Indian Meteorological Society, Chennai Chapter Newsletter

Vol.17, Issue No.2, Dec 2017 and
Vol.18, Issue No.1, June 2018

Contents

EDITORIAL BOARD

From the Chairman's Desk... ..

Dear members of IMS Chennai chapter and readers of BREEZE,

It is my pleasure to update the members / readers of Breeze about the recent activities of the IMS, Chennai Chapter (IMSCC) since the release of the previous issue of BREEZE dated June 2017 (Vol.17, Issue 1) in Oct 2017.

The following meetings were held.

i) Seminar on Monsoons 2017 on 28.02.2018 at RMC Chennai
ii) The Annual General Body Meeting on 15.05.2018. Election of office bearers for the biennial 2018-20 was also conducted.
iii) The first meeting of the members of the Local Council on 27.08.2018.
iv) Lecture on "Coastal and Marine Pollution" by Dr. Uma Shankar Panda, Scientist-E, National Centre for Coastal Research, Pallikaranai on 20.09.2018.

Bank formalities for operating the Savings Account of IMSCC by the Secretary and Treasurer of the Local Council of 2018-20 have been completed.

One new Life Member joined IMSCC. The list of members is being updated. Members of IMSCC are requested to mail their contact address, e-mail ID and phone number for updating the list.

My sincere thanks to all members who have contributed articles for this issue of BREEZE. I am optimistic that you will have the pleasure of reading. It is heartening to see that weather bloggers have enthusiastically contributed articles for this issue. In this centenary year of the birthday celebrations of Miss Anna Mani, retired Deputy Director General of Meteorology, India Meteorological Department(IMD), we have obtained a tribute from a retired senior officer (who does not wish to be named) of IMD. Another official from IMD, Pune has willingly contributed an article on moments spent with Miss Mani.

All members are requested to send articles for the forthcoming issue so that it can be released well ahead in time.

With best regards
R. Suresh, Chairman, IMS Chennai Chapter, Chennai
Dated: 20 Oct 2018.

Life Membership details of IMS Chennai Chapter (as on 12 Oct 2018): 151

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

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Kerala rain surplus and deficit

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This year 2018, Kerala got 34% excess rainfall from 1 June to 27 August. This is for the State as a whole and there may be differences in departures from district to district. But in recent years, concern has been expressed that SW Monsoon rainfall in Kerala is decreasing and 'drought" has been reported in some years.

According to our colleague R. Lakshminarayanan, 2012 was the year with the greatest deficit **(-24%)** up to that time since 1901. [See Breeze Vol.15, Issue No.1, June 2013]. But Lakshminarayanan again reported that 2016 was the worst deficit year, the departure of SW monsoon rainfall being **-34%.** (Breeze Vol.16, Issue No.2, Dec 2016). Larger negative departures are common in other States but for Kerala these deficits are considered serious.

It is to be mentioned that the NE monsoon rain in Kerala in 2016 was also in deficit by 62%. Rathore et al [STATE LEVEL CLIMATE CHANGE TRENDS IN INDIA, *Meteorological Monograph No. ESSO/IMD/ EMRC/ 02/2013 , By* L S Rathore, S D Attri and A K Jaswal, 2013] find that the SW Monsoon rain in Kerala has a negative trend of as high as **-2.42mm/year** for the period 1951-2010. This should certainly be of concern.

The term "**drought**" is being loosely used for referring to deficit rainfall. This is misleading and encourages authorities to blame it as an act of God instead of taking preparatory measures to manage water resources. Water scarcity is not the same as rain deficit. This has been discussed in detail in Breeze Vol.17, Issue No.1, Jun 2017.

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The magnificent Deepavali monsoon and the homecoming

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The fascination for long train journeys coupled with the obsession of soaking in the monsoon frenzy has been one regular feature which till date is an unforgettable feel and experience. Needless to say, it has left a lasting impression on me . A sort of a travelogue if I can call it, Train No.12163 and the monsoon chase of year 2005. Every single time the years spent in Bombay/ Navi Mumbai marked the unparalleled excitement which used to creep in unknowingly just at the thought of the magical rail journey to Madras (MAS). It was a sort of fondness to soak in the Deepavali festive mood coupled with getting swamped by the cool northeasterly winds and getting drenched in the unrelenting manic North East monsoon.

The probability of getting a confirmed berth in 12163 was riddled with more suspense than the monsoon itself as the journey was always few days ahead of the festival of lights. The magical feel of heading back to the city you had come from would start in all earnest, right from the time I stood in the long queue at the sprawling Vashi Railway station. In between all these chaotic thoughts, the mind would just give a breathing space to murmur few prayers and seek divine blessings to get a confirmed ticket. A huge sigh of relief the moment you see S 6 - 32, 33 & 34 printed in the rectangular piece of paper, a prized possession so to say.

The Journey day, cometh the hour, cometh the excitement....Yes, the day has arrived with luggage packed and ready, which was always on the lighter side in keeping with the often heard line "Less luggage more comfort". I would always prefer the Vashi- Wadala Road CR Harbour line train to evade the evening rush hour chaos to reach the station. Entering Platform No.7 will never be complete without a quick darshan of Lord Hanuman and Shridi Baba located just at the entrance of the station.

Walking through Platform No.7 was always a brisk affair in compliance with what eagerness is all about. Yes, S 6 coach is here at last to quell, dispel the frantic thoughts and nerves of reaching on time. The Turkish towel comes in handy to wipe off the sweat caused by the famous October heat & humidity of Mumbai and the hustle & bustle to reach the coach.

Its now time to adjust, squeeze the luggage beneath the seats hoping it will be safe till dawn. The start time is nearing. Its 1950 hours IST and the Deepavali monsoon journey begins. The first signs of Chai, Coffee is heard as

12163 crosses Matunga ever slow...slowly.. A hot cuppa coffee to relive the sensation along with a peevish look from my wife. I can read her mind. " kaapi kudikarthuku velai nerame kidayadhu, adhuvum indha sugar syrup pa yaavadhu kudiche aaganum"....Don't bother looking at her...Meanwhile, 12163 is on a roll, picks up well to zip pass Thane and heads towards the first scheduled stop Kalyan Jn. A hot Tomato soup just before Kalyan Jn. is always a routine. The train leaves Kalyan Jn. only to find the coach almost cramped for space by now.

