Hydrometeorological Design Studies Center
Progress Report for Period
1 July to 30 September 2022

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

October 20, 2022

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.

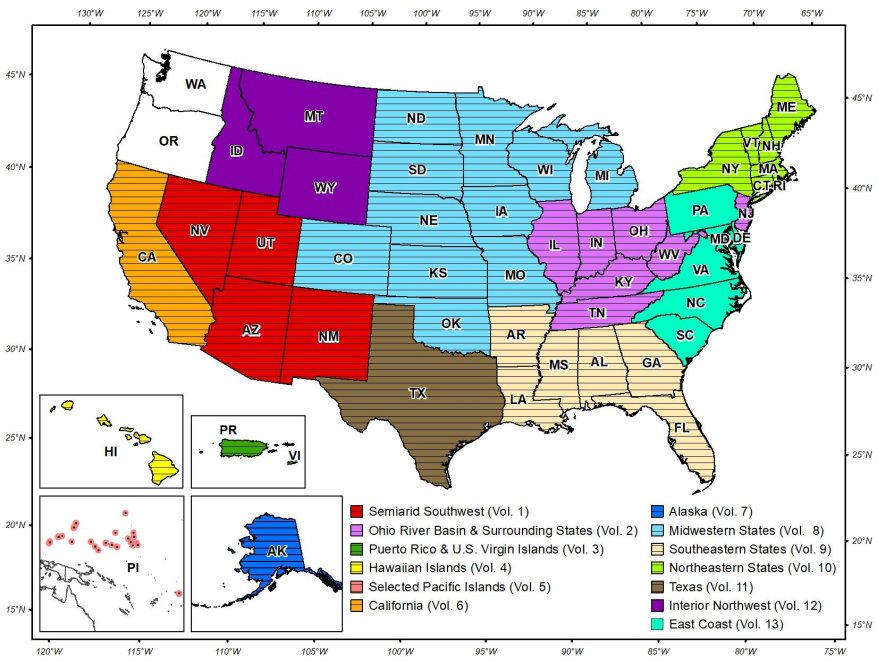

Figure 1. States or territories associated with each of the volumes of the Atlas.

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 is December of 2023, subject to change based on the availability of funds and personnel to support the development of two volumes.

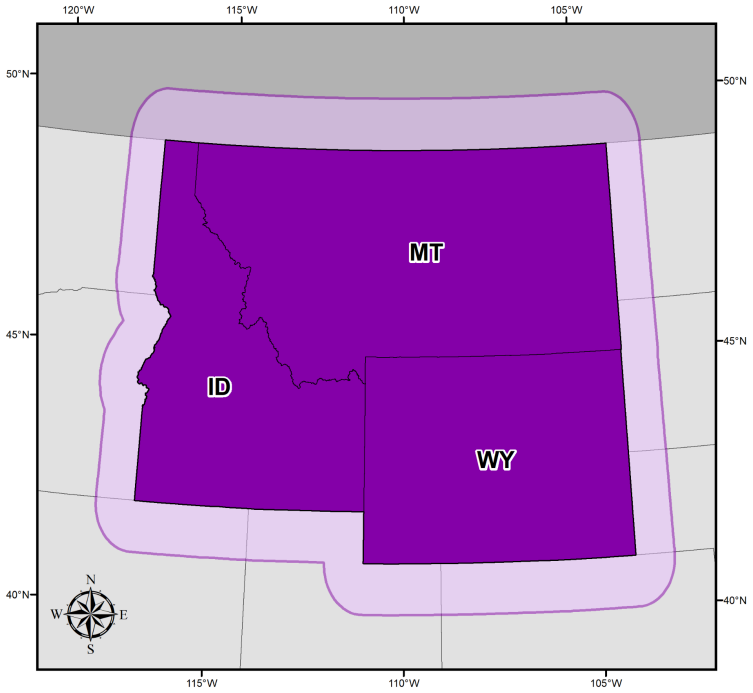

Figure 2. NOAA Atlas 14, Volume 12 extended project area (shown in purple).

