Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

Coastal improvements for tidal models: the benefit of ALES retracker

G. Piccioni, D. Dettmering, W. Bosch, M. Passaro, F. Seitz

Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

Ocean Surface Topography Science Team Meeting (OSTST) 2017
Miami, 23-27.10.2017

Outline

- Motivation
- ALES retracker
- Tide model approach
- Exercise along-track
- Results at grid nodes
- Conclusions
- Outlook

Motivation

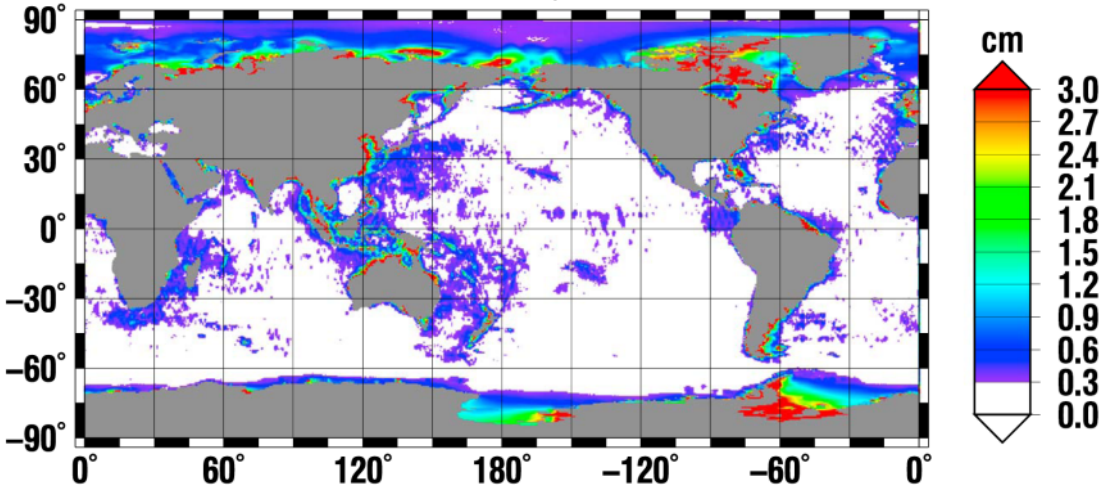
- Large impact of tides at coast
- Still coastal issues in tide models (Coastal Altimetry Workshop - Feb2017):
  - High discrepancies among models in coastal areas
  - Degradation at coast due to extrapolation
  - Effects on ocean models

Expertise at DGFI-TUM:

- EOT11a
- ALES retracker

→ EOT update

Elevation differences among tide models for M2

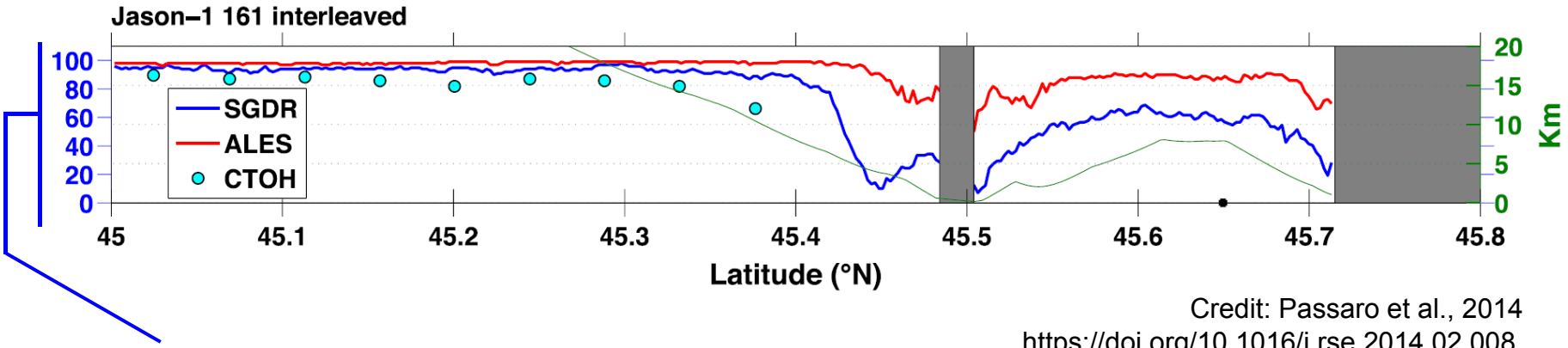


Credit: Stammer et al. 2014

The Adaptive Leading Edge Subwaveform (ALES) Retracker

- Finds optimal subwaveform according to sea state > subwaveform retracking
- More reliable at the coast:
  - Higher amount of data
  - Larger correlation with in situ data

Passaro et al., 2014. ALES: A multi-mission adaptive subwaveform retracker for coastal and open ocean altimetry



Credit: Passaro et al., 2014
https://doi.org/10.1016/j.rse.2014.02.008.

Number of cycles with correlation ≥ 0.9 with respect to in-situ timeseries

Tide model approach

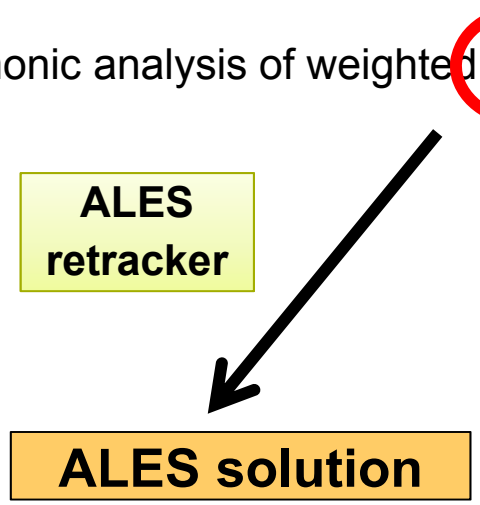
- First investigations on the way to a new global model
- ~ 14 years of high-rate data: Jason-1 + Jason-2
- Solutions for major tidal constituents: M2, N2, S2, K2, K1, O1, Q1, P1
- Along-track solution: node on the track, 30-km cap-size
- Gridded solution: nodes on regular grid, variable cap-size according to bathymetry
- Least-squares-based harmonic analysis of weighted SLA corrected for EOT11a

Tide model approach

- First investigations on the way to a new global model
- ~ 14 years of high-rate data: Jason-1 + Jason-2
- Solutions for major tidal constituents: M2, N2, S2, K2, K1, O1, Q1, P1
- Along-track solution: node on the track, 30-km cap-size
- Gridded solution: nodes on regular grid, variable cap-size according to bathymetry
- Least-squares-based harmonic analysis of weighted **SLA** corrected for EOT11a

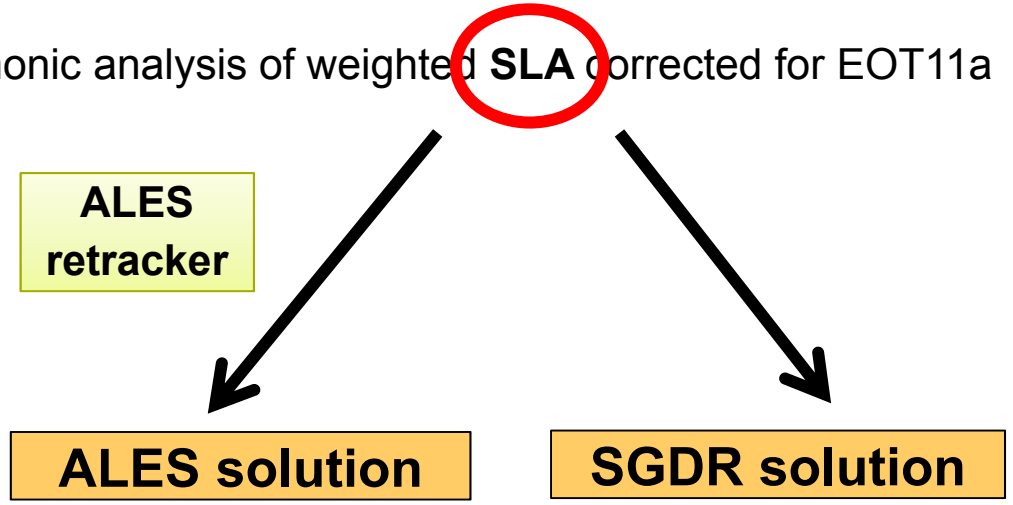
Tide model approach

- First investigations on the way to a new global model
- ~ 14 years of high-rate data: Jason-1 + Jason-2
- Solutions for major tidal constituents: M2, N2, S2, K2, K1, O1, Q1, P1
- Along-track solution: node on the track, 30-km cap-size
- Gridded solution: nodes on regular grid, variable cap-size according to bathymetry
- Least-squares-based harmonic analysis of weighted **SLA** corrected for EOT11a



