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Global fluvial flood modelling – a sensitivity analysis

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In this contribution a systematic sensitivity analysis of global fluvial flood models (GFFMs) focusing on delta areas is carried out. The contribution aims to provide a better understanding of the relative importance of different river routing processes, and the spatial variation therein, on a global scale.

This is important as estimates of global and national scale flood risk assessments are usually based on the results of GFFMs. Whilst flood risk estimates based on these models have contributed to increased awareness of flood risk, GFFMs have their limits compared to local flood risk models and large discrepancies in flood risk estimates exist among GFFMs. In order to progress in the field of global flood modelling there is an urgent need for a better understanding of the sensitivity of GFFMs to internal model physics as well as external model forcing. This contribution aims to provide a better understanding of the relative importance of different river routing processes, and the spatial variation therein, on a global scale.

Most GFFMs consist of a model cascade including a global hydrological model, a 1D river routing model, and a downscaling procedure or 2D hydraulic model to calculate flood extent, all of which have different sources of uncertainty. Recent studies have shown that river routing schemes play a critical role in the simulation of peak discharges in GFFMs, especially the explicit representation of floodplains in the river routing model component (Zhao et al. 2017). Channel bifurcations (Yamazaki et al. 2014) as well as interactions between river and sea (Ikeuchi et al. 2017) have been shown to be important for the correct flood modelling in large deltas. Furthermore, GFFMs suffer from errors in topography data, such as the known “vegetation bias” in the global SRTM DEM, which causes large errors in modelled flood extent in flat delta regions. Uncertainties originating from 1) bifurcation scheme, 2) sea-river interactions, and 3) errors in SRTM elevation on routing and flood extent have been the subject of research in local case studies. However, a systematic global sensitivity study of GFFMs to these processes has not yet been carried out.

In order to systematically assess the sensitivity of GFFMs to these processes on a global scale, the CaMa-Flood river routing model (Yamazaki et al. 2011) is run with (combinations of) the following model configurations: 1) with river channel bifurcations; 2) with sea-river interactions using GTSR (Global Tide and Surge Reanalysis, Muis et al. 2016); and 3) using elevation data from the MERIT DEM (Multi-Error-Removed Improved-Terrain DEM, Yamazaki et al. 2017). Furthermore, the skill of the different model configurations is assessed by benchmarking simulated daily peak discharge (magnitude and timing) against observed discharges and simulated flood extent against remote sensing observations.