Reply to Reviewer #2:

We thank the reviewer for the time and efforts she/he spent reading our manuscript and providing valuable suggestions and advices. Please find below a discussion of the reviewer's comments (italic). Changes/additions made to the text are underlined and given in quotes.

Major concerns:

The overwhelmingly dominant surface type for this study is snow-covered ice. Should that be reflected in the title?
We agree with the reviewer, that the validation is mainly attributed to the parameterization performance of snow covered ice. For the season May/June bare ice and melt ponds surface types are still in minority. However, the range of surface albedo values of snow covered ice underlies strong variations due to changing snow reflection properties and a decreasing snow depth which has to be well characterized for a sufficient parameterization. This magnitude of variation is in the same order than for melt ponds. With the planned observations during the MOSAiC campaign in 2020 we will also cover the melt pond season for an extended validation.
Instead of changing the title (which would make it even longer), we pointed out in the abstract that the validation has some restrictions concerning the observed surface types:
"The selected low-altitude (less than 100 m) flight sections of overall 12 flights were performed over surfaces dominated by snow covered ice. It was found that the range of parameterized SIS albedo for individual days is smaller than that of the measurements."
In addition, we added in the Summary and conclusion:
"The presented results are valid for nearly 100% snow covered sea ice."

The conclusions of this manuscript, as stated p. 18, line 3 provide only limited scientific insight. The details of the model parameterization and the data set being used to validate it are nicely described, but there is not a lot of fresh scientific insight that results.
The presented "offline" method to evaluate the SIS albedo parameterization in terms of temperature, snow and cloud cover based on airborne measurements is a reasonable and well suited method. It bridges the local observations of ground-based validation data (which only partly represents the variability of surface characteristics) and satellite comparisons (albedo product derived from multi-day observation and only under cloudless conditions).
By using concurrent measurements as input parameters, the "offline" method allows a validation which is not affected by the uncertainty of modeled parameters (e.g., surface temperature) caused by the complexity in a coupled climate model. From previous studies (e.g. Dorn et al., 2009) it is known that an improved simulation of feedback processes can finally only be obtained by a harmonized combination of improved parameterizations. In a later study we will implement the adapted parameterization into the model, will perform ensemble runs and evaluate statistically the model skills. Also here, the one-year observations during MOSAiC will serve as perfect test bed.
This validation clearly reveals limitations of the current version of the SIS albedo parameterization in HIRHAM-NAOSIM, which as mentioned are the choice of temperature thresholds when reflection properties change significantly, and the illumination dependence. Since a number of other climate models include similar parameterizations, this study may encourage also other modelers to revise their approaches. From the measurement point, it was already well known that clouds have an impact of the magnitude of the surface albedo, but our study reveals directly the effect of including this information on the performance of the SIS albedo parameterization, which is worthwhile to point it out in a publication.
We tried to improve the Summary and conclusion section.

Minor points:

Abstract line 5: "The SIS albedo parameterization was tested using measured quantities of the prognostic variables surface temperature and snow depth to calculate the surface albedo and the individual fractions of the ice surface subtypes (snow covered ice, bare ice, and melt ponds) derived from digital camera images taken onboard of the Polar 5/6 aircraft." It would be helpful to include the albedo measurement in this list (broadband? Spectral?).
We included the observations a little bit earlier here:
"Therefore, the sea ice surface (SIS) albedo parameterization of the coupled regional climate model HIRHAM--NAOSIM was examined against broadband surface albedo measurements performed during the joint ACLOUD (Arctic CLoud Observations Using airborne measurements during polar Day) and PASCAL (Physical feedbacks of Arctic boundary layer, Sea ice, Cloud and AerosoL) campaigns which were performed in May/June 2017 north of Svalbard."

abstract line 10: "...a temporal bias was observed..." Is this necessarily a temporal bias? It's probably more likely a surface type bias. I doubt the bias depends explicitly on time, but it more likely depends on surface type.
We exchanged the phrase "temporal" by "time-variable" to emphasize that the bias was variable during the course of the campaign. Nevertheless, the change of surface properties (and consequently the surface albedo) is not instantaneously changing with the increase of temperature. Therefore, one could call it a time-dependent bias.
"Furthermore, a time-variable bias was observed with higher values compared to the modeled SIS albedo (0.88 compared to 0.84 for 29 May 2017) in the beginning of the campaign, and an opposite trend towards the end of the campaign (0.67 versus 0.83 for 25 June 2017)."

