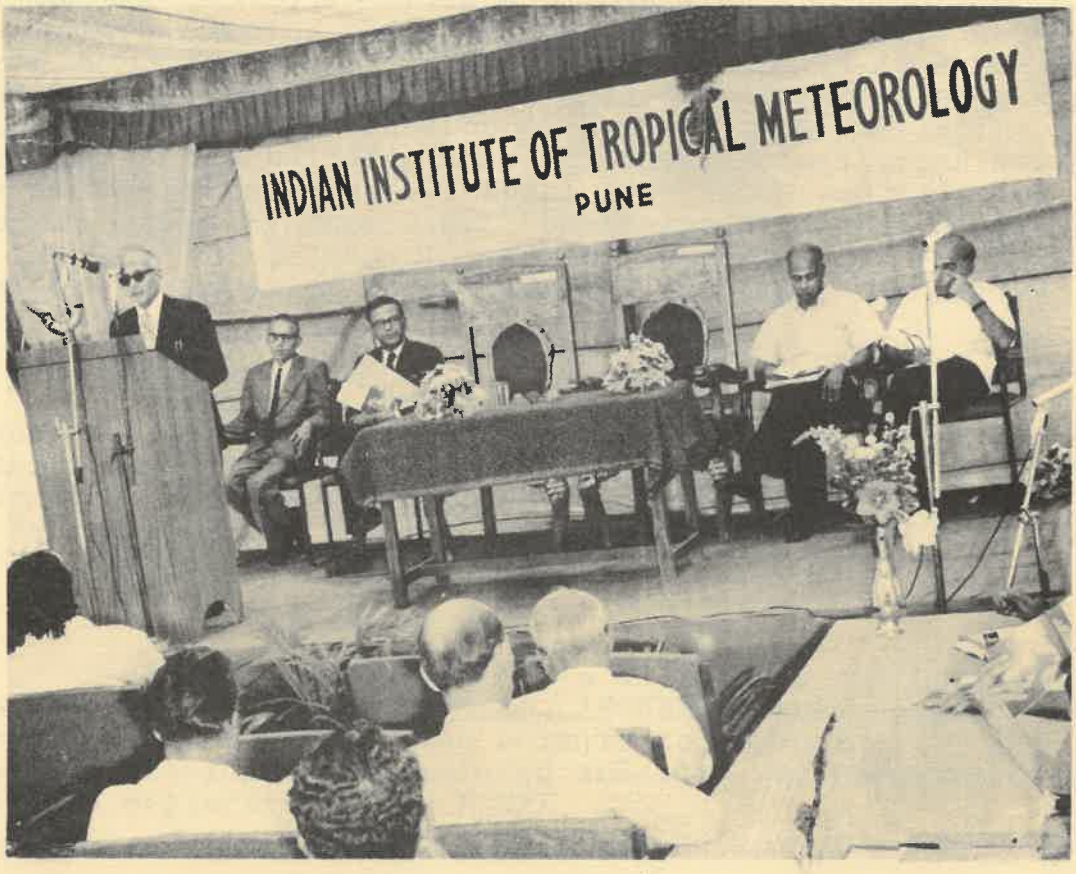
Indian Institute of Tropical Meteorology

ANNUAL REPORT
1979-80

Ramdurg House, University Road,
Pune 411 005
India

Foundation Stone Laying Ceremony 3 April 1979
Shri S.M.L. Bhatnagar, Secretary, Ministry of
T. and C. A. seen laying the foundation stone.

C O N T E N T S



Foundation Stone Laying Ceremony, 3 April 1979.
Inaugural speech by Chief Guest Shri S.M.L.
Bhatnagar.

Introduction

It has been a year of all round development and activities punctuated by events of significance in the short history of this Institute. Being scattered in five different locations for want of a proper accommodation of its own, the Institute has so far been functioning against heavy odds. The first phase of construction of functional laboratories for the Institute, covering a plinth area of about 2800 m^2, was taken up during the year, at Pashan, Pune. The construction activity was making good progress and it is expected that the new building would be ready for occupation by about April 1981. On the occasion of foundation stone laying ceremony of the building a solemn function was organised at the construction site on 3 April 1979 which was attended amongst others by Shri S.M.L. Bhatnagar, the then Secretary to the Govt. of India, Ministry of Tourism and Civil Aviation and a number of scientists and visiting dignitaries.

Research activities were pursued with renewed vigour and dynamism throughout the year. Experimental field observational programmes were arranged at Pune and Raichur (Karnataka) on the occasion of the Total Solar Eclipse on 16 February 1980. Analysis of the data collected have revealed some interesting results.

Active participation in all facets of the prestigious multi-national programme, 'MONEX' earned commendation for this Institute from the scientific community. A new area of research was introduced and work was undertaken on the data collected during MONEX.

With a view to exploring the possibilities of augmenting natural rainfall in drought-prone areas by artificial cloud seeding technique, the Institute continued to conduct its aerial cloud seeding experiments over the Pune region during the monsoon.

During the year under review, the Institute had the privilege of welcoming a few distinguished scientists from abroad and other important dignitaries. Special mention may be made of Prof. Ernest C. Kung, Agriculture College, University of Missouri, U.S.A., Shri T. K. Murithi, Director General, Kenya Meteorological Department, Dr. Allan H. Murphy, Associate Professor of Atmospheric Sciences, Oregon State University, U.S.A. and Prof. C. C. Chang, Emeritus Professor, Catholic University, U.S.A.

Collaboration with universities and other scientific Institutions was continued. Results of research were shared and views exchanged in various scientific forums of national and international standing, which were attended to by the Institute's scientists. Thirty-five research papers were published and thirty-nine accepted for publication in the leading scientific journals of India and abroad during the year 1979-80.

The detailed activities of the Institute during the year are given in the succeeding chapters of the Report.

I.I.T.M., Pune.
Date : December 1980.

Bh. V. Ramana Murty
Director.

Plantation of sapling by Smt. I. Liberhan, Member, Governing Council at the construction site at Pashan, Pune. Chairman and other members of the Council seen looking on.

1. IMPORTANT EVENTS

The Indian Institute of Tropical Meteorology (erstwhile Institute of Tropical Meteorology), was established in November 1962 as a part of the India Meteorological Department. Later, on 1 April 1971, the Institute was converted into an autonomous research organisation. 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.

Research carried out in the Institute is aimed at better understanding of the physical dynamical processes of the tropical atmosphere and towards developing indigenous technology for probing and understanding the different aspects of weather in this country like , cyclones, droughts and floods. The results of research are of benefit to the common man.

Foundation Stone Laying Ceremony

Foundation stone for the Institute's buildings at Pashan, Pune was laid by Shri S.M.L. Bhatnagar, Secretary, Government of India, Ministry of Tourism and Civil Aviation, New Delhi on 3 April 1979. Dr. P. K. Das, Director General of Meteorology, India Meteorological Department and Chairman, Governing Council of the Institute, Prof. P. R. Pisharoty, Emeritus Scientist, Physical Research Laboratory, Ahmedabad who was the first Director of the Institute, and a large number of scientists and dignitaries attended the ceremony. A folder projecting,in brief, the historical background and current activities of the Institute was released on the occasion.

Participation in MONEX 1979

S/Shri D. R. Sikka, Senior Scientific Officer, Grade I, and D. K. Paul, Junior Scientific Officer participated in the field phase of MONEX 79 at the Summer Monsoon Operational Centres (SMOC), Bombay and Calcutta. They lent support to the various scientific and organisational functions like aircraft flights, daily analysis and map discu-

ssions, mission flight planning, handling of data tapes etc. At the close of the SMOC, the scientists presented their research contributions in a 'Quick Look' symposium held on 27 July 1979 at Calcutta.

At the request of the Director General of Meteorology, Dr. D. A. Mooley, Assistant Director and Shri D. R. Sikka, Senior Scientific Officer, Grade I participated in the analysis of synoptic charts prepared during Monex 79. These charts formed a part of the 'quick look' data set of the experiment. On completion of the analysis, microfilm of these charts was to be supplied to the World Data Centre. Using 'quick look' data set, collected during the field phase of the Monex, research contributions were completed for communication to Deputy Director, International Monex Management Centre (IMMC) for being brought out as W.M.O. Publications. Shri Sikka delivered a talk covering the field phase research activities of Monex, arranged under the auspices of the Indian Meteorological Society.

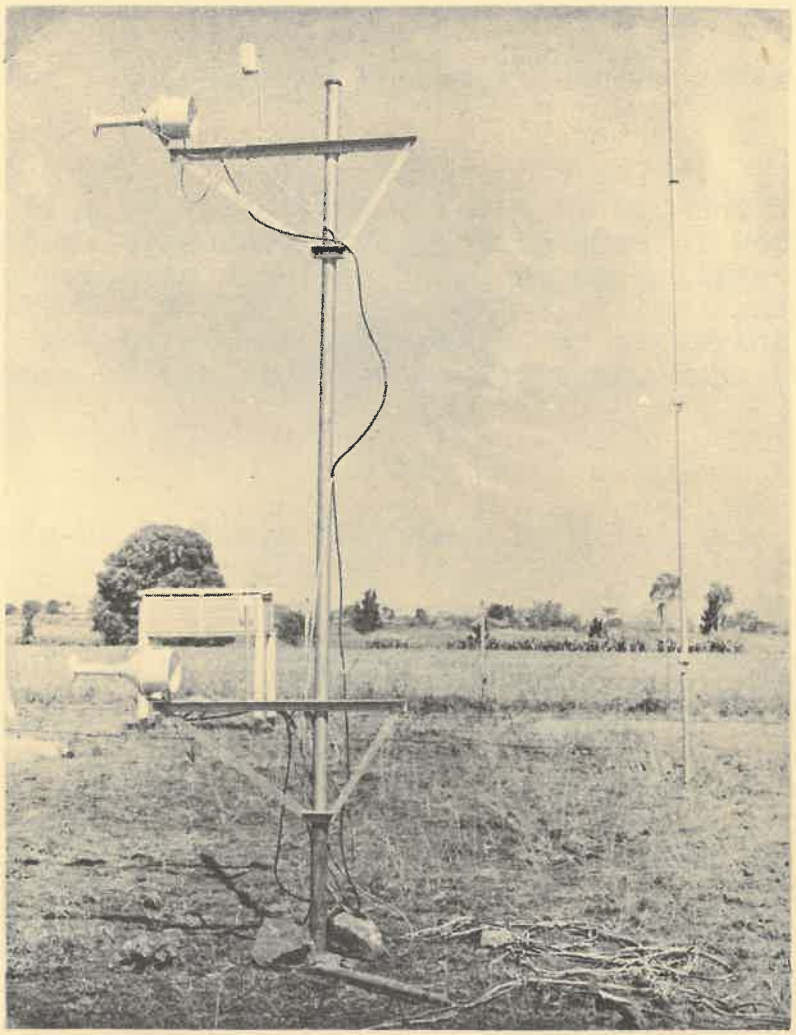
TV Film on Monex / FGGE

Miss Nancy Dale, Staff Co-ordinator and Mr. Robert Howard, Chief Photographer of the US Monex Team accompanied by Shri M. B. Mathur, representative, Ministry of External Affairs, Govt. of India visited the Institute in June 1979 and filmed some of the important activities of the Institute.

Cloud Seeding Experiments

Cloud seeding experiment in the Pune region was resumed in July 1979 after a gap of two monsoon seasons (1977, 1978). Aircraft for the experiment was chartered from M/s Air Works India, Bombay. The experiment was conducted on 8 pairs of days.

A team of scientists was on tour to Bombay from 5-12 September 1979 in connection with the cloud seeding experiment over the Arabian sea for studying the effect of massive salt seeding on maritime warm cumulus clouds.



Total Solar Eclipse Observational Programme, 16 February 1980. Temperature and Humidity sensors used for the measurement of Bowen's Ratio.

An officer from the Institute was deputed to advise and assist the Government of Gujarat in their cloud seeding programme.

Total Solar Eclipse Observational Programme

A team of scientists, headed by Dr. Bh. V. Ramana Murty, Director, organised a field programme of work at Raichur in connection with the Total Solar Eclipse on 16 February 1980. A field experiment was also conducted in the lowest 2 metres of the atmosphere for measuring electric field and space charge profiles at Yerawada, Pune on this occasion.

Indo-US Exchange Programme of Scientists

Prof. Allan H. Murphy, Associate Professor, Oregon State University, U.S.A. visited the Institute under the Indo-US exchange programme during the period 15-23 November 1979. During his stay, Prof. Murphy exchanged views with the scientists of the Institute on weather forecasting with particular reference to the applications of statistical techniques. He also gave several seminars on Statistical Forecasting in U.S.A., Quantifying the Uncertainty in Weather Forecasts, Evaluation of Weather Forecasts, Quality of Weather Forecasts etc.

Continuance of Academic Recognition

The local inquiry committee appointed by the University of Poona with Prof. M. R. Bhiday, Director, College Development Council, University of Poona, Pune - 7 as Chairman visited the Institute on 20 March for continuation of recognition of this Institute by the University beyond June 1980.

2. RESEARCH AND DEVELOPMENT

2. Details of the research work carried cut under the scientific divisions of the Institute in various research projects under specific areas of research are given below :

2.1 Forecasting Research - I

2.1.1 Numerical Weather Prediction

2.1.1.1 Development of short range (1-3 days) dynamical weather prediction models for the tropics

Development of five level Primitive Equation (P.E.) model was continued. The lower boundary condition of the model was changed from 1000 mb height tendency equation to surface pressure tendency equation to ensure mass and energy conservation in the finite difference scheme. Nine cycles of forward and backward integration were carried cut for balancing the initial data. At the end of the integration, surface pressure showed development of $2\Delta x$ wave. To achieve the balance, the number of iterative cycles were being increased.