During July, 1 to Sep, 30 2022 reporting period, we completed quality control for daily stations at base duration. We also began 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 (July - Sep 2022)

1.1.1. Data collection and data screening

The primary source of NOAA Atlas 14 Volumes 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. Since we started this project, we have contacted numerous agencies for assistance with the data and would like to thank all of those who responded to our inquiry and/or provided the data.

Table 1. Sources of datasets considered, contacted, downloaded or formatted for the precipitation frequency analysis for NOAA Atlas 14 Volume 12.

FID	Data Provider	Dataset name	Abbr.	Base Duration	Status
1	National Centers for Environmental Information (NCEI)	Automated Surface Observing System	ASOS	1M	formatted
2		DSI 3240, DSI 3260	DSI 3240, DSI 3260	15M, HLY	formatted
3		Global Historical Climatology Network	GHCN-DAILY	DLY	formatted
4		Environment Canada	GHCN-DAILY	DLY	formatted
5		Integrated Surface Data (Lite)	ISD_LITE	HLY, DLY	formatted
6		Local Climatological Data	LCD	HLY	formatted
7		Hourly Precipitation Data (HPD) v1.0 Beta and v2.0 Beta	HPDv1, HPDv2	HLY,15M	formatted
8		United States CoCoRaHS	GHCN-DAILY	DLY	formatted
9		Canada CoCoRaHS	GHCN-DAILY	DLY	formatted
10		Snow Telemetry	GHCN-DAILY	DLY	formatted
11		Weather Bureau Army Navy (WBAN)	GHCN-DAILY	DLY	formatted
12		U.S. Climate Reference Network (USCRN)	USCRN	5M, HLY, DLY	formatted
13	Ada County Highway District	Precipitation Gauge Network	AC	DLY, HLY, VARYING	formatted

FID	Data Provider	Dataset name	Abbr.	Base Duration	Status
14	Boise State University	Dry Creek Experimental Watershed	DCEW	HLY	formatted
15	City of Caldwell, Idaho	City of Caldwell	CC	DLY	formatted
16	Environment and Climate Change Canada	Historical Climate Data Network	EC	DLY, HLY, 15M	formatted
17	High Plains Regional Climate Center (HPRCC)	Automated Weather Data Network (AWDN)-CoAgMet, NDAWN, and WACNet	AWDN	DLY, HLY, 15M	formatted
18	Idaho National Laboratory (INL)	Air Resources Laboratory (ARL) Mesonet	INL_ARL	DLY, 5M	formatted
19	Midwestern Regional Climate Center (MRCC)	CDMP 19th Century Forts and Voluntary Observers Database	FORTS	DLY	formatted
20	National Atmospheric Deposition Program (NADP)	National Trends Network	NADP	DLY	formatted
21	National Weather Service (NWS)	Snowpack Telemetry (SNOTEL) Network	SNOTEL	DLY, HLY	formatted
22	North Dakota Atmospheric Resource Board	Cooperative Observer Network (ARBCON)	ARBCON	DLY	formatted
23	U.S. Bureau of Reclamation (USBR)	HydroMet	HYDROMET	DLY, HLY	formatted
24		Agricultural Weather Networks (AgriMet)	AGRIMET	DLY, 15M	formatted
25	University of Montana	Montana Mesonet	MT_MESONET	DLY	formatted
26	University of Utah Synoptic Data	MesoWest	MESOWEST	HLY	formatted
27	University of Wyoming Water Resources Data System	Wyoming Agricultural Climate Network	WACNet	DLY, HLY	formatted

FID	Data Provider	Dataset name	Abbr.	Base Duration	Status
28	U.S. Dept of Agriculture (USDA), Agricultural Research Service, The Northwest Watershed Research Center (NWRC)	Reynolds Creek Experimental Watershed Data (RCEW)	RCEW	DLY, HLY	formatted
29	U.S. Dept of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	Soil Climate Analysis Network (SCAN)	SCAN	DLY, HLY	formatted
30	U.S. Dept of Agriculture (USDA) Forest Service	Coram Experimental Forest	CEF	DLY	formatted
31	U.S. Dept of Agriculture (USDA) Forest Service	Priest River Experimental Forest	PREF	DLY	formatted
32	U.S. Dept of Agriculture (USDA), Forest Service	Remote Automated Weather Station Network (RAWS)	RAWS	HLY	formatted

Table 2 contains information on additional datasets that will not be used in the analysis. They largely contain information already included in other datasets, or data assessed as not reliable for this specific purpose, or they contain only stations with short records unsuitable for merging with nearby stations.

