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Global estimates of fresh submarine groundwater discharge

Elco Luijendijk (1), Tom Gleeson (2), and Nils Moosdorf (3)

(1) Georg-August Universität Göttingen, Geoscience center, Structural Geology and Geodynamics, Göttingen, Germany (elco.luijendijk@geo.uni-goettingen.de), (2) Civil Engineering, University of Victoria, Victoria, British Columbia, Canada, (3) Leibniz-Zentrum für Marine Tropenökologie (ZMT), Bremen, Germany

Fresh submarine groundwater discharge, the flow of fresh groundwater to oceans, may be a significant contributor to the water and chemical budgets of the world's oceans. We present new estimates of the flux of fresh groundwater to the world's oceans. We couple density-dependent numerical simulations of generic models of coastal basins with geospatial databases of hydrogeological parameters and topography to resolve the rate of terrestrially-derived submarine groundwater discharge globally. We compare the model results to a new global compilation of submarine groundwater discharge observations. The results show that terrestrially-derived SGD is highly sensitive to permeability. In most watersheds only a small fraction of groundwater recharge contributes to submarine groundwater discharge, with most recharge instead contributing to terrestrial discharge in the form of baseflow or evapotranspiration. Fresh submarine groundwater discharge is only significant in watersheds that contain highly permeable sediments, such as coarse-grained siliciclastic sediments, karstic carbonates or volcanic deposits. Our estimates of global submarine groundwater discharge are much lower than most previous estimates. However, many tropical and volcanic islands are hotspots of submarine groundwater discharge and solute fluxes towards the oceans. The comparison of model results and data highlights the spatial variability of SGD and the difficulty of scaling up observations.