The Upcoming NASA SWOT Mission and Its Potential to Advance Fluvial Geomorphology and Applied Hydraulics

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Extended Abstract

NASA has several next generation high-resolution satellite missions to study the hydrologic cycle that are launched or soon to be launched, yet these missions remain relatively unknown to most users of water data. Several of these missions were conceived in part to measure different aspects of surface water: The Surface Water and Ocean Topography (SWOT) Mission to measure water surface elevations and extents, the NASA ISRO Synthetic Aperture Radar (NISAR) Mission to study wetland and floodplain inundation; and the ICESat-2 Mission to measure surface elevation and shallow bathymetry. In this talk, we will focus on the aspects of SWOT that make it particularly appealing to users of water data.

The upcoming SWOT Mission will provide first-of-its-kind satellite swath altimetry with simultaneous water surface elevations (WSE) and water extent data for wetlands, rivers, lakes, tidal zones and oceans. Scheduled for launch in 2021, SWOT utilizes a Ka-band (~8mm wavelength) interferometric synthetic aperture radar to simultaneously collect sub-decimeter simultaneous water surface elevation, slope, and extent. SWOT data will cover a large, 120km swath (Figure 1a), with repeat times at most locations of two to three times per 21-day orbit cycle in temperate latitudes (Figure 1b). While the initial point cloud of water surface elevations will contain a fair amount of scatter, the river center line averaged 'node' product will be much cleaner and likely will be used by most users. SWOT mission requirements are that WSE measurements are within ten centimeters of true WSE (1σ, 1km^2 area), river slopes are within 1.7 cm/km (17 μrad, 1km^2 area), and surface water extents are within 15% of true extent (1km^2 area). As these satellite measurements are as good or better than conventional ground surveys, are near instantaneous for large swaths of inland waters, have unprecedented temporal and spatial coverage, and will provide data over the three-year planned mission life, these are clearly large advances for user of water data. And the data are free.

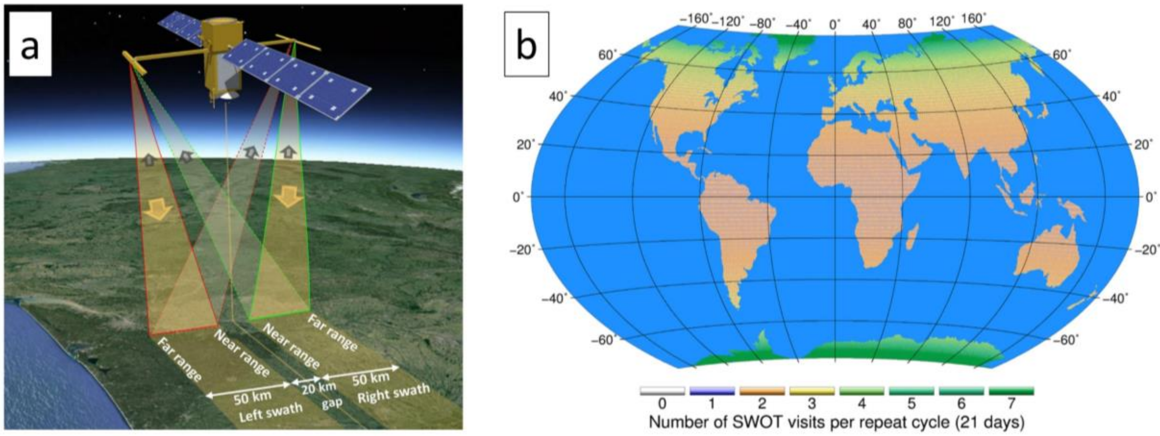

Figure 1a,b. a.) Schematic of the SWOT instrument with 120km wide ground swath shown (from *Biancamaria et al. 2016*). b.) temporal repeat coverage of SWOT per 21-day repeat cycle (~two to three times per 21 days for temperate latitudes; from *Biancamaria et al. 2016*).

Clearly, the SWOT Mission has great potential to advance global hydrology, particularly in locations lacking sufficient hydrologic measurements (e.g., lacking river gages, etc.). In areas with gage data, SWOT also has potential to advance our understanding of inland surface water processes. In particular, the two related fields of fluvial geomorphology and applied hydraulics will be able to benefit from SWOT measurements. Some examples include: 1.) developing and calibrating large-scale hydraulic and hydrologic models such as the National Water Model (an expensive proposition at present), 2.) determining hydraulic resistance at existing gage locations, 3.) creating bathymetry for hydraulic models, 4.) determining local geomorphic units (pools, riffles, etc.) and local estimates of hydraulic parameters, and 5.) calculating depth-slope products to estimate sediment transport rates.

In this talk, we will make the case that SWOT data can be used to advance applications within the fields of fluvial geomorphology and applied hydraulics, using a compilation of recently published SWOT papers, recent SWOT simulation data and AirSWOT (a SWOT-like prototype plane) data collections in 2015 and 2017, along with contemporary water- and ground-surface measurements. Of particular focus will be the utility of using SWOT data to create an inland bathymetry dataset, called the "Inland Bathymetry Estimates from SWOT" or IBES dataset. In addition, we will discuss using direct SWOT measurements (relative depth and slope) to calculate shear velocities at reach scales for sediment transport calculations, and the potential to do so at geomorphic unit scale (e.g., riffles, pools, etc.) using smoothing techniques. In all, SWOT has great potential for many types of users of water data.

References

Biancamaria, S., Lettenmaier, D.P., and Pavelsky, T.M., 2016. The SWOT Mission and Its Capabilities for Land Hydrology. Surveys in Geophysics, 37:307-337.