SWOT Short & Longterm Goals

Oceanographic Science Goals

Rosemary Morrow & Lee-Leung Fu
II. Oceanographic Goals:

1. **Confirm our notion about the space and time scales of ocean variability at wavelengths less than 100 km.**
   
   Our current knowledge is based on limited in-situ observations and coarse resolution satellite observations and model simulations.

Action Items:

- Improve present analysis of alongtrack nadir altimetry data & SST / Ocean colour data at these scales
- Encourage in-situ data process studies with emphasis on observability from SSH
- Encourage v. high resolution modelling studies – dynamics + internal tides + surface waves/swell
- Others?
2. **Ensure the usefulness of sea surface height (SSH) for determining the upper ocean circulation.**

Although the surface quasi-geostrophic (SQG) theory promises the prospects of computing the three-dimensional ocean velocity, the ocean is not strictly quasi-geostrophic at the small scales. We have models that are capable of resolving small scales in and below the mixed layer that are much more general than SQG, and so not dependent upon the particular assumptions.

Action items …
- We need to explore the degree to which such models are constrained by SSH alone.
- More fully explore the observability of mixed-layer, upper ocean & frontal dynamics with SSH (combined with SST?) (see next item)

Others?
3. **Define the synergy of SWOT SSH with high-resolution SST and ocean color observations.**

Sea surface temperature (SST) and ocean color images provide detailed views of the effects of submesoscale ocean currents. How can we use these observations in conjunction with SWOT SSH observations in determining upper ocean circulation, and heat and possibly carbon budgets?

**Action Items:**

**III.1.7. SDT Action: Understanding SST, Passive Tracers, and SSH**

- **State-of-the-art ocean general circulation models** are needed to understand the relationship between SST, passive tracers, and SSH at scales from 10 km to 100 km. These results will be used to develop strategies of combining SST, ocean color, and SSH for understanding upper ocean circulation processes.

- **Develop techniques for combining SWOT with other satellite obs** (eg nadir altimeter observations, SST, ocean colour observations) for improving the temporal sampling of ocean dynamics.
4. **Validate the SWOT measurement concept and error budget as applied to oceanography.** The challenge for SWOT is to reduce the measurement noise by two orders of magnitude from the Jason-1 performance, i.e., 1 cm RMS noise at SWOT’s 1 km x 1 km pixels.

**Action Items:**
- Mission team!
4a Determine the SSH signatures of waves & wave-current interactions. There are issues in the effects of ocean waves: the residual effects of long swells on SSH after spatial smoothing. Gravity waves & swell & seiching impact directly on SSH but also modify the surface currents at scales from 10-100 km.

Action items:

Develop a coastal & offshore framework for estimating the surface wave impact on SSH signatures. Modelling of SSH & currents, surface wave satellite observations (SAR, altimetry), in-situ observations (HF radar, buoys).
5. **Evaluate the effects of water vapor in coastal oceans.** Scales in the coastal ocean become smaller and magnitudes become larger compared to the open ocean, thus we will evaluate the need for a high-frequency radiometer for SWOT water vapor correction.

**Action Items:**

**III.1.8. SDT Action: Correcting for Water Vapor Over Land, Open Ocean, and Coastal Zones**

- Corrections include both model and measurement approaches. Thus, an assessment is needed regarding the accuracy of atmospheric models as well as combinations of models and radiometer observations for improving water vapor corrections across the swath width, and especially in coastal zones. This could be addressed by assimilation of radiometer observations into models and evaluate the performance by comparing to in-situ observations. A twin experiment with a high-resolution atmospheric model might be a useful first step.
6. **Determine the temporal decorrelation of ocean features.** SWOT will have relatively long repeat sampling intervals compared to the temporal scales of open ocean fronts and filaments and of coastal currents and eddies. We will need to define such decorrelation time scales and evaluate the feasibility of **model assimilation** or multi-mission data sets for reconstructing temporal evolution of these features.

Action Items:

**III.1.9. SDT Action: Data Assimilation and Modeling of Open Ocean and Coastal Zones**

- we will need to use state-of-the-art modeling and assimilation techniques to assess the feasibility of reconstructing the temporal evolution of coastal & open-ocean submesoscale processes from infrequently sampled SWOT observations.
- also need to address the design of the fast-sampling phase of the SWOT mission to optimize the gain in understanding rapidly changing oceanic processes around the globe.
7. **Determine the SSH signatures of coastal and internal tides.** To study ocean circulation physics at scales from 10-100 km, the SSH of coastal and internal tides must be understood and modeled to allow their removal from the SWOT SSH. We will need to accelerate progress in the modeling of these phenomena though both observations and modeling.

**Action Items:**

**III.1.6. SDT Action: Develop a Global Framework of Tide Models (larger lakes?)**

- Tide corrections are needed for SWOT’s SSH measurements. Regional coastal-based tide models, integrated in a global framework, will provide these corrections. We will need to coordinate and expand the current activities in improving coastal tide models and create a global inventory of such models with assessment of their accuracies.

- Internal tides also need to be corrected along with knowing their accuracies. We will need to establish a global internal tide modeling program, similar to the gravity improvement program for the TOPEX Mission. applications.
8. **Merge data and map sub-mesoscale features in the ocean.** The production of high-level products is a challenge. SWOT will provide infrequent synoptic observation of small-scale, rapidly evolving features of SSH over a finite swath. How to combine different swaths of data to create synoptic maps of ocean surface circulation is a key question to be addressed.

**Action Items:**

**Modelling & assimilation studies**

SWOT Karin swath measurements may be **combined with a constellation of nadir altimeters** in 2019 (Jason-CS, Sentinel-3A & B, GFO-2, Iridium constellation ?). MDT & SDT groups need to work on developing mapping techniques for large-volume SWOT data with multi-altimeter constellations.
Define the utility of SWOT measurements for understanding estuaries. What is the utility of SWOT observations to the understanding and modeling of the dynamics of river outflow interacting with open ocean processes?

Action Items:

III.1.10. SDT Action: Estuaries

- High-resolution estuary circulation models are needed to investigate the utility of SWOT’s SSH measurements.
- Develop assimilation strategies for using SSH for improving estimation of estuary circulation parameters.
- Develop multi-data techniques for estuaries (SSH, SST, SSS, color)
- Better bathymetry & geoid models
Oceanographic modeling framework. We will need to develop the capability of high-resolution (sub km) models for understanding these ocean processes, and assimilation studies for SSH swath data. How to produce high-level SSH maps of the ocean which are consistent at all scales.

... others?
III.1.3. SDT Action: Determine Geoid and Related Errors (Hydro & Oceano)

- Cross-swath geoid errors will be a problem for ocean applications near steep or unresolved bathymetry. How will SWOT identify and overcome these geoid related errors is a question that individual SDT PIs could address.

III.1.5. SDT Action: Identify Fast-Phase and Cal-Val Targets (Hydro & Oceano)

- formalize the process for selecting targets for the three-day fast-phase of the SWOT mission, & the CalVal locations. Airborne campaign will also sample cal-val locations, a selection process needs to be developed. We expect that SDT funded researchers will participate in the airborne campaign, and thus their collaboration on site locations is needed.
Global CalVal techniques. SWOT Karin swath measurements will be cross-calibrated with a constellation of nadir altimeters in 2019 (Jason-CS, Sentinel-3A & B, GFO-2, Iridium constellation ?). SDT needs to work on developing calibration techniques for large-volume SWOT data with multi-altimeter constellations.

Others … ?