

# INDIAN INSTITUTE OF TROPICAL METEOROLOGY

Annual Report  
1980-81

*Ramdurg House,, University Road,,*

*Pune 411 005*

*॥ मदीम*



## C O N T E N T S

	INTRODUCTION	1
2.	RESEARCH AND DEVELOPMENT	5
2.1	Forecasting Research I	7
2.2	Forecasting Research II	12
2.3	Climatology and Hydrometeorology	13
2.4	Physical Meteorology and Aerology	19
2.5	Instrumental and Observational Techniques	23
2.6	Theoretical Studies	27
2.7	Research carried out by Honorary Fellow/Emeritus Scientist	29
3.	PUBLICATIONS	33
3.1	Papers published	35
3.2	Papers accepted for publication	49
3.3	Institute's Research Reports	55
4.	PARTICIPATION IN SEMINARS/SYMPOSIA/ MEETINGS AND CONTRIBUTION OF PAPERS	57

5.	COLLABORATION WITH UNIVERSITIES AND OTHER SCIENTIFIC INSTITUTIONS	79
5.1	Collaboration with Universities	81
5.2	Collaboration with Scientific Institutions/Organisations	82
6.	FACILITIES FOR RESEARCH EXTENDED TO OTHER INSTITUTIONS	85
6A	ESTABLISHMENT OF FIELD UNIT AT BANGALORE	89
7.	VISITORS	93
8.	GENERAL	99

APPENDIX	I	Members of the Governing Council
----------	---	-------------------------------------

APPENDIX	II	Organisational Profile
----------	----	---------------------------

APPENDIX	III	Officers of the Institute
----------	-----	------------------------------

## Introduction

The Institute has completed yet another year of its work since it was established towards the end of 1962. In this year the Institute also completes a decade of its autonomous status. This decade is marked by a tremendous growth of research in Atmospheric Sciences in particular and in Tropical Meteorology in general, the latter resulting to a large extent through the organisation of several international experiments like the ATEX (Atlantic Tropical Experiment), the GATE (GARP Atlantic Tropical Experiment), the ISMEX (Indo-Soviet Monsoon Experiment), the Monsoon-77 and the Monex-79. The decade has also witnessed another major development in the concept of international field experiments and research - the PEP (Precipitation Enhancement Project), an area of great interest to the Institute as we have been actively engaged in India for over 25 years in weather modification work.

Research carried out in the Institute under different areas, which are reviewed in this report, is primarily aimed at better understanding of the physical and dynamical processes of the tropical atmosphere, climate and weather phenomena as well as towards developing an indigenous technology for probing, understanding and predicting the weather over different time and space scales. The report gives in brief the progress made in different research areas during the year 1980-81.

Scientific research has become extremely complex. It is also becoming increasingly expensive and understandably more demanding with respect to the accountability on the part of an Institute and its scientists. As such, our standing research programmes are carefully planned, goals are set and the programmes are monitored.

During the year under review, the Institute took advantage of the Sixth Five Year Plan for the five year period 1980-85. In the preparation of the plan document, we attempted to keep a balance between strengthening some of our on-going research programmes, technological/administrative support needed for them and for introducing a few new research schemes. The Government finally allocated a sum of Rs. 15,000,000 for our plan schemes. Of this amount, the Institute has provided 66 percent for the second phase of its building activity and residential quarters for staff, 24 percent for strengthening on-going research programmes and introducing new research schemes and 10 percent for augmenting technical and administrative facilities.



The first phase of the Institute's building on its own land has made satisfactory progress and some of its functional laboratories are expected to move to the new building by end of 1981. It is expected that with the allocation made for the second phase in the Five Year Plan 1980-85, a step has been taken for the continuation of the building programme of Institute, which in not too distant future would remove some of the odds of having to function in different hired buildings for want of a proper accommodation of its own.

The new research programmes included in the Plan are aimed towards (i) Monex Studies, (ii) Study of Vagaries of the summer monsoon over India from climatological point of view, (iii) Study of error characteristics in numerical models for simulation and their relation to the atmospheric predictability, (iv) Creation of weather modification research unit, (v) Strengthening of basin rainfall studies for the development of water resources and (vi) Strengthening of the projects on Instruments and Observational Techniques. Over the year the research activities of the Institute have been showing steady growth and with the further increase envisaged in the next five years, it was felt necessary to plan for the augmentation of available technical facilities for research, e.g. Library, Publication, Reprography, Workshop, Technical Stores, Purchase and Supply. I hope that the Institute would make optimum use of the existing and the anticipated new resources and continue its march forward towards achieving the desired goals.

Atmospheric sciences are attracting greater public interest. Meteorology, which was linked with the traditional human needs such as food and water, is increasingly becoming very relevant to our search for new sources of energy (wind, solar, tidal etc.) as well as our concern for keeping safe our greatest natural asset - the Environment. Bold ideas generated and pursued vigorously in these areas ought to be our objectives for the coming years. Long and sustained efforts are needed for achieving these objectives. For the talented scientists, the research areas being pursued in the Institute offer tremendous intellectual challenges and enormous opportunities exist for the potential usefulness of the knowledge which they seek.

The Institute's collaboration with Universities and research organisations has also grown substantially over the past few years. This has been a source of strength to us. Besides being actively involved in several major field experiments, our own modest efforts in designing and conducting weather modification experiments, field studies on atmospheric electricity and atmospheric boundary layer measurements have given us great confidence.

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. K. Gambo, University of Tokyo, Japan; Dr. Bryan Johns, Professor of Meteorology, University of Reading, U.K.; Dr. V.D. Walshaw, University of Oxford, U.K. and Dr. S. Nagarajan, Research Fellow, Department of Physics, Technische Hogeschool, Eindhoven, Netherlands.

The Institute's scientists also participated in several national and international symposia of interest to their work which included (i) International Conference on cloud physics and III WMO scientific conference on Weather Modification held in France during 15-25 July 1980; (ii) International conference on 'Early results of FGGE and Monsoon Experiment' in U.S.A. 12-17 January 1981; (iii) Meeting of experts on 'Warm cloud modification' organised by the W.M.O. during 18-24 March 1981 in Malayasia, (iv) National symposium on 'Early results of monsoon experiments' during 9-11 March in New Delhi etc. Some of the scientists of the Institute were also deputed during the year to visit advanced centres of meteorological research in U.K. and U.S.A. under the UNDP programme. The visits of our distinguished guests to the Institute and our scientists to other centres of research mentioned above have strengthened our bonds with other organisations.

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

IITM, Pune

Date : January 1982.

Bh. V. Ramana Murty  
Director.



Governing Council in session.



Governing Council in session.

2. RESEARCH AND DEVELOPMENT



## 2. Research and Development

The details of research work carried out 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

Efforts were continued to develop five level primitive equation (P.E.) model for forecasting over Indian monsoon region. Several experiments to obtain balance fields of temperature, moisture, mass and momentum at the initial time were carried out. An experiment, which was done to initialise the data by increasing the number of iteration cycles, did not yield the desired results. The problem was further diagnosed and the procedure for dynamic initialisation was suitably altered to achieve satisfactory initial balance among the variables. The fields mentioned above, as well as the vertical velocity after initialisation were found to be in close agreement with the observed fields.

Work on cumulus parameterisation has been taken up with the objective of incorporating these effects into the five level model.

Numerical experiments were continued to study the effects of higher orography (maximum 2 km at the centre of the region) utilising a three level primitive equation model developed during the last year. The model was also changed to include 5 levels in the vertical.

Semi-implicit version of the primitive equation barotropic model was developed and applied for the prediction of monsoon disturbances. Forecast movements of the few cases of monsoon depressions up to 48 hours were found to be satisfactory and comparable with the results obtained from the explicit version developed during earlier years.

### 2.1.1.2 Multi dimensional initialisation for NWP models

Numerical experiments were performed to incorporate friction and heating effects in a P.E. barotropic model. The heating effect was simulated by introducing perturbations in the initialised geopotential field obtained through dynamic initialisation. It was found that by taking frictional coefficients equal to  $3 \times 10^{-5}$  and using the Euler-backward time integration scheme, the amplitude of the oscillations in the geopotential height tendencies were reduced in comparison to the earlier experiments without the inclusion of heating and friction.

### 2.1.1.3 Objective analysis of Meteorological Fields

Optimum interpolation scheme for objective analysis of the wind field were further tested with the data at 850 mb and 700 mb. Root mean square (r.m.s.) errors obtained by comparing analysed wind fields, interpolated at the observing stations, with the observations were found to vary from 3.5 to 4.5 m.p.s. for 850 mb level and from 4.0 to 7.0 m.p.s. for 700 mb level. Geopotential height and temperature data for three years have been collected and preliminary computations (like those of obtaining autocorrelation functions) have been made in connection with the development of a multivariate optimum interpolation scheme.

Objective analyses of wind field by successive correction method for four cases of monsoon depressions (about 20 days) were made with different data density in order to evaluate the impact of Monex-79 data on the analyses. The series of experiments yielded the following results :

- (i) Additional Monex-79 data improved the quality of analyses
- (ii) Improvement was found to be more in the data-void regions,
- (iii) Inclusion of aircraft/ship data improved the analyses more than the wind data based on satellite information.

The comparative performance of the optimum interpolation scheme and the successive correction method was also evaluated using Monex-79 data collections. Successive correction method was found to perform better in terms of the r.m.s. error than the analyses based on optimum interpolation technique.



## 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 study was made to determine the efficiency of analogue forecasting. For this purpose the usefulness of single best correlated analogue and 20 best correlated analogues, selected from 20 years of daily fields of mean sea level pressure anomaly and 700 mb contour height, in predicting daily rainfall probability during July and August at 15 well distributed stations over India has been investigated. Verification of such forecasts carried out for 3 seasons showed that the forecasts based on twenty best analogues perform better in terms of 'Brier Score' than those based on single best analogue.

Predictions of 5 and 7-day monsoon rainfall for 10 subdivisions based on the multiple screening regression technique were issued to Weather Central, Pune. The forecasts, when verified in terms of three categories viz. excess, normal and deficient, were found to be in correct category on 45% of the occasions.

A Markov chain model for the prediction of pentad rainfall for the Konkan region was developed. The model was tested on independent data. Results showed that the prediction of pentad rainfall during south-west monsoon through this model was better than the chance prediction.

Empirical Orthogonal Functions (EOF) analysis was used to study the dominant patterns of 700 mb monthly mean geopotentials for the months June through September over Asia based on 15 years of data (1964 to 1978). The analysis showed that the first five dominant EOFs explain about 80% of the total variance; thus affording a method by which 93% of the data reduction is possible in each of the months considered. The technique was also used to determine analogues of the mean monthly pressure patterns.

Relationship of several synoptic parameters like 700 mb geopotentials, 700 mb geostrophic vorticity, mean sea level pressure anomaly, location of monsoon trough axis etc. with subsequent 24 hr. rainfall of some meteorological subdivisions over India were explored graphically and were confirmed statistically. Multiple regression equations developed using these parameters for predicting

daily rainfall of western Madhya Pradesh in 3 equally probable categories showed skill score of 0.36.

Probability of rainfall ( $\geq 2.5$  mm), heavy rainfall ( $\geq 65.0$  mm) and average amount of rainfall over a moving grid around the monsoon disturbances located in various  $2.5^\circ$  lat./long. squares over the country were determined using daily rainfall data of 232 stations spread over the country for 19 years (1955-73). Analysis for about 200 depression days and about the same number of days with well marked 'low pressure systems' revealed some dissimilarities in the patterns of rainfall distribution and that of rainfall probability associated with monsoon disturbances over different parts of India. The differences between the climatological probability and probability of rain for each of the 232 stations associated with these and other types of synoptic situations were also investigated.

#### 2.1.2.2 Synoptic climatological studies of monsoon for understanding and prediction of periods exceeding 3 days

(a) A region over Central India, comprising of eleven subdivisions (about 42% of the total area of the country) was delineated as a region, whose deficient monsoon rainfall contributes significantly to deficient monsoon rainfall over the entire country. Monthly and seasonal rainfall departure series for the summer monsoon months (June to September) based on the past 20 years were prepared for this region. Upper tropospheric anomalies for the same year during the premonsoon and monsoon seasons were correlated with the rainfall series for long range forecasting of large scale drought over the country.

The study of upper tropospheric anomalies was extended to give long range forecast of monsoon seasonal rainfall over peninsular India and north-west India.

(b) Spherical Harmonic and Fourier analyses were done for the geopotential height for the years 1973, 74 and 77 during April to August at the levels of 700 mb and 300 mb. Meridional transport of momentum and of sensible heat were also computed and analysed in the wave number domain for the northern hemisphere at the stratospheric levels of 50 and 30 mb during the months January through December for the years 1972 and 1977.

(c) As in the past two years, daily (24 hrs) forecasts of rainfall distribution over the meteorological subdivisions



of India were issued on an operational basis for the monsoon months July and August 1980. This was based on analogue method for which the data of past 30 years were used. The result of this experiment revealed that the forecast issued by analogue method was correct on nearly 78% of occasions, within one category of rainfall distribution, over different subdivisions of India. This was comparable with the success of operational forecast issued by Weather Central, Pune.

### 2.1.3 Monex Studies

The data collected during the Monex-79 were used in several studies relevant to the scientific objectives of the Experiment. Results of these studies are summarised below :

(a) The kinetic energy budget of a case of monsoon depression from 4-8 July 1979 was analysed. The results suggested that the dominant source of energy is the generation term and the major sink is the dissipation and horizontal flux divergence terms.

(b) Tropospheric wind data (from 1000 mb to 100 mb) observed by the USSR research ships array in the Arabian sea during 2-14 June 1979 and in the Bay of Bengal during 11-23 July 1979, were utilised to diagnose the structure of synoptic scale disturbances which affected the ship array. The study showed that whereas four disturbances affected the ship array during 2-14, June 1979 (Arabian sea phase) only one weak disturbance could be detected during 11-23 July 1979 (Bay of Bengal phase). Changes in relative vorticity, divergence, vertical velocity, mixing ratio were also studied at the centre of the ship array. Some diurnal fluctuations in these parameters were observed. However, dominant modulations were brought out by the synoptic scale disturbances. The rate of conversion of zonal ( $K_z$ ) to Eddy kinetic energy ( $K_E$ ) was found to be negative during the Arabian sea phase and positive during the Bay of Bengal phase.

