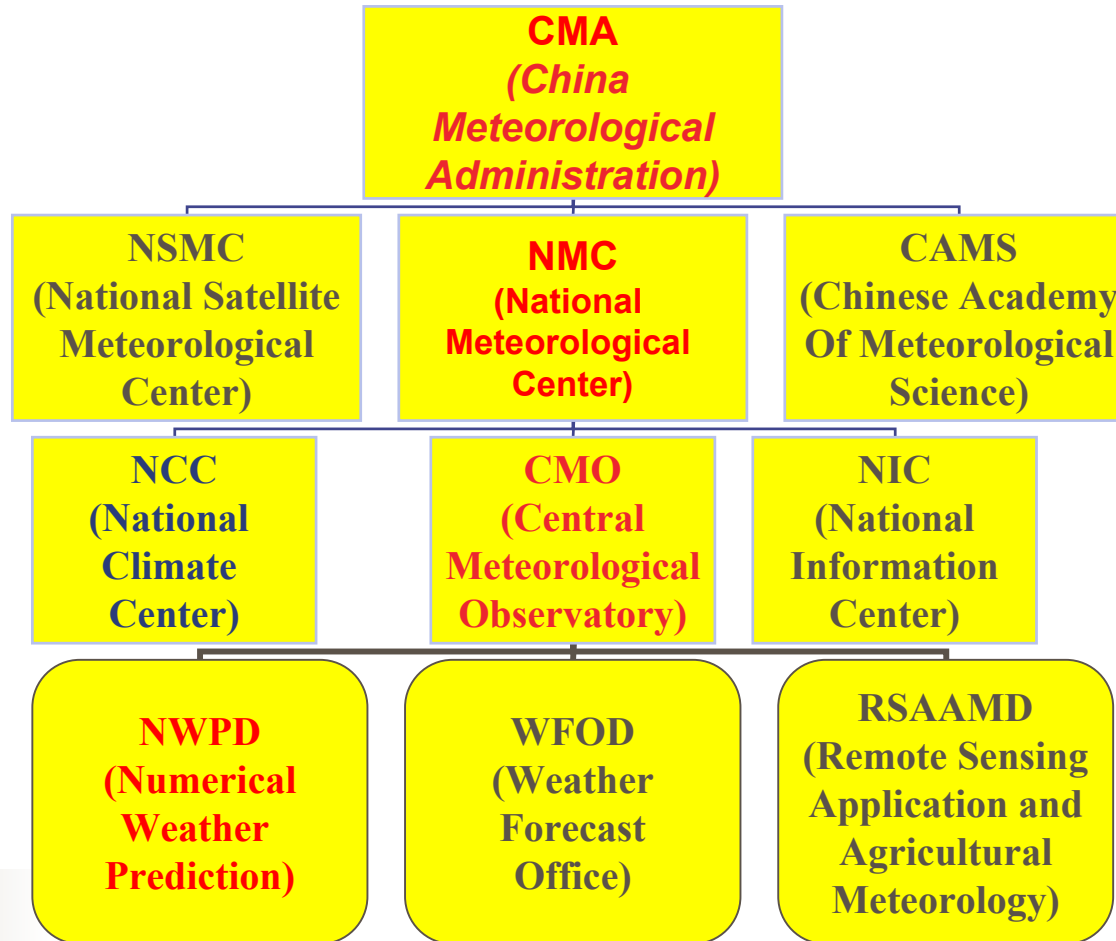


A new operational medium-range numerical weather forecast system of CHINA



NWPD/NMC/CMA
(Beijing, CHINA)

Organizational Chart of CMA



Role of NWPD : Research, development and support of the models meant for operational weather prediction



Operational Numerical Forecast Systems

■ **Main Numerical Forecast Systems**

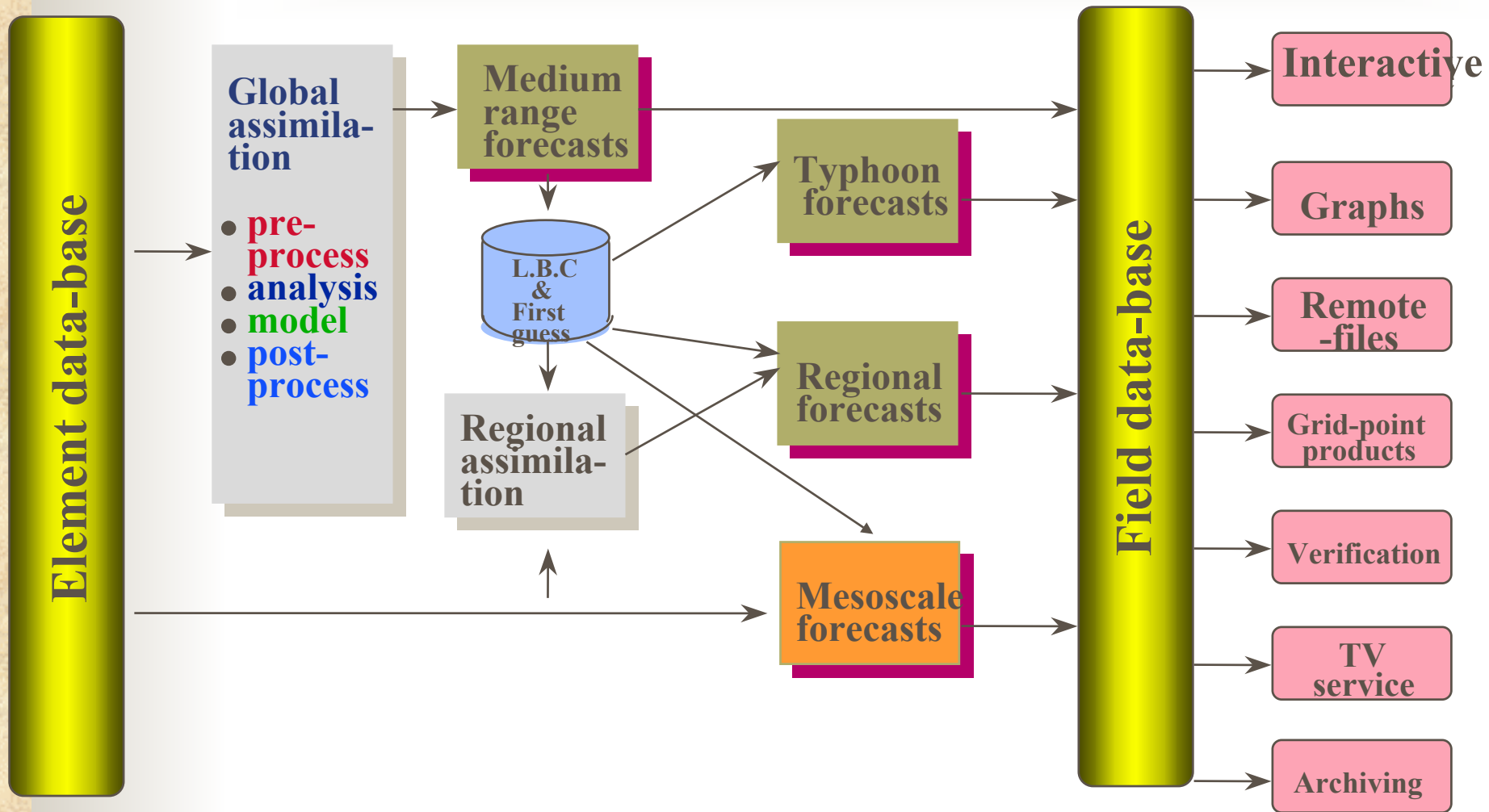
- **Global Forecast System (T213)**
- **Regional Forecast System (HLAFS)**
- **Typhoon Track Forecast System (MTTP)**
- **Mesoscale Forecast System (MM5)**
- **Ensemble Forecast System (T106)**



- **Environmental Meteorology Forecast Systems
Based on Main Model Systems**

- **Forest Fire Meteorological Condition Forecast System**
- **Nuclear Contamination Dispersion and Transportation Forecast System**
- **Ultraviolet Index Forecast System**
- **Dust Devil Forecast System**
- **Air Quality Forecast System**

Structural Chart of the Operational NWP Systems





New Medium-range Forecast System T213

- **Put into full operation**
in place of previous operational system (T106) on September 1st 2002.
- **Runs twice a day**
from 00 UTC up to 72h range and from 12 UTC up to 10days range



New Medium-range Forecast System T213

- **Runs on the massive parallel computer**

the first operational medium-range weather forecast system

Operational machine: IBM/SP with 88 processors and peak calculation speed up to 80 GFLOPs



New Medium-range Forecast System T213

- **Contituents of the New System**

- T213L31 global spectral model

- Data preprocessing

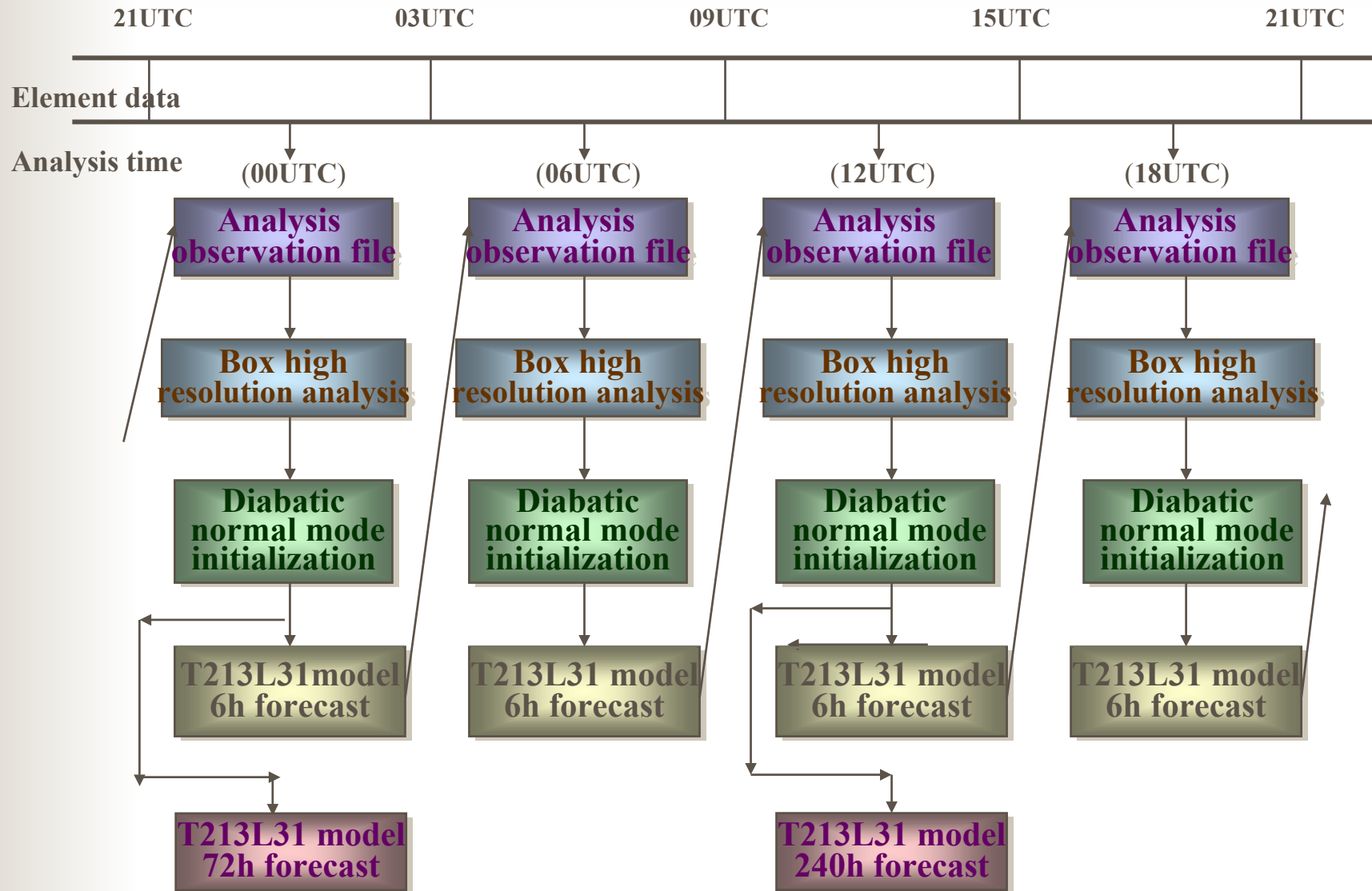
- Optimum Interpolation (OI) analysis

- Post-processing

- Job running watching

- Field database, archiving , forecast verification ,
product making and distribution

