Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

ALES coastal processing applied to ERS: Extending the coastal sea level time series

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Summary

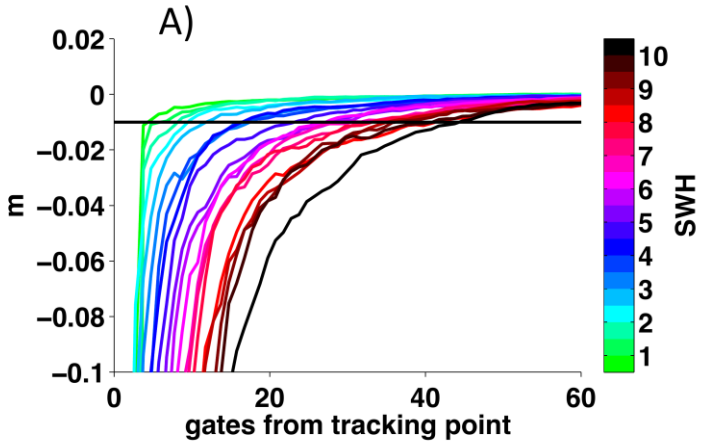
- ALES extension to ERS-2
- Validation of ALES on new SSB and ERS-2 with in situ data
- Performances
- Sea Level Analysis (work in progress)
- Distribution: From ALES to COSTA

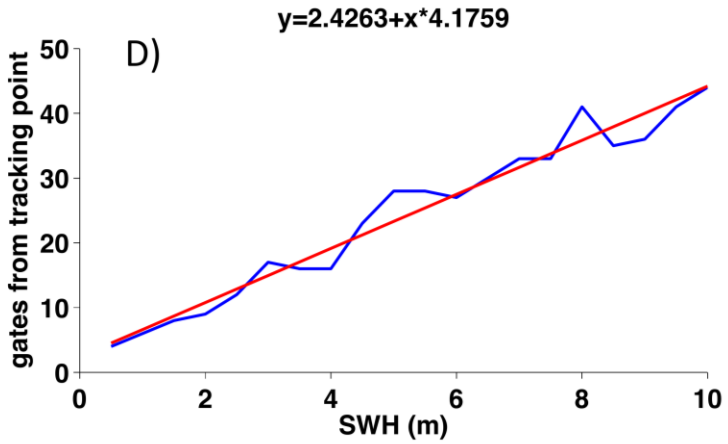
Extension of ALES retracking strategy to ERS-2

Remember ALES?

- Adaptive Subwaveform Retracker: key step -> Subwaveform Width proportional to Sea State
- Objectives: avoid perturbations of the signal, do not degrade precision/accuracy from open ocean to coast
- Birth of ALES concept: Montecarlo Simulation

RMS Difference of Full Waveform Range Error – Subwaveform Range Error



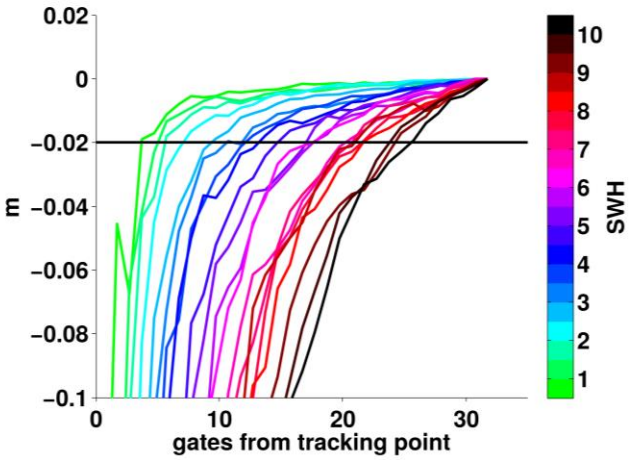


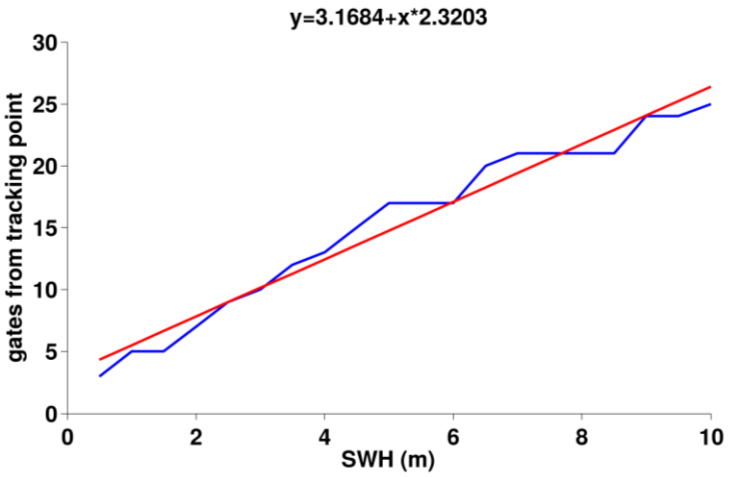
Extension of ALES retracking strategy to ERS-2

Problem:
Envisat PRF =1800 Hz →18-Hz waveforms from 100 IE
ERS2 PRF = 1050 Hz →20-Hz waveforms from 50 IE

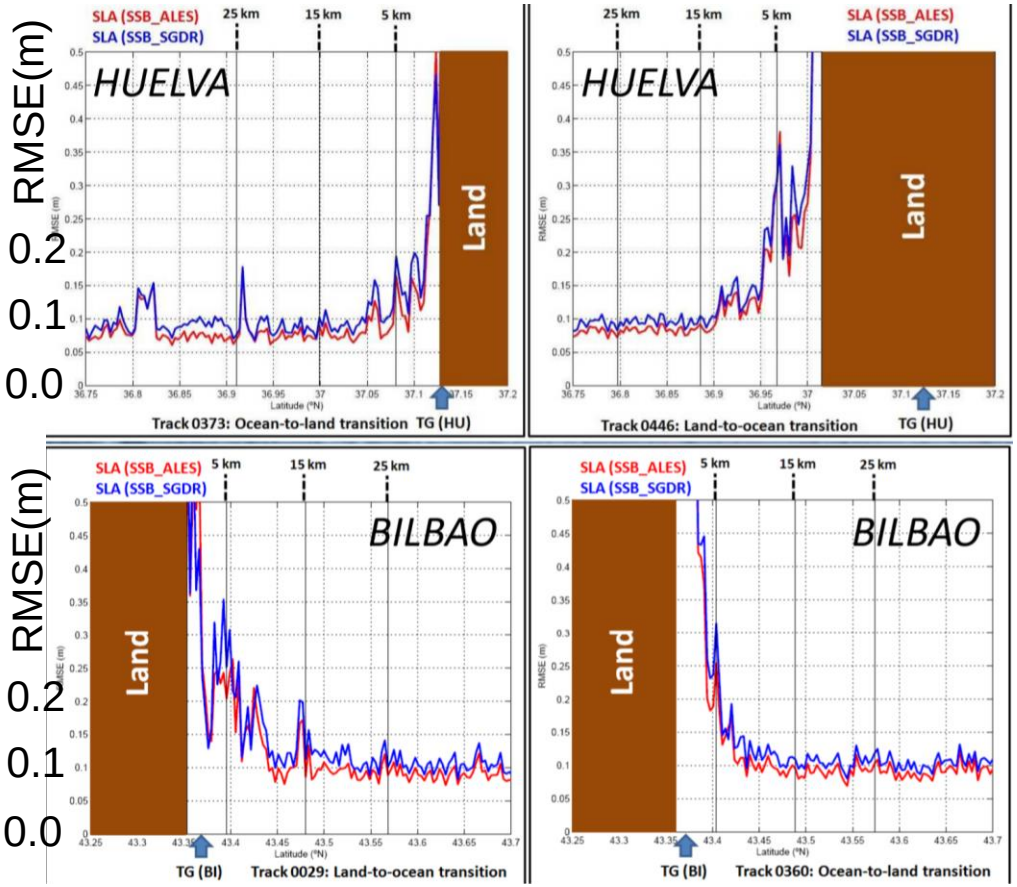
Compromise: tolerance bar set at 2 cm at 20 Hz, i.e. 0.45 cm at 1 Hz

