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How is climate warming altering the carbon cycle of a tundra ecosystem in the Siberian Arctic?

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Climate has been warming over the the Arctic region with the strongest anomalies taking place in autumn and winter for the period 2000-2010, particularly in northern Eurasia. The quantification of the impact on climate warming on the degradation of permafrost and the associated potential release to the atmosphere of carbon stocked in the soil under the form of greenhouse gases, thus further increasing the radiative forcing of the atmosphere, is currently a matter of scientific debate. The positive trend in primary productivity in the last decades inferred by vegetation indexes (NDVI) and confirmed by observations on the enhanced growth of shrub vegetation represents indeed a contrasting process that, if prevalent could offset GHG emissions or even strengthen the carbon sink over the Arctic tundra.

At the site of Kytalyk, in north-eastern Siberia, net fluxes of CO_2 at ecosystem scale (NEE) have been monitored by eddy covariance technique since 2003. While presenting the results of the seasonal (snow free period) and inter-annual variability of NEE, conceived as the interplay between meteorological drivers and ecosystem responses, we test the role of climate as the main source of NEE variability in the last decade using a data oriented statistical approach. The impact of the timing and duration of the snow free period on the seasonal carbon budget is also considered. Finally, by including the results of continuous micrometeorological observations of methane fluxes taken during summer 2012, corroborated with seasonal CH_4 budgets from two previous shorter campaigns (2008, 2009), as well as an experimentally determined estimate of dissolved organic carbon (DOC) flux, we provide an assessment of the carbon budget and its stability over time.

The examined tundra ecosystem was found to sequester CO_2 during the snow free season with relatively small inter-annual variability (-97.9±12.1gC m^{-2}) during the last decade and without any evident trend despite the carbon uptake period tended to start earlier in the course of the year, potentially leading to a greater carbon sink. The large meteorological variability during the arctic summer controlled indeed the duration of the carbon uptake period and the flux rates with no clear evidence of changes in the response patterns of CO_2 fluxes to climatic drivers (global radiation and air temperature) emerged from the analysis. The carbon loss associated with seasonal CH_4 emissions and lateral DOC fluxes resulted equal for both terms and 6.2 gC m^{-2} in total.
Hence the tundra ecosystem was found to act so far as a steady carbon sink exerting a negative feedback to climate warming.