Hydrometeorological Design Studies Center

Progress Report for Period
1 January 2022 to 31 March 2022

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

April 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 commenced work on a NOAA Atlas 14 Volume 12 for a full precipitation frequency analysis covering the states of Idaho and Montana. Recently Wyoming has also been added to the project area, which will now be referred to as the Interior Northwest. The NOAA Atlas 14 Volume 12 precipitation frequency estimates are expected to be published by December 2023. Figure 1 shows the new project area as well as updated project areas included in NOAA Atlas 14, Volumes 1 to 12. For any inquiries regarding NOAA Atlas 14, please send an email to hdsc.questions@noaa.gov.

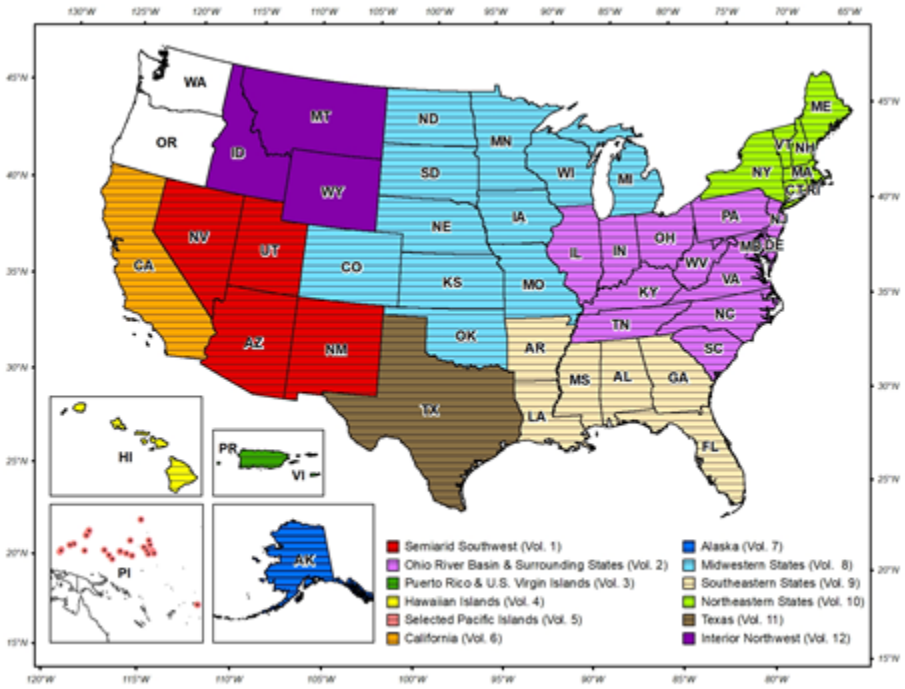

Figure 1. States or territories associated with each of the volumes of the Atlas.

II. CURRENT NOAA ATLAS 14 PROJECTS

1. VOLUME 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 includes the states of Idaho, Montana and now Wyoming with an approximately 1-degree buffer around these states (Figure 2). This project's planned completion date is December of 2023.

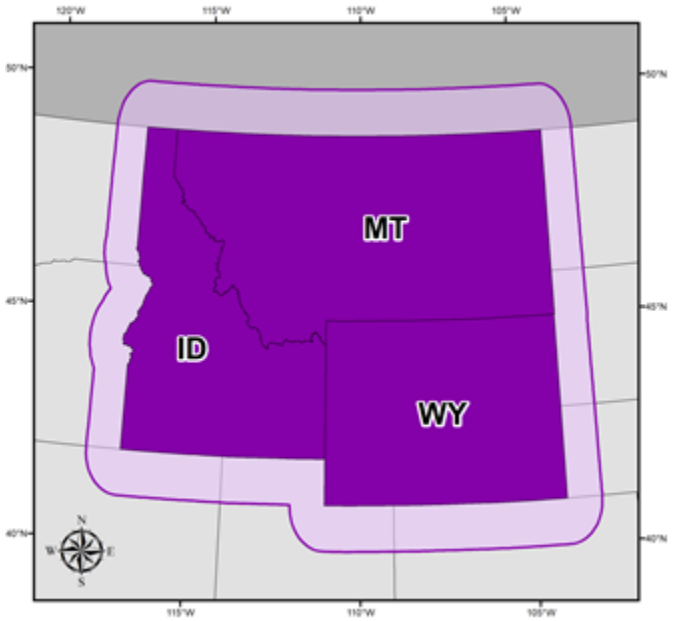

Figure 2. NOAA Atlas 14, Volume 12 extended project area (shown in purple).

