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Interactive comment on "Projected intensification of sub-daily and daily rainfall extremes in convection-permitting climate model simulations over North America: Implications for future Intensity–Duration–Frequency curves" *by* Alex J. Cannon and Silvia Innocenti

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Below we present replies (Reply) to the reviewer comments (Comment) below.

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Comment 1): How does the station-specific estimates based upon GEVSS compare with the estimates based upon the regional frequency analysis?

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Discussion paper

Reply: The reviewer raised an interesting question regarding the performances of the GEVSS model compared to other classical IDF estimation methods, such as Regional Frequency Analysis (RFA). The direct comparison of station-specific GEVSS IDF with RFA IDF would in fact allow to evaluate more thoroughly the GEVSS performances and refine the validation of IDF simple scaling models that have been undertaken in some previous studies [e.g., Blanchet et al. 2016, Innocenti et al. 2017, Boukhelifa et al. 2018].

However, a more sophisticated methodology should be considered to accurately define a meaningful comparison between GEVSS and RFA IDF. For instance, the estimation of RFA IDF relies on the identification of homogeneous geographical regions that allow to pool stations with similar characteristics. This can be achieved by various methods [e.g., Grimaldi et al, 2011; Hosking and Wallis, 1997; among others] which yield different performances in different specific analyses. While it is beyond the scope of this study to perform such additional analyses, the revised manuscript will stress the importance of considering alternative methods for the estimation and validation of IDF curves in practical situations.

Boukhelifa M, Meddi M, Gaume E. Integrated Bayesian Estimation of Intensity-Duration-Frequency Curves: Consolidation and Extensive Testing of a Method. Water Resources Research. 2018 Oct; 54(10):7459-77

Grimaldi S, Kao S-C, Castellarin A, Papalexiou S M, Viglione A, Laio F, Aksoy H and Gedikli A(2011) Statistical Hydrology. Peter Wilderer (ed.) Treatise on Water Science, vol. 2, pp. 479–517 Oxford: Academic Press.

Hosking, J.R.M., Wallis, J.R., 1997. Regional Frequency Analysis: An Approach Based on L-moments. Cambridge, UK, 244pp

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Comment 2) As mentioned in the line 12 of the manuscript, what interpolation method

did you use to interpolate the data from grid points to the station locations? Did you try considering different interpolation schemes to see which scheme introduces the least error?

Reply: As suggested by the reviewer, the method used to associate points and grid box estimates at different spatial resolutions inevitably affects the results of gridded dataset evaluation. Moreover, it is generally difficult to quantitatively assess the effects of this resolution mismatch and various interpolation methods should be compared for different errors statistics, including those considered in our study. However, a comprehensive evaluation of the relative contribution of the resolution mismatch to the overall difference between grid and point rainfall estimate is beyond the scope of the paper. For sake of simplicity, stations were thus associated to the corresponding (overlapping) grid box of each gridded dataset without the use of additional interpolation methods. To clarify this point the following sentence will be added to the text (p. 12 l.17): "Locations were identified by station coordinates and stations were associated to the overlapping (nearest centroid) grid box within each dataset."

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Comment 3) Are there any significance tests for the statistics MLAR and MALAR? If yes, it would be better to include results of the tests in figures 5,7-8.

Reply: No significance test was initially considered for the analysis of MLAR and MALAR. Mention of the field significance [Wilks, 2006] of permutation test results could be added to the revised manuscript to stress the significance of the two aggregated error statistics.

Wilks, D.S., On "field significance" and the false discovery rate. Journal of Applied Meteorology and Climatology. 2006 Sep; 45(9):1181-9.

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Comment 4) Please explain in detail how did you perform "permutation test" mentioned

in line 26.

Reply: The description of the applied permutation test (p. 12 l.26) will be modified to: “A permutation test was used to estimate the statistical significance of the RE values. Assuming the equality of station and grid box distribution of X, the permutation test considers a null hypothesis of quantile equality. Under this null hypothesis, station and grid box annual maxima were pooled for each given location. Pooled observations were then randomly reassigned to two permutation resamples (i.e. two annual maxima series of shuffled observations) having equal length than the station and grid box original (unpermuted) samples. For each station-grid box pair, the distribution of the RE statistics were thus approximated on 5000 random permutation resamples and the p-value was computed as the fraction of resamples generating RE absolute values equal or larger than those observed on the original annual maxima samples.”

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Comment 5) Please explain the term "Pseudo-global warning”.

Reply: The description of the pseudo-global-warming technique [e.g., Rasmussen et al. 2017 and references therein] will be added to the revised manuscript.

Rasmussen, K. L., Prein, A. F., Rasmussen, R. M., Ikeda, K., and Liu, C.: Changes in the convective population and thermodynamic environments in convection-permitting regional climate simulations over the United States, Climate Dynamics, https://doi.org/10.1007/s00382-017-4000-7, 2017.

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Comment 6) please explain the term "convection-permitting". Reply: A brief explanation of the term will be added in Sect. 2 of the revised manuscript, as well as the reference to key discussions about convection-permitting modeling techniques [e.g., Prein et al. 2015 and Kendon et al., 2017].

Kendon EJ, Ban N, Roberts NM, Fowler HJ, Roberts MJ, Chan SC, Evans JP, Fosser

G, Wilkinson JM. Do convection-permitting regional climate models improve projections of future precipitation change?. Bulletin of the American Meteorological Society. 2017 Jan; 98(1):79-93.

Prein AF, Langhans W, Fosser G, Ferrone A, Ban N, Goergen K, Keller M, Tölle M, Gutjahr O, Feser F, Brisson E. A review on regional convection-permitting climate modeling: Demonstrations, prospects, and challenges. Reviews of Geophysics. 2015 Jun; 53(2):323-61.

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