Climate and Atmospheric Science Standing Committee review of "Changes in Hourly and Daily Extreme Rainfall Amounts in NJ since the Publication of NOAA Atlas 14 Volume" and "Projected Changes in Extreme Rainfall in New Jersey based on an Ensemble of Downscaled Climate Model Projections"

The Climate and Atmospheric Science Standing Committee of the New Jersey Department of Environmental Protection Science Advisory Board reviewed two reports on extreme rainfall, "Changes in Hourly and Daily Extreme Rainfall Amounts in NJ since the Publication of NOAA Atlas 14 Volume" (hereafter "Atlas 14 report") and "Projected Changes in Extreme Rainfall in New Jersey based on an Ensemble of Downscaled Climate Model Projections" (hereafter "Projected Changes report").

The overall sense of the committee members who contributed to the review (M. Aucott, A. Broccoli, N. Davi, P. Hopke, R. Leichenko, A. Robock) is that the reports were professionally done and should be potentially quite useful to NJDEP in aspects of its mission to which extreme precipitation is relevant. The authors have used methods that are consistent with the state of the science. That said, the problem of how best to downscale information from global climate models remains an area of active research, such that the results presented in the Projected Changes report should be regarded as provisional.

Although the committee has a positive impression of these two reports, some aspects could be improved. These are enumerated and discussed below.

1) The statistical tests and methods of determining uncertainty are not adequately documented. For example, the Atlas 14 report discusses the patterns of statistical significance of changes in recurrence levels. How was significance determined? It appears that a Monte Carlo method was used, but it is not well documented. With regard to uncertainty, the choice of the 17th-83rd percentile range as the "likely" range should either be justified, or percentile ranges should be presented so that the users can determine what level of uncertainty is appropriate for their purposes.

2) Some additional explanation of terminology would be helpful. For example, the description of partial duration rainfall series in the Atlas 14 report is unclear. Generalized extreme value (GEV) analysis methods are often categorized as either "block maxima" or "peaks over threshold." The GEV analysis method used would appear to be the latter, but clearer discussion would eliminate any ambiguity.

3) Many of the figures in both reports are difficult to read. Furthermore, their interpretation is complicated by using different color scales in figures that depict the same quantities, such as change factors. The captions could be improved also. For example, ratios should not be labelled as differences, as they are in the maps in the Atlas 14 report.

4) The Atlas 14 report should have an abstract or executive summary preceding it.

5) There are a substantial number of typos in the Atlas 14 report. In addition, the tables on pp. 68-79 of the Projected Changes report are blank.

6) The data in both reports are presented as adjustments to recurrence levels (i.e., the amount of precipitation associated with a particular recurrence interval). Might it also be helpful to document changes in recurrence intervals for particular precipitation thresholds?

7) Because it uses past events as analogs, it would seem that LOCA downscaling used in the Projected Changes report is constrained by what has happened in the past. How does this method account for the possibility—or perhaps likelihood—that there may be future events that have no historical analogs?

Finally, there is one last point that may be difficult to directly address but perhaps could be discussed as a caveat in the Atlas 14 report. Given that the report documents the sensitivity of recurrence levels to individual heavy rain events, how would the recent excessive rains from Ida and Henri change the results?

Responses to the Climate and Atmospheric Science Standing Committee review of "Changes in Hourly and Daily Extreme Rainfall Amounts in NJ since the Publication of NOAA Atlas 14 Volume" and "Projected Changes in Extreme Rainfall in New Jersey based on an Ensemble of Downscaled Climate Model Projections"

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The overall sense of the committee members who contributed to the review (M. Aucott, A. Broccoli, N. Davi, P. Hopke, R. Leichenko, A. Robock) is that the reports were professionally done and should be potentially quite useful to NJDEP in aspects of its mission to which extreme precipitation is relevant. The authors have used methods that are consistent with the state of the science. That said, the problem of how best to downscale information from global climate models remains an area of active research, such that the results presented in the Projected Changes report should be regarded as provisional.

Thanks for this very positive assessment of our work

Although the committee has a positive impression of these two reports, some aspects could be improved. These are enumerated and discussed below.

