Weather Forecasting at NCMRWF

Preveen Kumar D

National Center for Medium Range Weather Forecasting(NCMRWF)

Government of India

New Delhi, India

OBJECTIVES OF NCMRWF

- Development of numerical models for Medium Range Weather Forecasting (3-10 days).
- Preparation and dissemination of NWP model output to user agencies.
- Promotion and Coordination of R & D in Medium Range Weather Forecasting and related areas in the country by providing support to concerned research groups in Indian Institutes of Technology, Universities and National Laboratories.
- Networking to Centre, IMD, Agro Meteorological Field Units and other Units through a Satellite/ Land based communication network.
- Organisation of field experiments and trials to develop locale specific agromet predictive models; crop management expert systems, techniques for interactive communication with farmers and advisories useful to their technical coordination with agromet field units and other concerned organisations.

Computing Resources at NCMRWF

Cray SV1: 24-Processors- 1.2 GFlops per processor,
8 GB Main Memory, 800 GB Disk

DEC-ALPHA: *Parallel Processing System*
2- Servers AS4100 @600 MHz, Memory– 1GB each
9-Work Stations @600 MHz, Memory– 512MB each
Switch: Gigabit Ethernet Smart Switch Router

ORIGIN 200: *Parallel Processing System*
2- Servers: 4 CPU each @225 MHz, Memory– 1GB each

ORIGIN 200: *Single CPU Servers*
3- Servers @270 MHz, Memory– 512 MB each
1- Server @180 MHz, Memory– 512 MB

4- O2 WORK STATIONS: @200 MHz, Memory– 512MB each

PARAM 10000: *Parallel Processing System*
2- SUN Ultrasparc-II Servers (4 CPU each) @300 MHz,
Memory– 1GB each, (Switch: MYRINET)

LOCAL AREA NETWORK: on Fast Ethernet.
4- LINUX SERVERS: (WEB, FTP, PROXY, PRINT)

Internet: 64 KBPS Leased Line

NUMERICAL WEATHER PREDICTION MODELS AT NCMRWF

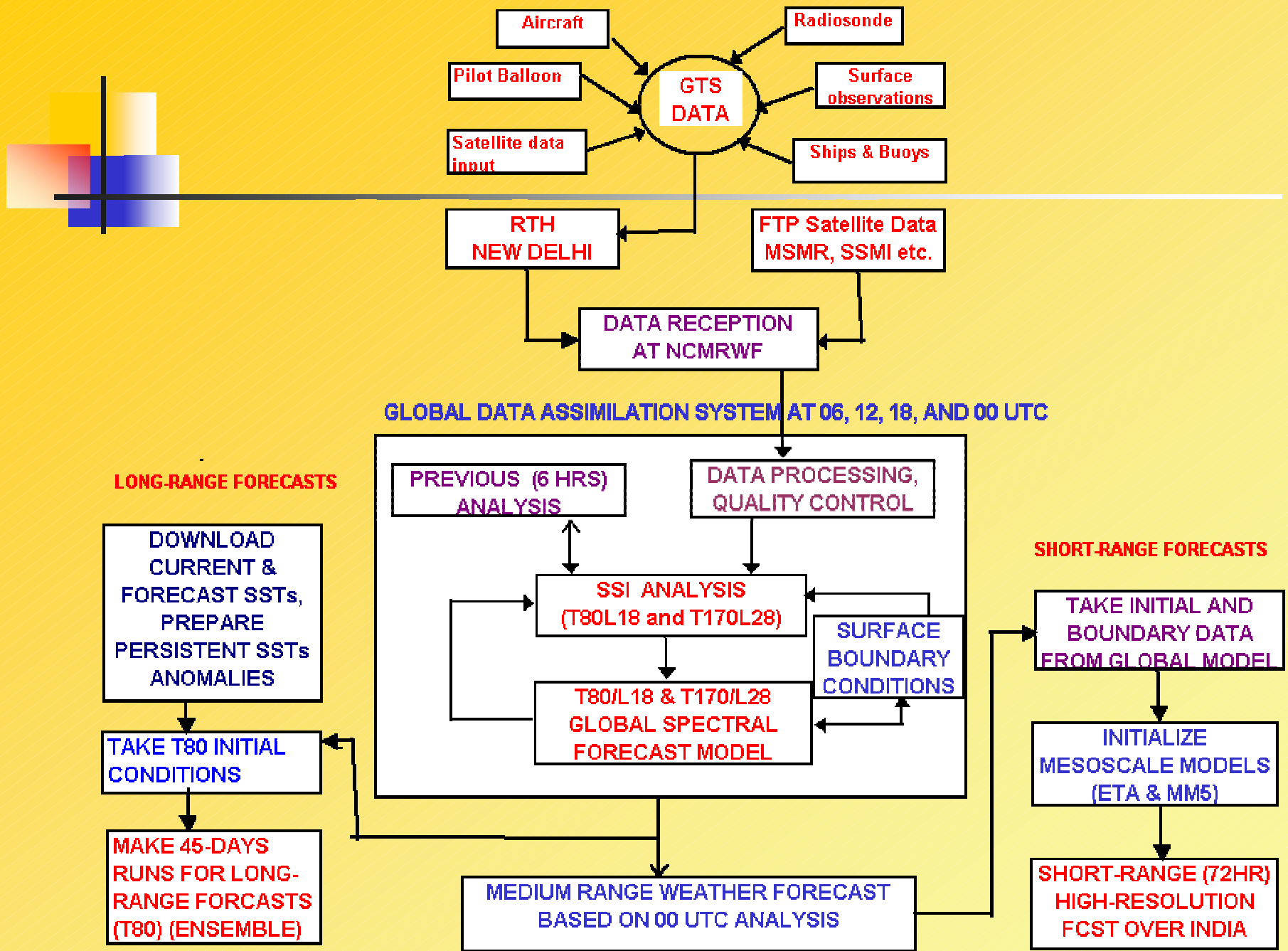
MODEL	HORIZONTAL RESOLUTION	VERTICAL LAYERS
Global Spectral T-80#	160KM	18
Global Spectral T-170	70KM	28
Regional Spectral	50KM	18
Mesoscale MM5#	30KM	23
Mesoscale Eta #	48KM	38

 # Operational Model

NCMRWF Operational Forecast Model (T80)

- Global Spectral Model
- 80 waves in Triangular truncation
- 1.5 deg. (~150 km) resolution
- 18 layers in normalized pressure
- 135 billion mathematical operations required for 1 day's forecast
- ~12 million words of memory required for the model

THE NCMRWF WEATHER FORECASTING SYSTEM

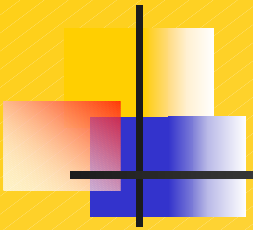


Archival Details/DAY

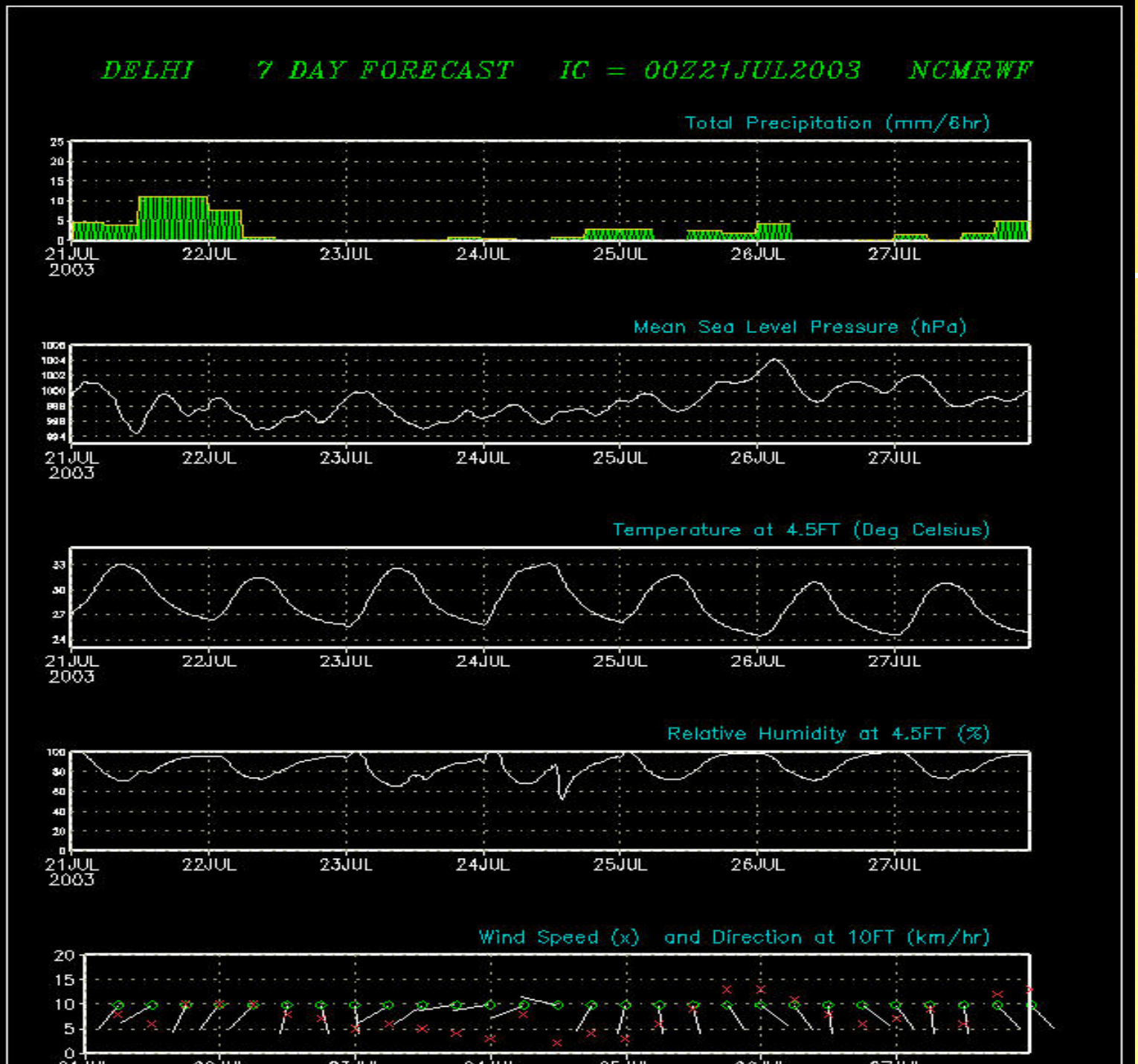
T80	643.6 MB
T170	936.8 MB
MM5	233 MB
ETA	70.1 MB
MISC	500MB

