Weather Modeling and Geospatial Information

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NCMRWF

Mission:

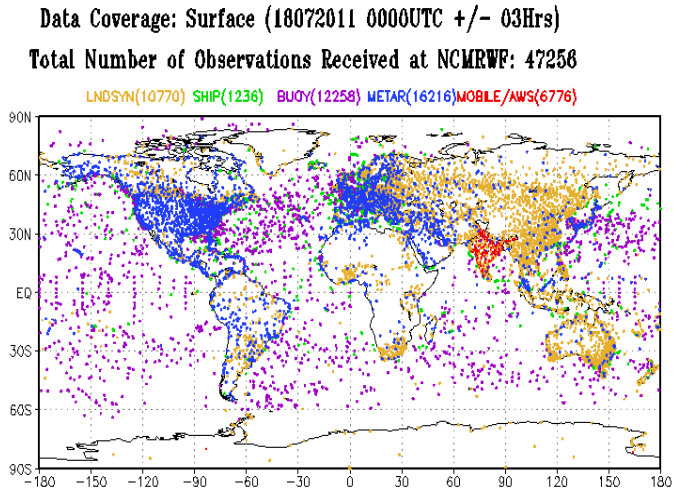
To continuously develop next generation of numerical weather forecasts, in terms of reliability and accuracy over India and neighboring regions through research, development and demonstration of new and novel applications, maintaining highest level of knowledge, skills and technical bases.

Objectives

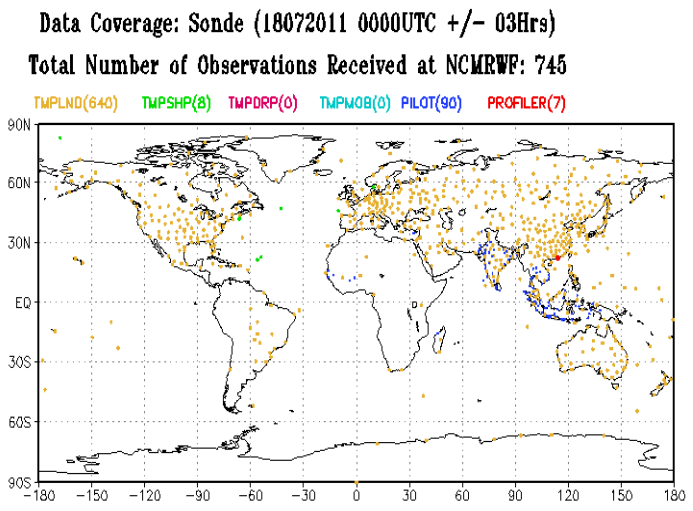
- Improvement of Numerical Weather Prediction System with high reliability over India and neighboring regions
- Development of coupled ocean-atmosphere modeling system for extending the temporal range of forecasts.
- Establishment, maintenance and enhancement of physical, computational and associated infrastructure for carrying out research and development activities

