HYDROMETEOROLOGICAL DESIGN STUDIES CENTER QUARTERLY PROGRESS REPORT

1 January 2008 to 31 March 2008

Office of Hydrologic Development

U.S. National Weather Service

National Oceanic and Atmospheric Administration

Silver Spring, Maryland

April 2008

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 purpose other than for what it was intended does so at their own risk.

Table of Contents

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 selected average recurrence intervals accompanied by additional information (e.g., 90% confidence intervals, temporal distributions, seasonality) are published in NOAA Atlas 14. The Atlas is divided into volumes based on geographic sections of the country. NOAA Atlas 14 is a web-based document available through the Precipitation Frequency Data Server (http://www.nws.noaa.gov/ohd/hdsc). We are currently working on updating precipitation frequency estimates for Hawaii (NOAA Atlas 14, Volume IV) and the remainder of California (Volume 5). We are also finalizing agreements to update estimates for the southeastern states of Florida, Georgia, Alabama and Mississippi. A proposal for updating estimates for Alaska is under consideration, and there have been discussions for updating estimates in midwestern states.

In addition, HDSC is developing depth-area relationships (known also as Areal Reduction Factors - ARF) that will enable conversion of point rainfall frequency estimates to areal average frequency estimates for the same duration and same average recurrence interval. The results of this supplementary study will be applicable to all volumes of NOAA Atlas 14.

II. CURRENT PROJECTS

1. PRECIPITATION FREQUENCY FOR HAWAII

1.1. PROGRESS IN THIS REPORTING PERIOD

1.1.1. Data

a. Consistency of AMS data across durations

Due to incomplete records and because annual maxima for each duration are extracted separately, it could happen that an extracted maximum for a given year for a shorter duration is greater than for a longer duration. To mitigate any such inconsistencies, longer duration annual maxima were set equal to any higher value at shorter durations in these cases. Consistency across durations was tested and applied to both daily and hourly durations.

b. Inter-site dependence of daily AMS data

Inter-site (in)dependence of daily annual maximum series (AMS) data was assessed. Cases where annual maxima were concurrent (overlap by +/- 1 day) at stations within 50 miles were analyzed. Pairs of stations with correlation coefficients statistically significant at the 90% confidence level were investigated. Little impact on the final quantiles was observed when stations were removed to eliminate cross-correlation. This may be further investigated at later time.

c. Conversion factors

Conversion factors for daily data are used to convert constrained to unconstrained (i.e., with no pre-defined start time). Based on the most recent investigation of concurrent constrained and unconstrained 24-hour annual maxima obtained from co-located daily and hourly stations, it was decided to use a conversion factor of 1.17 for the 1-day to 24-hour conversion and 1.07 for the 2-day to 48-hour conversion.

d. Significant event study

Very heavy rain that fell on February 1-3, 2008 produced flooding, forced evacuations and closed bridges on several Hawaiian Islands. At several locations, the 72-hour totals exceeded current 200- to 500-year estimates. The impact of this event on precipitation frequency estimates was assessed using hourly data collected by the NWS Honolulu Forecast Office for stations in the For the Record Report. Data were aggregated to daily durations and assigned to the nearest daily station in the project area. In addition, some daily data were obtained from the electronic submissions of the NWS Cooperative Observer Program stations and assigned to the nearest station. For one station, data were collected from the Climate Reference Network. Precipitation frequency estimates from AMS that included the 2008 event were computed using regional L-moment approach.

The overall impact of the 2008 event on precipitation frequency estimates across all daily durations was negligible with respect to variability in the estimation process. The greatest impact was a 3% increase in the mean annual maximum at a station and 4% increase in the 1,000-year average recurrence interval for 4-day duration. These data were temporarily added as part of a study and will not be included for the final estimates.

1.1.2. Regionalization

After a careful review of regional heterogeneity measures (H1 statistics) and spatial distribution of possible biases in daily precipitation frequency estimates, it was decided to revisit previously defined homogenous regions. Twenty-four regions, shown in Figure 1, were developed. The most noteworthy differences relative to the previous regionalization map are:

a. the formation of a coastal region and inland/upslope regions on the windward side of the Big Island

b. the division of a windward transitional region (old region 10) on Oahu into northern and southern components

c. the modification of the windward coastal regions on Kauai into three separate north, south and inland/upslope regions.

