National Satellite
Meteorological Center
(National Center for Space Weather)

Leveraging Fengyun (FY) Satellite Capabilities for Advanced Typhoon Monitoring and Analysis

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Outline

The Critical Role of Satellites in Typhoon Monitoring

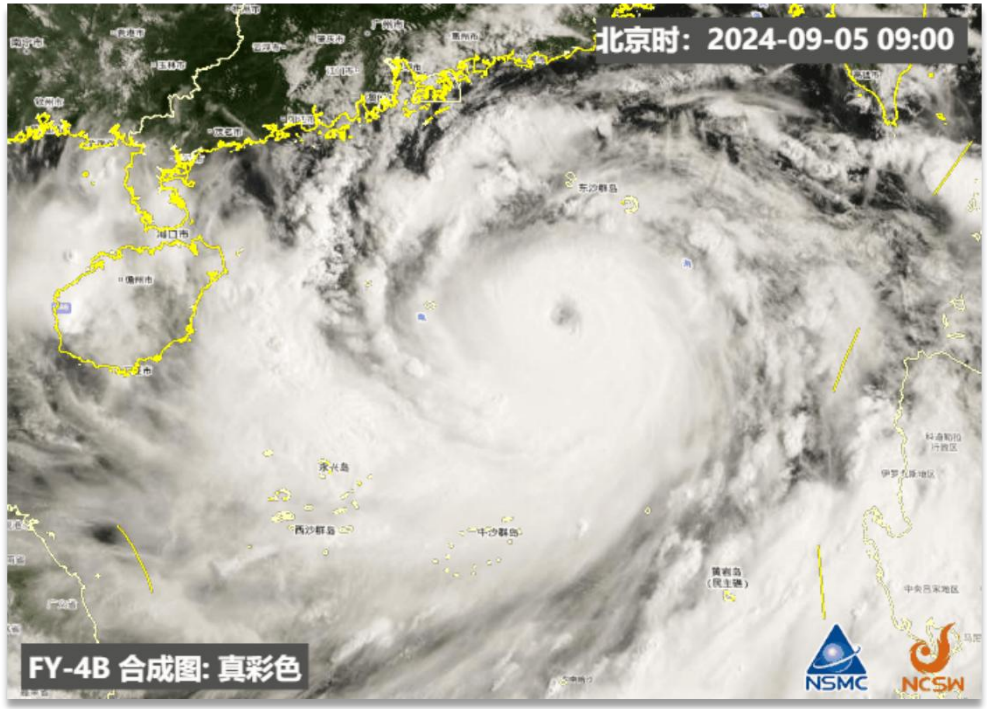
Typhoons are one of the most devastating natural disasters in the world

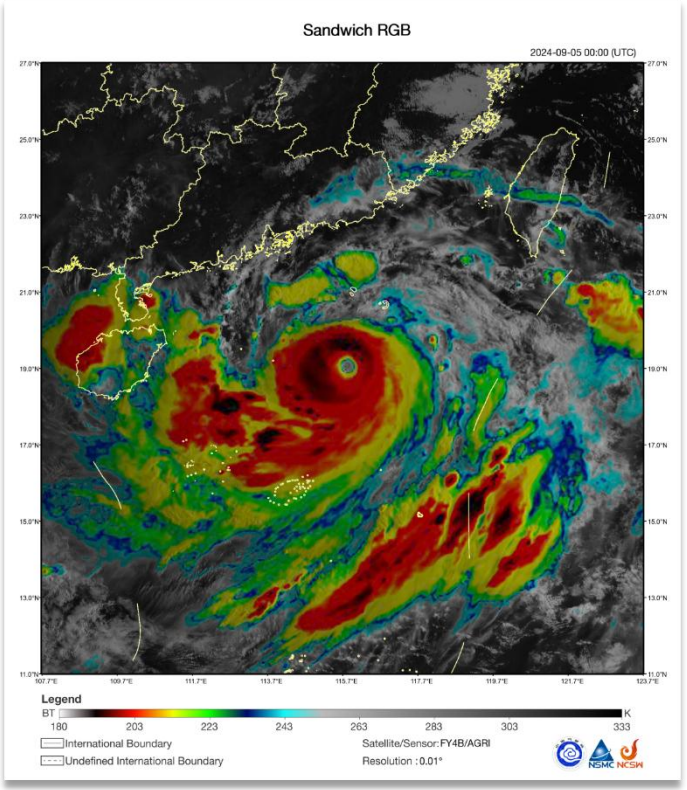
- **Direct disasters caused by typhoons: strong winds, heavy rain, and storm surges**

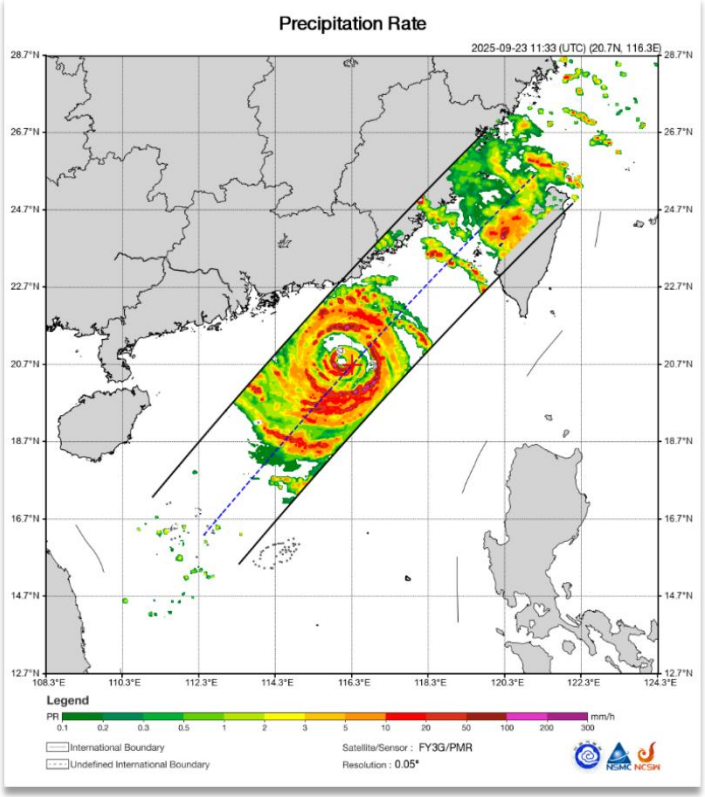
- **On July 27, 2023, Typhoon Doksuri exerted sweeping impacts on China. The CMA activated its Level-I emergency response**

The Critical Role of Satellites in Typhoon Monitoring

Continuous, Flexible, High-precision







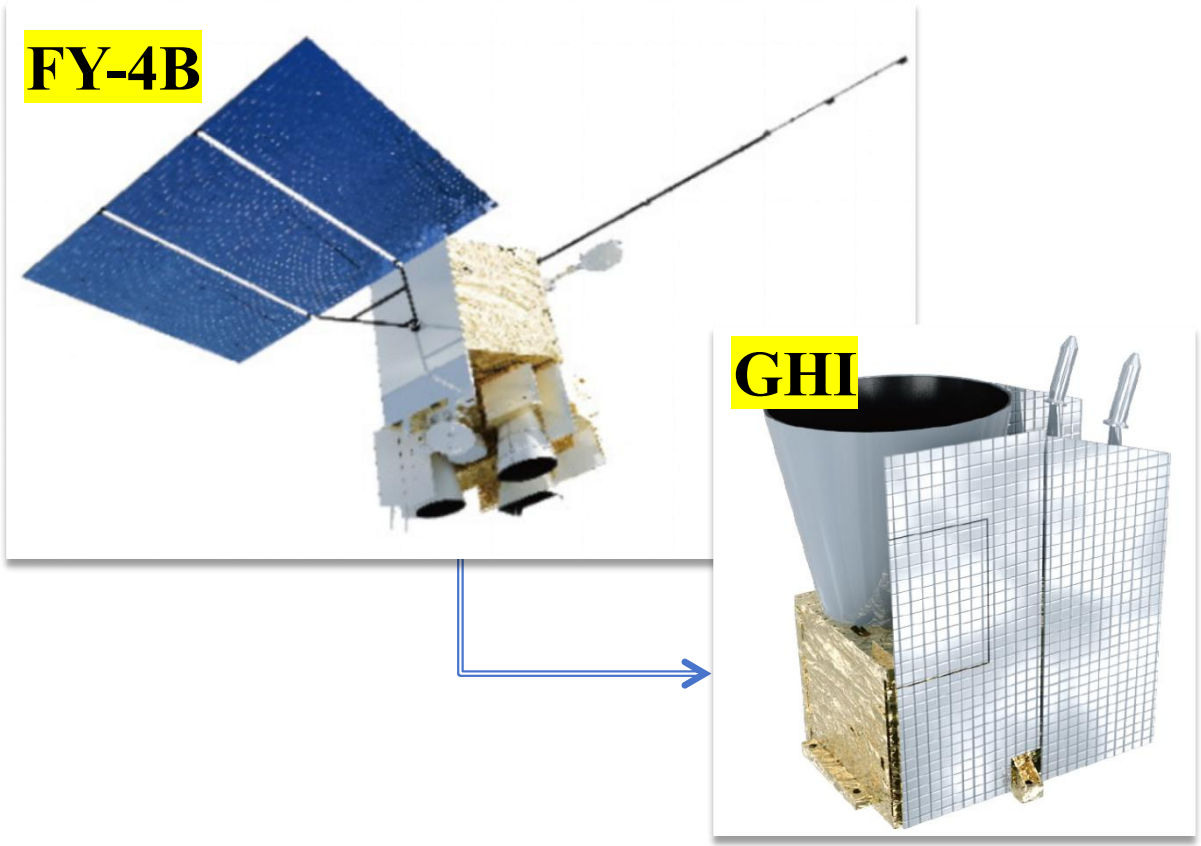
Geostationary Satellites:

