

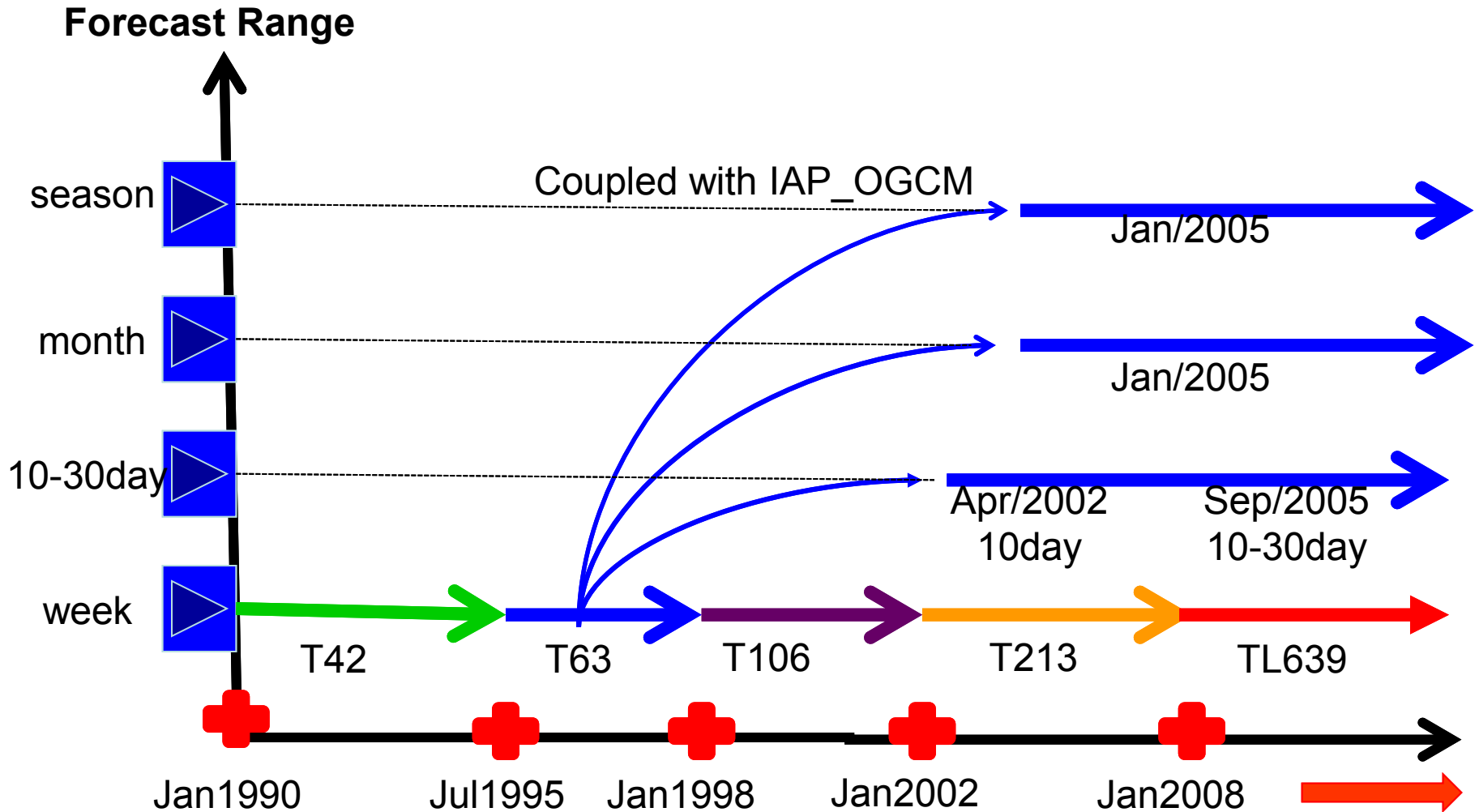
Introduction of Medium and Extended-range Weather Forecast Services in CMA

Xueshun Shen, Peiqun Zhang and Hua Tong
Center for Numerical Prediction
China Meteorological Administration

Contents

1. Medium and extended range forecast services in CMA
2. Supporting NWP systems
3. Development

History of CMA global medium to long range forecast systems



Medium and Extended Range Forecast Services

Kind of Forecast	Date of Issue	Forecast Model
1-week	00UTC & 12UTC, every day	<ul style="list-style-type: none"> • T_L639L60 • T213L31ensemble with fixed SST (since 2006)
10-30day forecast	<ul style="list-style-type: none"> ● End of every pentad:10day fcst. ● End of every 10-day: 20-day fcst. 	T63L16ensemble with persistent SSTA
1-month forecast	<ul style="list-style-type: none"> ● 28th of each month: monthly forecast ● 1st、6th、11th、16th、21th、26th of each month: 30-day forecast 	T63L16ensemble with persistent SSTA
3-month forecast	28 th of the month	CGCM
Flood season forecast (JJA)	1 April	CGCM
Annual forecast (DJF, MAM)	1 November	CGCM

Operational dissemination

NMC

NCC

NSMC

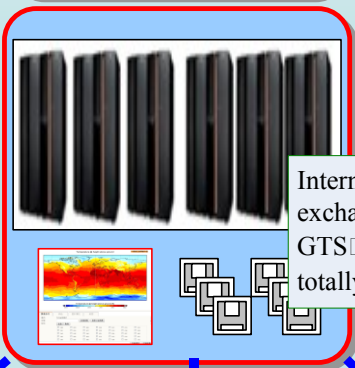
National Operational Center

CMA PRIVATE NET with about 10Mbps

Local net with 1000Mbps

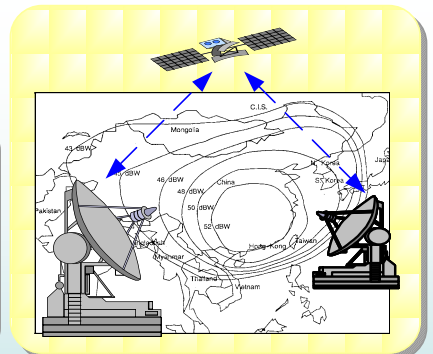
CMACAST covers China and surroundings with 70Mbps

Numerical Prediction Center

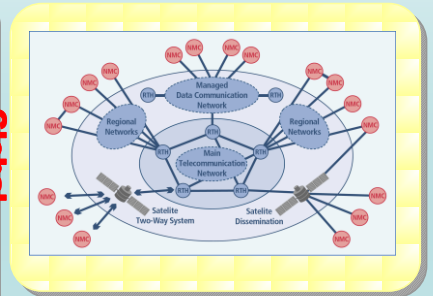


International exchange with GTS 6Mbps totally

Satellite cast



Global Telecommunication System

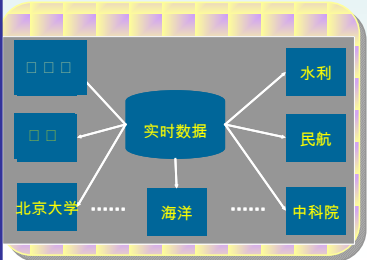


Regional/Province Operation Center



Leased line with 100Mbps

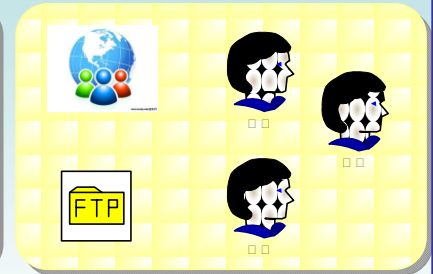
National ministries/universities



Human services calldesk



Global public



Internet

Web browse and FTP download by internet

Medium range forecast system

1-week forecast

Based on T639 deterministic forecast

	Global Spectral Model (T_L639L60)
Forecast range	Short- and Medium-range forecast
Forecast domain	Global
Horizontal resolution	T _L 639(0.28125 deg)
Vertical levels / Top	60 0.1 hPa
Forecast Hours (Initial time)	240 hours(00、 12 UTC) 84 hours (06、 18 UTC)
Initial Condition	Global Analysis (NCEP GSI)

T639 DA: GSI/NCEP

(grid-point statistical interpolation: *Wan-Shu Wu, R.*

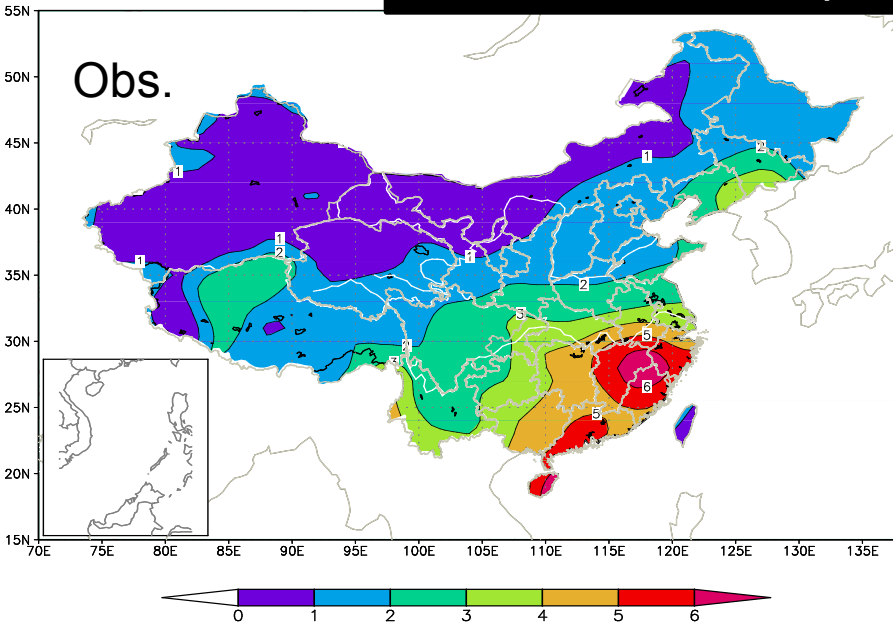
James Purser and David F. Parrish, 2002)

	Global Analysis
Analysis scheme	GSI 3DVAR
Analysis time	00, 06, 12, 18 UTC
Data cut-off time	3 hours 29 minutes (00, 12 UTC) 5 hours 45 minutes (06, 18 UTC) [Early Analysis] 10 hours (00, 12 UTC) 7 hours 40 minutes (06, 18 UTC) [Cycle Analysis]
Resolution	TL639L60
Assimilation window	-3 hours to +3 hours of analysis time

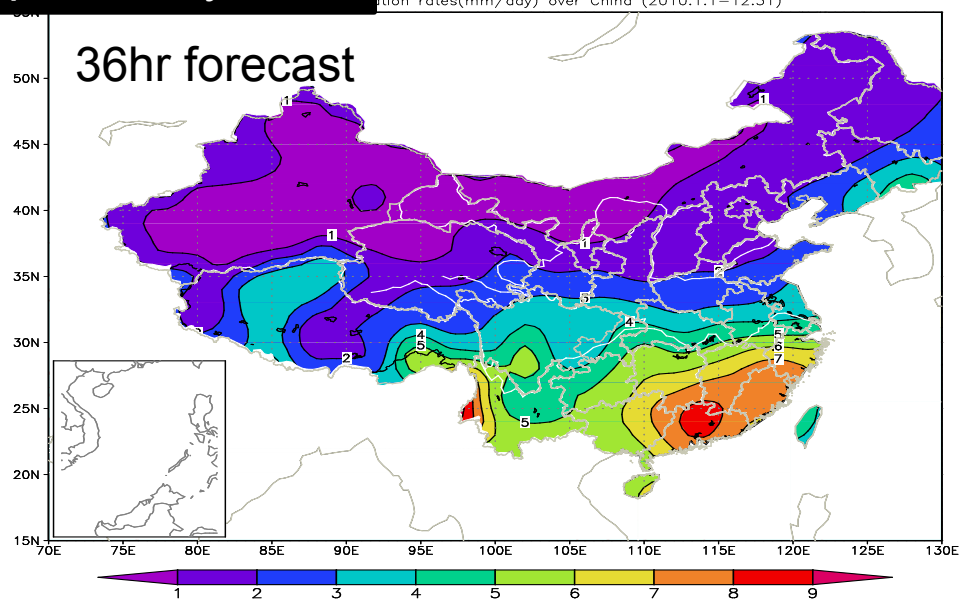
Conventional data
radiosondes,
aircraft,
synop,
ship,
buoy,
AMVs-Infrared
Satellite data
NOAA-15,-18 AMSUA
NOAA-15, AMSUB
NOAA-18, MHS

2010 annual mean precipitation by T639

Obs.