MEDIA DETAILS

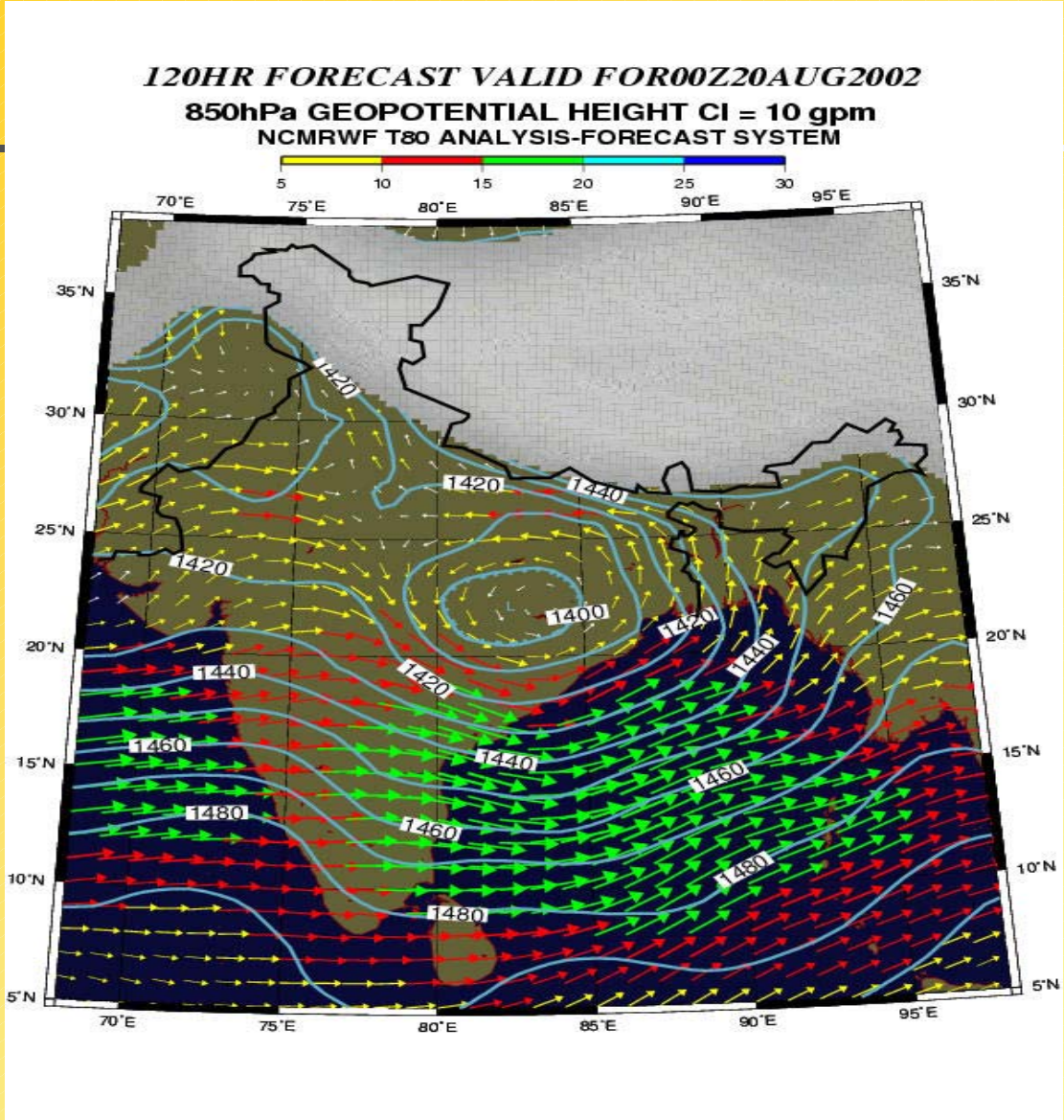
- DAT,DLT,CDROM,EXABYTE drives are available in the center.
- Data is archived in various Media.
- For operational purpose usually DLT media is used.
- When a specific data set is prepared for an outside agency, data is sent in DAT / DLT/ CDROM.
- Data is also sent using the FTP public outgoing area, were it can be accessed by the outside agency.

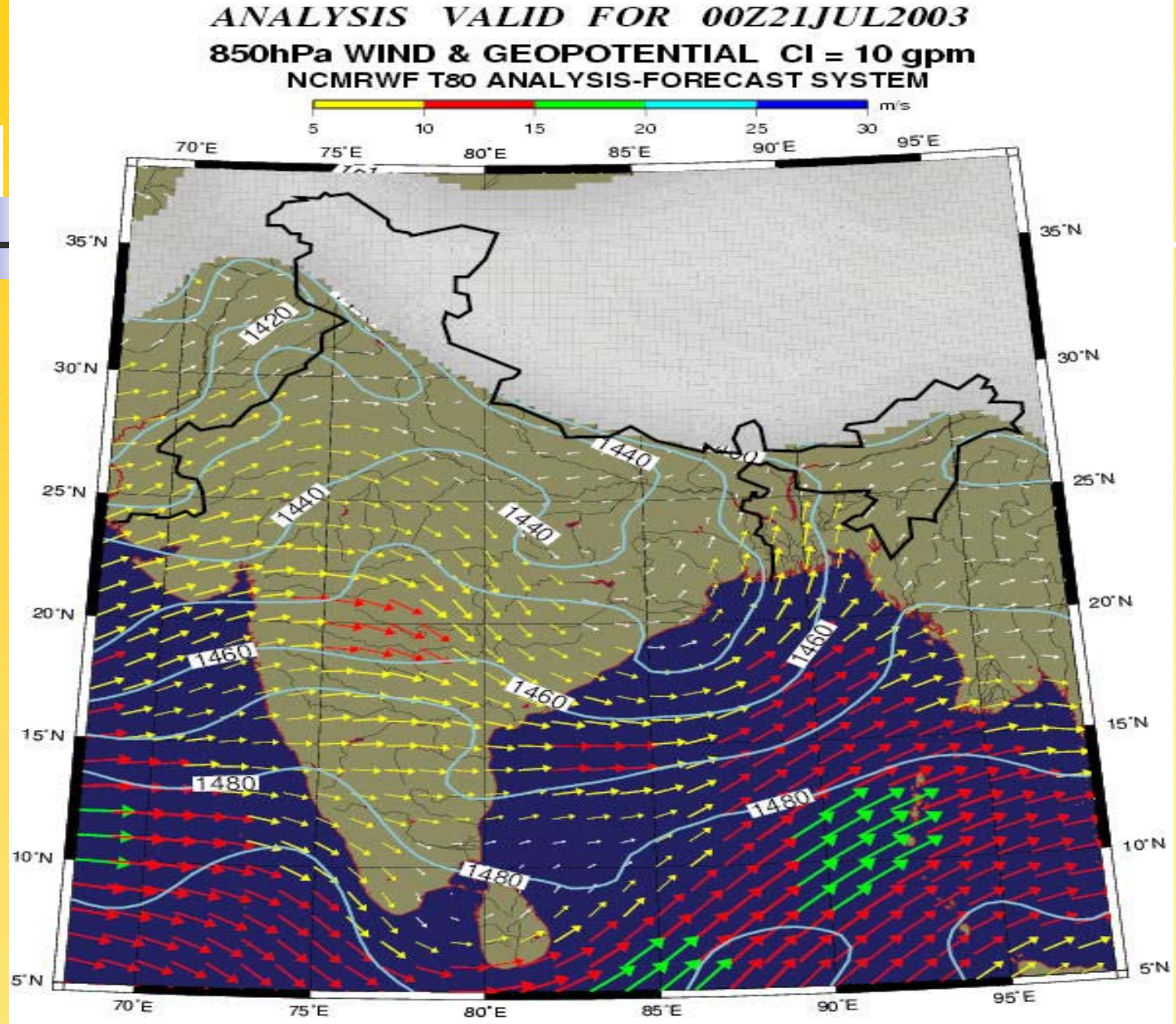


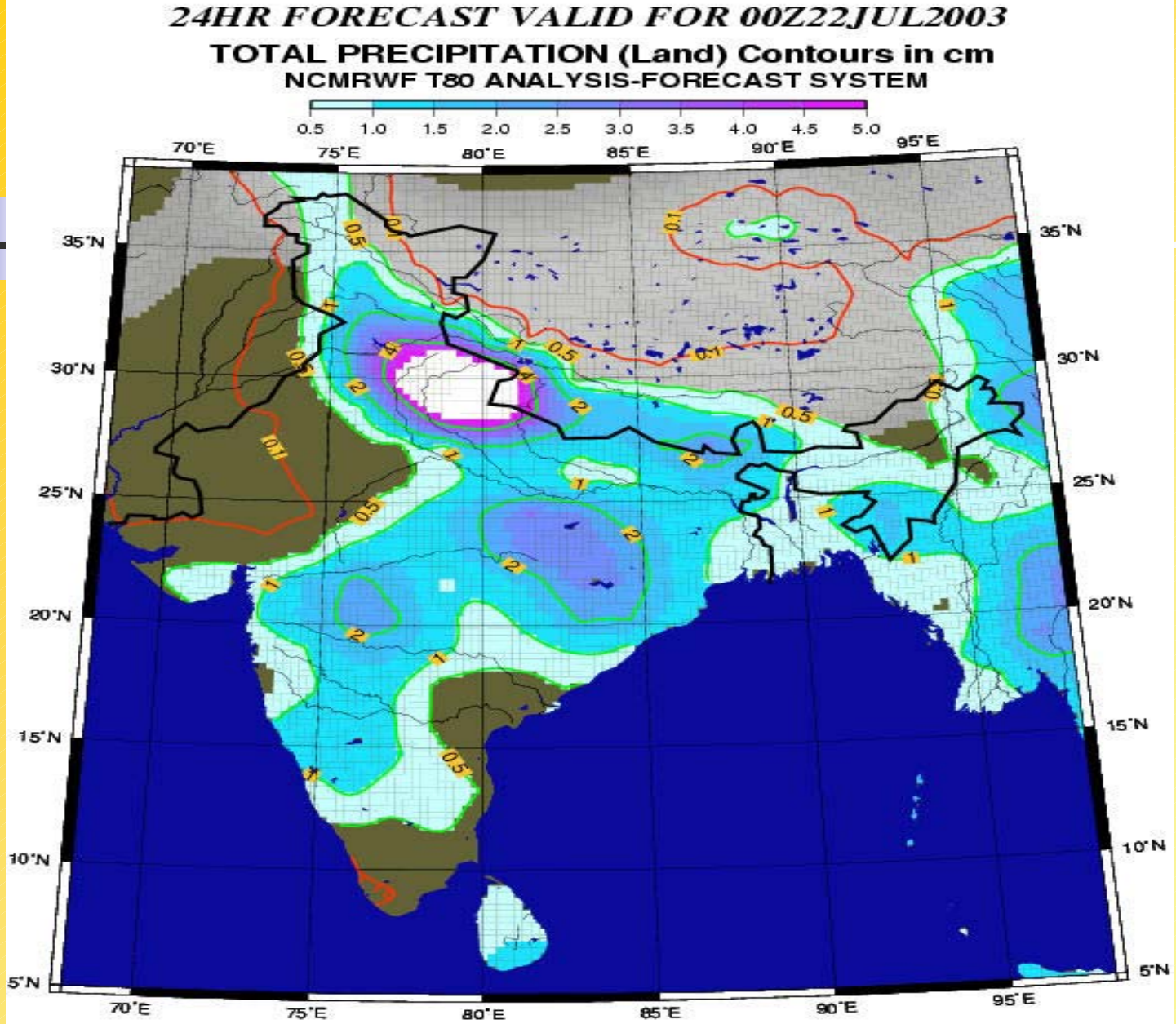
NCMRWF'S PRODUCTS


DELHI 7 DAY FORECAST IC = 00Z21JUL2003 NCMRWF
Total Precipitation (mm/6hr)
25
20
15
10
5
0
21JUL 2003
22JUL
23JUL
24JUL
25JUL
26JUL
27JUL
Mean Sea Level Pressure (hPa)
1006
1004
1002
1000
998
996
994
21JUL 2003
22JUL
23JUL
24JUL
25JUL
26JUL
27JUL
Temperature at 4.5FT (Deg Celsius)
33
30
27
24
21JUL 2003
22JUL
23JUL
24JUL
25JUL
26JUL
27JUL
Relative Humidity at 4.5FT (%)
100
80
60
40
20
0
21JUL 2003
22JUL
23JUL
24JUL
25JUL
26JUL
27JUL
Wind Speed (x) and Direction at 10FT (km/hr)
20
15
10
5
0

