PRELIMINARY CONSTRUCTION OF MULTI-HAZARD EARLY WARNING AGENT FOR TYPHOON (MAZU-TC)

SHANGHAI METEOROLOGICAL SERVICE OF CMA
(COEW, AP-TCRC)

NANNING/CHINA. 20250918

A Global Mission：United Nations EW4All Initiative

Early warning Initiative (2022-) are effective measures against climate change, as extreme weather events are on the rise.

WMO leads the monitoring and early warning pillar. Moreover, it partly undertakes and supports the other three pillars, namely risk assessment, information dissemination, and emergency response.

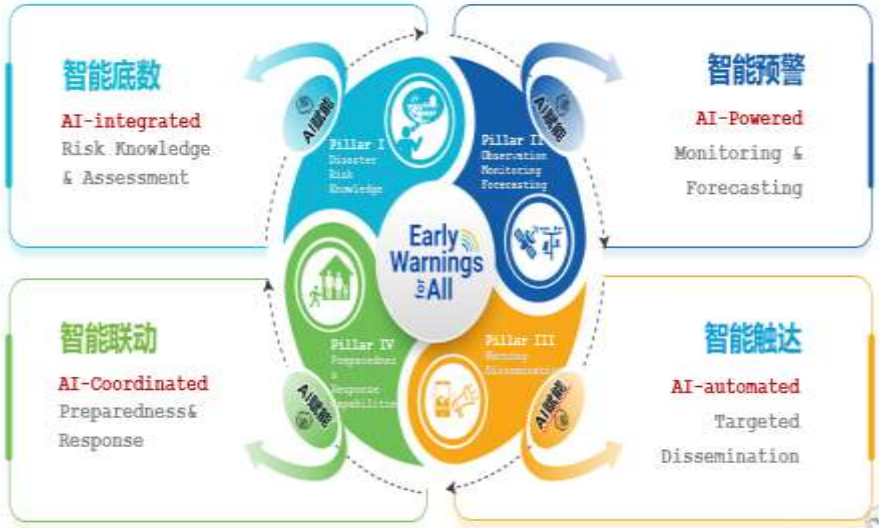
Early Warnings for All

Everyone on Earth is protected by early warning systems by **2027**.

China has responded proactively, put forward a three-years action plan

AI全链赋能早期预警四大支柱

All-in AI Approach for the Four Pillars



Release：China’s Action on the “Early Warnings for All "initiative Powered by AI

China’s Solution to Early Warnings for All：MAZU

MAZU
Multi-hazard Alert
Zero-gap and Universal

Multi-hazard
Alert
Zero-gap
Universal

She was honored as MAZU in China

AI Agent for Urban Multi-hazard Early Warning (MAZU-Urban).
It was developed under CMA’s international cooperation brand “MAZU”, with a focus on urban areas.

Release: AI Agent for Urban Multi-Hazard Early Warning (MAZU-Urban)

➢ **FDP of WMO: EXPO-Shanghai (2010) → Pilot Project （2025）：Center of urban multi-hazard Early Warning (CoEW)**