Breath of fresh air as Karjat arrives. I still keep awake to find a vada pav vendor walk briskly past our coach. A quick bite before the journey marches on towards Lonavala. It is time to enjoy the cool climes of the hill station and buy a packet of the famous Lonavala Chikki. It is well past midnight and time to pull over the blanket and take rest.

Feeling fresh as I wake up at Wadi Jn. and its 7am. The train is running as per schedule. Can hear from the Tamizh speaking family say " Madras la nethi konjam mazhayaam.. Sounds good is it not... Now I eagerly await for the most sought after station in the day long journey, that is Guntakal.. It's almost lunch time and invariably you get some good tasty food here to satisfy the taste buds. The train chugs along to reach RU (Renigunta). It reaches on the dot at 5.30 pm and the dusk is settling in slowly. You turn around to look at the Seven hills (Sapthagiri) and offer a gentle prayer to Lord Balaji. 12163 leaves Renigunta and within no time it begins to sink in.... that extraordinary feel, warmth of your favorite city not that far off waiting to welcome you. The adrenaline is already on a high as the train leaves Tiruttani not before a quick glance at the hill temple.

Its AJJ now and the euphoric feel is immense as I hear the song " Oru Maalai " from the just released film Ghajni blasting from the road side speakers. Indeed, it is a wonderful evening, pleasant as the north easterly winds find their way inside the coach as we near Avadi. Smiles all around the coach, yes, we are so near, its striking distance only now. Excitement reaches the Zenith as 12163 enters MAS Central station . Wonderful journey of mixed emotions. Saying sort of a good bye to South West Monsoon and eager to say Hello to North East Monsoon.

It didn't take much of a time to soak in the splendid feel of a monsoon known to throw in lot of surprises. October 27, 2005. What a day it turned out to be.. Never imagined that monsoon can be so poetic. Indeed it was. Have never missed the "Aura" and the “Aroma” of Deepavali with our family and friends and it was a cracker of a routine every year. A visit to MAS is must during Deepavali to rejuvenate oneself. Needless to say the ever mysterious North East Monsoon added to the excitement.

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The quintessential weather soldier

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Since 2002, this ever faithful soul was cuddled, nourished , groomed in the best possible manner befitting a toddler, a new born (Neonat) would get. This young child understood the responsibilities at a such an young age and was aware and made sure that it can't even blink for a second . Thanks to the understanding parents and their unflinching support, this child was mature enough to imbibe all the qualities required to shine as a star, an angel year after year.

This child was very much aware of the enormous reputation it was bestowed upon and the demands of performance of the highest order. Years passed by the side but not the enthusiasm to fulfill its potential. It withstood challenges in many forms, be it maniac rains or the swirling winds.

This indefatigable soldier wouldn't give an inch or budge or cow down to tantrums thrown at him. Epitome of discipline and unmatched zeal. A Roger Federer' s longevity so to say.

It's understandable that expectations and the enormous work pressure was perhaps taking a toll on this soldier's broad shoulders.

A soldier will never put his foot down. We strongly believe him to march on and on and ahead.

Bravo, young son. You deserve all the accolades. We are with you.

(Name of the Soldier referred to is given in Page 27.

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Introduction to dust storms – A quick primer

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Dust storms – overview

Dust storms are common but disruptive hazards that occur in arid/semi-arid regions of the planet. Dust storms are formed when large amount of sand and dust are lifted from the dry surface and transported due to strong winds. Generally strong winds lift large amounts of sand and dust from bare, dry soil into the atmosphere, and transport them hundreds to thousands of kilometres away. Dust storms are known to cause significant damage in certain parts of the world. They could potentially cause damage to health and also damage the environment in a substantial scale.

How are dust storms formed?

The primary driver to dust transport is Wind. There are also other physical factors involved like saltation, creeping etc. which amplify the process. Before we examine how dust storms are formed, we also need the environment to be favourable for dust storms.

Some of the key aspects are:-

- Wind at low levels (high speeds, direction that favors high speeds and turbulence, occurrence over and direction away from dust sources)
- Regions with low precipitation
- Low relative humidity
- Low soil moisture due to lack of precipitation
- High temperature at surface and low level turbulence at low levels
- Little vegetation covering land surface
- Human disruption of land surfaces /desertification

Observing and forecasting dust storms

The primary driver to dust storms is the availability of dust source, prevalent in arid regions of the world. However, the climatology of the region plays a vital role in occurrences of dust storms. The dust availability and propagation can be different during different times of the year based on the region's climatic conditions. Dust storms in Sahara Desert peak in May while the maximum values of African dust storms shift northward from winter to summer. In Gobi Desert it peaks in March, April, though severe storms can occur from

spring through Autumn. Interestingly, the dust storms also collide with the highest precipitation and high temperature months in these regions.

Aeolian dust transport

Dust storms in other words are Aeolian turbidity currents. Air over deserts is cooled significantly when rain passes through it. This cooler and denser air sinks toward the desert surface. When it reaches the ground, the air is deflected forward and sweeps up surface debris in its turbulence as a dust storm. If we look at the simple processes around Aeolian dust transport, dust particles are transported by winds through Suspension, Saltation, and Surface Creep.

Suspension is lofting of particles by winds, especially turbulent winds. *Saltation* is the downwind movement of particles in a series of jumps and skips. *Surface Creep* is the forward and rolling movement of the heavier dust grains when saltation occurs.

Structures associated with Aeolian movement

Some of the structures that play a role in Aeolian transport are Sand Dunes, Sand Sheets, Ripples etc. These by themselves are a resultant of dust transport and hold the clue to the type of climatic conditions of a particular region. One key aspect to the dust availability is desertification of land, the desertification is a process which occurs naturally, however recently there has been a lot of human /man made desertification zones primarily due to overgrazing, timber cutting and poor farming methods etc.

Global spread of dust sources

Globally, the two most important dust source areas are in the Sahara Desert: the Bodélé depression in Chad and an area in the south-western region that encompasses Mali, Mauritania and Algeria. In addition, the Arabian Peninsula, Central Asia, desert basins in China and in central and southeastern Australia, the Mojave Desert, the Sonoran Desert, the Chihuahuan Desert, the Great Plains region of western North America and the Pampas and Patagonian regions of southern South America are well known Dust source regions.

