series (We have used here the monthly homogeneous rainfall series (1901-2008) (Ref. Guhathakurta

& Rajeevan, "Trends in rainfall pattern over India", *International J. of Climatology*, 28: 1453–1469 (2008). In Table 2, third column is the Standard deviation of SW monsoon rainfall for each of the sub-division in percentage of mean (normal) which is varying from 8.3 to 38.5.

Using the formula of pooled variance

$$s_p^2 = \frac{\sum_{i=1}^{k}((n_i - 1)s_i^2)}{\sum_{i=1}^{k}(n_i - 1)}$$

or with simpler notation,

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2 + \cdots + (n_k - 1)s_k^2}{n_1 + n_2 + \cdots + n_k - k}$$

of 36 meteorological sub-divisions we got the value of the variance as 43493.4mm and standard deviation as 208.5mm which is 19.6% of mean (mean is here calculated as simple arithmetic mean of column 4 of Table 2).

In order to use uniform criterion for all the sub-divisions (which is naturally more understandable to the common users) the use of Standard Deviation (SD) of all the 36 subdivisions is thus 19 % is more preferable. Therefore the sample value which is within 19% of normal (long term mean) is considered in the category of normal.

Three times of Standard Deviation (SD) values coming from this data series is 59%. Thus when the sample value is between -20% to -59% of normal (long term mean), it is categorized as deficient rainfall and if it is less than -59% of normal (long term mean) it is categorized as scanty rainfall.

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GSM-GPRS TECHNOLOGY FOR WEATHER BASED AGRICULTURAL COMMUNICATIONS

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The agricultural production of any place is dependent on weather as more than 50 per cent of crop productivity is relays on weather. The tropical country like India is not an exception where the dynamism of weather is higher than temperate countries. Hither to farmers get weather information once in a day through mass communication facilities like radio, television and news papers, little later than their counter parts elsewhere in other countries. Real time weather information will give an opportunity to the farmers to plan their agricultural operations and to evade risks due to weather. Similarly weather forecast information, which is vital for tactical farm decisions also need to be provided to the farmers in time. This article discusses our experience in utilising GSM-GPRS technology for providing weather-based information to the farmers.

The Tamil Nadu Agricultural University, a leader in the agricultural information technology in the country proposed a project under National Agricultural Development Programme for establishing Tamil Nadu Agricultural Weather Network in order to provide real time weather information and weather forecast for farmers of Tamil Nadu. The project envisages establishment of 224 Automatic Weather Stations (AWS) throughout Tamil Nadu. The AWS has to be installed in remote places in crop environment either in the farmers field or agricultural research stations. The atmospheric conditions recorded on hourly basis has to be made available to the farmers on real time which was not attempted before in India. So the timely communication here is a vital issue and there are wide options available.

Use of satellite communications

The data logged in remote areas can be communicated through satellite, which requires directional Yagi antenna to push the data to the satellite and the cost is around Rs.50,000/- per antenna. The data need to be pushed in specific time slots to the satellite by each of the AWS failing which the data cannot reach the satellite as transmitter uses Time Division Multiple Access (TDMA) technology. To retrieve the lost data one has to visit individual AWS and has to connect its logger. We have observed around 5-10 per cent data loss in the AWS installed by Indian Space Research Organization (ISRO). World wide it has been reported around 5 per cent data loss. Again to receive the data in time we need an earth station which may cost us around 10 million rupees. The communication here is only one way as it is possible to receive the data from AWS through satellite by an earth station while sending back any communication to the AWS is not possible. One more additional expense is that we need to pay annually around Rs.35,000/- to the Department of Telecommunications for utilizing this service.

Use of dial-up modems

One can use any telemetry services to dial up individual AWS and get the data. This requires wired connection to all the AWS and we cannot dial up all the stations at a time and receive the data in time to host the data in the web. One has to schedule the job of automatic dialing and in the case of failure of telemetry network one has to reconfigure and redial to get all the data. It is practically very difficult to dial all the AWS every hour in a large network like that established by Tamil Nadu Agricultural University to receive data in real time basis. Though wired connections to each of the AWS is difficult for telemetry connections, the cost per month will be around Rs.500/- per month for 24 calls per day. Communicating to all the stations at a time is difficult here ie if we need to issue instruction to the logger to change the recording time.

Use of Local Area Network and broadband

The Tamil Nadu government was interested in utilizing their TNSWAN for this purpose. The problem again to make wired connections to all the AWS is very difficult as it was planned to be established in rural areas in cropped environment. There is possibility that an Internet Service Provider can establish broadband connection for all the AWS, which requires wired connection. Though we may encounter with problems of damage with wired connections, the cost of broadband connectivity at the minimum is expected around Rs.500/- per month. Here two-way communication is possible and any type of modification between communication unit and receiving unit is possible.

Use of GSM SMS service

One can use the Global System for Mobile Communication (GSM), the wireless technology used for voice and data transfer to send SMS (Short Messaging Service) to the receiving unit. This may cost cheaper per message but there is possibility of clogging of receiving unit due to more SMS. Some time the SMS are not delivered in time, which may create problems in hosting the data in time. Again each SMS has to be read and the database has to be updated. Though there is possibilities for two-way communication the SMS will not be able to change the required configuration in the communication unit as it can be done through internet services.

Use of GSM-GPRS technology

GSM-GPRS (General Packet Radio Services) data transmission technology is optimized for "bursty" datacom services such as wireless Internet/intranet and multimedia services. It is also known as GSM-IP (Internet Protocol) because it will connect users directly to Internet Service Providers. One of the main benefits of this packet-switched technology is that users are always connected, always on-line, and may be charged only for the amount of data that is transported. Voice calls can be made simultaneously over GSM-IP while a data connection is operating. There may

be latency issues, which is the time taken for data packets to pass through the GPRS bearer, normally measured as a round-trip time. Theoretically, GPRS can offer a maximum transmission rate in excess of 115Kbps and real-world throughput is around 20 to 50 Kbps. The GSM also uses TDMA technology, but the overlay of GPRS on GSM makes it as reliable a cheaper data transmission technique.

The EDGE (Enhanced Data Rate for Global Evolution), is another GSM technology for Global Internet Connectivity. This technology provides data transmission rate of 384 Kbps nearly three times over GSM-GPRS. Now we have the third generation 3G mobile technologies after 2G, based on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications programme, "IMT-2000". This technology enables network operators to offer broadband wireless data in a mobile environment and the expected data transfer is 5-10 Mbps.

