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The beginnings of LASPEX-97

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ABSTRACT

The background, origin and planning of land surface processes experiment is briefly described. The objective was to collect data for evaluation of surface processes and fluxes required for parameterizing land surface process at global circulation model (GCM) scale levels. Instrumentation and their specification are briefly discribed.

Key words : LASPEX -97, MONTBLEX -90, Instrumentation, Sensors specification

The role of land surface processes in shaping weather and climate has been recognized in the recent decades. The coupling of the land surface processes with the atmospheric layers occurs through the exchange of heat, momentum and moisture. Biospheric processes also influence these exchanges. It is thus necessary to understand the physical processes of individual components and the feedback between different components close to the land - air interface more specifically the microclimatic processes close to the earth's surface, since the boundary layers significantly influences the evolution of the atmospheric circulation on the medium and long-range time scales. Till recently land-surface-atmosphere interactions were parameterized in GCMs by using simple schemes, which treated the processes of radiative transfer (albedo), momentum transfer (roughness length), and the surface hydrology (sensible and latent heat transfer) as independent and separable entities. These three are closely related to each other through characteristics of vegetation, soil, and land use at a given location which act as a trigger to the physical processes related to climate and its variation. Besides, transfer of water from soil to atmosphere is partly controlled through vegetation, land use, and available water. Therefore it was felt necessary to carry out special field experiments in areas representative of different types of land surfaces aimed to provide a data base such as surface and subsurface hydrology, soil, land surface and atmospheric parameters which are needed for testing and incorporation into the general circulation models.

MONTBLEX-90

In addition to several field experiments carried out Internationally the Indian scientists carried out Monsoon Trough Boundary Layer Experiment (MONTBLEX-90) in 1990 in the region of the monsoon trough in the Gangetic plains (Sikka and Narsimha, 1996). The focus was to study boundary layer processes during different phases of the summer monsoon and to isolate the role played by moist and dry convection in the evolution of the boundary layer with a view to parameterize the surface fluxes of heat and momentum for incorporation in weather forecasting models. The experiment, besides yielding valuable data

for understanding boundary layer processes in the monsoon trough, has also generated expertise for designing and managing experimental field programmes using the resources available within the country. The programme had, however, one limitation in that soil moisture measurements were not planned/included. These measurements are important in the development of moist convective boundary layer and are required for parameterizing land surface processes in the GCMs for weather/climatic simulation. To remove this lacuna, a land surface processes experiment (LASPEX) was proposed.

ORIGIN AND PLANNING OF LASPEX

Noting the recent trends of research in the understanding of land-surface processes for dynamical models, the Indian Institute of Tropical Meteorology, Pune, organized a meeting of the Indian scientific community interested in such studies during 25-26 February 1992. About 70 scientists from 40 organizations in India participated and discussed problems relating to land-surface processes. The meeting recommended that a land surface experiment (LASPEX) may be organized in India and the Indian Institute of Tropical Meteorology (IITM) be a nodal agency. The boundary layer group at IITM carried out a preliminary experiment at Pune in May 1992 on the energy balance at the land - air interface. This provided background to the scientific community to undertake a systematic field experiment over a GCM grid scale. (Anonymous, 1995)

Monitoring group for LASPEX

The Department of Science and Technology (DST), Government of India, constituted an expert committee in January 1993 for formulation of a proposal for land surface process (LSP) experiment. The committee brought out a draft proposal giving all technical details and financial estimates.

Objectives

The main objectives of the programme were

1. To collect a complete surface and sub-surface atmospheric-hydrological data base against which parameterized models for land surface processes i.e., energy exchange, radiative, sensible and latent heat fluxes can be tested for improvement and further development.
2. To foster the development of observing techniques, data management and assimilation systems.
3. The generated data shall be used in addressing the problem of determining evaporation flux and parameterizing land-surface processes at the scale of GCM-grid square, i.e., approximately $100 \times 100\ km^{-2}$
4. To provide in-situ measurements as ground truths for the data to be obtained through ERS-I, for evaluating soil moisture over the region.

