GRACE Level 2 RL07 data processing at JPL

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Introduction

The RL07 series of GRACE gravity field products generated at JPL is a reprocessing of updated V04 Level 1B data for the entire mission duration.

Processing updates at Level 2 include changing the background gravity field to GOCO06s, updated planetary ephemerides, using AOD RL07, estimation and application of stationary observation noise models determined using variance component estimation, and use of GPS receiver antenna maps specific to the activation state of the occultation antennae.

This poster shows preliminary results from a reprocessing of most of the GRACE time span of data. Likely upcoming updates to RL07 processing standards will include tide model updates.

Degree Amplitudes

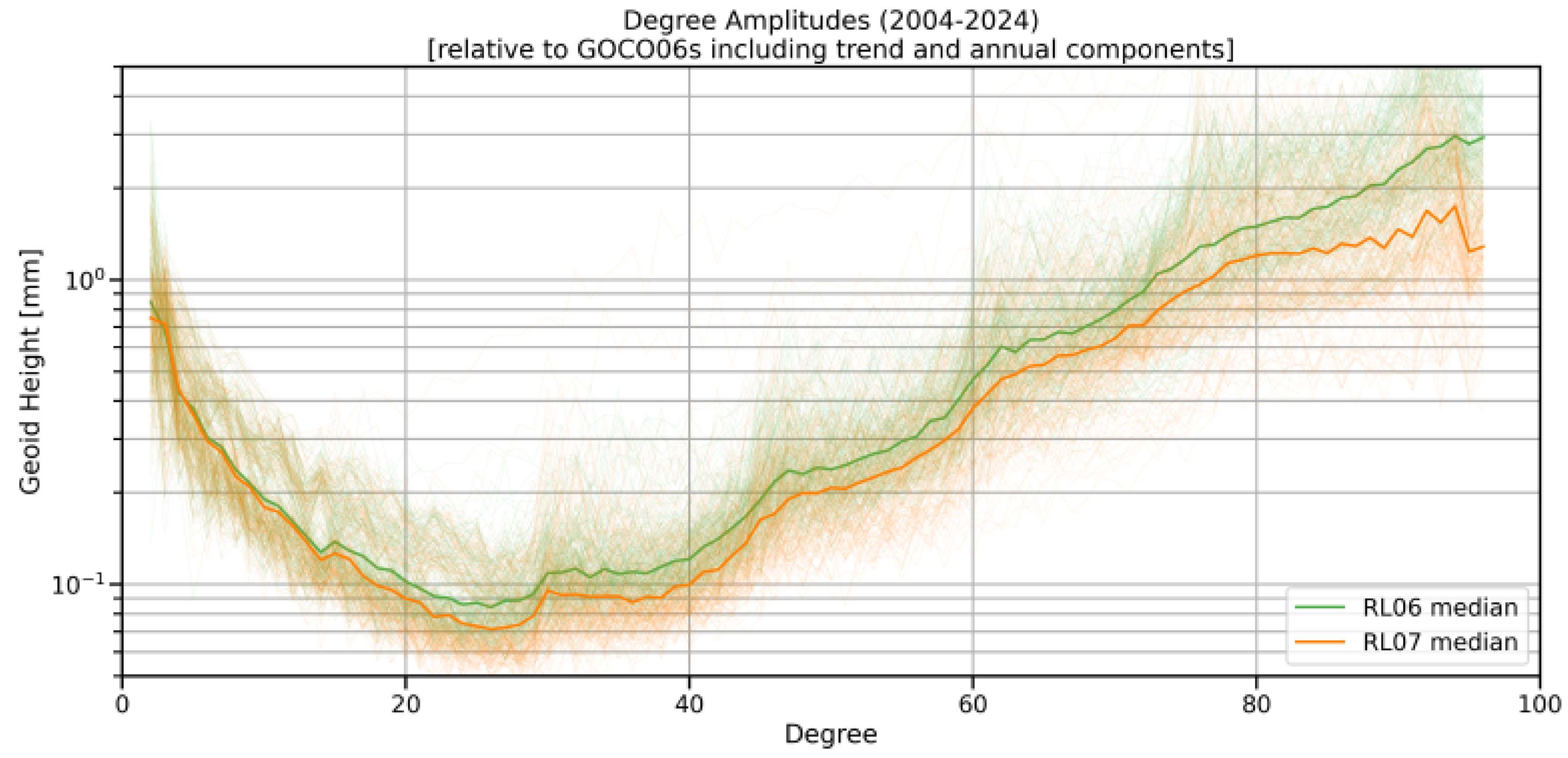
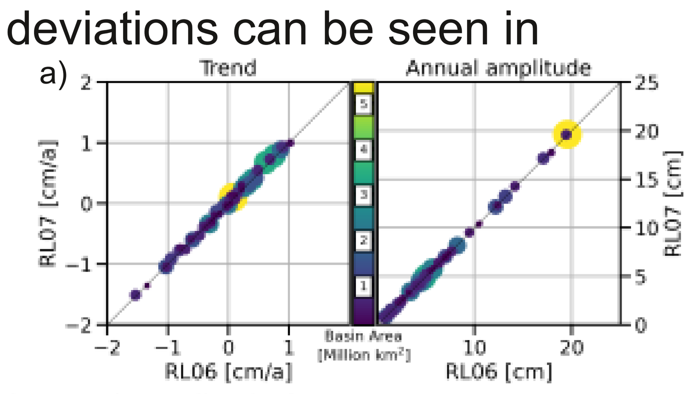