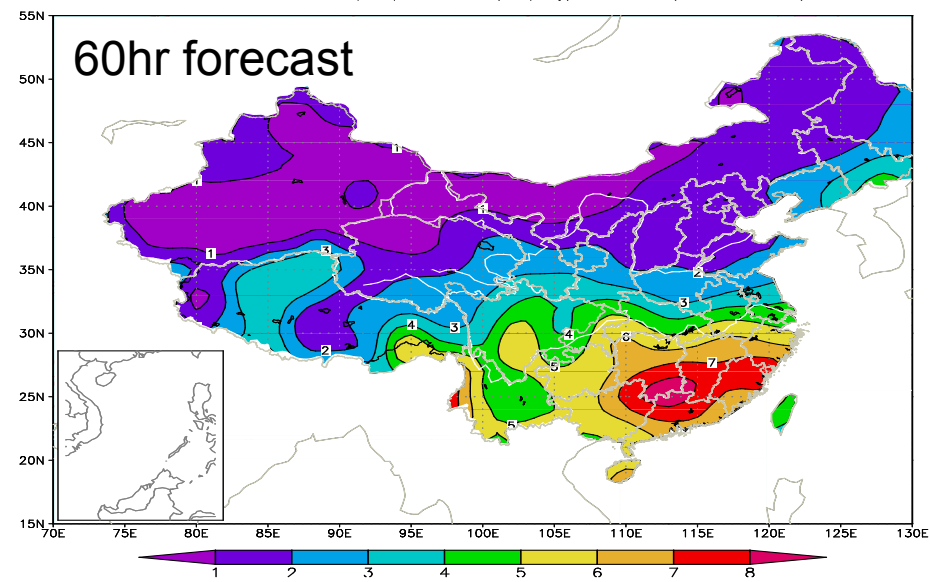


36hr forecast



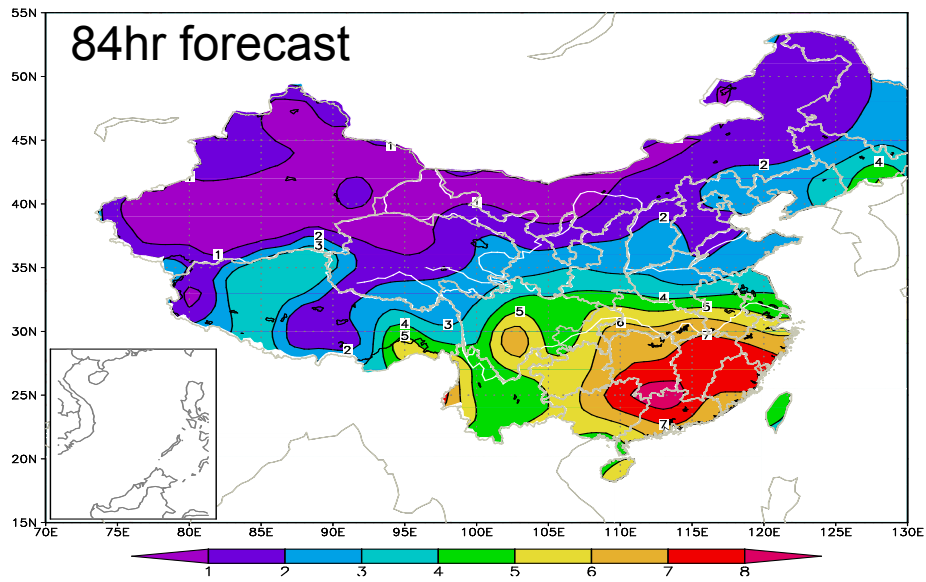
t639 60h forecast mean precipitation rates(mm/day) over China (2010.1.1-12.31)

60hr forecast

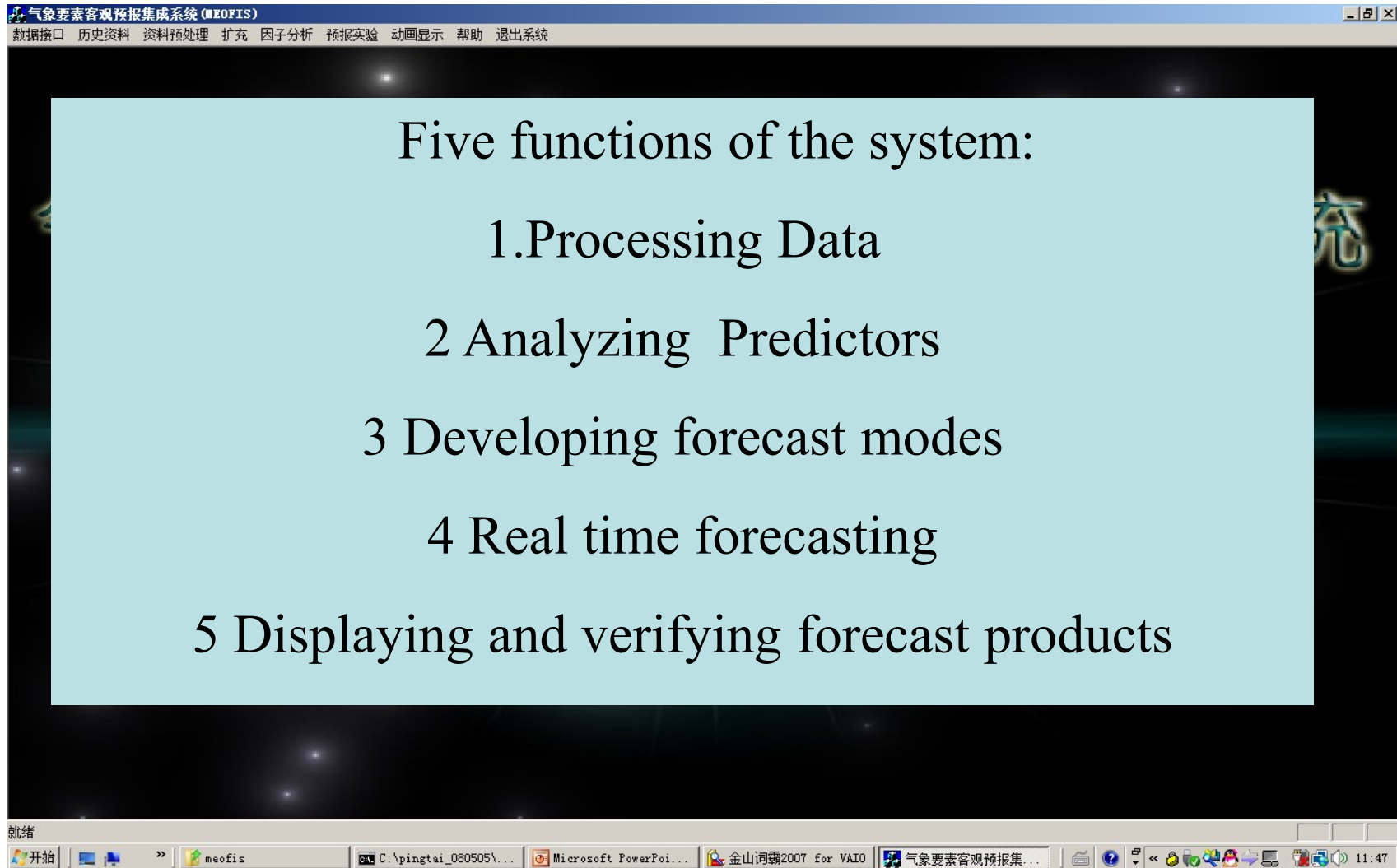


t639 84h forecast mean precipitation rates(mm/day) over China (2010.1.1-12.31)

84hr forecast



The CMA Objective Meteorological Forecast System



气象要素客观预报集成系统 (MEOPFS)

数据接口 历史资料 资料预处理 扩充 因子分析 预报实验 动画显示 帮助 退出系统

Five functions of the system:

1. Processing Data
- 2 Analyzing Predictors
- 3 Developing forecast modes
- 4 Real time forecasting
- 5 Displaying and verifying forecast products

就绪

开始 | meofis | C:\pingtai_080505\... | Microsoft PowerPoi... | 金山词霸2007 for VAI0 | 气象要素客观预报集... | 11:47

Medium-range forecast examples of guidance used in CMA

About 2600 stations
Valid at 00 & 12 UTC

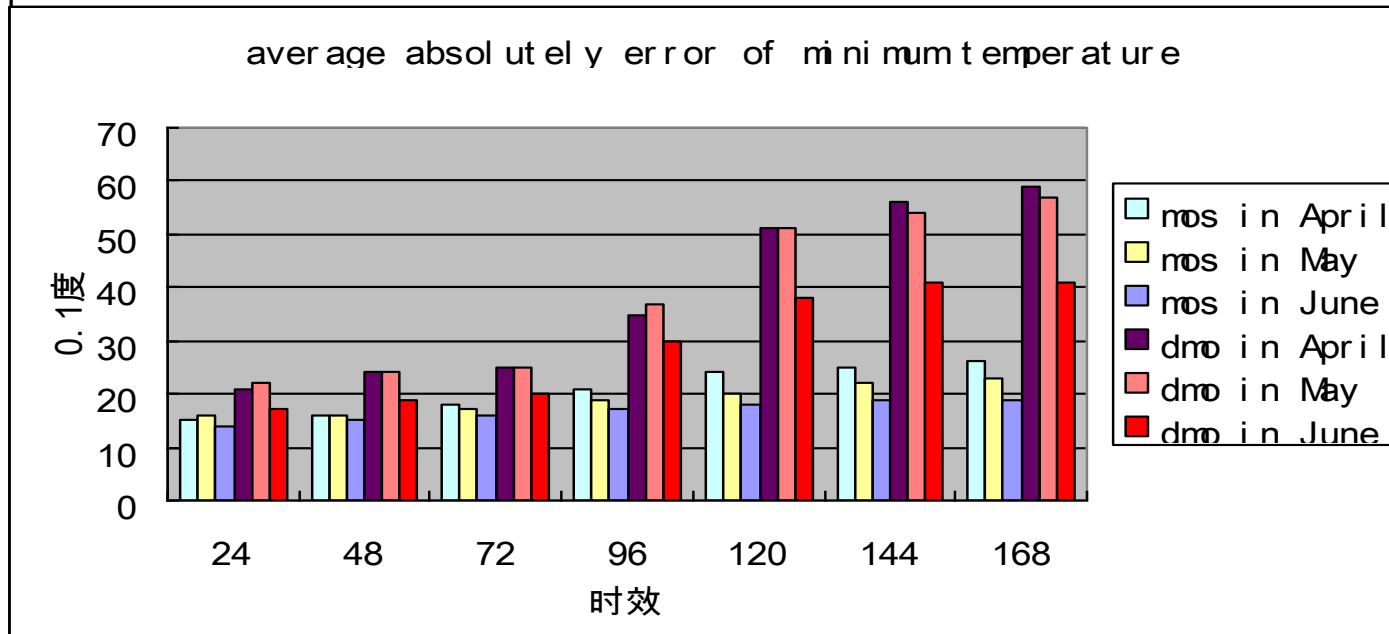
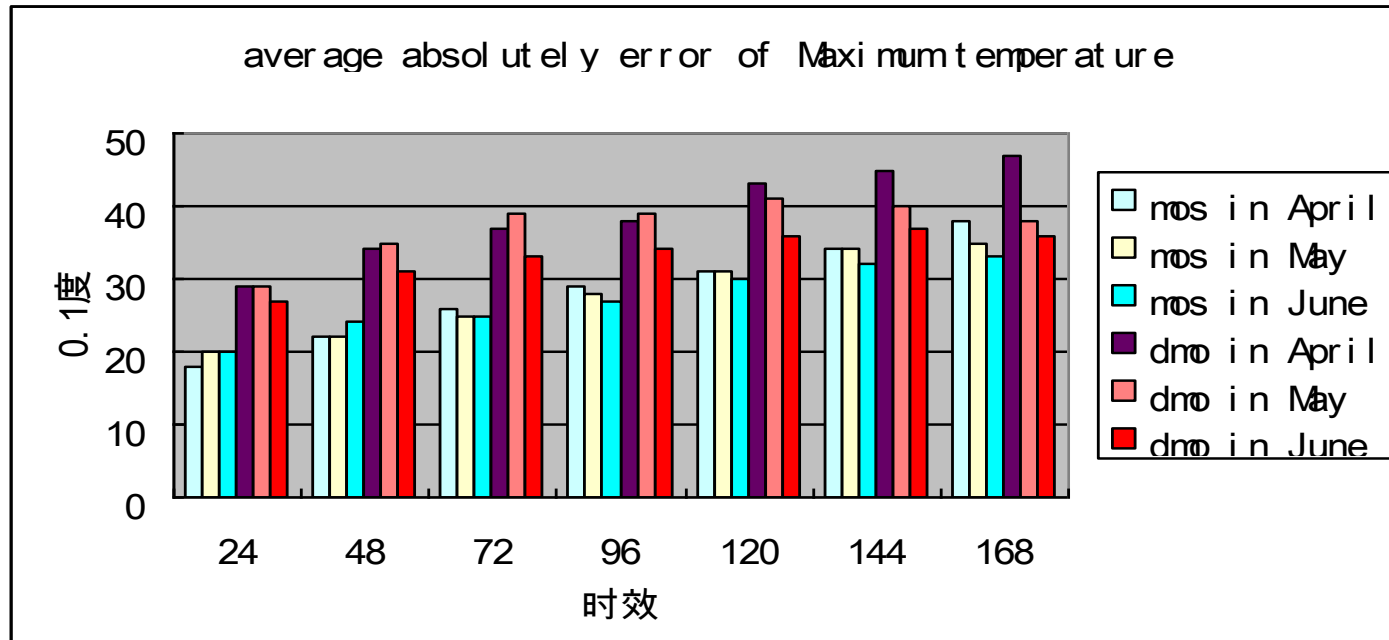
- **Algorithm**

- Neural network
- Kalman filter

- 12-h precipitation
- wind speed and wind direction (*prevailing during 12 hours*)
- cloud cover (*averaged during 12 hours*)
- max/min temperature
- max/min relative humidity
- Categorized weather

