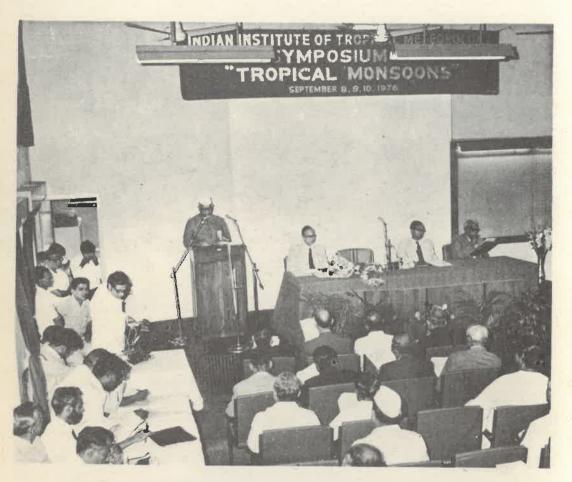
OF TROPICAL METEOROLOGY

ANNUAL REPORT 1976-77

RAMDURG HOUSE, UNIVERSITY ROAD, POONA-5.

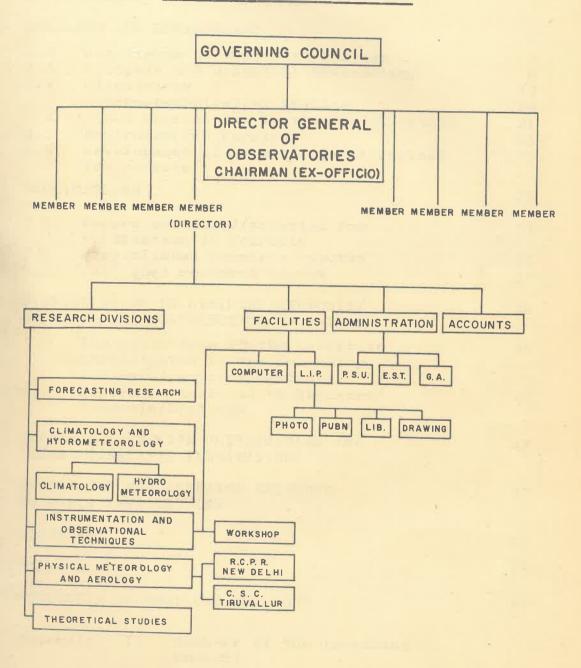
INDIA



Inauguration by the Minister of Tourism and Civil Aviation

INDIAN INSTITUTE OF TROPICAL METEOROLOGY

ORGANISATIONAL PROFILE



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1. INTRODUCTION



Welcome address by Director Dr. K.R. Saha

The Institute of Tropical Meteorology, which was a part of the India Meteorological Department, was constituted as an autonomous research organisation known as the Indian Institute of Tropical Meteorology and registered as a Society under Societies Registration Act (XXI) of 1860 on 1st April 1971.

The Institute is a National Centre for basic and applied research in tropical meteorology. Its primary functions are to promote, guide and conduct research in the field of meteorology in all its aspects, including weather modification, with special reference to the tropics and sub-tropics. The perspective and the scientific activities are oriented towards achieving fundamental understanding of the natural processes operative in this region as distinct from those in higher latitudes.

The scientific work of the Institute is carried out by the following research Divisions:

(1) Forecasting Research, (2) Climatology and Hydrometeorology, (3) Physical Meteorology and Aerology, (4) Instrumentation and Observational Techniques and (5) Theoretical Studies. A Computer Unit as well as a separate Library, Information and Publications Division provide the necessary supporting facilities.

The highlight of the year is the symposium on 'Tropical Monscons' held under the auspices of this Institute at Pune in September 1976. The Minister of Tourism and Civil Aviation, Government of India, inaugurated the symposium which was attended by a large number of national and international delegates. About 70 original scientific papers were discussed during the deliberations. The symposium at its concluding session held under the Chairmanship of Prof. Y.P. Rao, DGO and Chairman, IITM, GC, made certain broad recommendations regarding the future research work to be carried out on 'Tropical Monscons'. The proceedings were brought out by the Institute as a priced publication.

Two courses of Orientation Training in Meteorology were conducted at the Institute for providing the necessary background in Meteorology primarily to the members of the Institute pursuing research work, one from 5th April 1976 to 29th May 1976 and the other from 25 October 1976 to 17 December, 1976.

2. RESEARCH AND DEVELOPMENT



A section of the audience - Session in progress

2.00 Highlights of Research findings

The highlights of research carried out during the year 1976-77 are given below:

- i) A dry adiabatic frictionless fivelayer primitive equation model was developed and applied to two synoptic situations for prediction. The results were satisfactory.
- ii) A complete balanced diagnostic numerical model was developed and applied to study the intensification and structure of the monsoon depressions.
- iii) A numerical model for tropospheric infra-red cooling due to water vapour, including the effects of clouds, was developed.
- iv) Hemispheric meridional transport of sensible heat in the wave number regime during contrasting monsoon years was computed and studied for the period April to August. The results show that the northward transport of heat is more in the weak monsoon than in the strong monsoon.
- v) A technique that was developed for prediction of 5-day monsoon rainfall of various sub divisions gave satisfactory performance for Gujrat and Maharashtra when tested on 12 cases. As an aid to the conventional synoptic forecasting model, a technique was developed to help predict the rainfall probability at 110 stations in India. The technique may be useful provided the synoptic features on a day closely resemble those considered in the study.

- vi) Aerial cloud seeding experiments were conducted in the Poona Region during the monsoon of 1976.
- vii) It was concluded from the studies on barotropic instability of monsoonal zonal flow that the disturbance around the Bay of Bengal in the month of July can grow by receiving kinetic energy from the zonal flow even in the lower troposphere, and propagate westward with a phase speed around 8 m sec⁻¹. This may be one of the possible mechanism for the initial growth of depression.
- viii) One of the five parachutes sent to ISRO Thumba was flight tested. Of the ten Rocket Pay Loads developed, three were tested at ISRO with Menaka II Rockets. However, all the three flights proved futile due to technical difficulties.
- 2.01 Details of research activities
- 2.1 Synoptic and Dynamical Meteorology
- 2.1.1 Numerical Weather Prediction

(a) Barotropic model

A limited area primitive equation barotropic model using quasi-Lagrangian advective scheme was applied to predict the movement of monsoon depressions and tropical cyclone. The model was found to perform satisfactorily for advecting these disturbances upto 48 hours.

A technique was initiated for constructing the initial wind field around the centre of a tropical cyclone in a data gap region utilising available satellite cloud imagery and vertical temperature profile data. This technique was applied to the case of a tropical cyclone in the Bay of Bengal for the preparation of input data to the barotropic model,

(b) Multi-layer Primitive equation model

Development of a five layer primitive equation model was taken up. Computer programme of the model including effects of diabatic heating and frictional dissipation was written and tested. The model was in the stage of debugging.

Work on the parameterisation of cumulus convection for inclusion in the model was also continued. The modified Kuo's scheme was attempted. Applications of the Discrete version of the Arakawa's cumulus parameterisation technique was under development.

(c) Multidimensional initialisation for NWP models

The simple, linear, barotropic version of the primitive equations was utilised to prepare a balanced set of wind and height field, which might be suitable for being used as the initial data for NWP models. The 'dynamic' initialisation technique was used and two schemes were tested, viz., (i) averaging scheme (ii) Euler-backward scheme. Preliminary tests were conducted on both these schemes by comparing the mean divergences after a selected number of forward-backward iterations.

(d) Objective Analysis of Meteorological fields

A scheme for analysing objectively the meteorological fields like wind field was under preparation and experiments were in progress to incorporate the satellite data and other non-conventional data over oceanic regions and other

data sparse region for achieving a better analysis.

