NOAA Atlas 14

Precipitation-Frequency Atlas of the United States

Volume 7 Version 2.0: Alaska

Sanja Perica[1], Douglas Kane[2], Sarah Dietz[1], Kazungu Maitaria[1], Deborah Martin[1], Sandra Pavlovic[1], Ishani Roy[1], Svetlana Stuefer[2], Amy Tidwell[2], Carl Trypaluk[1], Dale Unruh[1], Michael Yekta[1], Erica Betts[2], Geoffrey Bonnin[1], Sarah Heim[1], Lillian Hiner[1], Elizabeth Lilly[2], Jayashree Narayanan[2], Fenglin Yan[1], Tan Zhao[1]

[1]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service

and

[2]University of Alaska Fairbanks, Water and Environmental Research Center

Silver Spring, Maryland, 2012

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Table of Contents

1. Abstract

NOAA Atlas 14 contains precipitation frequency estimates for the United States and U.S. affiliated territories with associated 90% confidence intervals and supplementary information on temporal distribution of heavy precipitation, analysis of seasonality and trends in annual maximum series data, etc. It includes pertinent information on development methodologies and intermediate results. The results are published through the Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds).

The Atlas is divided into volumes based on geographic sections of the country. The Atlas is intended as the U.S. Government source of precipitation frequency estimates and associated information for the United States and U.S. affiliated territories.

2. Preface to Volume 7

NOAA Atlas 14 Volume 7 contains precipitation frequency estimates for selected durations and frequencies with 90% confidence intervals and supplementary information on temporal distribution of heavy precipitation , analysis of seasonality and trends in annual maximum series data, etc., for the state of Alaska. The results are published through the Precipitation Frequency Data Server (PFDS) (http://hdsc.nws.noaa.gov/hdsc/pfds).

This project was a collaborative effort between the Hydrometeorological Design Studies Center within the Office of Hydrologic Development of the National Oceanic and Atmospheric Administration's National Weather Service and the Water and Environmental Research Center of the University of Alaska Fairbanks.

Any use of trade names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Citation and version history. This documentation and associated artifacts such as maps, grids, and point-and-click results from the PFDS are part of a whole with a single version number and can be referenced as:

Sanja Perica, Douglas Kane, Sarah Dietz, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Svetlana Stuefer, Amy Tidwell, Carl Trypaluk, Dale Unruh, Michael Yekta, Erica Betts, Geoffrey Bonnin, Sarah Heim, Lillian Hiner, Elizabeth Lilly, Jayashree Narayanan, Fenglin Yan, Tan Zhao (2012). NOAA Atlas 14 Volume 7 Version 2.0, *Precipitation-Frequency Atlas of the United States, Alaska*. NOAA, National Weather Service, Silver Spring, MD.

The version number has the format P.S where P is a primary version number representing a number of successive releases of primary information. Primary information is essentially the data. S is a secondary version number representing successive releases of secondary information. Secondary information includes documentation and metadata. S reverts to zero (or nothing; i.e., Version 2 and Version 2.0 are equivalent) when P is incremented. When new information is completed and added (such as draft documentation) without changing any prior information, the version number is not incremented.

The primary version number is stamped on the artifact or is included as part of the filename where the format does not allow for a version stamp (for example, files with gridded precipitation frequency estimates). All location-specific output from the PFDS is stamped with the version number and date of download.

Table 2.1 lists the version history associated with the NOAA Atlas 14 Volume 7 precipitation frequency project and indicates the nature of changes made.

Table 2.1. Version history of NOAA Atlas 14 Volume 7.

Version number	**Date**	**Notes**
Version 1.0	August 2011	Draft data used in peer review
Version 2.0	February 2012	Final data released

3. Introduction

3.1. Objective

NOAA Atlas 14 Volume 7 provides precipitation frequency estimates for the state of Alaska for 5-minute through 60-day durations at 1-year through 1,000-year average recurrence intervals. The estimates and associated bounds of 90% confidence intervals are provided at 30 arc-seconds resolution. The Atlas also includes information on temporal distributions and seasonal information for data used in the frequency analysis. In addition, trends in annual maximum series data were also examined.

The information in NOAA Atlas 14 Volume 7 supersedes precipitation frequency estimates for Alaska contained in the following publications:

a. *Technical Paper No. 47, Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska for Areas to 400 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years* (Miller, 1963);

b. *Technical Paper No. 52, Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in Alaska* (Miller, 1965).

3.2. Approach and deliverables

Precipitation frequency estimates have been computed for a range of frequencies and durations using a regional frequency analysis approach based on L-moment statistics calculated from annual maximum series. This section provides an overview of the approach; greater detail is provided in Section 4.

Annual maximum series were extracted from precipitation measurements recorded at 15-minute to 1-day time increments obtained from various sources; 5- to 60-minute annual maxima series were also obtained from corresponding monthly maxima. The table in Appendix A.1 gives detailed information on all stations whose data were used in the frequency analysis. The annual maximum series data were screened for erroneous measurements. An attempt to quantify rain gauge under-catch during extreme events and to apply a bias correction to the annual maximum data was unsuccessful; more details are provided in Appendix A.2. The 1-day and 1-hour annual maximum series data were also analyzed for potential trends (Appendix A.3).

A region of influence approach was used for the regional L-moments computation at each station across all durations. A variety of probability distribution functions were examined for each region and duration and the most suitable distribution was selected. Distribution parameters, and consequently precipitation frequency estimates, were determined for each duration based on the mean of the annual maximum series at the station and the regionally determined higher order L-moments. Higher order L-moments were smoothed across durations to ensure consistency in precipitation frequency estimates. L-moments for all stations used in frequency analysis across daily durations are listed in Appendix A.4. Due to the lack of suitable stations recording precipitation at sub-daily intervals, precipitation frequency estimates for hourly durations were calculated by assuming that standardized statistics were constant across hourly durations. Sub-hourly durations were computed from corresponding 1-hour estimates by applying scaling factors.

Partial duration series-based precipitation frequency estimates were calculated indirectly from the annual maximum series using Langbein’s formula.

Frequency analysis was also done on rainfall (i.e., liquid precipitation only) data for durations up to 24 hours, but analysis of the limited available data showed that for the range of durations there was very little difference between the rainfall and total precipitation magnitudes across all frequencies.

A Monte-Carlo simulation approach was used to produce upper and lower bounds of 90% confidence intervals for the precipitation frequency estimates.

Grids of precipitation frequency estimates and 90% confidence intervals were determined based on mean annual maxima grids and at-station precipitation frequency estimates. The mean annual maxima grids for daily and hourly durations were derived from at-station mean annual maxima using a hybrid statistical-geographic approach for mapping climate data (Appendix A.5). The grids of precipitation frequency estimates and confidence limits for all frequencies were then derived in an iterative process using the inherently strong linear relationship that exists between mean annual maxima and precipitation frequency estimates at the 2-year recurrence interval and between precipitation frequency estimates at consecutive frequencies for a given duration. The resulting grids were examined and adjusted in cases where inconsistencies occurred between durations and frequencies. Scaling factors were used to derive grids for sub-hourly durations. Both spatially interpolated and point estimates at selected durations and frequencies were subject to external peer review (Appendix A.6).

Climate regions were delineated based on characteristics of annual maxima data. The regions were used in the extraction of annual maximum series, calculations of temporal distributions, and in a seasonality analysis. For the temporal and seasonality analyses, regions were grouped to increase sample sizes. Temporal distributions, expressed in probability terms as cumulative percentages of precipitation totals, were computed for precipitation magnitudes with less than 50% exceedence probability for selected durations (Appendix A.7). The seasonality analysis was done on annual maxima by tabulating the number of annual maxima exceeding several selected threshold frequencies for selected durations (Appendix A.8).

NOAA Atlas 14 Volume 7 precipitation frequency estimates for any location in the project area are available in a variety of formats through the Precipitation Frequency Data Server (PFDS) at http://hdsc.nws.noaa.gov/hdsc/pfds (via a point-and-click interface); more details are provided in Section 5. Additional types of results and information available there include:

- ASCII grids of partial duration series-based and annual maximum series-based precipitation frequency estimates and related confidence intervals for a range of durations and frequencies with associated Federal Geographic Data Committee-compliant metadata;
- cartographic maps of partial duration series-based precipitation frequency estimates for selected frequencies and durations;
- annual maximum series used in the analysis;
- temporal distributions;
- seasonality analysis of annual maxima.

