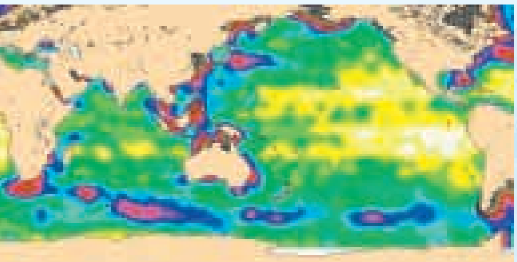

Jason-1 Calval results

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Since the beginning of the mission, Jason-1 IGDR and GDR products have been continuously analyzed to assess the quality of Jason-1 measurements [Picot et al., 2001]. Many papers have already addressed the quality of Jason-1 data, through the analysis of Jason-1 and Topex/Poseidon (T/P) measurements acquired during the Jason-1 verification phase (e.g. Desai and Vincent [2003] for real-time products, Vincent et al. [2003], Chambers et al. [2003], [Leben and Powell, 2003] for offline IGDR data).

This short paper deals with the long-term monitoring of the main Jason-1 GDR parameters to derive system and algorithm performance. Classical editing procedures are used to work with valid data sets. First, flags are used to sort measurements over land and ice. Then, threshold criteria are applied on altimeter, radiometer and geophysical parameters as described in Picot et al. [2001]. Last, a spline criterion is applied to remove the remaining spurious data.

We will restrict the following sections to small selection of results derived from: (i) comparison of Jason-1 and Topex/Poseidon (T/P) sea surface height (SSH) crossovers, (ii) analysis of the along-track differences, and (iii) evaluation of Jason-1 to T/P SSH bias and the mean sea level (MSL) trends. An extended set of results from long-term monitoring of the quality of Jason-1 measurements can be found in Ablain et al. [2004].

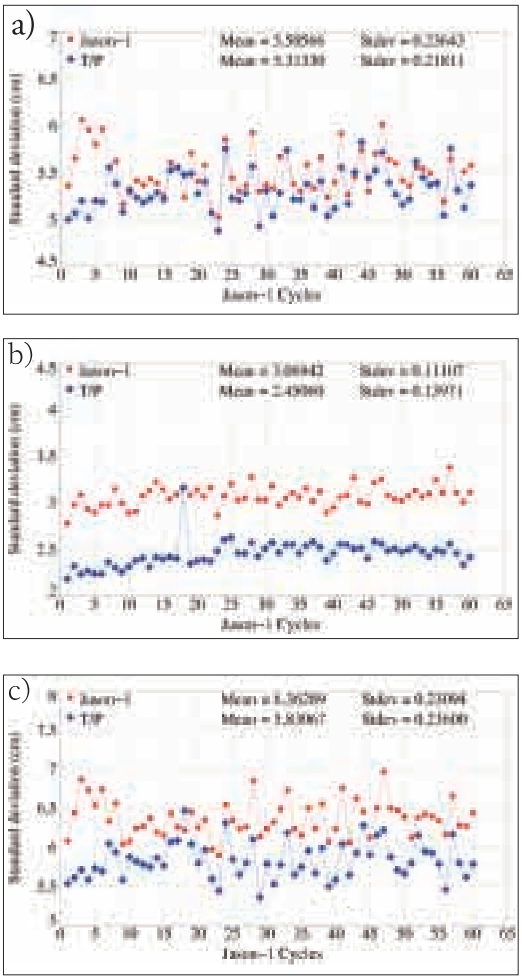


Figure 1. Cycle-per-cycle standard deviation of crossovers differences for long-wavelength content (a), short-wavelength content (b) and total content (c)

Crossover analysis

Crossover differences are systematically analyzed to estimate the quality of the data and compare T/P and Jason-1 performance. It is worth mentioning that T/P products have been upgraded to use the same algorithms and models as for Jason-1, whenever it makes sense. Note that for Topex, a non-parametric sea-state bias (SSB) law has been recomputed over the Topex B period using collinear data following Gaspar et al. [2002]. For Poseidon-1 data, we used the four-parameter SSB estimate in the M-GDR products.

