MAZU

China Intelligent Meteorological Early Warning Solution

China Meteorological Administration

Multi-hazard Alert
Zero-gap and Universal

Outline

Part 1: What is MAZU

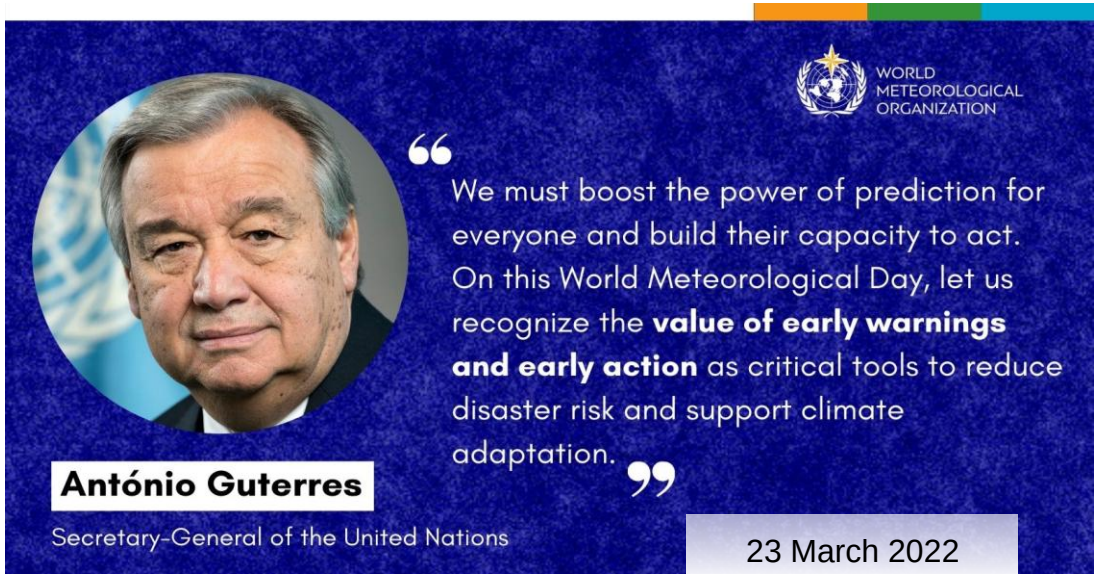
Part 2: AI Engine for Forecasting Products

Part 3: Cloud-Based Early Warning System

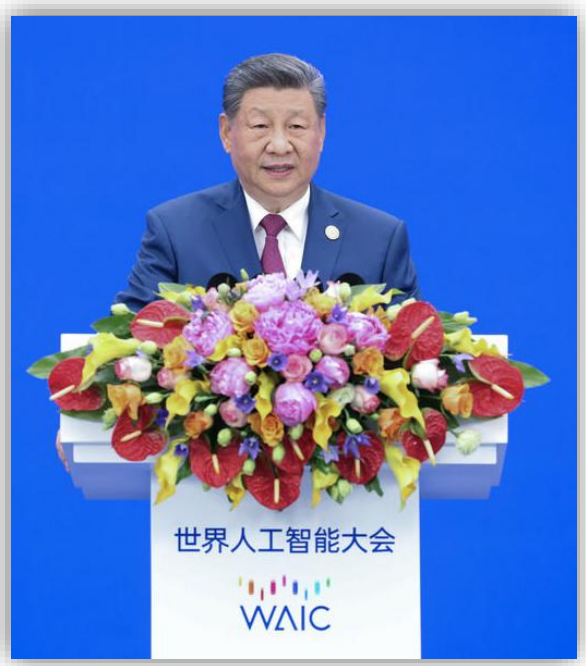
Part 4: Open Collaboration and Future Prospects

1. Background: UN Initiative Early Warnings for All

- **Early warning has become a key foundation** for global disaster prevention and mitigation.
- **The Global Challenge**:
- Half of the WMO members lack adequate multi-hazard early warning systems.
- One out of every three people globally does not have access to timely early warning information.
- **UN proposed the EW4All initiative. WMO leads the Pillar II.**



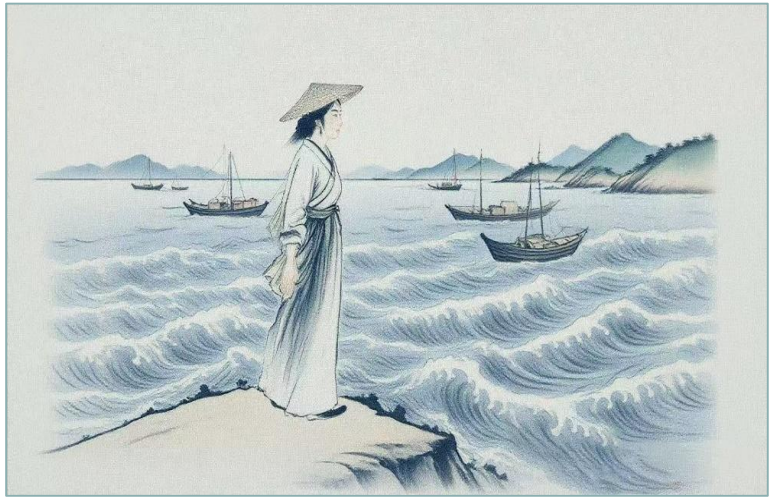
2. China's Solutions to Early Warnings for All



- The concept of **building a community with a shared future for mankind**.
- The instruction on **building a meteorological early warning operational platform.**
- Over the **next 5 years**, China will deploy locally-tailored versions of MAZU **in 30 countries.**

In July 2025, CMA launched MAZU, China Intelligent Meteorological Early Warning Solution, which includes **disaster risk knowledge, technologies, products, operational systems, tools-boxes, equipments, and China's experience in disaster prevention and mitigations**.

Multi-hazard
Alert
Zero-gap
Universal

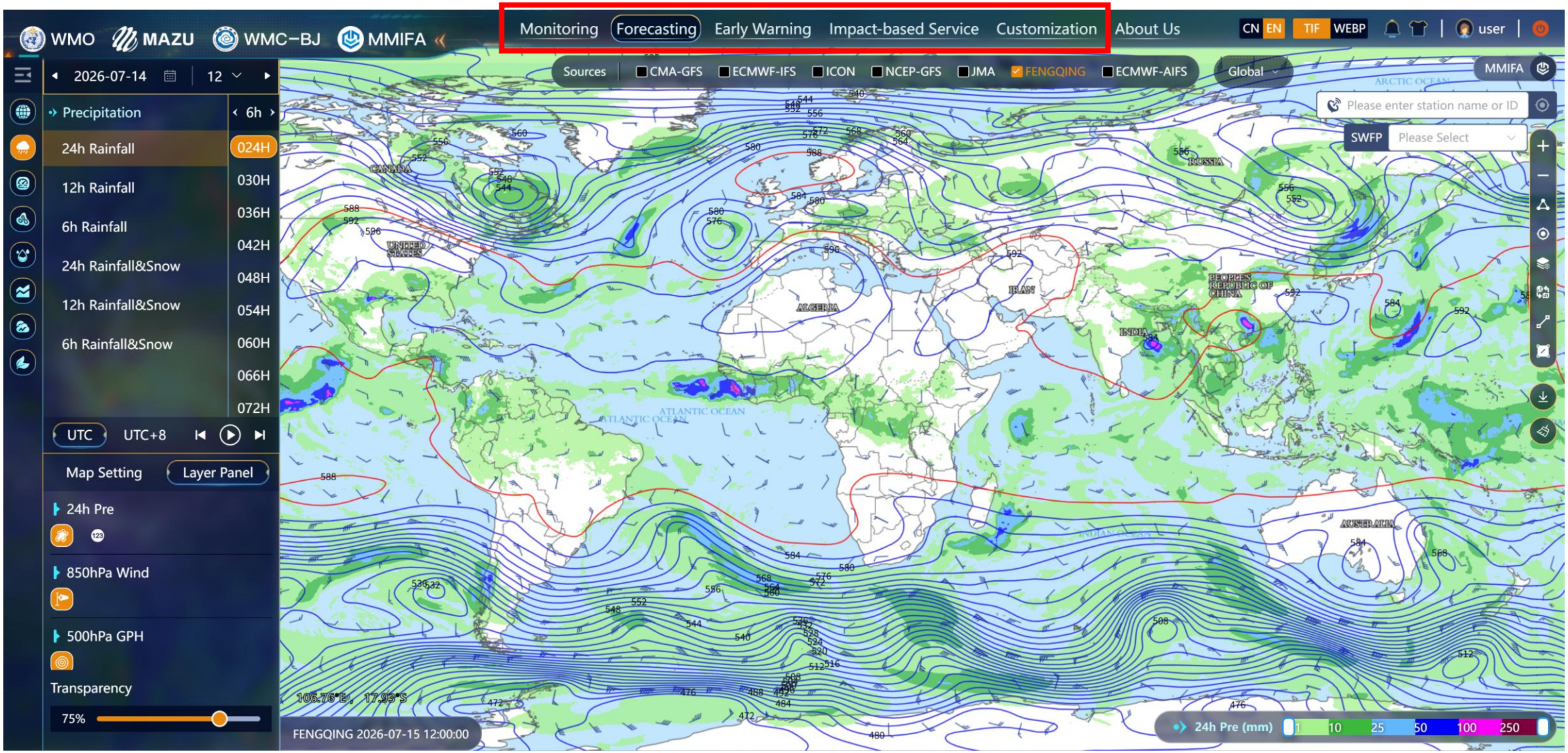


MAZU is the respectful title of a sea goddess and protector against maritime disasters in China and Southeast Asia. Her birthday was 23rd March, 960 A.D, which is the same day as the World Meteorologcial Day.

2. Core Platforms of MAZU

Cloud-Based Early Warning System (CEWS)

(An open access operational platform)



3. MAZU Application

MAZU has been applied in more than 40 countries via cloud, and deployed in 7 countries.

3. MAZU Application

CEWS Customized for Pakistan

Achieve the integration of multi-source data, including the CMADaas Platform, Overseas Cloud, CMACast, Fengyun receiving system, 226 local ground observation stations, 2 radars, upper-air stations, lightning monitoring systems, and PMD-WRF.

Access to Local Multi-source Observation Data


Radar

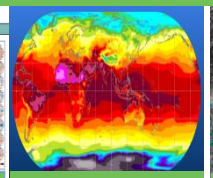

AWS

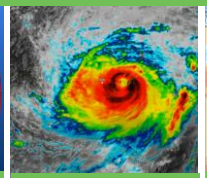

CMACast


FY receiving station

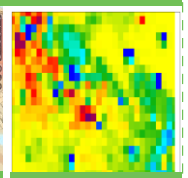
CMA-Oversea Cloud


AI Models


CMA-Reanalysis

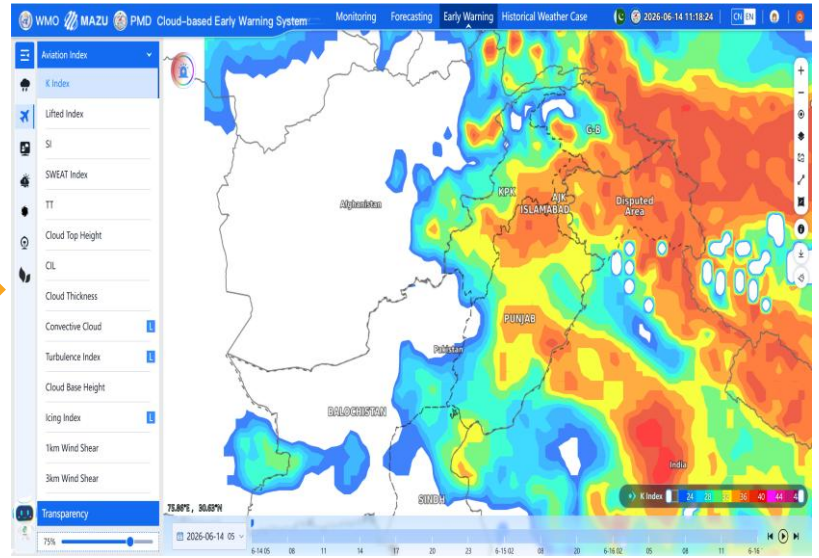

FY-Satellites


Climate Prediction


CMA-NWP

All-In-One Machine


MAZU-Pro System localization



3. MAZU Application

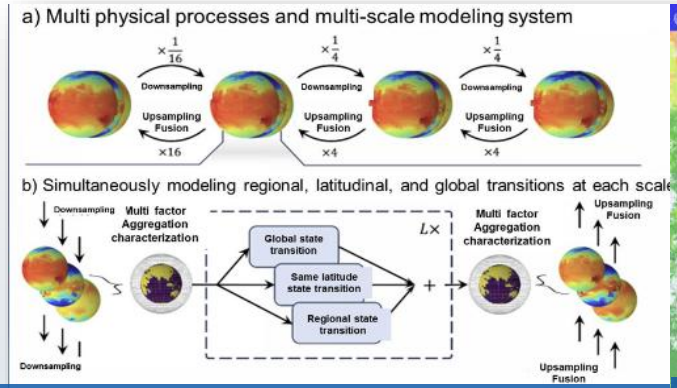
CEWS Customized for Ethiopia

Functions

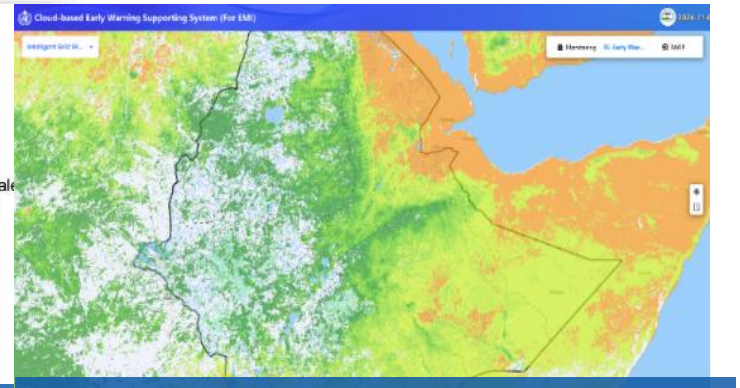
Fengqing AI model localization and downscaling on all-in-one machine

Toolboxes

- Rainstorm Warning
- Toolboxes of **Agriculture, River Basin, Marine and Aviation**.



