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Simulation of absolute water surface elevations in a global river model: a case study in the Amazon River

Dai Yamazaki (1), Hyongki Lee (2), Doug Alsdorf (3), Emanuel Dutra (4), Hyungjun Kim (5), Shinjiro Kanae (6), Taikan Oki (5), and Paul Bates (1)

(1) University of Bristol, Bristol, UK (Dai.Yamazaki@bristol.ac.uk), (2) University of Houston, Houston, TX, USA, (3) The Ohio State University, Columbus, OH, USA, (4) ECMWF, Reading, UK, (5) The University of Tokyo, Tokyo, Japan, (6) Tokyo Institute of Technology, Tokyo, Japan

Water level dynamics in continental-scale rivers is an important factor for surface water studies and flood hazard management. However, most continental-scale river models have not focused on the reproduction of water level because the storage and movement of surface waters are regulated by smaller scale topography than their grid resolutions. Here we analyzed the water level dynamics simulated by a state-of-the-art global river model, CaMa-Flood, with sub-grid representation of floodplain topography. As a case study, hydrodynamics simulation in the Amazon River was accomplished, and the simulated water surface elevations along the mainstem were compared against Envisat altimetry. The seasonal cycle of the simulated water surface elevations are in agreement with the altimetry (correlation coefficient >0.69, annual amplitude error <1.6 m). The accuracy of absolute water surface elevations was also good (averaged RMSE of 1.83 m), and the associated errors were within the range of the model uncertainty due to channel cross-section parameters. Then, the ocean tide variation at river mouth was incorporated for simulating the tidal effect in the inland Amazon basin, which requires realistic representation of absolute water surface elevations. By applying power-spectra analysis to the simulated water level variations, the 15-day cycle due to spring and neap tides was detected at Obidos located 800 km upstream from the river mouth. The reproduction of the ocean tide propagation to the inland region suggests that CaMa-Flood includes the main physical processes needed to accurately simulate the water level dynamics in continental-scale rivers.