

Hundred years of World Meteorology

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(Received 10 April 1973)

ABSTRACT. A review of International Meteorology during the past 100 years with reference to its impact on India and the contribution of India during this period has been presented. National developments in the recent past have been described briefly. An outlook for the next 100 years indicating the increased role of satellites, computers and weather modification techniques that could enable man to anticipate and control his atmospheric environment to his betterment is visualised.

1. Introduction

Meteorology, which is the science of the earth's atmosphere and the weather phenomena that take place within it, is inherently an international science because weather moves from one part of the world to another without regard to political frontiers. Weather over any area is influenced not only by conditions in adjacent areas but those in far distant areas. Thus to study the weather over an area it is essential to have observations from areas covering a few thousand miles on all sides. This has become specially necessary with the advent of jet aviation. This needs international co-operation in collecting and exchanging meteorological observations in internationally recognised codes and plotting them on weather maps covering almost a whole hemisphere or the whole globe according to an internationally standardised method, so that aircraft crew of any nationality looking at the weather map in a meteorological office can readily understand and appreciate the weather situation. When supersonic air transport services begin operating in the next few years, flying at heights of 60 to 80 thousand feet at speeds of about 2,000 miles per hour it will be necessary for the main meteorological offices to prepare weather charts covering almost a whole hemisphere. Preparation of such extensive weather maps will certainly need international co-operation.

The need for international co-operation in meteorology was first realised more than a century ago, in 1853, when a number of maritime countries held a meeting in Brussels and drew up a scheme of international collaboration in meteorological observations by ships at sea.

The Crimean war of 1853-56 in which the vital need for advance information about a catastrophe due to weather was realised led to the development of weather forecasting as a science. It was just round about this time—in 1851 to be exact—that the London Meteorological Office used its first weather chart.

The increasing interest in meteorological research led to a demand for far reaching co-ordination and standardisation of the methods and procedures in use in different countries. With these objectives, the world's foremost meteorologists came together at the First International Meteorological Congress which met in Vienna from 2 to 16 September 1873. The conference was attended by 32 representatives from 20 Governments. India participated in this meeting. The International Meteorological Organisation (I.M.O.) was formed in 1873, of which India was a founder member. This was a non-governmental body with Directors of national meteorological services as members and did very useful work. In September last year, the 100th anniversary of the I.M.O. was celebrated in Vienna.

The seventh conference of Directors held at Warsaw in 1935 established Regional Commissions of which Regional Commission for the Far East was one of the first two to be formed.

With the establishment of the United Nations, the I.M.O. was transformed into the World Meteorological Organisation on 23 March 1950. The W.M.O. Charter was signed by Dr. A. Ramaswami Mudaliar, Chairman of ECOSOC Committee on Negotiations with Inter-governmental Agencies on behalf of the United Nations. The

objectives of the organisation were to facilitate world-wide cooperation in the establishment of networks of meteorological observation stations and to promote the development of centres capable of providing the services of meteorology to promote the rapid exchange of weather information and the standardisation of meteorological observations and their publication, to further the application of meteorology to human activities and to encourage research and training in meteorology. The W.M.O. had 30 Member countries to start with and this number has now increased to 136 very close to universal membership. The four-year W.M.O. budget which stood at (U.S.) \$ 1,273,000 in the beginning rose to \$17,300,000 for the current period 1972-1975.

2. India's role in International Meteorology

2.1. *During the I.M.O. Period* — As mentioned earlier, India was a founder-member of the I.M.O. and was invited more than once to serve on some of the important committees. Mr. J. H. Field, a former Director General of Observatories, was elected member of the International Meteorological Committee in 1926. Dr. K. R. Ramanathan was elected member of Radiation Commission of the I.M.O. in 1932. Dr. S. K. Banerji was nominated Indian representative in 1936 on the Commission for Aeronautical Meteorology set up by the I.M.O. Shri S. Basu attended the I.M.O. Regional Conference held at Hong Kong in January 1937. The first session of the Regional Commission for Asia of the International Meteorological Organisation was held at New Delhi in November 1948 and was inaugurated by Late Prime Minister Shri Jawaharlal Nehru. At this conference, Dr. S. K. Banerji, the then Director General of Observatories, was elected unanimously as the President of the Regional Commission for Asia.

