Comment on egusphere-2022-69
Nicholas Tyrrell (Referee)

Referee comment on "Pacific Decadal Oscillation modulates the Arctic sea-ice loss influence on the midlatitude atmospheric circulation in winter" by Amélie Simon et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-69-RC1, 2022

Review for 'Pacific Decadal Oscillation modulates the Arctic sea-ice loss influence on the mid-latitude atmospheric circulation in winter', Simon et al. 2022.

Summary

This paper used coupled and atmospheric-only model experiments to investigate the interaction of Arctic sea ice loss and the PDO. A range of sensitivity experiments were performed where sea ice was artificially reduced. It was shown that the mid-latitude and stratospheric response to sea ice loss was similar to the response to the warm phase of the PDO. A linear regression algorithm was used to determine that the effect of sea ice and PDO was not additive, and the atmospheric response to sea ice loss was dampened by the PDO.

Overall, I thought this was a well written paper with interesting results. I recommend publication with minor revisions. Mostly I have only minor comments and clarifications, however, I was unsure about the results in Figure 9 which seemed to contradict earlier key results.

General comments:

Figure 9: If the combined effect of future sea ice and the PDO is not additive, and the PDO dampens the sea ice response (e.g. Figs. 3-7), why does Figure 9 not show a difference between the gradient of the lines in Fig. 9? For example, Fig. 4, bottom row, shows a difference in the combined Aleutian Low/PDO response between PD:PDO and FUT:PDO,
since it's a linear regression would that also mean that the response of the PDO is dampened by reduced sea ice (apologies if I am misunderstanding this)? Which would imply that in PD should have a steeper gradient that FUT in Fig. 9.

My other general comment concerns the PDO in the experimental setup, if the experiments consist of 200 x 12 month periods, how can there be decadal variability?

**Minor comments:**

Line 32: North Atlantic Oscillation (NAO)

Line 34: "while in the stratosphere the polar vortex weakens"

Introduction: Is there a hypothesis for the mechanism for reduced sea ice -> negative NAO, and could that be briefly stated in the introduction?

Line 74: "late autum"

Line 227: Why were concatenated outputs used for the EOF analysis? Taking the second EOF as a physical mode can be problematic (e.g. Dommeng et & Latif, 2002 https://doi.org/10.1175/1520-0442(2002)015%3C0216:ACNOTI%3E2.0.CO;2) and, as stated in the text, the first EOF is due to the reduced sea ice, so would taking the EOF from each experiment first and combining them be better?

Line 228: "This EOF analysis uses the member dimension instead of the time dimension, as classically used" Since each member is one year, I assume it's equivalent to using annual means, is that right? Could that be briefly specified.

Line 252: "... winter, defined as the 3-month mean in December-February-March" Is that meant to be Dec-Jan-Feb, or is there a reason for excluding January from the winter mean?

Line 269 and 273: "\( \beta_{PD} \) is the regression coefficient determining the effect of the sea ice in PD (FUT) when compared to PI (same for \( \beta_{FUT} \) with FUT);". To make it easier to read, I recommend separating the description of \( \beta_{PD} \) and \( \beta_{FUT} \) into two sentences rather than using parentheses.
Line 455: Define DCPP

Line 477: "Concerning the amplitude of the response to sea ice loss". The amplitude of what?