

Improving bottom pressure fields using GRACE data in ECCO

Rui M Ponte

Atmospheric and Environmental Research/JANUS Research Group

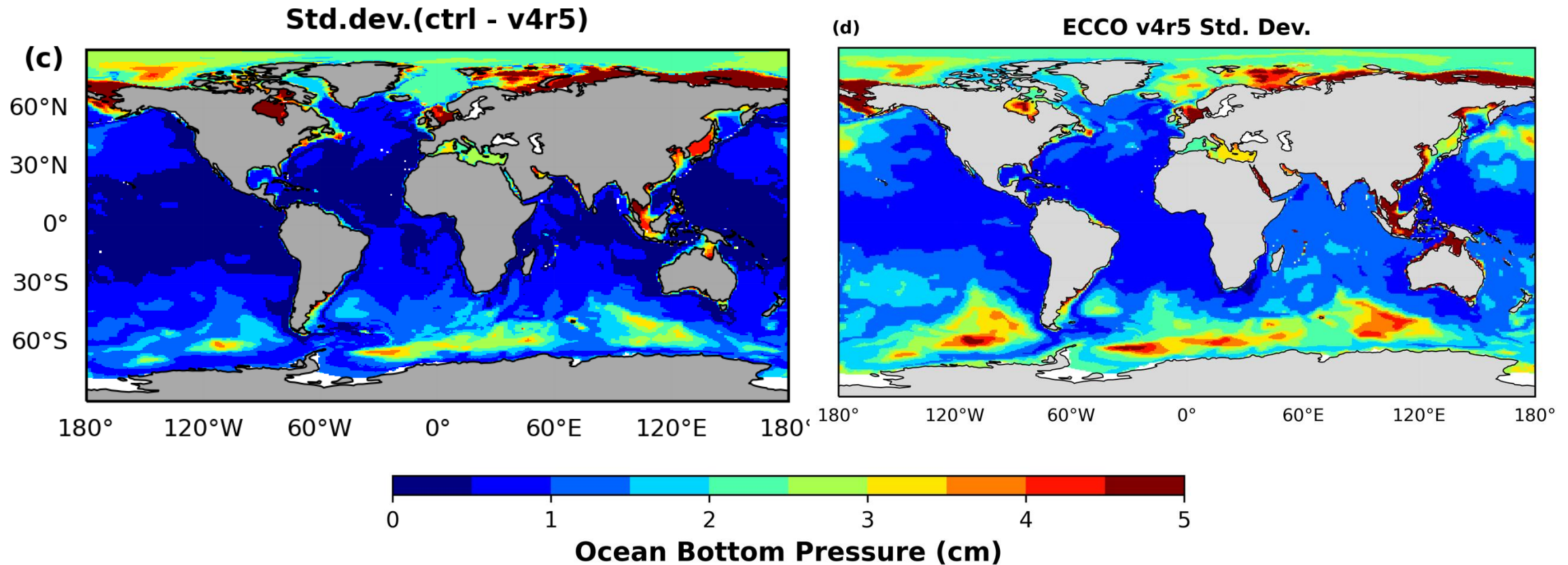
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Use of GRACE data in ECCO state estimates

- Assimilation of ocean bottom pressure data from GRACE and GRACE Follow-On missions into ocean models remains relatively rare and unexplored
- Recent ECCO ocean state estimates (from Version 4 Release 4 onward) have included constraints to both gridded local bottom pressure anomalies and estimates of global mean ocean mass or barystatic sea level derived from GRACE(-FO)
- Here we provide an initial assessment of the impact of assimilating GRACE(-FO) monthly bottom pressure data on the ECCO Version 4 Release 5 (v4r5) optimized solution