**from 24 to 168-h projection
with 12-h interval**

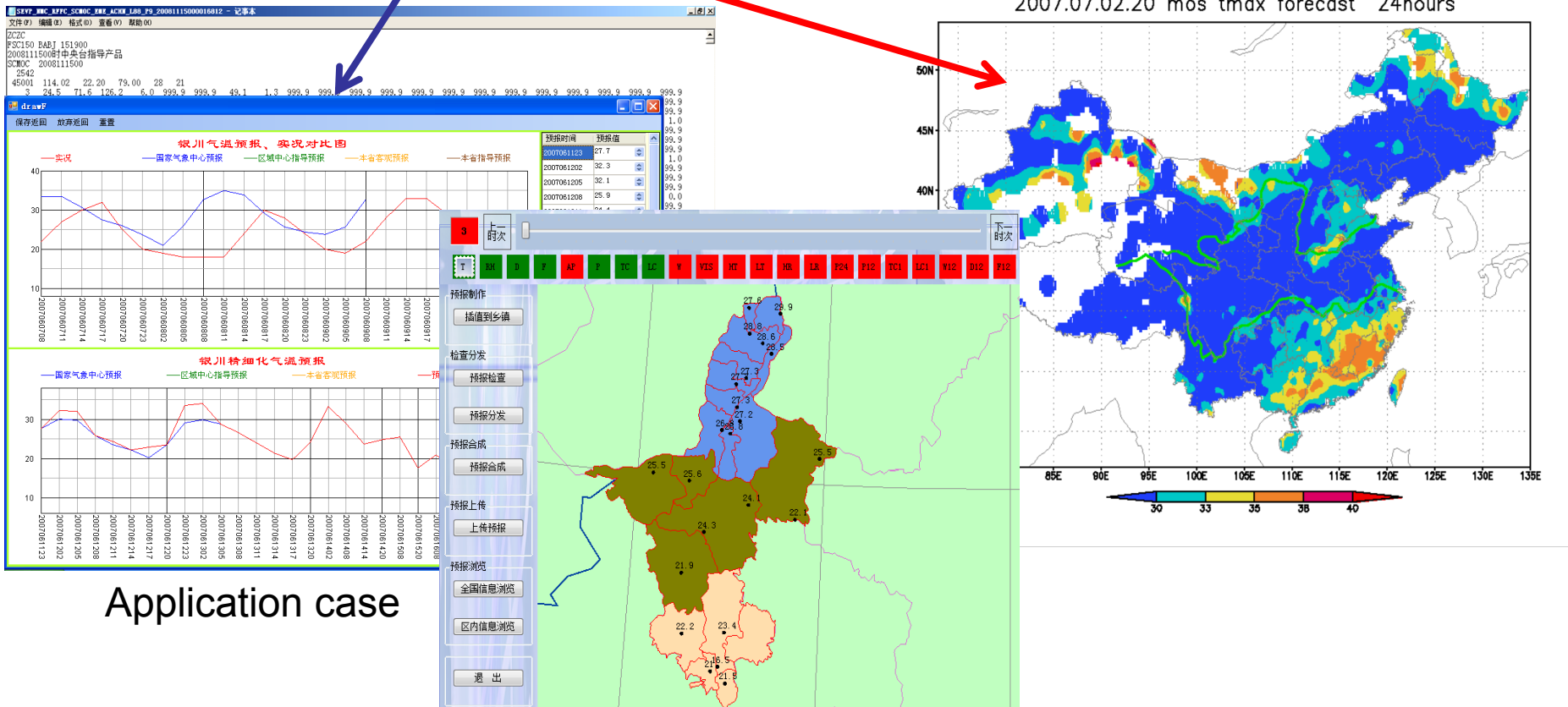
Error of Max/Min temperature of MOS and DMO in Apr.~Jun. 2008



Guidance issuance

- Data with MICAPS format
- Graphic form

Meteorological Information
Comprehensive Analysis and Process
System



Application case

10 and 10-30 day forecast model

Horizontal resolution	T63 (~1.875° Gaussian grid)
Vertical levels	16 (Top Layer Pressure:25hPa)
Time integration range	45 days
Executing frequency	Once every pentad
Ensemble size	40 members
Initial values & perturbation method	CMA global analysis SV & Lagged Average Forecast (LAF) method
SST	Persisted anomaly
Land surface Parameters	Initial conditions of land parameters are provided by climatology

forecast products by T63L16 40m ensemble with persistent SSTA

- (1) 10-day mean precipitation anomaly percentage
- (2) 10-day mean precipitation most likely categories
- (3) 10-day mean temperature anomaly
- (4) 10-day mean temperature most likely categories
- (5) 10-day mean 500hPa height anomaly
- (6) 10-day mean sea level pressure anomaly
- (7) 10-day mean 200hPa wind anomaly
- (8) 10-day mean 700hPa wind anomaly

10 and 10-30day forecast guidance

Methods:

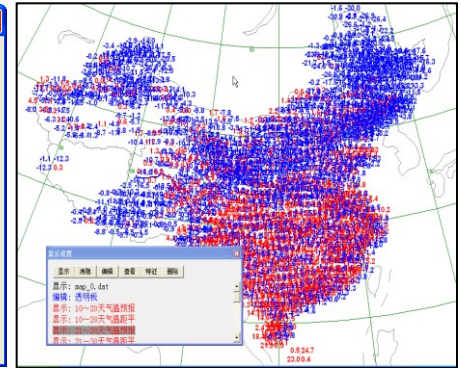
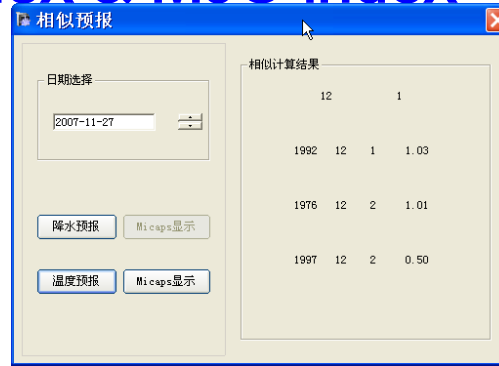
- T63L16 ensemble forecast (40members) with persistent SSTA

- Synoptic theory: westerly index & MJO 基于统计方法的综合相似预报

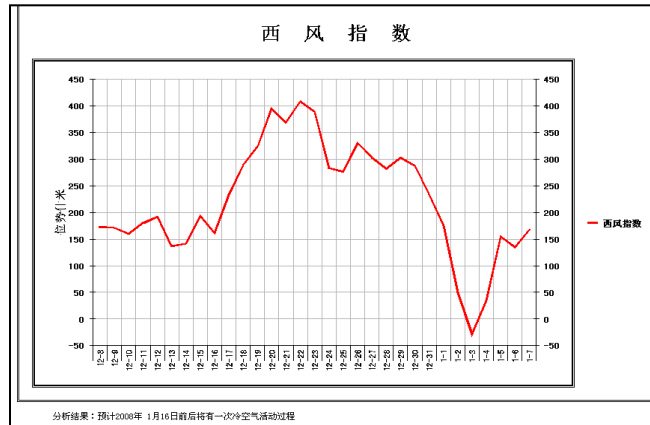
- Statistics: pattern similarity

$$I_{ij} = r_{ij} \left(1 - \frac{E_{ij}}{n\sigma}\right)$$

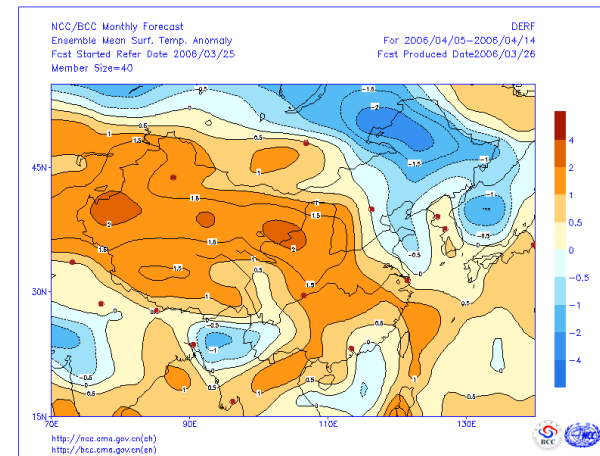
利用天气气候学方法，建立的基于西风指数循环理论的寒潮天气过程延伸期预报方法



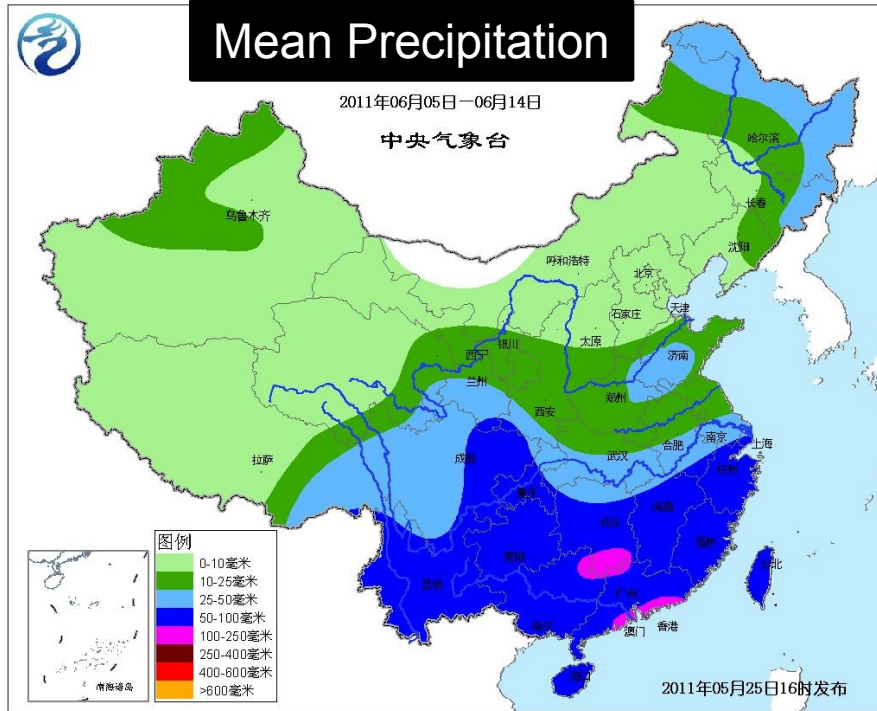
国家气候中心月动力延伸集合预报产品



基于西风指数循环理论的强冷空气过程延伸期预报模型

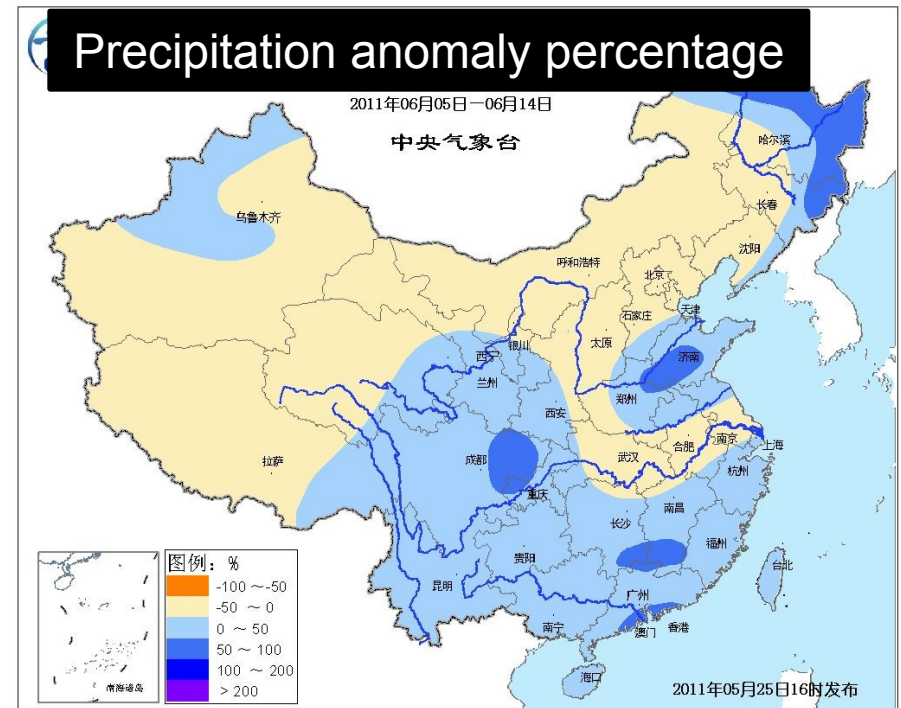
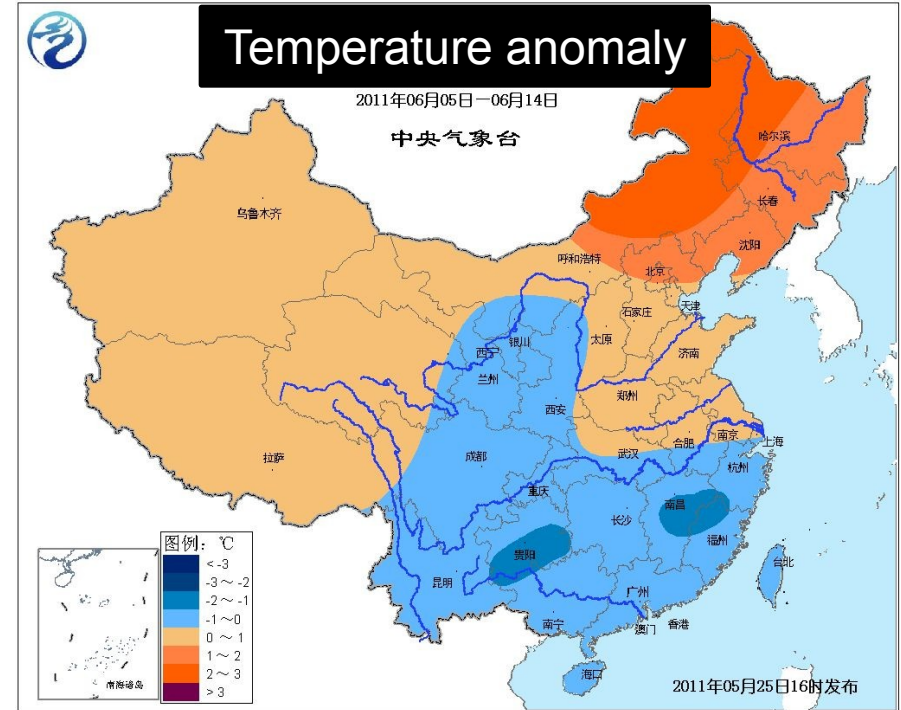


