

## Anonymous Referee #2

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### General Comments:

The authors examined the onset of snow melt over Antarctic sea ice using data sets from scatterometers (ERS-1/2, QSCAT and ASCAT) and passive microwave radiometers. Between 1992 and 2015, they found insignificant changes in onset dates which they claim be consistent with the small trends in Antarctic sea ice extent. Also, they used the differential lag in onset timing between the observing instrument to develop a conceptual model for inferring the evolution of the depth/temperature-dependent snow processes during the onset period, and conclude that multi-wavelength instruments may be able to provide information on the behavior of the snow column on Antarctic sea ice during early melt.

Throughout the paper, the authors contrasted the behavior of the Arctic and Antarctic – I find those discussions to be interesting and useful.

We highly appreciate the great work that the reviewer put into revising our manuscript and we realized that he/she is really familiar with the topic of our manuscript. Therefore, we thank the reviewer, as the constructive comments, improved significantly the quality of our manuscript.

The only comment is that the authors inferred from only a few samples (12) the general behavior of the onset-dates of circumpolar ice cover and their relationship to the observed trend in ice extent. This is less credible without more justification as to why a non-uniform sampling of the ice cover (Fig. 1) is sufficient for this analysis.

We had actually conducted our analysis for individual pixels and groups of 3x3 pixels. We agree that a larger region of 3x3 pixels will provide more representative results for the respective areas. Therefore, we are now reporting the results of the analysis of the 3x3 pixel regions. However, this has no effect on the presented results in the manuscript but the given dates shifted slightly by 1-2 days back or forward. However, we refrain from applying the analysis to the entire Antarctic sea-ice area, as there is, so far, no reliable data set on the respective ice types in the ice-covered Southern Ocean.

I would like the comments below addressed prior to publication.

### Detailed Comments:

Page:Line number

1:28 While it is true that the circumpolar ice extent has changed insignificantly over the period of study, the trends are significant in the different sectors (e.g., Ross Sea sector). I think that fact should be noted and there are implications as far as the discussions in the remainder of the text regarding expected trends in the onset dates and ice extent.

We agree that it is worth mentioning the regional differences in the temporal evolution of the sea-ice extent over the past decades. We therefore added this fact in the manuscript.

3:20 This is in contrast to what is expected in the Arctic, where backscatter from perennial ice is expected to decrease during the summer. Perhaps another point to note.

This point is already noted in the beginning of page 3 and is therefore not noted again.

6:19 Need clarification: Is it the daily product that was used or the twice daily product? On p.6, the text indicated only the daily product is used.

The word “daily” was wrong and misleading at that point. As mentioned in the following line, QSCAT is given as a twice-a-day product, which is also used here for the analysis of diurnal variations in the snowpack.

7:10 Please specify which ice concentration product is used here.

We used the Bootstrap sea-ice concentration data product. We added this information.

7:15 Perhaps it's good to point out how the samples were ‘carefully’ chosen to reflect/represent the large-scale behavior/trends of the Southern Ocean ice cover.

The chose locations were the same as those from Haas (2001) in order to ensure both a proper comparison between both studies and a reasonable continuation of the given time series. To point that out, we added the respective reference.

9:1 I don't think 'extensive' is appropriate here – let the reader decide.

We agree and deleted that word.

Figures 3&4. Shouldn't the seasonal ice in sample D disappear during the summer?

Yes, it does disappear. That's why the time period between end of December and end of March is shaded gray in Figure 4b.

Figure 5. Are the backscatter for both C-band and Ku-band merged here? If so, please indicate so because one would expect differences between the two wavelengths.

Yes, we added that.

18:8 Large oceanic heat flux (I imagine relative to the Arctic) – a reference is appropriate here.

Yes, we added a respective reference: Martinson, D. G., and R. A. Iannuzzi (1998), *Antarctic Ocean-ice interaction: Implications from ocean bulk property distributions in the Weddell Gyre*, Wiley Online Library, doi:10.1029/AR074p0243.

18:13 meaningful for? For indicating the ice extent?

We referred that statement to the overall upcoming analysis and discussion (as e.g. sea-ice season duration). To make this clearer, we added this to the given sentence.

18:24 I think this is what you are referring to above, i.e., 18:13.

See previous comment.

Section 4.2 the suggestion here that snow processes may be secondary in explaining the ice extent is important – perhaps worth noting in the abstract. Your work points to that and it is geophysically important, but saying that it is 'NOT' important may be a bit too strong without more discussion and supporting evidence.

We agree and weakened the given statement in the respective context. However, we do not see the need to add this to the abstract as the main focus should be kept on the seasonal snow processes.

20:14 This conceptual model depends on the initial changes to occur in the subsurface prior to that on the surface such that permittivity changes in the interior, while in the pendular regime, leads the change at the surface. I think this is perhaps too dependent on the temperature argument. Is the temperature profile entirely necessary?

Temperature is the key physical indicator for snow metamorphism and variations in liquid water content, and therefore we believe that we can not argue with heavily relying on the snow temperature profile and its diurnal and seasonal variations.