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SEA LEVEL ECV QUALITY ASSESSMENT VIA GLOBAL OCEAN MODEL ASSIMILATION

SEA LEVEL CLIMATE CHANGE INITIATIVE (SL cci)

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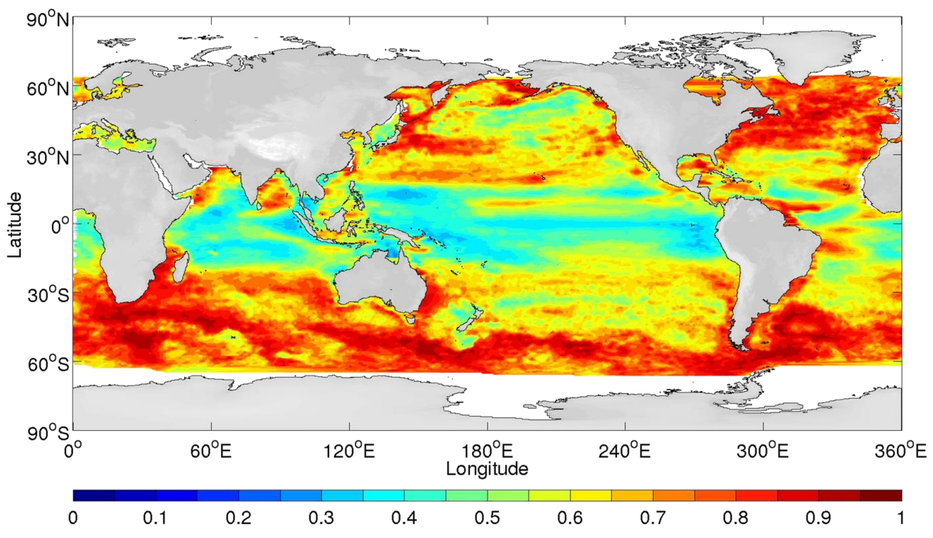
We aim to quantify improvements in Sea Level data obtained through the ESA - Climate Change Initiative **(SL_cci)** effort, to test the consistency of the Essential Climate Variable of SL (SL_ECV) with other ECVs through the assimilation process and demonstrate the improved model solution.

F**or this purpose we assimilate along-track SSH data jointly with in situ ocean data into the GECCO2 assimilation framework.**

Because the dynamically consistent ocean state estimation adjusts only uncertain model parameters to bring the model into consistency with ocean observations, improvements in data products can be investigated by studying the residuals between the different data products and the constrained model. While assimilating **SL0** (the original AVISO product) into the GECCO2 synthesis **(G0)** we are able to demonstrate that in many regions the SL_cci product **SL1** has been improved compared to SL0. However, there are regions where SL1 is further away from the model "truth“ G0, as the GECCO2 synthesis tried to adapt to the assimilated SL0. In contrast, when comparing the G0 synthesis results to the updated improved SL_cci data set **SL1.1**, further improvement can be seen.

When now assimilating the improved SL1.1 product in the GECCO2 synthesis **(G1.1)**, the model tried to adapt to SL1.1. The G1.1 synthesis results demonstrate not only an improved G1.1 solution compared to G0 but also a further improvement of the updated SL_cci product SL1.1.

TOPEX/POSEIDON series



G0_SL0

(2) RMS differences are shown exemplarily for G0_SL0, the GECCCO2 solution (G0), that assimilated the original AVISO data (SL0), as it is compared to the AVISO along-track data itself (SL0).

