HYDROMETEOROLOGICAL DESIGN STUDIES CENTER
QUARTERLY PROGRESS REPORT

1 July 2010 to 30 September 2010

Office of Hydrologic Development

U.S. National Weather Service

National Oceanic and Atmospheric Administration

Silver Spring, Maryland

October 2010

DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various technical 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 Hydrologic Development of National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) is updating precipitation frequency estimates for various parts of the United States. Updated precipitation frequency estimates for durations from 5 minutes to 60 days and average recurrence intervals between 1- and 1,000-years, accompanied by additional relevant information (e.g., 95% confidence limits, temporal distributions, seasonality) are published in NOAA Atlas 14. The Atlas is divided into volumes based on geographic sections of the country and affiliated territories. NOAA Atlas 14 is a web-based document available through the Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/index.html).

HDSC is currently updating estimates for California, Alaska, the following southeastern states: Alabama, Arkansas, Georgia, Florida, Louisiana and Mississippi, and the following midwestern states: Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin. California precipitation frequency estimates are expected to be published by February 2011 in NOAA Atlas 14, Volume 6. Figure 1 shows new project areas as well as updated project areas included in NOAA Atlas 14, Volumes 1 to 5.

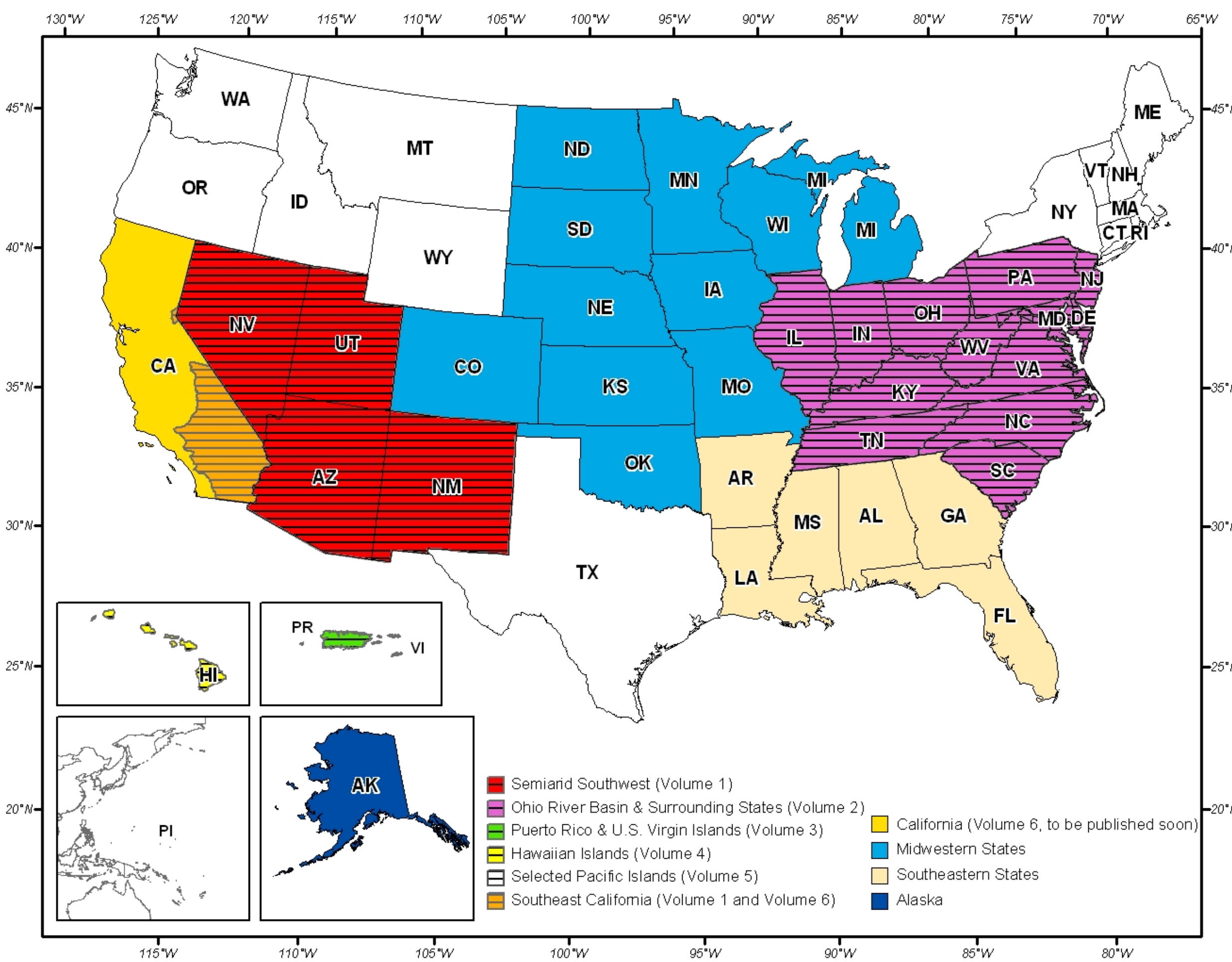

Figure 1. Map showing current project areas and project areas included in published NOAA Atlas 14, Volumes 1-5.

