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Test With the First Swot data in MOi system

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2023 SWOT Science Team Meeting
September 19, 2023 - September 22, 2023

Mercator Ocean international
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- Carrying out various OSSE experiments to update the assimilation system

(see Poster: Developing an Effective assimilation of SWOT data in Mercator Ocean Systems (DESMOS)
(Benkiran et al., 2021; Tchonang et al., 2021)

- Validation (comparison with the model forecast) of the first SWOT data (fast sampling)
 - First assimilation tests of SWOT (1-Day) data in the global forecasting system
 - Validation of SWOT data on the 21-day orbit
-

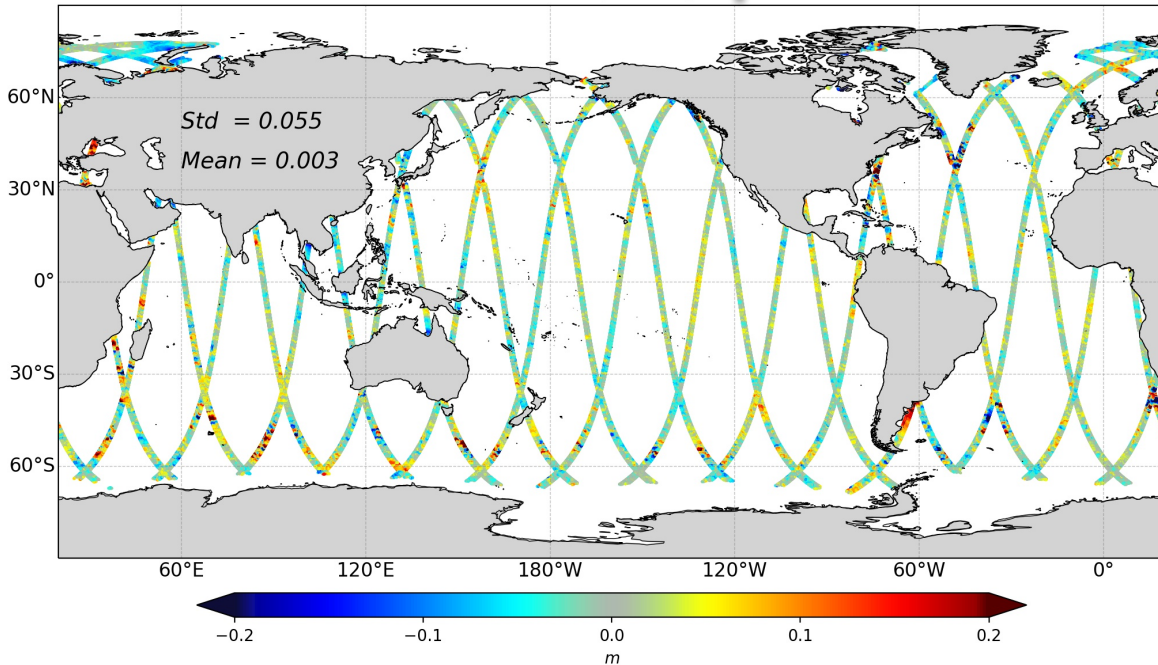
First test in cmems system:

- SWOT Level 3 (CNES DUACS : **SWOT Level-3 Overview algorithms and examples** (Dibarboure et al.))
 - Copernicus Marine / MOi system (global 1/12° high-resolution)
 - Start : from operational system (03/05/2023)
 - Period : from 03/05/2023 to 30/06/2023
 - **OSE1** : SST (ODYSSEA,1/10), Temperature and Salinity profiles (Copernicus Marine in situ TAC) and SLA from altimeters (c2n, h2b, j3n, s3a, s3b, s6a_hr, **SWOT(fast-sampling, not assimilated)**, Saral/altika (**not assimilated for validation**))
 - **OSE2** : SST (ODYSSEA,1/10), Temperature and Salinity profiles (Copernicus Marine in situ TAC) and SLA from altimeters (c2n, h2b, j3n, s3a, s3b, s6a_hr, **SWOT(fast-sampling, assimilated)**, Saral/altika (**not assimilated for validation**))
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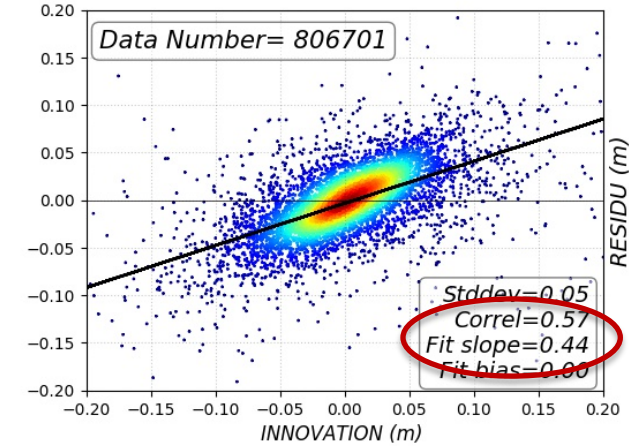
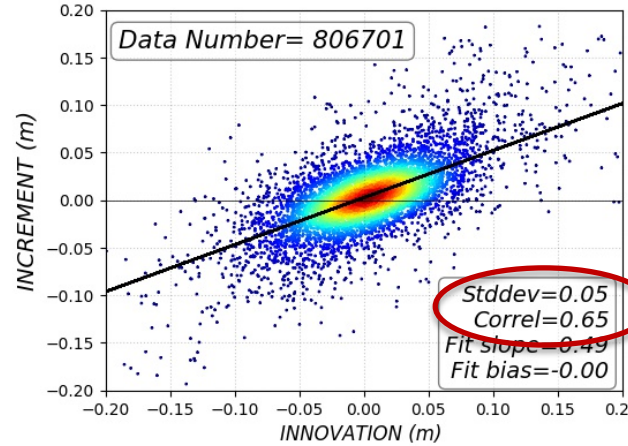
Verification of the assimilation Impact under the swaths