P. E. barotropic model was used to study the impact of additional data collected during Monex on the forecast movement of a monsoon depression. A three level P. E. model was integrated for 5 days under idealised conditions (zonal wind 10 mps without shear) and elliptic barrier with maximum height of 1 km at the centre of the region. The results showed proper development of up-stream ridge and down-stream trough due to barrier effects of large scale orography. The oscillation of 'Rossby type' wave was also indicated on the lee-ward side. The numerical result of the model for the departure of height from the mean height at 650 mb was found to be in agreement with the analytical solution based on the linear theory for the east-west section passing through the centre of the orography.

2.1.1.2 Multidimensional initialisation

The P. E. barotropic model incorporating the dynamic initialisation scheme was integrated up to 48-hr

using the 500 mb data of typical monsoon situations during the years 1968, 1973 and 1979. The u and v components of the observed, initialised and 24 and 48 hrs forecast wind were each subjected to fourier analysis limited to the domain of the integration. It was found that the energy distribution for the observed winds for the cases of 1968 and 1973 were maximum in the (1, 0) component whereas for the 1979 case, maximum energy was contained in the (0, 1) component. The process of initialisation, however, concentrated the energy in the (1, 0) component in each case.

2.1.1.3 Objective analysis of meteorological fields

'Using optimum interpolation method, objective analyses of wind field were carried out for seven cases and compared with those obtained by subjective methods in the case of 850 mb and 700 mb. The results were found to be satisfactory. A number of cases of analyses made at 500 mb were being compared against the corresponding subjective analyses. Work on the development of multivariate optimum interpolation scheme was taken up. Cressman's analysis scheme was used in the case of a monsoon depression of July 1979 to assess the results of additional data, collected during Monex, on the objective analysis scheme. A report on the objective analysis was sent to the National Working Group on Numerical Weather Prediction.

2.1.2 Extended Range Prediction

2.1.2.1 Development of statistical dynamical techniques for prediction of monsoon rainfall for periods exceeding 3 days

(a) Forecasting monsoon rainfall from objectively determined analogs

The usefulness of objectively determined analogs in forecasting rainfall occurrence at a few stations during the monsoon season was tested by using 20 years' of daily charts of 700 mb and anomaly of sea-level pressure. The method was also tested for forecasting rainfall over the meteorological

sub-divisions of India. The skill of these forecasts was compared against climatology, persistence and synoptic-climatological methods developed in previous studies. Forecasts based on analogue methods were also prepared for the months of July and August 1979.

(b) Empirical studies of monsoon rainfall

A few more statistical models like Markov chain of first and second order, modified by logarithmic model, were fitted to the summer monsoon rainfall of 22 stations over India. The test of fitness revealed that Markov chains fit the frequencies of spells of rainfall of different durations better than the log model. Normal and gamma distribution were fitted to the daily and 5-day sub-divisional rainfall. Several forms of normalising of transformation were tested. The cube-root transformation was found to be the best.

A simple Markov chain model was used to obtain frequency and duration of heavy precipitation for 25 meteorological sub-divisions of India. The model gave 98 percent probability estimates of 24-hr precipitation that would not exceed the observed rainfall amount in a 30, 10, 5, 3 and 2-day period for the four monsoon months.

(c) Forecasting Five and Seven days monsoon rainfall by objective methods

The experimental forecasting of 5 and 7 days monsoon rainfall over different sub-divisions of India, was continued using the regression equations developed earlier for the purpose. When verified according to 3 categories viz. normal, excess and deficient, 63 percent of forecasts were found in the correct category.

2.1.2.2 Synoptic climatological studies of monsoon for understanding and prediction of periods exceeding three days

(a) Studies connected with the relationship of anomalies in circulation parameter in the pre-monsoon months with the rainfall in the following monsoon seasons were continued. Anomalies of meridional component of wind at 200 mb and the angular momentum at 200 mb during the month of May over the northwest Indian stations were found to be inversely related with the subsequent monsoon season rainfall for the whole of India. Linear regression equations were developed using (i) upper tropospheric parameters viz, thickness anomaly between 300-100 mbs layer during April and May, (ii) anomaly of meridional wind and (iii) angular momentum anomaly during May, as predictors and monsoon seasonal rainfall for India as predictand based on thermal anomaly in April-May 1979. Seasonal monsoon rainfall forecast for the 1979 season indicated a below normal monsoon activity, which was verified to be correct.

(b) Spherical harmonic analyses of geopotential heights at 700 and 300 mb for the northern hemisphere for the months of April through August of the years 1973, 1974 and 1977 were completed. The amplitude and phase of ridge lines, transport of angular momentum and that of sensible heat and the wave-wave and wave-zonal interactions were computed. The results were under study to establish contrasting features of the circulation in good and bad monsoon years. Stratospheric height data at 50 and 30 mb levels were also analysed for good and bad monsoon years.

(c) The major fluctuations of the monsoon seasonal rainfall for the period 1891 to 1977 were studied in relation to (i) heating and cooling in the northern hemisphere and (ii) Walker circulation as given by the occurrence of EL-Nino phenomenon in the Pacific Ocean. It was found that more years of monsoon deficit rainfall had occurred during the periods of cooling in the northern hemispheric temperatures and periods of frequent occurrence of El-Nino phenomenon. Several of the regional scale circulation parameters during the months of July and August for a set of five good monsoon years and for a different set of five bad monsoon years were studied. The frequency of formation of monsoon 'Lows' rather than the monsoon depressions was found to be a better indicator of the performance of monsoon.

2.1.3 Monex Studies

Several scientists of the Division actively participated in the Monex Field Phase activities at the Summer Monsoon Operational Centres (SMOC) at Bombay and Calcutta during May to July 1979. They were involved in the analysis of data, planning of research aircraft flights, data management activities etc. At the end of the field phase, co-operation was also extended for the processing of data acquired by the flights of the Indian research aircraft AVRO.

The 'Quick Look' data sets emerging from the field phase of the Monex-79 were utilised to study the onset of monsoon, the structure of the ITCZ during the onset and the established phase of monsoon, the mid-tropospheric cyclone, the monsoon depression, large scale features of circulation during the Monex field phase and the impact of additional data acquired during Monex on the analysis and prediction system etc. The results of these studies were communicated to the International Monex Management Centre, New Delhi for inclusion in the W.M.O. publication on the research of field phase activities of Monex.

The data collected during the Indo-Soviet Monsoon Experiment conducted in 1973 (ISMEX-73) were utilised in the studies connected with computations of kinetic energy budget of monsoon circulation under the influence of simultaneous existence of two disturbances in the region of monsoon trough. From the results it may be inferred that the generation caused by cross-contour flow term is most important for the maintenance of the monsoon disturbances.

2.2 Forecasting Research - II

2.2.1 Short Range Prediction

Studies on (i) objective prediction of storm motion field in the Indian basin, (ii) short range prediction by stochastic dynamic method, (iii) changes in the planetary scale circulation at the time of onset of the monsoon and (iv) smoothening the analysed wind field using cubic spline technique were taken up.

2.3 Climatology and Hydrometeorology

2.3.1 Climate and Climatic Change

2.3.1.1 Studies of large scale droughts over India

(a) Casual factors for large scale droughts / floods

Droughts/floods over India were studied with emphasis on a casual understanding of these extreme climatic events in terms of monsoon circulation. An objective and numerical drought index based on monthly monsoon rainfall and durations, developed earlier in the Institute for the assessment of drought/flood intensity, was used to identify large-scale drought/flood years over India. The information on surface pressure, frequency of breaks in the monsoon and tracks of monsoon storms/depressions was examined by preparing composite maps for large scale drought and flood regimes. Weaker meridional pressure gradient, larger northward shift of monsoon trough, larger number of days of break in monsoon, smaller frequency of depression and shorter westward extent of their tracks appeared to be the major causal factors for large-scale droughts. Features opposite to this were observed for large-scale floods.

Year to year changes in the areal extent of droughts/floods over India revealed a weak triennial cycle in the area affected by drought and highly significant quasi-periodicity of about 20-years, near a double sunspot cycle, in the area affected by floods. The flood area seemed to expand and contract with a period of the Hale double sunspot cycle and large-scale floods were more frequent in the large amplitude maximum phase of sunspot cycle. Flood area changes seem to be associated with the Hale double sunspot cycle.

(b) Vagaries of the summer monsoon over India

In a large country like India, monsoon rainfall is not evenly distributed over time and space - while some

portion gets deficient monsoon rains in any particular year, rainfall is excessive over certain other portions of the country in the same year. However, there are some years when the total portion of the country which gets deficient and excess rain is quite large and the behaviour of the monsoon can be termed as vagarious. The percentage area of the country having deficient and excess monsoon rainfall was examined for each of the years during the period 1871-1978 and was found to be a gamma distributed variable. On the hypothesis of this distribution, the probability of this percentage exceeding 55 was found to be 0.13. The criterion of this percentage exceeding 55 was adopted as the one for identifying the years of such unusual behaviour of the summer monsoon. The time interval between successive years of this type of monsoon behaviour is seen to be random and the occurrence of the event can be taken to be random. Both the Binomial and the Poisson probability distributions showed a good fit to the number of such years in a five-year period. This is apparently due to the fact that when p, the probability of occurrence of an event is near about 0.10, there is transition from Poisson to Binomial distribution and in a situation of transition, both the distributions are expected to show good fit.

2.3.1.2 Studies in Palaeo-climatology

A study of droughts over India from historical accounts and other documentary sources like the Famine Commission Reports was undertaken. The principal droughts which affected India adversely during 1771-1977 were identified and were found to occur randomly in time. The meteorological, political and economic factors which had an important bearing on the sufferings of the people during droughts were looked into. Poisson probability model showed a very good fit to the number of droughts in a five-year or ten-year period. The probabilities of one, two or three droughts occurring in a five or ten year period could be computed by this model. Information based on these probabilities could be used in planning funds for drought mitigation.

2.3.1.3 Climatological study of severe cyclonic storms of the Bay of Bengal

The severe cyclonic storms which formed over the

Bay of Bengal and those which struck the coast around the Bay during the long period 1877-1977 were examined. It was found that the severe storms which had formed during 1965-77 as well as those which struck the coast during 1965-77 had mean annual frequency significantly higher than that for any 13-year period before 1965. The percentage of storms intensifying into severe storms was also significantly higher during 1965 than that during any preceding 13-year period. The possible causes for this feature were looked into. By and large, the formation and landfall of the severe storms were random events in time continuum, and these events were found to be consistent with the Poisson Stochastic process. The probabilities of one, two or three severe storms striking the coast in the specific period could be completed on the basis of the Poisson probability model.

2.3.2 Hydrometeorological Studies

2.3.2.1 Basin rainfall studies for the development of water resources

(a) Probable Maximum Precipitation (PMP) studies

A generalized probable maximum precipitation (PMP) chart was prepared for the southern half of the Indian peninsula lying between 8°N to 16°N, using rainfall data of about 600 long-period stations distributed over Tamil Nadu, Kerala, South Karnataka and southern portions of Andhra Pradesh. This study showed that one-day PMP estimates over this region range from 25 - 85 cm and the ratios of PMP to observed maximum rainfall vary from 1.6 to 2.4

(b) Estimation of one-day point rainfall for different return periods for north Indian plains using district average rainfall ratios

A simple procedure was developed for evaluating maximum point rainfall for different return periods from 2 to 100 years for any station in the plains of north India. According to this procedure, 2-year one-day rainfall of a station can be estimated from the 2-year generalized chart

of the region. Average district rainfall ratios for higher return periods of 5, 10, 25 and 50 years to 2-year return periods can be obtained with the help of (i) district average ratio map of 100/2 and (ii) frequency interpolation nomogram. The magnitudes of 5, 10, 25, 50 and 100-year rainfall can then be found out by multiplying the 2-year value by the corresponding district average ratio pertaining to different return periods.

(c) Onset of monsoon and subsequent rainfall distribution over the west coast sub-divisions

The association between the onset of monsoon and the subsequent rainfall distribution over the three west coast sub-divisions viz. Kerala, Coastal Karnataka and Konkan was examined using 50 years' (1921-1970) data. It was found that the rainfall received in the three west coast sub-divisions during the early monsoon month of June and the monsoon season as a whole (June to September) is independent of the date of onset of monsoon over these sub-divisions. It was also seen that whether the onset of monsoon is early or late over these sub-divisions, it provides no clue to the amount of rain that would fall during the month of June and the monsoon season as a whole.

(d) Influence of tropical disturbances on the rainfall distribution of individual monsoon months

The influence of tropical disturbances (i.e. depressions/cyclonic storms) on the rainfall of individual monsoon months and the season as a whole was examined considering the 80-year data of rainfall and tropical disturbances, north of Lat. 15°N. This study showed that the individual monsoon months from June to September do exhibit a significant relationship between rainfall and the corresponding frequency of tropical disturbances but the monsoon season as a whole does not show such relationship.

(e) Rainfall distribution during monsoon months over India in the absence of tropical disturbances

The distribution of rainfall over the Indian land area north of Lat. 15°N, excluding the hilly regions of the Himalayas and northeast India, was studied for those monsoon months of June to September which were free from tropical disturbances (i.e. monsoon depressions/cyclonic storms) during the 80-year period from 1891 to 1970. This study showed that in the absence of these tropical disturbances, the country can experience on an average, deficient rainfall of the order of 7, 13, 13 and 41 percent in the monsoon months of June, July, August and September respectively.

(f) Rainfall distribution in Karnataka

The seasonal and annual areal rainfall data for a period of 80 years from 1891 to 1970 of Karnataka state and its three meteorological sub-divisions were analysed and its various features were discussed. It was found that there is an increasing trend in the annual rainfall of coastal Karnataka and Interior South Karnataka sub-divisions and the state as a whole. It was also seen that after the worst drought of 1918, the state as a whole and its two sub-divisions (viz. Coastal Karnataka and Interior South Karnataka) did not experience any large deficiency of rainfall.

