Sea Level ECV Quality Assessment via Global Ocean Model Assimilation

Sea Level Climate Change Initiative (SL CCI)

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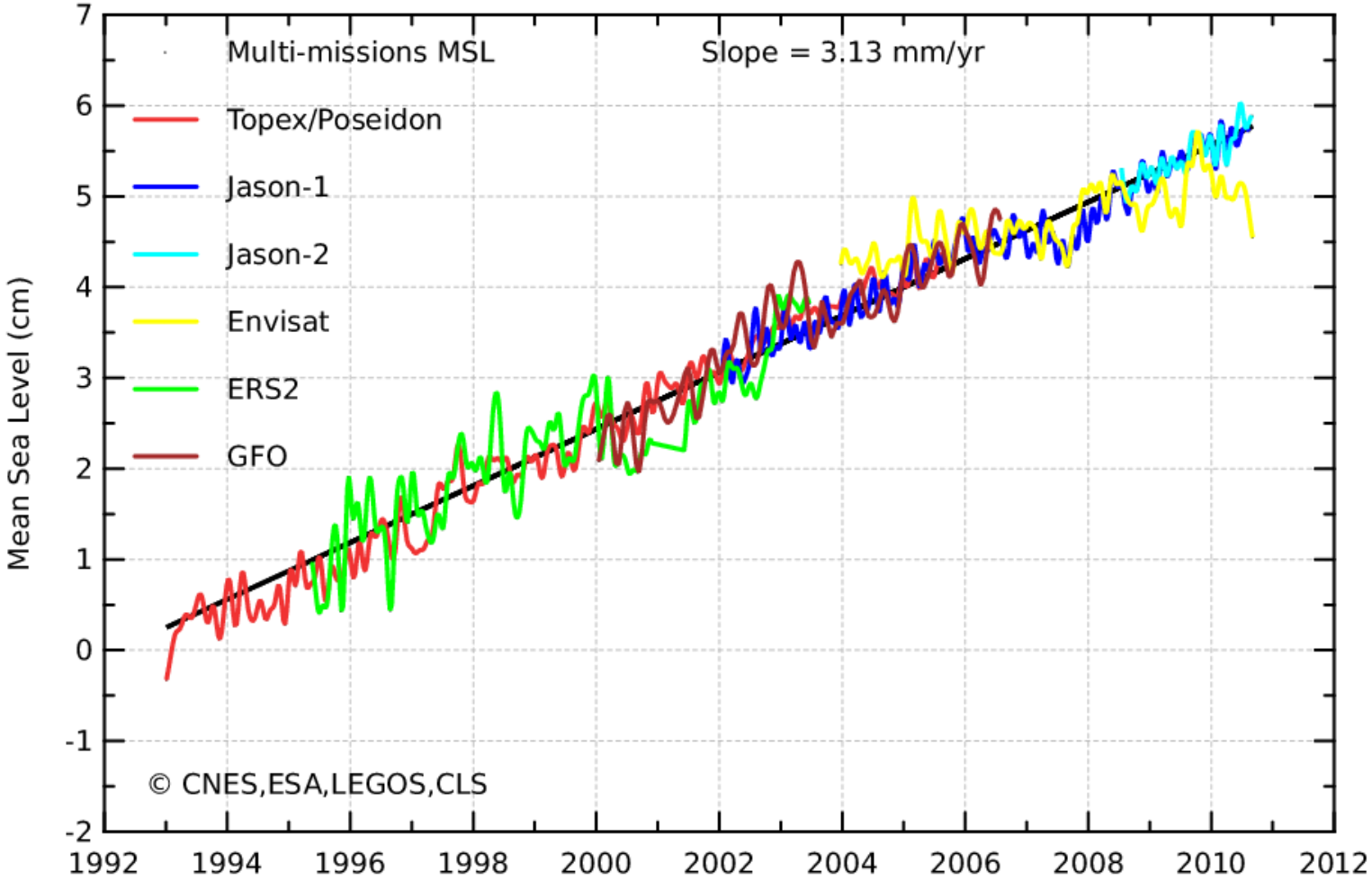
SL CCI

Multi-mission global sea level trend from altimetry



SSH assimilation – user assessment

- SSH fields are used presently by the climate modeling community primarily for testing the models in a gross sense.