Cartographic maps were created to serve as visual aids and are not recommended for estimating precipitation frequency estimates. Users are advised to take advantage of the PFDS interface or the underlying ASCII grids for obtaining precipitation frequency estimates. Precipitation frequency estimates from this Atlas are estimates for a point location and are not directly applicable for an area.

4. Frequency analysis

4.1. Project area

The project area, shown in Figure 4.1.1, encompasses the entire state of Alaska. Alaska is the largest state in the United States with land covering 586,412 square miles (1,518,800 km^2). It is also the most northern state reaching into the Arctic Circle. It is mostly surrounded by water with the Arctic Ocean and the Beaufort and the Chukchi Seas to the north, the Bering Sea to the west and the Pacific Ocean and Gulf of Alaska to the south. The Aleutian Islands, a chain of 300 small volcanic islands, extend over 1,200 miles (1,900 km) westward into the Pacific. Canada borders the land to the east. Two mountain ranges dominate the topography – the Brooks Range in the northern Arctic region and the Alaska Range in the south, separated by an interior plateau. The land north of the Brooks Range, termed the North Slope, is primarily uninhabited tundra but with a few villages and the northernmost U.S. city, Barrow. The interior is primarily uninhabited wilderness but also includes the city of Fairbanks, the second largest city in Alaska. The Alaska Range houses the highest point in the United States, Mt. McKinley which is 20,320 feet above sea level. Most of the population lives in the south-central region near Anchorage and along the southern coast. The state capital, Juneau, resides in southeast Alaska on the strip of land closest to the lower contiguous United States.

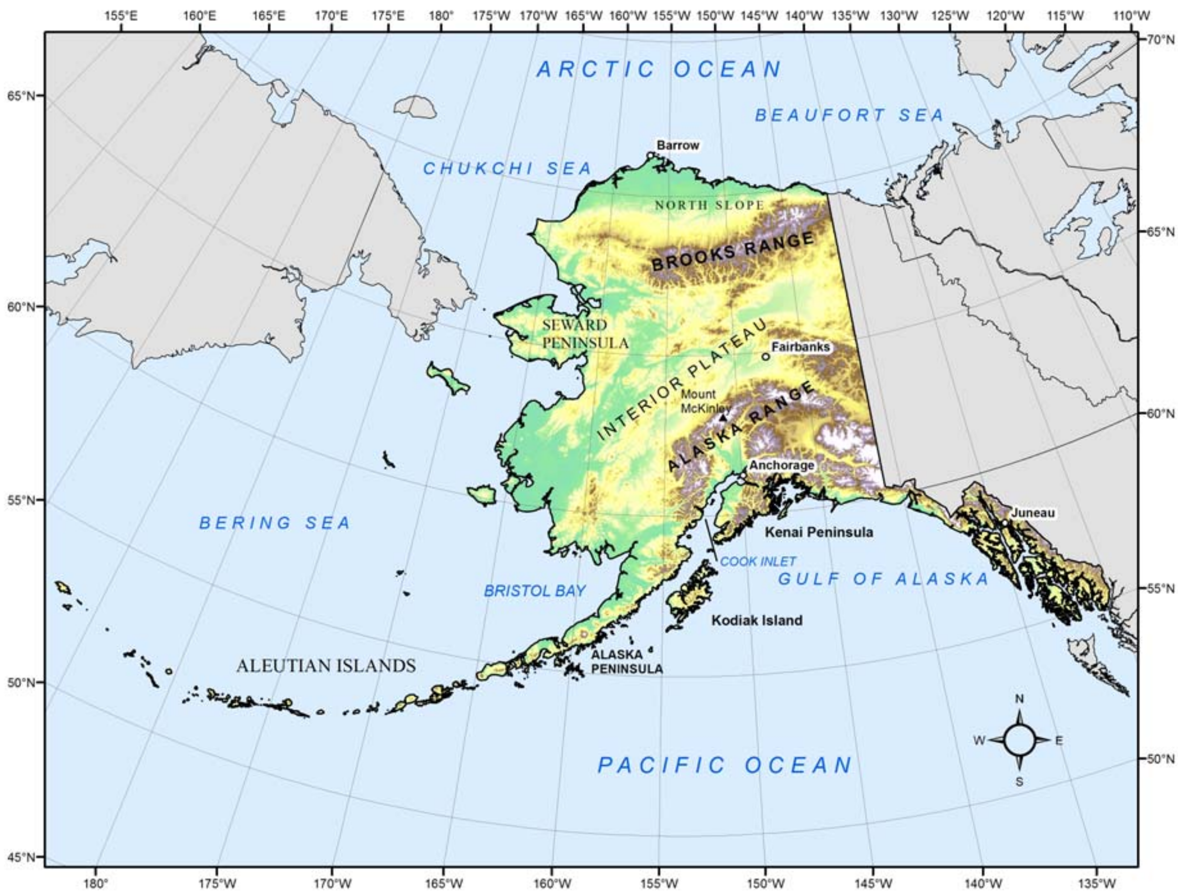


Figure 4.1.1. Project area for NOAA Atlas 14 Volume 7.

Climatology of heavy precipitation. The climatology of heavy precipitation in Alaska varies widely across the state and depends on latitude, elevation and the distance from the coast. The northern portion of Alaska lies within Arctic Circle where the Arctic Ocean along the northern coast is frozen about eight months of the year. This, combined with the low elevation, the dominance of the polar high, and the blockage of moisture from the south due to the Brooks Range, causes the northern region to receive the least amount of precipitation in the state.

During the summer months, a large area of high pressure that resides over the northern Pacific Ocean, the North Pacific High, dominates much of the state below the Arctic. Radiational warming due to increased hours of sunlight helps to destabilize the atmosphere creating areas of convection in the interior region. The convective storms can be triggered and intensified by the passing of an upper-level trough or a cold front, which are more prevalent during the warm season. Under the right large-scale pressure pattern, strong southwest flow over Alaska can bring warm moist subtropical air from the Pacific into the state. The remnants of tropical systems can be picked up in this flow and supply additional moisture for the air mass as it surges northeast over the Alaska Range. Such was the case in August 1967 when the Fairbanks area received more than half of its annual precipitation amount in less than a week.

Towards the end of summer, the polar jet stream moves south in the North Pacific away from the Arctic circle and a persistent flow of large-scale low pressure systems begins to develop. Strong thermal gradients, ample moisture and the semi-permanent Aleutian low over the southwest islands allow for the genesis and intensification of these sub-polar cyclones before they move into western Alaska or travel along the southern coast. This is the typical storm track for low pressure systems in the North Pacific causing these regions to receive some of the highest annual maximum rainfall totals in North America. Occasionally, these storms can become as strong as hurricanes producing damaging winds, storm surge and heavy precipitation.

During the winter and early spring, the track of these storms tends to move further south over the Gulf of Alaska where the large mountain chains over western North America act as a barrier to the westerly flow causing the low pressure systems to stall. During this scenario copious amount of rainfall can fall over the southern coast and southeast Alaska. The high elevations along the southern coast provide strong lifting on the windward sides which can create some of the heaviest rainfalls in the state. Most of the moisture in the air is released on the windward side of the mountain and as air flows down the leeward side it is much drier creating a rain shadow effect. Coastal lows can also develop right off-shore and intensify quickly advecting relatively warm moist air from the Pacific northward up over the mountainous coast.

Based on the characteristics of annual maximum series (AMS) data used in the precipitation frequency analysis, seven climate regions were formed and used in this project for AMS extraction (Section 4.3) and portrayal of temporal distributions (Appendix A.7) and the seasonality of annual maximum data (Appendix A.8). Initial regions were formed based on the climatological classification from *The Climate of Alaska* (Shulski and Wendler, 2007) and then refined to depict wet seasons of annual maxima across a range of durations by assessing the periods in which the majority of annual maxima occur (see Section 4.3 for more details). Consideration was also given to spatial variations in 24-hour mean annual maxima (MAM) and monthly maxima for n-minute durations. The final climatic regions are shown in Figure 4.1.2.