Use of CDMA

The Code Division Multiple Access (CDMA) is another wireless mobile technology allows simultaneous conversations and the provider can handle more subscribers. The extended reach offers an opportunity to reach subscribers in rural packets. The major disadvantage is the lack of international roaming as the CDMA is mostly available in Asia and North America and not in other countries. The availability of Subscriber Identity Modules (SIM), which are smart cards that provide secure data encryption give GSM a commercial advantage.

Utility of GSM for weather based agricultural services

a. Real time AWS data transmission

After a thorough analysis of different communication systems we have narrowed down to the GSM wireless connectivity because of its denser network in Tamil Nadu. The cost of operation also cheaper as it is ranged from Rs.100 to 200 per month per AWS. The communication device used to transmit the data will cost less than Rs.10,000/-. Unlike satellite technology this offers two-way communications, which enabled us to contact each of the AWS units separately, or all the units at a time.

In the case of network failure the communication device can be configured to store the data from the logger and upon the service got resumed it can send the data to the server. In fact there are two storage devices in the AWS unit viz., the logger and the communication device. We were able to display AWS data from various parts of Tamil Nadu on real time with this technology in the website tawn.tnau.ac.in. On can see the data for the hour within 2-3 minutes on the top of the hour, which is not, practiced nowhere in India.

b. Monitoring the observation traffic

The failure of AWS in data transmission and the status of failure of sensors as monitored by server could be passed on to individuals' incharge of AWS units to take immediate steps to rectify the defects if any in the AWS units.

c. For utilizing weather information

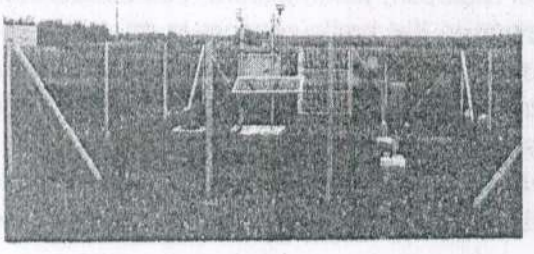
The observed weather data can be transmitted to the required people like Agricultural Officers, farmers or scientists either from the individual units or from the server is possible. Instantaneous SMS can be sent to reach all of them in real time so that each one can plan their activities based on weather. Under the present wireless communication scenario, most of the farmers of Tamil Nadu posses mobile units which can also be utilized to their benefits. Agricultural officers and scientists can develop weather based agro advisories and pass on to the farmers through GSM, so that farmers can take timely management and benefit from such advice.

Possible other uses

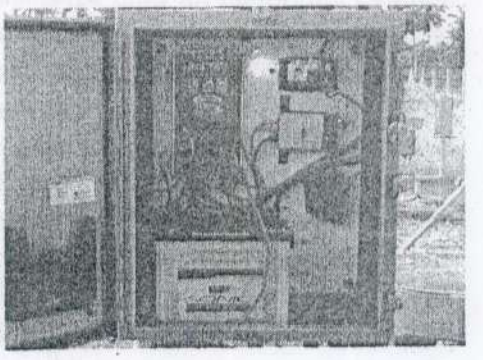
a. Farmers can be provided with market information, for which TNAU has already taken initiative to provide this information to the registered farmers under a separate project.

b. There are plans to setup an agricultural network to cater to the needs of farmers, which can provide technologies to the farmers periodically. Farmers can get clarified their doubts by sending queries to the network and even mobiles can be configured to send photos of diseased or pest infested crops and get remedies.

c. Similarly the hydrological information like water availability in tanks and dams besides flood information can be passed on to required individuals for appropriate measures.



GPRS AWS site at Kinnathukadavu, Coimbatore Dt.



Set-up of datalogger and GSM module

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VARIABILITY IN RAINFALL RECORDED BY AWSs IN CHENNAI AND NEIGHBOURHOOD DURING NORTHEAST MONSOON-2010

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Introduction

Under the modernisation plan of India Meteorological Department(IMD), satellite-based Automatic Weather Stations (AWS) are being installed in a phased manner all over India. During the year 2007, 35 AWS were installed in the southern states, under Regional Meteorological Centre(RMC), Chennai. These AWS transmit to the INSAT-3A satellite using Pseudo Random Burst Sequence(PRBS) Technique. During the year 2010, 70 more AWS which includes 30 Agro AWS were commissioned and transmit hourly data to the INSAT-3A, using Time Division Multiple Access(TDMA) Technique.

AWS around Chennai

One AWS installed during the year 2007 is co-located with the surface meteorological observatory at Nungambakkam(NBK), Chennai. For the first time, an Agro AWS was commissioned at Madhavaram(MDV), 15 km north of Chennai during Sep 2010. An AWS at Ennore(ENN) was also commissioned in Oct 2010. In all, three AWS as shown in Fig.1 provide data which serve as crucial inputs on the urban variation in meteorological parameters. A surface observatory exists at Meenambakkam, Chennai also.

Fig.1 AWS in and around Chennai

Parameters measured by AWS

Automatic Weather Stations use state-of-art data logger and transmitter with sensors interfaced for data sampling and recording of meteorological parameters. Sensors for Air Temperature, Relative Humidity, Atmospheric Pressure, Rainfall, Wind Speed and Wind Direction are interfaced with AWS. Agro AWS have sensors for global radiation, soil moisture, soil temperature, leaf temperature and leaf wetness in addition to the basic sensors in an AWS. Soil moisture measurement is done at 20 cm depth. Soil temperature is measured at two depths 5 cm and 20 cm. Fig.2 is the Agro AWS site at Madhavaram. As on 15 June 2011, there are 105 AWS in RMC Chennai region. The break-up of the number of AWS in each State is given in Table 1. In addition, 15 ISRO-type of AWS are also planned for installation, 14 in Tamil Nadu and one in Kerala, by the end of year

2011. All the AWS have their timings synchronised to the Global Positioning System(GPS) satellites.

Table 1
Number of AWS in RMC Chennai region (as on 15 June 2011)

State	PRBS AWS (installed during 2007)	TDMA (installed during 2010)	
		AWS	Agro AWS
Tamil Nadu	9	9	8
Pondicherry(UT)	2	0	0
Andhra Pradesh	13	14	8
Karnataka	5	13	8
Kerala	5	4	6
Lakshadweep (UT)	1	0	0
Total (Each type)	35	40	30
Total (AWS + Agro AWS) = 105			