Fig 1: Degree amplitude ensemble of RL06 and RL07 monthly solutions for 2004-01 to 2024-06 (thin lines), and their respective medians (thick lines).

The median solutions show mostly consistent signal amplitudes at longer spatial scales, up to around degree 15. RL07 shows lower amplitudes in intermediate degrees up to around degree 30, where noise starts to dominate the recovered signal.

Basin mass balance

Basin mass balances were computed from D/O 60 solutions (destriping, 300km Gaussian smoothing, fit of bias, trend, annual, semiannual, S_2/K_2 alias). Mass balances are consistent between RL06 and RL07 solutions. The largest deviations can be seen in amplitudes of small basins, where some few months of badly determined solutions due to deep repeat periods skew results.



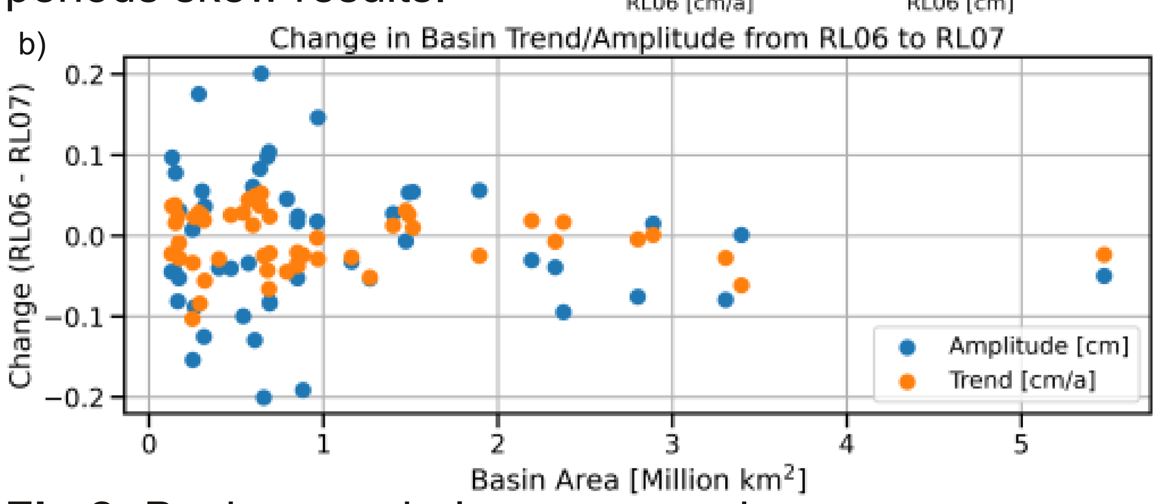


Fig 2: Basin mass balance comparison.

Noise models

JPL RL07 spherical harmonics solutions use colored noise models for low-low and high-low satellite-to-satellite tracking observations, replacing the previously used white noise model. These models are estimated using the same variance component estimation approach popularized for GRACE and GRACE-FO processing with the ITSG-Grace series of gravity field solutions published by TU Graz[1].

The noise of the GRACE and GRACE-FO satellite tracking observables is assumed to be stationary. Under this assumption, it can be described by a Toeplitz covariance matrix, which can be parametrized through a covariance function, or its Fourier equivalent, the **Power Spectral Density**. This covariance matrix is then used in the least squares adjustment for gravity field parameters.

In an iterative procedure, the power spectral density of observation postfit residuals is estimated, and then used in the gravity estimation procedure, converging to a noise model of the input observations.

