HYDROMETEOROLOGICAL DESIGN STUDIES CENTER QUARTERLY PROGRESS REPORT

1 April 2012 to 30 June 2012

Office of Hydrologic Development

National Weather Service

National Oceanic and Atmospheric Administration

U.S, Department of Commerce

Silver Spring, Maryland

July 2012

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 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 and affiliated territories. 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 (PFDS; http://hdsc.nws.noaa.gov/hdsc/pfds/index.html).

HDSC is currently updating estimates for 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. Contracts have been finalized with the Federal Highway Administration's (FHWA) Pooled Fund Program and we are also beginning work to update estimates for the following northeastern states: Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. Figure 1 shows new project areas as well as updated project areas included in NOAA Atlas 14, Volumes 1 to 7.

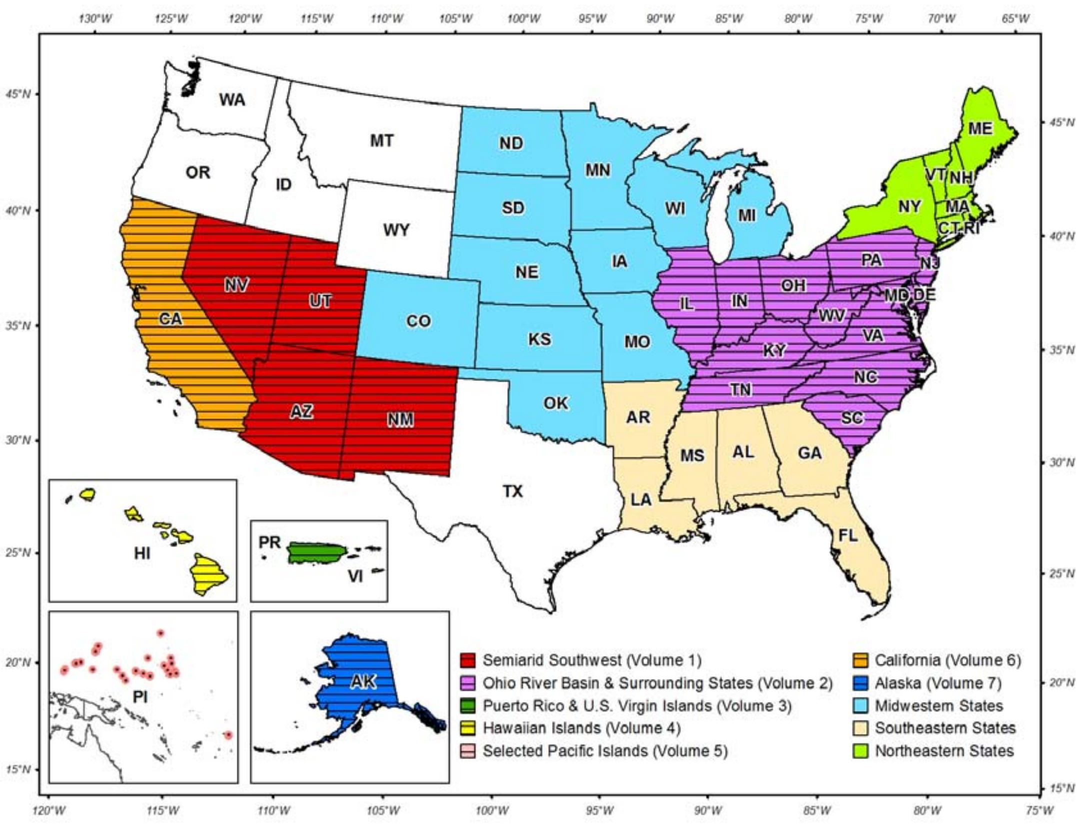

Figure 1. Current project areas and project areas included in published NOAA Atlas 14, Volumes 1-7.

II. CURRENT PROJECTS

1. PRECIPITATION FREQUENCY PROJECTS FOR THE MIDWESTERN AND SOUTHEASTERN STATES

1.1. PROGRESS IN THIS REPORTING PERIOD (Apr - Jun 2012)

To facilitate a more efficient process, the Midwestern and Southeastern precipitation frequency projects are being done simultaneously. Because of that, the results shown in this section apply for both projects. Both project areas are shown in Figure 2.

