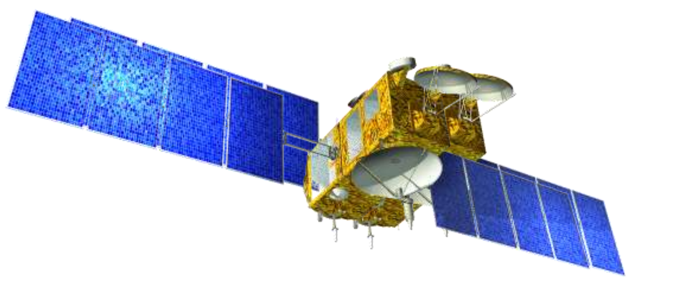
Jason-1 data quality assessment and cross-calibration with Jason-2 and TOPEX/Poseidon



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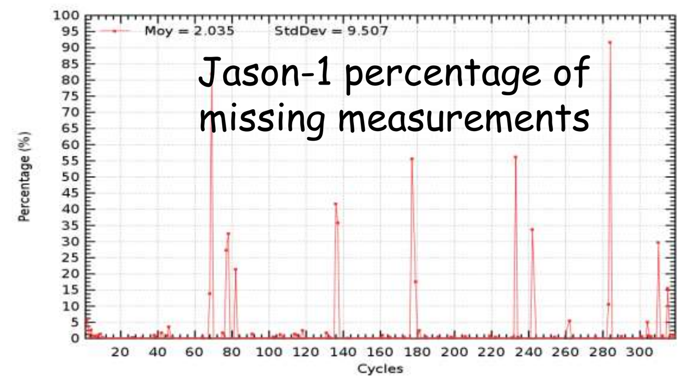
Overview

This study concerns global data quality assessment of the Jason-1 (JA1) altimetry system, from all GDR products available to date (GDR-C release, homogenous over all the period). This includes careful monitoring of all altimeter and radiometer parameters, performance assessment and geophysical evaluation. We also pay a particular attention to the long-term stability of the Jason-1 MSL, but also the evolution of the performances in relationship with degraded performances of star trackers and gyro wheel occurred in 2010. Moreover, comparisons with Jason-2 (JA2) SLA are performed too.

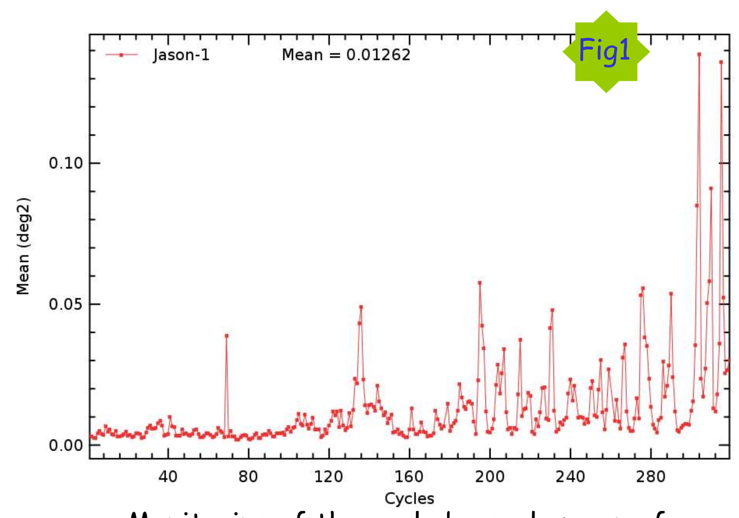
Note that between January and September 2010, the percentage of missing measurements over ocean grew up several times due to high platform mispointing (cycles 304, 310, 315) leading to altimeter lost of track (and therefore to data gaps).



