Meteorological Forum of 2025 WAIC, Shanghai, China

Advancing Typhoon Prediction with AI: Activities and Future Plan in Typhoon Committee

Yihong DUAN

ESCAP/WMO Typhoon Committee

Acknowledgements:
Dr. Mengqi Yang from Shanghai Typhoon Institute
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Dr. Clarence Fong and Dr. Jinping Liu from Typhoon Committee Secretariat

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Typhoon Committee

- ✓ Introduction to the Typhoon Committee
- ✓ Challenges and Opportunities in Improving Typhoon Forecasting
- ✓ Key Activities of the Typhoon Committee on AI Applications
- ✓ Conclusion and Future Plan

Introduction to the Typhoon Committee

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Typhoon Committee

Typhoon Committee is a intergovernmental body established in 1968, under the auspices of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and World Meteorological Organization (WMO);


Cambodia


China


DPRK


Hong Kong, China


Japan


Laos PDR,


Macao, China


Malaysia


ROK


Philippines


Singapore


Thailand


USA


Vietnam

Currently evolved into a collaboration of 14 Members from Asia Pacific area

Introduction to the Typhoon Committee

ESCAP/WMO Typhoon Committee

The Typhoon Committee has been repeatedly recognized as an outstanding regional body who has integrated the actions and plans of the meteorological, hydrological, and disaster risk reduction (DRR) components to produce meaningful results.

- **Vision:** The Typhoon Committee is the world's preeminent inter-governmental, regional organization for improving the quality of life of the Members' populations through integrated cooperation to mitigate impacts and risks of typhoon-related disaster risks and to enhance beneficial typhoon-related effects.
- **Mission:** To integrate and enhance regional (Meteorological, Hydrological, and Disaster Risk Reduction) activities of Members within international frameworks to reduce the loss of lives and minimize social, economic, and environmental impacts by typhoon-related disasters.

Structure of Typhoon Committee

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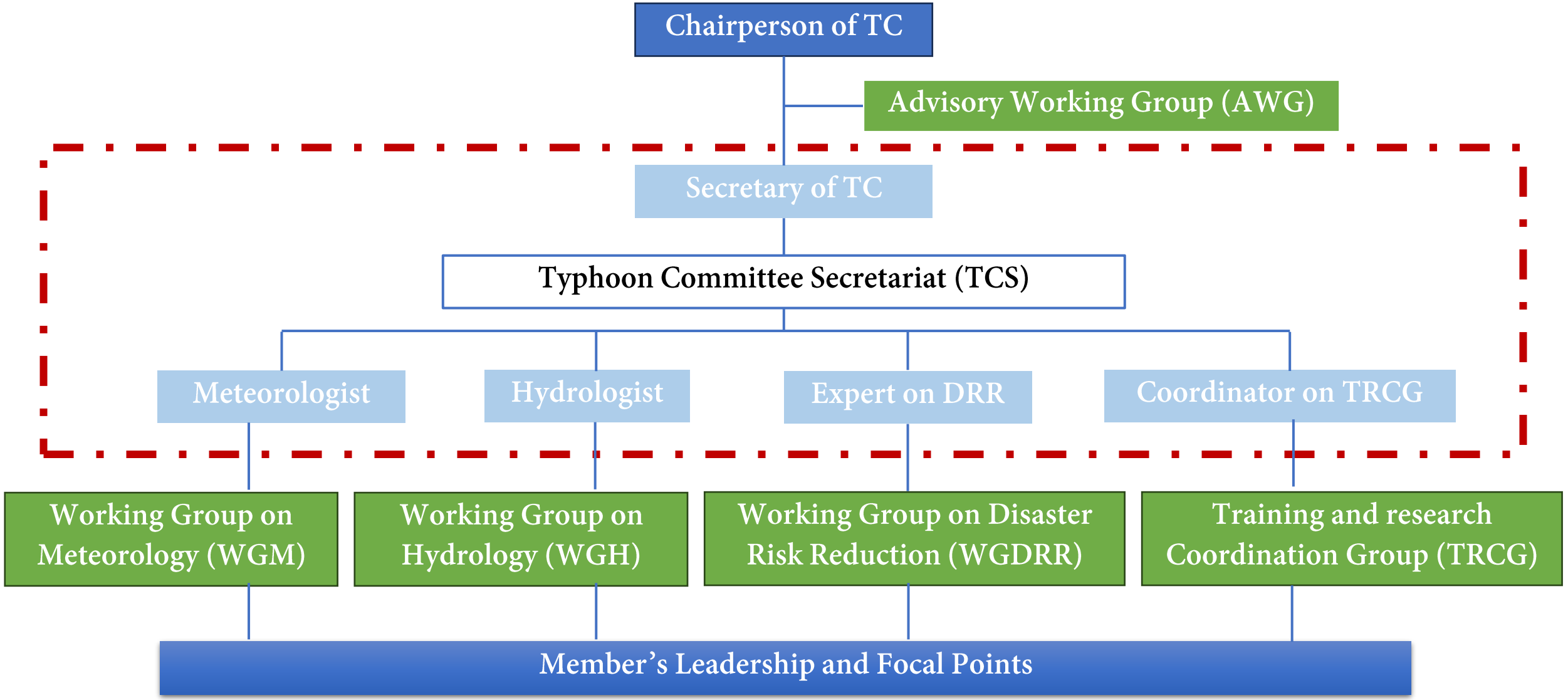
Typhoon Committee



Introduction to the Typhoon Committee

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Typhoon Committee

The Secretariat of the Typhoon Committee is located in the Macao Special Administrative Region, China. Main function is to advise Members on the technical and administrative coordination for the implementation of improved meteorological, hydrological and DRR, and other facilities needed in the mitigation of typhoon damage.

Introduction to the Typhoon Committee

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Typhoon Committee

- Session
- Integrated Workshop
- Working Group Meetings
- Roving Seminar
- Workshops/Trainings/Seminars:

Introduction to the Typhoon Committee

2nd Five Year Strategic Plan 2012-2016

3rd Five Year Strategic Plan 2017-2021

4th Five Year Strategic plan 2022 -2026

The Five-Year Strategic Plan is the guiding document for the work of the Typhoon Committee. We update the Strategic Plan every five years, and the latest plan covers the period from 2022 to 2026.

Introduction to the Typhoon Committee

ESCAP/WMO
Typhoon Committee

1. Enhance capacity to monitor the impacts of tropical cyclone related disasters and strengthen tropical cyclone related disaster risk reduction (DRR) activities in various sectors.
2. Enhance capacity in tropical cyclone forecast and disaster risk prediction using multi-hazard impact-based forecast warnings, understandable information designed in collaboration with users, and cutting –edge information technology, leveraged from the latest advances in big data analytics, artificial intelligence, machine learning, and social science to support early warning systems, decision making and disaster response.
3. Improve flood mitigation measures and integrated water resource management to reduce the impacts of flooding caused by tropical cyclones.
4. Strengthen capacity development activities in meteorology, hydrology, DRR and civil protection sections, to enhance nationally to locally coordinated mechanisms for tropical cyclone early warning information to reach the last mile and combine public awareness with the appropriate response to protect life and property from tropical cyclones.
5. Promote visibility and enhance Typhoon Committee's Regional and International collaboration mechanisms to build partnerships, enhance capacity development, share best practices, and encourage capacity development, share best practices, and encourage active participation of international organizations in the disaster risk reduction programmes.
6. Advance collaborative scientific research amongst operational tropical cyclone centers and research communities, particularly in relation to climate change, and include support for translating research outcomes to services by developing relevant experiments, research projects, conducting fields surveys, and publishing and promoting research findings.
7. Enhance the resilience of vulnerable communities to tropical cyclone impacts, especially communities along the coast and inland areas with high risk floods and flash floods, such as hillside or mountainous regions and low lying floodplains along rivers.

