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Climate of the Past Discussions

Interactive comment on "Snow and weather climatic control on snow avalanche occurrence fluctuations over 50 yr in the French Alps" *by* H. Castebrunet et al.

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Thanks very much for your interest and comments. Please find our answers for each of your points:

(a) Among the variables considered it would be great to underline in the results and discussion sections the wind variable, considering the great contribution of this meteorological factor to the slab formation and the avalanche release. Did you find any trend concerning the wind speed? See for example Vautard, R., Cattiaux, J., Yiou, P., Thépaut, J.N., Ciais, P., 2010. Northern Hemisphere atmospheric stilling partly attributed to an increase in surface roughness. Nature Geoscience 3, 756-761. If I understood

the maximum wind speed and the associated direction are an output of the SAFRAN model.

»> Indeed, wind speed and its associated direction are SAFRAN outputs. However, this SAFRAN analyzed wind is not the 10m synoptic wind but a variable adapted for the calculation of turbulent fluxes in CROCUS. Thus, we cannot use it to take into account the effect of snow transport by wind.

Taking into account an increase of the surface roughness, resulting in lower winds (Vautard et al., 2010), seems applicable with difficulty considering the spatial and temporal scales of our models, because of the high variability of the snowpack in alpine massifs.

A new model chain is currently in test in CEN/Météo-France, integrating the snow transport by wind. We added section 4 p.4201 l.11 "A new parameterization into the SCM model chain, currently in test in CEN/Météo-France, will integrate the snow transport by wind."

(b) Other comments

(b1) Pag 4175 line 13 add temperature fluctuations and wind activity

»> Ok.

(b2) Pag 4175 line 26 What about the potential of sedimentology and stratigraphy in avalanche hazard research? See for example Blikra L.H. and T. Saemundson. The potential of sedimentology and stratigraphy in avalanche-hazard research. NGI Publication n_ 203 (1998) 60-64.

»> Thank you for the reference. We added "Sedimentology in stratigraphical profiles within snow avalanche prone areas reveal valuable information that attest the past recurrence of snow avalanches (e.g. Blikra and Sæmundsson, 1998)."

(b3)Pag 4176 line 24 add . at the end etc..

»> Ok.

(b4) Pag 4178 lines 7, 10: : :: : :delete. and add ; at the end of the sentences

»> Ok.

(b5) Pag 4179 line 26 : : :.. delete . and add ; at the end of the sentences

»> Ok.

(b6) Pag 4181 line 3 add a.s.l. after 3000 m

»> Ok.

(b7) Pag 4181 line 6 Why did you consider a threshold value of 40° slope for the avalanche release?

»> We worked in this study with numerous parameters: 60 snow and weather variables, considering all elevations and aspects. Therefore, we decided considering only 3 elevations and 4 main aspects, not to overcomplicate the models. Concerning slope, the model takes into account 3 slopes: 0, 20 and 40°. We chose then 40° because it is the only significant value for an avalanche release. Moreover, avalanche releases rarely occur on greater slopes, where snow does not accumulate. Note that we have treated here mean values at annual scale and massif scale. However, as slope is determinant for avalanche release, tests of sensitivity should be very interesting for further work at smaller scale.

(b8) Pag 4181, line 11: Wet snow is defined with a liquid water content greater than 0,01 %. Explain why, as usually the value is 8% (volumetric moisture). Only if the water content reaches 7% by volume does strength start to considerably decrease. See for example Mitterer et al., 2011 Annals of Glaciology 52(58) 2011

»> Yes, you're right: 8% is the value for a layer in water saturation and, of course, a high water content decreases the strength. However, we just give here a thermal definition of wet snow, not a stability definition: CROCUS model considers that the snow is wet

when the water content is greater than 0,01%. It's a minimum.

Note that MEPRA model considers, among others factors, snow layer water content to evaluate the snowpack stability.

We added ". . . wet snow layers thermally characterized by a liquid water content greater than 0.01% . . .".

(b9) Pag 4181 line 20: Why you didn't consider the meteorological seasons?

»> We consider these periods to take into account meteorological seasons and also, somewhat arbitrarily, both avalanche types (winter and spring releases, corresponding – once again, somewhat arbitrarily- to avalanches due, respectively, to snow accumulation and melting. Indeed, for snow and avalanches, these periods are more appropriate due to the main snow accumulation in winter and melting in spring. We added "These periods take into account meteorological seasons and also, somewhat arbitrarily, both avalanche types (winter and spring releases, corresponding – once again, somewhat arbitrarily- to avalanches due, respectively, to snow accumulation and melting."

(b10) Pag 4182 line 11: change "– the 57 explanatory SAFRAN-CROCUS snow and weather covariates" into ""– the 57 explanatory SAFRAN-CROCUS weather and snow covariates

»> Ok.

(b11) Pag 4184 line 3 add . at the end etc..

»> Ok.

(b12) Pag 4187 line 24. The stabilizing effect of large snow accumulation may be explained by the prevalence of destructive metamorphism? In this case it could be important to consider also if the large snow accumulation took place early in the winter season. This might be also an artifact of the stepwise procedure, but it would be interesting also to consider the previous thoughts. The same inverse correlation was

found also in analyzing the years of high avalanche activity (sections 3.3-3.6).

»> Yes, you're right, large snow accumulation have a stabilizing mechanic effect. However, we do not consider here recent snow accumulation but the total snow depth from the ground (potentially containing old snow layers). Moreover, we work at large temporal scale (year or season) and the analyze of snow and weather parameters variation during the season was not in the scope of this paper.

(b13) Pag 4190 line 22. Add "It also affected the Western Piedmont Alps, in Italy" (Maggioni et al., 2009)

»> Ok.

(b14) Pag 4193 lines 7-10 see comment above

»> See answer (b12)

Interactive comment on Clim. Past Discuss., 7, 4173, 2011.