A introduction of WMO RA II Research Development Project/ 19th Hangzhou Asian Games Reasearch Development Project on Convective-scale Ensemble Prediction and Application(*Hangzhou RDP*)

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Oct 23, 2023

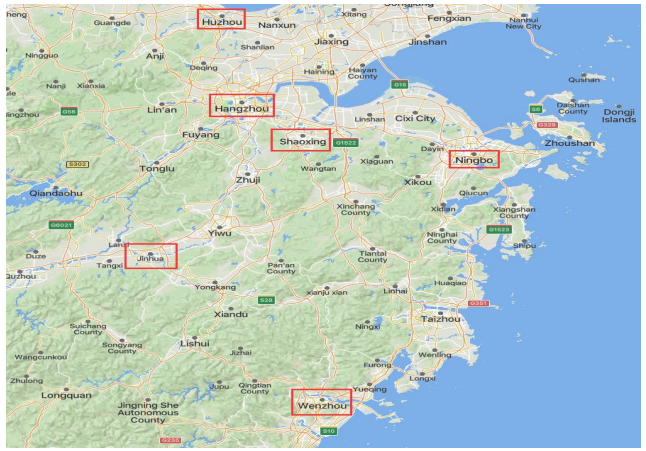
19th Asian Games Hangzhou 2022

Hangzhou 2022 Asian Para Games

Outline

1. Background Review
2. Recent Progress
3. Chanllenges

Background(1)



The 14 meteorological disasters have impacts on Hangzhou	
Cyclones	Dry
Torrential Rain	Thunderstorm
Cold Wave	Torrential Snow
Heavy Fog	Frost
Low Temperature	Tornado
High Temperature	Gale
Haze	Hail

•Asian Games Hangzhou 2022 , Asian Para Games

✔ Date: September 23--- October 8, October 22-28, 2023

✔ Venue: Hangzhou, Ningbo, Wenzhou, Jinhua, Shaoxing, Huzhou

•Meteorological Service Requirements

✔ Accurate forecasting of temperature, precipitation, wind, visibility, etc.

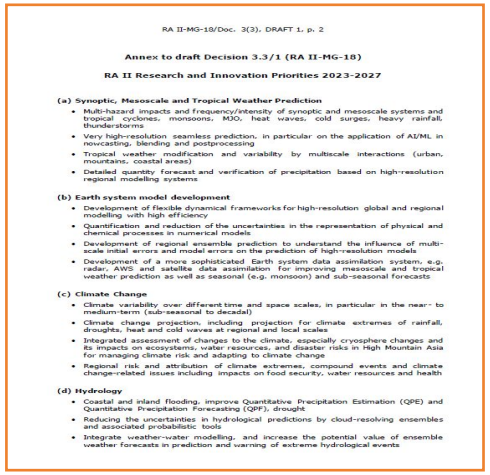
•Challenges

✔ The threat of extreme weather during the summer-autumn transition in Zhejiang Province.

✔ The gap between the forecasting skills for high-resolution deterministic models and the high demand of forecast accuracy.

It is necessary to develop the ensemble forecast products for the forecast and early warning needs of the Asian(Para) Games.

Background(2)



RA II-MG-18/Doc. 3(3), DRAFT 1, p. 2

Annex to draft Decision 3.3/1 (RA II-MG-18)

RA II Research and Innovation Priorities 2023-2027

(a) Synoptic, Mesoscale and Tropical Weather Prediction

- Multi-hazard impacts and frequency/intensity of synoptic and mesoscale systems and tropical cyclones, monsoons, MJO, heat waves, cold surges, heavy rainfall, thunderstorms
- Very high-resolution seamless prediction, in particular on the application of AI/ML in nowcasting, blending and postprocessing
- Tropical weather modification and variability by multiscale interactions (urban, mountains, coastal areas)
- Detailed quantity forecast and verification of precipitation based on high-resolution regional modelling systems

(b) Earth system model development

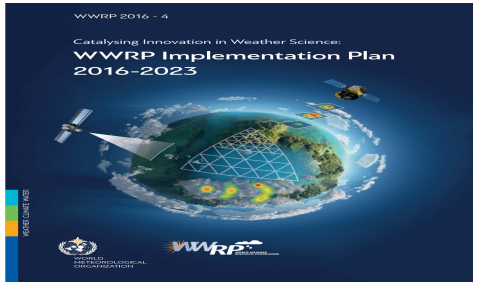
- Development of flexible dynamical frameworks for high-resolution global and regional modelling with high efficiency
- Quantification and reduction of the uncertainties in the representation of physical and chemical processes in numerical models
- Development of regional ensemble prediction to understand the influence of multi-scale initial errors and model errors on the prediction of high-resolution models
- Development of a more sophisticated Earth system data assimilation system, e.g. radar, AWS and satellite data assimilation for improving mesoscale and tropical weather prediction as well as seasonal (e.g. monsoon) and sub-seasonal forecasts

