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# Evaluation of HSCAT Observations from HY-2B and HY-2C Satellites in KIM Data Assimilation

Hyemin Shin, Jeon-Ho Kang, In-Hyuk Kwon
(Korea Institute of Atmospheric Prediction Systems, KIAPS)

hmshin@kiaps.org

# Korean Integrated Model (KIM)

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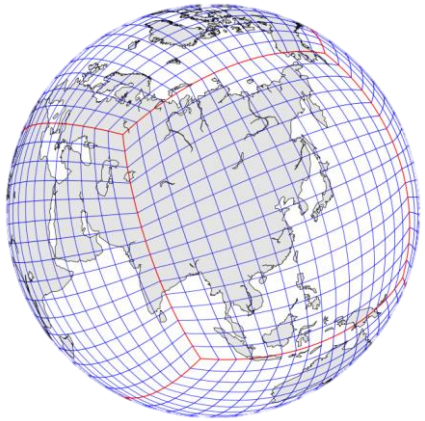
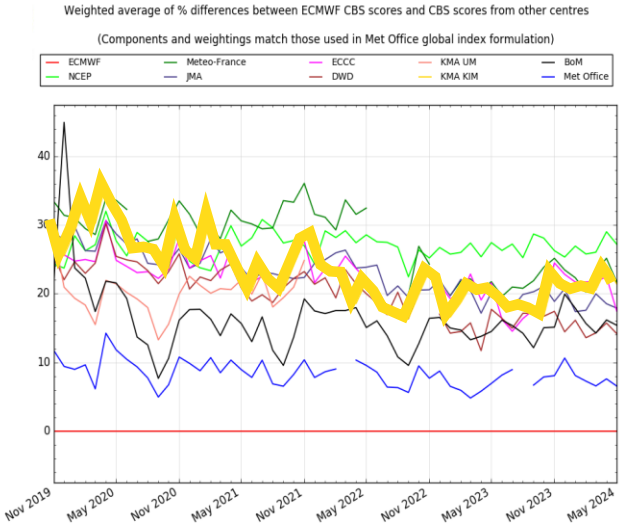
- KIM has been used in KMA's operational system since April 2020 (Hong et al., 2018).



| | Dynamics |
|---|---|
| Numerical method | Spectral Element method |
| Spherical grid | Cubed-sphere (Equi-angular gnomonic projection) |
| Equation | Non-hydrostatic (Perturbation form) |
| Temporal approximation | Split-explicit RK3, second-order for nonlinear equation |
| Explicit spatial diffusion | 6th order horizontal diffusion + divergence damping |



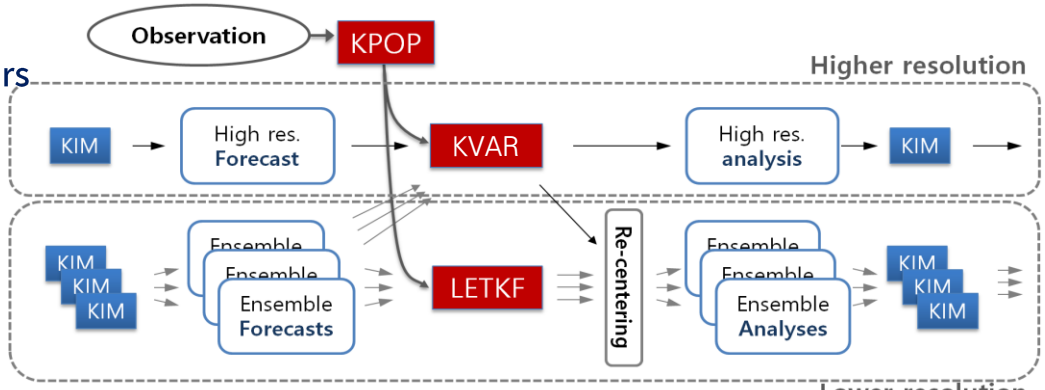

- **Hybrid-4DEnVar** on cubed-sphere grid
- Qualified observation from **KPOP** (KIAPS Package for Observation Processing)
- Ensemble background error provided by **LETKF-based EPS**

