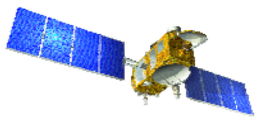
Assessment of Jason-2 and Jason-1 orbit quality from SSH analysis



M. Ablain[1], I.Pujol[1], S. Philipps[1], N.Picot[2]

[1]*CLS, Space Oceanography Division, Toulouse, France*
[2]*CNES, Centre National d'Etudes Spatiales, Toulouse, France*

Overview

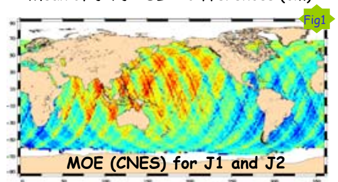
The OSTM/Jason-2 satellite was successfully launched on 20th of June, 2008. Since 4th of July Jason-2 is on the same orbit as Jason-1 spaced out by 55 seconds. The Cal/Val phase allows us to check very accurately the Sea Surface Height (SSH) consistency provided by both satellites. Actually, as the altimeter parameter consistency between both missions seems very good, the Jason-1/Jason-2 SSH cross-calibration directly provides an estimation of the quality of the orbit underlining eventual geographically correlated biases, jumps or drifts. The objectives of this study is then to present the quality of Jason-2 and Jason-1 orbits (DIODE, MOE and preliminary POE orbits) through the SSH calculation. Along-track and crossover analyses are performed from the beginning of the mission to compare the system performances using the different orbits in the SSH calculation provided by Jason-1 and Jason-2. Cross-calibration with Envisat data is also performed to complete these analyses.

Along track SLA analyses / Comparisons with Jason-1

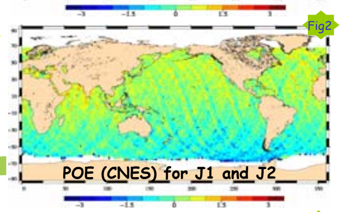
Jason-1 and Jason-2 SLA differences are mapped over all the Jason-2 period using successively MOE orbits (from IGDRs) from cycles 1 to 10 and POE orbit provided by CNES and GSFC from cycles 1 to 7. Jason-2 POE orbits are preliminary since Jason-2 GDRs are not yet available. Note that no correction is applied to the SLA calculation (only Orbit – Range – MSS) since both altimeters are spaced out by 55s.

Mean of J1/J2 SLA differences (cm)

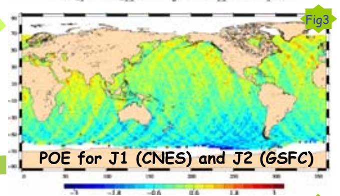
SLA differences with CNES MOE orbits (fig.1) highlight large correlated geographically biases within +/-3 cm in average. These biases vary in space and time (for each cycle) and they can reach +/- 5 cm.



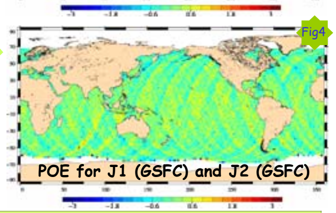
Using CNES POE orbit, Jason-1/Jason-2 SLA consistency (fig.2) are dramatically improved. However, weak hemispheric differences remain close to 1 cm. In addition, this correlated geographically bias is stable in space and time.



Replacing CNES POE orbit by GSFC orbit only for Jason-2 SLA has no impact on Jason-1/Jason-2 SLA consistency (fig.3) : the weak hemispheric differences are still observed.



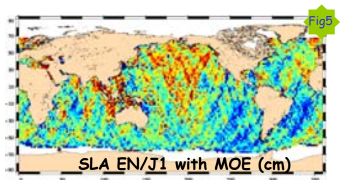
Finally, using GSFC POE orbits provided for both missions, allows us to obtain a more homogenous map. SLA differences are now lower than 0.5 cm and do not show any specific structures (fig.4).

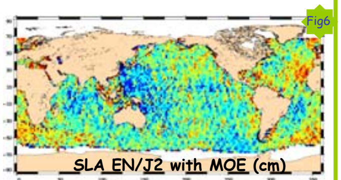


This analysis shows the great impact of the orbit calculation on the SLA consistency between Jason-1 and Jason-2. It highlights that the small residual differences observed on SLA consistencies (with POE) are mainly due to the orbit calculation. However it does not allow us to determine which is the best orbit solution.

Cross-Calibration with Envisat

Using MOE orbit, the SLA consistency is better between Jason-2 and Envisat than between Jason-1 and Envisat.



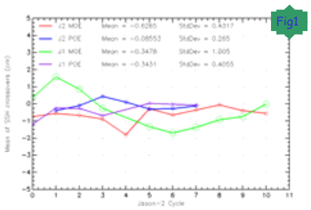


Cross-calibration with Envisat measurements is also performed to check the SLA consistency with Jason-1 and Jason-2. But in this case, both Jason satellites do not measure the same SSH at the same time. Then it is mandatory to cumulate SLA differences over a long enough period to average the oceanic variability discrepancies. Then, we focus here our analysis on SLA differences calculated with MOE orbits, since 11 Jason-2 cycles are available.