Observations assimilated at NCMRWF on a typical day

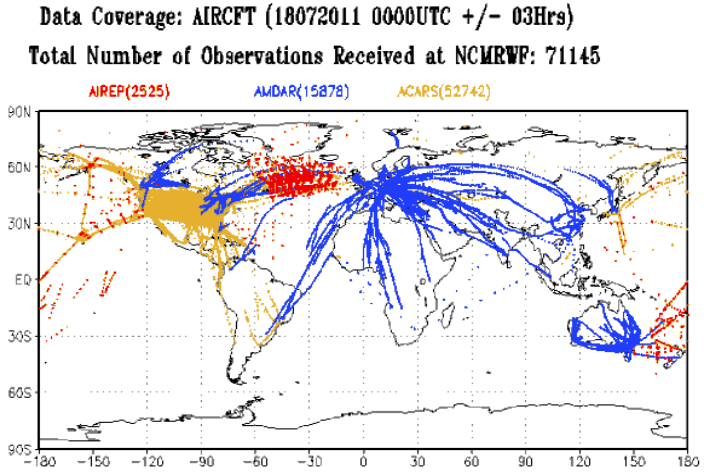
Surface

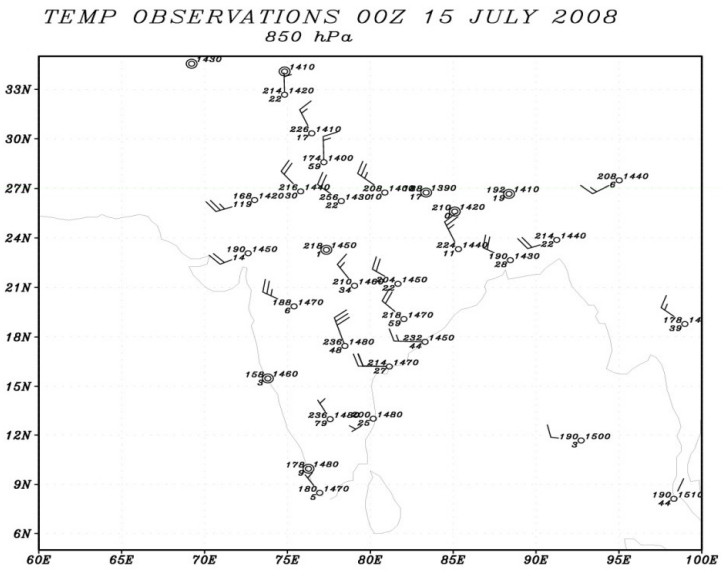


Upper-air sondes



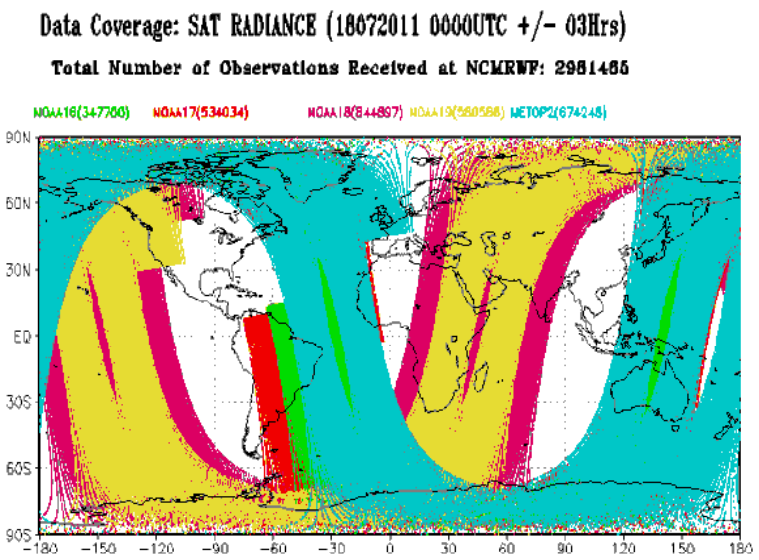
Aircraft



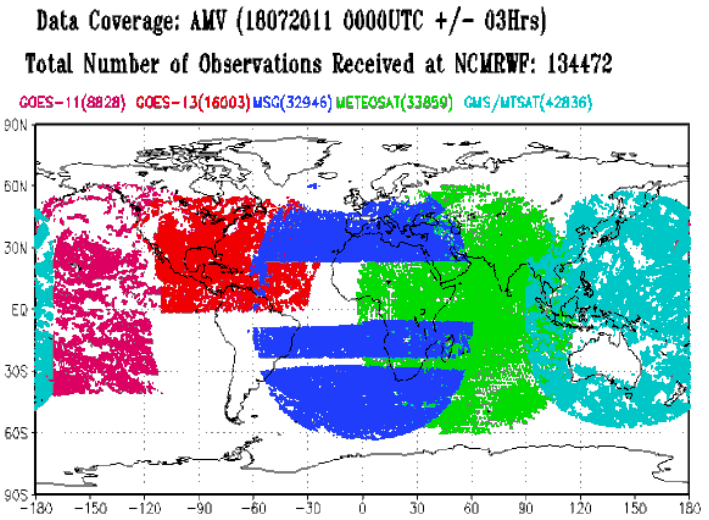


Observations assimilated at NCMRWF on a typical day

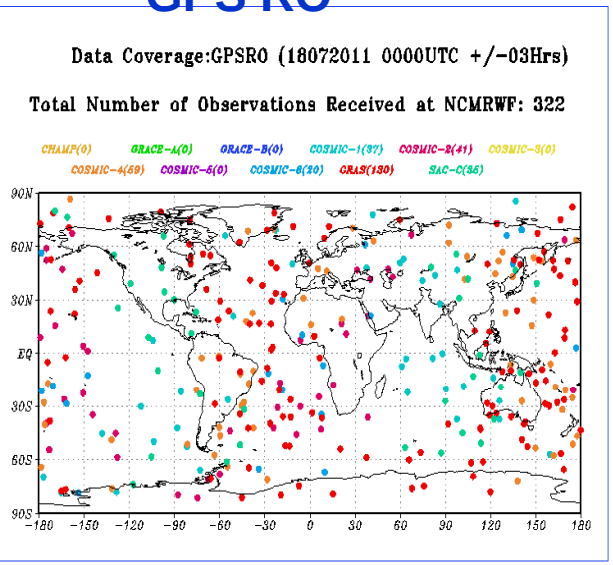
Satellite Radiances



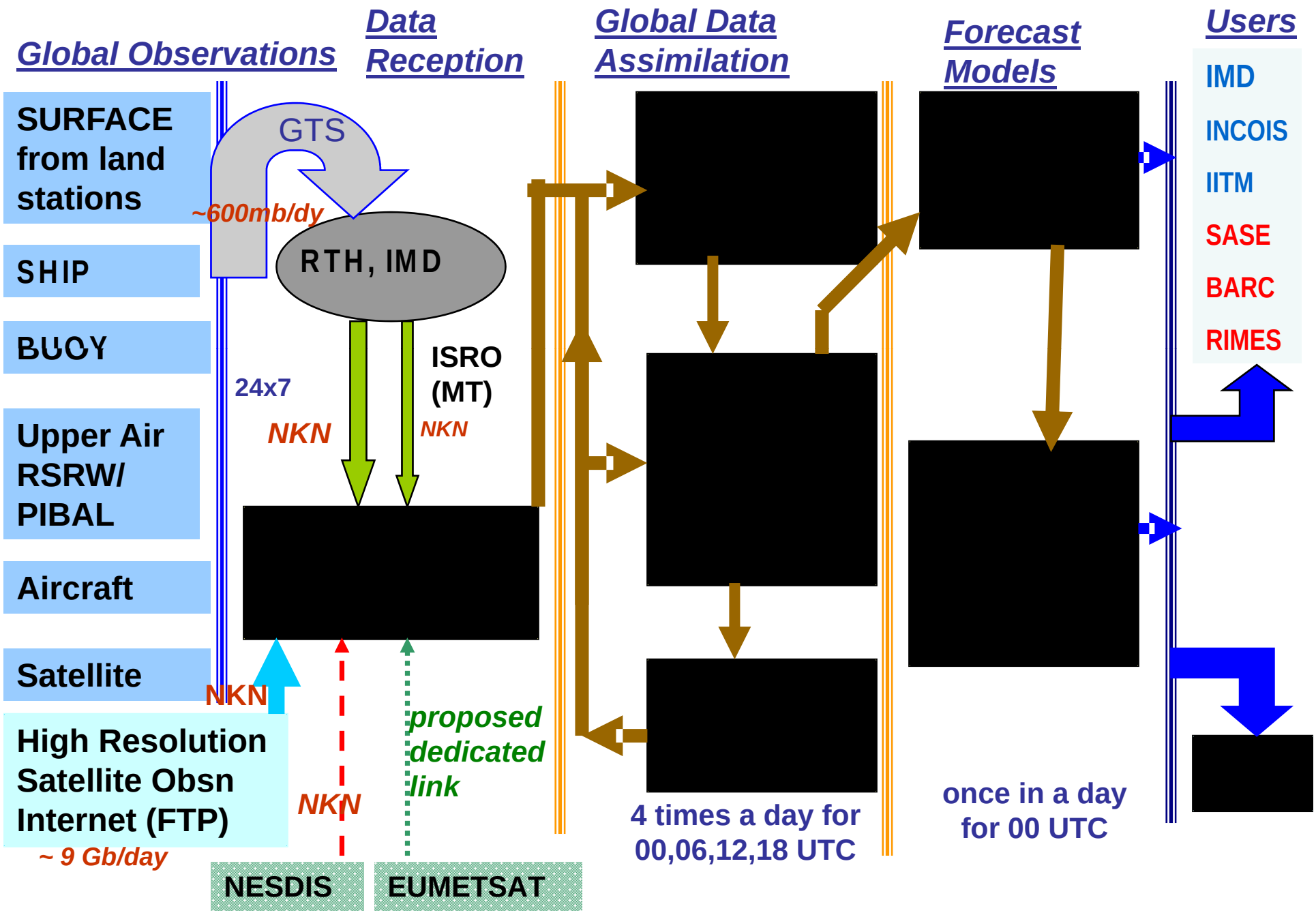
Satellite Winds



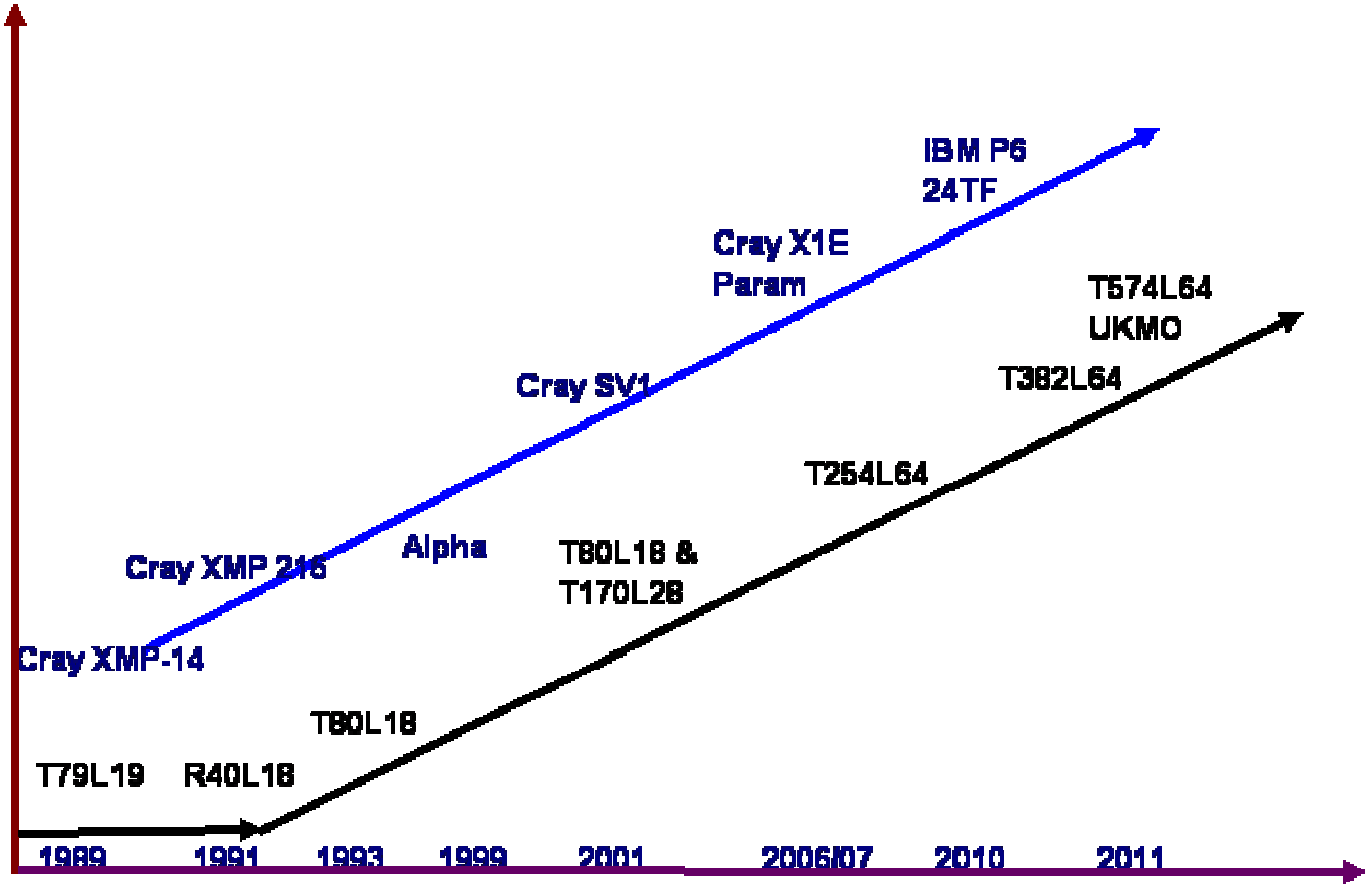
GPS RO



