

Interactive comment on “The growth of sublimation crystals and surface hoar on the Antarctic plateau” by J.-C. Gallet et al.

Anonymous Referee #3

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General comment.

The paper addresses a very interesting subject, and includes the first attempt to explain the observed diurnal formation and evolution of snow crystals at the surface of a cold snowpack. The method adopted to identify favorable conditions for two different mechanisms of snow grain formation is very interesting, although I think it is partly incorrect and it should be refined. In fact, using the adopted method, the conditions for the formation of sublimation crystals occur around noon, during the warmest hours of the day. The authors do not clearly specify which size or shape the hypnotized sublimation crystals would have, but implicitly assume that they would be similar to surface hoar, and they would raise the surface albedo. This contradicts both their observations (see detailed comments below) and previous results (also from the same site,

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see Pirazzini (2004)), which show that the minimum diurnal albedo occurs in the early afternoon, during the warmest hours. In my opinion, the authors correctly identified the two mechanisms for the formation of surface snow crystals, but instead of applying the maximum subsurface temperature in the calculation of the criteria to identify near surface super-saturation, they should perhaps look at the magnitude of the subsurface temperature gradient. I am not sure though, it is just an instinctive guess, based on the observation that a fast raise in albedo usually occurs in the late afternoon, when the surface cooling becomes strong. I am afraid that the utilized dataset is too limited, and with a too coarse temporal resolution, to unambiguously support the ambitious goal of the paper, but the authors could still try to revise their method. In conclusion, I invite the editor to accept the paper only if the requested major revision will be done.

Detailed comments.

p 5978, section 3.2: the authors discuss the two mechanisms responsible for the daily crystal formation at the surface: nocturnal condensation and diurnal sublimation. The authors should more clearly relate these grain generating mechanisms to the observed grain typologies described in section 3.1: (1) clusters of crystals with sharp, dendride-like outgrowths, 2) faceted crystals, and 3) faceted-round crystals. Or, at least, the authors should clarify which snow grain characteristics (faceted shape, sharp outgrowths?) they associate to the hypothesized crystal formation mechanisms, and why. p. 5978, second paragraph: the observed SSA relevant variations are named as event I.1 and I.2 (increases) and D.1 and D.2 (decreases) in the text, but they are not evidenced or marked as such nor in Figure 2 neither in the rest of the paper. These relevant variations should be put in evidence in Figures 2 and 8, and, above all, they should be referred to in the final discussion and used as a basis for it.

p. 5984, lines 3-4: “Between 18 January 14:30 and 19 January noon, the SSA increase due to the growth of sublimation crystals. . .” The authors probably refer to the hypothesized sublimation growth occurring on 19 January around noon. If the correct time of the observation on 19 Jan is 11:30 (as in Table 1) and not around 15:00 (as in Figure 2

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and 8, see my comment for those Figures), then most probably the observed SSA raise was due to early morning formation of surface hoar crystals (in correspondence of the coldest surface temperatures), possibly preceded by a 18-Jan-late-afternoon formation of sublimation crystals (in correspondence of still warm subsurface temperatures and strong surface cooling).

p. 5985, paragraph from line 3 to 11: the authors explain that sublimation crystals can be identified as surface hoar if only looking at the crystal appearance. What is then the difference between the two types of crystals? Is there some physical basis to conclude that the two hypothesized formation mechanisms produce similar crystals? The authors should compare their results with the observations of Pinzer and Schneebeli (Pinzer, B. R., and M. Schneebeli (2009), Snow metamorphism under alternating temperature gradients: Morphology and recrystallization in surface snow, *Geophys. Res. Lett.*, 36, L23503, doi:10.1029/2009GL039618), which revealed the lack of facets in grains that underwent to strong temperature gradients.

Figure 2, 4 and 7: Time in x-axis should be labelled in a clearer way (for instance, with more tick marks and shorter labels, showing hours without day and month).

Figure 2 (a) and 8: the temporal coordinates of SSA and snow density do not correspond to those marked in Table 1: on 19 Jan 2009, the data marked at 11:30 in Table 1 appear located around 15:00 in Figure 2(a). Albedo time series in Figure 8 corresponds to the SSA time series of figure 2(a) and therefore does not follow Table 1. This is not a small detail, as the corrected figures (supposing that Table 1 is correct) would more clearly show a drop in SSA and albedo during the warmest hours of the day (between 11-11:30 and 14:30-17:00) on both 18 and 19 January, contradicting the main thesis of the paper, which claims that the strong subsurface heating occurring at midday induces a growth of sublimation crystals that increases SSA and albedo.

Figure 4: please show the same time interval as in Figure 2 and Figure 8.

Figure 7: symbols are too small, they can hardly be identified. Color and symbols in the

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figure's legend do not correspond to the description in the figure's caption (probably, in the caption, red should be light blue, and green should be red, right?)

Interactive comment on The Cryosphere Discuss., 7, 5971, 2013.

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