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Observation Impact Studies at Mercator Ocean

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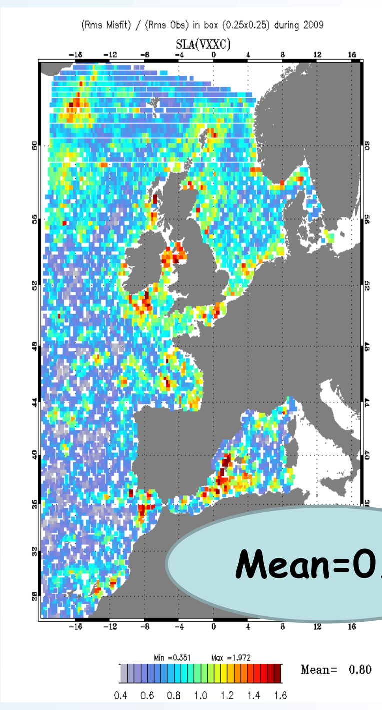
Motivations

Observation impact studies are performed regularly with the real-time Mercator Ocean monitoring and forecasting systems. They help to:

- **quantify the impact** of the present observation network in Mercator Ocean analysis and forecasts,
- **verify that observation information is « optimally » used** in the analysis step:
  - ✓Improve the assimilation components (H,R)
- **demonstrate the value of an observation network** for operational ocean analysis and forecasts,
- **help designing** the future observation network.

Improving the DA components

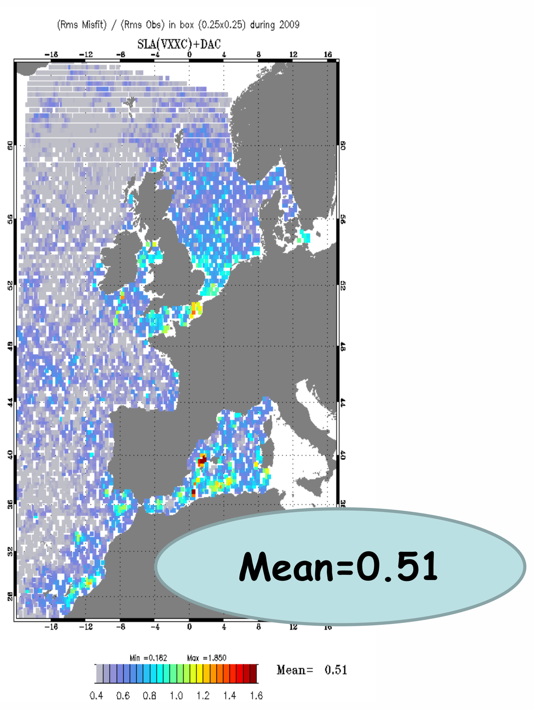
Observation error variances and observation operators are key components in a data assimilation system and have to be carefully specified.
In the framework of the TAPAS initiative within the MyOcean project, along track **Tailored Altimeter Product for Assimilation Systems** (TAPAS) are defined. Intercomparison experiments are performed with the regional 1/12° Mercator Ocean system, IBI. In the first experiment, the "classic" filtered, subsampled and corrected along track L3 Ssalto/Duacs SLA are assimilated, in a second experiment the unfiltered TAPAS SLA are assimilated without dynamical atmospheric corrections (high frequency and pressure forcing) and Long Wave Error.



Rms(Misfit)/Rms(Data)) in 0.25° x0.25° boxes (2009)

« classic » SLA

« TAPAS » SLA without DAC and LWE added



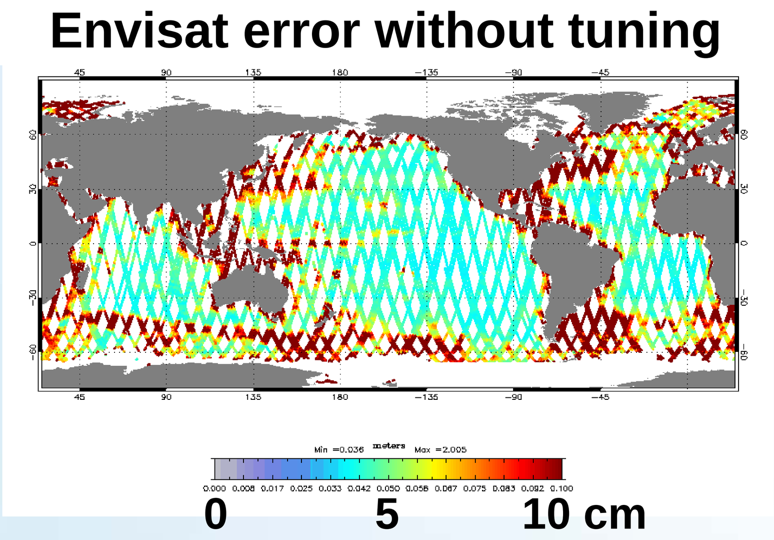
The ration Rms(Misfit) / Rms (Data) shows a better noise over signal ratio for all the domain when TAPAS SLA without DAC and LWE are assimilated. The observation versus model coherency is improved as the model equations explicitly represent the atmospheric pressure and wind forcing response, they should not been removed from the data, especially in the open ocean. Tides are removed from both model and data.