**KIM** resolution (NE180NP3 ~ 25 km)

**Ensemble** resolution (NE090 ~ 50 km), 50 members

**Analysis** resolution (NE090 ~ 25 km)

Ensemble B ratio:
**0.7 near tropics,**
**0.3 near poles**

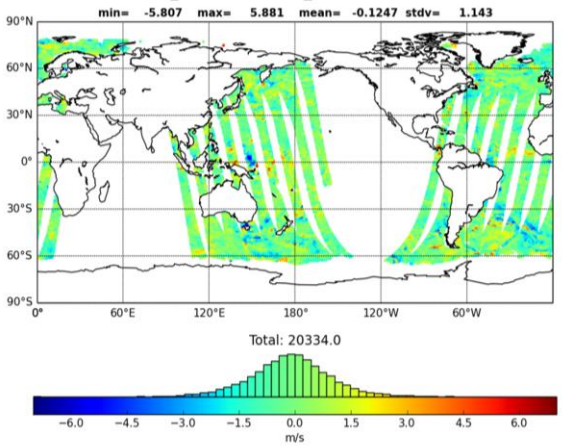


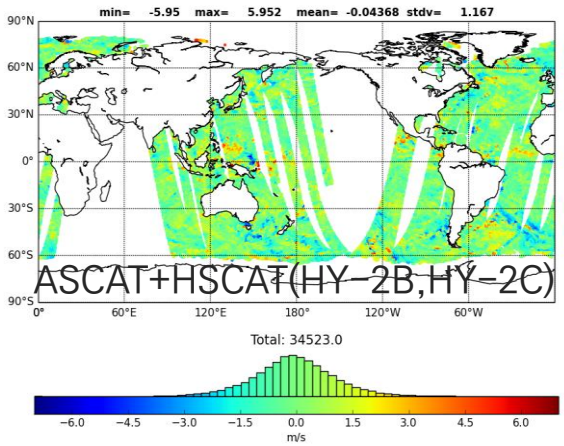
# Scatterometer Specifications and Data Coverage

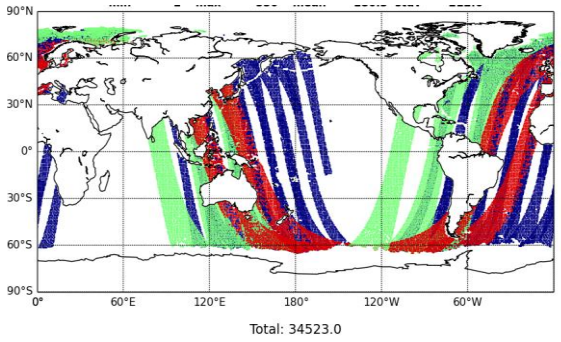
- HaiYang Scatterometer(HSCAT) is ocean dynamic environment satellite of China
- HSCAT has a wider swath than ASCAT, allowing for the acquisition of more observations.
- Adding HSCAT increases data coverage by 83.5% (HY-2B: 51.8%, HY-2C: 31.7%).

| | Advanced Scatterometer (ASCAT) | HaiYang Scatterometer (HSCAT) |
|---|---|---|
| Satellite | Metop-A, Metop-b, Metop-C | HY-2B,HY-2C |
| Frequency | C-band (5.255 GHz) | Ku-band (13.25 GHz) |
| Scanning Technique | - Fam beam<br>- Two 550-km swath separated by a 700km gap along track<br>- 3 looks each pixel (45°, 90° and 135° azimuth angle) | - Rotating beam<br>- Two beams, providing four views per spot from different angles; swath 1800km |

