The Cryosphere Discussions

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Comment on tc-2021-138

Anonymous Referee #2

Referee comment on "Weddell Sea polynya analysis using SMOS–SMAP apparent sea ice thickness retrieval" by Alexander Mchedlishvili et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-138-RC2, 2021

Summary,

Weddell Sea polynya is a large anomalous opening that does not always appear and had a 40 years absence before the 2017 occurrence again. Differing from many costal polynyas that are mostly due to the katabatic wind events, the Weddell polynya was mostly due to upward of warm deep water that melts the overlying sea ice and stops the surface water from refreezing to become ice. If this warm water continues, the polynya continues; otherwise, refreezing happens and thin ice forms, until the next upward of warm water to melt the ice and open the polynya again. This paper develops a SMOS and SMAP thin ice thickness product to map the thin sea ice (indicating the polynya), as well as the ERA5 surface wind reanalysis data to develop/support a theory that direct atmosphere forcing is a major factor for the polynya occurrence, beside the warm deep water forcing. And they conclude various different factors must occur simultaneously for the polynya to occur.

Specific comments

Based on the definition of this type of polynya, open water is obvious indicator of the polynya. Thin ice is an indirect indicator that shows open happened here but now thin ice and will soon become thick ice if the warm water upward does not appear again in a later date. In my opinion, the open water is better mapped by the ASI ice concentration map (6.5km resolution) as indicated in the paper and prior studies. The new thin ice thickness product is 45km and is not a good indicator of the small opening; also there is publication about thin ice thickness retrieval from passive microwave remote sensing such as the AMSE-E/2, that could be up to 6.5km in spatial resolution (see paper Dai et al., 2020, Remote Sens. **2020**, 12(9), 1484; **https://doi.org/10.3390/rs12091484**). However, this paper did not mention this method in their paper at all, indicating some lack in

literature review. To confirm and validate their thin ice method for mapping polynya, Sentinel-1 SAR image is a much better approach than the ASI concentration since the Sentinel-1 has much higher spatial resolution (also in Dai et al., 2020 paper and other papers).

In the paper, authors made it clear that their SMOS-SMAP retrieval algorithm assumes ~100% SIC, while there is low SIC with polynya. This causes a concern on their results. For example, in their text line 108-110, "Thin ice thickness is … a combined ice area and thickness anomaly and not be used to calculate... ice volume…".

This paper claimed that it is the first time to confirm that wind is a major factor for the Weddell Sea polynya, although I am not sure if they have enough data to confirm this finding from these polynya events 4o years ago. Otherwise, are you so confident that the results from these two years of data can apply to other times?

they conclude various different factors must occur simultaneously for the polynya to occur. But this statement is not an approved statement.

the paper writing needs to improve, I have listed a few in the details below, but many can be found throughout the paper. One big comment is the section 4 (conclusions). Most of the content in this section should be in the discussion not in the conclusions

Details:

L2, "fully opened again on …2107", but figure 1 and text shows 2016 opened.

L3, "lasted until melt" is not clear and confused. Maybe change to "lasted until the summer melting season"? "80 days, 2017," should be "80 days in 2017.", right? are you sure it reached early December before all surrounding ice melted?

L4, "actually was not the…", what is the subject of this sentence? You missed it.

L59-61, I have question for this purpose of the study: "we aim to ….", why you want to using the thin ice thickness which is not already existing and will be much coarse

resolution as compared with the exiting ASI ice concentration data. AMSR-E/2 can also be used to derive thin ice thickness. Is this your thickness compatible with the AMSR-E/2 derived?

L85: a root mean square difference (RMSD)

L92, "growing sea ice", do you mean "sea ice growing season"?

L110-111, I am not sure how long this thin ice would last once the upward of warm deep water stops or weaken, since most of the time the Weddell Sea polynya is an open water area as indicated (for 80 days in 2017). Once the upward of warm deep water stops, thin ice would form and would thicker, also thicker ice from surrounding would come to fill the open and thin ice area soon as I can imagine.

L141: Can you explain why 2017 and 2018 are chosen?

L143-144: Can you clarify the strength of SMOS-SMAP SIT compared to the SIC datasets?

L149: Can you mention this spatial resolution of ASI SIC in section 2.2?

L169, "….area that is classified as open water". I have question. this means it was 0% open water before Sept 13? if this is the case, then 100% ice covered, then ice thickness should be higher but why it was actually lower compared with after Sept 13? this is not possible. am i wrong?

L170, 0% open water should come with high SIC and SIT, right?

L175: There is no section 3.2. Please check it. Should it be "4. Discussion"?

L180: Can you add any references here?

L191: Can you present any statistical parameters, such as correlation coefficient (R)?

L193-194: I guess the higher resolution of ASI SIC can affect this result. In Figure 3 and Figure 6, it seems that ASI SIC (6.25 km) has a much finer spatial resolution than SMOS SIT (45 km?). If so, the ASI SIC data should underestimate the thin-ice (or open water) area compared to the SMOS SIT data. Maybe you need to discuss the effect of different spatial resolution.

L201-203, sentence "we see… freeze up", please break up…

L213, "east and southeast directions", but the figure 4 does not show these directions.

L216-219, Figure 7: Can you mark the extent of sea ice anomaly area in Figure 7?

L226-227, "therefore also…", please cite papers here since it is your finding.

L 237-238: I just wonder if there is any possibility of sea ice advection (e.g. drift of thin sea ice from other regions?). By seeing the time-series video of SIT, you may be able to confirm if those thin ice events are all really "polynya-type" events or they are advection of thin ice from surrounding area.

L268-269, the last sentence "Moreover, it is the combination….". this sentence is suspicious, since your paper did not approve it.

L281, "…low SIC (most likely minor lead openings) is recorded". I really hope the paper use the Sentinel-1 SAR data to validate or confirm…

Figure 1: Can you briefly explain how to define/distinguish "polynya events" and "ice thinning anomalies"?

Figure 3. what are the resolutions for them? it is really not easy to match the two sets.

Figure 4 and Figure 5: I am just curious why you mention 2017 (Figure 5) first, and then 2018 (Figure 4). Would it better to mention 2017 first prior to 2018? In Discussion, you

describe 2017 first and then 2018, so it is somehow confusing to read the text and figure together. And same for Figure 7 (2018) and Figure 8 (2017). Also Figure 4b, if 0% SIC for open water, should be 100% sea ice, but figure 4c shows 0% ice from August 11-Sept 4, please explain?

Figure 6, really the SIC and SIT do not match much, except the 2016 and 2017.

Figure 8: Same to Figure 7, can you mark the extent of sea ice anomaly area in Figure 8?