Weather & Climate Modeling Activities at MoES Relevant to MAHASRI

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Ministry of Earth Sciences (MoES)
National Centre for Medium Range Weather Forecasting
Government of India

Presentation at MAHASRI Planning Meeting, January 2007, Tokyo, Japan

Ministry of Earth Sciences (MoES) in Government of India has been created recently by bringing all Departments/ Institutions related to Meteorology and Oceanography under one umbrella.

Major Institutions for Weather & Climate in MoES are

India Meteorological Department (IMD)

National Centre for Medium Range Weather Forecasting (NCMRWF)

Indian Institute of Tropical Meteorology (IITM)

Indian National Centre for Ocean Information Services (INCOIS)

Weather & Climate in MoES

IMD- **Lead Institute for Meteorological Observations & Public Interface for Weather & Climate Information**

NCMRWF- **Lead Institute for Modeling of Weather & Climate in all scales and for Global & Regional Data Assimilation (NCMWC)**

IITM- **Lead Institute for Research & Process Studies**

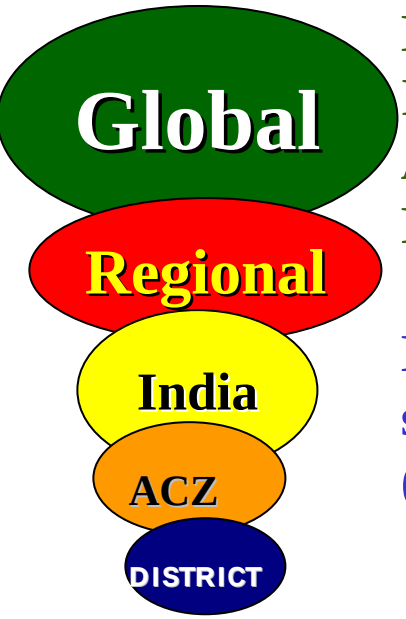
INCOIS- **Lead Institute for Ocean Observation, Modeling and Information**

Scientists of the NCMRWF have developed (put together) a

Real-Time Global Data Assimilation and Forecast System.

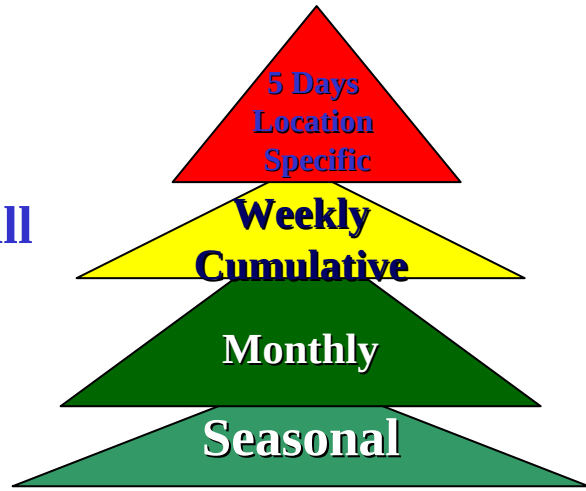
The Analysis/Forecast System is regularly upgraded assimilating Research done at NCMRWF and also elsewhere.

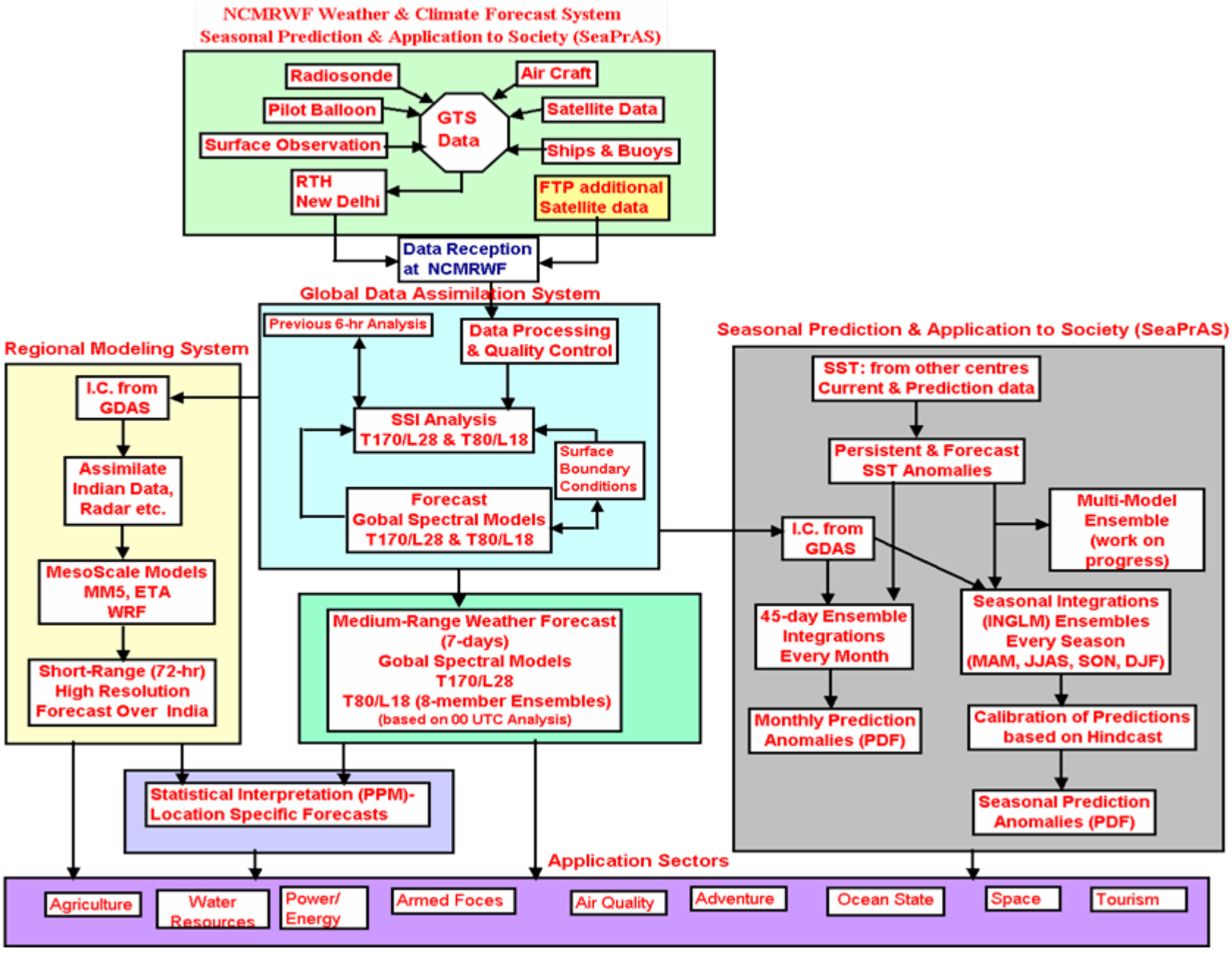
Scientists also carry out Research on Dynamical & Physical Processes in the Atmosphere to understand and model the Weather & Climate Variability



NCMRWF is the only Organization in India where Real-Time Global Data Assimilation and Forecast Systems are Run every day

NCMRWF'S Forecasts are available in all spatial scales and are in all timescales (from Day to Seasonal Scales)




NCMRWF Weather & Climate Forecast System
Seasonal Prediction & Application to Society (SeaPrAS)
Radiosonde
Air Craft
Pilot Balloon
GTS Data
Satellite Data
Surface Observation
Ships & Buoys
RTH New Delhi
FTP additional Satellite data
Data Reception at NCMRWF
Global Data Assimilation System
Previous 6-hr Analysis
Data Processing & Quality Control
SSI Analysis T170/L28 & T80/L18
Surface Boundary Conditions
Forecast Gobal Spectral Models T170/L28 & T80/L18
Regional Modeling System
I.C. from GDAS
Assimilate Indian Data, Radar etc.
MesoScale Models MM5, ETA WRF
Short-Range (72-hr) High Resolution Forecast Over India
Medium-Range Weather Forecast (7-days) Gobal Spectral Models T170/L28 T80/L18 (8-member Ensembles) (based on 00 UTC Analysis)
Statistical Interpretation (PPM)- Location Specific Forecasts
Seasonal Prediction & Application to Society (SeaPrAS)
SST: from other centres Current & Prediction data
Persistent & Forecast SST Anomalies
I.C. from GDAS
Multi-Model Ensemble (work on progress)
45-day Ensemble Integrations Every Month
Seasonal Integrations (INGLM) Ensembles Every Season (MAM, JJAS, SON, DJF)
Monthly Prediction Anomalies (PDF)
Calibration of Predictions based on Hindcast
Seasonal Prediction Anomalies (PDF)
Application Sectors
Agriculture
Water Resources
Power/ Energy
Armed Foces
Air Quality
Adventure
Ocean State
Space
Tourism

Computing Resources at NCMRWF

PARAM PADMA

64 Processors IBM P-5 based (0.5 TF)

CRAY X1E

64 Processors Vector System (1 TF)

CRAY SV1

24-Processors Vector System (28 GF)

DEC-ALPHA Servers & Workstations

SGI ORIGIN Servers & Workstations

Procurement Process has begun to have further upgradation

Global Model & Data Assimilation System

Data Assimilation at T170/L28 & T80/L18 Resolutions

Global Model at T170/L28 & T80/L18 Resolutions
(experiments with T254/L64, work related to T382 has begun)

Ensemble Prediction at T80/L18 Resolution
8 Member Ensemble (Breed Vector)

Global Data Assimilation System

Data Assimilation at T170/L28 & T80/L18 Resolutions

(A 3-dimensional Variational Analysis Scheme)

(Recently upgraded to T254L64)

Issues addressed:

Development of schemes to assimilate

Satellite data (derived products)