RMS Difference of Full Waveform Range Error – Subwaveform Range Error





Validation of ALES SSB with in situ data



SSB recomputed for ALES, example with Envisat

The accuracy (in terms of RMSE) improved by about 14% (25-15 km), 12% (15-5 km) and 9% (5-1 km).

Abatement of uncertainty (precision): by 25% (25-15 km from the coast), 18% (15-5 km) and 11% (5-1 km)

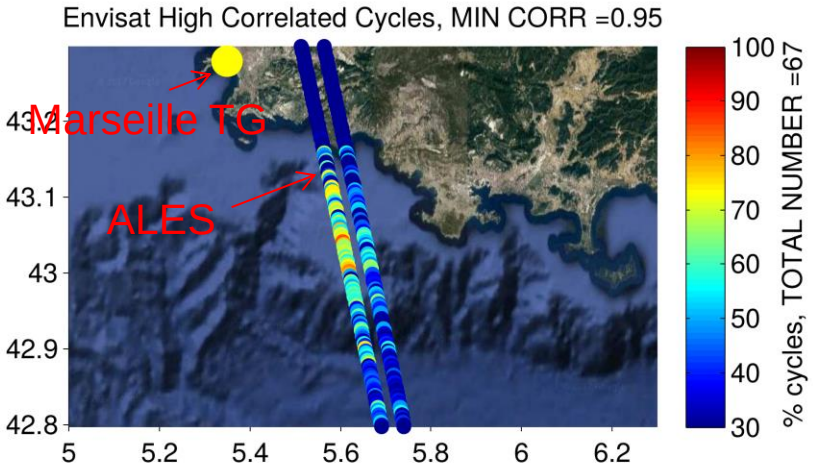
J. Gomez-Enri, P. Cipollini, M. Passaro, S. Vignudelli, and J. Coca, "Recomputed sea state bias correction for coastal altimeter products" presented at the ESA Living Planet Symposium, Prague, Czech Republic, 2016a.

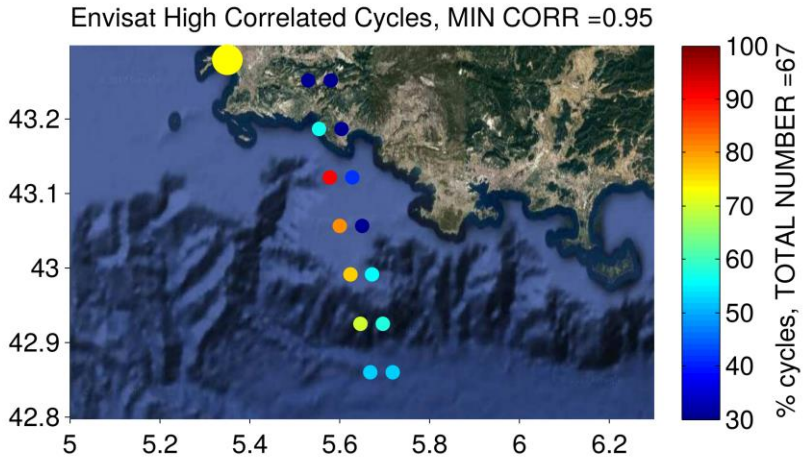
Validation of ALES for ERS-2 with in situ data

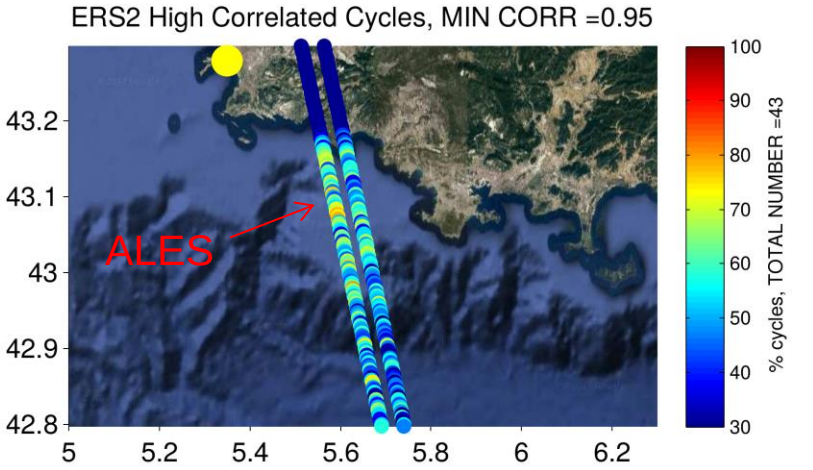
What do we validate?
Total Water Level Envelope = Sea Level including tidal signal

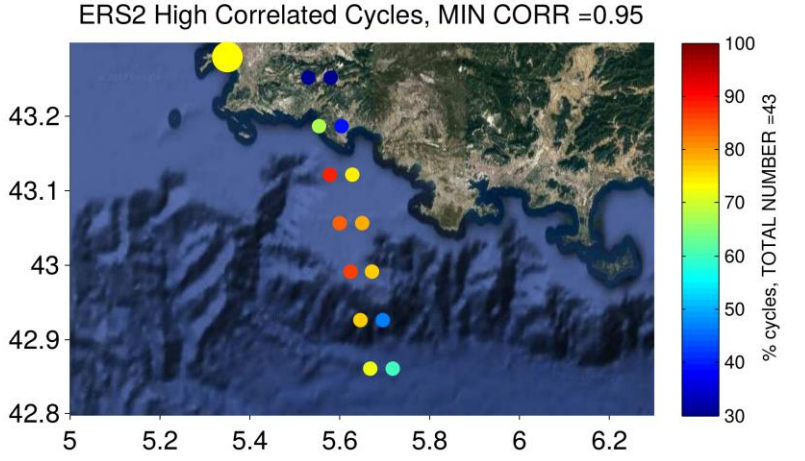
Validation Criterion:
PCHC: Percentage of cycles usable to obtain >0.95 w.r.t. Tide Gauges time series
‚Percentage of good cycles‘