Fengqing AI Model Downscaling

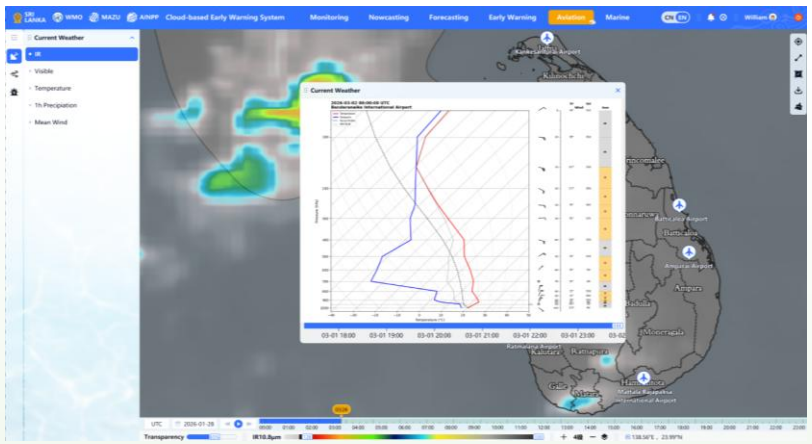


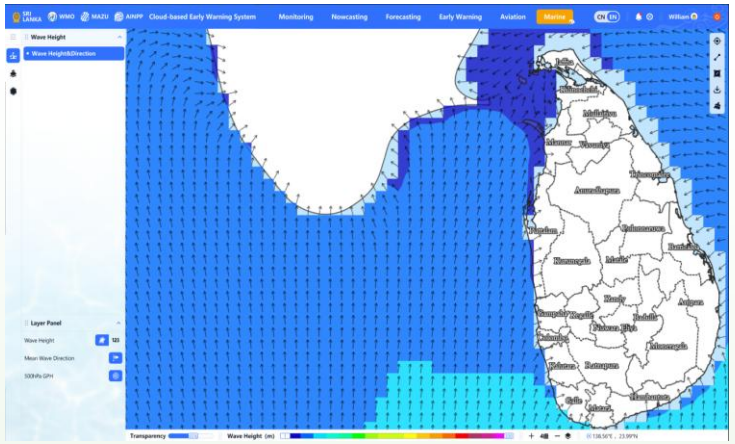
Agricultural toolboxes

CEWS Customized for Sri Lanka

Functions

- Tailored systems for **Aviation** and **Marine** sectors have been designed.
- Integrate AI-based nowcasting products under AINPP to provide targeted support for key local industries.





Specialized Application | Aviation | Marine

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Global Forecasting Technologies: Driven by AI

核心引擎 – “风”系列AI预报模型矩阵
Core Engines – The "Feng" Series AI Model Matrix

A comprehensive suite of AI models covering different forecast timescales, from nowcasting to sub-seasonal

1 FengLei 风雷
Nowcasting (0-3h)

- Convective storm & precipitation nowcasting
- Physics-informed AI for superior storm evolution prediction

2 FengQing 风清
Medium-Range (0-15 days)

- Global 3D atmosphere forecasting
- Physics-constrained deep learning on a global scale

3 FengShun 风顺
Sub-seasonal (Weeks-Months)

- Extended-range ensemble forecasting
- Flow-dependent AI for capturing long-term climate signals

4 FengYu 风宇
Space Weather

- Solar activity & space environment
- First AI model significantly outperforming traditional MHD

5 FengHe 风和
AI Agent

- LLM-based intelligent weather assistant
- Natural language interface for on-demand, impact-based services

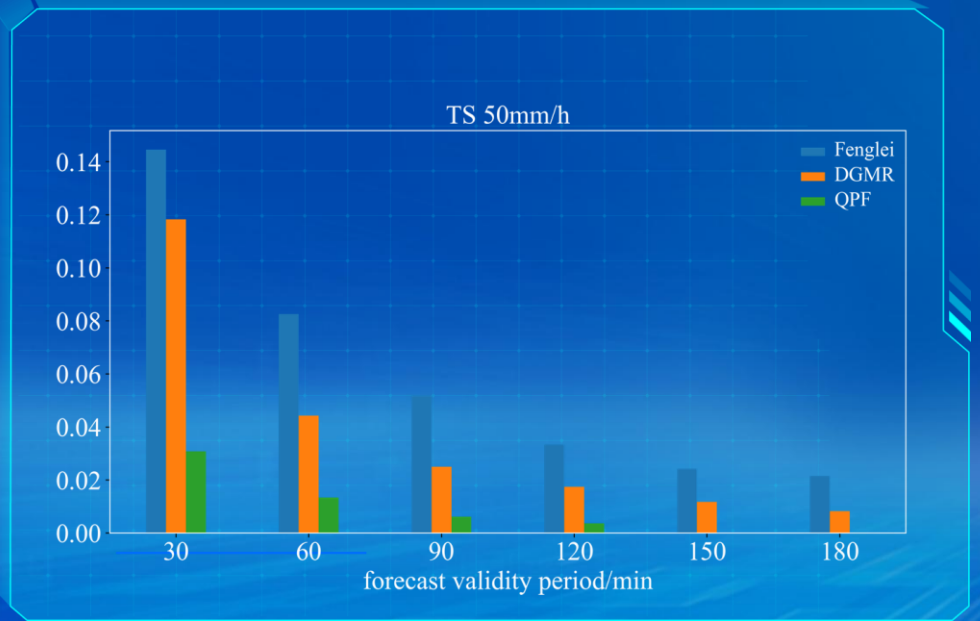
6 Other Systems

- FengYuan, End-to-End AI forecast model
- Regional High Resolution Model
- .....

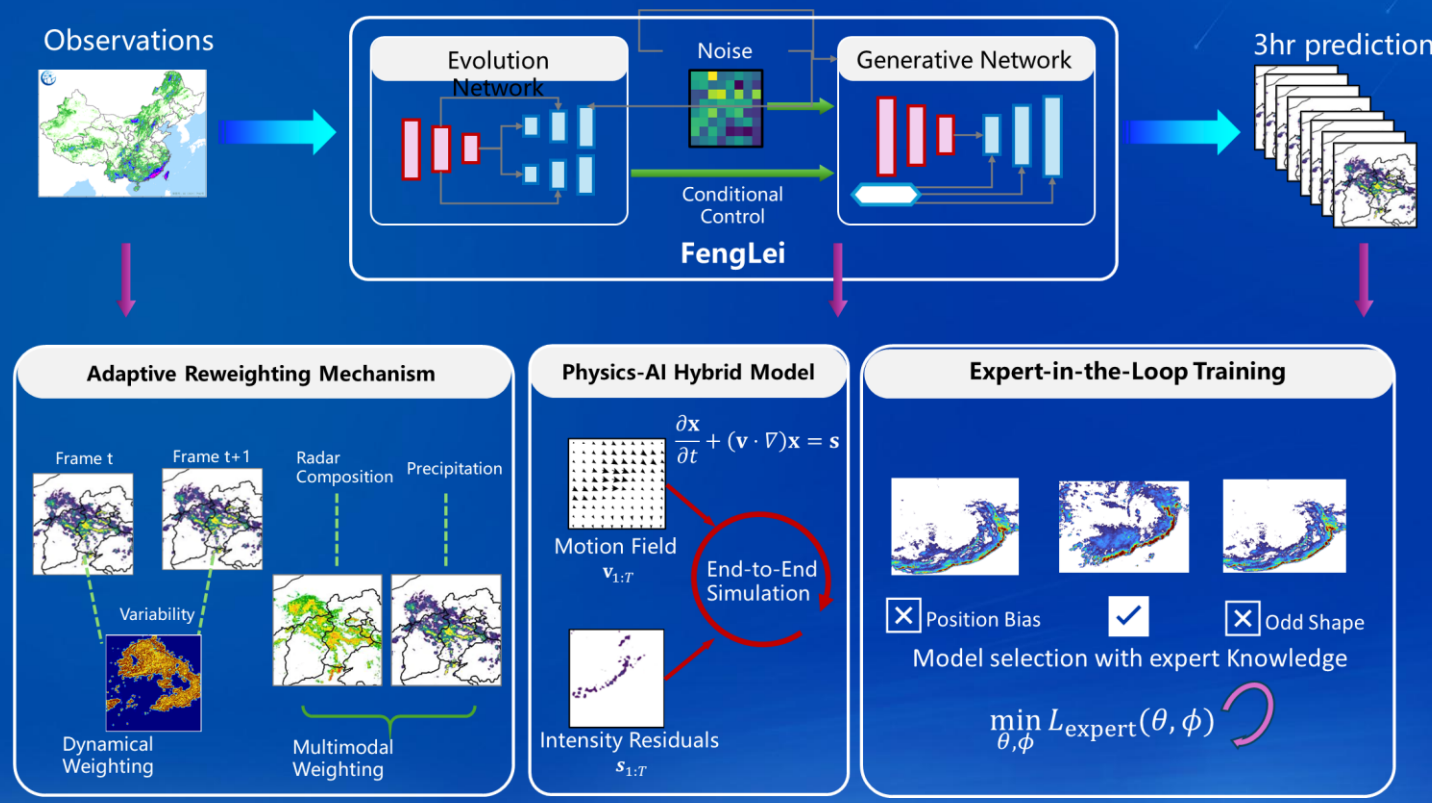
1. Fenglei: 0-3 Hour Nowcasting Model

Key Features:

- **Fast and efficiency**: 0-3 h forecasts at 1km resolution, updated every 6-10 minutes.
- **Technical Innovation**: A Physics-AI hybrid model trained with an "Expert-in-the-Loop" mechanism to bridge the gap between objective scores and subjective forecast quality.
- **Data Foundation**: Utilizes a high-quality, multi-source fused precipitation dataset.



1km-resolution precipitation forecast product with 10-min rolling updates



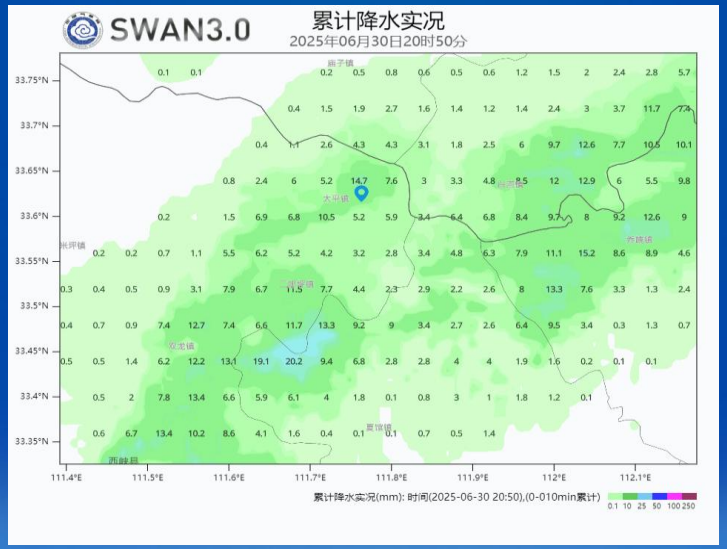
- **Results show significant improvements in Threat Score (TS) for precipitation forecasting. 50 mm/h heavy rainfall TS: +487% vs operational products; +92.3% vs DGMR.**

Case Study: Extreme Warm-Sector Rainfall

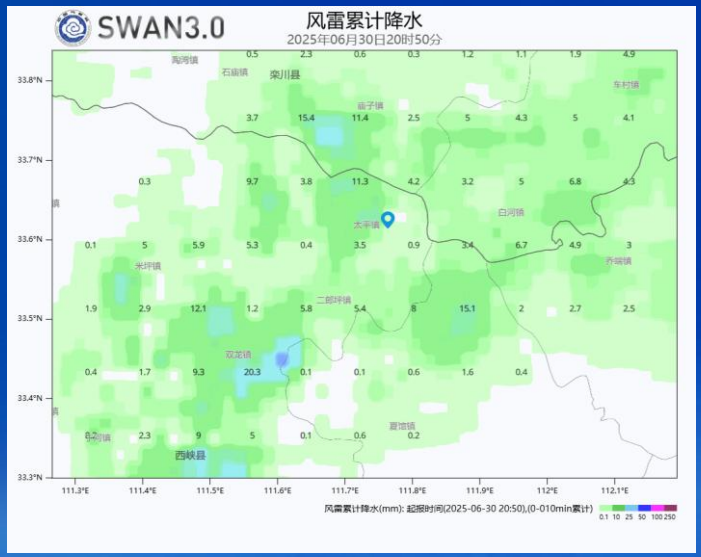
Sudden warm-sector rainstorms are highly destructive and pose a major forecasting challenge. On June 30, 2025, Nanyang in Henan was hit by such a storm, recording over 200 mm of rain in just three hours. Despite only light precipitation at 20:50, the **Fenglei system had predicted two hours earlier that Nanyang would see over 120 mm of accumulated rain (110 mm/h intensity) within three hours**. This highlights FengLei's strong ability to forecast extreme warm-sector precipitation.

