Validation of a global dataset based on subwaveform retracking: improving the precision of pulse-limited satellite altimetry

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Summary

- Introduction: Background, Motivation, Data Sources
- High-rate Noise and new Sea State Bias
- Crossover Analysis
- Conclusions

Background

ALES (Adaptive Leading Edge Subwaveform) was created as a retracker: it fits the signals from satellite altimetry

Originally planned to improve the data near the coast; improvements validated through tide gauges in several publications

ALES is, in the context of this study, the name of a processing scheme for altimetry data, consisting in:

1) A dedicated re-fitting of the radar signal (retracking algorithm), since 2014
2) A dedicated „sea state bias“ correction, since 2017
3) The application over a multi-mission dataset, the post-processing to derive sea level and the cross-calibration (using MMXO method from Bosch et al., 2014)

Disclaimer

Disclaimer: ALES is not anymore only a retracker, it is an effort to provide a comprehensive homogeneous multi-mission open ocean & coastal sea level dataset.

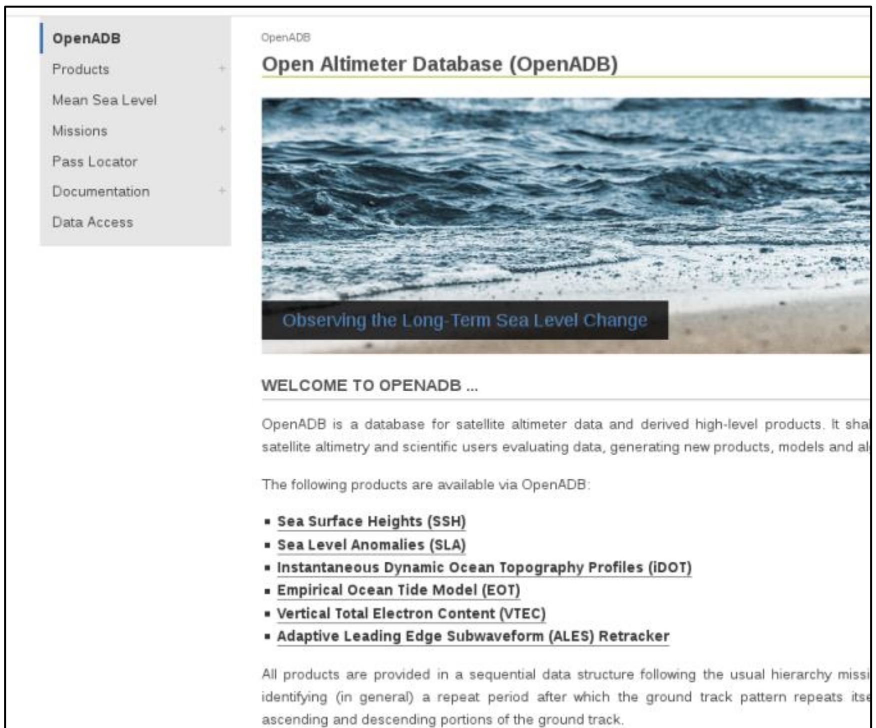
We are not saying that ALES retracking of LRM altimetry cannot be improved (see ideas from many papers after ALES: e.g. Roscher et al. 2017, Peng&Deng 2018)