Table 2. Additional datasets investigated.

Source of data and dataset/network name (if available)
Montana Department of Transportation- Engineering Division, Highways Bureau, Hydraulics Section Precipitation Study
NCEP Meteorological Assimilation Data Ingest System (MADIS)
U.S. Geological Survey (USGS): Nation Water Information System (NWIS)
Idaho National Engineering and Environmental Laboratory (INEEL) Network
Idaho Transportation Department (ITD) / Montana Department of Transportation: Road Weather Information Systems (RWIS)
Idaho Power Company
South Dakota University
University of Nebraska Lincoln: Nebraska Mesonet

The total number of retained stations per recording period so far is listed in Table 3.

Table 3. Number of stations per recording period.

Recording period	Number of stations
1-day	8,113
1-hr	6,679
15-min, n-min, varying	862
TOTAL	**15,654**

Locations of formatted daily stations are shown in Figure 3. Only stations with at least 30 years of useful data (shown as blue circles) will be considered for frequency analysis, although allowances may be made for isolated stations. Similarly, Figure 4 shows the locations of formatted stations recording at 1-hour (shown as red circles) and at sub-hourly (shown as green circles) durations, respectively, where stations have at least 20 years of useful data.

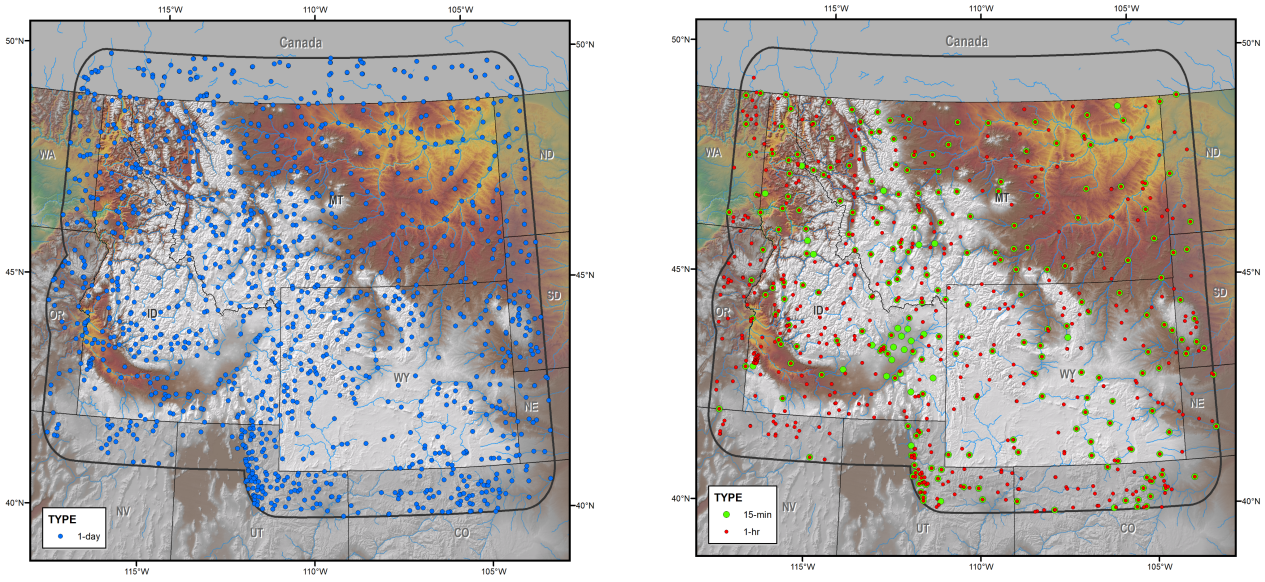

Figure 3. Left) Map showing 1,399 formatted stations recording at 1-day interval with 30 years of data; right) Map showing 778 formatted stations recording at 1-hour and 250 at 15-minute with at least 20-years of data.

