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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effect of retreating sea ice on Arctic cloud cover in simulated recent global warming" *by* Manabu Abe et al.

Anonymous Referee #1

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This study investigates the relationship between Arctic sea ice retreat and local cloud cover using the MIROC5 GCM. The subject matter is timely, and the results are generally consistent with recent research suggesting a positive feedback between expanding open water in the Arctic and cloud coverage that enhances downwelling radiation to the surface. As such, this new study is relevant and appropriate for ACP. In this revised version, the authors have improved the manuscript considerably and have addressed my major concerns, the biggest of which is distinguishing cause-and-effect between the monthly changes in cloud cover and sea ice coverage. I still have some suggested changes to help clarify and clean up the article, as described below.

Major comments:

1. I appreciate the addition of Figure 4c, which addresses the causality question.

However, it's hard for me to follow the lead-lags in this figure that are described in the text. It would help to label on the figure which variable is leading which for positive and negative values on the x axis. Also, providing a clear example in the text would also help readers. For instance, I think—but I'm still not sure–that the green diamond for a Lead/Lag of -1 represents where September cloud leads October ice and that the red diamond for a Lead/Lag of -1 represents where September sea ice leads October cloud.

2. The sensitivity tests added in this version are helpful in making the authors' case. One minor point, however, is that I don't understand the meaning of the chosen names (A2K, TA2K, etc.). A brief explanation in the introduction would help.

3. I think the description of Figure 6 could be condensed, as it takes up nearly three pages. The central explanation of the entire figure seems to be that cloud cover changes are a function of relative humidity changes, which in turn depend on the competing influences of the warming versus moistening at each level. These relationships differ in understandable ways between the delta ai+ and delta ai- points because of differences in the magnitude of surface heating between these two surface types.

4. Figure 8: I appreciate the authors taking my suggestion to heart by analyzing the role of atmospheric stability as a potential explanation for the increased October cloudiness simulated over the interior Arctic, but I'm not sure that the trend in this variable is the most relevant to address this question. If atmospheric stability is playing such a role, I would suspect that the relevant difference is not temporal but spatial: the presumably higher atmospheric stability over perennial sea ice points in either time period, compared with the declining stability over the recently melted-off areas along the periphery. It's possible that the injection of so much moisture into the Arctic during October in recent years could be trapped more effectively within lower tropospheric layers above the colder perennial ice pack and thus promote more cloudiness in the later time period.

Minor comments:

1. Abstract: The sentence from lines 17-19 is confusing, because it reads as if the oceanic heat is directly responsible for the reductions in overlying sea ice, but I think the authors mean that the enhanced oceanic heat fluxes to the atmosphere have a time-lagged effect on subsequent ice coverage.

2. Page 2, lines 16-18: Do the authors really mean that the ice-albedo feedback is larger in fall (than summer) or rather that the impact of this feedback is larger in the fall?

3. Page 5, line 17: Changing ". . .the surface DLR and those due to increased air temperature. . . " to ". . .the surface DLR versus those due to increased air temperature. . . " would make the sentence clearer.

4. Page 6, line 22: Similarly, replacing "considered" with "applied" sounds better.

5. Page 7, line 18: Define "AA" in its first usage.

6. Page 9, lines 4 and 5: Change "substantially" to "substantial" and remove "also".

7. Figure 5: I understand why higher evaporation could lead to more clouds, but why would higher sensible heat fluxes? Is the figure and accompanying text implying that increases of both fluxes are contributing to more Arctic clouds?

8. Figure 6: Why does cloud fraction increase above the 0.95 level overlying delta ai+ points, even though the change in relative humidity at these levels for these points is negative? There is no such mismatch between cloud fraction and RH for the delta ai- points.

9. Figure 6: What do the horizontal bars on the delta ai+ curves represent, and why are there no such error bars on the delta ai- curves? This information should appear in the figure caption.

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