Comments on "Simulation of cold powder avalanches considering daily snowpack and weather situations to enhance road safety"

by

Julia Glaus, Katreen Wikstrom Jones, Perry Bartelt, Marc Christen, Lukas Stoffel, Johan Gaume, and Yves Bühler" (2024):

General comments:

The authors present a study that investigates the predictive capabilities of an existing coupled dense & powder flow model within the RAMMS:Extended software. To achieve this, they include a formulation of snow temperature and a formulation of snow cover entrainment with a variable distribution of erodible snow into their model.

First at all, it is not clear if these formulations are new in this publication or arise from earlier publications about the extended version of RAMMS. For example, entrainment is included since at least Bartelt, 2012 or Bartelt, 2018a. And for the temperature formulation, I know at least of the work by Valero, 2015 which includs release temperature already. It would add to the paper's quality if some information about how these connect to this publication is added.

I did not check the model equations, partially because the multitude of symbols is rather confusing. What I do not find is how the snow temperature alters the friction law. Eq. 15 states, the only temperature dependent parameter is beta. It is also completely unclear why alpha has no temperature dependence; to my understanding, the generation of the powder cloud is clearly temperature dependent. A discussion of why such a relation is chosen is missing.

Most of the results and discussion of the paper are on a parameter variation for the model input (release temperature, entrainment and gradients thereof) on a synthetic topography. While this is valuable standard approach to check the model and effects of the implementation, it is not sufficient as a proof for the formulated model assumptions, i.e. many explanations about the simulation study in sec. 4.1 sound too much like one would know these processes and effects from real avalanches (line 320ff., line 339ff).

It is unclear to me if the chosen synthetic topography is suited. The main parameter is runout distance or avalanche length (which needs precise definition by the way), but you never give those distances on the topography. Where is 900m, where is 1600m? See comment below to Fig. 3. To my knowledge, the Bramabuhl avalanche track is very steep from top to bottom, and then completely flat. So, everything runs basically to the valley floor. How would the results change if you had chosen a parabolic profile?

The comparison and discussion of the simulation on real topography with the measured data is weak. I do not understand how these three avalanches can support the claimed temperature and erosion gradient model formulation. These three avalanches experience the same snow cover. And Sec. 4.2 actually fits the friction parameters to one of the avalanches. However, a good point is that all three avalanches can be modelled with the same set of friction parameters.

I generally do not understand why you do not use data from your own test-site Vallee de la Sionne. Mass balances and snow temperatures have been measured there for more than a

decade. Generally, the paper lacks comparison and discussion with recent advances and publications from experimental avalanche measurements.

Specific comments:

L53: reference to r.avaflow missing. Or do you mean the AvaFrame (2023) reference, which points to a different model?

Fig3: Right side: Please add color scale, potentially remove the black background, and add lines that indicate runout distance (or avalanche length?)

Fig4: Why did you swap the colormap direction between both panels? Please be consistent, see also Fig. 16. Add elevation contour lines, add map corner coordinates, draw avalanche outlines in left panel. The left panel is too small to see anything, what about having the left panel in textwidth and three smaller panels underneath showing each release area (and not only Ruechi). Where can I see the wind redistribution effects?

L109: What is this post-processing tool and where are max. velocity, flow height and pressure used? In the ISSW publication and in here only runout distance is presented. BTW: I like Fig.4 from the ISSW publication, would have helped in here as well (Reference entry is missing ISSW, year and URL)

Sec. 2.2: A precise definition of runout distance or avalanche length is missing. Please add.

Fig5: Right panel: The smooth temperature gradient shows how bad the rainbow colormap is: The temperature gradient appears to have sharp changes at -8 and -6 degrees. Not to mention red/green color blindness. (A suggested good read on this topic is "Choosing Colormaps in Matplotlib" or “Somewhere over the rainbow…” https://journals.ametsoc.org/view/journals/bams/96/2/bams-d-13-00155.1.xml)

Fig6: Why not include the values from the particular avalanche into the example box (from Tab1)?

L153: Are all three literatures relevant here? You are not dealing with water content as you state in the very next sentence.

L156: All your measurements are from flat fields, but you project the temperatures onto a north facing slope. Some reasoning of why this is applicable would be helpful

L160: Missing Z of runout area.

L165: Christen, 2010, is a reference to normal RAMMS. Choose one for the extended version.

L171: If all those citations are important, please elaborate what each contribution is. Please give a short statement on each or use them throughout the description of the model in this section.

L234: Tab 3.2 is not typesetted as a table, caption missing.

L245: The experimental results from the cited publication must be discussed in respect to your results later in the publication. I guess there are more suited literature that backs the sentence here (e.g. Ancey 2007 or others)

L297: Sec.4.1 should be snow temperature+entrainment and Sec.4.3 comparison to measured avalanches

Fig8: You may indicate location of Fig.9 at -6°C with vertical line. Why is the chosen value for Delta_T 0.3 instead of 0.5 as indicated in Tab.1?