✓ **Integration of three terminals of MAZU-Urban (PC, Tablet, Phone)**

All-in-one Terminal

Smart Tablet　　Smart Phone

✓ **International public products:**

AI Agent for Urban Multi-hazard Early Warning (MAZU-Urban).
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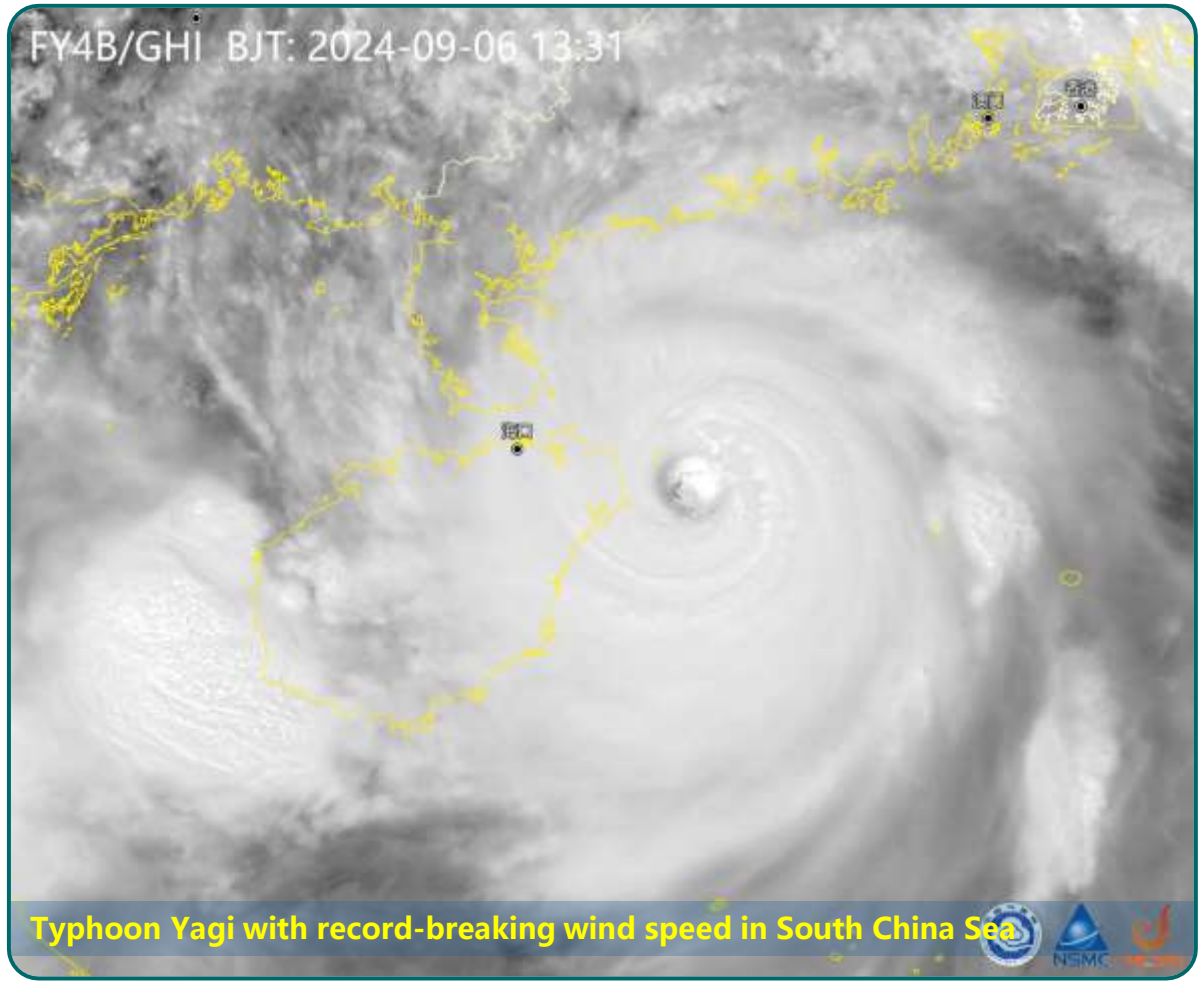
Climate Changes → Weather Rages (Record-breaking has become the new normal)

- Typhoon: the most severe natural disasters in Southeast Asia


Flash Flood in northern China


Severe Drought in Southern China


Severe Flood in Pakistan



Typhoon Yagi with record-breaking wind speed in South China Sea

Typhoon Bebinca
Strongest over 75 years in Shanghai

启动台风多灾种早期预警智能体“MAZU-TC”建设工作

Launch of the Construction Work for Typhoon Multi-Hazard Early Warning Intelligent Agent "MAZU-TC"

Pillar 1
Tropical Cyclone Dataset

- Typhoon Best Track Dataset
- Typhoon Wind and Rainfall Impact Dataset
- Global Typhoon Forecast Dataset
- Global Atmospheric Reanalysis Dataset

Pillar 2
AI-powered Monitoring and Forecasting Analysis Tool

- Shanghai Typhoon Model (SWARMS-TC)
- Shanghai Intelligent Typhoon Model (ISTM)
- Guangxi-ASEAN Typhoon AI Forecasting Model

Pillar 4
Typhoon Progressive Service Response Plan

- Typhoon Early Outlook
- Initial Stage of Typhoon Formation
- Typhoon Entering the Warning Zone
- Before and After Typhoon Landfall