〈O−B distribution〉 2023.06.25.12 UTC



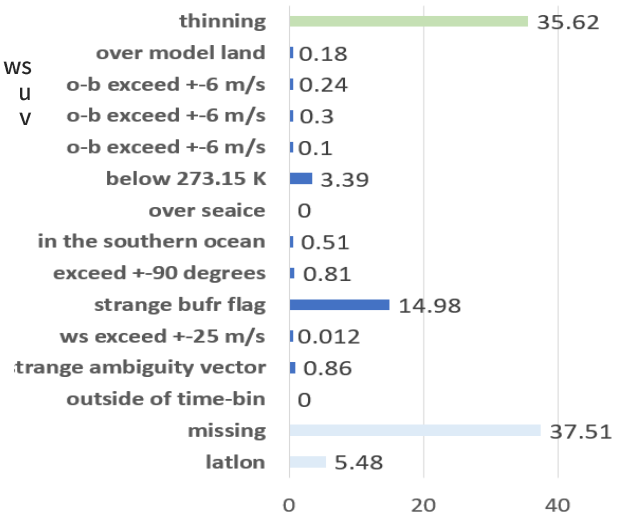

ASCAT+HY−2B+HY−2C

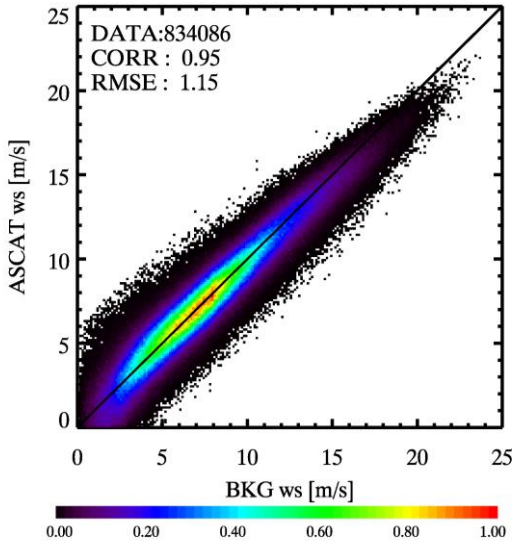
# Comparison of ASCAT, HY-2B and HY-2C

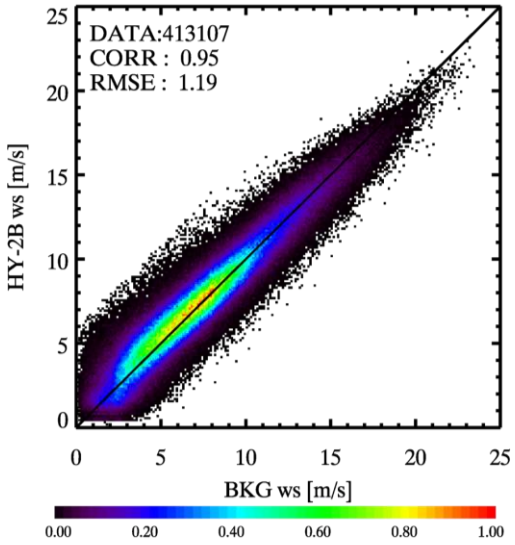
- ASCAT shows the lowest RMSE, followed by HY-2B and HY-2C. However, the small differences and similar correlation suggest comparable data quality.
- The O–B departures show different patterns depending on wind speed.

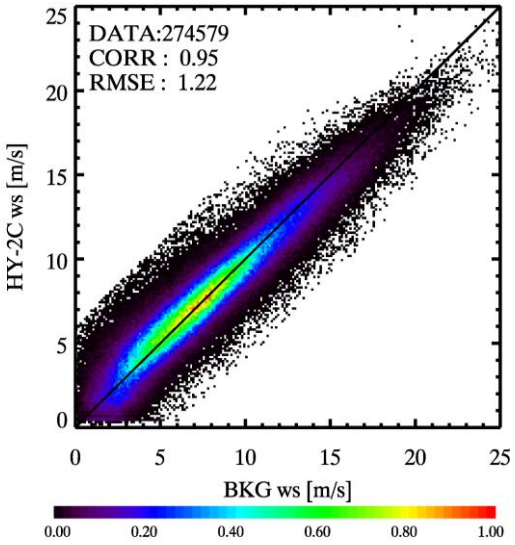
***Accordingly, we apply a quadratic-regression-based bias correction !***