(c) Climate Change

- Climate variability over different time and space scales, in particular in the near- to medium-term (sub-seasonal to decadal)
- Climate change projection, including projection for climate extremes of rainfall, droughts, heat and cold waves at regional and local scales
- Integrated assessment of changes to the climate, especially cryosphere changes and its impacts on ecosystems, water resources, and disaster risks in High Mountain Asia for managing climate risk and adapting to climate change
- Regional risk and attribution of climate extremes, compound events and climate change-related issues including impacts on food security, water resources and health

(d) Hydrology

- Coastal and inland flooding, improve Quantitative Precipitation Estimation (QPE) and Quantitative Precipitation Forecasting (QPF), drought
- Reducing the uncertainties in hydrological predictions by cloud-resolving ensembles and associated probabilistic tools
- Integrate weather-water modelling, and increase the potential value of ensemble weather forecasts in prediction and warning of extreme hydrological events



RA II Research and Innovation Priorities 2023-2027

WMO strategic plan 2020-2023:
Objective 2.3, 3.2, 4.1
Goal 3

World Weather Research Programme (WWRP) implementation plan 2016-2023

Priorities

Improvement of the forecast or predict capability of high-impact weather

Development of earth system model and numerical analysis

Enhancement of scientific understanding and service

Background(3)

Obtained the support of the PR of China with WMO, Mr. ZHUANG Guotai

Submitted the proposal to WMO RA II secretariat

Accepted by 18 session of RA II management Group

Kick-off meeting: March 15 during RECO conference

中 国 气 象 局
CHINA METEOROLOGICAL ADMINISTRATION
46 Zhongguancun Nandajie, Beijing 100081, China

Date: November 15, 2022
To: Dr. Abdulla Ahmed Al Mandous, President of Regional Association II
Fax No.: +97 126661575
From: Mr. ZHUANG Guotai, Permanent Representative of China with WMO
Number of pages including this one: 1
Annex: 1

Our Ref.: CMA/F1/WMO/22-44

Subject: Submission of New Demonstration Project

Dear Dr. Abdulla Ahmed Al Mandous,

The 17th session of RAII requests the RAII Focal Points on research to identify the research and innovation priorities of RAII from 2021 to 2024 in cooperation with relevant bodies, and to submit the priorities to the Management Group for approval. The long-term goal 2 of WMO Strategic Plan 2020-2023 aims to strengthen the earth system observation and prediction. In this regard, the China Meteorological Administration (CMA) would like to propose the 19th Hangzhou Asian Games Research Development Project on Convective-scale Ensemble Prediction and Application (the concept note is attached for your reference), to support the implementation of the above requirements in RAII.

This demonstration project intends to develop higher-resolution products based on convective-scale ensemble prediction, look into the uncertainty in the forecast of severe weather events, and demonstrate the enhancement of forecast and early warning of weather events at 100-meter scale and minute scale by the uncertain information from ensemble forecast, in a bid to provide technical methods and experience for RAII Members in forecast and early warning of severe weather events.

I sincerely hope that this project, which is open to all RAII Members, would be approved by you and RAII Management Group as a RAII research and innovation priority.

Yours sincerely,

(ZHUANG Guotai)

CC: Regional Office for Asia and the South-West Pacific and RAII Focal Points on Research

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•WMO ideas

- ✔ Enhance the role of RAs.
- ✔ Promote the implementation of WMO research plans and development ideas in RAs.

•RA II Regional Focal Points on Research support the proposal of HangzhouRDP

- ✔ Jing Chen, China
- ✔ Ashis K. Mitra, India
- ✔ Mai khiem, Vietnam

Annex to Decision 3.3/3 (RA II-MG-18)

