

The Fifty-sixth Session of ESCAP/WMO Typhoon Committee
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Technical Presentation

Enhancing Prediction of Precipitation and Winds during Typhoon Approaches

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National Typhoon Center / KMA

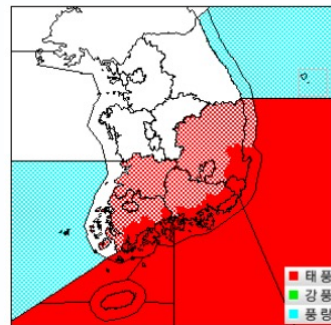
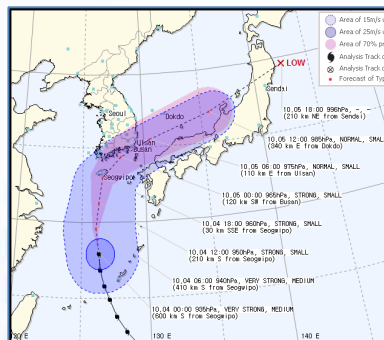
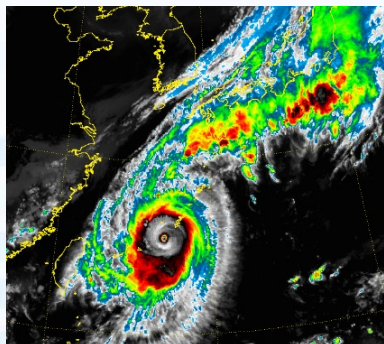
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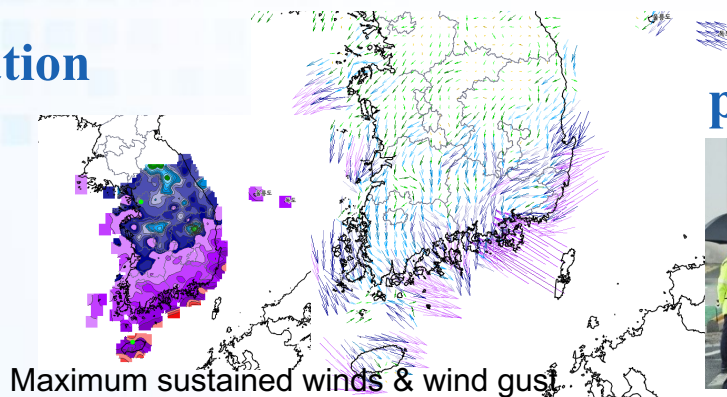
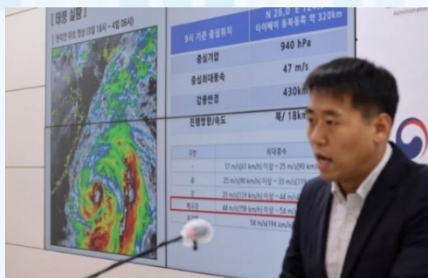
1. Motivation

- In KMA, when a typhoon occurs, **NMSC/KMA detects** typhoons by analyzing satellite data, **NTC/KMA forecasts typhoon track**, intensity, radius of strong winds, etc. And **NMC/KMA issues warnings** and regional weather forecasts.
- During emergencies, communicate with media and disseminate information for local preparedness.

Detection, observation, monitoring, analysis, forecasting



Dissemination, communication



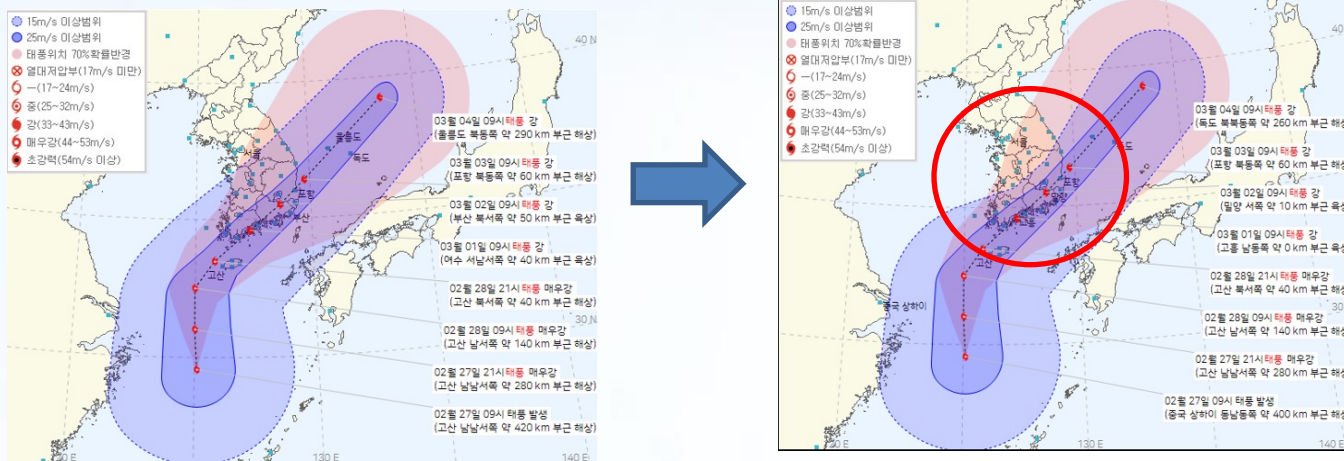
Maximum sustained winds & wind gust

preparedness

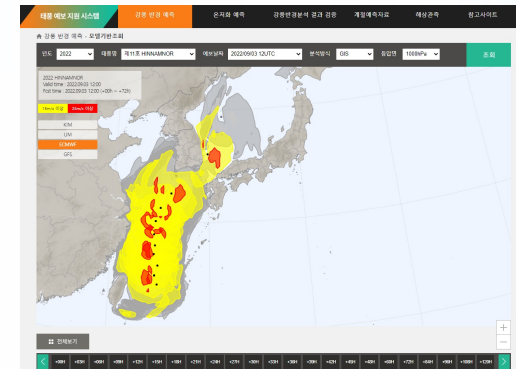
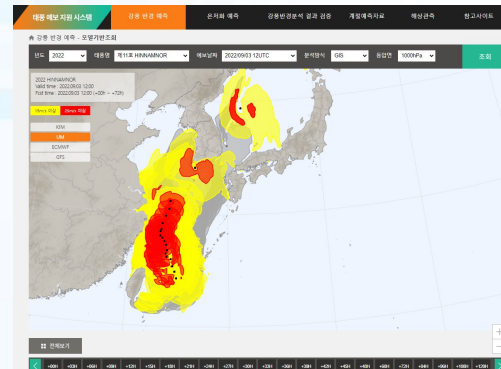
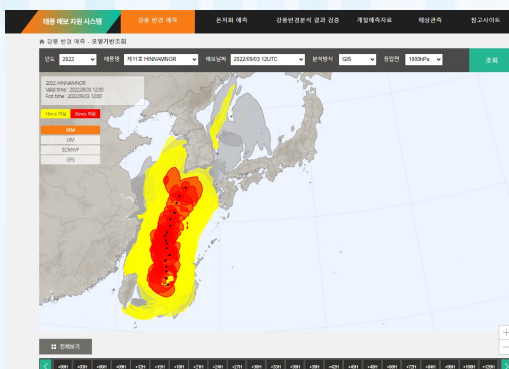


1. Motivation

- KMA has continued to **improve typhoon information** to enhance understanding and preparedness for approaching typhoons.



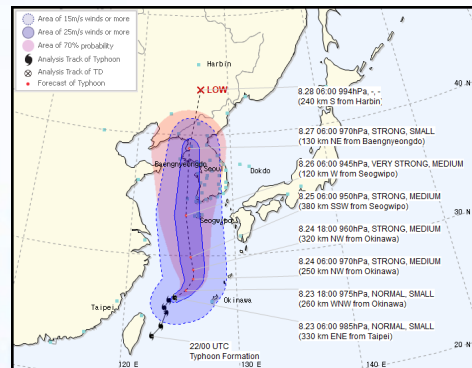
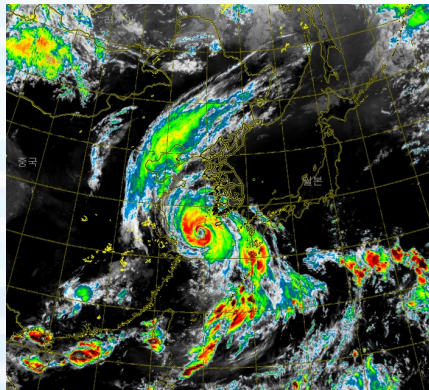
- **NWP-based forecast guidance** for strong winds is operated internally, providing area of strong winds for each prediction time and each model (KIM, UM, ECMWF) to support typhoon forecasting.