**Observation removal rate (%) : HY2B**



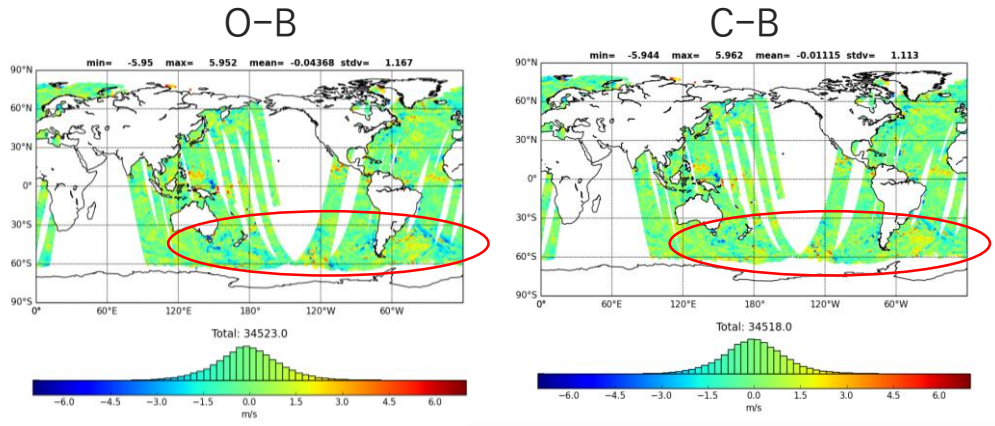



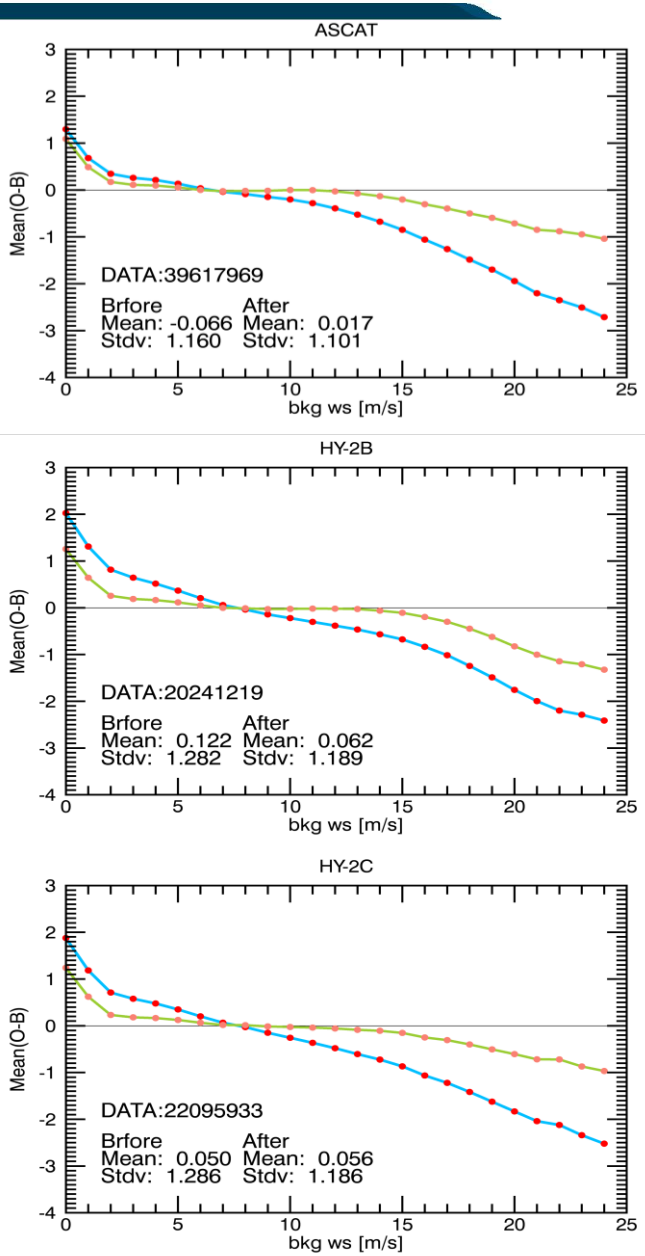




2023.06.16. 06 UTC – 2023.06.27.12 UTC

# Bias correction : quadratic regression

- O–B differences are larger at weak (≤3 m/s) and strong (≥15 m/s) wind speeds.
- This characteristic is consistently observed in ASCAT, HY-2B, and HY-2C.
- Applying bias correction resolves the issue and leads to improved statistics .
- In addition, bias correction further improves the Southern Hemisphere, where O–B differences are particularly large.