Concept Note for a RA II Research Development Project

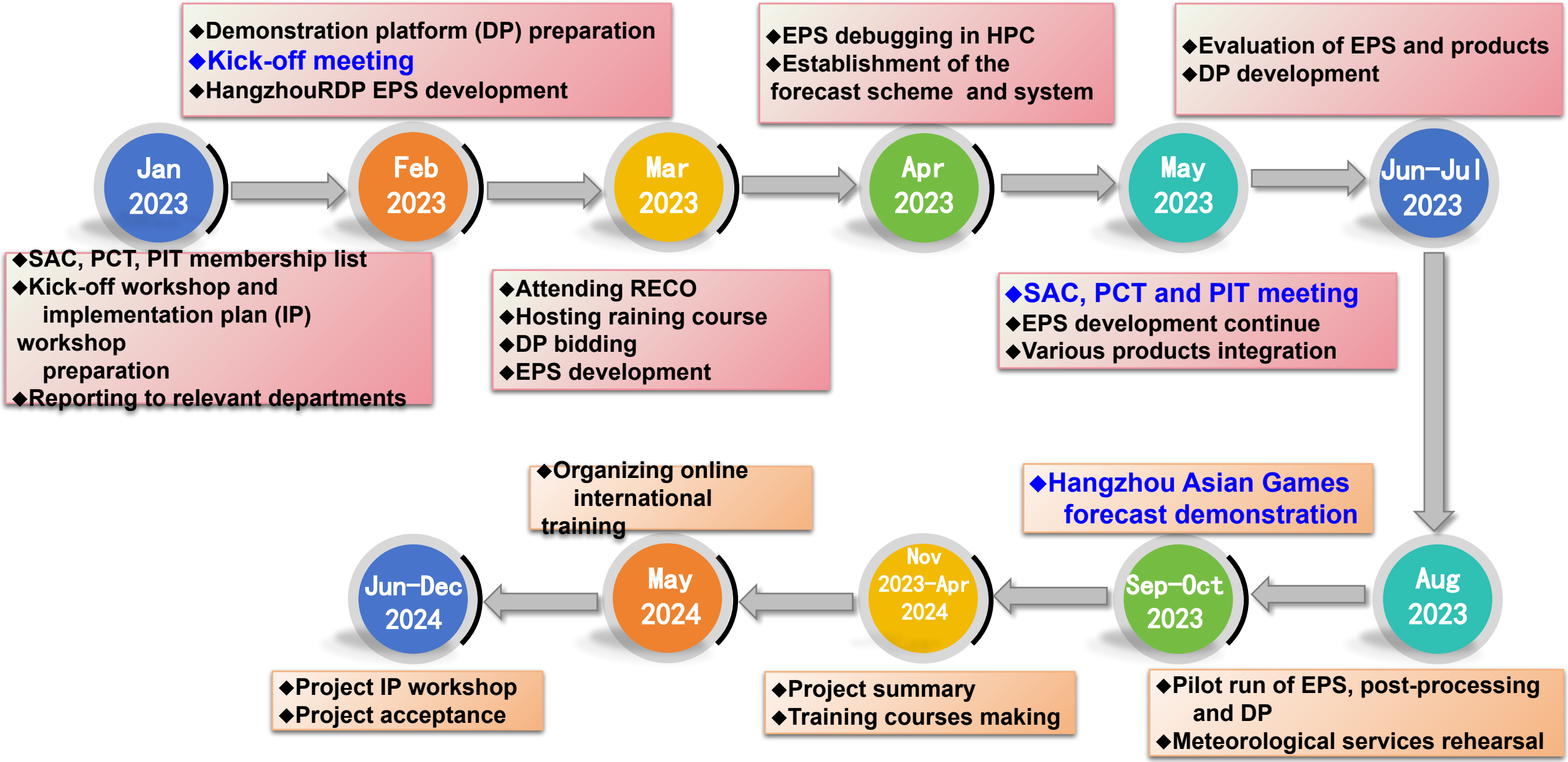
19th Hangzhou Asian Games Research Development Project on Convective-scale Ensemble Prediction and Application (HangzhouRDP)

Home Page: http://www.wmc-bj.net/hangzhou-rdp

Scientific objectives

- **Understand**
  - The impact of multi-scale initial errors and model errors on the prediction of high-resolution models
  - The forecast uncertainty of local severe convective weather.
- **Demonstrate**
  - The improvement of forecasting and early warning capabilities at sub-kilometer scale and minute scale by utilizing the uncertainty information from ensemble forecast.
- **Develop**
  - Convective-scale ensemble prediction, postprocessing and verification method at sub-kilometer meter and minute scale.
- **Share**
  - The experience gained with RA II members through training courses.