Validation of ALES for ERS-2 with in situ data





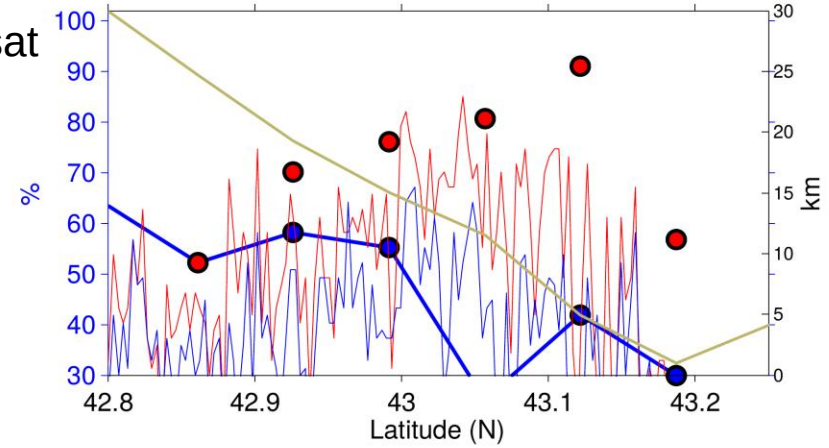




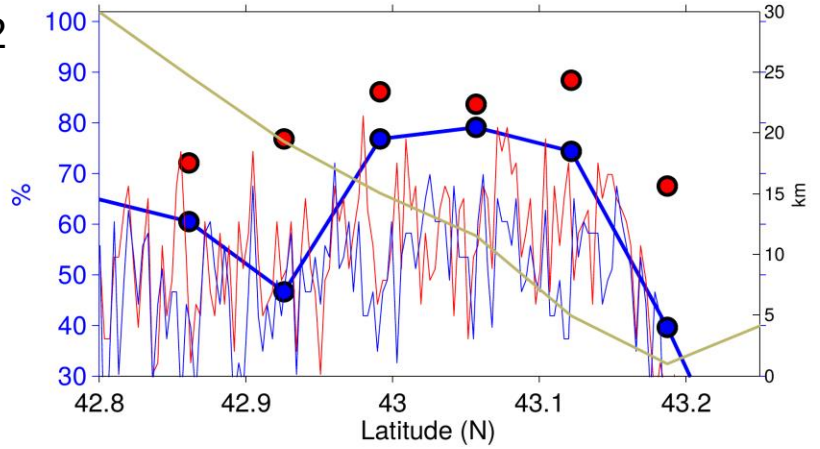
Validation of ALES for ERS-2 with in situ data

ALES
SGDR

PCHC Envisat



PCHC ERS-2



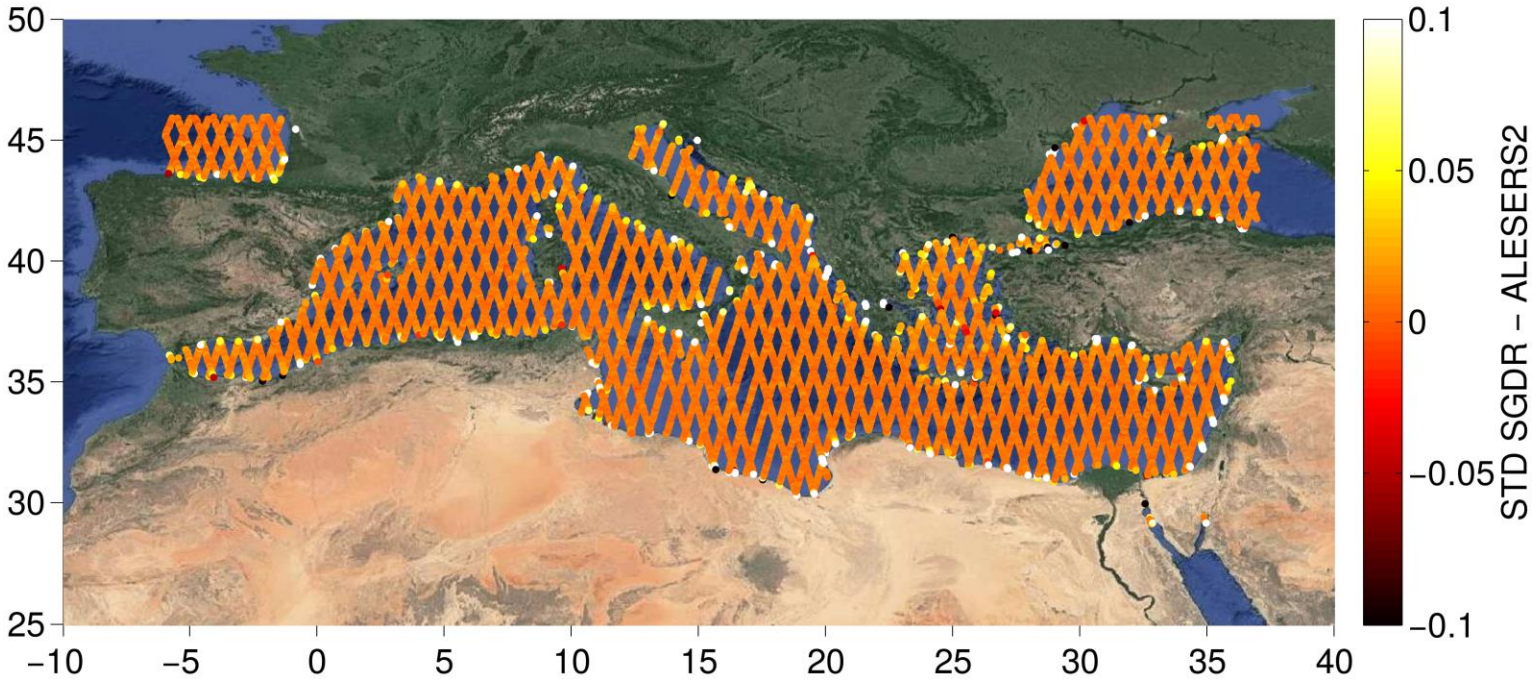
Distance from the coast

Performance analysis

Difference of Noise Statistics (std within 1-Hz block)

