

メガシティ規模の大気汚染解析に向けたTROPOMI NO₂データを含む複数衛星観測の全球高解像度データ同化

A high-resolution global data assimilation for air pollution analysis on megacity scale using multi-sensor satellite measurements including TROPOMI NO₂ data

*関谷 高志¹、宮崎 和幸^{2,1}、Henk Eskes³、Folkert Boersma³、大越智 幸司¹、須藤 健悟^{4,1}、滝川 雅之¹

*Takashi Sekiya¹, Kazuyuki Miyazaki^{2,1}, Henk Eskes³, Folkert Boersma³, Koji Ogochi¹, Kengo Sudo^{4,1}, Masayuki Takigawa¹

1. 国立研究開発法人 海洋研究開発機構、2. NASAジェット推進研究所／カリフォルニア工科大学、3. オランダ王立気象研究所、4. 名古屋大学 大学院環境学研究科

1. Japan Agency for Marine-Earth Science and Technology, 2. Jet Propulsion Laboratory/California Institute for Technology, 3. Royal Netherlands Meteorological Institute (KNMI), 4. Graduate School of Environmental Studies, Nagoya University

Intensive human activities lead to high emissions of air pollutants at megacities, causing severe damages to human health. The number of megacities is expected to rise in developing regions in the near future. Thus, it is important to provide information on air pollutants and their emissions on a megacity scale for the globe in a consistent way. In this study, we present the results from global chemical data assimilation of multi-species satellite observations with a resolution of 0.56 degree using an ensemble Kalman filter approach (Miyazaki et al., 2015) and high-resolution global chemical transport model, CHASER (Sekiya et al., 2018). Assimilated data were obtained from the OMI, GOME-2, and SCIAMACHY for tropospheric NO₂ column, the TES for O₃ profile, the MOPITT for total CO column, the MLS for O₃ and HNO₃ profiles, and the OMI for total SO₂ column. Data assimilation at 0.56-degree resolution largely improved agreements with the observed surface NO₂ pollutions on megacity scale, with reductions of the root mean square errors (RMSEs) relative to in-situ measuring networks (AirBase, AQS, Hong Kong EPD, and NIES) by 33% for Europe, by 67% for the U.S., and by 75% for East Asia, compared to the model simulations without data assimilation. With increasing horizontal resolution from 2.8 to 0.56 degree, the global total NO_x emission estimates became lower by 10% mainly because of the effects of non-linear O₃-HO_x-NO_x chemistry, while resolving higher NO_x emissions by a factor of 4-5 in most of the megacities than their surrounding areas. Using the high-resolution data assimilation system and applying advanced super-observation approach, we demonstrated that assimilation of tropospheric NO₂ retrievals from TROPOMI improved agreements of tropospheric NO₂ column with the assimilated TROPOMI data itself by 62% and with OMI by 40% (not used for data assimilation) compared to model simulation at 1.1-degree resolution for April 2018. These improvements primarily resulted from substantial emission reductions over the U.S., China and India and increases over rural regions relative to the a priori emissions (HTAP_v2.2+GFED4 +GEIA). These results demonstrated the potentials of the high-resolution global data assimilation with the combined use of advanced satellite observations to provide valuable information on spatial and temporal variations of air pollution on a megacity scale globally.

キーワード：対流圏NO₂、メガシティ、データ同化、排出量逆推定、衛星観測

Keywords: Tropospheric NO₂, Megacity, Data assimilation, Emission inversion, Satellite observation