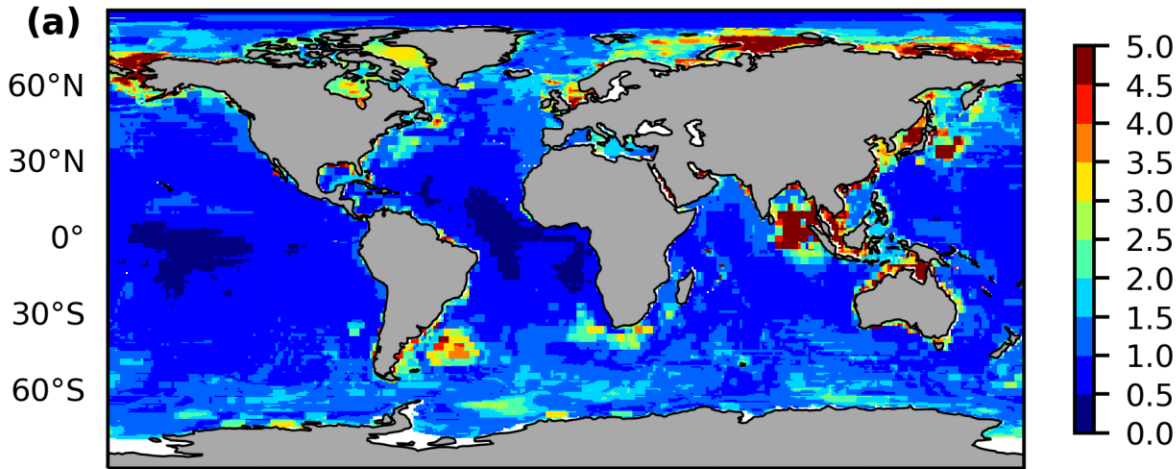
Does the optimization affect bottom pressure fields?



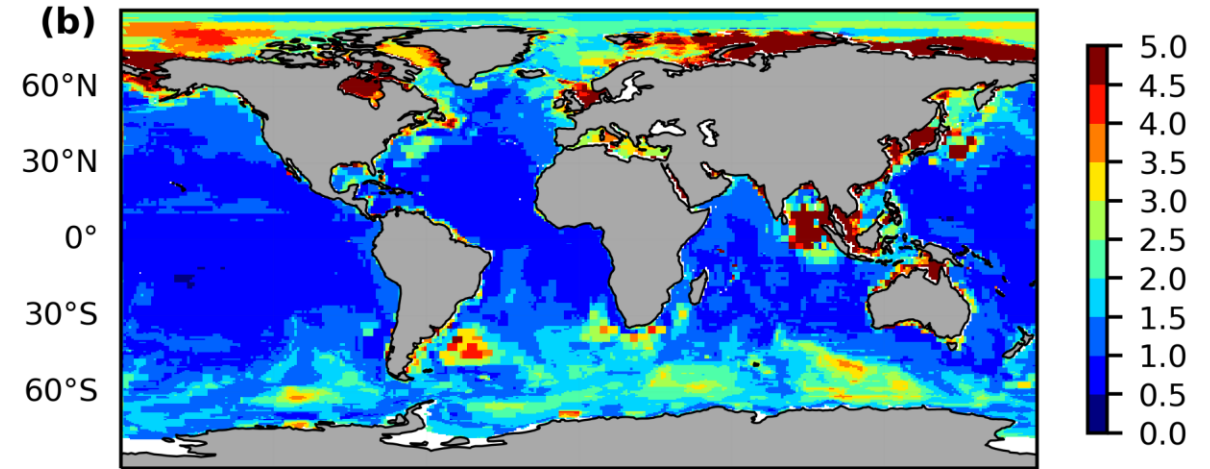
- Standard deviations in bottom pressure range from ~ 1 cm at low latitudes to more than 5 cm in the Arctic, Southern Ocean and several coastal regions
- Adjustments in bottom pressure fields resulting from the optimization are comparable in magnitude to variability in many regions

Is there an improved fit to the GRACE data?