Pillar 3
Typhoon Disaster Risk and Benefit Assessment

- Typhoon Catastrophe Risk Assessment
- Typhoon Disaster Prevention and Mitigation Benefit Evaluation
- Street-Level Dynamic Typhoon Risk Assessment

第一支柱 – 热带气旋数据集

Pillar 1 Tropical Cyclone Dataset

Pillar 1
Disaster Risk Knowledge and Management

Best track dataset	Wind and rain impact dataset	Storm Chase observation dataset	Forecast and verification dataset	Remote sensing dataset	Global observation dataset	Global reanalysis dataset

Typhoon climate atlas and yearbook

Geographic Distribution of Users on the Tropical Cyclone Data Website (79 Countries and Regions)

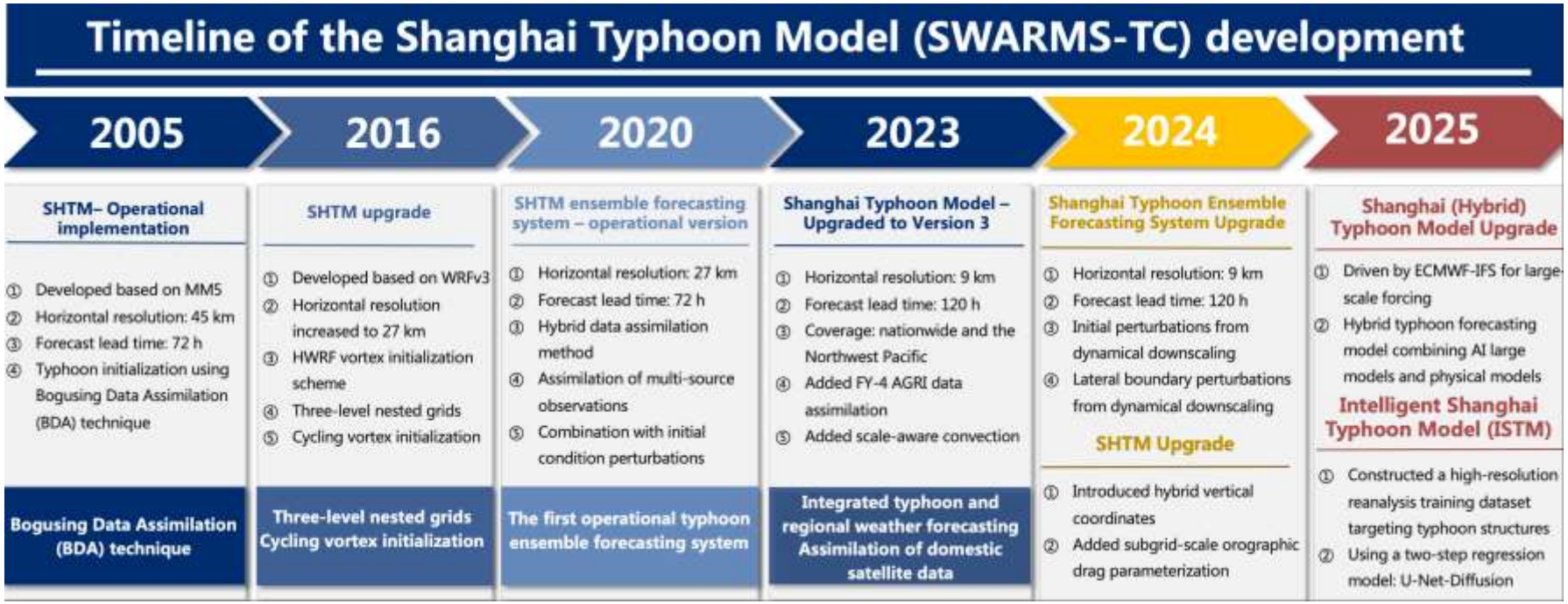
The "Western North Pacific Tropical Cyclone **Retrieval** System" can provide real-time typhoon forecasts, historical typhoon queries, similar typhoon retrieval, and wind and rain impact data inquiries, among other services.

