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## Hyporheic exchange: a local process with a global reach

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River systems are a significant source of nitrous oxide (N2O) emissions to the atmosphere, contributing an estimated 10% of anthropogenically generated N2O. The primary biogeochemical transformations that lead to N2O emissions are denitrification (NO<sub>3</sub>- to N2) and nitrification reactions (NH4+ to NO<sub>3</sub>-) that are mediated by microbes mainly living in benthic biofilms, subsurface sediments of the hyporheic zone, and within the water column. These three zones form the riverine corridor, whose hydromorphological characteristics depend on land use land cover, biomes, climate and geological characteristics. Here, we present a simple dimensionless framework to analyze and predict N2O emissions from the riverine corridor and show the relative importance of each of these three zones along the river continuum. The model was developed with data collected by the 2nd Lotic Intersite Nitrogen eXperiment (LINXII) project and then validated with measurements taken in different reaches from 10 river networks across the world including headwater streams, medium and large rivers and a tidal system with different morphology, land cover, biomes and climatic conditions. The model shows the key contribution of hyporheic and benthic processes in small streams, contrasting with the dominant contribution of water column processes in rivers. We show that the contributions of the external forcing are captured within a dimensionless framework, and we suggest that approaches like this one can help upscale local processes, thereby transferring information from the local reach scale to the river network scale.