From the Potential Forecast of Typhoons to Hazards Emergency Response

——A Case Study of Super Typhoon "Yagi"

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2024/12/27

Severe/hazardous Weather

?

Meteorological disasters

- **Weather**: The atmospheric conditions at a specific time and place
- **Severe weather or high-impact weather**: any weather conditions that pose a significant threat to life, property, and commerce. Such as typhoon, heavy rain, thunderstorm, etc.

- The sudden events caused by meteorological factors that pose a threat to human society. These events can lead to casualties, property damage, ecological and environmental destruction, and socio-economic impacts.

Meteorological disasters

Severe weather (Typhoons)

- ✓ **Tracks**
- ✓ **Intensity**
- ✓ **Strong wind**
- ✓ **Heavy rain**
- ✓ ……

Vulnerable entity

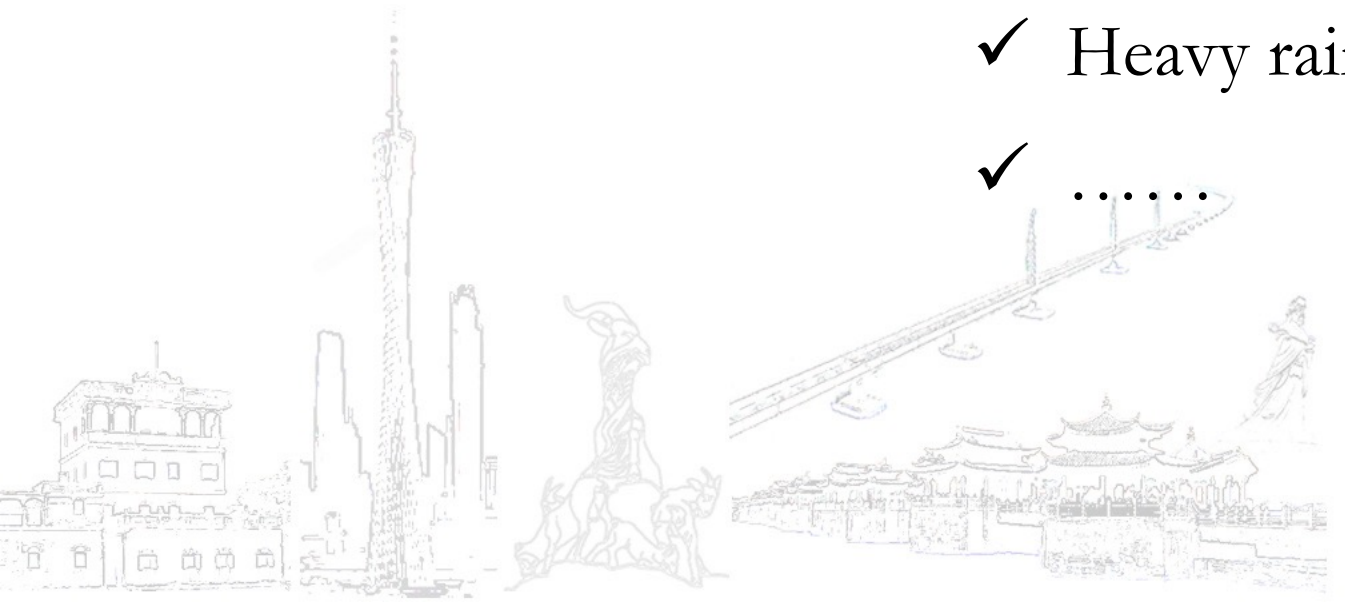
- ✓ National comprehensive risk survey of natural disasters ---- confirm the thresholds and spreads of meteorological elements for disasters risk
- ✓ Meteorological disaster risk prediction

Disaster prevention and mitigation mechanism

- ✓ Early warning mechanism
- ✓ "call for action" mechanism
- ✓ **Emergency response mechanism**

Severe weather (Typhoons)

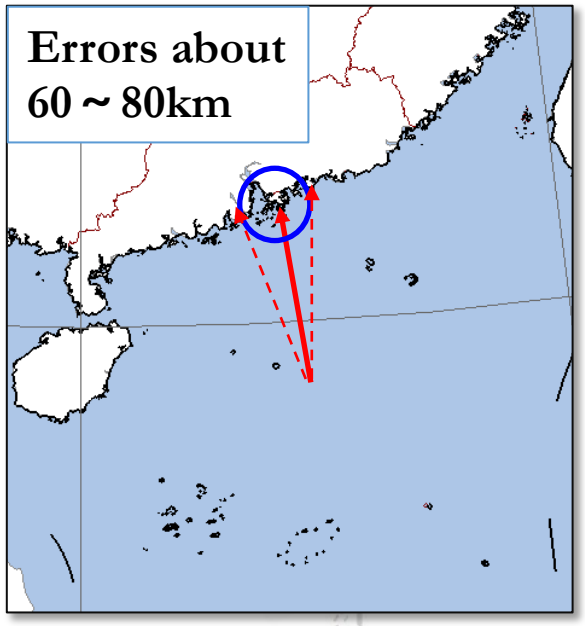
- ✓ Tracks
- ✓ Intensity
- ✓ Strong wind
- ✓ Heavy rain
- ✓ ……

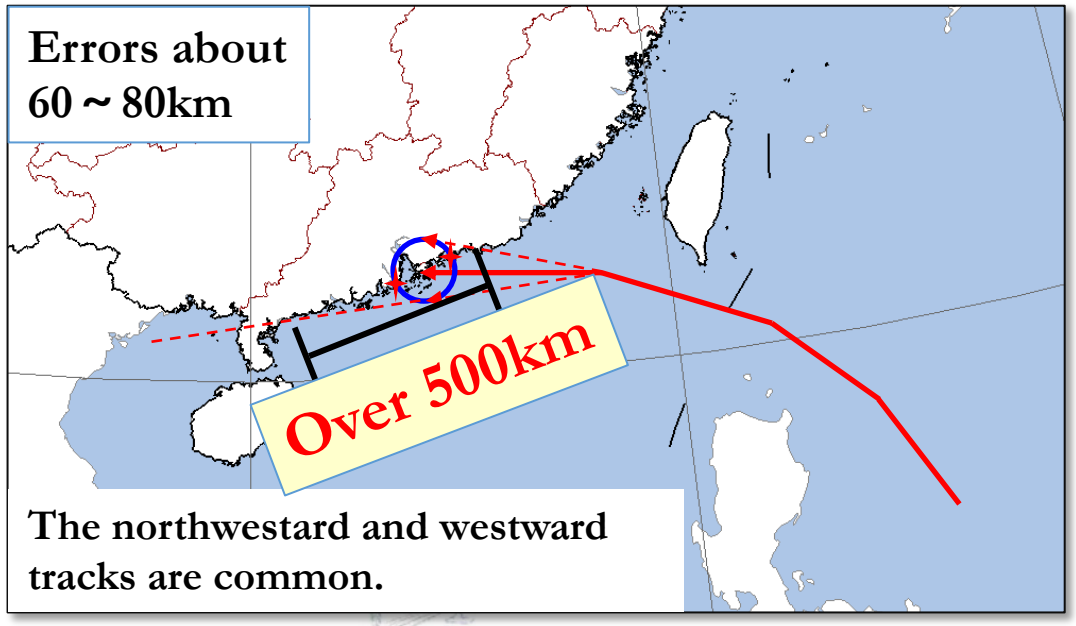


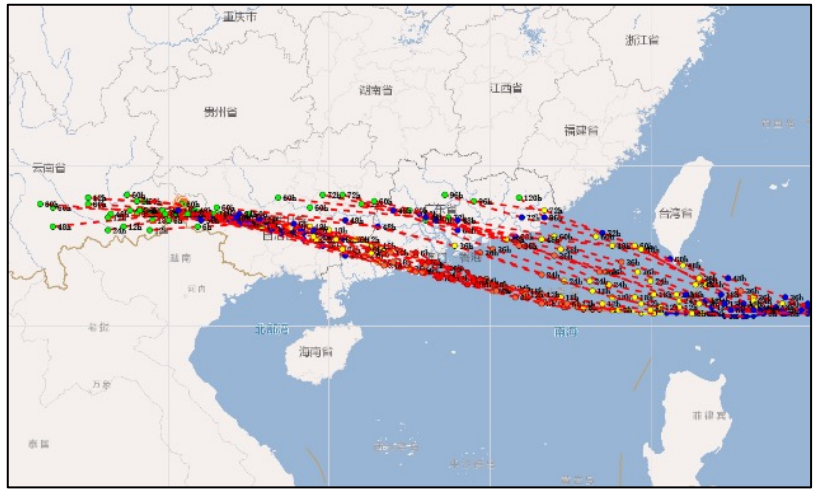
Problem 1: typhoon track

- Applications of the **EPS** and the **TYTEC** method by National Meteorological Center (NMC) has improved the ability of typhoons tracks forecast.