- INNOVATION : Observation - Model forecast
- INCREMENT : Correction (Analysis result)
- RESIDU : Residual Analysis Error

SLA : INNOVATION (07/06/2023, SWOT)

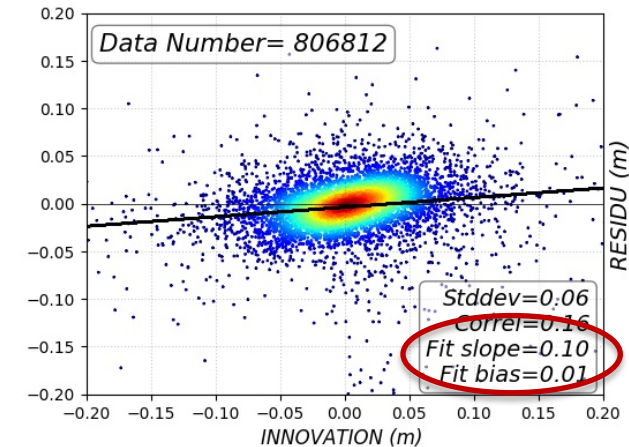
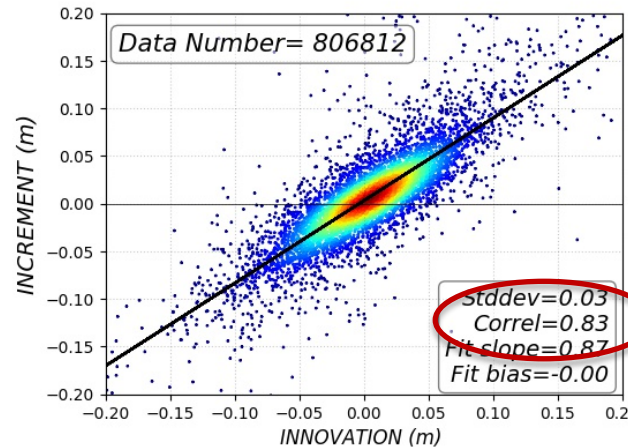


SLA: NOVATION vs INCREMENT vs RESIDU (swot, Run: 20230607)



Not Assim SWOT

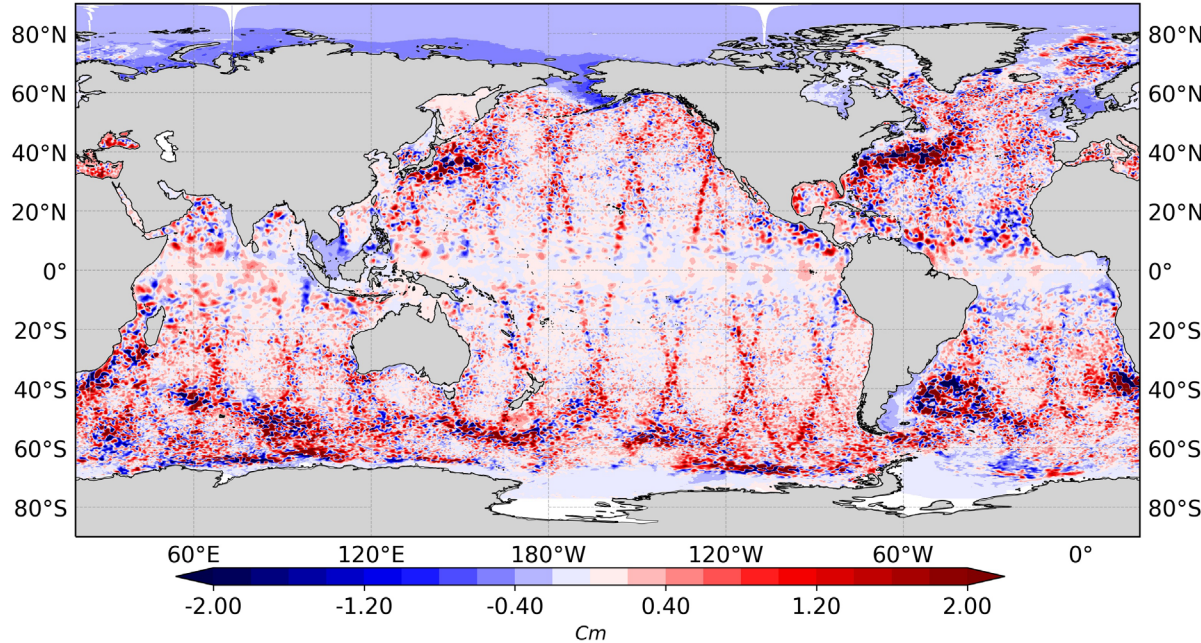
SLA: NNOVATION vs INCREMENT vs RESIDU (swot, Run: 20230607)