Along Track / Spatial SLA analyses

Monitoring of the Jason-1 square-off nadir

Recently, several degradations of the on-orbit performance of the star trackers and gyro wheel on JA1 has caused large off-nadir angles of the platform (see Figure 1, cycles 304,310,315). This occurs especially, when the satellite is in yaw fix mode and is related to bad beta angle environment. This leads often to edited measurements (mispointing out of thresholds, altimeter parameters at default value) and sometimes to missing measurements (altimeter lost of track).
On 2010-04-14 (cycle305), a gyro swap was performed.

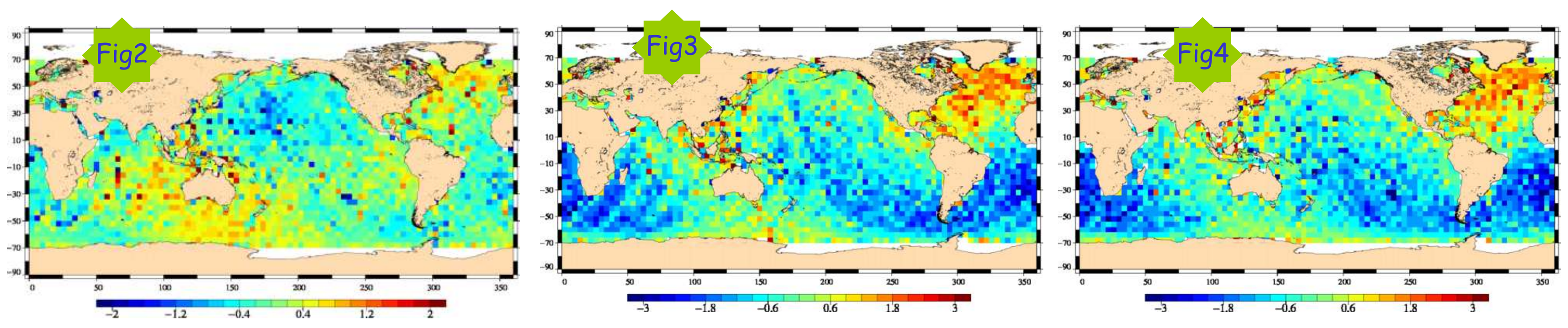


Monitoring of the cycle by cycle mean of square-off nadir on Jason-1

➡ Jason-1 is periodically impacted by high mispointing

Jason-1/Jason-2 SSH performances at crossover

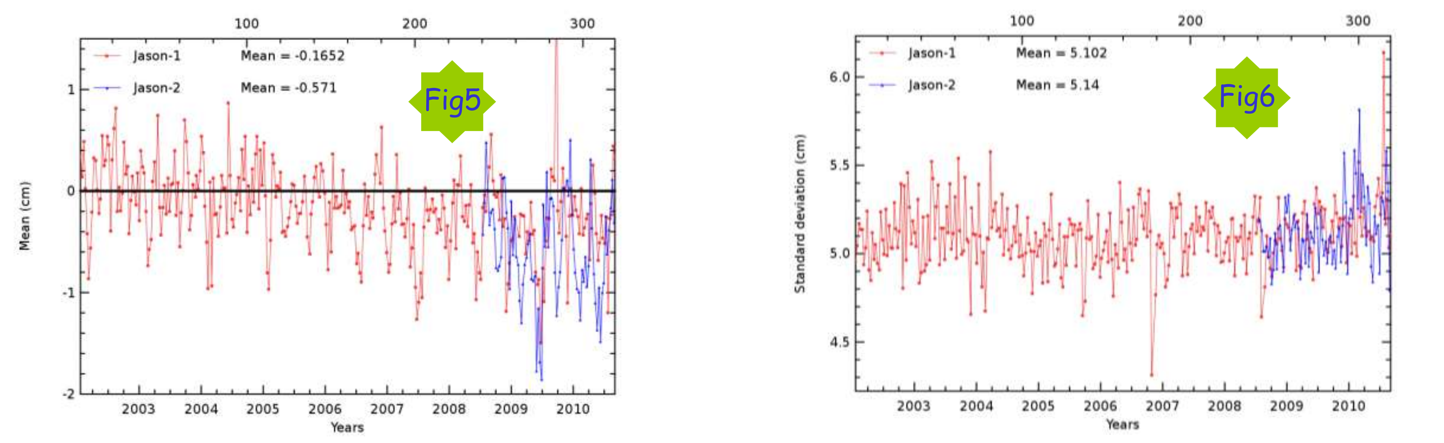
SSH performances are monitored so as to assess the global system performances since the beginning of Jason-1 and now Jason-2 altimeter mission. The GDR versions used are 'C' for Jason-1 and 'T' for Jason-2, which are comparable.
Maps of mean of SSH differences at crossovers show small geographically correlated patterns (see Figure 2). Over Jason-2 period, these structures are the same for Jason-1 and Jason-2 (see Figures 3 and 4): positive in North Atlantic, negative in South Atlantic.