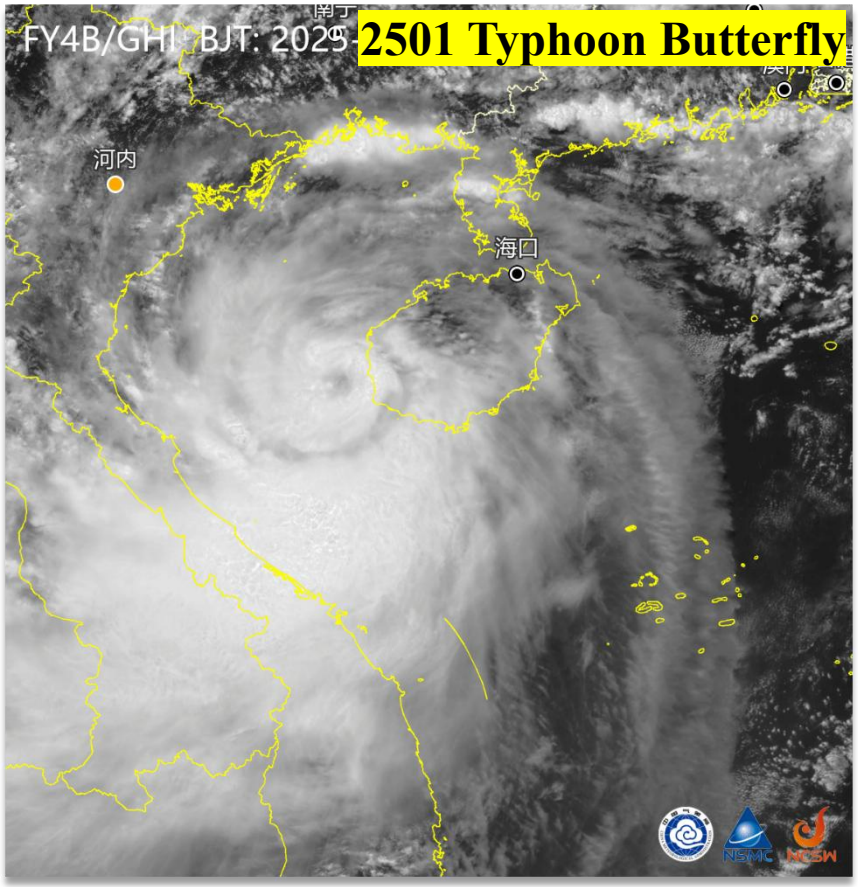
- ✓ Typhoon's cloud features
- ✓ Real-time identification of typhoon position and intensity
- ✓ Continuous monitoring of landfall timing and location

Polar-orbiting Satellites :

- ✓ Internal thermodynamic and cloud-precipitation structures
- ✓ Large-Scale Circulation Background Monitoring

FY Satellite Series——FY-4B

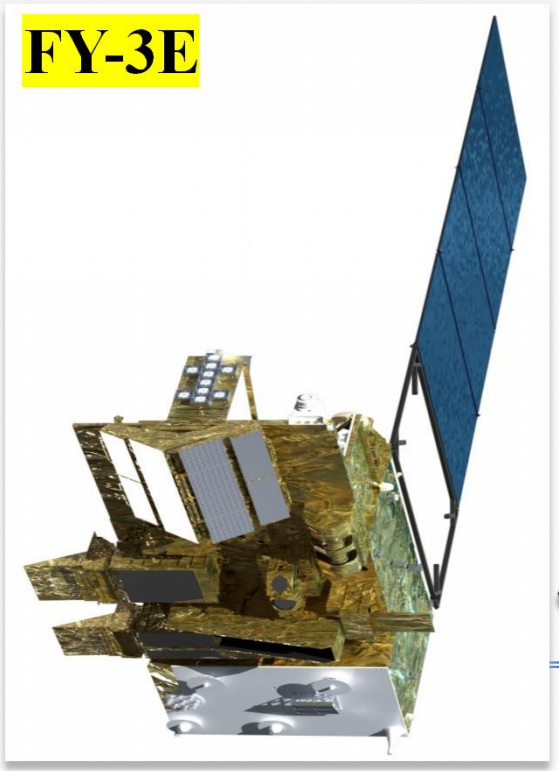




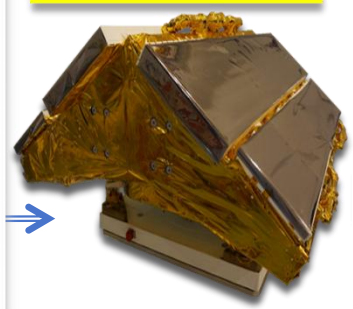
Geo High-speed Imager (GHI)

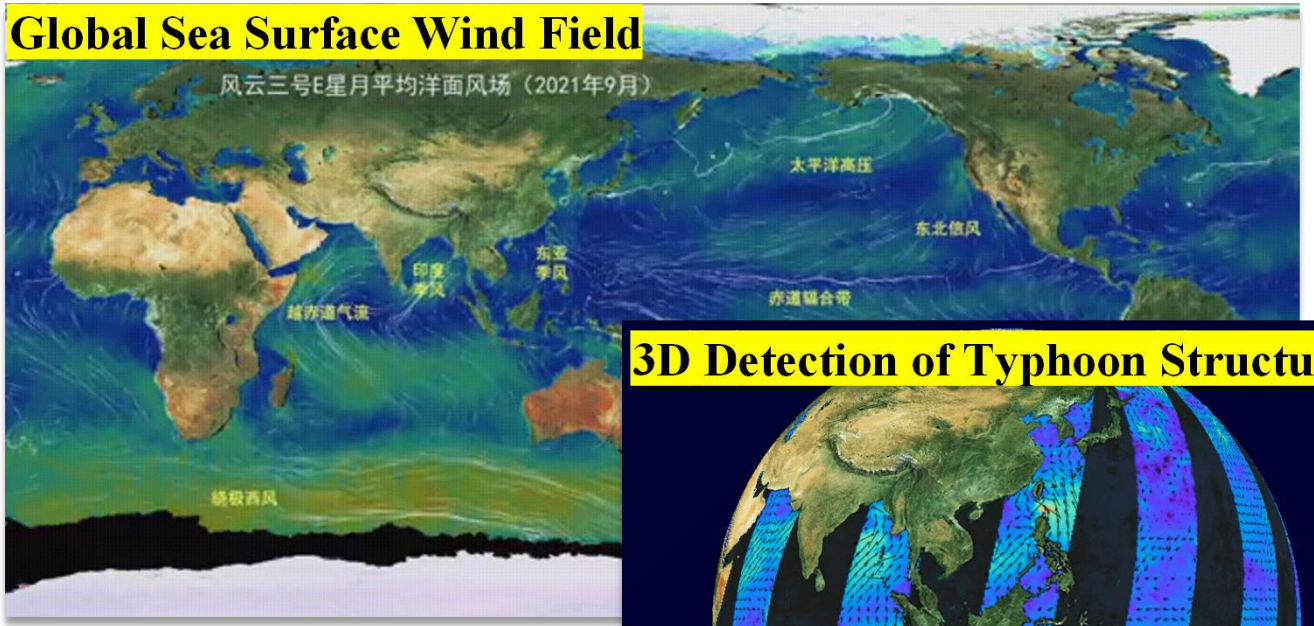
- ✓ **Key Feature:** Achieves 250-meter spatial resolution with 1-minute
- ✓ Primary Application: Improves tracking and monitoring of severe weather systems

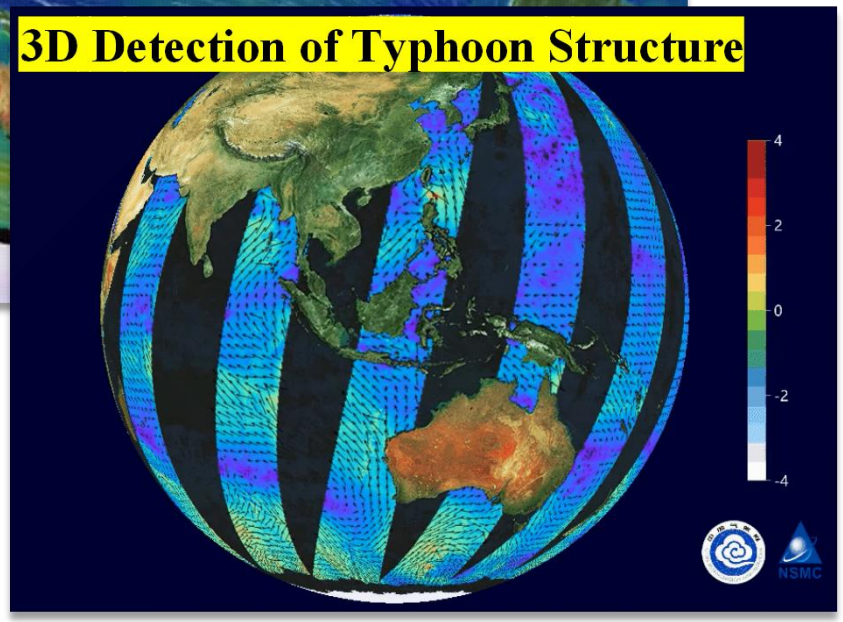
FY Satellite Series——FY-3E



WindRAD





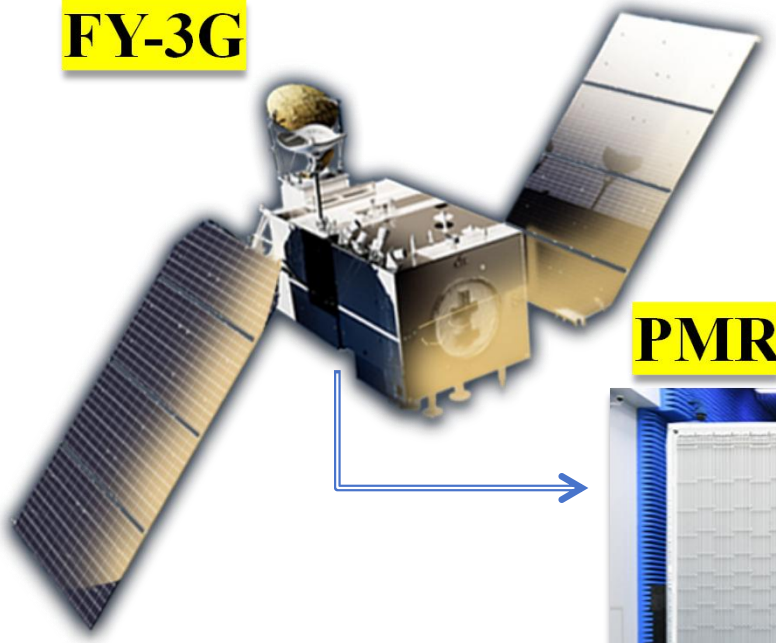


Wind Radar (WindRAD):

