



Current status and future of climate prediction and services in BCC

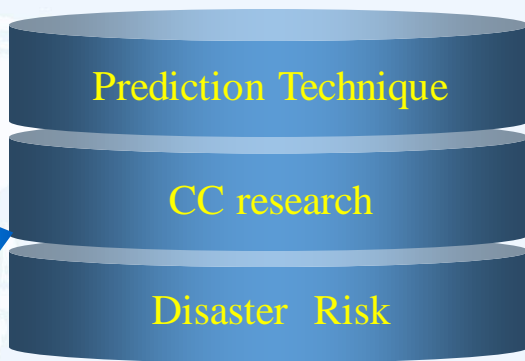
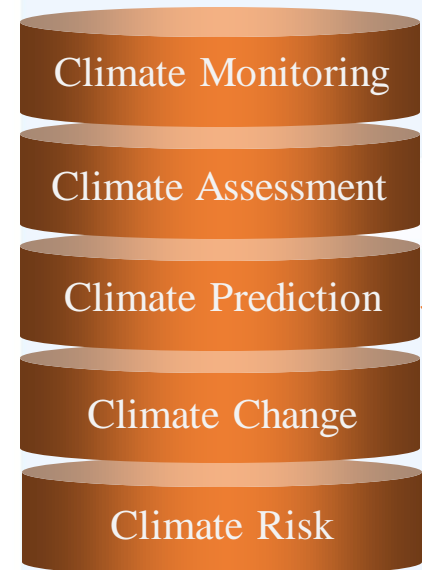
Jia Xiaolong

Being Climate Centre, China

EASCOF-11, Nov. 7, 2023



National Climate Centre (Beijing Climate Centre)



- NCC Established on Feb. 21, 1994
- WMO Regional Climate Centre in RA II (2009) ;
- Global Producing Centre for long-range forecast (2006) ;
- East Asian Monsoon Activity Centre (2006);
- Centre for Extreme Events Monitoring in Asia (2010)
- Third Pole Regional Climate Centre (2018)



Outlines



- **Climate Monitoring and prediction**
- BCC-Climate Model and Multi-model Ensemble Prediction
- Meteorological Disaster Risk Pre-assessment
- Climate services in BCC
- Future plan

Climate Monitoring and Diagnosis

China
Reanalysis
girded data



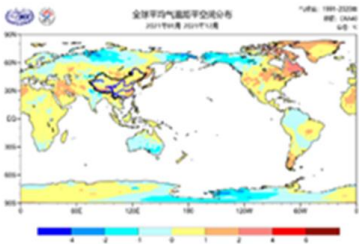
Independent monitoring,
precise monitoring
Foreign data → Independent data

FY data

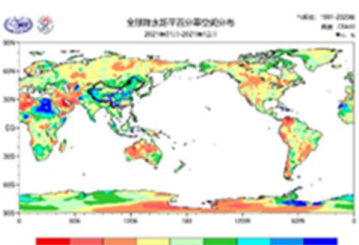


1. Basic Climate State

Global Temperature

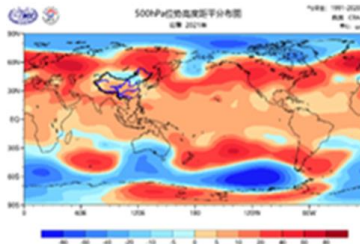


Global Precipitation



2. Atmospheric Circulation

Key Circulation System

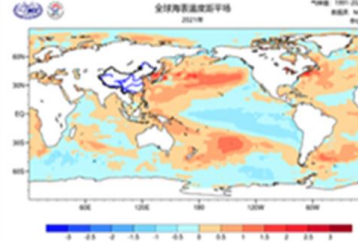


Global Monsoon System

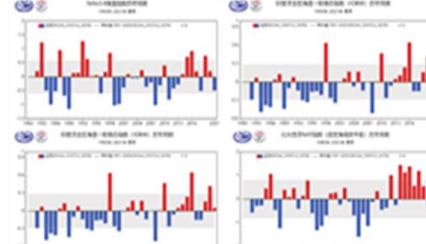


3. Global Ocean

Global Ocean Temperature

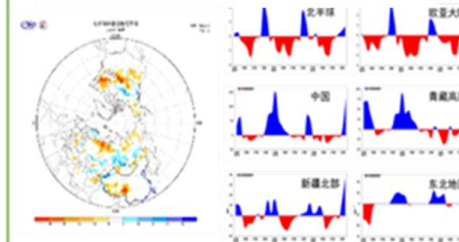


Ocean Temperature Index

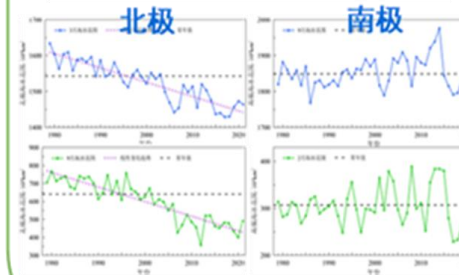


4. Snow Cover and Sea Ice

Snow Cover



Extent of Sea Ice



5. Major Disaster

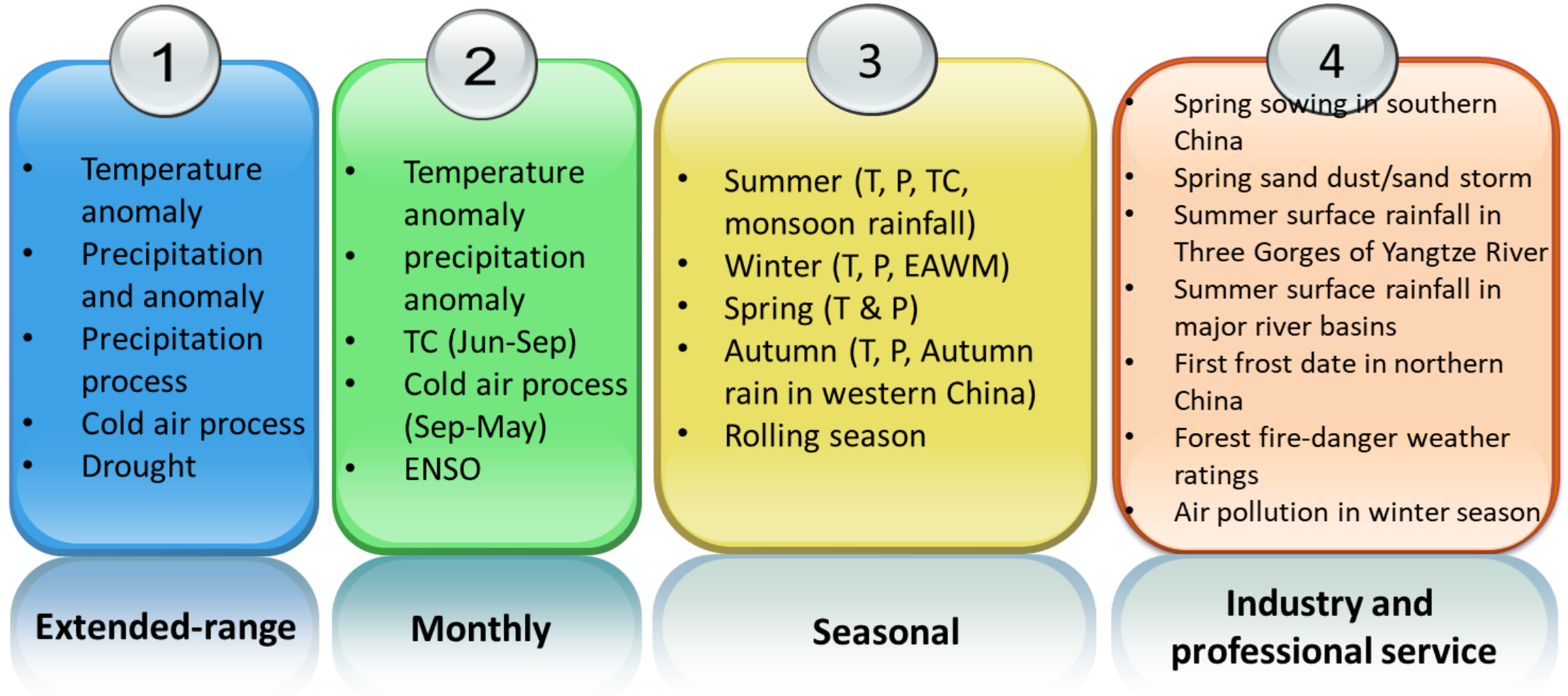
Global Disaster



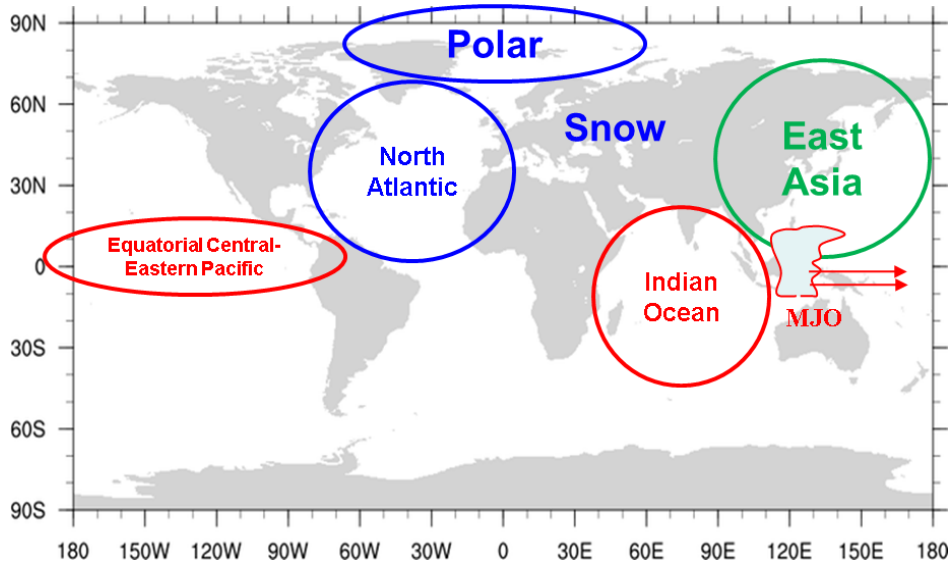
Climate Extremes

Rainstorm and Flood
Tropical Cyclone
Heat Wave
Blizzard and Snowstorm
Severe Convection Weather

Climate prediction covers many aspects

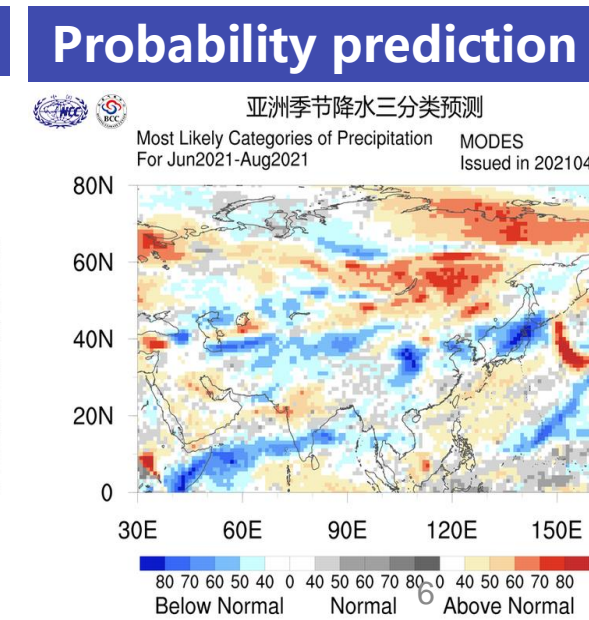
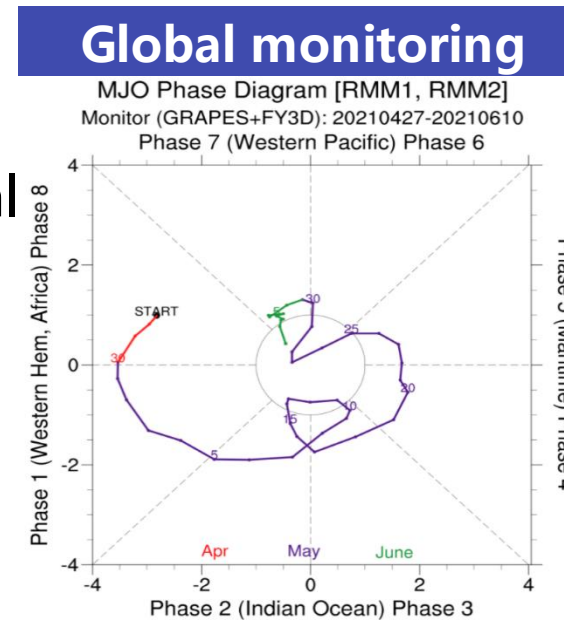


Global monitoring, global prediction and global service



- **Global monitoring:** Real time monitoring of the most important climate phenomena, basic elements, and extreme climate disasters in the ocean, tropical, and polar regions.