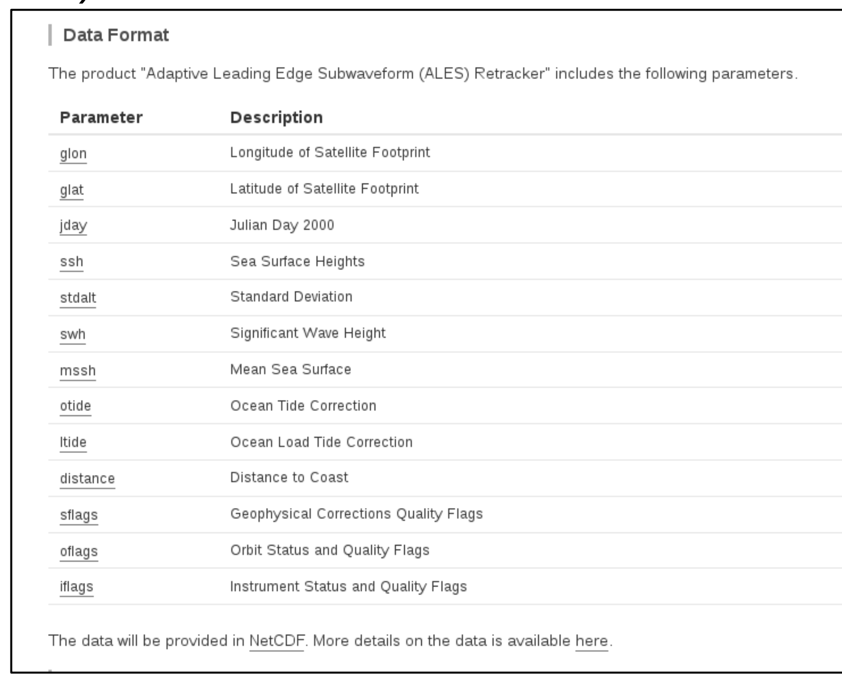
What about an independent validation of ALES retracker against other existing coastal-retracked dataset? See Xu and Birol, Remote Sensing, 2018. Also several presentations in this Workshop

Latest global data availability: ALES in OpenADB

In the framework of OSTST Project RECAP24 (REprocessed Coastal Altimetry Products)

- From https://openadb.dgfi.tum.de/, in netCDF
- No hassle, made for users: Sea Surface Height already computed (corrections and 20Hz data available on request)





Data Format

The product "Adaptive Leading Edge Subwaveform (ALES) Retracker" includes the following parameters.

Parameter	Description
glon	Longitude of Satellite Footprint
glat	Latitude of Satellite Footprint
jday	Julian Day 2000
ssh	Sea Surface Heights
stdalt	Standard Deviation
swh	Significant Wave Height
mssh	Mean Sea Surface
otide	Ocean Tide Correction
ltide	Ocean Load Tide Correction
distance	Distance to Coast
sflags	Geophysical Corrections Quality Flags
oflags	Orbit Status and Quality Flags
iflags	Instrument Status and Quality Flags

The data will be provided in NetCDF. More details on the data is available here.

Scope and Data Sources

Today‘s menu: internal global single-mission validation, i.e. noise and crossovers statistics.

Scientific question: can ALES be used with confidence in the global ocean?

Data sources:

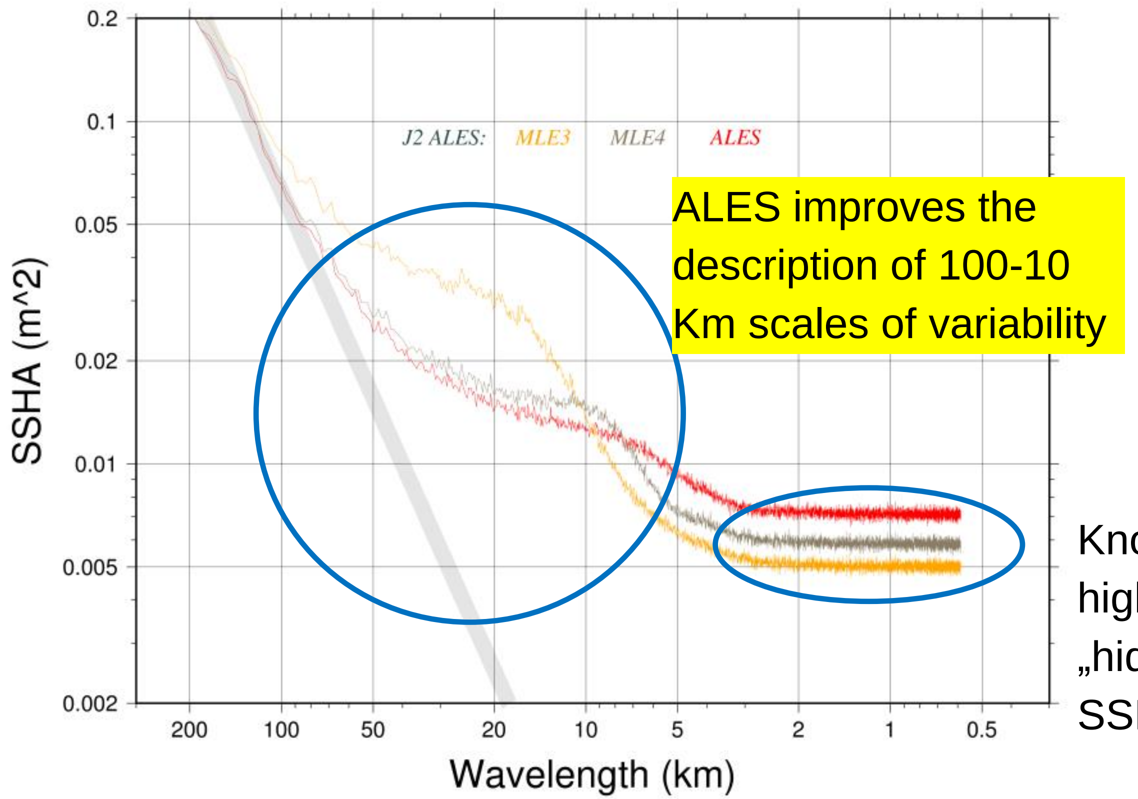
- High frequency: ranges and sea state bias from SGDR data (default mle4 retracker for Jason) and from ALES.