2023.06.25. 12 UTC – 2023.07.31.18 UTC

# Data Assimilation Cycle Experiment

| | Contests |
|---|---|
| EXP1 | Results of Additional HSCAT Experiment |
| EXP2 | Result of Scatwind Bias Correction Experiment |

- Cycle experiments were performed for summer and winter.
  - ✓ Summer : 2023.06.25 – 2023.07.31
  - ✓ Winter: 2023.12.26 – 2024.01.31
- Evaluation of analysis and forecast fields
  - ✓ Comparison of differences relative to IFS
- Evaluation of Typhoon
  - ✓ Verification of the track and intensity forecasts for typhoon KHANUN during 26 July–10 August 2023

# Results of Additional HSCAT Experiment

(without BC)

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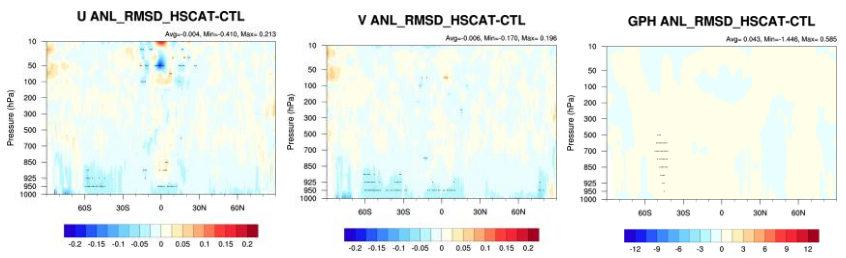
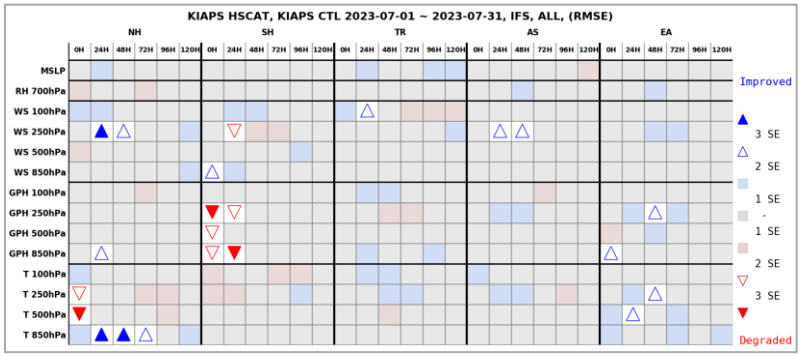
- In the analysis field, the lower-level u and v winds showed improvement where the observations were assimilated.
- In the forecast field, performance was improved over Asia during the summer season.
- Performance in the Southern Hemisphere degraded in both summer and winter.

