Hydrometeorological Design Studies Center

Progress Report for Period
OCTOBER 2018 to MARCH 2019

Office of Water Prediction
National Weather Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Silver Spring, Maryland

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DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various tasks associated with these projects. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any other purpose does so at their own risk.

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I. INTRODUCTION

The Hydrometeorological Design Studies Center (HDSC) within the Office of Water Prediction (OWP) of the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) has been updating precipitation frequency estimates for various parts of the United States and affiliated territories. Updated precipitation frequency estimates, accompanied by additional relevant information, are published as NOAA Atlas 14 and are available for download from the Precipitation Frequency Data Server (PFDS).

NOAA Atlas 14 is divided into volumes based on geographic sections of the country and affiliated territories. Figure 1 shows the states or territories associated with each of the volumes of the Atlas. To date, precipitation frequency estimates have been updated for AZ, NV, NM, UT (Volume 1, 2004), DC, DE, IL, IN, KY, MD, NC, NJ, OH, PA, SC, TN, VA, WV (Volume 2, 2004), PR and U.S. Virgin Islands (Volume 3, 2006), HI (Volume 4, 2009), Selected Pacific Islands (Volume 5, 2009), CA (Volume 6, 2011), AK (Volume 7, 2011), CO, IA, KS, MI, MN, MO, ND, NE, OK, SD, WI (Volume 8, 2013), AL, AR, FL, GA, LA, MS (Volume 9, 2013), CT, MA, ME, NH, NY, RI, VT (Volume 10, 2015), and TX (Volume 11, 2018). No funding is available to extend NOAA Atlas 14 coverage to the remaining five northwestern states: ID, MT, OR, WA, WY in Volume 12.

For any inquiries regarding NOAA Atlas 14, please send an email to HDSC.questions@noaa.gov.

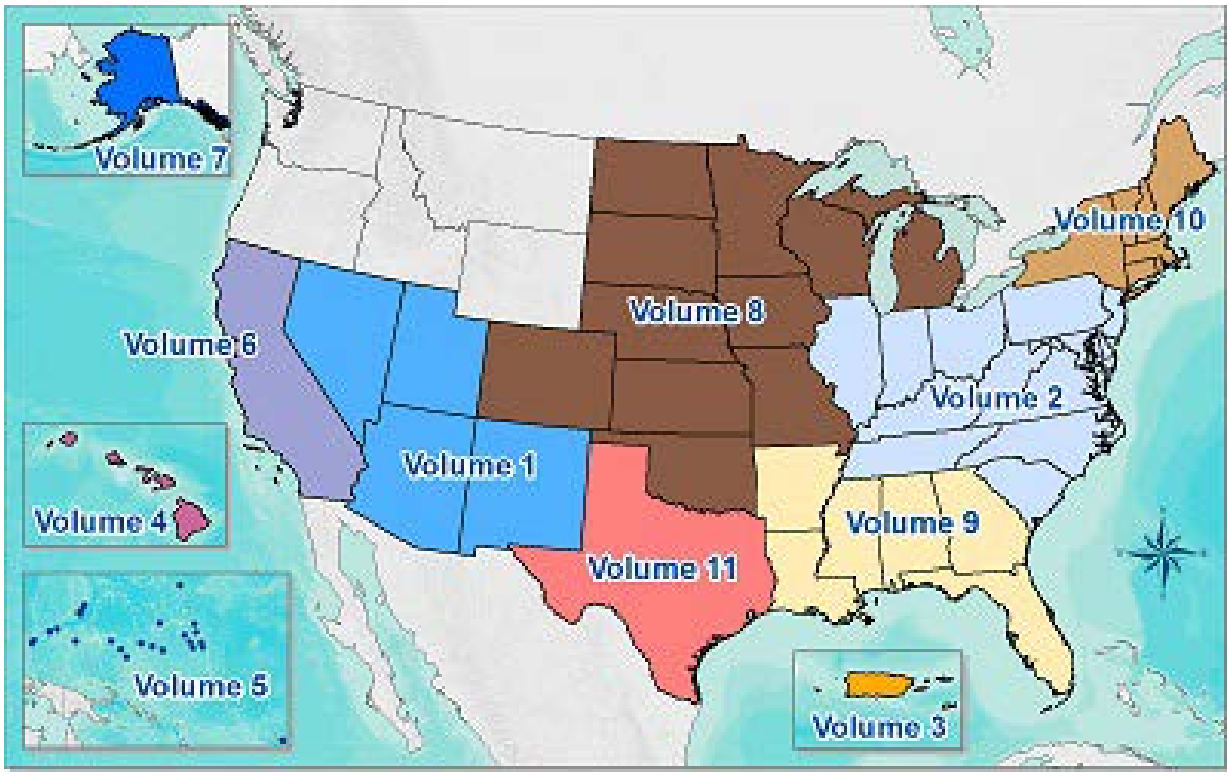

Figure 1. States or territories associated with each of the volumes of the Atlas.

