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1983-84

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India

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### Introduction

I have great pleasure in presenting the Institute's Annual Report for the year 1983-84. The Institute pursued its research and allied activities with vigour and dynamism. Efforts were also continued to improve the laboratory facilities and other infra-structure. In the following paragraphs, I wish to mention some of the note-worthy activities of the Institute during the year.

The Institute participated, in collaboration with the National Institute of Oceanography (NIO), Goa, in a field observational programme on board Gaveshani during 8-20 May 1983 for the study of characteristics of marine boundary layer over the Indian seas. During this experiment measurements on several parameters relating to atmospheric chemistry, cloud physics, atmospheric electricity and boundary layer were undertaken.

A Dendroclimatology laboratory with facilities for preparation of tree-ring samples as well as for their microscopic analysis and ring-width measurement was established at the Institute.

A CW Argon Ion laser radar system with operating wavelengths 4880A° (blue line) and 5145A° (green line) was acquired by the Institute as a radar facility for remote sensing of atmospheric aerosols.

Institute's Field Research unit at Bangalore processed and analysed the surface and upper wind data for the period 1958-1970 and brought out a publication entitled 'Wind Energy Data for India'. The publication contains 96 maps and diagrams and 623 tables of wind speed and energy data. The project was completed with the financial assistance provided by the Commission for Additional Sources of Energy, Department of Nonconventional Energy Sources.

The Institute had earlier (in November 1981) organised a symposium at Pune on 'Environmental Physics and Atmospheric Boundary Layer'. As a follow-up of the recommendations made in the symposium, the Institute has started issuing a Newsletter on "Environmental Physics and Atmospheric Boundary Layer". The Newsletter covers the work being carried out in these fields at different research organisations in the country.

The Seventh Five Year Plan (1985-90) proposals, covering an outlay of Rs.6.25 crores, together with a write-up on perspective planning for the ensuing decade (1990-2000) were submitted by the Institute. The new Plan (1985-90) includes six new research projects and Capital Works for the completion of the Institute's building at Pashan (Pune).

At the request of the Dam Review Panel Committee for the Narmada Sagar Dam and the Chief Engineer, Planning & Monitoring, Government of Madhya Pradesh, the Institute undertook hydro-meteorological studies for evaluation of design storm for the Narmada river basin up to Narmada Sagar dam site. The Institute also provided necessary technical guidance to a team of Engineers deputed by the Government of Madhya Pradesh.

Under the Technical Co-operation Scheme (TCS) of the Colombo Plan, Mr. Basman D. Talib, Meteorologist, Typhoon Moderation Research, Pagasa, Oregon, Philippines was attached to the Institute for training in Meteorology (Weather Modification) for a period of one month from 30 June 1983.

The Institute was included among the organisations participating in the Indo-U.S. Collaborative Programme on Monsoon Research, being co-ordinated by the Department of Science and Technology (DST), Government of India. Dr. S.S. Singh, Senior Scientific Officer, Grade I of the Institute was deputed by the DST from 19-29 September 1983 to U.S.A. as a member of the Indian delegation to initiate the research programme.

Two scientists of the Institute received training, under UNDP Fellowship programme, in the fields of (i) Instrumentation for cloud physics and weather modification and (ii) Hydrometeorology, in USA and Australia respectively.

Institute's scientists participated in a number of important national and international seminars/symposia/conferences. Specific mention may be made of the following five conferences for which Institute's scientists were invited:

- i) XVIII General Assembly, International Union of Geodesy and Geophysics (IUGG) and Symposium of the International Association of Geomagnetism and Aeronomy (IAGA), IUGG, Hamburg, West Germany from 15 to 27 August 1983;
- ii) Second International meeting on Statistical Climatology, Lisbon, Portugal from 26 to 30 September 1983;
- iii) 15th Session of the EC Panel/CAS working Group on Cloud Physics and Weather Modification, World Meteorological Organisation, Geneva, Switzerland from 12 to 17 December 1983;
- iv) XIII International Conference on Stochastic Processes and their Applications, Banaras Hindu University, Varanasi, India from 17 to 21 December 1983;
- v) National Space Science Symposium, University of Poona from 7 to 10 December 1983.

The Institute & sponsored the following two symposia during the year: (i) National Space Science Symposium at Pune from 7-10 December 1983 and (ii) Seminar on 'Tropical Cyclones and Disaster Preparedness' at Bhubaneshwar from 11-14 January 1984.

Institute's cloud seeding experiment in the Baramati and Sirur regions of Maharashtra was conducted for the eighth monsoon season from 04 July to 09 September 1983 on 13 pairs of days (26 days).

The Institute received permanent recognition from the University of Poona for prosecuting advanced Postgraduate studies leading to the award of M.Sc. (partly by papers and partly by research) and Ph.D. degrees in Atmospheric Sciences.

Two scientists of the Institute were awarded Ph.D. degree and one scientist M.Sc. degree by the University of Poona.

Shri D.R. Sikka, Assistant Director was elected as a Fellow of the Indian Academy of Sciences, Bangalore.

Dr. P.E. Raj, Junior Scientific Officer was awarded 'Prof. P.T. Rao Shastiabdhipoorthy Prize' for his Ph.D. thesis entitled, 'Studies on some F-region phenomena and sporadic-E at Waltair using phase path technique', submitted to the Andhra University, Waltair.

Shri S.K. Sharma, Mechanical Assistant, was awarded 'B.P. Kapadia Memorial Prize', for his paper entitled, 'Sequential equipment for continuous monitoring of gaseous pollutants in the atmosphere', presented at the 64th Annual Convention of The Institution of Engineers (India) held at Patna during 2-6 February 1984.

Scientists of the Institute contributed 30 research papers to scientific journals of national/international standing and published 15 research papers in the proceedings of different symposia/seminars.

Dr. O.N. Dhar, Assistant Director (Retd.) was awarded with a position of Emeritus Scientist in the Institute.

The Institute provided facilities to Dr. G.C. Asnani, Asst. Director (Retd.) and formerly Professor, University of Nairobi (Kenya), for continuing his research programme.

Further progress was made in the Capital Works Programme of the Institute. The Institute's Workshop started functioning in the newly constructed workshop building at Pashan, Pune. Construction of staff quarters also witnessed a satisfactory pace of progress. Construction of 24 staff quarters and 8 transit type accommodation were completed by the CPWD. Construction of 32 Type III staff quarters was also nearing completion.

A detailed account of the activities of the Institute during the year 1983-84 is reflected in the following pages.

Pune

Bh. V. Ramana Murty September 1984 Director

### Research High-lights

A five-level primitive equation numerical weather prediction model (pressure coordinate) was successfully integrated up to 48-hours on a case of monsoon depression. The model produced satisfactory forecast about the motion of the depression, distribution of large scale rainfall and other structural features.

A five-level primitive equation global spectral model was developed for simulation of monsoon and tropical circulation systems.

Studies made on the barotropic and baroclinic instability of the atmospheric flow indicated that the Ekman boundary layer friction played an important role in determining the zonal scale of the monsoon depression.

Energy conversions associated with a monsoon depression of 4 to 10 July 1973 were studied. It was shown that with the strengthening of the monsoon flow associated with the intensification of the depression, northward transport of momentum and the southward transport of heat also increased.

Analysis of data for the period 1951-80 suggested an inverse relationship between the anomaly of the mean monthly northern hemispheric surface temperature during winter season and the anomaly of the rainfall over India during the ensuing summer season.

The contribution of the winter precipitation over the eastern Himalayas was found to be meagre in building up the seasonal snow cover.

Climatological studies revealed the existence of two 20-year periods (1901-1920 & 1961-1980) in the All-India rainfall series having the highest incidence of droughts i.e. 4 to 5 drought years in each period. Also, it was found that the 10-year running mean average rainfall in the All-India rainfall series from 1899 to 1953 indicated a rise of about 10 cm.

The one-day probable maximum precipitation (PMP) over the north Indian plains was found to range from 45 to 110 cm. The maximum 1-day and 10-day duration rainfalls for the stations in Kerala were found to range from 21 to 53 cm and from 62 to 243 cm respectively. No association was found to exist between the rainfall of the southwest monsoon and that of the northeast monsoon for Kerala.

The total carbon budget in the Indian plant ecosystem was estimated. It was found that 9.41 x 10<sup>15</sup> gm of carbon was accumulated in the Indian plant ecosystem which was 1.68% of the total global carbon pool in the plant ecosystem.

A study made showed that the dominant source for the production of carbon di-oxide in the country was the consumption of firewood.

An instrument for measuring the atmospheric electrical conductivity from aircraft was designed, fabricated and calibrated.

Six cup-anemometers of magnetic-chopper type were developed for boundary layer studies.

2. RESEARCH AND DEVELOPMENT

2. Research and Development

The details of research work carried out under various research projects are given below:

- 2.1 Forecasting Research Division-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.

Development of the five level primitive equation (P.E.) model.

A five-level primitive equation (P.E.) model (pressure coordinate), which was under development for the past few years, was successfully integrated upto 48-hrs on a case of monsoon depression. Several physical processes, viz. horizontal and vertical diffusion, air-sea interaction, cumulus convection, large scale condensation and dry convective adjustment were included in the model. Evaluation of the forecast results revealed the following:

- i) 24-hr forecast movement of the depression was better than the one produced by a P.E. barotropic model;
- ii) Distribution of large-scale rainfall was realistic in the forecast. However, the rainfall rates were under\_estimated;
- iii) Structural features such as, the cold core, the maximum vorticity and upward vertical velocity, associated with the depression were well predicted.

Further testing of the model was taken up using the FGGE III(b) data-set for the cases of monsoon depressions, which formed during the period June to August 1979.

The three level P.E. model was integrated for five days with the initial zonal wind profile having meridional and vertical shears typical of the Indian summer monsoon season. The effect of idealised low orography of India, Burma and Tibetan area (maximum height = 1 km.) on the evolution of the flow was investigated. The results showed formation of a trough on the lee-side of Burma mountains and another weak trough in the region of the head Bay of Bengal.

2.1.1.2 Multi-dimensional initialization for NWP models

The application of bounded derivative method, for obtaining the initial balance between the flow and the mass field over the Indian region for the shallow water equation was not found fully satisfactory.

Derivation of constraints between the mass and the wind fields for the initialisation of a six-level P.E. model in sigma coordinate system was attempted.

2.1.1.3 Objective analysis of meteorological fields for NWP models

Experiments were made, using the successive correction method to determine the optimum grid length for analysis of the wind field with the existing network of observing stations over India and neighbourhood. Objective wind analyses were performed for 700 mb level with different grid lengths viz. 1°, 2°, 2.5°, 3°, 4° and 5° for 31 days of July 1979. It was found that the root mean square error for the vector wind was minimum for the 3° grid length. A computer program was developed to plot the wind-vectors at grid points through a plotter routine.

Data over an extended region around India for three more years were collected for computing structure and autocorrelation functions at all standard levels for the wind, temperature and geopotential height fields. Further computations were carried out with a view to developing the multivariate optimum interpolation scheme for objective analysis.

An experiment was conducted to estimate the impact of variability of the wind analysis, on a dynamical forecast. The variability of the analyses was determined based on the grid-point data of a synoptic situation analysed by 16 different experienced meteorologists. The analyses were used as independent inputs to a non-divergent barotropic model. Considerable differences, found among the forecast wind field, were discussed in relation to variability in the analyses.

- 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

Monthly rainfall data of 290 stations and daily rainfall data of 380 stations were obtained from the India Meteorological Department for the period 1901-1980. Certain quality control checks were made on the daily rainfall data. The monthly data of 70 stations having records for all the 80 years were used to study the major spatial patterns with the help of

- i) Empirical orthogonal function analysis,
- ii) Chart-to-chart correlation method and
- iii) 'k-mean' clustering method.

Two main patterns obtained from these classifications showed deficient or excess rainfall over the western longitudes of the country.

Predictability of the monsoon circulation for July and August was examined by comparing the observed variance of the circulation fields (signal) to the natural variance (noise) attributable to the day to day variability. The signal and noise components were obtained on the basis of the analysis of 21 years of 700 mb contour heights and 30 years of sea-level pressure data. The study revealed that signal to noise ratio increased monotonically from north to south ranging from about two at 35°N to about seven at 5°N. This suggested high potential predictability of monsoon circulation on the monthly scale.

Pentad rainfalls during the monsoon season of 60 years were used to compute the following:

- i) Two-state viz. dry and wet transition probabilities for eight stations viz. Nagpur, Vishakhapatnam, Jaipur, Allahabad, Cochin, Ahmedabad, Simla and Calcutta, representing various climatic regimes and
- ii) Four-state viz. dry, light, moderate and heavy (depending upon certain specified thresholds of rainfall) transition probabilities for Pune.  $\chi^2$ -test showed significant persistence for all stations except Calcutta. A skill score of 0.24 was obtained when the four-state transition probabilities were used to forecast rainfall on three years of independent data.

The Empirical Orthogonal Functions (EOF) of monthly outgoing long-wave radiation over the Indian region (for all months) and the sea level pressure data (for the summer monsoon months only) over the north Indian ocean were determined for studying the major fluctuations in these fields. The first two functions for the pressure field, which together explained 60 percent of the variance, were found to be statistically significant by Monte Carlo simulation. The first two functions of the radiation fields explained about 90 percent of the variance. The first of these functions represented the annual cycle whereas the second one showed a see-saw relationship between north Indian and the equatorial regions.

### 2.1.2.2 Synoptic climatological studies

- a) Analyses of the last 100 years' data of the Northern-Hemispheric surface air temperature and large-scale monsoon rainfall activity over India, indicated a relationship between the temperature change and the monsoon rainfall variability on decadal and longer time scales. It was revealed that a warmer climatic epoch lasting for 4-decades (1921-1960) was associated with higher decadal-averages in monsoon rainfall, smaller coefficient of rainfall-variability and a very small frequency of monsoon failures. In contrast, the two cooler climatic epochs lasting for two decades each viz. 1901-1920 and 1961-1980, were associated with the lesser decadal-averages of monsoon rainfall, large coefficient of rainfall variability and greater frequency of monsoon failures.
- b) On the inter-annual scale during the last 3-decadal period (1951-1980), correlation analyses between the mean monthly Northern Hemispheric surface air temperature anomaly during winter and the summer monsoon rainfall of India, showed an inverse relationship. The relationship may provide a useful tool in long-range forecasting of monsoon, particularly in foreshadowing large-scale failure of the monsoon about 4 months in advance.
- c) The actual performance of the seasonal summer monsoon rainfall for India as a whole for 1983 was evaluated against the long-range forecast (outlook) for the season, on the basis of antecedent upper tropospheric parameters of May 1983. The actual rainfall happened to be above normal (about +12% departure from normal) vis-a-vis the forecast being normal (+5% departure from normal). The northern-hemispheric surface temperature anomaly during January and February 1983 had indicated an above normal (+16% departure) monsoon rainfall.

Several anomalous features of the regional monsoon circulation for the season of 1983, e.g. late onset, small number of depressions, absence of a typical break period vis-a-vis the above normal performance of the monsoon rainfall over the country, were under investigation with a view to understanding the regional anomalies in terms of the planetary scale features.

d) Surface/upper air mean monthly maps of pressure/geopotential height, temperature and wind for the months of May through September for India and the neighbouring region were prepared from a 10-year data set of 1967-1976 collected from the Monthly Climatic Data of the world.

### 2.1.3 Monex Studies

Studies relating to the dynamics of large scale monsoon systems utilising Monex 1979 and ISMEX-1973 data were continued. Further results obtained from these studies are as follows:

- a) The meridional transport of momentum, wave to wave and wave-zonal interactions obtained using monthly wind data for the year 1979 for the months April to August at 700 and 300 mb between the latitudes 48° 1'S and 48° 1'N were analysed. The analysis revealed the convergence of momentum between the equator and 10°N at 300 mb, leading to the weaker easterlies in 1979 during the summer monsoon months in the upper troposphere. In respect of energetics, the year 1979 showed similarity with the deficient monsoon rainfall year 1972 and stood in contrast to the good monsoon rainfall year 1967.
- b) For the months of May and June 1979, day to day amplitude, phase of meridional flux of angular momentum in wave number frequency domain at ~ 30°N and at 300 mb were computed with a view to investigate the large-scale features of the upper troposphere during early summer and to link these features or changes in circulation to the fluctuations in the activity of summer monsoon 1979.