! Some exceptions.







- The forecast errors are the same. But the **forecast spread and striking probability are great different.**
- **The long-time forecast(potential forecast) is hard!**
- **Moving directions forecast are important for disaster prevention and mitigation.**

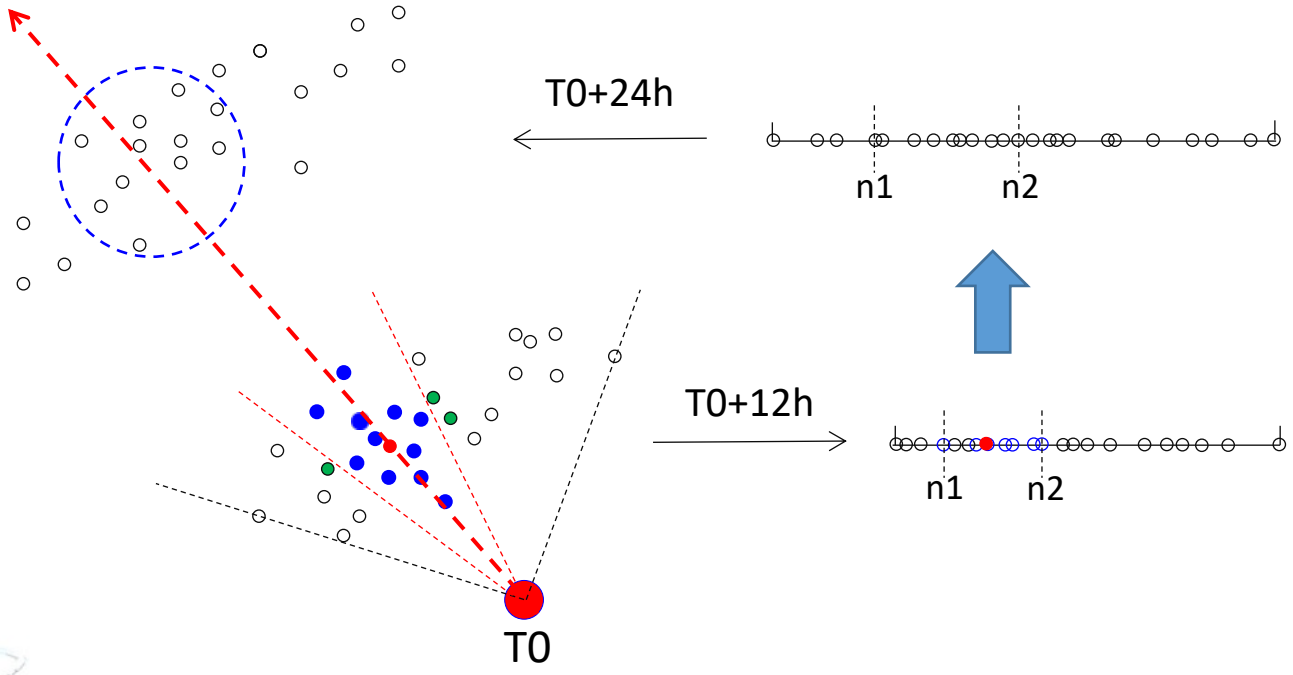
Problem 1: typhoon track

➢ Optimal consensus tracks method based on moving direction errors of EPS

A. EPS is 12hr late for the daily forecast

B. Choose top 25% members with the smallest **moving direction errors** (not the distance errors)

C. Assume these members are optimal



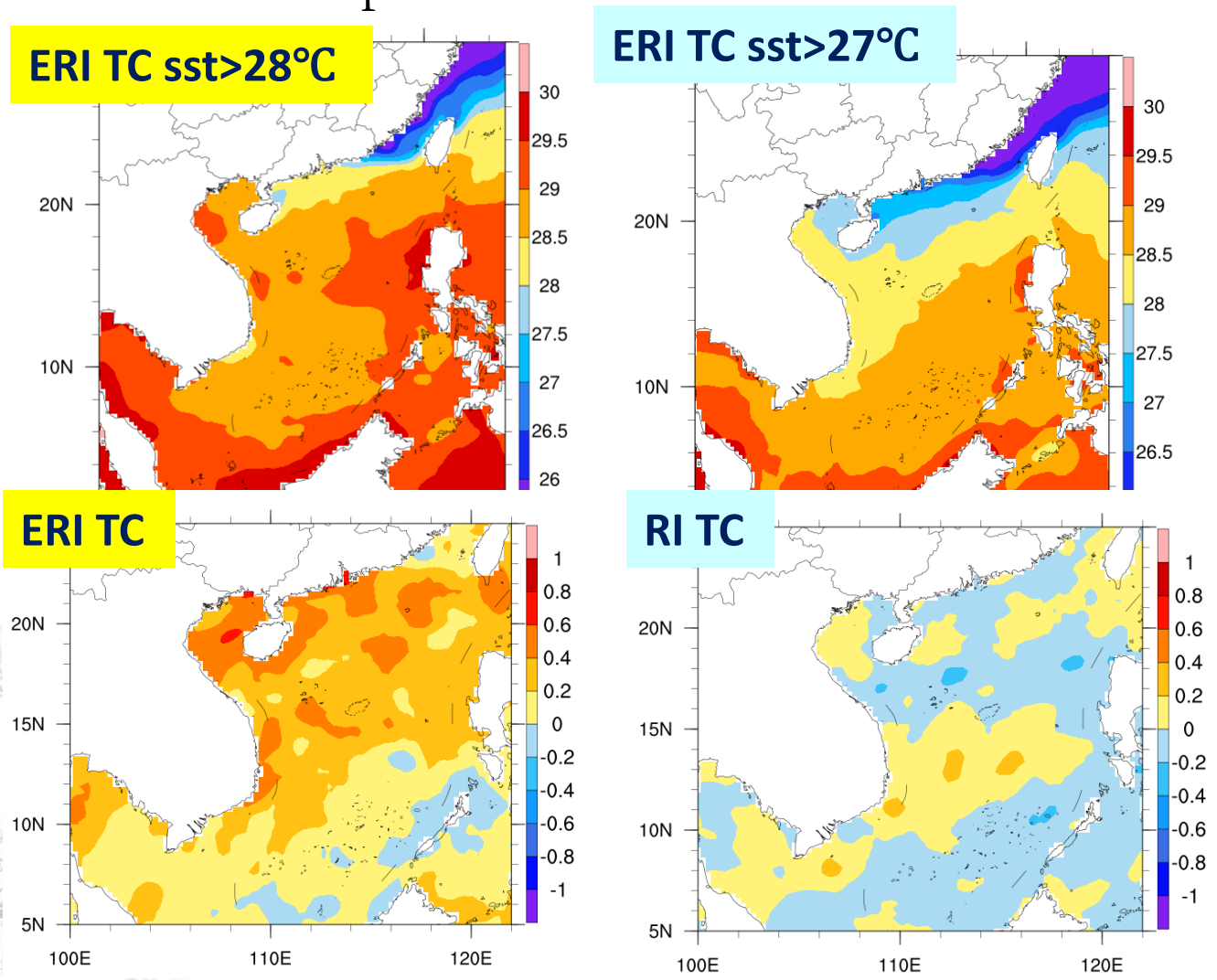
Optimal consensus track based on moving direction errors of EPS

Problem 2: typhoon intensity

- Rapid intensity(RI) and extremely rapid intensification(ERI) typhoons are difficult to predict and may be the most dangerous situations for disaster prevention.