II. CURRENT PROJECTS

1. PRECIPITATION FREQUENCY PROJECT FOR CALIFORNIA

1.1. PROGRESS IN THIS REPORTING PERIOD (Jul - Sep 2010)

1.1.1. Change in project scope

Original project scope has changed to: a) include southeastern California that was previously published in NOAA Atlas 14 Volume 1, b) perform in parallel precipitation and rainfall-only frequency analysis for hourly durations between 1 and 24 hours, and c) explore alternative parameterization and regionalization approaches for precipitation frequency analysis.

1.1.2. Peer review of initial precipitation frequency estimates

The peer review of precipitation frequency estimates for selected durations began on July 22nd and while originally scheduled to close on August 27th, was extended through September 15th. Comments were received from five different individuals or groups. For more details on the review, see the previous progress report, http://www.nws.noaa.gov/oh/hdsc/current-projects/pdfs/HDSC_PR_Jul10.pdf. The reviewers' comments will be addressed in the upcoming months.

1.1.3. Review and update of precipitation data used in frequency analysis

a. Data update

After the review, it was decided to update records to include the most recent data for daily, hourly and 15-minute National Climatic Data Center (NCDC) stations, as well as the daily Snow Telemetry (SNOTEL) stations from the Natural Resources Conservation Service (NRCS).

During the update process, a considerable number of daily stations were found in the NCDC database that were not initially available for the download, due in part, to NCDC's Climate Database Modernization Program. Similarly, for some of the daily stations used in the initial frequency analysis, updated periods of record did not match periods of record initially obtained. New stations and stations with updated periods of record, with at least 30 years of data, were added to the analysis.

Daily data from the U.S. Army Corps of Engineers, Sacramento District, were re-formatted to properly account for accumulated and missing data.

Automated Local Evaluation in Real Time (ALERT) telemetry system event-based precipitation data collected from various counties were initially used primarily to calculate n-minute ratios for the estimation of precipitation quantiles at sub-hourly durations (see NOAA Atlas 14 documentation for more information). Recently, a decision was made to investigate the direct use of the ALERT data in frequency analysis. All available event data were reformatted into 15-minute intervals and regarded as 15-minute stations. Stations with at least 20 years of data were added to the dataset for frequency analysis. Data from some stations were used to extend the records at co-located hourly or daily stations. Additionally, data from the San Bernardino County Flood Control District were added to the dataset.

b. Station screening

Added daily NCDC stations were reviewed for co-location with 15-minute or hourly NCDC stations. Where appropriate, daily station records were deleted (e.g., if the hourly station's data covered the same period of record) or extended (e.g., if the hourly station's data covered additional years not found in the daily station's data).

In addition, stations from different data sources with different reporting intervals (i.e., 15-minute or 1-hour) that were located within 2 miles of added NCDC daily stations were identified. Cases were reviewed to confirm data consistency between the data types to be treated as co-located. Where appropriate, station records were deleted, merged, or extended.

1.1.4. Review of station metadata

Based in part to peer reviewers' input, the metadata for United States Geological Survey (USGS) and Contra Costa County Flood Control District's daily stations were reviewed and corrected.

1.1.5. Quality control of updated annual maximum series (AMS)

High and low outliers and other suspicious values were identified in the distribution of the AMS for all added data at the base durations (15-minute, 1-hour and 1-day). Questionable maxima were flagged and verified by reviewing spatial plots, raw data, scanned observation forms found on NCDC's Environmental Document Access and Display System (EDADS), and other storm information from various resources. All identified outliers were corrected or removed from the data set. High and low outliers in the AMS will also be identified and quality controlled for updated data across all durations.