Maps of SSH at crossover. Left: Jason-1 over whole mission. Middle: Jason-1 over Jason-2 period. Right: Jason-2

The cyclic monitoring of mean of SSH differences at crossovers shows a small drift (see Figure 5), which causes discrepencies in MSL trend when seperating ascending and descending passes. During JA2 period, both satellites show similar results, though JA1 is less impacted by 120 days signals. Nevertheless, this signal is strongly reduced for JA2, when using other orbit solution (see poster « **Orbit quality assessment through SSH calculation** », S. Philipps).

Concerning the SSH standard deviation at crossover, the cyclic monitoring shows a raise which appears on both Jason-1 and Jason-2 at the beginning of 2010, around cycle 300 (see Figure 6). The high value (> 6 cm) of cycle 315, is related to fuel depletion maneuvers, as due to the numerous maneuvers, orbit is an assembled MOE, instead of POE.



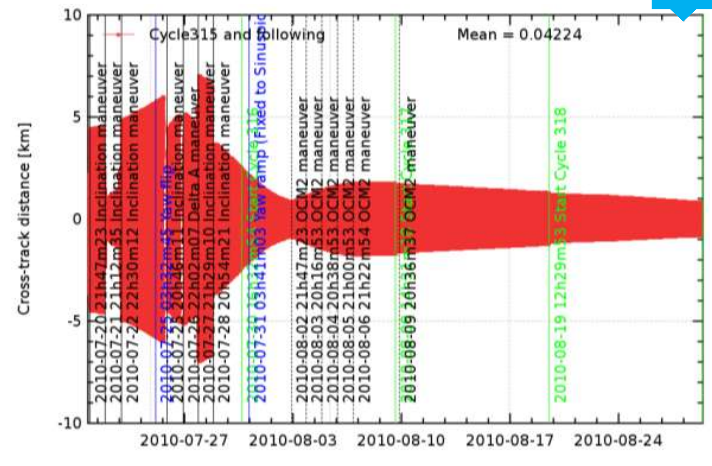
Cyclic SSH crossover differences monitoring of Jason-1 and Jason-2. Left: mean. Right: standard deviation. The following selections are used: |latitude|< 50°, Bathymetrie < -1000 m, low ocean variability (< 20 cm)

➡ SSH performances at crossovers are good

Jason-1 Fuel depletion Maneuvers

In order to reduce the risk of an explosion in the event of anytype of collision, several inclination maneuvers were performed to deplete partially the fuel tank. They impacted most of cycle 315 (starting on 2010-07-20). In consequence, JA1 ground track departed up to +/- 7 km from its nominal ground track (see Figure 7). In the following cycles it comes gradually back to the +/- 1km.

➡ Cycle 315 should be used with caution



Jason-1 cross-track distance (km)

Conclusion

Despite the degraded performances of star trackers and the maneuvers linked to Jason-1 fuel depletion this year, results are reliable and display a good consistency with Jason-2. The long-term stability of the Jason-1 MSL is still relevant. However, recent studies on wet troposphere or wind speed corrections underline the current need to go on assessing precise altimeter and radiometer corrections in order to improve the accuracy of the estimate of the sea surface elevation and thus enhance the delivered scientific products.