(c) Vertical structure and characteristic features of the near equatorial oceanic ITCZ over the north Indian ocean and the adjoining west Pacific ocean during the evolution of summer monsoon system through different phases were studied. It was observed that, at the onset phase, ITCZ is characterised by :

(i) A narrow shear zone having maximum cyclonic vorticity, convergence, colder lower tropospheric temperature, high moisture content and convective weather;

(ii) At the time of onset of summer monsoon the ITCZ abruptly intensifies and moves north/northwestward;

(iii) The oceanic ITCZ again becomes prominent during the established phase of monsoon when the monsoon progresses from active phase to a 'break' phase. The characteristic features during this transition remain more or less similar to those during the onset phase.

The study also compares and contrasts the structure and characteristic features of the ITCZ over the north Indian ocean with that over the adjoining Pacific Ocean during different phases of summer monsoon.

(d) 700 mb data for five cases of monsoon depressions during the Monex-79 were analysed with successive increase in the density of data by the inclusion of observations from different platforms, viz. WWW, research aircraft, research ships, satellites. Different versions of the analyses were used as input for two versions of the barotropic P.E. model in order to study the impact of additional observations on the forecast movement of the depressions. The results did not show significant impact of the additional data. However, the analyses of the depressions did considerably improve with the additional data.

## 2.2 Forecasting Research - II

### 2.2.1 Short Range Prediction

Analysis of the Empirical Orthogonal Function (EOF) was carried out to study the dominant patterns of the sea surface anomaly obtained from ships' reports for the months pressure May to October for the years 1961 to 1968 over the Arabian sea and the Bay of Bengal. The EOFs were correlated with the Indian summer monsoon rainfall for the sub-divisions comprising of central and coastal India. The concurrent significant relation at 95% level was found for the following subdivisions : Gangetic West Bengal, Bihar, East Uttar Pradesh, Madhya Pradesh, Gujarat, Saurashtra and Kutch and Konkan. Significant relation was also found



for the rainfall one month in advance for the subdivisions : Orissa, West Uttar Pradesh, West Madhya Pradesh, Gujarat and Konkan.

A study was undertaken to perform objective analysis by using spline technique for interpolation of winds. Results showed a root mean square error of 8 to 10 mps between the observations and objectively analysed winds when interpolated to observing stations. This error was appreciably high compared to analysis made by the optimum interpolation method and the Cressman method.

Effect of surface drag on the intensity of monsoon depressions over India was computed using a quasigeostrophic <sup>(a)</sup> equation. The rate of filling for an average monsoon depression (with a radius 1000 km and extending upto 500 mb in the vertical) was shown to be about 4 mb/day which was very near to the observed values.

## 2.3 Climatology and Hydrometeorology

### 2.3.1 Climate and Climatic Change

#### 2.3.1.1 Studies of large scale droughts over India

##### (a) Annual rain-water over India

The total volume of rain-water over India was computed for each of the years from 1871 to 1978 on the basis of a fixed and well-distributed net work of rain-gauges. The result was a homogeneous and random series to which the Gaussian distribution gave a good fit. The mean and the standard deviation of the series were 3140 and 300 cu km respectively. The serial correlation was too low to suggest any relationship between successive terms of the series. Using specific criteria, the years of well-marked deficiency/excess of rain water over India were identified. Occurrence of the same was found to be random. The adverse effect of deficiency of rainwater on food grain prices/production was in general clearly seen, but that of excess rainwater was seen clearly in some cases only. It was also found that the adverse impact of the well-marked deficiency of rain-water in 1918 was the maximum.

- (b) Relationship between flood index for India and the double (Hale) sunspot cycle

Detailed analysis of an objectively defined numerical flood index for India and sunspot numbers of the double (Hale) sunspot cycle revealed a highly significant ( $\sim 22$  years) cycle in the flood index, varying in phase with the double (Hale) sunspot cycle. Furthermore, the large-scale flood events over India occurred remarkably in the major maximum of sunspot cycle. However, large scale droughts over India showed no reference for any particular phase of the sunspot cycle. The strong evidence of relationship between flood index for India and the double sunspot cycle shares a relationship reported recently for the drought index for the western United States, but in the opposite sense of weather characteristics, i.e. for flood rather than drought.

#### 2.3.1.2 Studies in Palaeo-climatology

On the basis of the inferences from the available multi-disciplinary evidences on the Holocene climatic change in northwest India, a climatological picture of the last 10,000-year period was prepared for the north-west India.

#### 2.3.1.3 Other climatological studies

- (a) Wind characteristics and wind power potential

The hourly wind data over Saurashtra-Kutch, Gujarat and Peninsular India were examined for the summer monsoon season and the main characteristics of wind energy were brought out. Wind power computations showed that the wind power was large over Saurashtra-Kutch and the adjoining coastal belt in southern parts of the Peninsula and at a few stations on the Deccan plateau. In particular, over and around the Gulf of Kutch, the wind power potential is high. The available wind power during the summer monsoon season may be utilised for various purposes, except irrigation, since the need for irrigation in the monsoon season is generally small.

- (b) Application of Gamma probability model to river flow data

On the basis of the data for the long period



1917-'73, it was observed that the Gamma Probability Model was a good fit to the monthly river flow data of the Cauvery and its tributaries in Karnataka state for the months June to November. The model can be applied to obtain the river flow probabilities that may be required for planning the utilisation of river water potential.

(c) Spatial variability of rainfall  
and adequacy of network

Coefficient of variation in space of rainfall over Vidarbha and two sub-areas of Vidarbha of sizes 12000 and 24000 sq. km. was analysed for varying networks of raingauges for the period 1901-'60. It was found that when the area is fixed and the number of uniformly spaced raingauges over the area is increased, a stage is reached when the distribution of the coefficient of variation in space stabilises. Considering the raingauge network, which results in the stabilisation of the distribution of the coefficient of variation in space as adequate, the same was obtained for all the three areas for the months June to September, for the season and for the year.

(d) Structure functions of the rainfall  
field and their application to  
network design

Structure functions as well as the correlation functions of the monthly (June-September), monsoon seasonal and annual rainfall fields were evaluated for the four quadrants of Vidarbha and in four directions from the centre. The structure functions were found to be neither homogeneous nor isotropic over Vidarbha but were approximately homogeneous and isotropic over the west and east Vidarbha separately. The correlation functions were found to be approximately homogeneous and isotropic over Vidarbha. Utilising these functions, the relationships were developed between the error of linear interpolations and the distance, from which maximum spacings allowed between rain-gauges for a specified tolerable interpolation error was obtained for the months June to September, for the season and for the year.

(e) Network density for the estimation  
of areal rainfall

Using the method of optimum estimation, the network density for estimation of areal rainfall for area over Vidarbha

was obtained. This method considers the local variations as well as the inter-station characteristics of rainfall over an area while assigning weights. Network density required for different prefixed tolerable errors in estimation of areal rainfall for the months June to September, for the season and for the year was determined for different sizes of area over Vidarbha.

- (f) Errors in areal mean rainfall arising out of missing observations

This was an experimental study for Amaravati district in Vidarbha subdivision for which monthly rainfall data were available for all the 13 stations in the district for the period 1901-'70. Missing observations as specified by different patterns were simulated on the computer and errors in areal rainfall for the monsoon months, the monsoon season and the year were obtained and examined. Frequency distributions and the extreme values of the percentage relative errors were brought out in situations of one, two, three, four and five stations missing. Root mean square error in areal rainfall was obtained for the typical monsoon month of July and for the monsoon season, when the observations were missed randomly.

- (g) Conditions over the Arabian sea during the pre-onset and onset phases of the summer monsoon during 1979

Conditions over the two stationary polygons formed by four USSR ships over south-west Arabian sea during the latter half of May and first half of June 1979 were examined. It was found that the surface pressure was above normal in late May and early June over south-west Arabian sea. This situation appears to have delayed the monsoon onset over Kerala. The power spectrum analysis of the air-sea fluxes of latent heat, sensible heat and momentum showed an oscillation of 4-5 days.

#### 2.3.1.4 Climatological study of severe cyclonic storms of the Bay of Bengal

The series of storms formed over Tamil Nadu, Andhra Pradesh, Orissa, West Bengal, Bangladesh and

Arakan coasts were studied for the period 1877-1980. The mean annual frequency of storms incident on Bangladesh coast showed a highly significant increase during the period 1965-1980. For each of these coasts, the percentage of storms intensifying into severe storms was significantly higher during the period 1965-1980. Poisson distribution gives a good fit to number of storms incident on each of these coasts in a year.

### 2.3.2 Hydrometeorological Studies

#### 2.3.2.1 Basin rainfall studies for the development of water resources

##### (a) Space-time distribution of worst recorded floods

The highest ever recorded floods in the major river basins of the country were catalogued. The space-time distribution of these recorded floods showed that the states of Bihar, Assam, U.P., Gujarat, Orissa and West Bengal are more vulnerable to severe floods and the years 1973 and 1978 were the worst flood years of this country during the past few decades. The meteorological situations responsible for causing these floods were also studied.

##### (b) Storage reservoirs and utilisation of monsoon rainfall

The availability of water potential during the monsoon season and its utilisation by the existing dams on the selected river basins of the country were studied. Preliminary results showed that most of the existing dams utilise 5% to 15% of the total monsoon rainfall of their respective basins up to the dam sites. This study highlighted the fact that there is an ample scope for large-scale utilisation of monsoon rainfall by constructing more storage reservoirs on these rivers.

##### (c) The Vamsadhara flash flood of September - 1980

The rainstorm which caused unprecedented flash floods in the Vamsadhara basin in September - 1980 was



analysed. It was found that this basin experienced a very heavy rainfall associated with the westward passage of a deep depression from the Bay of Bengal. This study showed that the rainfall to the left of the depression track was four times more than that on the right side of the track. It is considered that this feature caused devastating flash flood in the basin as it happened to fall on the left side of the track.

(d) Aridity index over Rajasthan

Trends in the aridity index over Rajasthan desert were determined for south-west monsoon months and the year as a whole. This analysis revealed that there is a definite decreasing tendency in aridity in this region. This has a relevance to the basic issue, whether, climatologically, aridity over this region is static or changing.

(e) Analysis of severest rainstorms over the central Indian peninsula between  $12^{\circ}\text{N}$  to  $16^{\circ}\text{N}$

Severe rainstorms numbering about 18 which occurred in the past 60 to 70 years over the central Indian peninsula lying between lat.  $12^{\circ}\text{N}$  to  $16^{\circ}\text{N}$  were analysed. Maximum areal raindepths based upon the analyses of these rainstorms were worked out by depth-area-duration (DAD) method. It revealed that rainstorms of 27-29 September 1908 and 28-30 September 1964 were the severest rainstorms over this region. A generalized Probable Maximum Precipitation (PMP) chart of 1-day duration was also prepared for this region. This showed that extreme rainfall over this region can vary from 25 cm to 85 cm in one-day.

(f) Some facts about Indian rainfall from hydrological considerations

Important hydrometeorological studies on Indian rainfall, which were carried out during the last 15 years at this Institute, were summarised. This was done with a view to putting all the important findings so far obtained at one place so that these may be useful to field engineers and hydrologists of this country.

## 2.4 Physical Meteorology and Aerology

### 2.4.1 Cloud Physics and Weather Modification

#### 2.4.1.1 Studies in atmospheric electricity

(a) The electrical phenomena associated with the thunderstorms forming during pre-monsoon, monsoon and post-monsoon seasons were investigated using the continuous recordings of electric field, point discharge current, lightning frequency, raindrop charge and rain intensity obtained at Pune during 1971-'75. A total of 35 cases of thunderstorms was considered in the study. The important results obtained were :

- (i) the lightning frequency associated with the pre-monsoon thunderstorms was significantly higher than that associated with the monsoon and the post-monsoon thunderstorms and
- (ii) the pre-monsoon thunderstorms transfer, through the point discharge current and rain current, a resultant negative charge whereas the monsoon and post-monsoon thunderstorms transfer a resultant positive charge. The possible electrification mechanisms in the thunderstorms forming during the three seasons were investigated during the above observations.

(b) The possible solar influence on atmospheric electric field was investigated using the data on atmospheric electric field and Solar Magnetic Sector Boundary (MSB) crossings. The electric field data for Colaba, Bombay for the period of solar maximum (1957-'58) and for the period near solar minimum (1961-'62) were used in the study. The results of the analysis suggested that the electric field has a periodicity of 6 to 7 days. This wave-length corresponds to the average time interval between any two successive magnetic sector boundary crossings. For the physical understanding of the above result the association between equatorial  $D_{ST}$  index (measure of equatorial geomagnetic activity due to ring current alone) and electric field was investigated. The peaks in negative  $D_{ST}$  indices occurred when maximum values of electric field were observed. The results were explained on the hypothesis that solar modulation of electric field takes place due to emission of low energy protons at the time of sector boundary crossings across the earth.

(c) The electrical, microphysical and dynamical conditions in ground-based clouds were investigated as a part of the field programme organised at Mahabaleshwar during

the summer monsoon of 1977. Some of the important results obtained are as below :

- (i) The electric field showed sign reversal from its normal fair weather positive to negative during the onset of rain. The field reversal and the incidence of positively charged drops at the surface were almost simultaneous.
- (ii) There is a significant correlation between rain intensity and the electric field.
- (iii) The diurnal curves of rainfall and electric field exhibited two peaks. The early morning peak in rainfall and the afternoon peak in electric field were significant. The early morning peak in rainfall is attributed to the enhanced convergence caused by the radiation imbalance in the cloud and the cloud free regions during active monsoon conditions. The afternoon peak in the electric field was attributed to the cloud formation due to convection. Based on these results and the radar estimated cloudtop heights, the rain-formation and the electrification mechanisms in monsoon clouds were investigated.

#### 2.4.1.2 Radar study of rain and rain-bearing clouds

The vertical growth and decay rates and duration of the convective cloud cells were computed using the observations obtained from a 3 cm weather radar in the Delhi region. A study relating to 33 cloud cases suggested that the growth and decay rates vary between 0.7-12.5 m/sec and 0.3-19.5 m/sec respectively. The growth rates were higher in 18 of these cases compared to their decay rates. The average duration of the cells was about an hour.

