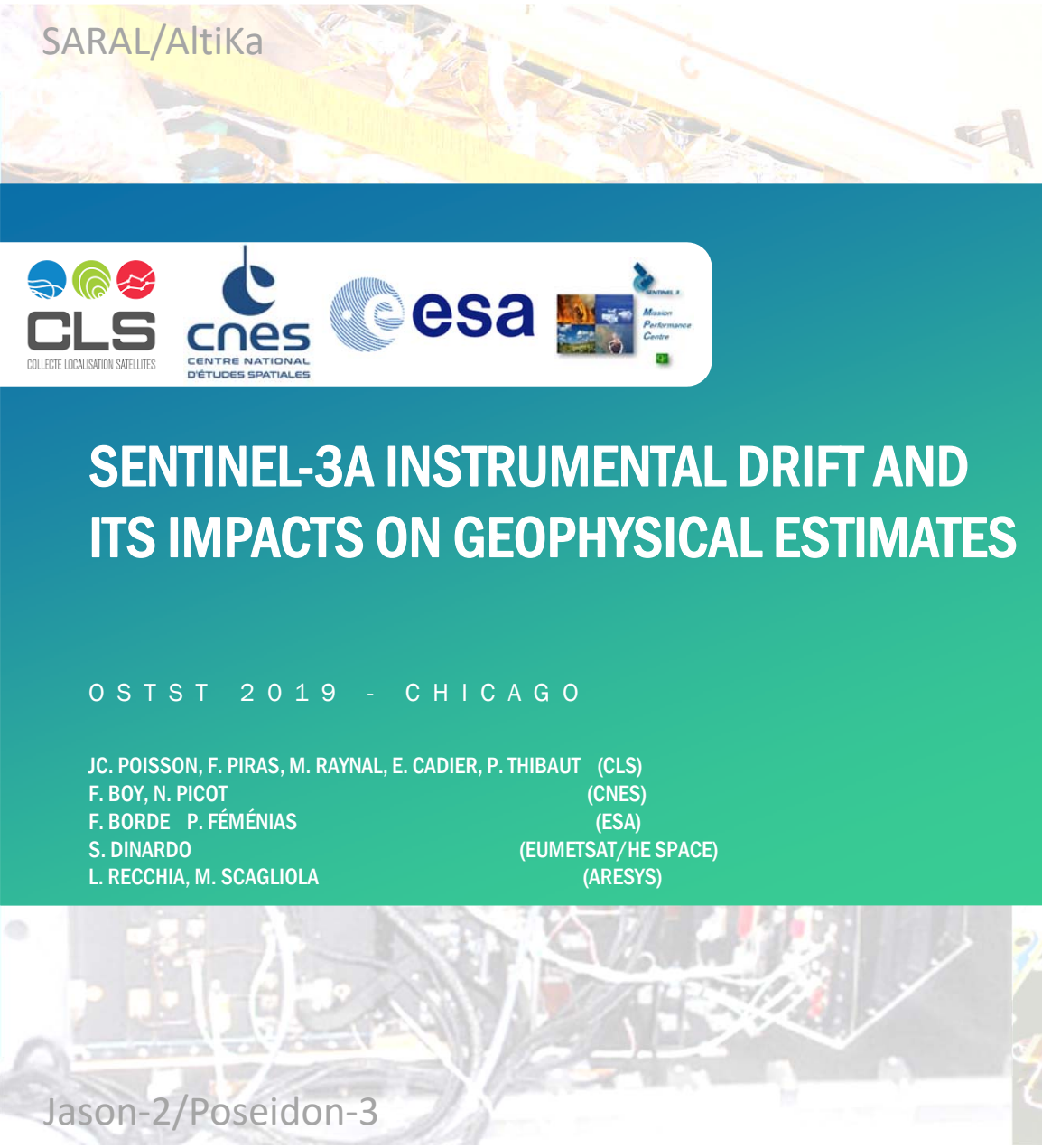


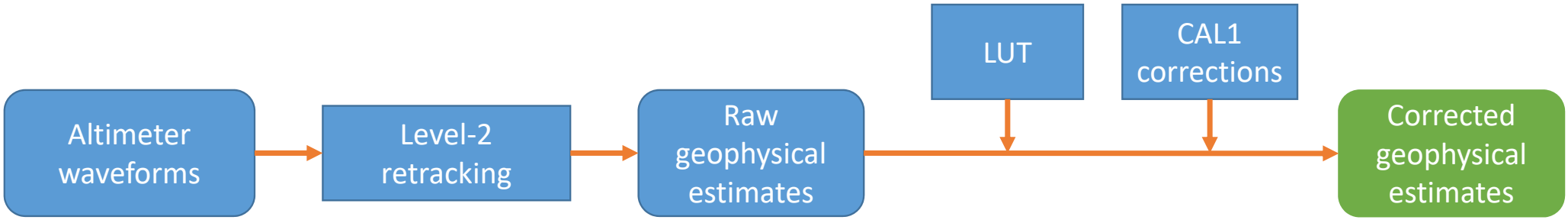
SENTINEL-3A INSTRUMENTAL DRIFT AND ITS IMPACTS ON GEOPHYSICAL ESTIMATES

OSTST 2019 - CHICAGO

JC. POISSON, F. PIRAS, M. RAYNAL, E. CADIER, P. THIBAUT (CLS)
F. BOY, N. PICOT (CNES)
F. BORDE P. FÉMÉNIAS (ESA)
S. DINARDO (EUMETSAT/HE SPACE)
L. RECCHIA, M. SCAGLIOLA (ARESYS)