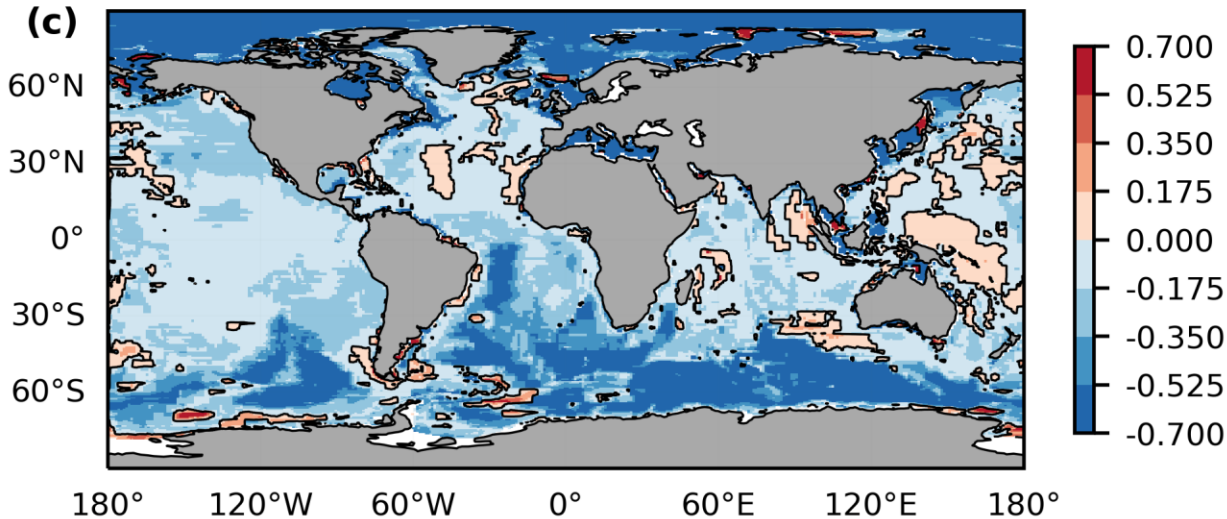
Std.dev.(GRACE - v4r5)



Std.dev.(GRACE - ctrl)

