HYDROMETEOROLOGICAL DESIGN STUDIES CENTER QUARTERLY PROGRESS REPORT

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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 selected average recurrence intervals (1-year to 1,000-year) 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://hdsc.nws.noaa.gov/hdsc/pfds/index.html).

HDSC is currently updating precipitation frequency estimates for Hawaii (NOAA Atlas 14, Volume 4) and the remainder of California (NOAA Atlas 14, Volume 5) not included in NOAA Atlas 14, Volume 1. We are also updating precipitation frequency estimates for the U.S. Pacific Islands. While formal agreements are being put into place, we initiated precipitation frequency projects for the Southeastern states (Alabama, Arkansas, Georgia, Florida, Louisiana and Mississippi), the Midwestern states (Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin), and Alaska. Figure 1 shows new project areas as well as project areas included in NOAA Atlas 14 Volumes 1 to 3.

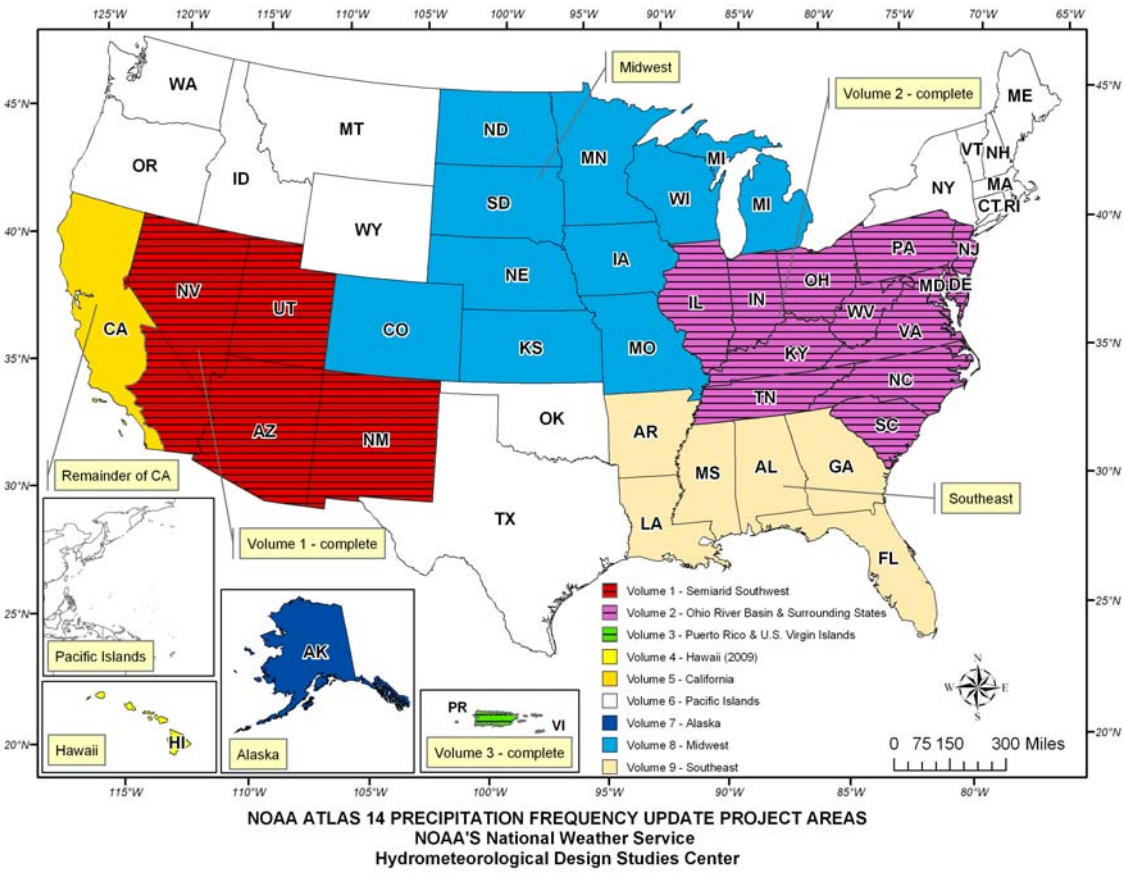

Figure 1. Map showing current project areas and project areas for NOAA Atlas 14 Volumes 1-3.

