Hydrometeorological Design Studies Center
Progress Report for Period
1 October to 31 December 2022

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) updates precipitation frequency estimates for parts of the United States and affiliated territories, in coordination with stakeholder requests. 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).

HDSC is currently working on two NOAA Atlas 14 Volumes: Volume 12 and Volume 13, and supporting planning for Atlas 15 development. The Volume 12 project area covers the states of Idaho, Montana and Wyoming, while the Volume 13 project area covers the states of Delaware, Maryland, North Carolina, Pennsylvania, South Carolina, Virginia and Washington D.C. and approximately a 1-degree buffer around these states.

Figure 1 shows the new and updated project areas included in NOAA Atlas 14, Volumes 1 to 13. The proposed schedules for the two projects are contingent on funding and a timely hiring process. For any inquiries regarding NOAA Atlas 14, please email hdsc.questions@noaa.gov.

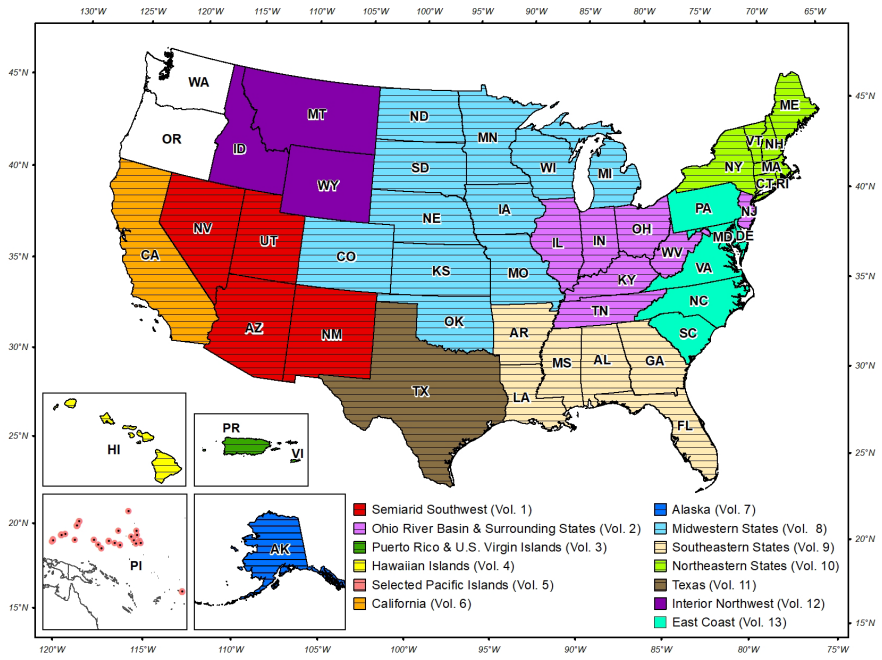

Figure 1. States or territories associated with each of the volumes of the Atlas.

II. CURRENT NOAA ATLAS 14 PROJECTS

1. VOLUME 12: INTERIOR NORTHWEST

On May 26, 2021, the HDSC commenced work on a new NOAA Atlas 14 Volume 12. The precipitation frequency estimates for this volume include the states of Idaho, Montana, and Wyoming, with an approximately 1-degree buffer around these states (Figure 2). The expected project's completion date has been revised to Q2 of 2024, due to continued delays with availability of personnel to support the development of two volumes. In this reporting period, OWP explored contractor support as well as the new NOAA/NWS Cooperative Institute for Research to Operations in Hydrology (CIROH) for additional personnel to support the development of two Atlas volumes in parallel.

