Assimilation experiment of HSCAT winds in JMA's NWP Systems

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1. Introduction

- Ocean vector wind products retrieved from scatteorometer observations provide essential information on sea surface wind for numerical weather prediction system. Assimilation of ocean vector products improve analysis field of not only surface wind but also other elements such as surface pressure[1].
- The observing system experiment (OSE) technique is used to assess the impact of adding the wind products from HSCAT onboard HY-2B and HY-2C, which have been operationally disseminated since November 2021 from the Ocean and Sea Ice Satellite Application Facility (OSI-SAF)[2].
- The OSEs use the latest global and mesoscale assimilation system of JMA.

2. Overview of Pre-Analysis Procedure

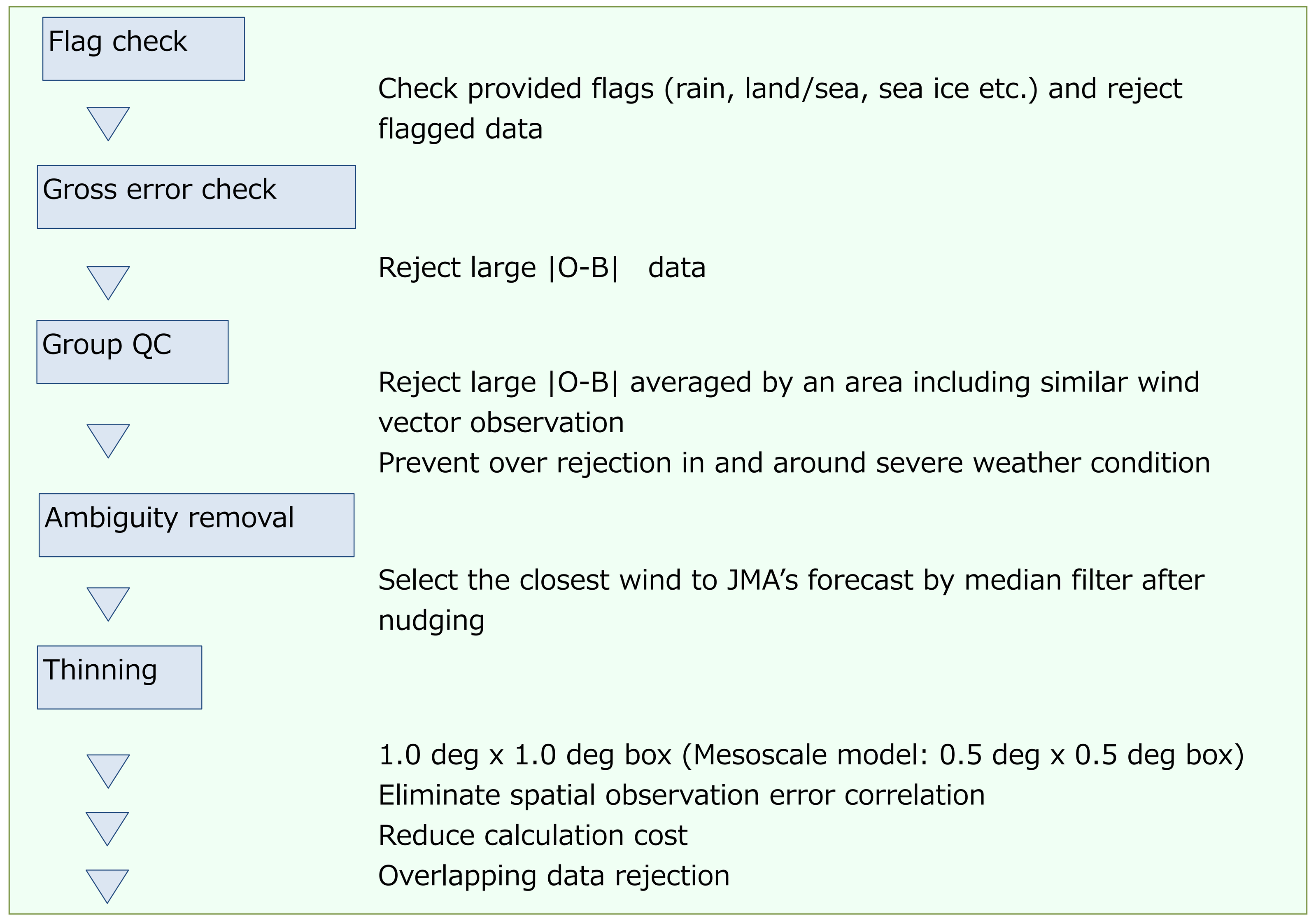


Fig.1 Pre-Analysis Procedure for Scatterometer Winds on JMA's NWP Systems

Pre-processing procedure applied to HSCAT wind products in this is same as the operational pre-processing system for ASCAT winds. This preprocessing system is also applied to HSCAT wind products in this experiment.

3. Specification of the experiment

- Control experiment (CNTL)
  - Assimilate Metop-B,C/ASCAT winds
  - Same as of Mar 2023 global and mesoscale assimilation system of JMA [3]
- TEST
  - Assimilate Metop-B,C/ASCAT winds and HY-2B,C/HSCAT winds
  - Preprocessing system is unchanged from CNTL.

- Verification period(Global model)
  - 2022Winter : From 1 Jan 2022 to 25 Jan 2022
  - 2022Summer : From 1 Aug 2022 to 31 Aug 2022
- Verification period(Mesoscale model)
  - 2022Winter : From 1 Jan 2022 to 25 Jan 2022
  - 2022Summer : From 1 Jul 2022 to 31 Jul 2022

Summary

- JMA has investigated the data assimilation of HY-2B and -2C wind product on the operational global and mesoscale NWP systems.
- Result of OSEs show that assimilated data numbers of scatteorometer increased twofold by using HSCAT wind products.
- Increase in assimilated data leads improvement of first-guess field of wind, sea surface pressure and temperature.
- By assimilating HSCAT winds, forecast skills in the global and mesoscale model are also improved.