- **Global prediction:** Develop global deterministic and probabilistic predictions based on multimodal sets, as well as objective prediction products for major climate phenomena
- **Global services:** Play the role of WMO regional climate centre



Accurately predicting the temperature trend of winter in China in the past five years

2018 (69.4)

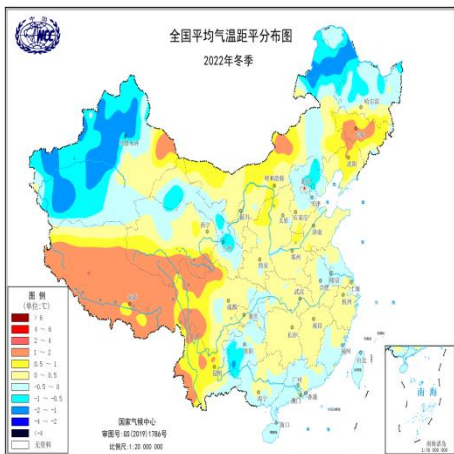
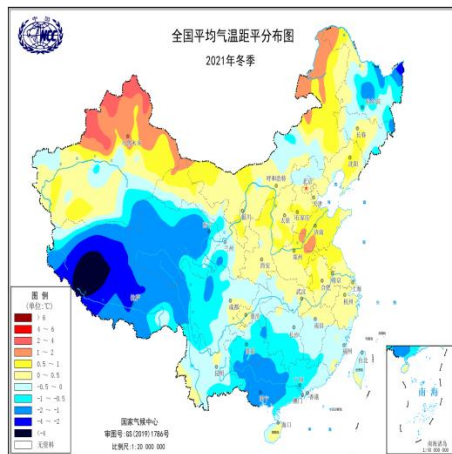
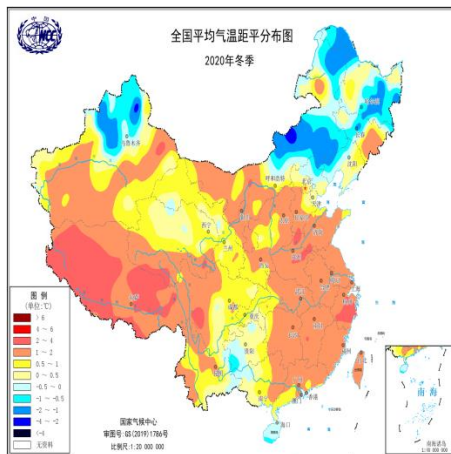
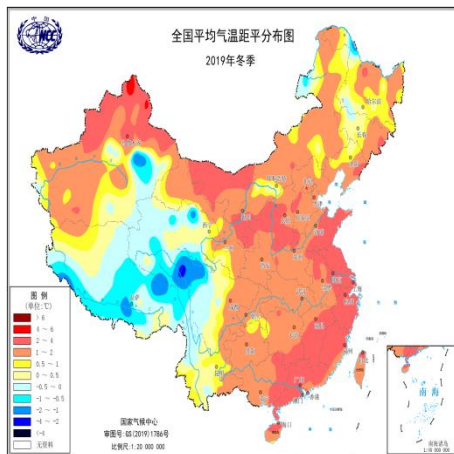
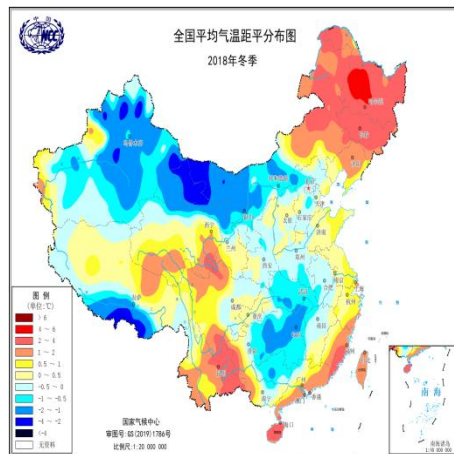
2019 (90.2)

2020 (75.9)

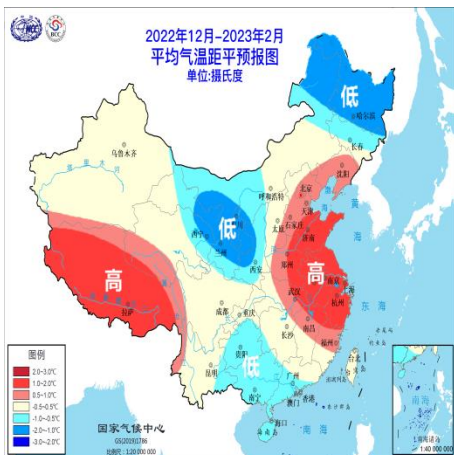
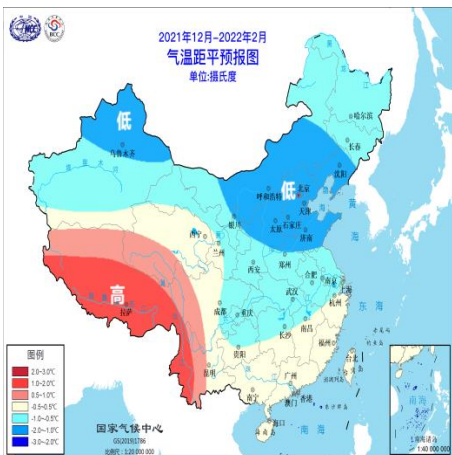
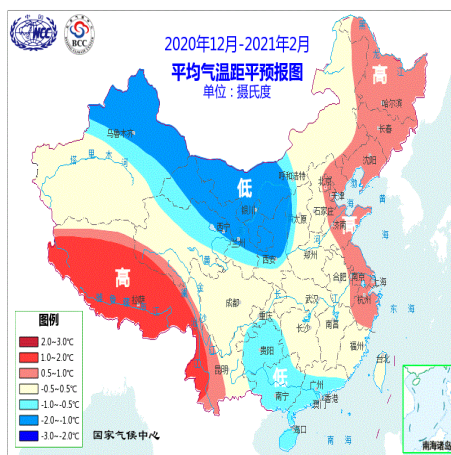
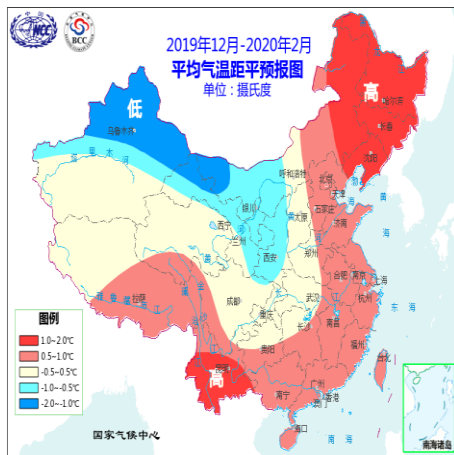
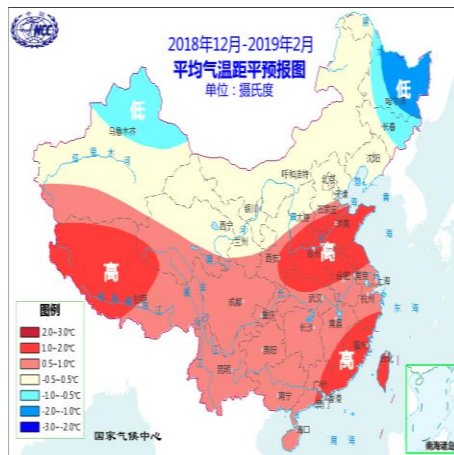
2021 (41.7)

2022 (75.8)

obs



Pred (Oct)



The average predicted winter temperature in China in the past 5 years is 70.6 points












Outlines



- Climate Monitoring and prediction
- **BCC-Climate Model and Multi-model Ensemble Prediction**
- Meteorological Disaster Risk Pre-assessment
- Climate services in BCC
- Future plan

BCC climate model development

			业务系统建设	国际计划	
Phase 4	2015-2020		BCC-AGCM: T266—T382(576X1152,~0.313°) L26—L56 (0.1hPa) BCC-AVIM: T266—T382 MOM5-L50(1/4°~25km) CICE5(1/4°~25km)	BCC-CPSv3 第三代模式预测系统 (2016-2020)	WCRP CMIP6 耦合模式比较计划第六阶段 (2017-2020)
	2012-2017		BCC-AGCM3(T266L26) BCC-AVIM2(T266) MOM4-L40v2(1/3°~30km) SIS(1/3°~30km)		
Phase 3	2012-2016		BCC-AGCM3(T106L46) BCC-AVIM2(T106) MOM4-L40v2(1/3°~30km) SIS(1/3°~30km)	BCC-CPSv2 第二代模式预测系统 (2006-2015)	WCRP CMIP5 耦合模式比较计划第五阶段 (2009-2012)
	2012-2016		BCC-AGCM3(T42L26) BCC-AVIM2(T266) MOM4-L40v2(1/3°~30km) SIS(1/3°~30km)		
Phase 2	2014-2015		BCC-AGCM2.3(T106L40) BCC-AVIM1.0(T106) MOM4-L40v2(1/3°~30km) SIS(1/3°~30km)	BCC-CPSv1 第一代模式预测系统 (1995-2005)	WCRP CMIP3 耦合模式比较计划 第三阶段
	2005-2011		BCC-AGCM2.2(T106L26) BCC-AVIM1.0(T106) MOM4-L40v2(1/3°~30km) SIS(1/3°~30km)		
	2005-2009		BCC-AGCM2.1(T42L26) BCC-AVIM1.0(T42) MOM4-L40v1(1/3°~30km) SIS(1/3°~30km)		
	2005-2008		BCC-AGCM2.0(T42L26) CLM3(T42) POP(1/3°~30km) CSIM(1/3°~30km)		
Phase 1	1995-2004		BCC-AGCM1.0(T63) NCC/LASG OGCM(T63)		



CMA Climate Model Prediction System

CMA-CPS v3

CMA-CPS v2

Quasi-operational application in March 2021		Operational application from 2015	
Coupled Model Components	Atm.	BCC-CSM2-HR BCC-AGCM3-HR(T266L56)	BCC_CSM1.1m BCC-AGCM2.2(T106L26)
	Land	BCC_AVIM2(T266)	BCC_AVIM1(T106)
	Ocean	MOM5-L50 (1/4°)	MOM4-L40(1/3°~30km)
	ICE	SISv2 (1/4°)	SISv1(1/3°~30km)
Run frequency	monthly	monthly	
Integration	7 months	13 months	
Initial condition	Coupled Data Assimilation system (Ocean & ICE)	Atm.: NCEP R1; Ocean: NCEP_GODAS	
Ensemble scheme	SPPT+LAF	15LAF+9SV (SST)	
Ensemble members	21	24	
Hindcast period	2001-2020	1991-2014	

◆ The First Improvement

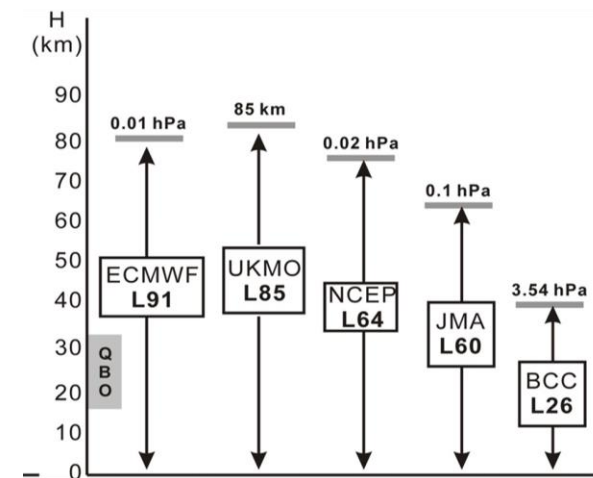
- Horizontal & vertical resolution: T106→T266, L26→L56
- Height of top model level of the Atmosphere model: 40 km-→60 km

◆ The Second Improvement:

Several Physical process parameterizations

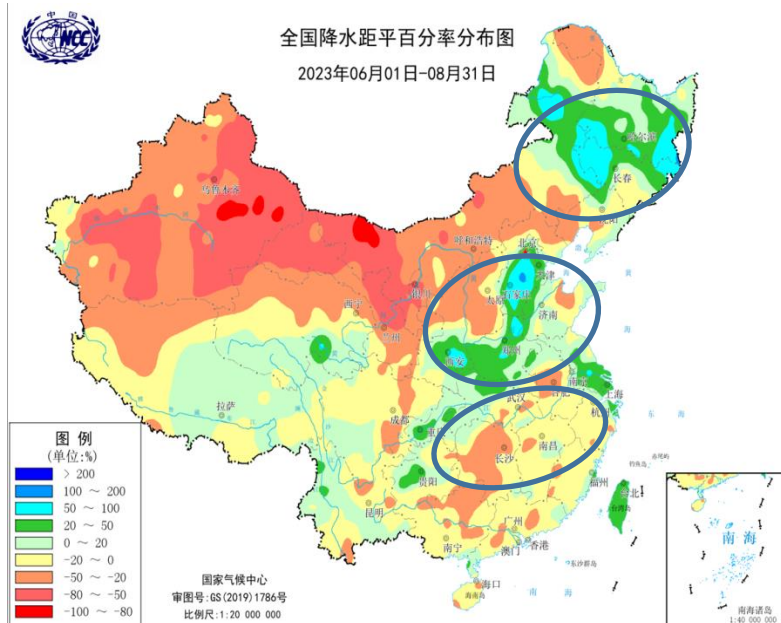
◆ The Third Improvement:

Coupled Data Assimilation system for ocean and ice



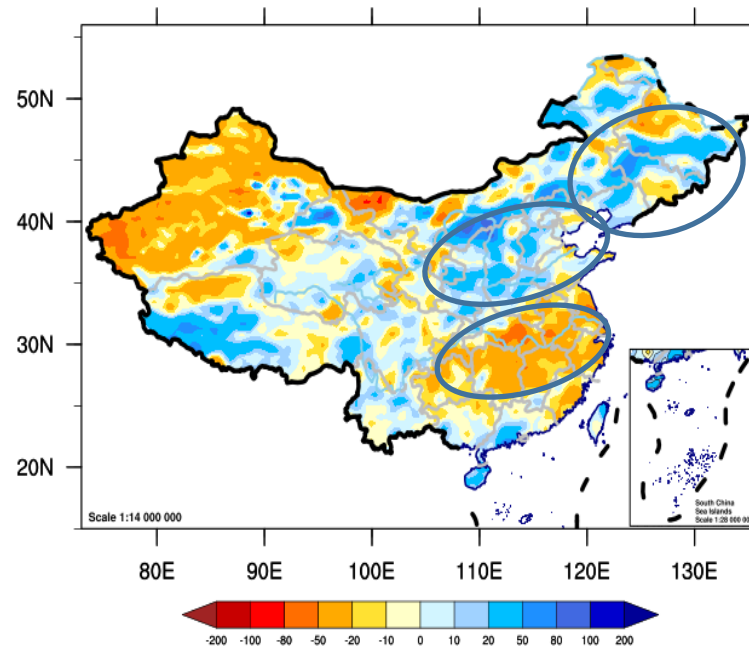
Prediction Review for percentage of Precipitation rate in 2023JJA

Observation for JJA 2023

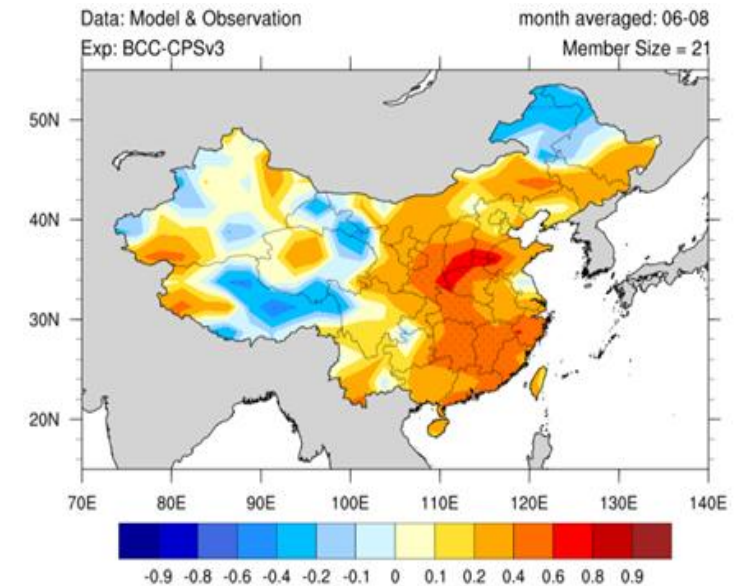


Prediction for JJA 2023

Departure Percentage of Precipitation rate Dates: 202306 - 202308
 CMA-CPSv3 seasonal forecast Ensemble Size = 21
 Initial date: 20230301 Units: %



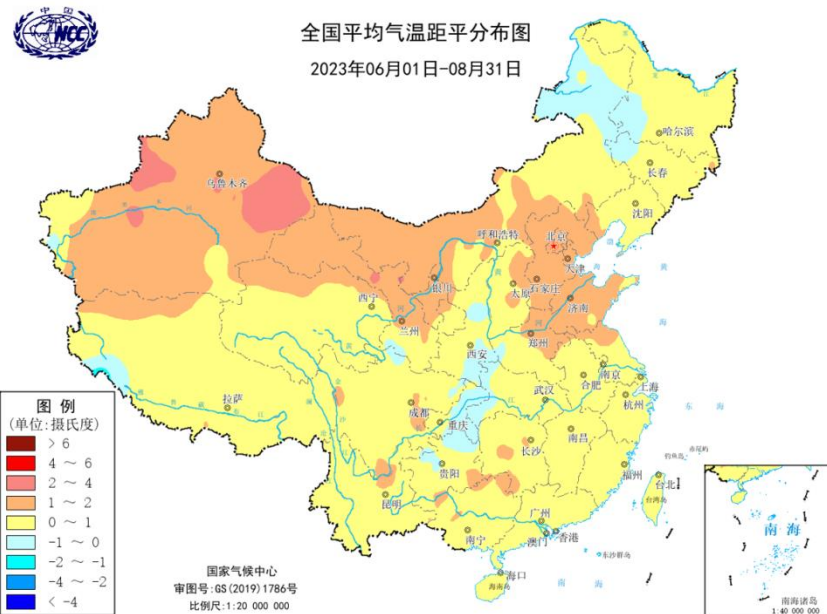
TCC of JJA Precip.