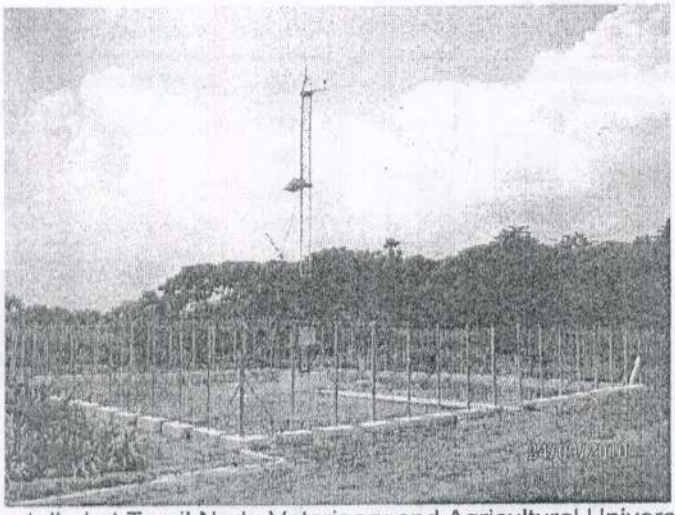

Fig.2 Agro AWS installed at Tamil Nadu Veterinary and Agricultural University, Madhavaram, near Chennai, Tamil Nadu

PRBS and TDMA-type of AWS

PRBS-type AWS transmit the 422-bit data in UHF frequency of 402.75 MHz, every hour in their allocated time slots at the rate of 4.8 kbps. The data is received by the Data Relay Transponder (DRT) of the geostationary satellite INSAT-3A and is retransmitted to the Central Receiving Earth Station located at Pashan, Pune. In PRBS-type, a maximum of 400 AWS can be accommodated for transmission using a single frequency. In TDMA-type of AWS, each AWS has a unique time stamping of 1 sec at which it transmits the hourly data to the satellite. The frequency of uplink for TDMA AWS is 402.74 MHz for AWS. The downlink frequency is 4503.24 MHz for PRBS AWS and 4504.19 MHz for TDMA AWS. Advantage of TDMA is that more number of AWS can be accommodated in one carrier frequency. IN TDMA technique, maximum of 3600 AWS (1 hour = 60 minutes x 60 sec = 3600 sec) with no repeat transmission and 1800 AWS with one repeat transmission can be uplinked. Less transmission power is required and data loss is minimized. Reliability of data reception and better data quality can be ensured.

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 the Automatic Message Switching System(AMSS), Mumbai via ftp through 64 kbps leased line which is then uploaded to the Global Telecommunication System (GTS). The AWS data are available in IMD web site http://www.imd.gov.in/. An exclusive web site http://www.imdaws.com is now available for the users to monitor and use the AWS data in real time.

Rainfall during northeast monsoon (NEM) - 2010

In view of the recent installation of AWS in MDV and ENN, which were hitherto meteorologically unrepresented, rainfall data could be obtained during the northeast monsoon season of the year 2010 from suburban Chennai city. Four years of rainfall data (2007-2010) obtained from AWS at NBK has already been validated and that of the northeast monsoon season (Oct-Dec) is provided in Fig.3. It is seen that the rainfall amount realised shows a decreasing trend from 2008 to 2010. The normal rainfall of NBK based on the period 1969-2009 for the NEM season is 859.6 mm. The seasonal total rainfall recorded by the AWS and observatories around Chennai is given in Table 2.

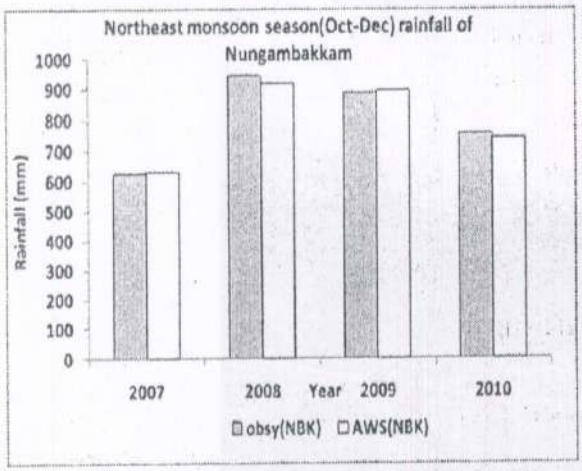

Fig.3 Rainfall of Chennai city (2007-2010)

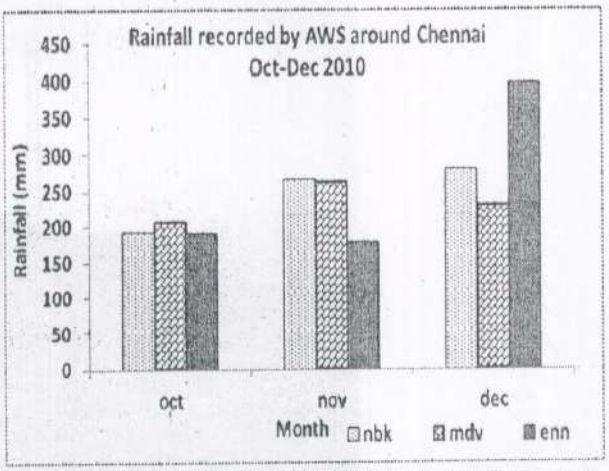

Fig.4 Rain recorded by AWS around Chennai

Table 2

Seasonal total of NEM rainfall (Oct-Dec 2010)

No.	Station	Rainfall (mm)
1.	Chennai Nungambakkam observatory	757.1
2.	AWS at Nungambakkam	740.5
3.	Meenambakkam observatory	660.1
4.	AWS Madhavaram	700
5.	AWS Ennore	766

The rainfall of MDV was almost the same as NBK and ENN during Oct and more than that of ENN in Nov whereas ENN recorded comparatively more rainfall than that of NBK and MDV during Dec 2010 which is evident from Fig.4.

Variability in AWS hourly rainfall

In order to analyse the hour(UTC) at which maximum rainfall occurred around Chennai city during the northeast monsoon season, the mean rainfall of each of the hours for Oct, Nov and Dec was computed and is graphically shown in Fig.5. The mean maximum rainfall / UTC of occurrence was 1.7 mm / 23 UTC, 1.4 mm / 20 UTC and 2.0 mm / 21 UTC respectively for NBK, MDV and ENN during October. Similarly, for November it was 1.5 mm / 06 UTC, 1.2 mm / 12 UTC and 1.4 mm / 11 UTC and for December 1.1 mm / 00Z, 0.6 mm / 12&16 UTCs and 1.4 mm / 12 UTC.

