

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2022-137

Anonymous Referee #2

Referee comment on "Changes in the annual sea ice freeze–thaw cycle in the Arctic Ocean from 2001 to 2018" by Long Lin et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2022-137-RC2>, 2022

Review of “Changes in the annual sea ice freeze-thaw cycle in the Arctic Ocean from 2001 to 2018” by Long Lin et al.

This paper documents the changes of the annual sea ice freeze-thaw cycle from 2001 to 2018 using several datasets in the Arctic Ocean. The timing and variability of surface and basal melt/freeze onsets is characterized using satellite data (passive microwave sensors), and in-situ data (Ice Mass Balance buoys (IMB), Ice-Tethered Profilers (ITP) and Upward Looking Sonar ULS data). In addition, the surface radiation is analyzed using reanalysis data. Results show that estimates of surface melt and freeze onsets from satellite data and surface temperature are consistent with the results from IMB buoys. Analysis of melt and freeze onset from IMB data show regional differences with consistent surface and basal melt in the central Arctic but a 17days difference in the Beaufort Gyre due to early surface melt. These differences are attributed to available oceanic heat. Conversely, timings of pan-Arctic freeze up reveal that bottom ice growth occurs ~3 months after surface freeze-up. Results indicate that this delay is largely correlated to the ice cooling index. In the Beaufort Gyre, comparison of observations from IMB buoys and ULS upward looking sonar show consistent trends of earlier melt onset. In contrast, IMB data on multi-year ice point to a trend of earlier basal freeze onset while a delay is captured from ULS observations on seasonal ice.

General comments:

This is a clear, well-written paper, which represents a good and interesting contribution to our understanding of the Arctic sea ice free-thaw cycle. The authors provide a comprehensive and thorough investigation of the surface and bottom melt-freeze cycle in the Arctic, but also insights in the potential driving mechanisms of the observed changes since the beginning of our century. I therefore recommend the publication with a few technical corrections.

Specific comments:

L12: Replace "from surface" by "of the surface".

L94: Replace "show" by "showed".

L156-157: I would rephrase the definition of the continuous melt/freeze onset to the "the day after which ice surface melting/freezing conditions persist".

L224: There is no Table S1.

L241: Paragraph 3.1 (Comparison of ice surface melt and freeze onsets from different methods): The period of time covered by this analysis is unclear. You mention that you use 55 IMB trajectories but not the time period.

L265: I would replace Figure 3 by a table since half of the entries are empty.

L291: I would suggest using days instead of "d" here and throughout the manuscript

L308-309: Please rephrase "FO is primarily controlled by the decline of net shortwave radiation as the approaching of polar night". The sentence is confusing, not clear.

L 310: Table 2 is not referenced in the text.

L314: Can you be a little more specific than "~several mK"?

L327: "absorbs" instead of "absorb".

L331-332: I would rephrase "Here we further investigate the mechanism relevant to the BFO from the perspectives of both sea ice itself and underlying Ocean". It is unclear.

L334: you mention Figure 5b but there is no previous mention of Figure 5a.

L356: Delete "here".

L381: Table 4 is not referenced in the text.

L435: I believe you are referring to Figure 4 instead of Figure 3?

L501: Replace "ascribe" by "attributed".

L502: replace "Lagrangion" by "Lagrangian".

L507-507: I would rephrase "Second, the presences of ice interior melt" to "Second, interior ice melt".

L516: Replace "varieties" by "diverse".