- In the ocean modeling community satellite data, especially SSH fields, are assimilated on a regular basis. The importance of assimilating SSH fields originates from their dynamical relevance for constraining the ocean's flow field.

- Ocean models assimilate all available ECVs with measurable success. Respective results are available from many models. Results can be inter-compared and can be used for assessing processes involved in SSH changes.

- ECVs as SSH are not only essential for testing the quality of a model
  but in contrast,
  models constrained by SSH data can help testing the quality of the data as well.

GECCO2 assimilation approach (Köhl and Stammer, 2008a, b)

Is targeted to quantifying changes in SL-data through the CCI effort.

Investigate its consistency with a coupled ocean-sea ice model, to test the consistency of the new SL CCI ECV with other ECVs through the assimilation process and investigate where remaining inconsistencies exist and why.

- This involves the assimilation of the SL CCI ECVs as constrains jointly with other available ECVs over the ocean and in situ data.
- The dynamically consistent ocean state estimation adjusts only uncertain model parameters to bring the model into consistency with ocean observations.
- Testing the consistency of observations with ocean dynamics and with prior information about uncertainties relies very much on mathematically consistent data assimilation approaches.
- We use the existing dynamically self-consistent assimilation approach of GECCO2 to test the improvement of the new SL_ECV_V1 compared to the SL_ECV_V0 (AVISO) in terms of regional dynamics, trends, consistency with heat and freshwater content etc.

GECCO2 assimilation approach – Phase 2

We perform new assimilation runs with GECCO2
1) using SL_ECV_V0 (AVISO)
2) using SL_ECV_V1.1 and
3) using SL_ECV_V1.1 jointly with other new ESA ECVs

- The model adapts to the assimilated variables V0 or V1.1 respectively, in the best possible way
- Smaller residuals will be interpreted as an improvement of the data set
- Residuals will be investigated in this respect globally and regionally, as RMS differences, seasonal cycle, SSH trends, among other dynamical parameters

1) GECCO2 assimilates along-track ssh of V0. (**completed**) Iteration: 23-28
2) GECCO2 assimilates along-track ssh of V1.1 (**completed**) Iteration: 23-28
2) GECCO2 assimilates along-track ssh of V1.1 + other ECVs Iteration: 23-28