1.1.2. Annual maximum series (AMS) extraction

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. AMS at stations formatted during this period were extracted for all durations equal to or longer than the base duration (or reporting interval) up to 60 days. The criteria for extraction were designed to exclude maxima if there were too many missing or accumulated data during the year, especially during critical months when precipitation maxima were most likely to occur. All annual maxima that resulted from

accumulated data were flagged and screened to ensure that the incomplete data did not result in erroneously low maxima.

1.1.3. AMS quality control

In this reporting period, we completed the daily AMS quality control task, and implemented a total of 2,523 corrections to the daily annual maximum time series data in this project area. In addition, we implemented 12,948 corrections to the GHCN NCEI dataset involving conflicts between the PRCP (1-day) and MDPR (multiday) precipitation variables. These typically have a QFLAG (quality flag) of “L” in the GHCN-daily dataset, and indicate that a period is covered by both PRCP and MDPR variables that conflict with each other. We found that the MDPR was the “correct” variable in all data 1950 and earlier, where many 1-day variables should have been multiday values (overwrite PRCP with MDPR). Conflicts in more recent years needed manual examination to determine to keep PRCP vs MDPR. In the next reporting period, we will complete the hourly AMS quality control task at base duration.

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.

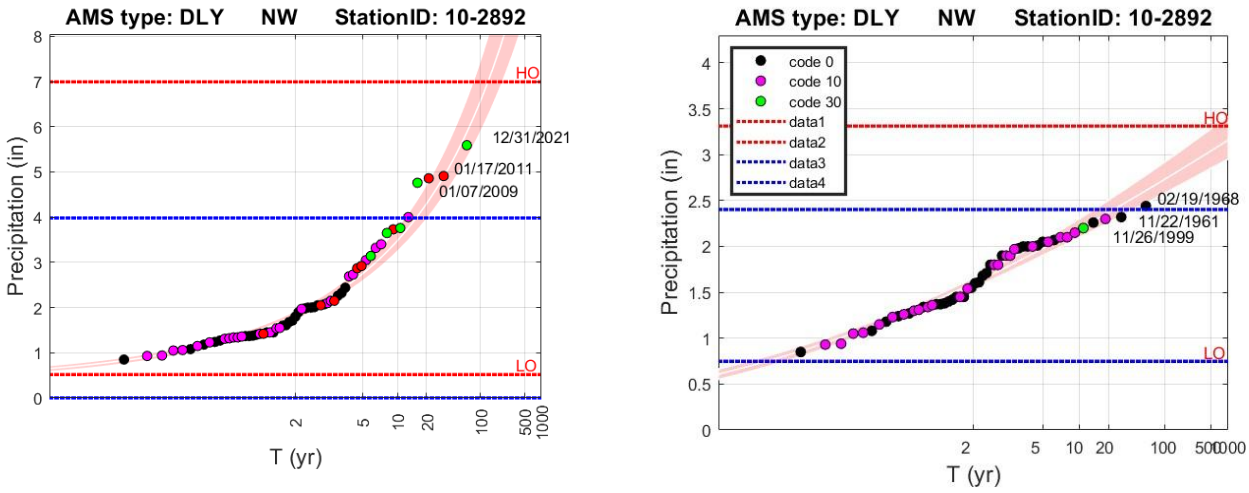

Figure 5: Left) 1-day distribution plot for 10-2892 with many data quality issues b) 1-day distribution plot for 10-2892 with corrected time series data. The new corrected time-series data estimates a 100-year 1-day value below 3 inches, more than half of the value calculated from the original time series.

One hurdle encountered during quality control was cooperative observer form availability. The original observer forms are often reviewed to either confirm or disprove a particular extreme event. For Idaho, forms were not available for any station before 1980 and also for many stations in Montana. During the quality control of the daily data for these two states, a list was made of stations and specific dates we hoped to obtain copies of these forms for further review. After consulting with NCEI, we were able to request and receive around 100 forms for events flagged during the quality control that required additional checking. For additional information on the issues encountered while quality controlling the annual maximum time series for the Volume 12 project area, please see April-July, 2022 Quarterly Progress Report.

