Dear DUACS users,

As mentioned in earlier messages, ENVISAT has been recently moved to a new orbit (altitude lowered by 17km) and to a different ground track. The new orbit features a 30-day cycle, although the ground track is not strictly repetitive at high latitudes. There were two error-budget risks associated with this new orbit:

1. a risk to see a different behaviour of the altimeter (altitude change, switch off/on),
2. a new error due to the lack of a precise temporal reference to derive Sea Surface Height Anomalies along the new and uncharted ground track

The dissemination of the first Envisat data on its new track started in early November, but as a conservative measure, ENVISAT processing in DUACS have been stopped until today.

First of all, let's start with excellent news. The analyses of ENVISAT data on the new orbit exhibit no major instrumental anomaly on Level 2 Sea Surface Height data from ESA, so risk #1 is very likely a non-issue. ENVISAT still has the potential to remain a precious sensor for DUACS users in Near Real Time.

Concerning risk #2, the orbit change means that in place of a traditional Mean Profile and repeat track analysis (see [Ref 1]), ENVISAT sea level anomalies must be derived from a gridded Mean Sea Surface proxy. This backup solution is an achievement made possible by the recent improvements of recent gridded MSS (CNES/CLS10, DTU10, DNSC08). For the sake of comparison, in the exact same situation, TOPEX/Poseidon was not used by DUACS for almost one year after it was moved to the tandem ground track.

However, using a gridded MSS in place of a precise along-track reference involves additional errors. Various analyses were recently performed and presented to the Ocean Surface Topography Science Team, specifically in the framework of the so-called Jason-1 Extension of Life group. We think the error on DUACS products is not a showstopper, but not a trifle either (see [Ref 2] for a detailed analysis).

To that extent, we have been actively working on ENVISAT since its orbit change, both on the Cal/Val front, on the re-integration in DUACS and in MyOcean's SL-TAC. We have updated many technical and scientific processing parameters to account for the orbit change. The biggest change is that sea level anomalies are now computed versus a temporal reference derived from the CLS/CNES 2010 Mean Sea Surface. This gridded surface is not only good, but also the most coherent with other DUACS standards and processes. Note that known outliers from seamounts have been edited out.

To validate this change, we have compared older ENVISAT data from the 35-day phase and the historical processor, with outputs of the new system and the MSS proxy. As expected from earlier

Jason1 studies, the discrepancies observed are of the order of 2.5 to 3 cm (along the ENVISAT track, after cross-calibration, see [Figure 1]).

Fortunately, so far only ENVISAT is affected by this error. Neither Jason1 nor Jason2 are using the gridded proxy and their SSH anomalies are still derived from classical repeat track analysis and mean profiles. As a result, three-satellite maps are less affected than along-track ENVISAT products: the impact is a difference (map from new processing minus map from old processing) of about 1 cm rms (see sample in [Figure 2]) with local signatures in the shape of "fake" stationary SSHA structures as high as 3 to 5cm (more problematic wherever oceanic variability is less than 7 to 12 cm). Larger errors are observed at high latitudes (>66°), where only ENVISAT can provide SSH observation, and the error is generally larger along bathymetry gradients and in coastal areas.

Note that these tests were made on the 35-day phase of ENVISAT. The gridded MSS proxy is known to be more accurate along the charted ENVISAT/ERS track than on the new uncharted 30-day ground track. We are observing only error terms #E, #F and #J from [Ref 2a]. Errors #G, #H and #I appear only with the new orbit.

The first multi-satellite maps based on ENVISAT 30-day data exhibit a similar behaviour, and no showstopper was observed on actual data from the uncharted track. Residual anomalies probably contain similar or higher local errors (1cm to 3cm rms), but we need more data and offline Delayed Time products to investigate things further as we have no NRT reference dataset to measure the stationary MSS error.

Knowing that ENVISAT SSHA is not as trustworthy on the new track as it was with standard repeat track analysis processing, we do try to mitigate its impact on multi-satellite maps. Indeed, we have increased the error prescribed on ENVISAT in various processing steps. Among others, the ENVISAT mapping error covariances have been changed to integrate the error estimates from [Ref 2] (geographical error patterns and wavelength separation are taken into account). This strategy is relevant mainly because neither Jason1 nor Jason2 are affected by the exact same error from a common reference surface (optimal merging based on a priori error prescribed for each sensor).