All modifications were carefully considered for extreme precipitation climatology and tested for the impact on regional growth factors.

Each region was renumbered according to general climatic/geographic zones:

- Regions 1-7: windward coasts
- Regions 8-11: windward uplands
- Regions 12-17: windward transitional regions
- Regions 18-23: leeward lowlands and slopes
- Region 24: high elevation.

Table 1 provides a brief description and number of daily stations in the 24-hour analysis for each region. Table 2 shows the H1 measures for all daily durations. An H1> 2.0 indicates possible heterogeneity. Further investigation may result in additional site redistribution.

Table 1. Daily region descriptions and number of 1-day stations.

Region	Description	Number of 1-day stations
1	Hawaii: windward coastal area	24
2	Maui: windward coastal area	5
3	Molokai and Lanai: windward coastal area	7
4	Oahu: windward coastal area	5
5	Oahu: windward coastal	5
6	Kauai: north windward coastal area	5
7	Kauai: south windward coastal area	34
8	Hawaii: windward upslope area	21
9	Maui: windward uplands area	11
10	Kauai: interior windward uplands area	8
11	Oahu and Kauai: windward uplands areas	15
12	Hawaii: windward transitional area	4
13	Hawaii: windward transitional area	6
14	Hawaii: north tip windward transitional area	11
15	Maui: windward transitional area	19
16	Maui and Oahu: windward transitional areas	15
17	Oahu: north half of windward transitional area	23
18	Hawaii, Maui, Molokai, Lanai, Oahu: leeward coastal areas	40
19	Hawaii: Kona coast, leeward area	7
20	Hawaii: Kona coast leeward lowlands and slopes	7
21	Maui: leeward area	24
22	Oahu: south half of leeward uplands	18
23	Kauai: leeward coast-upland area	23
24	Maui and Hawaii: high elevation area	5