Project Schedule



Research contents(1)

•Development of a convective-scale Ensemble Prediction System

- ✔ **Develop the methodology for perturbation of initial conditions and model formulation in dynamics and parameterization.**
- ✔ **Provide basic data for the research of sub-kilometer and minute scale ensemble forecasting post-processing products.**
- ✔ **Understand the influence of multi-scale initial and model errors on the prediction of high-resolution models.**

CMA-HZ-CAEF

CHEN Feng
ZJPMS, China

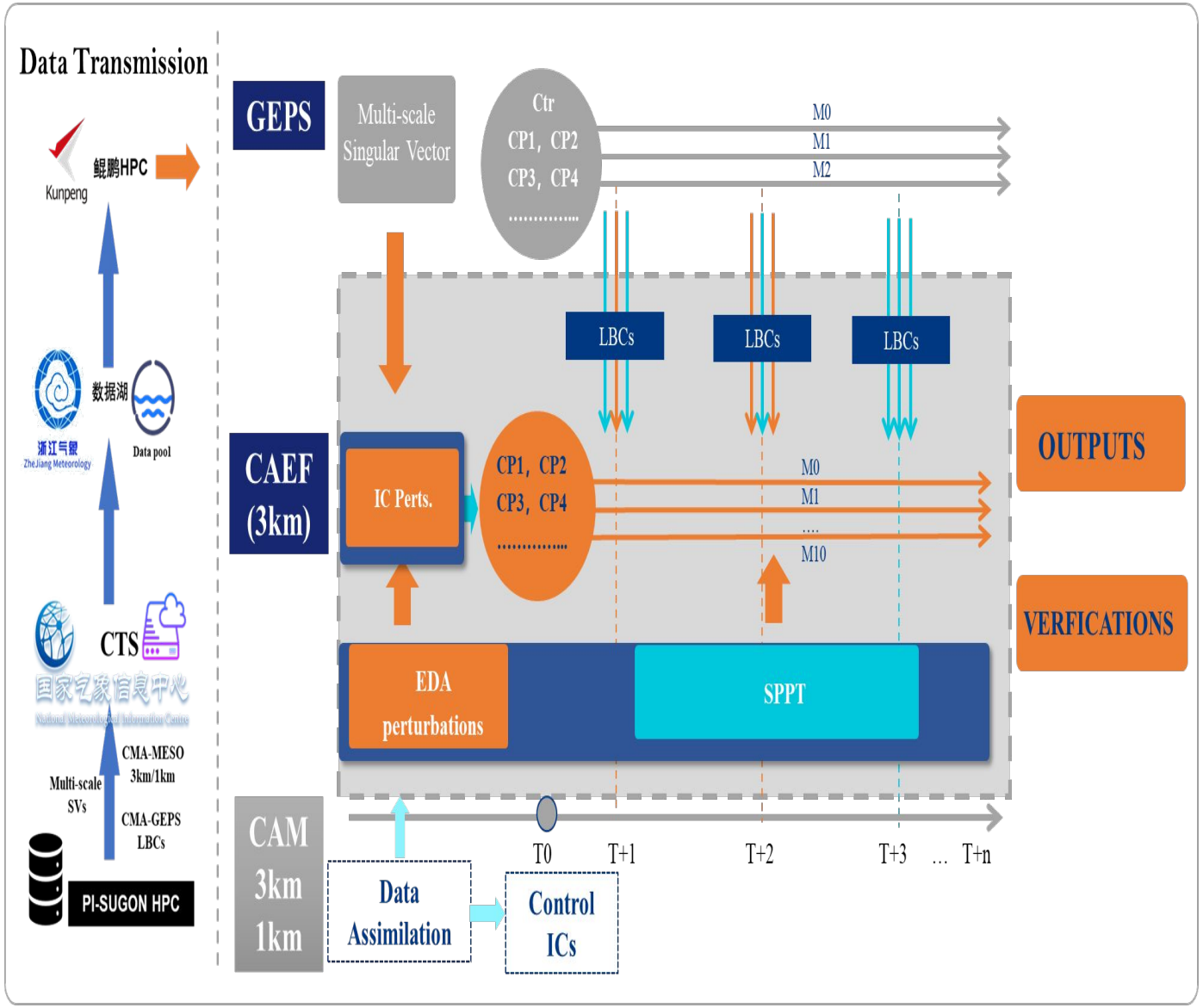
Partner：NU-HZ-CAEF

LEI Lili
Prof NU

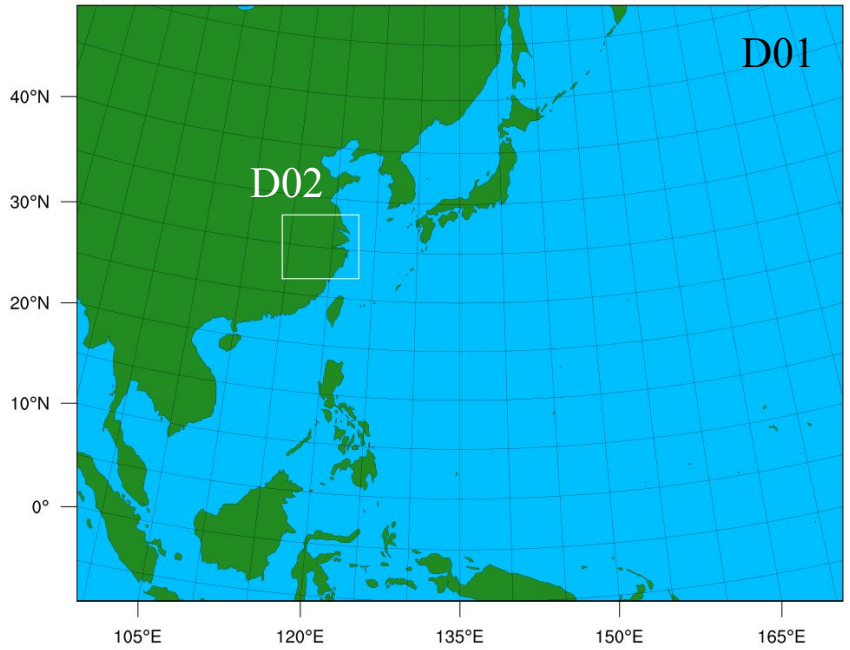
CMA-HZ-CAEF

Core Model	CMA_MESO 5.1
Resolution	0.01°--0.03°(3km) /51 layers
Vertical Coordinate	Height-based terrain following coordinates
Integration	Semi-implicit semi-Lagrangian
Domain	106.12-129.88°E 19.51-43.45°N
Number of grid points	793 × 799
Background	GFS+GEPS
Assimilation	3dvar、cloud analysis
Initial perturbation	EDA+Multi-scale SVs
Model perturbation	SPPT
Boundary perturbation	GFS Background+GEPS Perts.
