Jason/CS Level 2 processing development from GPP to PDAP

Performance analysis and validation strategy using both simulated Sentinel-6 and real Sentinel-3 data

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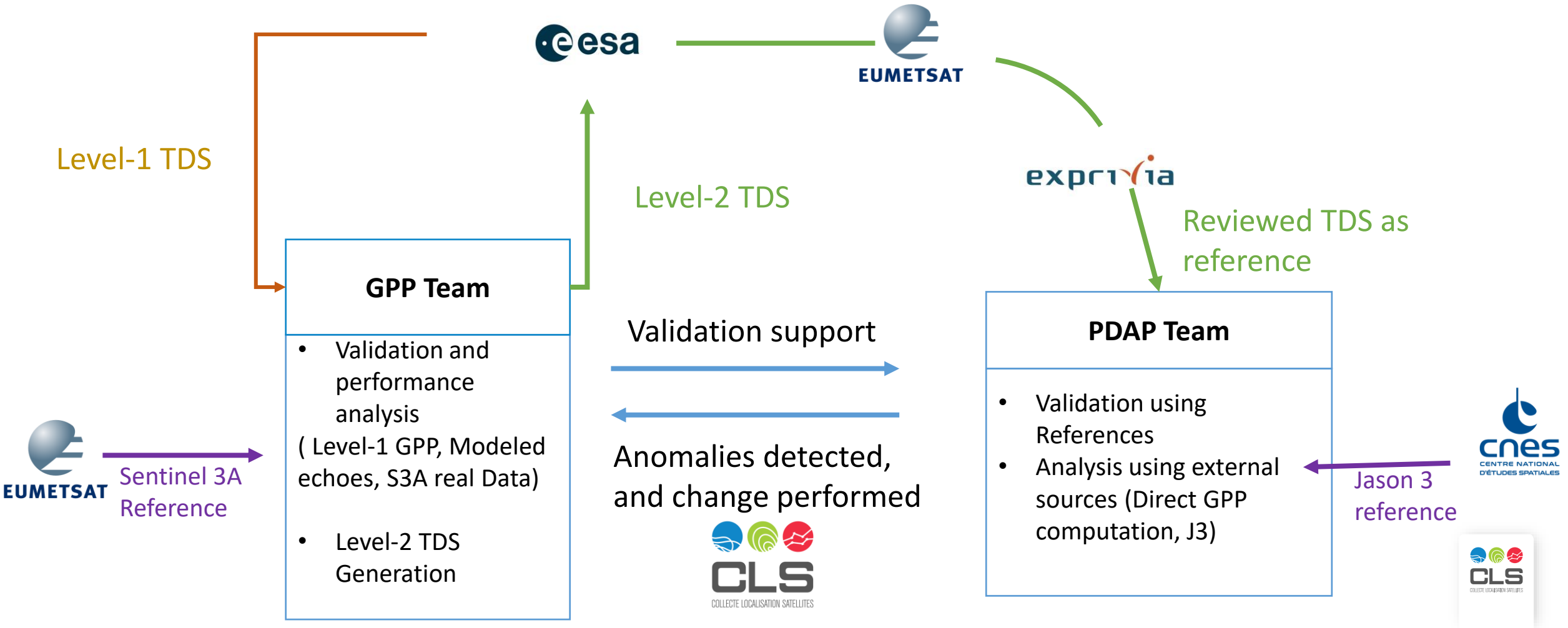
illustration

Altimeter Level-2 : Plan

- Global strategy validation
- GPP assessment using S3A reconditioned data
- New Range compression assessment
- Impact of the damping factor parameter on SAMOSA
- Impact of the doppler beam sampling in SAMOSA model
- Conclusion and recommendation

Altimeter Level-2 : global validation strategy



Altimeter Level-2 : Main differences between PDAP/ GPP

	GPP	PDAP
SWH (LR)	Allows negative wave and negative Sigma C. It will be aligned with PDAP for version used for commissioning	Allows negative wave but not negative Sigma C
Range compression	Compression on Range with trend correction.	Compression on ssh with trend correction. Then 1Hz altitude is Added to obtain Range 1Hz
SAMOSA fit routine	MPFIT	CMINPACK (as for current S3 chain but different parametrization)

GPP: performance on 1500 Radar cycles simulation

A set of Data with different scene parameters was used to assess the performance of different processors :

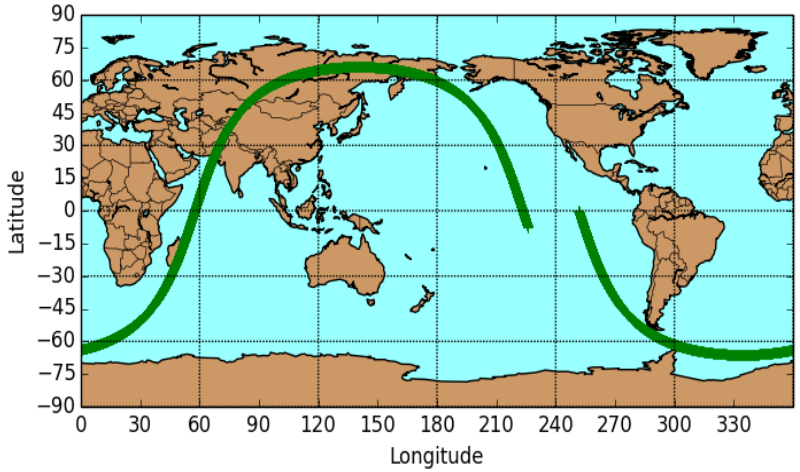
SWH	Zero padding	Mispointing		Sea surface slope	Altitude rate
		Roll (deg)	Pitch (deg)		
1, 2, 5, 8 m	With and without	0, 0.1	0, 0.1	0, 2m/s	Low / High

