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INDIAN INSTITUTE OF TROPICAL METEOROLOGY

Annual Report

1981-82

Ramdurg House, University Road,
Pune 411 005
India

C O N T E N T S

Introduction

The second decade of autonomous status of the Institute commenced with this year. Two of our Scientists, Shri S.K.Mishra and Smt. P.S. Salvekar, won the 'W.M.O. award for encouraging young Scientists', for the year 1981, for their paper entitled, 'Role of baroclinic instability in the development of monsoon disturbances'.

The Institute organized a symposium on 'Environmental Physics and Atmospheric Boundary Layer' during 24 to 26 November 1981. The symposium on this theme, which was the first of its kind in India, focussed the attention of scientists on the importance of the inter-disciplinary areas of research in this field.

During the year under review, an amount of Rs.27.00 lakhs was allocated by the Government of India for pursuing the plan projects approved for the 6th Five Year Plan (1980-85). The amount allocated under the project, 'Construction of buildings and staff quarters for the Institute', was fully utilised. The first phase of construction of the Institute's new building at Pashan, Pune was completed and its possession was taken over. Action was initiated to shift some of the functional laboratories of the Institute to the new building.

The cloud seeding experiment undertaken by the Institute in the Sirur and Baramati regions of the Maharashtra State entered its 6th year. At the request of the Karnataka Government, three of our scientists were deputed to Bangalore to assist in their cloud seeding operations in the Chitradurga and Bangalore districts.

The Field Research Unit of this Institute at Bangalore successfully completed the project, 'Preparation and Publication of a Hand Book of Solar Radiation Data for India'. The unit published their results in two volumes.

During the year under review, the Institute welcomed a number of scientists from abroad. Special mention may be made of Dr. Tcheremissive Felex, Sr. Scientist, USSR academy of Science, Prof. Jaya Srivastava, Colorado State University, Prof. Mike Douglas, Florida State University, Prof. Ronald B. Smith, Yale University and Prof. T. Nitta, University of Tokyo. Prof. Nitta worked in the Institute as a visiting scientist under the programme of exchange of scientists between the Indian National Science Academy, New Delhi and the Japan Society for the Promotion of Science, Tokyo.

The Institute's scientists participated in various national and international symposia. Specific mention may be made of the following :

i) 2nd World Instrumentation Symposium and International Trade Exposition, Bombay, ii) International Conference on 'Scientific Results of Monsoon Experiment', Bali, Indonesia, iii) WMO Symposium on 'Meteorological Aspects of Tropical 'Droughts', New Delhi, iv) IAMAP Symposium on 'Dynamics of the General Circulation of the Atmosphere', Reading, U.K.

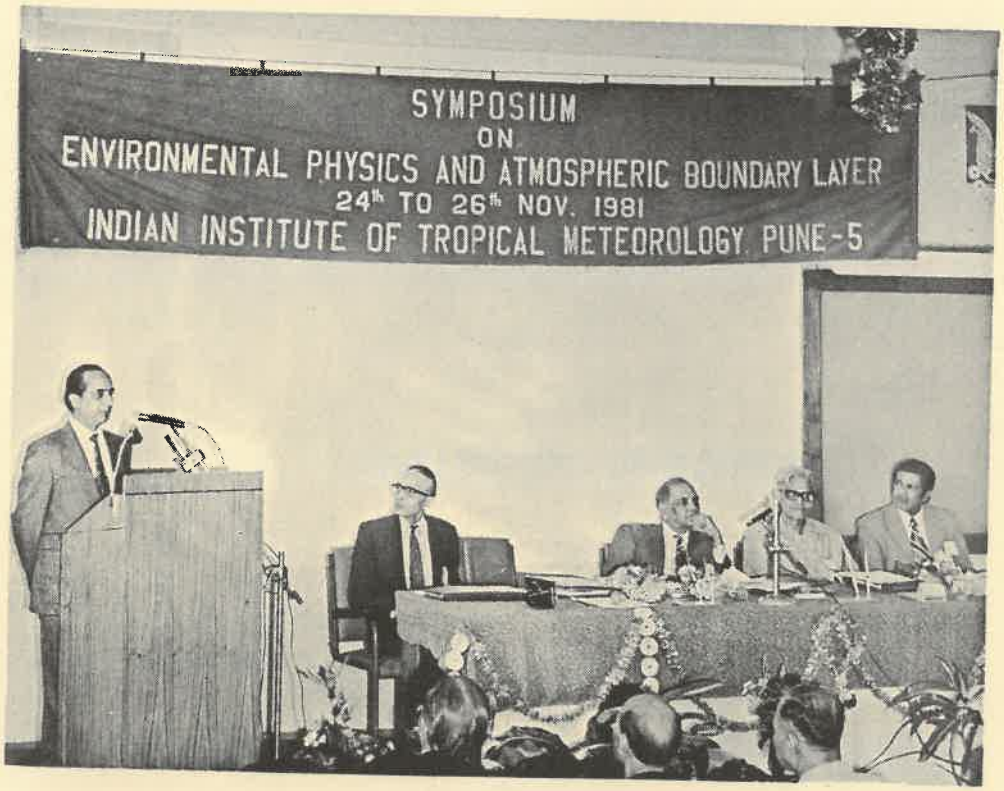
Under the UNDP Fellowship Programme, four scientists of the Institute underwent training at i) Florida State University, Tallahassee, U.S.A., ii) Colorado State University, Fort Collins, U.S.A., iii) European Centre for Medium Range Weather Forecasts, Reading, U.K., iv) NOAA's facilities in U.S.A., v) Lamount - Doherty Geological Observatory, Columbia University, New York and ivi) Tree-ring Research Laboratory, University of Arizona.

The Institutes' collabration with Universities and Research Organizations continued to make progress.

The detailed activities of the Institute, carried out during the year 1981-82, are given in the succeeding chapters of the report.

Pune
October 1982

Bh. V. Ramana Murty
Director



Opening ceremony of the symposium

2. RESEARCH AND DEVELOPMENT

2. Research and Development

The details of research work carried out in the Scientific Divisions under various research projects 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) dynamic weather prediction models for the tropics

The five level primitive equation (P.E.) model was integrated for forecasting the fields and movement of a monsoon depression of 4 August 1968 after obtaining the initial balance through dynamic initialisation. The 24 hour forecast fields and movement of the depression were found reasonably good.

Arakawa's scheme of cumulus parameterisation was followed to compute the cloud mass flux distribution parameters, fractional rate of entrainment, total cloud mass flux etc. for the period 2-4 July 1979. The results were found to be comparable with those of other workers.

The radiative cooling rates due to the presence of water vapour in the atmosphere were computed, based on the data for four radiosonde stations over India. The computed cooling rates were found to be of proper magnitude.

The three level P.E. model, with surface friction and diffusion of momentum and temperature terms included in the model equations, was integrated for 5 days using idealised wind (u = 10 m.p.s.) and low orographic barrier with maximum height 1 km at the centre of the barrier (Hm = 1 km) and for 36 hours with higher orographic barrier (Hm = 2 km). The integration showed proper development of the flow forced by the orography.

A computer program was developed for the solution of the linear steady state vorticity equation with the forcing, due to terrain height, at different grid points along the latitude circle. It was tested for zonal flow and topography along 20°N.

The effects of smooth topography were included in the P.E. barotropic model. The results suggested that the inclusion of topography enhances the westward movement of cyclonic circulation.

The effects of random error in the observations and analysis of wind and height fields on the kinetic energy budget were investigated. Although the random errors modified the individual terms considerably, the basic inferences in respect of source and sink terms remained unaltered. The effects of divergent wind on the kinetic energy budget were also investigated. The results suggested that the neglect of divergent component might lead to sizable errors in the budget estimates.

2.1.1.2 Objective analysis of Meteorological Fields for NWP models.

Structure and auto-correlation functions of the wind, temperature and geopotential height fields at 850 mb level were computed for the month of July over the Indian and Chinese regions separately in connection with the development of multivariate optimum interpolation method of objective analysis.

To evaluate the impact of the special observational data, collected during Monex-79 by research aircraft, ships and satellite, on the objective analysis of wind field, one more experiment was carried out by using normal wind field for the month of July as the initial guess field, instead of the wind field of the previous day. No major changes in the analyses were obtained by using either the climatology or the persistence of wind field as initial guess, provided the data coverage was fairly good. This study also confirmed the earlier inferences that the addition of Monex-79 data improved the quality of the analysis. The improvement was more in the data void regions and the performance of the data from aircraft and ships was better than that from satellite.

2.1.2 Extended Range Prediction

2.1.2.1 Development of statistical-dynamical techniques for prediction of monsoon rainfall for periods exceeding three days.

Empirical Orthogonal Functions (E.O.F.) were determined for daily, 5-day and 30-day mean sea level

pressure anomalies, 700 mb contour heights and rainfall over India during the summer monsoon. First few EOFs explained about 90% variance of the pressure fields. The EOFs of daily and monthly pressure fields were found to have significant correlation with the concurrent rainfall of the meteorological subdivisions in the western and central India. The first 3 EOFs of daily mean sea level and 700 mb level fields showed quasi-periodicity of 4-7 days and the EOF of monthly 700 mb fields showed quasi-periodicity of about 3 years. An experiment was conducted to predict monthly contour heights over India one month ahead by development of regression equations from the EOF of the past month. The root mean square error of these predictions was found to be less than 10 g.p.m.

In order to determine a proper statistical model for the occurrence of rainfall events, Geometric models based on Markov chains of the orders of 3, 2 and 1 were fitted to the runs of wet and dry days during July and August at 13 stations using data of 73 years. Maximum likelihood ratio approach was also used to establish the order of dependence. Both the approaches suggested a third order dependence. A simple Markov chain model developed earlier for prediction of 5-day monsoon rainfall of Konkan region was extended for different thresholds of rainfall.

Auto-Regressive (A.R.) models of order 1 to 5 and autoregressive moving average model of order (1, 1) were fitted to daily subdivisional monsoon rainfall. The residual variances from these models suggested that A.R.(1) is an adequate fit to the rainfall data. Hence, this model was used to obtain the frequency and duration of monsoon rainfall in 24 hours for five meteorological subdivisions representing different climatic regimes. The model generated satisfactorily the probabilities of exceeding different threshold values of rainfall over spells of various lengths.

2.1.2.2 Synoptic Climatological Studies

a) The outlook for the country was given as 'Near-Normal', based on the results of studies carried out under the project, showing relationship of upper tropospheric anomalies of the month of May with the monsoon seasonal rainfall. The actual rainfall activity was also near-normal (Departure -3.0 per cent).

b) During the visit of one of the scientists of the project under the UNDP Fellowship to the European centre for Medium Range Weather Forecasting (ECMWF), the ECMWF Global Spectral Model was utilised to study the inter-annual variability of the model-generated temperature and flow fields at 850 mb and 200 mb levels over the Asiatic region during May to August. An experiment was conducted to simulate the summer monsoon flow starting with real data.

c) The scientist, during his assignment at the National Meteorological Centre, NOAA, Washington D.C., studied the satellite derived mean monthly data of outgoing long wave radiation (OLR) for 6 years over the Indian region. Inter-annual variability of OLR was found to be related to the performance of the large-scale monsoon rainfall.

2.1.3 Monex Studies

a) Study of the large scale fluctuation and characteristics of near equatorial ITCZ over the north Indian Ocean and the adjacent west Pacific Ocean during different phases of summer monsoon of 1979 was carried out utilising the data obtained through Monex-79. The study suggested that during the onset phase of the summer monsoon, the ITCZ in the north Indian Ocean activated first and this was followed after about a week by the activisation of the ITCZ in the western Pacific Ocean. In the established phase of the monsoon, the western Pacific ITCZ weakened first in the second week of July 1979 and followed (by about a week) by the weakening of the monsoon over the Indian region. The revival of the ITCZ activity over both the regions was almost simultaneous.

b) A pilot study was conducted to understand the outbreak of large scale severe convection over the eastern India during the pre-summer monsoon season. Data were collected in respect of the strength of low level wind, temperature and moisture at 850 mb. No clear-cut stratification of any of these parameters with respect to major outbreak of the severe thunderstorm activity could be obtained through this study.

c) Radiosonde data collected by the USSR research ships during Monex-79 were used to study the kinematic and thermal structure over the south-east

Arabian sea for 2-14 June 1979. These computations were being used for estimating the budgets of moisture and heat.

d) A study was made to identify the energy characteristics of small scale waves during different phases of the Indian summer monsoon, using the MONEX research ship data and utilising a 2-D filter. It was found that the percentage of total kinetic energy, which is concentrated in scales of 760 km and less, varies from a minimum of 15% at the pre-onset phase to a maximum of 40% during the established phase.

e) Monthly mean geopotential height data at 700 and 300 mb over the northern hemisphere for the months April through August 1979 were collected which were subjected to Harmonic and Fourier analyses. Meridional transport of momentum and sensible heat in the wave number domain were computed. The computations were being examined with a view to having a better understanding of the planetary scale processes which were associated with the failure of monsoon rains over India during the monsoon season of 1979.

The grid point data of winds from tape were picked up for the year 1979 at the levels 700 mb and 300 mb between latitudes 47°S and 47°N for the months April through August. The transport of momentum and sensible heat, wave to wave and wave to zonal interactions were being computed.

f) Spherical harmonic and fourier analyses were done for the monthly mean geopotential height data at 50 mb and 30 mb levels for all months from 1972 to 1979. The meridional transport of momentum and of sensible heat in wave number domain were computed.

g) The mechanism for the onset of monsoon over southern India was examined with respect to large scale events in the northern and southern hemispheric subtropics. It was shown that the onset is triggered by the intensification of the cross equatorial flow after the passage of intense baroclinic disturbances across the Mozambique channel. However, before the occurrence of this event, the large scale circulation features in the troposphere in the northern hemispheric subtropical region become favourable for the onset of monsoon.

h) Interhemispheric daily synoptic maps for the months May to October were examined for eight years to study the cross hemispheric influences on the onset of summer monsoon over India as well as on the formation of monsoon depressions. The analyses showed that the mid-latitude baroclinic disturbances passing across the Cape of Good Hope and Mozambique channel modulate the low level cross-equatorial flow which, under favourable conditions, leads to the intensification of ITCZ.

i) Radiometer sonde data over India and neighbourhood were analysed for various phases of the monsoon activity over India. The study showed large differences in the outgoing infra-red radiation particularly over the central parts of the country. The differential heating between the active monsoon region characterised by multi-layered clouds and the cloud-free region was linked with the activity of the monsoon.

j) Abnormally prolonged monsoon 'break' which commenced towards the middle of August 1979 and from which the monsoon system over the western and central India did not fully recover before the withdrawal phase had begun, was studied. Abnormal features of the large scale circulation over i) the western pacific, ii) the subtropical region to the north of India and iii) the subtropical parts of the western Indian ocean in the southern hemisphere were associated with the persistent break.

k) Dropsonde winds as well as radiosonde data by research vessels which operated over the Arabian sea during ISMEX-73, Monsoon-77 and Monex-79 were utilised to study the structure and modulation of the boundary layer over the Arabian sea, under different convective categories. The study showed that the monsoon boundary layer over the Arabian sea is more moist under all convective categories than the trade winds' boundary layer over the Atlantic and the Pacific Oceans. The modulations of the boundary layer from stable to convective category typically occur on the synoptic scale during the growth of a disturbance. Besides, on a typical day in the summer monsoon season, the boundary layer over the Arabian sea shows large scale variations in the horizontal space. These variations were brought about by several processes such as sensible heat transfer, influences within the cloud layer and synoptic scale disturbances.

l) Data on the measurement of radon concentrations, collected during different phases of the Monex-79, were studied in collaboration with two scientists of the Tata Institute of Fundamental Research (TIFR). The study showed that major fluctuations in the Radon concentrations were indicative of the changes in the large scale horizontal/convective processes occurring over the Arabian sea and the Bay of Bengal.

m) Based on the photographs snapped by the geostationary satellite which operated over the Indian ocean region during Monex-79, the low level winds derived from the cloud motion vectors were compared with the wind observations of research ships at different levels in the lower troposphere. It was found that the best correlation between the two sets of data for both wind speed and direction could be obtained at 900 mb, which is close to the cloud base. This study indicated that the winds derived from the Indian National Satellites (INSAT) observations would be of potential use for monitoring the large scale fluctuations of the low level monsoon over the Indian ocean.