- c) Further study on the fluctuation and characteristics of near equatorial oceanic Inter-tropical Convergence Zone (ITCZ) over the north Indian and the adjacent west Pacific ocean established a 30-40 day periodicity in both the basins between the epochs of intensification of oceanic ITCZ and its northward propagation from the near equatorial region to its near normal position (  $\sim$  20°N).
- d) Changes in the air-sea interactions (Sensible and latent heat flux) and in the characteristics of the atmospheric boundary layer (ABL) over the equatorial Arabian Sea for the undisturbed and disturbed ITCZ conditions during the onset phase of summer monex-79 were studied. When compared to the undisturbed conditions, the disturbed ones showed: increase of (i) difference between sea surface and air temperature by 2 to 3 times (ii) sensible heat flux by 4 to 5 times (iii) latent heat flux by 2 to 3 times and (iv) Bowen's ratio by about 2 times. Reduction of convective instability in the lowest one kilometer layer of the atmosphere due to cold down-drafts, initiated by the precipitation from the cumulus clouds was also evident in the disturbed ITCZ conditions.
- e) Momentum, sensible heat, latent heat and total heat flux were calculated to study the exchange process at the air-sea interface for the periods i) 21 May to 3 June and (ii) 8 to 18 June, using Monex-79 data obtained by the research vessel 'Gaveshani' over the East Central Arabian Sea. The results showed variations in these parameters which depended chiefly on the fluctuations in wind speed and air temperature rather than the ones in the sea surface temperature.
- f) Relationship between the satellite-derived high level winds and the upper atmospheric winds at 300, 250 and 200 mb observed by USSR research ships in the polygon formation during May, June and July 1979 was examined. The observed wind at 300 mb was found to be the best match for satellite derived wind. This relationship showed potential use of the wind data derived through geostationary satellites, such as INSAT, for

monitoring large scale fluctuations of high level monsoon circulation over the Indian ocean.

- g) Mean monthly upper air data for the stations located within the monsoon trough zone for July 1979 were used along with the normal data for the month of July for 20 years (1951-70) to compute the mass flux, sensible heat flux and latent heat flux in the lower and middle troposphere. Preliminary computations showed that the import of sensible heat and latent heat in the lower troposphere within the trough zone in July 1979 was almost half of the normal magnitude, whereas their export in the middle troposphere exceeded the normal magnitude by about 50%.
- h) Daily variations in the production of kinetic energy by the mean meridional circulation were computed from 1000 to 100 mb for the period 4 to 8 July 1979 over the Indian region. The result indicated the production of kinetic energy for 7 and 8 July and its consumption on 5 and 6 July. The results were in agreement with the intensification and weakening of depression during this period.
- i) Simultaneous formation of tropical vortices on either side of the equator during the transition seasons was studied on the basis of climatological data and satellite information. Strengthening of equatorial westerlies in the lower troposphere was found to be one of the important precursors in the formation of such vortices.
- 2.2 Forecasting Research Division II
- 2.2.1 Short Range Prediction

The change in sea surface temperature (SST) field due to movement of tropical disturbances was analysed for a representative depression and a tropical cyclone over the Bay of Bengal region for the month of October. The change was found to be proportional to the intensity of disturbance.

The zonal and eddy available potential energy and their conversions to kinetic energy were studied over the Indian region extending from 2°N to 40°N and 50°E to 110°E with a view to understanding the large scale processes and energy conversions associated with a monsoon depression of 4-10 July 1973. It was revealed that i) the available potential energy and the zonal K.E. increased with the strength of the monsoon and that ii) the northward transport of momentum and southward transport of heat increased with the increase in monsoon activity.

- 2.3 Climatology and Hydrometeorology Division
- 2.3.1 Studies on climate and climatic change
- 2.3.1.1 Studies of large-scale droughts over India
  - a) The southern oscillation characteristics as evidenced by satellite data:

Satellite-derived global anomalous outgoing longwave radiation data were examined with a view to put the southern oscillation (S.O.) features in the proper perspective. The global pattern of anomalies of outgoing longwave radiation was examined for the months of June through August for the year 1982, a drought year for India. A number of characteristics of the S.O. were revealed. Areas with high values (low values) of outgoing longwave radiation were found to indicate less than (more than) normal cloudiness and rainfall while the high values of outgoing radiation observed over India, Indonesia and Australia implied negative rainfall anomalies. The drought over these countries seemed to be the result of general eastward shift of rainfall zones of the western tropical Pacific.

b) Monsoon activity and Pacific sea surface temperature (SST) anomalies

The inter-annual variations in the seasonal SST anomalies over the eastern equatorial Pacific Ocean (0-10°S and 180-90°W) and the Drought Area Index (DAI)/Flood Area Index (FAI) over India during monsoon were examined for a period of 89-years (1891-1979) to determine the lead and lag relationships. The coherence and correlation analysis indicated that the variations of DAI/FAI during monsoon lead the equatorial SST by about two seasons. The occurrence of drought (flood) during monsoon in India was found to have some potential for providing useful guidance for predicting the non-occurrence of cold (warm) SST anomalies and associated weather of the following season (December-January-February) in the eastern equatorial Pacific Ocean.

- 2.3.1.2 Vagaries of the Indian Summer Monsoon
  - a) Fluctuations in All-India summer monsoon rainfall

The All-India summer monsoon (June-Sept.) rainfall for the period 1871-1983, based on fixed number of raingauge stations (306), was analysed for trends, periodicities and droughts/floods. The following features were revealed:

The mean rainfall of India as a whole for the summer monsoon season works out to be 85.3 cm. This is 78% of the annual rainfall of India and has a coefficient of variation of 9.5%.

The highest (101.70 cm) and the lowest (60.37 cm) summer monsoon season's rainfall were observed in the years 1961 and 1877 respectively, the range being about 41 cm which is 48% of the long term average.

There were 15 drought years in the All-India rainfall series viz. 1877, 1899, 1901, 1905, 1911, 1918, 1920, 1941, 1951, 1965, 1966, 1972, 1974, 1979 & 1982. The series also contained 10 flood years viz. 1874, 1878, 1892, 1894, 1917, 1933, 1956, 1961, 1975 & 1983.

A continuous rise of about 10 cm was observed in the decadal average rainfall from 1899 to 1953.

Analysis of the All-India Rainfall Series showed that two 10-year periods i.e. 1896-1905 and 1965-1974 received highly low rainfall.

Four major climatological periods (epochs) in the rainfall series were detected to show:

- i) Increasing tendency during 1878 to 1898 (21 years),
- ii) Becreasing tendency during 1899 to 1932 (34 years),
- iii) Increasing tendency during 1933 to 1964 (32 years) and
- iv) Decreasing tendency after 1965.

Two cycles comprising of 14 and 2.80 years were noticed in the entire period of the data. However, these cycles were not consistently observed throughout the data record and were seen during the last 30 years of the data period only.

b) The association between Indian summer monsoon and El-Nino

The significance of association between the All-India and sub-divisional summer monsoon rainfall and strong moderate El-Nino events was assessed by chi-square test to the contingency table for the period 1871-1978.

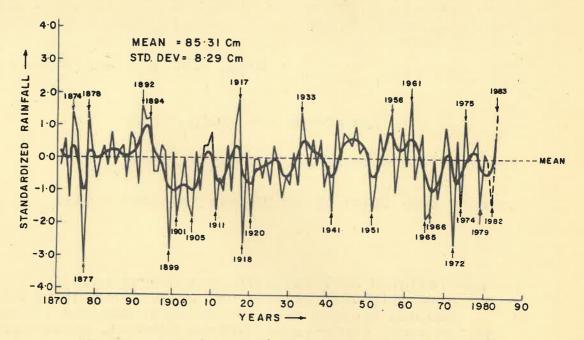
The analysis indicated that during 22 El-Nino years, the Indian monsoon rainfall was mostly below normal over most of the parts of country.

The association between El-Nino and deficient rainfall years (droughts) was statistically significant over the sub-divisions of India situated to west of 80°E and north of 12°N. During the five strong El-Nino years, viz. 1877, 1899, 1911, 1918 and 1972 many areas of India suffered large deficiency in rainfall (severe droughts). There were four moderate El-Nino years, viz. 1887, 1914, 1953 and 1976 when the rainfall deficiency was marginal.

### 2.3.1.3 Studies in Palaeoclimatology

A Dendroclimatology Laboratory with facilities for these tree-ring sample preparation and their microscopic analysis and ring width measurement was established at the Institute. A computer programme was developed for cross-matching among the time series of ring-width measurements from large number of trees. The programme was applied to the data collected from the western Himalayas.

The following techniques were successfully applied to the tree-ring-width time series to filter



All-India summer monsoon (June to Sept.) rainfall standardized actual and low-pass filtered values: 1871-1983



Tree-ring samples being measured in the Institute's Dendro-Climatology laboratory

the non-climatic growth trend :

- i) Cubic spline for smoothing,
- ii) Negative exponential least square fit and
- iii) Ratio of ring-width to total wood volume.

Tree growth for Chir-pine from Nainital was studied in relation to the monthly rainfall, mean monthly maximum temperature, mean monthly minimum temperature and mean monthly temperature range during the years of growth and the year prior to growth.

Four cross-matched and dated samples of teak from Thane region (Maharashtra) were sent to the Stable Isotope Group, Physical Research Laboratory, Ahmedabad for the Carbon and Hydrogen isotope ratio (C 13/C 12 & D/H) measurements.

- 2.3.2 Hydrometeorological Studies
- 2.3.2.1 Basin rainfall studies for the development of water resources
  - a) Estimation of maximum and probable maximum point rainfall

An up-to-date generalized one-day probable maximum precipitation (PMP) map of the north Indian plains

north of Lat. 20°N was prepared by updating the maximum point rainfall data of about 1000 long-period rainfall stations. It was found that the one-day PMP over this region ranges from about 45 cm to 110 cm. Greater magnitudes of PMP were found to occur over Gujarat and Orissa coasts.

The magnitudes of maximum point rainfall for 1 to 10 day durations for about 100 stations in Kerala State were determined. The maximum rainfall varied from 21-53 cm for 1-day, 31-85 cm for 2 day, 33-117 cm for 3-day, 31-143 cm for 4-day, 40-170 cm for 5-day, 44-194 cm for 6-day, 48-214 cm for 7-day, 56-222 cm for 8-day, 61-230 cm for 9-day and 62-243 for 10-day durations. These estimates are useful for various hydrological applications.

The long period daily rainfall data of about 100 stations in and around the Narmada basin were analysed to determine the estimates of maximum rainfall for the return periods of 10, 50 and 100 years for durations of 1 to 7 days. 21 generalized maps for 10, 50 and 100 years return periods for rainfall durations of 1 to 7 days were prepared. It was found that the maximum one-day rainfall for 10, 50 and 100-year return periods over this basin vary from 14-28 cm, 19-40 cm and 21-45 cm respectively. However, for 7-day duration, these estimates vary from 26-66 cm, 35-83 cm and 39-91 cm respectively.

# b) Water potential studies

The available water potential of six major catchments of India was assessed in terms of annual rainfall using the rainfall data of 80-year period 1891 to 1970. It was revealed that the rainfall of Brahma-putra catchment showed no relationship with the rainfall of other catchments. Using a first order Markov model the likely future annual rainfall sequences were generated. The statistical properties of the historical data and those of the generated data were compared. It was seen that the model preserves the statistical properties of the historical data.

Maps showing the probability (between 10 to 90%) of receiving an annual rainfall of 50 cm, 100 cm, 150 cm and 200 cm over different parts of India were prepared, using annual rainfall data of about 460 stations uniformly distributed over the country.

### c) Evaporation studies

The space time distribution of monthly evaporation over the country was studied by means of harmonic analysis. It was seen that the first two harmonics permit almost a complete characterization of the space-time variations of evaporation. The largest amplitude of 4.5 mm per day in the annual wave occurs over an area extending from east to west between lat. 20°N to 25°N. The lowest amplitude of the order of 1 mm per day occurs over northeast India, southern peninsula and along the west coast.

The normal monthly potential evapo-transpiration values of 240 stations distributed uniformly over India were subjected to harmonic analysis. It was revealed that the largest amplitude of the annual wave or the first harmonic varies from 20 mm in the southernmost parts of the peninsula to more than 100 mm over west Rajasthan. The date of occurrence of maximum amplitude annual waves was around 1 March over the west coast of South India and around 4 July over the southernmost parts of the peninsula.

# d) Precipitation studies

The precipitation distribution over the north-western Himalayas showed that the stations in this region receive about 38%/of their annual precipitation during winter and spring seasons respectively.

<u>/</u>& 33%

The precipitation data collected during the six snow-survey expeditions conducted during 1947-49 in the eastern Himalayas were examined. The precipitation during the winter season was found to be too meagre to build up the seasonal snow cover. Observations revealed that up to an altitude of 17000 ft asl, whatever snowfall occurs in winter season, it melts away rapidly.

Rainfall characteristics of Nepal Himalayas bounded between Long. 80°E to 88°E and Lat. 28° 30'N to 30° 15'N were analysed. The analysis showed that the eastern half of Nepal receives heavy rainfall as compared to the western half. It was further revealed that the mean annual rainfall along the foothills and Terai region is about 150 mm, increasing to about 300 cm in the central parts and then decreasing continuously until the Great Himalayan range is reached. It was also observed that two stations viz. Lamachaurs and Lumla to the north of Pokhara valley receive annual rainfall of more than 500 cm.

The spatial variation in rainfall during winter and summer monsoon months over the Garhwal-Kumaon region was studied. The analysis revealed that the winter and the summer monsoon months contribute about 10 to 40 cm and 50 to 200 cm of rainfall respectively. One-day PMP estimates over this region was found to vary from about 32 to 78 cm. Estimates of 100-year 1-day rainfall over this region ranged from 15 to 48 cm.

Correlation analysis between the southwest (SW) and northeast (NE) monsoon rainfall over 24 stations in Kerala revealed that at none of the stations the two series were found to be negatively correlated. However, the southwest monsoon rainfall was found to be uniformly distributed throughout the state as compared to that of the northeast monsoon season. It was further observed that the inter-station correlations were independent of the distance between the stations.

The characteristics of rainfall over the Saurashtra-Kutch region were studied using 90 years'

rainfall data. The analysis revealed that there were no increasing or decreasing long-term trends in the occurrence of excess ( > +20%) or deficit ( < - 20%) rainfall over this region. However, two periods between 1909 to 1918 and 1966 to 1975 were found to be worst regarding the incidence of excess and deficit rainfall.

Investigations of severe floods during the monsoon season of 1982 revealed that despite large deficiency in rainfall over different sub-divisions, the country recorded 12 highest floods which had exceeded their previous records. Uttar Pradesh region alone experienced 7 out of these 12 floods.

## e) Analysis of rainstorms

The severemost rainstorm of 1 to 5 July 1941 which caused exceptionally heavy rains over north Konkan and Gujarat coasts was analysed. The average areal raindepths for 1 to 3 day durations that were yielded from this rainstorm exceeded the depths for same durations which occurred over other tropical regions of USA and Australia. The efficiency of this record storm was also found to be the highest among the world's severemost rainstorms.

- 2.4 Physical Meteorology and Aerology Division
- 2.4.1 Cloud Physics and Weather Modification
- 2.4.1.1 Studies in atmospheric electricity

On the basis of certain physical processes taking place in the atmosphere, a new physical mechanism was proposed for the maintenance of global fair weather electric field. The upward transport of large ions (charged particles/aerosols) from the surface layers to

the ionospheric levels and the downward transport of negatively charged small ions from higher to lower levels, were taken into consideration. Such a transport gives rise to an aerosol current as the surface aerosols, by and large, carry positive charges. The transport of large and small ions takes place due to the vertical mass exchange. It was shown that the vertical mass exchange takes place by a chain of eddies in the atmosphere, through a gravity wave feed-back mechanism. Equations were derived to show that this vertical aerosol current is of the right magnitude and direction to produce the observed fair weather atmospheric electric field, its vertical profile and diurnal variation. The vertical aerosol current was also shown to be responsible for the variation of the 'H' component of the geomagnetic field.

The value of 'electrical relaxation time' of the atmosphere near the earth's surface was calculated using the electric field measurements made at Raichur during the period of the total solar eclipse on 16 February 1980. The calculated value agreed well with those reported by others, based on conductivity measurements.

Raindrop size and charge spectra were measured during the shower-type rain at Pune using a double induction ring sensor arrangement having suitable electrometer amplifier circuits. The raindrop size spectrum was found to follow the Marshall-Palmer distribution. A few positively charged large raindrops were noticed first, followed by a large number of negatively charged smaller ones.

A Complementary Metal Oxide Semi-conductor (CMOS) switching device was incorporated in the conventional rotating cylindrical field mill, developed at the Institute. With this device, the atmospheric electric

field can be measured directly without any need to rotate the cylindrical sensing head of the instrument. All the three components (x, y, z) of the electric field can henceforth be measured using a single sensor head.

# 2.4.1.2 Radar study of rain and rain-bearing clouds

Radar observations of convective clouds within 100 km around Delhi, made during the 3 years period June 1980 to May 1983, were analysed. The results relating to the season of 1982 revealed that i) about 27 percent of the clouds had vertical extent exceeding 6 km. These clouds may be of cumulonimbus type, ii) the cloud-top-height was limited to 12 km in about 98 percent of the convective clouds whereas only in about 0.3 percent cases, the top penetrated the tropopause and (iii) the maximum echo-top height observed was 19.2 km.