第二支柱 – 上海台风模式（SWARMS-TC ）

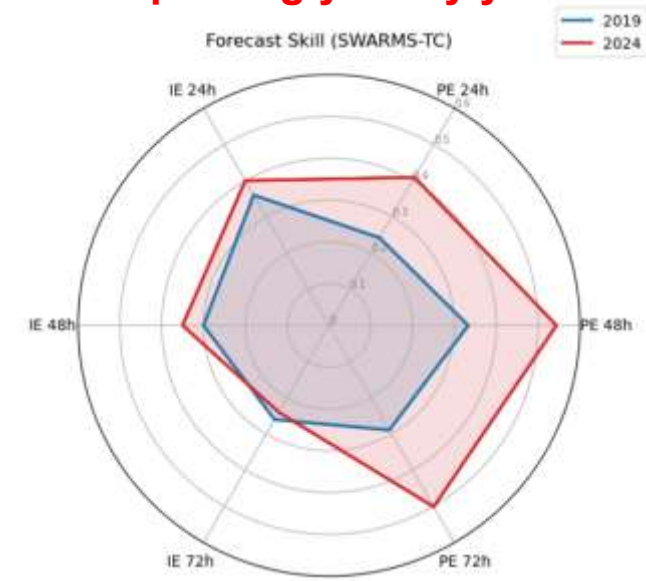
Pillar 2 An AI-powered Monitoring and Forecasting Analysis Tool

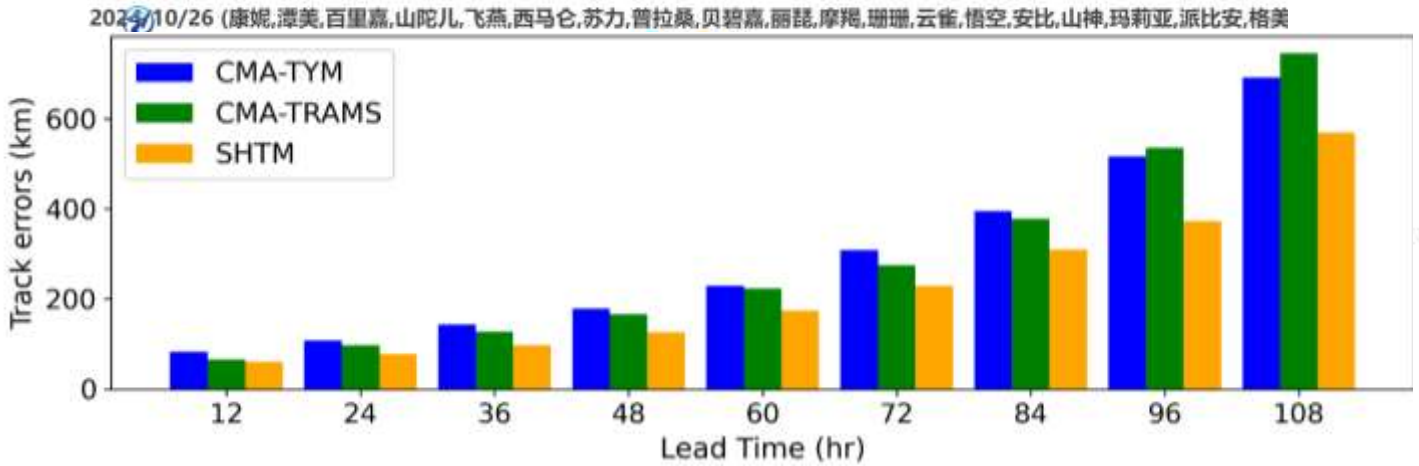
Pillar 2
Detection, Observation, Monitoring, Analysis, and Forecasting

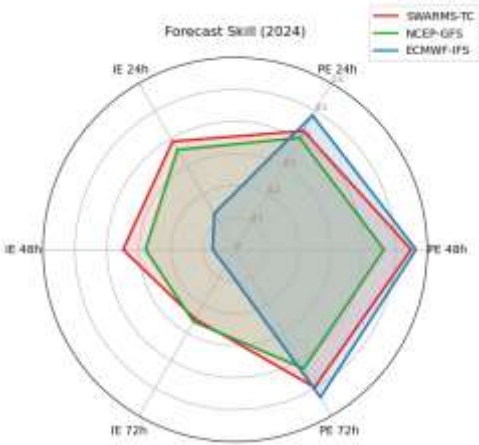
➢ NWP（SWARMS-TC）



The forecasting capability of SWARMS-TC has been improving year by year.