1.1.6. Rainfall-only frequency analysis

Investigation continues into methods to extract rainfall-only AMS for hourly durations (1-, 3-, 6-, and 12-hour) since there are not enough hourly stations with direct snowfall or temperature measurements with a sufficient number of data years to allow for meaningful statistical analysis. The approach discussed in the previous progress report based on use of 3-hour temperature grids from the National Climatic Data Center's (NCDC) North American Regional Reanalysis (NARR) was reviewed and abandoned. An investigation of the modeled temperature vertical profiles identified many cases still requiring manual and subjective decisions. NARR grids are also only available for the last 30 years. An alternative approach was developed using daily snowfall measurements at stations where available and maximum, average and/or minimum daily temperature data for other stations and is currently under investigation.

1.1.7. Regionalization for frequency analysis

A decision was made that for this project a (modified) region-of-influence regionalization approach will be used. In this approach, each station has its own region; regions are initially defined to consist of nearby stations that have similar elevation and 1-day mean annual maximum to the station of interest. The maximum number of stations allowed per region is 10 and the minimum number of years of data for all stations combined is 250 (exception are allowed in regions with sparse rain gauges). All regions are carefully investigated by inspection of spatial maps (to investigate locations of stations in the region with respect to mountain ridges, etc.) and by inspection of similarities/dissimilarities in L-moment statistics at stations across durations (from 5-minute to 60-day). Investigation is done on the original L-moments, as well as L-moments standardized with corresponding 1-day moments.

1.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Oct - Dec 2010)

During the next quarter, all updated data will be quality controlled. The regionalization will be completed. Peer review comments will be addressed. AMS-based and partial duration series-based precipitation frequency estimates with associated confidence limits will be computed.

1.3. PROJECT SCHEDULE

Due to the change in project scope and the unforeseen data update, publication date is extended to February 2011.

Data collection, formatting and initial quality control [Complete]

Extraction of annual maximum series (AMS); additional quality control and data reliability tests (e.g., outliers, trend analysis, independence, consistency across durations, duplicate stations, candidates for merging) [Complete]

Regionalization and frequency analysis [Complete]

Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [Complete]

Peer review [Complete]

Revision of PF estimates [July 2010; revised to November 2010]

Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [August 2010; revised to January 2011]

Web publication [September 2010; revised to February 2011]

2. PRECIPITATION FREQUENCY PROJECT FOR THE SOUTHEASTERN STATES

2.1. PROGRESS IN THIS REPORTING PERIOD (Jul - Sep 2010)

The project includes the states of Alabama, Arkansas, Florida, Georgia, Louisiana and Mississippi and an approximately 1-degree buffer around the core states included to assist in the delineation of homogenous regions with respect to heavy precipitation characteristics (Figure 2).

