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Journey of India Meteorological Department during last 150 years

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सार – लेख उन विकासों का वर्णन करता है जिनके कारण 1875 में भारत मौसम विज्ञान विभाग की स्थापना हुई, राष्ट्र की सेवा में पिछले 150 वर्षों के दौरान अग्रदूतों और दूरदर्शी लोगों के मौलिक और प्रेरक योगदान और आईएमडी की निरंतर प्रगति।

ABSTRACT. The article describes the developments that led to the establishment of the India Meteorological Department in 1875, the seminal and inspiring contributions of the pioneers and the visionaries and IMD's continuing progress through the last 150 years in the service of the nation.

Key words – India, Observatories, Meteorology, IMD, History.

1. Before the journey

Any journey must have a purpose and a motivation if it is to be worthwhile. The journey of the India Meteorological Department which commenced in 1875, was in fact preceded by an 80-year long preparatory phase. India was then being ruled by the British, who had a natural fascination for observatories: astronomical, meteorological, as well as geomagnetic. The British East India Company established its first astronomical observatory in Madras (now Chennai) way back in 1792. The earliest meteorological observations were recorded there the following year and made regularly and continuously from 1796 onwards. The Company set up more observatories at Colaba in Bombay (now Mumbai) in 1823, Calcutta (now Kolkata) in 1829 and Simla (now Shimla) in 1841. The Colaba observatory started functioning fully only in 1841. In the same year, another major observatory became operational in Trivandrum (now Thiruvananthapuram). This was an exception in the sense that it was built not by the British but by the Maharaja of Travancore, Balarama Varma, a young progressive ruler and a patron of arts and sciences.

Besides these observatories, the provincial governments on their own initiative were setting up smaller stations for measuring rainfall and other weather parameters. At the same time, there were numerous individuals who pursued astronomy and meteorology as a serious extra-curricular activity while being engaged in their own occupations. These included civilian and army officers, medical doctors, college professors, geographers, sailors, surveyors, and even Christian missionaries, who meticulously maintained their personal meteorological records (Buist, 1855).

One such enthusiast was James Prinsep, who came to India in 1819 at the youthful age of 21 as the Master of the Mint at Benares (now Varanasi). In 1832, he was transferred to the Calcutta Mint. Prinsep had many other interests ranging from Sanskrit and Persian languages to Indian scriptures and oriental antiquities. He was a Fellow of the Royal Society and the Secretary of the Asiatic Society of Bengal in Calcutta. At heart, however, he was a meteorologist. While at Benares, Prinsep had himself made a series of systematic meteorological observations between 1824 and 1826. Later he organized simultaneous observations at Benares, Calcutta, Madras and other places, and studied the atmospheric pressure gradients across India. He also compared them with similar measurements made in other countries (Buist, 1855, Kejariwal, 2011). James Prinsep died young in 1840, but the city of Kolkata still remembers him with the Prinsep Ghat, Prinsep Street and Prinsep Park, all named after him.

Henry Piddington, who was born in England in 1797 and died at Calcutta in 1858, was a man of extraordinary

vision. Nowadays we have satellite images showing how tropical cyclones look like from space. In the early nineteenth century, however, little was known about these storms, except that they wrecked ships on the high seas and caused untold destruction and loss of life while crossing the coast. It was Henry Piddington who could visualize their structure and the rotating nature of their winds. Earlier as a British sea captain, he had a first hand experience of such storms and then as the President of the Marine Courts of Inquiry at Calcutta, he dealt with claims arising out of ship damages. Piddington had made a thorough investigation of a storm in the Bay of Bengal in December 1789 that had caused untold misery and the death of over 20,000 people. He presented his results before the Asiatic Society of Bengal in 1840 and described the storm as a 'cyclone', a name he derived from the Greek word 'kuklos' meaning going around or encircling, like the coil of a snake. Piddington wrote several handbooks that described the laws that governed tropical cyclones in simple conversational format (Piddington 1844, 1852). The books had guidance material for ship captains caught in a storm on how to sail out into safer waters.

The observatory set up in Calcutta in 1829 was located in the compound of the Office of the Surveyor General of India on Park Street. In 1852, Radhanath Sikdar, then 'Chief Computor' of the Great Trigonometric Survey of India, was given charge of this observatory in addition to his surveying work. Sikdar was the first Indian to occupy such a position in British India. He managed the observatory exceedingly well until his retirement in 1862. He introduced a system of hourly observations and the application of bar reduction corrections to the pressure readings. Sikdar became a member of the Asiatic Society of Bengal and all his observations were published regularly in the Society's Journal and Proceedings. While working in the Survey of India at Dehra Dun earlier, Radhanath Sikdar had computed the precise height of Peak XV in the Himalayas and found it to be the tallest in the world. It was later named after the Surveyor General, George Everest (Lahiri, 2000) and we now know it as Mount Everest.

The Royal School of Mines was established in London in 1851 and soon thereafter William Thomas Blanford and his younger brother Henry Francis Blanford enrolled as its students. On the completion of their studies, both the Blanford brothers came together to India and joined the Geological Survey of India in 1855. William remained in the GSI until his retirement in 1882 but Henry later became a meteorologist. Henry Blanford left the GSI in 1861, finding the work too strenuous for his health and joined as a professor of physics and chemistry at the Presidency College, Calcutta. He developed an interest in meteorology when in 1864, a cyclone hit eastern India, killing 70,000 people and damaging the Calcutta port. Blanford wrote a report on this disastrous event and his recommendations which found support from high-level committees and the Asiatic Society, were accepted. In recognition of his work, he was appointed as Meteorological Reporter in charge of the Provincial Meteorological Department of Bengal in 1867.

