

Interactive comment on “Evaluation of Release-05 GRACE time-variable gravity coefficients over the Ocean” by D. P. Chambers and J. A. Bonin

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Dear Katy, Thank you for your comments. We will review them briefly below and then give our response. Thanks, Don & Jenni

1. Page 2188, Line 7: "...are more consistent than the previous RL04 data." Please clarify that the three processing centers are more consistent with each other rather than with respect to the ocean models (unless you meant that).

Reply: We did mean that the data from the three centers were more consistent in RL05 than with RL04. We have revised that sentence to read: "...are more consistent among themselves than the previous RL04 data were."

2. In the 2nd to last paragraph of the introduction where RL05 is first discussed it would

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be helpful to have a couple of sentences and/or references on the major differences between RL04 and RL05.

We have added a few sentences on what we know has been changed, but there is no citable reference for this at the moment, other than presentations at Science Team meetings. "Major changes between RL04 and RL05 include improved knowledge of alignments between the star camera, accelerometer, and K-band ranging system for Level-1B data, and updated mean gravity field, ocean tide, pole tide, and de-aliasing models for Level-2 processing."

3. Paragraph starting Page 2192, Line 27: which version/iteration of JPL_ECCO are you using?

We have added the following comment to describe precisely which version of JPL_ECCO we use:

"We use monthly values of ocean bottom pressure derived from version kf080 that is available at <http://grace.jpl.nasa.gov>. This version of JPL_ECCO is a baroclinic model forced by winds, pressure, and heat and freshwater fluxes from the National Center for Environmental Prediction (NCEP) operational analyses products and also assimilates satellite altimetry (Fukumori, 2002; Kim et al., 2007)."

4. Page 2194, Line 19: Please clarify how this variance reduction is calculated. Is it relative to JPL_ECCO? The figure caption for Fig 4 is also confusing.

We have used a standard definition of variance reduction, but have included the exact equation to avoid confusion in the revision:

"To better quantify improvement we compute the variance reduction (Δvar) as

$$\Delta\text{var} = 100 * (\text{var}(\Delta\text{RL04-ECCO}) - \text{var}(\Delta\text{RL05-ECCO})) / \text{var}(\Delta\text{RL04-ECCO}) \quad (1)$$

where $\text{var}(\Delta\text{RL04-ECCO})$ is the variance of the residuals between RL04 maps and JPL_ECCO maps in each grid, $\text{var}(\Delta\text{RL05-ECCO})$ is the variance of the residuals be-

tween RL04 maps and JPL_ECCO maps in each grid, and the formulation computes the change relative to the variance in the old RL04 residuals as a percentage. If the variance in the RL05 residuals has become lower, then Δvar is positive, indicating an improvement, while if it is negative, RL05 maps are more different from JPL_ECCO than RL04. Values are plotted in Figure 4. The overall improvement, in terms of variance reduction relative to RL04 residuals, is between 50% and 80% over the majority of the ocean. The correlation between OBP from RL05 and that of JPL_ECCO is also significantly higher, with most values above 0.7 and many above 0.8 (Figure 5)."

(note: the revised text in Word shows the equation better than this).

We believe with this expanded discussion, the caption to Figure 4 should no longer be confusing, but we modified it slightly:

Figure 4. Percent of variance reduced in Release-05 residuals compared to Release-04 residuals for coefficients processed by CSR (top), GFZ (middle), and JPL (bottom). Positive values mean the Release-05 residual variance is reduced, negative values mean that variance is increased relative to Release-04. All GRACE data were de-stripped and smoothed with a 300 km Gaussian. Please see text and Equation (1) for details of the calculation.

5. Page 2195, Line 6 and Figure 6: Why aren't the time series for RL04 shown? It would be useful to visually compare with RL05.

We felt that the time-series plots would be too cluttered if we added 3 curves, however, it is a simple thing to add, and we have done it in the revised version.

6. Figure 1 caption: clarify which data center and release used.

Figure 1 shows the differences between smoothed and unsmoothed output from JPL_ECCO. We thought the caption made this clear, but we can see where there may have been a misunderstanding. We have modified the caption to read:

"Figure 1. Standard deviation of differences between unsmoothed OBP from C840

JPL_ECCO and a) JPL_ECCO OBP truncated to spherical harmonic degree/order 40 and smoothed with a 300 km Gaussian, b) JPL_ECCO OBP truncated to degree/order 40 and smoothed with a 500 km Gaussian, and c) JPL_ECCO OBP truncated to degree/order 40 and smoothed with a 750 km Gaussian."

7. Figures 3,4,5,12 captions: clarify smoothing level used (300km Gaussian?)

We stated this in the text, but neglected to do so in the Captions. We have changed this. Figures 3,4,5 used 300 km smoothing. Figure 12 used 500 km smoothing, which we had previously determined to be optimal.

8. Figures 3,4,5,7,8,9,10,12: Why is the extended land mask being used? It be more useful to see the entire ocean (e.g. Figures 1 and 2) to understand the effects of land leakage.

We meant to comment on this at the start of Section 5, but we forgot to. This has been corrected in the revised version. The reason is because we are comparing to unsmoothed JPL_ECCO data. In addition to the leakage effects in GRACE, there will be large differences in the coastal regions related to short-wavelength OBP variations related to baroclinic interactions with the shelves. In order to emphasize the improvement over the deep ocean (where GRACE will be more accurate), we chose to mask this out. We have added the following sentences at the beginning of Section 3 to describe this:

"Note that for the rest of the analysis, we mask out areas within 500 km of coastlines. This is to focus attention on the deep ocean where OBP variations are longer-wavelength and more resolvable by GRACE, and to quantify accurate statistics for the deeper ocean areas that are unbiased by higher errors near the coast. Coastal regions have very large, short-wavelength signals related to baroclinic interactions with the shelves, which are present to some extent in the JPL_ECCO data (Figure 1), but will never be resolvable in GRACE. Additionally, even with the leakage correction described in Section 2, GRACE data still have higher uncertainty in near-coastal waters."