The Arctic region receives the least amount of precipitation and has the lowest MAMs across durations in the state. The Interior region has slightly higher mean annual precipitation (MAP) as well as higher MAMs than the Arctic region but is still quite dry. Similarly, the West Coast region also has only slightly higher MAP and MAMs than the Arctic. The Southwest Interior region contains a portion of the Alaska Range and is a transitional region between the dry north and wet south. MAMs and MAP are higher here than in the northern regions especially at higher elevations, but values are not as high as the southern coastal regions.

Islands in the Southwest Islands region are fairly low in elevation, but their location in the middle of the North Pacific Ocean allows for long durations of light rainfall. Cook Inlet region is very similar in climate to the transitional Southwest Interior region except it is prone to higher rainfalls at longer durations which is similar to the other coastal regions. Storms often travel along the southern coast or through the Gulf of Alaska and then slow down as they approach the steep terrain along the southeast coast. The high elevations along the coast in South/Southeast Coast region provide strong lifting on the windward sides which can create some of the heaviest rainfalls in the state and therefore the largest MAP and MAM values.

To increase sample sizes for temporal and seasonality analyses, regions were grouped in two larger regions. The Arctic, Interior, West Coast and Southwest Interior regions comprise the Northern Region and the Southwest Islands, Cook Inlet, and South/Southeast Coast regions comprise the Southern Region.

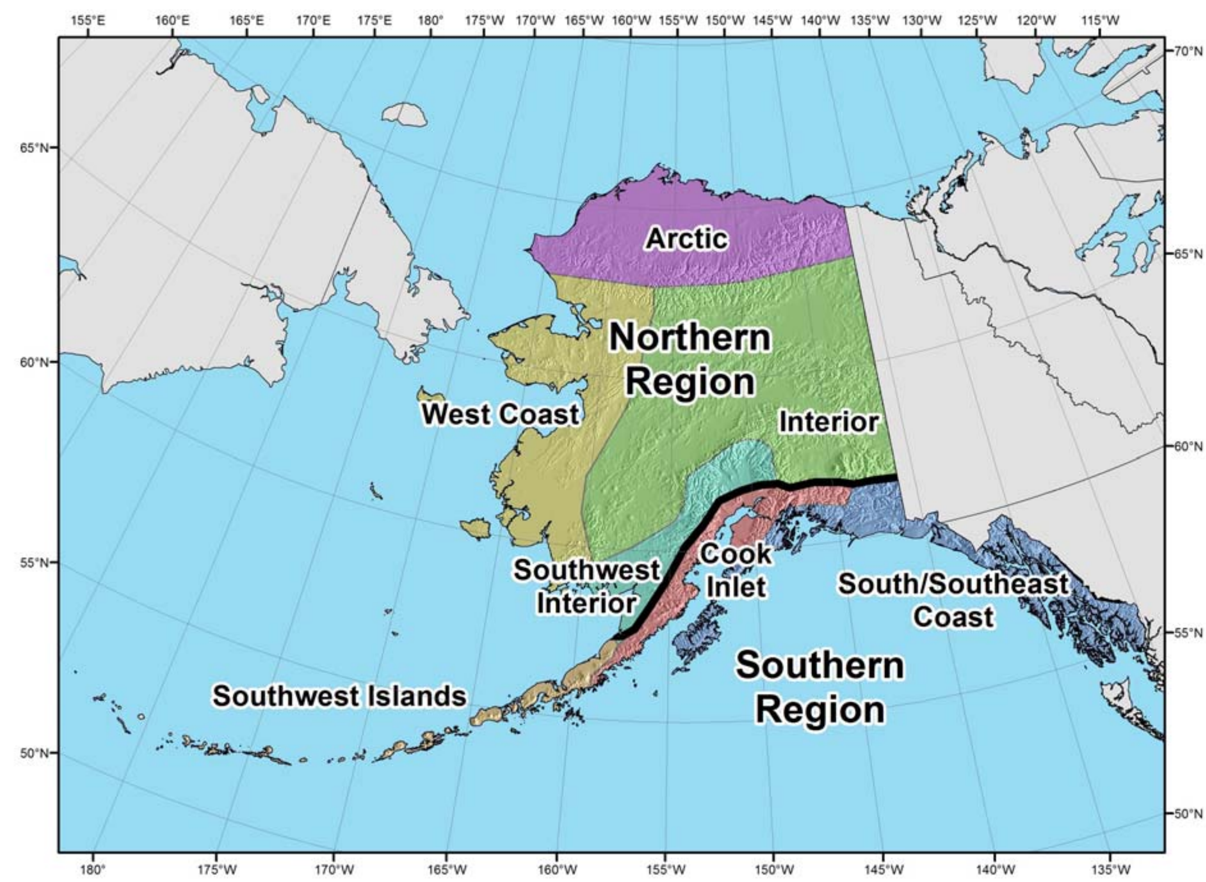


Figure 4.1.2. Seven climatic regions used in NOAA Atlas 14 Volume 7.

4.2. Precipitation data collection and formatting

Precipitation measurements were obtained for 1,689 stations from a number of federal and state agencies, the University of Alaska Fairbanks (UAF), and Environment Canada. The majority of the stations were from the National Weather Service (NWS) Cooperative Observer Program's database maintained by the NOAA's National Climatic Data Center (NCDC). Each station was assigned a unique six digits identification number (station ID) where first two digits were common for all stations from the same data provider in order to have a uniform system of numbering. Except for NCDC stations, assigned identification numbers do not match identification numbers assigned by agencies that provided the data. A list of all agencies that provided the data for this project together with abbreviated names used in this document and the first two digits of stations' identification numbers are shown in Table 4.2.1. The 19th Century Forts and Voluntary Observers data received from the Midwestern Region Climate Center were appended to the corresponding stations in the NCDC's DSI-3200 dataset.

All data were formatted to a common format at one of three base durations that corresponded to the original reporting period: 15-minute, 1-hour, or 1-day. Where available, records extended through May 2011. Table 4.2.2 lists the total number of stations that were obtained and formatted for each reporting interval. In addition, monthly maxima for various n-minute durations (5-minute through 60-minute) were obtained for 36 NCDC stations; they were used to develop scaling factors used for sub-hourly precipitation frequency estimates (Section 4.6.3).

Table 4.2.1. Agencies that provided data for the project with their dataset names, abbreviations, data reporting interval and common first two digits of station identification numbers.

Data provider	**Dataset name**	**Abbrev.**	**Reporting interval**	**Common digits**
Alaska Dept. of Transportation	Road Weather Information System	RWIS	1-day,1-hour	60
Environment Canada	N/A	ENV CANADA	1-day,1-hour	21
Midwestern Region Climate Center	19th Century Forts and Voluntary Observers Database	NCDC	1-day	50
National Climatic Data Center	DSI-3200	NCDC	1-day	50
	DSI-3240	NCDC	1-hour	50
	DSI-3260	NCDC	15-min	50
	Integrated Surface Hourly	ISH	1-hour	70
National Interagency Fire Center, Western Region Climate Center	Remote Automatic Weather Stations	RAWS	1-hour	80
National Weather Service and Federal Aviation Administration	Automated Surface Observing System	ASOS	1-hour	55
Natural Resources Conservation Service	SNOwpack TELemetry	SNOTEL	1-day, 1-hour	10
United States Geological Survey	N/A	USGS	1-day	90
University of Alaska Fairbanks	Arctic Long-Term Ecological Research	ARCTIC LTER	1-day, 1-hour	30
	Arctic Transitions in the Land-Atmosphere System	ATLAS	1-hour	41
	Bonanza Creek Long-Term Ecological Research	BONANZA LTER	1-hour	31
	Water & Environmental Research Center, North Slope	WERC	1-hour	40

Table 4.2.2. The number of stations that were obtained per reporting interval.