1.1.4. Correction for constrained observations

We began developing factors to convert constrained observations (e.g., 1-day) to unconstrained values (e.g., 24-hour). Quality-controlled, concurrent constrained and unconstrained annual maxima from hourly stations will be used in a zero-intercept regression model to develop correction factors for daily durations, while collocated hourly (constrained) and n-minute/15-minute (unconstrained) concurrent annual maxima will be used to develop correction factors for hourly durations.

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

Mean annual maxima (MAMs) for all durations between 15-minute and 60-day were sent on September 16th to 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 will be carefully reviewed 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 (Oct - Dec 2022)

The large portion of the work in the next reporting period will be on finalizing quality control of AMS data for base durations (1-hr, 12-hr, 10-days). We will complete conversion factors and the rainy season, and plan to review 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, December 2023 is still the projected completion date for this volume.

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 January, 2023]
- Regionalization and frequency analysis [Revised to March 2023]
- Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [Revised to March, 2023]

- Peer review [Revised to June, 2023]
- Revision of PF estimates [Revised to November, 2023]
- Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [Revised to December 2023]
- Web publication [December 2023]

2. VOLUME 13: EAST COAST STATES UPDATE

On July 28, 2021, 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.

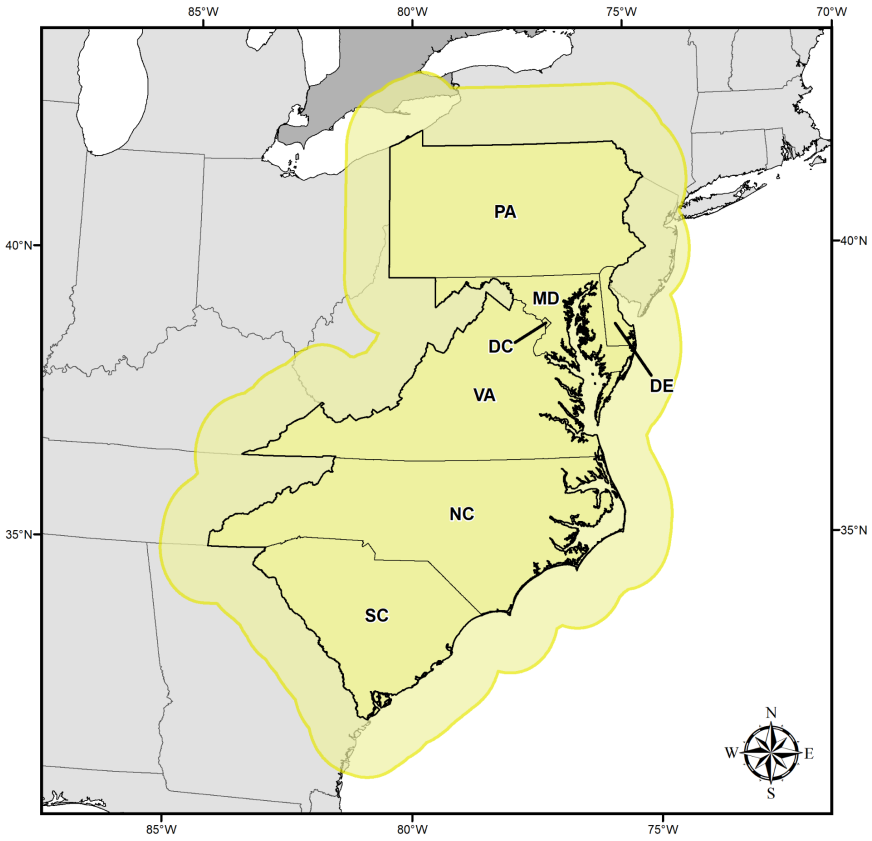

Figure 5. NOAA Atlas 14, Volume 13 extended project area (shown in yellow).

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 (July - Sep 2022)

2.1.1. Data collection and data screening

During July 1, 2022 to September 31, 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. 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. In this reporting period, we also started formatting the NCEI datasets for this project area.

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 12.

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
7		Hourly Precipitation Data (HPD) v1.0 Beta and v2.0 Beta	HPDv1, HPDv2
8		United States CoCORAHS	GHCN-DAILY

FID	Data Provider	Dataset name	Abbr.
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.

