Ocean simulator for science applications
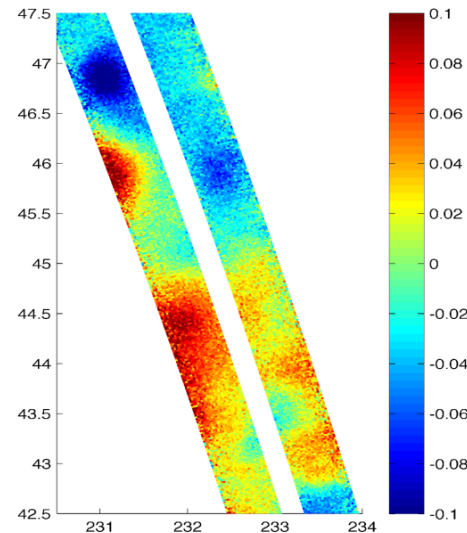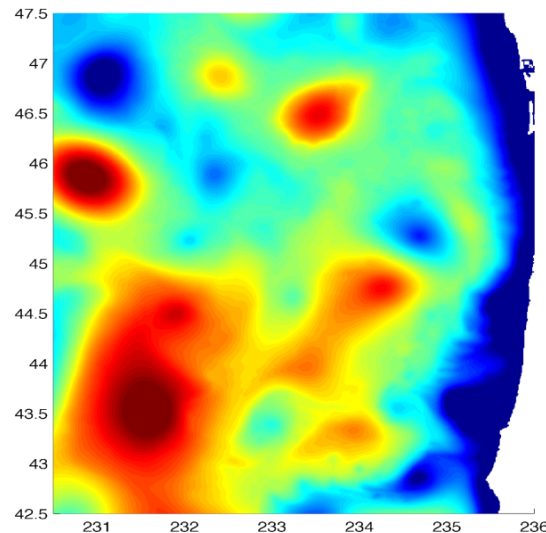
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Jinbo Wang, Nathalie Steunou, Nicolas Picot, Gérald Dibarboure

OceanDataLab

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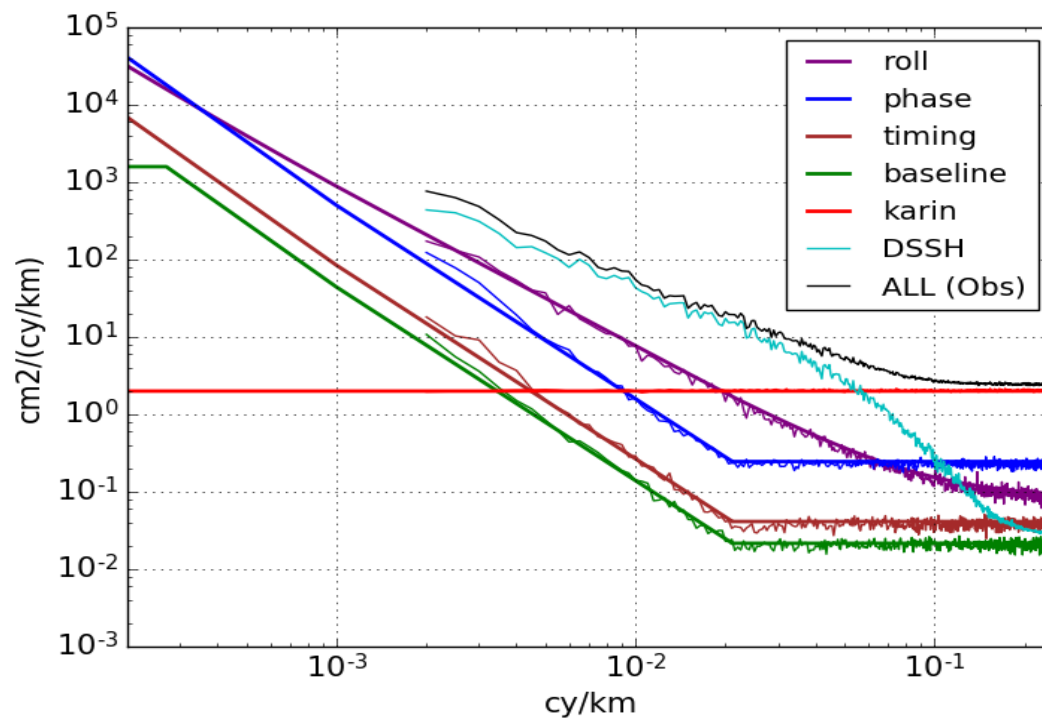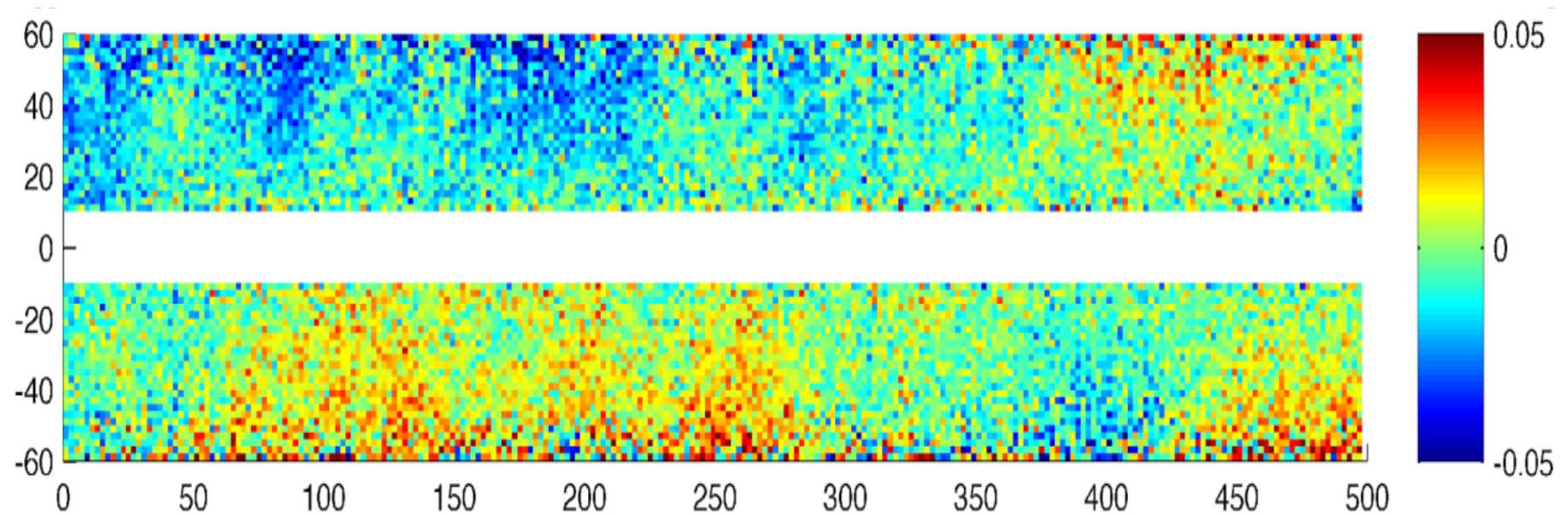
SWOT simulator for Ocean Science