Radar data of convective clouds within 100 km around Delhi, collected during the 22 years period from June 1958 to May 1980, were analysed with a view to studying the mechanism of precipitation initiation in convective clouds. The overall result relating to the study of 11,709 cloud cases indicated that the precipitation growth was purely due to condensation-coalescence process in about 40 percent of the cases.

A study based on 20 years radar data (1959-1978) of tall convective clouds (cloud tops ≥ 12 km) observed during the pre-monsoon and monsoon seasons suggested that tropopause acts as a barrier to the vertical development of these clouds.

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setre (கோராக் (Alph) அருக்கும் (Beake) (புரைக்கும்)

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

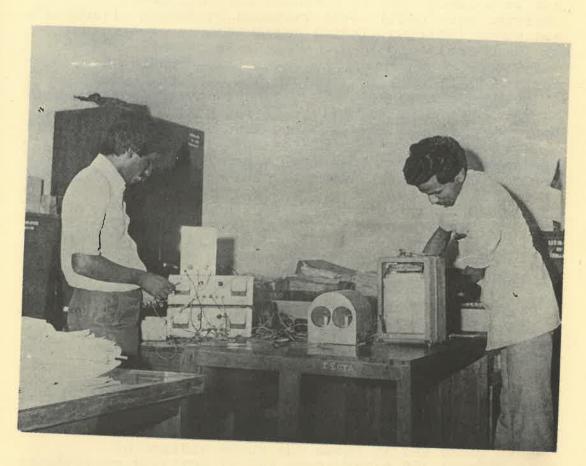
Cloud seeding experiment in the Baramati and Sirur regions of Maharashtra State was conducted on 24 days during the period 4 July - 3 September 1983. Extensive observations of cloud microphysical dynamical and electrical parameters were made during the experiment. Measurements of atmospheric aerosols and collection of cloud/rain water samples from the aircraft were carried out.

A detailed analysis of the rainfall data relating to the cloud seeding experiment conducted in the Pune region on 106 pairs of days during the eight summer monsoon seasons (1973-74, 1976, 1979-83) showed that the root double ratios/positive on 45 pairs, / were negative on 35 pairs and inconclusive on 26 pairs of days.

Results of the cloud physical observations collected in 30 pairs of randomly seeded and not-seeded clouds showed significantly higher values of temperature, liquid water content and cloud depth (vertical extent) in case of the seeded clouds. The respective increases were of the order of 1°C for temperature, 100 - 200% for the liquid water content and 60% for the cloud depth.

Numerical simulation studies carried out with the warm cloud model developed at the Institute suggested that seeding of clouds with common salt enhance the total cloud growth processes by 100 per cent.

Design of the optical systems (telescopes, optical filters, collimetering optics and mirror) required for a laser radar system under development at the Institute, was finalised after completion of the theoretical computations relating to the retrieval of atmospheric aerosol size spectra.



Laboratory testing of aircraft instrument used for measurement of atmospheric electrical conductivity during `loud seeding experiment

### 2.4.2 Environmental Physics

### 2.4.2.1 Studies of atmospheric boundary layer

Investigations relating to the dynamics of the atmospheric planetary boundary layer (PBL) were carried out taking into consideration certain physical processes taking place in the atmosphere. A simple cloud model was developed, based on the dynamical structure of the PBL. It was shown that the microscale-fractional-condensation in turbulent eddies of surface frictional origin gave rise to a net upward vertical velocity to the mean flow. The microscale-fractional-condensation process increased with the solar insolation at the surface. There is. thus, a solar zenith angle dependent mean upward motion of the day-time PBL. Turbulent eddies of surface frictional origin are carried upwards by this mean motion. The environment of the turbulent eddies is warmed by the latent heat release in the microscale fractional condensation process and thus a microscale capping inversion layer defines the upper limit of the mean upward flow. Microscale capping inversion is carried upward by the mean upward motion and is observed as the rising inversion of the day-time PBL in radiosonde and echosonde records. The mean upward motion occurs in the stable environment of the microscale-capping-inversion and thus generates gravity or 'buoyancy' waves which get carried by the mean wind. The atmospheric PBL is thus suggested to contain a continuous spectrum of gravity waves.

In another study the slope of the wind/
temperature spectrum in the atmospheric PBL is mathematically derived as -1.8 for a decadic wavelength scale
range. The derivation is found to be in agreement with
the observations. It has been also theoretically shown
that the above mechanism of gravity wave generation in
the atmospheric PBL also leads to the logarithmic wind
profile. The value of the Von Karman's constant which
has been earlier determined by the observations to be
0.4, is now derived from the new theory and it is
the fractional volume dilution rate of the large eddy
by the turbulent eddy for the scale ratio of 10.

The eddy mixing process has been shown to be a universal phenomenon and the equations have been applied to cloud growth process in the atmosphere. The new cloud model gives a simple analytical equation for the following vertical profiles of in-cloud parameters viz. i) temperature lapse rate, ii) vertical velocity, iii) ratio of measured liquid water to adiabatic liquid water (Q/Qa), iv) total water content, v) cloud drop size spectrum and vi) raindrop size spectrum. The rate of rainfall and the raindrop size spectrum at the ground are also derived. The above parameters are computed for a representative sample cloud and the computed values are found to agree with the observed ones.

Computations of temperature structure parameter  $(C_T^2)$  were carried out using the aircraft high resolution temperature data obtained in cloud and in clear-air during the summer monsoon of 1976. The values of  $C_T^2$  showed marked differences during the active and weak monsoon conditions. The differences were explained in relation to the dynamical characteristics of the atmospheric boundary layer.

# 2.4.2.2 Studies in upper atmosphere

Monthly mean stratospheric zonal wind data for Balbova (9°N, 80°W) were examined in relation to the rainfall data of India for the period 1951-82. The results indicated a strong relationship between the phases of the zonal wind in the tropical lower stratosphere and the gross rainfall activity over India.

In another study of the effect of well defined and significant solar proton events (E > 10 MeV) on major magnetic disturbances for the 18-year period, (1955-1972) was examined. Preliminary results indicated that major magnetic disturbances occurred mostly between 0 to 3 days after the entry of high energy solar protons into the earth's atmosphere.

Eddy transport of the sensible heat (W'T') was computed using rocketsonde temperature and wind data for Thumba for the two contrasting summer monsoon seasons of 1972 and 1975. The results suggested that the upward eddy transport of sensible heat from the stratosphere to mesosphere could be responsible for some of the cases of summer warmings observed in the stratospheric/mesospheric regions.

### 2.4.2.3 Studies in air pollution

Surface measurements of Aitken Nuclei (AN) were made at i) Pune - representing urban environment ii) Sinhagad - representing non-urban environment and iii) over the oceanic regions (the Arabian sea, the Indian Ocean and the Bay of Bengal) representing maritime environ-The periods of measurement ranged from a few days to a few years (1980-83) depending upon the measurement site. Measurements in the oceanic regions were carried out during the cruise of the research vessel 'Gaveshani', from Goa to Madras in May 1983. Aircraft observations of Aitken Nuclei (AN) and Condensation Nuclei (CN) were made in the Pune region in the lower troposphere in cloud and cloud-free air during the summer monsoons of Preliminary analysis of the above observations 1980-82. revealed that :

- i) The vertical distribution of AN and CN increased with the height up to 7000 ft and decreased thereafter;
- ii) The concentrations were significantly higher inside clouds than in cloud-free air and are low at cloud-base levels on days with precipitation;
- iii) In the marine environment, the concentration of AN depended on the airmass characteristics;

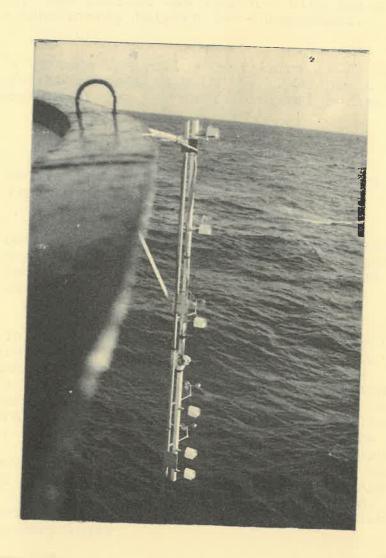
iv) The concentrations of AN were markedly higher over the Bay of Bengal than those over the Arabian sea during the pre-monsoon.

90 rainwater samples sent by the India Meteorological Department were analysed for Sodium, Potassium, Calcium and Magnesium using the Atomic Absorption Spectrophotometer.

- 2.5 Instrumental and Observational Techniques Division
- 2.5.1 Development of meteorological payload for rockets and satellites
- 2.5.1.1 Development of rocket payload for upper atmospheric research and to carry out related physical studies

Two rocket payloads were tested under simulated atmospheric pressure and temperature (up to 80 km level) in a Thermovac Chamber at the Space Applications Centre, Ahmedabad. Ten payloads and six mylar film mounts were fabricated for use on RH-200 rocket flights. Two payloads were launched with RH-200 rockets at Thumba on 19 & 20 October 1983. Data were obtained for the 42-20 km region for the flight on 19 October 1983. The temperature profile of this layer agreed with the data obtained by the M-100 rocket flight released at Thumba on the same day. Due to non-ejection of the parachute, data could not be obtained from the flight on 20 October 1983.

Two more payloads were sent to Thumba Equatorial Rocket Launching Station for carrying out the radiation checks.



Cup anemometers and thermistor temperature sensors mounted on a boom projecting outwards from the bow of the ship

Two balloon payloads were developed using twin thermistors. One payload was launched with balloon to verify the consistency between two thermistors.

A Voltage Controlled Oscillator (VCO) circuit was developed in connection with the development of wire as a temperature sensor for meteorological rocket payload.

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

In collaboration with the National Institute of Oceanography (NIO), Goa, field observations on (i) wind and temperature profiles, (ii) vertical wind, (iii) sensible heat flux by eddy correlation technique and (iv) sea surface temperature were carried out on board the research vessel 'Gaveshani' at selected points over the Arabian sea, Indian Ocean and the Bay of Bengal. Preliminary analysis of wind and temperature profiles revealed the existence of the day-time mixed layer on 10 and 20 May 1983 in the 3-6 m level above sea surface. The profile-derived fluxes of momentum, sensible and latent heat were studied over the marine surface boundary layer.

Mean wind velocity profiles over smooth and rough tunnel floor downstream of honeycomb flat plate were studied. The flow over rough floor was found to be fully rough. The simulated height of boundary layer, roughness length and the estimated Reynolds stress were found to correspond to these values of rural terrain on a scale of 1: 1136.

To study the wind and temperature structure over a complex terrain near the ground in the Institute's premises at Pashan (Pune), the profile measurements were made upto 3.2 m using cup anemometer and thermistors as sensors. Hourly observations were taken during day-time for a period of two weeks. Temperature was measured at 2, 4 and 10 m heights also, using a fast response thermocouple giving an output of 10 mV/°C output. An indigenous data logger was used to record temperature at every second at these levels.

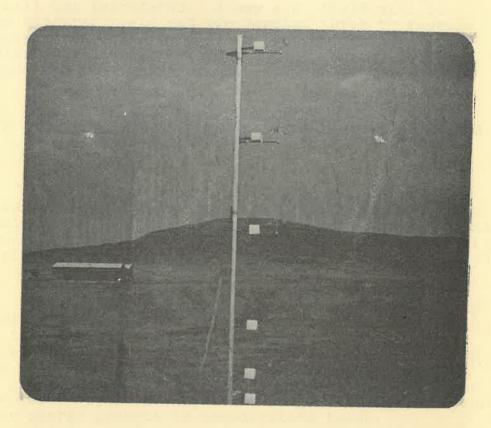
Wind data (4-10 m) and temperature data (1-13 m) collected for the period 1-3, 5-6, 7-8 November 1977 at the College of Agricultural Meteorological Observatory (CAMO), Pune were analysed. The stability functions and the sensible heat fluxes were computed.

Six cup anemometers with magnetic chopper mechanism were fabricated and the shaping circuit for the anemometer output was finalized.

Three types of aircraft thermometers viz. Vortex (dry), Vortex (wet) and reverse flow thermometers were put in operation in the cloud seeding experiment conducted during the 1983 monsoon season.

A radiometer to record direct, diffuse and global radiation was developed and put in operation.

A chip circuit to measure temperature with thermocouple was designed to give 10 mV/°C without using the ice point reference.



A 10 m mast fitted with anemometers and temperature sensors to measure the wind and temperature profiles over a nonhomogeneous terrain in the Institute premises

- 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

Design of d.c. field mill was modified and the field mill was fabricated. A new a.c. field mill to measure electric field and two Gerdian tubes to measure atmospheric conductivity were under fabrication. Amplifiers and associated electronic circuitry required for these and other instruments were fabricated.

2.5.3.2 Development of simulation techniques for cloud physics studies

Experiments were conducted to study the behaviour of charged and uncharged waterdrops under high vertical and horizontal electric field using the vertical wind tunnel. Special attention was given to the stability and disintegration of drops. The drops were photographed.

Electrical atomization of water drops dripping from insulated ice pieces, placed in high electric field and at temperatures above freezing point, was studied. It was observed that ice pieces produce smoke phenomenon at some high value of electric field. Residual charges on ice pieces were measured. The results indicated that the phenomenon could be important in generating the lower positive charge pockets in thunderstorm bases.

A simple technique was devised to simultaneously suspend more than one drop in the vertical wind tunnel. Photographs of drops were taken up to five drops suspended simultaneously in the test section of the tunnel. Experiments were performed on generating small water drops by vibrating a capillary by an incident compressed air jet. Experiments were also conducted to produce uniform water droplets by vibrating a needle attached to a loudspeaker to which audio signal was fed from an oscillator.

- 2.6 Theoretical Studies Division
- 2.6.1 Studies on dynamic instability
- 2.6.1.1 Barotropic and baroclinic instability of the atmospheric flow

A linear divergent barotropic model with Ekman friction was formulated and the stability analysis of the low level monsoonal zonal flow was performed using different meridional grids in the model. It was revealed that the solutions were sensitive not only to the grid size but also to the grid point locations in the channel for the grid sizes > 0.8° latitudes.

The growth rate, vertical structure and energetics of the short unstable baroclinic waves having wavelengths less than 3000 km, which correspond to the scale of monsoon depressions, were computed by using the quasi-geostrophic baroclinic model in the presence of Ekman boundary layer friction for different vertical shears of the zonal wind in the boundary layer. The results indicated that the friction played an important role in determining the zonal scale and zonal plane distribution of the short preferred wave. However, the changes due to friction are dependent on the vertical wind shear below the westerly maximum level. cases of lower boundary were also studied wherein the top of boundary layer was at 1000, 920 and 880 mb and the results indicated that the growth rate of the waves was inversely proportional to the height of the boundary layer. The intensity of the warm core at lower levels started decreasing and finally a cold core emerged with the decrease in wind shear. The reversal in the direction of low level meridional heat transports from northward to southwards could be explained by this phenomenon.

The energetics, angular momentum transports and structure of barotropic unstable quasi-linear waves, corresponding to the upper tropospheric disturbances in the vicinity of the tropical easterly jet, were computed by the integration of global spectral model. The results indicated a strong correlation between the location of primary (secondary) wave amplitude maximum and those of  $\overline{q}_y$  ( $\overline{q}$ ) maximum (minimum). The energy source of the unstable waves was found to lie to the south of the jet centre. It was concluded that the zonal-wave interaction played an important role in locating the wave amplitude maxima and in determining the wave phase speed and the wave transport properties.

Computer programmes were developed to study the role of stationary ultralong waves in the formation and growth of synoptic scale transient waves in the tropical upper troposphere during summer monsoon season.

Mathematical expressions for the interactions between the divergent and rotational parts of the wind were derived for the barotropic case.

Computer routines were developed and tested for computations of the primitive equation energetics at different levels in the vertical. The routines were used in computing the complete energy cycles from the meteorological fields forecast by the NWP model in order to identify the causes for the departure of forecast fields from the observed ones.

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

The role of barotropic instability and the effects of ageostrophic motions and friction on the formation and growth of monsoon onset vortex, which was formed over the southeast Arabian sea on 16 June 1979,

were investigated. Barotropic stability analysis of the zonal wind profiles during 10-14 June 1979 at 700 mb level, averaged over the longitude interval 40°E - 80°E was performed using the primitive equation, non-divergent and divergent barotropic models. It was found that the growth rates and the phase speeds obtained from the simple divergent barotropic model were in good agreement with the values obtained from the more complex primitive equation model. However, the structure obtained from the later model was found to compare more favourably with the observations than that obtained from the former one. It was also noticed that many observed features viz. the meridional tilt and the location of onset vortex were mainly due to the superposition effect of the vortex on the large scale monsoon current. The energy conversions and momentum transports associated with the primitive equation unstable wave were computed. The comparison of momentum transports and the ones implied by the quasigeostrophic approximation revealed that in the equatorial region the two transports were in opposite direction. The result suggested that for some tropical disturbances an erroneous conclusion regarding the source of energy may be arrived at by observing their tilt alone.