- 1-Hz averages: original ranges at 1-Hz from SGDR, computed averages from ALES

- To derive sea level data, same corrections applied to all dataset

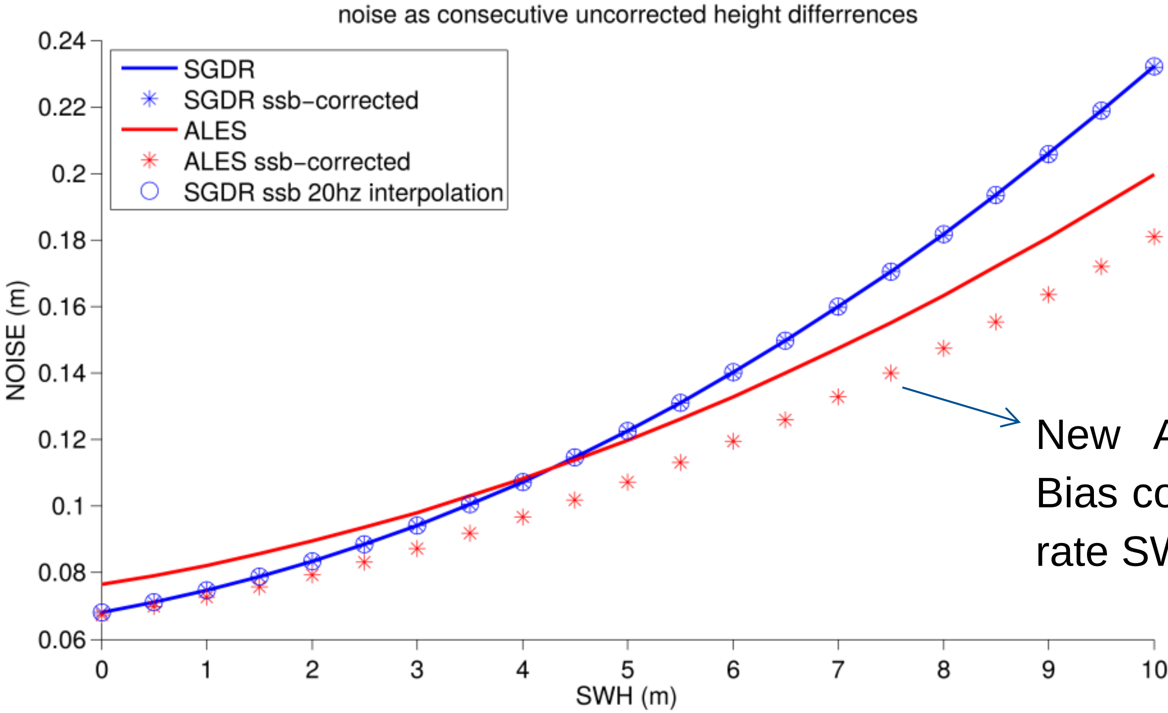
Spectral Analysis – Jason 2 example

From Smith et al., 2017 (OSTST)