Global data assimilation system flow chart





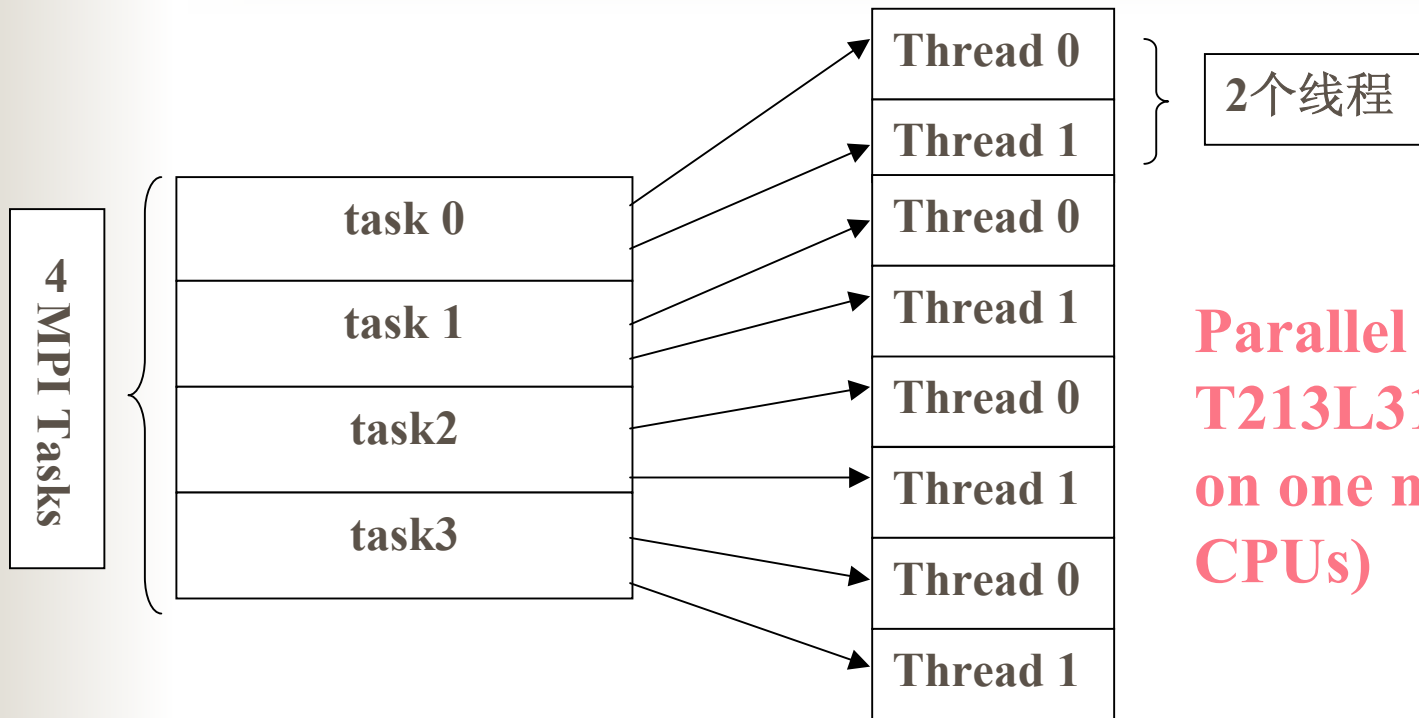
Data assimilation

- **Operational:** optimized interpolation
- upgrading the previous operational 3D-OI with a resolution of T106L19
- Optimized and Parallelized using MPI
- Using 8 CPU of IBM sp
- 10 minutes to complete each assimilation
- **Test running:** 3Dvar



Global spectral model T213L31

- **Based on global model constituent of IFS**
March, 1998 from ECMWF
- **Optimizing subroutines**
with large quantity of computation (FFT,
Legendre transformation)
- **Using asynchronous and nonblocking message passing**
increase the speed of communication
- **Joint application of distributed memory and shared memory parallelization**
reduce communication and memory use



Parallel mode of T213L31 on one node (8 CPUs)

Using 6 nodes (48 CPUs), 10 days forecast can be finished in 2.5h



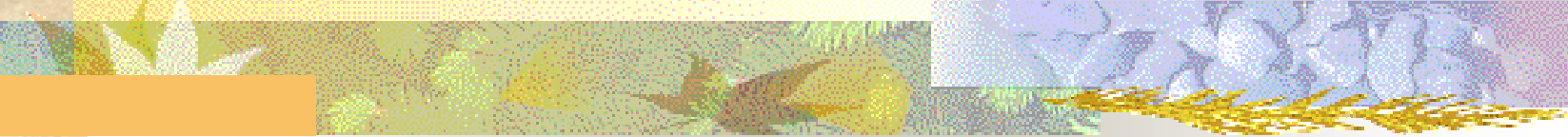
Global spectral model T213L31

- **Dynamical Feature**
- triangular truncation, resolving 213 waves around a great circle on the globe; 31 levels (up to 10 hPa).
- Semi-lagrangian, semi-implicit temporal integration, time step 15 minutes.
- use of a reduced Gaussian grid.
- Hydrostatic.
- Fourth order linear horizontal diffusion.

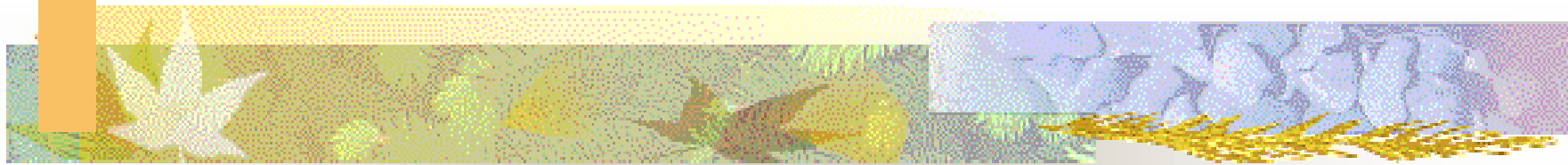


Global spectral model T213L31

- **Physical process**
- **orography** (terrain height, US Navy data-set, 10 minutes of arc resolution)
- **three surface and sub-surface levels** (allowing for vegetation cover, gravitational drainage, capillarity exchange, surface and sub-surface runoff, deep-layer soil temperature and moisture),
- **clouds** (high, medium, low, convective)
- **stratiform and convective precipitation,**
- **carbon dioxide** (345 ppmv fixed), **aerosol,**
ozone

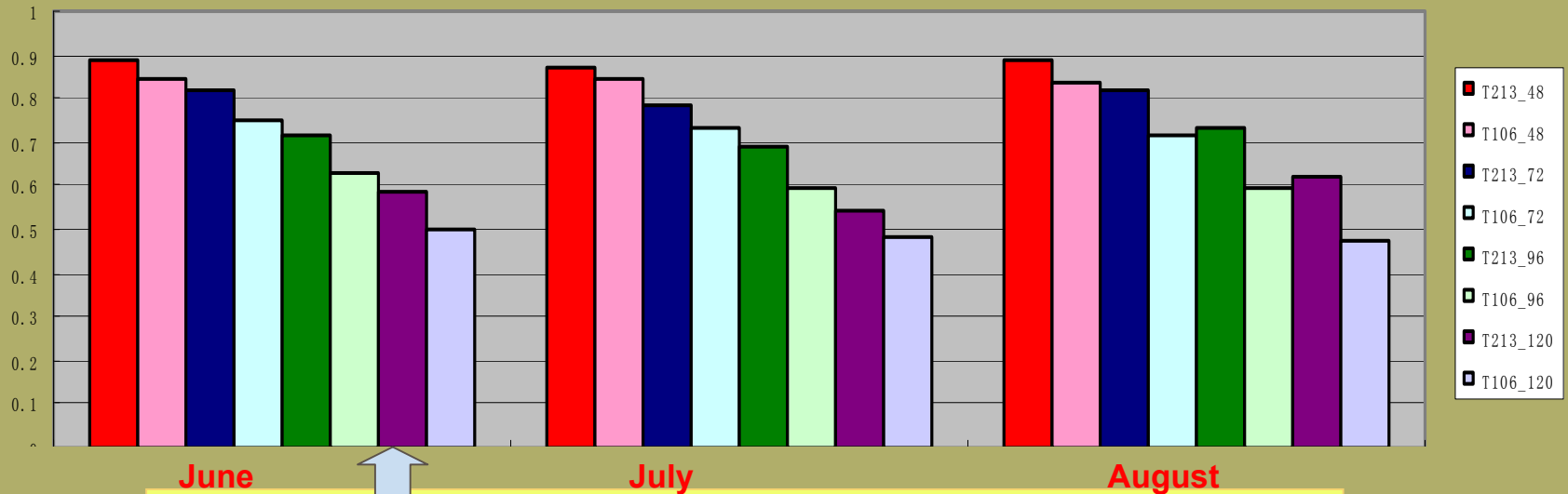
- 
- **diffusion**
 - **ground and sea roughness, ground and sea-surface temperature, ground humidity, snow-fall, snow-cover & snow melt**
 - **radiation** (incoming short-wave and out-going long-wave)
 - **friction** (at surface and in free atmosphere)
 - **gravity wave drag**
 - **evaporation, sensible and latent heat flux**

Verification of T213 in last year



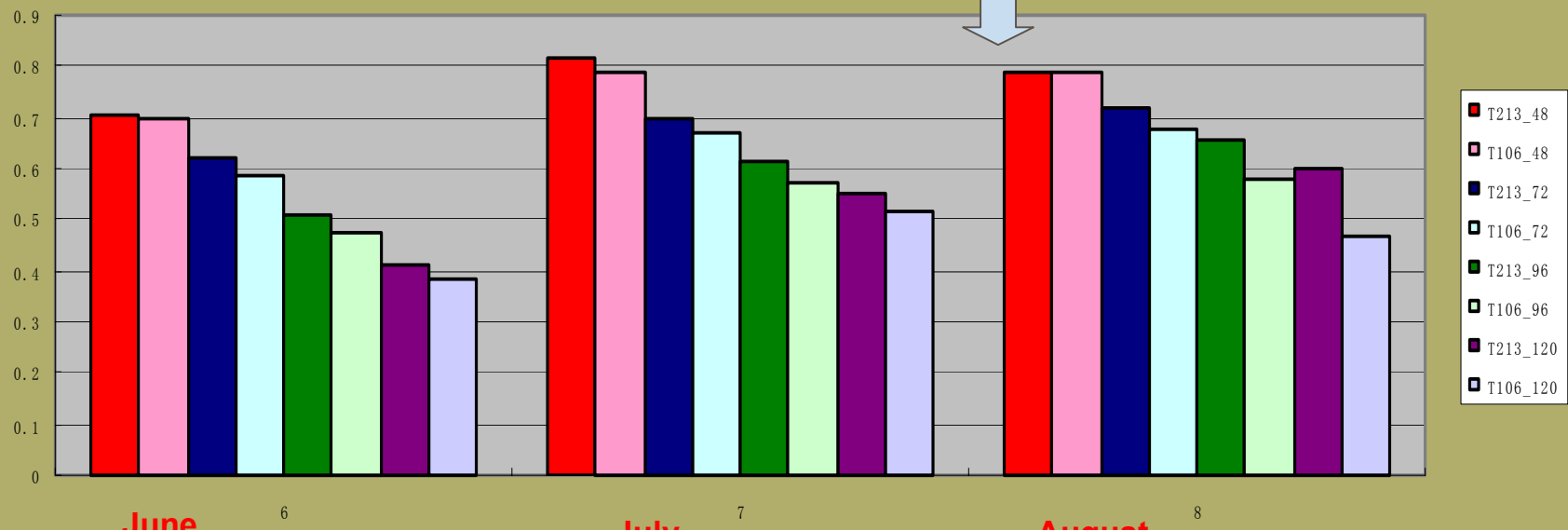
---parallel running of T213 and T106

500 hPa height monthly mean anomaly correlation coefficient comparison of T213/T106 in June-August, 2002