Data reporting interval	Number of stations
1-day	913
1-hour	667
15-minute	73

4.3. Annual maximum series extraction

The precipitation frequency analysis approach used in this project is based on analysis of annual maximum series (AMS) across a range of durations. AMS for each station were obtained by extracting the highest precipitation amount for a particular duration in each successive calendar year. AMS at stations were extracted for all durations equal to and longer than the base duration (or reporting interval) up to 60 days. AMS for the 1-day through 60-day durations were compiled from daily and hourly records (15-minute data were not used because they had too few data years). To accomplish this, hourly data were first aggregated to constrained 1-day (hours 0 to 24) values before extracting 1-day and longer duration annual maxima. Hourly data were also used to compile AMS for 1-hour through 12-hour durations.

The procedure for developing an AMS from a precipitation dataset used specific criteria designed to extract only reasonable maxima if a year was incomplete or had accumulated data. Accumulated data occurred in some records where observations were not taken regularly, so recorded numbers represent accumulated amounts over extended periods of time. Since the precipitation distribution over the period is unknown, the total amount was distributed uniformly across the whole period. All annual maxima that resulted from accumulated data were flagged and went through screening to ensure that the incomplete data did not result in erroneously low maxima (Section 4.5.1).

The criteria for AMS extraction were designed to exclude maxima if there were too many missing or accumulated data during the year and more specifically during critical months when precipitation maxima were most likely to occur ("wet season"). Wet seasons were resolved by assessing the periods in which two-thirds of annual maxima occurred at each station and by inspecting histograms of annual maxima for the 1-day and 1-hour durations in a region. The final wet season months were allocated for each of the seven climatic regions described in Section 4.1; they are shown in Table 4.3.1.

Table 4.3.1. Wet season months for each region for daily and sub-daily durations.

Region	Wet season months	
	Daily durations	Sub-daily durations
Arctic	June - September	June - August
West Coast	June - October	June - September
Interior	June - October	June - August
Southwest Islands	July - February	July - November
Southwest Interior	July - December	July - December
Cook Inlet	July - December	July - December
South/Southeast Coast	August - January	August - December

The flowchart in Figure 4.3.2 depicts the AMS extraction criteria for all durations. Various thresholds for acceptable amounts of missing or accumulated data were applied to the year and wet season. In Alaska, data are not always collected during the cold, dry winter months. Assuming that annual maxima are most likely to occur during wet months and that missing data during cold months can be neglected, the criterion for missing data within the entire year was essentially omitted for this project (to accomplish this within the current software's framework, up to 90% of measurements were allowed to be missing during a year). To determine the allowable amount of missing data during the wet season for each climate region, the impact of various allowable percentages on number of extracted years of data was examined. Results suggested that allowing missing data for up to 1/3 of the wet season (~33%) was adequate, particularly given that later quality control efforts screen low outliers in the AMS (Section 4.5.1).

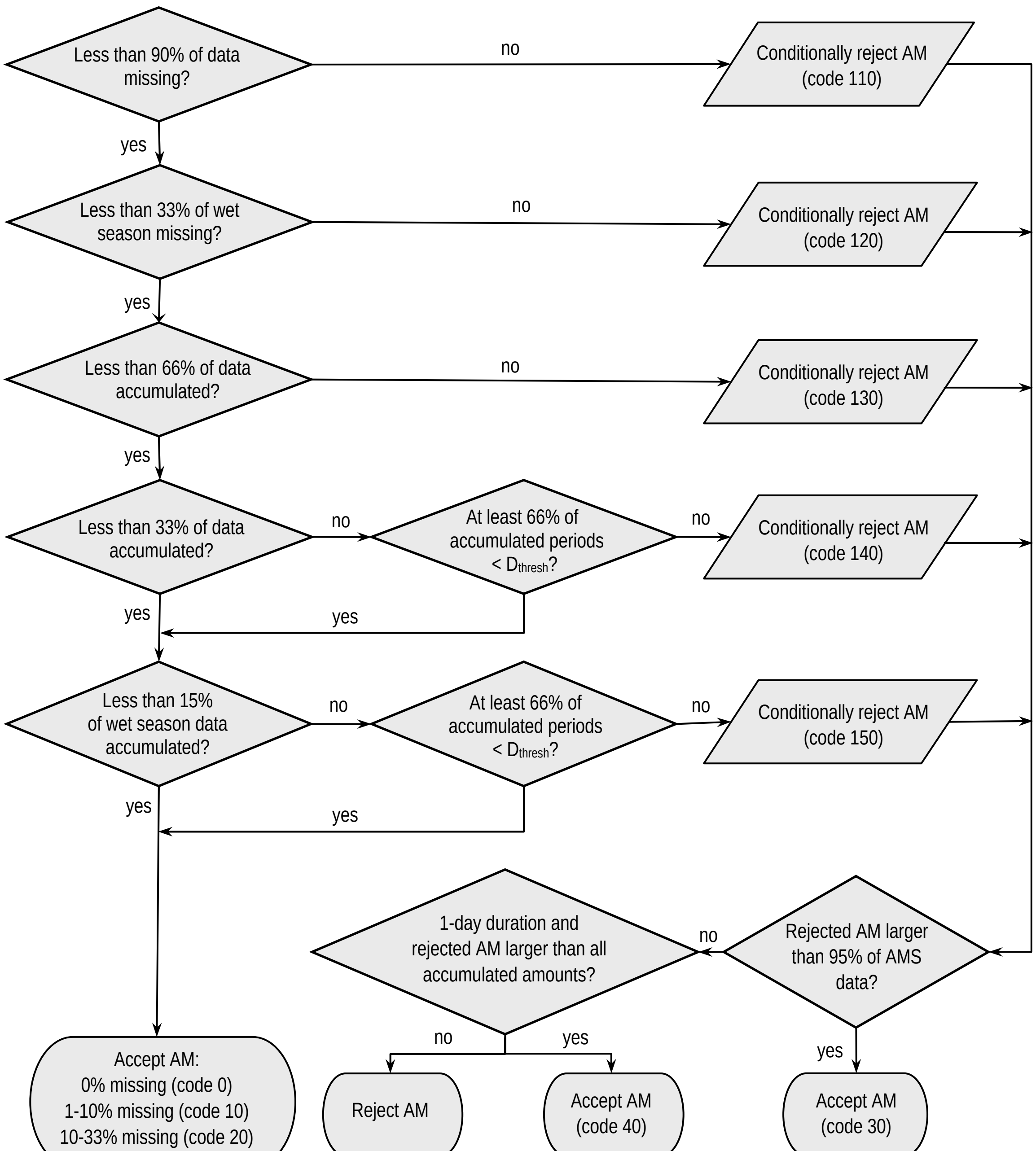


Figure 4.3.2. Criteria used to extract annual maxima. Data quality codes were assigned based on acceptance and rejection; D_{thresh} depends on duration.

The extracted maximum value for a given year had to pass through all of the criteria in the flowchart to be accepted. For example, in a year with less than 33% of measurements missing during the assigned wet season, if more than 66% of measurements were accumulated, then the maxima for that year for that duration was (conditionally) rejected. If the year had between 33% and 66% accumulated data, then it was further screened by assessing the lengths of the accumulated periods. If the lengths of accumulation periods for more than 33% of the accumulated data were equal to or longer than threshold accumulation period lengths (D_{thresh}), then a maximum for that year was rejected. Threshold accumulation period lengths matched the selected duration for durations less than 2 days, were equal to half of duration period for durations between 2 days and 20 days, and were equal 15 days for durations of 30 days or longer. If the year had less than 33% accumulated data, the extracted maximum was passed to another set of criteria for accumulations during its wet season, etc.

If a rejected annual maximum was higher than 95% of the accepted maxima at that station, then it was kept in the series. Also, if a rejected 1-day annual maximum was higher than any accumulated amount in a year, then it was kept in the series. Years in which a maximum was rejected were marked as missing in the series. Various codes were assigned to both, accepted and rejected maxima, based on the amount of missing and accumulated data in each year (see Figure 4.3.1) to assist in further quality control of AMS described in Section 4.5.1.