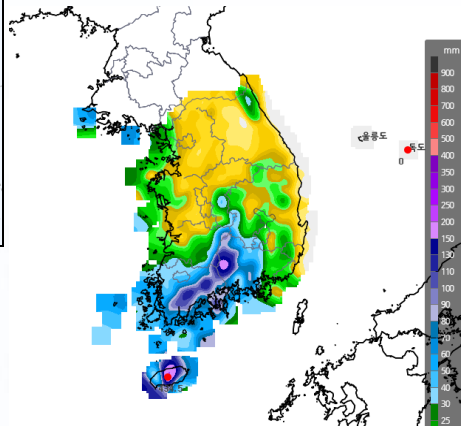
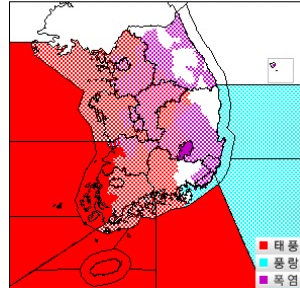
1. Motivation

BAVI (2020. 8. 22. 00UTC – 8. 27. 06 UTC)

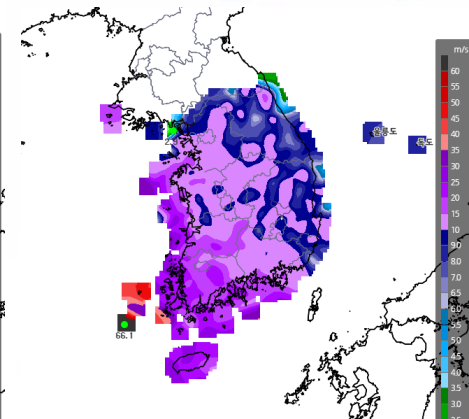
- Entered the EZ (north of 28N, west of 132E) within 2 days after TS upgrade
- As it approached the populous mainland, severe damage was expected
- Typhoon warnings have been issued as it northward along the West Coast
- As moved through the West Sea, **heavy rainfall and strong winds were recorded**



특보 발효현황 (2020.08.26, 23:00 이후)



Accumulated rainfall

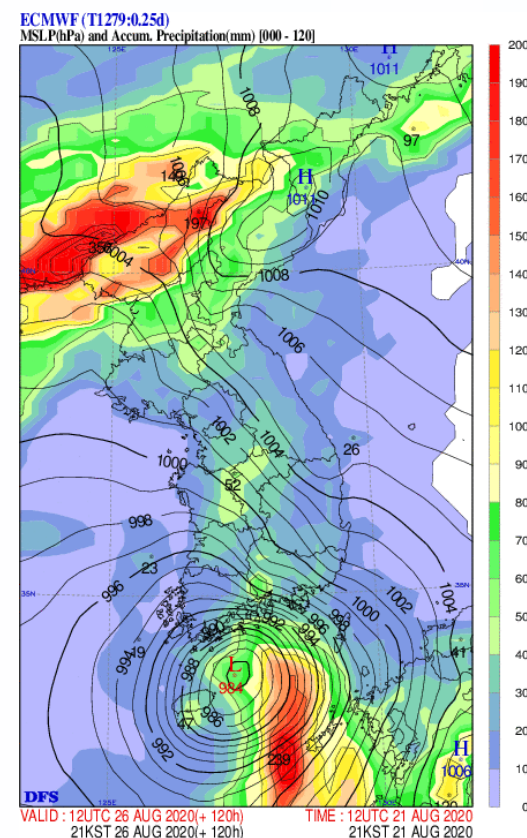
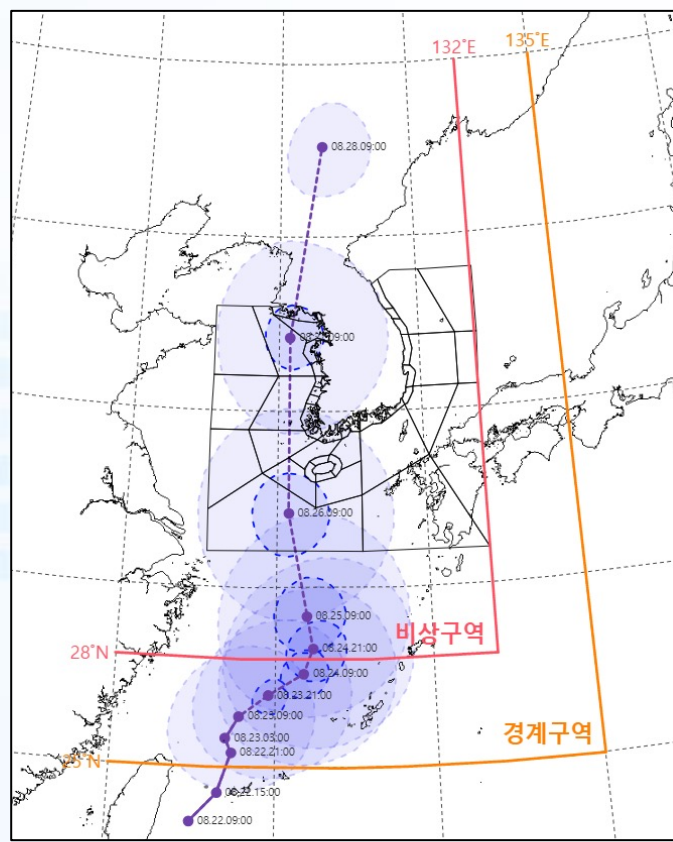
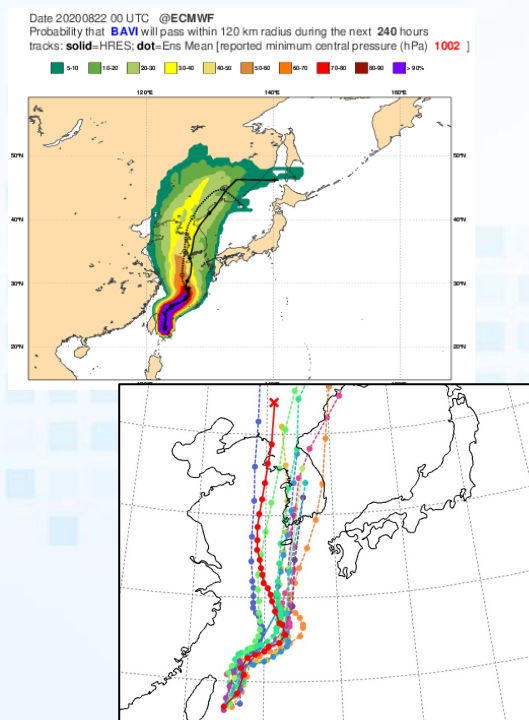


Maximum wind

1. Motivation

BAVI (2020. 8. 22. 00UTC – 8. 27. 06 UTC)

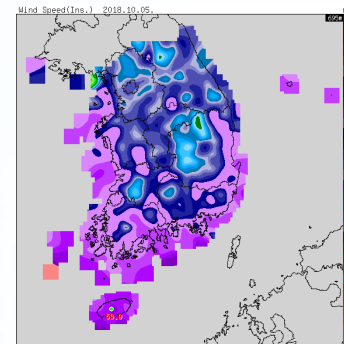
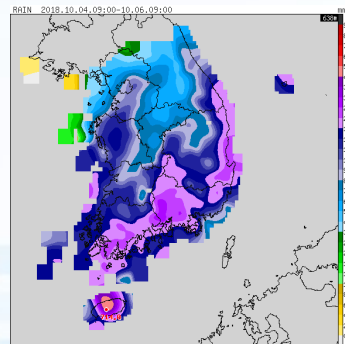
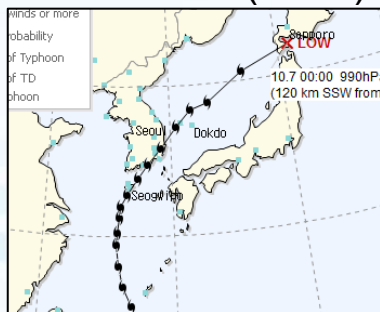
- In the early stages, NWP predicted tracks showed wide spread
- Large gaps between consensus forecast tracks and NWP predicted results.
- Had to forecast the areas affected by precipitation and winds caused by the typhoon.
- Required precipitation and wind fields consistent with the forecasted track



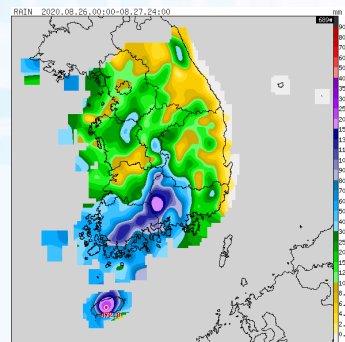
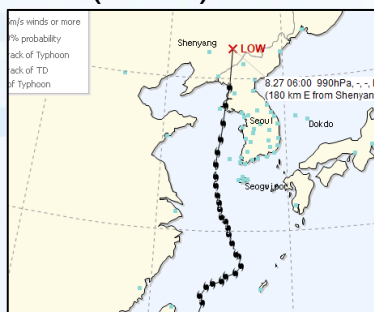
2. Prediction techniques using past observations

- ❖ In previous typhoon cases, **specific patterns of rainfall and strong winds** have been observed **along the track of typhoons approaching the Korean Peninsula**.
- ❖ Due to the topographical effects of mountain ranges by TC tracks, precipitation and strong winds area showed different distribution.