- 2.1.2 Extended Range Weather Prediction
 - (a) Statistical / Dynamical Prediction
 - (i) Prediction of 5-day and 10-day summer monsoon rainfall

Multiple linear regression equations were developed for predicting 5-day and 10-day rainfall of 33 meteorological sub-divisions in different monsoon months. The predictors were 5-day mean contour height and 5-day and 5-day mean-contour-height-anomaly at 104 grid points covering a region between 10°-45°N and 20°-145°E. The development sample consisted of 48 pentads and verifying sample of 12 pentads. The results were encouraging for western India (Gujarat and Maharashtra) in June and September.

(ii) Monthly fluctuation of tropical pressure field

Daily pressure data over the latitudinal belt 20°-30°N in the northern hemisphere were analysed to isolate the wave number 1 in the period range of 30-50 days. Preliminary analysis revealed that the trough/ridge position of this wave might have relationship on the fluctuations of large scale monsoon rainfall over India.

- (b) Synoptic climatological studies
 - (i) Synoptic climatology of daily upper level flow

Daily contour height patterns of 700 mb level over India, during summer monsoon season were classified by chart to chart correlation method, for

each month (July-September) for a period of 15 years. The conditional probabilities of 2.5 and 10 mm. or more rain at 109 stations associated with each type were computed. The utility of persistence and the conditional probabilities in forecasting rainfall over India for each day up to fifth day were compared. It was found that while persistence was a better forecast for the next day, the synoptic climatology could give better forecast beyond the 3rd day over the country.

(ii) Some characteristics of daily rainfall

Length of average dry and wet spells of rain days (> 2.5 mm.) for a period covering July and August and for a period covering July, August and September for 220 stations over India were computed. Rainfall contributed by falls of more than 2.5, 10, 35, 50 and 65 mm. were also computed for same stations in July and August. The fluctuation of monsoon rainfall between 15° to 25°N latitudes was studied through power spectrum analysis.

(iii) Fluctuations of pressure anomaly field in relation to circulation and rainfall

Daily pressure anomaly fields over the monsoon trough region over India (20°N-27.5°N and 72.5° to 95.0°E) for the months of July and August, were studied for 30 years. The pressure fluctuations were found to have a large scale (5000 km.) in the horizontal. The pressure anomaly field was also found to have a large persistence in time (5 to 10 days). Daily fluctuations of the anomaly of pressure, rainfall and shear of the zonal wind at 900 mb across the monsoon trough along 80°E were examined by spectral technique and distinct quasi periodicities were found in the period ranges of 10-12 days and 4-6 days.

(iv) Interaction between the West Arabian Sea and the Indian Monsoon

The hypothesis that the sea surface temperature in the west Arabian has a feed back effect on the monsoon rainfall, was examined through the analysis of surface pressure anomalies for a whole season. This analysis revealed that weakening and strengthening of the Indian monsoon were mainly related to the changes in general circulation over Indo-African region. The study also showed that the activity of the Indian monsoon did not depend on the strength of the cross equatorial flow of the SE trades known as the Somali Jet but the strength of the Jet did fluctuate in response to the monsoon activity.

(v) Energy aspects of the Summer monsoon circulation

A study on energy aspects of the summer monsoon circulation with July 1963 data, was completed. The important inferences were during the month of July 1963, there was conversion of available potential energy from zonal form to both standing and transient eddies and from standing eddy to transient eddies. There was conversion of kinetic energy almost in the reverse direction, the eddies supplying kinetic energy to zonal form. There was conversion of available potential energy to kinetic energy in cases of zonal current and standing eddy. The study also showed that there was generation of both zonal and standing eddy available potential energy due to diabatic heating.

(vi) Effects of long wave radiative cooling on synoptic scale monsoon disturbances

A numerical model for tropospheric infrared cooling due to water vapour including the effects of clouds was used to study the radiative effects in synoptic scale monsoon disturbances over the Indian region. Clouds were parameterised from the large scale moisture field as well as from the satellite observations and their effects were found to be most important in modulating the radiation field. Differential radiative cooling rates between cloudy and cloud free regions of the disturbances were found to play dynamically significant roles.

(vii) Basic and eddy kinetic energy during monsoon season

Zonal, meridional, total and eddy kinetic energy at several tropospheric levels for several Indian stations were studied for July and August for several years. The study revealed interesting features in the transient components during years of sub-normal monsoon rainfall vis-a-vis years of normal or above normal monsoon rainfall.

(viii) Study of Monsoon Depressions

A study on the vorticity budget and vertical velocity distribution associated with the life cycle of the monsoon depression over India during 3 to 6 August 1968 was completed. Three dimensional structure of the depression in wind, temperature and moisture field was discussed. Vertical velocity as computed by balanced diagnostic model was found to be in good agreement with the observed asymmetric distribution of rainfall around the depression. The presence of a low level of nondivergence (>> 800 mb) was found to play a significant role in the dynamics of the depression.

Vorticity budget over the period of intensification of the depression was computed and it was

found that deep convective clouds play an important role in the vertical transport of sub-grid scale vorticity in the western sector of the depression. These transports were also linked with the intensification and westward movement of the depression.

Three dimensional data of wind, temperature and moisture for another case study during the period 1st July to 10th July 1973 were completed for study of simultaneous formation and intensification of monsoon depressions in the Bay of Bengal and Northeast Arabian Sea.

(ix) Studies on mean monthly transport of momentum

Mean monthly momentum transport for the months of April through August by the standing eddies was computed during 1972 typical of a sub-normal monsoon rainfall year and during 1967 typical of a near normal monsoon year. The data utilised were at 700 mb and 300 mb level for the northern hemisphere. The study revealed significant differences in the transport of momentum by different wave numbers. Wave number 3 was found to transport momentum very much northward in 1967 compared to 1972. Contributions from higher wave number were found to be more prominent in 1967.

Sensible heat transport in the wave number domain was computed at 500 mb for the same two years. Wave numbers 1 and 2 showed contrasting features in the two years.

Non-linear energy exchanges between different wave numbers in the northern hemisphere for the sub-normal monsoon rainfall year (1972) and near normal monsoon rainfall year (1967) and for the mean monsoon conditions (based on mean data for 1951-1960) for the

months of April to August, were computed.

Meridional transport of momentum in the wave number regime based on the 5 day mean data for the months of July for the years 1958 to 1961 at selected latitudes was also computed. It was noticed that the transport of momentum at 50°N was very much southward in the situations dominated by western disturbances (mid-latitude troughs in the westerlies) and this transport was mostly contributed by wave numbers 2 to 5. The transport by wave number 1 was mostly northward.

2.1.3 Theoretical Studies

- (a) Dynamic Instability of the zonal flow
 - (i) Eigenvalue approach

Pure barotropic, pure baroclinic and a mixed (both barotropic and baroclinic combined) instability problem for zonal flow were solved and the preliminary results were scrutinised. The main conclusion was that the monsoonal zonal flow was stable baroclinically, but quite unstable barotropically.

(ii) Initial value approach

This approach was undertaken to study the effect of the structure of initial disturbance on barotropically unstable wave and the instability characteristics of monsoonal zonal flow analytically. Two symmetric and one anti-symmetric initial disturbances were considered and the barotropic energy conversion tendencies and the phase speeds of the disturbances were obtained from the analytical expressions derived for this purpose. A zonal flow

which was constructed from the first five harmonics of an observed mean pattern was taken as the basic flow. The anti-symmetric disturbance was stable, but the two symmetric disturbances, one of which corresponds to neutral Rossby wave, were unstable. The instability and the width of unstable spectrum was more for neutral Rossby wave compared to the other symmetric initial disturbance.

Analytical expressions to simulate the vertical profile of the monsoonal zonal flow and the static stability distribution were constructed and tested. These expressions were used to generate the basic initial inputs to the theoretical/numerical models.

(b) Simulation of mean monsoon circulation

A theoretical model of a jet stream was developed to simulate the various thermal characteristics associated with it. The preliminary results indicated existence of multiple tropopause, jet stream front and well-defined zones of clear air turbulence, in the field of the jet stream, where these might be generally observed in a real case. The model also showed steep vertical and horizontal temperature gradients in the areas where the clear air turbulence was likely to be observed.