Example of 10-day forecast guidance



每候末发布：第2旬降水量预报、降水量距平和气温距平预报。

每旬末发布未来第2、3旬降水量预报（夏半年）、未来第2、3旬气温距平预报（冬半年）。



Successful example of 10-day forecast service flood in Huai River in July, 2007



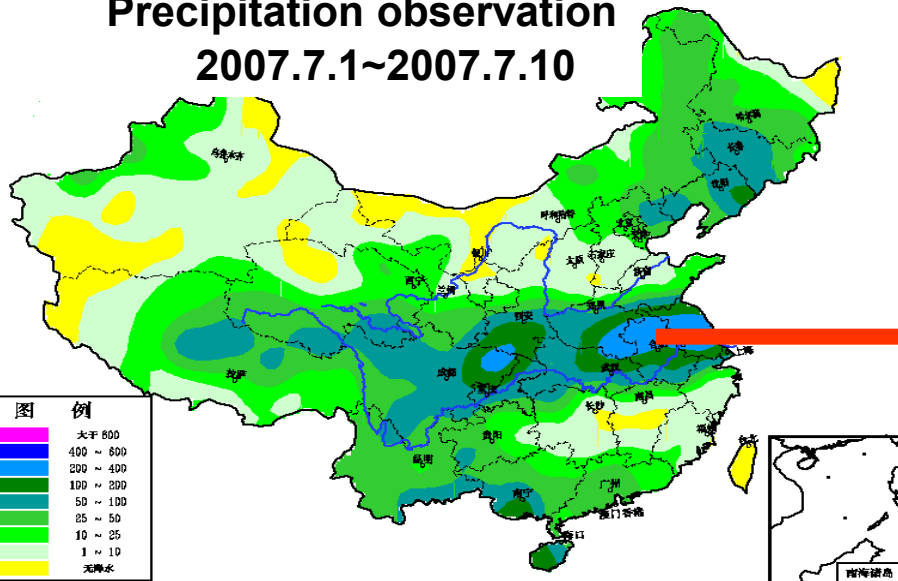
中期旬报

中国气象局中央气象台 预报: 牛若芸 2007年06月29日
签发: 王秀文

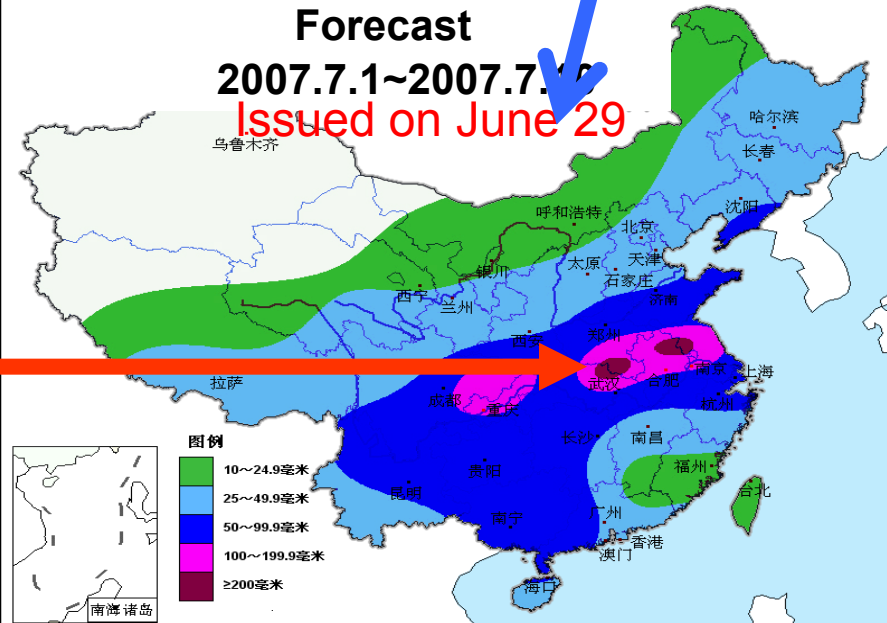
7月上旬天气趋势预报

一、上旬天气趋势
 预计7月上旬, **主要雨带将位于四川盆地东部至淮河流域一带, 旬雨量一般有60-90毫米, 部分地区有100-180毫米, 局部可超过200毫米; 降雨量较常年同期偏多, 成至1倍, 局部地区偏多2倍以上。** 华北地区东部、东北地区多阵性降雨, 降雨量一般有10-25毫米, 其中东北地区南部的局部地区有30-50毫米; 大部分地区雨量基本与常年同期持平。西北地区东部、西南地区多阴雨天气, 降水, 华北多雨, 东北多雨, 部分

Precipitation observation
2007.7.1~2007.7.10

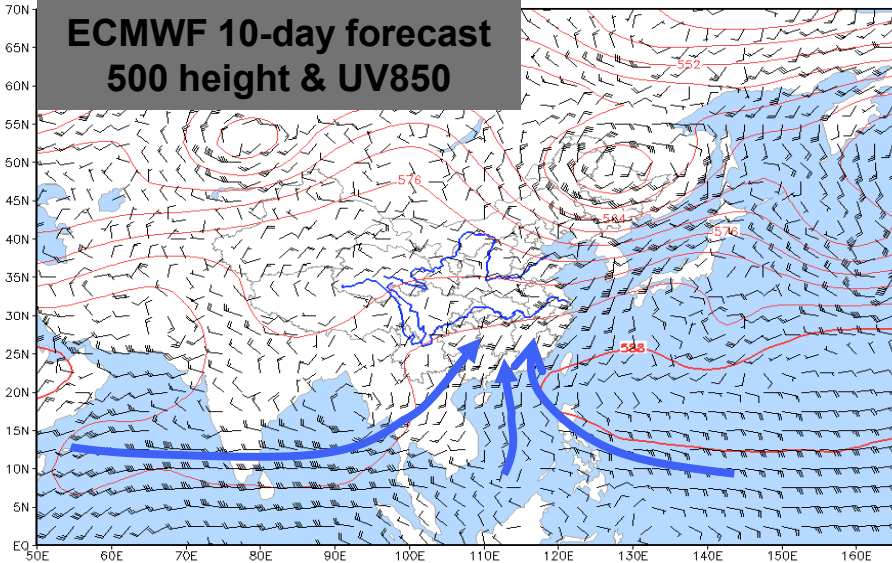


Forecast
2007.7.1~2007.7.10
Issued on June 29

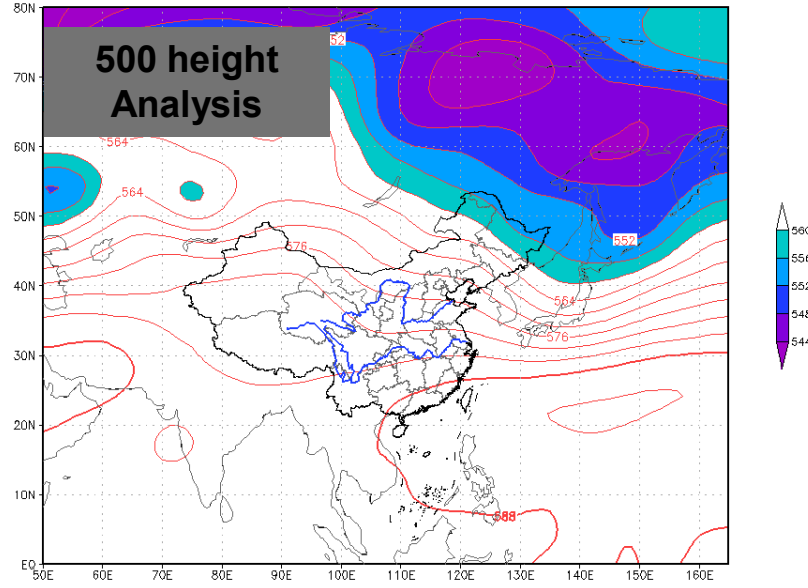


Application of ECMWF medium-range forecast

500hPa Height & 850hPa Wind 240HR Forecast
Initial Time: 20Z26MAY2011



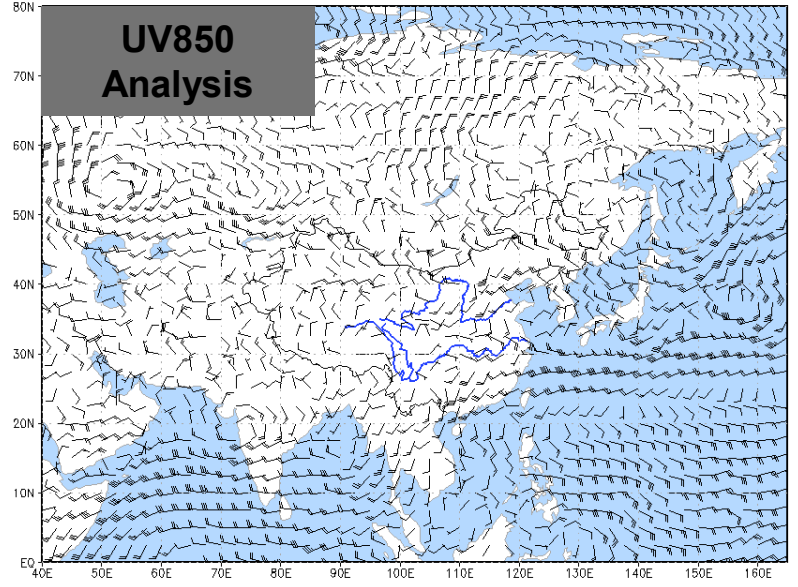
Average 500hPa HGT from 20Z05JUN2011 to 20Z05JUN2011



Successfully predict the transition of weather regime from draught to wet.

- Severe draught over the southern China during April-May,2011.
- The EC 10-day forecast from May 26 showed the transition: southerly wind will become dominant & subtropical high will move westward.

Average 850hPa Wind from 20Z05JUN2011 to 20Z05JUN2011



Outline of CMA's Long-range Forecasts

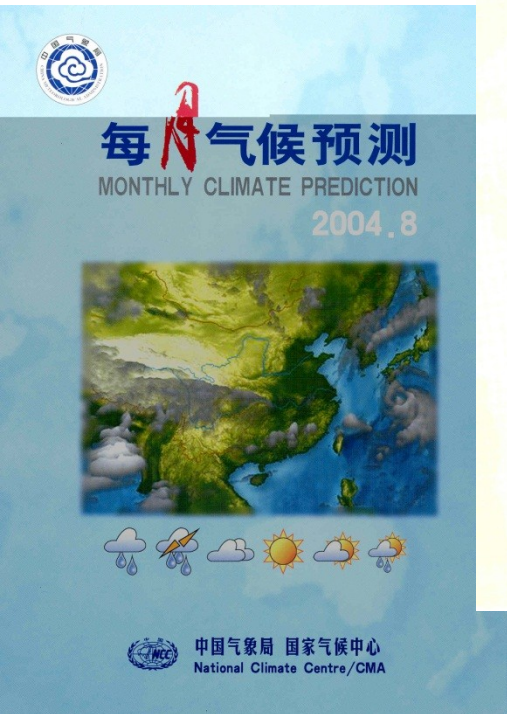
3-month and 1-month forecast

Kind of Forecast	Three-month/flood season/annual forecast	One-month forecast
Date of issue	Model: 22th of the month Official issue: 28th of each month	Model: 21th of the month Official issue: 28th of each month
Products	<ul style="list-style-type: none"> • precipitation and its anomaly percentage • surface temperature anomaly • most likely precipitation categories • most likely temperature categories • 200hPa wind anomaly • 850hPa wind anomaly • 500hPa height and its anomaly 	<ul style="list-style-type: none"> • precipitation anomaly percentage • mean precipitation most likely categories • temperature anomaly • mean temperature most likely categories • 500hPa height anomaly • sea level pressure anomaly • 200hPa wind anomaly • 700hPa wind anomaly
Forecast Method	CGCM Statistical methods	T63L16 Statistical methods

Other Guidance Products for long-range forecast based on the CGCM ensemble

- **Monthly/Seasonal precipitation and temperature**
- **Tropical cyclone frequency**
- **Cold air activities**
- **Climate condition of crop seeding**
- **First frost date**
- **Monsoon onset and withdraw date and its intensity**
- **Forest and grassland fireproofing**
- **Sand storm frequency**
- **and**

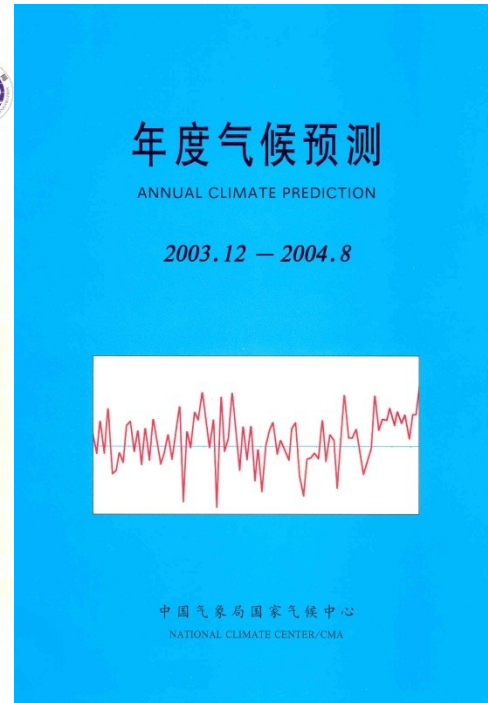
Issuance of Climate Prediction Products



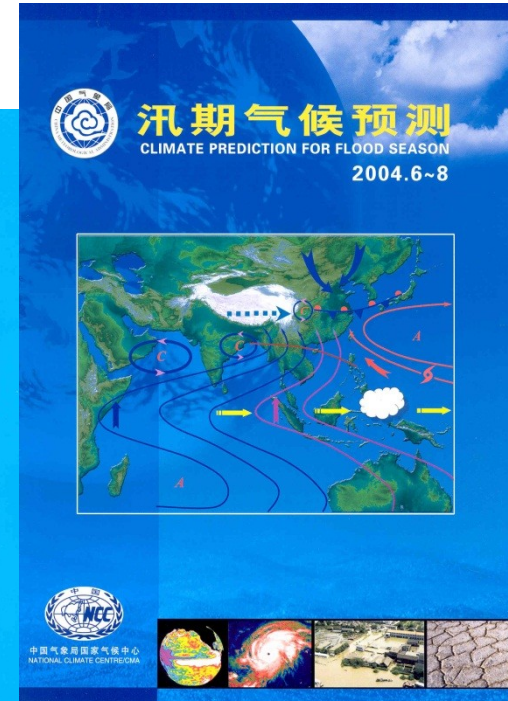
Monthly



July and August



Annual



Summer

Issuance of Climate Prediction Products

Beijing Climate Center - Windows

http://bcc.cma.gov.cn/en/

文件(F) 编辑(E) 查看(V) 收藏夹(A) 工具(T) 帮助(H)

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Beijing Climate Center

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NEWS

Latest Drought Monitoring and Prediction in China—August 22, 2011

Latest Drought Monitoring and Prediction in China—August 15, 2011

Latest Drought Monitoring and Prediction in China—June 13, 2011

Latest Drought Monitoring and Prediction in China—May, 16, 2011

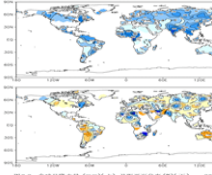
Latest Drought Monitoring and Prediction in China—May, 9, 2011

Latest Drought Monitoring and Prediction in China—May, 3, 2011

more news >>

EAMAC
East Asian Monsoon Activity Centre

BCC Visiting Scholar Programme



1 2 3 4 5

Global Monthly Precipitation Total

Climate System Monitoring
Climate System Monitoring Bulletin

World Meteorological Organization WMO

CMA www.cma.gov.cn

开始 | Introduction of ... | CMA REPORT [兼容... | Sep1-1 | Beijing C

Beijing Climate Center - Windows Internet Explorer


http://cmdp.ncc.cma.gov.cn/en/index.php?product=md

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Beijing Climate Center



中国气象局国家气候中心

气候系统监测·诊断·预测·评估



HomePage About Us News Monitoring Prediction Download Special Columns

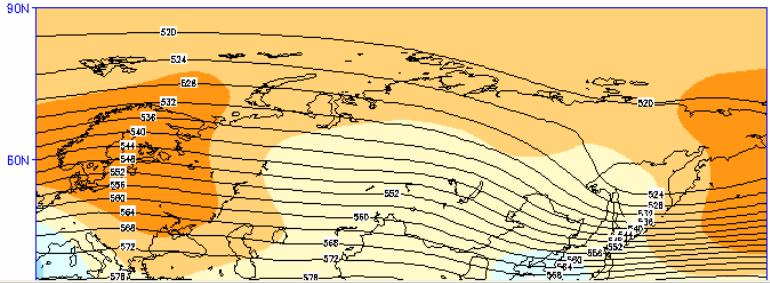
Position: Homepage -> What's New!