During January, 1 2022 to March, 31 2022 reporting period, we worked on collecting and re-formatting additional datasets and completing related station screening and initial quality control tasks. The individual sections below describe in more detail the major tasks performed during this reporting period.

1.1 PROGRESS IN THIS REPORTING PERIOD (Jan - Mar 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.

For this project area, we are interested in collecting all available precipitation datasets (daily, hourly, 5-minute, etc.) for stations in Idaho, Montana, and Wyoming as well as in adjacent portions of

neighboring states (Colorado, Nebraska, Nevada, North Dakota, Oregon, South Dakota, Utah, and Washington) and also in Canada.

In this reporting period, we continued to download and format the 15-minute, hourly and daily datasets we received, and we continued to contact data providers of the newly identified datasets. Datasets are cross checked to ensure that they are formatted correctly. Table 1 lists all sources of data collected so far and the current status of the data formatting task.

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
14	Boise State University	Dry Creek Experimental Watershed	DCEW	HLY	formatted
15	City of Caldwell, Idaho	City of Caldwell	CC	DLY	formatted
16	Colorado State University	Colorado Agricultural Meteorological Network	COAGMET		contacted

FID	Data Provider	Dataset name	Abbr.	Base Duration	Status
17	Environment and Climate Change Canada	Historical Climate Data Network	EC	DLY, HLY, 15M	formatted
18	High Plains Regional Climate Center (HPRCC)	Automated Weather Data Network (AWDN)- CoAgMet, NDAWN, and WACNet	AWDN	DLY, HLY, 15M	formatted
19	Idaho National Laboratory (INL)	Air Resources Laboratory (ARL) Mesonet	INL_ARL	DLY, 5M	formatted
20	Idaho Transportation Department	Road Weather Information System (RWIS)	RWIS	5M	not used
21	Midwestern Regional Climate Center (MRCC)	CDMP 19th Century Forts and Voluntary Observers Database	FORTS	DLY	formatted
22	Montana Department of Transportation (MDT)	Engineering Division, Highways Bureau, Hydraulics Section Precipitation Study	MT_DOT	HLY	duplicate of NCEI
23	Montana Department of Transportation (MDT)	Road Weather Information System (RWIS)	RWIS	5M	not used
24	National Atmospheric Deposition Program (NADP)	National Trends Network	NADP	DLY	formatted
25	National Centers for Environmental Prediction (NCEP)	Meteorological Assimilation Data Ingest System (MADIS)	MADIS	DLY, HLY, VARYING	duplicate
26	National Weather Service (NWS)	Hydrometeorological Automated Data System	HADS	HLY	received
27	National Weather Service (NWS)	Snowpack Telemetry (SNOTEL) Network	SNOTEL	DLY, HLY	formatted
28	University of Nebraska Lincoln	Nebraska Mesonet	NE_MESONET	HLY	received
29	North Dakota Atmospheric Resource Board	Cooperative Observer Network (ARBCON)	ARBCON	DLY	recieived
30	South Dakota University	South Dakota Mesonet	SD_MESONET	DLY, HLY	contacted
31	U.S. Bureau of Reclamation (USBR)	HydroMet	HYDROMET	DLY, HLY	formatted
32		Agricultural Weather Networks (AgriMet)	AGRIMET	DLY, 15M	formatted
33	U.S. Geological Survey (USGS)	Nation Water Information System (NWIS) dataset	NWIS	15M	not used

