

Interactive comment on “Decadal Changes in the Leading Patterns of Sea Level Pressure in the Arctic and Their Impacts on the Sea Ice Variability in Boreal Summer” by Nakbin Choi et al.

Anonymous Referee #2

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This study examines the rapidly increasing influence of summer Arctic dipole mode (AD) on September sea ice extent over the last decade using reanalysis and observational data. The authors show that the negative AD event has been more frequent since mid-2000's (Fig. 3), and has strongly influenced September sea ice extent (Fig. 5) by decreasing sea ice cover over the Pacific sector of the Arctic (Fig. 6). The authors further present that the increasing influence of AD on summer sea ice cover is partly because of sea ice thinning (Fig. 8), which increases the sensitivity of sea ice cover to southerly winds.

This study nicely expands on the work of Wang et al. (2009), but the main conclu-

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sions of this study are somewhat redundant with those of Serreze et al. (JGR 2016), which carefully analyzed the relationship between AD and summer Arctic sea ice extent. While it is a little difficult to argue that this study has enough novelty to justify publication at this stage, I think this study has great potential to become an influential paper. I am optimistic that the authors will be able to improve the manuscript through the revision. I recommend publication subject to the following major revisions.

General Comments

(1) Net surface heat flux anomalies associated with AD: Sea ice growth & melting rates are associated with the net surface heat flux. I suggest examining the response of net surface heat flux to the summer negative AD. In particular, is there an increasing sensitivity of net surface heat flux (more downward heat flux anomalies) to the summer negative AD? The net surface heat flux anomalies might be presented in the lower panel of Figure 7.

(2) Increasing sensitivity of sea ice cover to southerly wind strengthening: Figures 6 and 8 are the main findings of this study and these results should be explained further in detail. As the authors stated, Arctic sea ice becomes more vulnerable to the dynamical forcing such as southerly wind strengthening because of the continuous ice thinning. I recommend showing the PIOMAS ice thickness in the lower panel of Figure 8. Although PIOMAS ice thickness has large uncertainties, the general trend of ice thinning is reasonably well captured by PIOMAS.

(3) Case study: As shown in Serreze et al. (JGR 2016), I recommend examining the impact of AD on sea ice cover during the recent summers of 2016 and 2107. As noted in Serreze et al. (2016), each negative AD event has markedly different pressure and temperature patterns.

(4) Possible impacts of PDO on AD (Figures 9 & 10): The connection between PDO and AO is highly speculative. I am not sure whether these results need to be presented. I recommend deleting Figures 9 and 10 as well as Section 4 (Further Discussion).

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Specific Comments

(5) Page 1 (lines 28-29): "Screen and Simmonds (2010) suggested the surface warming in the Arctic (a.k.a. polar amplification) plays a critical role in sea ice melting": This is not true. Screen and Simmonds (2010) suggested that diminishing sea ice has had a leading role in recent Arctic amplification.

(6) Page 6 (lines 16-17): It is difficult to tell the difference of PC time series between Fig. 3 and Fig. 5a-c. I thought these two are identical - both are PC time series of JJA mean SLP in the Arctic - am I misunderstanding? Please explain the differences more in detail.

(7) Page 6 (lines 19-24): I cannot agree with this argument. To me, there is no significant difference in the AD's SLP composites between the early and the late periods. There has been more frequent negative AD events since mid-2000's, but the individual negative AD's amplitude and pattern may not have changed much.

(8) Page 7 (lines 1-3): Rigor et al. (2002), more recently by Park et al. (2018) showed a strong relationship between winter AO and summer sea ice extent. Park, H.-S., A. L. Stewart and J.-H. Son, 2018: Dynamic and thermodynamic impacts of the winter Arctic Oscillation on summer sea ice extent. Journal of Climate, 31, 1483-1497.

(9) Page 7 (line 5): "AD in the recent period, which feature is not evident in the early period": I suggest checking grammar of this sentence.

(10) Page 7 (lines 16-17): "in order to better represent the condition for sea ice melting over far off the coast of Russia and North America": How about changing this to "to better represent the southerly wind-induced ice loss over the Pacific sector of the Arctic"?

(11) Page 7 (lines 26-29): Again, this speculative statement should be quantitatively diagnosed by calculating the net surface heat flux anomalies.

(12) Page 7 (lines 32-33): Ogi et al. (2010) did not explicitly state that the surface

wind-induced ice drift is more important than other factors. Please rephrase or delete this sentence.

(13) Page 8 (lines 4-7): I found it difficult to understand this sentence. If Figure 8 has limitation in explaining the recent changes of the AD's effect on sea ice, why is this plot presented?

(14) Page 8 (lines 10-11): I am not sure whether the outflow through the Fram Strait has recently increased. There is no obvious difference between Figs. 8a and 8b.

(15) Page 8 (lines 13-15): Figure 2b does not show any obvious changes in wind vectors around the Bring Strait.

(16) Page 9 (lines 31-32): As the authors stated, the relationship between PDO shifts and the AD center is difficult to elucidate. Again, I suggest deleting Figures 9, 10, and Section 4 (Further discussion), which is a distraction.

(17) Page 10 (line 2): "AO modulates sea ice" should be changed to "winter AO modulates sea ice". Again, more recently, Park et al. (2018) showed a nontrivial connection between the winter AO and summer sea ice.

(18) Page 10 (lines 18-19): I cannot understand this sentence. Please rephrase.

(19) Page 10 (lines 21-22): Did the authors imply "anticyclonic circulation anomalies over the Beaufort Sea"? Again, Figure 6 does not support the authors' argument.

(20) Page 10 (lines 26-27): Again, please delete this sentence.

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