GECCO2 assimilation approach – Phase 2

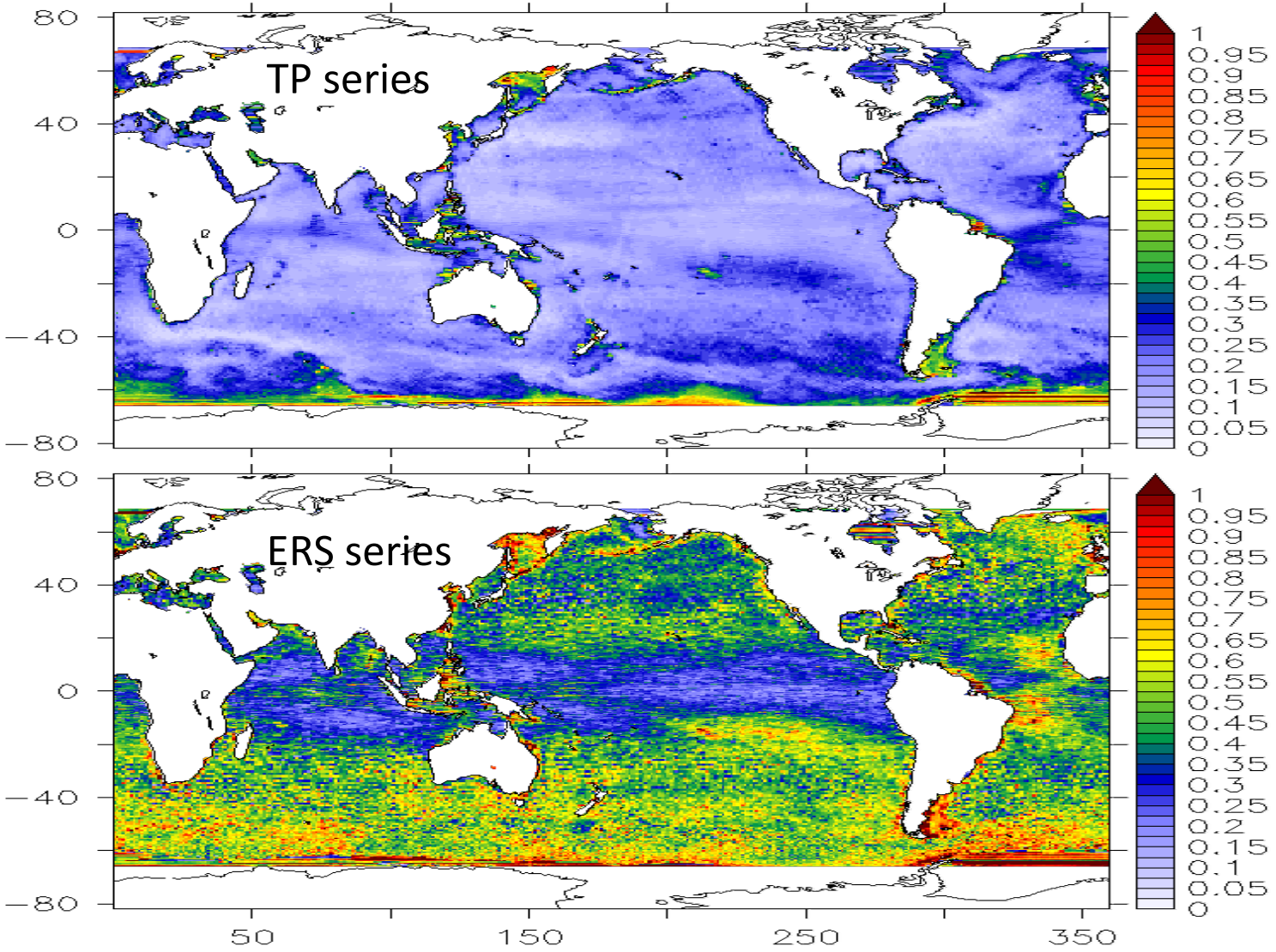
- The daily GECCO2 synthesis results at model resolution are now taken as „truth“.
- The three synthesis results will be compared to V0 (AVISO) and to V1.1 (SL CCI).
- An RMS reduction thus means an improvement of the data set (relative to other dataset).
- Comparisons will be performed for ERS series and TP series.

First two assimilation runs have just been finished.

- Results shown here are quick preliminary results for the OSTST, at model resolution not along track

- the extensive evaluations that are currently performed will be along-track as well as at model resolution