A total of 151 countries (77 per cent of all parties to the United Nations Convention to Combat Desertification) are affected directly by sand and dust storms. Of them, 45 countries (23 %) are classified as sand and dust storm source areas, 44 countries (22 %) are sand and dust storm deposition areas, and 62 countries (32%) are affected by wind erosion. Most of the countries classified as source areas (38 of 45 countries, or 84 %) are in Africa and Asia (Middleton and Kang, 2017).

Sand and dust storms occur in the Middle East, northern China, South-West Asia and Australia and also Western North America and Southern South America. Of the more than 2 billion tons of dust emitted into the global atmosphere every year, the Sahara Desert in North Africa is the largest contributor, at ~1.43 billion tons as of 2012. The Asia-Pacific region is the second-largest dust emitter, at slightly more than half a billion tons per year (Akhlaq, Sheltami and Mouftah, 2012).

A dust storm was blowing large quantities of dust out over the Persian Gulf and Arabian Sea on Saturday, December13, 2003.
Image source :
https://eoimages.gsfc.nasa.gov/images/imagerecords/69000/69554/Pakistan.A2003347.0835.2km.jpg

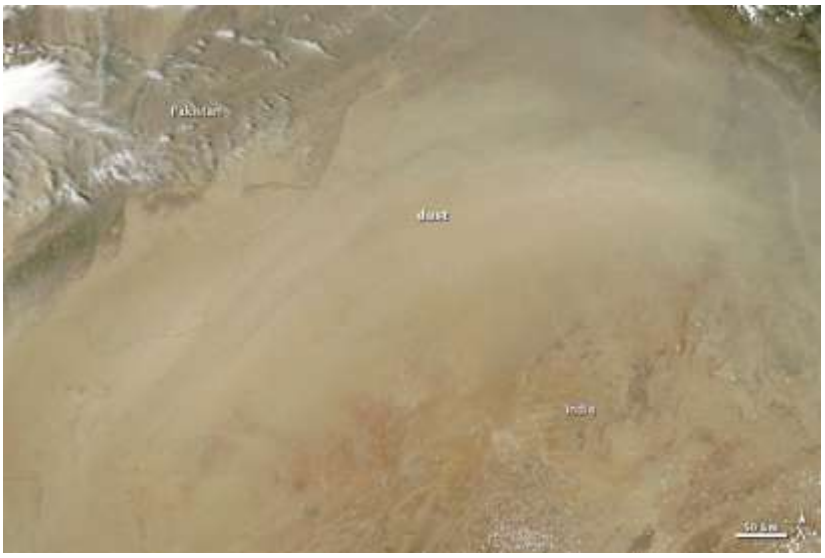
About half of the annual dust supply to the Amazon basin is emitted from a single source: the Bodélé depression located northeast of Lake Chad, approximately 0.5% of the size of the Amazon or 0.2% of the Sahara. Placed in a narrow path between two mountain chains that direct and accelerate the surface winds over the depression, the Bodélé emits dust on 40% of the winter days, averaging more than 0.7 million tons of dust per day.

Dust storms in India

Dust storms in India are a common feature during pre-monsoon months, this is a pattern in the north and north west of India comprising Delhi, Haryana, Punjab, Uttar Pradesh and Rajasthan.

There are both pressure gradient type and the 'convective' type storms. Usually the convective thunderstorms during this season bring swaths of dust along with them. In this region, the lowest atmospheric layers have very high temperature and low moisture content, which makes the thunderstorms have high bases above the ground on the order of 3–4 km. The ground being dry over long periods, there is plenty of loose and fine dust avail- able. These factors

enable the severe thunderstorms of northwest India to generate dust storms. They are usually brief but can block out the sun, drastically reduce visibility, and cause property damage and injuries. Of late the occurrences and magnitude of these storms have been on the rise and also linked to climate change.



A wide swath of dust blew over western India on June 2, 2010.
Source:https://earthobservatory.nasa.gov/images/44172/dust-over-india

Dust storms on a synoptic scale

Dust storms are classified according to the processes that occur in a specific region. For example, in the Middle East the dust storms are caused by prefrontal and post frontal winds that primarily occur in winter and the storms in summer are propelled by northerlies.

i) Pre-frontal

Prefrontal dust storms are generated by the winds that blow ahead of moving low pressure areas in the Middle East, Arabia, Jordan, in certain areas of Iraq and some times ahead of Mediterranean cyclones. In this region, the convergence of the polar jet and the subtropical jets create an upper level trough. A strong cold front induces strong prefrontal winds ahead of the upper level trough. The prefrontal westerly winds are pretty strong, these winds lift off the dust, mobilise and transport them towards East and North East regions.

ii) Post frontal

Widespread dust can also occur after post-frontal events, for example in the Arabian Peninsula, during winter months, a cold frontal passage leads to strong North westerly winds on the backside of the front. This resulting dust storm is also referred to as 'Shamal. These produce wide spread weather across the region which can last for a minimum of 24 hours to 36 hours and some 3 to 5 days. The sustained winds can reach 30 kts and the stronger gusts can reach

around 40kts in general. Subsequent winds can bring precipitation which can wet the soil, however winds above 25kts can still lift off dust. Not necessarily these post-frontal dust storms are local to the Arabian Peninsula but also these happen in other parts of the world.

iii) Summer Shamals

Summer Shamals are winds that blow from the Persian Gulf into Iraq during the months of May, June and July. They can typically last from a few days up to a few weeks. They typical synoptic pattern to watch out for is a semi-permanent high pressure from the east Mediterranean to norther Saudi Arabia on one side, besides the monsoon trough extending till south of Arabia, in addition a low pressure over Afghanistan.

