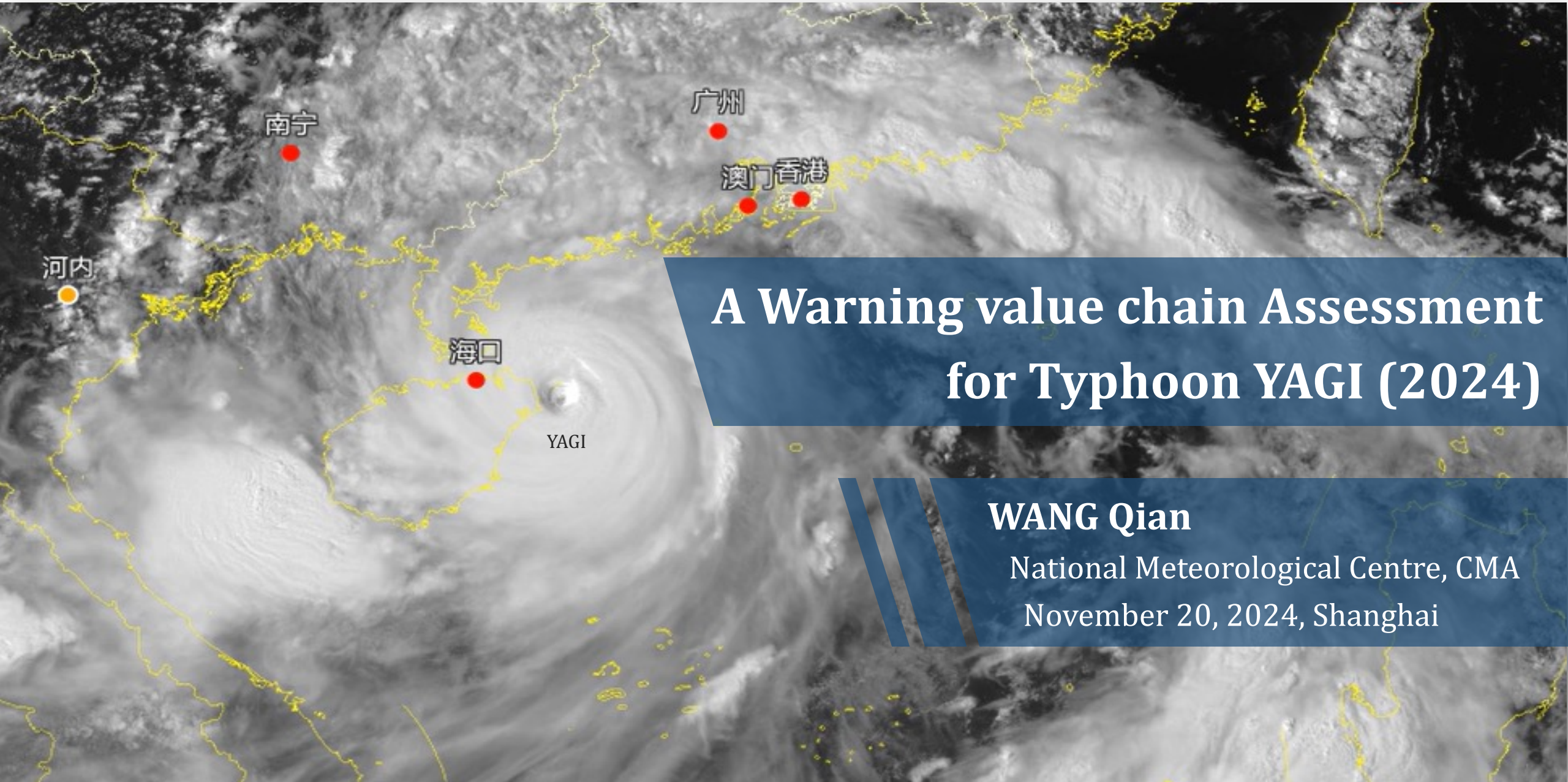


A Warning value chain Assessment for Typhoon YAGI (2024)

WANG Qian
National Meteorological Centre, CMA
November 20, 2024, Shanghai

MANGKHUT (1822)

Before

Famous spot for tourists in China.
Which expressed a beautiful prayer for forever love.

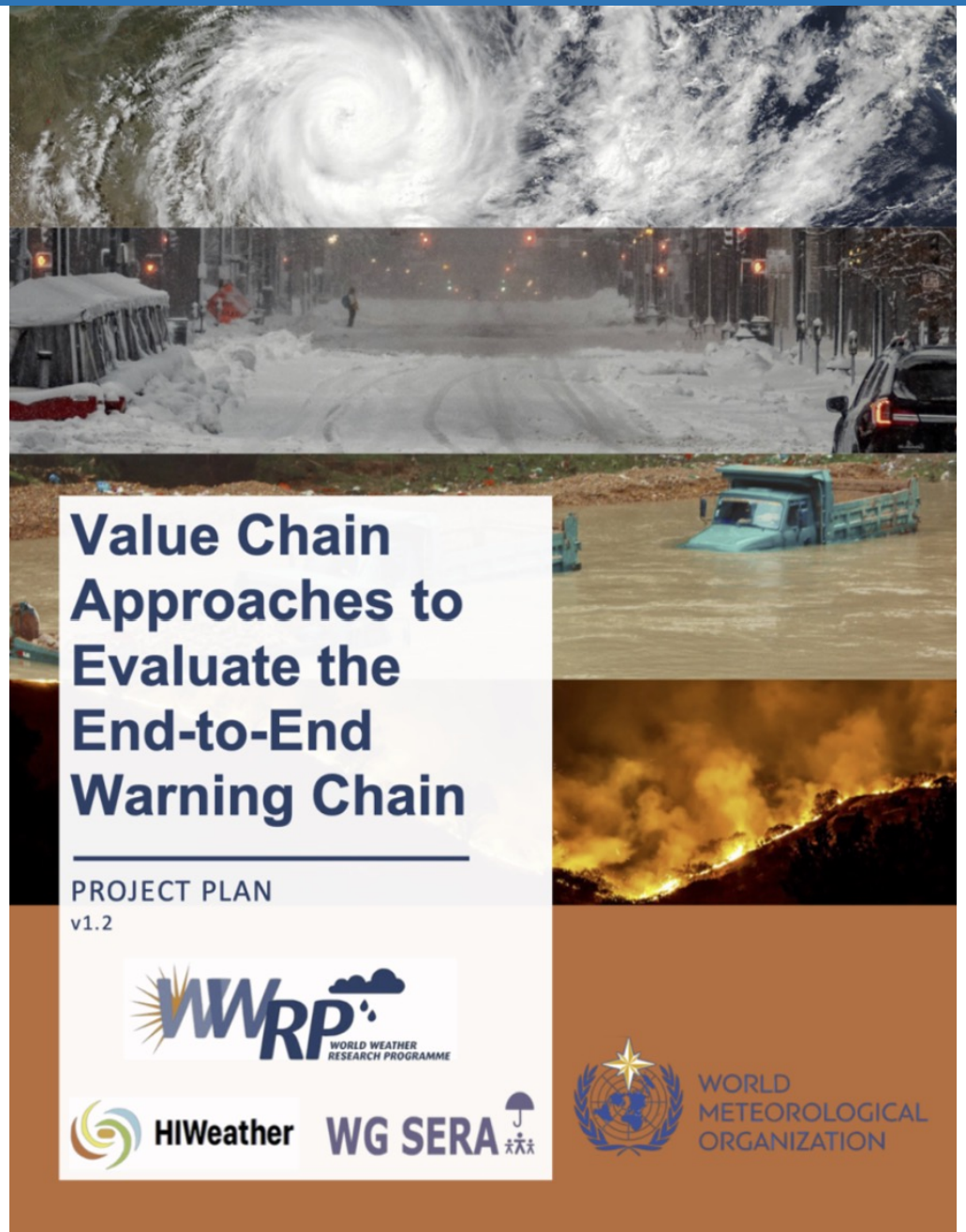
After

A sad story, perhaps another famous spot for singles.

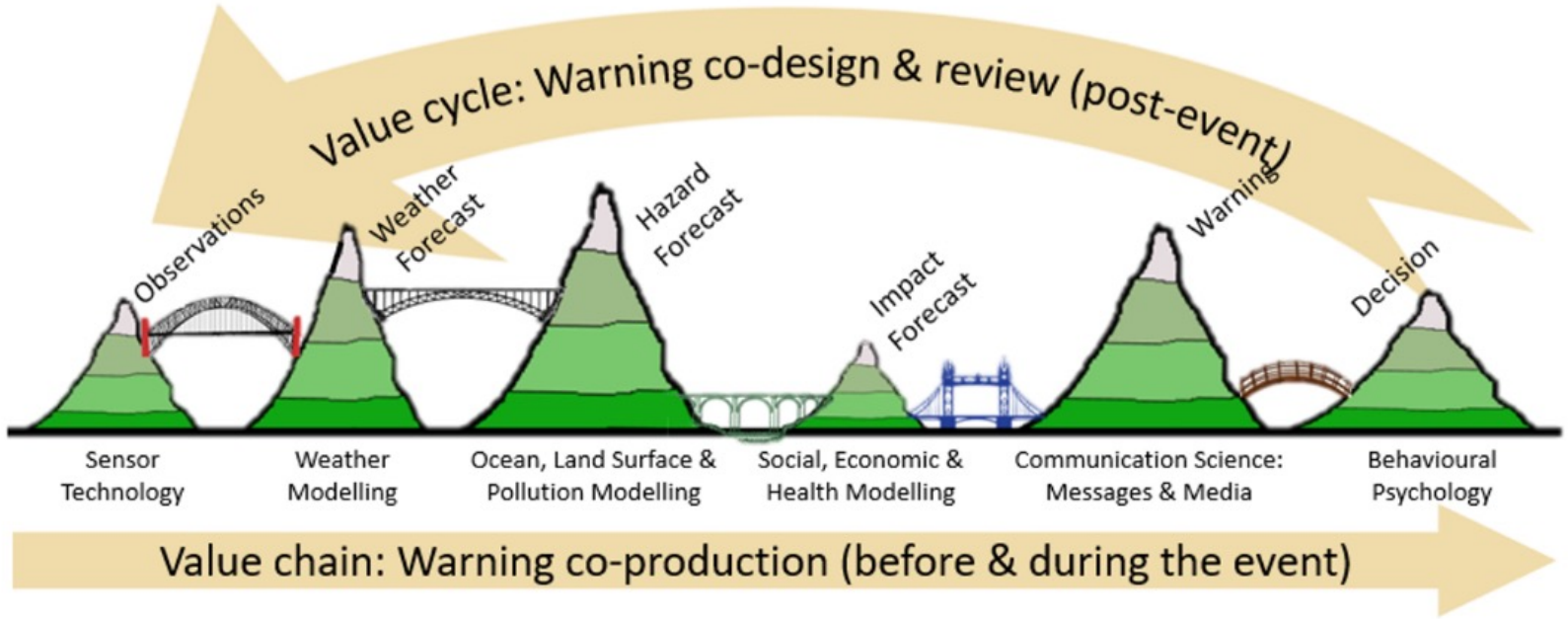
The value chain for high impact weather warnings

WORLD METEOROLOGICAL ORGANIZATION

HIWeather



The value chain for high impact weather warnings



(Golding, 2022)

This simplified view of the value chain for high impact weather warnings shows the capabilities and outputs (green "mountains“) where value is added, and information exchanges (**bridges** crossing the “valleys of death” where value is lost) linking the capabilities and their associated communities.

