

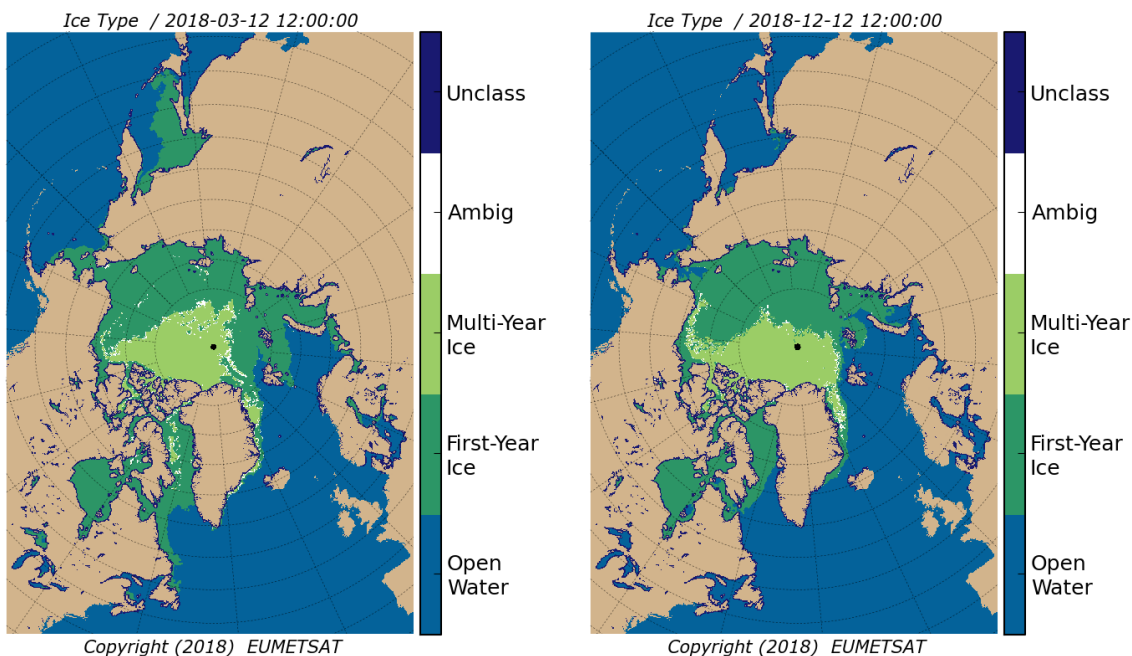
Summary

This paper aims to evaluate Arctic sea-ice volume changes from 1979 until now, using PIOMAS Freezing-Degree Days (FDD) based on ERA Interim surface air temperature reanalysis, and Cryosat-2 sea ice thickness estimates. The authors try to investigate causes and consequences of the decline in ice volume over the past decades.

General comments:

This paper reads like a blog or review, but it significantly lacks scientific rigor and the methods do not seem sound. There are several inconsistencies and inaccuracies in the paper, listed in the following:

1. L26-27 (and later): „In 2018 the Arctic MYI vanished almost completely for the first time ever over the past 40 years“. Surely, the amount of MYI has decreased over the past decades and especially the very old sea ice. But I cannot follow this statement and I think it is wrong. Below are quicklooks of the OSI SAF ice type product from March and December 2018, still showing a significant amount of MYI in the Arctic. The authors refer to the cumulative FDD sea ice thickness-based estimation, which I think is very problematic (see next point).



2. I think FDD are useful for the evaluation of first-year sea ice growth, but in order to estimate pan Arctic sea-ice volume, this approach is too simplistic. The snow cover is not represented realistically, ice dynamics are not taken into account, and as the authors state (L 281-282), the FDD cannot explicitly account for MYI. Of course, the winter ice growth is very much driven by thermodynamics, and therefore, the authors find a rude correlation between the FDD volume and the PIOMAS estimates. However, in order to model pan-Arctic ice volume, this FDD approach is not state of the art.
3. In general the paper lacks crucial information about the applied methods. How is the ice volume calculated? Is it consistent for the three different methods (CryoSat-2, FDD, PIOMAS)? Then there are also a lot of statements without being proofed by either own findings or other studies, e.g. L 70-71, or L 306-312. In the summary (L 465 - 468), the authors state they have “confirmed the prediction of Wang and Overland [2009] for a blue (summer ice-free) Arctic Ocean by 2037 or even earlier (2030-2035)”. I cannot find any predictions in the paper.
4. The quality of the figures is very low and sometimes it is impossible to discriminate the different colors and symbols.

Therefore, I suggest to reject the paper.

Detailed Comments:

L70-71: Needs a citation. Based on which study?

L 269-271: How do you really compute the volume? The ice extent is a binary value and does not represent the actual ice covered area. Over which area did you calculate the volume? Did you use the same land/ocean masks for CryoSat-2, the FDD, and PIOMAS? All these information are crucial and not given here.

L 273: Why 1% uncertainty for the ice extent? Based on what?

L 281-281: "Consequently FDD cannot explicitly account for MYI": I think that is a major shortcoming here. You shouldn't apply it then for MYI.

L 416-417: I don't see how this is predicted in the paper. And based on the chosen methods, I am not sure if any prediction would be reasonable.

Figures 5, 8 and 10: It is really hard and almost impossible to discriminate all the different colors or symbols.