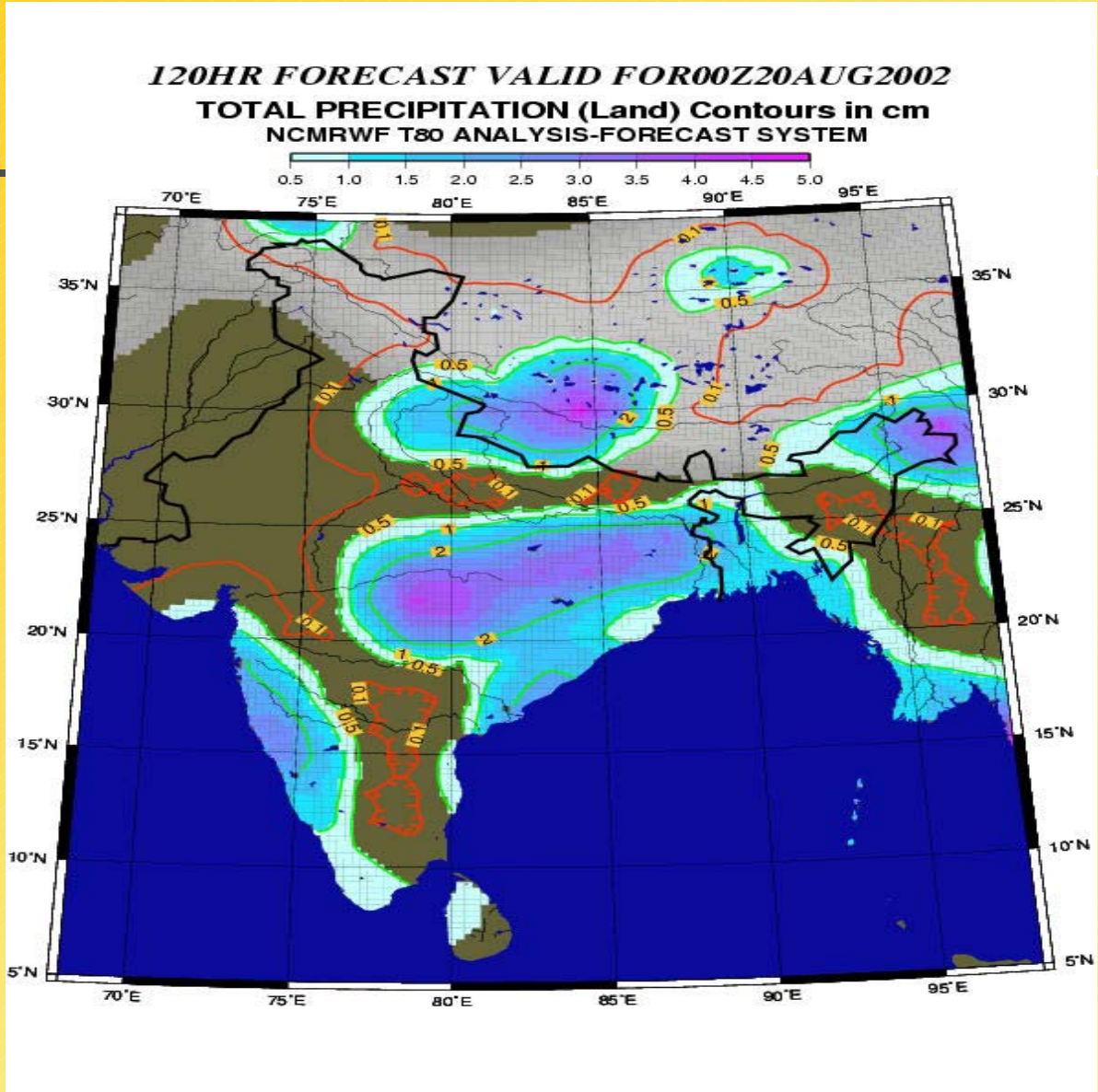
WIND FORECAST (5 DAYS IN ADVANCE) FROM NCMRWF'S MODEL

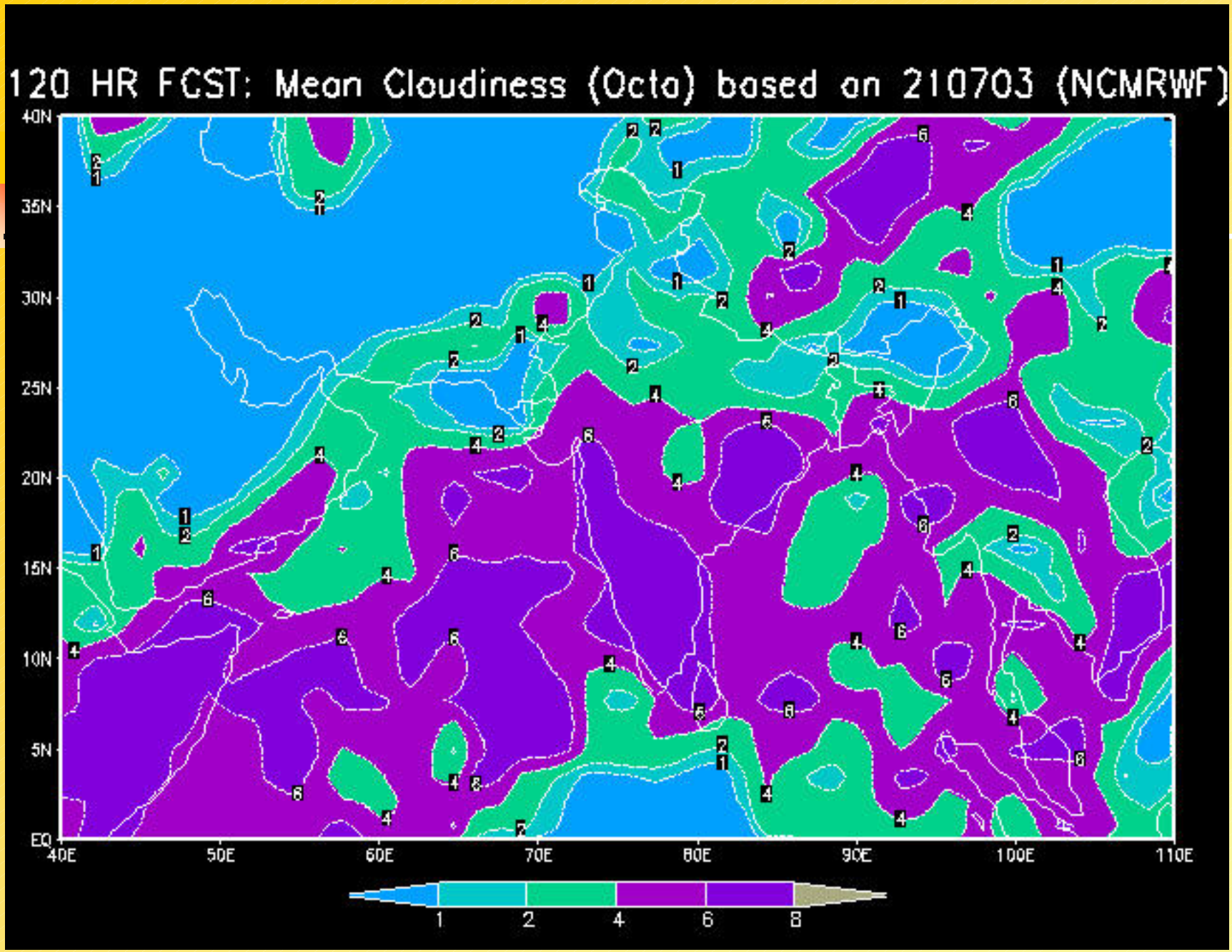



ANALYSIS VALID FOR 00Z21JUL2003
850hPa WIND & GEOPOTENTIAL CI = 10 gpm
NCMRWF T80 ANALYSIS-FORECAST SYSTEM
m/s
5
10
15
20
25
30
70°E
75°E
80°E
85°E
90°E
95°E
35°N
30°N
25°N
20°N
15°N
10°N
5°N
1420
1440
1460
1480

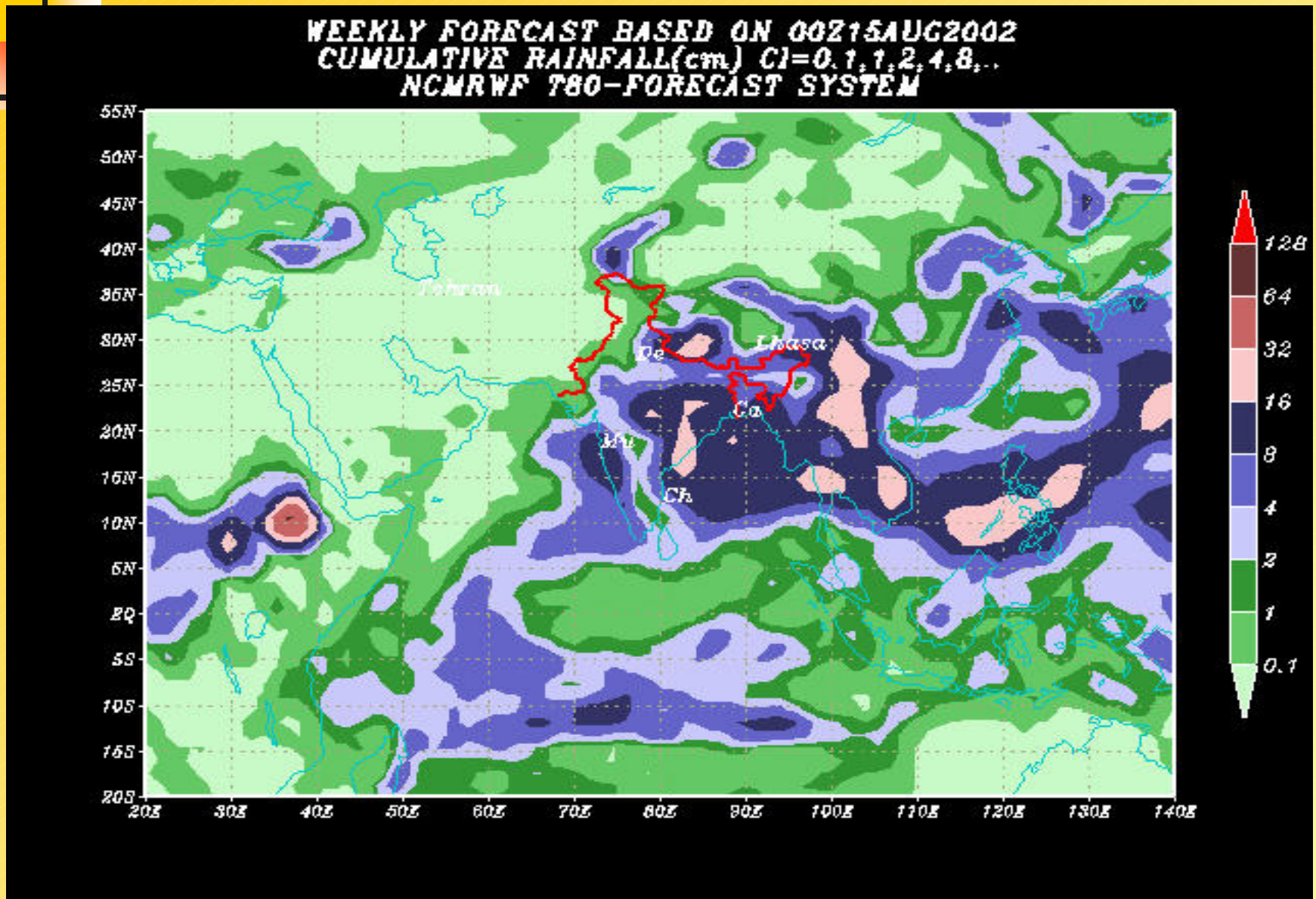

24HR FORECAST VALID FOR 00Z22JUL2003
TOTAL PRECIPITATION (Land) Contours in cm
NCMRWF T80 ANALYSIS-FORECAST SYSTEM
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
70°E 75°E 80°E 85°E 90°E 95°E
35°N 30°N 25°N 20°N 15°N 10°N 5°N