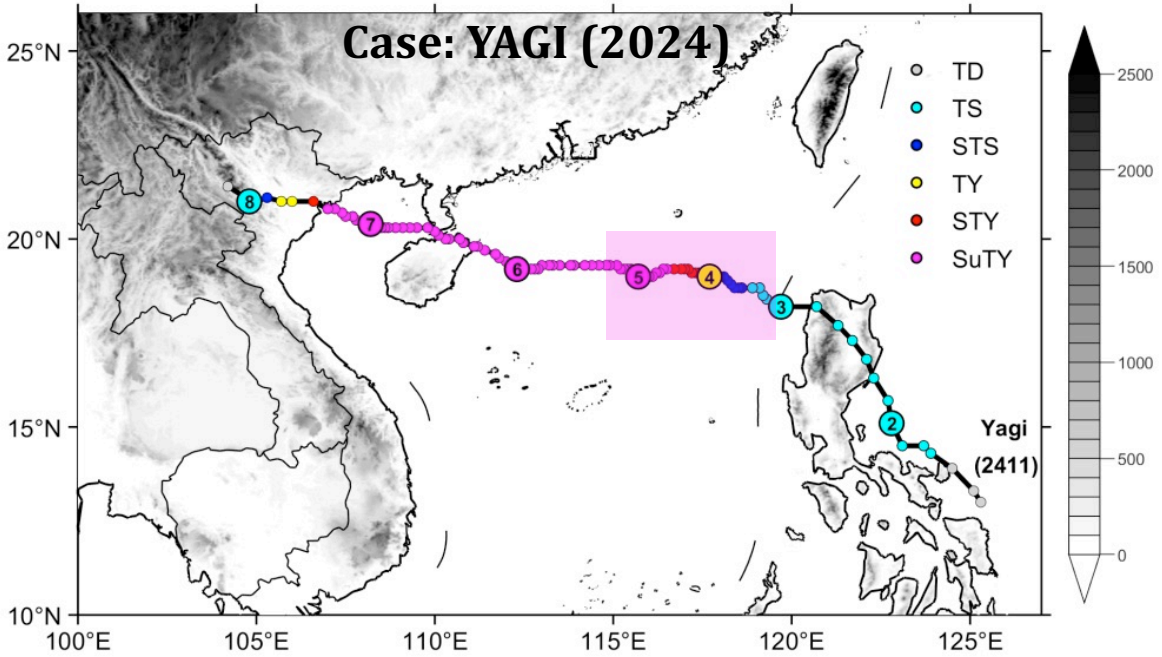
中央气象台
NATIONAL METEOROLOGICAL CENTRE

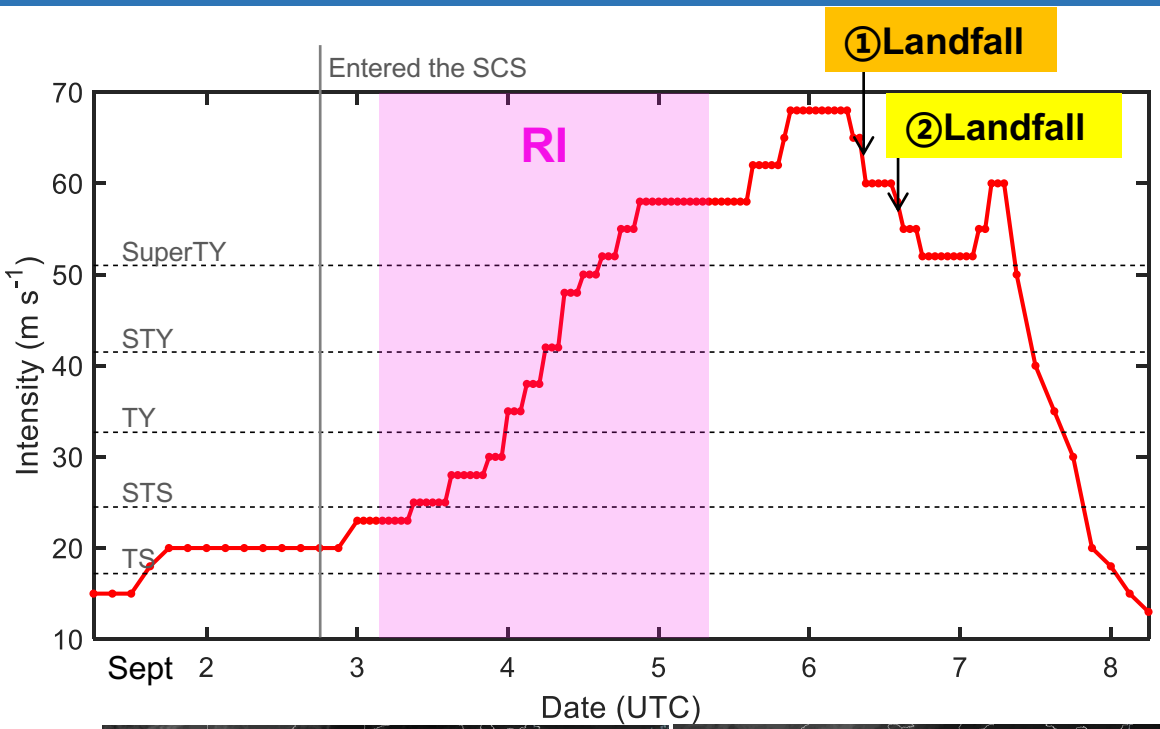
Contents

Part 1: Essential information

- Brief introduction of YAGI
- Main characteristics

1.1 Brief introduction of YAGI

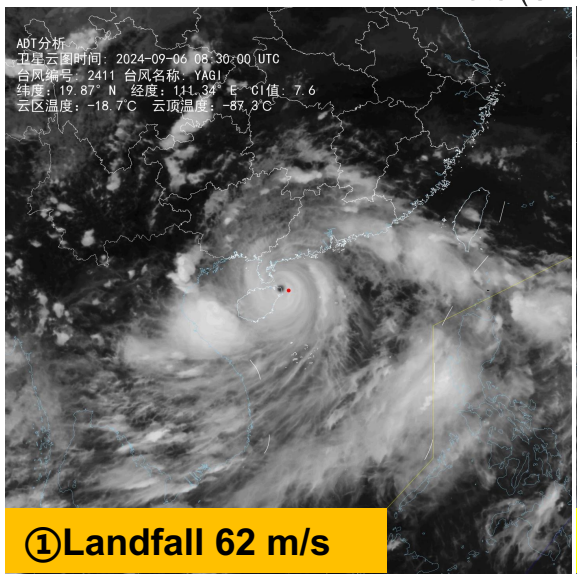


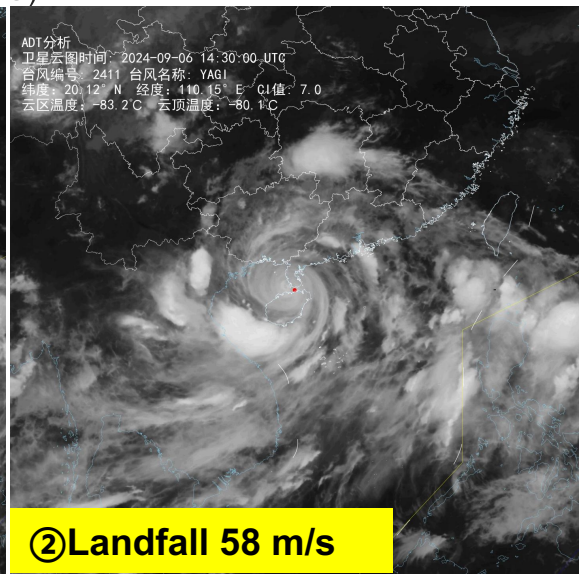


- **CMA timely upgrade the warning levels and issue the red typhoon warning** (46 hours ahead of Landfall)

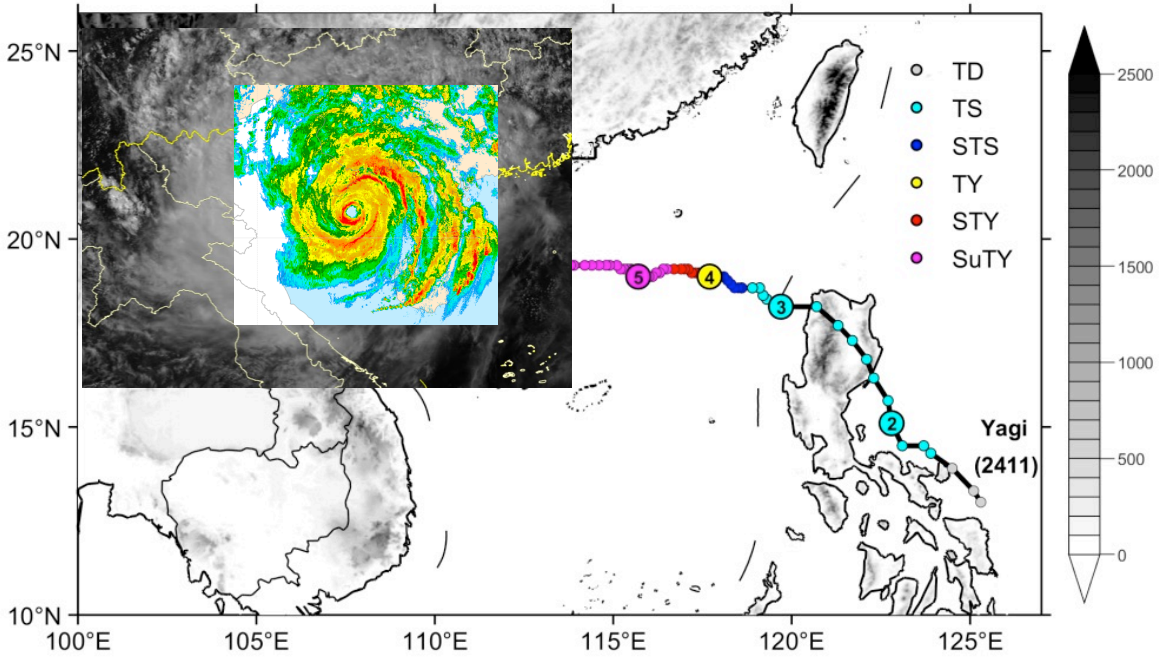
10:00 3rd → 18:00 3rd → 06:00 4th → 18:00 4th

Level II Emergency response in CMA
Level I Emergency response in Guangdong and Hainan Meteorological Service



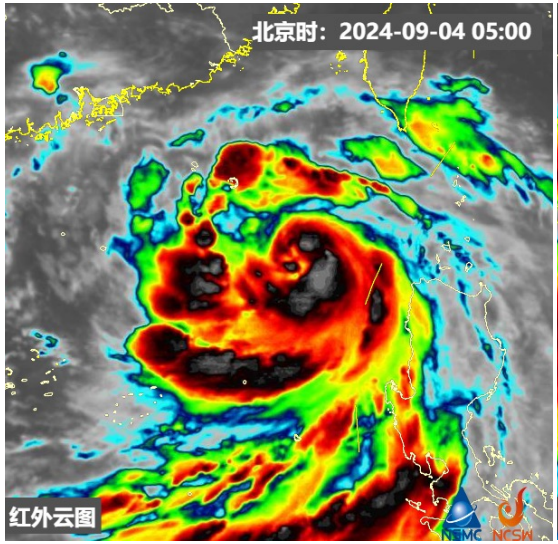


1.2 Characteristics

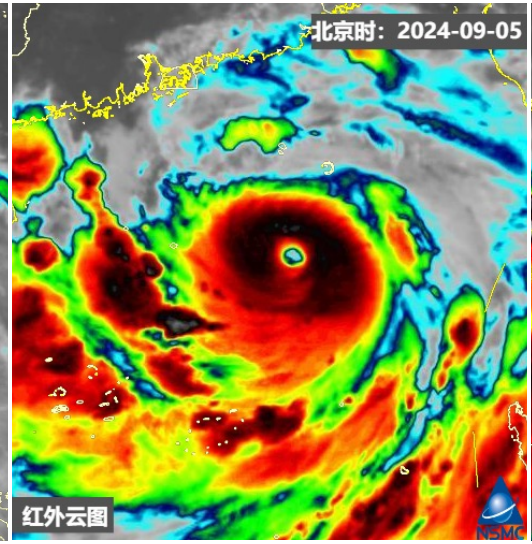


I. Extremely strong when landfalling

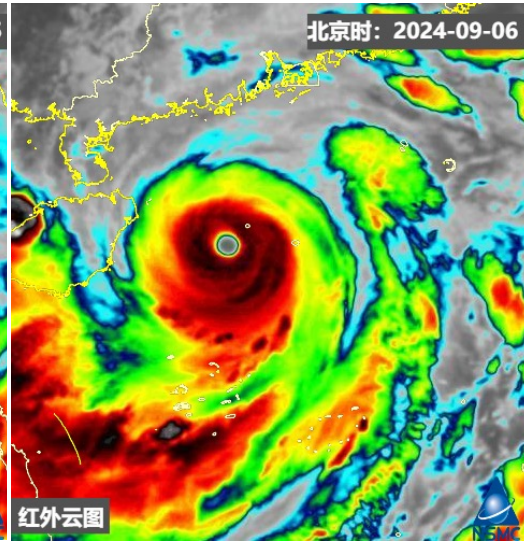
- YAGI made 1 landfall in Phillippines, 2 times in China, and 1 in Vietnam，among them 3 landfalling with intensity of **SuperTY**.
- YAGI is strongest landfall TC of China in Autumn (SON) in the history, and also the strongest typhoon in Beibu Gulf.



4 Sept. STS 30 m/s



5 Sept. SuperTY 58 m/s

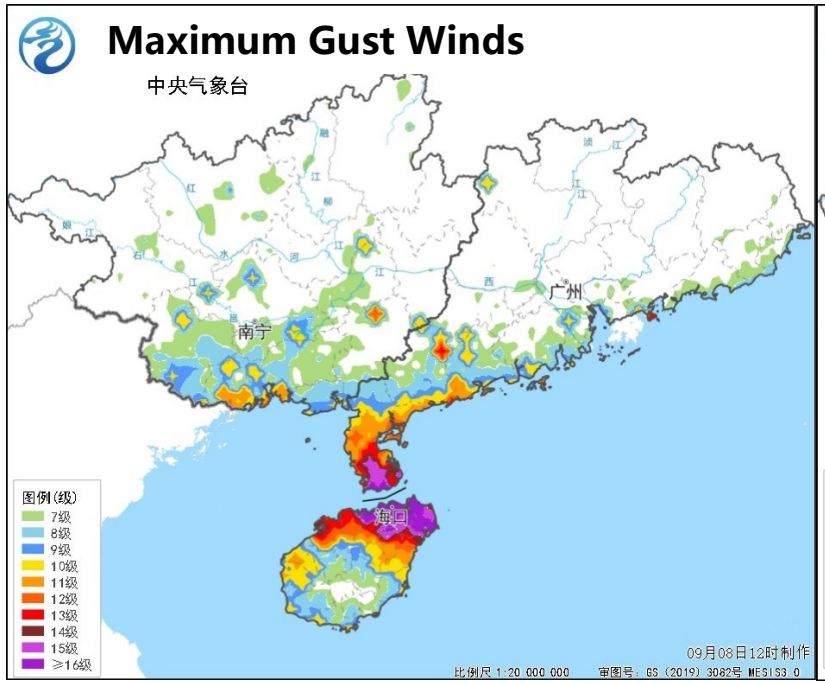


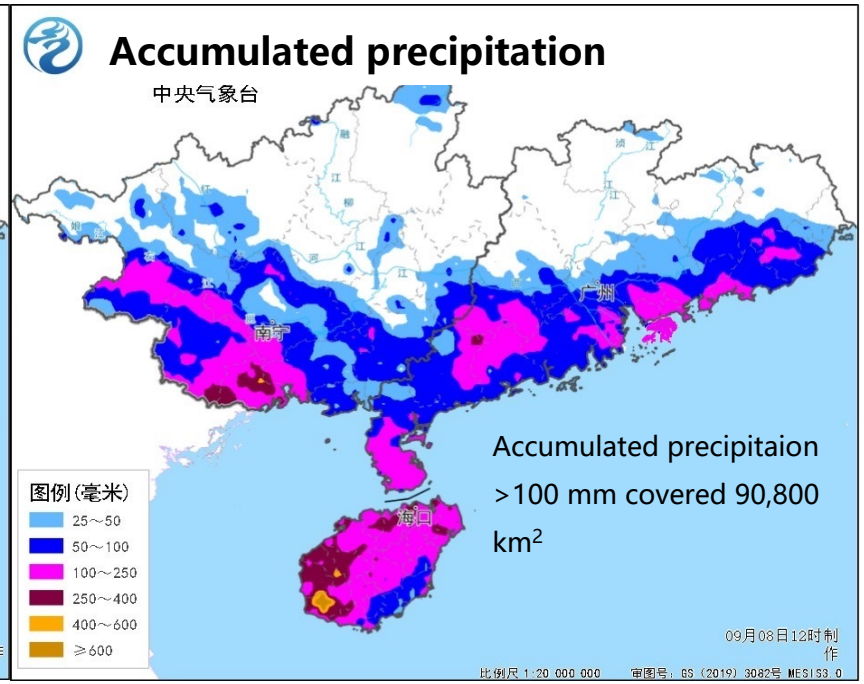
6 Sept. SuperTY **68 m/s (LMI)**

II. RI & long-lasting SuperTY

- YAGI underwent **RI**
- the period of **SuperTY lasted for 64 hours** before its final landfall in Vietnam

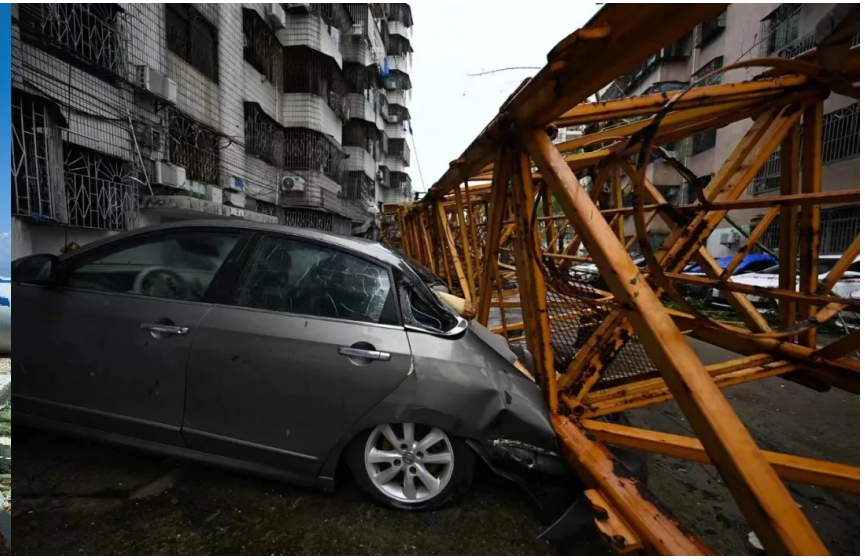
1.2 Characteristics





III. widespread of rainfall, extraordinary gust winds

- The maximum gust wind **66.7 m/s** in Longlong, Wenchang (land) and **68.6 m/s** in oil platform of Wenchang (sea)
- The maximum is **691.2 mm** in Ledong, Hainan



IV. Extremely destructive and significant impacts

- Yagi severely impacts urban operation, infrastructure, transportation, agricultural production, ecological environment, etc.

After YAGI (2024) passed by...

After YAGI (2024) passed by...