1) *The statistical tests and methods of determining uncertainty are not adequately documented. For example, the Atlas 14 report discusses the patterns of statistical significance of changes in recurrence levels. How was significance determined? It appears that a Monte Carlo method was used, but it is not well documented. With regard to uncertainty, the choice of the 17th-83rd percentile range as the "likely" range should either be justified, or percentile ranges should be presented so that the users can determine what level of uncertainty is appropriate for their purposes.*

   The 17th and 83rd percentile range was presented at the request of the DEP. Apparently this was to align the uncertainty range used for extreme rainfall projections with that used for sea-level rise projections. In addition to these percentiles, data files supplied to DEP included the 10th, 25th, 75th and 90th percentiles as well as the median.

   In the Atlas 14 report, pages 9 and 10 describe the procedure used to assess significance in some detail. It is not clear what additional documentation can be added. Rather, the results section of the report was modified to redirect the readers to this earlier discussion if the resampling technique. The sentence at the top of page 22, now reads "Figures 10 and 11 show that the general increase in RI rainfall amounts since 2000, are at many stations greater than would be expected to occur randomly, based on the resampling procedure outlined in section 3b."

2) *Some additional explanation of terminology would be helpful. For example, the description of partial duration rainfall series in the Atlas 14 report is unclear. Generalized extreme value (GEV) analysis methods are often categorized as either "block maxima" _or "peaks over threshold." _The GEV analysis method used would appear to be the latter, but clearer discussion would eliminate any ambiguity.*

We have used a block maxima approach analogous to that used by NOAA in the development of Atlas 14. The text has been clarified to address this comment. A sentence was also added to the report to define a partial duration series.

3) *Many of the figures in both reports are difficult to read. Furthermore, their interpretation is complicated by using different color scales in figures that depict the same quantities, such as change factors. The captions could be improved also. For example, ratios should not be labelled as differences, as they are in the maps in the Atlas 14 report.*

   We are not sure how to improve the readability of the graphs, the color schemes etc. were developed iteratively with the DEP. Essentially, we have used brown tones to signify decreases in rainfall and blue and green to depict increases. In the projection data, the desire to show fairly narrow change factor intervals (e.g. 0.025) necessitated the use of a broad color spectrum while trying to retain the brown to blue continuum. Showing the upper bounds of the confidence intervals required a shift in palette to reds and pinks given the range in values that needed to be mapped.

   The confusion between differences and ratios is understandable. The figure captions have been revised, replacing difference with ratio.

4) *The Atlas 14 report should have an abstract or executive summary preceding it.*

   This has been added.

5) *There are a substantial number of typos in the Atlas 14 report. In addition, the tables on pp. 68-79 of the Projected Changes report are blank.*

   This has been fixed

6) *The data in both reports are presented as adjustments to recurrence levels (i.e., the amount of precipitation associated with a particular recurrence interval). Might it also be helpful to document changes in recurrence intervals for particular precipitation thresholds?*

   This is an excellent idea, unfortunately this work is outside the scope of the original project. We are exploring implementing this approach in other work.

7) *Because it uses past events as analogs, it would seem that LOCA downscaling used in the Projected Changes report is constrained by what has happened in the past. How does this method account for the possibility—or perhaps likelihood—that there may be future events that have no historical analogs?*

   The LOCA methodology addresses this possibility by using an anomaly approach. An anomaly field is generated representing the change in climatology between the historical and future period. Ultimately this is added to the downscaled variable field. Moreover, the use of CORDEX downscaled data and the use of change factors as opposed to simulated precipitation amounts also compensates for this potential source of uncertainty.

8) *Finally, there is one last point that may be difficult to directly address but perhaps could be discussed as a caveat in the Atlas 14 report. Given that the report documents the sensitivity of recurrence levels to individual heavy rain events, how would the recent excessive rains from Ida and Henri change the results?*

   This is another excellent idea, but unfortunately outside the scope of the original project. As an off-shoot of this project, the website http://precipchange.nrcc.cornell.edu has been developed. This site updates station-based extreme rainfall statistics annually, so updated results that include Ida and Henri will be available in early 2022.