

A NEW REGIONAL MODEL IN KERGUELEN ISLAND FOR CAL/VAL ACTIVITIES

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Motivation

In the context of FOAM project (CNES), a new CAL/VAL site is proposed on the Island of Kerguelen, to complement other sites by providing CAL/VAL of altimeter height measurements in different sea-state conditions.

CalNaGeo, a GNSS towed sheet has been designed to map the Sea Surface Height (SSH). Two CalNaGeo campaigns were carried in 2016 and 2018.



Figure 1: CalNaGeo campaign, jan. 2018

To determine the precise local marine geoid, a high resolution hydrodynamic model is developed to evaluate the contribution of tide and atmospheric forcing in CalNaGeo height measurement:

$$\underset{\text{CalNaGeo}}{\text{SSH}} = \underbrace{H_{\text{Tide}} + H_{\text{Atm}}}_{\text{Model}} + H_{\text{Geoid}} + \delta H$$

Infrastructure

The site of Kerguelen is overflowed by many altimetry missions including TP/J, SARAL/AltiKa and Sentinel-3A (see next figure). In addition to CalNaGeo campaigns of 2016 and 2018, the area benefits from substantial instrumentation, including:

- ★ Permanent tide gauge at Port-au-Français (KER) since 1993, part of the ROSAME tide gauges network.
- KER16 and KER16B deployed during FOAM campaign of 2016, providing 4 years of measurements under Jason and SARAL tracks.
- Tidal Constituents computed from 10 temporary tide gauges.