Tide model approach

- First investigations on the way to a new global model
- ~ 14 years of high-rate data: Jason-1 + Jason-2
- Solutions for major tidal constituents: M2, N2, S2, K2, K1, O1, Q1, P1
- Along-track solution: node on the track, 30-km cap-size
- Gridded solution: nodes on regular grid, variable cap-size according to bathymetry
- Least-squares-based harmonic analysis of weighted **SLA** corrected for EOT11a



What is the impact of ALES at the coast when used within a tide model with respect to a solution with an ordinary retracker?

Evaluation

- Two experiments:

  along-track

  at grids

- Compare SGDR and ALES solutions

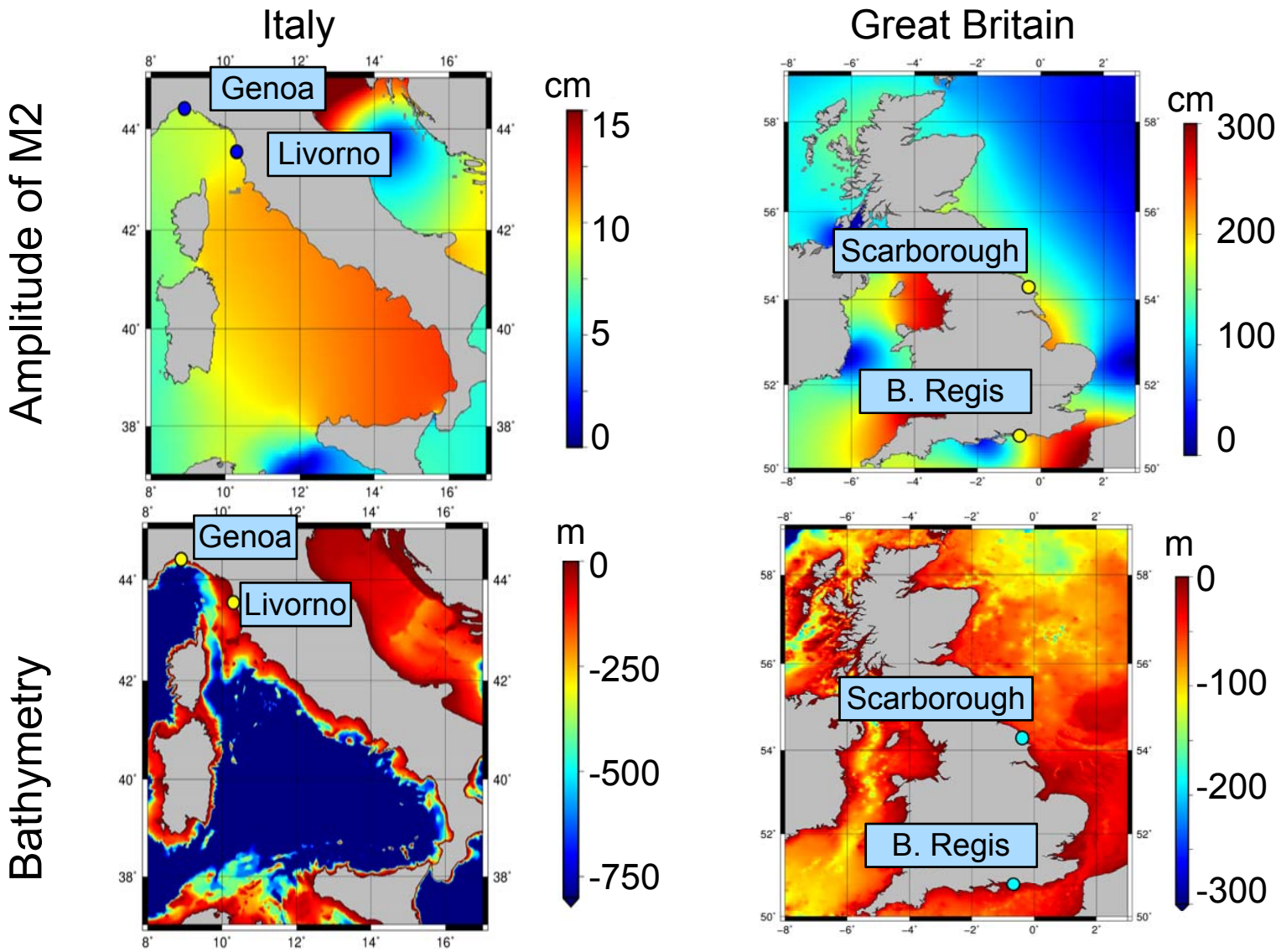
- Root-Mean-Squares (RMS) of ALES solution (A) and SGDR solution (S) VS tide gauge :

  Relative difference: $$\Delta\mathrm{RMS}\,[\,\%\,] = \frac{\mathrm{RMS_S} - \mathrm{RMS_A}}{\mathrm{RMS_S}} \cdot 100$$

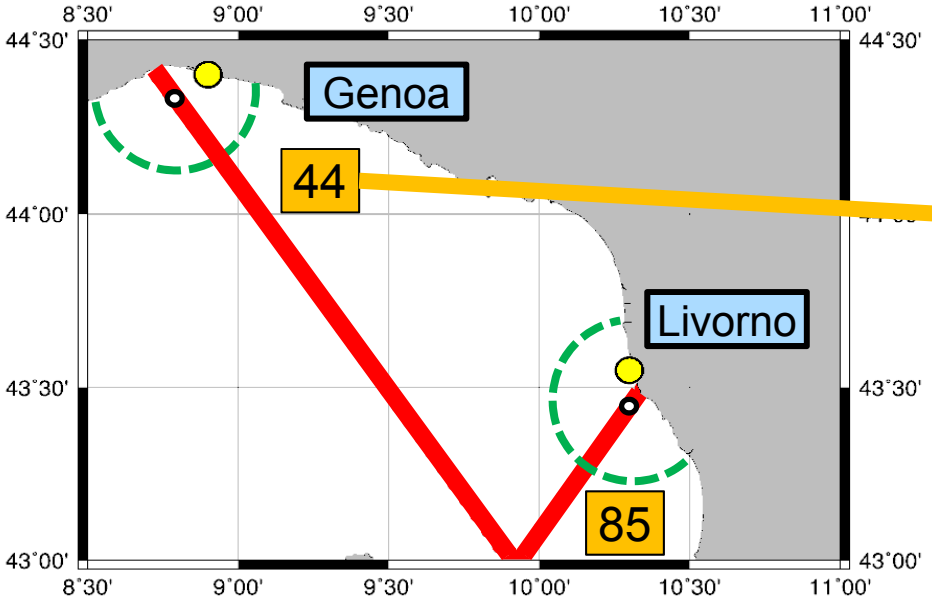
  Absolute difference: $$\Delta\mathrm{RMS}\,[\,\mathrm{cm}\,] = \mathrm{RMS_S} - \mathrm{RMS_A}$$

