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Linkage between the temporal and spatial variability of dissolved organic matter and whole stream metabolism

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Dissolved organic matter (DOM) is an important resource for microbes, thus affecting the whole stream metabolism. The factors influencing its chemical composition and thereby also its bio-availability are complex and not thoroughly understood. We hypothesized that the whole stream metabolism itself can affect the DOM composition and that the coupling of both is influenced by seasonality and different land use forms. We tested this hypothesis in a comparative study on two pristine forestry streams and on two non-forestry streams. The investigated streams were located in the Harz Mountains (Central Europe, Germany). The whole stream metabolism was measured with a classical two station oxygen change technique and the variability of DOM with fluorescence spectroscopy. We take also into account the geochemical and geophysical characteristic of each stream.

All streams were clearly net heterotrophic, whereby the non-forestry streams showed a higher primary production in general, which was correlated with irradiance and with the total phosphorus concentration. The whole stream metabolism but also the chromophoric DOM (CDOM) showed distinct seasonal patterns. We detected three CDOM component groups (C1, C2, C3) by the use of the parallel-factor-analysis (PARAFAC) and found temporarily variable, typical component fingerprints (C1:C2, C1:C3, C3:C2) for CDOM originated from forestry streams and from non-forestry streams. Based on comparative literature studies and correlation analysis with different indices, we demonstrate that two of the components are clearly from terrigenous sources (C1, C3) and one is rather autochthonously (C2) derived. The whole CDOM matrix was dominated by humic like, high molecular-weight substances, followed by humic like, fulfic acids, low molecular-weight substances, and with minor amounts of amino-acids and proteins. We showed for the first time a correlation between the gross primary production (GPP) and the autochthonously derived, low molecular weight DOM. The amount of autochthonously produced DOM increased overall with increasing GPP, as indicated by a tight, positive correlation between the fluorescence index (FI, R^2=0.84) or C2 (R^2=0.48) and the ratio of GPP and the daily community respiration (CR_{24}).

This study showed for the first time the linkage between whole stream metabolism and DOM composition, based on a new integrated approach. We demonstrated that this relationship is influenced by seasonality and different land use forms. These complex mechanisms lead to typical DOM fingerprints for streams pass through the different land use forms.

Reference: Halbedel, S., Büttner, O., and Weitere, M.: Linkage between the temporal and spatial variability of dissolved organic matter and whole stream metabolism, BGD, 9, 18253-18293, doi:10.5194/bgd-9-18253-2012, 2012.