Earth Syst. Sci. Data Discuss.,
https://doi.org/10.5194/essd-2019-25-RC3, 2019

Open Access Earth System Science Data Discussions

Interactive comment on "GRACE-REC: a reconstruction of climate-driven water storage changes over the last century" *by* Vincent Humphrey and Lukas Gudmundsson

Anonymous Referee #3

Received and published: 27 March 2019

General Comments:

The paper "GRACE-GEC: a reconstruction of climate-driven water storage changes of the last century" presents a set of statistical models of TWS trained to two GRACE mascon solutions using multiple precipitation and temperature forcing inputs. The discussion in the paper well framed, providing a detailed methodology and explanation of relevant key decisions in developing that methodology. The paper then provides a product description and evaluation that conveys the information content of the developed models and provides an analysis of that content in a straightforward and logical way. The paper itself is well written, and I did not find any typographical errors or major

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grammatical issues anywhere. The level of detail is such that anyone generally familiar with the subject matter can nicely comprehend the discussed work and outcomes. As a whole, I believe that this paper is very close to a final form, and primarily have clarification questions and small probing questions that I would like to possibly see further discussed.

Data access was straightforward and is well documented. My only suggestion would be to have a more meaningful naming schema for the zip files. For example, a name that tells me "trained with JPL, forced by MSWEP, spanning 1979-2016", as in the names of the NetCDFs themselves, rather than requiring that I refer to the README for that information. As for ease of use, I was able to create a Jupyter Notebook with Python 3.7 in under two minutes that already had me using the data. The choice of NetCDF is very much appreciated.

As a general comment, with the release of JPL's RL06 Mascons, do you plan to update the JPL-trained models? Or perhaps more generally, is there a plan in place to continually produce new models when new GRACE solutions are available for training? Similarly, when GRACE-FO is operational, what plan is in place to extend the training datasets with new months? Will this be continually re-done, or is there even a benefit to doing a new run with each new month? A general comment in the paper discussing the sensitivity of the models to additional months of GRACE forcing would be appreciated.

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Specific Comments:

- p. 5 line 5 / Table 1 - Did you consider using formulations of the two mascon solutions that have equivalent GIA models removed? For example, on looking at the GSFC mascon website, those mascons are distributed with either the A et al. model or ICE-6G model removed. You could compute consistent reconstructions for both mascon sets but using consistent GIA models. Also, does any of this matter since you are using a detrended dataset for the training of your reconstructions? This should probably be

clarified.

- p. 5 line 5 / Table 1 - For JPL, why have you selected the CRI filtered solution and what considerations must be made as a result of that choice? Are you using that solution at it's gridded resolution (0.5 degree x 0.5 degree) or on a mascon-by-mascon basis (4551 mascons). If at the gridded level, are you forcing reconstruction outputs to be equal over all grid cells in each mascons or allowing for spatial variation within individual mascons? Same question for the temperature and precip inputs over these mascons? Also, are there any other differences between the mascons that are important to consider (or alternatively, is this even in the scope of your paper)?

- Section 2.1 - Relating to the last two questions, do you handle each solution at their own native resolutions or are they placed onto a common grid? It appears that the model outputs from the GSFC-driven runs were placed onto a half-degree grid. How were they handled in the training portion of the products developments?

- p. 8 line 9 - Why is the seasonal cycle removed prior to the calibration step? What are the repercussions of this decision on the reconstruction? This is somewhat addressed in Section 3 but at the time is a major open question to the reader.

- p. 8 line 20 - In your discussion of error sources, how do spatially correlated errors in the GRACE solutions impact the work? You have "mascon binned" your reconstruction, so to speak, but the GRACE mascons themselves are not independent mass estimates (especially in the case of the 1-arc-degree GSFC mascons). This bias error source is in addition to the measurement errors from GRACE and is difficult to address. Have you included anything to account for this?

- p. 16 line 18-22 - This seems redundant with section 3.5.

- p. 16 line 23-p. 17 line 2 - It is unclear if/why this is unexpected. If training was done at the mascons scale, it would seem that larger scales aggregating multiple mascons would show well calibrated agreement se a necessary but not sufficient condition on

the dataset.

- Section 4.2 - In addition to the lower spatial resolution, the Kalman smoothed daily GRACE solution is correlated in time; is your comparison to the GRACE-REC products at all different than for the monthly solutions as a result of this?

- Figure 7 - The dark/light distinction could be a little more obvious, rather than having to read deeply into the caption, and also have a stronger contrast.

- p. 19 line 8 - GSFC mascons are smaller, yes, but does the GSFC solution actually have better resolution than the JPL mascons? This is related to the comments about how the JPL mascons are handled and how spatial correlations in the solutions are handled (ex: higher cross-mascon correlations in the GSFC solution than with JPL due to the smaller mascon sizes).

- In the abstract, possible user groups and applications were identified. Would an example of the application of this work in one of those areas be within the scope of this paper? Also, if the reconstruction is based on de-seasoned and de-trended GRACE information, is bridging the GRACE/GRACE-FO gap actually an application? What limitations are placed on such a use?

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