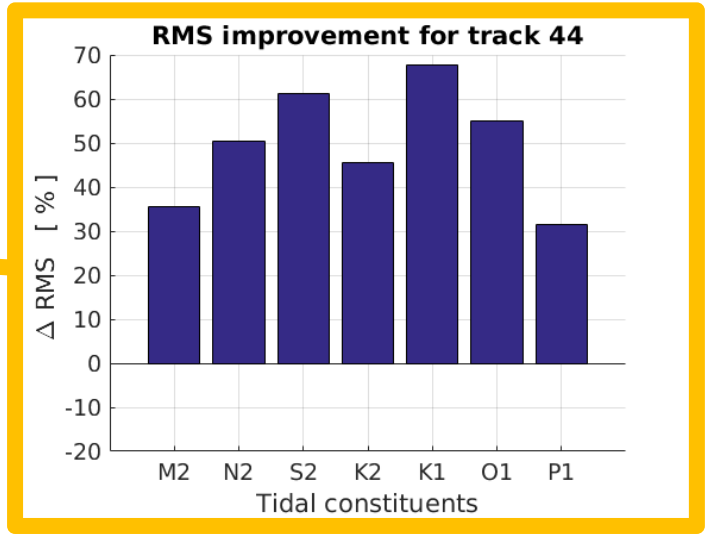
- RSS for overall accuracy
- Number of observations VS distance to tide gauge

Areas of study

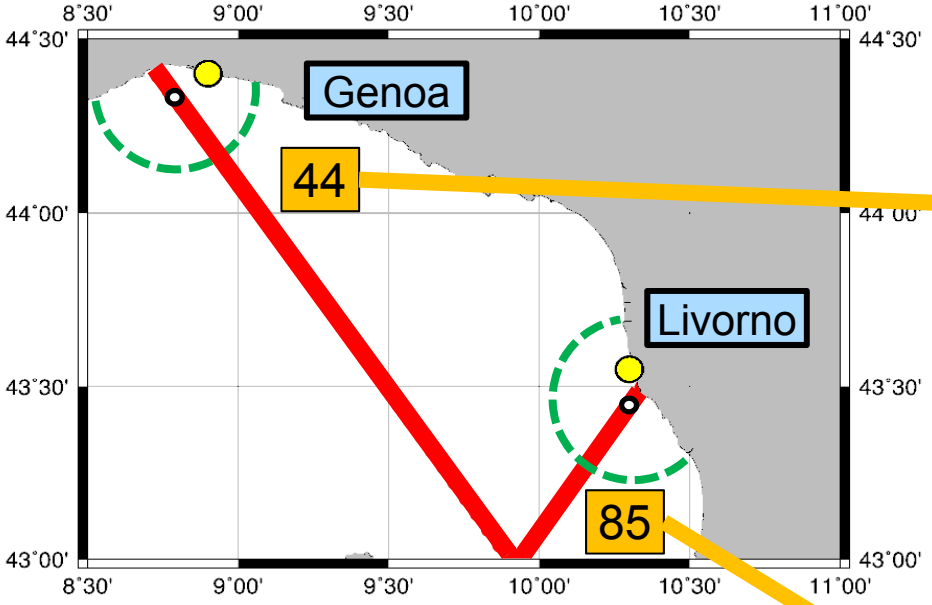


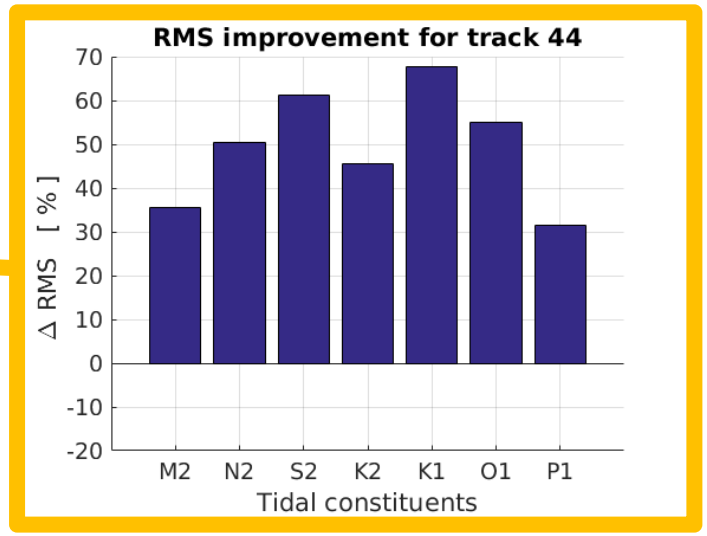
Along-track exercise: western Italian coast

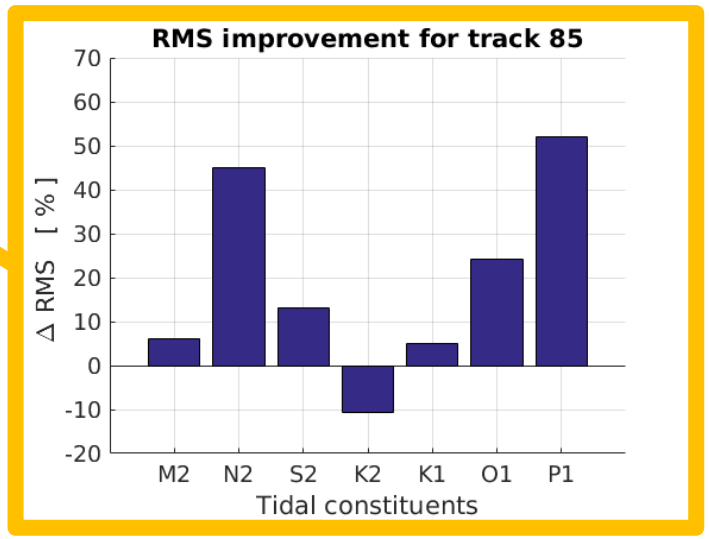




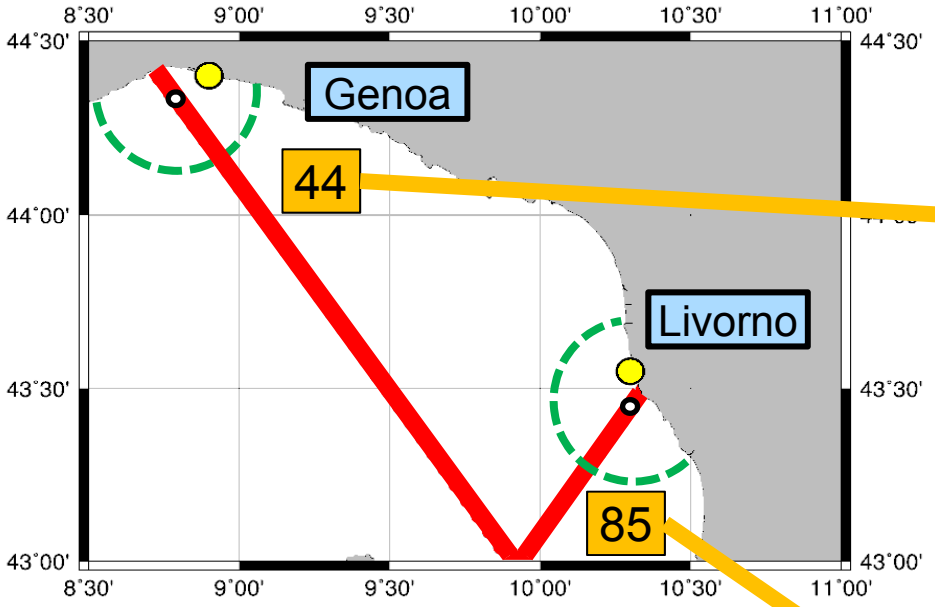
Along-track exercise: western Italian coast