(g) A study of heavy rain spell which caused Morvi dam disaster in August 1979

The heavy rainspell of August 1979 over Machhu basin and its neighbourhood in Saurashtra was analysed by Depth-Area-Duration (DAD) and Depth Duration (DD) methods. Some important aspects of heavy rainfall distribution, viz. incidence of severe rainstorms, maximum point rainfall of different return periods and probable maximum precipitation (PMP) were also studied. It was observed that the August 79

rainstorm was not the severemost rainstorm of this region. The antecedent basin conditions prior to the heavy rain spell of 10 to 12 August 79, perhaps, played a significant role in generating a flood volume which the earthern flanks of the dam could not withhold and as such gave way causing death and destruction on an unprecedented scale.

(h) A review of rainfall relationships based upon Indian data

A brief review of the results of some of the important studies on rainfall distribution carried out earlier in the Institute was prepared for the benefit of the field Engineers.

2.4 Physical Meteorology and Aerology

2.4.1 Cloud Physics and Weather Modification

2.4.1.1 Studies in atmospheric electricity

(a) A study of the electrical, microphysical and dynamical responses to salt seeding in warm maritime cumulus clouds was carried out using the aircraft observations made in the Bombay region during the monsoon season of 1979. No corona discharge current was observed in clouds whose thickness was less than 3000 ft.. Positive corona discharge current was observed in clouds having vertical thickness more than 3000 ft..The cloud liquid water content showed increases up to 113 percent and corona discharge current up to 400 percent following seeding in target clouds. Such marked increases in liquid water content and corona discharge current were not observed in control clouds.

The in-cloud temperatures showed increases, following seeding, in all the four target clouds whereas a decrease was noticed in three out of four control clouds. The maximum increases noticed in the target and control clouds were 1.2°C and 0.1°C respectively. The maximum decrease in temperatures noticed in the control clouds was 1.4°C. The cloud droplet observations showed broadening of

the spectra following seeding and increases up to 250 percent in the mean volume diameter. Such increases were not noticed in case of control clouds.

(b) A study of the solar influence on atmospheric electric field was completed using the data of atmospheric electric field for Colaba for the period 1936-66. Significant 10-year and 18-year periodicities in the electric field were noticed to be in phase for all the six categories of days of observation. The 18-year periodicity in the electric field contained maximum variance in a broad wavelength range covering 15-30 years and appeared to be in phase with the Hale double sunspot cycle with positive peaks in the surface electric field coinciding with the positive peaks in the magnetic polarity of the sunspots. The 10-year periodicity in the electric field showed positive peaks coinciding with the time at which the magnetic polarity of the sunspots change from either positive to negative or vice versa. The magnetic polarity of the sunspots appeared to influence the atmospheric electric field.

(c) Field observations taken at Raichur on the atmospheric nuclei, electrical parameters, sky light intensity, turbidity and water vapour content during the Total Solar Eclipse of 16 February 1980 suggested that the atmospheric vertical electric field, space charge and cloud condensation nuclei showed a decrease during the total solar eclipse. The maximum decreases noticed in the above parameters were respectively 70, 120 and 80 percent. The power spectral analysis of the electric field showed a 30 percent increase in the high frequency component of the noise during the period of the total solar eclipse.

The skylight intensity decreased by 3 orders of magnitude during the totality. The atmospheric turbidity exhibited a sharp increase up to 300 percent during the totality which was attributed to a sudden drop by about 2-3°C, in the air temperature causing decrease in transparency of the atmosphere due to increase in humidity. Also, the turbidity showed maximum increase in the 0.4 μm wavelength. The precipitable water vapour showed a small increase during the total solar eclipse which was attributed to the drop in temperatures.

(e) Aircraft observations on the cloud electrical and microphysical parameters of monsoon clouds made during the summer monsoon of 1979 indicated that the Liquid Water Content (LWC) was maximum near the cloud base level. It decreased with height at Pune and it showed no marked variations with height at Bombay. The in-cloud temperatures at both the places showed either marked decrease in lapse rate or temperature inversion in the region of higher liquid water content. This was attributed to the increase in temperature caused by the latent heat of condensation. The corona discharge current was maximum at the cloud base level and decreased with height. Higher values of corona discharge current were noticed a little below the zone of maximum liquid water content. The clouds exhibited positive electrical polarity and the extent of electrification was proportional to the vertical thickness of the cloud.

(f) A study of the electrical and microphysical conditions made, using the observations obtained at the cloud base level at a hill station during the summer monsoon season of 1977, suggested that the rainfall and negative electric field were correlated. The diurnal curve of rainfall and electrical field exhibited two maxima. The early morning peak in rainfall and the afternoon peak in the electric field were significant. The early morning peak was attributed to the enhanced convergence caused by radiational imbalance in the cloud and cloud-free regions during the active monsoon conditions. The afternoon peak in the electric field was attributed to the turbulent convection in the lower layers resulting in cloud formation. Based on the above results, the possible electrification mechanisms in the monsoon clouds were reviewed.

2.4.1.2 Radar study of rain and rain-bearing clouds

(a) Radar evaluation of the salt seeding experiments conducted in the Bombay region during the monsoon season of 1979 was completed. Four target (seeded) and four control (not-seeded) clouds were studied. Three out of the four seeded clouds showed increase in the areal extent following seeding and one showed decrease. The height of the echo tops increased in two cases and there was no change in one case. The duration of the echoes was significantly higher in two cases and in the other two cases no marked difference was noticed compared to the control clouds.

(b) Mock cloud seeding experiments were conducted for the Delhi region using the rainfall data for the monsoon seasons of 1967-78. The result was positive in 6 seasons, negative in 2 seasons and inconclusive in 4 seasons.

2.4.1.3 Studies in cloud microphysics and investigation of the feasibility of increasing rainfall by cloud seeding

(a) Salt seeding experiments using aircraft were conducted for the fourth year during the monsoon season of 1979 on six pairs of days. The rainfall analysis indicated that the result was positive in 4 pairs, negative in 1 pair and inconclusive in another pair. The results were not statistically significant.

(b) Numerical simulation of cloud seeding experiments were conducted using the historical rainfall data of Maharashtra and incorporating the seeding criteria for the seedable days which had been adopted in the actual aircraft seeding experiment conducted over Pune since 1973. The results suggested that 5, 10, 15 and 20 percent increases in rainfall could be detected in a 7 year experiment with 20, 65, 90 and 100 percent probability respectively.

(c) Numerical simulation of cloud seeding experiments, performed with the help of the historical rainfall data of 12 summer monsoon seasons (1957-68) and 12 winter seasons (1957-68) for the Delhi region, suggested the following :

During the summer monsoon, 30 percent increase due to seeding can be detected with more than 80 percent probability in 12 years.

During the winter season, 60 percent increase in rainfall due to seeding can be detected with 55 percent probability in 12 years.

(d) A numerical simulation experiment performed with the help of the rainfall data relating to 39 pairs of days of the aircraft salt seeding experiments conducted during the summer monsoons of 1973, 1974 and 1976 suggested the following :

The increase in rainfall noticed in 3 out of 20 pairs of days of the actual aircraft salt seeding experiments is significant at 5 percent or lower levels. None of the decreases noticed in any of the 11 pairs of the experiments is significant.

2.4.2 Environmental Physics

2.4.2.1 Studies of atmospheric boundary layer

(a) The temperature fluctuations at a single level of the cloud laden air stream were studied using the observations made at a hill station. The temperature variations during rain were not significant when the rain intensity exceeded 4 mm/hr. For lower intensities, the temperature variations were found to be directly proportional to rain intensities. The variations in the temperature during lower intensities of rainfall may be attributed to the transport of latent heat by the down-drafts in the fall-streak zone of the precipitating clouds.

(b) Vertical and horizontal thermal structures of the atmospheric boundary layer over the Deccan Plateau were studied using the aircraft temperature observations made during the summer monsoon of 1976 as a part of the cloud seeding experiment. Based on these observations, the structure of the atmospheric boundary layer was classified into four different categories, depending on the thickness of the mixed layer and gradients of potential temperature in the stable layer. The horizontal temperature distribution at 900 m above the ground level was, by and large, normal. The horizontal temperature spectra showed a significant peak with a wavelength of 5 km.

(c) High resolution temperature observations were made in clear air at 14 levels along the aircraft flight lengths

of 30 km in the atmospheric boundary layer (up to 3 km ASL) over the Arabian sea during the summer monsoon of 1979. Cloud condensation nuclei (CCN) were also measured at 8 levels. The results of the study suggested the following :

The atmospheric boundary layer consists of near isothermal layers of thickness up to 1000 ft with alternating layers having dry adiabatic lapse rate. The concentration of CCN decreases in general with height. In the region of isothermal layers the concentrations are higher, up to about 100 percent than those in the respective preceding layers. All wavelengths exceeding 2 km of the dry and wet-bulb temperature spectra at all the levels of observation are significant. These wavelengths may correspond to the gravity waves.

The slope of the wet-bulb temperature spectra increased with height and tend to -5/3 at higher levels. The slope of the dry-bulb temperature spectra was less than -5/3 at all levels. The slopes of the wet-bulb temperature spectra were more than those of the dry-bulb ones at all levels which were attributed to the differences in the diffusivity of water vapour and heat in the atmosphere. The variance of the temperature spectra of dry-bulb was higher than that of the wet-bulb and the maximum values were found at the cloud base levels. The longer wavelengths of the temperature spectra were found to contain more energy in the case of wet-bulb than in the case of dry-bulb. The energy dissipation rate from the longer to the shorter wavelengths of the temperature spectra was more in the case of wet-bulb than that in the case of dry-bulb. The slope of the dry-bulb temperature spectra in isothermal layers was less than that in the layers having dry adiabatic lapse rate. The slope of the wet-bulb temperature spectra showed an opposite trend to that of the dry-bulb. In isothermal layers, the energy dissipation rates were less in the case of the dry-bulb temperature spectra and more in the case of the wet-bulb ones. This feature was more markedly seen in the shorter wavelength region of the spectra. The above result was attributed to the negative correlation which exists between the water vapour mixing ratio and temperature in the clear air conditions.

(d) Based on 32 aerological soundings obtained from 4 Russian ships during Monex-77, it was found that the extent of the atmospheric boundary layer over the Arabian sea region

(10° - 14°N, 64° - 68°E) might be up to 1.5 - 2 km. This, however, might vary depending on the monsoon activity on any particular day. The vertical temperature distribution indicated an unstable layer near the surface with an overlying layer of moist-adiabatic stratification capped by relatively unstable layer. In this type of temperature stratification, the ascent of moist air is possible only if there exists some mechanism to break the inversion layer.

2.4.2.2 Studies in upper atmosphere

(a) The possible relationship between the sunspot numbers and the rainfall of Tamil Nadu State, South India, during the southwest (July-September) and northeast (October-December) monsoons for the 10-year period (1961-70) was investigated using the cross-spectral technique. The coherency spectra between the sunspot numbers and rainfall showed a peak corresponding to the period of 30-days which is significant at 5 percent level with a relative phase lag of less than two days during the southwest monsoon when the sun remains at all times in the northern hemisphere. No significant peaks or values were detected during the north-east monsoon when the sun remains at all times in the southern hemisphere.

(b) A study on the total ozone, solar activity and Indian summer monsoon was undertaken using the total ozone and the meteorological data for the period 1969-78 for (i) Alma-Ata (43° 14'N, 76° 56'E), (ii) New Delhi (28° 36'N, 77° 12'E) and (iii) Kodaikanal (10° 14'N, 77° 28'E), stations, which are located almost along the same meridian. The total ozone at Alma-Ata during June-September showed a significant negative correlation with the activity of summer monsoon (June-September) over the Indian sub-continent. Also, the geopotential height and temperature of the 200 mb level at Alma-Ata during the same period showed significant positive correlations with the activity of the summer monsoon. The total ozone at Kodaikanal during March-April (pre-monsoon) showed a significant negative correlation with the activity of the summer monsoon. The above features may have application value in forecasting.

2.4.2.3 Studies in air pollution

(a) The chemical composition of the rainwater collected in the cloud seeding experimental area on seeded and not-seeded days during 1974 was studied. The concentrations of chloride and sodium in the rain water on seeded days were higher by 200 percent when compared to the average concentrations of not-seeded days. The concentration of the giant size hygroscopic particles sampled at cloud base levels showed an increase of 34 percent following seeding which is consistent with the higher concentrations of chloride and sodium noticed in the rainwater samples collected on seeded days. The rainfall analysis of the seeding experiment on these seeded days showed increases in rainfall ranging between 14 and 137 percent.

(b) Atmospheric trace gases and hygroscopic nuclei were measured at Raichur during the total solar eclipse of 16 February 1980. Preliminary analysis indicated marked decrease in the concentrations of ozone and the oxides of nitrogen during the period of total eclipse. Sulphur dioxide and ammonia did not show any noticeable change. The concentration of aerosols in the giant size range showed marked increase.

(c) The size distribution and the chemical composition of the total aerosol in the size range between 0.1 and 10 μm were studied using the observations made during the summer monsoon and winter seasons of 1978-79 over the Deccan Plateau. The size distribution of the aerosols exhibited a bimodal distribution in the size ranges 0.4-0.6 μm and 5-6 μm. Chloride and sodium components exhibited, by and large, a unimodal distribution. Ammonium and sulphate components exhibited a bimodal distribution during the monsoon and unimodal distribution during the winter. Nitrate component exhibited a bimodal distribution during the summer monsoon and winter. The component appeared to be Ammonium Nitrate in the sub-micron range and Sodium Nitrate in the higher size range (1-10 μm).

2.5 Instrumental and Observational Techniques

Chief guest viewing the rocket payload model.

