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Reconciling the carbon balance of northern Scandinavia through the integration of observations and modelling

Anusha Sathyanadh[1], Guillaume Monteil[2], Marko Scholze[2], Anne Klosterhalfen[1], Hjalmar Laudon[1], Zhendong Wu[2], Christoph Gerbig[3], Erik van Schaik[4], Vladislav Bastrikov[5], Mats B. Nilsson[1], and Matthias Peichl[1]

[1]Swedish University of Agricultural Sciences, Dept of Forest Ecology and Management, India (anusha.sathyanadh@slu.se)
[2]2Dep. of Physical Geography and Ecosystem Science, Lund University, Sweden
[3]Max Planck Institute for Biogeochemistry, Jena, Germany
[4]Meteorology and Air Quality, Wageningen University and Research, Wageningen, The Netherlands
[5]Laboratoire des Sciences du Climat et de l'Environnement, Institut Pierre-Simon Laplace, CEA-CNRS-UVSQ, CE Orme des Merisiers, 91191 Gif-sur-Yvette CEDEX, France

The boreal biome is an important component of the global carbon (C) cycle. However, current estimates of its sink-source strength at regional scales and its responses to climate change rely primarily on models and thus remain uncertain. We investigated the C balance over a north Scandinavian boreal region by integrating observations of land-atmosphere fluxes and atmospheric CO_2 concentrations at landscape to regional scales. We also placed a special focus to understand the impact of 2018 drought on the region. Flux estimates can be obtained through various techniques such as in-situ flux measurements, eddy covariance (EC) observations, vegetation modelling and inverse modelling of CO_2 observations. These techniques are however typically relevant at very different spatial scales ranging from plot scale to country-scale, which makes it difficult to compare them. The -Svartberget site (SVB), an established ICOS (Integrated Carbon Observation System) station in Northern Sweden offers a unique range of observations, from in-situ flux measurements to EC fluxes and tall-tower concentration measurements. Here we used several vegetation models and an atmospheric transport model to connect the different scales for the period 2016-2018. The land-atmosphere carbon fluxes are from four different vegetation models (VPRM, LPJ-GUESS, ORCHIDEE and SiBCASA) and are used in the LUMIA/FLEXPART atmospheric transport model (Lund University Modular Inversion Algorithm) to generate estimates of atmospheric CO_2 concentration. We found that the northern Sweden region remained as a C sink for the study period with models differed in sink strength. It was also noticed that the site SVB can be taken as a representative for the northern Sweden region. All models indicate similar but small reductions in the net CO_2 uptake for the drought year 2018 in northern Sweden except LPJ-GUESS that reveal limitations which call for further model improvement. Our work highlights the interest of using combined ecosystem,-atmosphere ICOS sites such as SVB in the Scandinavian region and shows that it is a promising way forward to monitor CO_2 fluxes at the regional scale.