

Interactive comment on “Observationally constrained surface mass balance of Larsen C Ice Shelf, Antarctica” by Peter Kuipers Munneke et al.

Anonymous Referee #1

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Well-written and thoroughly described set of observations, and comparison with climate models, discussing the accumulation pattern and SMB variations of the Larsen C ice shelf. Overall, an excellent compilation of work by several groups that addresses one issue, and integrates the variety of observations with a model to come up with a consistent picture. While nothing too surprising is noted, the number of measurements, breadth of measurements, careful corrections, etc. make this a highly citable reference for Larsen C net surface mass balance in the early 21st century (and extending earlier, through the radar profile measurements).

However, the Discussion and Conclusions need to be expanded significantly to include foehn effects – these are events that occur without concurrent snowfall, that do indeed lead to strong surface melting as you note, but also result in high rates of evaporation, and therefore a reduction in the net SMB. Seasonally and annually. Clearly the RACMO

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model needs to improve this aspect of its estimation of conditions in the area. Foehn events can occur at any time of year in the northern Larsen C. A component of the explanation for the observed northeast-to-southwest gradient is a north (high) to south (lower) gradient in foehn frequency along the western margin of the LCIS, and therefore in the evaporation component. Figure 10 is making this point quite clear, as is Figure 7. Foehn effects are localized, but significant. Previous studies of SMB on the northern Peninsula (van Wessem et al., 2016) have made it clear that the ‘snow desert’ in the lee of the Peninsula (i.e. the eastern ice shelves) is due to foehn.

Abstract – Abstract, and throughout the paper — Why not use cm for the SMB values, rather than mm? since that is a more appropriate scale to use given the error and nature of the measured quantity? – Last sentences – but you show that SMB does in fact decrease to the west, due to the ablation effects of foehn wind — and this has also been highlighted recently in Cape et al., 2014; Turner et al., 2016, Oliva et al, 2017. You should look at / include these papers in the Discussion. The end of the abstract needs to be re-written to better reflect all your results.

Introduction – you cite Turner et al. , 2016 here but not in references; also, not sure which paper you are referring to.

P4L23 – remove ‘in reality’... it’s all reality. P6L15 – untangle epsilon and the reference: “. . . its dielectric constant (ϵ ; Kovacs et al., 1995), which. . .” P10L10 – change to: ‘This assumes that there is no. . .’ passive voice is actually clearer here. Table 2 – The errors in Winter SMB seem too small, given Figure 5. P12L4 – although it is true that the permittivity would change with temperature, by listing it first you imply that it would be the most common, and that’s not the case, the other three are more commonly invoked (if not volcanic ash/acid). P13L5 – I wonder if Alison Cook (who I think has looked at every aerial photography taken in the pre-satellite era) would have a notion about a year of extensive melting during this 1930s/1940s period. . . just a thought. P13L6 – I would start this as ‘Airborne radar is another, independent. . .’ P13L11 – check wording and meaning here: ‘. . . radar data are unlike to low-frequency. . .’ P13L13-14 –

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you already introduced this idea in methods with Figure 2. . . need to re-state somehow, further up or here. Perhaps the last line of the paragraph here could be deleted, and the first line of the next paragraph could begin: “To test our earlier assumption that this reflector is the previous summer’s melt horizon, . . .” P13L22 – In methods, the error was given as 6cm? (based on 2GHz bandwidth) ..reconcile. P17L1 and 2 – RACMO-2 is a model. . . While it ‘provides a broader context to the different observations presented above’ (suggested wording change) it really can only ‘. . .suggest (or imply)’ that the SMB gradient is northeast-southwest (suggested wording change). P17L5-6 – No, it is dictated by snowfall and evaporation – and RACMO2 is clearly not getting the foehn-derived evaporation component right.

Figure 1 – please use the data citation for Mosaic of Antarctica (Haran et al., 2014. . . at nsidc.org) ; and the data citation for the IceBridge flightlines as well. Figure 2 – Need to describe the sensor used for this radar profile in the caption, and, could indicate where this profile came from in Figure 1 (latter not all that critical) Figure 4 – you could make the depth-integrated lines at the top of (a) bigger – push the 0.0 depth scale down a bit to make more room. . . Nice plot over all. Figure 5 – this plot would take on additional meaning if you added the mean SAM index for the winter period as a bar graph along the bottom, with a right-side y-axis. Start the left-side y-axis at 0 to make room. This would warrant a paragraph discussion in the Discussion. Figure 6 – please note where on the Larsen C this profile was acquired, perhaps in Figure 1. This one is a bit more important, since it shows some location – specific structure at depth.

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