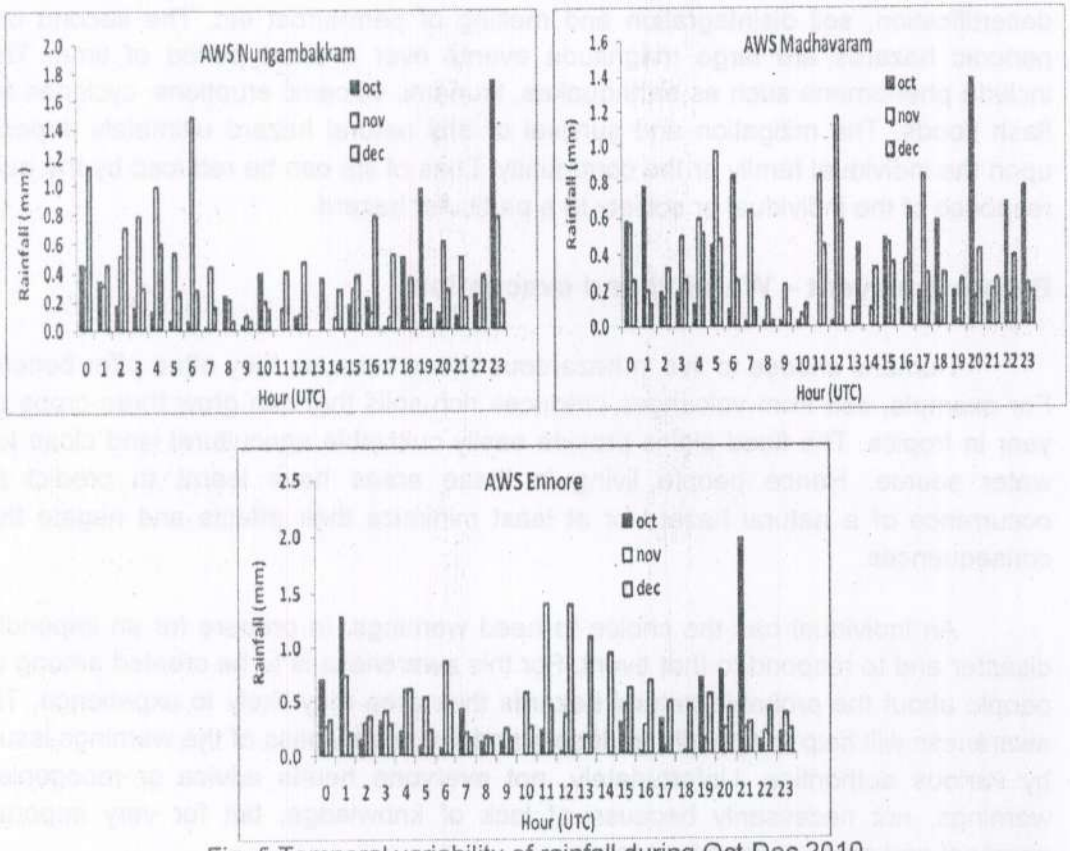

Fig. 5 Temporal variability of rainfall during Oct-Dec 2010

During Oct, rain occurred during early morning and late night in all the three AWS and in Nov rainfall was more during day time and well-distributed among all hours under the influence of a cyclonic storm activity and due to the low pressure in the Bay of Bengal. In December, rain has occurred in the evening and early morning hours. Seasonal characteristics of rainfall during NEM, as per climatology, has been captured by the AWS in and around Chennai city. The significant spatial variability in rainfall of three stations located at the vertices of a spatial triangle separated by 15-30 km from each other needs to be studied in-depth, not only in the urban context but also on the basis of terrain and location-specific aspects.

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SOCIAL IMPACTS OF NATURAL HAZARDS

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Natural Hazards

If we say – "People live in a hostile environment over which they have very little control" – then, it may not be totally untrue. Each day, one part or the other in the world suffers a calamity. Calamities are "acts of God", events that make headlines on the 24x7 news channels, events that you might wish on your worst enemy, but, would never want to witness yourself. Natural Calamities/Hazards can be broadly classified in to two groups. The first, chronic hazards, would include desertification, soil disintegration and melting of permafrost etc. The second one, periodic hazards are large magnitude events over a short period of time. They include phenomena such as earthquakes, tsunami, volcanic eruptions, cyclones and flash floods. The mitigation and survival of any natural hazard ultimately depends upon the individual family or the community. Loss of life can be reduced by the quick response of the individual or society to a particular hazard.

Before the event – Warning and evacuation

Humans choose to live in hazardous areas because they often offer benefits. For example, ash from volcanoes produces rich soils that can grow three crops per year in tropics. The flood plains provide easily cultivable agricultural land close to a water source. Hence people living in these areas have learnt to predict the occurrence of a natural hazard or at least minimize their effects and negate their consequences.

An individual has the choice to heed warnings, to prepare for an impending disaster and to respond to that event. For this awareness is to be created among the people about the probable natural hazards their area may likely to experience. This awareness will help the people to understand the seriousness of the warnings issued by various authorities. Unfortunately, not everyone heeds advice or recogonises warnings, not necessarily because of lack of knowledge, but for very important personal and socio economic reasons.

Poor people living in the coastal area of our nation would be hesitant to move out of their dwellings because of the fear that they may loose the place permanently. "**Why should I move? I have nothing to lose**" is also an attitude among the people. Sometimes a warning of imminent disaster can invoke a casual reaction bordering on disregard. A non-evacuation reaction may be macho based bravado, a public display of fearlessness or a religious taboo or peer-group pressure. (If you are the only one to evacuate in your surroundings, then you may be ridiculed or made to look silly, this is peer-group pressure). The '**Cry Wolf**' syndrome sometimes make people disregard the warnings on an impending disaster.

Dealing with the event and its aftermath

Large / Medium scale weather events can predicted well in advance, thanks to the modern computing systems, satellites, radars, automatic weather stations etc. Reaching out to the general public through government authorities, audio, visual and print media is now very much possible. The general instinct of the people is to protect their own family first and then help others. One of the immediate aspects of a disaster is coping with the injured and dead. The dead have to be identified and the same is the case of cattle, because these involve the issue of government compensation. While rescue operations tend to take precedence over coping with dead, dead bodies pose serious problems, both hygienically and legally.

