Leveraging SWOT observations for global reservoir monitoring

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Abstract

Global evaluation of historical and future water security requires models that can accurately simulate reservoir operations, including reservoir storage and release. Reservoir models rely on time series of reservoir operation patterns (inflow, storage, and release) as inputs to estimate key model parameters; however, such in-situ data is limited and therefore spatially scarce. Satellite remote sensing and hydrological modeling offer another avenue for determining reservoir operation patterns. Recently, advances in satellite technology for the Surface Water and Ocean Topography (SWOT) satellite mission have substantially increased the spatial coverage of globally observed reservoirs. Here, we leverage water surface elevation (WSE) observations from SWOT and simulated flows from the Hydrological Modeling and Analysis Platform (HyMAP) to evaluate a globally applicable framework for simulating reservoir operations. In a case study focused on reservoirs in Brazil, we perform a set of experiments to characterize the error of simulated reservoir operations when using different combinations of in-situ, altimeter, and modeled data sources to optimize reservoir model parameters. To have a baseline, we also compare results using SWOT for parameter optimization to results using the global water measurements (GWM) satellite altimeter dataset, which has less spatial coverage but

longer WSE time series. Our results indicate that incorporating satellite observations into reservoir parameterization improves simulated releases compared to using HyMAP naturalized flow alone for both SWOT and GWM. We find that using GWM for parameter optimization results in better performance compared to SWOT; however, further analysis suggests that the performance of reservoir operations using SWOT may increase with a longer observation record. Overall, our study suggests that incorporating satellite observations into hydrological models enhances simulated surface water dynamics, and that SWOT holds promise for the global assessments of reservoir operations.