RESPONSE TO ANONYMOUS REFEREE
TO MANUSCRIPT tc-2021-56-RC3

Title: Evaluating a prediction system for snow management
Authors: Pirmin Philipp Ebner et al.

We thank the anonymous referee for his positive feedback, constructive comments and suggestions. To your comments:

Comment #1: L153-155 Is there any reference to show the accuracy of GNSS? Also, does the GNSS has similar accuracy for wet snow?

> *[ANSWER]* We used the information provided by the companies' webpage (Leica and SNOWsat) to define the accuracy. It makes no difference in snow accuracy if the snow is dry or wet. In general, this technique is based on differential GNSS measurements, which allow an accuracy of snow depth measurements of a few centimetres. During the snow-covered period, the relative position of the groomer is tracked at each location. In combination with a precise digital elevation model derived in snow-free conditions (reference), the snow depth at a certain date and location is measured. The value that results after deducting the vehicle height is then compared with the altitude of a digital terrain model without snow cover stored in the system. The snow depth at the current vehicle position is the difference between these two altitudes.
>
> We will add the following sentence:
>
>> Line 155: "*GNSS snow depth measurements were provided by the companies Leica-Geosystems and SNOWsat*."

Comment #2: L241-242 Can you point out where the biggest difference due to snow gliding or avalanche in Figure 3? Also, this discrepancy may be reduced by integrating avalanche dynamics model. Do you have a plan to integrate a snow redistribution model and avalanche dynamics model into this system? If there are any views for future implementation of them, description of it is desirable.

[ANSWER] At current stage, we do not plan to implement this in the models, however, we agree it could be an interesting topic for further research.

Comment #3: L250-254, Figure 4: I guess that the better accuracy in high altitude is due to the ratio of snow cover area is near 1 (it may be most of them are true positive). Including the figure of simulated or observed snow cover ratio for each elevation and slope direction helps the relation of this ratio with OA.

[ANSWER] There was a mistake. We don't mean Figure 3 but Figure 4 (left). We will correct this and will also add the following sentence:

L249: *„A better accuracy is obtained in high altitudes due to the fact that the ratio of snow cover area is near 1."*

Comment #4: L255-256 Figure 5 shows the amount of MD and RMSD for snow depth. I think the information snow depth is also necessary to check relative errors. Can you add the figure of snow depth data for simulation and observation?

[ANSWER] Yes, we will include a sub-plot of snow depth for simulation and observation beneath the MD and RMSD sub-plots for each resort in Figure 5. We will change Figure 5 as shown below. In our opinion, the separation in solid lines for RMSD and dashed lines for MD should be now clear enough by adding more information for clarification also in the figure subtitle. Moreover, we included information on simulated and measured SD below, as we believe this helps to better interpret MD and RMSD in the course of time over the season with varying SD.