- The needs for a light/portable tool to easily simulate SWOT L2 data with realistic sampling and errors/noise has been pointed by the SDT team.

- **The tool relies on spectral error budget specifications from the project team**
  → **It is NOT an instrument simulator.**

- Open source, use git version or download tar on the github:
  https://github.com/SWOTsimulator/swotsimulator.git

INPUTS: user's model Sea Surface Height Coordinates

OUTPUTS:
SWOT synthetic data sampled on a swath grid
Each error is saved separately

Random error realizations

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:
indatadir='[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:

Orbit	Repeat cycle (days)	Number of passes
Fast Sampling orbit	0.99349	28
Science orbit	20.8646	584

- Turn on long-wavelength roll errors : remove the 1,500 km cutoff that 'simulate' cross calibrations
⚠ Changing that cutoff has a significant impact on the level of systematic errors

- Possibility to simulate other altimetric observations (e.g. Jason, AltiKa, Sentinel, …): OSSEs with a constellation of nadir altimeters
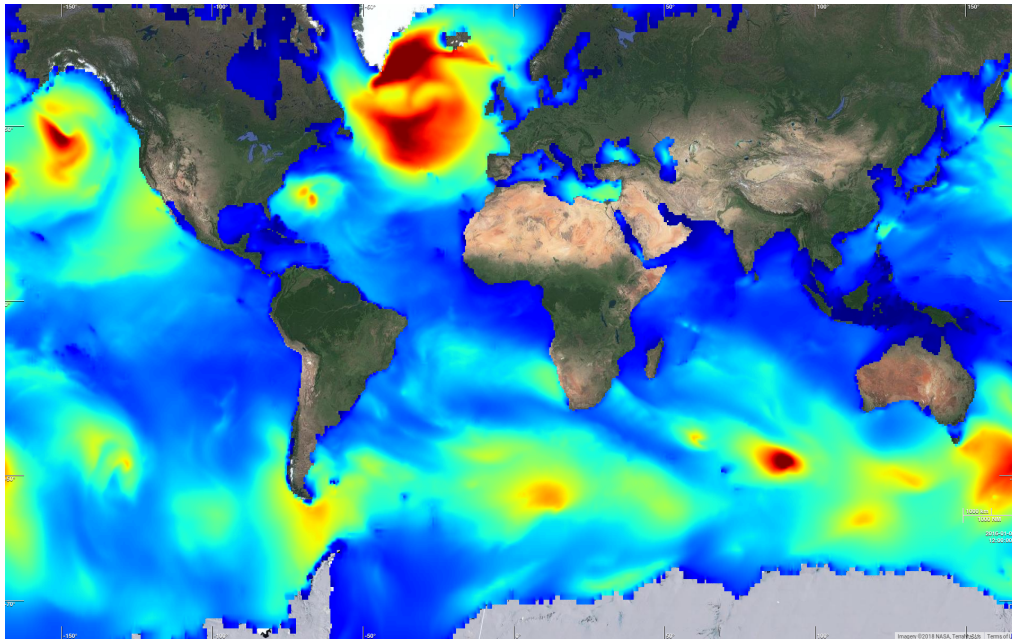
A few updates on scientific aspects

