Development of SCALE-Chem and its application for regional simulation targeting on urban area and mountain area of Japan

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A chemical transport model (CTM) (Kajino et al., 2019) was implemented into a meteorological model; Scalable Computing for Advanced Library and Environment (SCALE; Nishizawa et al., 2015; Sato et al., 2015) for investigating the local scale transport of aerosol. The CTM coupled with SCALE (SCALE-Chem) enabled us to conduct numerical simulations with fine grid spacing (O(10 ~ 100 m)) enough to resolve the local scale phenomena contributing to the local scale transport of aerosols and chemical tracer. Using SCALE-Chem, we conducted the numerical simulation targeting on urban area of Osaka, Japan, and the validity of the SCALE-Chem was confirmed through the comparison between the aerosol optical thickness (AOT) and particulate matter measured by the observation campaign of Distributed Regional Aerosol Gridded Observation Networks (DRAGON) Osaka (Holben et al., 2018; Sano et al., 2016) and those simulated by SCALE-Chem. Figure 1 shows the DRAGON-Osaka site distribution. Our analyses indicated that SCALE-Chem successfully simulated the observed aerosol properties. As well as the simulation for the urban area of Osaka, we will conduct numerical simulations targeting on mountain area of Nagano Prefecture, Japan to investigate the contribution of the local aerosol and aerosols transported from continent to aerosols measured by the observational campaign of Joint work to the Aerosol Properties and process Simulations (J-ALPS).

Figure 1. These black circles indicate AERONET (Aerosol Robotic Network) station and these open circles indicate sites that sun photometers are put into place during a period of DRAGON field campaign. The extended figure shows DRAGON-Osaka site distribution. Osaka, Kobe, Kyoto, and Nara are located in very close each other.

Reference

Kajino, M., Deushi, M., Sekiyama, TT., Oshima, N., Yumimoto, K., Tanaka, TY., et al., NHM-Chem, the Japan meteorological agency’ s regional meteorology –chemistry model: Model evaluations toward the consistent predictions of the chemical, physical, and optical properties of aerosols. J. Meteorol. Soc. Japan. 2019;97(2):337–374.

Nishizawa, S., Yashiro, H., Sato, Y., Miyamoto, Y., Tomita, H., Influence of grid aspect ratio on planetary boundary layer turbulence in large-eddy simulations. Geosci. Model Dev. 2015; 28;8(10):3393–341.

Sato, Y., Nishizawa, S., Yashiro, H., Miyamoto, Y., Kajikawa, Y., Tomita, H., Impacts of cloud microphysics on trade wind cumulus: which cloud microphysics processes contribute to the diversity in a large eddy simulation? Prog. Earth Planet. Sci. 2015;2(1):23. doi:10.1186/s40645-015-0053-6

Holben, B. N., Kim, J., Sano, I., Mukai, S., Eck, T. F., Giles, D. M., Schafer, J. S., Sinyuk, A., Slutsker, I., Smirnov, A., Sorokin, M., Anderson, B. E., Che, H., Choi, M., Crawford, J. E., Ferrare, R. A., Garay, M. J., Jeong, U., Kim, M., Kim, W., Knox, N., Li, Z., Lim, H. S., Liu, Y., Maring, H., Nakata, M., Pickering, K. E.,

Piketh, S., Redemenn, J., Reid, J. S., Salinas, S., Seo, S., Tan, F., Tripathi, S. N., Toon, O. B., and Xiao, Q, An overview of meso-scale aerosol processes, comparison and validation studies from DRAGON networks, Atmos. Chem. Phys. 2018;18 (2): 655-671

Sano, I., Mukai, S., Nakata, M., Holben, B. N., Regional and local variations in atmospheric aerosols using ground-based sun photometry during distributed regional aerosol gridded observation networks (DRAGON) in 2012, Atmos. Chem. Phys. 2016; 16, 14795-14803, doi:10.5194/acp-16-14795-2016

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