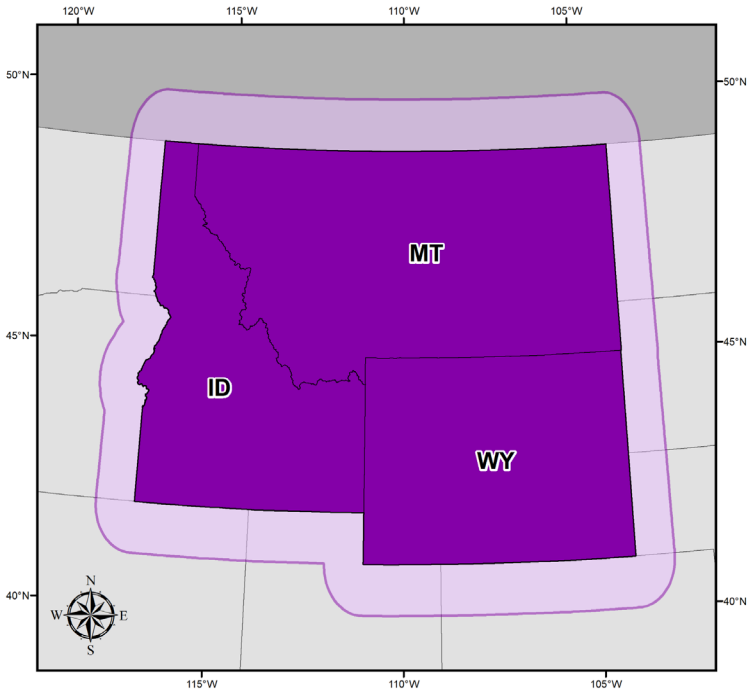

Figure 2. NOAA Atlas 14, Volume 12 extended project area (shown in purple).

During the Oct, 1 to Dec, 30 2022 reporting period, we worked on quality control for hourly stations at base duration, and continued working on mean annual maximum and conversion factors. The individual sections below describe in more detail the major tasks performed during this reporting period.

1.1 PROGRESS IN THIS REPORTING PERIOD (Oct - Dec 2022)

For the sources of datasets considered, contacted, downloaded or formatted for the precipitation frequency analysis for NOAA Atlas 14 Volume 12, please see July - Sept, 2022 Progress Report.

1.1.3. AMS quality control

The precipitation frequency analysis approach we used in this project is based on AMS analysis across a range of durations. AMS for each station whose data were formatted were obtained by extracting the highest precipitation amount for a particular duration in each successive calendar year.

The AMS data at both high and low extremities can considerably affect precipitation frequency estimates, they have to be carefully investigated and either corrected or removed from the AMS if due to measurement errors. We use different statistical tests to identify high and low outliers in the distribution of at-station precipitation AMS. All identified outliers and other questionable maxima at base durations (1-hour and 1-day) are now being verified. First, they are mapped with concurrent measurements at nearby stations. If the values cannot be confirmed from similar measurements at nearby stations, they are investigated further using information from monthly climatological data publications, cooperative observation forms, and monthly storm data reports obtained primarily from the NCEI's Image and Publication System (IPS). Additional resources, such as historical storm reports and surface weather observations, are accessed through NCEI's Environmental Document Access and Display System, Version 2 (EV2). Gridded precipitation products and other NEXRAD radar products are also used in some cases to verify and help disprove events for areas with good radar coverage.

In this reporting period, we worked on quality controlling the hourly AMS quality control task at base duration. Due to the continued delays in the availability of existing personnel referenced above, we were not able to complete the quality control of the hourly base durations during this reporting period.

One hurdle during hourly quality control we encountered relates to incorporating SNOTEL hourly data in this volume. We rely heavily on SNOTEL daily precipitation gauges in remote and high-elevation areas; however, we lack hourly precipitation data in many areas that SNOTEL daily stations predominantly cover. To improve the quality and reliability of sub-daily estimates, we are selectively quality-controlling SNOTEL hourly stations. While many of these stations have poor data quality and frequently have erroneously high hourly values during the winter months, we aim to clean as many as possible so that they may potentially be used in areas if needed. For additional information on the issues encountered while quality controlling the daily annual maximum time series for the Volume 12 project area, please see April-July, 2022 Quarterly Progress Report.

1.1.5. Spatial analysis of mean annual maximum (MAM) data

We received the first iteration of mean annual maxima (MAMs) for all durations between 15-minute and 60-day from the PRISM Group at Oregon State University for high-resolution spatial interpolation using their hybrid statistical-geographical approach for mapping climate data. The mean annual maxima (MAMs) grids created by the PRISM Group at Oregon State University by spatially interpolating at-station estimates for the base duration, 1-hour, 12-hour, 24-hour, and 10-days. In this reporting period, we started carefully reviewing for inconsistencies resulting from stations that may have had less reliable sampling (shorter record or missed several heavy events) relative to nearby stations or any inconsistent areas unduly influenced by the interpolation process or a lack of stations. The development of final gridded MAM estimates will require several iterations with the PRISM group.

1.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan - March 2023)

A large portion of the work in the next reporting period will plan on finalizing quality control of AMS data for base durations (1-hr, 12-hr, 10-days), completing conversion factors and the rainy season, and completing the mean annual maximum grids at base duration.

