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Geodetic instrumentation to validate altimetry sea-level measurements in the Noumea Lagoon – New results from the GEOCEAN-NC 2019 campaign

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- New results from the GEOCEAN-NC 2019 campaign -

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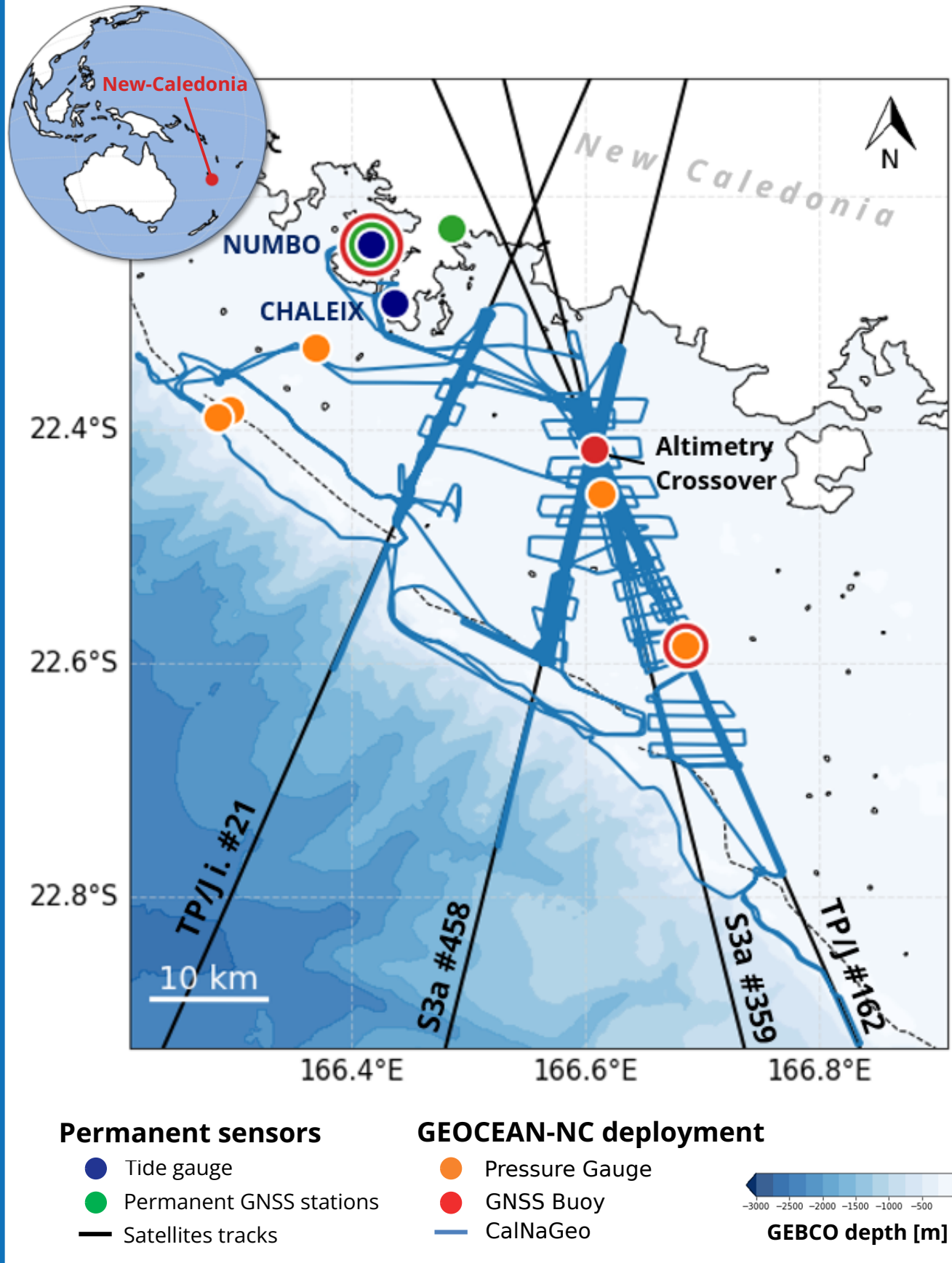


Context

Today, monitoring the evolution of sea level in coastal areas is of importance, since almost 11% of the world's population live in low-lying areas (i.e. < 10m above sea level) [1]. Reducing uncertainties in sea level estimates requires a better understanding of both altimetry measurements and local sea level dynamics. In New-Caledonia, the GEOCEAN-NC 2019 campaign addresses these issues with the deployment of various geodetic sea level observing systems (e.g. GNSS Buoy, pressure sensor, CalNaGeo GNSS towed carpet), with a particular focus on the intersection of 3 altimetric tracks (i.e. 1 Jason and 2 Sentinel-3a tracks). This work presents a method inspired from altimetry validation studies to re-analyse about 20 years of altimetry data and re-address the question of sea level evolution in the lagoon.

