Response to reviewer #2

This paper goes to a lot of trouble to explain how the different data sources with their various strengths and weaknesses are used to estimate surface mass balance (SMB) over Larsen C Ice Shelf (LCIS). There are other scientists who can assess this part of the work much better than I can. From a practical point of view however, the qualitative conclusion that SMB increases from north to south overprinted with a gradient of increasing SMB to the west is a major disappointment and fails the stated aim on line 20 to provide a coherent picture of SMB for LCIS. Surely the goal should be a grid of SMB values in mm of water equivalent for a particular set of years, and even better broken into winter and summer. The paper is on the verge of doing this but doesn't deliver. The authors should perform such an analysis as part of this manuscript.

In the original manuscript, we were reluctant to provide a gridded SMB product, and instead presented a map of gridded normalized SMB in figure 10. However, motivated by reviewer #2, we have looked into a way to connect three sources of information to construct an estimate of absolute SMB values.

The first step is already in the manuscript: the pattern of normalized snow mass above the reflection horizon is used to adjust the spatial pattern of SMB from RACMO2. Added in the revised manuscript is the next step, in which RACMO2 SMB is adjusted to match the sonic height ranger observations. This process is described in the fully revised section 3.4 (which now has the title **A map of SMB and its origin**):

The 1979-2014 average SMB from RACMO2 was normalized with respect to its spatial mean, and so were the GPR data. Next, we determined a linear regression of the normalized RACMO2 SMB values to the normalized GPR data. We used this regression to adjust the RACMO2 SMB to maximize its match to the GPR data while conserving the spatial mean SMB. The result is a RACMO2-guided extrapolation of the GPR over the unsurveyed portions of LCIS, shown in Figure 10c, where the spatial pattern of RACMO2 SMB is adjusted to the spatial pattern of the GPR observations.

The next step was to adjust the absolute values of RACMO2 SMB to available sonic height ranger observations. We converted RACMO2 SMB back from normalized to absolute values, again using the spatial mean SMB. We determined a weighted mean bias between RACMO2 SMB and all available sonic height ranger observations, selecting the periods for which both were available. We used the length of the height ranger observation period as a weight for the averaging, reflecting that short-term variability plays a smaller role in longer time series. Compared to the sonic height rangers, RACMO2 underestimated SMB by 14 ± 10%. Applying a bias adjustment leads to the gridded SMB shown in Figure 10a. An estimate of SMB uncertainty was based on (1) the fit between normalized GPR and RACMO2 SMB, and on (2) the 10% uncertainty of the RACMO2 bias. The resulting uncertainty is typically 15% of the SMB value, shown in Figure 10b.

The underestimation of RACMO2 snowfall over LCIS was noted by Kuipers Munneke et al. (2014) and may be the result of the representation of snow formation in clouds, or with underestimated evaporation in the Weddell Sea, the most important source region for moisture precipitated over LCIS. The underestimation of RACMO2 snowfall is also apparent in the comparison with Operation Ice Bridge radar data and amounts to -13 ± 10% (Figure 8), reinforcing the robustness of our bias estimate.