A 0.56˚-resolution global data assimilation of multi-chemical constituent satellite measurements

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Tropospheric ozone (O_3) and its precursors (NO_x, CO, and VOCs) are important for human health, ecosystems, and climate. Chemical transport models (CTMs) have been used to study controlling processes of spatial and temporal variations of O_3 and related species. We have demonstrated that a 0.56˚-resolution CTM improves the model performance, especially over the areas with strong sources (Sekiya et al., 2017). However, current CTMs still have other uncertainties in representing variations of O_3 and related species, including large uncertainties in bottom-up emission inventories used in the simulation. Thus, we have developed a 0.56˚-resolution global chemical data assimilation system based on an ensemble Kalman filter to combine multi-species observations from multiple-satellite sensors, including OMI, GOME-2, SCIAMACHY, TES, MOPITT, and MLS, with a global CTM (CHASER) (Miyazaki et al., 2017). An increase in horizontal resolution can be expected to improve data assimilation performance, through reducing spatial representation gaps between satellite retrievals and model simulations and improving forecast model performance.

In this study, we evaluate the performance of high-resolution (0.56˚) and 64-member ensemble Kalman filter data assimilation for a week from April 23rd to 29th 2008. The tropospheric NO_2 column bias with respect to OMI was reduced in the data assimilation by 45% over China, 85% over Europe, and 91% over the eastern United States, compared to the model simulation. Comparisons of NO_2 with independent surface observation networks revealed mean bias reductions by 25% in the 39 selected urban agglomerations over Europe and the United States in the data assimilation. Compared to globally available ozonesonde observations, tropospheric O3 concentrations were also improved in the data assimilation, with negative bias reductions by 20% between 850-500 hPa and 22% between 500-200 hPa. These results suggest the potentials of using high-resolution global chemical data assimilation system for studying megacity-scale air pollution over the entire globe. We will show the results of one month-long data assimilation in the presentation.

Keywords: Tropospheric chemistry, data assimilation, chemical transport model

