The Sentinel-3A SRAL Instrument calibration Monitoring

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ABSTRACT

The Sentinel-3A is the most recent altimetric mission of a long historical series, and the first altimeter of the Copernicus constellation. It is well known the crucial importance of the instrumental calibration when processing the altimeter data, in order to produce reliable and accurate L2 geophysical retrievals, such as sea surface height, significant wave height, or wind speed over the oceans.

isardSAT, as ESA Expert Support Laboratory within the Sentinel-3A Mission Performance Centre team, is responsible for monitor the calibration parameters during the Sentinel-3A mission. This poster presents the results of the first 22 cycles of Sentinel-3A SRAL instrument Calibration Monitoring, data acquired during the Commissioning and Routine Phases.

The SRAL altimeter operates in two modes, LRM (low resolution) and SAR (high resolution), and in two frequency bands, Ku and C. For the 4 combinations, CAL-1, CAL-2 and Autocal calibration modes are monitored and analysed from L1b data. Also the on-board thermal variations and USO frequency are monitored. Tracker performance is studied at L2 stage.

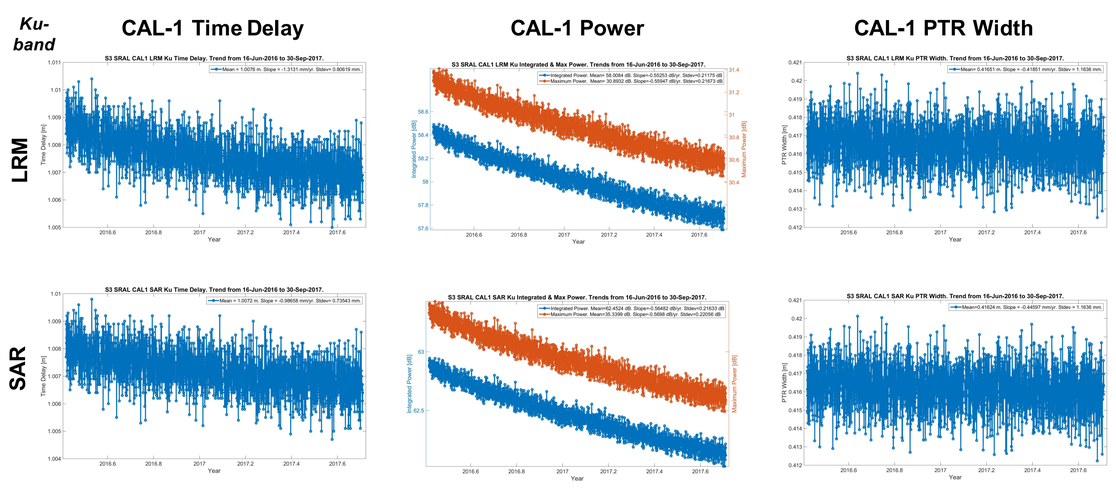
CAL-1

All calibration parameters impacting the L2 science data and a large set of secondary parameters are monitored by cycles. Here are the main:

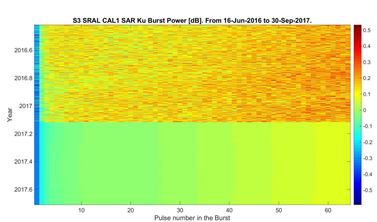
CAL-1 Time Delay → direct impact on the range (hence, the L2 variable Sea Surface Height), as an additive term.

CAL-1 Power → The winds (sigma naught) and waves (Significant Wave Height) estimates at L2 are impacted by this calibration parameter.

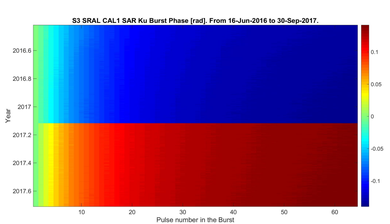
CAL-1 PTR width → The main L2 variable impacted is the Significant Wave Height, through the retracking processing.



