Impact of ATOVS data in a mesoscale assimilation- forecast system over Indian region

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OUTLINE

1. About NCMRWF

2. Regional Data Assimilation System at NCMRWF

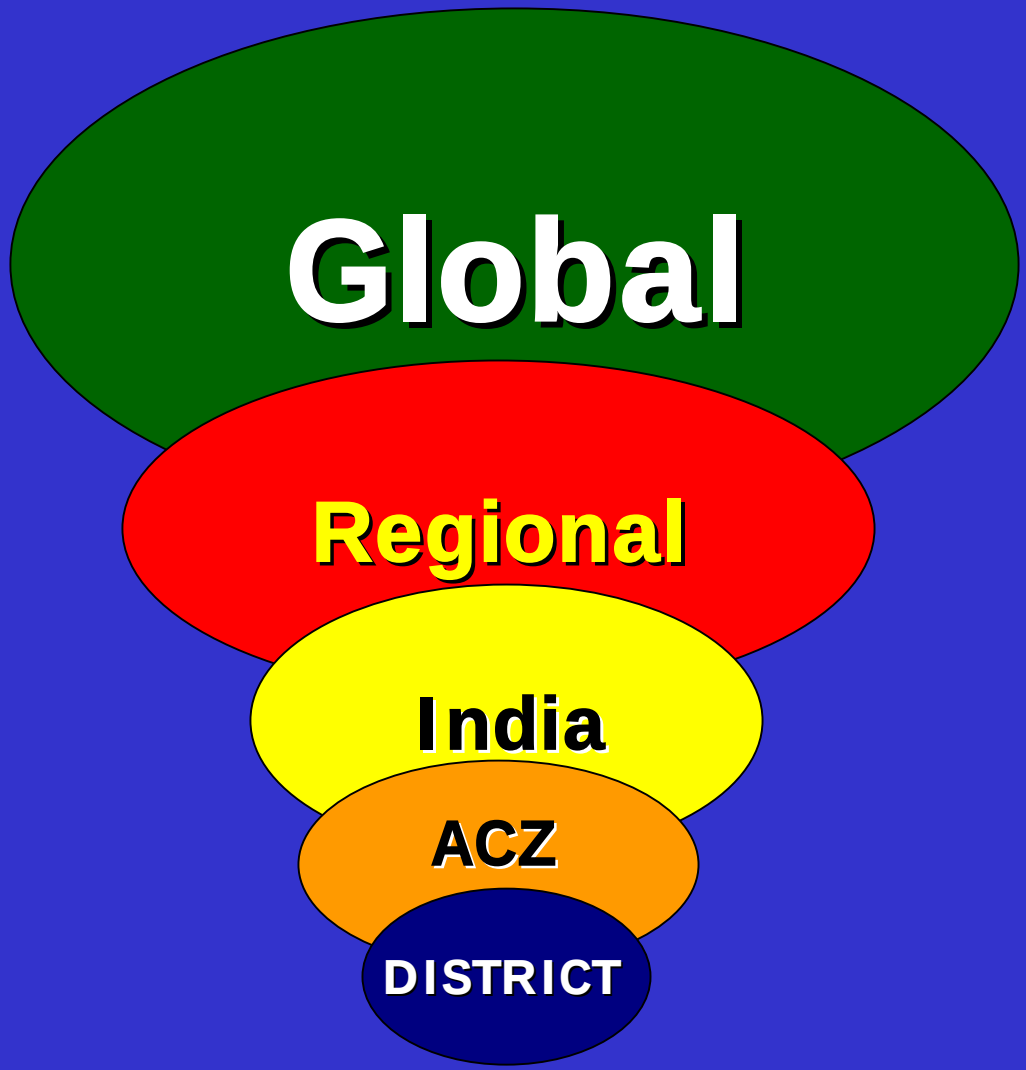
3. Experiments with ATOVS data

About NCMRWF

The National Centre for Medium Range Weather Forecasting (NCMRWF) is the premier institution in India to provide Medium Range Weather Forecasts through deterministic methods and to render Agro Advisory Services (AAS) to the farmers.

The centre offers challenging research opportunities in Numerical Weather Prediction, Diagnostic studies, Crop Weather Modeling and Computer Science.

NCMRWF'S Forecasts are available in all spatial scales



Models at NCMRWF

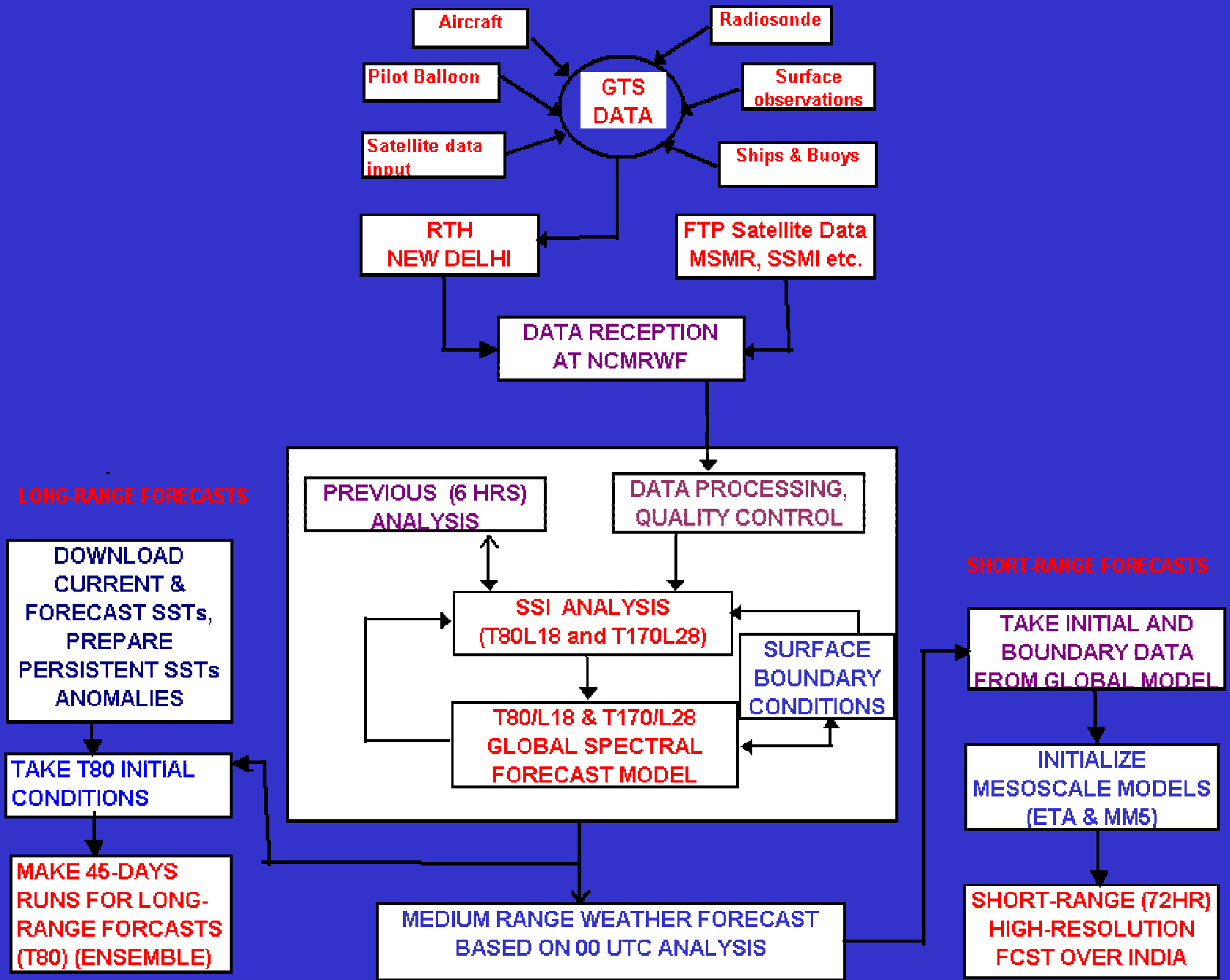
NWP models

- **Global Model**
  - **T80 at 150x150 km resolution [Operational]**
  - **T170 at 75x75 km resolution [Experimental]**
- **Mesoscale Models**
  - **MM5 (Nested 90, 30, 10 km)[Operational]**
  - **ETA at 48 km resolution [Operational]**
- **Ocean Wave Model**
  - **WAVEWATCH-III at 1 Degree for Global Oceans**