2.2. *During W.M.O. Period* — With the formation of the World Meteorological Organisation in 1950, India's activities in the field of international cooperation in Meteorology increased and gained importance.

Shri V. V. Sohoni, Director General of Observatories was elected President of the Regional Association for Asia in April 1951 and on his retirement in May 1953, the post went to Shri S. Basu, who continued to be the President of the Association till November 1959. Dr. S. N. Sen was elected Vice-President of the Technical Commission for Synoptic Meteorology during 1958-62 and later served as President of this Commission for two consecutive terms during the

period 1962-1968. Dr. L. S. Mathur was similarly the President of the Commission on Instruments and Methods of Observation for two consecutive terms during 1962 to 1967. India, except for a brief period has all along been a member of the W.M.O. Executive Committee. At the 6th Congress of the W.M.O. held at Geneva in 1971, Dr. P. Koteswaram, Director General of Observatories was elected a Vice President of the Organisation. This is the first time that an Asian has been elected to the high executive post in the Organisation and India got this honour after nearly 97 years of devoted service to the W.M.O.

India had the privilege of hosting conferences of major constituent bodies of the W.M.O. on three occasions. The first session of the Regional Association for Asia was held at New Delhi in February 1955, the Commission for Synoptic Meteorology held its second session at New Delhi in January-February 1958 and the second session of the Commission for Instruments and Methods of Observation also at New Delhi in January-February 1962. A number of W.M.O. working group meetings were held in the country since then. The sixth I.M.O. Prize was awarded for the first time to an Indian Dr. K. R. Ramanathan, in 1962. This is an award made to a distinguished meteorologist every year.

3. India's contribution to International Meteorological co-operation

India has provided members of Technical Commission and working group of the W.M.O. since its inception. 31 scientists have served as W.M.O. Experts in various countries in Asia, Africa and Latin America and at the W.M.O. Secretariat. Shri K. Parthasarathy and Shri S. K. Gupta, retired Meteorologists are now the Director of the Technical Co-operation Division of the W.M.O. and the Personal Assistant to the Secretary General respectively. Shri G. Vardarajan, Prof. Asstt. has recently joined as a technical officer. Dr. S. N. Sen, a retired Deputy Director General has been serving as Secretary of the ECAFE/WMO Typhoon Secretariat at Bangkok (recently shifted to Manila) since 1968. Indian Meteorologists have contributed significantly in the establishment/running of W.M.O. Regional Meteorological Training Centres at Lagos and Nairobi in Africa.

Another significant contribution made by India to international co-operation in meteorology is in providing facilities for training for quite a number of scientists from the Middle East and South East Asian countries in meteorology and related sciences. The Departmental Training

Directorate at Poona has, during the war years and thereafter, trained many foreign candidates, some of whom are now holding responsible positions in the Meteorological Services of their countries. The total number of foreign scientists so trained is 64 during the period 1947-72.

Special mention should be made of the significant role played by India Meteorological Department in some of the major international programmes of the Organisation like the International Geophysical Year/International Geophysical Co-operation Programmes (1958-60), International Quiet Sun Year (1964-65), International Hydrological Decade, International Pollution Studies Programme, Integrated Global Ocean Station System etc. Of current importance are the World Weather Watch (W.W.W.) and the Global Atmospheric Research Programme (GARP). The GARP is jointly sponsored by the W.M.O. and the I.C.S.U. since 1967 for the study of the physical processes in the troposphere and stratosphere that are essential for an understanding of the transient behaviour of the atmosphere and of the factors that determine the statistical properties of the general circulation of the atmosphere. A Special Monsoon Experiment (MONEX) is being organised under this programme for obtaining a better understanding of our Southwest Monsoon.

4. International Contribution to Indian Meteorology

The India Meteorological Department has been able to obtain from W.M.O. and UNDP substantial technical assistance in the shape of equipment, experts and training facilities abroad. Equipment and expert assistance of the value of U.S. \$ 873,000 was received from U.N. Special Fund in 1963-66 for the International Meteorological Centre, Bombay and the Institute of Tropical Meteorology. Telecommunication computers of the value of U. S. \$ 1.7 million are to be supplied by the Government of Netherlands early during the next plan period under the Voluntary Assistance Programme of the W.M.O. These will be housed in the new multi-storeyed building which is expected to be ready by the end of 1974.

