CALIBRATION OF SENTINEL-3 ALTIMETER DATA USING A CORNER REFLECTOR

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Introduction

Corner reflectors (CR) are commonly used to calibrate and characterize the quality of SAR images. With the Fully Focused SAR (FFSAR) method, the along-track resolution is now sufficient enough for CR to be detected by altimeters, opening new possibility for altimetry calibration with CR.
CR are passive devices offering some advantages: maintenance is reduced, there is no deformation of the across-track impulse response, there is no need in regular calibration as it is the case for transponders' internal path delay or antenna gain… Also, because the signal is only backscattered and not amplified, CR theoretically allow for the calibration and the monitoring of the absolute sigma0.

With all these advantages and this new opportunity of calibration, CNES has decided the development of a CR dedicated to SAR altimetry calibration.

Experimentation description

CR Design

Square-side trihedral CR

- L = 2m
- $RCS = \frac{12\pi L^4}{\lambda^2} = 61\ dBm^2$ for Ku

Manufactured in 2019 with Luntech

Site

Specification

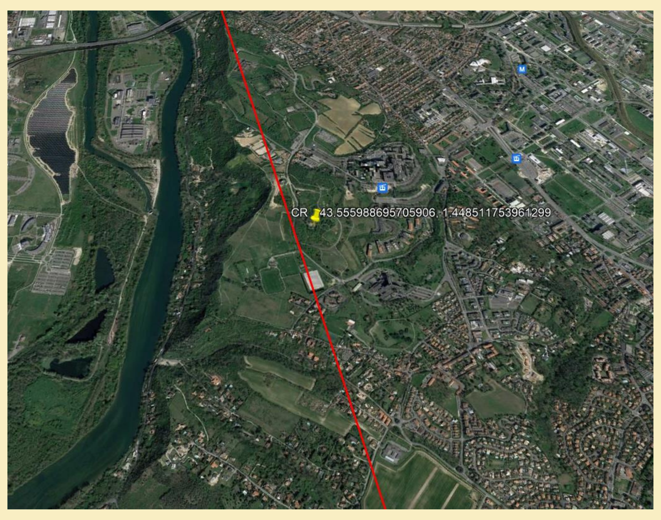
- Under S3 tracks
- Weak clutter
- Local topography