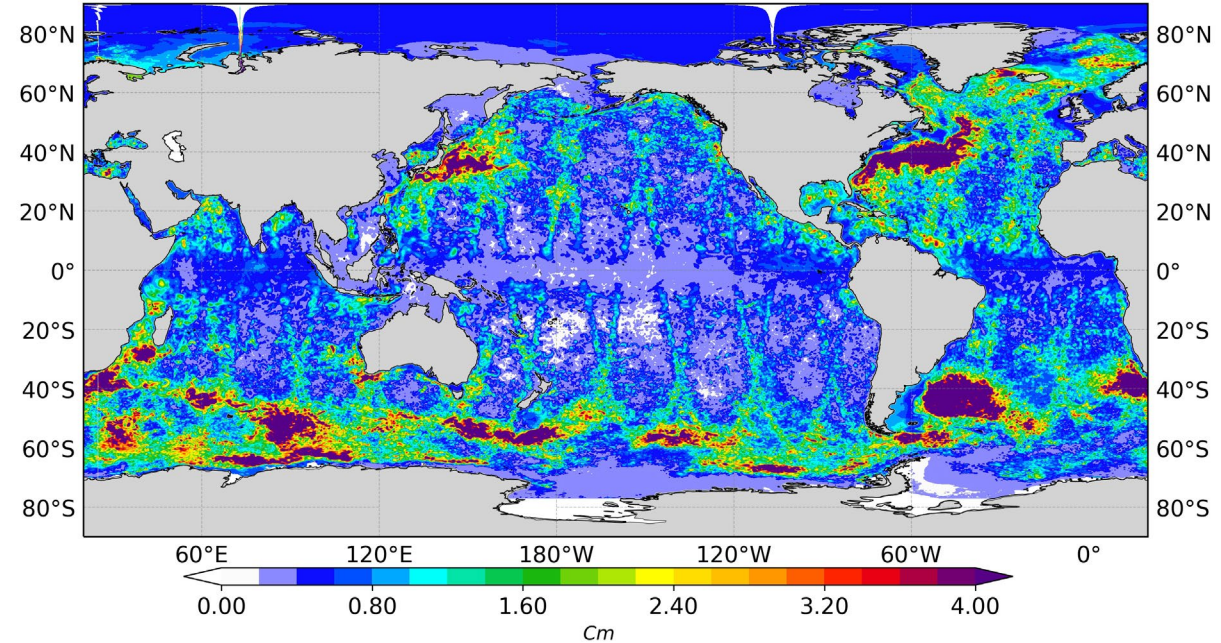
Assim SWOT

SLA Difference : Sla (**with** Assim SWOT) – Sla (**Without** Assim SWOT), May and June 2023

Mean Sla Difference: (Sla(Assim SWOT) - Sla(No Assim SWOT))



Rms Sla Difference: (Sla(Assim SWOT) - Sla(No Assim SWOT))



➤ Impact :

- North Atlantic (Gulf Stream)
- ACC
- Agulhas....
- regions with high variability.....

➤ The model propagates information (from 1-day SWOT) both under the swaths and outside the swaths

➤ Impact of SWOT (fast-sampling) assimilation in swaths

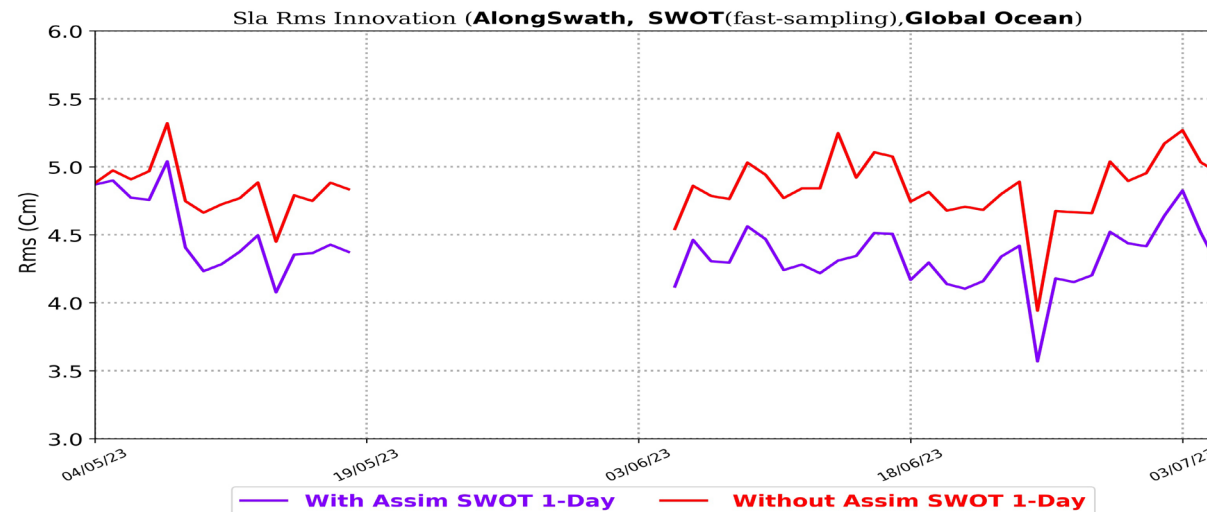
Innovation = Observations – Model Forecast

Add of SWOT (fast sampling) :

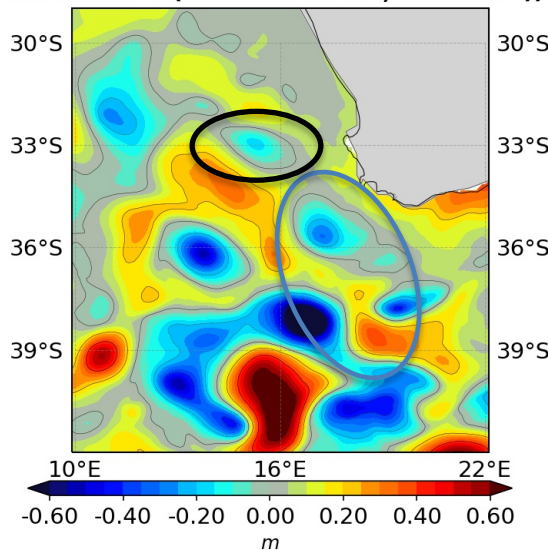
➤ Data assimilation reduces analysis error by >15% under SWOT swaths over the global Ocean

➤ Helps relocate eddies in the model

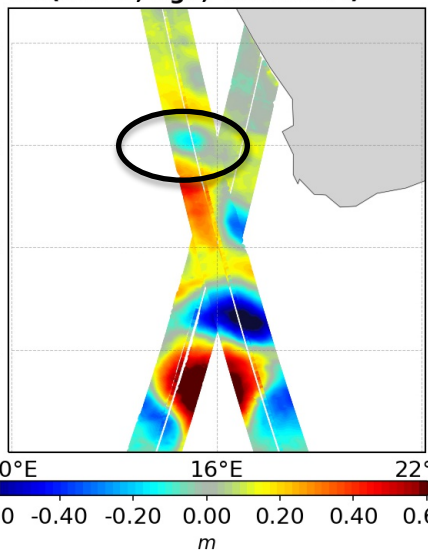
Assimilation Score (OSE)



