

Interactive comment on “Arctic sea-ice extent and its effect on the absorbed (net) solar flux at the surface, based on ISCCP-D2 cloud data for 1983–2007” by C. Matsoukas et al.

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We thank Referee #2 for the valuable suggestions and corrections. We have tried to address the raised points one by one. Please find our response below, with the referee comments in italic.

- The discrete ordinate method (DOM) and the spherical harmonic DOM (SHDOM) are methods for detailed directional and 3-D solutions. Such methods would give perhaps a better representation of the radiation transfer, but such complexity is beyond the scope of this work. We agree with the referee in that our models are adequate for this kind of study.

C8294

- Our definition of “forcing” has been further clarified in the new manuscript, see below.

The referee requires a response for the following points.

1. *It's not clear to me what the figure 1 really means. It seems to me that seasonally freezing areas are included, only are those never-freezing areas excluded from the plot, right?*

Correct. In order to elucidate this, in our manuscript we have added the following to the caption of Fig. 1: “Seasonally freezing areas are included in the analysis, while ice-free locations throughout the year are masked out.”

2. *Please clarify that your definition of sea-ice radiation forcing is actually the net solar fluxes without ice minus the net solar fluxes with ice. So this value should always be positive.*

We have rewritten the second paragraph of the Introduction defining the sea-ice radiation forcing, in order to clarify more its meaning. It now reads: “By ‘surface forcing’ of the sea ice in this study, we mean the net surface fluxes with sea ice absent from the system, minus the same fluxes when sea ice is present, without any consideration for feedbacks. Note that this definition of forcing is different than the one in IPCC, in two ways. First, IPCC examines the flux difference at the tropopause, while we only look at the surface. Second, the IPCC forcing is the difference between the factor present and the factor absent, while ours is the other way round. Therefore, the sea-ice forcing we calculate here is always positive, even though sea ice is a cooling factor for the Earth system.”

3. *Authors mention a few cells with increasing sea-ice cover and of course decreasing net solar flux, but not further more discussion on it. Those opposite trend cells may worth more discussions.*

C8295

We have added the following sentences in our manuscript: “Of the cells with statistically significant sea-ice extent trends 92% had a decreasing trend, while only 8% had an increasing one. The cells with increasing trends are generally scattered. There is some agreement with Perovich et al. (2007) who found a belt of increasing sea ice on the northern edge of the Canadian Archipelago, but in our coarser dataset this feature is not clearly discernible. There are also a few cells with positive trends close to Severnaya and Novaya Zemlya, in Bering Sea and Hudson Bay. This finding is loosely supported by Fig. 1 of Stroeve et al. (2005), showing increases in sea-ice cover for Septembers of 2003 and 2004 in the Canadian Archipelago, Barents, Kara and Laptev Seas. However, this agreement is circumstantial and based on sporadic data.”

4. *For sensitivity study, the cases should be selected to avoid ceiling of 100% on the sea ice extent and total cloud amount.*

We followed the Referee’s suggestion and for the sensitivity analysis we selected only the cells which did not exceed the value of 100% after increasing their cloud amounts and sea-ice cover by 5%. Of course, this way we are limited to cells with smaller sea-ice cover values. Table 2 below has the new values which support the absence of non-linearities, as before.

Table 2. Sea-ice forcing sensitivity analysis with respect to sea-ice extent and cloud cover. Percentage values show the forcing change compared to the control case.

| | | Cloud cover | | |
|---------|-----|-------------|-------|-------|
| | | 0% | -5% | 5% |
| Sea ice | 0% | 0% | 2.0% | -2.0% |
| | -5% | -2.4% | -0.4% | -4.3% |
| | 5% | 2.4% | 4.5% | 0.3% |

The values of the forcing sensitivity are smaller than Table 2 in the original C8296

manuscript, because we are excluding cells with large sea-ice cover from the sensitivity study. Large areas of the Arctic Ocean remained unaffected by our cloud and ice cover changes, so the difference of forcings between the perturbed and the control cases has decreased. The exclusion of large sea-ice cover values here highlights better the interplay between sea ice and clouds in the net shortwave flux. However the numbers from the sensitivity study with no cells excluded (as in the original manuscript) have more physical meaning. We propose to leave Table 2 as it was, and keep this version of the sensitivity study in the article discussion.

5. *“Buffin” should be “Baffin” in many places of the paper.*
The correct “Baffin Bay” is now used throughout the manuscript.