57 officers of the Department have so far received advanced training in specialised branches of meteorology in foreign countries during 1947-72 under 'Overseas training programme' of Technical Co-operation Scheme such as Colombo Plan, UNDP etc.

5. World Weather Watch

Under the World Weather Watch programme of the W.M.O., New Delhi has been designated

as a Regional Meteorological Centre and a Regional Telecommunication Hub. Since August 1971, India has been disseminating the analysis and prognosis of surface and upper air charts by facsimile broadcasts round the clock. An I.B.M. 360/44 Computer prepares computerised weather forecasts for the whole of south Asia which would be broadcast round the clock for the benefit of weather sensitive activities like agriculture, irrigation, marine and aerial navigation etc in India and neighbouring countries. New Delhi has also been designated as the Area Forecast Centre under the International Civil Aviation Organisation.

As a Regional Telecommunication Hub, New Delhi is connected to Moscow, Melbourne, Tokyo, Cairo, Bangkok through direct RTT circuits. The global data exchanged through these systems is also disseminated through broadcast for the use of other countries.

6. National Developments

Hand-in-hand with international developments, India has been progressing rapidly in promoting Meteorology as a science and a service.

6.1. *Improvement in Cyclone Warning Organisation*

Of the 8 Cyclone Warning Radars planned to be installed along the east and west coasts of India, the one at Visakhapatnam has been functioning since 1970 and Madras since January 1973. The radars for Calcutta and Paradeep are to be installed before the end of 1973. Those at Masulipatnam, Karaikal, Goa and Bombay will be set up during the next 2 years. While the first 4 are imported foreign made radars, the other four will be manufactured in India by the Bharat Electronics Ltd. The radars will help the forecasters for issuing precise warnings of tropical cyclones to affected coastal areas.

Weather Satellite monitoring stations are functioning at Bombay, Delhi, Madras, Calcutta and Poona. Excepting the first one, the equipment for the rest has been manufactured indigenously by the Meteorological Department.

Cyclone Distress Mitigation Committees were formed by the Govt. of India for Andhra Pradesh and Orissa under the chairmanship of the Director General of Observatories to consider ways and means to mitigate human distress in the event of cyclones. The usefulness of the various programmes recommended by these Committees is already noticeable from the reduced death toll due to cyclones.

6.2. Meteorological Centres at State Capitals

To help the various States actively in their various development programmes, Meteorological Centres are being organised at the Capitals of all major States in addition to the existing 5 Regional Meteorological Centres at Bombay, Calcutta, Madras, Nagpur and New Delhi. Such centres have started functioning at Gauhati, Jaipur, Bangalore, Hyderabad, Trivandrum and Lucknow and others will commence at Bhubaneswar, Srinagar, Ahmadabad and Patna. Similar centres at other State Capitals will be established in the next plan period.

6.3. Flood Meteorological Offices

For effective support to flood warning, a special scheme of Flood Meteorological Offices has been sanctioned by the Govt. Six such offices are to be started in 1973. These will be responsible for computing quantitative precipitation forecasts and expected run-off in various river stages to be used by the flood forecasting centres of the Central Water and Power Commission. During the 5th Plan period, the whole country is proposed to be covered by 10-cm radars assisted by mini-computers that can be used for quantitative estimate of the flood potential of such storm.

6.4. Drought studies and crop Yield forecasts

A drought research unit has been established at Poona which is giving special attention to the occurrence of agricultural droughts in various parts of the country their intensity, periodicity etc. As a part of meteorological support for dry farming the probabilities of rainfall of different amounts during different weeks of the crop season on a district-wise basis have been worked out for 162 stations. Useful formulae have been developed for expected crop yields in different meteorological divisions based on antecedent weather factors like rainfall and temperatures.