L305: I don't see that Dent (1998) backs your statement here.

L320: This is written as a fact, but fundamentally a model assumption. I suggest to discussion with your colleagues from Vallee de la Sionne about powder snow avalanches.

L322: Why should -10°C be more realistic?

L323-326: Also quite speculative.

L334 and Fig9: wording d* maximum erosion depth or snow height, be consistent.

Fig10: Please use same temperature range for colormap in all 3 panels (0 -- -13°C), currently all three panels look basically the same. You may indicate the location of Fig.8 at 0.3°C/100m with a vertical line. Legend overlaps value of runout especially in middle panel.

L339: Which experience? I would say PSAs need a lot of new (erodible) snow but are rather independent of absolute snow height.

L342: Large avalanches can erode much more than 1 meter, e.g. Fig 16 the middle part of the track is snow free.

Fig11: Evolution over time can be shown with a plot over time. Your ISSW paper suggests you can easily extract runout distance for different time steps. Please show the results in a runout distance over time representation.

L348ff: Please extend the discussion incorporating the prior mentioned publication Steinkogler,2015, Fischer,2018, Kohler,2018, Li,2020, Ligneau,2022 to suggest some.

L352: Why show Wildi avalanche here and not Ruchi? What I understood is, that you use Ruchi as the main avalanche for Sec.4.2, so it would be good to show this avalanche in greater detail.

L358: Reaction to entrained snow temperature can be rather fast, see for example the rapid changes in front velocity reported by Kohler,2018.

Sec.4.2: By the way, what kind of parameter mu0, xi0, N0 are used in Sec.4.1?

Eq24: As stated in Tab3.2, xi(t) limits the flow velocity and mu(t) the runout. How to find a good xi, when no velocity data is used?

L382: You never elaborate on the true runout distance of the avalanches.

L384: Sentence is unclear. Explain in more detail.

Fig12: I believe the avalanche runout is at 1600-1650m, because this shows the best fit square. However, Fig 8, 9, 10 only show very few parameter constellations that are able to reach this far. Therefore, it seems the "high point" at -8°C in Fig8 is absolutely needed… Please comment/discuss this. Also, your best fit parameters are on the border of your parameter space study (lowest row), how does this matrix extend to values of mu0 > 0.55?

L393: Missing mentioning of Fig14 in text. Before it was Fig13 and now Fig15? Please extend discussion on Fig14, also include the drone data into Fig14 for comparison.

L393ff: Fig15 shows the height of the dense core and a picture of the cloud. How can we compare both and get a "good agreement"?

L396: How do you know the air blast never exceeded 5kPa?

F16: Please annotate the mentioned avalanche arm (L399). Do both panels show snow depth? Or does the simulation show the deposition depth? What is the bow shaped deposition in the simulation and why is the other deposition in the river/road only, and not as smoothly distributed as suggested by Glaus, 2023, Fig3? Please extend description and discussion on Fig16.

L405ff: Why is the simulated deposition volume outside the mapped area not taken into account?

L407ff: Sentence is unclear. Reformulate and extend.

L409ff: The sentence comes rather unexpectedly. Where do I see wind scour? What does that mean for the simulations? Have you run the simulation with less snow?

L415: Impact pressure of powder cloud does not play a role in this publication. I also doubt that it's the most relevant danger for cars and people.

L418: I don't believe the model assumptions are correct for temperatures near melting, and this already starts at -1 to -2°C. The Ruchi avalanche shows -8 to -5 degrees.

L429: Evolution of finger was not well discussed.

L433: Snow cover models are not needed to calculate cloud coverage. Snow cover models would directly give a snow temperature and more (see work of Wever,2016,2018). I don't believe that cloud coverage will alter the snow temperature more than 20cm into the snow cover, but relevant avalanches for the road have easily >1m release height.

As said earlier, please think of using the data of Vallee de la Sionne as a future outlook.

L448: JG, MC missing. Who is AV, AW, PRJ?

Carefully check reference again. My list may be incomplete.

L461: DOI missing

L464: DOI missing

L478: weird characters in german title. Is there any other publicly availiterature?

L480ff: entry twice

L484: DOI missing

L504: list of authors incomplete

L506: missing journal and year

L510: DOI missing

L513: DOI missing

L515: DOI missing

L523: reference to published version, not discussion

L530: DOI missing

L536: any publicly available resource?

L543: Journal and DOI missing

L548: reference to published version, not discussion

L545ff: consistently use either Vera Valero or Valero (I believe later one). Check duplicates (Valero,2015,2018 and Vera,2015,2018)

L557: reference to published version, not discussion