The Midwestern 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 these core states.

The Southeastern project includes the states of Alabama, Arkansas, Florida, Georgia, Louisiana and Mississippi and an approximately 1-degree buffer around these core states.

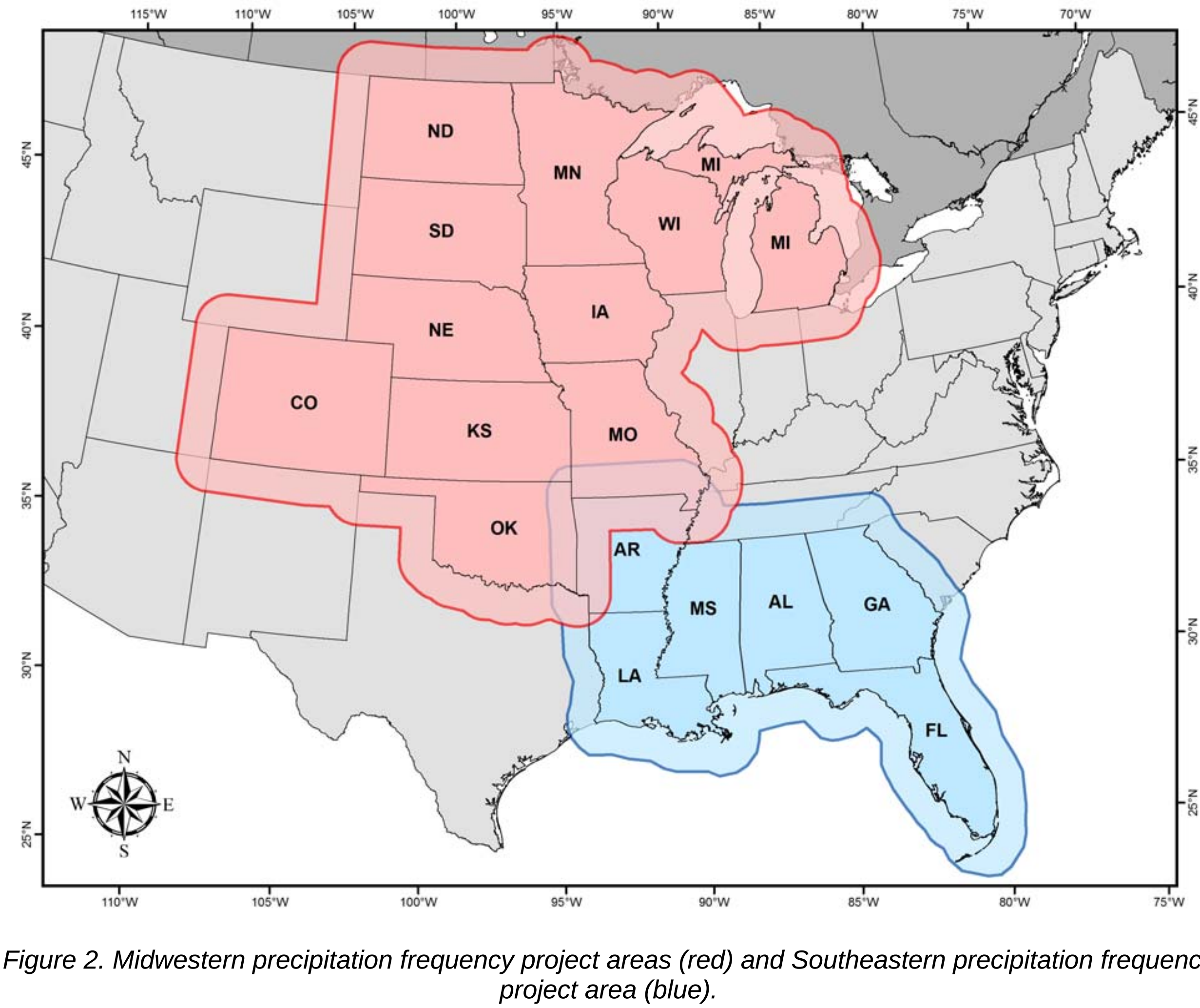

Figure 2. Midwestern precipitation frequency project areas (red) and Southeastern precipitation frequency project area (blue).