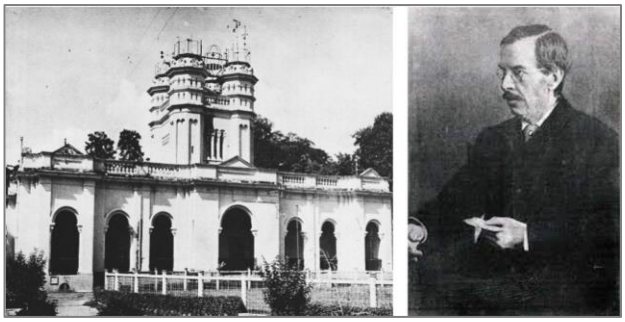

Fig. 1. (Left) IMD's central observatory in Alipore, Calcutta, built in 1877 (Right) Henry Blanford, first Imperial Meteorological Reporter to the Government of India, 1875-1889

2. The journey begins

By 1874, all provinces in India had their own meteorological systems in place and there were about 80 observatories across India. The time had come to bring all of them under the umbrella of a unified establishment. The Government of India decided to call it the India Meteorological Department. It was to be headed by the Imperial Meteorological Reporter to the Government of India and Henry F. Blanford was the obvious choice for this newly created post (Fig. 1). He received the offer in August 1874 while on leave in his home country. On returning to Bombay on 15 January, 1875, he assumed charge of IMD and proceeded on a tour of the provinces. This is regarded as IMD's Foundation Day and the beginning of its journey of 150 years.

Blanford, after his discussions with the provincial heads, came back to Calcutta and submitted to the Government a detailed scheme for reorganizing the meteorological setup of the country. This was accepted in its entirety by the Government and the decision communicated to him in a letter dated 27 September, 1875, on which day IMD may be said to have been established in a formal sense.

Blanford had already realized from his experience that the application of meteorology in India had to be very different from what it was in the western world. His foremost objective therefore was to make a systematic study of the meteorology and climatology of the entire country which he undertook very meticulously and

published as a monograph (Blanford, 1877). He had also become aware of the diverse observational practices followed in various provinces and the different types of instruments used for the purpose. His priority was therefore to bring in uniformity of practices, standardization of instruments and proper maintenance of records across the country and to further strengthen the observational network. With that end in view, Blanford first established a central observatory at Alipore in Calcutta in 1877 (Fig. 1).

In 1875, IMD's area of responsibility extended across the entire south Asian subcontinent from what is presently Pakistan to Burma (now known as Myanmar). However, IMD was a scientific department and it took the liberty of deviating from the British political map by (*i*) dividing large presidencies and provinces into smaller meteorological subdivisions, (*ii*) combining small territories, agencies and states that were meteorologically homogeneous into larger meteorological subdivisions and (*iii*) naming them differently (Kelkar and Sreejith 2021).

3.1. *Circuitous Route*

Like the monsoon, the India Meteorological Department's journey over the last 150 years has followed a circuitous route. It began in 1875 in Calcutta, from where the British government ruled the country. In 1905, IMD moved its headquarters to Simla (now Shimla), a cool place at a height of 2.2 km and the epitome of colonial culture. It moved out in 1928 to Poona (now Pune), a centre of education and social reform, and a place known for its salubrious climate. In 1944, IMD re-located itself to where it was most relevant, to New Delhi, which was soon to become the capital of independent India.

While IMD established its first headquarters in Calcutta, it had to set up almost simultaneously, a branch meteorological office in Simla, which since 1864 used to be the summer capital of colonial India and was therefore equally important. For many years, the headquarters office of IMD functioned in a leased accommodation on 5 Russell Street in Calcutta. It was much later in 1899 that IMD built its own office building in the compound of the Alipore observatory.

As the years went by, greater responsibility got assigned to the Simla branch office and its activities went on increasing. From 1885 onwards, the Indian Daily Weather Report, monthly and seasonal summaries and the long range forecasts were all issued by IMD from Simla. Eventually, in 1905, the role reversal became official, as Simla became the headquarters of IMD and Calcutta was reduced to the status of a branch office.

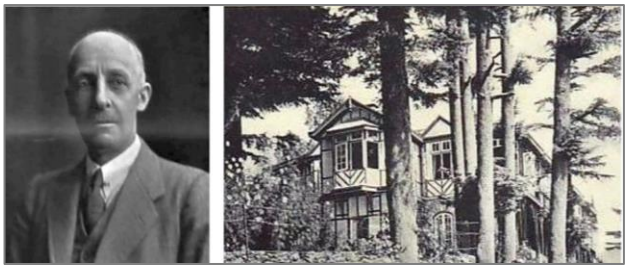

Fig. 2. (left) Gilbert Walker, Director General of Observatories, 1904-1924 (right) IMD's offices in "Constantia" building in Simla, 1890-1908

Figs. 3(a). IMD's headquarters in Poona, 1928-1943, now popularly known as "Simla Office"

Fig. 3(b). "Aerological Offices and Observatory", IMD's headquarters in New Delhi, 1944-1975

Fig. 3(c). "Mausam Bhavan", IMD's headquarters in New Delhi, since 1976

To begin with, the Simla branch office of IMD was temporarily housed in the Government Telegraph Office. Later on, from 1890 to 1908, IMD functioned in an old bungalow named 'Constantia' (Fig. 2) until the Governor General decided to acquire it for establishing the Young Women's Christian Association (YWCA) there. IMD then moved out into a larger bungalow on the Yarrows estate in Simla, but this was already old and deteriorating. In 1916, IMD moved once again, this time to a temporary and hurriedly constructed building on the Kennedy House estate. 'Constantia' stands today in a properly maintained condition and still houses the YWCA but there is no trace of the other buildings now (Kulshrestha, 2003; Vachharajani, 2023).

Finally, in 1928, IMD decided to move out of Simla to Poona, into a tall, imposing and magnificent building of its own, constructed on a 10-acre plot in Bhamburda (now Shivajinagar). All activities of IMD, scientific, operational and administrative, were shifted to Poona. The building is now popularly known as Simla Office and is an outstanding landmark of the city [Fig. 3(a)].