Mesoscale dust storms

i) Dust storms due to downslope winds

Dust storms can happen due to terrain through a downslope wind. For example, certain dust storms in the northern Afghan are due to downslope winds that occur in a south westerly direction, due to a pressure gradient built up along the terrain (NE to SW), which can trigger these winds downslope.

ii) Gap flows

Gap flows also can be a reason for some dust storms that occur in Afghanistan and similar mechanism causes some plumes that come from Iran and Pakistan into the Arabian Sea. This strong flow is due to the result of air coming through the mountain gap and lifting off dust from dry lake beds in the Hindukush region.

iii) Convective Downbursts(Haboob)

Haboob are caused due to the gust front of a dry downburst from a convective storm. Typically, they are smaller in size,ie of the order of 100 to 150km. They typically are short lived and not sustain more than 3 hours. Summer thunderstorms can induce such haboobs. Some regions near Persian Gulf, western Sahara, Central Australia are popular examples. Typically, they are harder to forecast in advance as they are generated primarily due to convective thunderstorms.

iv) Inversion downbursts

Inversion downburst is another type of a mesoscale dust storm which primarily forms in coastal regions with sufficient dust sources of Red sea, Persian Gulf. These lead to a very narrow stream of dust however they can be very strong. They are primarily caused due to the sea breeze conversion which breaks the cap of a strong inversion and hence strong winds blow out due to the instability caused.

v) Dust devils

These are small and less intense small-scale dust storms can be found across the world. They are usually short lived but can also last for an hour at times. These are formed in areas with strong surface heating, where the surface temperature can rise much higher than layers above a dust source. Once the air mass rises above due to cooler air above, hot air fills underneath and also created a spinning vortex, resulting in a funnel like chimney which continues to move as long as the instability is maintained.

Remote Sensing

Detection of dust storms is possible with a number of remote sensing options.

- Visible and IR storms are the first lines of observation, but RGB and multispectral products would also be required to identify dust storms
  - Day time dust detections through Visible are recommended for mid-day over water surfaces and also over dusk and dawn times where forward and back scattering is observed to determine the presence and extend of dust.
  - On the other hand, IR imagery is preferred for Land surfaces

- Aerosol optical depth products would also be of prime interest while observing dust storms
  - AOD is a strong indicator of dust in that region
  - They may not directly correlate with the surface visibility, but they serve as an indicator of how dusty the atmosphere could be.

- Animation products can really be useful for determining the direction on extent of dust

- RGB animation during night helps during the night as the visible and IR imagery would not be effective to determine dust during the night.
- Overlaying wind barbs would be crucial in combination with some of the above maps.

Forecasting

Dust storm forecasting incorporates, Satellite imagery, Surface and upper air observations, wind charts, RGB imagery and also NWP models plus dust aerosol models. Typically, long range, medium and short-range forecasts are available for dust storms in various regions of the world. The study of local features is going to be extremely important to correlate the forecasts, for e.g.: Soil, terrain, dust sources like lake beds, salt flats and arid regions.

i) Long range forecasts

- Typically, these are large scale forecasts over 72 hours that would require interpretation of numerical models over a synoptic scale, for e.g. DTA-GFS, NAAPS
- One important feature to look for is the occurrence of a mid-latitude trough in the forecasts, which can be a prime driver to pre-frontal and post frontal dusts in winter and Shamals in the summer.
- The above two can be correlated with each other to draw the forecast inferences, to correlate the synoptic features with the dust outbreak from dust models

ii) Medium range forecasts

- These are typically around 24-72 hours
- Mesoscale dust model output from models like COAMPS, DTA-MM5, DTA-WRF can be used in correlation with DTA-GFS and NAAPS in addition to NOGAPS
- Typically, 300mb wind forecasts are used to track troughs and jet streaks, an upper level trough indicating an intensifying low-pressure area which can propel strong surface winds
- 500mb vorticity charts to track troughs
- Surface pressure and wind charts to identify strong wind forecasts
- Vertical Wind profile is also going to be pertinent along with the RH at 700mb

iii) Short range forecasts

- These are intraday or 24-hour forecasts for dust storms in a region
- Dry adiabatic lapse rate to be studied along with the wind profile aloft to determine the potential of a dust event
- Again, the terrain aspects like surface wetness and other localized dust features have to be give good importance
- The output from DTA-GFS and NAAPS can be correlated with the localized dust features to arrive at the short-term forecasts

Summary

Dust is generated by wind erosion over arid or semiarid land surfaces and is transported locally and over vast distances, causing adverse environmental and weather issues. Dust particles are disruptive, they reduce visibility, significantly affect air quality therefore disrupting transportation and affecting human health. Besides they also play a role in the distribution of naturally occurring aerosols, in turn affecting radiation budget directly by influencing solar and infrared radiation and indirectly, altering cloud properties etc.

Dust events are very much dependent on the climatology, ecology and topography of different regions and localized factors play an important role in dust transport and propagation in addition to synoptic or mesoscale features.Dust storms can take down trees, bury equipment and cause damage to houses. In the final years of the Dust Bowl, farm animals were found dead in the fields and people started suffering from dust pneumonia.

It is therefore important to be aware of the natural and anthropogenic causes of dusts and how they affect the climatology of a region. Competent forecasting methods are available which combine remote sensing products and purpose-built numerical models which help predict dust events well in advance to be prepared to avert potential disasters. It is also imperative to take measures to minimize avoid desertification in vulnerable zones of the globe.