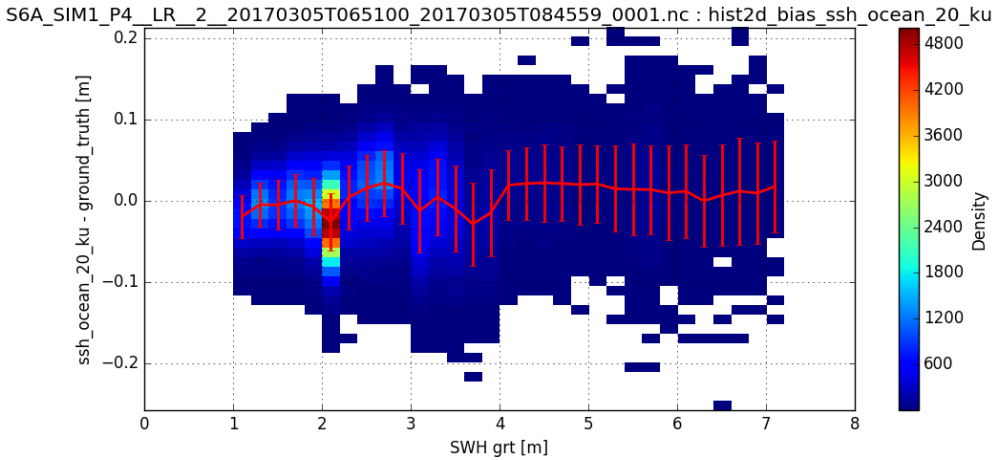
→ The Comparison of results with scene and orbital parameters allow to assess the performance of the GPP

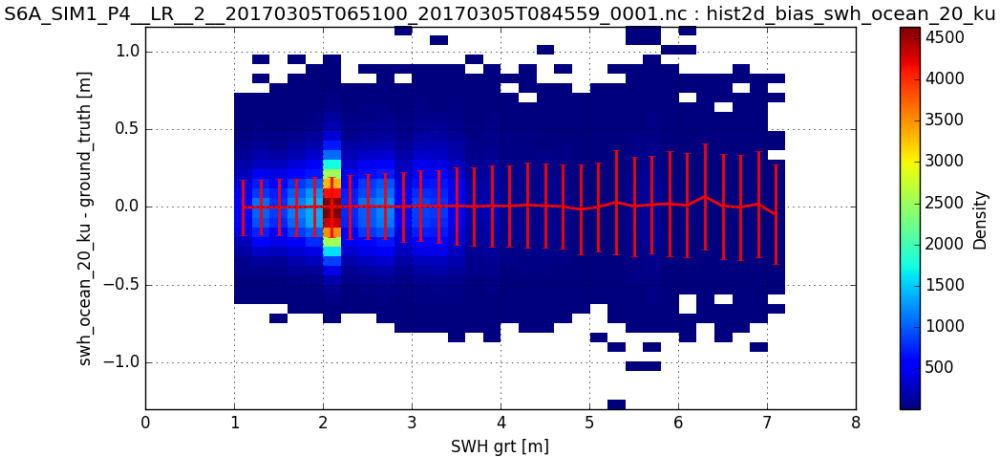
→ The P4 GPP Altimeter requirements are met

GPP: performance on 1-Orbit Simulation

1-Orbit Simulation have been used to assess the performance of processor, especially the SWH dependance





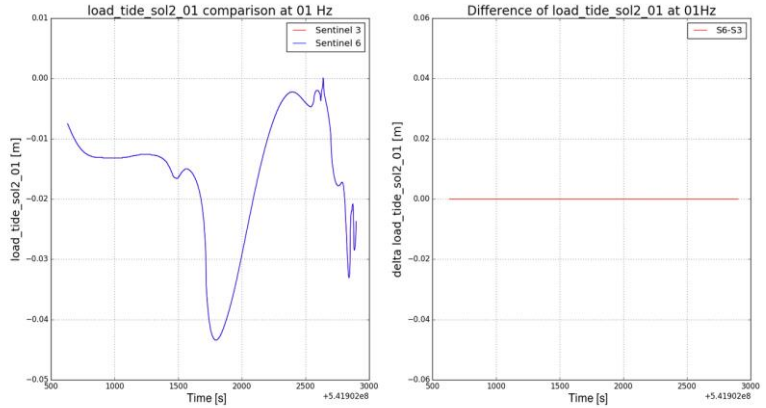


- These performances have been confirmed by 1 Cycle of reconditioned S3 Real data
- This 1-Orbit simulation was useful for PDAP scientific validation

S3 reconditioned analysis : geophysical correction assessment

Geophysical correction have been validated using as reference reconditioned Sentinel-3A Real

- Sentinel 3a data have been reconditioned to be computed with S6L2GPP
- Geophysical correction computed with S6L2GPP have been compared to the ones computed by IPF Sentinel-3A



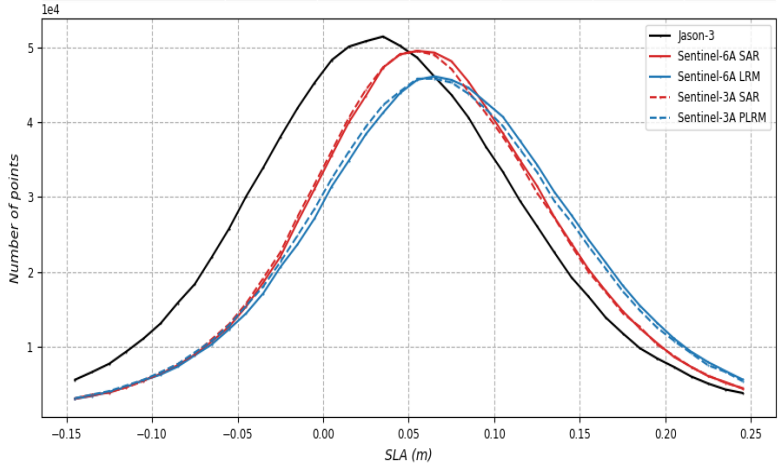
Load tide computed with FES model

Sentinel 3a reconditioned fully assess the geophysical correction computation.