While the death of close family may seem to be the worst outcome of a disaster, the destruction of property may leave longer-lasting scars. Priceless possessions viz. certificates, dress materials, important photographs, trophies etc. cannot be compensated. In a country like India even losing ration card is losing one's own identity. On seeing their destructed home often people tend to get angry with Weather Department for not providing effective warnings or government for not providing proper shelters. Also there is the problem of anti-social behavior like looting etc. Visit of dignitaries to the affected area may also pose a problem to the relief work. After the event the people would like to go back and resettle in the same place they were living beforehand. This is another problem to tackle.

Finally, it should be understood that human beings are very resilient and apt at surviving and in particular, are gifted with the capability to cope with disasters. They have a remarkable ability during calamities to rescue, survive and recover from such events.

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REPORT ON THE COMPETITIONS CONDUCTED FOR SCHOOL CHILDREN

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As part of continuing efforts to popularise the science of meteorology and kindle interest in the subject amongst the youth, quiz and essay competitions were held for school students. English essay competition was conducted for students of Stds.IX-XII on the topic "**Alternate Energy Resources**" on 03 Aug 2010 in which 12 students from 7 city schools participated.[Good Earth School (2 students),Gill Adarsh Matriculation Higher Secondary School (1), Maharishi Vidya Mandir (2),SBOA School & Junior College (2),Sri Sankara Senior Secondary school (2),St.John's International Residential School (2), St.Matthias Anglo Indian Higher Secondary School (1)].

Officers of Regional Meteorological Centre, Chennai, Shri E.Kulandaivelu, Director, Shri P.S.Kannan, and Ms.B.Amudha, both Meteorologist Gr.Is, served in the panel of judges.

The following students from the schools in Chennai were adjudged as winners:

S.JANANI, XI Std.	SBOA School and Junior College	I Prize
K.ASHWIN, XII Std	St. Matthias Anglo Indian Higher Secondary School	II Prize
H.PRIYANKA, X Std	Good Earth School	III Prize
R.ANSHUL, X Std	Sri Sankara Senior Secondary School	Consolation Prize

A quiz in meteorology was conducted on 11 Aug 2010 in which 7 teams (of 2 students each) participated from 7 city schools. The schools are : 1) Sri Sankara Senior Secondary School, 2) Padma Seshadri Bala Bhavan Sr Sec School, 3)Kaligai Ranganathan Montford Mat. Hr. Sec. School, 4)Maharishi Vidya Mandir, 5)S.B.O.A School & Junior College, 6)DAV Boys' Sr. Sec. School and 7) St.John's International Residential School.

Dr.S.R.Ramanan, Scientist-E, RMC Chennai was the Quiz Master, Ms.B.Amudha, Meteorologist Gr.I, the Scorer and Smt.V.Radhika Rani, Scientific Assistant, the Time Keeper.

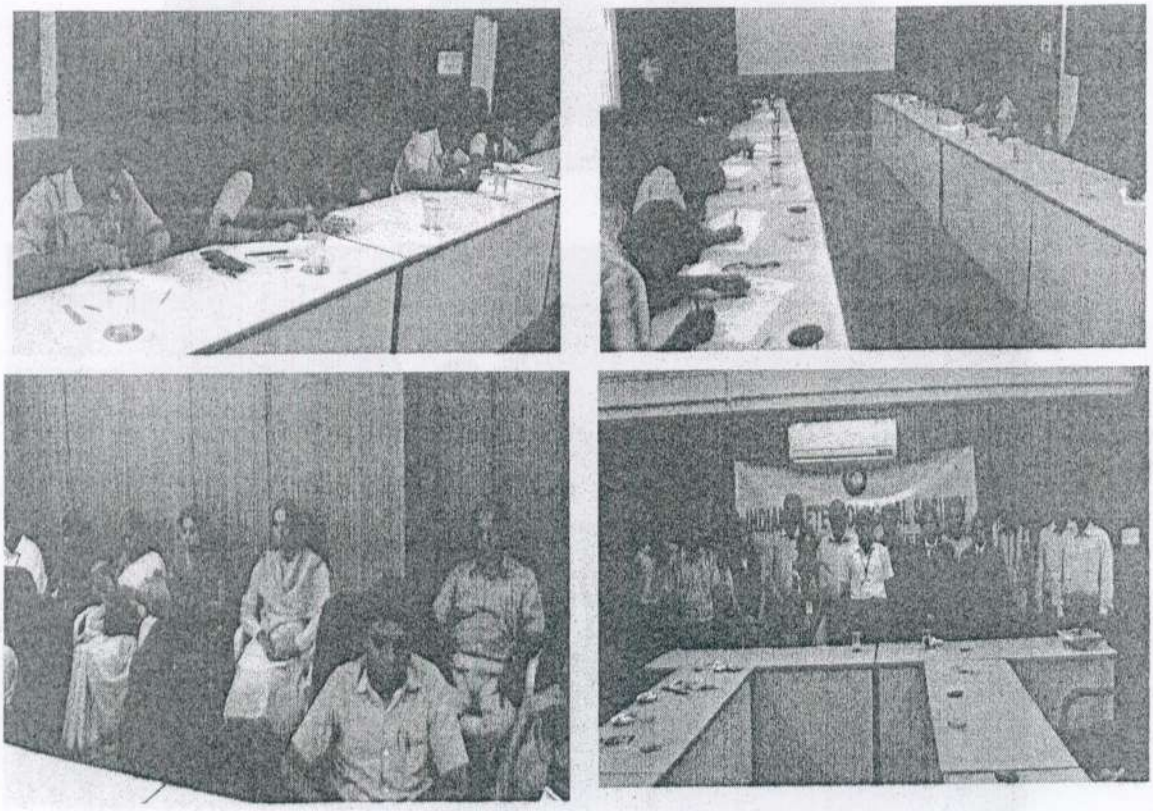
The winners were :

Padma Seshadri Bala Bhavan Sr Sec School – I Prize
S.B.O.A School & Junior College – II Prize
DAV Boys' Sr. Sec. School – III Prize
Sri Sankara Senior Secondary School – Consolation Prize

A prize distribution function was held on 11 Aug 2010 in which all winners were given trophies. Participation certificates were given to all participants. Feedback from various schools was very encouraging. IMS, Chennai Chapter thanks all the schools which nominated their students. Hearty congratulations to the winners and appreciation to all participants for their keen interest and active response.