- ✓ **Key Feature:** A FY Satellite First, active detection of wind conditions
- ✓ Provision of direct and accurate initial field data for typhoon and rainstorm prediction

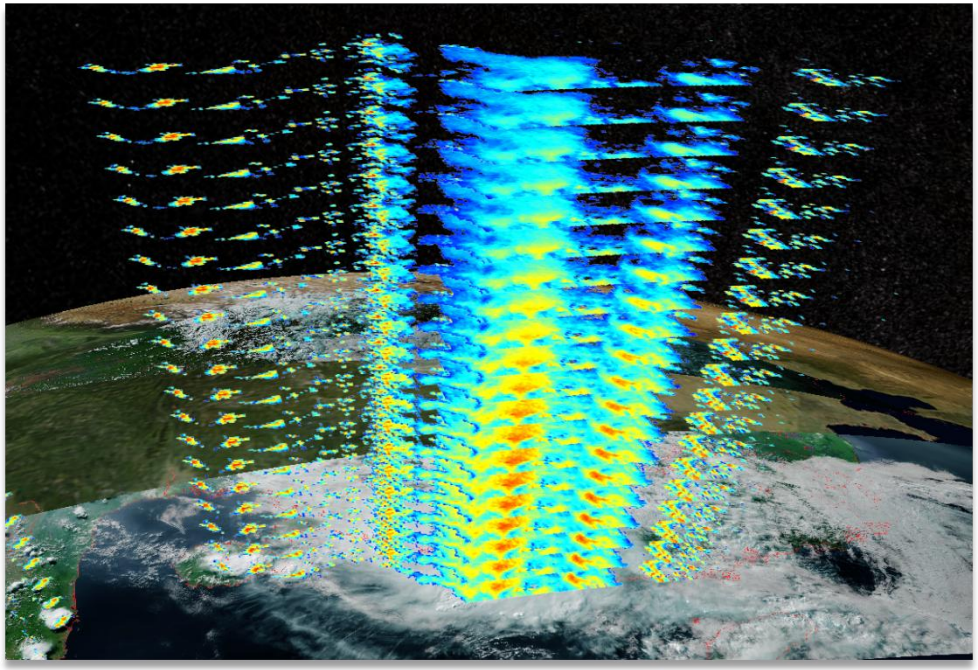
FY Satellite Series——FY-3G

FY-3G



PMR

3D Display of Precipitation During Typhoon Talim

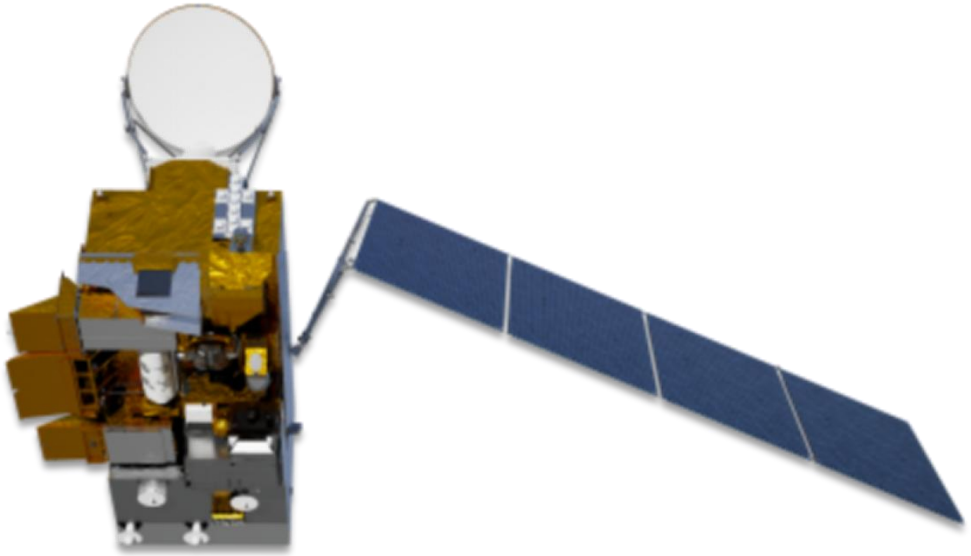


Precipitation Measuring Radar (PMR) :

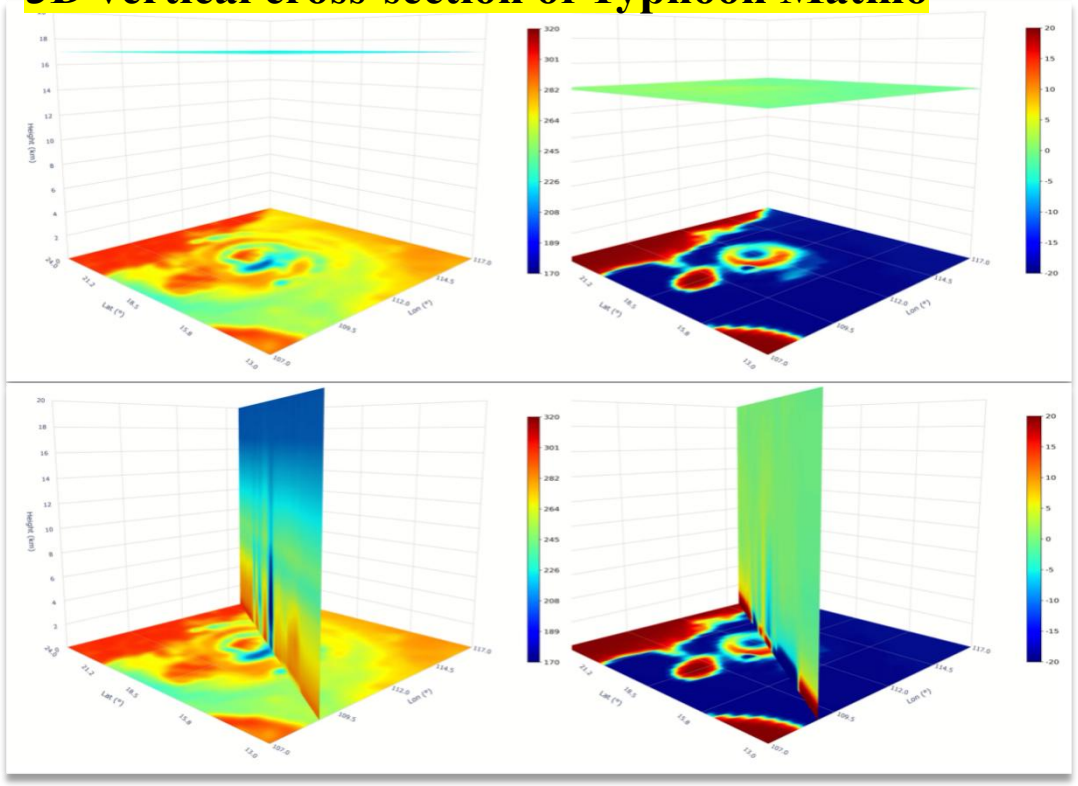
- ✓ **Key Feature:** First satellite-borne precipitation measuring radar
- ✓ monitor precipitation in catastrophic weather systems, and observe the internal 3D structure of typhoons, rainstorms, blizzards and other precipitation systems