II. CURRENT NOAA ATLAS 14 PROJECTS

1. VOLUME 10: NORTHEASTERN STATES

Precipitation frequency estimates for the following seven northeastern states: Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont were released in September 2015 as NOAA Atlas 14 Volume 10 Version 2. We revised the estimates and published them as Version 3 in March 2019. The publication includes artifacts similar to those provided in previous NOAA Atlas 14 volumes, including access through the Precipitation Frequency Data Server (PFDS), base grids in standard formats together with error estimates, electronic copies of maps, charts of seasonal distributions and probabilistic temporal distributions of heavy precipitation, and detailed documentation.

The NOAA Atlas 14 Volume 10 Version 3 information supersedes the information published in NOAA Atlas 14 Volume 10 Version 2.

The release of Version 3 estimates with accompanying documentation marks the completion of the Volume 10 project.

1.1 PROGRESS IN THIS REPORTING PERIOD (OCT 2018 - MAR 2019)

During this reporting period, we completed work on the NOAA Atlas 14 Volume 10 project. We updated the NOAA Atlas 14 Volume 10 Version 2 precipitation frequency estimates and accompanying information, including documentation, and published them as Version 3. The updates included adjustments to precipitation frequency estimates at the Warren, NH and Woonsocket, RI stations, improved shape of the depth-duration-frequency curves, and minor adjustments on the lower bounds of the 90% confidence interval for longer daily durations. The updates in Version 3 are described below and also in the Addendum of the NOAA Atlas 14 Volume 10 Version 3 document.

a. Adjustments to precipitation frequency estimates at the Warren, NH and Woonsocket, RI stations

1000-year estimates at the Warren, NH (27-8885) station and estimates for average recurrence intervals (ARIs) of 100-year and above at Woonsocket, RI (37-9423) from Version 2 were unreasonably high due to a data-entry error for in 24-hour AMS. After correction, the 100-year 24-hour estimate for Warren decreased from 6.75 to 6.13 inches and the 1000-year estimate went down to 8.97 inches from 11.75 inches. The 1000-year 24-hour estimate at Woonsocket changed from 13.36 inches to 12.63 inches. This change affected the estimates in the vicinity of the two stations. The map in Figure 2 illustrates the differences between Version 3 and Version 2 1000-year 24-hour estimates in inches.

b. Improved shape of depth-duration-frequency curves

We replaced a smoothing function used in Volume 2 with a piecewise cubic hermite interpolating polynomial function to further improve the shape of depth-duration-frequency curves. The overall change to estimates across all durations and frequencies due to this modification was trivial. Figure 3 shows, as illustration, the difference in inches between 20-day 200-year estimates from Versions 3 and 2 where the highest adjustment was observed. Section 4.6.3 in the documentation provides more information on this process.

c. Adjustments on lower bounds of 90% confidence interval

Version 2 lower bounds of the 90% confidence interval for durations longer than 20-day and ARIs above 100-year from Version 2 failed consistency checks in some locations by fractions of an inch. In Version 3 that error was fixed. Figure 4 shows, as an example, the areal extent and magnitude (in inches) of the changes to the 60-day lower bounds at 1000-year ARI where the highest adjustments were observed.

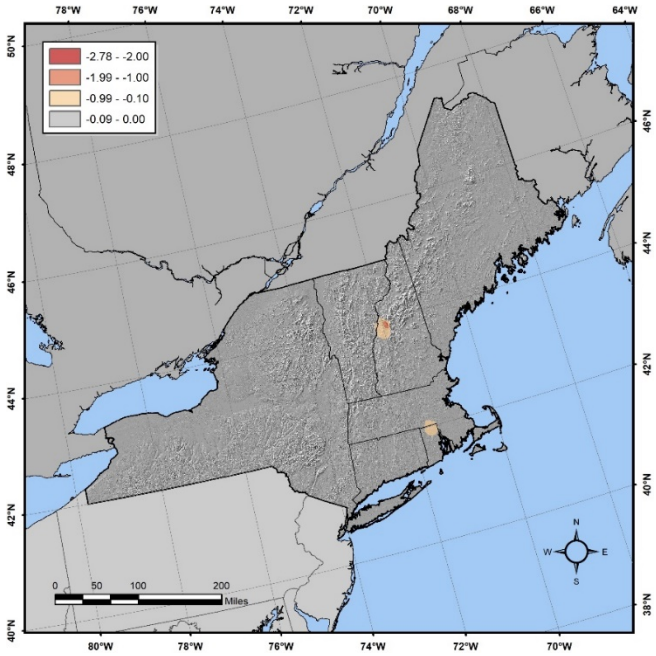

Figure 2. Differences (in inches) between 1000-year 24-hour estimates from Version 3 and Version 2.