Geodetic instrumentation in the Lagoon

GEOCEAN-NC Campaign



New-Caledonia and the Noumea Lagoon

- World largest lagoon (24.000 km²)
- Near Nouméa : Average depth ~20m
- Tidal range [0,6 - 1,4m]

Satellites measurements

- Nadir missions (TOPEX, Jason, Sentinel, etc.)
- SWOT Cal/Val path and planned field campaign [2]

➔ Crossover point Jason / Sentinel-3a

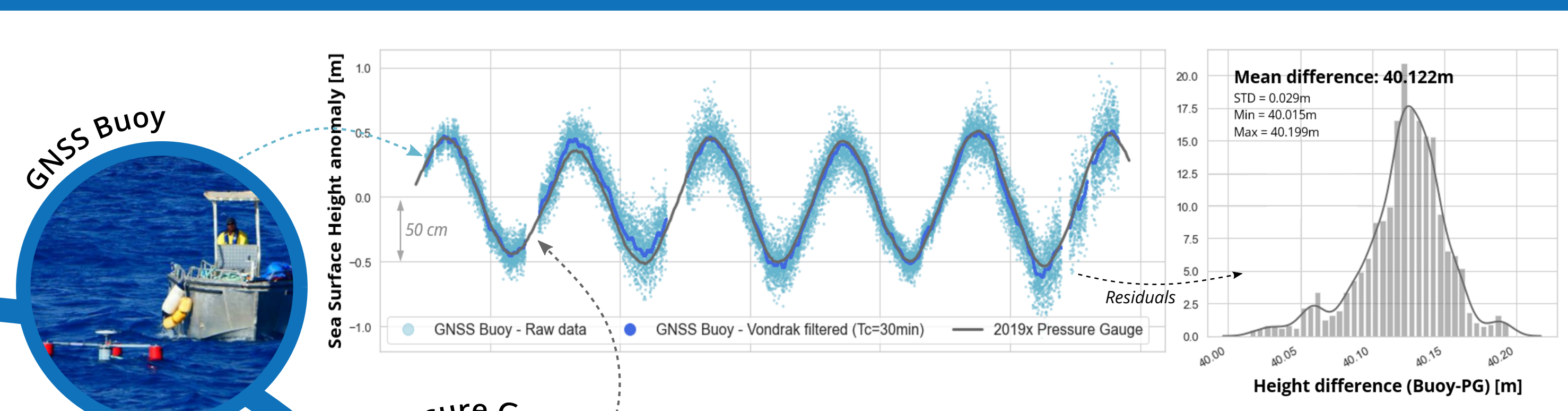
GEOCEAN-NC 2019

- 3 weeks field campaign onboard N/O ALIS

➔ Address the question of long-term sea level evolution in the lagoon

In situ geodetic measurements

1 Link pressure sensor observation to a global reference frame by comparing with GNSS buoy data over their common observation period



GNSS Buoy

- 3 days measurements at the satellite crossover point
- Processing in PPP mode using GINS software [3]

Pressure gauge

- SBE 26 plus deployed at 20m depth over 1 year
- Tidal correction to account for tidal differences between the buoy and the pressure gauge location (~ 4km)