Key Results Areas (KRAs) for TC Strategic Plan 2022-2026

ESCAP/WMO Typhoon Committee

Table 1 The list of WGM POP/AOP/PPs in 2025			
Item	Projects	Driver	Since
POP1	Improve the Algorithm of Typhoon Summer Prediction	ROK	2021
POP2	Tropical Cyclone Research and Review	China	2013
POP3	Verification of Tropical Cyclone Operational Forecast	China	2015
AOP1	Enhanced Use of Ensemble Forecast	Japan	2011
AOP2	Improve the Performances and Impacts of South China Sea Typhoon Model	China	2012
AOP3	Development of Regional Radar Network	Japan	2011
AOP4	Radar Nowcasting Based on RaINS/SWIRL	Malaysia	2019
AOP5	Storm Surge Watch Scheme	Japan	2012
AOP6	Contribution for the Experiment on Typhoon Intensity Change in Coastal Area (EXOTICCA-II)	China	2014

Table 2 The list of WGM POP/AOP/PPs in 2025

Item	Projects	Driver	Since
AOP7	Enhancing Utilization of Himawari 8/9 Products	Japan	2018
AOP8	Parallel Analysis of Satellite Data in Operational Tropical Cyclone Monitoring	China	2018
AOP9	Enhancement of Disaster Risk Reduction Against Heavy Rain in Collaboration of AOP7 of WGH	Japan	2019
AOP10	GK2A Utilization for Tropical Cyclone	ROK	2021
AOP11	4th Assessement Report on Impacts of Climate Change on Tropical Cyclones in Typhoon Committee Region	China	2023
AOP12	Tropical Cyclone Monitoring using Drifting Buoys	ROK	2023
AOP13	**Promoting Technical Exchange of AI Applications in Tropical Cyclone Analysis and Forecasting**	**Hong Kong, China**	**2024**
PP1	Utilization of FengYun Satellite for High-Frequency Observation of Tropical Cyclone	China	2025

Table 3 The list of WGH AOPs in 2025 and beyond

Item	Projects	Driver	Duration
AOP1	Knowledge Sharing on Storm Surge Inundation Mapping	USA	2020~2026
AOP2	Improvement of Hydrological Data Quality Control System by Using AI technology	ROK	2023~2027
AOP3	Improvement of Flood Forecasting modelling by Using AI technology	ROK	2023~2027
AOP4	Review and enhancement on specifications for hydrological information and forecasting in TC Members	China	2025~2027
AOP5	Application Study on New Generation of Integrated Micro-siphon Rain Gauge in TC Members	China	2025~2027
AOP6	Flood Risk Mapping with Ground/Satellite Observation Data	Japan	2024~2027
AOP7	Flood resilience enhancement through Platform on Water Resilience and Disasters	Japan	2023~2027
AOP8	Training Course on Hydrological Monitoring and Flood Management for Developing Countries	China	2023~2028
AOP9	Synergized Standard Operating Procedures for Coastal Multi-Hazard Early Warning System (SSOP)-Phase III	USA	2025~2027

Table 3 The list of DRR AOPs in 2025 and beyond			
Item	Projects	Driver	Duration
AOP1	Capacity Building/Knowledge Sharing in DRR	Members	2020~2026
AOP2	Installation of Early Warning System related to typhoon disasters	ROK	2023~2027
AOP3	WGDRR Annual Meeting	ROK	2023~2027
AOP4	Benefit Evaluation of Typhoon Project	China	2018~2025
AOP5	Sharing Information related to DRR		2018~2025
AOP6	Making video related to DRR	Hongkong China	2019~2026

