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nhess-2016-61 Co-authors: N. Wever, Y. Bühler, L. Stoffel, S. Margreth and P. Bartelt.
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Response to Reviewer # 2

We thank reviewer 2 for his careful examination of the manuscript.

Reviewer:
The paper Modelling wet snow avalanche runout to assess road safety at a high- altitude mine in the central Andes is of good quality. The topic is definitely an impor-tant issue. It gives a clear overview of the actual research on wet snow avalanchesexplained with 5 examples. The paper consist of two parts: one part deals with wetsnow modelling and the second part provides a case study from a mining road in thecentral Andes. In my opinion the title promises rather a case study, but in the end itis a combination of in depth explanation of the new wet avalanche modelling and the5 examples in Chile. The material seems for me good enough for two good papers.This enables the authors to describe the new wet avalanche model precisely (with 2-3 different and simple examples for the explanation) as well as to display the applicability of the model in the Andes in more detail in an another paper. The users would be interested to get to know how the model really works in practice (i.e. in the Andes).I am interested especially in the interface to SNOWPACK in more detail. It seems to me that the fracture depth is insignificant as you have a growth factor (of volume) of about 20-90!

Response: The reviewer is right: because the initial mass is so small, the release zone height has no influences on the final simulation result. What is important is the entrainment depth. In fact, all events are more or less controlled by the snowcover properties.

Reviewer:
What about the xi-values? You are mentioning that you rather concentrate on the current snow conditions, but what about the quite rough and rocky terrain? You are discussing avalanches of max. 10.000m3

Response: In the paper *Dense avalanche friction coefficients: influence of physical properties of snow" Journal of Glaciology, 2013, 59(216), 771-782. M. Naaim found that there was a correlation between μ and the snow conditions (temperature) but he did not find a correlation between ξ and snow conditions. In the model ξ is function of the random kinetic energy (Bartelt, 2009) but does not depend on the liquid water content of the snow. Because the decay of random energy is higher in wet flows, the value of ξ is very much different than in dry flows.

Reviewer:
here the local terrain features (even partly without snow cover) will definitely have a strong impact on the simulations. So I would expect a few more sentences on this fact, especially as you have a 2m airborne laser scanner data available. The purpose of this paper is the explanation of the modelling, so it would be helpful for the readers to display the simulations in a suitable scale. You have aerial photographs,GPS points and mappings, you can display the mappings together with the simulations. The congruence of the avalanche events with the modelling is good, so you can also visualize it.

Response:
Done it in Figs. 6 to 10. The simulations results are plotted together now with the GPS measurements.

Reviewer:
Have you observed some rather random run out behaviour of the wet avalanches as turning almost in circles in the Andes as well? Have you taken into account this pattern of random

turns in wet snow avalanches? What would be the consequence for the modelling? I would be very curious of a few words on this.

Response:

It is an interesting point. In this particular valley all the avalanche paths are steep and end at the flat valley bottom. Therefore the avalanche paths have not this smooth transition with long run outs at rather flat slope angles. The avalanche records available from the mine show the avalanche always stopping at the lowest point without doing smooth curves.

Reviewer:

Line 89: An additional problem – there is no previous problem mentioned

Response:

Changed for One problem is thank you.

Reviewer:

Line 108: remove comma

Response:

Removed. Thank you.

Reviewer:

Line 125 (Equ. 2): 3 times the same the equations – the symbols a in the second and w in the third equation are missing.

Response:

Corrected. Thank you.

Reviewer:

Line 158: the notation (.) – already earlier in Equation (3) used (describe already there)

Response:

Corrected. Thank you.

Reviewer:

Line 165: this is an important sentence, please elaborate this more in details or give a cite

Response:

Citation included [Steinkogler, W., Sovilla, B., and Lehning, M. Influence of snow cover properties on avalanche dynamics. Cold Regions Science and Technology, 97, 121-131, 2014.]

Reviewer:

Line 179/ 180: explain in more detail or cite

Response:

Citations included Buser, O., and Bartelt, P. Production and decay of random kinetic energy in granular snow avalanches. J. Glaciol., 55(189), 3-12, 2009 And P. Bartelt and O. Buser and C. Vera Valero and Y. B/"uhler. Configurational energy and the formation of mixed flowing/powder snow and ice avalanches. Annals of Glaciology, 57(71), 179-188, 2016. Added

Reviewer:

Equ. (12): Suggestion: full derivation in appendix?

Response:

As we address to the first reviewer: Thank you, we made a big effort to improve the paper in comparison to the original manuscript. We also believe that climate change is an important aspect of the wet snow avalanche problem. Therefore, our goal was to write a self-contained manuscript describing the avalanche model in its entirety as well as several applications. We placed a special emphasis on the description of the special problems involved in modelling wet snow avalanches, including lubrication, meltwater production and moist-snow entrainment.

Reviewer:

Line 208: derivation – of the thermal layer

Response:

Corrected. Thank you.

Reviewer:
Line 216: the symbols i, a, w are used earlier, it would be helpful already in Line 120
Response:
Corrected. Thank you.
Reviewer:
Line 275: hs – see Figure 3?! (no hs in Fig. 4)
Response:
in figure 3 h_s denotes flow height. In figure 4 H_w denotes water content within the flow measured in mm of water.
Reviewer:
Line 297: why? Is this the result of observations? more details on the observation or cite.
Response:
It is an assumption we modelled like that. We chose this expression after the observations of the references.
Reviewer:
Line 326: when access is possible
Response:
Corrected. Thank you.
Reviewer:
Line 417: The avalanche – was observed
Response:
Corrected. Thank you.
Reviewer:
Line 447: – then show the GPS points in the figures of the examples All the GPS measurements are now included in the Figures 6 to 10 together with the avalanche simulations.
Reviewer:
Line 575: Cite this observation or give more details of the source; tan9=0,12?? – see Line 297/298
Response:
Corrected. Thank you.
Reviewer:
Line 612 to 619: – should be in the introduction instead of the conclusion!
Response:
These lines summarize the major goals of the paper and we consider them a good introduction for the conclusions.
Reviewer:
Figure 9: description: The model accurately .?? the avalanche – missing word
Response:
Corrected. Thank you