

Interactive comment on “Sea-level fingerprints emergent from GRACE mission data” by Surendra Adhikari et al.

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The manuscript “Sea-level fingerprints emergent from GRACE mission data” by the authors Adhikari, Ivins, Frederikse, Landerer and Caron presents a new data sets on relative sea-level change resulting from contemporary continental ice and water mass changes as observed by GRACE satellite at monthly time scale. Beside the relative sea-level change, the manuscript provides geoid height change and solid Earth deformation. The methodology description including solving the sea-level equation, spherical harmonic analysis and synthesis is quite well-explained and is one of the strongest part of the article that could favor the Earth science community. The authors are extremely knowledgeable on the sea-level science, solid Earth and satellite gravimetry. These data sets will contribute significantly to advancing the interpreting sea-level

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records from tide gauges and altimetry, coastal vertical land motion from geodetic techniques and future techniques for measuring sea-floor deformation. I therefore enthusiastically support the publication of the manuscript in Earth System Science Data. I have a series of minor comments and suggestions that could improve the quality of the manuscript:

- The numerical methodology for solving the sea-level equation is well-documented in the appendices. However, due to iterative solutions and implementing spherical harmonic synthesis and analysis at different steps, it would enable the reader to better follow the sea-level solvers throughout visualization in a flow chart (for example, as an additional appendix). This will be also useful to readers who are interested to calculate their own sea-level fingerprints based on different Earth models (load Love numbers) and a range of available GRACE solutions (e.g. ITSG, GRGS, ITG and etc).
- The geoid height change and solid Earth deformation depend on the choice of reference frame origin. This is not well-explained in the manuscript. For example, degree one Love number in the Green's functions depends on the frame. I would suggest to add a paragraph explaining the frame choices and produce these results in the center of mass (CM) frame as well as the center of figure (CF) frame. This, for instance, will improve consistency when applying the model of solid Earth deformation to the observed deformation from GPS.
- The fingerprints in relative sea-level change (Figure 3) are dominated by the near field effects of ice sheet melting. However, it's hard to see the pattern in the far field, in particular within the mid-latitude regions (e.g., between -40 S and 40 N) where most tide gauges, GPS and low-lying regions including deltas are located. I would suggest to change the limit of color scale to -2 to 2 or something so that smaller scale fingerprints within the ocean basins are better shown. or simply split this map into two maps with different color scale bars.
- The authors present a nice example of how sea-level fingerprints could be used for

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interpreting tide gauge records (Figure 3, lower panel). However, this important practical example is covered up in the Figure's caption while this could be elaborated and highlighted inside the text.

- Figure 2: A more comprehensive (and convincing) way to show the effect of scaling in both low and high frequencies is to show the degree variance spectrum for unscaled and scaled select fields. This will bring a broader insight over the entire spectrum, from degree 0 to degree 60 or 90.

More detailed suggestions and some small typos:

P 1, Ln 21: land ice » land ice and water.

P 2, Ln 10: GRACE » GRACE (Gravity Recovery and Climate Experiment).

P 3, LN 12: sea-level » sea level.

P 3, Ln 15: sea surface height » sea-surface height and elsewhere.

P 3, Ln 26: field variables » global field variables.

P 3, Ln 32: continental water storage » on-land ice and water storage.

P 4. Lns 3, 12 and 14: sea-level » sea level.

P 4, Ln 17 and P 13, Ln 1: For a self-gravitating elastically-compressible rotating Earth: Which Earth model is used for calculations?.

P 5, Ln 2: Remove extra “the”.

P 5, LN 22: what is the typical value for number of iterations and the desired convergence criteria?.

P 7, Ln 16: relative sea-level » relative sea-level change.

P 10, Figure 3 middle panel, right: Uncertainties in sea-level change » Uncertainties in relative sea-level change.

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P 11, Conclusions: It's worth mentioning here, the authors plan to provide the sea-level fingerprints (of course if this is at the top to-do list) as soon as GRACE-FO products become available to the scientific community.

P 14, Eqs. (B2-B3): These are not practical formulas for calculating associated Legendre functions! Please replace with recursive normalized formulas.

P 17: Please briefly explain here how the spectral coefficients L_{pq} are calculated. Maybe this can be incorporated into the suggested flow chart.

P12, Eq. A1: the variables inside the integral should have accent (') as they refer to the integration point.

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