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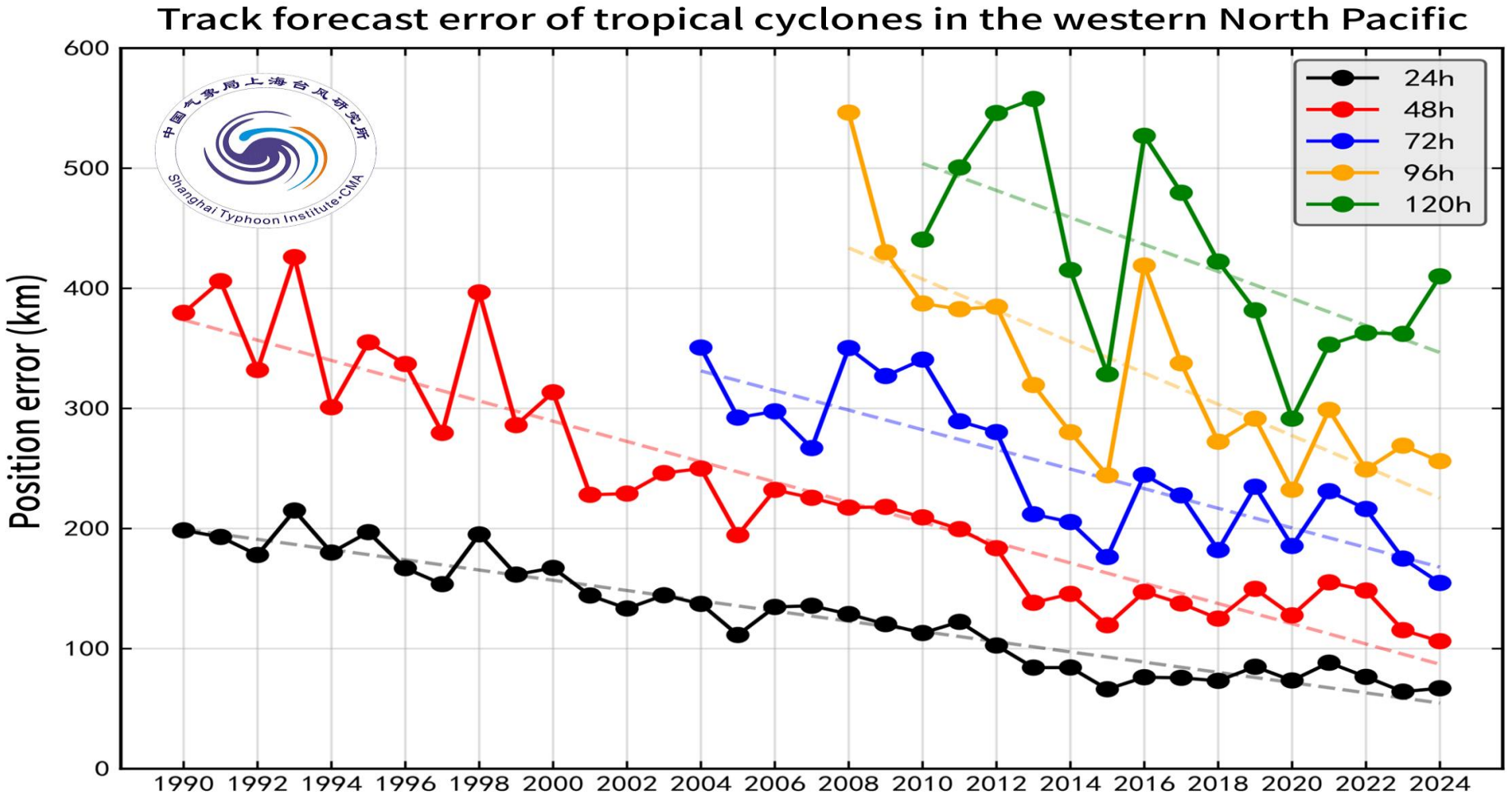
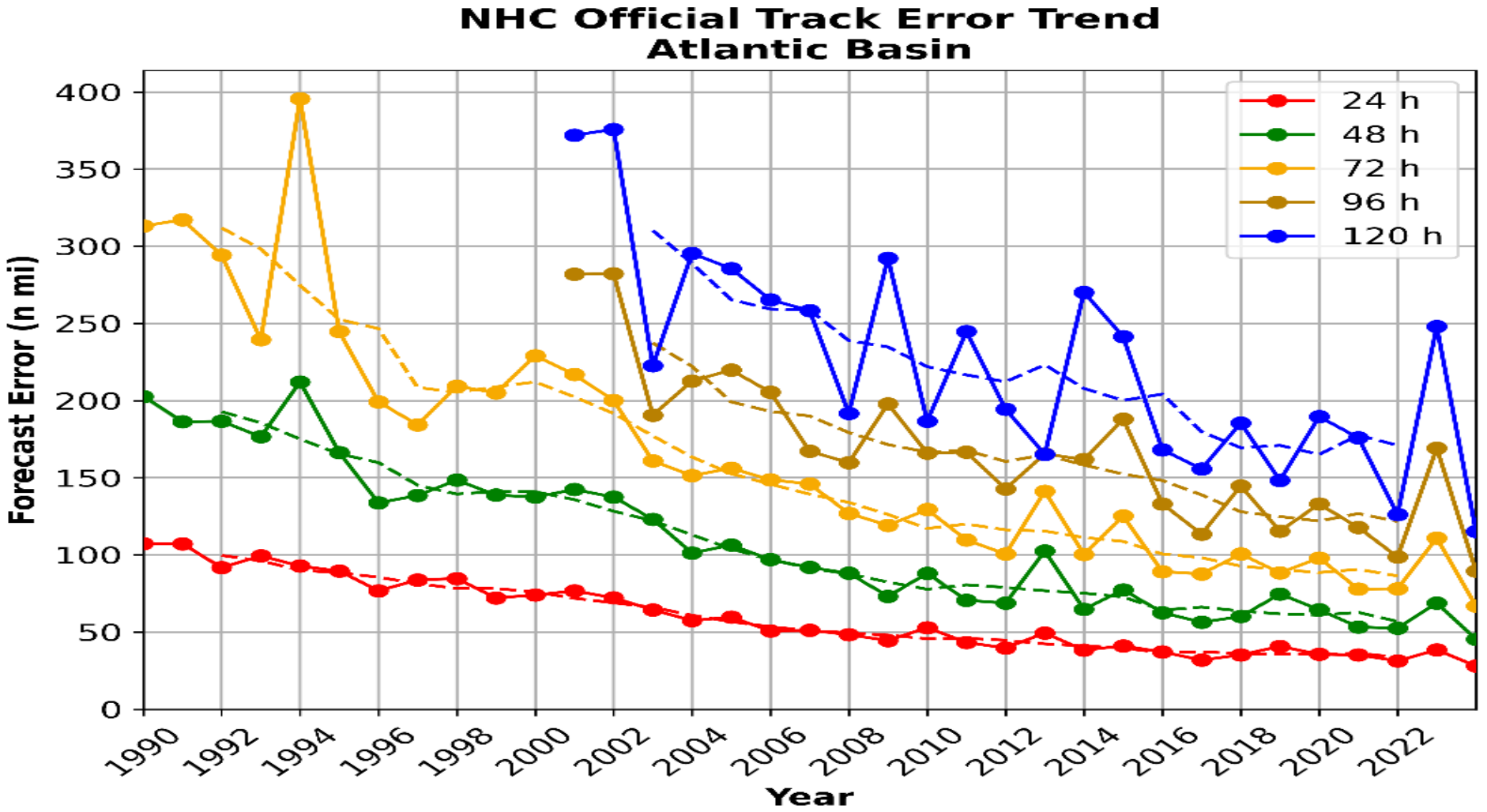
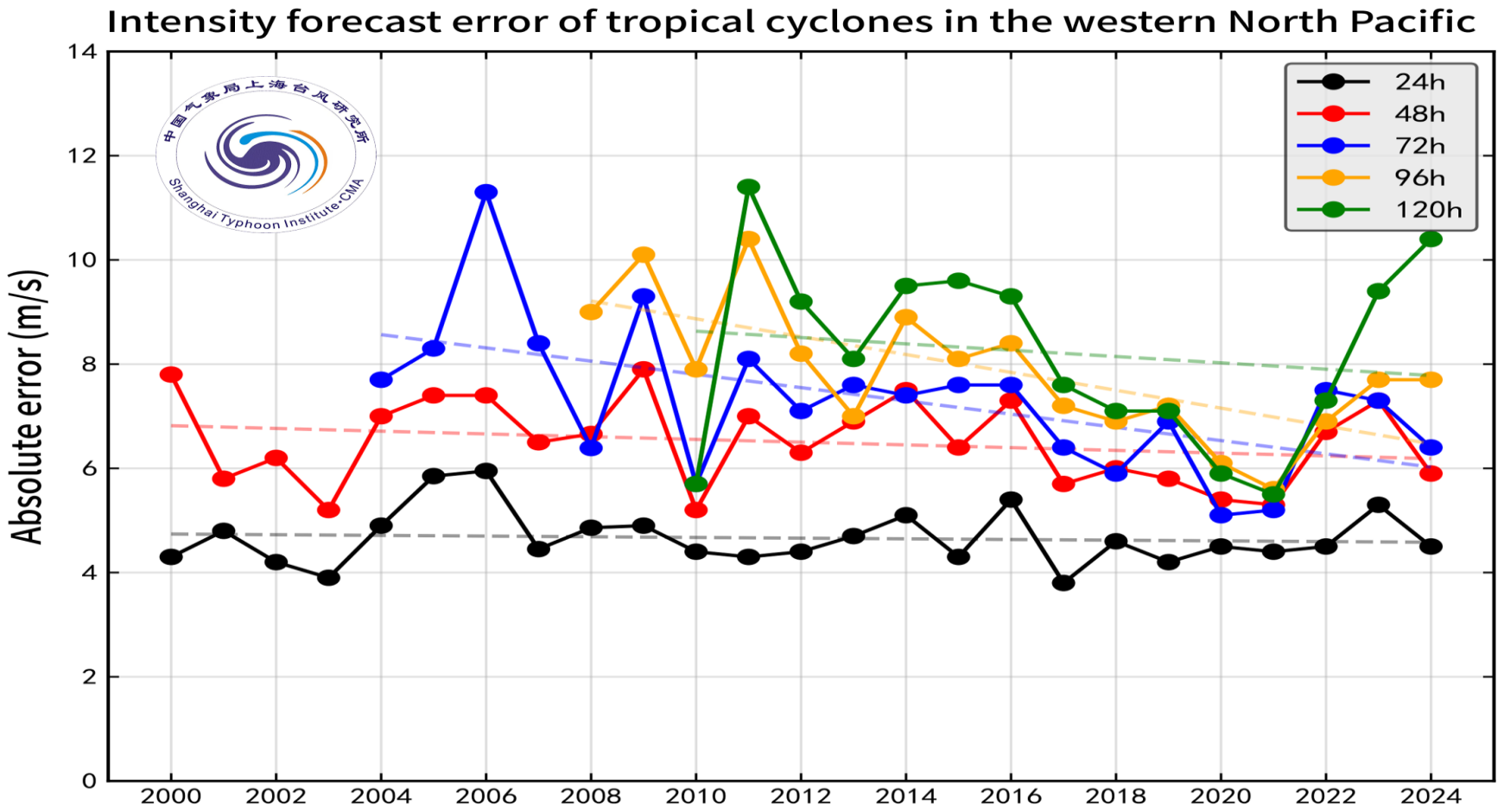