Future improvement: science

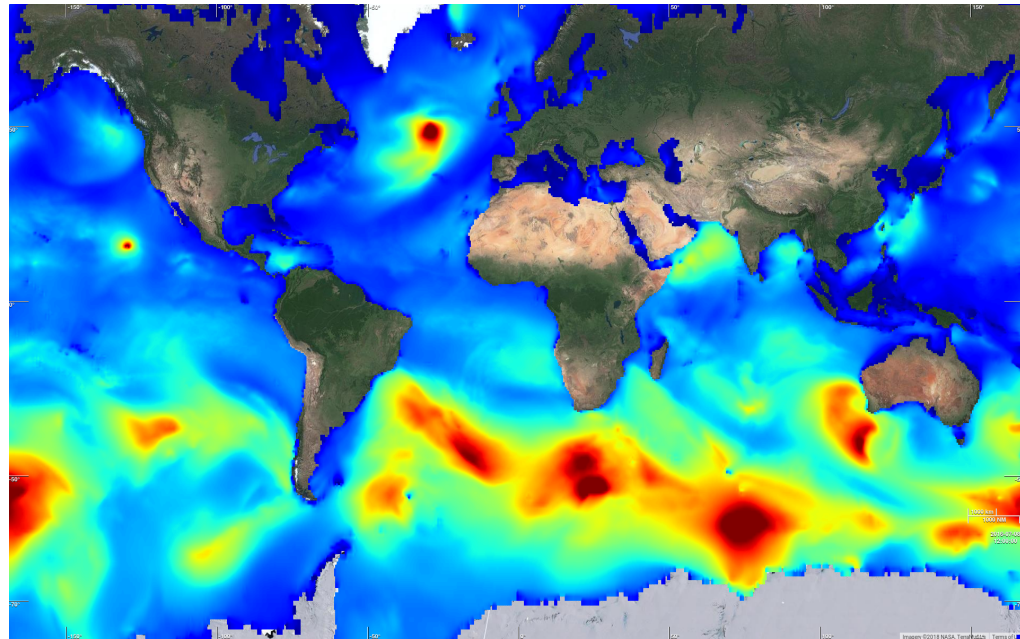The new release at the end of the year will include:

- SWH varying with in time and space using a climatology from WW3 model.

- Possibility to apply a series of simulated crossover calibration for roll/phase/baseline/timing errors (format to be discussed) instead of spectrally filtered signal

Implement a SWH varying in time and space instead of a fixed number:
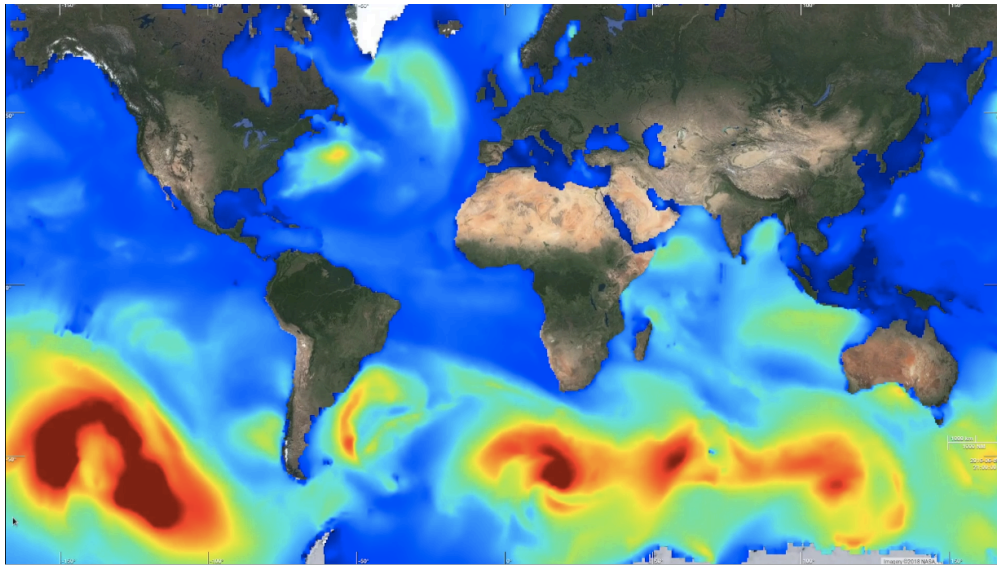

