ERR Splinter Session Summary

Quantifying Errors and Uncertainties in Altimetry Data

Summary
Quantifying Errors and Uncertainties in Altimetry Data

- **5 talks, 2 posters:**

⇒ **Error formalism and method** :

- Ensemble approach to characterize uncertainties in altimeter sea ice thickness products (**Florent Garnier**)
- 2D spectra to represent the error budget of any altimeter mission (**Pierre Thibaut**)
- New method to denoise altimeter measurements for high-resolution geophysical signals (**Yves Quilfen**)

⇒ **Error detection and characterization:**

- Description of the senintnel-3A error budget description (**Matthias Raynal**)
- Errors of daily harmonics of ionospheric Total Electron Content for single-frequency altimeters (**Richard Ray**)

⇒ **Error reduction** :

- Improvement of DAC de-aliasing model by combining GRACE gravity data (**Jennifer Bonin**)
- Harmonization of the altimeter Rain Flags (**Matthieu Talpe**)

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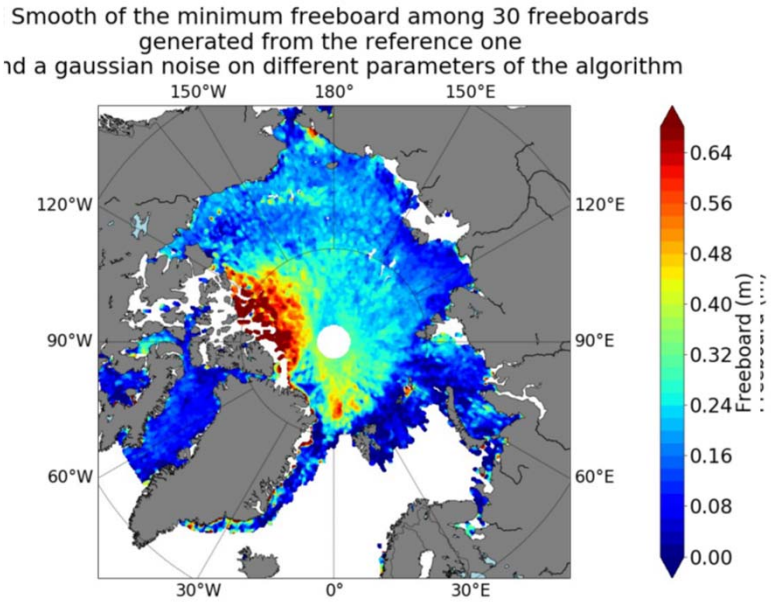
- **New approach to better characterize uncertainties in altimeter sea ice thickness products (Florent Garnier)**

  - the different sources of errors are not considered to provide Sea Ice Thickness Uncertainties => Freeboard uncertainty is currently very likely too weak : 0.037 mm for Cryosat and 0.093 mm for Envisat.

  - Uncertainties can be more realistically described by producing an ensemble of observation by on EnKF stochastic method (Evensen, 2003 ; Burgers et al, 2018)

  ⇒ **These more realistic errors should be provided in ice thickness products**



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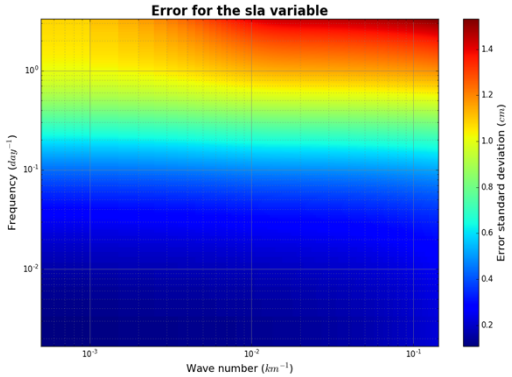
- **2-D spectra approach to represent and estimate the errors of altimetry data at any spatial and temporal time scale (Pierre Thibaut)**

  - Based on a simple description of altimetry errors : variance and wavelength of errors
  - Applicable to any altimeter missions : past, current and future

  ⇒ **Error budget table could be improved by independent studies based on uncertainty calculation dedicated to each source of error.**