RAINFALL FORECAST (5 DAYS IN ADVANCE)

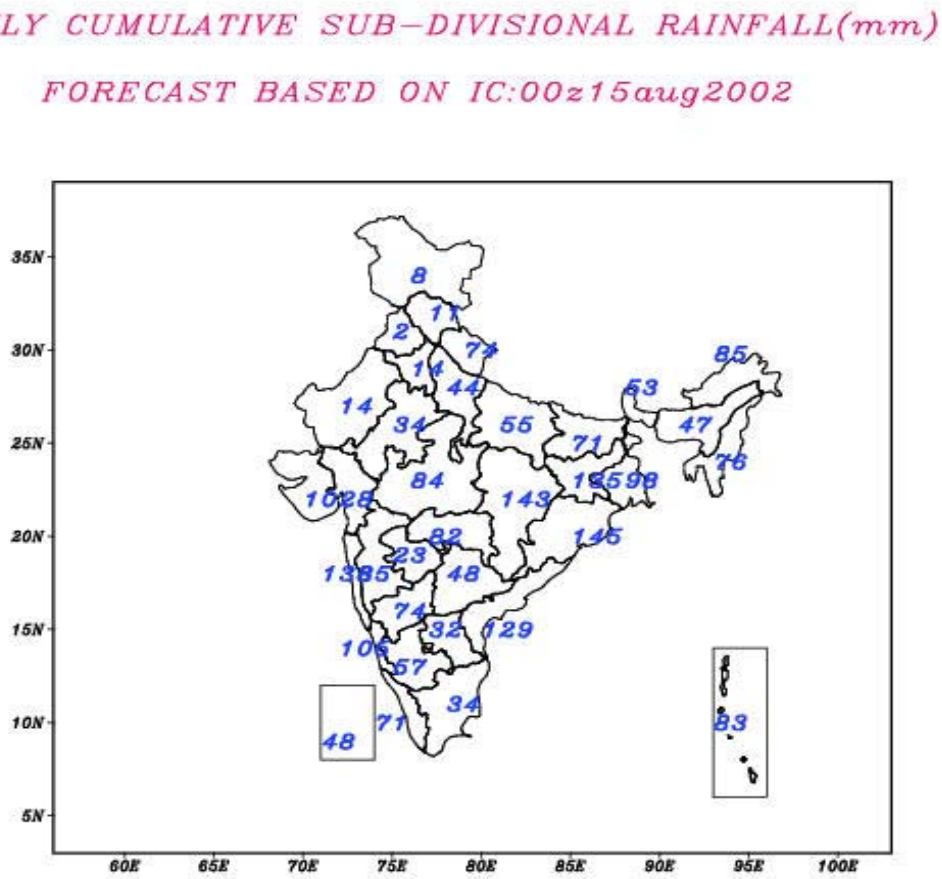



120 HR FCST: Mean Cloudiness (Octa) based on 210703 (NCMRWF)
40N
35N
30N
25N
20N
15N
10N
5N
EQ
40E
50E
60E
70E
80E
90E
100E
110E
1
2
4
6
8

WEEKLY CUMMULATIVE RAINFALL FORECAST



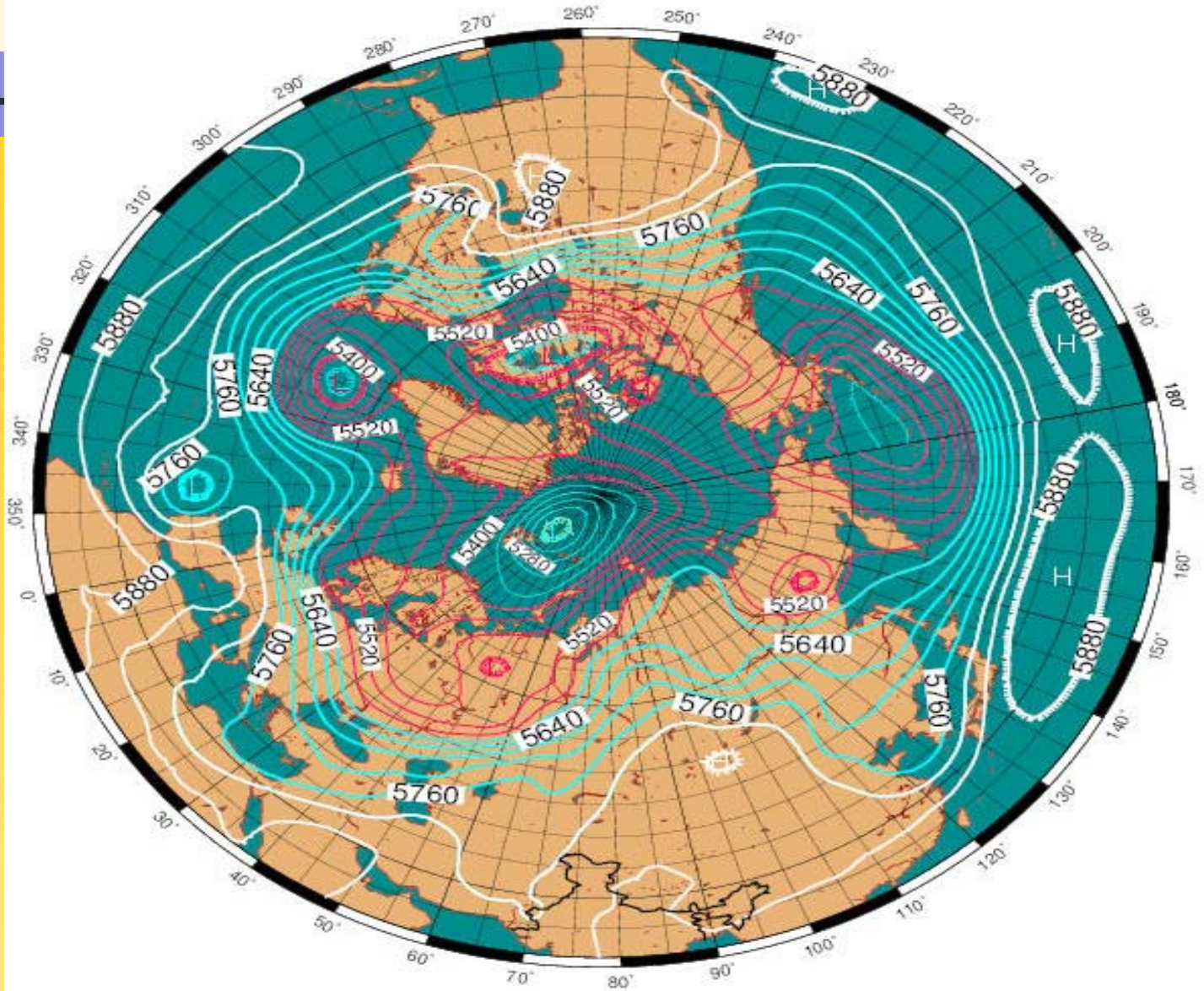
WEEKLY CUMMULATIVE SUB-DIVISIONAL RAINFALL FORECAST



