Factors influencing export of dissolved inorganic nitrogen by major rivers: A new seasonal, spatially explicit, global model

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Substantial effort has focused on understanding spatial variation in dissolved inorganic nitrogen (DIN) export to the coastal zone and specific basins have been studied in depth. Much less is known, however, about seasonal patterns and controls of coastal DIN delivery across large spatial scales. Understanding sub-annual patterns of sources and delivery DIN export from rivers to coastal areas is critical to efforts to predict and mitigate impacts of coastal eutrophication, such as algal blooms and hypoxic areas, which are often seasonal phenomena. Here we describe, test, and apply NEWS2-DIN-S, the first global model capable of predicting seasonal DIN export to coastal regions for over 6,000 rivers for the contemporary period (2000). NEWS2-DIN-S used spatially explicit, seasonal N-inputs and was calibrated with measured DIN yield (kg N km-2 y-1) for 78 global rivers. Of the catchment characteristics considered, DIN export was positively related to runoff and negatively related to temperature across seasons (r^2 = 0.32 to 0.49, $p<0.0001$), due likely to flushing effects and increased retention by plants and soils, respectively. NEWS2-DIN-S incorporated these insights and performed well in predicting DIN yield (Nash-Sutcliffe Efficiency = 0.54-0.69, depending on season). Model runs showed that catchments were effective in retaining DIN and average export rates were generally lower during the growing season (3-5%) compared to other seasons (6-10%) for major latitude bands. Model output was relatively insensitive to changes in the magnitude of N inputs, suggesting that further refinement of seasonal N budgets will not substantially improve predictive performance. Rather, better representation of land-to-river N transfers could improve the predictive capacity of future models because of the importance of landscape N-attenuation.