In 2024, typhoon track forecasting performance of SWARMS-TC ranked first among regional numerical models.

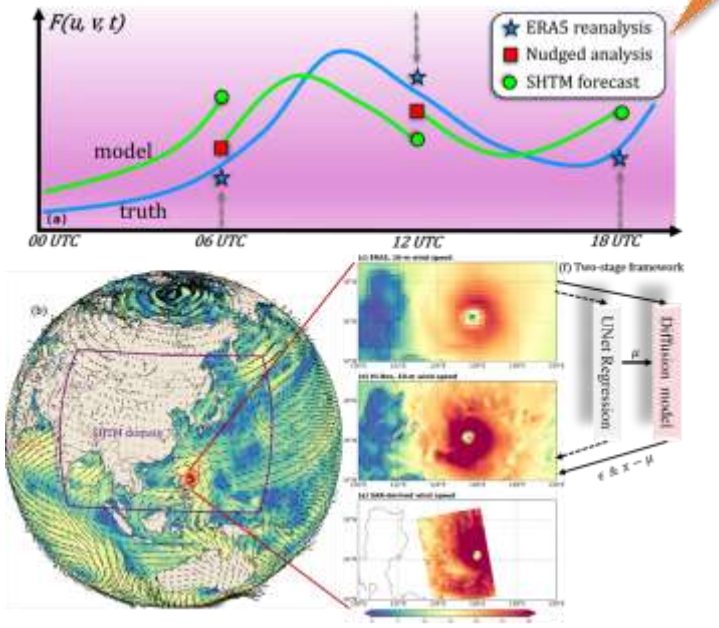
第二支柱 – 上海台风智能模型（ ISTM ）

Pillar 2
Detection, Observation, Monitoring, Analysis, and Forecasting

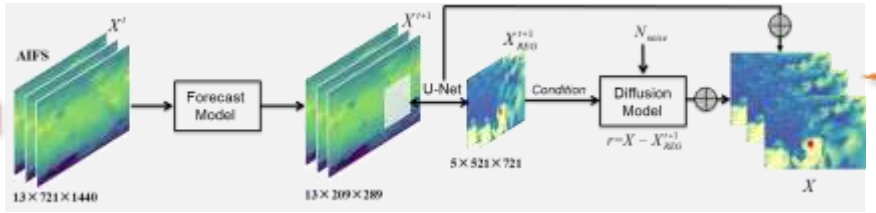
Pillar 2 An AI-powered Monitoring and Forecasting Analysis Tool

- AI model

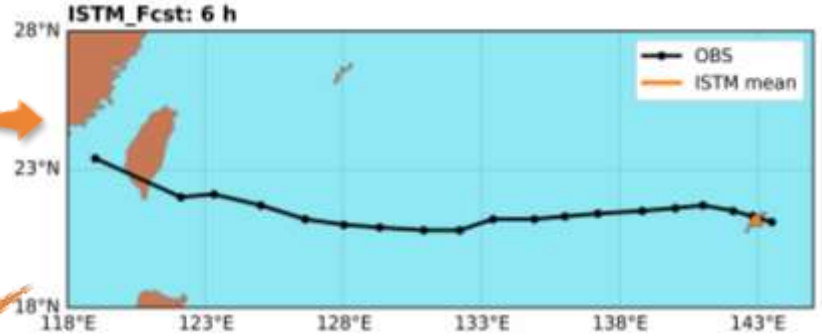
1. Self-developed high-resolution reanalysis training dataset