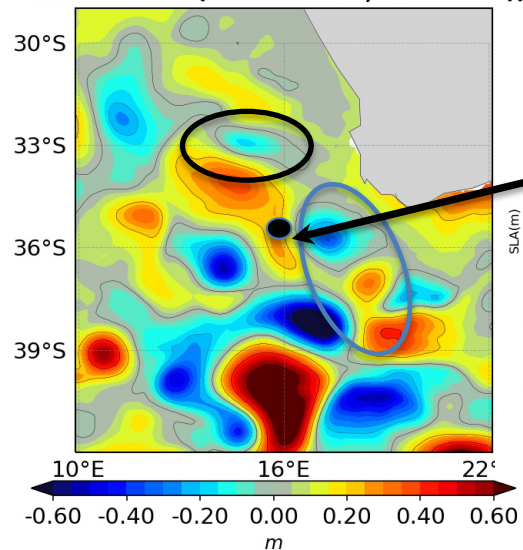
Sla Forecast (No Assim SWOT, 20230614)



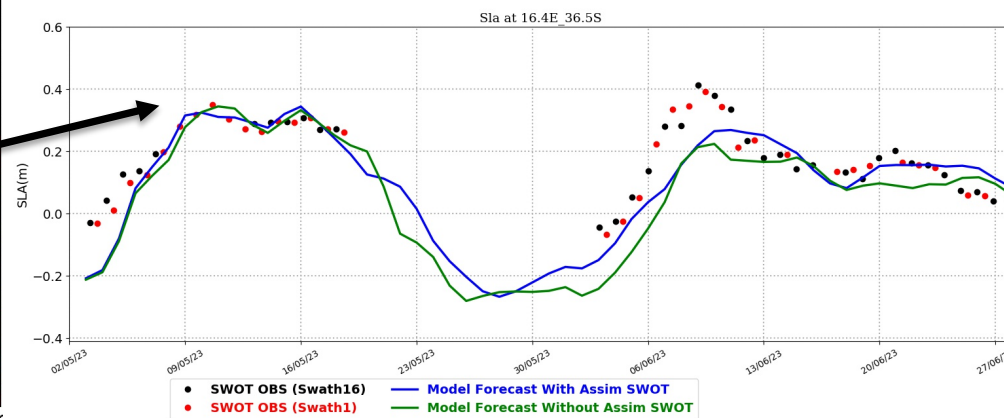
Sla(SWOT, Agu, 20230614)



Sla Forecast (Assim SWOT, 20230614)



SLA : SWOT vs Model Assim SWOT vs Model No Assim SWOT



➤ Impact of SWOT (fast-sampling) assimilation in swaths

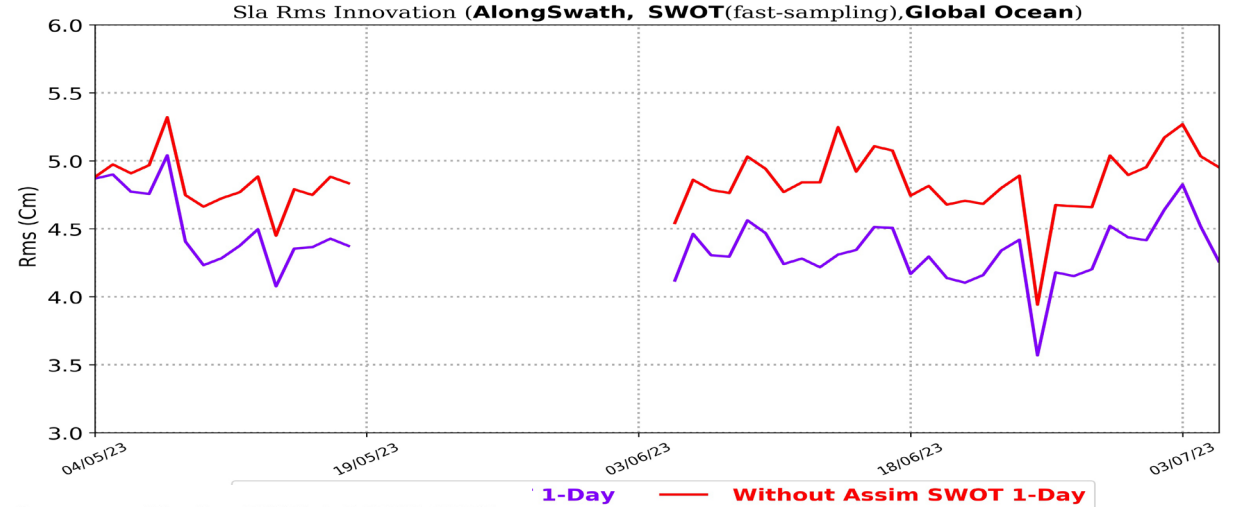
$$\text{Innovation} = \text{Observations} - \text{Model Forecast}$$

Add of SWOT (fast sampling) :

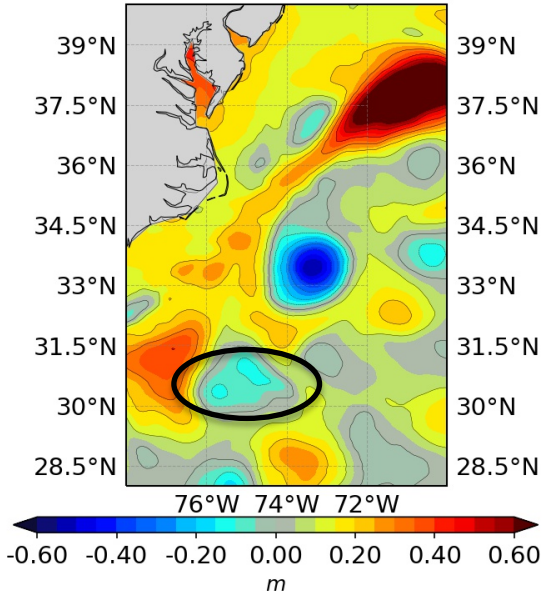
➤ Data assimilation reduces analysis error by >15% under SWOT swaths over the global Ocean