Members	1 Control+14 ensemble（0.03°） 1 Control(0.01）
Lead time	84 hours (00/12 UTC)
Output frequency	1 hour
Output format	BIN, GRIB2, JPG

CMA-HZ-CAEF flow chart



NU-HZ-CAEF



- D01 has 720x560 grid points with 12-km resolution, which is designed for WNP TCs
- Nested D02 has 360x300 grid points with 2.4-km resolution, which is designed for Hangzhou RDP

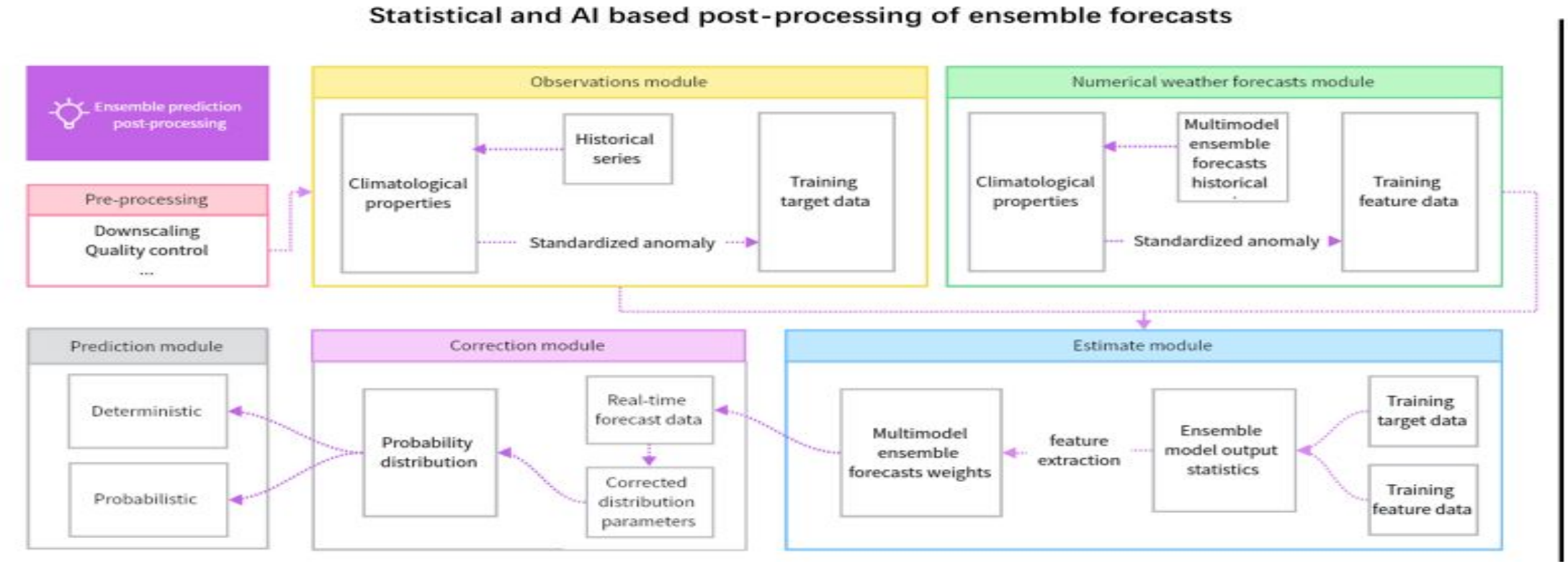
- Model simulations use WRFV3.9
- Model physics: RRTM long/short wave radiation scheme, WSM 6-class graupel microphysics scheme, Noah land surface model, YSU PBL scheme, and Tiedtke cumulus scheme only for d01
- Lateral boundary conditions (LBCs) are interpolated from the 6-h NCEP GFS analyses/forecasts with 0.25° resolution, and ensemble LBCs are obtained by adding perturbations to the LBCs
- Only the ensemble initial conditions (ICs) at the beginning of the TC season (i.e., cold start) are obtained by adding perturbations to the IC interpolated from the NCEP GFS analysis, and the following ensemble ICs are produced by the cycling WRF/EnKF

