Predicting change in biogeochemical potential of subsurface systems with changing hydrogeological conditions

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In a changing climate scenario, we expect weather event patterns to change, both in frequency and in intensity. The subsequent impacts of these changing patterns on ecosystem functions are of great interest. Water quality particularly is critical due to public health concerns. Already, seasonal variation of water quality has been attributed to varying microbial community assemblages and nutrient loading in the corresponding water body but the contribution of the variations in the quantity of groundwater recharge is a missing link. It is thus beneficial to establish links between external forcing such as changing infiltration rate or recharge on nutrient cycling in the subsurface. We undertake this study to investigate the impact of temporal variation in external forcing on the biogeochemical potential of spatially heterogeneous subsurface systems using a numerical modeling approach. We used geostatistical tools to generate spatial random fields by considering difference combinations of the variance in the log conductivity field and the anisotropy of the domain. Tuning these two parameters assists in effective representation of a wide variety of geologic materials with varying intensity of preferential flow paths in the heterogeneous domain. We ran simulations using OGS#BRNS that enables us to combine a flexibly defined microbial mediated reaction network with the mentioned spatially heterogeneous domains in transient conditions. We propose that a combination of estimated field indicators of Damköhler number, Peclet number (transformed Damköhler number: Daₜ), and projected temporal dynamics in surface conditions can assist us in predicting the change in biogeochemical potential of the subsurface system. Preliminary results indicate that we miss potentially critical variations in reactive species concentration if we neglect spatio-temporal heterogeneities for regimes where 1<Daₜ<40. For regimes characterized by values outside this range, we propose that spatio-temporal heterogeneities due to subsurface structure and changing hydrological forcing may not be relevant.