North Western Pacific and South China Sea

Provided by Shanghai Typhoon Institute /CMA

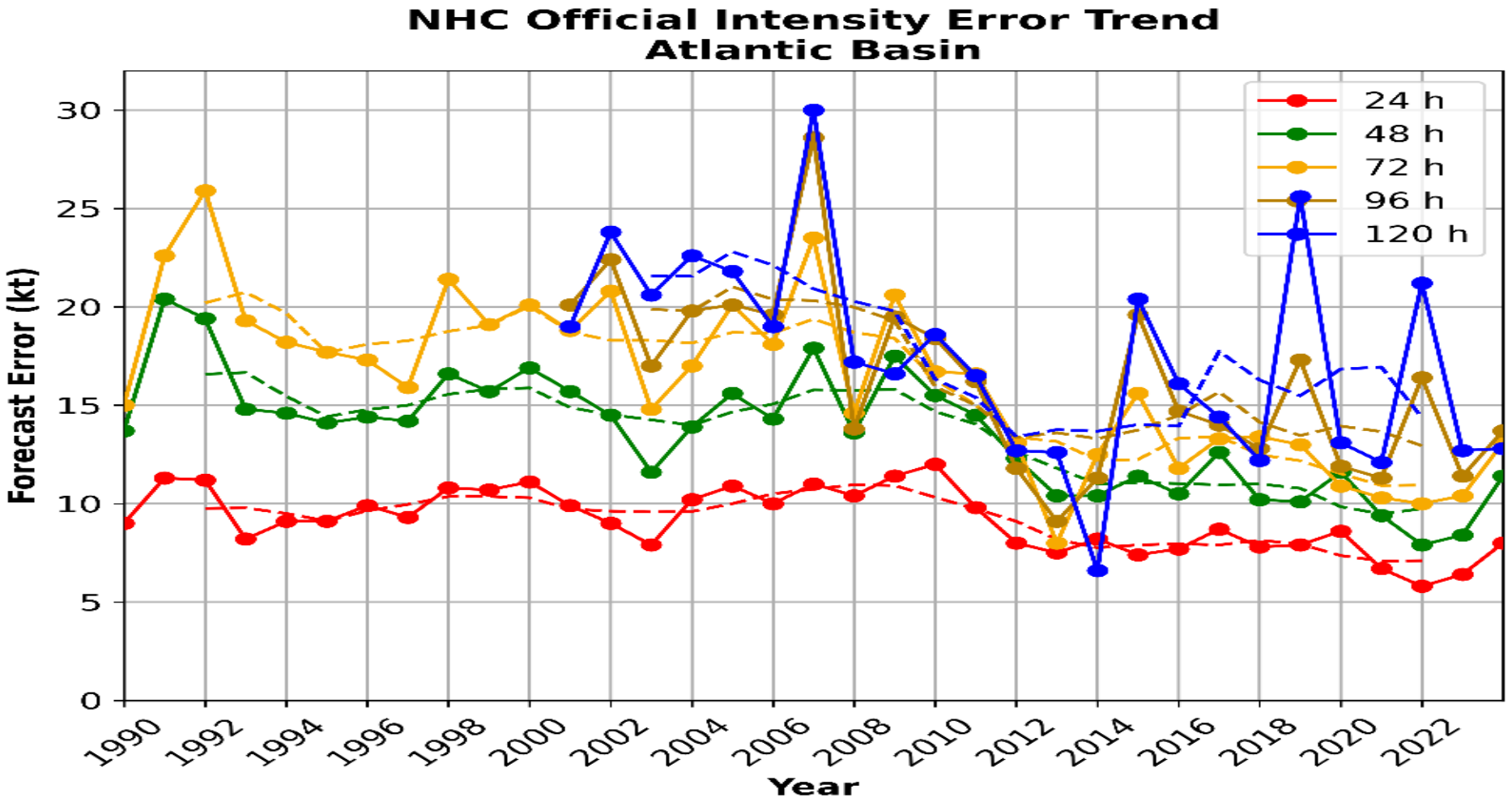


The Atlantic (from NHC/NWS Website)



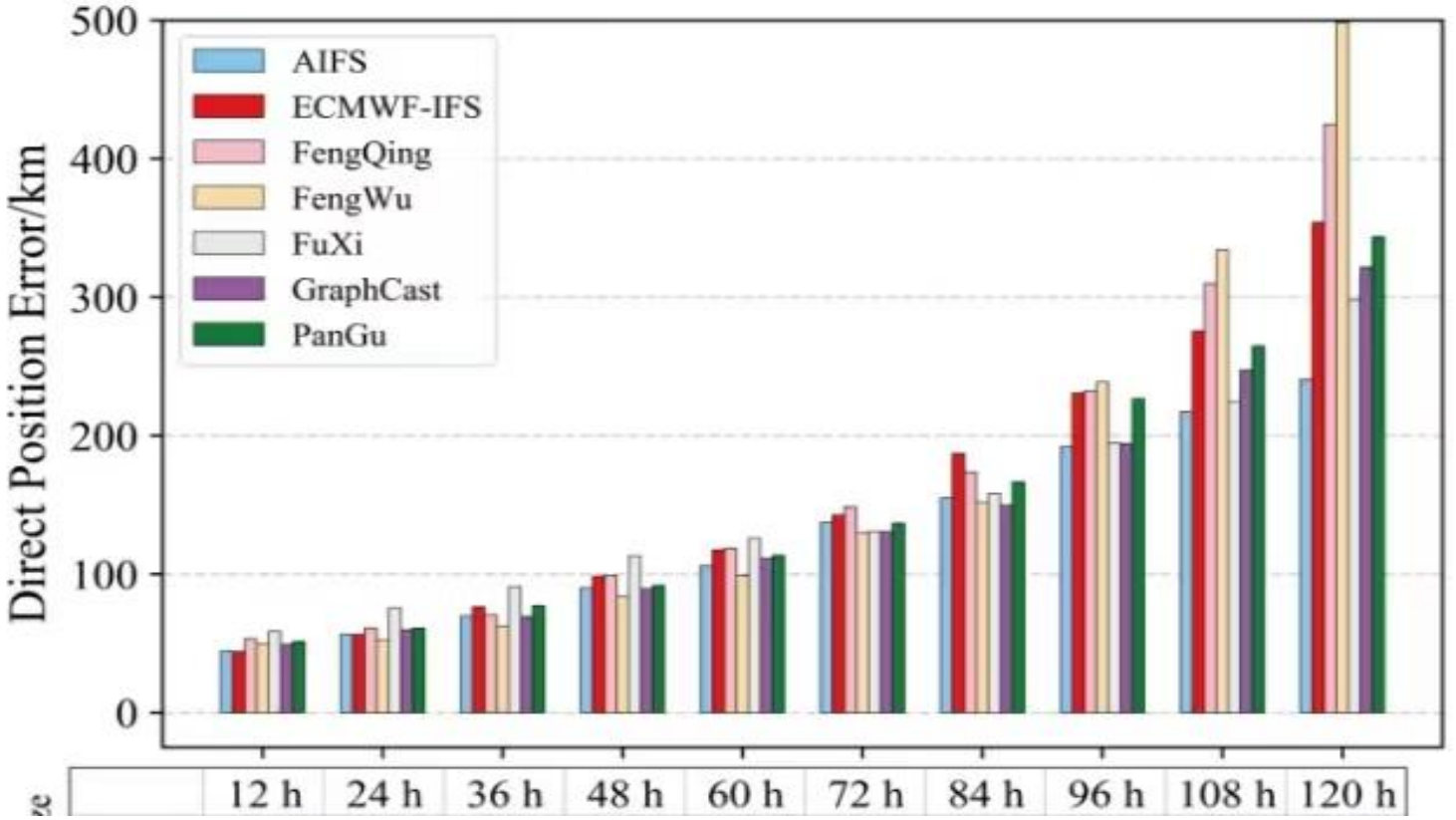
Time serious of tropical cyclone intensity forecast errors in the Northwest Pacific

Provided by Shanghai Typhoon Institute/CMA



Time serious of tropical cyclone intensity forecast errors in The Atlantic

(from NHC/NWS Website)

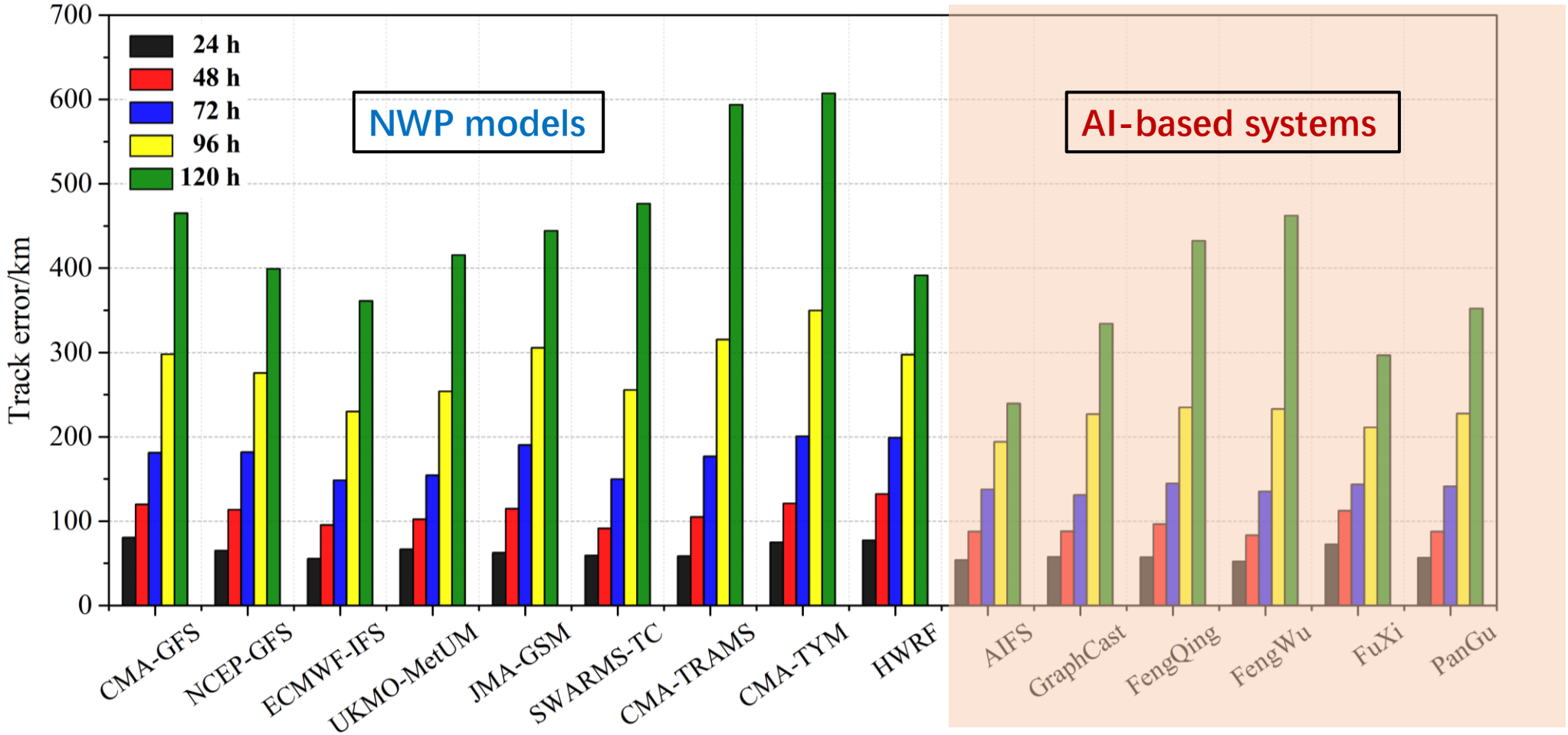


Bar chart of the average forecast errors in typhoon track prediction for ECMWF and AI-based system in 2024.