Location: Toulouse

- Distance to the theoretical track: 1.56 km
- OLTC update with CR location

Deployed: 10/08/2020

About one year of S3 data



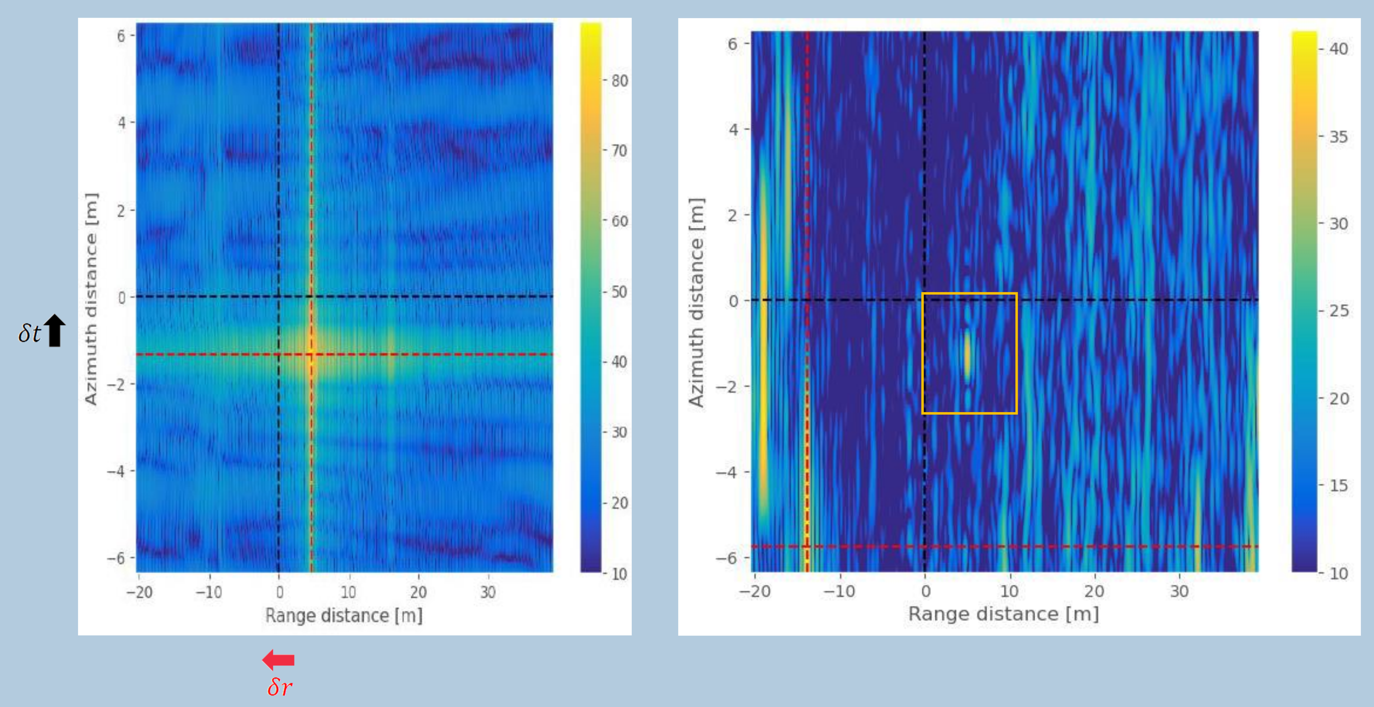
Method and Results

The **SMAP** (Standalone Multi-mission Altimetry Processor) processing tool is used [1].

Back-projection is used as the clutter level is lower compared to omega-kappa [2].

We use a **PTR based method to retrieve the δr range bias and the δt datation bias** (figure below; full stack radargam method is too noisy for CR).

To avoid false detections with brighter targets, we restrain our research of peak position around the CR position.