  ⇒ **Providing error budget of altimeter missions with this formalism**

Error Source	STD (cm)	Spatial correlation length	Temporal correlation length	References
Altimeter Random error	1,2	0 km	0 day	S3 performance doc (CLS)
SSB Noise	0,3	300 km	Inf.	S3 performance doc (CLS)
SSB correlated	0,1	100 km	1 day	Tran & al, 2019
Ionosphere	0,15	600 km	0 day	S3 performance doc (CLS)
Wet Troposphere	1	50 km	1 hour	Brown & al, 2015; Stum & al, 2011
Dry Troposphere	0,2	600 km	2 days	S3 performance doc (CLS)
Mean Sea Surface	0,5	1 km	Inf.	Pujol & al, 2018
Ocean Tides	1	1000 km	< 1 day	Lyard & al, 2018
Orbit solution	1,5	> 10 000 km	< 1 day	Ollivier & al, 2018; Couhert & al, 2015



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- **Description of the Sentinel-3A error budget (Matthias Raynal)**

  - Very good performances: availability and quality

  - Submesoscale error : although the SARM noise floor (instrumental + processing) is lower than for conventional altimetry, it is affected by swell waves (depends on swell period and direction)

  - Climate scale error : linear trend of in (SARM -P-LRM) range differences, close to 1 mm/yr over 3 years : not yet explained.

  ⇒ **These errors should be investigated to improve our understanding of the SARM sensitivity to geophysical effects**

Param	Error	Amplitude	Wavelength
Range & SWH	Swell impact (T02, Dir)	~several cm	<= 10 km
Range	Meridional wind speed effect	2 cm	>100 km
SWH	Wave height dependency	10/15 cm	>100 km
SWH	Swell dependency	5/10 cm	>100 km
SWH	waveform centering dependency	10 cm	> 100 km
Sigma0 / WS	Radial velocity dependency	0.1 dB / 30 cm/s	> 100 km
Range	Temporal drift	1 mm/y	> month
?	others	?	?

Sentinel-3A error budget

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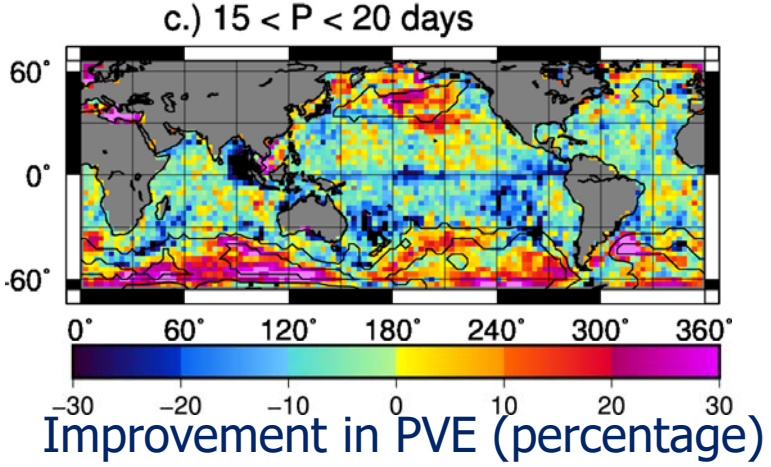
- **Harmonizing the Jason-1, Jason-2, Jason-3 Time Series of Rain Flags (Matthieu Talpe)**
  - Altimeter and radiometer rain flag discrepancies can be harmonized : 1) mitigating altimeter rain flag inconsistencies and 2) setting altimeter LWC threshold to 0.75 kg/m2 ensures consistency in number and geographic coverage.
  - "Rain flag" = rain event detection?... or just a measurement quality flag?

  ⇒ **Need to revisit the rain flags in L2 altimeter products : calibration and for which use ?**

- **Proof of concept to improve the DAC de-aliasing model by combining with sub-monthly GRACE gravity data (Jennifer Bonin)**
  - Current DAC model dominates at high frequencies and near equator.
  - At longer periods and at higher latitudes, GRACE can add value.

  ⇒ **Could be proposed to revisit the DAC**



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- **Summary of discussions :**

⇒ **Need for systematic (and rigorous) uncertainty estimations, need for agreed formalism**

- Standard uncertainty formulation: drifts, calibration/Validation results, climate signals
- Input for applications: a) Assimilation into ocean models, b) Climate studies: MSL close out budget, c) Some gaps to fill: variance/covariance matrix of Orbit Errors and MWR WTC for, e.g. local MSL trend estimates

⇒ **From Science Team: Stability of Sentinel-3**

- Need to propose and adopt an error formalism to estimate drift impact and corrections.
- Each drift impact study or correction should then be presented according to this formalism

⇒ **Improving the involvement of user community (e.g. from assimilative systems) in OSTST in order to better understand their needs in terms of data quality and to collect uncertainty requirements**

- Open question : should OSTST target specific fora: Ocean, Hydro, Climate, etc. ?
- How to make these communities contribute, then report (feedback) to OSTST