Improving the Dynamic Atmospheric Correction for delayed-time and real-time applications of altimetry

L. Carrere, Y. Faugère, R. Baghi – **CLS** - **lcarrere@cls.fr**
F. Lyard, D. Allain - **LEGOS**
J.M. Lachiver, N. Picot, E. Bronner **CNES**

Introduction

Altimeter measurements are corrected for several geophysical effects in order to isolate the oceanic variability; the Dynamic Atmospheric Correction (DAC) is the second most important one after the tide correction; the DAC allows for the removal of high frequency ocean variability induced by the atmospheric forcing and aliased by the altimeter sampling.
The DAC is composed with the high frequency part of the MOG2D sea level (barotropic simulation forced by atmospheric pressure and wind ; Carrere and Lyard 2003), and the low frequency of the inverse barometer response (IB), using a 20-days cutoff-period (= Nyquist period of T/P-Jason altimeters' sampling).

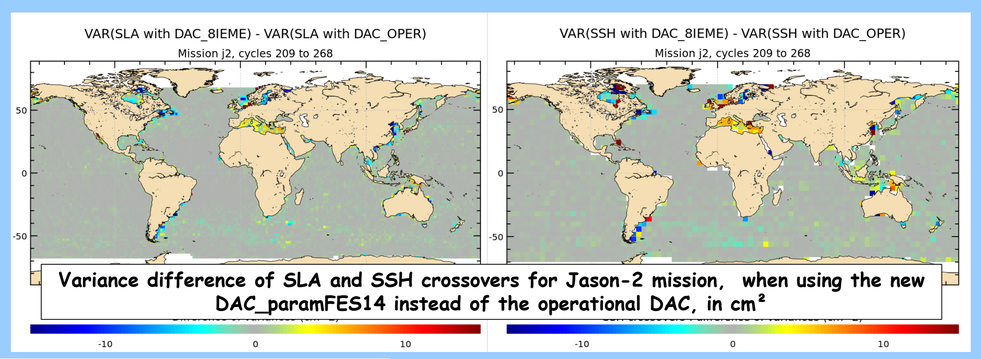
Recent/coming improvements of the DAC are described in this poster :
• The DAC has been recently improved for the Near Real Time (NRT) and the Short Time Critical (STC) delivery modes thanks to the use of 10 days meteo forecasts.
• The new high-resolution mesh and bathymetry provided by FES2014 study have been tested to improve the global DAC performances.
• The processing of S1 and S2 frequencies is reviewed for DAC and the Dry Tropospheric correction, and some ways of improvements are proposed

Description of DAC products for the Delayed time, Short Time Critical and Near Real Time altimeter products

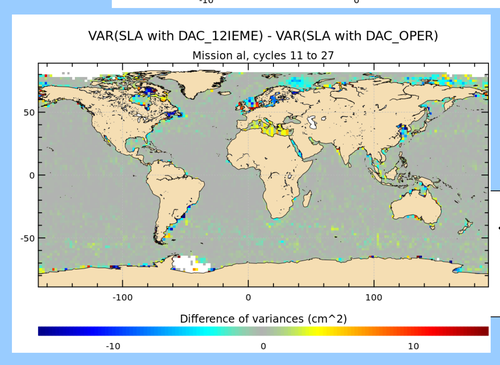
• For **GDR/NTC** products, DAC is performed in delayed time and uses a centered filtering window for the 20-days filtering (=nearly optimal configuration of the filtering).
• For **IGDR/STC** products, DAC is performed within a few hours delay corresponding to the ECMWF analysis delivery. This DAC uses a decentred filtering window for the 20-days filtering, using the forecasts available in the future (D+10 since 04/10/2017).
• For **OGDR/NRT** products, only a forecasted IB correction is used currently. A forecasted DAC (D+10 since 04/10/2017) is generated for DUACS products only as it was not yet enough robust for dissemination.

Using FES2014 parameters to improve DAC solution

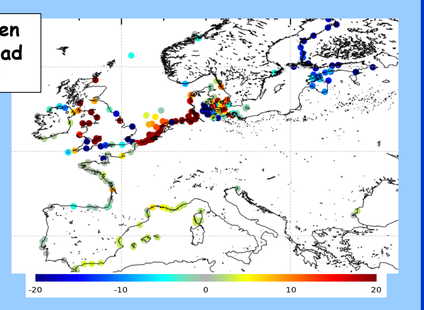
The FES2014 tidal model parameters include a higher resolution mesh (resolution increased on shelves and on deep ocean topography gradients) and a better bathymetry field including many in situ data.
Using these parameters, MOG2D simulations have been performed on 2014-2015 period and several DAC series have been computed with ¼°, 1/8° or 1/12° resolution (noted DAC_paramFES14). The new DAC are compared to the operational DAC and variance reduction is estimated for J2 and AltiKa missions and for tidal gauges (from GLOSS, REFMAR, MyOcean networks).



