

Interactive comment on “Mechanism of Seasonal Arctic Sea Ice Evolution and Arctic Amplification” by K.-Y. Kim et al.

K.-Y. Kim et al.

kwang56@snu.ac.kr

Received and published: 28 June 2016

Interactive comment on “Mechanism of Seasonal Arctic Sea Ice Evolution and Arctic Amplification” by K.-Y. Kim et al.

Anonymous Referee #1 Received and published: 20 May 2016

As the Authors point out there is still considerable uncertainty as to the actual impact of a range of possible processes which could contribute to the so-called Arctic Amplification of the temperature trends. This paper potentially clarifies a number of these issues. The investigation reveals many interesting aspects of relevant feedbacks and the timescales of these. Valuable also is their insightful analysis of the different regional responses and why, e.g., the relative importance of these processes in the Barents and Kara Seas differs significantly from that in the Beaufort Sea. The paper could poten-

C1

tially make a valuable contribution in TC. However I have identified places where the explanations need to be more accessible and some additional relevant literature be incorporated into the discussion.

Comment1(C1): PAGE 2, LINE 5 - ‘Serreeze’ should be ‘Serreze’

Response1(R1): Corrected. [P2 L5]

C2: PAGE 3, LINES 24-25 – The use of CSEOF is very interesting in this study, and it would be worth presenting a few more words of justification and explanation. I would suggest explicitly referring here to Kim et al. (2015) as it presents possibly a more approachable explanation of CSEOF and illustrates this with useful examples.

R2: The reference was added in the revised manuscript. [P4 L8] We also revised the “method of analysis” section significantly so that the discussion therein is easier to understand. [P4 L7 – P6 L13]

C3: PAGE 4, LINE 7 – ‘physically related’ is perhaps a more accurate expression than ‘physically consistent’

R3: The two loading vectors $\{B_n(r,t)\}$ and $\{C_n(r,t)\}$ are physically consistent in the context of the governing equation connecting the two variables. In other words, $\{B_n(r,t)\}$ and $\{C_n(r,t)\}$ satisfy the governing equation. Thus, the loading vectors are more than “physically related”. Please let us keep the expression “physically consistent”.

C4: PAGE 5, LINE 15 - Do the authors mean ‘well separated statistically’ rather than ‘well separated dynamically’? Also, we need a quantitative backup for this statement. What test was used to establish independence (eg the North test)?

R4: The first CSEOF mode represents Arctic Amplification, whereas the second CSEOF mode represents Arctic Oscillation [Kim, K.-Y. and Son, S.-W.: Physical characteristics of Eurasian winter temperature variability, Environ. Res. Lett., 11, 044009, 2016.]. There is no such test as “North’s rule of thumb” in CSEOF analysis. The Arctic warming mode is nearly independent with the second and third leading modes as can

C2

be seen in Figure R1.

Figure R1; two time series are independent if correlation is zero for any lag. As can be seen in Figure R1, correlation is sufficiently low (in terms of R2 value, it is less than 0.1). In other words, we cannot explain the first PC time series reasonably by lagging either the second PC time series or the third PC time series. Thus, the Arctic warming mode is (nearly) independent of the next two CSEOF modes. We added the reference Kim and Son (2016). [P7 L17: ... averaged AO index (Kim and Son, 2016).]

C5: PAGE 6, LINES 18-20 - Another important aspect of this issue (involving another subtle positive feedback) which should also be mentioned here is that due to warming more Arctic precipitation is now falling as rain and less as snow, with strong implications for surface albedo. Refer here to analysis of Screen et al., 2012: Declining summer snowfall in the Arctic: Causes, impacts and feedbacks. *Climate Dyn.*, 38, 2243-2256.

R5: The reference was added in the text. [P8 L24, reference added]

C6: PAGE 9, LINES 7-12 - Also refer here to the recent new insights of Årthun, M., and T. Eldevik, 2016: On anomalous ocean heat transport toward the Arctic and associated climate predictability. *Journal of Climate*, 29, 689-704, doi: 10.1175/jcli-d-15-0448.1.

R6: The reference was added in the text. [P11 L10, reference added]

C7: PAGE 12, LINE 15 – Perhaps the authors have not fully appreciated the interpretation of the results in Vladimir Alexeev's paper. Central to their study is the presence of AA in an aquaplanet model without sea ice feedbacks. This key result pertaining to the origins of AA should be mentioned much earlier in the paper.

R7: Correct. We made a mistake. We removed this discussion.

C8: PAGE 12, LINES 19-21 – The authors are making an excellent point here in connection with the role of synoptic systems in the Arctic region and their relationship with trends. Very valuable here to also reference Simmonds et al. 2008: Arctic climate change as manifest in cyclone behavior. *J. Clim.*, 21, 5777-5796.

C3

R8: Thank you for your suggestion. We added the reference. [P14 L19]

C9: Need for correction in References . . . PAGE 13 – Year of publication of Alexeev et al. paper is 2005, not 2015

R9: The reference was removed as mentioned in comment #7.

C10: PAGE 15 – Last reference. Please note correct spelling of author name Sorteberg, A., and Walsh, J. E.

R10: Author's name has been corrected. [reference]

* The combined response file including a marked-up manuscript is attached.

Please also note the supplement to this comment:

<http://www.the-cryosphere-discuss.net/tc-2016-69/tc-2016-69-AC1-supplement.pdf>

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-69, 2016.

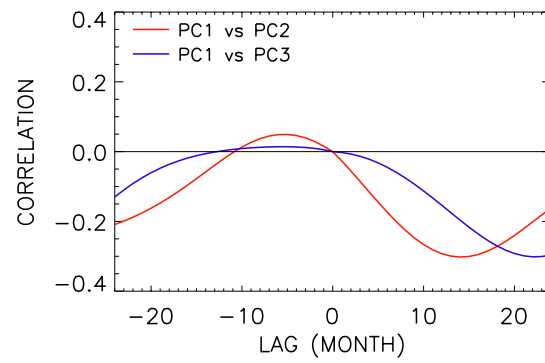


Fig. 1. Cross-correlation of the first PC time series against the second (red) and third (blue) PC time series for the lag range of (-24,24).