II. CURRENT PROJECTS

1. PRECIPITATION FREQUENCY PROJECT FOR HAWAII

1.1. PROGRESS IN THIS REPORTING PERIOD (Oct-Dec 2008)

1.1.1. Peer Review

The Hawaii precipitation frequency peer review began on 22 September 2008 and concluded on 31 October 2008. Briefly, the review material included the regionalized groups of stations used to compute precipitation frequency estimates, point precipitation frequency estimates (via the interactive Precipitation Frequency Data Server), spatially interpolated maps for mean annual maxima (MAM) and annual maximum series-based 100-year precipitation frequency estimates for 60-minute, 12-hour, 1-day, and 10-day durations (in PDF format).

We received comments from six individuals, some of whom also represented comments from their staff. There were thirteen unique comments that required a response. The comments were parsed into those pertaining to spatial interpolation and maps, those pertaining to regions of similar precipitation frequency climatology and general questions, comments and feedback.

We have addressed the comments and made some changes as a result (discussed below). We will share the comments and our responses in a consolidated document with users through our list-server (www.nws.noaa.gov/oh/hdsc/listserver). The consolidated document will also be made available on the HDSC web site (www.nws.noaa.gov/oh/hdsc).

Several changes to the estimates resulted from comments received during the peer review.

1) A 100-year 60-minute bulls eye on the northern Kona Coast (on the Big Island), which was the result of an oversight in the development of supplemental (or “pseudo”) hourly data at daily-only stations around station 51-3987 (KEALAKEKUA 4 74.8), was corrected in the spatial interpolation process.

2) After thorough investigation, the maxima along the north slope of Kauai was extended southward and eastward by adding a “pseudo” station to the top of MOUNT WAIALEALE (station ID 51-6565), which is among one of the wettest places on earth. This station didn’t have sufficient precipitation data to be included in the precipitation frequency analysis, but based on the available data, interpolated values from nearby stations, and information from Technical Papers 43 and 51, we’ve been able to objectively construct 60-minute through 60-day mean annual maxima for this location. By including this station, the maxima will increase and extend to the southeast.

3) Mismatches between the Hawaii GIS mask and island boundaries were evaluated and corrected.

1.1.2. Spatial interpolation of at-site mean annual maximum estimates

After resolving several issues from the peer review, revised at-site mean annual maximum (MAM) estimates were submitted to Oregon State University's PRISM Group for spatial interpolation. A comprehensive internal review of the returned gridded MAM estimates is currently underway. Locations where we included MAMs for stations with limited data are receiving close scrutiny to confirm the resulting MAM spatial patterns and to justify their ultimate inclusion in the MAM interpolation.

1.1.3. Precipitation frequency estimates from partial duration series

PDS-based precipitation frequency estimates were computed from AMS data using Langbein's (Chow's) formula that relates average recurrence intervals for annual maximum and partial duration series data.

1.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan-Mar 2009)

1.2.1. Peer review

HDSC will share the questions and responses in a consolidated document with users through our list-server. The consolidated document will also be made available on the HDSC web site.

1.2.2. Temporal distributions

Temporal distributions for extreme rainfall will be finalized during the next reporting period.

1.2.3. Trend analysis

The results of the previous trend analysis will be confirmed using updated AMS daily data and documented during the next reporting period.

1.2.4. Final at-site MAM and precipitation frequency estimates

At-site MAMs will be finalized and submitted to PRISM group for spatial interpolation.

1.2.5. Confidence limits

Confidence limits will be finalized for all durations and frequencies.

1.2.6. Final MAM and PF grids

The MAM grids from the PRISM group will serve as the basis for spatial interpolation of the precipitation frequency estimates and confidence limits. The final precipitation frequency grids will be posted to the PFDS so a final internal review of the final results can take place before release to the public.

1.3. PROJECTED SCHEDULE

Development of precipitation frequency estimates for PD series [Complete]

Development of final precipitation frequency grids for all durations based on PRISM deliverables and other remaining tasks (seasonality, temporal distributions, etc.) [February 2009]

Web publication and documentation [March 2009]

2. PRECIPITATION FREQUENCY PROJECT FOR THE REMAINDER OF CALIFORNIA

2.1. PROGRESS IN THIS REPORTING PERIOD (Oct-Dec 2008)

While the formal agreement for this work has been signed, the process of actually transferring funds from the State of California to NWS has not been completed. These contractual and fiscal processes continue to require considerable effort.

2.1.1. Data formatting

HDSC has made progress in compiling and formatting the datasets collected from a number of sources into a format suitable for our analysis software. Table 1 provides basic information on datasets: data type, data source, number of stations in each processed dataset, and current status of data formatting including some comments/notes. The numbers of stations are subject to change as we further review the data, eliminate duplicate stations, impose a minimum number of years of data, merge appropriate stations, etc.