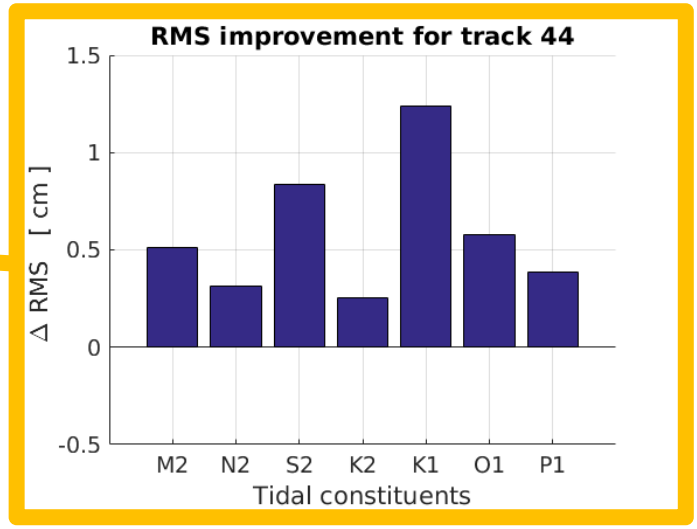


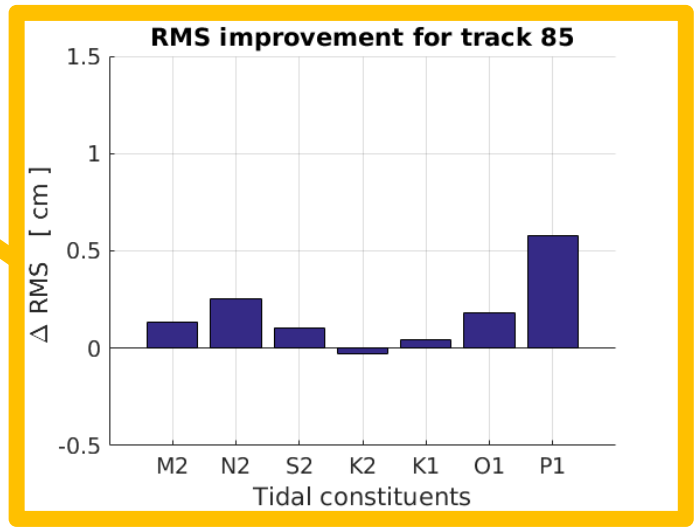




Along-track exercise: western Italian coast

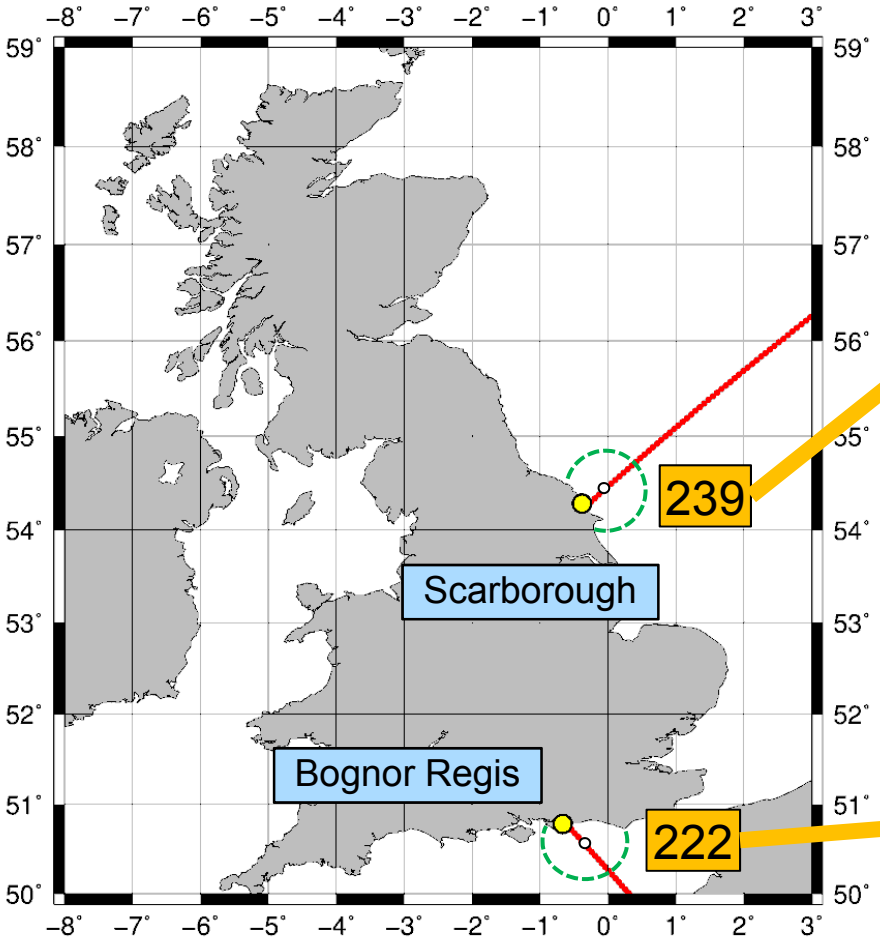


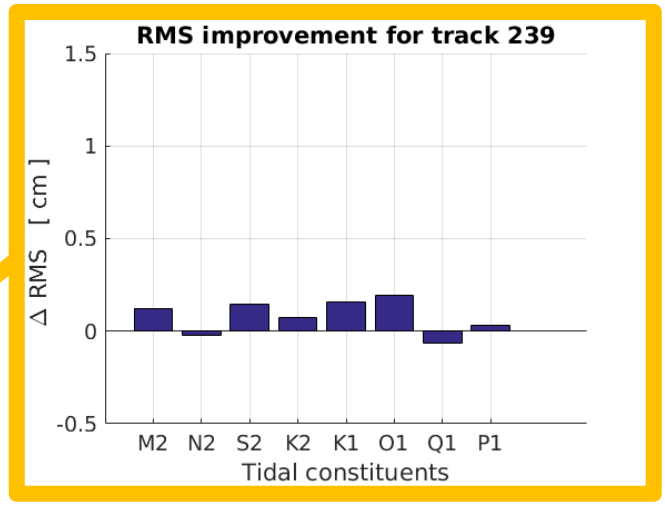


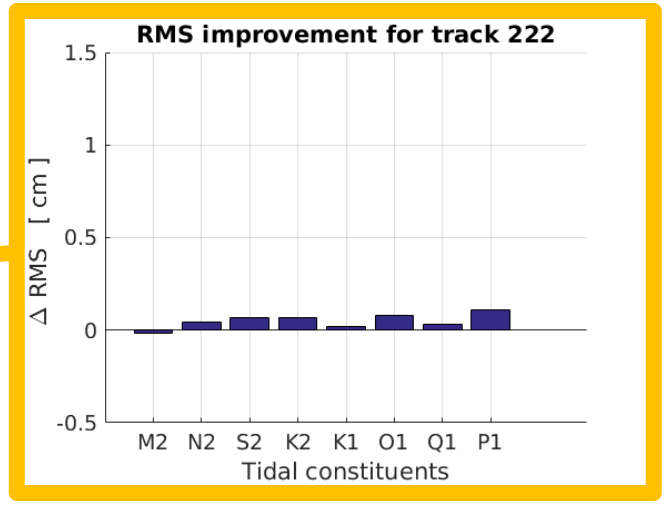


RSS [cm]	track 44	track 85
ALES	1.06	1.22
SGDR	1.52	1.36