4.4. Station screening

Station screening was done in the following order: a) examination of geospatial data, b) screening for duplicate stations, c) screening for duplicate records at co-located daily, hourly, and/or 15-minute stations and extending records using data from co-located stations, c) screening nearby stations for potentially merging records or removing shorter, less reliable records in station dense areas, and d) screening for sufficient number of years with usable data.

Geospatial data. Latitude, longitude, and elevation data for all stations were screened for errors. Several stations had to be re-located because they plotted in the ocean or were clearly misplaced based on inspection of satellite images and maps. Misplacement was typically the result of no seconds recorded in latitude and longitude data. There were also several stations with no elevation data; for those stations, elevation was estimated from high-resolution digital elevation model (DEM) grids.

Duplicate stations. In some instances, the same station was reported by more than one source. For example, NCDC's hourly data from the DSI-3240 dataset were also included in their ISH dataset. Duplicate stations were kept only in one of the datasets.

Co-located stations. Co-located stations were defined as stations that have the same geospatial data, but report precipitation amounts at different time intervals. The screening of co-located stations was done as follows:

- If co-located 15-minute and hourly stations provided data for the same period and there were no differences in AMS for constrained 1-hour maxima (15-minute data aggregated based on the clock hour), only the 15-minute station was retained and used to extract AMS for all longer durations. For this project area, aggregated 15-minute data were used to extend AMS at some hourly stations, but no 15-minute stations had sufficient length to be included directly in the analysis.
- If an hourly station provided data for the same period as a co-located daily station and there were no differences in AMS for constrained 1-day maxima (1-hour data aggregated from 0 to 24 hours), only the hourly station was retained and used to extract AMS for all durations.

- If periods of record at co-located hourly and daily stations were consistent but did not completely overlap, aggregated data from the hourly station were used to extend the record of the daily station.
- If the daily station had a longer period of record than co-located hourly station, both stations were retained.

Nearby stations. Nearby stations were defined as stations located within five miles with consideration to elevation differences. Their records were considered for merging to increase record lengths. The Student's two-sample *t*-test at the 90% confidence level was used to ensure that the annual maximum series of merged stations were from the same population.

Record length. Record length was characterized by the number of years for which annual maxima could be extracted (i.e., data years) rather than the entire period of record. Typically, in other NOAA Atlas 14 volumes, only stations with at least 30 data years were considered for frequency analysis, with allowances made for isolated stations or stations recording at very short intervals. Since there were not enough stations that satisfied that requirement in Alaska, all stations with 15 data years or more were included in the initial dataset. Several isolated and/or hourly stations with 9-10 years of data were also retained.

Figure 4.4.1 shows histograms for the number of data years of stations available for frequency analysis across daily and hourly durations after all the screenings were done. No 15-minute stations had sufficient number of data years to be included in the analysis. The average and median record lengths as well as corresponding ranges of record lengths are given in Table 4.4.1.

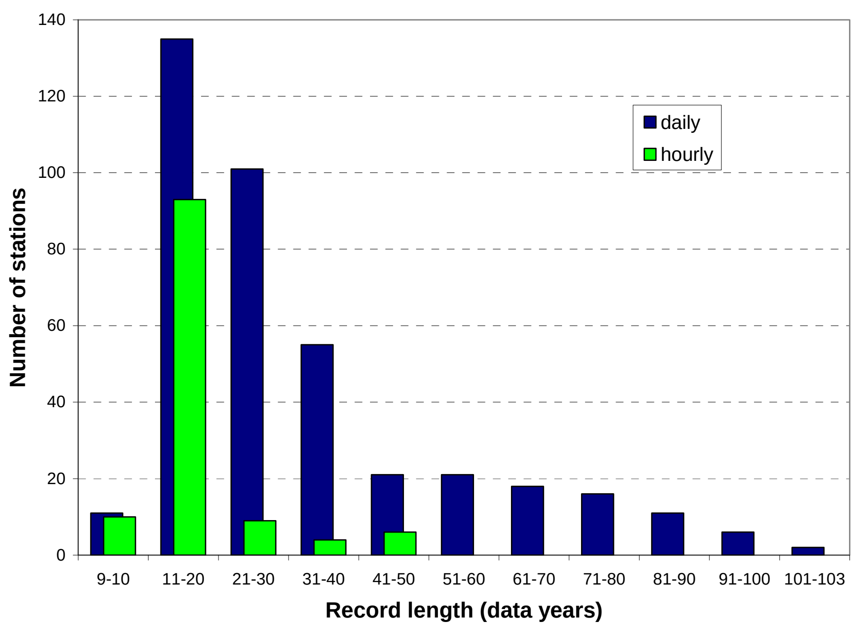


Figure 4.4.1. Number of stations used for precipitation frequency analysis grouped by record length. for daily and hourly durations.

Table 4.4.1. Record length statistics for stations used in frequency analysis for different durations.

Duration (D)	Number of stations	Record length (data years)		
		average	median	range
Daily (1-day ≤ D ≤ 60-day)	396	32	25	9 – 103
Hourly (1-hr ≤ D < 24-hr)	121	18	15	10 – 49

Locations of stations recording precipitation data at 1-day intervals that were used in the frequency analysis are shown in Figure 4.4.2 and locations of stations recording at 1-hour and n-minute intervals are shown in Figure 4.4.3. More detailed information on each station whose data was used to calculate precipitation frequency estimates is given in three tables in Appendix A.1. The first table in the appendix lists stations in Alaska. The second table lists Canadian stations at the border with Alaska. The third table lists n-minute stations that were not directly used in frequency analysis but assisted in calculation of constrained correction factors (see Section 4.5.2) and precipitation frequency estimates at sub-hourly durations (see Section 4.6.3). Information provided for each station includes: source, name, identification number and data reporting interval, as well as latitude, longitude, elevation, and period of record. All adjusted geospatial data are shown in bold font in the latitude, longitude, and/or elevation columns. Bold font in the period of record column was used to indicate stations whose records were extended with the data from co-located stations or whose records were lengthened by merging with another station. The metadata from the station listed as the 'Post-merge station ID' was retained in the dataset for the merged record; the metadata for this station will reflect the combined periods of records in bold text. If an hourly and a daily station with different IDs were co-located, then the metadata, including ID, of the daily station shown in the 'Co-located station ID' column of the table should be used to locate the hourly station on the PFDS web page.

