Improving ocean bottom pressure fields through use of space gravity data in state estimation

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Use of GRACE data in ECCO state estimates

- Assimilation of ocean bottom pressure data from GRACE(-FO) into ocean models remains relatively rare and unexplored

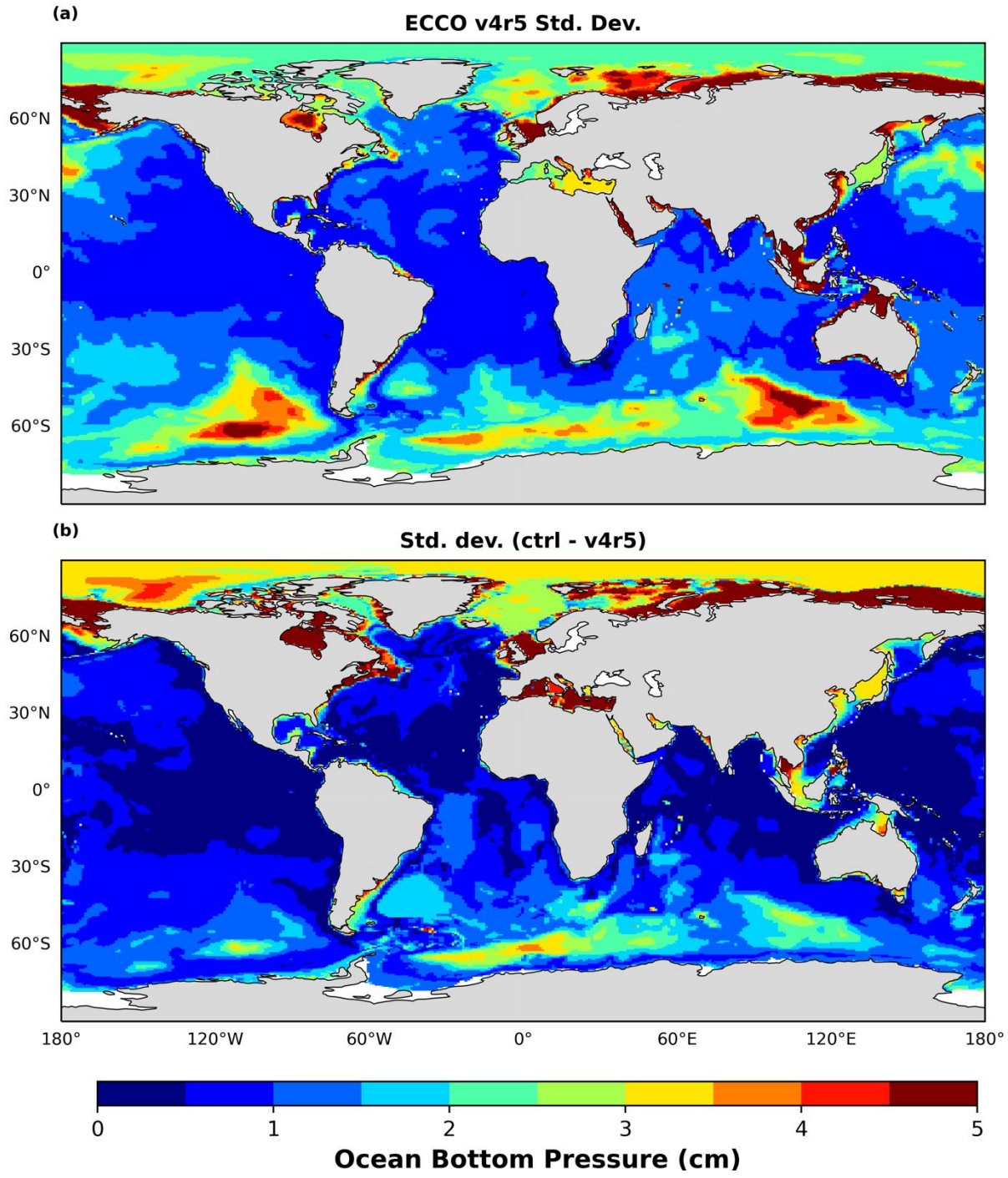
- Recent ocean state estimates from the project for Estimating the Circulation and Climate of the Oceans (ECCO) have included constraints to both gridded local bottom pressure anomalies and estimates of global mean ocean mass or barystatic sea level derived from GRACE(-FO)

- Here we provide an initial assessment of the impact of assimilating GRACE(-FO) monthly bottom pressure data on the latest ECCO Version 4 Release 5 (v4r5) optimized solution

