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Earth System Dynamics
Discussions

Interactive comment on "Winter hydrometeorological extreme events modulated by large scale atmospheric circulation in southern Ontario" *by* Olivier Champagne et al.

Anonymous Referee #2

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The authors investigate the occurrence of rain on snow events with a single model ensemble. Overall this is a very interesting paper with a good application of the bottom-up approach that has recently been endorsed for studying compound events.

Using the compound exceedance of a precipitation and temperature threshold seems relatively naive, given that large increases in temperature in the future will lead to very different snow cover patterns, a key determinant of ROS events. A more appropriate variable than temperature seems to me the difference in surface snow amount between consecutive days, which could be used as a proxy for snowmelt. This is available from the model output. With this it should be possible to build a better compound index that

should also be more reliable in future projections.

I suspect streamflow is very non-gaussian distributed. In particular, it's asymmetric and bounded from below. Taking the mean +3 standard deviations as an indicator for extremes is thus very unintuitive and not really appropriate for such a distribution. I would suggest to use a high percentile (e.g. above the 99th percentile, or something similar, could also be more extreme). This can then also be translated easily into a return period.

Would it be an option to us only the weather patterns based on the observations and classify the models according to those? This might reduce differences between models and observations with respect to the occurrence rate of heavy precip and warm events (the authors discuss this point in sec 4.1).

Please mention somewhere explicitly how the compound index is defined. Is it just the occurrence of events where both temperature and precipitation exceed a certain threshold? Or the number of such occurrences?

Minor comments: I would recommend the authors to do a thorough spell check and grammar check. There are a number of minor grammatical errors and typos in the text.

L 49: start new paragraph

L59: "preconized" ?

L67: "contributes to": maybe better: "explains the variability of"

L69: "occurrence of the index": an index does not occur, it has a certain value. Better "relationship between the index and recent large-scale atmospheric circulation" ("past" sounds a bit like historical)

L84: Univariate bias correction might induce artefacts when studying compound events (Zscheischler et al., 2019), this might be highly relevant here. Consider applying a multivariate bias correction approach.

Figure 2: “blue lines correspond to high flows” is unclear. There is one blue line in the precipitation figure and a red line in the temperature figure. It looks as if they would just correspond to the mean of the boxplots. It would be surprised if the highflows would align so well with the precipitation amounts. Please clarify.

Section 3.2: I assume this is after bias correction?

Figure 4 and following: are these comparisons on the same spatial grid?

Figure 8: why do so few events result in high streamflow?

Consider reporting the events as relative numbers (e.g. sections 3.2, 3.3). This might be more intuitive as it is easier for the reader to put the occurrence probability into context.

Some method description appear in the results, e.g. L 215 and following.

L220: I assume TOT are the events as simulated with the hydrological model? This should be mentioned somewhere explicitly.

References: Zscheischler, J., Fischer, E. M. & Lange, S. The effect of univariate bias adjustment on multivariate hazard estimates. Earth Syst. Dyn. 10, 31–43 (2019).

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