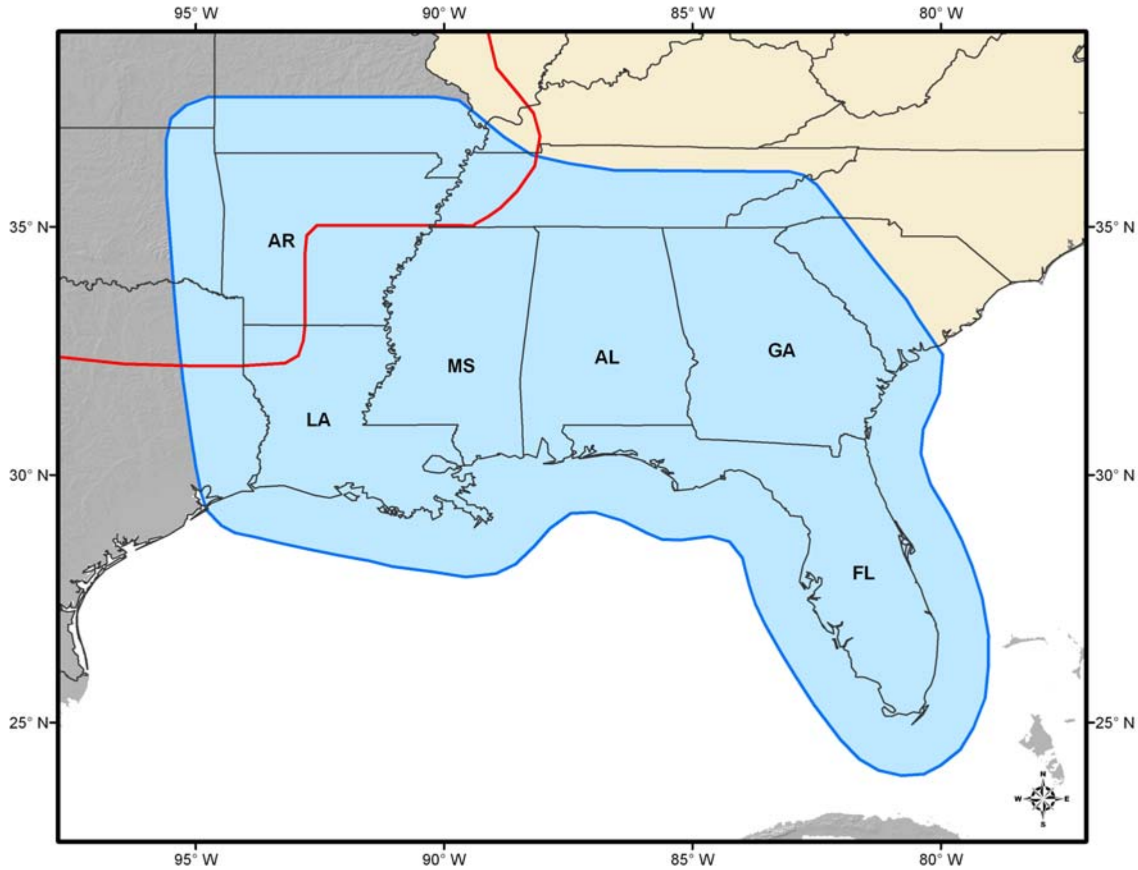

Figure 2. Southeastern precipitation frequency project area (shown in blue). Also shown is the border of the Midwestern precipitation frequency project area (red line).

2.1.1. Data collection and formatting

During this reporting period, data from the U.S. Forest Service's Remote Automated Weather Stations (RAWS) were reviewed and reformatted to correct the handling of missing and accumulated data.

To facilitate a more efficient process, stations from the Midwestern and Southeastern precipitation frequency projects are screened simultaneously. Table 1 shows the number of stations in both projects for each data reporting interval before and after the screening (described in Section 2.1.2). Automated Local Evaluation in Real Time (ALERT) telemetry system precipitation data and other data provided in variable time increments were formatted to 5-minute data.

Table 1. Number of precipitation stations in the Midwestern and Southeastern projects per reporting interval before and after data screening.

Data reporting interval	Number of stations formatted	Number of stations after screening
n-min*	331	TBD
variable	1,519	TBD
15-min	1,748	1,572
1-hour	3,909	3,161
1-day	16,358	15,523

* N-minute (n-min) stations are National Climatic Data Center's (NCDC) stations for which data are provided as monthly maxima for various n-minute durations (5-minute, 10-minute, 15-minute, etc.).

2.1.2. Station screening

a. Station merging

Stations that report data at the same time interval that were within 5 miles distance and maximum 300 feet elevation difference were considered for merging to increase record lengths in the 15-minute, hourly and daily datasets. Time series plots of the annual maximum series for station pairs were reviewed and merge candidates were identified. Statistical t-test was used to ensure that the annual maximum series of stations considered for merging were from the same population. Data for stations that were candidates for merging based on the t-test were further checked using a double mass analysis approach.

The merging effort for the 15-minute and hourly stations is completed. For the Midwestern and Southeastern projects combined, 83 15-minute station pairs were merged and 244 hourly station pairs were merged. Stations were also identified for deletion if they either had less than 10 years of data and could not be merged or had duplicate data of a nearby station with a longer record. 88 15-minute stations and 508 hourly stations were deleted.

The work for daily stations is in progress with the 4,282 potential pairs considered for merging. So far, 375 station pairs have been merged and 438 stations have been deleted.

b. Co-located station clean-up

Co-located stations are defined as stations that have the same (or very similar) metadata but report data at different time intervals (15-minute, 1-hour, and 1-day).

1,685 co-located 15-minute and hourly NCDC station pairs in the Midwestern and Southeastern project areas were screened for duplicate records. When AMS from co-located stations overlapped exactly, the hourly station was flagged for deletion and the 15-minute station was kept. 343 hourly stations have been flagged for deletion. At 16 hourly stations, it was possible to extend records using aggregated 15-minute data.

2.1.3. AMS Outliers

For this project, outliers are defined as annual maxima which depart significantly from the trend of the remaining maxima at a given station for a given duration. Since 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. Low and high outliers are identified based on statistical tests for outliers and visual inspection of AMS distribution plots and spatial plots (see NOAA Atlas 14, Volume 5 documentation for more details).

During this reporting period, existing algorithms were customized for the Midwestern and Southeastern projects to address handling of such large amounts of data. High and low outliers were identified in the AMS of daily stations.

2.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Oct - Dec 2010)

In the next reporting period, work on daily station merging, co-located station cleanup, and examination of geospatial data will be completed.