Rainstorm-induced geohazards

Observation

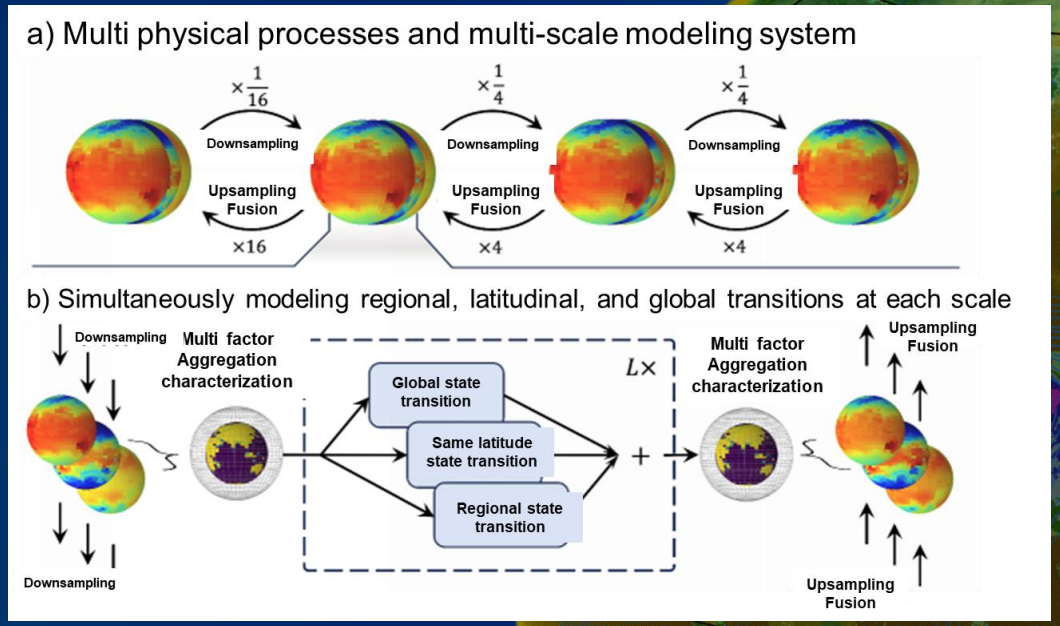


Fenglei's 10-min interval 3h precipitation forecast



2. Fengqing: Global Short-Medium Forecast (0-15 Day)

- **Key Capabilities:**
  - **Fast & Efficient**: Delivers a 15-day global forecast in ~3 minutes on a single GPU.
  - **Physics-Informed**: Integrates physical laws to improve model stability and reduce systematic errors.
  - **Impact-Oriented**: Enhanced prediction of surface variables like precipitation and wind, critical for energy, agriculture, and water management.
  - **Open & Accessible**: The model code is openly available on GitHub for research and use. ***https://github.com/nmcdev/CMA-AIM-GFS-Fengqing***

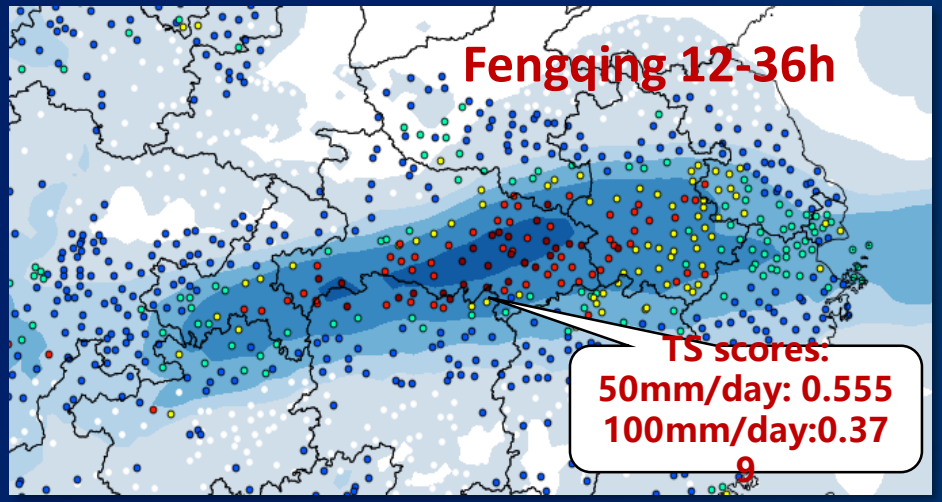


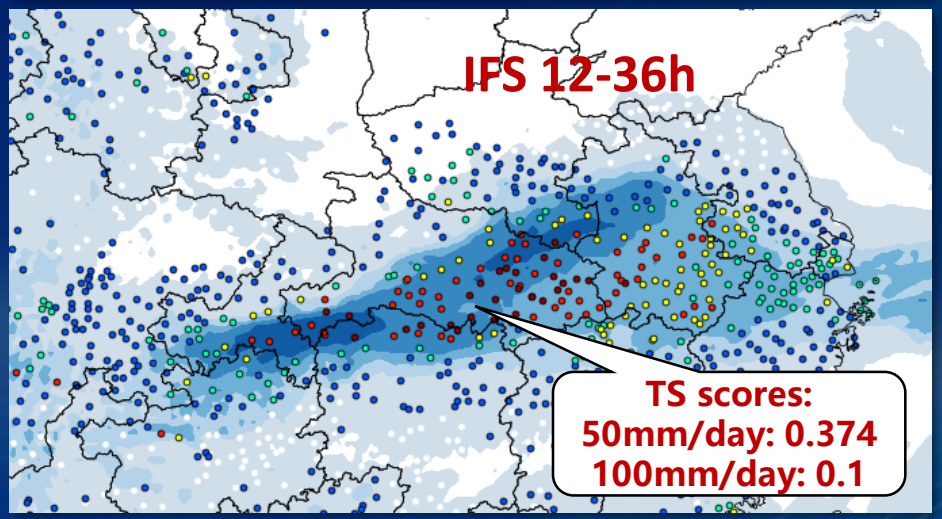
Modeling the multi-scale physical state transitions of atmospheric processes

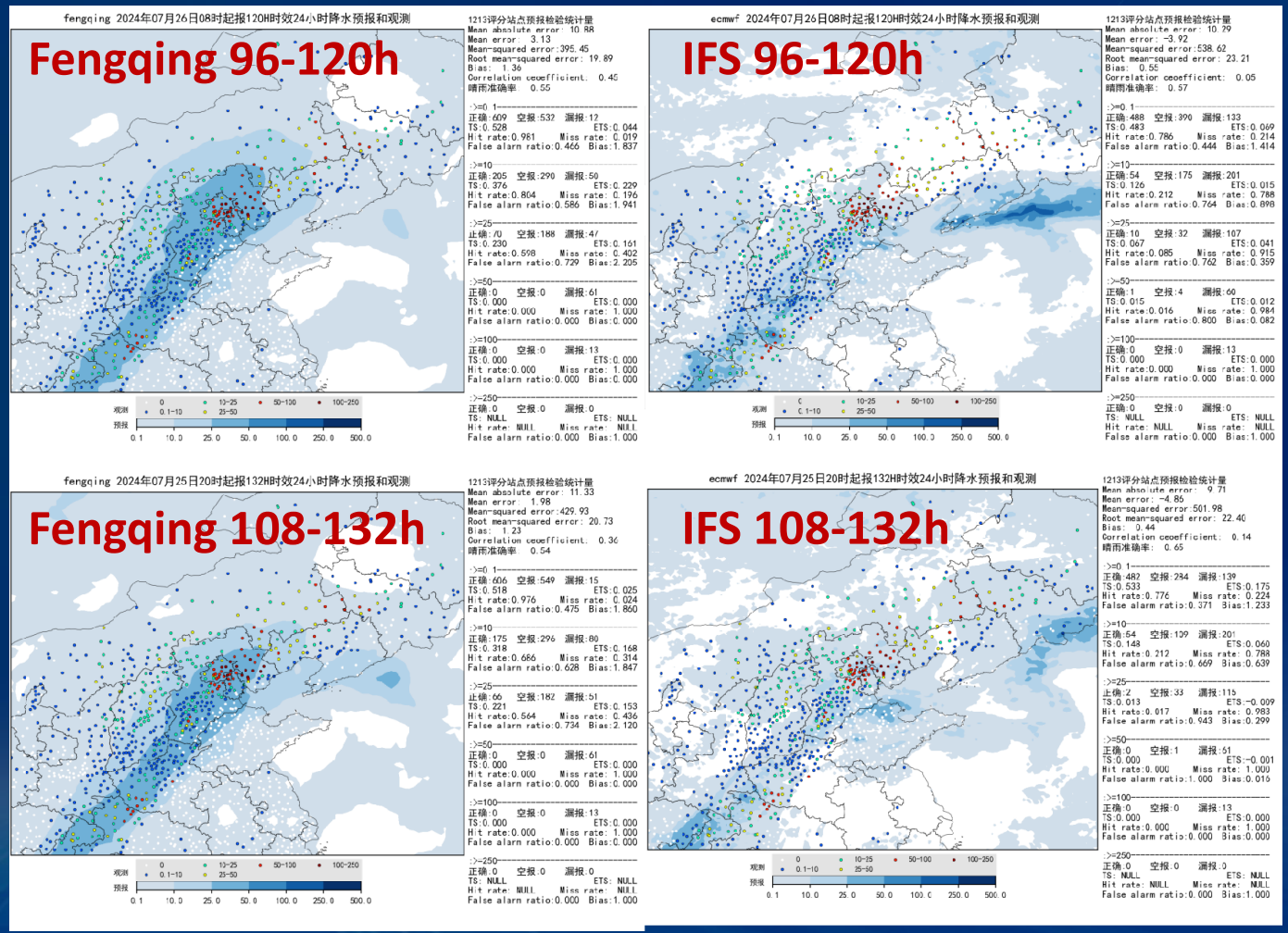
2023.1-2023.7	2023.7-2023.12	2024.1-2024.6	2024.7-2024.9	2025.1-2025.7
Pre-research work on data-driven models	**Early version development**	**Fengqing V1.0 Official Release**	**Operational Application**	**Further Technological Breakthroughs**
Collaborate with Tsinghua University to initiate AI model R & D	Based on the Transitor architecture	2024 June: CMA officially launched the FengQing Model	2024 September: passed the operation access review by CMA	Released Fengqing V1.5, a physics-constrained AI model

Enhanced Prediction of Critical Weather Elements

- 2024 Meiyu Front: Fengqing demonstrated **stable prediction** of the rainband position and higher Threat scores.
- 2024 North China Heavy Rain: Fengqing provided **an early signal for this event** at a 132h lead time, showing high consistency in subsequent forecasts.

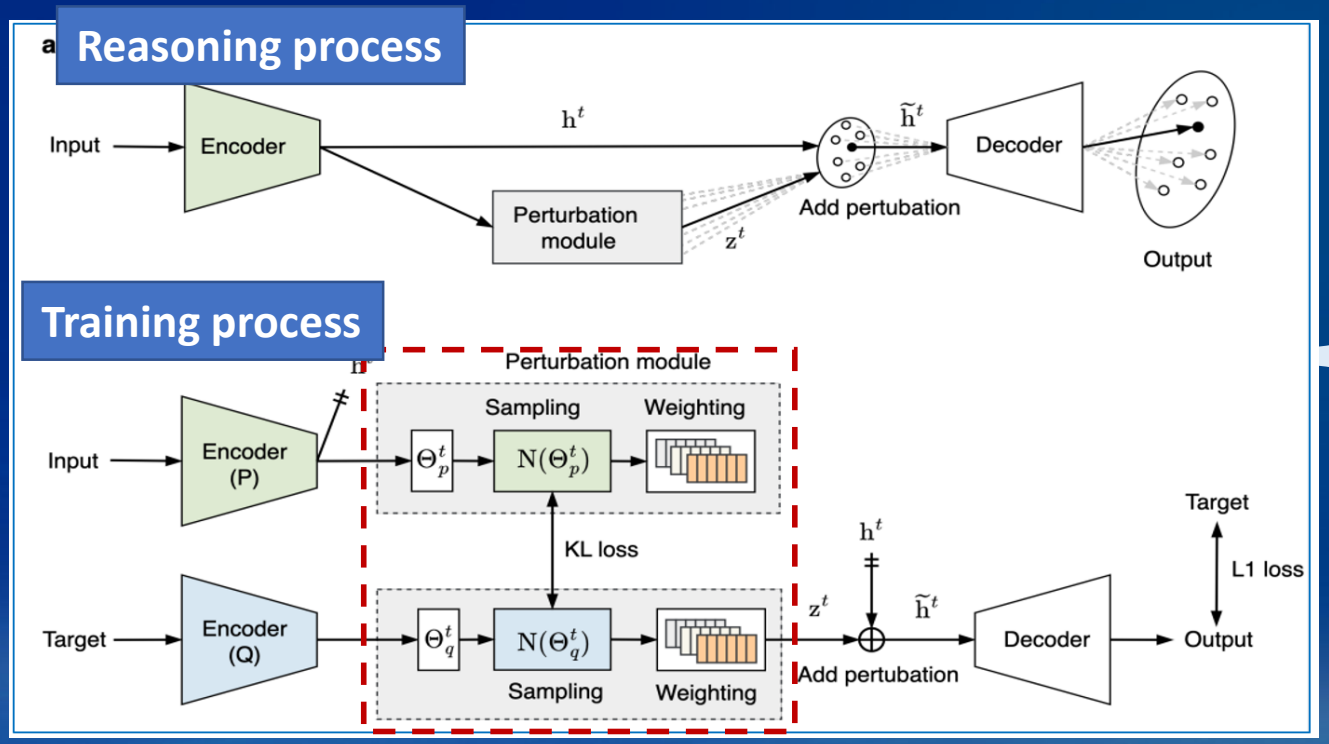






3. Fengshun: S2S Climate Prediction Model (15-60 Day)

- **Scope**: Sub-seasonal to seasonal forecasting using multi-sphere data (atmosphere, ocean, land, sea ice).
- **Technical Innovation**: A flow-dependent ensemble perturbation technique generates physically consistent ensemble members, improving forecast reliability.
- **Performance**: Shows improved prediction skill for MJO, weekly precipitation (3-6 weeks), and extremes.



