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An assessment of reservoir storage change accuracy from SWOT

Elizabeth Clark (1), Delwyn Moller (2), and Dennis Lettenmaier (3)

(1) University of Washington, Civil and Environmental Engineering, Seattle, WA, United States (eclark@hydro.washington.edu), (2) Remote Sensing Solutions, Pasadena, CA, United States (dkmoller@remotesensingsolutions.com), (3) University of Washington, Civil and Environmental Engineering, Seattle, WA, United States (dennisl@u.washington.edu)

The anticipated Surface Water and Ocean Topography (SWOT) satellite mission will provide water surface height and areal extent measurements for terrestrial water bodies at an unprecedented accuracy with essentially global coverage with a 22-day repeat cycle. These measurements will provide a unique opportunity to observe storage changes in naturally occurring lakes, as well as manmade reservoirs. Given political constraints on the sharing of water information, international data bases of reservoir characteristics, such as the Global Reservoir and Dam Database, are limited to the largest reservoirs for which countries have voluntarily provided information. Impressive efforts have been made to combine currently available altimetry data with satellite-based imagery of water surface extent; however, these data sets are limited to large reservoirs located on an altimeter's flight track. SWOT's global coverage and simultaneous measurement of height and water surface extent remove, in large part, the constraint of location relative to flight path. Previous studies based on Arctic lakes suggest that SWOT will be able to provide a noisy, but meaningful, storage change signal for lakes as small as 250 m x 250 m. Here, we assess the accuracy of monthly storage change estimates over 10 reservoirs in the U.S. and consider the plausibility of estimating total storage change. Published maps of reservoir bathymetry were combined with a historical time series of daily storage to produce daily time series of maps of water surface elevation. Next, these time series were then sampled based on realistic SWOT orbital parameters and noise characteristics to create a time series of synthetic SWOT observations of water surface elevation and extent for each reservoir. We then plotted area versus elevation for the true values and for the synthetic SWOT observations. For each reservoir, a curve was fit to the synthetic SWOT observations, and its integral was used to estimate total storage, which we then compared to observed total storage. Two reservoir forms emerge: 1) reservoirs with conical-type volumes, for which a linear fit is appropriate, and 2) reservoirs with horn-shaped volumes, which require a nonlinear fit. The ability to distinguish between these forms depends on the variability of both elevation and area during SWOT's lifetime. The synthetic SWOT-based estimates of storage change, which will arguably provide a reasonable estimate of variability in active storage, are highly accurate for both of these forms.