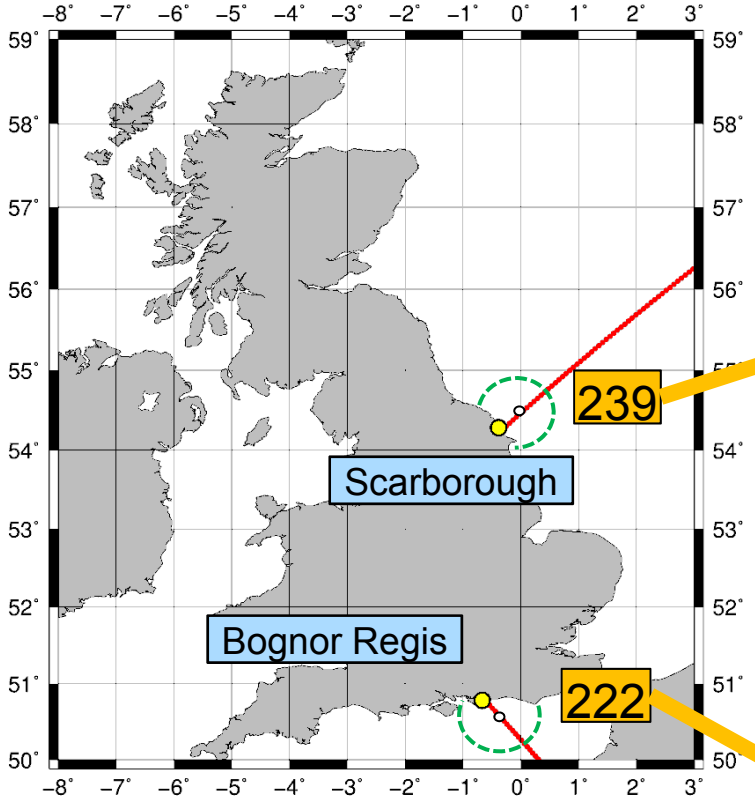
Along-track exercise: Great Britain



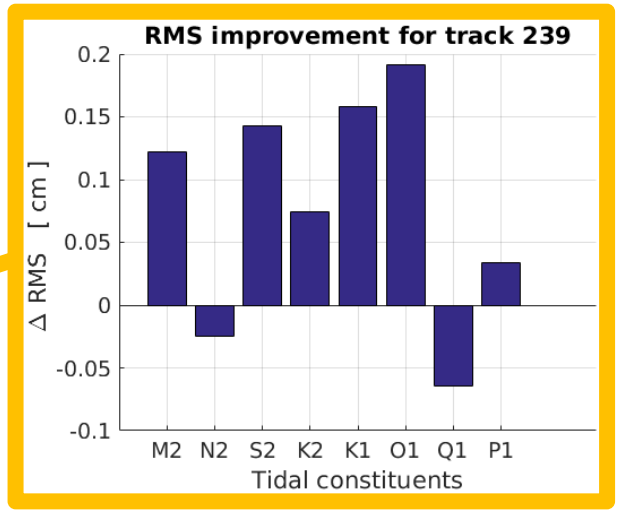


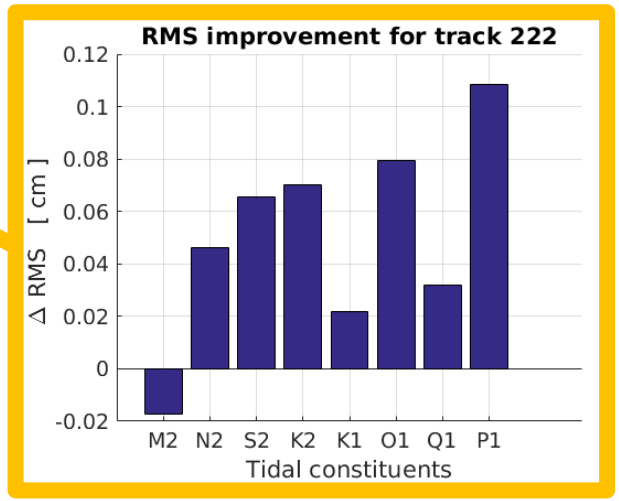


Along-track exercise: Great Britain

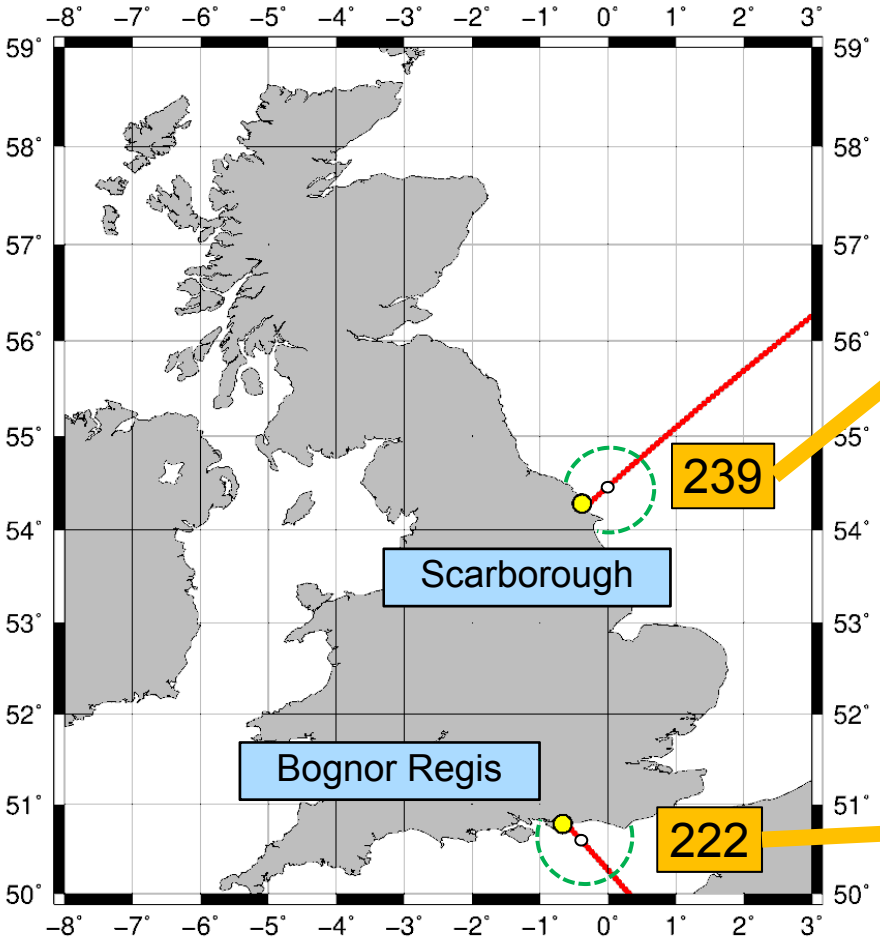


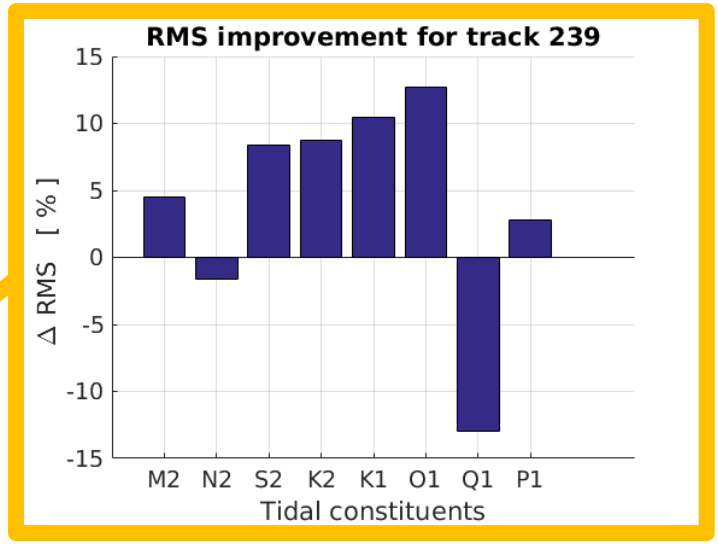
RSS [cm]	track 239	track 222
ALES	1.65	2.35
SGDR	1.70	2.43

