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Interactive comment on “Greenland Ice Sheet seasonal and spatial mass variability from model simulations and GRACE (2003–2012)” by P. M. Alexander et al.

Anonymous Referee #1

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The manuscript is a valuable contribution on our current degree of understanding mass changes of the Greenland Ice Sheet on regional spatial scales and seasonal temporal scales. Mass variations derived from GRACE Level-1 data by the mascon method of Luthcke et al. are compared to modelled changes due to SMB and ice flow based on the MAR Regional Climate Model and the ISSM Ice sheet model. One of the merits of this work is the comprehensive explanation and illustration of the complex filtering associated to the GRACE mascon results and of the way how the GRACE-versus-modeling comparisons account for this filtering.

The manuscript is very well structured and well readable despite the technical nature

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of part of the discussion. The figures are excellent.

I just have a few points.

An important point concerns the calculation of the seasonal cycles shown in many figures and introduced on p. 6360, line 4ff. It is unclear why (and how) a two-year composite seasonal cycle was constructed. Why not a one-year composite cycle? How does the two-year cycle relate to the one-year plots? Seasonal cycles shown in plots like Fig. 8b, Fig. 11d,e etc. sometimes show very different values at the left end and the right end of the plot, although both values are to represent Dec. 31 and Jan 1, respectively. Since the paper is on the seasonal cycles, it is important that the way of deriving these cycles be explained in more detail.

The authors do an excellent job in describing the complex filtering inherent to the GRACE mascon solutions. The figures illustrate that the GRACE processing may, to some degree, distort (not just smooth) the spatial pattern of signals. Most remarkably, Fig. 1 illustrates that the partitioning of GRACE mascons into mascons below and above 200m elevation does not precisely match the limits between distinct regimes of modelled SMB and dynamically induced mass balance. The authors could somewhat more account for these limitations when discussing the GRACE-versus-modeling results later-on in the manuscript. For example, on p. 6367, they write: "the timing of GRACE-LM peaks tends to be clustered in groups, suggesting that the spatial variations in GRACE-LM timing are not random". It could be discussed whether the observed clustering could be a consequence of the GRACE-LM filtering effect, even if its actual origin is "random". Likewise, when discussing the GRACE-versus-modeling differences in the zone above 2000m (Fig. 12b) it could be pointed out that these differences could well originate from modeling errors for regions below 2000m (given much higher signal amplitudes there), which may leak into the high-elevation results.

P. 6369, line 4f: It is not clear to what result or figure the "early start to the period of net mass loss in the northeast from November through February" refers. Similarly, on p.

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6372, line 12, it is not clear to what result the mention of "northeast Greenland" refers.

Minor points:

I was initially confused about the use of MAR v2.0 versus MAR v3.5.2. Maybe it could be mentioned at an early place that the comparison with GRACE is ultimately done for v3.5.2, while MAR v2.0 is used to assess different filters because the numerically most expensive filter was previously applied to v2.0 but not to v3.5.2.

P. 6357, line 11 "A different σ_i value is chosen for each mascon": Maybe add "as explained below", to keep the reader patient about an explanation.

There is an unnecessary repetition about how λ_{ij} are defined, before and after Equation 8. Instead, you could add "as explained below" again, to keep the reader patient about the mystery of these coefficients.

P. 6358, line 21: Symbol σ_l was not introduced before. Please homogenize annotation.

Line 6360 last line. For better clarity, write "GRACE-LM `_filtering_` vs. Gaussian filtering"

P. 6364, line 17ff. It is not clear why the discussion concentrates on the region where ISSM underestimates ice thickness and it cannot be seen from any figure that ISSM underestimates ice velocities at these places.

P. 6364, l. 23. Avoiding the SSA acronym (used at only one occasion) would make the text more readable.

P. 6370, line 3-4: Please clarify. It is not clear to me, what "it" and "The Greenland-wide cycle" refer to.

Fig. 4 Caption "a temporal filter has not been applied": The legend within the figure, instead, says "Gaussian(Spatial, `_Time_`) Filtered" for one of the curves.

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Interactive comment on The Cryosphere Discuss., 9, 6345, 2015.

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