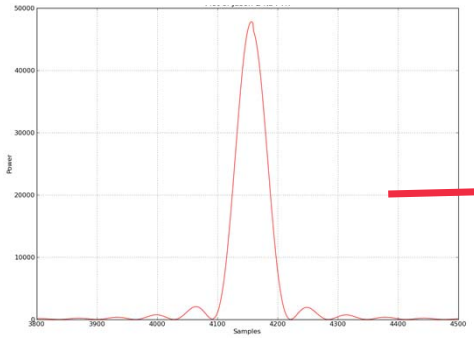
INTRODUCTION

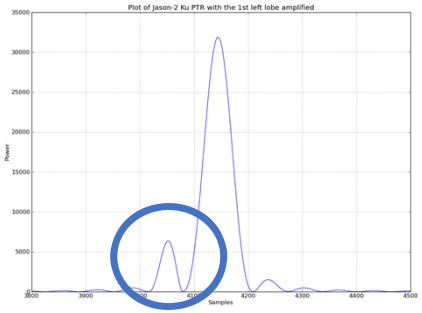
- In all altimetry missions, in-flight calibrations are regularly performed to monitor the instrument health
- In all altimeter ground processing, Level-2 ocean retracking algorithms use a gaussian approximation of the PTR in their physical model: **MLE-3**, **MLE-4**, **SAMOSA**, etc…
- Look Up Tables are used to **correct Level-2 estimates from the differences between a true instrument PTR and the Gaussian approximation. LUT are not dynamic.**
- Parameters are computed on CAL1 (Instrument PTR) and corrections are derived to correct Level-2 estimates of the **linear** PTR evolutions: **internal path delay**, **internal calibration correction**, etc …

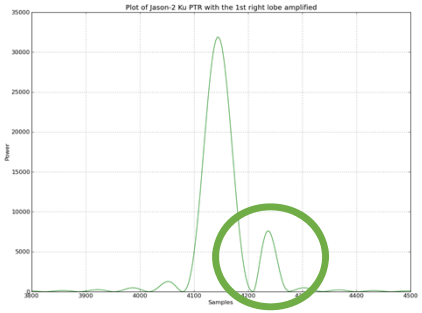


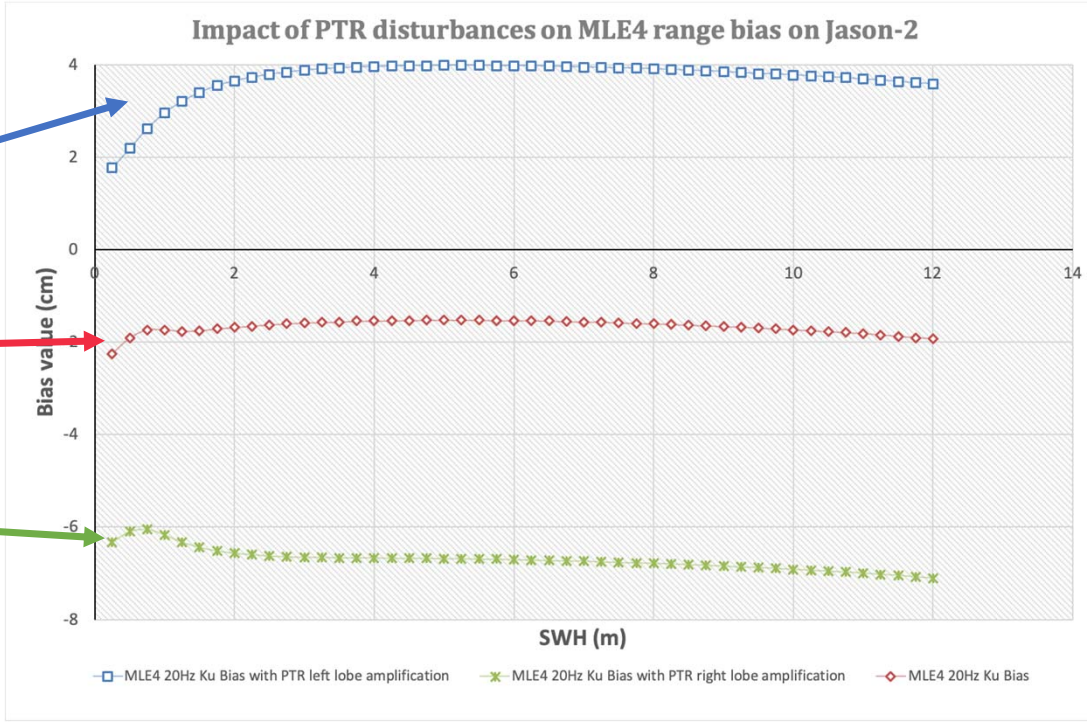
IMPACT OF THE INSTRUMENT PTR ON GEOPHYSICAL ESTIMATES

Reference Jason-2 PTR





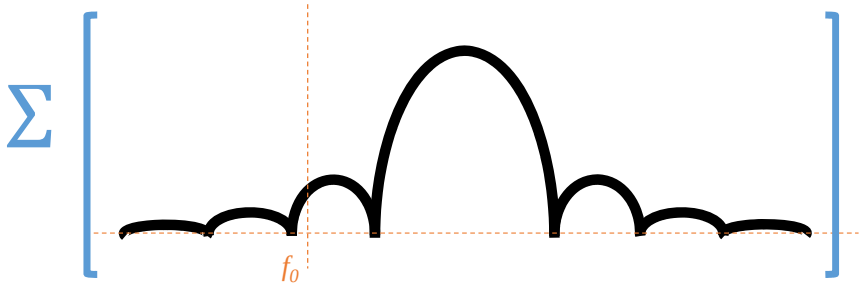




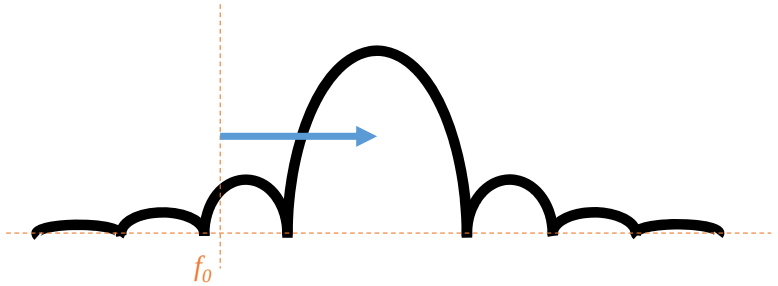
- Any PTR **disturbance/dissymmetry directly impacts the estimation bias**, both on **range and SWH** and both in **LRM and SAR mode.**
- If the **PTR disturbance/dissymmetry evolves with time**, the bias evolves too ➔ **drift on estimates**