1 Hz points generated from raw 20 Hz estimations (same criteria)

ERS-2



>10 cm of improvement in coastal areas

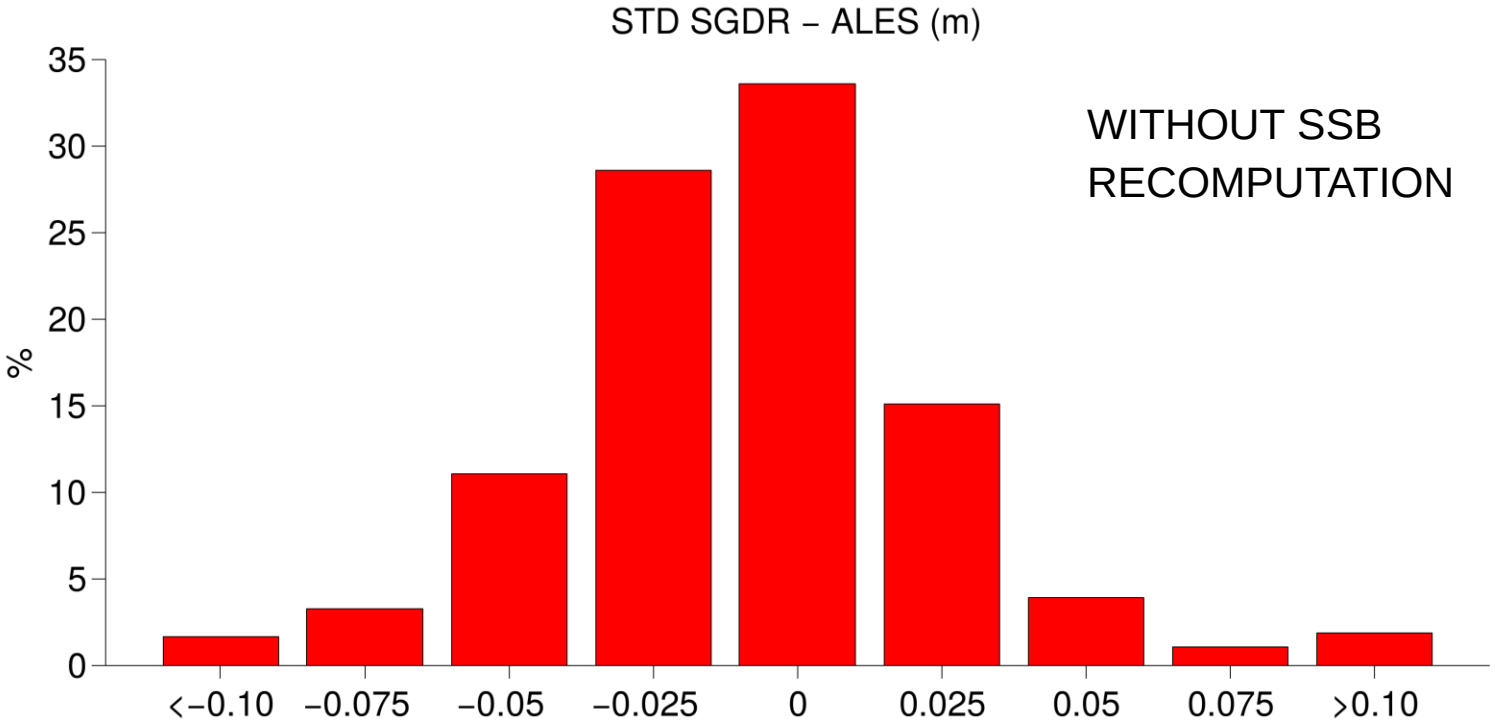
ALES less noisy than original SGDR (using same corrections except SSB)

Performance analysis

Difference of Noise Statistics (std within 1-Hz block)

1 Hz points generated from raw 20 Hz estimations (same criteria)

ERS-2 (North Sea)



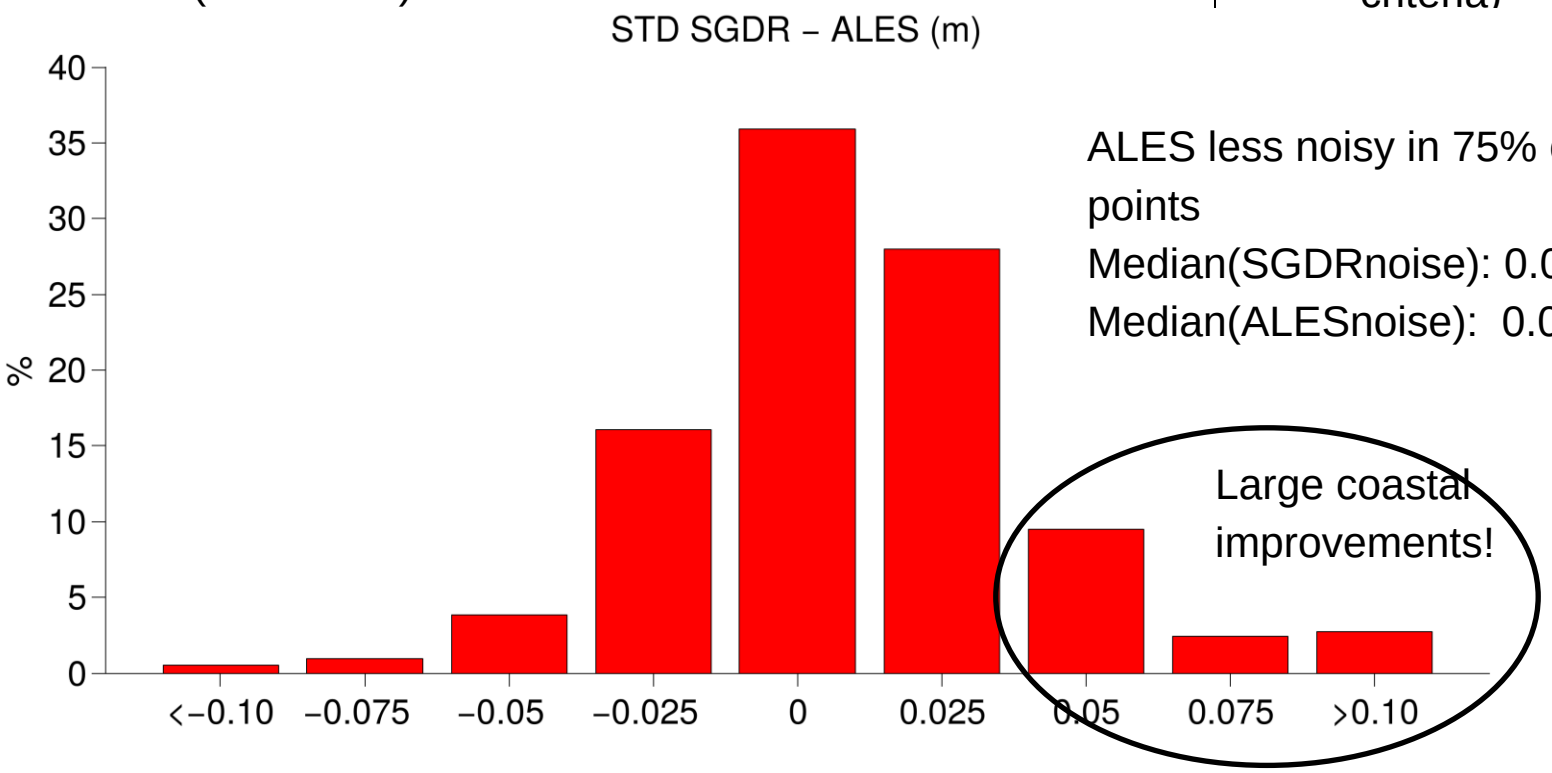
WITHOUT SSB RECOMPUTATION

Performance analysis

Difference of Noise Statistics (std within 1-Hz block)

1 Hz points generated from raw 20 Hz estimations (same criteria)

ERS-2 (North Sea)



ALES less noisy in 75% of points
Median(SGDRnoise): 0.078
Median(ALESnoise): 0.068

Large coastal improvements!