1.1.1. Quality control of AMS

All high outliers in annual maximum series (AMS) have been verified, corrected, or removed from the dataset for all durations between 15-minutes and 60-days. Plots of at-station AMS distributions were checked and high outliers and any other questionable values were reviewed relative to nearby stations. Any that could not be confirmed were investigated further using climatological observation forms, monthly storm data reports and other historical weather event publications. During this reporting period, the remaining quality control of the daily dataset was completed.

1.1.2. Correction for constrained observations

Factors to convert constrained observations (e.g., 1-day) to unconstrained values (e.g., 24-hour) were developed. The correction factor for each daily duration was estimated as the coefficient of a zero-intercept regression model using concurrent (occurring within +/- 1 day) constrained and unconstrained annual maxima from hourly stations as independent and dependent model variables, respectively. Correction factors for all daily durations are given in Table 1.

Table 1. Correction factors applied to constrained AMS data across daily durations.

Duration (days)	1	2	3	4	7	>7
Correction factor	1.12	1.04	1.03	1.02	1.01	1.00

Similar adjustments were needed on hourly AMS data to account for the effects of constrained ‘clock hour’ on observations. The correction factors for hourly AMS were developed using constrained and unconstrained concurrent annual maxima from 15-minute stations; they are shown in Table 2.

Table 2. Correction factors applied to constrained AMS data across hourly durations.

Duration (hours)	1	2	3	6	>6
Correction factor	1.09	1.04	1.02	1.01	1.00

1.1.3. Mean annual maxima analysis

An analysis of at-station mean annual maxima (MAMs) across durations was completed. MAMs were reviewed for spatial consistency for 1-hour, 1-day and 10-day durations. Inconsistencies can occur when a station has a different period of record or missed several heavy events relative to nearby stations. Decisions were made on a case by case basis to keep, edit, or delete certain data/stations.

Final at-station MAMs were sent to Oregon State University’s PRISM Climate Group for high-resolution spatial interpolation using a hybrid statistical-geographic approach for mapping climate data named Parameter-elevation Regressions on Independent Slopes Model (PRISM).

1.1.4. Regionalization and at-station precipitation frequency analysis

Regional approaches to frequency analysis use data from stations that are expected to have similar frequency distributions to yield more accurate estimates of extreme quantiles than approaches that use only data from a single station. The number of stations used to define a region should be large enough to smooth variability in at-station estimates, but also small enough that regional estimates still adequately represent local conditions. The region of influence approach used in this volume defines regions such that each station has its own region with a potentially unique combination of nearby stations.

Regions were created for each of the 4,631 stations in this project. Initial regions for each station were formed by grouping the closest 10 stations. Stations were then added to or removed from regions based on examination of their distance from a target station, elevation difference, inspection of their locations with respect to mountain ridges, etc. and assessment of similarities/dissimilarities in the progression of relevant L-moment statistics across durations compared with other stations in the region. During the process, some inconsistent stations were removed from the analysis if their records were short, particularly if a nearby station had a much longer record.

Precipitation frequency estimates for each station were computed using the regional L-moment statistics and the Generalized Extreme Value (GEV) distribution as the selected distribution.

1.1.5. Analysis of spatial patterns in 100-year precipitation frequency estimates

100-year estimates at 1-hour, 1-day and 10-day durations were analyzed for spatial consistency. An HDSC-developed spatial interpolation technique termed the Cascade, Residual Add-Back (CRAB) was used to convert preliminary mean annual maximum grids into grids of precipitation frequency estimates. (A full description of this technique can be found in the documentation for NOAA Atlas 14 Volume 6.) The precipitation frequency estimates were then reviewed for any bulls' eyes or inconsistencies relative to expected spatial patterns. The inconsistencies are being resolved on a case by case basis.

1.1.6. Peer review preparation

Web pages for the peer review of preliminary results have been prepared. We are waiting for the PRISM products to start the peer review; it is expected to start in August 2012.