In connection with the parameterization of convection, the problem of variability of eddies was considered and solutions obtained which were on the process of physical inter pretations.

A revised version of the primitive equation barotropic model, which was two and a half times faster than the earlier one, was developed. In addition, some computer routines to compute the geopotential from the stream function, spectral distribution of kinetic and potential energies, angular momentum and enstrophy were included in the main programme.

The solutions of an Ekman boundary layer model, in which the divergence arising out of 'p' effect was included, showed weak negative (downward) vertical velocities during pre-monsoon and post-monsoon seasons and strong positive values during active monsoon season, over head Bay of Bengal.

- 2.2 Climatology
- 2.2.1 Studies on summer monsoon
 - (a) Monsoon rainfall and airflow along the east African Coast

Relationship between the monthly mean sea level pressure difference between Aden and Zanzibar and monthly rainfall over the Indian west coast was investigated. This pressure difference was a broad measure of the air flow, ultimately reaching the Indian west coast in the lower levels. The extent of relationship concurrent as well as that with lag, between pressure difference and monthly rainfall at about 25 stations on the Indian west coast, was examined. Relationship between monthly pressure at on the west coast was also examined. The monthly rainfall and the west coast was also examined. The monthly rainfall along some sections of the west coast was significantly related to the pressure difference and the pressures at each of these two stations. For some sections and months, the relationship was highly significant.

(b) Oscillations of a monsoon system

The oscillations of the elements of a monsoon system were determined from spectral analysis. The elements of the monsoon system included the pressure of the monsoon trough, pressure of the Mascarence high, cross-equatorial low-level jet,

Tibetan high, tropical easterly jet, monsoon cloud cover, monsoon rainfall, dry static stability of the lower troposphere, and moist static stability of the lower troposphere. The salient result of this study was that there seemed to exist a quasi-biweekly oscillation in almost all of the elements of the monsoon system. Dominant modes were also found in the shorter time scales (6 days). A sequential ordering of elements of the monsoon system for the quasi-biweekly oscillation was carried out in terms of their respective phase angle. The principal result was that soon after the maximum dry and moist static instabilities were realized in the stabilizing phase, there occurred in sequence an intensification of the monsoon trough, satellite brightness, Mascarence high, Tibetan high and the tropical easterly jet. Soon after that, the rainfall maximum over central India, arising primarily from monsoon depressions, was found to be a maximum. The following possible reasons for biweekly oscillation in monsoon system were offered: (i) Response of the monsoon system to winter hemisphere disturbances, (ii) Planetary scale propagation waves in the pressure and satellite brightness over the northern hemisphere global tropics, or (iii) Natural oscillation of the broad scale monsoon system due to its own inherent dynamics.

(c) Statistical properties of southwest monsoon rainfall of northwest India

Summer monsoon rainfalls of 5 sub-divisions of northwest India, viz. West Rajasthan, East Rajasthan, Gujarat, Saurashtra - Kutch and West Madhya Pradesh, for the period 1901-75 were examined. Rainfall over each of these sub-divisions was normally distributed. The highest coefficient of variation of 37% was found over Saurashtra - Kutch. A significant increasing trend in rainfall was observed over the west Madhya Pradesh. Thus there was no reason to believe that rainfall over northwest India was decreasing. Power spectrum analysis indicated the presence

of Quasi-Biennial Oscillation in the rainfall of all the sub-divisions of northwest India except west Madhya Pradesh.

- 2.3 Hydrometeorological Studies
- 2.3.1 A study of October, 1955 rainstorm which caused unprecedented rainfall in the Beas-Sutlej Region

The incidence of most-severe rainstorms over the Beas-Sutlej region was examined. The rain storm of October, 1955, was found to be unprecedented over this region as it gave maximum rain depths over a large area and caused severe flood in all the rivers of Punjab. A detailed hydrometeorological analysis of this unique rain storm was therefore undertaken. It was found that during the period 3rd to 6th October 1955, the Beas basin upto Pong dam site experienced a record rain depth of 11.3 inches which was equal to about 2.9 x 106 acre-feet of water.

2.3.2 Estimation of maximum water potential generated by severe-most rain storms over and near Betwa basin upto Rajghat dam site

To determine the water resources potential of the Betwa river basin, the severe rain storms which occurred over the basin during the past 76 years were analysed. It was seen that of these severe rain storms, the June, 1945 rain storm was the most severe one and caused a rain depth of 31 cms. over the basin in 3 days. The water potential generated due to this storm was found to be of the order of 5012 x 106 cubic meters. Frequency analysis of rain storms over the Betwa basin showed that the frequency of occurrence of this storm was of the order of 175 years. It was

also observed that in case September 1910 rain storm, which had its centre outside the basin, had occurred over the basin, it would have generated a volume of water equal to 5908 x 10⁶ cubic meters. The frequency of occurrence of this rain storm was found to be of the order of 650 years.

2.3.3 A study of maximum probable point precipitation (PMP) over Karnataka State

One-day PMP estimates of about 300 rainfall stations spread uniformly in and near the three subdivisions of Karnataka State viz. (a) Coastal, (b) Interior north and (c) Interior South Karnataka, were determined using Hershfield statistical technique, as approved by the W.M.O. For this purpose, extreme annual rainfall data were scanned for a period of about 78 years (1891 to 1966). On the basis of this study, a generalised point PMP chart for one-day duration for this region was prepared for the use of hydrologists and hydraulic engineers.

2.3.4 A preliminary study of travel time of monsoon depression over the Indian sub-continent

Travel time of about 260 monsoon depressions which occurred during the period 1931-70 was studied from the time of their crossing the east coast to the time they finally got dissipated over the land or moved into the Arabian Sea. It was seen that on an average 6 to 7 depressions crossed the east coast during the monsoon. A maximum of 9 depressions and a minimum of two depressions crossed the east coast in the year 1937 and 1938 respectively. The average speed with which these disturbances travelled over the land area was found to be of the order of 300 kms, per day. However,

on the day of crossing the east coast, the average speed was found to be slightly higher. The maximum and the minimum speeds were found to be of the order of 885 and 50 kms. per day respectively. It was, however, found that on rare occasions, a disturbance took more than 4 to 6 days to move through a basin or a group of basins. As an example, in September 1900, it took nearly 5 days for a disturbance to move through the lower Mahanadi basin.

2.3.5 Estimation of maximum one-day point rainfall for different return periods over North Indian plains using average sub-divisional rainfall ratios

An attempt was made to obtain one-day maximum point rainfall of different return periods for stations in the plain areas of north India with the help of a 2-year generalised rainfall chart and corresponding average rainfall ratios of 5, 10, 25, 50 and 100-year to 2-year rainfall. To obtain fairly accurate estimates, ratios were worked out separately for each meteorologically homogeneous sub-divisions of north Indian plains. It was seen that the maximum rainfall estimates obtained by this method for any station in north Indian plains tallied well within + 3% of the estimates obtained by using Gumbel's extreme value distribution. The procedure might be useful to the design engineers in working out maximum rainfall for any station in the north Indian plains without undertaking detailed and time-consuming calculations.

- 2.4 Cloud Physics and Weather Modification
- 2.4.1 Cloud Physics

Research work on atmospheric electricity, cloud microphysics and cloud seeding was continued. Certain investigations undertaken earlier on (i) the electrical and microphysical characteristics of

clouds in maritime and urban environments, (ii) the vertical distribution of cloud condensation nuclei in the maritime and continental environments, (iii) the electrical and microphysical characteristics in warm cumulus clouds before and after seeding, (iv) the rainfall variations around a thermal power station and on (v) the electrical and microphysical conditions in clouds of the upwind and downwind regions of a thermal power plant, were completed.

The preliminary evaluation of the cloud seeding experiments conducted on 18 pairs of days during 1975 by the Gujarat State Government suggested positive result on 8 pairs, negative result on 6 pairs, and inconclusive result on 4 pairs. The results were not statistically significant. Preliminary analysis of the available rainfall data on 15 pairs of cloud seeding experiments conducted at Poona during 1976 suggested positive result on 6 pairs, negative result on 5 pairs and inconclusive result on 4 pairs. The results were not statistically significant.