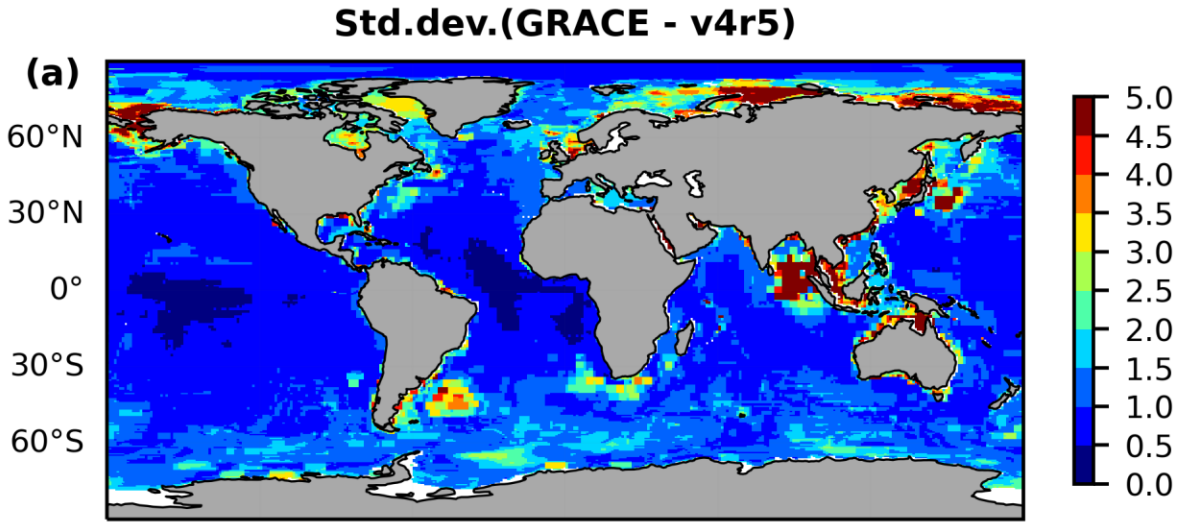
Does the optimization affect bottom pressure fields?

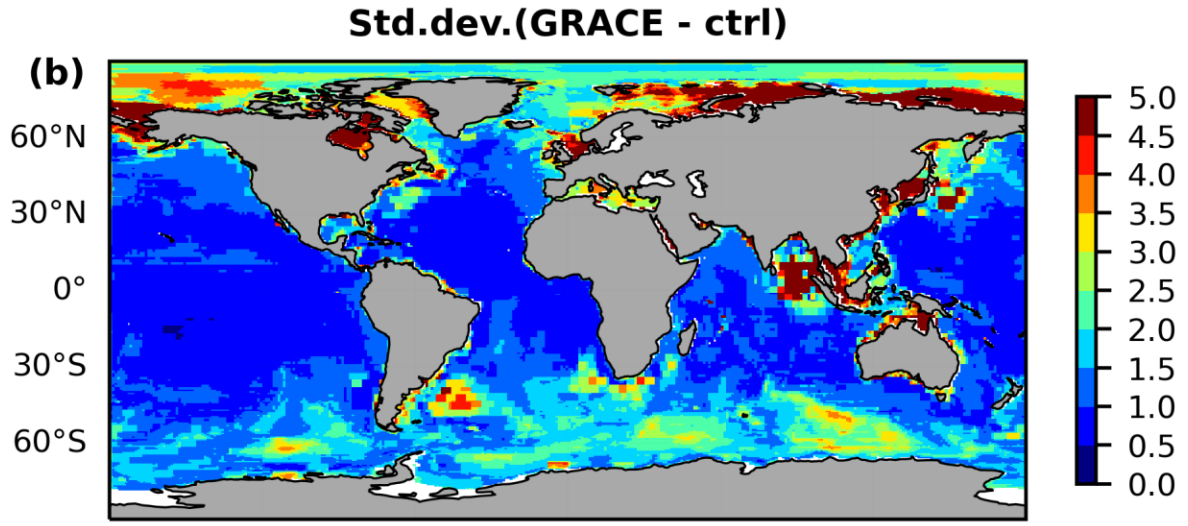
- Standard deviations in bottom pressure range from ~ 1 cm at low latitudes to more than 5 cm in the Arctic, Southern Ocean and several coastal regions