1.1.7. Rainfall frequency analysis

Precipitation frequency estimates represent precipitation magnitudes regardless of the type of precipitation. For some applications it may be important to differentiate frequency estimates from liquid precipitation (i.e., rainfall) only. To explore differences in total and liquid-only precipitation frequency estimates, concurrent rainfall and precipitation AMS will be extracted at stations which have information useful for distinguishing the type of precipitation. To this end, temperature and snowfall data at NCDC daily stations were downloaded and formatted.

1.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jul - Sep 2012)

In the next reporting period, a peer review of precipitation frequency estimates at base durations (1-hour, 1-day and 10-day) will occur. Additionally, we will work on the following tasks: revision of precipitation frequency estimates based on comments received during the peer review process, temporal distribution analysis, seasonality analysis and rainfall frequency analysis.

1.3. PROJECT SCHEDULE

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 [July 2012]

Peer review [July 2012; revised to August 2012 to await PRISM products]

Revision of PF estimates [November 2012]

Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [January 2013]

Web publication [March 2013]

2. PRECIPITATION FREQUENCY PROJECT FOR THE NORTHEASTERN STATES

2.1. PROGRESS IN THIS REPORTING PERIOD (Apr - Jun 2012)

The project area includes the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont and an approximately 1-degree buffer around these core states (Figure 3).

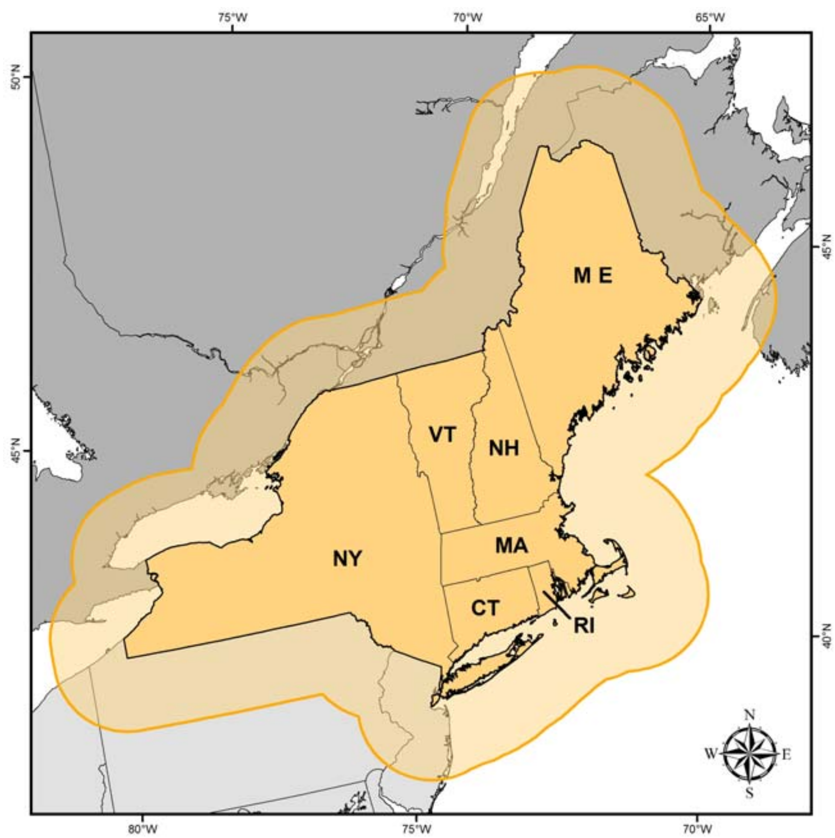

Figure 3. Northeastern precipitation frequency project area (shown in orange).

2.1.1. Data collection

The primary source of data is the National Climatic Data Center (NCDC), but data measured at reporting intervals of 1-day or shorter are also being collected from all known data sources. Table 3 reports the potential sources being investigated so far.

If you have any information about additional available data, please contact us at HDSC.Questions@noaa.gov.

Table 3. Potential sources of data for the precipitation frequency analysis that we are currently investigating.

