Geophysical Research Abstracts
Vol. 19, EGU2017-8897, 2017
EGU General Assembly 2017

Climate warming impacts on boreal landscape net CO_2 exchange

Manuel Helbig (1), Natascha Kljun (2), Laura E Chasmer (3), Ankur R Desai (4), William L Quinton (5), and Oliver Sonnentag (1)

(1) Department of Geography, Université de Montréal, Montréal, Canada (manuel.helbig@umontreal.ca), (2) Department of Geography, Swansea University, Swansea, UK (n.kljun@swansea.ac.uk), (3) Department of Geography, University of Lethbridge, Lethbridge, Canada (laura.chasmer@uleth.com), (4) Department of Atmospheric and Oceanic Sciences, University of Wisconsin-Madison, Madison, USA (desai@aos.wisc.edu) , (5) Department of Geography, Wilfrid Laurier University, Waterloo, Canada (wquinton@wlu.ca)

In boreal peatlands of the North American sporadic permafrost zone, climate change causes permafrost thaw and induces changes in vegetation composition and structure. Boreal landscape net carbon dioxide (CO_2) fluxes in these regions will thus be modified directly through the changes in the meteorological forcing of ecosystem processes and indirectly through changes in landscape functioning associated with thaw-induced land cover changes. How the combined effects alter net ecosystem CO_2 exchange of these landscapes (NEE_{LAND}), resulting from changes in gross primary productivity (GPP) and ecosystem respiration (ER), remains unknown. Here, we quantify indirect land cover and direct climate change impacts on NEE_{LAND} for a boreal forest-wetland landscape in the organic-rich Taiga Plains of northwestern Canada.

Using 1.5 years of nested eddy covariance flux tower measurements, we observe both larger GPP and ER at the landscape-level (50% forested permafrost plateaus & 50% permafrost-free wetlands) compared to the wetland-level (100% permafrost-free wetland). However, the resulting annual NEE_{LAND} (-20±6 g C m^{-2}) was similar to NEE of the wetland (-24±8 g C m^{-2}). Indirect thaw-induced wetland expansion effects thus appear to have negligible effects on NEE_{LAND}. In contrast, we find larger direct climate change impacts when modeling end-of-the-21st-century NEE_{LAND} (2091-2100) using downscaled air temperature and incoming shortwave radiation projections. Modeled GPP indicates large spring and fall increases due to reduced temperature-limitation. At the same time, light-limitation of GPP becomes more frequent in fall. The projected warmer air temperatures increase ER year-round in the absence of moisture stress. As a result, larger net CO_2 uptake is projected for the shoulder seasons while the peak growing season net CO_2 uptake declines.

The modeled annual NEE_{LAND} is projected to decline by 25±15 g C m^{-2} for a moderate (RCP 4.5) and 103±37 g C m^{-2} for a high warming scenario (RCP 8.5), potentially reversing recently observed increasing net CO_2 uptake trends across the boreal zone. At the end of the 21st-century, modeled annual NEE_{LAND} was not significantly different from 0 g C m^{-2} for the RCP 4.5 scenario (+16±42 g C m^{-2}) and positive for the RCP 8.5 scenario with +94±54 g C m^{-2}. Thus, even without moisture stress, net CO_2 uptake of boreal forest-wetland landscapes may decline – and likely cease - if anthropogenic CO_2 emissions are not reduced. Future NEE_{LAND} changes are thus more likely driven by direct climate than by indirect land cover change impacts.