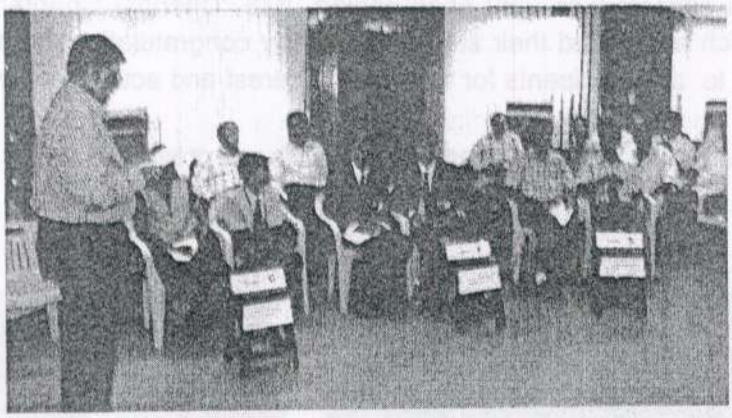
A few photographs covering these events are presented below.

Photographs covering the events



During the Essay competition…

During the quiz competition …



Quiz master in action …

The prize winners along with Secretary, Dy.Director General of Meteorology, RMC Chennai and the Quiz Master

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SOME QUESTIONS FROM THE QUIZ IN METEOROLOGY

(conducted on 11 Aug 2010 for school students)

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1. *What are the winds called that cause heavy rainy summers and dry winters in India and Southeast Asia?*

   It is the Monsoons. Monsoons are worldwide winds, not just local to Southeast Asia and India, where they are just more intense. They are caused by the differential in the temperature of the water of the oceans and the temperature of the land masses.

2. *What is the line on a weather chart which joins points of equal pressure?*

   Isobar. The term first appeared around 1864, and is from the Greek word isobars meaning 'of equal weight'.

3. *Who invented the mercury thermometer?*

   Daniel Gabriel Fahrenheit (1714 - Fahrenheit was German but worked mostly in the Dutch Republic. Galileo Galilee actually first devised the thermometer principle using water in 1593.)

4. *Okta is a unit of measurement of what?*

   Cloud cover (according to the UN's weather and climate agency, the World Meteorological Organization, an Okta is a "Fraction equal to one eighth of the celestial dome, used in the coding of cloud amount." The scale is actually made of nine parts because there is a zero, and ranges from 0 okta - clear sky, to 8 oktas - completely overcast.

5. *Treasure Island author Robert Louis Stevenson's father was responsible for what significant weather-related invention?*

   The Stevenson Screen. It is a white wooden box used for protecting weather instruments and to increase the consistency of measurements.

6. *What common term refers to the movement of air from a high pressure to a low pressure zone?*

   Wind (first recorded in this form in AD725 in the Anglo-Saxon epic poem Beowulf, and traceable along with similar sounding foreign equivalent words for wind back to the earliest languages of European settlers)

7. *What's the more exotic name of the 'Northern Lights' visible under certain conditions in the Northern Hemisphere night sky?*

Aurora Borealis (the Southern Hemisphere equivalent is the Aurora Australis - both North and South phenomena result from atoms colliding in the upper atmosphere, becoming energised and then giving off their energy as light, the colour of which varies according to the atomic gases and altitudes involved.)

8. *What is an "Andhi"?*

A sandstorm (a Andhi is a big sandstorm, most common in the thar desert of Rajasthan , but also occurring in Sahara and Arab peninsula. typically following thunderstorms or during period of strong pressure gradients)

9. *What is the childlike name given to the significant weather activity linked to sea temperature rise in the Pacific Ocean?*

El Nino (properly 'Niño' and pronounced 'neenyo' - it means 'the little boy', or 'Christ child', and causes severe weather of various sorts notably in South America and the Western Pacific region) (thanks R Hannah)

10. *What are the narrow bands of strong winds called which move around the world between about six and twelve miles high?*

Jet Streams (Airlines make use of jet streams to optimise travel times, although this has nothing to do with the word jet in this context, which derives ultimately from the Latin root jectare, to throw forth, which gave us the words project and projectile, and came to English via the French jeter, to throw)

11. *Towards which direction (North, East, South or West) is a rainbow normally seen in the afternoon?*

East (because sunlight is usually from behind the viewer - so morning rainbows are normally in the West - sun rises in the East and sets in the West)

12. *What is the significance of March 21st?*

In Equator the sun's rays directly strike the earth's surface twice each year. It is on the March 21st and again on September 21st. On that day, hours of night and day would be equal (spring and vernal equinox), for places closer to equator.

13. *What does the word "Doldrums" mean in Meteorology?*

It means the 'Inter-tropical Convergence Zone', where the trade winds meet near the equator, to produce a band of relatively very still air, which can strand sailing ships. The same convergence also creates heavy rainfall which on land is partly responsible for the rain forests.

14. *What is the most common gas in the earth's atmosphere?*

Nitrogen (accounting for about 78%, followed by about 20% Oxygen, and relatively far smaller amounts of other gases including Argon, Carbon Dioxide, Neon, Methane, Helium, Ozone and water vapour)

15. *What is minus 40 degrees in meteorology?*

-40 degree Fahrenheit and Centigrade/Celsius are same. It is also known as Schaffer point and no super cooled water can exist at this temperature.

16. *What is the most highly variable gas in our atmosphere (i.e., which gas's concentration fluctuates the most in time and space)?*

Water vapour is by far the most variable gas in the earth's atmosphere.

17. *Why is the sky blue?*

Scattering of solar radiation is most effective in blue region and is due to Rayleigh scattering. Since individual air molecules are considerably smaller than the wavelength of visible light passing through the atmosphere, scattering in the Rayleigh region predominately occurs.

18. *What is the zone of weather also known as?*

It is the troposphere. The troposphere extends up to about 18,000 feet. You're standing on the lithosphere.

19. *What do isohyets represent?*

"A line of equal rainfall". One can see isohyets on a rainfall map/chart.

20. *Zulu time is the time if you were in what area?*

Greenwich, England.

21. *What weather-related reason is the leading cause of aircraft accidents?*

"Downbursts (Microbursts)". Inside a thunderstorm, there are strong winds. These very intense downward winds are called downbursts-or the smaller version microbursts.

22. *Like Fathers day, Mothers day and Teachers day, which is the important day for meteorological services?*

It is the World Meteorological Day celebrated on 23 March, every year.

23. *What is a "kal baishakhi"?*

It is violent thunderstorm activity during pre monsoon season in North east India.

24. *What causes maximum loss of human life during very severe Cyclones?*

It is the storm-surge. Water that is pushed up onto otherwise dry land by onshore winds is called storm-surge. Friction between the water and the moving air creates drag that can build the surge up to depths greater than 20 feet.