During the Second World War, IMD was asked to provide specialized meteorological services to the Royal Air Force and so in 1944, the headquarters of IMD were once again shifted to New Delhi into its building on Lodi Road named as 'Aerological Offices and Observatory' [Fig. 3(b)]. In 1947, after independence, it was decided that the IMD headquarters would continue to remain in New Delhi. As time went by, this single-storied red coloured building became grossly inadequate for IMD's growing activities which had to be accommodated in several small hutments. In 1976, a new six-storied building named 'Mausam Bhavan' [Fig. 3(c)] and in 1980, another six-storied building called 'Mausam Upagrah Bhavan' came up on the sprawling Lodi Road complex of IMD.

4. Gilbert walker

No history of IMD can ever be complete without a reference to Sir Gilbert Walker. Born in 1868, Gilbert Thomas Walker grew to be a brilliant mathematics scholar at Cambridge, a Senior Wrangler in 1889 and a Fellow of Trinity College in 1891. Walker worked in many fields, including the path of projectiles and boomerangs, but his main interest was in electromagnetism.

In 1904, however, Walker was chosen by the Government of India to be the Director General of IMD and he continued to occupy this position for the next 20 years (Fig. 2). During this period, Walker received the Sc. D. degree from the University of Cambridge, and was elected as a Fellow of the Royal Society, President of the Asiatic Society of Bengal and President of the 1918 Indian Science Congress. He was also a member of the Board of Governors of the Indian Institute of Science, Bangalore. He was knighted in 1924, the year of his retirement. On return to England, he taught meteorology at the Imperial College, London, and pursued research in diverse fields like convection in unstable fluids, formation of clouds, and the flight of birds. He died in 1958 at the age of 90.

Sir Gilbert Walker, lived decades ahead of his times. The phenomenon which we now abbreviate as ENSO (El Nino Southern Oscillation) and monitor with the help of satellites, was in fact discovered along with the North Atlantic Oscillation by Walker at a time when there were no satellites. Again in an era in which postcards and telegrams were the prime means of acquiring data, Walker could establish the fact that the Indian monsoon was not an isolated system but had strong tele-connections with the global climate. In an age in which there were no computational aids whatever, Walker was able to apply statistical techniques to the foreshadowing of Indian monsoon rainfall by discovering numerous antecedent parameters from different parts of the world (IMS 1986, RMS 2023). Even a hundred years after Walker left India, his statistical approach continues to be used here for long range forecasting of the Indian southwest monsoon rainfall, the difference being mainly in the choice of the parameters.

Walker's memory has been enshrined by the global meteorological community by naming the east-west circulation over the eastern Pacific Ocean as the Walker Circulation. In 2006, the University of Reading established a research institute dedicated to his memory, named as the Walker Institute for Climate System Research (WICSR, 2023).

5. Indianization

Although in the early times, the central and provincial meteorological reporters were all British, Indians were soon given a place in IMD. Lala Ruchi Ram and Lala Hem Raj were the first two Indians to be appointed in 1885 and 1887 respectively as Assistants to help Blanford in his scientific work. Lala Ruchi Ram soon left his job but Lala Hem Raj continued in IMD and was the first Indian to be appointed in the senior position of Imperial Meteorologist in 1911 (Fig. 4). During Walker's tenure, many Indians were inducted into IMD. In 1922, Dr. S. K. Banerji and V. V. Sohoni joined IMD and both of them rose in the hierarchy to head the Department later on. By 1925, IMD had only three Britishers but several Indians as Meteorologists, such as Dr. S. R. U. Savoor, Dr. M. W. Chiplonkar, Dr. S. N. Sen and V. D. Iyer. In 1944, when the IMD headquarters were moved to Delhi,

Fig. 4. (left) John Eliot, first Director General of Observatories - 1899, (centre) George Simpson, Member of first British Expedition to Antarctica - 1910 and (right) Lala Hem Raj, first Indian to be appointed Imperial Meteorologist - 1911

Fig. 5. (left) S. K. Banerji, first Indian to be appointed Director General of Observatories - 1944, (centre) Y. P. Rao, first Director General of Meteorology-1976 and (right) Anna Mani, first Woman Meteorologist in India - 1948

Dr. Charles Normand retired as the Director General and Dr. S. K. Banerji was appointed in his place (Fig. 5). Thus IMD had an Indian at the topmost position even before independence.

6. A global role

The International Meteorological Organization was established in 1873 for facilitating the collection and exchange of weather information across countries and India became its member in 1878. While IMD was still in its formative stage, observatories were opened in many neighbouring countries with the help of IMD personnel. Several IMD meteorologists were members of IMO commissions and committees.

The IMO was superseded in 1950 by the World Meteorological Organization, a United Nations agency, with headquarters in Geneva. India joined WMO as its founder-member and has since been actively associated with its activities and programmes. India has almost always occupied a seat on the WMO Executive Council. Indian meteorologists have been members of WMO commissions and other bodies. Dr. P. Koteswaram, DG - IMD and a Padma Bhushan awardee, was the first Indian to be elected as Vice-President of WMO for the 1971-1975 term (Fig. 6). Dr. N. Sen Roy, DG-IMD served as Vice-President for the 1995-99 term. Dr. M. Mohapatra,

Fig. 6. (left) K. R. Ramanathan, first Director, Physical Research Laboratory, Ahmedabad, Padma Vibhushan, (centre) P. C. Mahalanobis, founder-Director, Indian Statistical Institute, Calcutta, Padma Vibhushan and (right) P. Koteswaram, first Indian elected as Vice-President of WMO, Geneva, Padma Bhushan

currently the Director General, is Vice-President of WMO for the 2023-27 term. IMD hosts and runs the WMO Regional Specialized Meteorological Centre for Tropical Cyclones at New Delhi and the Regional Meteorological Training Centre at Pune and it is an active member of the WMO/ESCAP Panel on Tropical Cyclones.