Numerical Weather Prediction System of NCMRWF



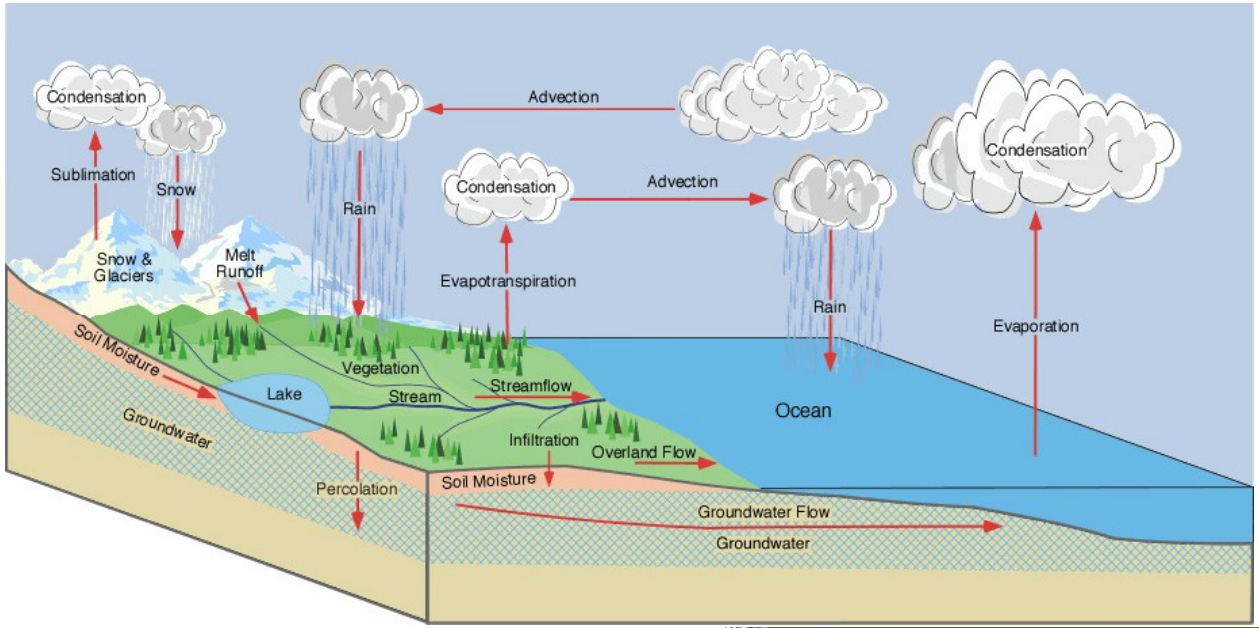
HPC &Global Modeling at Data Assimilation at NCMRWF



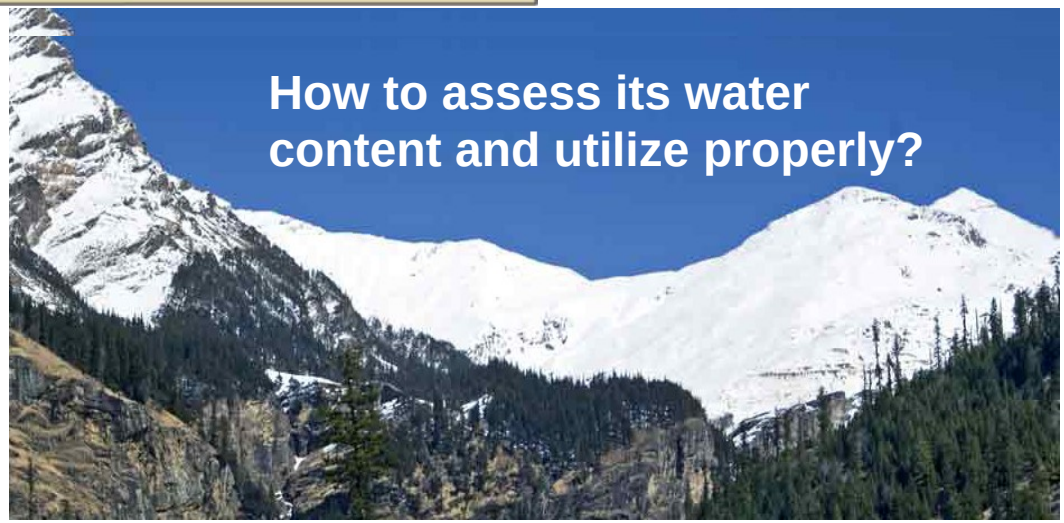
Current Operational Global Models

- **GFS (T574L64) : 10 day forecast – for 00 UTC**
  - **3 day forecast -12 UTC**
  - **3D-Var DA**
  - **GEFS (T190L28) -10 day ensemble forecasts (21 members)**
- **UM (25kmL70) – 7 day forecast**
  - **4D-Var DA**
  - ***UM based global EPS (~33 km/L70; 24 members) getting ready***