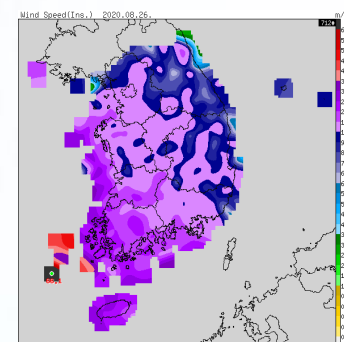
KONG-REY(1825)



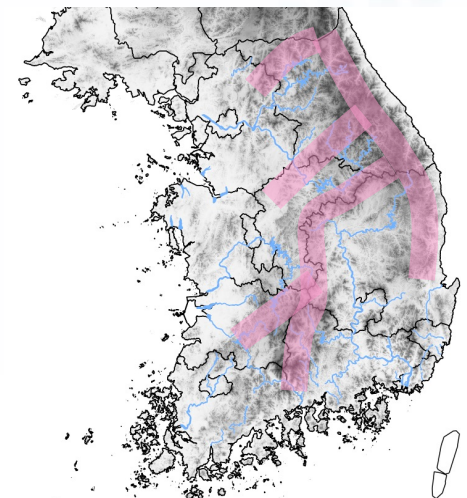
BAVI(2008)



Accumulated rainfall



Maximum wind speed



2. Prediction techniques using past observations

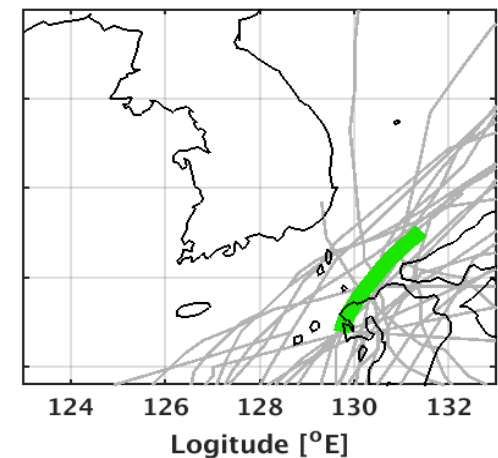
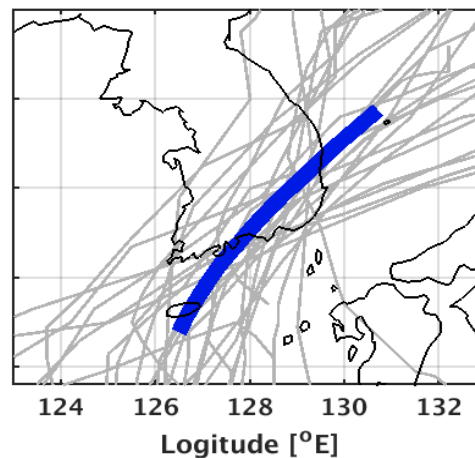
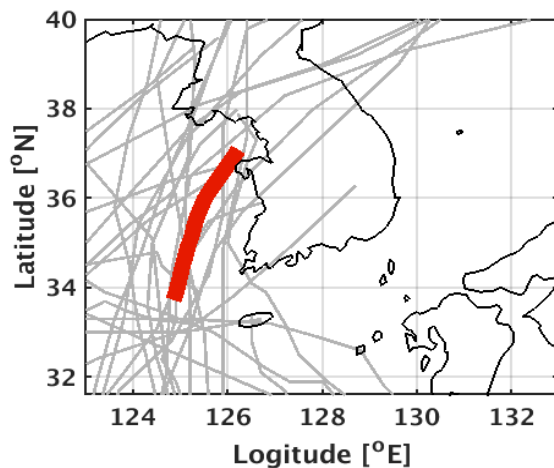
Characteristics of track type of typhoons affecting the Korean Peninsula

- Analysis period: 1997 - 2021
- Method: K-mean clustering
- Typhoon track classification(total): 81 cases

C1: Landfall on the western(28 cases)

C2: Landfall on the southern(28 cases)

C3: Passing through Korea Strait(25 cases)



2. Prediction techniques using past observations

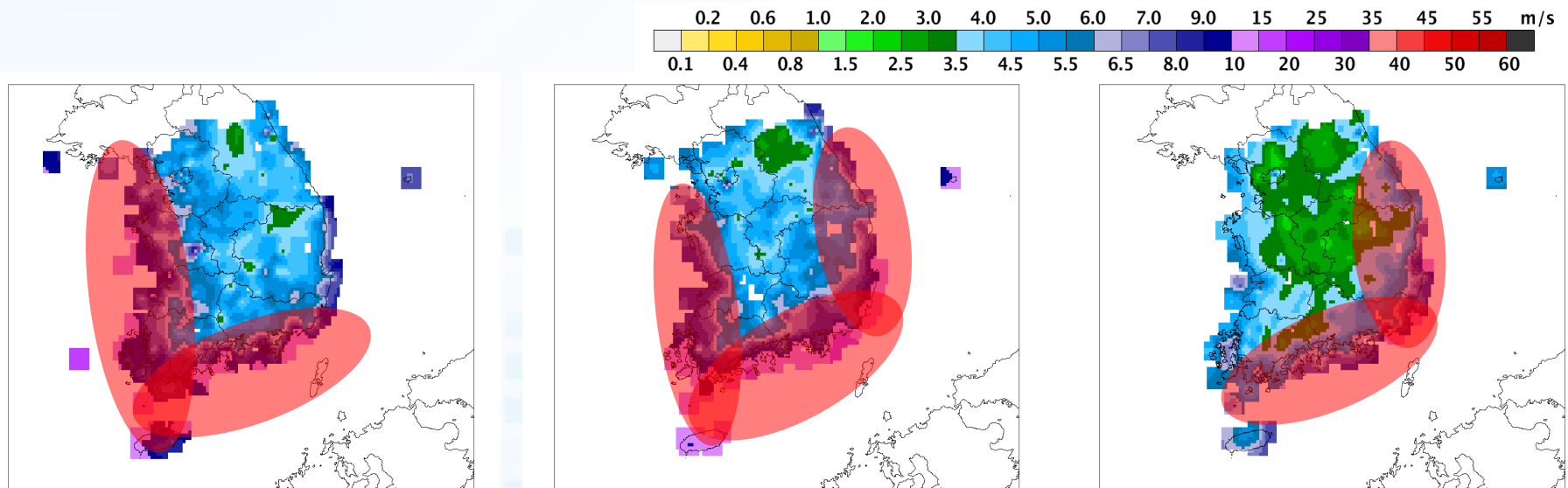
Characteristics of **strong wind** area caused by typhoons affecting the Korean

- Typhoon track classification(total): 81 cases

C1: Landfall on the western(28 cases)

C2: Landfall on the southern(28 cases)

C3: Passing through Korea Strait(25 cases)



During the period of typhoon making landfall on the western (southern) coast showed the L (U)-shaped distribution of strong wind, and the J-shaped distribution of strong wind is appeared when typhoons passing through the Korea Strait.