Crop models

- **CERES model for cereals**
- **CROPGRO model for legumes**

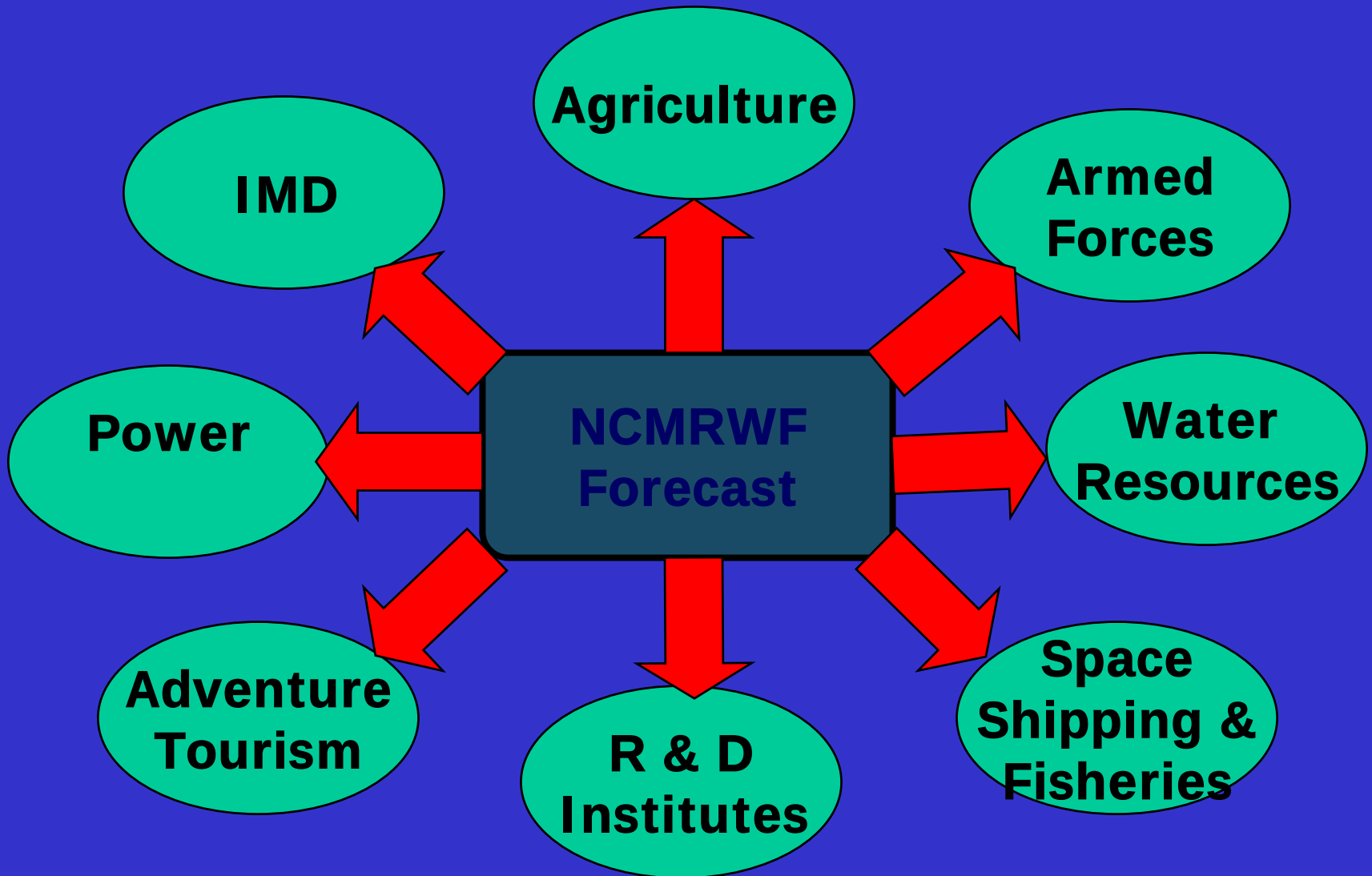
THE NCMRWF WEATHER FORECASTING SYSTEM



Comparison of global observations received at NCMRWF (through GTS and ftp) & ECMWF in Jan-2005

Platform	*Observations received at NCMRWF per day*	*ECMWF*
SYNOP (Land)	24785	57980
SHIP	6451	6872
BUOY	12511	19000
AIREP	2756	57469
TEMP	1057	1181
SATOB 400-150 hPa 1000-700 hPa	 8954 5571	418526 231535
ATOVS	32000 ***(approx.)***	600000 ***(approx.)***
SSMI	100000 ***(approx.)***	

Forecast to different Sectors



Regional Assimilation- Forecast system at NCMRWF

-MM5 Model (Since 2002)

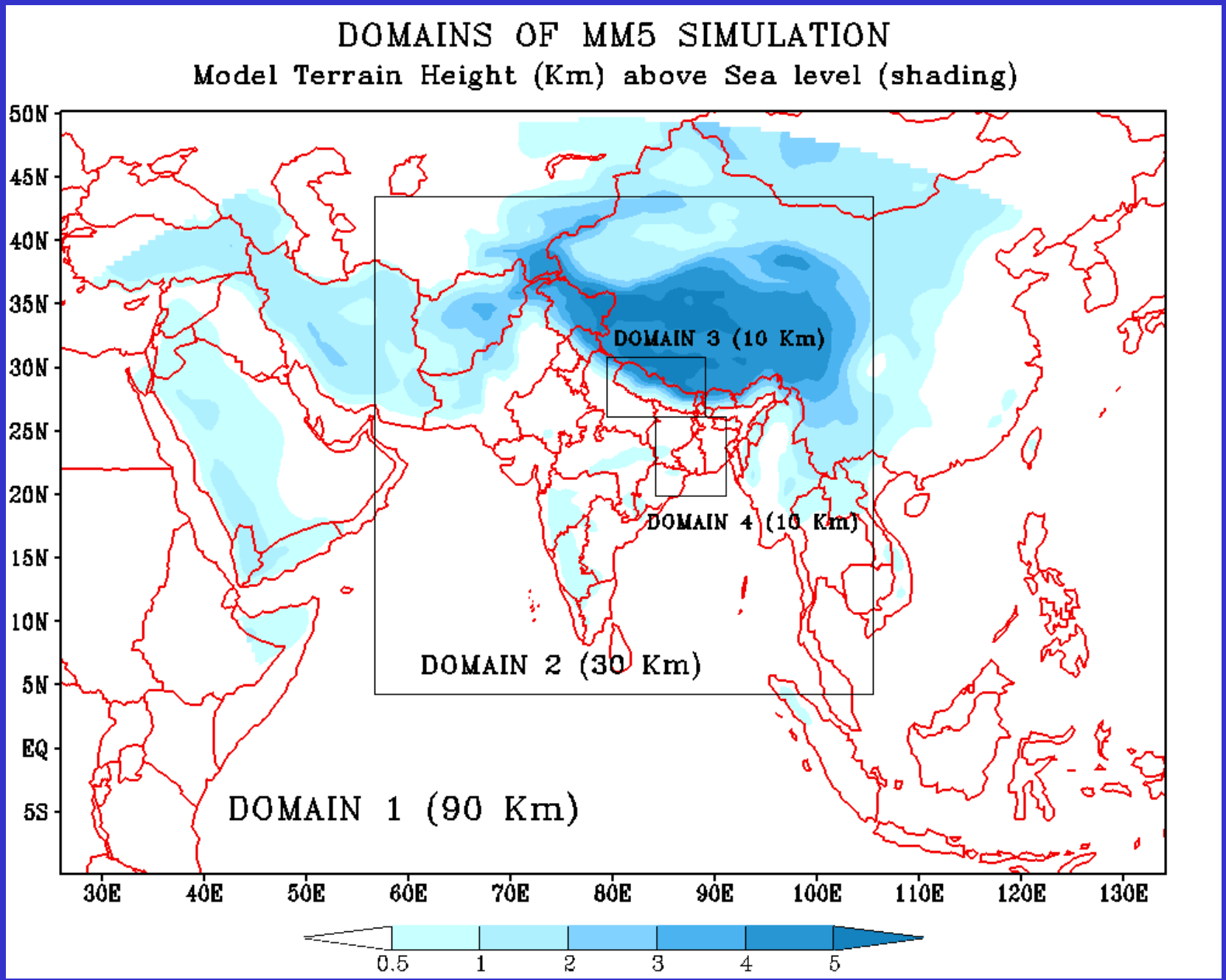
-NCAR MM5-3DVAR (Implemented in January 2005)

NCMRWF is running MM5 Model (NCAR) in real time basis since 2002

Domain:

- Horizontal (Triple Nested)
- Vertical: 23 Levels (Sigma-Hybrid)
- Time Steps: Domain-1: 270 S,
  Domain-2: 90 S,
  Domain-3 &4: 30 S
- Topography: USGS (Interpolated depending on resolution)
- Vegetation/ Land use: 25 Categories (USGS)

- **initial and lateral boundary conditions are from NCMRWF's global MODEL (T80) surface and upper air fields**
- **Boundary conditions are updated every 12 hours.**


DOMAINS OF MM5 SIMULATION
Model Terrain Height (Km) above Sea level (shading)
50N
45N
40N
35N
30N
25N
20N
15N
10N
5N
EQ
5S
30E
40E
50E
60E
70E
80E
90E
100E
110E
120E
130E
DOMAIN 3 (10 Km)
DOMAIN 4 (10 Km)
DOMAIN 2 (30 Km)
DOMAIN 1 (90 Km)
0.5
1
2
3
4
5

NCAR MM5-3DVAR at NCMRWF

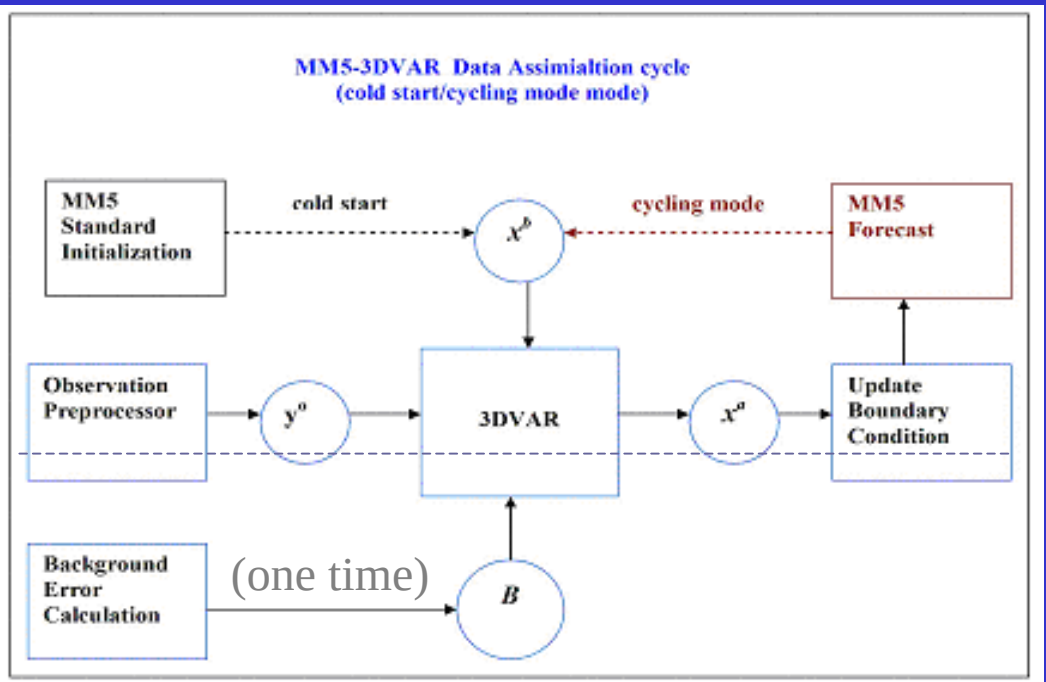
MM5-3DVAR system mainly consists of the following four components

(a) Background Pre-processing

(b) Observation Pre-processing and quality control

(c) Variational Analysis

(d) Updation of Boundary Conditions



3DVAR has been implemented as 6-hrly intermittent scheme

with ±3UTC window

Basic aim of MM5 3DVAR is to produce an optimal analysis through iterative solution of

$$J(x) = J^b + J^0 = \frac{1}{2}(x - x^b)^T B^{-1}(x - x^b) + \frac{1}{2}(y - y^o)^T (E + F)^{-1}(y - y^o)$$

where $\boldsymbol{x}$ analysis state

$\boldsymbol{x^b}$, background

$\mathbf{y^o}$ observation

B, ***E*** and ***F*** are the background, observation (instrumental) and representivity error covariance matrices respectively