2.4.2 Weather Modification

Mock cloud seeding experiments were carried out during the winter season of 1976-77 at Delhi. Evaluation of results of winter mock cloud seeding experiments from radar and rainfall data for the period 1957-68 was in progress.

Study of percentage frequency of occurrence of convective type echoes of different vertical extent at Delhi was in progress.

Measurement of SO2 concentration and aerosols in the air over Delhi was carried out in connection with the study of atmospheric pollutation.

Ground based cloud seeding experiments were conducted from 1st June to 31st December 1976 at Tiruvallur, Tamil Nadu.

2.5 Environmental Physics

Research work on atmospheric boundary layer, upper atmosphere and on air pollution was continued. Certain investigations undertaken earlier on (i) the singularities in northeast monsoon rainfall in Tamil Nadu and (ii) on the solar activity and rainfall pattern in Tamil Nadu during the northeast monsoon, were completed.

Studies on the (i) chemical state of the atmosphere and its influence on the local rainfall, (ii) stratospheric warmings and their influence on the Indian summer and winter monsoons using the rocketsonde temperature and wind data, (iii) association between the terrestrial and extraterrestrial phenomena and the Indian rainfall and on the (iv) atmospheric flow in the baroclinic boundary layer of the atmosphere, were in progress.

- 2.6 Development of Meteorological Payload for rockets
- 2.6.1 Development of meteorological Payload for Rockets and Satellites

Five parachutes were sent to ISRO - Thumba for testing on Menaka-II Rocket. One of them was flight tested by deploying at 46.6 KM. and tracking

upto 36 Km.

Ten Rocket payloads were developed for flight test at ISRO - Thumba.

Some studies of satellite-based temperature measurement physics and data retrieval from satellite radiance measurements were completed.

Thumba rocket data analysis was being carried out towards thermal and wind structure studies.

2.6.2 Development of Instruments for Boundary-Layer Studies

Field tests of the instruments for wind profile measurement were conducted. Some of the work on Digital data acquisition system was completed.

A beginning was made towards theoretical and experimental studies pertaining to the development of a wind tunnel for laboratory simulation of the atmospheric boundary layer.

3. PUBLICATIONS



Chairman organising committee explaining his paper at Symposium on 'Tropical Monsoons'

Sr. No.	Title of the paper	Author(s)	Journal in which published
6.	High level Summer Warmings and their possible association with monsoons.	B.K.Mukherjee and Bh.V.Ramana Murty	Ind.J. of Radio and Space Phy- sics, Vol. 5, March 1976
7.	Solar Activity and rainfall patterns of Tamil Nadu during northeast Monsoon.	R.S.Reddy, B.K.Mukherjee and Bh.V.Ramana Murty	Ind.J. of Radio and Space Phy- sics, Vol. 5, March 1976.
8.	Singularities in northeast monsoon rainfall of Tamil Nadu.	R.S.Reddy and Bh.V.Ramana Murty	Ind.J. of Radio and Space Phy- sics, Vol. 5, No.4, 1976.
9.	Numerical Experiment with primitive equation barotropic model to predict movement of monsoon depressions and tropical cyclones.	S.S.Singh and K.R. Saha	J. of Applied Met. U.S.A., Vol.15, No.8, 1976.
10.	Electrical and micro- physical measurements in warm cumulus clouds before and after seeding.	A.S.R.Murty, A.M.Selvam, R.Vijaykumar, S.K.Paul and Bh.V.Ramana Murty	J.of Applied Met., U.S.A., Vol.15, No.16, 1976.

Sr. No.	Title of the paper	Author(s)	Journal in which published
11.	Rainfall variations around a Thermal power station.	A.M.Selvam, G.K.Manohar and Bh.V.Ramana Murty	J.Atmos. Environment. U.K., Vol.10, 1976.
12.	Airborne electrical and microphysical observations in the environment of a thermal power station.	A.M.Selvam, A.S.R.Murty, R.Vijaykumar and Bh.V.Ramana Murty	J.Atmos. Environ- ment. U.K., Vol.10, No.11, 1976.
13.	Reply to 'comments on the role of electric forces in charge separation by falling precipitation in Thunder Clouds-W.D. Scott and Z.Levin'.	A.K.Kamra	J. of Atmos. Sc., U.S.A. Vol.33, No.10, Oct. 1976.
14.	Oscillations of a monsoon system Part-I Observational Aspects.	H.N. Bhalme and T.N.Krishna- murti	J. of Atmos. Sc., U.S.A. Vol.33, No.10, Oct. 1976.
15.	Comments on 'Effects of Arabian sea-surface temperature anomaly on Indian Summer Monsoon. A numerical experiment with the GFDL model'.	D.R.Sikka and K.Raghavan	J. of Atmos. Sc., U.S.A. Vol. 33, No. 11, Nov. 1976.

Sr. Title of the paper Author(s) Journal in which published

- 16. Prominent wave disturbances over the region east of Indian Ocean during a quasibiennial oscillation.
- 17. An operational rain stimulation experiment using warm technique over Rihand Catchment in northeast India during

summer monsoons of

18. Results of two years of randomised cloud seeding experiment in the Deccan Plateau-India.

1973-74.

- G.Appa Rao and Bh.V.Ramana Murty
- R.K.Kapoor, K.Krishna, R.N.Chatterjee, A.S.R.Murty, S.K.Sharma and Bh.V.Ramana Murty
- K.Krishna,
 R.K.Kapoor,
 A.S.R.Murty,
 S.Rajamani,
 A.M.Selvam,
 L.T.Khemani,
 K.K.Kanuga,
 B.K.Mukherjee,
 S.K.Paul,
 R.S.Reddy,
 G.K.Manohar,
 Brij Mohan,
 R.Vijaykumar
 and
 Bh.V.Ramana

Murty

- J. of Pure and Applied Geophysics, Switzerland, Vol.114, 1976.
- J. of Weather Modification, California, Vol.8, No.1, Oct. 1976.
- J. of Weather Modification, California, Vol.8, No.1, Oct. 1976.

Sr.	Title of the paper	Author(s)	Journal in which published
19.	Results of precipitation enhancement project by surface seeding during winter at Delhi.	R.N.Chatterjee, R.K.Kapoor, Gurumukh Singh and Bh.V.Ramana Murty	J. of Weather Modifica- tion, California, Vol.8, No.1, Oct. 1976.
20.	A study of moisture flux across the west coast of India and Rainfall during the southwest monsoon.	S.N.Bavadekar and K.R. Saha	Quart. J. Roy.Met. Soc. U.K. Vol.103, 1977.

3.1 (B) Papers accepted for Publication in Journals

Sr.	Title of the paper	Author(s)	Journal
1.	Local influence of SE trades of the west Indian ocean.	K.Raghavan and D.R.Sikka	Ind.J.Met. Hydrol. Geophys.
2.	Relationships bet- ween central rainfall and its fluctuations over Andhra Pradesh.	O.N.Dhar and B.K. Bhattacharya	Irrigation and Power, CBI and P, New Delhi.
3.	A review of the basic studies of the phy- sics and dynamics of clouds in India.	A.K. Kamra	Vayu Mandal.
4.	Effect of the incli- nation of the elec- tric field on induc- tive charging mecha- nism in thunder clouds.	A.K. Kamra	J. of Atmos. Sc., U.S.A., April, 1977.
5.	Comments on calculation of electric field growth within a cloud of finite dimension.	A.K. Kamra	J. of Atmos. Sc., U.S.A., May, 1977.

3.2 Prepublished research reports

Sr.	Title of the	Author	Research
No.	Research Report		Report No.
1.	On the behaviour of the 24 hour pressure tendency oscillations on the surface of earth:	B.M.Misra	RR-011 A

3.3 Published research report

Spectrum Analysis for the Extra tropical station.