2. Prediction techniques using past observations

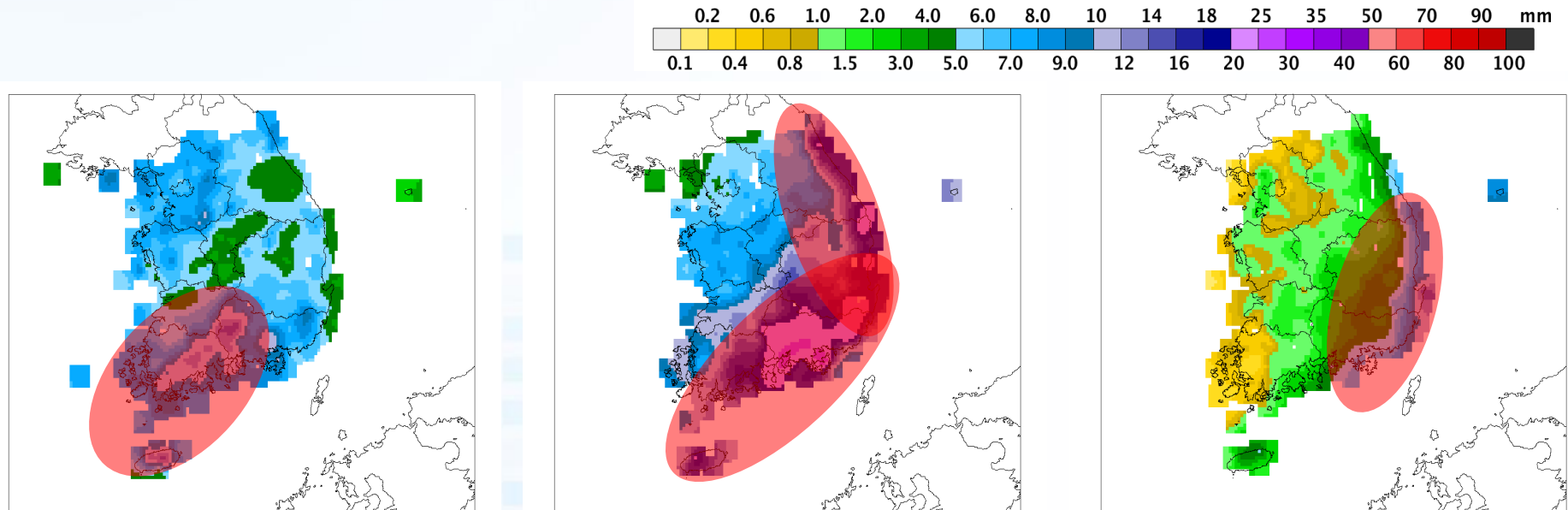
Characteristics of heavy rain area caused by typhoons affecting the Korean

- Typhoon track classification(total): 81 cases

C1: Landfall on the western(28 cases)

C2: Landfall on the southern(28 cases)

C3: Passing through Korea Strait(25 cases)



- The precipitation area showed each pattern according to the typhoon track.
- Depending on the TC track, the accumulated rainfall distribution during the period is similar to wind (the precipitation area depends on the track). Possibility of predicting the distribution of wind and precipitation using historical observations (development of a prediction system)

3. Data and Method

❖ Development of an **analog-based technique to predict precipitation and wind** by utilizing **past observation data from similar typhoon track cases**

- **Data**

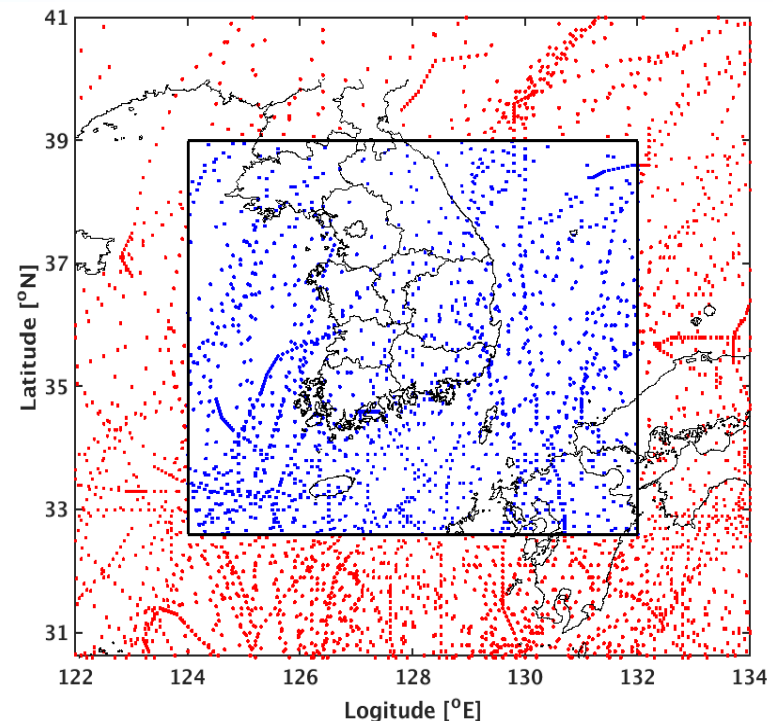
- hourly rainfall observations from AWS
- 10min averaged wind speed observations from AWS
- JMA best track data

- **Analysis Period**

- 1997~2021

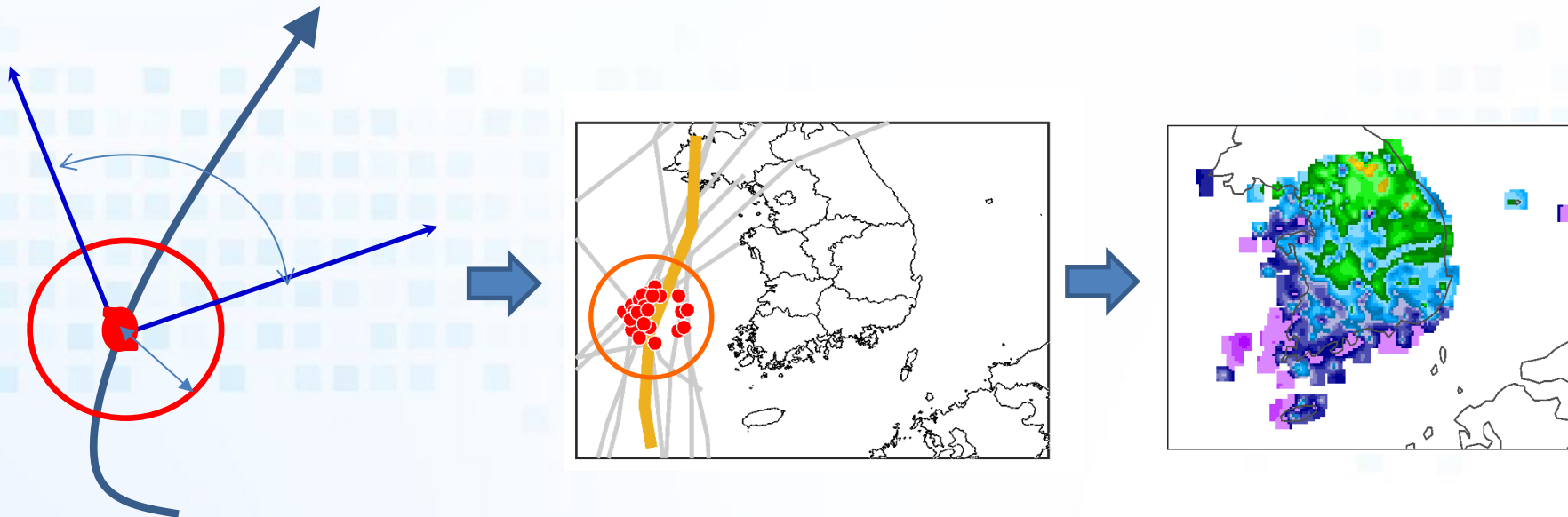
- **Domain** (small square area)

- 32.6~39°N, 124~132°E



4. Construction of the prediction model

- ❖ Selecting factors for similar typhoon cases from the past
 - ① distance between TC centers,
 - ② direction of movement,
 - ③ TC size
- ❖ Combined observation rainfall and strong wind data from selected cases for every 1 hour during the period
- ❖ Making prediction fields for precipitation/wind during typhoon period



