SWOT Error Performance Discussion

Rosemary Morrow
Jean-Francois Cretaux
LEGOS- CNES
SWOT Error Performance Discussion

SWOT Mission Performance and Error Budget Document
• rare so early in a mission
• Will evolve over time (like the SWOT Science Document!)

Discussion initiated today with SDT
• Project / SDT will continue to work on algos and errors within Algorithm Team (discussion Wed), and report back to SDT
• Similar concept to OSTST organisation
Certain errors/performances will impact on hardware design and choices

- Project may ask us to establish «tiger team» working groups to study impact of certain errors/performances on our science & applications (e.g. orbit choice and HR mask in 2013)

- Other errors/performances need continual investigation/improvements before and after SWOT launch
SWOT Error Performance Discussion Topics

1. Impact of onboard presuming factor on error budget for Hydrology and oceanography

2. Changes in power or total error – impact on Height over ocean and continent

3. Accuracy of 2D wet tropospheric correction over oceans and hydrological surfaces

4. Impact of wind direction and waves on SSH observability & accuracy of sea-state bias errors at 1x1 km resolution

5. Accuracy of 2D geophysical models for SSH estimates (geoid/MSS, tides, etc)

6. Roll error estimation & error reduction techniques ... impact on SSH and water height over continent

7. Impact of Random performance across the SWATH
1. Impact of onboard presuming factor on error budget for Hydrology and oceanography

- Nadir altimetry – long history of storing waveforms, calibration allowing for re-processing later

- Not possible with SWOT onboard ocean processor (OBP) nor pre-summing for hydro

- SDT / Project needs to understand the impact of pre-summing / OBP on different phenomenology

  ⇒ oceans: coasts, effects of fronts or different wave conditions, ...
  ⇒ Hydro: impact on phenomenology
  ⇒ Sensitivity wrt position in the swath

- HR Simulations? Test with AirSWOT? Case study ocean / coastal regions with HR? within Algorithm Team structure?
High Resolution Data Coverage (HRDC)

Following on from Paris SDT Meeting June 2013...

• HRDC options (depending on downlink capacity)
  – HR azimuth resolution
    • 5m (presuming of 2) vs. 6.6m (presuming of 2.5)
  – HR mode switch method
    • Nadir vs. Swath
  – OA mode
    • 1-km vs. 250-m resolution

( as in Mission Performance & Error Budget Document)

• Different choices need to be further investigated – within Algorithm Team structure?
2. Changes in power or total error – impact on Height

Hydrology

- What is the sensitivity of the presuming factor on the slope error over different type of rivers in term of:
  - Width
  - Averaging length

To meet the requirement?

Will be discussed in the phenomenology discussion Wed

Clarification needed for mapping under vegetation ...
2. Changes in power or total error – impact on Height

Ocean:

- Changes in power (SNR) result in lower ocean resolution – already discussed with SDT in 2013. Also impacts on the derivatives (velocity, vorticity), still to be examined.
- Loss in height accuracy might also impact the ability to observed non-stationary phenomena (e.g., fronts, wave groups, filaments) that are not well captured by the spectrum.
- Another issue for the ocean is the decreased capability to flag for rain and ice at the swath edges.
3. Accuracy of 2D wet tropospheric correction over oceans and hydrological surfaces

Oceans

- Wet tropospheric correction has 2D « mesoscale » structure
- Requirement (SRD): 2D wet tropo corrections over swath
- Studies needed to understand interaction of mesoscale eddies and atmospheric perturbations (wind, wet tropo, ..)
- Analyses of aircraft & satellite obs, alongtrack wet tropo etc.
3. Accuracy of 2D wet tropospheric correction over oceans and hydrological surfaces

Hydrology

- For hydrology the wet tropospheric corrections will be released from model: what is the best approach: how model will be chosen?
  - Several options: using path Delay from GPS international network
  - Using ECMWF reanalysis
  - Using Objective analysis
  - ...
- What is the dependence of model error to ground topography in the near vicinity of water bodies?
- How to evaluate spatial variability of wet tropospheric correction’s errors?

Is the information provided by a meteorological model accurate enough? What is the best approach for estimating the PD over land? (WG report)
4. Impact of wind and waves on SSH observability & sea-state bias

Wind-wave effects
- Spectral bump of noise in nadir altimetry associated with non-homogeneous wave / $\sigma$-0 conditions within footprint, greatly reduced with SAR. SWOT ???
- Simulations needed to estimate SWOT « off nadir » effects & 1 km averaging in non-gaussian wave / $\sigma$-0 conditions
- Wave modulation by strong currents (& vica versa) – impact on observability/errors
- Should the data be downlinked at higher resolution (e.g., 250m) to mitigate the effects of OBP to ~1km?
4. Impact of wind / waves on SSH observability & sea-state bias

AirSWOT / Simulations / buoy obs will be invaluable for testing wind/wave effects on observability over 1 km...

AirSWOT ship wakes and waves – Santa Barbara Channel - E. Rodriguez
Sea State bias?

- Sea state bias – wave troughs are better radar reflectors that crests at nadir (EM bias) and skewed wave distribution also biased towards troughs (skewness bias)

- Nadir altimetry: estimated from wave height (SWH) & wind speed, U, using 4 parameter model (Error Budget Doc):
  
  \[ SSBB(U, SWH) = (-0.021 - 0.0035 \cdot U + 0.00014 \cdot U^2 + 0.0027 \cdot SWH) \cdot SWH \]

- Need to understand bias « off nadir » at 4° - different wind/wave conditions => impact the mesoscale/submesoscale or the long-wavelength circulation?
- Interactions wave-currents? Use AirSWOT & AltiKa observations & simulations?
5. Accuracy of 2D geophysical models for SSH estimates (geoid/MSS, tides, ...)

- SWOT will bring a great improvement to 2D geoid / MSS and tides / internal tides
- Improvements needed before launch at 1 km resolution globally, and higher resolution in coasts / estuaries?

- How sensitive is SWOT 1 km SSH to MSS errors?
- New HR geoid / MSS needed based on GOCE /Grace & recent geodetic altimetric missions (J1, Cryosat-2, HY-2?, ...)

- Local HR geoid for AirSWOT / CalVal sites & error estimation?
5. Accuracy of 2D geophysical models for SSH estimates (geoid/MSS, tides, ...)

Tide models – special ocean session
Development of estuary models
- need ocean / hydro communities working together

- Hydro models need precise ocean tidal forcing
- Tidal models need precise river discharge variations

See talks from
B. Laignel & Yi Chao
6. Roll error estimation & error reduction techniques … impact on SSH and water height over continents

• Separating roll error from ocean or water height signals
• Need to test different approaches (crossover, direct, etc) and estimate space/time character of roll error – simulations
• Need to test sensitivity of systematic error to alignment of river with respect to the satellite track
7. Impact of Random performance across the SWATH

KaRIn random performance across the swath (requirement is specified from 10 to 60 km).

Which impact on averaging length along rivers to meet the 1cm/km slope error?

Which impact on lakes estimation of water height depending on their position across the swath

How does it affects the total error budget?