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Interpreting carbon fluxes from a peatland with thawing permafrost

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Various microforms, created by spatially differential thawing of permafrost, make up the subarctic heterogeneous Stordalen peatland complex (68°22′N, 19°03′E), Abisko, Sweden. This results in significantly different peatland vegetation communities across short distances, as well as differences in wetness, temperature and peat substrates. We have been measuring the spatially integrated CO_2, and heat and water vapour fluxes from this peatland complex using eddy covariance and the CO_2 exchange from specific plant communities within the EC tower footprint since spring 2008. With this data we are examining if it is possible to derive the spatially integrated ecosystem wide fluxes from community level simple light use efficiency (LUE) and ecosystem respiration (ER) models developed using several years of continuous autochamber flux measurements for the three major plant functional types (PFTs) and knowledge of the spatial variability of the vegetation, water table and active layer depths.
LIDAR was used to produce a 1 m resolution digital evaluation model of the complex and the spatial distribution of PFTs was obtained from concurrent high resolution digital colour air photography trained from vegetation surveys. Continuous water table depths have been measured for four years at over 40 locations in the complex, and peat temperatures and active layer depths in surveyed every 10 days at more than 100 locations. The EC footprint is calculated for every half-hour and the PFT based models are run with the corresponding environmental variables weighted for the PFTs within the EC footprint. Our results show that the Sphagnum, palsa, and sedge PFTs have distinctly different LUC models, and that the tower fluxes are dominated by a blend of the Sphagnum and palsa PFTs. We also see a distinctly different energy partitioning between the fetches containing intact palsa and those with thawed palsa: the evaporative efficiency is higher and the Bowen ration lower for the thawed palsa fetches.