4. Result of OSEs

4.1 Data coverage

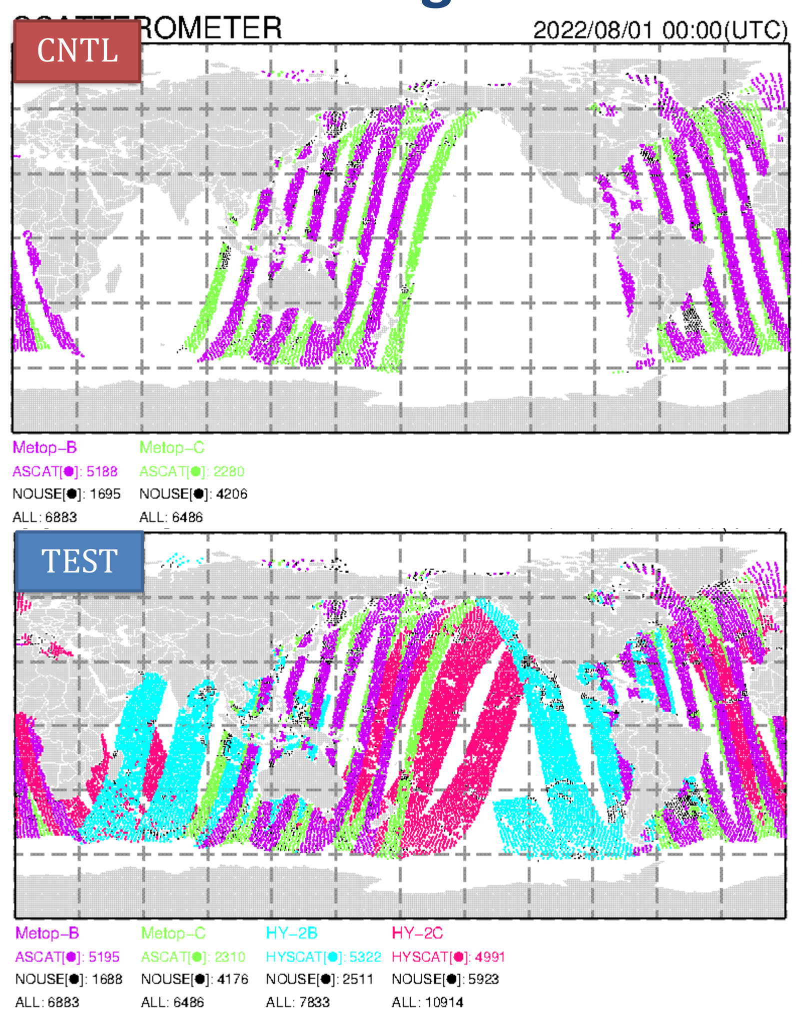
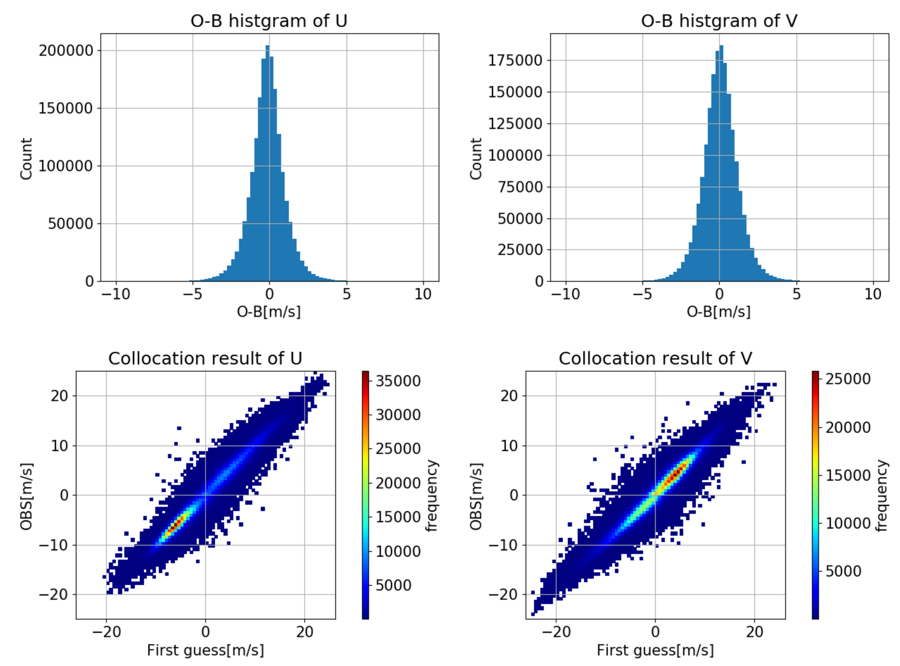


Fig 2. Data coverage of assimilated scatterometer data on 00UTC in August 1st, 2022

The distribution of the assimilated data. HSCAT wind products (cyan and pink) compensate the coverage of the Indian Ocean and the Pacific Ocean in the TEST. As a result, the number of assimilated scatterometer data increased twofold from CNTL.

4.2 Data quality and improvement on analysis field



	U	V
Data num	1858697	
Bias (m/s)	-0.130 (ASCAT:-0.129)	-0.069 (ASCAT:0.129)
STDV (m/s)	1.159 (ASCAT:1.254)	1.198 (ASCAT:1.363)

Fig.3 O-B histogram and collocation result of HSCAT winds on global analysis (Summer experiment)