„NEW“ ALES LESS NOISY THAN STANDARD RETRIEVAL ALSO IN THE OPEN OCEAN

Sea Level Analysis (work in progress)

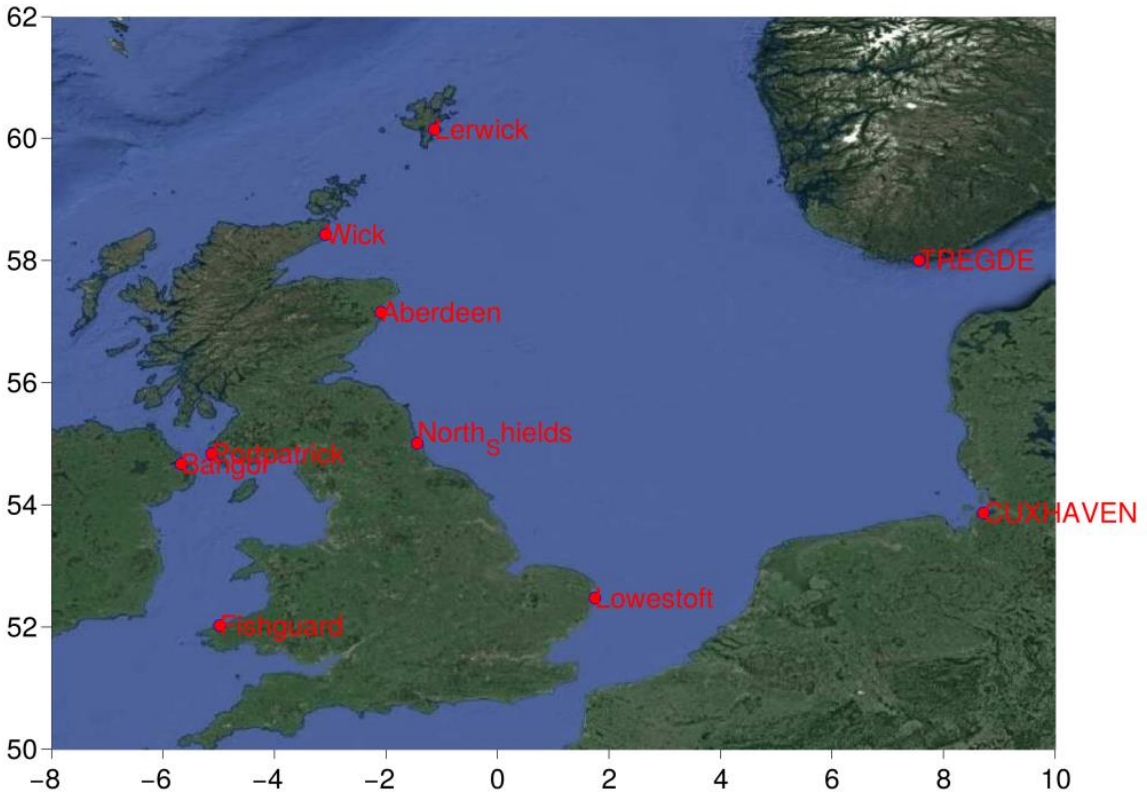
Current development stage: comparison of sea level variability w.r.t. in-situ data

Multimission Altimetry Time Series (cross-calibrated)

Comparison with hourly TG (detided and DAC removed)

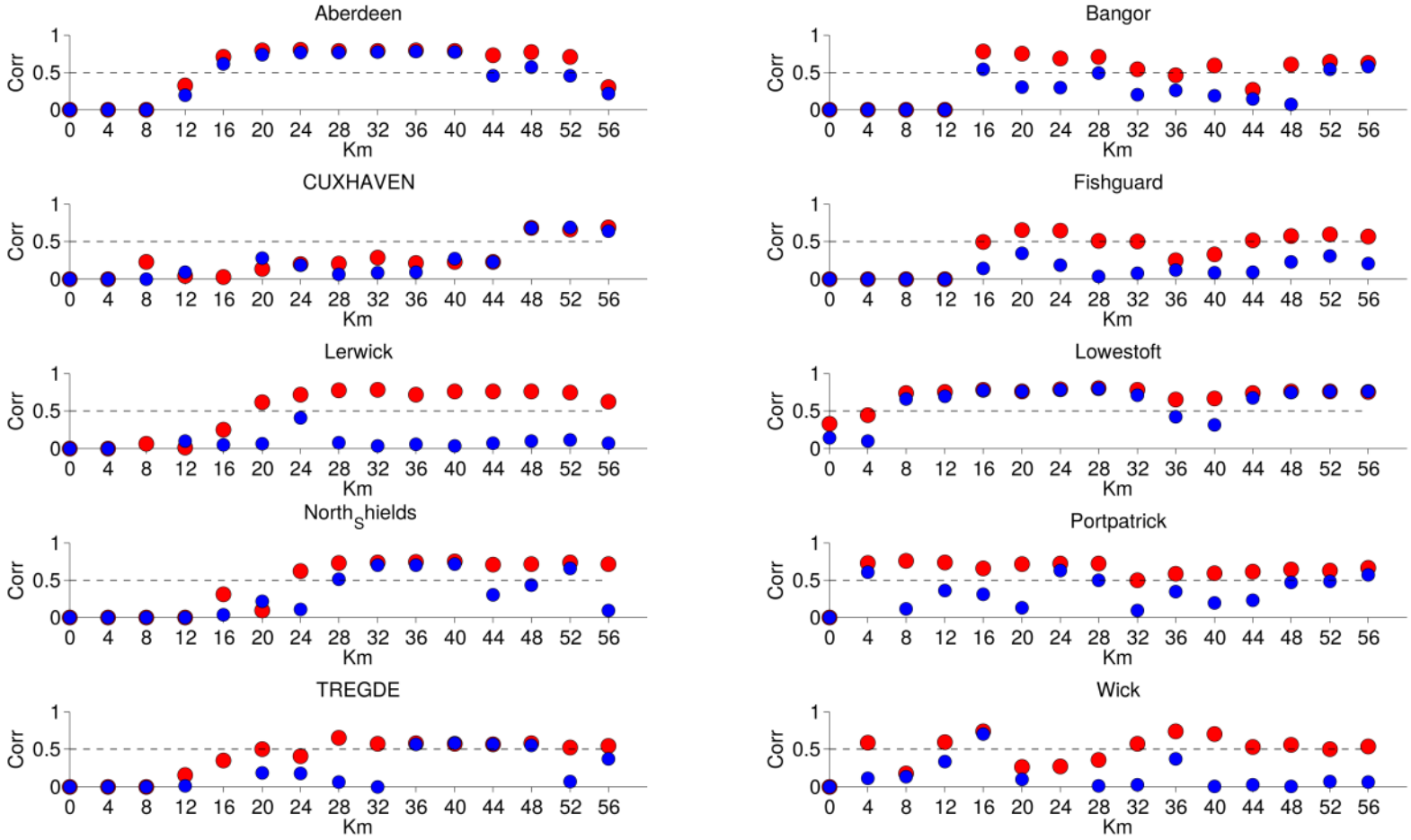
20 Hz altimetry data averaged at bands of distance from TG (0-4 Km, 4-8 Km, 8-12 Km, etc.)

