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Interactive comment on "The contributions of the leading modes of the North Pacific sea surface temperature variability to the Arctic sea ice depletion in recent decades" *by* Lejiang Yu et al.

Anonymous Referee #1

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Peer review of "The contributions of the leading modes of the North Pacific sea surface temperature variability to the Arctic sea ice depletion in recent decades" by L. Yu et al.

This work considers the effect of internal climate variability from the Pacific Decadal Oscillation (PDO) and background global warming on Arctic sea-ice retreat. The two leading empirical orthogonal functions (EOFs) of the sea-surface temperatures in the North Pacific are estimated and argued to represent PDO and global warming respectively. The Arctic sea-ice extent is regressed onto these modes and the portion of variability and trends of the sea-ice extent explained by these modes are estimated. In order to study physical processes in the coupling between the North Pacific tempera-

ture trends and Arctic sea ice, also fields of geopotential height, surface pressure, wind and temperatures are regressed onto the two leading North Pacific SST EOFs.

The EOF and regression approaches are simple, and the work clearly shows that Arctic sea-ice decline is coupled to both global warming and and long-term change of the PDO phase representing a given mode of internal variability in the climate system. However the attempt to explore the physical processes in the coupling between the North Pacific SST EOFs and the Arctic sea ice is little convincing. Below I have some suggestions for improvements. I recommend major revisions.

Specific comments

I am critical to the arguments presented in the section Mechanisms:

1) Line 173-175: Based on Figs. 8a and 9a it is claimed that "the global warming mode resemble the global warming mode of NAO and AO. I couldn't see this from the figures, and the lack of connection is also consistent with no general trend in the AO and NAO indices over the last decades.

2) Line 175-178: It is here claimed that an anticyclone in the Bering sea in summer brings warm air into the Arctic causing ice melt. The reader is lead to Fig. 11a for the warming pattern, but I couldn't find it.

Most of the section continues with discussing patterns in the regression plots that are difficult or not possible to see. The choice of variables may not be appropriate for studying the physical processes relevant for the coupling between the EOF modes and the Arctic sea ice. Here are two suggestions:

i) Temperature anomalies are not appropriate when investigating effect of advection over sea ice in summer, since convergence of energy associated with the advection often goes directly into sea-ice melt rather than warming. More appropriate variables would be the surface energy budget, and water vapour and clouds, where the later two are coupled to the changes of the greenhouse effect over sea ice. Also the greenhouse

effect in itself can be estimated, as the difference between outgoing longwave radiation at the top of the atmosphere and the surface.

ii) Apply lagged regression with a daily resolution in order to study cause and effect between variables.

Note that PDO variability may not cause sea-ice variability even though the two appear related as shown by the regressions. Another process may cause both warming of the North Pacific and melting of the Arctic sea ice at the same time.

Small suggestions and typos:

Line 25: “The” in front of “Arctic”, move “sea ice” to after “decrease in”.

Line 26-29: This sentence is difficult to read and should be reformulated.

Line 48: “decline” -> “declining”.

Line 69: Comma after “forcings”.

Line 79-82: This sentence also needs a reformation.

Line 125: “corrected” -> “correlated”.

Line 135: What are the units of the numbers mentioned in this line?

Line 150: “The” in front of “sea ice”, “shows” with “s”

Line 153: “sharper” -> “stronger/larger”

Line 156: “into” -> “onto”, and many other places.

Line 160: “also” before “be”.

Fig 7.: The colour scaling is not so well chosen, I suggest to let the scale goes from -1 to 1.

Fig. 8-11: What is the reason why these figures are shown upside down relative to Fig.

7?

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