FengShun technical structure

Higher Skill for Precipitation Anomalies Beyond 15 Days

Compared to ECMWF, FengShun improves prediction skill for global average precipitation beyond 15 days by approximately:

- 21% overall
- 17% in the tropics
- 30% in extratropical regions

Skill improvement validated by Bootstrapping significance tests

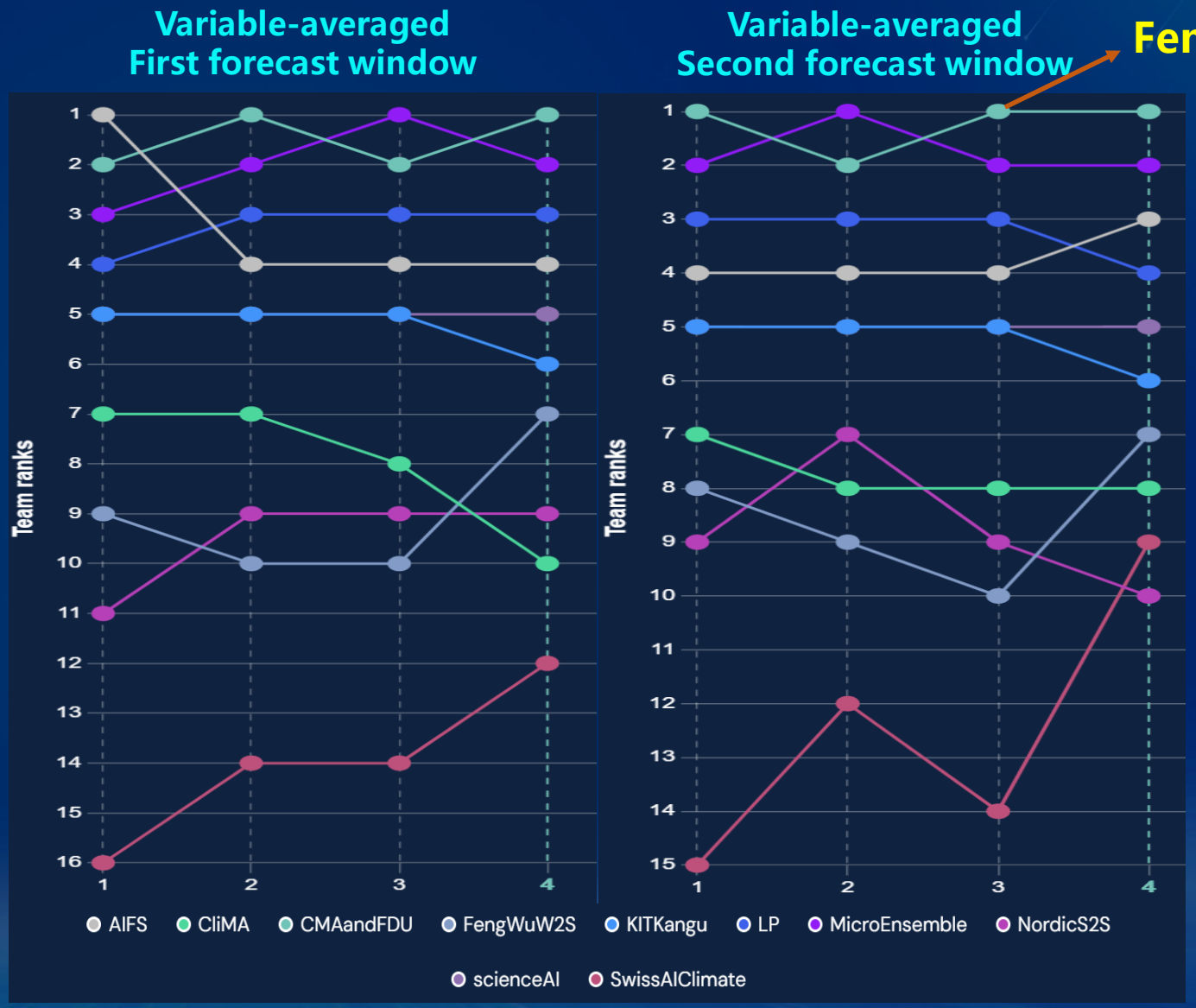
Higher Skill for Monsoon Precipitation

Over two-thirds of the global population lives in the seven major monsoon regions.

Except for the South American monsoon region, FengShun shows higher predictive skill than ECMWF IFS in monsoon precipitation prediction.

Fengshun Performance in the AI Weather Quest

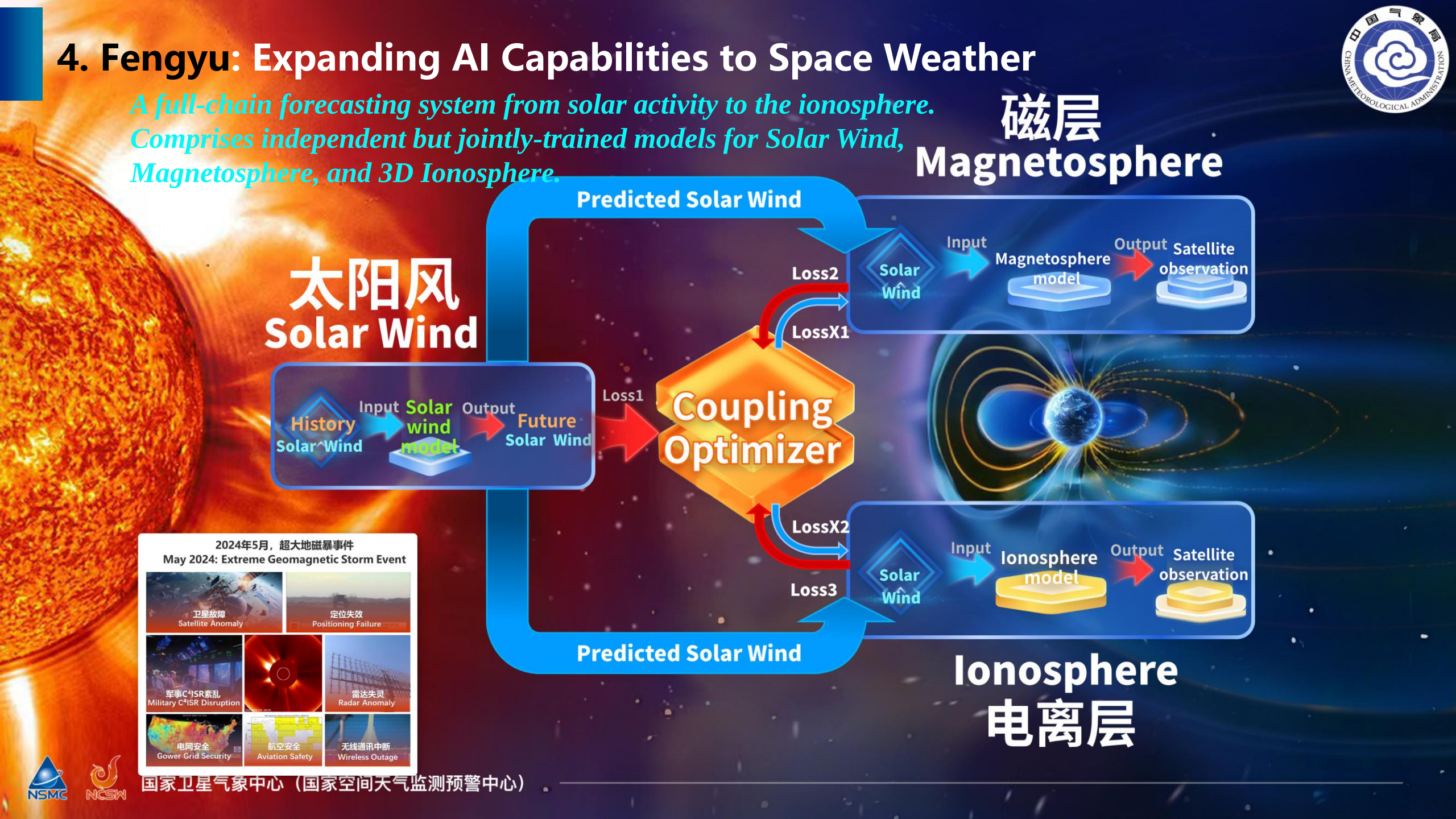
- We are pleased to participate in the AI Weather Quest, an excellent initiative by WMO and ECMWF.
- The Fengshun model demonstrates competitive performance against other leading international models, which provides valuable insights for our ongoing development.



Evolution of teams' rankings based on weekly RPSS scores updated on 10th Oct. 2025

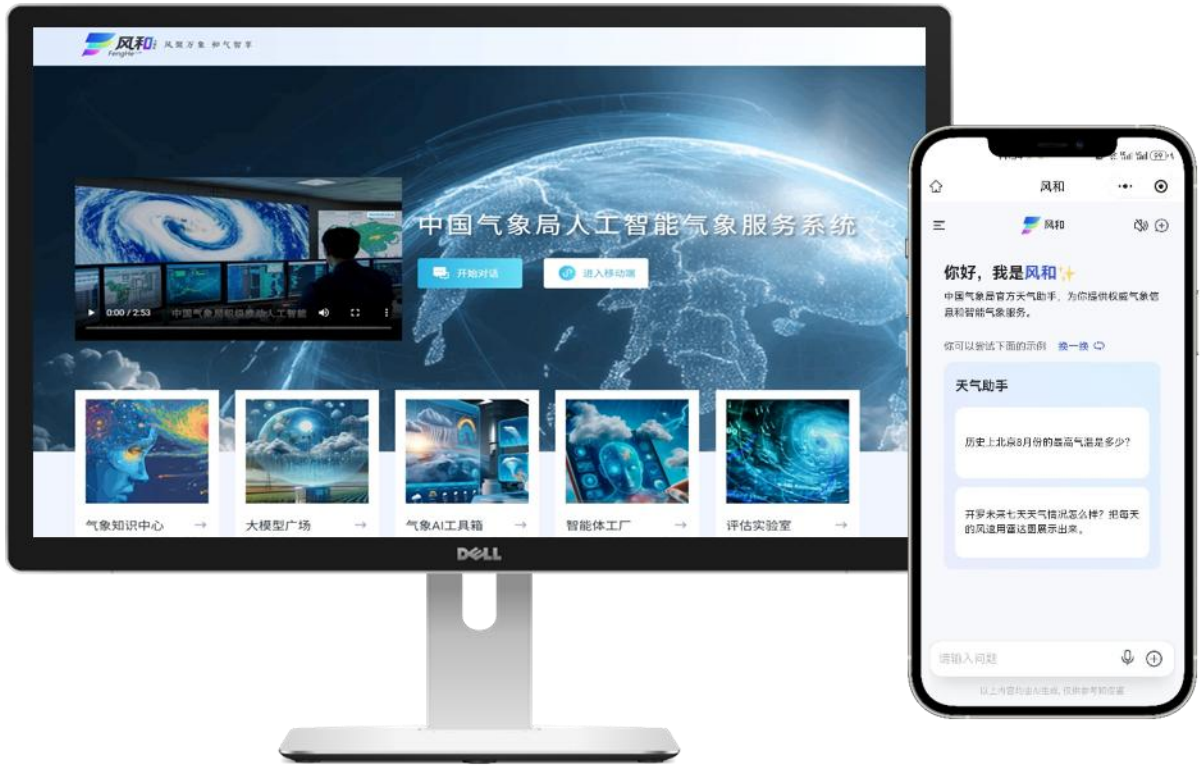
4. Fengyu: Expanding AI Capabilities to Space Weather