## Summer

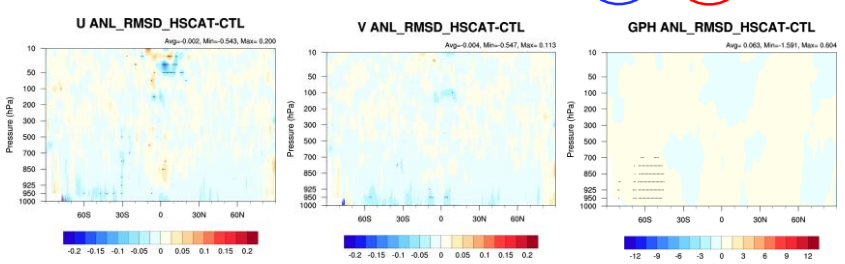
2023.06.25 – 2023.07.31

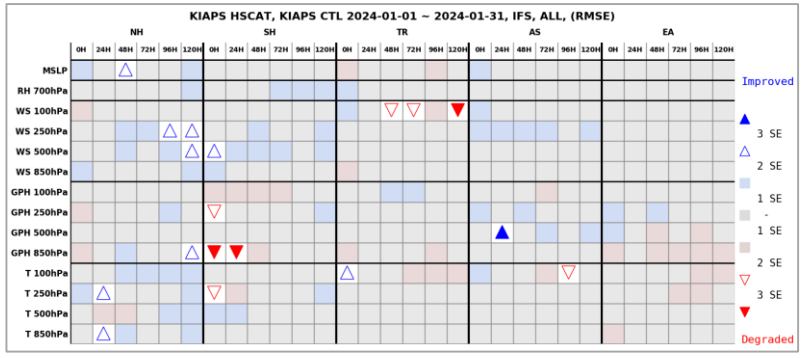



## Winter

2023.12.26 – 2024.01.31

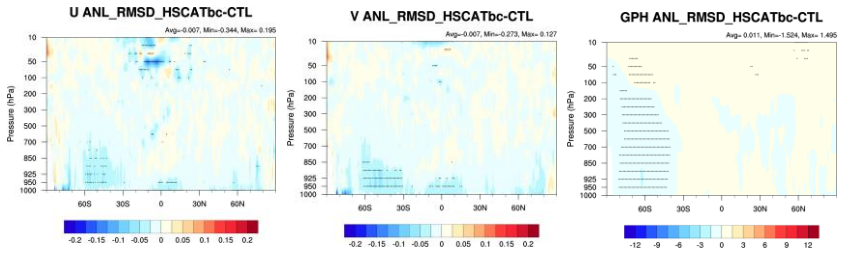


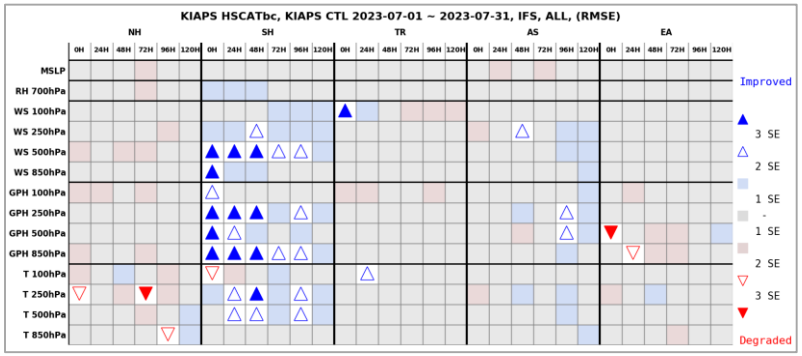



# Result of Scatwind Bias Correction Experiments (BC impact)

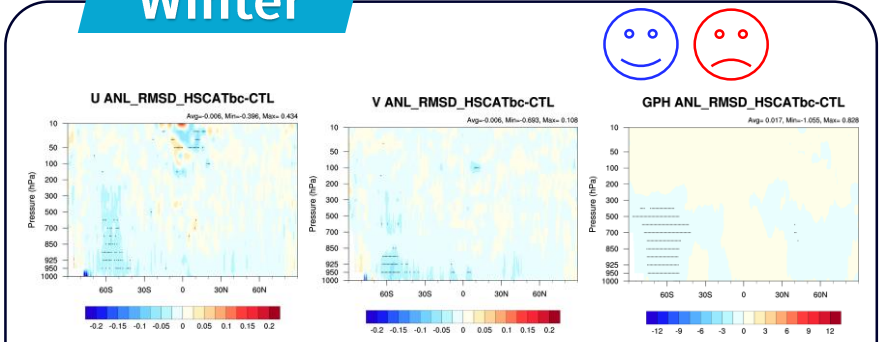
- Bias correction enhances lower-level u and v winds more effectively than the uncorrected experiments, with improvements reaching the upper levels as well.
- It is also noteworthy that the GPH in the Southern Hemisphere has improved.
- In the forecast field, performance was significantly improved in the Southern Hemisphere, with a slight performance degradation over Asia.