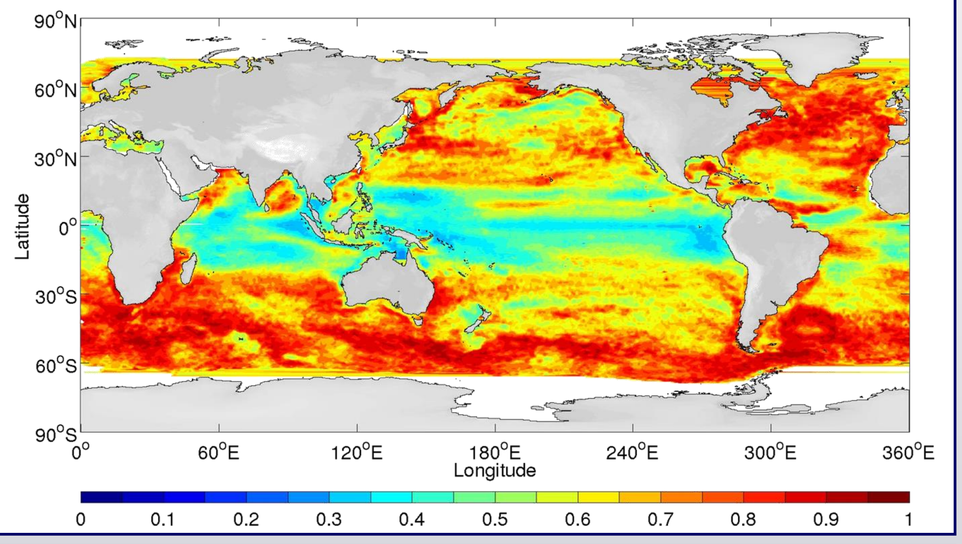
BLUE: very good adjustment of GECCO2 to the assimilated data SL0.

RED: poor adjustment of GECCO2 to the assimilated data SL0.

G0 adapts very well in the tropics whereas it neglects the assimilated data in the more red regions to satisfy the model physics.

When comparing two RMS differences to each other less red means the closer agreement of the used model and the data set.

ERS series



normalized RMS

σ	STD	**G0_SL0**	$= \frac{\sigma_{(G0 - SL0)}}{\sqrt{\sigma^2_{G0} + \sigma^2_{SL0}}}$
G0	GECCO2 assimilated SL0	**G0_SL1**	$= \frac{\sigma_{(G0 - SL1)}}{\sqrt{\sigma^2_{G0} + \sigma^2_{SL0}}}$
G1.1	GECCO2 assimilated SL1.1	**G1.1_SL0**	$= \frac{\sigma_{(G1.1 - SL0)}}{\sqrt{\sigma^2_{G1.1} + \sigma^2_{SL0}}}$
SL0	AVISO SSH	**G1.1_SL1.1**	$= \frac{\sigma_{(G1.1 - SL1.1)}}{\sqrt{\sigma^2_{G1.1} + \sigma^2_{SL1.1}}}$
SL1	SSH from SL_cci		
SL1.1	SSH from SL_cci, improved		