A. Conclude the **definition** of RI and ERI in the **South China Sea**.

B. Statistical analysis on the **affecting factors** of the typhoon intensity change: **SST, vertical wind shear, upper-level outflow/divergence, water vapor flux, the size of TC** ……



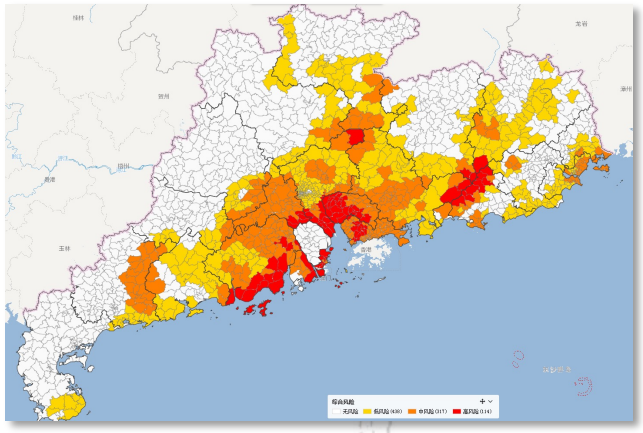
Vulnerable entity

- ✓ National comprehensive risk survey of natural disasters
- ✓ Meteorological disaster risk prediction

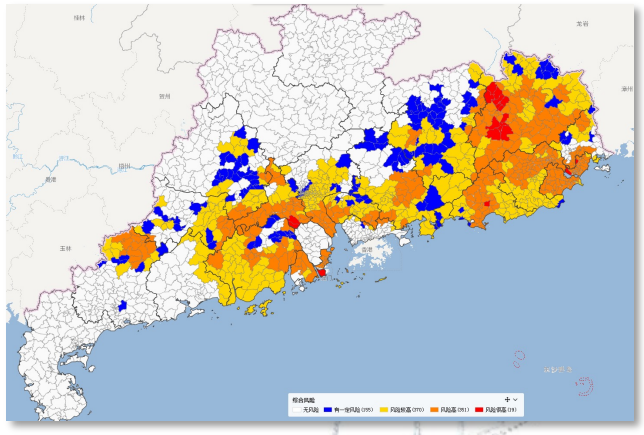
Comprehensive risk survey & disaster risk prediction

- **National comprehensive risk survey**: Leading by central government, the departments of meteorology, hydrology, traffic, geology, etc, and work on the comprehensive risk survey of natural disaster.

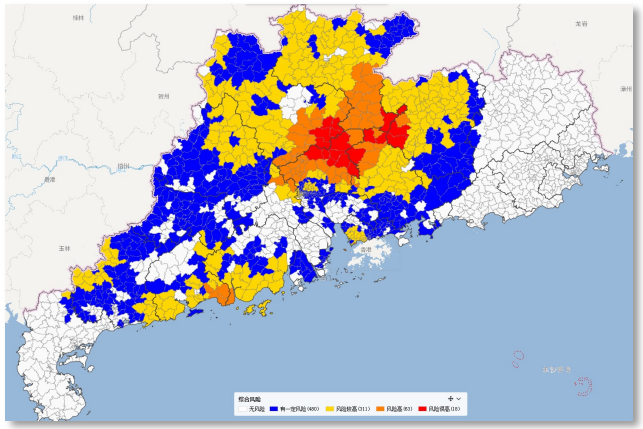
- Impact-based forecast & high-impact weather risk forecast



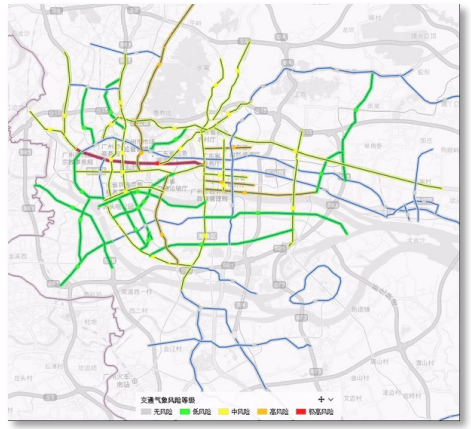
Integrated risk forecast product



Flood risk forecast product of rivers, cities & town



Geological disaster risk forecast product



Traffic jam forecast product

Disaster prevention and mitigation mechanism

- ✓ Early warning mechanism
- ✓ “call for action” mechanism
- ✓ Emergency response mechanism

Early warning mechanism

➢ Meteorological warning signals

---- **Trigger**

Rainstorm alerts

- 3hr cumulative precipitation is over 100mm.
- Average wind speed over 32.7m·s^{-1}(kts)

Typhoon warnings

Local area will be affected by TC in 48hr.

- Local area will be affected by TC in 12hr or has being affected.
- Average wind speed over 32.7m·s^{-1}(kts)

Tingkeling

Suspend or cease of classes in school:

- ✓ APP 'Tingkeling'
- ✓ Short messages
- ✓ Website
- ✓ WeChat
- ✓ ……

“call for action” mechanism

- Dual “call for action” ---- **Trigger**

Rainstorm alerts
(The highest level alert)

Meteorological administration

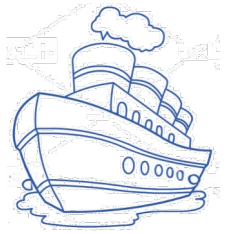
Local chief executive
(governor, mayor, head of town, etc)

Emergency management department

Emergency response mechanism

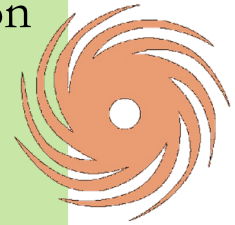
- Responsibilities of all the departments

  ---- **cross-department coordination**



Forecasting department

- ✓ Meteorological information
- ✓ Hydrological information
- ✓ Oceanic information
- ✓ Disaster information
- ✓ ……



Industry command department

- ✓ Constructive dept.
- ✓ Agricultural dept.
- ✓ Traffic dept.
- ✓ Energetic dept.
- ✓ ……

Local government

Local chief executive

Emergency management department

Rescue department

- ✓ Fire dept.
- ✓ Specialized rescue team
- ✓ Soldiers
- ✓ Medical team.
- ✓ ……

Integrated support department

- ✓ Food, clothes & houses
- ✓ Medical service
- ✓ Telecommunication
- ✓ Electronic service
- ✓ Cost of goods
- ✓ Media
- ✓ Security force
- ✓ ……

Emergency response mechanism

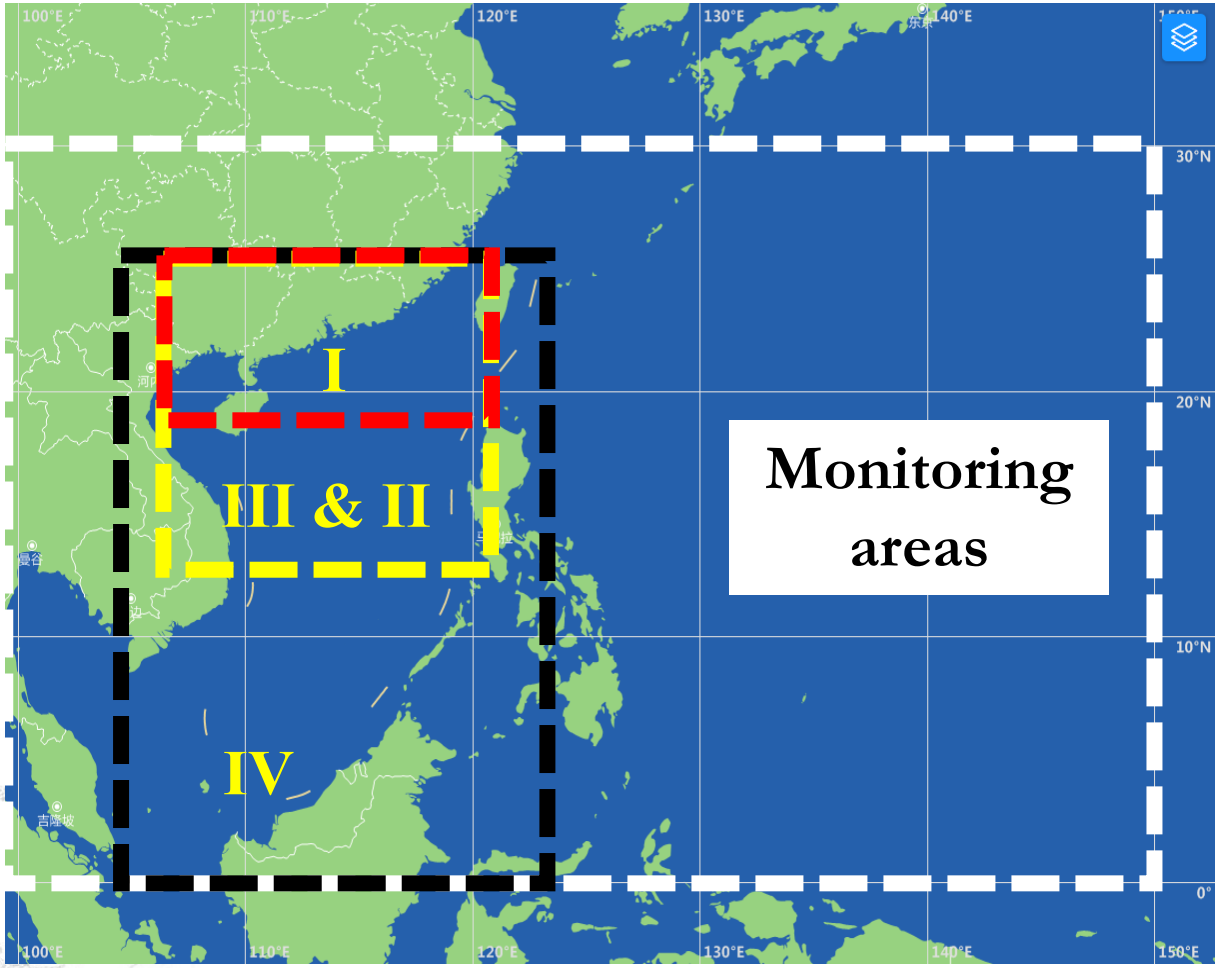
- Emergency response levels

Level I:
STY will hit local areas in 24hr.

