Simulation of CO_2 and CH_4 in the subarctic using coupled Eulerian-Lagrangian model

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The subarctic is a region in the Northern Hemisphere south of the Arctic and covering much of Alaska, Canada, Iceland, the north of Scandinavia, Siberia, and the Shetland Islands. Generally, subarctic regions fall between 50°N and 70°N latitude, depending on local climates. The subarctic regions contain large amounts of plant biomass and soil organic carbon, so these regions are the largest carbon reservoirs in the world with a substantial source and sink of CO_2 and CH_4. The magnitude and distribution of CO_2 and CH_4 fluxes are still uncertain, so accurate estimation of carbon fluxes and study of CO_2 and CH_4 seasonal cycles in the subarctic regions are essential.

In this work, we use forward simulation employing the Global Eulerian–Lagrangian Coupled Atmospheric (GELCA; Ganshin et al. 2012) model in order to estimate CO_2 and CH_4 seasonal cycles in the subarctic. GELCA consists of an Eulerian National Institute for Environmental Studies global Transport Model (NIES-TM; Belikov et al., 2011) and a Lagrangian particle dispersion model (FLEXPART; Stohl et al., 2005). This approach utilizes the accurate transport of the Lagrangian model to calculate the signal near to the receptors, and efficient calculation of background concentrations using the Eulerian global transport model.

We setup a long simulation period to obtain a better understanding of the role of emissions (using a set of CO_2 and CH_4 emissions scenarios), and transport model characteristics, such as the stratosphere/troposphere exchange and tracers concentration variations in the troposphere. We also analyzed modeled and observed long and short-term trend, seasonal cycle of CO_2 and CH_4.

Model results were compared with observations from the World Data Centre for Greenhouse Gases (WDCGG 2015) and the Siberian observations obtained by the Center for Global Environmental Research (CGER) of the National Institute for Environmental Studies (NIES) and the Russian Academy of Science (RAS), from six tower sites (JR-STATION) as described by Sasakawa et al. (2010).

The analyses have shown that CELGA is effective in capturing the seasonal variability of atmospheric tracer at observation sites strongly influenced by local emissions and global transport at the same time.

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