Assessment- Impact of New data on Analysis & Forecasts

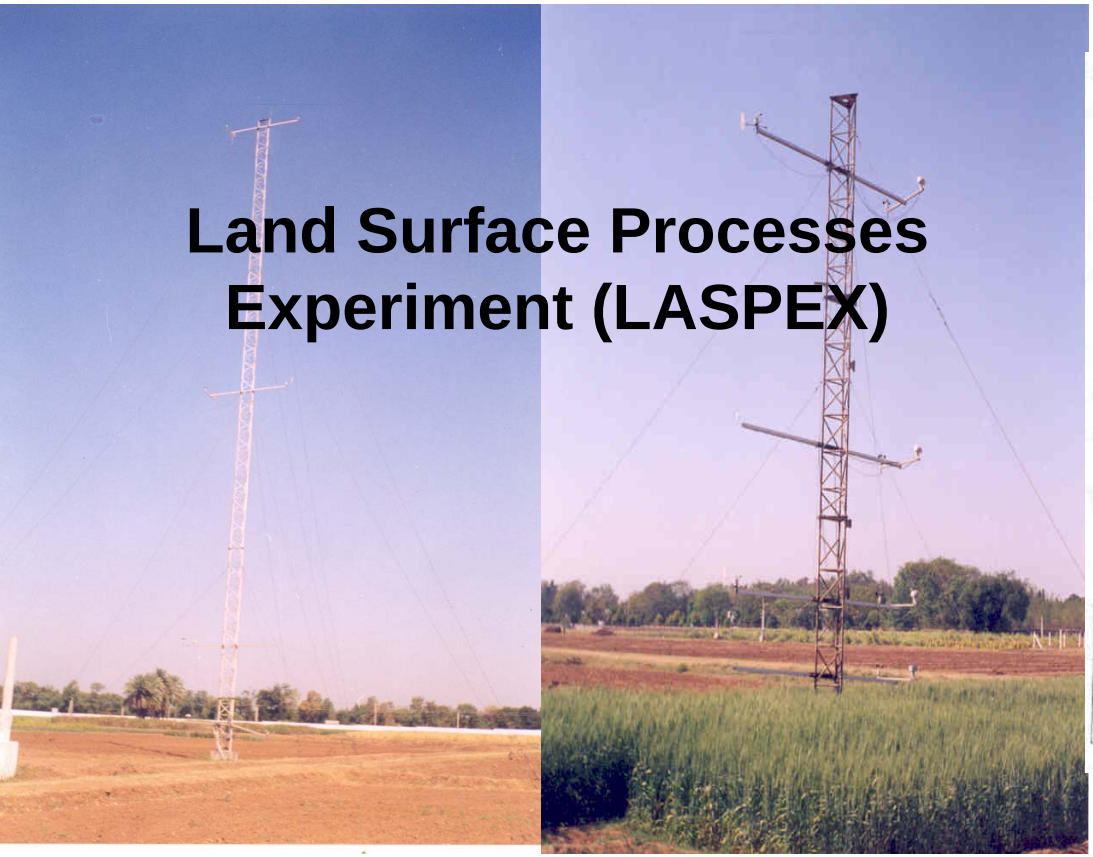
Assessment of Model Bias on Analysis

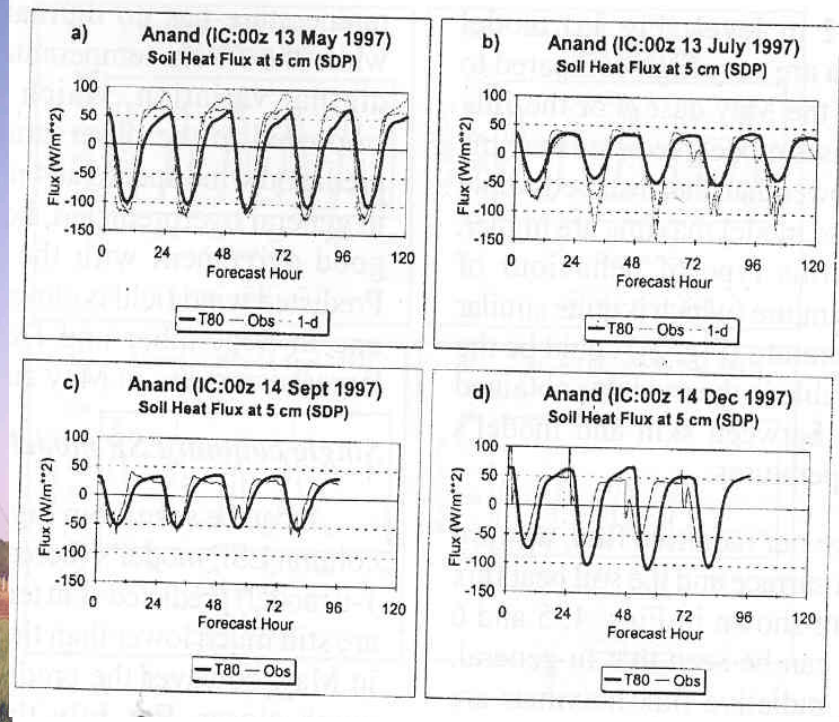
Issue to be addressed:

Assimilation of Direct Radiance

4-dimensional Variational Analysis

Land Surface Processes Experiment (LASPEX)





NCMRWF is the only organization in India which validates Its model with data from Field Campaigns

Arabian Sea Monsoon Experiment (ARMEX)

Major Objectives :

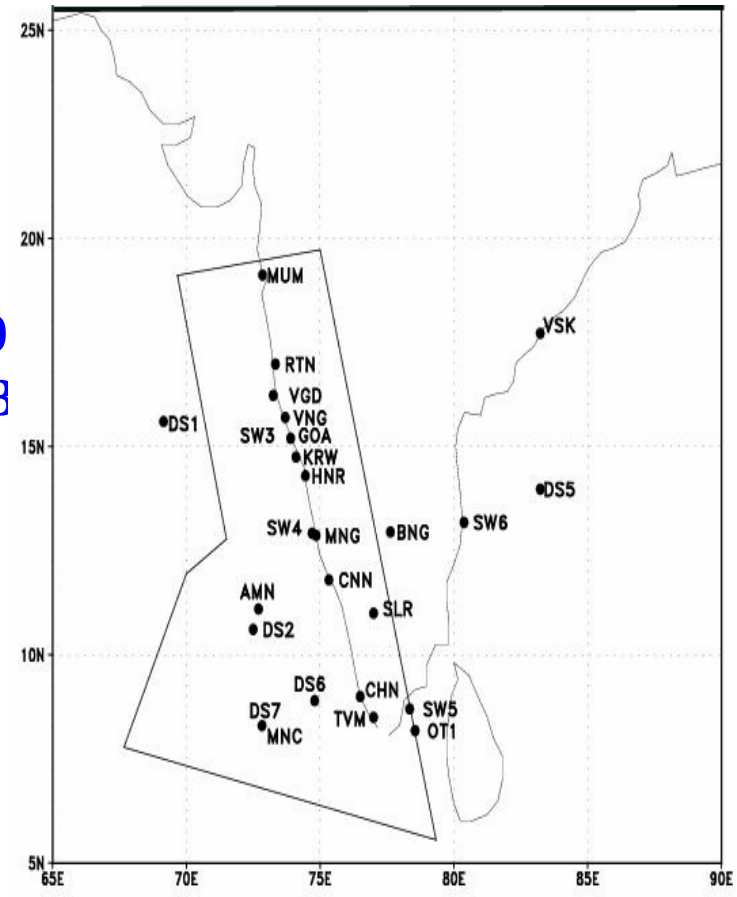
Phase I -Offshore-Trough

Phase II - Arabian sea Warm pool

Period : Phase I : 15 June- 15 August 200

Phase II : Nov. 2002 to June 2003

Phase IIa : April-May 2005



ARMEX-Infrastructure deployed

Land-based Platforms:

RS/RW Network of IMD, Synoptic & Agromet Stations, Atmospheric Fluxes (Towers), AWS, Slow-rising balloons, Wind Profilers

Ocean-based Platforms:

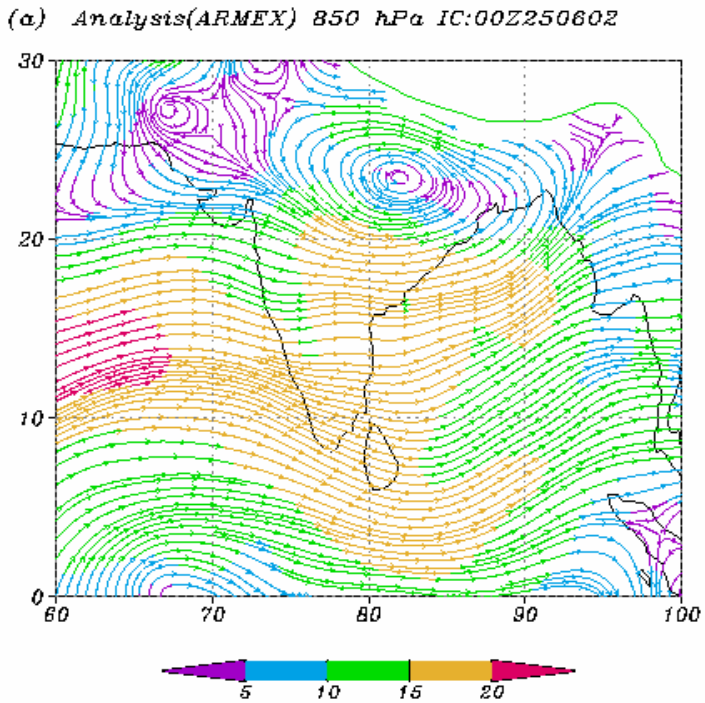
Ships, Buoys, CTD, XBT, LADCP Moorings, AWS, Slow-rising balloons, Atmospheric Fluxes, Radiation, Underwater Radiation Profiles, Chemistry & Aerosols,