25. *If caught outside during a thunderstorm activity, which is the safest place to take shelter?*

The best place is either a house or the car.

26. *In a house in Chennai, a south facing window or balcony is preferred. Why?*

The sea breeze, after it sets in, changes its direction to south easterly/southerly due to coriolis force caused by earth's rotation and reduces the discomfort causes due to oppressive heat.

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ALTERNATE ENERGY RESOURCES

(This essay was awarded the First Prize in the competition held on 3 Aug 2010)

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Preface – Why need alternative energy

Are you one of those who put out 10,000 holiday lamps in the chilly Christmas eve? Or are you one of those who keep their air conditioner cold enough to have frozen nights in summer or are you simply one among those who love the modern electric convenience? Then, you really need to be worried on how the nation will generate power for the future.

Are we in no danger of running out of coal? We have known for decades that our survival depends on finding new sources of energy. Yet, we worship coal mines, don't we? We can have any number of thermal power plants or nuclear plants. But, the reality ? The **pollution and safety impacts** of these technologies compel us to forecast their demises too.

Demises of current power generating technologies

Thermal power plants emit **sulphur** and **carbon monoxide** among the other pollutants they release. These have done only one thing in unity – causing scars – both on man and on the environment.

Nuclear plants must be better, then? nuclear plants are very clean in terms of emissions. They don't even release **carbon monoxide**, the most common pollutant known to man. But let us not forget that the disposal of radioactive wastes still remain as a "**scarlet mystery**"

"Necessity is the mother of invention"

So, where do we look in for electricity in the future? Where do we go? What do we do? Sometimes, it is true that adversity leads to necessity, necessity leads to knowledge and knowledge brings inventions. We need to make studies towards cleaner technologies like **wind, solar, wave, etc.**

Alternative energy – a boon

People have be harnessing the power of alternative energy for centuries together. For instance, the light upon the power of wind is never thrown until it turns out as a **tornado** ! So is solar and tidal energy.

Alternative energy is **appealing** for several reasons it is abundant, cheap, inexhaustible, widely distributed, climate venign – a set of attributes that no

technology would match. And also, they are **cost effective.** Once you get cheap electricity, money could be spent on infrastructural development which is very essential for a country like India we cannot conserve on our way to **energy independence** ---- can we conserve on our way of having enough energy available. Therefore, we have to do both.

Having a power generation of 54% from thermal power and less than 8% from renewable source, India, really needs to turn its prospect towards alternative energy.

Wind power

Wind power refers to the conversion of wind energy into any useful form of energy like **wind turbines** for power generation, **wind pumps** for water drainage, **wind sails** for transport etc. India stands **5th** in the production of wind power. It gets about **10,925 MW** per year. The development in India started only in 1990s, but it is making significant development in the recent years.

Barriers of wind power

The disadvantages of wind powers are minor. There has always been a issue of the noise produced by the blades. But, with careful planting and advancement in technology, this could no longer be considered as a **eyesore**. Moreover we only receive an output of 1.6% of the estimated 6.8%. This is because the government policies are geared more towards its installation not its operation. Basically the barriers for the widespread of wind power are not technical but political.

Solar energy

The radiant heat and light from the sun are harnessed by the humans science ancient times using a range of ever evolving technologies. Only a minuscule fraction of the energy is being utilized. Their application however has a wide scope like architecture, agriculture, horticulture, transport, power generation, house hold etc.

Setbacks of solar energy

Through India lies in the tropical zone and has always been sunny, it suffers from setbacks. Primarily, the cost involved in setting up these are a little expensive. Secondly, the occupy comparatively larger areas. Moreover, pollution detoriates the photovoltatic cells. And also, these cells could perform only when there is sunshine. To overcome this, solar operated rechargeable batteries are used in the night. Above all, we get only a functional output of 98.4 MV from the estimated capacity of 13,242.18 MV. This accounts to about less than one percent.

Geothermal energy

This method is not widely used but has great potentiality for India. The reason behind this is that we have got geysers and hot springs in the northern part of India. India, therefore, should utilize this rare yet potential source of energy.

Wave power

Wave power derives energy from ocean surface waves and is very often misconcepted as "TIDAL ENERGY". Wave energy, again can influences India to a great extent as the mainland is covered by water on three sides.

Tidal energy

This is one of the oldest methods of production of energy though widely not used. Historical evidences traces back to the early 400s where tidal energy was widely used by the Romans. In this method, energy is derived from high tides. This type of production of electricity may lead to the death of various fishes and prawns that also get trapped during tides. Research, however, is on to have a check over the mortality of fishes.

In world "standards"

Almost every country in the world seems to realize the power of alternative energy. From the superpowers to the underdeveloped nations, everybody is into this race.

- ✓ United Kingdom, satisfies the needs of 10 million by alternative source of energy.
- ✓ Tiny Denmark gets an impressive 20% from alternative energy.
- ✓ Germany overtook USA in the production of alternative energy in 1997.
- ✓ Spain is also closing in.

Every nation has realised that no one is neither against conservation nor innovation and introduction of new technologies.

Need for awakening in India

With India still researching alternative energy, the need for alternative energy its comfortably in the pockets of Indians every time they receive the electricity bills or get their vehicle fueled.

Lester Brown, Founder and President of the Earth Policy Institute has remarked in his latest book "Rescue of the planet by alternative energy" that India is one of the most influential countries because of India's peculiar yet appealing topography.

Interface – The ultimatum

Still, there are many "naysayers" who call it "silly" to blanket our nation with "windmills" and "solar sheets" ! But, won't it be equally silly to leave the current power generating technologies blanket our nation with pollution?

The pessimism in them makes them see things and ask "Why?" but the optimism in us should make us look into things and say "why not?".

All we need is an awakening.
A cleaner one, a greener one.
A noble one, a global one.

JF KENNEDY once said, ***"All men can prosper if they can invoke the pleasure of science, rather than its terrors!!"***

Need I say more ?

And, isn't it always better to stop something that isn't working to get what we want ?

Will the present generation awaken? Well, the day cannot be far !!