Reference: Convective Scale EPS for Hangzhou RDP in Nanjing University, Lei Lili, HangzhouRDP Workshop, 10 – 12 July 2023

Research contents(2)

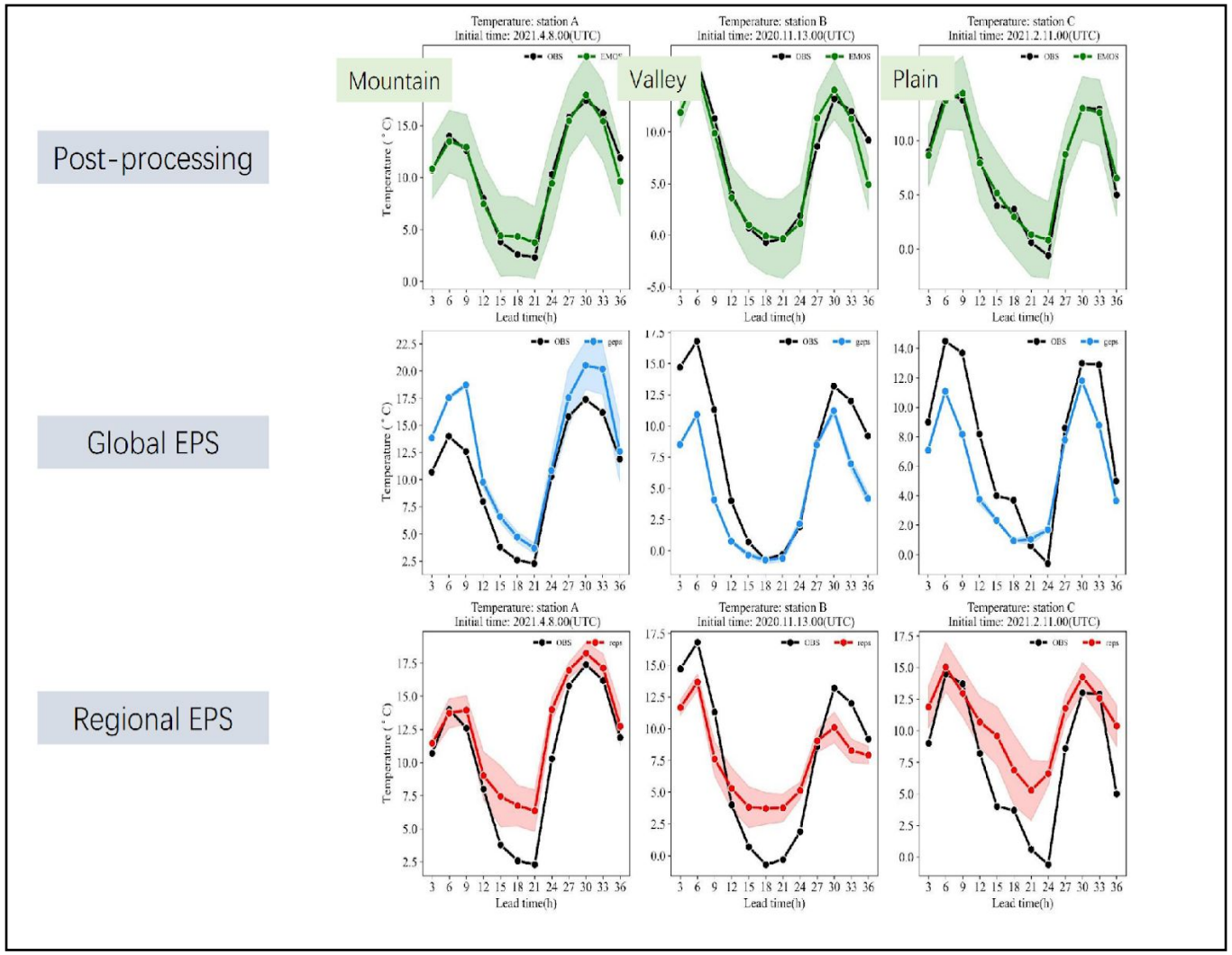
•Development of ensemble prediction postprocessing method at 100-meter scale and minute scale