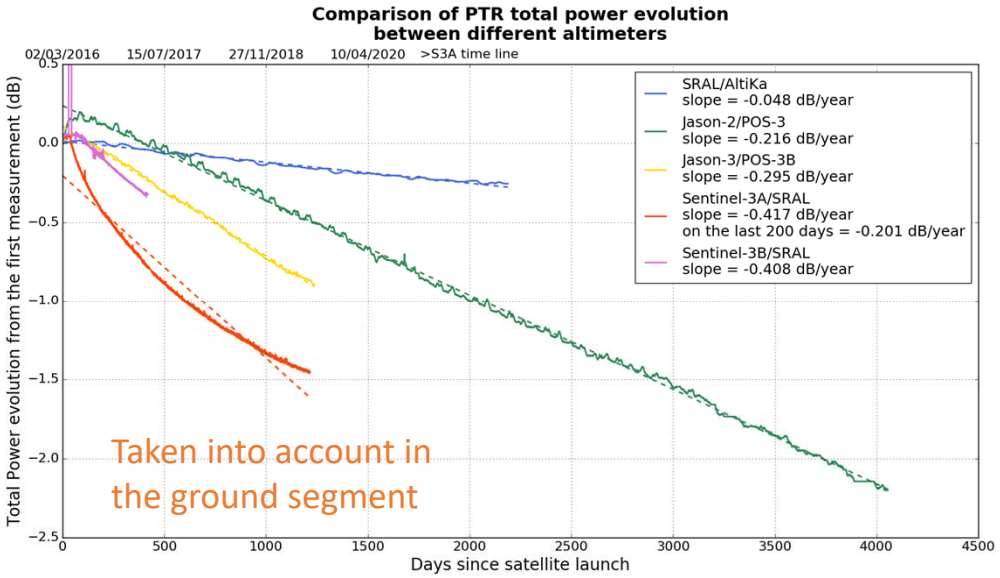
COMPARISON OF PTR EVOLUTION BETWEEN ALTIMETERS

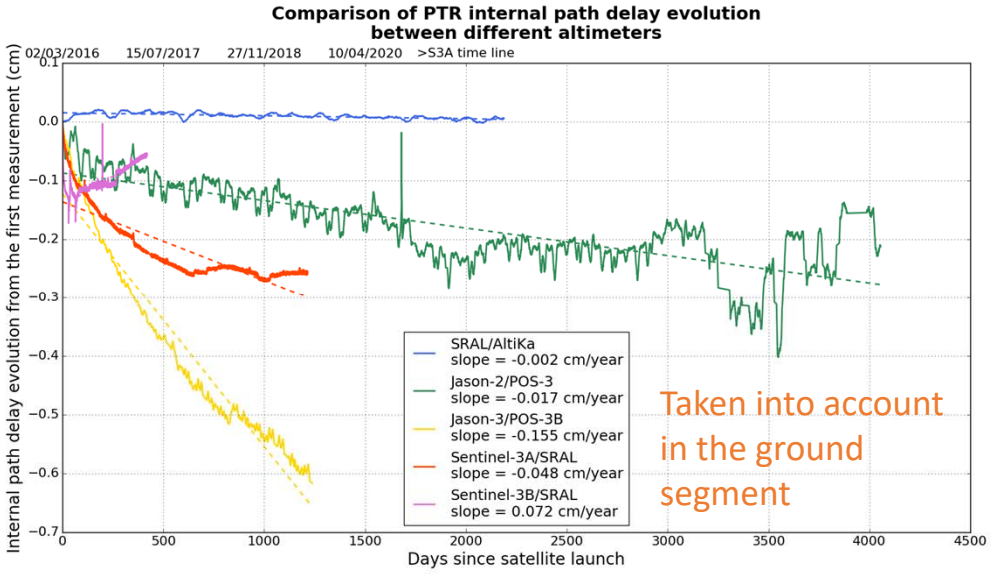
PTR Total Power



PTR Internal Path Delay

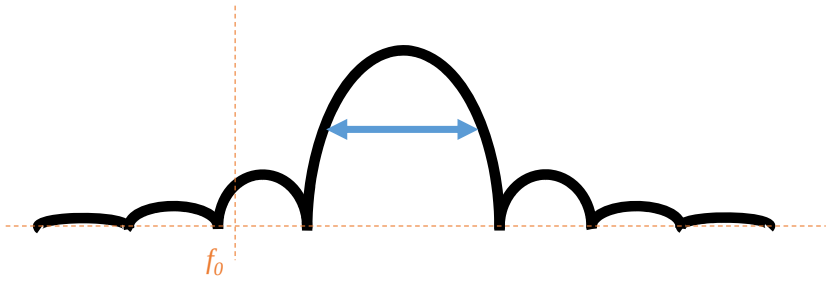






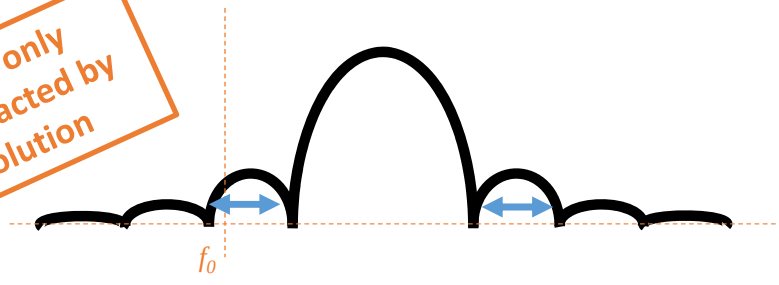
COMPARISON OF PTR EVOLUTION BETWEEN ALTIMETERS