S3 reconditioned analysis : Long-wavelength discrepancies

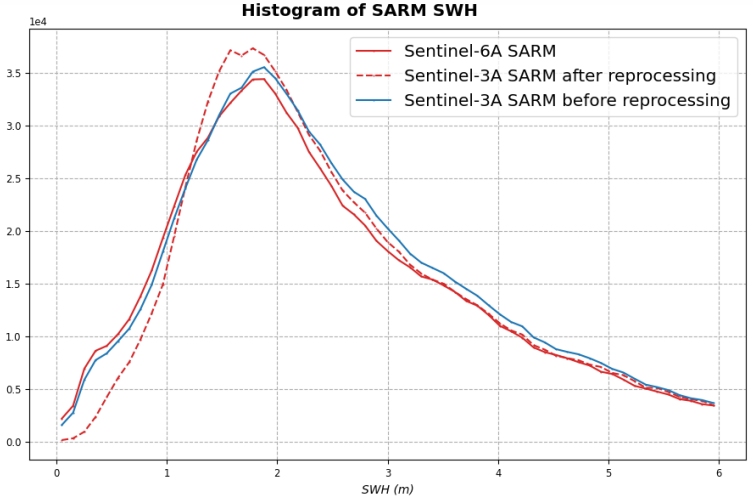
Histogram of SLA

	nbr	min	mean	med	max	std
Jason-3	1074219	-2.639	0.03701	0.035	2.85	0.1105
Sentinel-6A SAR	944135	-4.509	0.06237	0.061	3.082	0.1031
Sentinel-6A LRM	943201	-1.919	0.07081	0.0701	3.07	0.1063
Sentinel-3A SAR	943715	-2.514	0.06165	0.0598	4.117	0.1032
Sentinel-3A PLRM	942403	-1.931	0.06819	0.0672	3.072	0.1065



Good consistency between S3A and S6 GPP SLA
1 cm of bias between PLRM and SAR as expected due to pulse to pulse correlation in PLRM.

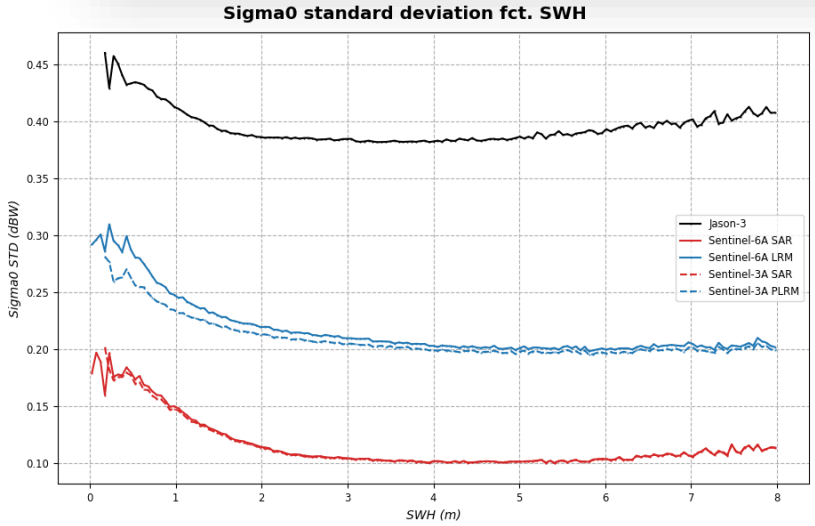
Histogram of SARM SWH



Direct difference S3A – S6-GPP:
In SARM: 10 cm bias and up to 30 cm difference for SWH < 1 m. Due to SARM fitting routine difference between the 2 processings.

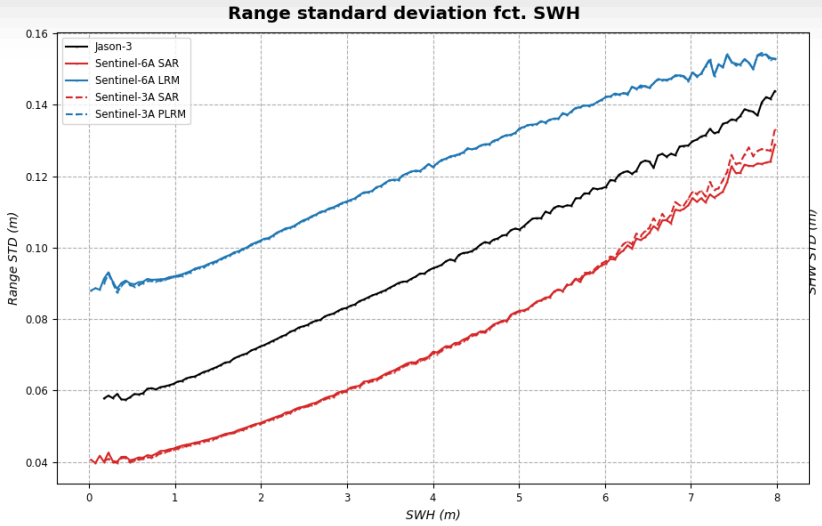
S6-GPP in agreement with previous S3 IPF version.