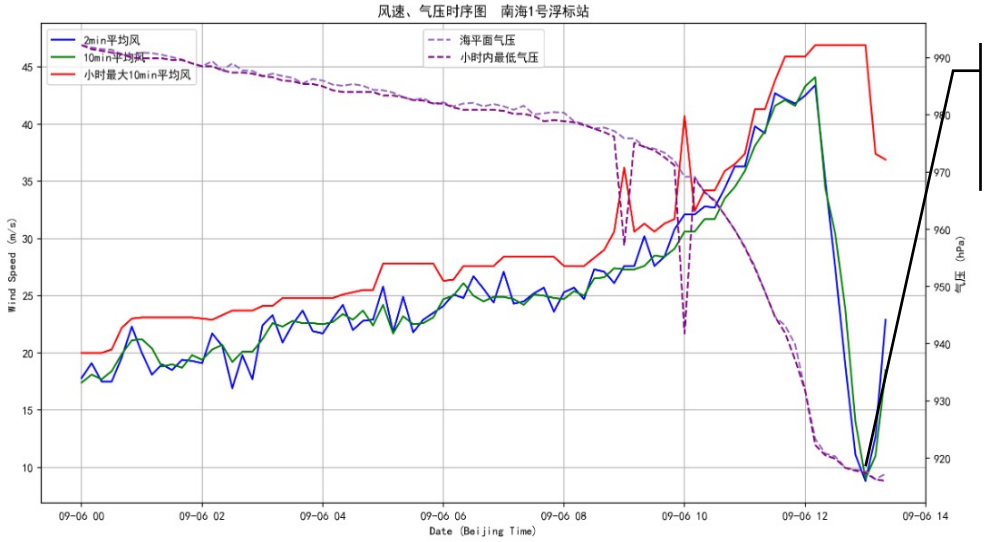
After YAGI (2024) passed by...

Part 2: Supplementary information about the warning chain

- Observations
- Weather forecasts
- Hazard forecasts
- Impact forecasts
- Warning communication
- Warning response

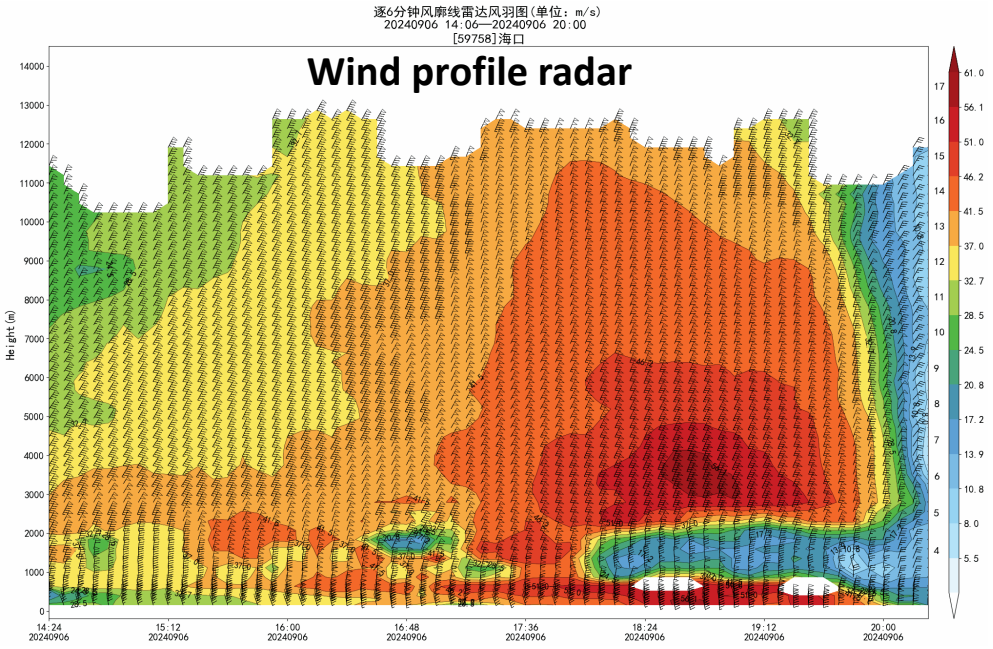
2.1 Observations

Coastal AWS stations and buoy
2-min averaged sustained wind (14th Sept.)



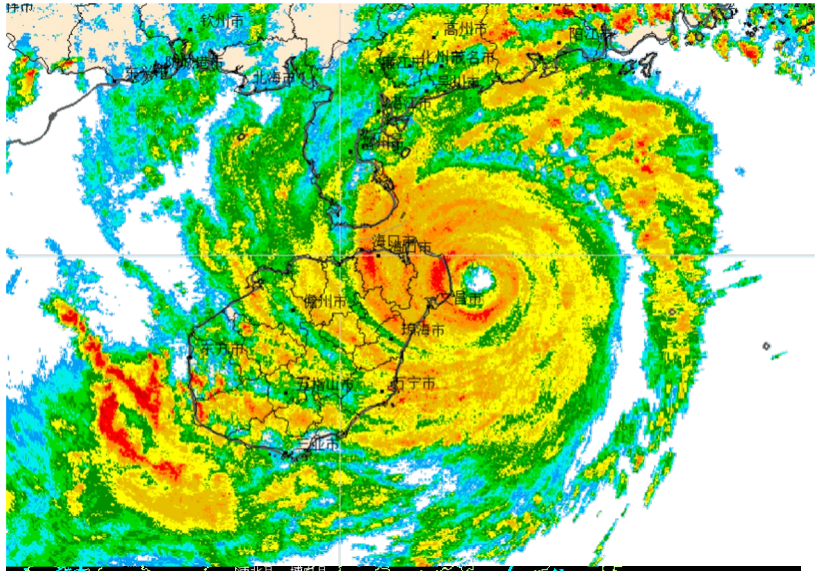
Gust: 65.8 m/s

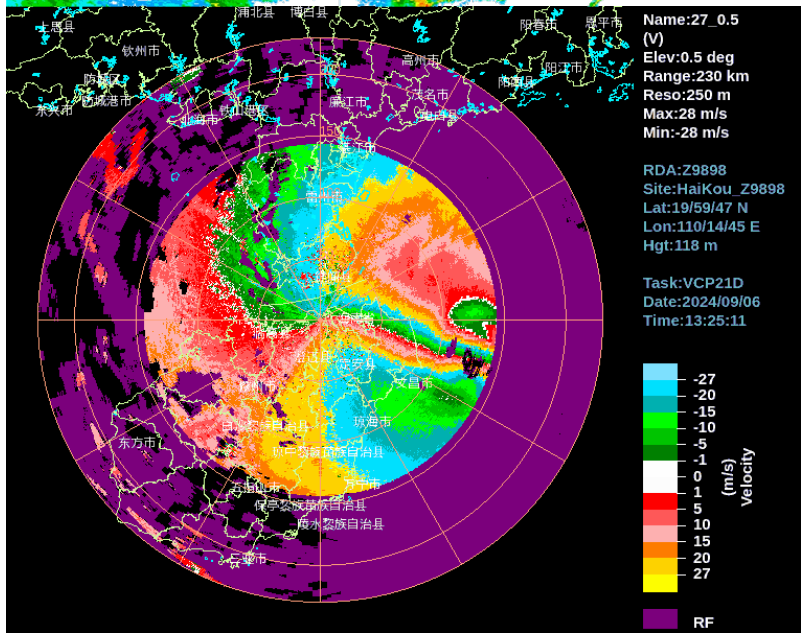
SLP: 916 hPa



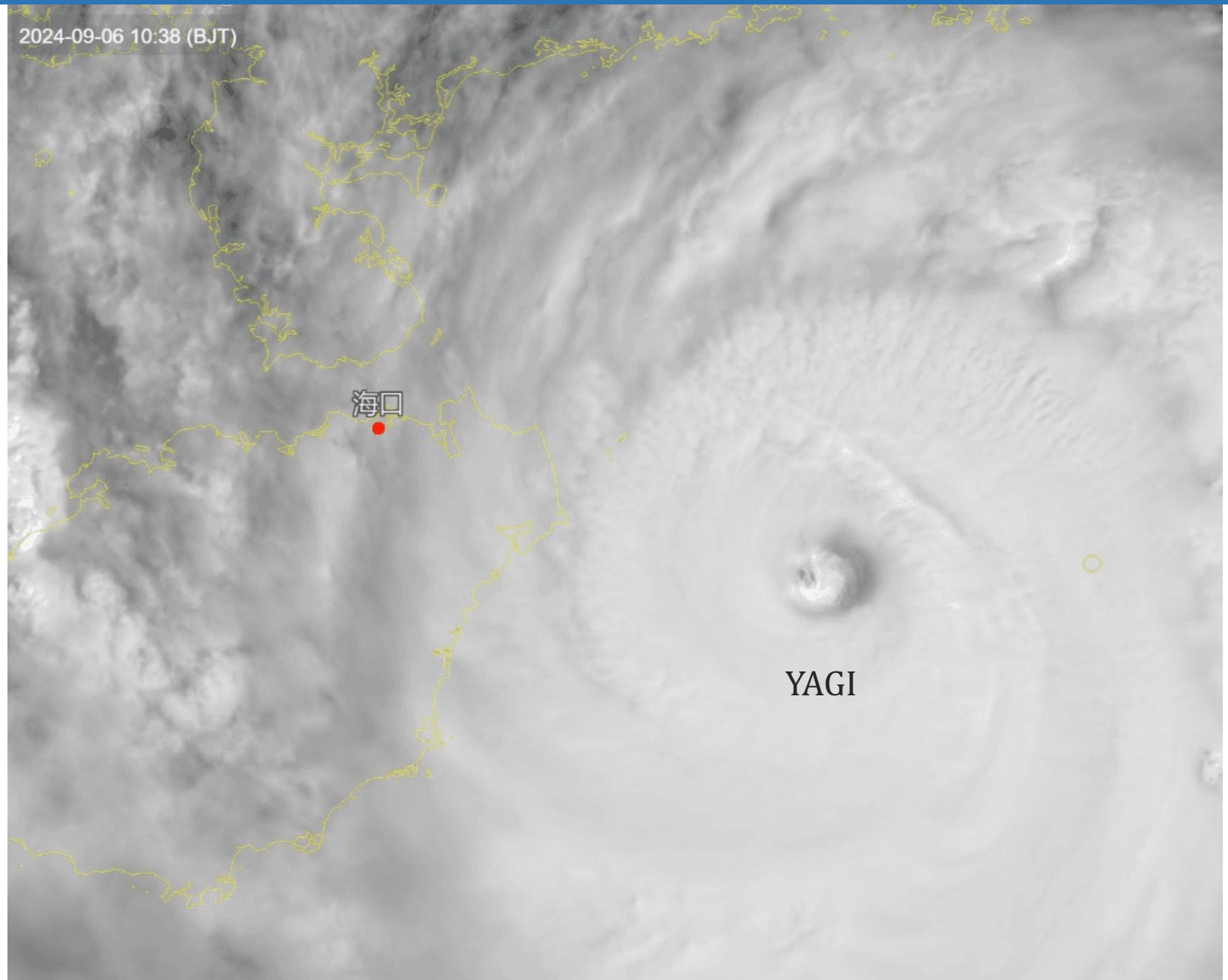
- ✓ Based on the multi-source observations, the peak intensity of YAGI is captured, as well as the destructive gale distribution.