2.2 Forecasting Research II

2.2.1 Short Range Prediction

The Geopotential height at 200 mb level around the 40°N latitude interpolated at 5° interval for five years (1975-79) were subjected to Harmonic and Spectral analyses to examine whether there was any change in the large scale circulation over the mid-latitudes at the time of onset of monsoon over India. The analysis did not show any consistent relationship between the circulation at the upper troposphere over mid-latitudes and the monsoon onset. However, the mean height of this level at this latitude showed some relationship with the overall performance of the monsoon in the respective years.

The growth characteristics of the tropical cyclones in the Arabian sea and the Bay of Bengal were examined in terms of T numbers (Tropical Cyclone Intensity Index). The growth rates were seen to be similar to those observed in the North Pacific. Nearly 70 % of the cyclones

grow with average growth rate of one T-number per day. The rapid (1.5 T/d) and the slow (0.5 T/d) rates of growth occur approximately 20 % and 10 % of the time respectively. The intensification was found to have stopped during the looping period of a looping cyclone.

To understand the large scale processes and energy conversions associated with the evolution of the monsoon depressions, the zonal and eddy available potential energy, zonal and eddy kinetic energy and their conversions were computed utilising the data for the period 1-10 July 1973 (Part of ISMEX-73) over the Arabian sea region extending from 2°N to 40°N and 50°E to 110°E. During the period of the study, two monsoon depressions (one each in the Bay of Bengal and the Arabian sea) had developed. The main findings were i) Available potential energy increased during the formation and intensification of disturbances, ii) Both zonal and eddy energy increased during intensification of disturbances which suggested that when the monsoon depression was intensified, the over-all monsoon circulation for the region also got strengthened, iii) During the active stage of the depressions, the northward transport of momentum in the entire troposphere and the southward transport of heat in the lower troposphere increased.

2.3 Climatology and Hydrometeorology

2.3.1 Climate and Climatic Change

2.3.1.1 Studies of large scale droughts over India

a) Southern oscillation and large-scale droughts

Relationship between the Southern Oscillation (S.O.) and the country's area under drought/flood was examined with a view to gaining an insight into the possible role of S.O. as a causative factor for the large scale droughts/floods over India during summer monsoon. For this, a pressure index, based on the pressure anomalies at Djakarta, Bombay, Santiago and Perth during April, was used as a measure of the Southern Oscillation. The results showed that the influence of the S.O. might be an important climatic feature for introducing the most common period from 3 to 6 years for the recurrence of large scale droughts over India.

b) Impact of large scale droughts on the Indian economy

Years of large-scale drought over India were identified. The available rainfall series of India of 108 years (1871-1978) was arranged in ascending order. The years comprising the first decile were considered to be the large-scale drought years of the country. During these years, the area of the country, having deficient rainfall, varied from 36 to 75 percent. The effect of drought on the production as well as the prices of food grains, rice and wheat in particular, was assessed by computing the percentage change in the production and in the prices of the grains in the drought-year from the preceding non-drought year. The study brought out that the mean percentage drop in the production of food-grains, rice and wheat, resulting from the large-scale droughts was 16, 11 and 12 percent respectively. In an individual drought year, the drop may reach 30-35 percent. The mean-percentage rise in prices resulting from a large-scale drought year was 26, 26 and 21 percent for food-grains, rice and wheat respectively. In an individual drought-year, the price rise may reach 50-65 percent. The average loss to the country due to the fall in production of food-grains was found to be about 25 percent of the Annual Budget of India.

2.3.1.2 Vagaries of the Indian Summer Monsoon

a) Relationship between index of dryness/wetness over India and some measure of tropical circulation

In a large country like India, some parts experience dry conditions during the summer monsoon season every year, while at the same time some parts experience wet conditions. Utilising the objectively defined Indices of Dryness and Wetness over India, the series of these two indices were obtained for the period 1871-1978. The objective criteria for defining these indices take into account the mean and standard deviation of seasonal rainfall, both varying from one portion of India to another. The series were found to be homogeneous, random, highly variable and positively skewed. Relationships, concurrent as well as lag, between these series and circulation features, like Wright's Southern Oscillation Index for different seasons, Index of

Walker Circulation based on the pressure anomalies at Darwin and Apia for April, July and October and sea surface temperature anomaly in eastern equatorial Pacific ocean were examined.

In addition, utilising objective criterion for years of large-scale dryness/wetness over India, such years were identified under the two categories viz. dry and wet. The mean values of these pressure indices and of sea surface temperature anomaly were obtained for these two categories of the years. These mean values showed good contrast.

b) Incidence of drought/flood over India and its subdivisions during the summer monsoon

Utilising criteria for drought/flood based on standard deviate of seasonal rainfall, the incidence of drought over India as a whole and over its subdivisions was examined. The years of drought for the period 1871-1980 were identified. The monsoon depressions forming in the Bay and the land area east of 80°E, were examined for each of the drought/flood years in respect of frequency, direction of movement, extent of westward penetration, number of depression days and dissipation of depressions. Also, the total period during July and August when the trough was over the foot-Himalayas (break monsoon), was studied.

2.3.1.3 Studies in Palaeo-climatology

Samples of sections from selected species of old living trees from two climatologically different regions of the country were analysed. Attempt was made to understand their dendroclimatic potential and the relationship between the annual tree growth and local climatological variables.

Computer models based on the tree-ring data and current tree growth/climate relationship were used for the reconstruction of regional climate of Thane and Nainital regions. Study of Teak trees indicated that the annual rings were identifiable and the ring-width was influenced by the length of the monsoon season. As for Chir, the years of severe droughts in the region, were well reflected by the significantly low values of tree-ring indices.

Because of the complexity of growth in tropical regions, a high correlation between the tree-ring series and a single climatological variable was not expected. However, the use of 24 variables of monthly mean rainfall and temperature values for the year of growth and the year prior to growth, in the response function analysis, brings out the importance of these variables in order of their significance in the tree growth.

2.3.1.4 Storm risks to ports on coast around the Bay of Bengal

The annual series of cyclonic storms affecting 10 selected ports on the coast around the Bay was examined. The series for Chittagong showed a highly significant increase in the annual mean frequency from the period 1877-1964 to the period 1965-80. Poisson probability model was a good fit to the number of storms affecting the ports in a year as well as to the number of storms affecting the port severely in a five-year period. This model was used to evaluate the risks in terms of probabilities of 1, 2, 3 etc. for the storms affecting each of the ports in a year and also in respect of those severely affecting the ports in a five-year period.

2.3.2 Hydrometeorological Studies

2.3.2.1 Basin rainfall studies for the development of water resources

a) Probable Maximum Precipitation (PMP) Studies

A generalised 1-day probable maximum precipitation (PMP) chart for the peninsular region of India (lat. 8°N to 20°N) was prepared by using the latest statistical model. The long period rainfall data of about 800 stations were analysed in this connection. The study showed that the stations along the east coast of the peninsula and over and near the western ghats can experience one-day highest rainfall of the order of 50 to 85 cm, while for those located in the central parts of the peninsula the value varies from 30 to 40 cm.

Long period 1-day maximum rainfall data for about 100 stations in and around Uttarakhand Himalayan region were analysed to estimate and prepare the generalised charts of 10 and 100-years maximum rainfall and probable maximum rainfall (PMP) for one-day duration. In this region, 10-year and 100-year rainfall values were found to vary from 10 to 30 cm and 20 to 45 cm respectively, whereas the PMP estimates ranged from 50 to 85 cm.

One-day maximum rainfall for different return periods ranging from 2 to 100 years were estimated for about 232 stations in Tamil Nadu. A nomogram was prepared for estimating maximum rainfall of intermediate return periods from 5 to 50 years for any station in this region. One-day probable maximum rainfall values for stations in this region were also estimated which were found to vary from 25 to 75 cm.

b) Studies on fluctuations in rainfall series

Annual rainfall data of six heavy rainfall stations viz. Bhagamandala, Gaganbavada, Matheran, Mahabaleshwar, Neriamangalam and Peermade, in the western ghats were analysed for long-term trends. Mahabaleshwar and Neriamangalam stations showed a decreasing trend in rainfall with a linear trend of 14.4 and 67.6 mm per year respectively. Spectral analysis showed peaks at frequencies corresponding to the time periods of 2.3 to 8.8 years. The cycles of 11, 45 and 22 years were also observed in respect of these stations.

The north-east monsoon (October-December) rainfall data of Tamil Nadu were analysed. The analysis showed no long-term trends either in the individual months or for the season as a whole. The spectral analysis revealed the existence of two distinct peaks in the region around i) 2 to 2.4 and ii) 3.6 to 4.4 years.

c) Relationship between south-west and north-east monsoons over Tamil Nadu

The correlation analysis between the south-west and the north-east monsoon rainfall distribution over Tamil Nadu for the 100-year period (1877 to 1976) showed that the south-west monsoon (June-September) rainfall is

negatively correlated with the north-east monsoon (October-December). A χ^2-test of dependence further indicated that the rainfall in the two monsoons are not independent of each other. This negative relationship can be used in foreshadowing the north-east monsoon rainfall over Tamil Nadu.

d) Rainfall distribution over India during monsoon months in the absence of depressions and cyclonic storms

The rainfall distribution over India was studied for those individual monsoon months of June to September which did not experience tropical disturbances during the 80 years' period from 1891. The study showed that the absence of these disturbances in the individual monsoon months coupled with certain other meteorological situations can cause considerably deficient rainfall and consequently slight to severe drought conditions over the country. Of the 4 monsoon months, the month of September gets worst affected by the absence of these disturbances so far as rainfall deficiency is concerned.

e) Analysis of severe rainstorms over different parts of the country

The rainstorm of 2 July 1941 over south Gujarat-north Konkan region was found to give the highest one-day areal rain depths for different sizes of areas in this country. A comparison with similar areal raindepths of tropical rainstorms of USA revealed that the areal raindepths of the July 1941 rainstorm were higher in magnitude for practically all the standard areas.

Severemost rainstorm of 1980 monsoon season :

A detailed analysis of rainstorms during the monsoon season of 1980 showed that there were only 4 severemost rainstorms which affected different parts of the country. A comparison with the past severemost rainstorms of the respective regions showed that though the flood damage caused by these 4 rainstorms of 1980 was considerably higher, none of them was of unprecedented nature.

July 1927 rainstorm over Gujarat :

The Depth-Area-Duration (DAD) analysis of 24-29 July 1927 rainstorm which caused severe floods over Gujarat region was found to give the highest areal raindepths in this country for a duration of 3 days and more. A comparison of areal raindepths of this rainstorm with similar raindepths of severemost rainstorms of the tropical USA for 3-day duration showed that the raindepths of July 1927 rainstorm were higher than those of the tropical U.S.A.

July 1981 rainstorm over Rajasthan :

The rainstorm of 17-21 July 1981 which caused unprecedented floods in Rajasthan was studied. Areal raindepths of this rainstorm when compared with the past severemost rainstorms of this region showed that the July 1981 rainstorm gave unprecedented raindepths upto 38,850 sq. km (15,000 sq. miles). It was also observed that 7 stations in the rainstorm area broke their 80-year record of 1-day rainfall and 2 of these stations equalled their respective estimates of PMP for one-day.

2.4 Physical Meteorology and Aerology

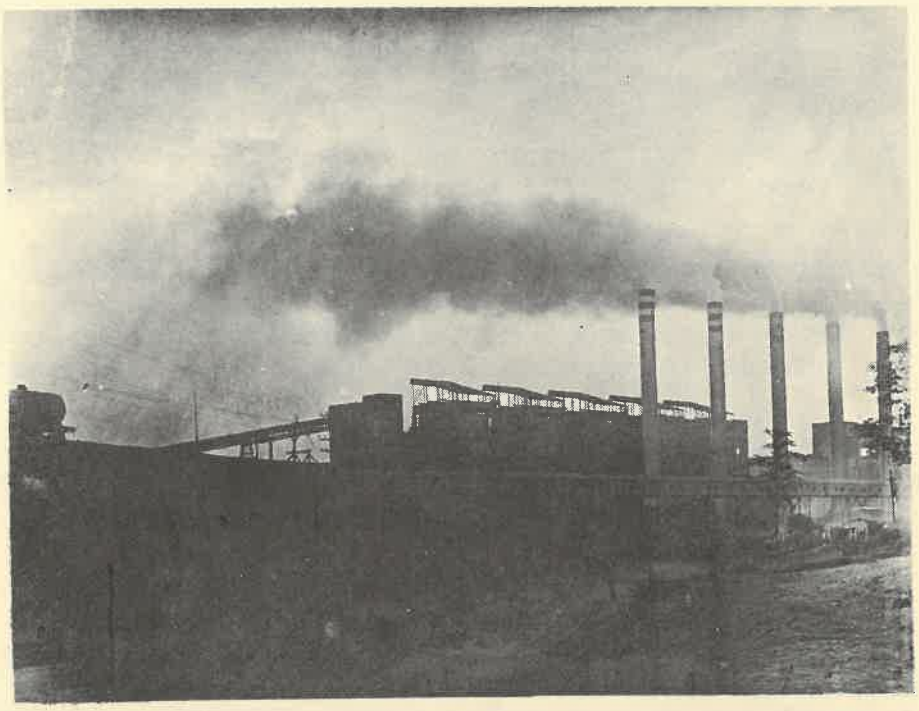
2.4.1 Cloud Physics and Weather Modification

2.4.1.1 Studies in atmospheric electricity

A field programme to study the electrical characteristics of the environment of Satpura Thermal Power Station at Sarni, Madhya Pradesh was undertaken during 27 July - 5 August 1981. The main objective of the programme was to investigate the reasons for the high frequency of lightning observed in the area and to suggest remedial measures for the frequent failure of lightning arresters installed at the Power Station.

Preliminary analysis of three days' observations on electrical parameters made during the experiment suggested the following :

i) The electric field and point discharge current were negative throughout the day. The electric



Plume from chimneys of the Power Station, Sarni under normal atmospheric conditions

Equipment in use for sampling atmospheric particulate and gaseous pollutants

field was in the range-1500 to -4000 VM^{-1}.

ii) The point discharge current was maximum during 0830 - 1630 hrs. and minimum during 1730 - 0130 hrs.

iii) The fatigue caused by the surge currents passing through the lightning arresters due to very high fields present even during non-thunderstorm conditions might be one of the causes for the failure of lightning arresters.