User: Password: **Login** **Register**

NEW	月模式预测	季节模式预测	ENSO模式预测	季风	冰雪监测	厄尔尼诺与南方涛动
	最近10天	最近20天	最近30天	月平均	本月截至今日	本季截至今日
中国						
全球						

NCC/BCC Monthly Forecast
Ensemble Mean 500hPa Height Anomaly
Fcst Started Refer Date 2011/10/05
Member Size=40

DERF
For 2011/11/05-2011/11/14
Fcst Produced Date 2011/10/06



90N

60N

16
8
4
2
0
-2

Home Chinese

Monitoring Diagnosis
Sea Ice & Snow Cover
Global Extreme Weather and Climate Events
El Nino/Southern Oscillation
Climate System Monitoring Bulletin

Climate Prediction
monthly seasonal
Verification(monthly seasonal)

Special Columns
Monsoon Drought
Hot Waves
Extended Range Process

Data Center
Observations / Analysis
Data / Model Output

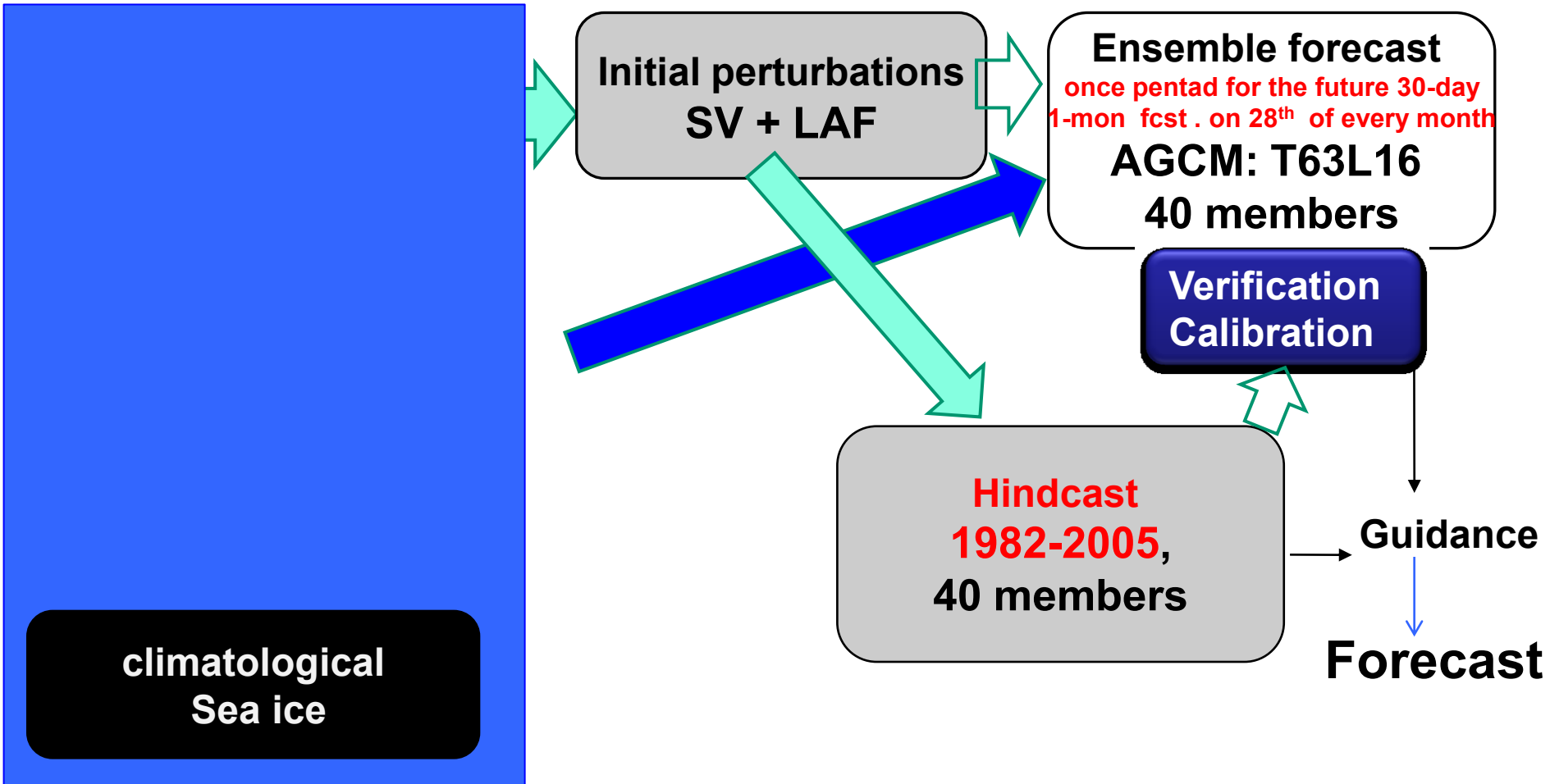
Visits (the recent 100 days)

开始 | Introduction of ... | CMA REPORT [兼容... | Sep1-1 | Beijing Climate ... | Beijing Climate ...

<http://bcc.cma.gov.cn>
<http://ncc.cma.gov.cn>

One-month Forecast System

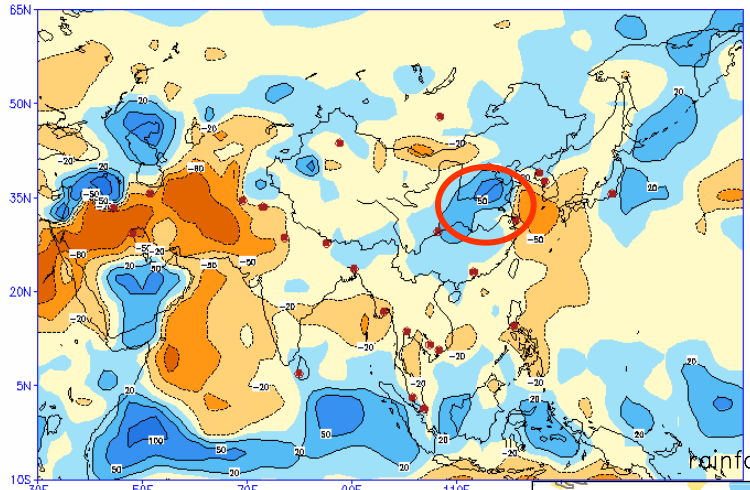
Initial Values & Boundary Conditions



An example: 30-day mean precipitation anomaly percentage (left) and the most likely categories (right) August. 2011

NCC/BCC Monthly Forecast
Ensemble Mean Preci Anomaly Percentage
Fcst Started Refer Date 2011/07/19
Member Size=32

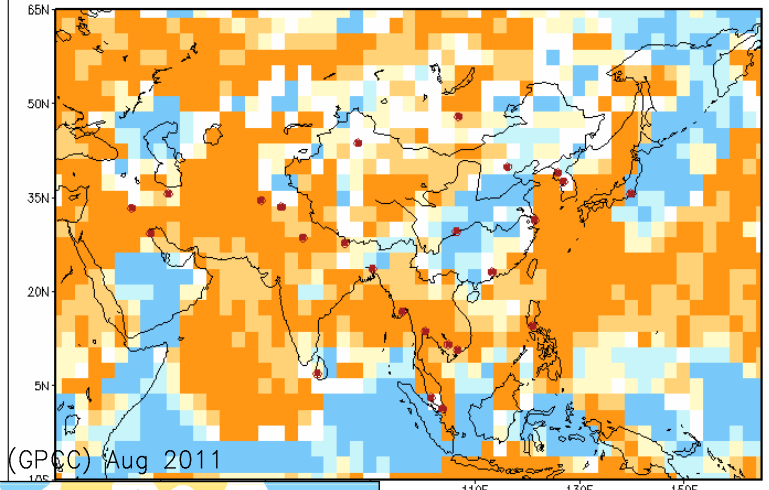
DERF
For 2011/07/31-2011/08/29
Fcst Produced Date 2011/07/20



[http://ncc.cma.gov.cn\(ch\)](http://ncc.cma.gov.cn(ch))
[http://bcc.cma.gov.cn\(en\)](http://bcc.cma.gov.cn(en))

NCC/BCC Monthly Forecast
Most Likely Precipitation Categories
Fcst Started Refer Date 2011/07/19
Member Size=32

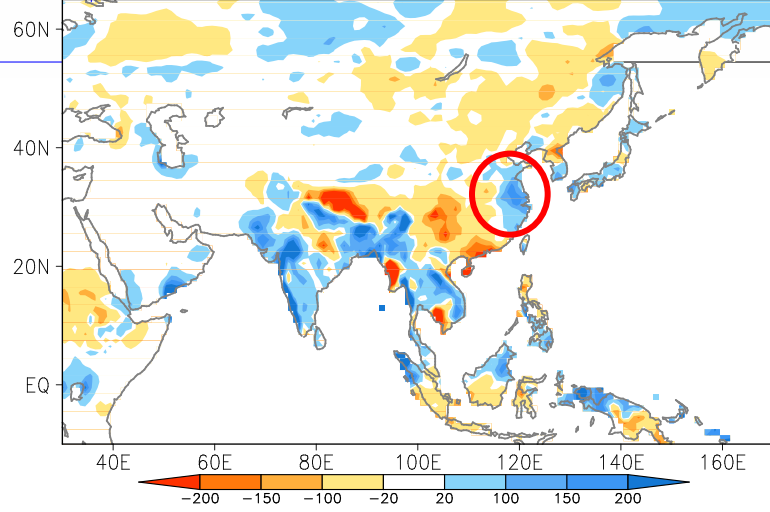
DERF
For 2011/07/31-2011/08/29
Fcst Produced Date 2011/07/20



wet
normal
dry



rainfall anom. (GPCP) Aug 2011



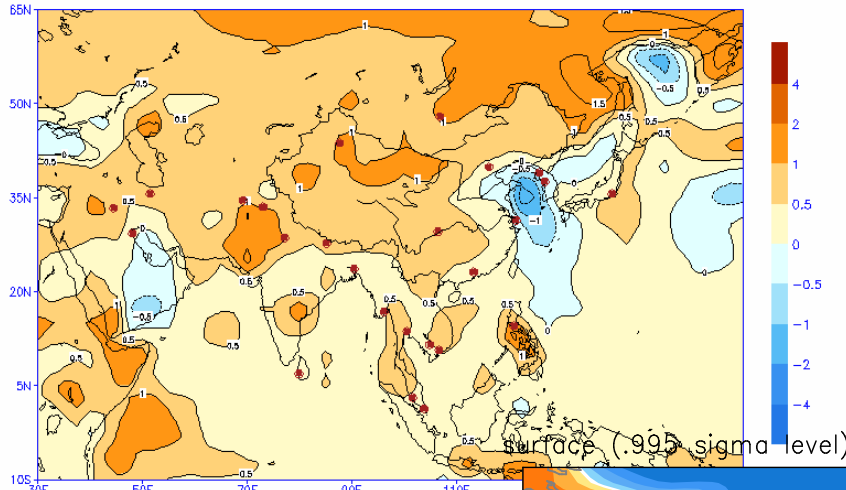
GPCP rainfall anomaly

30-day mean temperature anomaly (left, unit:°C) and the most likely categories (right)

August. 2011

NCC/BCC Monthly Forecast
Ensemble Mean Surf. Temp. Anomaly
Fcst Started Refer Date 2011/07/19
Member Size=32

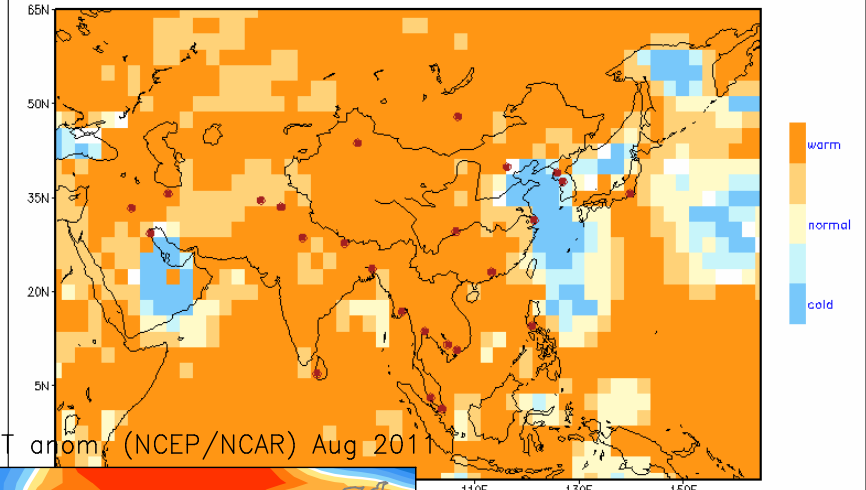
DERF
For 2011/07/31-2011/08/29
Fcst Produced Date 2011/07/20



