A development of global-scale river discharge estimation framework by assimilating satellite altimetry

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Understanding spatial and temporal variation of surface waters is important for global hydrological cycle studies and water resources management. The future SWOT (Surface Water and Ocean Topography) satellite mission will measure the elevation and slope of surface waters at a spatial resolution <100 m, and will be utilized for river discharge estimation at a global scale. In order to achieve spatially and temporally continuous discharge estimation, frameworks for assimilating the SWOT measurements into river hydrodynamic models have been developed. However, previous studies on SWOT assimilation were performed only at regional or local scales. In this research, we developed a global-scale framework for river discharge estimation for the first time. We used the CaMa-Flood global river model as a hydrodynamics core and assimilated SWOT-observed water surface elevations using LETKF (Local Ensemble Transform Kalman Filter). The developed framework was tested by virtual experiments using synthetic SWOT observations, and we estimated truth river discharge by correcting simulations with corrupted runoff forcing. We found the assimilation significantly improved river discharge estimation in continental-scale rivers. Especially in the downstream reaches, discharge was estimated with little errors even when there is no local SWOT observation since corrected hydrodynamic states in upstream propagated downstream. We also found that discharge at the most downstream reaches could be accurately estimated by assimilation even if realistic precipitation or runoff forcing data is unavailable. These results suggested the potential of the future SWOT mission for spatially and temporally continuous estimation of river discharge at a global scale.

Keywords: data assimilation, SWOT, LETKF, river discharge, satellite altimetry