Data involved in this process have been screened using several criteria:

- Shallow water areas (depth > -1000 m), as well as areas of high ocean variability (> 20 cm) and high latitude regions (> |50| degrees) have been removed.
- Sea Surface Height (SSH) crossovers are interpolated with a spline tension parameter equal to 0: Therefore, the SSH is not filtered along track.
- From cycle 28 onwards, all Jason-1 crossovers corresponding to the missing T/P crossovers have been removed to get equivalent coverage for the two missions.

The cycle-per-cycle standard deviation of crossover differences is plotted on Figure 1 (bottom panel) for Jason-1 (red curve) and T/P (blue curve). It first appears that Jason-1 performance is slightly degraded during the first eight cycles: This is because the POE orbits have not been reprocessed for these cycles, and it is known that maneuvers were poorly processed. Generally, T/P standard deviation figures are slightly lower than the Jason-1 figures. To better understand this result, the SSH – MSS (Mean Sea Surface) differences have been filtered along-track (using a low-pass filter) for both satellites. The short- and long-wavelength contents have been separated using a 50 km cut-off wavelength:

- the short-wavelength signal (middle panel in Figure 1) helps identify the impact of different ground processing applied to T/P and Jason-1 [Zanifé et al, 2003]. The standard deviation is about 1.9 cm rms higher for Jason-1 than for T/P. Note that data from Jason-1 cycle 18 and T/P cycle 361 show that performance of the Poseidon-1 and Poseidon-2 instruments is equivalent.
- long wavelengths (top panel in Figure 1) mainly show the impact of orbit errors on both missions (among other possible errors).

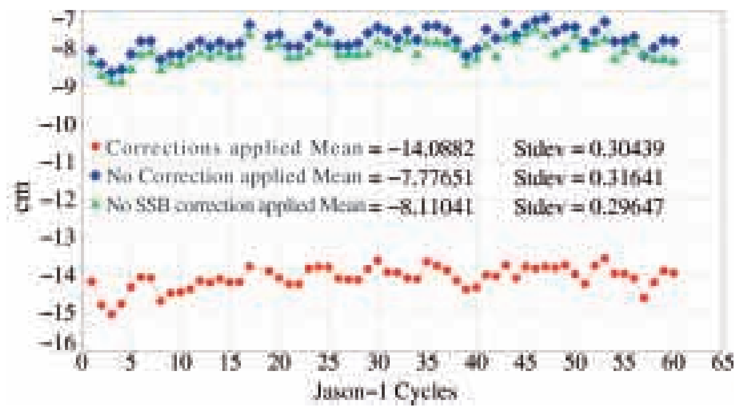


Figure 2. Cycle-per-cycle mean of (T/P – Jason-1) SSH differences. X-axis: time in 10 day cycles, Y-axis: relative bias in cm.

Along-track analysis

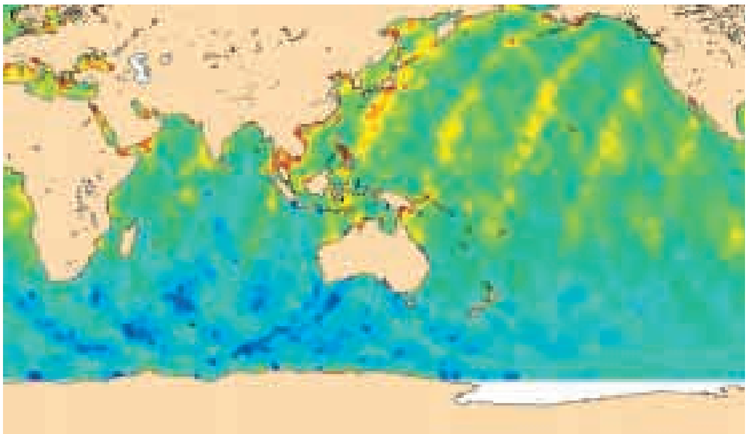
The primary goal of along-track analysis is to compute sea level anomaly (SLA) and ocean variability. It can also be used to determine the SSH bias between Jason-1 and T/P, and the mean sea level trend.