FID	Data Provider	Dataset name	Abbr.	Base Duration	Status
34	University of Montana	Montana Mesonet	MT_MESONET	DLY	formatted
35	University of Utah Synoptic Data	MesoWest	MESOWEST	HLY	formatted
36	University of Wyoming Water Resources Data System	Wyoming Agricultural Climate Network	WACNet	DLY, HLY	formatted
37	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
38	U.S. Dept of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	Soil Climate Analysis Network (SCAN)	SCAN	DLY, HLY	formatted
39	U.S. Dept of Agriculture (USDA) Forest Service	Coram Experimental Forest	CEF	DLY	received
40	U.S. Dept of Agriculture (USDA) Forest Service	Priest River Experimental Forest	PREF	DLY	formatted
41	U.S. Dept of Agriculture (USDA), Forest Service	Remote Automated Weather Station Network (RAWS)	RAWS	HLY	formatted

Locations of formatted daily, hourly and 15-minutes stations are shown in Figure 3. Daily stations are shown as blue circles, hourly as red, and 15-minutes as green circles. Only stations with at least 30 years of useful daily data and at least 20 years of useful hourly and sub-hourly data will be considered for the development of NOAA Atlas 14 estimates. However, these stations will be filtered after all the additional datasets have been added and the quality control and cleanup procedures (described in the sections below) are completed.

At the start of this project, we also contacted our network of users and stakeholders to help us identify the data sources in the project area. We would like to thank all of those who responded to our inquiry and/or provided the data. 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.