The vertical and meridional transport of zonal and meridional momentum and sensible heat were computed for each day for a period of 3-7 July 1979, in order to identify the physical mechanism responsible for the formation of the depression on 7 July 1979.

- 2.6.2 Simulation of monsoon and tropical circulation systems
- 2.6.2.1 Simulation of mean monsoon circulation

The computer code developed earlier for the primitive equation barotropic global spectral model was modified. The modified code was found to be computationaly more efficient than the earlier one. The model efficiency

was found to increase further by more than 15% by incorporating an efficient algorithm for Legendre transform. Rayleigh friction, diffusion, bi-harmonic diffusion and topography were also included in the model.

A flexible computer code was developed for the 5-level primitive equation global spectral model in sigma co-ordinate. The model did not include friction, diabatic heating, orography and moisture. The code is useful for the integration of linear, quasi-linear and non-linear models. The code also provides the additional options of using the model with triangular and rhomboidal truncations. It saves computer storage and time. It needs a computer storage of 34K words for the integration with a triangular truncation M = 15. The efficient semi-implicit scheme for the time integration is used and the transform method is utilised for computing the non-linear terms. The preliminary testing of the code was completed successfully. Further tests with initial analytic field were in progress.

A linear quasi-geostrophic model including in it the mechanical and thermal dissipative processes, was developed and utilised for simulating the stationary planetary waves induced by orography and the thermal forcings during the summer monsoon. The necessary inputs required for the experiment were prepared.

2.6.2.2 Study of error characteristics in numerical models for simulation and their relation to the atmospheric predictability

A linear baroclinic model was integrated for four days with varying time steps from 10 to 60 minutes by stream-function fields for an idealised depression as the initial input. The differences in the final forecast stream-function fields with different time steps were found to be insignificant compared to the errors arising out of other factors in the dynamical forecasting models.

#### 2.7 Other Studies

- a) Secular variation of surface air temperature over India from 1901 to 1982 was studied. It was found out that there was gradual increase in temperature throughout the period. It was also revealed that the eastward temperature gradient was increasing and the increase in temperature along the foot hills of Himalayas was more significant. A cooling trend was observed over Rajasthan and some parts of Punjab.
- b) Studies on total Carbon budget in the Indian planet ecosystem revealed that 9.41 x 1015 gm of carbon is accumulated in the Indian plant ecosystem which constitutes 1.68% of the total global carbon pool in the plant ecosystem.
- c) Production of Carbon dioxide through the consumption of petrolium products, natural gas, coal, cement and firewood was estimated from 1960 to 1982. It was found that consumption of fire wood is the major contributory factor for production of carbon dioxide in India.
- d) In a comprehensive study of the atmospheric tidal pressure oscillations over India, harmonic analysis of the hourly pressure data of 62 stations was carried out. It was observed that the first two harmonics account for 95 to 99 percent of the variance for the monsoon months.
- e) In a study relating to the onset phase of the southwest monsoon, the superposed epoch analysis for the daily surface pressure data of four stations revealed a sharp increase in the pressure gradient between Trivandrum and Bombay coincident with the data of onset of the monsoon over Kerala.

- f) Storm associated mean rainfall distribution along the coast on either side of the point ('P'), where the storm struck the coast normally, was studied by considering the post monsoon cyclonic storms of the Bay of Bengal. It was observed that while the higher mean rainfall extended to a longer distance north of 'P' than to the south, the case was opposite for the variability of rainfall being more to the south of 'P' than to its north.
- g) A computer program was developed for interpolation of meteorological and dynamical parameters in one dimension by cubic spline method. The results obtained by the cubic spline method were found to be better than those from other methods. The same method was used for interpolating wind fields in the horizontal planes and in the meridional planes.
- h) The Scripps Topography Data on 1° Global Grid were collected and stored on a magnetic tape for utilization by users.
- i) Data for the Global outline map were collected and the computer routine was developed for drawing the world coast line.
- j) A computer program was also developed for plotting the wind vector along with the coast line of the region in the background.

3. PUBLICATIONS

#### 3.1 Papers Published

on the vertical resolution of a numerical model.

# 3.1.1 Papers published in the Scientific Journals

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Sr. No.		Author(s)	Publication
1.	Application of a semi-implicit scheme of integration to barotropic prediction.	Singh S.S. & Bandyopadhyay A.	Proc. of Indian Academy of Scien- ces, 92, July, 1983, 105-113.
2.	Cloud microphysics versus synoptic situation.	Kapoor R.K., Chatterjee R.N., Paul S.K. & Sharma S.K.	Vayu Mandal, 13, 3 & 4, July- December, 1983, 12-16.
3.	Combined barotropic- baroclinic instabi- lity study of the upper tropospheric easterly jet.	Mishra S.K. & Tandon M.K.	Journal of Atmospheric Sciences, 40, 11, November, 1983.
40	Contribution of baroclinic mechanism in the formation of the depression during MONEX-79.	Salvekar P.S., George L. & Mishra S.K.	Archiv fur Meteoro- logie, Geophysik und Bioklimatologie, Sr.A, 32, 1983, 55-69.
5.	Contribution of diver- gent wind component to the kinetic energy budget over the Indian summer monsoon region.	Singh S.S., Master A.H. & Kulkarni A.A.	Mausam, 35, 1, January, 1984, 11-16.
6.	Dependence of non- geostropic baro- clinic instability of wave disturbances on the vertical resolution of a	Subrahmanyam D.	Archiv fur Meteoro- logie, Geophysik und Bioklimatologie, Sr. A, 32, 1983, 289-300.

Sr. No.	Title	Author(s)	Publication
7.	Electrical atomiza- tion of water dripping from plant leaves.	Kamra A.K. & Ahire D.V.	Journal of Climate & Applied Meteoro- logy, 22, 3, March, 1983, 509-511.
8.	Estimation of Bowen's ratio from temperature & humidity measurements using thermistors & water vapour fluxes over a bare cotton soil.	Sadani L.K. & Raibole U.P.	Mausam, 34, 3, July, 1983, 257-262.
9.	Estimation of peak- flood at Machhu-2 dam on the day of disaster of 11th August 1979.	Rakhecha P.R. & Mandal B.N.	Vayu Mandal, 13, 3 & 4, July-December, 1983, 71-73.
10.	Foreshadowing north- east monsoon rainfall over Tamil Nadu.		Monthly Weather Review, 111, 1, January, 1983, 109-112.
11.	Impact of Monex-79 data on the objective analysis of the wind field over the Indian region.	Rajamani S., Talwalkar D.R., Upasani P.U. & Sikka D.R.	Pure & Applied Geophysics, 120, 3, 1982, 422-436.
12.	Indian summer monsoon and the east equatorial pacific sea surface temperature.	Mooley D.A. & Parthasarathy B.	Atmosphere ocean, 22, 1, March, 1984, 23-35.

Sr.	Title	Author(s)	Publication
13.	Intensification characteristics of tropical cyclones in Indian seas using satellite imagery.	Joshi P.C.	Vayu Mandal, 13, 3&4, July-December, 1983, 41-43.
14,	Mesospheric warming/cooling over tropics during January-February 1979.	Mukherjee B.K., Indira K. & Ramana Murty Bh.V.	Indian Journal of Radio and Space Physics, 12, 6, December, 1983, 213-214.
15.	Note on the nece- ssary condition for baroclinic instabi- lity of monsoon zonal current.	Mishra S.K. & Chakraborty D.R.	Pure & Applied Geophysics, 120, 3, 1982, 453-462.
16.	Onset phase of the South-west monsoon.	Ananthakrishnan R. & Aralikatti S.S.	Current Science, 52, 16, 20 August, 1983, 755-765.
17.	Phenomenon of rain gush in thunder-storms.	Kamra A.K.	Vayu Mandal, 13, 1 & 2, January- June, 1983, 37-41.
18.	Probabilities of droughts and floods over India during the south-west monsoon season.	Parthasarathy B., Sontakke N.A. & Kothawale D.R.	Current Science, 53, 2, 20 January, 1984, 94-96.
19.	Production of charged monodisperse water droplets by electrical dispersion,	Ahire D.V. & Kamra A.K.	Mausam, 35, 1, January, 1984, 27-32.

Sr. No.		Author(s)	Publication
20.	Raindrop charges, electric field & space charge measurements at a mountain station covered with monsoon clouds.	Kamra A.K. & Sathe A.B.	Archiv fur Meteoro- logie, Geophysik und Bioklimatologie, Sr. A, 32, 1-2, 1983, 145-153.
21.	Rainfall & temperature distribution in Andhra Pradesh & its suitability for growing rice, sugarcane & millet.	Subramayya I. & Rup Kumar K.	The Andhra Agricultural Journal, 28, 5&6, 1981, 175-183.
22.	Small scale characteristics during the Indian summer monsoon.	Sinha S. & Sinha S.K.	Archiv fur Meteoro- logie, Geophysik und Bioklicatologie, Sr.A, 32, 3, 1983, 281-288.
23.	Study of the cyclo- nic storms incident on the different sections of the coast around the Bay of Bengal.	Mooley D. A. & Mohile C.M.	Mausam, 34, 2, April, 1983, 139-152.
24.	Study of maximum & probable maximum rainfall over Uttarakhand Himalayas & its neighbourhood.	Dhar O.N., Kulkarni A.K. & Mandal B.N.	Journal of Himalayan Studies & Regional Development, 5-6, 1981-82.

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No.	Title	Author(s)	Publication
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25.	Suicidal adventure of a fanatic on Everest.	Dhar O.N.	Journal of Himalayan Research & Develop- ment, 2, 1, January, 1983, 73-77.
26.	Surface pressure anomaly pattern types and their application in forecasting daily rainfall distribution over India.	Singh S.V., Kripalani R.H. & Paul D.K.	Mausam, 35, 1, January, 1984, 47-54.
27.	Transient and steady state supersaturation in a thermal diffusion cloud chamber.	Chaudhuri S.	Archiv fur Meteoro- logie, Geophysik und Bioklimatologie, Sr.A., 32, 3, 1983, 269-279.
28.	Variability of the Indian summer monsoon & tropical circulation features.	Mooley D.A. & Parthasarathy B.	Monthly Weather Review, 11, 5, May, 1983, 967-978.
29.	Was the July 1981 rainstorm over Rajasthan unprecedented ?	Dhar O.N., Rakhecha P.R., Mandal B.N. & Sangam R.B.	Pure & Applied Geophysics, 120, 3, 1982, 483-494.
30.	Wave to wave & wave to zonal mean flow kinetic energy exchanges during contrasting monsoon years.		Pure & Applied Geophysics, 120, 3, 1982, 463-482.

3.1.2 Papers published in the Proceedings of Seminars/ Symposia etc.

Sr. Title Author(s) Publication

1. Assesment and simulation of annual rainfall of major catchments of India.

Rakhecha P.R. & Soman M.K.

Proc. of Nat. workshop on Interbasin transfer of water, Calicut, 27-28 January, 1984.

2. Brief appraisal of hydrometeoro-logical studies on Indian rainfall.

Dhar O.N., Rakhecha P.R., Mandal B.N. & Ghose G.C. Proc. of sem. on Hydrological investigations during the last 25 years in India, Waltair, 23-24 May, 1982.

3. Changes in concentrations of cloud and precipitation particles in the highly electrified regions of thunder clouds.

Kamra A.K.

Proc. of the conf. on Atmospheric electricity, Manchester, England, 28 July - 1 August 1980, 277-279.

4. Droughts and floods over India in summer monsoon seasons: 1871-1980.

Mooley D.A. & Parthasarathy B.

Proc. of the symp. on variations of the global water budget, Oxford, U.K., August, 1981, 239-252.

5. Measurement of temperature, humi-dity and water vapour profiles as determined from the instrumented DC-3 aircraft during cloud seeding experiments near Pune, India.

Vernekar K.G., Brij Mohan & Srivastava S. Proc. of the 5th symp. on Meteorological Observations and Instrumentation, Toronto, Ontario, Canada, 11-15 April, 1983, 239-242.

Sr. No.	Title	Author(s)	Publication
6,	Modelling of plume dispersion in a wind tunnel.	Sivaramakrishnan S.	Souvenir, Third Annual Conf. on Air Pollution, The Institute of Energy Management, Bombay, 4-5 April, 1983, F-1 - F-7.
7.	Numerical models for weather fore-cast and climate studies in IITM-present status and future plans.	Singh S.S., Rajamani S., Sinha S. & Mishra S.K.	Proc. of symp. on Climate and its variability, IIT, New Delhi, 26-27 February, 1984.
8.	Prediction experiment on monsoon depression.	Singh S.S., Sugi M. & Kanamitsu M.	Proc. of Spring conf. of Japan Meteorological Society, 18-20 May, 1983.
9.	Role of eddy correlator technique for measuring vertical transport of gaseous pollutants.	Vernekar K.G., Brij Mohan & Srivastava S.	Souvenir, Third Annual conf. on Air Pollution, The Inst. of Energy Management, Bombay, 4-5 April, 1983, G-1 - G-4.
10.	Solar influence on atmospheric electric field.	Selvam A.M., Joshi R.R., Murty A.S.R. & Ramana Murty Bh.V.	Proc. of conf. on Atmospheric elec- tricity, Manchester, England, 28 July - 1 August, 1980, 121-124 (Published in 1983).

Sr. No.	Title	Author(s)	Publication
11.	Some aspects of heavy rainfall distribution over Andhra Pradesh.	Dhar O.N., Kulkarni A.K., Mandal B.N. & Soman M.K.	Proc. of sem. on Hydrological inves- tigations during the last 25 years in India, Waltair, 23-24 May, 1982.
12.	Some interesting features of the July 1981 rainstorm over and near Jaipur district in Rajasthan.	Dhar O.N., Kulkarni A.K., Mandal B.N. & Soman M.K.	-do-
13.	Temperature payload for 80-20 km range.	Vernekar K.G.	Proc. of IMAP Workshop on Balloon and rocket experi- ments, ISRO, Banga- lore, 29 November - 1 December, 1982, 60-68.
14.	Variations in atmospheric nuclei and electrical parameters during the total solar eclipse-1980.	Selvam A.M., Manohar G.K., Murty A.S.R., Vijayakumar R. & Ramana Murty Bh.V.	Proc. of conf. on Atmospheric elec- tricity, Manchester, England, 28 July - 1 August, 1980, 99-101 (Published in 1983).
15.	Water potential of Kerala State.	Saseendran S.A., Rakhecha P.R. & Dhar O.N.	Proc. of sem. on Hydrological investi- gations during the last 25 years in India, Waltair, 23-24 May, 1982.

### 3.2 Papers accepted for publication

## 3.2.1 Papers accepted for publication in Journals

Sr.	Title	Author(s)	Journal
1.	Analysis and predic- tion of short period droughts during summer monsoon over India.	Singh S.V., Kripalani R.H., Shaha P. & Prasad K.D.	Mausam
2.	Cyclonic storms of the Arabian sea, 1877-1980.	Mooley D.A. & Mohile C.M.	Mausam
3.	Double (Hale) sun- spot cycle and floods and droughts in India.	Bhalme H.N. & Jadhav S.K.	Weather
4.	Droughts over penin- sular India during 1861-1980 and asso- ciated circulation features.	Mooley D.A., Parthasarathy B. & Sontakke N.A.	Mausam
5.	Dynamic effects of orography on the large-scale motion of the atmosphere. (Zonal flow and elliptic barrier with maximum height of one Km.).	Bavadekar S.N. & Khaladkar R.M.	Mausam

Sr.	Title	Author(s)	Journal
6.	Dynamics of the stationary eddies in the lower stratos-pheric circulation in the wave number domain & monsoon activity.	Raja Rao K.S., Awade S.T. & Nair M.V.H.	Proc. of Indian Academy of Sciences (Earth & Planetary Sciences).
7.	Electrical atomiza- tion of water dripp- ing from melting ice pieces & its possible role in thunderstorms.	Kamra A.K. & Ahire D.V.	Journal of Climate and Applied Meteorology.
8.	Energetics of the monsoon circulation over south Asia: Part I - Diabatic heating and the generation of available potential energy.	Rajamani S.	Mausam
9.	Fluctuations in All- India summer monsoon rainfall during 1871-1978.	Mooley D. A. & Parthasarathy B.	Climatic change.
10.	Highest observed 1 to 10 days point and areal rainfall over Kerala State.	Saseendran S.A., Rakhecha P.R. & Dhar O.N.	Indian Journal of Power & River Valley Development.
11.	Indian rainfall in relation to the sun-spot cycle: 1871-1978.	Ananthakrishnan R. & Parthasarathy B.	Journal of Climatology.