The project milestone schedule has been revised to align with the availability of funds and personnel (current and projected). At this time, we expect to complete this volume by Q2 of 2024.

1.3. PROJECT SCHEDULE

- Data collection, formatting, and initial quality control [Completed]
- Extraction of annual maximum series (AMS); additional quality control and data reliability tests (e.g., outliers, independence, consistency across durations, duplicate stations, candidates for merging)] [In progress; revised to Q2 2023]
- Regionalization and frequency analysis [Revised to Q2 2023]
- Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [Revised to Q3 2023]
- Peer review [Revised to Q4 2023]
- Revision of PF estimates [Revised to Q2 2024]
- Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [Revised to Q2 2024]
- Web publication [Q2 2024]

2. VOLUME 13: EAST COAST STATES UPDATE

On July 28, 2022, the NOAA Atlas 14 Volume 13 kickoff meeting was held to commence work on a new NOAA Atlas 14 Volume 13. The precipitation frequency estimates for this volume include the states of Delaware, Maryland, North Carolina, Pennsylvania, South Carolina, Virginia and Washington D.C. and approximately a 1-degree buffer around these states (Figure 5). This project's expected completion date is December 2025, subject to change based on the availability of funds and personnel to support the development of two volumes. In this reporting period, OWP explored contractor support as well as the new NOAA/NWS Cooperative Institute for Research to Operations in Hydrology (CIROH) for additional personnel to support the development of two Atlas volumes in parallel.

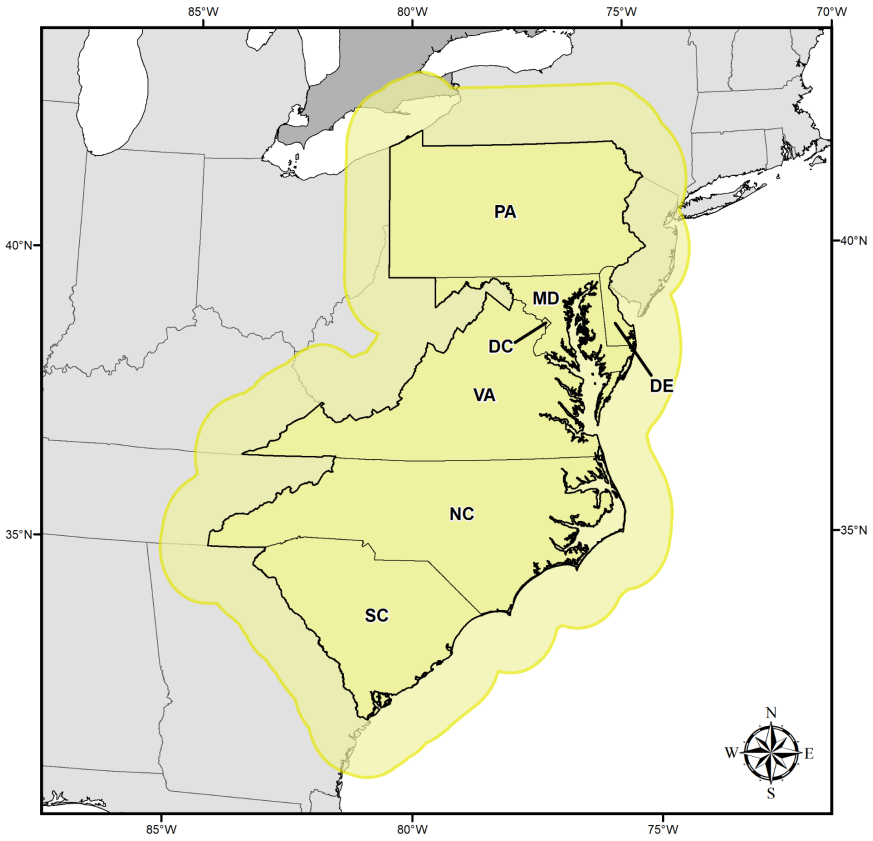

Figure 5. NOAA Atlas 14, Volume 13 extended project area (shown in yellow).

For this project area, we are interested in collecting all available precipitation datasets (daily, hourly, 5-minute, etc.) for stations in Delaware, Maryland, North Carolina, Pennsylvania, South Carolina, Virginia, and Washington D.C. as well as in adjacent portions of neighboring states (Georgia, Kentucky, New York, New Jersey, Ohio, Tennessee, West Virginia) and also in Canada. We welcome any information on the data for this project area. If you have any relevant information, please contact us at hdsc.questions@noaa.gov.