4. Construction of the prediction model

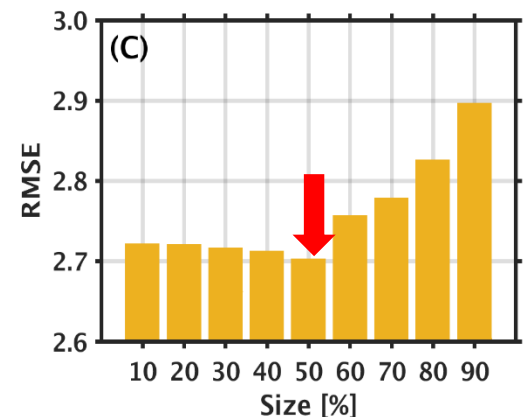
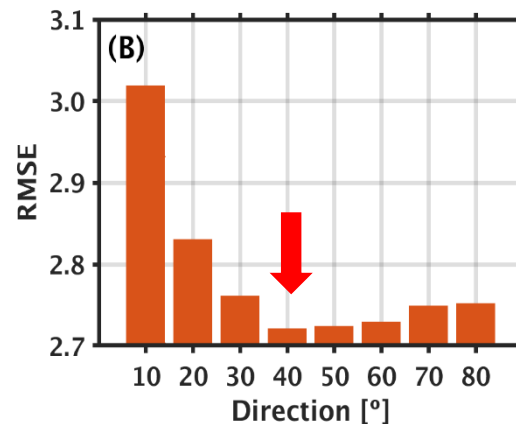
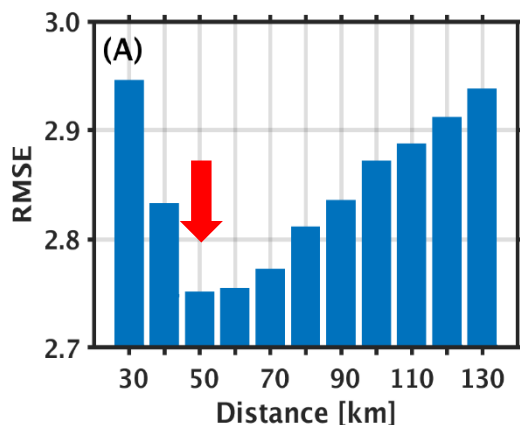
❖ Sensitivity experiments to determine the condition for selecting similar historical typhoon cases

- Result of optimal threshold conditions for **strong winds** prediction

Distance between the TC center locations : 50 km

Direction of typhoon track : 40°

Size of the typhoon: 50 %



4. Construction of the prediction model

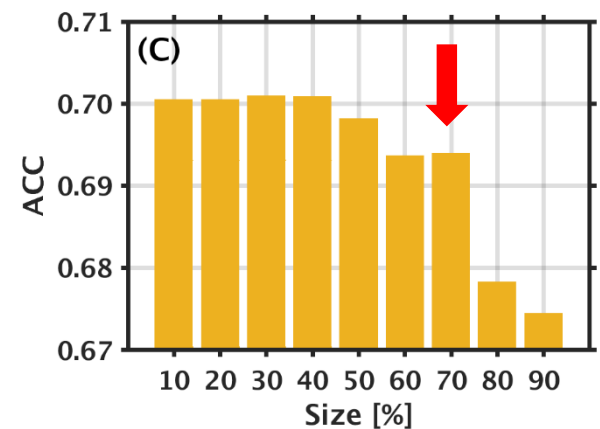
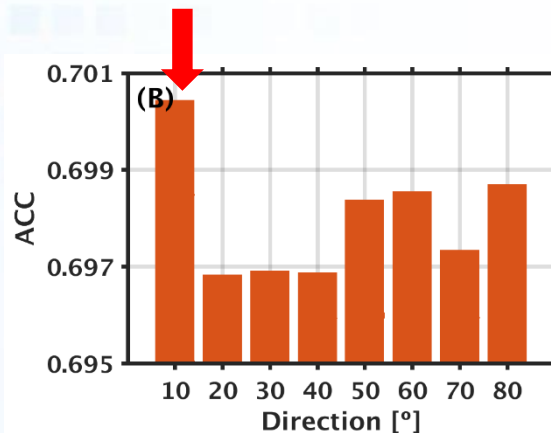
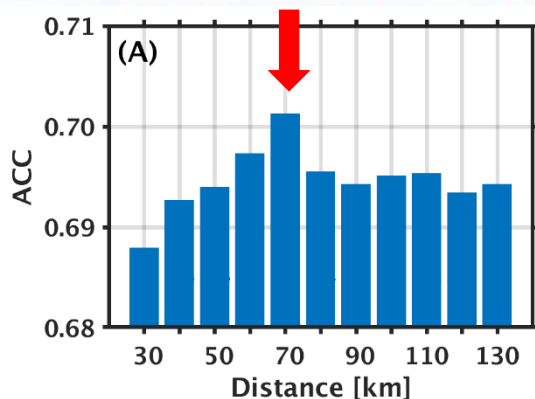
❖ Sensitivity experiments to determine the condition for selecting similar historical typhoon cases

- Result of optimal threshold conditions for **precipitation** prediction

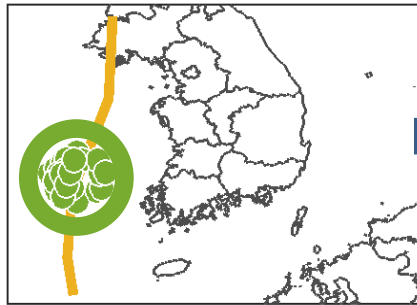
Distance between the TC center locations : 70 km

Direction of typhoon track : 10°

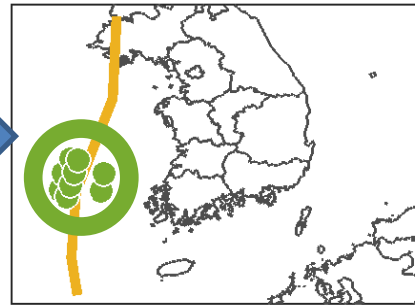
Size of the typhoon: 70 %



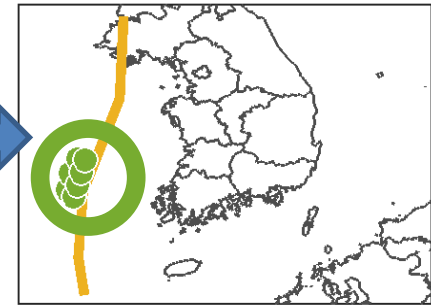
4. Construction of the prediction model



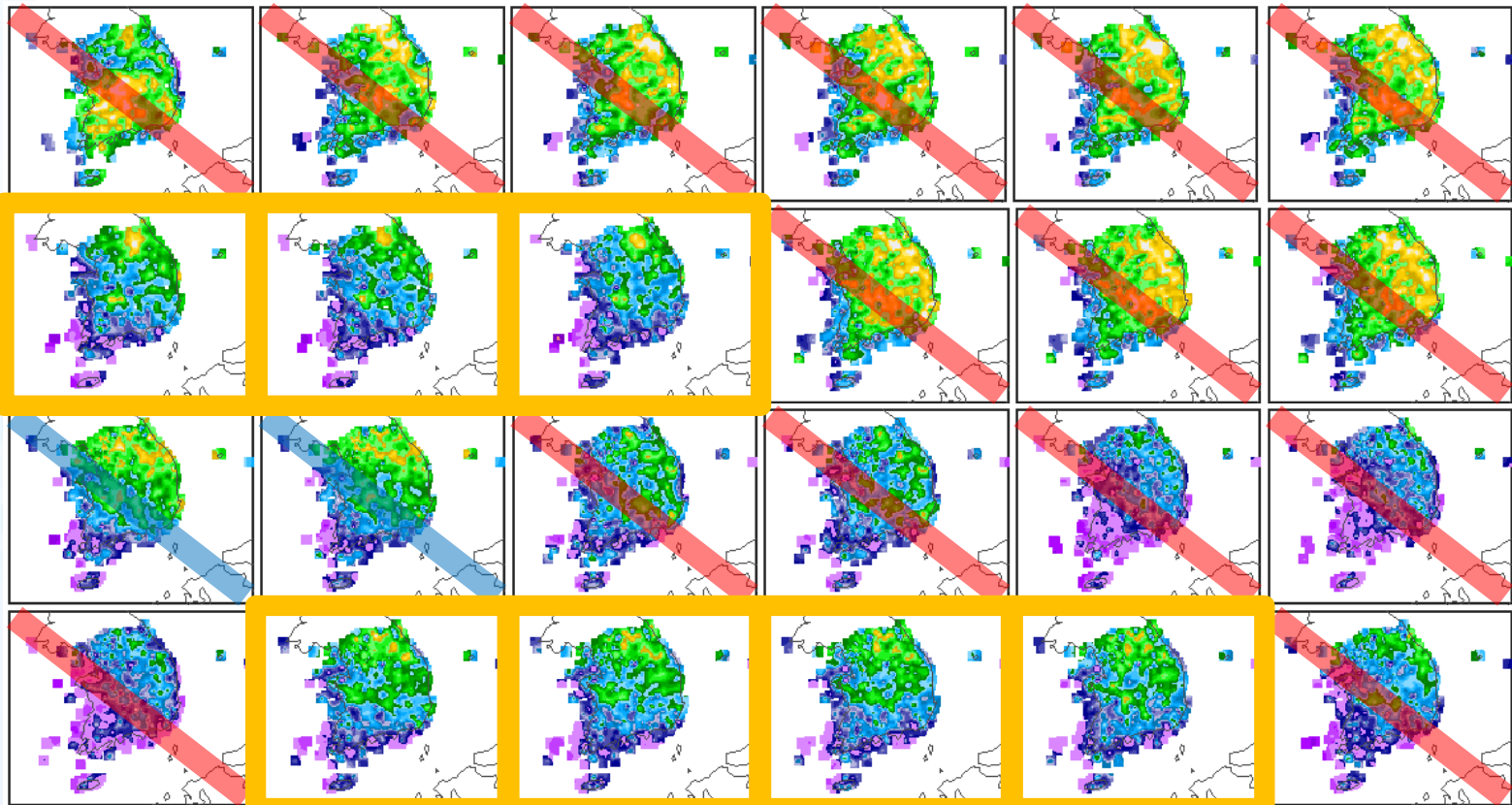
Similar to center position(24 cases)