Efforts were being made to identify the causes for the observed negative high fields during normal conditions.

2.4.1.2 Radar study of rain and rain-bearing clouds

Mock cloud seeding experiment was carried out using the radar observations made at Delhi during 13 monsoon months (1967-73, 1975-79, 1981). The result was found to be positive (11 percent) which is not statistically significant.

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

a) The cloud seeding experiment in the Baramati and Sirur regions of Maharashtra state for the monsoon season-1981 commenced on 4 July and ended on 10 September. Experiment was conducted on 17 pairs of days using about 76 hours of aircraft flying time. Cloud microphysical observations were carried out during the experiment.

b) The results of the cloud seeding experiments conducted in the Pune region during the summer monsoon seasons of 1973, '74, '76, '79, '80 and '81 were evaluated. The results suggested that the rainfall on seeded days increased by about 6 percent which is not statistically significant.

c) At the request of the Government of Karnataka, technical assistance was provided to that Government for undertaking cloud seeding operations in the Chitradurga and Bangalore districts.

d) Cloud electrical and microphysical responses to salt seeding were studied using the aircraft observations made in seeded and not-seeded cloud cases in the Bombay region during the summer monsoon season of 1979. Increases in cloud liquid water content up to 113 percent and corona discharge current up to 400 percent were noticed in seeded clouds. But no such marked increases were observed in not-seeded clouds. The in-cloud temperatures were increased by 1.2 Celsius following seeding in all the four seeded clouds and decreased by 1.4 Celsius in three such clouds out of the four not-seeded ones and in the fourth cloud, it increased by 0.1 Celsius. The cloud droplet spectra broadened following seeding, with increases up to 250 percent in mean volume diameter, but no such increases were found in not-seeded clouds.

e) High resolution temperature data and cloud liquid water content data were obtained in seeded and not-seeded clouds. There was a net-energy gain in the longer wave-lengths ($>$ 540 m) and net-energy loss in the shorter wave-lengths ($<$ 540 m) of the temperature spectra of the seeded clouds. The net-energy gain in the longer wave-lengths following massive salt seeding could be due to the condensation of water vapour on the salt particles. The net-energy loss in the shorter wave-lengths could be due to the decrease in the small scale turbulence resulting from the invigoration of updraft.

f) Urban effects on atmospheric electric fields and selected meteorological parameters were investigated using the surface data recorded at Bombay for the periods 1936-40 and 1962-66. The study suggested the following :

i) The seasonal mean values of all the parameters except wind speed, showed increases during the latter period (1962-66),

ii) The increases noticed in the atmospheric electric field during winter, pre-monsoon and post-monsoon seasons and the decreases noticed in the wind speed during winter and pre-monsoon seasons were significant,

iii) The variations observed in all the parameters during the monsoon season were minimum.

g) Aircraft observations of chloride aerosols in the lower atmosphere (below 12,000 ft. a.s.l.) were made during the summer monsoon season of 1973 in the Rihand (Inland), Bombay (maritime), Kalyan (urban) regions and over the Arabian sea, 25 km off the coast at Santacruz. The size distributions of the chloride particles in the vertical were studied using the observations made at the above places. The distributions in the vertical, by and large, follow the power law proposed by Junge. The slopes of the distribution were found to be different in the three regions.

2.4.2 Environmental Physics

2.4.2.1 Studies of atmospheric boundary layer

a) Numerical simulation experiments relating to the one-dimensional cumulus cloud model developed by Prof. W.R. Cotton (Colorado State University) were carried out on NCAR CRAY-I computer system with different sets of input data. The experiments were carried out by a scientist of the Institute during the period of UNDP training. The input data included the aircraft microphysical (Cloud drop-size distribution, concentration, cloud liquid water content) and temperature observations obtained during the summer monsoon seasons of 1973, 1974 and 1976 and the radiosonde/rawinsonde observations made in the Bombay and Pune regions. The cloud model which includes bulk entrainment can predict the distribution of water substance, among the five phase components viz. water vapour, liquid cloud water, liquid rainwater, frozen rainwater and ice crystals. The predicted cloud liquid water content profiles agreed with the observations. The predicted cloud top heights were in good agreement with the observations when the cloud diameter was around 1 km. Results of the cloud model runs undertaken with different sets of input data suggested that the cloud model was useful for the simulation of the summer monsoon cumulus clouds in the Indian region.

b) The model was used to study the evolution of warm stratocumulus clouds formed by mesoscale lifting during the summer monsoon season over the Indian region. The cloud model consisted of (i) a partially diagnostic higher order turbulence model, (ii) an atmospheric radiative transfer through a clear, fully cloudy or partially cloudy atmosphere and (iii) a partial condensation scheme to replace the traditional 'all or nothing' condensation.

The tropical planetary boundary layer during the monsoon season was characterised by wind speeds up to 10 m/sec, pseudo-adiabatic lapse rates and high precipitable water vapour contents (more than 6 gm kg^{-1}).

The model results were used to study the turbulence profile, budgets and entrainment in the cloud layer. The clouds are convective with buoyant production being a major contributor to the turbulent kinetic energy. The turbulent vertical velocity variance exhibits a sharp peak at cloud-top due to entrainment. This peak gets enhanced due to the radiative cooling and latent heat release following the cloud layer convection.

The downward turbulent thermal flux due to entrainment forms only a small fraction (less than 0.1 %) of the mean upward thermal flux of buoyant cloud convection. However, due to the large amount of moisture present in the atmosphere, the entrainment-induced upward turbulent moisture fluxes form an appreciable part (up to 30 %) of the mean in-cloud moisture flux. Thus, a small increase in the turbulent thermal flux can act as a 'trigger' for an appreciable increase in the cloud water content. Such an effect may explain the reported increase in the cloud liquid water content up to 200 percent following the seeding of warm cumulus clouds, with hygroscopic nuclei over the Indian region.

The aerological soundings and aircraft observations of the cloud liquid water content made during the summer monsoon (June-September) seasons of 1980 and 1981 at Pune (18° 32'N, 73° 51'E, 559 m ASL) were examined. The relative humidity profile in the cloud layer showed under saturation (relative humidity 80-90 percent) in the lower half of the cloud layer and near saturation (relative humidity $\sim$ 100 percent) in the upper half of the cloud (near cloud top). The above distribution was present even on days with overcast cloud conditions. The under saturation condition in the lower half of the stratocumulus cloud was attributed to the phenomenon of cloud top vertical mixing.

c) High resolution aircraft observations of dry-bulb, wet-bulb temperature, atmospheric pressure and cloud electrical and microphysical observations were made in the Pune region during the summer monsoon season of 1981. Using

the above observations, the turbulent fluxes of momentum, heat and moisture were computed. The vertical gradient of the turbulent momentum flux was computed using the equation of continuity. The vertical gradients of turbulent heat and moisture fluxes were computed using equations for heat and moisture transports in a turbulent atmosphere in the absence of radiative and condensation processes.

d) The temperature and water vapour mixing ratio spectra in cloud and cloud-free air were computed using the high resolution aircraft observations made in the Pune region during the summer monsoon season of 1979. The magnitudes of the scalar turbulent fluctuations of temperature and humidity and their correlations were computed.

The dominant eddies with wave-lengths greater than 1 km are related to the Brunt-Vaisala frequency. The dissipation rates of temperature and water vapour mixing ratio variances in general were found to be less in cloud-air than in clear-air. The intensity of small scale turbulence decreased with the increase in cloud liquid water content. The cloud electrical activity increased with the liquid water content.

2.4.2.2 Studies in upper atmosphere

a) Computations of vertical velocity in the stratosphere-mesosphere regions were carried out using Thumba Rocketsonde temperature and wind data relating to two contrasting monsoon seasons viz. 1972 and 1975. Similar computations were made using the special Rocketsonde observations made at 6 hour interval during 18-20 August 1976. The values of vertical velocity varied between -22 cm sec^{-1} and + 11 cm sec^{-1}.

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

c) Variations in the tidal character for 3 stations viz. Kandla (50 % eclipse), Bombay (90 % eclipse) and Karwar (100 % eclipse) during the solar eclipse of 16 February 1980 were studied using the low and high tide data. The study suggested an increase in high tide and decrease in low tide. Karwar exhibited maximum variation in the tidal activity.

d) A study of the possible relationship between the total ozone and the solar activity was undertaken using the monthly total ozone data and the corresponding sunspot data for Alma-Ata, New Delhi and Kodaikanal for 1958-1979. Preliminary results of the study indicated different associations between the total ozone and solar activity at the three stations and were in agreement with the results of the earlier study undertaken for the period 1969-78. These differences were explained on the basis of the general circulation characteristics of the atmosphere.

e) A study was undertaken to examine the relationship between the solar proton events (E > MeV) and the geomagnetic activity using the data for the period 1955-'72. The study indicated that major magnetic disturbances occur mostly between 0 and 3 days after the entry of solar protons in to the earth's atmosphere. Also, a significant increase of 200 to 500 per cent in A_p (geomagnetic index) was noticed, following the event.

2.4.2.3 Studies in air pollution

a) A field programme was organised at Sinhagad during 11-17 January 1982. Measurements on atmospheric turbidity, total ozone (Chappius method), precipitable water vapour (water vapour absorption method), atmospheric electric space charge, electric field, atmospheric total suspended particulates and their size distribution, cloud condensation nuclei and atmospheric trace gases were made.

b) Analysis of the cloud water and rainwater samples collected from aircraft during the Pune cloud seeding experiment-1981 was completed. The results suggested

that the concentrations of chloride and sodium in cloud water were respectively 238 per cent and 109 per cent higher in the samples collected in seeded clouds than in not-seeded clouds. The chloride and sodium concentrations were respectively 135 per cent and 126 per cent higher in the rain-water samples collected from the seeded clouds than in those from the not-seeded clouds.

c) A gadget was designed, fabricated and fitted to the cloud seeding aircraft for collection of cloud water. Several cloud water samples in not-seeded and seeded clouds were collected during the Pune cloud seeding experiment-1981.

d) Ninety three rainwater samples received from the India Meteorological Department, Pune, were analysed by the Atomic Absorption Spectrophotometer for estimation of calcium, potassium and sodium.

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

Ten meteorological rocket payloads were fabricated for test with Rohini-200 rocket from Thumba. Four payloads were launched, 2 each on 24 February 1982 and 3 March 1982. For the first time, systematic signals were received from three payloads. Temperature data received up to 48 km altitude, was found to be comparable to that from M-100 rocket flights.

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

The research project 'Development of wind tunnel for simulation studies of the atmospheric boundary layer' was merged with the project 'Development of instruments for the fluxes and profile measurements in the atmospheric boundary layer and to carry out related studies'.

Observations were made at the central Agricultural Meteorological Observatory (CAMO) Pune, using a 6 channel wind profile system at 10, 20, 40, 80, 160 and 320 cm levels to estimate the shear stress and to compare it with that measured by the drag meter.

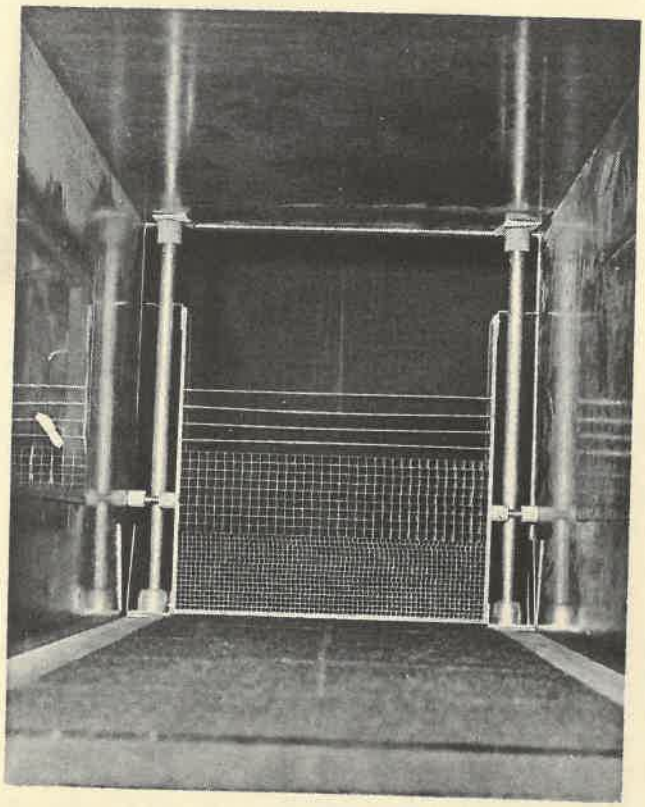
Lyman alpha hygrometer was fabricated and tested in the laboratory and was put on board aircraft during the cloud seeding experiments.

Bowen's ratio and mass flux due to evaporation were estimated from temperature and humidity observations taken at CAMO, Pune during 15-17 February 1980.

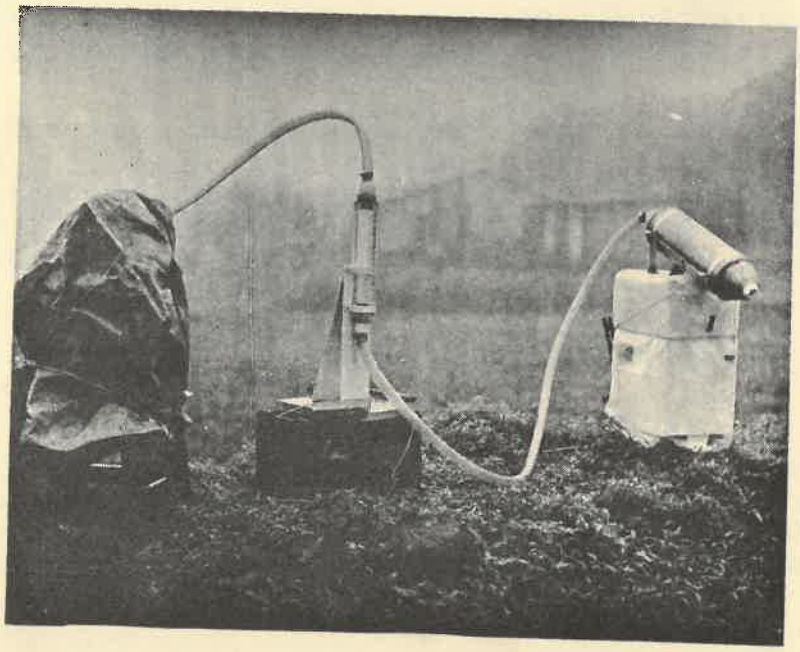
Wind and temperature profiles over bare black cotton soil were analysed.

Using fine thermocouple, a temperature measuring gadget was developed. The same was used in the experiment, 'Mobile Survey of Air Pollution of Pune City', conducted by the India Meteorological Department (I.M.D.) on 24 January 1982.

Simulation experiments on mean velocity profiles were carried out using honeycomb-cum-flat plate (HFP) and a long fetch of rough surface, in a low speed wind tunnel at CWPRS, Khadakwasla, Pune. Profiles over smooth and rough floor were measured at different downstream stations for different free stream velocities. Smoke diffusion studies were attempted by injecting smoke into the tunnel through model stacks fitted to the tunnel floor in the region where the boundary layer flow exhibited developed profiles. The trajectories of plumes for different tunnel speeds were photographed. The data collected were analysed and the Reynolds stress values were computed from the logarithmic profiles depicted in the lower boundary layer. Diffusion lengths were computed from the plume trajectories.