**CPSv3 model suggested that in 2023 Summer:
 More Rainfall in North, Southwest, and South China.
 Less Rainfall in middle and lower reaches of the Yangtze River**

Prediction Review for 2m Air Temperature Anomaly in 2023JJA

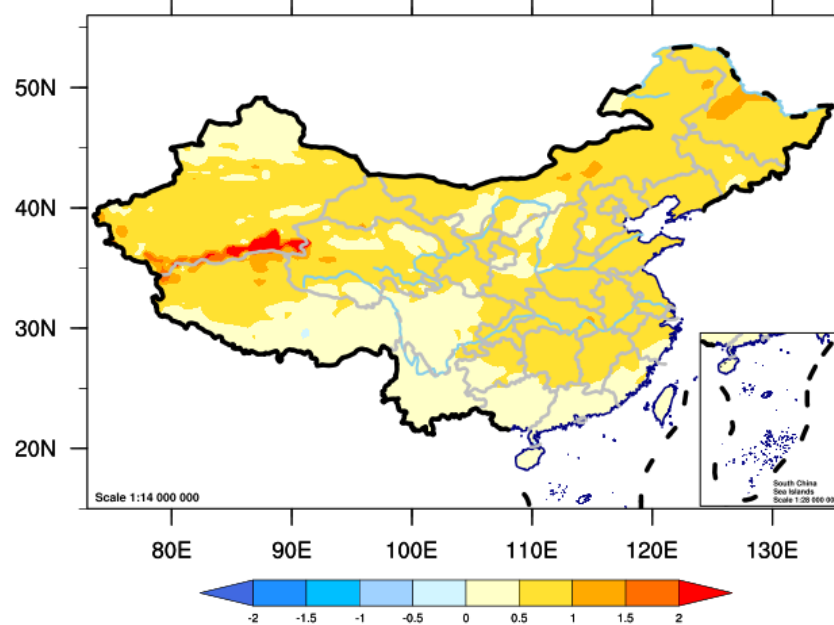
Observation for JJA 2023



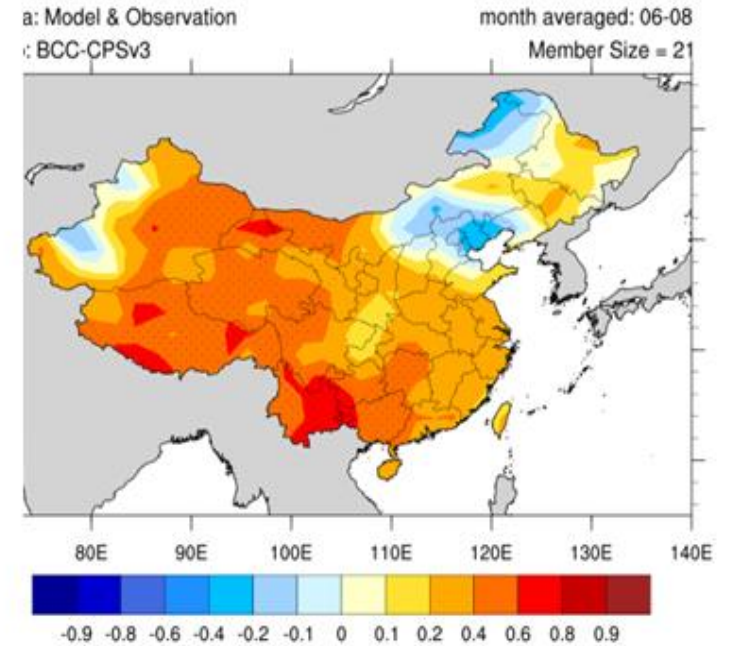
Prediction for JJA 2023

2-m Air Temperature Anomaly
CMA-CPSv3 seasonal forecast
Initial date: 20230301

Dates: 202306 - 202308
Ensembler Size = 21
Units: degC

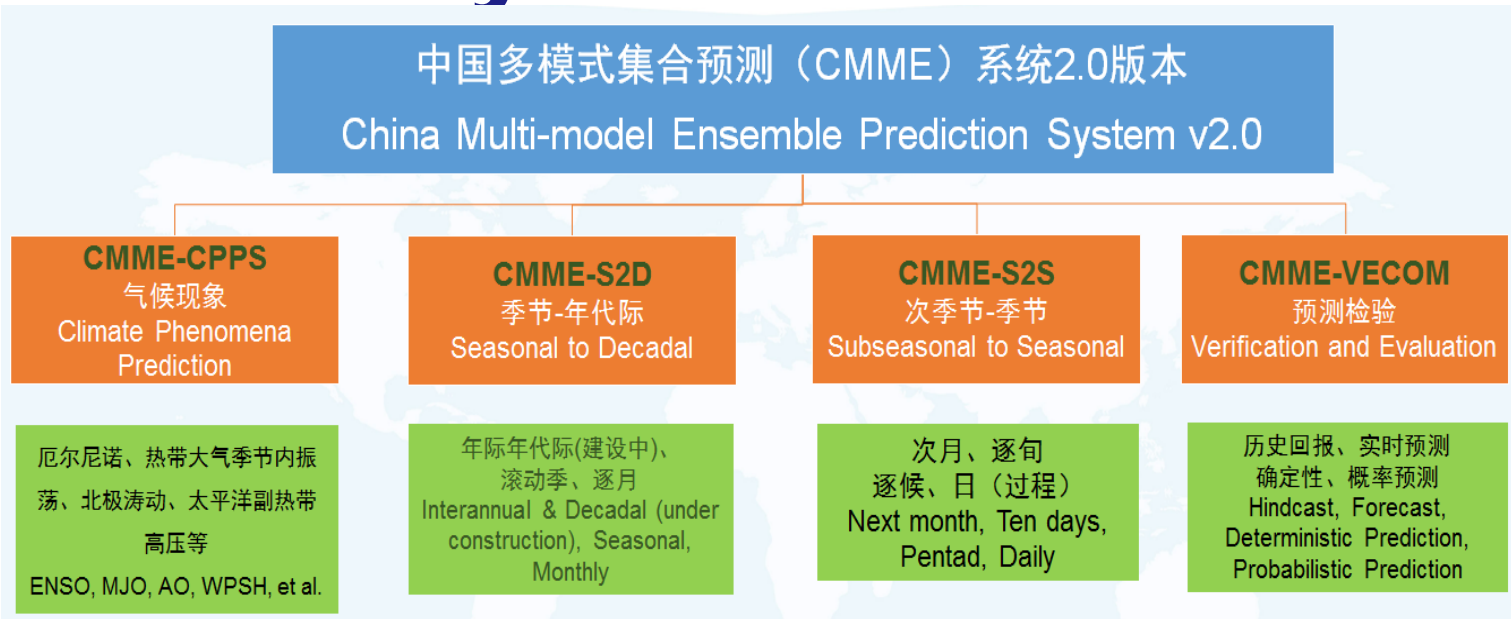
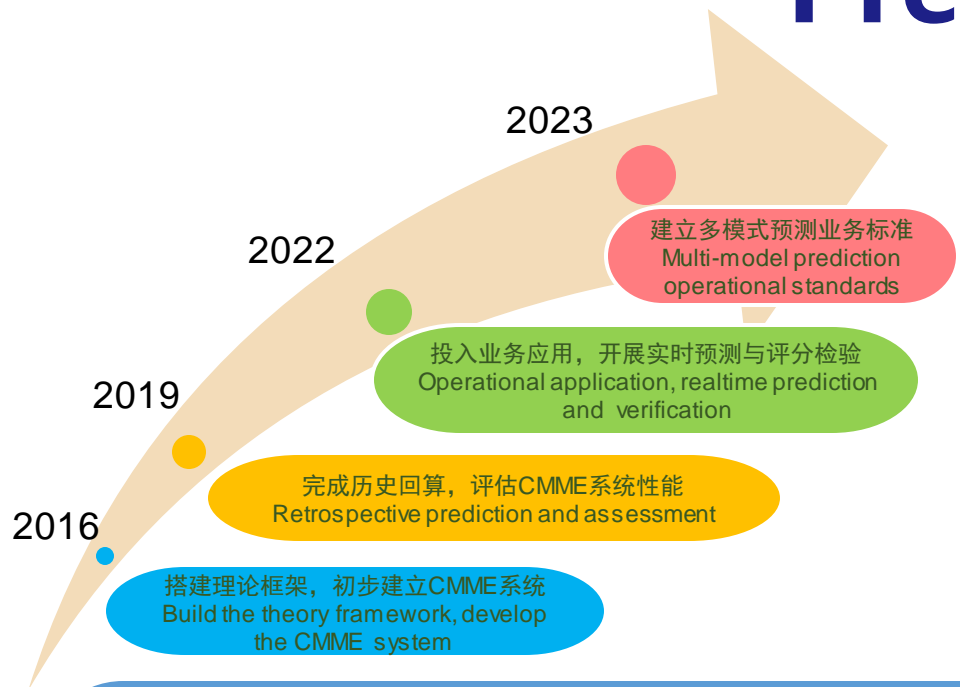


TCC of JJA T2m



The CPSv3 model predicted an above normal warm summer in China.

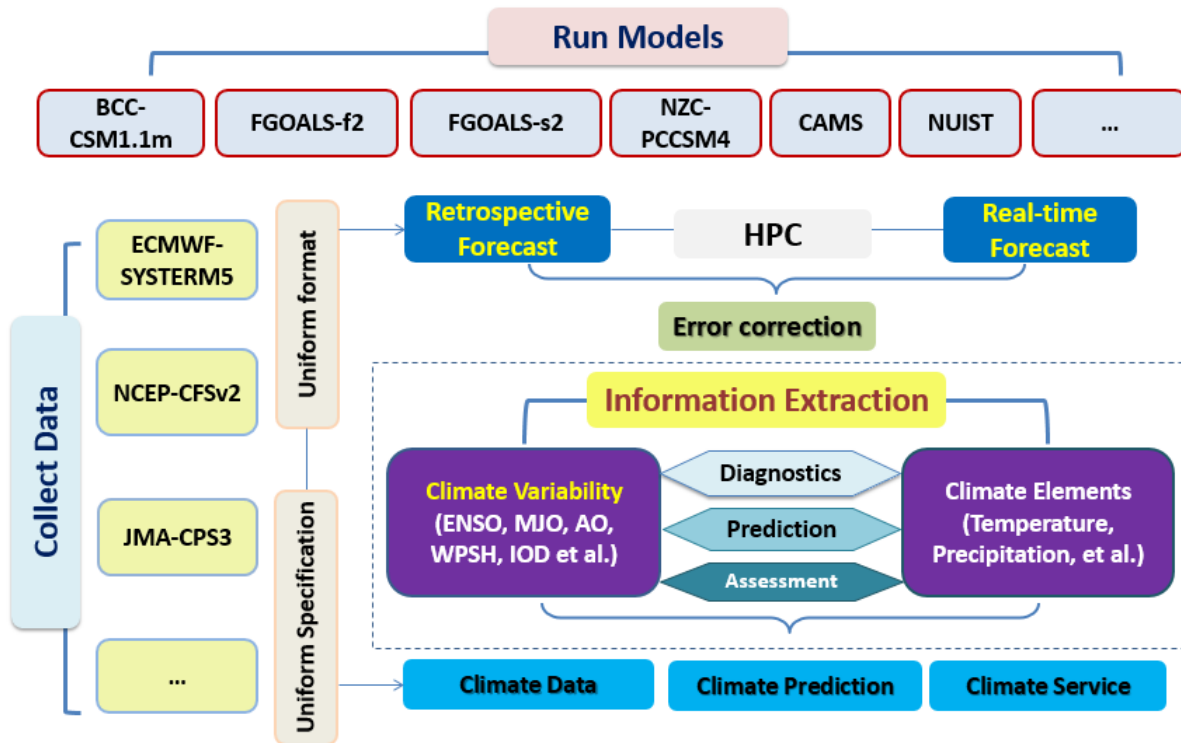
China Multi-model Ensemble Prediction System



Based on several domestic operationally-run climate models and internationally imported data, Beijing Climate Centre has established the China Multi-model Ensemble Prediction System(CMME). It provides the prediction and verification products of basic climate elements such as temperature and precipitation, as well as the primary climate variability modes.