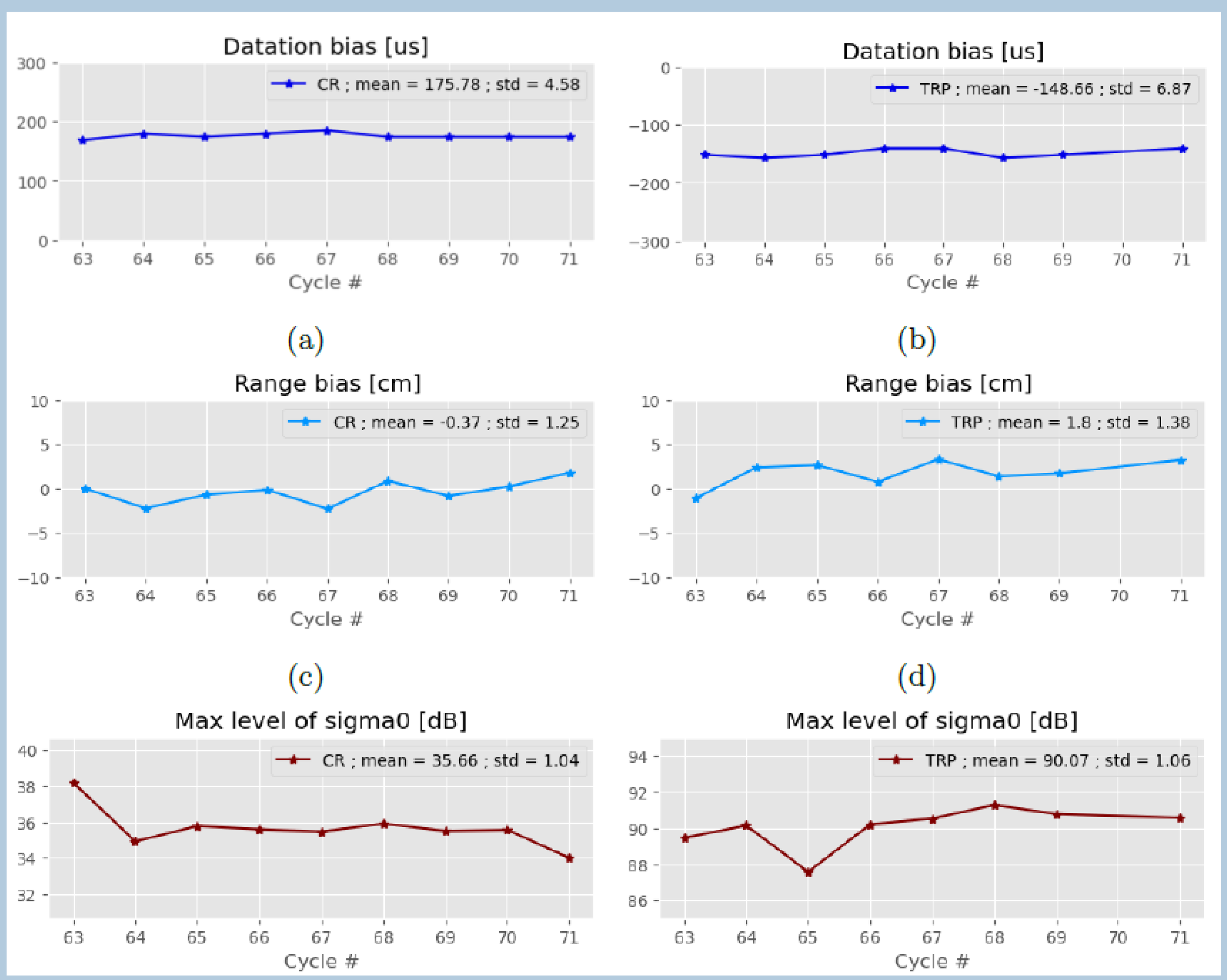
The internal path delay of the transponder (TRP) is provided by the Technical University of Crete. For the CR, we correct from the distance between the GNSS acquisition and the CR phase center position.

Range bias is corrected from geophysical corrections extracted from the operation products. Sigma0 is corrected from the scale factor, the atmospheric attenuation and the antenna pattern.

IR shape and size parameters: perfect sinc squared shape in range for the CR, same resolutions for both CR and TRP (42cm and 62cm respectively in range and azimuth).

Range and datation biases are well estimated with CR data and have the same level of stability than the TRP data.

CR should theoretically allows for the absolute sigma0 monitoring (while sigma0 is amplified on TRP). The sigma0 estimated on the CR is of 35.66dB with an uncertainty of about 1dB. Instabilities may be due to CR plates' distortion (e.g. thermoselastics effects), but longer time series and deeper analysis are needed to validate this assumption [3, 4].



Conclusions

This first very successful experience of altimetry calibration with CR opens new possibility to install such passive devices in combination with active devices.

CNES is now looking for another place in the Pyrenees to re-deploy the CR. The place will be situated under a Sentinel-6 cross-over, allowing for calibration under both ascending and descending tracks.

CNES CR has also be detected by the SWOT KaRin instrument during SWOT CalVal phase. CR band independency is a key advantage for future multi-band altimeter calibration (e.g. Cristal).

References

[1] Rieu et al. (2021)
https://doi.org/10.5270/esa-cnes.sentinel-3.smap
[2] Egido A. and Smith W. (2017)
https://doi.org/10.1109/TGRS.2016.2607122
[3] Maraldi et al. (2023). Corner reflector analysis on Sentinel-3. 2023 Sentinel-3 altimetry Council Meeting.
[4] Mertikas et al., in preparation. The TPX group: an international network of experts with ground reference transponders and corner reflectors for calibrating and monitoring performance of the Sentinel-6 satellite altimeter.