RMS GECCO2-V0 with GECCO2-V1.1

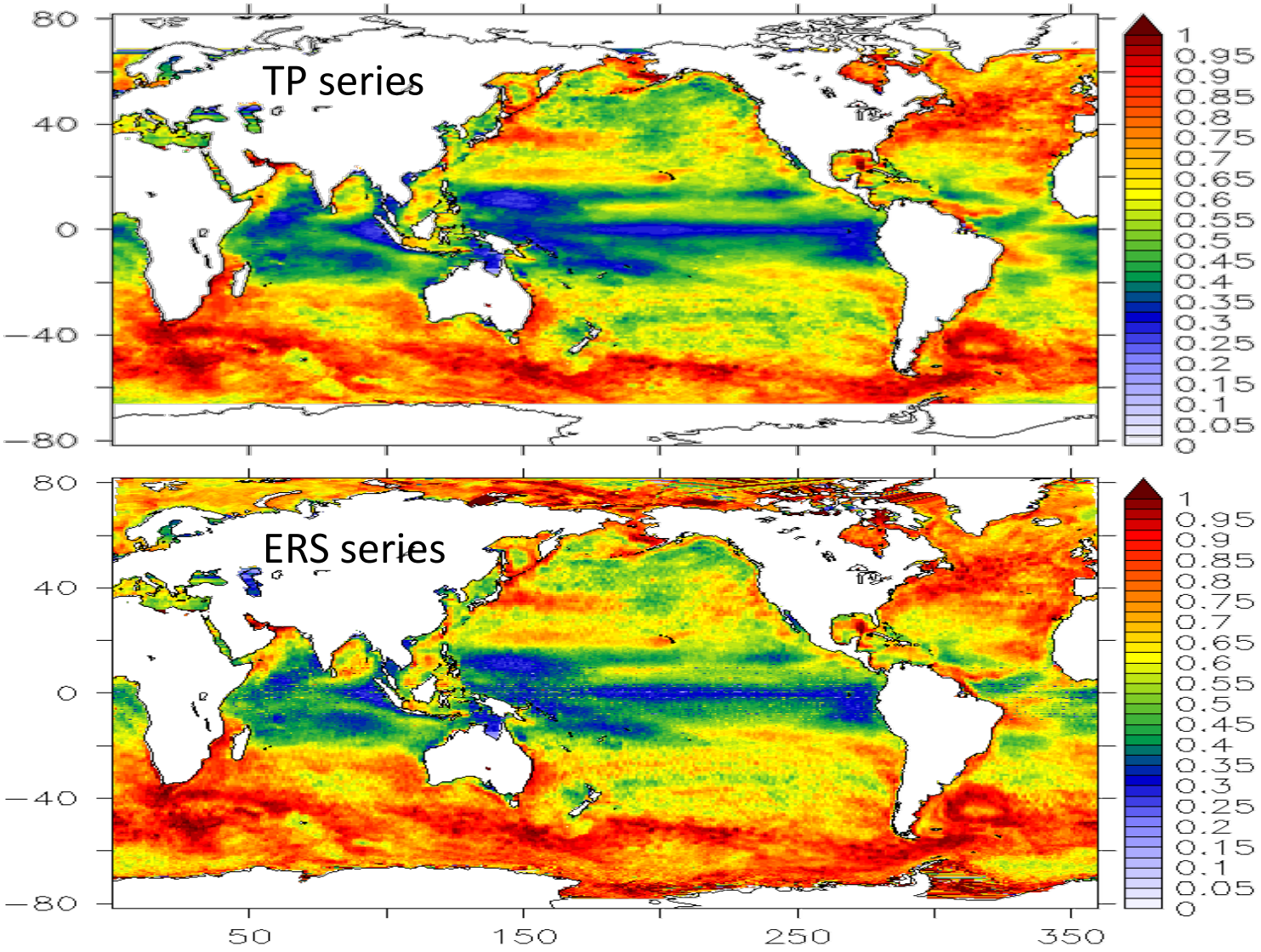


RMS

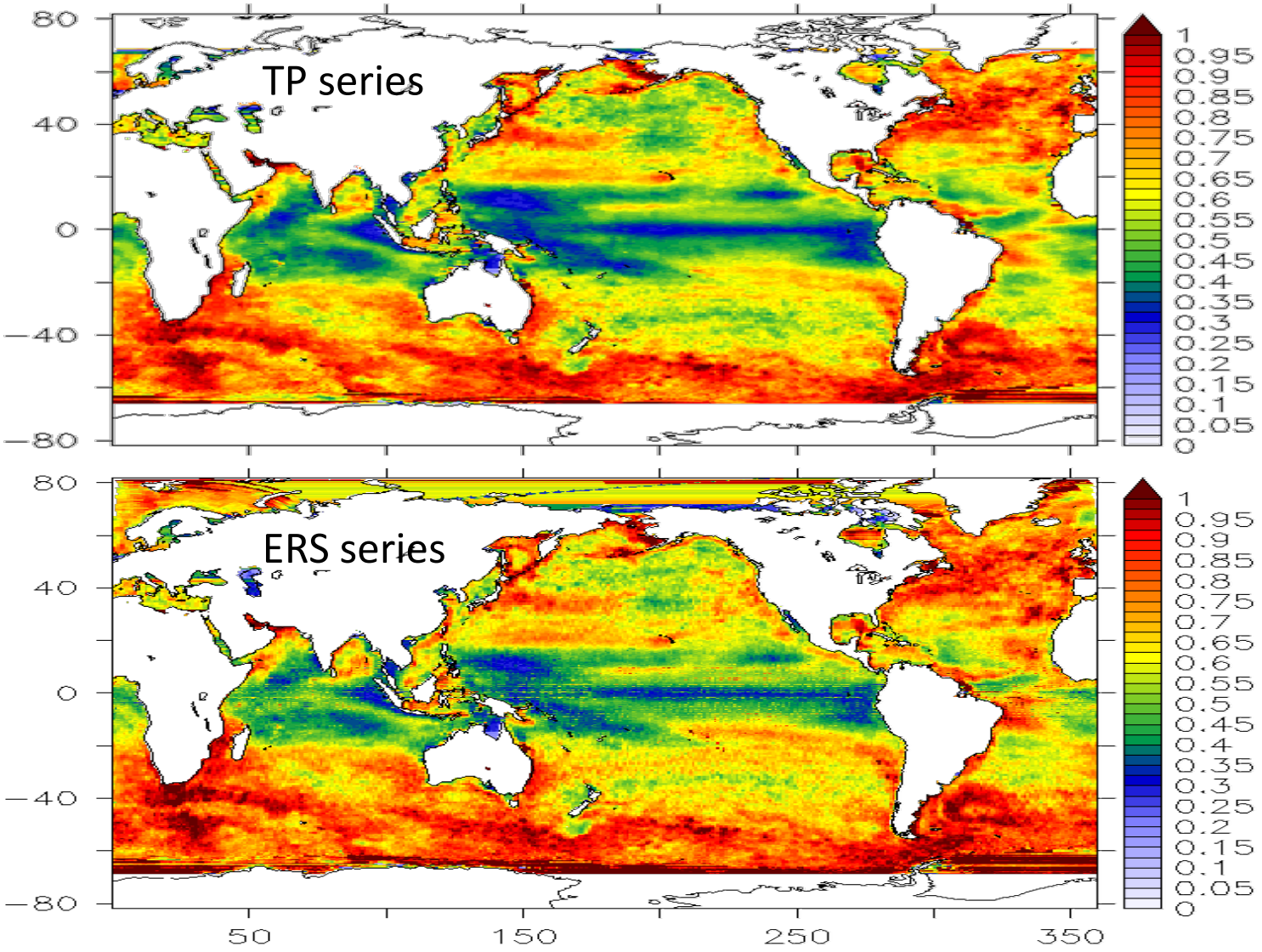
GECCO2 V0 and GECCO2 V1.1

shows an improvement for both satellite series

RMS GECCO2-V1.1 with data-V1.1



RMS GECCO2-V0 with data-V0



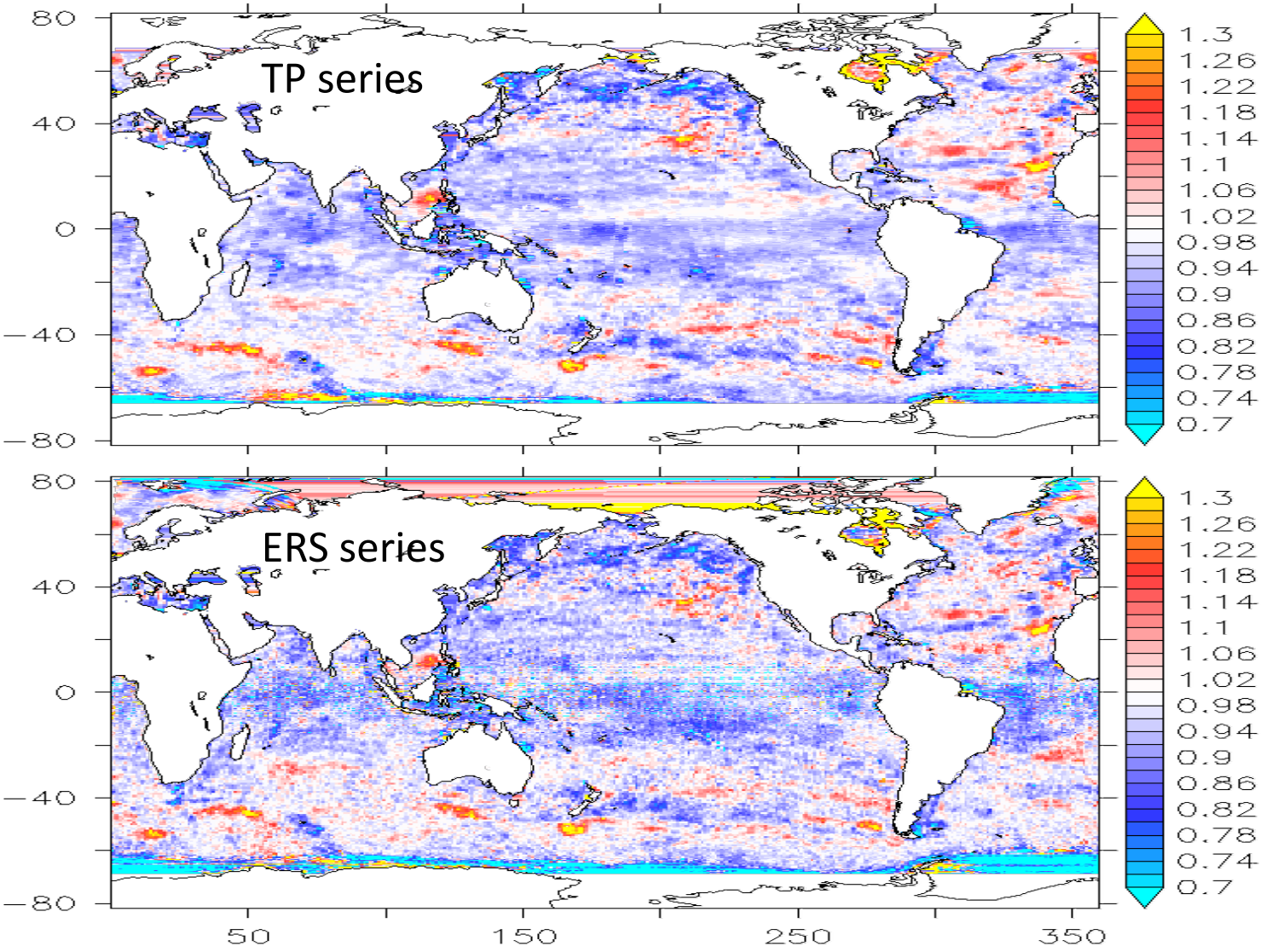
RMS differences

GECCO2 V1.1 and data V1.1

shows smaller values compared to the RMS differences

GECCO2 V0 and data V0

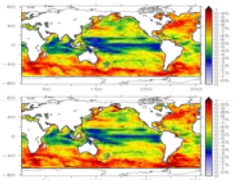
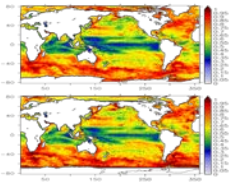
DIFF RMS GECCO2-V1.1 with data-V1.1 - GECCO2-V0 with data-V0



Blue indicates an improvement of the SL CCI V1.1 data set

Ratio comparison

TP series **ERS series**