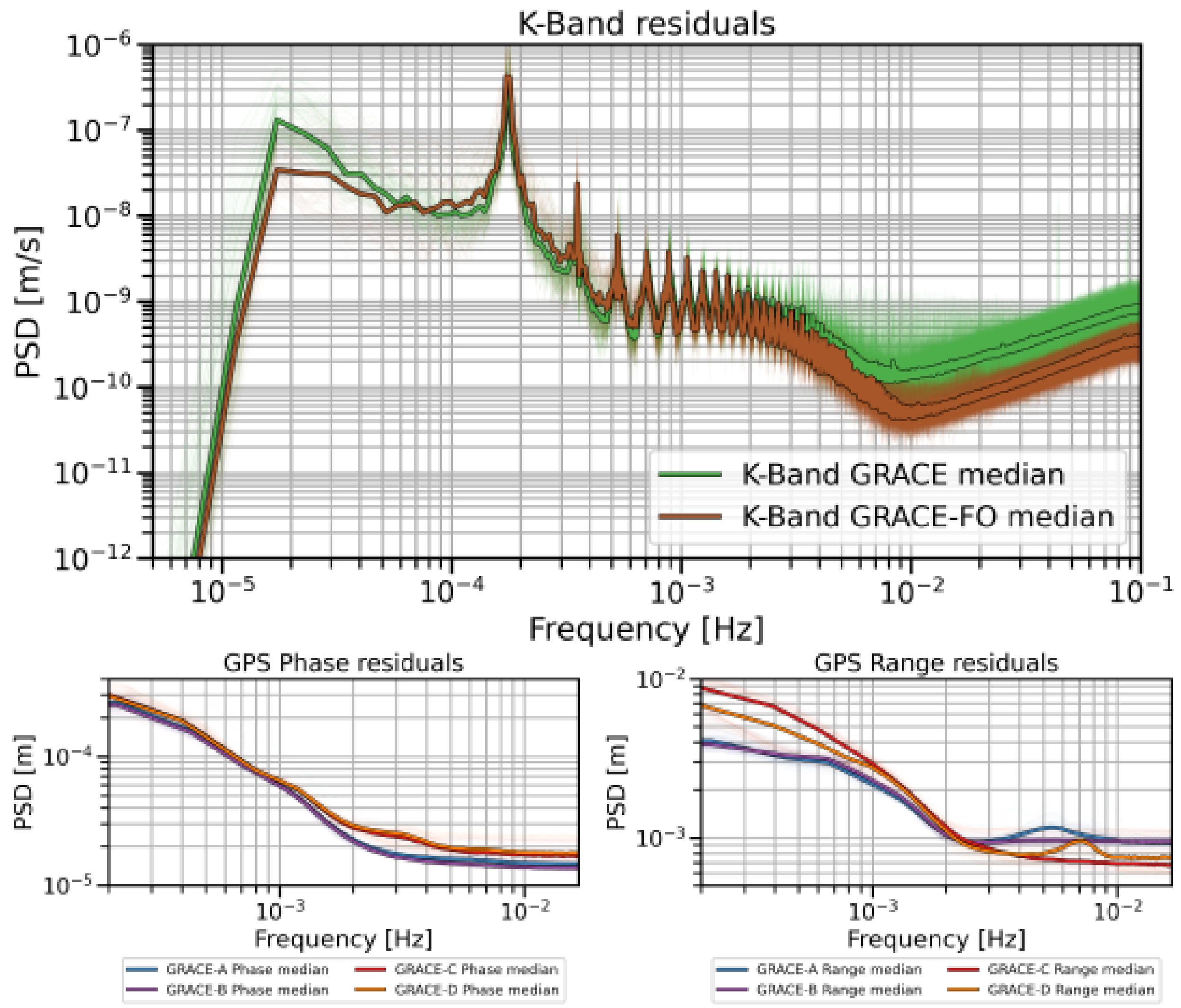


Fig 3: Estimated power spectra of observation residuals.

