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Interactive comment on "Definition differences and internal variability affect the simulated Arctic sea ice melt season" *by* Abigail Ahlert and Alexandra Jahn

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Response to Referee 1

This work investigates the dates of sea ice melt onset, freeze onset, and the length of the melt season as identified from a variety of daily CESM LE model outputs. The authors examine the melt season by defining several melt and freeze onset estimates from the model output variables that make physical sense to replicate melt and freeze onset dates derived from passive microwave satellite observations, highlighting the mismatch between melting parameters available from the models and melt as observed

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from brightness temperatures. The analysis provides a through comparison of several definitions of melt from the models and assesses the effect of internal variability on the melt season definitions.

Results show that none of the model definitions produce trends in melt season length as large as those from the satellite data and that the melt onset dates are less consistent across definitions than freeze onset dates. Further, some of the model definitions are similar to the satellite observations, but no single definition replicates the satellite observations.

The paper is generally well written and reports an interesting study of some of the challenges when trying to compare model output with observations. Overall, I think the study is timely, thorough, and of value for both the modeling and remote sensing communities. Before publication I recommend that the authors check that their data are accurately cited and clarify a few points in their data and methodology section as noted in my specific comments.

We thank the referee for his/her thoughtful and constructive comments. We have revised the data citations and clarified the issues raised. Each specific comment is addressed below individually. The original referee comments are shown in italic, the author reply in bold.

Specific comments:

P3, L4: The AHRA method for MO detection is independent from the Smith (1998) method for MO, while the Markus PMW algorithm incorporates the Smith method as one of its components. In line 4, it is more accurate to state that the AHRA method to detect MO dates is an improvement over earlier work that provided melt onset dates only over MYI rather than stating that the AHRA "builds upon" the Smith method.

Action taken: Thank you for the clarification. The phrasing has been changed as suggested.

P3, L11: "All of this..." is too vague. I suggest modifying this sentence to begin by stating what this is referring to.

Action taken: We agree. The sentence has been rephrased for specificity.

P4, L5: The Markus data set gets updated and modified periodically. Please cite where and specifically when the data were accessed in this section.

Action taken: The data are now cited with information about how and when the data were accessed.

P4, L14: It would be worth noting the continuous melt season length as defined here differs from various melt season lengths defined in other studies of PMW melt/freeze dates. For example, Stroeve et al., (2014) defines inner (EFO-CMO) and outer (CFO-EMO) melt season lengths that differ from the CFO-CMO melt season used here.

Action taken: A note has been made to distinguish the melt season length definition used here from the melt season lengths used in Stroeve et al., (2014).

Table 1: Assuming that the threshold values are met for the appropriate number of consecutive days shown in this table, is the initial day of the 3, 5, or 21 day consecutive timescale accepted as the MO or FO date? It wasn't clear to me from reading the text (page 5, lines 3-11) and the supplement which date in the time period is used as the onset date.

Action taken: The initial day of the timescale is the accepted melt onset/freeze onset date. A statement has been added to the Supplementary Material to clarify this.

Figure 3: I suggest citing the Bootstrap sea ice concentration data in the figure caption as "(Comiso, 2017)" and in the list of references as requested by NSIDC: Comiso, J. C. 2017. Bootstrap Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS, Version 3. [Indicate subset used]. Boulder, Colorado USA.NASA National Snow and Ice Data Center Distributed Active Archive Center.doi:https://doi.org/10.5067/7Q8HCCWS4I0R. [Date Accessed]. In the result sections, the place names used are fairly common (e.g., Central Arctic, East Siberian Sea, etc.), but may not be known to all readers. Labels could be added to one of the panels in Figure 3 or a region map identifying the locations referred to could be placed in the supplement.

Action taken: Comiso, (2017) is now cited with the appropriate information. A map including labels of most major features of the Arctic Ocean and the marginal seas has been included in the Supplementary Material and referenced in the Methods Section.

P14, L3-5: This sentence is a bit awkward. Are you stating that adjusting the 36-year time series window to begin in 1981 removes the outlier positive trend in Figure 6c? I suggest rephrasing and not beginning the sentence with but.

Author response: Adjusting the 36-year time series window to begin in 1981 removes the outlier positive trend in Figure 6c. This is true for all 36-year trend start-years after 1981 as well.

Action taken: The statement has been rephrased for clarity.

P14, L26: Specify that the largest differences are to the north of the Beaufort Sea rather than in the Beaufort Sea.

Action taken: As suggested, we now specify that the largest differences are to the north of the Beaufort Sea rather than in the Beaufort Sea.

P14, L29-30: Spell out what you mean by "shelf seas" since this term isn't used elsewhere in the paper.

Action taken: Changed phrasing of "shelf" seas to "marginal" seas for consistency with other uses in the paper.

Figure 7: This comment really applies to all of the maps, but is most apparent in figure 7. How are the effects of the retreating ice edge in the Atlantic sector during the satellite era accounted for in the calculation of the statistics shown in your maps? Are nans ignored? Could this be contributing to the mix of positive and negative trends seen in the Barents Sea and east of Greenland? A statement (a few sentences) about how the statistics are calculated should be included in the methodology section and some discussion in text of how changes in the ice edge may be contributing to the patterns shown in Fig 7a-f could be included near P14, L8.

Author response: Trends in melt season characteristics at individual grid cells are calculated as the slope of the least squares linear regression from 1979–2014, given that the grid cell has a valid melt season characteristic for at least 20 years of the 36-year period. NaNs are ignored, and trends are not calculated for grid cells with less than 20 years of melt/freeze/melt season length data. This is the same approach used in Stroeve et al., (2014). The changing ice edge is therefore only partially accounted for and could still affect the reliability of the trends along the ice edge.

Action taken: A description of the methods used for pan-Arctic means, pan-Arctic trends, and individual grid cell trends has been included in the Methods section. We have also added the mean position of the ice edge to Figure 7 as in Figure 3, and included some additional discussion of the impact of the changing Atlantic ice edge near the recommended location in the original manuscript.

Figure 11: Cite the sea ice index data with the following reference: Fetterer, F., K. Knowles, W. Meier, M. Savoie, and A. K. Windnagel. 2017, updated daily. Sea Ice Index, Version 3. [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi:https://doi.org/10.7265/N5K072F8. [Date Accessed].

Action taken: Fetterer et al., (2017) is now cited with the appropriate information.

P19, L30: A short description of how sea ice sensitivity is derived should be included.

Action taken: As suggested, a short description of how sea ice sensitivity is derived has been included.

All suggested technical corrections from Referee 1 were implemented.

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