A careful prescription of the observation errors in the assimilation systems is required. An **adaptative tuning of the observation error** is currently being tested in the systems to be implemented later in the real time production. It is based on the Desroziers ratio.

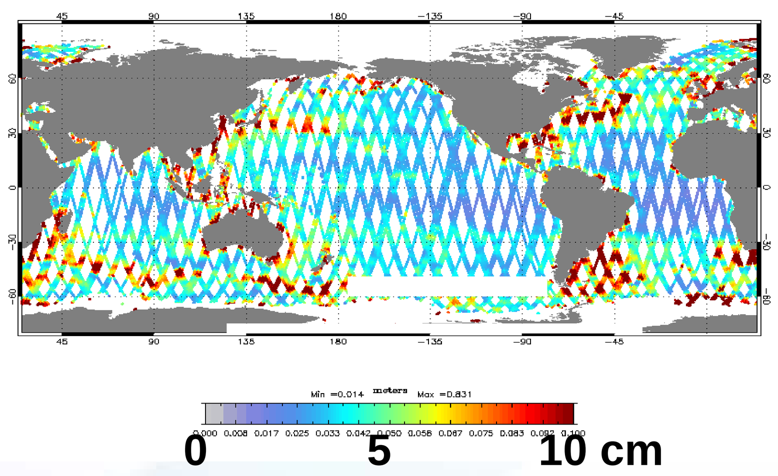
$$\text{Ratio}_{\text{Desroziers}} = \frac{\mathrm{E}[\text{Residual}.\text{Innovation}^{T}]}{\mathrm{R}}$$

Ideally, ratio=1, ratio < 1 means obs. error overestimated and ratio > 1 means obs. error underestimated. Figures show the a priori and adapted observation error for Envisat SLA, for one week in december 2006.

Envisat error without tuning



Envisat error with tuning

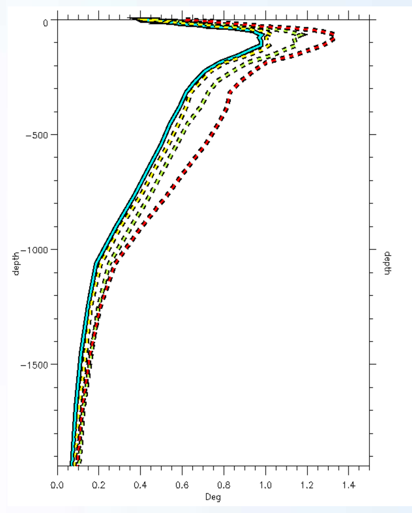


A priori and adapted observation error using the Desroziers diagnostic for Envisat SLA, for one week in december 2006, in cm.

Present observation networks

1-year OSEs are performed to assess the **sensitivity of the ocean global ¼° analysis and forecasts to the Argo float** network in the framework of the E-AIMS project.
Regions of higher impact were highlighted:

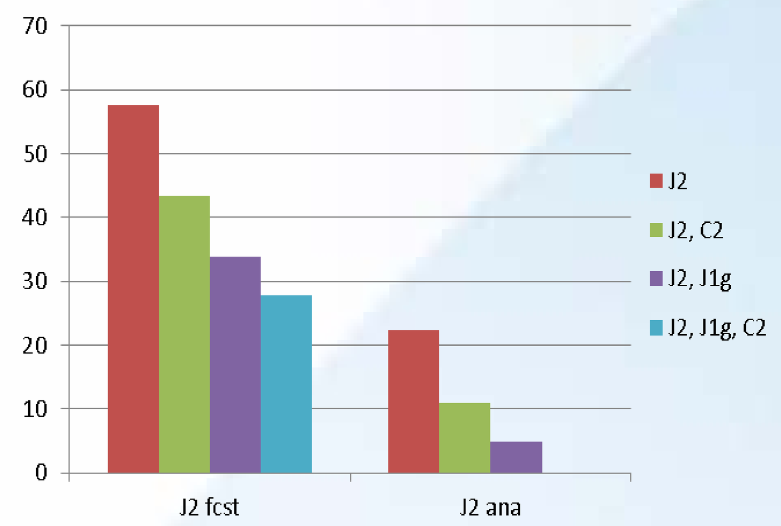
- at depth, water masses from outflow or deep convection are better represented,
- in the surface layers, the largest impact is found in the tropical band and energetic ocean regions (WBC,…),
- keeping only half of the ARGO floats degrades significantly the forecasts as can be seen on the figure.



