National Aeronautics and Space Administration

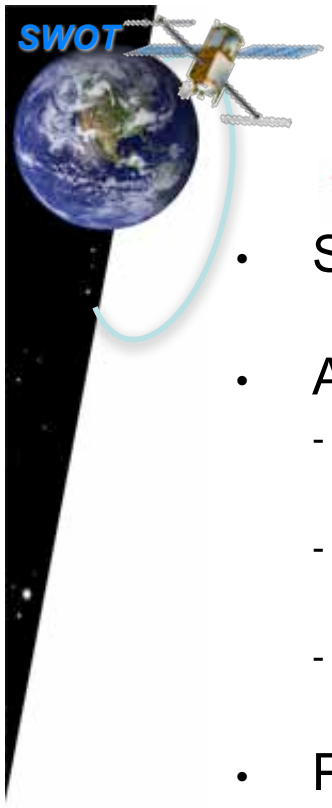
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

http://swot.jpl.nasa.gov

Surface Water and Ocean Topography (SWOT) Mission

Montreal, Canada, June 26-29, 2018

Hydrology Breakout Session Summaries



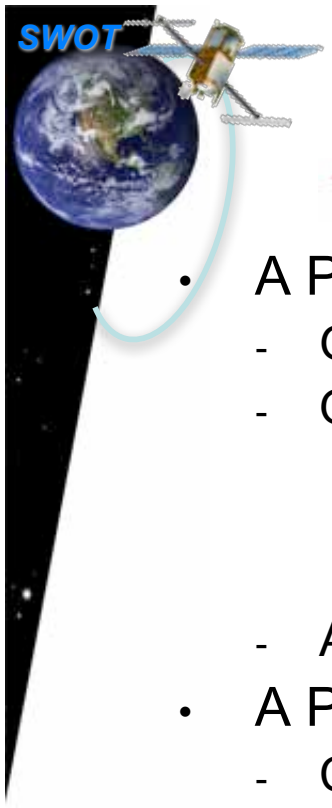
Cal/Val Key Points

- SWOT Cal/Val Study Plan was publicly released Jan. 2018

- AirSWOT participation in ABoVE in summer 2017 was a big success
  - In eight weeks: collected >28,000 km of flight lines in US and Canada, >40,000 Landsat-observable water bodies
  - New processing workflow has sped up production and is expected to improve AirSWOT data products
  - Valuable scientific insights into SWOT observations and utility

- Pre- and Post-launch Hydrology Cal/Val is well developed, though a few key questions remain
  - In discussion: Improving wetland/tidal Tier 1 sites; NISAR/SWOT joint Cal/Val sites, Ka-band phenomenology through canopy
  - Access to Tier 2 data in due time for 1 day orbit validation still requires some coordination with local actors
  - New launch date could impact the actual Tier 1 sites (ice): Discussion needed on impact to Cal/Val Study Plan

- Additional Cal/Val discussions and efforts between US, France, Canada and UK are suggested:
  - Funding, merging plans, method comparison, new launch date considerations
  - Ideas: Separate Cal/Val meeting in Fall, Cal/Val working group



A Priori Datasets & Algorithms (1)

- A Priori river datasets:
  - GRWL-based dataset currently below 60N;
  - Ongoing efforts:
    - MERIT DEM and hydrography above 60N;
    - Global river width implementation in Google Earth Engine;
    - Multi-temporal river width variability.
  - A final, global-coverage river dataset in ~2 years.
- A Priori lake datasets:
  - Circa-2015 UCLA global lake database nearly completed;
  - Ongoing efforts:
    - Cross-validation and harmonization of Circa-2015 and Circa-2000 lake products.
    - Circa-2015 dataset of Europe has been released to CNES;
  - CNES is generating a priori lake dataset using Circa-2015 database for Europe together with other local lake databases.
  - A final, global-coverage a priori lake dataset in ~2 years.
- To be done: harmonization of a priori river and lake datasets.