References : *Web sources.*

Meteorological Crossword

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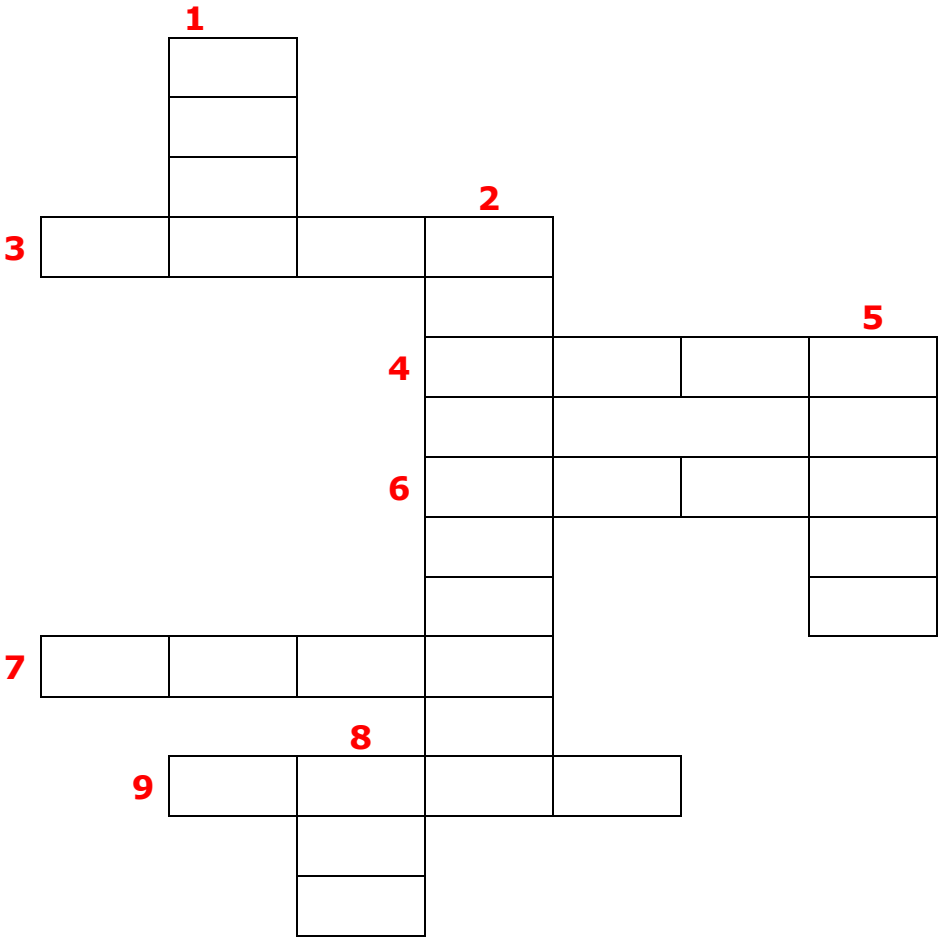

Top to Down (Descending)	**Left to Right**
1. Upper level feature affecting NW Pacific and Altlantic – Systems during northern hemisphere summer 2. Mechanism of Heat Transfer 5. Wind speed and wind direction data over ocean is obtained from this 8. Kavali cyclone of India affected Thailand, 1989	3. Headquarters of this U.S. Agency is located in an island. 4. Amercian Scientific Agency 6. Seasonal ocean current along Indian Coast 7. Cyclone known for explosive intensification 9. Smallest cyclone that occurred over North Indian Ocean

Answers are given in Page 27.

Miss Anna Mani – a legend

On the occasion of centenary birthday celebrations of
Miss Anna Mani(23 Aug 1918 to 16 August 2001),
a pioneer Meteorologist and the first woman Deputy Director General of Meteorology
in India Meteorological Department – A Tribute by a retired IMD official.

Post Independence, India was actively engaged in achieving self-reliance in every sphere during the 1950s. India Meteorological Department (IMD) was no exception in this activity. An indomitable and redoubtable person as he was, Shri.S.P. Venkiteshwaran, the then Chief of the Instruments wing at the Pune offices, took upon the challenge of indigenous manufacture of surface meteorological instruments in the then small repair workshop. In spite of headquarters at New Delhi, a beginning was made in the making of meteorological instruments. This later grew steadily into basic manufacturing hub for surface meteorological instruments and IMD gradually could meet its entire internal requirements of all types of surface meteorological instruments in its vask network of stations. Even high precision mercury barometers and anemographs were made in Pune.

At this initial critical junction, Miss Anna M. Mani was posted to the Instruments Section at Pune as a Meteorologist. She had been trained exhaustively on the various aspects of instrument manufacturing, in U.K. (especially London) and in USA. She gave a mighty push to the indigenous making of instruments joining whole heartedly with Shri. Venkiteshwaran in this venture. She succeeded Shri. Venkiteshwaran as Director (Instruments) on the latter's retirement. Soon specifications for various types of instruments and instruction manuals for their operation and maintenance were drawn up. The small repair shop grew to an instruments section and then to Instruments Division. Miss Mani worked tirelessly towards this end.

Following India adopting metric system of measurements, IMD also had to follow and implement it. This, Miss Mani could carry it out by having the engineering drawings redone by personal participation, over a period of 2-3 years. To ensure the international standard quality, precision machinery were added to the workshop floors despite limited executive powers. Thanks to the various schemes approved, the Division was augmented with skilled manpowers – both in workshops and in the laboratories. Quality control procedures were laid down and put into practice to ensure the international quality of the instruments made. The Division diversified the manufacture into special fields like aeronautical instruments, automatic rain measuring gauges, solar radiation instruments and special high altitude upper air sondes.

In mid-fifties of the last century, International Union of Geodesy and Geophysics (IUGG) was formed to ensure uniform standards in the various scientific activities. International Association of Meteorology and Atmospheric Physics (IAMAP) was one of the subgroups among the various groups formed. This was concerned with atmospheric and geocentric sciences like meteorology, oceanography and seismology.

To cater to meteorology, World Meteorological Organisation (WMO) was tasked to coordinate measurements and research at different centres and in different countries. The measurements being made at individual centres were brought into an international activity under the International Geophysical Year (IGY), 1957 and International Geophysical Cooperation (IGC), 1958. India actively participated in this. Special measurements on solar radiation, atmospheric ozone and atmospheric electricity and seismology were included and actively pursued. The senior scientists in Delhi and Pune meteorological offices actively participated in these programmes. Thus active involvement of Miss Mani in solar radiation measurements, in particular, got evolved.

The instruments manufactured in the Workshops were subjected to critical checks and rigorous calibrations in laboratories and then put into use at field stations. The admirable standards achieved especially on solar radiation measurements and the high quality of data generated from the field stations was highly appreciated and the data accepted readily by international scientific community. This was possible, thanks to the tireless and watchful supervision by Miss Mani.

CIMO is one of the Commissions formed under WMO to ensure universal acceptability of meteorological measurements. Miss Mani was selected as Chairman of Working Group on Solar Radiation Measurements for two consecutive terms in 1962 and also as Chairman of Working Group on Special Radiation Instruments. Her terms saw high level activities. She organised and successfully conducted two International Pyrheliometer Comparisons at Davos, Switzerland which ensures compatibility of the measurements with different types of standard pyrheliometers. It was during this period, the scientific community realised the fragile basis of the then International Pyrheliometric Scale. Hectic development activities on designing and manufacturing of high precision cavity radiometers, several series of intercomparisons, totaling more than 10,000, of these cavity radiometers of different makes ensured a strong World Radiometric Reference (WRR). This is now the reference standard for all radiation measurements.