7. Expeditions and experiments

The first Indian scientific expedition to Antarctica landed there on 9 January 1982 under the leadership of Dr S. Z. Qasim. Of the 21 team members, two were from IMD, A. K. Sharma and K. N. Katyal. Since then, over 40 Indian teams have been to Antarctica and all of them have had IMD members. As many as 9 of these expeditions have been led by IMD scientists. India has established permanent research stations in Antarctica, named Dakshin Gangotri in 1984, Maitri in 1988 and Bharati in 2012.

IMD's Antarctic connection, however, dates way back to 1910. George Clarke Simpson, who was teaching meteorology at the University of Manchester was appointed by IMD as Imperial Meteorologist at Simla in 1906 (Fig. 4). In 1910, he left for Antarctica as a member of the first British Expedition to the South Pole under the leadership of Captain Robert Falcon Scott. Simpson had carried with him an excellent well-calibrated set of meteorological instruments, and he himself recorded the temperature and wind observations at the base camp at Cape Evans for two years. He also held charge of this station after Scott and his party went to the South Pole, never to return.

In 1912, Simpson came back from Antarctica to his IMD posting at Simla. The First World War broke out in 1914, and he was drafted for military service. In 1916, he served as the meteorological adviser to the British Expeditionary Force in Mesopotamia, now a part of Iraq. After the war ended in 1918, Simpson was appointed as the Director of the Meteorological Office, London, a

position he held from 1920 to 1938. Simpson was awarded honorary doctorates by several universities and knighted in 1935.

From September 1959 to 1965, an extensive multinational hydrographic survey of the Indian Ocean was carried out under the International Indian Ocean Expedition (IIOE) with as many as 45 research vessels from 14 countries. IIOE had a major meteorological component in which India participated enthusiastically from 1962 onwards. IMD set up an International Meteorological Centre at Bombay to coordinate the operations, gather weather data, analyse the weather charts and provide forecasts for the Indian Ocean region. The centre had the facility to receive satellite imagery from the U.S. TIROS satellites. It was equipped with the IBM 1620 electronic computer for processing the data. The IMC was headed by C. S. Ramage of the University of Hawaii and C.R.V. Raman of IMD. The IIOE expedition resulted in the collection of a wealth of data and several atlases of the Indian Ocean were produced. After the end of IIOE, an Indian Ocean and Southern Hemisphere Analysis Centre (INOSHAC) was set up in IMD at Pune as a measure of continuity and the IBM 1620 was also sent to Pune for use in research work.

IIOE was followed by several such coordinated experiments, national and international, aimed at enhancing our understanding of the monsoon. In all of them, IMD played a significant role as a participant, host or supporter. Besides unravelling some of the mysteries of the monsoon, these experiments have also led to capacity building in institutions outside IMD, in terms of both infrastructure and manpower. In the 1970s, small scale experiments like ISMEX-73 and MONSOON-77 were conducted. However, the Monsoon Experiment of 1979 (MONEX-79) was a major international effort (UCAR 2023). IMD played a significant role as a participant as well as the host. Twenty other countries including the U.S., U.S.S.R., Japan, France, Australia, and China participated in MONEX-79. The experiment was conducted in three phases: the Saudi Arabia Experiment based in Dhahran in May, the Arabian Sea Experiment based in Bombay in June and the Bay of Bengal Experiment based in Calcutta during July and August. A massive amount of observational data was collected over land and ocean through satellites, research aircraft, ships, radars, balloons and rocket soundings.

MONEX-79 investigated planetary scale aspects like establishment and movement of equatorial troughs, the onset of the monsoon and breaks in the monsoon. The synoptic scale aspects studied were the low-level monsoon flow, the low-level Somali jet, boundary layer inversion, mid-tropospheric cyclones, components of heat sources, development and structure of monsoon depressions, structure and energetics of monsoon troughs.

In subsequent years, several such field experiments were organized over land and sea, in which IMD either participated or provided supporting infrastructure or both, such as the Monsoon Trough Boundary Layer Experiment (MONTBLEX) in 1990 and the Land Surface Processes Experiment (LASPEX) during 1997-1998. Three major national monsoon experiments were organized under the Indian Climate Research Programme (ICRP), *viz*. the Bay of Bengal Monsoon Experiment (BOBMEX) in 1999, the Arabian Sea Monsoon Experiment (ARMEX) in 2002-2005 and the Continental Trough Convergence Zone Experiment (CTCZ) in 2008-2010 (Bhat and Narasimha, 2007).

An Indian field programme named as Severe Thunderstorm Observation and Regional Modelling (STORM) was organized in 2006-08, with intensive observations and modelling studies aimed at understanding the dynamics of the pre-monsoon phenomena called nor'westers. Its scope was later expanded to include the SAARC countries and it came to be known as the SAARC STORM project of 2013-15 (Kamaljit Ray *et al*., 2017).

8. Creating new institutions

Kalpathi Ramakrishna Ramanathan, Prof. C. V. Raman's first student and the first D. Sc. of Madras University, joined IMD as a Meteorologist in Simla in 1925 (Fig. 6). He later headed IMD's geomagnetic, astrophysical and climatological units at Colaba, Kodaikanal and Poona respectively. Dr. Ramanathan's pioneering work was, however, in the measurement of atmospheric ozone at a time when its importance had not been realized. After his retirement from IMD in 1948, Dr. Vikram Sarabhai invited him to be the Director of the Physical Research Laboratory at Ahmedabad, which Sarabhai had just established. Ramanathan was the Director of PRL until 1965 and brought it up to become a premier institution that did research of global standard in geosciences, planetary science and solar physics. PRL now functions as an autonomous body under the Department of Space. Dr Ramanathan was awarded the Padma Bhushan in 1965 and the Padma Vibhushan in 1976.