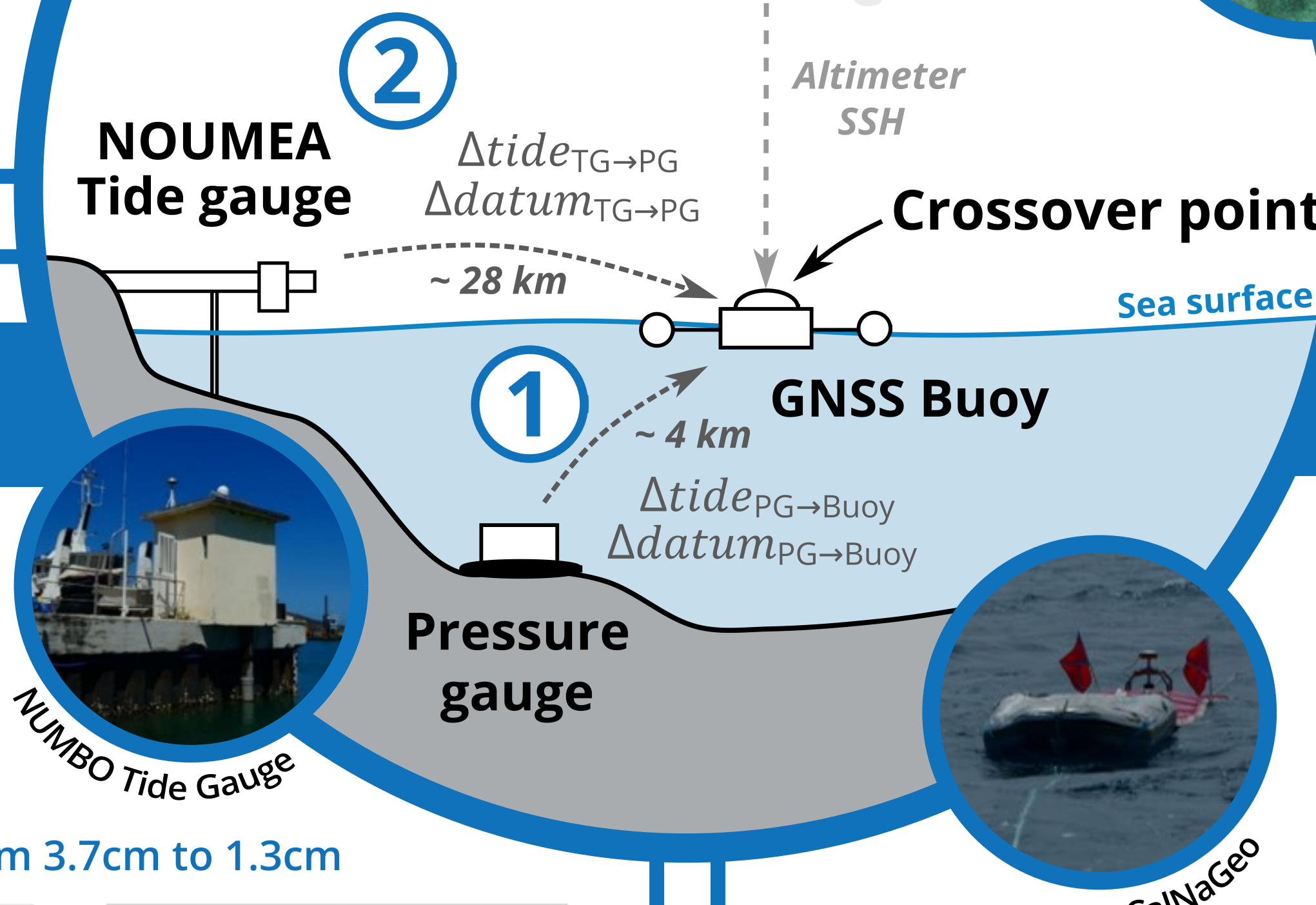
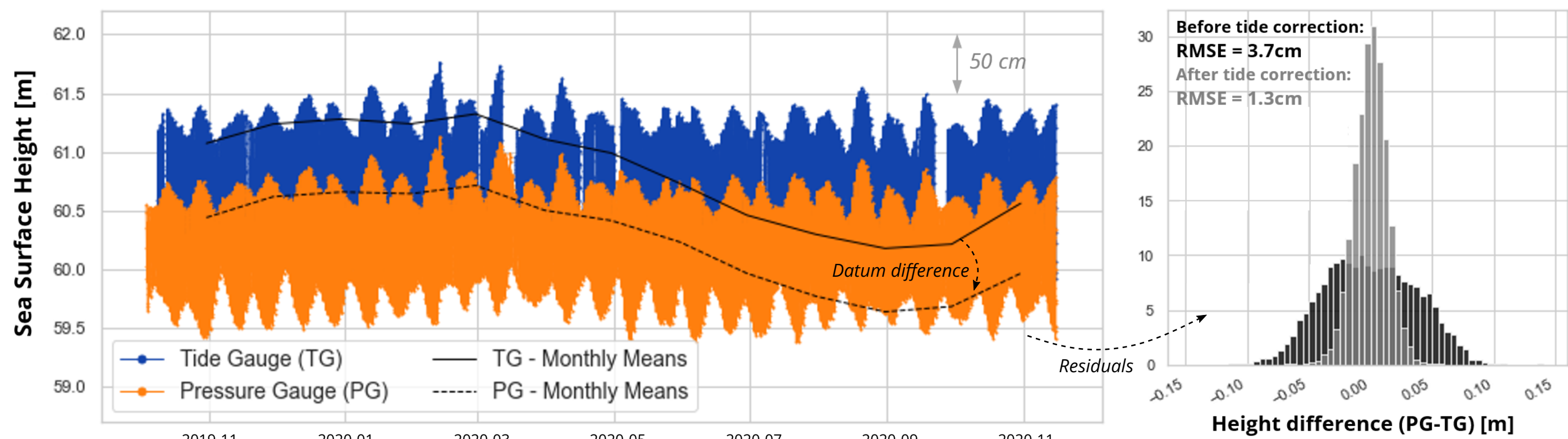
➔ Basis of the absolute referencing of the in situ observations