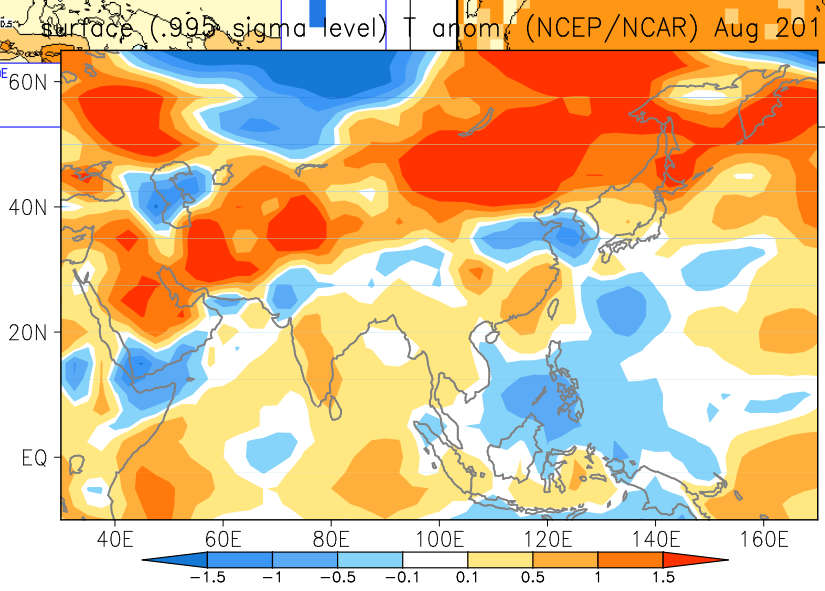
<http://ncc.cma.gov.cn/zh>
<http://bcc.cma.gov.cn/en>

NCC/BCC Monthly Forecast
Most Likely Temperature Categories
Fcst Started Refer Date 2011/07/19
Member Size=32

DERF
For 2011/07/31-2011/08/29
Fcst Produced Date 2011/07/20



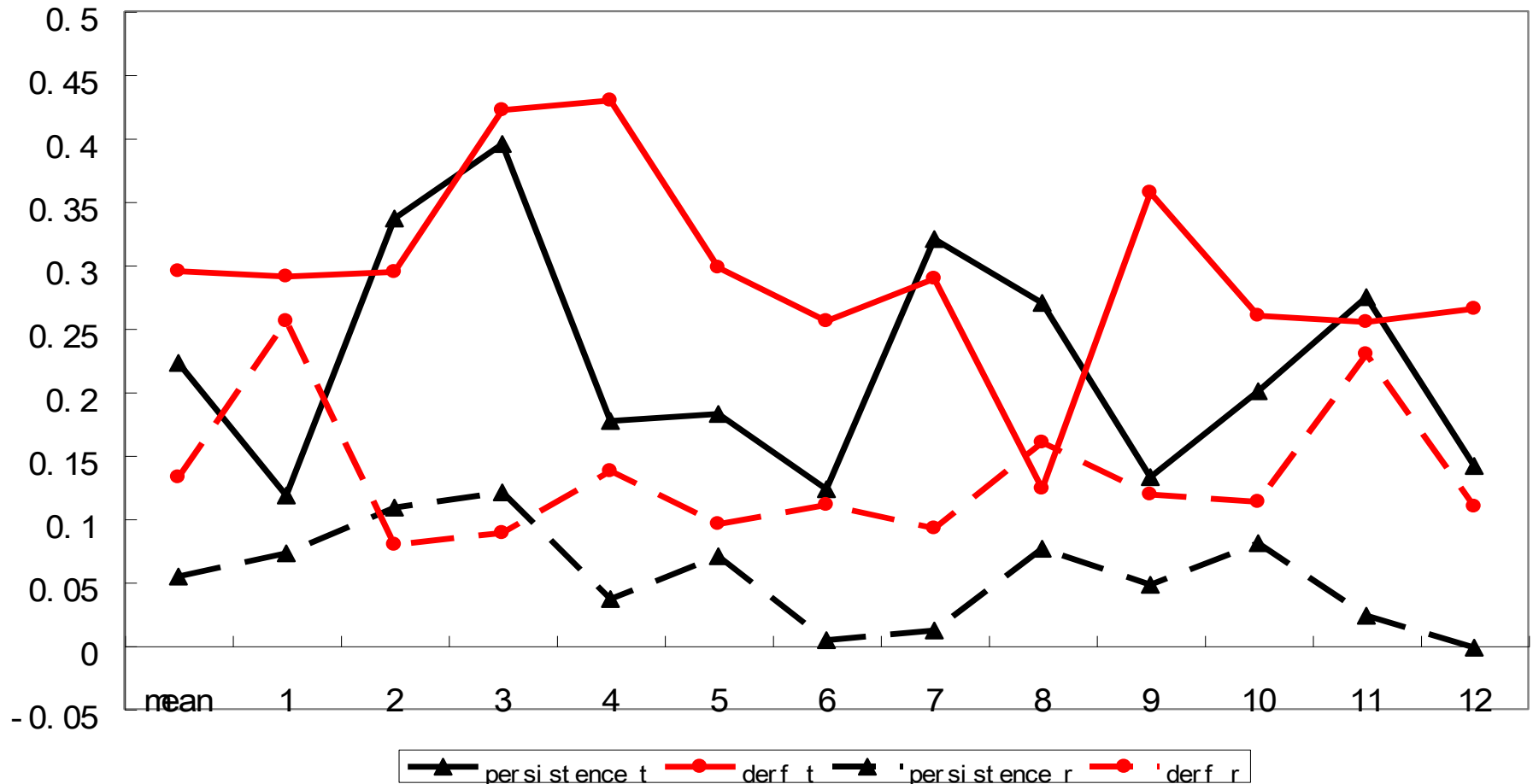
BCC NCC



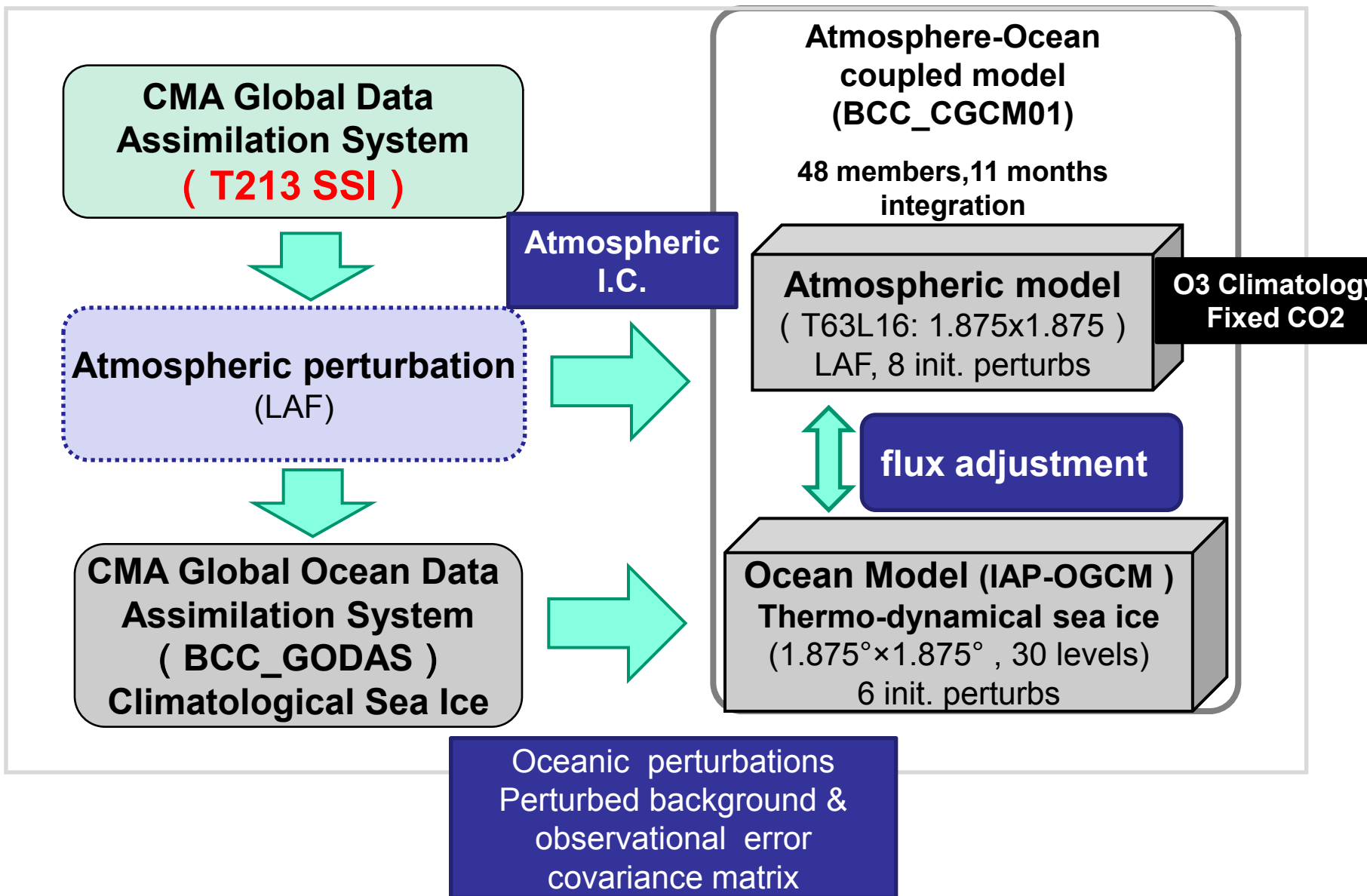
NCEP/NCAR analysis
T at sigma=0.995

Skill of precipitation and temperature in China (verification method: ACC)

ACC(82_05)



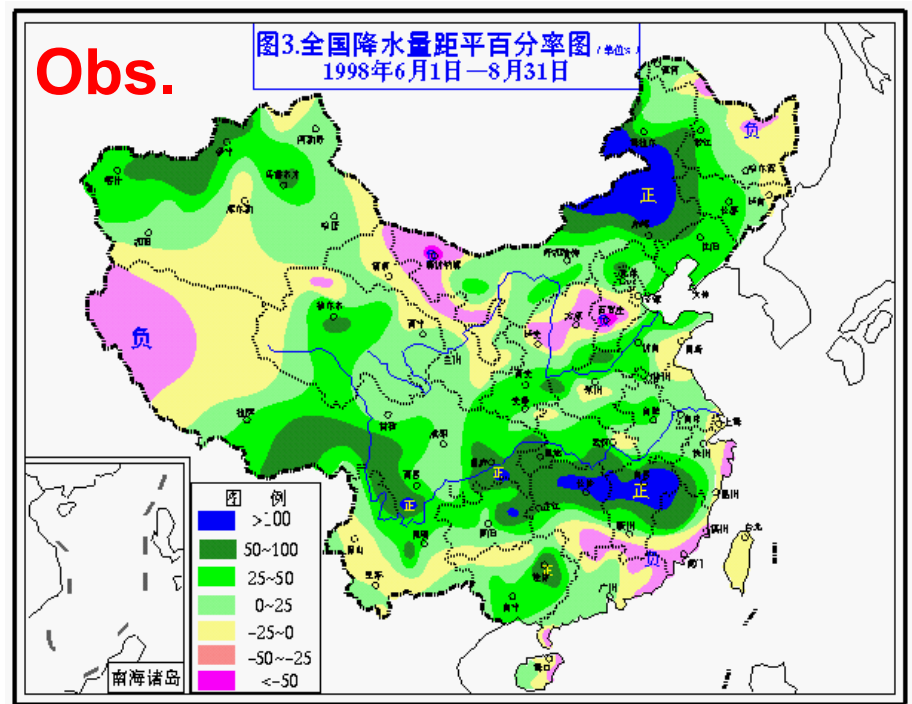
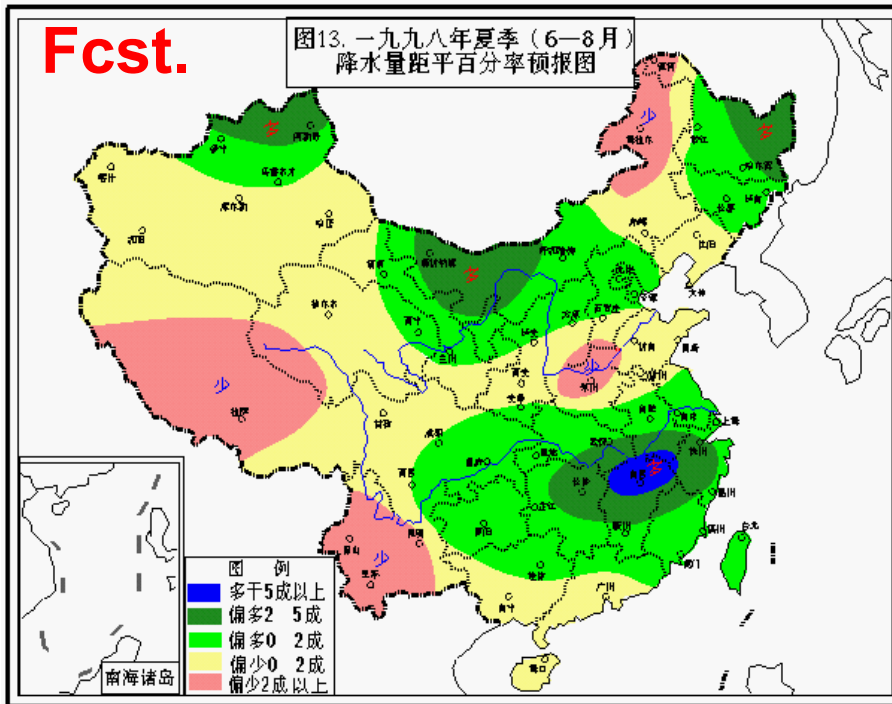
Seasonal Forecast Model System