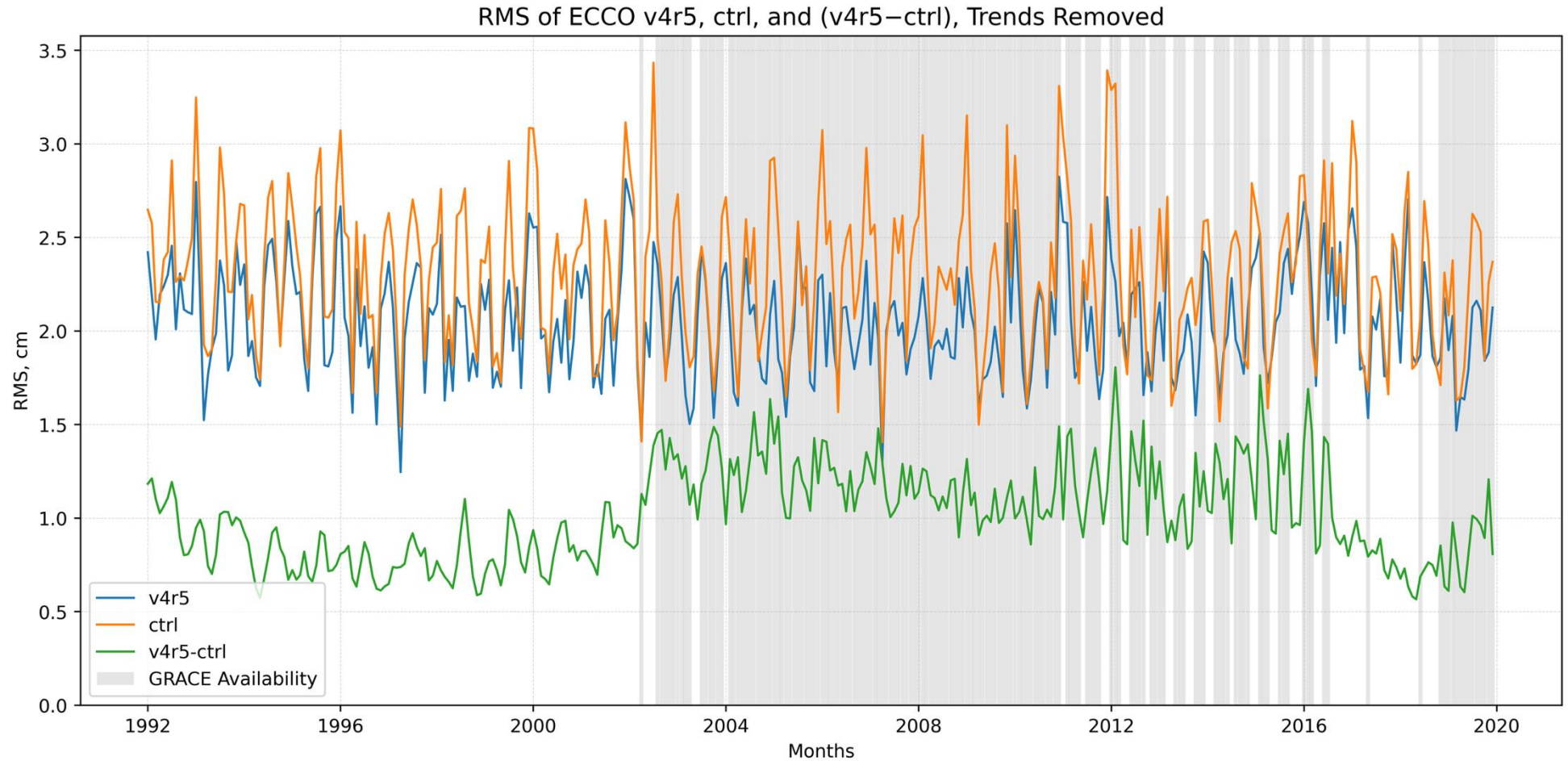


Std. Dev. (GRACE-v4r5) minus Std. Dev. (GRACE-ctrl)



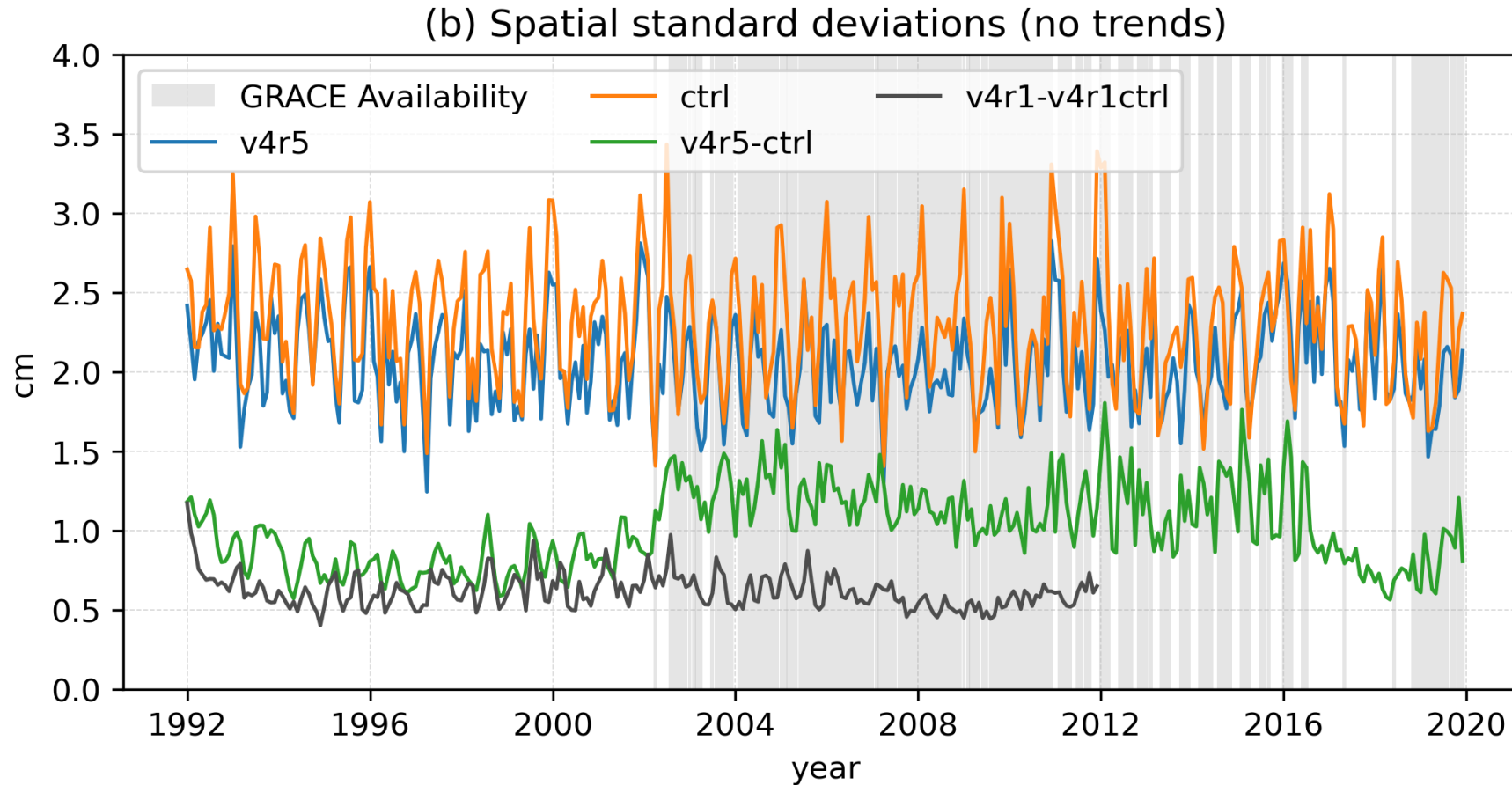
- Mostly smaller misfits to the data after optimization
- Sizeable decreases clear in Southern Ocean, Arctic Ocean, Mediterranean Sea where variability is larger
- Similarly for many marginal seas and coastal regions