Other Platforms

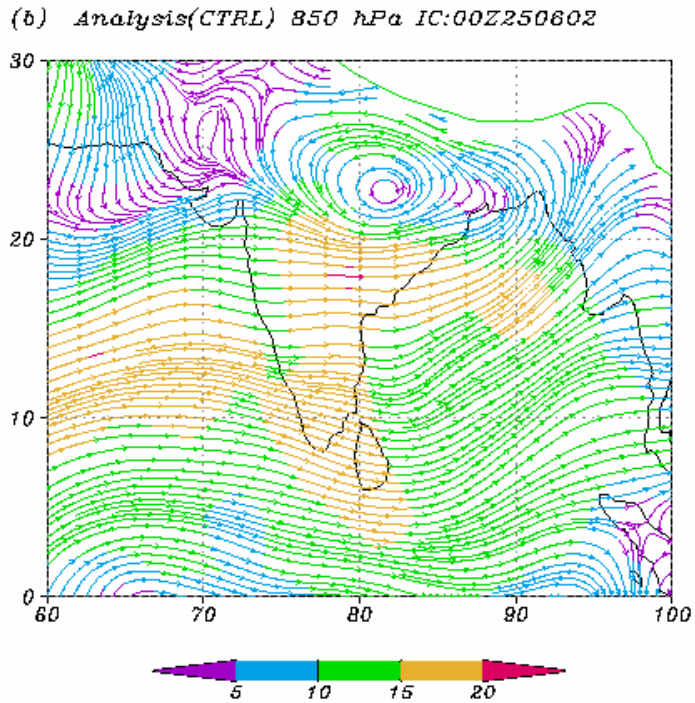
Aircrafts, Satellites

Impact of ARMEX observations (active monsoon case)

Armex exp

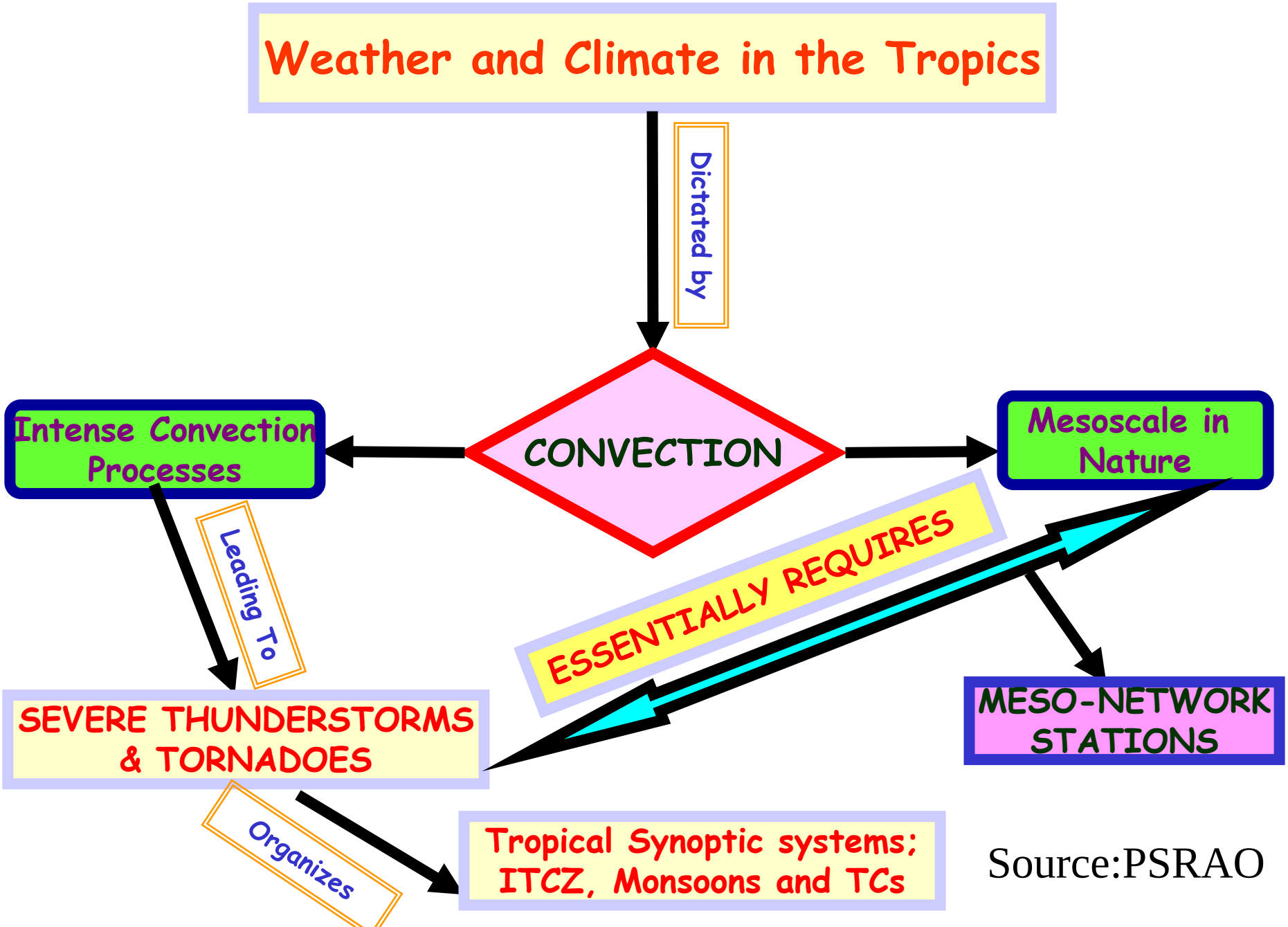


Control



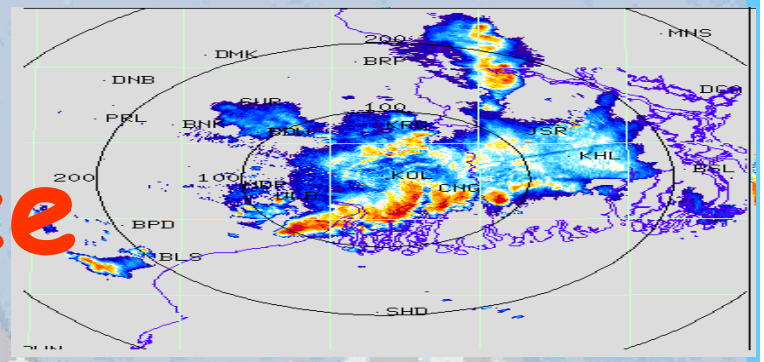
Strengthening of LLJ and monsoon low in ARMEX analysis

NCMRWF carries out Reanalysis with special data from Field Campaigns. Also functions as ARMEX Data Centre.



Source:PSRAO

Severe Thunderstorms – Observations & Regional Modeling (STORM) Programme



Science Plan

NCMRWF is a key Partner in STORM Program

Source:PSRAO

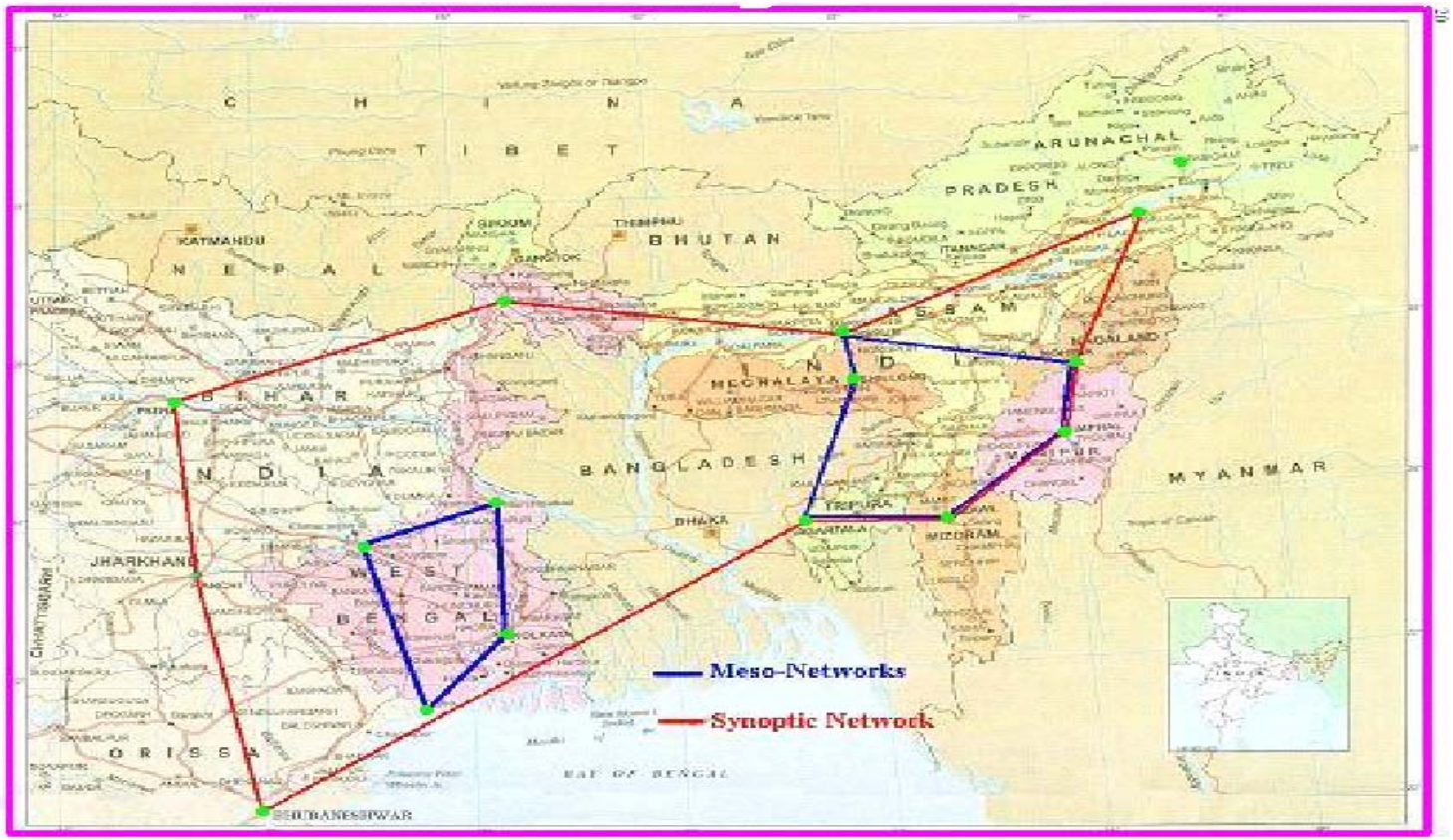
To understand the genesis, development and propagation of severe thunderstorms over eastern and north-eastern India.