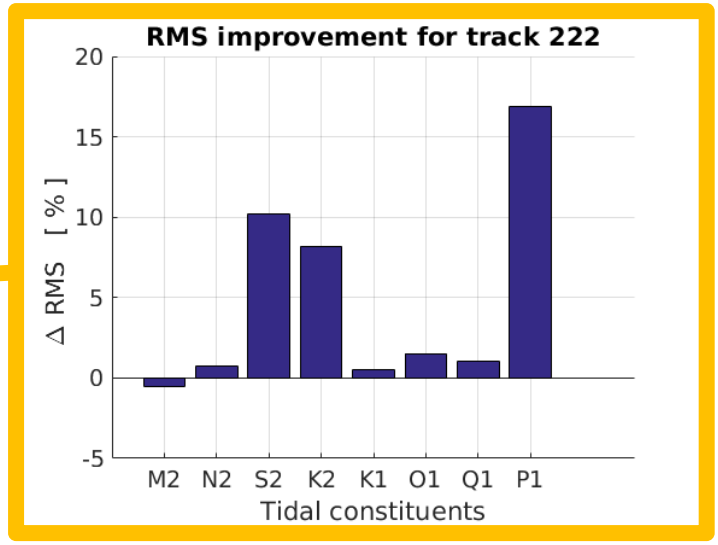




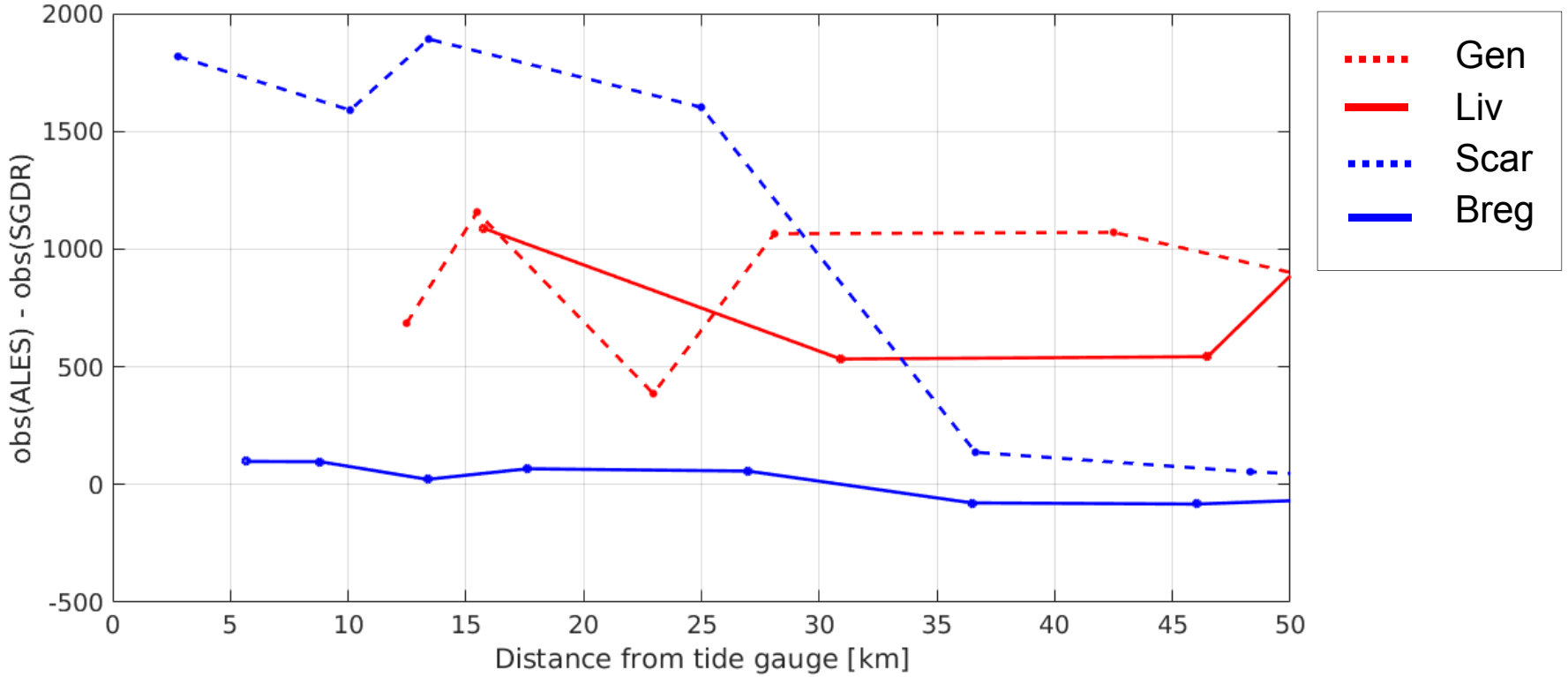
Along-track exercise: Great Britain



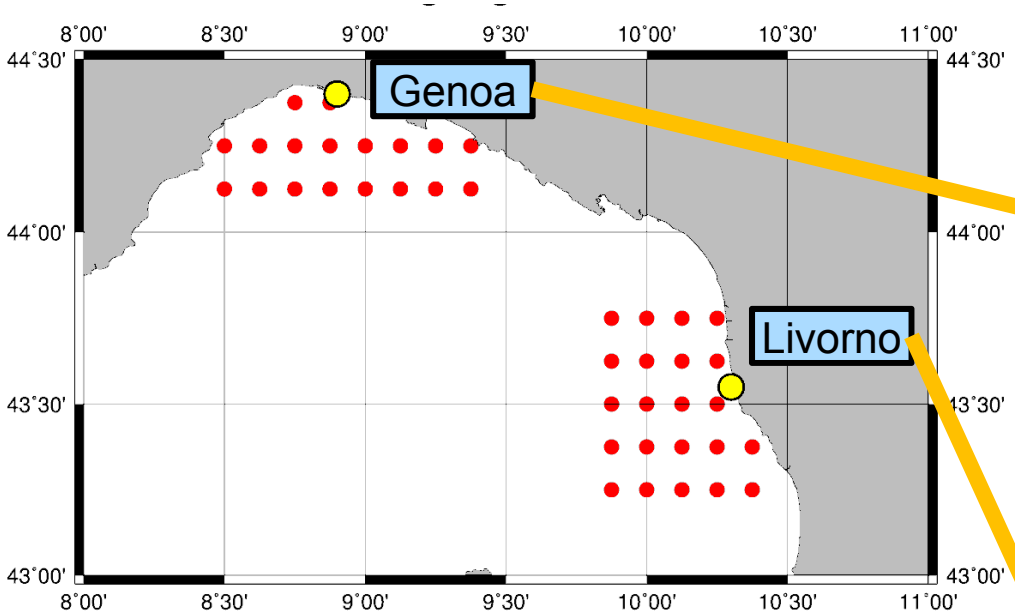


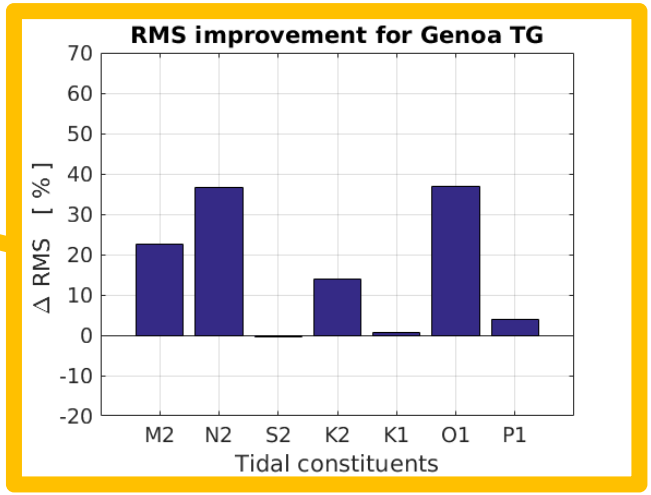


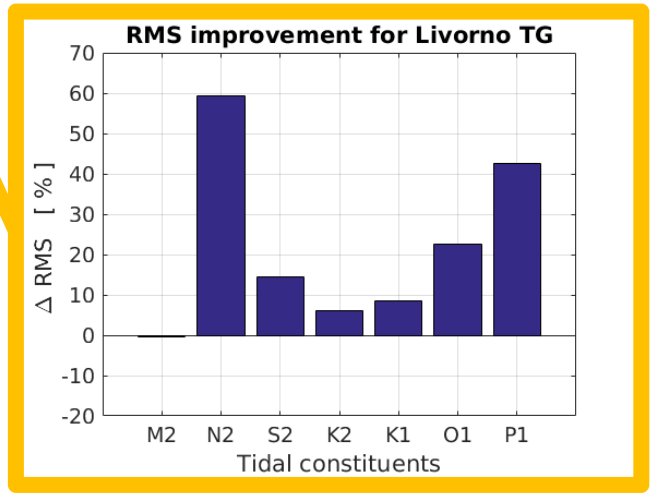
Along-track exercise: observations VS distance to tide gauge