Prasanta Chandra Mahalanobis was, in today's parlance, a multi-tasker (Fig. 6). Between 1922 and 1926, he was a Meteorologist at IMD's Alipore office, professor of physics at the Presidency College in Calcutta and General Secretary of Rabindranath Tagore's Viswa Bharati University at Shantiniketan, In parallel, with

Fig. 7. Rabindranath Tagore with P. C. Mahalanobis and his wife, under the banyan tree in IMD's Alipore campus in 1926

Tagore's encouragement he was pursuing statistics, then a little-known subject. His tenure at Alipore coincided with disastrous floods in Bengal and Orissa and he applied his statistical techniques to study them in relation to rainfall. Tagore often visited Calcutta and would be a guest of Mahalanobis and his wife Nirmal Kumari in their residence on the first floor of the Alipore office building. Tagore had a room for himself, but he preferred the shade of the giant banyan tree that it overlooked, under which he sat and penned his literary masterpieces (Fig. 7). It was in the fitness of things, that the Nobel Prize-winning monsoon poet, drew his inspiration from clouds and rain in the campus of a meteorological observatory. Tagore's room at Alipore has now been converted into a small museum and the banyan tree continues to stand at the hallowed spot in homage to his memory. Mahalanobis had statistics as his first love and he soon left IMD to establish the Indian Statistical Institute in Calcutta in 1931, which is now an institution of world renown, with university status and having centres across India. He was awarded the Padma Vibhushan in 1968.

In their early years, observatories in India made different kinds of observations and measurements: meteorological, astronomical, geomagnetic and seismological. As time went by, core groups evolved at different places, specializing in tropical meteorology at Poona, geomagnetism at Colaba and Alibag, astronomy and astrophysics at Madras and Kodaikanal. Eventually, these units grew large enough to merit a separate, fuller existence and identity. To begin with in 1962, IMD established the Institute of Tropical Meteorology as its own research wing in Poona. Later in 1971, it was renamed as the Indian Institute of Tropical Meteorology and made an autonomous body functioning directly under the Ministry. At the same time, the Indian Institute of Geomagnetism was created at Colaba and the Indian Institute of Astrophysics at Kodaikanal as autonomous bodies.

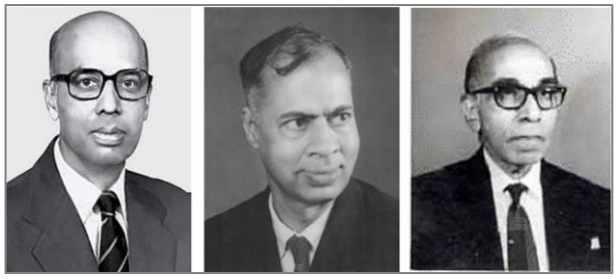

Fig. 8. (left) M. K. Vainu Bappu, first Director, Indian Institute of Astrophysics, Kodaikanal, Padma Bhushan, (centre) P. R. Pisharoty, first Director, Institute of Tropical Meteorology, Poona, Padma Shri and (right) R. Ananthakrishnan, second Director, Institute of Tropical Meteorology, Poona, Padma Shri

Pisharoth Rama Pisharoty, born in 1909, did his graduation and post-graduation with the University of Madras and then worked as a physics lecturer from 1932 to 1941. During the summer vacations he used to work under Prof. C. V. Raman at the Indian Institute of Science, Bangalore. On his recommendation, Pisharoty joined IMD in 1942. Later, he earned his M.S. and Ph.D. degrees in Meteorology from the University of California. On returning to India, Dr. Pisharoty became the Director of Colaba and Alibag Magnetic Observatories in 1959 and the first Director of the Institute of Tropical Meteorology in 1962 (Fig. 8). After retirement in 1967, at the invitation of Dr. Vikram Sarabhai he joined the Physical Research Laboratory, Ahmedabad where he worked for 30 years on the applications of remote sensing technology in India. He was awarded the Padma Shri in 1970.

Pisharoty was succeeded as Director ITM by another eminent meteorologist, Dr. R. Ananthakrishnan who had also been a student of Prof. C. V. Raman and had a D.Sc. degree from University of Madras (Fig. 8). He too had joined IMD and occupied several important positions. He retired in 1971 and then developed the Department of Atmospheric Science at Cochin University. He was awarded Padma Shri in 1969.

Manali Kallat Vainu Bappu, joined IMD as the Director of the Kodaikanal Observatory in 1960, at the young age of 33 (Fig. 8). He had already established himself as India's foremost optical astronomer and was known for the Wilson-Bappu Effect. He became the first Director of the Indian Institute of Astrophysics in 1971. Dr. Vainu Bappu undertook the pioneering though arduous task of building indigenously a large optical telescope for the observatory at Kavalur. The work was completed in 1986, but he did not live to see it and both the telescope and the observatory were named after him. Today, IIA has its headquarters in Bangalore, the Solar Physics Observatory at Kodaikanal, the Vainu Bappu Observatory at Kavalur and the Indian Astronomical Observatory at Hanle in

Ladakh. Dr. Vainu Bappu was awarded the Padma Bhushan in 1981.

The Indian Institute of Geomagnetism, which was also carved out of IMD in 1971 along with IITM and IIA, now has its own new campus in Panvel and several regional centres and field stations across the country.

Amar Nath Tandon, born in 1912, joined IMD in 1942. IMD had been operating seismological observatories in India since 1898 and had established the Central Seismological Observatory in Shillong in 1902. It was, however, Dr. Tandon who played a pivotal role in the promotion and development of seismology in India. His first attempt was to prepare a seismic zoning map for India and he also ventured into the indigenous design and development of seismometers. Under his leadership, the seismological network grew rapidly across the country. His research work was globally acknowledged and he had collaborated with Dr. C. F. Richter, after whom the Richter earthquake magnitude scale is known. Dr. Tandon retired from IMD in 1970 (Dattatrayam, 2012). Although seismology was unrelated to meteorology, IMD nurtured it until the formation of a separate National Centre for Seismology, under the Ministry of Earth Sciences in 2014. NCS is now the nodal agency for monitoring earthquake activity in the country and it maintains the national seismological network of 150 stations, each having state of art equipment.

