Observing Simulation System Experiment (OSSE) of Spaceborne Doppler Wind Lidar

[*1,2]Kozo OKAMOTO, [2]Shoken ISHII, [2]Philippe BARON,
[1]Toshiyuki ISHIBASHI, and [1]Taichu TANAKA

1. Meteorological Research Institute (MRI) of Japan Meteorological Agency (JMA)
2. National Institute of Information and Communications Technology (NICT)
*E-mail: kokamoto@mri-jma.go.jp

1. Introduction and OSSE system

Spaceborne Doppler Wind Lidar (DWL) can provide global wind profile observations, which are significant for improving numerical weather prediction. To assess the quantitative impact of DWL, we have been developing the OSSE system and a full-scaled lidar simulator called ISOSIM-L (Integrated Satellite Observation SIMulator for a spaceborne coherent Doppler lidar; Baron et al., 2012). OSSE is based on the Sensitivity Observing System Experiment (SOSE) approach (Marseille et al., 2008) A pseudo-truth field is created in SOSE from adjoint sensitivity and existing observations. ISOSIM-L inputs the pseudo-truth winds and three-dimensional cloud and aerosol fields, and then calculates optical parameters of aerosols and clouds, backscattered power, and line of sight (LOS) wind speeds. The aerosol field is generated by the MRI global aerosol model MASINGAR (Model of Aerosol Species in the Global Atmosphere; Tanaka and Chiba, 2005), constrained by the pseudo-truth winds. Simulated LOS wind speeds are assimilated in the global data assimilation system based on the four-dimensional variational (4D-Var) scheme used in the operational system at JMA. Figure 1 presents the flow of OSSE.

2. Assimilation pre-processing of DWL wind data and preliminary results

ISOSIM-L estimates a LOS wind-speed error from a simulated signal-to-noise ratio after spatial averaging, for example, over 100 km along the satellite track and 0.5 to 2.0 km in the LOS direction. The error estimate is used for observation error assignment and quality control (QC) criteria in the data assimilation pre-processing. Figure 2 presents an example of the QC result in a data assimilation experiment. We assume a 2.0 μm coherent DWL having two laser systems with a nadir angle of 35 degrees and orthogonal azimuthal angles of 45 and 135 degrees on a sun-synchronous polar-orbiting satellite crossing the equator around 1800 local time at 220 km altitude. Much data is rejected between 30 and 60 degrees latitude in the Southern Hemisphere as a result of a large error estimate due to few aerosols. In contrast, in the mid-latitudes of the Northern Hemisphere, many DWL LOS winds pass the QC with a relatively large amount of continental aerosols. In the upper troposphere of the Northern Hemisphere and Tropics, much DWL data is available due to strong backscattering from high clouds.

3. Plans

We are implementing several one-month data assimilation experiments including DWL LOS winds to validate the OSSE system. The second step of our development is evaluating the impact of DWL winds on forecast accuracy for various combinations of data assimilation parameters, such as observation errors and QC criteria, and DWL parameters such as lidar power and averaging distance. Comparison is also necessary using various OSSE approaches including a nature-run OSSE, helping us to carefully interpret OSSE results.

References

Baron P., S. Ishii, K. Mizutani, T. Itabe, and M. Yasui, 2012: The Integrated Satellite Observation

SIMulator for a Coherent Doppler Lidar (ISOSIM-L). The proceedings of 30th Japanese laser sensing symposium, Kagawa, Japan, 6–7 September 2012, ISBN:978-4-9902916-6-2
Marseille, G. J., A. Stoffelen, and J. Barkmeijer, 2008a: Sensitivity observing system experiment (SOSE): A new effective NWP - based tool in designing the global observing system, *Tellus A*, **60**, 216–233.
Tanaka, T. Y. and Chiba, M., 2005: Global simulation of dust aerosol with a chemical transport model, MASINGAR, *J. Meteor. Soc. Japan*, **83A**, 255–278.

