Improving the dynamic atmospheric correction for mean sea level and operational applications of altimetry

L. Carrère, Y. Faugère – **CLS**
E. Bronner – **CNES**; J. Benveniste – **ESA-ESRIN**
lcarrere@cls.fr

Introduction

Given its current accuracy and maturity, altimetry is considered a fully operational observing system dedicated to various applications such as climate studies or operational oceanography. Altimeter measurements are corrected for several geophysical effects in order to isolate the oceanic variability; the dynamic atmospheric correction (DAC) allows for the removal of high frequency variability induced by the atmospheric forcing and aliased by the altimetric measurements.

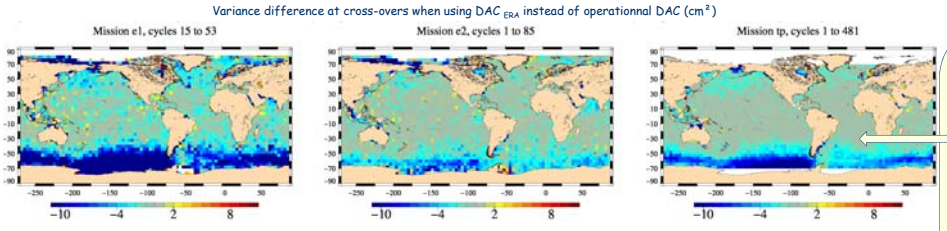
The purpose of this study is to improve the performances of the DAC for users of altimetry, and particularly for older altimeter missions and for mean sea level applications and also for operational altimetry.

Several analyses have been performed using multi-mission (Topex-Poseïdon, Jason-1, Jason-2, ERS) analysis of crossovers differences (SSH) and sea level anomalies (SLA) and also global and regional mean sea level estimations (MSL).
Note that the results presented here have been obtained within the SALP/CNES project and the CCI/ESA project.

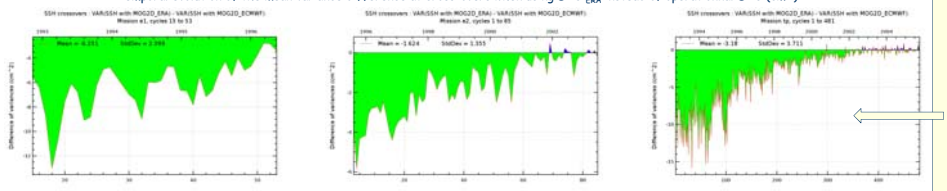
DAC forced by ERA Interim reanalysis

- **Problematic** =
  - bad quality of ECMWF meteorological data on first years of altimetry (old model version + lack of observations)
  - operationnal ECMWF analysis time serie shows jumps/discontinuities due to model evolutions
  - this is not optimal for
    - Mesoscale studies on the first years of altimetry
    - Mean Sea level applications
- **ERA-Interim** =
  - last ECMWF reanalysis available on the entire altimetric period
  - 6 hours analysis data, on N128 gaussian grid (~0.7°)
  - reanalysis= stable and homogeneous time-serie
- ERA-Interim was used to force the barotropic MOG2D model and compute the new DAC :
  $DAC_{ERA} = MOG2D_{ERA}\_HF$ (T < 20 days) + IB_{ERA}_LF (T > 20days)
- Impact of DAC_{ERA} was compared to the operational DAC and analyzed for ERS-1, ERS-2, T/P and Jason-2 missions; several years of data have been used for each old mission.