Level II:
STY will hit local areas in 48hr.

Level III:
TY will hit local areas in 48hr.
STS or TS will hit local areas in 48hr.

Level IV:
TS will form or move into the SCS, and will affect local areas in 72hr.



Emergency response mechanism

➢ During the disasters

- Emergency rescue
  Firemen
  Specialized rescue team
  Soldiers
  Medical team.
  ……

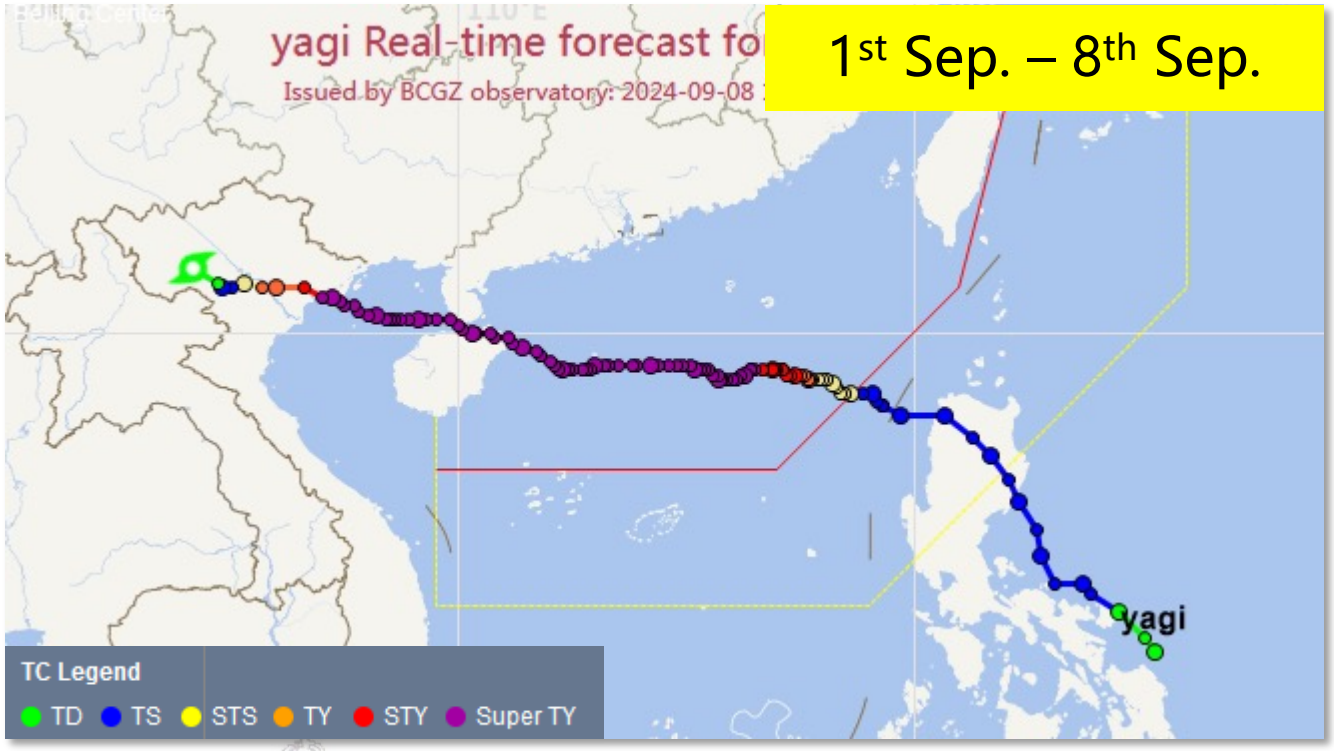
➢ Daily time / usual work

- Update the emergency response plan regularly
- Training regularly
- Check and prepare disaster relief supplies & evacuation centers
- Science popularization efforts

➢ After the disasters

- Organize post disaster reconstruction

Super Typhoon Yagi

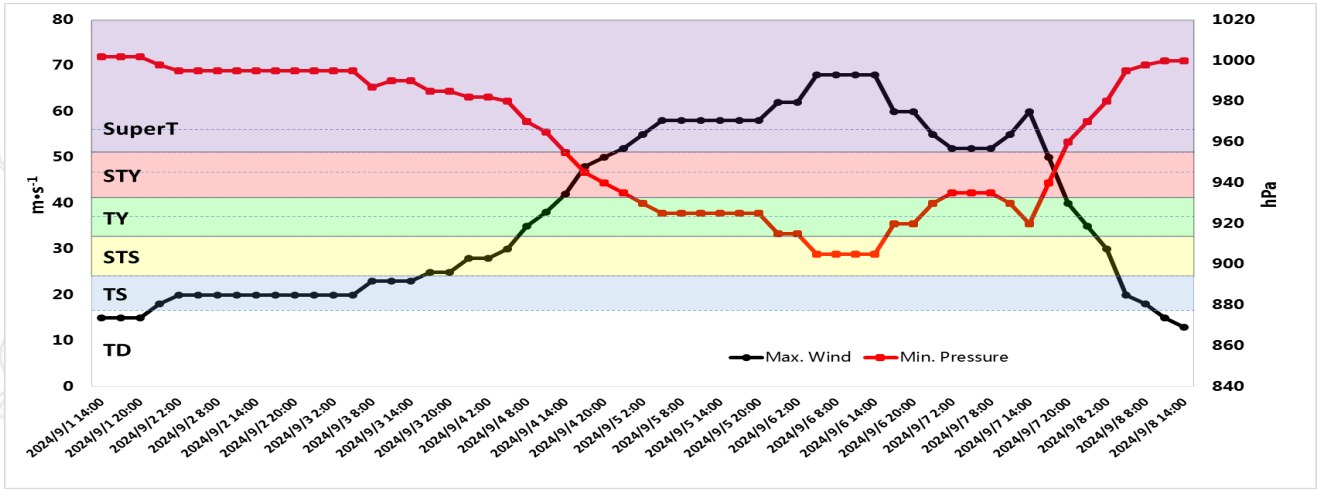


1. Extreme intensity

- Peak intensity: 68m·s^{-1}
- The strongest typhoon that has made landfall in China mainland in autumn
- Intensity of landfall:
  Hainan: 62m·s^{-1}, grade 17
  Guangdong: 58m·s^{-1}, grade 17
  Vietnam: 58m·s^{-1}, grade 17