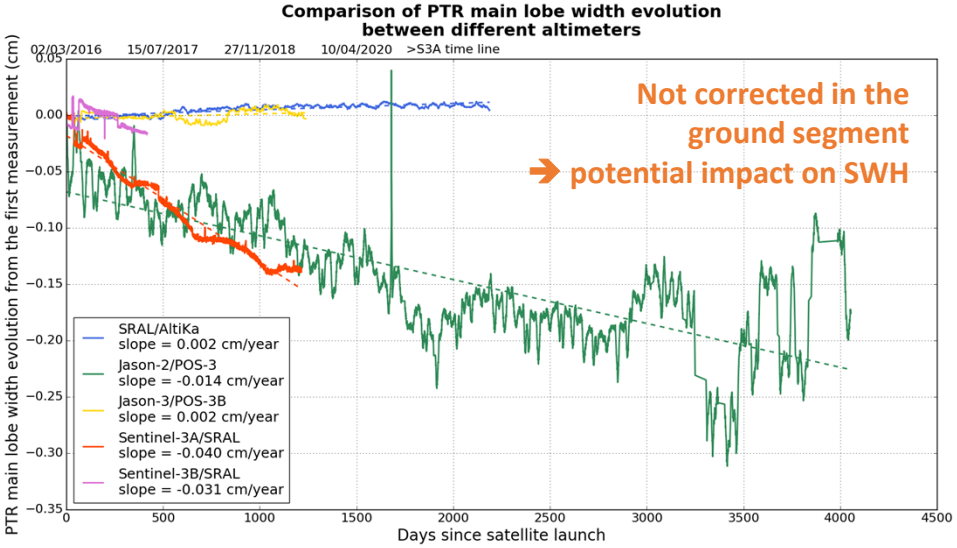
PTR main lobe width

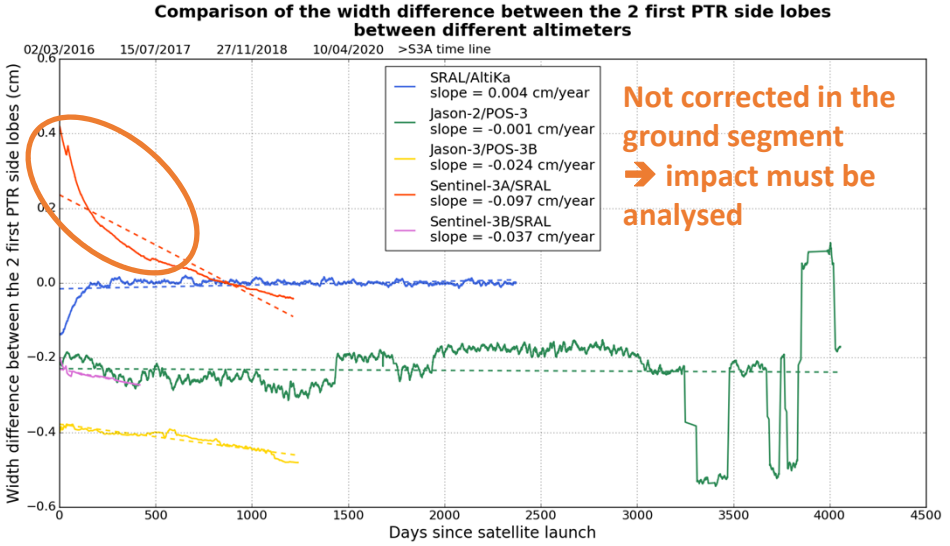


PTR first lobes dissymmetry

Sentinel-3A/SRAL is the only altimeter to be such impacted by this dissymmetry evolution



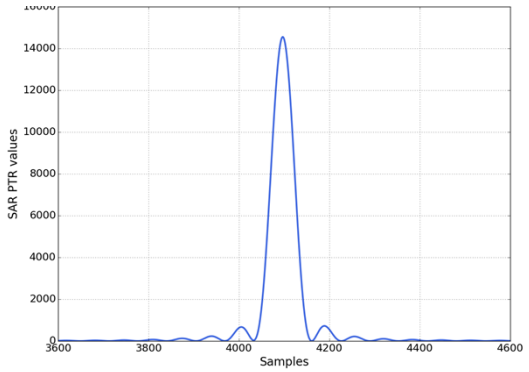




IMPACT ON SENTINEL-3A SAR MODE ESTIMATES (SAMOSA)