To enhance the knowledge of dynamical and thermo-dynamical structure and the role of micro-physical processes on intensification of these severe storms.

To study the behaviors of atmospheric electrification during intensification of these storms and their interaction with cloud microphysical processes.

Development/ customization of mesoscale prediction systems with improved forecast skill for prediction of these severe thunderstorms.

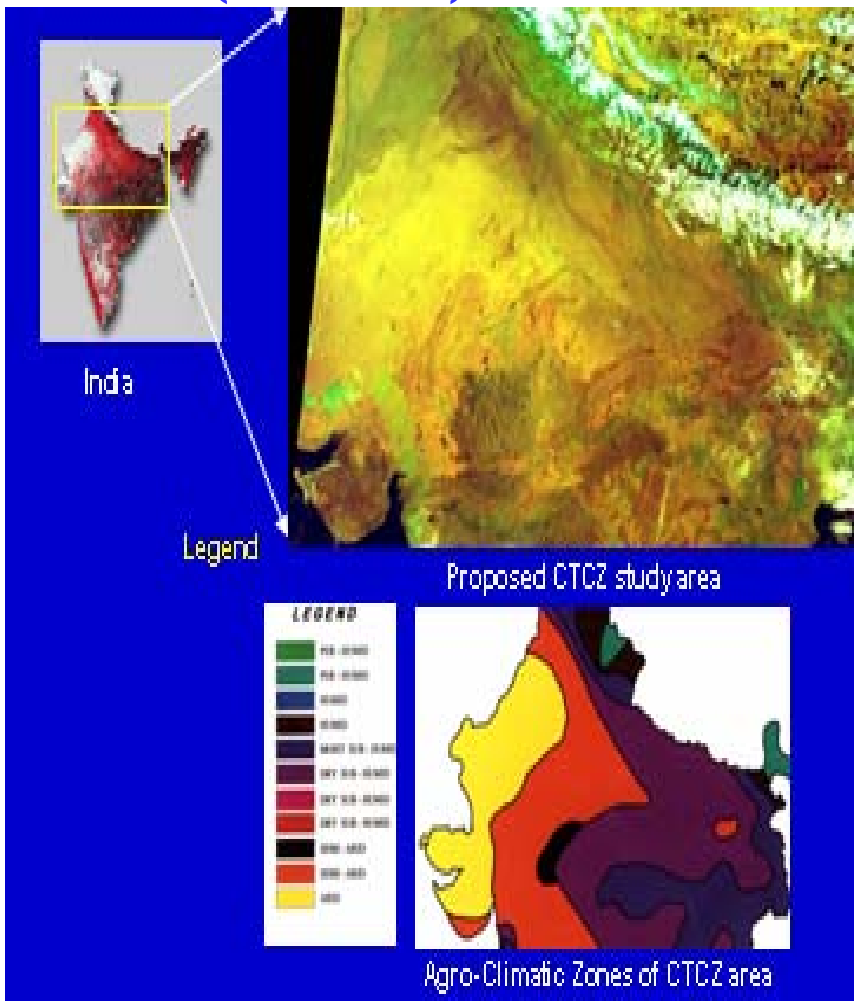
Synoptic- and Meso-scale Domains of STORM during 2006-2010



Pilot Experimental Design
14 April- 31 May 2006

Main Field Experiments
(2007-2010)

Continental Tropical Convergence Zone (CTCZ) under ICRP during 2007-2010



Major Components

- **Boundary Layer Processes**
- **Land Surface Processes**
- **Hydrological Processes at the River basin scale**
- **Cloud-Aerosol Interactive Processes**
- **Convection – Direct and Indirect Effects on the Energy and Water cycles**
- **Regional and Meso-scale Modeling**

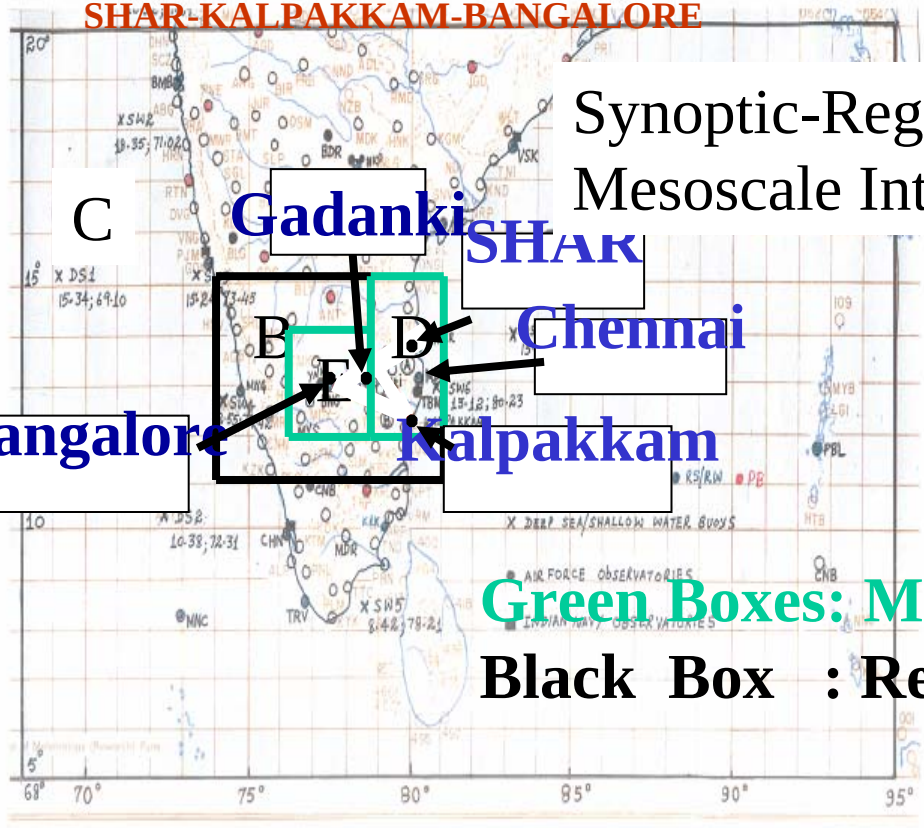
NCMRWF shall assimilate all data and carry out Modeling works Relevant to CTCZ

