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Source and age of carbon in peatland surface waters: new insights from 14C analysis

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Peatlands are a significant source of carbon to the aquatic environment which is increasingly being recognised as an important flux pathway (both lateral and vertical) in total landscape carbon budgets. Determining the source and age of the carbon (in its various forms) is a key step to understanding the stability of peatland systems as well as the connectivity between the soil carbon pool and the freshwater environment.

Novel analytical and sampling methods using molecular sieves have been developed for (1) within-stream, in situ sampling of CO_2 in the field and (2) for the removal/separation of CO_2 in the laboratory prior to 14C analysis of CH4. Here we present dual isotope (δ13C and 14C) data from freshwater systems in UK and Finnish peatlands to show that significant differences exist in the source and age of CO_2, DOC (dissolved organic carbon) and POC (particulate organic carbon). Individual peatlands clearly differ in terms of their isotopic freshwater signature, suggesting that carbon cycling may be “tighter” in some systems compared to others. We have also measured the isotopic signature of different C species in peatland pipes, which appear to be able to tap carbon from different peat depths. This suggests that carbon cycling and transport within “piped-peatlands” may be more complex than previously thought.

Some of our most recent work has focussed on the development of a method to measure the 14C component of CH4 in freshwaters. Initial results suggest that CH4 in peatland streams is significantly older than CO_2 and derived from a much deeper source. We have also shown that the age (but not the source) of dissolved CO_2 changes over the hydrological year in response to seasonal changes in discharge and temperature. Radiocarbon measurements in the peat-riparian-stream system suggest that a significant degree of connectivity exists in terms of C transport and cycling, although the degree of connectivity differs for individual C species.

In summary, 14C analysis of peatland surface waters reveals multiple sources and ages for CO_2, CH4, DOC and POC with different ages characterising individual peatlands. This implies that carbon transport from peat to stream is more complex than previously thought. Dual isotope (δ13C and 14C) analysis of carbon in its various aquatic forms is clearly a powerful tool in developing a better understanding of the functioning and stability of carbon-rich landscapes.