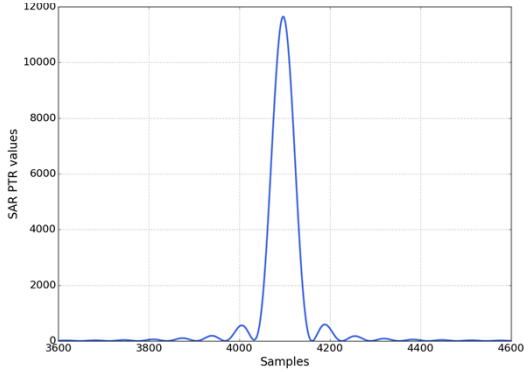
SRAL PTR 28/06/2016

SAR FSSR * PDF *



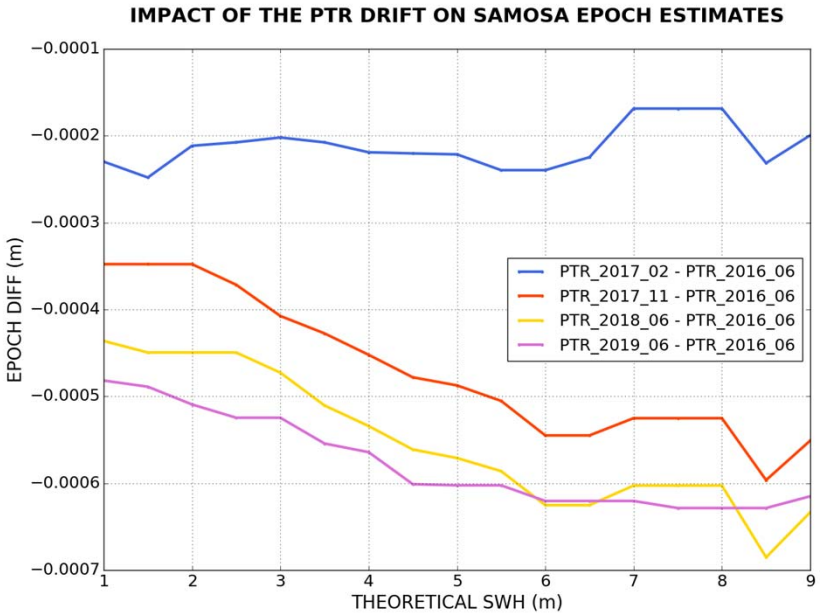
SRAL PTR 13/06/2019

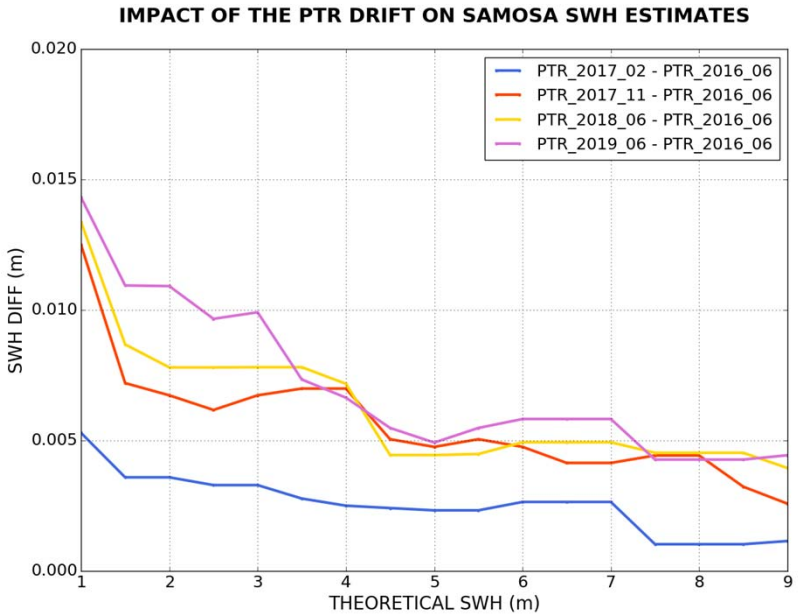
SAR FSSR * PDF *



SAMOSA RTK → COMPARISON ← SAMOSA RTK

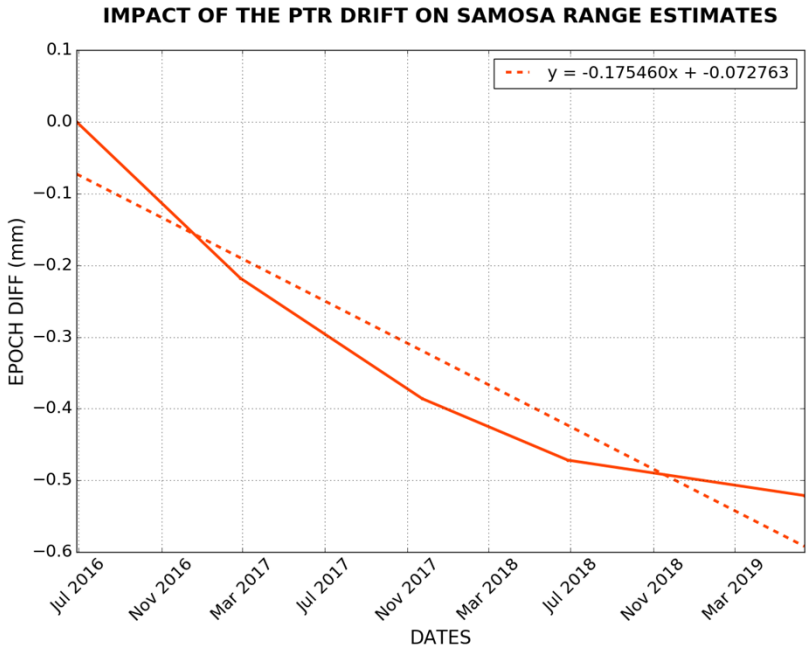
IMPACT ON SENTINEL-3A SAR MODE ESTIMATES (SAMOSA)

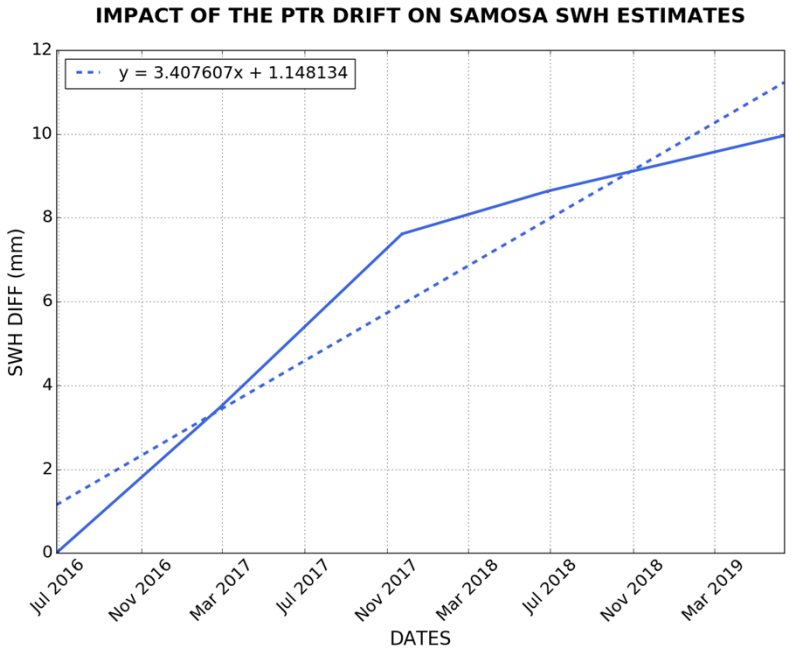




- The impact on range and SWH estimates is **SWH dependent**
- In the following results, an average between 1 and 4 m of SWH (most of the SWH population) is performed

IMPACT ON SENTINEL-3A SAR MODE ESTIMATES (SAMOSA)