Noumea Tide gauge

2 Compute a tidal gradient (amplitude and phase) and a datum correction between the pressure gauge and the Noumea tide gauge

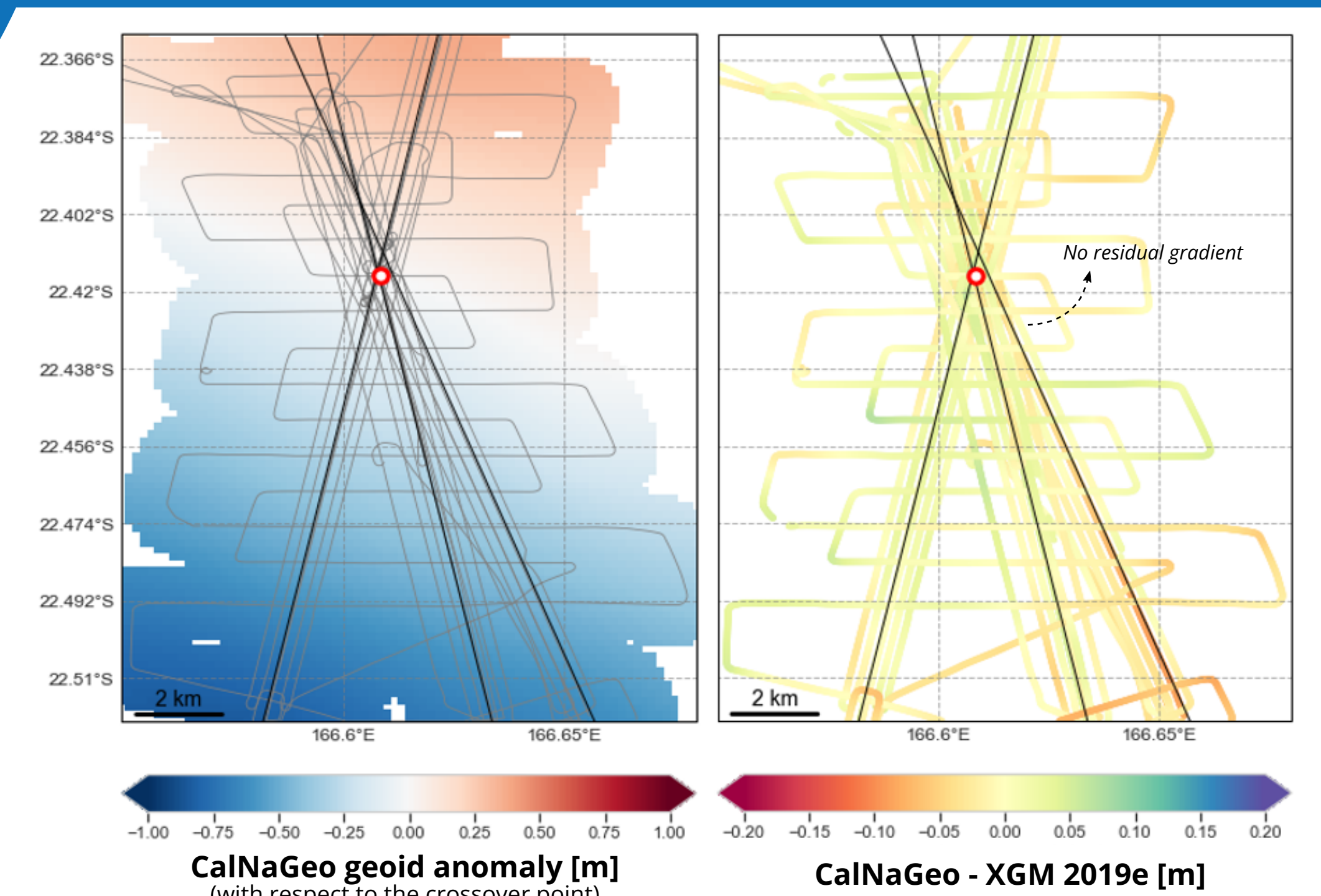
- Long-term sea level time series [1957-present] : Chaleix and Numbo tide gauges observations linked by Aucan et al. (2017) [4]
- Harmonic analysis over [Pressure gauge - Tide gauge] residuals
- Datum correction : 57.1 cm (consistent wrt. geoid models estimates)
- Tidal gradient : main difference of M2 (~4.5cm) and S2 (~1.7cm)