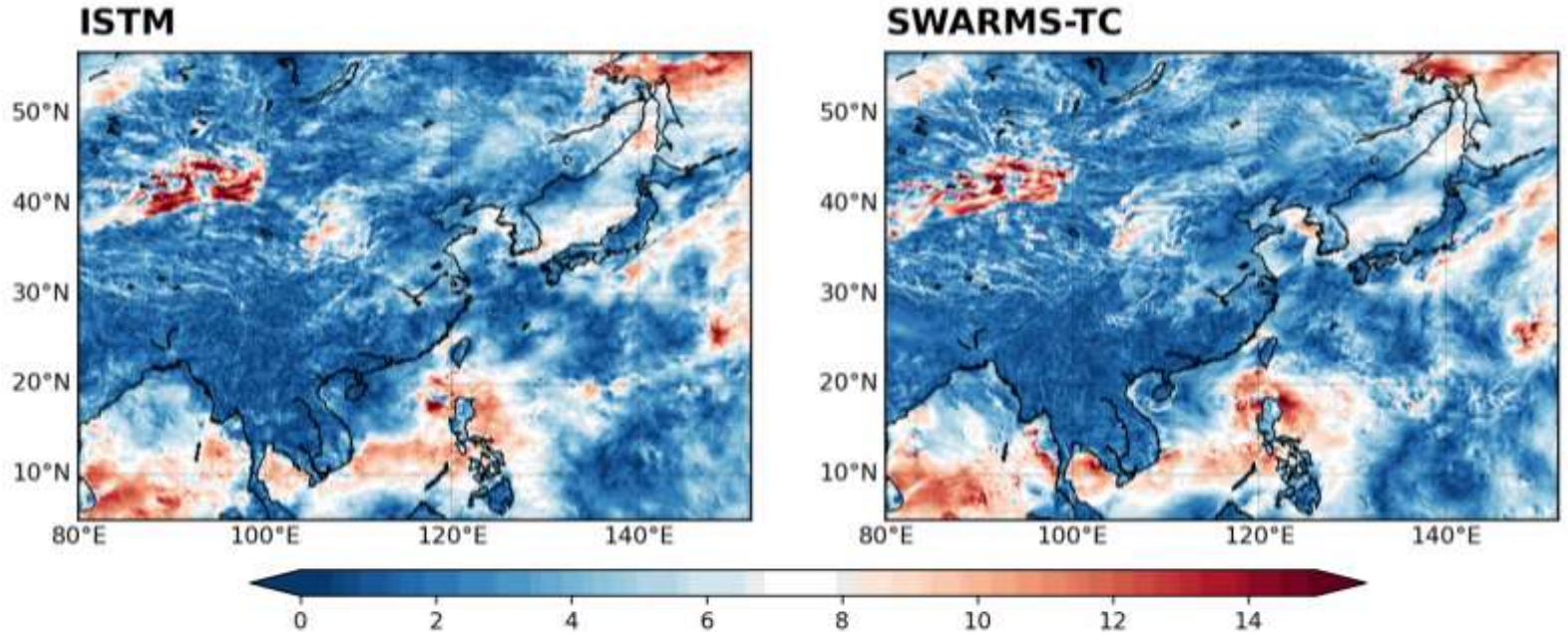
2. A two-step strategy based on U-Net-Diffusion model



