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Discussions

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Interactive comment on "21st century estimates of mass loss rates from glaciers in the Gulf of Alaska and Canadian Archipelago using a GRACE constrained glacier model" *by* Lavanya Ashokkumar et al.

Anonymous Referee #4

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Dear authors, For time reasons, I have only looked at the GRACE processing part of the manuscript "21st century estimates of mass loss rates from glaciers in the Gulf of Alaska and Canadian Archipelago using a GRACE constrained glacier model" by Lavanya Ashokkumar and Christopher Harig. The authors use localized base functions to determine glacier mass balances from GRACE. This approach has been shown to facilitate a slightly higher spatial resolution compared to estimates based on global spherical harmonics alone. It is quite well established and was previously applied to determine mass changes in Greenland. Below are some comments that I would like to

see resolved in the revision of the paper.

A major concern are the treatment of signal overlaps between regions, particularly important for estimates of North Arctic Canada: could there be an influence of mass changes in Greenland on the glacier estimates? Looking at Fig. 1, considerable amount signal overlaps exist.

Another concern that would need more explanation is the calibration of the degree-day scheme of the glacier models with the GRACE data. As I understand, misfit is calculated as difference of monthly model estimates and GRACE observations. How sensitive are the optimal calibration parameters to the time scale considered for calibration? Would calibration and projection yield different results if, e.g. mainly trends or multi-year temporal components were considered?

Detailed comments

L64: Sun et al. 2016 showed that including the sea-level equation in the estimation of the geocenter motion affects recovered mass trends and annual amplitudes over the ice sheets. You are dealing with much smaller spatial scales (less impacted by low-degree harmonics). But have you checked the effect? Using Sun et al. 2016 is the recommendation of the SDS centers.

L66: Similarly to c20 (and c30) – have you checked the sensitivity to the coefficients replaced? SDS recommend Loomis et al. 2019, https://doi.org/10.1029/2019GL082929

L73: Please clarify at what stage the hydrological signals are removed – subtracted from the final mass time series or as a correction on the gravity field coefficients? Depending on the omission error and the response of your inversion approach, this could make a significant difference.

L73: Which temporal components are removed? Full signal? Only trends? Please comment on the reliability of trends and the spread of different hydrological models.

L76: "and typical inversion strategy" seems out of place. Is it the "gravity field determi-

nation approach employed"?

L83: Please provide another sentence how exactly the approach of Wahr et al. 2006 is adopted. I assume you are deriving RMS residuals from the GRACE coefficient time series? Or are you calibrating formal errors provided with the GRACE L2 data?

L114: Cut-off degree L=60 seems to be an arbitrary choice, eventually defining your Shannon number, hence spatial resolution. Why not use L=90 provided by the SDS center and truncate according to significance?

L117: What are "clear estimates of noise uncertainty"? Please specify. In addition, coefficient uncertainties are only part of the total uncertainties relevant for the mass time series. How do you deal with uncertainties related to the choice of your inversion approach (e.g. internal and external leakage), or parameters used in it? An easy way to do this is to compare to e.g. CSR mascons.

Fig. 1 and text: How do you deal with signal correlations / leakage into the region of interest?

Fig. 2, Panels a – should the label be "Total mass loss (Gt)", not "Total mass loss rate". b – "C" needs a degree symbol (you could take it for example from the legend of Figure 3 in "°K" (ïĄŁ). c – should this be Precipitation rate (mm/year) or similar?

Fig. 2, Panel 2a, there is a strange black line at the beginning of the time series. Please check.

Fig. 2 and Fig. 4 are never referenced in the text, I think. In addition, there is inconsistency with regard to using capitals and abbreviation for the text figure. . .

References

Sun, Y., Riva, R. & Ditmar, P. Optimizing estimates of annual variations and trends in geocenter motion and J 2 from a combination of GRACE data and geophysical models. J. Geophys. Res. Solid Earth 121, 8352–8370 (2016).

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