About the Control Experiment

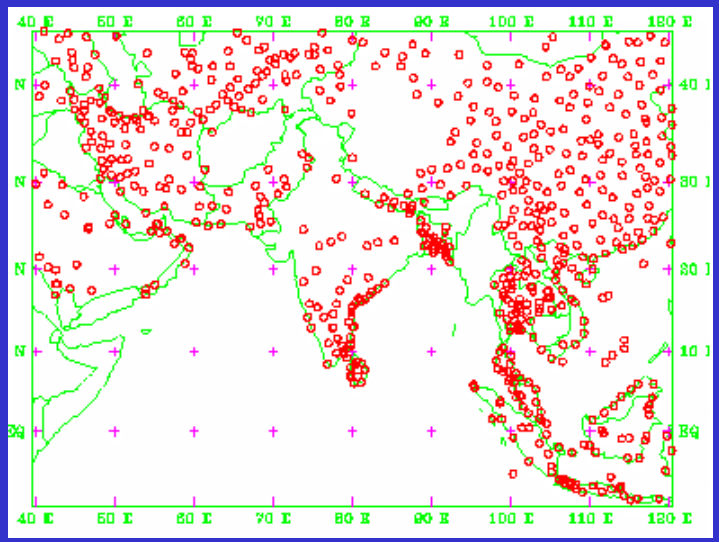
MM5-3DVAR assimilation cycle (6 hr intermittent) has been run a period of 12 days (0006UTC 21st - 0000 UTC31st July 2004)

Conventional data such as SYNOP, SHIP, BUOY, AIREP, AMDAR, TEMP, PILOT and SATOB used (CRTL)

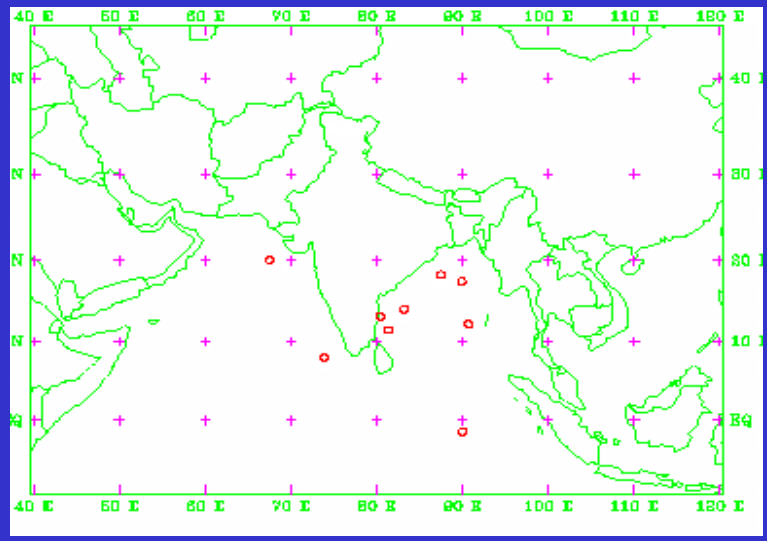
RMSE and Bias of background and Analysis have been computed against observations for different parameters to examine the steadiness of the system

CRTL analysis have been compared with Interpolated Global analysis (IGLB - at T80 resolution)

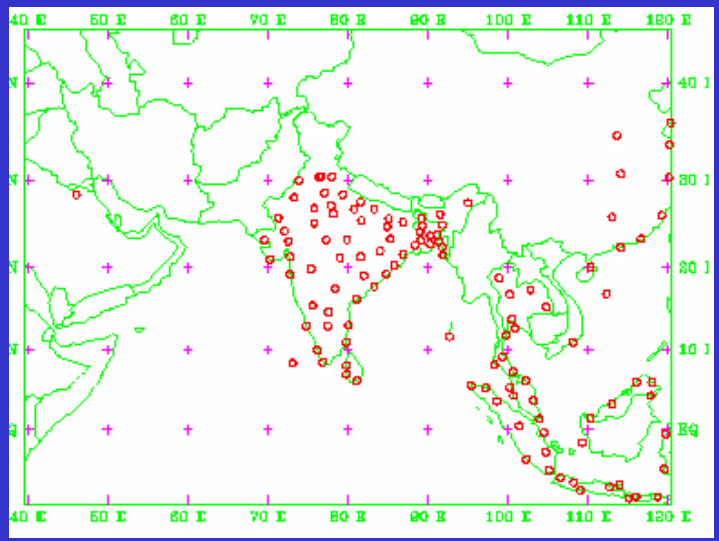
Coverage of conventional data used in the assimilation cycle