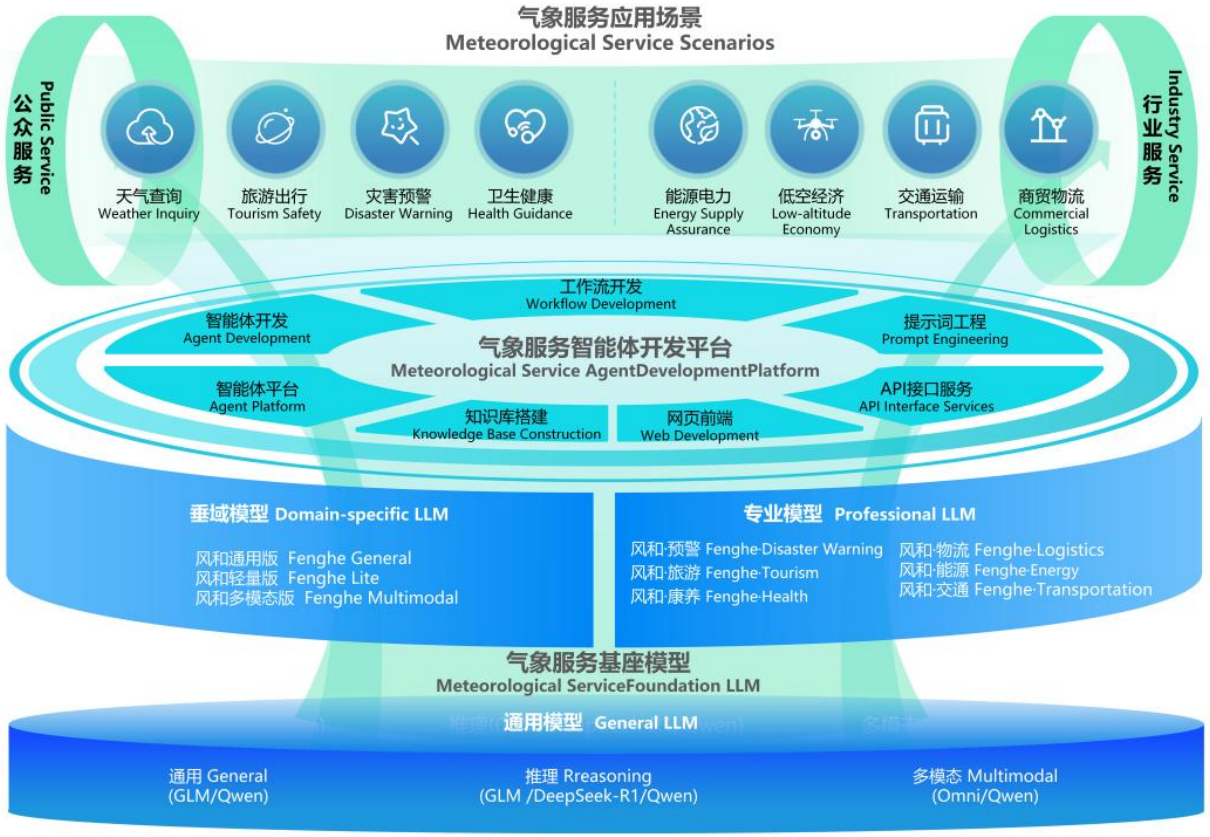
A full-chain forecasting system from solar activity to the ionosphere.
Comprises independent but jointly-trained models for Solar Wind, Magnetosphere, and 3D Ionosphere.



5. Fenghe: AI Meteorological Service Language Model

- In October 2025, **Fenghe V1.0** was released as the first 100-billion-parameter generative LLM elaborately designed for meteorological service.
- FengHe employs a “1+1+N” architecture. One meteorological LLM as the brain, one agent platform as the limbs, empowering N meteorological service scenarios.





PC端：https://www.fenghe-ai.cma.cn

移动端（Mini Program）

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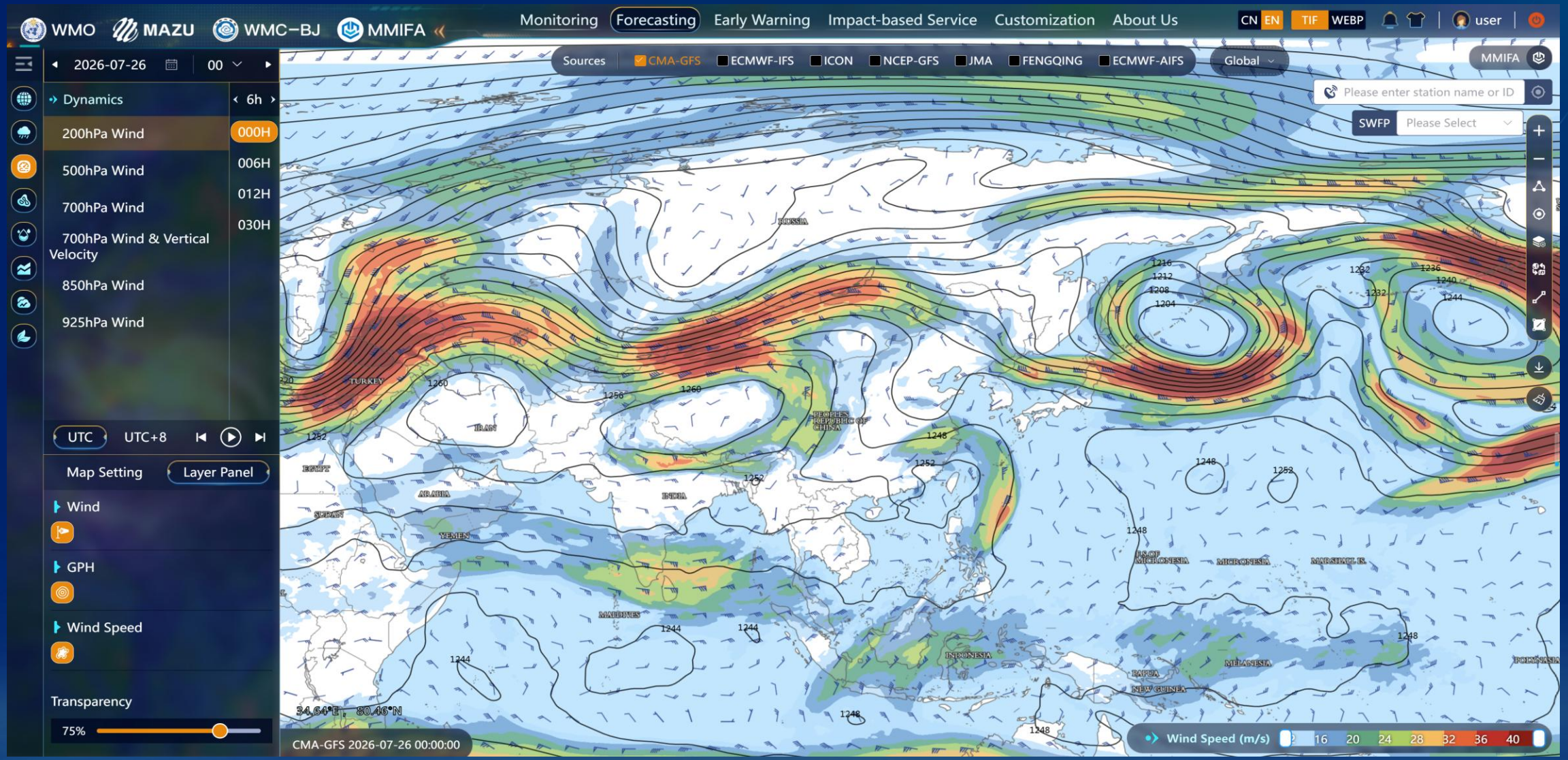
Cloud-Based Early Warning System: An Open Access Operational Platform

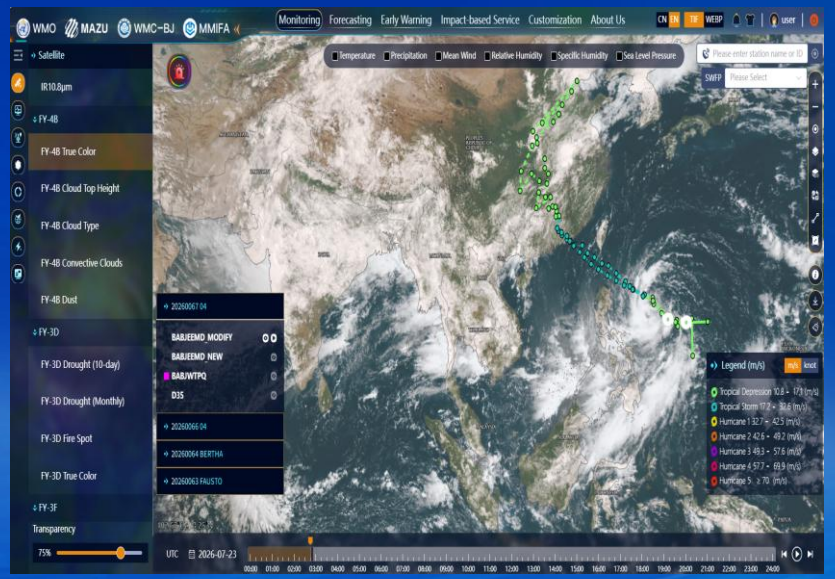


The CEWS platform is organized into 5 main modules, providing a complete workflow from observation to service delivery.

Function 1: Monitoring - High-Resolution Satellite & Multi-Source Observation

CEWS provides a comprehensive, global view of atmospheric conditions by integrating multiple observation sources.

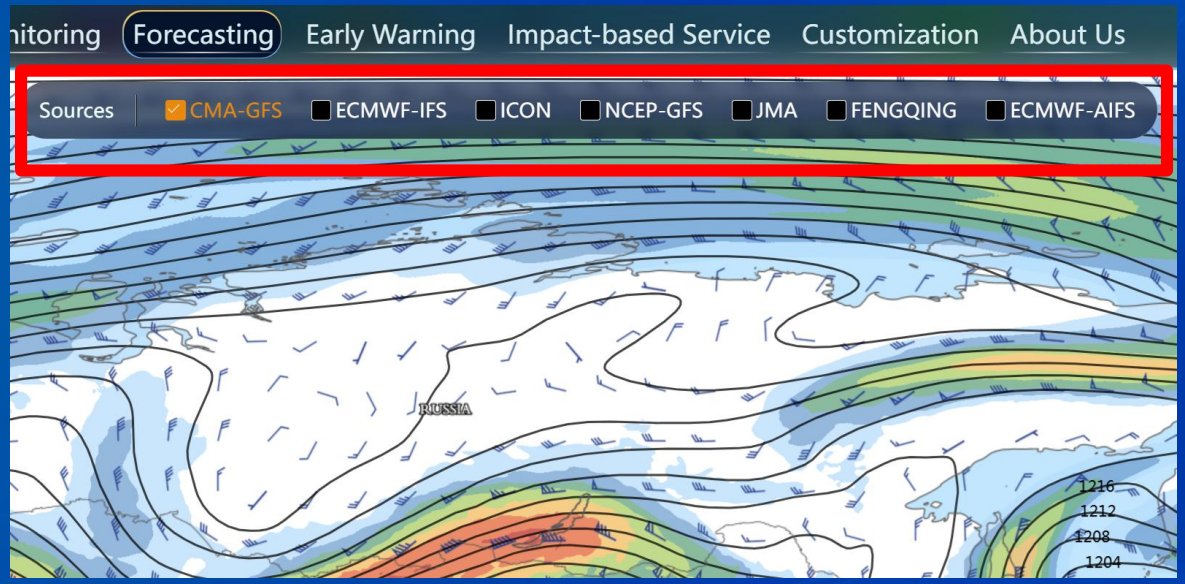
- **High-Resolution Satellite Imagery**: Real-time access to products from FY-4B and global geostationary satellite composite enhanced products. This allows for the clear identification and tracking of weather systems like tropical cyclones and convective cloud clusters.
- **Multi-Source Data Overlay**: Users can overlay satellite imagery with various real-time analysis products, including temperature, precipitation, wind, relative humidity, and sea-level pressure, for a comprehensive analysis.
- **GTS Station Monitoring**: The platform integrates WIGOS station observations, allowing users to search for specific stations and view time-series data for key meteorological elements.



Function 2: Forecasting - The Power of Multi-Model Integration

CEWS integrates a suite of the world's leading Numerical Weather Prediction (NWP) models and advanced AI models, providing a unified and efficient service for forecasters.

