

Interactive comment on “Measurement of specific surface area of fresh solid precipitation particles in heavy snowfall regions of Japan” by Satoru Yamaguchi et al.

Leena Leppänen (Referee)

leena.leppanen@fmi.fi

Received and published: 22 May 2019

General comments

The manuscript proposed by Satoru Yamaguchi and others provided interesting description of a study, where properties of precipitation particles were analyzed within 1-2 hours after snowfall events. SSA was observed with methane absorption method and grain type and riming was analyzed from microphotographs. In addition, size and fall speed of falling particles were observed with CCD camera and snowfall modes were defined from Doppler radar measurements. Meteorological parameters were observed to define melting stage and a site specific empirical equation to derive SSA from wind

C1

speed and wet-bulb temperature.

Weak PP layers consisting unrimed crystals is the main reason for weak layers and avalanches in Japan. The study concluded that SSA of fresh PP is influenced by riming, threshold value $90 \text{ m}^2\text{kg}^{-1}$ was found between unrimed and rimed crystals, and riming degree is related to synoptic weather conditions. The established equation describes fluctuations better than the absolute values of SSA based on meteorological observations, but it is a first step to future development of physical snow model to estimate evolution of weak PP layers for avalanche prediction.

The manuscript is well-structured and presents background, results and conclusions clearly. In addition, comparison with other studies is complete. Following minor comments would improve the manuscript.

Specific comments

Page 2 Line 20: Riming could be described with one sentence

Page 3 Line 13: “over short intervals” could need specification, for example, “over short intervals (1-2 h)”

Page 3 Line 30: “The PP photographs” does it mean CCD camera photos or some other photos like microphotos? Clarify this in the text.

Page 3 Line 32: Figure of the CCD camera system could be nice in Fig. 1.

Page 4 Line 26: Figure of methane absorption device would be nice to be included to Fig.1

Page 4 Line 31: Figure of the SSA sample would be nice in Fig.1

Page 5 Line 4: Microphotography could be described with more details or reference could be added if exists.

Page 5 Line15: References for the equation should be added

C2

Page 5 Line 29: It remains a bit unclear why albedo is mentioned and how the result in Page 6 Line 4 is related to conclusions of this manuscript. My recommendation is to either remove the text or clarify its significance better. In addition, it would be good to compare results with other studies on SSA and NIR albedo/reflectance.

Page 6 Line 21: What means “the selected results”? Please clarify the text.

Page 7 Lines 27-31: Sentences could be moved to Introduction and text could be modified as “The disastrous avalanches in Japan presented in chapter 1 were caused by...”

Page 8 Line 25: “small SSA” could be defined with number

Page 8 Line 29: Chapter 3.4 is more difficult to understand than the other chapters, possibly originating from different types, modes and groups for snowfall which are easily mixed without knowing better the definitions, text could be clarified.

Page 9 Line 9: Why only UFE data with similar trend as no melt events (which have larger SSA than melt events but can still include small SSA values, Page 6 Lines 32-33) is used? It is good to have uniform PP type and no melting? One sentence about this could be added for clarification.

Page 9 Line 26: Could you describe the trend with few words?

Page 11 Line 22: “empirical parametrization” How this parametrization was formed, could be described with one sentence.

Page 13 Line 15: “especially due to the introduction of wind speed in the parameter”, which parameter? clarify in the text.

Figure 1d: Is “falling snow crystal photos” CCD camera photos or microphotos?

Figure 2a caption: Add “Optical grain radius is calculated for the data sets by using Eq. (1).”

C3

Figure 12: It would be good to have line for SSA value 90 also in the first column and explanation for the lines needs to be added to the caption.

Figure 13: Could you add lines fitted to the points? It would show more clearly increase or decrease of SSA with meteorological data.

Technical corrections

Page 1 Line 5: Vincent Vionnet, I would assume

Page 1 Line 19: Replace “sometimes” with “have potential to”

Page 1 Line 20: Replace “It is” with “Weak PP layers are”

Page 1 Line 21: “weak PP layer” could be also “those layers”

Page 1 Line 27: “degree of riming of PP” could be “degree of PP riming”

Page 2 Line 7: Consider to remove “of snow cover”

Page 2 Line 12: Replace “sometimes” with “can” or “have potential to” or “occasionally”

Page 2 Line 20: Remove “,”

Page 2 Line 21: Replace “because its initial density is small” with “due small initial density”

Page 3 Line 1: Remove “ ’s”

Page 3 Line 5: Replace “degree of riming of PP” with “degree of PP riming”

Page 3 Line 10: Add “e.g. in the Crocus snowpack model”

Page 3 Line 11: Remove “treats that”

Page 3 Line 11: Replace “maximal value of SSA of PP” with “maximum SSA value of PP”

Page 3 Line 15: Replace “on these data” with “on these parameters”