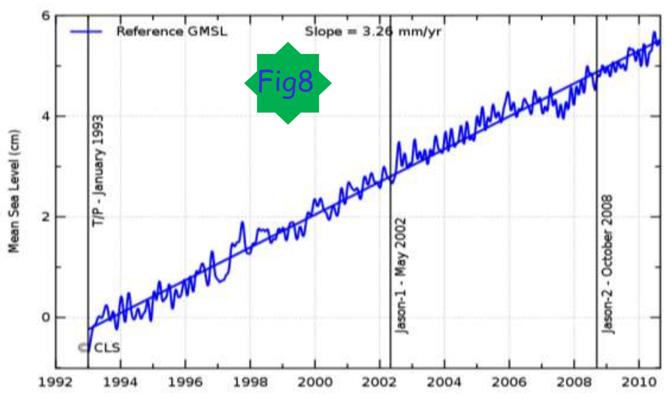
References:

- Ablain, M., Cazenave, A., Valladeau, G., and Guinehut, S.: **A new assessment of the error budget of global mean sea level rate estimated by satellite altimetry over 1993–2008**, Ocean Sci., 5, 193-201, doi:10.5194/os-5-193-2009, 2009
- Philipps, S.: **Orbit quality assessment through SSH calculation**. OSTST Poster

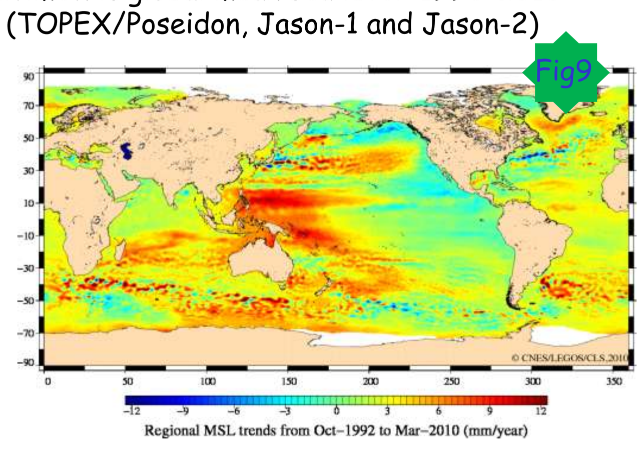
Mean Sea Level

Global and local Mean Sea Level

Permanent monitoring of quality during the missions and studies of the necessary corrections of altimetry data regularly add to our understanding and knowledge.
With the TOPEX/Poseidon, Jason-1 and Jason-2 satellite altimetry missions, the global mean sea level (GMSL) has been calculated on a continual basis since January 1993, which results in a 3.26 mm/year global trend (see Figures 8 and 9, GIA applied).
Verification phases, during which the satellites follow each other in close succession help to link up these different missions by precisely determining any bias between them.
For further informations, please refer to the AVISO website:
http://www.aviso.oceanobs.com/en/news/ocean-indicators/mean-sea-level