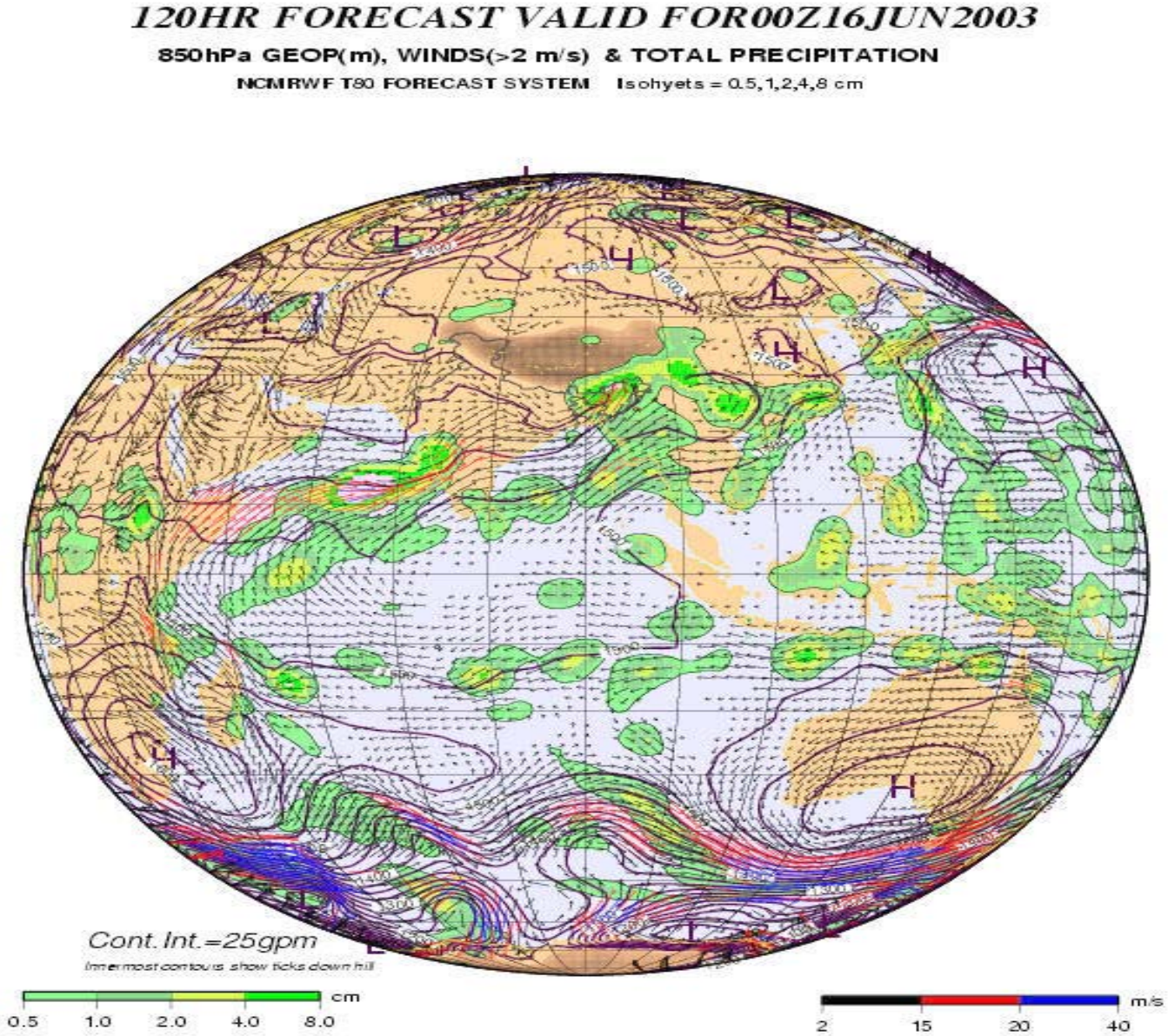
120HR FORECAST VALID FOR00Z16JUN2003

500hPa GEOPOTENTIAL HEIGHT CI = 40 gpm

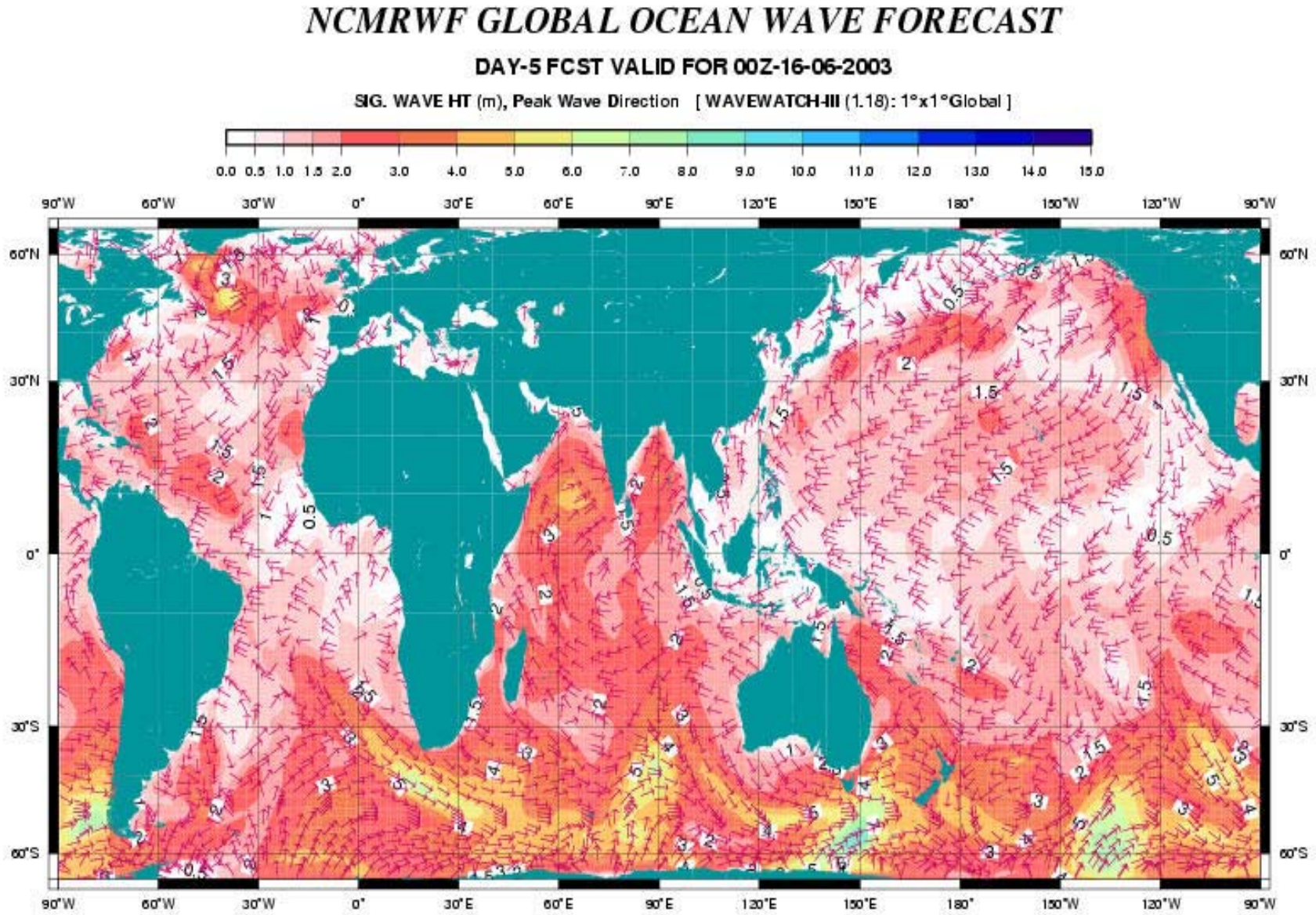
NCMRWF T80 ANALYSIS-FORECAST SYSTEM



Monsoon View Chart



Ocean State Forecasting

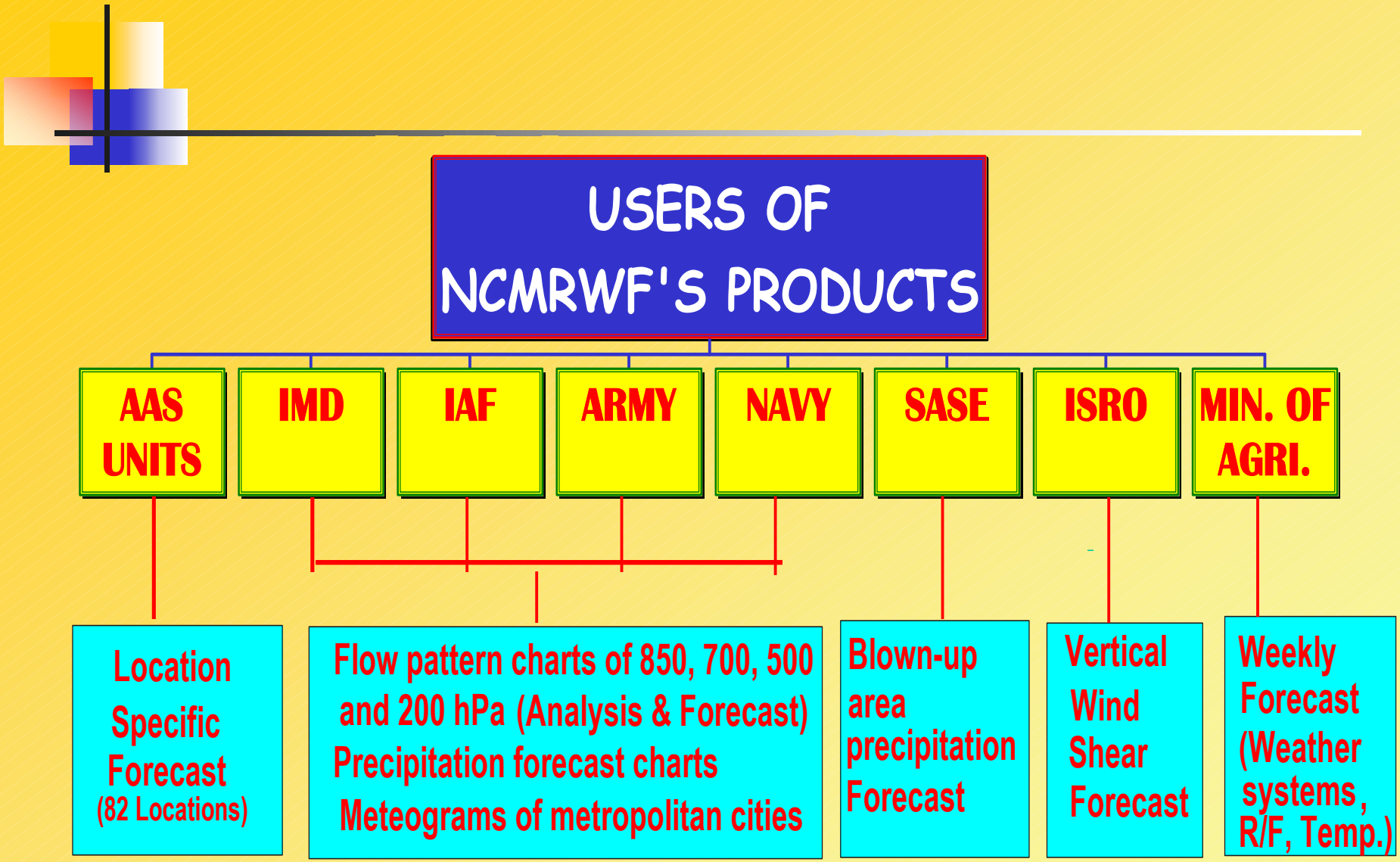


SPECIAL/ CUSTOMIZED FORECASTS/ PRODUCTS

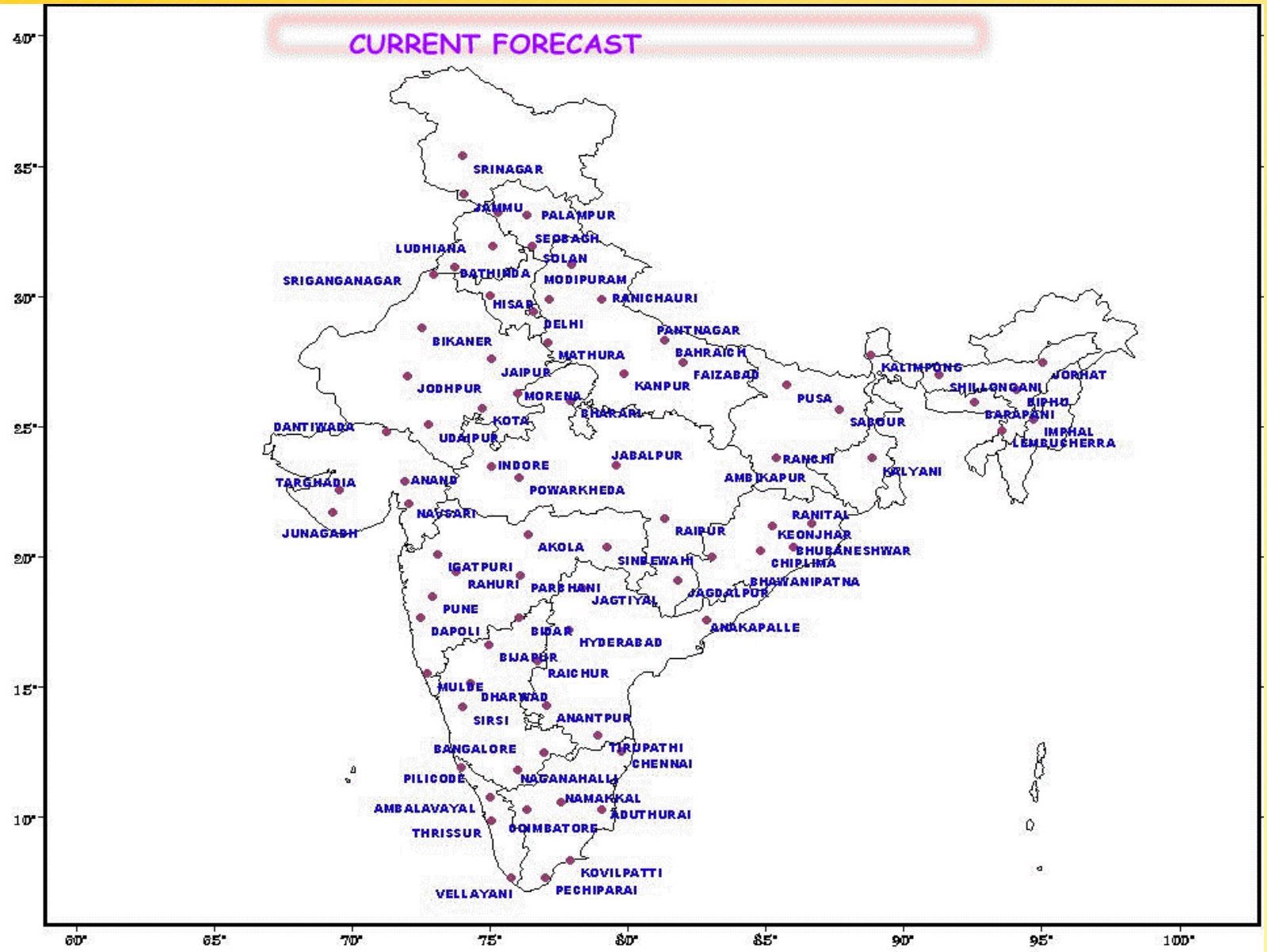
Forecasts for Defence Operations and Exercises.