To ensure compatibility of the various radiation instruments and the data from them, Miss Mani embarked, during her tenure as Chairman, on the intercomparison of radiation instruments of same genre at different centres

under different climate and geographical regimes. Pune, India was one among them. The international comparisons of different types of (i) sunshine recorders (ii) pyranometers and (iii) net pyrradiometers were conducted simultaneously for a three year period. Specially skilled personnel were detailed to carry out the daily maintenance and regular in-situ calibrations at periodic intervals. The high quality data collected were analysed by the accepted experts in the field. Their findings and recommendations were collated and submitted to WMO in the form of reports and the WMO Congress adopted them. This coordinated activity was a remarkable achievement, given the then polarised political divides.

She was also elected as Chairman of Working Group on Radiation for RA-II (Asia) during the same period for two terms. During this tenure, she arranged two intercomparison of Regional Standard Pyrheliometers - once in one of the two Regional Radiation Centres, viz. Tokyo and later at Pune, the other Centre. The Regional Standard Pyrheliometer was also taken to seven different nations in the Region for Standardisation of the national standard instruments.

Miss Mani also collected information on the then prevailing status of radiation instruments, including the instruments in use, at each Member countries in RA-II (Asia) Region. They were collated into a report and got published as a WMO Report. This was deeply appreciated by WMO and the Member Countries. Besides radiation, she was elected as a member of various working groups such as on barometers, atmospheric ozone, atmospheric electricity, precipitation gauges and aeronautical instruments. International comparisons were also conducted at different locations in India on different types of precipitation gauges. She used to personally participate in the international barometric comparisons, whenever held in India at Calcutta, where the standard barometer is being kept and maintained.

The upper air soundings of long wave radiation was germinated in India by her, initially with Kuhn radiometer sondes. Prof. Bryson and Prof. Kuhn of Michigan University brought few of these radiometers to India to demonstrate their operation. Soon a regular network activity of radiation sounding of the upper atmosphere was initiated with Indian radiometer sondes made in Pune office. She also organised an intercomparison of radiometer sondes of Japanese make and Indian ones at New Delhi and ensured that Indian ones were of same high quality. She was a far-sighted scientist and she had planned long term plan for continuous measurements of ultraviolet radiation and net terrestrial radiation which have high control over the human living environment. These measurements are being carried out now in the radiation network., albeit after three decades since she retired from IMD in 1976.

Having ensured the high reliability of radiation data, Miss Mani started monthly publication of network radiation data in the form of Monthly Radiation Bulletin which was continued up to 1979. This was later got subsumed in other IMD publications. She participated actively in various scientific seminars and meetings on meteorology and on radiation in specific and presented numerous scientific papers which were well received and appreciated. She also encouraged her junior colleagues in such related activities.

India participated actively in the measurement of atmospheric ozone, viz. atmospheric total ozone. Having succeeded in making radiometer sondes and successfully making regular upper air measurements, she embarked on designing a suitable ozone sonde. She gave full encouragement to a suitable design within the available facilities and succeeded in a reliable design of ozone sonde which IMD is now using for ozone sonde upper air measurements. These design principles were used for developing the surface ozone measurement, a vital component in the biosphere for healthy living conditions. Again, the instruments are in use in selected locations for regular data generation.

Miss Mani was also actively involved in the network measurement of atmospheric electricity despite the extremely difficult logistic problems in these measurements. Successful upper air measurement of atmospheric potential gradient was also included in this. However these measurements on network scale could not be sustained and the measurements by IMD was discontinued during the first decade of the current Century.

Like her predecessor S.P.Venkiteshwaran, Miss Mani would also undertake field work. In the initial stages of the radiation network activity, she herself carried out field calibrations from sunrise to sunset. Similarly she used to personally carry out the intercomparison of standard barometers, a very strenuous task. She actively participated in the Total Solar Eclipse on 8 June 1956. IMD had organised a special observational programme at Phalodi, Rajasthan on this occasion. She even stayed in tents for the purpose.

Miss Mani, despite retirement, participated in the 1980 Total Solar Eclipse programme held at Raichur, Karnataka. She brought a team of scientists from Raman Research Institute, Bengaluru to make special measurements. She actively guided the IMD programme also at the camp. She also actively participated in the High Altitude Radiosonde Ascents arranged at Hyderabad in association with US Weather Bureau. Another important field measurement she was involved in was the high altitude measurements of various radiation parameters and surface atmospheric electricity. This was held over a fortnight at Gulmarg, Kashmir. Measurements were made over grassy meadow at Gulmarg during the day and night as well. Special measurements of radiation was also made over fresh and old ice surfaces at Khilanmarg about 350m

above Gulmarg and 1000m above at Alpathar. She herself trekked up to Khilanmarg and took few measurements. She had organised all logistic support for this expedition. The results were published in a highly acclaimed research paper.

Not to be limited with measurements over the land surfaces, Miss Mani actively organised special measurements during International Indian Ocean Expedition (IIOE) campaign and subsequent oceanographic campaigns. IMD had in collaboration with UK had organised some special aircraft measurements during the early seventies of last century to study the cloud and atmospheric conditions during the monsoon season. The aircraft, as a specific requirement, was fitted with two solar radiation pyranometers one at the top to receive incoming solar irradiation and the other at the bottom surface to measure the reflected radiation. The data collected from several sorties were analysed - to i) study the radiation at the top of clouds (ii) radiation below the clouds and this gave the attenuation effect of various types of clouds (iii) the reflected radiation from different surfaces – clouds and earth surface along with their changing terrain and vegetations. That was the first time such measurements were made in India and a rich haul of data was made. Such studies were followed in later years when cloud seeding experiments were conducted by I.I.T.M. with Varanasi as the base. Yes, she was indomitable in such activities.

She was asked by WMO to go on deputation to Egypt for training the Egyptian meteorologists on solar radiation theory, instrumentation and measurement over a six month period. The lecture notes she had then prepared were very lucid and well received by the trainees and the Egyptian Meteorological Department, Cairo. The crowning moment came when she was given the arduous task of revising and enlarging the scope of the CIMO's Guide on Meteorological Instruments and Observation Practices. The revision came out as the 3rd Edition. The succeeding editions were largely based on this edition and more specialised techniques based on recent developments are included in the later editions.