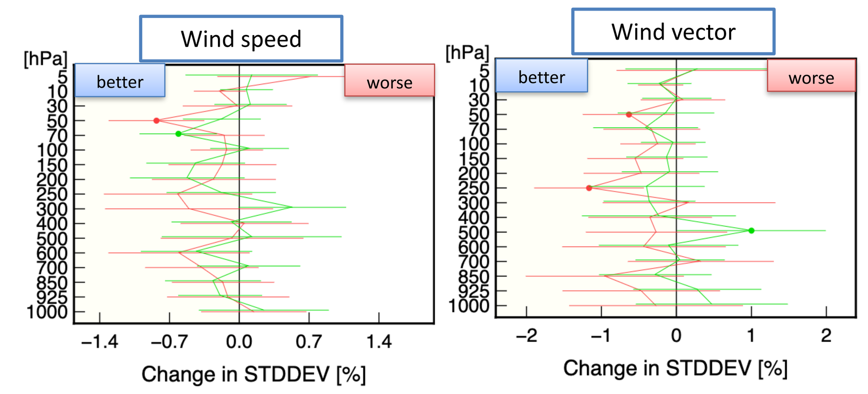


Fig.4 Change in normalized standard deviation (STDDEV) of the first-guess departure ($(STDDEV_{TEST}-STDDEV_{CNTL})/STDDEV_{CNTL}$ for radiosonde wind observations(Red: Summer, Green:Winter).
Error bars represent 95% confidence intervals, and dots are statistically significant.

Regarding the data quality, HSCAT wind product is consistent with the model (Fig.3), and bias and standard deviation (STDV) are similar to ASCAT winds.

By assimilating HSCAT winds, accuracy of first-guess field of wind (Fig. 4), sea surface pressure and temperature (Not Shown) on TEST becomes better than CNTL.

4.3 Forecast score of global model

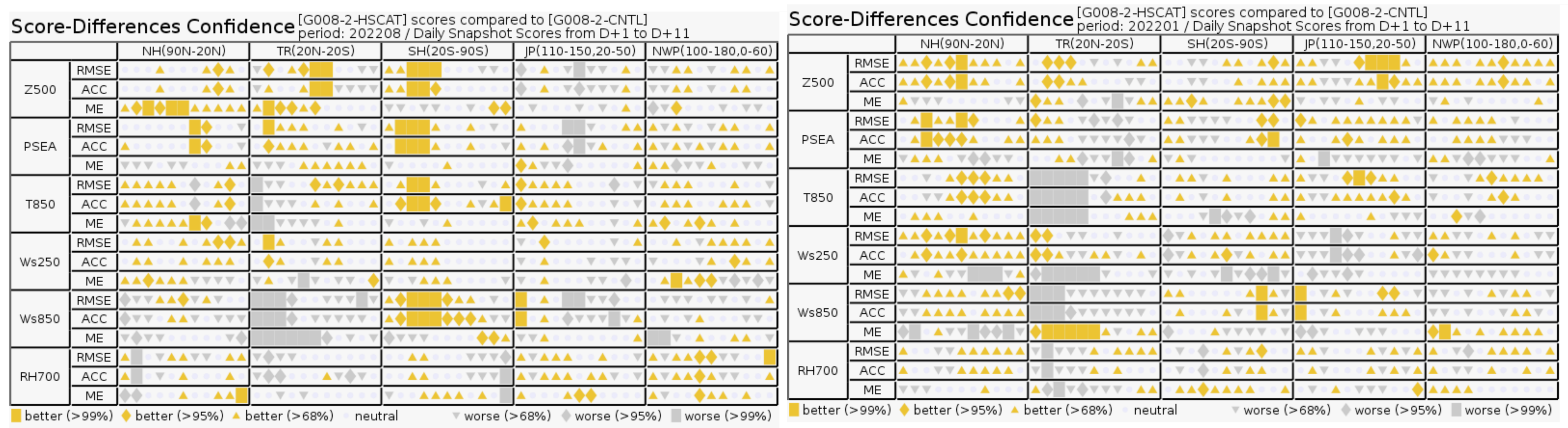


Fig 5. Forecast score difference of summer (left) and winter (right) experiments. Yellow sign means the improvement of forecast score.

Positive impacts are also found on forecast skills of sea surface pressure, temperature and wind at 850hPa and geopotential height at 500hPa (Fig. 5).
PSEA is improved in line with the improvement of the surface wind.
These improvements are pronounced in the Southern Hemisphere, which is in line with the effect of HSCAT data to extend the observation coverage over the sea surface.