2.5.1 Development of meteorological payload for rockets and satellites

2.5.1.1 Development of rocket payload for upper atmospheric research and to carry out related physical studies

Rocket payload circuit was modified using integrated circuits. Battery mould was also modified to ease the integration problems. Two Skua type parachutes were procured for use in the Rohini-200 rocket. Six payloads were made ready for the above proposal. The microbead thermistors were re-calibrated from +30°C to -60°C.

M-100 rocket data were analysed for studying the turbulence decay rate over Thumba over 20-80 km region.

2.5.2 Development of Instruments for Boundary Layer Studies

2.5.2.1 Development of instruments for the fluxes and profiles measurements in the atmospheric boundary layer and to carry out related studies

Circuit for measuring sensible flux using the eddy correlating technique was modified. A calibrating unit to generate low frequency eddies was designed for the eddy correlation instrument. A multiplier unit to compute the variance of vertical velocity was assembled. A three channel fast temperature recorder was designed and fabricated. A linearized thermistor was used as a sensor. A technique of centering the recorder for the thermistor resistance was utilized. Temperatures were recorded at ground, 10 cm and 100 cm levels during the total solar eclipse of 16 February 1980 at the Central Agricultural Meteorological Observatory (CAMO), Pune. Dry and wet bulb temperatures were recorded at 1 m difference.

Vortex (dry and wet) and reverse flow thermometers were put in operation aboard the aircraft during the cloud seeding experiment and the temperature profile near Bombay was obtained.

An anemometer for use with tethered balloon was constructed. Work on kytoon payload was in progress.

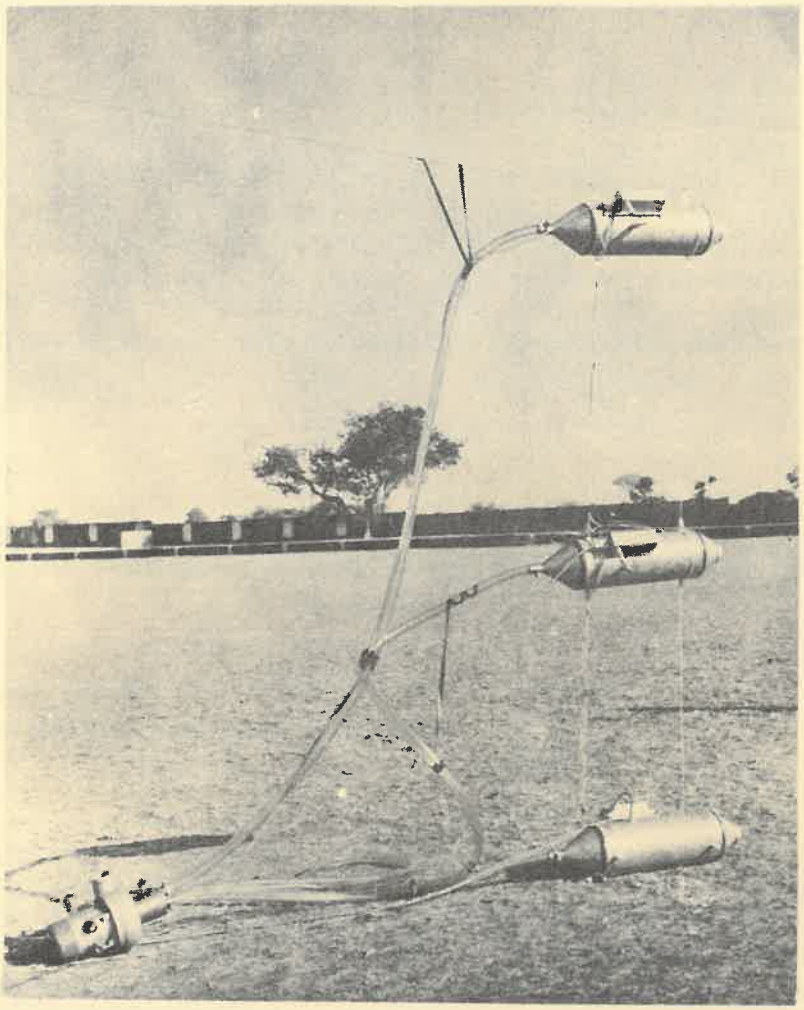
2.5.2.2 Development of wind tunnel for simulation studies of the atmospheric boundary layer

A honeycomb-cum-flat-plate and a three dimensional traverse were fabricated. Experiments on the simulation of mean wind velocity profiles were conducted using honeycomb-cum-flat-plate in the wind tunnel available in the I.M.D. Offices, Pune and the mean wind velocity profiles downstream of it were measured. Due to limitations in the wind tunnel of I.M.D., the profiles measured were not very well developed and indicated the need for further measurements over a longer fetch downstream. Further measurements were carried out at the wind tunnel available in the Central Water and Power Research Station (CWPRS), Pune. Simulation of mean wind velocity profiles in a neutrally stratified atmosphere over a level country was realized.

A low speed, open circuit blower type wind tunnel of test section 3' x 3' and length 30', with a provision to heat the tunnel floor to a temperature of 200°C for investigation of the thermally stratified flows, was designed for simulation studies of the atmospheric boundary layer. The design work was carried out in the Department of Aeronautical Engineering of the Indian Institute of Science, Bangalore.

2.5.3 Instrumentation for cloud physics and weather modification studies

2.5.3.1 Development of instruments and observational techniques for cloud electrification studies



Three space charge tubes suspended in the field for the measurements of atmospheric electric space charge profiles during the solar eclipse of 16 February 1980.

A spherical field-mill to measure the electric field vector was fabricated involving fabrication and assembly of about a hundred small and big mechanical parts.

Three space charge tubes to measure atmospheric electric space charge using direct filtration technique and the electronic circuitry required for the amplification of their processing of these signals were developed. Using these space charge tubes, a field experiment was conducted during the Total Solar Eclipse of 16 February 1980. Space charge profiles and the electric field were measured in the lowest 2 meters of the surface layer continuously for about a week. A decrease in the electric field and an increase in the space charge fluctuations at 2 metres above the ground were indicated.

A regulated power supply and other electronic circuitry required for the AC and DC field mills were assembled.

2.5.3.2 Development of simulation techniques for cloud physics studies

Work on the development of a vertical wind tunnel for studies on the micro-physics of clouds was continued. Three screens to streamline the air-flow were fitted into the vertical wind tunnel. Different types of screens to create a velocity well in the test section of the tunnel were fabricated and tested. Attempts were under way to improve the stability of the water drops which could be suspended in the test section for longer periods of time.

Generation of highly charged water droplets was tried by applying high voltage to a thin stream of water.

Some theoretical studies on the interaction of the cloud electrification with the micro-physics of cloud were made. It was found that in the highly electrified regions of the cloud, there might occur an accumulation of cloud and precipitation particles. Dependence of these accumulations on the various electrical and meteorological variables was

studied.

2.6 Theoretical Studies

2.6.1 Studies on dynamic instability

2.6.1.1 Barotropic and baroclinic instability of the atmospheric flow

A few numerical experiments with a multi-level quasi-geostrophic baroclinic model were performed in order to understand the role of vertical walls at the lateral boundaries, the wind distribution in vertical and the meridional shear on the baroclinic instability characteristics of monsoon zonal wind. The following conclusions were drawn from the experiments :

(a) The presence of the vertical walls reduces the growth rate significantly for the longer unstable waves along with a shift in the preferred scales both in the shorter and the longer unstable wavelength regions, toward the longer wavelengths.

(b) For the growth of the shorter unstable waves, ($L < 3500$ km) only the low level westerlies are important, whereas for the longer waves ($L > 3500$ km) the high level easterlies are important.

(c) The presence of meridional shear decreases the baroclinic growth rates of the longer wavelengths.

The study on the effect of vertical resolution of a numerical model on the instability of non-geostrophic disturbances indicated an increase in the growth rate with the resolution due to the better resolution of the vertical variation of the amplitude and phase of disturbances, which is not linear.

Some analytical functions were constructed in order to represent the observed three dimensional structure of monsoon depression, specifically the thermal, the wind and the associated diabatic heating distributions. It was noted that the quasi-geostrophic approximation was quite valid.

A study of the stability of upper level planetary waves was made with an equivalent barotropic model, suitable for application to the monsoon flow at any pressure level in the 400 mb to 150 mb region. The growth rates were observed to depend on the uniform zonal motion, which is absent in the non-divergent model. Further, the generated meridional distribution of zonal wind showed a close similarity with the observed distribution of wind in the easterly jet.

The divergent barotropic instability of the easterly jet was analysed by a spectral method based on initial value approach. Preliminary results indicated a deeper form of instability for the disturbances than that found with a non-divergent model.

The jet stream front, the Clear Air Turbulence (CAT) zones and the break in the tropopause, in a westerly jet stream, were simulated with the help of a theoretical model, with the zonal wind as the independent and the thermal stratification as dependent parameters.

2.6.1.2 Study of dynamic instability of synoptic scale systems in tropics

A primitive equation model for CISK (Conditional Instability of Second Kind) instability of monsoon zonal wind was formulated and programmed.

2.6.2 Simulation of monsoon and tropical circulation systems

2.6.2.1 Simulation and mean monsoon circulation

Development of the primitive equation barotropic spectral model was achieved by incorporating linear drag and the momentum diffusion processes in the model, along with a suitable time integration scheme.

Comparison between the results obtained from the low and high resolution integrations of the barotropic unstable wave of wave number 8, suggested that the large error in the low resolution integration was due to the non-physical accumulation of energy in the shortest wave.

3. PUBLICATIONS

3.1 Papers Published

Sr. No.	Title	Author(s)	Publication
1.	Calibration for measurements of droplet size distributions of ground based clouds - A laboratory investigation.	Paul S.K., Sharma S.K. and Kapoor R.K.	Journal of Indian Institute of Science, 61 (B), June, 1979, 135 - 141.
2.	Contributions of cloud and precipitation particles to the electrical conductivity and the relaxation time of the air in thunderstorms.	Kamra A. K.	Journal of Geophysical Research, 84, C8, August, 1979, 5034 - 5038.
3.	Effect of electrical forces on charge separation caused by the combined effect of the precipitative and convective mechanisms in thunderclouds.	Kamra A. K.	Journal of Geophysical Research, 84, C8, August, 1979, 5039 - 5045.
4.	Experimental investigation of the influence of electric field on the collision - coalesence of water drops.	Paul S.K., Selvam A.M. and Ramana Murty Bh. V.	Tellus, 31, 4, August, 1979, 279 - 289.

Sr. No.	Title	Author(s)	Publication
5.	Field-testing of two cloud droplet samplers.	Sharma S.K.	Journal of The Institution of Engineers (India), Students' Journal, 13, S4, March, 1980, 110 - 112.
6.	Geomagnetic activity and rainfall during northeast monsoon.	Reddy R.S., Parasnis S.S. and Ramana Murty Bh. V.	Indian Journal of Radio and Space Physics, 8, 5/6 October/ December, 1979, 277 - 280.
7.	Heavy rainfall distribution over Rajasthan.	Rakhecha P.R., Kulkarni A.K., Mandal B.N. and Dhar O. N.	Proc. of the Seminar on 'Water Resources Management in Rajasthan' Jaipur, 20-21 July, 1979, 1 - 15.
8.	High level warmings, winds and Indian summer Monsoon.	Mukherjee B.K., Reddy R.S. and Ramana Murty Bh. V.	Monthly Weather Review, 107, 12, December, 1979, 1581 - 1588.
9.	Incidence of heavy rainfall in the Indian desert region.	Dhar O.N. and Rakhecha P.R.	Proc. of the IAHS Symposium on the 'Hydrology of Areas of Low Precipitation' Canberra, Australia, 10-13 December, 1979, 33-42.

Sr. No.	Title	Author(s)	Publication
10.	Indian monsoon and its economic impact.	Saha K.R., Mooley D.A. and Saha S.	Geo-journal Federal Republic of Germany, 3, 2, 1979, 171 - 178.
11.	Induction type wind vane.	Brij Mohan and Vernekar K. G.	Mausam, 30, 4, October, 1979, 525.
12.	Is the number of cyclonic disturbances traversing India during a monsoon season related to the rainfall in that season ?	Dhar O. N., Rakhecha P.R., and Mandal B. N.	Mausam, 31, 1, January, 1980, 119 - 124.
13.	Maximum one-day point rainfall estimation over north Indian plains using district average rainfall ratios.	Dhar O. N., Kulkarni A.K. and Rakhecha P. R.	Pure and Applied Geophysics, 118, 3, 1980, 743 - 752.
14.	Meteorological rocket payload for Rohini-200, its developmental details and associated physical aspects.	Vernekar K.G., Gupta R.K. and Brij Mohan	Indian Journal of Radio and Space Physics, 8, 5/6, October/ December, 1979, 266 - 272.

Sr. No.	Title	Author(s)	Publication
15.	Meteorology of Kerala.	Ananthakrishnan R., Parthasarathy B. and Pathan J. M.	Commemoration Volume on the occasion of sixtieth Birthday of Prof. C.V. Kurian, Head of Deptt. of Marine Science, University of Cochin, November, 1979, 60-125.
16.	Numerical simulation of cloud seeding experiments in Maharashtra State.	Selvam A. M., Murty A.S.R. and Ramana Murty Bh. V.	Journal of Weather Modification, 11, 1, April, 1979, 116-140.
17.	On the performance of modified Palmer Index.	Bhalme H.N. and Mooley D. A.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. B, 27, 4, October, 1979, 281 - 295.
18.	- do -	- do -	Proc. of the International Symposium on 'Hydrological Aspects of Droughts' New Delhi, 3-7 December, 1979, 373 - 383.