Time series length: 1996 - 2010



Sea Level Analysis (work in progress)

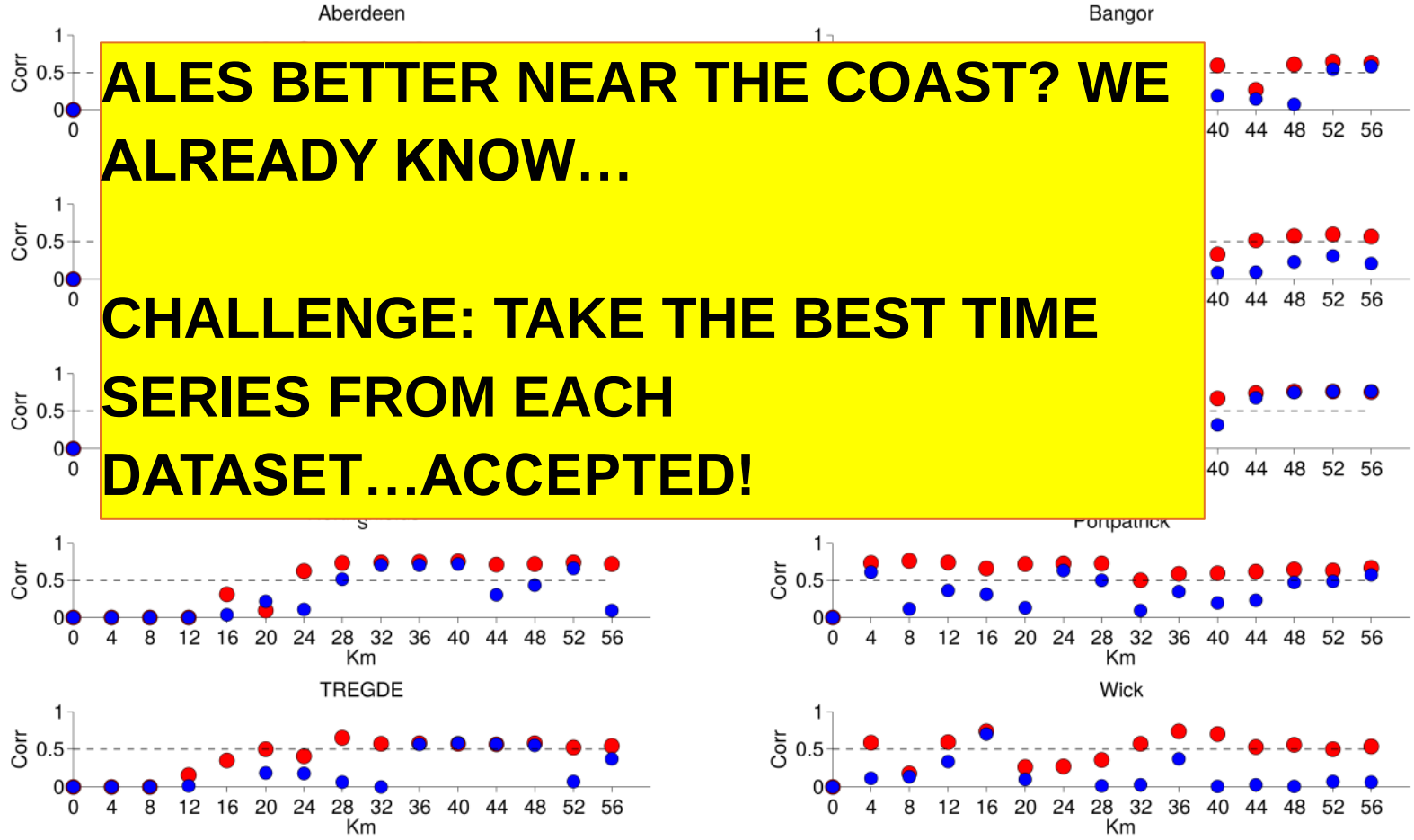
ALES SGDR



X-axis: distance altimetry band w.r.t. TG

Sea Level Analysis (work in progress)

ALES SGDR



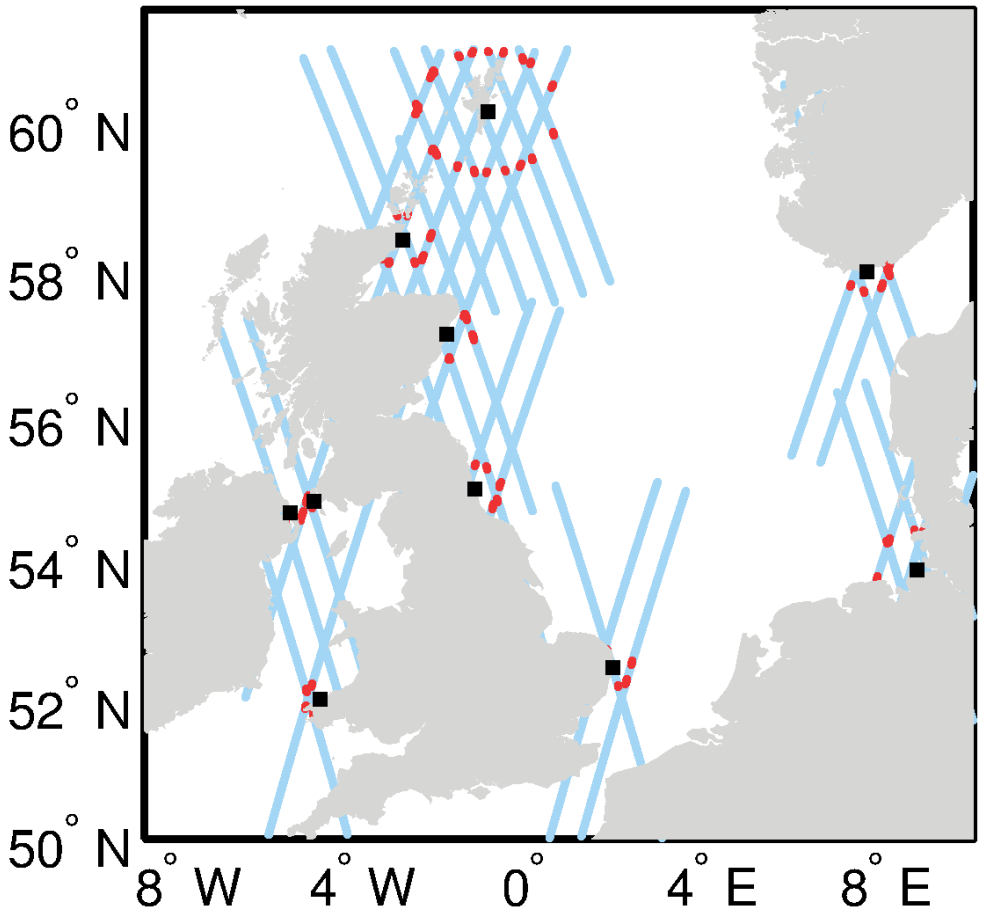
X-axis: distance altimetry band w.r.t. TG

Sea Level Analysis (work in progress)