Provided by Shanghai Typhoon Institute/CMA

Challenges and Opportunities in Improving Typhoon Forecasting

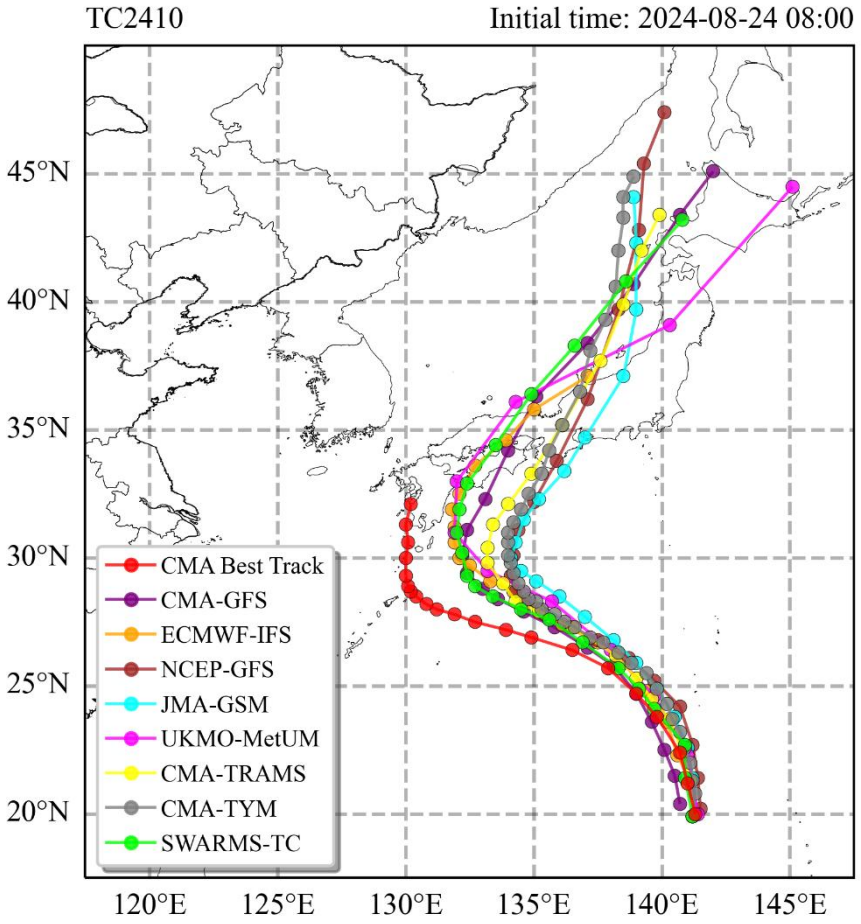
ESCAP/WMO Typhoon Committee



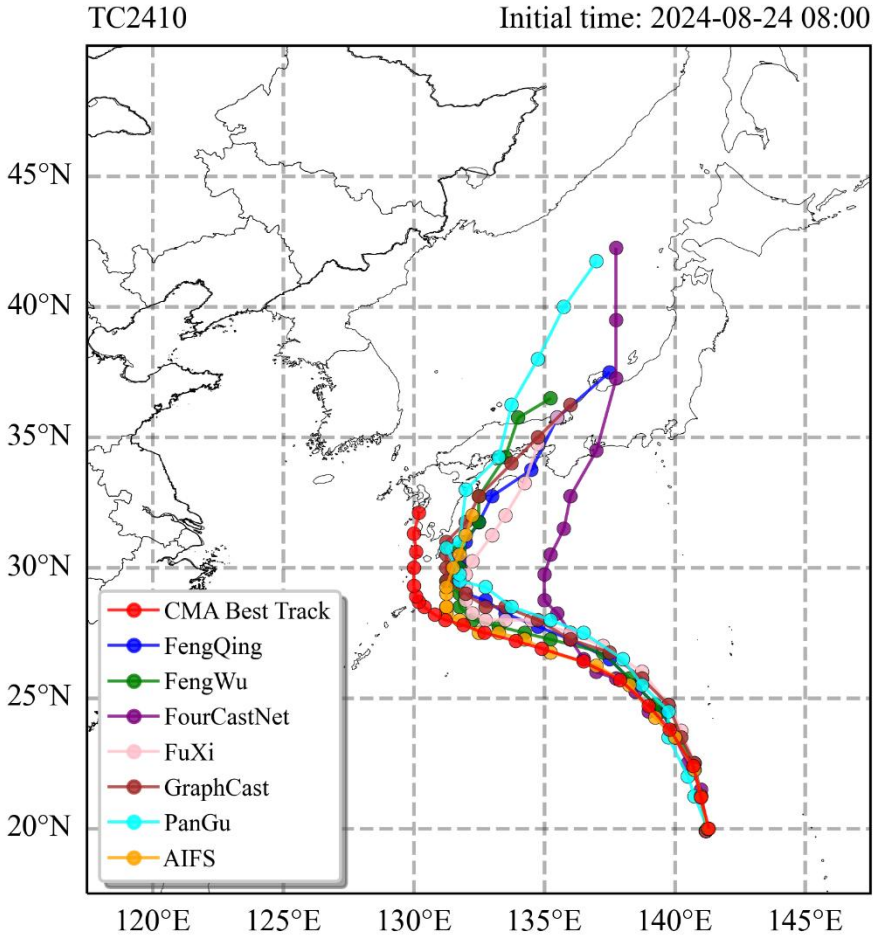
Bar chart of the average forecast errors in typhoon track prediction for global and regional numerical models and AI-based meteorological models in 2024.