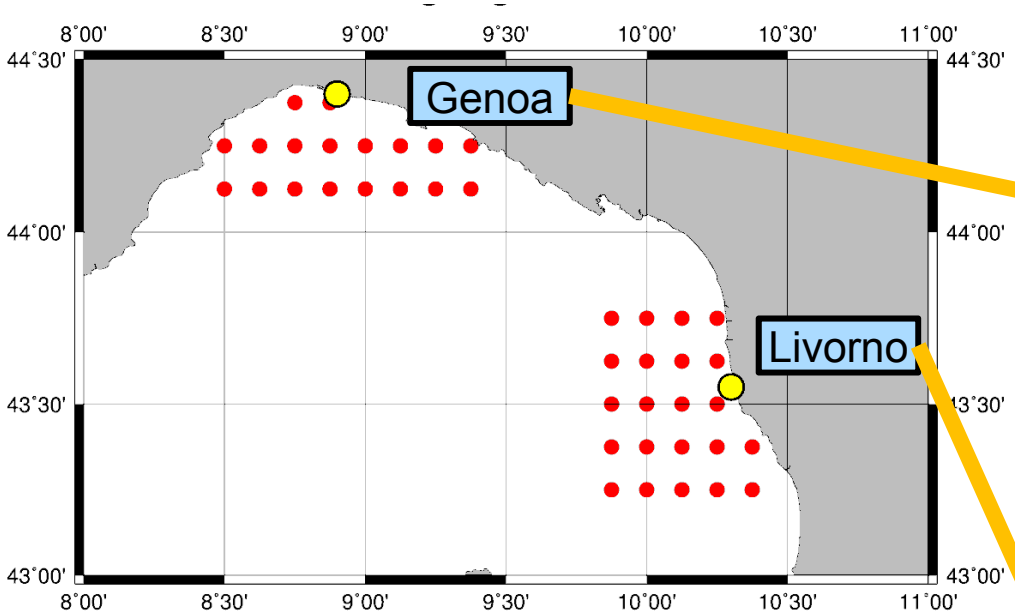
Results at grid nodes: western Italian coast



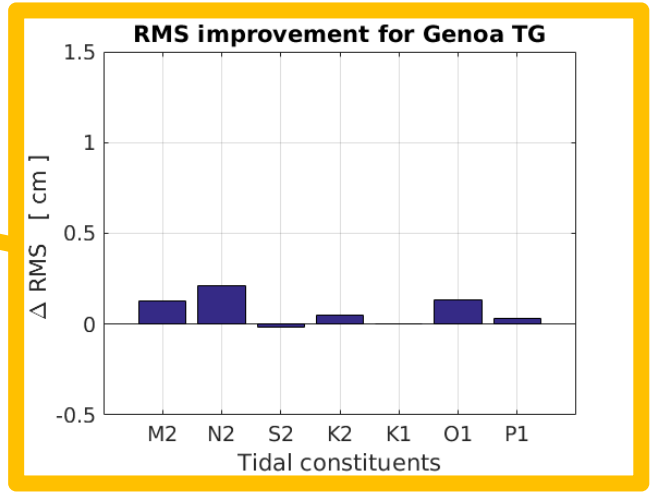


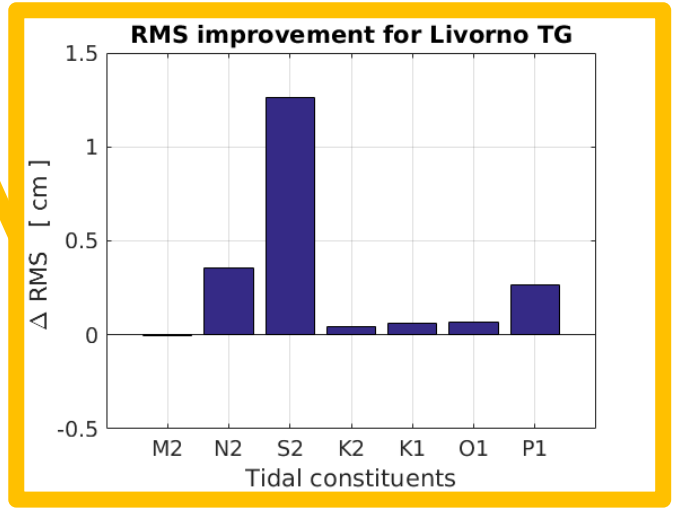


Results at grid nodes: western Italian coast

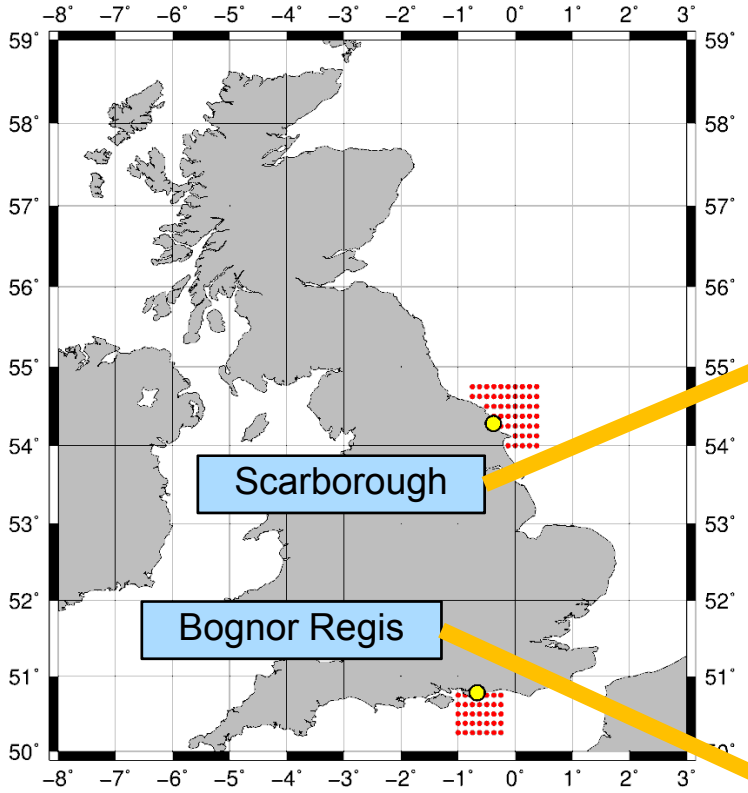


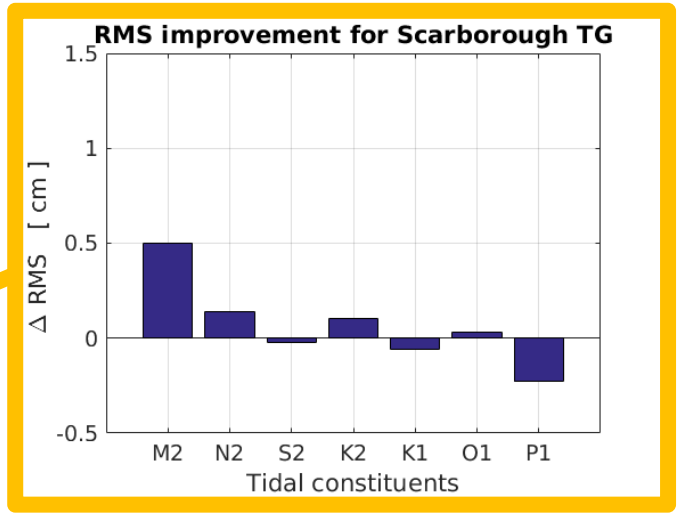
RSS [cm]	Genoa TG	Livorno TG
ALES	1.28	1.82
SGDR	1.34	2.97