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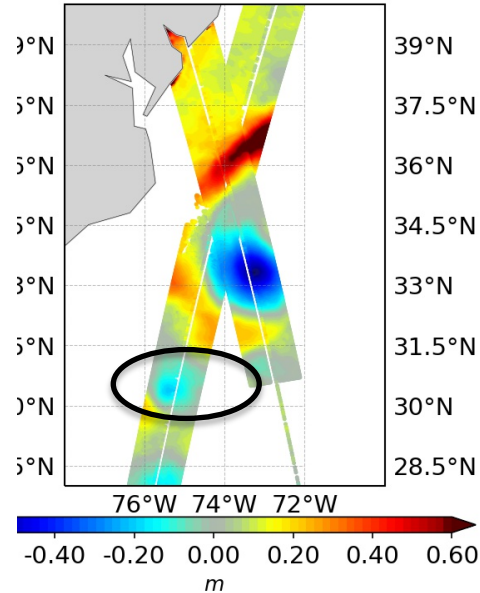
Assimilation Score (OSE)



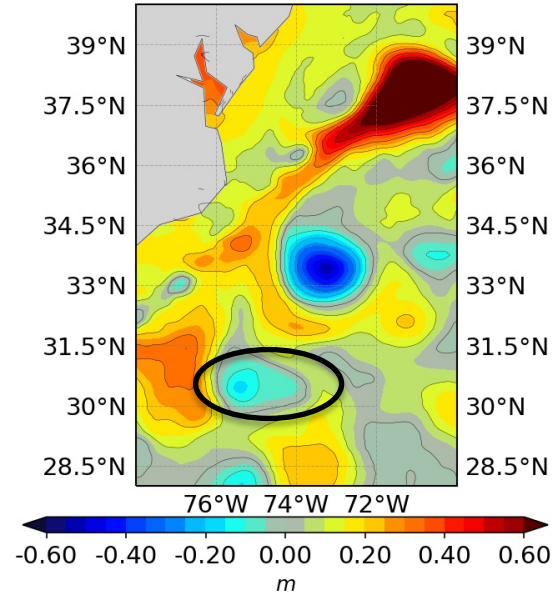
Sla Forecast (No Assim SWOT, 20230623)



Sla(SWOT, GS, 20230623)

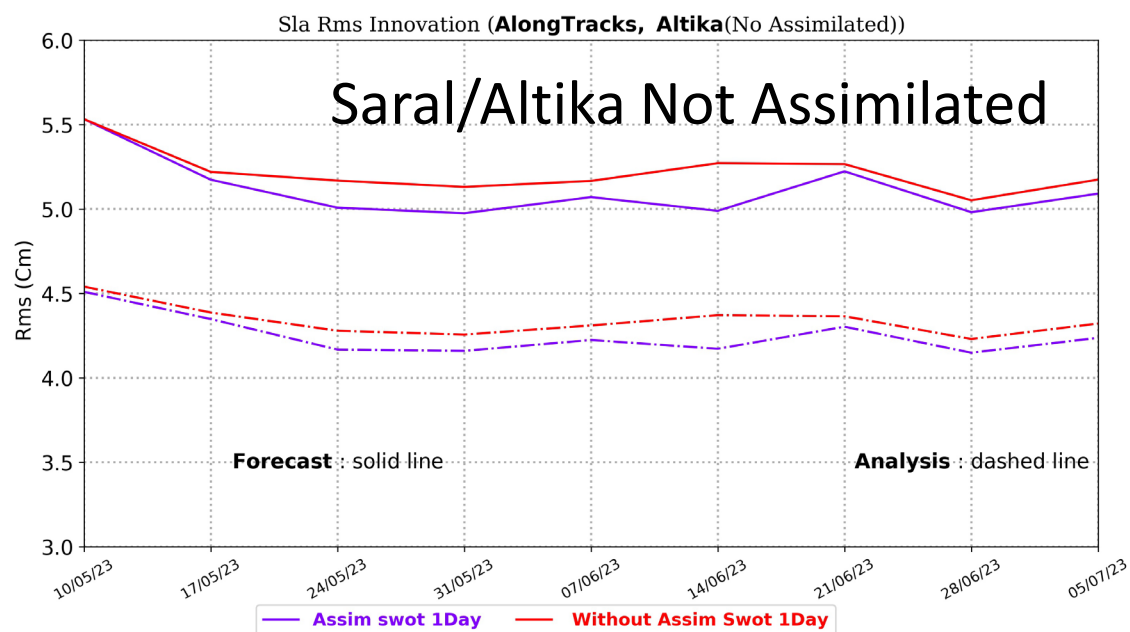


Sla Forecast (Assim SWOT, 20230623)