Known tolerance on high-rate noise, „hidden“ by new SSB correction

High-rate noise as consecutive differences



New ALES Sea State Bias correction with high rate SWH and Wind

Example cycle 50 of Jason-2

Crossover Analysis - Methods

- Crossover: intersection of two tracks, assumes the same sea level for ‚small‘ space-time differences

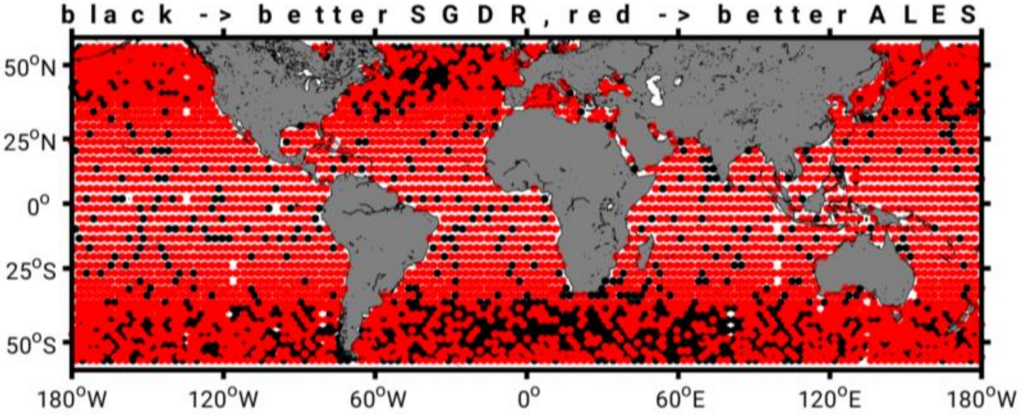
- Statistics: standard deviation of the crossover differences in space and time

- Max 5 km distance in space, Max 10 days difference, one measurement for each crossover location per cycle (median value if more than one point)

- Outliers are: Missing points & SLA absolute value > 3 m

Crossover analysis – in space

Jason-1

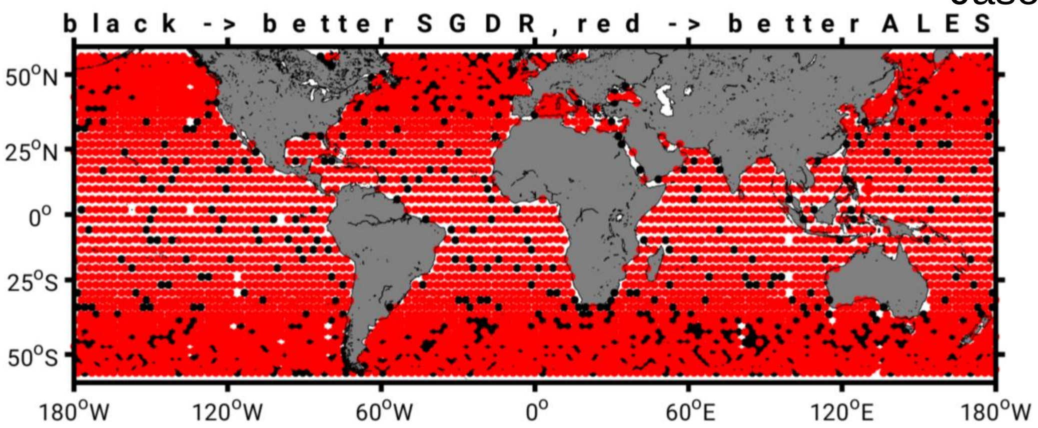


ALES is better in the 74% of the locations

Standard Deviation of the Crossovers

RED: std(ALES)<std(SGDR)