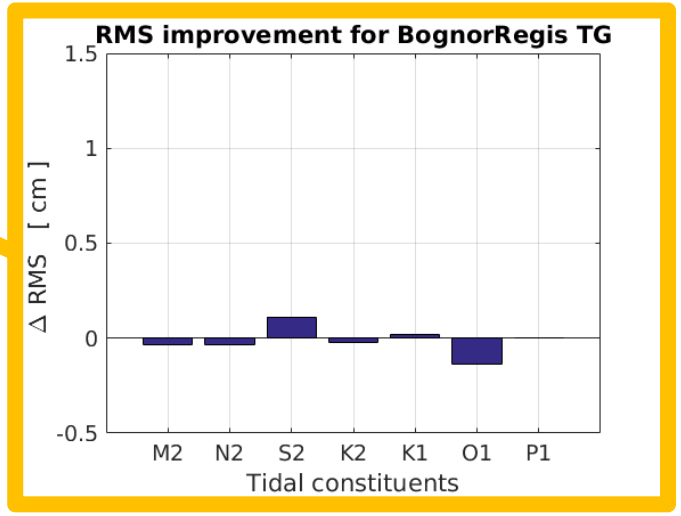




Results at grid nodes: Great Britain

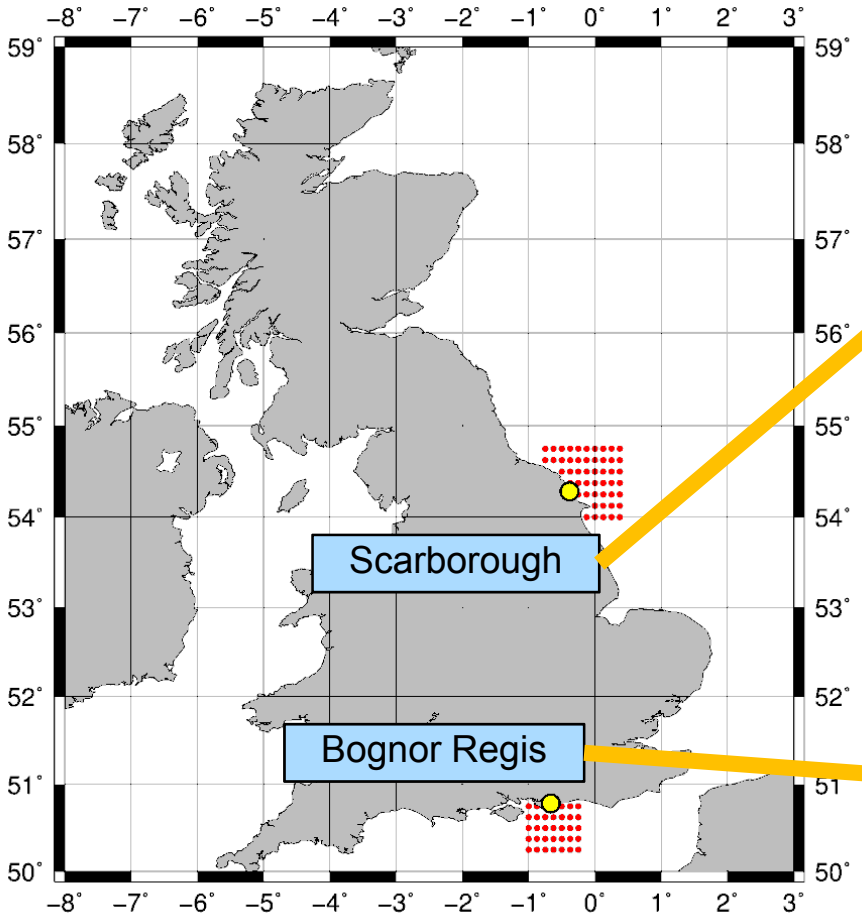


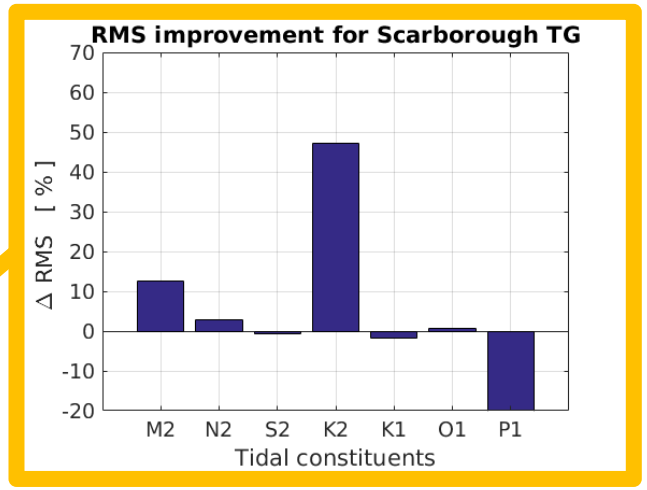


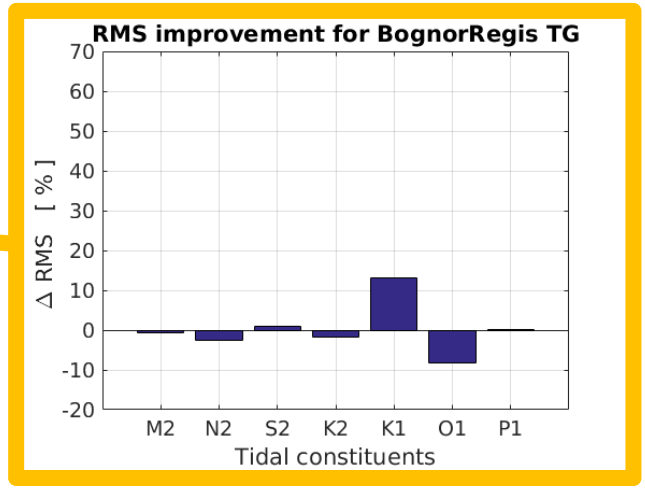


RSS [cm]	Scarb. TG	B. Regis TG
ALES	2.33	2.47
SGDR	2.36	2.46

Results at grid nodes: Great Britain







Conclusions

- General improvement of tide model with ALES retracker along-track:
  - Largest improvement at Genoa site (ΔRMS 0.3-1.2 cm → ~ 30-70 %)
  - Small impact at North Sea (ΔRMS less than 0.2 cm)

- Reduced impact for gridded solutions:
  - ΔRMS show maximum improvement of ca. 0.5 cm on single constituents
  - RSS show no notable differences except for Livorno station due to larger ΔRMS (1 cm)

- As expected, with ALES we have more along-track observations below 20 km distance from tide gauges, however no direct influence on results is found: different quality and distribution of data can affect final results

Outlook

- Extend investigation on different areas
- Along-track investigation: is the low impact in the North Sea due to tidal regime, to ALES‘s sea-state dependency?
- What are the drivers for a smoother impact at gridded solutions?
- Is the contribution of 20Hz data relevant for coastal tide modeling?
- What happens if the same investigation is applied for minor tides?
- Long-term goal: new global EOT model
  - Use FES2014 model as reference
  - Implement multi-mission approach
  - …

Thank you!