➔ Application of tidal gradient reduce RMSE on residuals from 3.7cm to 1.3cm



CalNaGeo survey

3 Validate XGM 2019e gravity field model [7] in our area to account for geoid gradient in altimetry measurements



CalNaGeo

- GNSS floating carpet towed by N/O ALIS
- Map sea surface in motion in various sea and weather conditions [5,6]
- Processing in PPP mode using GINS software [3]

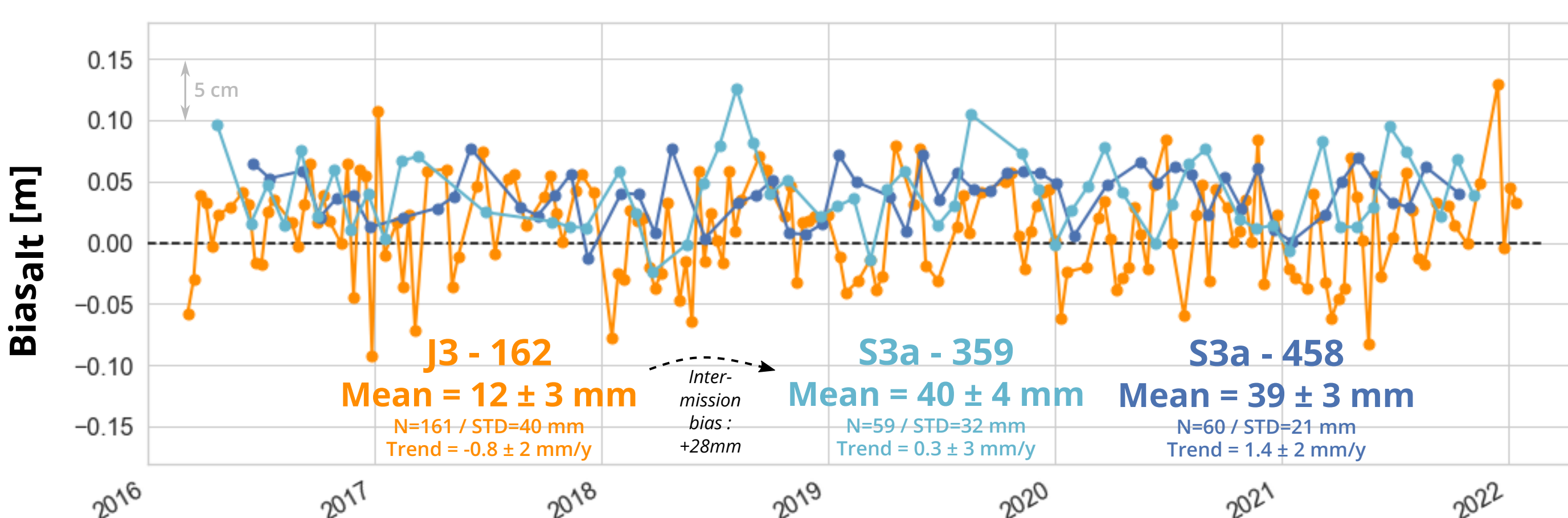
Altimetry validation

Multi-mission comparison

Altimetry data

- GDR long-track data processing to derive SSH_{alt} at the crossover point
- Validation of radiometer wet tropospheric delays compared to GNSS and ECMWF model estimates
- Atmospheric and geophysical corrections from GDR (ionospheric delay, sea state bias, solid earth tide, etc.)