Variance difference at cross-overs when using DAC_{ERA} instead of operationnal DAC (cm^2)



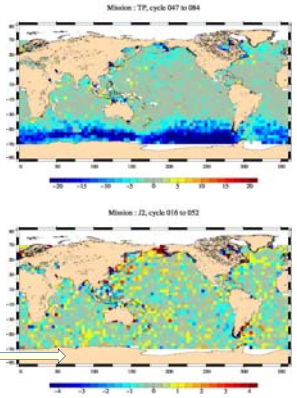
Temporal evolution of the mean variance difference at cross-overs when using DAC_{ERA} instead of operationnal DAC (cm^2)



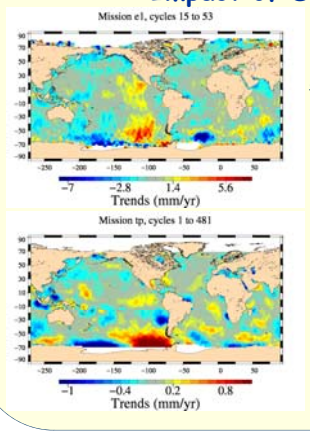
Impact of DAC_{ERA} on Mesoscale:

- Strong variance reduction for all missions
- Mostly located at high latitudes where the variability of the correction and the forcing is maximum (>10 cm^2)
- Significant reduction of SSH variance in Bering Strait + Hudson Bay
- Improvement evolves with time
- Maximum on the first years of altimetry, where quality of operational ECMWF analysis was not as good as today
- $DAC_{ERA\ Interim}$ and operational DAC have similar results from 2002, although the resolution of ERA-Interim is lower than operational model

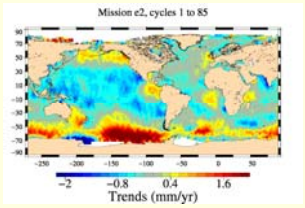
Variance difference at cross-overs when using DAC_{ERA} instead of operationnal DAC : up = one year of T/P ;bottom= one year of Jason-2 (cm^2)



Impact of DAC_{ERA} on MSL estimation



SLA trend differences when using DAC_{ERA} instead of operationnal DAC



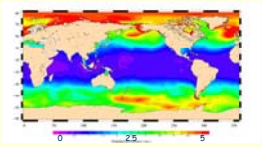
Impact of DAC_{ERA} on regional MSL:
- Strong : several mm/yr
- Maximum at high latitudes and in some shallow water regions

Impact of DAC_{ERA} on global MSL:
- No impact for E2 and TP, weak impact for E1
- No significant impact on ascending/descending trend differences

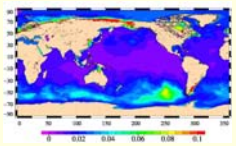
DAC for Near Real Time products, IGDR and OGDR

- **Problematic**=
  - The limitation of DAC for these products comes from the availability of the operational analysis meteorological data:
    - Meteorological analysis are available with about 6-7-hours delay
    - => OGDR : no DAC is available and a predicted IB is used
    - => IGDR : a real-time DAC is used: it is degraded if compared to the delayed-time DAC (used for GDR) because of the use of a de-centered filtering window.
- The idea is to use forecasts of DAC to improve those products
  - 2 days of meteorological forecasts are delivered each day : from J, 18h until J+2, 12h
  - barotropic model is run forced by these data => model sea level and IB available until J+2, 12h
  - => compute a forecasted DAC until J+2, 12h, which can be used for OGDR
  - => improve the real-time DAC used for IGDR, while re-centering the filtering window by all forecasts available.
- The expected improvement can reach several cm mostly at high latitudes and in shallow waters (results available by end of 2011)

Impact on the DAC of using a de-centered filtering window compared to a centered one (cm)



Standard deviation of the difference between the IB forecast and the DAC forecast (m)



Conclusions and recommendations

- The impact of **ERA-Interim** is very interesting
  - strong variance reduction for the old missions: ERS-1, ERS-2 and T/P
    - useful for mesoscale studies and MSL –climate applications
  - performances of DAC_{ERA} become similar to operational one on more recent years (from 2002), although ERA-Interim has a lower spatial resolution than the operational meteo model
  - **recommandation is thus to use the DAC_{ERA} for old missions (for mesoscale + climate applications) and likely also for more recent missions for climate issues.**
- We are currently developping improved corrections for **Near Real Time products** :
  - **OGDR** : using forecasts of DAC instead of IB
  - **IGDR**: recentring the filtering window thanks to the use of forecasts of DAC
  - the gain should reach several cm mostly localized at high latitudes and in shallow waters (results will be available by the end of 2011).