Model Members of CMMEv2.0

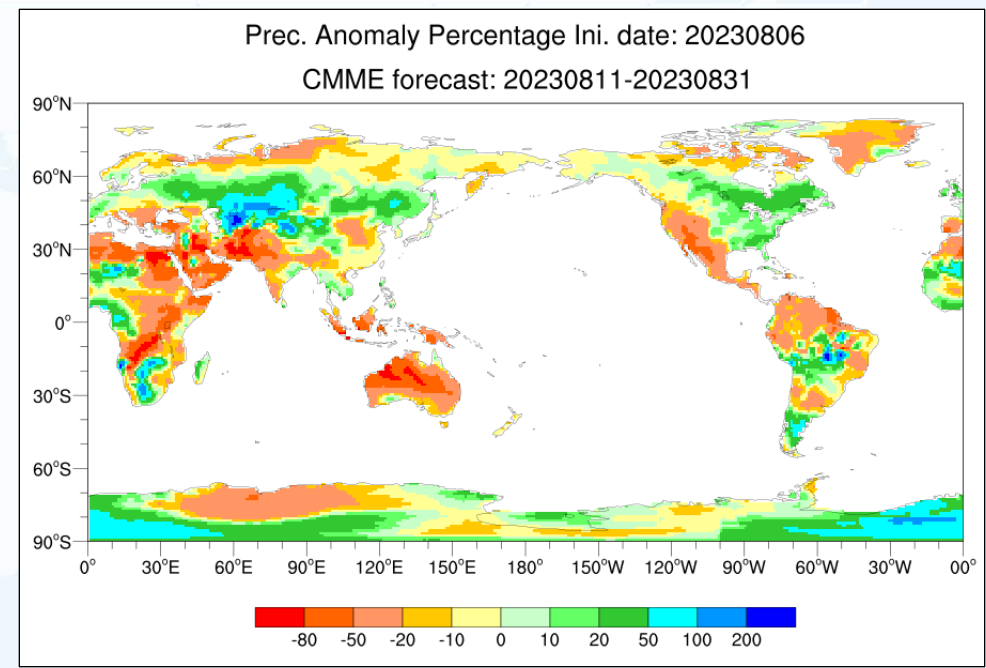
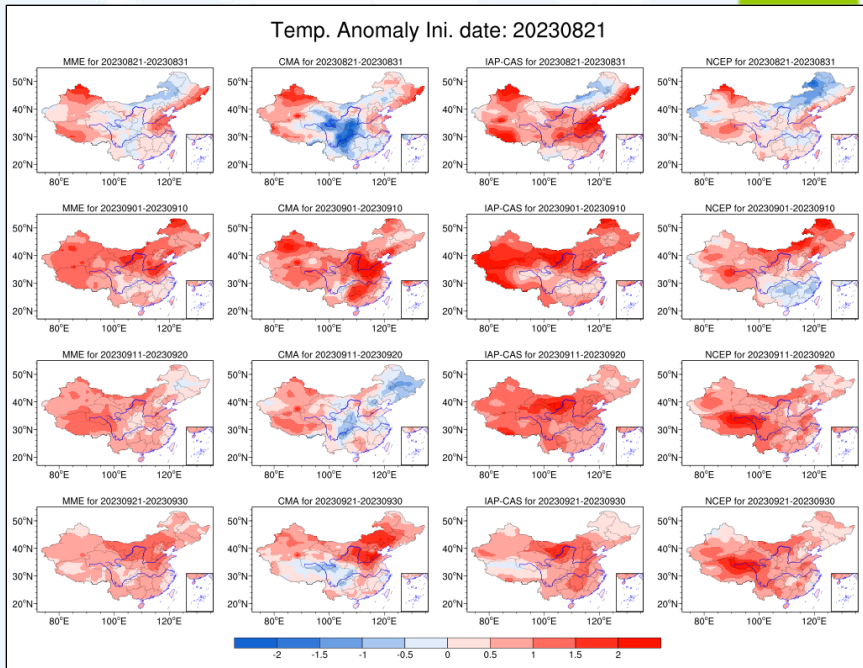
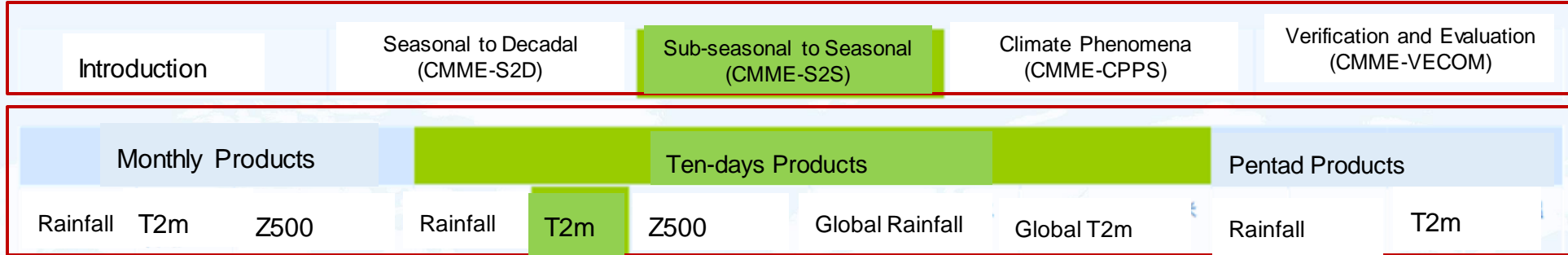
China Multi-Model Ensemble System



Models	Institution	Atm. Resolution	Ocn. Resolution	Ensemble Size	Lead times (months)
BCC-CSM1.1m	BCC(China)	T106, L26	1×1 L40	24	13
FGOALS-f2	IAP(China)	100km×100km, L32	1×1 L50	35	6
FGOALS-s2	IAP(China)	R42, L26	1×1 L30	4	6
NZC-PCCSM4	IAP(China)	2.5×1.9 L26	1×1	8	6
CAMS-CSM	CAMS(China)	T106, L31	1×1, L50	8	6
NUIST	NUIST(China)	T106, L19	2×2(tropic 0.5), L40	9	24
ECMWF-SYSTEM5	ECMWF(EURO)	T319, L91	ORCA 0.25 L75	15	6
NCEP-CFSv2	NCEP(USA)	T126, L64	1×1 L40	4	9
JMA-CPS3	JMA(Japan)	TL319, L100	0.25 x 0.25, L60	100	6

The CMME-S2D subsystem is composed of 9 climate models, providing the deterministic and probabilistic prediction products of the air temperature, precipitation and sea surface temperature in the next six months on monthly and seasonal timescale.

CMME-S2S Products (Products: ten-day)



Ten-day forecast: Provide forecasts of precipitation, temperature, and H500 for each mode and multimodal ensemble on the first day of each ten-day

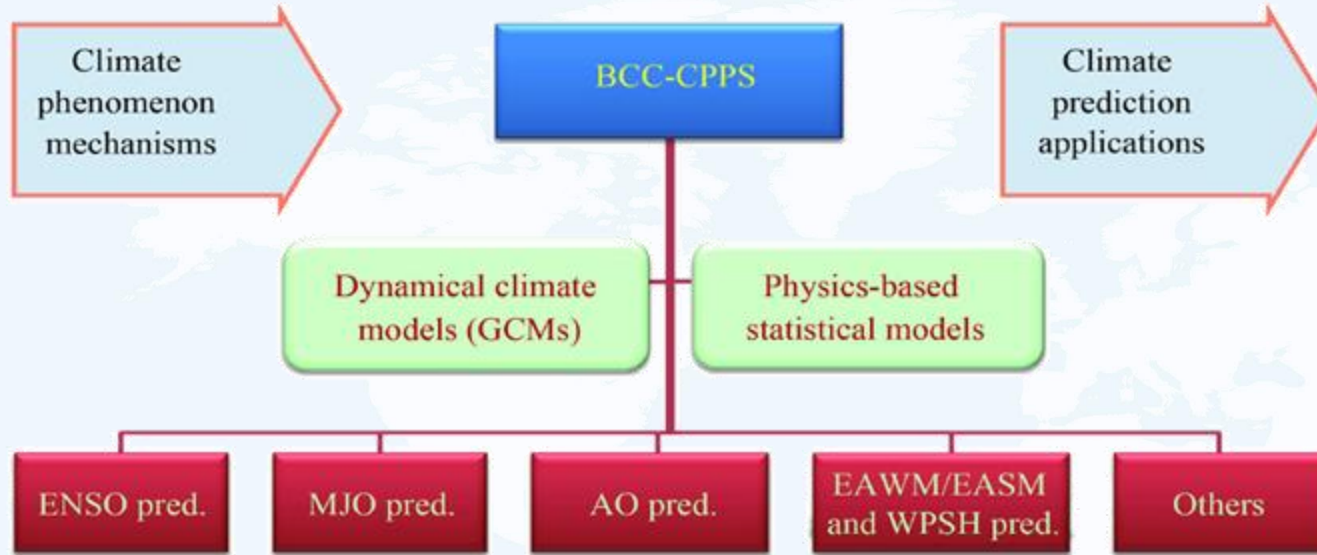
Ten-day forecast: Provide forecasts of precipitation and temperature for multimodal ensemble on 1st and 6th day of each month



CPPS Based on CMMEv2.0

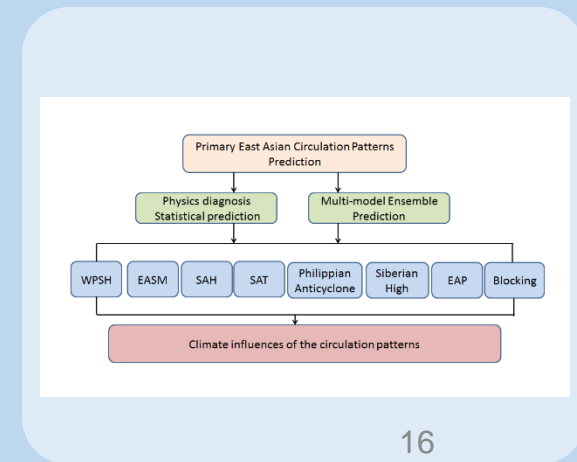
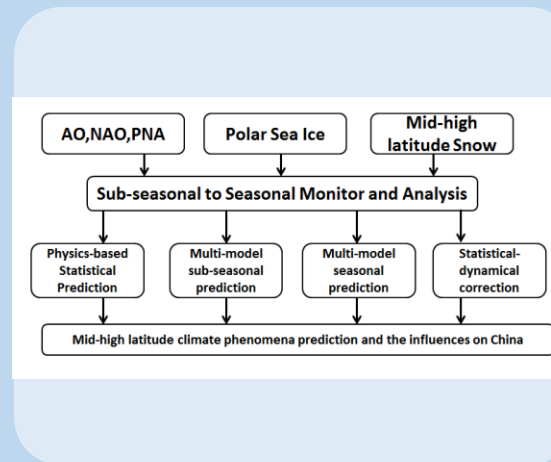
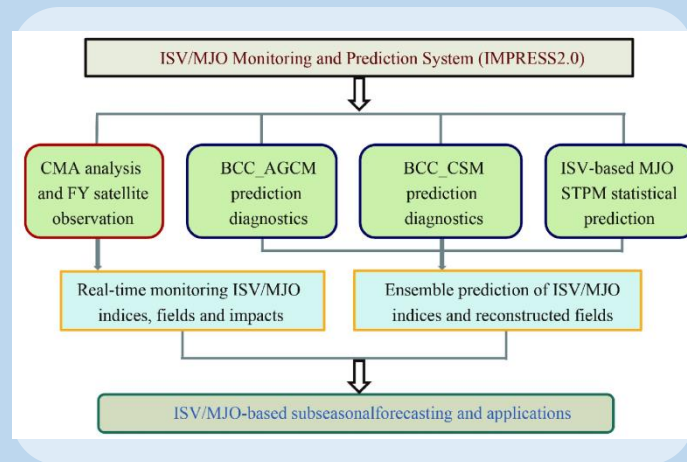
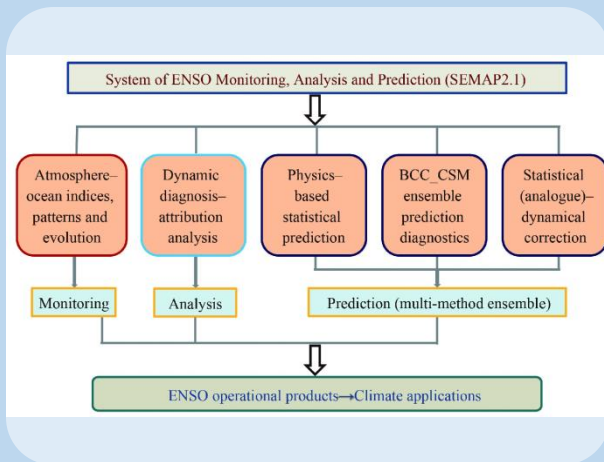


CMME-CPPS: Climate Phenomena Prediction subsystem



CMME-CPPS:

- SEMAP2.1 (ENSO)
- IMPRESS2.0 (MJO)
- MATES (Sea-ice, Mid-high latitude)
- PEACE (East Asian circulation)

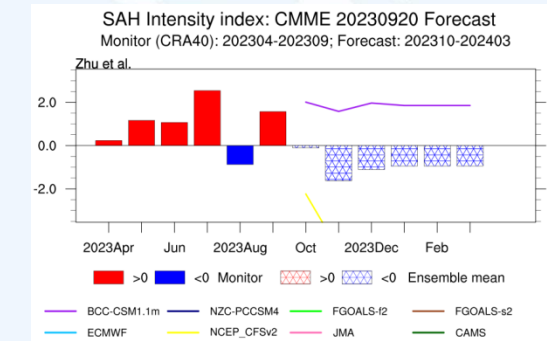
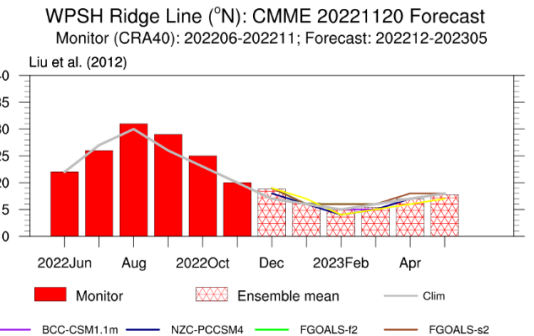
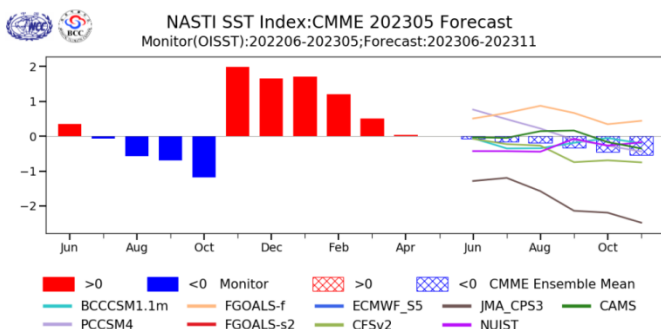
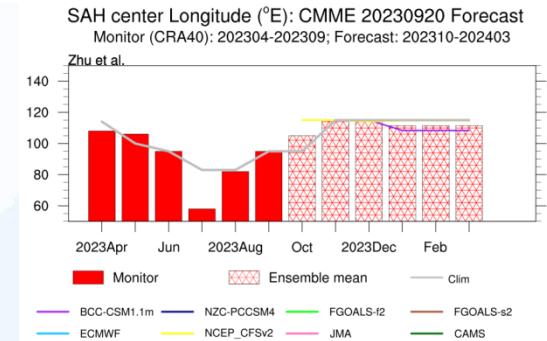
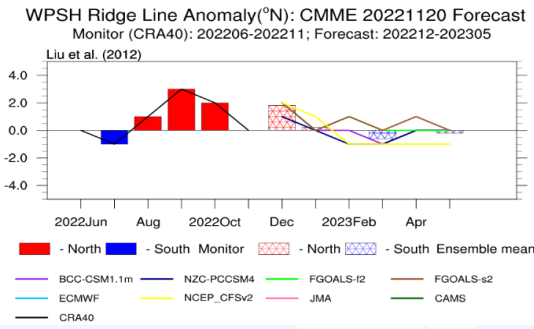
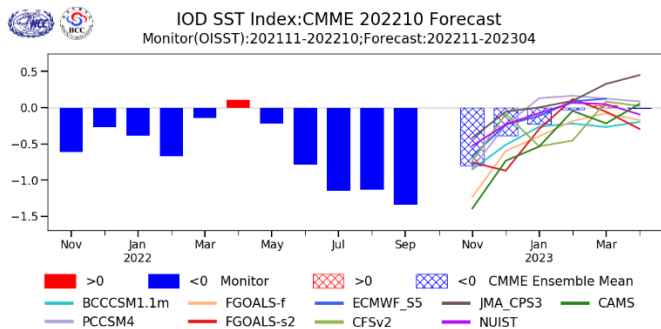
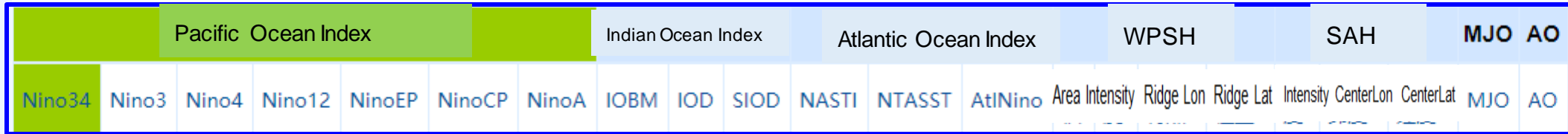
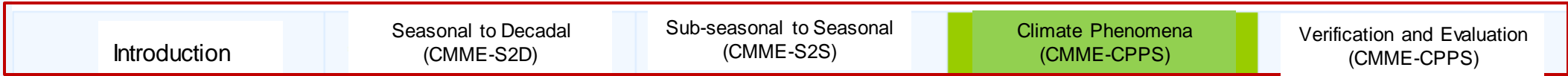