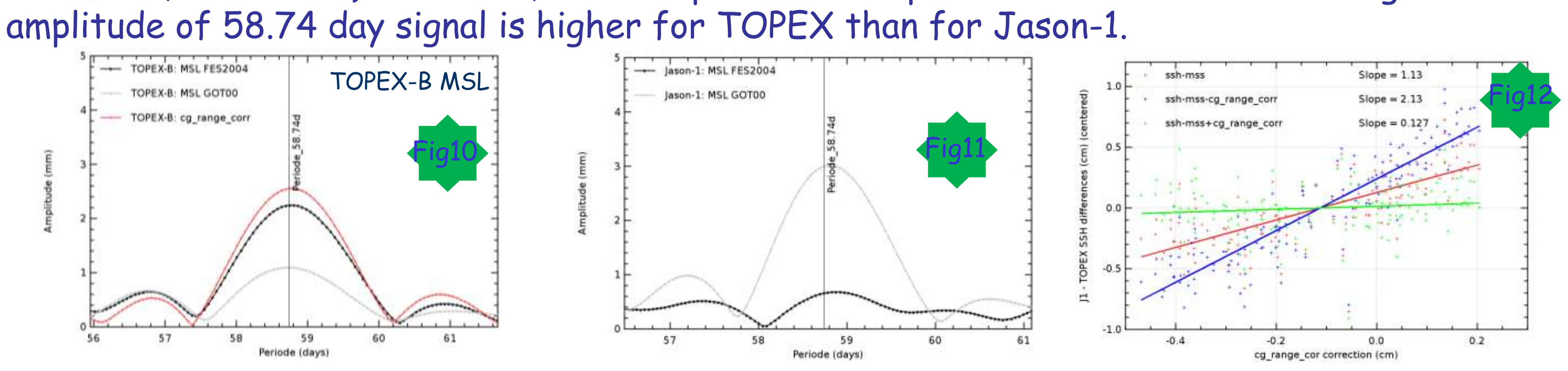


Altimetric global mean sea level 1993-2010 (TOPEX/Poseidon, Jason-1 and Jason-2)



58.74-day signal on Jason-1 MSL

A 58.74 day signal is observed on MSL derived from Jason-1/Jason-2 and TOPEX data. Using GOT ocean tide models, this signal is more important for Jason-1 than TOPEX. Analysis by M. Ablain (see talk « **MSL investigations: 59-day signal differences between Jason-1&2 and TOPEX** », M. Ablain) indicates, that amplitude is dependant on tide model: using FES2004, amplitude of 58.74 day signal is higher for TOPEX than for Jason-1.



Amplitude of 58.47-day signal for MSL of TOPEX (left) and Jason-1 (middle) for different ocean tide models. Right: Mean of cyclic J1 – TOPEX SLA differences as function of mean of TOPEX cg_range_corr. Cg_range_corr is either applied (with different signs) to TOPEX SLA or not.

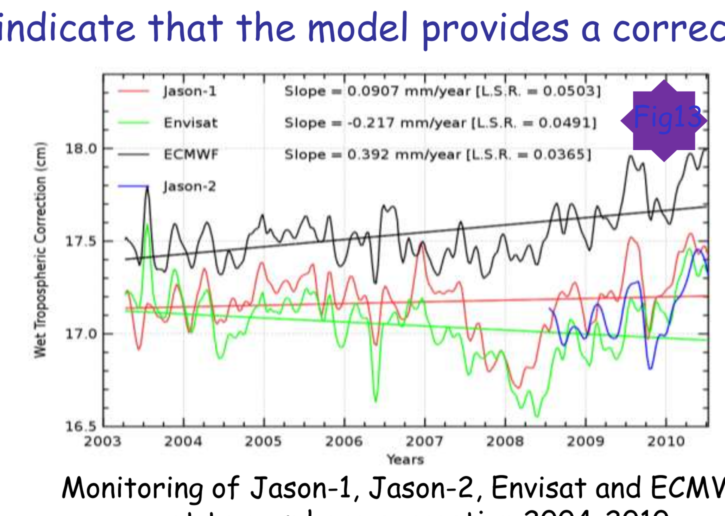
➡ It has been demonstrated that GOT models absorbed TOPEX semi-diurnal signal errors, which are therefore redistributed on Jason-1 MSL. This might be linked to the wrong sign of TOPEX mass center correction (CG_RANGE_CORR) in M-GDR products.