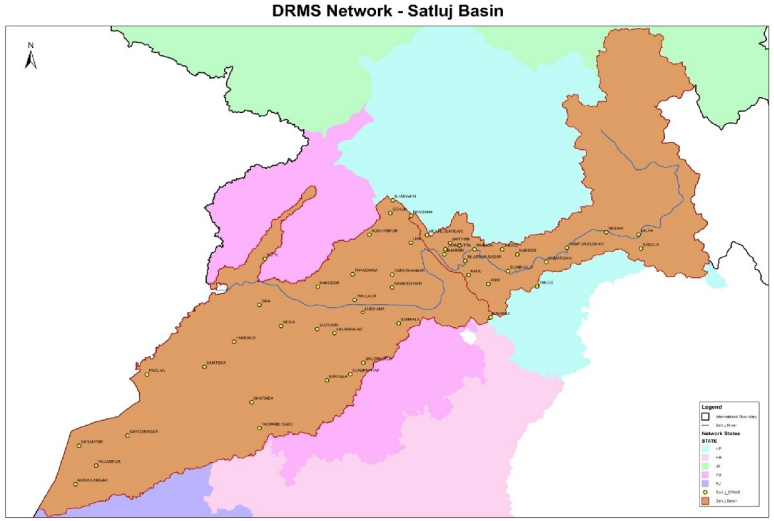
Integrated Program on Climate, Water Cycle and Prediction



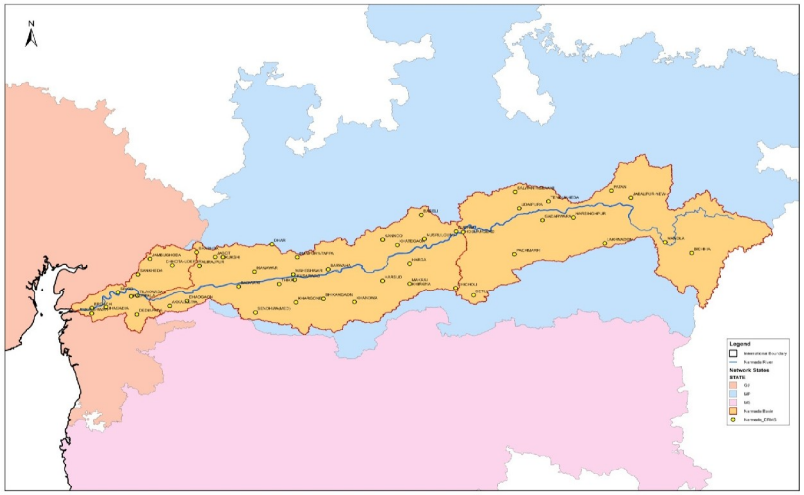
Water Cycle



Satluj Basin



Narmada Basin



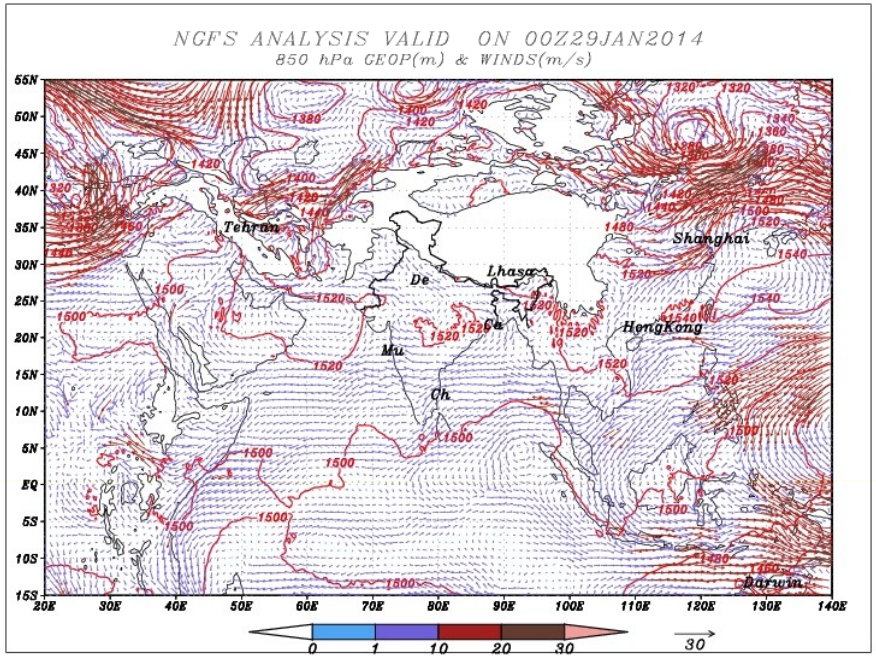
-To integrate the present knowledge on water and climate (observed data, models, decision support systems etc)

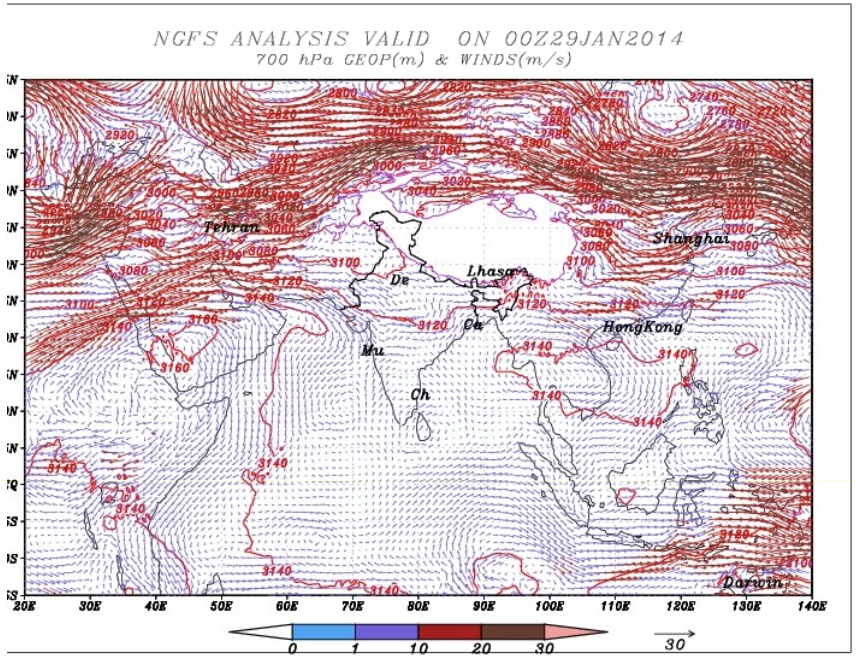
-To get a quantified estimate of water balance in the river catchment/basins (using precipitation, evaporation, snow melt, stream flow, runoff, infiltration from existing observing stations and newly established stations)

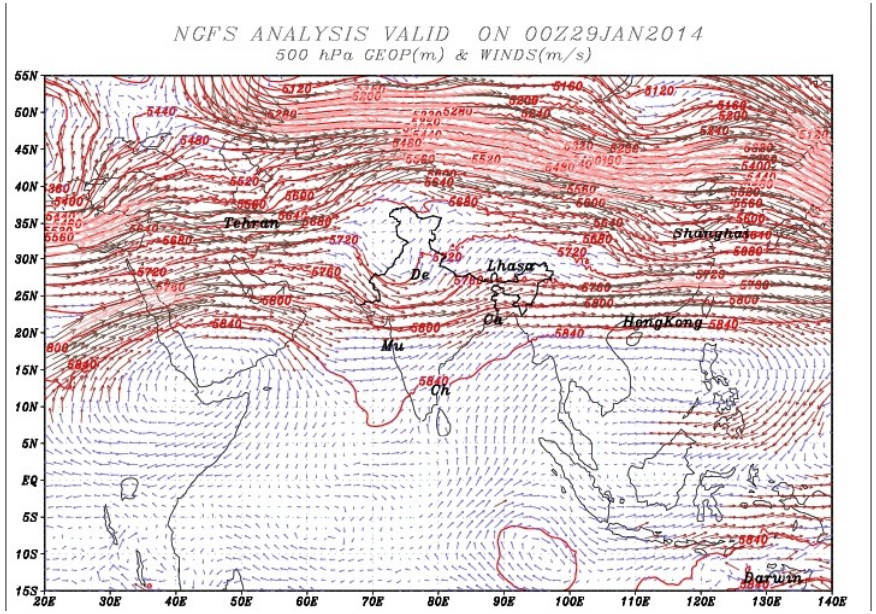
-To develop advanced high-resolution modeling systems to enhance predictions of hydro-meteorological variables at catchment/basin scale. Extensive use of hydrological modeling and GIS