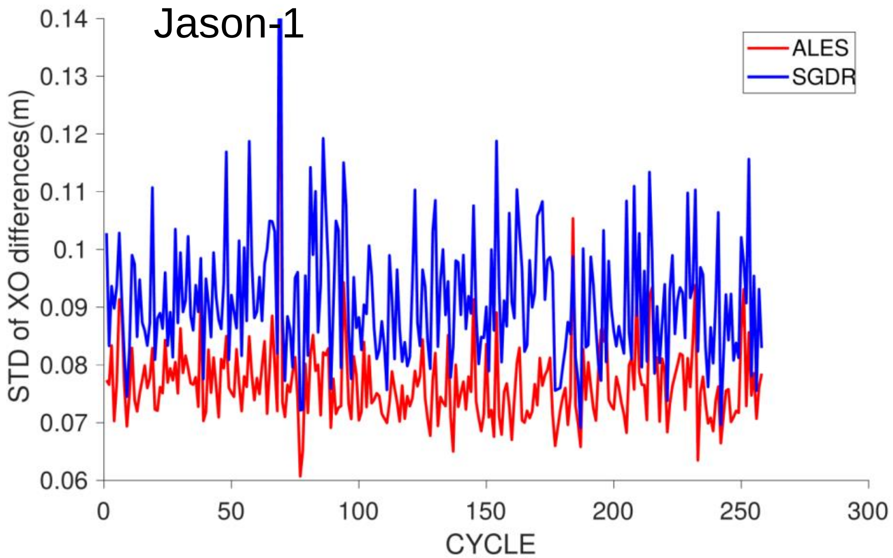
Jason-2



ALES is better in the 85% of the locations

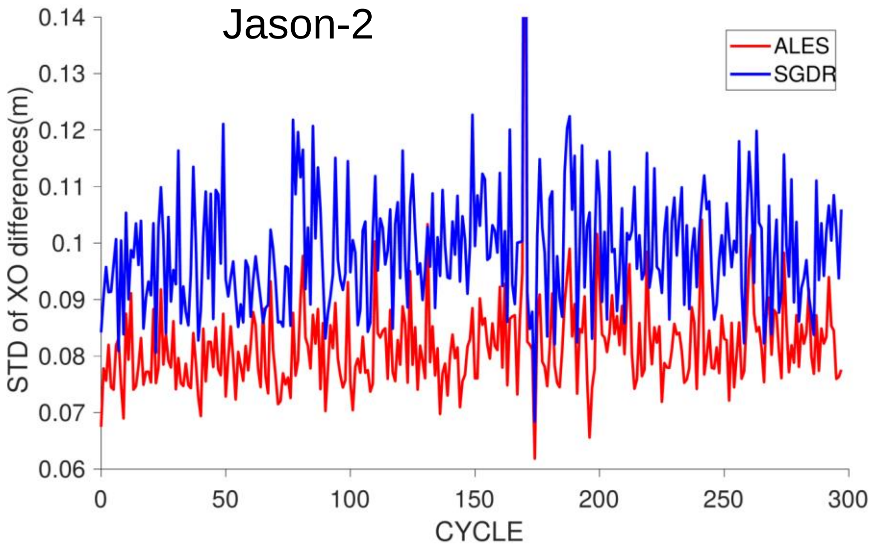
ALES IMPROVEMENT IS NOT RESTICTED TO THE COAST