Do GRACE constraints directly affect bottom pressure values?



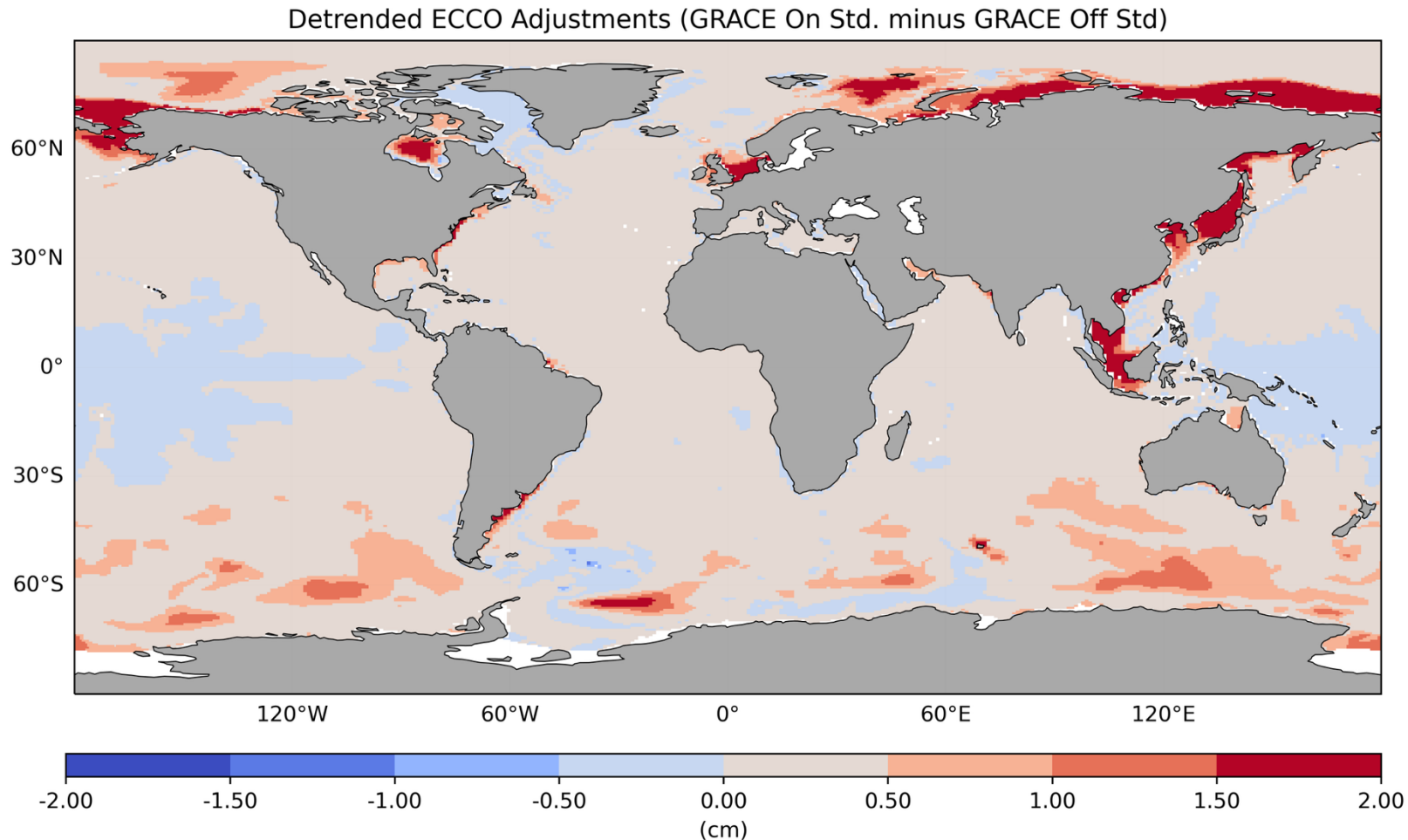
- Bottom pressure adjustments generally higher after onset of gravity data
- Consistently weaker adjustments for months with data gaps within the GRACE period

Do Argo float data constraints directly affect bottom pressure fields?