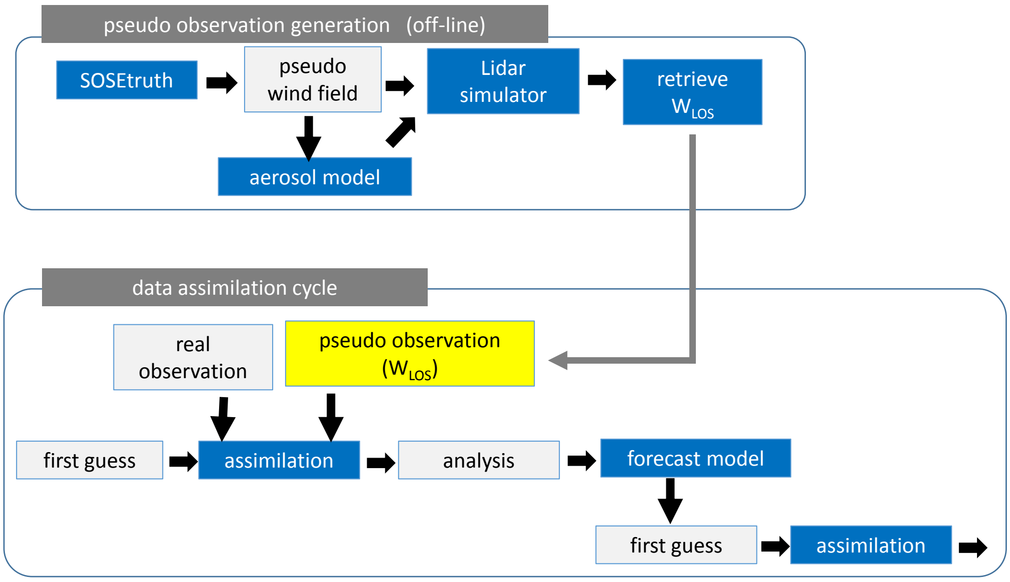

Fig.1. A flow of SOSE-OSSE. The top box is a DWL wind simulation step and the bottom box is a data assimilation step.

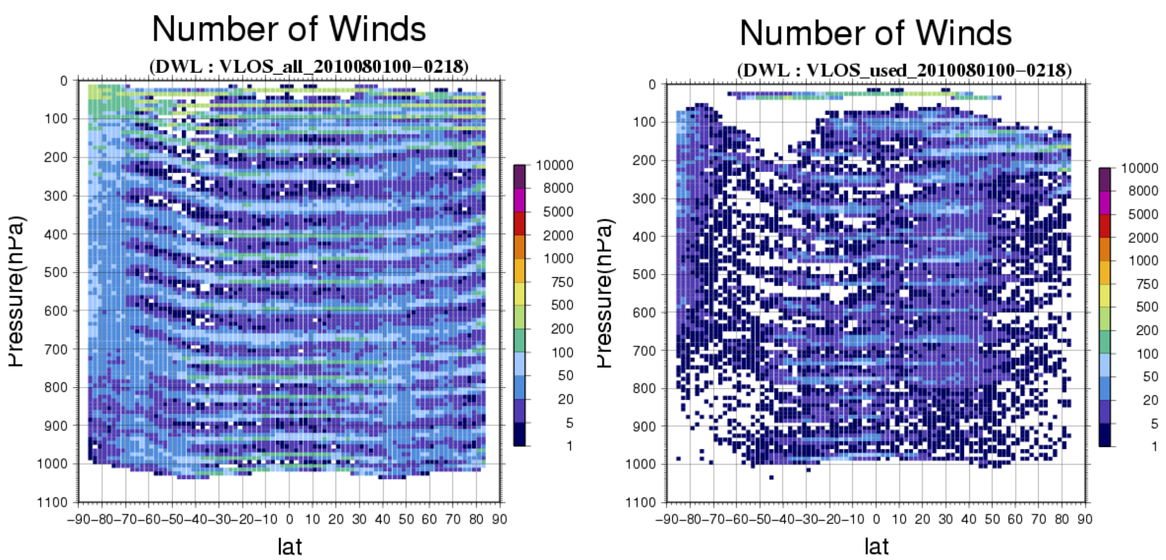

Fig.2. Zonally accumulated number in 2 degree x 20 hPa box from 1 to 2 August 2010 for DWL (left) before the QC (right) after QC.