All questionable maxima at stations will be further investigated by reviewing spatial plots, raw data, scanned observation forms found on NCDC's Environmental Document Access and Display System (EDADS), and other storm information from various resources. Confirmed outliers will be removed from the data set. Investigation of high and low outliers in the AMS will be completed across all base durations.

Work on regionalization will begin.

2.3. PROJECT SCHEDULE

Completion date is revised slightly for some tasks but will not impact the final publication date.

Data collection, formatting, and initial quality control [Complete]

Extraction of annual maximum series (AMS); additional quality control and data reliability tests (e.g., outliers, trend analysis, independence, consistency across durations, duplicate stations, candidates for merging) [July 2010; revised to November 2010]

Regionalization and frequency analysis [November 2010; revised to January 2011]

Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [May 2011]

Peer review [July 2011]

Revision of PF estimates [October 2011]

Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [April 2012]

Web publication [May 2012]

3. PRECIPITATION FREQUENCY PROJECT FOR THE MIDWESTERN STATES

3.1. PROGRESS IN THIS REPORTING PERIOD (Jul - Sep 2010)

The project area includes the states of Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin and an approximately 1-degree buffer around the core states is included to assist in the delineation of homogenous regions with respect to heavy precipitation characteristics (Figure 3).

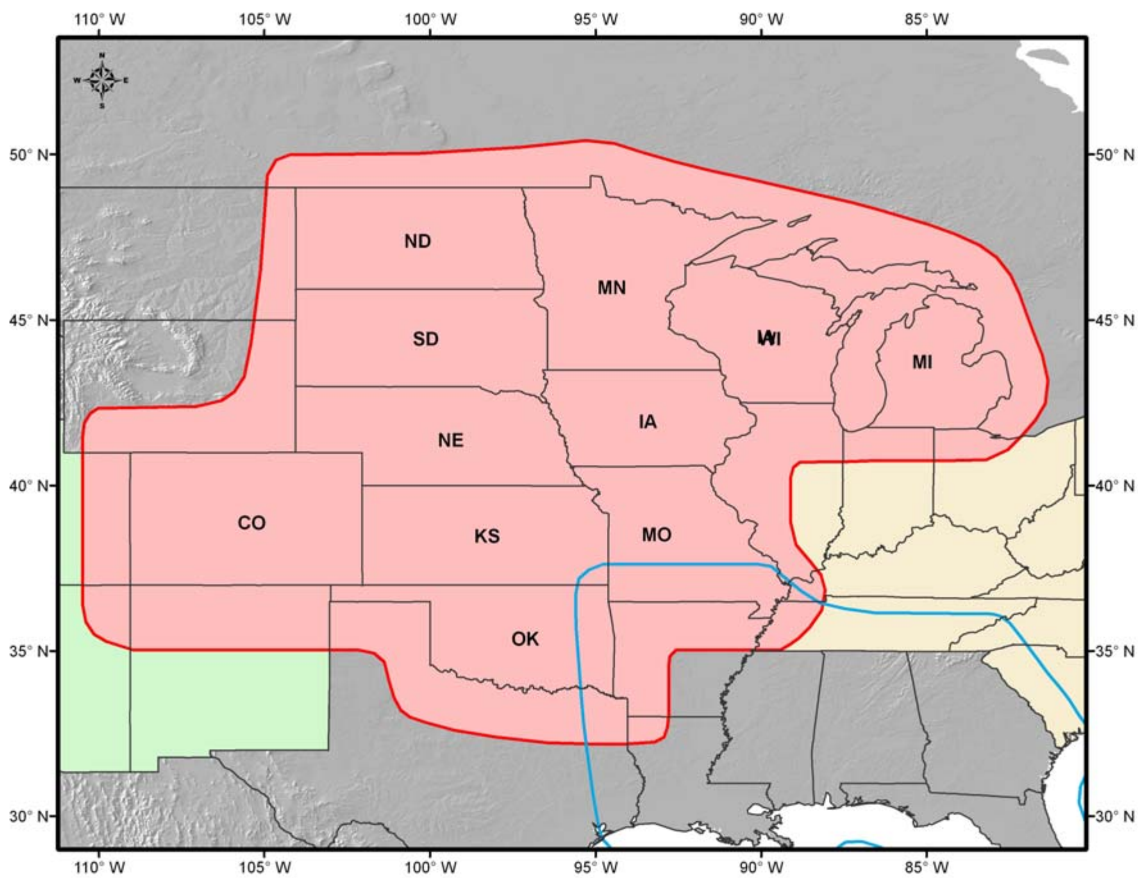

Figure 3. Midwestern precipitation frequency project area (shown in red). Also shown is the border of the Southeastern precipitation frequency project area (blue line).