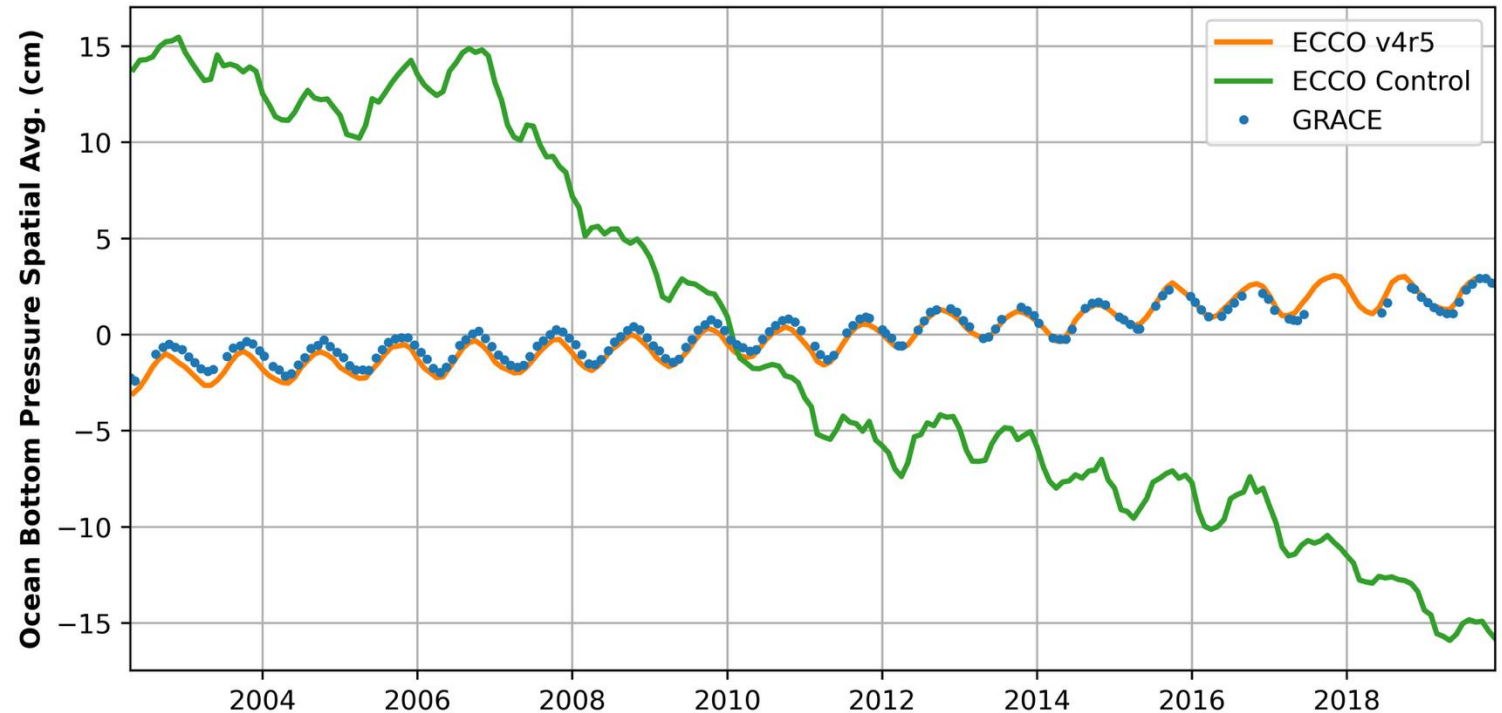
- No visible enhancement in bottom pressure adjustments after the onset of Argo in the early 2000s

Do GRACE constraints directly affect bottom pressure fields?