FY Satellite Series——FY-3H

FY-3H

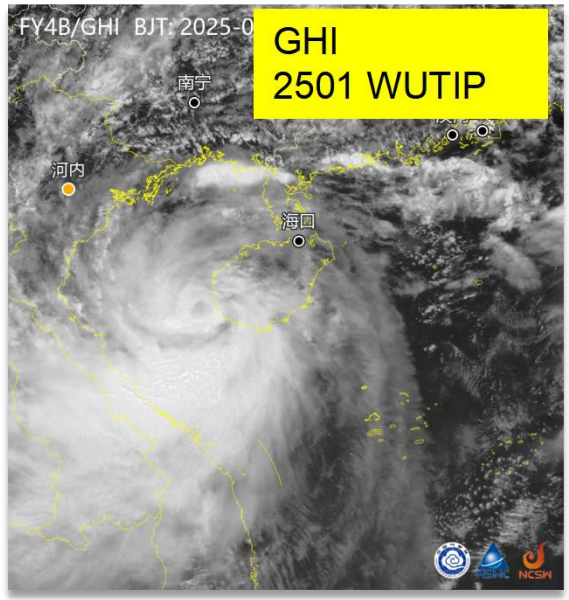


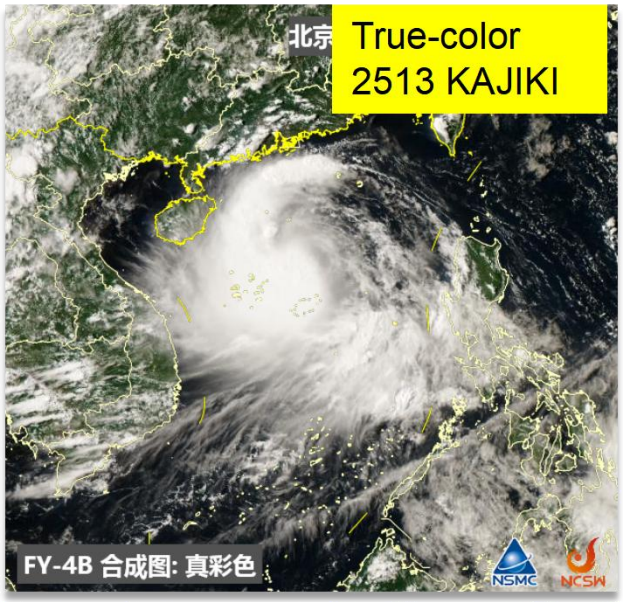
3D vertical cross-section of Typhoon Matmo

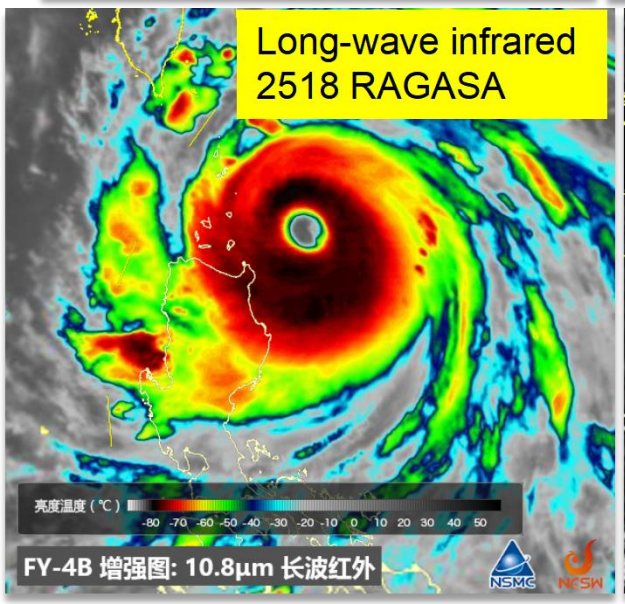


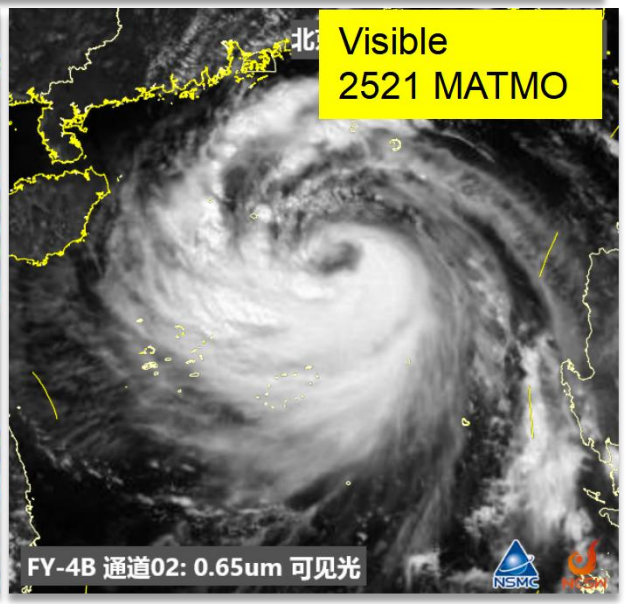
- ✓ **Key Feature:** coordinated observations from advancd microwave temperature and humidity sounders
- ✓ capture detailed internal profiles

Key Contributions of FY Satellites in Typhoon Monitoring and Analysis









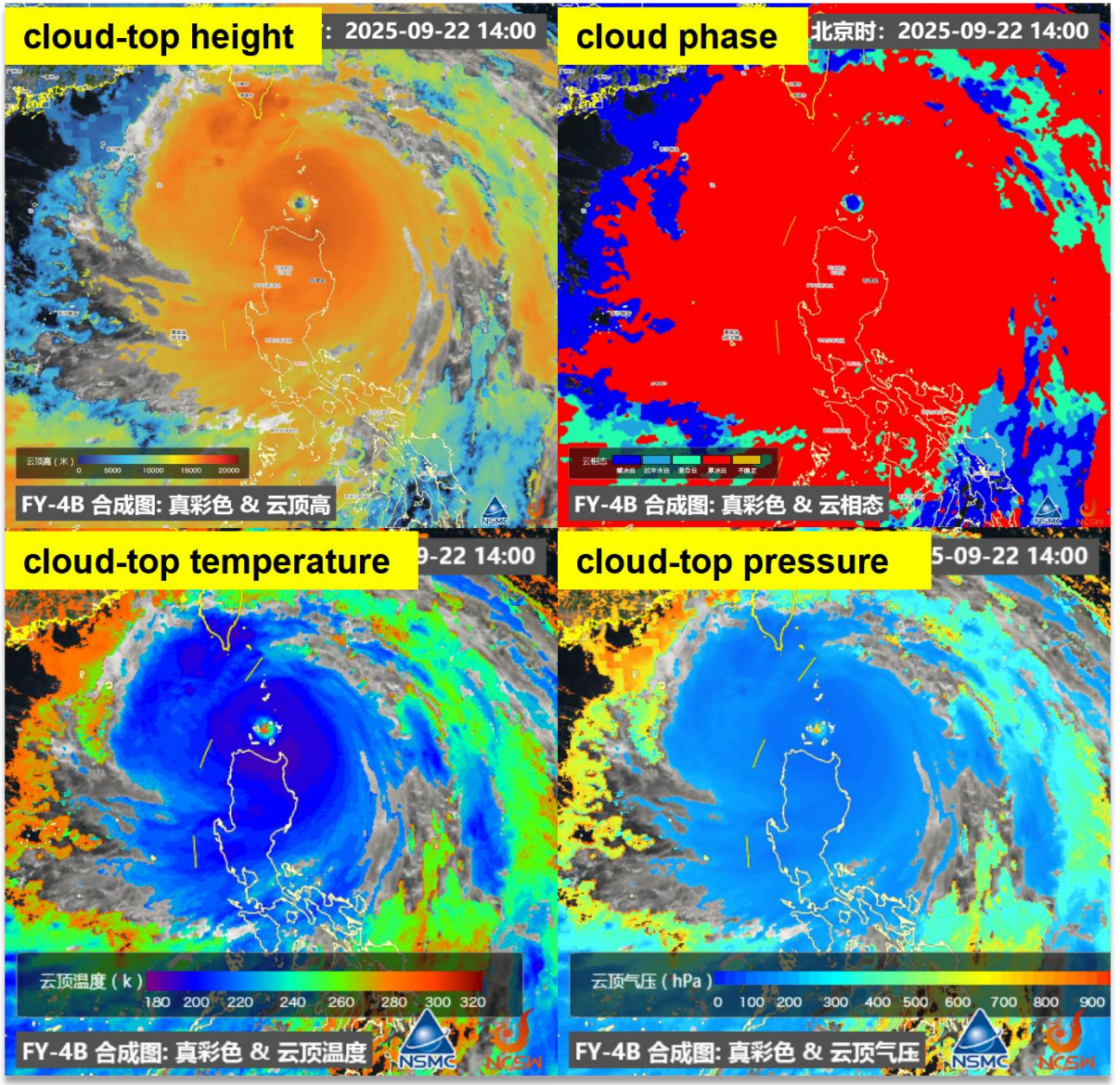
Cloud System Monitoring qualitative description

- Utilizing FY-4B/AGRI (visible, true-color, long-wave infrared imagery et al.) and GHI data
- **Qualitative characterization of typhoon cloud systems,** including their morphology, structure, and convective development