2. Rapid Intensification

- 24hr: 28m·s^{-1}
- 12hr: 18m·s^{-1}



Super Typhoon Yagi

3. Destructive disaster

Fishery

Wind power

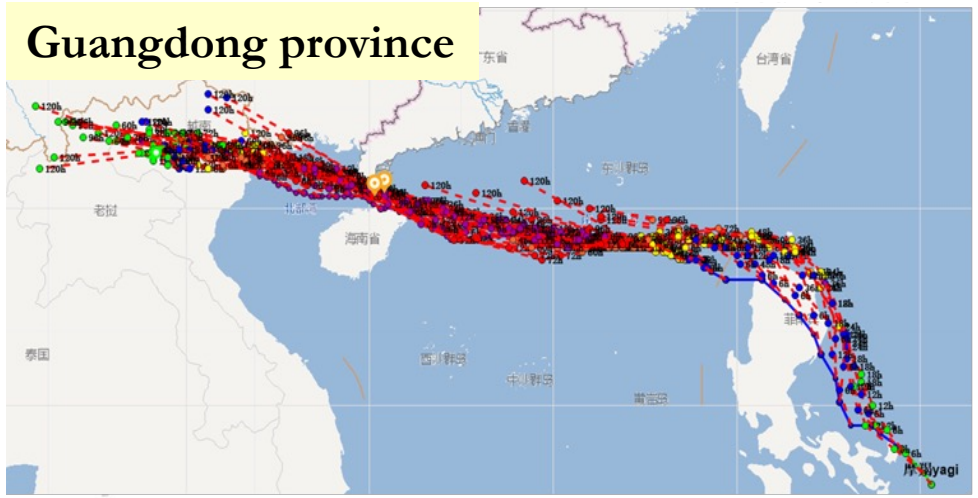
Agriculture & woods

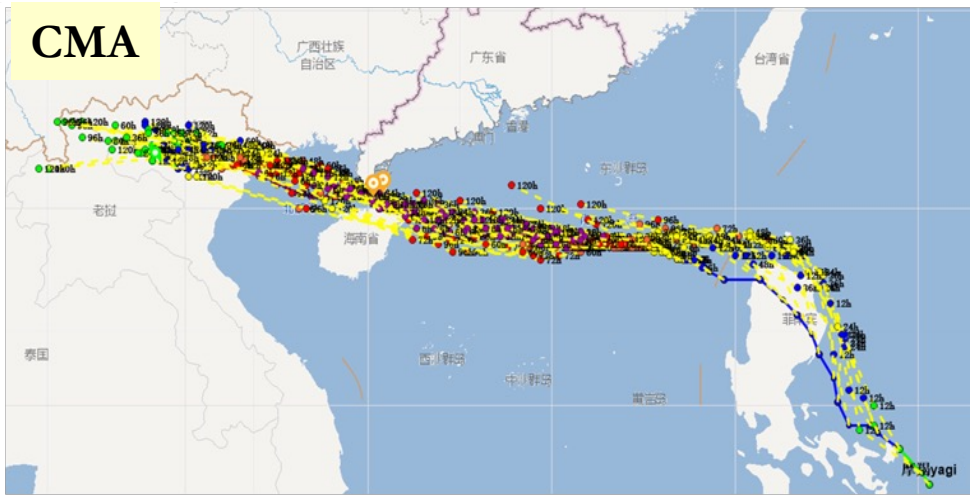
Vietnam

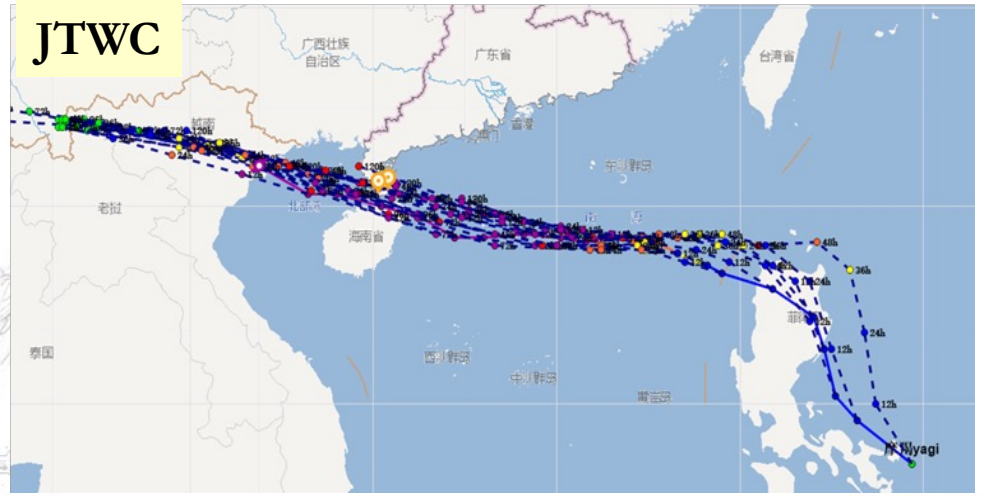
Thailand

Super Typhoon Yagi

- **Track forecasts of Yagi**





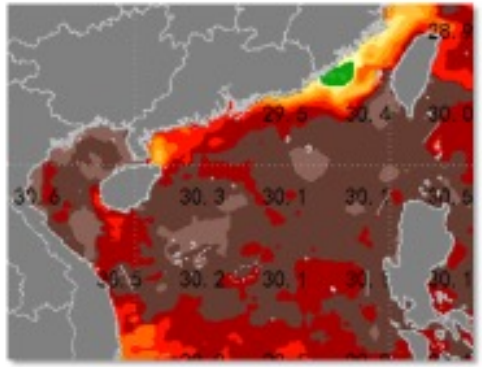


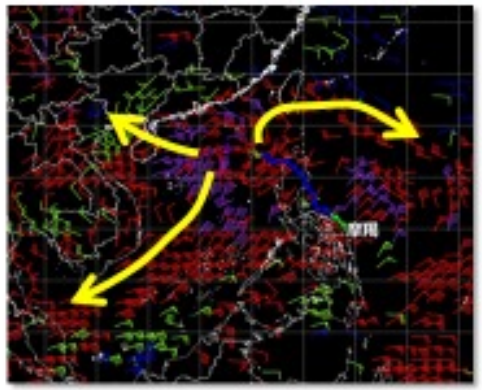
Super Typhoon Yagi

➢ Intensity forecasts of Yagi

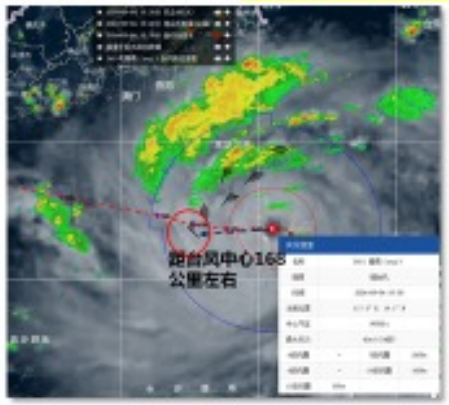
✓ Using FY4/FY3 satellite, Dual-Pol Doppler weather radar, NWP, Dropsonde by CMA(STI) and HKO

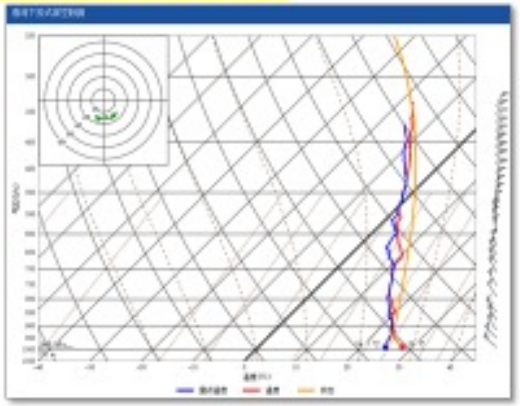
Yagi will intensify rapidly and continuously