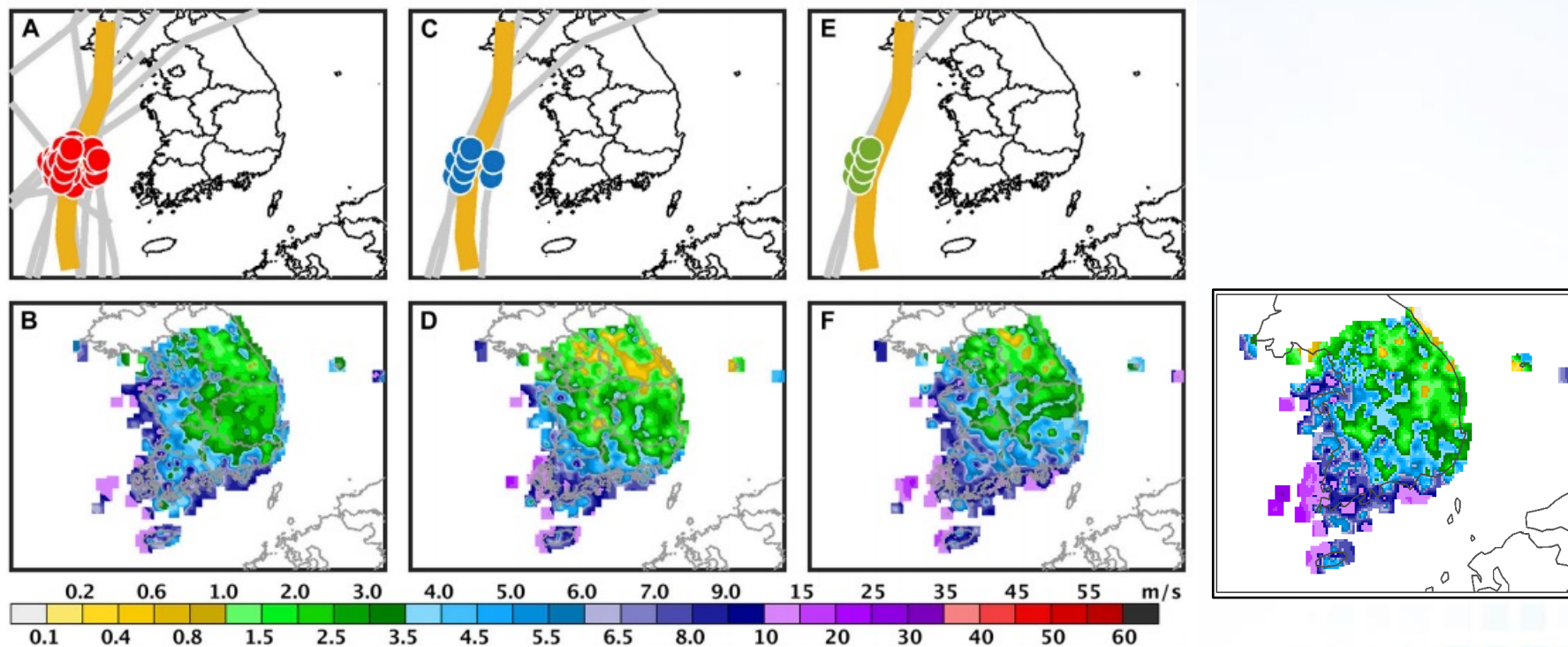
Similar to moving direction(9 cases)



Similar to typhoon size(7 cases)

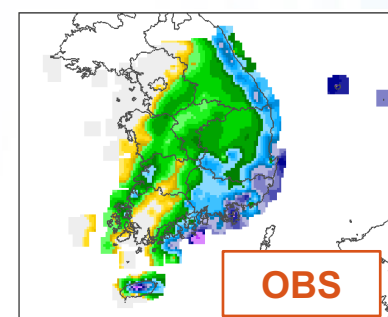
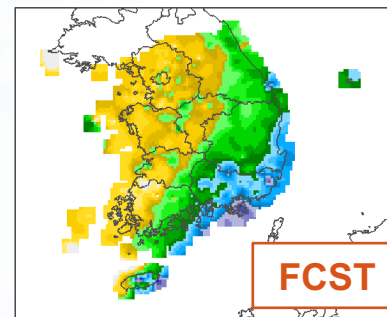
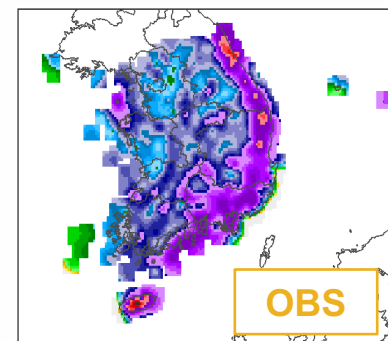
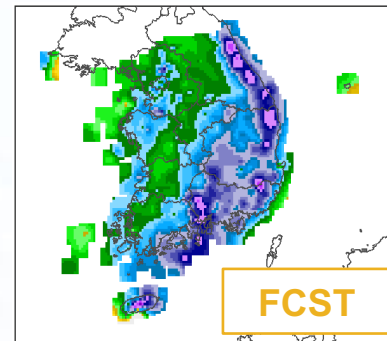
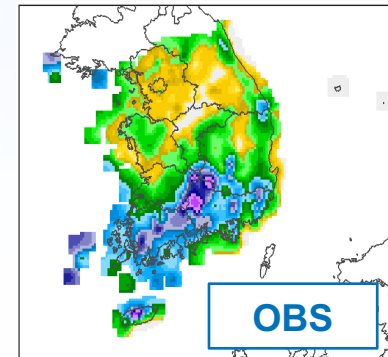
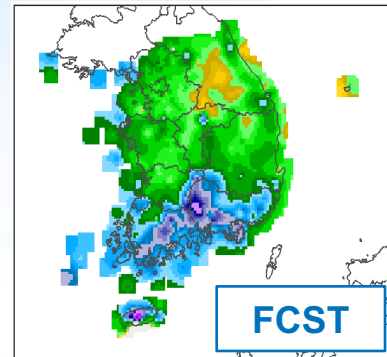
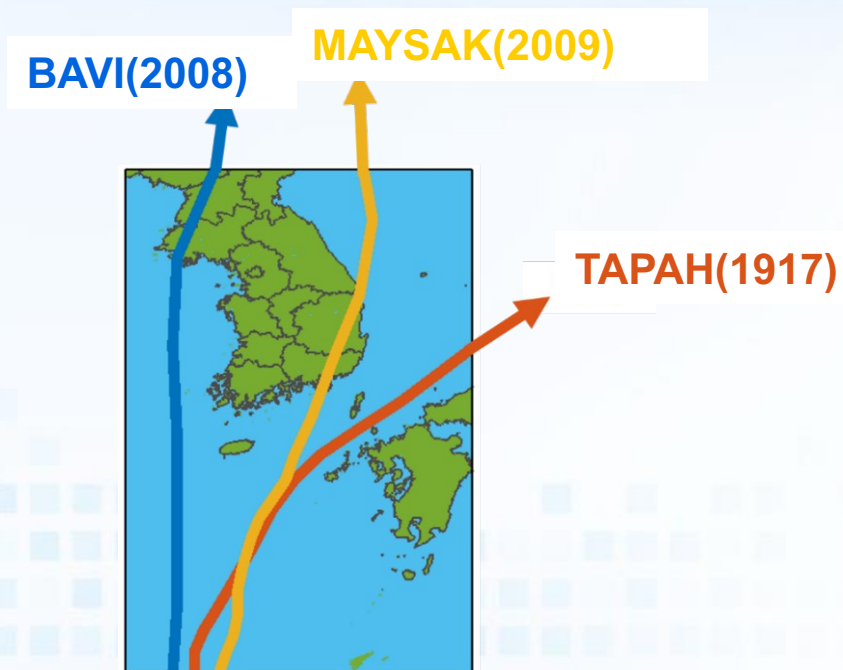