- **Launch of Space Vehicles** (NCMRWF predicted profiles are better tallying than NHAC predicted profiles)
- **Weekly weather forecasts** (for Crop Weather Watch Group of Dept. of Ag.& Coop)

- **Forecasts of Onset/Advancement/Withdrawal of Monsoon to IMD**
- **Forecasts on special events** (National day, Solar eclipse,Indian Science Congress)
- **Forecasts for Avalanche prediction**
- **Forecasts for tourism and adventure** (Amarnath yatra, Everest expeditions).
- **Organization of field experiments** [INDOEX (trajectories for release of balloons) and BOBMEX (special observations)]
- **Wind fields for Ocean State Forecast** (Assimilation of MSMSR data).
- **Agrinet** (Portal for farmers)
- **Antarctica Expedition** (Communication failure)
- **Govt. of Andhra Pradesh Disaster Mitigation Project**
- **Initial conditions for Climate Experiments, Extended Range forecasting and Meso-scale modeling.**
- **Merged Gauge and Satellite data sets.**


USERS OF
NCMRWF'S PRODUCTS
AAS UNITS
IMD
IAF
ARMY
NAVY
SASE
ISRO
MIN. OF AGRI.
Location Specific Forecast (82 Locations)
Flow pattern charts of 850, 700, 500 and 200 hPa (Analysis & Forecast)
Precipitation forecast charts
Meteograms of metropolitan cities
Blown-up area precipitation Forecast
Vertical Wind Shear Forecast
Weekly Forecast (Weather systems, R/F, Temp.)

NETWORK OF AGROMET ADVISORY SERVICE (AAS) UNITS OF NCMRWF

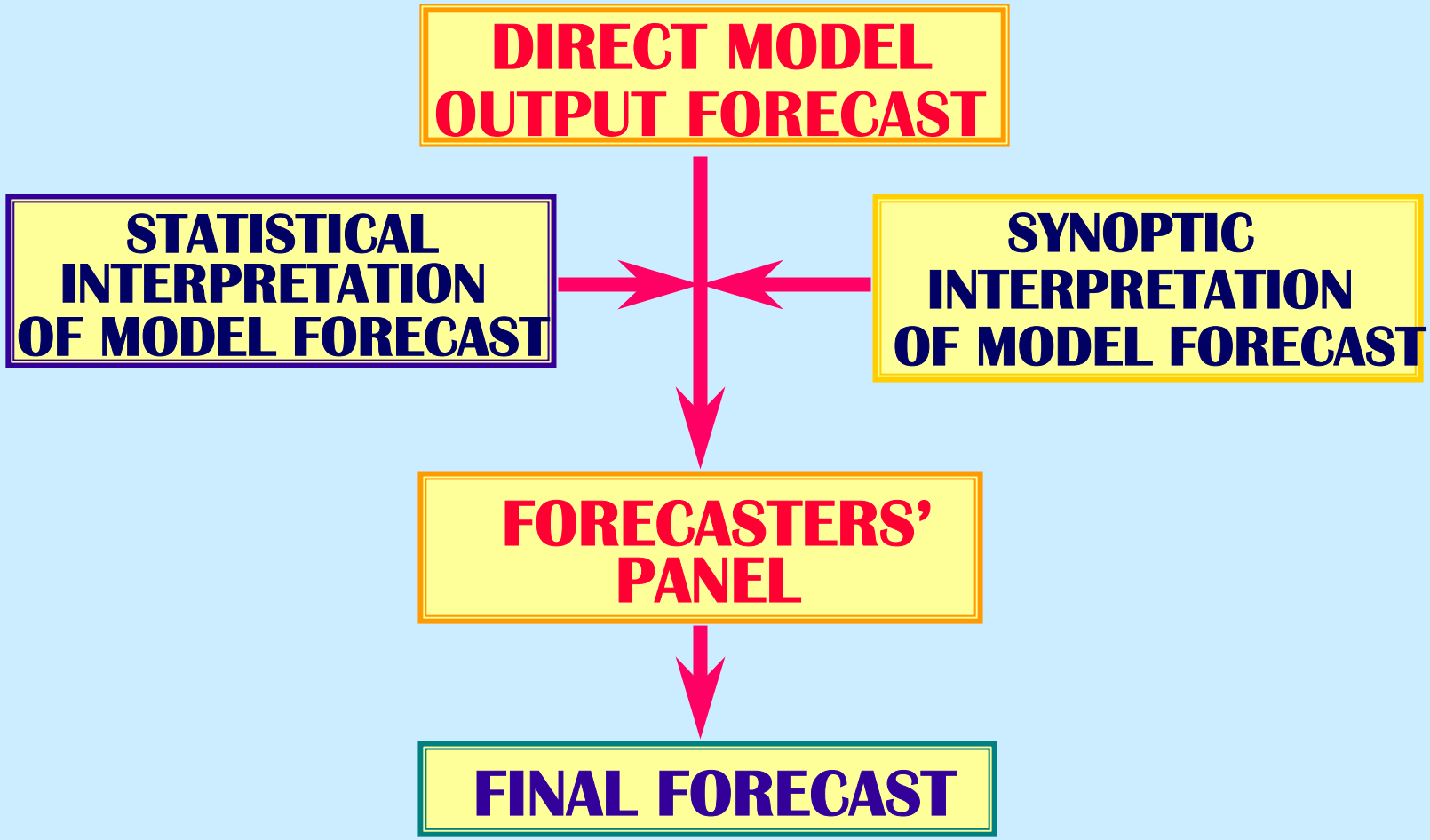


NCMRWF FORECAST PRODUCTS DISSEMINATED TO AAS UNITS

- 24 HR PRECIPITATION (MM)
- AVERAGE CLOUDINESS (OKTA)
- AVERAGE WIND SPEED (KMPH) AT 10 FT HEIGHT
- PREDOMINANT WIND DIRECTION (DEG.) AT 10 FT HEIGHT
- MAXIMUM TEMPERATURE TREND (DEG. C) AT 4.5 FT HEIGHT
- MINIMUM TEMPERATURE TREND (DEG. C) AT 4.5 FT HEIGHT

Frequency of Forecast : Twice-a-week
Dissemination : On Tuesday and Friday
Period covered : 4 days

SCHEME FOR PREPARATION OF LOCATION SPECIFIC WEATHER FORECAST AT NCMRWF



FORMAT FOR AGROMET ADVISORY BULLETIN

❑ WEATHER INFORMATION

- Weather summary of preceding week,
- Climatic normal for the week,
- Weather forecast and
- Crop moisture index, Drought severity index etc.

CROP INFORMATION

- Type, state and phenological stages of the crops
- Information on pest and disease and
- Information on crop stresses

ADVISORY BULLETIN

- Crop-wise farm management information tailored to weather sensitive agricultural practices like sowing, irrigation scheduling, p & d control operation, fertilizer use etc.
- Spraying condition for insect, weed and their products
- Wildfire rating forecasts in wildfire prone areas
- Livestock managemnet information for housing, health and nutrition etc.

Country Forecasts

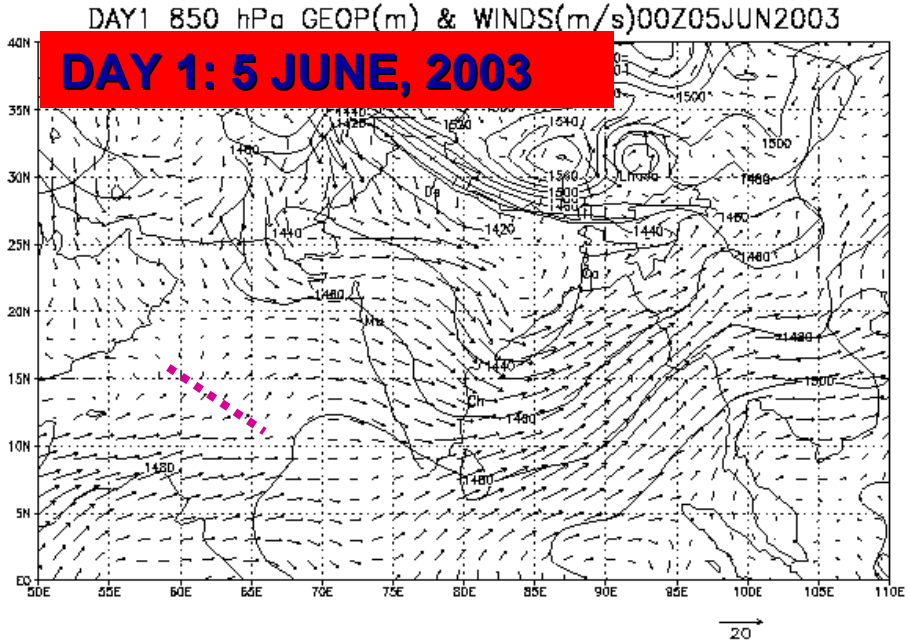
- AFRICA REGION
- QUATAR REGION
- KENYA REGION
- SRI LANKA REGION
  - Weather Forecast Charts and Rainfall Charts are posted everyday.