T/P – Jason-1 SSH bias and mean sea level

In order to compute the (T/P – Jason-1) SSH bias, the same environmental and geophysical corrections have been used to calculate the Jason-1 and T/P SSH. The radiometer wet troposphere correction has been replaced by the ECMWF model wet troposphere correction to avoid any disturbance due to the abnormal behavior of the JMR correction. The SSH bias is plotted on a cycle basis on Figure 2 (red curve): It is quite stable at about –14 cm. The Northern and Southern distributions of this bias (not shown) are quite similar from cycle 28 to 53. However, differences can reach 1.5 to 2 cm over cycles 1-17, 22-27. Let us recall that: (i) the Jason-1 Precise Orbit Ephemeris have not been reprocessed for the first eight cycles, for which it is known that the maneuvers are poorly processed; (ii) the T/P orbit change occurred between cycle 22 and 25. This could explain part of the differences observed. The orbit reason may be confirmed when looking at the map of the (T/P - Jason-1) SSH differences averaged over the verification phase of the mission (first 21 cycles): indeed, differences then appear to be geographically correlated. From cycle 54, the difference between both hemispheres increases, which is still under investigation.

The SSH bias has also been computed applying no correction at all (blue curve), and applying all corrections except for the sea-state bias (SSB) correction (green curve). The resulting two curves are very similar: they display a –8 cm T/P – Jason-1 SSH bias. We can thus estimate a global –6 cm relative bias between T/P and Jason-1 SSB.

The cycle-per-cycle mean sea level (MSL) has been computed over the T/P period (not shown). There is a pretty good agreement between the T/P and Jason-1 curves (as also shown by other authors during the Arles (2003) Science Working Team meeting–e.g. S. Nerem). While T/P and Jason-1 MSLs are fully consistent over cycles 1-25, the two signals are somewhat biased by 0.6 cm over cycles 26-60: this may be due to the JMR wet troposphere correction (whose behavior is under investigation at JPL – S. Desai, personal communication).