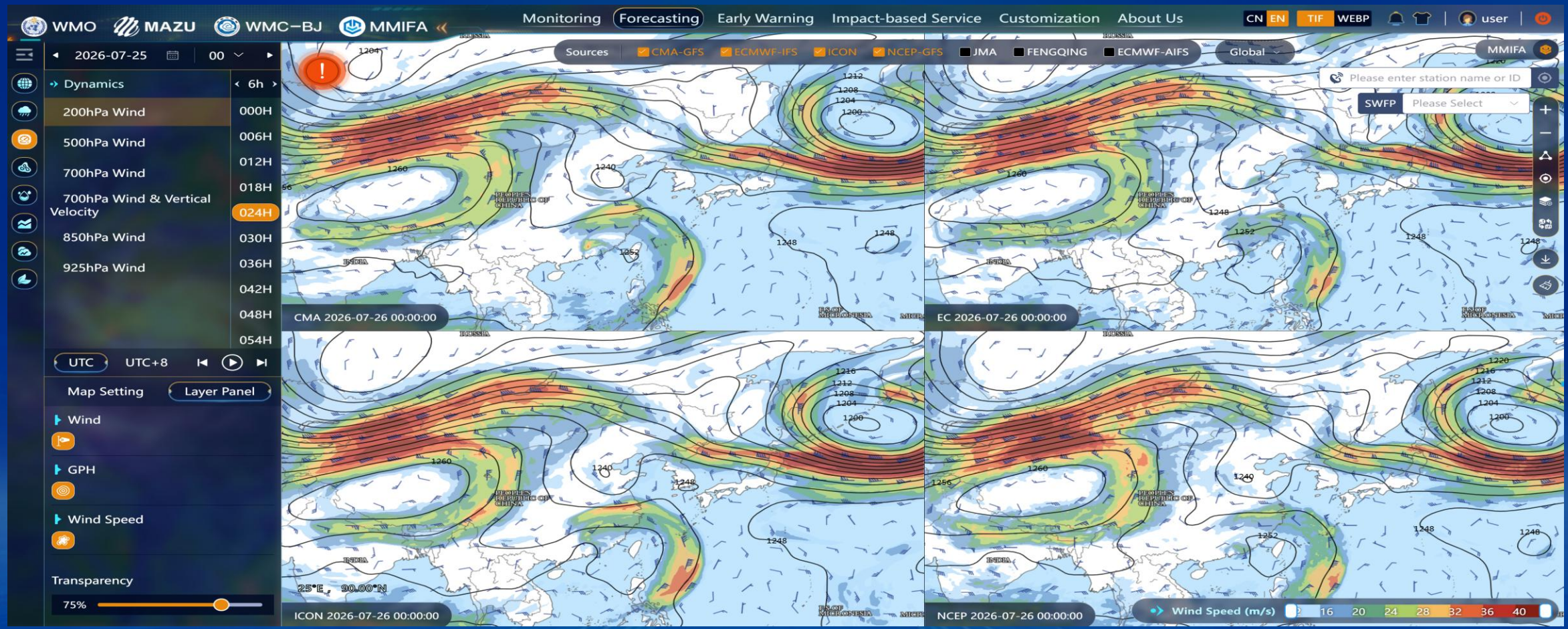
- **Numerical Models: 5 numerical weather prediction models:**
  - ✓ **CMA-GFS**
    (China Meteorological Administration Global Forecast System)
  - ✓ **ECMWF-IFS**
    (European Centre for Medium-Range Weather Forecasts)
  - ✓ **ICON**
    (German Weather Service)
  - ✓ **NCEP-GFS**
    (National Centers for Environmental Prediction, USA)
  - ✓ **JMA**
    (Japan Meteorological Agency)



- **AI Models: EC+CMA "Feng" Series AI prediction models, including:**
  - ✓ **FENGQING...**
  - ✓ **ECMWF-AIFS**
- **Benefits: "One-Stop" Service: The integration of these models provides a unified, efficient service for early warning operations, enabling users to access multiple models and their outputs in a single platform.**

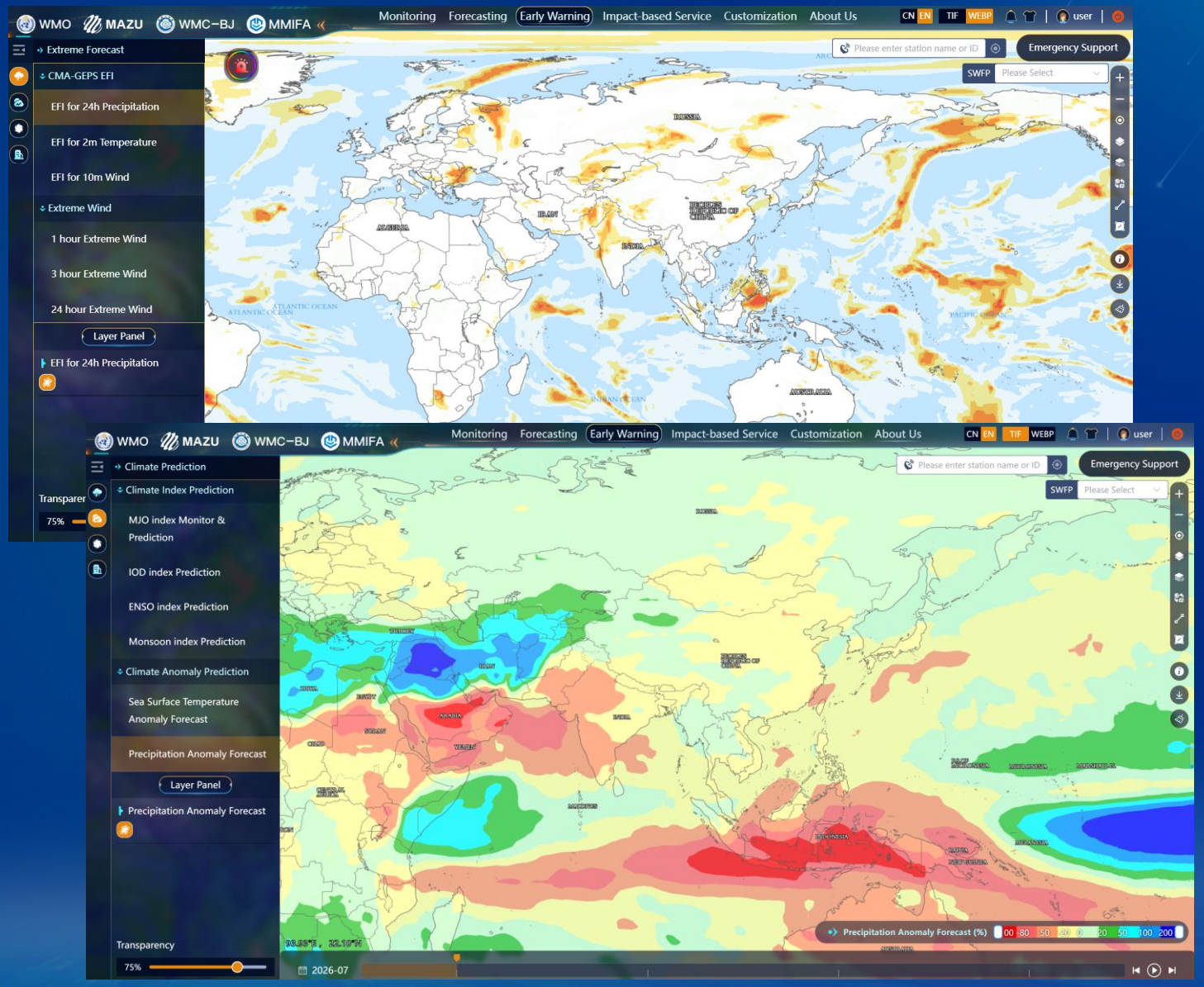
Forecasting: Deep-Dive with Interactive Tools

CEWS is more than just a data viewer; it's an interactive analysis environment. This interactive visualization capability represents a core experiment of the WMO MMIFA pilot project, designed to address a critical challenge: how WMO member countries can effectively utilize massive volumes of forecast data provided by the ten World Meteorological Centres. Given that these data are too large for timely network transmission, MMIFA focuses on delivering effective real-time weather forecast analysis through interactive visualization tools to support operational forecasting.



Function 3: Early Warning - Global Digital & Extreme Weather Forecasts

- **Extreme Weather Products:** CMA-GEPS EFI 10-day forecasts for extreme wind, high temperature, and low temperature events, supporting proactive warnings.
- **Tropical Cyclone Forecasting:** A dedicated module provides multi-model track forecasts and objective algorithm-based strike probability products.
- **Other Hazards:** The system also includes forecasts for hazards like dust surface mass concentration.



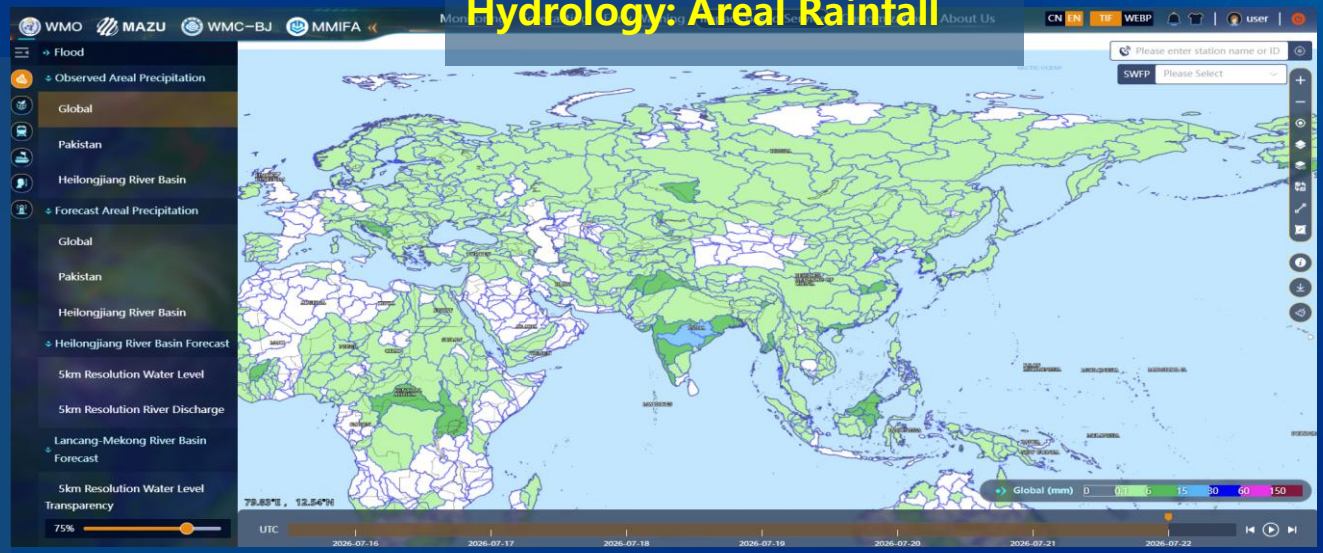
Function 4: Services - Impact-Based Early Warning

Shifting focus from "what the weather will be" to "what impacts the weather will bring". CEWS delivers impact-based forecasts and sector-specific service products to help decision-makers identify and assess potential risks.

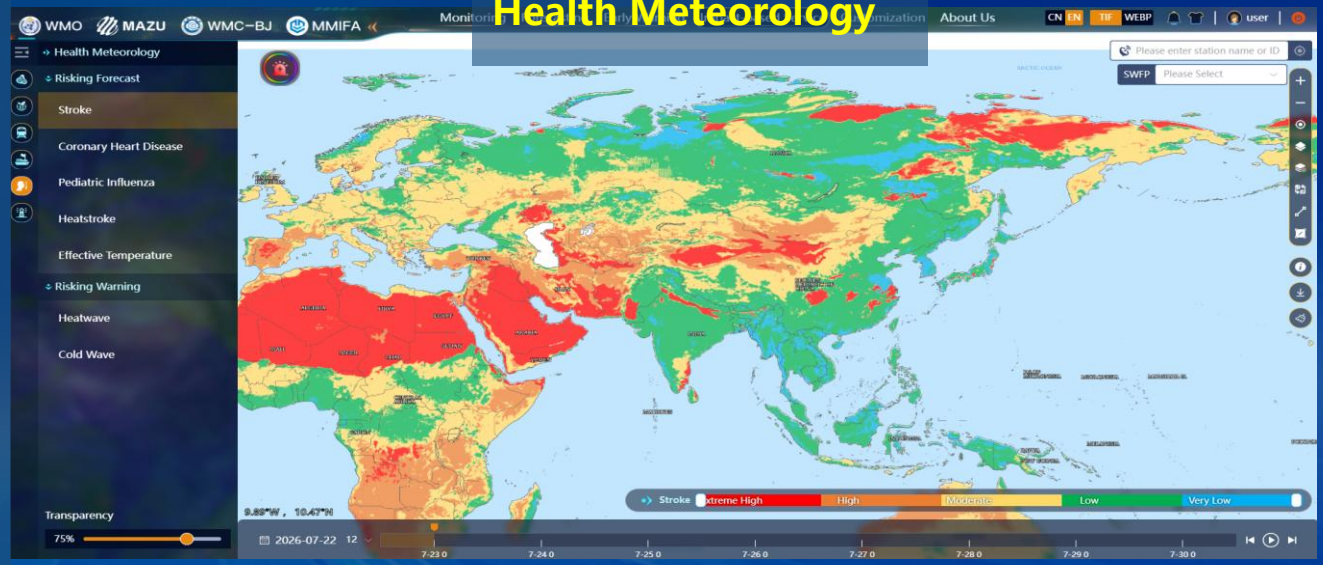
Example Applications:

- Hydrology: Areal Rainfall forecasts to assess flood risk in river basins.
- Health: Forecasts for weather conditions conducive to the spread of pediatric influenza.
- Transport: Specialized weather services for critical infrastructure like the China-Europe Railway.
- Agriculture: Products for crop monitoring and yield forecasting.
- Marine: Fishery Vessel Impacted Forecasts, combining weather data with fishing zone information.
- Building: NP-DMP, BEM Weather Data

