SENTINEL-6-MF POSEIDON-4 MAIN RESULTS FROM THE FIRST YEAR OF MISSION FROM THE S6PP LRM AND UF-SAR CHAIN

Salvatore Dinardo [1], Emeline Cadier [1], Thomas Moreau [1], Claire Maraldi [2], Francois Boy [2], Picot N.[2]

Email address: sdinardo@groupcls.com

[1]CLS, [2]CNES

Introduction

Sentinel-6 is an Earth Observation satellite constellation part of the EU Copernicus Programme. The first satellite of the Sentinel-6 constellation (Sentinel-6 Michael Freilich, in short S6-MF) has been launched on 21 November 2020.
The S6-MF satellite embarks as main scientific payload the sensor Poseidon-4 (POS4) which is a dual frequency redundant radar altimeter. It represents a significant breakthrough with respect to its predecessors Jason-class altimeters thanks to its digital architecture based on an on-board digital matched-filtering. In the frame of the exploitation of the Sentinel-6-MF altimetry mission, CNES has contracted CLS for the development of the Sentinel-6 Processing Prototype (S6PP). S6PP is a multi-chain (LRM, UF-SAR, FF-SAR, Pulse-Pair, Transponder) processor in which the novel algorithms developed in the CNES/CLS R&D activities are implemented and validated in support to the different thematic applications (in particular inland water and ocean) and in view of promoting them for a possible implementation in operational ground segment.