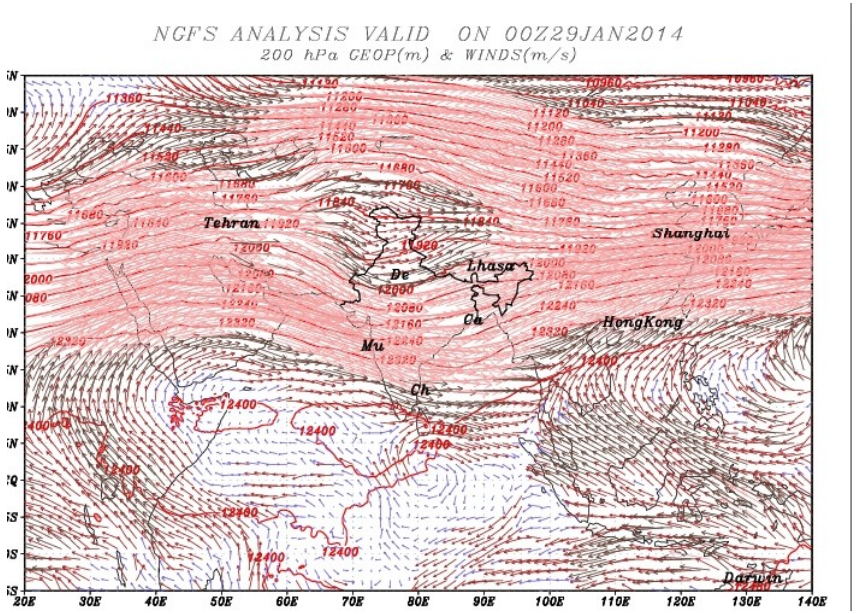
- It is a joint project of : NCMRWF, IMD

Weather Analysis of a Day: Winds and Geopotential Height at various Pressure level