Radar monitoring network
combined reflectivity & radial velocity



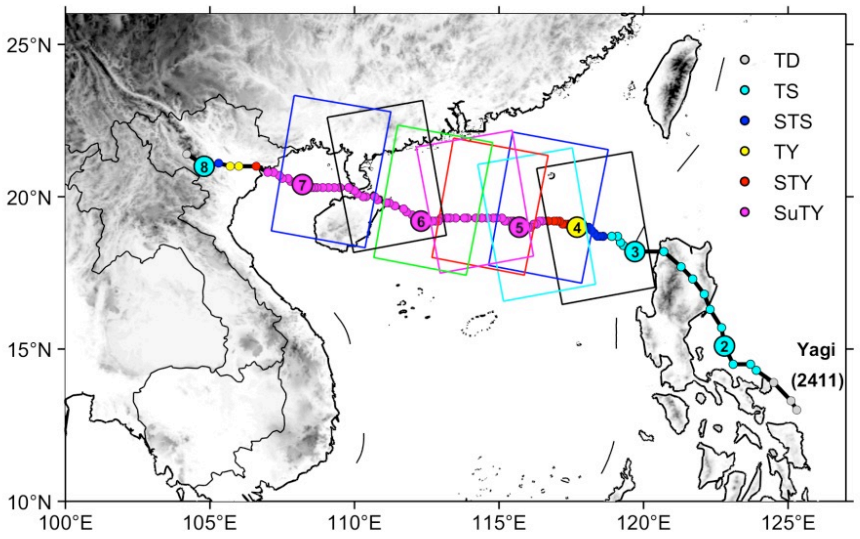


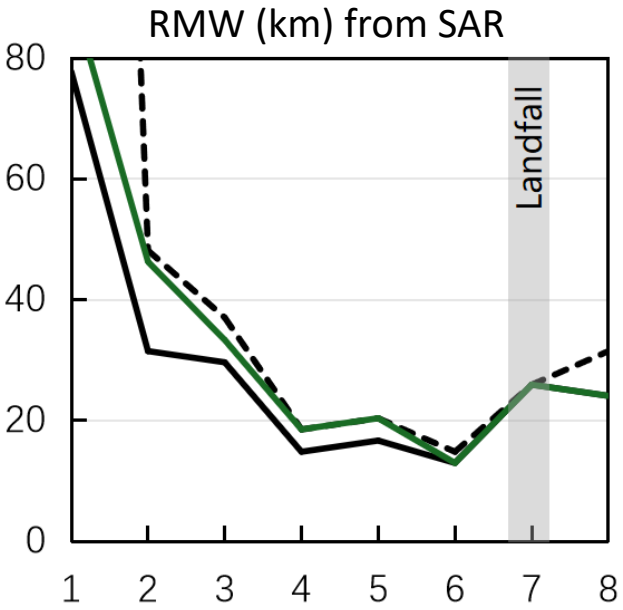
2.1 Observations

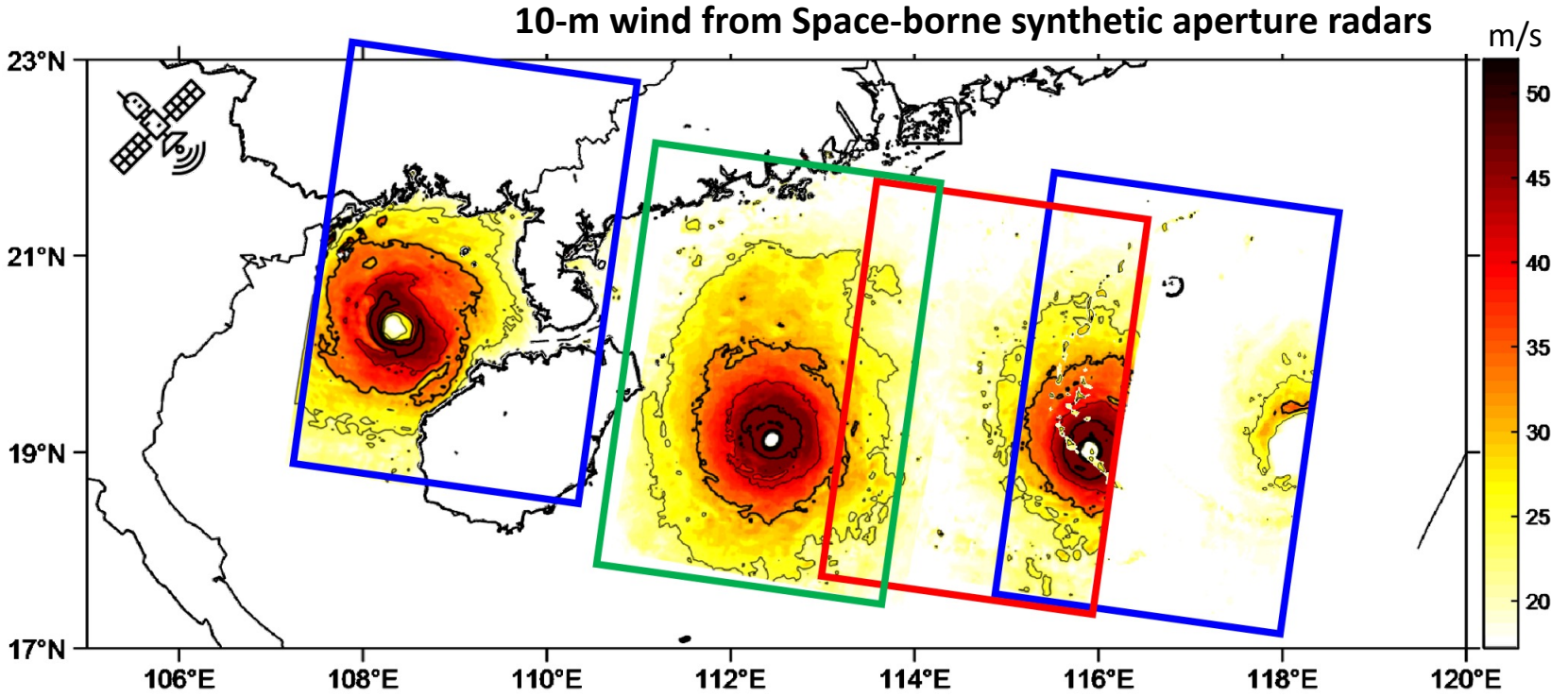


FY4B rapid monitoring

2.1 Observations





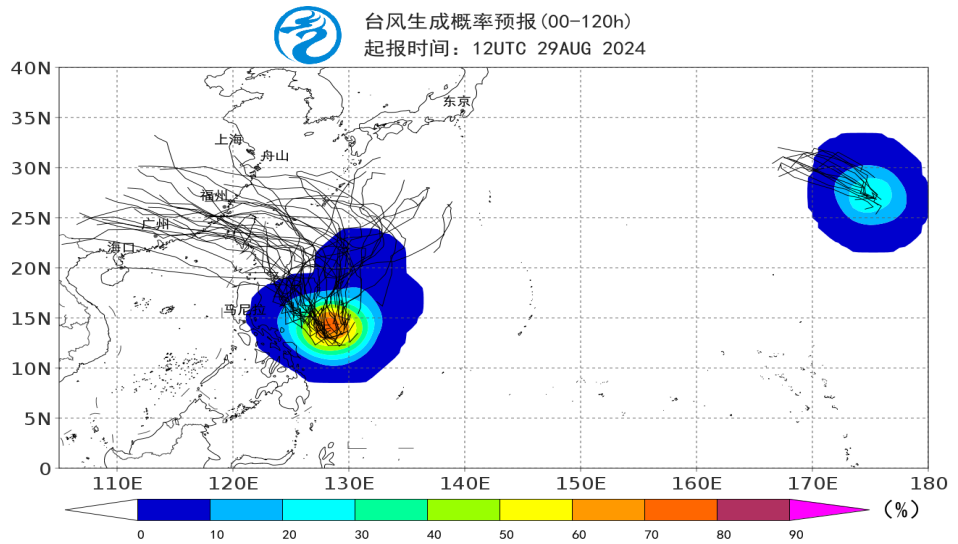


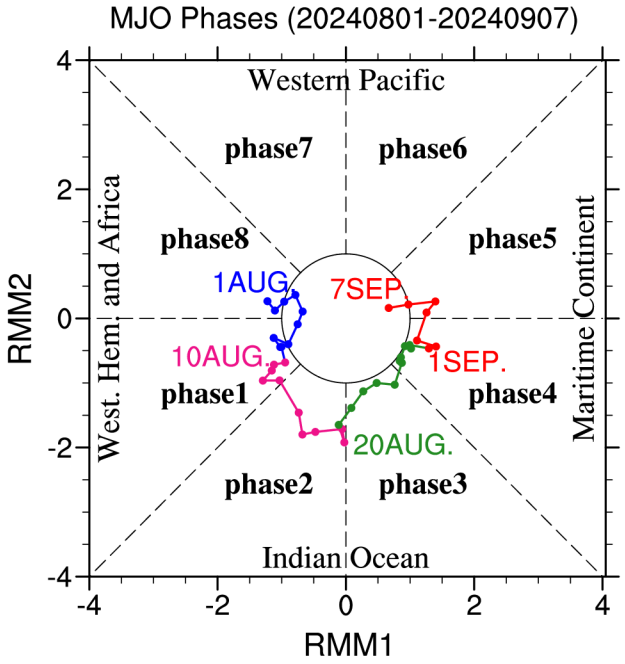
- ✓ **Observations with high spatial and temporal resolution are used to analyze the TC intensity and structure**
- ✓ **We pay special attention to the evolution of TC inner core based on multi-source observations.**

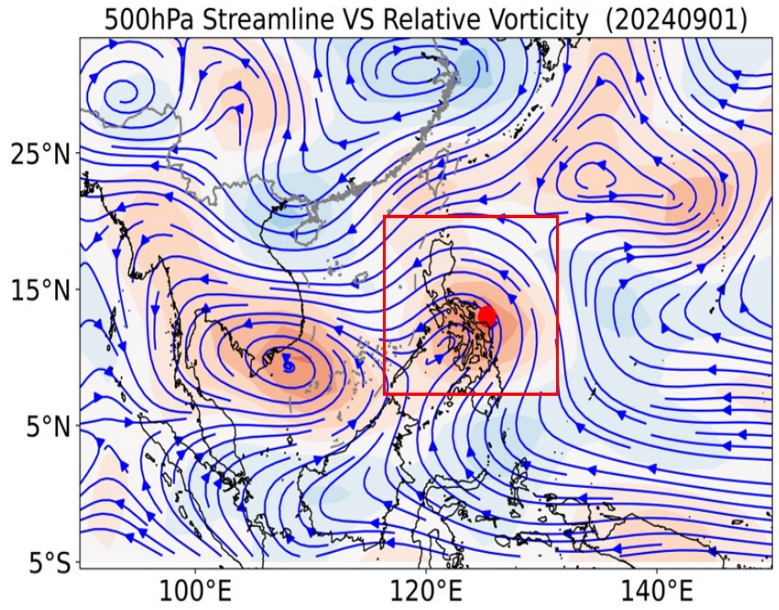
2.2 Weather forecasts

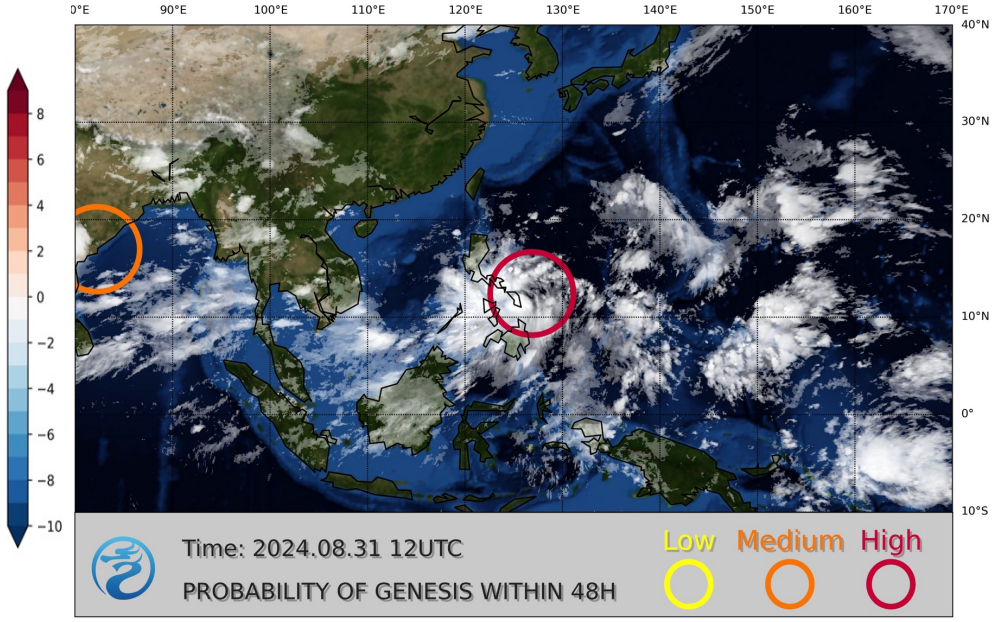
✓ Formation Alert

- 29 Aug, pay attention to the tropical disturbance east of the Phillippines. The "*Typhoon Formation Potential Forecast*" was released 4 days in advance.
- 31 Aug, genesis probability within 48 h is **High**
- 1 Sept, TD bulletin









2.2 Weather forecasts

✓ Typhoon bulletin

- 06:00 on 3 Sept

"Landfall along the coast from the eastern part of Hainan Island to the western part of Guangdong from the afternoon to the night of the 6 Sept"

(**Accurate forecast of the landing site 82 h in advance**)

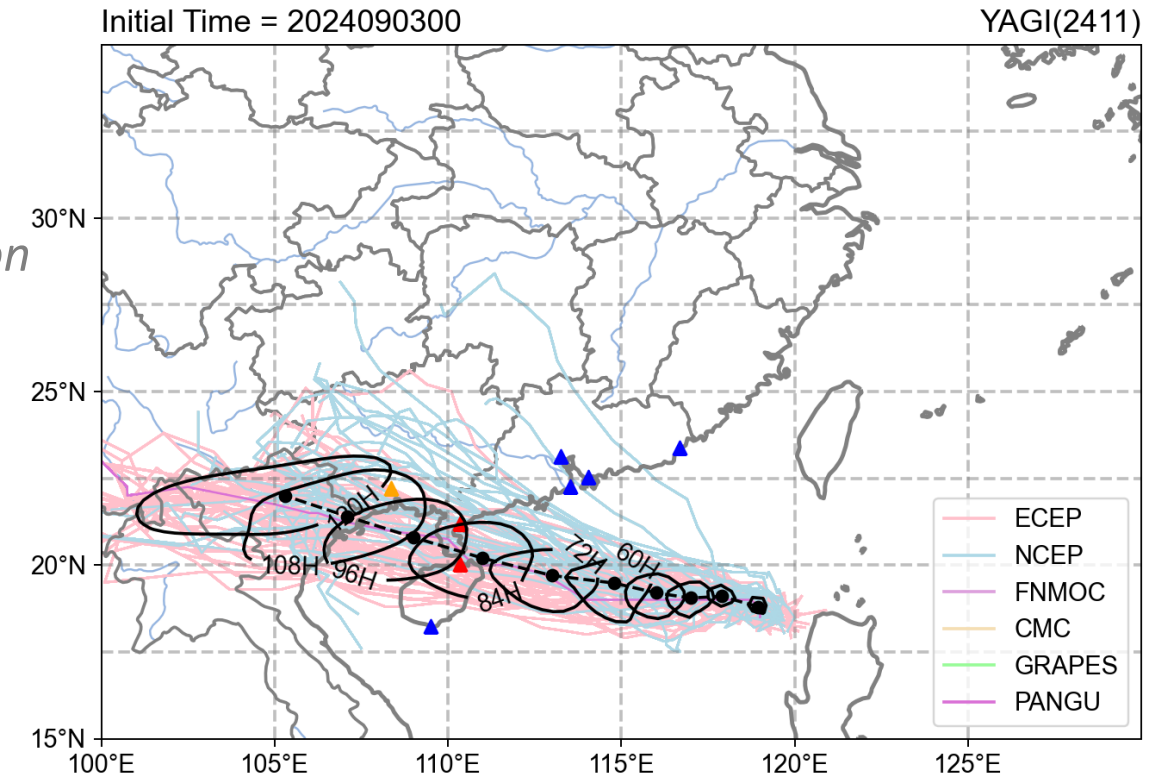
- 06:00 on 4 Sept

"The intensity may reach the super typhoon level when it makes landfall"

(**Accurate landing intensity catagory 58 h in advance**)

- 18:00 on 5 Sept

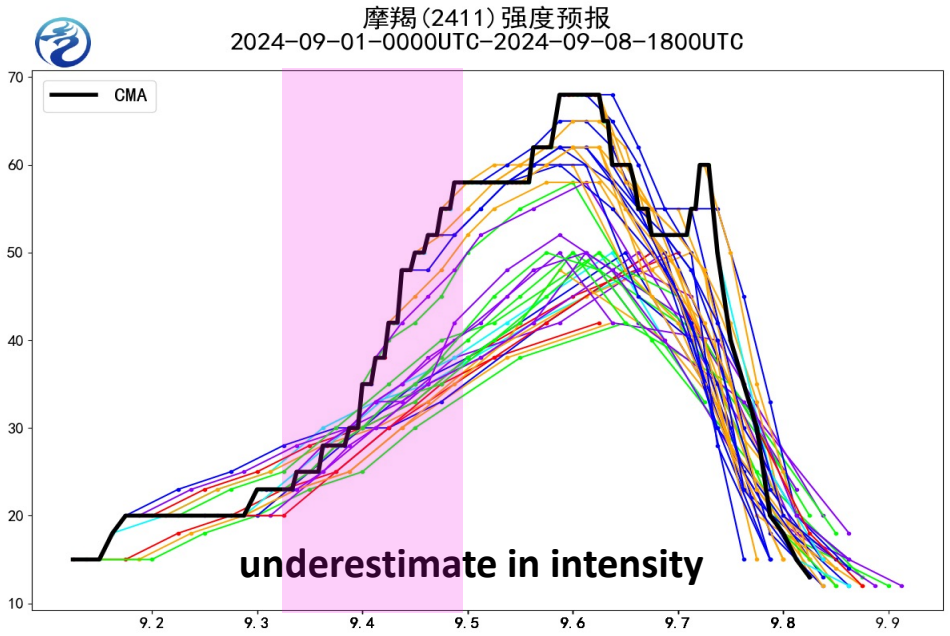
the landing area was narrow down: *"the maximum possible landfall on the coast from Wenchang, Hainan to Zhanjiang, Guangdong"* (**Accurate prediction of landing sites**)



Strike Probatility

HaiKou: 74.1%
ZhanJiang: 71.8%
Fangchenggang: 55.3%
ZhuHai: 12.9%
Sanya: 11.8%
ShenZhen: 3.5%
Guangzhou: 3.5%

2.2 Weather forecasts



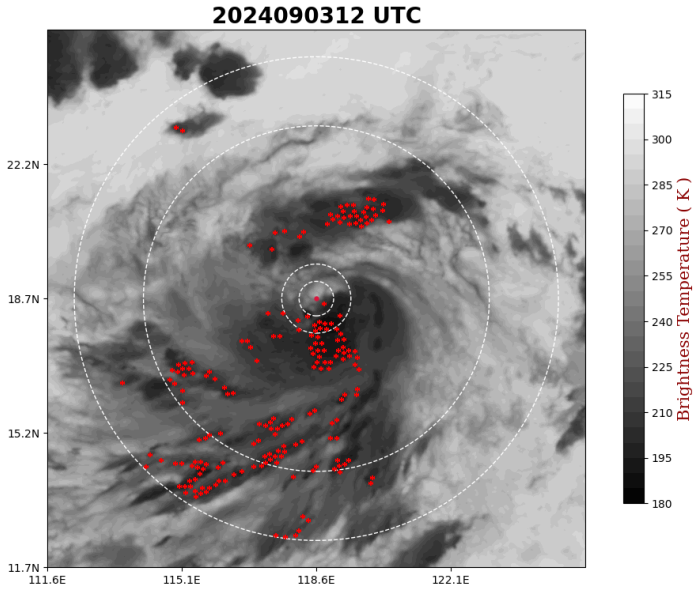
■ Forecast challenge ①： RI

(1) **Based on analyze of observations and regional models:** e.g. objective identification based on satellite imagery to identify signs of RI