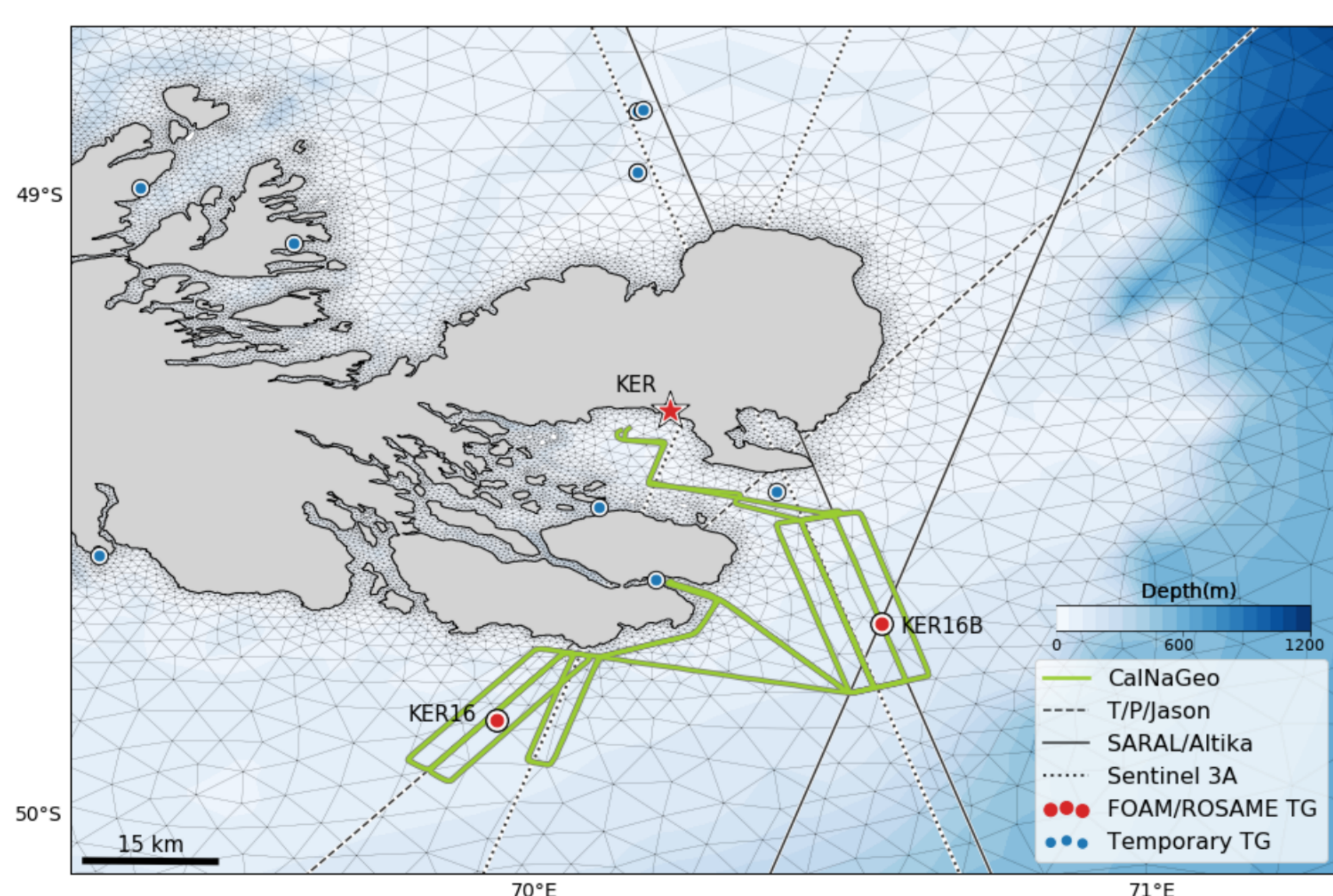


Figure 2: In-situ deployment and altimetry tracks over Kerguelen.

References

- [1] L. Testut, F. Birol, and C. Delebecque. Regional tidal modeling and evaluation of jason-2 tidal geophysical correction. *Marine Geodesy*, 35(sup1):299–313, 2012.
- [2] Y. J. Zhang, F. Ye, E. V. Stanev, and S. Grashorn. Seamless cross-scale modeling with schism. *Ocean Modelling*, 102:64–81, 2016.

Model

The model used in this study is SCHISM in the 2D barotropic mode (Zhang et Al., 2016 [2]), with an unstructured grid of 36684 elements. The resolution of meshes depends on the bathymetry and slopes, varying from 10 km in the deeper ocean to 200 m near the coastline.

Tide elevations and potential are derived from the FES2014 atlas in its assimilated version (Noveltis, Legos and CLS). Pressure and wind fields are recovered from the ERA5 reanalysis data set of ECMWF.

Tide Validation

The tide model is validated by computing complex errors [1] at 13 stations (temporary data set and FOAM/KER tide gauges). After performing harmonic analysis on observed and modeled water levels, complex errors rely on complex difference between both tidal constituents (with A and ϕ the amplitude and phase obtained by harmonic analyse):

$$|\Delta z| = |A_{obs}e^{i\phi_{obs}} - A_{mod}e^{i\phi_{mod}}|$$

The Root Sum Square (RSS) gives the combine error of the model, **RSS = 2.30 cm**.