Honeycomb-flat plate velocity profile generator for accelerating boundary layer growth in wind tunnel simulation studies of atmospheric boundary layer



Equipment used for Atmospheric Electrical space charge measurements in cloudy conditions at Mahabaleshwar during south-west monsoon season

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

Several atmospheric electrical phenomena such as the electrode effect, sunrise effect, convection currents and the inhomogeneities in the space charge distribution in the lowest 2 meters of the atmosphere were studied from the space charge data obtained at different levels during the solar eclipse experiment conducted at Pune in February 1980. A few meteorological conditions favourable for the manifestation of the electrode effect were identified.

Data on raindrop charge, electric field, space charge and rainfall intensity obtained during the field experiment conducted at Mahabaleshwar in August 1980 was analysed. Net charge being transported by precipitation to the ground was found to be negative. The electrical characteristics of five different showers, when analysed, did not show any distinct division in groups.

Amplifier circuit in the spherical field-mill was changed and the noise in all the three amplifiers was brought down to reasonable levels. Some preliminary tests of the spherical field-mill to measure atmospheric electric field vector in the atmosphere gave satisfactory results.

Several changes were incorporated in the apparatus fabricated earlier to measure electrical charges on precipitation, cloud and aerosol particles, in order to make it impossible for the particles collected in one stage to produce any spurious signal in the other stage.

2.5.3.2 Development of simulation techniques for cloud physics studies

Effect of cloud electrification on the initiation and development of downdraft in thunderstorms was studied. It was found that the changes in the velocity of the raindrops, due to electrical forces acting on them, would change

the drag force vector imparted by the drops to the air through which they are falling. These changes in the drag force may influence the initiation and development of the downdraft in thunderstorms. Changes in the development of balance levels and the effect of inclined electric fields on cloud dynamics were also studied.

A laboratory experiment was conducted to generate uniform water droplets by applying high voltage to water in a capillary. Variations of size, charge and frequency of the droplet in relation to the flow-rate voltage and capillary characteristics were investigated. Stability of charged water drops was also studied.

Different parts of a vertical wind tunnel, fabricated earlier, were put together and several tests were carried out for suspending water drops in the test-section. The suspended drops showed some improvement in their stability in space.

Experiments were conducted on the electrical atomization of water dripping from plant leaves. It was observed that when a high positive d.c. voltage of 8-10 Kv was applied to the plant, the dripping water atomized into a monodisperse smoke of micron-sized droplets. Currents associated with the smoke were measured and the smoke was photographed.

2.6 Theoretical Studies

2.6.1 Studies on dynamic instability

2.6.1.1 Barotropic and baroclinic instability of the atmospheric flow

The studies on the role played by barotropic, baroclinic, and the combined instability of the monsoon flow in the generation and development of the monsoon depressions and the upper tropospheric waves were undertaken in this project. A linear, three-dimensional, quasi-geostrophic, multi-layer numerical model was developed for

this purpose. It was found that the growth of the upper tropospheric waves was due both to the baroclinic and the barotropic instability mechanisms. Their westward propagation is mainly due to the advection of planetary vorticity. The most unstable wave has wavelength of 6700 km and a westward speed of about 20 m/s, which are in good agreement with the observations. The computed net southward transport of easterly momentum associated with the wave agreed well with the observations and it was mainly due to the asymmetric nature of the easterly jet.

The pure baroclinic version of the above numerical model also indicated that both the lower level westerly and the upper level easterly jets were baroclinically unstable and the instability increased with the decrease in their half-widths, increase in their core speeds and with the downward shift of their locations. These conclusions are also supported by the analytic expression derived for the minimum easterly and the westerly jet strengths necessary for baroclinic instability. The necessary condition for the combined zonal and meridional flow was developed. The basic meridional flow was incorporated in the linear quasi-geostrophic model, developed earlier.

2.6.1.2 Barotropic and baroclinic instability of the atmospheric flow in the summer monsoon (MONEX Study)

The quasi-geostrophic baroclinic and barotropic instability analysis of the area-averaged vertical profile and the zonally averaged meridional profiles respectively of the observed zonal flow during the Monex period was made in order to identify the physical mechanisms responsible for the formation of the depressions during the period. It was found that both the barotropic and the baroclinic mechanisms could be responsible for the formation of the 7 July 1979 depression in the head Bay of Bengal. The structure of the most unstable wave agrees well with the observed features of the depression.

The grid point values of mean monthly zonal winds for the upper troposphere (100, 200 and 300 mb) in the region 4°S - 32°N and 50°E - 120°E were picked up

from analysed charts to study the month-to-month variation of the barotropic instability of the zonal flow during the monsoon season of 1979.

2.6.2 Simulation of monsoon and tropical circulation systems.

2.6.2.1 Simulation of mean monsoon circulation

Work on the development of a five level global spectral model in sigma co-ordinate system for the simulation studies was taken up.

2.6.3 Work done at the Florida State University (F.S.U.), U.S.A. during the deputation of Institute Scientist as UNDP/WMO Fellow from 20 March 1981 to 5 March 1982 :

a) Prognostic Research Work

The 96 hour numerical weather prediction experiment on the monsoon depression of 7 July 1979 (Monex period) was carried out with the barotropic and one level primitive equation models of F.S.U., with the 3 July 1979 data as input.

b) Diagnostic Studies

i) Harmonic analysis was made of the 200 mb level U and V components of wind for 1967, 1972 and 1979 and satellite brightness values for 1979. The variance spectrum for these parameters, during some active and break periods of the Indian summer monsoon was evaluated.

ii) The 30-50 day mode tropical oscillation components in the flow patterns at 850, 700 and 200 mb levels during the Monex period were picked up and their

relation to the active-break-active phases of the monsoon was evaluated.

iii) An atlas on the mean monthly flow pattern, mean monthly deviation from the normals and the southern oscillation components of the tropical atmosphere (30°S to 40°N) was prepared on the basis of a ten year (1966-1975) period data set.

iv) The southern oscillation component (30 - 50 months cycle) in the monthly mean sea surface temperatures in the north Pacific (20°N - 60°N) was extracted from a set of data for 30 years (1947-1976) and its relationship to the El-Nino phenomenon in the Pacific was studied.

2.7 Research carried out by Honorary Fellow/ Emeritus Scientist

2.7.1 Sun-weather climate relationships

The association between the annual rainfall of India and Zurich sunspot numbers was examined utilising the data for the period 1871 to 1978 spanning nearly ten sunspot cycles. The association was found to be of a complex nature, the correlation coefficients showing large fluctuations in space and time.

2.7.2 Diurnal variations in the tropics

Studies were continued on diurnal variation of pressure and low level winds. The diurnal variation of rainfall at some stations along and off the Kerala coast was taken up for study by utilising the record of autographic charts.

2.7.3 Dynamics of the lower stratosphere

Daily values of geopotential heights in the upper troposphere and lower stratosphere over Gan Island for the

period 1964-70 were subjected to Power spectral analysis to identify the Kelvin and Mixed Rossby Gravity Waves. Disturbances with period 2-3, 3.1-6 and 20 days were identified. Semi-annual variation is discernible at all the levels. Larger power in the good monsoon years rather than in the bad monsoon ones in the 20 days wave in the months June to September suggested a close association between Kelvin wave activity and the monsoon circulation.

2.8 Field Research Unit, Bangalore

The Institute's Field Research Unit at Bangalore completed the project i.e. preparation and publication of a 'Handbook on Solar Radiation Data for India' in two volumes. The second volume entitled, 'Solar Radiation over India' was published in January 1982. This volume contains solar radiation data on horizontal and sloped surfaces for 145 stations, covering all major climatic zones of the country. Two methods were used to compute the data, one using regression techniques to derive solar radiation from sunshine and cloudiness and the other from extra - terrestrial radiation, allowing for its depletion by absorption and scattering in the atmosphere.

Miss Mani, Chief Scientist, Field Unit,
Bangalore, Chairing a Session

3. SYMPOSIUM

Symposium in progress - a section of the audience

3. Symposium on 'Environmental Physics and Atmospheric Boundary Layer' 24-26 November 1981.

The Institute organised a symposium on 'Environmental Physics and Atmospheric Boundary Layer' during 24-26 November 1981 at Pune. It was co-sponsored by the India Meteorological Department (I.M.D.), Department of Atomic Energy (D.A.E.) and Department of Space (D.S.).

The symposium was inaugurated by Prof. P. Koteswaram, Member, Governing Council and former Director General of Observatories and Vice-President, World Meteorological Organisation. At the inaugural function, Dr. T.A. Hariharan, Head, Division of Meteorology, Space Applications Centre, Ahmedabad represented the Department of Space while the Department of Atomic Energy was represented by Dr. K.G. Vohra, Head, Division of Radiological Protection, Bhabha Atomic Research Centre, Bombay.

The symposium covered three major research areas viz. Atmospheric Boundary Layer, Environmental Physics and Air Pollution. It provided an excellent opportunity for interaction between the scientists working in theoretical, experimental and observational aspects of environmental physics, atmospheric boundary layer and air pollution. This symposium helped in getting an overview of the recent developments in the subjects and in identifying priorities for further research and for developing inter-disciplinary areas of research.

Scientists from forty four research organisations participated in the symposium. Eighty-one scientific papers were presented and discussed.

The following invited talks were delivered -

1.	Air Pollution - Urban effects.	Prof. P. Koteswaram Andhra University.
2.	Air-act and environmental Physics.	Prof. P.R. Pisharoty Physical Research Lab., Ahmedabad.

3.	Formation of aerosols in the atmosphere and their role in atmospheric processes.	Dr. K.G. Vohra, Bhabha Atomic Research Centre, Bombay.
4.	Remote sensing techniques for the studies in environmental physics.	Dr. C. A. Reddy, Vikram Sarabhai Space Centre, Trivandrum.
5.	Atmospheric Boundary Layer Phenomena and Microwave communications.	Dr. B. M. Reddy, National Physical Laboratory, New Delhi.

Action was under progress with regard to bringing out extended abstracts of the papers in the form of a 'Symposium Proceedings'.

Now is the time for relaxation!

4. PUBLICATIONS

4. Publications

4.1 Papers Published

Sr. No.	Title	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, 31, 1-2, January, 1982, 117-126.
2.	Analogue in the South-west monsoon.	Paul D.K., Mujumdar V.R. and Sikka D.R.	Mausam, 33, 1, January, 1982, 121-130.
3.	Anemometer for tethered balloon.	Sadani L.K.	Journal of the Institution of Electronics and Tecommunication Engineers, 27, 9, September, 1981, 324-325.
4.	Annual oscillation of the tropospheric temperature in the northern hemisphere.	Verma R.K. and Sikka D.R.	Proceedings of Joint IUTAM/IUGG International symposium on 'Monsoon Dynamics', New Delhi, 5-9 December, 1977 (Published in 1981) 49-64.
5.	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, 1, 2, April-June, 1981, 167-186.

Sr. No.	Title	Author(s)	Publication
6.	Applicability of the poisson probability model to severe cyclonic storms striking the coast around the Bay of Bengal.	Mooley D.A.	Sankhya, 43, Sr.B., pt. 2, 1981, 187-197.
7.	Application of the dynamic initialisation technique to a primitive equation model.	Sinha S. and Kulkarni P.L.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 31, 1982, 91-104.
8.	Automatic temperature controller.	Chaudhari S. and Vernekar K.G.	Students' Journal of Institution of Electronics and Telecommunication Engineers, 23, 1, 1982, 3-6.
9.	Catalogue of major and devastating floods of India and their space-time distribution.	Dhar O.N., Ghose G.C. and Kulkarni A.K.	Proceedings of International conference on 'Flood Disasters', Indian National Science Academy, New Delhi, 3-5 December 1981.
10.	Chemical composition and size distribution of atmospheric aerosols over the Deccan Plateau, India.	Khemani L.T., Momin G.A., Naik M.S., Vijaykumar R. and Ramana Murty Bh.V.	Tellus, 34, 2, April, 1982, 151-158.
11.	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, 13, 1, April, 1981, 182-183.
12.	Computer method for amplitude spectrum analysis.	Devara P.C.S. and Ahmed M.I.	Defence Science Journal, 31, 2, April, 1981, 97-103.

Sr. No.	Title	Author(s)	Publication
13.	Contrasting features of the large scale dynamics of tropospheric circulation in wave number domain in relation to the performance of monsoon rainfall over India with special reference to monsoon experiments.	Awade S.T., Totagi M.Y. and Sikka D.R.	Proceedings of International conference on 'Early results of FGGE and large scale aspects of monsoon experiments', Tallahassee, USA, 12-17 January 1981, 5.52 - 5.56.
14.	Cyclic fluctuations in the flood area and relationship with double (Hale) sunspot cycle.	Bhalme H.N. and Mooley D.A.	Journal of Applied Meteorology, 20, 9, September, 1981, 1041 - 1048.
15.	Divergent barotropic instability of the tropical asymmetric easterly jet.	Mishra S.K., Subrahmanyam D. and Tandon M.K.	Journal of Atmospheric Sciences, 38, 1981, 2164-2171.
16.	Droughts in India over the last 200 years, their socio-economic impact and remedial measures for them.	Mooley D.A. and Pant G.B.	Book entitled, 'Climate and History' by Wigley T.M.L. et al., 465-478.
17.	Echo duration and diffusion coefficient measurements using meteor wind radar.	Devara P.C.S., Ahmed M.I. and Rao M.S.	Radio Science, 16, January-February, 1981, 111-119.
18.	Effect of elevation on monsoon rainfall distribution in the central Himalayas.	Dhar O.N. and Rakhecha P.R.	Proceedings of Joint IUTAM/IUGG International symposium on 'Monsoon Dynamics', New Delhi, 5-9 December 1977, (Published in 1981), 253-260.

Sr. No.	Title	Author(s)	Publication
19.	Electrical and microphysical 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, 13, 1, April, 1981, 174-176.
20.	Empirical orthogonal analysis of 700 mb geopotential during the summer monsoon over India.	Sikka D.R. and Prasad K.D.	Journal of Climatolog 1, 4, October-Decembe 1981, 367-379.
21.	Energetics of open atmospheric systems: case study of an extratropical cyclone.	Pant G.B.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie, Sr.A., 31, 1982, 49-62.
22.	Forecasting monsoon rainfall by objectivised synoptic methods.	Singh S.V. and Kripalani R.H.	Proceedings of symposium on 'Current Problems of Weather Prediction', Vienna, Austria, 23-26 June 1981, 231-234.
23.	Ground based salt seeding in Tamil Nadu State, south India, 1973-1977.	Pillai A.G., Reddy R.S., Vijaykumar R., Murty A.S.R., Selvam A.M. and Ramana Murty Bh.V.	Journal of Weather Modification, 13, 1, April, 1981, 177-181.
24.	Impact of additional summer monex wind data on the prediction of monsoon depressions during June-August 1979, with two versions of P.E. barotropic model.	Sikka D.R., Sinha S., Singh S.S., Kulkarni P.L. and Kulkarni A.A.	Proceedings of International Conference on 'Early results of FGGE and large scale aspects of monsoon experiments', Tallahassee, USA, 12-17 January 1981, 7.37 - 7.40.