Source:PSRAO

PRWONAM Observational Programme

Meso-Net Experimental Test Region

SHAR-KALPAKKAM-BANGALORE



Synoptic-Regional-Mesoscale Interactons

Pilot phase Field Expt: May 2006

October 2006

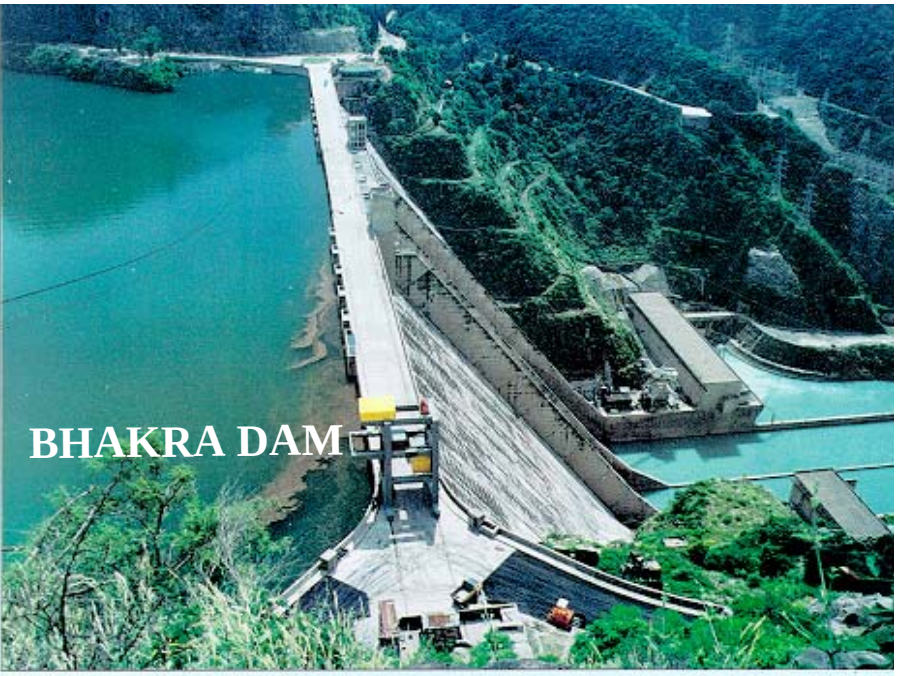
Main Phase Field Expt: May 2007

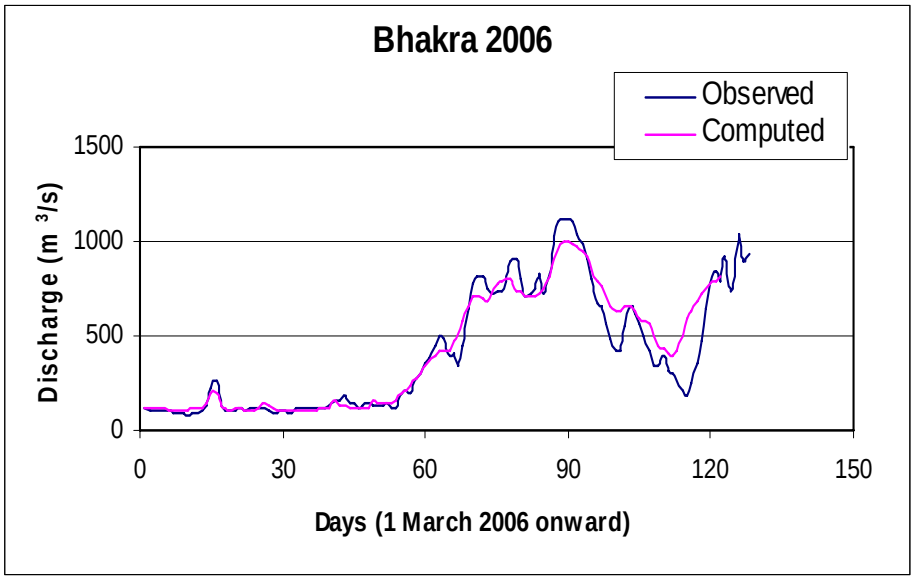
NCMRWF-

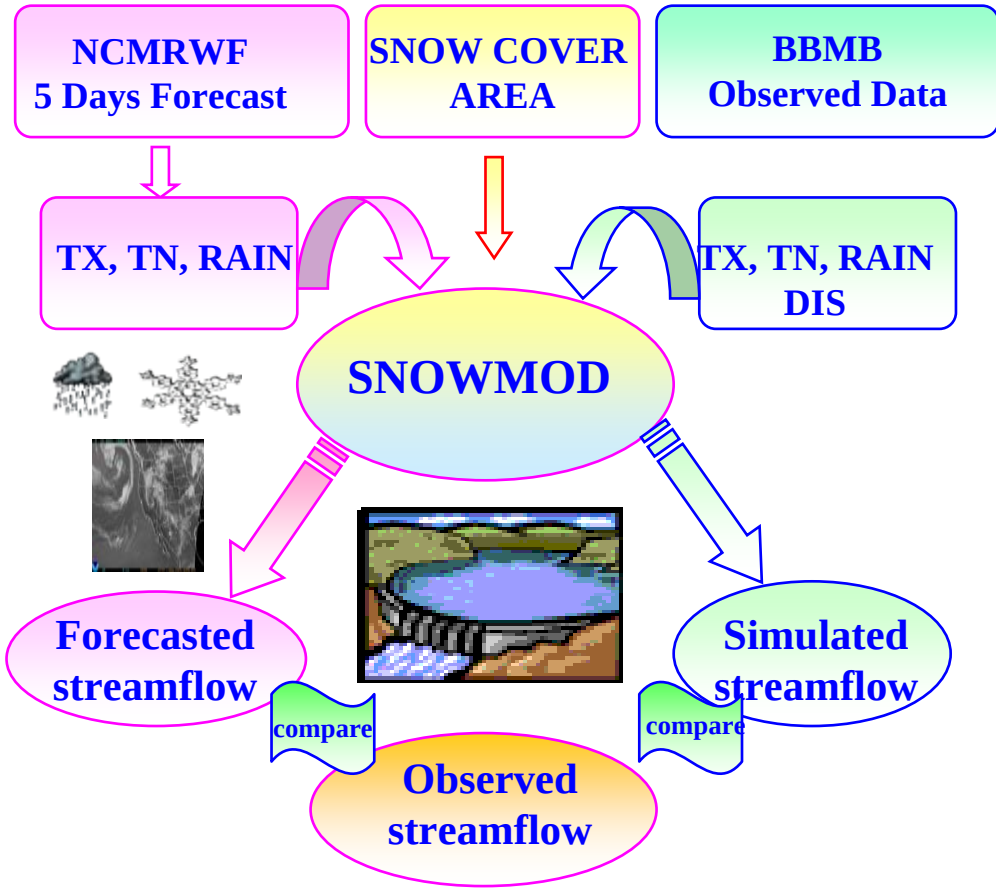
Products of Analysis-Forecast System for Indian region from Global/Meso-scale systems.

Satellite derived water vapour channel winds from Meteosat.

Applications in Water Resources







Issues to be addressed:

Accuracy of meteorological forecasting
Delay in data communication
Information on snow covered area

Mesoscale Model & Data Assimilation System

Mesoscale Data Assimilation over India - WRF

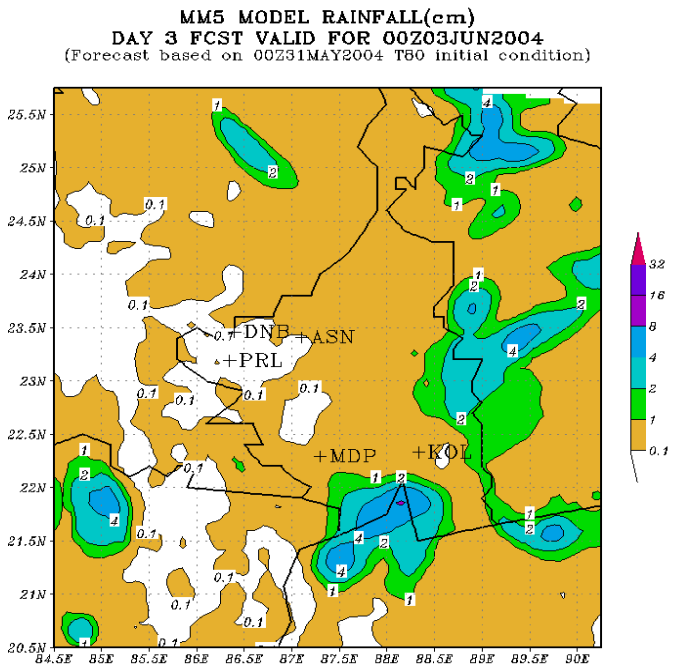
Mesoscale Models Indian Several Domains over India

MM5
WRF
ETA
RSM

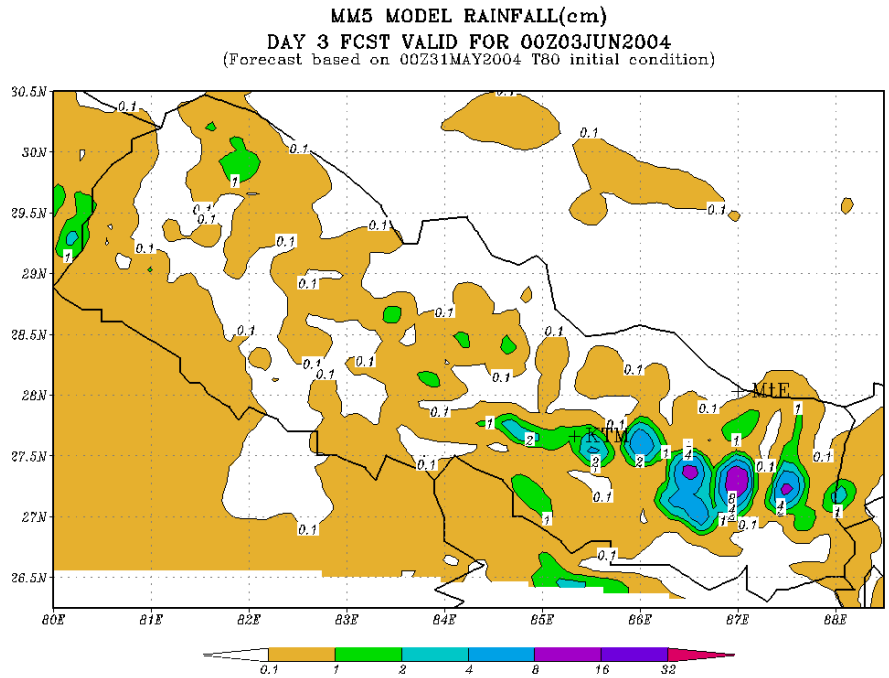
These Models are run using Initial and Boundary Conditions from NCMRWF Global Models

Very High Resolution Forecast (For prediction of Localized Weather Events)

MM5 10 km Rainfall Forecast for West Bengal & Adj. areas

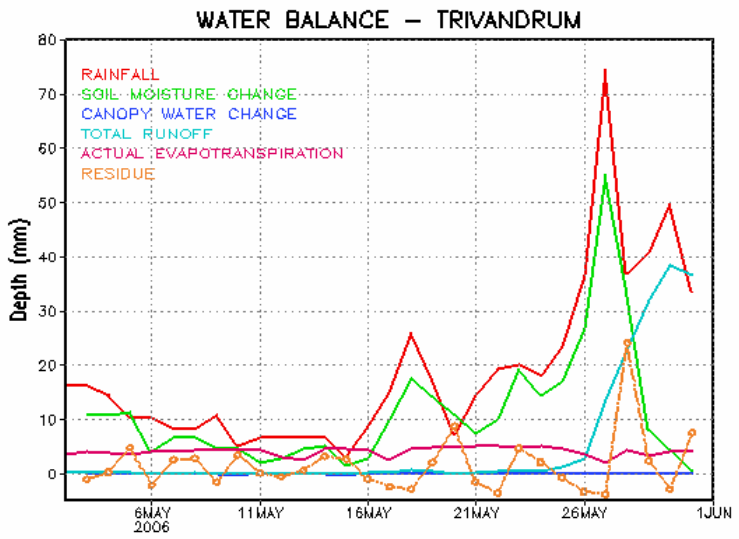


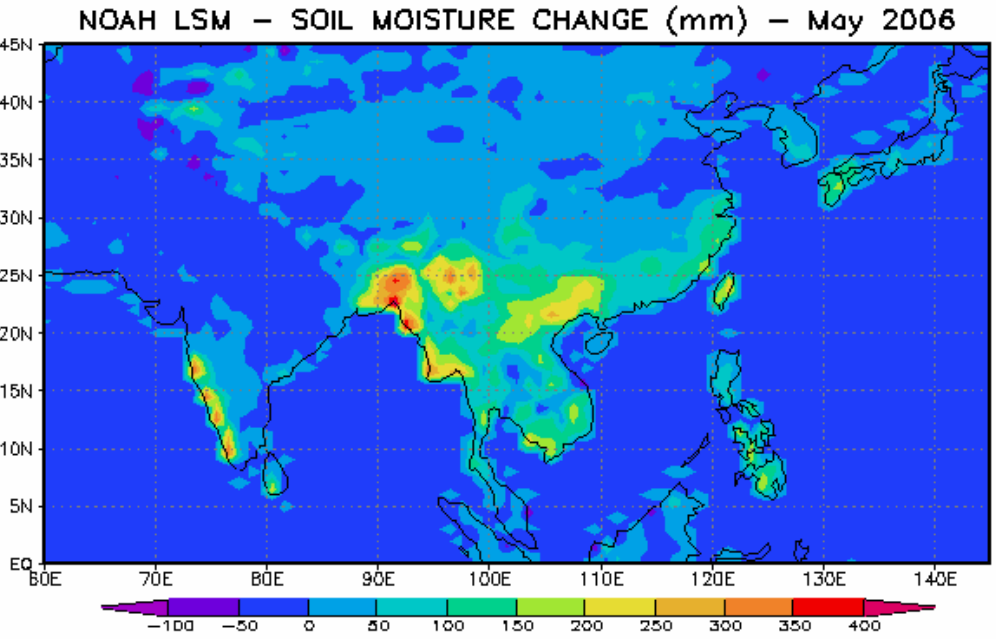
MM5 10 km Rainfall Forecast for Central Himalaya

