Evaluating biogeochemical transformations in freshwater systems along a drainage basin

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Carbon and nitrogen arriving to freshwater systems undergo a series of transformations which could ultimately lead to the formation of greenhouse gases (e.g. carbon dioxide, methane, and nitrous oxide). Carbon and nitrogen loads into freshwater systems have exacerbated since the industrial age due to intensifying manufacturing and agriculture, wetland encroachment, and the steep growth in (urban) population. In this study we use results from a gridded, "leaky bucket" hydrological model coupled to results from an integrated assessment model to force a process-based numerical model which incorporates various sets of biogeochemical interactions. The model is used to evaluate the changes in river chemistry that have taken place along drainage basins over the course of the 20th century. We parametrize various reactions to test the pathways for greenhouse gas formation and discuss the feasibility for these reactions with respect to measured datasets. Model results suggests that, although freshwaters reach the river mouth on rather short timescales (< 10^0 yr), carbon and nitrogen losses to the atmosphere may be significant along the drainage pathway, especially in locations where the residence time of the water substantially increases, such as lakes and reservoirs. This model serves as a basis for future studies concerning the global output of greenhouse gasses from freshwater systems, where it can aid in constraining the carbon and nitrogen budgets over the Anthropocene.