2019 SWOT ROSES TOSCA (Hydrology)

The primary objective of SWOT hydrology, described in the Science Requirements Document at https://swot.jpl.nasa.gov/docs/D-61923_SRD_Rev_A_20160318.pdf, is to "characterize the spatial and temporal variations in surface waters, globally." In particular, SWOT aims to measure variations in lake and wetland water storage and river height, slope and discharge at submonthly, seasonal, and annual timescales. SWOT will provide these measurements for rivers wider than 100 m, globally, and for lakes larger than $(250\ m)^2$. These measurements will constitute the first globally consistent database of surface water storage and fluxes from space and will substantially advance hydrologic science in several areas, as specified in the Science Description Document at https://swot.jpl.nasa.gov/docs/SWOT_MSD_1202012.pdf. We anticipate advances in three primary areas:

2.1.1 River, Lake, and Wetland Science

The storage of water in lakes and reservoirs, fluxes through rivers, and interactions with inland and coastal floodplains and wetlands are critical to understanding a broad range of science questions focused on hydrology, hydraulics, biogeochemistry, water resources engineering, etc. For example, the SWOT Science Definition Team identified the following core SWOT hydrology science questions:

- What is the spatial distribution of freshwater storages and runoff through rivers, lakes, and reservoirs? Does inclusion of the knowledge “close” water budgets of regional/global hydrology and climate models?
- What are the impacts of water impoundments in reservoirs and natural lakes, human water withdrawals, and trans-boundary rivers on the global water cycle, societal water supply, and global sea level rise?
- What are the regional-to-global-scale responses of lake volumes and river flows to climatic phenomena, e.g. droughts, floods, and a warming Arctic?
- What are the three-dimensional forms of waves propagating through natural river channels, and how may these be used to improve hydrodynamic models of flood hazard and risk?
- What are the spatial and temporal dynamics of water storage in millions of unmapped lakes and river floodplains, and how do they impact biogeochemical fluxes of carbon, nutrients, and greenhouse gases, waterborne diseases/public health, sediment transport, and ecosystem functioning?

There are also many other fruitful science questions related to SWOT hydrology, including in the areas of remote sensing science (e.g. radar phenomenology), the terrestrial cryosphere (e.g. snow processes), and the science of deltas and estuaries.

The SWOT Science Team projects focused in this category will finalize development of ways to address science questions before launch and then use the first SWOT data post-launch to begin addressing them. Science investigations may focus exclusively on SWOT data or may use a combination of SWOT measurements, other satellite or in situ data, and/or numerical models. All projects should make clear their plans for both pre-launch and post-launch activities.

2.2.2 SWOT Algorithms and Data Products

In order to effectively address science questions using SWOT, robust algorithms and high-quality data products are essential. The SWOT Science Team is integrally involved in development of such algorithms and data products. Key areas that are solicited here include:

- Development and implementation of algorithms to produce river discharge estimates from SWOT data globally. These may be based on so-called mass-conserved flow law inversion algorithms or other novel or established algorithms. Emphasis should be on global-scale implementation of algorithms rather than in only a few rivers. Proposals on discharge may also seek to integrate multiple existing or novel discharge algorithms into multimodel ensembles.
- Development and implementation of algorithms and data products based on assimilation of SWOT river, lake, and/or wetland data into hydrologic or hydrodynamic models
- Development of data products, led by the Science Team, that combine SWOT data with other remote sensing or in situ datasets to aid in addressing key SWOT science questions. Examples of other satellite instruments providing data that could be used in combination with SWOT data include nadir altimeters such as the JASON series, GRACE-FO, various Sentinel satellites, BIOMASS, ICE-Sat 2, MODIS/VIIRS, the Landsat suite, and NISAR.

All proposals in this category should demonstrate that it is possible to fully develop and distribute any proposed data products using proposed resources.

2.2.3 Key Areas in Calibration and Validation

The initial release of the SWOT calibration and validation plan, available at https://swot.jpl.nasa.gov/docs/D-75724_SWOT_Cal_Val_Plan_Initial_20180129u.pdf, describes two different tiers of validation sites. Tier 1 sites will be extensively instrumented in support of

SWOT, while Tier 2 sites will leverage existing infrastructure (e.g. networks of stream gauges). The SWOT Science Team will play a key role in acquiring and analyzing calibration and validation measurements. Two primary activities related to these sites are solicited here:

- Development and data collection at Tier 2 validation networks. These sites will be used to validate lake water surface elevation and inundation extent and river water surface elevation, width, slope, and discharge from SWOT. There is no upper limit on the number of suitable Tier 2 sites, and we anticipate that efforts to develop large Tier 2 networks in the United States and worldwide will substantially improve knowledge of SWOT performance and its geographic variability. Proposals to develop robust tier 2 networks should include partners who operate existing infrastructure as collaborators.
- Development and data collection at Tier 1 sites outside of the U.S. As described in the calibration and validation document, the core Tier 1 validation sites that NASA will lead are located in the United States. However, inclusion of additional sites outside the U.S. will help to ensure the quality of SWOT hydrology data around the world. Proposals to develop Tier 1 validation sites outside the U.S. should include partners in the relevant countries as collaborators.

Proposals in this category should plan to both develop calibration/validation sites prelaunch and to collect and analyze appropriate data after SWOT launch.