A Priori Datasets & Algorithms (2)

- River width enhancing algorithms:
  - Incorporating river heights to improve width measurement.
- Lake storage change algorithms:
  - Objective: to generate a module to compute lake storage changes between two observations.
  - Ongoing efforts:
    - Mathematical algorithms using lake area and height measures only;
    - DEM-based algorithms when DEM/bathymetry is available;
    - Preliminary algorithms deriving DEM/bathymetry;
- Ice flagging algorithms:
  - Option 1: Directly measure ice from moderate resolution optical imagery
  - Option 2: Use a static climatology
  - Option 3: Use a simple model between temperature and ice breakup
- Water detection algorithms:
  - Iterative Markov Random Field water classification algorithms;
  - Dark water flagging is crucial since dark water is a major source of error;
  - Pekel's water possibility map is being used as a priori data set.

Pre-SWOT Hydrology Phenomenology and Science

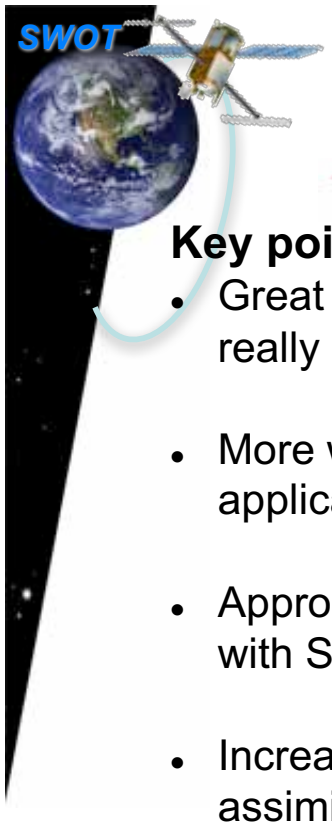
1) 2015 AirSWOT obtained reasonable estimates of WSE with no ground calibration. However, not all of the AirSWOT estimates achieved SWOT accuracy requirements. 2017 AirSWOT data over the Canadian Shield appear to be of high quality (presented by L. Pitcher, UCLA)
2) Analysis of repeat 2015 AirSWOT flight collected over the Tanana River showed good repeatability and generally met SWOT accuracy requirements, with some bias (presented by E. Altenau, UNC-Chapel Hill)
3) A huge volume (~28,000 km) of AirSWOT data were collected across Canada and Alaska in 2017 for the NASA Arctic-Boreal Vulnerability Experiment (ABoVE). These data are being finalized and for public release distribution on ORNL.
4) Preliminary analysis of 2017 data suggest excellent AirSWOT radar detection of open water surface in near-range (<15 degrees), while detecting water at mid- and far-swath will require further training by the CIR camera. "Bright mud" may be a new phenomenology concern alongside vegetation and dark water (presented by L. Smith, UCLA)
5) Topographic layover may be less of a problem than feared, i.e. "More noisy data is better than less noisy data". Therefore, the mission is now proposing to not correct for layover in SWOT data products. Additional details were presented by C. Chen, JPL.

Hydrology Data Products Summary (1)

- B. Williams & R. Fjortoft: Pixel Cloud Data product status
  - Data products and algorithms were reviewed for both the PIXC and PIXC_VEC products. Most algorithms have been baseline and tested at this time.
  - Algorithms to compute uncertainty estimates are in progress
- R. Frasson: River Data product status
  - Basic & expert, Node & reach products were reviewed
  - Planform area data products, methods for partially-observed reaches, and a review of special cases were presented
- C. Pottier: Lake River Data Products
  - Single-pass polygon of lakes & reservoirs and unknown objects. One mean height value for each lake and other properties are computed
  - Cycle-based polygon of lakes & reservoirs from a priori databases; best way to handle lake boundary computations is under investigation
  - Work is under way to homogenize the lake & river products as possible

Hydrology Data Products Summary (2)

- T. Pavelsky: Raster Data Product Status
  - Preliminary algorithm has been developed at UNC and submitted to JPL for review.
  - Example data products were presented.
- Discussion points
  - Lake & river topology was raised multiple times: ADT must ensure data products are appropriate in regions of high complexity
  - It was suggested that lake height spatial variability be added as a separate data element for lakes
  - The need for height and area uncertainty estimates for both lakes and rivers was highlighted multiple times