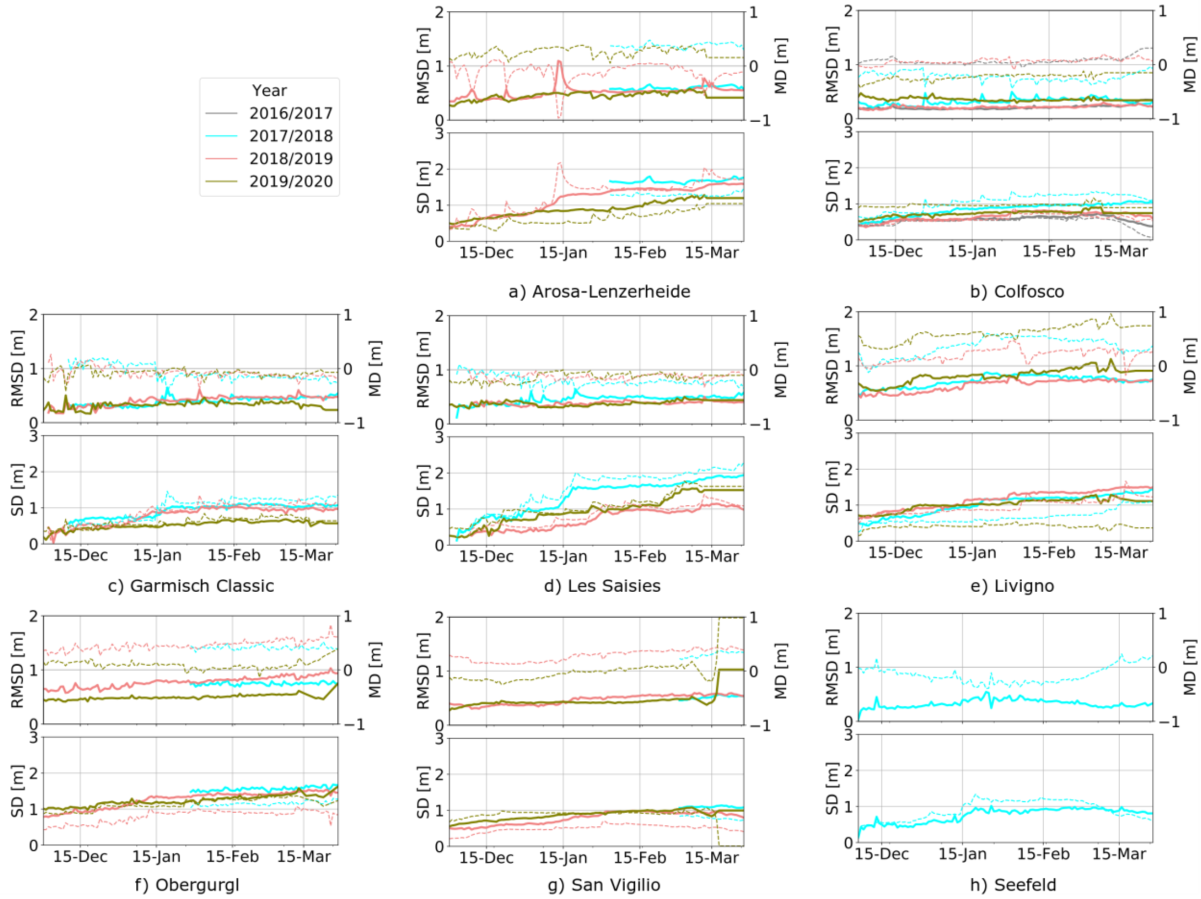

Figure 5: Root mean square deviation (RMSD) (upper subplots: solid line, left axis) and mean deviation (MD) (upper subplots: dashed line, right axis) averaged over space between GNSS measured snow depth (SD) (lower subplots: solid line, left axis) and simulated SD (lower subplots: dashed line, right axis) over time for the ski resorts. Within the period 2016-2020 we considered all valid GNSS measured snow depth data which were available.

Comment #5: L262-263 Although I haven't used and am not familiar with the grooming module, this error seems to be reduced if this module can turn on and off depending on the situation. This result can make suggestions to add them to improve the system.

[ANSWER] Correct but the snow management configurations of the simulations are currently not adapted to the daily snow management decision of the ski resorts managers. However, in future, we aim to include this; it is ongoing work.

Comment #6: L278-280 I think the averaging effects for RMSD can be avoided when 10m meshed GNSS (not averaged) and SRU averaged simulated data are compared. In this case, larger SRU size leads to larger RMSD. This comparison is not a requirement, but it is worth a try.

[ANSWER] In general, we think that this makes not so much sense to test this as the spatial variability of the 1 m resolution of the original GNSS data is too high to get plausible results compared to the simulated data. We decided to calculate the errors of the averaged snow depths, where the average is calculated with respect to the different SRU discretizations. This is of course (according to the reviewer) introducing averaging effects. Regarding the updated Figure 7 (see below), RMSD is getting smaller for coarser resolutions, whereas MD is more or less stable with variations that are not systematic. The RMSD shows that coarser resolutions work better due to these averaging effects, and this is what we actually want to show with this analysis. In other words, the simulations do not capture the high spatial variability of the snow depth as already mentioned in the manuscript. The aim was to find a good trade-off between high variability of GNSS and the inevitable coarse resolution of the SRU. According to this figure we state that 50 or 100 m altitudinal bands are a good trade-off in this sense. The potential analysis mentioned by the reviewer would only be another point of view for getting the same result.