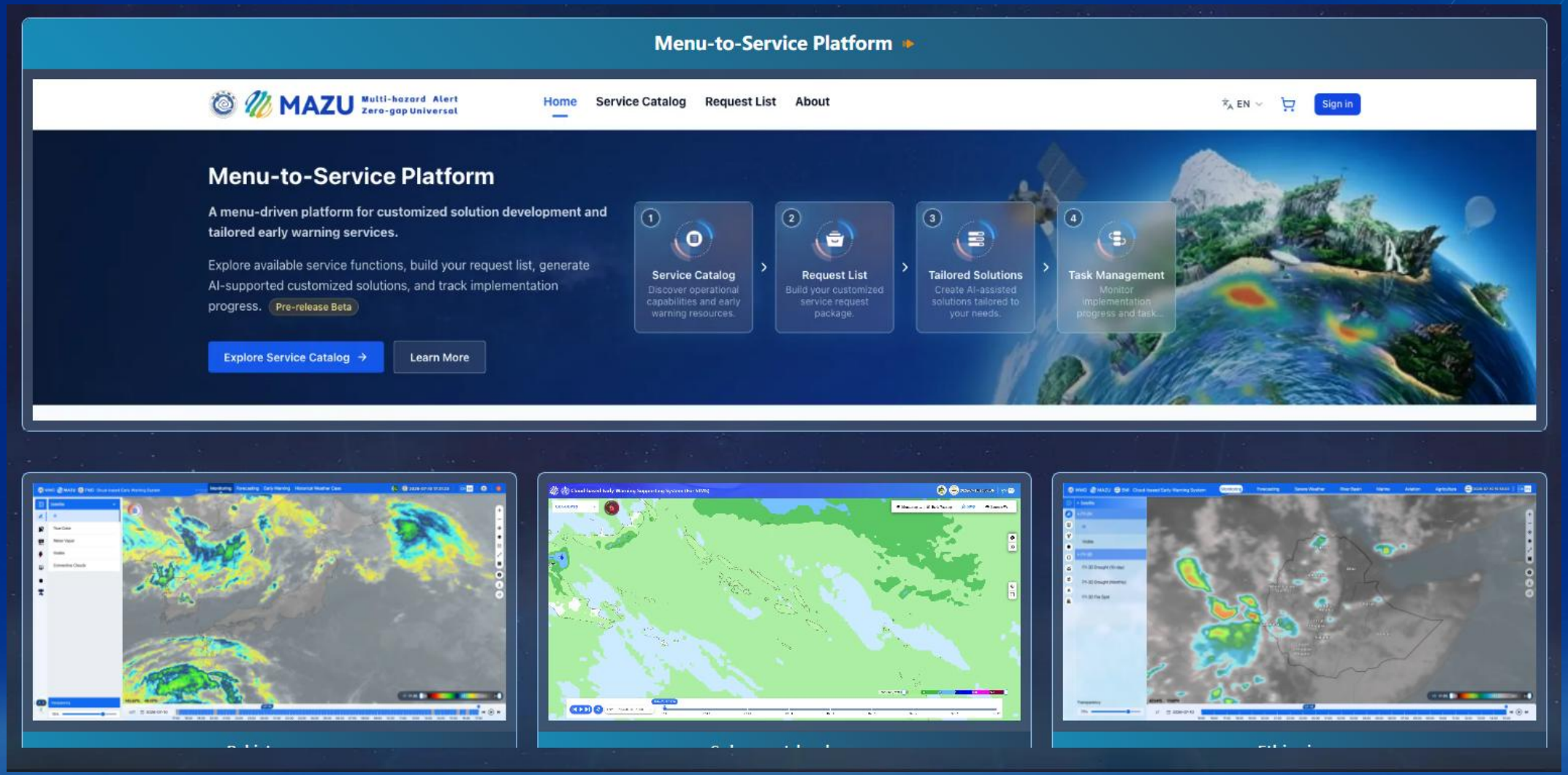
Hydrology: Areal Rainfall



Health Meteorology

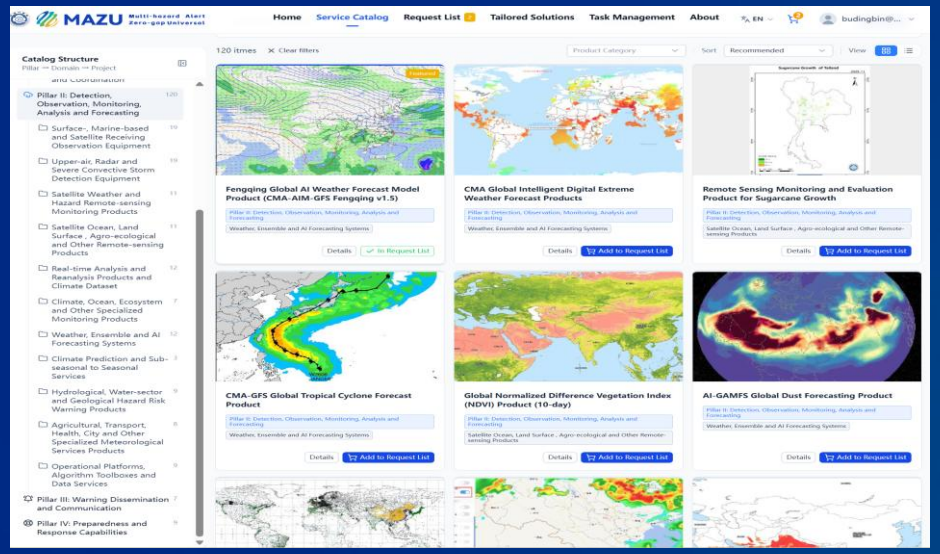


Function 5: Customization via Menu-to-Service Platform
(Designed for customization and list all the contents of MAZU)

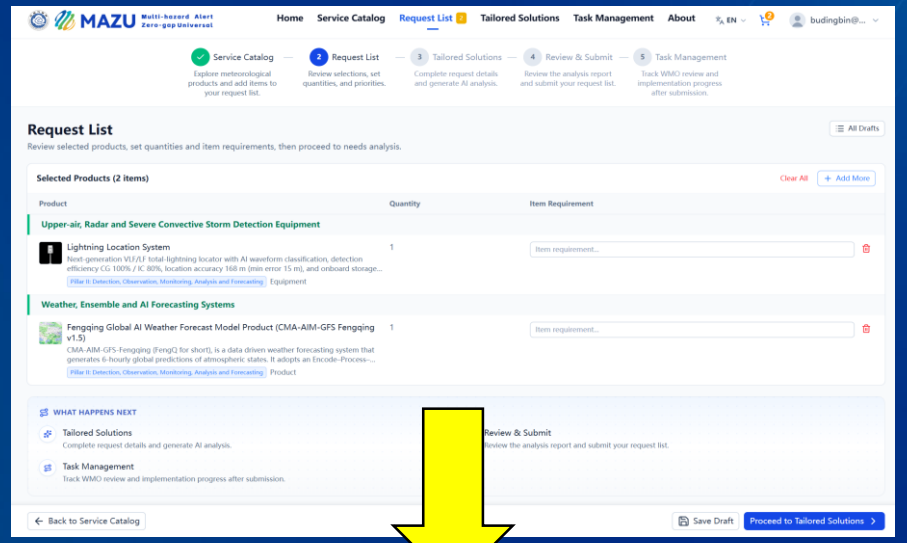


Function 5: Customization via Menu-to-Service Platform

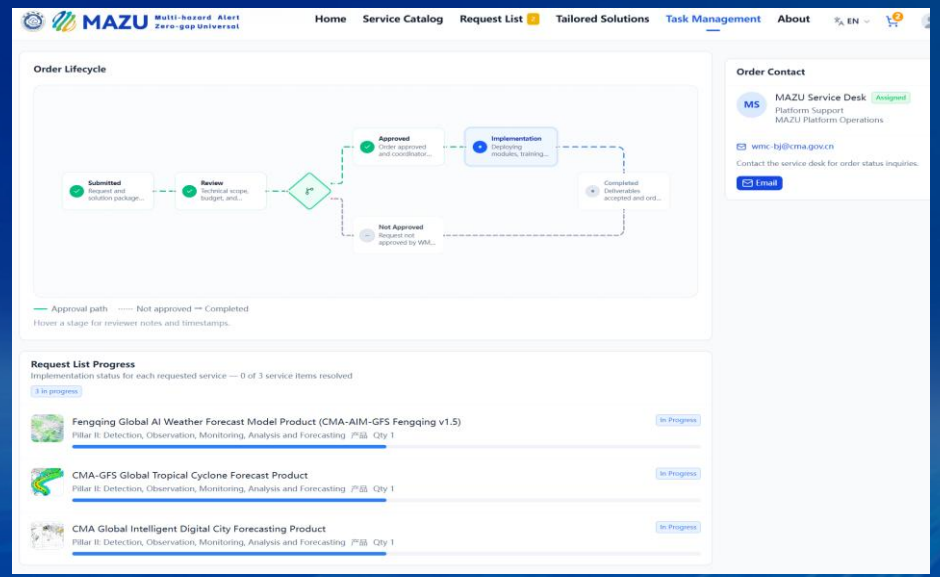
Service Catalog



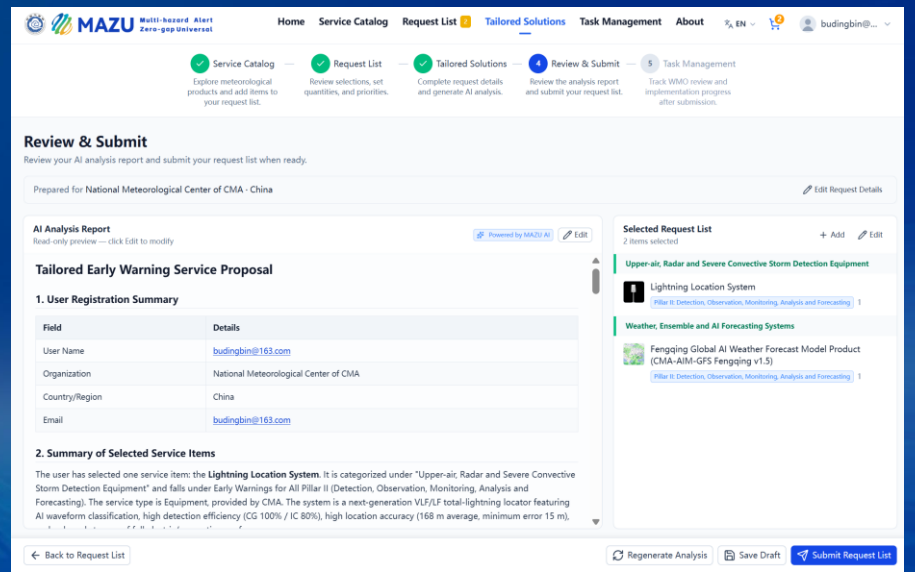
Request List



Task Management



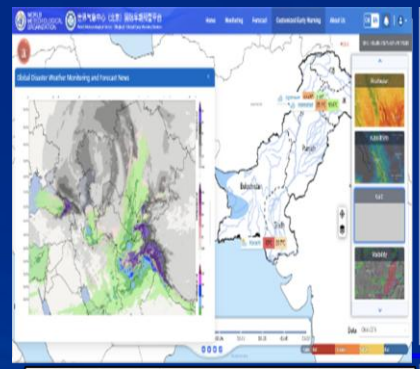
Tailored Solutions

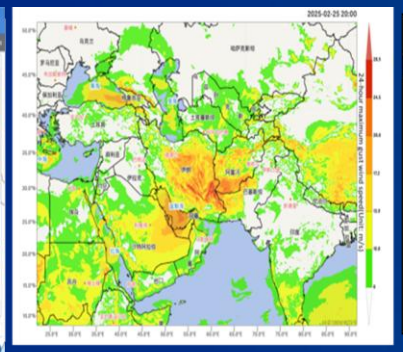


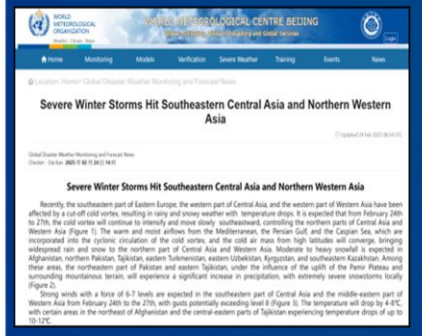
CEWS Application: Supporting Global Disaster Risk Reduction (DRR)

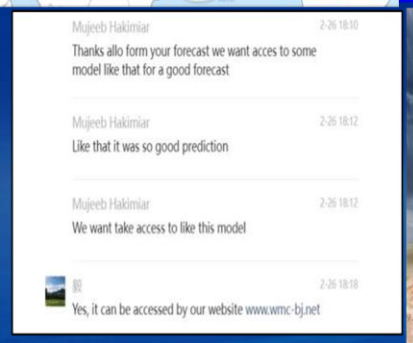
CEWS is not a theoretical platform. It is an operational tool used daily to support global DRR efforts.

Example 1: Severe Winter Storms in Asia: The platform was used to monitor and forecast the severe winter storms that hit Southeastern Central Asia and Northern Western Asia, providing critical information for international consultation.