In particular, we obtained five new datasets since last quarter. Data were received from Contra Costa Flood Control District and Water Conservation District (daily and 5-minute), Santa Clara Valley Water District (hourly), and Monterey County Water Resources Agency (ALERT). N-minute data were obtained from the National Climatic Data Center (NCDC) and formatted. Lastly, daily data for Mexico were obtained from the CLIMVIS Global Summary of the Day through NCDC (http://cdo.ncdc.noaa.gov/CDO/redirector?datasetabbv=GSOD&georegionabbv=&countryabbv=) and formatted.

The buffer area around the project area was expanded to include stations from NOAA Atlas 14 Volume 1 (Semiarid Southwest) which increased the number of NCDC stations and included other local datasets originally used in that analysis.

Table 1. List of data types, data sources, number of stations in each processed dataset, current status of formatting and comments (ALERT data are Automated Local Evaluation in Real Time gauges that measure precipitation using tipping buckets in increments of 0.04 in).

Data Type	Data Source	Number of Stations	Status of Formatting	Comments
Daily	National Climatic Data Center (NCDC)	1,356	Done	
	CA Department of Water Resources	382	Done	
	U.S. Army Corps of Engineers	43	Done	
	Santa Barbara County Flood Control District	161	Done	
	LA County Dept. of Public Works	1,180	Done	
	San Diego County Flood Control District	67	Done	
	California Nevada River Forecast Center	553	Done	6-hr ALERT data accumulated to daily; 1-hr data not available
	Ventura County Watershed Protection District	104	Done	
	City of Roseville, Dept. of Public Works	6	Done	
	Santa Clara Valley Water District	130		Currently reviewing data

	U.S. Geological Survey	10	Done	
	Contra Costa Flood Control District and Water Conservation District	15	Done	
	SNOTEL	152	Done	
	NCDC's CLIMVIS Global Summary (Mexico)	32	Done	
Hourly	National Climatic Data Center	540	Done	
	CA Department of Water Resources	345	Done	
	U.S. Army Corps of Engineers	43	Done	
	Metro Flood Control District, Fresno	8	Done	
	Jim Goodridge, Retired State Climatologist	337	Done	
	RAWS	250	Done	
	City of Roseville, Dept. of Public Works	5	Done	
	USGS	6	Done	
	SNOTEL	64	Done	
15-min	National Climatic Data Center	477	Done	
5-min	National Climatic Data Center	24	Done	
	Ventura County Watershed Protection District	105	In progress	
	Santa Barbara County Flood Control District	49	In progress	
	LA County Dept. of Public Works	41	Done	
	Riverside County Flood Control District	TBD		
	Contra Costa Flood Control District and Water Conservation District	5	In progress	
ALERT	Orange County California Dept. of Parks & Recreation	45	Done	
	San Diego County Flood Control District	70	Done	
	Marin County Flood Control and Water Conservation District	5	Done	
	Monterey County Water Resources Agency	107		

2.1.2. Data quality control

a. Metadata

The quality control of metadata (latitude, longitude, elevation) continues. A review of station metadata allows us to identify erroneous metadata (by comparison with high resolution DEM) and assign new elevation, longitude and/or latitude as needed. A high-resolution (90-meter) DEM was created using elevation data from the USGS National Map Seamless Server (http://seamless.usgs.gov/index.php) for the project area. 15 stations that are missing elevation in their metadata will be assigned an elevation from this grid. 2,006 daily and hourly stations whose elevation in their metadata differed from the DEM by more than 100 feet were flagged for verification of their location and of those 201 differed by more than 900 feet. There are also 1,047 daily and hourly stations that did not have seconds in the latitude and longitude coordinates that require verification.

b. Merging

The merging of station data forms longer continuous records and decreases spatial overlaps. Spatial criteria of 0.5 mile in distance and 100 feet in elevation and 5 years of tolerant gap in records were used to search for stations located in close proximity for potential merging. Based on these criteria, a total of 550 groups of stations were identified for daily stations and a total of 36 groups of stations were identified for hourly stations. These groups of stations were first examined by a t-test. 95 groups of daily stations and 19 groups of hourly stations that did not pass the t-test were removed from the potential merge list. In addition, 164 groups of daily stations with stations appearing in other groups of stations (e.g., subgroup of a larger group) were also removed. Geographic locations and physical environment of the remaining groups of stations were then virtually inspected using Google Earth (©2008 Google). Groups of stations with discrepancies in environment or geographic locations were noted. This inspection resulted in 291 groups of daily stations and 17 groups of hourly stations left to be considered further for merging.