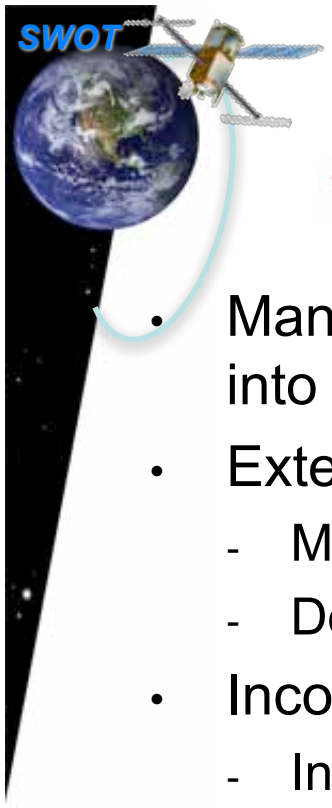
SWOT, Hydrological and Hydrodynamical Models, and Data Assimilation I

Key points :

- Great progress made towards assimilating SWOT data across scales : methods now seem to be really gaining maturity and have advanced quite a bit.
- More work being done on the large to global scale (or with an eye towards global scale applications)
- Approaches should use start using ancillary (observed or model-satellite derived) data along with SWOT
- Increasing recognition of the importance of uncertainty quantification with implication for data assimilation and algorithms
- Need a lead or project on assembling variety of ancillary data (GRDC, altimetry, and other remote sensing-based products, derived river characteristics: e.g. celerity...)
- The error characteristics (systematic or random) that can be expected from the Discharge algorithms working group or the hydro modeling working group will interplay in the near future. Some increased communication among these teams may inform strategic choices made in the methodology.

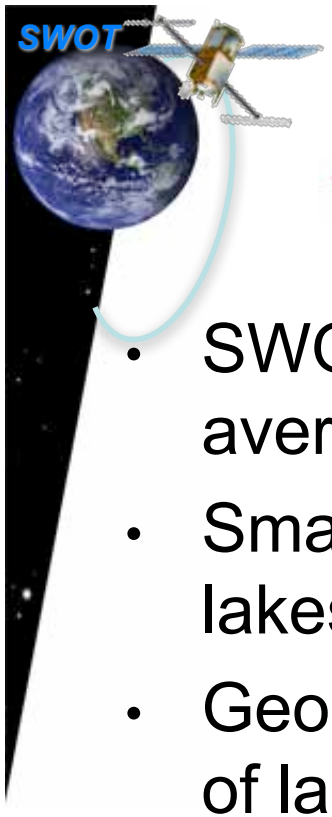
Moving forward :

How can we merge our activities : algorithm working group together with the hydrological/hydrodynamic modeling community? Next meeting is last ST : what can we do in the next year (roadmap)?



SWOT Data Assimilation Studies

- Many studies that have successfully assimilated SWOT observations into hydrodynamic models (impact of space/time sampling)
- Extending these approaches to
  - Merge these observations into land surface hydrology models
  - Derive improved approximations to models (parameters etc.)
- Incorporation of lake energy balance model in ORCHIDEE
  - Insertion of SWOT observations improved predictions of lake temperature and evaporation (next step: assimilation)
- Reduced model to approximate 1.5-D hydrodynamic model
  - Facilitates sensitivity analysis and parameter estimation through assimilating SWOT observations



SWOT Cycle-average Products

- SWOT orbital sampling complicates the derivation of cycle-average area/storage of lakes as well as river discharge
- Smaller lakes can have almost full coverage but larger lakes can have only partial coverage
- Geometric approach to derive cycle-average (median) area of lakes
- Simple arithmetic mean of discharge as baseline algorithm
- River routing model to produce prior time series of discharge and assimilation of SWOT-observed discharge
- Need to examine trade-offs between different approaches for deriving cycle-average products