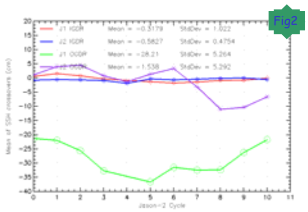
SLA consistency is better between Jason-2 and Envisat than with Jason-1 (fig.5 and 6). Correlated geographically biases observed from Envisat/Jason-1 (fig.5) are very well correlated with those detected from Jason-1/Jason-2 (fig.1). This brings out the good consistency of Jason-2 and Envisat MOE orbit. This may indicate also that Jason-1 MOE could be refined.

SSH Crossovers analyses / Comparisons with Jason-1

The monitoring of Jason-1 and Jason-2 SSH statistics at crossovers are performed using successively DIODE, MOE and POE orbits, allowing us to compare the relative performances of each orbit. Thanks to the new Jason-2 DIODE orbit, a dramatic improvement is observed: mean of SSH crossover are more stable and better centered than Jason-1 (fig.2) and standard deviation are significantly lower (fig.4).
Concerning MOE and POE orbits, similar statistics are plotted (fig.1 and 3). A slightly improvement is observed using Jason-2 MOE in comparison with Jason-1 especially for the standard deviation (5.5 cm RMS for J2 instead 5.7 cm RMS for J1 (fig.3)). Results is reversed comparing the GDRs products, but the CNES Jason-2 's POE orbit is preliminary at the moment.

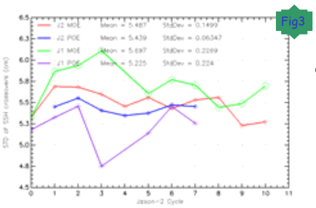


Mean of SSH crossovers (cm)

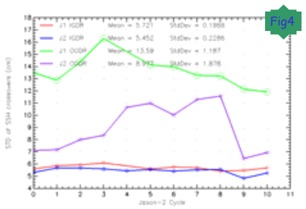


Impact of MOE and POE orbits for J1 and J2

Impact of DIODE orbits for J1 and J2

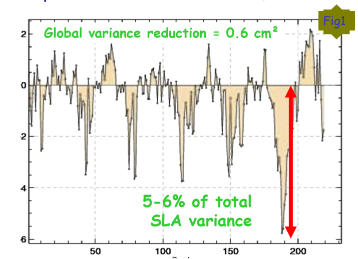


Standard deviation of SSH crossovers (cm)



Performances of New GDR-C Jason-1 orbit over all the Jason-1 period

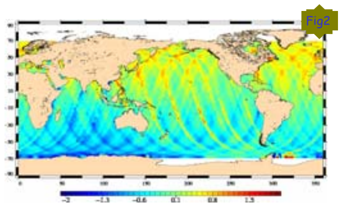
GDR-C orbit is a SLR/DORIS/GPS orbit as GDR-B but uses the EIGEN-GL04C gravity field, taking into account annual and semi-annual time variability, atmospheric contribution of the gravity field and ocean pole tide effects. In addition, the new reference frame used is ITRF2005.



Cycle by cycle SLA variance reduction (cm²) using new Jason-1 orbit (GDR-C) / old Jason-1 orbit (GDR-B)

Mean differences at crossovers are more homogeneous geographically, proving a better coherence with version C (not shown here). A stronger improvement is observed from along-track analyses. Indeed, the SLA variance difference using successively GDR-C and GDR-B POE orbits highlights an annual signal (fig.1) with a strong reduction of variance (until 6 cm²). This feature has also been observed when comparing the altimetry to in situ measurements (Tide gauges and ARGO T/S profiles).

The impact of new GDR-C orbit on global MSL trend is weak (< 0.1 mm/yr). But hemispheric regional trends are impacted by the new ITRF2005 solution within +/-2 mm/yr (fig.2). Hemispheric MSL trend differences are now more homogenous (1.94 mm/yr slope difference with GDR-B orbit instead of 1.40 mm/yr with GDR-C orbit). However, the impact on hemispheric MSL trends is weaker compared to the GSFC ITRF2005 orbit (see Ablain's poster : Error estimation of the global and regional mean sea level trends).



Regional MSL trend differences (mm/yr) using new Jason-1 orbit (GDR-C) / old Jason-1 orbit (GDR-B)

Conclusion

This study aims at underlining the very good quality of Jason-2 orbits. It's especially true for the DIODE orbit which dramatically improves SSH statistics at crossovers in comparisons with Jason-1. Though, MOE and POE orbits show similar performances for both satellites at crossovers, the analysis of SLA consistency highlights a better coherence between Jason-2 and Envisat MOE than with Jason-1 MOE. These not negligible differences (+/- 5 cm) , probably due to the Jason-1 MOE calculation impact directly the quality of multi-mission products using Jason-1 as the main altimeter mission (DUACS product for instance). Finally, the SLA consistency analysis using different POE orbits (CNES, GSFC) is in a good agreement (+/- 1 cm). However it also shows that the POE orbit calculation remains the main source of SLA discrepancies between Jason-1 and Jason-2.

Collecte Localisation Satellites
8-10 rue Hermes
31520 Ramonville Saint-Agne - France

OSTST
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