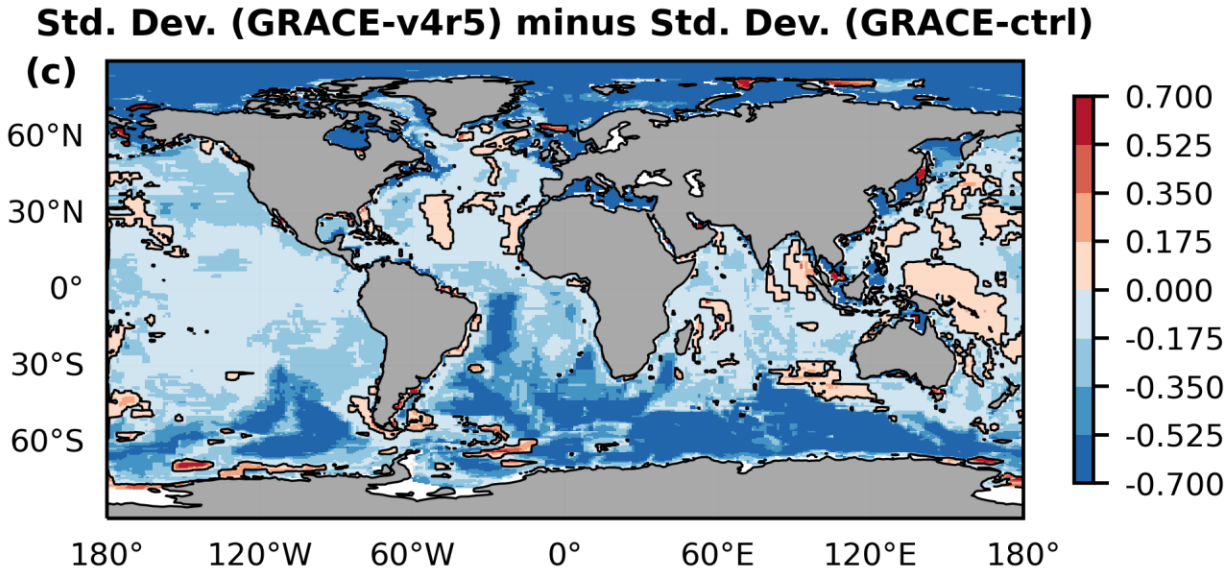
- Adjustments in bottom pressure fields resulting from the optimization are comparable in magnitude to variability in many regions



Is there an improved fit to the GRACE data?