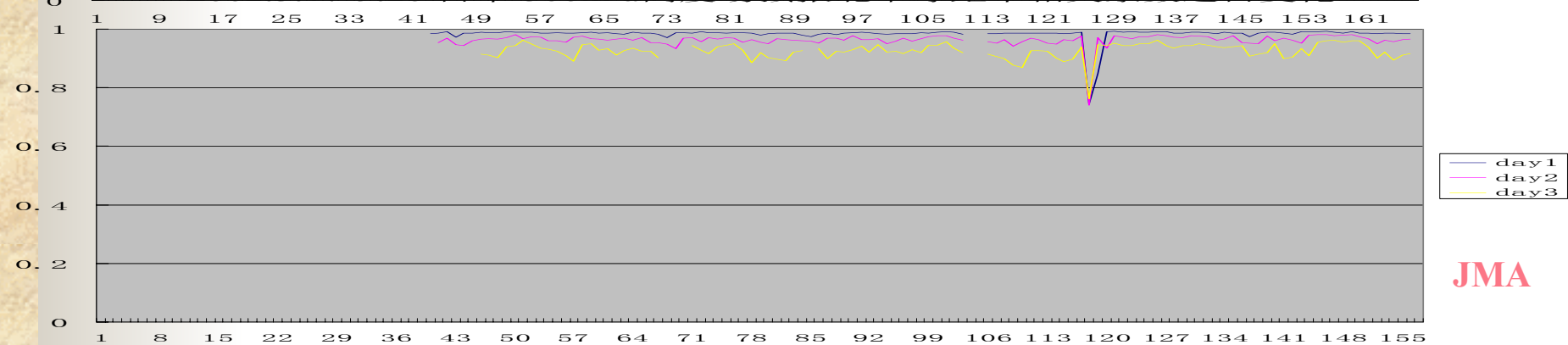
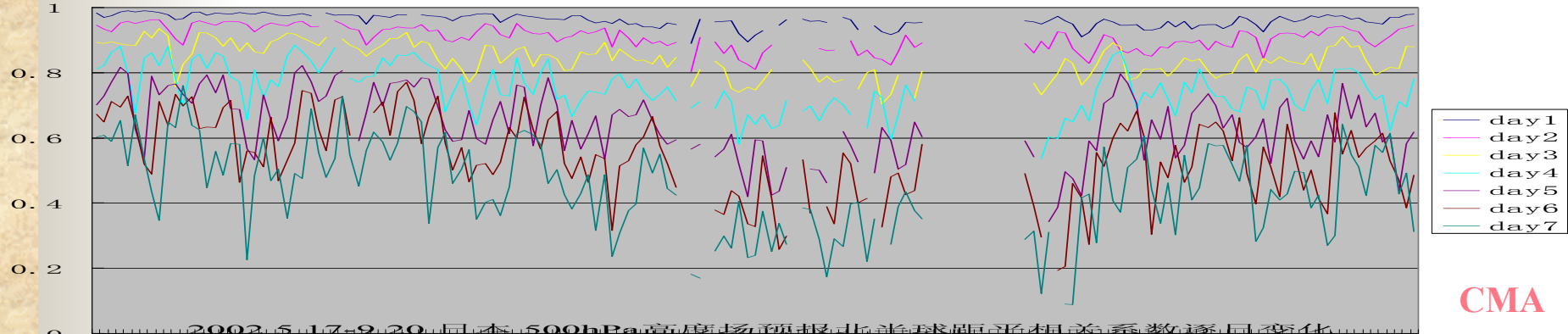
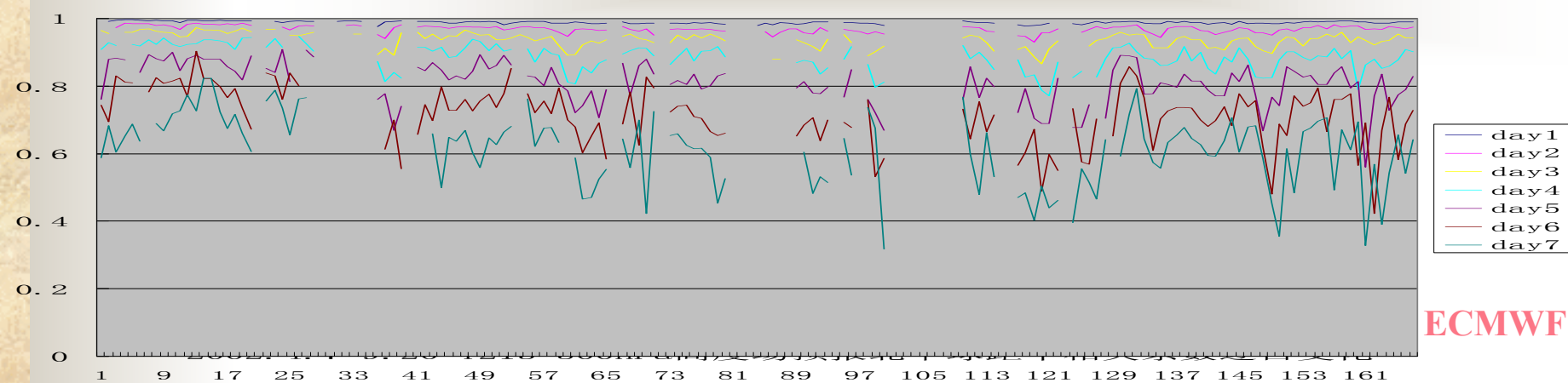


North Hemisphere

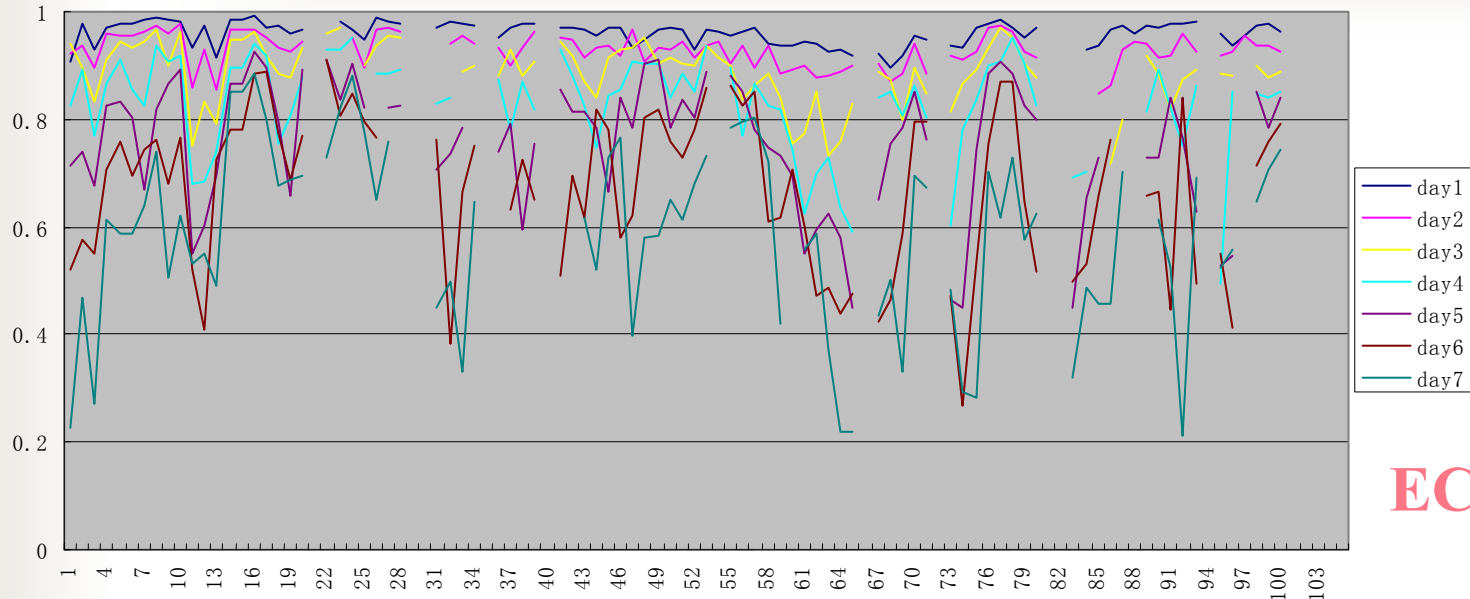
East Asia



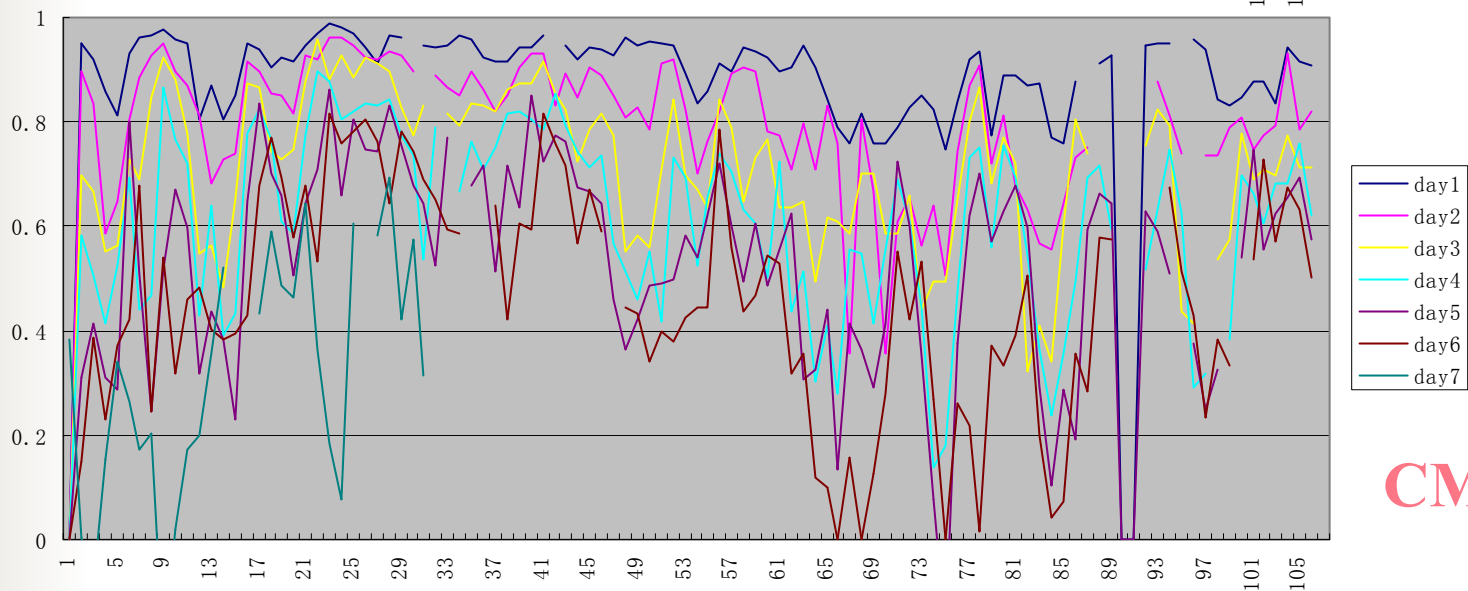
500 hPa height anomaly correlation coefficient evolution with day in North Hemisphere (April 7-September 20, 2002)



500 hPa height anomaly correlation coefficient evolution with day in East Asia (April 7-July 20, 2002)



ECMWF



CMA

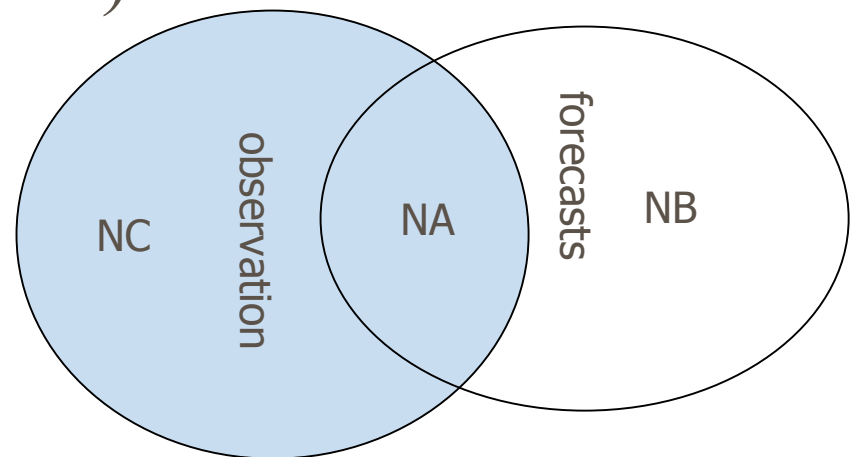
Verification Statistic of Precipitation

- Threat Score

$$TS = NA / (NA + NB + NC)$$

- Forecasting Bias

$$B = (NA + NB) / (NA + NC)$$



Standard station: 400 stations;

- grid  standard station;
interpolation

rank:

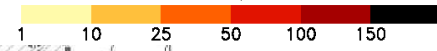
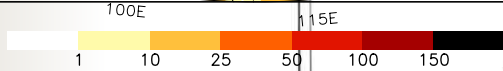
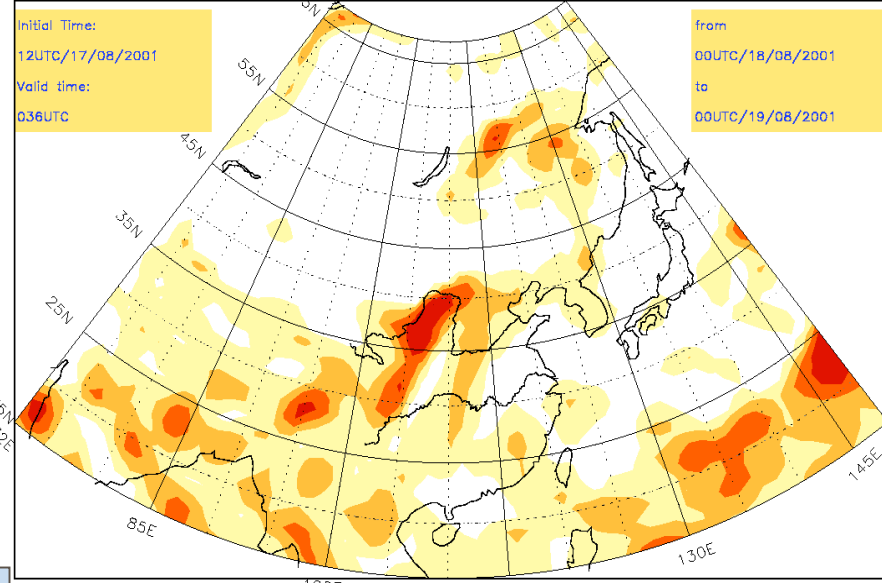
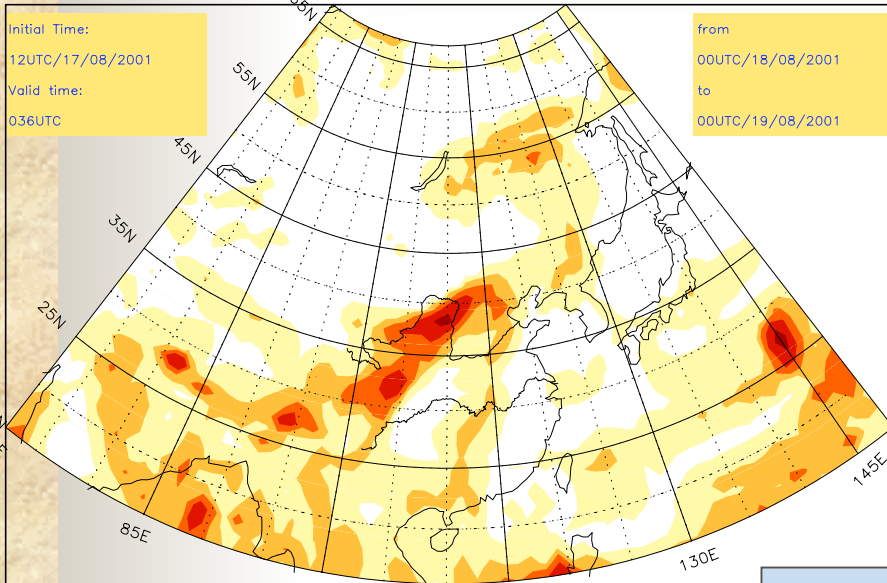
- **Light rain:** 0.1 mm ~ 9.9mm
- **Moderate rain:** 10.0 mm ~ 24.9mm
- **Heavy rain:** 25.0 mm ~ 49.9mm
- **Storm rain:** 50.0 mm ~ 99.9mm
- **Torrential rain:** 100.0mm ~