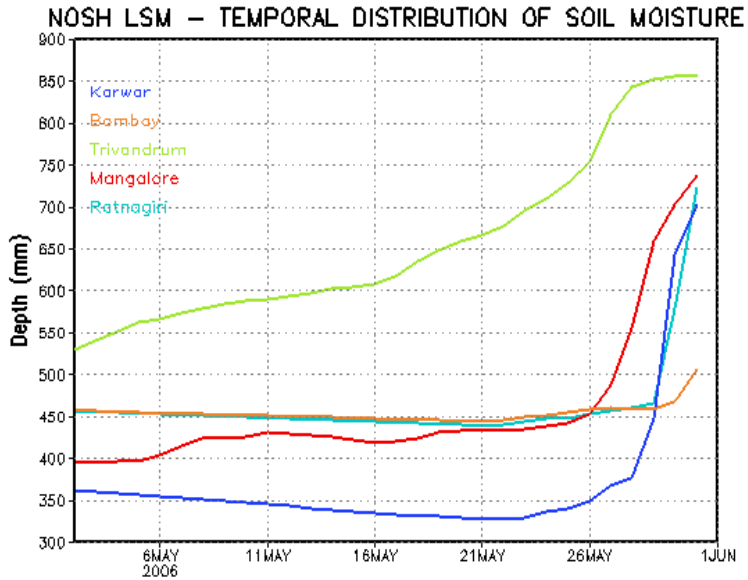


NOAH LSM

- Experimental runs were made for May 2006 at 1x1 global grid.
- Enhanced soil moisture across west coast and northeast India with the onset of Indian monsoon on 26th May 2006
- Residue in the simulation of water balance is reasonably low.







Climate Prediction Program of NCMRWF

First-time in India:

Monsoon Simulation: MONEG

Seasonal Simulation using Global Model

Real-time Monthly Prediction for Monsoon

Long-term Simulations AMIP-type

Sensitivity Studies (Seasonal)

Aerosol & Climate (Simulation Studies)

Real-time Monitoring & Prediction of MJO/ISO

Impact of Solar Variability on Climate Simulations

Regional Climate Modeling (Dynamic Downscaling)

Atmospheric Chemistry and Climate

Climate and Crop Yield

Climate Prediction Program of NCMRWF

WCRP
WORLD CLIMATE RESEARCH PROGRAMME

The World Climate Research Programme
Strategic Framework 2005-2015

Coordinated Observation and Prediction
of the Earth System (COPES)

→ A new perspective of Continuum of Prediction: blurring distinction between Shorter-term and Longer-term climate predictions.

→An Initial-value problem. Knowledge of the current state of Atmosphere, Oceans, Cryosphere, and Land Surface

→Climate Models: with the highest possible Resolutions

→Ability to relate the Structure, Parametrizations and Performance of models

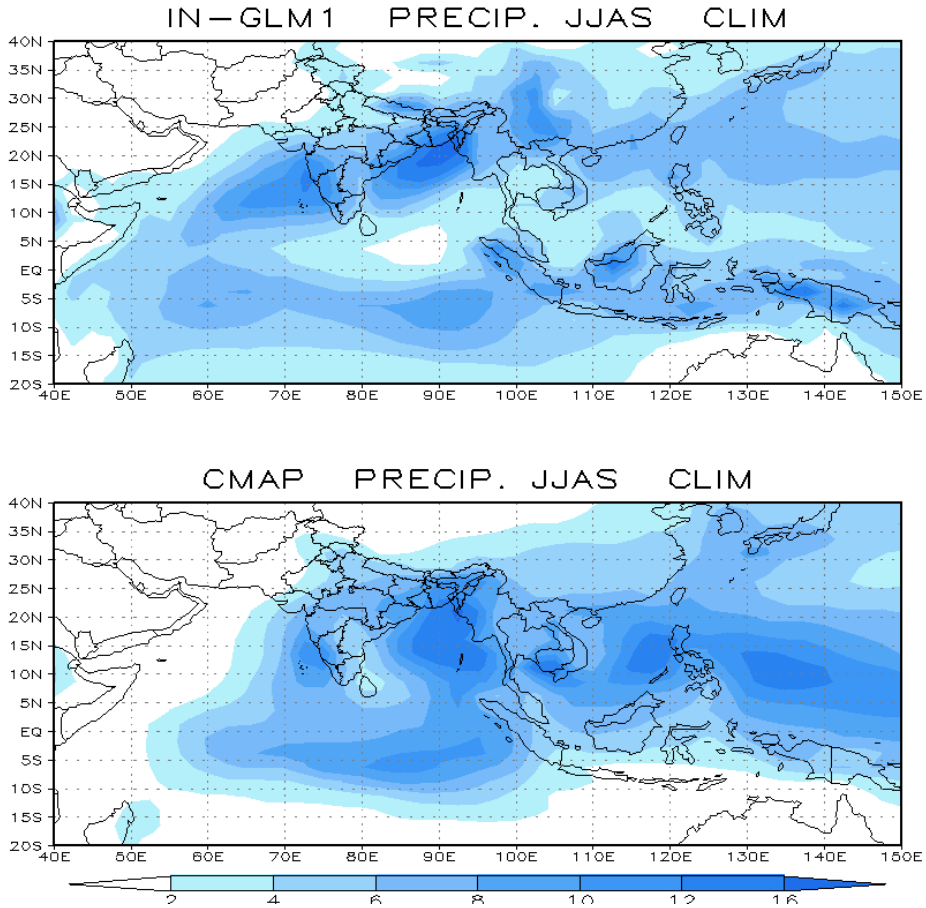
→Practical approach → Unified: Models aimed at different time-scales and phenomena may have large commonality but place emphasis on different aspects of the system.

→Models to include Atmospheric Chemistry, Carbon Cycle, evolving Vegetation, etc.

→Theoretical basis of Predictability: what Predictions and what Techniques to attempt

Seasonal Predictions- Modeling Monsoon Variability

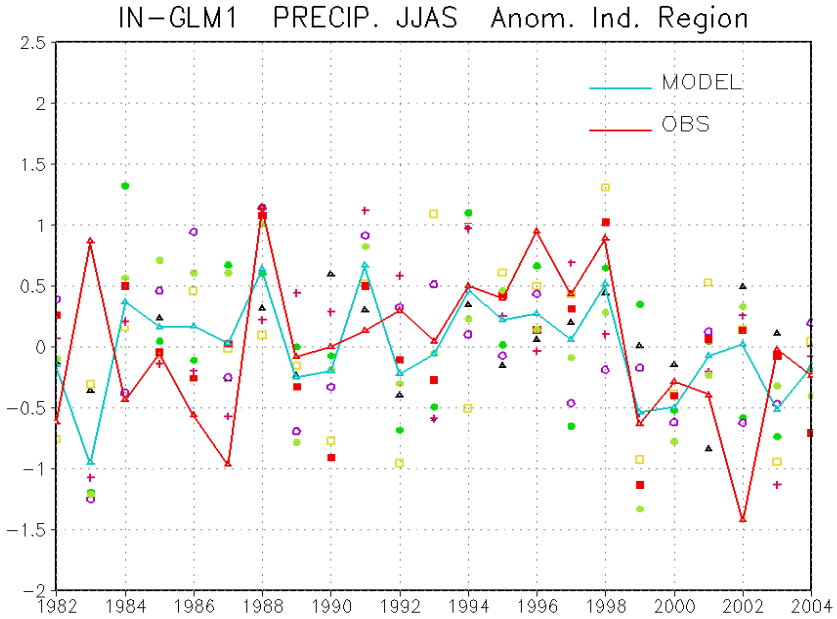
SeaPrAS

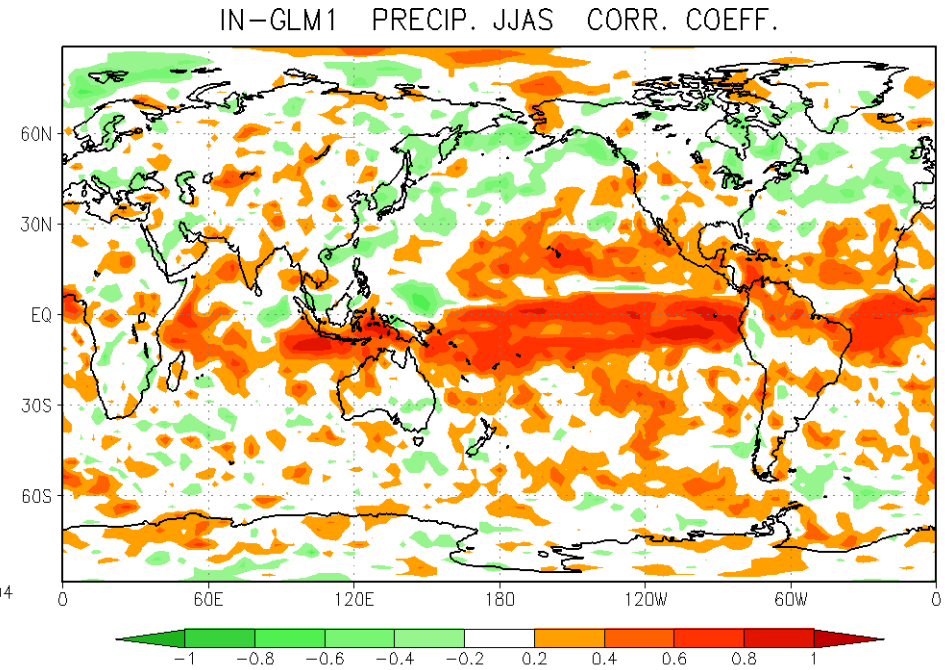


IN-GLM1
Model has been integrated for 1982-2005 using Initial conditions from April 15-20 each year with Observed SST, & Climatological SST.