- ✔ Develop sub-kilometer minute scale (wind, temperature, precipitation, humidity) ensemble forecast (0-24 hours, 500-meter resolution, 10-minute update, 10 members) based on observational data and ensemble forecast system.
- ✔ Develop new postprocessing technology for ensemble forecast
- ✔ Improve the application value of ensemble forecasting.



Research contents(2)

Post-processing and calibration for ensemble forecasts



WANG Yong
Chair, Austria

Alan SEED
NMR, Australia

Reference: Calibrating multi-models and multi-ensemble forecasts, Wang Yong, HangzhouRDP Workshop, 10 – 12 July 2023

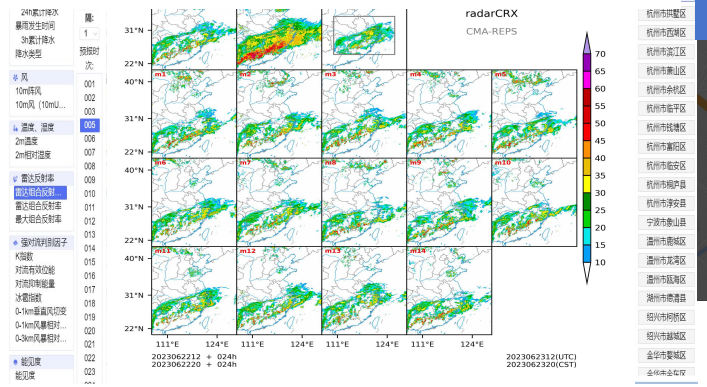
Research contents(3)

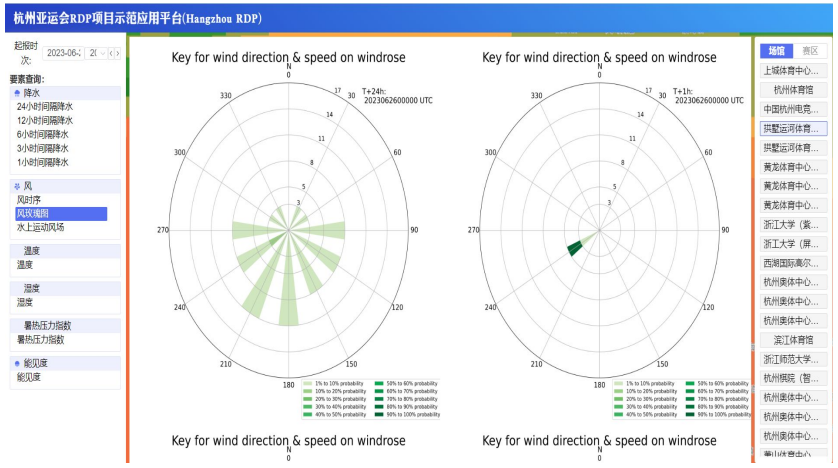
•Convective-scale ensemble prediction applications and demonstration

- ✔ Develop a demonstration application platform for convective scale ensemble prediction model products and post-processing products.
- ✔ Demonstrate and evaluate the 100-meter scale and minute scale ensemble prediction products and the uncertainties

