SWOT simulator for ocean science

Clement Ubelmann, Lucile Gaultier, Lee-Lueng Fu
The needs for a light/portable tool to easily simulate SWOT L2 data with realistic sampling and errors/noise was pointed during the last SDT.

The tool would rely on spectral error budget specifications from the project team.

It is NOT an instrument simulator.

Open source, download online: https://swot.jpl.nasa.gov/science/

INPUTS: user’s model Sea Surface Height

OUTPUTS: SWOT synthetic data sampled on a swath grid.
Random error realizations

Baseline requirements
Total error budget – 1-beam radiometer
Total error budget – 2-beam radiometer

Roll
Phase
Baseline dilation
Timing
Wet tropo residual – 1-beam
Wet tropo residual – 2-beam
Wet-tropo signal
Karin noise at 2km across-swath
Karin noise at 7.5km across-swath

Averaged performances between 10km and 60km
A processed dataset is now available for non-modelers: 250 days worth of MITgcm data
• The tool is designed to explore science applications:

→ Consider the two mission phases: 1-day orbit and 21-day orbit: What science can we learn during the fast sampling phase

→ Reconstruct the 2D signal: Deal with long time gaps to reconstruct continuous SSH, deal with high frequency waves and short mesoscales, Impact of the noise for high-order derivative quantities (e.g. vorticity)

→ Reconstruct 3D dynamics: Retrieve vertical velocities?

• The tool can also be used to test calibration algorithms to improve L2 products:
→ Roll error: test cross calibration techniques
Playing with the simulator

Fill the parameter file:

# ------------------------------#
# Files and directories
# ------------------------------#
# ------ Directory that contains orbit file:
dir_setup=’[yourpath]/SWOT_simulator/data/’
# ------ Directory that contains your own inputs:
datadir=’[yourpath_to_yourdata]/’
# ------ Directory that contains your outputs:
outdatadir=’[yourpath_to_outputs]/’
# ------ Orbit file:
filesat=dir_setup+’/orbit292.txt’

# ------------------------------#
# SWOT swath parameters
# ------------------------------#
# ------ Satellite grid file root name:
#     (Final file name is root_name_[numberofpass].nc)
filesgrid=outdatadir+’/[your_grid_root_name]’
# ------ Force the computation of the satellite grid:
makesgrid=True or False
# ------ Give a subdomain if only part of the model is needed:
#     (modelbox=[lon_min, lon_max, lat_min, lat_max])
#     (If modelbox is None, the whole domain of the model is considered)
modelbox=None or [yourlon_min, yourlon_max, yourlat_min, yourlat_max]
# ------ Distance between the nadir and the end of the swath (in km):
halfswath=60.
# ------ Distance between the nadir and the beginning of the swath (in km):
halfgap=10.
# ------ Along track resolution (in km):
delta_al=1.
# ------ Across track resolution (in km):
A few technical possibilities

- Consider the provided orbits for the two phases of the mission:

<table>
<thead>
<tr>
<th>Orbit</th>
<th>Repeat cycle (days)</th>
<th>Number of passes (orbits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Sampling orbit</td>
<td>0.99349</td>
<td>14</td>
</tr>
<tr>
<td>Science orbit</td>
<td>20.8646</td>
<td>292</td>
</tr>
</tbody>
</table>

- Test cross calibration algorithm: remove the 1000 km filtering that ‘simulate’ cross calibrations

- Possibility to simulate other altimetric observations (e.g. Jason, AltiKa, ...): OSSEs with a constellation of nadir altimeters
Users community:
~15 active users so far, interested in gridding SSH, data assimilation, 3D dynamic reconstructions, internal tide issues, ...

Following presentations:
- Using the simulator to build covariance error matrices for state estimation problems (*Emmanuel Cosme*)
- Assimilation of SWOT altimetry data (*Pierre-Yves Le Traon, Mounir Benkiran*)
- Explore possibilities to separate high-frequency signals (*Anna Savage, Brian Arbic*)
- Infer vertical velocities (*Bo Qiu*)