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The Cryosphere Discussions

Interactive comment on "Energetics of Surface Melt in West Antarctica" *by* Madison L. Ghiz et al.

Anonymous Referee #2

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This research looks at how various meteorological conditions alter the surface energy balance (SEB) and produce melt at a number of locations in the West Antarctic region. Surface melting, even during summer, is still spatially limited in the Antarctic, compared to Greenland. However, recent studies, including this one, have highlighted the potential for intense melt events on the surface of ice shelves, which has important implications for ice shelf stability and dynamics. The authors present a number of case studies and explain the causes for the melt, and which SEB components initiated it. A range of processes and mechanisms are included, such as thick thermal-blanket clouds, thin cloud cover and föhn winds. The authors use a range of available data and evaluate it thoroughly. I believe this work is novel, relevant and an important contribution to the field. It also fits the scope of the journal very well. An interesting aspect was the inclusion of manual observations of clouds and visibility, which you don't regularly read in manuscripts now, but undoubtably offer important insight into cloud characteris-

tics as they are so poorly represented in reanalysis and models. Whilst the analysis is robust and thorough, the manuscript suffers from some presentation issues as well as being overly long and descriptive. Some of this is due to the number of case studies, which leads to repetition of both figure types and meteorological description. However, I think with some re-structuring and inclusion of some maps, the manuscript is a good scientific publication which should be accepted. I have outlined the larger issues below and also included line-references for more specific edits. Whilst I give specific areas to cut out and reduce the length, I do urge the authors to also go through and decide on any other areas which can be slimmed down.

Minor suggestions: The length of the manuscript and the repetition in results and their presentation currently makes it feel a little harder to read than it needs to be. There are 6 case studies provided, which is quite a lot for a 'case study' style paper. However, all are valid and important. I therefore suggest restructuring or combining some case studies. Here I have some potential ideas, but I think the authors should decide what works best for them and the manuscript. 1) Combine the December 2011 case studies. Whilst different processes are at play in these case studies, the larger-scale processes and synoptic situation will be the same/similar. Combining them to discuss the elements which are the same will reduce repetition, whilst highlighting the differences between them which show how local-scale processes are important for melting. 2) Combine the case studies by location. E.g combine the PI and Thwaites case studies for December 2011, January 2012 and February 2013. Again, I know that different processes are at play, but it could be advantageous to plot these together to see how melt magnitude/length etc vary between the different meteorological conditions. 3) Combine by melt-mechanism: combine the 'thermal blanket' cases, the ones dominated by turbulent fluxes etc. This would highlight which situation happens more frequently, and which ones are less frequent (but could perhaps generate more melt). The conclusion summarises the case studies very well, and groups them into the cases that have an individual mechanism, and ones that have interplaying mechanisms. Perhaps you could try and include this structure and succinct approach throughout the results.

I really like the conclusions section: it is clear, rounds the paper off well and includes the limitations to the study.

The introduction is quite long and currently reads a bit like a thesis chapter or review paper. This hides your motivation a little, even though there is a need for your research. I would move the section on SEB modelling into the data/methods section, and slim it down. Currently your objectives are at the end of the fourth page, but could be at the forefront if some lines/paragraphs were removed.

Be clearer with which AWS observations you use. As they are mentioned in the data section, but only in passing (e.g line 155/156). And they are mentioned in figure captions (e.g Fig 20 'over the RIS region containing Tom and Sabrina'), but I couldn't be sure where exactly the data are used besides Figure 24. If you do use them elsewhere, you need to make it clearer which locations and which variables. I would also include them on your Figure 1 map.

Figures: âĂć Figure 1 should be improved to include more information. For instance, an insert of the whole of Antarctica is needed with indication of where this zoomed in section is. Number 3 is missing. Could you add the AWS locations? Some schematics or overlays could aid the reader in understanding the large-scale flow in the region, or some arrows to highlight the main air flow directions in your case studies. âĂć Additional figures would also be preferential in highlighting main weather systems for the different case studies. Often in case study analysis (especially in atmosphere-SEB studies), there is a modelling aspect which provides some cross sectional or 2d plots with maps of airflow and such things, which aids understanding for the reader. I am not suggesting you do extra work, but only that you use figures to better represent more useful information. âĂć Perhaps some synoptic charts would help show information, such as the Dec 2011 case with the low-pressure system and föhn winds. Such maps could also indicate the locations of the grid cells used to look at spatial patterns of emissivity. âĂć Many figures of the same style and type- a consequence of a multi-case study analysis- but could be panelled together to avoid repetition. Or move some

to a supplement if some of them are not definitely useful. For instance, is the LWP and IWP plot needed for the case studies where cloud properties are less relevant?

Some of the decision making on ERA5 vs CERES could be moved to a supplement. You could state only what you finally use in the manuscript and move the evaluations and mix-match tests to supplement. Otherwise, it is quite hard to follow which method/dataset you are actually using. For example, after line 200/page 7, I assumed that you weren't using ERA5 anymore. However, you state at the end of page 9 that you do indeed use ERA5.

Is there a timing offset between ERA5 and CERES LWP? In some of the figures, the peaks appear to be always a day or two later.

Specific Suggestions:

Ln 105: GIS hasn't been defined previously Ln 106: Do you have a reference or evidence that these clouds are common in the polar regions? Ln 110: Föhn winds are only common in areas with mountain ranges and perpendicular air flow, which is a relatively small area of the Antarctic. I would say, common in some regions within the Antarctic. Ln 118,119: Föhn winds can't occur anywhere or on any ice shelf- there are many ice shelves in the East where föhn winds do not occur. These may be affected by katabatic winds, but evidence of föhn is lacking. Zhou et al. 2018 only looked at W. Antarctic ice shelves and föhn. Föhn are only common on Antarctic Peninsula ice shelves and Ross Ice Shelf. Throughout: do you have any DOIs or URLs to point the reader to the sources of your data? Ln 206: Add 2016 to the date here. Ln 250-260: I have a hard time knowing how spatially uniform (ln 256) the surface emissivity is, when you don't say which 5 grid cells you are looking at. Where are the 5 grid cells? This sort of information would be better represented as a spatial plot on top of a map, so that we can see the area of interest. Figure 6: a/b/c. . . missing on figures. Figure 7a/10a: timing offset? Ln 356: 'In Figure 9 the sampled percentiles are referenced to the max Tb on 21 December'. I don't understand what this means. Is it the wrong Figure you

are pointing to? Ln 594-595: I don't understand what you are trying to say here. Figure 24: are you able to plot RH? As this is a key variable in determining föhn winds.

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