EGU2020-3389
https://doi.org/10.5194/egusphere-egu2020-3389
EGU General Assembly 2020

Predicting microbial redox dynamics and nutrient cycling in the subsurface considering spatio-temporal heterogeneities

Swamini Khurana[1], Falk Heße[2], and Martin Thullner[1]
[1]Helmholtz Center for Environmental Research (UFZ), Environmental Microbiology (UMB), Leipzig, Germany (swamini.khurana@ufz.de)
[2]Helmholtz Center for Environmental Research (UFZ), Computational Hydrosystems (CHS), Leipzig, Germany (falk.hesse@ufz.de)

Biogeochemical cycles are extensively studied as they control the flow of matter (carbon and nitrogen, specifically) up to the global scale, further impacting ecosystem functions and services. To be able to predict carbon and nitrogen budgets, it is necessary to study carbon and nitrogen cycles in all compartments of the biosphere, from forests to water, to soil and deep subsurface. Since the soil and deeper subsurface compartments store a high share of the global carbon and nitrogen budget, it is necessary to study the carbon and nitrogen cycles in the subsurface at a higher resolution. Given the spatial heterogeneity and temporal dynamics exhibited by the subsurface, coupled with lack of observational opportunities, the prediction of these cycles in the subsurface is a challenge. For this purpose, this study aims to resolve microbial mediated carbon and nitrogen dynamics in the subsurface with respect to spatial and temporal heterogeneity using a numerical modeling approach. The model considers the response of microbial growth and activity to varying environmental conditions such as access to nutrients and energy sources.

The obtained results show a linear relationship between the relative impact on carbon and nitrogen removal and relative difference in breakthrough times between homogeneous scenarios and the spatially heterogeneous scenarios. In contrast, the temporal dynamics of changing flow rates induces minimal aggregated impact on the carbon and nitrogen cycles in the subsurface. This implies that short term temporal dynamics do little to influence the long-term nutrient cycles, given the same average water flux through the entire simulation period. The findings of this study can assist in identification of drivers of microbial dynamics and nutrient cycling in the Critical Zone. This, in turn, can assist towards the regional scale modeling of biogeochemical cycles resulting from microbial dynamics.