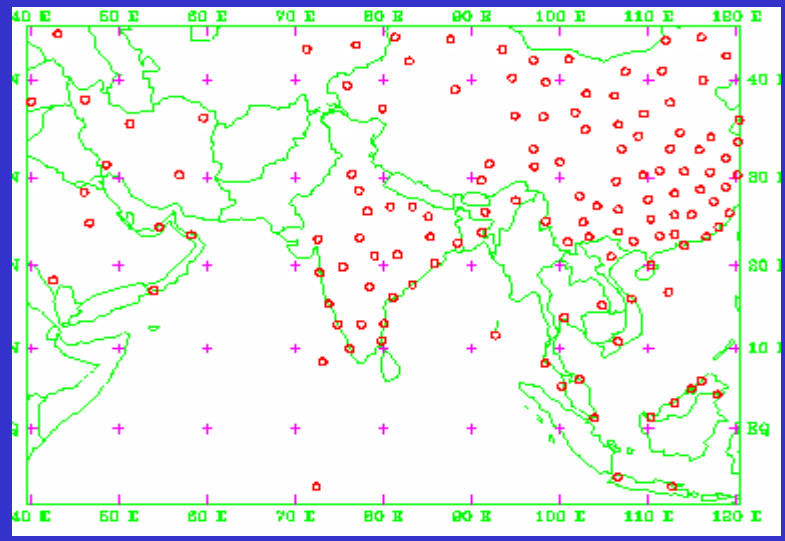
SYNOP



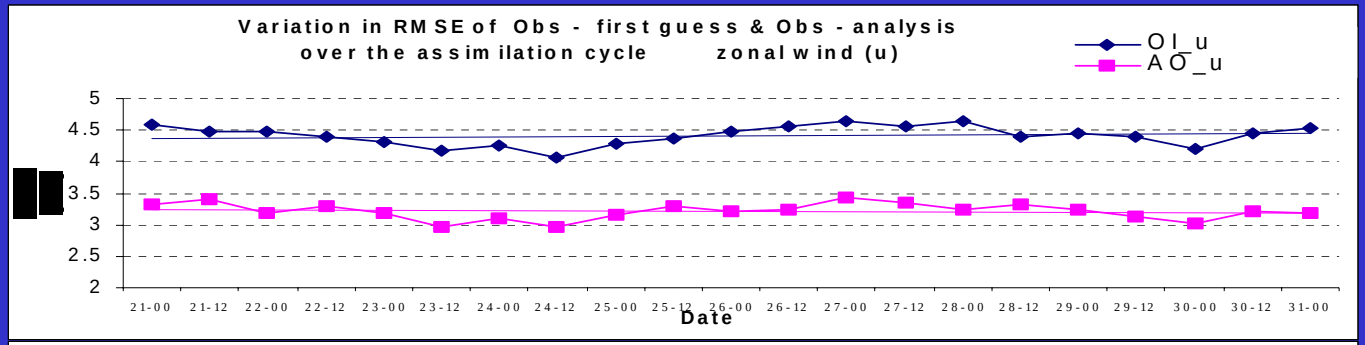
BUOY

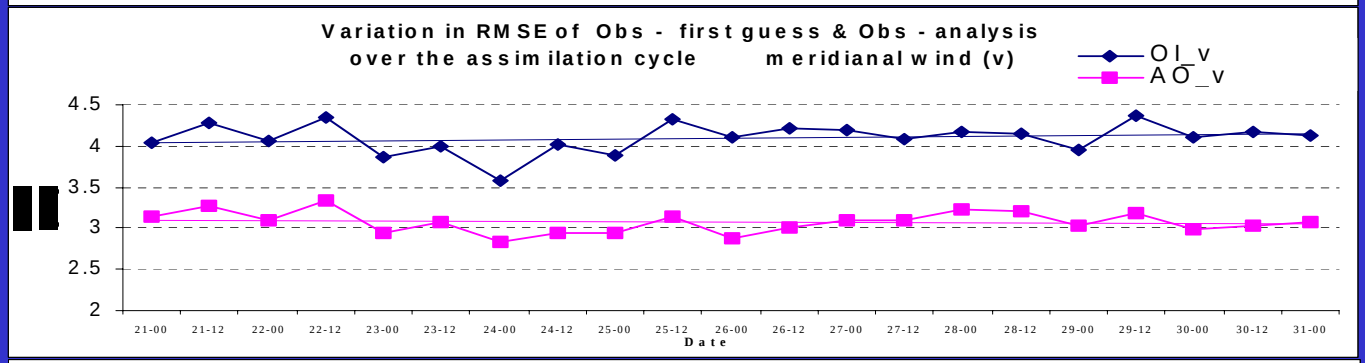


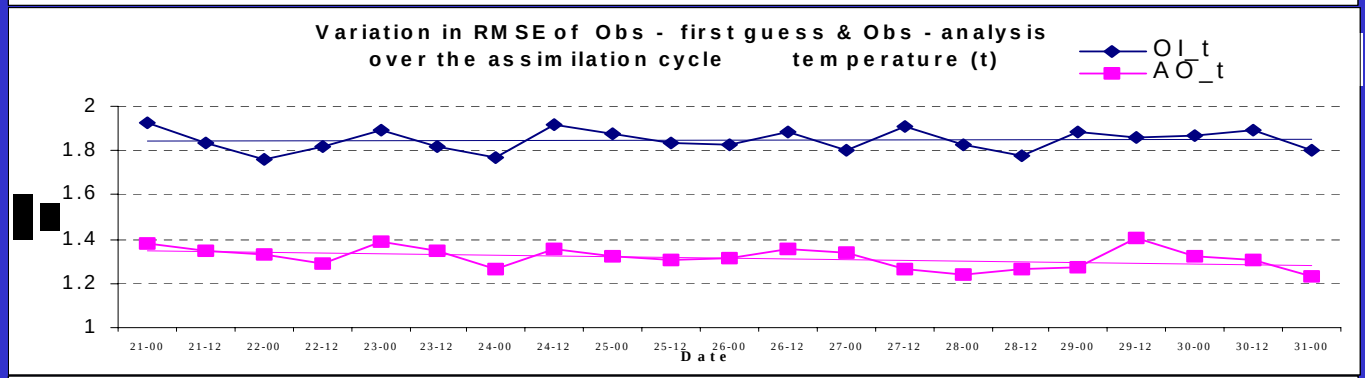
PILOT

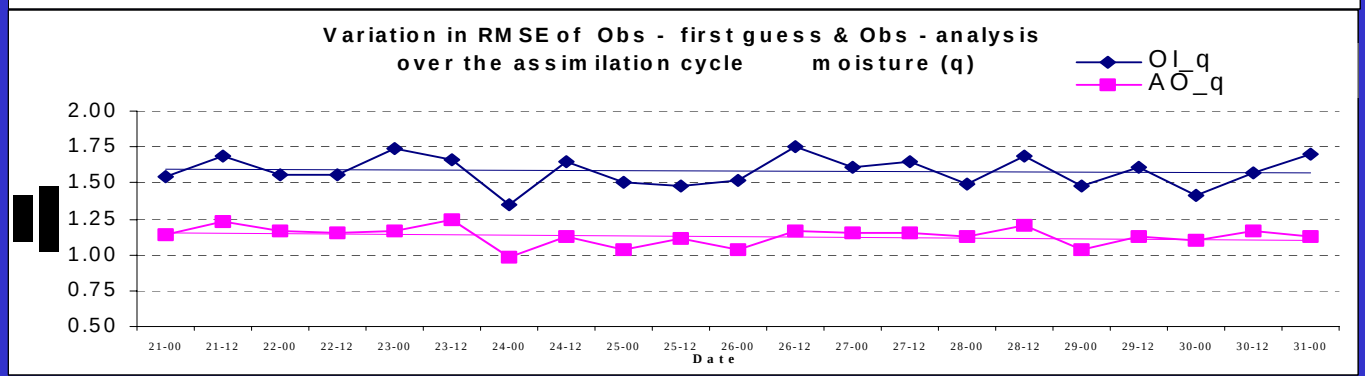


TEMP



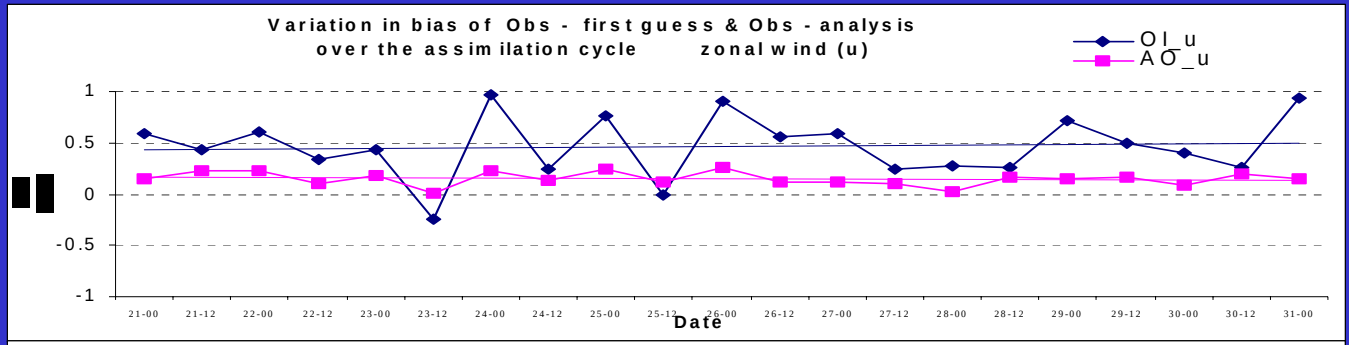


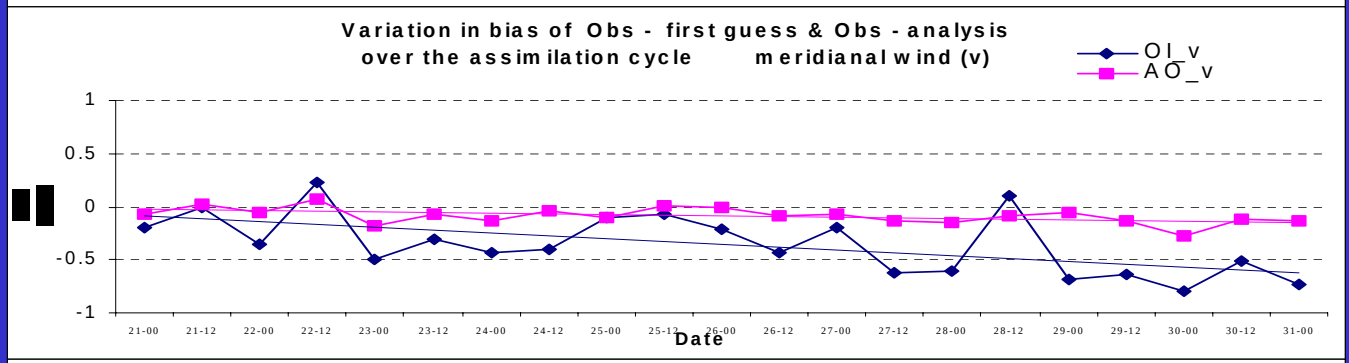


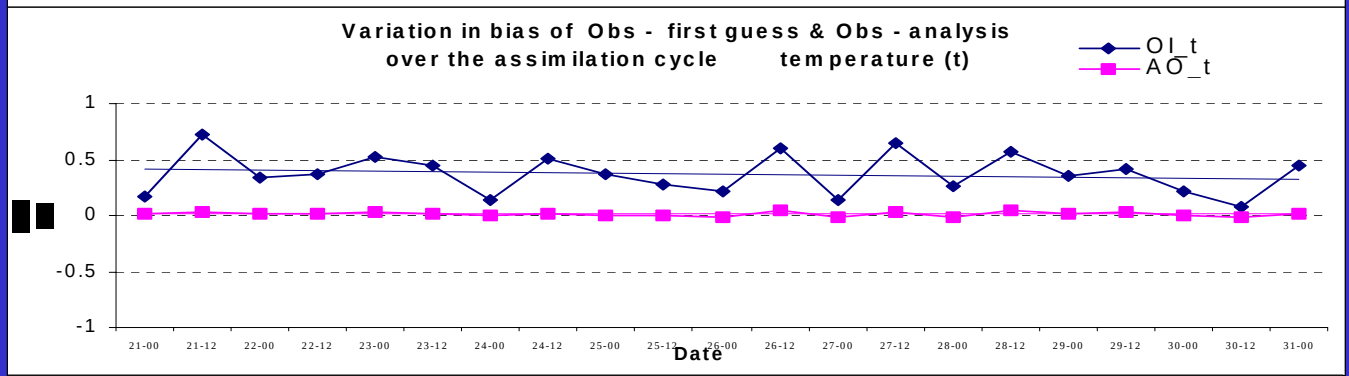


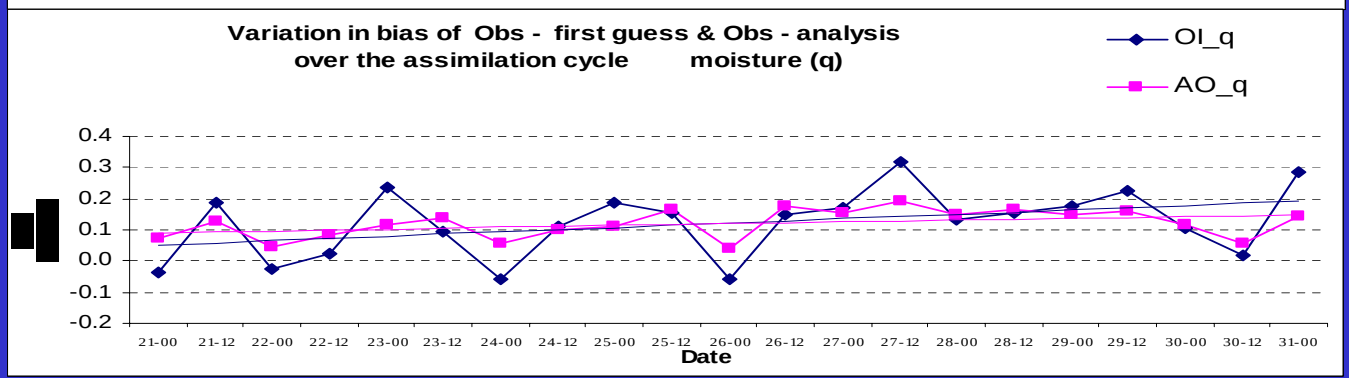
Variation of RMSE over the cyclic assimilation period (21st –31st July 2004) of

Back ground – Observation (OI) & Analysis – Observation (AO) computed against RS/RW data