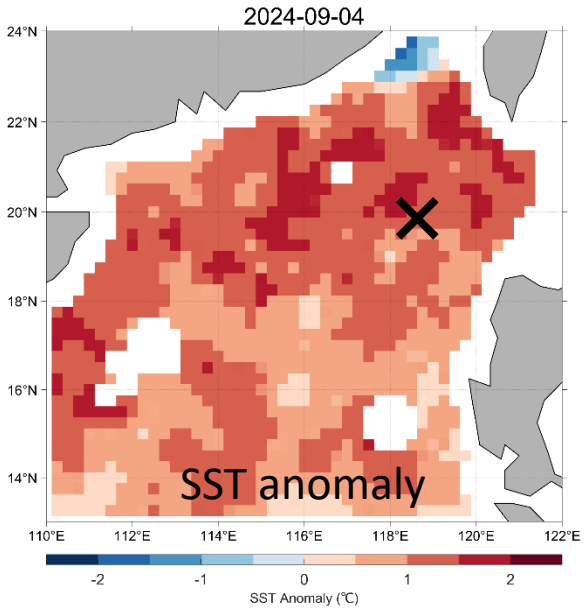
(2) **Pay attention to the underlying ocean conditions and upper level outflow:** warmer SST and warm mesoscale vortex

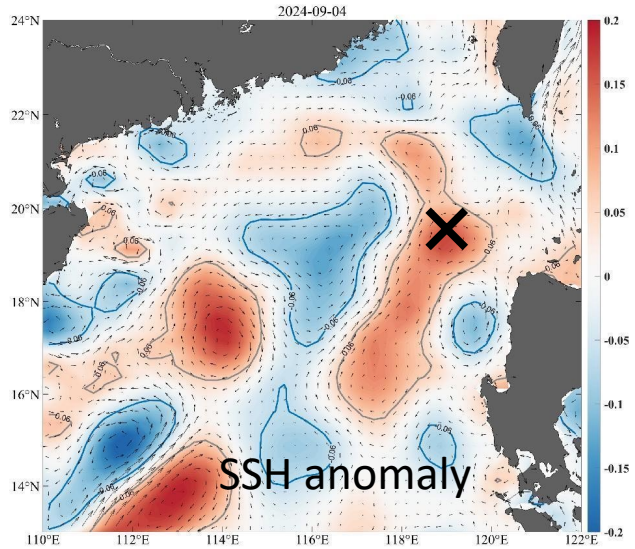
(3) **Forecaster's experience and courage:** Combining historical cases with atmospheric dynamics knowledge, forecasters need the courage to make bold prediction

(1)



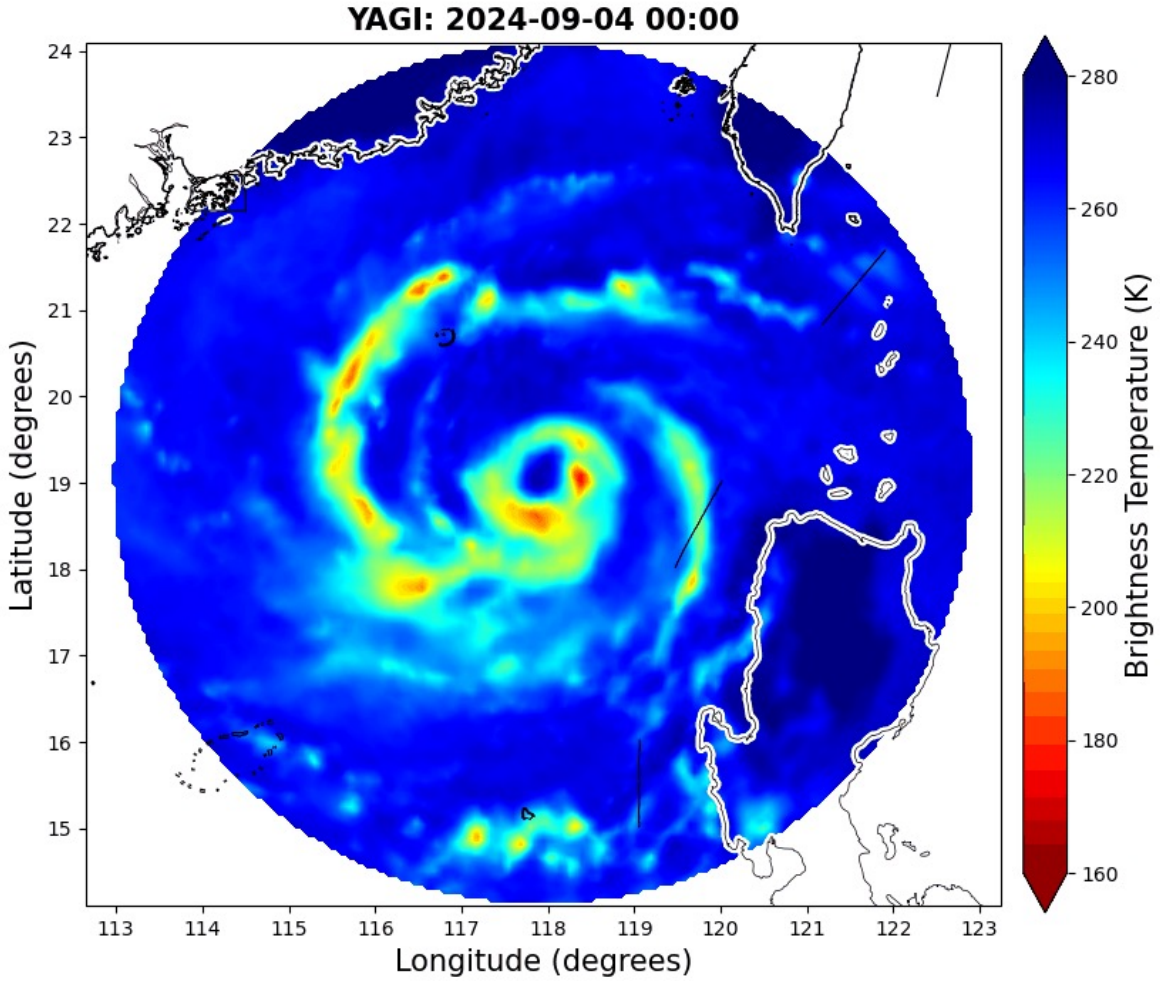
(2)





2.2 Weather forecasts

■ Forecast challenge ②： Intensity oscillation during concentric eyewall replace cycle

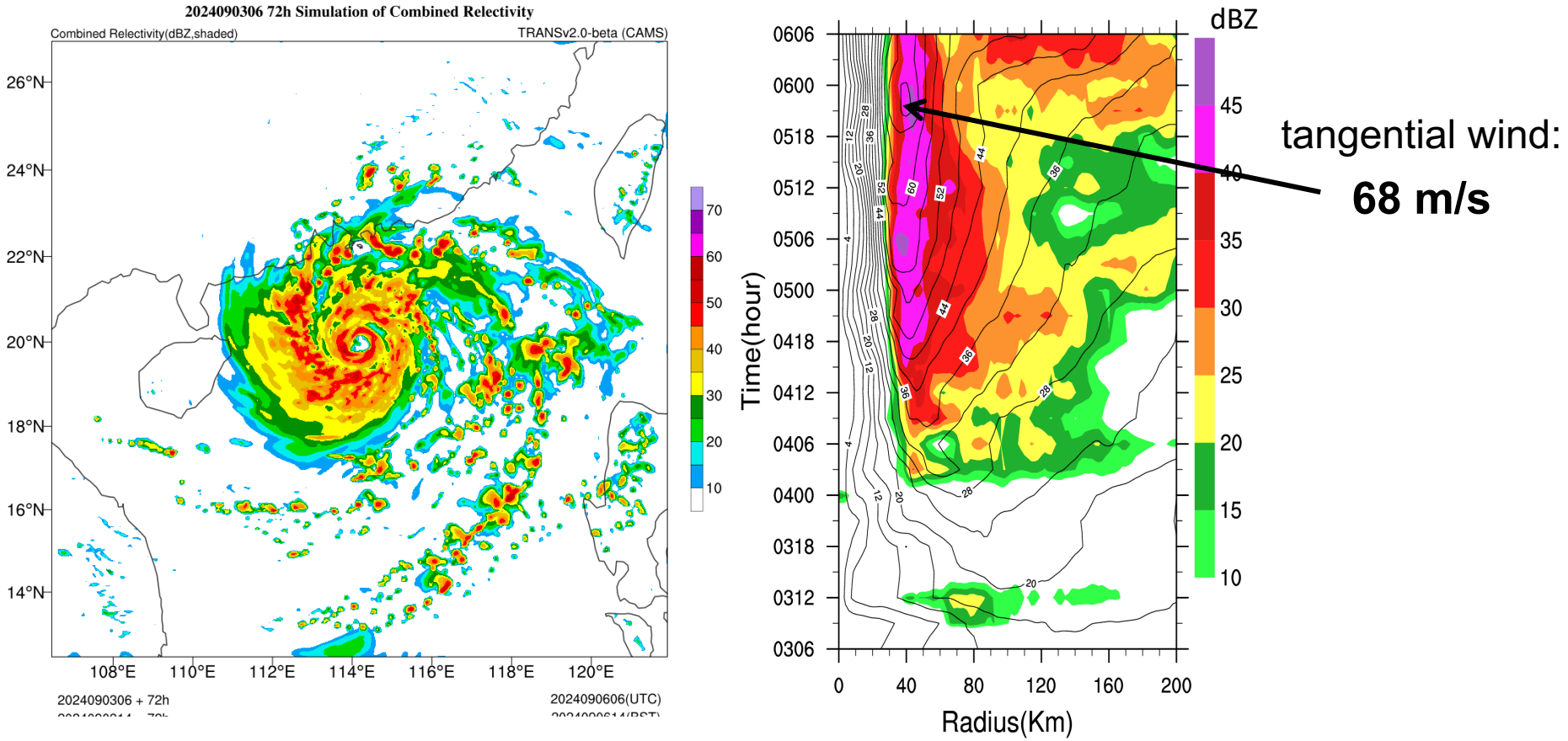


When and where does the ERC take place?

Does the landfall intensity hold or rapidly weakened?

2.2 Weather forecasts

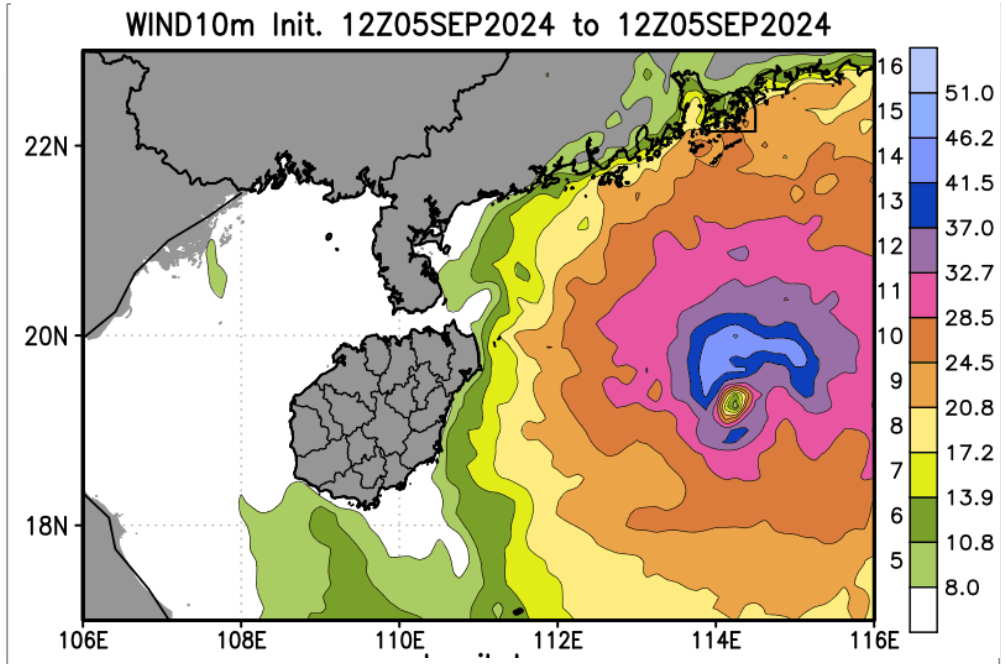
■ Forecast challenge ②： Intensity oscillation during concentric eyewall replace cycle



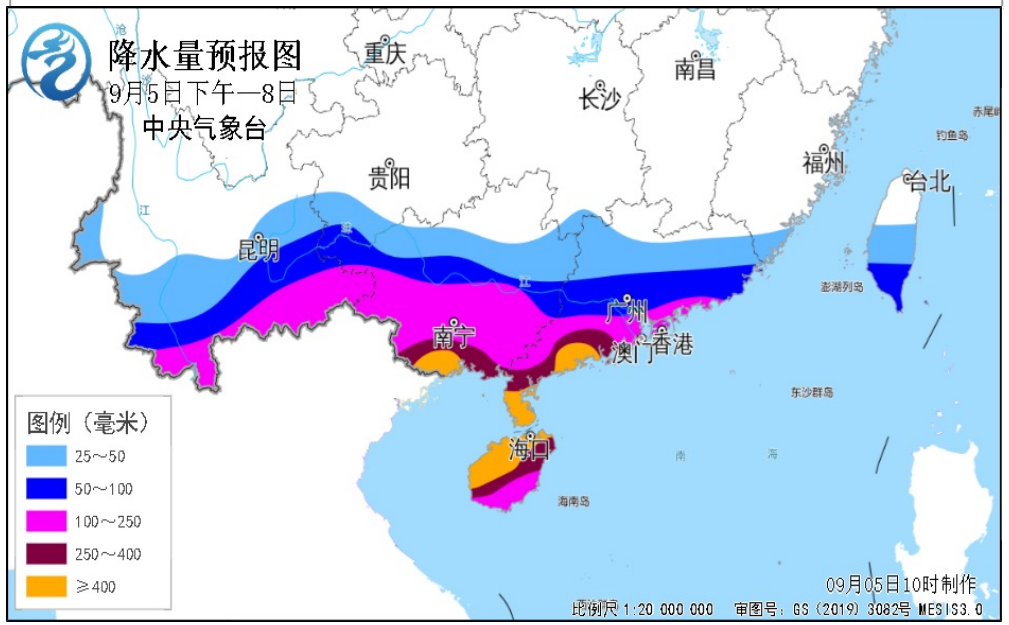
In-depth analysis based on CAMS AI-TRANS (Duan et al., 2019)

