Tailored Altimeter Products for Assimilation Systems (TAPAS products)

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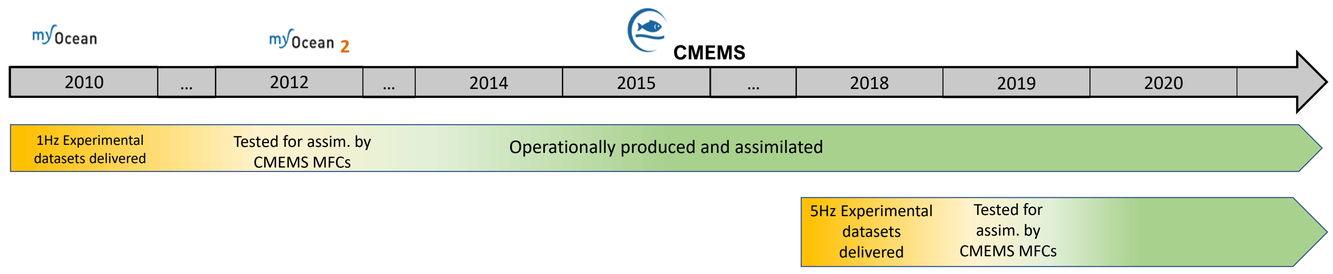
The TAPAS initiative, towards Tailored Altimeter Products for Assimilation Systems

The TAPAS initiative was launched in 2010 in the framework of the MyOcean project with a main objective **: define and set up a new generation of products for assimilation and validation of model outputs**. After a test phase in the MyOcean project, a specific Level-3 1Hz altimeter product was implemented in operational production and is still available in the CMEMS catalogue. It allows the users to fit the altimeter physical content to they application.

This products includes different variables that allow the users to fit the SLA physical content for they applications.

Now, to leverage the new altimeter technology (e.g. noise reduction from Sentinel-3 Delay Doppler mode), a new development phase started: higher resolution experimental products (5Hz) were delivered and impact in the physical models start to be analyzed.



TAPAS 1Hz products presentation

- Operational production → up-to-date measurements available on CMEMS catalogue (currently as "SEALEVEL_*_PHY_*" products).
- Regional production (Europeans Seas) in Near Real Time (NRT) and Delayed Time (DT/REP) + Global production in DTE/REP (NRT expected in 2020).
- With full 1Hz (~7km) spatial sampling.
- Gives assess to raw and noise filtered measurement : "sla_filtered " field for easy access to SLA field with noise measurement errors reduced; "sla_unfiltered" for access to the raw measurement.
- Gives access to others variables → Small set of oceanography-related variables : the product can be adjusted to model-specific assimilation needs (still without the complexity of instrument and processing parameters).

Name of variable	Content
sla_filtered	Sea Level Anomaly relative to MSS, with noise reduction by filtering
sla_unfiltered	Sea Level Anomaly relative to MSS
lwe	Long Wavelength Error
dac	Dynamic atmospheric correction
ocean_tide	Ocean tide height
mdt	Mean dynamic topography

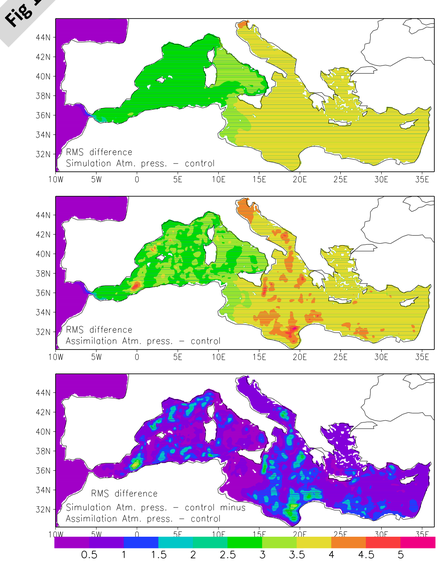
List of the different variables that are proposed in Level-3 along-track "PHY" products

Impact study in the MFS and IB models

Change of the physical content

MFS Simulation and assimilation experiments

Fig 1



RMS of the differences between the sea level (cm) in January 2009 from simulations **with and without the atmospheric pressure gradient forcing**.