C4

Page 3 Line 25: Replace “greater” with “larger”
Page 3 Line 30: “windless conditions”
Page 3 Line 30: Consider to remove “in winter”
Page 4 Line 6: Replace “The authors of the current paper. . .” with “The detailed characteristics of falling snow produced by the CMF was used when. . .”
Page 4 Line 15: “. . .for estimating the SSA with an empirical equation.”
Page 4 Line 17: Remove “the SIRCS’s”
Page 4 Line 30: Remove “new”
Page 4 Line 31: Replace “but” with “however”
Page 4 Line 32: Replace “Because of” with “Due to”
Page 5 Line 1: Sentences “The measures SSAs. . .” and the next one could be moved before the previous sentence “Because of”.
Page 5 Line 8: Add “For the methane absorption method, the averaged heat of adsorption . . .”
Page 5 Line 10: Replace “our results” with “results of this study”
Page 5 Line 12: “The figure also shows the optical radius (Ropt) for the data sets. . .”
Page 5 Line 29: Is “more than three-fold” correct expression?
Page 5 Line 33: Replace “impurities-free” with “impurity free”
Page 6 Line 9: Replace “sometimes” with for example “partly” or “occasionally” or “mostly”
Page 6 Line 23: Remove “one”
Page 6 Line 32: Remove “an”

C5

Page 7 Line 10: Replace “sixty” with “60”
Page 7 Line 11: Replace “Figure 6 is the results of. . .” with for example “Figure 6 presents the results from. . .”
Page 7 Lines 14-15: Rephrase as “aggregation and riming to be predominant (Fig. 5c).”
Page 7 Line 31: Replace “All of these avalanches” with “The avalanches”
Page 7 Line 33: Replace “introduction of information of PP type to numerical” with “description of PP type information in numerical”
Page 8 Line 3: Replace “To investigate the measurements” with “When the measurements under M-type are investigated. . .”
Page 8 Line 7: Replace “fifty-three” with “53”
Page 8 Line 8: Replace “sets of data” with “data sets”
Page 8 Line 11: Replace “For more information” with for example “for information of grain shape and riming”
Page 8 Line 21: It is bit confusing to have snowfall types and modes defined both with letters (including M-type and M mode). I would recommend to use full names for monsoon-type and cyclone-type.
Page 8 Line 23: Replace “classification of the degree of riming” with “classification of the riming degree”
Page 8 Line 33: Replace “Ishizaka et al. (2016)’s CMF distribution” with “CMF distribution of Ishizaka et al. (2016)”
Page 9 Line 3: “In such case, these. . .”
Page 9 Line 7: “49”

C6

Page 9 Line 8: "Figure 10"
Page 9 Line 9: Replace "became" with "is"
Page 9 Line 9: Replace "its" with "UFE"
Page 9 Line 11: "Figure 6"
Page 9 Line 11: "...synoptic scale condition, and... "
Page 9 Line 11 and 12: Remove "its"
Page 9 Line 14: It is confusing to have S mode and S particle group. I would recommend to use for example "AGG", "GRA" and "SMA" groups.
Page 9 Line 15: Remove "in their paper"
Page 9 Line 16: Replace "the authors in this study treated" with "this study treated"
Page 9 Line 20: Replace "Third" with "The third physical characteristic"
Page 9 Line 21: Replace "five-min" with "five minute"
Page 9 Line 23: Consider to remove "(p)"
Page 10 Line 2: Replace "the reason D and SSA in the G group are related" with for example "the reason for relationship between snowfall mode D and SSA in the M-type snowfall group G "
Page 10 Line 7: "classification of riming degree"
Page 10 Line 12: "graupelike" to "graupellike"
Page 10 Line 18: Remove "their"
Page 11 Line 24: "the valid range in Eq. (2)"
Page 11 Line 33: Replace "periodically changed" with "alternated"

C7

Page 12 Line 22: Remove "calculation"
Page 12 Line 23: Replace "In fact, the authors of this study" with "In fact, the unrimed PPs were observed in Nagaoka on Jan 30, 2015 as expected (Figure 17)."
Page 12 Line 32: "from" to "between"
Page 13 Line 12: "...derived. This equation..."
Page 13 Line 12: "...M-type..."
Page 13 Line 14: Replace "Thus, although it has its limits stemming from" with "Although, regardless of limiting site-dependent parametrization"
Page 13 Line 19: Remove "its"
Figure 5 caption: Two first sentences needs "." in the end.
Figure 6 caption: "fresh PP"
Figure 7 caption: Replace "Each mode is shown in Table 1." with "Each mode is described in Table 1."
Figure 9 caption: Remove "." from "1 min." in the first row.
Figure 12 caption: "C-type (C type)"
Figure 16: Legend has "SD" instead of "HS"
Figure 16 caption: To the last row could be added "...the fluctuations of simulated SSA during..."

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-78>, 2019.

C8