Particular investigations

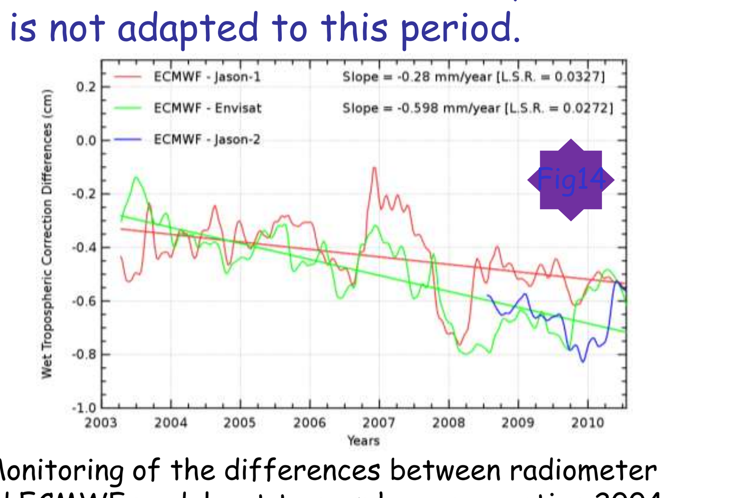
Radiometer Wet Troposphere correction

In order to provide the best SSH assessment and thus accurately estimate climate change, altimetric and geophysical corrections have to be precisely determined. Hereafter, wet troposphere correction is analysed, as it shows different behaviour between Jason-1 (JMR), Jason-2 (AMR), Envisat (MWR) radiometer data and ECMWF model data.

A strong decrease of ~0.4 cm is observed at the beginning of 2008 with radiometer corrections (see Figures 13 and 14). This evolution could be associated with the 2008 La Nina event. Note that the correction from ECMWF model doesn't show this evolution, which would indicate that the model provides a correction which is not adapted to this period.



Monitoring of Jason-1, Jason-2, Envisat and ECMWF wet troposphere correction 2004-2010

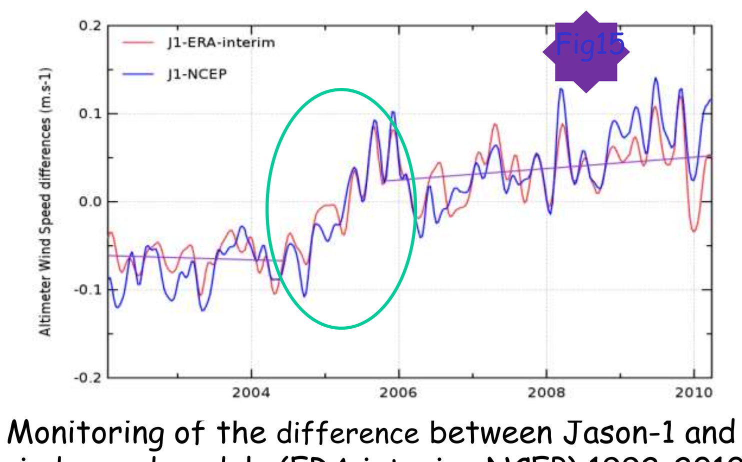


Monitoring of the differences between radiometer and ECMWF model wet troposphere correction 2004-2010

➡ This difference implies a +/- 0.3 mm/year uncertainty on the estimate of the Mean Sea Level slope. Moreover, this study demonstrates that to date the method is not adapted yet to an accurate assessment of the wet troposphere correction regarding radiometer as well as model corrections (see talk « **Trend and variability of the atmospheric water vapor: a mean sea level issue** », E. Obligis).

Ocean Wind Speed stability over the Jason-1/Envisat time period

Another specific investigation is related to the evolution of the wind speed. Wind speed cross-comparisons (altimeter and models) allows us to detect jumps or drift in altimeter wind speeds and therefore in Sigma0 parameter .
Using reanalysis, a 10 cm.s-1 wind speed jump is detected on Jason-1 in 2005 (see Figure 15) (corresponding to a 0.025 dB Sigma0 jump), which means an increase of 0.6 mm on the Mean Sea Level.



Monitoring of the difference between Jason-1 and wind speed models (ERA interim, NCEP) 1992-2010

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