- Positive values indicate larger bottom pressure adjustments for periods with GRACE data
- Impact of GRACE constraints clear in Arctic, Southern Ocean, coastal regions, marginal seas

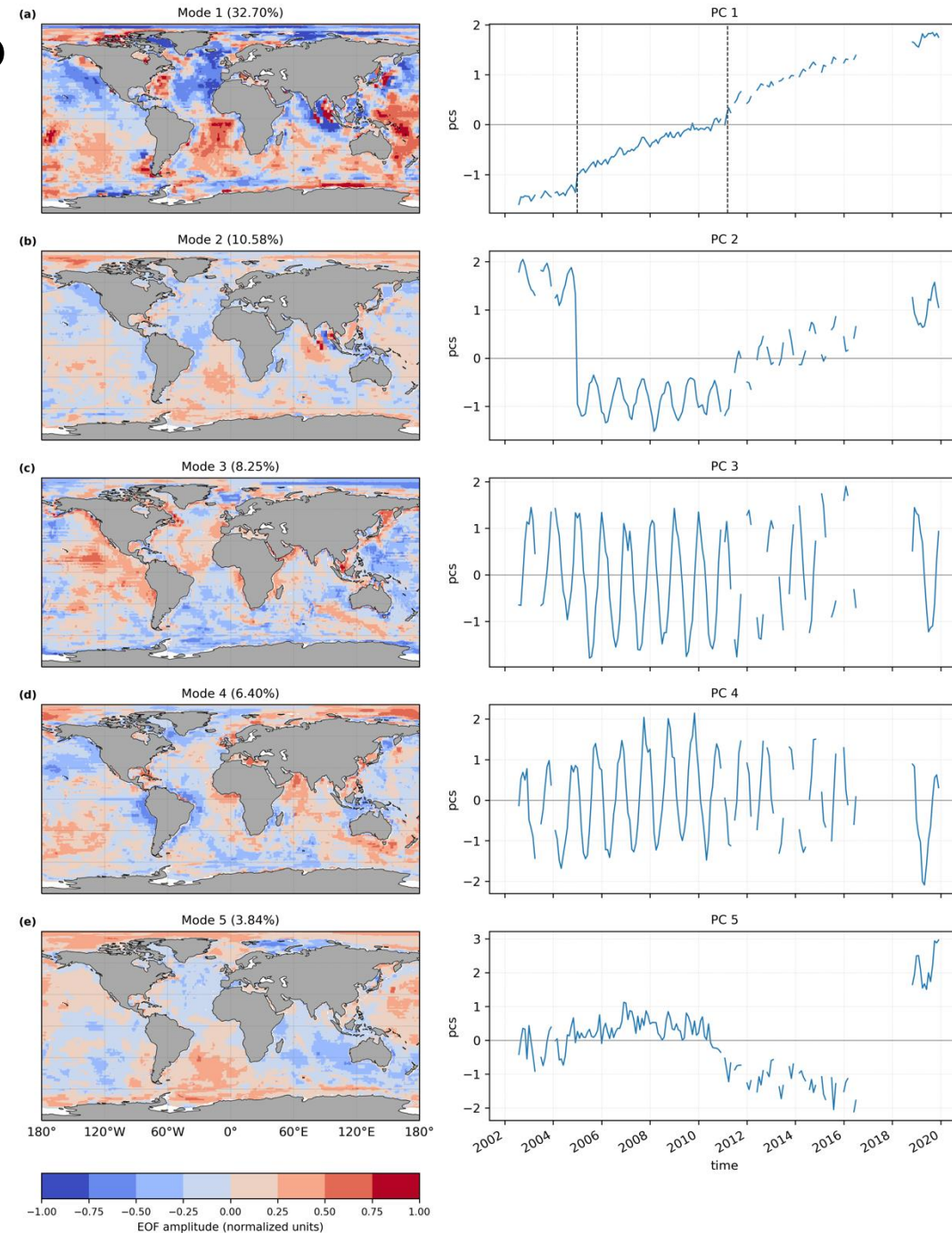
Effects on ocean mean mass/barystatic sea level?