Sr. No.	Title	Author(s)	Publication
19.	Poisson distribution and years of bad monsoon over India.	Mooley D. A.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. B., 27, 4, October, 1979, 381 - 388.
20.	Procedure for computation of vertical velocity in the Indian region including Himalayan region.	Rao K.V. and Rajamani S.	Mausam, 31, 2, March, 1980, 309 - 312.
21.	Profile and flux measurements over Jowar Canopy.	Vernekar K.G. and Sadani L. K.	Mausam, 31, 1, January, 1980, 125 - 132.
22.	Rainfall study of severe drought years of India.	Dhar O. N., Rakhecha P.R. and Kulkarni A. K.	Proc. of the International Symposium on 'Hydrological Aspects of Droughts', New Delhi, 3-7 December 1979, 363 - 372.
23.	Rainstorm which contributed the greatest areal raindepths in India.	Dhar O. N., Rakhecha P.R. and Mandal B. N.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 29, 1-2, March, 1980, 119 - 130.

Sr. No.	Title	Author(s)	Publication
24.	Relative importance of circulation at various levels in specifying and predicting 5 and 10-day monsoon rainfall.	Singh S. V., Mooley D. A., Kriplani R.H. and Ubale P.D.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 28, 1979, 169 - 185.
25.	Review of rainfall relationships based upon Indian data.	Dhar O.N. and Rakhecha P.R.	ESCAP's Water Resources Journal, Sr.C., 123, December, 1979, 16-25.
26.	Role of baroclinic instability in the development of monsoon disturbance.	Mishra S. K. and Salvekar P. S.	Journal of Atmospheric Sciences, 37, 2, February, 1980, 383 - 394.
26.	Role of tree ring analysis and related studies in Palaeoclimatology : Preliminary Survey and scope for Indian region.	Pant G. B.	Mausam, 30, 4, October, 1979, 439 - 448.
28.	Solar activity and Indian monsoon.	Bhalme H. N., Reddy R. S., Mooley D. A. and Ramana Murty Bh. V.	Proc. of the Indo-US Workshop on Solar Terrestrial Physics, Udaipur, 12-16 June 1979, 101 - 105.

Sr. No.	T i t l e	Author(s)	Publication
29.	Some analytical vertical profiles of monsoonal zonal wind over India.	Mishra S. K.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 29, 1980, 109 - 117.
30.	Some features of the southwest monsoon rainfall along the west coast of India.	Ananthakrishnan R., Aralikatti S.S. and Pathan J.M.	Proc. of the Indian Academy of Sciences - Sect. A., Pt. II, (Earth and Planetary Sciences), 88, November, 1979, 177 - 199.
31.	Study of the chemical components of aerosols and snow in the Kashmir region.	Kapoor R. K. and Paul S.K.	Tellus, 32, 1, February, 1980, 33 - 41.
32.	Study of rainfall frequency relationships for the Karnataka region.	Dhar O. N., Kulkarni A.K. and Ghose G.C.	Indian Journal of Power and River Valley Development, 28, 11, November, 1978, 309 - 314.
33.	Temperature fluctuations inside cloud laden air stream flowing over a hill station.	Sadani L. K., Krishna K., Vernekar K.G., Kulkarni C.P. and Parasnis S. S.	Boundary Layer Meteorology, 17, 2, September, 1979, 202 - 212.

Sr. No.	T i t l e	Author(s)	Publication
34.	Was the year 1978 the worst flood-year of the country ?	Dhar O.N. and Ghose G. C.	Journal of Indian Association of Hydrologists, 3, 1 and 2, May, 1979, 15-20.
35.	वर्षाकी प्रक्रियाएँ तथा कृत्रिम वर्षा	Sharma P. N. and Pant G.B.	Journal of The Institution of Engineers (India), 60, HI-1, 1979, 130 - 134.

3.2 Papers accepted for Publication

Sr. No.	Title	Author(s)	Publication
1.	Characteristics of temperature spectra in the atmospheric boundary layer.	Parasnis S.S., Selvam A.M., Vernekar K.G., Brij Mohan, Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VIII International Conference on Cloud Physics, Clermont - Ferrand (France), 15-20 July 1980.
2.	Coherency between sunspot activity and rainfall.	Reddy R. S., Parasnis S.S. and Ramana Murty Bh. V.	Proc. of the 22nd COSPAR meeting and symp. on 'Low Latitude Aeronomical Processes, Bangalore, 30 May - 1 June 1979.
3.	Diurnal and seasonal variations of space charge, electric field and cloud condensation nuclei in the lowest layer of the atmosphere.	Selvam A. M., Manohar G. K., Kandalgaonkar S.S., Murty A.S.R. and Ramana Murty Bh. V.	Tellus.
4.	Does early or late onset of monsoon provide any clue to the subsequent rainfall during monsoon season ?	Dhar O. N., Rakhecha P.R. and Mandal B. N.	Monthly Weather Review.
5.	Droughts in India over the last 200 years, their socio-economic impact and remedial measures for them.	Mooley D. A. and Pant G.B.	Proc. of the International meeting on 'Climate and History', Norwich (U.K.), 8-14 July 1979.

Sr. No.	Title	Author(s)	Publication
6.	Dynamical characteristics of the sub-cloud layer in a maritime environment.	Selvam A. M., Bandyopadhyay B.K., Vernekar K. G., Brij Mohan, Vijaykumar R., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VIII International Conference on 'Cloud Physics, Clermont - Ferrand (France), 15-20 July 1980.
7.	Dynamical characteristics of warm monsoon clouds and their responses to salt seeding.	Parasnis S.S., Selvam A. M., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the III W.M.O. Scientific Conference on 'Weather Modification', Clermont - Ferrand (France), 21-25 July 1980.
8.	Dynamics of the lower stratosphere in the wave number domain in relation to monsoon activity.	Raja Rao K.S., Awade S.T. and Nair M.V.H.	Journal of Atmospheric and Terrestrial Physics.
9.	Electrical phenomena in monsoon clouds.	Selvam A. M., Manohar G. K., Bandyopadhyay B.K., Vijaykumar R., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VI International Conference on 'Atmospheric Electricity', Manchester (England), 28 July - 1 August 1980.
10.	Electrical phenomena in pre-monsoon thunderstorms.	Selvam, A. M., Manohar G. K., Kandalgaonkar S.S., Murty A.S.R. and Ramana Murty Bh. V.	- do -

Sr. No.	Title	Author(s)	Publication
11.	Fluctuations in SST over Somali region during GATE.	Singh S. V. and Kirichak A. A.	Tellus.
12.	High level temperatures and winds over tropics and Indian summer monsoon.	Mukherjee B.K., Reddy R.S. and Ramana Murty Bh. V.	Proc. of the International Symposium on 'Middle atmosphere dynamics and transport', Illinois (USA), 28 July - 1 August 1980.
13.	Importance of upper troposphere anomalies for long range forecasting of Indian summer monsoon activity.	Verma R. K.	Monthly Weather Review.
14.	Incorporating some climatological features in the objective analysis over Indian region.	Rajamani S., Ray S.P. and Talwalkar D.R.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. B.
15.	Indian summer monsoon, its economic aspects, its vagaries and remedial measures for them.	Mooley D. A.	Series on 'Agricultural Geography', School of Economics, Delhi.
16.	Large-scale droughts/floods and monsoon circulation.	Bhalme H. N. and Mooley D. A.	Monthly Weather Review.
17.	Numerical simulation of cloud seeding experiments in Maharashtra State, India.	Selvam A. M., Murty A.S.R., Bhosale C. S. and Ramana Murty Bh. V.	Proc. of the III W.M.O. Scientific Conference on 'Weather Modification', Clermont-Ferrand (France), 21-25 July 1980.

Sr. No.	Title	Author(s)	Publication
18.	Numerical evaluation of the aircraft salt seeding experiments in the Deccan Plateau.	Selvam A. M., Bhosale C.S., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the III W.M.O. Scientific Conference on 'Weather Modification', Clermont - Ferrand (France), 21-25 July 1980.
19.	Numerical simulation of cloud seeding experiments in north India.	Selvam A. M., Chatterjee R.N., Bhosale C.S., Murty A.S.R. and Ramana Murty Bh. V.	- do -
20.	Observations on atmospheric electrical parameters during heavy rainfall occasions.	Selvam A. M., Manohar G.K., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VI International Conference on 'Atmospheric Electricity', Manchester (England), 28 July - 1 August 1980.
21.	Observations on skylight intensity, atmospheric turbidity and water vapour content during the total solar eclipse 1980.	Vijaykumar R., Selvam A. M., Murty A.S.R., Khemani L.T. and Ramana Murty Bh. V.	Proc. of the International Symposium on 'Radiation', Boulder, Colorado, (USA), 11-16 August 1980.

Sr. No.	Title	Author(s)	Publication
22.	On kinetic energy budget of monsoon circulation over Indian region during ISMEX-73.	Singh S. S., Kulkarni A.A. and Bandyopadhyay A.	Pure and Applied Geophysics.
23.	On some aspects of initialisation and forecast in Indian monsoon region.	Singh S. S., Kulkarni A.A. and Sikka D. R.	Monthly Weather Review.
24.	Power spectral analysis of atmospheric electric field and rainfall.	Selvam A. M., Manohar G.K., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VI International Conference on 'Atmospheric Electricity', Manchester (England), 28 July - 1 August 1980.
25.	Probability model for the calamitous behaviour of the summer monsoon over India.	Mooley D. A. and Parthasarathy B.	Proc. of the International meeting on Statistical Climatology, Hachi-oji, Tokyo (Japan), 29 November - 1 December 1979.
26.	Radar evaluation of salt seeding responses in warm maritime cumulus clouds.	Chatterjee R.N., Murty A.S.R., Selvam A.M. and Ramana Murty Bh. V.	Proc. of the III W.M.O. Scientific Conference on 'Weather Modification', Clermont - Ferrand (France), 21-25 July 1980.

Sr. No.	Title	Author(s)	Publication
27.	Solar influence on atmospheric electric field.	Selvam A. M., Joshi R. R., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VI International Conference on 'Atmospheric Electricity', Manchester (England), 28 July - 1 August 1980.
28.	Some aspects of the large scale fluctuations of summer monsoon rainfall over India in relation to fluctuations in the planetary scale and regional circulation pattern.	Sikka D. R.	Proc. of Indian Academy of Sciences, Sr. A.
29.	Some characteristics of the PBL over ocean during the Indian summer monsoon.	Sinha S. and Khade V. V.	Boundary Layer Meteorology.
30.	Some electrical and microphysical aspects of monsoon clouds.	Selvam A. M., Bandyopadhyay B.K., Revathy N., Vijaykumar R., Manohar G.K., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VI International Conference on 'Atmospheric Electricity', Manchester (England), 28 July - 1 August 1980.
31.	Some thermodynamical and microphysical aspects of monsoon clouds.	Selvam A. M., Murty A.S.R., Vijaykumar R., Paul S. K., Manohar G. K., Reddy R. S., Mukherjee B. K. and Ramana Murty Bh. V.	Proc. of the Indian Academy of Sciences, Sr. A.

Sr. No.	Title	Author(s)	Publication
32.	Study of the instability of meridional flow - Part I.	Mahanti A.C.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
33.	Suitable probability model for the severe cyclonic storms striking the coast around the Bay of Bengal.	Mooley D. A.	Proc. of the International meeting on Statistical Climatology, Hachi-oji, Tokyo (Japan), 29 November - 1 December 1979.
34.	Summer Monex Field Phase.	Sikka D. R. and Datta R.K.	Vayu Mandal.
35.	Super-Geostrophic zonal flow and transverse circulations in a westerly jet stream.	Subrahmanyam D.	Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
36.	Temperature stratification of the atmospheric boundary layer over the Deccan Plateau, India, during the summer monsoon.	Parasnis S.S., Krishna K. and Brij Mohan.	Boundary Layer Meteorology.
37.	Thermal, microphysical and chemical conditions in an urban environment.	Khemani L.T., Momin G. A., Naik M. S., Selvam A. M., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of the VIII International Conference on 'Cloud Physics', Clermont - Ferrand (France), 15-20 July 1980.

Sr. No.	Title	Author(s)	Publication
38.	Variations in atmospheric nuclei and electrical parameters during the total solar eclipse 1980.	Selvam A. M., Manohar G.K., Murty A.S.R., Vijaykumar R. and Ramana Murty Bh. V.	Proc. of the VI International Conference on 'Atmospheric Electricity', Manchester, (England), 28 July - 1 August 1980.
39.	Variations in the surface ozone, atmospheric trace gases and acrosols during the Total Solar Eclipse-1980.	Khemani L.T., Momin G. A., Naik M. S., Murty A.S.R., Selvam A. M. and Ramana Murty Bh. V.	Proc. of the 'Symposium on Atmospheric Ozone', Boulder, Colorado (USA), 4-9 August 1980.

3.3 Institute's Research/Technical Reports

Sr. No.	T i t l e	Author(s)	Remarks
1.	Poisson distribution and years of bad monsoon over India.	Mooley D.A. and Parathasarathy B.	Under Publication.
2.	Modification of Palmer drought Index.	Bhalme H. N. and Mooley D. A.	- do -
3.	Wind tunnel for simulation studies of the atmospheric boundary layer.	Sivaramakrishnan S.	- do -

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

4.1 The following Seminars/Symposia/Meetings were attended during the year

Sr. No.	Seminar/Symposium/Meeting	Participant(s)
1.	Meeting of Board of Studies of Marathwada University, Aurangabad for framing syllabus of degree courses in Geography, 11-12 April, 6 August and 9 October 1979 and 23 February 1980.	Gondhalekar Y. S.
2.	Meeting of the Monex monitoring group for NRSA Aircraft Instrumentation, 11 April and 15 June 1979.	Murty A. S. R.
3.	Colloquium on Satellite Meteorology, I.I.Sc., Bangalore, 27 April 1979.	Sikka D. R.
4.	Meeting with Prof. Narasimha, Member, Governing Council of I.I.T.M., in connection with the project on 'Data Management and Archiving', Bangalore, 29 and 30 April 1979.	Ramana Murty Bh.V. and Suryanarayana R.
5.	Meeting of the National Institute of Oceanography, Panjim, Goa, 10-14 May 1979.	Ramana Murty Bh.V.
6.	22nd COSPAR meeting and symposium on 'Low Latitude Aeronomical processes', ISRO, Bangalore, 29 May - 9 June 1979.	Ramana Murty Bh.V. and Reddy R. S.

