A high-resolution global atmospheric composition data assimilation of multiple satellite measurements during NASA’ s KORUS-AQ aircraft campaign

*Takashi Sekiya[1], Kazuyuki Miyazaki[1,2], Koji Ogochi[1], Kengo Sudo[3,1], Masayuki Takigawa[1]

1. Japan Agency for Marine-Earth Science and Technology, 2. Jet Propulsion Laboratory-California Institute of Technology, 3. Graduate School of Environmental Studies, Nagoya University

Ozone (O_3) and its precursors (NO_x, CO, and VOCs) in the atmosphere are important for human health, ecosystems, and climate. Chemical transport models (CTMs) have been used to study controlling processes of variations of O_3 and related species (e.g., Sekiya and Sudo, 2012). However, current CTMs still have large uncertainties in representing variations of O_3 and related species, including large uncertainties in bottom-up emission inventories used in the simulations. We have developed a global chemical data assimilation system based on an ensemble Kalman filter to combine multiple-species observations from multiple-satellite sensors, including OMI, TES, MLS, MOPITT, GOME-2, and SCIAMACHY, with a global CTM (CHASER) (Miyazaki et al., 2017). High-resolution modeling is considered to be important for improving data assimilation performance, by improving the general model performance, reducing spatial and temporal gaps between the simulation and observations, and improving resolving small-scale processes. By conducting forward calculations, we have found that an increase of horizontal model resolution from 2.8° to 1.1° substantially improved the forecast model performance (Sekiya et al., in preparation).

In this study, we demonstrate the performance of high-resolution data assimilation during the NASA’ s KORUS-AQ aircraft observation campaign conducted over South Korea in May 2016. The tropospheric NO_2 column bias in the data assimilation compared to OMI satellite retrievals is reduced by 57% over South Korea and by 43% over central Japan, by increasing horizontal model resolution from 2.8° to 1.1°. The 1.1° analysis also led to improved agreements with vertical profiles by DC-8 aircraft measurements. Surface NO_x emissions derived from the data assimilation also differed by 17% over South Korea and by 4% over central Japan by changing the model resolution, with substantial differences over many megacities in Asia. Data assimilation performance could further be improved using a model with horizontal resolution higher than 1.1°. Based on sensitivity calculations conducted under the post-K project, we will discuss the potential benefit of using a 0.5° resolution model in chemical data assimilation, in reproducing the spatio-temporal variations of major pollutants over Asia.

Reference

Miyazaki et al. (2017), Atmos. Chem. Phys., 17, 807–837.
Sekiya and Sudo (2012), J. Geophys. Res., 117, D18303.

Keywords: atmospheric chemistry, atmospheric environment, data assimilation