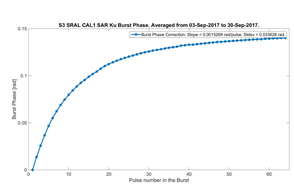
CAL-1 burst corrections (only SAR mode, Ku band). Corrects for the power and phase variations over a burst. A code fix has been applied on cycle 15.



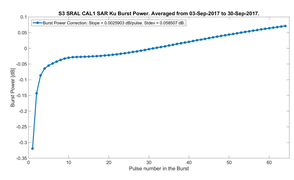
CAL-1 power burst correction along the mission



CAL-1 phase burst correction along the mission



CAL-1 phase burst correction shape. Cycle 22.

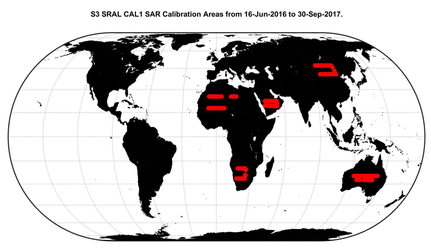


CAL-1 power burst correction shape. Cycle 22.

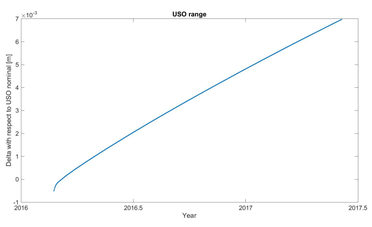
Whole mission CAL-1 parameters statistics:

Calibration Parameter	Ku band			C band		
	mean	annual slope	standard deviation	mean	annual slope	standard deviation
LRM CAL1 time delay	1.0076 m	-1.31 mm	0.81 mm	0.8933 m	-0.69 mm	2.81 mm
SAR CAL1 time delay	1.0072 m	-0.99 mm	0.74 mm	0.8939 m	-0.54 mm	2.81 mm
LRM CAL1 power	58.01 dB	-0.55 dB	0.21 dB	51.43 dB	0.01 dB	0.22 dB
SAR CAL1 power	62.45 dB	-0.56 dB	0.22 dB	48.93 dB	0.01 dB	0.22 dB
LRM CAL1 PTR width	0.4165 m	-0.42 mm	1.16 mm	0.4547 m	-0.25 mm	6.93 mm
SAR CAL1 PTR width	0.4162 m	-0.45 mm	1.16 mm	0.4546 m	-0.27 mm	6.92 mm

Notable better performance of the main band, the Ku band. Similar results for both modes in each of the bands.



USO

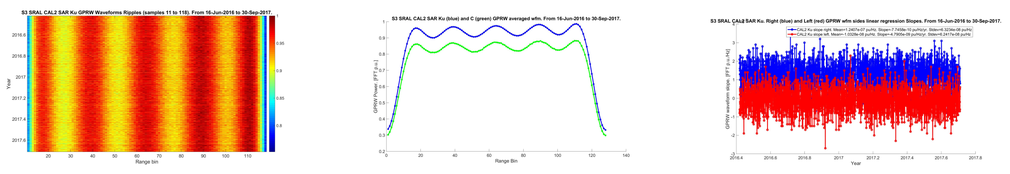


The USO (Ultra-Stable Oscillator) clock frequency has a multiplicative impact on the range, and therefore at L2 variable Sea Surface Height. The USO clock performance in the figure has been plotted considering a Long Term Monitoring USO Auxiliary File (DELTAF_MOD field) with date 2017/06/06. The conversion from Hz to meters of range has been done considering a circular orbit at 815 Km over a spherical Earth. A drift of around 0.5 cm / year is observed.

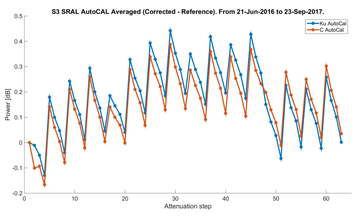
CAL-2

The CAL-2 waveform represents the System Transfer Function of the instrument.

Here below are, from left to right: the CAL-2 Ku-band ripples, the CAL-2 waveforms of both bands (green is C-band, blue is Ku-band) averaging the whole mission and the CAL-2 sides slopes along the mission.