S3 reconditioned analysis : Hight frequency analysis



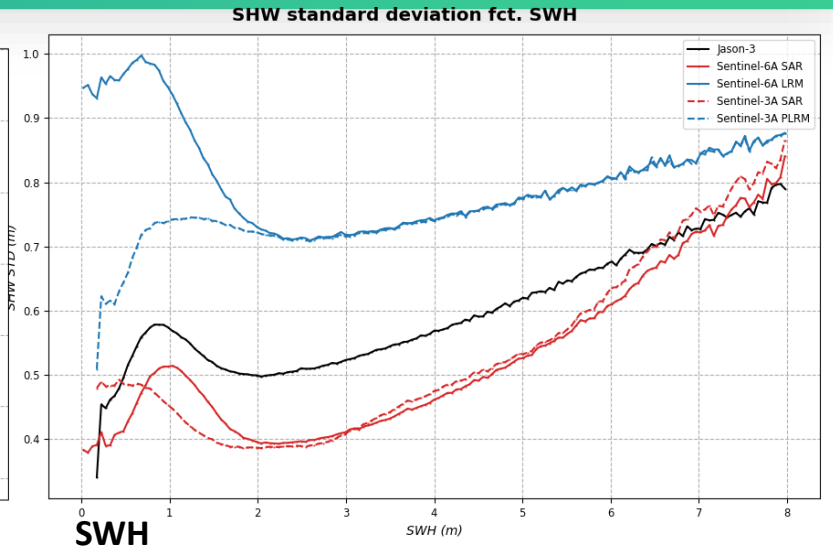
Sigma0
Perfect agreement between the two processings.

Level of noise at 2 m wave :
- 0.115 dB in SARM
- 0.22 dB in LRM



Range
Perfect agreement between the two processings.

Level of noise at 2 m wave :
- 5.1 cm in SARM
- 10.2 cm in LRM

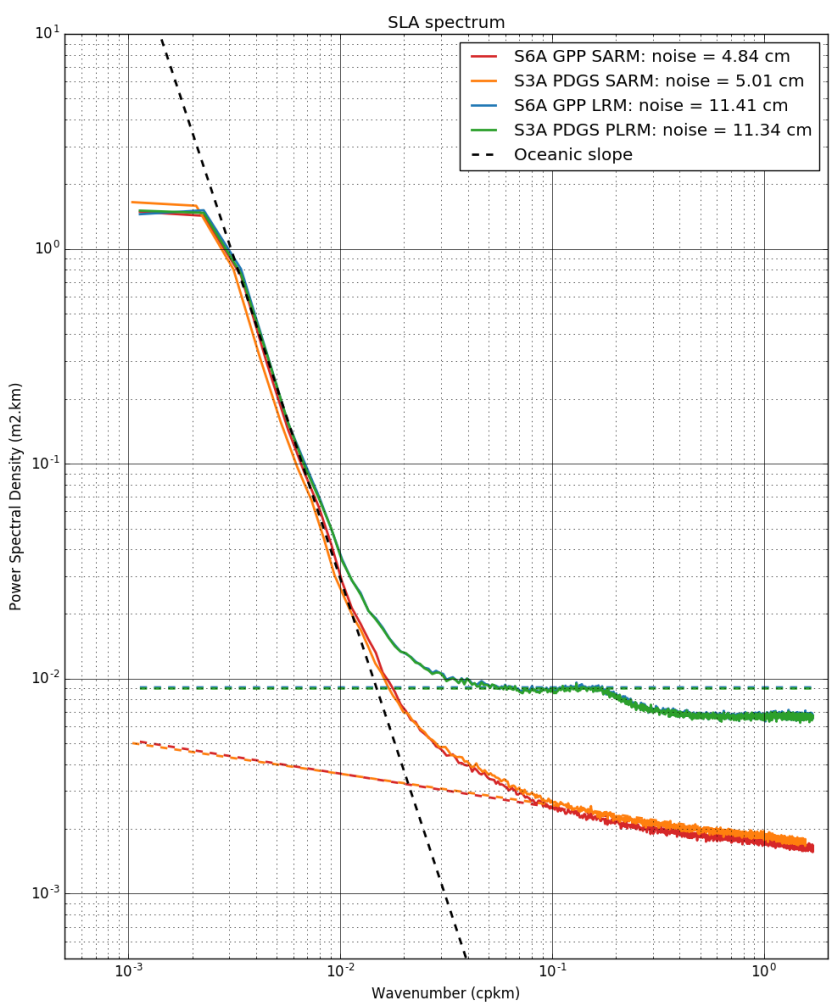


SWH
SARM: expected differences due to S3-PDGS fitting routine update.

LRM: Perfect agreement for SWH>2m. For SWH<2m, significant bias between the 2 processings. The extension to negative SWH in S6-GPP seems to degrade LRM performances. (To be corrected in the new L2 GPP version)

Level of noise at 2 m wave for S6-GPP :
- 39 cm in SARM
- 73 cm in LRM

S3 reconditioned analysis : Sea Level anomaly assessment



SLA spectra:

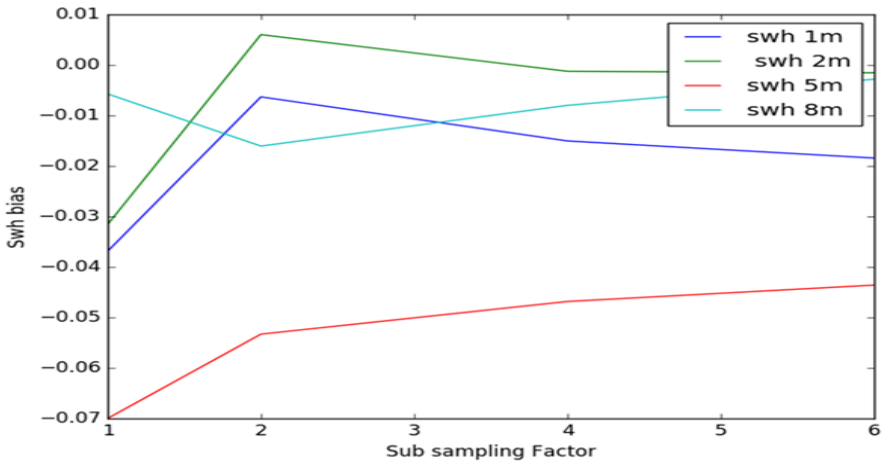
LRM and PLRM spectra in perfect agreement