$$\text{Bias}_{\text{alt}} = \text{SSH}_{\text{alt}} - \text{SSH}_{\text{in situ}}$$



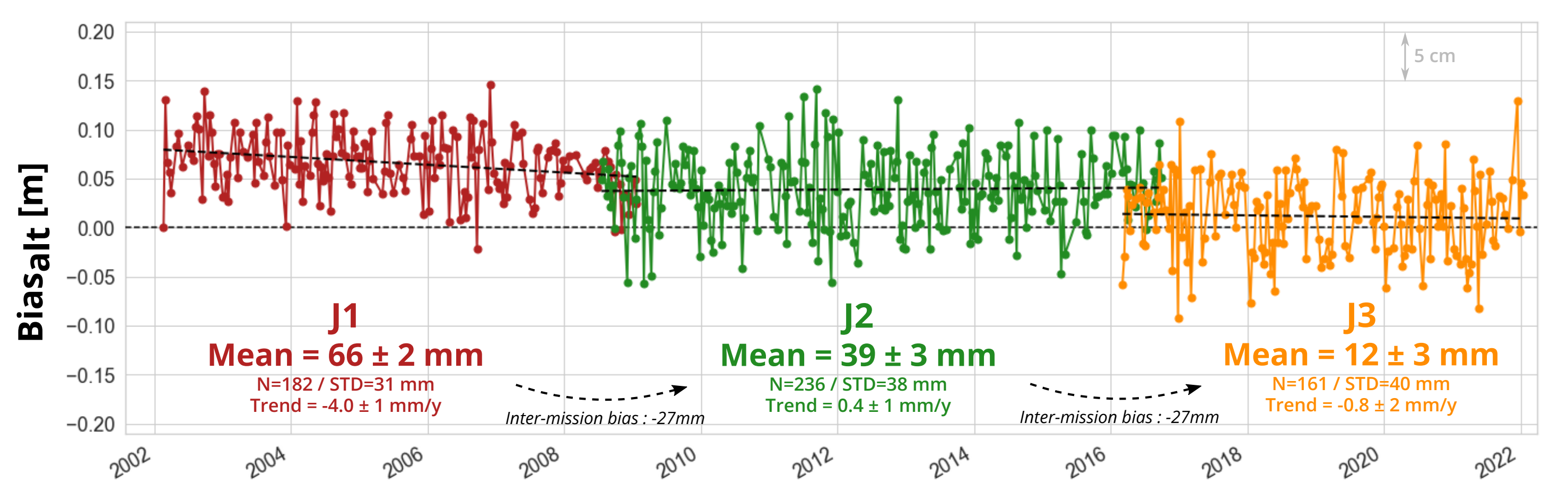
➔ Mean biases and inter-mission biases estimates in line with historical Cal/Val sites

Long-term comparison

Long-term sea level evolution in Noumea Lagoon

- Altimetry, tide gauges and land-based GNSS stations do not provide consistent informations
- Uplift of 1.41 mm/y [1993-2013] from altimetry and tide gauge difference [4]
- Subsidence around -1.3 mm/y from nearby permanent GNSS stations [8,9]

$$\text{Bias}_{\text{alt}} \sim \text{VLM@TG}$$



➔ VLM linear trend of -0.2 ± 0.1 mm/y [2002-2022] over the Jason 1/2/3 period

Conclusion

Method to re-analyse 20 years of altimetry data in Noumea Lagoon with a 3 weeks field campaign

- Altimeter biases and inter-mission biases consistent with historical Cal/Val sites

What's next ?

- Better constrain the absolute bias estimate and consolidate the vertical datum
- Extend the comparison with TOPEX/Poseidon, Sentinel 6 and SAR measurements
- Computation of a Mean Sea Surface model using CalNaGeo measurements
- Extend the comparison to other sites

	J1	J2	J3	S3a
Harvest	+12 ± 2	+8 ± 2	+14 ± 2	-
Corsica	+43 ± 3	+16 ± 2	+4 ± 2	+22 ± 4
Bass Strait	+41 ± 2	+15 ± 2	-4 ± 2	+25 ± 2
Noumea	+66 ± 2	+39 ± 3	+12 ± 3	+40 ± 4 (#359) +39 ± 3 (#458)

Altimeter mean biases for the 3 historical Cal/Val sites [10]

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