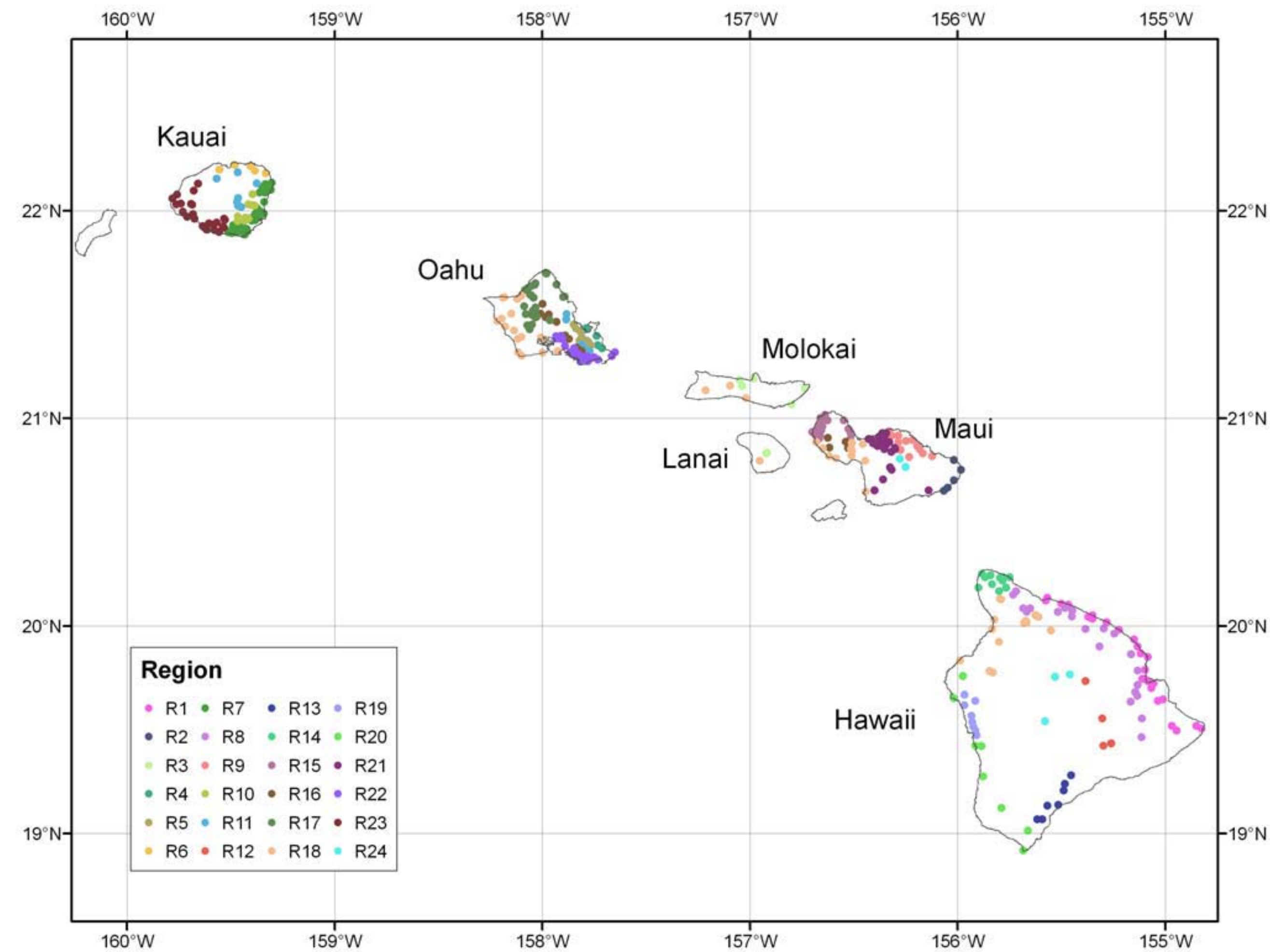

Figure 1. Twenty-four daily regions (applicable for durations 24-hour through 60-day).

Table 2. Statistical heterogeneity measure (H1) for all daily regions and durations.

Region	Duration								
	24-hour	**2-day**	**4-day**	**7-day**	**10-day**	**20-day**	**30-day**	**45-day**	**60-day**
1	0.93	-0.07	-0.28	0.16	0.69	0.88	2.81	2.13	1.89
2	-1.21	-0.96	-0.44	-0.92	-0.36	0.44	0.16	0.37	-0.13
3	0.50	-0.54	-1.23	-0.21	-0.43	0.69	0.72	1.41	1.31
4	-0.23	0.10	0.40	0.02	-0.20	-0.48	-1.13	-0.63	-1.01
5	0.96	-1.28	-1.16	-1.82	-1.60	-0.10	-0.07	0.59	0.75
6	0.85	-0.34	0.00	-0.14	0.43	0.43	-0.05	-1.02	-0.61
7	-0.53	0.33	1.38	1.43	0.29	-0.25	0.13	0.62	0.80
8	-0.08	1.04	0.77	1.00	1.47	1.15	1.77	2.07	3.13
9	0.29	0.69	2.24	0.55	0.09	-0.40	-0.11	0.16	-0.15
10	-0.20	n/a	1.74	1.17	0.94	0.10	-0.42	-0.54	-1.00
11	0.18	0.65	1.15	1.33	1.50	2.20	2.48	2.84	4.65
12	2.05	-1.29	-0.57	-0.47	-0.59	-0.86	-1.05	-1.25	-1.33
13	2.61	1.90	1.38	1.54	2.16	1.35	0.93	1.04	1.44
14	-0.51	-1.65	-1.42	-1.94	-2.12	-1.64	-0.37	-0.57	0.76
15	-0.53	-0.46	0.10	0.62	0.87	1.99	2.74	3.10	3.82
16	0.49	1.43	2.33	1.70	1.57	0.98	1.40	0.99	1.42
17	-0.73	-0.38	-1.16	-1.34	-1.33	-0.71	-0.57	-0.22	-0.54
18	-0.06	-1.19	-0.77	-0.54	-0.19	0.14	1.08	2.17	2.46
19	1.08	0.61	1.12	1.22	0.93	1.07	2.08	2.97	2.30
20	0.26	0.64	1.04	1.33	2.76	2.36	2.79	4.10	3.60
21	-0.48	0.31	-0.26	-0.38	0.96	0.70	1.93	2.69	3.40
22	-0.27	-1.44	-1.13	-0.12	1.02	1.52	1.42	1.65	2.69
23	-0.83	1.44	0.21	0.71	1.51	3.33	3.67	4.21	4.40
24	-1.35	-0.37	-0.88	-1.12	-1.01	0.19	0.55	0.55	0.14

1.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (FY08/Q3)

1.2.1. Distribution selection for AMS data

Different frequency distributions will be evaluated based on selected statistical tests for each region and for each duration.

