Permeable sediment denitrification under non-steady state conditions

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In recent years, there has been an appreciable increase into biogeochemical research in permeable sediments, where solute transport is dominated by advection – the flow of water through the sediment – rather than diffusion. Various studies have investigated oxygen (e.g. [1]), carbon (e.g. [2]) and nitrogen (e.g. [3]) cycling under classical, rippled bedforms under a variety of conditions. Typically, these studies involve computational modelling of an environemntal system and/or laboratory modelling, usually using flow-through reactors to model or flume tanks to replicate advective flow.

One common trait of most of these studies is that they neglect non-steady state conditions over the minutes-to-hours scale – in particular variations in the flow velocity of the overlying water, and migration of the ripples "downstream" with the predominant flow.

We use a combined reactive-transport modelling approach, anchored by measurements of real sands in our laboratory flume tank, to investigate the effects of these parameters on the transport of oxygen, nitrate and ammonium in the sediment, and the resultant affect on denitrification.

The results show that while solute distributions vary greatly under moving ripples compared with stationary ripples, nitrification increases only marginally, and denitrificaiton is hardly affected [4].

Under unsteady flow, sub-surface advection velocities can vary by as much as an order of magnitude. In these cases, high flow promotes deeper advection of solutes, and low flow promotes slower transport, allowing these deeply trnasported solutes to react more completely.

[1] Precht *et al*. (2004) Limnol. Oceanogr. **49**, 693-705. [2] Cook *et al*. (2006) Limnol. Oceanogr. **52**, 1943-1963. [3] Kessler *et al*. (2012) Limnol. Oceanogr. **57**, 1217-1232. [4] Kessler *et al*. (2015) J. Geophys. Res.-Biogeo. **120,** 538-548.