Source	Reporting interval	Comments
Automated Surface Observing Systems (ASOS)	1-minute	Available for download via web site.
Colorado Climate Center: Community Collaborative Rain, Hail and Snow Network (CoCoRaHS)	1-day	
Environment Canada	1-day, 1-hour	
Illinois State Water Survey: National Atmospheric Deposition Program (NADP) dataset	1-day	
Massachusetts Department of Conservation and Recreation (DCR)	1-day	Data received on CD.
Midwestern Region Climate Center (MRCC): 19th Century Forts and Voluntary Observers Database	1-day	
National Climatic Data Center (NCDC)	1-day, 1-hour, 15-minute, n-minute	Available for download via web site.
NRCS: Soil Climate Analysis Network (SCAN)	1-hour, 6-hour	
Northeast Regional Climate Center (NRCC): CLimate Information for Management and Operational Decisions (CLIMOD)	1-day	
Rhode Island Department of Environmental Management, Office of Water Resources	1-hour	1 station received via email.
U.S. Army Corps of Engineers	1-hour	
U.S. Department of Agriculture: Agricultural Research Service (ARS)	variable	Available for download via web site.
U.S. Forest Service: Remote Automated Weather Stations (RAWS) dataset	1-hour	
U.S. Geological Survey (USGS): National Water Information System dataset	1-day, 15-minute	

2.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jul - Sep 2012)

Data collection and formatting will continue. Quality control of the NCDC metadata will begin.

2.3. PROJECT SCHEDULE

Data collection, formatting, and initial quality control [June 2013]

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) [December 2013]

Regionalization and frequency analysis [July 2014]

Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [December 2014]

Peer review [December 2014]

Revision of PF estimates [June 2015]

Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [July 2015]

Web publication [September 2015]

3. AREAL REDUCTION FACTORS

3.1. PROGRESS IN THIS REPORTING PERIOD (Apr - Jun 2012)

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. HDSC is testing two existing methods and developing a new copula-based method for calculating ARF. Please see the July – September 2010 Quarterly Report (http://www.nws.noaa.gov/ohd/hdsc/current-projects/pdfs/HDSC_PR_Oct10.pdf) for more information on the methods. Limited work continued this reporting period as time allowed on the application of three exiting ARF methods to a test dataset in Oklahoma.

3.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jul - Sep 2012)

This project continues to be on hold to allow us to focus on precipitation frequency projects.

3.3. PROJECT SCHEDULE

It is expected that this project will be completed by the end of March 2013.

III. OTHER

1. RECENT CONFERENCES

A member of HDSC, Ishani Roy, attended the hydrologic frequency sessions of the American Society of Engineer's (ASCE) World Environmental and Water Resources Congress 2012 in Albuquerque, New Mexico on May 20-24, 2012.

2. ARCHIVED DOCUMENTS

HDSC is in the process of scanning and making available on-line all previous publications from this office. Plans are to publish on our website all Technical Papers, Technical Memoranda, Technical Reports, and Hydrometeorological Reports published by our office dating back to 1938. The publications will be made available on the HDSC web site (http://www.nws.noaa.gov/oh/hdsc/index.html) during the next quarter.

3. STORM ANALYSIS

HDSC developed a map (Figure 4) for the NWS Southeast River Forecast Center showing the annual exceedance probabilities of the worst case 48-hour rainfall from Tropical Storm Debby that lashed the Gulf Coast on June 23-27, 2012. The storm delivered total rainfall amounts that exceeded 18-20 inches in some locations as it slowly moved through the area and caused extensive river flooding. The map shows areas in dark blue that experienced a 48-hour point rainfall magnitudes with a less than 1-in-500 annual exceedance probability (i.e., greater than 500-year recurrence interval).

Rainfall amounts used in the analysis were based on point observations collected at almost 350 stations and multi-sensor quantitative precipitation estimates. Frequency estimates were preliminary results from unpublished NOAA Atlas 14 Volume 9 (see Section 1).

In developing this map, we looked at a range of rainfall durations. The 48-hour duration produced the lowest probability cases. Longer and shorter durations showed rainfall accumulations that were more common (i.e., higher annual exceedance probabilities).