Proceedings of Symposium on 'Tropical Monsoons'

4. PARTICIPATION IN SEMINARS/ SYMPOSIA/MEETINGS AND CONTRIBUTION OF PAPERS



A happy re-union at Symposium on 'Tropical Monsoons'

4.1 The scientists of the Institute participated in the following seminars/symposia/meetings.

		THE PERSON NAMED IN
Sr. No.	Seminars/Symposia/Meetings	Name(s) of scientists who attended
1.	19th COSPAR meeting and associated Symposia held at Philadelphia, USA from June 4 to 29, 1976.	Dr. K.R. Saha
2.	3rd Annual Convention of Poona Chapter of Computer Society of India at Poona June 18-19, 1976.	Shri S.S.Aralikatti Shri D.R.Sikka Shri R.Suryanarayana
3.	International Conference on Cloud Physics, held at Boulder, Colorado July 26-30, 1976.	Shri R.K. Kapoor (Co-Chairman)
4.	International Conference on Weather Modification, August 2-6, 1976, held at Boulder, Colorado, USA.	Shri R.K. Kapoor
5.	International Symposium on 'Recent Climatic Change and Food Problems' held at Tsukuba and Tokyo, Japan from October 3-10, 1976.	Dr. K.R. Saha
6.	'ECOBAL' Programming Training conducted by Poona Chapter of Computer Society of India, October 15-18, 1976.	Shri K.C.Sinha Ray

Sr.	Seminars/Symposia/Meetings	Name(s) of scientists who attended
7.	'Bhakra Dedication Day' Technical Symposium held at Nangal Township, Punjab on October 15, 1976.	Dr. O.N. Dhar Shri A.K.Kulkarni
8	Meeting of the Advisory Group on MONEX held at Physical Research Laboratory, Ahmedabad in October 1976.	Shri D.R. Sikka
9.	Quality improvement programme course on 'turbulence in fluid flow' organised by Aeronautical Engineering Department I.I.T., Kanpur, December 4-23, 1976.	Shri S.Sivarama- krishnan
10.	Quality improvement programme course on 'Some laboratory experiments on basic fluid mechanics' organised by Department of Aeronautical Engineering, Indian Institute of Science, Bangalore January 5-10, 1977.	Shri R.N.Sengupta
11.	12th Annual Convention of Computer Society of India, held at Pune, January 9-12, 1977.	Shri K.Krishna Shri R.Suryanarayana Shri S.S.Aralikatti
12*	Space Science symposium, January 18-21, 1977, at Vikram-Sarabhai Space	Shri K.G.Vernekar Shri R.K.Gupta

Centre, Trivandrum.

Sr.	Seminars/Symposia/Meetings	Namess) of scientists who attended
13.	Indo-French Workshop on Numerical Weather Fore- casting held at IIT, New Delhi in January, 1977.	Shri S.S.Singh Shri Shrinivas Moorthi Shri S. Sinha
14.	Golden Jubilee Session of the Central Board of Irrigation and Power and Symposium on 'Silting of Reservoirs' at New Delhi, March 1-4, 1977.	Dr. O.N.Dhar
15.	International Symposium on Monsoon held at New Delhi March 7-12, 1977.	Shri D.R. Sikka Shri S.V. Singh Shri D.K. Paul Shri S.Rajamani Shri S.T. Awade Shri K. Raghavan
16.	International Symposium on Monsoon held at New Delhi March 7-12, 1977.	Dr. O.N. Dhar
17,	The Special Course on Fortran-10 Programming with Graphics, at Poona March 17-24, 1977.	Shri S. S. Arali- katti

- 4.2 Papers contributed to Seminars/Symposia/Meetings
- (A) COSPAR meeting and associated symposia, Philadelphia, USA, June 8-19, 1976:
 - i) Satellite input to analysis for prediction of movement of tropical cyclones in the Indian monsoon region K.R. Saha, S.S. Singh.
- (B) International Conference on Cloud Physics, July 26-30, 1976, Boulder, Colorado:
 - i) Cloud droplet spectra, aerosol concentrations and rain activity in maritime, modified maritime and continental region R.K. Kapoor, S.K.Paul, L.T.Khemani, S.K. Sharma, A.S.R. Murty, K.Krishna and Bh.V.Ramana Murty.
 - ii) Aircraft measurements relating to secondary ice crystal production in Florida cumuli John Hallet, Dennis Lamb, A.S.R. Murty, Robert L. Sax.
 - iii) Field measurements obtained with 'Two Optical Ice Particle Counter' in cumulus clouds over Florida F.M.Turner,
 A.S.R. Murty, R.L.Sax and L.F. Radke.
- (C) 2nd W.M.O. Scientific Conference on Weather Modification, August 2-6, 1976, Boulder, Colorado:
 - i) Frequency of occurrence of seedable clouds based on measurements of droplet spects R.K. Kapoor, S.K.Paul, B.K. Mukherjee, S.K. Sharma and Bh.V. Ramana Murty.

- ii) An operational rain simultation experiment using warm technique over Rihand Catchment in north east India during Summer monsoons of 1973 and 1974 R.K. Kapoor, K. Krishna, R.N. Chatterjee, A.S.R. Murty, S.K. Sharma and Bh.V.Ramana Murty.
- iii) An experimental study of medium scale diffusion at cloud base level K.Krishna, L.T. Khemani, K.K. Kanuga, B.K. Mukherjee, S.K. Sharma, G.A. Momin and Bh.V.Ramana Murty.
- (D) Proceedings of the technical symposium on Bhakra Dedication Day at Nangal Township, October 15, 1976:
 - i) A study of October, 1955 rainstorm which caused unprecedented rainfall in the Beas-Sutlej region O.N. Dhar and P.R.Rakhecha.
- (E) Space Sciences Symposium held in Trivandrum, January 18-21, 1977:
 - i) Estimated temperature correction for Menaka-II Meteorological Rocket Payload.
- (F) International symposium on 'Monsoons' held at New Delhi, March 1977:
 - i) Meridional transport of momentum in the wave number regime during the contrasting monsoon years S.T.Awade, K.S.Raja Rao and G.C.Asnani.
 - ii) Monitoring of semi-permanent troughs and ridges in relation to monsoon G.C. Asnani and S.T. Awade.
 - iii) On the vorticity budget and vertical velocity distribution associated with life cycle of a monsoon depression - S.M.Daggupaty and D.R.Sikka.

- iv) Influence of the topography of the Indian sub-continent on the mean summer circulation Sulochana Gadgil and D.R. Sikka.
 - v) Large scale rainfall over India during the summer monsoon and its relation to the lower and upper tropospheric vorticity D.R.Sikka and Sulochana Gadgil.
- vi) Interaction between the West Arabian Sea and the Indian monsoon K. Raghavan, P.V.Puranik, V.R.Muzumdar, D.K.Paul and P.M.M.Ismail.
- vii) Diagnostic study of monsoon depression K.V.Rao, G.S.P.Rao and S.Rajamani.
- viii) Numerical Experiment with primitive equation barotropic model using quasi-Lagrangian advection scheme to predict the movement of monsoon depression and tropical cyclone S.S.Singh and K.R.Saha.
 - ix) Dynamics of Orographic Rainfall K.C. Sinha Ray.
 - x) An analytical study on barotropic energy conversion in the lower tropospheric monsoonal flow S.K. Mishra.
 - xi) On some aspects of Orographic rainfall in India Dr. R.P.Sarker, K.C.Sinha Ray and U.S.De.
- (G) National Seminar on 'Time and Frequency' held at National Physical Laboratory, New Delhi.
 - i) A technique of pulse-modulation telemetry using a logical model of multiplexing R.N.Sengupta and K.G.Vernekar.
 - ii) Digital clock and elapse time generator data acquisition system L.K.Sadani.

