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Interactive comment on "The evolution of snow bedforms in the Colorado Front Range and the processes that shape them" *by* Kelly Kochanski et al.

Anonymous Referee #1

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This manuscript provides excellent physical insights into snow bedform dynamics, built on qualitative and quantitative observations of the snow surface evolution in the Colorado Front Range. The authors attempted a comprehensive exploration of the main factors influencing formation and evolution of a number of snow bedforms. I particularly appreciated the effort that the authors made to provide physical interpretations of their observations, discussing the complex interplay among snowfall, drifting snow, and sintering. The discussion session is enlightening with respect to the dynamics of snow step erosion and the similarities/differences between sand and snow dunes. Moreover, the manuscript seems to identify a new type of snow features, the stealth dune.

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Discussion paper

I think this is a valuable contribution to our understanding of snow bedform evolution that advances well beyond previous work. I recommend publication after the authors consider the comments below.

- Page 1, line 2: Maybe replace warmth with heat

- Page 1, line 8: the authors use the expression "retreating downwind" here and in other places. The verb retreat seems to me more suitable to describe an upwind movement. I would suggest to replace with advect to avoid confusion.

- Section 1.1: the authors differentiate between isolated dunes and close-packed dunes. However, the minimal distance at which dunes do not affect each others is not specified. I imagine that this distance is larger for dunes aligned with the wind direction, as the upwind dune can shed a wake several times its height. Conversely, side by side dunes can behave independently at reasonably short distance. Can the authors provide any estimations?

- Section 2.1: It would be useful to know the orientation of the ridge with respect to the main wind wind direction. This would tells us something more about the overall mass balance of the study site, such as the occurrence of snowfall preferential deposition and the relative importance of erosion and deposition.

- Section 2.2: Additional information on the camera setup would be useful. Was the camera looking perpendicular to the main wind direction? What was the elevation from the surface? What are the errors on the estimations caused by the distortion by distance?

- Page 6, line 6: "The falling snow that we observed often settled into plane beds". I imagine this was only the case for low wind speed conditions.

- Page 6, line 16: I think that self-similarity is not exactly what the authors show. Self-similarity would imply that the surface features look similar across different length scales, but the range of distances here seems to be quite narrow. You could simply say

that dune height and width scale linearly.

-Page 6, line 18: remove second 'of'.

- Page 6, line 26: It is not clear to me how you could track simultaneously blowing snow and dune evolution. Was the surface always visible from the camera during blowing snow? Or did you take manual measurements?

- Page 6, line 33: "Instead of the other way around". What do you mean exactly? It is hard to imagine how blowing snow fluxes could be affected by dune velocities.

- Figure 2, caption: Please mention that panel (b) only shows to close-packed dunes and (d) only isolated barchan dunes.

- Figure 3: Can you assign units to the axes? Approximate distances are better than no units.

- Page 8, line 13: the term "frequency" seems to indicate a cyclic process rather than a displacement. I think 'velocity' would be more appropriate. Can you assign approximate distance units based on camera pixels and/or distance from the camera?

- Page 8, line 18: What is your interpretation of the observation that sand-free ripples faded away? Is it related to larger sublimation?

- Figure 4c: Can you plot the correlation coefficient rather than the cross-correlation? It would help to evaluate how important is the correlation peak.

- Figure 9: I think you are expressing distances in too many different ways. Sometimes approximate distance units (figure 3), sometimes no units, sometimes fraction of image (here). The quality of the paper would improve if you could be consistent in the method used to quantify distances.

- Page 17, line 13: "snow dunes must somehow give way to snow waves and vicev-ersa". From Figure 11 there seem to be no transitions from snow waves to snow dunes.

- Figure 11: In the text, you seem to describe region 2 and 3, but I didn't notice any reference to region 1 and 4. Why do you differentiate these two regions?

- Page 18, line 3: "The cyclic behavior is shown by the transition in region 3". From what you say earlier, all points laying below the 1:1 line are unidirectional. Then I think you are referring just to the part of region 3 above the 1:1 line in Figure 11?

- Page 19, line 5: Why do you list isolated barchan dunes in mixed-surface bedforms only? Did you not observe isolated dunes in loose-snow conditions? And viceversa, did you not observe close-packed dunes in mixed-surface conditions?

- Page 20, line 5: 'but much higher than the standard values for planar snow (0.5 mm)". 0.2 mm is not much higher than 0.5 mm, or am I missing something?

- Page 20, line 9-10: Readers may not be familiar with the interplay between shear velocity and settling velocity in setting the transport dynamics of particles. Please provide some references.

- Page 20, line 1-15: Overall, I find this paragraph not very well connected to the previous discussion. I suggest you clarify why this information is relevant for bedform dynamics.

- Page 20, line 22: rather than "time-dependent" I would say that it depends on snow properties such as grain size, grain shape, and sintering, which vary in time.

- Page 20, line 27: Can you clarify why suspension is relevant to dune evolution? If suspended particles do not interact with the surface, how can they influence the dunes?

- Page 21, line 3: How did you calculate the effective density?

- Page 21, line 30: Correct "grans" with "grains".

- Page 22, line 1: In high Reynolds number flows, the length of the recirculation zone should not be sensitive to the wind speed. Can you provide any reference to previous studies that showed this?

- Page 23, line 7: Similarly to my previous comment, I'm not sure that the length of the stagnation zone changes with the wind speed - assuming the flow is Reynolds number independent, as I assume may be the case here. Please provide some additional explanation or references.

- Page 23, line 12: What is this threshold energy? Previous studies suggested that this threshold energy is that necessary to break cohesive bonds (e.g., Comola and Leaning 2017, Gauer 2001). So this threshold depends on the conditions of the snow surface.

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