Successful prediction case

Issued in April

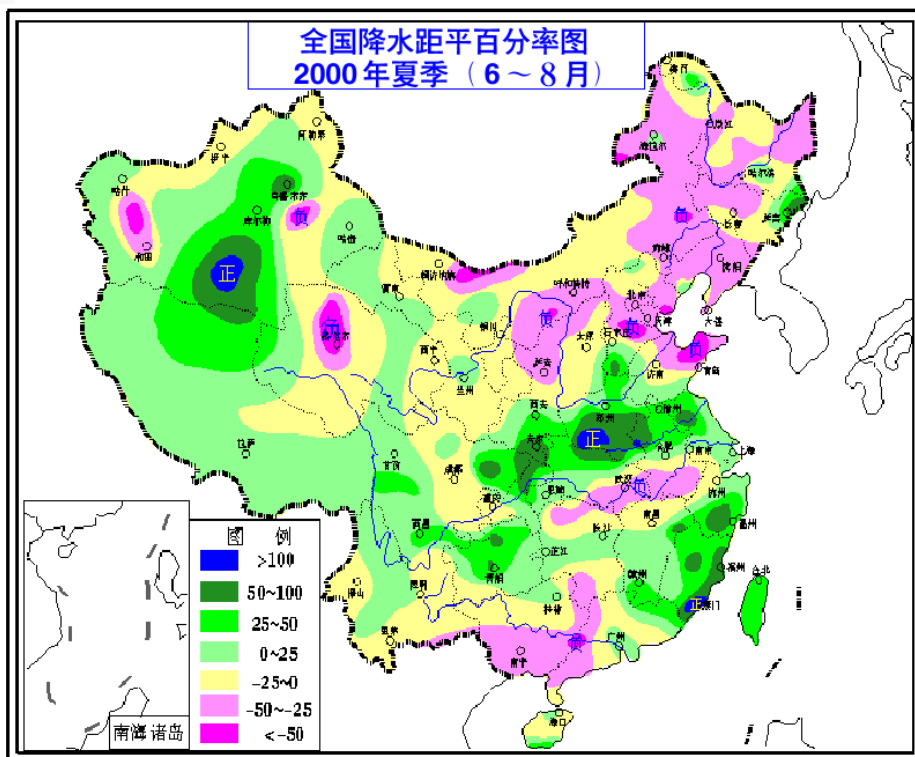
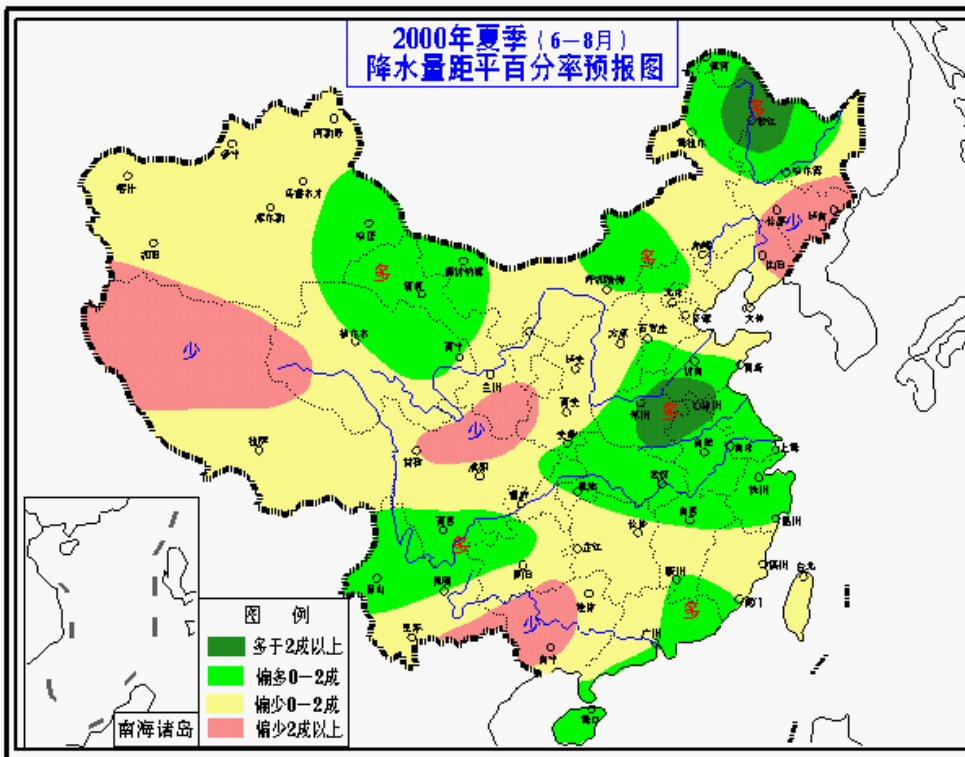
The summer rainfall anomaly percentage forecast (left) and observation (right) in 1998



Successful prediction case

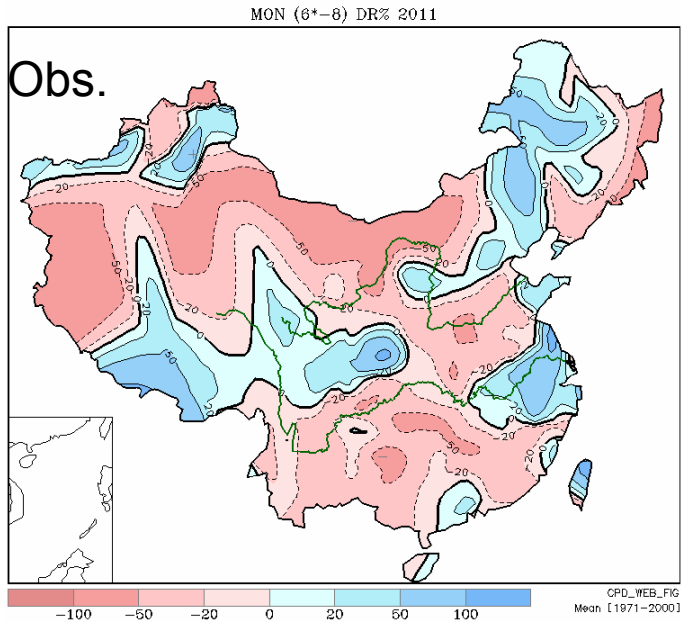
Issued in April

The summer rainfall anomaly percentage forecast (left) and observation (right) in 2000

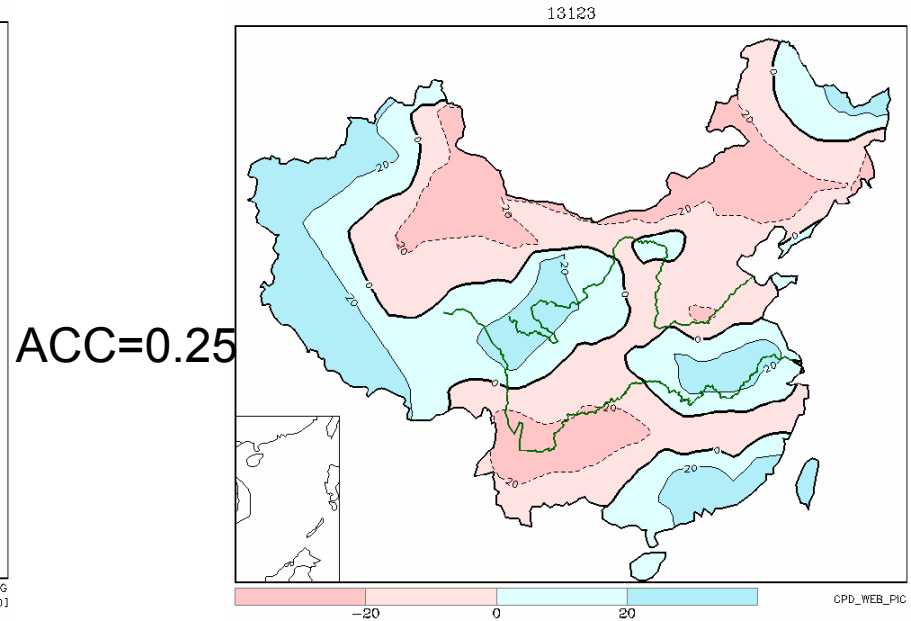


Flood season forecast in 2011

Precipitation anomaly percentage JJA/2011



Seasonal forecast guidance (Issued on 26th March,2011)



CGCM performance



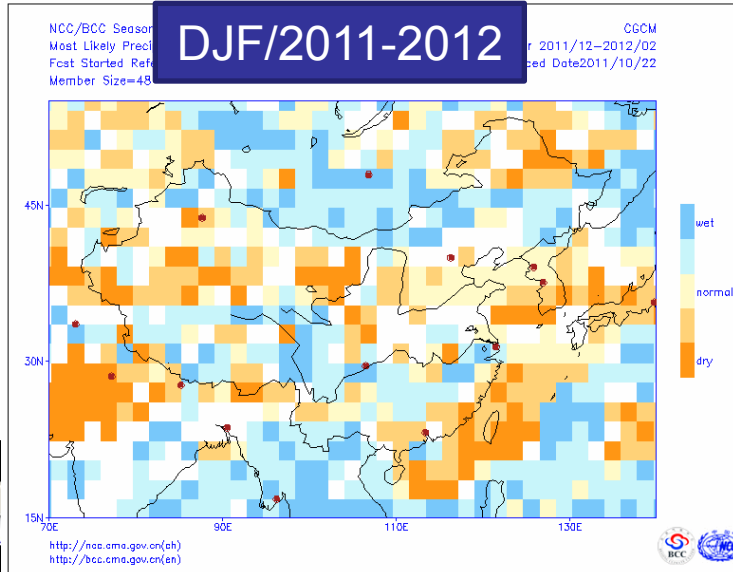
Anomaly Correlation coefficients

(Initial Condition : Mar, Period of Forecast: JJA)

Averaged period:1983-2002

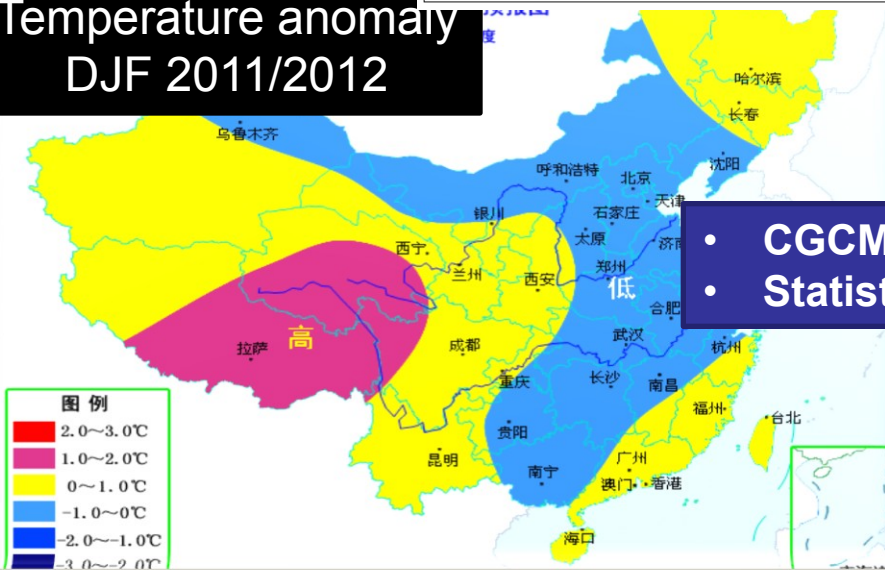
	Global	N. H.	E. Asia
Z₅₀₀	0.20	0.18	0.21
T₈₅₀	0.07	0.07	0.15

Planned forecast guidance for this winter



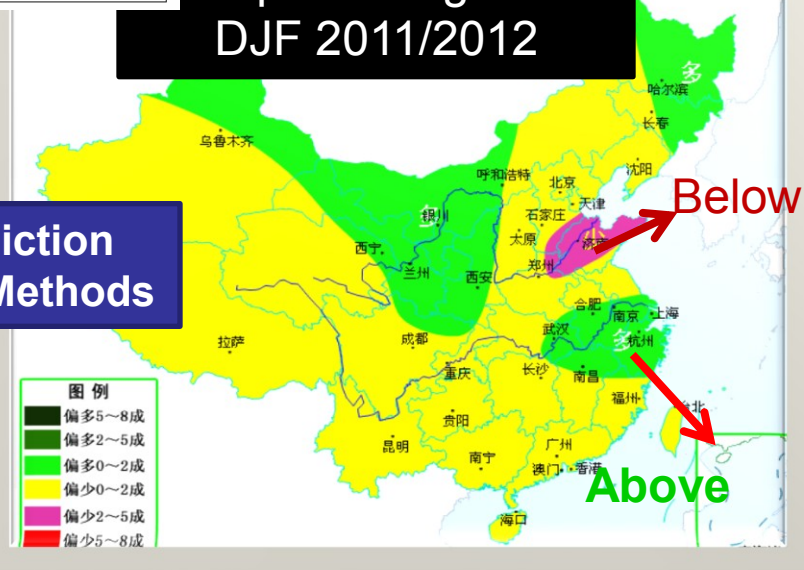
CGCM prediction
Preci. anomaly percentage