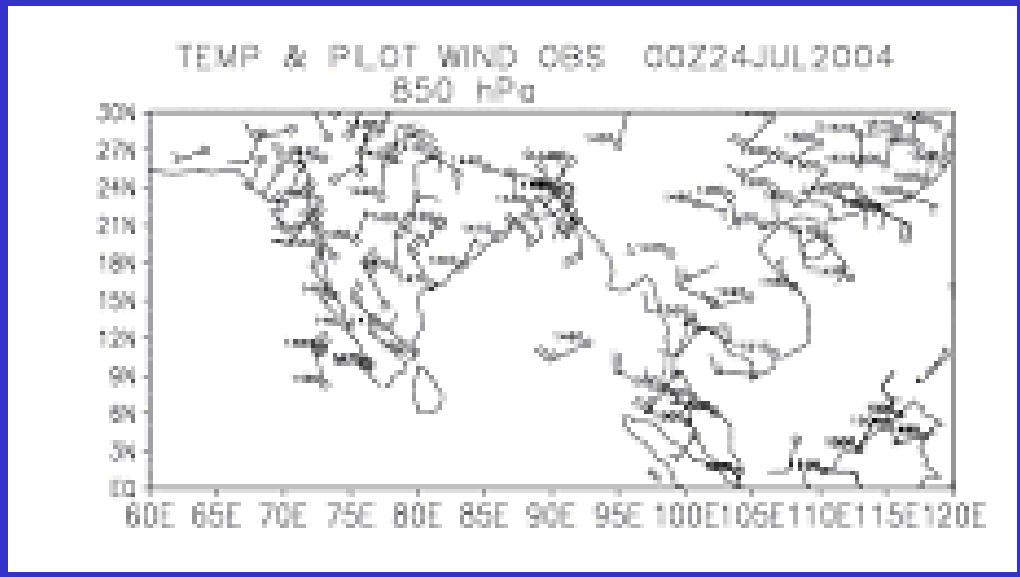


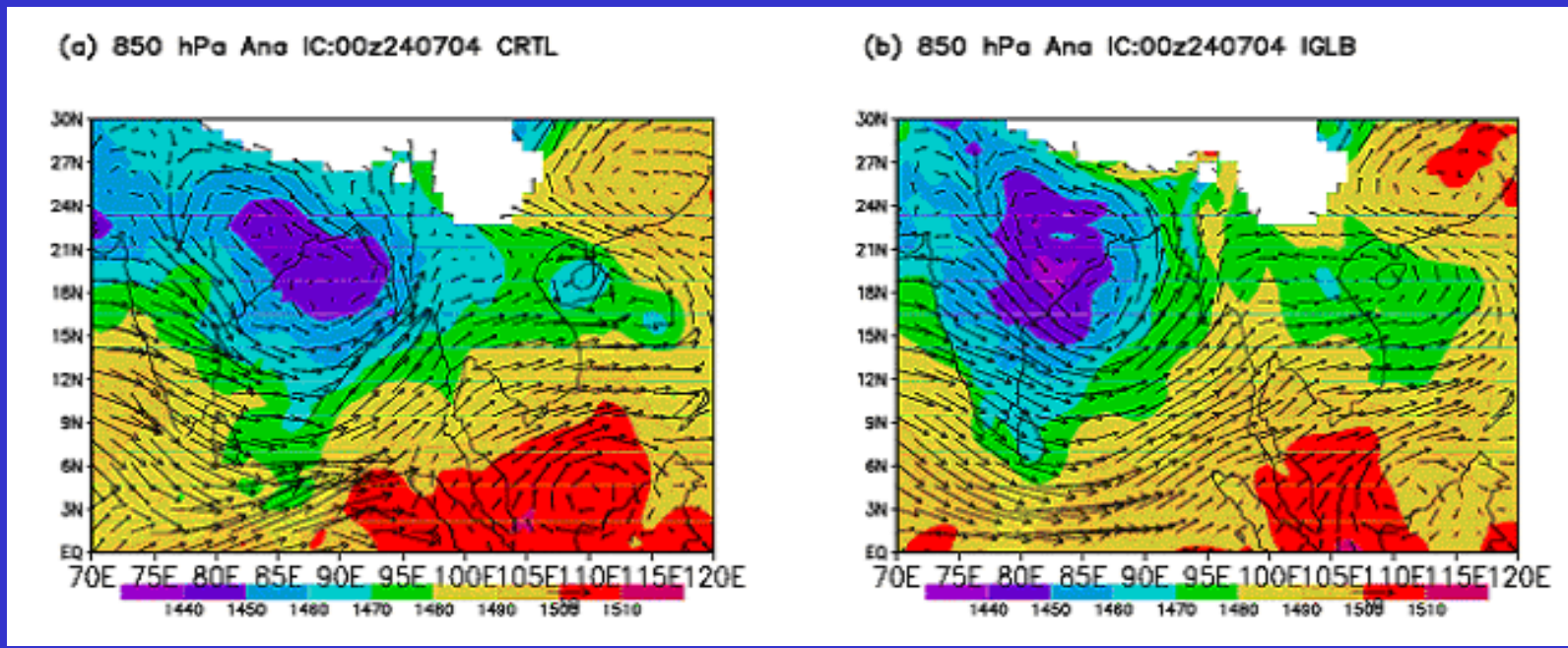


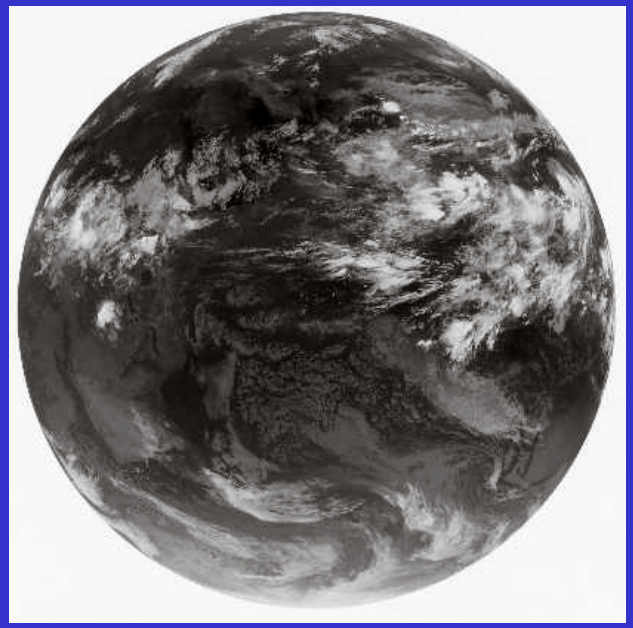


Variation of Bias over the cyclic assimilation period (21st -31st July 2004) of

Back ground - Observation (OI) & Analysis - Observation (AO) computed against RS/RW data


TEMP & PLOT WIND OBS 00Z24JUL2004
850 hPa
30N
27N
24N
21N
18N
15N
12N
9N
6N
3N
EQ
60E 65E 70E 75E 80E 85E 90E 95E 100E105E110E115E120E


(a) 850 hPa Ana IC:00z240704 CRTL
(b) 850 hPa Ana IC:00z240704 IGLB
30N
27N
24N
21N
18N
15N
12N
9N
6N
3N
EQ
70E 75E 80E 85E 90E 95E 100E105E110E115E120E
1440 1450 1460 1470 1480 1490 1500 1510



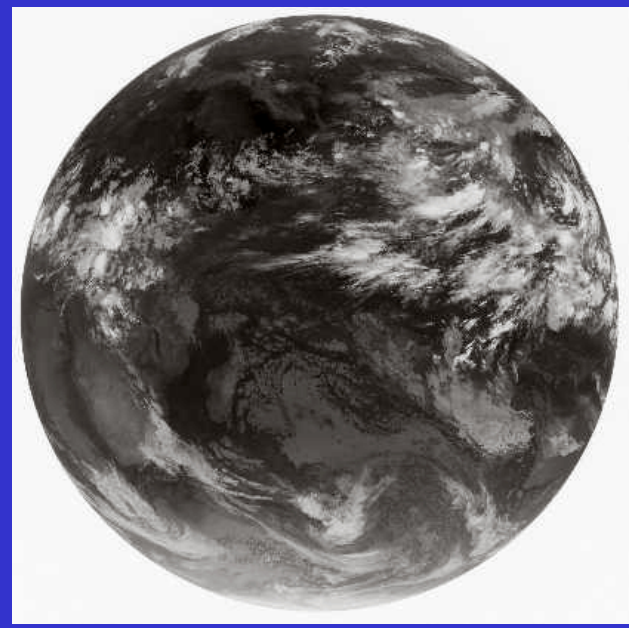
METEOSAT -5

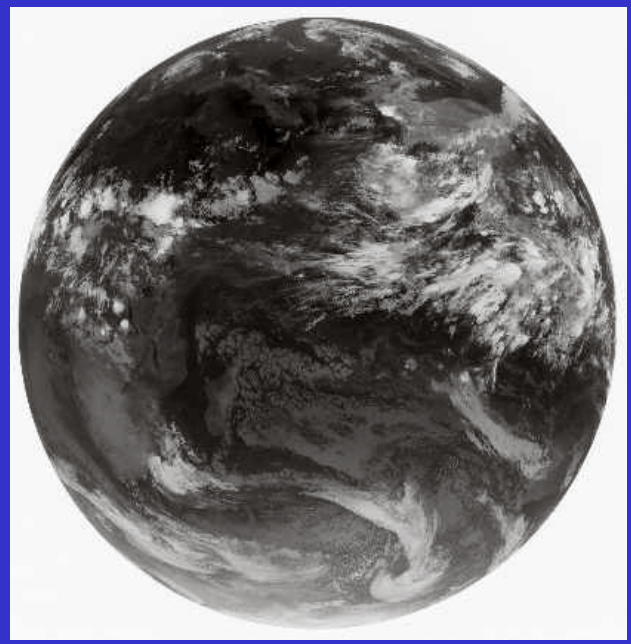
00 UTC image

27 July 2004(L)

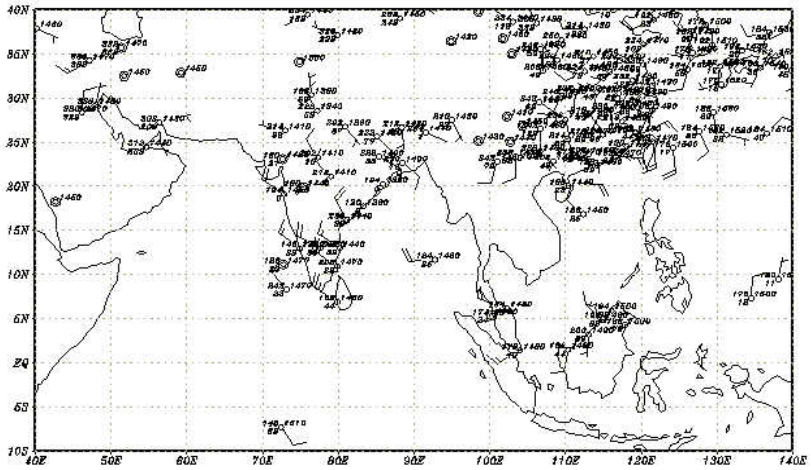
28 July 2004(R)