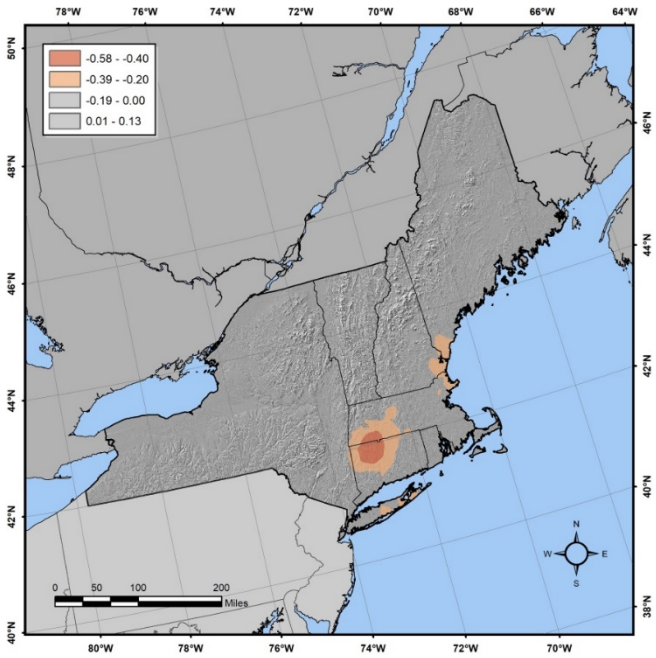

Figure 3. Differences (in inches) between 200-year 20-day estimates from Version 3 and Version 2.

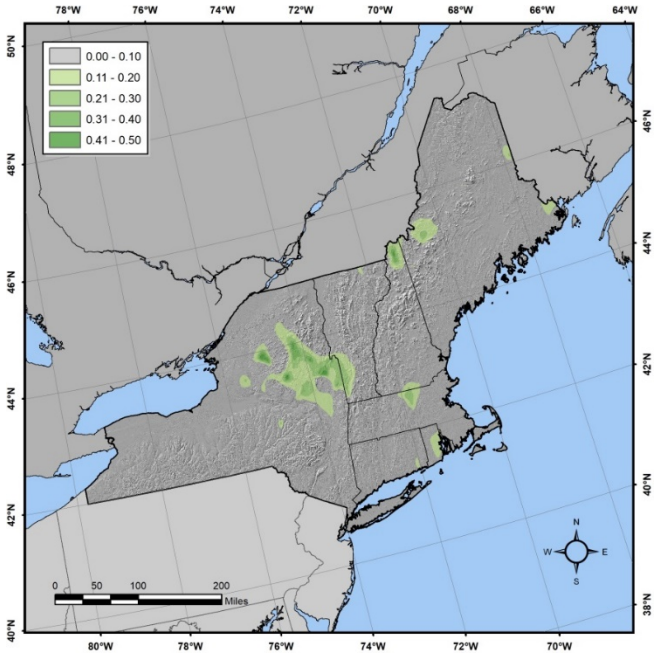

Figure 4. Differences (in inches) between Version3 and Version 2 lower bounds of 90% confidence interval for 1000-year 24-hour estimates.

d. Documentation

Work on Volume 10 documentation, which was put on hold in 2015 due to some unresolved funding issues, resumed during this reporting period. Documentation for this volume was published in March 2019, and is available for download here: Volume10 document.

The documentation is similar in layout, coverage, and depth to documentation prepared for previous NOAA Atlas 14 volumes. It describes all aspects of the development of each artifact in sufficient depth to allow the knowledgeable user to understand the basis of the estimates and their scope and applicability. It also includes information on the comments received during the peer review process and HDSC follow-up actions (see Appendix 5), describes differences between Version 3 and Version 2 estimates (Addendum), and compares current NOAA Atlas 14 estimates with corresponding estimates from superseded NOAA publications (Section 7).

1.2 PROGRESS IN THE FOLLOWING REPORTING PERIOD (APR - JUN 2019)

No further activities are planned on this project.