Next, a double mass analysis was conducted to examine the data consistency of the merged daily stations. The ratios between the slopes of the double mass curves of the two adjacent merged periods were computed and used as an objective index for detecting data inconsistency. Stations with ratios less than 0.7 and larger than 1.4 were identified for further investigation. The double mass curves of the 291 merged daily stations were also visually inspected to ensure data quality. After the examination, 29 daily stations were removed from the merged list. In the final count, 262 daily station groups and 17 hourly station groups were merged.

c. Quality control of AMS

New software and procedures have been prepared to improve the efficiency of quality control of the AMS data for all durations (60-minute through 60-day). An objective, spatially-based software tool, *QCseries*, identifies maximum precipitation values that are suspect relative to concurrent data at nearby stations. Another software tool flags statistically low or high outliers in a series. Once the metadata check is completed, the quality control using these tools will commence.

2.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan-Mar 2009)

HDSC will complete formatting all data and evaluating all metadata. We will work on the quality control of the daily and hourly data.

2.3. PROJECTED SCHEDULE

Data collection, formatting and initial quality control [January 2008]

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) [February 2009]

Regionalization and frequency analysis [March 2009]

Initial spatial interpolation of PF estimates and consistency checks across durations [May 2009]

Peer review [June 2009]

Revision of PF estimates [July 2009]

Remaining tasks (e.g., development of precipitation frequency estimates for PD series, seasonality, temporal distributions, documentation) [August 2009]

Web publication [September 2009]

3. PRECIPITATION FREQUENCY PROJECT FOR THE U.S. PACIFIC ISLANDS

3.1. PROGRESS IN THIS REPORTING PERIOD (Oct-Dec 2008)

HDSC continues a project to update the precipitation frequency estimates of the U.S. Pacific Islands. The project is being performed with funds provided by the NOAA Climate Program. It covers the following islands:

- Territory of Guam,
- Saipan and Rota of the Commonwealth of Northern Mariana Islands (CNMI),
- Yap, Chuuk, Pohnpei and Kosrae of the Federated States of Micronesia (FSM),
- Republic of Palau,
- Majuro Atoll of the Republic of the Marshall Islands (RMI),
- Tutuila and Manua of American Samoa, and
- Wake Island.

3.1.1. Data collection

The project area was defined and a high-resolution DEM (ranging from 1/3 second to 3 seconds, which is roughly 10m - 80m) was created using elevation data from the USGS National Map Seamless Server (http://seamless.usgs.gov/index.php) for the project area.

Table 2 provides basic information on datasets for the project: data source, data type, number of stations in each dataset (subject to change), and some comments/notes. During this reporting period, TRMM data were evaluated and found unsuitable for precipitation frequency analysis due to the short length of records (<9 years) and substantial amounts of missing data. PACRAIN stations were also evaluated. The majority of the PACRAIN stations in the project area are NCDC stations which we already have, but we are reviewing other stations from that dataset for potential use.

We have been in contact with the USGS Pacific Islands Water Science Center regarding their data. Precipitation data that are available through their website are being evaluated. A preliminary examination of the AMS from three sites suggests they are consistent with other NCDC stations nearby. Some of these sites are located in otherwise data sparse areas.

After evaluating metadata from the National Weather Service Forecast Office in Guam, we contacted them regarding additional precipitation data they may have that would supplement our database available from NCDC. For example, they may have additional data from Japanese records during World War II or more recent data that has yet to be entered at NCDC for some stations. In addition, we've contacted the Water and Environmental Research Institute of the University of Guam regarding data.

N-minute data were obtained from NCDC and formatted.

Table 2. List of data sources, data types, number of stations in each dataset with comments.

Data Source	Data type	Number of stations	Comments
National Climatic Data Center	daily	58	All have been formatted.
	hourly	12	
	15-min	13	
	n-min	9	
Tropical Rainfall Measuring Mission (TRMM) rmm-fc.gsfc.nasa.gov/trmm_gv/	n-min	~25	Ground validation program in Guam and Kwajalein of Marshall Islands. Data available for 1997-2008.
Comprehensive Pacific Rainfall Data Base (PACRAIN) http://pacrain.evac.ou.edu/	varies	TBD	Developed under NOAA/Office of Global Programs research grant
U.S. Geological Survey (USGS) http://hi.water.usgs.gov/studies/project_waterdata.htm	hourly	16	16 stations with 12 years of data, spread among Saipan, Guam, Palau and American Samoa

3.1.2. Data quality control

Quality control of the NCDC data has begun. Annual maximum series (AMS) data were generated and evaluated to discern allowable amounts of missing data. Questionable values are being compared with previous studies.