Spectral characteristics

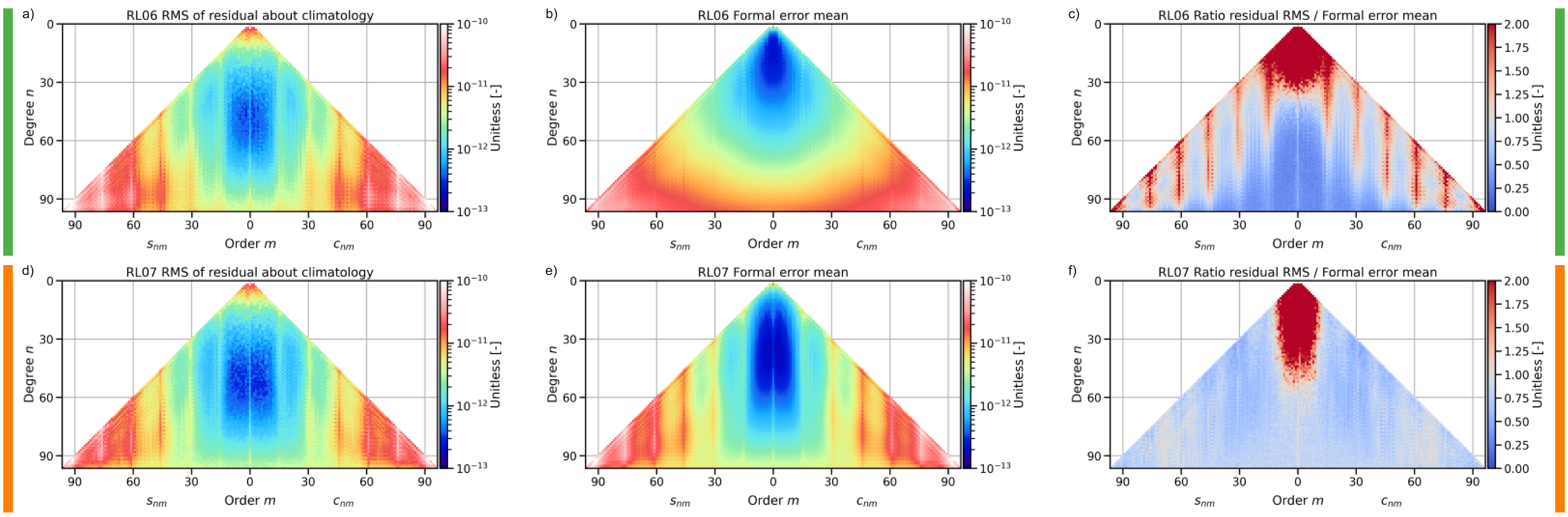


Fig 4: Spherical harmonics triangles of the solutions' average climatology residual magnitude, average formal error, and the ratio between the two. A climatology fit (bias, trend, annual, semi-annual) is reduced from the solution time series, before computing the RMS, a proxy for solution error at high degrees. Formal error is the simple average of all computed months. The formal error of the RL07 solution (e) shows an increase for coefficients close to resonance orders, manifesting as vertical stripes. This corresponds to an increase in signal RMS observed in both the white noise and full covariance solutions (a,d). No such increase is visible for the white noise solution formal errors (b). Therefore, the ratio of signal to formal error for the full covariance solution (f) shows less discrepancy than that of the white noise solution (c).

