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Complex interactions of in-stream DOM and nutrient spiralling unravelled by Bayesian regression analysis

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The carbon cycle in aquatic environments is of high interest because of its effects on water quality and greenhouse gas production as well as its alteration through anthropogenic activities with unknown outcomes. Uptake and release of dissolved organic matter (DOM) compounds is depending on the molecular structure and is strongly linked to N and P dynamics. Current research has not fully revealed the complex patterns behind.

To investigate the interactions between DOM components, we performed ten plateau addition experiments with different, realistic, complex DOM leachates (cow dung, pig dung, corn, leaves and nettles) in a small stream. The DOM quality was determined by fluorescence measurements and parallel factor (PARAFAC) decomposition and the nutrient concentrations were measured at eleven consecutive points in the stream at plateau conditions. The hydrological transport processes were incorporated by using the results of a 1-D hydrodynamic model.

The nutrient spiralling concept and its application in nutrient dynamics is a valuable basis for the analysis of our data. However, we could not find a data analysis approach, that suited the nature of our questions and data. Based on previously observed nutrient uptake models, we extended the nutrient spiralling concept by additional non-linear terms to analyse interactions between different DOM components.

We developed the “Interactions in Nutrient Spirals using BayesIan REgression (INSBIRE)” approach to analyse DOM uptake and retention mechanism. This approach can disentangle complex and interacting biotic and abiotic drivers in nutrient uptake metrics, show their variability and quantify their error distribution. We successfully used INSBIRE to show DOM-compound-specific interactions and draw conclusions from the data of our experiment. The applicability of INSBIRE has still to be tested in other studies, but we see a high potential not only in DOM dynamics but any kind of solute dynamics where interactions are crucial.