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Continuous CO_2/CH_4 measurement at Zotino Tall Tower Observatory (ZOTTO) in Central Siberia

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Global climate change has particular impact on Siberia, where one tenth of global vegetation and soil carbon is stored. The increase in temperature lengthens the vegetation period and consequently enlarges the carbon sink. On the other hand, a warming climate will enhance thawing of permafrost which contains organic carbon that can be released either as carbon dioxide or methane depending on the local hydrological conditions.

Long-term biogeochemical trace gas measurements on tall towers ($>$ 250 m) over continents help to improve the knowledge about surface source/sink processes at regional to continental scales. Without the usage of aircrafts, the height of the tower allows regular probing of the mixed part of the boundary layer, which is – unlike the surface layer – only moderately influenced by diurnal variations of local surface fluxes and thus representative for a larger region ($\sim$1000km). The recently established Zotino Tall Tower Observatory (ZOTTO, 304 m, www.zottoproject.org) is located near the village of Zotino at the Yenisei River in central Siberia (60°N, 89°E). The ZOTTO facility was built in the perspective to monitor and determine variability and trends in the carbon balance of central Siberian forests.

Since April 2009 we measure CO_2 and CH_4 from 6 height levels reaching from 4 to 301 m with an analyzer based on the cavity ring-down spectroscopy technique (Picarro Inc., CA, USA, model G1301). Experiments have shown that reliable accurate measurements can be obtained even without drying the sample gas. To obtain dry air mixing ratios for CO_2 and CH_4, the simultaneous water vapor measurements are used to correct dilution and pressure broadening effects, resulting in a precision and accuracy that is better than WMO recommendations. Furthermore, the system requires only a very low amount of calibration gases, because calibration takes place only every 100 hrs. These two aspects allow keeping maintenance low, which is an important requirement for this remote station.

In each sampling line buffer volumes integrate the atmospheric signal over a typical time period of 40 minutes. With these the periodic switching from line to line every three minutes with only one single analyzer provides a quasi continuous, concurrent measurement from each height level. As a consequence of the averaging as well as the precision of the analyzer, the data show a low noise level and still moderately high temporal resolution, and gradients between different levels can be determined to a very high accuracy.

The new data from 2009 and 2010 will be presented and interpreted in the context of regional sources and sinks of CO_2 and CH_4 in central Siberia. As the nocturnal boundary develops during night, it locally traps respired CO_2 and CH_4 and builds up vertical gradients. The analysis of the gradients allows estimating the trapped carbon amount in this layer which can be assigned to a certain region by using the Lagrangian transport model STILT.