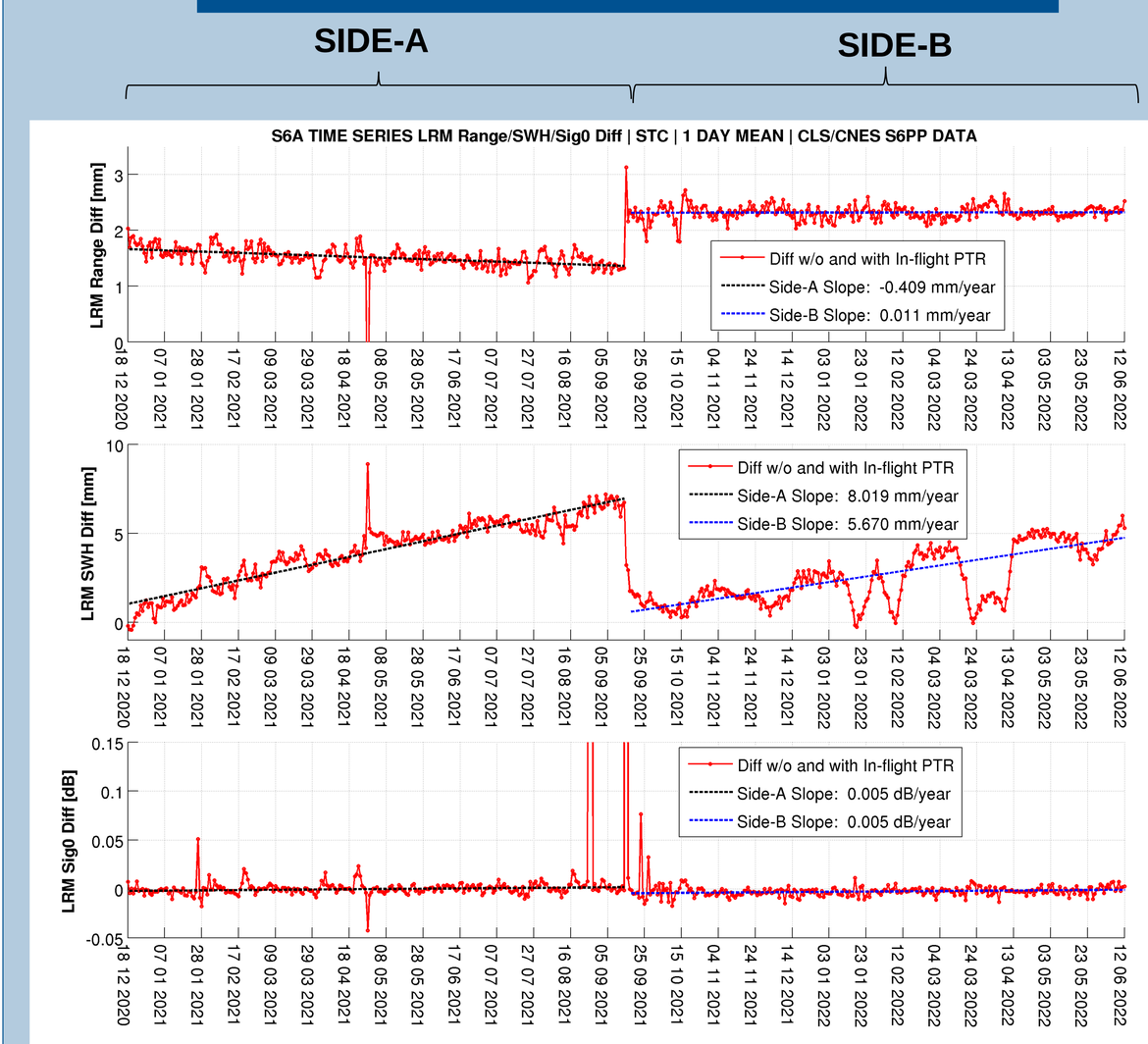
LRM Processing Baseline

- ❑Antenna aperture in Ku-band: **1.34** degrees (PDAP 1.33 deg)
- ❑Numerical Retracking [4] with interface to **ECHO-CAL PTR**
- ❑Retracking window size in Ku-band: [2:140], same as PDAP
- ❑Thermal noise window: [2:12], same as PDAP
- ❑Skewness in retracking: 0.1 , same as PDAP
- ❑Negative SWH -> Yes, same as PDAP
- ❑No Pulse-to-Pulse Correlation Correction

UF-SAR Processing Baseline

- ❑Antenna aperture in Ku-band: **1.34** degrees (PDAP 1.33 deg)
- ❑Numerical Retracking [4] with interface to **ECHO-CAL PTR**
- ❑Retracking window size in Ku-band: [10:132], same as PDAP
- ❑Thermal noise window: [12:16], same as PDAP
- ❑Skewness in retracking: **0.1** , **0.0** in PDAP
- ❑Negative SWH -> Yes, same as PDAP
- ❑Range-Walk applied via **CZT**
- ❑Number of look (stack subset): **448** (full-stack)
- ❑Doppler Ambiguities **not masked-out** (but **modellized** in the waveform's model)
- ❑Beam-Sampling **3** out of 7 (1 out of 7 in PDAP)
- ❑Mispointing: pitch = **-0.005** deg and roll **0.03** deg (mispointing null in PDAP)

PTR Stability Analysis



Dis-symmetries in the sidelobes of the PTR and/or evolution of the PTR main lobe can give a rise to a drift in the altimetry GMSL (Global Mean Sea Level) measurement in LRM and UF-SAR mode [2].

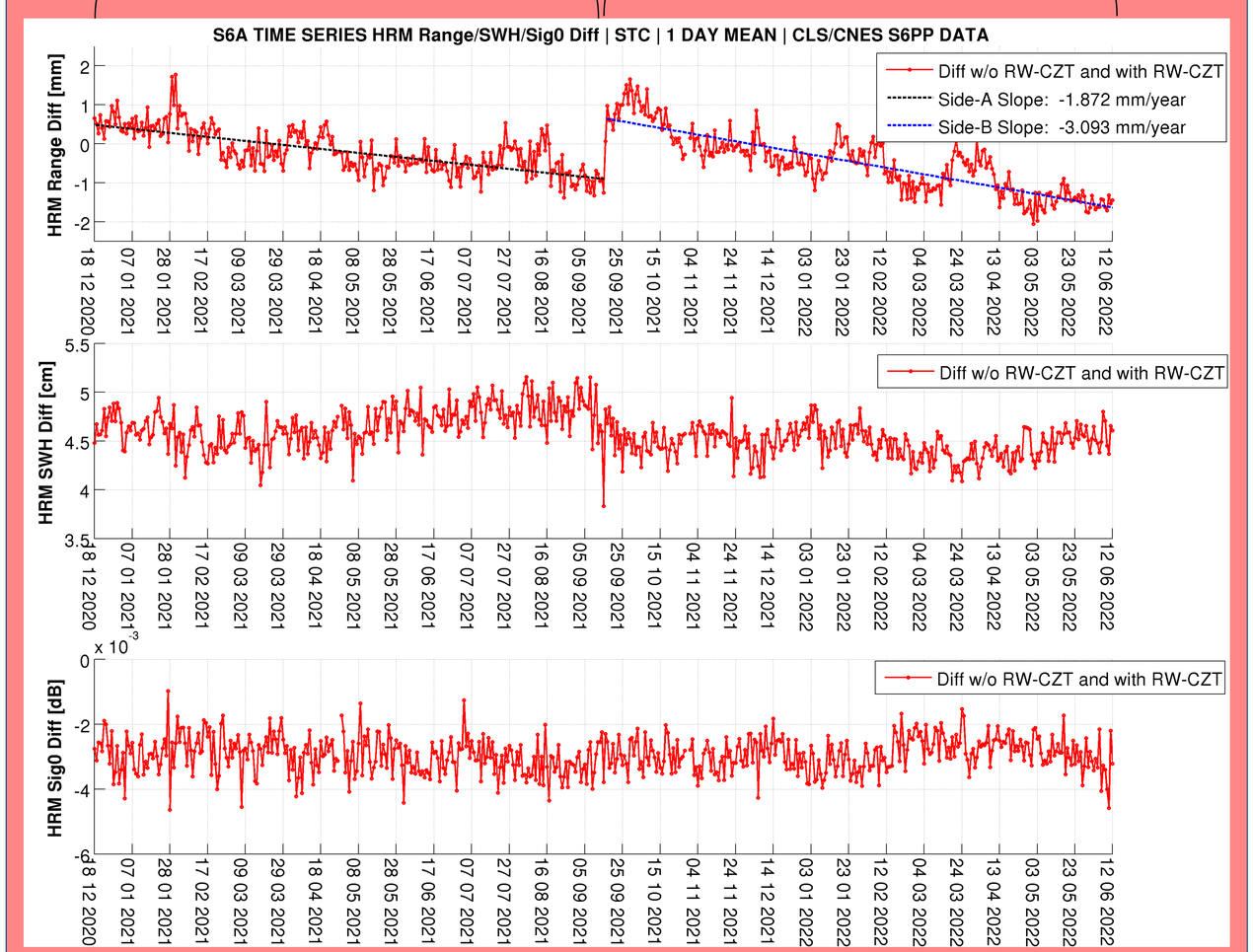
Numerical retracking with and without inflight-PTR is a way to assess this drift.