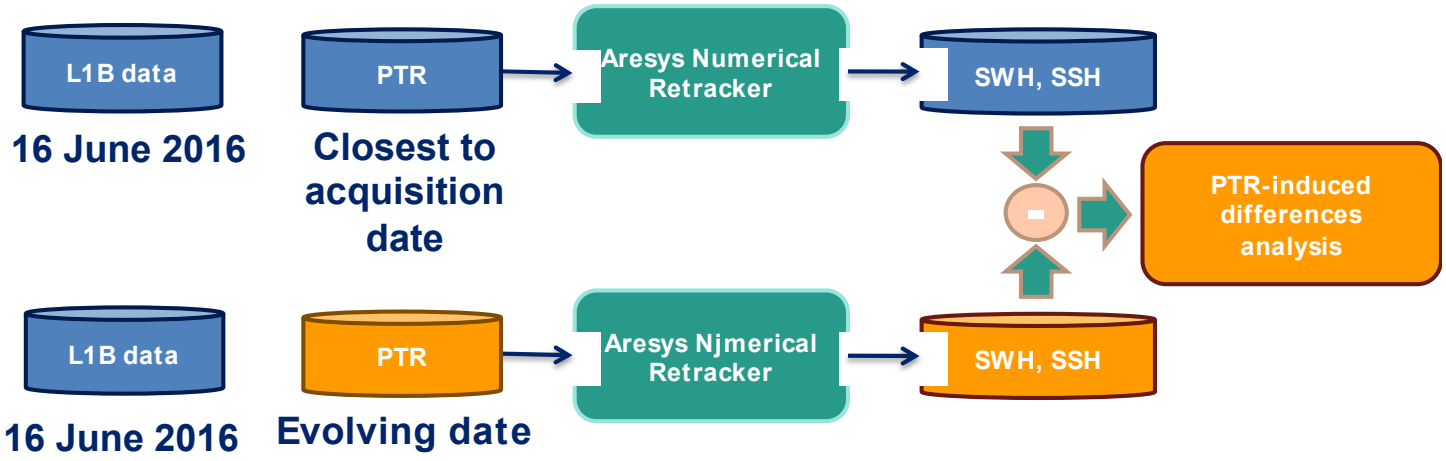


- The impact on the **range** estimates from the SAMOSA retracker is **-0.1754 mm/year**
- The impact on the **SWH** estimates from the SAMOSA retracker is **+3.4076 mm/year**
- The **SSB drift** linked to the SWH drift is **-0.102 mm/year** ➔ the **SSH** drift is about **+0.2774** mm/year
- **The PTR drift is much less important during the last year**

PTR DRIFT ANALYSIS BY S. DINARDO AND ARESYS

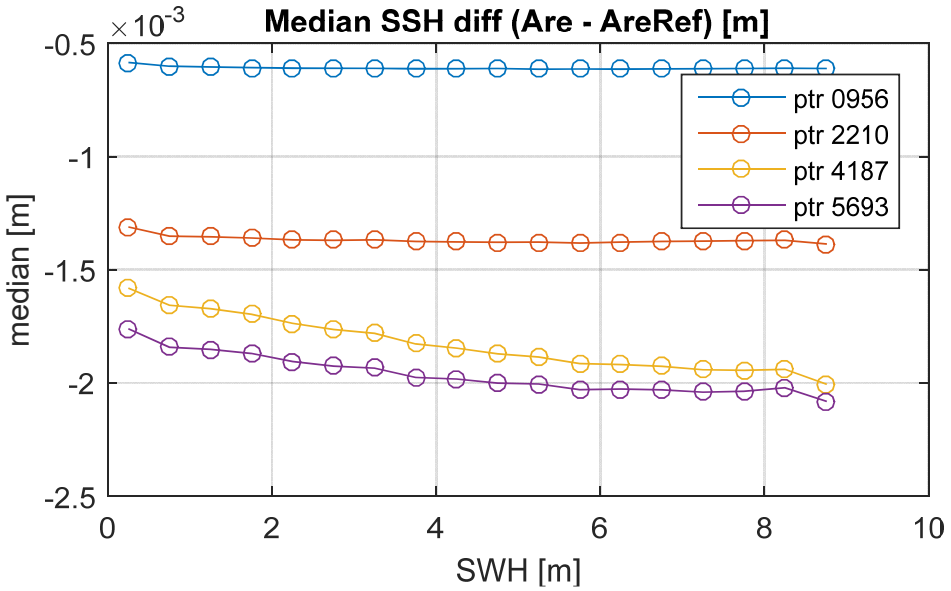
- S. Dinardo and ARESYS did another interesting analysis using the ARESYS semi-analytical SAR retracker

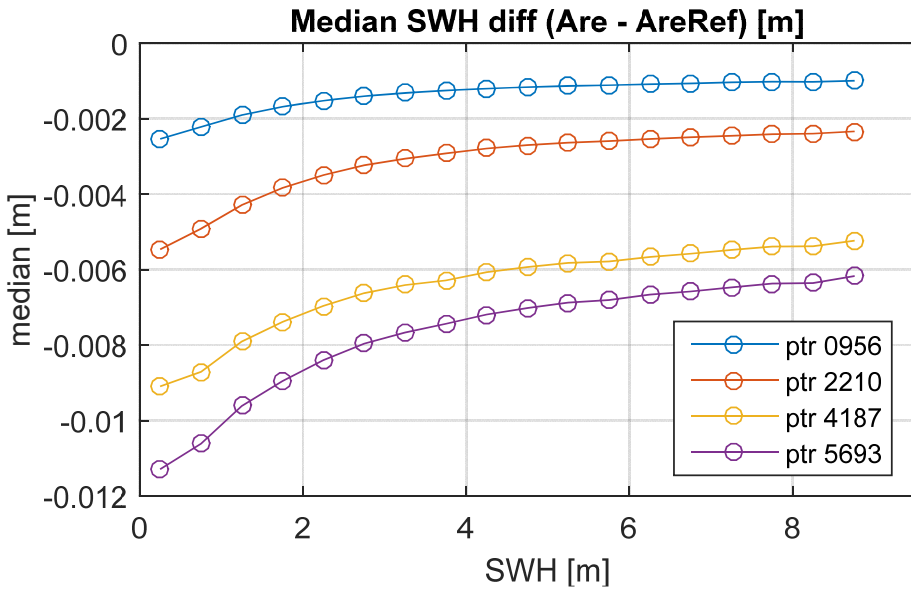
➔ The same L1B dataset has been retracked 4 times using the ARESYS semi-analytical retracker with 4 different PTRs taken at different dates.



- Since drift is the model (is real PTR-based model) and not the data, we have to remind that the effect on SSH and SWH needs to be sign-reverted.

