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Breathing of Siberia: large-scale quantifying of sources and sinks of atmospheric carbon

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, the 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 continental 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. The observatory was erected as a result of joint efforts of SIF SB RAS (Russia) and MPI-BGC (Germany) and consists of a 304-m tall mast for continuous high-precision measurements of carbon dioxide, methane, carbon monoxide, ozone, reactive nitrogen species, meteorology and a multitude of aerosol properties in the well-mixed planetary boundary layer (PBL). Sampling of the PBL is essential for the “top-down” approach, 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 PBL measurements at the tall tower are linked with eddy covariance measurements of exchange fluxes of greenhouse gases (GHG) over locally representative ecosystems (a “bottom-up” approach). Since 2008 the eddy covariance flux tower is available in the northern taiga mature larch forest (64□‹12' N; 100□‹27'E) and two more towers were erected in 2012 in a *Pinus sylvestris* forest and on a peat bog site (60□‹48' N; 89□‹22' E). Since 2015 and 2016, eddy covariance flux measurements were started in a mid-taiga dark coniferous forest (60□‹01' N; 89□‹49' E) and in a forest-tundra ecotone (67□‹28' N; 86□‹29' E), respectively. All eddy covariance stations are integrated into the large-scale observation network “KrasFLUX” lead by SIF SB RAS and MPI-BGC. This network captures exchange fluxes of CO_2 and CH_4 in the representative ecosystems of the main biogeochemical provinces for the whole 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 summer 2017, it is being planned to expand the observation network and erect a new station for a long-term atmospheric monitoring of GHG („R„O_2/„R„N_4/„N_2„O) near the Dikson city on the shore of the Arctic ocean (73□‹33' N; 80□‹34' E) - the Dikson Atmospheric Measurement Integration Station (DIAMIS). This new Arctic/oceanic research platform will be complementary to ZOTTO, permitting to better constrain the budgets of biogeochemical trace gases in Central Siberia, trace the ocean-continent transport of GHG, and extend the circum-Arctic observation network.
Here we summarize the scientific rationale of the observation network, infrastructure details of the stations, the local environments and give some results obtained from the measurements.
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