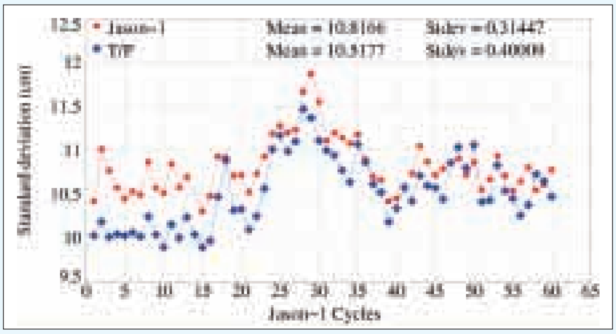


Figure 3. Cycle-per-cycle standard deviation of SLA

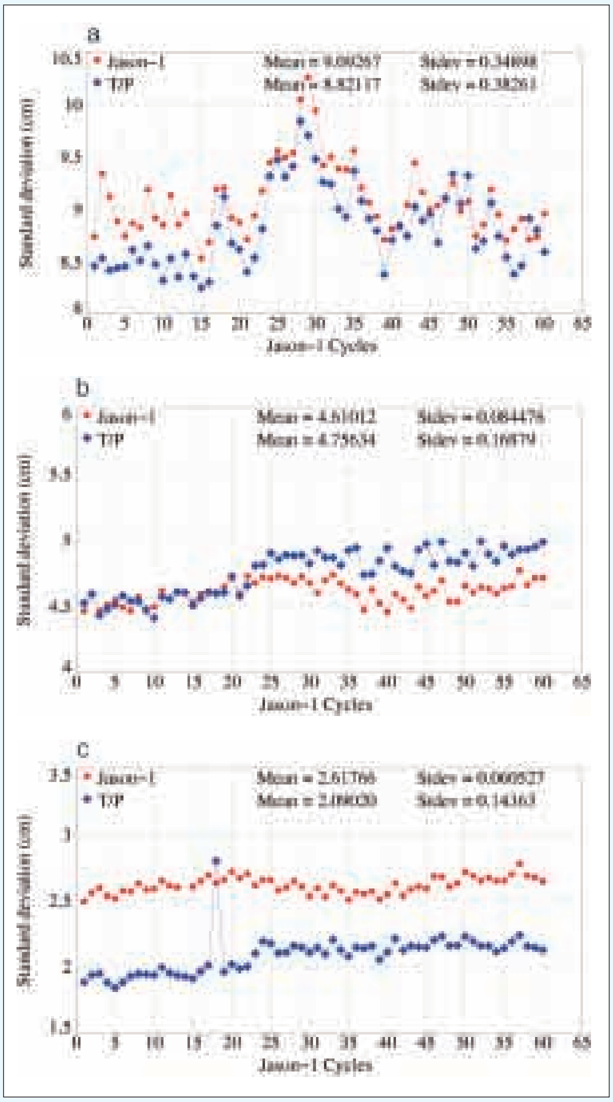


Figure 4. Cycle-per-cycle standard deviation of SLA for long-wavelength content (a), medium-wavelength content (b) and short wavelength content (c)

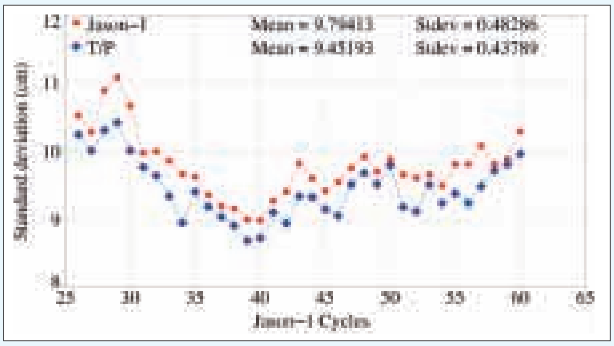


Figure 5. Cycle-per-cycle standard deviation of SLA based on dedicated T/P and Jason-1 mean profiles

Standard deviation of Sea-level anomalies

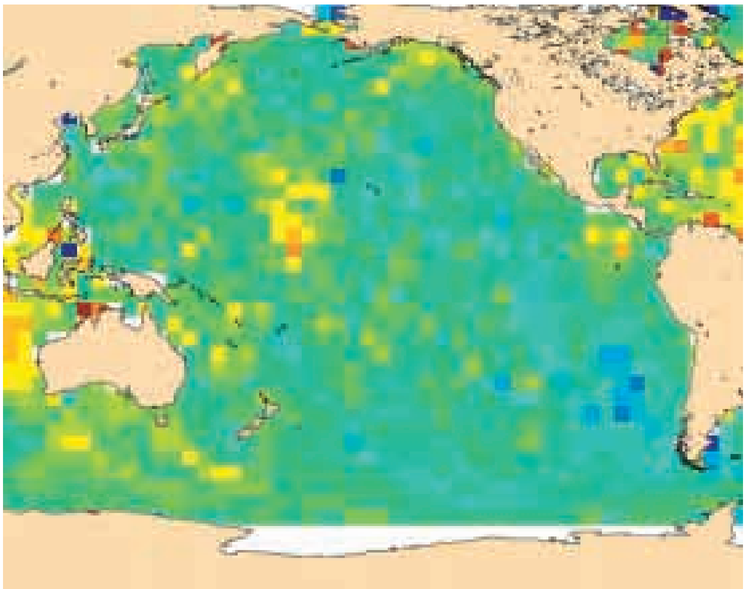
The standard deviation of the sea level anomaly (SLA) is plotted on Figure 3 for Jason-1 (red curve) and T/P (blue curve). It exhibits similar performance for both satellites. During the Jason-1 verification phase, the variability is slightly higher for Jason-1, whereas T/P and Jason-1 performance is very similar from cycle 26 onwards. A significant signal is observed from cycle 25 and 35, due to the 2002-2003 El Niño [McPhaden, 2003].