Integrations of other versions of the model are in progress

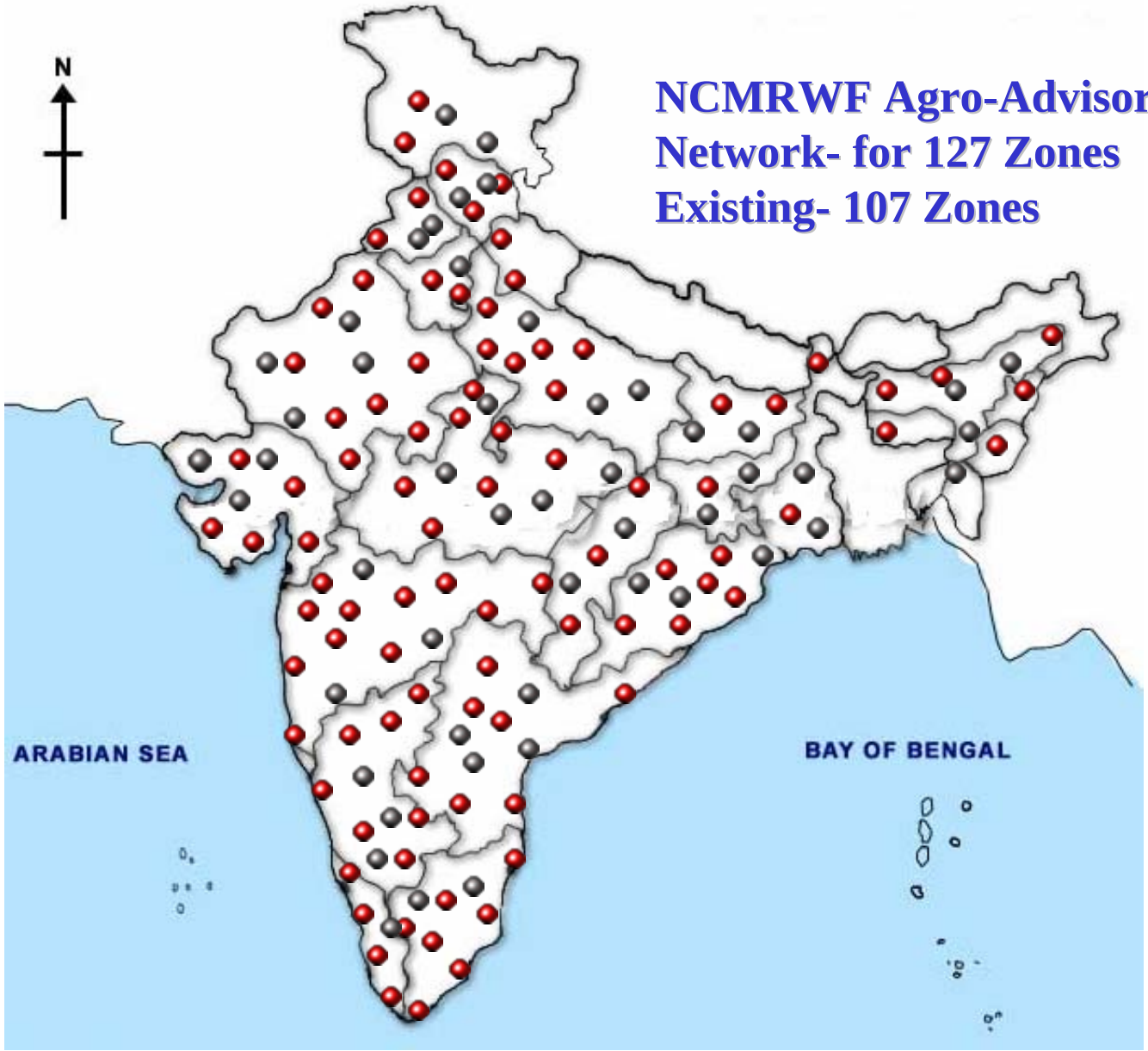
Model Climate compared to Observation (1982-2005)





Inter-member Spread is quite large- Possibility of making Probabilistic Predictions?

Current Skill Level Worldwide for Precipitation Prediction is too Low


N
NCMRWF Agro-Advisory Service
Network- for 127 Zones
Existing- 107 Zones
ARABIAN SEA
BAY OF BENGAL