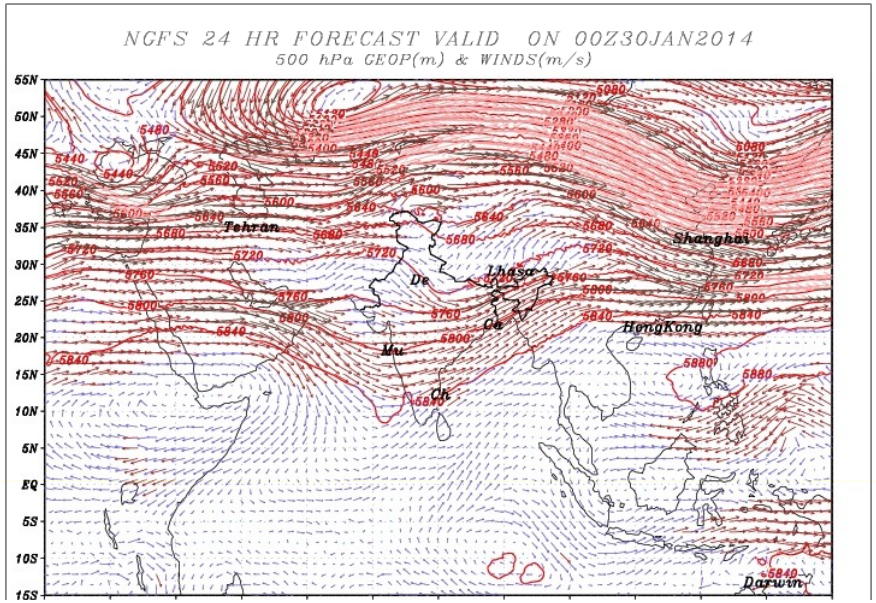


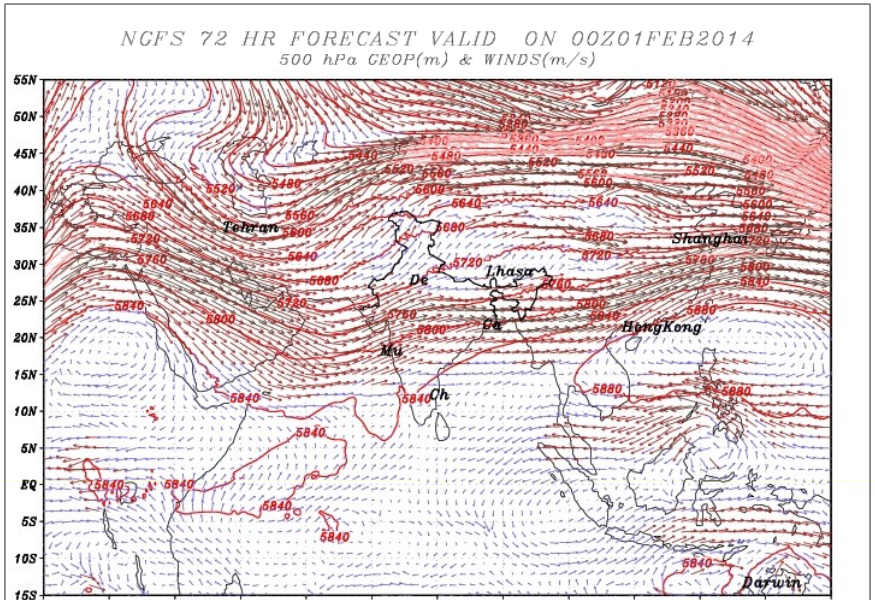


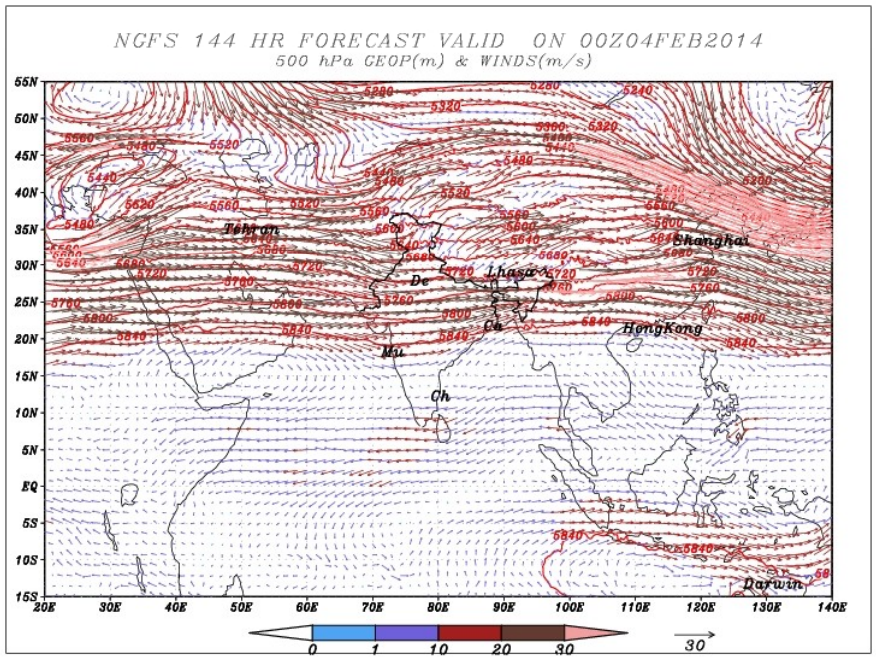


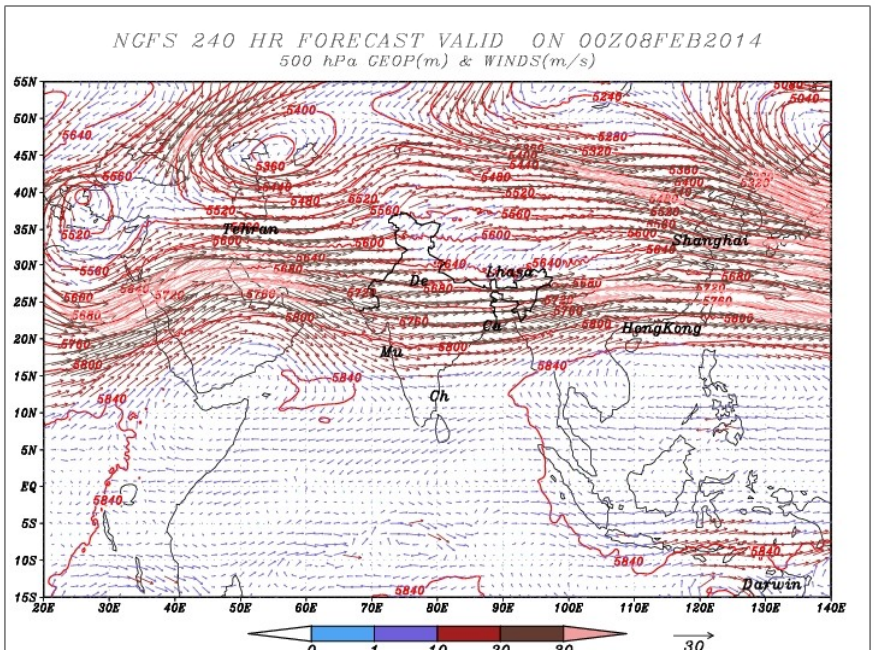


Wind & Height at 500hPa Forecasts: Day-1, Day-3, Day-6 and Day-10



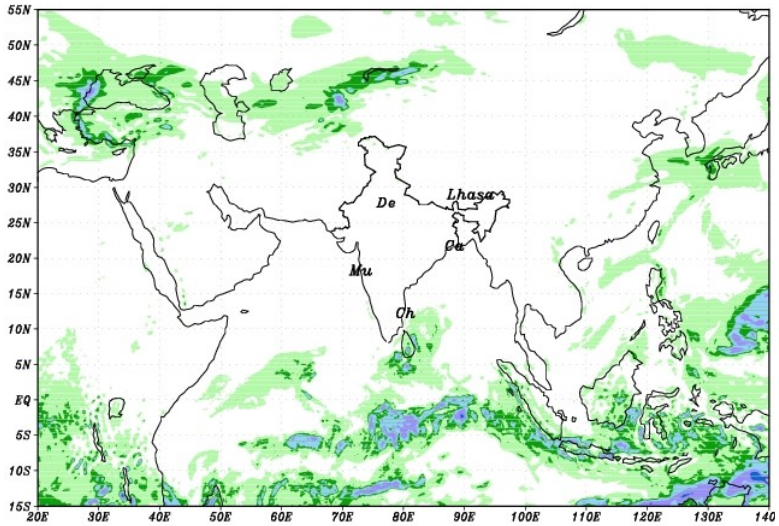




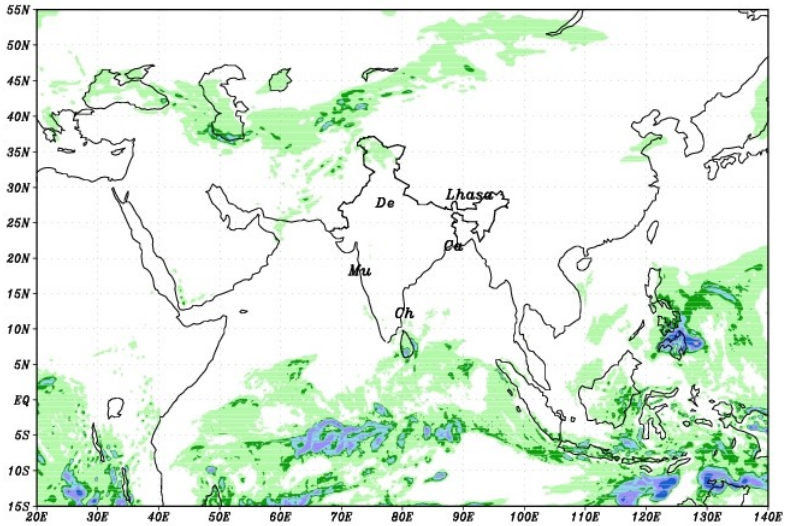


Rainfall Forecasts Day-1, Day-3, Day-6 and Day-10 Forecasts

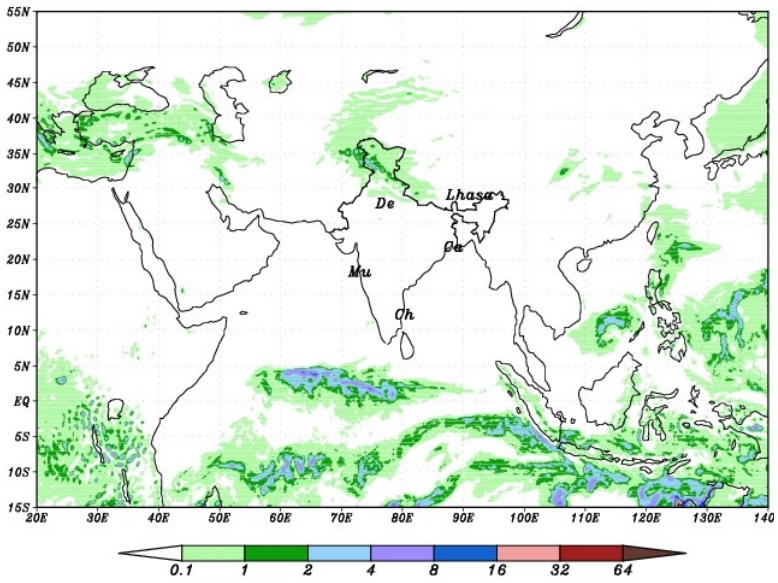
NGFS DAY 1 FORECAST VALID ON 00Z30JAN2014
RAINFALL(cm) CI=0.1,1,2,4,8,..



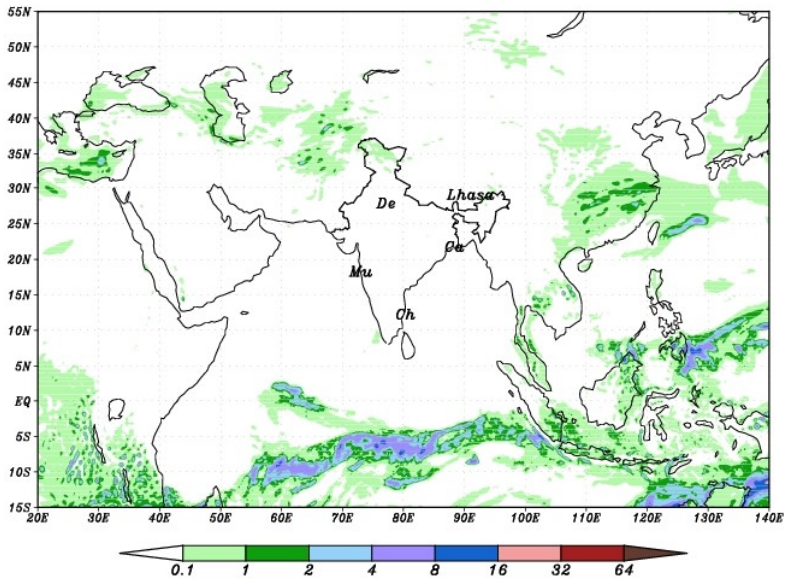
NGFS DAY 3 FORECAST VALID ON 00Z01FEB2014
RAINFALL(cm) CI=0.1,1,2,4,8,..



