Eddy Covariance Flux Measurements from a Tall Tower in Northern Sweden: a Footprint Analysis

Anne Klosterhalfen[1], Jinshu Chi[1], Natascha Kljun[2], Anders Lindroth[3], Hjalmar Laudon[1], Mats B. Nilsson[1], Matthias Peichl[1]

[1] Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, Sweden
[2] Centre for Environmental and Climate Research, Lund University, Lund, Sweden
[3] Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden

Over the last few years, the land-atmosphere exchange of water vapor, CO_2, and CH_4 has been monitored via various measurement techniques at a managed boreal forest landscape (~68 km^2) in northern Sweden. On the tall tower of the ICOS-Svartberget station eddy covariance systems are installed at measurement heights of 32.5, 60, and 85 m. This set-up allows the analysis of the continuous exchange between biosphere and atmosphere from the ecosystem- to the landscape/regional-scale. Thus, the measured fluxes are composed of several sinks and sources across the heterogeneous landscape including forest stands of varying ages, clear-cut areas, grasslands, mires, and lakes. The contribution of each canopy type depends on the relevant measurement footprint of each eddy covariance system.

The objective of this study is to investigate the water vapor, CO_2, and CH_4 fluxes and balances using the multi-level tall tower measurements. Taking the differing measurement footprints and their diurnal development into consideration, the composition of the net fluxes, the effect of advection and atmospheric stability (especially during nighttime), and the random and systematic uncertainty can be analyzed. During nighttime the footprint of eddy covariance measurements tends to expand, thus, the sampled source area differs between day- and nighttime. Here, the extent of the footprints can be matched by switching between the higher measurement level (85 m) during daytime and the lower level (60 m) during nighttime. This multi-level approach also affects the estimation of the net fluxes and their uncertainty.

Furthermore, mires and lakes, which mostly lie in the north of the fetch within the landscape, are in the spatial scale relatively well-defined sources of CH_4. This allows a further analysis of the footprint modeling approach based on these tall tower eddy covariance measurements.