Cloud System Monitoring-quantitative analysis

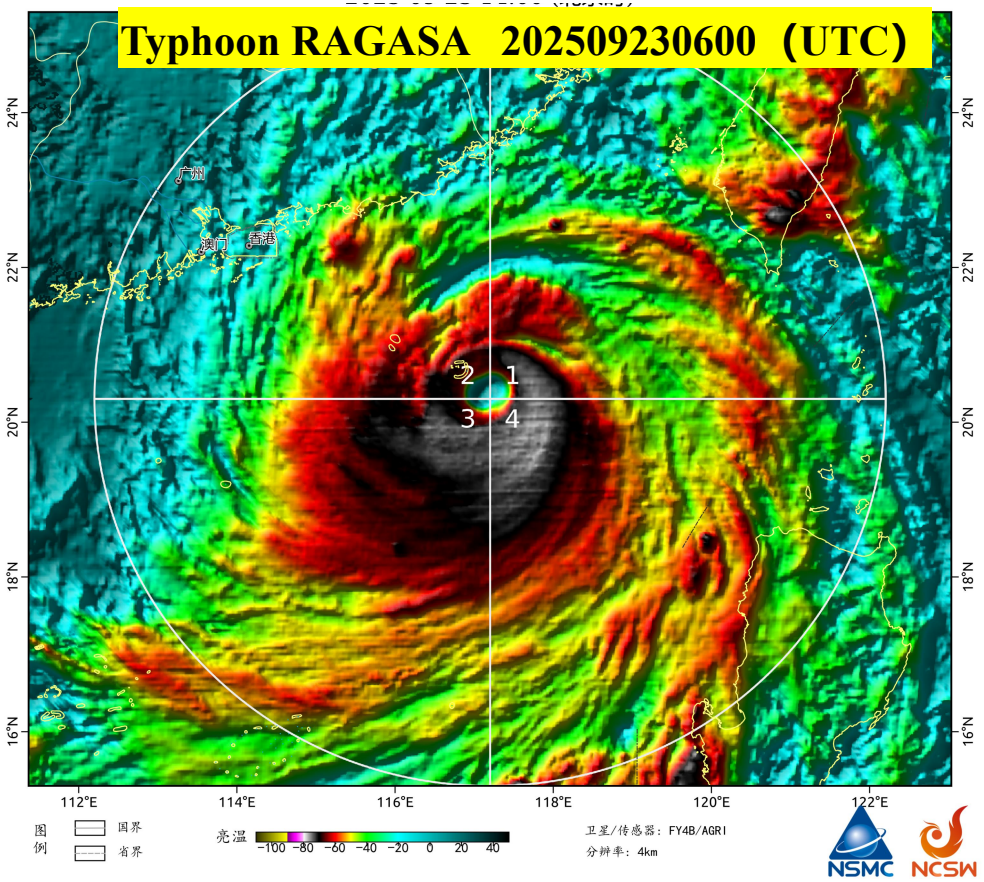
Quantitative analysis in Typhoon RAGASA was assessed by monitoring **cloud properties:**

- ✓ **Cloud-top height** exceeded 16 km;
- ✓ **Cloud-top temperatures** fell below 200 K;
- ✓ **Cloud-top pressure** reached 200 hPa;
- ✓ **Cloud-top phases** were primarily thick ice, indicating intense convection

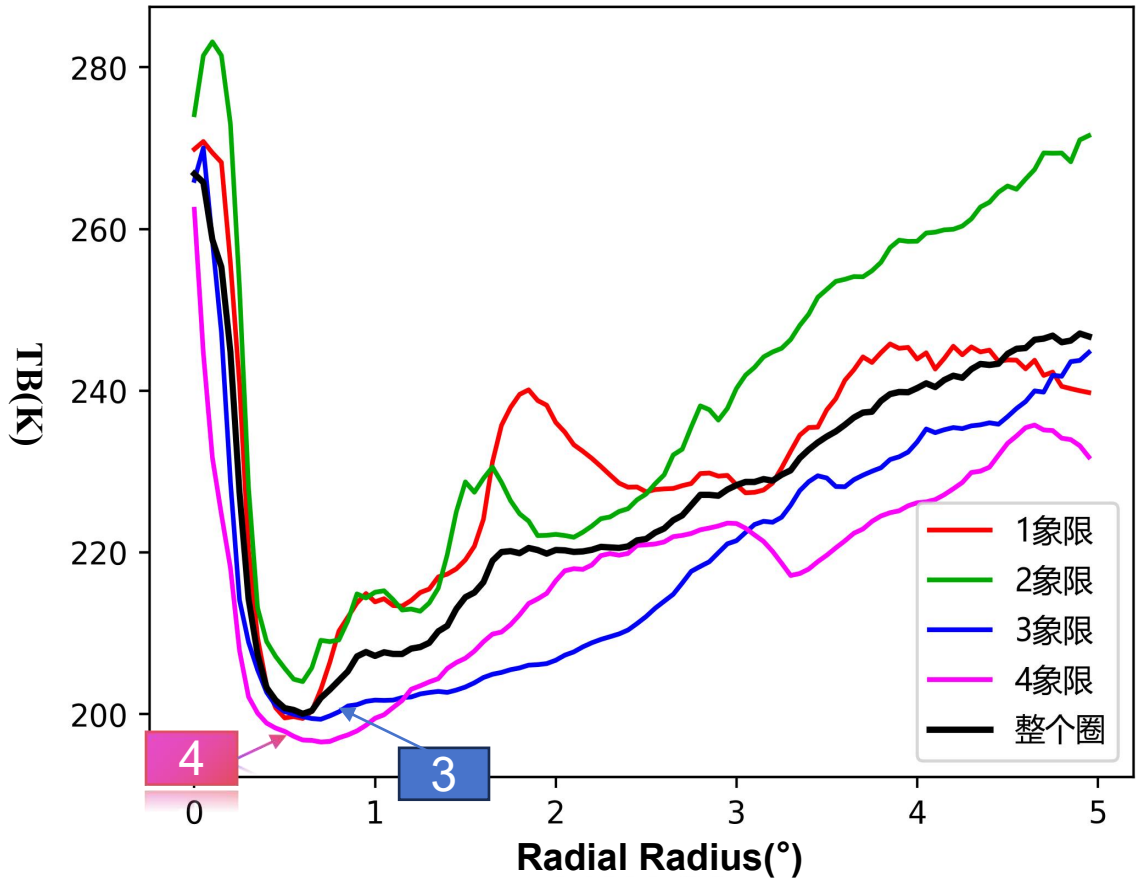


Cloud System Monitoring-quantitative analysis

: Four-quadrant analysis

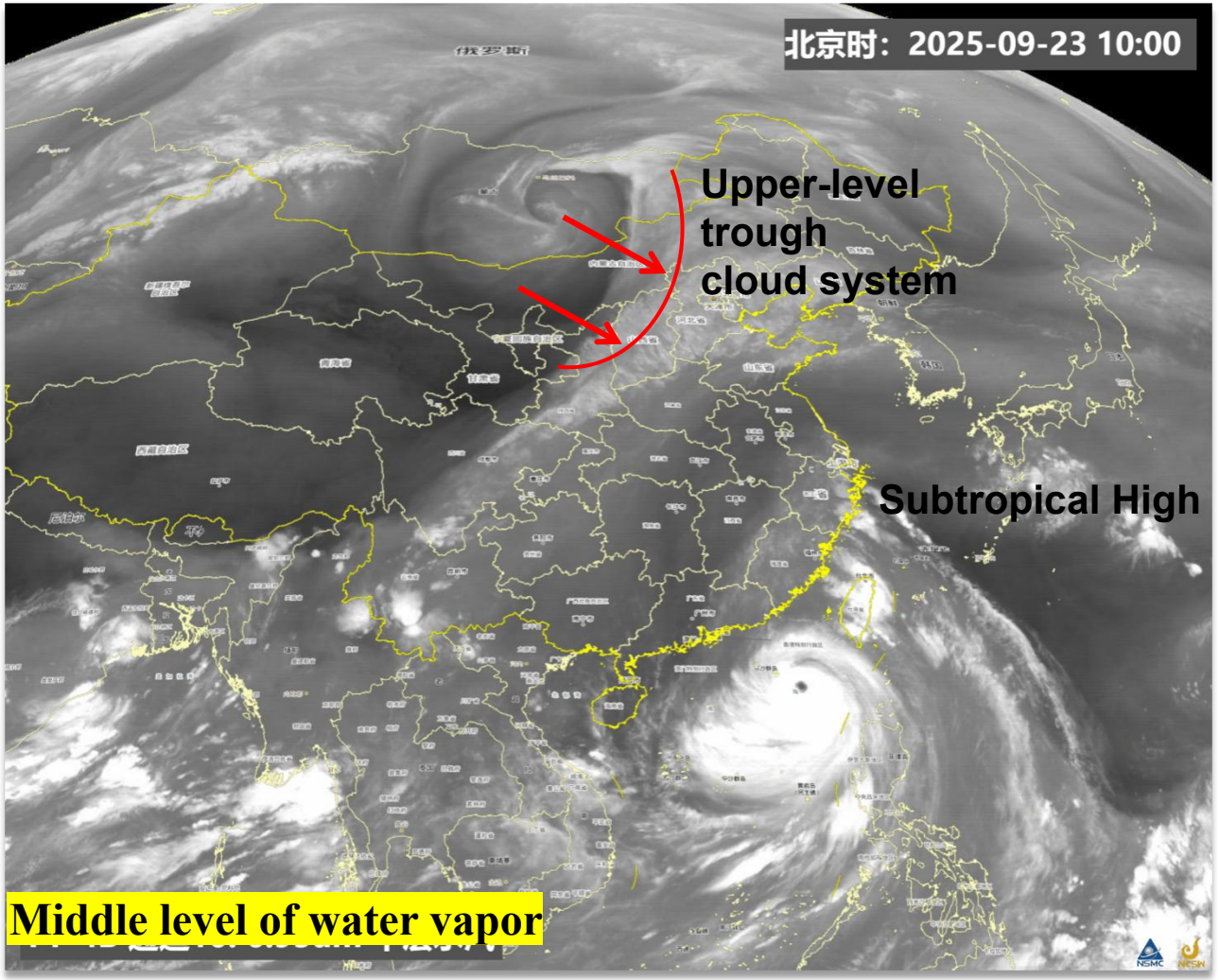


Radially averaged brightness temperature



- Typhoon RAGASA exhibited intense convection **in SW and SE quadrants**, with radial average brightness temperatures below 200 K