Stations within 0.5 miles and 100 feet in elevation with a gap of 5 years or less were considered for merging. There were 6 potential pairs of daily stations. Four pairs passed the statistical t-test to ensure their AMS data are from the same population and so were merged.

Inconsistent maxima in AMS data for co-located daily and hourly stations (e.g. hourly 24-hour < daily 1-day for a given year) are being resolved.

3.1.3. Conversion factors

Conversion factors for daily data are used to convert from constrained to unconstrained (i.e., with no pre-defined start time) rainfall. Based on an investigation of concurrent constrained and unconstrained 24-hour annual maxima obtained from co-located daily and hourly stations, a preliminary factor of 1.16 was computed. The factor was developed using regressions of 108 quality-controlled concurrent paired annual maxima from 8 sites. It is comparable to factors used in other NOAA Atlas 14 volumes which range from 1.10 (Hawaii) to 1.21 (Puerto Rico).

3.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan-Mar 2009)

Data collection, reformatting and quality control will be completed. Regionalization of data for frequency analysis will begin.

3.3. PROJECTED SCHEDULE

Data collection, formatting and initial quality control [January 2009]

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) [February 2009]

Regionalization and frequency analysis [March 2009]

Initial spatial interpolation of PF estimates and consistency checks across durations [May 2009]

Peer review [June 2009]

Revision of PF estimates [July 2009]

Remaining tasks (e.g., development of precipitation frequency estimates for PD series, seasonality, temporal distributions, documentation) [August 2009]

Web publication [September 2009]

4. PRECIPITATION FREQUENCY PROJECT FOR THE SOUTHEASTERN STATES

4.1. PROGRESS IN THIS REPORTING PERIOD (Oct-Dec 2008)

The process of establishing a formal agreement for both this work and the midwestern states precipitation frequency update with the Federal Highway Administration (FHWA) Pooled Fund Program has still not been completed. However, FHWA has made its first response to contract documents proposed by NWS. We are hoping to be able to send consensus documents for legal review by both agencies in late January. These contractual and fiscal processes continue to require considerable effort.

While working on formal agreements, we continue data collection and formatting efforts for the states of Alabama, Arkansas, Georgia, Florida, Louisiana and Mississippi.

We are reviewing potential data sources from responses to our data solicitation email sent on 22 August 2008. Certainly, if you have or know of any other available data, please let us know (email HDSC.Questions@noaa.gov). Table 3 provides a summary of the potential data sources and data types.

Table 3. Current list of precipitation data sources and data types.

Data Source	Data Type
National Climatic Data Center	daily, hourly, 15-min, n-min
Natural Resources Management Office, Brevard County, Florida	daily
Public Waters and Utilities Administration, City of Melbourne, Florida	TBD
University of Central Florida, Orlando, Florida	TBD
Brevard County Utility Services Department, Florida	daily
USGS, Georgia Water Science Center	daily
Earth Science Office, NASA, Cooperative Huntsville Area Rainfall Measurements (Alabama)	daily
U.S. Climate Reference Network (NCDC)	Hourly, 15-min

4.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan-Mar 2009)

The main focus will continue to be data acquisition, evaluation and reformatting.

4.3. PROJECTED SCHEDULE (as months from start)

Data collection, formatting and initial quality control [+3 months]

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) [+14 months]

Regionalization and frequency analysis [+18 months]

Initial spatial interpolation of PF estimates and consistency checks across durations [+24 months]

Peer review [+ 26 months]

Revision of PF estimates [+29 months]

Remaining tasks (e.g., development of precipitation frequency estimates for PD series, seasonality, temporal distributions, documentation) [+35 months]

Web publication [+36 months]

5. PRECIPITATION FREQUENCY PROJECT FOR THE MIDWESTERN STATES

5.1. PROGRESS IN THIS REPORTING PERIOD (Oct-Dec 2008)

As noted above, the process of establishing a formal agreement for both this work and the southeastern states precipitation frequency update with the Federal Highway Administration (FHWA) Pooled Fund Program has still not been completed. However, FHWA has made its first response to contract documents proposed by NWS. We are hoping to be able to send consensus documents for legal review by both agencies in late January. These contractual and fiscal processes continue to require considerable effort.