Sr. No.	Seminar/Symposium/Meeting	Participant(s)
7.	Indo-US Workshop on Solar Terrestrial Physics, Department of Science and Technology, New Delhi, Astronomical Observatory, Ahmedabad, Physical Research Laboratory, Ahmedabad and Indo-US co-operative scientific programme at Udaipur Solar Observatory, Udaipur, 12-16 June 1979.	Ramana Murty Bh.V. and Bhalme H. N.
8.	Conference on 'Climate and History', University of East Anglia, Norwich, U.K., 8-14 July 1979.	Mooley D. A.
9.	Inter-departmental meeting convened by the Ministry of Finance, UNDP country programme 1979-84, New Delhi, 13 July 1979.	Suryanarayana R.
10.	Monex-79 field phase at SMOC, Calcutta, 27 July 1979.	Sikka D. R.
11.	Meeting of the Board of Studies in Geography of University of Bombay, 9 August 1979.	Gondhalekar Y. S.
12.	Meeting of the Confirmation Committee, I.M.D., New Delhi, 27-30 August 1979.	Ramana Murty Bh.V.
13.	Meeting of the ISRO's Board on Meteorology, Application and Science at TIFR, Bombay, 12 September 1979 and at Trivandrum, 15 March 1980.	Sikka D. R.
14.	7th meeting of the Scientific Advisory Committee (MONEX), New Delhi, 22 September 1979.	Ramana Murty Bh.V.

Sr. No.	Seminar/Symposium/Meeting	Participant(s)
15.	Meeting of the Board of Studies in Geography and Meteorology of Shivaji University, Kolhapur, 6 October 1979.	Gondhalekar Y. S.
16.	Selection Committee meeting for Air India Fellowships, Bombay, 13-15 November 1979.	Dhar O. N.
17.	International Symposium on 'Hydrological Aspects of Droughts, I.I.T., New Delhi, 3-7 December 1979.	Dhar O. N., Bhalme H. N., Rakhecha P.R. and Kulkarni A. K.
18.	Meeting of the ISRO, Bangalore, 4-7 December 1979.	Ramana Murty Bh.V.
19.	Meeting at the Andhra University, Waltair, Visakapatnam, 15-19 December 1979.	Ramana Murty Bh.V.
20.	Meeting of the Council for Meteorology and Atmospheric Sciences (CMAS), Bangalore, 27-30 December 1979.	Ramana Murty Bh.V.
21.	Symposium on Advances in methods of data collection, validation, storage, retrieval and analysis, Indian Statistical Institute, Calcutta, 17-20 January 1980.	Aralikatti S. S.
22.	National Space Sciences Symposium, Banaras Hindu University, Varanasi, 22-26 January 1980.	Sikka D. R., Vernekar K.G. and
23.	National Working Group on Numerical Weather Prediction, New Delhi, 28 January 1980.	Sikka D. R.

Sr. No.	Seminar/Symposium/Meeting	Participant(s)
24.	Monex data processing group, IMMC, New Delhi, 29 January 1980.	Sikka D. R.
25.	Indo-French school on recent advances in computer techniques in Meteorology, Bio-mechanics and Applied Systems, I.I.T., New Delhi, 4-13 February 1980.	Sikka D. R., Singh S. S., Mishra S.K. and Salvekar P. S.
26.	Symposium on 'Industrial Aerodynamics', The Institution of Engineers (India), Aeronautical Engg. Division, Bangalore, 7-8 February 1980.	Sivaramakrishnan S.
27.	Students' Technical Session during the Diamond Jubilee Convention of The Institution of Engineers (India), Calcutta, 14-20 February 1980.	Sharma S. K.
28.	DST/SERC working group meeting on Satellite Meteorology, Space Application Centre, Ahmedabad, 27-28 February 1980.	Sikka D. R.
29.	First meeting of SERC working group on Atmospheric Chemistry, Department of Science and Technology, New Delhi, 11 March 1980.	Chatterjee R. N.
30.	Meeting on 'Ion-molecule reaction in the atmosphere', University of Roorkee, Roorkee, 29-31 March 1980.	Kamra A. K.

4.2 Papers contributed to Seminars/Symposia/Conferences

Sr. No.	Seminar/Symposium/ Conference	Title of the paper	Author(s)
1.	Seminar on Satellite Meteorology, I.I.Sc., Bangalore, 27 April 1979.	Meteorological Satellites in research and operations.	Sikka D. R.
2.	Monex Seminars, Summer Monsoon Operational Centre, Bombay, May 1979.	i) Broad scale aspects of monsoon.	Sikka D. R.
		ii) Onset of monsoon.	Sikka D. R.
		iii) On some synoptic scale models of monsoon.	Singh S. V.
3.	22nd COSPAR, meeting symposium on 'Low Latitude Aeronautical Processes', ISRO, Bangalore, 29 May - 9 June 1979.	Coherency between sun spot activity and rainfall.	Reddy R. S., Parasnis S.S. and Ramana Murty Bh. V.
4.	Indo-US Workshop on Solar Terrestrial Physics, Udaipur, 12-16 June 1979.	Solar activity and Indian Monsoon.	Bhalme H. N., Reddy R. S., Mooley D. A. and Ramana Murty Bh. V.
5.	Water Resources Management in Rajasthan, Jaipur 3-4 August 1979.	Heavy rainfall distribution over Rajasthan.	Rakhecha P. R., Kulkarni A. K., Mandal B.N. and Dhar O. N.

Sr. No.	Seminar/Symposium Conference	Title of the paper	Author(s)
6.	International Conference on Statistical Climatology, Hachi-oji, Tokyo, Japan, 29 November-1 December 1975.	i) Probability model for large scale vagaries of the summer monsoon.	Mooley D. A. and Parthasarathy B.
		ii) Probability model for the calamitous behaviour of the summer monsoon over India.	Mooley D. A. and Parthasarathy B.
		iii) Suitable probability model for severe cyclonic storms striking the coast around the Bay of Bengal.	Mooley D. A.
7.	International Symposium on Hydrological aspects of droughts, Indian Institute of Technology, New Delhi, 3-7 December 1979.	i) On the performance of modified Palmer Index.	Bhalme H. N. and Mooley D.A.
		ii) Rainfall study of severe drought years of India.	Dhar O. N., Rakhecha P. R. and Kulkarni A. K.
8.	67th session of the Indian Science Congress Association, Calcutta, January 1980.	Poisson probability model for severe cyclonic storms striking the coast around the Bay of Bengal.	Mooley D. A.

Sr. No.	Seminar/Symposium/ Conference	Title of the paper	Author(s)
9.	National space sciences symposium, Banaras Hindu University, Varanasi, 22-26 January 1980.	Characteristics of upper atmospheric turbulence decay rate over Thumba.	Vernekar K. G. and Brij Mohan.
		ii) Onset of monsoon studied with Monex-79 data.	Sikka D. R.
		iii) Some aspects of the fluctuations of maximum cloud zone over Indian longitudes during the southwest monsoon.	Sikka D.R. and Gadgil S.
		iv) Some thermodynamical studies of the atmospheric boundary layer over the Arabian sea region during the summer monsoon.	Parasnis S. S., Selvam A. M., Bhosale C. S. and Ramana Murty Bh. V.
10.	Indo-French school on recent advances in computer techniques in Meteorology, Biomechanics and Applied Systems, Indian Institute of Technology, New Delhi, 4-13 February 1980.	i) Mid-tropospheric cyclone of the Arabian sea.	Sikka D. R.
		ii) On accelerating the FFT of Cooley and Tukey.	Mishra S. K.

Sr. No.	Seminar/Symposium Conference	Title of the paper	Author(s)
		iii) On computational efficiency of primitive equation barotropic model.	Mishra S. K.
		iv) Some results of the impact of additional data collected during Monex-79 on the performance of an objective analysis scheme and barotropic prediction.	Sikka D. R., Singh S.S. and Rajamani S.
		v) Uses in linearised quasi-geostropic numerical model.	Salvekar S. S.
		vi) Zeros of Legendre polynomial for high order Gaussian Quadrature.	Mishra S.K. and Asnani G. C.
11.	Students' Technical Session, Diamond Jubilee convention of The Institution of Engineers (India), Calcutta, 14-20 February 1980.	Field-testing of two cloud droplet samplers.	Sharma S. K.

Sr. No.	Seminar/Symposium/ Conference	Title of the paper	Author(s)
12.	Meeting on Ion-Molecule Reactions in atmosphere, University of Roorkee, 29-31 March 1980.	On the electrical conductivity and the relaxation time of the air in thunderclouds.	Kamra A. K.
13.	Conf. on Indian society for theory of probability and its application, Tirupati, 8-10 July 1980.	i) Application of stochastic model to prediction over India during southwest monsoon.	Kamte P. P., Ismail P.M.M., Khade V.V. and Dahale S. D.
		ii) Some statistical characteristics of daily summer monsoon rainfall over India.	Singh S. V., Kriplani R. H., Shaha P. and Prasad K. D.
14.	Climate and History, University of East Anglia, Norwich, 8-14 July 1979.	Droughts in India over the last 200 years, their socioeconomic impact and remedial measures for them.	Mooley D. A.
15.	Field phase research with Monex 79 data, Calcutta, 27 July 1979.	Proposed studies with Monex 79 data.	Sikka D. R.
16.	International Radiation Symposium, Fort Collins, U.S.A., 11-16 August 1980.	Radiometer sounding over the Indian ocean during Monex.	Mani A., Sikka D. R., Srinivasan V. and Srivastav G. P.

Sr.	Seminar/Symposium/ Conference	Title of the paper	Author(s)
17.	W.M.O. Symposium on probabilistic and statistical methods in weather forecasting, Nice, France, 8-12 September 1980.	i) Forecasting monsoon precipitation by synoptic-cum-statistical methods.	Singh S. V., Kriplani R. H., Ismail P.M.M. and Shaha P.
		ii) Inverse behaviour of large-scale weather over India and middle region of U.S.A.	Bhalme H. N. and Mooley D.A.
		iii) Simple Markov chain model for the prediction of pentad rainfall.	Kamte P. P.
		iv) Statistical technique for long range forecasting of summer monsoon activities over India.	Verma R.K. and Kamte P. P.

5. COLLABORATION WITH UNIVERSITIES AND OTHER SCIENTIFIC INSTITUTIONS

5.1 Collaboration with universities

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.

The local inquiry committee appointed by the University of Poona with Prof. M.R. Bhiday, Director, College Development Council as Chairman and Dr. K.B. Pawar, Head, Department of Geology, University of Poona, Pune and Dr. A.B.P. Sinha of National Chemical Laboratory, Pashan, Pune as Members visited the Institute on 20 March for continuation of recognition of this Institute by the University of Poona beyond June 1980.

Dr. O.N. Dhar, Assistant Director (H) was on tour to Bombay to conduct viva-voce test of an M.Sc. (Physics) student of the University of Bombay as an external examiner on 30 April 1979.

During the year under review, 3 theses were examined and assessed by Dr. O.N. Dhar, Assistant Director and reports were submitted to the Registrar, University of Bombay.

Dr. Y.S. Gondhalekar, S.S.A. continued to function as a member of the Board of Studies in Geography and Meteorology of Shivaji University, Kolhapur and also as a member of the Board of Studies in Geography of the Marathawada University, Aurangabad. He was appointed as a member of the 'Board of Inter-disciplinary Studies in Physical and Life Sciences in the Faculty of Science by the Shivaji University, Kolhapur, and was co-opted as a member of the Board of Studies in Geography of the University of Bombay.

Shri S.T. Awade, Junior Scientific Officer, submitted a Ph.D. thesis on 'Some features of the large scale circulation during south-west monsoon' to the University of Poona.

5.2 Collaboration with Scientific Institutions/ Organisations

1. Shri P. R. Rakhecha, Junior Scientific Officer, gave a course of lectures on 'Rainfall and Hydrometeorology' to the participants of the 2nd River Engineering Course for the Executive and the Deputy Engineers of the Govt. of Maharashtra, at the Staff Engineering College, Nasik during 11-14 July 1979.

2. Shri S. K. Sharma, Mechanical Assistant, delivered a lecture on 'Artificial Rainmaking Experiment' in the Pune Centre of The Institution of Engineers (India), Calcutta on 19 July 1979.

3. Shri A. K. Kulkarni, Senior Scientific Assistant, delivered a lecture on 'Hydrometeorological Studies' to the visiting trainee class I Engineers from the Staff Engineering College, Nasik on 1 August 1979.

4. Shri D. R. Sikka, S.S.O.I, gave a course of lectures on 'Satellite Meteorology' to the trainees of the Advanced Training batch at the India Meteorological Deptt. Training School at Pune.

5. Dr. O. N. Dhar, Assistant Director, was nominated by the Karnataka State Council for Science and Technology as a member on their panel of experts for scrutinizing and evaluating their research reports.

6. Shri P. R. Rakhecha, Junior Scientific Officer, delivered a lecture on 'Hydromet Research Work being done in the Institute' to a group of visiting trainee I.A.F. Officers from the Administrative College, Coimbatore during 11-14 March 1980.

7. At the request of the respective Editors of Journals, several scientific papers were reviewed by the scientists of the Institute.