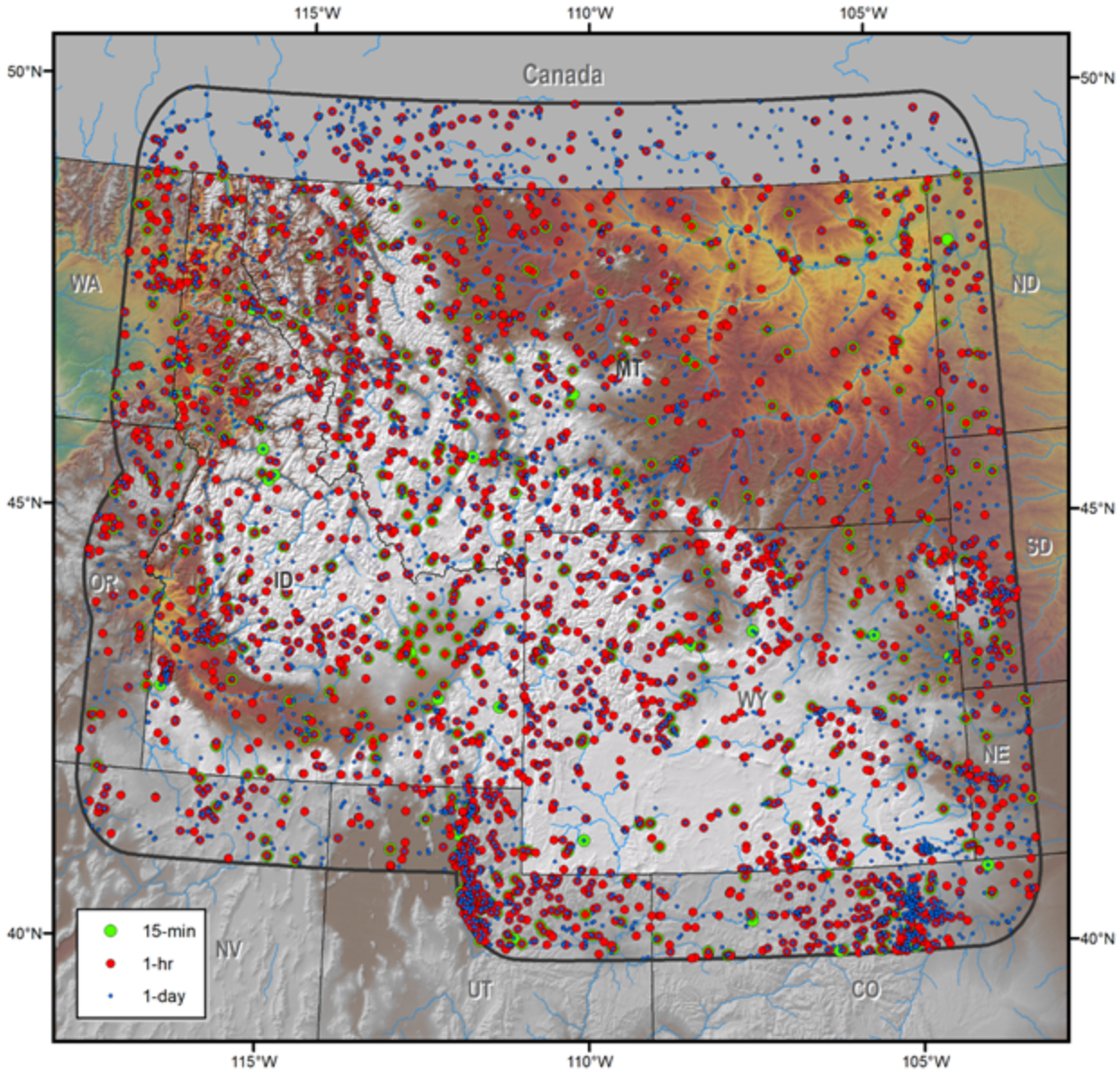

Figure 3. Map showing 4,367 formatted stations recording at 1-day interval, 3,371 at hourly and 428 at 15-minute.

1.1.2. Metadata quality control

We finished screening stations' metadata for errors and implemented all corrections. In this reporting period, we screened the metadata information from additional datasets considered: Additional NCEI datasets, NADP, Montana Mesonet, and USBR. In this task, stations with potential errors were identified by reviewing published coordinates and elevations for large changes over the course of the station's lifetime. Stations with assigned elevations that were more than 10% different from elevations extracted from a 1 arcsecond (approx. 30 meters) digital elevation model (DEM) are being investigated. Such stations may be relocated based on inspection of satellite images, maps and records of the station's history. Misplacements were typically the result of latitude and longitude data having inadequate precision. Original and revised coordinates for all stations used in the analysis will

be provided in Appendix 1 of the accompanying NOAA Atlas 14 Volume 12 document. Stations with no elevation information were assigned DEM elevations and also investigated for possible location errors.

1.1.3. Station cleanup

In this reporting period, we completed and implemented changes from the second round of cleanup, which looked at all stations within a 1-mile radius. We also began work on the 3-mile station cleanup for all formatted stations.

Station cleanup investigation involves reviewing time series plots of annual maxima for 1-hour, 12-hour 1-day, 2-day and 60-day durations for multiple stations within a target radius. If the station with a shorter reporting interval provides the same information as a longer reporting interval, then the station with the longer reporting interval is removed. If the station with the longer reporting interval has a longer period of record, then it was retained in the dataset in addition to the co-located station with the shorter reporting interval. Where appropriate, we identify data from stations recording at shorter intervals to extend records or to fill in gaps in records for collocated stations recording at longer intervals. Stations with the same reporting interval but recording different time periods are merged together to create longer time series.