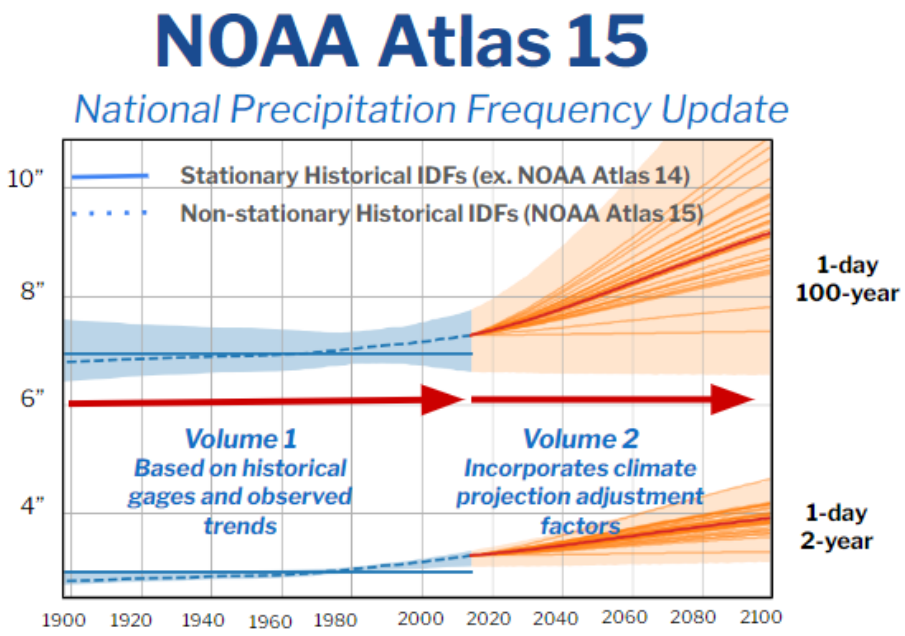

Figure 6. Envision Atlas 15 historical and future intensity-duration-frequency curves (IDFs).

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 to notify the public and collect feedback on the proposed statistical methodology update and integration of future climate projections.

The proposed changes include:

A. Updating the statistical methodology to account for temporal nonstationarity as follows:

1. changing parameterization estimation technique
2. adding covariates to the estimation of the distribution parameters
3. altering regional technique
4. altering the spatial interpolation technique
5. altering confidence interval technique

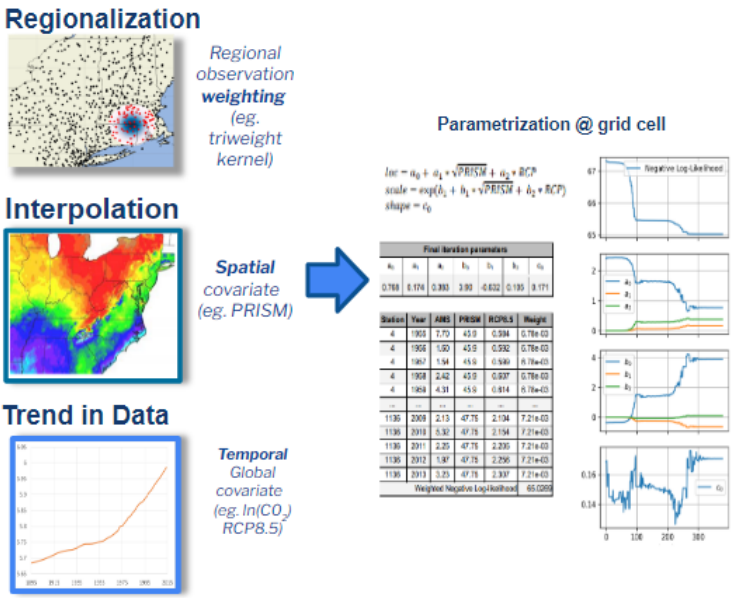

Figure 7: Schematic of the proposed nonstationary regional maximum likelihood estimation methodology.

