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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Summer Sea Ice Albedo in the Arctic in CMIP5 models" *by* T. Koenigk et al.

**Anonymous Referee #2**

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This manuscript deals with simulations of the summer sea ice albedo over the Arctic in CMIP5 atmosphere-ocean global coupled models (AOGCMs). Simulated summer sea ice albedo is compared to a sea ice albedo derived from CLARA-SAL product (1982-2005) and OSI-SAF sea ice concentrations. The authors highlight biases in the simulated spatial distribution of the albedo and in the temporal evolution of the albedo throughout the summer. They show that current AOGCMs individually underestimate the spread of the summer albedo. The albedo distribution is uniform in individual models, but the ensemble mean compares fairly well to observations. Additionally, they show that in CMIP5 models the summer sea ice albedo is governed by surface temperature and snow conditions, which may have an impact on the simulated temporal evolution of the albedo.

## General comments



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This paper is relevant and timely, as it deals with one major uncertainty in sea ice modeling. Uncertainties in summer sea ice albedo within AOGCMs impact AOGCMs simulations and reliability of future climate projections. The manuscript is well organized and well written. The use of observational albedo data seems to me quite innovative as it has not been widely used before in sea ice studies. The authors are clear about the limitation of their study, as they do not address differences in ice albedo in the different models (which might be of interest for future studies). Nevertheless, this paper gives insights into possible ways to improve the modeled ice surface in AOGCMs simulations.

I would recommend this paper for publication in ACP once the following very minor comments have been answered.

**Specific comments**

My major concern deals with the model ice albedo used for comparison. I thought the sea ice albedo was a model output required in CMIP5 protocol. At least, the albedo of the marine surface (ice+water) is. As I understand, the authors compute a surface albedo 'from scratch' from downward and upward surface solar radiation. Is there a justification (else than 'all centers did not provide the surface albedo') to do so?

The authors should be careful while using ERA-Interim surface temperature over the Central Arctic (80-90°N), as it is mainly determined by the state of the surface (temperature/albedo) used to generate the ERA reanalysis. See e.g. Lüpkes et al. (2010) or Jakobson et al. (2012) for discussions on this topic that highlight relatively high uncertainties. The authors should also mention what they mean as 'surface temperature': 2m-temperature or ice surface temperature?

The paper is well-structured; the analysis is comprehensive while also synthetic. In section 3, I would recommend to highlight more the differences between spatial patterns simulated by the individual models and the resulting ensemble mean. This could help the reader who would not be familiar with such analyses. Maybe it could also be relevant to add a few words to justify why it is interesting to look at the ensemble mean



ACPD
13, C9401–C9404, 2013

of models with different setups and physics.

**Technical corrections**

25221 L23: 'climate models react very sensitive to...'. This sentence reads to me awkward.

25222 L4: reference for SHEBA should be cited (and acronym too). See Utall et al. (2002).

25223 L22-25: what is the average grid resolution of the CMIP5 outputs (I guess 1-2°)? Are model data interpolated on the same grid? Is it useful to have so detailed data to compare model outputs with?

25224 L12-15: Is it 2m-Temperature? Uncertainties of surface temperature in ERA-Interim (and other reanalyses) have been discussed in the literature. See e.g. Lüpkes et al. (2010) and Jakobson et al. (2012).

25225 L10-11: 'outperform'. Based on what criteria? What is the use of this lonely sentence?

25225 L23-24: 'Arctic climate reacts very sensitive...'. Same comment as above.

25228 L1-5: Some models use an ice albedo formulation for thin ice (thinner than 0.8m) depending on sea ice thickness (Flato and Brown, 1996).

25229 L1: 'react less sensitive'. Same comment.

25229 L3: How did the authors deal with the trend when ice disappreas from a particular grid cell? Do trends still mean anything relevant? I appreciated in the following that the authors only considered ice albedo averaged over 80°N-90°N.

25230 L29 and sq: Very long sentence, hard to understand. Consider fractioning.

25233 L3-4: I would have thought that models with low albedo would tend to simulate thin ice. If not, please explain.



ACPD

13, C9401–C9404, 2013



25234 L27-29 'tuning parameter': the melting ice albedo is a tuning parameter (as it often aggregates bare ice+meltwater ponds). During the winter, ice albedo is generally the albedo of snow, so it is less a tuning parameter (and depends on the snow scheme used over sea ice). Please replace 'sea ice albedo' here by 'melting ice albedo'.

25235 Acknowledgments: Do not forget to acknowledge CMIP5 data providers using the formal formulation.

**References**

Flato, G and R. Brown (1996), Variability and climate sensitivity of landfast Arctic sea ice. JGR, 101(C1).

Jakobson, E et al. (2012), Validation of atmospheric reanalyses over the central Arctic Ocean. GRL, 39, L10802.

Lüpkes, C et al. (2010), Meteorological observations from ship cruises during summer to the central Arctic: a comparison with reanalysis data. GRL, 37, L09810.

Utall T., J.A. Curry, M.G. McPhee, D.K. Perovich et al. (2002), Surface heat budget of the Arctic Ocean. BAMS, 83, 255-275.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 25219, 2013.