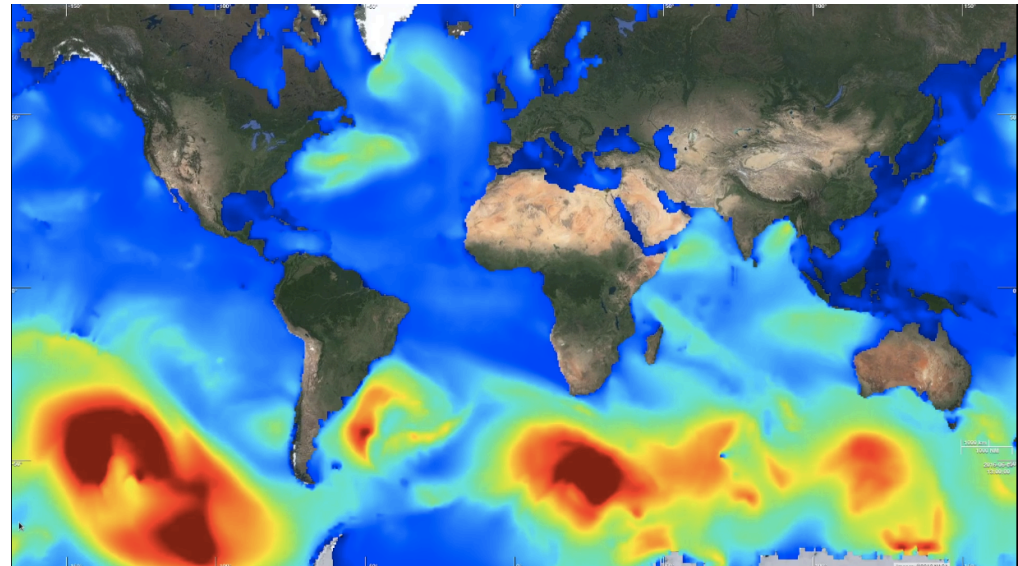SWH from WW3, mid-January 2016

SWH from WW3, mid-July 2016

✓ Big seasonal variability

Future improvement: SWH

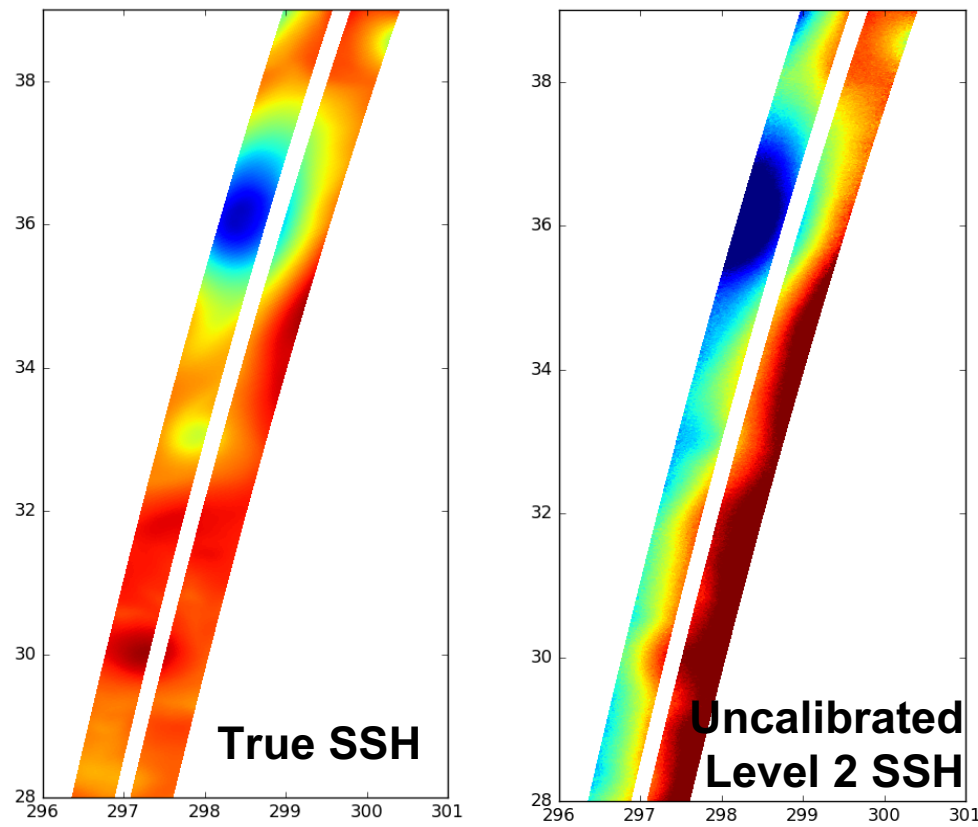Implement a SWH varying in time and space instead of a fixed number:

