

Interactive comment on “Using Satellite Laser Ranging to measure ice mass change in Greenland and Antarctica” by Jennifer A. Bonin et al.

Anonymous Referee #1

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General Remarks:

With interest I've read the manuscript by Bonin et al. The manuscript describes 2 inversion methods of Satellite Laser Ranging (SLR) data, in order to solve for mass changes in Antarctica and Greenland. The inversion method's ability to recover the complete signal is tested with a simulation (with 'perfect' data based on models). Results with real data are compared to GRACE over the GRACE time period. For comparison two SLR solutions are compared, each with a different spherical harmonic truncation degree (5 versus 10).

I found the paper easy to read, and appreciate the transparent assessment of the

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capabilities of SLR. Together with the supplement, I can imagine that the paper is informative for readers of the Cryosphere, especially those who have an affinity with geodesy. It has to be said that a related piece of work has recently appeared (Talpe et al. 2017), but from my point of view the differences w.r.t. this paper are large enough to justify the publication of this work. Nevertheless, there are a few remarks, which I think need to be addressed before accepting the manuscript.

* Replacement of C20 by SLR derived estimates This issue has already been mentioned by Matt King in his short comment. So this is to reconfirm that this issue also stroke me as somewhat tricky. By replacing C20 by an SLR-estimate a dependency is introduced which may be favorable for the CSR-SLR solution in the comparison. To clear this up, maybe the authors could show how much C20 contributes to the estimated time series.

* Use of diagonal SLR and GRACE error-covariances, and thus neglecting off-diagonal error-covariance. I think this is the most serious issue I can find in the paper. Since I don't know whether this is going to have a large impact on the results I'm recommending a major revision to allow the authors to clarify this. I suspect that in particular SLR may have significant off-diagonal components in its error-covariances. The SLR network is very sparse and may not be optimal for the retrieval for ice mass change signals at higher latitudes. To account for this, one would in principle need to propagate the full SLR error-covariance on the 1x1 degree grid used as observations. The associated error-covariance matrix of the gridpoints will consequently be quite unstable (e.g. from 36 SLR 'observations' one produces 360x180 observations, without adding more information), which potentially could break down the inversion scheme as it is implemented now. In the current setup, the authors ignored error-covariances and by choosing an equidistant 1x1 grid also artificially increased the density of observations at higher latitudes inversely proportional to cosine(lat). In a broad sense, ignoring off-diagonal contributions and artificial increase of observations can be interpreted as a regularization, which the authors should justify. I therefore, propose that the authors ei-

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ther justify their choices for the 1x1 grid in combination with a diagonal error-covariance or better: that the authors replace matrix H (see eq S1) by an operator which directly maps Stokes coefficients to the unknown vector a. When full error-covariances are available these can then also be implemented with hopefully relatively little effort.

* Neglecting degree 1 contributions I understand the decision of the authors to not account for the degree 1 signal, based on remaining errors in the SLR data. However, the potential influence of degree 1 neglect may be too large to ignore. As an alternative, maybe the authors can treat the degree 1 signal as noise and assess its influence on the results by producing an ensemble of realistic variations and propagating this through the inversion?

Minor details *The supplement has a *.zip ending but actually is in *tgz format

* abstract: maybe add some numbers in the abstract to quantify things a bit more

* Does the average TC reader know what is meant by 5x5, 10x10?

* eq 1 shouldn't the '1-' be outside of the fraction?

* "and thus heavily dependent on the same very low degree spherical harmonics" Maybe quantify this with formal error correlations?

* "indicative of a systematic interannual-scale error in the SLR inversion" What is meant by this? Maybe add a reference, which illustrates the problem at hand?

* "451 +1 Gt/yr" I assume this is for Antarctica and Greenland? Maybe explicitly mention this again

References: Talpe, M.J., Nerem, R.S., Forootan, E., Schmidt, M., Lemoine, F.G., Enderlin, E.M., Landerer, F.W., 2017. Ice mass change in Greenland and Antarctica between 1993 and 2013 from satellite gravity measurements. *J Geod* 1–16. doi:10.1007/s00190-017-1025-y

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