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Influence of porewater velocity and ionic strength on DOC concentrations in and losses from peat-sand mixtures

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Organic soils play an important role in the global carbon cycle as they can act as a source or a sink for greenhouse gas emissions. The new IPCC Wetlands Supplement accounts for the first time for CO_2 emissions from the decomposition of dissolved organic carbon (DOC). While there is a wealth of studies on "true" peat soils, knowledge on DOC losses from organic soils heavily disturbed by e.g. mixing with sand is fragmentary. Moreover, there are only a few studies on the influence of soil hydrological properties on DOC transport.

This study investigates physico-chemical controls on the concentration and losses of DOC from a peat-sand mixture in a saturated column experiment with undisturbed columns. The soil originates from the study site "Grosses Moor" (Northern Germany) which is a former bog where peat layers remaining after peat mining were mixed with the underlying mineral soil. We studied the influence of the flow regime and the ionic strength of the irrigation solution on DOC concentrations and losses. Three different pumping rates and two different ionic strengths determined by different concentrations of a sodium chloride-calcium chloride mixture in the irrigation solution were applied. Transport properties of the soil were obtained by analyzing breakthrough curves (BTCs) of a conservative tracer (potassium bromide). For interpretation of the BTCs, the transport model STANMOD which is based on the two-region (mobile/immobile) non-equilibrium concept was fitted to the data.

The shape of the BTCs and the STANMOD results showed that three of the four columns had a dual porosity structure, which affects the porewater velocity and the contact area. After a large initial peak, DOC concentrations equilibrated to nearly constant values. Increased porewater velocities decreased the concentration of DOC, but increased the losses. A new equilibrium concentration was reached after nearly all changes of the porewater velocity. At maximum pumping rates as determined from field infiltration experiments, no saturation of the losses could be observed. A high ionic strength caused a strong reduction of the pH-value. The combination of these two factors strongly reduced the DOC concentration in the effluent and supported iron flocculation and coagulation. The strong response of the DOC concentrations on the high ionic strength or on the low pH-value suggests that DOC concentrations and losses in these soils are controlled by its coagulation properties, but limited by the actual flow regime and the presence or absence of immobile zones.