Sr. No.	Title	-Author(s)	Journal
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12.	Indian summer monsoon and El-Nino.	Mooley D.A. & Parthasarathy B.	Pure & Applied Geophysics.
13.	Large scale April pressure index connected with the Southern Oscillation and its potential for prediction of large-scale droughts over India.	Jadhav S.K.	Mausam
14.	Monthly variation of the total mass of the atmosphere over India.	Hingane L.S. & Ramana Murty Bh.V.	Mausam
15.	Most severe rainstorm in India - a brief appraisal.	Dhar O.N., Kulkarni A.K. & Mandal B.N.	Journal of Hydrological Sciences.
16.	Observed air-sea interface conditions and a monsoon depression during Monex-79.	- Seetharamayya P. & Master A.	Archiv fur Meteorologie, Geophysik und Bioklimatologie, Sr.A.
17.	Ozone in the mesos- phere and lower thermosphere.	Hing <b>e</b> ne L.S.	Proc. of Indian Academy of Sciences (Earth & Planetary Sciences).
18.	Physics of monsoon rain processes.	Devara P.C.S. & Ramana Murty Bh.V.	Mausam
19.	Rainfall characteris- tics of Saurashtra region - a brief appraisal.	Dhar O.N., Soman M.K. & Mulye S.S.	Irrigation & Power.

Sr. No.	Title	Author(s)	Journal  Live and the same and	TOTAL COMME
20.	Rainfall distribution over India during the monsoon months in the absence of depressions and cyclonic storms.	Dhar O.N., Mandal B.N. & Rakhecha P.R.	Mausam	
21.	Rainfall over the southern slopes of the Himalayas and the adjoining plains during 'breaks' in monsoon.	Dhar O.N., Soman M.K. & Mulye S.S.	Journal of Climatology,	.ar
22.	Regression equations between mean wind power density and mean hourly wind during the monsoon season.	Mooley D.A. & Aralikatti S.S.	Mausam	181
23.	Some aspects of winter and monsoon rainfall distribution over Garhwal - Kumaon Himalayas - a brief appraisal.	Dhar O.N., Kulkarni A.K. & Sangam R.B.	Journal of Himalayan Research & Development	,31
24.	Some physical processes in the middle atmosphere.	Mukherjee B.K., Raja Rao K.S. & Ramana Murty Bh.V.	Indian Journal Radio & Space Physics.	of
25.	Southern oscillation and its relation to the monsoon rainfall.	Bhalme H.N. & Jadhav S.K.	Journal of Climatology.	
26.	Spatial and temporal relationships between the Indian summer monsoon and the east equatorial Pacific sea surface temperature.	Mooley D.A. & Parthasarathy B.	Atmosphere — Ocean,	

Sr. No.	Title	Author(s)	Journal
		The state of the s	and this size had any too seek peep mee ray this easy the mad any and any size mad mad
27.	Spatial and temporal relationships between the Indian summer monsoon rainfall and the Southern Oscillation.	Parthasarathy B. & Pant G.B.	Tellus
28.	Spherical field meter for measurement of electric field vector.	Kamra A.K.	Review of Scientific Instruments.
29.	Stochastic model of drought.	Kamte P.P. & Dahale S.D.	Mausam
30.	Technique of tempera- ture measurement using wire sensor.	Chaudhuri S.	Journal of Indian Institute of Science.
31.	Testing of an image intensifier tube for astronomical applications.	Singh M., Jadhav D.B. & Joshi S.C.	Optical society of India.
32.	Unprecedented rainfall at Sambalpur in August 1982.	Dhar O.N., Kulkarni A.K. & Sangam R.B.	Journal of the Indian Association of Hydrologists.
33.	Vertical motions within the Indian Tropical Middle Atmosphere.	Mukherjee B.K., Raja Rao K.S. & Ramana Murty Bh.V.	Journal of Atmospheric Sciences.

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3.2.2 Papers accepted for publication in Proceedings of Seminars/Symposia.

Sr.	Title	Author(s)	Proceedings
1.	Aircraft observations of cloud condensation nuclei in maritime and continental environments.	Murty A.S.R., Vijayakumar R., Sikka P., Selvam A.M. & Ramana Murty Bh.V.	XI Int. conf. on Atmospheric aero- sols, condensation and ice nuclei, Budapest, Hungary, 2-7 Sept. 1984.
2.	Aircraft observations of condensation and ice nuclei at a tropical station.	Paul S.K., Sharma S.K., Selvam A.M., Murty A.S.R. & Ramana Murty Bh V.	<b></b> d 0·∞
3.	Bay depression which caused the greatest raindepths in India.	Dhar O.N., Kulkarni A.K. & Sangam R.B.	Sem. on Tropical cyclones and disaster preparedness, Bhubaneshwar, 11-13 Jan. 1984
4.	Behaviour of temperature structure parameter in cloud-and clear-air during the summer monsoon.	Devara P.C.S., Selvam A.M. & Ramana Murty Bh.V.	IX Int. Cloud Physics conf., Tallinn, USSR, 21-28 Aug. 1984.
5.	Characteristics of stability of upper atmosphere over equatorial stations.	Vernekar K.G., Brij Mohan, & Srivastava S	Middle Atmospheric Science Symp. (MUA-1) XVIII Assembly of IUGG, Hamburg, 22-26 Aug. 1983.
6.	Characteristics of temperature spectra in warm monsoon clouds.	Selvam A.M., Devara P.C.S., Parasnis S.S., Paul S.K., Murty A.S.R. & Ramana Murty Bh.V.	IX Int. Cloud Physics conf., Tallinn, USSR, 21-28 Aug. 1984.

Sr. No.	Title	Author(s)	Proceedings
7.	Chemical composition of atmospheric aerosols at Delhi.	Khemani L.T., Naik M.S., Momin G.A., Kumar R., Chatterjee R.N., Singh G. & Ramana Murty Bh.V.	XI Int. conf. on Atmospheric aero- sols, condensation and ice nuclei, Budapest, Hungary, 2-7 Sept., 1984.
8.	Cloud droplet spectra in warm monsoon clo clouds.	Paul S.K. Pillai A.G., Selvam A.M., Murty A.S.R. & Ramana Murty Bh.V.	IX Int. Cloud physics conf., Tallinn, USSR, 21-28 Aug., 1984.
9.	Cylindrical field mill for measurement of atmospheric electric field.	Jadhav D.B. & Raj P.E.	Nat. symp. on Instrumentation (NSI-9), Srinagar, 3-5 May, 1984.
10.	Electrical atomiza- tion of water in the atmosphere.	Kamra A.K. & Ahire D.V.	VII Int. conf. on Atmospheric elec- tricity, Albany, New York, 4-8 June, 1984.
11.	High light gathering power monochromator for extend source studies.	Jadhav D. B. & Tillu A.D.	Nat. symp. on Instrumentation (NSI-9), Srinagar, 3-5 May, 1984
12.	Ice nucleating characteristics of Capparis Aphylla, an Indian herb.	Murty A.S.R., Selvam A.M., Devara P.C.S. & Ramana Murty Bh.V.	XI Int. conf. on Atmospheric aero- sols, condensation and ice nuclei, Budapest, Hungary, 2-7 Sept., 1984.
13.	Initiation of first snow surveys over the north-western Himalayas.	Dhar O.N., Kulkarni A.K. & Mandal B.N.	First Nat. symp. on Seasonal snow cover, New Delhi, 28-30 Apr., 1983.

Sr.	Title		Proceedings
14.	Microphysical observa- tions in warm clouds.	Khemani L.T., Momin G.A., Paul S.K., Kumar R., Murty A.S.R. & Ramana Murty Bh.V.	IX Int. Cloud physics conf., Tallinn, USSR, 21-28 Aug., 1984.
15.	New hypothesis for the vertical distri- bution of atmospheric aerosols.	Selvam A.M., Murty A.S.R. & Ramana Murty Bh.V.	XI Int. conf. on Atmospheric aero- sols, condensation and ice nuclei, Budapest, Hungary, 2-7 Sept., 1984.
16.	New mechanism for the maintenance of fair weather electric field and cloud electrification.	Selvam A.M., Murty A.S.R., Manohar G.K., Kandalgaonkar S.S. & Ramana Murty Bh.V.	VII Int. conf. on Atmospheric elec- tricity, Albany, New York, 4-8 Jun., 1984.
17.	New physical hypo- thesis for vertical mixing in clouds.	Selvam A.M., Murty A.S.R. & Ramana Murty Bh.V.	IX Int. Cloud physics conf., Tallinn, USSR, 21-28 Aug., 1984.
18.	Portable photometer for measurement of atmospheric aerosols.	Jadhav D.B.	Nat. symp. on Instrumentation (NSI-9), Srinagar, 3-5 May, 1984.
19.	Possible solar influence on atmospheric electric field.	Sikka P., Selvam A.M., Murty A.S.R. & Ramana Murty Bh.V.	VII Int. conf. on Atmospheric elec- tricity, Albany, New York, 4-8 Jun., 1984.
20.	21-	Vernekar K.G., Brij Mohan & Srivastava S.	XXV COSPAR meeting GRAZ, Austria, 25 Jul., 1984.

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Sr. No.	Title	Author(s)	Proceedings
21.	Proposed programme for the optical observations of comet Halley at Poona.	Rath S., Misal D.K., Chaudhary P.B., Jadhav D.B. & Tillu A.D.	IX Astronomical Society of India meeting, Osmania University, Hyderabad, 22-24 Nov., 1983.
22.	Role of frictional turbulence in the evolution of cloud systems.	Selvam A.M., Murty A.S.R. & Ramana Murty Bh.V.	IX Int. Cloud physics conf., Tallinn, USSR, 21-28 Aug., 1984.
23.	Temperature fluctua- tions in cloud-and clear-air during the summer monsoon.	Devara P.C.S., Selvam A.M. & Ramana Murty Bh.V.	IX Int. Cloud physics conf., Tallinn, USSR, 21-28 Augu, 1984.
24.	Thermal diffusion chamber for the measurement of cloud condensation nuclei.	Chaudhuri S. & Vernekar K.G.	XI Int. conf. on Atmospheric aero- sols condensation and ice nuclei, Budapest, Hungary, 2-7 Sept., 1984.
25.	Winter and spring precipitation over the north-western Himalayas - a brief appraisal.	Rakhecha P.R., Kulkarni A.K., Mandal B.N. & Dhar O.N.	First Nat. symp. on Seasonal snow cover, New Delhi, 28-30 Apr., 1983.

3.3 Research Reports, published in the series "Contributions from the Indian Institute of Tropical Meteorology".

Report	No. Title .	Author(s)
R-39	Developmental details of vortex and other aircraft thermometers.	Vernekar K.G., Brij Mohan & Srivastava S.
R-40	Note on the preliminary results of integration of a five level P.E. model with westerly wind and low orography.	Bavadekar S.N., Khaladkar R.M., Bandyopadhyay A. & Seetharamayya P.

4. PARTICIPATION IN SEMINARS/SYMPOSIA/ MEETINGS AND CONFERENCES 4. Participation in Seminars/Symposia/Meetings

The Institute deputed scientists to participate and present papers in several National and International seminars/symposia/meetings. Details in this regard are given below:

4.1 Participation in seminars/symposia

Sr. Seminar/Symposium Participant(s) Papers presented (if any) - Author(s)

1. First Nat. Symp.
on Seasonal snow
cover, New Delhi,
28-30 April 1983.

Sikka D.R. & Kulkarni A.K.

- i) Impact of interannual variation of winter & spring time snow cover over Eurasia on the short term climatic fluctuations of the summer monsoon over India Sikka D.R.
- ii) Initiation of first snow surveys over the north western Himalayas - Dhar O.N., Kulkarni A.K. & Mandal B.N.
- iii) Winter & spring precipitation over the north western Himalayas a brief appraisal Rakhecha P.R., Kulkarni A.K., Mandal B.N. & Dhar O.N.

2. First Nat. Agrometeorological Congress, Andhra University, Waltair, 6-8 June 1983.

Kamte P.P., Singh N. & Sontakke N.A.

- i) Incidence of droughts/floods over different meteorological subdivisions of India during last one century Parthasarathy B. & Sontakke N.A.
- ii) On global annual precipitation distribution Singh N.

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Sr. Seminar/Symposium Participant(s)

Papers presented (if any) - Author(s)

iii) Role of persis-

tence in dry and wet pentad rainfall in

First Nat. Agrometeorological Congress, Andhra University. Waltair. 6-8 June 1983.

Seminar on Hydrology 3. & Second Annual Convention of the Assn. of Hydrologists of India. Osmania University, Hyderabad, 8-10 June 1983.

Kulkarni A.K., Soman M.K. & Saseendran S.A.

- crop planning Kamte P.P. & Dahale S.D. i) Distribution of maximum rainfall over Kerala during durations of 1 to 10 days - a pilot study - Saseendran S.A. &
- ii) Estimation of probable maximum rainfall over plain areas of north India - Kulkarni A.K., Mandal B.N. &

Dhar O.N.

Dhar O.N.

- iii) Rainfall distribution over the central Himalayas during break monsoon situations -Dhar O.N., Soman M.K. & Mulve S.S.
- iv) Seasonal oscillations of evaporation in India - Rakhecha P.R., Soman M.K. & Dhar O.N.
- i) Application of stochastic model to monsoon rainfall -Kamte P.P. & Dahale S.D.
- ii) Probability density function of an ensemble of initial states in stochastic dynamic weather prediction -Sikka D.R. & Joshi P.C.

Fourth Annual Conf. Kamte P.P. 4. of the Indian Society for Theory of Probability & its Application (ISTPA), Indian Institute of Management, Calcutta, 16-18 June 1983.

Sr.	Seminar/Symposium	Participant(s)	Papers presented (if any) - Author(s)
110.			
5.	Workshop on sate- llite Meteorology, Indian Institute of Science, Bangalore, 4-9 July 1983.	Sikka D.R.	or all control of the
6.	IMAP Workshop on Ground Based Experi- ments, Andhra Uni- versity, Waltair, 25-27 July 1983.	Mukherjee B.K. & Reddy R.S.	Some aspects of mode- lling of the stratos- pheric warming over tropics - Mukherjee B.K., Indira K., Reddy R.S. & Ramana Murty Bh.V.
7.	Assembly, International Union of Geodesy and Geophysics (IUGG), Hamburg, W. Germany, 15-27 August 1983.	Reddy R.S.	i) Characteristics of the ABL over the equa- torial Arabian sea during undisturbed and disturbed ITCZ condition as observed during summer Monex - Bhide U.V., Nagar S.G., Mahajan P.N., & Sikka D.R.
			ii) Equatorial wester- lies and cloud bands over the Indian ocean and formation of cyclo- nic vortices on either side of the equator - Sikka D.R.
, Li			iii) Geomagnetic activity responses to solar proton events - Reddy R.S., Mukherjee B.K. & Ramana Murty Bh.V.

Sr. Seminar/Symposium Participant(s) Papers presented (if any) - Author(s)

8. MATSCIENCE Conf. on Probabilistic Methods, Monte Carlo Techniques and Applications, Ootacamund, 15-20 September 1983.

9.

Kamte P.P. & Kripalani R.H.

National Space Science Symposium, University of Poona, Pune, 7-10 December 1983. A team of 36 Scientists from the Institute.

- i) Probability estimates of weather elements through Monte Carlo . techniques - Kamte P.P. & Dahale S.D.
- ii) Stochastic model & distribution functions of monsoon rainfall Kripalani R.H.
- i) Application of satellite derived outgoing longwave radiation for monsoon circulation studies over Indian region - Verma R.K. & Prasad K.D.
- ii) Atmospheric ozone:
  determination by
  Chappuis band absorption Sikka P.,
  Vijaykumar R.,
  Selvam A.M. &
  Ramana Murty Bh.V.
- iii) Atmospheric tidal pressure oscillations over India Ananthakrishnan R., Aralikatti S.S. & Vatsala P.
- iv) Chemical & physical characteristics of atmospheric aerosols in different environments in India Khemani L.T., Momin G.A., Naik M.S. & Ramana Murty Bh.V.

National Space Science Symposium, University of Poona, Pune, 7-10 December 1983.

- v) Climate research problems & perspectives in the Indian context
  Sikka D.R. (Invited talk).
- vi) Detection of green and red coronal emission lines against the photospheric background Kamatgi A.J., Jadhav D.B. & Tillu A.D.
- vii) Chemical kinetics of ozone in the troposphere and stratosphere - Hingane L.S.
- viii) Dynamical characteristics of warm monsoon clouds Selvam A.M., Goyal S.S., Murty A.S.R. & Ramana Murty Bh.V.
- ix) Electrical charge separation mechanism in monsoon warm cumulus clouds Selvam A.M., Manohar G.K., Kandalgaonkar S.S., Murty A.S.R. & Ramana Murty Bh.V.
- x) Empirical orthogonal functions of monsoon circulation, their statistical behaviour & relationship with rainfall Singh S.V. & Kripalani R.H.

