Aviso one-satellite-based Mean Sea Level reprocessing

In January 2014, the MSL products have been reprocessed to take into account improvements performed on altimeter corrections and on the MSL processing methodology.. The changes impact on both the global and the regional one-satellite time series.

The impact of these two modifications will be discussed in the third section.

1. Geophysical corrections

The changes to the geophysical corrections have been made accordingly to recent public (Sea State Bias) or intern (troposphere, ocean tide…) studies in order to improve the accuracy of the Aviso MSL indicators.

The table 1 summarizes the changes to the corrections for the three main missions: TOPEX/Poseidon, Jason-1 and Jason-2.

The impact of these new corrections will be discussed along with the impact of the new method in Section 3.

	T/P	J1	J2
Orbit		GDRD	
Sea State Bias		New SSB J1 (Tran, et al., 2012)	New SSB J2 (Tran, et al., 2012)
Ionosphere	New Altimeter ionosphere corrections based on iterative filtering method (SLOOP project)		
Dry troposphere	Era Interim based		
DAC	Era Interim based		
Ocean tide	New model : GOT 4.8		
MSS	New MSS CNES-CLS 2011 (Ref 20 years)		
Specific corrections	Global bias to set the 1993 year on 0.0	New TP/J1 bias	New J1/J2 bias

Table 1: New sea-level corrections applied on AVISO MSL indicators

2. Improvement of the global and regional Mean Sea Level processing methodology

(Henry, et al., 2013) showed differences between Aviso and Colorado University GMSL time series in the order of a few millimeters during extreme events. These are partly explained by the difference between the processing methodologies. Investigations have been carried out to identify and correct inaccuracies in the Aviso GMSL processing methodology.

Before January 2014, the method consisted in using a 2x2° grid to average altimetric data recorded during a cycle (~10 days for Jason satellites). The 2x2° boxes were then averaged with weights corresponding to the latitude cosine. These weights enable to project the grid on a sphere.

(Henry, et al., 2013) highlighted some boxes of the 2x2° grid contain an amount of data that is too small to be statistically meaningful for the Jason missions. These boxes are mainly located at low latitudes (where the inter-tracks distance is the largest) or on the coastline. The distance between two Jason ascending (resp. descending) tracks at low latitudes is ~2.8°. The spatial distribution of the 2x2° grids makes it inevitable that some full-ocean boxes are located exactly between two ascending and two descending tracks -in the middle of the diamond- and contains just a small amount of data in the corners. Concerning the coastline, the concerned boxes are overlapping land. Hence just a portion of their surface covers ocean and contains data. Naturally, the amount of data in a box is linked to its ocean-covered surface.

The processing methodology has been slightly modified in order to solve these issues. The grid dimensions have been set to 1x3° (3° along the longitudinal axis). This way, the full-ocean boxes are necessarily crossed by two ascending and descending tracks. Tests showed -

even though the boxes dimensions were diminished by 1 degree square- the minimum amount of data was doubled. In addition to the latitude cosine weighting, a weighting grid is also applied so that each box impacts the global mean in proportion to its surface covering ocean.

Validation of this new method was similar to (Henry, et al., 2013): synthetic altimetric data has been created from Mercator-Océan GLORYS reanalysis over the Jason-1 period. GLORYS has been considered as the "real ocean" (the accuracy of the product is not relevant, it is just a reference), and the synthetic data as the satellite observations. We may then compare the MSL computed from our synthetic data with different methodologies to our reference GLORYS. Results show the new processing methodology improves the accuracy of Global MSL by at least 55% depending on the metrics.

	slope (mm/yr)	**formal error (mm/yr)**	**Monte-Carlo uncertainty (mm/yr)**
Old methodology	0.0896	0.0255	0.143
New methodology	0.0200	0.0164	0.0545

Table 2: Performances comparison between new and old AVISO MSL

The table 2 presents the statistics obtained by subtracting the GMSL computed with GLORYS from the GMSL computed from the synthetic data -using the old and the new methodology- on the 2002-2009 time-period. The Monte-Carlo uncertainty enables to take into account the measurements correlation, and in fine provides a realistic error. The slope,the formal error and the Monte-Carlo uncertainty significantly decrease with the new methodology, demonstrating its improvement.

3. Impact of reprocessing

The figure below plots the difference between the new and the former Aviso GMSL products. Blue dots represent the simple difference, a 2-months low-pass filter has been applied on the red curve and a 6-months on the green one. The vertical black lines represent the switch from one satellite to another.

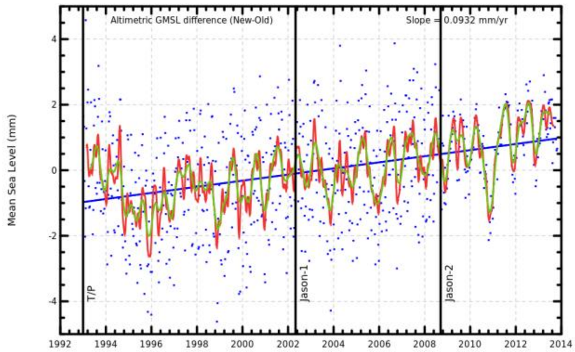

Figure 1: GMSL differences between new and old releases.

The new ocean tide correction (GOT4V8) decreases significantly the 60-days MSL signal error characterized in GOT4V7 (Ablain, et al., 2010). It is clearly visible on the TOPEX and Jason-1 periods, whereas GOT4V8 was already used for the Jason-2 period in Aviso 2013.

The impact on the 2010 Niña event is also visible with a -1.5 mm difference. Aviso 2013 was overestimating the intensity of this extreme event according to comparisons with the Multivariate ENSO Index (MEI). Aviso 2014 thus represents this event more accurately.

Finally, it is worth noticing the improvements applied on the Aviso products estimate the trend with a 0.093 mm/yr increase.

4. Bibliography

Ablain, M., Philipps, S., Valladeau, G., Carrere, L., Legeais, J.-F., Bronner, E., & Picot, N. (2010, Octobre 20). *Analysis of the 58.74-day signal observed on the MSL derived from Jason-1&2 and TOPEX data*. Download the pdf from Aviso.

Henry, O., Ablain, M., Meyssignac, B., Cazenave, A., Masters, D., Steve, N., & Garric, G. (2013). Effect of the processing methodology on satellite altimetry-based global mean sea level rise over the Jason-1 operating period. *Journal of Geodesy*.

Tran, N., Philipps, S., Poisson, J.-C., Urien, S., Bronner, E., & Picot, N. (2012, Septembre 28). *Oral : Impact of GDR-D standards on SSB corrections*. Download the pdf from Aviso.