While formal agreements are being put into place, we began data collection for the states of Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.

We are reviewing potential data sources from responses to our data solicitation email sent on 22 August 2008. Certainly, if you have or know of any other available data, please let us know (email HDSC.Questions@noaa.gov). Table 4 provides current list of data sources and data types available.

Table 4. Current list of precipitation data sources and data types.

Data Source	Data Type
National Climatic Data Center	daily, hourly, 15-min, n-min
Minnesota State Climatology Office, Department of Natural Resources	daily
North Dakota State Water Commission	daily; monthly
Minnesota Department of Transportation	TBD
Kansas Department of Transportation	n-minute
Colorado Climate Center, Colorado State University	TBD
Oklahoma Mesonet	n-minute; hourly
Arkansas-Red Basin River Forecast Center, NWS	daily; hourly
Univ. of Missouri, Atmospheric Sciences Department	daily; hourly
Colorado Springs Utilities	daily
North Dakota Agricultural Weather Network	hourly
US Army Corps of Engineers, Omaha District Office	daily; hourly
Metropolitan Council Environmental Services, MN	15-min
Milwaukee Metropolitan Sewerage District	TBD
Kansas State University, State Climate Office	TBD
HIDEN Network, MN	daily

5.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan-Mar 2009)

The main focus will continue to be data acquisition, evaluation and reformatting. Thereafter, some initial quality control may begin.

5.3. PROJECTED SCHEDULE (as months from start)

Data collection, formatting and initial quality control [+3 months]

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) [+14 months]

Regionalization and frequency analysis [+18 months]

Initial spatial interpolation of PF estimates and consistency checks across durations [+24 months]

Peer review [+ 26 months]

Revision of PF estimates [+29 months]

Remaining tasks (e.g., development of precipitation frequency estimates for PD series, seasonality, temporal distributions, documentation) [+35 months]

Web publication [+36 months]

6. PRECIPITATION FREQUENCY PROJECT FOR ALASKA

6.1. PROGRESS IN THIS REPORTING PERIOD (Oct-Dec 2008)

The University of Alaska, Fairbanks (UAF) is moving forward on the joint effort with NWS to update precipitation frequency estimates for Alaska. UAF continues with data collection.

On November 24th and 25th, two principle investigators from UAF visited HDSC. Data formatting and quality control procedures were discussed and priorities and schedules were established. They expect to complete data collection, quality control and bias correction for undercatch by December 2009.

6.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan-Mar 2009)

The main focus during the next reporting period will continue to be data acquisition and reformatting.

6.3. PROJECTED SCHEDULE

Data collection, formatting and initial quality control [March 2009]

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) [January 2010]

Regionalization and frequency analysis [September 2010]

Initial spatial interpolation of PF estimates and consistency checks across durations [January 2011]

Peer review [March 2001]

Revision of PF estimates [May 2011]

Remaining tasks (e.g., development of precipitation frequency estimates for PD series, seasonality, temporal distributions, documentation) [August 2011]

Web publication [September 2011]

7. AREAL REDUCTION FACTORS

7.1. PROGRESS IN THIS REPORTING PERIOD (Oct-Dec 2008)

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, rainfall duration and area size, the areal reduction factor (ARF) is defined as a ratio of average point depth and areal depth with the same recurrence interval.

Insufficient time and resources have prevented this project from moving forward, but that is expected to change as HDSC expands its human resources.

7.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Jan-Mar 2009)

No progress is expected to be made on this project during the next reporting period. When additional resources become available, the HDSC will investigate an approach that utilizes radar-estimated precipitation.

III. OTHER

1. PRESENTATIONS AND MEETINGS

On 15 December 2008 Geoff Bonnin and Sanja Perica had a teleconference with potential stakeholders of a precipitation frequency project for the northeastern United States (Connecticut, Massachusetts, Maine, New Hampshire, New York, Rhode Island and Vermont). They intend to use the Federal Highway Administration's pooled fund website (http://www.pooledfund.org/) to coordinate funds for the project.

The U.S. Environmental Protection Agency (EPA) contacted HDSC regarding the role of precipitation frequency in water quality and regulation. At an invitation-only conference on 6-7 January 2009, Geoff Bonnin will present information on precipitation frequency and climate change.

2. PERSONNEL

We were joined on November 3 by Fenglin Yan. Mr. Yan received his B.S. from Nanjing University in China and his M.S. degree in Environmental Science from Lehigh University. He has strong background in GIS, remote sensing, computer programming and statistics.