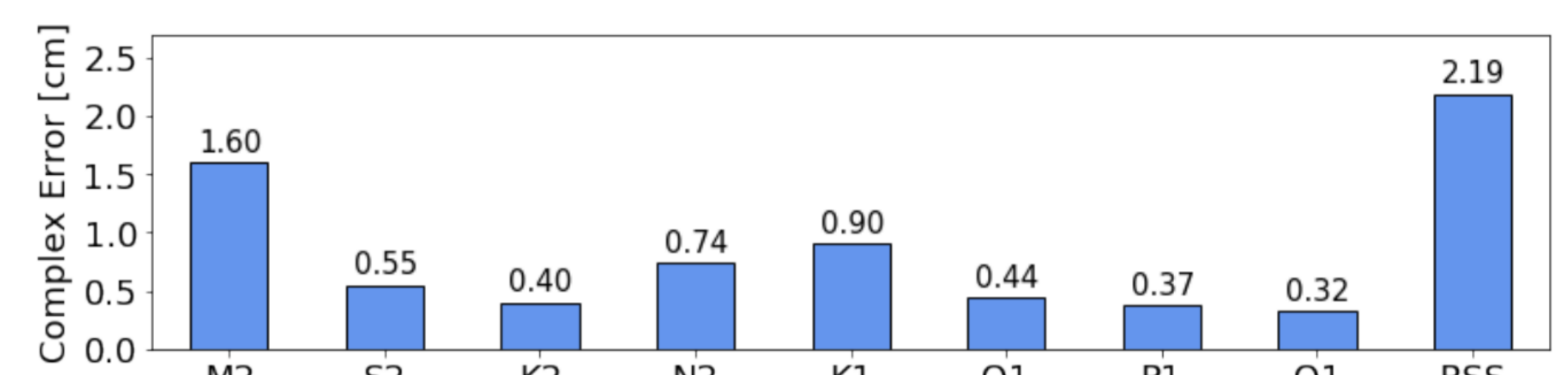
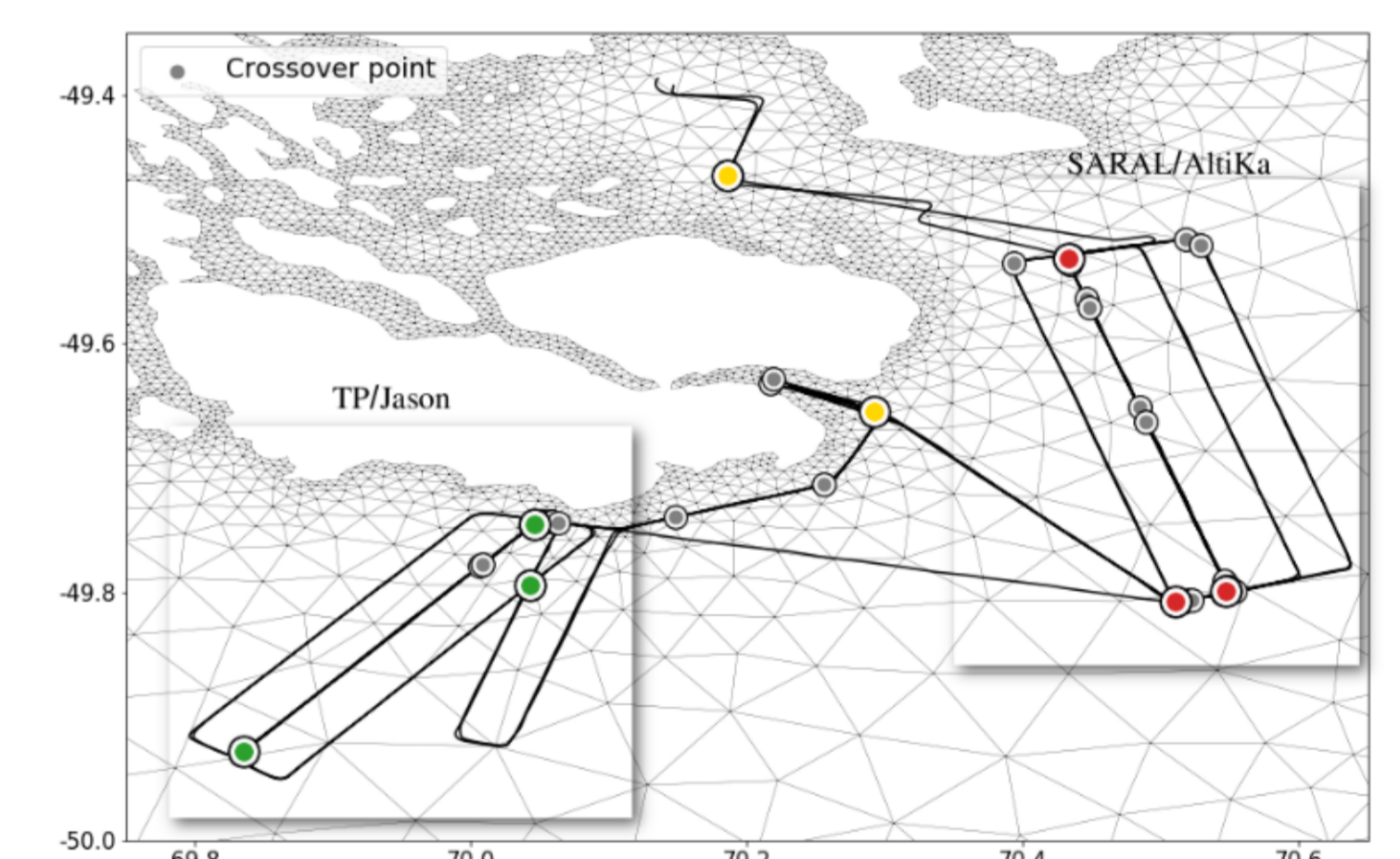


Figure 3: Complex error [cm] for the 8 major constituents

Crossover points

The second part of the 2018 CalNaGeo campaign (jan. 25-27) is an overlapping of the outward journey (jan. 23-25).