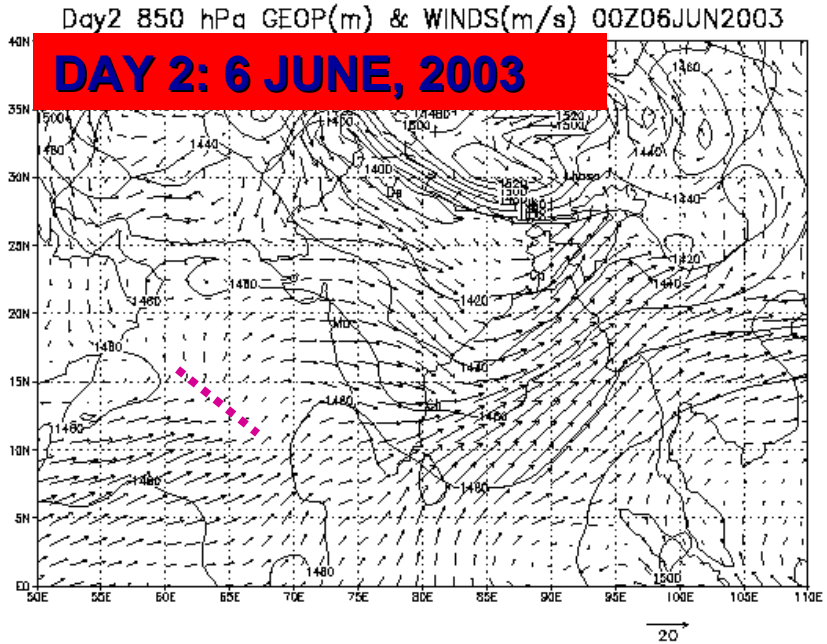
NCMRWF Model Prediction of Monsoon onset -2003

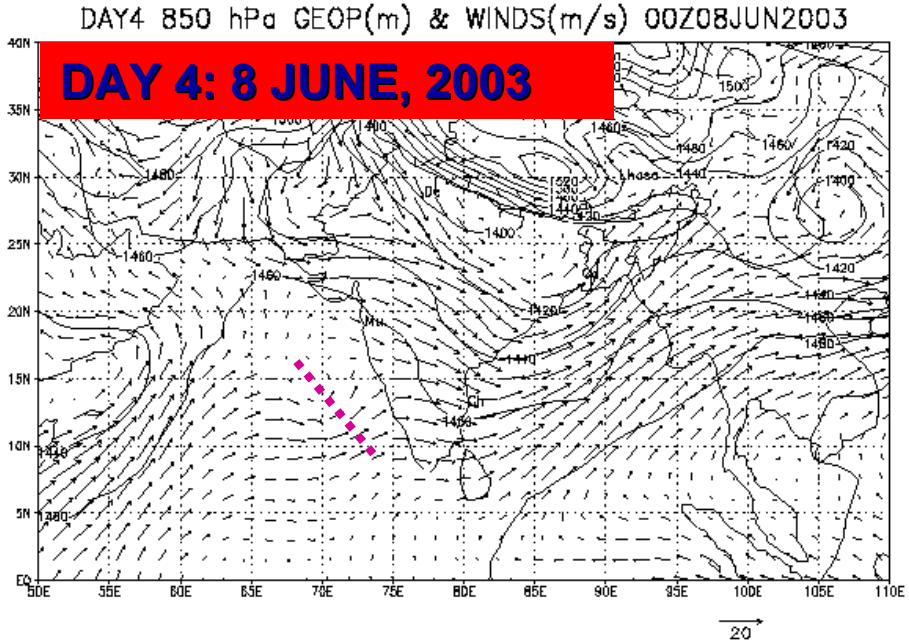
Verification of NCMRWF Forecast (As provided to CWWG)

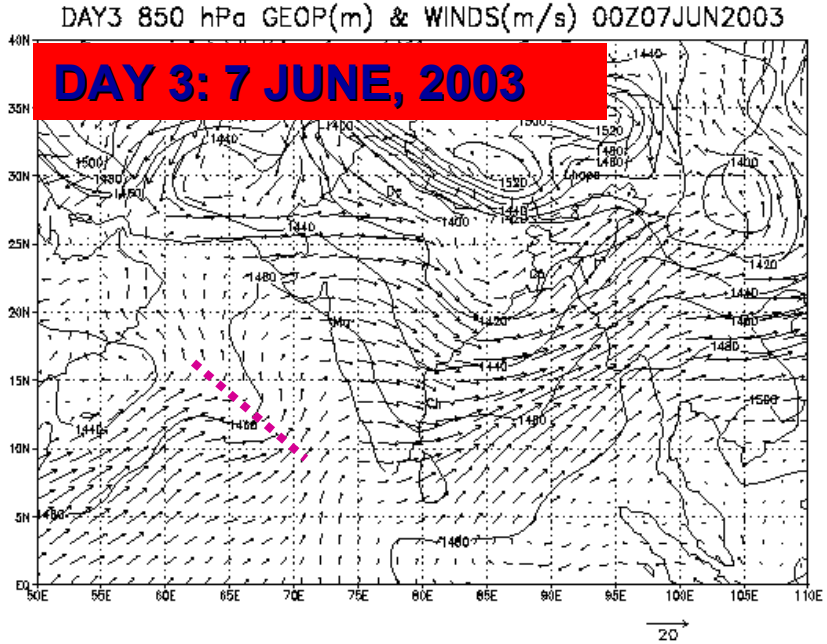
NCMRWF PREDICTION ON 2 JUNE	OBSERVATION TILL 9 JUNE
Onset of Southwest Monsoon over Kerala NOT likely till 6 June, 2003.	Onset of Monsoon did not take place till 6 June, 2003.
The improvement in different monsoon parameters shown by the model is gradual but remains below their threshold value till 6 June, 2003.	Gradual improvement in different monsoon parameters
However, perceptible change in situation is likely on 8 and 9 June, 2003 indicating possible onset of monsoon over Kerala around these dates	Monsoon advanced into Kerala on 8 June, 2003.

Strengthening of Arab. Sea flow and shifting of N-S trough towards west coast



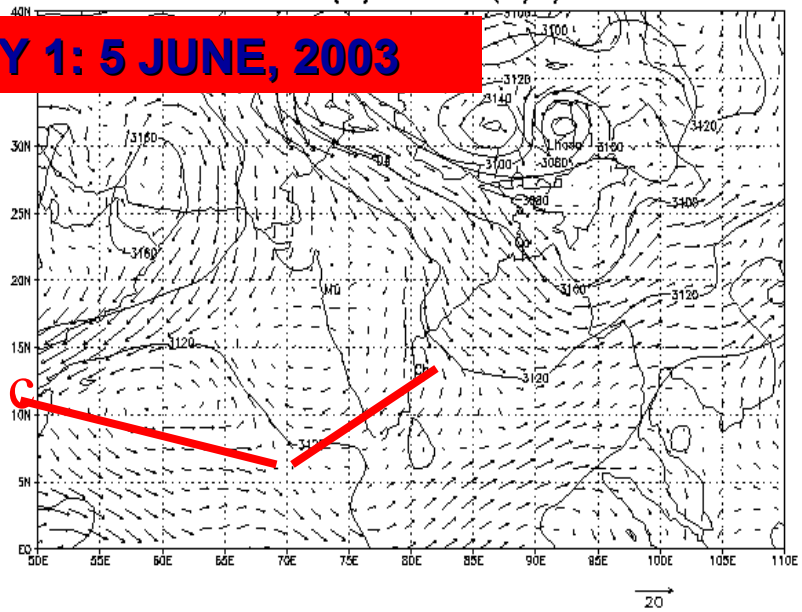




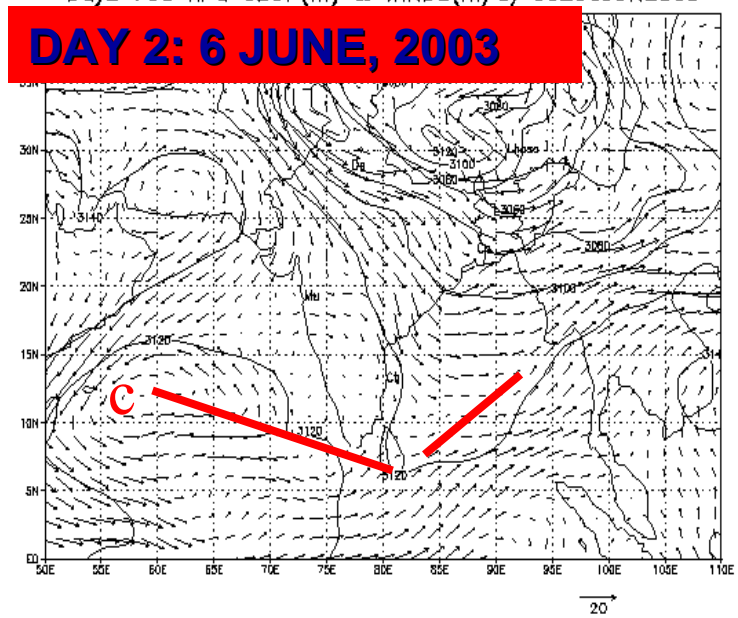


Northward movement of E-W shear zone and formation of a Cyclonic Circulation over SE Arabian Sea

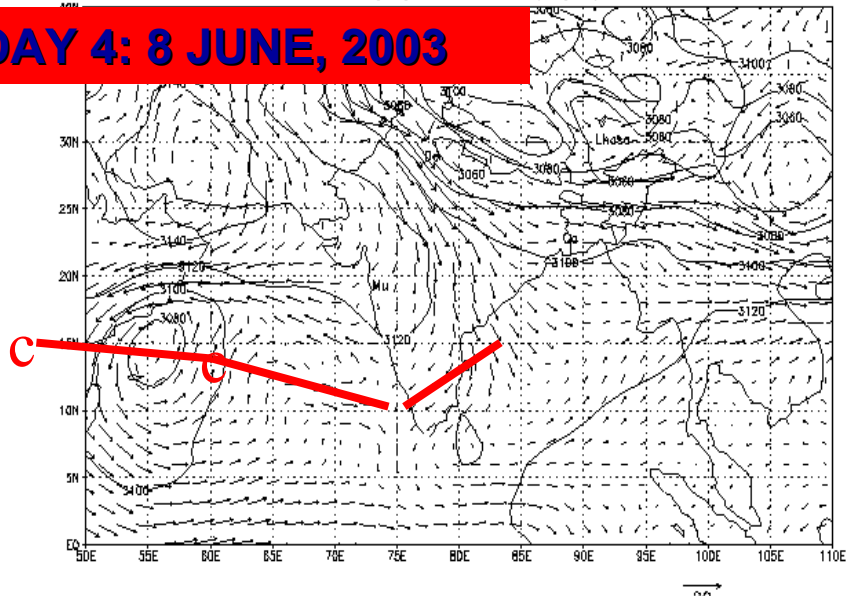
DAY1 700 hPa GEOP(m) & WINDS(m/s)00Z05JUN2003



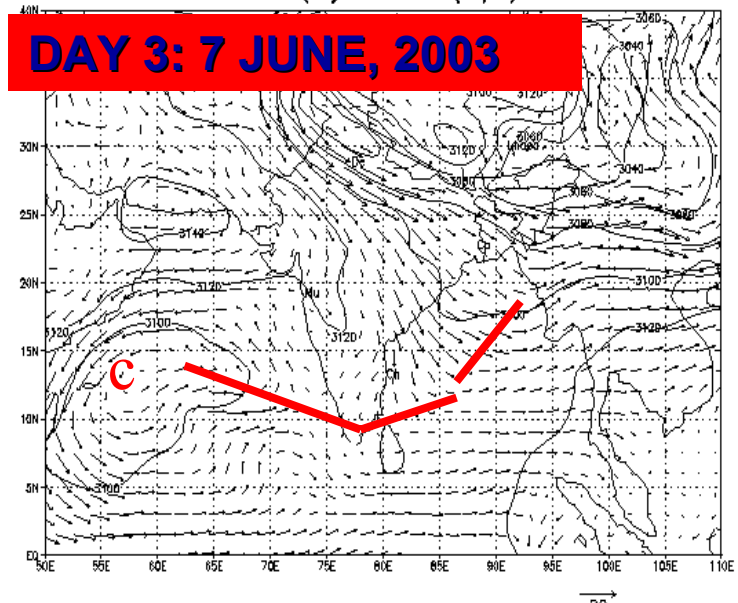
Day2 700 hPa GEOP(m) & WINDS(m/s) 00Z06JUN2003