Sr. No.	Title	Author(s)	Publication
25.	Impact of summer monex special observational data on the objective analysis of wind field over Indian region.	Rajamani S., Talwalkar D.R., Upasani P.V. and Sikka D.R.	Proceedings of International conference on 'Early results of FGGE and large scale aspect of monsoon experiments' Tallahassee, U.S.A., 12-17 January 1981, 7.33 - 7.36.
26.	Indian summer monsoon, its economic aspects, its vagaries and remedial measures.	Mooley D.A.	Book entitled, 'Perspectives in Agricultural Geography', Vol.II by Noor Mohammed, 89-121.
27.	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.
28.	Long-range prediction of monsoon activity - a synoptic diagnostic study.	Verma R.K.	Mausam, 33, 1, January, 1982, 35-44.
29.	Meteor wind radar studies at Waltair.	Devara P.C.S., Ahmed M.I., Rao M.S. and Rao B.R.	Indian Journal of Radio and Space Physics, 10, 6, 1981, 228-236.
30.	Nature of diurnal variation of atmospheric electric field.	Chaudhuri S.	Mausam, 32, 3, July, 1981, 263-268.

Sr. No.	Title	Author(s)	Publication
31.	Network density for the estimation of areal rainfall.	Mooley D.A. and Ismail P.M.M.	Hydrological Sciences Bulletin, 26, 4, December, 1981, 369-378.
32.	Neutral wind measurements over Waltair using Meteor wind Radar.	Devara P.C.S., Ahmed M.I., Rao M.S. and Rao B.R.	Journal of Atmospheric and Terrestrial Physics, 43, 3, 1981, 239-242.
33.	On dynamic initialisation experiments in Indian region.	Singh S.S., Kulkarni A.A. and Sikka D.R.	Mausam, 33, 1, January, 1982, 45-50.
34.	On the electrical conductivity and the relaxation time of the air in thunderstorms.	Kamra A.K.	Proceedings of symposium on 'Ion-molecule reactions in atmosphere', University of Roorkee, 29-31 March 1981.
35.	On the kinetic energy budget of summer monsoon circulation over Indian region during ISMEX-1973.	Singh S.S., Kulkarni A.A. and Bandyopadhyaya A.	Pure and Applied Geophysics, 119, 1, 1980-81, 16-23.
36.	On the northward advance of the ITCZ and the onset of the southwest monsoon rains over the southeast Bay of Bengal.	Ananthakrishnan R., Pathan J.M. and Aralikatti S.S.	Journal of Climatology 1, 2, April-June, 1981 153-165.
37.	On the occurrence of rainfall over South-west sector of the monsoon depression.	Rajamani S. and Rao K.V.	Mausam, 32, 3, July, 1981, 215-220.

Sr. No.	Title	Author(s)	Publication
38.	On some hydromet aspects of heavy rainfall distribution over the principal arid zone of Rajasthan.	Dhar O.N. and Rakhecha P.R.	Annals of Arid Zone, 19, 4, December, 1980, 413-420.
39.	Origin of tropical disturbances.	Mahanti A.C.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie, Sr.A. 30, 1981, 167-183.
40.	Oscillation between Rossby wave and zonal flow in a barotropic fluid.	Mahanti A.C.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie, Sr.A. 30, 1981, 211-225.
41.	Overview of the weather modification research.	Ramana Murty Bh.V.	Journal of Weather Modification, 13, 1, 165-166.
42.	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., 30, 1981, 261-277.
43.	Persistency in sequence of wet and dry pentads over Bombay.	Kamte P.P., Dahale S.D. and Khade V.V.	Mausam, 32, 3, July, 1981, 253-258.
44.	Possible linkage between atmospheric total ozone and solar sector boundary passage.	Raja Rao K.S. and Nair M.V.H.	Journal of Atmospheric and Terrestrial Physics, 43, 1981, 367.

Sr. No.	Title	Author(s)	Publication
45.	Probability model for droughts in ancient China.	Mooley D.A.	Monthly Weather Review, 109, 1, January, 1981, 191-193.
46.	Probable maximum point rainfall estimation for southern half of the Indian peninsula.	Dhar O.N., Kulkarni A.K. and Rakhecha P.R.	Proceedings of the Indian Academy of Sciences (Earth and Planetary Sciences), 90, 1, March, 1981, 39-46.
47.	Problems of classification in Meteorology and Climatology.	Singh S.V.	The Classification Society Bulletin, 4, 4, 1980, 10-15.
48.	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.
49.	'Reply' to 'Comment on contributions of cloud and precipitation particles to the electrical conductivity and the relaxation time of the air in thunderstorms' by A. J. Weinheimer and A.A. Few'.	Kamra A.K.	Journal of Geophysical Research, 86, C 5, 1981, 4305-4306.

Sr. No.	Title	Author(s)	Publication
50.	Role of barotropic mechanism in the development of monsoon depression: A MONEX Study.	Subrahmanyam D., Tandon M.K., George L. and Mishra S.K.	Pure and Applied Geophysics, 119, 1981, 901-912.
51.	Salt seeding from aircraft over Linganamakki catchment, South India.	Murty A.S.R., Selvam A.M., Kulkarni C.P., Chatterjee R.N. and Ramana Murty Bh.V.	Journal of Weather Modification, 13, 1, 1981, 167-173.
52.	Severemost rainstorm of July 1927 which caused devastating floods in Gujarat region.	Dhar O.N., Rakhecha P.R. and Mandal B.N.	Proceedings of International conference on 'Flood Disasters', INSA, New Delhi, 3-5 December 1981.
53.	Solar activity and Indian weather/ climate.	Bhalme H.N., Reddy R.S., Mooley D.A. and Ramana Murty Bh.V.	Proceedings of Indian Academy of Sciences, (Earth and Planetary Sciences), 90, 3, November, 1981, 245-262.
54.	Some aspects of an association between the southern oscillation and Indian summer monsoon rainfall.	Pant G.B. and Parthasarathy B.	Archiv fur Meteorologie und Bioklimatologie, Sr. B., 2 2, 1981, 245-252. Geophysik
55.	Some aspects of the interhemispheric interactions on the onset of monsoon over India as revealed by the Monex data.	Sikka D.R., Nagar S.G. and Paul D.K.	Proceedings of International conference on 'Early results of FGGE and large scale aspects', Tallahassee, U.S.A., 12-17 January 1981, 5.52-5.56.

Sr. No.	Title	Author(s)	Publication
56.	Some facts about Indian rainfall - a brief appraisal from hydrological considerations.	Dhar O.N., Rakhecha P.R. and Mandal B.N.	Indian Journal of Power and River Valley Development, 31, 7-8, July - August, 1981, 117-125.
57.	Stability of monsoon depression.	Mahanti A.C.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr. A., 30, 1-2, 1981, 39-53.
58.	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. B, 30, 1-2, 1982, 95-105.
59.	Study of the errors in areal mean rainfall arising out of missing observations.	Mooley D.A. and Munot A.A.	Mausam, 33, 1, January, 1982, 65-72.
60.	Study of the instability of the meridional flow - Part II.	Mahanti A.C.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie, Sr. A, 30, 1-2, 1981, 23-28.
61.	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 Bioclimatologie, Sr. A., 30, 1981, 99-109.

Sr. No.	Title	Author(s)	Publication
62.	Study on chloride aerosols in maritime and well inland regions.	Paul S.K., Sharma S.K. and Kapoor R.K.	Journal of Indian Institute of Science, 63(B), 6, 1981, 97-108.
63.	Use of empirical orthogonal functions for rainfall estimates.	Rakhecha P.R. and Mandal B.N.	Proceedings of Joint IUTAM/IUGG International symposium on 'Monsoon Dynamics', New Delhi, 5-9 December 1977 (Published in 1981) 627-638.
64.	Use of the equation of continuity of water vapour for computation of average precipitation over peninsular India during the summer monsoon.	Bavadekar S.N. and Mooley D.A.	Proceedings of Joint IUTAM/IUGG International symposium, on 'Monsoon Dynamics', New Delhi, 5-9 December 1977 (Published in 1981) 261-268.
65.	Vamasadhara flash floods of September 1980 - a brief appraisal.	Dhar O.N., Mandal B.N. and Ghose G.C.	Vayu Mandal, 11, 3 and 4, July - December, 1981, 7-11.

4.2 Papers accepted for publication

Sr. No.	Title	Author(s)	Publication
1.	Analytic study on the horizontal motion of monsoon depression.	Mishra S.K., Chakraborty D.R. and Desai S.S.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie, Sr. A.
2.	Analytical representation of the three dimensional structure of monsoon depression.	Mishra S.K., Chakraborty D.R. and Desai S.S.	- do -
3.	Application of a stochastic model to frequency and duration of monsoon rainfall.	Kamte P.P., Prasad K.D., Khade V.V. and Dahale S.D.	Pure and Applied Geophysics.
4.	Correlation functions of rainfall field and their application in network design in the tropics.	Mooley D.A. and Ismail P.M.M.	- do -
5.	Dendroclimatic potential of Juniper trees from the Sirsar range in Karakoram.	Bilham R., Pant G.B. and Jacoby G.C.	Man and Environment
6.	Drought and flood over India in summer monsoon season: 1871-1980.	Mooley D.A. and Parthasarathy B.	Proc. of International Symposium on 'Variations in the Global Water Budget', Oxford, U.K., 10-15 August 1981.
7.	Droughts over Peninsular India during 1861-1980 and associated circulation features.	Mooley D.A., Parthasarathy B. and Sontakke N.A.	WMO Symposium on 'Meteorological Aspects of Tropical Droughts', New Delhi, 7-11 December 1981.

Sr. No.	Title	Author(s)	Publication
8.	Estimation of maximum and probable maximum one-day point rainfall for Tamil Nadu.	Dhar O.N., Kulkarni A.K. and Mali R.R.	Indian Journal of Power and River Valley Development.
9.	Fair weather space charge distribution in the lowest 2 m. of the atmosphere.	Kamra A.K.	Journal of Geophysical Research.
10.	Fluctuations in the deficiency of the summer monsoon over India and their effect on economy.	Mooley D.A. and Parthasarathy B.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie, Sr. B.
11.	Fluctuations in northeast monsoon rainfall of Tamil Nadu.	Dhar O.N., Rakhecha P.R. and Kulkarni A.K.	Journal of Climatology.
12.	Foreshadowing northeast monsoon rainfall over Tamil Nadu.	Dhar O.N. and Rakhecha P.R.	Monthly Weather Review.
13.	Greatest observed one-day point and areal rainfall of India.	Dhar O.N. and Mandal B.N.	Pure and Applied Geophysics.
14.	High-level temperatures and winds over tropics and Indian summer monsoon.	Mukherjee B.K., Reddy R.S. and Ramana Murty Bh.V.	Journal of Geophysical Research.

Sr. No.	Title	Author(s)	Publication
15.	Impact of Monex-79 data on the objective analysis of wind field over Indian region.	Rajamani S., Talwalkar D.R. Upsani P.U. and Sikka D.R.	Pure and Applied Geophysics.
16.	Incidence of droughts and floods over India and its sub-divisions in the summer monsoon season during the period 1871-1980	Mooley D.A. and Parthasarathy B.	Proc. of the symposium on 'Variations in Global Water Budget', Oxford, U.K., 9-15 August 1981.
17.	Measurement of electric field and vertical distribution of space charge close to the ground during the Solar Eclipse of 16 February 1980.	Kamra A. K., Teotia J.K.S. and Sathe A. B.	Journal of Geophysical Research.
18.	Meteor wind radar investigation at Waltair (18°N, 83°E).	Devara P.C.S., Ahmed M.I., Rao M.S. and Rao B.R.	Indian Journal of Radio and Space Physics.
19.	Meteor wind radar system at Waltair.	Ahmed M.I. Devara P.C.S., Premkumar M. Rao M.S. and Rao B.R.	Journal of the Institution of Electronics and Telecommunication Engineers.
20.	Objective analysis of wind field over Indian region by optimum interpolation method.	Rajamani S., Talwalkar D.R., Ray S.P. and Upasani P.U.	Mausam

Sr. No.	Title	Author(s)	Publication
21.	Possible effect of the cloud electrification on the downdraft in thunderstorms.	Kamra A.K.	Geophysical Research Letters.
22.	Precipitable water and dew point temperature relationship during the Indian summer monsoon.	Sinha S. and Sinha S.K.	Pure and Applied Geophysics.
23.	Rainfall distribution over India during the monsoon months in the absence of depressions and cyclonic storms.	Dhar O.N., Mandal B.N. and Rakhecha P.R.	Proc. of the WMO symposium on 'Meteorological aspects of Tropical droughts', New Delhi, 7-11 December 1981.
24.	Some aspects of the major rainstorm of 1980 monsoon season.	Dhar O.N., Mandal B.N. and Kulkarni B.D.	Journal of Indian Association of Hydrologists.
25.	Storing monsoon rainfall in Indian reservoirs.	Dhar O.N., Rakhecha P.R. and Mandal B.N.	Journal of International Water Power and Dam Constructions.
26.	Surface drag contribution to the depth of monsoon depression over Indian region.	Ray S.P.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie, Sr. A.
27.	Thirty to fifty day mode at 850 mb during MONEX.	Krishnamurty T.N. and Subrahmanyam D.	Journal of Atmospheric Sciences.

Sr. No.	Title	Author(s)	Publication
28.	Was the July 1981 rainstorm over Rajasthan unprecedented ?	Dhar O.N., Rakhecha P.R., Mandal B.N. and Sangam R.B.	Pure and Applied Geophysics.
29.	Water vapour transport across the section parallel to west coast of India during contrasting summer monsoon periods.	Bavadekar S.N. and Khaladkar R.M.	Archiv fur Meteorologie, Geophysik Und Bioklimatologie.
30.	Water vapour transport of pre-monsoon period and the general performance of the Indian Summer Monsoon.	Bavadekar S.N.	Pure and Applied Geophysics.

4.3 Research Reports, published in the Series, 'Contributions from the Indian Institute of Tropical Meteorology'.

Report No.	Title	Author(s)
R - 34	Meteorological rocket payload for Menaka-II/ Rohini 200 and its developmental details.	Vernekar K.G. and Brij Mohan
R - 35	Harmonic analysis of normal pentad rainfall of Indian stations.	Ananthakrishnan R. and Pathan J.M.
R - 36	Pentad rainfall charts and space-time variations of rainfall over India and the adjoining areas.	Ananthakrishnan R. and Pathan J.M.