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



(a) A new numerical technique for the simulation of cloud seeding experiments with rainfall variability as the input was developed. Based on this technique the numerical experiments were performed using the rainfall data relating to 35 meteorological sub-divisions of the country for the south-west and north-east monsoon seasons of the five year period 1975-1979, in order to identify the suitable regions in the country for undertaking weather modification experiments. It was suggested that the Karnataka and Tamil Nadu were the most favourable regions in the country for undertaking the cloud seeding experiments during the south-west and north-east monsoon seasons respectively.

(b) Aircraft measurements were made on direct solar radiation in the  $0.6\ \mu\text{m}$  and  $0.4\ \mu\text{m}$  wavelengths in clear sky conditions using sunphotometers in the lower atmosphere (upto 10,000 ft. A.S.L.). Computations on the turbidity coefficient showed that at higher levels (10,000 ft.) the scattering of the solar radiation in the  $0.6\ \mu\text{m}$  wavelength was more than that in  $0.4\ \mu\text{m}$  wavelength. The scattering of solar radiation in the longer wavelengths could be due to the appreciable amount of water vapour, present in the atmosphere on clear days during monsoon and which would condense on large size hygroscopic particles present at higher levels possibly originating from the stratospheric aerosol layer.

(c) Cloud droplets were sampled, from an aircraft flying at 54 ms<sup>-1</sup>, on slides coated with thin layers of Magnesium oxide, Carbon soot and Silicone oil. Calibrations were made for obtaining true droplet sizes from craters formed on oxide and soot layers assuming that the droplets retain their original shape and size in the oil film.

(d) A preliminary rainfall analysis of the cloud seeding experiment conducted on 17 pairs of days in the Pune region during 20 June - 9 September 1980 revealed that the result was positive on 10 pairs of days and negative on 7 pairs of days.

(e) The results of the cloud seeding experiment conducted in north India during 1957-'66 were reevaluated using the Bayesian statistical technique. Results of this technique were in conformity with those obtained earlier by the application of standard statistical tests.

## 2.4.2 Environmental Physics

### 2.4.2.1 Studies of atmospheric boundary layer

(a) The geostrophic balance in the Arabian sea and the Bay of Bengal regions was investigated using the aircraft data obtained in the Atmospheric Boundary Layer during Monex-79. The study suggested the following :

(i) The observed wind south of  $20^{\circ}$  N is sub-geostrophic with 95 percent departures, and

(ii) In a few cases north of  $20^{\circ}$  N, the observed winds at 10,000 ft A.S.L. are found to be super-geostrophic in the regions of enhanced monsoon activity/cyclonic circulation.

(b) Harmonic analysis of the meridional component of the wind at four different levels viz. surface, 0.04, 0.15, 0.34 km was done using the special aerological observations made during the summer monsoon periods of 1976, 1979 and 1980 in connection with the cloud seeding experiments in the Pune region. A significant periodicity of 5, 7, 15 and 30 days was found out in the wind. Harmonic analysis of the rainfall data for the corresponding period also showed significant periodicity of 30 days. The results were explained on the basis of the Sun's rotation periodicity (about 30 days) and associated magnetic sector boundaries.

### 2.4.2.2 Studies in upper atmosphere

(a) The variations noticed in the temperatures and winds in the stratosphere/mesosphere region during the periods of major solar flares (July-August 1972) were investigated using the rocket-sonde data for Ascension Island ( $8^{\circ}$  S,  $14.4^{\circ}$  W) and Thumba ( $8.5^{\circ}$  N,  $76.9^{\circ}$  E). The results of the study indicated that, the variations up to  $10^{\circ}$  C in temperature and those up to 26 mps in wind, occasionally with a change of direction, can occur following a major flare in the 40-80 km range of the upper atmosphere. / solar

(b) The statistical analysis of the satellite radiance data for the different latitudinal belts  $0^\circ$ ,  $10^\circ$ ,  $20^\circ$ ,  $30^\circ$  and  $40^\circ$  of both the hemispheres for the months of June and December 1969 suggested that (i) during June (Southern winter) the values of the radiances at different latitudes in the southern hemisphere were dependent on the position of the Sun while during December (northern winter), the values of the radiances at different latitudes in the northern hemisphere did not depend on the position of the Sun, (ii) During June, the maximum radiance was observed at  $0^\circ$  and  $40^\circ\text{N}$  and at  $40^\circ\text{S}$  while it was minimum at  $20^\circ$  and  $30^\circ\text{N}$  and at  $10^\circ$  and  $20^\circ\text{S}$ . During December, the maximum variance was observed at  $0^\circ$  and  $10^\circ\text{N}$  and at  $10^\circ\text{S}$  and it was minimum at  $30^\circ\text{N}$  and  $40^\circ\text{S}$ .

The study of the power and cross-spectral analysis of geo-magnetic activity and rainfall of Tamil Nadu during the north-east monsoon (October-December) for the period of 1961-'70, pointed out a common 15-day periodicity in the geo-magnetic activity and rainfall. A similar study with respect to geo-magnetic quiet days, on the other hand, showed that the rainfall singularities observed earlier do not correspond to the quiet days.

#### 2.4.2.3 Studies in air pollution

(a) Analysis of Aitken nuclei measurements made at Pune during June - December 1980 was completed. The concentrations of the nuclei in the surface air layers varied between  $18 \times 10^3 \text{ cm}^{-3}$  and  $60 \times 10^3 \text{ cm}^{-3}$ . The concentration in the vertical, increased with height up to 7000 ft A.S.L. during monsoon but decreased thereafter.

(b) Continuous measurements of the atmospheric trace gases and condensation nuclei were made at Pune during 2-13 March 1981 to study their diurnal variations. Surface ozone and condensation nuclei showed significantly higher concentrations during the afternoon hours than those observed a few hours after mid-night. The concentrations of Sulphur Dioxide, Ammonia and Nitrogen Dioxide were maximum during morning hours and minimum during the afternoon hours.

### 2.5 Instrumental and Observational Techniques

#### 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

Two meteorological payloads for measuring wind and temperature were launched with Rohini-200 rocket using Skua type parachute on 8 and 14 May 1980. The first payload was successful but data could be received only during low elevation angles of the receiver antenna, due to some snag in the receiver. In the case of the second payload, which got detached from the parachute, signals were received during low elevation of receiver antenna.

- 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

An eddy correlator was developed with its calibrating unit to measure sensible heat flux. The minisonde circuit was modified to account for loading effects.

A Thronthwaite six channel wind profile system with a mechanical counter facility was coupled with an analog recorder for continuous recording of output in analog form.

Dry bulb, wet bulb, vortex and reverse flow thermometers were put in operation aboard the aircraft during the cloud seeding experiment and the temperatures were measured.

A drag plate was designed and fabricated to measure the vertical shear stress. The plate is under field test.

The temperature data acquired at three levels above ground (10, 20 and 100 cm) during Total Solar

Eclipse of February 1980 were analysed. The relative temperature difference between 10 and 20 cm levels was less during the eclipse than the one before the eclipse.

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

The data collected during the experiments on mean wind velocity profiles down stream of a honeycomb-cum flat plate (HFP) in the wind tunnel available at Central Water and Power Research Station, (CWPRS), Pune were analysed. It was found that the profiles exhibit power-law wind profile characteristics of flow, under adiabatic conditions of the atmosphere, over terrain of a level country with numerous scattered obstructions. At a given distance downstream of HFP, the profiles follow different power-law with different speeds of free stream.

Further analysis of these profiles revealed that they exhibit the logarithmic law variation, in the surface boundary-layer region, typical of a neutral atmosphere. The similarity parameters, namely, the roughness length and the friction velocity, were computed for the profiles. For the simulation of wind characteristics over the rough terrain features, roughened flat plates and some auxiliary devices were fabricated.

#### 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

A particle charge measuring apparatus was fabricated to measure the electrical charges residing on precipitation particles, cloud particles and the aerosol particles and ions, separately in three different stages. Precipitation particles were collected by gravitational settling, cloud particles by centrifugal forces acting on them and aerosol particles and ions by direct filtration through an absolute filter in three different parts of the apparatus.

High impedance amplifiers for the three outputs

of the spherical field-mill were wired in specially designed chassis and fitted in to the field-mill. Gains of the three amplifiers were adjusted to minimize the noise in the outputs. Arrangements were also made to mount the field-mill on a teflon rod. Some preliminary tests conducted in the laboratory were found to be satisfactory.

A calibrating unit was fabricated for calibration of spherical field-mill.

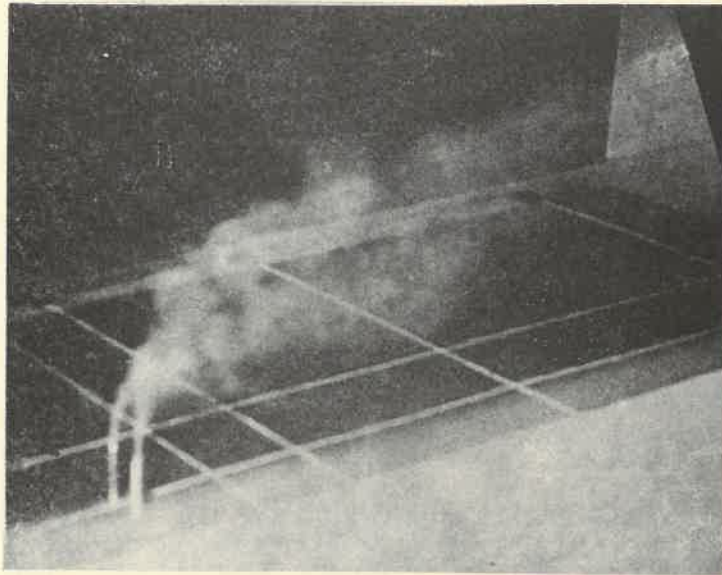
Two regulated power supplies were wired for use with the operational amplifiers.

A field experiment was conducted at Mahabaleshwar from 18 to 28 August, 1980. Electric field, space charge, precipitation particle charges and rainfall were measured at the bases of clouds.

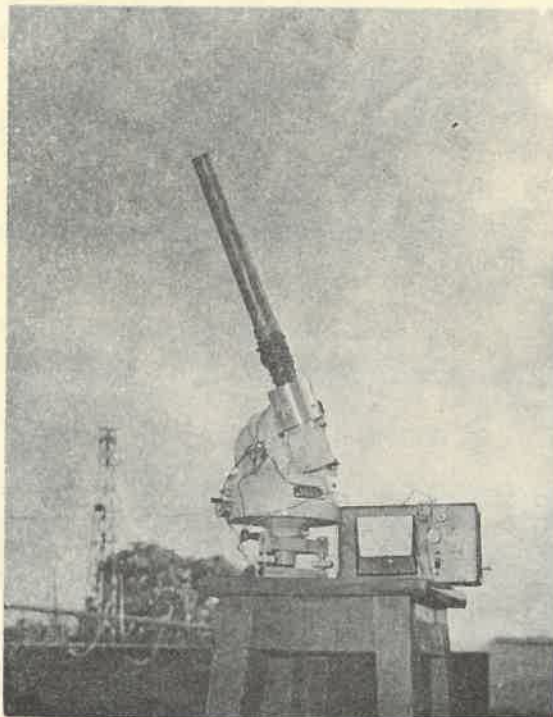
Atmospheric electrical data obtained during the Total Solar Eclipse experiment conducted in February 1980 were analysed and studied. The results showed that for some time during the eclipse period, the electric field decreased and became zero while the space charge in a height of 2 m above the ground, became negative. Further, the space charge at 2 m level experienced excessive fluctuations with no parallel changes at lower levels.

From the data obtained during the field experiment of Total Solar Eclipse conducted at Pune in February 1980 the diurnal variations of the space charge and its vertical profiles at different times of the day were worked out for the lowest 2 metres of the atmosphere. It was found that the space charge at these levels shows small positive values during the day time and very large negative values during the night. During night-times the negative values were found to decrease with height. Exceptionally high values of negative space charge, of the order of  $10^4$  el/cm<sup>3</sup>, were observed during night time as compared to the normal positive space charge values of the order of 10 or 100 el/cm<sup>3</sup> during day time. The data were used to study the sunrise effect, electrode effect, space charge cells and the presence of convection currents at these levels. Analysis of the diurnal variations and vertical profiles of the space charge and the electric field shows that large convection currents may flow in this region of the atmosphere. To explain the phenomenon of sunrise effect, it seems essential to consider the presence of these convection currents.





Diffusion of smoke from chimneys simulated in a laboratory wind tunnel at low speed.



Skylight intensity meter designed for measuring light intensity in the 460-540 nm wavelengths. The skylight after passing through a gelatin filter falls on a selenium photocell and an operational amplifier. The output current from the photocell is measured with an electronic circuit consisting of operational amplifier and monitored with a microammeter.

### 2.5.3.2 Development of simulation techniques for cloud physics studies

To reduce the turbulence in the vertical wind tunnel, cross-sectional area of the tunnel was increased and additional screens were put in to it. Various sections of the tunnel such as the flow straightner, convergent and test-sections in addition to honeycomb and screens were re-fabricated with increased cross-sectional area. An adjustable air-vent was fabricated and fitted in to the air blower.

Velocities of the charged cloud and precipitation particles moving in intense electric fields of thunderstorms were calculated. Velocity-changes due to the electrical forces acting on the particles, cause a change in the concentration of the cloud and precipitation particles in the intensely electrified regions of the cloud. These changes in concentrations of the particles were calculated in a simplified model. Dependence of the accumulation of particles on the electric field, charge and size of the particles, updraft velocity and the size of the region of intense electrification 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

The zonally averaged mean asymmetric easterly jet over India was found to be barotropically unstable with a preferred wavelength of 6500 km and an e-folding time of 6.5 days and west-ward phase speed of  $23.5 \text{ m s}^{-1}$ . The zonal scale of the preferred wave was nearly equal to the Rossby radius of deformation of the upper troposphere. It was found that the anti-symmetric components of the jet flow contribute to a significant southward shift of the maximum amplitude, a considerable decrease in the meridional scale of the wave and three-fold increase in the ratio of the computed maximum southward to northward easterly momentum transport.