An indicator of the model ability to remove the non-stationary part of sea-level in CalNaGeo measurement is to investigate the differences at crossover points before and after corrections. At each crossover point, the standard deviation of measurements corrected by FES2014 and SCHISM is computed. Standard deviations for a subset of 8 crossover points are represented on the bar chart below.



These selected crossover point are representative of errors computed in the 3 areas (TP/Jason and SARAL/AltiKa calibration sites in addition to bayes).

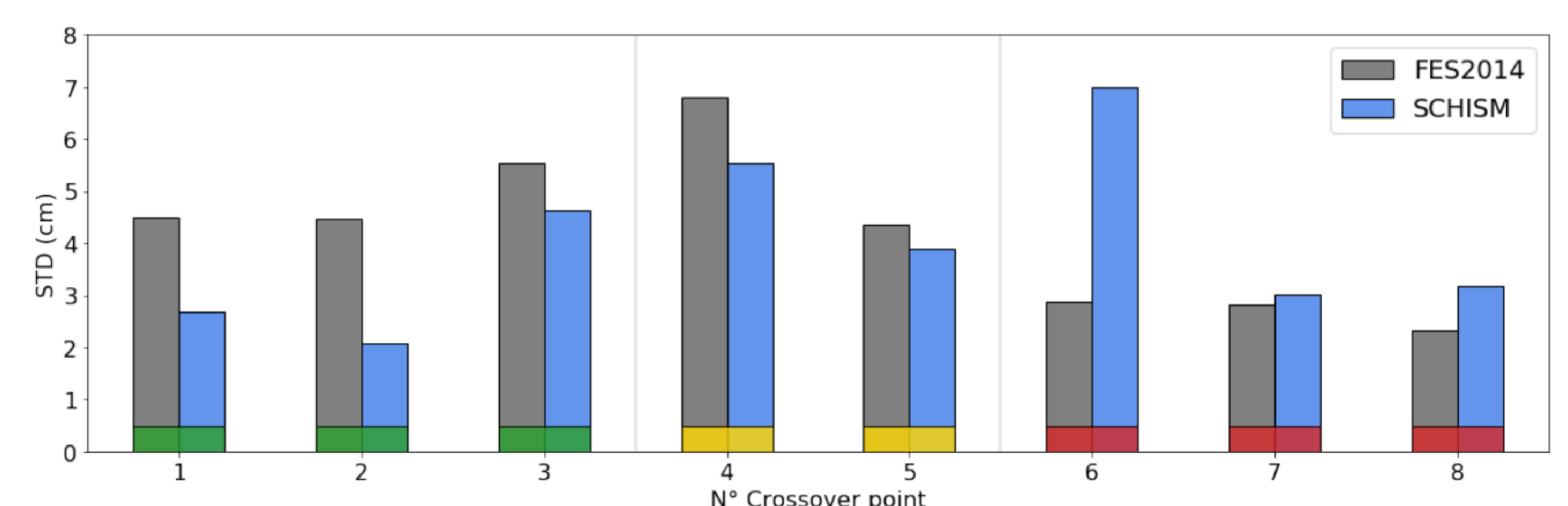


Figure 4: Standard deviation at selected crossover points, computed for CalNaGeo measurements corrected from FES2014 and SCHISM.

For each calibration area, the RMSE is computed by averaging standard deviations of all included crossover points. On the TP/Jason area, **RMSE = 3.3 cm** for SCHISM against **4.8 cm** for FES2014. It represents a gain in accuracy of almost 1.5 cm. However, our results are worse than expected in the SARAL/AltiKa area with a RMSE of **4 cm** for SCHISM model against **2.7 cm** for FES2014.

While first results are promising for CAL/VAL operations on TP/Jason, the tide model has to be improved by investigating the spatial disparities in errors which affect especially the SARAL/AltiKa calibration area.

The work is conducted in the framework of the CNES project FOAM (From Ocean to inland waters Altimetry Monitoring).