Natural Hazards
and Earth System
Sciences

Discussions

Interactive comment on "Enhancing the operational value of snowpack models with visualization design principles" *by* Simon Horton et al.

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In their manuscript "Enhancing the operational value of snowpack models with visualization design principles", the authors present the application of different visualization design principles in the domain of avalanche forecasting using data from the widely used model SNOWPACK.

General Comments

The manuscript is technically very well written, as well as easily readable and understandable. I list some general comments and specific remarks in the following.

I fully understand and appreciate the usefulness of the presented visualizations and their simplificatiion and aggregation character, however, I still would like to additionally see some conventional map plots at the top-level of the dashboard. This would be very helpful to get an overview of the domain and the spatial distribution of specific snow characteristics and avalanche problems. Examples of such visualizations are presented in e.g. Morin et al. 2020. Your aggregated plots would be a perfect summarizing and aggregating approach in a second visualization step.

In my opinion, the most important missing approach in the presented framework is the implementation of validation data. You state in different parts of the manuscript that practitioners lack trust in the integrity of model data. They won't gain any if they do not see the model performance at some validation points at a glance in the operational setup or at least in some hindcast simulations. I think some of the presented visualizations are perfectly suited to include observed validation data. You could simply include an interface to integrate measured snow profiles and plot them right into your visualizations as single highlighted data points or in the best case, somehow link them to their respective model grid point (this way, they could be included in all your visualizations, even the "sorted-by-depth" ones). I understand that it could be complicated to do this in a visually attractive way, but I think it would be well worth the effort.

While I very much like the presentation of your new color profiles, I am kind of torn as they are very much tailored to previous existing expert knowledge (potential weak layer = surface/depth hoar = highly visible) and is not very generic. Of course, this is very useful to detect the targeted wind slab avalanche problems, but what about other common avalanche problems (e.g. wet-snow avalanches). Are they also clearly visible in your visualizations? Regarding this remark, - if feasible - it would be very beneficial for the manuscript to include an additional example for a very different avalanche situation in the same domain.

I don't see the point of having so many words printed in italic letters even if they refer to specific technical terms. I think this is not necessary here and they could all just be

changed to normal fonts.

As the manuscript provides a technical report of the application of a visualization concept, it would be very beneficial to add information about the minimum requirements for a snowpack model in terms of resolution, simulation variables and output that is needed to feed the visualization software and dashboard. It is obvious that the software was developed for the use with SNOWPACK as a well-known and established snow (layer) model, but it would be interesting to read some more technical details about input requirements and portability.

It would also be useful to include some more variables displayed in your visualizations, e.g. depth profiles of snow temperatures or snow density which might also be useful for avalanche practitioners and should be provided by the SNOWPACK model.

The user survey presented in section 4 is very little explained and far from being representative, so you should consider removing the section and just move the last sentence of the section to your conclusions.

I have two other comments, which might well be beyond the scope of this paper, but could be a useful addition for the future development of the presented approach: In addition to the above-mentioned validation data, it would be very useful to provide a framework for ensemble simulations including uncertainty measures. The implementation of visualizations for multi-model results and corresponding model spreads and uncertainties (ensemble model outputs from e.g. different initial conditions, different meteorological forcing data, and different snow pack models) would be a logical and highly valuable (or even necessary) next step for the application of snowpack models in real-world operational avalanche forecasting settings (similar to NWP). You should add this somewhere in your conclusions. Another helpful addition for avalanche forecasters and practitioners would be the visualization of the meteorological input in your visualization framework, e.g. wind speed and gusts, (min./max./mean.) air temperature, liquid/solid precipitation, SW/LW radiation, all separated for elevation and aspect

bands and sectors (of course depending on resolution and origin of the gridded meteorological forcing, domain size, etc.).

Specific Comments

P. 1, L. 8/9: Rephrase the sentence "Examples of visualizations that support these tasks are presented and follow established perceptual and cognitive principles from the field of information visualization.", to e.g. "Examples of visualizations that support these tasks and follow established perceptual and cognitive principles from the field of information visualization are presented."

P.1, L. 18 and others: Regarding the term "workstations". Maybe Benjamin et al. 2019 labelled the development of software, more powerful computers and more available model and observation data as kind of mythical "workstations", I would prefer just to call it what it is, namely more powerful computers, more data, and better visualization tools that gradually developed in NWP and of course in all other fields.

P. 2, L. 7 and others: update citation Morin et al., is published now.

P.5, L. 10: "as hardness profiles" instead of "as a hardness profiles"

P. 6. Fig. 1: Do you have a version with better image quality available? The figure is very hard to read. However, I would suggest to remove Fig. 1 anyways as it does not contain important information in the context of the manuscript. If you decide to keep it, you should add some more information to the manuscript explaining what the reader is supposed to see in the figure.

P. 9, Fig. 2, x-axes right panel-plots: Please add explanation for the hardness abbreviations and a "hardness" x-axis label. It becomes clear from the text, but should be included in the figure or at least in the figure caption. That also holds for the hardness test abbreviations (F, 4F, 1F, P, K) which are clear for an avalanche practitioner (fist, 4 fingers, 1 finger, pencil, knife), but the article might be interesting for a broader (snow) scientific audience. Please add explanations.

P. 9, L. 15: "Herla et al., in preparation" should be removed if not already published by now.

P. 10, Fig. 3: Even if it is clear when reading the manuscript and figure caption, I would prefer to have an arrow-type label on the x-axis (e.g. "Thinnest snowpack <-> Thickest snowpack")

P. 11, L. 7: "way to visualize" instead of "way visualize"

P. 11, L. 10: I suggest to rephrase the sentence: "Instead, using eyes to...", e.g. "Instead, simultaneously comparing 1D/2D visualizations..."

P. 13, Fig. 6, caption: "slab" instead of "slabs"

P. 14, Fig. 7: Labels "Sep 30" and "Sep 23" overlap, please solve this issue.

P.14, L. 2: Please use italic here ("Tableau") as this seems to be the name of a commercial software developing company. Just a comment: it would be very beneficial if you would develop the dashboard in R or a similar open source programming language, as you have already done with the visualizations. This would foster the use of your very useful software by different target groups.

P. 15, Fig. 8: Could you provide a screenshot with better quality? The very useful dashboard is kind of hard to acknowledge here.