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Analysis of CO_2 concentrations simulated by NIES transport model and retrieved from GOSAT in the subarctic regions

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The arctic and subarctic regions are large soil carbon reservoirs in the world. Permafrost soils covering about 25% of the land surface in the Northern Hemisphere store almost twice as much carbon as is currently present in the atmosphere. However, the rates of carbon release from permafrost soils due to permafrost thaw and the microbial decomposition of previously frozen organic carbon are highly uncertain. Moreover, the carbon cycle in the subarctic remains poorly investigated due to the insufficient observations. At present, the spatial coverage of direct carbon flux measurements needed to map the fluxes accurately is not enough, especially in the high-latitudes of the Northern hemisphere.

This work describes investigation of carbon dioxide distribution in the subarctic regions using numerical simulation with the National Institute for Environmental Studies (NIES) three-dimensional transport model (TM) and retrievals from the Greenhouse gases Observing SATellite (GOSAT). Simulated by NIES TM with several flux combinations column-averaged dry air mole fractions of atmospheric CO_2 (XCO_2) was compared with GOSAT data for different latitude bands over land in the subarctic. We revealed relatively large deviations between XCO_2 modeled and retrieved from GOSAT with positive bias in spring/summer and negative in autumn, indicating some fluxes inaccuracy, which may be caused by uncertainty in emission/sink of CO_2. We analyzed flux uncertainty reduction and improvements in seasonal cycle reproduction following fluxes optimization with the inverse modeling system. XCO_2 simulated with optimized fluxes was evaluated against the Total Carbon Column Observing Network (TCCON) ground-based high-resolution Fourier Transform Spectrometer (FTS) measurements at two the most northern sites Ny Alesund and Sodankyla. CO_2 distribution obtained through inverse modeling using the ground based, aircraft observations and GOSAT data together appear to be closer to FTS measurements, than without GOSAT data. Thus, we have shown XCO_2 retrieved from GOSAT can be used to evaluate modeled results and as additional constrain in flux optimization with inverse model in the subarctic regions.

Keywords: carbon dioxide, atmospheric forward and inverse modeling, remote sensing