4. Construction of the prediction model

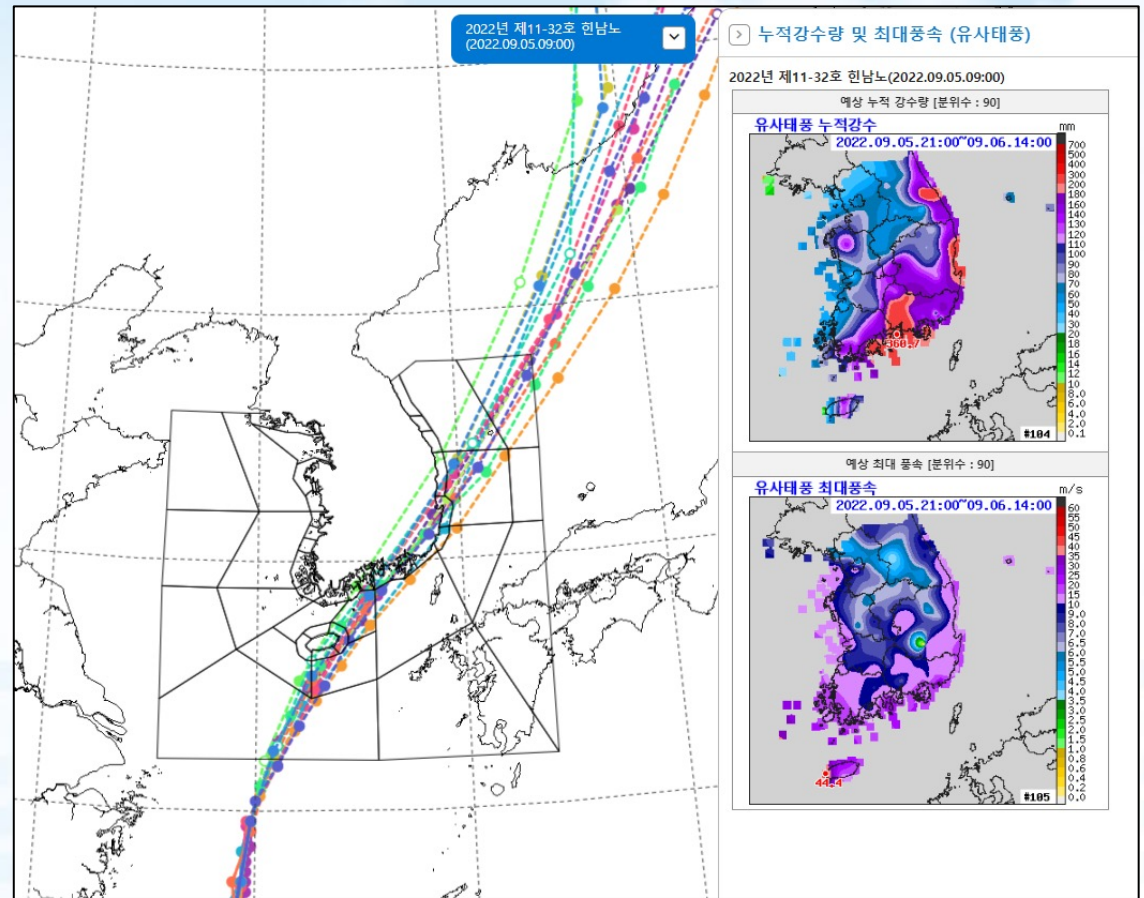
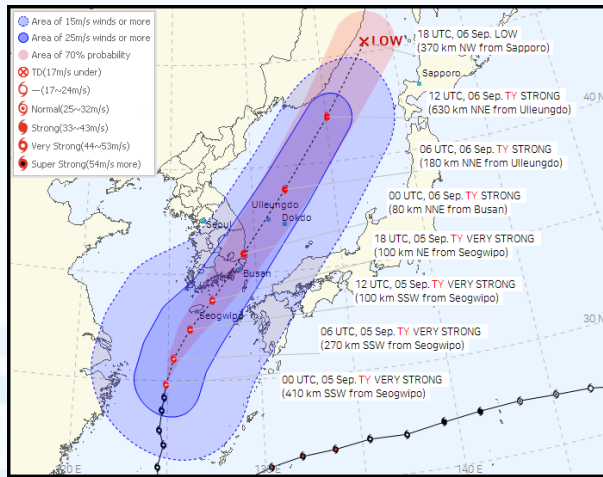


- Composite considering the distance between the centers, the direction of movement, and the size of the typhoon
- Calculate the precipitation/strong wind forecast field for the period passing through the area (32.6-39°N, 124-132°E)

5. Results

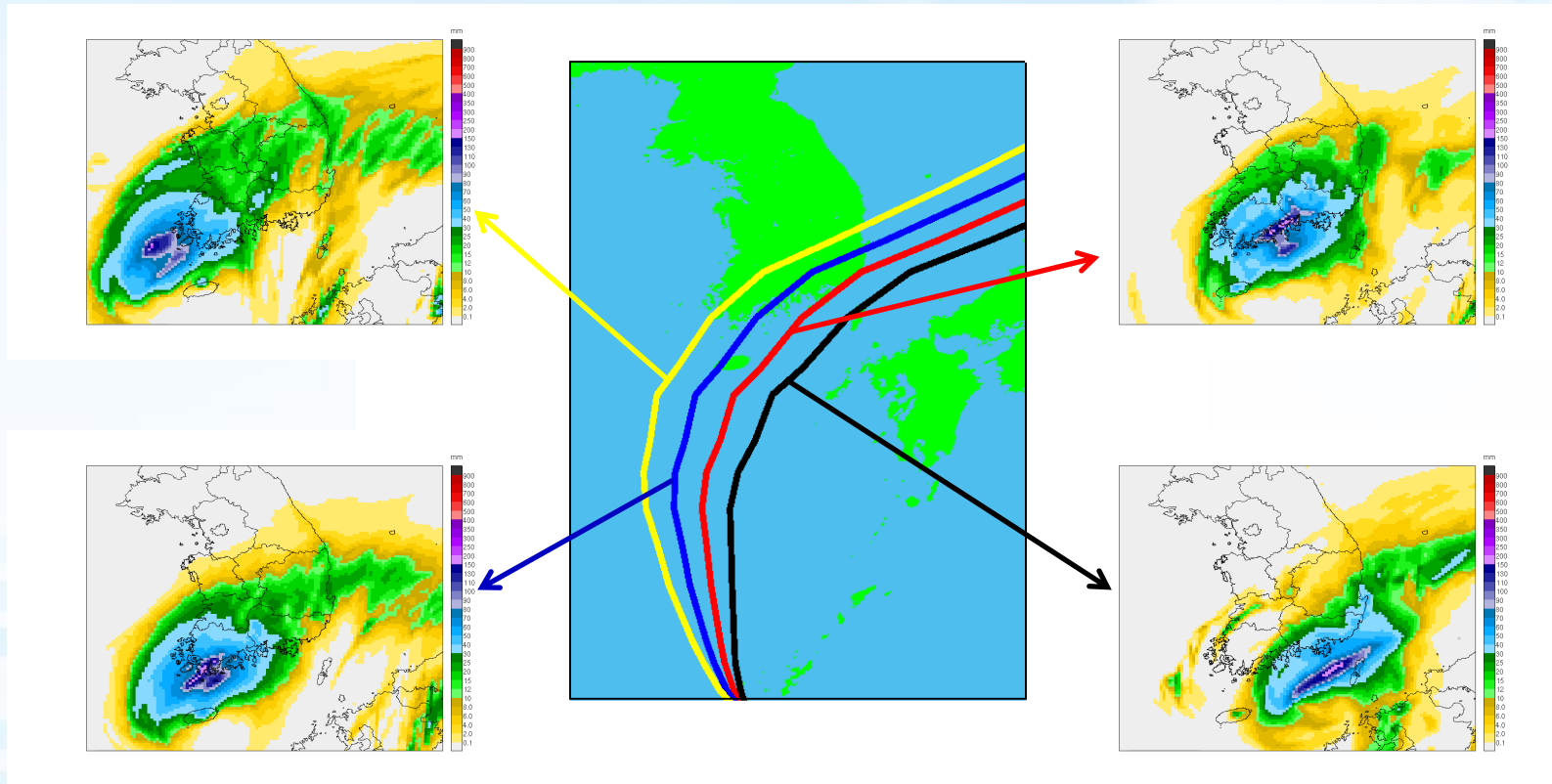


5. Results



- ❖ When a typhoon is forecasted to approach the Korean Peninsula, **strong winds and precipitation predictions are automatically generated** based on the typhoon track in the internal operational system to support decision-making in issuing warnings.

