

# Review of the manuscript

## Manuscript title

Measurement of specific surface area of fresh solid precipitation particles in heavy snowfall regions of Japan

### 5 General comments

Within the manuscript, measurements of the specific surface area (SSA) of precipitation particles (PP) using the methan adsorption method are presented for a heavy snowfall region in Japan during four winters between 2013 and 2017. The influence of melting events, the synoptic meteorological condition, the degree of riming, as well as meteorological parameters measured at the observation site on the SSA are investigated. After careful classification of the snow samples, a parameterization of the SSA with respect to wind speed and wet-bulb temperature is derived. In reproducing observed fluctuations of the SSA with this parameterization, the study aims to provide a first step in describing the development of weak PP layers within snow cover models which is essential for avalanche forecasting. Even though the parameterization is site-dependent, the methodology can be readily applied to other observation sites.

The manuscript is clearly structured and the great amount of work going into analyzing and selecting suitable snow samples for the development of the parameterization should be acknowledged. Overall, the figures are of good quality and help to convey the arguments of the authors. However, there are some aspects that need further focus in my opinion. After some general comments, the more specific comments follow below.

A detailed discussion of the measurement uncertainties connected with the SSA measurements is missing. The statistical variations along the different snow samples need to be clearly separated from instrumental uncertainties.

Section 3 follows many different steps of selection of snow samples for the final parameterization. A separate subsection within Section 2 (Methodology) where the individual steps (melting, synoptic situation, CMF analysis...) are introduced is highly recommended.

Most of the time, the figures were just referenced within the text without being described in more detail first (e.g., Fig. 9a at page 9). At the beginning, each figure should be explained and described before being discussed. This will definitely foster reading comprehension if changed throughout the manuscript.

At some points, difficult sentence constructions and the use of English prevent fluent reading. Within the technical corrections at the end of this review, some typing errors and suggestions for re-formulating are stated. Please consider spending some more time on proof reading the manuscript as this would improve its clarity.

## Specific comments

### Introduction

P2 Line 7: For these reasons... please revise the sentence, the meaning is not clear.

5

### Results and discussion

P5 Lines 16-26: The whole paragraph needs revision. More detail is needed concerning the chosen data samples by Domine et al. and Schleef et al (sampling strategy, observation site,...). The paragraph raises questions whether these datasets are comparable at all (other region, variability in PP, ...).

10 Figure 2: specify the figure caption, Measurement of SSA and Ropt, explain the different symbols within the plots

P6 Line 2: This is due to the spectral behaviour of the imaginary part of the complex refractive index of ice and should be stated here.

P6 Line 3: are these integrated values for the albedo? Please give the spectral range corresponding to the albedo values.

P6 Line 33: Is this really just the melting effect? SSA samples of different days are used, so different meteorological conditions within the clouds and the atmosphere will influence the SSA of fresh PP anyway, even without melting. You demonstrate this yourself later in this section.

15

P6 Line 27: move this paragraph to the introduction?

P9 Line 3: How are size and fall speed measurements done? Within Section 2 (Methodology), you just mention the CCD camera system and reference Ishizaka et al. (2004). It has to be included that the size corresponds to the maximum horizontal width.

20

Figure 10: The values illustrated by the gray box plot and the mean value of NME in Figure 10 are not the same as in Figure 3. Why is this the case?

Figure 11: adding sampled data and demonstrating the characterization within this plot would be more convincing.

P9 Line 25: Ropt decreases with increasing SSA. Add within the discussion that D and Ropt are different.

25 P9 Line 26: why is C-type not classified due to PP type?

P10 Lines 10-19: this discussion is doubtful as the different trends stated within the manuscript for values below and above 90 m2 kg-1 are solely dependent on one measurement (lowest SSA).

P11 Line 24: Add the percentage of snowfall events at which Eq. 2 is applicable with respect to wind speed and Tw.

P12 Line 2: For the development of Eq. (2), 1-min meteorological data was used (as explained in Section 3.2). Why do you switch to 10-min meteorological data now?

30

### Technical corrections

P1 Line 24: gas adsorption method

P1 Line 24: font size of PP is larger than in the rest of the text

35 P2 Line 14: LaChapelle

- P4 Line 8, 19, and 21: delete whitespace at section reference
- P4 Line 11: radiation, no plural
- P4 Line 12: snow water equivalent, no plural
- P4 Line 17: gathers information on snow clouds during
- 5 P4 Line 27: use  $\{[(...)]\}$  bracket convention, and include the reference in the bracket
- P4 Line 29: measurement interval
- P4 Line 30: unit is ml, not mL
- P5 Line 11: no brackets around sentence: Hereafter, data ...
- P5 Line 27: winter instead of fourth season
- 10 P6 Line 1: NIR, explain acronym here, not in Line 3
- P6 Line 1: show the albedo at the near-infrared (NIR) wavelengths is affected more significantly by the change in SSA than the albedo at the visible wavelength range.
- P6 Line 4: These results indicate that the information on SSA variation of fresh PP is important for the simulated evolution of the local surface radiation budget.
- 15 P6 Line 11: adjust the hyphen
- P6 Line 25: PP falling at T
- P6 Line 32: that fresh PP can have a small SSA
- P7 Line 32: To predict... : please split this sentence for better reading comprehension.
- P8 Line 8: L mode
- 20 P8 Line 9: could not be determined
- P9 Line 8: wrong reference, Figure 9 should be Figure 10
- Figure 11: label for group (G) should be graupel group, not groupel group
- P9 Line 21: use the symbol  $\rho$  for density
- P9 Line 22: the initial deposited... the meaning of this part of the sentence is unclear.
- 25 P9 Line 32: This is only a hypothesis, ...
- P11 Line 6: use subscript for  $T_a$
- P11 Line 7: surface air pressure, also: use physical symbol  $p$
- P12 Line 7: in the liquid phase
- P12 Line 21: values show some difference
- 30 P13 Line 1: whitespace around hyphen
- P13 Line 12: missing ' ' after derived.
- P13 Line 15: first step towards
- P13 Line 20: fresh PP
- P13 Line 22: fresh PP