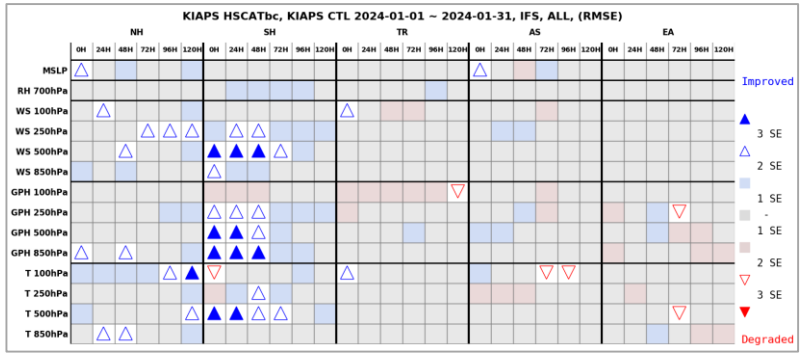
## Summer 2023.06.25 – 2023.07.31



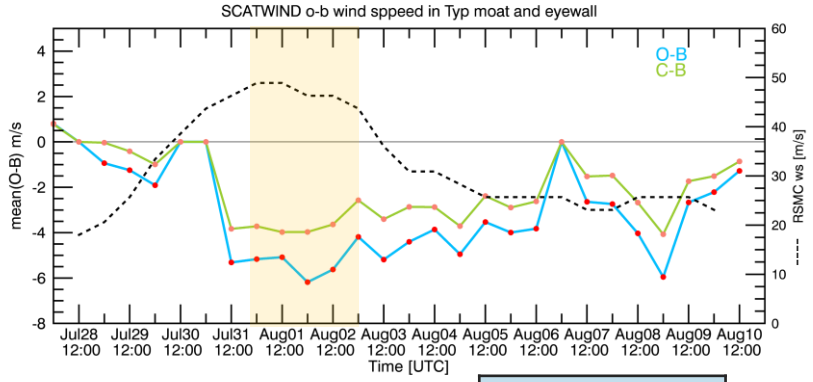

## Winter 2023.12.26 – 2024.01.31

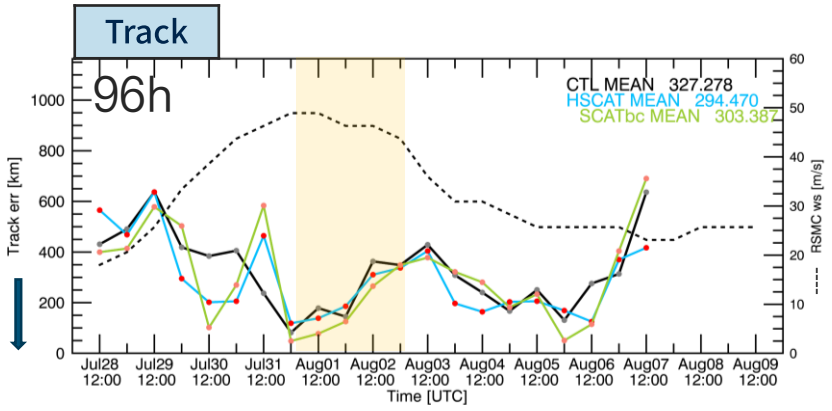


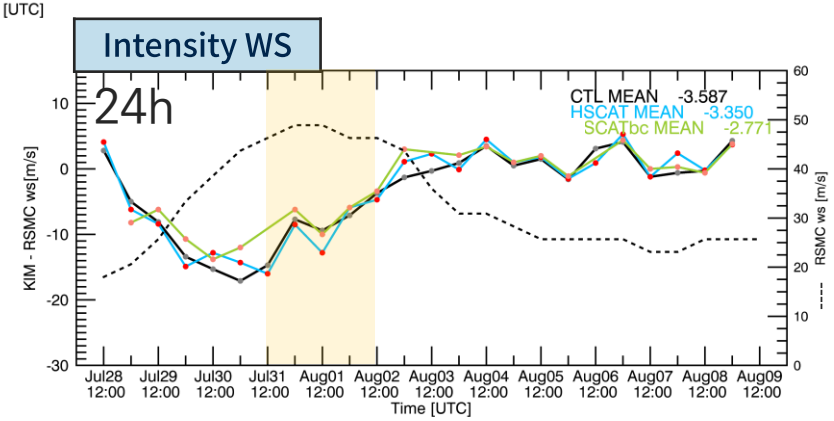



# Case Study of Typhoon KHANUN (2023)

- The mean O–B is largest during intense typhoons. Applying bias correction at this time leads to a notable improvement, with a greater reduction compared to other periods.
- In addition, forecasts initialized during this period show greater improvements in typhoon track and intensity when bias correction is applied.
- A similar pattern continues to appear in 3–5 day track forecasts, while the impact on wind intensity is confined to 1-day forecasts.
- For wind intensity, forecasts from day 1 to 5 show the best agreement with RSMC when bias correction is applied before typhoon intensification.



# Summary

- ASCAT, HY-2B, and HY-2C provide comparable wind observation quality (correlation ~0.95; RMSE: 1.15–1.22 m/s).
- Systematic O–B biases are observed, especially at weak (<3 m/s) and strong (>15 m/s) wind speeds.
- HSCAT assimilation improves low-level u, v analysis fields.
- Bias correction further improves wind analysis at all levels and enhances GPH in the Southern Hemisphere.
- Forecast skill in the Southern Hemisphere is significantly improved with bias correction.
- During Typhoon KHANUN, bias correction improves track and intensity forecasts.

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# Thank you !

If you have any additional questions, please don't hesitate to email me!

hmshin@kiaps.org