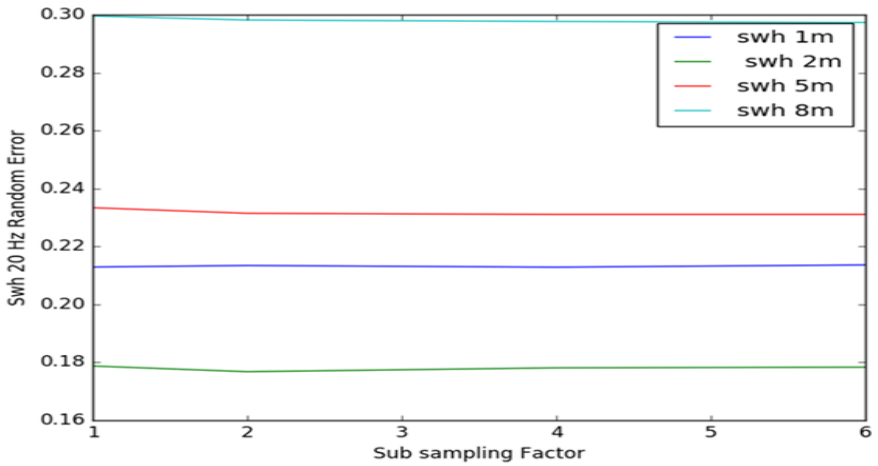
SARM spectra in good agreement. Correlated errors slightly smaller for S6-GPP (-1.7 mm).

Doppler Beam sampling: impact on retrieved parameters (SWH, SSH)

The sampling factor parametrizes the number of doppler beam used in SAMOSA model :

- A value of 1 corresponds to a model of 64 beams
- A value of 7 corresponds to a full doppler beam (448) model



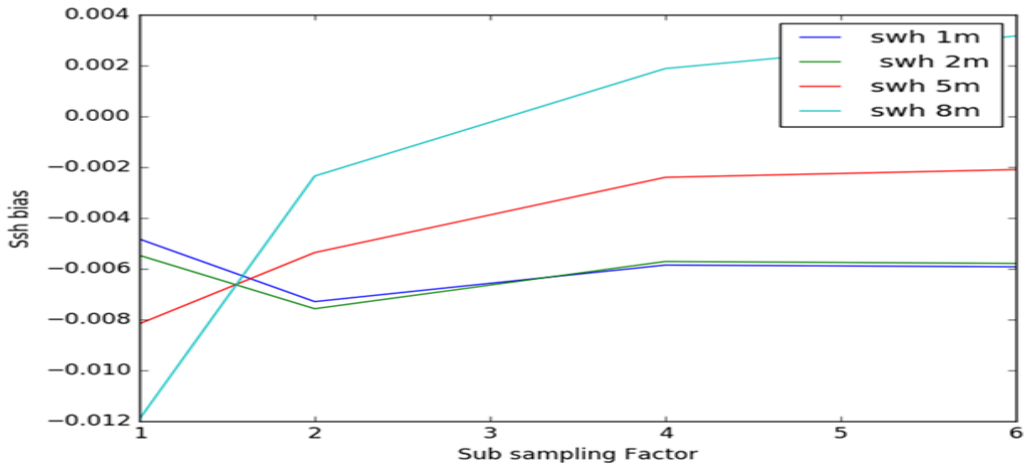


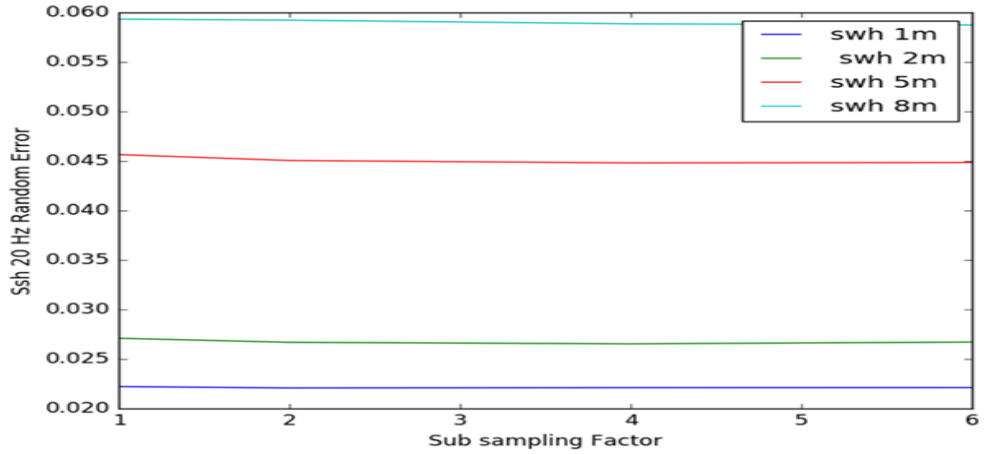
- Mean SWH variations for different sampling configuration.
- No significant impact of the doppler beam on the 20 Hz noise
- Same dynamic have been observed by Salvatore Dinardo (see his presentation) on numerical retracker
- A stabilization is observed for a sampling factor of 3-4 (i.e 192-256 doppler bean)

Doppler Beam sampling: impact on retrieved parameters (SWH, SSH)

- Mean SSH variations for different sampling configuration.
- No significant impact of the doppler beam on the 20 Hz noise
- Same dynamic have been observed by Salvatore Dinardo (see his presentation) on numerical retracker