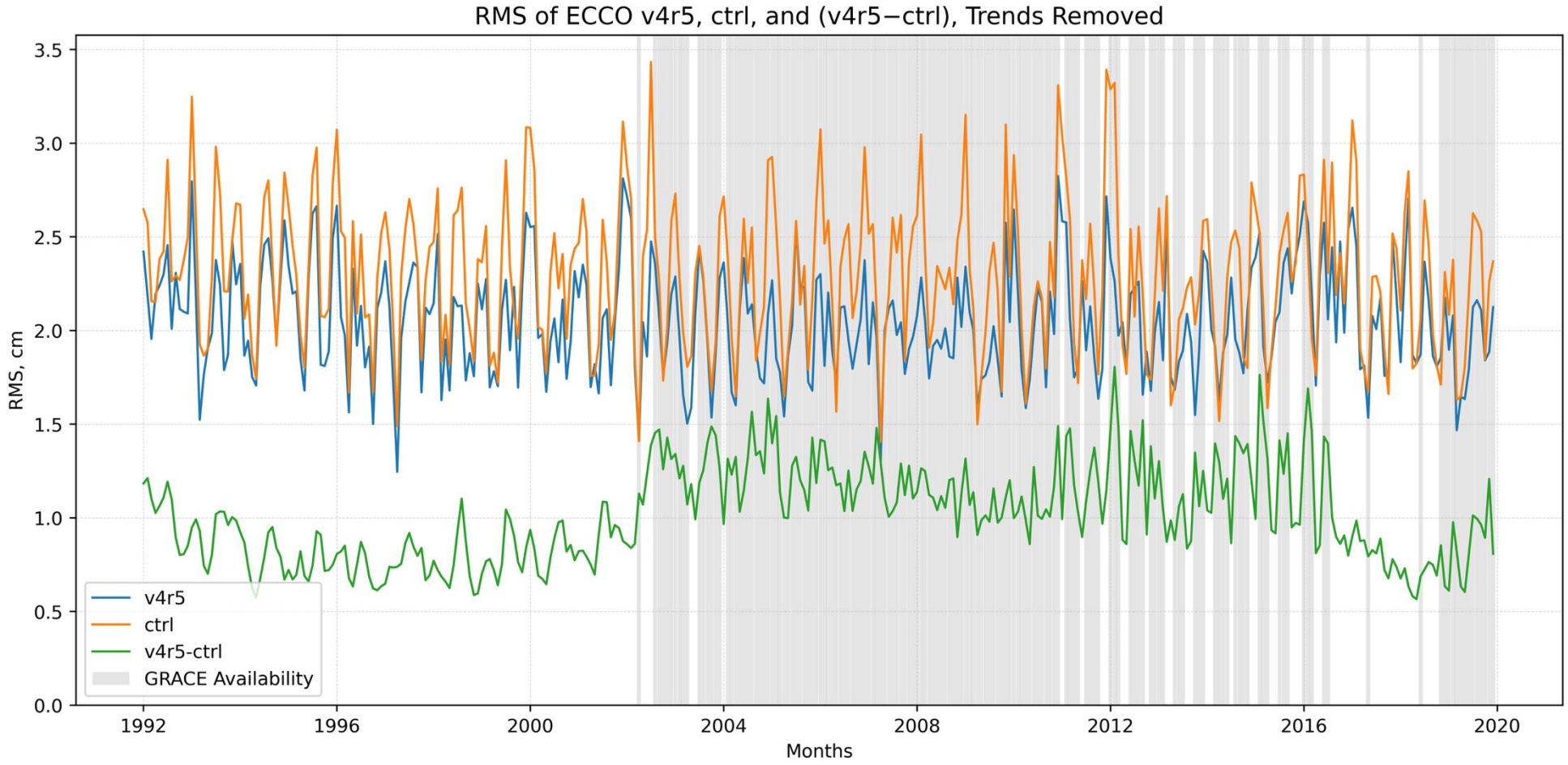






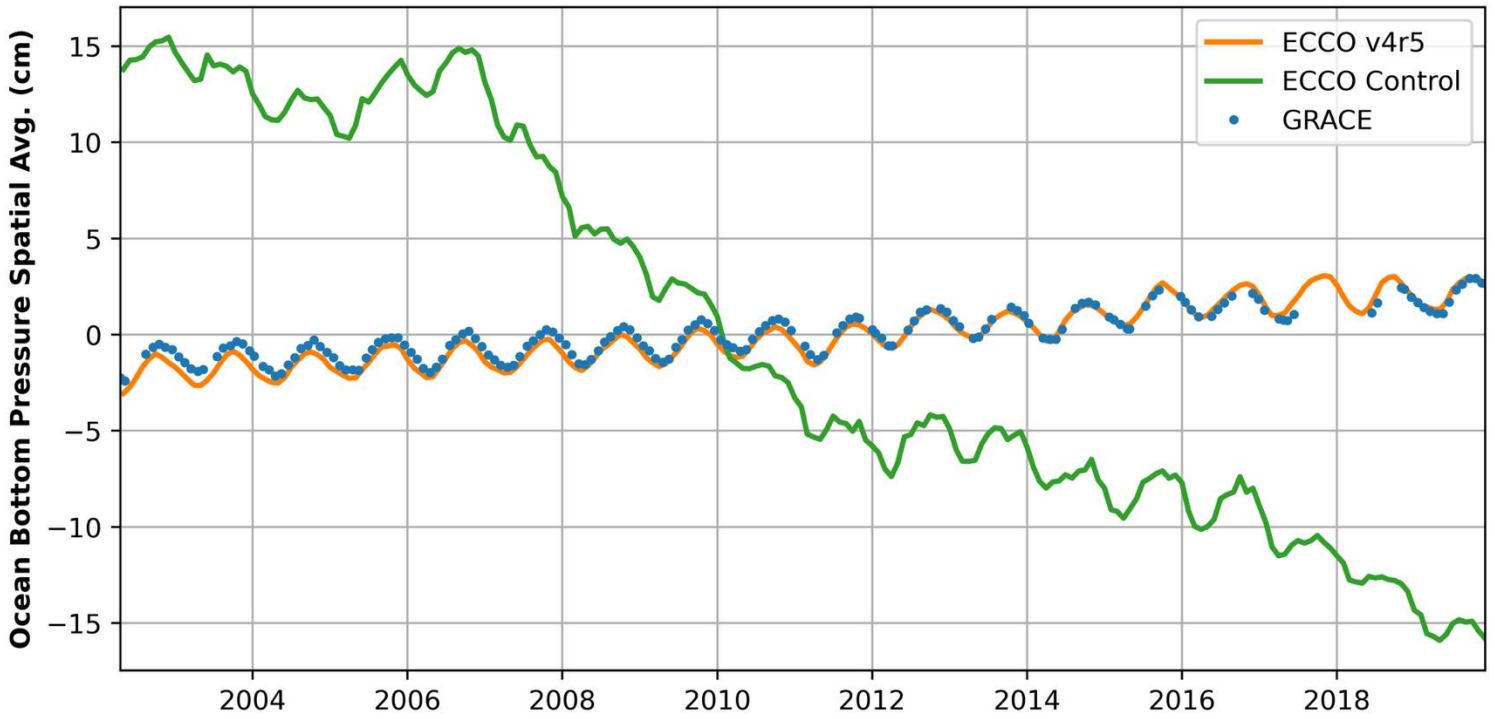
- Mostly smaller misfits to the data after optimization
- Sizeable improvements clear in Southern Ocean, Arctic Ocean, Mediterranean Sea where variability is larger
- Similarly for many marginal seas and coastal regions

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

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