



Long-term CO₂ exchange at ICOS supersite in Northern Finland

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The ICOS ecosystem station of Sodankylä is situated in northern Finland (67°21'N, 26°38'E), 100 km north of the Arctic Circle. The Arctic Research Center of Finnish Meteorological Institute offers excellent facilities for the long-term measurements in harsh high-latitude conditions and provides extensive set of supporting environmental measurements. The eddy covariance measurements of CO₂ exchange over a Scots pine forest have been running since January 2000 as a part of various EU projects (LAPP, Carboeuroflux, Carboeurope-IP). Presently this station belongs to one of the supersites in the ICOS.

Due to the cool and short summer the annual NEE is typically relatively small in most ecosystems at these latitudes. At Sodankylä forest the annual NEE varies from being a sink to being a source of CO₂. On the average, the ecosystem has actually acted as a net source of carbon during the recent decade. The tree inventory conducted in the forest, however, suggests that the trees are growing and thus accumulating carbon. In order to understand this discrepancy we have initiated some new studies in the area. One suggested reason for the imbalance is the growth of the reindeer population since 1950s, which has resulted in the disappearance of the thick lichen (*Cladonia* spp.) cover from the ground. We estimated the influence of this lichen carpet on the soil respiration by installing automatic soil chambers on grazed and ungrazed forest floor on the area which has been partly fenced since 1950s. We also analyzed soil samples from both sides of this fence in order to compare soil carbon content with and without the insulating lichen cover. We have conducted similar soil C survey at the actual flux measurement site twice, in 2004 and 2011, in order to assess the long-term carbon loss from the soil.

One possible error source of the flux measurements is the limited fetch of the EC measurements in certain wind directions. In east, the measurement forest is bounded by a peatland which may have an effect on the EC fluxes on the night time. We installed a second EC system closer to the wetland area to compare the fluxes from different areas of the forest with different wind directions. We have also started CO₂ and CH₄ flux measurements on the wetland itself enabling the estimation of the CO₂ exchange over greater area. The wetland measurements cover also the CH₄ balance that is an essential part of the greenhouse gas balance of a wetland.

In addition to flux measurements we have started CO₂ background concentration measurements on a 50 m tower. Sodankylä FTIR (Fourier Transform Infrared Spectroscopy) station has been operational from the beginning of 2009 providing column concentrations of CO₂, CH₄ and N₂O. Pallas-Sodankylä GAW site also forms important satellite calibration-validation test area.