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Environment and phenology: CO_2 net ecosystem exchange and CO_2 flux partitioning at an acid and oligotrophic mire system in northern Sweden

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Static chamber and environmental measurements in combination with vegetation indices (i.e. vascular green area (VGA) and the greenness chromatic color index (gcc) derived from digital camera images) were used to investigate effects of environment and phenology on the CO_2 net ecosystem exchange (NEE) and CO_2 flux partitioning at the Degerö Stormyr site in northern Sweden (64°11' 23.565" N, 19°33' 55.291 E) during two environmentally different years. Our measurement design included a control plot, a moss plot (where vascular plants were removed by clipping) and four heterotrophic respiration (RH) collars (where all green moss and vascular plant biomass were removed) to partition between soil heterotrophic and plant autotrophic (moss and vascular plants) respiration (RA), as well as between moss and vascular plant gross primary production (GPP). Environmental conditions, especially the shallow snow cover, peat soil frost and cold spring in 2014 caused delayed onset of spring green up, reduced soil respiration flux and reduced GPP of vascular plants. Soil temperature measured in 26 cm depth started to rise from spring temperatures of $\sim$ 0.6 °C in 2013 and 0.15 °C in 2014 about 20 days earlier in 2013 compared to 2014. With earlier onset of the growing season and higher soil temperatures in 2013, heterotrophic soil respiration was higher in year 2013 than in year 2014. In 2013, RH dominated the total ecosystem respiration in all months but June and August. On contrary, autotrophic respiration dominated ecosystem respiration in all months of 2014. In both years, vascular plants and mosses were more or less equally contributing to autotrophic respiration. We measured higher GPP in year 2013 compared to year 2014. Also VGA and gcc were higher in spring and throughout the rest of 2013 compared to 2014. The onset of VGA was delayed by $\sim$ 10 days in 2014. In general, total GPP was dominated by GPP of vascular plants in both years, although moss GPP had substantial contribution and exceeded GPP of vascular plants in June of 2013 and July and September of 2014, respectively. NEE was lower (i.e. greater net CO_2 uptake) in 2013 compared to 2014. Our study highlights the importance of phenology in relation to ongoing environmental change, which in turn exerts a strong control on the CO_2 exchange and its partitioning into component fluxes.