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Temporal variability in aquatic carbon and GHG concentrations and fluxes in a peatland catchment

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Here we present a complete 5-year dataset of all aquatic carbon and GHG species (POC, DOC, DIC, CO_2, CH4, N2O) from Auchencorth Moss, an ombrotrophic Scottish peatland. The study aims to analyse and explain temporal variability in concentrations and fluxes (both downstream export and evasion) at weekly, seasonal and annual time scales. The aquatic pathway is increasingly being recognised as an important component of catchment carbon and greenhouse gas (GHG) budgets, particularly in peatland systems due to their large carbon store and strong hydrological connectivity. However, due to a lack of long-term measurements few studies have been able to adequately consider temporal variability in total concentrations and fluxes.

We show that short-term within year variability in concentrations exists across all species and this is strongly linked to changes in discharge. Seasonal cyclicity was only evident for DOC, CH4 and N2O concentrations; however temperature correlated with monthly means in all species except DIC. Whilst the temperature dependence in monthly DOC and POC concentrations appeared to be related to biological productivity in the terrestrial system, we suggest the temperature correlation with CO_2 and CH4 was primarily due to in-stream temperature-dependent solubility of the two gases. Interannual variability in total aquatic carbon concentration was strongly correlated with catchment gross primary production (GPP) indicating a strong linkage between the terrestrial and aquatic systems. DOC represented the largest aquatic carbon flux term (19.3 $\pm$ 4.59 g C m-2 yr-1), followed by CO_2 evasion (10.0 g C m-2 yr -1). Despite an estimated contribution to the total annual aquatic carbon flux of between 8 - 48%, evasion estimates contained the greatest uncertainty and therefore represent an area which requires a significant future research effort. Interannual variability in total carbon export was low in comparison with variability in terrestrial fluxes, and could be explained primarily by temperature and precipitation. Hence changes in catchment carbon cycling resulting from climatic or land-use influences may be easier to identify in terms of aquatic C fluxes compared to land-atmosphere exchange flux terms such as GPP and net ecosystem exchange (NEE).