We recommend to use a sampling factor between 3 and 4



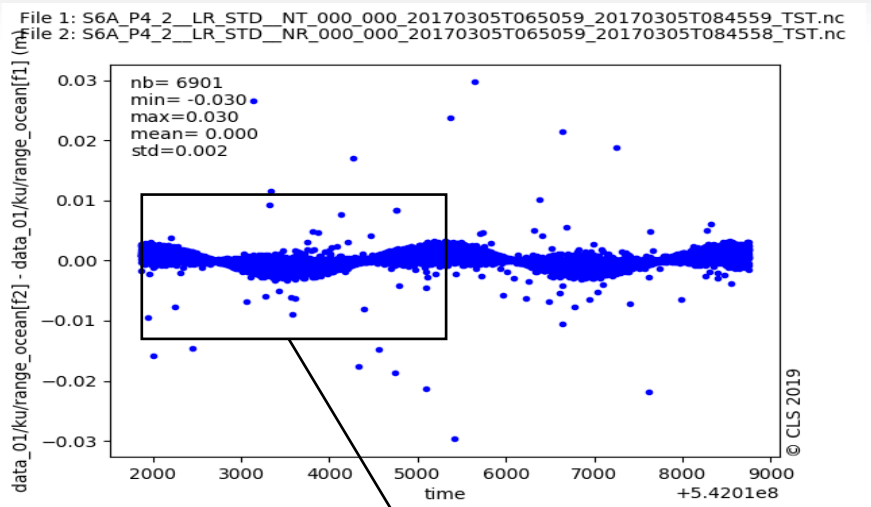


ALT L2 PGS/ GPP: difference on the range compression

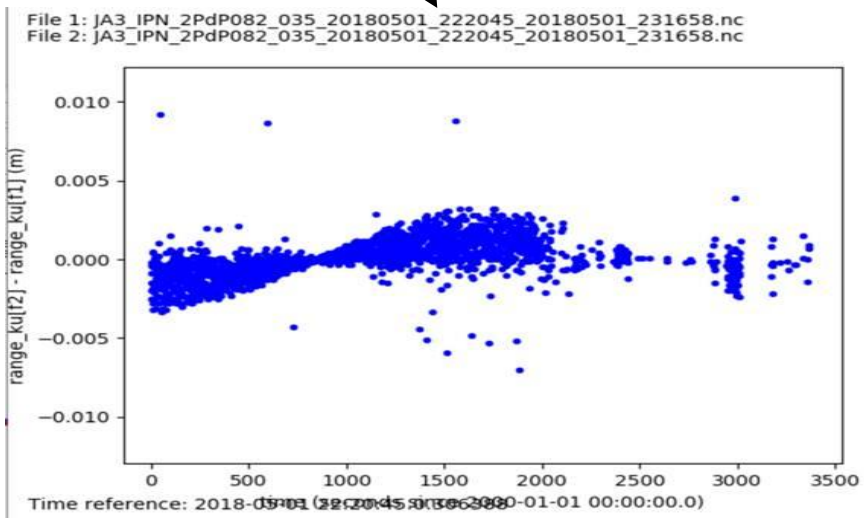
GPP : Compress range removing the trend

PDAP : As specified by Eumetsat, the range compression is remplaced by a ssh compression

- PDAP approach allow to consider superior order where GPP compression only consider trend