5. Results

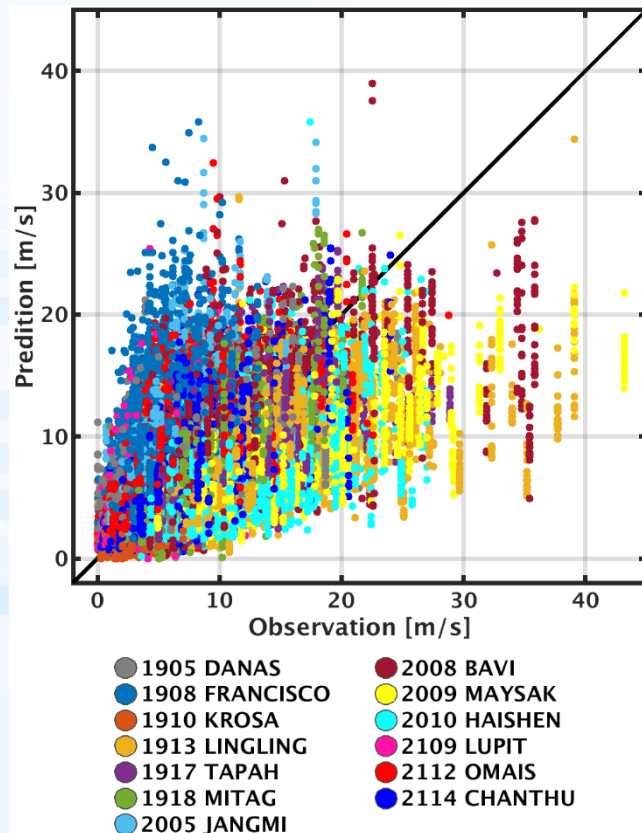


- ❖ From the development the guidance, **when a typhoon is approaching with an uncertain track**, it is possible to quickly **estimate the disaster impact for each potential track** and **create warning scenarios accordingly**.

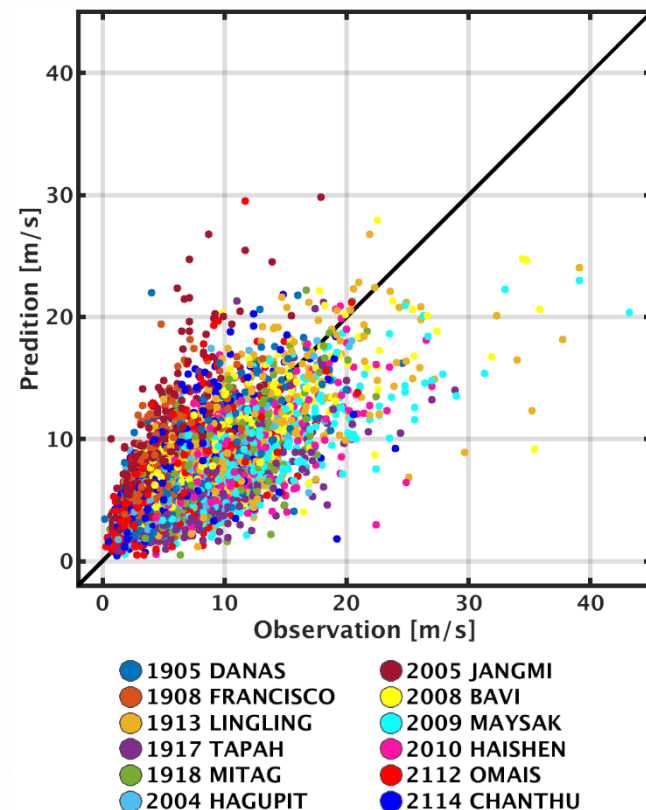
6. Verification

- The verification results of strong winds for affecting typhoon cases
- Improved accuracy in predicting precipitation and wind can be expected if the track is accurate

Predicted wind along **the forecast tracks**



Predicted wind along **the best track**

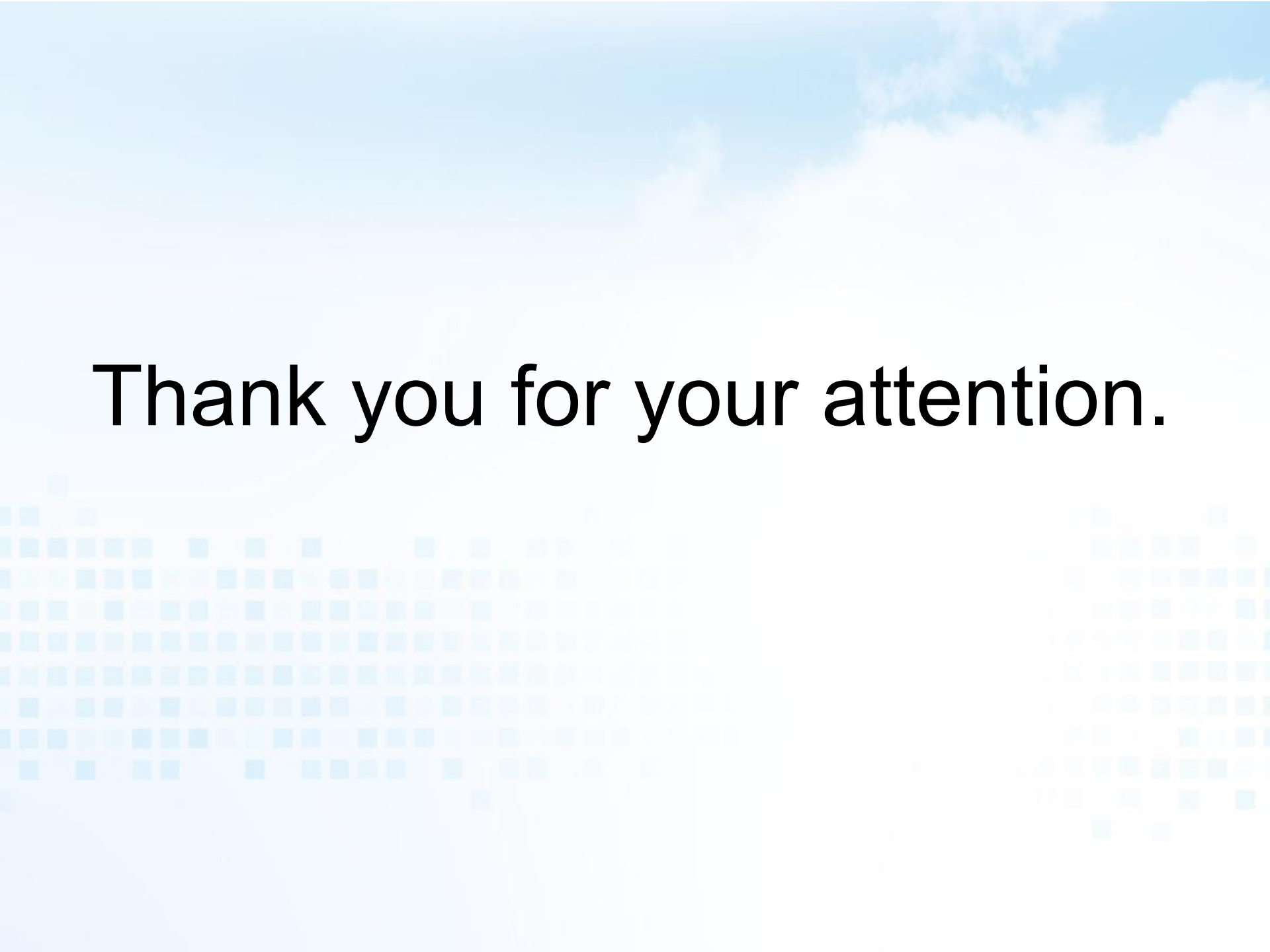


7. Summary

- **Depending on the typhoon track, accumulated rainfall and strong wind areas showed specific patterns** → Confirmed the availability of using historical data.
- **Development of a precipitation/wind prediction system** consistent with typhoon forecast track using the historical observation data.
- **When a typhoon is forecasted to approaching the Korean Peninsula, strong wind and precipitation prediction automatically generated** based on the typhoon track (currently operational).
- **If the typhoon track is forecasted, it is possible to quickly provide a precipitation/wind forecast field** before the numerical model results.

Reference

Kim M, Won S and Lee H (2024), Development of a prediction system for precipitation- and wind-causing typhoons affecting the Korean peninsula using observational data. Front. Earth Sci. 12:1327170. doi:



Thank you for your attention.