29 July 2004(B)

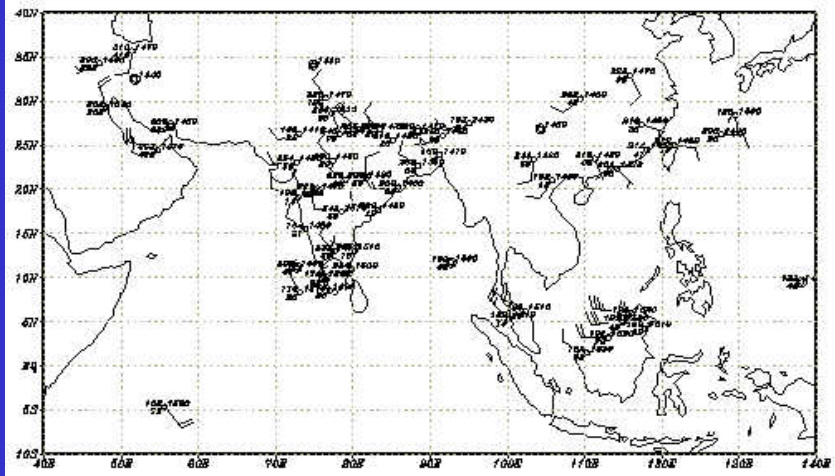




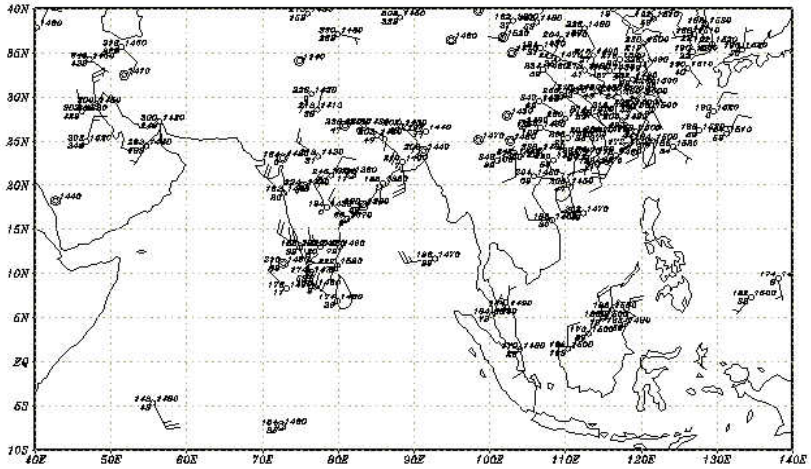
TEMP OBSERVATIONS 12Z26JUL2004
850 hPa



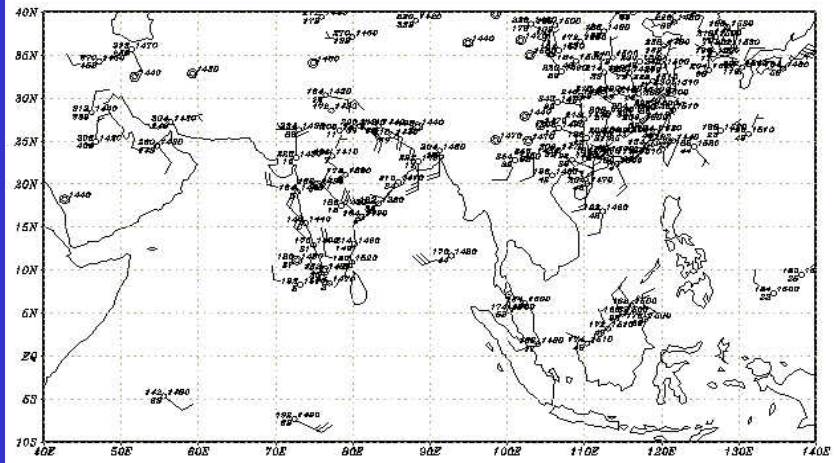
TEMP OBSERVATIONS 12Z27JUN2004
850 hPa



TEMP OBSERVATIONS 12Z28JUL2004
850 hPa



TEMP OBSERVATIONS 12Z29JUL2004
850 hPa

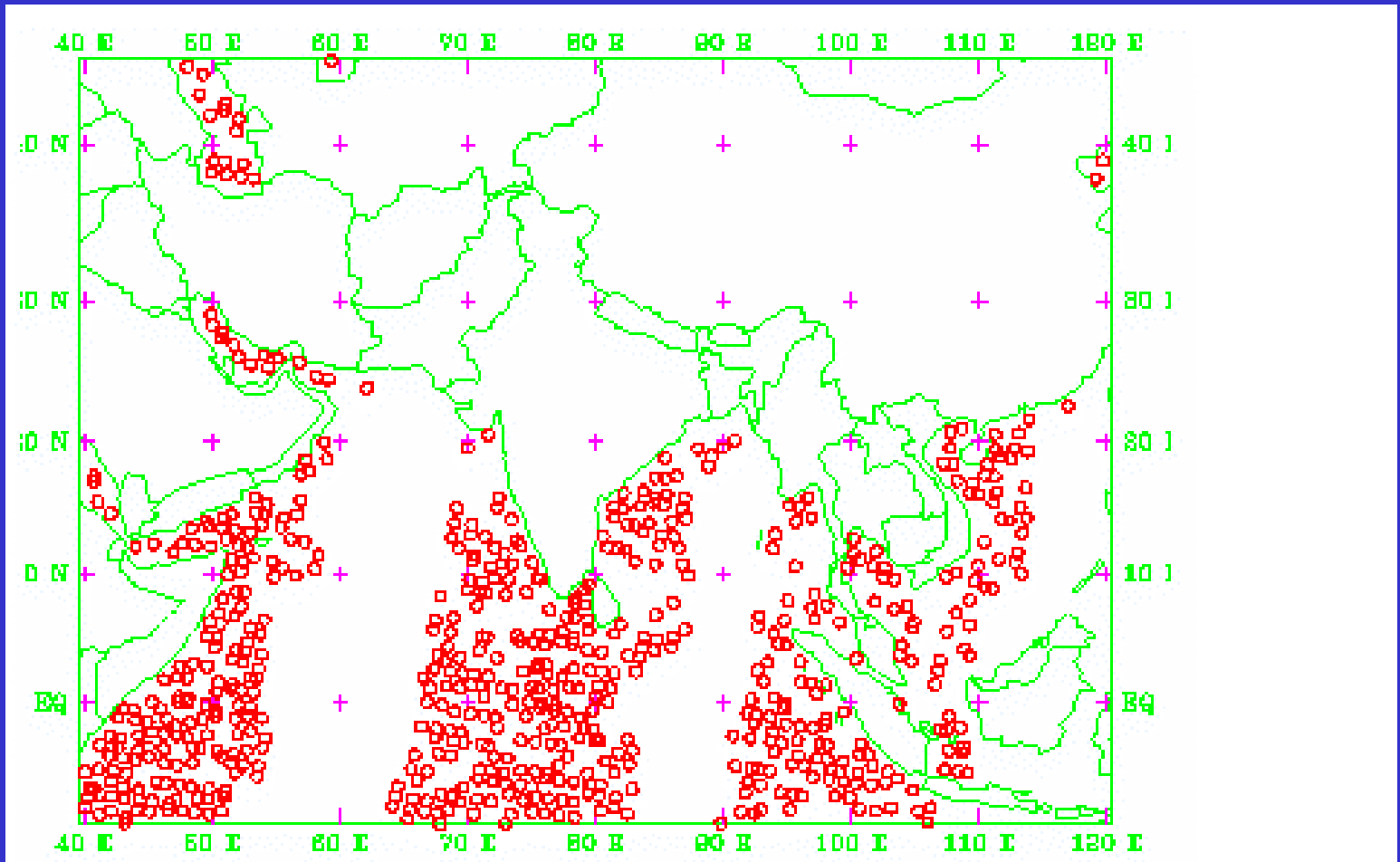


Assimilation experiments have been carried out with few non-conventional data sets

