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Groundwater modelling across the scales: Assessing the sensitivity of a global-groundwater model to surface water body parameterization at different spatial resolutions

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Gradient-based global-scale groundwater models have been proposed recently to improve the simulation of the hydrologic cycle. This development is still impaired by data availability and computational demands.

Current large scale groundwater models only show simulated hydraulic head to observed hydraulic head rather than simulated groundwater depth to well observations. This suggests that further refinements of large scaled groundwater models are needed.

Topography is an important driver of simulated groundwater flow which is not represented well in coarse scale models as e.g. surface elevation is assumed to be an average of the elevation per grid cell. Though topography data is globally available at high resolutions its incorporation into low resolution ($1 - 5$ km grid cell size) groundwater models is challenging. Related to topography is the elevation of surface water bodies. Since surface water bodies interact with groundwater, their elevations influence the gradient between both compartments determining if groundwater is a source or a sink.

Using the recently developed global groundwater model G^3M we investigate the effects of different grid sizes and related surface water body elevations on simulated groundwater depth by comparing results of three simulations with G^3M at grid cell sizes of $\sim$ 9000 m, 900 m and 90 m. To keep the analysis feasible we limit our area of interest to New Zealand as it offers a complex climate, topography and is surrounded mean sea level.

Our results indicate that the influence of surface water body elevation on simulated groundwater flow strongly depends on scale: coarser grid cell size leads to a higher correlation between simulated groundwater heads and surface water body elevation. Learning from the hyper resolution models we present a scale adapted surface water body parameterization approach for global scale models.