1.2.2. Development of precipitation frequency estimates for partial duration series (PDS)

Precipitation frequency estimates will be computed for all durations using both types of time series, AMS and PDS.

1.2.3. Development of n-minute ratios

The 5-minute, 10-minute, 15-minute, 30-minute, and 60-minute durations are collectively called “n-minute”. Because of the small number of stations with 5-minute data available to generate n-minute precipitation frequency quantiles for the whole study area, they will be estimated by applying linear scaling factors. Those factors will be developed using ratios of n-minute quantiles to 60-minute quantiles from co-located 5-minute and hourly stations.

1.2.4. Development of PRISM grids for mean annual maxima

HDSC expects Oregon State University’s PRISM Group to complete their spatial interpolation of mean annual maximum estimates for 1-hour, 12-hour, 24-hour and 10-day durations in April 2008. The resulting grids will then be used to develop gridded 100-year precipitation frequency estimates that will be submitted for a peer review by the end of the next quarter.

1.3. PROJECTED SCHEDULE

Frequency analysis for all durations [April 2008]

Development of precipitation frequency grids for 1-hr, 12-hr, 24-hr, and 10-day durations based on PRISM deliverables [May 2008]

Peer review of estimates [June 2008]

Development of precipitation frequency grids (all durations) based on PRISM deliverables [August 2008]

Development of PDS quantiles [September 2008]

Remaining tasks and web publication [December 2008]

2. PRECIPITATION FREQUENCY FOR REMAINDER OF CALIFORNIA

2.1. PROGRESS IN THIS REPORTING PERIOD

HDSC has made progress in compiling and formatting the metadata for the datasets collected for the California project.

- The project area including buffer areas that extend beyond California was defined so that stations in the buffer areas could be included in the analysis.
- The compiling of metadata for all datasets is complete. We communicated with several local contacts to resolve stations with missing metadata.
- Since the data arrive in various forms, we are processing the data into a common format. Six datasets were completed and one started in the past quarter. During the formatting of the data, gross errors, such as daily values that exceed 99.99", are being corrected and log files of the corrections are retained for future inspection.
- We received additional data from the U.S. Geological Survey.
- Currently, we are downloading additional hourly data from the Remote Automated Weather Station (RAWS) Network for the project area.

Table 3 provides basic information for each dataset: data type, data source, number of stations in each processed dataset, and current status of data formatting including some comments/notes about the task. The numbers of stations are subject to change as we review the data further and eliminate duplicate data, require a minimum number of years of data, merge appropriate stations, etc.

Table 3. List of data types, data sources, number of stations in each processed dataset, and current status of data formatting including some comments/notes about the task. (ALERT data are Automated Local Evaluation in Real Time gauges that measure precipitation using tipping buckets in increments of 0.04mm.)

Type of data	Data Sources	Number of Stations	Status of Formatting	Comments/Notes
Daily	NCDC	1225	Done	Data thru 2006; will get 2007 data in March ’08.
	CA Department of Water Resources	411	Done	
	U.S. Army Corps of Engineers, Sacramento District	43	Done	
	Santa Barbara County Flood Control District	62		
	LA County Dept. of Public Works	591	Done	
	Jim Goodridge, Retired State Climatologist			Metadata will be compiled as the data are formatted.
	County of San Diego Flood Control	3		
	California Nevada River Forecast Center	650	Done	6-hour ALERT data were accumulated to daily
	SNOTEL	152	Done	
Hourly	NCDC	509	Done	Data thru 2005; will get 2006
	CA Department of Water Resources	495	Done	
	U.S. Army Corps of Engineers, Sacramento District	43	Done	
	Metro Flood Control District, Fresno	8		
	Jim Goodridge, Retired State Climatologist			Metadata will be compiled as the data are formatted.
	RAWS	367 in CA; 72 in OR		All CA data have been downloaded; 19 of 72 in OR have been downloaded so far; NV remains.
	USGS	11		Nevada only
	SNOTEL	66		
15-min	Metro Flood Control District, Fresno	8		
	County of San Diego Flood Control			
	USGS	12		3 from OR; 9 From CA
5-min	Ventura County Watershed Protection District	105		
	Santa Barbara County Flood Control District	49		
	LA County Dept. of Public Works	41	Done	
	Riverside County Flood Control District			
ALERT	California Dept. of Parks & Recreation (Orange Cnty)	45		
	County of San Diego Flood Control	70	50% done	

2.2. PROBLEMS/CONCERNS

The formal agreement between HDSC and the California Department of Water Resources for this project is delayed. The final agreement is going through formal approval processes. Resolution is anticipated by May 2008.