2.3 Hazard forecasts

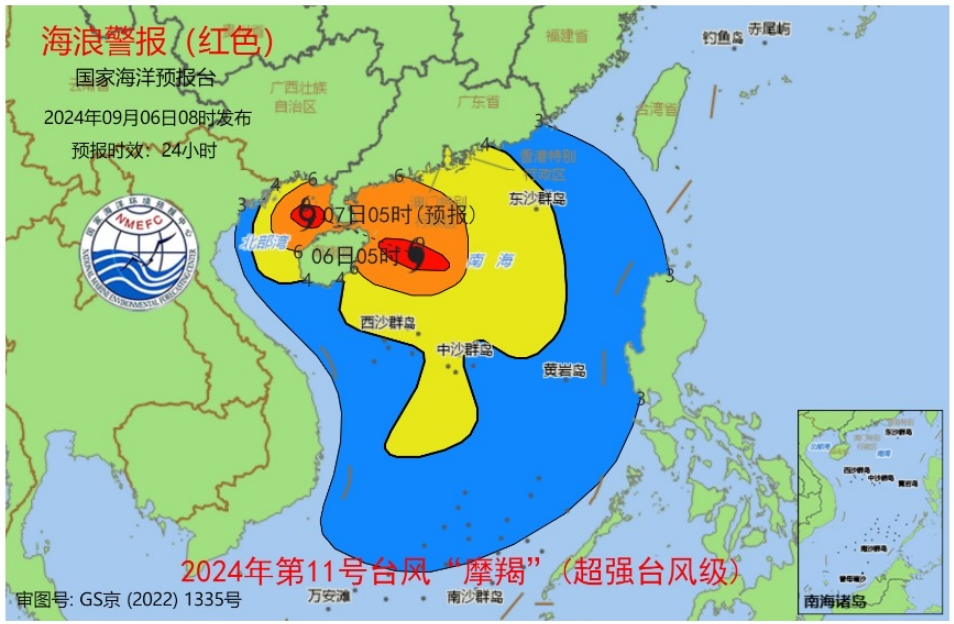
Gale



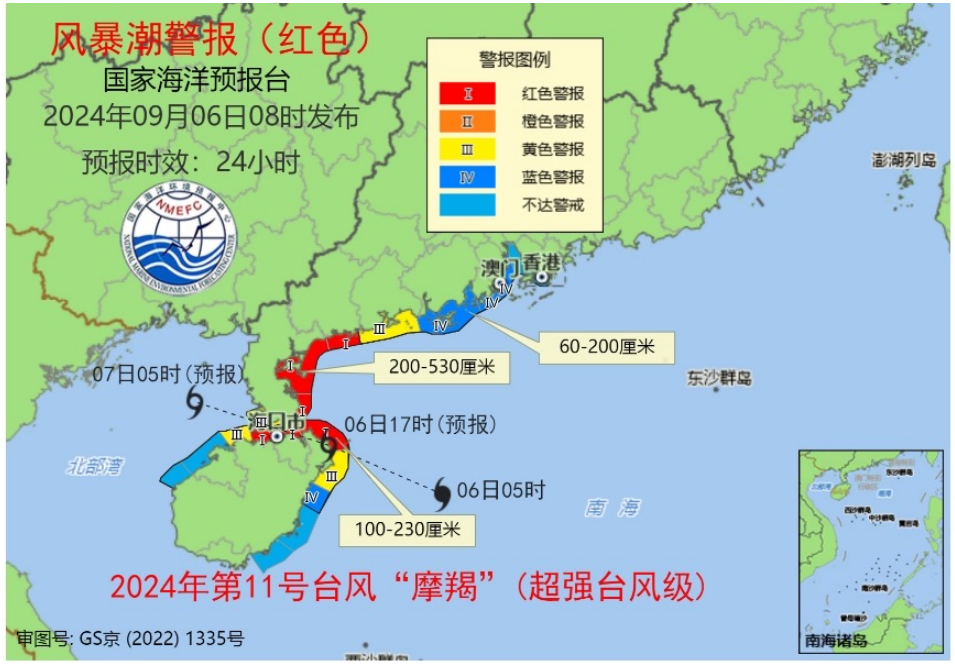
rainfall



Wave



Storm surge



2.4 Impact forecasts

- **Typhoon impact forecast products**

Meteorological risk pre-assessment Report

气象灾害综合风险预估

2024 年第 22 期（总第 57 期）

国家气候中心　　2024 年 9 月 6 日

台风“摩羯”风险预估

一、台风“摩羯”基本情况

Report on major meteorological information

重大气象信息专报

第 46 期

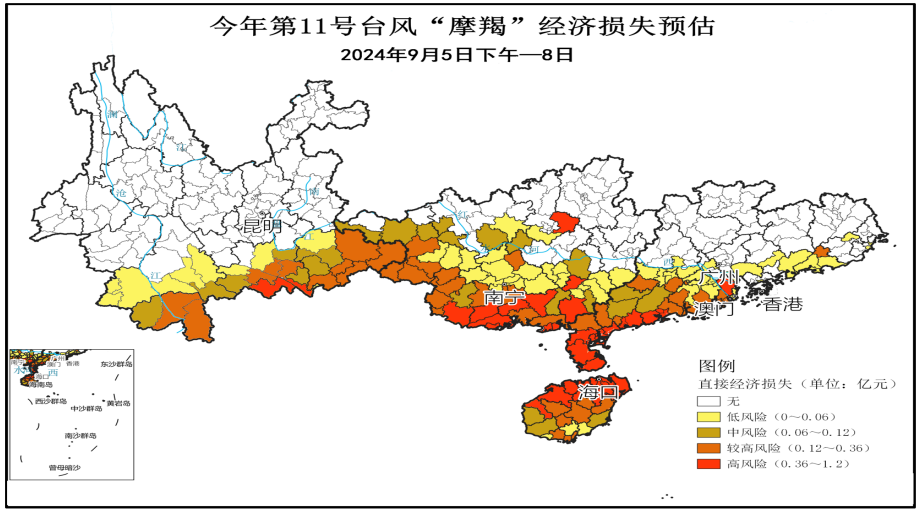
中国气象局　　2024 年 9 月 5 日

“摩羯”将以超强台风级登陆文昌至湛江一带

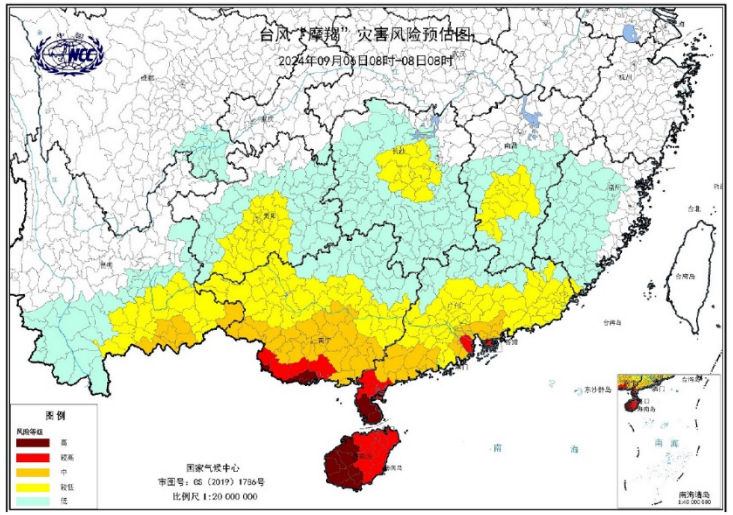
登陆强度和风雨影响极端性强 致灾风险极高

摘要：预计今年第 11 号台风**“摩羯”将以超强台风级**于 6 日傍晚到前半夜在海南文昌到广东湛江一带沿海登陆（16～17 级，52～58 米/秒）；5 日下午至 8 日，海南岛、

Pre-assessment of economic losses



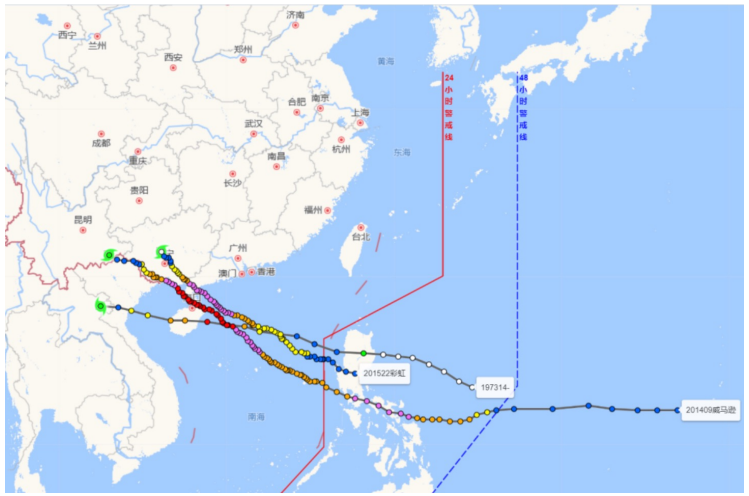
Pre-assessment of disaster risk



Review similar cases in history

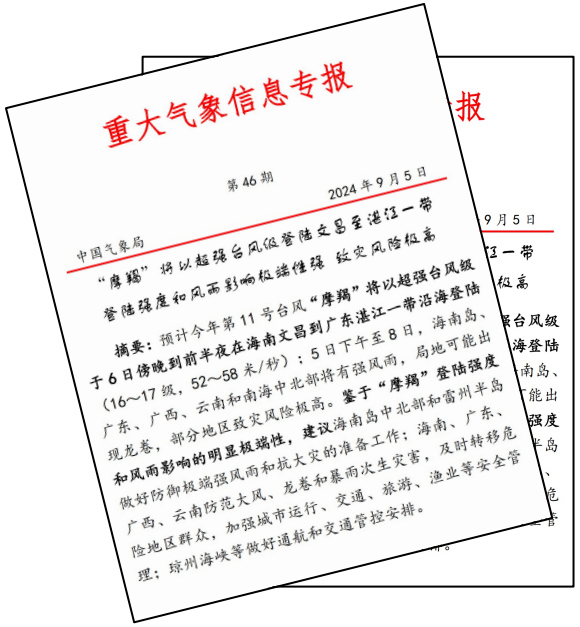
表 1 1949 年以来登陆华南地区的超强台风及其灾情

编号及名称	登陆时间（月.日）	登陆地点	登陆强度（m/s）	死亡失踪人数（人）	直接经济损失（亿元）
7314 玛琪	9.14	海南琼海	60	903	/
1409	7.18	海南文昌	70	88	446.5
威马逊	7.18	广东徐闻	62		
	7.19	广西防城港	50		
1522 彩虹	10.4	广东湛江	52	24	300.1



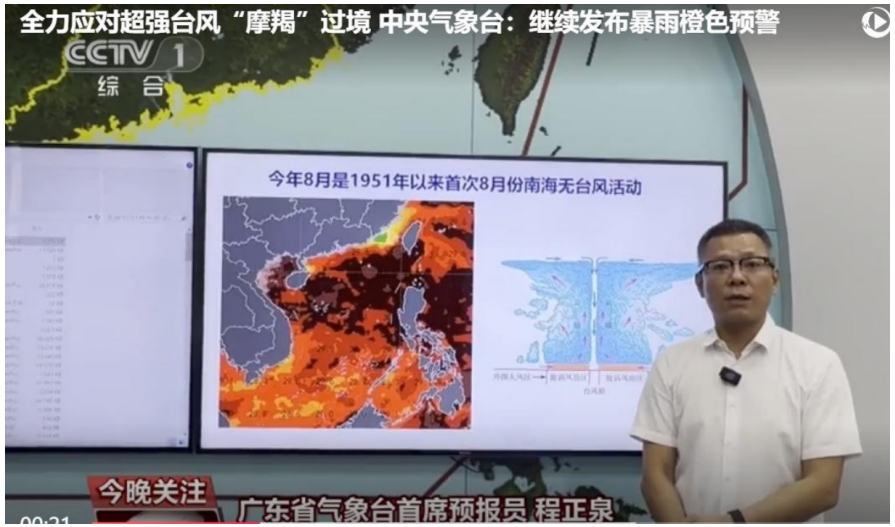
2.4 Impact forecasts

Meteorological service focus and objective (for decision maker)					
	1-3 Sept	4-5 Sept	6 Sept	7 Sept	8-9 Sept
Focus on	Typhoon tendency	The likelihood and impact of typhoon landfall	Landfall forecast, wind and rain forecast, disaster risk forecast	Information on the landfall in Hainan and Guangdong， gale and rainfall observation, Up-to-date forecast and disaster	Summary of the typhoon
Objective	Bring attention	Refine forecasts, focus on typhoon impact	Frequent rolling updates of weather facts and forecasts, with a strong focus on disaster risks and impacts		The impact is coming to an end, wrap up the review



Directly to the government

2.5 Warning communication



✓ Authoritative release by mainstream media

Carried out **7 joint live broadcasts**, with more than **1.59 million** viewers.

110 articles were published in central and provincial media such as *People's Daily Online*, *China News Service*, CCTV , *Guangdong TV*, and *Nanfang Daily, Nanhai Net;*

✓ Proactive science popularization

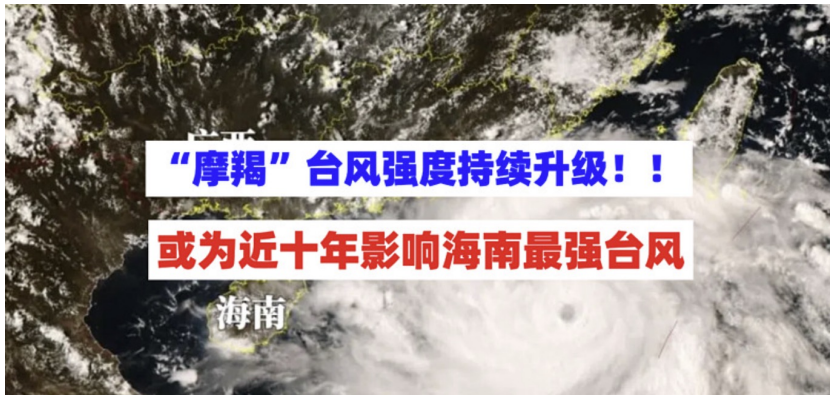
Produced **9** issues of "***Chief Forecasters Talks about the Weather***". A single Douyin video of "*Guangdong Weather* " got 500,000+ views.

✓ Focus on vulnerable areas

Guangdong's **4,810 screens** and **8,360 rural loudspeakers** released **1,514** pieces of information, and broadcast 225 meteorological **warning signal** to ensure that the warning is well-known in rural area.

2.5 Warning communication

The topic #海口气象台回应为何把自家大门焊上# has been viewed 23.83 million times



✓ Make full use of social media

The *Guangdong Weather* published a total of **330** Weibo posts, hosted **4** topics, and accumulated **37.05 million** views. **7,313** pieces of typhoon information, covering more than 14.3 million followers.

Hainan released various warning information and the latest weather forecast **989** times, with about 2.2296 million views, and the *Haikou Meteorological Bureau* was watched by about **11.535 million** people.

✓ Pay attention to the wide dissemination of warning

Through *China Mobile*, *China Telecom* and *China Unicom*, **28.14 million typhoon warnings SMS** were sent to mobile phone users in Hainan, as well as **5.5 million** TV users.