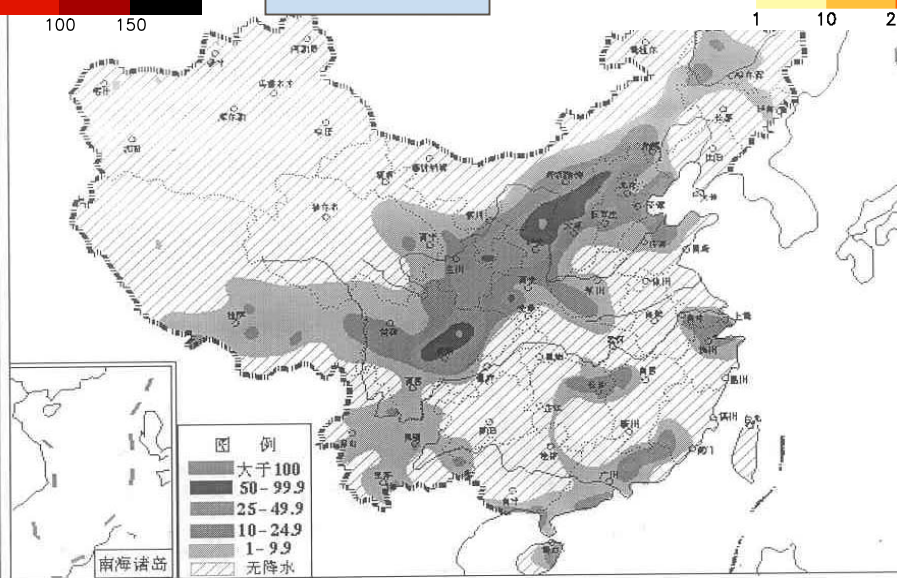
Rainfall forecast Comparison of T213 and T106 (12-36h) with observation (18-19, august, 2001)

T213 24H Accumulated Precipitation (mm) NMC/CMA

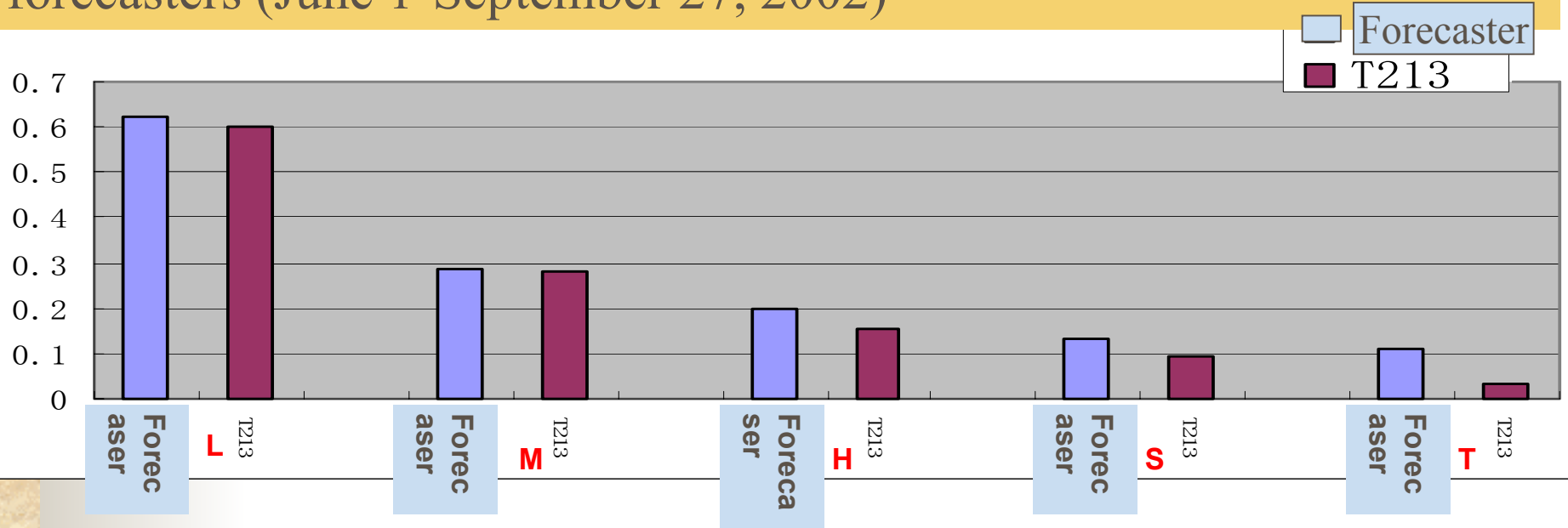
T106 24H Accumulated Precipitation (mm) NMC/CMA



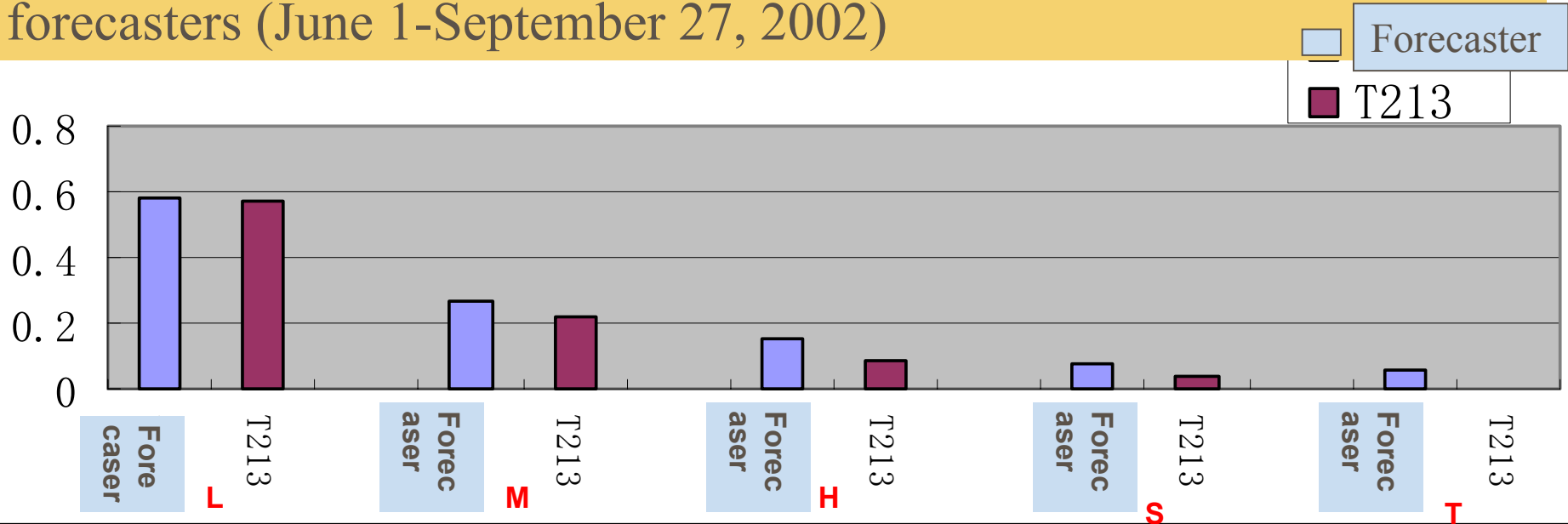
observation



forecasters (June 1-September 27, 2002)



Threat Scores of 48h forecasting accumulative rainfall of T213 and forecasters (June 1-September 27, 2002)