RMS of the differences between the sea level (cm) in January 2009 from the analyses **with and without the atmospheric pressure gradient forcing**

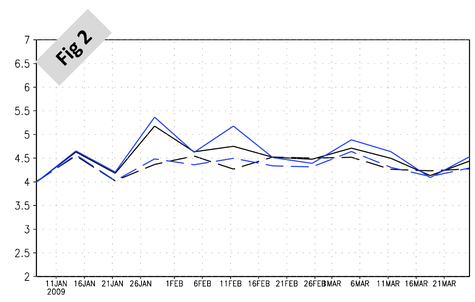
RMS of the differences between the sea level differences (cm) in January 2009 obtained **from the simulations and from the analyses** with and without the atmospheric pressure gradient forcing

TAPAS 1Hz products were used for assimilation tests in the Mediterranean Forcasting System (MFS) (Dobricic et al, 2012) and in the Iberian (IBI) system (Benkiram et al, in prep).

MFS Main results: This study shows that, in order to achieve the most efficient extraction of the information from the SLA observations, **all processes influencing the sea level variability in the Mediterranean should be included**.
In particular, in the experiment that used a model forced by atmospheric pressure and observations containing the full atmospheric signal at high frequencies, **the RMS of SLA, temperature and salinity residuals was consistently lowered** with respect to other experiments in which either the model was not forced by atmospheric pressure or the high-frequency signal was removed from the observations. (Fig 1 & 2)

Assimilation of SLA along track observations in the Mediterranean with an oceanographic model forced by atmospheric pressure, S. Dobricic, C. Dufau, P. Oddo, N. Pinardi, I. Pujol, and M.-H. Rio, Ocean Sci., 8, 787-795, 2012

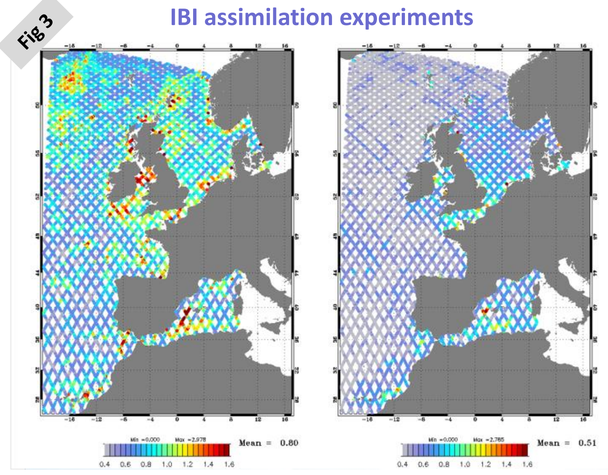
Fig 2



RMS of SLA residuals (cm) for experiments that assimilated the **TAPAS data set with the high frequency atmospheric signal** (blue lines) and **without it** (black lines). The RMS of residuals is calculated with respect to SLA observations either with the high frequency correction (full lines) or without it (dashed lines**).**

IBI assimilation experiments

Fig 3



a) RMS of the SLA model misfit (in % of rms of the data) in 2009 along Jason-2 and Jason-1 interleaved tracks, from simulations **with SLA corrected from the atmospheric pressure gradient forcing**.

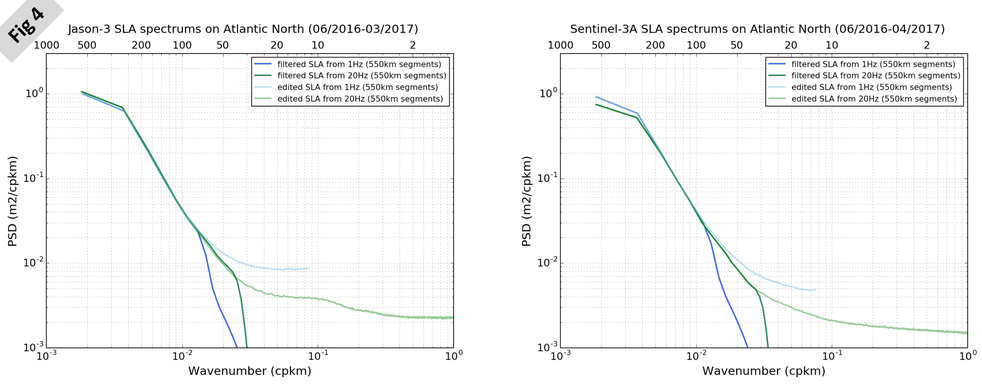
b) Same as a), but with SLA not corrected from **the atmospheric pressure gradient forcing to be consistent with the IBI model characteristics**.

IBI results: Similar experiments done with the IBI model, forced by wind and pressure, also showed that assimilating SLA measurement including the high frequency signal induced by wind and pressure, significantly reduce the model rms misfit. (Fig 3; Benkiran et al, in prep)

TAPAS 5Hz products presentation

- Experimental production → samples are available on AVISO+
- Regional production : over Europeans Seas and Agulhas current.
- Delivered with 5Hz (~1.3km) spatial sampling.
- Gives assess to noise filtered measurement: noise is reduced by lancsoz filtering with cut-off wavelengths fitted to the different altimeters capabilities: between 30 and 35 km instead of 65km user in 1Hz processing.(Fig 4)
- Gives access to different variables → allow the users to change the physical content and enable to have observations coherent with the application considered. Also access to across-track geostrophic velocities.