The positive consequence is that residual MSS errors from the uncharted ENVISAT track are less prone to corrupt multi-satellite maps: we observe a moderate improvement with the new parameters. When comparing maps based on the MSS proxy, with historical maps (same data, repeat track analysis) we observe that the difference is locally reduced by about 10 to 30%.

The downside is that the contribution of ENVISAT to multi-satellite maps is reduced by the higher error we prescribe. From a relative contribution to multi-altimeter maps of 32% in historical processing (observed from DFS analysis, see [Ref 3] and [Figure 3]), the contribution of ENVISAT is reduced to a global 27% and locally less than 20%, with geographical signatures coherent with the theoretical error of the CNES/CLS 2010 MSS (see [Figure 4] and [Figure 5]).

Considering the large improvements associated with an additional satellite in Near Real Time, we decided to re-activate ENVISAT processing in Near Real Time as soon as possible. The good sampling

complementarity between ENVISAT and the Jason tandem, and the good instrumental behavior of ENVISAT largely outshine the degraded accuracy linked to local MSS imperfections.

However, we strongly encourage DUACS users not to take along-track ENVISAT data for granted, and to analyze them in details. We also encourage users of DUACS' along-track SLA to increase the error prescribed (e.g. in assimilation) on ENVISAT SSHA by 2 to 3 cm rms (ideally with higher errors in coastal areas or at high latitudes, where the gridded MSS used is likely less accurate) in order to mitigate the impact of artificial mesoscale signatures (e.g fake stationary eddy) created by gridded MSS residuals errors.

As per usual, any feedback on recent ENVISAT products is welcome to try and improve the processing of ENVISAT in DUACS.

Best regards,

Gerald Dibarboure and M.I.Pujol, on behalf of the DUACS team.

References

[Ref 1] Dibarboure et al, 2010a: Jason-2 in DUACS, first tandem results and impact on processing and products (submitted)

[Ref 2] Proceedings of OSTST 2010 meeting and most specifically, the session on Jason1 Extension of Life (slides and conclusions soon available on AVISO) and also:

a. http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2010/Dibarboure_MssError.pdf
b. http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2010/Dibarboure_EolSampling.pdf
c. Dibarboure et al, 2010b: Finding desirable orbit options for the "Extension of Life" phase of Jason-1 (submitted)

[Ref 3] Degrees of Freedom of Signals, see section #3 from [Ref 1] or :

- http://www.aviso.oceanobs.com/fileadmin/documents/OSTST/2010/Dibarboure_DFS.pdf