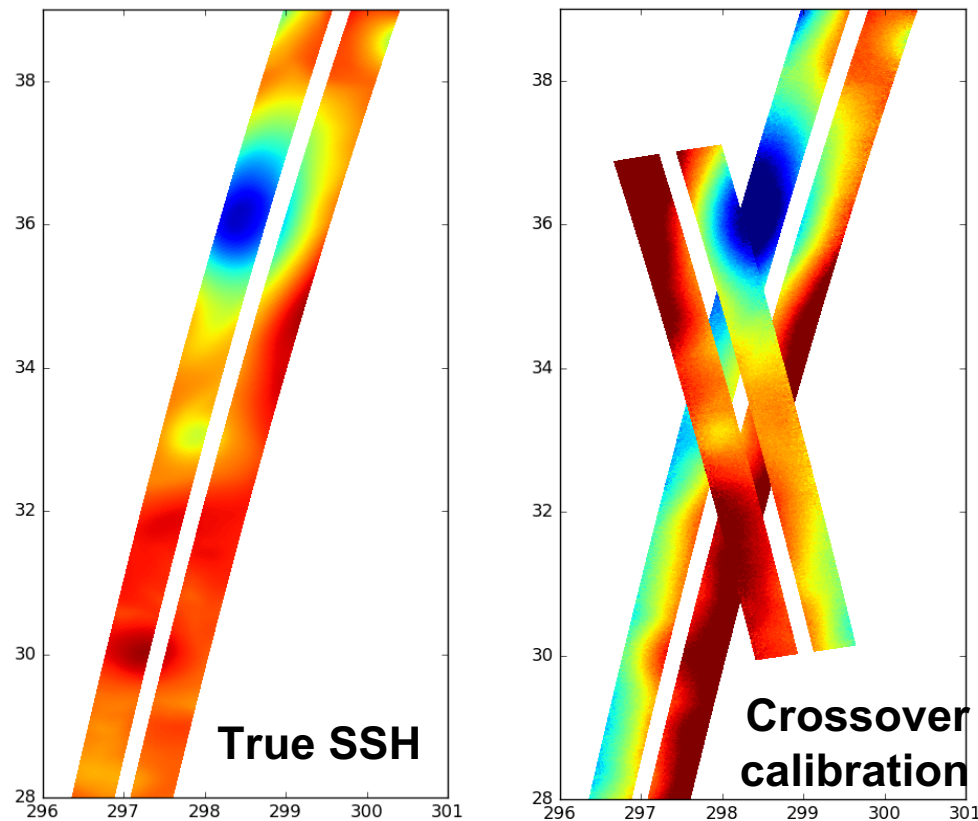SWH from WW3, 8th of January 2016

SWH from WW3, 9th of January 2016

✓ Big seasonal variability
✓ Even daily changes
   → Different options: Climatology? Seasonal or monthly mean? Daily fields?

Simulated crossover calibration
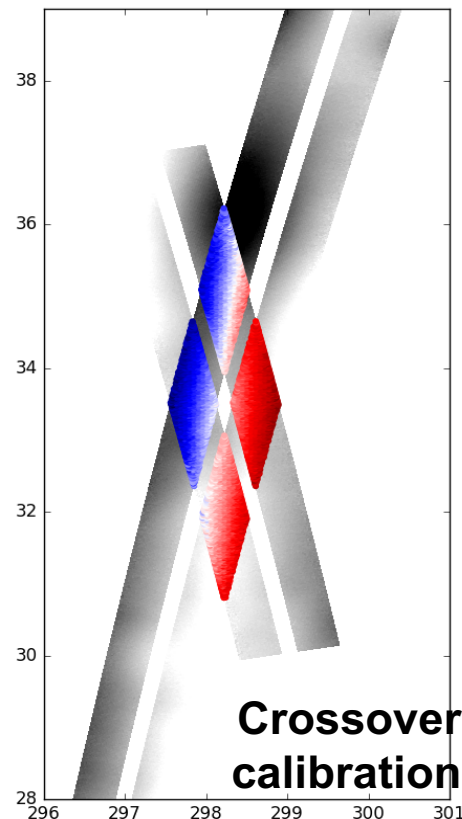

True SSH

Uncalibrated
Level 2 SSH

- The systematic errors, roll in particular, feature strong biases (compliant with requirements) presently filtered by default in the simulator (**crude approximation**)

- **Operational crossover calibration** for hydrology can be applied on the Ocean to correct for **long-wavelength error (>2000km).** More details in Backups.

Simulated crossover calibration

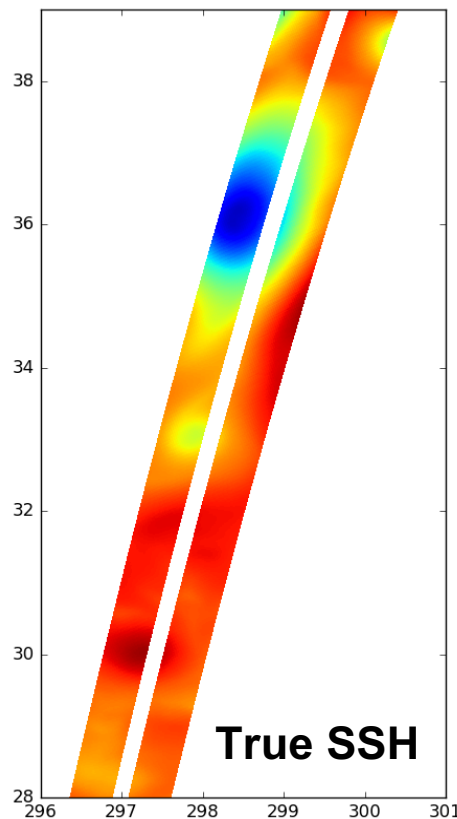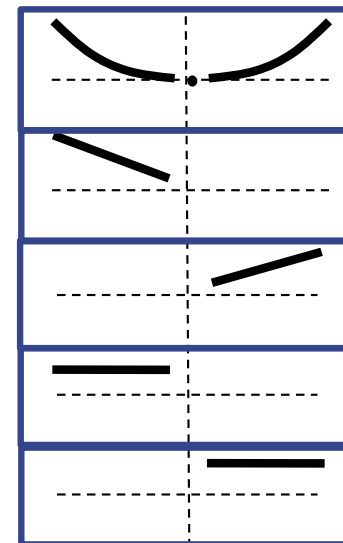True SSH