Side-A was very unstable because of strong aging of the altimeter.

Side-B (as from 14th sept 2021) is much more stable. Still a drift in SWH (+5.7 mm/year) is detected even for side B

	Impact of numerical retracking Side A // side B
Range	-0.4 // -0.01 mm/year
SWH	8.0 // 5.7 mm/year
SSB (3% SWH)	0.3 // 0.2 mm/year
Sigma0 (not shown)	Stable
Error on GMSL	**0.7 // 0.3 mm/year**

Range-Walk Stability Analysis



Neglection of the range-walk correction can induce a drift in the UF-SAR range measurement [1].

The range walk was applied inside S6PP via CZT algorithm [3], and the data processed with and without range walk.

The impact is large for side A and side B (resp. -1.8 and -3.1 mm/y) which is related to a strong power decay of the PTR power.

This reinforces the need to apply the range walk correction on operational ground-segment.

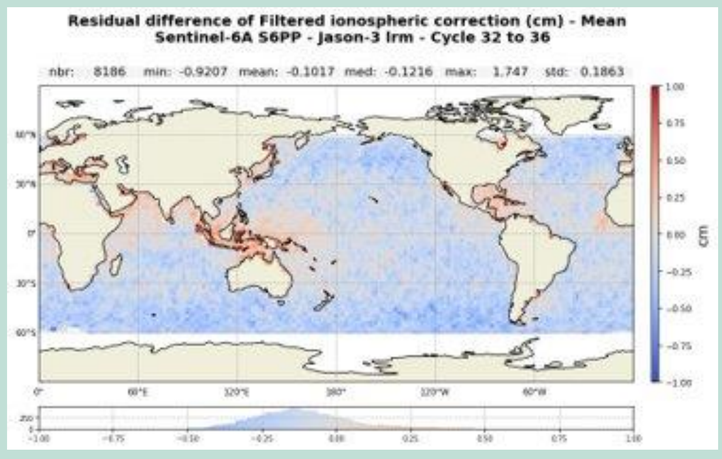
	Impact of range walk Side A // side B
Range	-1.8 // -3.1 mm/year
SWH	5 // 5 **cm bias, stable**
SSB (3% SWH)	Stable
Sigma0 (not shown)	Stable
Error on GMSL	**PTR+range walk effect 2.5 // 3.4 mm/year**

Processing C-Band Data

The numerical retracking has been applied as well to C-Band data to estimate the dual-frequency ionospheric correction.

The filtered dual-frequency ionospheric correction from S6PP is very close to the one from Jason-3 mission, with a std of less than 2 mm and a bias of only -0.1 mm

Residual discrepancies are related to the compression algorithm to average C-Band data from 20 Hz to 1 Hz. An update of this compression algorithm is foreseen



Conclusions

Thanks to S6PP, the importance of technical evolutions as numerical retracking and range-walk has been understood and considered necessary for S6-MF mission. These evolutions will be soon ported in the operational ground-segment (PDAP).
Users can have access to S6PP data from aviso website. Please contact CNES for more information

References

[1] Aublanc J., Dinardo S., Cadier E., Raynal M., Moreau T., Maraldi C., Boy F., Picot N., Femenias P.: Impact of the Range Walk Processing in the Sentinel-3A Sea Level Trend. OSTST 2020 oral presentation

[2] Dinardo S., Cadier E., Moreau T., Maraldi C., Boy F., Guerou A., Picot N.: Sentinel-6-MF Poseidon-4: Main results from the first year and half of mission from the S6PP LRM and HRM Chain. OSTST 2022 presentation

[3] Dinardo S., Maraldi C., Cadier E., Rieu P., Aublanc J., Guerou A., Boy F., Moreau T., Picot N.:Sentinel-6 MF Poseidon-4 Radar Altimeter: Main Scientific Results from S6PP LRM and UF-SAR chains in the first year of the mission. Submitted

[4] Buchhaupt C., Fenoglio-Marc L., Dinardo S., Scharroo R., Becker M.: A fast convolution-based waveform model for conventional and unfocused SAR altimetry. Advances in Space Research, Vol. 62, Issue 6, 2018, Pages 1445-1463, ISSN 0273-1177. https://doi.org/10.1016/j.asr.2017.11.039