Study on energetics and vertical structure of the baroclinic disturbances in the monsoonal zonal flow indicated that the vertical extension of the short preferred wave depends on its wavelength but its vertical tilt depends on the vertical shear of the low-level westerlies. The computed energetics of the short preferred wave showed the existence of thermally indirect circulation below 800 mb and is maintained by the downward wave energy flux coming from the upper layer direct circulation region.

It was seen that the vertical scale of the short (long) preferred wave is close to the vertical scale associated with the westerly (easterly) jet.

The preferred location, zonal and meridional scales and the equatoward easterly momentum transport associated with the observed transient waves in the vicinity of the easterly jet seemed to be due to the barotropic instability of the asymmetric jet.

The west-ward movement of various low-level tropical disturbances, their growth rates and standing nature of wave number one and two in the upper troposphere were attributed to the diabatic heating associated with them.

From an analytical study on the horizontal motion of monsoon depression it was concluded that the orography is the most important single factor in inducing west-ward motion in the boundary layer. The Laplacian of thermal advection and the differential vorticity advection are the two important physical processes responsible for the west-ward movement in the middle layer. It was also concluded that the sub-grid scale convective transport of cyclonic vorticity ahead of depressions from the boundary layer to the middle layer contributes towards removing the non-uniform motion in the lower and middle layers, which are induced by the other physical processes.

Multilayer, linear, quasi-geostrophic model was developed and tested for studies on the barotropic-baroclinic combined instability of the upper tropospheric easterly jet and also for baroclinic instability of combined zonal and meridional lower tropospheric monsoonal flow.



The barotropic and baroclinic instability of the lower tropospheric monsoon westerly flow were studied using MONEX data of 3 July 1979, prior to the depression of 7 July 1979 observed over the Bay of Bengal. It was concluded that both barotropic and baroclinic instability mechanisms were responsible for their initial growth. The baroclinic growth rates of short waves were found to increase with the decrease of the static stability in the lower layers.

## 2.6.2 Simulation of monsoon and tropical circulation systems

### 2.6.2.1 Simulation of mean monsoon circulation

The space-time spectral analysis of monthly normal geopotential field of Northern hemisphere at standard levels was performed in order to know the actual zonal and meridional scales associated with various time periods of the fluctuating standing waves. It was found that a few spectral components are sufficient to explain the observed fluctuations in the ultra-long waves. Furthermore, the characteristics of ultra-long waves of the lower troposphere in monsoon season were obtained from the normal geopotential field.

## 2.7 Research carried out by Honorary Fellow/ Emeritus Scientist

### 2.7.1 Studies in Monsoon Meteorology

The northward movement of the ITCZ and the onset of the summer monsoon rains in the South-east Bay of Bengal were investigated utilising the daily rainfall data of six observatory stations in the Andaman-Nicobar group of islands for the period 1953 to 1978. The study revealed that the date of onset of the monsoon is appreciably ahead of the date shown in the diagram of onset dates currently in use in the India Meteorological Department.

The normal pentad rainfall values of 160 Indian stations were subjected to Harmonic Analysis. It was found that the first harmonic alone can account for over 90% of the variance for the Assam stations. The first five har-

monics account for over 90% of the variance at most of the other stations.

A set of 73 normal pentad rainfall charts was prepared bringing out the space-time variations of rainfall over India and adjacent area.

#### 2.7.2 Diurnal variations in the tropics

Studies on i) Harmonic Analysis of hourly pressure values at 64 stations and ii) Diurnal variation of low level winds upto 3 km at about 50 stations, were undertaken to examine the diurnal variation of certain meteorological parameters over India.

#### 2.7.3 Long period waves in the equatorial lower stratosphere

Using suitably designed numerical filters, long period waves were isolated in the mean monthly zonal winds in the lower stratosphere over Trivandrum, Gan Island and Ascencian Island. Spatial and temporal variations in the intensity and phase of the principal waves were studied. It was inferred that the 24 month wave may originate in a narrow band above 30 mb level over the equator. Annual wave in the monsoon regime modifies the 24 month wave.

#### 2.7.4 Dynamics of the lower stratosphere

A study was carried out on the dynamics of the lower stratosphere by spherical harmonic and Fourier analyses of the grid point values of the monthly mean geopotential heights in the northern hemisphere for 1972 and 1975. Seasonal variations in the amplitudes and tilts of these waves were studied. Weakening of the equator to pole temperature gradient was found to be associated with bad monsoon. Transfer of kinetic energy from eddies to zonal flow in 1975 suggested that the strengthening of the easterlies extends to 30°N and beyond. Large fluctuations in the amplitude in low latitudes were attributed to the equatorial wave disturbances.

### 2.7.5 Sun weather relations

Superposed epoch analysis of the daily values of total ozone at 70 stations for the period 1972-75, with solar magnetic sector boundary passage past the earth as the key-day suggested large variations in high latitudes and larger variations in winter than in summer. Similar analysis with the day on which the boundary crossed the central meridian of the sun as key-day did not reveal any discernible ozone variations. The results suggested that the link between solar activity and total ozone may be corpuscular radiation. It was speculated that the Mev protons in solar wind may be causing the variation in atmospheric ozone in association with solar magnetic sector boundary passage.



### 3. PUBLICATIONS

## 3. Publications

## 3.1 Papers Published

Sr. No.	T i t l e	Author(s)	Publication
1.	Analysis - prediction experiment - a case study with a monsoon depression in the Bay of Bengal.	Sikka D.R., Singh S.S. and Rajamani S.	Global Atmospheric Research Programme (GARP), FGGE Global Weather Experiment, Vol.9 - Results of Summer Monex Field Phase Research - Part A, June, 1980, 151 - 159.
2.	Anomalous thermal patterns during early summer season of 1979 over the Afro-Asian region and the large scale performance of monsoon rains over India.	Verma R.K. and Sikka D.R.	Global Atmospheric Research Programme (GARP), FGGE Global Weather Experiment, Vol.9 - Results of Summer Monex Field Phase Research - Part A, June, 1980, 44 - 48.
3.	Bayesian statistical analysis as applied to cloud seeding experiments.	Sharma P.N. and Kapoor R.K.	Mausam, 31, 4, December, 1980, 581 - 586.
4.	Brief appraisal of India's worst recorded floods.	Dhar O.N., Ghose G.C. and Mandal B.N.	Journal of the Indian Association of Hydrologists, 4, 1 and 2, June, 1980, 7 - 17.
5.	Calibration for studying micro-structure of clouds sampled from an aircraft.	Paul S.K., Sharma S.K. and Kapoor R.K.	Journal of Indian Institute of Science, 62 (B), 6, June, 1980, 83 - 88.

Sr. No.	T i t l e	Author(s)	Publication
6.	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 VIII International Conference on cloud physics, Clermont-Ferrand, France, 15-20 July 1980, 565 - 568.
7.	Coherency between geomagnetic activity and rainfall during north-east monsoon.	Reddy R.S. and Ramana Murty Bh. V.	Proc. of 14th ESLAB Sym. on 'Physics of Solar Variations', Scheveningen Netherlands, 16-19 September 1980.
8.	Diurnal and seasonal variations of space charge, electrical 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, 32, 3, June, 1980, 232 - 244.
9.	Does the early or late onset of monsoon provide any clue to subsequent rainfall during the monsoon season ?	Dhar O.N., Rakhecha P.R. and Mandal B.N.	Monthly Weather Review, 108, 7, July, 1980, 1069 - 1072.
10.	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 VIII International Conference on 'Cloud Physics', Clermont-Ferrand, France, 15-20 July 1980, 555 - 558.



Sr. No.	T i t l e	Author(s)	Publication
11.	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 III WMO Conference on 'Weather Modification', Clermont-Ferrand, France, 21-25 July 1980, 127 - 132.
12.	Dynamics of the lower stratosphere in 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, 42, 1980, 867 - 876.
13.	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 VI International Conference on 'Atmospheric Electricity', Manchester, England, 28 July - 1 August 1980.
14.	Electrical phenomena in pre-monsoon thunderstorms.	Selvam A.M., Manohar G.K., Kandalgaonkar S.S., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of VI International Conference on 'Atmospheric Electricity', Manchester, England, 28 July-1 August 1980.
15.	Exploratory data analysis - an application to weather prediction.	Singh S.V., Saha P. and Kripalani R.H.	Proc. of 2nd Conference of Indian Society for Theory of Probability and its Application (ISTPA), IIT, Bombay 2-4 December 1980.

Sr. No.	T i t l e	Aurhor(s)	Publication
16.	Forecasting monsoon precipitation by synoptic cum statistical methods (Lead paper).	Singh S.V., Kripalani R.H., Ismail P.M.M. and Saha P.	Proc. of WMO Sym. on 'Probabilistic and statistical method in weather forecasting', France, 8-12 September 1980, 407 - 413.
17.	High level temperatures and winds over tropics and Indian summer monsoon.	Mukherjee B.K., Reddy R.S. and Ramana Murty Bh. V.	Proc. of International sym. on 'Middle Atmosphere Dynamics and Transport', Illinois, U.S.A., 28 July - 1 August 1980.
18.	Importance of upper tropospheric thermal anomalies for long range forecasting of Indian summer monsoon activity.	Verma R. K.	Monthly Weather Review, 108, 7, July, 1980, 1072 - 1075.
19.	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. A., 29, 3, 1980, 333 - 343.
20.	Increase in the annual frequency of severe cyclonic storms of the Bay after 1964 - Possible causes.	Mooley D. A.	Mausam, 32, 1, January, 1981, 35 - 40.

Sr.No.	T i t l e	Author(s)	Publication
21.	Influence of Arabian sea cyclonic systems on the onset of monsoon.	Mukherjee A.K. and Paul D.K.	Global Atmospheric Research Programme (GARP), FGGE Global Weather Experiment, Vol.9 - Results of Summer Monex Field Phase Research - Part A, June, 1980, 62 - 67.
22.	Influence of tropical disturbances on monthly monsoon rainfall of India.	Dhar O.N. Rakhecha P.R. and Mandal B.N.	Monthly Weather Review, 109, 1, January, 1981, 188 - 190.
23.	Is aridity increasing or decreasing over Rajasthan ?	Rakhecha P.R., Kulkarni A.K. and Dhar O.N.	Proc. of the National seminar on 'Development of Desert and Drought-prone Areas', Jaipur, 6-8 March 1981.
24.	Large scale droughts/floods and monsoon circulation.	Bhalme H.N. and Mooley D.A.	Monthly Weather Review, 108, 8, August, 1980, 1197 - 1211.
25.	Life cycle of a monsoon depression on the Bay of Bengal.	Sikka D.R., Rajamani S. and Singh S.S.	Global Atmospheric Research Programme (GARP), FGGE Global Weather Experiment, Vol.9 - Results of Summer Monex Field Phase Research - Part A, June, 1980, 129 - 136.



Sr.No.	T i t l e	Author(s)	Publication
26.	Maximum one-day point rainfall estimation for 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.
27.	Mean wind velocity profiles in an artificially thickened boundary layer.	Sivaramakrishnan S.	Journal of the Indian Institute of Science, 62 (A), 5, May, 1980, 89 - 99.
28.	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 III WMO Scientific Conference on 'Weather Modification', Clermont-Ferrand, France, 21-25 July 1980, 141-144.
29.	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 III WMO Scientific Conference on 'Weather Modification', Clermont-Ferrand, France, 21-25 July 1980, 151 - 157.
30.	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.	Proc. of III WMO Scientific Conference on 'Weather Modification', Clermont-Ferrand, France, 21-25 July 1980, 145 - 150.

Sr.No.	T i t l e	Author(s)	Publication
31.	Observations on atmospheric electric parameters during heavy rainfall occasions.	Selvam A.M., Manohar G.K., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of VI International Conference on 'Atmospheric Electricity', Manchester, England, 28 July - 1 August 1980.
32.	Observations on sky-light 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 Sym. on 'Radiative Processes in the Atmosphere', Boulder, Colorado, U.S.A., 11-16 August 1980, 175 - 177.
33.	On computational efficiency of primitive equation barotropic hemispheric spectral model.	Mishra S.K.	Contribution to Atmospheric Physics, 54, 1, January, 1981, 72 - 85.
34.	On the maximum cloud zone and the ITCZ over Indian longitudes during the southwest monsoon.	Sikka D.R. and Gadgil S.	Monthly Weather Review, 108, 11, November, 1980, 1840-1853.
35.	On some aspects of initialization and forecasts in Indian monsoon region.	Singh S.S., Kulkarni A.A. and Sikka D.R.	Monthly Weather Review, 108, 9, September, 1980, 1315-1325.
36.	Oscillator circuit with a linear relation between frequency and temperature.	Chaudhuri S.	Journal of Indian Institute of Science, 62(A), 9, September, 1980, 179-185.

Sr.No.	T i t l e	Author(s)	Publication
37.	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 VI International Conference on 'Atmospheric Electricity, Manchester, England, 28 July - 1 August, 1980.
38.	Probable maximum point rainfall estimation for the southern half of the Indian Peninsula.	Dhar O.N., Kulkarni A.K. and Rakhecha P. R.	Proc. of the Indian Academy of Sciences, 90 (A), 1, March, 1981, 39 - 46.
39.	Probability model for the calamitous behaviour of the summer monsoon over India.	Mooley D.A. and Parthasarathy B.	Proc. of the 1st International Conference on 'Statistical Climatology', 29 November - 1 December 1979, Tokyo, Japan, 375 - 382.
40.	Probability model for droughts in ancient China.	Mooley D. A.	Monthly Weather Review, 109, 1, January, 1981, 191 - 193.
41.	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 III WMO Conference on 'Weather Modification', Clermont-Ferrand, France, 21-25 July 1980, 133 - 139.