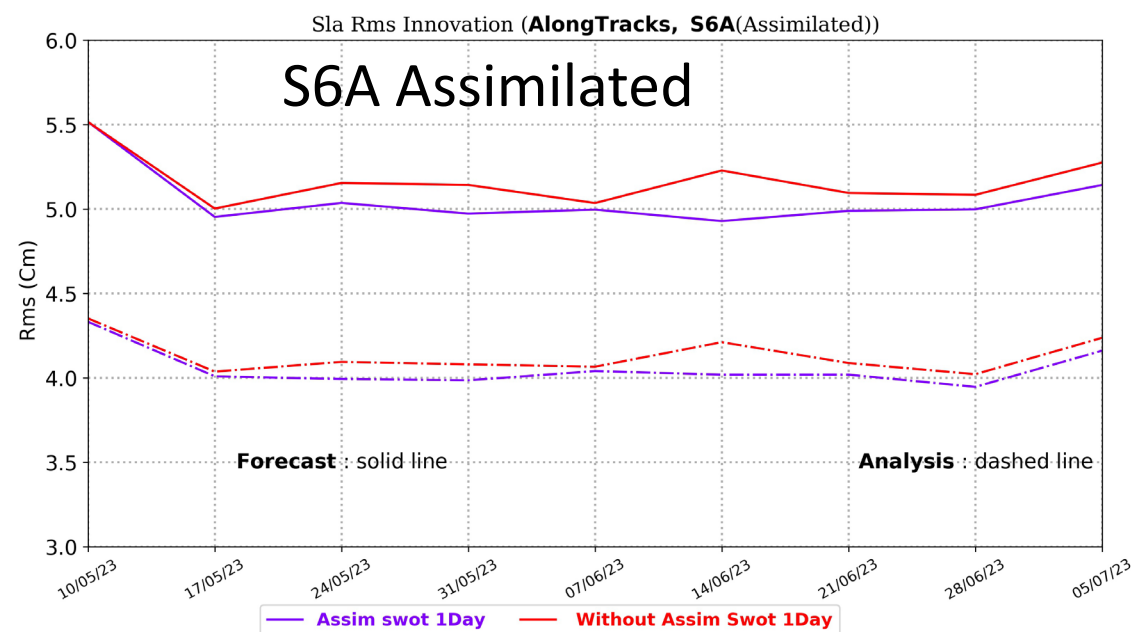


➤ Impact of SWOT assimilation (**fast-sampling**) on other Nadirs constellations

Assimilation Score (OSE)



Assimilation Score (OSE)

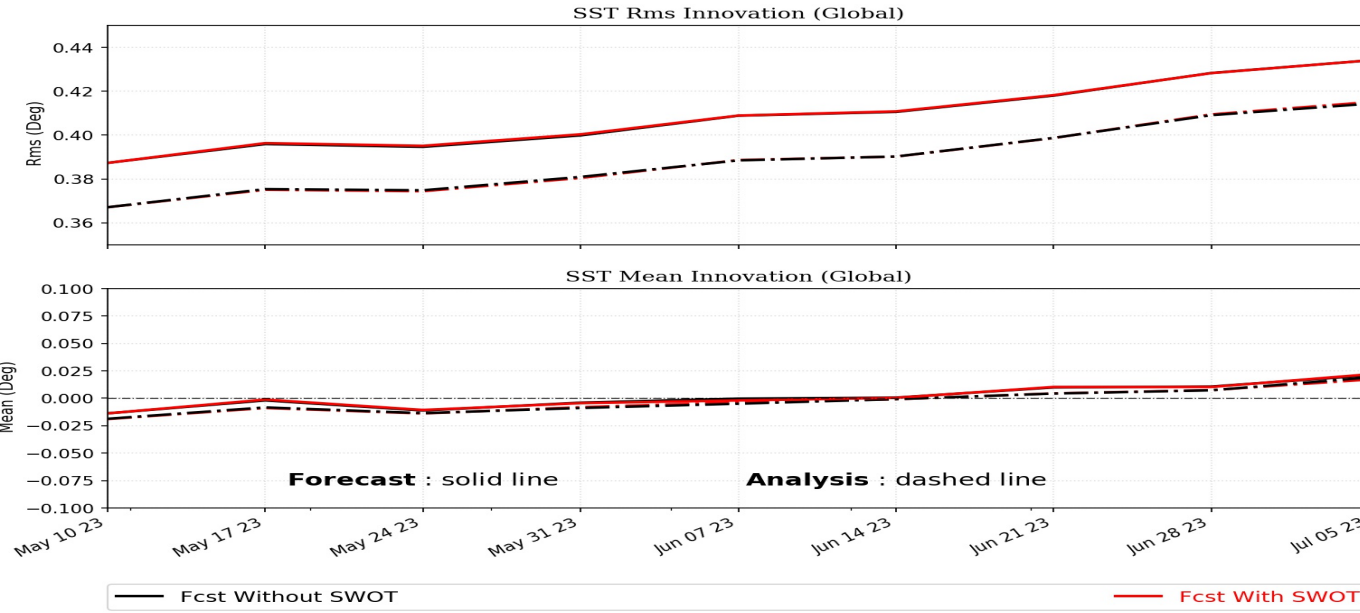


Add SWOT (fast-samplin) :

- No degradation of scores under the tracks of other altimeters,
- This leads to an improvement in global ocean analysis and forecasting.