In order to better understand the differences between T/P and Jason-1, the short- and long-wavelength components of the SLAs (wavelength respectively shorter and longer than 500 km) have been separated (see figure 4), illustrating the difference between Jason-1 and T/P in terms of ground processing, as well as orbit quality differences. Medium and short wavelengths show a drop in T/P performance after the orbit change: This is due to the use of a dedicated T/P MSS to compute SLA. Indeed, when used off the nominal T/P – Jason-1 ground track, this MSS exhibits errors at the wavelengths under consideration. To confirm this interpretation, SLAs have been computed with respect to dedicated mean profiles, both for Jason-1 and T/P (cycles 26-60). The MSS effect is then perfectly illustrated when comparing results plotted on Figure 3 (SLA relative to MSS) and results plotted on Figure 5 (SLA relative to a dedicated mean profile).

Conclusion

Thanks to GDR reprocessing operations performed in 2003 at JPL and CNES, more than two years of Jason-1 data (GDR) are now available. It has been demonstrated that crossover and along-track performances are very similar for both T/P and Jason-1 satellites, and that the T/P – Jason-1 SSH bias is very stable at about -14 cm.

Having both T/P and Jason-1 missions orbiting at the same time has been (and still is) a very good opportunity to better evaluate the performance of each mission and identify possible sources of improvement. In this regard, the work by the Science Working Team (SWT) has been crucial, as is the continuous monitoring of T/P and Jason-1 data quality by the Project teams. The extended and comprehensive quality analysis performed by the SWT and Project Teams may then lead to plans to issue homogeneous and highly accurate time series of T/P and Jason-1 altimetry data.



To conclude, it is worth noting that, beyond the quality analysis exercise, the teams at JPL and CNES/CLS have been closely involved in generating and distributing higher-level altimetry products. In this respect, since mid-January 2004, JPL PO.DAAC is making available four types of new products: (i) Jason-1 Sea Surface Height Anomaly (J1SSHA), (ii) Topex/Poseidon Sea Surface Height Anomaly (TPSSHA), (iii) Jason-1 Along Track Gridded Sea Surface Height Anomaly (J1ATG), and (iv) Topex/Poseidon Along Track Gridded Sea Surface Height Anomaly (TPATG). The SSHA products provide compatible measurements of sea level residuals for both missions, with much smaller file sizes than Geophysical Data Records (GDRs). The ATG products provide the sea surface height anomaly with respect to a Mean Sea Surface (MSS) and are interpolated along track to a set of common points. On the CNES/CLS side, in addition to the now classical SLA and MSLA series of products that were recently completed with Jason-1 + ERS-2 and Jason-1 + Envisat products, the SSALTO/DUACS near-real-time products made available since mid-February 2004 now merge Jason-1, T/P, Envisat and GFO data; absolute dynamic topography products are also added to the usual SLAs and geostrophic currents.

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Data, documentation, and software of T/P and Jason-1 PO.DAAC new high-level products are available via the PO.DAAC anonymous ftp site: ftp://podaac.jpl.nasa.gov/sea_surface_height/ (see /jason and /topex_poseidon). For more detailed information on the SSHA products, see http://podaac.jpl.nasa.gov/dcatalog/ssha.html.

Information and data from the CNES/CLS SSALTO/DUACS system are available at http://www.aviso.oceanobs.com/duacs/