

Interactive comment on “Arctic Climate: Changes in Sea Ice Extent Outweigh Changes in Snow Cover” by Aaron Letterly et al.

Anonymous Referee #2

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Background

The authors use 34 years of satellite data from AVHRR (1982 – 2015), over the Arctic to study the impact of decreases in ice and snow on the trend of solar absorption in that region. They find large differences in the absorbed solar energy over the Arctic Ocean as compared to the land areas and estimate that the magnitude of the ice-albedo feedback is four times that of the snow-albedo feedback in summer.

General comments

1. It is stated that the time of the high-to-low albedo transition each year is moving toward the high sun of the summer solstice over ocean but moving away from the summer solstice over land. Some explanation is needed why this happens.

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2. They claim that decreasing sea ice cover, not changes in terrestrial snow cover may play an even larger role in future Arctic climate change. The paper is not about prediction of future state of the arctic so there is no substantiation of what might happen in the future.

3. There is confusion when dealing with the surface and top of the atmosphere (TOA). At TOA not only surface properties matter but also clouds so it is a mixed signal (example to be given in Specific Comments).

4. There is some lack of clarity about the impact of changes at the surface and the latitudinal changes in the solar radiation reaching the ground on the amount of absorption at the surface. How do you separate these two factors?

5. MERRA-2 is also used in the analysis. Nothing is said about the differences in spatial and temporal scales of MERRA-2 and AVHRR. What impact does it have on the conclusions?

Specific Comments

Stated: Between 1979 and 2011, the Arctic top-of-atmosphere (planetary) albedo decreased from 0.52 to 0.48 (Pistone et al., 2014), and subsequent years with record or near-record low sea ice extent have further increased the amount of heat absorbed in the Arctic (Pistone et al., 2014). Comment The connection here between TOA and surface is confusing. Stated: Snow extent has decreased over Eurasia and North America since the late 1980s Robinson & snow cover and the radiative balance over mid- and high-latitude land in the Northern Hemisphere (Groisman et al., 1994), in which retreating snow cover has led to a lower polar Comment The topic is the Arctic, so need to be focused. Stated: preconditioning of sea ice in the winter can influence the albedo into the fall of the following year, illustrating how changes in cloud cover during different seasons may affect the planetary albedo (Letterly et al., 2016; Liu & Key, 2014). Comment Above is a mixed bag of statements. Needs to be cleared. Stated: This study focuses on the effects of snow and ice cover changes on the surface shortwave radia-

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tion budget of the Arctic - defined as the area poleward of 60°N - not the remote effects of mid-latitudes on the Arctic Comment Why to invoke remote effects of mid-latitudes on the Arctic? This topic is not of relevance here and the comment does not add much to the discussion. Stated: Furthermore, since terrestrial snow cover has mostly melted by June, the main drivers of absorption trends over land during the summer may be changes in cloud cover or vegetation (Chapin et al., 2005; Lorantý et al., 2011)

Comment There is no discussion of changes in vegetation after melt and its impact on absorption.

Stated: In contrast, most of the sea ice lasts through early summer, but changes in sea ice thickness still allow for changes in absorption (Perovich & Polashenski, 2012).

Comment The impact of ice thickness on absorption was not addressed in this paper. Needs more discussion.

In summary, additional work is needed to streamline the text, add explanations and remove redundancy.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-115>, 2018.