Temperature anomaly
DJF 2011/2012

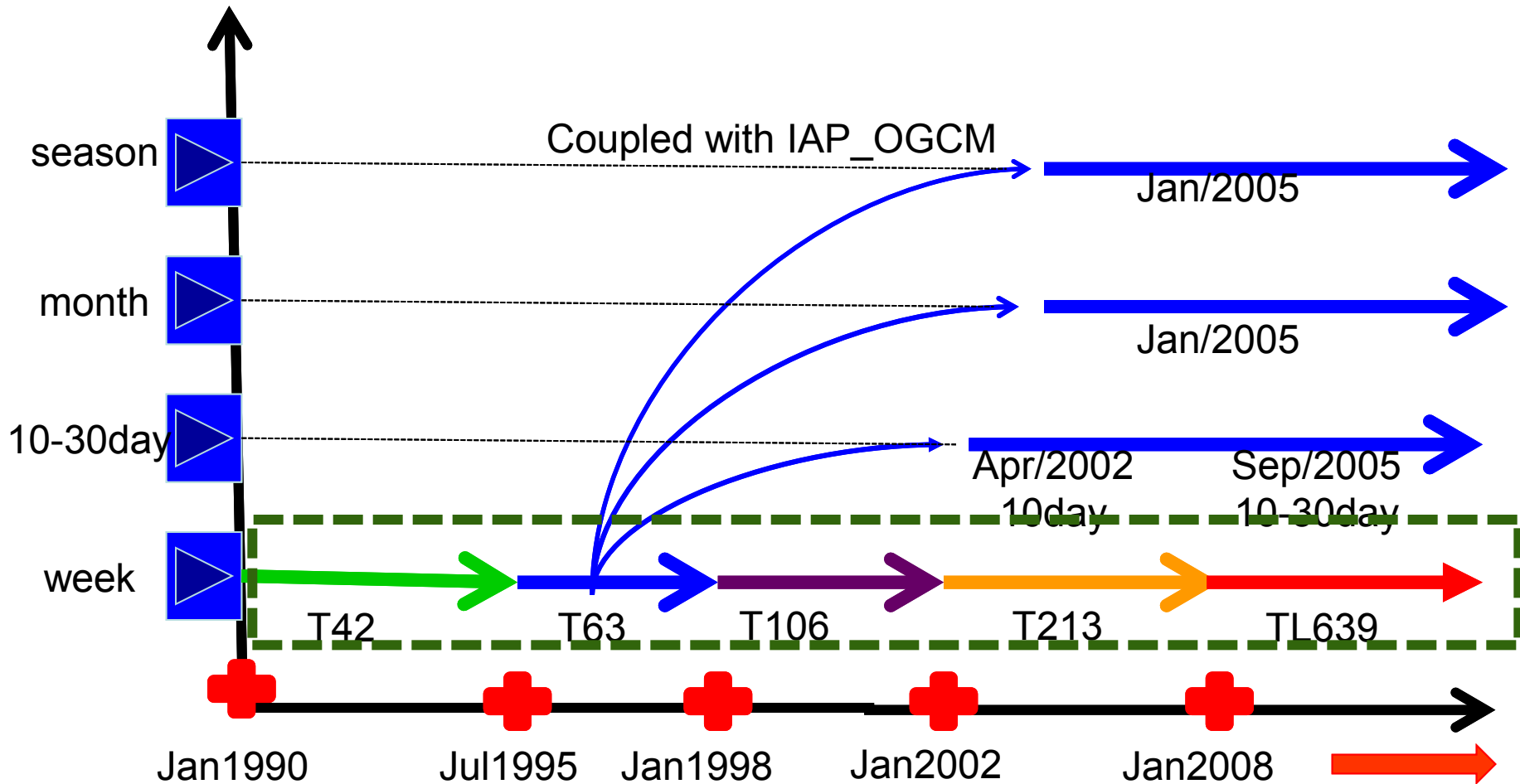


- CGCM prediction
- Statistical Methods

Preci. anomaly percentage
DJF 2011/2012



History of CMA global medium to long range forecast systems



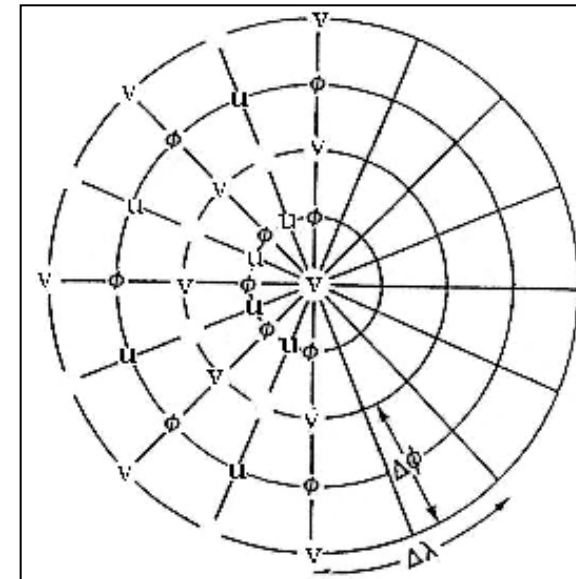
GRAPES: Global and Regional Assimilation & Prediction System
since 2001

A Unified Global and Regional NWP System

- Global model
- Meso-scale model
- Global VAR
- Regional VAR

Unified GRAPES Model Dynamic Core

- ◆ Fully compressible equations with shallow atmosphere approximation
- ◆ 2-time-level semi-implicit semi-Lagrangian (SISL) time-stepping
- ◆ QMSL or CSLR for scalar advection
- ◆ 3D vector form for momentum equations
- ◆ Height-based terrain-following coordinate
- ◆ Option of hydrostatic and non-hydrostatic
- ◆ Arakawa-C grid but V at poles
- ◆ Charney-Phillips vertical grid
- ◆ GCR for Helmholtz Eq.
- ◆ Spherical & polar effects of trajectory calculation
- ◆ Quasi-cubic interpolation
- ◆ Mass fixer $\longrightarrow \int \frac{(\pi + \Delta\pi)^{C_p/R-1} dV}{\theta} = M_{initial}$
- ◆ Polar filter



Model top

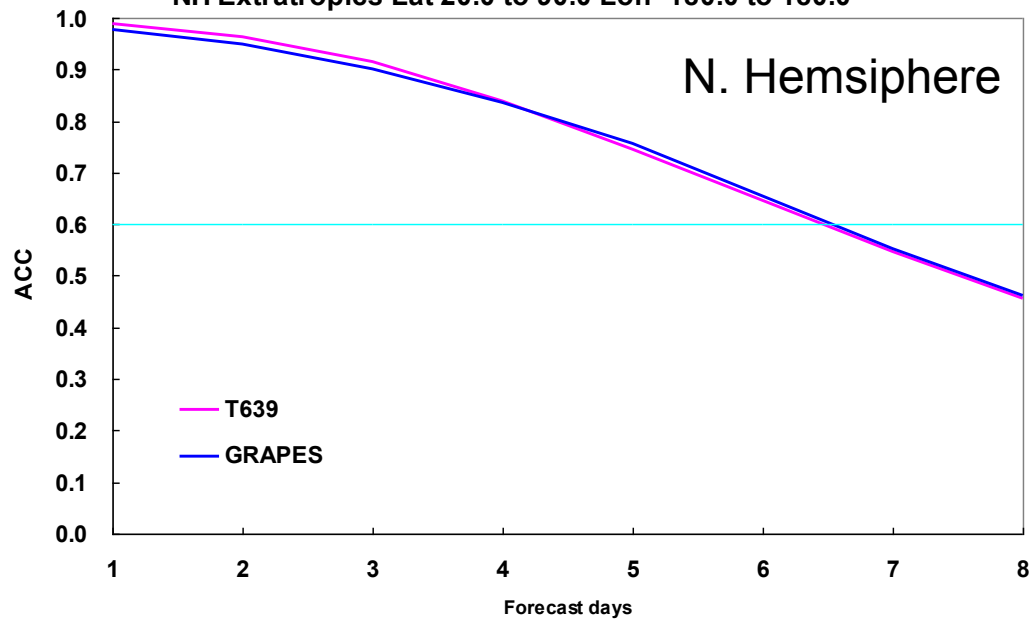
$z, \hat{z}, \theta, w, \hat{w}$
 $z, \hat{z}, \rho, P, u, v$
 $z, \hat{z}, \theta, w, \hat{w}$
 $z, \hat{z}, \rho, P, u, v$
 •
 •
 •
 $z, \hat{z}, \theta, w, \hat{w}$
 $z, \hat{z}, \rho, P, u, v$
 $z, \hat{z}, \theta, w, \hat{w}$
 $z, \hat{z}, \rho, P, u, v$
 z, \hat{z}, w, \hat{w}

Surface

Configuration of GRAPES_GFS

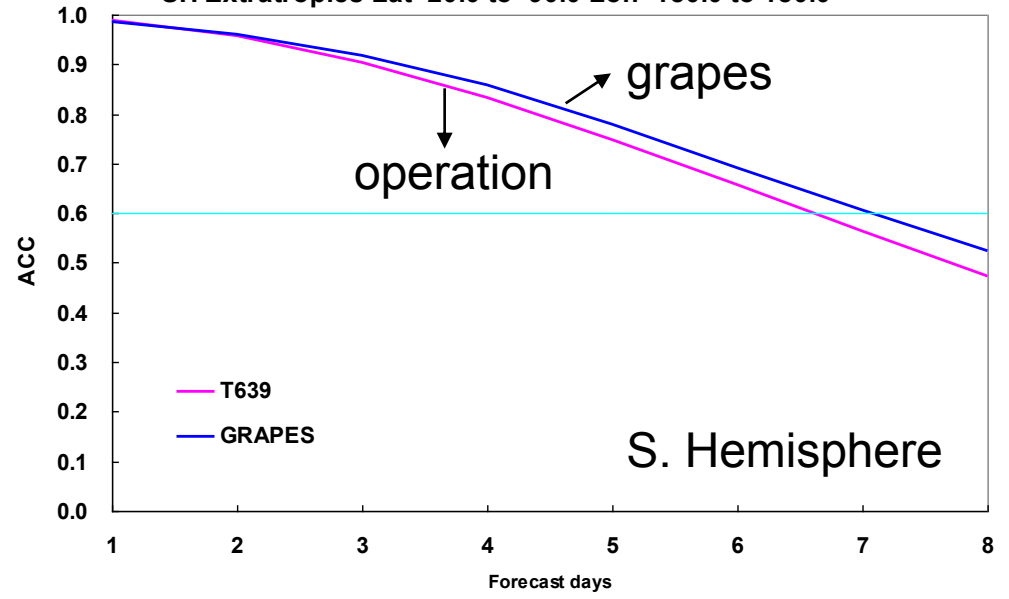
- **GRAPES_GFS** : medium-range global forecast
 - **GRAPES_Global 50km L36 with model top at 10 hPa**
 - **GRAPES_3DVAR at 1.125 degree**
 - **6-hourly cycle**
 - **240 hour forecast (00,12UTC)**
 - **Assimilated Obs.**
 - **GTS conventional data**
 - **NOAA15, 16, 18, 19**
 - **METOP-2 amsu**
 - **COSMIC Refraction**
 - **AIRS**
 - **FY-3 radiance**
 - **METEOSAT-9 & MTSAT AMV**
 - **MODIS polar AMV**

forecast verification 200906-200908 12UTC
geopotential 500hPa
Correlation coefficient of forecast anomaly
NH Extratropics Lat 20.0 to 90.0 Lon -180.0 to 180.0

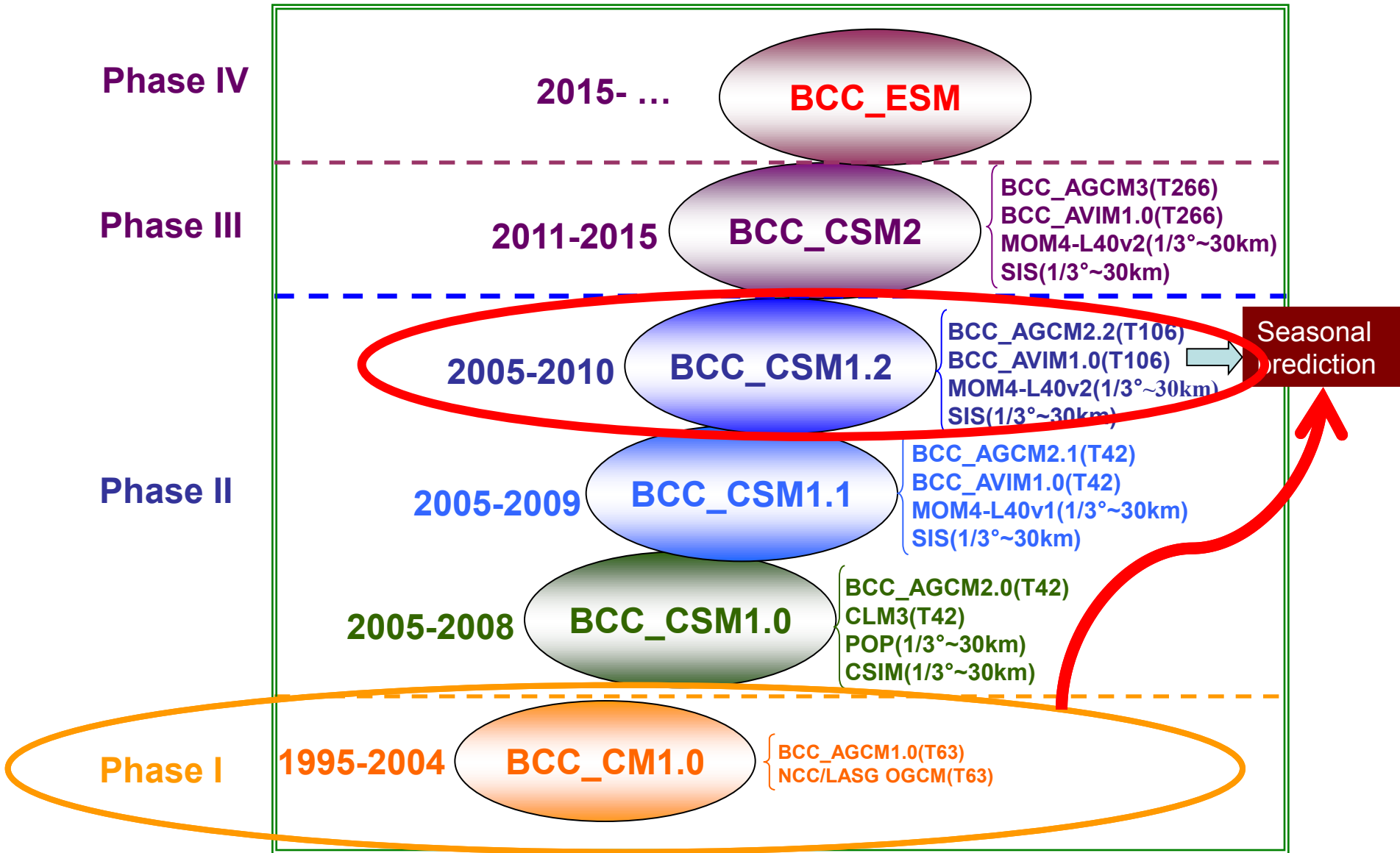


ACC 500hPa Z
JJA 2009

forecast verification 200906-200908 12UTC
geopotential 500hPa
Correlation coefficient of forecast anomaly
SH Extratropics Lat -20.0 to -90.0 Lon -180.0 to 180.0



Future development of long-range forecast system



THANK YOU