Crossover calibration

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Simulated crossover calibration

True SSH

Crossover calibration

Inverted parameters :

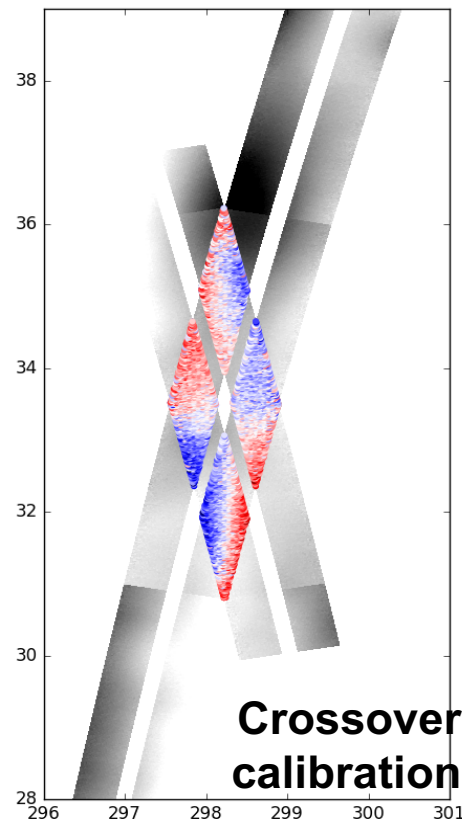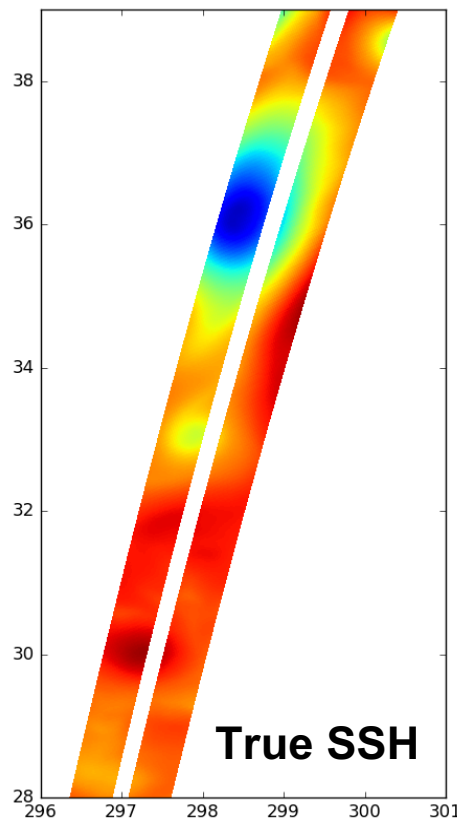Quadratic (baseline dilation)

Linear left (phase+roll)

Linear right (phase+roll)

Offset left (timing)

Offset right (timing)

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True SSH

Crossover calibration

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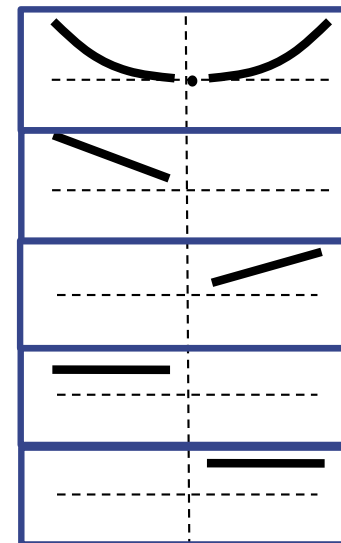Linear right (phase+roll)