Miss Mani was an able administrator and organiser. The various intercomparisons conducted on her prodding and under her guidance speak volumes about her abilities. Before the World Radiation Centre took final shape at Davos, the Physikalish Meteorologisches Observatorium, Davos (PMOD) was being funded by the Swiss Government. At one stage, the Government discontinued funding and PMOD was facing closure. Miss Mani, on coming to know about the plight, used all her persuasive abilities and could convince WMO. And WMO accorded the status of World Radiation Centre to Davos and provided necessary funds. This brought accolades to Miss Mani from the radiation experts all over the world and the PMOD personnel even referred to her as a goddess and savior and were generous in showering encomiums on her

ability. The radiation experts from India, who visited Davos in later International Pyrheliometer Comparisons were treated with warmth and extended all facilities. This was possible only due to Miss Mani's standing at international levels.

The instruments Division was managed very efficiently throughout her leadership. To manage and run an office which included more than 200 workers is a challenging task which Miss Mani admirably and successfully carried out. Punctuality not only in attending the office but also in completing an assigned work is a golden rule for her. Lunch breaks cannot exceed the prescribed 30 minutes. She used to visit workshops at least once a day and check the progress in each job. Non-supply of raw materials for whatever reason is no excuse. The purchase wing was always on their toes in keeping the stores items adequately stacked so that work in the workshop is not held up. A visit to the Stores after workshop was a routine with her. She would then visit each laboratory viz. surface conventional instruments laboratory, electronic laboratory and radiation laboratory. Any defects in the workshop products are checked in these laboratories and she could issue instructions on them.

All planning of future activities and developments on the instruments are considered only after office hours. The intention is not to disturb the regular works as the tested and certified instruments are needed for despatch to network stations. During these sessions, only the selected and concerned laboratory persons will be involved. All design developments and data research are dealt in these sessions.

After retiring from IMD, Miss Mani did not lead a retired life. She joined Raman Research Institute (RRI), Bangalore as an honorary research scholar. She was a research scholar in spectroscopy under Prof. (Dr.) C.V. Raman, immediately after her Masters in Physics from Madras University. On the prodding of Prof. Raman, she had joined IMD. In RRI, after retirement, she collated radiation data and published two important volumes – Handbook of Radiation Data of India based on actual radiation measurements made and another Handbook of Radiation Data based on measured data and derived radiation data. These two books were received with acclaim by the Solar Energy Entrepreneurs and other industrial establishments. She contributed quite a lot to the Solar Energy Association of India. She participated in most of their deliberations. She lent technical help to an entrepreneur in Coimbatore in the manufacture of Angstrom pyrheliometers and pyranometers and arranged IMD to carry out quality checks and calibrations in the initial stages.

She also launched a wind survey programme in which actual measurements of wind speed and direction were started at a number of locations all over the country augmenting the IMD's network. The instruments were procured, installed and carefully maintained. She got the data collected,

published and wind potential mapping was carried out. Retired IMD employees who were capable of carrying out field works were detailed for these activities. This activity again was well received by industry.

She was recognised as a research guide for doctoral studies by several Universities and a handful of scientists completed their doctorate under her guidance. She also published a number of research papers in various journals including foreign ones and presented research papers in various forums in India and abroad.

Cleanliness is of utmost importance. She would always say that a person who keeps working place shabby and unclean can never be given responsibility for any highly skilled work. The entire office including the bathrooms were always maintained spic and span. Not even natural dust was allowed to settle. Her office was always an envy for any visiting persons. Even the officers of sister Divisions in the campus would hesitate to even enter the Instruments Division for fear of being caught and admonished for wasting their own time during working hours besides disrupting the ongoing works in her office. Yes, this had created an impression that Miss Mani is a harsh and an unforgiving person. It is so, for members who avoid work and purposely delay in completing the assigned work.

To those who carry out the routine activities in the normal way, she is an efficient officer and a hard task master. To those who strive to excel and work hard to complete the works ahead of the targeted time, she is very affable and considerate. She would defend her juniors to a fault, even if there had been a major error which had somehow crept in. She would try to get maximum output even from a mediocre person but would never send the person out on transfer. And she had not caused any harm to anyone's career and the annual reports did not bring out any individual in bad light.

She was kind and large-hearted to loyal workers. She knew the family particulars of every individual in her office even of the mechanics and mazdoors. She used to fund the expenses on studies of the children of selected and needy low paid staff, but not by giving money. She would arrange to pay the school fees directly and to buy uniforms and books and other stationery needed.

An agnostic, she was well read on the basic philosophies of all major religions and would use them to convince her staff to act properly and without fear. Though she respected individual freedom in the personal life of her juniors, the duty is always foremost priority vis-à-vis religious freedom.

To sit and have a look back of the old days and the associations with her, always makes it a pleasure to think and feel wonderful about the rich legacy she left behind. The edifice, the Instruments Division, Pune speaks volumes about her extraordinary capabilities which none of the successors could even try to emulate.

Long live the memory of Miss Anna Mani.

Group photo taken in 1980 after the total solar eclipse measurements in Raichur, Karnataka

The article is a valuable contribution from a very senior retired IMD official who had worked with Miss Anna Mani.

Moments with Miss Anna Mani

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I have come across Miss Anna Mani only once in my career in India Meteorological Department. I feel very proud to share the moment when I met her in a seminar in 1992, in New Delhi.

The seminar was at IIT, New Delhi conducted by Solar Energy Centre. I had to present a paper on "**Standardization Facilities for Solar Radiation Instruments**". Mrs. Kanade, one of my senior colleagues working in Radiation Lab and who is no more now, was going to present a paper on "**Management of Indian Network of Radiation stations".**

We both had gone to the venue for presentation of our papers in the seminar. Miss. Anna Mani also had come there to receive an award given by the Ministry. That time her health was not so good. She required somebody's assistance to walk. Still, when she came to know that 2 ladies from Instruments Division, Pune have come for presenting paper, she came to meet us in person and was very glad to see us there. We also felt very happy to see her there and receiving the award.

Although we had not worked under her, we had heard about her great personality and her tremendous contribution to the Department from our seniors who were directly associated with her. We felt very much lucky to present our paper in front of her. Of course she was omniscient about the subject and we were quite new at that time.