8. Two research reports entitled, 'Severemost floods in Kosi river in August 1954' and 'Meteorological situations responsible for causing major floods in the country' received respectively from Dr. C. Ramaswamy, D.G.O. (Retd.) and Dr. N. Patnaik, Member (Agri.), National Flood Commission, were reviewed by the scientists of the C. and H. (H) Division.

9. Shri D. R. Sikka, S.S.O.I, was elected as a member of the International Radiation Commission of the IAMAP (IUGG).

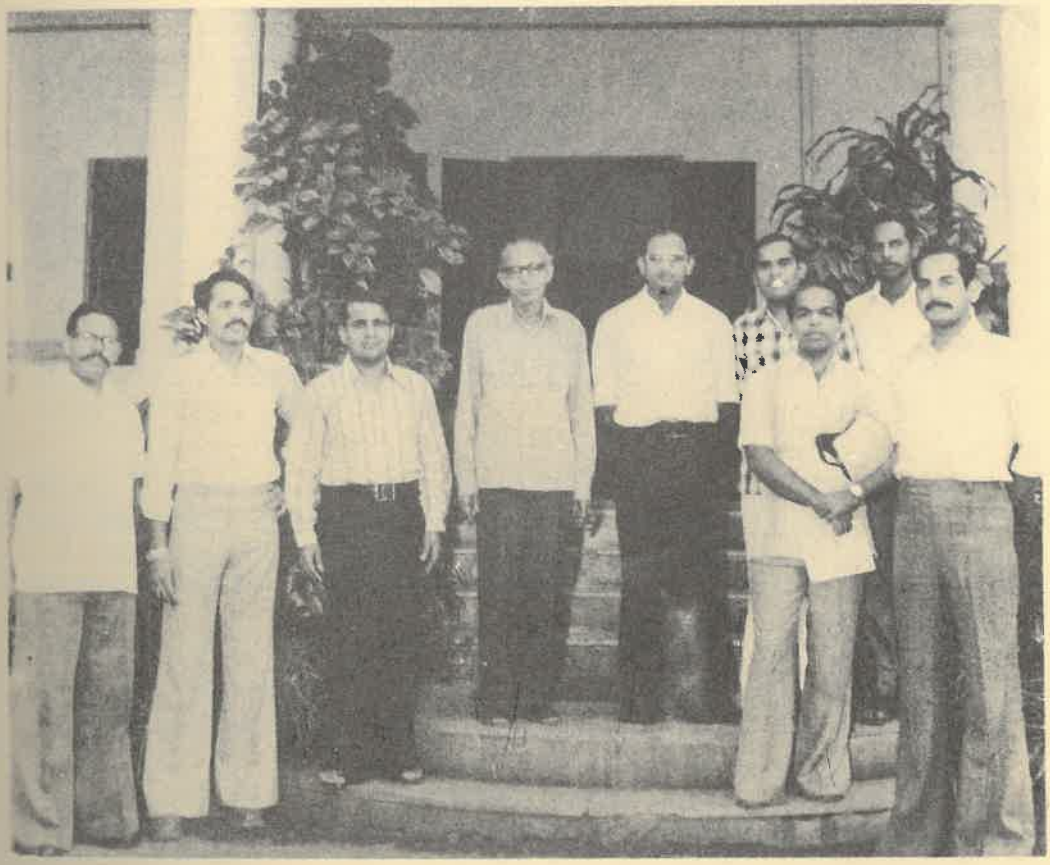
6. FACILITIES FOR RESEARCH EXTENDED TO OTHER INSTITUTIONS

6. Facilities for Research extended to other Institutions

Dr. K. S. Raja Rao, Director, Agricultural Meteorology (Retd.) India Meteorological Department, who was appointed as an Emeritus Scientist by the Council of Scientific and Industrial Research to work on his research project, 'Physics of Equatorial Strato-Mesosphere' at the Institute, continued to avail himself of the various research facilities available in the Institute.

Shri P. K. Jaykumar was awarded with the Air India Research Fellowship with effect from 21 December 1979. He was associated with the project, 'Studies in Atmospheric Electricity' currently being pursued in the Physical Meteorology and Aerology Division.

7. VISITORS



Visit of IAF Trainee officers of Air Force
Administrative College, Coimbatore.

7. Visitors

Sr. No.	Particulars	Date of Visit
1.	Dr. P. K. Das, DGM, IMD, New Delhi and Chairman G.C., I.I.T.M., Pune.	2-4 April 1979.
2.	Shri S. M. L. Bhatnagar, Secretary, Government of India, Ministry of Tourism and Civil Aviation, New Delhi.	3 April and 22 August 1979.
3.	Dr. P. R. Pisharoty, Professor Emeritus, Physical Research Laboratory, Ahmedabad.	3 April 1979.
4.	Miss Linden Vincent, Lecturer in Natural Resources, School of Development Studies, University of East Anglia, Norwich, U. K.	7 April 1979.
5.	Shri V. P. Shimpi, Superintending Engineer, Water Planning Unit, and Shri P. D. Damle, Executive Engineer, Design Division (WP) Central Design Organization (ED), Nasik.	25 June 1979.
6.	Professor Ernest C. Kung, College of Agriculture, Department of Atmospheric Sciences, University of Missouri, Columbia, U.S.A.	7 and 8 August 1979.
7.	Major (Retd.) G. S. Thosar, Pune.	18 August and 18 October 1979.
8.	Shri K. G. Krishna Murty, Member, CMAS, New Delhi.	23 August 1979.

Sr. No.	Particulars	Date of Visit
9.	Shri D. D. Bidwani, Subdivisional Engineer, Design Division, Central Design Organisation, Nasik.	24 September 1979.
10.	Shri T. K. Murithi, Director General, Kenya Meteorological Department and his colleague Shri Musasi, Kenya Met. Dept., Nairobi.	14 November 1979.
11.	Dr. Allan H. Murphy, Associate Professor of Atmospheric Sciences, Oregon State University, U.S.A.	15-23 November 1979.
12.	Dr. H. S. S. Sinha and Dr. V. Satyan, Scientists, Physical Research Laboratory, Ahmedabad.	10-15 December 1979.
13.	Dr. (Mrs.) S. Gadgil, Assistant Professor, I.I.Sc., Bangalore.	7-11 January 1980.
14.	Prof. C. C. Chang, Emeritus Professor, Catholic University of America, U.S.A.	21 January 1980.
15.	A Batch of IAF trainee officers, Coimbatore.	11-14 March 1980.

8. GENERAL

Governing Council members discussing the progress of construction of the IITM building at Pashan, Pune.

8. General

8.1 The Governing Council

The management of the Institute is vested in the Governing Council consisting of nine members, nominated by the Government of India. A list of members is given in Appendix I.

8.2 Construction of Institute's buildings and staff quarters

The construction of the Institute's buildings at Pashan, Pune covering a plinth area of 2800 m^2 (approx.) was in progress. The buildings would help accommodate some of the functional laboratories of the Institute. The estimated cost of Rs. 38.00 lakhs was deposited with the CPWD authorities. It is expected that the buildings would be ready by April 1981.

Administrative approval and expenditure sanction for construction of 24 staff quarters (8 each of types A, B and C) was communicated to CPWD. The estimated cost for the proposed quarters is Rs. 10.00 lakhs and the same was deposited with the CPWD, Pune. Tenders for construction of the staff quarters were received and are being processed by the CPWD. The work is expected to commence soon.

8.3 Facilities

8.3.1 Library, Information and Publication

A. Library

Statistics

245 books in the meteorological and allied fields

were added and 50 journals of national and international repute were subscribed to during the year.

Sale of volumes of the Institute's publication 'Proceedings of Symposium on Tropical Monsoons, Pune, 8 - 10 September 1976'

The priced publication brought out in 1977 by the Institute received a good response from interested scientists from India and abroad. 42 copies were sold during the year under review.

Collected Reprint Volume 1978

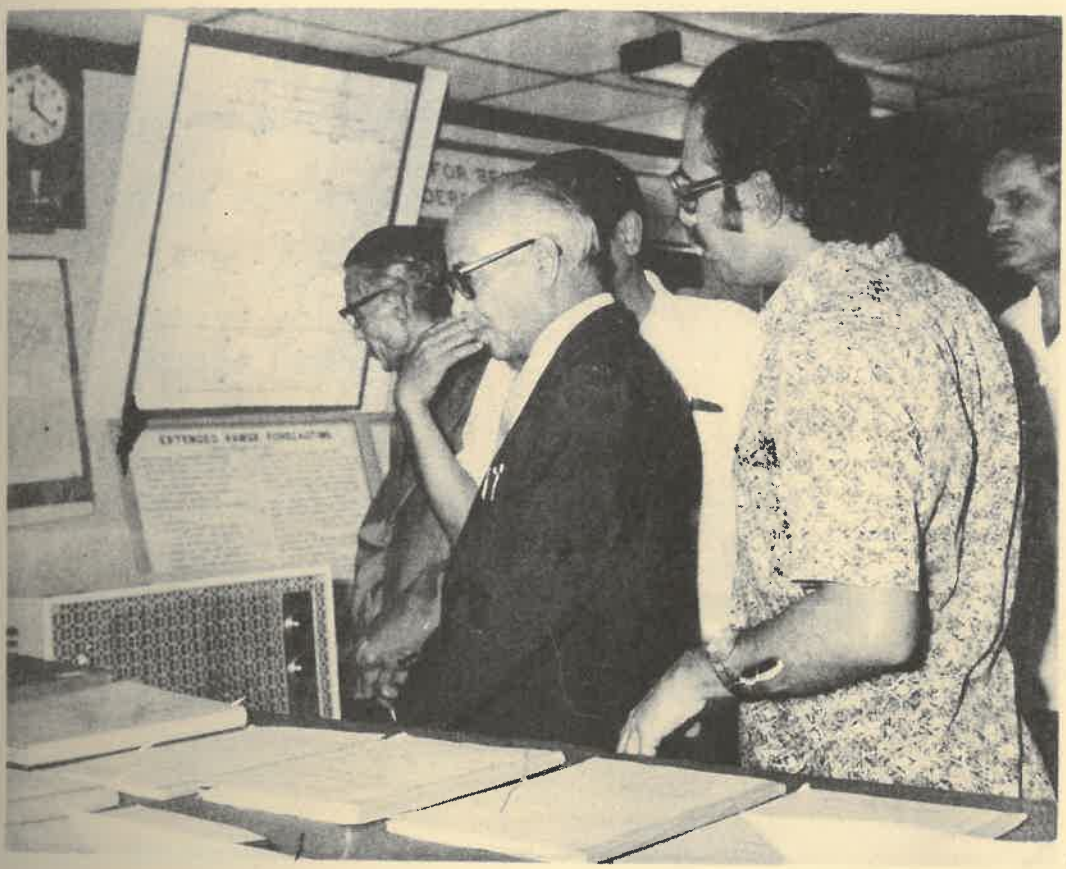
Reprints of papers published by the Institute's scientists during the year 1978 in various national and international journals were compiled.

B. Exhibition

On the occasion of the Foundation Stone Laying Ceremony of the Institute's buildings at Pashan, Pune, an exhibition was organised on 3 April 1979 depicting the salient activities of the Institute.

C. Planning

Annual Plan (S. and T. Component) 1980-81 was formulated and sent to the Ministry of Tourism and Civil Aviation, Govt. of India



Chief guest Shri S.M.L. Bhatnagar examining
the documents displayed.

8.3.2 Computer

The IBM 1620 computer worked during the year as follows :

		Hrs.	Mts.
Institute's Jobs	...	1124	45
Data Processing of I. Met. D.	...	192	25
Break down / Maintenance	...	454	50
Paying Users	...	102	25

On special request from the DDGM (C. and G.), Pune, drop wind sonde data collected by the US Aircraft Missions during the field phase of Monex-79 and Radiometer sonde data were processed on the IBM 1620 computer on priority basis. Temperature and wind data collected by AVRO Aircraft Missions were also punched and processed. Suitable programs for processing the data as desired by DDGM (WF), Pune, were developed.

8.3.3 Workshop

The following work was carried out during the year :

i) Fabrication work connected with the rocket payload project.

ii) Assembly of three channel temperature recorder and fabrication of drag meter, kytoon payload, temperature shield for the Boundary Layer Studies.

iii) Fabrication of traverse instrument for the wind tunnel studies and the mechanical fabrication for the vertical wind tunnel.

8.4 Training

S/Shri P. N. Sharma, Senior Scientific Officer, Gr. II, A. G. Pillai and C. P. Kulkarni, Senior Scientific Assistants underwent training in Radio-sonde Operation at RS/RW station, Santacruz, Bombay during 6-13 July 1979.

Shri S. S. Aralikatti, Junior Scientific Officer, attended a three day course on 'George - 3 Operating System' conducted by the Regional Computer Centre, Pune, during 20-22 September 1979.

The following staff members underwent Elementary/ Intermediate/Advanced training in Meteorology conducted by the India Meteorological Department, Pune as shown below :

Sr. No.	Trainee	Meteorological Training Course
1.	Dr. S. P. Ray, Senior Scientific Assistant	Intermediate and Advanced
2.	Shri U. P. Raibole, Senior Scientific Assistant	Intermediate
3.	Dr. S. K. Sinha, Scientific Assistant	Intermediate
4.	Shri M. Y. Totagi, Scientific Assistant	Intermediate
5.	Shri S. M. Baviskar, Scientific Assistant	Elementary

Sr. No.	Trainee	Meteorological Training Course
6.	Shri M. W. Sonawane, Junior Scientific Assistant	Elementary
7.	Shri S. S. Dugam, Junior Scientific Assistant	Elementary

8.5 Deputation

Dr. D. A. Mooley, Assistant Director was on deputation to U. K. from 7-20 July 1979 to participate in the conference on 'Climate and History' organised by the University of East Anglia, Norwich and presented a scientific paper. He also visited the Climate Research Unit, School of Environmental Sciences, University of East Anglia and the British Meteorological Office, Bracknell.

