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Spatial and temporal variations of sensible and latent heat fluxes due to permafrost related landscape structures of the wet polygonal tundra at the Lena River Delta, Siberia

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Introduction:
Land-atmosphere interactions are an important element in the energy and water budget of permafrost regions. We present spatially distributed Eddy-Covariance measurements of sensible and latent heat fluxes at a typical polygonal tundra site at the Lena River Delta, Siberia. The polygonal micro structures, which usually consist of wet centers surrounded by elevated dry rims, determine the surface characteristics such as moisture content and vegetation cover. Spatial distinctions in water levels, thermo karst erosion and complex lake structures create a diverse landscape pattern which strongly affects the ratio of dry and wet areas on larger scales. This ratio is critical to sensible and latent heat exchange processes between soil surface and atmosphere. Thus, small scale variations of polygonal landscape features should affect larger scale energy balance processes.

Method:
This work concerns measurements of sensible and latent heat fluxes and their variations in time and space due to small scale differences in surface morphology. Field work for this purpose were carried out during summer 2008 on Samoylov Island which is located in the southern part of the Lena Delta. Spatial variations of sensible and latent heat fluxes were detected by comparing the data of a mobile Eddy-Covariance station with a second stationary reference system. Three different locations along a west-east transect across the island were instrumented by the mobile system while the reference station was set up at the western end of the transect. Both Eddy systems were mounted on two meter towers typically resulting in flux source areas of about 1000 square meters depending on wind conditions. The proportions of wet and dry micro structures contributing to the measured fluxes were estimated by a simple analytical foot print model and a surface classification. The classification was generated based on orthorectified color (VIS) and near infrared (NIR) aerial images.

Results:
Differences in sensible and latent heat fluxes were observed within the wet polygonal tundra site, although landscape variations are very small. In particular, this can be observed during clear sky conditions, when distinct differences of energy flux partition between dry and wet surfaces occur. Most pronounced differences in sensible heat fluxes were measured at the second position of the mobile system, where dry surface conditions are dominant. Here, sensible heat flux measurements showed up to 20% higher values than the reference station. Differences in latent heat fluxes could be observed at the third location where free water bodies characterize the surrounding area. Latent heat fluxes are up to 30% lower compared to the reference station. Based on micro scale heat flux estimations by surface temperatures and lysimeter data it was possible to trace back regional heat flux differences to micro structures. This suggests that micro scale surface variations of the polygonal tundra affect larger scale heat flux processes.