NGFS DAY 6 FORECAST VALID ON 00Z04FEB2014
RAINFALL(cm) CI=0.1,1,2,4,8,..



NGFS DAY 10 FORECAST VALID ON 00Z08FEB2014
RAINFALL(cm) CI=0.1,1,2,4,8,..



Why embark on this project

- Demands of products in geo-referenced format
- Create a consistent data format/archive that is useful by all organizations
- Enable more accurate and timely weather and climate assessment using value added information
- Promote collaborative efforts between organization

- To explore the role of GIS as an integrating tool for weather/climate research and applications at NCMRWF and in the geosciences community.

- To foster collaborations in interdisciplinary GIS-based studies in meteorology, climatology, and related earth system science research.

- To improve communication between the academic, private, and government sectors in weather and climate GIS applications.

- Collaborate activities with user community

- **Transition NCMRWF's suite of weather monitoring, assessment and forecast products into GIS format**

- **Provide NCMRWF's data to user community in GIS format through interactive, web-based system as well as direct data transfer**

Geographic Information Systems In Weather, Climate, And Impacts

by Olga V. Wilhelmi and Jeffrey C. Brunskill

Bulletin of American Meteorological Society October 2003

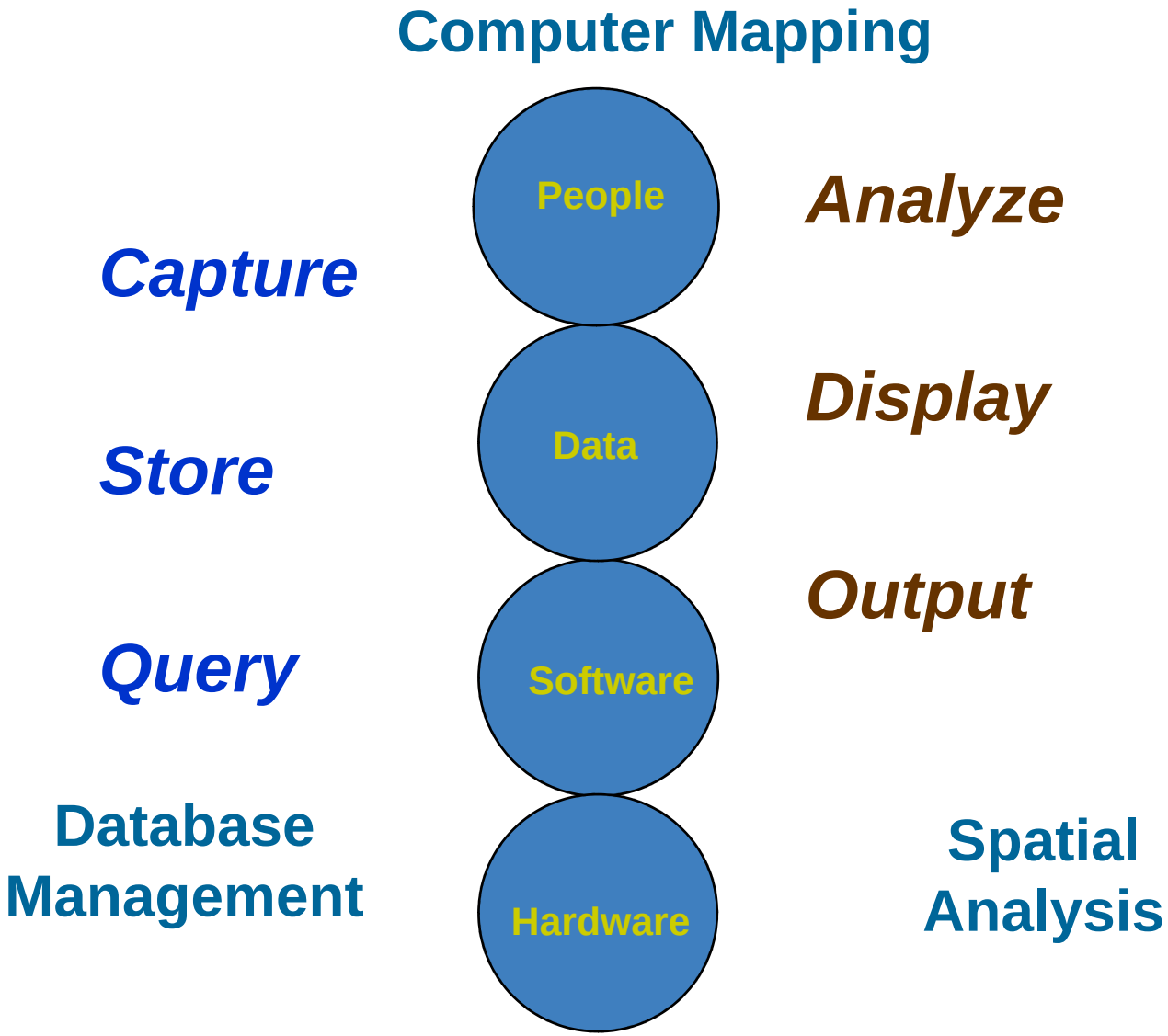
- **GIS Science is a multidisciplinary field concerned with developing a theoretical basis for GIS.**

- **The discipline incorporates principles from a range of fields including cognitive science, geography, philosophy, information science, and computer science.**

- **Relevant research considers the unique characteristics of geographic information with respect to spatial cognition, data collection, representation in digital data models, spatial analysis, and visualization.**

- **From this perspective, a GIS is a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth**

Geographic Information Systems



Organizing Spatial Data

Weather

Atmospheric Conditions

Population

Hydrology

Topography

Geology

✓**Definition of GIS encompasses a broad range of spatial information systems.**

✓**The atmospheric science community is traditionally accustomed to developing their own software to manage, analyze, and display spatially referenced data.**

✓**These custom-developed systems often limit the integration of atmospheric science data with data from other geo- and social sciences, which are more accustomed to commercial GIS packages.**

✓**GIS is frequently defined based upon these commercial applications alone.**

✓**While commercial GIS software packages offer many potential benefits to the atmospheric community, they represent only a limited range of concepts and models.**

Atmospheric Information System & GIS

A coherent effort to develop GIS within the atmospheric science community might best be served by incorporating a broad definition of a GIS in an effort to develop an atmospheric information system.

This is important because the issue at hand is not only tied to technical issues (*GIS as a tool*) such as data transformations, software compatibility, and interoperability.

It is also tied to a theoretical discussion of the manner in which meteorologists represent atmospheric space

Existing GIS software provides

a vast set of spatial concepts,

standards, and

tools (including spatial statistics)

that can be used to explore spatial patterns in meteorological data, climate variability & change.

GIS can provide a standardized platform for atmospheric diagnostics—a common set of tools.

Geospatial databases could be very useful in

bringing multiple, large datasets together for climate research,

making databases more readily accessible for multiple applications, and

making data access and manipulation more transparent.