2. VOLUME 11: TEXAS

Precipitation frequency estimates for Texas were published in October 2018 as NOAA Atlas 14 Volume 11. The publication included the artifacts provided in previous NOAA Atlas 14 volumes, including access through the Precipitation Frequency Data Server (PFDS), base grids in standard formats together with error estimates, electronic copies of maps, charts of seasonal distributions, and probabilistic temporal distributions of heavy precipitation. Documentation for this volume was published in February 2019.

The release of the documentation for NOAA Atlas 14 Volume 11 marks the completion of the Texas project.

2.1 PROGRESS IN THIS REPORTING PERIOD (OCT 2018 - MAR 2019)

During this reporting period, we completed work on the NOAA Atlas 14 Volume 11 documentation. Documentation was released in March 2019, and is available for download from here: https://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume11.pdf.

The documentation is similar in layout, coverage and depth to documentation prepared for previous NOAA Atlas 14 volumes. It describes all aspects of the development of each artifact in sufficient depth to allow the knowledgeable user to understand the basis of the estimates and their scope and applicability. It also includes information on the comments received during the peer review process and HDSC follow-up actions (see Appendix 5), and relates current NOAA Atlas 14 estimates with corresponding estimates from superseded NOAA publications (Section 7).

2.2 PROGRESS IN THE FOLLOWING REPORTING PERIOD (APR - JUN 2019)

No further activities are planned on this project.

III. OTHER

1. ANALYSIS OF IMPACTS OF NON-STATIONARY CLIMATE ON NOAA ATLAS 14 ESTIMATES

The current NOAA Atlas 14 method used to calculate precipitation depth-duration-frequency relationships assumes stationarity in the annual maximum series (AMS) data used for frequency distribution selection and fitting. For each project area we apply several at-station and regional parametric and non-parametric statistical tests for detecting trends, but none of the tests show geographically consistent trends in the AMS data (for more information, see, for example, Appendix 2 of the Volume11 document).

HDSC continues to investigate this issue with the goal of assessing the added value of precipitation frequency estimates developed using approaches capable of accounting for non-stationary climate with respect to traditional NOAA Atlas 14 estimates and recommending an approach for national implementation.

With that goal in mind, we developed a modeling framework that allows non-stationary climate effects to be integrated into the NOAA Atlas 14 process and we are testing the feasibility of incorporating future climate projections into precipitation frequency analysis.

a) Non-Stationary Precipitation Frequency Analysis ("NOAA Atlas 14") Method

During the 2016-2018 period, together with a team of scientists from Penn State University, HDSC has worked on assessing the suitability of different non-stationary frequency analysis methods with respect to NOAA Atlas 14 process. We performed analysis on daily and hourly precipitation data from NOAA Atlas 14 Volume 10 (Northeastern states and investigated several aspects of the process:

a) use of a partial duration series (PDS)-based modeling approach as an alternative to AMS-based modeling of extreme precipitation;

b) use of different distribution parameter estimators (L-moments, maximum likelihood, generalized maximum likelihood) based on accuracy of average recurrence interval estimation under varying sample sizes and parameters;

c) selection of statistical tests to be used to detect temporal trends in: exceedance rates; the distribution of PDS data; and the distribution of AMS data;

d) level of complexity required for accommodating non-stationarities in the distribution of extremes;

d) inferring the distribution of extreme precipitation at both observed and unobserved locations by pooling spatial information from nearby rain gauge locations.

b) Feasibility of incorporating future climate projections into precipitation frequency analysis

Work on testing the feasibility of incorporating future climate projections into precipitation frequency analysis started in 2018 and is done in collaboration with researchers from the University of Illinois at Urbana-Champaign and the University of Wisconsin-Madison.

Most of the work so far has focused on evaluation of four Coupled Model Intercomparison Project Phase 5 (CMIP5) downscaled data sets based on their ability to reproduce observed precipitation frequencies from NOAA Atlas 14 Volume 10 (Northeastern states). Preliminary results for the 1960-2005 period demonstrate that the downscaled data sets can reproduce many features of the observed precipitation frequencies.

Based on the performances of the downscaled data sets investigated, we selected the UW CMIP5 and LOCA data to analyze their future projections. At this time we are examining future precipitation frequency estimates under two emission scenarios, RCP 4.5 and RCP 8.5.

2. CONFERENCES

On March 26, Mark Glaudemans, Director of the Geo-Intelligence Division, gave a presentation “NOAA Atlas 14 - Planned Updates and Upgrades” at the Association of State Dam Safety Officials West Regional Conference: Engineering for Extremes – Precipitation, Hydrology, and Hydraulics, 25-27 March 2019.