Using digital repeat photography to investigate phenology and its control on carbon dioxide exchange processes in a boreal minerogenic mire

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Phenology is an important driver of the net ecosystem exchange (NEE) of carbon dioxide (CO_2) since seasonal plant development is tightly coupled to the processes of photosynthesis and respiration. Digital repeat photography has been previously used in other terrestrial ecosystems (i.e. forest, cropland and grassland) to continuously monitor and quantitatively describe changes in ecosystem phenology. Here, we present a first attempt to apply this technique in a peatland. We use the chromatic greenness index (Gc) derived from digital images analysis to investigate the control of phenology on the ecosystem CO_2 exchange measured by the eddy covariance technique in a minerogenic mire in Northern Sweden over two growing seasons (2011 – 2012). We found that Gc was closely linked to the leaf area index of the vascular plant community. Moreover, Gc correlated well with gross ecosystem production (GEP) and ecosystem respiration (ER) during the spring green-up and the autumn periods. During the late summer however, the patterns of Gc and GEP were decoupled and environmental conditions (i.e. drought stress) were the dominating control on GEP during this period. Meanwhile, no correlation was observed between Gc and NEE. We conclude that digital repeat photography may serve as a simple, cheap and automated method to continuously track seasonal changes in phenology and to evaluate its effects on the CO_2 exchange in peatland ecosystems. We further suggest that Gc derived from digital image analysis could help improving gap-filling of flux data and modeling of the seasonal development of GEP, especially during the shoulder seasons.