5. COLLABORATION WITH UNIVERSITIES AND OTHER SCIENTIFIC INSTITUTIONS

5.1 Collaboration with Universities:

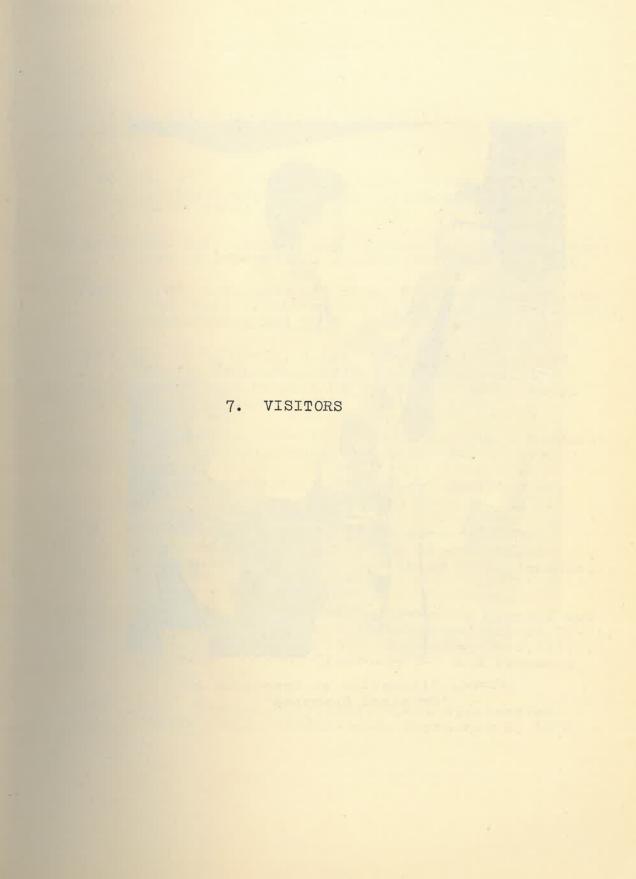
- (a) The Institute continued to be recognised by the University of Poona as an approved Institution for research in atmospheric sciences, leading to the award of M.Sc. and Ph.D. degrees. It also continued to be recognised as a centre for advanced research in Physics (Meteorology) by the following Universities:
 - i) Banaras Hindu University, Varanasi,
 - ii) Nagpur University, Nagpur,
 - iii) Bombay University, Bombay,
 - iv) Andhra University, Waltair,
 - v) Bangalore University, Bangalore,
 - vi) Kerala University, Trivandrum,
 - vii) Maharaja Sayajirao University, Baroda.
- (b) Shri Y.S.Gondhalekar, Senior Scientific Assistant, L.I.P. Division, was awarded Ph.D. degree in Geography in the Faculty of Science by the University of Poona for his thesis entitled 'Spatial Analysis of Yields of Major Crops of Maharashtra in relation to climatic conditions'.
- (c) Shri D.R.Sikka, Senior Scientific Officer, Grade I participated in research in tropical meteorology at the Florida State University, Tallahassee (USA) during November 1976 to March 1977.
- (d) Dr. Y.S. Gondhalekar continued to be a member of the Board of Studies in Geography and Meteorology of Shivaji University, Kolhapur, Maharashtra.

- (e) On invitation from the Honorary Director, U.G.C.
 Refresher Course in Geography, University of
 Poona, Dr. D.A. Mooley, Senior Scientific Officer
 Grade I, delivered a lecture on 'Some aspects of
 the Summer Monsoon of Asia' to the University
 Geography Teachers attending the Refresher Course.
- 5.2 Collaboration with other scientific Institutions:
 - (a) The Institute continued to be Institutional member of Marathi Vidnyan Parishad.
 - (b) Dr. D.A. Mooley, Assistant Director (Climatology), was elected as a Fellow of the Maharashtra Academy of Sciences.
 - (c) On invitation from the I.I.Sc., Bangalore Shri D.R.Sikka visited the centre for Theoretical Studies in October, 1976.
 - (d) Shri R. Suryanarayana delivered ten lectures to the Officers undergoing Senior Forecaster's Course at the Air Force Administrative College, Coimbatore, during October 11-15, 1976.

6. FACILITIES FOR RESEARCH EXTENDED TO OTHER INSTITUTIONS

Air India instituted two fellowships for research in tropical meteorology at the Institute. Shri B.K. Bandyopadhyay was awarded the Air India Research Fellowship with effect from 14.3.1977.

Kumari P.G. Kulkarni, Air India Research Fellow, continued her research study in the Institute.





Informal discussion at Symposium on 'Tropical Monsoons'

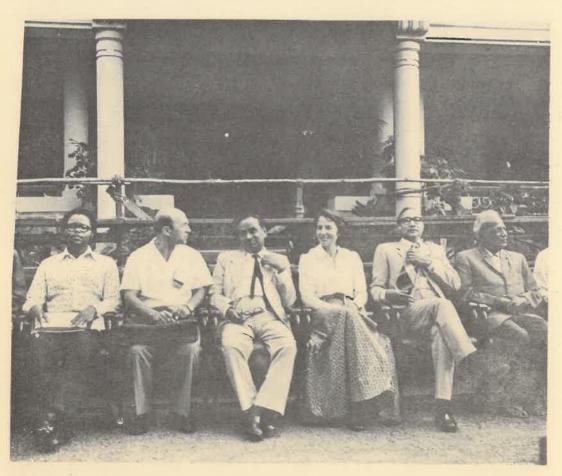
The following visited the Institute during the year of report:

- i) A batch of 8 Meteorological Officers from Administrative College, Coimbatore, May 5-15, 1976.
- ii) Dr. S.P. Pandya, Deputy Director, Physical Research Laboratory, Ahmedabad-6, May 15, 1976.
- iii) Prof. A.M. Kale and Prof. L.R. Ganeshan of the Institute of Social Engineers and Entrepreneurs, Bombay, May 28, 1976.
- iv) Dr. P.C. Chain, Chief Technical Adviser and Mr. S. Nesadurai, Technical Adviser of the Tech. Support unit of the W.M.O./ESCAP Panel on Tropical Cyclones, June 28, 1976.
 - v) Three scientists from the Indian Space Research Organisation, Bangalore, July 19-21, 1976.
- vi) Shri N.K. Mukherji, Secretary, Ministry of Tourism and Civil Aviation, July 28, 1976.
- vii) Review Committee for India Meteorological Department appointed by the Government of India under the Chairmanship of Dr. R.Ramanna, August 30-31, 1976.
- Viii) Shri Y.P. Rao, Chairman, Governing Council and Director General of Observatories, August 30-31, 1976, September 1, 1976, September 7-10, 1976, December 31, 1976, February 2-3 and February 25-26, 1977.
 - Prof. Yashpal, Director, Space Application Centre, ISRO, Ahmedabad-2, September 2, 1976.

- x) Shri G.D. Budhiraja, Section Officer, Ministry of Tourism and Civil Aviation, September 20-21, 1976.
- xi) Dr. Hari Narain, Director, National Geophysical Research Institute, Hyderabad and Member, Governing Council, I.I.T.M., September 21, 1976.
- xii) Teachers and a batch of 50 students belonging to B.Sc. Class, from Udai Pratap College, Varanasi, September 27, 1976.
- xiii) Wg. Cdr. M.S. Mawla, Director, Bangla Desh Met. Service, October 7, 1976.
 - xiv) Fifty students from Maharashtra Vidyalaya, Barsi (Dist. Sholapur), October 20, 1976.
 - xv) A batch of probationers belonging to the Indian Statistical Service, November 20, 1976.
 - xvi) Thirty Eight participants of Re-orientation Course in Mathematics from Abasahab Garware College, Fune, November 26, 1976.
- xvii) Dr. Rolando Garcia from International Federation of Institutes for Advanced study, December 6, 1976.
- xviii) Shri A.S. Bhatnagar, Joint Secretary, Ministry of Tourism and Civil Aviation and Member, Governing Council, I.I.T.M., December 7, 1976.
 - xix) Shri S.D. Kulkarni, Additional Chief Engineer (Irrigation) and Shri P.K. Kulkarni, Executive Engineer, Irrigation Department, Aurangabad, December 20, 1976.
 - A team of 10 members from India Meteorological Department Pune, undergoing Advanced Refresher's course on Numerical Weather Prediction, December 24, 1976.