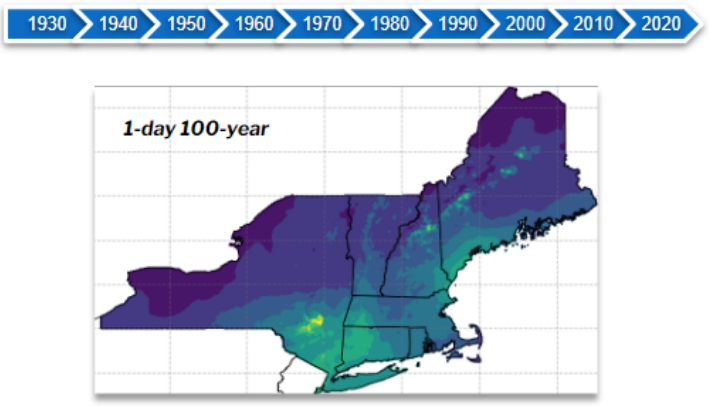

Figure 8: Pilot study preliminary gridded historic 100-year 1-day precipitation frequency estimates calculated using the nonstationary maximum likelihood approach (see schematic in Figure 7)

B. Adding new product features to account for future precipitation information:

1. providing future estimates as adjustment factors to Volume 1
2. multi-model approach to account for the uncertainties
3. apply methodology in part A to calculate the precipitation adjustment factors to methods that rely on extreme time series from downscaled climate models

We encourage our users and OWP stakeholders to provide comments and feedback on this proposed update through November 15, 2022. For additional feedback or any questions, please get in touch with us at hdsc.questions@noaa.gov.

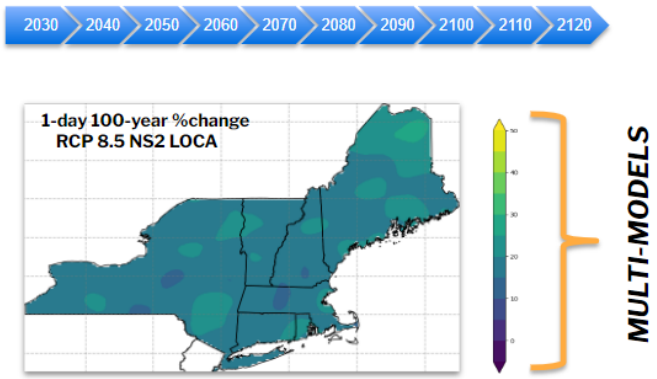

Figure 9: Pilot study preliminary gridded future 100-year 1-day precipitation frequency estimates calculated using the nonstationary maximum likelihood approach and LOCA dataset, as a percent change from the future (2100) to the current period. The percent change represents the mean of 32 models of the LOCA RCP 8.5 CMIP5 pathways.

Currently, the OWP is planning requirements for the Atlas 15 research, development and publication. That said, our stakeholders and users will have more than one additional opportunity to comment on the Atlas 15 development. We will have a peer review of the preliminary Atlas 15 estimates. The peer review process allows critical feedback and local knowledge to be integrated into the federally-generated product, ultimately improving estimates. We envision that the Atlas 15 peer review

preliminary estimates will closely follow the Atlas 14 peer review process which is well defined in the Atlas 14 documentation. Currently, the peer review for the preliminary estimates for the contiguous United States is expected in FY2025, and the final publication in FY2026.

IV. ARTICLES, CONFERENCES, MEETINGS

On July 21, 2022, HDSC's Sandra Pavlovic gave a 30-minute briefing on the NOAA Atlas 14 and proposed nonstationary modeling framework to the Association of State Floodplain Managers (ASFPM) webinar series.

On July 26, 2022 and September 21, 2022, Fernando Salas, Geo-Intelligence Division Director, and HDSC Mission lead, gave a 30-minute briefing on the proposed NOAA Atlas 15 update to the NWS Regional Directors and the NWS Hydrology Program leadership team.

On August 22, 2022, Sandra Pavlovic provided the virtual briefing on NOAA Atlas 15 proposed methodology to the NOAA Science Advisory Board, the Climate Working Group (CWG).

Sandra Pavlovic attended the virtual American Society of Civil Engineers (ASCE) workshop, entitled "Leveraging Earth System Science and Modeling to inform Civil Engineering Design:Temperature and Rainfall". September 9 and 23, 2022.