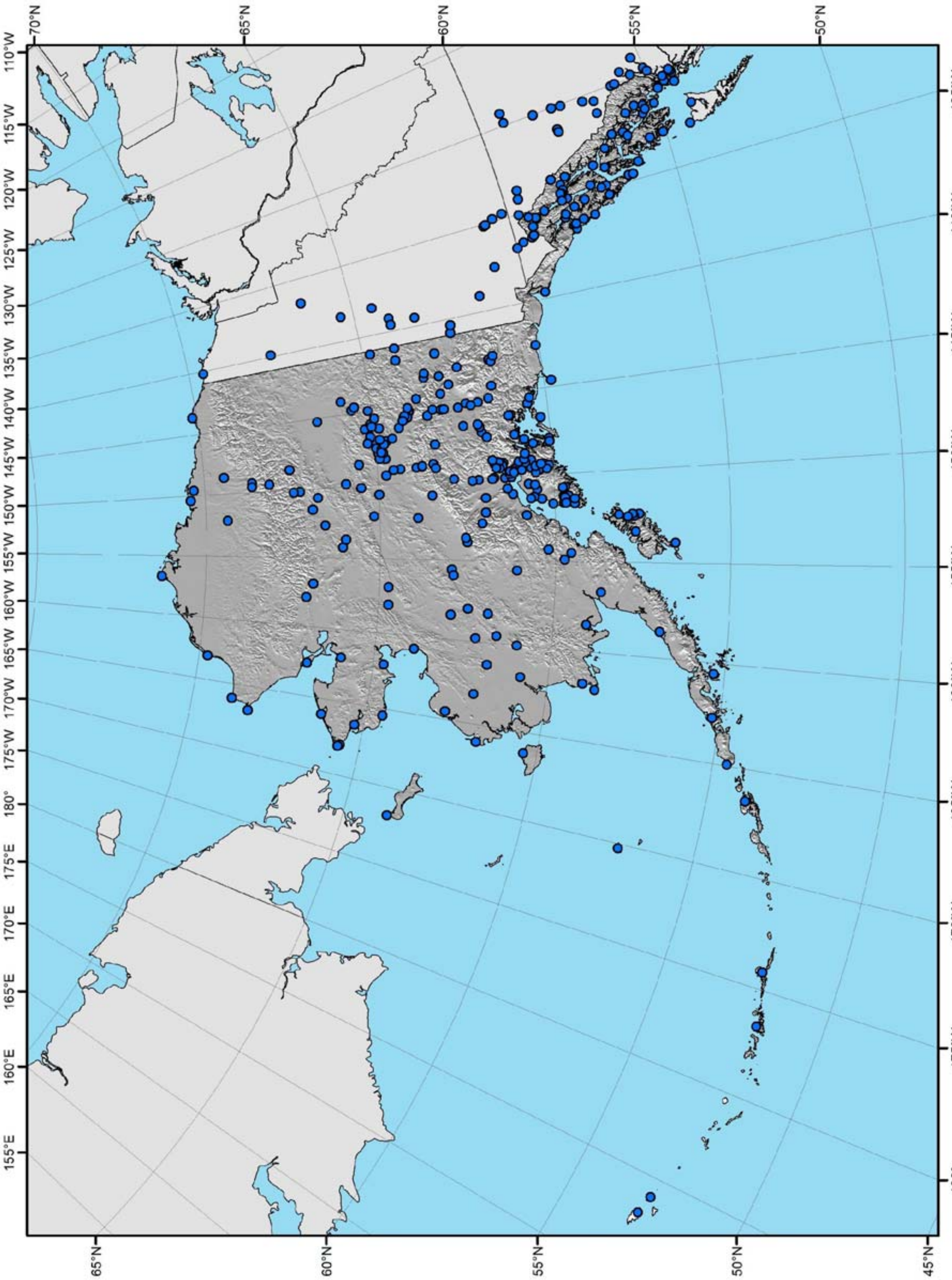


Figure 4.4.2. Map of stations recording at 1-day intervals used in frequency analysis.

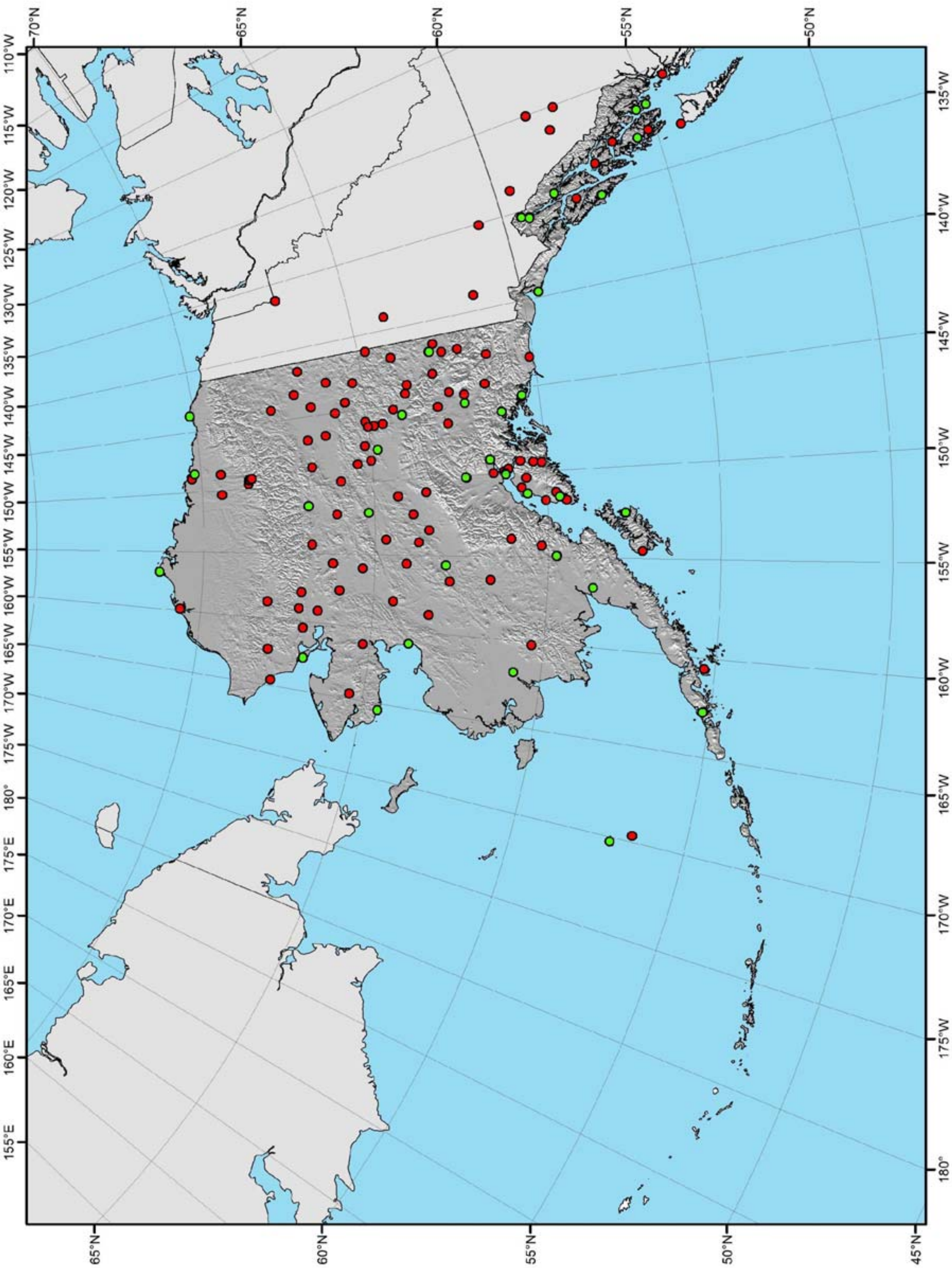


Figure 4.4.3. Map of stations recording at 1-hour (red circles) and n-minute intervals (green circles) used in the analysis.

4.5. AMS screening and quality control

4.5.1. Outliers

For this project, outliers are defined as annual maxima which depart significantly from the trend of the corresponding remaining maxima. 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. The high and low outliers thresholds from the Grubbs-Beck statistical test (Interagency Advisory Committee on Water Data, 1982) and the median +/- two standard deviations thresholds were used to identify low and high outliers for all durations. An example of outlier examination is shown in Figure 4.5.1. Low outliers which frequently came from years with missing and/or accumulated data were typically removed from the annual maximum series. All values identified as high outliers were mapped with concurrent measurements at nearby stations. Questionable values that could not be confirmed were investigated further using climatological observation forms, monthly storm data reports and other historical weather events publications. Depending on the outcome of each investigation, values were either kept as is, corrected, or removed from the datasets. For example, statistical tests indicated two high outliers in 24-hour AMS at Angoon station (50-0310): 15.20 inches recorded on October 12, 1982 and 5 inches recorded on November 14, 1931. Further investigation showed that both measurements were likely clerical errors (e.g., measurements were recorded times a magnitude of ten) and were removed from the dataset. It is interesting to note that the 15.20 inches amount has been frequently cited in literature as the official 24-hour record precipitation amount for Alaska. At the time of publication, the Alaska state climatologist is reviewing this finding.