GIS will allow easier integration of different datasets and formats.

GIS could link atmospheric models with datasets and models developed outside the atmospheric community.

GIS could also make weather and climate information more usable outside the meteorological community.

Making atmospheric data accessible through existing GIS software would help people outside the atmospheric community explore

- **spatial patterns in the data,**
- **incorporate weather data into practical decisions (e.g., risk management), and**
- **improve meteorological education at various levels.**

Limitations of GIS

Static cartographic maps provide the conceptual foundation for the representation of space in geographic information systems.

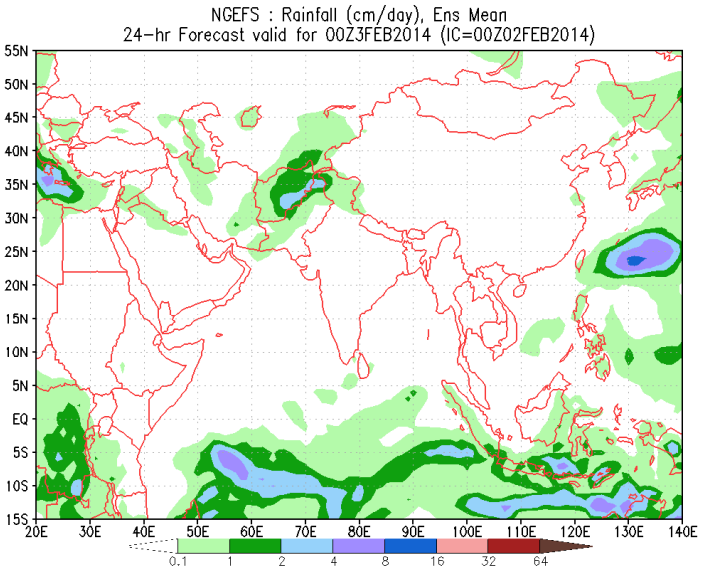
The GIS models were developed for purposes and domains other than atmospheric space.

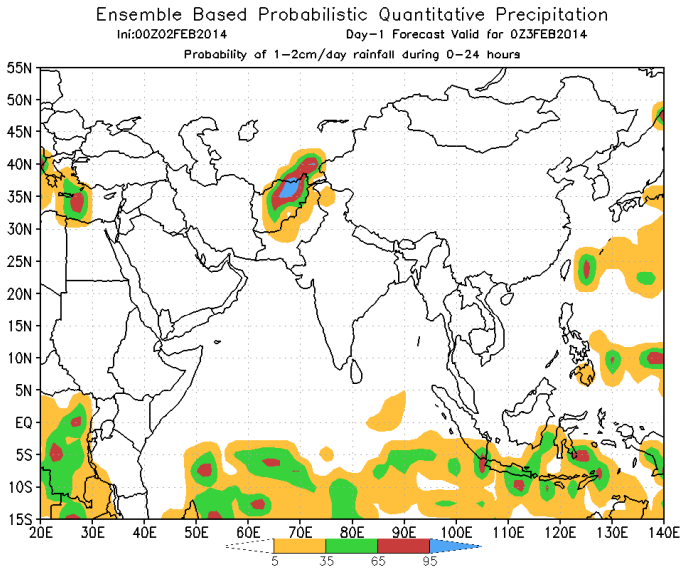
Existing GIS are limited in their ability to represent the spatiotemporal dynamics of natural phenomena.

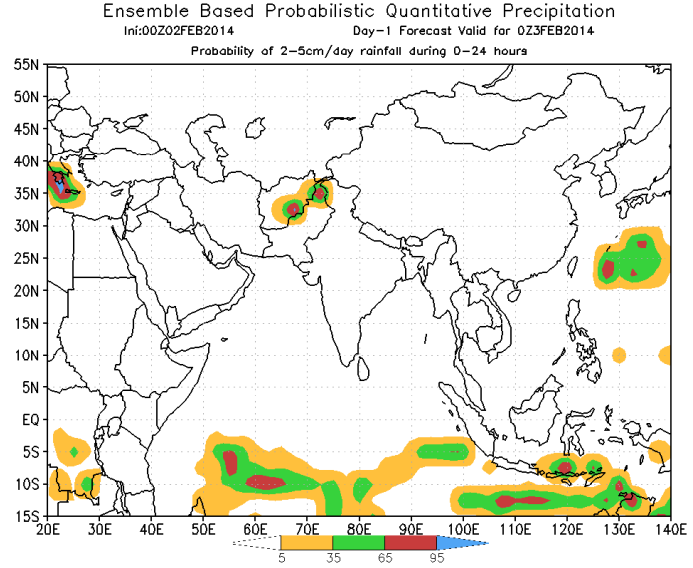
The inability of existing GIS models to easily represent four-dimensional (space and time), real-time data is one of the primary reasons for the lack of GIS usage in meteorology and associated geosciences.

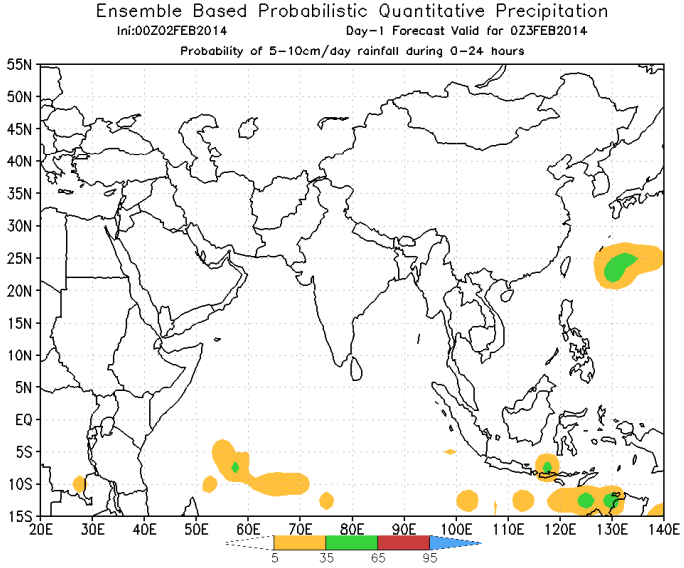
Global Ensemble Prediction System

How to represent Uncertainties in the Forecasts









Limitations of GIS

GIS focus primarily on two-dimensional, static data like roads, political boundaries, and land-use classifications.

These models are based on an overlay method where each layer represents a thematic variable. The discrete object model
and the continuous field model represent spatial entities within each layer.

Efforts to accommodate these models would likely require the development of a standardized system to represent atmospheric entities/data within existing GIS models.

NCMRWF's Plan for Geospatial Database Preparation

Comprises of 2 primary steps

-Initial design / testing (internal to NCMRWF)

-Full conversion /dissemination of all NCMRWF forecast prodcuts

(data products to be released in phases)

-The initial project will test the conversion process on a limited suite of products including

Analysis and forecasts (Day-01 to Day-10) of winds, Geopotential Height and Precipitation

Data Conversion Details

Original data are provided in a variety of formats
-Binary, GRIB, NetCDF, Ascii, Gif, Jpeg etc

Output Data Types
Continuous grids are converted to raster GeoTiff formats

Discrete points or contours are converted to Vector Shapefile format

Internet Dissemination of GIS data

Will enable the users to view, download and manipulate NCMRWF's GIS data

Users can locally manipulate GIS data downloaded from our site.

Maintaining the GIS there, all data will be spatially referenced and thus easily comparable

Future plans will allow for creation of on-the-fly products such as time series, anomalies, model skill, trends etc.

Thank you