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Can regional to continental river hydrodynamic models be locally relevant? A cross-scale comparison

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Regional to global river hydrodynamic models are now a reality, and have largely improved in recent years due to increasing computation power and new modeling and remote sensing techniques. Despite all recent advances, it is still necessary to understand to which extent these models can provide locally relevant estimates of variables as discharge, water surface elevation and flood inundation, and how current and future remote sensing data should be used to improve them. We compare here three versions of a river hydrodynamic model (MGB) at local, regional and continental scales. It was applied to the Itajaí-Açu basin in Brazil (15,000 km^2) using river spatial discretization, river bathymetry and floodplain DEM representative of local, regional and continental scales. Results are compared to a detailed HEC-RAS model applied at basin scale (>600 cross sections over ∼850 km) as a benchmark reference. To evaluate model accuracy, discharge, water levels and flood extent metrics were classified into locally relevance categories based on the accuracy requirement for flood related studies, typical reach scale models' errors, and observation uncertainties. The hydrodynamic model at all scales provided locally relevant discharge estimates, while regional and local versions yielded satisfactory water level anomalies. Less accurate estimates of water level and flood extent indicated the general difficulty on predicting these variables by current large-scale hydrodynamic models. Smaller river reaches (i.e. 1 km river reaches) improved discharge, water level and flood extent estimates. A locally derived DEM did not lead to significant improvements in relation to a global DEM. The cross-scale comparisons also indicate the potential of improving river bathymetry, by means of in situ surveys or remotely sensed river widths and altimetry. In the context of remote sensing, studies like these provide interesting insights on how using future remote sensing data to improve large-scale hydrodynamic models.