2.3. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (FY08/Q3)

HDSC will continue to format data and evaluate for any data overlap. We will prepare the daily data for quality control.

2.4. PROJECTED SCHEDULE

Data quality control [September 2008]

Regionalization and frequency analysis for 1-hr and 24-hr AMS [December 2008]

Development of precipitation frequency grids for 1-hr and 24-hr durations based on PRISM deliverables [December 2008]

Peer review of estimates [February 2009]

Regionalization and frequency analysis for other durations [February 2009]

Development of precipitation frequency grids for all durations based on PRISM deliverables [April 2009]

Remaining tasks and web publication [July 2009]

3. AREAL REDUCTION FACTORS (ARFs)

3.1. PROGRESS IN THIS REPORTING PERIOD

HDSC is developing geographically-fixed areal reduction factors that can be used to convert point precipitation frequency estimates into corresponding areal estimates in the United States. For a given average recurrence interval (ARI), rainfall duration and area size, the areal reduction factor (ARI) is defined as a ratio of average point depth and areal depth with same ARI. The HDSC ARF team continues to investigate an approach that utilizes radar-estimated precipitation. A pilot study to evaluate the value of radar-estimated precipitation grids for the ARF in the Louisville, KY area provided encouraging results.

In anticipation of utilizing radar-based multi-sensor precipitation estimates for ARFs around the country, we completed the acquisition, decoding and reformatting of estimates for the period 1996 through 2007. The database is comprised of hourly estimates in a GIS ASCII grid format. The period prior to 2002 is comprised of estimates prepared by each NWS River Forecast Center (RFC) for their individual forecasting domains. For the period 2002 through 2007 we are using a merged version of the RFC estimates which provides U.S. coverage.

3.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (FY08/Q3)

Optimization, debugging and testing of the new ARF estimation procedure will continue during the next reporting period. Methods will also be developed to identify radar-based “study areas” in locations with radar data of suitable quality for this study.

3.3. PROJECTED SCHEDULE

Data collection and quality control [March 2008]

Selection of the ARF computational approach [June 2008]

Calculation of geographically-fixed ARFs [October 2008]

Peer review [December 2008]

Web publication [February 2009]

III. OTHER

1. Presentations and Meetings

Geoff Bonnin will attend the American Society for Civil Engineer's World Environmental & Water Resources Congress 2008, May 12-16, in Honolulu, Hawaii. He will present "Updated NOAA Precipitation Frequency Estimates for Hawaii" in the *Water Resources Planning and Management* track, *Stochastic Modeling of Rainfall Processes* session.

On January 14th, 2008, Geoff Bonnin presented "Updates to Precipitation Frequency Estimates, Temporal Distributions, and Areal Reduction Factors – A Status Report" to the Transportation Research Board 87th Annual Meeting in Washington DC in the session *Improvements in Determination of Design Storms for Flooding and Water Quality*.

Final agreements between the Federal Highway Administration and NOAA/NWS to update the southeast states of Florida, Georgia, Alabama and Mississippi have been prepared jointly and have been submitted to FHWA for formal approval. Once approved at FHWA they will be submitted to the Department of Commerce for approval.

Geoff Bonnin met with faculty of the University of Alaska Fairbanks to discuss a joint agreement to update precipitation frequency estimates for Alaska. The Alaska Department of Transportation has indicated its support and support is being sought from the Alaska University Transportation Center (AUTC). Additionally, support for the update has been obtained from the NOAA Climate Program through NOAA's Alaska Region Collaboration Team.

There have been discussions with the midwestern states of North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, and Missouri to organize funding for updating precipitation frequency estimates. To date each of those states with the exception of Missouri has indicated funding will be available. We expect to complete funding discussions by the end of June, contract negotiations with FHWA during the following three months, and begin a three-year update project in September. Discussions are underway with Colorado for it to join the project.

There have been discussions with Michigan and Wisconsin to organize funding for updating precipitation frequency estimates. These discussions are ongoing.