Simulation of CO_2 and CH_4 seasonal cycles in Siberia

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Siberia contains large amounts of plant biomass and soil organic carbon, making this region one of the largest carbon reservoirs in the world with a substantial source and sink of CO_2 and CH_4. However the magnitude and distribution of CO_2 and CH_4 fluxes are still uncertain. Accurate estimates of carbon fluxes in Siberia are essential, both for understanding global and regional carbon cycles. Many studies have used "bottom-up" or "top-down" approaches to estimate carbon fluxes. "Top-down" approaches calculate land-atmosphere carbon fluxes based on atmospheric budgets and inverse modeling. "Bottom-up" approaches rely primarily on measurements of carbon stock changes (the 'inventory' approach) or on spatially distributed simulations of carbon stocks and/or fluxes using process-based modeling (the 'forward model' approach). Each of these general approaches builds on different knowledge foundations and employs different driver data (Hayes et al., 2012). Whereas current carbon fluxes in Siberia are very uncertain, accurate comparison of different fluxes obtained using various method is essential.

In this work, we use forward simulation employing the National Institute for Environmental Studies (NIES) three-dimensional transport model (TM) developed by Belikov et al., (2013) in order to estimate performance and quantify errors of monthly CO_2 and CH_4 fluxes on a subcontinental scale over Siberia. Simulated distributions of CO_2 and CH_4 are compared with unique 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). These observations consist of precise aircraft measurements (over Surgut, Yakutsk, and Novosibirsk) and tower observations from Siberian tower network (Japan-Russia Siberian Tall Tower Inland Observation Network, JR-STATION) as described in Table 1 (Sasakawa et al., 2010).

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.

Table 1. Tower network sites in Siberia (JR-STATION).

Identifying code	Location	Latitude	Longitude	Sampling height (m)
DEM	Demyanskoe	59°47′29″	70°52′16″	63
IGR	Igrim	63°11′25″	64°24′56″	47
KRS	Karasevoe	58°14′44″	82°25′28″	67
NOY	Noyabrsk	63°25′45″	75°46′48″	43
SVV	Savvushka	51°19′30″	82°07′40″	52
VGN	Vaganovo	54°29′50″	62°19′29″	85
YAK	Yakutsk	62°05′19″	129°21′21″	77

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