Variance difference of SLA and SSH crossovers for Jason-2 mission, when using the new DAC_paramFES14 instead of the operational DAC, in cm²



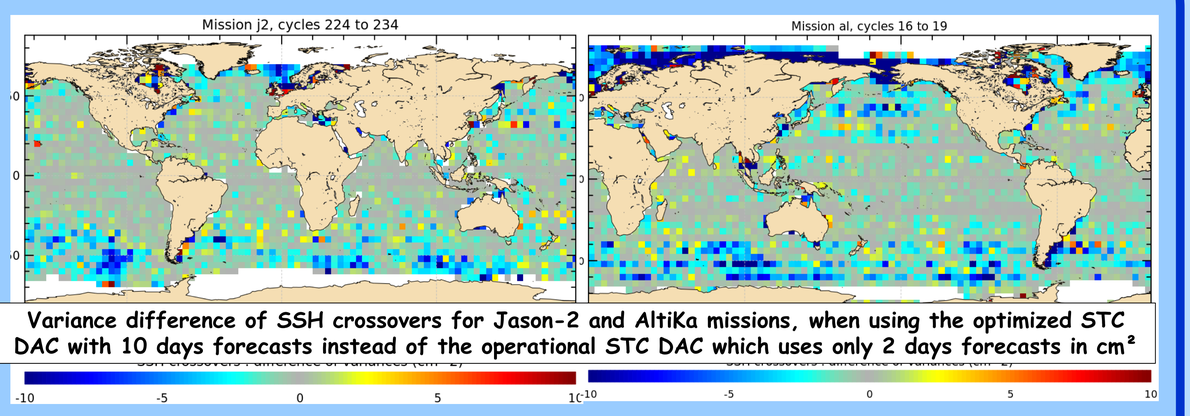
Variance reduction at TG when using DAC_paramFES14 instead of operational DAC, in cm²



Variance difference of SLA for AltiKa mission, when using the new DAC_paramFES14 instead of the operational DAC, in cm²

• **The DAC_paramFES14 correction allows reducing the altimeter variance in most of shallow water regions and in semi-enclosed seas.** Statistics on AltiKa mission also shows **a significant variance reduction in the Arctic Ocean**.
• The resolution of final product has a very weak impact on the altimeter statistics as these are performed on 1° to 4° grids, but it has some impact on TG analysis => **better to use higher resolution than ¼°.**
• We notice a variance increase in the North Sea, in the Mediterranean Sea and in the Arafura Sea. **On the Arafura sea, the variance increase is likely due to a low frequency effect**, as using non filtered MOG2D sea level has a stronger impact. **The variance increase in North Sea might by explained by some bathymetry reference levels effects**, but these variance increase problems are still under investigation on the different regions.

Using 10 days of meteo forecasts - impact on IGDR L2 products

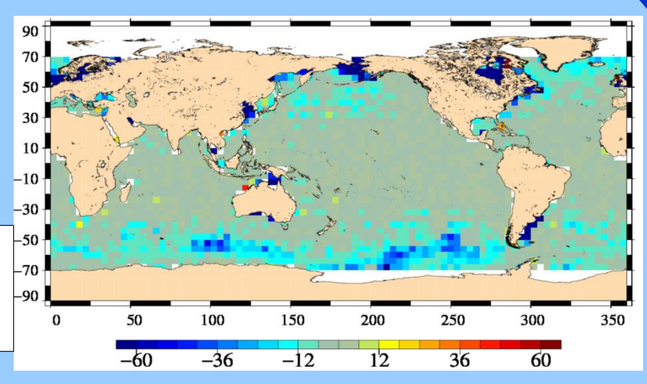


Variance difference of SSH crossovers for Jason-2 and AltiKa missions, when using the optimized STC DAC with 10 days forecasts instead of the operational STC DAC which uses only 2 days forecasts in cm²

As 10 days of ECMWF meteorological forecasts are available daily, they can be used to improve the **STC DAC** for IGDR products. Results for Jason-1 and AltiKa missions show a strong improvement when using the 10 days forecasts instead of only 2 days forecasts within the DAC filtering window: more than 10 cm² of variance reduction in DAC high variability regions (southern high latitudes and shallow waters and in the Arctic ocean: cf. figure above).
⇒ **This improved IGDR/STC DAC product is available operationally since 04/10/2017 for IGDR.**

Using meteo forecasts - impact on OGDR L2 products

**Impact for OGDR :
Variance difference of SSH crossovers for Jason-2 mission, when using the NRT DAC instead of the forecasted IB correction in cm²**



The availability of ECMWF meteorological forecasts daily allows producing DAC forecasts daily on the same time span; it is named **DAC NRT/OGDR**.
Using the forecasted DAC instead of the IB allows reducing significantly the altimeter variance (cf. figure above for 1 year of Jason-2 L2 data).
This NRT DAC is generated operationally since september 2013 and it is used in DUACS products only at present time.
⇒ **This NRT DAC benefits from the 10 days forecasts window since the 04/10/2017. It could be available for OGDR products soon.**

S1 and S2 processing

• ECMWF operational meteorological analysis have 6-hours sampling which makes S2 and S1 atmospheric signals badly resolved => this problem impacts both the DAC and the Dry Tropospheric correction (noted DT).
•S1S2 climatology of pressure is used to remove aliased atmospheric tides from pressure:
  • we produce a DAC without S1S2. This DAC is coherent with Tide corrections which include these frequencies.
  • S1S2 air tide model (Ray Ponte 2003) is added to the corrected pressure to compute a correct DT
• **Proposed ways of improvements are listed below:**
  • **use new HR climatologies on recent years (N640 grid)**
  • **use a more recent air tide model for DT (Schindelegger Ray 2014)**
  • **test the impact of higher resolution forcing :**
    • **3h data = interlaced analysis-forecasts or LWDA 3h data**
    • **filter noise at very high frequencies**
    • **test the new ERA-5 meteorological reanalysis (higher spatial & temporal resolution)**

**Variance difference of Jason-2 SSH crossovers, when using the new HR S1S2 climatology instead of the operational clim. for the DT correction (in cm²).
New HR climatology globally reduces the J2 variance, but the impact is weak.**