PTR DRIFT ANALYSIS BY S. DINARDO AND ARESYS

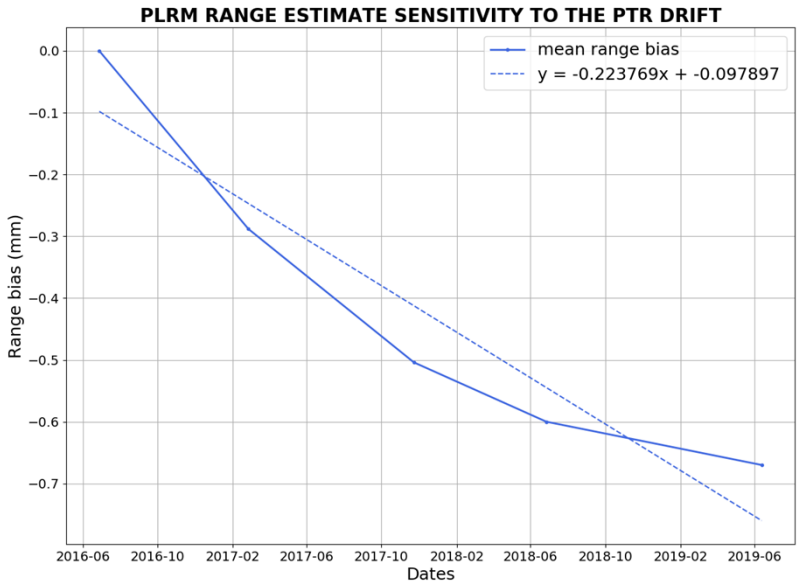


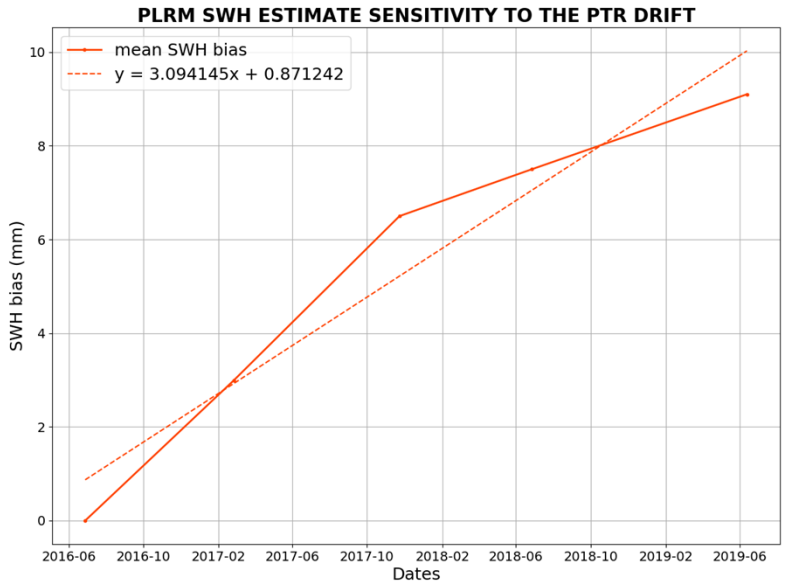


- A different approach, but similar behaviour observed:
- Bias are SWH dependant (more important on SWH estimates)
  - ➔ SWH drift of +3.2 mm/year
  - ➔ Range drift of -0.22 mm/year

See the Salvatore's poster in IP session:
Impact of the Sentinel-3A SRAL PTR Evolution on the L2 Marine Measurements (S.Dinardo et al.)

IMPACT ON SENTINEL-3A PLRM ESTIMATES





- The same approach than for SAMOSA study is applied but on PLRM echoes with the MLE4 retracker
- The impact on the **range** estimates from the MLE4 retracker is **-0.2238 mm/year**
- The impact on the **SWH** estimates from the MLE4 retracker is **+3.0941 mm/year**
- The **SSB drift** linked to the SWH drift is **-0.0928 mm/year** ➔ the **SSH** drift is about **+0.3166 mm/year**

HOW TO MANAGE THIS DRIFT

- The **Sentinel-3A SSH drift** in **SAR** and **PLRM** is close to **+0.3 mm/year** due to the PTR drift which is not negligible for climate studies (GMSL)

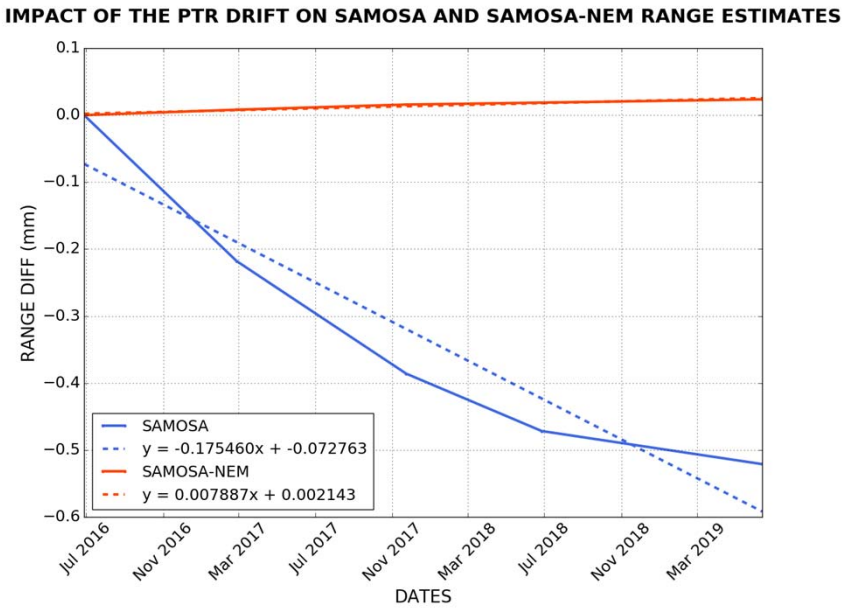
- S. Dinardo propose to compute a new PTR parameter: the **COG correction** (cf Salvatore's Poster)

