Planned Approach to SWOT Hydrology Cal/Val

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Preliminary Thoughts

- We should leverage the expertise and capabilities of operational agencies such as the USGS and WMO to the greatest extent possible.

- We must have developed specific plans for cal/val, including selection of major focus sites, prior to PDR.

- We will need two different types of sites: gold-standard locations with highly detailed, multitemporal *in situ* measurements and secondary sites that will leverage existing observation capabilities with much more limited (or no) additional *in situ* work.
Key Points: Rivers

- Discharge should largely be validated using existing gauges (paired where possible) supported by ADCP measurements.
Characterization of Discharge

Leverage the existing gauge networks in the U.S. and France.

Work with partners in other parts of the world to provide gauge-derived measurements

Request operational agencies to make ADCP measurements coincident with SWOT overflights.

Question: do we need to go beyond operational agencies?
Key Points: Rivers

- Discharge should largely be validated using existing gauges (paired where possible) supported by ADCP measurements.

- Slope can be validated using three methods: long profiles from boats/drivers, pressure transducer arrays, paired gauges. All sites should have at least one long profile.
GPS long profile example: Tanana River

The most robust way to validate SWOT slope will be to make continuous GPS profiles of rivers coincident with SWOT overpasses.

GPS measurements can be made continuously using a survey-grade GPS mounted on a boat or, preferably, on a platform towed behind the boat for greater stability.

AirSWOT field experiments have provided significant experience in making these measurements.
Example of an array of water level loggers for SWOT cal/val

AirSWOT Alaska Field Campaign 2015
Tanana River Instrument Locations
Key Points: Rivers

- Slope can be validated using three methods: long profiles from boats/drivers, pressure transducer arrays, paired gauges. All sites should have at least one long profile.

- Discharge should largely be validated using existing gauges (paired where possible) supported by ADCP measurements.

- We will need to have two different levels of river cal/val sites: gold standard sites and secondary sites.
Gold Standard Sites

Gold standard sites should include the following measurements:

- Should be a reach at least 50 km long
- Stream gauge or gauges already present or installed
- Pressure transducers installed and leveled to measure slope
- Capability to conduct long-profile surveys of water surface elevation and ADCP Discharge
- Bathymetry surveyed, 2-D hydrodynamic model built, SWOT simulator run prior to launch.
- LiDAR DEM available
- Aerial photography of inundation extent feasible simultaneous w/ SWOT
Secondary Sites

Level 2 sites should include the following measurements:

- Two gauges allowing measurements of slope, height Q
- One long profile measurement coincident with or preceding SWOT observation.
- Thorough examination of historical remotely sensed inundation data

There will be a limited number of gold-standard sites. We should aim to have as many Level 2 sites as possible.
Key Points: Lakes

- Validation of lake storage changes:
  - One possible method is to use storage changes developed from a combination of optical imagery and nadir altimetry derived over time for lakes with visible shorelines (e.g., Lake Poopo).
  - No science requirement to validate storage change, so this may be a science team effort.

- Validation of height and inundation extent:
  - Height from leveled pressure transducers/gps surveys
  - Inundation extent from satellite imagery (large lakes) and aerial imagery (small lakes)

- Need to instrument a range of lake sizes from \((100 \, \text{m})^2\) to very large lakes in order to determine SWOT capabilities and limitations.
Validation of Height and Slope from geoid a priori calculation

1D orbit sampling phase over lakes Athabasca and Issykkul
Validation/characterization of hydrology derived products
(storage change, cycle-based lakes)

Storage change of a lake: no requirement of accuracy given in the SRD

How to characterize?

Can we use satellite altimetry previous missions as a priori data set for C/V?

Which data to collect prior to the mission: Bathymetry, DEM?
Characterization of environment: vegetation, snow cover, mountain

Permanent site / temporary expedition? => impact on the performances

Indirect measurements: trough rating curves built before the launch

Example of lake Poopo: is there a need to extend that to other sites prior to the launch?
Let’s take both height and mask from SWOT, and then independent data source (Modis or equivalent) and we could calculate water volume. Let’s do that every cycle of SWOT and due to the high variability of water extent of this lake, we could investigate the limit of SWOT for small water body, and its capability to provide water storage variations. We can also calculate water storage from combination of water masks and bathymetry on one hand, and from water height and bathymetry on the other hand and compare them.

_Do we reproduce this on other sites?_
Key Points: Validation Sites

- We will not validate SWOT globally, but we will validate it at a set of globally representative sites.
- Sites should be divided between essential project-funded sites and additional science team funded sites.
- Need to have globally and morphologically representative validation sites:
  - Polar, Mid-Latitude, and Tropical Rivers
  - Large, Small Rivers
  - Single-channel, Multichannel, tidal, high-banked, etc. rivers
  - Large lakes
  - Small lakes
  - Vegetated wetlands
  - Ice-covered rivers and lakes (range of ice conditions)
- Long-wavelength capabilities should be validated using arrays of “virtual” sites that do not require extensive in situ work.