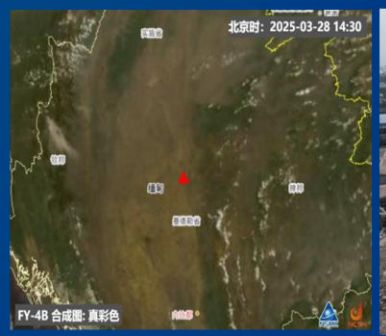


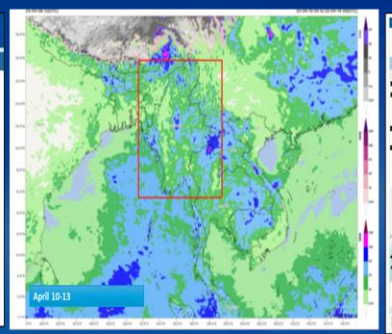


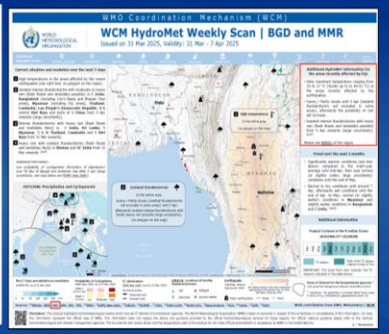




Example 2: Earthquake Support in Myanmar: Following an earthquake, CEWS provided specialized weather forecasts and services for the affected areas from April 10-13, supporting humanitarian relief efforts.







Outline

Part 1: What is MAZU

Part 2: AI Engine for Forecasting Products

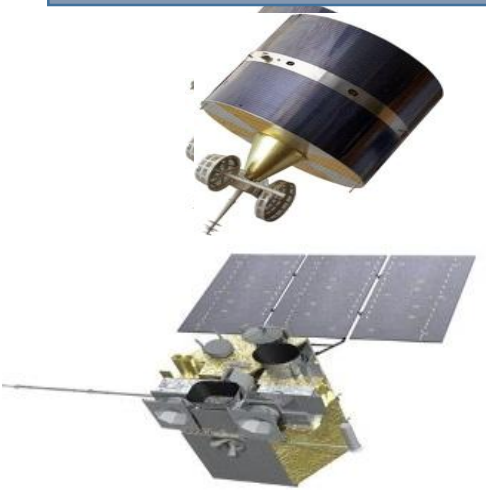
Part 3: Cloud-based Early Warning System

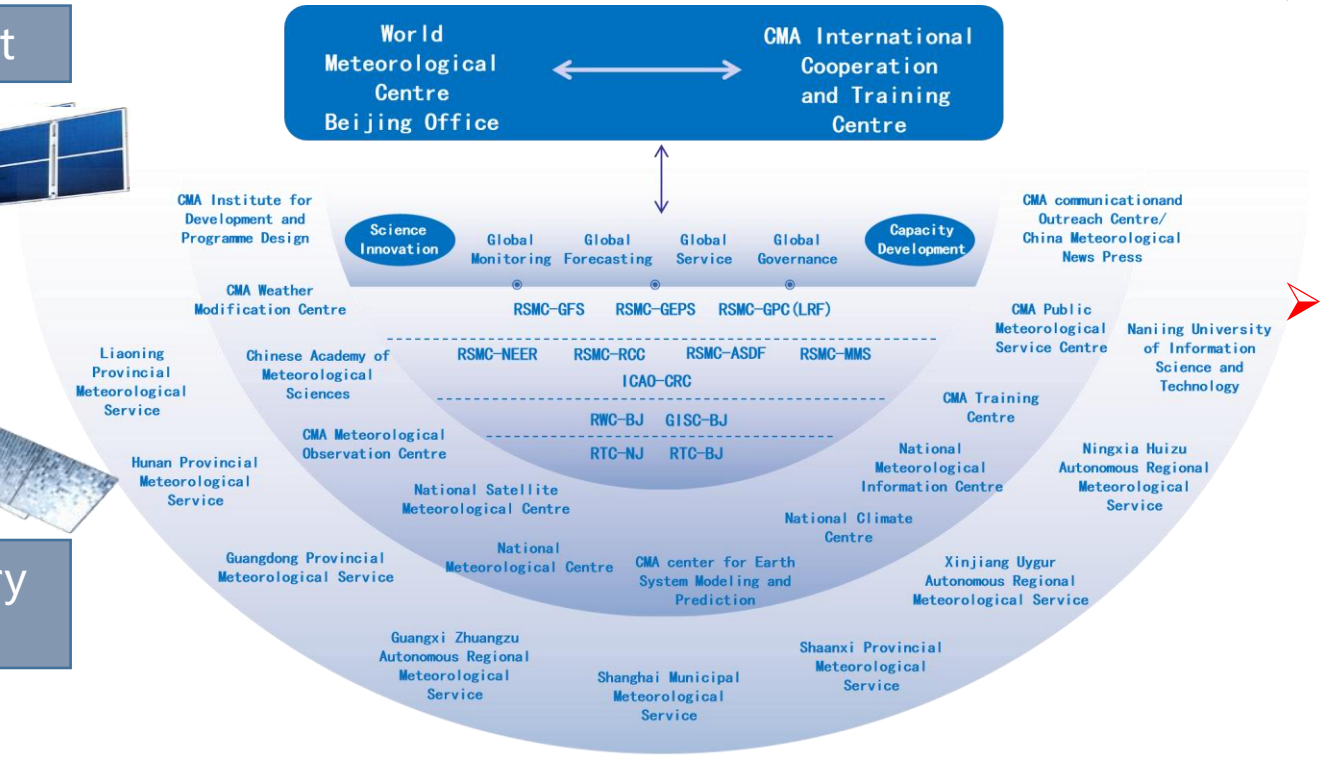
Part 4: Open Collaboration and Future Prospects

Next Steps

5 FY Polar Orbit

5 FY Geostationary Orbit





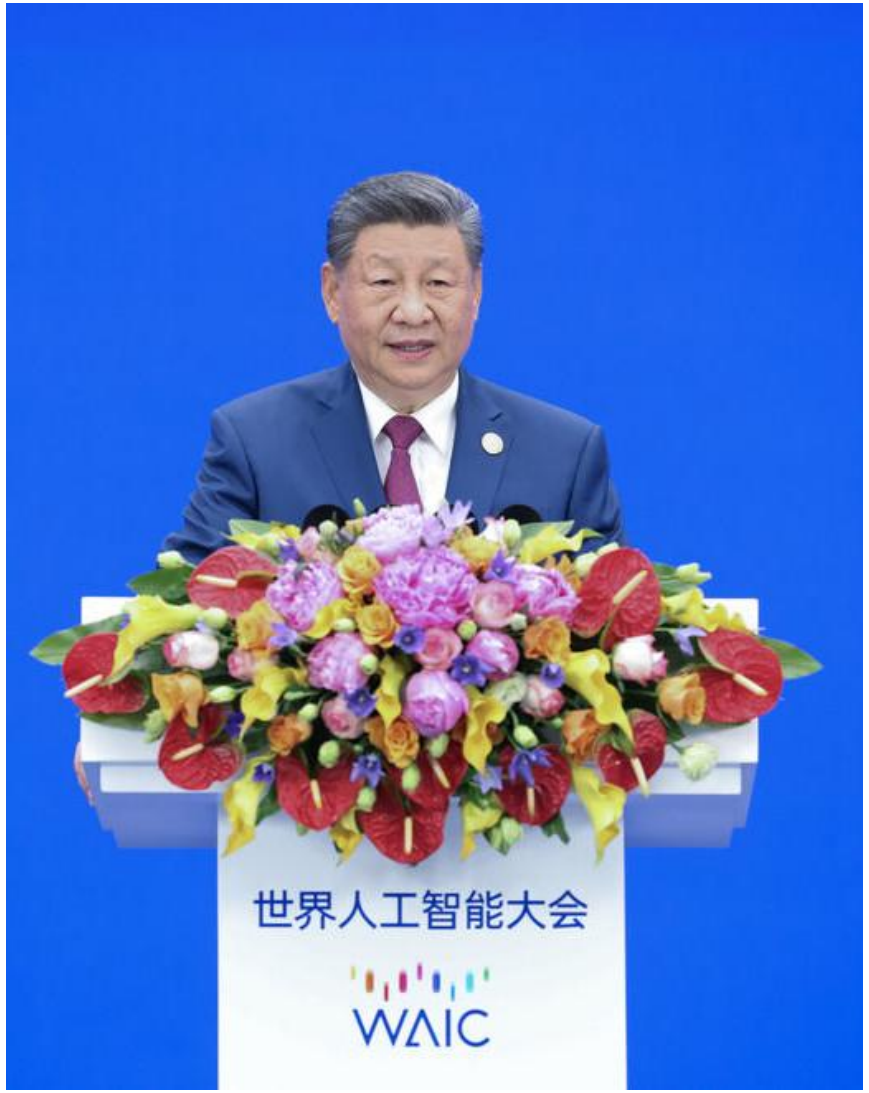
AI -Powered models:
FENGLEI
ENGQING
FENGSHUN
FENGYUAN
FENGYU
FENGHE

NWO models:
CMA-GFS：12.5km
CMA-GEPS：50km/25km
CMA-CPS：45km
CMA-REPS：10km/3km
CMA-TRAM：9km
CMA-GD：3km/ 1km

Capacity development:
Education and training
BRI visiting scholarship
Development projects
Global partnership
…

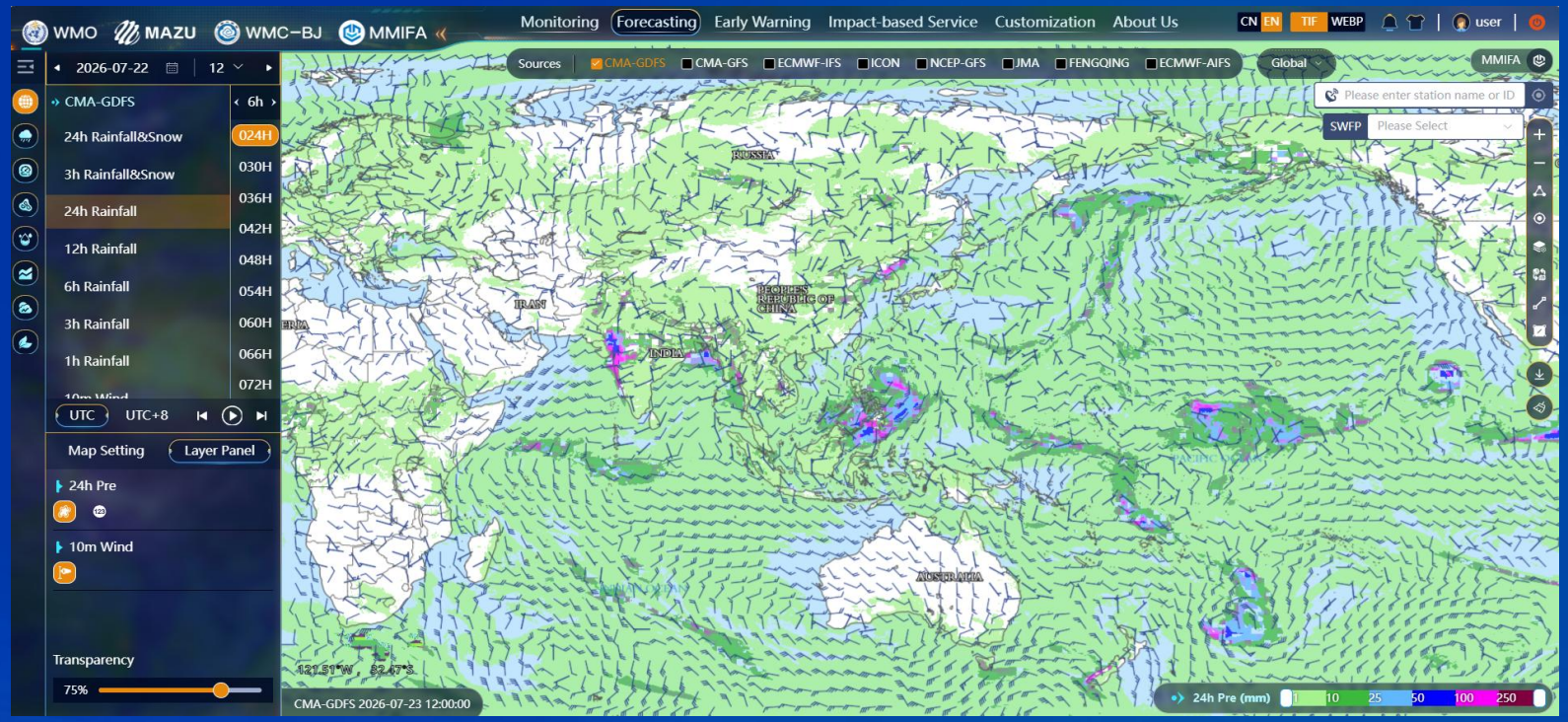
- **Continue to build the MAZU Cloud-Based Early Warning Platform for global public by World Meteorological Centre (Beijing) office.**
- **Deepen cooperation with Global South countries and relevant international organizations through CMA International Cooperation and Training Centre, and forge a closer network of global meteorological partnerships.**
- **Take actions and scale-up support for developing countries in enhancing their capacity for early warning.**

Next Steps



At the opening ceremony of the 2026 World AI Conference & High-Level Meeting on Global AI Governance (WAIC), President Xi solemnly announced that over the next 5 years, China will deploy locally-tailored versions of MAZU in 30 countries.

THANKS!



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