DAY4 700 hPa GEOP(m) & WINDS(m/s) 00Z08JUN2003



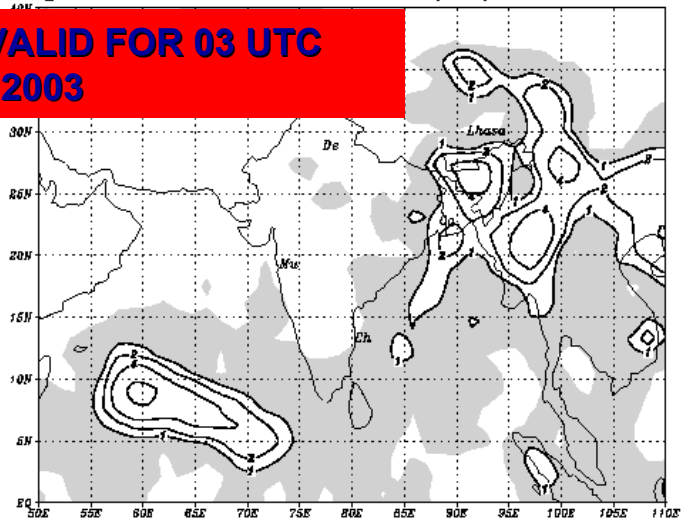
DAY3 700 hPa GEOP(m) & WINDS(m/s) 00Z07JUN2003



Eastward shifting of rainfall zone and onset of monsoon over Kerala

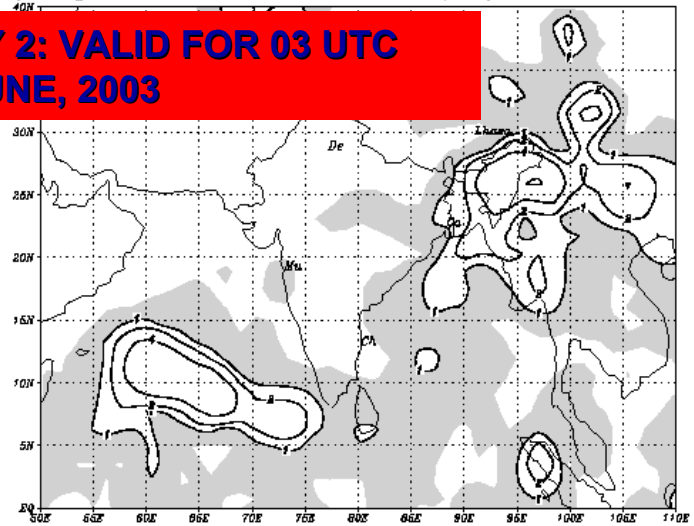
a)Day1 OPR FORECAST RAINFALL(cm) 03Z06JUN2003

DAY 1: VALID FOR 03 UTC 6 JUNE, 2003



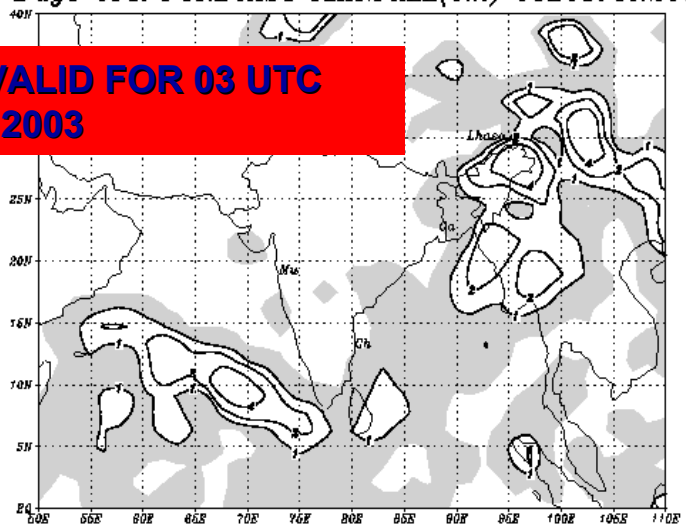
b) Day2 OPR FORECAST RAINFALL(cm) 03Z07JUN2003

DAY 2: VALID FOR 03 UTC 7 JUNE, 2003



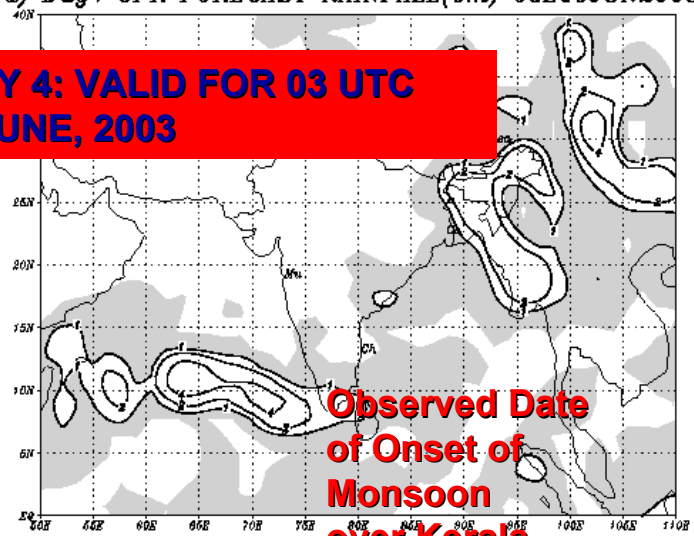
c) Day3 OPR FORECAST RAINFALL(cm) 03Z08JUN2003

DAY 3: VALID FOR 03 UTC 8 JUNE, 2003



d) Day4 OPR FORECAST RAINFALL(cm) 03Z09JUN2003

DAY 4: VALID FOR 03 UTC 9 JUNE, 2003



Observed Date of Onset of Monsoon over Kerala

A number of stations in Kerala reported more than 1 cm rain.

One station reported 14 cm rain

Future Road Map of Modeling Activity at NCMRWF

Model Resolution T340L60

Ensemble Runs

Meso-Scale 10km over the entire Indian Region 1 km models for Clouds

Use of more Satellite Data Direct Radiance Assimilation

Real-time Seasonal Prediction

Climate Variability and Change AMIP-type Runs

Infrastructure upgradation Plans

(a) **Procurement of Param Padma**

(b) **Upgradation of Cray SV1**

(c) **Upgradation of Anupam**

(d) **Increase Storage to 20TB**

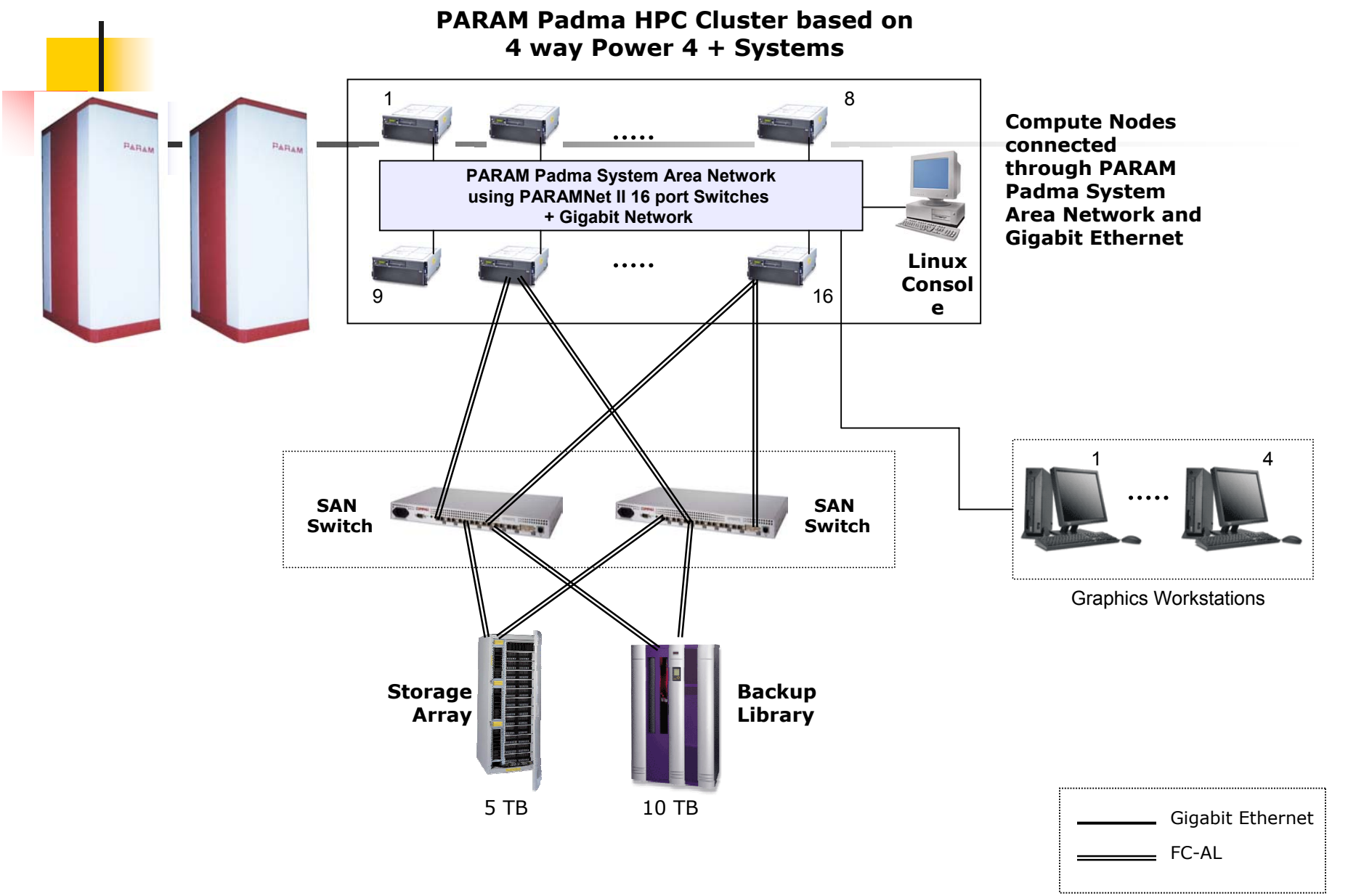
(e) **Create a SAN solution**

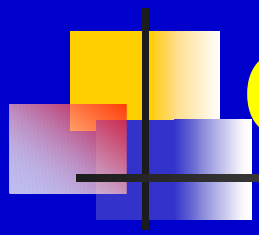
(f) **Upgradation ILL capacity**

PARAM Padma

- Member of the Top500 HPC list
- Supports applications based on professional Unix and Linux
- At present it is certified for AIX and Linux
- By supporting above Operating Systems, PARAM technology becomes more or less Vendor independent
- Supports Parallel Development tools and Parallel File System (PFS)
- Proven Platform running applications ranging from Scientific to Databases to Financial Modeling

PARAM Padma Compute Cluster Layout





CRAY SV1 ex

- A 500 MHz clock
- Low-latency high bandwidth cache
- A 32 Gbyte internal SSD
- SDRAM twice the bandwidth of SV1 DRAM
- Vector processing rate of 2 Gflops per CPU
- Scalar processing rate of 500MIPS

ANUPAM-Xeon/128

- Processor :64 Dual Xeon Servers
- Speed :2.4 GHz
- Peak Performance :202 Gflops
- Memory/processor :2GB
- Interconnect Tech. : Scalable Coherent Interface(SCI)
- OS : LINUX

Conclusion

- Computing Resources at NCMRWF are moderate
- Plans to enhance resources are underway
- Strong case for sharing of information on use of different technologies, and
- Technology transfer to less advanced centres

Thank You !