➤ Impact of SWOT assimilation (**fast-sampling**) on Temperature and salinity

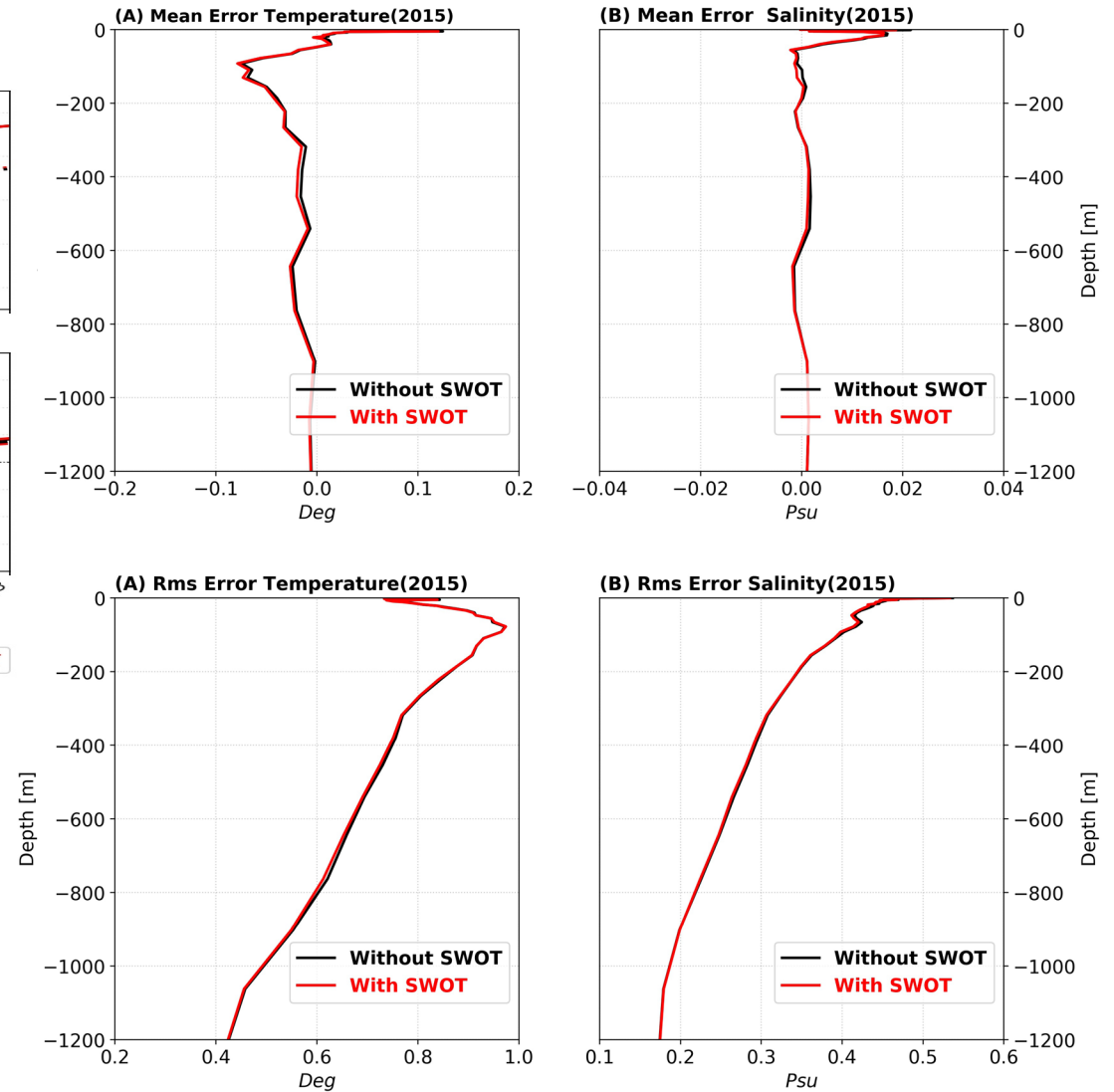
Impact on SST



Add SWOT:

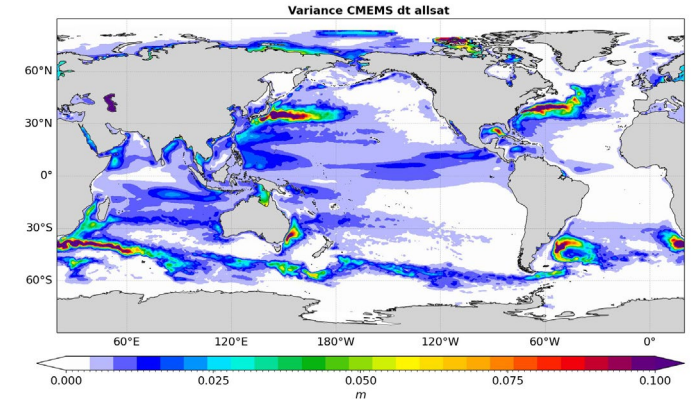
No degradation in the temperature and salinity forecast scores.

Impact on S and T profiles



VarError : Variance(Model Error relative to Saral/Altika (All Scale))

VarSLA : SLA Variance (cmems, All Nadirs)