CMME-CPPS Products



China Multimodel Ensemble Prediction System (CMMEv2.0)



Monitoring and Multi-model Prediction of Ocean SST Indices

Monitoring and Multi-model Prediction of West Pacific Subtropical High Indices

Monitoring and Multi-model Prediction of South Asian High Indices

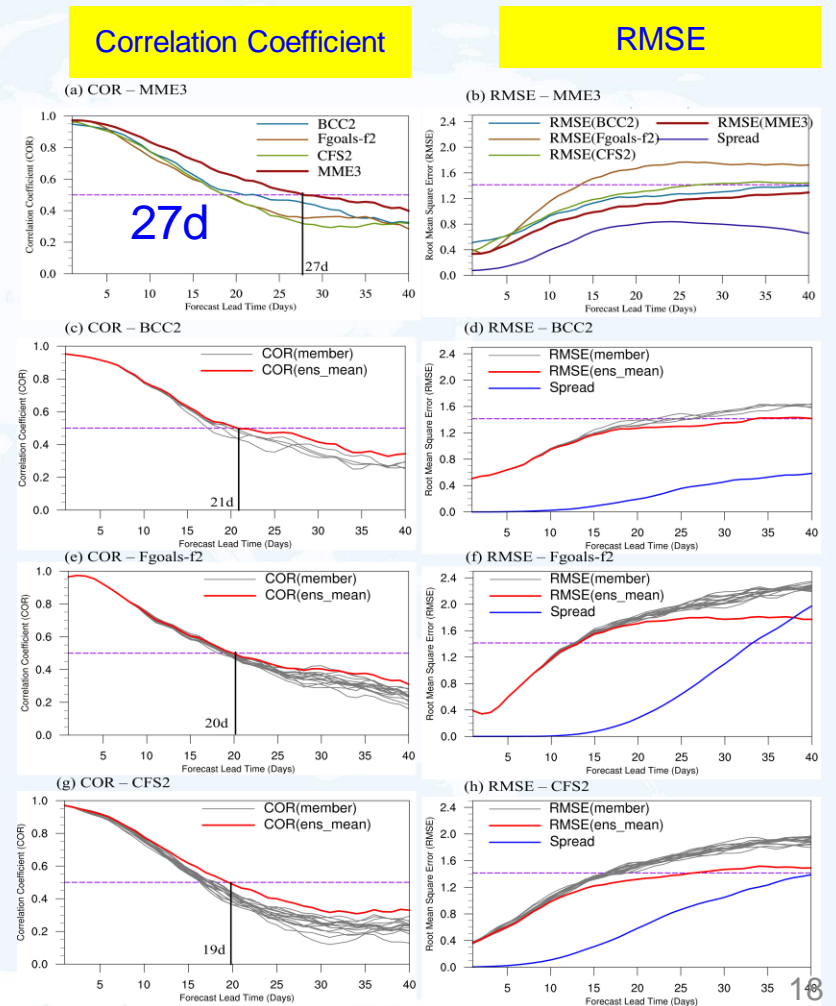
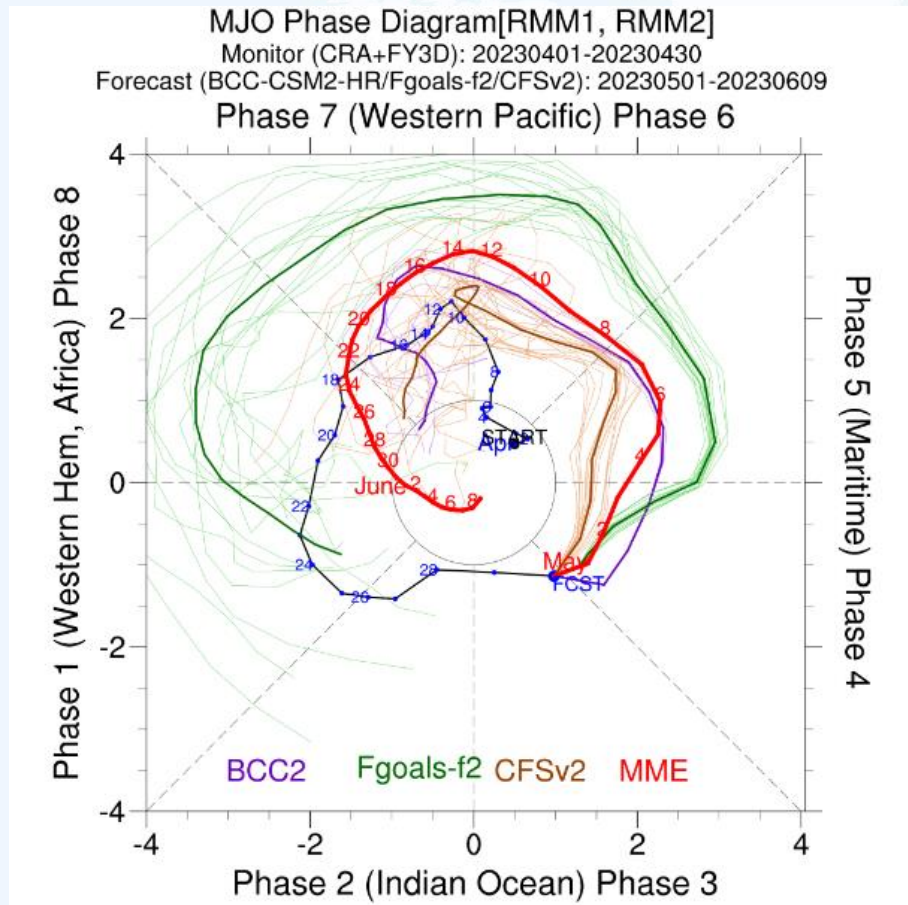


MJO MME Prediction

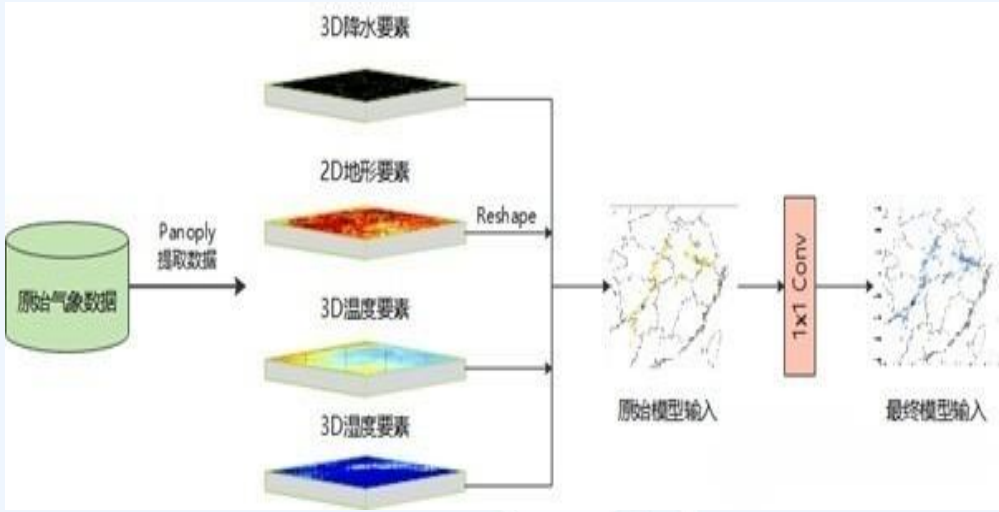


- MJO Multi-model ensemble prediction

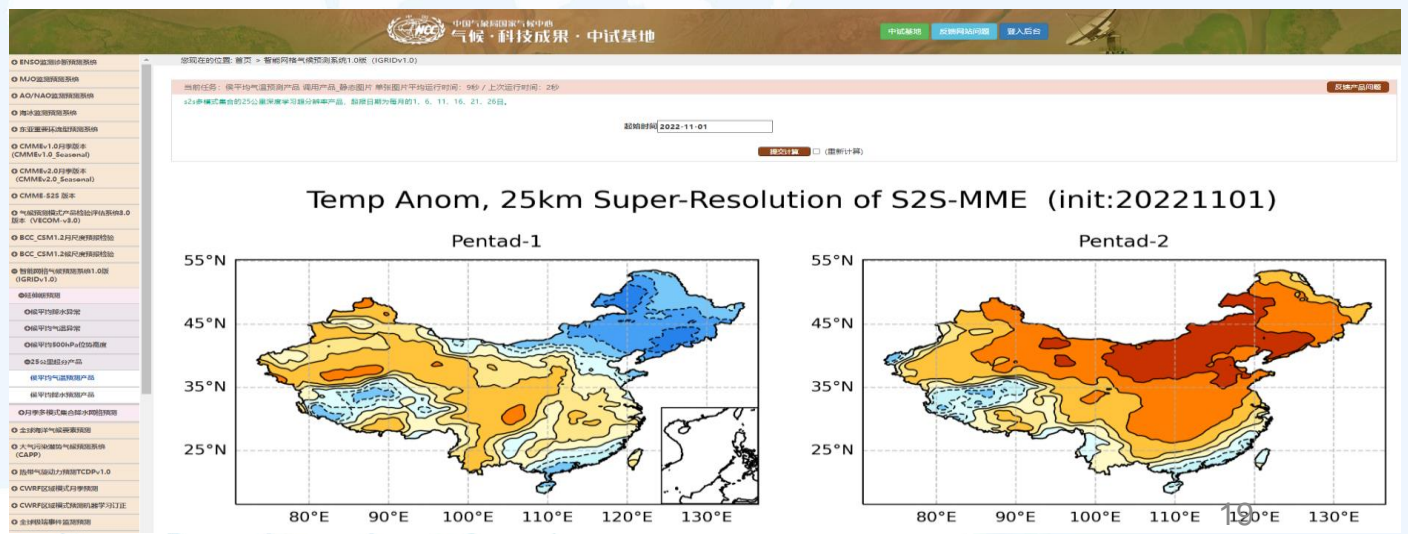
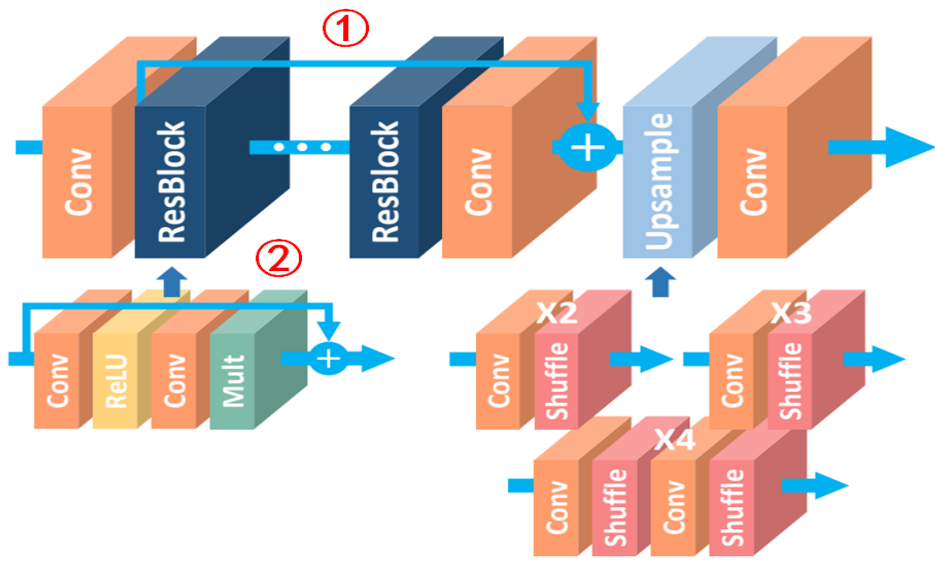
- MJO prediction skill is about 27 days (correlation exceeding 0.5) during the past 3 years.