p. 2, line 2: "...the second main contributor." compared to what process?
We added the lapse rate feedback:
"Pithan and Mauritsen (2014) quantified the strength of various feedback mechanisms contribution to Arctic amplification using climate simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5; Taylor et al., 2012) and found that the snow/ice albedo feedback is the second main contributor besides the lapse rate feedback."

p. 2, line 6: "the spread of climate model results with respect to the snow/ice albedo feedback has been discussed" can this be made more specific? I think I understand this sentence is trying to convey that the sensitivity of climate model results to parameters directly related to snow/ice albedo feedback are discussed, but this is not clear.
The sentence introduces the more specific subsequent paragraph. However, we changed the wording:
"In particular, the spread of climate model results quantifying the snow/ice albedo feedback has been discussed (Qu and Hall, 2014; Thackeray and Fletcher, 2016; Thackeray et al.,2018)."

Table 1: Where do the min and max values come from? 0.51 - 0.57 seems like a range that I would expect to be biased low.
The numbers given in Table 1 are suggested by Køltzow (2007) who introduced the sea ice albedo scheme of HIRHAM. The range of the bare ice albedo (0.51 – 0.57) is taken from Table 7:

Table 7. Albedo Values for Different Surface Types in the Proposed New Sea Ice Albedo Scheme

$\alpha_{DRYSNOW} = 0.84$	*Grenfell and Perovich* [1984], *Grenfell et al.* [1994], *Curry et al.* [1996] and [*Curry et al.*, 2001]
$\alpha_{MELTING\_SNOW} = 0.77$	*Curry et al.*, 2001, *Lindsay and Rothrock* [1994] and *Perovich et al.* [2002a]
$\alpha_{BARE\_ICE} = 0.57$	[*Persson et al.*, 2002; *Eicken et al.*, 1994]
$\alpha_{MELTING\_SEA\_ICE} = 0.51$	*Curry et al.* [2001]
$\alpha_{MELTPONDS}$ $(T_S) = 0.36-0.1$ $(2 + T_S)$ $T_S \geq -2°C$	*Tschudi et al.* [2001], *Perovich and Grenfell* [1981], *Langleben* [1969] and *Perovich et al.* [2002a]

(from Køltzow, 2007)

p. 10, line 14: "This implies that the reflected radiation from side directions has a minor contribution than radiation coming from directly below the aircraft." Please rewrite for clarity– "...has a minor contribution relative to radiation..."?
We changed the wording:
"This implies that the reflected radiation from side directions has a minor contribution relative to the radiation coming from nadir direction."

p.12 line 6: delete "it", also please explain what is meant by "structured snow covered ice".
We adjusted the sentence and used now the term "surface roughness" instead of the phrase "structured snow covered ice". "Surface roughness" is probably more appropriate in this scientific field:
"This results in an increase of surface roughness on 31 May which is also apparent from the digital camera images."

p. 14, line 2 -3: If I understand correctly, this albedo parameterization does not account for varying grain size and snow depth? That seems like it is important to mention.
As suggested, we explicitly mentioned it now in a separate sentence:
"In fact, the decrease in SIS albedo is mainly caused by a temporal change (Figure 8b) of the surface properties, as grain size and snow thickness. As obvious from Eq. (3), both parameters are not considered in the SIS albedo parameterization of HIRHAM-NAOSIM."

p. 14, line 7: "...also the illumination conditions might have an impact on the variation of the surface albedo. Lower SIS albedo values were measured for all cases under cloudless and broken cloud conditions compared to overcast situations with similar surface temperatures ranges." That is expected and it would be helpful to acknowledge that here.
We gave some references of publication where the illumination dependence was discussed:
"Besides snow property changes, also the illumination conditions might have an impact on the variation of the surface albedo (Choudhury and Chang, 1981; Pirazzini et al., 2015)."