National Space Science Symposium, University of Poona, Pune, 7-10 December 1983. xi) Influence of thermal power plants on atmospheric electrical parameters - Selvam A.M., Manohar G.K., Murty A.S.R. & Ramana Murty Bh.V.

xii) Measurements of the extinction coefficients
Kulkarni J.T.,
Chaudhary P.B.,
Jadhav D.B. & Tillu A.D.

xiii) Microprocessor controlled double diffraction monochromator for the measurements of day sky radiations - Agte S.A., Tade M.R., Jadhav D.B. & Tillu A.D.

xiv) Momentum transport in the lower thermosphere over mid-latitudes - Devara P.C.S & Ahmed M.I.

xv) Monsoon activity & coupling between low latitude & high latitude stratospheric activities - Raja Rao K.S., Awade S.T. & Nair M.V.H.

xvi) Night time F-layer vertical movements at low & mid latitude stations - Raj P.E., Devara P.C.S. & Ramana Murty Bh.V.

National Space Science Symposium, University of Poona, Pune, 7-10 December 1983.

xvii) Observed response of the ocean to monsoon depression: a case study - Seetharamayya P. & Master A.H.

xviii) On the possible ionosphere-troposphere coupling - Selvam A.M., Raj P.E., Murty A.S.R. & Ramana Murty Bh.V.

xix) On the variation of wind & temperature observed in the first few meters above sea surface - Vernekar K.G., Sivaramakrishnan S., Brij Mohan, Srivastava S. & Deshpande C.G.

xx) Possible solar atmosphere coupling -Selvam A.M., Sikka P., Murty A.S.R. & Ramana Murty Bh.V.

xxi) Rainfall & temperature variations at
some of the urban &
non-urban stations in
India - Pethkar J.S.,
Selvam A.M. &
Ramana Murty Bh.V.

xxii) Remote sensing of atmospheric precipitable water vapour - Sikka P., Vijaykumar R., Selvam A.M. & Ramana Murty Bh.V.

National Space Science Symposium, University of Poona, Pune, 7-10 December 1983. xxiii) Report on temperature perturbations in the tropical middle atmosphere during 1982-83 - Indira K., Mukherjee B.K., Reddy R.S. & Ramana Murty Bh.V.

xxiv) Response of the middle atmosphere over Thumba and volvograd to geomagnetic and solar activity changes - Raja Rao K.S., Nair M.V.H. & Reddy R.S.

xxv) Role of southern oscillation in monsoon variability as evidenced by satellite data - Bhalme H.N. & Sikder A.B.

xxvi) Some design aspects of LIDAR system for measurement of aerosols in the lower atmosphere - Jadhav D.B., Devara P.C.S. & Ramana Murty Bh.V.

xxvii) Temperature wave structure in the 20-50 km region as revealed by the meteorological rocket payload - Vernekar K.G., Brij Mohan & Srivastava S.

National Space Science Symposium, University of Poona, Pune, 7-10 December 1983. xxviii) Upper air meridional wind analysis during years of contrasting monsoon activity - Maliekal J.A., Hingane L.S. & Patil S.D.

10. 15th session of the EC Panel/CAS working Group on Cloud Physics & Weather Modification, Geneva, Switzerland, 12-17 December 1983.

Ramana Murty Bh. V.

11. XIII International
Conf. on Stochastic
Processes & their
Applications,
Banaras Hindu University, Varanasi,
17-21 December 1983.

Singh S.V., Kamte P.P. Prasad K.D., Singh N., Kripalani R.H. & Parasnis S.S.

- i) Application of stochastic model to mon-soon rainfall Kripalani R.H.
- ii) Average probability relationships of Indian rainfall and its role in planning water based enterprises Singh N.
- iii) Probability estimates of cloud base
  heights & moisture flux
  in the planetary boundary layer Parasnis S.S.,
  Selvam A. M. &
  Ramana Murty Bh.V.
- iv) Resolution of signal & noise in the observed meteorological field through Monte Carlo technique Prasad K.D.

XIII International Conf. on Stochastic Processes & their Applications, Banaras Hindu University, Varanasi, 17-21 December 1983.

- 12. Symp. on 'Water
  Balance & National
  Development',
  Waltair, 19-21
  December 1983.
- 13. International Conf. on 'Biometeorology', New Delhi, 26-30 December 1983.

Krishnakumar K.

Pant G.B.,
Rakhecha P.R.,
Rupkumar K.,
Hingane L.S.,
Kulkarni A.K.,
Maliekal J.A.,
Mandal B.N. &
Soman M.K.

- v) Statistical distribution of onset & withdrawal of rains over India - Singh N.
- vi) Stochastic prediction of rainfall Kamte P.P. & Dahale S.D.
- Oscillations in potential evapotranspiration over India Krishna Kumar K. & Rakhecha P.R.
- i) Assessment of water budget & temperature during years of contrasting weather behaviour over Kerala & their impact on crop production Maliekal J.A. & Saseendran S.A.
- ii) Characteristics of Sourashtra's rainfall Dhar O.N., Soman M.K. & Rakhecha P.R.
- iii) Forest growth & Climate relationship for Nainital Mukteswar region in U.P. Hills Borgaonkar H.P. & Pant G.B.

International Conf. on 'Biometeorology', New Delhi, 26-30 December 1983.

A self-of fellow

iv) Growth-rings of trees for Kashmir Himalaya as palaeoclimatic indicators -Pant G.B. & Borgaonkar H.P.

v) Highest floods of 1982 monsoon season - a brief appraisal - Mandal B.N., Ghose G.C., Kulkarni B.D. & Dhar O.N.

vi) Possible interaction of carbon dioxide plant Ecosystem in India - Hingane L.S. & Ramana Murty Bh.V.

vii) Some aspects of southwest monsoon rainfall distribution over contiguous Indian area - Kulkarni A.K.,
Mandal B.N., Mali R.R.
& Dhar O.N.

viii) Study of maximum rainfall over the Narmada basin for different durations - Dhar O.N., Mandal B.N., Kulkarni A.K. & Saseendran S.A.

ix) Study of rainfall distribution over Kerala State for durations of one to ten days & return periods of 2 to 100 years - Saseendran S.A., Sangam R.B. & Dhar O.N.

International Conf. on 'Biometeorology', New Delhi, 26-30 December 1983. x) Time oscillations of normal potential evapotranspiration over India - Rakhecha P.R. & Kumar K.K.

xi) Was the July 1941 coastal rainstorm the severemost rainstorm of India? - Dhar O.N., Kulkarni A.K., Mandal B.N. & Sangam R.B.

xii) Weather induced yield response model for sugarcane and identification of macrometeorological systems affecting the crop in northeast Andhra Pradesh - Rupa Kumar K.

xiii) Yield-weather relationship of finger millet-crop under different manurial treatments
- Rupa Kumar K.

14. Seminar on Tropical Sikka D.R., Cyclones and Mohile C.M. & disaster preparedness, Sangam R.B. Bhubaneshwar, 11-13 January 1984. i) Bay depression which caused the greatest raindepths in India - Dhar O.N., Kulkarni A.K. & Sangam R.B.

			a very final and and dark dark from mind before many from the final fina
Sr. Semin	nar/Symposium	Participant(s)	Papers presented (if any) - Author(s)
Cyclo ter p Bhuba	ar on Tropical nes and disas- reparedness, neshwar, 11-13 ry 1984.		ii) Simultaneous occurrence of cyclonic vortices on either side of the equator - Sikka D.R. & Joshi P.C.
	to min on (v		iii) Zones of maximum rainfall associated with Bay Cyclonic storms - Mohile C.M. & Mooley D.A.
<pre>fer of Calicut</pre>	rbasin Trans- water,	Soman M.K.	*Assessment and simula- tion of annual rainfall of major catchments of India - Rakhecha P.R. & Soman M.K.
16. 8th All Students Seminar Environs Pollution Patna, 2	on on	Sharma S.K.	Sequential equipment for continuous moni-toring of gaseous pollutants in atmosphere - Sharma S.K.
Indian (	the te of the Heographers, University, Ed, 9-11	Pant G.B., Rakhecha P.R. & Kulkarni A.K.	i) Appraisal of maximum point rainfall in the Narmada basin for different durations - Rakhecha P.R., Saseendran S.A., Mali R.R. & Dhar O.N.
			ii) Droughts & floods over Gujarat State during the last one century - Pant G.B. & Parthasarathy B.

Fifth Annual
Conf. of the
Institute of the
Indian Geographers,
Gujarat University,
Ahmedabad, 9-11
February 1984.

iii) On some rainfall characteristics of Nepal Himalayas - Dhar O.N., Soman M.K. & Mulye S.S.

iv) On some rainfall features of the June 1983 rainstorm over coastal saurashtra - Mandal B.N., Kulkarni B.D. & Dhar O.N.

v) Two biggest rainstorms of Gujarat a brief appraisal - Kulkarni A.K., Kumar K.K., Ghose G.C. & Dhar O.N.

18. Symposium on Climate & its variability, Centre for Advanced studies in Atmospheric & Fluid Sciences, IIT, New Delhi, 26-27 February 1984.

Sikka D.R., Singh S.S. & Bhalme H.N. \*Numerical models for weather forecast and climate studies in I.I.T.M. - Present status and future plan - Singh S.S., Rajamani S., Sinha S. & Mishra S.K.

19. Workshop on
Microprocesses in
cloud, University
of Roorkee,
Roorkee, 21-24
March 1984.

Kamra A.K. (Chaired one of the sessions) On the validity of microphysical correlations in thunderclouds - Kamra A.K.

<sup>\*</sup>Published in the proceedings.

# 4.2 Participation in Meetings

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Sr. No.	Mootive	Date	Participant(s)
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1.	Meeting of the IMAP Working group on Tropospheric- stratospheric circulation, New Delhi.	6-7 April 1983	Sikka D.R.
2.	Meeting of Programme Management Board of IMAP, Space Applications Centre, Ahmedabad.	19 April 1983	Vernekar K.G.
3.	Fifth IMAP Working Group meeting on Atmospheric Dyna-mics & Fourth meeting of IMAP Management Board, Ahmedabad.	18 & 19 May 1983	Mukherjee B.K.
4.	First meeting of the Hindi Salahkar Samiti of Min. of T & C A., Hotel Kaniska, New Delhi.	10 June 1983	Kapoor R.K.
5.	Advisory Comiittee meeting of the Centre for Atmospheric & Fluid Sciences, I.I.T., New Delhi.	14 & 15 June 1983 & 24 Feb- ruary 1984	Ramana Murty Bh.V.
6.	Meeting of the Council for Meteorology and Atmospheric Sciences (CMAS), I.Met. Deptt., New Delhi.	6 July 1983 & 25 November 1983	Ramana Murty Bh.V.
7.	Meeting of the Indian scientists to finalise the Indian comments on the US proposal on monsoon research under Indo-US collaborative programme, Physical Research Laboratory, Ahmedabad.	13-14 July 1983	Singh S.S.

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Sr.	Meeting	Date	Participant(s)
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8.	Meeting of the Board of Studies in Meteorology & Oceanography, Andhra University, Waltair.	26 July 1983	Ramana Murty Bh.V.
9.	INSA Organised meeting on International Satellite Land Surface Climatology Project, New Delhi.	2 & 3 August 1983	Sikka D.R. & Bhalme H.N. Shri Sikka D.R. presented a paper 'Inter annual variability of equatorial and tropical climate utilising satellite radiation data'.
10.	Meeting of the Indian scientists under Indo-US collaborative programme, Deptt. of Science & Technology, New Delhi.	26 August 1983	Singh S.S.
11.	Meeting of Aerosol campaign of ISRO - Physical Research Laboratory, Ahmedabad.	30 August 1983	Khemani L.T. & Vijaykumar R.
12.	Meeting of the Indian scientists under Indo-US Collaborative Programme on Monsoon Research, Planning Commission, New Delhi.	14 Septem- ber 1983	Singh S.S.
13.	Initiating meeting to finalise the scope of Indo-US Collaborative Programme on Monsoon Research, National Academy of Sciences, Washington, USA.	21-23 September 1983	Singh S.S.

	the two days and the days are day and the the total days and the the two days are the two	and one state that the tree date and the and the tree tree tree tree	MAND SAME SAME SAME SAME SAME SAME SAME SAME
Sr No	Mooting	Date	Participant(s)
14.	Second International meeting of Statistical Climatology, Lisbon, Portugal.	26-30 September 1983	Singh S.V. He presented a paper 'Climatic Characteristics of monsoon rainfall, over India.'
15.	49th Annual meeting of the Indian Academy of sciences, National Chemical Laboratory, Pune.	7-9 November 1983	Sikka D.R.
16.	Meetings convened by the Ministry of Tourism & Civil Aviation for discussions on the Institute's draft 7th Five Year Plan Proposals.	16 & 17 November 1983	Ramana Murty Bh.V. & Sikka D.R.
17.	Meeting of the Scientific Advisory Committee (SAC) of Indian Middle Atmospheric Programme (IMAP), Bangalore.	2 December 1983	Mukherjee B.K.
18.	Meeting of the Working Group on Atmospheric Dynamics, Pune.	9 December 1983	Sikka D.R.
19.	Evaluation of the DST project on Palaeoclimato- logy, Physical Research Laboratory, Ahmedabad.	15 December 1983	Sikka D.R.
20.	Annual Plan 1984-85 Meeting of the Ministry of Tourism & Civil Aviation, New Delhi.	27 December 1983	Sikka D.R.
21.	Sixth meeting of the working group on Meteorological Rocket payload, Bombay.	28 December 1983	Kamra A.K., Vernekar K.G. & Brij Mohan.

Sr. No.	Meeting	Date	Participant(s)
22.	Meeting with the Chief Engineer, C.P.W.D., Bombay.	6 January 1984 & 30 March 1984	Ramana Murty Bh.V. & Kshirsagar D.W.
23.	Indo-Soviet Co-operative programme on 'Space Meteoro-logy and Aeronomy' Tata Institute of Fundamental Researches, Bombay	17 January 1984	Vernekar K.G. & Mukherjee B.K.
24.	Meeting of the working group on Meteorology, Airline House, Bombay.	14 February 1984	Ramana Murty Bh.V. & Chatterjee R.N.
25.	National Committee on World Climate Programme (INSA) I.M.D., New Delhi.	28 February 1984	Sikka D.R.
26.	Meeting of Dam Review Panel (DRP), Narmada Dam site, Punasa, M.P.	1-3 March 1984	Rakhecha P.R.
27. ∠&	Meeting regarding the planning of Indo-US workshop on Ocean-atmospheric interactions, Deptt. of Science/Technology, New Delhi.	21 & 22 March 1984	Sikka D.R.

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5. COLLABORATION WITH UNIVERSITIES AND OTHER SCIENTIFIC INSTITUTIONS

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5. Collaboration with Universities and other Scientific Institutions/Organisations

## 5.1 Collaboration with Universities

University of Poona granted permanent recognition to this Institute as a recognised Institute for prosecuting post graduate studies leading to the award of M.Sc. (Partly by papers and partly by research) and Ph.D. degrees in Atmospheric Science.

Dr. D. Subrahmanyam, Senior Scientific Officer-I, was appointed by the Andhra University, Waltair as an external examiner for a thesis for the award of Ph.D. Degree.

Shri S.K. Mishra, Assistant Director has been awarded Ph.D. Degree in Physics by the University of Poona for his thesis entitled "Dynamics of the Upper Tropospheric Disturbances of the Tropical Easterly Jet".

Shri P.V. Joseph, Director, Training Directorate, India Meteorological Department, Pune who had worked under the guidance of Dr. R. Ananthakrishnan, Hon. Fellow, I.I.T.M., was awarded Ph.D. degree by the University of Poona for his thesis entitled, 'Inter-annual variability of Indian Summer Monsoon Rainfall'.

Shri R.S. Reddy, Senior Scientific Officer, Gr.II who worked under the guidance of Dr. Bh.V. Ramana Murty, Director, was awarded Ph.D. degree by the University of Poona for his thesis entitled "Investigations of singularities and periodicities in rainfall of Tamil Nadu, south India and their association with solar terrestrial phenomenon'.

Shri Ernest P. Raj, Junior Scientific Officer was awarded Ph.D. (physics) Degree by the Andhra University, Waltair for his thesis entitled 'Studies on some F-region phenomena and sporadic-E at Waltair using phase path technique'.

Shri G. Appa Rao, Meteorologist, I.M.D., who worked under the guidance of Dr. Bh.V. Ramana Murty, Director, I.I.T.M., was awarded the Ph.D. degree by the University of Poona for his thesis entitled 'Studies of summer monsoon over India during two consecutive years of drought and good monsoon'.

Shri M.V.H. Nair, CSIR Research Scholar who worked under the guidance of Dr. K.S. Raja Rao, Emeritus Scientist, C.S.I.R., attached to this Institute, was awarded the Ph.D. degree by the University of Poona, for his thesis entitled, 'Some aspects of the physical processes in the middle atmosphere'.

Miss P.L. Kulkarni, Junior Scientific Officer, was awarded the M.Sc. degree by the University of Poona for her thesis entitled, 'Some features of the southwest monsoon failure over India during 1972'. Miss Kulkarni worked under the guidance of Dr. D.A. Mooley.