Through telephone, 1.43 million meteorological text messages were sent to the public in the province. The 12121 **hotline was called 19,107 times for 32,535 minutes.**

2.6 Warning response

For example in Hainan, after the early warning issued

Fishing boats take shelter

- Recommendation since 2 Sept
- 35,000 fishing boats took shelter before 4 Sept
- All 78,000 fishermen were relocated

Personnel transfer

- People in villages affected by tiled/dilapidated/prefabricated houses, and storm surges, as well as the elderly who are lonely and widowed, need to be urgently relocated
- 461,000 people in dangerous areas were dynamically resettled and transferred

Hidden danger investigation

- All departments conduct risk investigations on geological disasters, construction sites, rivers and reservoirs, power communications, and traffic
- 9,920 hidden dangers were remediated

Urban wrecker

- Emphasized that super typhoon will cause a large number of trees to fall and tower cranes to collapse
- Completed the removal of 349,800 tree barriers
- supervised the removal of the tower crane

2.6 Warning response

✓ Jointly cooperation in DRR

- Before YAGI entered the South China Sea, 35,000 fishing boats were organized to take shelter in safe areas, and all 78,000 fishermen were relocated to shore.
- A comprehensive risk investigation was carried out such as geological disasters, construction sites, reservoirs, power communications, road traffic, etc, and 9,920 hidden dangers were rectified. 461,000 people in dangerous areas were dynamically transferred.
- 12,000 tons of vegetables, 39,000 tons of rice, and 6,500 tons of edible oil were reserved, and emergency reserves such as thermal coal, natural gas, and refined oil were implemented.
- Hainan Power Grid has made arrangements for the province's power generation plan in advance, coordinated the maintenance of power, and made every effort to improve the reliability of power supply.
- Solid investigation and management of hidden dangers of tree barriers were carried out, and 349,800 tree barriers were cleared.
- Department of Housing and Urban-Rural Development completed the full coverage of the province's construction projects, strengthened 76 deep foundation pits, and strengthened or lowered 615 tower cranes.
- Inspect 36,026 farmhouses, transfer 301 rural households.

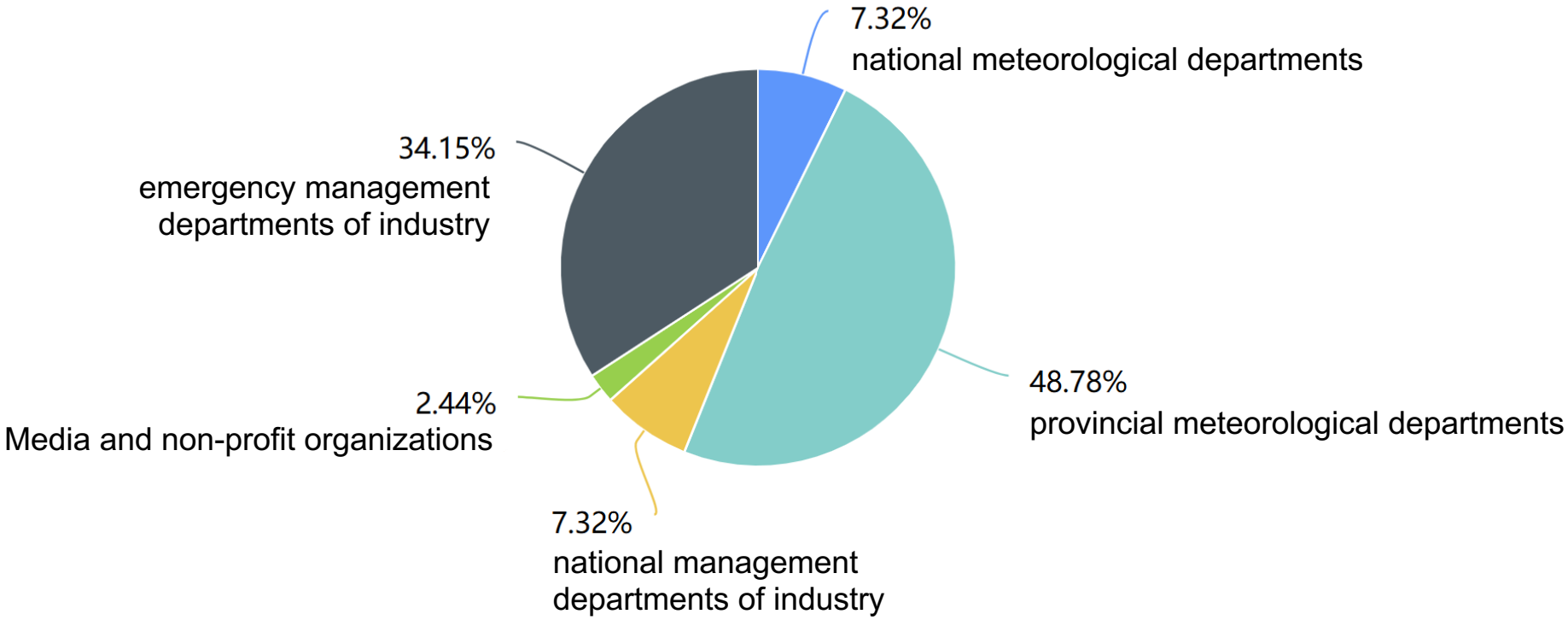
Part 3: Assessment of the warning chain

- Analysis of the warning chain
- Subjective scoring

A survey based on the warning value chain questionnaire of Typhoon YAGI

By designing a questionnaire, a survey was carried out to evaluate how does the warning value chain act during Super Typhoon YAGI (2024).

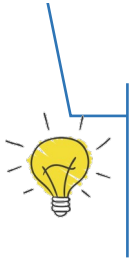
- **Scope of participation in the survey**



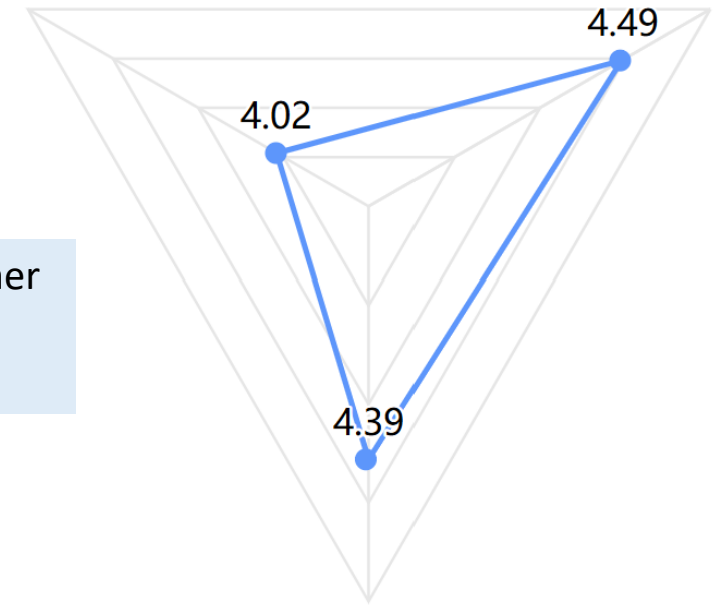
- **Subjective scoring**

3.1 Analysis of the warning chain >>Observations

Can **scientific observation data support real-time** operational services?



More direct observation of TC inner core to improve TC intensity and structure forecasting



Is there a **comprehensive range** of observational data to support operational forecasting?

Is the observatory data that supports the operational forecast obtained in a **timely** manner?

3.1 Analysis of the warning chain >>Weather forecasts

Forecast of the landfall intensity?

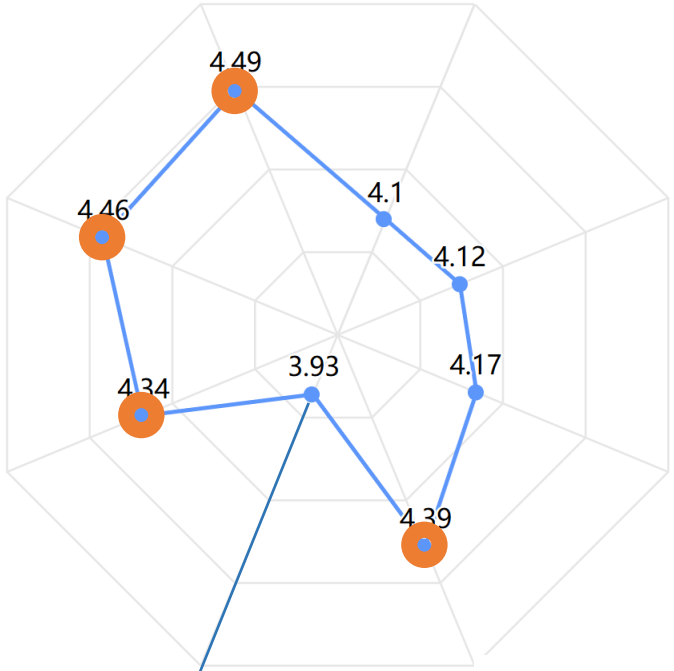
Accurate **forecast of the landing site**

Predict the RI in advance?

Consistency between different forecasting agencies?

More discussions and comunications within the Typhoon committee members.

NWP performance?



AI Model performance?

Reliability and accuracy of the forecast at different initial times?

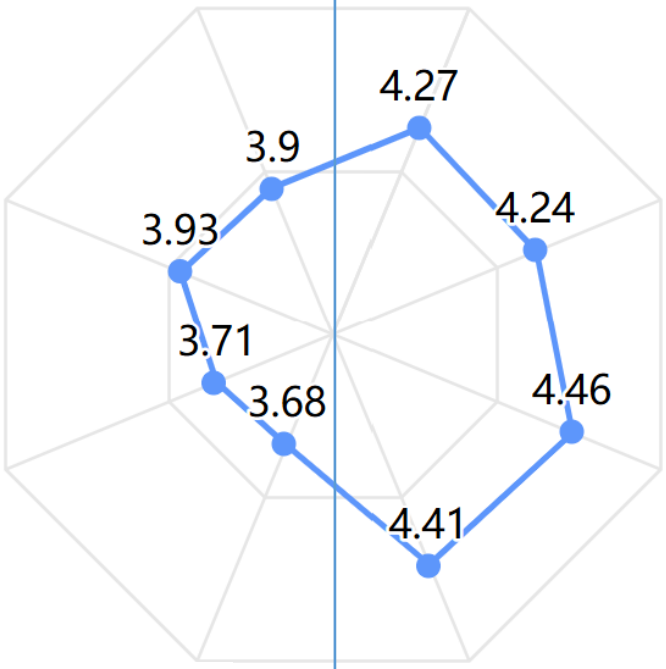
Provide users with **effective explanations or guidance**?

3.1 Analysis of the warning chain >>Hazard forecasts

How accurate is the typhoon

geological hazards

How reliable is



How reliable is the typhoon

extreme precipitation forecast

How accurate is

How accurate is the typhoon

storm surge

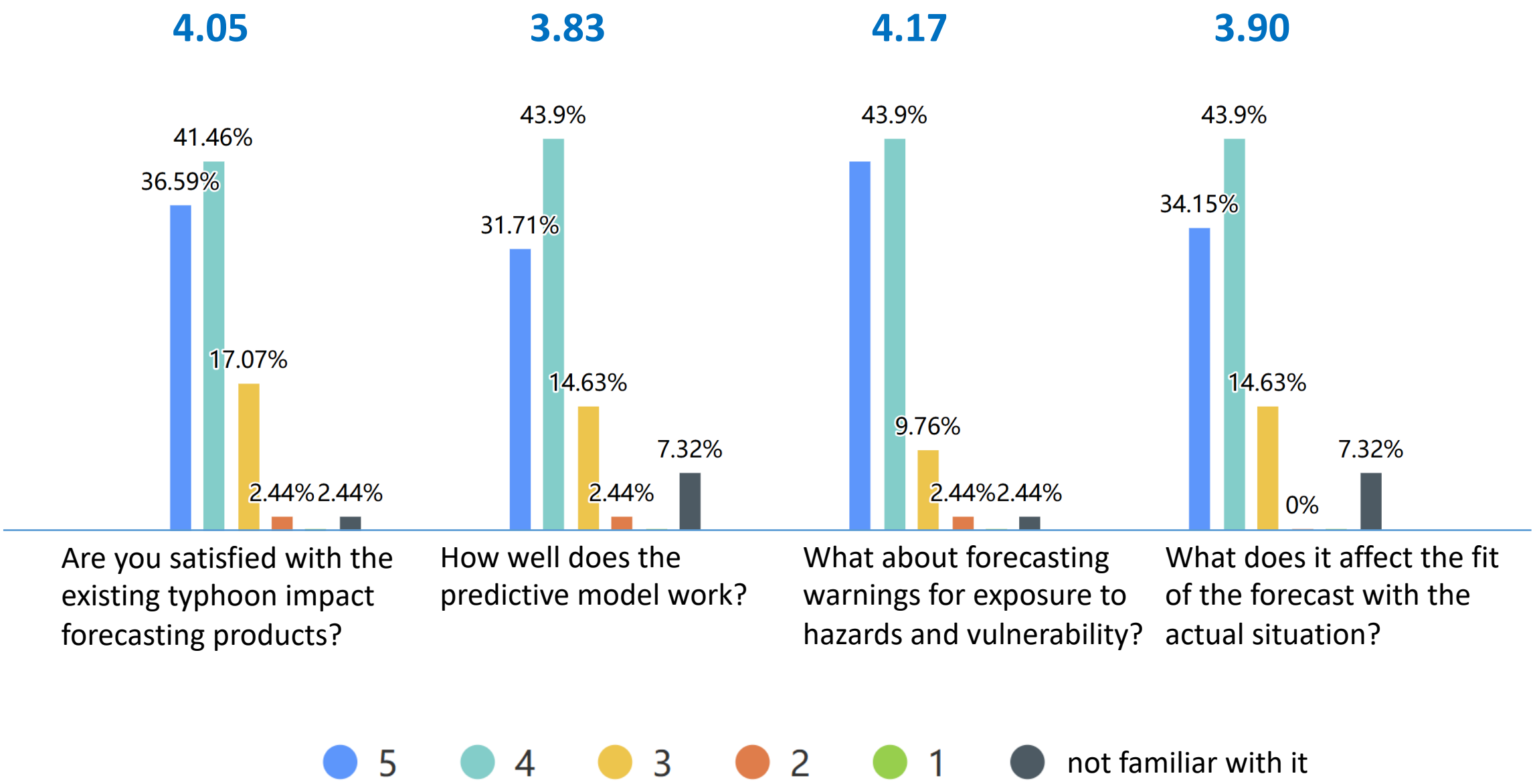
How reliable is

How reliable is the typhoon

catastrophic gale forecast

How accurate is

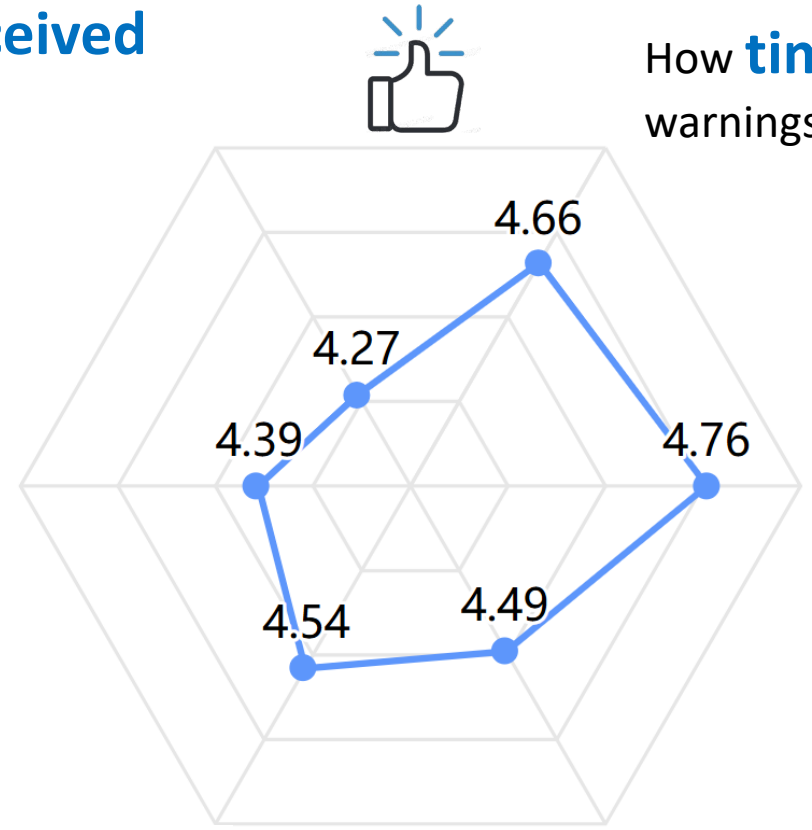
3.1 Analysis of the warning chain >>Impact forecasts



3.1 Analysis of the warning chain >>Warning communication

To what extent were the warnings **received** and **understood** by the public?