3.1.1. Data collection and formatting

During this reporting period, data from the U.S. Forest Service's Remote Automated Weather Stations (RAWS), U.S. Army Corps of Engineers Omaha District Office, and U.S. Army Corps of Engineers St. Louis District Office databases were reviewed and reformatted to correct the handling of missing and accumulated data.

To facilitate a more efficient process, stations from the Midwestern and Southeastern precipitation frequency projects are screened simultaneously. Table 1 shows the number of stations in both projects for each data reporting interval before and after the screening (described in Section 2.1.2). Automated Local Evaluation in Real Time (ALERT) telemetry system precipitation data and other data provided in variable time increments were formatted to 5-minute data.

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* N-minute (n-min) stations are National Climatic Data Center's (NCDC) stations for which data are provided as monthly maxima for various n-minute durations (5-minute, 10-minute, 15-minute, etc.).

3.1.2. Station screening

a. Station merging

Stations that report data at the same time interval that were within 5 miles distance and maximum 300 feet elevation difference were considered for merging to increase record lengths in the 15-minute, hourly and daily datasets. Time series plots of the annual maximum series for station pairs were reviewed and merge candidates were identified. Statistical t-test was used to ensure that the annual maximum series of stations considered for merging were from the same population. Data for stations that were candidates for merging based on the t-test were further checked using a double mass analysis approach.

The merging effort for the 15-minute and hourly stations is completed. For the Midwestern and Southeastern projects combined, 83 15-minute station pairs were merged and 244 hourly station pairs were merged. Stations were also identified for deletion if they either had less than 10 years of data and could not be merged or had duplicate data of a nearby station with a longer record. 88 15-minute stations and 508 hourly stations were deleted.

The work for daily stations is in progress with the 4,282 potential pairs considered for merging. So far, 375 station pairs have been merged and 438 stations have been deleted.

b. Co-located station clean-up

Co-located stations are defined as stations that have the same (or very similar) metadata but report data at different time intervals (15-minute, 1-hour, and 1-day).

1,685 co-located 15-minute and hourly NCDC station pairs in the Midwestern and Southeastern project areas were screened for duplicate records. When AMS from co-located stations overlapped exactly, the hourly station was flagged for deletion and the 15-minute station was kept. 343 hourly stations have been flagged for deletion. At 16 hourly stations, it was possible to extend records using aggregated 15-minute data.

3.1.3. AMS Outliers

For this project, outliers are defined as annual maxima which depart significantly from the trend of the remaining maxima at a given station for a given duration. Since 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. Low and high outliers are identified based on statistical tests for outliers and visual inspection of AMS distribution plots and spatial plots (see NOAA Atlas 14, Volume 5 documentation for more details).

During this reporting period, existing algorithms were customized for the Midwestern and Southeastern projects to address handling of such large amounts of data. High and low outliers were identified in the AMS of daily stations.

3.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Oct - Dec 2010)

In the next reporting period, work on daily station merging, co-located station cleanup, and examination of geospatial data will be completed.

All questionable maxima at stations will be further investigated by reviewing spatial plots, raw data, scanned observation forms found on NCDC's Environmental Document Access and Display System (EDADS), and other storm information from various resources. Confirmed outliers will be removed from the data set. Investigation of high and low outliers in the AMS will be completed across all base durations.

Work on regionalization will begin.

3.3. PROJECT SCHEDULE

Completion date is revised slightly for some tasks but will not impact the final publication date.

Data collection, formatting, and initial quality control [Complete]

Extraction of annual maximum series (AMS); additional quality control and data reliability tests (e.g., outliers, trend analysis, independence, consistency across durations, duplicate stations, candidates for merging) [July 2010; revised to November 2010]

Regionalization and frequency analysis [November 2010; revised to January 2011]

Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [May 2011]

Peer review [July 2011]

Revision of PF estimates [October 2011]

Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [April 2012]

Web publication [May 2012]

4. PRECIPITATION FREQUENCY PROJECT FOR ALASKA

4.1. PROGRESS IN THIS REPORTING PERIOD (Jul - Sep 2010)

The University of Alaska, Fairbanks (UAF) and HDSC are jointly working on this project.

4.1.1. Data collection and formatting

UAF has completed data collection and a review of the datasets. It was observed that the Road Weather Information System (RWIS) dataset (collected by the Alaska Department of Transportation and Public Facilities) had numerous discrepancies. These stations only had about 10 years of data but were located in areas of very sparse data. After a fairly detailed review, it was decided to delete this dataset (15 stations) from the analysis. Table 3 shows the number of stations for each data reporting interval before and after initial data screening and quality control described in Section 4.1.4.