Shri S.V. Singh, Senior Scientific Officer, Gr.I. submitted his thesis entitled, 'Prediction of summer monsoon circulation and rainfall over India' to the University of Poona for award of Ph.D. degree.

5.2 Collaboration with other scientific Institutions/Organisations

The Institute participated, in collaboration with the National Institute of Oceanography (NIO), Goa in the Field Observational Programme in the Arabian sea/Indian ocean/Bay of Bengal during 8-20 May 1983 in the cruise of the research vessel 'Gaveshani' from Goa-Cochin-Sri Lanka-Madras. Extensive observations were taken for undertaking studies in Atmospheric Chemistry, Cloud Physics, Atmospheric Electricity, Boundary Layer Experiments, Wind and Temperature profiles, Vertical Wind, Sensible Heat Flux by Eddy Correlator Technique and Sea Surface Temperature. Several scientists from the Institute took part in the field programme.

Technical guidance was being provided to the three Assistant Engineers deputed by the Office of the Chief Engineer, Planning and Monitoring, Bhopal, M.P., regarding storm transposition and working out the design storm depths.

Shri D.R. Sikka, Assistant Director, was elected as a Fellow of the Indian Academy of Sciences, Bangalore.

Shri D.R. Sikka, Assistant Director, participated in the evaluation of the DST project on Palaeoclimathlogy at the Physical Research Laboratory, Ahmedabad at the request of the funding agency.

Shri D.R. Sikka, Assistant Director, was nominated to work as a member in the Radiation budget study group of the Indian Middle Atmosphere Programme.

On being requested, Shri D.R. Sikka, Assistant Director, assessed the progress of fesearch projects at various research Institutions under the grant-in-aid programme of the India Meteorological Department.

On invitation, Shri D.R. Sikka, Assistant Director, delivered a lecture on Fundamentals of Satellite Meteorology at the Indian Institute of Science, Bangalore during 4-9 July 1983.

On invitation, Shri D.R. Sikka, Assistant Director, delivered a lecture on 'Climate Research Problems and Perspectives in the Indian Context', in the plenary session of the National Space Symposium held at the University of Science Poona, Pune during 7-10 December 1983.

Dr. D. Subrahmanyam, Senior Scientific Officer, Gr.I, and Shri M.K. Tandon, Junior Scientific Officer, attended a series of lectures on the 'Procurement of large scale computer systems' delivered by Prof. Gordon Black, UMIST, Manchester University, U.K. from 17-27 August at CWPRS, Khadakwasla, Pune.

At his request, a short note regarding the preparation of generalized rainfall frequency maps for the lower Narmada basin was supplied to Prof. Satish Chandra, Professor of Hydrology, School of Hydrology, University of Roorkee.

Manuscript of a monograph entitled, 'Advances in Meteorology of Summer Monsoon in India' by Shri D.R. Sikka, Assistant Director, was sent to the Indian National Science Academy (INSA), New Delhi for inclusion in their Gelden Jubilee publication.

Shri H.N. Bhalme, Senior Scientific Officer, Gr.I., delivered a talk on 'Climatic variability' at the meeting of the International Satellite Land Surface Climatology Project, organised by the Indian National Science Academy (INSA) at New Delhi during 2 & 3 August 1983.

On invitation from the DDGM (WF), I.M.D., Pune, lectures to the Meteorologists, Gr.II trainees of I.M.D., Pune were delivered by Dr. G.B. Pant and Shri H.N. Bhalme, Senior Scientific Officers, Gr.I on 'Mechanism of Climate and Climatic Variability' and 'Atmospheric circulation aspects of droughts and floods over India' on 28 and 29 November 1983 respectively.

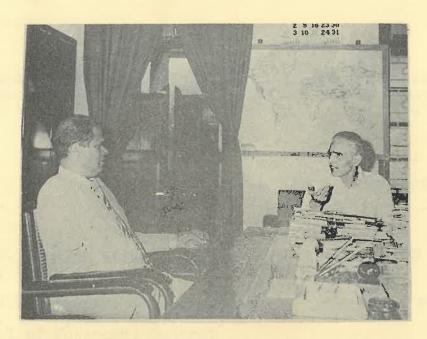
6. FACILITIES FOR RESEARCH EXTENDED TO OTHER INSTITUTIONS

6. Facilities for Research extended to other Institutions

Dr. K. S. Raja Rao, Director (Retd.), Agricultural Meteorology, India Meteorological Department, availed himself of the various research facilities available at the Institute, as an Emeritus Scientist by the Council of Scientific and Industrial Research from 4 December 1978 to 30 June 1983.

S/Shri D.V. Ahire and G. Balan, who had earlier been awarded the Air India Research Fellowship, continued to work in the Instrumental and Observational Techniques and Theoretical Studies Divisions of the Institute respectively.

7. VISITORS



Shri S.K. Das, Director General of Meteorology & Chairman, Governing Council discussing with the Director during his visit to the Institute



Dr. L.D. James, World Bank Consultant called on the Director during his visit to the Institute

#### 7. Visitors

A number of Meteorologists and specialists in allied disciplines from India and abroad visited the Institute during the year. The list of visitors is given below:

Sr. No.	7.7	Visitor-Credential	Date of visit
1.	Dr. NASA	J. Shukla, Meteorologist, A, USA.	9 & 10 May 1983
2.	Scho	K.M. Kotadia, Hon. Professor, c. of Physics, University & ool of Sciences, Gujarat versity, Gujarat.	17-19 May 1983
3.	Cons	S.V.C. Aiya, sulting Electronics Engineer, galore.	18 May 1983
4.	Dept	Richard Pasch & Mrs. Naomi Surgi, of Meteorology, Florida State ersity, USA.	6-19 June 1983
5.	i)	Dr. L.D. James, World Bank Expert & Director, Utah Water Research Laboratory, Utah, USA.	18 June 1983
	ii)	Dr. K.V. Ramana Murty, C.R.O., CWPRS, Pune.	
	iii)	Smt. V.M. Bendre, S.R.O., CWPRS, Pune. and	
	iv)	Shri F.J. Mathew, S.R.O., CWPRS, Pune.	V. vionoeveli Distriction

Sr.	Visitor-Credential	Date of visit
6.	Mr. Basman D. Talib, Meteorologist, Typhoon Moderation Research, PAGASA Quezon City, Philippines.	30 June 1983- 29 July 1983
7.	Shri N.P. Vithal, Commissioner of Railway Safety, Bombay.	5 & 8 July 1983
8.	Prof. Yashpal, Chief Consultant, Planning Commission, New Delhi.	25 July 1983
9.	Miss Pratima K.S. Naidu, Executive Engineer	3 August 1983
	and	R. Dr. K.H. Dag Dept. of Phys
	Shri D.D. Bidwai, Sub-divisional Engineer, Central Design Organisation, Nasik.	Frot, della
10.	Local Inquiry Committee appointed by the University of Poona, Pune.	12 <b>A</b> ugust 1983
	and Pr. A.S. Nigvekar,	University, U
	Members of the Committee appointed by the University of Poona, Pune.	5, 1) inc. (
11.	Shri I.M. Shah, Chief Engineer, Irrigation, Govt. of Gujarat.	18 August 1983
	and Shri S.C. Desai, Liaison Officer at Pune, Govt. of Gujarat.	LILL STEEL CALL
12	. A batch of students of M.Sc. Meteorology Course,	30 August 1983
	411217	



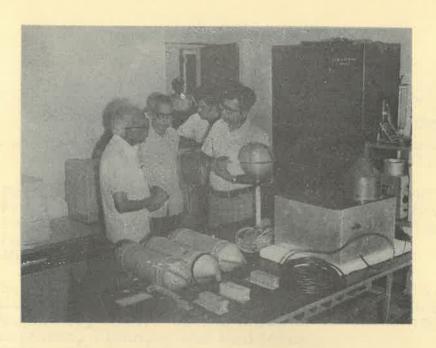
Dr. A. P. Mitra, Member, Governing Council during his visit to the Institute seen with the Director and Dr. K S. Raja Rao, Emeritus Scientist, CSIR



Mr. Michael Priestley, U.N.D.P. Resident Representative in India seen with the Director during his visit to the Institute.

Sr. No.	Visitor-Credential	Date of visit
13. i)	S/Shri N.B. Sen & S. Sheshadri, Chief Engineers, Narmada Sagar Project, Bhopal, M.P.	5 & 6 September 1983
ii)	Shri B.S. Bhavani Shankar, Chief Engineer, Water Management, Ministry of Irrigation, Govt. of India, New Delhi.	Price Charles
14. Shri Mini Govt	S.W. Oak, Financial Controller, stry of Tourism & Civil Aviation, . of India, New Delhi.	15 September
15. i)	Dr. L.D. James, World Bank Expert & Director, Utah Water Research Laboratory, Utah, USA.  Dr. K.V. Ramana Murty, CRO, CWPRS, Pune. and	1983 19 September 1983
iii)	Dr. K.S. Rajagopalan, SRO, CWPRS, Pune.	
ii) l	Dr. Y.K. Murthy, Chairman, Dam Review Panel, Narmada Sagar Dam, M.P. Mr. James Legas, World Bank Expert, USA.	26 September 1983
iii) S	Shri P.N. Mane, Member, Dam Review Panel, Pune	
iv) S	Chri R. Ghose, Member  Cam Review Panel	Connecta
v) s D	hri M.S. Balsundaram, Member, am Review Panel	

Sr.	Visitor-Credential	Date of visit
	vi) Shri S. Sheshadri, Chief Engineer, Narmada Sagar Project, M.P.	26 September 1983
	vii) Shri N.B. Sen, Chief Engineer, Narmada Sagar Project, M.P. and	
	viii) Shri B.S. Bhavani Shankar, Chief Engineer, Water Management, Ministry of Irrigation, Govt. of India, New Delhi.	The Bridge of the State of the
17.	Shri A.S.R.H. Baruah, Executive Engineer, Brahmaputra Control Board, Assam.	7 <b>0</b> ctober 1983
18.	Shri N.K. Kapoor, Superintending Engineer, Govt. of M.P., Bhopal.	27 October 1983, 14 November 1983, 20-21 January 1984, 18-21 February 1984, 28-29 March
		1984.
19.	Mr. Michael Priestley, UNDP Resident Representative, New Delhi.	31 October 1983
20.	Dr. A.P. Mitra, Director, National Physical Laboratory, New Delhi & Member, Governing Council, I.I.T.M.	7 November 1983 & 9 March 1984
21	Do G Dhewan Secretary.	9 November 1983
	ii) Prof. R. Narasimha, Dept. of Aeronautical Engineering Indian Institute of Science, Bangalore.	



Prof. K.R. Ramanathan, Professor Emeritus, Physical Research Laboratory, Ahmedabad, discussing with Dr. A.K. Kamra, Head of the I & O T Division during his visit to the Institute



Prof. P. Koteswaram, Member, Governing Council giving a seminar

Sr. No.	Visitor-Credential	Date of visit
22.	Prof. K.R. Ramanathan, & Prof. P.R. Pisharoty, Professors Emeritus, Physical Research Laboratory, Ahmedabad.	10 November 1983
23.	Shri N.K. Kapoor, Superintending Engineer alongwith three Assistant Engineers, Office of the Chief Engineer, Planning and Monitoring, Govt. of M.P., Bhopal.	14 November 1983
24.	Prof. P. Koteswaram, D.G.O. (Retd.) & Member, Governing Council, I.I.T.M.	5-7 December 1983
25.	Prof. V.V.J.Sarma, Secretary & Treasurer, Association of Hydrologists of India, Waltair.	6 December 1983
26.	i) Dr. L.D. James, World Bank Expert & Director, Utah Water Research Laboratory, USA.	23 December 1983
	ii) Dr. K.V. Ramana Murty, C.R.O., CWPRS, Pune.	
	iii) Shri N.T. Mathew, Deputy Executive Engineer, Narmada Project, Dam Design Circle. and	
	iv) Shri S.C. Desai, Liaison Officer to the Govt. of Gujarat, Pune.	entail and end
27.	A batch of M.Sc students, Department of Meteorology & Oceanography, Andhra University, Waltair.	26 December 1983

Er.	Visitor-Credential	Date of visit
28.	Prof. M.P. Singh, Head, Centre for Atmospheric & Fluid Science, I.I.T., New Delhi & Member, Governing Council, I.I.T.M.	28 December 1983
29.	Shri K.J.M. Shetty, Joint Secretary (Finance), Ministry of Tourism & Civil Aviation, New Delhi.	10 January 1984
30.	Shri R. Ramesh, Research Scholar, Physical Research Laboratory, Ahmedabad.	23-25 January 1984
31.	Dr. J.L. Van Hamme, Project Manager, F.A.O., Rome.	8 February 1984
32.	Prof. P. Ramaswamy, Head, Crystal Growth Centre, Anna University, Madras.	25 February 1984
33.	A batch of four Trainee Officers and one Instructor, Air Force Administrative College, Coimbatore.	6 & 7 March 1984
34.	Shri S.K. Das, Director General of Meteorology, I.Met.D. & Chairman, Governing Council, I.I.T.M.	12 March 1984

27. A marco of H. So sendosta, Haper I was of the control of the c



Shri K.J.M. Shetty, Joint Secretary, Ministry of Tourism and Civil Aviation, listening to Director during his visit to the Institute



Prof. M.P. Singh, Member, Governing Council, replying to questions after delivering a seminar

8. GENERAL

- 8. General
- 8.1 Construction of Institute's Buildings & Staff Quarters.

The construction work of the A, B & C types (24) staff quarters and that of the transit type accommodation (8) was completed. The construction of 32 type III staff quarters was in progress.

The construction of the workshop building was also completed and the workshop started functioning in its new building at Pashan.

Preliminary action was in progress for construction of Hostel and Guest House and for the Second Phase Building Programme.

- 8.2 Facilities
- 8.2.1 Library, Information and Publication:

To help the scientists in their pursuit of research, the Division of Library, Information & Publication renders necessary scientific and technical services by way of:

- i) Procuring books/journals, data etc. for the Institute's Library,
- ii) Rendering necessary timely facilities viz. preparation of drawings, tracings, diagrams, charts, photoprints, slides, microfilms, ammonia prints, etc.,
- iii) Dissemination of appropriate scientific information,
  - iv) Documentation and current awareness service, and
- v) Preparation, publication and presentation of various scientific/research reports and allied materials projecting the activities of the Institute.

Formulation of various plan documents (Annual Plan, Five Year Plan, Quarterly and Mid-term Plan reviews etc.) and monitoring of the on-going plan projects are also dealt with by this Division.

#### a) Library:

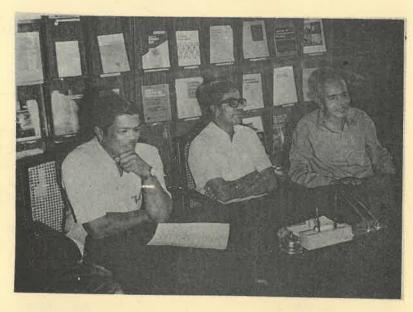
During the year, 195 books in Meteorology and allied subjects were added and 77 periodicals of national and international repute were subscribed to. A number of useful scientific/technical reports were also added to the library. Reprints of 40 papers authored by the Institute's scientists and published in different scientific journals of national and international standing were procured. Inter-library loan facilities are arranged through the courtesy and coperation of a large number of research libraries in the country.

### b) Seventh Five Year Plan

Institute's proposals for the seventh Five Year Plan (1985-90) were formulated by the Divisions and a well-connected document was prepared. The Plan proposals were submitted to the Governing Council of the Institute and the document was slightly modified in the light of the recommendation of the Council. The final draft plan proposals were submitted to the Government of India for their consideration. The draft Plan provides for the following new programmes:

- 1) General Circulation and climate modelling.
- 2) Forecasting research and hydrometeorological studies with satellite-input.
- 3) Middle atmosphere studies.
- 4) Studies of air-sea interaction.
- 5) Weather modification of cold clouds
   Silver iodide seeding.
- 6) Division of radio-meteorology (with emphasis on remote sensing).
- 7) Acquisition of a high speed computer.

The financial outlay proposed for the plan period is Rs. 6.25 crores.



