The Cryosphere Discussions

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Comment on tc-2021-276

Anonymous Referee #2

Referee comment on "Natural climate variability is an important aspect of future projections of snow water resources and rain-on-snow events" by Michael Schirmer et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-276-RC2, 2021

This study assesses projected evolutions of snow-related events in a small alpine region located in Switzerland, using a simulation chain composed of dynamical climate simulations, a stochastic precipitation generator, a snow model. This study provides interesting results about these possible future events, and the methodological choices seem reasonable, at least for the simulations, but there are two main aspects of the manuscript that need to be improved.

1. Presentation of the methodology

Section 2 is difficult to follow for several reasons. The first reason is that the different subsections 2.2, 2.3, 2.4 do not follow a logical order. When the snow model is described, we do not know how its inputs (total precipitation, air temperature, etc.) are obtained, or their spatial resolution. Another example, factors of change are first introduced in Subsection 2.3 whereas they are obtained from climate model outputs in Subsection 2.4. I advise following the order of the simulation chain: 1/Climate models, 2/ Weather generator, 3/ Snow model.

Secondly, while I understand that all the details of the methodology cannot be provided, the current presentation lacks important information. In particular, from Table 1, it seems that the different precipitation products are used to fit different properties of the precipitation fields (i.e. monthly mean rainfall using optimal interpolated fields, mean areal rainfall using weather radar data). Does it mean that the variability of precipitation at a monthly scale (mean, variance, skewness, etc.) is reproduced using these optimal interpolated fields? What information is used to reproduce statistical properties at a finer resolution (hourly, daily)? For example, how the largest ("extreme") values at daily and sub-daily scales are reproduced? Since this is an important aspect of the study which focuses on intense rain-on-snow events, it needs to be clarified. It was also unclear if there is any information of snow data at a daily scale. To my knowledge, weather radar data do not provide this kind of information. At a monthly scale, it is indicated at l.

110-111 that "optimal interpolation (OI) of snow depth sensor data and a gridded precipitation product, RhiresD) are used, but in Table 1, the line "Optimal interpolated fields" indicates that it is used to fit "Monthly mean rainfall", not snow, so that it is unclear if these OI fields provide total precipitation values or only rainfall. I am not sure where the product RhiresD appears in Table 1. What should be clarified is the list of the statistical properties (statistic, spatial and temporal resolution) of snow and rain that are fitted (and simulated) by the weather generator, and what source of information is used for each of these statistics.

At l. 131, it is indicated that factors of change are calculated, but no details are provided. For example, the factors of change are usually computed with respect to a reference period, but I could not find this information.

2. Uncertainty assessment

The uncertainty assessment really puzzled me. There is a large number of publications on uncertainty partitioning for climate model simulations (Déqué et al., 2007; Hawkins and Sutton, 2009; Northrop and Chandler, 2014; and many others). These papers all apply an Analysis of Variance (ANOVA) method which provides a clear and rigorous framework in order to obtain a total variance and its components. The different contributions logically sum to one. I do not really understand the approach proposed in Fatichi et al. (2016) which is based on the evaluation of percentile ranges. At l. 154, it is indicated that the 5-95th percentiles obtained from the ten climate models actually refer to the minimum and the maximum, which seems to be a major flaw of the method. Low and high percentiles cannot be obtained from a very limited number of climate simulations (even if you emulate these simulations) and the evaluation of the dispersion (variance) is the best that you can obtain. Secondly, I cannot understand how we can interpret the different contributions if they do not sum to one (l. 167). Fractional uncertainty, as a percentage (e.g. Fig. 3 in Hawkins and Sutton, 2009) provides a direct assessment of the most important contributors to the uncertainty. At l. 164-165, it is indicated that "weights [are used] to avoid overweighting days with only low climate change signal uncertainty". I do not see the problem of having a low climate change signal uncertainty, and why it becomes a problem using your approach. For all these reasons, I strongly recommend using a standard ANOVA approach for the uncertainty assessment.

3. Minor comments:

- All figure captions: Usually "(a)", "(b)", etc. are placed before the description of the respective subpanels.
- Figure 2: The labels of the y-axis are ILWR and ISWR for panels (c) and (d) whereas in the caption, it is inverted.
- 260: "by definition, only determined by natural variability": I am not sure what you mean by "definition". There is also an important part of model uncertainty for the current climate periods. This kind of uncertainty is usually removed mechanically using factors of change (as you did probably). A clarification would be appreciated here.

- 14 – l. 293: I guess “Figure 7” is missing.
- 17: Figure 9 is not presented and described.

References

Déqué, M., D. P. Rowell, D. Lüthi, F. Giorgi, J. H. Christensen, B. Rockel, D. Jacob, E. Kjellström, M. de Castro, and B. van den Hurk. 2007. “An Intercomparison of Regional Climate Simulations for Europe: Assessing Uncertainties in Model Projections.” *Climatic Change* 81 (1): 53–70. https://doi.org/10.1007/s10584-006-9228-x.

Hawkins, E., and R. Sutton. 2009. “The Potential to Narrow Uncertainty in Regional Climate Predictions.” *Bulletin of the American Meteorological Society* 90 (8): 1095–1107. https://doi.org/10.1175/2009BAMS2607.1.

Northrop, Paul J., and Richard E. Chandler. 2014. “Quantifying Sources of Uncertainty in Projections of Future Climate.” *Journal of Climate* 27 (23): 8793–8808. https://doi.org/10.1175/JCLI-D-14-00265.1.