After independence, IMD assisted the Indian Air Force in building up its own separate Directorate of Meteorology which by 1962 became afull-fledged Meteorological Branch with its own officers. Several IMD officers who had been seconded to the IAF,chose to continue their careers with the IAF Met Branch. Of these, Air Commodore P. A. Menon, Air Vice Marshal S. Lakshminarayanan and Air Vice Marshal R. K. Mathur rose to head the IAF Met Branch.

9. Womanpower

The distinction of being the first woman meteorologist in IMD goes to Anna Mani. Born in 1918, she got her B.Sc. honours degree from the University of Madras in 1939. Thereafter she worked as a student of Prof. C.V. Raman at the Indian Institute of Science, Bangalore, on the spectroscopy of diamonds and rubies. In 1945, she proceeded to England on a scholarship to pursue further studies on x-ray crystallography at Imperial College, London. In 1948, she returned to India and joined IMD's instruments laboratories in Poona (Fig. 5). Anna Mani was a perfectionist and she made IMD self-sufficient in the design and production of meteorological instruments. She also did her own research on atmospheric radiation and ozone which got her global recognition (Taba, 1991). After retirement from IMD as Deputy Director General in 1976, Anna Mani worked for a few years at the Raman Research Institute, Bangalore, on the assessment of potential resources for solar and wind energy in India.

IMD is no longer a male-dominated department. Over the years, more and more women have been choosing meteorology as their career and excelling in it. Dr. B. Amudha, Scientist in IMD, was awarded the prestigious Vilho Vaisala Award by the World Meteorological Organization in 2016 in recognition of her work for the development of instruments and methods of observation. The 20th Indian Antarctic Expedition in the year 2000 had S. Stella as a woman participant from IMD Currently, women constitute 15 per cent of the total workforce of IMD and several top positions have been or are presently occupied by women. Dr. N. Jayanthi was Additional Director General of Meteorology (Research) during 2006-07. IMD's women scientists like Dr. B. Shyamala, Dr. Surinder Kaur, Ranju Madan, Dr. Kamaljit Ray, Dr. K. Sathi Devi, Dr. Medha Kolhe, Dr. Soma Sen Roy and Shubhangi Bhute, to cite a few examples, have made important contributions in diverse fields like cyclone warning, hydrometeorology, instrumentation and weather forecasting.

10. Date and time

Since the beginning, IMD had been providing time signal for shipping in the Arabian Sea and the Bay of Bengal as a part of its services. Ships docked at Bombay and Calcutta ports would synchronize their clocks with signals given by Colaba and Alipore observatories. These observatories had astronomical clocks and telescopes for accurately determining the time. Later precision pendulum clocks and more accurate chronometers were acquired by IMD. At exactly 0830 am daily a red time ball would be dropped through a shaft as a signal for ships at the Bombay port. As wireless communications became available to ships this practice was slowly discontinued. From 1939 onwards, Colaba would broadcast six pips at 0845 am and 0845 pm daily through All India Radio, Bombay. In the 1950s, the National Physical Laboratory at New Delhi, developed sophisticated methods of time measurement with modern technology and gradually took over IMD's work of time keeping. However, IMD was called upon to accept a very different kind of responsibility.

At the time of independence, the Gregorian calendar was in official use, while as many as 30 different panchangs were being followed by people for observing festivals and other purposes. In 1952, a Calendar Reform Committee

was constituted under the chairmanship of Prof. Meghnad Saha to develop a unified national calendar that would not only be based upon accurate astronomical data but which would also promote national integration. The committee recommended the preparation of (*i*) an Indian Ephemeris and Nautical Almanac, (*ii*) the adoption of a National Calendar of India using Saka Era with timings of tithis, nakshatras, yogas and festival dates, and (*iii*) the preparation of a common Rashtriya Panchang. with a solar calendar system for civil purposes and a luni-solar calendar system for religious purposes. This task was assigned to IMD and for implementing it a Nautical Almanac Unit was set up in Calcutta in 1955. This was renamed in 1979 as Positional Astronomy Centre and upgraded to an independent unit of IMD that now has its own building.

The Indian Astronomical Ephemeris is published annually by the Positional Astronomy Centre for providing astronomical data to observational astronomers and other users such as Panchang makers. The Rashtriya Panchang is also published every year in all major Indian languages including Sanskrit and Urdu. The National Calendar of the Saka era is compiled for every new year and it is displayed in all government offices and used in official documents.

IMD was earlier the timekeeper of the country. Now it keeps its dates with the nation. On 26 January every year, at the end of the spectacular Republic Day parade, IMD has the privilege of releasing into the skies thousands of tricolour balloons as the grand finale. Likewise on 15 August every year, the official function on Red Fort comes to an end with IMD's balloons flying high in the sky.

11. Evolution of IMD's services

When IMD was established in 1875, its two priority areas were shipping and agriculture. In the early years, ships were warned of impending storms only through visual signals hoisted at ports. Much later, around 1912, IMD began sending warnings to ships at sea by wireless messages. The interactions with ships were two-way as captains of ships docking at ports would also brief IMD meteorologists about the weather they had encountered at sea. In this manner, IMD could compile atlases of storm tracks over the Bay of Bengal and Arabian Sea. These atlases are still used for reference purposes. However, over the years, IMD's cyclone warning system has undergone a sea change.

In a country suffering from chronic droughts and aberrant rainfall, IMD saw the need to establish a Division of Agricultural Meteorology dedicated to improving agricultural productivity as early as in 1932. This was set up at Poona under the direction of Dr. L. A. Ramdas, who has come to be regarded the world over as the father of agricultural meteorology. IMD worked in close collaboration with agricultural institutions and set up a network of cooperating agromet observatories in the country besides its own central observatory at Poona. This Division compiled crop-weather calendars that farmers could consult for timing their field operations. Crop-weather relationships were arrived at for predicting crop yields. IMD started issuing farmers' weather bulletins over All India Radio in the 1950s and an Agromet Advisory Service for farmers was started in the 1970s which is now functional in all agroclimatic zones.