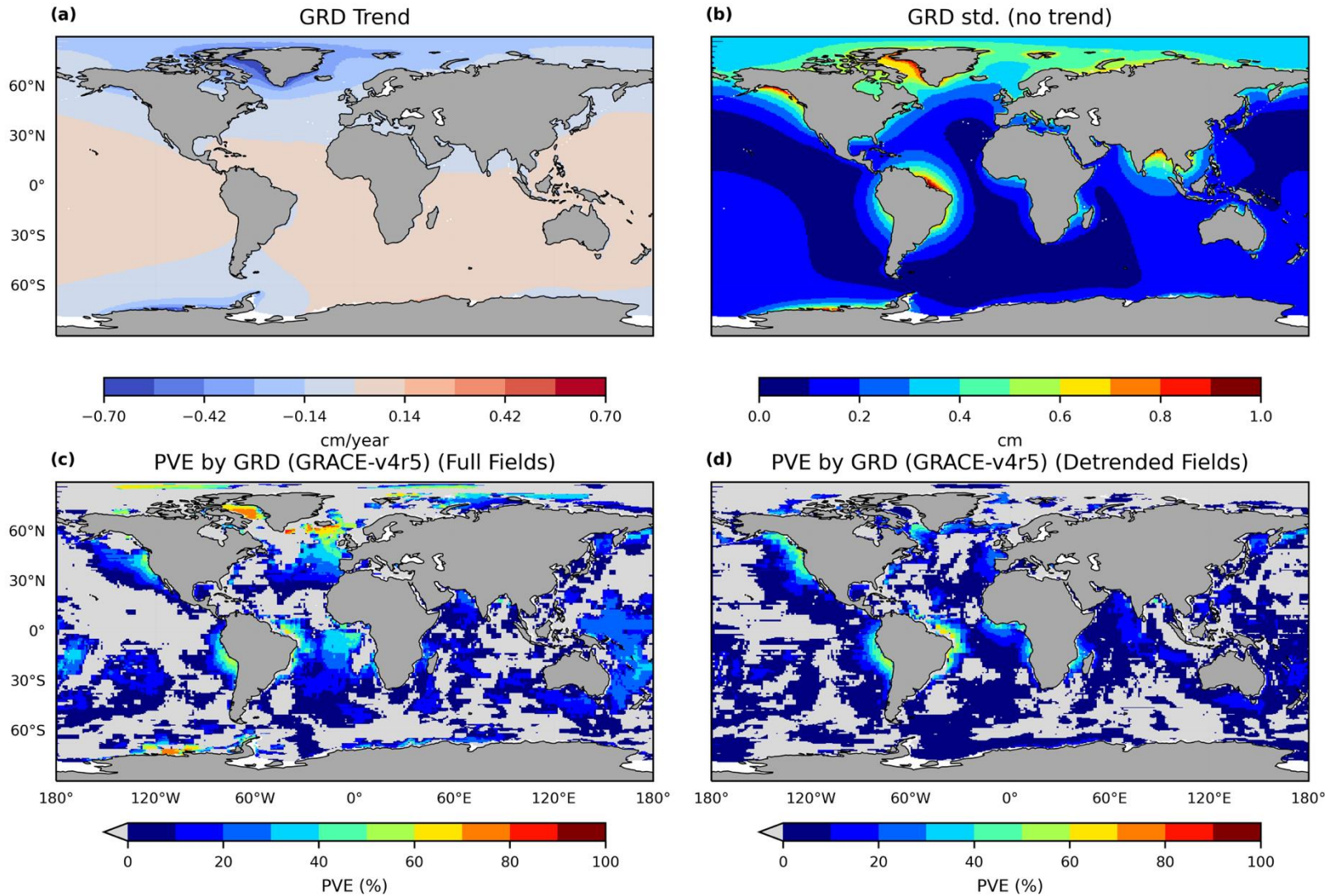
- Control run shows a drop of about 30 cm(!) in barystatic sea level due to large imbalances in freshwater flux in first-guess surface forcing fields
- Optimized solution fits the GRACE estimates of barystatic sea level much better, both for annual cycle and long-term trend
- GRACE constraint is key for correcting issues with first-guess freshwater fluxes

How to improve GRACE constraints?

- Correct data for the effects of large earthquakes
 - Correction for JPL fields under development
- Correct data for so-called GRD (gravitation, rotation and deformation) effects
 - Correction recently made available for JPL fields (Wiese and Landerer)
- Update GRACE data weights
- Use data inversions at higher time sampling



GRD effects on current solution misfits?



- Largest trends around Greenland (land ice melt signal)
- Sizable seasonal cycle in many coastal areas
- GRD corrections explain substantial variance in ECCOv4r5 minus GRACE misfits