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Figures and captions

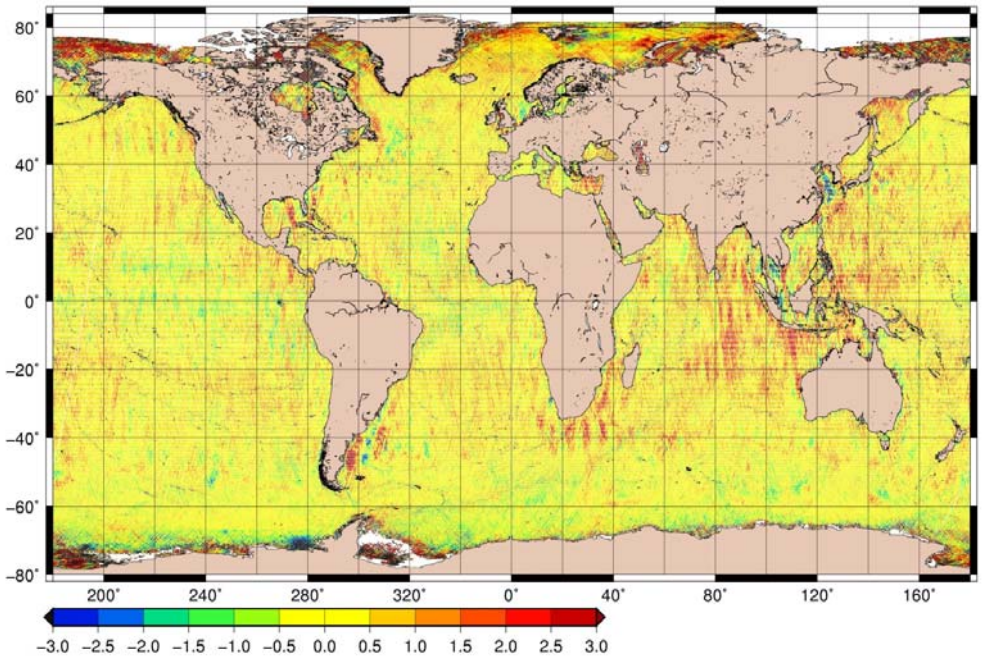

Figure 1 : Along-track difference between historical ENVISAT Sea Level Anomalies (repeat track analysis), and SLA derived from the gridded MSS proxy. Observed on data from ENVISAT's 35-day phase.

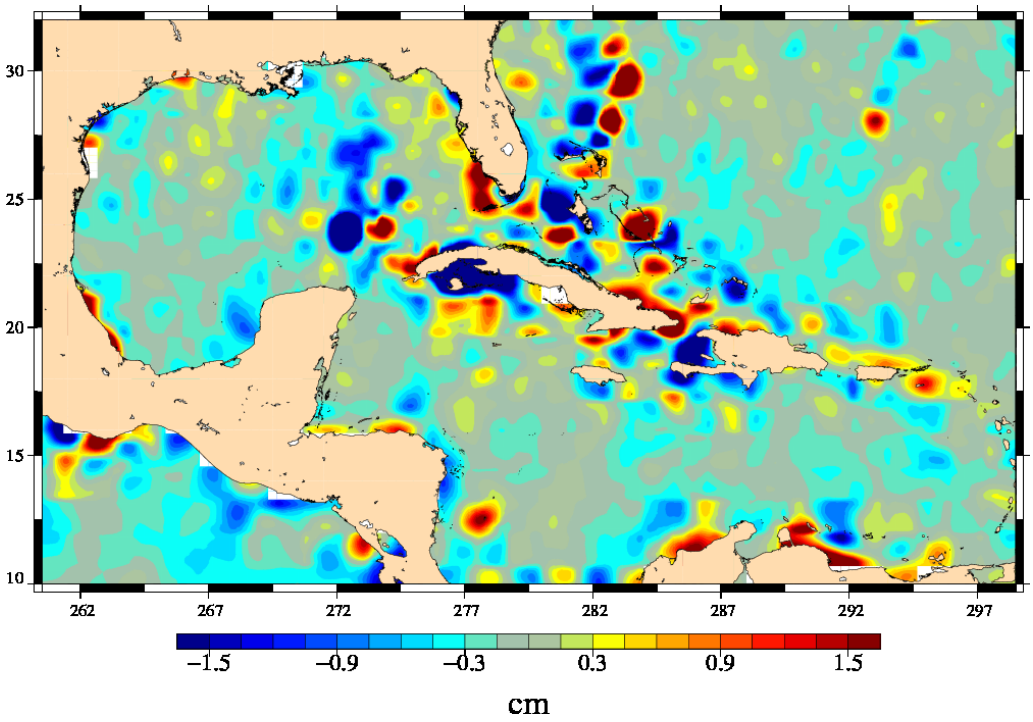

Figure 2 : Difference between a 3-satellite SLA map where ENVISAT is processed with the repeat track analysis, and the same map where ENVISAT is processed with the gridded MSS proxy. Jason1 and Jason2 are processed normally (no proxy). Computed before ENVISAT's orbit change.