ALES SGDR

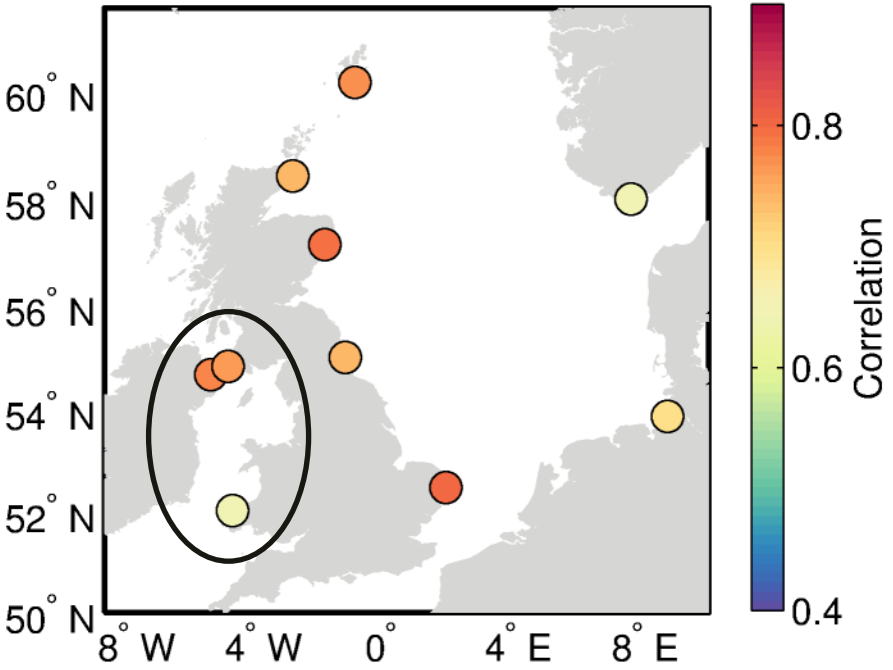
ALES BET
ALREADY

CHALLEN
SERIES FF
DATASET.

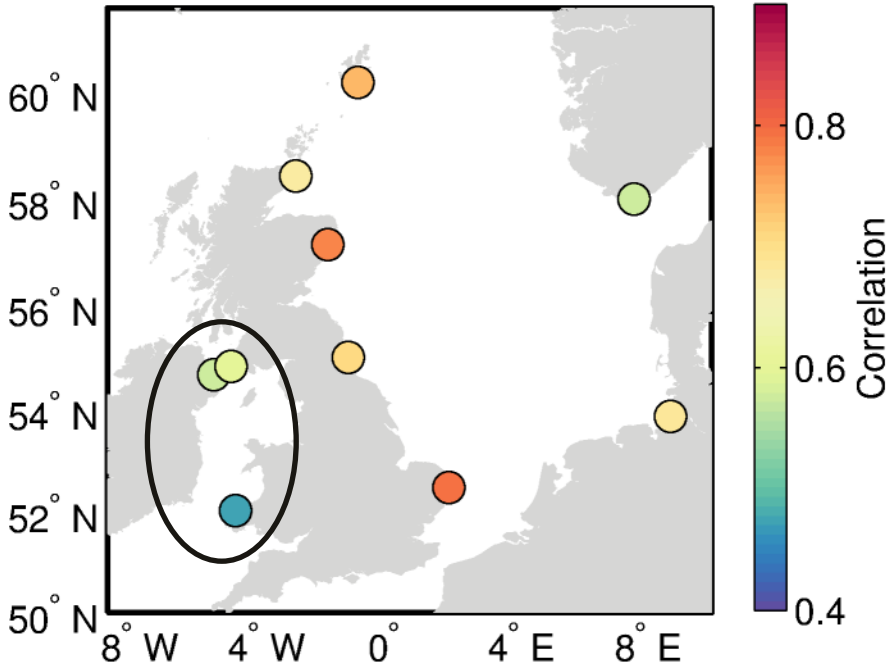


Sea Level Analysis (work in progress)

ALES



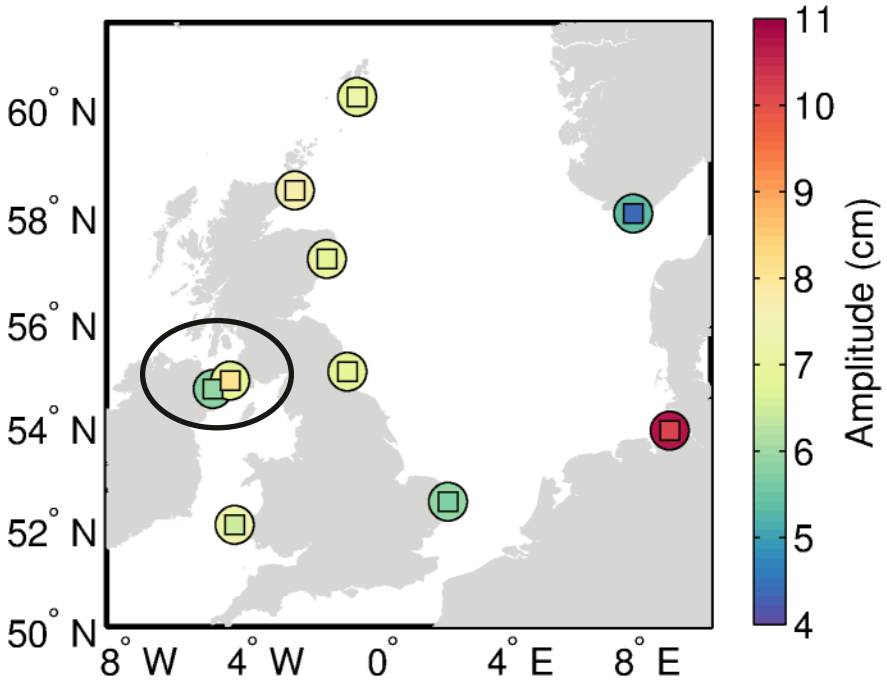
SGDR



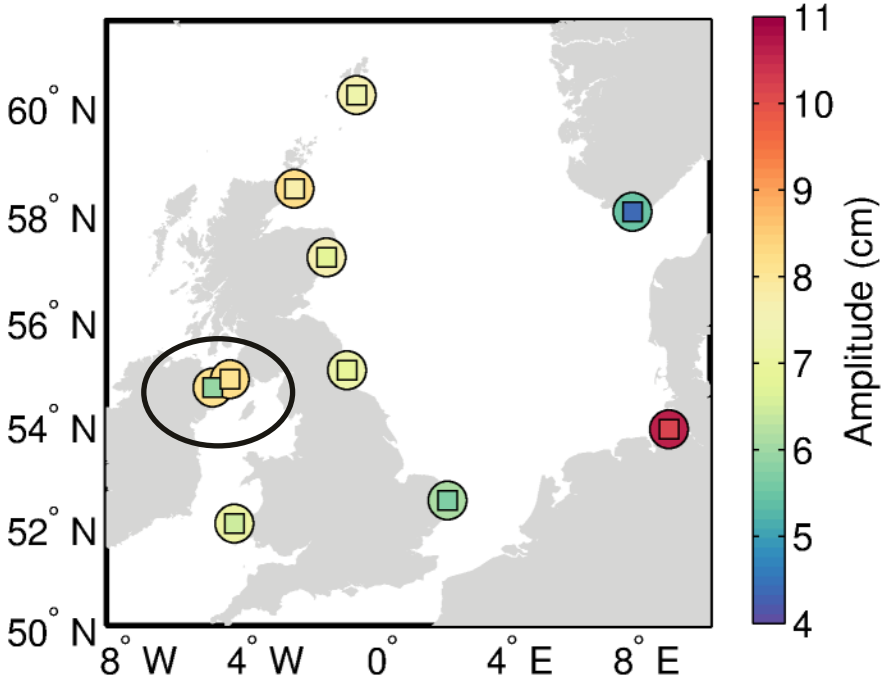
Even choosing the MOST CORRELATED observations for each dataset, significant improvements with ALES