Crossover analysis – in time



J1 Median improvement=1.3 cm

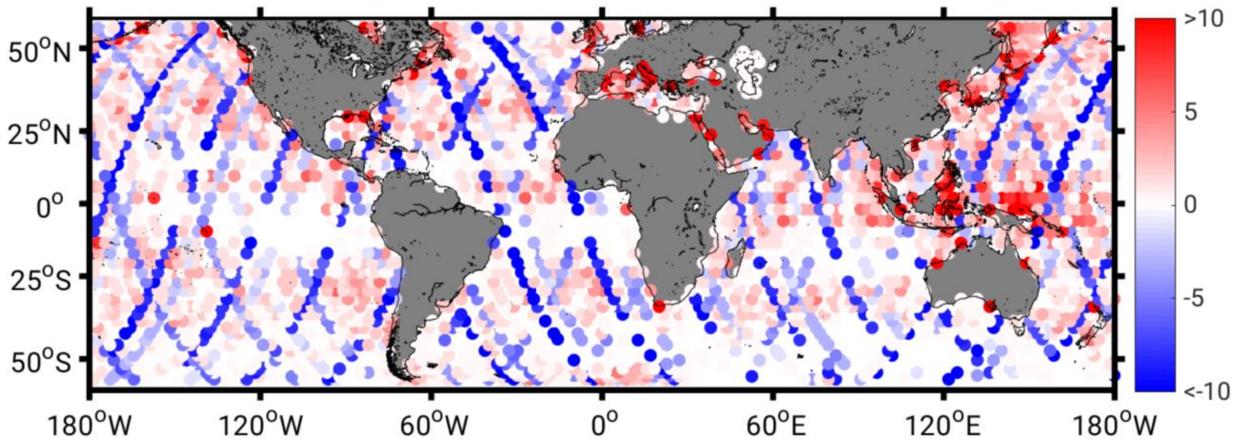
29% Variance Reduction



J2 Median improvement= 1.7 cm

30% Variance Reduction

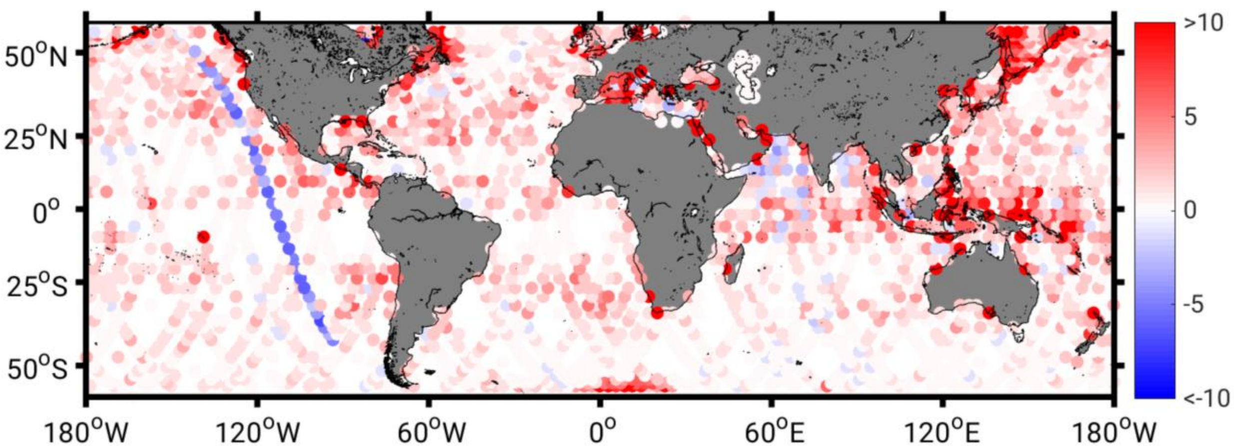
Outliers analysis – in space



Number of outliers SGDR-ALES

Jason-1

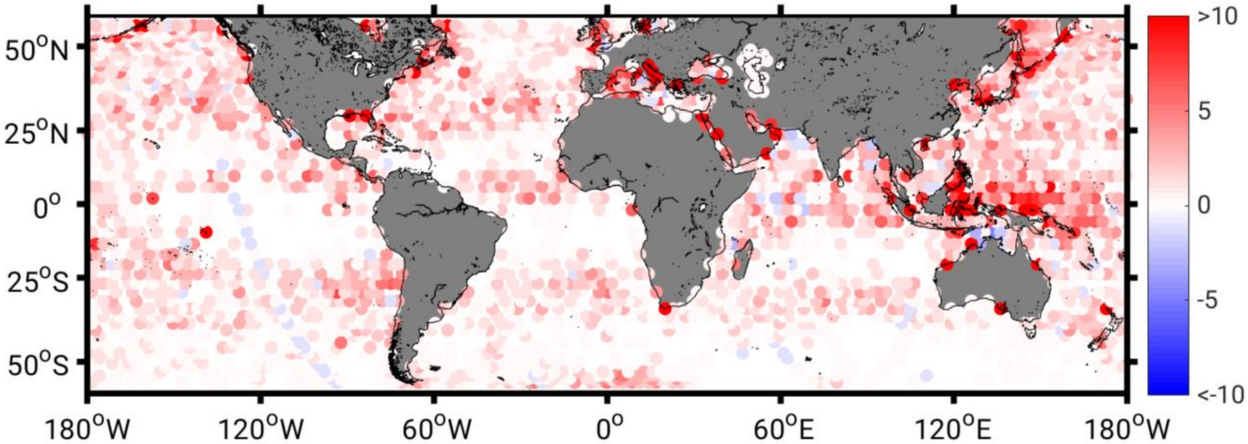
Outliers are:
- Missing measurements at crossovers
  Abs(SLA) at Crossover >3 m