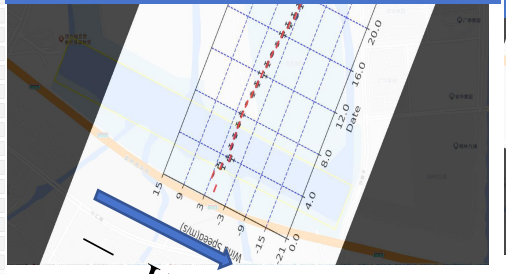
Colouring picture

Stamp

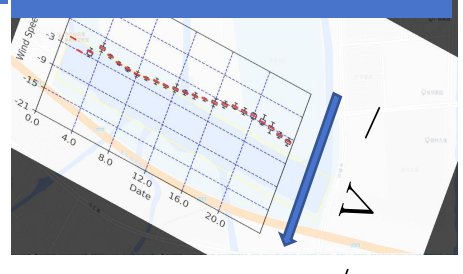


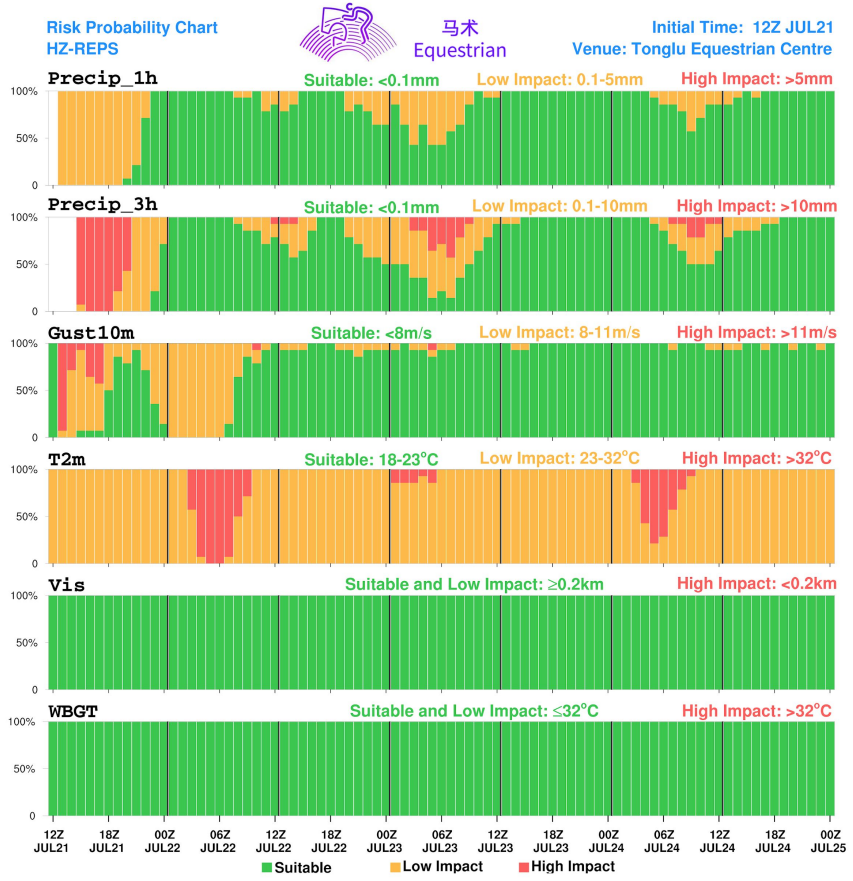


Downwind and headwind



Crosswind





Research contents(4)

•Evaluation of convective-scale ensemble prediction application benefit

- ✔ Study the evaluation method of ensemble forecast, formulate the inspection and evaluation strategy, and evaluate the forecast service benefit when there is ensemble forecast or not.
- ✔ Study the evaluation method of ensemble forecast, formulate the inspection and evaluation strategy, and evaluate the forecast service benefit when there is ensemble forecast or not.

Preliminary verification for CMA HZ CAEF

DAI Kan
NMC, China

•International training courses of convective-scale ensemble prediction and its applications

- ✔ Design international training courses such as the basic knowledge of ensemble forecasting, the post-processing of ensemble forecasting, the evaluation of ensemble forecasting, and the demonstration forecasting effect of the Hangzhou Asian Games.

Training

CHEN Jinyang
CMATC, China

Expected outcomes

Challenges

- **How can we further engage in international cooperation and maximize the contribution of this project?**
- **What is the best way to organize the interest groups for optimal results?**

  Data assimilation, Ensemble prediction, Postprocessing, Verification
- **What is the effective way to establish a mechanism for training and sharing experiences?**
  - ✔ Cooperating with SAC members, share the newly-developed methods and experience with the WMO members.
  - ✔ We are planning to support 2-3 experts from RA II member countries to visit CMA for a short period to collaborate on developing RDP forecasting techniques.
- **How can we practice WMO Early Warning Service？**

  Cooperating and communicating with forecasters
  - ✔ ……

19th Asian Games
Hangzhou 2022

Hangzhou 2022
Asian Para Games

Thank you for your attention!