Sr.No.	T i t l e	Author(s)	Publication
42.	Radiometer soundings over Indian region during Monex.	Mani A., Sikka D.R., Srinivasan V. and Srivastava G. P.	Proc. of the International Radiation Sym., Fort Collins, U.S.A., 11-16 August 1980.
43.	Rainfall probabilities in Karnataka State during Summer Monsoon months.	Mooley D.A. and Deshpande V.R.	Geographical Review of India, 42, 2, June, 1980, 120-130.
44.	Rainfall of Karnataka and its three sub-divisions - a brief appraisal.	Dhar O.N., Rakhecha P.R. and Mandal B.N.	Indian Journal of Power and River Valley Development, 30, 5 and 6, May - June, 1980, 70 - 75.
45.	Rainstorm which caused the Morvi dam disaster in August 1979.	Dhar O.N., Rakhecha P.R., Mandal B.N. and Sangam R. B.	Hydrological Sciences Bulletin, 26, 1, March, 1981, 71 - 81.
46.	Rainstorms which contributed greatest areal rain depths 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.
47.	Severe cyclonic storms in the Bay of Bengal, 1877-1977.	Mooley D. A.	Monthly Weather Review, 108, 10, October, 1980, 1647 - 1655.
48.	Simple Markov chain model for the prediction of rainfall.	Kamte P. P.	Proc. of WMO Sym. on 'Probabilistic and Statistical method in weather forecasting', France, 8-12 September 1980.

Sr.No.	Title	Author(s)	Publication
49.	Solar influence on atmospheric electric field.	Selvam A.M., Joshi R.R., Murty A.S.R. and Ramana Murty Bh. V.	Proc. of VI International Conference on 'Atmospheric Electricity', Manchester, England, 28 July - 1 August 1980.
50.	Some aspects of the large scale fluctuations of summer monsoon rainfall over India in relation to fluctuations in the planetary and regional scale circulation features.	Sikka D. R.	Proc. of Indian Academy of Sciences, 89 (A), 2, July, 1980, 179 - 195.
51.	Some aspects of the oceanic ITCZ and its disturbances during the onset and established phase of the summer monsoon studied with Monex 1979 data.	Sikka D. R., Paul D.K. and Singh S. V.	Global Atmospheric Research Programme (GARP), FGGE Global Weather Experiment, Vol.9 - Results of Summer Monex Field Phase Research - Part A, June, 1980, 32 - 43.
52.	Some characteristics of the PBL over the ocean during the Indian summer monsoon.	Sinha S. and Khade V. V.	Boundary Layer Meteorology, 19, 1980, 235 - 247.
53.	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 VI International Conference on 'Atmospheric Electricity', Manchester, England, 28 July - 1 August 1980.

Sr.No.	Title	Author(s)	Publication
54.	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 Indian Academy of Sciences, 89 (A), 2, - July, 1980, 215 - 230.
55.	Statistical technique of long range forecasting of summer monsoon activity over India.	Verma R.K. and Kamte P. P.	Proc. of WMO Sym. on 'Probabilistic and Statistical method in Weather forecasting', France, 8-12 September 1980.
56.	Stochastic model of probability estimate of prevailing wind speed over Nagpur.	Kamte P.P. and Dahale S. D.	Proc. of the 2nd Conference of Indian Society for Theory of probability and its application, IIT, Bombay, 2-4 December 1980.
57.	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.
58.	Study of the gaseous and particulate pollutants in the environment of a thermal power plant project area.	Khemani L.T., Naik M.S., Momin G.A., Krishnanand K., Kachre S.D., Selvam A.M. and Ramana Murty Bh. V.	Water, Air and Soil pollution, 13, 3, September, 1980, 303 - 316.



Sr.No.	Title	Author(s)	Publication
59.	Study of the instability of meridional flow - Part I.	Mahanti A. C.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 29, 3, July, 1980, 235 - 247.
60.	Study of rainfall singularities, cyclonic disturbances and sea-level pressure over southern India.	Reddy R.S. and Ramana Murty Bh. V.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 29, 1980, 99 - 109.
61.	Suitable probability model for severe cyclonic storms striking the coast around the Bay of Bengal.	Mooley D. A.	Proc. of the 1st International Conference on 'Statistical Climatology', 29 November-4 December 1980, Tokyo, Japan, 349 - 357.
62.	Summer Monex Field Phase.	Sikka D.R. and Dutta R. K.	Vayu Mandal, 9, 3 and 4, July-December, 1979, 5 - 15.
63.	Super-geostrophic zonal flow and transverse circulation in a westerly jet stream.	Subrahmanyam D.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 29, July, 1980, 219 - 233.
64.	Survey and assessment of the design and evaluation techniques of cumulus clouds modification experiments for rain enhancement.	Sharma P. N.	Journal of the Indian Institute of Sciences, 63, 2, February, 1981.

Sr.No.	T i t l e	Author(s)	Publication
65.	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, 19, 2, September, 1980, 165 - 174.
66.	Temperature and wind variations in tropical stratosphere during the major solar flares of 1972.	Mukherjee B.K., Reddy R.S. and Ramana Murty Bh. V.	Proc. of 14th ESLAB sym. on 'Physics of Solar Variations', Scheveningen, Netherlands, 16-19 September 1980.
67.	Thermal, micro-physical 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 VIII Inter- national Conference on 'Cloud Physics', Clermont-Ferrand, France, 15-20 July 1980, 153 - 156.
68.	Total ozone, solar activity and Indian Summer Monsoon.	Mukherjee B.K., Reddy R.S. and Ramana Murty Bh. V.	Proc. of Sym. on 'Atmospheric Ozone', Boulder, Colorado, U.S.A., 4-9 August 1980.
69.	Upper atmospheric turbulence decay over Thumba.	Vernekar K.G. and Brij Mohan	Indian Journal of Radio and Space Physics, 9, 5, October, 1980, 191 - 195.

Sr.No.	Title	Author(s)	Publication
70.	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. VI International Conference on 'Atmospheric Electricity', Manchester, England, 28 July - 1 August 1980.
71.	Variations in the surface ozone, atmospheric trace gases and aerosols 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 Sym. on 'Atmospheric ozone', Boulder, Colorado, U.S.A., 4-9 August 1980.



## 3.2 Papers accepted for Publication

Sr.No.	T-i-t-l-e	Author(s)	Publication
1.	Absence of tropical disturbances and rainfall distribution during the summer monsoon months over India.	Dhar O. N., Mandal B.N. and Rakhecha P.R.	Archiv fur Meteorologie Geophysik und Bioklimatologie, Sr. A.
2.	Annual rainwater over India, its variability and impact on the economy.	Mooley D. A., Parthasarathy B., Sontakke N. A. and Munot A. A.	Journal of Climatology,
3.	Application of the dynamic initialization technique to a primitive equation (PE) model.	Sinha S. and Kulkarni P.L.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
4.	Chloride and Sodium ion increases in rain from salt seeded clouds.	Khemani L.T., Momin G. A., Naik M. S., Murty A.S.R. and Ramana Murty Bh. V.	Journal of Weather Modification.
5.	Computers in weather forecasting.	Singh S. V.	Computer Society of India.
6.	Electrical, microphysical and dynamical observations in summer monsoon clouds.	Selvam A. M., Bandyopadhyay B.K., Vijaykumar R., Manohar G.K. and Ramana Murty Bh. V.	Tellus.

Sr.No.	T i t l e	Author(s)	Publication
7.	Electrical, microphysical and dynamical responses to salt seeding in warm maritime cumulus clouds.	Murty A.S.R., Selvam A. M., Bandyopadhyay B.K., Revathy N., Pillai A. G. and Ramana Murty Bh. V.	Journal of Weather Modification.
8.	Energetics of open atmospheric systems : Case study of an extra-tropical cyclone.	Pant G. B.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
9.	Ground-based salt seeding in Tamil Nadu State, South India, 1973-77.	Pillai A. G., Reddy R. S., Vijaykumar R., Kapoor R. K., Murty A.S.R., Selvam A. M. and Ramana Murty Bh. V.	Journal of Weather Modification.
10.	Nature of diurnal variation of atmospheric electric field.	Chaudhuri S.	Mausam.
11.	On the atmospheric tidal wind variations at meteor heights.	Devara P.C.S. and Ahmed M.I.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
12.	On the occurrence of rainfall over south-west sector of monsoon depression.	Rajamani S. and Rao K. V.	Mausam.

Sr.No	Title	Author(s)	Publication
13.	On the northward advance of the ITCZ and the onset of the south-west monsoon rains over the south-east Bay of Bengal.	Ananthakrishnan R., Pathan J. M. and Aralikatti S.S.	Journal of Climatology.
14.	Oscillation between Rossby wave and zonal flow.	Mahanti A. C.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
15.	Persistence in daily and 5-day summer monsoon rainfall over India.	Singh S. V., Kripalani R.H., Saha P., Ismail P.M.M. and Dahale S.D.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
16.	Persistency in sequences of wet and dry pentads over Bombay.	Kamte P. P., Dahale S.D. and Khade V. V.	Mausam.
17.	Possible linkage between solar magnetic sector boundary passage and atmospheric total ozone.	Raja Rao K.S. and Nair M.V.H.	Journal of Atmospheric and Terrestrial Physics.
18.	Problems of classification in Meteorology and Climatology.	Singh S. V.	Bulletin of Classification Society.
19.	'Reply' to comment on 'Contributions of cloud and precipitation particles to the electrical conductivity and relaxation time of the air in thunderstorms' by A.J. Weinheimer and A.A. Few.	Kamra A. K.	Journal of Geophysical Research.



Sr.No.	Title	Author(s)	Publication
20.	Result of an operational aircraft salt seeding experiment in Linganamakki catchment.	Murty A.S.R., Selvam A. M., Kulkarni C.P., Chatterjee R.N. and Ramana Murty Bh. V.	Journal of Weather Modification.
21.	Results of the ground-based salt seeding experiments in Tamil Nadu State, South India.	Pillai A. G., Reddy R. S., Vijaykumar R., Kapoor R. K., Murty A.S.R. and Ramana Murty Bh. V.	Journal of Weather Modification.
22.	Salt seeding from aircraft over Linganamakki catchment.	Murty A.S.R., Selvam A. M., Kulkarni C.P., Chatterjee R.N. and Ramana Murty Bh. V.	Journal of Weather Modification.
23.	Some aspects of an association between the southern oscillations and Indian summer monsoon.	Pant G.B. and Parthasarathy B.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. B.
24.	Some aspects of initialisation and forecast in Indian monsoon region.	Singh S. S., Kulkarni A.A. and Sikka D.R.	Monthly Weather Review.
25.	Stability of monsoon depression.	Mahanti A. C.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.

Sr.No.	Title	Author(s)	Publication
26.	Structure functions of rainfall field and their application to network design in the tropics.	Mooley D.A. and Ismail P.M.M.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
27.	Study of the instability of the meridional flow, Part 2.	Mahanti A. C.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A.
28.	Warm monsoon cloud responses to salt seeding as evaluated from chloride and sodium ion concentrations in rain water.	Khemani L. T., Momin G. A., Naik M. S., Murty A.S.R. and Ramana Murty Bh. V.	Journal of Weather Modification.

### 3.3 Institute's Research Reports

The Institute started an internal publication series entitled 'Contributions from the Indian Institute of Tropical Meteorology' in place of the earlier one 'Research Reports'. The new series is meant to print Research Reports, Lecture Notes and Project Reports from the Institute's Scientists. For this purpose an Editorial Board was nominated by the Director. The current members of the Board are :

Prof. R. Ananthakrishnan,	Hony. Fellow,	
	Chairman	
Dr. D. A. Mooley,	Asstt. Director	Member
Shri D. R. Sikka,	" "	Member
Dr. A. K. Kamra,	" "	Member
Shri D. Bhattacharya,	S.T.O. I,	Member Convener

The following is the list of reports published during the year :

Sr. No.	T i t l e	Author(s)	Report No.
1.	Hundred years of Karnataka Rainfall.	Parthasarathy B. and Mooley D. A.	R-030
2.	Modification of Palmer drought index.	Bhalme H.N. and Mooley D.A.	R-033
3.	On accelerating the FFT of Cooley and Tukey.	Mishra S. K.	R-028
4.	Poisson distribution and years of bad monsoon over India.	Mooley D.A. and Parthasarathy B.	R-027
5.	Some aspects of oceanic ITCZ and its disturbances during the onset and established phase of summer monsoon studied with Monex-79 data.	Sikka D. R., Paul D. K. and Singh S. V.	R-032



Sr. No.	T i t l e	Author(s)	Report No.
6.	Study of the anomalous thermal and wind patterns during early summer season of 1979 over the Afro-Asian region in relation to the large-scale performance of the monsoon over India.	Verma R.K. and Sikka D. R.	R-031
7.	Wind tunnel for simulation studies of the atmospheric boundary layer.	Sivaramakrishnan S.	R-029

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

#### 4. Participation in Seminars/ Symposia/Meetings

The Institute deputed scientists to participate in several national and international seminars/symposia/meetings. The scientists also presented papers in these symposia etc. Details in this regard are given below :

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented - Author(s)
1.	Meeting of the SERC Working Group on Satellite Meteorology and Seminar-cum-Workshop on application of 'Bhaskara - SAMIR DATA', Space Application Centre, Ahmedabad, 2-5 April 1980.	Sikka D. R.	-
2.	Meeting of the Board of studies in Geography, University of Bombay, Bombay, 3 and 17 April and 22 December 1980.	Gondhalekar Y.S.	-
3.	Meeting of the Board of studies in Geography and Meteorology, Shivaji University, Kolhapur, 10 April 1980.	Gondhalekar Y.S.	-
4.	Meeting of the Council for Meteorology and Atmospheric Sciences (CMAS), 18 April 1980.	Ramana Murty Bh. V.	-



Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
5.	Meeting of the Board on Scientific Activities of Centre for Atmospheric Sciences, Indian Institute of Technology, New Delhi, 18-23 April 1980.	Sikka D. R.	-
6.	Meeting at Indian Institute of Technology, New Delhi, 20 April 1980.	Ramana Murty Bh. V.	-
7.	Annual Convention of Poona Chapter of Computer Society of India, Pune 7-8 June 1980.	Singh S. V.	Computer in Weather Forecasting Research - Singh S.V. and Suryanarayana R.
8.	Seminar on Bhaskara Performance, applications, science and technology, convened under the auspices of ISRO, Bangalore, 25-30 June 1980.	Sikka D. R.	-
9.	First Meeting of the Working Group on Meteorological Rocket Payload, Tata Institute of Fundamental Research, Bombay, 3 July 1980.	Kamra A. K., Vernekar K. G. and Brij Mohan	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presen- ted - Author(s)
10.	First conference of Indian Society for Theory of Probability and its application, (ISTPA), Tirupati, 8-10 July 1980.	Singh S.V. and Kamte P. P.	i) Application of stochastic model to pre- cipitation over India during south- west monsoon - Kamte P.P., Dahale S.D., Khade V.V. and Ismail P.M.M.  ii) Some sta- tistical cha- racteristics of daily su- mmer monsoon rainfall over India - Singh S. V., Kripalani R.H., Sharma P. and Prasad K.D.
11.	Meeting of the Working Group of SERC Panel on Weather Modification (Dept. of Science and Tech- nology), I.I.T.M., Pune, 13 July 1980.	Ramana Murty. Bh. V.	-
12.	Meeting of the Coun- cil for Meteorology and Atmospheric Sciences, I.Met.D., Pune, 14 July 1980.	Ramana Murty Bh. V.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented - Author(s)
13.	VIIIth International Conference on Cloud Physics, Clermont- Ferrand, France, 15-19 July 1980.	Chatterjee R.N.	<p>★ i) Character- istics of tem- perature spec- tra in the at- mospheric bound- ary layer - Parasnis S.S., Selvam A. M., Vernekar K.G., Brij Mohan, Murty A.S.R. and Ramana Murty Bh. V.</p> <p>★ ii) Dynamical characteristics of the sub- cloud layer in a maritime en- vironment - Selvam A. M., Bandyopadhyay B. K., Vernekar K.G., Brij Mohan, Vijaykumar R., Murty A.S.R. and Ramana Murty Bh. V.</p> <p>* iii) Thermal, microphysical and chemical conditions in an urban en- vironment - Khemani L.T., Momin G. A., Naik M. S., Selvam A. M., Murty A.S.R. and Ramana Murty Bh. V.</p>



Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented - Author(s)
14.	III WMO Scientific conference on Weather Modification, Clermont-Ferrand, France, 21-25 July 1980.	Chatterjee R.N.	<p>* i) 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.</p> <p>* ii) 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.</p> <p>* iii) 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.</p>

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented -- Author(s)
	III WMO Scientific conference on Weather Modification, Clermont-Ferrand, France, 21-25 July 1980.	Chatterjee R. N.	* iv) 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.
			* v) 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.
15.	VI International Conference on Atmospheric Electricity, Manchester, England, 28 July - 1 August 1980.	-	* i) 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.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented- Author(s)
------------	-------------------------------	----------------	-------------------------------

VI International  
Conference on Atmos-  
pheric Electricity,  
Manchester, England,  
28 July - 1 August  
1980.

\* ii) Elec-  
trical phe-  
nomena in  
premonsoon  
thunder-  
storms -  
Selvam A.M.,  
Manohar G.K.,  
Kandalgaonkar  
S.S., Murty  
A.S.R. and  
Ramana Murty  
Bh. V.

\* iii) Obser-  
vations on  
atmospheric  
electric  
parameters  
during hea-  
vy rainfall  
occasions -  
Selvam A.M.,  
Manohar G.K.,  
Murty A.S.R.  
and Ramana  
Murty Bh.V.

\* iv) Power  
spectral  
analysis of  
atmospheric  
electric  
field and  
rainfall -  
Selvam A.M.,  
Manohar G.K.,  
Murty A.S.R.  
and Ramana  
Murty Bh.V.



Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
	VI International Conference on Atmos- pheric Electricity, Manchester, England, 28 July - 1 August 1980.	-	<p>* v) Solar in- fluence on atmospheric electric field - Selvam A.M., Joshi R.R., Murty A.S.R. and Ramana Murty Bh.V.</p> <p>* vi) Some electrical and microphy- sical 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.</p> <p>* vii) Varia- tions 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.</p>

Sr. No.	Seminar/Symposium/Meeting	Participant(s)	Paper presented-Author(s)
16.	Symposium on Atmospheric Ozone, Boulder, Colorado, U.S.A., 4-9 August 1980.	-	* Variations in the surface ozone, atmospheric trace gases and aerosols during the Total Solar Eclipse - 1980 - Khamani L.T., Momin G.A., Naik M.S., Murty A.S.R., Selvam A.M. and Ramana Murty Bh.V.
17.	Meeting of the Monex Research Committee, I.Met.D., New Delhi, 5 August 1980.	Ramana Murty Bh. V. and Sikka D. R.	-
18.	Meeting of the Weather Modification Research Committee of SERC Panel, I.Met.D., New Delhi, 5 August 1980.	Ramana Murty Bh. V. and Sikka D. R.	-
19.	Meeting regarding reservation of jobs for the blind and handicapped persons in the Ministry of Tourism and Civil Aviation, New Delhi, 20 August 1980.	Ramana Murty Bh. V.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
20.	Meeting of the Board of University Teaching and Research for the Faculty of Science, University of Poona, Pune, 27 August 1980.	Mooley D. A.	-
21.	WMO symposium on probabilistic and statistical methods in Weather Forecasting, Nice, France, 8-12 September 1980.	-	<p>* i) Forecasting monsoon precipitation by synoptic-cum-statistical methods (Lead Paper) - Singh S.V., Kripalani R.H., Ismail P.M.M. and Shaha P.</p> <p>* ii) Simple Markov Chain model for the prediction of rainfall - Kamte P. P.</p> <p>* iii) Statistical technique of long range forecasting of summer monsoon activity over India - Verma R. K. and Kamte P. P.</p>
22.	14th ESLAB symposium on physics of solar variations, Scheveningen, Netherlands, 16-19 September 1980.	-	<p>* i) Coherency between geomagnetic activity and rainfall during north-east monsoon - Reddy R.S. and Ramana Murty Bh. V.</p>

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
------------	-------------------------------	----------------	---------------------------

\* ii) Temperature and wind variations in tropical stratosphere during the major solar flares of 1972 -  
Mukherjee B.K., Reddy R.S. and Ramana Murty Bh. V.

- |     |  |                               |  |
|-----|--|-------------------------------|--|
| 23. | Meetings convened by the Planning Commission and the Ministry of Tourism and Civil Aviation regarding discussions on the Institute's Sixth Five Year Plan (1980-85), New Delhi, 10 October 1980. | Ramana Murty Bh. V.           | -  |
| 24. | Meeting of the Council for Meteorology and Atmospheric Sciences (CMAS), New Delhi, 24 October 1980.  | Ramana Murty Bh. V.           | -  |
| 25. | II Conference of Indian Society for the Theory of Probability and its applications (ISTPA), Indian Institute of Technology, Bombay, 2-4 December 1980.   | Kamte P.P. and Kripalani R.H. | * i) Exploratory data analysis - an application to weather prediction -<br>Singh S.V., Shaha P. and Kripalani R.H. |



Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented - Author(s)
			* ii) Stochastic model of probability estimate of prevailing wind speed over Nagpur - Kamte P.P. and Dahale S. D.
26.	First Asian Congress on Fluid Mechanics, Bangalore, 8-13 December 1980.	Sikka D. R.	Fluctuations of the summer monsoon trough over India - Sikka D. R.
27.	68th Indian Science Congress Association, Varanasi, 3-7 January 1980.	Joshi P. C.	Comparison of the deterministic and the stochastic dynamic solutions of simple advection equation on weather prediction - Joshi P. C.
28.	International Conference on Early results of FGGE and monsoon experiments, Tallahassee, U.S.A., 12-17 January 1981.	Sikka D. R.	i) Contrasting features of the large scale dynamics of tropospheric circulation in wave number domain in relation to the performance of monsoon rains over India with special reference to monsoon experiments - Awade S. T., Totagi M.Y. and Sikka D. R.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented - Author(s)
	International Conference on Early results of FGGE and monsoon experiments, Tallahassee, U.S.A., 12-17 January 1981.	Sikka D. R.	<p>ii) Impact of additional summer monex wind data on the prediction of monsoon depressions/storms during June-August 1979 with two versions of divergent barotropic model - Sikka D.R., Sinha S., Singh S.S., Kulkarni P.L. and Kulkarni A. A.</p> <p>iii) Impact of summer special observational data on the objective analysis of wind field over the Indian region- Rajamani S., Talwalkar D.R., Upasani P.U. and Sikka D. R.</p> <p>iv) Some aspects of the inter-hemispheric interactions on the onset of monsoon over India as revealed by the Monex data - Sikka D.R., Nagar S.G. and Paul D. K.</p>

Sr. No.	Seminar/Symposium/Meeting	Participant(s)	Paper presented-Author(s)
29.	Workshop-cum-seminar on 'Opportunities for High Altitude - Balloon Experiments in India', Secunderabad, 19-21 January 1981.	Vernekar K. G.	Meteorological payload for constant volume balloon - Vernekar K.G.
30.	Meeting of the Academic Council of the University of Poona, Pune, 20 and 21 January 1981.	Mooley D. A.	-
31.	Meeting of the Air Head Quarters Mountain Project, I.Met. D., New Delhi, 22 January 1981.	Mishra S. K.	-
32.	Meeting of the Council for Meteorology and Atmospheric Sciences (CMAS), I. Met.D., New Delhi, 24 January 1981.	Ramana Murty Bh. V.	-
33.	International symposium on solar eclipse, Indian National Science Academy, New Delhi, 27-31 January 1981.	Kamra A. K., Khemani L. T., Reddy R. S., Vijaykumar R. and Brij Mohan	i) Effects of total solar eclipse of 16 February on tides- Reddy R. S., Mukherjee B.K. and Ramana Murty Bh. V.  ii) Electric field and space charge measurements in the lowest 2 metres of the atmosphere during the solar eclipse of 16 February 1980 - Kamra A.K., Teotia G.K. and Sathe A. B.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
	International symposium on solar eclipse, Indian National Science Academy, New Delhi, 27-31 January 1981.	Kamra A. K., Khemani L.T., Reddy R. S., Vijaykumar R. and Brij Mohan	<p>iii) Observations on 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.</p> <p>iv) Observations on surface ozone, atmospheric trace gases and aerosols 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.</p> <p>v) Temperature inhomogeneities in the surface boundary layer during solar eclipse of February 1980 - Brij Mohan.</p>



Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
			vi) Variations in skylight, atmospheric turbidity, water vapour and ozone content of the atmosphere during the total solar eclipse 1980 - Vijaykumar R., Selvam A.M., Murty A.S.R., Khemani L.T., Sikka P. and Ramana Murty Bh. V.
34.	National workshop on Atmospheric studies using high power VHF Radar, Ahmedabad, 2-4 February 1981.	Devara P.C.S. and Mukherjee B. K.	VHF Radar and cloud physics- Devara P.C.S. and Ramana Murty Bh.V.
35.	II Meeting of the Working Group on Meteorological Rocket Payload, I.I.T.M., Pune, 6 February 1981.	Kamra A. K., Vernekar K.G. and Brij Mohan	-
36.	61st Annual convention of the Institution of Engineers (India), Hyderabad, 6-9 February 1981.	Sharma S. K.	-
37.	Meeting of the Committee on 'Formation of Indian Institute of Seismology'. I.Met.D., New Delhi, 25 February 1981.	Ramana Murty Bh. V.	-

Sr. No.	Seminar/Symposium/Meeting	Participant(s)	Paper presented-Author(s)
38.	16th Annual convention of the computer society of India, New Delhi, 1-4 March 1981.	Aralikatti S.S.	-
39.	National seminar on 'Development of desert and drought-prone areas' HCM State Institute of Public Administration, Jaipur, 6-8 March 1981.	Rakhecha P. R.	Is aridity increasing or decreasing over Rajasthan- Rakhecha P.R., Kulkarni A.K. and Dhar O.N.
40.	National symposium on Early results of monsoon experiments, I.Met.D., New Delhi, 9-11 March 1981.	Ramana Murty Bh. V., Mooley D.A., Paul D.K., Bhide U.V., Salvekar P.S. and Talwalkar D. R.	i) Baroclinic mechanism and formation of a depression during Monex-79 - Salvekar P.S., George L. and Mishra S.K.  ii) Divergent barotropic instability of low level asymmetric westerly jet and formation of a depression during Monex-79 - Subrahmanyam D., Tandon M.K., George L. and Mishra S. K.  iii) Energy budget of a Bay depression during Monex-79 - Singh S.S., Kulkarni A.A. and Sikka D. R.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
	National symposium on Early results of monsoon experiments, I-Met.D., New Delhi, 9-11 March 1981.	Ramana Murty Bh. V., Mooley D.A., Paul D. K., Bhide U. V., Salvekar P.S. and Talwalkar D. R.	iv) Fluctua- tions in the air sea fluxes in the Arabian sea during the onset phase of 1979 monsoon and their re- lationship with rainfall over Kerala - Bhalme H.N., Mooley D.A. and Jadhav S.K.
			v) Structure of the oceanic ITCZ over the North Indian ocean and ad- joining paci- fic during the onset/ pre-onset/ established phase of the summer mon- soon over India during Monex-79 - Paul D.K., Deshpande V.R., Mujumdar V.R., Puranik P.V. and Sikka D. R.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented-Author(s)
	National symposium on Early results of monsoon experiments; I:Met.D., New Delhi, 9-11 March 1981.	Ramana Murty Bh. V., Mooley D.A., Paul D. K., Bhide U. V., Salvekar P.S. and Talwalkar D. R.	vi) Study of synoptic/ scale dis- turbances passing over the USSR research ship-arrays during su- mmer Monex -Bhide U.V., Nagar S.G. and Sikka D. R.  vii) Work on comparison of two ob- jective ana- lysis sche- mes - Su- ccessive correlation method and optimum interpola- tion method with Monex-79 - data - Rajamani S., Talwalkar D.R., Upasani P.U. and Sikka D. R.
41.	Meeting on warm cloud modification, organised by the World Meteorological Organisation, Kuala Lumpur, Malaysia, 16-25 March 1981.	Ramana Murty Bh. V.	-

\* Published in the Proceedings.



5. COLLABORATION WITH UNIVERSITIES AND  
OTHER SCIENTIFIC INSTITUTIONS/  
ORGANISATIONS

5. Collaboration with Universities  
and other Scientific Institutions/  
Organisations

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.

A team of Officers comprising of Dr. D.A. Mooley, Assistant Director, Dr. O.N. Dhar, Assistant Director and Shri D. Bhattacharya, Senior Technical Officer, Grade I called on Prof. M.R. Bhiday, Director, College Development Council, University of Poona at his office and had discussions with him regarding grant of permanent recognition to the Institute by the University of Poona on 3 April 1980.