Real SST Experiment

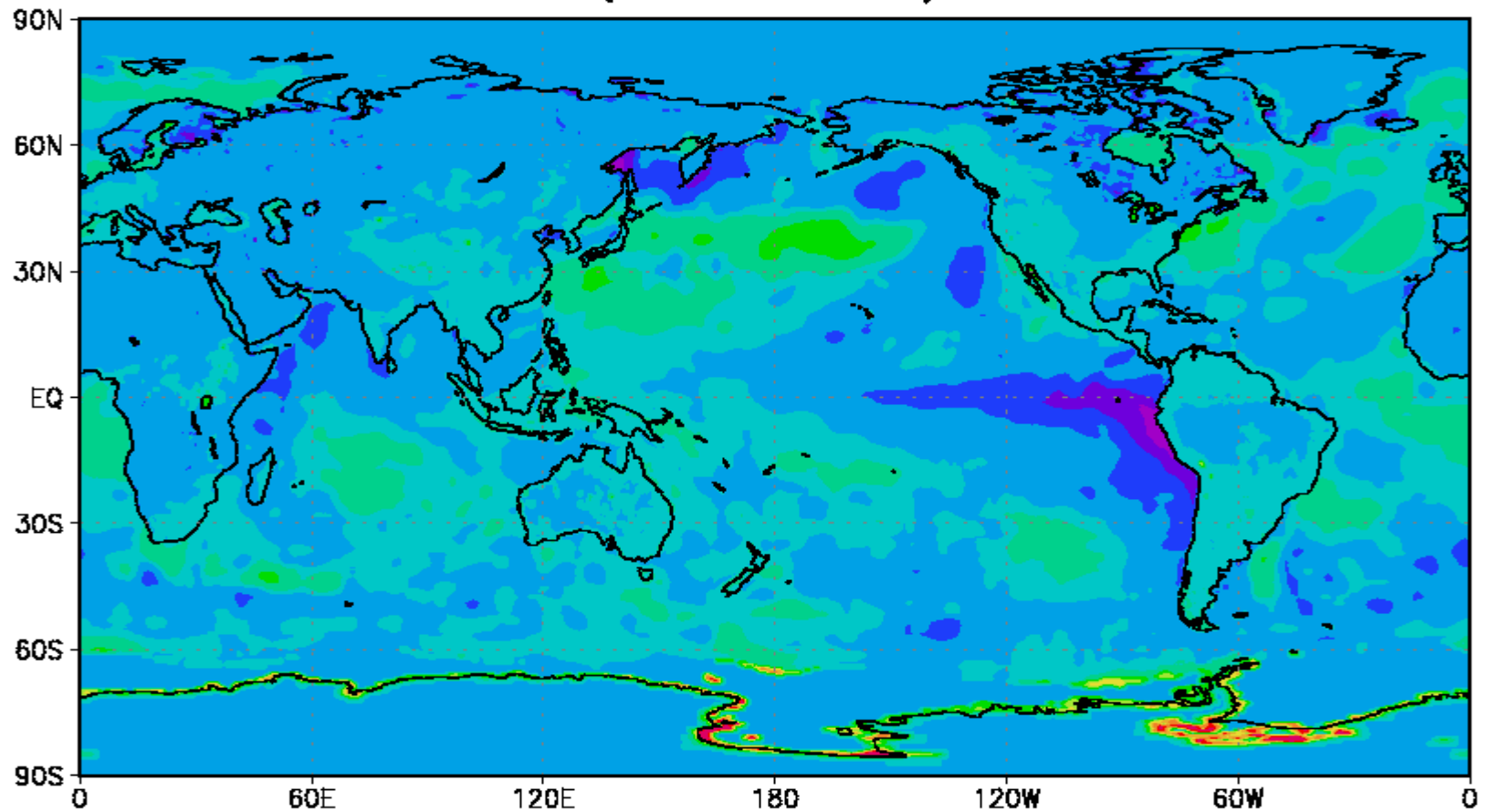




Real SST Experiment

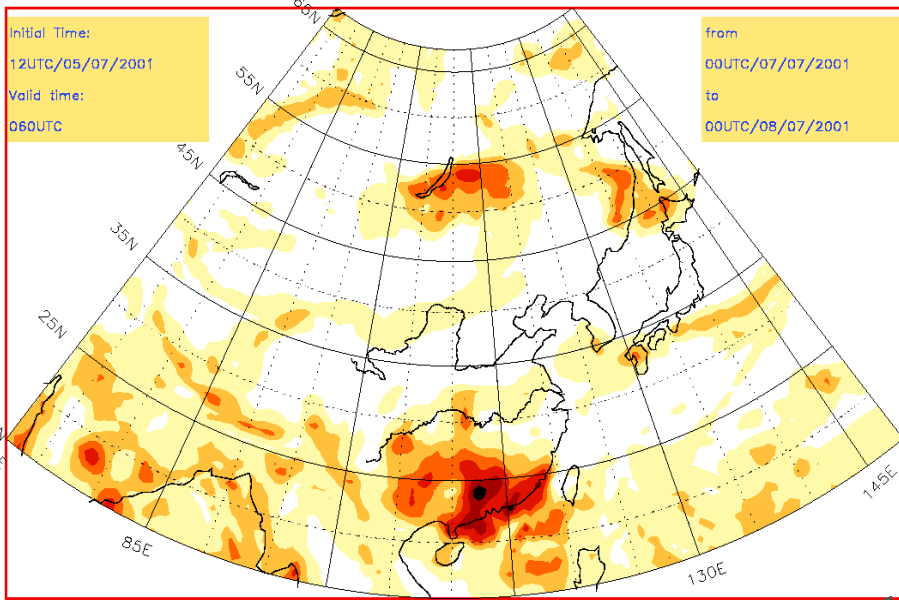
- The main problems exist in forecasting precipitation of T213 in CHINA in July to August in 2001.
the typhoon rainfall often lies southerly to the main land of CHINA and lies on the sea.
- Case Experiment
Five typhoon synoptic procedures which affected CHINA in July to August of 2001

sst difference(real-1997)-2001070412



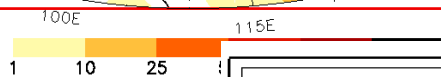
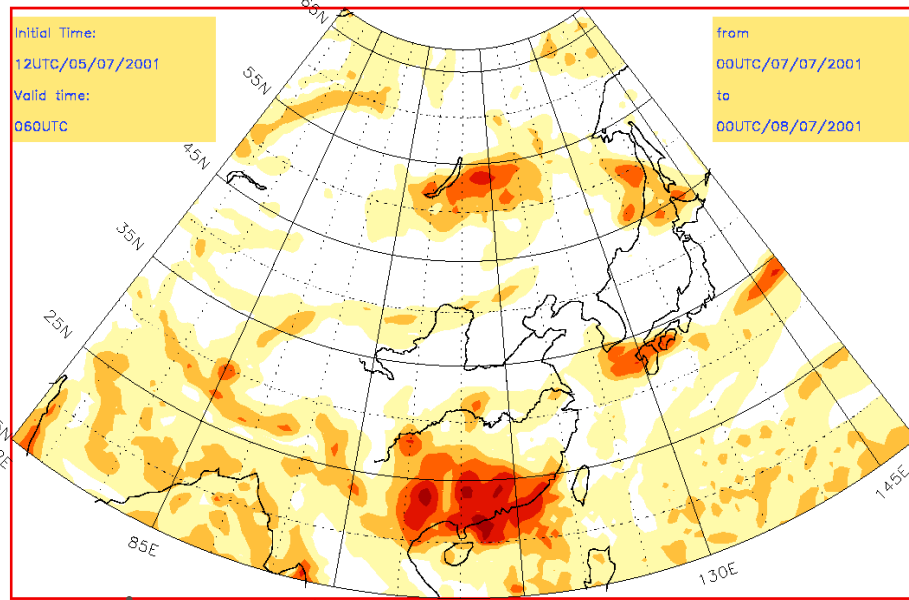
operational

T213 24H Accumulated Precipitation (mm) NMC/CMA

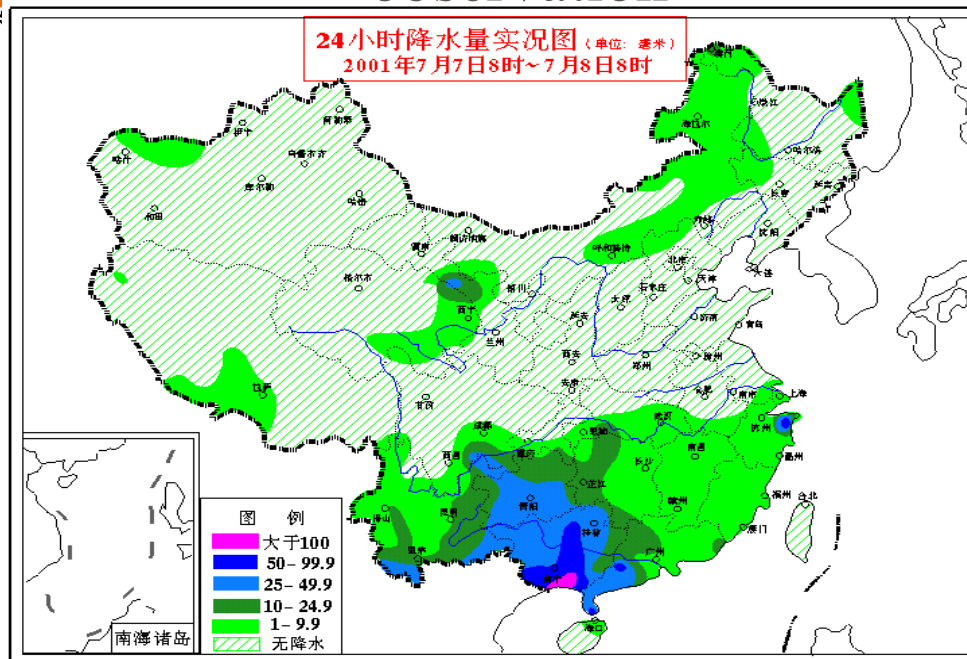
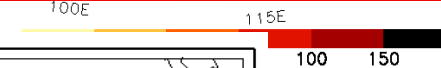


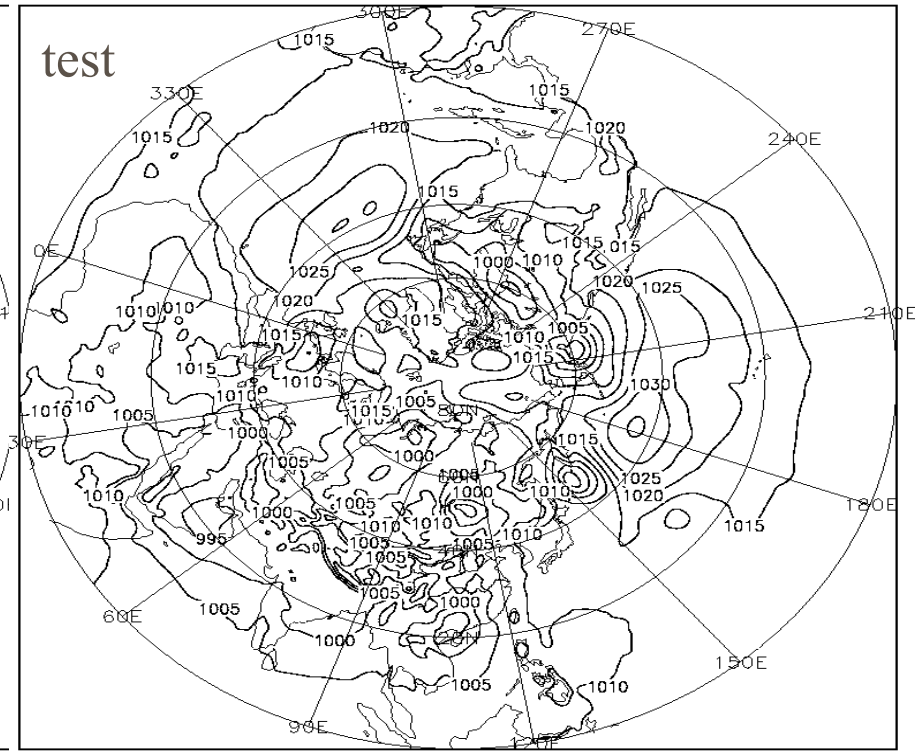
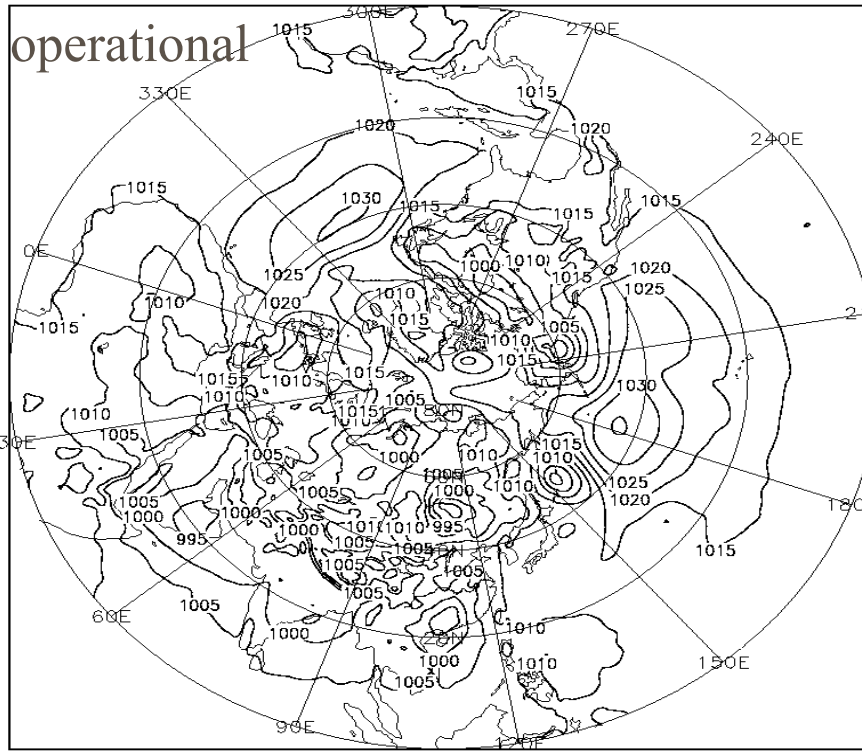
test