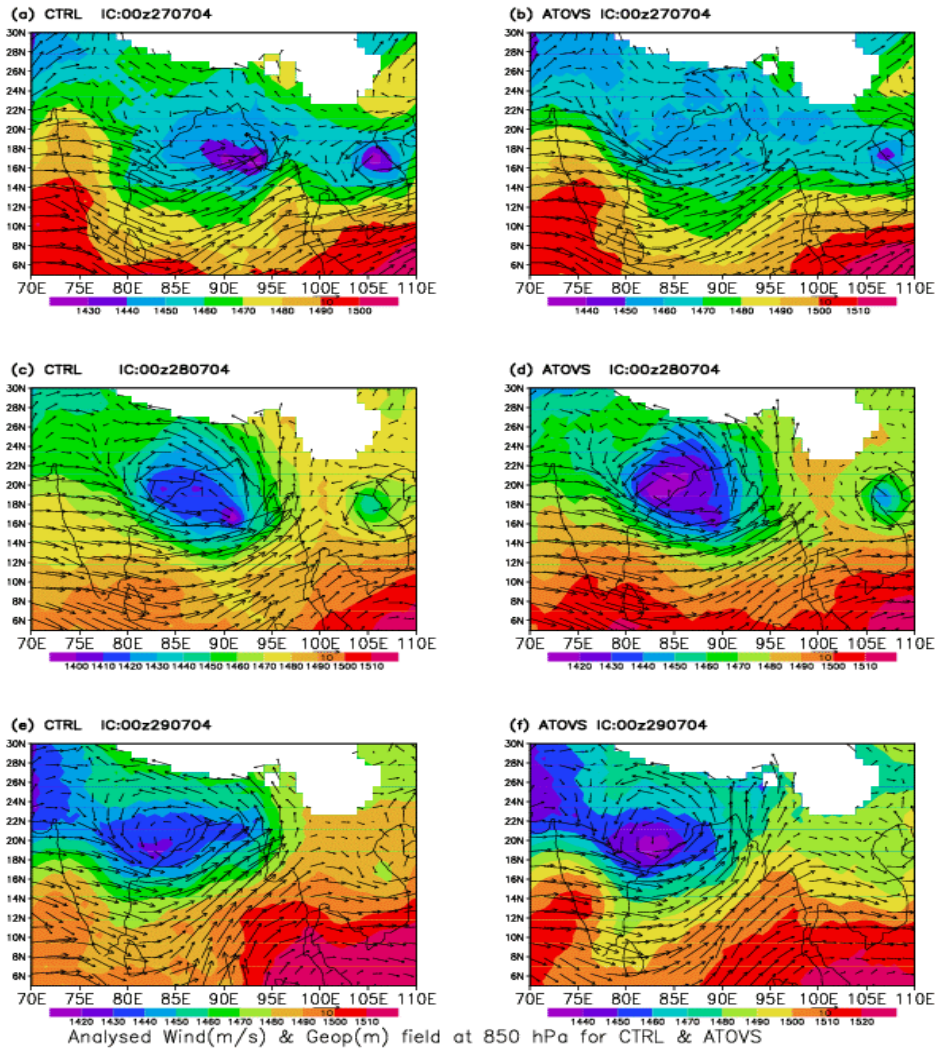
ATOVS temperature and humidity profile

SSM/I sea surface wind speed and total precipitable water

QSCAT sea surface wind direction and speed

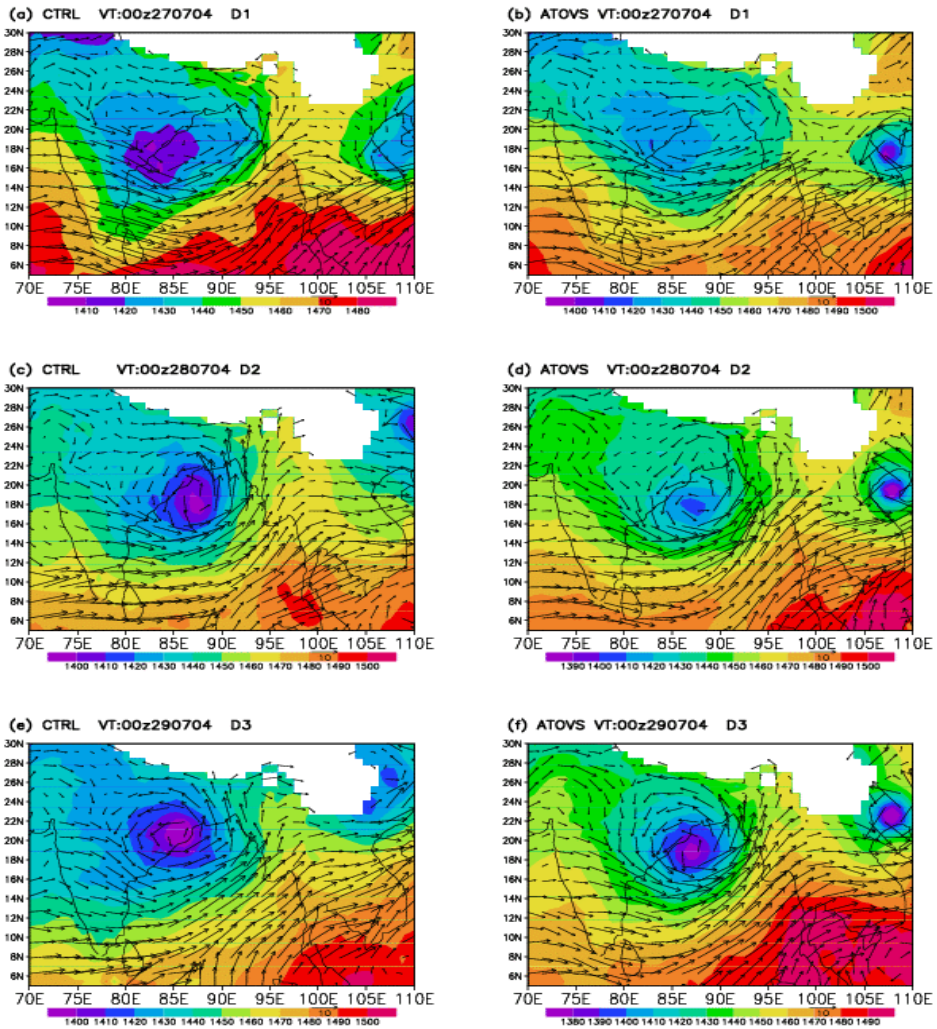


Coverage of ATOVS data on a typical day



Analysed Wind(m/s) & Geop(m) field at 850 hPa for CTRL & ATOVS

Analysed height and wind fields for CRTL & ATOVS run 850 hPa
00UTC 27th 28th 29th July 2004



FCST Wind(m/s) & Geop(m) field at 850 hPa for CTRL & ATOVS

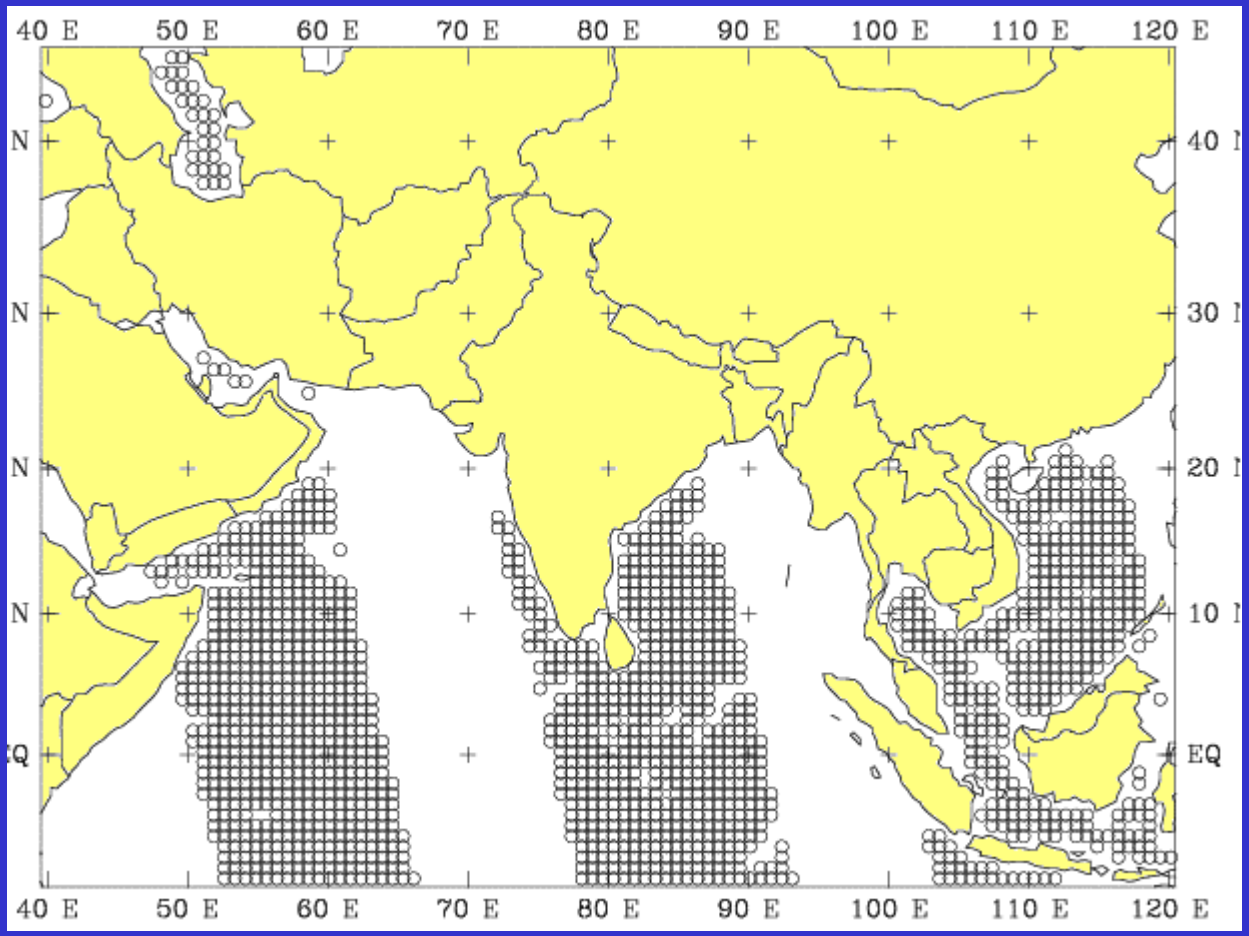
24, 48 and 72 hr. forecasts of ht. & wind fields for CRTL & ATOVS run 850 hPa based on 00UTC 26th July 2004

Results

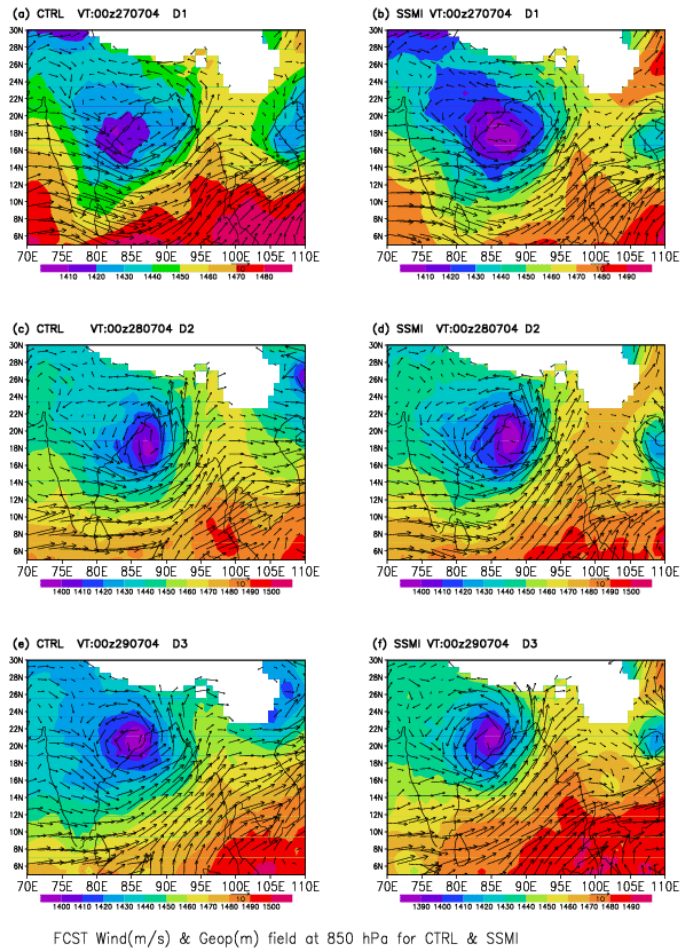
In ATOVS run, the centre of circulation in wind field coincide the centre of low in height field

Utilisation of ATOVS- Improves the track prediction

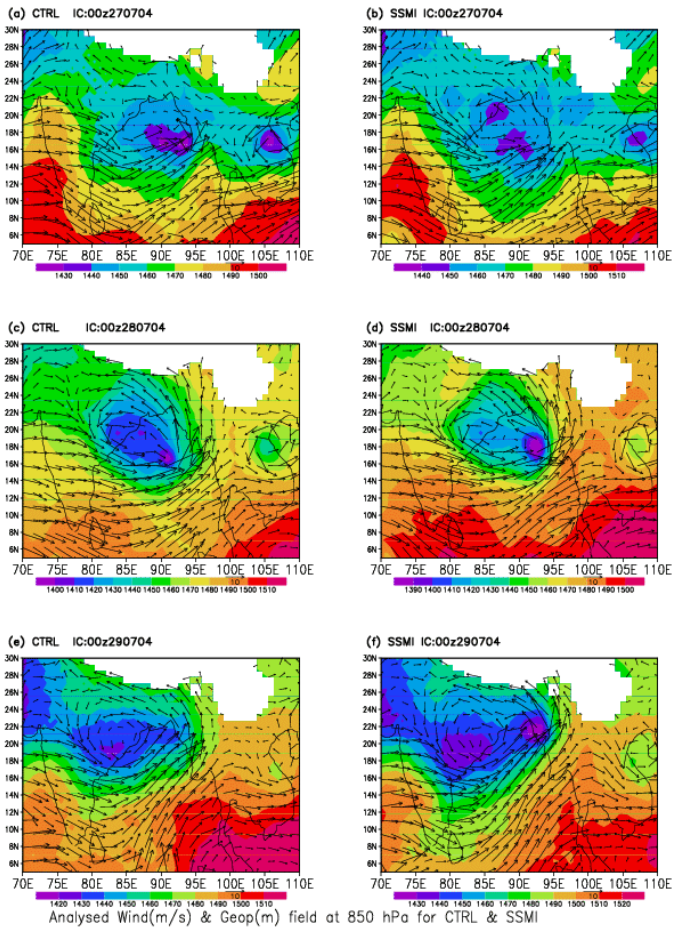
But intensity of the system is over predicted throughout the forecast period