- Dr. George W.Robertson, Agro-meteorologist and Consultant to UNDP FAO, December 30, 1976.
- xxii) Fifty students of Dnyan Prabhodhini, Pune, January 19, 1977.
- Shri J.M. Walker, Lecturer in the Department of Maritime Studies, University of Wales, Institute of Science and Technology, Cardiff, U.K. was attached to the Institute from December 21, 1976, to January 12, 1977.
 - xxiv) A batch of students from Agricultural University, Kanpur, January 28, 1977.
 - xxv) Prof. R. Narasimha, Member, Governing Council, I.I.T.M., February 6, 1977.
 - xxvi) Shri S.M. Virmani, Agro-meteorologist, International Crops Research Institute for Semi Arid Tropics, Hyderabad, February 11, 1977.
- xxvii) Dr. Elford G. Astling, Assistant Professor, Department of Meteorology, University of Utah, Salt Lake City, U.S.A., March 2-6, 1977.
- xxviii) Dr. Fredrick H. Carr, U.S. Scientist, Boulder, Colorado, March 14-17, 1977.
 - xxix) Wg. Cdr. K.R. Rao, Director, National Remote Sensing Agency, Secunderabad, March 28, 1977.
 - A batch of 9 Meteorological Officers from Air Force Administrative college, Coimbatore, March 29, 1977.

GENERAL 8.



A snap with the foreign delegates at Symposium on 'Tropical Monsoons'

8.1 The Governing Council

The Management of the Institute is vested in a Governing Council which consists of nine members including the Director of the Institute. List of members is given in Appendix I.

From January 1, 1977, the duties and functions of the Director are being performed temporarily by the Chairman, Governing Council, Indian Institute of Tropical Meteorology, on retirement on superannuation of Dr. K.R. Saha, Director.

8.2 Facilities

8.2.1 Library, Information and Publication

The Senior Technical Officer as head of the Division and a few trained and technically qualified staff joined the Division during the year under review. The Division extended facilities of Inter Library Loan to the research scientists and continued to have exchange facilities with the Institutes like University of Poons, National Chemical Laboratory, India Meteorological Department, Gokhale Institute of Economics and Politics, Deccan College, Maharashtra Association of Cultivation of Sciences and Central Water Power Research Station all situated in Poona and The Tata Institute of Fundamental Research, Indian Institute of Geo-Magnetism Indian Institute of Technology, at Bombay and Indian Institute of Science, Bangalore. Forty nine (National and International) Journals were subscribed to by the library. Two hundred and seventeen books were added to the library during the year.

Dissemination of information on subjects of interest to the scientists were made available to them for convenience. Scientific information was supplied to the various organisations/Institutions and to outside scientists on demand through various reports, reprints etc.

The Division was responsible for processing Registration work for seven members of the scientific staff towards M.Sc. and Ph.D. Courses of various Universities.

Reprints of papers published by the Institute scientists during the year 1973 and 1974 were compiled separately for each year and distributed as per the standing mailing list and facilities like Xeroxing, Drawing and Photography were made available for scientific, technical and administrative purposes.

8.2.2 Computer

The IBM 1620 Computer worked during the year in two shifts per day and seven days a week as shown below:

	Hrs.	Min.
Institute's Jobs	1537	35
Data Processing of IMD	1607	45
Break down/Maintenance	262	35
Paying Users	129	00

A three-week course in FOTRAN Programming with Numerical Methods was conducted from February 15 to March 5, 1977. Twenty four participants attended the course. Facilities for running a highspeed Third Generation Computer were made available to the research workers in collaboration with the Tata Institute of Fundamental Research, Bombay.

8.2.3 Training

8.2.3.1 A re-orientation training course in Tropical Meteorology was held at the Institute from April 5, 1976 to May 29, 1976. It was attended by 53 scientists of the Institute. A second course in Orientation Training in Meteorology held at the Institute from October 25, 1976 to December 19, 1976 was attended by 58 scientists.

- 8.2.3.2 The following four scientists of the Institute returned to India on the dates mentioned against their names, on completion of their meteorological training under the U.N.D.P. Programme.
 - (a) Dr. A.S.R.Murty, S.S.O.II April 1, 1976
 - (b) Shri S.K. Mishra, S.S.O.I. April 19, 1976
 - (c) Shri S. Sinha, S.S.O.II August 23, 1976
 - (d) Shri H.N. Bhalme, S.S.O.II May 27, 1976
- 8.2.3.3 The following eight Scientific Assistants completed the Intermediate Training Course in Meteorology conducted by the India Meteorological Department, Poona-5:
 - (a) Shri A.B. Sathe
 - (b) Shri G.A. Momin
 - (c) Shri Gulzar Singh
 - (d) Shri A.L. Londhe
 - (e) Shri Anupam Bandyopadhyay
 - (f) Shri R.P. Ramteke
 - (g) Shri D.R. Chakraborty
 - (h) Kum. J.S. Pethkar
- 8.2.3.4 The following scientific staff were deputed for the Advanced Training Course in Meteorology at the India Meteorological Department, Poona-5:
 - (a) Shri T.K. Saha
 - (b) Kum. A.H. Master
 - (c) Shri R.B. Sangam

- 8.2.3.5 Shri P.N. Sharma, S.S.O.II attended the Third Advanced Course on Tropospheric Environment Monitoring Propogation Characteristics and Communication Systems, conducted by the National Physical Laboratory, New Delhi, from February 14-28, 1977.
- 8.2.3.6 Shri B.Parthasarathy, J.S.O., Dr. Y.S.Gondhalekar, S.S.A. and Shri P.K. Joshi, S.S.A. attended the Advanced Refresher Course in Agricultural Meteorology, organised by the India Meteorological Department from February 25, 1977 to March 11, 1977.
- 8.2.3.7 Shri D.R.Sikka, S.S.O.I was on ex-India leave from November 10, 1976 to March 13, 1977, to take up a scientific assignment in the Florida State University, U.S.A. to work on the problems of monsoons.

Dr. R.V. Godbole, S.S.O.I was granted extention of Extra-ordinary leave (ex-India) for the period ending on March 10, 1977, to enable him to complete his assignment in a post doctorate position at the Florida State University, Tallahassee, U.S.A.

- 8.3 Awards
- 8.3.1 Dr. A.K. Kamra, Senior Scientific Officer Grade I, was given the 'World Meteorological Organisation research award for encouragement of Young Scientists, 1976'.

Dr. A.S.R. Murty, Senior Scientific Officer Grade II was selected for the 'Shri Hari Om Ashram Prerit Dr. Vikram Sarabhai Research Award for 1976 for his contribution in the field of 'Atmospheric Physics and Hydrology'.

- 8.4 Important Staff changes
- 8.4.1 Appointments
 - i) Dr. D.A. Mooley and Dr. O.N. Dhar, both Senior Scientific Officers Grade I were promoted to the post of Assistant Director with effect from 1.11.1976.
 - Dr. (Miss) Durga Ray, Shri S.K.Mishra, S.S.O.II, Shri K.G.Vernekar, S.S.O.II, and Shri S.S.Singh, S.S.O.II assumed charge of their posts as Senior Scientific Officer Grade I with effect from 19.4.1976, 28.5.76, 2.11.76 and 2.11.76 respectively.
 - iii) Dr. D. Subrahmanyam, Junior Scientific Officer assumed charge of the post of Senior Scientific Officer Grade II with effect from 23.4.1976.
 - iv) Shri T.K.Kamble and Shri S. Chaudhuri assumed charge of their posts as Junior Scientific Officer with effect from 14.9.1976 and 11.3.1977 respectively.
 - v) Shri D. Bhattacharya, assumed charge as Senior Technical Officer Grade I with effect from 17.2.1977.
 - vi) Shri A.N. Limaye, assumed charge as Accounts Officer with effect from 15.1.1977.
- 8.4.2 Three apprentices were engaged at the Institute during the year.
- 8.4.3 I.I.T.M. Fellow

The I.I.T.M. Research Fellowship in Meteorology was awarded to Shri C. Muthuvel with effect from November 1, 1976.