T213 24H Accumulated Precipitation (mm) NMC/CMA

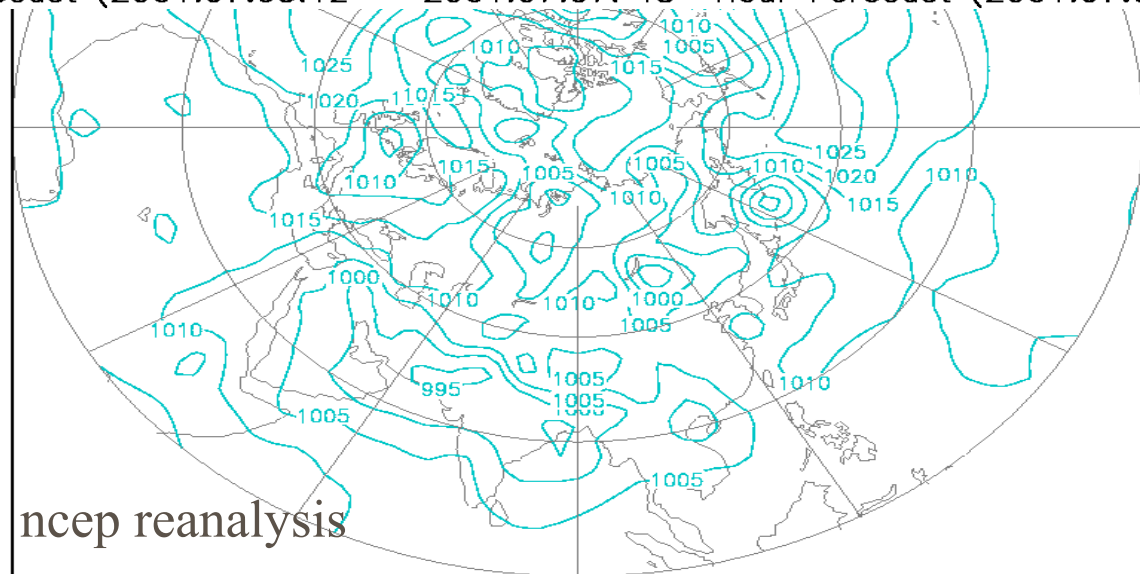


observation

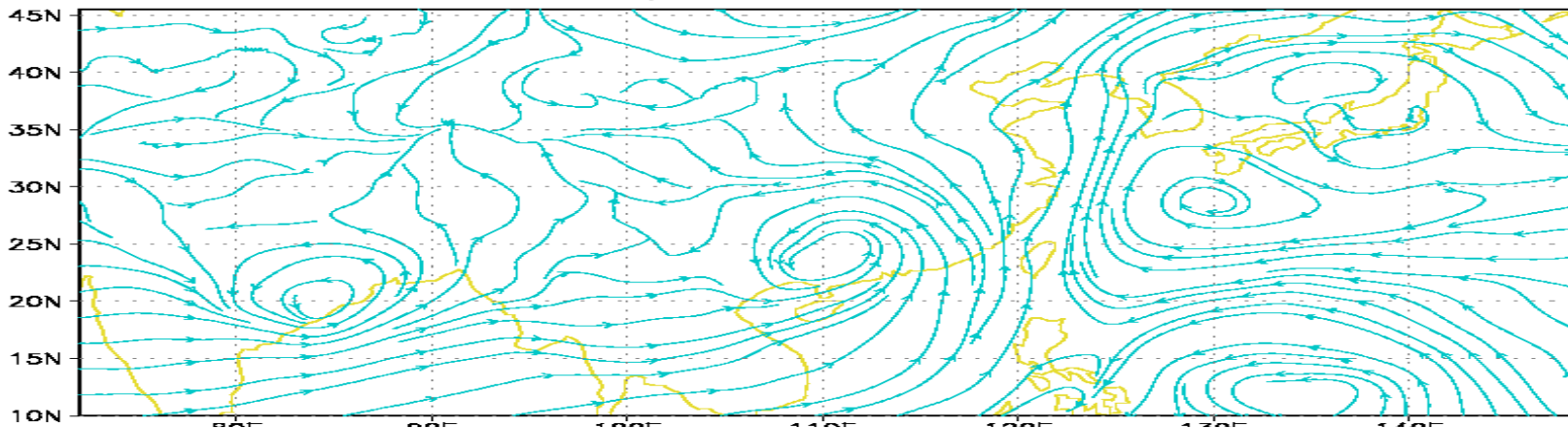




48 Hour Forecast (2001.07.05.12 --2001.07.07. 48 Hour Forecast (2001.07.05.12 --2001.07.07.12

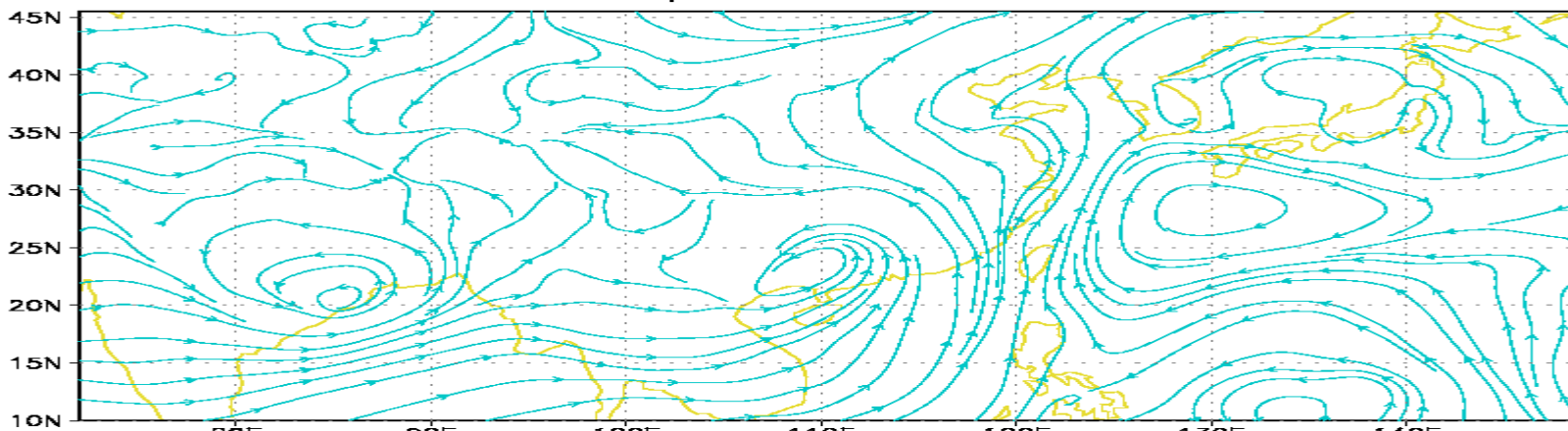


850Hpa UV—1997 sst

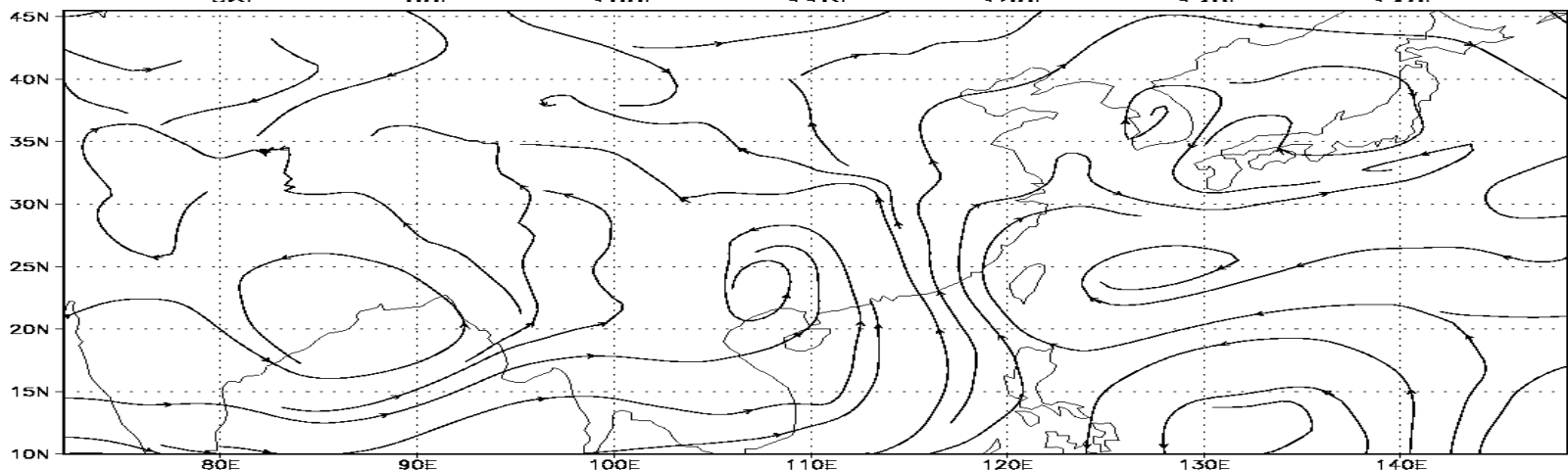


operational

850Hpa UV—real sst

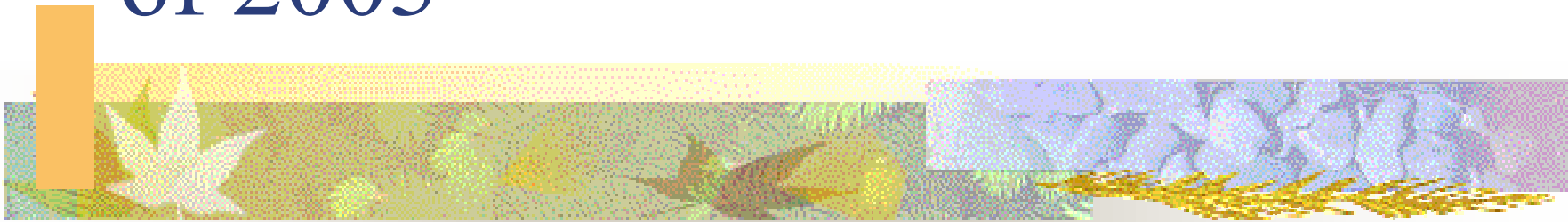


test

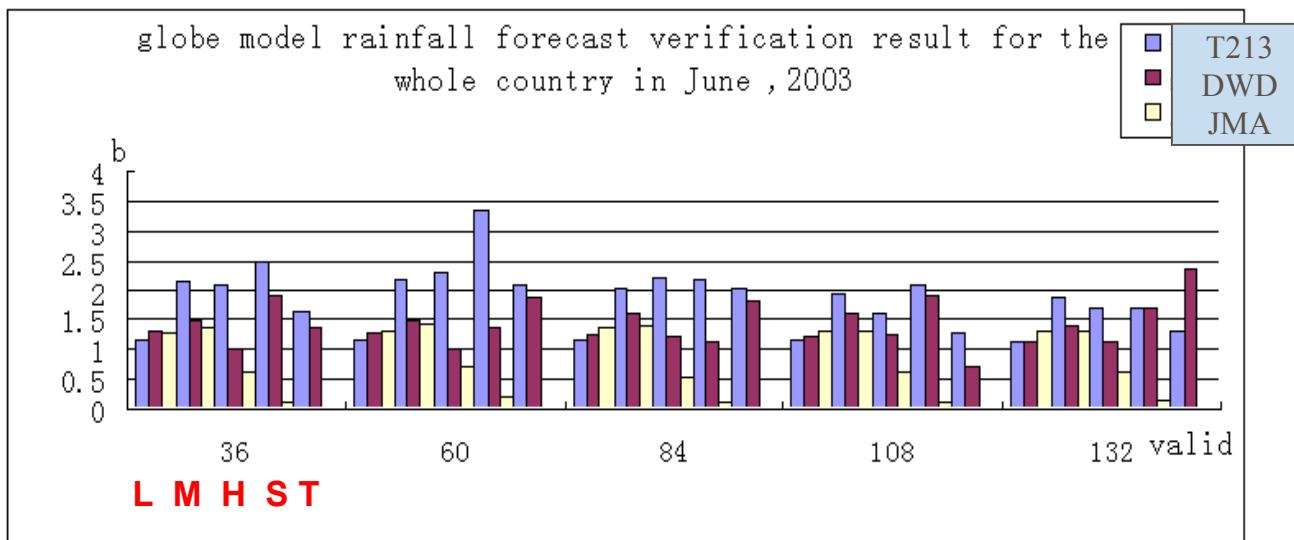
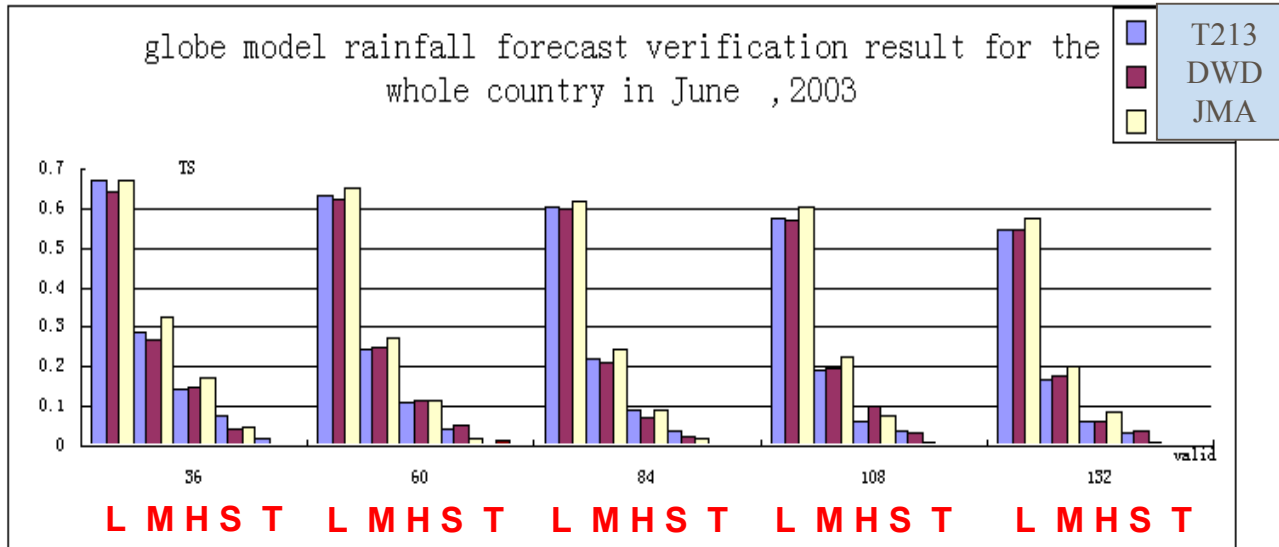