5. PARTICIPATION IN SEMINARS/SYMPOSIA/ MEETINGS AND CONFERENCES

5. 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 (if any) - Author(s)
1.	First meeting of the 'Ocean Science and Technology' Agency Panel on Meteorology, Physical and Chemical Oceanography, Department of Science and Technology, New Delhi, 8 April 1981.	Ramana Murty Bh.V.	-
2.	Meeting of the Academic Council of the University of Poona, Pune, 15 April 1981.	Mooley D.A.	-
3.	Second World Instrumentation Symposium and International Trade Exposition (WISITEX - 18), Bombay, 15-19 April 1981.	Ramana Murty Bh.V., Kamra A.K., Vernekar K.G. and Sivaramakrishnan S.	i) Drag plate to measure surface shear stress in the atmospheric boundary layer - Vernekar K.G. ii) Essential features of a wind tunnel for atmospheric boundary layer simulation studies - Sivaramakrishnan S. iii) On atmospheric space charge

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
	Second World Instrumentation Symposium and International Trade Exposition (WISITEX - 18), Bombay, 15-19 April 1981.		measurements in cloudy conditions by direct filtration technique - Kamra A.K. and Teotia J.K. iv) Instrumentation for studies in atmospheric boundary layer and cloud physics (Review Talk) - Ramana Murty Bh.V.
4.	Second WMO Summer Monex Informal Review Meeting, India Meteorological Department, New Delhi, 4-8 May 1981.	Mooley D.A.	-
5.	Fifth meeting of the SERC Panel on 'Atmospheric Science', Department of Science and Technology, New Delhi, 12 and 13 May 1981.	Murty A.S.R.	-
6.	Quarterly Review meeting of the Planning Commission to review the implementation of Sixth Five Year Plan - 1980-85, New Delhi, 19 May 1981.	Dhar O.N.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
7.	Meeting of the Advisory Committee for Space Sciences, Bangalore, 19 June 1981.	Vernekar K.G. and Mukherjee B.K.	-
8.	Seminar-Cum-Workshop on 'Sun-Weather Relationship', Centre for Earth Science Studies, Trivandrum, 16-18 July 1981.	Bhalme H.N., Reddy R.S. and Jayakumar P.K.	i) Linkage between rainfall singularities and geomagnetic activity - Reddy R.S., Parasnis S.S., Raja Rao K.S. and Ramana Murty Bh.V. ii) New evidence for effect of double (Hale) sunspot cycle - Bhalme H.N. and Mooley D.A. iii) Solar influence on atmospheric electric field - Selvam A.M., Jayakumar P.K. and Ramana Murty Bh.V.
9.	IUTAM/IUGG Symposium on 'Intense Atmospheric Vortices', Reading, U.K., 14-17 July 1981.	Sikka D.R.	Some aspects of the cyclogenesis in the Bay of Bengal - Sikka D. R.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (i any) - Author(s)
10.	Meeting of the Council for Meteorology and Atmospheric Sciences (CMAS), New Delhi, 27-29 July 1981.	Ramana Murty Bh.V.	-
11.	Third ISTPA Conference, New Delhi, 22-24 August 1981.	Dahale S.D.	Markov chain model for the prediction of 5 day rainfall - Kamte P.P. and Dahale S.D.
12.	Symposium on the 'Dynamics of the General Circulation of the Atmosphere', University of Reading, U.K., 3-7 August 1981.	Awade S.T.	Large scale dynamics of the mid-latitude tropospheric circulation in wave number domain in relation t monsoon activity - Awade S.T., Totagi M.Y., Bawiskar S.M. and Sikka D.R.
13.	Meeting of the 'Working Group on Marine Meteorology', India Meteorological Department, Pune, 4 August 1981.	Singh S.S.	-
14.	Meetings of the Board of University Teaching and Research, Science Faculty, University of Poona, Pune, 21 July and 7 August 1981.	Mooley D.A.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
15.	Meeting of OSTA experiment panel in Meteorology, Physical and Chemical Oceanography, Department of Science and Technology, New Delhi, 18 August 1981.	Singh S.S.	-
16.	Meetings of the Academic Council of Poona University, Pune, 11, 12 and 15 August 1981.	Singh S.S. and Mooley D.A.	-
17.	Meeting of the Board of Studies in Geography and Meteorology, Shivaji University, Kolhapur, 13 August 1981.	Gondhalekar Y.S.	-
18.	Quarterly meeting to review the implementation of Sixth Five Year Plan (1980-85), held in the Ministry and in the Planning Commission, New Delhi, 20 and 21 August 1981.	Kapoor R.K.	-
19.	International Solar Energy Convention, Brighton, U.K., 24-29 August 1981.	Mani A.	Study of solar radiation over India - Mani A.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
20.	Meeting of the Council for Meteorology and Atmospheric Sciences, India Meteorological Department, New Delhi, 17 September 1981.	Ramana Murty Bh.V.	-
21.	Fifth meeting of the 'Working Group on Arid Zone Research', Department of Science and Technology, New Delhi, 22 and 23 September 1981.	Kapoor R.K. and Chatterjee R.N.	-
22.	Meeting of the 'Town Official Language Implementation Committee', Controller of Defence Accounts, Southern Command, Pune, 24 September 1981.	Kamra A.K.	-
23.	International Conference on 'Scientific results of monsoon experiments', Bali, Indonesia, 26-30 October 1981.	Paul D.K.	i) Characteristics of the near equatorial oceanic intertropical convergence zone over north Indian ocean and the adjacent Pacific during the different phases of monsoon over India during Monex-79 - Paul D.K., Puranik P.V., Deshpande V.R., Mujumdar V.R. and Sikka D.R.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
	International Conference on 'Scientific results of monsoon experiments', Bali, Indonesia, 26-30 October 1981.		ii) Cross hemispheric actions and the onset of the summer monsoon over India - Sikka D. R. and Gray W.M. iii) Large scale features associated with the evolution and intensification of break monsoon over India during August 1979 - Sikka D. R. and Grossman R. L. iv) On the linkage of the genesis of monsoon disturbances and cyclones in the north Indian ocean with the passage of baroclinic waves across the south-west Indian ocean - Sikka D. R. and Gray W.M. v) Study of organised convective systems observed over the Arabian sea during the onset phase of summer Monex - Bhide U.V., Nagar S.G. and Sikka D.R. vi) Variations in infra - red

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
	International Conference on 'Scientific results of monsoon experiments', Bali, Indonesia, 26-30 October 1981.		radiative fluxes over the Indian region during Monex-79 - Mani A., Sikka D.R. and Srinivasan V.M.
24.	Sixth and Seventh meetings of the 'Working Group on Arid Zone Research', Department of Science & Technology, New Delhi, 13-14 and 29 October 1981.	Kapoor R.K. and Chatterjee R.N.	-
25.	J.S. Shirke memorial symposium-cum-workshop on 'Aeronomy in the Eightees', Physical Research Laboratory, Ahmedabad, 20-23 October 1981.	Mukherjee B.K., Vijaykumar R. and Brij Mohan	i) IITM Programme on development of meteorological rocket payload - Vernekar K.G. and Brij Mohan. ii) Some recent results of research on tropical middle atmosphere - Mukherjee B.K.
26.	Meeting regarding the preparation of report of the 'Working Group on Atmospheric Dynamics', Ahmedabad, 22-24 October 1981.	Sikka D. R.	-
27.	Meeting of the Editorial Board of the 'Proceedings of Indian Academy of Sciences', 'Trivandrum, 3-11 November 1981.	Sikka D. R.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
28.	Symposium on 'Environmental Physics and Atmospheric Boundary Layer', IITM, Pune, 24-26 November 1981.	I.I.T.M. Scientists	i) Aircraft thermometry for the study of atmospheric temperature in the boundary layer - Vernekar K.G., Brij Mohan and Srivastava S. ii) Automatic temperature controller - Chaudhari S. and Manohar G. K. iii) Chemical analysis of atmospheric total suspended particulates by atomic absorption spectrophotometry - Khemani L.T., Naik M.S., Momin G.A., Murty A.S.R. and Ramana Murty Bh.V. iv) Cross spectral analysis of atmospheric electric field observations made at Raichur during total sola eclipse - 1980 Selvam A.M., Manohar G.K., Kandalgaonkar S.S., Murty A.S.R. and Ramana Murty Bh.V. v) Eddy correlator to measure sensible

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
	Symposium on 'Environmental Physics and Atmospheric Boundary Layer', IITM, Pune, 24-26 November 1981.		flux in the surface boundary layer - Vernekar K.G. and Brij Mohan vi) Effect of urbanisation on rainfall distribution at Bombay - Kapoor R.K., Paul S.K., Prakash P., Sharma S.K. and Chatterjee R.N. vii) Environmental signals of the biosphere as detected from the annual growth rings of selected tree species of India - Pant G. B. viii) Instrument for measurement of Bowen's ratio and some estimation of fluxes of mass (E) associated with evaporation - Sadani L.K. and Raibole U.P. ix) Measurements on atmospheric turbidity and aerosols in Deccan Plateau - Vijaykumar R., Sikka P., Selvam A.M. and Ramana Murty Bh.V.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
	Symposium on 'Environmental Physics and Atmospheric Boundary Layer', IITM, Pune, 24-26 November 1981.		x) New method of determining the Angstrom turbidity coefficient - Rangarajan S., Daniel T.P. and Mani A. xi) Observations of electrode effect at the ground - Kamra A. K. xii) On some aspects of the mean wind profiles and plume trajectories simulated in a wind tunnel - Sivaramakrishnan S. xiii) Short term variations in atmospheric total ozone and its relation with solar sector boundary crossing events - Indira K., Selvam A.M. and Ramana Murty Bh V. xiv) Simple instrument for measurement of sky light intensity - Sikka P., Vijaykumar R. and Selvam A.M.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
	Symposium on 'Environmental Physics and Atmospheric Boundary Layer', IITM, Pune, 24-26 November 1981.		xv) Spatial and temporal variability of the monsoon boundary layer over the Arabian sea studied with the data collections of recently conducted field experiments on summer monsoon - Sikka D.R., Bhide U.V. and Nagar S.G.
			xvi) Using radon for delineating monsoon circulation and vertical mixing over the ocean - Rama, Amin B.S. and Sikka D.R.
			xvii) Variations in atmospheric precipitable water vapour and total ozone at Poona - Sikka P., Vijaykumar R. and Ramana Murty Bh.V.
			xviii) Variations in atmospheric electrical conductivity following solar flare events - Selvam A. M. and Srivastava S.
			xvix) Variation in SO_2 concentrations

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
	Symposium on 'Environmental Physics and Atmospheric Boundary Layer', IITM, Pune, 24-26 November 1981.		vis-a-vis meteorological parameters at Delhi - Singh G., Chatterjee R.N. and Kapoor R.K.
			xx) Warming and cooling rates in the atmospheric boundary layer - Parasnis S.S., Selvam A.M., Murty A.S.R. and Ramana Murty Bh.V.
29.	International conference on 'Flood Disasters', Indian National Science Academy, New Delhi, 3-5 December 1981.	Rakhecha P.R., Kulkarni A.K. and Mandal B.N.	i) Catalogue of major and devastating floods of India and their space - time distribution - Dhar O.N., Ghose G.C. and Kulkarni A.K.
			ii) Severemost rainstorm of July 1927 which caused devastating floods in Gujarat region - Dhar O.N., Rakhecha P.R. and Mandal B.N.
30.	WMO Symposium on 'Meteorological Aspects of Tropical Droughts', New Delhi, 7-11 December 1981.	Mooley D.A., Singh S.V., Parthasarathy B., Verma R.K., Awade S.T., Kamte P.P., Rakhecha P.R., Kulkarni A.K., Mandal B.N. and Sontakke N.A.	i) Analysis and prediction of short period droughts during summer monsoon over India - Singh S.V., Kripalani R.M., Shaha P. and Prasad K.D.

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	WMO Symposium on 'Meteorological Aspects of Tropical Droughts', New Delhi, 7-11 December 1981.		ii) Droughts over peninsular India during 1861-1980 and associated circulation features - Mooley D. A., Parthasarthy B. and Sontakke N.A. iii) Dynamics of the large scale tropospheric circulation during summer monsoon and Tropical Droughts - Awade S.T., Totagi M.Y., Bawiskar S.M. and Sikka D.R. iv) Large scale droughts over India and their impact on agricultural production - Mooley D.A., Parthasarathy B. and Munot A.A. v) Rainfall distribution over India during the monsoon months in the absence of depressions and cyclonic storms - Dhar O.N., Mandal B.N. and Rakhecha P.R.

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	WMO Symposium on 'Meteorological Aspects of Tropical Droughts', New Delhi, 7-11 December 1981.		vi) Some aspects of large scale physical processes associated with the 1979 drought over India - Verma R.K. vii) Stochastic mode of drought - Kamte P.P. and Dahale S.D.
31.	Meetings of the 'Board of Studies in Geography, University of Bombay and Marathwada University, 8 and 16 December 1981.	Gondhalekar Y.S.	-
32.	Thirtyfifth Annual Conference of the Indian Society of Agricultural Statistics, Indian Agricultural Statistics Research Institute, New Delhi, 28-30 December 1981.	Kapoor R.K. and Prakash P.	-
33.	Meetings on 'Annual Plan' 1982-83, held in Min. of T and C.A. and in Planning Commission, New Delhi, 19 and 21-22 December 1981.	Murty A.S.R. and Kapoor R.K.	-
34.	UNESCO sponsored regional workshop on 'System Analysis and its application to Engineering Problems', Indian Institute of Technology, Bombay, 11-16 January 1982.	Suryanarayana R. and Sikka D.R.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
35.	Workshop on 'Wind energy', National Aeronautical Laboratory, Bangalore, 21 January 1982.	Joshi P.C.	-
36.	National Solar Energy Convention-1981, Bangalore, 22-24 January 1982.	Rangarajan S.	Integrated study of solar and wind power availability in India - Rangarajan S. and Mani A.
37.	Ninth Forecasting Officers' Conference, India Meteorological Department, Pune, 28 January - 1 February 1982.	Singh S.V. and Singh S.S.	-
38.	Regional Conference on 'Climate for Africa', Arusha, Tanzania, 25-30 January 1982.	Mani A.	Methodologies for the assessment of solar energy potential - (Invited Talk) Mani A.
39.	Sixtysecond Annual Convention of 'The Institution of Engineers (India)', Bombay, 29 January - 2 February 1982.	Sharma S.K.	Simple gadget for collection of cloud rain water from aircraft - Sharma S.K.
40.	Meeting of the Heads of Department, called by the Hon'ble Minister of Tourism and Civil Aviation, New Delhi, 3 February 1982.	Mooley D.A.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
41.	National Space Science Symposium, Indian Institute of Science, Bangalore, 3-6 February 1982.	Kapoor R.K., Mukherjee B.K., Reddy R.S. and Mahajan P.S.	i) Atmospheric aerosols - their role in precipitation - Chatterjee R.N. and Kapoor R.K. ii) Comparative study of the satellite derived low level cloud motion vectors and surface winds observed by research ships over the Indian ocean during summer Monex - Sikka D. R. and Mahajan P.N. iii) Solar flare proton events under global total ozone during August 1972 - Reddy R.S., Mukherjee B.K. and Ramana Murty Bh.V. iv) Study of low-latitude stratospheric radiances as obtained from Nimbus-3 satellite - Mukherjee B.K., Reddy R.S., Pavgi S.B. and Ramana Murty Bh.V.

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
			v) Wave disturbances in the lower stratosphere in the equatorial region - Raja Rao K.S. and Nair M.V.H.
42.	Third Conference of Indian Geographers, University of Poona, Pune, 7-8 February 1982.	Gondhalekar Y.S.	Climatic influence on the yield of Jowar (Rabi) in district of Pune - Gondhalekar Y.S.
43.	Eighth Session of the W M O Commission for Atmospheric Sciences, Melbourne, Australia, 8-19 February 1982.	Ramana Murty Bh.V.	Led one-man delegation from India.
44.	Symposium on 'Local Severe Storms', Calcutta, 17-18 February 1982.	Kamra A.K., Chatterjee R.N. and Mukherjee B.K.	i) Cloud microphysics versus synoptic situation - Kapoor R.K., Chatterjee R.N., Paul S.K. and Sharma S.K.
			ii) Phenomenon of rain gush in thunderstorms - Kamra A.K.
45.	Planning Commission's Review meeting for the Quarter October-December 1981, New Delhi, 5 March 1982.	Chatterjee R.N.	-

Sr. No.	Seminar/Symposium/ Meeting	Participant(s)	Paper presented (if any) - Author(s)
46.	Conference on 'Air Pollution', National Productivity Council, New Delhi, 23 March 1982.	Khemani L.T.	-
47.	Fourth meeting of the 'Working Group on Rocket Payload', IITM, Pune, 25 March 1982.	Kamra A.K., Vernekar K.G. and Brij Mohan	-
48.	Seminar on 'Uttarkhand Himalayas and its environments' Srinagar, Garhwal, U.P., 25-27 March 1982.	Kulkarni A.K.	Study of maximum and probable maximum rainfall over Uttarkhand Himalayas and its neighbourhood - Dhar O.N., Kulkarni A.K. and Mandal B.N.