Large-Scale Circulation Background Monitoring

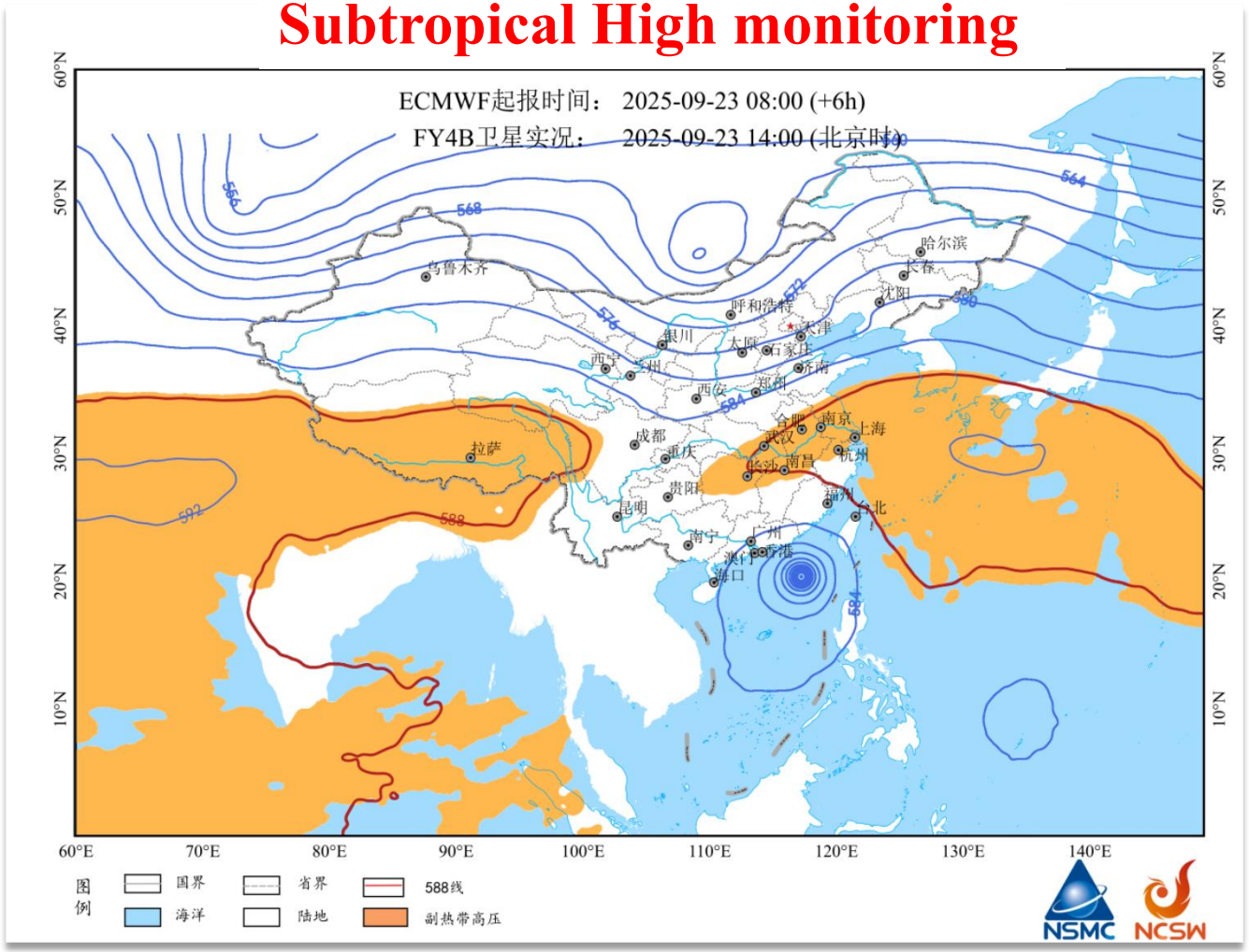


FY-4B Middle level of water vapor monitoring:

- With the stable western boundary of the **upper-level trough cloud system** to its north, Typhoon RAGASA experienced weak interactions
- **The northward shift of the subtropical high** likely contributed to an increased northward movement component in the typhoon's track

Large-Scale Circulation Background Monitoring

Subtropical High monitoring

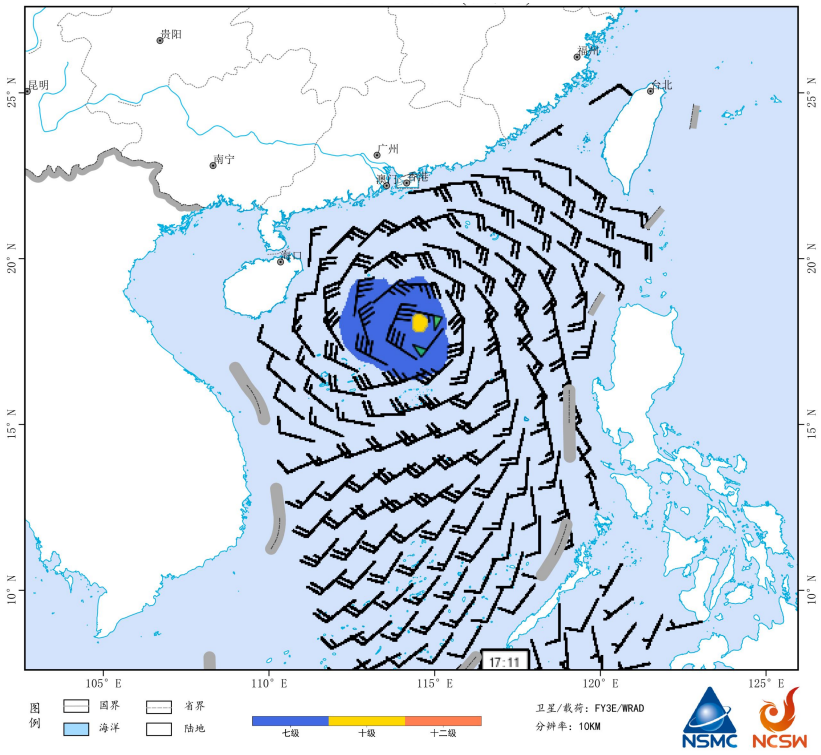


Typhoon RAGASA

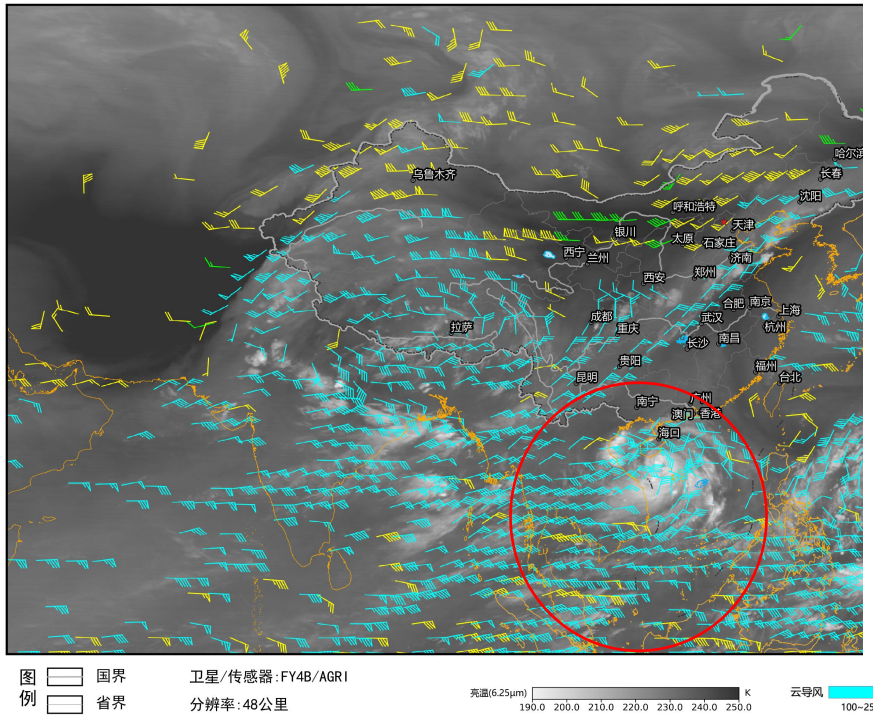
- The comparative analysis of **satellite imagery and model forecasts**
- the westward extent of the subtropical high range (**shaded regions in satellite**) exceeds the **model-predicted location (contour)**, which may contribute to sustaining the typhoon's westward movement

