Response to Interactive comment by Anonymous Referee #2

We thank the referee for this detailed review and for the numerous suggestions. Please find below our answers.

Specific comments: The manuscript lacks a description of (i) error measures of GSL data used as basis of the extreme value statistics, and (ii) general remarks on the reanalysis used to provide that data. In particular it would be crucial to tell something about the BIAS or absolute errors of the yearly maximum GSL values. Otherwise provided uncertainty assessments are less valuable. Furthermore a general description of some aspects of the reanalysis is missing. How is GSL calculated for the massif scale? Is the 50-year GSL return level computed by your models valid for the whole massif just depending on altitude? The abstract of Vernay (2019) states also a dependency on aspect and slope. You should clarify if your results are valid for distinct elevations or elevation bands (as it is stated here and there). In the latter case you should explain, how GSL values are assigned to that band (see lines 59, 71 in your manuscript).

The SAFRAN-Crocus reanalysis has been evaluated against various observation datasets, as reported in previous publications (Lafaysse et al., 2013, Vionnet et al., 2016, Revuelto et al., 2018, Vionnet et al. 2019). In most cases, the evaluation is carried out against in-situ snow depth observations and remote sensing snow cover information. For example, Vionnet et al., (2016) evaluated SAFRAN-Crocus snow depth data against 79 observed snow depth data in the French Alps for the 2010-2014 time period, with mean bias and standard error values of 18 cm and 37 cm, respectively. This corresponds to typical values for snow modelling systems applied in various regions on Earth. Because of lower data availability, evaluations against observed SWE values are less frequent than against snow depth data, although we note that Crocus has been shown to perform extremely well compared to other snow cover models, in terms of SWE, across many observation sites worldwide (Krinner et al., 2018) and SAFRAN-Crocus exhibits satisfying performance in terms of snow depth and SWE in the Pyrenees (Quéno et al., 2016), providing confidence, with respect to other existing datasets, in using this model chain for ground snow load (GSL) values. Further model evaluations, using additional datasets, are required to continue assessing and improving the quality of the model chain.

Furthermore, we highlight that we only used SAFRAN-Crocus reanalysis values on flat field, and we did not used simulations on slopes, hence it is not relevant to discuss the impact of slope and aspect on the results of this study.

Technical corrections:
We will correct expression/syntax mistakes that are mentioned. In the modified manuscript, we will clarify several points including:

80: As maximum values are relevant in this study, the procedure of _removing the top annual maximum when considered exceptional_ should be shortly addressed. I can imagine that one can find information about that in the given reference, but this is in French…

The procedure is as follows: «If the ratio of the largest load value to the characteristic load determined without the inclusion of that value is greater than 1.5 then the largest load value shall be treated as an exceptional value» (Sanpaolesi et al., 1998). This will be added to the revised version of the manuscript.

84: What exactly do you mean with _relative change_? Relative to what? (see also line 48)

We meant "relative change of 50-year return levels of GSL between 1960 and 2010". We will clarify it when necessary, and maybe refer to formula 4 (detailed expression).

126: I wonder if these complex expressions are necessary to understand the content? If not you could remove them.

We do not believe that the expression of the AIC is particularly complex. Most importantly, we think that this expression is necessary to understand the model selection, since the penalization of the log-likelihood by the number of fitted parameters clearly appears.

219: Why of all things 1800 m? Is this because Vercors top heights are around 1800m?

This is because French standards for extreme snow loads are defined from 200 m to 2000 m (Section 2). As we consider available altitudes between 200 m and 2000 m, only results obtained with reanalysis from 300 m to 1800 m are shown. However, the SAFRAN-Crocus reanalysis can provide results at higher elevation for the mountain areas peaking above 1800 m elevation.

Figure 8. Top left panel: Do you have a clue, why the uncertainties at lower altitudes are larger than at higher altitudes? With respect to the smaller number of available reanalysis stations at higher altitudes, this should be inverted, as can be seen in all other panels.

The reviewer must refer to the top-right panel (Vercors massif & Selected model) which is certainly different from the other panel.

Indeed, uncertainties usually grow larger with the altitude. Looking at similar plots to Figure 8 for all other massifs (not shown), this pattern is always seen for the left panels, i.e. with the stationary Gumbel model. However, for the right panels, i.e. for the selected model, 6 massifs out of 23 (Vercors, Ubaye, Oisans, Mercantour, Maurienne, Haut Var Haut Verdon) do not present this pattern, i.e. have larger uncertainties at lower altitudes. Some of these uncertainties might be due to variance in the estimated parameters. In particular, the shape parameter of the GEV distribution is known to be difficult to estimate. As shown in Figure 4, at 900 m the Vercors massif (most western massif) is colored in brown, meaning than its shape parameter roughly equals 0.3. This might explain the high uncertainty at 900 m in

the top-right panel, as small changes around 0.3 can have large effect in the 50-year return level.

257-258: You obtained the "same" results for time series with less than 10% of zero GSL values. Can you provide a similar number used by French standards for the decision to switch to a mixed discrete-continuous distribution?

In the French standards, the mixed discrete-continuous distribution was considered for all time series, those with less than 10%, of zero GSL values, as well as those with more than 10%.

299-300: This statement is unclear. I suggest to either remove it, or to provide more details. If you really would like to leave that here, you should provide at least a refer-ence for the European construction standards, and elaborate a little bit on those safety coefficients that might alter very widely according to country, professional, construction material, etc.

We agree with the reviewer that this paragraph should be more detailed, and this will be done in the revised manuscript. Concerning European standards (Sanpaolesi et al. 1998, page 32, equation 8), the design value for the structure equals the sum of i) the characteristic value of permanent action, i.e. self-weight, multiplied by a safety coefficient equal to 1.35 and ii) the characteristic value of variable action, i.e. roof snow load, multiplied by a safety coefficient equal to 1.5.

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