Quantifying denitrification in rippled permeable sands through combined flume experiments and modeling

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ABSTRACT: We measured denitrification in permeable sediments in a sealed flume tank with environmentally representative fluid flow and solute transport behavior using novel measurements. Numerical flow and reactive transport models representing the flume experiments were implemented to provide mechanistic insight into the coupled hydrodynamic and biogeochemical processes. There was broad agreement between the model results and experimental data. The model showed that the coupling between nitrification and denitrification was relatively weak in comparison to that in cohesive sediments. This was due to the direct advective transport between anoxic pore water and the overlying water column, and little interaction between the mostly oxic advective region and the underlying anoxic region. Denitrification was therefore mainly fueled by nitrate supplied from the water column. This suggests that the capacity of permeable sediments with nonmigratory ripples to remove bioavailable nitrogen from coastal ecosystems is lower than that of cohesive sediments. We conclude that while experimental measurements provide a good starting point for constraining key parameters, reactive transport models with realistic kinetic and transport parameters provide critical insight into biogeochemical processes in permeable sediment that are difficult to experimentally evaluate.