Dynamic structure Monitoring

FY-3E sea surface wind

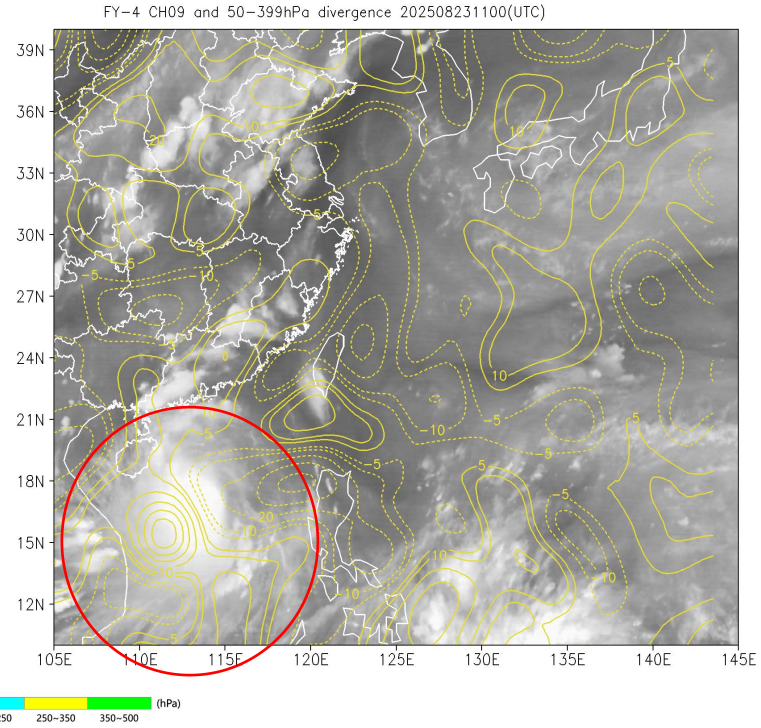


FY-4B upper-level atmospheric motion vectors（AMV）



FY-4B Divergence field

Convergence（dashed line）
Divergence（Solid Line）

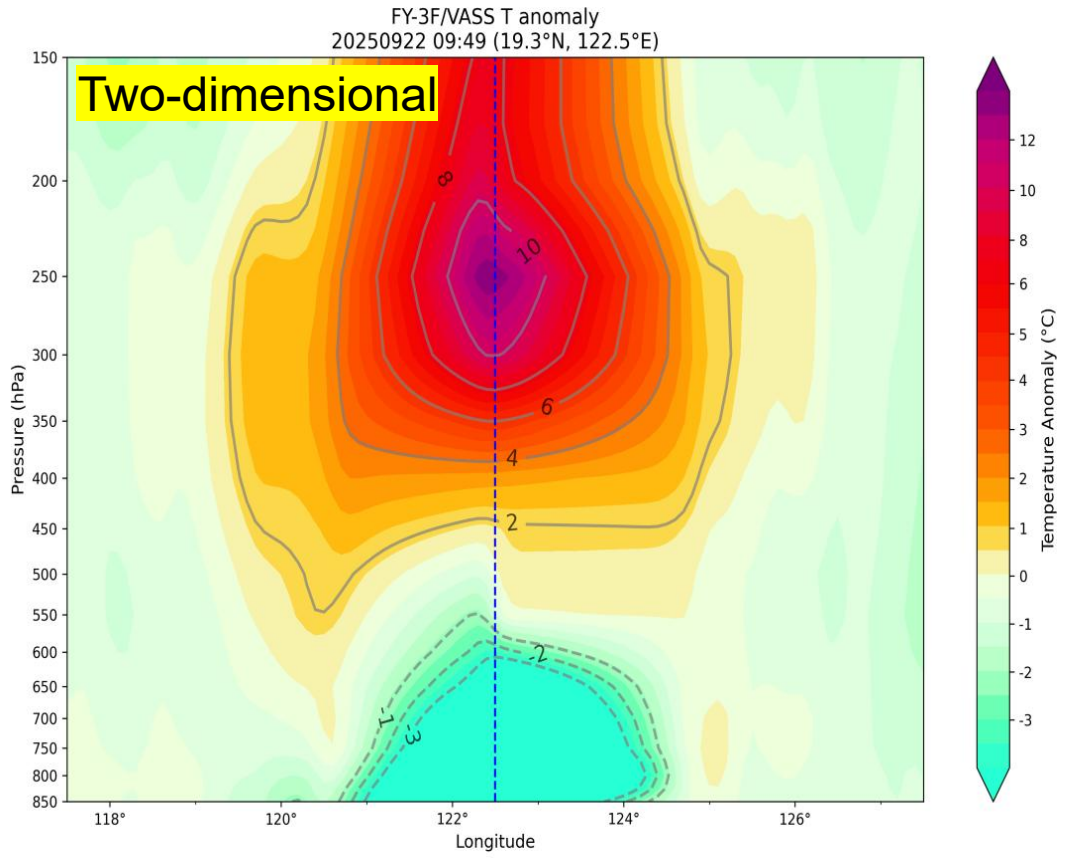


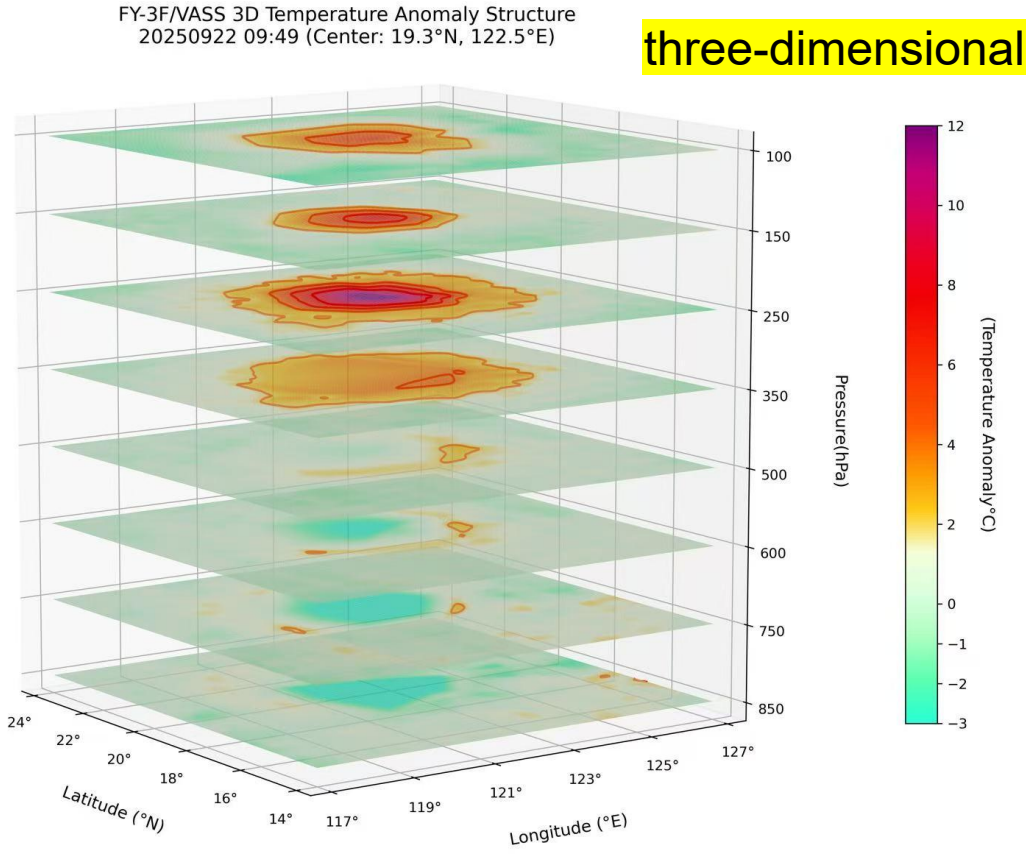
- the maximum wind speed near the typhoon center exceeds Force 8 on the Beaufort scale

- **The western and southern sectors** of the typhoon are situated within **an upper-level divergence zone**, the primary **outflow channel** is concentrated in these regions, which is conducive to the maintenance of typhoon intensity

Thermal structure monitoring

Based on FY-3F/VASS data, the warm-core structure of typhoons RAGASA has been developed to analyze the evolution of the warm core and achieve thermal structure analysis

