

Interactive comment on “Changes of the Arctic marginal ice zone” by Rebecca J. Rolph et al.

Court Strong (Referee)

court.strong@utah.edu

Received and published: 11 December 2019

The authors present an analysis of historical MIZ extent using available satellite products and the CICE-CPOM model. They find no historical trend in extent but an increase in the fraction of the total ice that is MIZ. MIZ extent provides an interesting perspective which is complementary to the previously published trends in MIZ position and width. Within the scope of the present study, an explanation for the lack of trend drawing on MIZ geometry and prior results could strengthen and contextualize the findings.

Major comments:

1. A poleward trending and widening MIZ does not necessarily need to conserve area, so the lack of trend reported here is potentially interesting. The manuscript

C1

would be strengthened by explaining how this result follows from the magnitude and direction of changes in MIZ width and position. One could, for example, simplify the geometry by approximating the MIZ as an annulus and then plug in the latitude rate of change (as a radius) and width rate of change from Table 1 of Strong and Rigor (2013). Over the satellite record, this gives changes in warm-season MIZ extent which are small relative to interannual variability.

2. Related to above, the authors touch on the concept of perimeter briefly in their remarks on lines 41 and 260, but this can be made more quantitative and also contextualized by prior related work. For example, Strong et al. (2017) calculated pan-Arctic MIZ extent in the bootstrap data, denoted by A_{Ω} in their equation (15), and used this time series in conjunction with MIZ perimeter (\bar{L}) to study the width trend. They also concluded that the widening is consistent with the decline in the inner pack ice area outpacing the decline in total ice area (expressed as effective radii; trends reported at the end of their Section 4a and Fig 8b).
3. Section 3.1: For model validation, the interpolation of concentration onto the model grid makes sense. However, to provide a definitive statement on MIZ extent trends, why not use the native ~25-km NSIDC grid? I think the nominal resolution around the pole in the 1-degree tripolar grid is about 85 km, although line 100 in Section 2.2. mentions ~40 km. Either way, potential artifacts of the re-gridding and interpolation should be considered because MIZ width ranges from about 50 to 150 km.
4. The abstract states that the MIZ is “trending northwards” and Section 4.3 is titled “MIZ trending northwards,” but the presented results seem restricted to maps of August 1993 and August 2013. I did not see the record-length analysis to support the statement in the abstract “The MIZ is trending northwards, consistent with other studies” (line14).
5. The MIZ fraction change is reported as “small” in the abstract, and a quantitative

C2

value would be informative here. Also, is it really small? If I understand the units correctly, a 0.003 / year trend would amount to an increase of 0.117 MIZ fraction over the record. For a quantity starting around 0.2, increasing to 0.3 would be a 50% increase.

6. We see that the model performance varies through the year as discussed in Section 4.1, but it is difficult to interpret the discrepancy from the warm-season observations because the spatial pattern is left implicit. Does the total extent error signal that the model MIZ has a position error, width error, or both? A more spatially explicit treatment of the model performance would help the reader to understand the purpose of including the model, and its intended role and weight in the suite of results.
7. Suggest including a paragraph somewhere in main text to detail the statistical methods (assumed degrees of freedom, tests were parametric versus bootstrap, etc.).
8. The title is very general. To more precisely reflect the presented analysis, suggest something like: "Historical analysis of Arctic marginal ice zone extent".

Minor comments:

1. Line 11 in abstract: I did not see an extrapolation of the results forward in time in the paper. If this remark just follows from the report of no trend, suggest removing to avoid implying that a supporting extrapolation with uncertainty analysis was performed.
2. Lines 14-16 recommends that future authors "provide a specific and clear definition when stating that the MIZ is rapidly changing." Suggest an edit here to clarify if future authors are being asked to specify the MIZ definition or to specify the particular MIZ property that is changing (width, area, latitude, etc.).

C3

3. Lines 22-24 state that the cited studies "tend to assume that marginal ice zone (MIZ) extent is increasing." I am familiar with these studies and looking back through a few of them as a sample, I found no assumption that MIZ extent is increasing. Instead, the remarks about MIZ change were literature-based and referred to specific properties.
4. Why was the NSIDC Climate Data Record not used? I think one of the motivations for CDR was to develop a consistent record suitable for trend analysis.
5. Line 202: It's not clear what is meant by "The interannual variability of the MIZ ... varies more than the sea ice extent." A more precise statement referencing specific variance statistics could clarify.
6. Line 212 and thereafter. Suggest using a consistent format when referring to the MIZ fraction trends. Something like "0.003 per year" as in the Table seems less likely to confuse than 0.3% (the latter could be interpreted as a percent change rather than change in percent).
7. Line 238: "Our results are robust" – not clear which specific results are referred to here.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-224>, 2019.

C4