After the Second World War, military aviation saw a decline, but civil aviation got a sudden boost and required major operational support from IMD. All phases of aircraft operations are influenced by weather and the safety and economy of air transport depend to a large extent on the availability of reliable current weather information and forecast. As a member of the International Civil Aviation Organization (ICAO) and the World Meteorological Organization (WMO), India has to follow international regulations. At present, IMD is providing aviation meteorological services at 100 airports through four Meteorological Watch Offices (MWOs), functioning at New Delhi, Mumbai, Chennai and Kolkata, 18 Aerodrome Meteorological Offices (AMOs) and 82 Aeronautical Meteorological Stations (AMSs). India had just two airports in 1925 while it has 100 airports now. IMD has installed state of art observing systems at all major airports and it operates an Online Briefing System (OLBS) for pilots.

There is one particular activity that was initiated by Blanford in 1886 and which still continues in IMD, *viz*., the long range forecast of the southwest monsoon rainfall. Blanford's forecast was based on the snowfall over the Himalayas in the preceding winter as a single parameter. During Walker's time, the number of parameters went up to a hundred. In 1988, IMD adopted a 16-parameter model that worked well until 2001. In subsequent models the number of parameters was reduced drastically. In recent years, probabilistic and dynamic models have also been brought into operational use. Models have now been developed for smaller homogeneous regions and each separate month, for the onset date over Kerala and the northeast monsoon as well.

Although IMD has always been Indian in every way, meteorology is a global science. Observational data needs to be obtained from around the world and the forecast products have likewise to be globally disseminated. Common meteorological practices have therefore to be

Fig. 9. (Left) 1875 -Thermometer hut, (Centre) 1982 - India's own satellite with meteorological component launched and (Right) 2002-IMD's first Doppler weather radar installed

Fig. 10. (left) 1947 - Farmers' weather bulletins broadcast on All India Radio and (right) Now -IMD's mobile apps for farmers

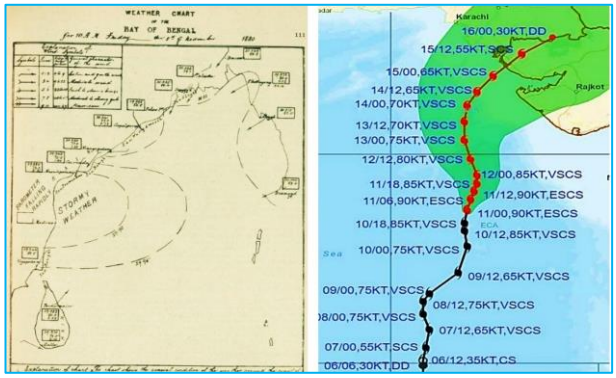

Fig. 11. (left) 1880 -Weather chartfor Bay of Bengal and (right) 2023 - Cyclone 'Biporjoy' track forecast

followed by all countries. It goes to IMD's credit that it has always been at par with the scientifically advanced countries in all respects. IMD has always acquired state of art technology, be it for observation, analysis, forecasting, dissemination or archival. This has helped IMD to always remain relevant to our country's growing and changing needs.

In 1875, thermometers would be hung in a frame inside an open hut and an observer would go in to record the temperatures (Fig. 9). By 1924, these huts were replaced by Stevenson screens as in other observatories elsewhere in the world. Methods and techniques of observation have since changed immensely and today, India has its own weather satellites and a countrywide radar network. IMD has developed mobile apps and people, especially farmers, can quickly get the weather information on their own mobiles (Fig. 10). In parallel with the advancement of technology, new branches of science like radar meteorology, satellite meteorology and numerical weather prediction have evolved over the last few decades. IMD runs its own numerical models on supercomputers, and disseminates its products over the internet, social media and mobile apps. IMD issues nowcasts, medium and extended range predictions and long range forecasts. Their spatial domains range from block level to the country as a whole. Tracks of tropical cyclones are now being predicted several days in advance (Fig. 11).

When Henry Blanford was appointed as the head of IMD in 1875, his designation was Imperial Meteorological Reporter to the Government of India. At that time, India was being ruled from Britain and IMD was basically expected to report on the weather situation here to the Crown. Accordingly, from 15 June 1878, IMD started issuing an Indian Daily Weather Report from Simla. In June 1886, after many years of trial runs, IMD ventured to issue its first long range forecast of the monsoon rainfall. In 1889, Blanford retired and was succeeded by John Eliot. During their tenures, IMD had grown far beyond its limited role of reporting. In 1899. Eliot's designation was changed to Director General of Observatories (Fig. 4). The underlying thinking was that his job was not just to report, but to direct and manage a fast-growing organization. This designation continued until 1976 when Y. P. Rao was the DGO (Fig. 5). Then once again, the topmost position in IMD was renamed as Director General of Meteorology, highlighting the importance of the science although it went hand in hand with service.

With the passage of time, IMD has had to redesign its core services as the country's priorities shifted from shipping to agriculture to civil aviation and so on. Unlike many other public service departments, IMD's services are derived from science. Their growth and efficiency are linked to advances in science and availability of newer technology. So by its very nature IMD is a scientific department. After independence, IMD had been under the administrative control of different ministries of the Government of India like Shipping, Transport, Communications, Tourism and Civil Aviation. It got its first recognition as a scientific department in 1986 when it was moved to the Ministry of Science and Technology. In 2006, after the creation of a new Ministry of Earth Sciences, IMD was brought under its purview. With the support provided by MoES, IMD has been able to modernize and expand its observational network and it has introduced several new concepts like impact - based

Fig. 12. IMD's logo (left) under the British Crown, (centre) after independence and (right) present

forecasting, colour-coded alerts and so on. MoES has also brought about a closer interaction between IMD and other institutions such as IITM, NCMRWF, NIOT and INCOIS under the MoES umbrella.