The full project scope has not been finalized, given that the OWP has received one-time funding through the Bipartisan Infrastructure Law (BIL) to update the precipitation frequency standard with the consideration for climate change. As a result of this new development, summarized in Section III of this document, the project scope may change to align efforts (e.g. parameter estimation methods) where

appropriate. For now, the project will continue as planned and follow the current project scope, including updating the estimates using the NOAA Atlas 14 methodology and the assumption of stationary climate. The detailed scope of work is outlined in the initial proposal available on the FHWA pool fund page.

2.1. PROGRESS IN THIS REPORTING PERIOD (Oct - Dec 2022)

2.1.1. Data collection and data screening

During the Oct, 1 to Dec, 30 2022 reporting period, we worked on searching and compiling a list of the precipitation networks that will be considered for the development of the Atlas 14 Volume 13 estimates, and formatting the NCEI datasets for this project area. As with all NOAA Atlas 14 Volumes, the primary source of data is the NOAA's National Centers for Environmental Information (NCEI). The NCEI is the most reliable data source network in the United States. The NCEI's precipitation data alone may not be sufficient to support the objectives of NOAA Atlas 14. Since the NOAA Atlas 14 estimates are based on the statistical analysis of the historical record of the observed precipitation data, denser spatial coverage may be needed to compute the robust and reliable precipitation frequency estimates. Therefore, for each project area, we also collect digitized data measured at 1-day or shorter reporting intervals from other Federal, State and local agencies.

As mentioned above, for this project area, we are interested in collecting all available precipitation datasets (daily, hourly, 5-minute, etc.) for stations in Delaware, Maryland, North Carolina, Pennsylvania, South Carolina, Virginia, and Washington D.C. as well as in adjacent portions of neighboring states (Georgia, Kentucky, New York, New Jersey, Ohio, Tennessee, West Virginia) and also in Canada. We welcome any information on the data for this project area. If you have any relevant information, please contact us at hdsc.questions@noaa.gov.

Table 2. Sources of datasets considered, contacted, downloaded or formatted for the precipitation frequency analysis for NOAA Atlas 14 Volume 13.

FID	Data Provider	Dataset name	Abbr.
1	National Centers for Environmental Information (NCEI)	Automated Surface Observing System	ASOS
2		DSI 3240, DSI 3260	DSI 3240, DSI 3260
3		Global Historical Climatology Network	GHCN-DAILY
4		Environment Canada	GHCN-DAILY
5		Integrated Surface Data (Lite)	ISD_LITE
6		Local Climatological Data	LCD

FID	Data Provider	Dataset name	Abbr.
7		Hourly Precipitation Data (HPD) v1.0 Beta and v2.0 Beta	HPDv1, HPDv2
8		United States CoCORAHS	GHCN-DAILY
9		Canada CoCORAHS	GHCN-DAILY
11		Weather Bureau Army Navy (WBAN)	GHCN-DAILY
12		U.S. Climate Reference Network	USCRN
12	Midwestern Regional Climate Center (MRCC)	CDMP 19th Century Forts and Voluntary Observers Database	FORTS
13	National Weather Service (NWS)	Mid-Atlantic River Forecast Center	IFLOWS
14	National Oceanic and Atmospheric Administration (NOAA)	National Estuarine Research Reserve	NERRS
15	National Atmospheric Deposition Program (NADP)	National Trends Network	NADP
16	North Carolina State University, State Climate Office	North Carolina Environment & Climate Observing Network	ECON
17	Tennessee Valley Authority (TVA)	Rainfall Gauge Data	TVA
18	U.S. Department of Agriculture (USDA)	Agriculture Research Service	ARS
19	U.S. Dept of Agriculture (USDA), Forest Service	Remote Automated Weather Station Network	RAWS
20	U.S. Dept of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	Soil Climate Analysis Network	SCAN
21	University of Delaware, Center for Environmental Monitoring & Analysis	Delaware Environmental Observing System	DEOS

In addition, we will consider other networks, including Aberdeen Proving Ground Network, Automatic Position Reporting System WX NET/Citizen Weather Observer Program, Synoptic Weather, Maryland Department of Transportation Road Weather Network, and WeatherSTEM.