Dr. A.K. Kamra, Assistant Director, Dr. A.S.R. Murty, Assistant Director, Dr. (Mrs.) A.M. Selvam, Senior Scientific Officer, Grade I were recognised by University of Poona as teachers to impart instructions in the Post-graduate course (by Research) in Physics (Meteorology/Atmospheric Sciences) from 19 September 1980.

Dr. D.A. Mooley, Assistant Director attended the meeting of the Board of University Teaching and Research for the Faculty of Science, University of Poona on 27 August 1980 and of Academic Council of Poona University on 20 and 21 January 1981.

One thesis for M.Sc. degree, referred by the Bombay University, was assessed by Dr. D.A. Mooley, Assistant Director.

Dr. D.A. Mooley, Assistant Director accepted the invitation of the Calcutta University to be a member of the Board of Examiners of M.A./M.Sc. Part II Examination of 1979 in Geography and to set paper in Meteorology for the examination to be conducted in April 1981.

Dr. Y.S. Gondhalekar, Senior Scientific Assistant was nominated by Shivaji University, Kolhapur as a member of the Expert Committee constituted for the purpose of considering applications from teachers for recognition as Research

guides. He was also appointed by this University as an examiner to examine a thesis for the award of Ph.D. degree in Geography in the Faculty of Science.

Dr. Gondhalekar attended a meeting of the Board of Studies in Geography at the University of Bombay on 22 December 1980 for framing the syllabus for Hydrology in the undergraduate course as well as that for Geography in the post-graduate course.

Dr. S.T. Awade, Senior Scientific Officer, Grade II was awarded Ph.D. degree by the University of Poona for his thesis entitled 'Some features of the large scale circulation during Indian south-west monsoon'.

Shri R.S. Reddy, Junior Scientific Officer, submitted a Ph.D. thesis on 'Singularities and periodicities in rainfall of Tamil Nadu, South India and their association with some solar-terrestrial phenomena' to the University of Poona.

Dr. Bh.V. Ramana Murty, Director and Shri D. R. Sikka, Assistant Director attended a meeting as members of the Board of Scientific activities of the Centre for Atmospheric Science, Indian Institute of Technology, New Delhi, in April 1980.

Dr. R. Ananthakrishnan, Hon. Fellow continued to function as Honorary Visiting Professor in the Department of Marine Sciences, University of Cochin.

## 5.2 Collaboration with Scientific Institutions/Organisations

On invitation from the Director, U.G.C. sponsored Summer Institute in Geography, organised at S.N.D.T. College, Pune, Dr. D.A. Mooley, Assistant Director delivered a lecture on 'The Indian Monsoon' on 1 June 1980 to the participants comprising of College lecturers in Geography from the four Universities of Maharashtra i.e. Marathwada, Shivaji, S.N.D.T. and Poona.

On invitation from the National Council of Education, Research and Training (NCERT), Pune, Dr. D. A. Mooley, Assistant Director, delivered a lecture on 'Monsoons - with special reference to India' to the trainees of the Orientation course in Teaching Geography for Teacher Educators of Maharashtra and Goa on 2 December 1980 at Pune.



Dr. D.A. Mooley, Assistant Director, gave a lecture on 'Poisson stochastic process and landfall of severe cyclonic storms from the Bay of Bengal' on 8 April 1980, under the auspices of the Indian Meteorological Society, Pune Branch, Pune.

Dr. A.K. Kamra, Assistant Director, delivered invited talks on 'Sink Mechanisms' for the training course on 'Application of Meteorology to Air Pollution Control' arranged by the India Meteorological Department for the Officers of the Central Board for the Prevention and Control of Water Pollution, during 30 April - 4 May 1980, at New Delhi.

On invitation from the Pune Students' Chapter of The Institution of Engineers (India), Dr. A.K. Kamra delivered a talk on 'Effect of solar eclipse on atmospheric electricity' to the Student Members on 7 January 1981.

Shri D.R. Sikka and Dr. A.S.R. Murty, Assistant Directors were on tour to Vikram Sarabhai Space Centre (VSSC), Trivandrum during 4-10 December 1980 in connection with the discussions regarding development of Silver iodide pyrotechnics and rockets for weather modification in collaboration with ISRO. Dr. Murty delivered a talk on 'Some aspects of weather modification techniques' at the VSSC on 7 December 1980.

Shri R.N. Chatterjee, Senior Scientific Officer, Grade I was on tour to Physical Research Laboratory, Ahmedabad from 29 April to 3 May 1980 for participation in the discussions regarding M.S.T. Radars.

On invitation, Shri K.G. Vernekar, Senior Scientific Officer, Grade I gave a review talk on 'Upper atmospheric temperature measurement with rockets with special emphasis on the meteorological rocket payload' at UGC-ISRO sponsored workshop-cum-seminar on 'Rocket Experiments' held at Thumba Equatorial Launching Station, Thumba, during 5-17 May 1980.

Shri L.T. Khemani, Junior Scientific Officer, was on tour to Ahmedabad during 2-11 August 1980 for rendering the necessary technical assistance to the Government of Gujarat for conducting cloud seeding experiment.



Shri A.K. Kulkarni, Junior Scientific Officer, gave a talk on 'Hydrometeorological Research work being carried out in the Institute' to the i) Third Year B.Sc. Students from Fergusson College, Pune, who visited this Institute on 26 September 1980 and ii) I.A.F. trainee officers of the Air Force Administrative College, Coimbatore on 9 March 1981.

At the invitation of Prof. S. Gregory, Editor, 'Journal of Climatology', Dr. R. Ananthakrishnan, Hon. Fellow joined as a member of the Editorial Board of the Journal.

### 3. PUBLICATIONS

6. Facilities for Research extended to other Institutions

Dr. K.S. Raja Rao, Director, Agricultural Meteorology (Retd.), India Meteorological Department, who was appointed as 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 Jaykumar, who was awarded with the Air India Research Fellowship, continued to associate with the project, 'Studies in atmospheric electricity' currently being pursued in the Physical Meteorology and Aerology Division of the Institute.

Shri D.V. Ahire was awarded with the Air India Research Fellowship with effect from 10 November 1980. He was associated with the project, 'Simulation in cloud physics' currently being pursued in the Instrumental and Observational Techniques Division of the Institute.

6 A

ESTABLISHMENT OF FIELD UNIT  
AT BANGALORE



6 A            Establishment of field  
                 unit at Bangalore

A field unit was established at Bangalore during the year for the implementation of a project for the preparation and publication of a 'Handbook on Solar Radiation Data for India', in two parts. The Handbook is designed to meet the longstanding need of solar energy users in India for solar radiation and climatological data required for the design and efficient operation of solar energy collectors and storage systems. The project is financed by the Department of Science and Technology, Government of India and is carried out in collaboration with the India Meteorological Department. The first part containing observed data at 18 radiation stations in India was published in December 1980. The second part containing derived data for 145 stations is expected to be published in 1982.

## 7. VISITORS

## 7. Visitors

The Institute being a centre of research in Tropical Meteorology and other aspects of Atmospheric Science in the country is visited by a large number of scientists within the country and from abroad. Details in this regard are given below :

Sr. No.	Name of visitor and his organisation	Date of Visit
1.	Dr. (Mrs.) Amita Biswas, Officer, Department of Science and Technology (DST), New Delhi.	14 May 1980
2.	Shri P.V. Ramaiah, Chairman, Karnataka Electricity Board and Shri M. Moses, Secretary, P.W.D., accompanied by S/Shri B.G. Rudrappa and M.K. Ranga Rao, Superintending Engineers.	17 May 1980
3.	Dr. S. Nagarajan, Research Fellow, Department of Physics, Technische Hogeschool, Eindhoven, Netherlands.	19 May 1980
4.	Shri R.K. Dutta, Director, Office of the Director General of Meteorology, India Meteorological Department, New Delhi.	23 May 1980
5.	A batch of 9 students and a lecturer from the Department of Marine Sciences, University of Cochin, Cochin.	26 and 27 May 1980
6.	Dr. (Mrs.) Sulochana Gadgil, Assistant Professor, Department of Theoretical Studies, Indian Institute of Science, Bangalore.	29 May 1980
7.	Shri V.S. Patel, Agricultural Meteorologist, Directorate of Agriculture, Ahmedabad, accompanied by Shri M.J. Chaudhari, Agricultural Supervisor.	26 and 27 June 1980

Sr. No.	Name of visitor and his organisation	Date of visit
8.	Dr. V.V. Babu, Head, Pyrotechnic Section, Vikram Sarabhai Space Centre, Trivandrum.	30 June 1980
9.	Dr. Y. Ramanathan, Meteorologist, Grade I, India Meteorological Department and visiting Scientist, Florida State University, U.S.A.	29 August 1980
10.	Dr. A.S. Ramanathan, Deputy Director General of Meteorology (Hydrology), India Meteorological Department, New Delhi.	4 and 5 September 1980
11.	Prof. K. Gambo, Geophysical Institute, Faculty of Science, University of Tokyo, Japan.	9-12 September 1980
12.	Shri D. Basu, Secretary, Machhu Dam-2 Enquiry Commission accompanied by Shri B.R. Shaha, Counsel for the Enquiry Commission.	10 September 1980 and 2 March 1981
13.	Shri V.L. Kerhalkar, Deputy Chief Engineer, M.P. Electricity Board, Jabalpur.	11 September 1980
14.	Dr. R.L. Grossman, Deputy Director, International Monex Management (IMMC), New Delhi.	29 September - 3 October 1980
15.	Dr. Bryan Johns, Professor of Meteorology, University of Reading, U.K.	9 and 10 December 1980
16.	Dr. C. Ramaswamy, D.G.O. (Rtd.), New Delhi.	24 December 1980





Academic Council of the Institute  
meeting with Prof. B. Johns of the  
Deptt. of Meteorology, Reading University.



Prof. B. Johns of the Deptt. of  
Meteorology, Reading University,  
having discussions with the  
Institute's Scientists.

Sr. No.	Name of visitor and his organisation	Date of visit
17.	Dr. V.M. Shrestha, Reader, Department of Physics, Tribhuvan University, Nepal.	17 January 1981
18.	Dr. C.D. Walshaw, University of Oxford, U.K.	29 January-3 February 1981
19.	Capt. R.N. Dogra, Aviation Advisor to Govt. of Gujarat.	23 February 1981
20.	A batch of IAF trainee officers, Air Force Administrative College, Coimbatore.	9-12 March 1981
21.	Shri N.D. Vadnere, Executive Engineer, Water Resources Division, Aurangabad.	11 March 1981
22.	S/Shri B.B. Shinde, Superintending Engineer, Narmada Project, Bhopal; A.S. Tembe, Deputy Director, Ministry of Irrigation, New Delhi and S.G.V. Rao, Executive Engineer, Narmada Dam Design Circle, Vadodra (Gujarat).	28 March 1981



A Seminar in Progress.



Prof. Gambo, University of Tokyo, Japan  
giving a seminar.

## 8. GENERAL



## 8. General

### 8.1 Construction of Institute's buildings and staff quarters

The first phase construction of the Institute's buildings at Pashan, Pune was in progress. The building comprising the functional laboratories is expected to be ready in 1981-82.

The construction work of the 24 staff quarters and 8 transit type accommodation was commenced during the year.

### 8.2 Facilities

#### 8.2.1 Library, Information and Publication

##### A. Library

The Institute's library caters to the requirements of the Institute's scientists. A Library Committee consisting of scientists of the Institute and a Senior Officer of the Library Information and Publication Division assists the Director in finalising the list of books and journals for addition to the library; the suggestions for which are periodically received from the Institute's scientists. The library also renders service in arranging inter-library loans.

During the year, 182 books in meteorological and allied subjects were added and 61 journals of national and international repute were subscribed to.

##### B. Exhibition

On the occasion of the 19th meeting of the Governing Council held at Pune, an exhibition was arranged on 12 July 1980 depicting the various activities of the Institute.

## 0. Planning

The Five Year Plan (1980-85) as well as the annual plan (1981-82) were revised. Revised proposals for both these plans were sent to the Ministry of Tourism and Civil Aviation, Government of India.

### 8.2.2 Computer

The IBM 1620 computer worked during the year as follows :

	Hrs.	Mts.
Institute's Jobs	1152	10
Data Processing of I.Met.D.	434	00
Break down/Maintenance	152	20
Paying Users	104	05

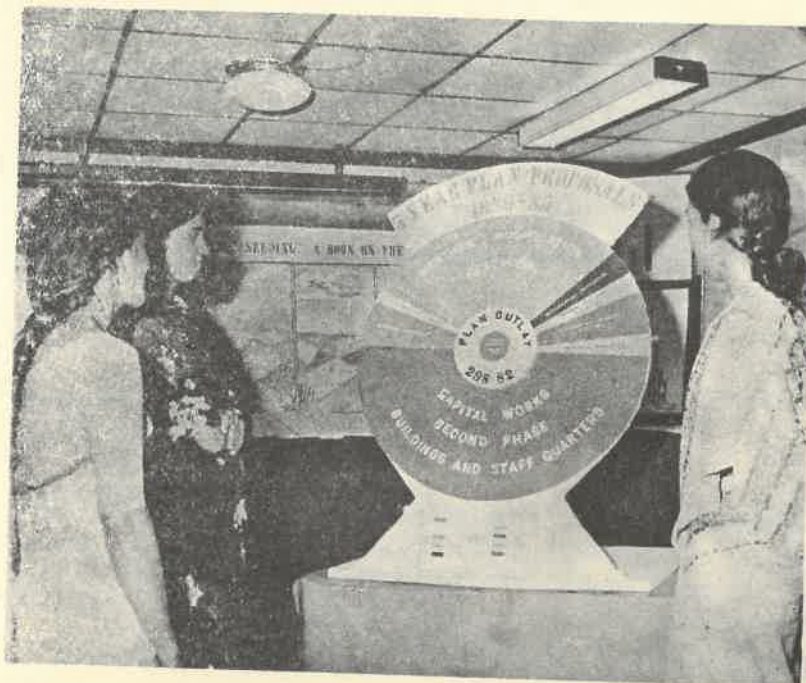
On special request from the DDGM (C and G), Pune, the radiation data were processed during August 1980 on the IBM 1620 computer on priority basis. The aerological data of India for Monex 79 was also processed by arranging the special runs on four holidays during November 1980.