南海协同观测试验飞行下投探空

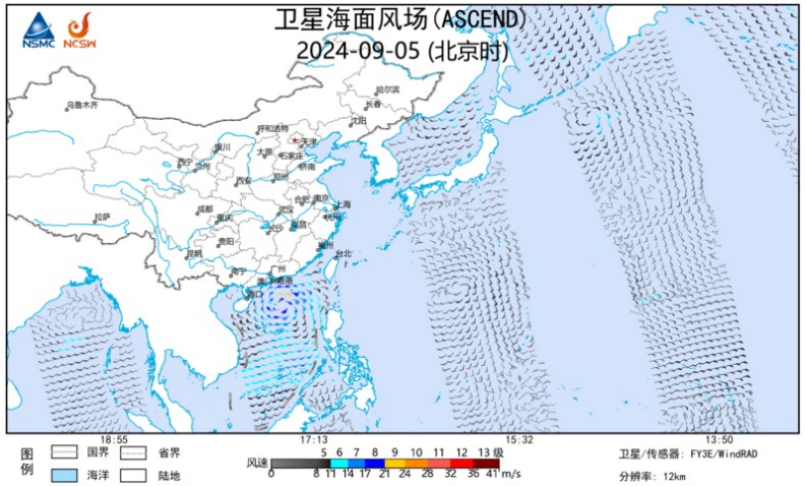




- 卫星探测反映结构对称、眼区对流旺盛
- 南海协同观测试验风圈预报基本吻合，路径前方环境垂直风切变小
- 大气、海洋环境有利略有加强

The slide used for analysis of Yagi at consultation video meeting with CMA

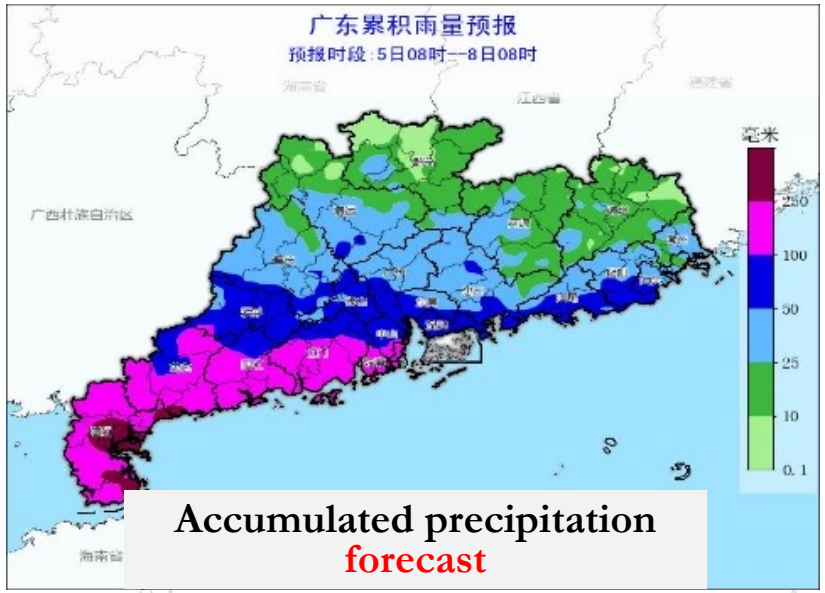
Surface wind by FY3E

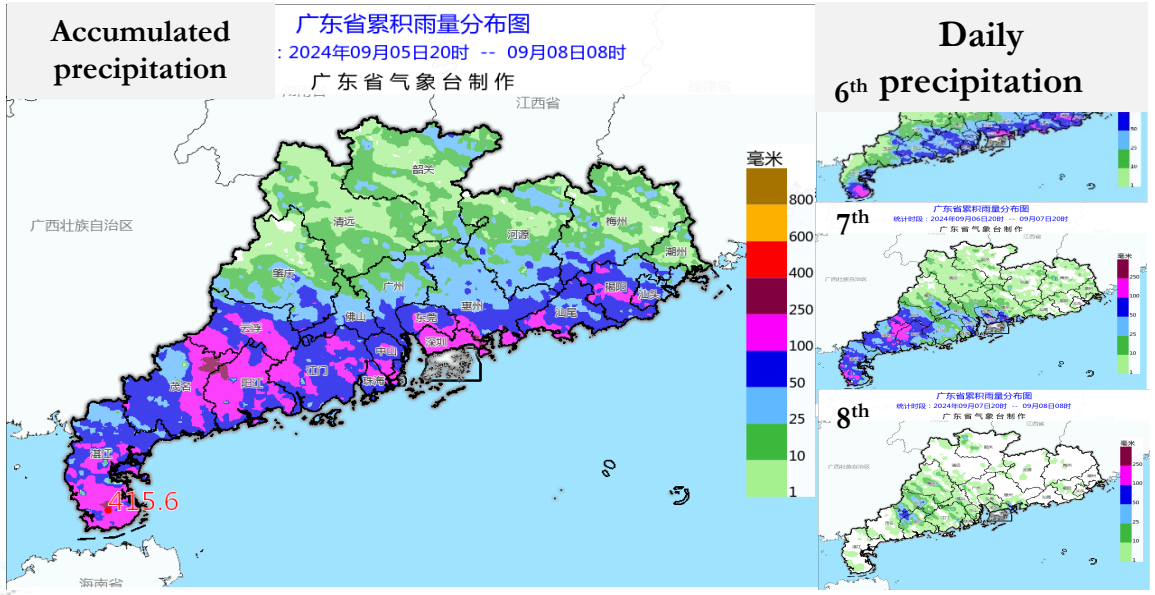


Super Typhoon Yagi

➢ Rainfall forecasts of Yagi

✓ Accurate rainfall forecast: duration, area, accumulated precipitation & maximum precipitation.





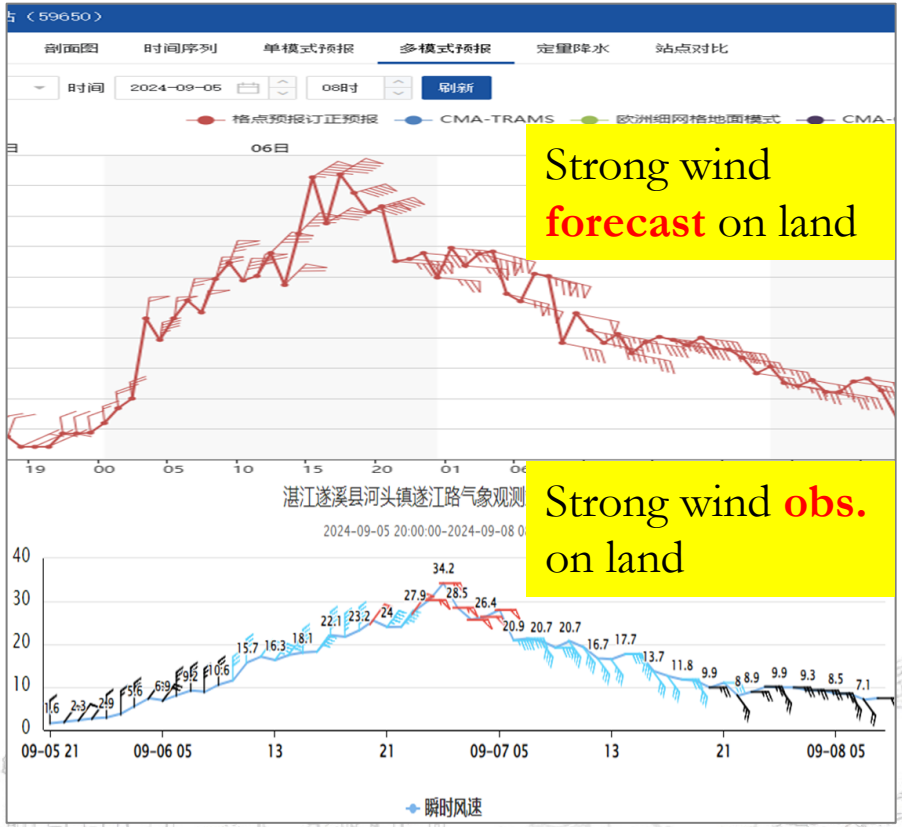
24hr TS of heavy rainfall

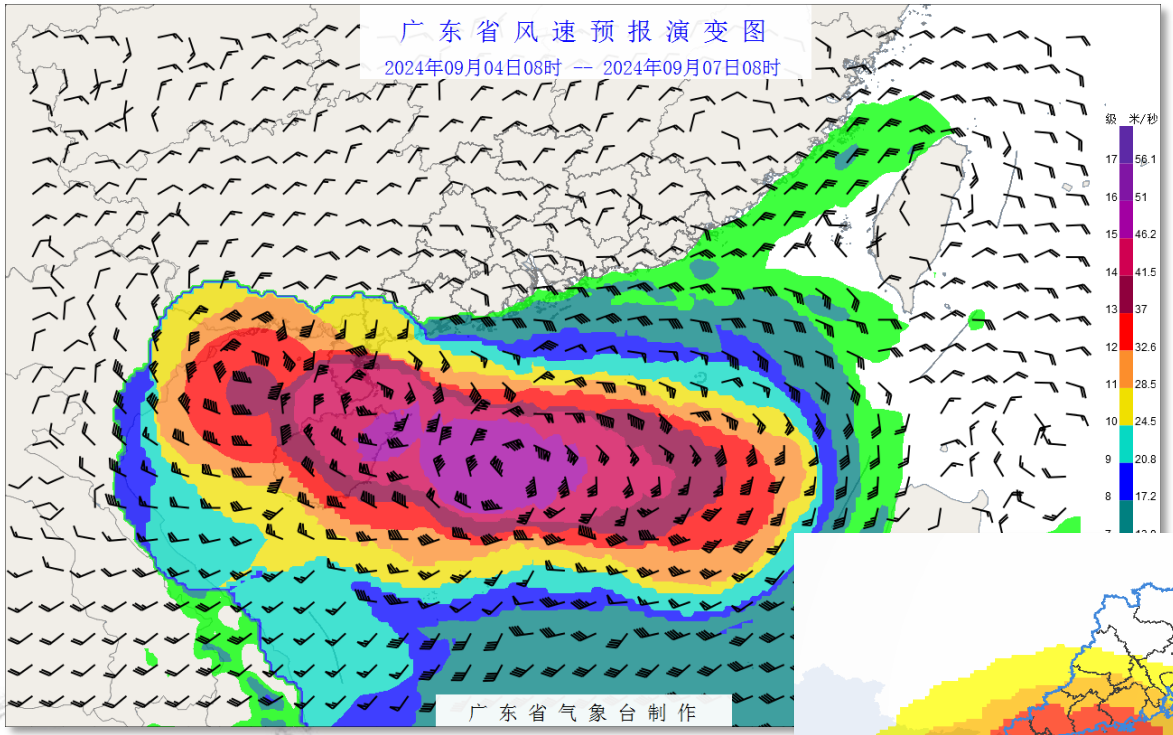
Initial time	Guangdong	CMA	ECMWF	NCEP	CMA-GFS	CMA-MESO	CMA-TRAMS	CMA-GD	CMA-GD(MT)	Interpretation method
08h+20h	**0.31**	0.34	0.22	0.23	0.26	0.25	0.35	0.26	0.26	0.39
08h	**0.36**	0.31	0.29	0.32	0.34	0.22	0.38	0.29	0.30	0.38
20h	**0.26**	0.36	0.16	0.16	0.18	0.28	0.33	0.24	0.22	0.40

