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Effects of land-use change on the greenhouse gas exchange in Western Siberia

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The interface between the steppe and the northern forest zone in Western Siberia plays a significant role in the global carbon cycle. Induced by changing climate and by changing socio-economic conditions, agricultural expansion and other fundamental land-use changes are expected in these regions. Such changes will exhibit a strong impact on the budgets of the greenhouse gases (GHGs) carbon dioxide and methane, which are the most important long-lived GHGs in the atmosphere. Nevertheless, hardly any research concerning this topic has been done in these regions.

In the framework of the research project SASCHA (Sustainable land management and adaptation strategies to climate change for the Western Siberian corn-belt), which is funded by the BMBF, the turbulent exchange of water vapor, carbon dioxide and methane between the surface and the atmospheric boundary layer, and the surface energy balance were measured over a grassland near the city of Tyumen in the Tyumen Oblast. Therefore, an eddy covariance station was operated from July to September 2012, which was equipped with a Gill R3-50 sonic anemometer (Gill Instruments, UK), a LI-7200 enclosed CO_2/H_2O analyzer (LI-COR Biosciences, USA), and a LI-7700 open-path methane analyzer (LI-COR Biosciences, USA). The grassland around the station was ploughed in mid-September in order to prepare it for crop production.

Before ploughing, the CO_2 fluxes showed daily courses, mostly with negative fluxes during daytime due to photosynthesis, and emissions during the night because of respiration. However, after the ploughing process, positive CO_2 fluxes throughout the days resulted because photosynthesis was inhibited. During the whole measurement period a positive CO_2 balance was found, for the period before ploughing as well as for the period after.

The fluxes of water vapor also showed clear diurnal courses with intense evapotranspiration from the surface to the atmosphere during daytime, and a small deposition flux during the nights. Despite the very low water content of the soil due to the extreme dryness in 2012, the water vapor emissions did not increase when the soil was wetted during rainy days. An effect of ploughing could not be identified.

It was also possible to detect methane fluxes over the dry grassland, but they fluctuated around zero so that the grassland could be neither identified as a clear source nor as a clear sink of methane during the period of investigation.

In 2013, two eddy covariance stations will be operated in parallel from March to October over a natural wetland and a neighbored oat field, respectively, which allows a direct comparison of the impact of the two different land-use types. In addition, continuous meteorological measurements will be performed nearby in order to obtain background information about the climatic conditions. The chosen study areas are representative for the region, so that the obtained data could be used for upscaling and developing future scenarios.