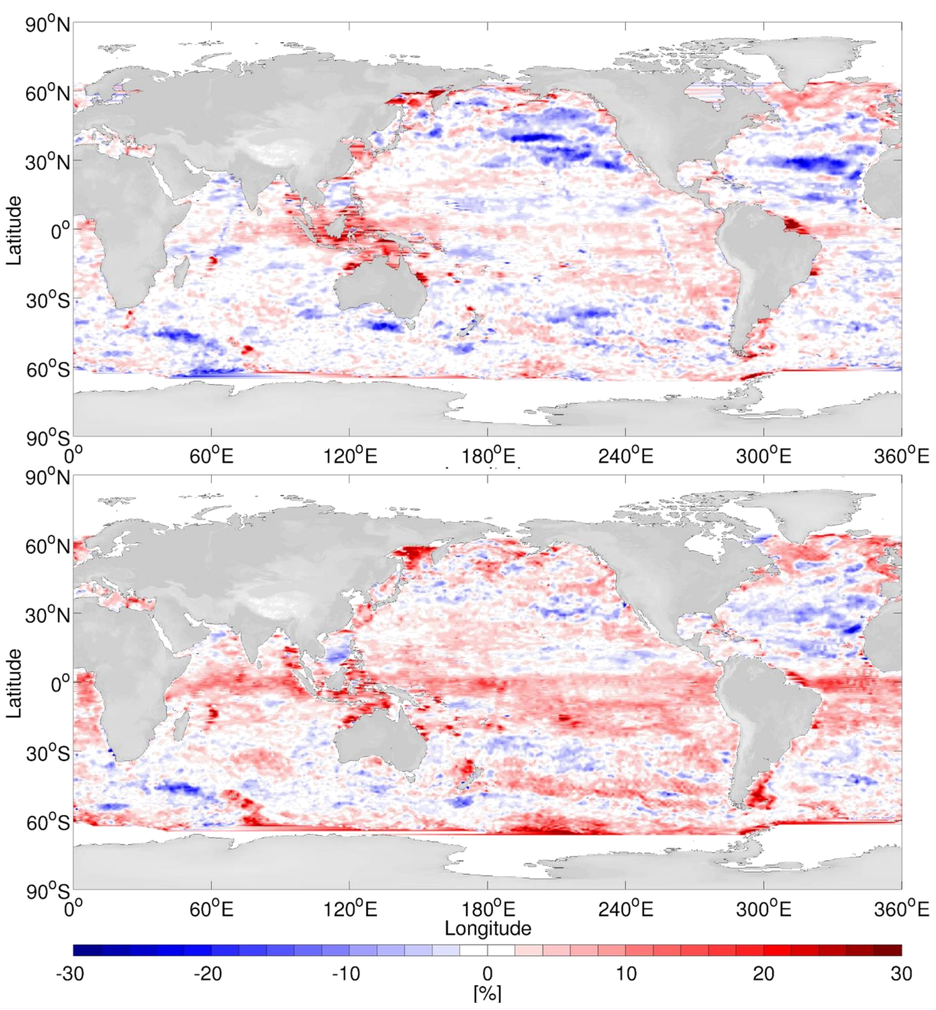
(1) Normalized RMS are calculated using the GECCO2 model solutions G0 and G1.1, and the SL data sets SL0, SL1 and SL1.1. The results are named with the model solution and the compared data set. All used combinations are shown. The square root of both variances is the most useful normalization for this analysis.

RMS ratio comparisons

(3) The RMS ratios are designed in a way that smaller residuals indicate a better agreement of the upper RMS difference of model (G) and data (SL), compared to the lower.

A consistency cross checking of different model-data combinations has been performed. The numbers to the right demonstrate the closer agreement of the upper model-data combinations as compared to the lower.

TP series		ERS series	
0.970	$\frac{G1.1\_SL1.1}{G0\_SL0}$	0.966	GECCO2 better adapted to the assimilated SL1.1 than to SL0.
0.990	$\frac{G1.1\_SL1.1}{G0\_SL1.1}$	0.990	Accordingly, SL1.1 is closer to G0 than it is SL0. Hence SL1.1 is better than SL0. G1.1 is closer to SL1.1 than G0.
0.980	$\frac{G0\_SL1.1}{G0\_SL0}$	0.970	SL1.1 is closer to G0 than it is SL0, hence SL1.1 is the better data set.
0.997	$\frac{G1.1\_SL0}{G0\_SL0}$	0.997	SL0 is in closer agreement to G1.1 than it is to G0. That demonstrates the improvement of the GECCO2 synthesis result from assimilating SL1.1.



G0_SL1 / G0_SL0

(4) For the maps, the RMS ratios are transformed into percent improvement.

RED: indicates a closer agreement of the upper model-data comparison (G0_SL1) as compared to the lower (G0_SL0). SL1 has been improved compared to SL0.

BLUE: indicates a less good agreement of the upper model-data comparison. In those regions G0 adaptet better to the assimilated data SL0.