Shri N.K. Sunder Rajan, Director (Finance), Ministry of T & C A, Govt. of India in the Institute's library during his visit to the Institute



Mr. Michael Priestley, U.N.D.P. Resident Representative in the Institute's library

# c) Information Supplied:

Nature of Report/Information	Sent to	Period
Material for quarterly Review Meetings for the quarter ending December 1982-information regarding the major projects under implementation.	Ministry of Tourism & Civil Aviation, New Delhi.	Oct-Dec. 1982
Quarterly Review Meetings (Plan) for the quarters end- ing March 1983 and December 1983.		Jan-Mar. 1983 & Oct-Dec. 1983
Annual Plan 1983-84 (Revised)	- do	1983-84
Annual Plan 1984-85	- do -	1984-85
Quarterly statements of plan expenditure for the quarters ending March, June, Sept. & December 1983.	- do -	Jan-Mar., Apr-June, Jul-Sept., Oct-Dec., 1983.
Analysis of the impact of time and cost over-runs.	- do -	1980-85
Note on the performance and Targets of the Departments/Organisations (Plan scheme).	- do -	1984-85
Eighty copies of the Institute's Annual Report (English & Hindi versions).	- do -	1982-83
Institute's contribution for the Annual Report 1983-84 of the Ministry of Tourism & Civil Aviation, Govt. of India (English & Hindi versions).	- do -	1983 <b>–</b> 84

Nature of Report/Information	Sent to	Period
Institute's contribution for preparation of performance budget of the Ministry of Tourism & Civil Aviation.	Ministry of Tourism & Civil Aviation, New Delhi.	198485
Information regarding Technical Assistance given by India under the Colombo Plan and the Special Common-wealth African Assistance Plan (SCAAP).	- do -	198485
Institute's contribution for Annual Report of the Ministry of External Affairs for 1983-84.	- do	1983-84
Institute's Seventh Five Year Plan proposals (1985-90).	Director General of Meteorology, New Delhi.	1985-90
Institute's revised Seventh Five Year Plan proposals (1985-90) covering an outlay of Rs.6.25 crores.	Director General of Meteorology, New Delhi & Working Group on Meteoro- logy.	1985-90
General information regarding the Institute for the period 1962-82, as required by the Poona Municipal Corporation.	A.D.G.M. (R), IMD, Pune, for onward transmission to Poona Municipal Corporation.	1962-83
National Survey of Scientific & Technological Activities 1982-83.	Dept. of Science & Technology, New Delhi.	1982-83
Annual Return (1982-83) of Scientific Research Activities of the Institute.	- do -	1982 <b>-</b> 83
Information in connection with biennial inspection and visit of Local Inquiry Committee to this Institute.	Members of the Local Inquiry Committee, University of Poona, Pune.	inivi-livid ines) ulbei (unulum).

Nature of Report/Information	Sent to	Period
m Selection Officer,	P. D. Dakingram, Borto	
Institute's contribution for Annual Report of the University of Poona.	University of Poona, Pune.	
Institute's contribution for Inputs for INCOSPAR report.	Member Secretary, ISRO, Bangalore.	1982-83
General information relating to this Institute.	The Association of Commonweath Universities, London.	Sire P.O. R.
General information relating to this Institute.	National Referral Centre, Library of Congress, Washington D.C.	interpretation of the state of

#### 8.2.2 Computer

The IBM 1620 computer worked during the year as follows:

	Hrs. Mts	3.
Institute's Jobs	1294 40	
Data processing of India Meteorological Department	26 40	
Breakdown/Maintenance	171 55	
Paying Users	9 15	

Monthly climatic data (surface) of 60 stations in the tropics for ten years (1971-80) were collected and punched.

At the request of the Additional Director General of Meteorology (Research), Pune, data processing on priority basis was arranged in connection with some special studies on monsoon rainfall.

### 8.3 Training

### 8.3.1 UNDP Training:

The following scientists of the Institute were deputed for training under the United Nations Development Programme:

i) Dr. A.K. Kamra, Assistant Director, for training in the field of 'Instrumentation for Cloud Physics and Weather Modification', in U.S.A. for a period of 5 months from 26 April 1983.

ii) Shri P.R. Rakhecha, Senior Scientific Officer, Gr.I for training in the field of 'Hydrometeorology' in Melbourne, Australia for a period of 6 months from 2 May 1983.

### 8.3.2 Training in India :

Smt. N.A. Sontakke, Senior Scientific Assistant and Shri P.G. Rao, Junior Scientific Officer were sponsored for 'Advanced' training conducted by the India Meteorological Department, Pune from 12 September 1983 and 14 March 1983 respectively.

S/Shri D.K. Paul, Senior Scientific Officer, Gr.II and P.N. Mahajan, Senior Scientific Assistant attended an Advanced Refreshers' course on Synoptic Analysis in Tropical with Special Reference to Aeronautical Meteorology organised by the India Meteorological Departmenty Pune from 27 February to 9 March 1984.

### 8.4 The Governing Council

Speaker

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

The council held two meetings during the year. The 26th & 27th meetings were held at India Meteorological Department, New Delhi on 11 October 1983 and 5 March 1984 respectively.

### 8.5 Lectures

Sr.No.

The following lectures were delivered by some of the visitors to the Institute:

Topic

Date

	MAINTENANT OF TAXABLE	THE TO SHOULD BE USED TO THE WOLLD'S	
1.	Dr. S.N. Rajaguru, Dept. of Archaeo- logy, Deccan College, Pune.	Geomorphological evidence of climatic change during the quaternary in India.	8 April 1983



Chairman, Governing Council addressing the employees of the Institute



A view of the Audience in the Seminar hall

Sr.N	Speaker Speaker	Topic mediana	Daté
2.	Shri M.B. Pant, Vedvigyan Mandal, Pune.	Square nature equations of Bhaskaracharya.	22 April 1983
3.	Dr. J. Shukla, Goddard Laboratory for Atmospheric Sciences (GLAS), NASA, USA.	Prospects for long range forecasting of monsoons.	10 May 1983
4. C	Prof. S.V.C. Aiya, Consulting Electro- nics Engineer, Bangalore.	Adverse effects of pollution on rainfall.	18 May 1983
5.	Mrs. Naomi Surgi, Florida State University, USA.	Dynamics of a monsoon depression.	17 Jûne 1983
6 <b>.</b>	Dr. Michael Douglas, Florida State University, USA.	Temperature structure of monsoon depressions	18 June 1983
7.	Dr. B.N. Goswami, IIT, New Delhi.	Analysis of 100 years of SST over the Indian Ocean.	11 July 1983
8.	Dr. B.N. Goswami, IIT, New Delhi.	Dynamics of the ITCZ experiments with a symmetric version of the GLAS climate model.	13 July 1983
9.	Dr. S. Sethuraman North Carolina State University, USA.	Some aspects of the research in Atmospheric Sciences in USA.	12 August 1983
10.	Shri N.Y. Joshi, Ved-Vigyan Mandal, Pune.	Gayatri Mantra and its scientific interpretation.	19 August 1983
11.	Dr. S.V. Sohoni, ICS (Retd.), Pune.	Knowledge of wind and cloud movements in the 5th Century A.D. in India.	7 September 1983

Sr.No	Speaker Speaker	Topica.	Date
12.	Prof. C.R.V. Raman, Ex-Jawahar Lal Nehru Fellow, Pune.	On his recent visit to China,	9 September 1983
13.	Dr. V.N. Bringi, Colorado State University, USA.	Differential polariza- tion radar studies of precipitation.	19 <b>October</b> 1983
14.	Shri S.K. Kelkar, Pune.	Prediction of earthquakes.	3 December 1983
15.	Dr. P. Koteswaram, D.G.M. (Retd.), Waltair.	Long-term periodicities in annual rainfall of India.	5 December 1983
16.	Prof. M.P. Singh, IIT, New Delhi.	Salient features of the research activities in the Atmospheric Sciences at IIT, New Delhi.	28 December 1983
17.	Prof. G.C. Asnani, Pune.	Atmospheric Tides	30 December 1983
18.	Prof. G.C. Asnani, Pune.	Inertial instability & its applications to tropical cyclones.	3 February 1984.
19.	Dr. J.L. Ven Hamme, Project Manager, FAO, Rome.	The need of synoptic meteorology in monitoring and forecasting of Desert Locust breeding from India to Senegal.	8 February 1984
20.	Dr. A.P. Mitra, Director, National Physical Laboratory, New Delhi.	- Vigyan Handal, scienti	9 March 1984
11. Dr. 5.V. Behorl,			



Ms. Naomi Surgi, Florida State University, U.S.A., giving a seminar

### 8.6 Institutional Seminars:

Speaker	Topic	Date
Shri S. Chaudhuri, Junior Scientific Officer.	Portable thermal diffusion cloud nucleus counter.	27 May 1983 & 21 June 1983
Shri S.S. Dugam, Scientific Assistant.	Monsoon-1983 : some large-scale features.	24 October 1983.
Shri S.V. Singh, Senior Scientific Officer, Gr.I.	Experiences of second International meeting on statistical climatology at Lisbon.	28 October 1983
Shri B. Parthasarathy, Senior Scientific Officer, Gr.I.	Variability of the Indian summer monsoon & related circulation features.	10 & 17 February 1984

# 8.7 Official Language Implementation :

A Hindi Officer has been appointed since October 1983. All name plates, signboards, rubber stamps etc. were made bilingual. Two employees were trained in Hindi. Two typists were undergoing training in Hindi Typing.

A Hindi workshop was conducted from 1 December 1983 to 14 February 1984 to train the staff to write notes and drafts in Hindi.

A sectional library of Hindi books and periodicals was set up as part of the activities of the Hindi cell.

Meetings of the Official Language Implementation Committee were held regularly. Periodical reports on implementation and progress of Hindi were forwarded regularly to the Ministry. Institutes' Annual Report (1982-83) and the Institute's contribution to the Ministry's Annual Report (1983-84) were forwarded in Hindi to the Ministry of Civil Aviation. New Delhi.

# 8.8 Appointment of Physically Handicapped Candidate:

The Institute has been implementing the Government of India orders regarding reservation of posts for the physically handicapped candidates. During the year under review, one orthopaedically handicapped person was appointed in the Institute.

## 8.9 Employment of Ex-servicemen:

Reservation for ex-servicemen is made, as per rules, in the case of groups '6' and 'D' posts of the Institute. The percentage of ex-servicemen: vis-a-vis total number of employees in groups 'B', 'C' and 'D' at the Institute was as follows:

Group 'B' ... 3
Group 'C' ... 1
Group 'D' ... 15

## 8.10 Budget, Accounts and Audit :

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

Figures: Rs. in lakhs

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SQ. & tings of the 80. Etcial Language ob. of the 100 nald Committee were held regularly. Periodical reports on implementation and progress of Hindi were forwarded regularly to the linistry.



Hindi Officer alongwith the participants of Hindi Workshop

Audit of the Institute's accounts for the year 1983-84 was conducted by M/s Kirtane & Pandit, Chartered Accountants, Pune.

8.11 Vigilance:

There was no vigilance case at the Institute during the year.

8.12 Public Grievances and Complaints:

No complaints were received from the public.

8.13 National Integration :

The Institute celebrated the Quami Ekta month on 23 November 1983.

## Governing Council

# Indian Institute of Tropical Meteorology, Pune - 411 005

Shri S.K. Das, Chairman, Director General of Meteorology, (Ex-officio) 1. Mausam Bhavan, Lodi Road, New Delhi 110 003.

Shri J.N. Kaul,

Joint Secretary (Admin.)

Member
5-7-1983 to
Ministry of Tourism and

Civil Aviation 2.A Civil Aviation, Sardar Patel Bhavan, Parliament Street, New Delhi 110 001.

Shri S.W. Oak, В Financial Controller, Ministry of Tourism and Civil Aviation, Sardar Patel Bhavan, Parliament Street, New Delhi 110 001.

Member 26-10-1983 to 27-12-1983

Shri S.C. Kohli. Financial Controller, Ministry of Tourism and Civil Aviation. Sardar Patel Bhavan, Parliament Street, New Delhi 110 001.

Member 27-12-1983 onwards

3. Shri N. Sunder Rajan, Member Director (Finance), Ministry of Tourism and Civil Aviation, Sardar Patel Bhavan, New Delhi 110 001. cal factoon? To aguragens meaned Shri H.M. Chaudhary, Member 4. Additional Director General of Meteorology (R), India Meteorological Department, Shivajinagar, Pune 411 005. Prof. P. Koteswaram,
Retired Director General
of Observatories,
'VARSHA' 8-1-11 Waltair Uplands, Member 5. Visakhapatnam 530 003. Prof. M.P. Singh,
Head, Centre for Atmospheric
Sciences, Indian Institute of
Technology Haug Khas 6. Technology, Hauz Khas, New Delhi 110 029. Member Prof. R. Narasimha, Member
Department of Aerospace Upto
Engineering, July 1983
Indian Institute of Science, 7.A Bangalore 560 012. Dr. A.P. Mitra,

Director,

National Physical Laboratory,

Hillside Road B Hillside Road New Delhi 110 012.

less Delted 110 Dol.

8. Dr. V.V.R. Varadachari, Member Director, National Institute of Oceanography, Dona Paula, Goa 430 004.

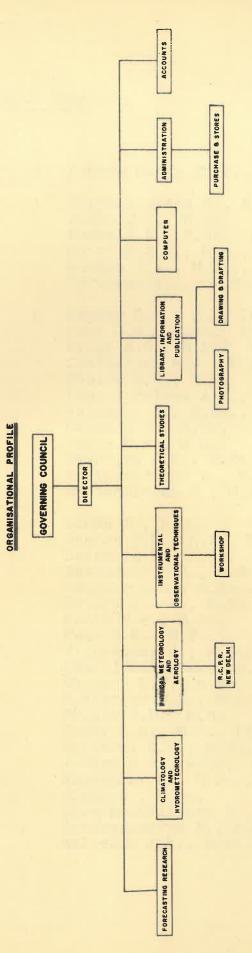
Member

9. Dr. Bh.V. Ramana Murty, Director, Indian Institute of Tropical Meteorology, Ramdurg House, Pune 411 005.

Shri D. W. Kshirasagar,
Administrative Officer,
Indian Institute of Tropical
Meteorology, Ramdurg House,
Pune 411 005.

Non-member Secretary

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



### Officers as on 31 March 1984

Director Ramana Murty Bh. V., M.Sc., Ph.D.

Assistant Directors Suryanarayana R., M.Sc.

Sikka D.R., M.Sc.

Kamra A.K., M.Sc., Ph.D. Murty A.S.R., M.Sc. (Tech.), Ph.D.

Mishra S.K., M.Sc., Ph.D.

Vernekar K.G., M.Sc.

Senior Scientific Officers, Grade I Kapoor R.K., M.A. (Maths) Pant G.B., M.Sc., Ph.D. Singh S.S., M.Sc., Ph.D.

Chatterjee R.N., M.Sc. (Tech.)

Bhalme H.N., M.Sc.

(Smt.) Selvam A.M., M.A., Ph.D.

Rajamani S., M.Sc., Ph.D.

Singh S.V., M.Sc. Verma R.K., M.Sc. Rakhecha P.R., M.Sc.

Parthasarathy B., M.Sc. (Tech.)

Subrahmanyam D., M.Sc. (Tech.), Ph.D.

Senior Scientific Officers, Grade II

Sinha S., M.Sc. Sharma P.N., M.A., Grad. I.T.E.

Sadani L.K., M.Sc. Bavadekar S.N., M.Sc.

Hingane L.S., M.Sc., Ph.D.

Devara P.C.S., M.Sc., Ph.D. Kamte P.P., M.Sc. Paul D.K., M.Sc. Vijaykumar R., M.Sc.

(Smt.) Salvekar P.S., M.A. (Maths)

Khemani L.T., M.Sc.

Mukherjee B.K., M.Sc., Ph.D.

Prasad K.D., M.Sc.

Reddy R.S., M.Sc. (Tech.)

Kulkarni A.K., M.Sc.

Jadhav D.B., M.Sc., Ph.D. Rupakumar K., M.Sc., Ph.D.

Singh N., M.Sc.

Sivaramakrishnan S., M.Sc. Seetharamayya P., M.Sc.

Maliekal J.A., M.Sc., M. Phil.

Junior Scientific Officers

Chaudhari S., M. Tech. Paul S.K., B.Sc. Aralikatti S.S., B.Sc. Pillai A.G., M.Sc. Manohar G.K., M.Sc. (Smt.) Bhide U.W., B.Sc. Mohile C.M., M.Sc. Mandal B.N., B.Sc. Mandal N.C., M.Sc. (Smt.) Naik M.S ., B.Sc. Kulkarni C.P., M.Sc. (Smt.) George L., B.Sc. Soman M.K., M.Sc. Rao P.G., M.Sc. (Geo-Engg.), M.Sc. (Tech.) Raj P.E., M.Sc. Brij Mohan, B.Sc. (Kum.) Kulkarni P.L., M.Sc., B.A. Pathan J.M., M.Sc. Tandon M.K., M.Sc. Parasnis S.S., M.Sc. Kripalani R.H., M.Sc.

Senior Technical Officer, Grade I : Bhattacharya D., B.Sc.(Hons.), (Cal.), B.C.E. (J.U.), C.Engg.(I), A.M.A.E., A.M.I.E., A.M.I. Struct.E.

Junior Technical Officer : (Smt.) Shiralkar A.A., M.Sc., B.Lib.Sc.

Administrative Officer

: Kshirasagar D.W., M.A., M.Com., LL.B.

Accounts Officer

: Asrani V.K., B. Com.

Purchase & Stores Officer Kesavan M.D., M.A., D.B.M.

Hindi Officer

: (Smt.) Mudaliyar V.M., M.A. (English & Hindi)