4.4 Forecast score of mesoscale model

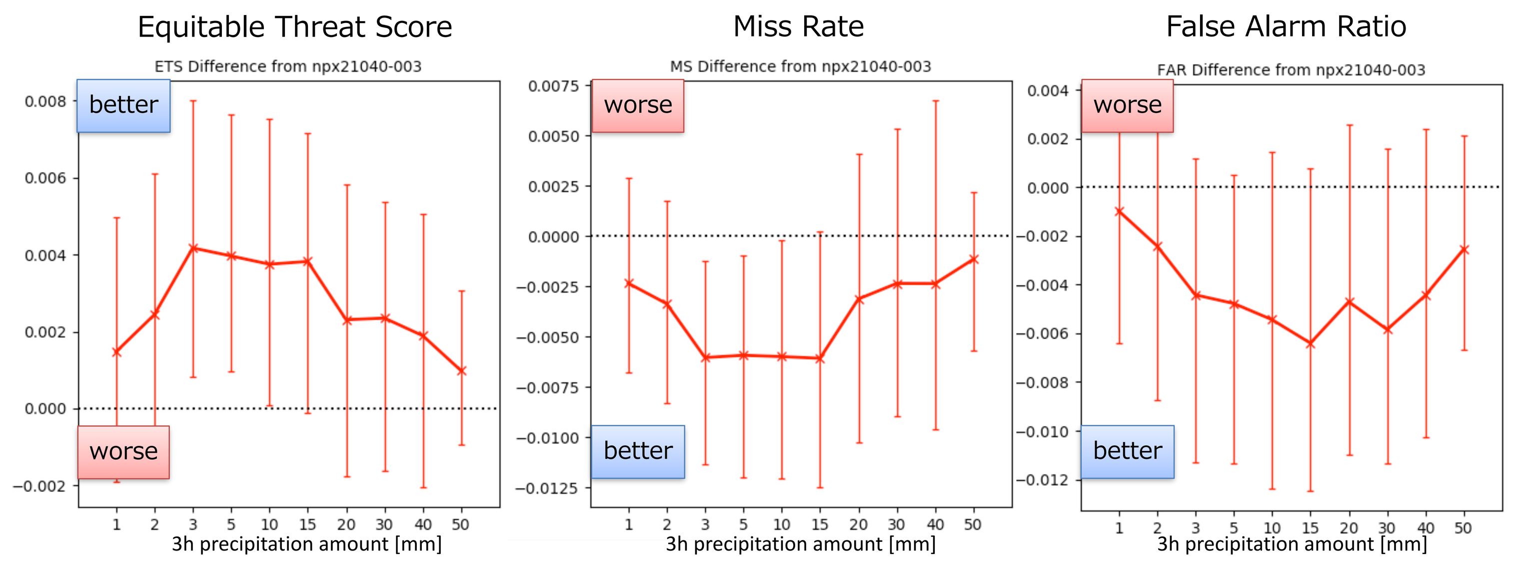


Fig.6 Forecast score difference of TEST-CNTL(Mesoscale model) on 3h precipitation forecast. Scores are classified by 3h precipitation amount.

In the experiment of mesoscale model, forecast score of precipitation is mainly improved (Fig. 6).
The result is likely to be involved with the improvement of surface wind vector field of mesoscale analysis and lateral boundary condition from outer global model.

Reference

[1] Isaksen, L. and Janssen, P. A., 2004: Impact of ERS Scatterometer Winds in ECMWF's Assimilation System. Q. J. R. Meteoro. Soc 130(600), 1794-1814 DOI: 10.1256/qj.03.110

[2] OSI SAF, 2021: HSCAT Winds at 25 km Swath Grid - Hai Yang 2B, EUMETSAT SAF on Ocean and Sea Ice, DOI: 10.15770/EUM_SAF_OSI_NRT_2000. http://doi.org/10.15770/EUM_SAF_OSI_NRT_2000

[3] Japan Meteorological Agency, 2023: Outline of the operational numerical weather prediction at the Japan Meteorological Agency. https://www.jma.go.jp/jma/jma-eng/jma-center/nwp/outline-latest-nwp/pdf/outline2023_Contents.pdf

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