G1.1_SL1.1 / G1.1_SL0

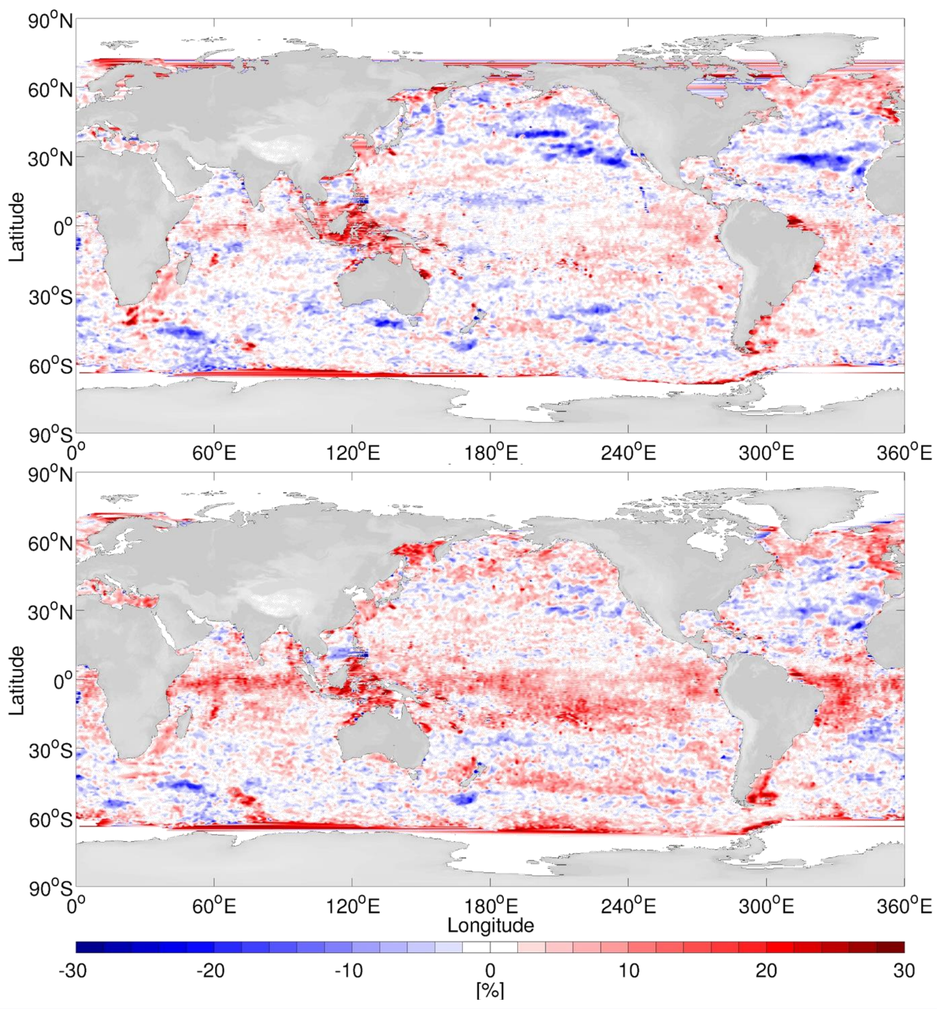
RED: indicates a closer agreement of G1.1 to SL1.1 than to SL0. Hence SL1.1 has been improved.

BLUE: indicates a less good agreement of G1.1 and SL1.1. The reason needs to be model physics that overruled the assimilated SL1.1.

Further, when comparing the top and bottom RMS ratio comparisons, the combination of

- 1) the improved data set SL1.1 above SL0 and SL1 as well as

- 2) the improved GECCO2 synthesis G1.1 get evident.



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Conclusions

The two different **GECCO2 synthesis results (G0 and G1.1)** showed, that the **SL1.1 p**roduct has been improved as compared to versions **SL1** and **SL0** by up to 30%.

The assimilation of the SL1.1 product into the GECCO2 synthesis demonstrates the changes in the model truth, which bring the GECCO2 model even closer to the assimilated SL data, giving rise that the model physics better accepts and adapts to the assimilated SL1.1.