Geophysical Research Abstracts
Vol. 17, EGU2015-9960, 2015
EGU General Assembly 2015

The sensitivity of peat soil and peatland vegetation to drought: release of dissolved organic carbon (DOC) on rewetting

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Organic rich peat soils are a major store of carbon worldwide. Their existence is predicated on high year-round water tables which create an anoxic environment, thus limiting decay, and also to the recalcitrance of plant litter (dead plant material) commonly found in peatland areas. Climate change threatens the stability of peat soils by altering the biogeochemical cycles which control plant decay, lowering water tables so that oxic degradation can occur and by changing habitat niches such that less recalcitrant species can thrive in peatlands. One of the major fluxes of carbon from peatlands is through dissolved organic carbon (DOC) in surface waters. As peatland areas in the UK are often used as source waters for drinking water supply this presents a problem to water utilities as DOC must be effectively removed to limit colour, odour and the formation of potentially carcinogenic by-products on disinfection. Changes in catchment vegetation may occur due to climate change, nutrient deposition and changing bioclimatic envelopes. How different peatland vegetation contribute to DOC flux and how this may change in the future is therefore of interest. A six week laboratory simulation was performed on typical peatland litter (Sphagnum spp., Calluna vulgaris, Molinea caerulea, Juncus effusus) and a peat soil collected from Exmoor National Park, UK. The simulation monitored DOC flux from the decaying litter/soil and considered the impact of different drought severities using the 50th, 25th, 10th and 5th percentiles of the mean July/August monthly rainfall for Exmoor. On rewetting following the drought, all sources produced significantly different amounts of DOC (Tukey HSD $p<0.05$) in the order Molinia>Juncus>Calluna>Sphagnum>peat. The source also had a significant (ANOVA $p<0.001$) effect on coagulation removal efficiency, a typical method of removing DOC during drinking water treatment, with Juncus DOC proving the easiest to remove whilst Sphagnum DOC was the most difficult. Sphagnum DOC had the lowest ratio of humic-like to protein-like fluorescence, which is indicative of DOC which is poorly removed by coagulation. An interactive effect was noted between DOC source and the drought treatment which was explored further using a one-way ANOVA with a Holm-Šidák correction. This suggested peat will produce significantly more DOC when affected by drought ($p=0.010$), possibly explained by increased oxygenation engaging the 'enzymatic latch' mechanism. A similar analysis was performed on the interaction between drought and DOC source for the specific UV absorbance at 254nm (SUVA) value (a measure of aromaticity). This suggested that Molinea caerulea produces DOC of significantly ($p=0.001$) higher aromaticity following periods of drought. Comparisons between drought and DOC source factors suggest the source in more important than climatic conditions of decay which is consistent with our previously published findings. These results have implications for marginal peatlands which may be at risk from increased water table drawdown in the future as climate changes and where Molinea caerulea, typically a fen species, is encroaching on bog communities.