6. COLLABORATION WITH UNIVERSITIES AND OTHER SCIENTIFIC INSTITUTIONS

6. Collaboration with Universities and other Scientific Institutions/Organisations

6.1 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.

Dr. S.S. Singh and Dr. S. Rajamani, S.S.O.Is were recognised by the University of Poona as teachers to impart instructions in the Post-graduate course (by Research) in Physics (Meteorology/Atmospheric Sciences).

Dr. D.A. Mooley, Assistant Director, was appointed by the University of Poona as an examiner of a Ph.D. thesis entitled, 'Climatology of Maharashtra'.

On invitation from the University of Calcutta, Dr. D.A. Mooley, Assistant Director, worked as a member of the Board of Examiners of M.A./M.Sc. Examination in Geography and evaluated papers in Meteorology for the Examination held in April 1981.

As requested by Shivaji University, Kolhapur, Dr. Y.S. Gondhalekar, Senior Scientific Assistant, reviewed the following two books entitled, i) Introduction to Climatology and ii) Agricultural Geography of India, for prescribing for the degree classes in Geography.

Dr. Y.S. Gondhalekar, Senior Scientific Assistant, was co-opted as a member of the Board of Studies in Geography and Meteorology of Shivaji University, Kolhapur for a term of three years (1982-84).

Shri P.M. Mohamed Ismail, Scientific Assistant was awarded M.Sc. degree by the University of Poona for his thesis entitled, 'The problem of adequacy of raingauge network for the estimation of rainfall in the tropics'.

A thesis entitled, 'High level warmings over the tropics and some related aspects of the middle atmosphere', by Shri B.K. Mukherjee, Junior Scientific Officer, was submitted to the University of Poona, for the award of Ph.D. degree in Physics.

6.2 Collaboration with Scientific Institutions/ Organisations

On invitation from the India Meteorological Department, Pune, Dr. D.A. Mooley, Assistant Director participated as a member of the Board for Viva-Voce examination, for Meteorologist Gr.II trainees at the end of 'B' phase of the training, held on 23 and 24 April 1981 and 21 September 1981.

As desired by the Director General of Meteorology, Dr. D.A. Mooley, Assistant Director, prepared an article on 'Use of Climatic Data for Indian Agriculture', for possible inclusion in the WMO report on the International symposium on 'Meteorological Aspects of Tropical Drought' held at New Delhi from 7 to 11 December 1981.

On a request from the Deputy Director General of Meteorology (Weather Forecasting), Dr. D.A. Mooley, Assistant Director, gave a lecture on 'Synoptic Climatology of India' on 18 August 1981 and 5 March 1982 to the first and second batches of Meteorologist Gr.II trainees.

On an invitation from the College of Engineering, Pune, Shri R. Suryanarayana, Assistant Director, delivered a lecture on 'Computer in Atmospheric Sciences', to the participants of the summer school in 'Information Systems and Data Processing' on 27 May 1981.

Dr. A.K. Kamra, Assistant Director, imparted training to the first batch of Meteorologist Gr.II trainees of India Meteorological Department in 'Atmospheric Electricity and Weather Modification' from 10 to 30 June 1981.

Dr. A.K. Kamra, Assistant Director, served on the Viva-Voce board for the examination of the first and second batch of Meteorologist Gr.II trainees of India Meteorological Department on 5-6 August 1981 and 27 January 1982 respectively.

Shri D.R. Sikka, Assistant Director, was nominated as a member of the working groups on i) 'Atmospheric Dynamics of the Indian Middle Atmospheric Programme' (IMAP) by the Advisory Committee for Space Sciences (ADCOS), Bangalore, and (ii) 'Modelling of Tropospheric Stratospheric Circulation of the Indian Middle Atmospheric Programme', by P.R.L., Ahmedabad. He was invited to serve on the Reconstituted Editorial Board of the Proceedings of Indian Academy of Sciences, Earth and Planetary Sciences, Bangalore.

Shri D.R. Sikka, Assistant Director, delivered three lectures on 'Large scale aspects of summer monsoon' at the UNESCO sponsored workshop on 'Monsoon Dynamics' held at Dacca, Bangla Desh during 27 January - 4 February 1982. He accepted the membership of the 'Indian National Committee on World Climate Programme' and 'Working group on 'Meteorology and Oceanography' of the Indian National Committee of I.U.G.G., on invitation of Indian National Science Academy, New Delhi.

At the invitation of the Deputy Director General of Meteorology (Weather Forecasting), Pune, Shri D.R. Sikka, Assistant Director, delivered two lectures on i) Summer Monex - its scientific objective and present state of research and ii) Tropical cyclones, on 11 and 14 August 1981 to the Meteorologist Grade II trainees of India Meteorological Department.

On invitation, Shri D.R. Sikka, Assistant Director, delivered a lecture on 'Weather in the Making' at Fergusson College, Pune on 4 January 1982.

Dr. A.S.R. Murty, Assistant Director and Shri L.T. Khemani, Junior Scientific Officer, visited the Air Monitoring Section, Bhabha Atomic Research Centre (BARC) and had discussions with the scientists of BARC regarding collaboration programme between the BARC and this Institute for the measurement of atmospheric carbon-dioxide.

Shri K.G. Vernekar, Senior Scientific Officer, Gr.I, was nominated as a member of i) Inter Working Group Campaign on I.M.A.P. - Stratospheric Warming and ii) Sub-group on 'Campaign on IMAP-Mesospheric Temperature'.

On invitation from the Meteorological Office, Pune, Shri H.N. Bhalme, Senior Scientific Officer Gr.I, worked as a member of the Board for Viva-Voce test for Meteorologist Gr.II trainees at the end of 'B' phase of training.

At the request of the Director, Engineering Staff College, Nasik, S/Shri P.R. Rakhecha, Senior Scientific Officer, Gr.II and A.K. Kulkarni, Junior Scientific Officer, delivered five lectures during 17 - 21 April 1981, on the topic 'Rainfall and Hydrometeorology with special reference to Maharashtra', to the trainees undergoing the River Engineering Course for the Junior Engineers and Deputy Engineers of the Irrigation Department of Maharashtra.

Shri A.K. Kulkarni, Junior Scientific Officer, delivered lectures on 'The Hydromet Studies that are being carried out in the Institute' to the following groups of visitors :

i) Trainee Engineers from The Staff Engineering College, Nasik on 27 April 1981, ii) M.Sc. Students from the Department of Marine Sciences, University of Cochin on 30 April 1981, iii) Medical Officers from the Department of Preventive and Social Medicine, B.J. Medical College, Pune on 7 November 1981 and iv) Trainee Officers from the Air Force Administrative College, Coimbatore on 16 March 1982.

Six scientific papers on 'Hydrometeorology', received from different scientific journals were refereed by the officers of the Hydromet project at the request of the respective Editors.

7. FACILITIES FOR RESEARCH EXTENDED TO OTHER INSTITUTIONS

7. Facilities for Research extended to other Institutions

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

Shri D.V. Ahire, who had earlier been awarded the Air India Research Fellowship continued his work in the Project, 'Simulation in Cloud Physics', currently being pursued in the Instrumental and the Observational Techniques Division of the Institute.

Guidance and laboratory facilities were provided to two students of Sir Parshuram Bhau College, Pune for undertaking projects in Cloud Physics as a part of their T.Y.B.Sc. Course.

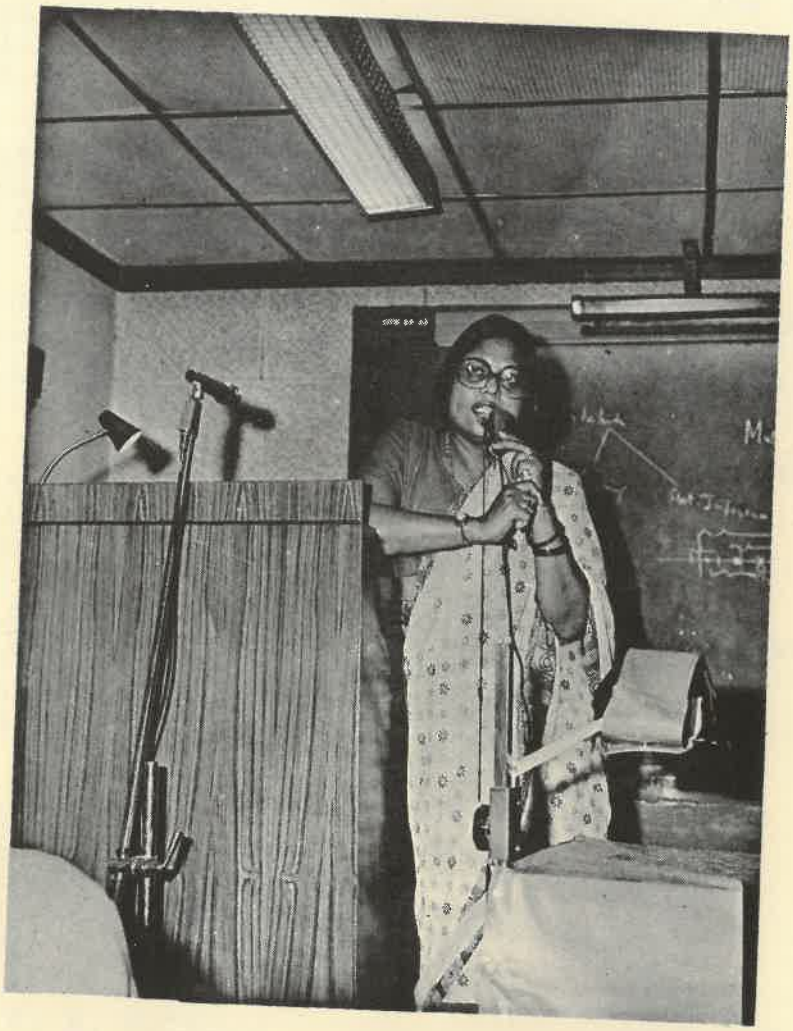
8. VISITORS

8. Visitors

The Institute welcomed the following visitors, during the year under review :

Sr. No.	Visitor - Credentials	Date of Visit
1.	Dr. Tcheremissive Felex, Sr. Scientist, Aerodynamics and Computation Mathematics, Computer Centre of the USSR Academy of Sciences, USSR.	16 and 17 April 1981
2.	Prof. Jaya Srivastava, Professor of Statistics and Mathematics, Colorado University, U.S.A.	23 - 25 April 1981
3.	Shri R.C. Patel, Junior Engineer, Central Design Organisation, Irrigation Department, Government of Gujarat.	29 and 30 April 1981
4.	Prof. S.V.C. Aiya, Consulting Electronics Engineer, Bangalore.	16 May 1981
5.	Major G. S. Thosar, Retired Army Engineer, Pune.	12 June 1981
6.	Shri V.S. Patel, Assistant Agricultural Meteorologist and Shri M.J. Chaudhari, Agricultural Supervisor, Directorate of Agriculture, Ahmedabad.	24 - 26 June 1981

Sr. No.	Visitor - Credentials	Date of Visit
7.	Shri N. P. Vithal, Commissioner of Railway Safety, Bombay.	2 July 1981
8.	Dr. P. K. Parkale, Head, Department of Farm Machine and Power, Mahatma Phule Agricultural University, Rahuri. and Dr. S. T. Koratkar, Research Engineer, College of Agriculture, Pune.	14 July 1981
9.	Dr. R. N. Keshavamurty, Physical Research Laboratory, Ahmedabad.	3 and 4 August 1981
10.	Mr. Mike Douglas, Florida State University, U.S.A.	4-7 August 1981
11.	Prof. M. C. Varshneya, Head, Department of Physics, Mahatma Phule Agricultural University, Rahuri. and Dr. R. K. Parkale, Head, Department of Farm Machine and Power, Mahatma Phule Agricultural University, Rahuri.	11 August 1981



Prof. Jaya Srivastava, Colorado University,
giving a seminar

Sr. No.	Visitor - Credentials	Date of Visit
12.	Prof. Ronald B. Smith, Department of Geophysics, Yale University, U.S.A.	18 and 22 August 1981
13.	Prof. S. R. Gogawale, Department of Physics, S. P. College, Pune.	7 September 1981
14.	65 Officers from Defence Service Staff College, Wellington.	19 and 23 September 1981
15.	Dr. S. M. Seth, Scientist (E), National Institute of Hydrology, Roorkee.	10 November 1981
16.	Prof. V.V. Sinnarkar, Professor of Agricultural Engineering, College of Agriculture, Pune. and Shri Pacharne, Assistant Professor, Agricultural Engineering, College of Agriculture, Pune.	17 November 1981
17.	Dr. S. M. Holi, Principal, Shri Sharanabasaveshwara College, Gulbarga, Karnataka.	19 November 1981
18.	Prof. R.P. Pearce, Professor and Head of the Department of Meteorology, Reading University, U.K.	17-19 December 1981

Sr. No.	Visitor - Credentials	Date of Visit
19.	Shri K. S. Rama Shastri, Scientist 'C', National Institute of Hydrology, Roorkee.	23 December 1981
20.	Shri V.L. Kerhalkar, Deputy Chief Engineer, Load Despatch, M.P. Electricity Board, Jabulpur, M.P.	31 December 1981
21.	Shri K. Kailashnathan, Scientist, Water Technology Centre, Indian Agricultural Research Institute, New Delhi.	4 January 1982
22.	Dr. P. B. Kukreja, Deputy Director (Hydromet), Central Water Commission, New Delhi.	1 February 1982
23.	Dr. J. Shukla, Goddar Space Flight Centre, NASA, U.S.A.	9 and 10 February 1982
24.	Dr. T. Nitta, Assistant Professor, Geophysical Institute, Faculty of Science, University of Tokyo, Japan.	15 February - 30 March 1982
25.	Dr. S. K. Trikha, Department of Physics and Astrophysics, University of Delhi, Delhi.	18 February 1982

Prof. Kebede, Sr. Officer, Ethiopean Meteorological Service, having discussions with the Institute's scientists

Director and senior scientists of the Institute alongwith a group of visiting scientists

Sr. No.	Visitor - Credentials	Date of Visit
26.	Prof. (Smt.) S. Gadgil, Indian Institute of Science, Bangalore.	19 and 20 February 1982
27.	A team of five scientists returning from 'The Monsoon Dynamics' Workshop at Dacca, Bangla Desh.	26 February 1982
28.	S/Shri G.A. Shomefun, M.C. Anilekwena and J.O.Olaleye, Meteorologists from Nigeria.	2 March 1982
29.	Shri D. Krishna Rao, Director (Retd.), Aviation Services, India Meteorological Department.	6 March 1982
30.	A batch of 7 Trainee Officers, Air Force Administrative College, Coimbatore.	15-16 March 1982
31.	Miss Asslefech Kebede, Senior Officer, Ethiopian Meteorological Service.	27 March 1982

9. GENERAL

9. General

9.1 Construction of Institute's Buildings and Staff Quarters.

The first phase of construction of Institute's building at Pashan, Pune was completed and the building was taken over from CPWD. The shifting of some of the functional laboratories to the new building was initiated.