Jason-2

Outliers analysis – in space

Jason-1 (without data gap cycles 185-195)



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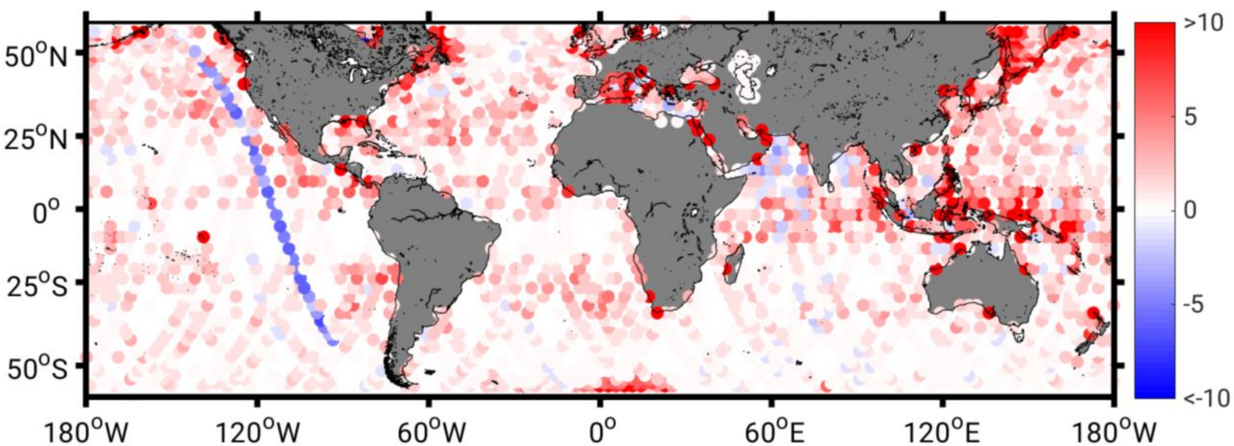
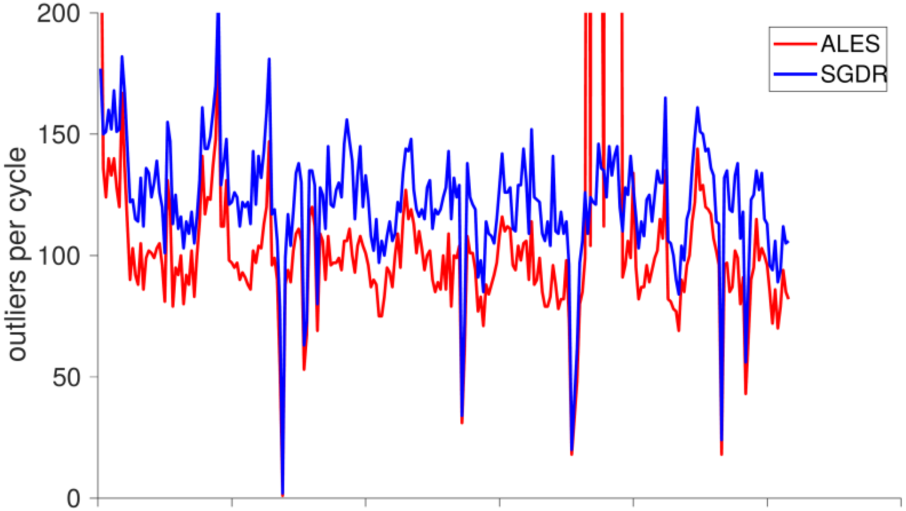
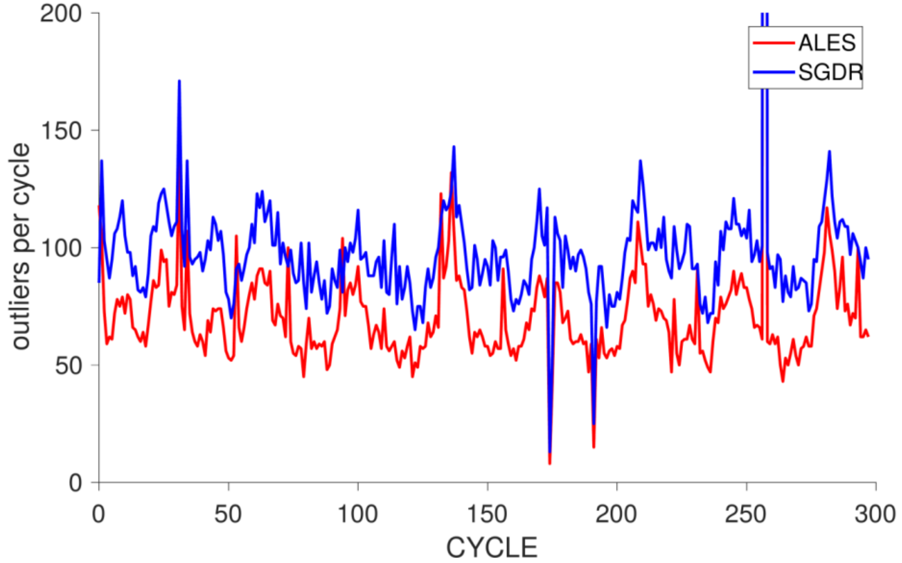
Jason-2