Provided by Shanghai Typhoon Institute/CMA

NWP models



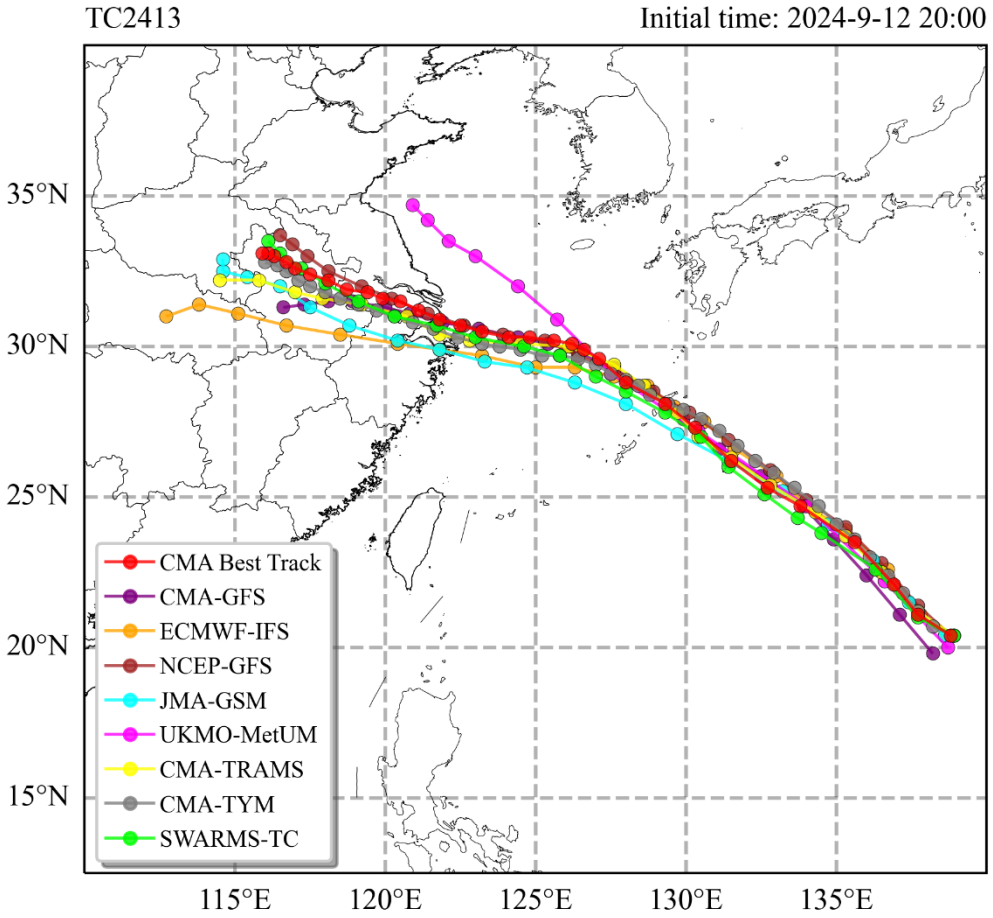
AI-model systems



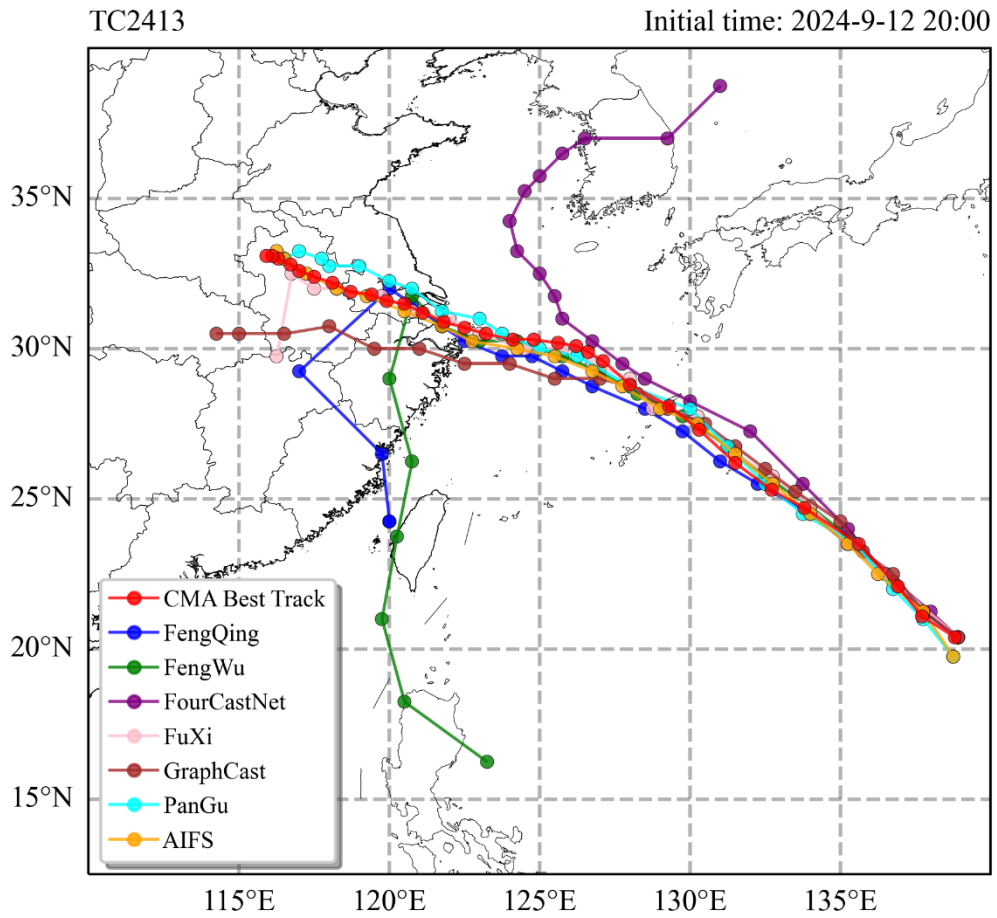
The prediction track of TC Shanshan (2410). The initial time at 08:00 on 24 August 2024

Result provided by Shanghai Typhoon Institute

NWP models



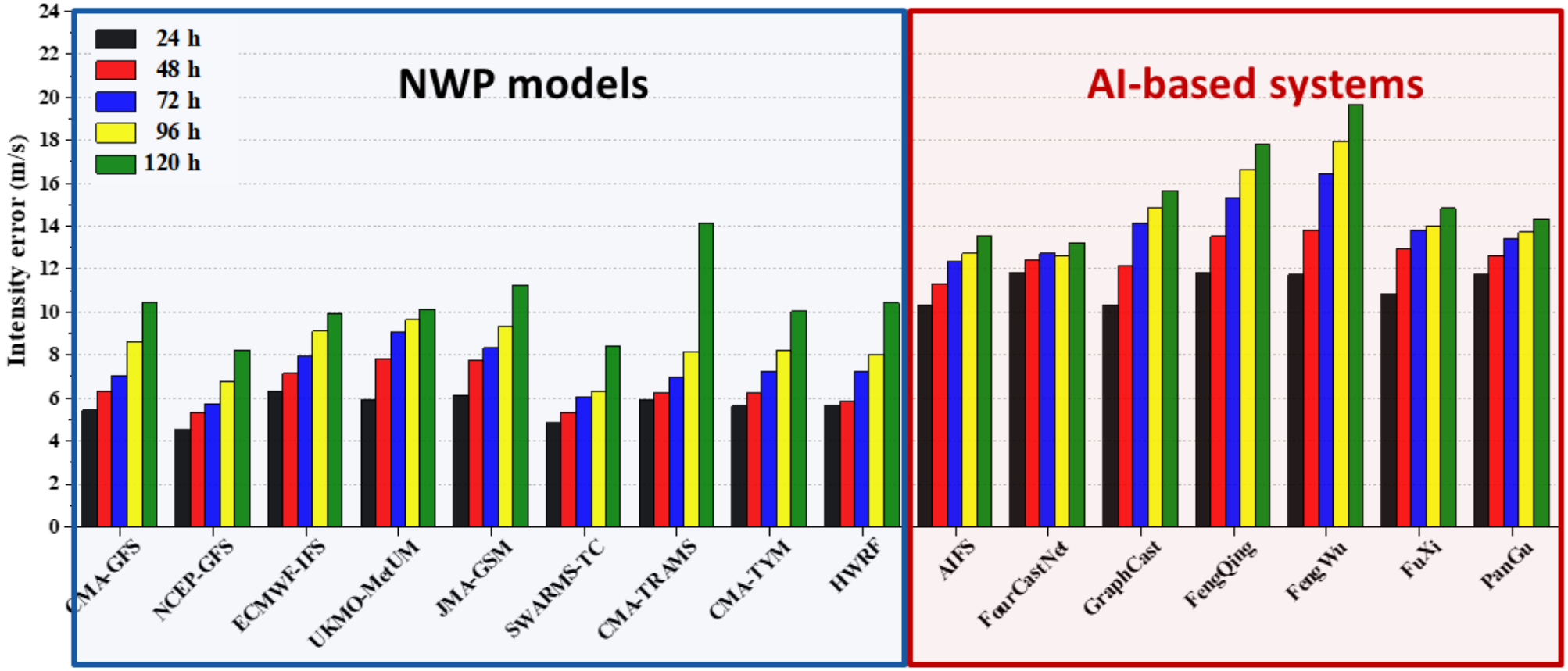
AI-model systems



The prediction track of TC Bebinca (2413). The initial time at 20:00 on 12 September 2024

Provided by Shanghai Typhoon Institute

Mean absolute intensity errors in 2024



Bar Chart of the Mean Absolute Error in Tropical cyclone Intensity in 2024

Provided by Shanghai Typhoon Institute/CMA

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Key Activities of the TC on AI Applications in Typhoon Science