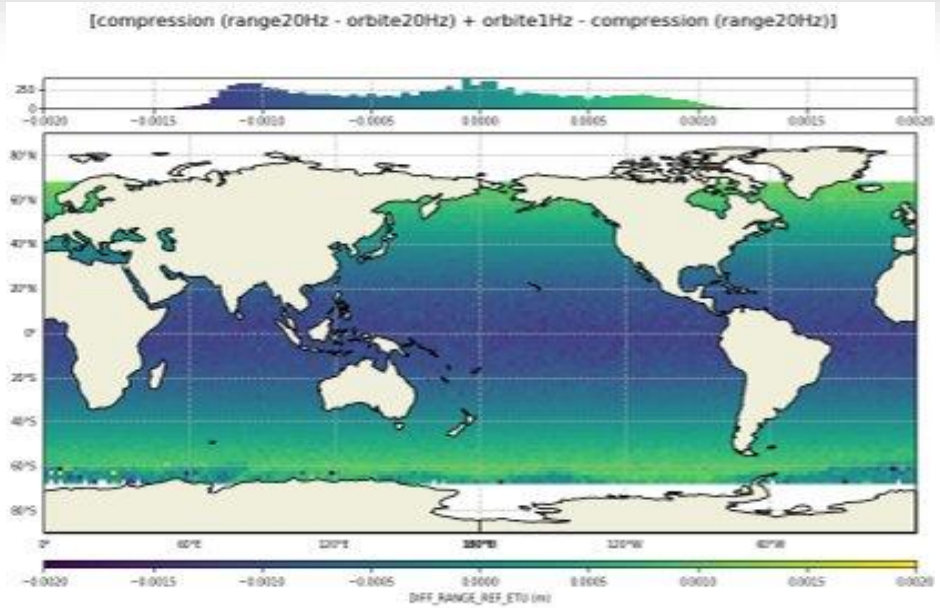


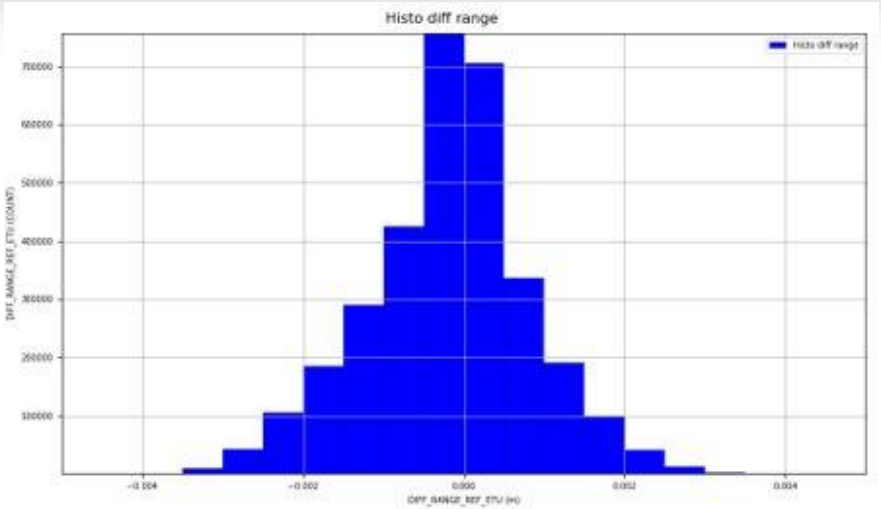
Zoomed for Jason-3 data

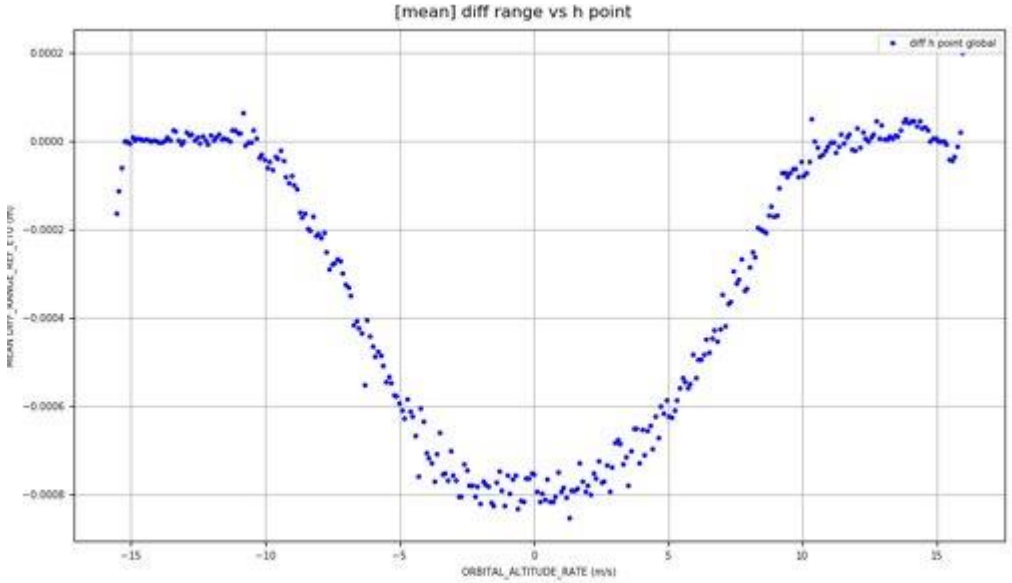


The Effect of the SSH/Range compression have been analyzed on Jason-3 computation and the magnitude of second order variation have been confirmed

difference on the range compression : with Jason-3 data







Differences between the 2 solutions (range_jsc - range_j3) :
Differences are centred in zero
Small differences, between -4 et 4mm, but with some outlier

Strongest differences are localized on low radial speed and high latitude

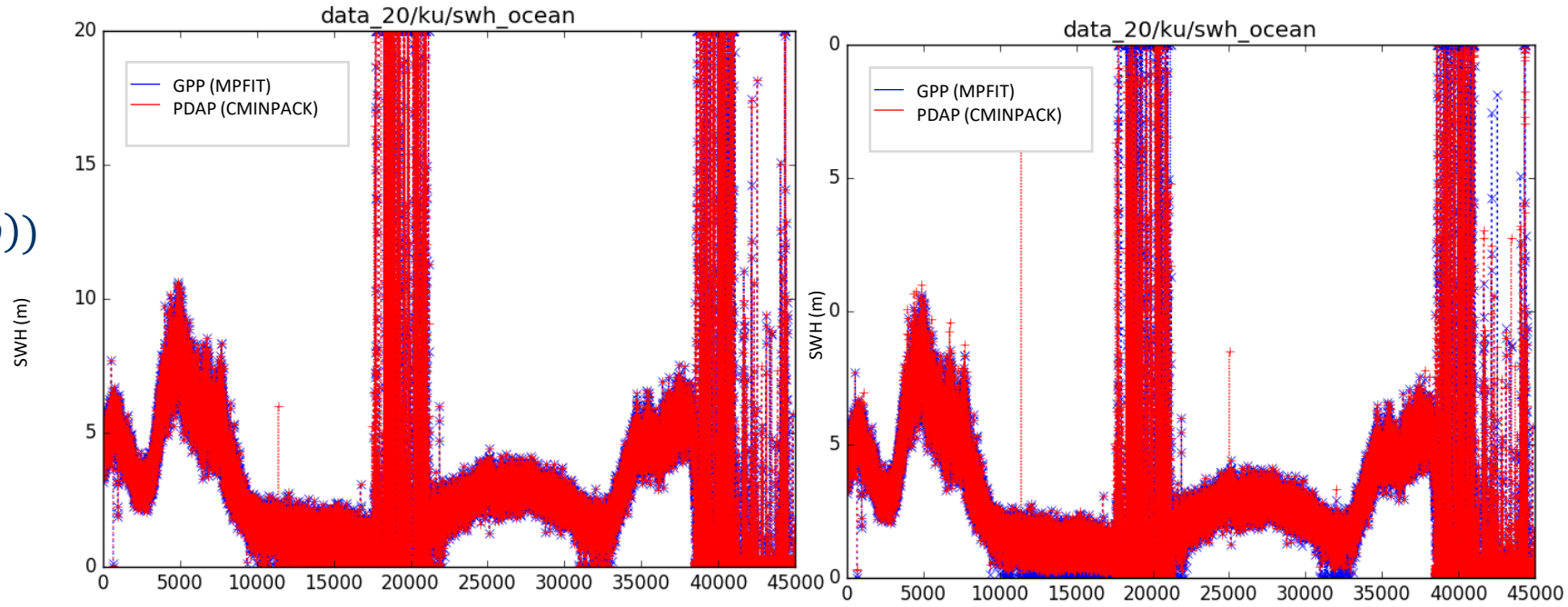
Differences are correlated to Hpoint with a bias lower than 1mm for lowest Hpoint.

