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Improvement of uncertainty estimation in global hydrological models by using high resolution satellite data as an interpolator

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Global hydrological models often ingest remotely-sensed observations supported by ground-truthed data in attempts to better quantify water balance components, e.g. soil water content, evapotranspiration, runoff/discharge, groundwater recharge. However, the scaling up process from local observations to that global, coarse, scale contains large uncertainty, often undermining the relevance of water balance calculations.

With recent more advanced high-resolution satellite data, freely available at 10m spatial resolution and (sub-) weekly temporal resolution, there is a possibility to reduce uncertainty in that upscaling. However, there are two challenges in doing so when working with global models: exponential increase of computational effort, and the need for quantifying the yet unknown uncertainty of assumptions that coarse global model cells and their underlying equations bring.

This study hypothesises that a bottom-up approach with high-resolution satellite data and in situ observations will better constrain and quantify uncertainty. By using these more spatially-explicit data, we make the case that the estimation of water balance components should become more data-driven. We propose a more data-driven model that improves uncertainty of estimation and scalability by using more sophisticated, remotely-sensed interpolation layers.

Our case study shows New Zealand-wide estimates of evapotranspiration and groundwater recharge at two resolutions: 1km x 1km, using an earlier developed model and MODIS satellite data; and a novel approach at 10m x 10m using Sentinel-1 and Sentinel-2 data to better incorporate impervious areas (e.g., anthropogenic urbanised land covers) and small land patches (e.g., small forestry areas). We then study the implications of using different spatial scales and quantify the differences between 10m x 10m versus 1km x 1km model pixel estimates. Our method is applied in the Google Earth Engine, a free-for-research high performance cloud computing facility, hence providing powerful computational resources and making our approach easily scalable to global, regional and catchment scales.

Finally, we discuss what underlying model assumptions in traditional models could be changed to facilitate a method that works consistently at these different scales.