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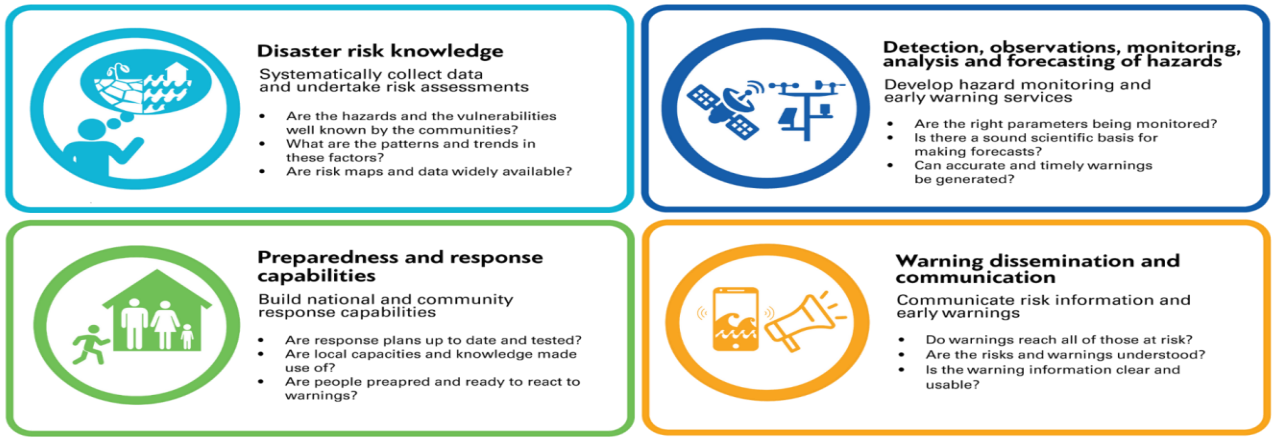
To address the challenge of **insufficient multi-hazard early warning systems**, the United Nations is spearheading the Early Warnings for All (EW4All) initiative to ensure everyone on the planet is protected by early warning systems by the end of 2027. EW4All is **co-led by WMO and UNDRR**, with the support of other agencies.



4 Pillars of EWS

At its 56th Session held in Kuala Lumpur, Malaysia in 2024, the Typhoon Committee decided to establish a project on Promoting Technical Exchange of AI Applications in Tropical Cyclone Analysis and Forecasting, with the aim of enhancing typhoon forecasting capabilities.

Kick-start Workshop for AI Applications in2024

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Typhoon Committee

- A kick-start workshop for the Project was held at the Hong Kong Observatory, Hong Kong, China, on 21-22 May 2024.

Kick-start Workshop for AI Applications in2024

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Typhoon Committee

- Experts from 11 Typhoon Committee Members, Chair of TRCG as well as TC Secretariat participated in the workshop. The workshop also invited leading AI development teams from WMO World Meteorological Centre, academia and information technology company to share the latest advancements in AI applications in weather forecasting.

- The participants engaged in technical sharing and in-depth discussions on the developments and applications of AI in tropical cyclone analysis and forecasting. Presentations covered objective analysis techniques of tropical cyclone, monitoring and forecasting extreme weather events, applications of data-driven models as well as verification.

- To better organize and implement this project, the Typhoon Committee established the Expert Team on AI Applications for Tropical Cyclone (ET-AITC)

The first face to face Meeting of the ET-AITC

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Typhoon Committee

The first face-to-face meeting of the Expert Team on AI Applications in Tropical Cyclone Analysis and Forecasting (ET-AITC) was held in Tokyo, Japan from June 24 to 26, 2025.

The first face to face meeting of the Expert Team (ET-AITC)

ESCAP/WMO
Typhoon Committee

- The meeting brought together leading meteorological experts and AI researchers from across the Asia-Pacific region to discuss and advance the integration of artificial intelligence into typhoon analysis and forecasting.
- The three-day event included presentations on the latest technological advancements in AI by expert team members and invited talks by renowned researchers from institutions such as the University of Cambridge, Huawei, and the ECMWF. The meeting also included discussions on verification results from recent typhoon cases, and the review of data exchange policies and requirements.
- The meeting also emphasized collaborative efforts, with discussions on potential partnerships with other World Meteorological Organization (WMO) initiatives. Participants outlined a comprehensive work plan for 2026–2027, focusing on enhancing the accuracy and efficiency of tropical cyclone forecasting through AI-driven methodologies.

Data Exchange Portal on AI Applications

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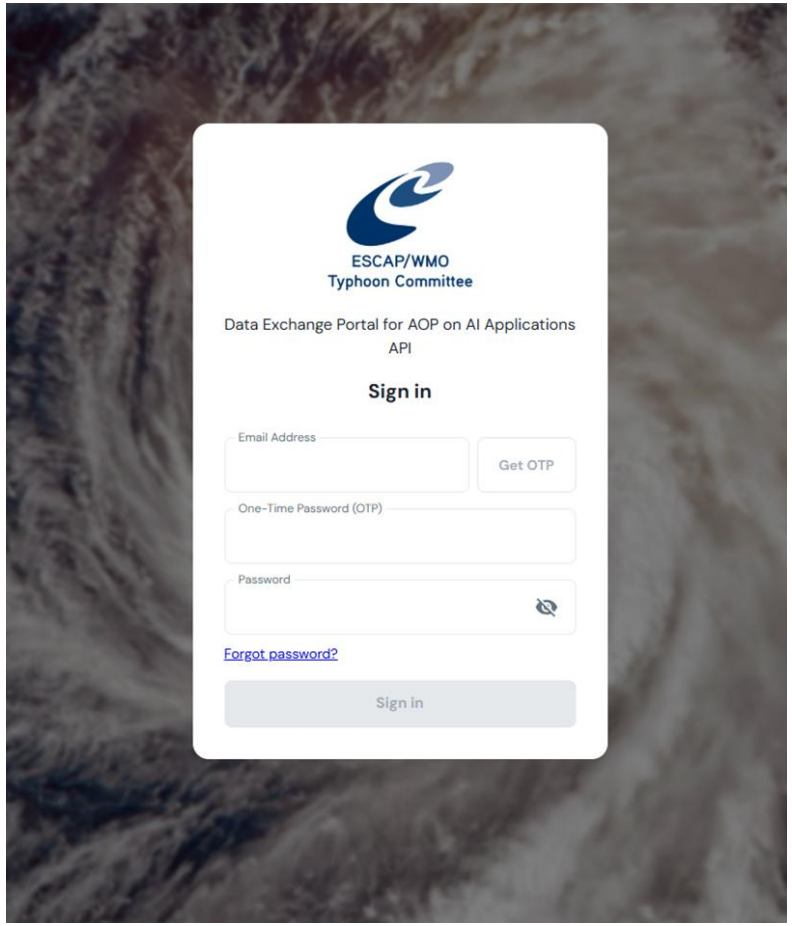
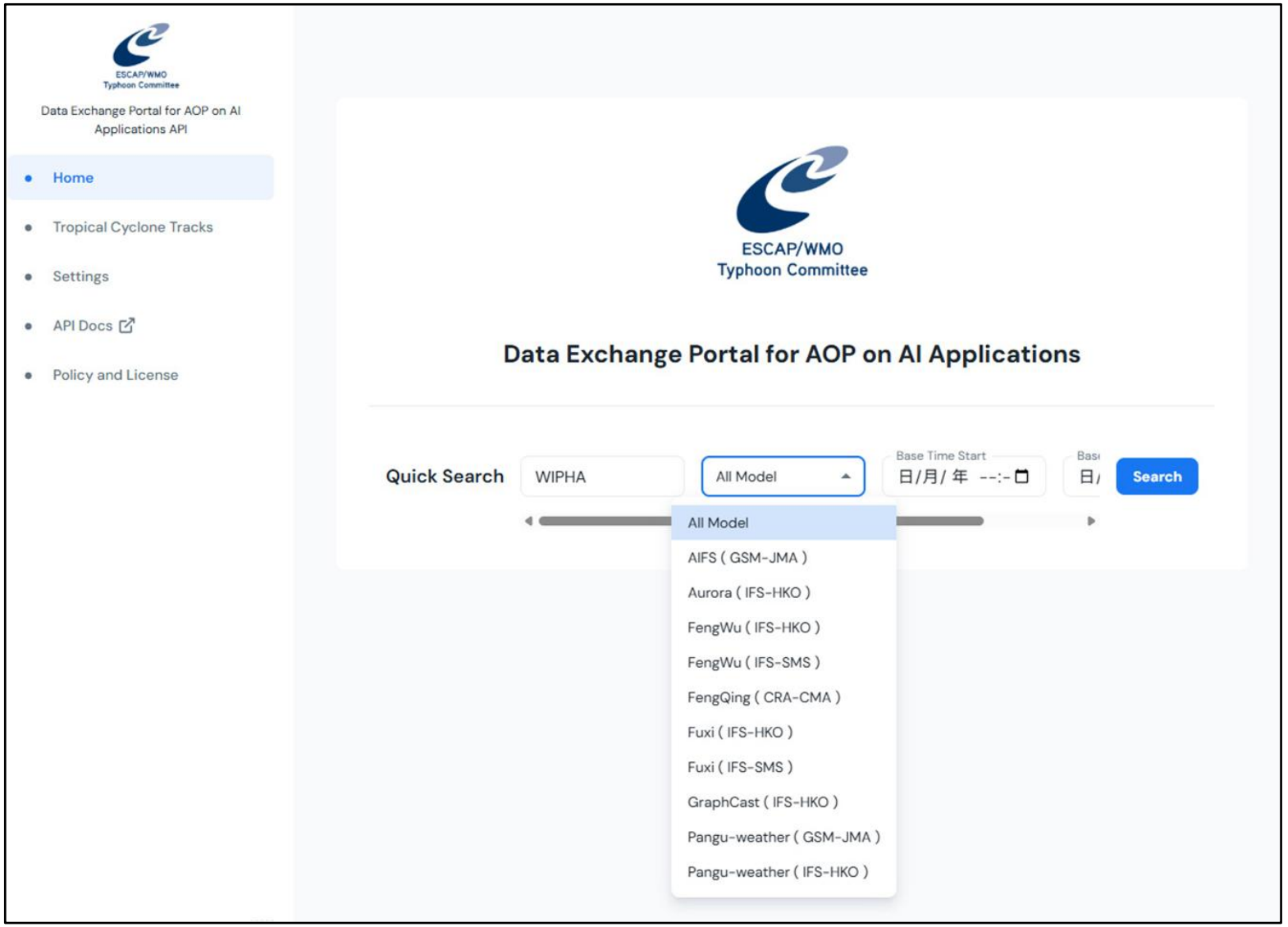
Typhoon Committee