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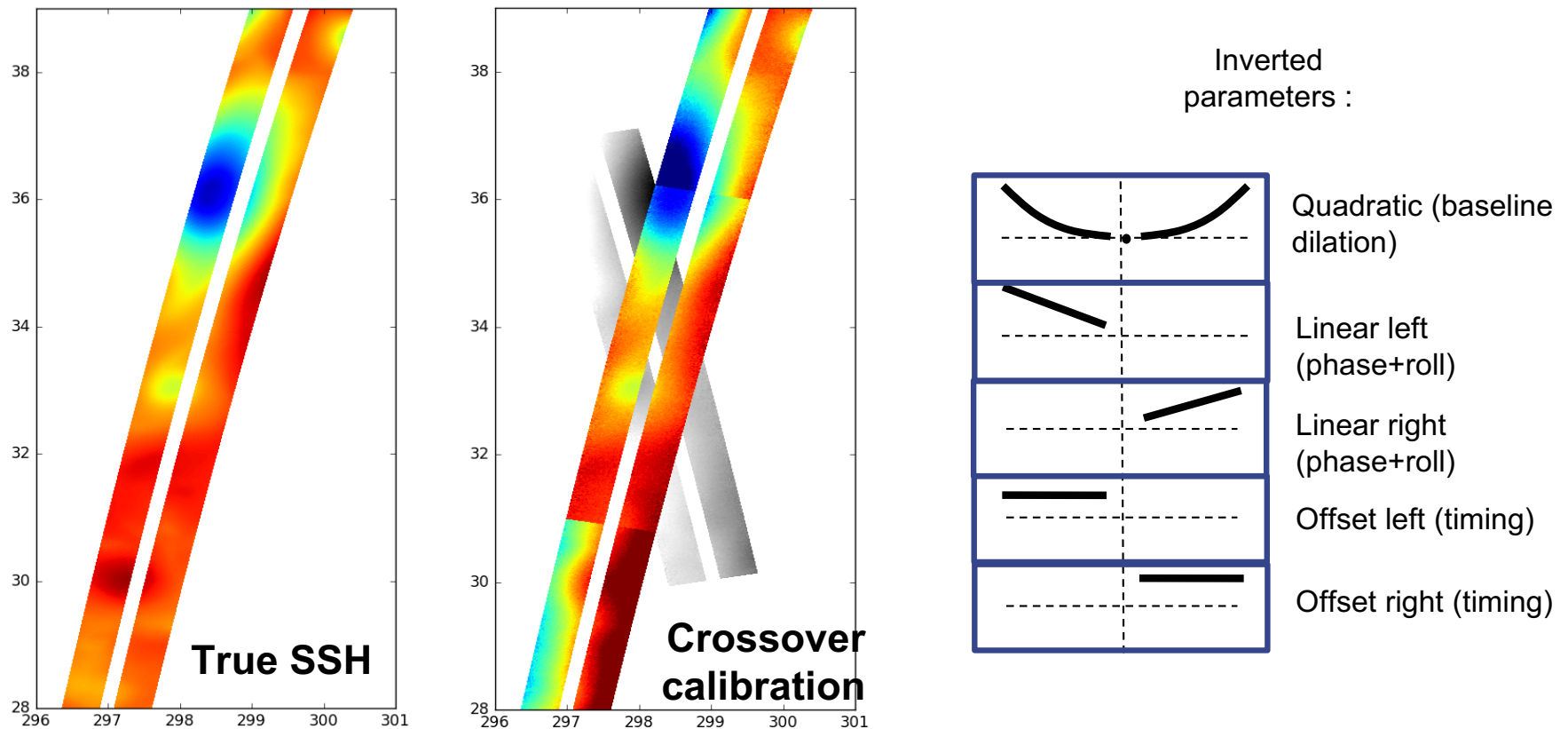Quadratic (baseline dilation)

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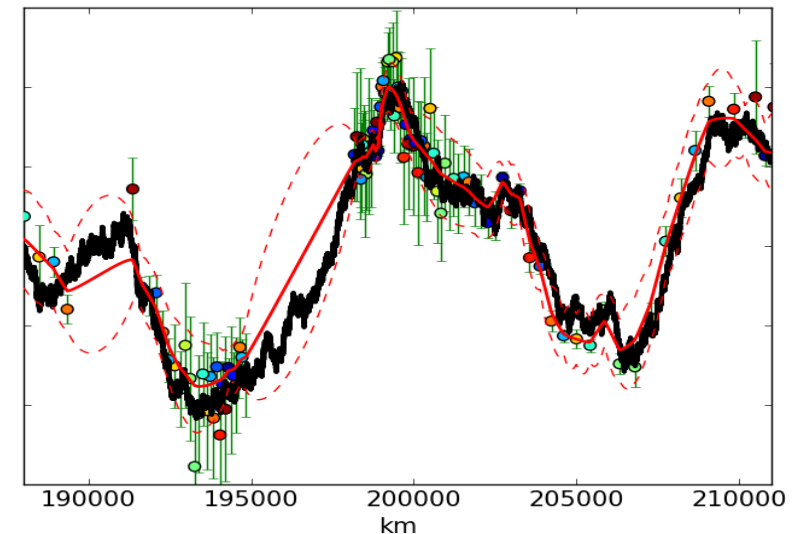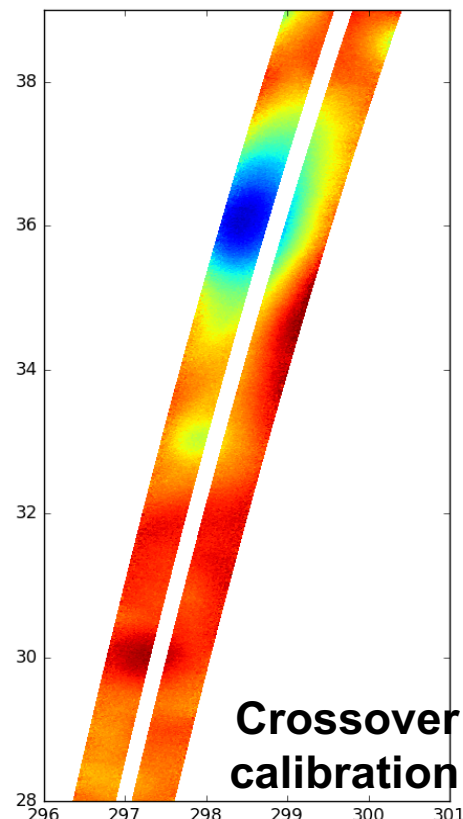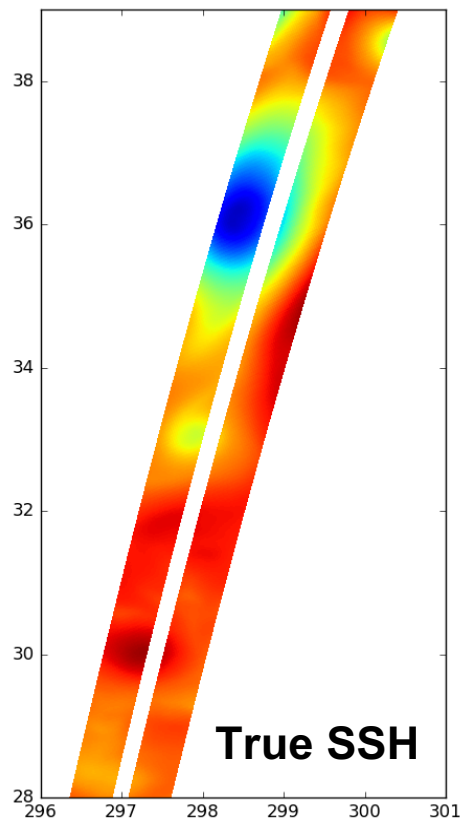
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A few updates on technical aspects