Shri S. Sivaramakrishnan, Junior Scientific Officer was deputed to the Department of Aeronautical Engineering, Indian Institute of Science, Bangalore in connection with the design work of wind tunnel for simulation studies of the atmospheric boundary layer for two months during August - October 1979.

8.6 Awards

Shri S. K. Sharma, Mech. Assistant received Second Prize at the hands of the Hon'ble Shri M. Hidayatullah, Vice President on the occasion of the inaugural ceremony of the Diamond Jubilee celebration of The Institution of Engineers (India) held at Calcutta on 17 February 1980 for his paper 'Field-testing of two cloud droplet samplers' presented earlier at the Students' Technical Session.

8.7 Institute's Research Fellowships

Smt. P. S. Salvekar was awarded a Fellowship with effect from 30 June 1979 to work in the project 'Barotropic and baroclinic instability of the atmospheric flow'.

Shri B. K. Bandyopadhyay was awarded a Fellowship from 14 March 1980 to work in the project 'Studies of cloud microphysics and investigation of feasibility of increasing rainfall by cloud seeding'.

Miss N. Revathy who had earlier been awarded the Fellowship continued her work on the topic 'Some thermodynamical and microphysical aspects of monsoon clouds'.

8.8 Governing Council Meetings

The seventeenth meeting of the Governing Council of the Institute was held at New Delhi on 15 November 1979 in the Office of the Director General of Meteorology, New Delhi.

The eighteenth meeting was held at Pune on 7 March 1980. The Chairman and the members paid a visit to the Institute's buildings under construction at Pashan, Pune and planted saplings at the site.

8.9 Lectures

1. Prof. Ernest C. Kung, College of Agriculture, Dept. of Atmospheric Sciences, University of Missouri, Columbia, U.S.A. delivered two lectures on 'Kinetic Energy in the Atmosphere' and 'Prediction of Indian Monsoon onset with preceding upper air conditions' on 7 and 8 August 1979 respectively.

Governing Council members seen examining the construction site at Pashan, Pune.

2. Dr. Allan H. Murphy, Associate Professor of Atmospheric Sciences, Oregon State University, U.S.A. delivered the following four lectures during 16-23 November 1979 :

i) Statistical Weather Forecasting in the United States,

ii) Quantifying the uncertainty in weather forecasts,

iii) Evaluation of weather forecasts

and

iv) Quality of weather forecasts.

8.10 Institutional Seminars

The following Seminars were arranged in the Institute during the year :

Speaker	Topic	Date
Dr. R. Ananthakrishnan, Hon. Fellow and Shri D.R. Sikka, S.S.O. (I)	Middle Atmosphere Programme.	12 April 1979
Dr. K.S. Raja Rao, Emeritus Scientist	Linkage between solar geomagnetic activities and atmospheric phenomena.	27 April 1979
Dr. K. Krishna, Hon. Scientist	A study of the temperature stratification in the atmospheric boundary layer over peninsular India in the summer monsoon.	28 May 1979

Speaker	Topic	Date
Shri R.K. Verma, S.S.O. (II)	Upper tropospheric thermal anomalies and long-range forecasting of Indian summer monsoon activity - An outlook for 1979 monsoon.	8 June 1979
Miss P.G. Kulkarni, I.I.T.M. Fellow	Role of Baroclinic Instability in the Development of Monsoon Disturbances.	22 June 1979
Dr. K.S. Raja Rao, Emeritus Scientist	22nd COSPAR Meeting held at Bangalore during May/June 1979.	6 July 1979
Dr. L. S. Hingane, Deptt. of Physics, University of Poona	Photochemical dissociative model for neutral minor constituents.	20 July 1979
Shri S. Sivaramakrishnan, J.S.O.	Wind tunnel simulation of the atmospheric boundary layer.	27 July 1979
Dr. D. A. Mooley, A. D.	International Conference on Climate and History held at the University of East Anglia, Norwich, U.K., 8-14 July 1979.	9 August 1979
Shri D.R. Chakraborty, S.S.A.	Truncation errors due to vertical differences in various numerical prediction models.	7 September 1979
Dr. D. Subrahmanyam, S.S.O. (II)	A dynamical model of Westerly jet stream.	14 September 1979

Speaker	Topic	Date
Shri R. K. Verma, S.S.O. (II)	Behaviour of monsoon 1979 and verification of its long-range forecast.	9 October 1979
Shri S. Sivaramakrishnan, J.S.O.	A wind tunnel for simulation studies of the Atmospheric boundary layer.	26 October 1979
Shri S. K. Mishra, S.S.O. (I)	Vertical propagation of planetary scale disturbances.	23 and 30 January 1980 and 20 and 27 February 1980
Shri D. K. Paul, J.S.O.	Some aspects of near equatorial oceanic ITCZ and its disturbances during onset and established phase of monsoon studies with Monex-79 data.	22 February 1980
Dr. A. C. Mahanti, J.S.O.	Instability of meridional flow.	14 March 1980
Dr. P. C. Joshi, S.S.O. (II)	Short Range Weather Forecasting by Stochastic Dynamic Method.	21 and 28 March 1980

8.11 Official Language Implementation

Nine staff members of the Institute attended classes conducted under the Hindi Teaching Scheme for Prabodh, Praveen and Pragya examinations.

Meetings of the Official Language Implementation Committee of the Institute were held regularly.

Action for filling up the post of Hindi Assistant was in progress.

One lower division clerk passed Hindi typewriting examination conducted in July 1979.

8.12 Budget, Accounts and Audit

The budget estimates and actual expenditure for the Institute for the period under review are as given below :

Figures - Rs. in lakhs

	Budget Estimates	Approved Revised Estimates	Actual Expenditure	Shortfall
Non-Plan	50.40	48.00	39.08	8.92
Plan	33.00	30.57	30.14	0.43

The shortfall in expenditure was mainly due to (i) non-filling up of vacant posts, (ii) non-utilisation of house building advance and (iii) non-receipt of imported stores and equipment.

The Institute received from the Government of India 'Grant-in-aid' totalling Rs. 73.62 lakhs including the unspent balance of the previous year and other receipts like computer charges, interest on fixed deposits, advance etc.

Out of this, an amount of Rs. 69.22 lakhs approx. was spent during the year 1979-80.

Audit of the Institute's accounts for the year 1979-80 was being conducted by M/s Kirtane and Pandit, Chartered Accountants, Pune - 411 002.

8.13 Family welfare

The Institute observed the family welfare fortnight (16 - 30 September 1979) by arranging for a talk on 'Changing concepts of family welfare , methods of family welfare etc.' by Dr. (Miss) N. M. Kaole, Medical Lecturer-cum-Demonstrator, Health and Family Welfare Training Centre, Pune.

Shri R. M. Dharmorikar, Extension Health Educator from the Centre also spoke on the Family Welfare Programme. A few documentary films highlighting the importance of Family Planning were also shown to the employees of the Institute.

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BHEGADE / 25.11.1980.

Hon'ble Shri M. Hidayatullah, Vice-President of India, presenting the Second Prize to Shri S.K. Sharma, at the Inaugural Ceremony of the Diamond Jubilee Celebrations of The Institution of Engineers (India) on the 17 February 1980, Calcutta.

APPENDIX - I

Names and Addresses of Members of Governing Council, Indian Institute of Tropical Meteorology, Pune.

1.	Dr. P. K. Das, Director General of Meteorology, C/o The Observatory, Lodi Road, New Delhi - 110 003.	Chairman (Ex-officio)
2.	Shri C. M. Chaturvedi, Joint Secretary, Ministry of Tourism and Civil Aviation, Sardar Patel Bhavan, Parliament Street, New Delhi - 110 001.	Member
3.	Smt. I. Liberhan, Under Secretary (F), Ministry of Tourism and Civil Aviation, C/o The Observatory, Lodi Road, New Delhi - 110 003.	Member
4.	Shri S. K. Das, Deputy Director General of Meteorology, (Admin. and Stores), The Observatory, Lodi Road, New Delhi - 110 003.	Member
5.	Prof. M. P. Singh, Head, Centre for Atmospheric Sciences, Indian Institute of Technology, Hauz Khas, New Delhi - 110 029.	Member

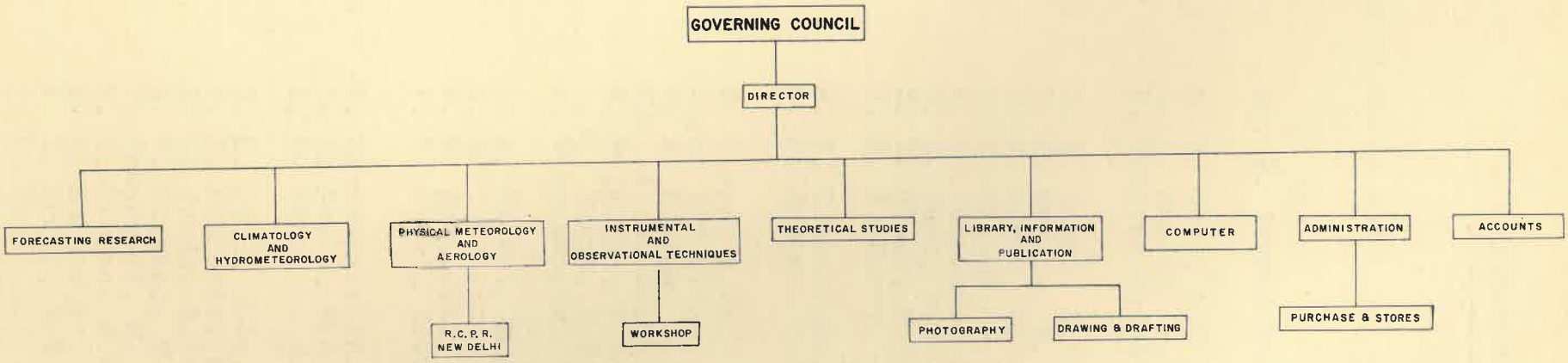
6.	Prof. P. Koteswaram, Director General of Observatories (Retd.), 11-2-B Wilderness Drive, Dasapalla Hills, Waltair - 530 003 (A.P.)	Member
7.	Prof. Yash Pal, Director, Space Applications Centre, Ahmedabad - 380 053.	Member
8.	Prof. R. Narasimha, Department of Aeronautical Engineering, Indian Institute of Science, Bangalore - 560 012.	Member
9.	Dr. Bh. V. Ramana Murty, Director, Indian Institute of Tropical Meteorology, Pune - 411 005.	Member
10.	Shri D. W. Kshirsagar, Administrative Officer, Indian Institute of Tropical Meteorology, Pune - 411 005.	Non-member Secretary

MINISTRY OF TOURISM & CIVIL AVIATION, GOVERNMENT OF INDIA

APPENDIX – II

INDIAN INSTITUTE OF TROPICAL METEOROLOGY

ORGANISATIONAL PROFILE



APPENDIX - III

Officers as on 31 March 1980

Director	:	Bh. V. Ramana Murty, M.Sc., Ph.D.
Assistant Directors	:	O. N. Dhar, M.Sc., Ph.D. D. A. Mooley, M.Sc., Ph.D. R. Suryanarayana, M.Sc.
Senior Scientific Officers, Grade I	:	D. R. Sikka, M.Sc. R. K. Kapoor, M.A. (Maths) A. K. Kamra, M.Sc., Ph.D. S. K. Mishra, M.Sc. K. G. Vernekar, M.Sc. G. B. Pant, M.Sc., Ph.D. S. S. Singh, M.Sc., Ph.D. A. S. R. Murty, M.Sc. (Tech), Ph.D. R. N. Chatterjee, M.Sc. (Tech) H. N. Bhalme, M.Sc.
Senior Scientific Officers, Grade II	:	S. Sinha, M.Sc. Shyam Vir Singh, M.Sc. P. N. Sharma, M.A., Grad. I.T.E. Mrs. A. M. Selvam, M.Sc., Ph.D. S. Rajamani, M.Sc., Ph.D. R. K. Verma, M.Sc. D. Subramanyam, M.Sc. (Tech), Ph.D. L. K. Sadani, M.Sc. B. Parthasarathy, M.Sc. (Tech) S. N. Bavadekar, M.Sc. P. C. Joshi, M.Sc., Ph.D.
Junior Scientific Officers	:	S. Sivaramakrishnan, M.Sc. P. P. Kamte, M.Sc. A. C. Mahanti, M.Sc., D.I.I.T., Ph.D. D. K. Paul, M.Sc. P. R. Rakhecha, M.Sc. S. T. Awade, M.Sc. L. T. Khemani, M.Sc. S. Chaudhari, M. Tech. K. D. Prasad, M.Sc. B. K. Mukherjee, M.Sc. R. S. Reddy, M.Sc. (Tech) S. K. Paul, B.Sc. S. S. Aralikatti, B.Sc.

Junior Scientific Officers	:	A. G. Pillai, M.Sc. G. K. Manohar, M.Sc. Mrs. U. V. Bhide, B.Sc. A. K. Kulkarni, M.Sc. C. M. Mohile, M.Sc.
Senior Technical Officer, Grade I	:	D. Bhattacharya, B.Sc., (Hons) (Cal), B.C.E. (J.U.); C. Engg. (I); A.M.A.E., A.M.I.E., A.M.I. Struct. E.
Junior Technical Officer	:	Mrs. A. A. Shiralkar, M.Sc., B.Lib.Sc.
Administrative Officer	:	D. W. Kshirsagar, M.A., M.Com., LL.B.
Junior Administrative Officer	:	V. K. Asrani, B. Com.
Accounts Officer	:	A. N. Limaye, M. A.

A view of the audience during the
Foundation Stone Laying Ceremony.