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A fusion of UAVs, digital cameras and micrometeorology to quantify the link between phenology and the carbon balance of a temperate peatland

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Peatland ecosystems are historical carbon sinks of global importance, whose management and restoration are becoming an increasingly popular approach to reach climate change targets via natural capital. However, the Net Ecosystem Exchange (NEE) of carbon dioxide (CO_2) can exhibit substantial variability on seasonal and inter-annual timescales, with some peatlands shifting from being a sink to a source of CO_2 between years. This variability is due to the complex interaction between factors such as meteorology and phenology, which are both known to control a peatland's net carbon sink strength. An improved understanding of these two drivers of peatland carbon cycling is needed to allow for better prediction of the impact of climate change on these ecosystems. This task requires us to study these environmental controls at multiple spatial and temporal scales. The role of vegetation in regulating NEE however, can be difficult to determine over shorter timescales (e.g. seasonal) and especially in peatland landscapes, which typically display strong spatial heterogeneity at the microsite scale (< 0.5 m). Digital phenology cameras (PhenoCams) and Unmanned Aerial Vehicles (UAVs), offer novel opportunities to improve the temporal resolution and spatial coverage of traditional vegetation survey approaches. UAVs in particular are a more flexible, often cheaper alternative to satellite products, and can be used to collect data at the sub-centimetre scale. We employ PhenoCam imagery and UAV surveys with a Parrot Sequoia multispectral camera to map vegetation and track its phenology using vegetation indices such as the Normalised Difference Vegetation Index (NDVI) over the course of two growing seasons at Auchencorth Moss, a Scottish temperate peatland. By combining this digital camera imagery with in-situ NEE measurements (closed chambers and eddy-covariance) and meteorological data, we seek to quantify the impact of weather and phenology on carbon balance at the site.