6.5. Weather modification

With respect to drought mitigation, the only practical method is artificial rain-making. Experiments conducted by ground seeding with the aid of common salt in the Delhi-Agra-Jaipur area suggested 10 to 20 per cent increase in rainfall. Intensification of weather modification experiments using latest techniques of seeding clouds from aircraft in order to stimulate rain and firing seeding material into clouds with the help of rocket for hail suppression will be attempted during the Fifth Plan period. Such experiments will be tried over drought affected areas every year with a view to augment rainfall from

pre-existing clouds. A committee has just been set up by the Government of India under the chairmanship of Dr. P. Koteswaram, Director General of Observatories to work out details of these experiments.

6.6. The New Building

The existing Headquarters building of the India Meteorological Department carries still the name 'Aerological Office' and was meant to house the 'Upper Air Office' shifted from Agra in 1941. During 1942, the office of the Director General of Observatories which was originally at Simla before 1928 and later at Poona, was shifted to New Delhi to meet the demands of World War II services and housed in this building. From that time, several directorates have been created at Delhi and the building was soon found to be insufficient. The special requirements for the computers made the need for the new building more urgent. To meet the requirements the Govt. of India agreed for erection of a multi-storeyed building. The foundation stone of which was laid by Dr. Karan Singh, Minister of Tourism and Civil Aviation on 23 March 1973. The new building will be eight storeyed one with floor area of about 11,000 sq. metres. The estimated cost will be about Rs. 77 lakhs.

The foundation stone laying ceremony on 23 March 1973 happily commemorated the Centenary of World Meteorology. When the building is completed in 1975, the India Meteorological Department would have completed its century and the opening ceremony would commemorate that event.

7. Outlook for the next 100 years

During the past 100 years of world meteorology, particularly during the recent 2 or 3 decades, meteorology has made phenomenal progress. From earth-based observations, man has soared into space and is now capable of global overview of the world's weather. The radar has been used to probe into the heart of weather systems and determine their internal structure.

The electronic computer has revolutionised weather forecasting and it is now possible to produce accurate forecasts 2 to 5 days ahead and for longer periods in the near future.

What about the next 100 years? It will be hazardous to even to guess, since science often outbeats the wildest imagination of man. From a conservative estimate based on present day technology we may expect earth satellites both of the orbiting and the geostationary varieties to take over the chores of observing and reporting

the world's weather on a global scale. They would keep a surveillance of disastrous weather phenomena like cyclones, flood producing storms, droughts etc and warn the public well in advance about their onset. They would also monitor the incoming and outgoing radiation of the earth and global pollution as well as the water content of clouds useful for flood forecasting. The occurrence of data gaps over oceans and uninhabited areas, that has bedevilled meteorologists so far will be a thing of the past and the satellite will be able to probe every nook and corner of the earth from the surface upto hundreds of kilometres.

A network of geostationary satellites would collect and relay data all over the world and giant computers at 2 or 3 World Meteorological Centres would digest the prodigious amount of data and prepare forecasts of the world's weather from a few days to a few month's ahead. When comprehensive data are available and the physical processes of the weather well understood, it should be possible to forecast phenomena like the Indian monsoon a few months ahead and enable agricultural and irrigational operations, and storage of reservoirs etc on a planned basis.

Apart from improvements in forecasting world's weather, one would expect the next one hundred years to establish man's ability to control it

and tailor it to his needs. Weather disasters, like cyclones would be tamed and made to produce desirable rains rather than destructive winds. Fogs would be dissipated at airports and aircraft diversion due to weather would have been eliminated. Hail would be suppressed and converted into useful water. Above all, clouds would be induced to grow and precipitate over areas where they are needed and dissipated from regions where rain is no longer needed. Weather modification would be a powerful tool in the hands of man both in peace and war.

With his growing awareness of man's impact on climate, man would keep a vigilant eye and take remedial steps against environmental degradation due to his increasing activities in polluting land, water and air and releasing heat into the atmosphere in amounts comparable to incoming solar radiation.

One would visualise during the next 100 years a tantalising panorama of human achievement in anticipating and controlling his atmospheric environment which could produce immense good if used judiciously and cooperatively but drown him or parch him out of existence when used for destructive purposes. Let us hope and pray that the self-preserving instinct that has motivated man on this planet for the past few million years would help him in sustaining himself for his betterment and happiness.