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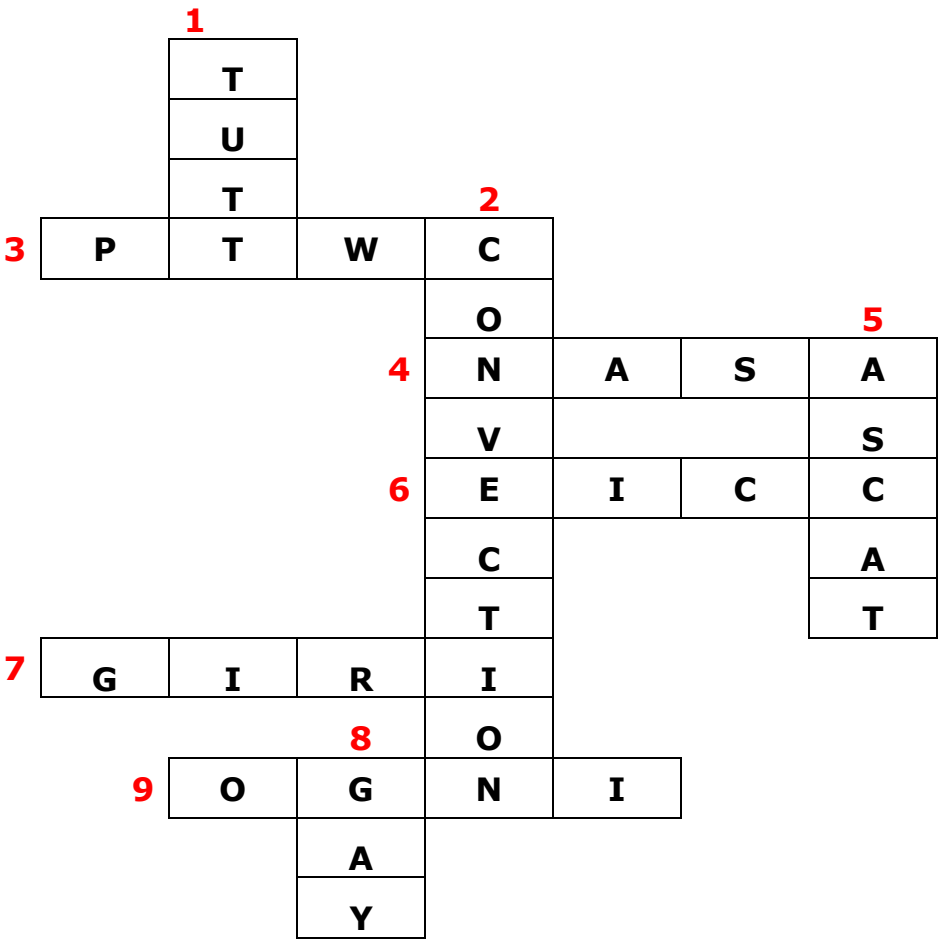
Answers for Meteorological Crossword in Page 17.



The quintessential weather soldier referred to in Page 8 is the "**Doppler Weather Radar**" atop Port Trust Building, Chennai functioning from February 2002.

Some photographs taken on 20.09.2018

Lecture on "Coastal and Marine Pollution" by
Dr. Uma Shankar Panda, Scientist-E, NCCR, Chennai.
Students of B.Sc. Physics, Anna Adarsh College for Women,
Anna Nagar, Chennai participated.

Obituary

Prof. T.N.Krishnamurti

Date of birth: 1932 **Date of death: 07th Feb 2018**

Position: Robert O. Lawton Distinguished Professor, Department of Meteorology
The Florida State University, Tallahassee, Florida, USA.

Education:
B.Sc. Physics (Honors), Delhi University, 1951
M.S. Meteorology, Andhra University, 1953
Ph.D. Meteorology, University of Chicago, 1959

Professional Activities:

- Dr. Krishnamurti specialized in studies of monsoon, hurricanes and numerical weather prediction and more recently on multi-model superensemble forecasts for global weather (including hurricanes) and climate.
- He has published over 250 papers and two textbooks.
- He has worked closely with the World Meteorological Organization and is a member of several of its committees especially on tropical meteorology and numerical weather prediction.
- He was active in teaching, research and national and international activities related to his field of interest.

Awards:

- Sir Gilbert Walker Gold Medal presented by the Indian Meteorological Society (2012)
- The American Meteorological Society, at its annual meeting in January 2012, included a special symposium entitled "***The T.N. Krishnamurti Symposium***"
- "Sir Gilbert Walker Chair" (Distinguished Professor) Center for Atmospheric Sciences, Indian Institute of Technology, Delhi, India (2009)
- Honorary Elected Member, American Meteorological Society (2008)
- Graduate Mentor Award, Florida State University (2007)
- American Geophysical Union, Editor's Award (2006)
- Monthly Weather Review Editor's Award (2004)
- Professorial Excellence Program Award, Florida State University (1997)
- International Meteorological Organization Prize, June 1996 - Awarded by the World Meteorological Organization. The award is the most prestigious international award in the field of meteorology and includes a gold medal, certificate and cash award.
- Florida Scientist of the Year Award (1986)
- Robert O. Lawton Distinguished Professor Award (1985) - The highest honor conferred by the Florida State University upon its faculty.
- Carl Gustaf Rossby Research Medal (1985) - The highest award of the American Meteorological Society.
- Second Half Century Award, the Charney Award (1974) - The second highest award of the American Meteorological Society.

Obituary

Smt V. Radhika Rani
Life Member No.2048, IMS Chennai Chapter
RMC Chennai

Smt. V. Radhika Rani, Scientific Assistant was born on 12.01.1973. She joined Regional Meteorological Centre, Chennai on 14.10.1997. She had served in Meteorological Observatory at Cuddalore also. She was working in Airport Meteorological Station, Gannavaram from 5.4.2018. Smt Radhika breathed her last on 16.9.2018 due to a massive heart attack. She is survived by her husband and two daughters.

Smt Radhika rendered commendable service to IMD for over 20 years and 11 months. Smt Radhika was a very sincere, dedicated, efficient and hardworking officer. She was an active IMS member and used to enthusiastically volunteer in conducting all the activities of the Chapter.

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