Fig 4



SLA spectral content visible on TAPAS 1Hz (blue lines) and 5 (green lines) Hz products, along Jason-3 (left) and Sentinel-3A (right) tracks. Spectrum of SLA before (light color) and after (dark color) noise reduction processing by low-pass filtering.

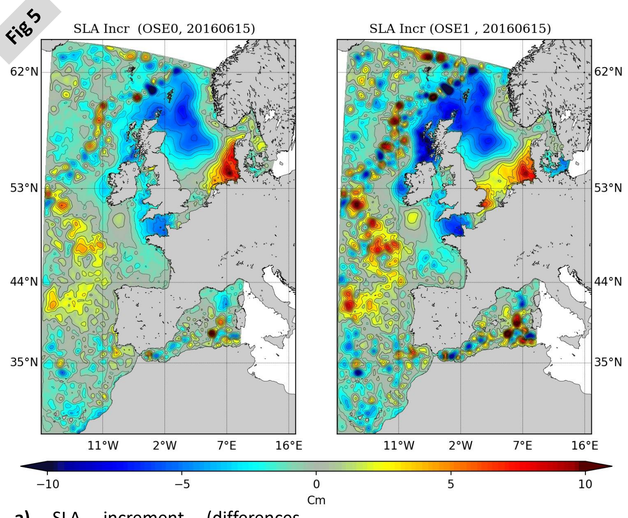
Impact study in the IB models

Change of the spatial resolution

IBI (Iberian, Biscay and Ireland) model, with 1/36° spatial resolution, was used to test the impact of the assimilation of the altimeter 5Hz products. Results underlined that the high resolution products significantly improve the model performances:

- Higher assimilation impact at mesoscales → visible on SLA increments (Fig 5)
- Model SSH forecast improved → better consistency between model forecast and observations: 20% gain (Fig 6)
- Positive impact on other variables → modelized SST better in accordant with observations when assimilation 5Hz altimeter products rater than 1Hz
- Better consistency between model output and independent measurement (Fig 7)

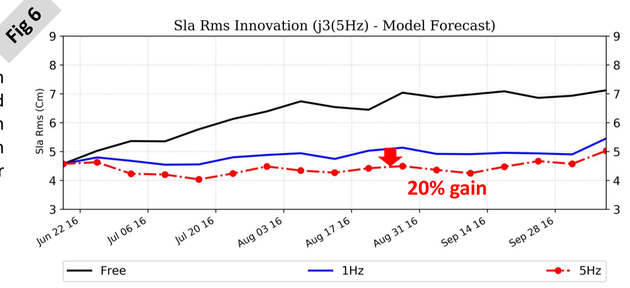
Fig 5



a) SLA increment (differences between SLA observed and model output just before assimilation), **with assimilation of classical 1Hz altimeter SLA measurements**.

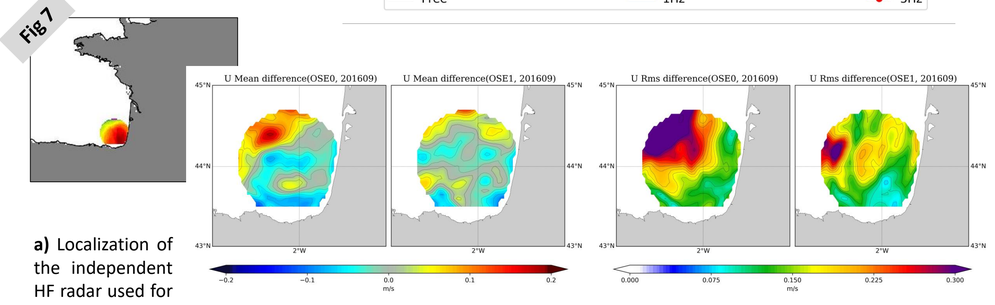
b) Same as a), but with model **assimilation experimental 5Hz altimeter measurement**

Fig 6



SLA innovation temporal evolution (difference between observation and model forecast) for model free run (black) and model assimilated with 1Hz (blue) or 5Hz (red) altimeter measurement

Fig 7



a) Localization of the independent HF radar used for validation

b) Mean difference between model output and observation, when model assimilates 1Hz measurements (left) or 5Hz (right). Zonal velocity component.

c) RMS of the difference between model output and observation, when model assimilates 1Hz measurements (left) or 5Hz (right). Zonal velocity component.