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Large-scale quantifying of sources and sinks of atmospheric carbon in Central Siberia: from middle taiga to Arctic tundra

Alexey Panov[1], Anatoly Prokushkin[1], Anastasiya Urban[1], Vyacheslav Zyrianov[1], Mikhail Korets[1], Nikita Sidenko[1], Jošt Lavrič[2], and Martin Heimann[2,3]

[1]V.N. Sukachev Institute of Forest SB RAS, Laboratory of BGC cycles in forest ecosystems, Krasnoyarsk, Russian Federation (alexey.v.panov@gmail.com)

[2]Max Planck Institute for Biogeochemistry, Jena, Germany

[3]University of Helsinki, Faculty of Science, Institute for Atmospheric and Earth System Research, Helsinki, Finland

The boreal and arctic zone of Siberia represents a «hot spot» area in the global Earth climate system, containing large and potentially vulnerable carbon stocks as well as considerable carbon dioxide (CO_2) and methane (CH_4) exchange fluxes with the atmosphere. Up to the recent time Siberian region was only sparsely covered by carbon flux measurements. Solely in the frame of EU-funded projects «Eurosiberian Carbonflux» and «Terrestrial Carbon Observing System – Siberia» (TCOS-Siberia) between 1998 and 2005 several atmospheric and terrestrial ecosystem stations were operational in European Russia and Siberia.

Since 2006, in order to monitor long-term biogeochemical changes, the Zotino Tall Tower Observatory (ZOTTO; www.zottoproject.org), a research platform for large-scale climatic observations, is operational in Central Siberia (60°48' N, 89°21' E) about 20 km west of the Yenisei river. Observatory consists of a 304-m tall mast for continuous high-precision measurements of greenhouse gases, meteorology and multitude of aerosol properties in the planetary boundary layer (PBL). Sampling of the PBL is essential for the «top-down» approach in observation strategy, since it minimizes local effects and permits to capture regional concentration signals. Such measurements are used in atmospheric inversion modelling to estimate sinks/sources at the surface over the large Siberian territory. In turn, the tall tower observations are linked with eddy covariance measurements of exchange carbon fluxes, introducing a «bottom-up» observational approach, over locally representative ecosystems: pine forest–bog complexes (60°48'N; 89°22'E); a mid-taiga dark coniferous forest (60°01'N; 89°49'E); a northern taiga mature larch forest (64°12'N; 100°27'E) and a forest-tundra ecotone (67°28'N; 86°29'E). This meridional observation network captures exchange fluxes of CO_2 and CH_4 in ecosystems of the main biogeochemical provinces for the Yenisey river basin of 2580 thousand km², that can be scaled up to the region using vegetation maps, forest biomass inventories and remote sensing information. Since 2018 observation network was expanded and a new coastal station for continuous atmospheric measurements of GHG (CO_2/CH_4/H_2O) and meteorology is operational on the shore of the Arctic ocean (73°33'N; 80°34'E) near the Dikson settlement. Such coastal station enhances the atmospheric signal derived at «ZOTTO» regarding the budget of trace gases in Central Siberia, permits tracing ocean-continent

transport of GHG and also extends the circum-Arctic observation network.

Here we summarize the scientific rationale of the observation network, infrastructure details of the stations, the local environments and provide some exemplary results obtained from measurements. The reported study was funded by the Max Planck Society (Germany), RSF project № 14-24-00113 and the RFBR projects № 18-05-00235 and 18-05-60203.