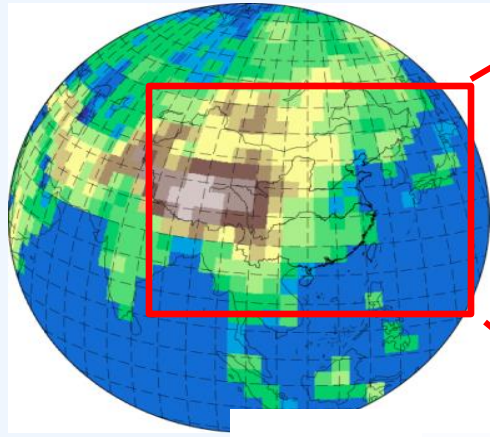
25km-resolution sub-seasonal grid prediction based on the Super-Resolution technique



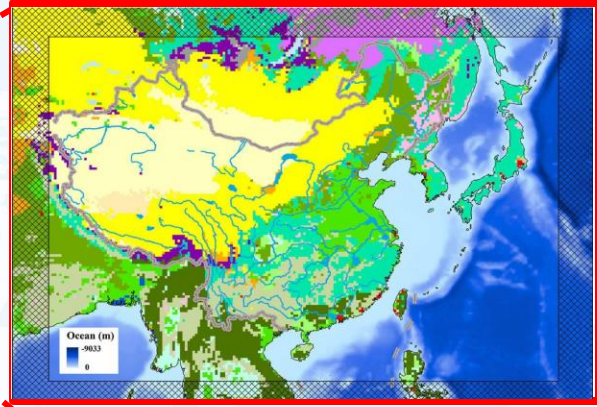
- ◆ With **Deep Learning-based Super-Resolution**, the output of CMME-S2S with **150km resolution** are downscaled to China with **25km resolution**
- ◆ The real-time grid prediction products of temperature and precipitation with 25km resolution for the future 12 pentads are released at the Test-Bed of NCC/CMA



Higher resolution prediction products based on dynamic downscaling



terrain

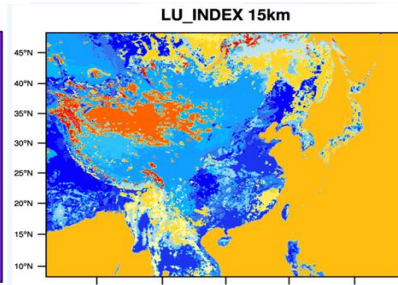
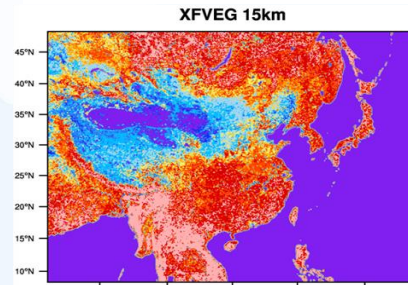
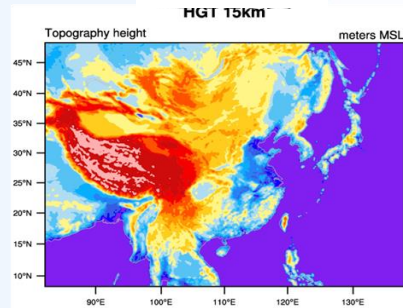


vegetation fraction

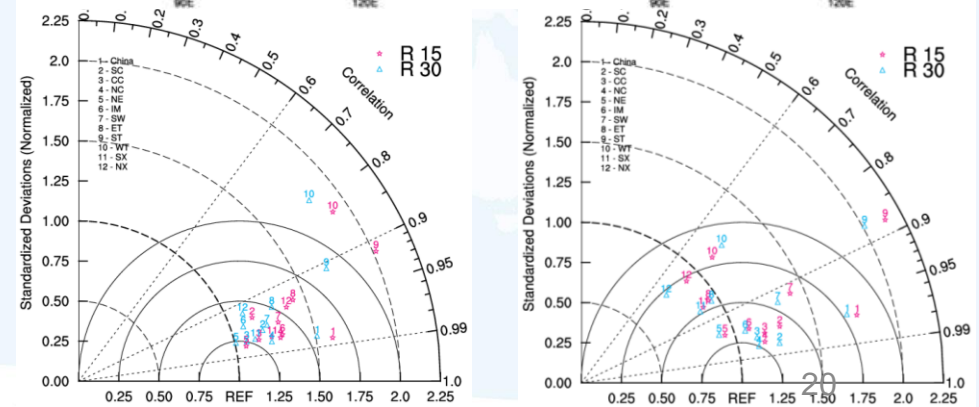
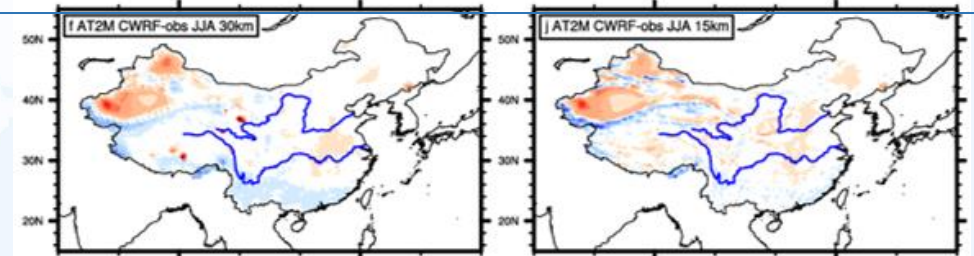
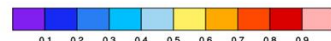
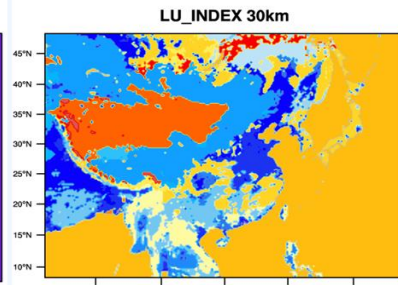
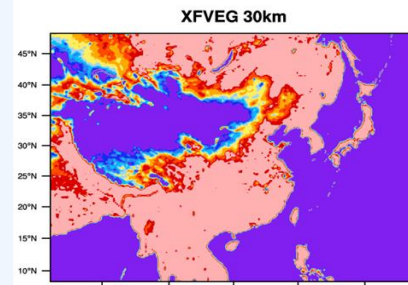
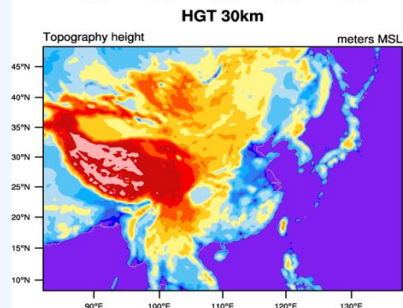
dominant category

- ◆ Development of 15km dynamic downscaling prediction model
- ◆ Lower simulation error of temperature and precipitation than that of 30km
- ◆ Sub-seasonal prediction nested CMA-CPSv3

15km



30km





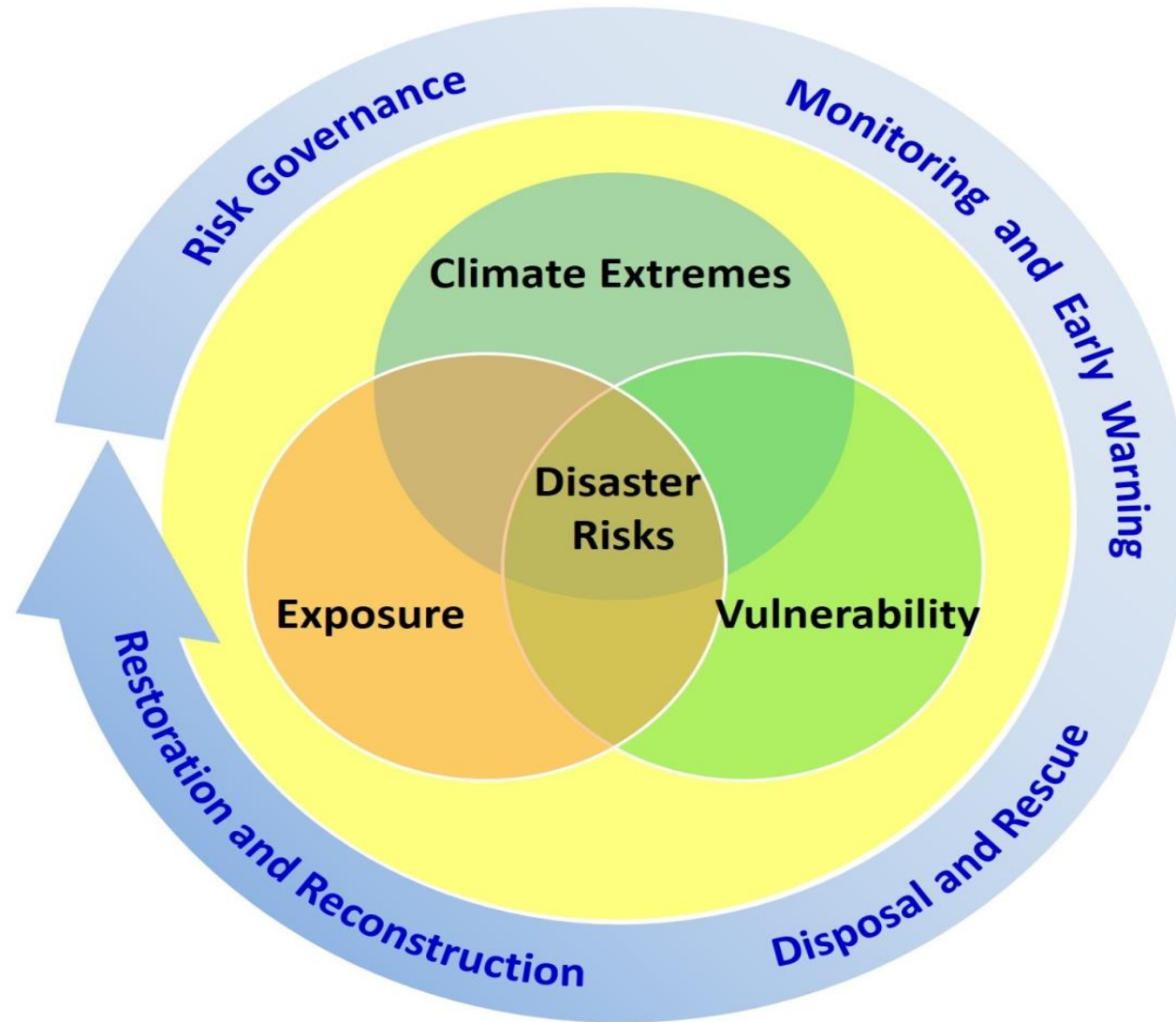
Outlines



- Climate Monitoring and prediction
- BCC-Climate Model and Multi-model Ensemble Prediction
- **Meteorological Disaster Risk Pre-assessment**
- Climate services in BCC
- Future plan



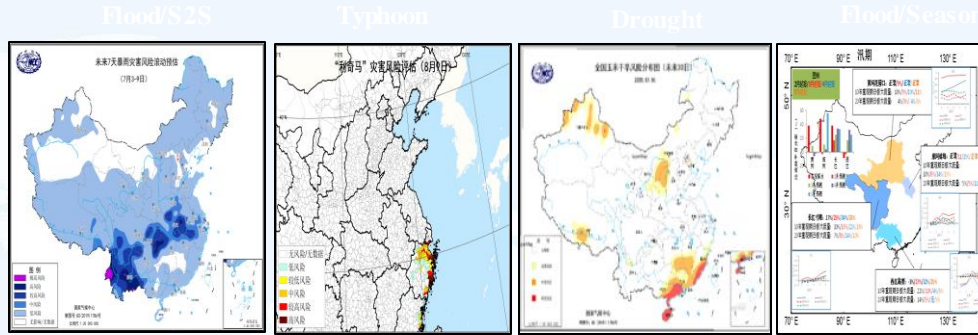
➤ Disaster Risk Reduction



BCC roadmap for Risk Management



2. Disaster Monitoring

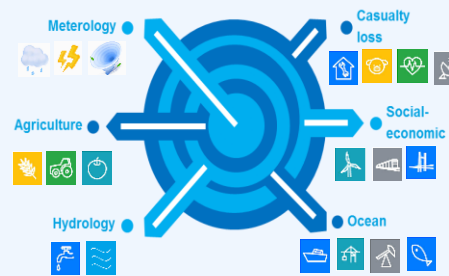


5. Risk assessment

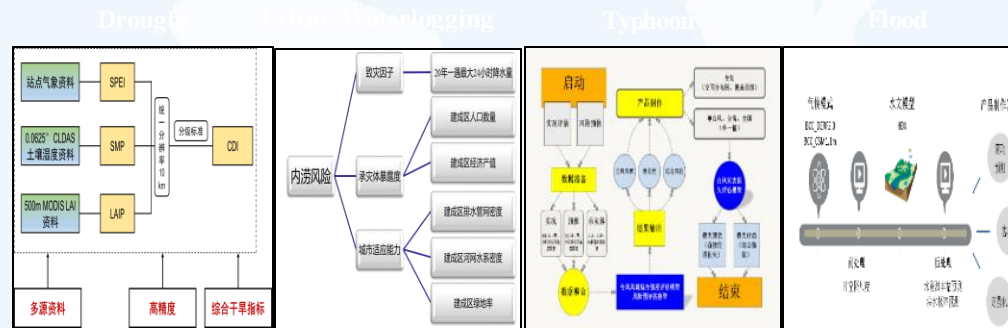


6. Early warning and climate service

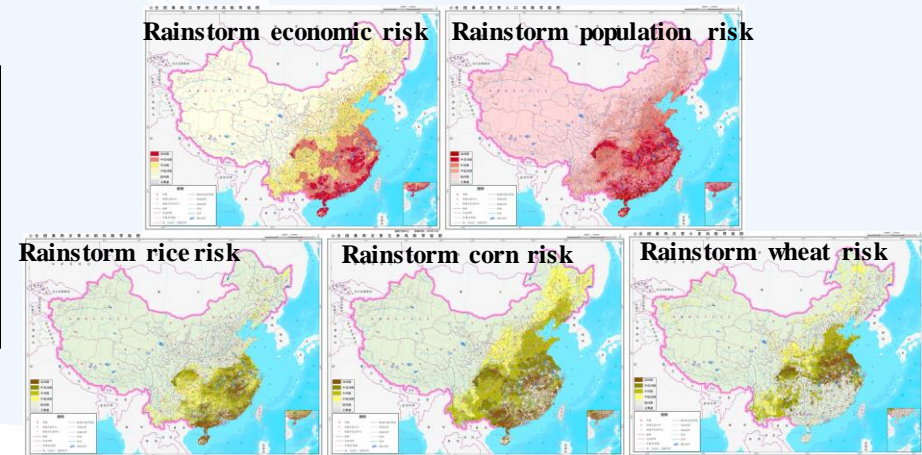
1. Risk census



3. Model and algorithm



4. Risk zonation



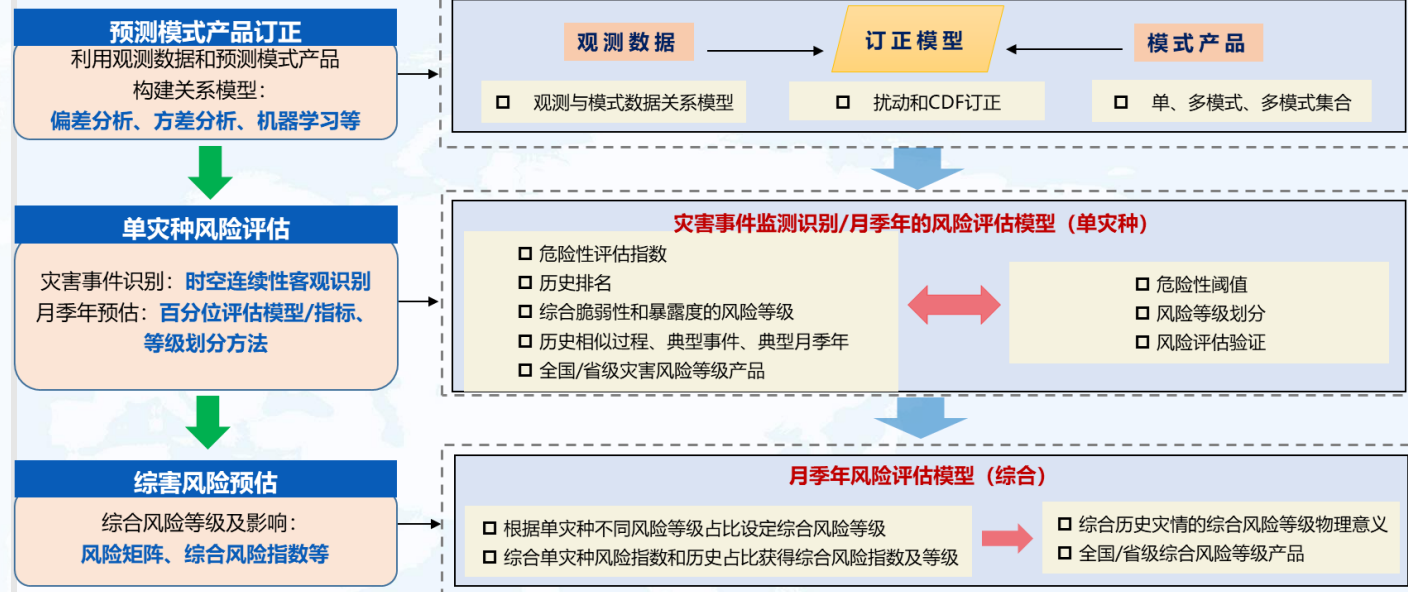
1. Establishing a technical scheme for objective risk pre-assessment of single disaster and comprehensive risks