ALT L2 PGS: Impact of Damping Factor and recommended configuration

SWH Comparison for different values of damping factor for S3 reconditioning TDS, MPFIT in blue and CMINPACK in red

The Levenberg-Marquardt algorithm solves at each step the following equation

$$\left(\left(\boldsymbol{J^T J} + \lambda\, diag\left(\boldsymbol{JJ^T}\right)\right)\boldsymbol{q} \approx \boldsymbol{J^T}(y - f(\boldsymbol{p})\right)$$



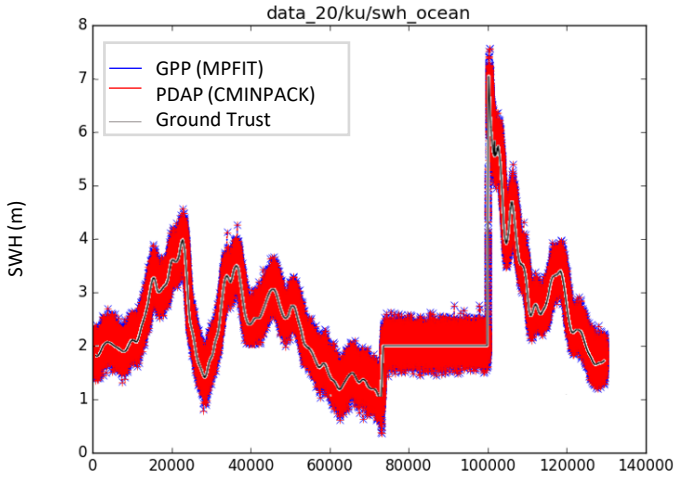
Damping factor = 10-5

Damping factor = 1.2 as S3

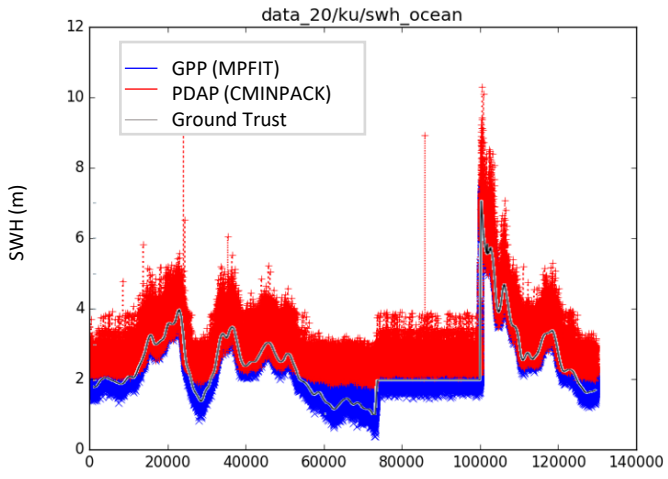
Result coherent with last IPF S3 upgrade and with a better fit of small waves (least zero wave)

ALT L2 PGS: impact of damping factor and recommended configuration

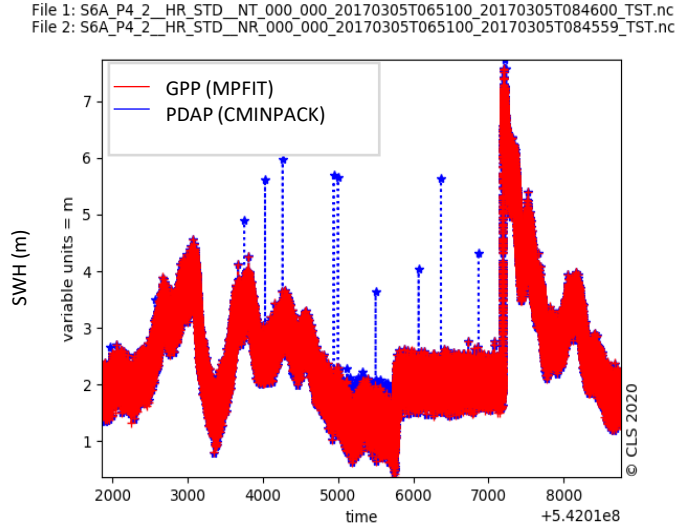
SWH Comparison for different values of damping factor and valid epoch domain, MPFIT in red and CMINPACK in blue



Damping factor = 10-5



Damping factor = 1.2 as S3



Damping factor = 1.2
Valid epoch domain increased to [-1200ns;1200ns]

We recommend to set damping factor to 10-5. This value will have to be tested with real data regarding the difference between S6 simulation, S3 Reconditioned real Data, and S3 Real data processed with IPF (See reconditioned analysis).

Conclusion

- GPP validation was successfully performed and met P4 L2 processors requirements
- PDAP is consistent with GPP
- Analysis enables the establishment of recommendations for the P4 L2 Processor parametrization :
  - We recommend to set the damping factor at 1E-5. Further analysis is needed with real data to confirm this;
  - We recommend to set the doppler beam sampling factor to 3 at least.
- Analysis enables to assess new algorithm S6 implementation (Range compression)