Site selection

While recommending the Sabarmati river basin as a probable area, the expert committee desired that the following sub-group might work out exact location for the experiment:

Dr. U.C. Mohanty, NCMRWF

Shri K.G. Vernekar, IITM, Pune

Prof. P.S.N. Sastry, IARI, New Delhi

The above sub-group met in October 1993 in DST and finalized the locations with the Anand Campus of Gujarat Agricultural University as the main center, and the Department of Agricultural Meteorology (Anand Campus) and IITM (Pune) coordinating the field experiments. The five observational stations chosen in the Sabarmati river basin on a GCM grid scale of area 100 km x100 km were Anand (Lat 22°35'N, Long 72°55'E, Alt 45.1m), Sanand (Lat 23°04'N, Long72°22'E, Alt 35.1m), Arnej (Lat 22°40'N, Long72°15'E, Alt 31.8m), Khandha (Lat 22°02'N, Long73°11'E, Alt. 28.12m) and Derol (22°40'N, Long73°45', Alt 84.73m). This area lies in the semi arid / arid part of western India and provides contrasting meteorological conditions from one season to another as well as the intra-seasonal variability of weather parameters on a weekly scale. Soil type in the region varying between alluvial to sandy has also important influence on the runoff and ground water re-charge characteristics and hence on the sub-basin to basin scale hydrological processes. Thus, in various aspects this large arid/semi arid zone lying just to the west of the moist monsoon belt of central and eastern India offered a sensitive spot for studying the interactions between the sub-regional to regional scale land-surface processes and between the moist eastern India and dry western India for the study of regional scale monsoon processes.

Work plan

It was proposed to do familiarization campaign during early 1994 so that all details of the work elements and requirements of the different sites might be quantified and attended to. IITM and IMD also envisaged it to procure and install all the necessary instruments by December 1994 at the selected sites after calibration. Data acquisition might be continued for another two years at lesser frequency interval as required for agrometeorological purposes. The measurement programme was envisaged for one year-aimed at the calendar year 1995. A pilot experiment was planned in the first quarter of the year 1995. The main experiment would consist of two parts (i) a continuous observational programme during a complete year and (ii) Intensive Observational Periods (IOP) of five days each in every month. Ten-meter high towers were planned to be installed at each station equipped with sensors to measure meteorological parameters such as wind direction and speed, air temperature, humidity at different heights with all the radiation components. In addition, soil moisture would be monitored along with rainfall intensity, runoff, surface evaporation and different crop observations. In addition, a 30-meter tower was also planned to be installed at the central station, Anand for an intensive study of boundary layer processes.

Instrumentation and data collection

For conducting the main experiment from January 1997 to February 1998, 10 m towers were installed at all the stations along with one 30m tower at the central station, Anand. Different sensors to measure temperature, humidity, wind speed and direction have been installed at 1,2,4 and 8m height. Incoming and outgoing short wave and long wave radiation and net radiation sensors were instrumented at approximately 2m heights along with pressure and rainfall measuring systems. Soil temperature sensors were placed at the surface and the depths of 5,10,20,40 and 100 cm. At Anand, all the three components of the wind were measured by the Sonic and Metek

Table 1 : Specifications of various sensors (Source : Users manual Doppler SODAR; sonic anemoneter; caparitur prbbes)

Type of Observations	Sensors/Models/Make	Brief specification
A. Tower Observations		
1. Wind Speed	3 Cup Anemometer/ DWA 8600B	Accuracy: ±2% of FSR, Range: 0.65 ms^{-1} Starting threshold: 0.3ms^{-1}
2. Wind Direction	Wind Vane connected to potentiometer/DWD8601B	Accuracy:±2%, Range:0-357°, Resolution:1° Output:0-5k ohm res. (0-358°)
3. Air Temperature	RTD element (PT1000)/ DTH8103	Accuracy:±1°C, Range: -40 to +60°C, Resolution: 0.1°C, Output: 0 to 1V (-40 to +60°C)
4. Relative Humidity	Solid state capacitive type sensor	Accuracy: 2%, Range:0-99%, Resolution:0.1% Output:0 to 1V (0-99%)
5. Radiation (Shortwave)	72 element Thermopile/ DWR8101(Pyranometer)	Sensitivity: 4m$VKW^{-1}m^{-2}$, Spectral range: 0.3 to 3μm
6. Radiation (Net)	Net Radiometer/DNR110	Sensityvity:40m$VKW^{-1}m^{-2}$, Spectral range: 0.3 to 60μm
7. Radiation (Long wave)	Pyrradiometer	Sensityvity:40m$VKW^{-1}m^{-2}$
8. Soil Temperature	Std. Platinum RTD element (PT100)/ DTS8108 1V	Accuracy:±0.25°C, Range: -10 to +90°C. Resolution: 0.1° C, Output:0 to
9. Rainfall	Tipping bucket rain gauge with Magnet & Reed switch/DTR8104	Accuracy:1mm, Resolution:0.2mm
10. Soil Heat Flux Plate	M/s. Rad. & Energy Balance System Inc., USA with thermopile	Thermal conductivity with 1.22$W^{-1}K^{-1}$ Resistance: 2ohms, Calibration: 40Wm^{-2} per mV
B. Doppler SODAR	Aerovironment Inc., USA, Model-200a with 3 antenna	Accuracy:±0.2m^{-1}, Vertical height res.: 30m, Pulse width: 180 ms NS & 240 ms vertical, Pulse interval:27s
C. Sonic Metek Anemometers	1. Appl. Technology Inc. Boulder, USA	Accuracy: ±1%, Range:i.Horizontal wind- 0 to 20 ms^{-1}, ii. Vertical wind- ±5 ms^{-1}, iii. Temperature- -20 to +50°C, Sampling rate: 10Hz
	2. METEK (Germany)	Measurement range: +60 ms^{-1}, Path length: 18cm, Accuracy: wind speed & temperature 1%
D. Soil Moisture	1. Neutron Probe	Intensity: 1.28105 Ns^{-1}, Detector: isotope enriched BF^3, Input: 9-15 V DC
	2. Capacitance Probe	Accuracy: 2%, Repeatability: better than 1%, Readout: frequency
E. Crop Observation	Biometric observations with green biomass and dry biomass at Anand	