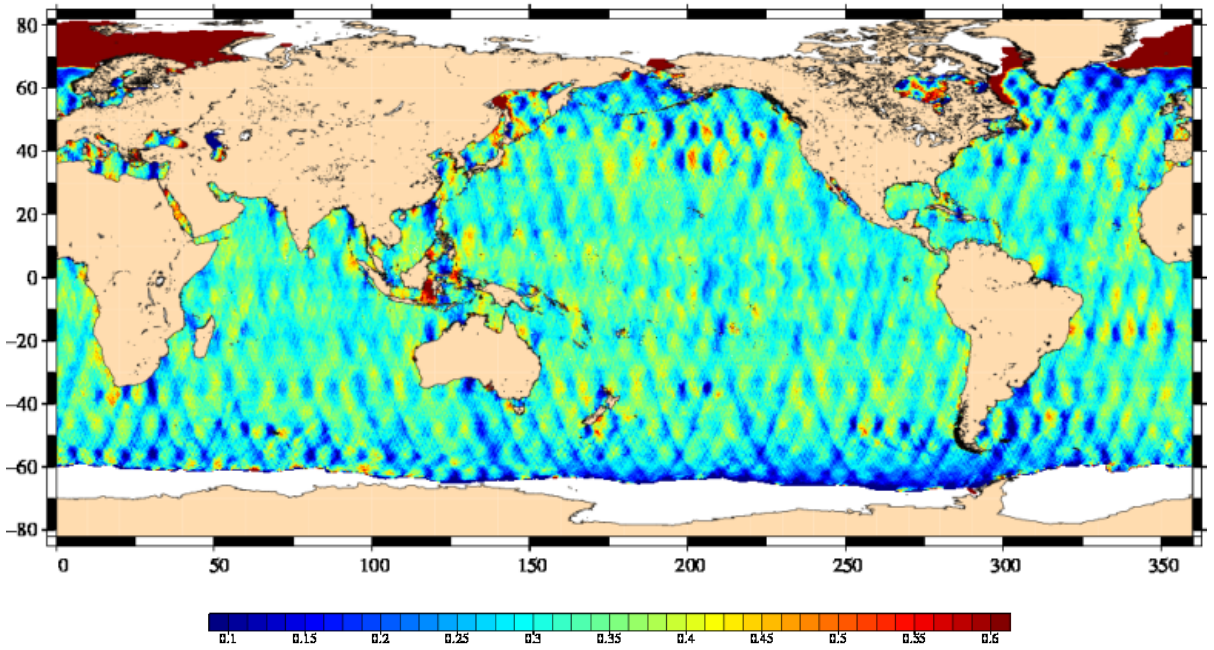

Figure 3 : Fraction of a 3-satellite DUACS-NRT map derived from ENVISAT with traditional repeat track analysis (average = 0.32, meaning that ENVISAT brings 32% of the multi-satellite content).