III. PROPOSED PRECIPITATION FREQUENCY STANDARD UPDATE

With support from the Bipartisan Infrastructure Law (BIL), OWP has received a one time funding opportunity to update the NOAA Atlas 14 precipitation frequency standard and fill in the existing product gaps. We anticipate this product update to be referred to as NOAA Atlas 15 and to be presented in two volumes. The first volume would account for temporal trends in historical observations, and the second volume would use future climate projections to generate adjustment factors for the first volume. These new estimates will provide critical information to design national infrastructure under a changing climate.

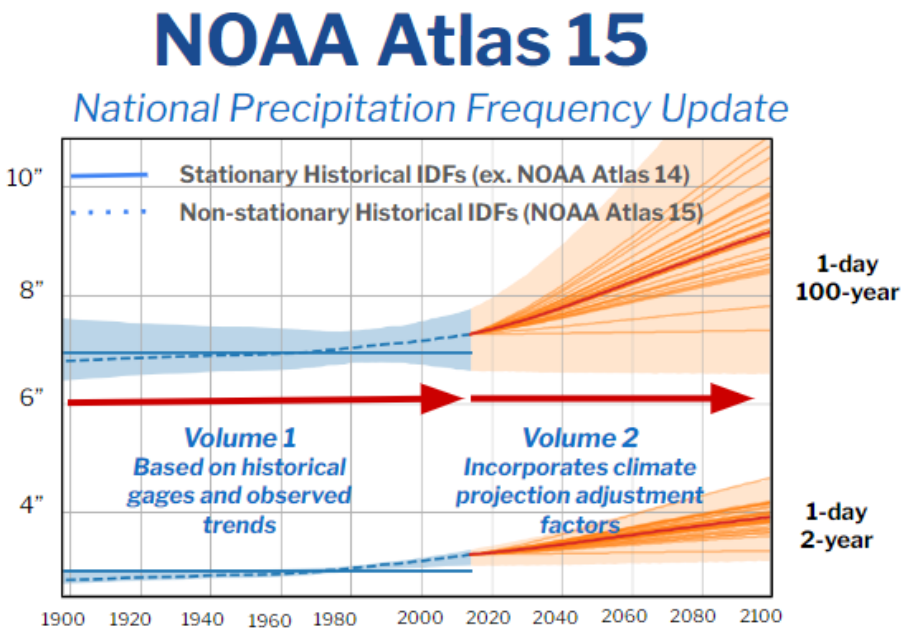

Figure 6. Envision Atlas 15 historical and future intensity-duration-frequency curves (IDFs).

This new update is anticipated to:

- Leverage results and recommendations from the research project performed in collaboration with academic partners over the last few years, sponsored by the FHWA. A detailed description of the research supporting the proposed framework update is available in the assessment report titled "Analysis of Impact of Nonstationary Climate on NOAA Atlas 14 Estimates".

- Develop a seamless spatial national analysis removing challenges posed by the piecewise approach to development.

- Replaces current Atlas 14 estimates based on historical data (historical IDFs), using a non-stationarity assumption with latest precipitation observations, for durations:
    - from 5 minutes to 60 days
    - recurrence intervals of 1 to 1000 years

- Add new product features to account for future precipitation information (future IDFs). This portion of work requires further research and development that would be completed with the help of the research community. It is anticipated that this work will consider, evaluate and include, accordingly, the most recent version of the climate projections and other approaches developed by the climate and research community in recent years.

- Atlas 15 supplementary products which will include research, enhancement, and development of the areal reduction factors.

- Atlas 15 enhanced web visualizations and data services.

In anticipation of this project, which is expected to last five years, OWP issued an NWS Public Information Statement on September 15, 2022 to notify the public and collect feedback on the proposed statistical methodology update and integration of future climate projections. PNS feedback closed on November 15, 2022. Currently, OWP is compiling the feedback received and defining requirements for Atlas 15 research, development and publication, which is expected to commence in Q2 2024.

IV. ARTICLES, CONFERENCES, MEETINGS, PERSONEL

On October 24th, HDSC welcomed Austin Jordan to the team. Austin has a diverse background in the fields of atmospheric science, statistics, energy business and finance, and programming. His work and project experience has focused generally on data quality control, analysis, and presentation. Austin has utilized a variety of statistical and programming tools to assess and quantify the impacts of weather and climate on society and the environment. He received his BS in Meteorology from Penn State University, and MA in Applied Statistics from the University of Pittsburgh.