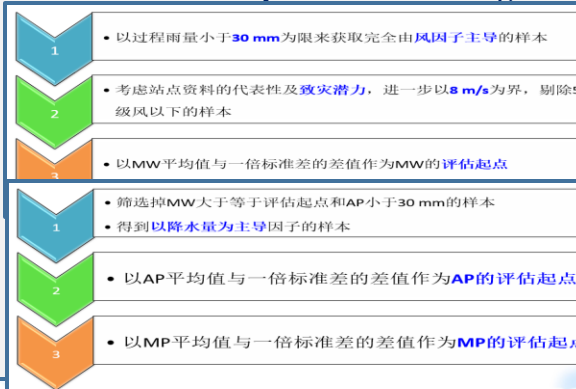
Development of the objective assessment:

- Key technologies for typhoon disaster risk assessment
- Rolling risk pre-assessment of typhoon disasters.
- A preliminary overall technical scheme for Meteorological Disaster Risk Pre-assessment at different time scales
- Risk pre-assessment products based on multi-model

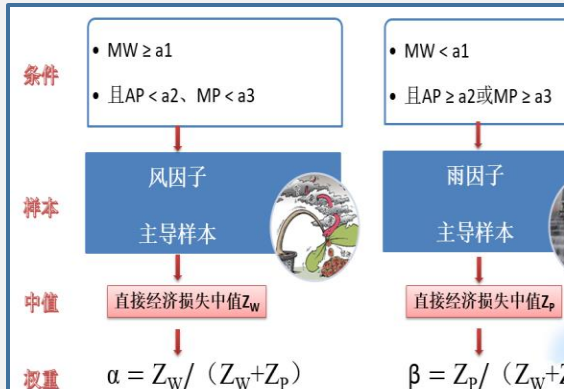
Technology of Meteorological Disaster Risk Pre-assessment



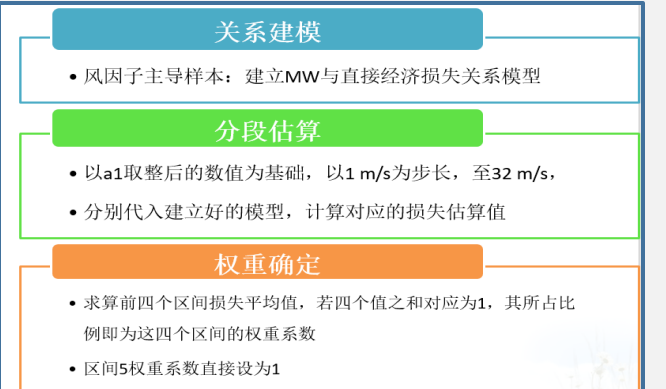
1. Separate wind and rain of Typhoon, establish the start point for assessing



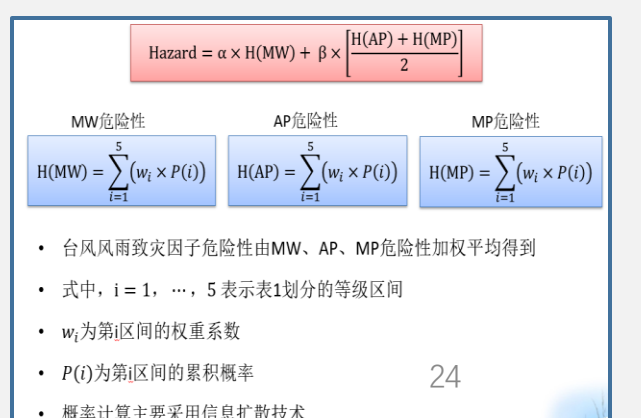
2. Determination the weights of wind and rain



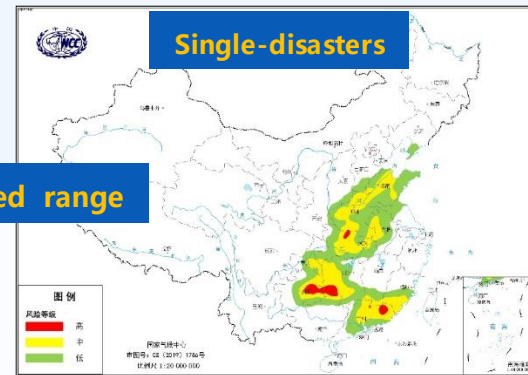
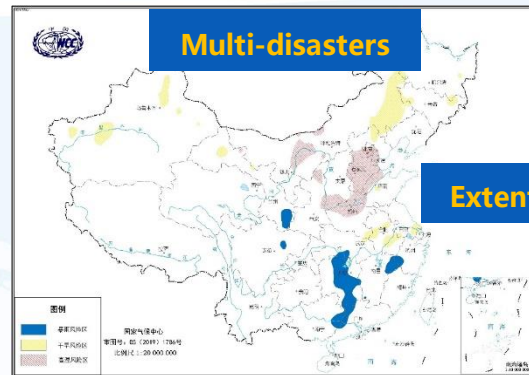
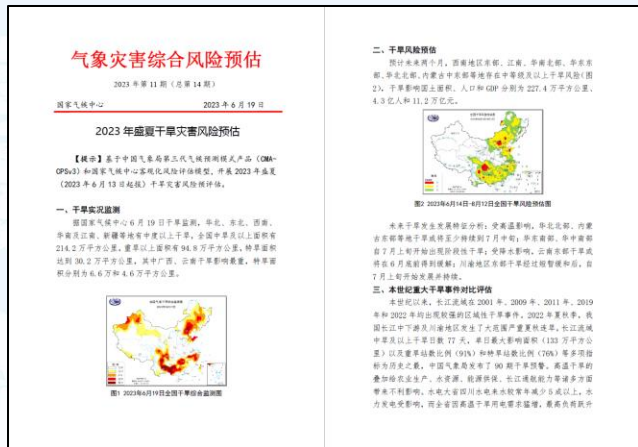
3. Determination the weights of wind and rain in different value intervals



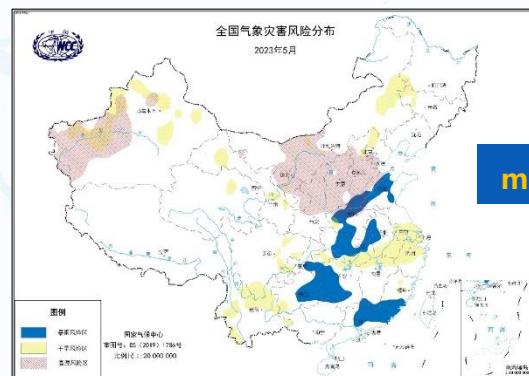
4. Comprehensive risk assessment technology



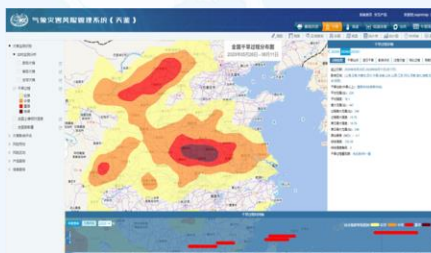
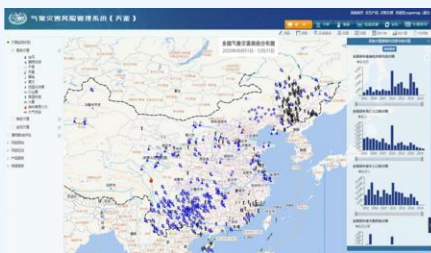
2: Establishing objective risk pre-assessment product system



Extended range



monthly



disaster monitoring

risk identification

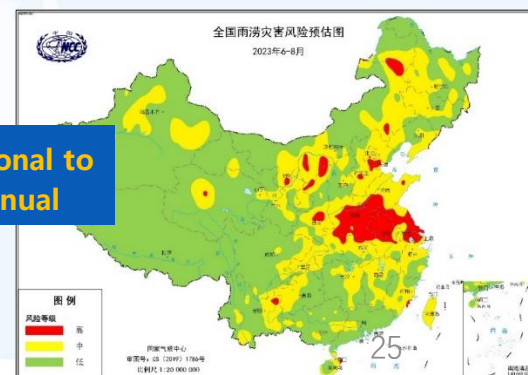
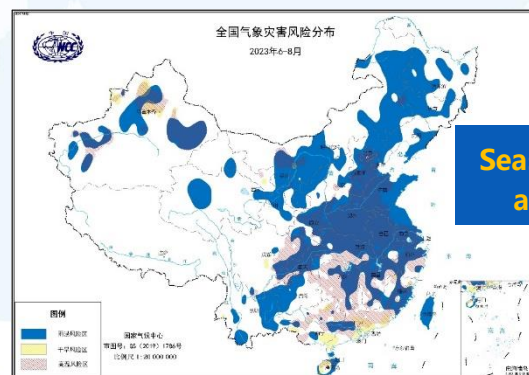
Impact assessment



historical comparative assessment

risk pre-assessment

risk zonation



Seasonal to annual

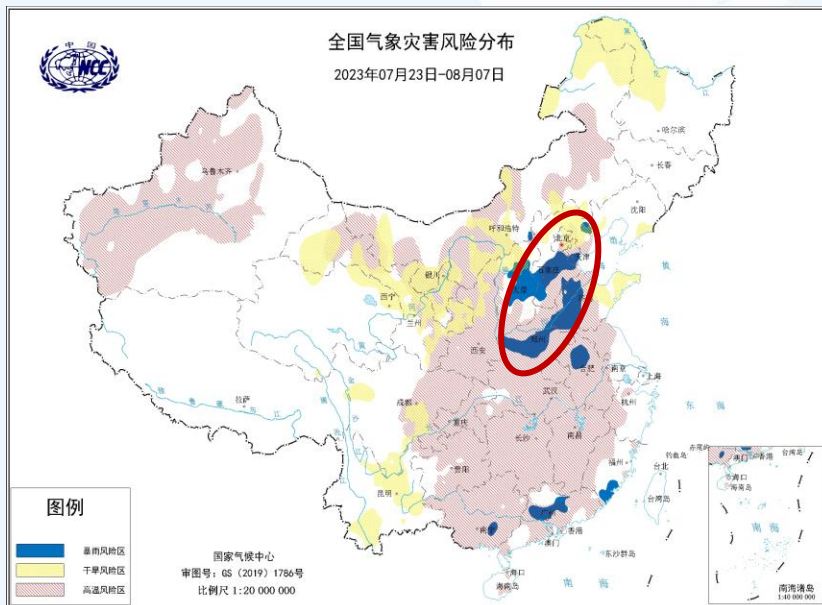
3: Realizing the "gateway forward" of disaster risk pre-assessment and playing a key role in decision-making services



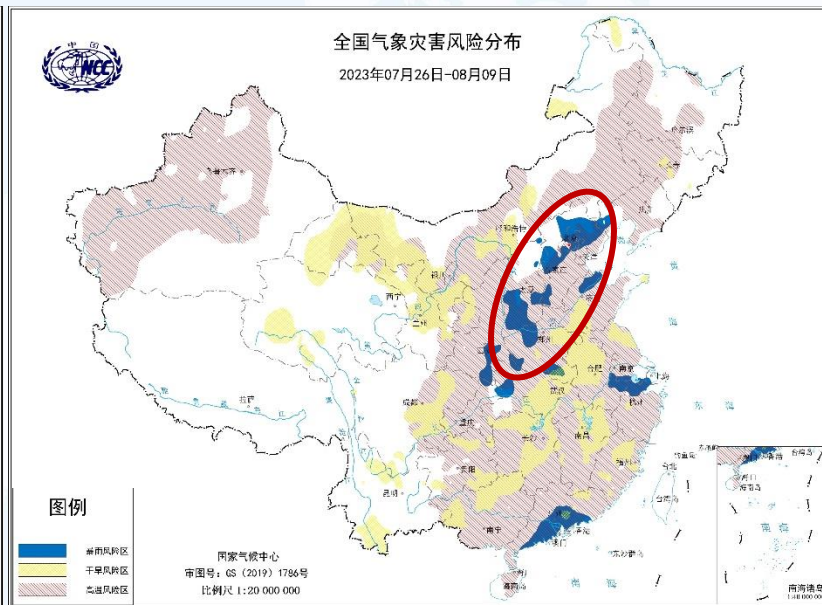
Risk pre-assessment of "Beijing-Tianjin-Hebei-Shandong-Henan extraordinary rainstorm disaster"

- Both the extension and monthly disaster risk pre-assessment have caught the initial date and location of high risk of this extraordinary rain storm disaster, realized the "gateway forward" of major disaster risk estimation, and provided technical support for "building the first line of defense for disaster prevention and mitigation".