Ncep
reanalysis

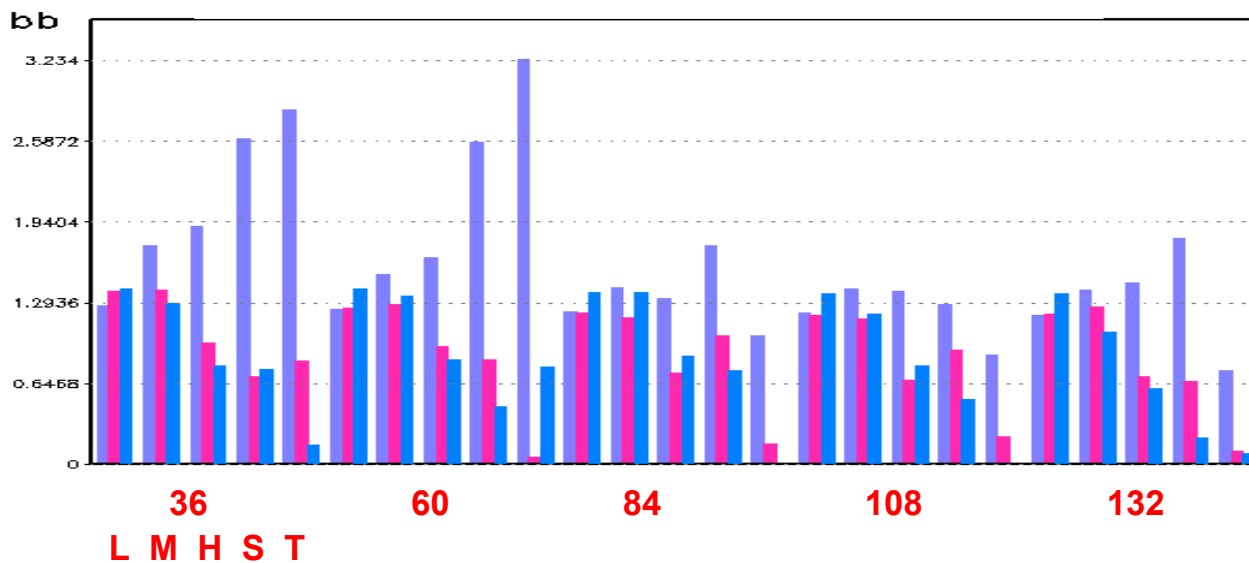
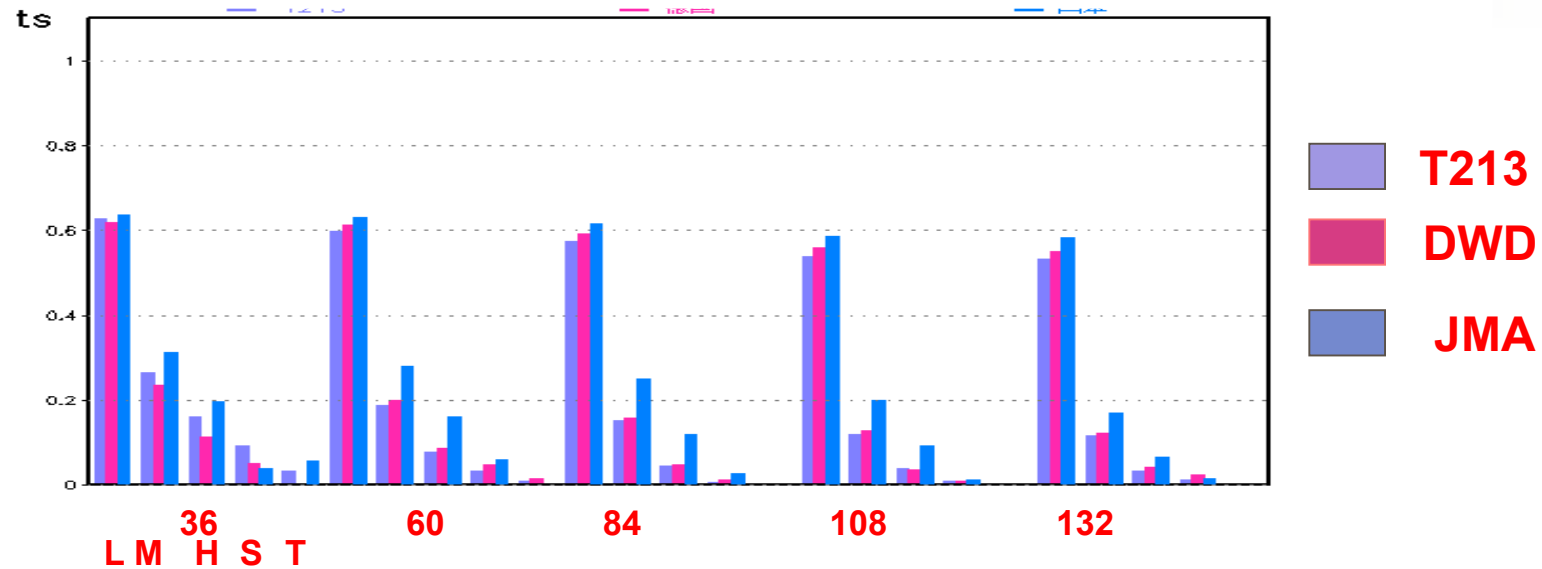
Rainfall Verification in Summer of 2003



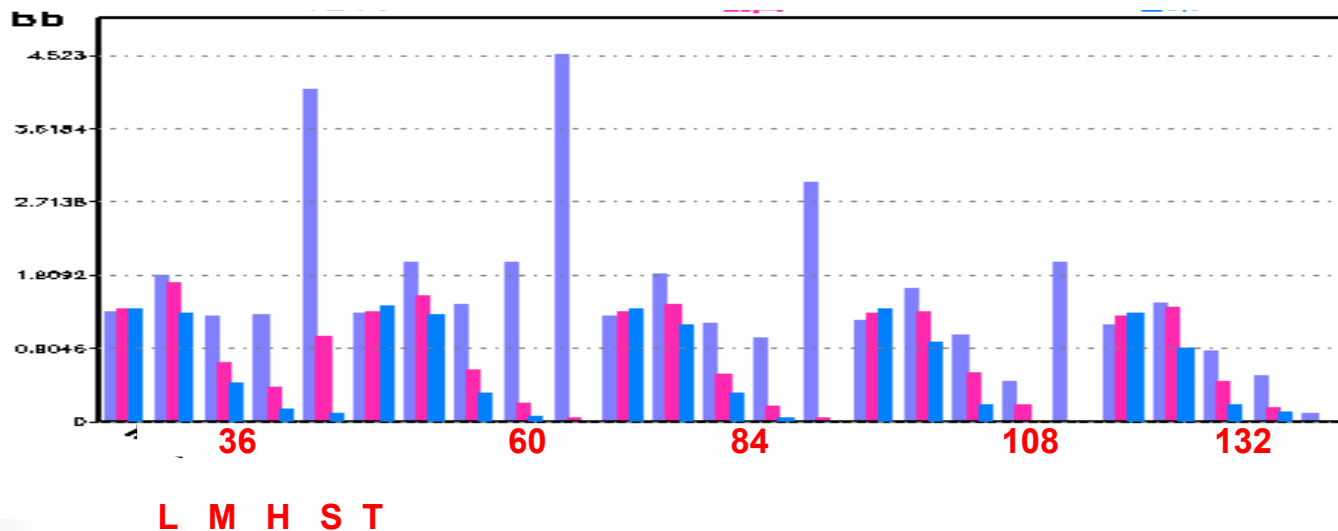
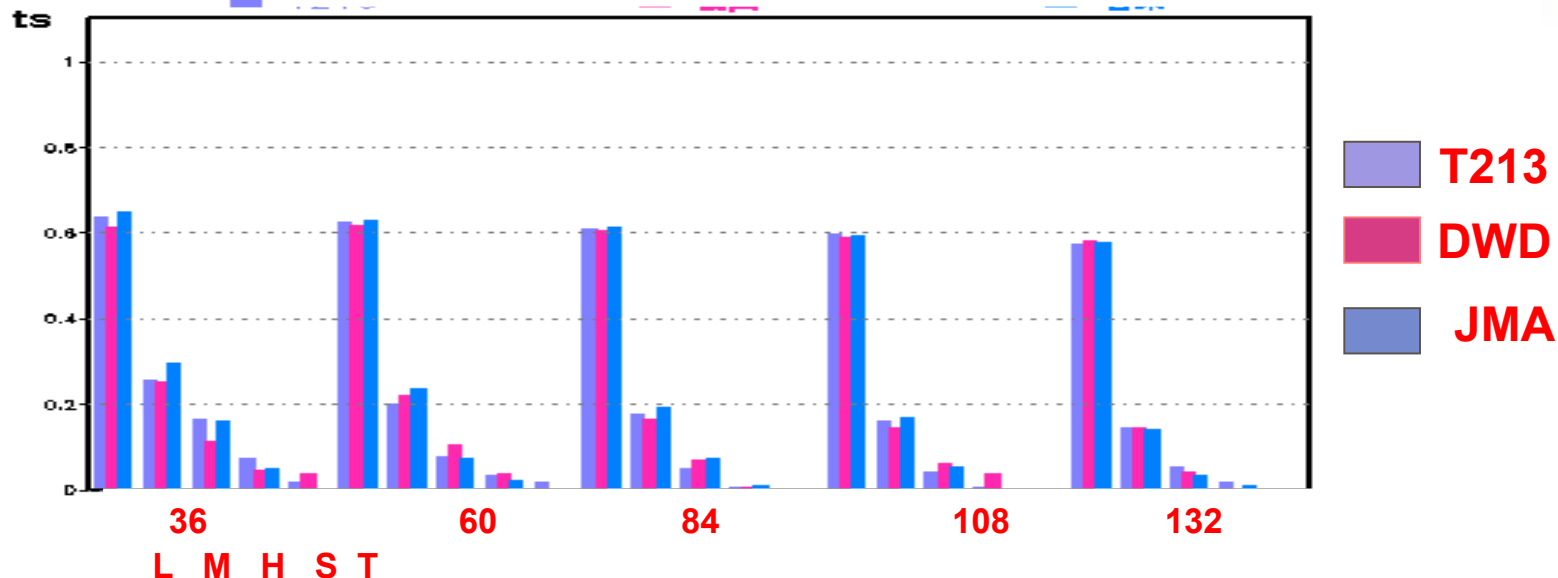
Comparison of rainfall verification for CHINA with different models (June, 2003)



Comparison of rainfall verification for CHINA with different models (July, 2003)



Comparison of rainfall verification for CHINA with different models (August, 2003)



Prospects for development





Prospects for development

improvement to operational system

- ◆ **Realization of SETTLS(Stable Extrapolation Two-Time_level Scheme):** with the kindly help of Dr. Hortal of ECMWF
- ◆ **Use of linear gaussian grid**
- ◆ **raise of resolution to T_{L511}L60(before 2008)**
- ◆ **More physical components in the models**
- ◆ **Improvement of assimilation algorithms,** with more efforts put on satellite and radar observation data
- ◆ **Development of surface analysis**



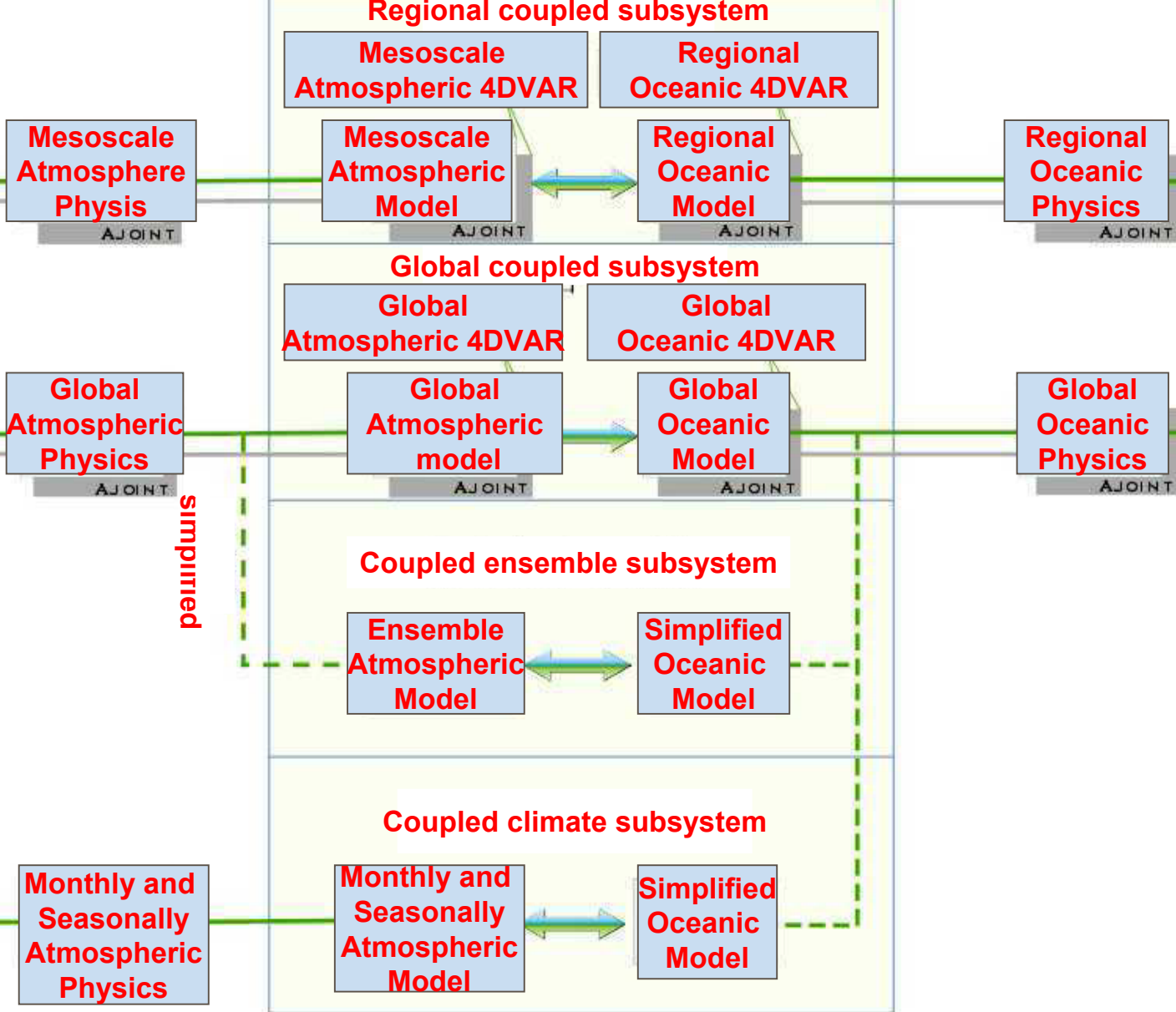
Prospects for development

Development of a unified model

- ◆ **Unified grid model**
- ◆ **Common dynamic frame used by multiply scale**
 - global, mesoscale and climate model**
- ◆ **4Dvar with stress on the use of satellite data**
- ◆ **Physical processes suitable to different scales**
- ◆ **Supportive environment**
 - program coding standards, graphic package, interface for research and development, product interpretation**