With the accelerated growth of the nation and its march towards a trillion dollar economy, the demand for meteorological services has been coming from many different quarters and IMD has always been responsive. IMD is now providing meteorological information and forecasts for optimum operation of a host of weather-sensitive activities like agriculture, irrigation, shipping, aviation, flood management, exploitation of solar and wind energy, offshore oil exploration, disaster mitigation, human health, air pollution, tourism and yatras. IMD has always kept pace with time as reflected in its logo (Fig. 12) and it is now future-ready.

12. On the right path

At the time of independence, India's population was 34 crores and its annual food grain production was 50 million tonnes. There were frequent droughts and food grains had to be imported. Today, India's population is 143 crores and its annual food grain production is 307 million tonnes. While our population has increased four times, our food grain harvest has increased six times. This is undoubtedly the result of a national effort, but IMD's weather services and forecasts for farming, agricultural planning, and water management have indeed played in it a crucial role. India is now an exporter of food, its granaries are full. Famines are a thing of the past. In a poor monsoon no one dies of hunger.

In the years gone by, tropical cyclones used to result in the death of tens of thousands of people, while the country could only watch helplessly. This is no longer so. With information received from radars and satellites, and with advanced numerical models, cyclone tracks and intensity are now being predicted accurately several days ahead, thus allowing time for disaster managers to alert people and move them to safer places. Even in an extremely severe tropical cyclone, loss of life has been reduced to near zero.

ॐ असतो मा सद्गमय । तमसो मा ज्योतिर्गमय । मृत्योर्मा अमृतं गमय । ॐ शान्तिः शान्तिः शान्तिः ॥ This is a prayer in the Brihadaranyaka Upanishad, beseeching the Divine to lead us from untruth to truth, from darkness to light, from death to immortality. The Bible too gives a glimpse of a future world which would be without sorrow, crying or pain, and in which there will be no more death.

IMD was established against the backdrop of the havoc caused by a tropical cyclone in 1864 and two famines in 1866 and 1871, with the expectation that advance information of storms and monsoon failures would become available. Today, IMD's mandate is much broader and more specific. However, deep in IMD's heart is the desire to do all it can towards the development of our nation and to protect precious lives from being lost because of inclement weather. Looking back on IMD's journey of 150 years we can say that it has largely succeeded in its endeavour and is on the right path heading towards a brighter future.

Acknowledgement

I am thankful to Dr. M. Mohapatra, DGM, for inviting me to write this article. Having spent 38 years of my life in IMD, starting as a scientific assistant, re-imagining IMD's long journey has been for me both nostalgic and inspiring. I have my own memories and recollections, but I have drawn mainly from the following three sources of information:

(*i*) A rare document dating back to mid-nineteenth century which the U. K. Met Office had been kind enough to trace out for me from their archives in Bracknell (Buist 1855).

(*ii*) The centenary volume of IMD in the production of which I had myself assisted as a young meteorologist (IMD 1976).

(*iii*) My own internet blog, Cloud and Sunshine, on which I have been writing since 2007 (Kelkar, 2023).

There are some pieces of information that I have obtained through personal communication. For these, I am indebted to late Dr. S. M. Kulshrestha, former DGM, Dr. O. P. Kejariwal, former CEO of Prasar Bharati and former Director of the Nehru Memorial Museum and Library, New Delhi and Amit Vachharajani, cinematographer and photographer.

Additional supporting material and a few photographs have been taken from internet sites in the public domain.

Disclaimer : The contents and views expressed in this study are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

References

Bhat, G. S. and Narasimha, R., 2007, "Indian summer monsoon experiments", *Current Science*, **93**, 153-164.

Blanford, H. F., 1877, "The Indian Meteorologist's Vade-Mecum", Thacker, Spink & Co. Calcutta, p281.

Buist, George, 1855, "History of Meteorological Research in India (1642-1850)", Dattatrayam, R. S., 2012, *Jour. Geol. Soc. India*, **79**, p98.

IMD, 1976, "Hundred years of Weather Service", India Meteorological Department, p207.

IMS, 1986, "Sir Gilbert Walker Selected Papers Long Range Forecasting of Monsoon Rainfall", Indian Meteorological Society.

Kejariwal, O. P., 2011, personal communication.

Kelkar, R. R. and Sreejith, O. P., 2020, "Meteorological sub-divisions of India and their geopolitical evolution from 1875 to 2020", *MAUSAM*, **71**, 4, 571-584.

Kelkar, R. R., 2023, Blog "Cloud and Sunshine", www.rrkelkar.wordpress.com.

Kulshrestha, S. M., 2003, personal communication.

Lahiri, Ashish, 2010, "Radhanath Sikdar Beyond the Peak", Boi-Chitra, Calcutta, p48.

Piddington, H., 1844, "The Horn-Book for the Law of Storms for the Indian and China Seas", Bishop's College Press.

Piddington, H., 1852, "Conversations about Hurricanes: for the Use of Plain Sailors", Smith and Elder Publishers.

RMS, 2023, Royal Meteorological Society web sites www.rmets.org/publication/classics/cp2.phpwww.rmets.org/publication/classics/walkerbliss.php.

Ray, Kamaljit, Kannan, B. A. M., Sharma, P., Sen, B. and Warsi, A. H., "Severe Thunderstorm Activities over India during SAARC STORM Project 2014-15 : Study Based on Radar", *Vayu Mandal*, **43**, 2, 2017 33.

Taba, H., 1991, "The Bulletin Interviews: Miss Anna Mani", *WMO Bulletin*, **40**, 287-297

WICSR, 2023, Walker Institute for Climate System Research web sitewww.walker-institute.ac.uk.

UCAR, 2023, University Corporation for Atmospheric Research, USA web site www.eol.ucar.edu/field_projects/summer-monex.

Vachharajani, Amit, 2023, personal communication.