anemometers. At each station soil moisture by the Capacitance and Neutron probes at different depths and the rate of evaporation by evaporimeter were measured. Soil moisture measurement was also taken by gravimetric method. Specification of the sensors is listed in Table 1.

Other than the tower instrumentation, at Anand, for the analysis of the thermodynamic diagram for convective instability and thunderstorm forecasting, inversion and lapse rate, mixing depths, etc., five RS/RW launches per day (at 0530, 0830, 1130, 1430 and 1730 IST) during each Intensive Observational Period (IOP) were conducted (Table 2) by India meteorological department. For the study of diurnal variation of lower troposphere winds, and influence of troposphere on low

Table 2 : RS/RW and PB flights at the grid stations

Month	AnandRS/RW	DerolPB	ArnejPB	KhandhaPB	SanandPB
Jan 97	24	30	19	22	07
Feb 97	26	30	22	27	17
Mar 97	25	30	21	24	23
Apr 97	25	30	25	18	18
May 97	25	30	26	07	X
Jun 97	25	15	18	20	X
Jul 97	25	25	X	X	X
Aug 97	25	25	21	X	X
Sep 97	26	22	21	12	8
Oct 97	25	25	20	20	20
Dec 97	25	25	22	20	20
Feb 98	25	25	23	16	20
Total	**301**	**312**	**238**	**186**	**125**

Table 3 : Pilot baloon observations during LASPEX -97

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Feb 98
Derol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	O	✓	✓
Khnadha	✓	✓	✓	✓	✓	✓	X	X	✓	✓	O	✓	✓
Sanand	✓	✓	✓	✓	X	X	X	X	✓	✓	O	✓	✓
Arnej	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	O	✓	✓

X Pilot baloon ascent not taken ; ✓ Data available ; O Experiment not conducted

level winds, IMD also conducted Pilot balloon observation (Table 3) five times daily at each peripheral station. A Doppler SODAR was operated for a limited period at central station Anand for the study of the three wind components at various heights starting from 45m above the surface to 1000 m. Lyman-Alpha Hygrometer was also procured and observations were taken during February 1998.

Data acquisition system

A specially fabricated data logger DL 1032 with 32 channels was utilized in this experiment. Data were stored on a 2MB memory module and when it is full the data were transferred to the PC at the central station Anand and subsequently to IITM, Pune, for editing and processing. The data are available minute wise for the IOP, but for the rest of days as 10 minute averages. At each of the tower stations a group of trained personnel from IITM and GAU Anand were engaged in acquiring the data according to the plan.

The pilot experiment

Before conducting the full fledged experiment one Pilot experiment was carried out during April 12 to July 30, 1995 at Anand Campus, GAU Anand by IITM boundary layer group lead by Shri K.G. Vernekar and GAU Anand headed by Dr. A. M. Shekh. The objectives of the experiment were to test functioning of all the tower instruments and the data acquisition system and to test if the system worked well, and for streamlining the work programme of the main experiment.

Training programme

A training programme for LASPEX participants was organized by the Division of Boundary Layer and Land surface Processes, IITM Pune in early 1996. They were trained for monitoring the experiment and data storage, calibration of instruments/sensors and trained on various data collecting methods and procedures used in the experiment. An intensive course on the atmospheric boundary layer and turbulence was conducted at India Meteorological Department (IMD) New Delhi from 17-25 September 1996.

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