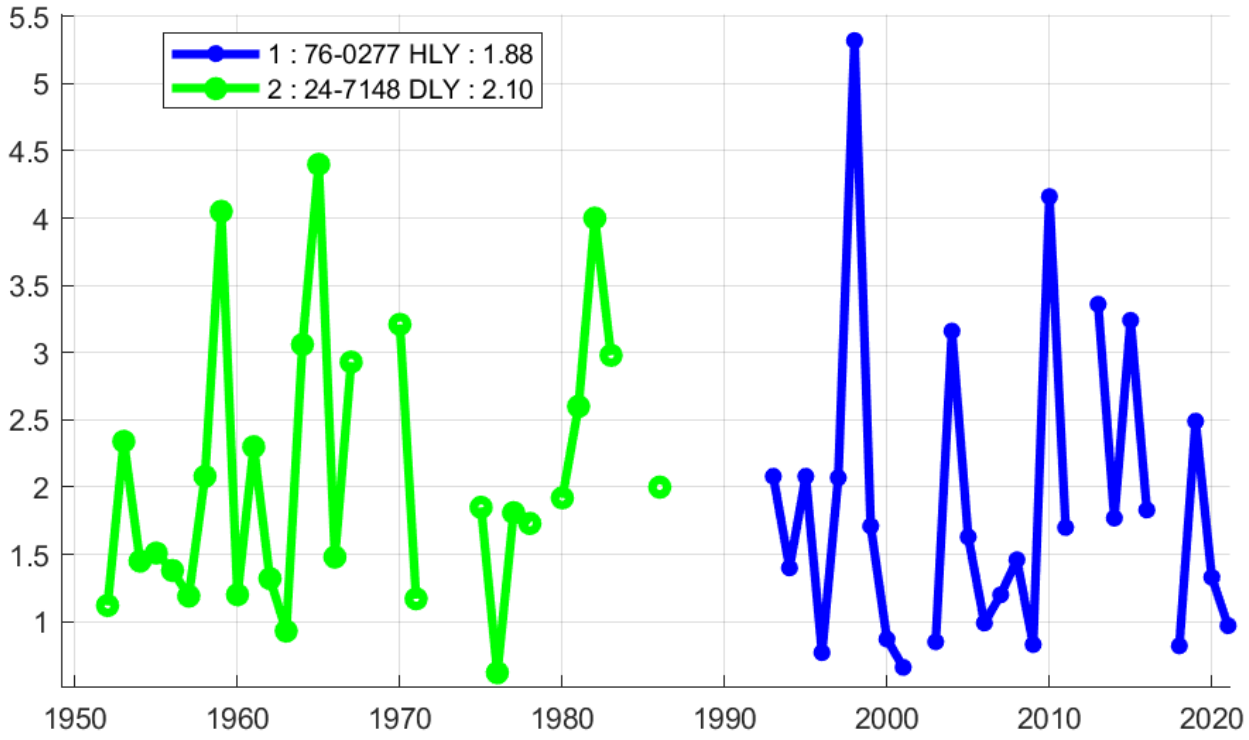

Figure 4: 1-mile cleanup example for extending a daily station with hourly data. These stations are 0.3 miles apart.

The station cleanup effort is performed to:

- screen for duplicate records
- extend records at longer-duration stations using data from nearby stations,

investigate large differences in annual maximum series (AMS) at collocated stations at critical durations such as 1-hour and 1-day

implement data corrections to ensure data consistency across multiple gauges

determining if overall datasets are of good quality and should be used in the analysis

Additional smaller cleanup rounds were conducted on individual datasets. USBR dataset had multiple precipitation variables which needed to be cleaned. Snotel hourly values above 1-inch in wintertime were removed. Mesowest and Cocorahs stations with the short records (>4 years) were deleted.

1.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan - March 2022)

We will continue with data collection, reformatting, station metadata, and quality control checks for any additional datasets that we are able to acquire. All collected data will be examined and formatted into a common format, where appropriate.

The large portion of the work in the next reporting period will be on finalizing station cleanup tasks including 3-mile, AMS extraction and working on quality control of AMS data. Work will begin on climate region development, and developing the mean annual maxima (MAM) grid in collaboration with the PRISM Group from Oregon State University.

1.3. PROJECT SCHEDULE

- Data collection, formatting, and initial quality control [March 2022]
- 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) [May 2022]
- Regionalization and frequency analysis [August 2022]
- Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [November 2022]
- Peer review [January 2023]
- Revision of PF estimates [March 2023]
- Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [September 2023]
- Web publication [December 2023]

III. OTHER

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

With help from academia, HDSC developed a modeling framework that will allow non-stationary climate effects to be integrated into the NOAA Atlas 14 process and produce credible precipitation frequency estimates that Federal water agencies can rely on. This project was carried out in collaboration with researchers from Pennsylvania State University, the University of Illinois Urbana-Champaign, and the University of Wisconsin-Madison and was funded by the Department of Transportation (DOT) Federal Highway Transportation Administration (FHWA).

The assessment report that provides an overview of research, results, and final recommendations was completed in January of 2022 and published on our webpage under General Information, Progress Reports. This report can be access directly by clicking the following link: Assessment Report: Analysis of Impact of Nonstationary Climate on NOAA Atlas 14 Estimates. The analysis and work performed by the academic partners are included as appendices in this report.

2. ARTICLES, CONFERENCES, MEETINGS

On January 18, 2022, HDSC Mission Lead Mark Glaudemans and HDSC's Acting Technical Director Sandra Pavlovic presented the Precipitation Frequency Estimates to the White House Flood Resilience Interagency Working Group Climate-Informed Science Approach (CISA).