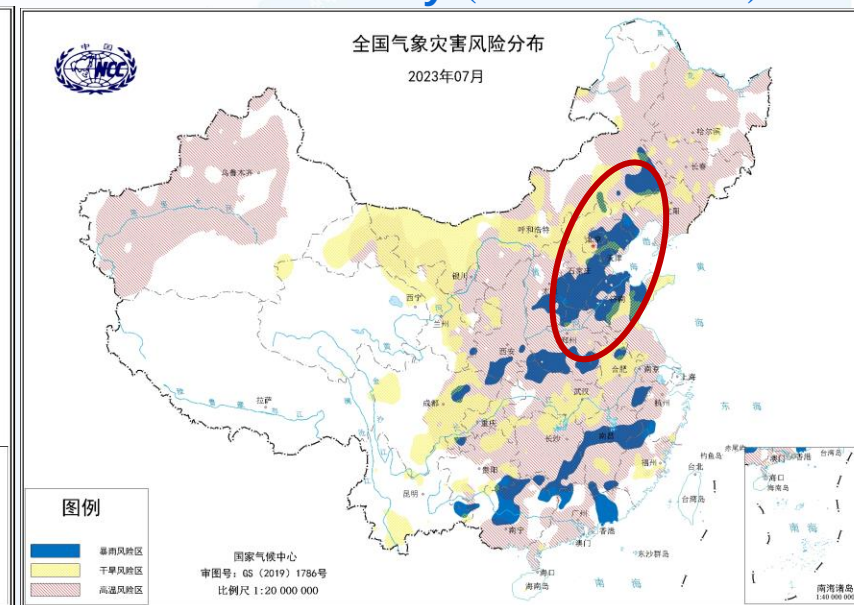
Short-term forecast (21th July start)



Extend range forecast (8th July)



monthly (28th June start)



3: Realizing the "gateway forward" of catastrophe risk pre-assessment and playing a key role in decision-making services

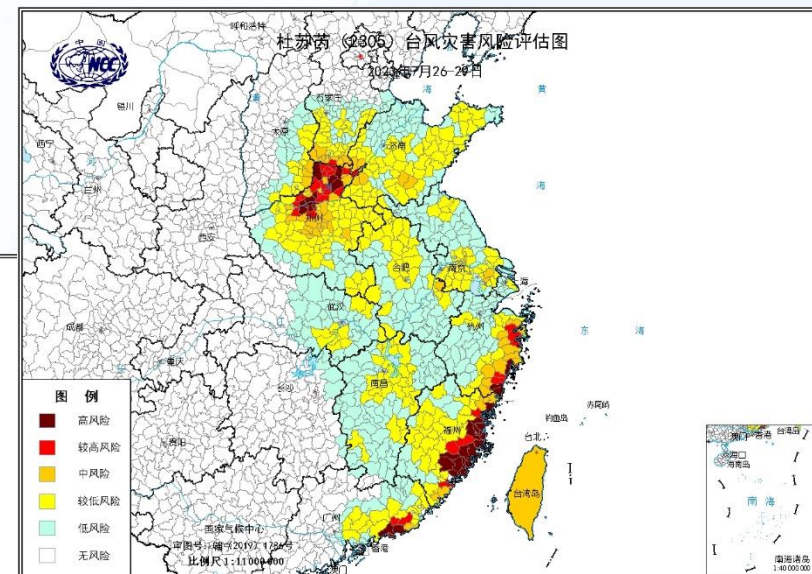
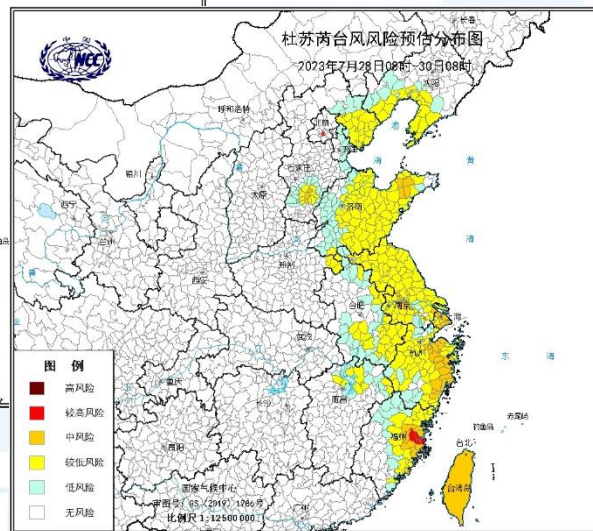
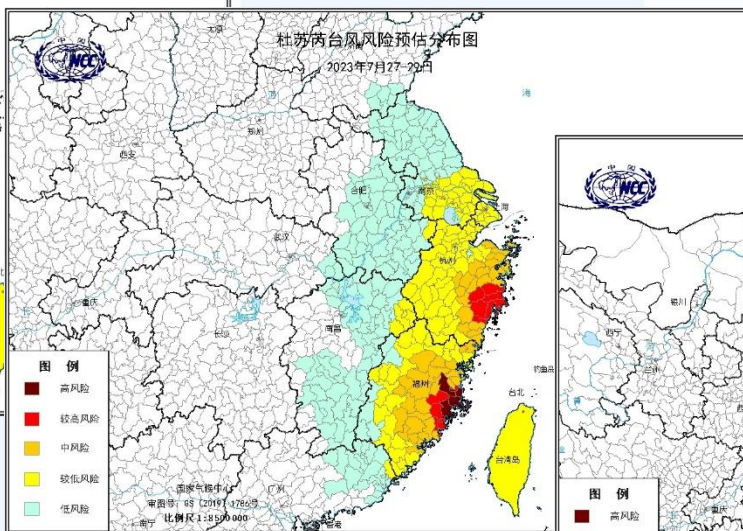
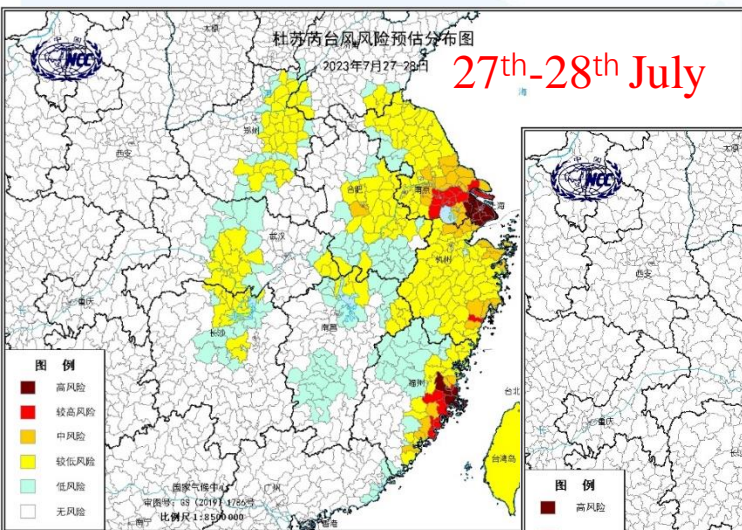


Super typhoon Doksuri (2305)

- Rolling risk pre-assessment products of Typhoon Doksuri (2305) and comprehensive assessment of its disaster risk in time.

Dussuri rolling disaster risk pre-assessment

Dussuri disaster risk assessment





Outlines



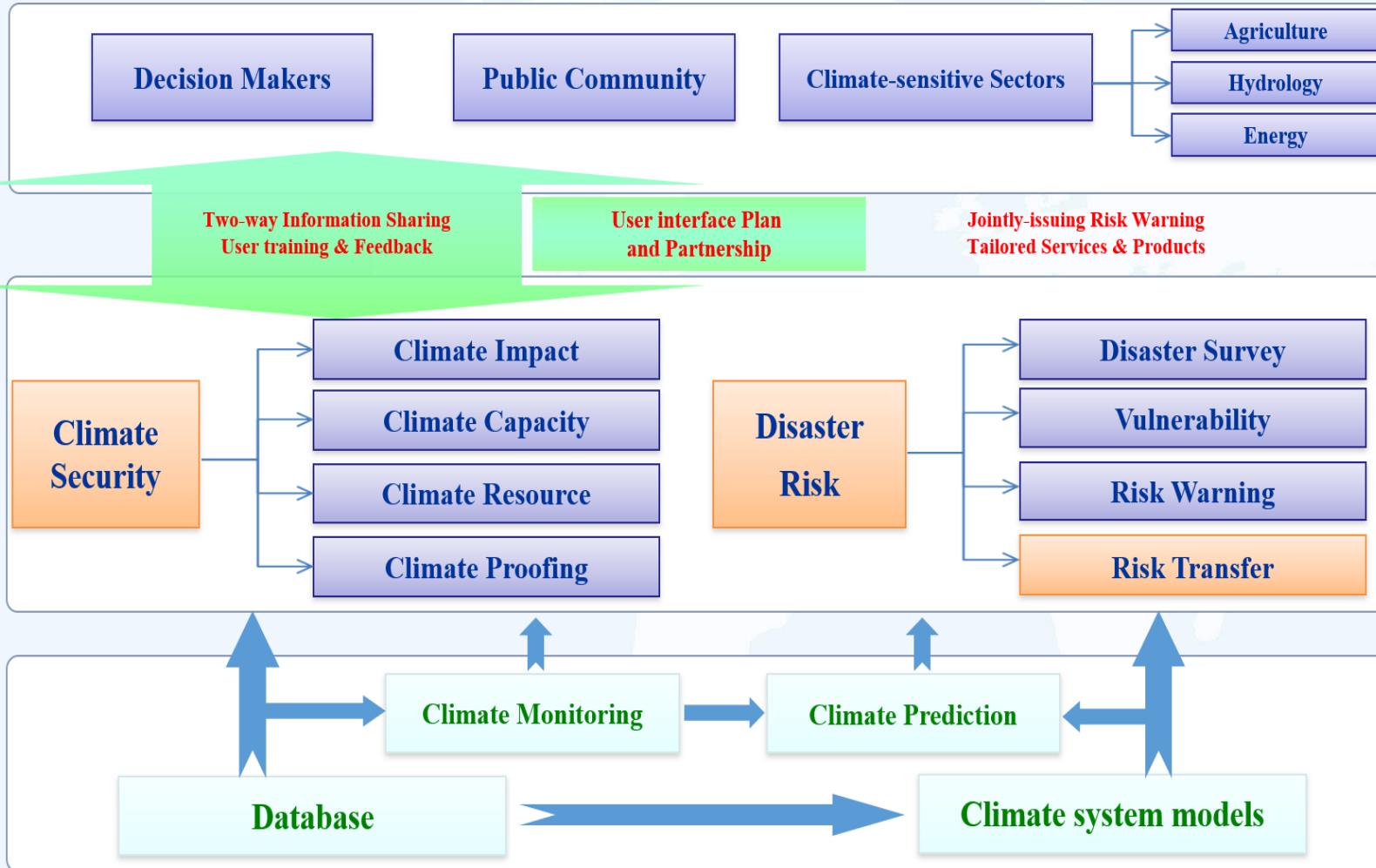
- Climate Monitoring and prediction
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- Future plan





Climate services

China Framework for Climate Services

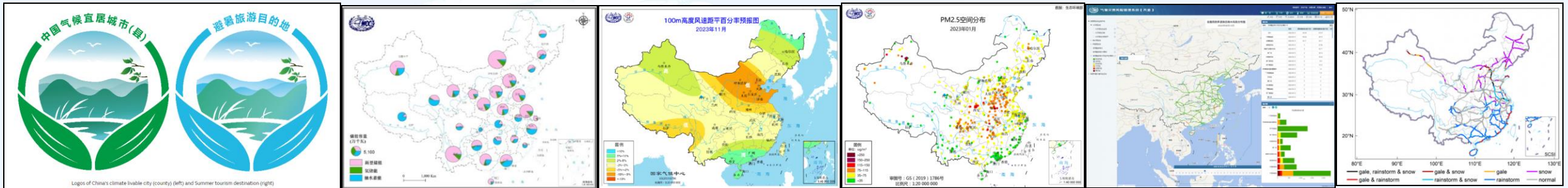


Climate Services for decision-maker:

For every year, more than 400 climate consulting reports are submitted to the central government and relevant sectors by BCC.

Climate services

Strong demand from climate-sensitive industries



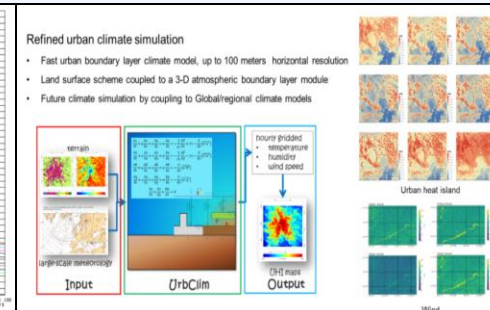
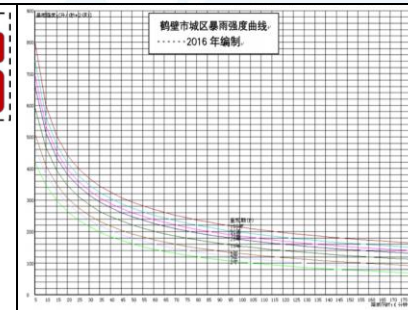
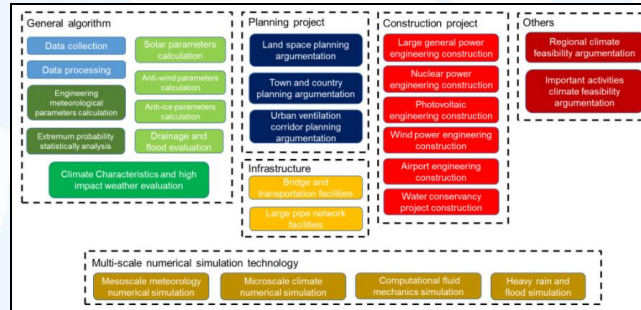
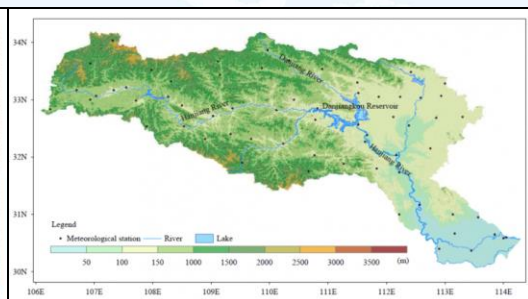
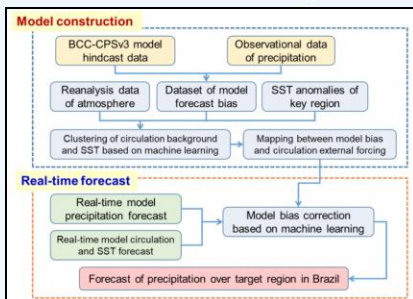
Ecology

Energy

Environment

Transportation

Engineering and climate feasibility services



Prediction services for water resource

Climate feasibility assessment

Refined climate services promote the development level of economic and social

Climate services for public



State Council press conference



CCTV Report



CMA press conference



Expert interpretation



BCC WeChat

Focusing on climate hotspots and major climate events, we organized experts to study and analyze them, provided technical support for the press conference of the State Council New Office, and responded to the concerns of the society in a timely manner through multi-channels such as the press conference of the China Meteorological Administration (CMA), the official WeChat of the National Climate Center (NCC), and the national mainstream media, etc. by making scientific voices and authoritative interpretation.



Climate knowledge science classroom



Outlines



- Climate Monitoring and prediction
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- **Future plan**

Future plan

- **Continuously conducting research on the mechanism and predictability of the East Asia monsoon**
- **Promoting the research and application of dynamic climate prediction models.(Upgrade CMME, AI ...)**
- **Developing disaster risk pre-assessment verification techniques**
- **Developing comprehensive disaster risk assessment model**
- **Exploring the establishment of an early warning system for climate change risks**

**Thank you
for your
attention**