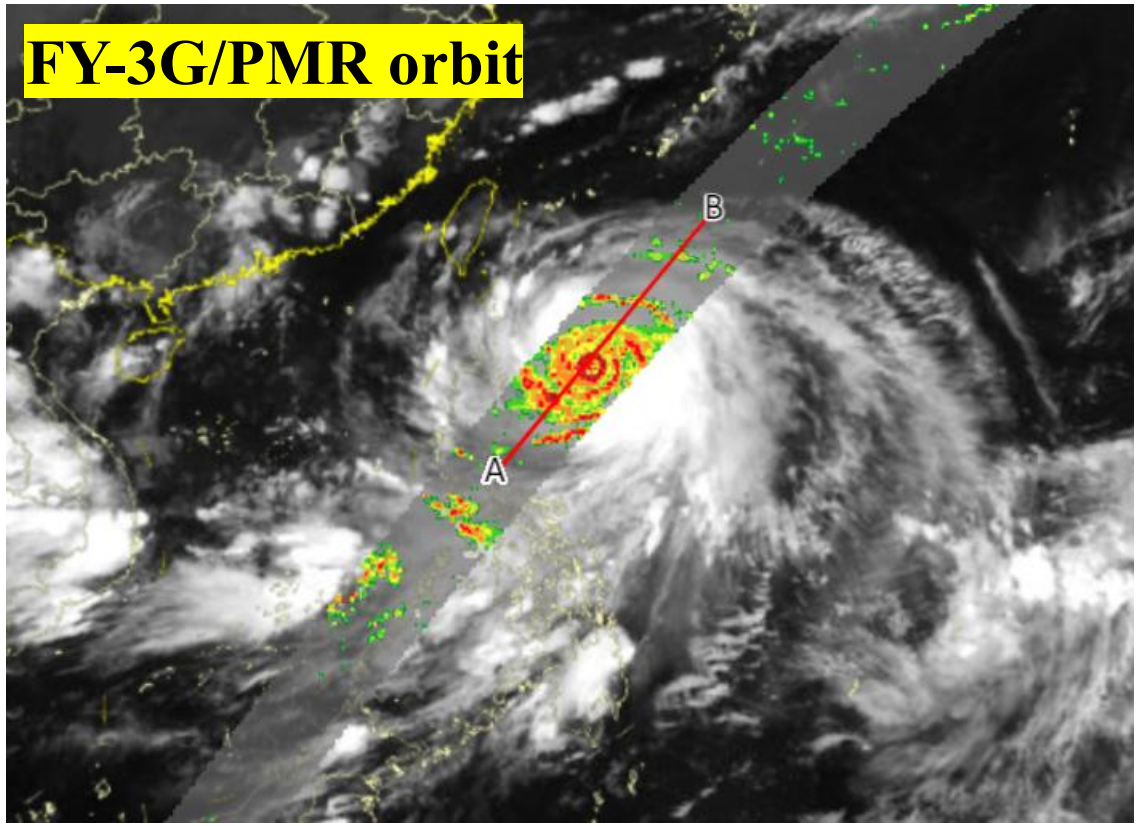


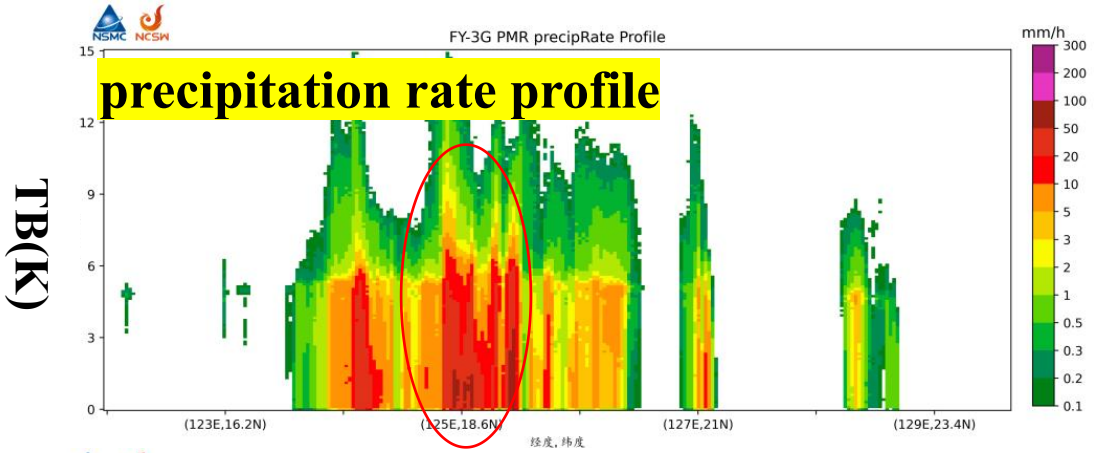


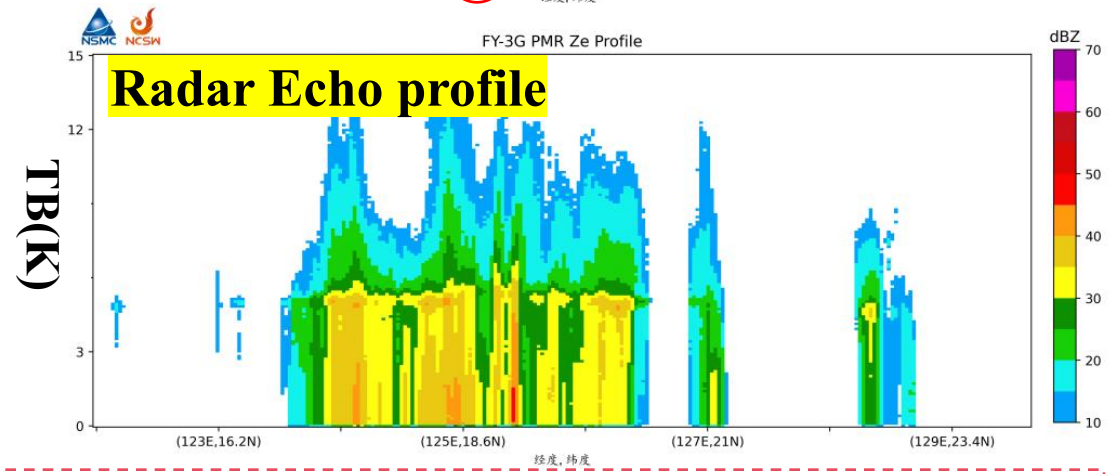
- **the warm core is located in areas of vigorous convection near the typhoon center and can extend vertically above the 250 hPa level**

Precipitation monitoring-PMR

Typhoon RAGASA 09220339 (UTC)



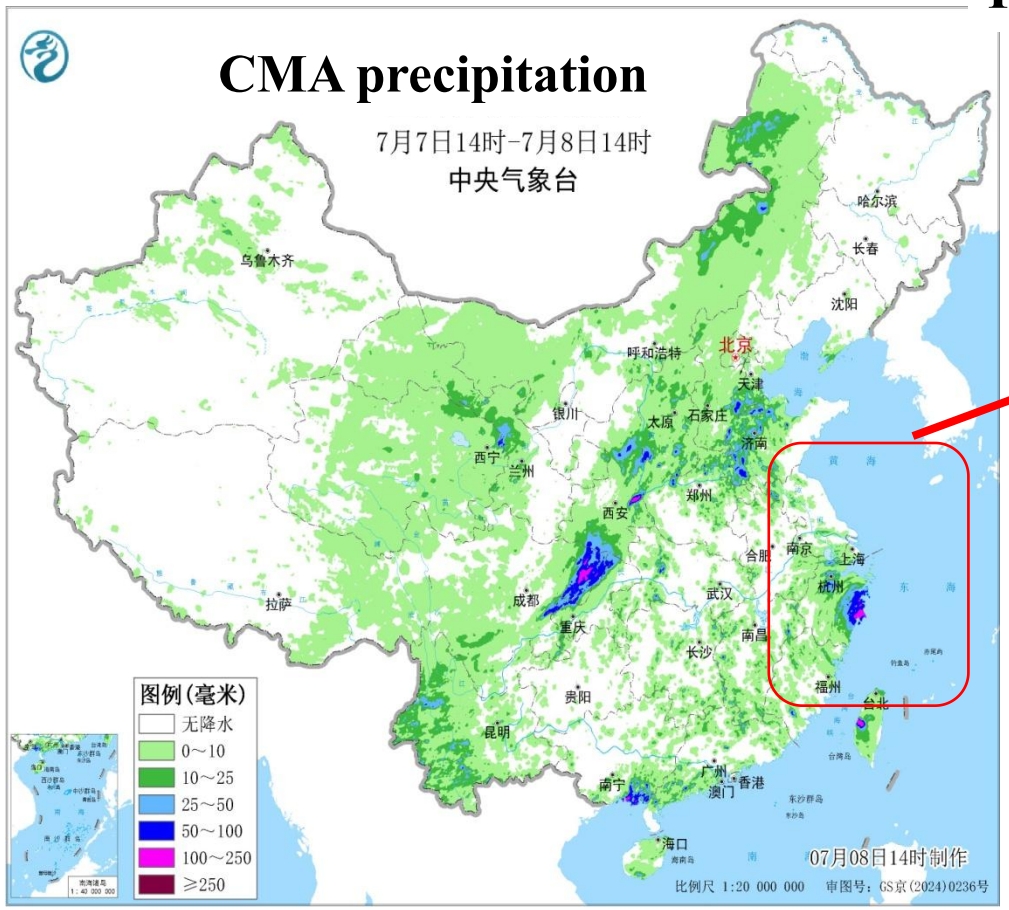


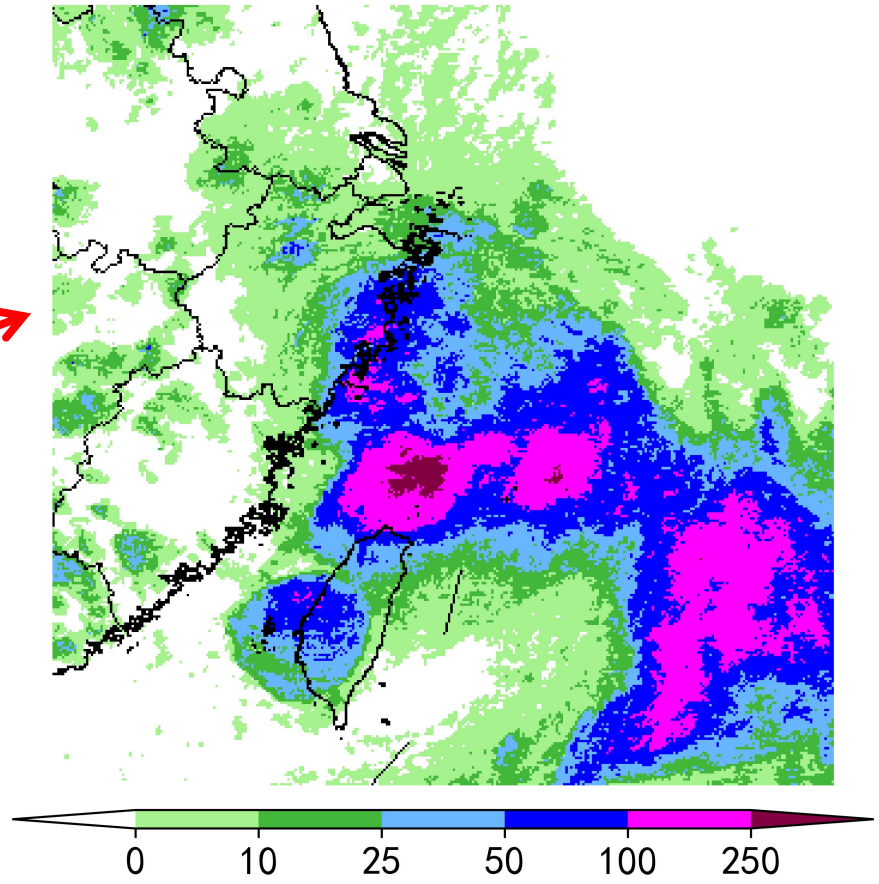


- Surface precipitation rates near the center surpassed 50 mm/h
- a pronounced echo core at approximately 18.6°N, 125.0°E, showing echoes up to 40 dBZ below 3 km and echo tops as high as 15 km

Precipitation monitoring-AI QPE

FY-4B AI-quantitative precipitation estimation (QPE)





- the maritime precipitation is located south of the typhoon, while the terrestrial precipitation distribution is largely consistent with the CMA's surface precipitation analysis

Conclusion and Future Perspectives

Progressive Refinement of Objective Techniques	→ Performance Evaluation of Objective Technique Products
Advancement of Intelligent Data Fusion Technologies	→ Deep Learning, AI
Enhance the Integrated Application of Multi-Source 、 Multi-Satellite、Multi-Channel Data	→ Multi-Dimensional Typhoon Monitoring Capabilities

Thank you!

NSMC NCSW