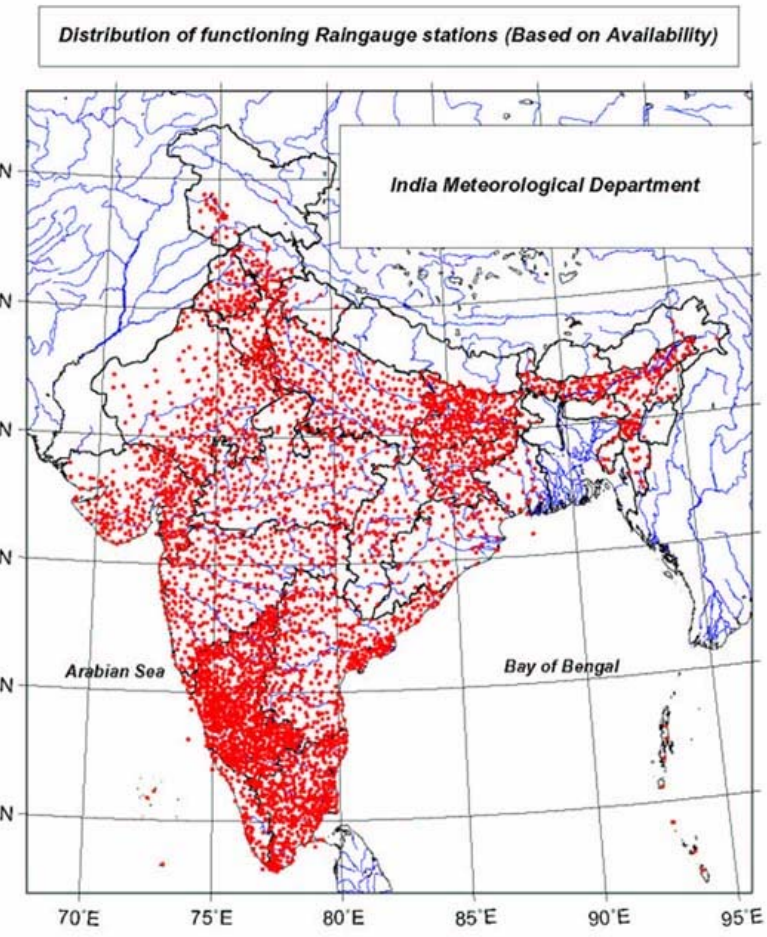
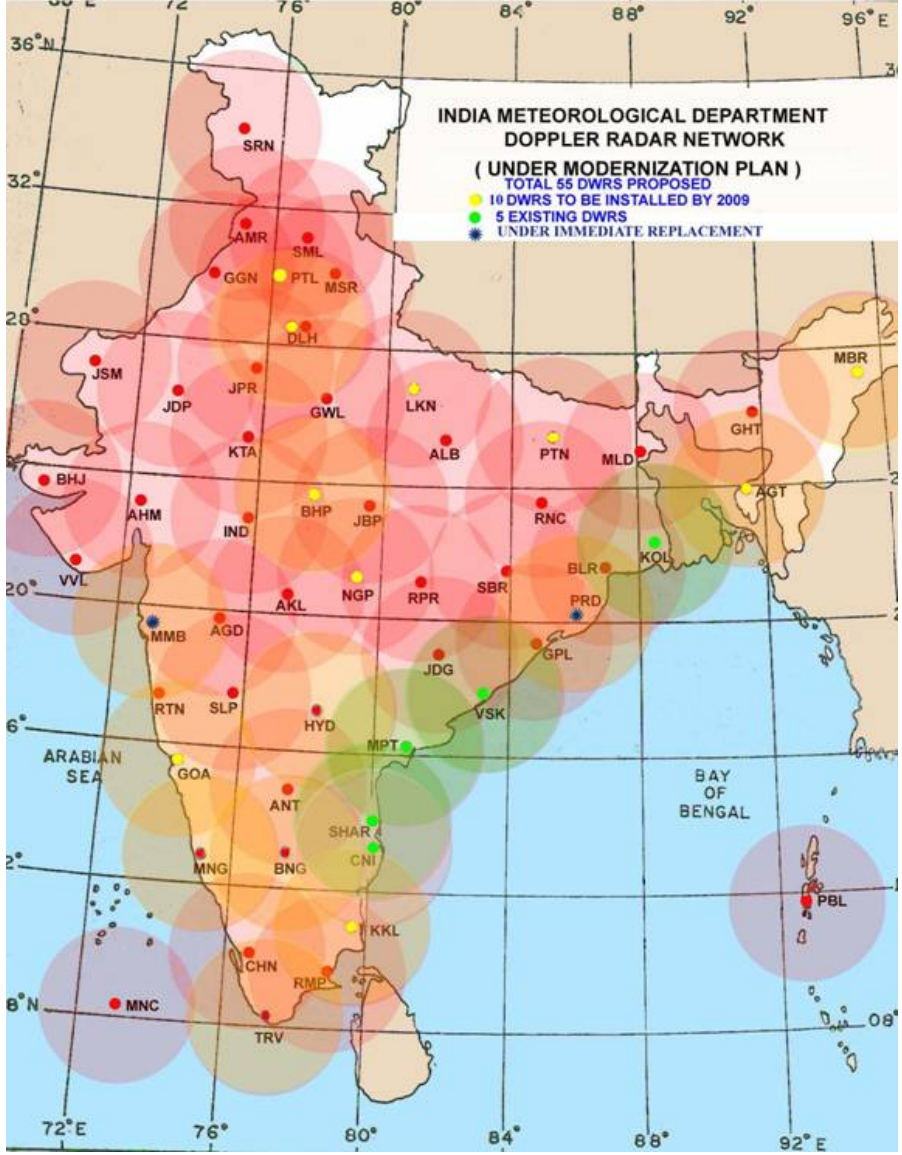
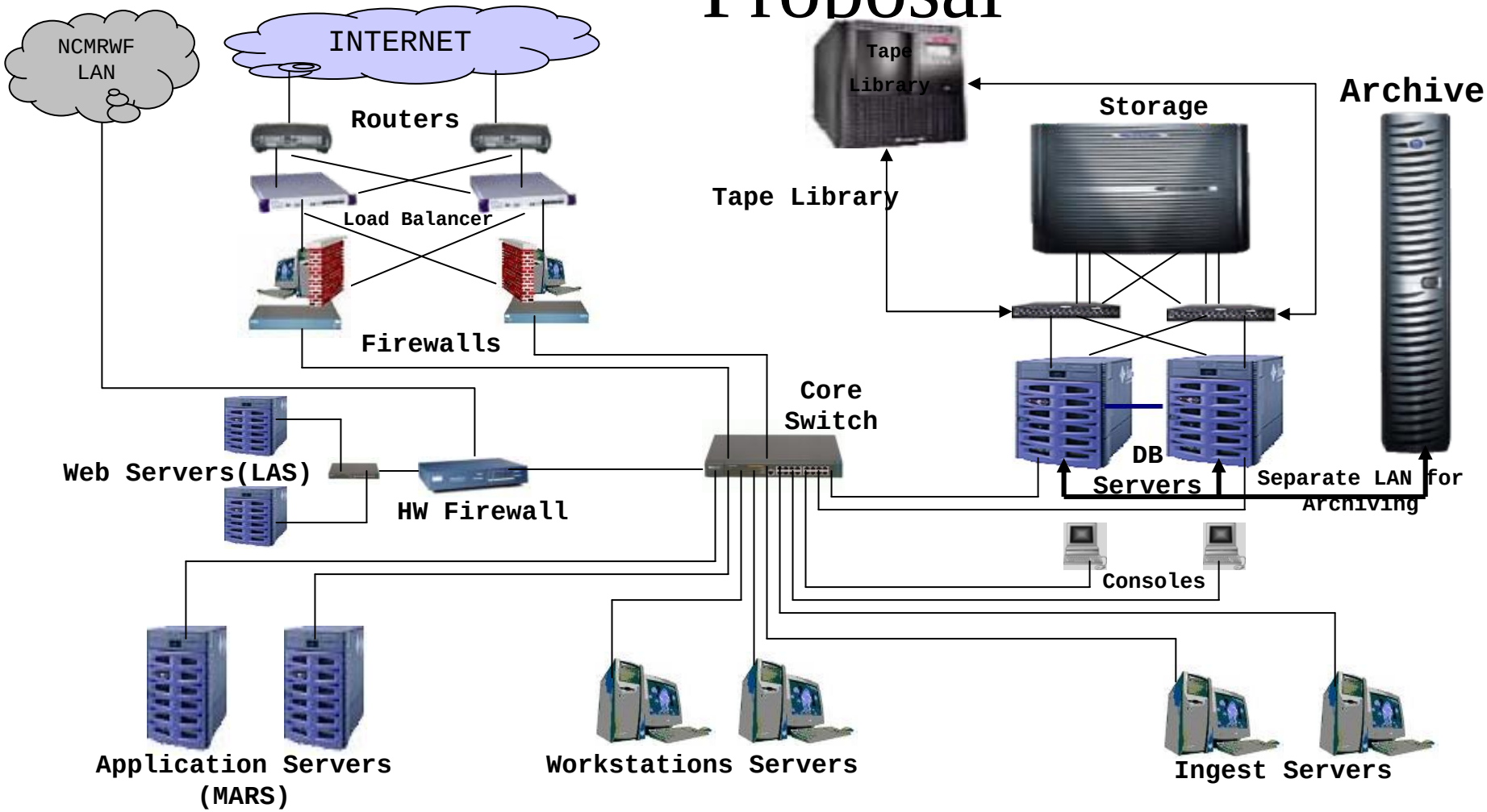


Fig. 1 Map showing the functioning rainguages



IMD under the MoES is having a massive Modernization Plan Of its Observing Network

Data Centre Proposal



NCMRWF proposes to actively participate in the MAHASRI Program

NCMRWF shall carry out near Real-time Assimilation to Include Data from MAHASRI (if agreed to by MAHASRI)

NCMRWF shall carry out Model simulations to understand the processes of Aerosol Impacts

The Centre shall participate in the Modeling of the Ocean-Atmosphere Coupling and Intra-Seasonal Variability

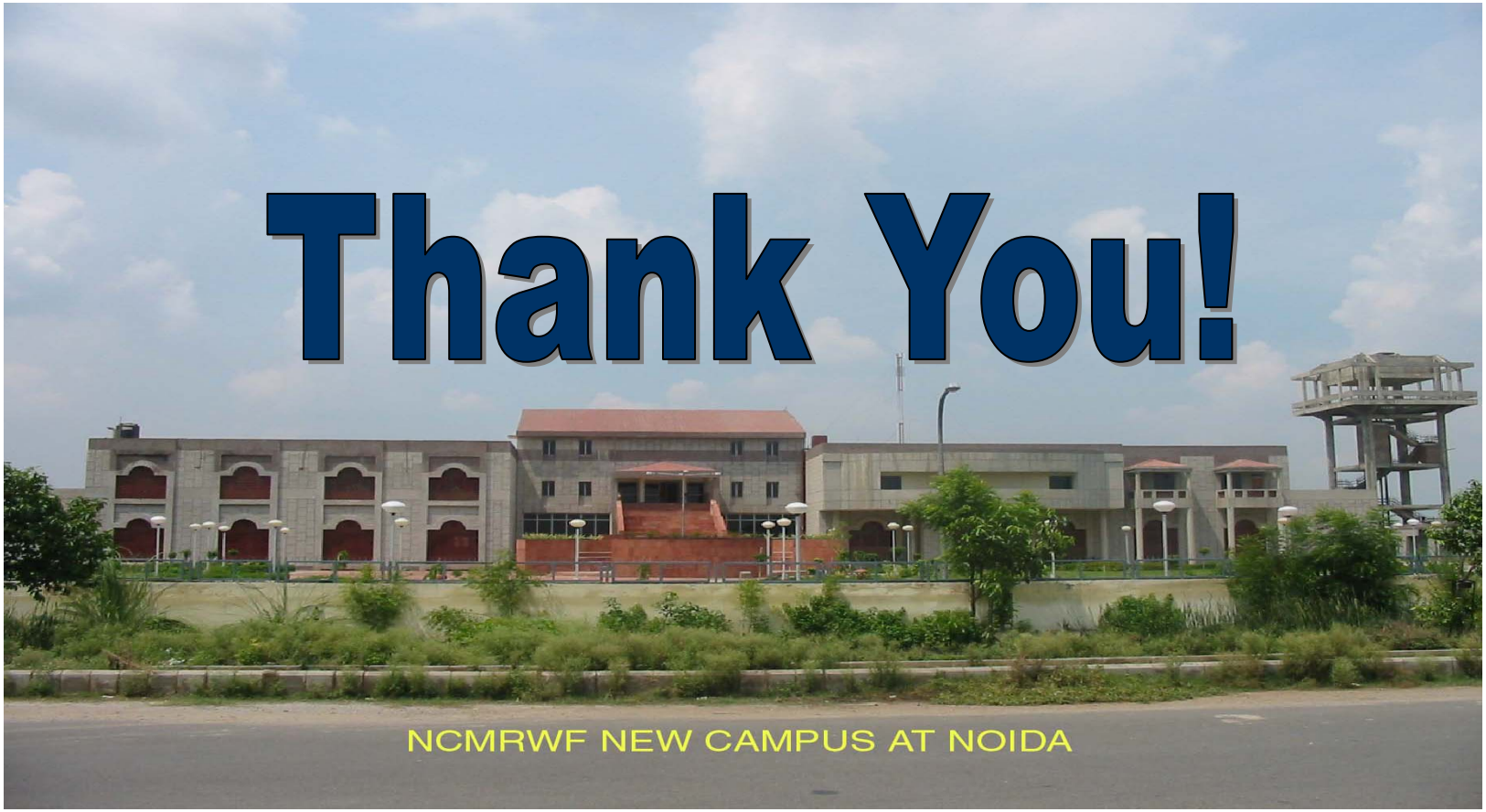
Preliminary proposal on Regional Reanalysis (Indian? South Asian?) is being discussed at NCMRWF.
(to study hydro-climatic variability, especially during monsoon)

The Centre is carrying out Systematic Hindcast Experiments to clarify predictability of the monsoon. The results of the study Can support the activities of MAHASRI

NCMRWF is in the process of implementing a Multi_Model Ensemble Seasonal Prediction System. The Centre shall join the efforts made through MAHASRI.

NCMRWF has a plan to implement Web based Data Service and a Data Centre for NWP products.

IMD has an ambitious Modernization Plan for its Observing Systems. These data can be made available through GTS or Processed data through NCMRWF


Thank You!
NCMRWF NEW CAMPUS AT NOIDA