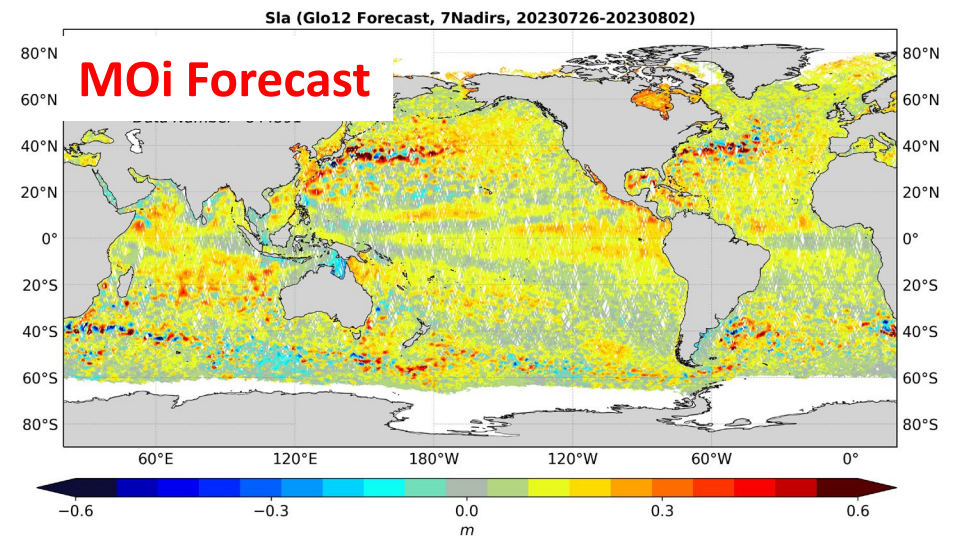
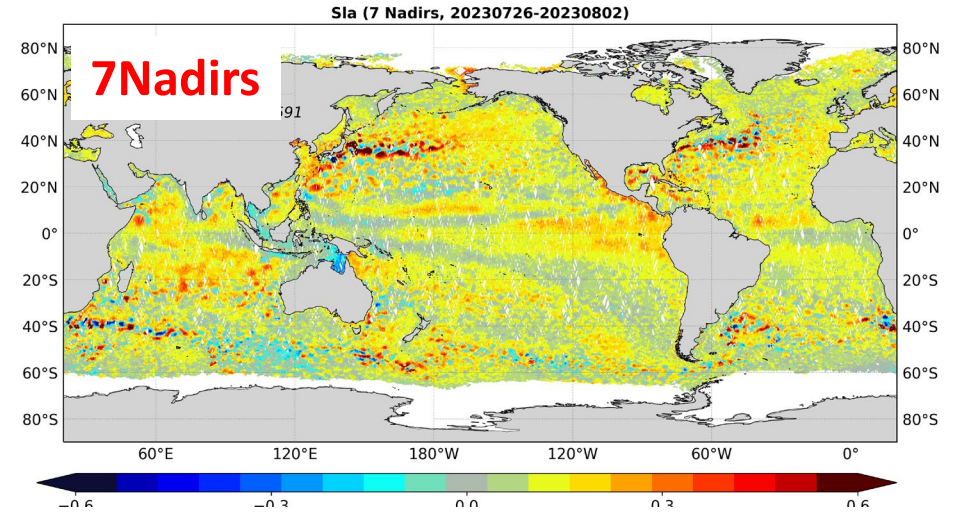
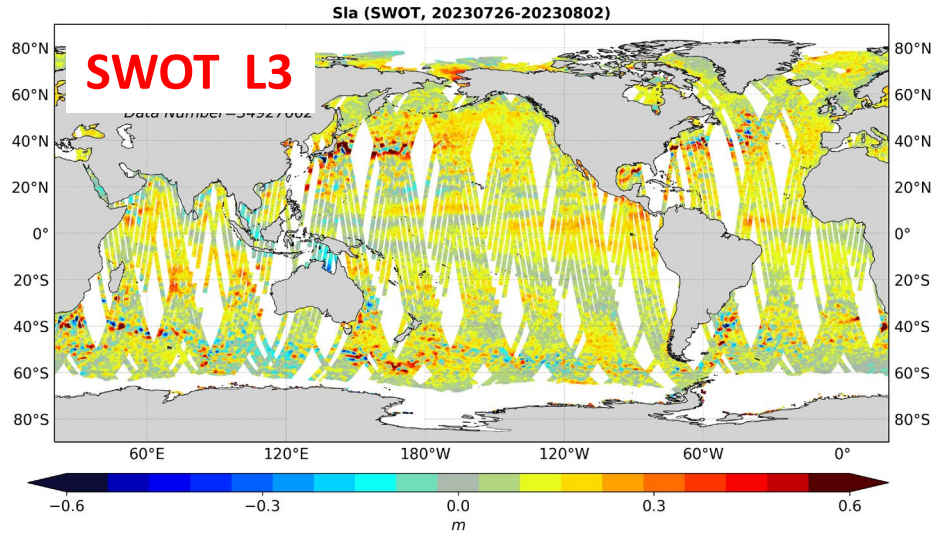


	Inside the Swath	Outside the Swath ([0-100Km])	Outside the Swath ([>100Km])
(Offshore>200km) & (VarSLA < 0.02m ²)	7.80	0.2	0.35
(offshore>200km) & (VarSLA > 0.02m ²)	12.92	0.77	0.92
(offshore<200km)	6.32	1.5	0.6

Improvement with SWOT

Degraded with SWOT

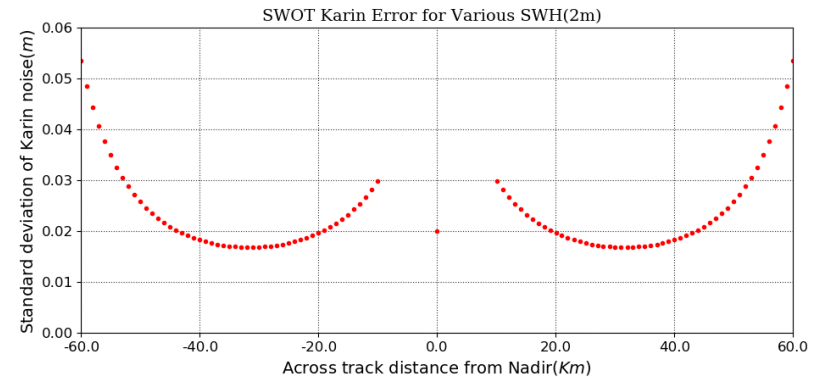
- The MOi/Copernicus Marine global ocean forecasting system is (almost) ready to assimilate SWOT data. Use of experimental L3 products.
 - SWOT data assimilation results (fast sampling phase) show already a promising improvement of the quality of ocean forecasts (gain : >15%).
 - The model is able to propagate this new information outside the SWOT Swaths.
 - spectral analysis, effective resolution
 - impact on model dynamics (horizontal and vertical vetices)
 -
 - Next step is to quantify the impact of SWOT 21-day phase data on analyses and forecasts and at different space/time scales.
-



SLA : SWOT vs 7Nadirs vs MOi global system forecast over 7 days (length of the MOi system's assimilation cycle).

The first SWOT measurements (21-days) show a good representation of oceanic phenomena (no anomalies) over the whole global area. A good correlation with the combination of 7 nadirs and the model forecast along these nadirs. These data are ready to be assimilated

- SWOT Data :
 - I3_extended (+nadir)
 - resolution 6km
 - Karin Error. (depending of the resolution)



- Assimilation system :
 - cmems system (Glo12, 1/12°)
 - Start : from Operational system (03/05/2023)
 - Assimilation : SST (ODYSSEA, 1/10°, SuperObs) T&S profiles Coriolis and SLA (c2n, h2b, j3n, s3a, s3b, s6a, **al (verif)**)