What has changed

- **Data format**

A mockup for future SWOT format has been implemented:
Option to save in classical or mockup format, **your feedback is important:**

✓ Change of type: integer or double for most variables with a scale and offset.
✓ Definition of max, min, fill_value in netcdf
✓ Name of variables be set to :
    SSH_KaRIn_swath for SSH_obs
    SSHA_uncert for karin_err
    time_day and time_sec for time
✓ Flags have been added (KaRIn_surf_type and rad_surf_type)
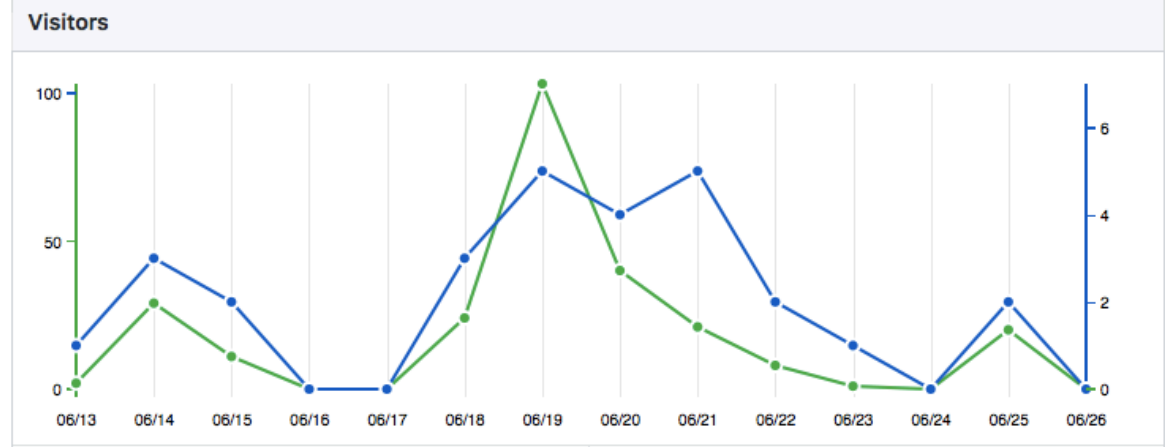✓ Many other geophysical have been added but set to fill_value.

Expert mode to save noises (except Karin) in 1D and module to reconstruct noise in 2D

What has changed

- Parallelization: multiprocessing is now possible,
⚠ note that you need enough RAM as every processor will load model data.

- Decorrelate left and right part of the mast for timing errors

- Random signals can be generated instead of random coefficients improving the randomness at very large scales (>2000 km):
⚠ saving this random signals to run reproducible runs is not implemented yet: **Does anyone need it?**

- **Python 2 will not be supported anymore**

- Compare the 2D signal with what other potential future mission: a similar simulator has been recently coded for the proposed SKIM surface current mission (ESA)

How it will evolve ?

- ~20 active users

- Many inputs from users have been integrated in the current version. Thank you!

- **Upcoming improvements and possible evolutions**:
    - SWH (x, y, t) impact on Karin noise level

    - Provide series of simulated crossover operational calibration (not just a spectral cutoff)

    - Toward more realistic error simulations. Example: Sea State Bias if some implementation can emerge from the recent studies ?