Table 3. Number of precipitation stations in the Alaska project per reporting interval before and after data screening.

Data reporting interval	Number of stations formatted	Number of stations after screening
n-min*	36	TBD
15-min	36	29
1-hour	427	306
1-day	818	571

* N-minute (n-min) stations are National Climatic Data Center's (NCDC) stations for which data are provided as monthly maxima for various n-minute durations (5-minute, 10-minute, 15-minute, etc.).

4.1.2. Rainfall under-catch correction

It was originally proposed for UAF to make bias corrections for undercatch to all Alaska precipitation gauges. This requires fairly accurate historical dates of Alter shields (wind shields) installation at the precipitation gauges. Scanned documents provided by NOAA's NCDC do not have enough information on the type of gauge at a given site and if and when it was instrumented with an Alter shield to make bias corrections. It also became clear that there was not a common time of installation of wind shields in Alaska. Therefore, UAF's conclusion was that bias corrections cannot be done accurately and therefore they will not be applied.

4.1.3. Precipitation versus rainfall annual maximum series (AMS) extraction

AMS will be extracted for both precipitation and for rainfall-only events. In order to distinguish between snowfall and rainfall, the project area was first divided into 7 climate regions based on the regions used in Shulski and Wendler (2007). Each climate region has been assigned an "extended warm season" that reflects the months during which liquid precipitation can reasonably be expected to occur, though snowfall may occur as well. Table 4 lists the proposed regions and seasons. Much of the annual precipitation in Alaska falls as solid precipitation; for the Alaskan Arctic, this can last seven months or more. In Interior Alaska, Alaskan West Coast and Alaskan Arctic, rain can (though rarely) occur in mid-winter. However, when this occurs, the rain does not effectively runoff until ablation occurs later. Because of the extreme environment, it either freezes within the snow pack or possibly percolates to the bottom of snowpack and then refreezes. In either case, it was decided to not include such events in the in the determination of the rainfall-only AMS as such winter events never generate runoff.

Table 4.Climatic regions, warm and cold seasons for the Alaska project area.

Region	Extended warm season	Cold season
Arctic	April 15 – September 30	October 1 – April 14
Interior	April 1 – October 31	November 1 – March 31
West Coastal	April 1 – October 31	November 1 – March 31
SW Islands	January 1 – December 31	Not applied
Bristol Bay/Cook Inlet	March 1 – November 30	December 1 – February 28
SE Panhandle	January 1 – December 31	Not applied
Other (Canada)	April 1 – October 31	November 1 – March 31

The approach to distinguish between rain and solid precipitation events can be summarized in the following three steps: 1) all precipitation during the cold season will be assumed to be snowfall; 2) precipitation during the warm season will be examined to see if the field observer designated it as solid precipitation or not; 3) if the form of precipitation was not noted by the observer, then a threshold daily mean air temperature will be used to determine whether it is solid or liquid precipitation. UAF will investigate different threshold values for segregating the phase of precipitation. Careful attention will be given to the transition period from warm to cold and vice versa when most of the ambiguous cases would occur. For the Arctic region, the whole warm season will be considered as the transition period, as it can snow there any day of the warm season.

4.1.4. Station screening

a. Station merging

HDSC joined UAF in execution of this task. Stations that report data at the same time interval that were within 5 miles distance and maximum 300 feet elevation difference were considered for merging to increase record lengths in the 15-minute, hourly and daily datasets. Time series plots of the annual maximum series for station pairs were reviewed and merge candidates were identified. Statistical t-test was used to ensure that the annual maximum series of stations considered for merging were from the same population. Data for stations that were candidates for merging based on the t-test were further checked using a double mass analysis approach.

There were no candidates for merging in the 15-minute dataset and only 1 merge in the hourly dataset. There were 84 merges identified and implemented in the daily dataset which are under closer review by UAF. Stations were also identified for deletion if they either had less than 10 years of data and could not be merged or had duplicate data of a nearby station with a longer record. 7 15-minute, 83 hourly and 187 daily stations were deleted.

b. Co-located station clean-up

Co-located stations are defined as stations that have the same metadata (or very similar) but report data at different time intervals (15-minute, 1-hour, and 1-day).

HDSC joined UAF in execution of this task. 35 co-located 15-minute and hourly NCDC station pairs were screened for duplicate records. When AMS from co-located stations overlapped exactly, the hourly station was deleted; this led to 24 deleted hourly stations. There were no hourly stations whose records could be extended using aggregated 15-minute data.