The construction work of staff quarters was commenced while the construction of workshop building was nearing completion.

9.2 Transfer of Movable and Immovable Properties.

Consequent upon autonomy of the Institute, the deed for transfer of movable and immovable properties, vested in the Government of India under the I.M.D., was executed and registered at the office of the Registrar, Tis Hazari, New Delhi, on 16 September 1981.

9.3 Facilities

9.3.1 Library, Information and Publication

a) Library

During the year, 312 books in meteorological and allied subjects were added and 57 periodicals of national and international repute were subscribed to. A large number of useful scientific/technical reports were also added to the library.

b) Donation of Books

Dr. K.S. Raja Rao, Retd. Director, I.M.D. and Emeritus Scientist attached to the I.I.T.M., donated a valuable collection of 'Journal of Geophysical Research' for about 16 years from January 1964.

c) Exhibition

An exhibition was arranged on the occasion of the Institute's symposium on 'Environmental Physics and Atmospheric Boundary Layer'. India Meteorological Department and Six private companies from Bombay dealing in Scientific Instruments also participated in the exhibition.

d) Planning

Annual Plan (1982-83) was revised and forwarded to the Ministry of Tourism and Civil Aviation, Government of India. Progress Reports of the Plan Scheme were forwarded to the Ministry of T. and C. A. for the Quarterly Meetings of Planning Commission.

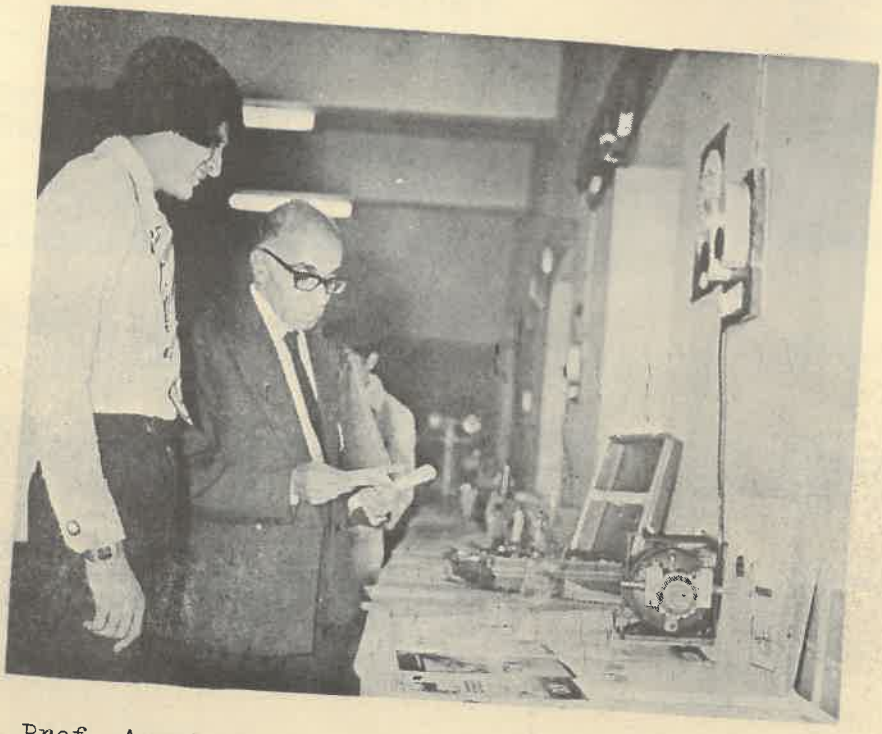
9.3.2 Computer

The IBM 1620 computer worked during the year as follows :

	Hrs	Mts
Institute's Jobs	1335	40
Data processing of I.Met.D.	188	25
Breakdown/Maintenance	84	55
Paying Users	43	00

Radar Observations, relating to the Monex level II-b data pertaining to 8 stations for the Monex-79 period, sent by the International MONEX Management Centre (IMMC) New Delhi, were punched and verified (Approx 15000 cards).

Prof. Koteswaram appreciating the exhibits



Prof. Ananthakrishnan going round the exhibition.

At the request of the Mathura Refinery Unit of the office of the Director General of Meteorology, New Delhi, the meteorological data (approx. 36,000 cards) collected by them were printed on the Institute's computer.

9.3.3 Workshop

Various jobs on fabrication and maintenance of instruments were done during the year. The major jobs completed include the fabrication of thermal diffusion chamber, drag plate, Lyman alpha humidity sensor and different parts of rocket payloads.

9.4 Training

9.4.1 The following staff members were sponsored for undergoing training in Meteorology conducted by the India Meteorological Department, Pune, as shown below :

Sr. No.	Name of the Trainee	Meteorological Training Course
1.	Dr. L.S. Hingane, Senior Scientific Officer, Gr.II.	Advanced
2.	Dr. P.C. Joshi, Senior Scientific Officer, Gr.II.	Advanced
3.	Shri P.N. Mahajan Senior Scientific Assistant	Advanced
4.	Shri N.C. Mandal Junior Scientific Officer	Advanced
5.	Shri P. Seetharamayya, Junior Scientific Officer	Advanced

Sr. No.	Name of the Trainee	Meteorological Training Course
6.	Shri D.R. Talwalkar, Senior Scientific Assistant	Advanced
7.	Smt. S.S. Vaidya, Senior Scientific Assistant	Advanced
8.	Shri H.P. Borgaonkar, Scientific Assistant	Intermediate
9.	Shri A.A. Munot, Scientific Assistant	Intermediate
10.	Shri M.W. Sonawane, Scientific Assistant	Intermediate
11.	Shri D.R. Kothawale Junior Scientific Assistant	Elementary
12.	Shri S.D. Patil Junior Scientific Assistant	Elementary

Dr. P.C. Joshi and Dr. L.S. Hingane, Senior Scientific Officers, Gr.II, were deputed to undergo a special course on 'Atmospheric Sciences' at the Indian Institute of Science, Bangalore, from 5 January to 17 April 1982.

9.4.2 UNDP Training

The following scientists of the Institute were deputed for training under UNDP :

1. Dr. D. Subrahmanyam, Senior Scientific Officer, Gr.II, for training in the field of 'Dynamic Instability of Tropical Flows' at the Florida State University, Tallahassee, U.S.A. for a period of one year from 20 March 1981.

2. Dr. (Mrs.) A.M. Selvam, Senior Scientific Officer, Gr.I, for training in the field of 'Cloud Dynamics and Cloud Modelling' at Colorado State University, Fort Collins, U.S.A. for a period of Six months from 15 April 1981.

3. Shri R.K. Verma, Senior Scientific Officer, Gr.II, for training in the field of 'Extended Range Prediction' at the European Centre for Medium Range Weather Forecasts (ECMWF), Reading, U.K. and at the NOAA's facilities in U.S.A. for a period of four months from 1 May 1981.

4. Dr. G.B. Pant, Senior Scientific Officer, Gr.I, was on deputation to U.S.A. for undergoing an advanced training in the field of 'Climatic Change' for a period of six months from 14 January 1981. He worked on the problems of dendroclimatology at the Lamont-Doherty Geological Observatory, Columbia University, New York and the Tree-ring Research Laboratory, University of Arizona.

9.5 Institute's Research Fellowship

Kumari K. Indira and Shri S.A. Saseendran who had earlier been awarded the Fellowship, continued their work in their respective fields.

9.6 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 22nd meeting of the Governing Council of the Institute was held at the India Meteorological Department, New Delhi on 14 September 1981.

9.7 Lectures

Dr. Tcheremissive Felex, Sr. Scientist, Aerodynamics and Computation Mathematics, Computer Centre of the USSR Academy of Science, USSR, delivered a lecture on 'Numerical method for the solution of the Boltzmann kinetic equation and its possible application to the problem of rain drop formation', on 16 April 1981.

Prof. Jaya Srivastava, Professor of Statistics and Mathematics, Colorado University, U.S.A., delivered a lecture on 'Statistical Planning' on 25 April 1981.

Prof. S.V.C. Aiya, Consulting Electronics Engineer, Bangalore, delivered a lecture on 'Some characteristics of Tropical lightning', on 16 May 1981.

Dr. R.N. Keshavamurty, from Physical Research Laboratory, Ahmedabad, delivered the following two lectures on 3 and 4 August 1981 :

i) The southern oscillation sensitivity studies with a global general circulation model and

ii) Stability of monsoon flow.

Mr. Mike Douglas, from Florida State University, U.S.A., delivered a lecture on 'Thermal structure of monsoon depressions', on 7 August 1981.

Prof. Ronald B. Smith, from Yale University, U.S.A., spoke on 'The theory of heat addition to a stratified air-stream with application to the orographic

rain, the coastal low and mountain thrust near Western Ghats' on 21 August 1981.

Prof. R.P. Pearce, Head of the Department of Meteorology, Reading University, U.K., delivered a talk on 'Recent advances in large-scale atmospherics' on 18 December 1981.

Dr. J. Shukla, Goddard Space Flight Centre, NASA, U.S.A., delivered a lecture on 'Predictability of monthly and seasonal means of meteorological parameters' on 10 March 1982.

9.8 Institutional Seminars

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

Speaker	Topic	Date
Shri P.P. Kamte, Senior Scientific Officer, Gr.II.	Application of stochastic Markov chain model to frequency of heavy precipitation during summer over India.	26 June 1981
Dr. P.C.S. Devara, Senior Scientific Officer, Gr.II.	Radio meteors and upper atmospheric wind investigations using meteor radar technique.	8 and 10 July 1981

9.9 Official Language Implementation

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

The staff members not trained in Hindi were deputed for attending Hindi language/Hindi typewriting classes.

One L.D.C. passed Pragya examination in Hindi.

One post of Hindi Officer was created in the Institute and necessary action was being taken to fill up the post.

The Annual Report (1980-81) and the Institute's contribution to the Ministry's Annual Report were forwarded in Hindi to the Ministry of Tourism and Civil Aviation, Government of India.

On behalf of the Institute, Dr. A.K. Kamra, Assistant Director, attended the meeting of the Town Official Language Implementation Committee held on 24 September 1981, at the Office of the Controller of Southern Command, Pune.

9.10 Employment of ex-servicemen

Reservation for ex-servicemen was made at the rate of 10% in Group 'C' and 'D' posts at the Institute. The percentage of ex-servicemen at the Institute vis-a-vis total group of B, C and D was as follows :

Group	B	4
Group	C	1
Group	D	14

9.11 Budget, Accounts and Audit

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

Figure : Rs. in lakhs

	Budget Estimates	Approved Revised Estimates	Actual Expenditure	Short fall
Non-Plan	61.38	59.00	56.11	2.89
Plan	27.00	27.00	26.76	0.24

The shortfall in expenditure was 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. 86.00 lakhs including unspent balance of the previous year. Out of this, an amount of Rs. 82.87 lakhs approx. was spent during the year 1981-82.

Audit of the Institute's accounts for the year 1981-82 was conducted by M/s Kirtane and Pandit, Chartered Accountants, Pune.

9.12 National Integration

The Institute observed the 'Quamy Ekta Week' from 19-25 November 1981. The employees of the Institute took a solidarity pledge on 19 November 1981.

APPENDIX - I

Names and Addresses of Members of Governing Council, Indian Institute of Tropical Meteorology, Pune - 5.

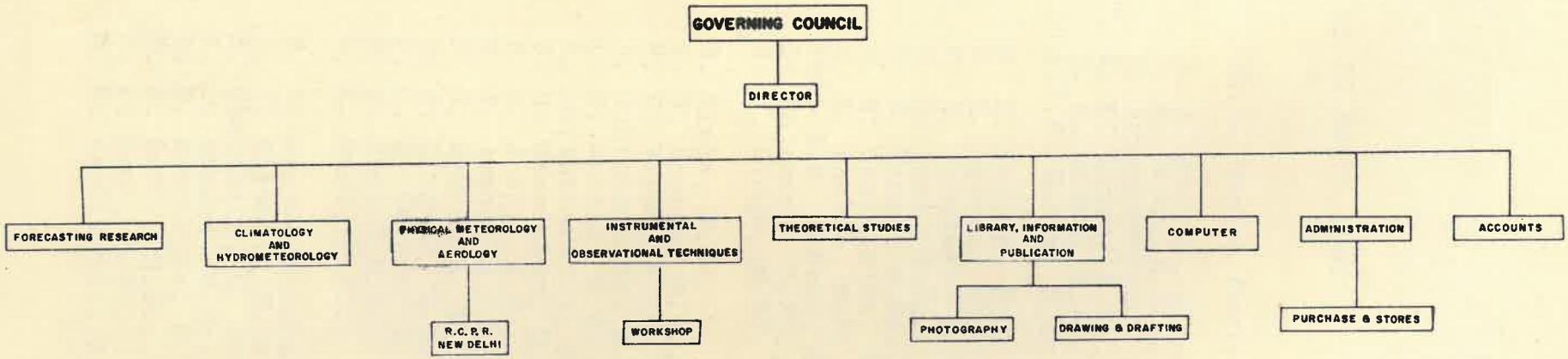
1.	Dr. P. K. Das, Director General of Meteorology, Mausam Bhavan, Lodi Road, New Delhi 110 003.	Chairman (Ex-Officio)
2.	Shri C. M. Chaturvedi, Joint Secretary, Ministry of Tourism and Civil Aviation, Sardar Patel Bhavan, Parliament Street, New Delhi 110 001.	Member
3.	Shri S. K. Das, Additional Director 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, Visakhapatnam 530 003 (A.P.)	Member

6.	Prof. R. Narasimha, Department of Aeronautical Engineering, Indian Institute of Science, Bangalore 560 012.	Member
7.	Prof. M. P. Singh, Head, Centre for Atmospheric Sciences, Indian Institute of Technology, Hauz Khas, New Delhi 110 029.	Member
8.	Dr. V.V.R. Varadachari, Director, National Institute of Oceanography, Goa 403 004.	Member
9.	Dr. Bh. V. Ramana Murty, Director, Indian Institute of Tropical Meteorology, Ramdurg House, University Road, Pune 411 005.	Member
10.	Shri D. W. Kshirasagar, Administrative Officer, Indian Institute of Tropical Meteorology, Pune 411 005.	Non-member Secretary

MINISTRY OF TOURISM & CIVIL AVIATION, GOVERNMENT OF INDIA

INDIAN INSTITUTE OF TROPICAL METEOROLOGY

ORGANISATIONAL PROFILE



Officers as on 31 March 1982

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. S. V. Singh, M.Sc.
Senior Scientific Officers, Grade II	:	S. Sinha, M.Sc. P. N. Sharma, M.A., Grad. I.T.E. R. K. Verma, M.Sc. D. Subrahmanyam, 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. P. P. Kamte, M.Sc. D. K. Paul, M.Sc.
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Accounts Officer	:	A. N. Limaye, M. A.
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Concluding session of the Symposium

Valedictory Speech