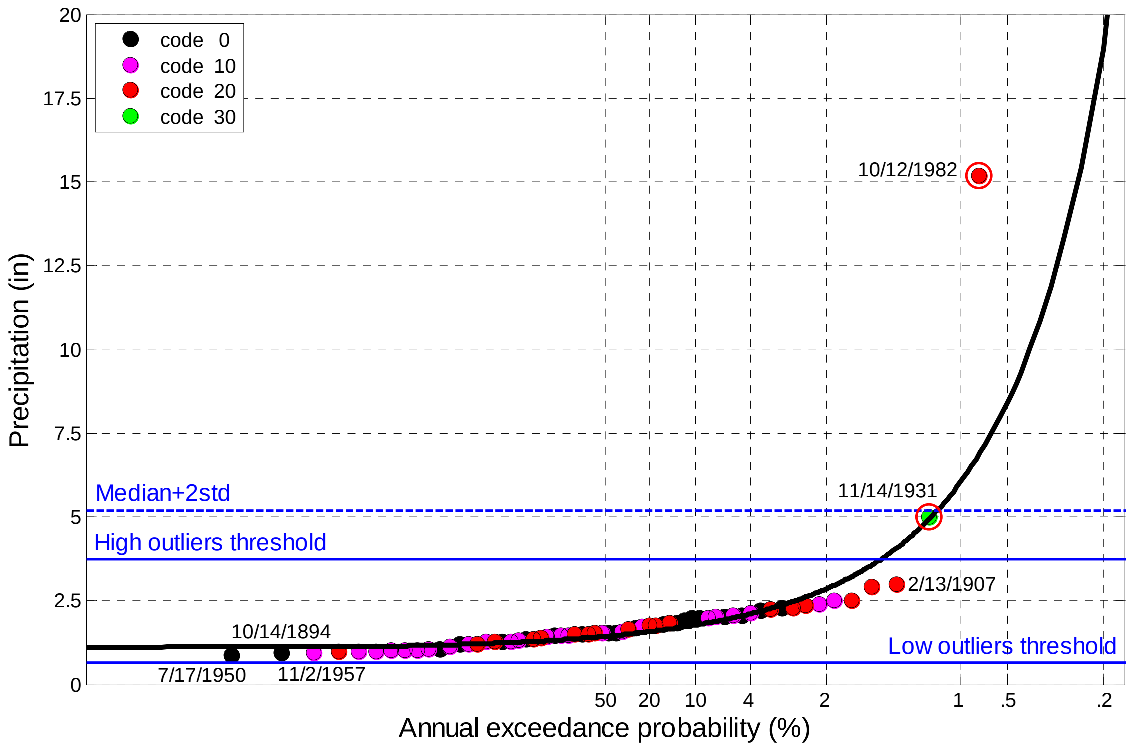


Figure 4.5.1. Outlier examination of 24-hour AMS at station 50-0310. Data quality codes were assigned to all annual maxima during the extraction process (Section 4.3).

4.5.2. Correction for constrained observations

Daily durations. The majority of daily AMS data used in this project came from daily stations at which readings were taken once every day at fixed times (constrained observations). Due to the fixed beginning and ending of observation times at daily stations, it is to be expected that extracted (constrained) annual maxima were lower than the true (unconstrained) maxima, especially for shorter daily durations. To account for the likely failure of capturing the true-interval maxima, correction factors were applied to constrained AMS. 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 4.5.1.

Table 4.5.1. Correction factors applied to constrained AMS data across daily durations.

Duration (days)	1	2	3	4	7	>7
Correction factor	1.12	1.05	1.04	1.03	1.02	1.00

Hourly durations. 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 co-located hourly (constrained) and n-minute (unconstrained) concurrent annual maxima; they are shown in Table 4.5.2.

Table 4.5.2. Correction factors applied to constrained AMS data across hourly durations.

Duration (hours)	1	2	3	6	>6
Correction factor	1.08	1.04	1.02	1.01	1.00

Sub-hourly durations. No correction factors were applied to durations under 1-hour.

4.5.3. Bias correction for precipitation undercatch

All precipitation gauges undercatch the true precipitation amounts to some degree. The amount of undercatch amount depends on a number of factors, with wind speed being the principal factor. Correction of the undercatch bias, is typically done through empirical equations, such as those resulting from World Meteorological Organization initiated studies (Goodison et al., 1998; Yang et al., 1998), but they require local meteorological data, such as type of precipitation (liquid, solid or mixed) and wind speed, and information on a gauge type and whether it is shielded or not. Due to a lack of wind data and information on installation of wind shields for stations in Alaska, it was concluded that the bias correction cannot be done accurately. Therefore, bias correction for precipitation undercatch was not applied on the annual maxima used in this project. Additional information on this analysis can be found in Appendix A.2.

4.5.4. Inconsistencies across durations

At co-located stations, it was not unusual that corresponding annual maxima differed for some years during their overlapping periods of record. Related 1-day AMS at co-located daily and hourly stations were compared and each pair of significantly different estimates was investigated. Effort was made to identify the source of the error and to correct erroneous observations across all durations that were affected.

Annual maxima at each station were also compared across all durations in each year to ensure that the extracted amount for a longer duration was at least equal to the corresponding amount for the successive shorter duration. Inconsistencies of this type occurred at stations with a significant number of missing and/or accumulated data and resulted from different AMS extraction rules applied for different durations (Section 4.3), or from the correction for constrained observations (Section 4.5.2). In those cases, shorter duration annual maxima were used to replace annual maxima extracted for longer durations. Typically, adjustments of this type were very small.

4.5.5. Trend analysis

Precipitation frequency analysis methods used in NOAA Atlas 14 volumes are based on the assumption of a stationary climate over the period of observation (and application). Statistical tests for trends in AMS and the main findings for this project area are described in more detail in Appendix A.3. Briefly, the stationarity assumption was tested by applying a parametric *t*-test and non-parametric Mann-Kendal test for trends in the 1-day and 1-hour annual maximum series data at 5% significance level. Only stations with at least 40 years of data were tested for trends. There were only 12 hourly stations with sufficient period of record and neither test detected any type of trend on a single station. For the 1-day duration, there were 154 stations with at least 40 years of data. Test results were generally in agreement; positive trends were detected at 8% of stations and negative trends at 7% of stations; no statistically-significant trends were detected in about 85% of stations. Spatial maps did not reveal any spatial cohesiveness in positive or negative trends in AMS.

The relative magnitude of any trend in AMS was also assessed for the state as a whole. AMS were rescaled by corresponding mean values and then regressed against time. The regression results were tested as a set against a null hypothesis of zero serial correlation. The null hypothesis of no trends in AMS data could not be rejected at 5% significance level.

Therefore, the assumption of stationary climate was accepted for this project area and no adjustment of AMS magnitudes was recommended.

4.6. Precipitation frequency estimates with confidence limits at stations

4.6.1. Overview of methodology and related terminology

Precipitation magnitude-frequency relationships at individual stations have been computed using a <u>regional frequency analysis approach based on L-moment statistics</u>. Frequency analyses were carried out on <u>annual maximum series (AMS)</u> for the following fifteen durations: 1-hour, 2-hour, 3-hour, 6-hour, 12-hour, 1-day, 2-day, 3-day, 4-day, 7-day, 10-day, 20-day, 30-day, 45-day and 60-day. Frequency estimates based on <u>partial duration series (PDS)</u>, which include all amounts for a specified duration at a given station above a pre-defined threshold regardless of year, were developed from AMS data using a formula that allows for conversion between AMS and PDS frequencies. Precipitation frequency estimates at four sub-hourly durations (5-minute, 10-minute, 15-minute, 30-minute) were derived from corresponding hourly estimates using scaling factors. To assess the uncertainty in estimates, 90% confidence intervals were constructed on AMS and PDS frequency curves.

<u>Frequency analysis</u> involves mathematically fitting an assumed distribution function to the data. The following distribution functions were analyzed in this project with the aim to identify a distribution that will provide accurate precipitation frequency estimates for the project area across all frequencies and durations: 3-parameter Generalized Extreme Value (GEV), Generalized Normal, Generalized Pareto, Generalized Logistic and Pearson Type III distributions; 4-parameter Kappa distribution; and 5-parameter Wakeby distribution.

When fitting a distribution to a precipitation annual maximum series extracted at a given location (and selected duration), the result is a frequency distribution relating precipitation magnitude to its <u>annual exceedance probability (AEP)</u>. The inverse of the AEP is frequently referred to as the <u>average recurrence interval (ARI)</u>, also known as <u>return period</u>. When used with the AMS-based frequency analysis, ARI does not represent the "true" average period between exceedances of a given precipitation magnitude, but the average period between years in which a given precipitation magnitude is exceeded at least once. Those two average periods can be considerably different for more frequent events. The 'true' average recurrence interval (ARI) between cases of a particular magnitude can be obtained through frequency analysis of PDS.

