Geophysical Research Abstracts
Vol. 18, EGU2016-13695, 2016
EGU General Assembly 2016
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The mysteriously variable half-life of dissolved organic matter in aquatic ecosystems: artefact or insight?

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Dissolved organic matter (DOM) fluxes from land to water represent an important loss term in the terrestrial carbon balance, a major pathway in the global carbon cycle, a significant influence on aquatic light, nutrient and energy regimes, and an important concern for drinking water production. Although freshwaters are now recognised as zones of active carbon cycling, rather than passive conduits for carbon transport, evidence regarding the magnitude of, and controls on, DOM cycling in aquatic systems is incomplete and in some cases seemingly contradictory, with DOM 'half-lives' ranging from a few days to many years. Bringing together experimental, isotopic, catchment mass balance and modelling data, we suggest that apparently conflicting results can be reconciled through understanding of differences in: i) the terrestrial sources of DOM within heterogeneous landscapes, and consequent differences in its reactivity and stoichiometry; ii) experimental methodologies (i.e. which reactions are actually being measured), and iii) the extent of prior transformation of DOM upstream of the point of study. We argue that rapid photo-degradation, particularly of peat-derived DOM, is a key process in headwaters, whilst apparently slow DOM turnover in downstream, agriculturally-influenced lakes and rivers can partly be explained by the offsetting effect of in situ DOM production. This production appears to be strongly constrained by nutrient supply, thus linking DOM turnover and composition to the supply of inorganic nutrient inputs from diffuse agricultural pollution, and also providing a possible mechanistic link between aquatic DOM production and terrestrial DOM breakdown via the mineralisation and re-assimilation of organic nutrients. A more complete conceptual understanding of these interlinked processes will provide an improved understanding of the sources and fate of aquatic DOM, its role in the global carbon cycle, and the impact of anthropogenic activities, for example in relation to drinking water supplies and land management.