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Evaluating the impact of SWOT observations[§] on the water balance of lakes and wetlands

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Lakes and wetlands can exert controls on the water and energy fluxes, playing an important role in the local and regional climate. The spatial extent and storage volume of water bodies globally is poorly known, due to lack of measurements over large areas. The planned Surface Water Ocean Topography (SWOT) satellite mission will provide observations of water surface elevation and inundated area globally at an unprecedented spatial resolution. Apart from being used directly, these observations can be used to constrain the water balance simulated hydrologic model over large-scale basins. In this study, the Variable Infiltration Capacity (VIC) macroscale hydrologic model is implemented over the Great Lakes region within an identical twin synthetic experiment. VIC solves an energy and water balance over a gridded domain, and represents lakes and wetlands dynamically as fractional areas of each model grid cell. A baseline simulation of the water and energy balance is designated as "truth", and errors in precipitation, temperature and model parameters are added to simulate a "first-guess" of hydrologic variables of interest. Synthetic SWOT observations are generated from the instrument simulator (developed at JPL) with the anticipated orbital and error characteristics. These "virtual" observations are then assimilated into the "first-guess" model to estimate runoff, evapotranspiration and sensible/latent heat fluxes. The assimilation technique used is the Ensemble Kalman Filter (EnKF), which solves the optimal estimation problem by approximating model and observation errors through a Monte Carlo ensemble approach. The "first-guess" simulation consists of an ensemble of model states that is propagated temporally until a SWOT observation becomes available. The impact of merging the SWOT observations is examined in terms of water and energy fluxes, and the sensitivity of the results to the different observation errors is assessed. The latter can include errors in lake/wetland area, storage change, as well as the effects of the SWOT temporal sampling.

[§]The SWOT mission has not been formally approved by NASA. The decision to proceed with the mission will not occur until the completion of the National Environmental Policy Act (NEPA) process. Material in this paper related to SWOT is for information purposes only.