The worst case 48-hour period is not necessarily the same period of time at each location. As a result, this map does not represent isohyets at any particular point in time, but rather within the whole event.

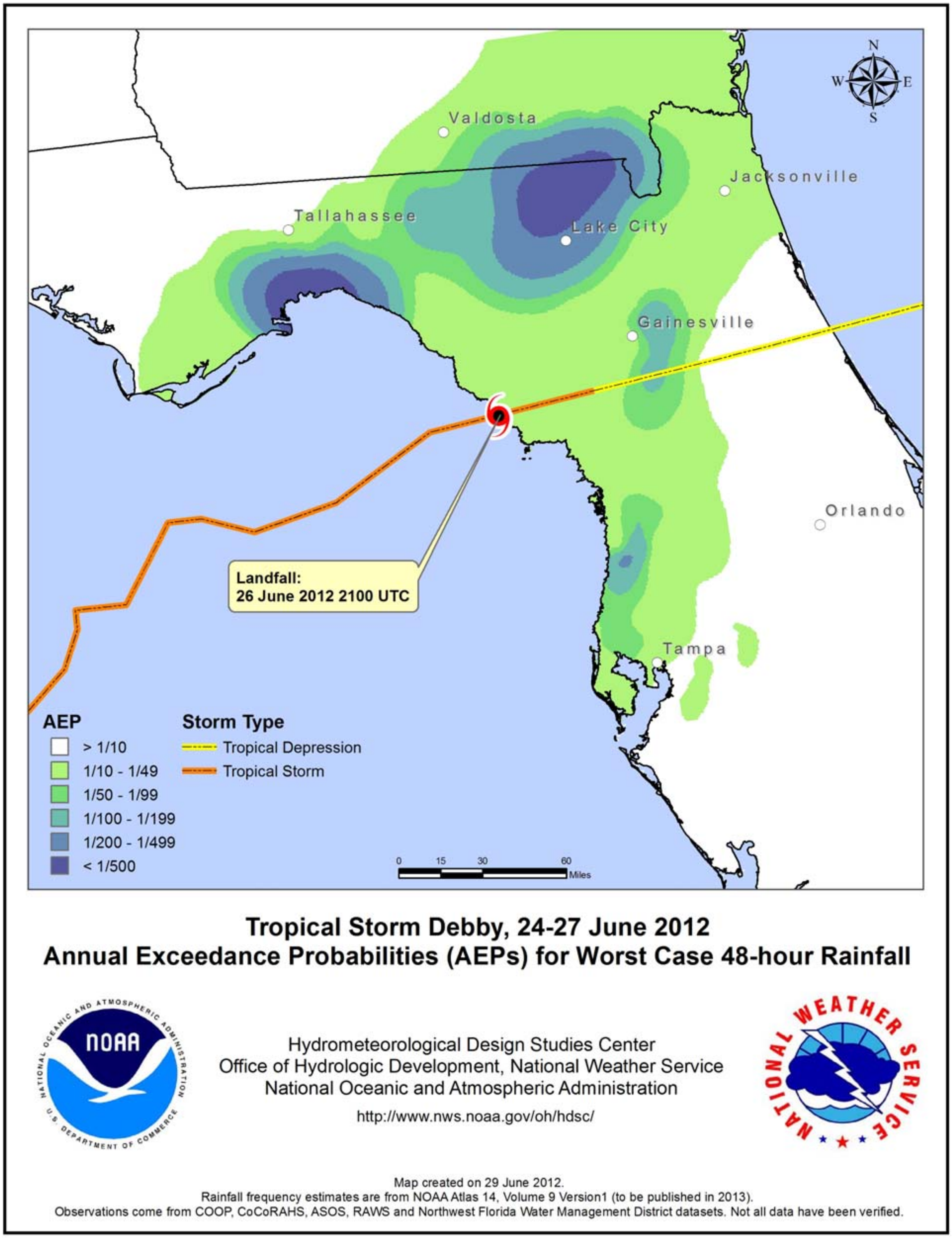

Figure 4. Annual exceedance probabilities for the worst case 48-hour rainfall for the Tropical Storm Debby.