Geophysical Research Abstracts
Vol. 19, EGU2017-10066, 2017
EGU General Assembly 2017

Observability of global rivers with future SWOT observations

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The Surface Water and Ocean Topography (SWOT) mission is designed to provide global observations of water surface elevation and slope from which river discharge can be estimated using a data assimilation system. This mission will provide increased spatial and temporal coverage compared to current altimeters, with an expected accuracy for water level elevations of 10 cm on rivers greater than 100 m wide. Within the 21-day repeat cycle, a river reach will be observed 2-4 times on average. Due to the relationship between the basin orientation and the orbit, these observations are not evenly distributed in time, which will impact the derived discharge values. There is, then, a need for a better understanding of how the mission will observe global river basins. In this study, we investigate how SWOT will observe global river basins and how the temporal and spatial sampling impacts the discharge estimated from assimilation.

SWOT observations can be assimilated using the Inverse Streamflow Routing (ISR) model of Pan and Wood [2013] with a fixed interval Kalman smoother. Previous work has shown that the ISR assimilation method can be used to reproduce the spatial and temporal dynamics of discharge within many global basins: however, this performance was strongly impacted by the spatial and temporal availability of discharge observations. In this study, we apply the ISR method to 32 global basins with different geometries and crossing patterns for the future orbit, assimilating theoretical SWOT-retrieved “gauges”. Results show that the model performance varies significantly across basins and is driven by the orientation, flow distance, and travel time in each. Based on these properties, we quantify the “observability” of each basin and relate this to the performance of the assimilation. Applying this metric globally to a large variety of basins we can gain a better understanding of the impact that SWOT observations may have across basin scales. By determining the availability of SWOT observations in this manner, hydrologic data assimilation approaches like ISR can be optimized to provide useful discharge estimates in sparsely gauged regions where spatially and temporally consistent discharge records are most valuable.

Pan, M; Wood, E F 2013 Inverse streamflow routing, HESS 17(11):4577-4588