How **timely** is the dissemination of early warnings?



Is the communication system functioning **effectively** when disaster strikes?

How **widespread** is the warning?

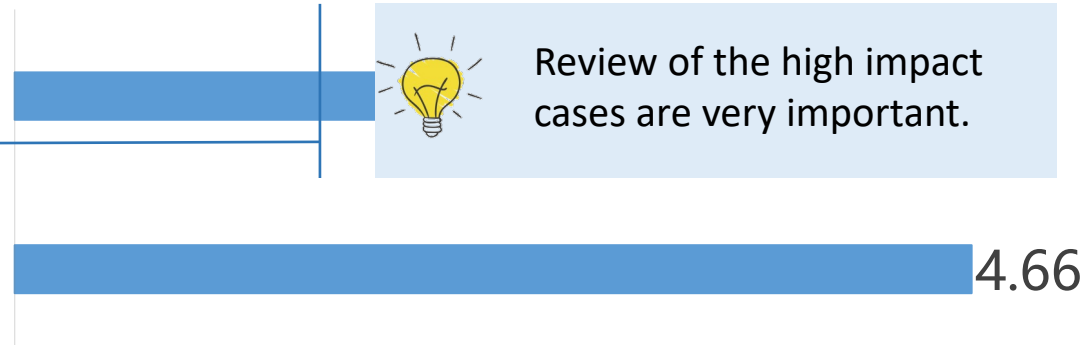
How **accurate** is the early warning information communicated to other organizations, including the media?

How **accurate** is the delivery of early warning information to decision-makers and industry users?

3.1 Analysis of the warning chain >>Warning response

How are emergency services, the public, and agencies responding to early warnings?

Compared to the Super Typhoon Rammasun warning, how does the warning response



	YAGI (2024)	Rammasun (2014)
Landfalls	4 tims（1 Phillipines、2 in China、1 in Vietnam)	4（1 Phillipines、3 in China)
Landfall intensify in China	• Wenchang, Hainan（62m/s，17+bf，SuperTY) • Xuwen, Guangdong（58m/s，17+bf，SuperTY)	• Wenchang, Haihai（**70**m/s，17+bf，SuperTY) • Xuwen, Guangdong（**62**m/s，17+bf，SuperTY) • Fangchenggang, Guangxi（50m/s，15bf，STY)
Time as SuperTY	**64hr**	24hr
Inner core in Hainan	**9hr**	3hr
Gusts No.	12+bf **174**，15+bf **37**	12+ bf 86, 15+bf 25
Rainfall spread	over 100mm covered 90,800km^2 , over 250mm coverend 10,3200km$^{2.}$, maximum accumulated rainfall is 691.2mm	over 100mm covered 98,700km^2 , over 250mm coverend 15,600km$^{2.}$, maximum accumulated rainfall is 702.1mm

3.1 Analysis of the warning chain >>Warning response

How are emergency services, the public, and agencies responding to early warnings?

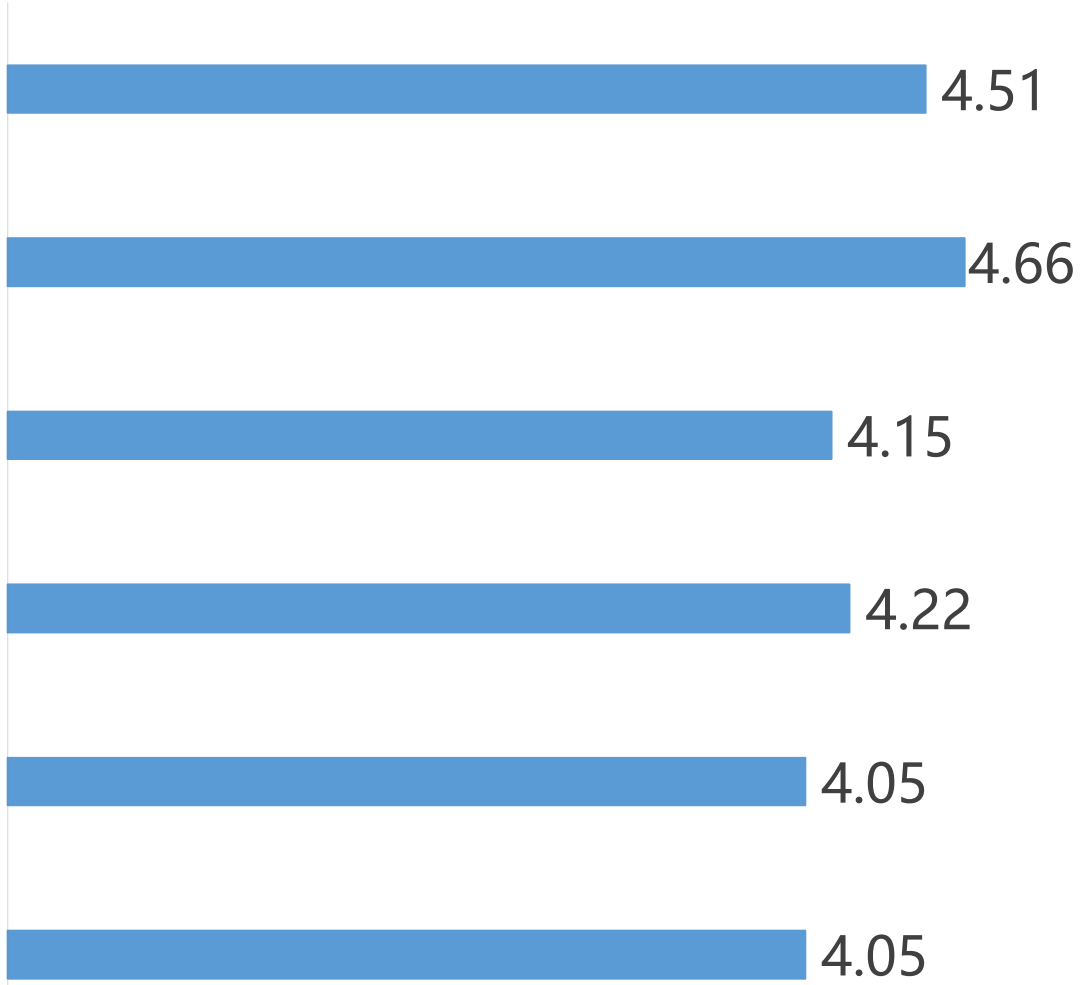
Compared to the Super Typhoon Rammasun warning, how does the warning response here?

Are disaster preparedness and response plans in place?

Performance of key decision-makers and institutions?

How well is the **community** aware of the hazards and the risks associated with them?

How can the **community** respond to early warnings?



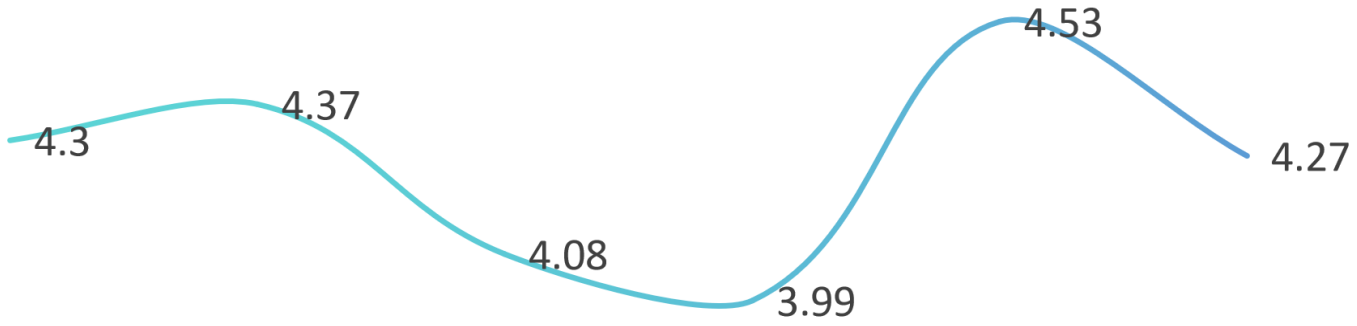
Strengthen the role of the community in DRR

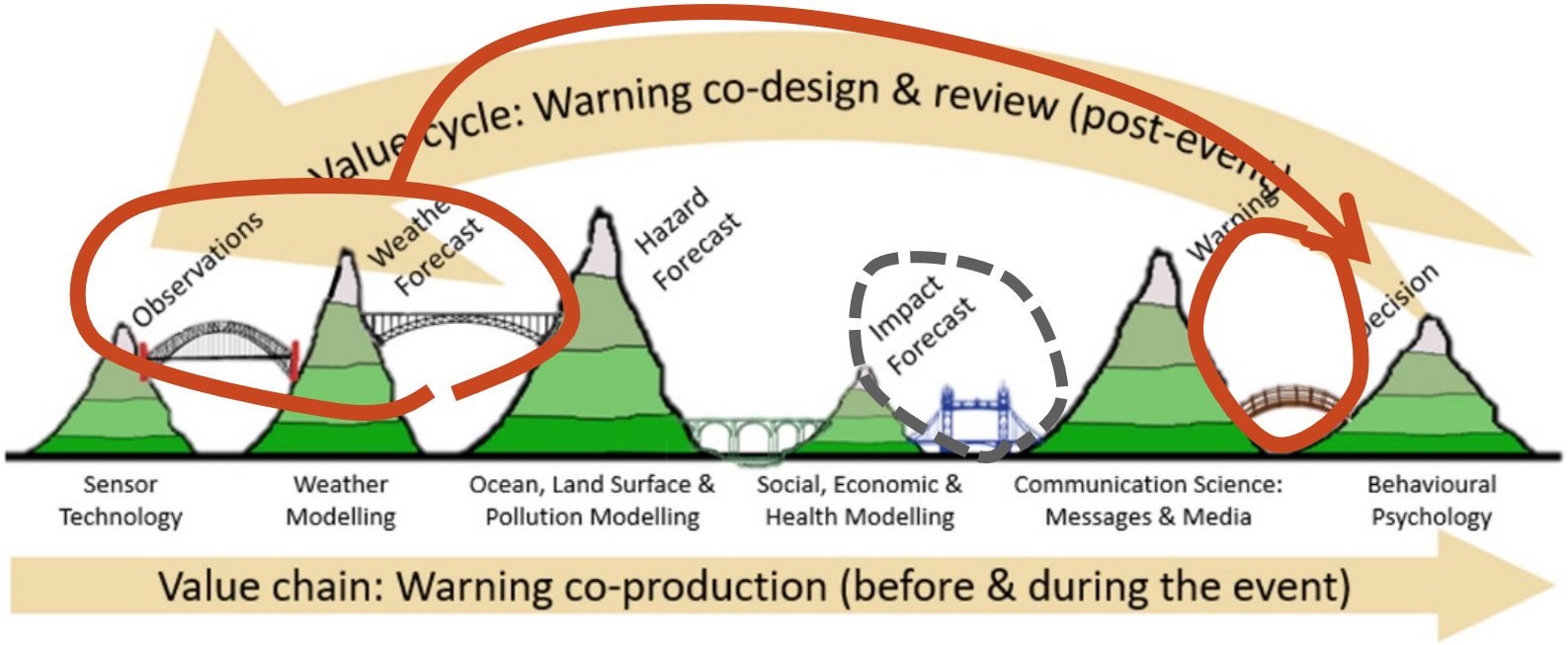
3.2 Subjective scoring

- The warning value chain performed very well overall
- The strongest links
- The weakest links

e.g. data sharing among different departments

accurate social, economic and health models





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Contents

Summary

The warning value chain for Typhoon YAGI has performed well overall, especially for **the accurate forecast of the TC landfall site and intensity. The subjective correction role of forecasters in RI is highlighted**.

Further improvements are needed to improve the ability to respond to extreme typhoons in the future, for the EW4ALL:

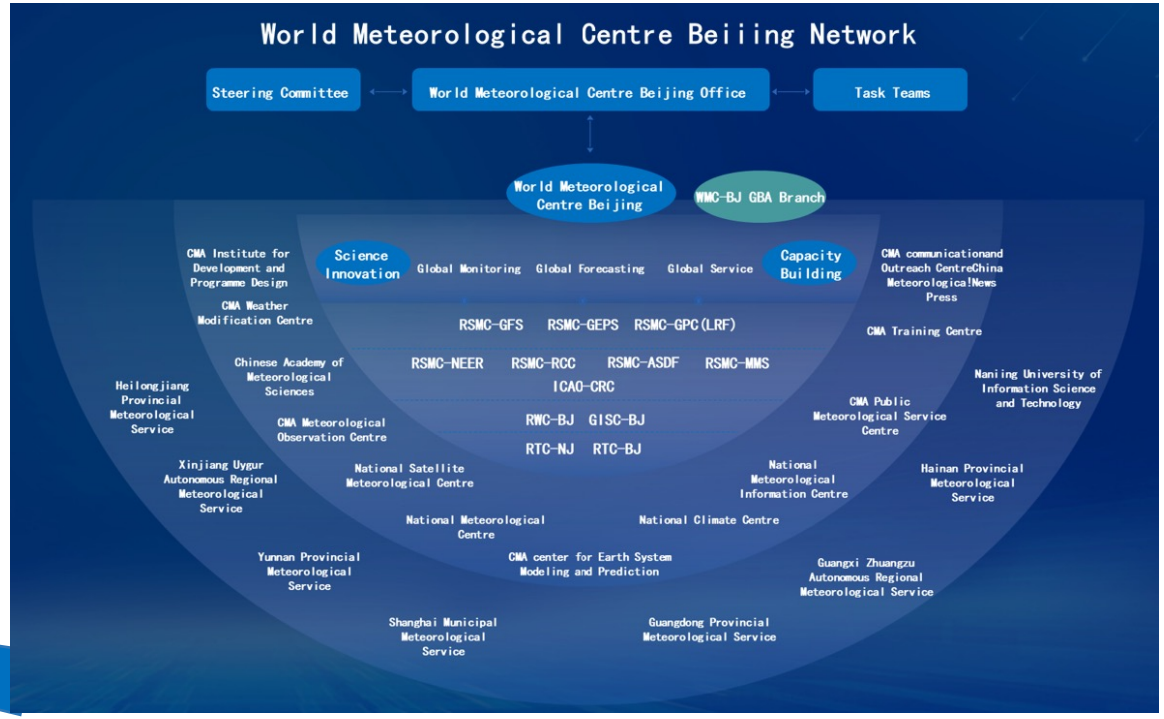
1. Strengthen the real-time application of scientific research observation data: It is recommended to further improve the integration of scientific research data and operational forecast to ensure that scientific research results can be transformed into practical applications in a timely manner.

2. Enhance forecast consistency: Coordination and information sharing among meteorological forecasting agencies should be strengthened to improve the consistency of forecast results.

3. Strengthen the impact-based forecast: The score is slightly lower on the fit between the effect of the impact prediction model and the actual situation, indicating that the impact forecast still needs to be strengthened.

Summary

Under the framework of the Typhoon Committee, CMA will continue to cooperate with the TC members and supporting EW4ALL in the future.



Thank you!

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A Warning value chain Assessment for Typhoon YAGI (2024)

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