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The Impact of Climate Manipulation on Photosynthetic and Spectral Properties of Peatland Vegetation

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Different components of climate regulate the processes in nature. Among them, temperature and rainfall are two of the most important components which are known to change plant productivity. Due to its high biodiversity, a huge amount of stored carbon, and their sensitivity to environmental changes, peatlands became important for climate manipulation experiments. Therefore, our work was focused on the response of Sphagnum peatland in Poland to manipulative experiment. The experimental set up consisted of four treatments (control, warming, reduced precipitation, and combined reduced precipitation & warming), three replicates each. Active manipulation with infrared heaters (1.0-1.4oC peat temperature increase) and an automatic curtain for reduction of rain during the growing season (37% reduction) was used from 2015-2017. Net ecosystem exchange (NEE), ecosystem respiration (Reco) and methane (CH4) fluxes were measured in high frequency by a prototyped automated chamber system equipped with fast response analyzers. Warming increased both Reco and gross primary production (GPP). The combined effect of warming and reduced precipitation, however, resulted in higher NEE in all years, specifically due to reduced Reco. Vegetation indices such as Normalized Difference Vegetation Index (NDVI), Photochemical Reflectance Index (PRI), and near-infrared reflectance of vegetation (NIRv), were also calculated to trace the impact of environmental manipulation on the plant community. NIRv is a newly formulated index in remote sensing, which has been shown to strongly correlated with Sun Induced Fluorescence (SIF), thus was used to estimate GPP. Along with this a significant variation in photosynthetic activity of four different plant species (Carex rostrata, Menyanthes trifoliata, Sphagnum spp. and Oxycoccus palustris) was measured by the active fluorescence method. Menyanthes trifoliata was observed to be very sensitive to warming and reduced precipitation, whereas Oxycoccus palustris was observed to better performing under heated condition, but lower precipitation results into a decrease in photosynthetic efficiency. Carex rostrata was observed to be slightly impacted by environmental manipulation, whereas in Sphagnum spp. the impact was observed to be severe due to drying of the moss surface in heated condition. A clear shift of 20 days in growing period of the vegetation was observed due to warming. Our results revealed that the simultaneous warming and reduced precipitation (a condition depicting global warming) would lead to a significant change in the structure of the current peatland vegetation and as a consequence it will modify carbon fluxes.

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