0.970  $\frac{\text{RMS (GECCO2 + V1.1, V1.1)}}{\text{RMS (GECCO2 + V0 , V0)}}$  0.966

Consistency cross checking of the GECCO2 model

0.990 $\frac{\text{RMS (GECCO2 + V1.1, V1.1)}}{\text{RMS (GECCO2 + V0 , V1.1)}}$ 0.990

0.980 $\frac{\text{RMS (GECCO2 + V0 , V1.1)}}{\text{RMS (GECCO2 + V0 , V0)}}$ 0.970

0.997 $\frac{\text{RMS (GECCO2 + V1.1, V0)}}{\text{RMS (GECCO2 + V0 , V0)}}$ 0.997

Model synthesis produces physical results independent of which data set is assimilated.

Outlook - Uncertainty estimates from SL CCI

For assimilation process

- can be usefull additional information during the assimilation process
- dependent on the variabiliy of the uncertainty estimate in time
- however, the model error is not small and therefore, would only make sence for highly variable uncertainties

For evaluation process

can be used to identiy regions where the model did not adapt to good data or where the model adapted to rather uncertain data

SL CCI V1.1 preliminary conclusion

The Sea Level data for constructing the essential climate variable (ECV) has been improved within the SL CCI effort.
The improvement can be visualized when in one case assimilating the previous (AVISO) and in the other case the updated data set (SL_ECV_V1.1) into the self consistent GECCO2 model and afterwards comparing the two data sets itself to the model output.