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

Anonymous Referee #4

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Overall, I found this to be a good paper and do not have a substantial criticism.
This is well written clearly presented manuscript. The paper addresses two non precipitation surface deposition processes on snow on the Antarctic plateau. Of particular interest are the "sublimation crystals". The experimental procedures and the Crocus model are appropriate to the study. Overall, the presentation is a worthwhile addition to the scientific literature. In my opinion the paper is generally suitable for publication.
In the paper by Style and Worster that is used in the analysis it is suggested that that the frost flower formation (sublimation crystals) is a nucleation driven process. They suggest that these nucleates might be provided by diamond dust crystals in the air or protrusions of ice platelets in the case of sea ice. I feel this is worth pointing out in the present paper. I do not think that the conditions governing sublimation of a surface can also be the same conditions driving deposition onto that same surface. This should be addressed.

We wish to thank reviewer#4 for his/her comments. Answers are in blue below.

In the case of FF formation, crystal growth usually has to occur over a brine (i.e. a liquid) so that a nucleation problem arises, and a nucleus has to be provided either by a DD crystal or ice protrusions. However, in a general case, if a crystal grows on an ice surface, the nucleation-limiting step disappears, and FF readily grow on fresh frozen water (Domine et al., 2005). Here as well, on a snow surface, the nucleation step is not a problem, and we can readily mention this in the revised version.
The conditions governing sublimation and condensation are not the same. Sublimation is governed by the steep temperature gradient between a warm surface heated in daytime by the absorption of solar radiation and colder air. Then a vapor water flux originating below the surface reaches the snow surface. As shown by our simulations, the regime under which a local supersaturation regime exists over a snow/ice surface is met under our conditions at Dome C (regime VI of (Style and Worster, 2009)), so that condensation occurs at the snow-air interface. Intuitively, it may sound surprising that crystal growth occurs over a sublimating surface. As explained in Figure 5, this is due to the supersaturation caused immediately over the surface by the large water vapor flux coming from the subsurface snow layers. The mechanism of formation of sublimation crystals is thermodynamically very similar to that forming frost flowers over ice. However, no brine or diamond dust is involved/observed during our measurements at Dome C. Nevertheless, it is not ruled out that the irregularity of the snow surface could emphasize the formation of sublimation crystals.

References cited:

Style, R. W., and Worster, M. G.: Frost flower formation on sea ice and lake ice, Geophysical Research Letters, 36, L11501
10.1029/2009gl037304, 2009.