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Interactive comment on "Simulating climate warming scenarios with intentionally biased bootstrapping and its implications for precipitation" *by* Taesam Lee

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Author response to the reviews of the paper "Simulating warming climate scenarios with intentionally biased bootstrapping and its implications for precipitation" (Manuscript # gmd-2016-188) Taesam Lee Reviewer #1

M. A. Ben Alaya (Referee) In this paper, the author presents a statistical non parametric resampling approach called intentionally biased bootstrapping (IBB) to simultaneously simulate temperature and precipitation at a single site taking into account the increase of the temperature according to observed global warming data. The manuscript is well organized and the methodology is adequate, reasonable and clearly presented. The problematic and the application are of great interest for GMD. Hence I suggest to

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publish this paper. However, there are a few statements that don't entirely ring true, and I'd like the author to address these a bit more carefully. Also, drawbacks of the proposed method should be mentioned and discussed. Reply: The author appreciates this reviewer's generous comment. The author tried his best efforts to improve the manuscript. Hope this improvement is satisfactory to this reviewer.

Below I list relatively minor points that could be addressed with some small revisions to the text and a few more figures: 1- Line 31: "The temperature variable is the most reliable of the GCM outputs". I'm not sure that this statement is true. Reply: The author really appreciates this reviewer's detailed comment. The sentence was modified accordingly as: "The temperature variable is more reliable than other variables in GCM outputs."

2- Line 57: I agree that moisture availability increases at the same rate with warming through the Clausius-Clapeyron (C-C) relation. Nevertheless this does not guarantee that precipitation intensity should also increase at the same rate, this presumably assumes stationarity of precipitation efficiency. Reply: The author totally agrees with this reviewer's comment. The sentence was circumvented as follows: " From the Clausius-Clapeyron (C-C) relation, saturation vapor pressure increases by 6-7% for each 1oC increase in temperature and rainfall intensity also increases in a similar rate with warming (Trenberth and Shea, 2005)." 3- The proposed approach is based on the assumption that only the mean of observed temperature changes in the future, and assumes a static variance in the future. This assumption should be mentioned. Indeed the proper reproduction of the temporal variability is a very important issue, because a poor representation of the temporal variability could leads to a poor representation of extreme events. Reply: The author really appreciates this reviewer's insightful comment. The limitation and its possible development is discussed at the conclusion section as the below. Hope this modification is satisfactory to this reviewer.

"The proposed IBB method is conditioned and assumed only on the mean temperature change. A further scheme can be developed to consider the changes of multiple

variables with classifying the conditions of interested variable."

For the relation of the temporal variability and extreme events, the author consider that this reviewer's comment can be true but not always as far as this reviewer's viewpoint. Further study relates on this issue can be studied in near future.

4- Line 166: "Unlike for the case of temperature, there is no variance reduction in the resampled precipitation data because the precipitation data are not conditionally resampled"; I'm not sure that this statement is true. The existence of dependence between precipitation and temperature which motivates this work implies the existence of a concordance in the ranks of these variables. In the case of dependence there will always be some reduction in the variability of precipitation using the IBB technique. I ask the author to verify this fact by comparing the observed variance and the simulated one in the case of precipitation. Reply: The author really appreciates this reviewer's insightful comment. The author compared the observed variance with the simulated one for all the 54 stations. No significant variance reduction was observed and even some stations (15 stations) present variance inflation (i.e. simulated variance is bigger than the observed variance). Therefore, the author consider that the statement can be true but with a little less certainty. The sentence was modified as: "not much significant variance reduction is expected in the resampled precipitation data because the precipitation data are not conditionally resampled."

5- The proposed approach is not appropriate to simulate change in extreme events, indeed as it is the case for most resampling approach the IBB technique suffers from the inability to simulate values that are more extreme than those observed. Reply: The author really appreciates this reviewer's insightful comment. The authors consider that long-term variability of extremes can be derived from the IBB method when it is related with other variables such as precipitation. But it might be limited since no physical mechanisms can be included. This limitation and possible extension were discussed from this reviewer and the other reviewer's comment at the conclusion as follows:

“The proposed IBB method is not a physical-based method but a statistical simulation approach in which a physical mechanism of precipitation cannot be taken into consideration. Substantial modification might be required to accommodate this mechanism. The proposed IBB method is conditioned and assumed only on the mean temperature change. A further scheme can be developed to consider the changes of multiple variables with classifying the conditions of interested variable. Another possible extension of the current study must be on analyzing the future variation of hydrological extreme events (e.g. extreme floods). When a long-term variation of hydrological extreme events is related with precipitation, the proposed IBB method can be used to derive the variation. ”

Please also note the supplement to this comment:
http://www.geosci-model-dev-discuss.net/gmd-2016-188/gmd-2016-188-AC2-supplement.pdf

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