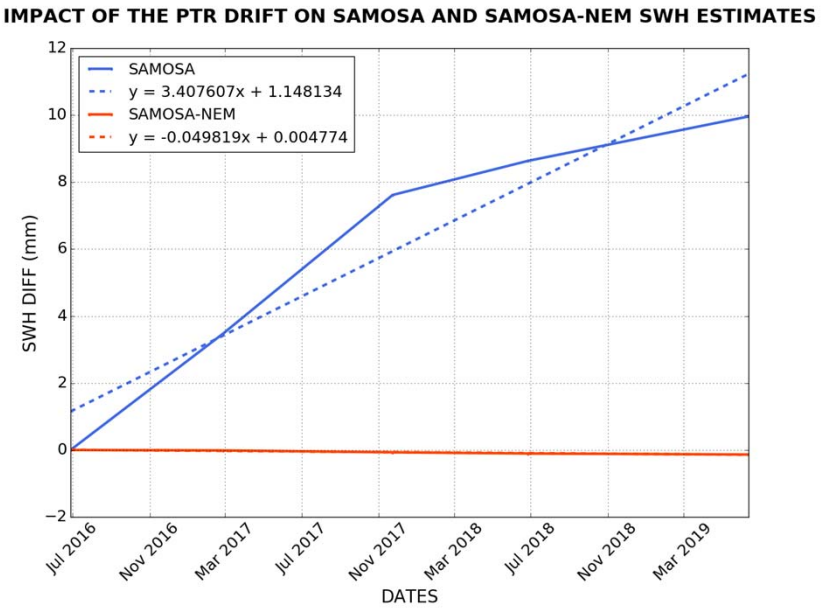
- The **most rigorous solution** is to use **Numerical Retracker for both SAR and PLRM** allowing to account for the true PTR

- For SAR, tests have been done by simulation and **a numerical version of the SAMOSA retracker**, the SAMOSA Numerical Enhanced Method (SAMOSA-NEM).
  → The range PTR has been introduced in the SAMOSA model after removing Alpha_P LUTs

- For PLRM, **4 cycles of PDGS data** have been retracked using the **Adaptive Retracker** which is a **Numerical Retracker**

THE SAMOSA-NEM RESULTS

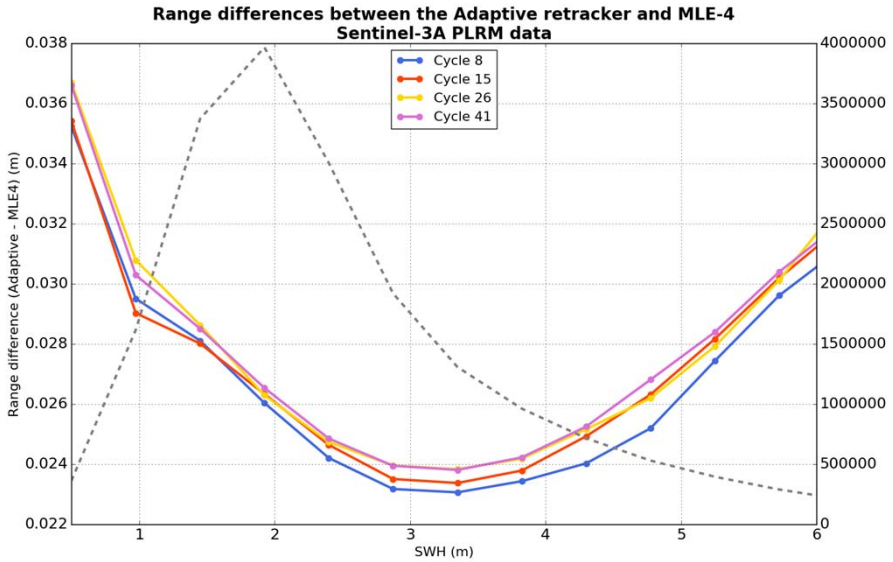


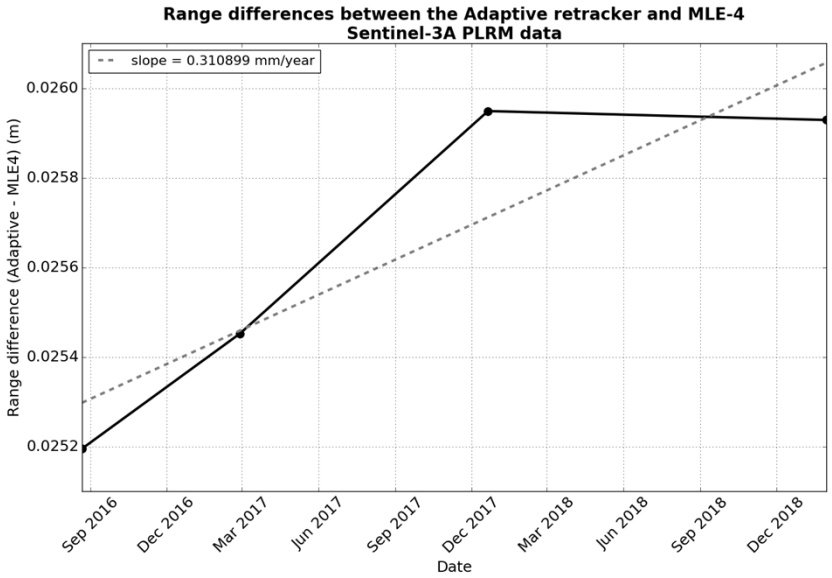


- The SAMOSA-NEM accounts for **the true instrument PTR (range)**. The same PTR used for generating synthetic SAR echoes is introduced in the SAMOSA-NEM retracker (evolving with time).

➔ The **drift is removed** using the **Numerical version of SAMOSA** for both range and SWH

THE ADAPTIVE RESULTS





- The **Adaptive Retracker** accounts for **the true instrument PTR.** PTR with a time-tag **corresponding to the middle of each cycle** is introduced into the Adaptive Retracker to process each cycle.

➔ The differences between MLE4 estimates and Adaptive Retracker estimates correspond to the PTR drift: +0.311 mm/year

CONCLUSIONS

- The Sentinel-3A/SRAL SAR PTR is drifting: **the dissymmetry is less stable** compared to other altimeters **mainly during the first 18 months of the mission ➔ impact of full SAR mode over all the globe, it is not abnormal but this impact must be accounted in the Level-2**

- Based on **different approaches** CLS/CNES and S.Dinardo/ARESYS have demonstrated that the impact on the SAR SSH is ~ **+0.3 mm/year** (range + SSB included)

- The impact on PLRM has been estimated also to ~ **+0.3 mm/year**

- This **instrumental drift is an issue for climatic GMSL** studies and must be corrected

- Numerical Retracker (Numerical version of SAMOSA) is the most appropriate approach to process all Sentinel-3 (A/B/C/D) SAR waveform affected by a PTR drift. This solution should also be considered for the future reference mission Jason-CS/Sentinel-6.

- Due to ground segment constraints, a solution based on updated calibration processing (CAL1 CoG) and LUT corrections is currently under study.