Impact on $C_{2,0}$

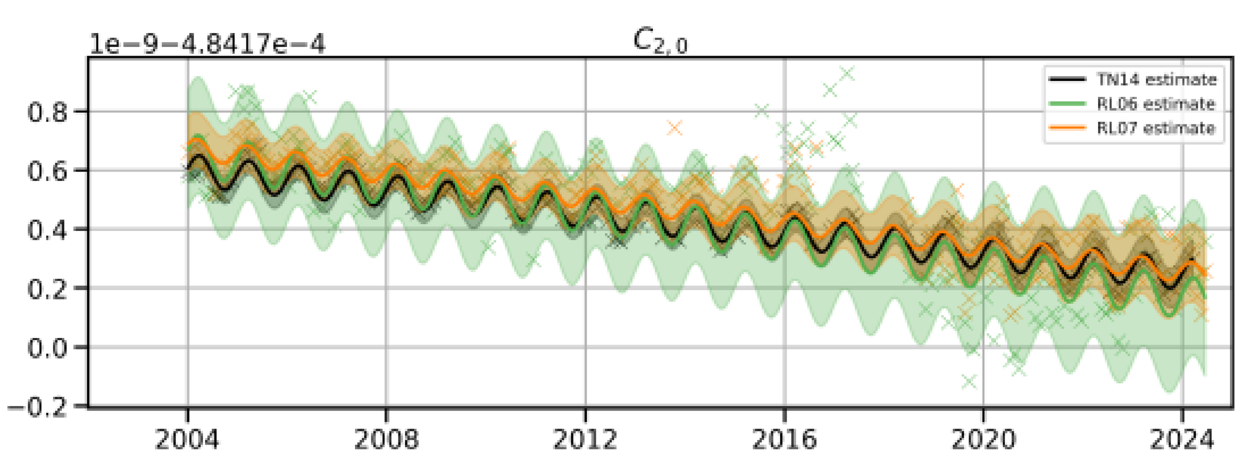


Fig 5: Estimated climatologies for $C_{2,0}$, with 10σ confidence intervals. In this analysis, the estimated trend in $C_{2,0}$ from RL07 fits better with that of TN14 than RL06 does. The higher confidence in the RL07 $C_{2,0}$ estimate is reflected in tighter confidence intervals.

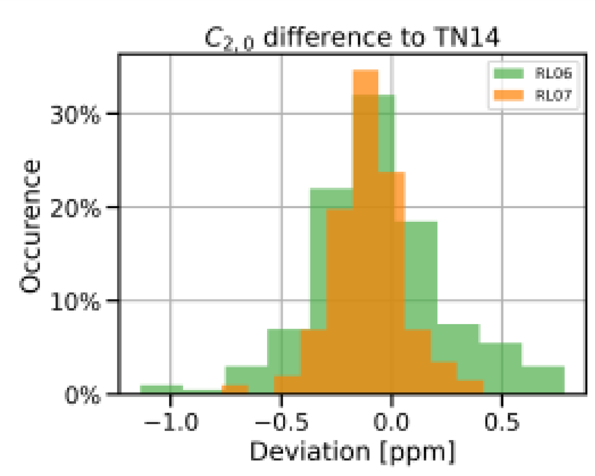


Fig 6: Absolute deviations from TN14 $C_{2,0}$ are smaller for RL07, with fewer outliers at the tails of the distribution.

Residual ocean anomaly RMS comparison

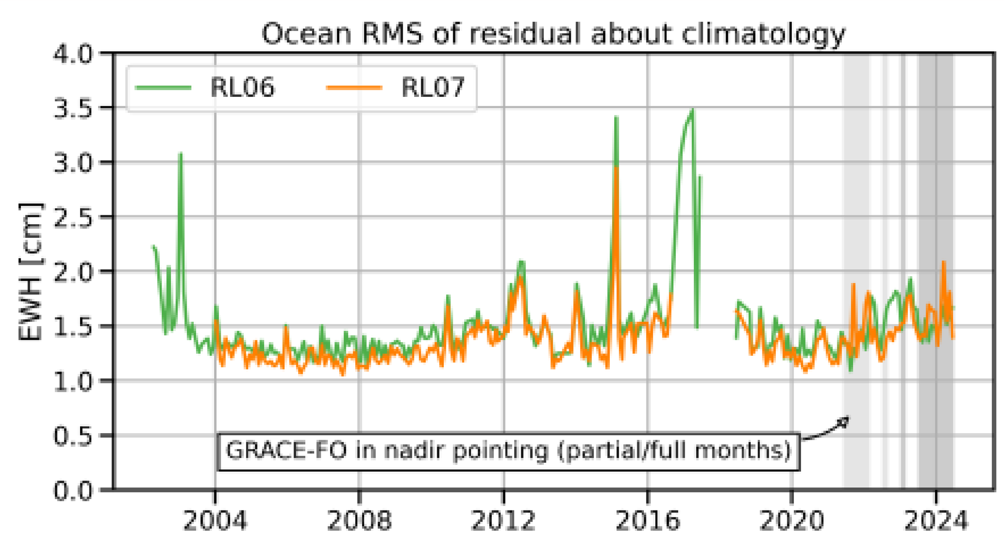


Fig 7: Ocean RMS anomaly for JPL solutions.

Ocean anomaly RMS is computed from D/O 60 fields by reducing a climatology fit (bias, trend, annual and semiannual) from each time series, then destriping, and smoothing (300km) the resulting series. Global oceans are selected with a land mask buffer of 350 km.

Ocean RMS is lower for RL07 solutions than for RL06, by an average of about 6%.

References

[1] Kvas, A., Behzadpour, S., Ellmer, M., Klinger, B., Strasser, S., Zehentner, N., Mayer-Gürr, T., 2019. ITSG-Grace2018: Overview and Evaluation of a New GRACE-Only Gravity Field Time Series. Journal of Geophysical Research: Solid Earth. https://doi.org/10.1029/2019JB017415

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