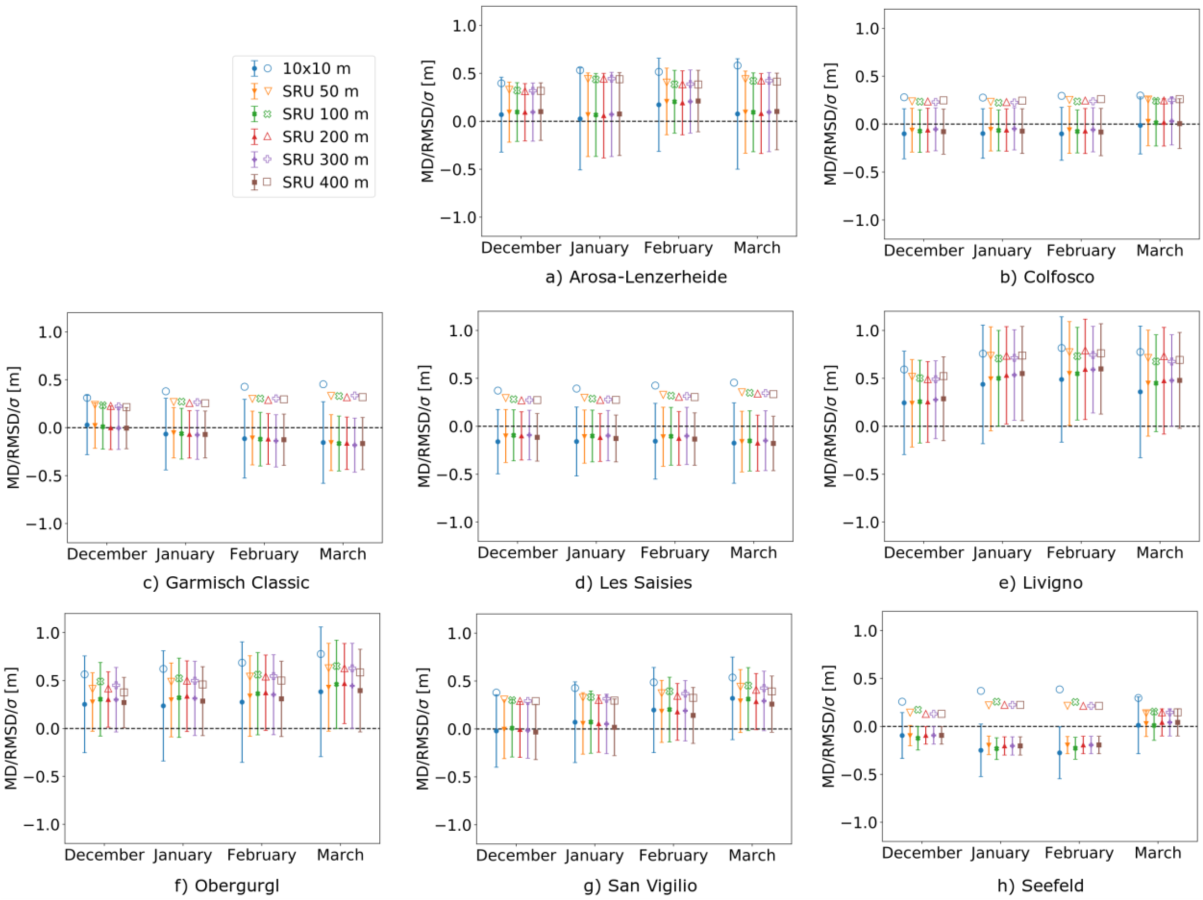

Figure 7: Overview of the root mean square deviation (RMSD, symbols), global average (MD) and standard deviation (σ, error bars) between simulated and GNSS measured snow depth considering all the time steps and the different resolution of the SRUs. The data are analysed for the four months December, January, February and March where GNSS data were available.

Comment #7: L355-362 I think it would be more informative if there is some mention of future plan, actuality to achieve, and level of importance for the improvement to resolve (1) - (5).

[ANSWER] We agree and will add the following paragraph to the “Conclusions and Outlook” section:

Line 423: “*Additionally, a detailed analysis to show the accuracy of the GNSS system to measure the snow depth is needed to validate the system. Moreover, integrating a snow redistribution model and an avalanche dynamics model into this system would help to point out where the biggest differences due to snow gliding or avalanches is given* *between the Sentinel-2 data and the simulations. Further studies on the topographic complexity of the snow-free terrain and the rather smooth piste surface are needed to e.g. implement an index of surface smoothing compared to the bare ground. Future studies investigatinghow skiers redistribute snow under certain meteorological conditions in combination with topographic conditions (e.g. aspect, slope angle…) would also help to overcome further potential errors."*

The authors