Punching of Radar observations relating to the Monex level II-b data sent by IMMC, New Delhi, was commenced as a part of joint responsibility.

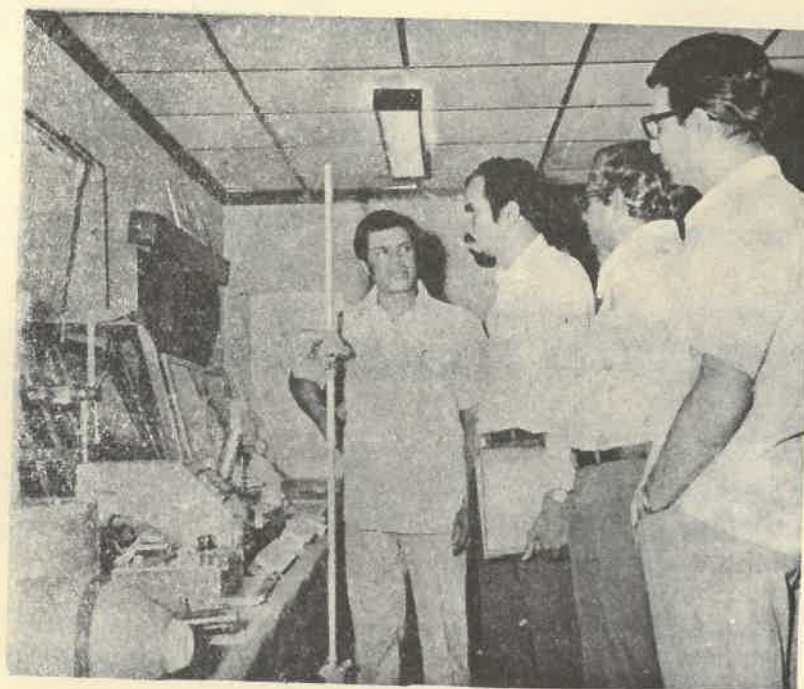
### 8.2.3 Workshop

A total of 32 jobs from different divisions/sections/units of the Institute were completed during this period. Among the major jobs which were completed include the fabrication of

The cup anemometers, accelerometer,  
particle charge measuring apparatus,



A view of the Institute's Exhibition.



Prof. R. Narasimha, Member of  
Governing Council going round  
the Exhibition.

different parts of the vertical wind tunnel, three dimensional traverse, drag-plate, frequency meter, thermal chamber and many parts of rocket payload.

Besides this, fabrication of several boxes, chassis and other small parts and repairs to many meteorological instruments were carried out.

### 8.3 Training

The following staff members were sponsored for undergoing the Intermediate/Advanced training in Meteorology conducted by the India Meteorological Department, Pune as shown below.

Sr. No.	T r a i n e e	Meteorological Training Course
1.	Shri P. N. Mahajan Senior Scientific Assistant.	Advanced
2.	Shri P. Seetharamayya Junior Scientific Officer.	Advanced
3.	Shri D. R. Talwalkar Senior Scientific Assistant.	Advanced
4.	Dr. P. C. Joshi Senior Scientific Officer, Grade II	Intermediate/ Advanced
5.	Dr. L. S. Hingane Senior Scientific Officer, Grade II	Intermediate/ Advanced
6.	Shri A. B. Sikdar Scientific Assistant	Intermediate



#### 8.4 Institute's Research Fellowship

Kumari K. Indira was awarded a Fellowship from 14 November 1980.

Shri S.A. Saseendran was awarded a Fellowship with effect from 15 November 1980.

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

#### 8.5 The Governing Council

The management of the Institute is vested in the Governing Council which consists of 9 members, including the Director of the Institute. A list of members is given in Appendix - I.

The 19th meeting of the Governing Council of the Institute was held at Pune on 12 July 1980.

The 20th meeting was held at India Meteorological Department, New Delhi on 25 October 1980.

The 21st one was held at Indian Institute of Science, Bangalore on 17 February 1981.

#### 8.6 Lectures

1. Shri K. Gambo, Professor of Meteorology, University of Tokyo, Japan delivered a lecture on 'Characteristics of ultralong waves' on 11 September 1980.

2. Dr. Bryan Johns, Professor of Meteorology, University of Reading, U.K. delivered two lectures on 'A comparative study of Numerical and Laboratory Simulation of turbulent flow over a wavy topography' and 'Numerical Simulation of surge generated by the 1977 Andhra cyclone' on 9 and 10 December 1980 respectively.

3. Dr. C.D. Walshaw, University of Oxford, U.K. delivered two lectures on 'Recent work at Oxford University in Meteorological Physics' and 'Satellite Meteorology - measurements of sea surface temperature, high cloud' on 31 January and 2 February 1981 respectively.

### 8.7 Institutional Seminars

The following seminars were arranged in the Institute during the year.

Speaker	Topic	Date
Dr. S.S. Singh SSO I.	Initialization and forecast in Indian monsoon region.	9 and 16 April 1980.
Shri S.K. Mishra SSO I.	Vertical propagation of planetary scale disturbances.	9 and 23 April 1980.
Dr. A.C. Mahanti SSO II.	Instability of meridional flow.	14 April 1980.
Dr. P.C. Joshi SSO II.	Short range weather forecasting by stochastic dynamic method.	11 and 25 April, 21 and 28 May 1980.
Dr. S.S. Singh SSO I.	Some aspects of initialisation of forecasting in Indian monsoon region.	9 and 16 May 1980.
Shri M.K. Tandon S.S.A.	Barotropic instability of an easterly zonal current.	29 May 1980.
Shri S.V. Singh SSO II.	Peristence of daily and 5-day monsoon rainfall.	4 July 1980.
Shri S. Sivaramakrishnan J.S.O.	Simulation of wind velocity profiles.	18 July 1980.

S p e a k e r	T o p i c	Date
Dr. A.C. Mahanti SSO II.	Stability of monsoon depression.	8 and 22 August 1980.
Smt. P.S. Salvekar J.S.O.	Energetics and vertical structure of baroclinic disturbances in the monsoonal zonal flow.	27 August 1980 and 24 September 1980.
Shri M.K. Tandon S.S.A.	Divergent barotropic instability of tropical easterly jet.	17 October 1980.
Dr. R. Anantha-krishnan Hon. Fellow	Ekman layer in the oceans and in the Atmosphere.	5 and 12 December 1980.
Shri S.N. Bava- dekar SSO II.	Dynamic effect of orography on the large scale motion of the atmosphere.	3 January 1981.
Shri D.R. Chakraborty S.S.A.	Analytic study on the horizontal motion of monsoon depressions.	13 February 1981.
Shri J.R. Kulkarni S.A.	Available potential energy and maintenance of general circulation.	6 March 1981.

## 8.8 Official Language Implementation

The quarterly meetings of the Official Language Implementation Committee of the Institute were held regularly.

The untrained staff was deputed for attending the Hindi classes/Hindi typewriting under Hindi Teaching Scheme.

Half yearly progress report for use of Hindi was sent to Controller of Defence Accounts (CDA) Southern Command, Pune 411 001.

On behalf of the Institute, Dr. D.A. Mooley, Assistant Director attended the meeting of Official Language Implementation Committee held on 24 November 1980 at the office of the Southern Command, Pune.

#### 8.9 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 Estima- tes	Approved Revised Estimates	Actual Exp.	Short- fall
Non-plan	50.40	52.40	50.57	1.83
Plan	10.00	10.00	8.85	1.15

The shortfall in expenditure was mainly due to (i) non-filling up of vacant posts and (ii) non-receipt of stores and equipment.

The Institute received from the Government of India 'Grant-in-aid' totalling Rs. 62.40 lakhs including the unspent balance of the previous year. Out of this, an amount of Rs. 59.42 lakhs approx. was spent during the year 1980-81.

Audit of the Institute's accounts for the year 1980-81 was being conducted by M/s Kirtane and Pandit, Chartered Accountants, Pune 411 030.



## 8.10 Family Welfare

The Institute observed the Family Welfare Fortnight (16-30 September 1980) by arranging a talk on 'Some aspects of Family Welfare' by Shri D.P. Kute, Health Education and Extension Officer, Health and Family Welfare Training Centre, Pune on 26-September 1980. On this occasion, a few documentary films high-lighting the importance of family planning were also shown to the employees of the Institute.

## 8.11 National Integration

The Institute observed the 'Quamy Ekta Week' (19-25 November 1980). On 25 November 1980, the employees of the Institute took solidarity pledge.

...

BHEGADE / 20.1.1982.

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

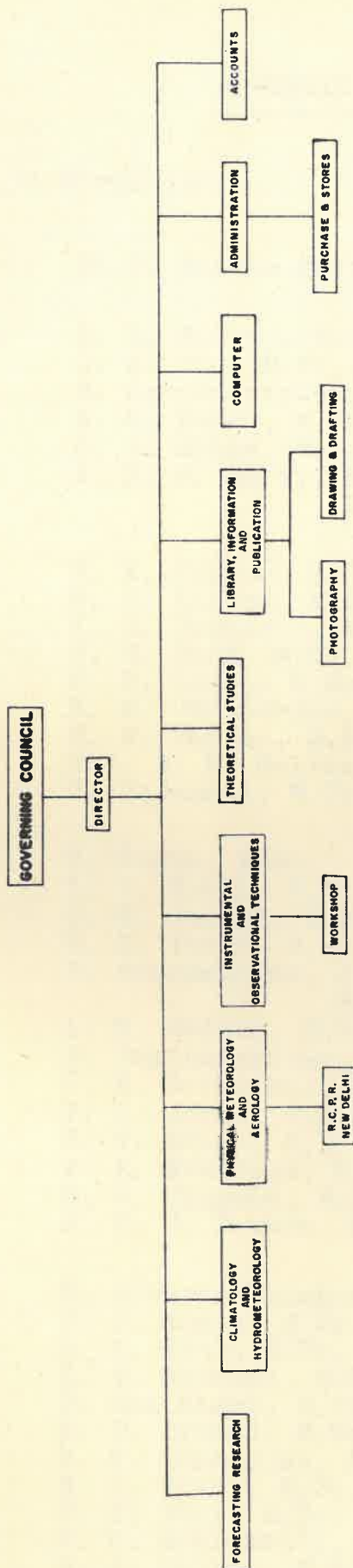
1. Dr. P. K. Das,  
Director General of Meteorology,  
Mausam Bhavan, Lodi Road,  
New Delhi 110 003. Chairman  
(Ex-Officio)
2. Shri C. M. Chaturvedi,  
Joint Secretary,  
Ministry of Tourism and  
Civil Aviation,  
Sardar Patel Bhavan,  
Parliament Street,  
New Delhi 110 001. Member
3. Shri S. K. Das,  
Additional Director General  
of Meteorology, Mausam Bhavan,  
Lodi Road, New Delhi 110 003. Member
4. Shri B. Mason,  
Deputy Secretary (Finance)  
Ministry of Tourism and  
Civil Aviation,  
Sardar Patel Bhavan,  
Parliament Street,  
New Delhi 110 001. Member
5. Prof. P. Koteswaram,  
Retd. Director General of  
Observatories and Honorary  
Professor, Department of  
Meteorology and Oceanography,  
Andhra University,  
8-1-11, Lawson Bay Road,  
Waltair Uplands,  
Visakapatnam 530 003 (A.P.) Member

6. Prof. R. Narasimha, Member  
Department of Aeronautical  
Engineering,  
Indian Institute of Science,  
Bangalore 560 012.
7. Prof. M. P. Singh, Member  
Head,  
Centre for Atmospheric Sciences,  
Indian Institute of Technology,  
Hauz Khas, New Delhi 110 029.
8. Prof. Yash Pal, Member (upto  
Director, 11 December  
Space Applications Centre, 1980)  
Ahmedabad 380 053.
9. Dr. Bh. V. Ramana Murty, Member  
Director,  
Indian Institute of Tropical  
Meteorology, Ramdurg House,  
University Road,  
Pune 411 005.
10. Shri D. W. Kshirsagar, Non-Member  
Administrative Officer, Secretary  
Indian Institute of Tropical  
Meteorology,  
Pune 411 005.

MINISTRY OF TOURISM & CIVIL AVIATION, GOVERNMENT OF INDIA  
INDIAN INSTITUTE OF TROPICAL METEOROLOGY

APPENDIX - II

ORGANISATIONAL PROFILE





## Officers as on 31 March 1981

Director	:	Bh.V. Ramana Murty, M.Sc., Ph.D.
Assistant Directors	:	D. A. Mooley, M.Sc., Ph.D. O. N. Dhar, M.Sc., Ph.D. R. Suryanarayana, M.Sc. A. K. Kamra, M.Sc., Ph.D. D. R. Sikka, M.Sc. A. S. R. Murty, M.Sc. (Tech), Ph.D.
Senior Scientific Officers, Grade I	:	R. K. Kapoor, M.A. (Maths) S. K. Mishra, M.Sc. K. G. Vernekar, M.Sc. G. B. Pant, M.Sc., Ph.D. S. S. Singh, M.Sc., Ph.D. R. N. Chatterjee, M.Sc. (Tech) H. N. Bhalme, M.Sc. Smt. A. M. Selvam, M.Sc., Ph.D. S. Rajamani, M.Sc., Ph.D.
Senior Scientific Officers, Grade II	:	S. Sinha, M.Sc. S. V. Singh, M.Sc. P. N. Sharma, M.A., Grad. I.T.E. 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. S. T. Awade, M.Sc., Ph.D. P. R. Rakhecha, M.Sc. L. S. Hingane, M.Sc., Ph.D. P. C. S. Devara, M.Sc., Ph.D.
Junior Scientific Officers	:	S. Sivaramakrishnan, M.Sc. P. P. Kamte, M.Sc. D. K. Paul, 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. A. G. Pillai, M.Sc. G. K. Manohar, M.Sc. Smt. U. V. Bhide, B.Sc.

Junior Scientific Officers	:	A. K. Kulkarni, M.Sc. C. M. Mohile, M.Sc. Smt. P. S. Salvekar, M.Sc. S. P. Ray, M.Sc., Ph.D. R. Vijaykumar, M.Sc. B. N. Mandal, B.Sc. P. Seetharamayya, M.Sc. N. C. Mandal, 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	:	Smt. 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.
Purchase and Stores Officer	:	M. D. Kesavan, M.A., D.B.M.