Outlier analysis - in time





Except for some data gaps, ALES 1Hz crossovers have systematically less outliers than SGDR.

Statistics

Jason-1 (without data gap)

	Between 20 and 3 km from the coast	In the global ocean
Std ALES	22.09 cm	7.99 cm
Std SGDR	25.41 cm	9.27 cm
Outliers XOs ALES*	6060	14679
Outliers XOs SGDR*	7248	20132

	Between 20 and 3 km from the coast	In the global ocean
Std ALES	28.66 cm	8.17 cm
Std SGDR	29.92 cm	9.86 cm
Outliers XOs ALES	6104	12773
Outliers XOs SGDR	8589	20245

Jason-2

Statistics

Jason-1 (without data gap)

	Between 20 and 3 km from the coast	In the global ocean
Std ALES	22.09 cm	7.99 cm
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Outliers XOs ALES*	6060	[illegible]
Outliers XOs SGDR*	7248	[illegible]

On average 6% more coastal points per cycle!

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Std ALES	28.66 cm	8.17 cm
Std SGDR	29.92 cm	9.86 cm
Outliers XOs ALES	6104	[illegible]
Outliers XOs SGDR	8589	[illegible]

On average 10% more coastal points per cycle!

Jason-2

Conclusions

This was a comparison between publicly available multi-mission global datasets.

Scientific question: can ALES be used with confidence as a global ocean retracker?

YES, it SHOULD, because it even IMPROVES the current standards.

The improvement is a mix of better retracking (-> much more data available in the coastal zone, better description of the 10-100-km scale of variability) and better sea state bias correction applied at high-rate (-> decrease in crossover variance, wait for the next OSTST for proof&justification)

- Compared to the current GDR products, ALES dataset has:
    1) A better representation of the spatial scales up to 10 km
    2) An improved precision
    3) 30% Variance reduction
    4) More data availability in the coastal zone

Conclusions

- A global 1-Hz ALES multi-mission dataset is now available in http://openadb.dgfi.tum.de/ via direct download. 20-Hz data on request.

Next Steps towards higher precision and accuracy

- Release of more missions (ALES on SAR altimetry in progress, waiting for funds)
- New ALES Sea State Bias MODEL for ALES (will hopefully be presented at the next OSTST and published)
- ALES is being regionally combined with X-Track Post-Processing from CTOH in the context of ESA‘s Sea Level Climate Change Initiative
- Further developments: ALES+, treatment of intra-1Hz covariant errors (led by G.Quartly), …….