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NEAR RECORD NORTHEAST MONSOON RAINFALL OF KERALA AND RECORD NORTHEAST MONSOON RAINFALL IN MOST SOUTHERN DISTRICTS OF KERALA IN 2010

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The period October to December is known as the northeast monsoon season of Kerala. Though the northeast monsoon starts in the middle of October but the rainfall for the season is accounted from 1 October. During the months October, November and December Kerala gets a normal rainfall of 29.2 cm, 16.4 cm and 4.3 cm respectively, thus totalling to a rainfall of 49.9 cm for the northeast monsoon which is about 16 % of the annual rainfall and about 24 % of the southwest monsoon rainfall. The beneficiary of the northeast monsoon is mainly the southern peninsula comprising of Tamil Nadu, Kerala, Coastal Andhra Pradesh and Karnataka. The normal rainfall for the northeast monsoon for Kerala is 49.9 cm, for Tamil Nadu it is 43.2 cm and for Coastal Andhra Pradesh it is 32.6 cm. It may be noted that Kerala gets slightly higher northeast monsoon rainfall than Tamil Nadu.

A look at the northeast monsoon rainfall of Kerala shows that during the period 1901-2009 the highest northeast monsoon rainfall of Kerala was received in the year 1932 with a rainfall amount of 83.5 cm while the lowest northeast monsoon rainfall was recorded in the year 1988 with rainfall amount of 18.0 cm. During the period 1901 -2009 the northeast monsoon rainfall of Kerala was normal in 58 years, excess in 21 years, deficient in 28 years and scanty in two years in 1974 and 1988. There were 6 years of deficient rainfall in the decade 1981-1990.

A look at the decadal average of Northeast monsoon rainfall of Kerala during the period 1901 -2000 shows that the highest northeast monsoon rainfall of Kerala was received in the decade1911 – 1920 with a rainfall of 59.6 cm and the lowest Northeast monsoon rainfall of 42.3 cm in the decade 1981 – 1990. A frequency distribution of northeast monsoon season rainfall of Kerala during the period 1901-2009 is given below.

In the year 2010 northeast monsoon Kerala received a rainfall of 82.6 cm as against a normal of 49.9 cm. and it is very close to the highest northeast monsoon rainfall of 83.5 cm ever received in the year 1932 since 1901.Tamil Nadu, Coastal Andhra Pradesh, Coastal Karnataka and South Interior Karnataka too received excellent rainfall in the northeast monsoon with 61.2,57.4,59.0 and 33.2 cm as against a normal of 43.1, 32.7, 25.8 and 20.1 cm respectively thus recording excess northeast monsoon rainfall. The excess rainfall of northeast monsoon in southern peninsula caused havoc for farmers in Tamil Nadu, South Kerala and coastal Andhra Pradesh causing crores of loss of paddy and other agricultural crops. Almost all the tanks and lakes in the southern peninsula seemed to have got filled up in this year's northeast monsoon rainfall.

Rainfall (in cm)	Number of years
0.1 – 10.0	0
10.1 – 20.0	1
20.1 – 30.0	4
30.1 - 40.0	20
40.1 - 50.0	25
50.1 – 60.0	25
60.0 - 70.0	24
70.1 - 80.0	8
80.1 – 90.0	2
Total	109

Districtwise weekly rainfall reports have been started from 1976 by India Meteorological Department and as per district wise weekly rainfall report of Kerala for the northeast monsoon the four districts Ernakulam, Kollam, Kottayam and Pathanamthitta recorded more than 100 cm of rain and the amounts are 120.4,101.1,111.3,and 107.0 cm as against the normal of 62.2,56.2,62.7 and 58.0 cm respectively. The northeast monsoon rainfall districtwise since 1976 shows that there have been hardly three occasions earlier when districtwise rainfall in northeast monsoon exceeded 100 cm. The details are Kollam district received 106.9 cm in 1992 and 113.9 cm in1987 while Trissur district received 128.3 cm the highest ever districtwise so far 128.3 cm in 1977.

It may be mentioned that Kerala received a rainfall of 80.3 cm in the northeast monsoon 1977 and the amount of 128.3 cm received by Trissur district in 1977 is the highest northeast monsoon rainfall received by any district since 1976 to till date. It is interesting to note that 4 districts received more than 100 cm in this year northeast monsoon 2010. It may be mentioned that out of the eight districts in South Kerala , five districts Thiruvananthapuram, Pathanamthitta , Kottayam, Alleppey and Ernakulam reported the highest ever northeast monsoon rainfall in this year 2010 with rainfall amounts of 92.9.1,107.0,111.3,96.1 and 120.4 cm respectively.

The highest northeast monsoon rainfall received in Kerala since 1901 is in the year 1932 with a rainfall amount of 83.5 cm. This year's rainfall of 82.6 cm is close to near record northeast monsoon rainfall thus becoming the second best. A look at the rainfall at the rainfall received by districts in South Kerala in 2010 shows that South Kerala received a northeast monsoon rainfall of average of 99.5 cm while north Kerala districts received an average rainfall of 63.3 cm showing that South Kerala received more than one and half times rainfall than that of North Kerala.

The most interesting thing abut this year's northeast monsoon is that normally North Kerala does not get much rainfall compared to South Kerala while this year uniformly entire Kerala got excellent northeast monsoon rainfall. In fact stations like Punalur, Kochi, and Kottayam received a rainfall of 121.9cm,1121cm, and 107.9 cm respectively in the northeast monsoon season of 2010. The excess rainfall of northeast monsoon has indeed created misery in inundating hundreds of acres of

paddy fields and damages to other agricultural crops in Tamil Nadu, Coastal Andhra Pradesh and also in Kerala.

The districts of Thiruvananthapuram and the adjoining Kanykumari district of Tamil Nadu were worsted affected by the very heavy rainfall that occurred in association with a depression which crossed south Andhra coast on 8th December 2010 morning causing land slip in the Trivandrum – Nagercoil railway line disrupting train services for about a week. Earlier a similar landslip occurred in Trivandrum – Nagercoil railway line on 4/5th November 1998 (during the first week of November 1998) when Trivandrum district and adjoining Kanykumari district was lashed by very heavy rainfall and thunderstorm on 4th /5th November 1998 and the train services between Trivandrum – Nagercoil was disrupted for about a month or so.

There have been only two years when Kerala had more than 80 cm of rainfall in the northeast monsoon season and the year and rainfall amount are 1977 with 80.3 cm and 1932 with 83.5 cm and thus this year's rainfall of 82.6 cm is the second highest and is very close to the record rainfall of 83.5 cm.

Studies have shown that Tamil Nadu gets normal to above normal rainfall in northeast monsoon season during La Nino phase as in the present case like this year. However no such study is available for Kerala as this is not the principal rainy season compared to the copious rainfall Kerala gets in the southwest monsoon season June to September.

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