Super Typhoon Yagi

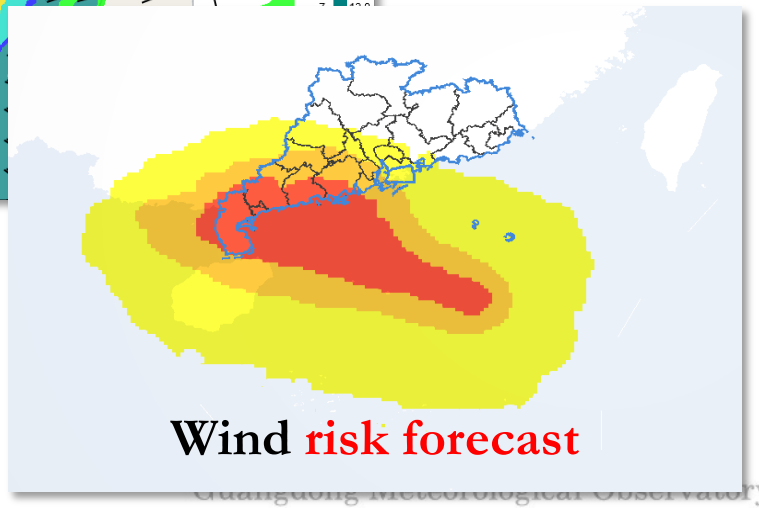
➢ Strong wind forecasts of Yagi

✓ Accurate strong wind forecast: all the vessels return to port in time





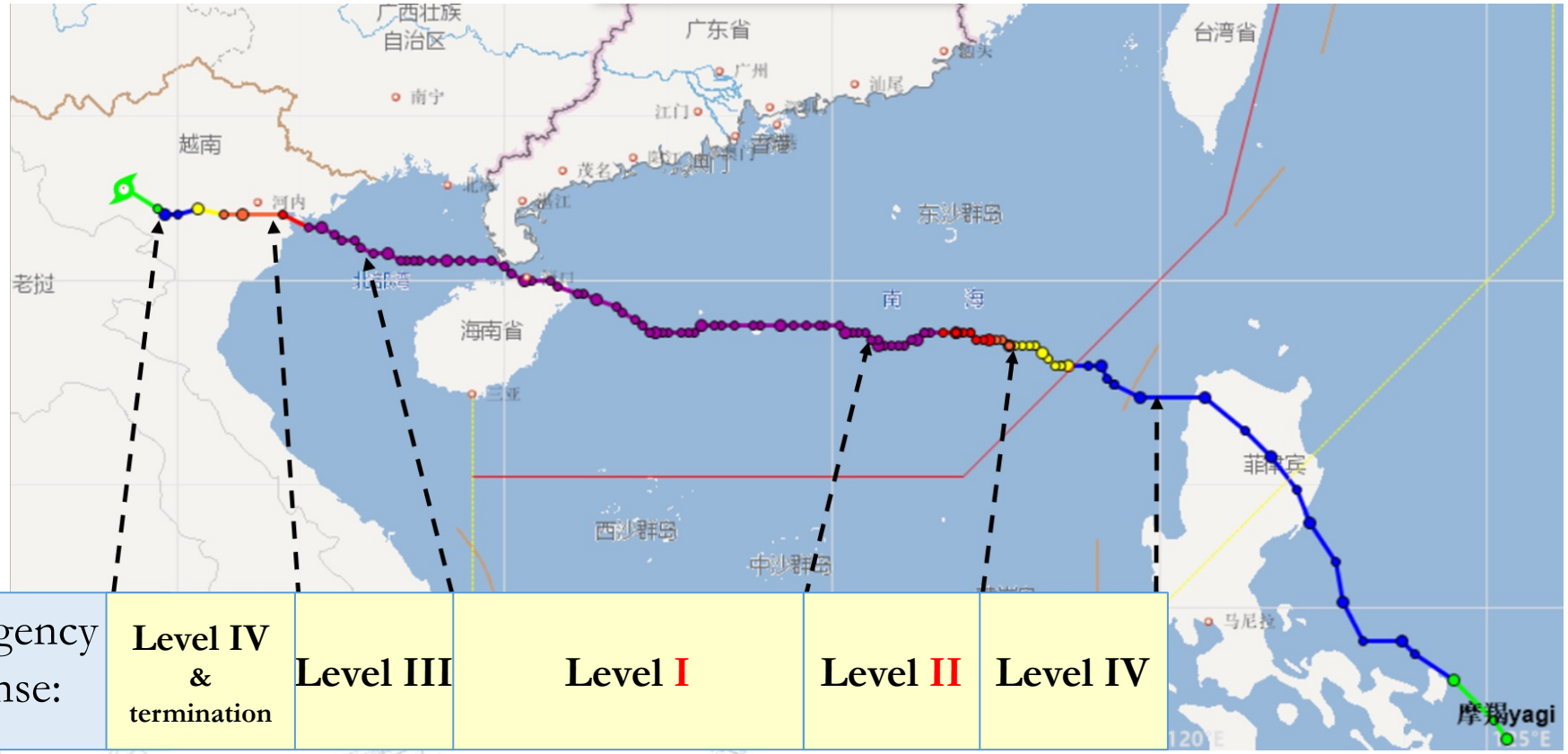
Strong wind forecast



Wind risk forecast

Super Typhoon Yagi

- **Timeline of the emergency response levels**



Super Typhoon Yagi

➢ **Timeline of forecast and emergency response levels**

Emergency response: level IV | level Ⅱ | level Ⅰ | level Ⅲ to IV | Termination

Formation of Yagi

From STS to SuperTY

16:20, make landfall at Hainan
22:20, make landfall at Guangdong

15:30, make landfall at Vietnam

17:00, dissipation of Yagi

1st Sep. | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th

Forecast: strong wind will appear over the northern part of the SCS

Forecast: Yagi will move to the area of Hainan and the southwestern Guangdong

Forecast: will make landfall in 6th

Forecast: will hit Leizhou peninsula

Forecast:: will be the strongest typhoon that make landfall in China mainland

Brief review of Yagi

Consultation on Yagi with government, emergency management department, etc face-to-face(5 times) or online(10 times)b

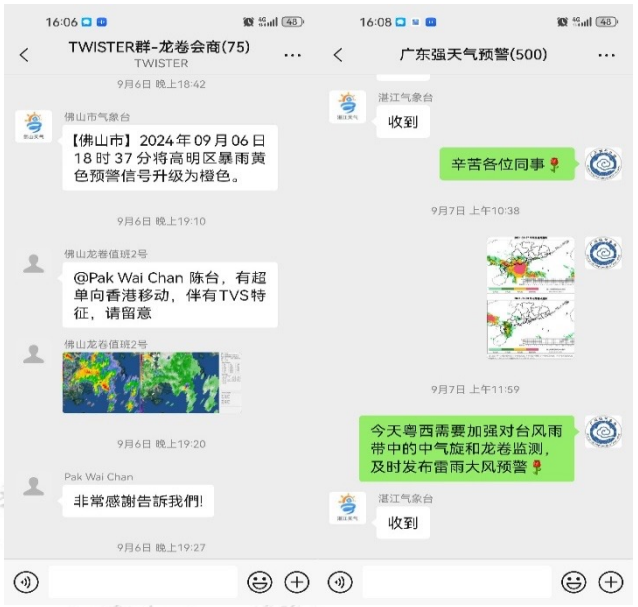
Super Typhoon Yagi

➢ Consultation with CMA and other provinces/cities

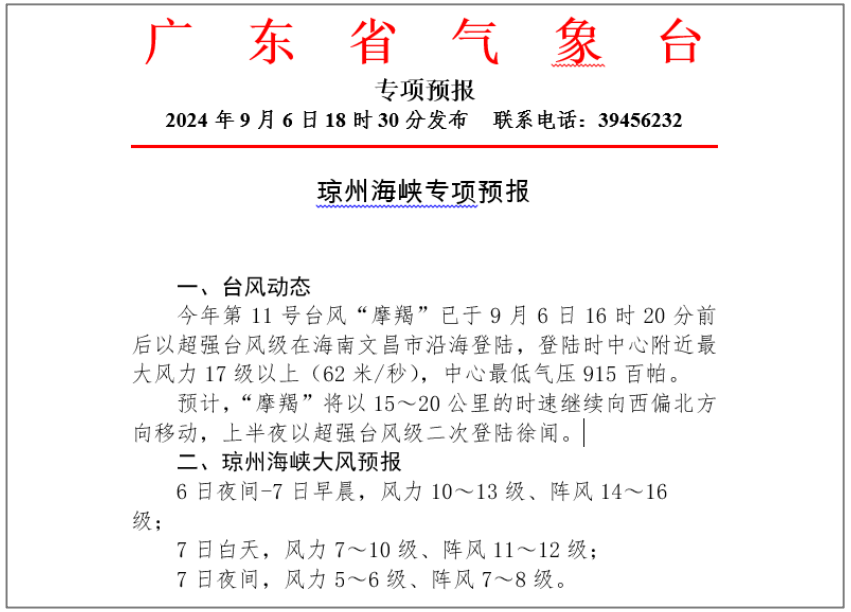
Emergency response: level IV　level Ⅱ　level Ⅰ　level Ⅲ to IV　Termination

