Interactive comment on "Basal traction mainly dictated by hard-bed physics over grounded regions of Greenland" *by* Nathan Maier et al.

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Dear Maier and coauthors,

I am happy to have been asked to review this paper. Its topic and methods are at the cutting edge and the results will be interesting to readers of the Cryosphere. I'd like to highlight several ways that the paper could be improved.

Sincerely,

Brad Lipovsky

1. Length scale for grid cells. I like the approach in Section 2.4 but I think it could be made better:

- My main concern is that Figure 2 compares different regions with different force balance approximations. Wouldn't it be better to compare the *same* regions with different force balance approximations? In other words, to carry out a grid-refinement study, and then examine the convergence behavior of different force balance approximations? -I would expect the relevant length scale for SIA-SSA differences to be quite high in the interior (far greater than 6km) but much smaller near the margins (perhaps even less then 6km). - Figure 2 could be on a log scale so we can see if there is a change in the power law. - The 6km cutoff seems arbitrary. I don't see anything special about 6km in Figure 2. Again, if you plot this on log-log axes I have a feeling it will make a straight line (i.e., a power law) with nothing special about the 6km cutoff.

2. How well resolved is the sliding law at high velocity? Of course there are many fewer data points in this regime because most of the ice sheet is slow-flowing. One idea is that, in Figure 5, plotting PDFs rather than CDFs would more accurately convey to the reader that there are very few data points at high velocity. This is an important point to convey.

Concerning Catchment 2, the increase in basal traction at high velocities is very strange. I'm worried that this increase is based on only a very small number of data points (CDF is almost flat at high velocities). Question: Is there some way that you could re-draw Figures 5 to *combine* the CDF and velocity/traction curve? Example: what if the opacity of the curve was set by the number of observations? Drawing the curves in this way would highlight the areas that are more well captured by the data. This is just a guess about how to convey this point. . . no worries if it doesn't work out.

3. Many catchments show rate strengthening at high velocities, a non-intuitive result for me. Based on Figure 3, I would have thought that these velocities were high enough to reach rate-weakening behavior. From Gagliardini's paper, Equation 24, we may therefore place bounds on subglacial parameters. It would be interesting to see if you could constrain A or C from your observations.