Sea Level Analysis (work in progress)

ALES



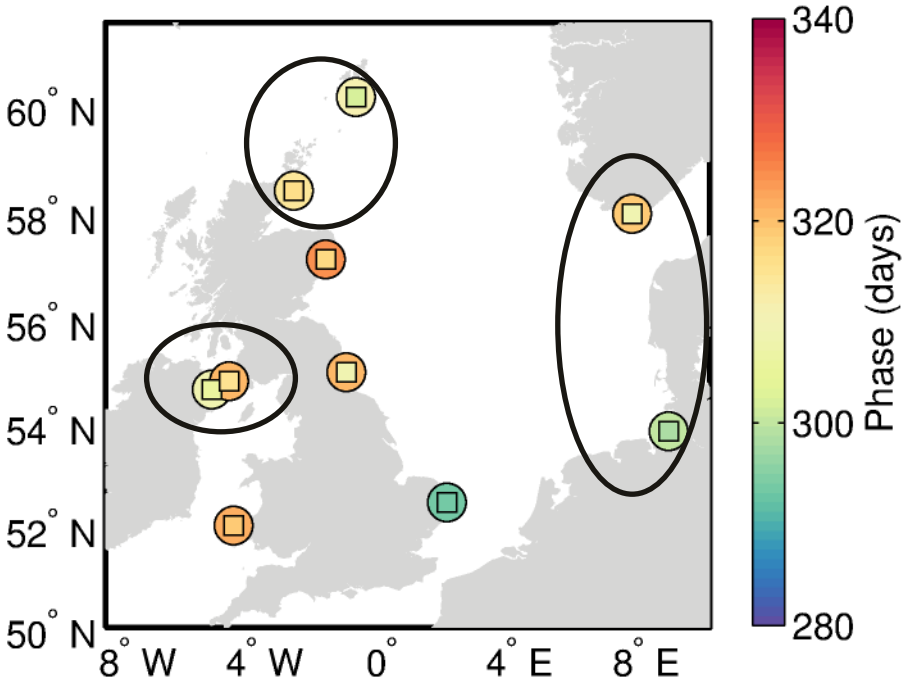
SGDR



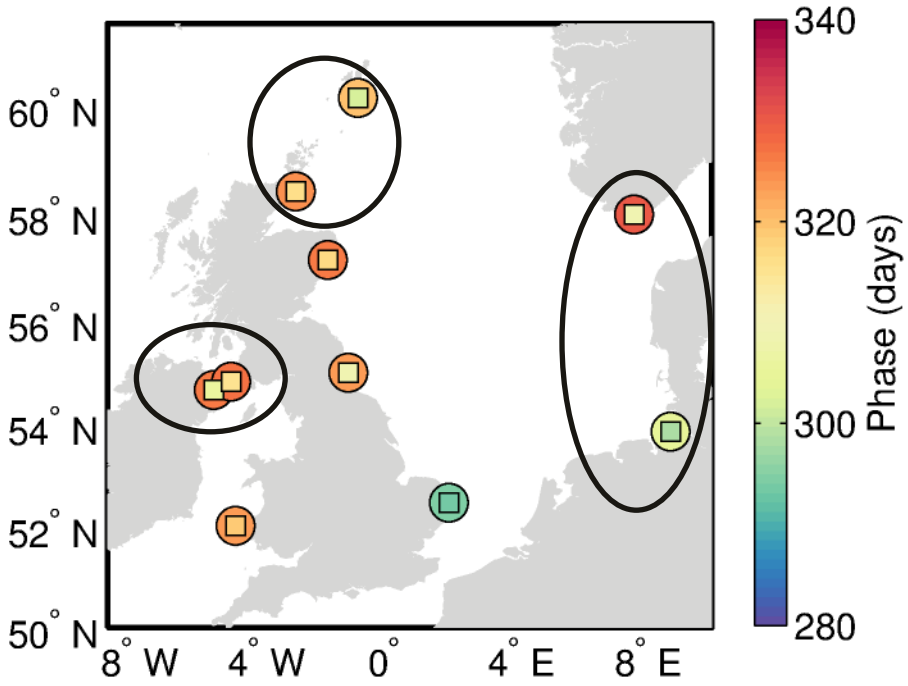
Note over 2 cm difference in Amplitude estimation at Bangor

Sea Level Analysis (work in progress)

ALES



SGDR



Note phase estimate changes of over a month from SGDR to ALES

Product availability and distribution

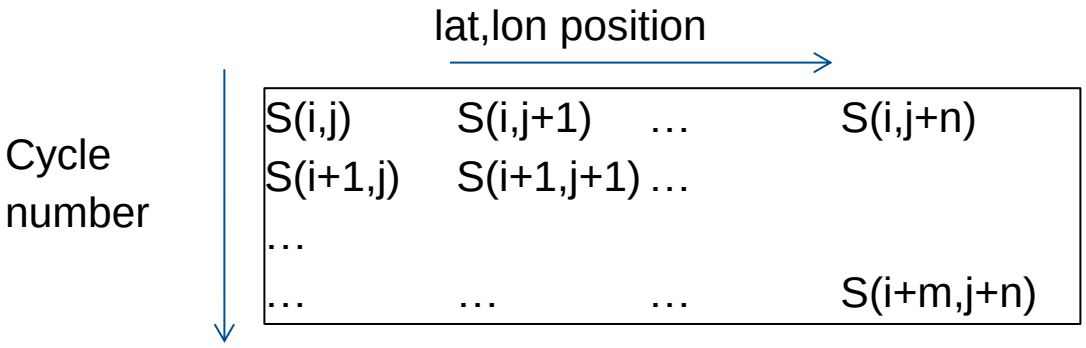
https://doi.pangaea.de/10.1594/PANGAEA.871920

DGFI-TUM proudly presents: COSTA
COastal
Sea level
Tailored
ALES
Developing platform.

Inspired by Anny Cazenave talk on sea level (OSTST2016), Coastal Altimetry needs:
- *Longer time series*
- *User-friendly high-level products*

User-friendly multi-mission post-processed product. Currently: along-track ERS2 and Envisat in North Sea and Mediterranean Sea.

For each track: SSHA matrixes



Conclusions

- COSTA sea level time series in North Sea and Med Sea are freely available from https://doi.pangaea.de/10.1594/PANGAEA.871920

- What‘s new: ERS-2 reprocessing, Sea State Bias recomputation for ALES

- The COSTA sea level time series are less noisy than the standard product also in the open ocean

- First comparisons with in-situ data show an improved description of the annual cycle

Next Steps

- Expand time series to ERS-1

- Expand the multi-mission process to the Jason series (badly needed: documentation for TOPEX waveforms)

- Looking for users to study variability and trends where no TGs (ex. South Med)