Data Exchange Portal on AI Applications

ESCAP/WMO Typhoon Committee

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Data Exchange Portal for AOP on AI Applications API

- Home
- Tropical Cyclone Tracks
- Settings
- API Docs
- Policy and License

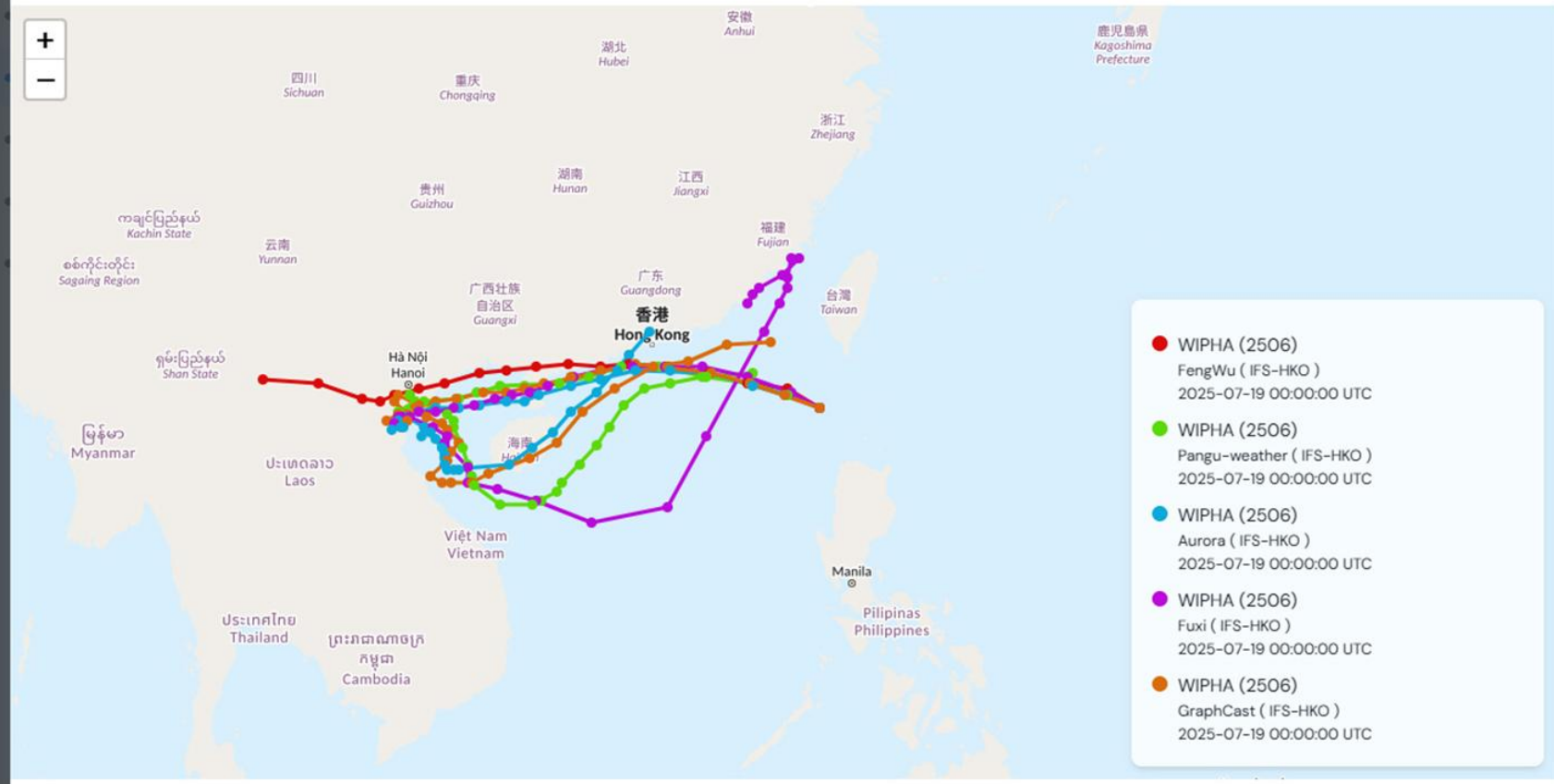
Tropical Cyclone Tracks

View Selected Tracks | Download Selected Tracks | Upload Track

Filters: WIPHA | All Model | Base Time Start 日/月/ 年 --:-- | Base Time End 日/月/ 年 --:-- | Apply Filters

Tropical Cyclone	TCID	Model (Init. Cond. - Contribu
WIPHA	2506	Pangu-weather (IFS-HKO)
WIPHA	2506	GraphCast (IFS-HKO)
WIPHA	2506	Fuxi (IFS-HKO)
WIPHA	2506	FengWu (IFS-HKO)
WIPHA	2506	Aurora (IFS-HKO)
WIPHA	2506	Pangu-weather (IFS-HKO)
WIPHA	2506	GraphCast (IFS-HKO)
WIPHA	2506	Fuxi (IFS-HKO)

Selected Tracks Map



The background geographical information in this page comes from OpenStreetMap. The use of OpenStreetMap is to aid users in appreciating the geographical location of the areas affected by tropical cyclones. This does not imply that information on the map is endorsed by the Hong Kong Observatory. The use of OpenStreetMap is subject to its License Terms.

The Status of AI Application in Hydrological Component

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WGH AOP2: Improvement of Hydrological Data Quality Control System by Using AI technology
WGH AOP3: Improvement of Flood Forecasting modelling by Using AI technology

Recent advancements in artificial intelligence (AI) have significantly improved hydrological data processing and flood forecasting within the hydrological domain. Key developments include:

- **Integration of multi-source data for real-time flood warnings and automated reporting**, reducing analysis time from minutes to mere seconds.
- **Application of digital twin technology** to enable dynamic simulations and optimize reservoir operations.
- **Fusion of radar-based rainfall data with coupled hydrological-hydrodynamic models**, leading to more accurate flood prediction.
- **Integration of meteorological, hydrological, and power grid data** to enhance the prediction of waterlogging risks in urban area.

Typhoon Committee Roving Seminar 2024

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- The Typhoon Committee Roving Seminar (TCRS) 2024 was successfully held in hybrid mode on 17 – 19 December 2024 in Bangkok, Thailand. It was organized Typhoon Committee and hosted by TMD. The theme of this Roving Seminar was on **Artificial Intelligence for Enhanced Tropical Cyclone Prediction and Emergency Response**

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Conclusions and Future Plan for 2025+

ESCAP/WMO Typhoon Committee

- AI is very promising to enhance our capacity on Typhoon-related disaster forecasting and warning; and to achieve our goal towards "Early Warnings for All".
- The AI application for tropical cyclone initiative will be a **Research-to-Operation** project in future:
  - ✓Data exchange of tropical cyclone forecast tracks (both real-time and non-real-time) from a number of data-driven models.
  - ✓Data or products provided by contributing Members.
  - ✓Verification and inter-comparison.
- Promoting application of data-driven models in tropical cyclone forecasting under WIPPS Pilot Project.
- Enhancing the cooperation with the AI research and developing communities.
- Organize the second AI application workshop in 2026.

THANK YOU

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