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Interactive comment on "Multi-scale snowdrift-permitting modelling of mountain snowpack" *by* Vincent Vionnet et al.

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This study introduces a modelling approach capturing processes which drive snow depth variability at the ridge and mountain range scale. While different models exist capturing snow redistribution processes at very small-scale, this study is able to efficiently model snow redistribution for large domains in a computationally efficient way. The paper is very well written and results are well presented. State-of-the art models and methods are combined to improve the spatial variability of snow depths at the ridge scale. Strengths and limitations of the model approaches are well discussed. Modelled snow redistribution was verified against ALS and SNETINEL-2 data at the end of the winter season. In my opinion a comparison with SNETINEL-2 data covering only the accumulation season would better represent snow distribution affected by snow redis-

tribution processes (without contribution of snow melt). It would also be interesting to see how process representation affects the spatio-temporal snow dynamics. Please find my minor comments below.

Comments: Abstract: The abstract is well-written and concise. The new wind downscaling strategy is mentioned in the abstract. I would recommend to add one sentence description of this method to abstract to give the reader a rough idea how the method works.

I recommend to better highlight the multi-scale approach by more clearly acknowledging the combination of regional-scale weather data and downscaling techniques allowing for snow redistribution modelling.

Only blowing snow is mentioned in the abstract. As you also calculate drifting snow via saltation this process should also be added; Introduction:

P2, 44: I would recommend to add the reference Schlögl et al. 2018 for heat advection processes

P3, L1: I am not convinced that 200 m resolution can be called a snow drift permitting scale, but this is open for discussion;

P 3, p89: you could add here the possibility of modelling preferential deposition in atmospheric models;

P5: please discuss the effect of the number of layers on the availability of erodible snow. Please add more details on whether the model distinguishes between hard and soft snow and which characteristics determine the erodibility of snow – e.g. wetness of snow?

P6, L179: is preferential deposition calculated as part of the suspension layer?

P 6, L 180: here you could also add the effect of snow redistribution by avalanches on glaciers or ice fields (Mott et al., 2019)

P8, L243: why has WindNinja used a bare ground instead of a smoother snow-covered ground? Is there any possibility to initialize WindNinja with a measured snow distribution?

P8, L 178: is 5 m enough to account for suspension plumes which can be much higher than 5 m?? In my opinion this arbitrary model height might be part of the discussion;

P 8: how sensitive is the blowing and drifting snow model to the model resolution? Why was the model resolution set to 50 m and not higher to better capture saltation but also to better resolve the wind field? Due to computational resources?

P 11, L325: please change Grunewald to Grünewald

P 14, L418: strong, spatial —- delete the comma

P 488-489: I do not understand this sentence

P 17, L 520 – again. Is there a reason why the simulations were limited to 50 m? I thought that it is the advantage of the meshed grid to locally allow for very high resolutions. Especially, at the ridges higher resolution could have a large effect

P 17: L 539: mass-conserving

P 17: What is the contribution of snow melt to final snow depth pattern observed by SNETINEL-2 data and ALS in late April. The SENTINEL-2 data (Figure 10) show the snow persistence index SP at the end of winter. There are some slopes with very low SP values where I could imagine that lateral snow redistribution processes are of minor importance for the snow distribution as these might be more affected by melt. I recommend to additionally use mid-winter SP values which would better reflect the contribution of snow redistribution processes. A comparison of SP values at different stages of the winter would be highly interesting to reflect spatio-temporal dynamics.

P 19: please also discuss the uncertainty due to the constant transfer function value fdown of 0.25. I could imagine that this value changes in downwind distance of the

ridge and might be a function of wind speed and atmospheric stability.

Figures 6 and 10: poor visibility of grid lines;

P 21, L 669: In my opinion subgrid topographic effects primarily affect the local flow field which then affect snow redistribution.

P 22, L 678: high-resolution observations of what?

Suggested reference: Schlögl, S., Lehning, M., Fierz, C., & Mott, R. (2018). Representation of horizontal transport processes in snowmelt modeling by applying a footprint approach. Frontiers in Earth Science, 6, 120 (18 pp.). https://doi.org/10.3389/feart.2018.00120

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