1st Sep.　2nd　3rd　4th　5th　6th　7th　8th

Weather consultation video meeting with CMA **from 2nd to 6th**



Consultation via WeChat with other cities anytime



广　东　省　气　象　台

专项预报

2024 年 9 月 6 日 18 时 30 分发布　联系电话：39456232

琼州海峡专项预报

一、台风动态

今年第 11 号台风“摩羯”已于 9 月 6 日 16 时 20 分前后以超强台风级在海南文昌市沿海登陆，登陆时中心附近最大风力 17 级以上（62 米/秒），中心最低气压 915 百帕。

预计，“摩羯”将以 15～20 公里的时速继续向西偏北方向移动，上半夜以超强台风级二次登陆徐闻。

二、琼州海峡大风预报

6 日夜间-7 日早晨，风力 10～13 级、阵风 14～16 级；

7 日白天，风力 7～10 级、阵风 11～12 级；

7 日夜间，风力 5～6 级、阵风 7～8 级。

Specialized weather report for Qiongzhou Strait

Super Typhoon Yagi

➢ Monitoring and alert of the tornado

Emergency response: level IV | level Ⅱ | level Ⅰ | level Ⅲ to IV | Termination

1st Sep. | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th

广东省天气会商安排表

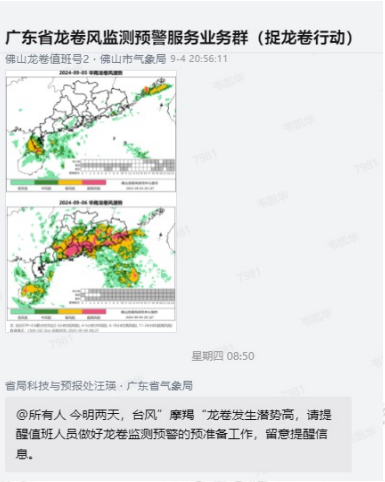
会商时间：2024年9月4日（星期三 9:30—10:00）

主 会 场：预警中心二楼会商室（020 - 39456361）

主 持 人：杨国杰

发言时间	发言单位	会商重点
3分钟	陆地岗—于玲玲	3+2天气 台风、高温、强降水（强对流）
3分钟	佛山市气象台	
3分钟	湛江市气象台	
3分钟	广州市气象台	
5分钟	首席岗—杨国杰	

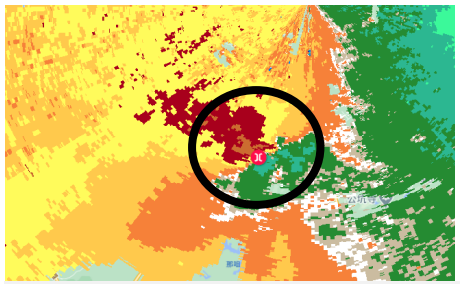
Daily weather consultation in Guangdong province



24 - 48hr Potential of tornado

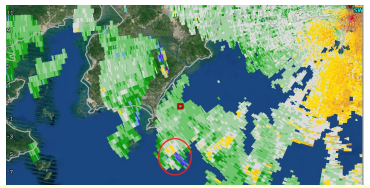
2-6hr nowcasting

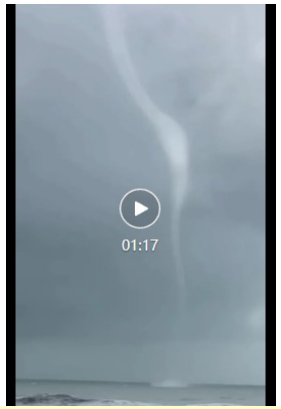
With HKO



Meso-cyclone & TVS. Alert

[鹤山雷雨大风橙色预警]预计未来1小时鹤山有强雷雨，伴有10级以上阵风和局地龙卷，鹤山市气象台2024年9月6日4时55分发布雷雨大风橙色预警信号，请注意防御。[鹤山市突发事件预警信息发布中心]





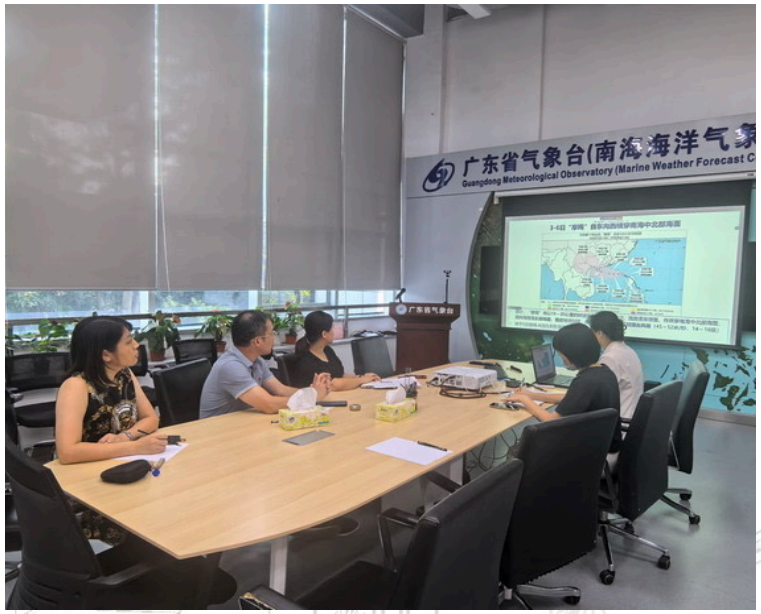
Post tornado analysis & investigation

Super Typhoon Yagi

➢ **Services for different departments, co. and corp.**

Emergency response: level IV level Ⅱ level Ⅰ level Ⅲ to IV Termination

1st Sep. 2nd 3rd 4th 5th 6th 7th 8th



Weather services for Marine Ranching

Weather services for electronic & energetic departments

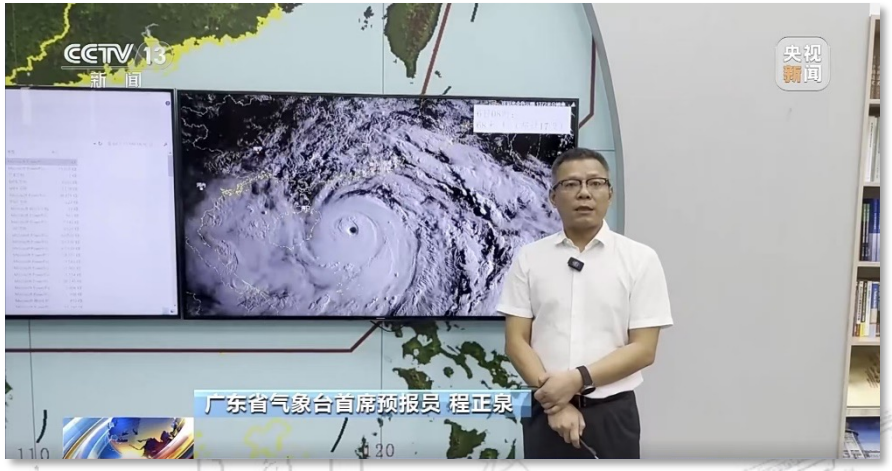
Weather services for Traffic department (Train & Metro)

Super Typhoon Yagi

➢ Public science communication efforts

Emergency response: level IV | level Ⅱ | level Ⅰ | level Ⅲ to IV | Termination

1st Sep. 2nd 3rd 4th 5th 6th 7th 8th



Convey the **latest information of Yagi** to the public **via media** (CCTV etc.)

Inform the public **how severe Yagi is**

Thanks for your attention!