Geophysical Research Abstracts
Vol. 13, EGU2011-8044, 2011
EGU General Assembly 2011

Seasonality suggests dominant biological control in DOC–SO4 relationship

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Organic soils represent an important reservoir of carbon; some work suggests these stores may be destabilising, with an increase in dissolved organic carbon (DOC) in surface waters over the last few decades. While there have been many hypotheses as to the cause of this phenomenon, recent work has focussed on the coincident decline in acid sulfate deposition, largley due to apparent inverse trends in sulfate and DOC concentrations in some organic soil systems. The suppressive influence of acidity on the solubility of DOC is thought to be reversing under a widespread recovery from acidification, giving rise to increasing trends in surface water DOC. This chemical relationship is likely to be complicated in the natural environment and work is needed to understand the fate of acid sulphate depostition and its influence on the carbon cycle.

This work comprises part of a series of laboratory and field experiments that study the biogeochemical coupling of sulphur and carbon in organic soils. In situ peat mesocosms at Thorne Moors, England, have been subjected to long term rainwater treatments in addtion to natural rainfall in order to simulate acid rain over 2 years. Triplicate mesocosms were treated with (1) control rainwater (based on modern deposition data); (2) high acid sulfate rainwater (based on peak acid sulfate deposition, 1989); (3) high acidity rainwater (as for 2, additional sulfate omitted); (4) pH neutral high sulphate deposition (as Na2SO4). These treatments allow the effect of acid sulphate, acidity, and sulphate loadings on peat biogeochemistry and DOC release to be examined individually, by regular sampling of peat soil waters at 0, 5, 30, 45 cm depth.

Despite the expectation that acid deposition would affect the release of DOC to soil water, with higher acid (and acid sulphate) loadings inhibiting DOC release, this is apparently moderated by biological activity. Seasonal variation in the release of DOC as a response to temperature and rainfall demonstrates the strongest trend. Sulphur cycling is also seasonal, with bacterial sulphate reduction dominating biogeochemistry in the summer months. The influence of deposition chemistry on these seasonal drivers is minimal, with some evidence that bacterial sulphate reduction is enhanced by higher sulphate loadings. Thus, on a year timescale, there is no evidence for a causal relationship between acid sulphate and DOC concentrations. Interestingly, the enhanced bacterial sulphate reduction may buffer pH, suggesting a feedback whereby acid sulphate deposition is mitigated by microbial activity. These data are comparable to our previous laboratory experiments which point to a dominance of biological rather than chemical or depositional driver of sulphur and carbon cycles in organic soils.