3. Minute-scale probabilistic typhoon forecasts



4. AI companion models that faithfully reproduce physical model processes



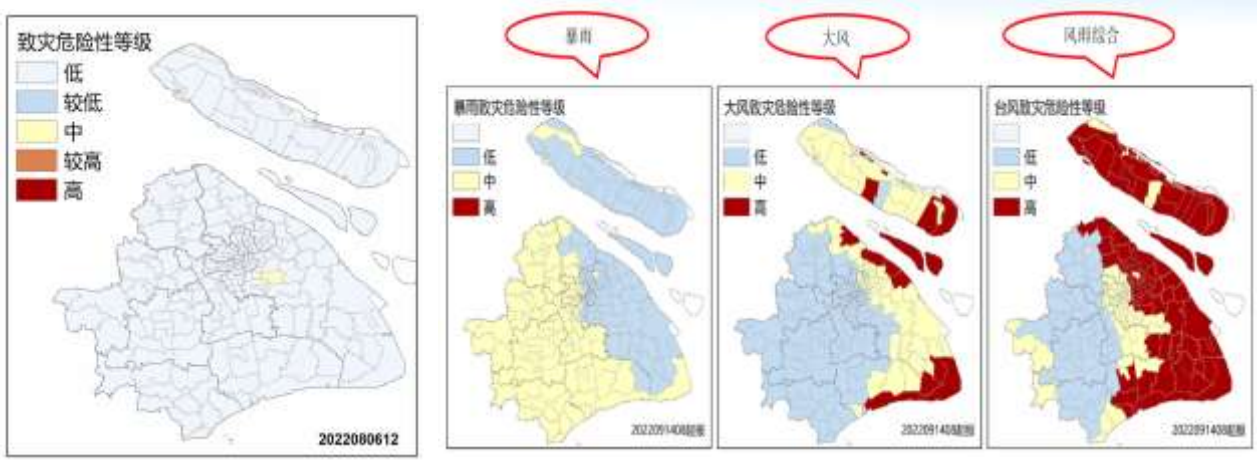
第三支柱 – 台风灾害风险与效益评估

Pillar 3 Typhoon Disaster Risk and Benefit Assessment

Pillar 3
Warning Dissemination and Communication

Typhoon Risk Assessment

Street-level Dynamic Risk Assessment



Typhoon Disaster Prevention and Mitigation Benefit Evaluation

- **ESCAP/WMO-TC:** AOP , WGDRR (2015-)
- **Member:** China, Malaysia, Laos, Vietnam


2017 and 2018：Malaysia


2019: Laos and Vietnem


2024: Malaysia


The Study of the Economic Benefit of Improving Track and Intensity Forecast of Landfalling Tropical Cyclones with Storm Surge Impacts


Output: Research report - 《EVALUATING THE CHALLENGES OF ASSESSING THE IMPACT OF GOVERNMENT STRATEGIES IN REDUCING THE FLOOD DAMAGE AND LOSS IN MALAYSIA》

第四支柱 – 台风递进式服务的科技支撑应对方案

Pillar 4 Typhoon Progressive Service Technology Support Response Plan

Pillar 4
Preparedness and Response Capabilities

5	3	2	1	6	
Early Stages of TC Development	TC Genesis	Entering the 48-hour Warning Area	Entering the 24-hour Warning Area	Landfall	Post-event Review
• **Typhoon Climate Prediction** • **Tropical Disturbance Monitoring** • **Disturbance Ensemble Forecasting**	• **Similarity Retrieval** • **Track and Intensity** Shanghai Typhoon Model Shanghai Muti-model consensus • **Strike Probability** Shanghai Ensemble system Ensemble probability Ellipse • **Landfall Probability** Probability of Landfall	• **Similarity Retrieval** • **Track and Intensity** Shanghai Typhoon Model Shanghai Muti-model consensus • **Strike Probability** Shanghai Ensemble system Ensemble probability Ellipse • **Landfall Probability** Probability of Landfall	• **Similarity Retrieval** • **Track and Intensity** Shanghai Typhoon Model Shanghai Muti-model consensus • **Wind and Rain** CMA-SH9 CMA-SH3 Shanghai Typhoon Model Wind Probability Shanghai Ensemble System • **Wave and Storm Surge** SWARMS-OCEAN • **Landfall Probability**	• **Similarity Retrieval** • **Track and Intensity** Shanghai Typhoon Model Shanghai Muti-model consensus • **Wind and Rain** CMA-SH9 CMA-SH3 Shanghai Typhoon Model Wind Probability Shanghai Ensemble System • **Typhoon Disaster Assessment** Probability Forecast for Diff. Disaster Risk Levels	• **Forecast Verification** • **Typhoon Disaster Assessment** • **Typhoon Impact Rank** • **Mechanism Analysis** • **Typhoon Post-event Review**
Typhoon Prediction Information (AP-TCRC)	Typhoon Special Brief 《Typhoon Bulletin》	Typhoon Special Brief 《Typhoon Bulletin》	Typhoon Special Brief 《Typhoon Bulletin》	Typhoon Special Brief 《Typhoon Bulletin》	Post-event Review (National or Regional)

Seek Collaborators:

台风多灾种早期预警智能体 (MAZU-TC)

MAZU-TC的建设，绝非任何一个国家或机构能够独立完成。它需要全球的协作。**我们在此诚挚倡议：请您和您的国家加入我们。**无论是数据、算力还是顶尖的科学家人才，每一份贡献都至关重要。

正如我们所说：独行快，众行远。面对全球性的气候挑战，唯有团结与合作，才是我们最坚固的防线。

The development of MAZU-TC is by no means a task that any single country or institution can accomplish alone. It requires global collaboration.

We sincerely urge: Please join us with your nation. Whether it is data, computing power, or top scientific talent—every contribution is crucial.

As the saying goes: *If you want to go fast, go alone; if you want to go far, go together.* In the face of global climate challenges, only unity and cooperation can form our strongest line of defense.


谢 谢
THANKS