Work began on co-located 15-minute/ hourly and daily NCDC stations.

4.1.5. Quality control of AMS data

For this project, outliers are defined as annual maxima which depart significantly from the trend of the remaining maxima at a given station for a given duration. Since 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. Low and high outliers are identified based on statistical tests for outliers and visual inspection of AMS distribution plots and spatial plots (see NOAA Atlas 14, Volume 5 documentation for more details). During this reporting period, high and low outliers were identified in the AMS of daily stations.

4.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Oct - Dec 2010)

In the next reporting period, work on co-located station cleanup and an examination of geospatial data will be completed. The quality control of precipitation AMS outliers at base durations will be completed and regionalization will begin. Extraction of rainfall-only AMS using temperature data will also be completed.

4.3. PROJECT SCHEDULE

UAF: data collection, formatting, and initial quality control [Complete]

UAF: extraction of annual maximum series (AMS) for precipitation and rainfall; additional quality control and data reliability tests (e.g., outliers, trend analysis, independence, consistency across durations, duplicate stations, candidates for merging). [February 2010; revised to December 2010*]

HDSC: regionalization and frequency analysis [September 2010, revised to March 2011]

HDSC: initial spatial interpolation of PF estimates and consistency checks across durations [January 2011, revised to April 2011]

HDSC: peer review [March 2011, revised to May 2011]

HDSC: revision of PF estimates [May 2011, revised to July 2011]

HDSC and UAF: remaining tasks (e.g., development of precipitation frequency estimates for PD series, seasonality, temporal distributions, documentation) [August 2011]

HDSC: web publication [September 2011]

** The schedule for this task has slipped due to delay in execution of data collection and formatting task. HDSC will join UAF in execution of this task to speed up the work. This will affect subsequent tasks, but the project is still expected to be completed on time.*

5. AREAL REDUCTION FACTORS

5.1. PROGRESS IN THIS REPORTING PERIOD (Jul - Sep 2010)

Areal reduction factors (ARFs) are needed to convert average point precipitation frequency estimates to areal estimates with the same recurrence interval for any area of interest. After extensive review of existing ARF methods, HDSC selected 2 methods for evaluation, bearing in mind the need for a nationwide application. Both selected methods have been well documented and extensively cited, and utilize sound theoretical concepts (previously tested in a variety of contexts) for rainfall phenomena.

The first method, developed by Sivapalan and Bloschl (1998), is an extension of the rainfall spatial correlation structure method of Rodriquez-Iturbe and Mejia (1974). This method estimates the areal-averaged extreme value distribution of rainfall from the point parent distribution using the spatial correlation of rainfall and extreme value theory and utilizes raingauge data in the analysis. Ultimately, the ARF is derived as the ratio of the areal intensity-duration-frequency (IDF) curve to the point IDF curve for selected quantiles.

The second method utilizes radar data and was developed by De Michele, Kottegoda and Rosso (2001). It is based on concepts of dynamic scaling and statistical self-affinity. This method essentially combines an analytical expression for the areal IDF curves with the dynamic scaling and statistical self-affinity of the average rainfall intensity in area and duration. Similar to the first method, the ARF is derived again as the ratio of the areal IDF to the point IDF.

In parallel, HDSC is developing a new method for calculating the ARF that is based on the reconstruction of spatial correlation structures of rainfall within the Gaussian copula framework (Renard and Lang, 2007) and utilizes both rain gauge and radar data.

Oklahoma was selected as a study area for the evaluation phase of this project. Daily rain gauge data came from the Midwestern project dataset. Radar data for the study area was obtained from the Arkansas-Red Basin River Forecast Center (ABRFC). The radar and rain gauge data were formatted and processed into MATLAB files to facilitate computation.

5.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Oct - Dec 2010)

HDSC will continue development and evaluation of selected ARF approaches.

5.3. PROJECT SCHEDULE

This project began on April 1, 2010. It is expected to take 2 years to complete.

III. OTHER

1. MEETINGS AND PRESENTATIONS

On September 2nd and 3rd, Geoff Bonnin, Chief of the Hydrologic Science and Modeling Branch, attended the Federal Highway Administration's (FHWA) National Hydraulic Engineering Conference in Park City, UT. Mr. Bonnin made a presentation on our progress in updating the nation's precipitation frequency estimates and the impact of climate change on the frequency of extreme rainfall.

2. WEB PAGE

HDSC is enhancing the web interface for the Precipitation Frequency Data Server (PFDS). The PFDS pages will be interactive and will make use of custom created Google Maps. Newly designed pages will increase download speed and provide precipitation frequency estimates with supplementary information much faster.

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