Atmosphere commonly used dynamic frame

Oceanic commonly used dynamic frame



The structure of the next generation numerical forecast system of CHINA

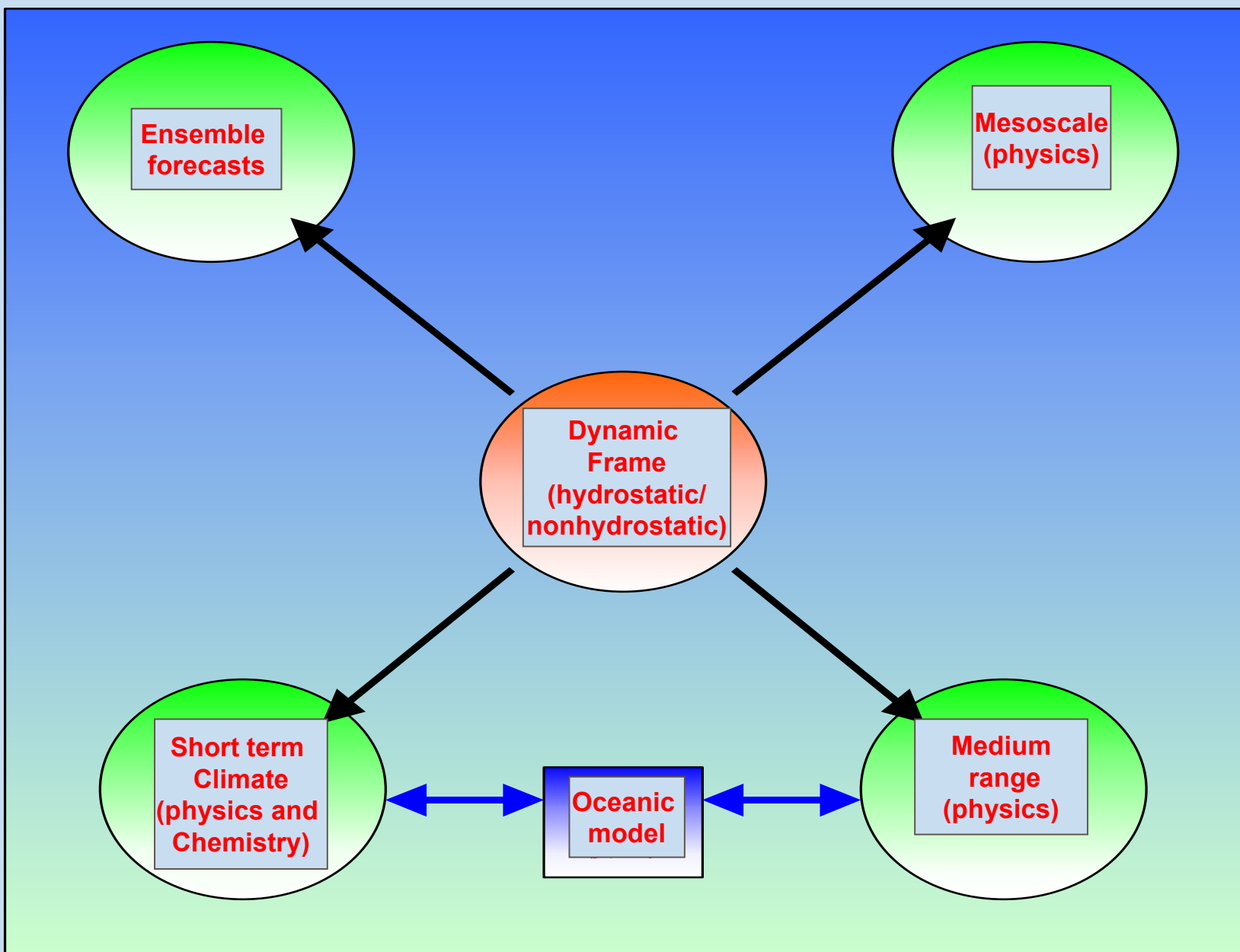
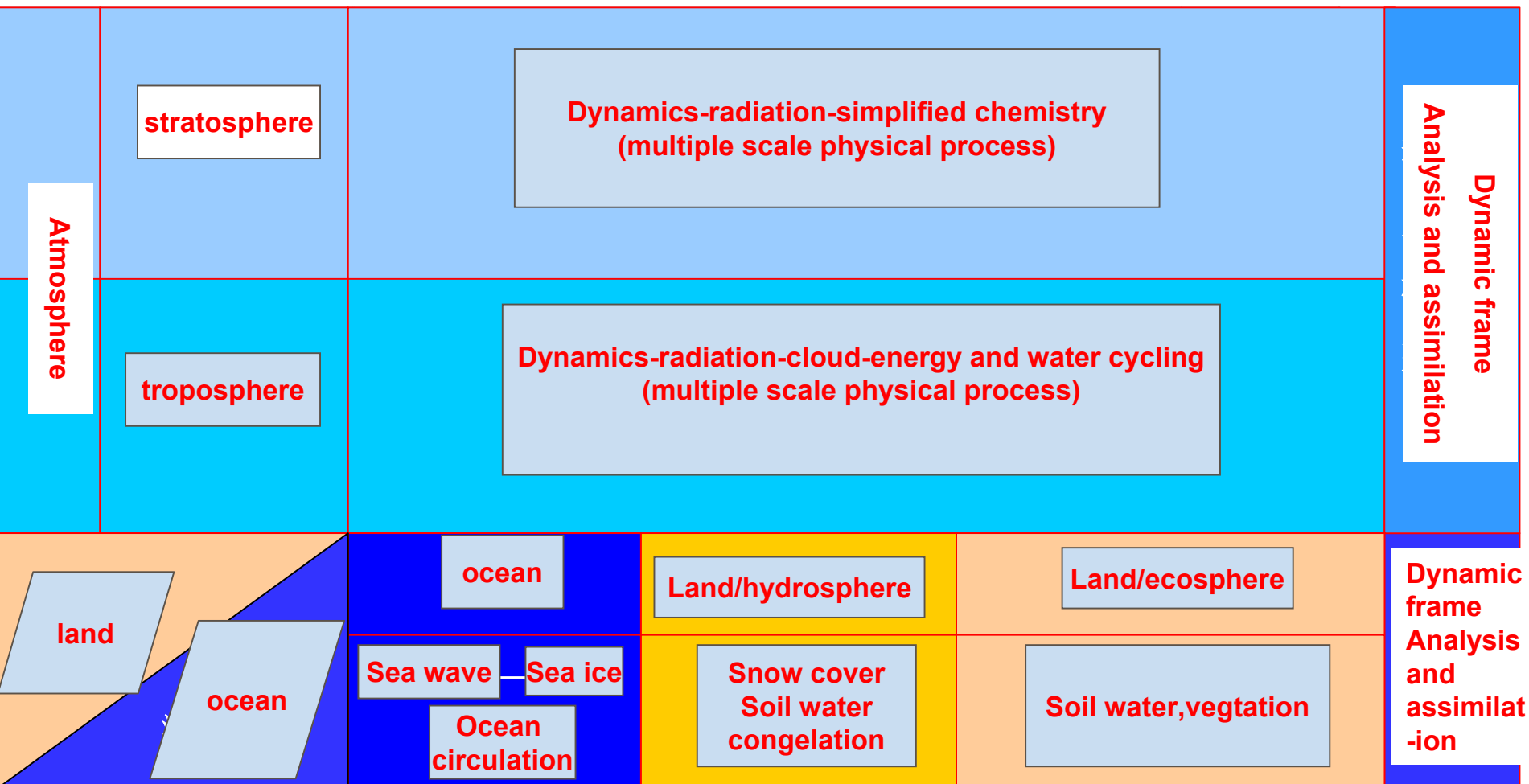
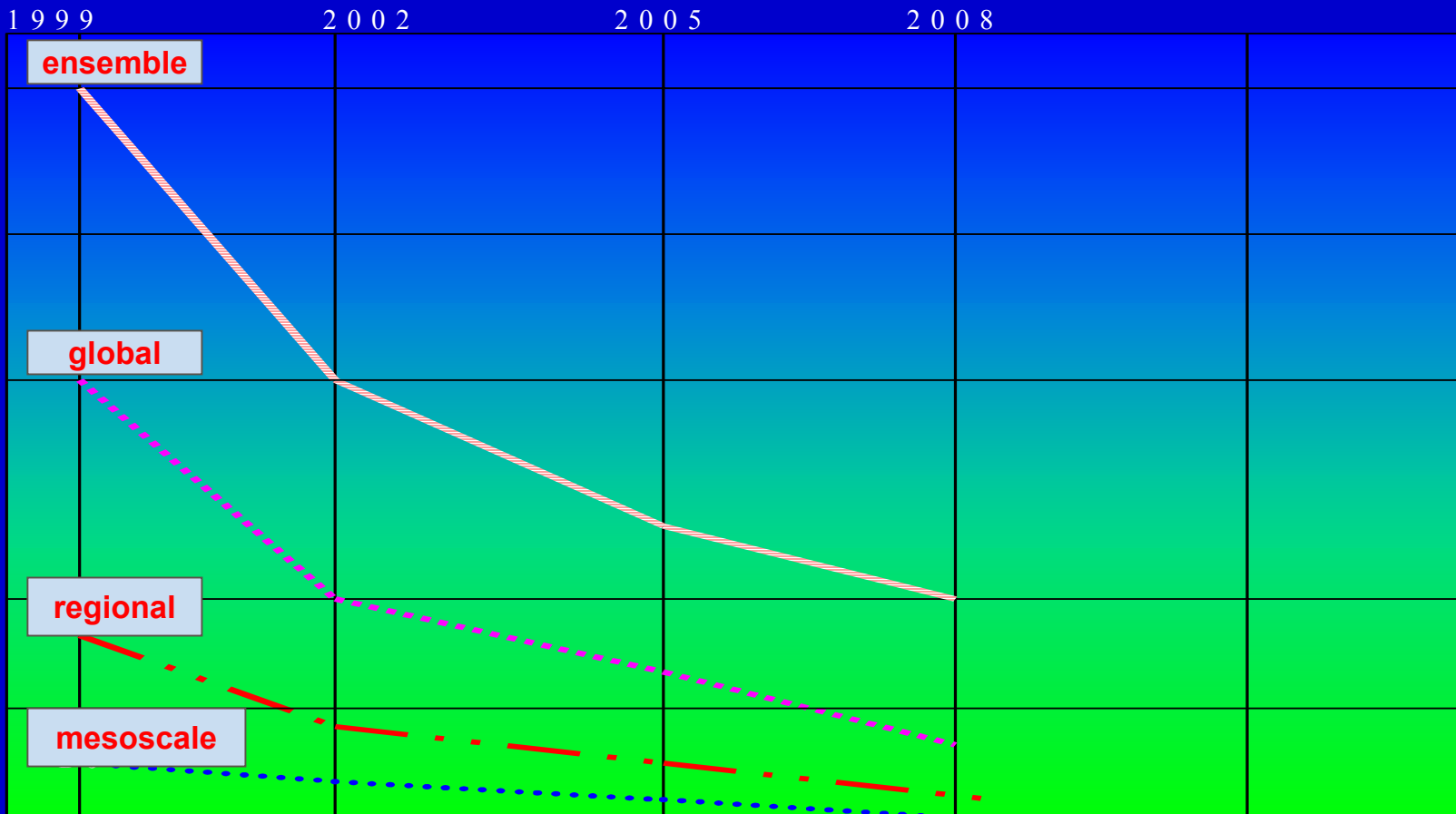


Illustration of multiple scale unified model

The unified model and assimilation system of CHINA



The increase of resolution of numerical forecast models as time goes on



year	1999	2001	2005	2008
mesoscale	15 K M	6 K M	3 K M	1 K M
regional	50 K M	25 K M	15 K M	5 K M
global	120 K M	60 K M	40 K M	20 K M
ensemble	200 K M	120 K M	80 K M	60 K M

Thank You!