Coverage of SSSM/I data on a typical day



Analysed height and wind fields for CRTL & SSM/I run 850 hPa 00UTC 27th 28th 29th July 2004

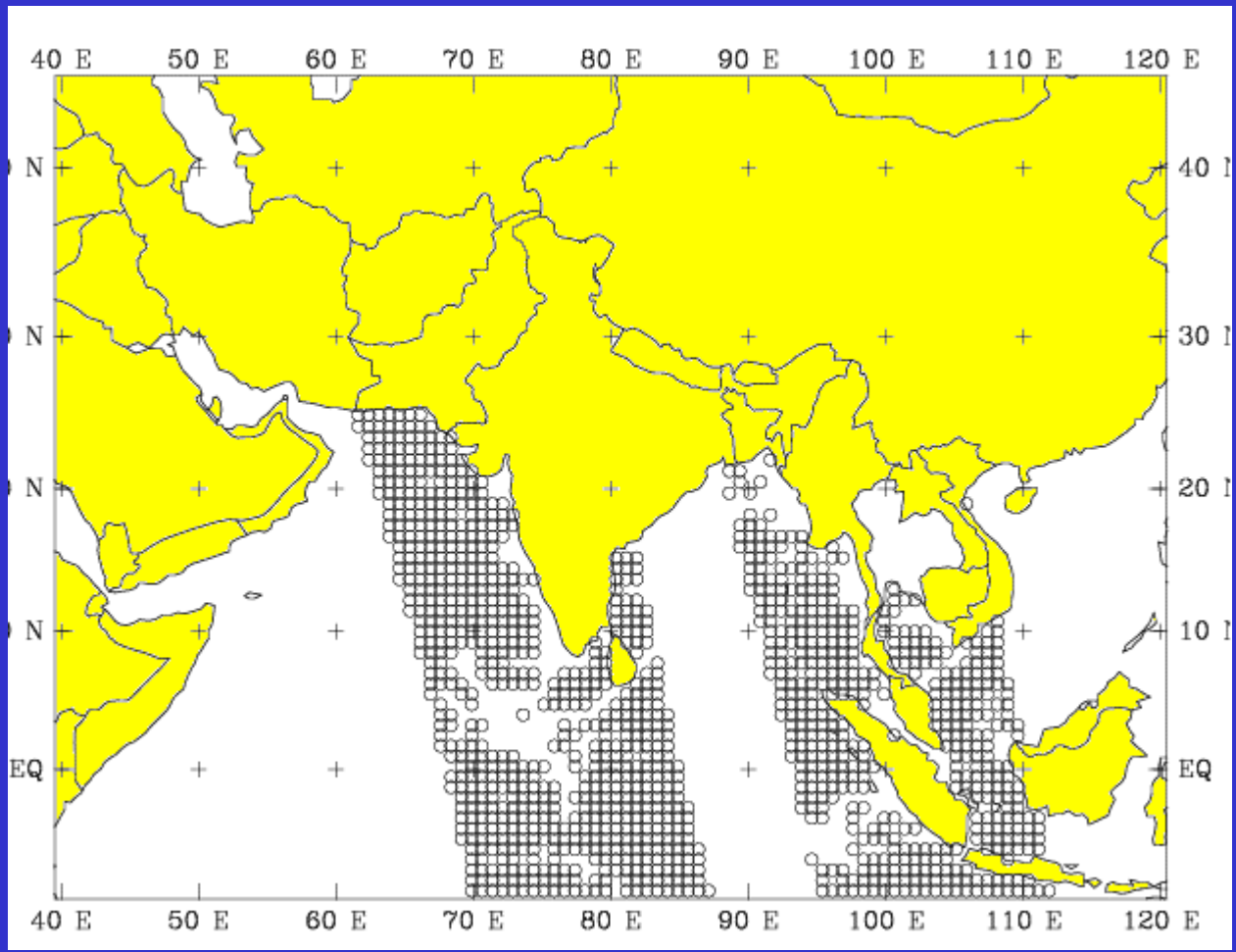


24, 48 and 72 hr. forecasts of ht. & wind fields for CRTL & SSM/I run 850 hPa based on 00UTC 26th July 2004

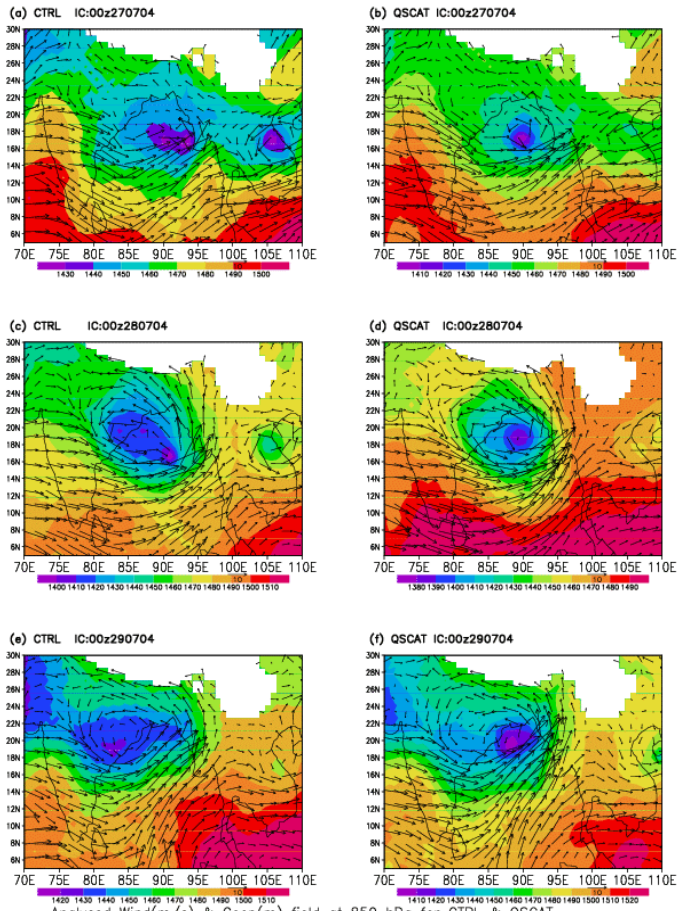
Results

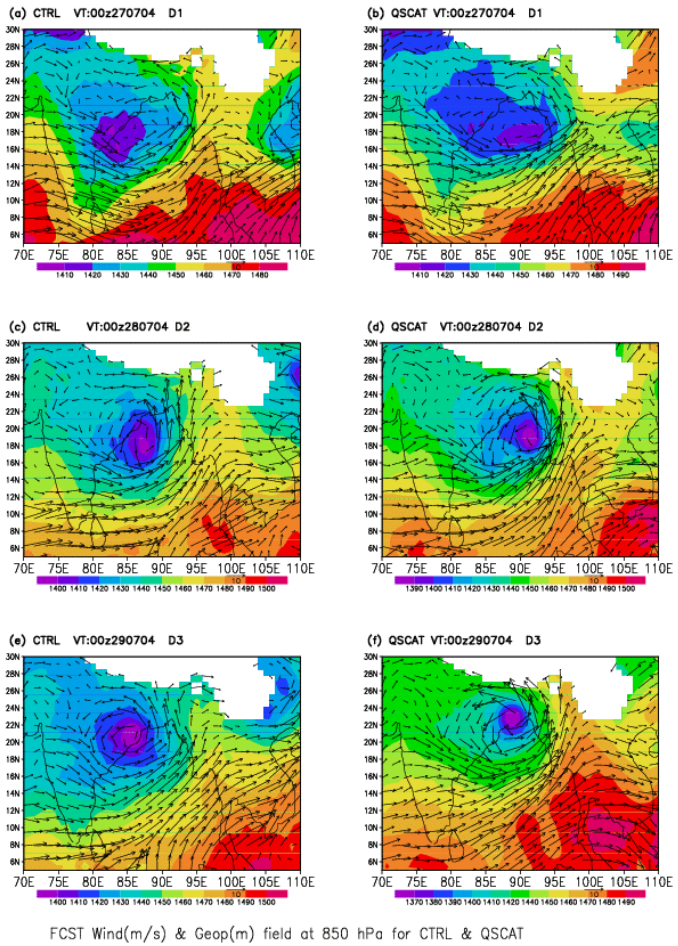
Winds over Bay of Bengal are stronger in SSMI analysis

Though the position of the system in subsequent forecasts are not very different in CTRL and SSMI run, but the intensity of the system is stronger in SSMI



Coverage of QSCAT data on a typical day





Analysed height and wind fields for CRTL & QSCAT run 850 hPa 00UTC 27th 28th 29th July 2004

24, 48 and 72 hr. forecasts of ht. & wind fields for CRTL & QSCAT run 850 hPa based on 00UTC 26th July 2004

Results

Though the structure of the cyclonic system over Bay of Bengal region in QSCAT analysis is better defined and also stronger than that of CTRL analysis at 850 hPa

The system is predicted much stronger in QSCAT run compared to that of CTRL. This emphasize that the further tuning (such as proper thinning, observation error etc.) is required before utilising QSCAT data in the assimilation system

Conclusions

- Small scale wind features are more prominent in CTRL analysis compared to interpolated global analysis (IGLB)
- Mismatch between circulation center in wind and height filed, as seen in case of Bay of Bengal circulation, in CTRL analyses is reduced considerably with utilization of ATOVS data
- SSM/I and QSCAT data intensify the circulation in Bay of Bengal both in analysis as well in forecast (unrealistic). This emphasizes the need of proper tunings before assimilation of these data.