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Land-atmosphere methane exchange at an acid and oligotrophic mire system in northern Sweden: a micrometeorological point of view

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The Degerö Stormyr site in northern Sweden (64°11' 23.565" N, 19°33' 55.291" E), an acid, oligotrophic and minerogenic mixed mire system has a long tradition in hosting fundamental research regarding biogeochemistry in general and carbon cycling in particular. Methane exchange as a part of the carbon cycle has been investigated there for twenty years with different kinds of chamber measurements. In 2013 this suite of instruments was completed by an eddy covariance system measuring sonic temperature, wind components and methane concentrations in high frequency (20 Hz) to get detailed knowledge about the atmospheric influence on land-atmosphere methane exchange. Supported is this eddy covariance system (measurement height 1.8 meter above ground) by a gradient mast detecting methane concentrations in 5 different levels (from 0.35 meter to around 3 meter above ground) with lower frequency (1 Hz). Both setups are part of the research infrastructure ICOS Sweden (ICOS = Integrated Carbon Observation System).

In this case study the first 15 months of data from this new eddy covariance system (including two growing seasons) are analyzed regarding the turbulent flux behavior dependent on season and atmospheric stability. Main problem in using the eddy covariance system data is slightly to strongly stable atmospheric stratification associated with low wind speeds. Under these conditions turbulence is damped or even missing which results in a strong accumulation of methane near the surface during night in summer. This accumulation is the precondition for maximum mixing rates in the morning on fair summer days, when turbulent exchange forced by incoming shortwave solar radiation starts again. Completed is this eddy covariance section with discussing footprint climatologies both for summer and winter conditions which differ in surface properties and also measurement heights due to a snow layer during winter.

In a next step the fluxes which are calculated using the eddy covariance system are served as a reference to analyze the performance of a gradient approach for calculating turbulent methane fluxes. Gradient approaches need an undisturbed gradient and well developed turbulence for a reasonable applicability. Situations which are sufficient for using this method are determined and classified by considering the atmospheric stability and development of turbulence and the results are compared to the eddy covariance output.

This study shall provide a gain of knowledge in understanding the micrometeorological processes influencing land-atmosphere methane exchange from a mire system in northern latitudes, which is in ideal case transferable to other similar sites.