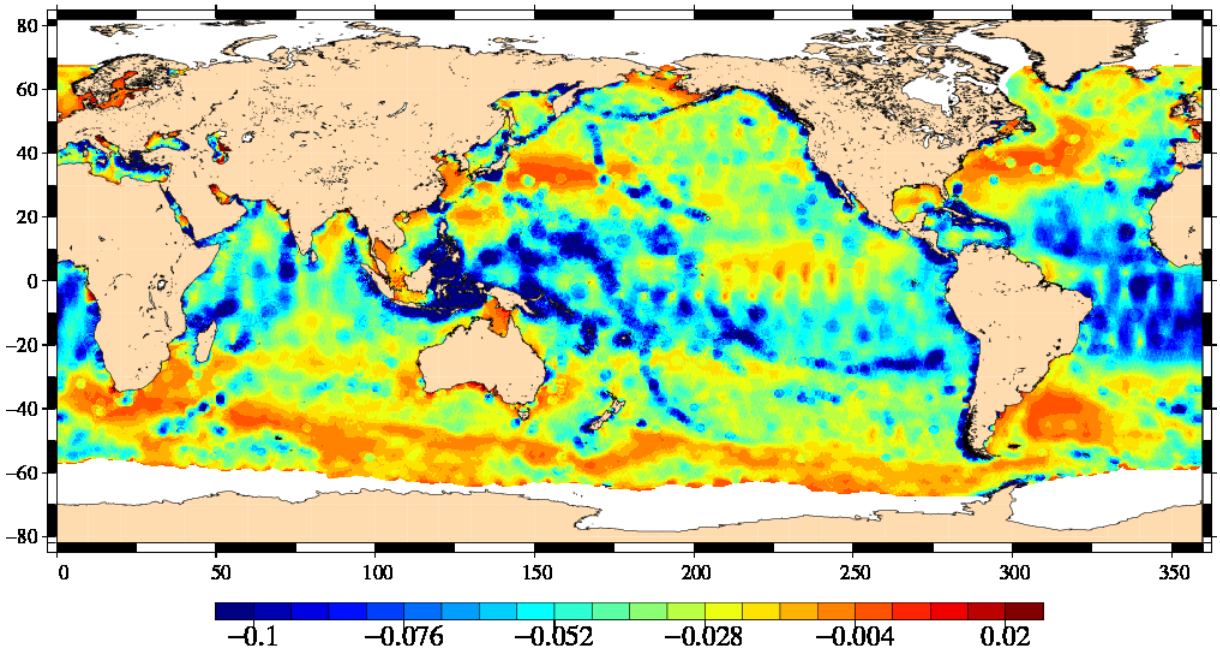

Figure 4: Difference between the fraction of the 3-satellite NRT maps from DUACS derived from ENVISAT with traditional repeat track analysis (i.e Figure 3), and the same quantity after tuning for the new ENVISAT orbit (error budget prescribed on ENVISAT increased). The contribution of ENVISAT globally decreases by 0.04 or 4% in average and locally by more than 0.1 or 10% (where ENVISAT used to bring more than 30% of the multi-satellite information, increasing the error bar decreases its contribution to less than 20%).

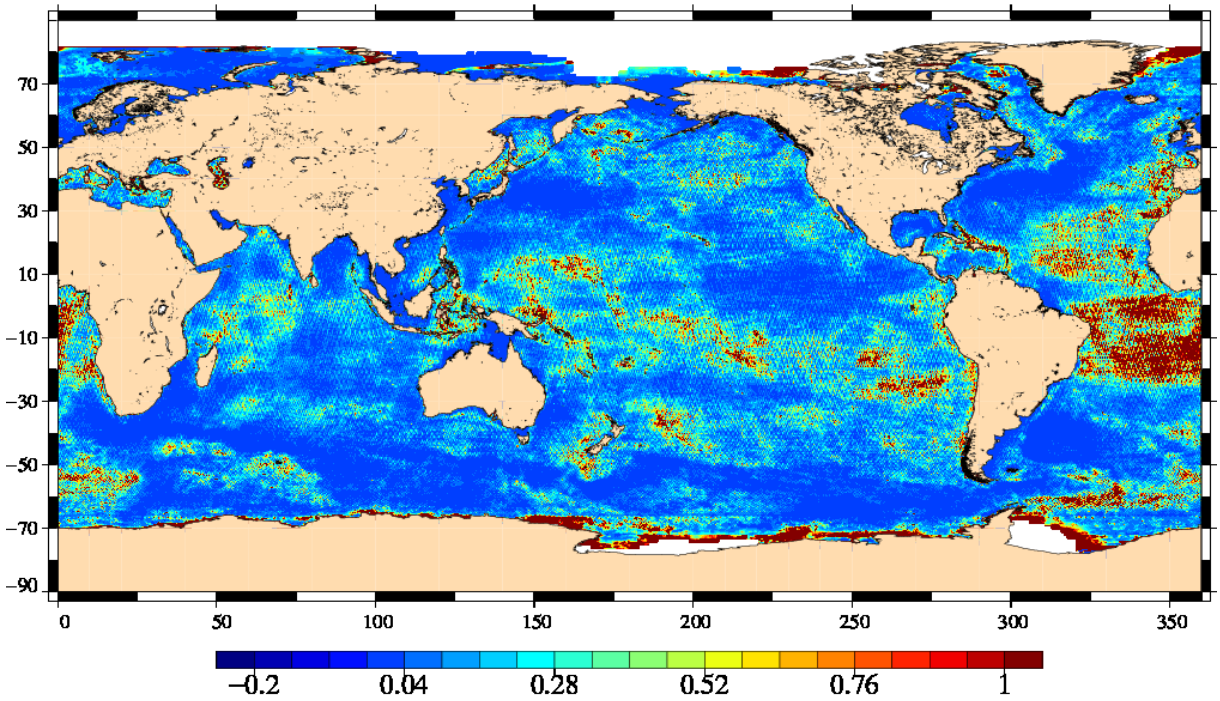

Figure 5 : Ratio between the theoretical error from CNES/CLS10 MSS (formal error distributed by AVISO) divided by the oceanic variability. A ratio of 0.3 means that the static MSS error of the new ENVISAT processing (gridded MSS proxy) is assumed to be locally as large as 30% of the ocean dynamics.