

Interactive comment on “The recent amplifying seasonal cycle of the Arctic sea ice extent related to the subsurface cooling in the Bering Sea” by Xiao-Yi Yang and Guihua Wang

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Received and published: 9 July 2019

This paper shows that the Bering Sea was a major contributor to the increased amplitude of the seasonal cycle of pan-Arctic ice extent in the first decade of the 21st Century. Perhaps more importantly, it addresses a topic that is in need of further understanding: the variability of Bering Sea ice extent over decadal timescales. While the paper contains some interesting results, it comes up short in two respects: (1) recent events have passed it by, and (2) the explanation of the Bering’s decadal variations is largely speculative.

With regard to (1), the paper’s analysis ends in 2015. Since 2015, the Bering Sea

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has been the region of perhaps the most remarkable extremes of sea ice extent in the historical record: the extreme minima of 2018 and 2019. Bering ice extents during these two winters were only about 50% of the previous minima of the satellite era (<http://nsidc.org/arcticseaicenews/2019/03/>; also see figure below). This represents a spectacular reversal from the positive anomalies of 2008-2013 that shape the results and conclusions of the present paper. The recent extreme minima have put the Bering at the forefront of climate discussions. There are obvious implications for the Bering sea ice trends highlighted in Figure 1 and elsewhere in the paper. As a result, the paper is seriously dated before it even gets into the publication process.

The explanation for the Bering Sea ice history, especially its decadal-scale variability, leaves the reader wondering about the value added. The authors show that there has been a cooling of the Bering sea at depth, coincident with the 2008-2013 positive sea ice anomalies, and that the water temperatures generally correlate well with the Bering ice extent over the entire record. But the reasons for the water temperature variations are only discussed speculatively: there is mention of Bering Strait throughflow (p. 6, lines 12-21) and atmospheric circulation variations (p. 5, bottom – p. 6, top), but there is no rigorous analysis. The text does not even indicate whether there was an increase in the heat exported through Bering Strait in the 2007-2008 timeframe, nor whether there would be a compensating inflow of heat from the south. The hypothesis about changes in ocean currents and Ekman pumping is also not supported by hard evidence, as no ocean current data were included in the analysis. The linkage between ice extent and water temperature does not distinguish cause and effect, and even the possible linkage with the PDO is rather murky in view of the lead-lag correlations in Figure 3d. In short, the paper does not provide a compelling explanation for the Bering Sea winter/spring ice expansion of 2008-2013 (let alone the spectacular abrupt decrease in 2018 and 2019).

Some specific comments:

1. Page 1, line 19: The decrease of pan-Arctic ice extent in recent decades has not

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really been “continuous”, as there have been ups and downs associated with interannual variability. One can also question the statement in line 20 that “the rate of ice loss accelerates from the 1990s”. If one calculates the trend of pan-Arctic September ice extent for the 2007-2018 period, the trend is essentially zero.

2. Page 1, line 32: Not a sentence.

3. Page 4, lines 32-33: In another example of the dated nature of the study, the PDO has been positive for nearly the entire period since 2015.

4. Page 6, lines 1-4: Figure 7 needs some elaboration, including an explanation of how Ekman pumping contributes to the proposed linkage between the atmosphere and the Bering Sea water temperatures and sea ice. In particular, what happens dynamically when Ekman pumping changes from negative to positive (color bar in Figure 7)? What causes the sign reversal, and how do upwelling and downwelling relate to changes in water temperature? In other words, please present more information on the mechanistic linkage alluded to here.

5. Page 6, lines 22-31: There should be some description of the NPO and NPO-NPGO, and some supporting references. As it now stands, the NPO and NPGO seem to appear out of the blue.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-37>, 2019.

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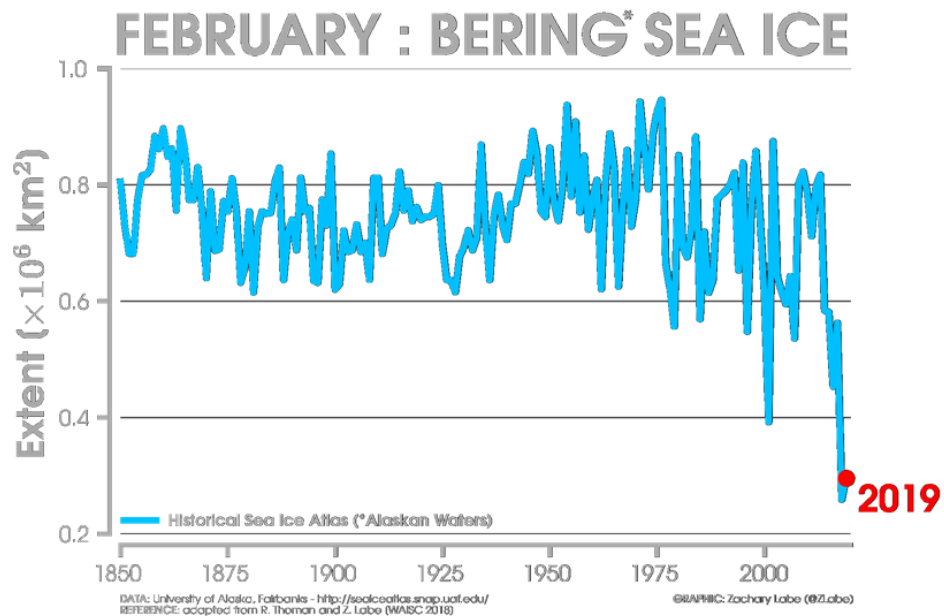


Fig. 1. Bering Sea ice extent through 2019