Vertical structure of RMS of temperature Innovations from 0-2000m for a simulation with all Argo floats assimilated (blue), half of them (yellow), none (green) and a free model simulation (red).

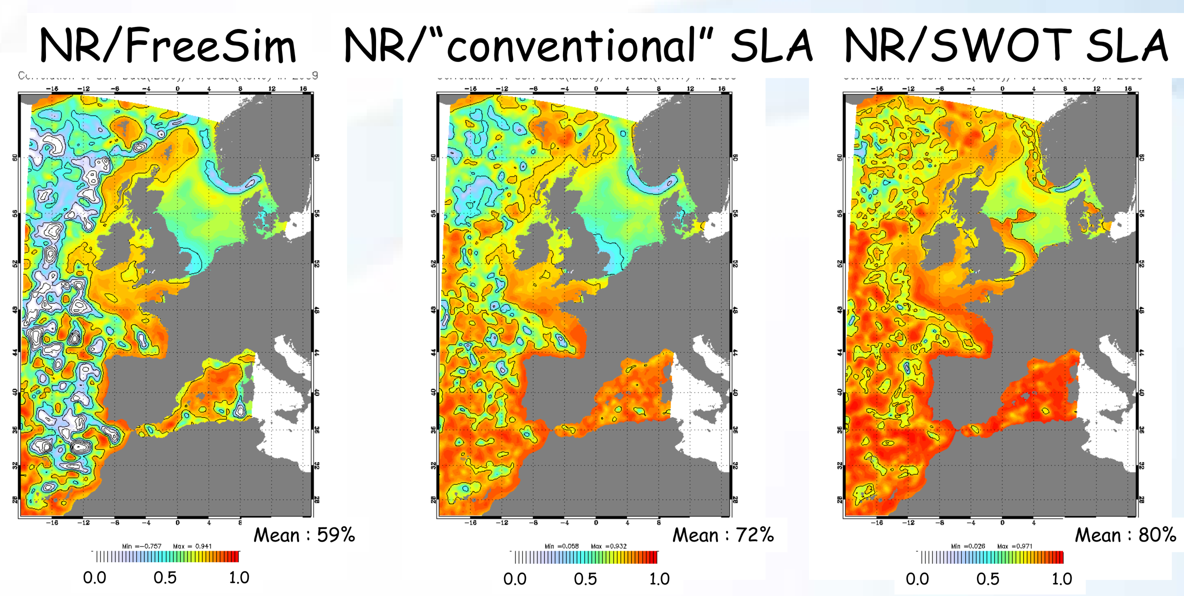
The impact of the **number of assimilated altimeters** was also studied (CNES fundings) in the global ¼° and Atlantic 1/12° systems. Higher impacts are found in region of high kinetic energy. The altimeter specificities, observation error and orbit, have also an influence on the analysis and forecast quality. The relative increase of the global model – SLA RMS misfit is shown on the figure.

Relative RMS SLA innovation and residual increase in % for Jason 2 depending on the number of altimeter assimilated. The reference is the Jason2 RMS residual when 3 altimeters are assimilated.



Future observation networks

To prepare the assimilation of **high resolution large swath altimeter data, like the future SWOT data**, OSSEs were setup with the regional 1/12° system IBI (CNES fundings). From the data assimilation point of view, the challenges concern the number of data to assimilate, the inhomogeneity of the spatio-temporal coverage and the correlated observation error specification. OSSEs allow us to explore step by step those different points.
Preliminary experiments show the ability of the system to "ingest" a large number of SLA data. The figures show the correlation of the 1-year time series of the SSH from a free simulation and different OSSEs with the nature run.



SSH correlation with the nature run of the free simulation (left), the OSSE experiment with Jason 1, Jason 2 and Envisat assimilated (middle) and SWOT SLA assimilated (right).

The added constraint of deep Argo measurements in the global ocean analysis was also explored with OSSEs.

Reference

Desroziers G., L. Berre, B. Chapnik and P. Poli, October 2005: Diagnosis of observation, background and analysis-error statistics in observation space, Q. J. R. Meteorol. Soc. Quarterly, Vol. 131, Issue 613, p. 3385–3396, Part C.
Lellouche J.-M.,Et al., 2013: Evaluation of global monitoring and forecasting systems at Mercator Océan,Ocean Science,9(1),57-81,doi:10.5194/os-9-57-2013.

Mercator Ocean
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