8.4.4 Relief

- i) Dr. K.R. Saha, Director, retired from service on the afternoon of December 31, 1976 on superannuation.
- ii) Dr. Punyatma Singh, Senior Scientific Officer Grade I, was relieved from the Institute on acceptance of his resignation with effect from April 18, 1976.
- iii) Shri J.A. Kulkarni, Accounts Officer was relieved from the Institute on acceptance of his resignation with effect from January 14, 1977

8.4.5.1 Important meetings

The following Selection Committee meetings and Departmental Promotion Committee Meetings were held during the year:

- i) Selection Committee for posts of :
 - a) Assistant Director,
 - b) Senior Scientific Officer Grade I,
 - c) Senior Technical Officer Grade I,
 - d) Senior Scientific Assistant,
 - e) Scientific Assistant,
 - f) Senior Technical Assistant,
 - g) Technical Assistant and
 - h) Junior Scientific Assistant.

- ii) Selection Committee Meeting was also held for the award of IITM Research Fellowship.
- iii) Departmental Promotion Committee meetings for promotion of a Lower Division Clerk and Office Attendants were also held during the year.
- 8.4.5.2 Selection Committee Meeting for the award of Air India Fellowship in Meteorology for 77 and 78 was held in the Air India's Office at Santa Cruz, Bombay and the Institute was represented by Dr. Bh.V. Ramana Murty, Assistant Director as a member of the Selection Committee.
- 8.4.6 The 12th and 13th meetings of the Governing Council were held on October 27, 1976 and March 28, 1977 respectively.
- 8.4.7 Appendix II gives the names of research scientists and administrative officers as on March 31, 1977.
- 8.5 Budget, Accounts and Audit

The Institute received from the Government of India grants totalling Rs. 37,94,820/- including the unspent balance of the previous year and other receipts like Computer charges, interest on fixed deposit, interest on advance etc. Out of this, an amount of Rs. 35,69,663/- approximately was spent during the year 1976-77.

Audit of the Institute's Accounts for the year 1975-76 was conducted by M/s Kirtane and Pandit, Poona-2.

9. SYMPOSIUM ON TROPICAL MONSOONS



Prof. Y.P. Rao, D.G.O., and Chairman, G.C., I.I.T.M., presiding over the concluding session

Symposium on 'Tropical Monsoons'

In the last few years, the Institute had cosponsored scientific symposia on various aspects of Tropical Meteorology in our country. In view of a major thrust on monsoon meteorology in the coming few years with the MONEX Programme, it was thought worthwhile to organise a symposium on 'Tropical Monsoons'. It was the first individual effort on the part of the Institute. Several scientific organisations in the country as well as abroad contributed to-wards the success of the symposium.

The symposium was held during the period 8 to 10 September and was inaugurated by the Hon'ble Minister for Tourism and Civil Aviation, Govt. of India on September 8. The three-day symposium was attended by a large number of National and International delegates and was divided into ten sessions.

The symposium provided a forum to scientists for presentation of their latest research work on the subject of monsoons and thorough discussions of this work. It also served to identify broadly the deficiencies and problems involved and the direction in which future research in this important field should be directed or intensified, specially taking advantage of the forthcoming global observational programmes on the 'monsoons'.

The participants were encouraged by the response from USSR, France, and East Africa, who had sent representatives to take part in the symposium.

The following main topics were covered in the first nine sessions of the symposium:

i) Dynamics and Prediction of monsoon circulation system,

- ii) Water potential of monsoons,
- iii) Climatic trend of monsoon rainfall,
 - iv) Prediction of monsoon rainfall.

The tenth and the final session of the symposium, held under the Chairmanship of Shri Y.P.Rao, Director General of Observatories and Chairman, Governing Council, Indian Institute of Tropical Meteorology, was devoted entirely to discussions on the topic of 'What we know and what we do not know of Tropical Monsoons - further research recommendations'.

The symposium identified three broad lines of research, as below, on the monsoon:

- i) Synoptic investigations,
- ii) Diagnostic and prognostic experiments by numerical models, and
- iii) Statistical studies to determine short and long term changes in the behaviour of the monsoon.

The recommendations in brief of the symposium were as follows:

- i) Research on monsoon meteorology may be further intensified by :
 - a) Synoptic investigations,
 - b) Numerical modelling and
 - c) Statistical studies.
- ii) Seminars/Symposia may be organised every alternate year in India. Representatives may be invited to such Seminars/Symposia from all countries interested in the Monsoon.

- Encouragement may be given in deserving cases to young scientists in research Institutes and iii) Universities in India, in order to attract scientific contributions from them.
 - iv) Assistance may be provided to active research groups, if necessary under the aegis MONEX, for intensifying research on field studies, which would provide the input for synoptic studies and numerical models.
 - ∇ Efforts may be made to extend computer facilities, and easy and quick access to data, to a larger group of scientists.

The following scientific papers were contributed towards the symposium :

Title of the paper Author(s) No. Longitudinal asymmetry of tropical K.R. Saha 1, monsoons. 2. Causes of the monsoon onset, burst R.F.Burlutsky and boundaries of the monsoon rain ocean. 3. The low-level air flow over the Danial CADET Indian Ocean as deduced from and Paul satellite-tracked super-pressure OLORY-TOGBE balloons and conventional meteorological observations. 4. The influence of tropical distur-Daniel CADET bances on the low-level air flow

over the Indian Ocean during the

northern summer.

and Paul

OLORY-TOGBE

Sr.	Title of the paper	Author(s)
5 •	Studies on the southwest mon- soon using radio-active tracers.	C. Rangarajan, S.Gopalkrishnan and C.D. Eapen
6.	On vertical velocities at 900 mb level over north Bay of Bengal during pre-post and mid-monsoon periods.	P.G. Kulkarni
7.	Preliminary results of integration of a five-layer primitive equation model.	S.S. Singh and K.R. Saha
8,	A study on orographic effects by a primitive equation model.	P.K. Das and H.S. Bedi
9.	Effect of stratification on flow past obstacles in rotating systems.	Solochana Gadgil
10.	Harmonic analysis of the thick- ness field and the summer monsoon of south Asia.	R.K. Verma
11.	On the mean-meridional circulation during the summer monsoon season: mechanical effects.	M.Sankar Rao and M.R. Kusuma
12.	The meridional transport of momentum in the wave number regime during July.	D.R.Talwalkar, S.V.Singh and S.T. Awade
13.	Energy aspects of monsoon circulation.	S. Rajamani
14.	Total energy profiles during summer monsoon and cold season over India.	N.Natarajan and A.G. Garde

Sr. No.	Title of the paper	Author(s)
15.	On the lowering of the surface temperatures in the Arabian Sea with advance of the southwest monsoon season.	D.P. Rao, R.V.N. Sarma, J.S.Sastry and K. Premchand
16.	Barotropic instability of tropical zonal flow over Indian Ocean.	K.R. Saha and D. Subrahmanyam
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 (Upto 31st December, 1976)

Ph.D.

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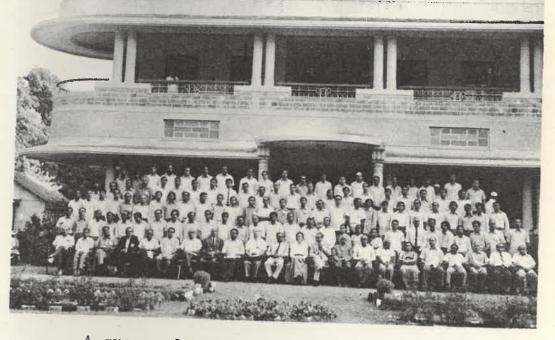
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