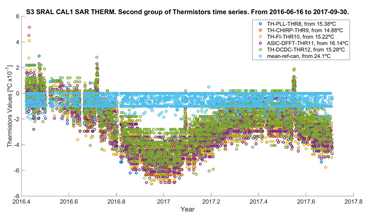


AUTOCAL



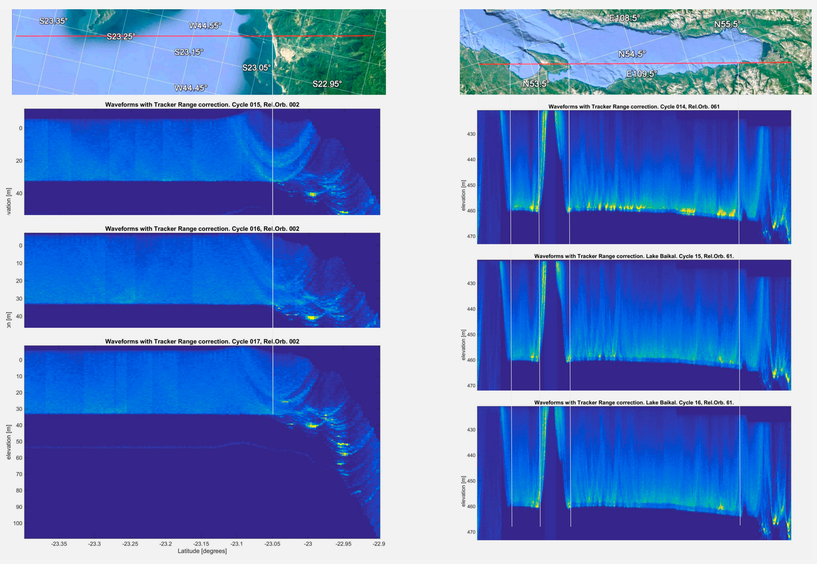
The ideal and real **Attenuation Tables** are present in the L1b products for the two bands, Ku and C. If we subtract one table to the other, we can observe how far the real attenuation values are from the ideal values. An average of this subtraction during the analysis period is shown in the figure.

THERMAL BEHAVIOUR



Temperatures on-board retrieved from the thermistors located in the different sections of the on-board HW, are analysed in order to check the relation of any calibration parameters anomaly with the thermal behaviour, and find solutions for modelling the instrument characterisation (for instance orbital oscillations) if needed.

ON-BOARD TRACKER



Brazilian Coast **Baikal Lake**

L2 enhanced products (PLRM waveforms) have been used for this study about the performance of the **On-Board Tracker**. Different scenarios are analysed over inland waters and over coastal regions, where the on-board tracking is specially interesting to be assessed, regarding a potential lose of track or the tracking of non expected targets (e.g. off-nadir targets, farther specular surfaces, backward locked facets).

CONCLUSIONS

All Calibration parameters are monitored during the Commissioning and Routine Phase. Every cycle a Monitoring Reports is delivered analysing cyclic and whole mission instrument performances, including CAL1, CAL2, Autocal, USO, and calibration with the TRP. All cyclic reports are available at:
https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-altimetry/data-quality-reports

- CAL-1 parameters show a nominal behaviour, showing at Ku-band better data stability (lower standard deviation) and also more signs of ageing (higher trends in absolute terms).
- CAL-1 power is the only variable with a remarkable long term drift, the power is decreasing. At BOM the trend was steeper (-1 dB/year), but becoming more stable in time.
- The transfer function CAL-2 waveform shows a nominal status, with a similar shape with respect to the one measured on ground.
- The thermal data shows a certain annual behaviour with some bumps that are not correlated to significant changes in calibration parameters.
- The on-board tracker performance shows a normal behaviour, although more parameters of the on-board tracker would be necessary for a more thorough study.
- The USO frequency shows a drift of around half a centimeter per year in terms of impact in the range (SSH).

Acknowledgments: Graham Quartly. PML, Plymouth, UK. / Sylvie Labroue, CLS, Toulouse, France.
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