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Hyper-resolution global modelling: what's next?

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Hydrologic processes such as precipitation variability, snow pack evolution, runoff generation, infiltration and subsurface water redistribution occur on very fine scales, but large-area models are forced to parameterize these processes at larger scales due to computational and observational limitations. Within the hydrological community, and related fields such as climate and earth system science, an increasing number of groups are devoting their research efforts towards modelling global terrestrial hydrology at increasingly higher spatial resolutions, not only to accurately represent these important fine-scale processes, but also in an attempt to be more relevant to regional and local water managers. All these groups face similar challenges, such as scale-dependent process representation, parameterization and increased computational efforts. These challenges result from finer grids and from describing in a spatially explicit manner processes that were previously parameterized. Obtaining and processing the extremely large information requirements for the model parameterizations, and subsequent calibration, validation and uncertainty analyses are additional obstacles to successful hyper-resolution simulation. In this opinion paper, we present the scientific and societal rationale behind recent efforts to model hydrology globally at hyper-resolution spatial scales (< 1 km). The main challenges are discussed and a case is made for setting up a research network on hyper-resolution global modelling.