Differences in magnitudes of corresponding frequency estimates (i.e., quantiles) from the two series are negligible for ARIs greater than about 15 years, but notable at smaller ARIs (especially for ARI ≤ 5 years). Because the PDS can include more than one event in any particular year, the results from a PDS analysis are considered to be more reliable for designs based on frequent events (e.g., Laurenson, 1987). To avoid confusion, herein the term AEP is used with AMS frequency analysis and ARI with PDS frequency analysis. The term 'frequency' is interchangeably used to specify the ARI and AEP.

L-moments (Hosking and Wallis, 1997) provide an alternative way of describing frequency distributions to traditional product moments (conventional moments) or maximum likelihood approach. Since sample estimators of L-moments are linear combinations of ranked observations, they are less susceptible to the presence of outliers in the data than conventional moments and are well suited for the analysis of data that exhibit significant skewness. L-moments typically used to calculate parameters of various frequency distributions include 1st and 2nd order L-moments: L-location (λ_1) and L-scale (λ_2), and the following L-moment ratios: L-CV (τ), L-skewness (τ_3), and L-kurtosis (τ_4). L-CV, which stands for "coefficient of L-variation", is calculated as the ratio of L-scale to L-location (λ_2/λ_1). L-skewness and L-kurtosis represent ratios of the 3rd order (λ_3) and 4th order (λ_4) L-moments to the 2nd order (λ_2) L-moment, respectively, and thus are independent of scale.

One of the primary problems in precipitation frequency analysis is the need to provide estimates for average recurrence intervals that are significantly longer than available records. Regional approaches, which use data from stations that are expected to have similar frequency distributions have been shown 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 (Burn, 1990) used in this volume defines regions such that each station has its own region with a potentially unique combination of nearby stations. Stations are selected based on the maximum allowable distance from the target station that is defined in a geographic space and in a space of selected statistical attribute variables. Like with other regionalization approaches, there is level of subjectivity involved in the process, for example, in choosing attribute variables, selecting the maximum allowable distances as well as attributes' weights and transformations for similarity distance algorithms. One of the main advantages of the region of influence approach is that it results in a smooth transition in estimates across regional boundaries, which is very relevant for the mapping of precipitation frequency estimates.

A frequency curve that is calculated from sample data represents some average estimate of the population frequency curve, but there is a high probability that the true value actually lies above or below the sample estimate. Confidence limits determine values between which one would expect the true value to lie with certain confidence. The width of a confidence interval between the upper and lower confidence limits is affected by a number of factors, such as the degree of confidence, sample size, exceedance probability, distribution selection, and so on. Simulation-based procedures were used to estimate confidence limits of a 90% confidence interval on frequency curves.

Precipitation frequency estimates from this Atlas are point estimates, and are not directly applicable for an area. The conversion of a point to an areal estimate is usually done by applying an appropriate areal reduction factor to the average of the point estimates within the subject area. Areal reduction factors are generally a function of the size of an area and the duration of the precipitation. Since there are no areal reduction factors developed specifically for Alaska, the depth-area-duration curves from the Technical Paper No. 47 (Miller, 1963), that are identical to curves from the Technical

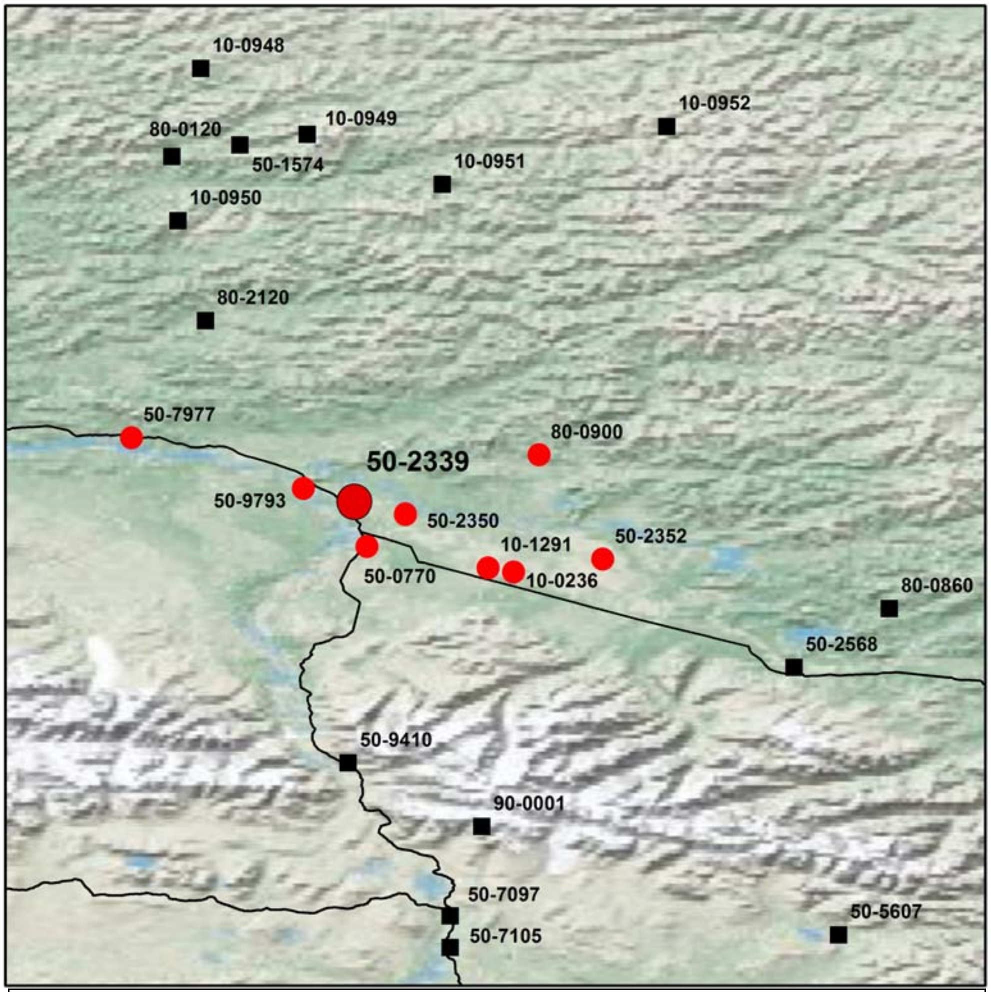
Paper No. 29 (U.S. Weather Bureau, 1960) developed for the contiguous United States, could be used for that purpose.

4.6.2. Regionalization

Initial regions for each station were created 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. (see an example in Figure 4.6.1) and assessment of similarities/dissimilarities in the progression of relevant L-moment statistics across durations compared with other stations in the region (see Figure 4.6.2). Typically, final regions included between 5 to 9 stations with a cumulative number of data years between 150 and 250 for daily durations and 40 and 80 for hourly durations. However, since there were large portions of the project area with very few stations, final numbers of stations per region were as low as a single station and/or have less than 20 data years, especially for hourly durations.

Regional L-moments calculation. For a given duration, regional estimates of L-moment ratios (L-CV, L-skewness and L-kurtosis) were obtained by averaging corresponding station-specific estimates weighted by record lengths. Regional L-moment ratios were then used to estimate higher order L-moments at each station.

Station dependence. Since stations were selected based on geographic proximity to a target station, it was possible that extracted annual maxima at nearby stations came from the same storm events. Dependence in AMS data for stations within a region was analyzed using a *t*-test for the significance of a correlation coefficient at the 5% level. Analysis indicated that cross-correlation among stations was statistically significant for several regions in areas with more dense network of rain gauges and that the number of dependent station pairs increased with duration length. The impact of station dependence on precipitation frequency estimates is considered to be minimal (e.g., Hosking and Wallis, 1997), so it was not addressed in the calculation of precipitation frequency estimates. However, it was accounted for during the construction of confidence intervals on estimates where it could have noticeable influence (see Section 4.6.5).



Station ID	Distance (mi)	Elev (ft)	ΔElev (ft)	MAM (in)	ΔMAM (in)	n_{daily}	n_{hourly}
			Suggested stations (red circles)				
50-2339	-	1048	-	1.28	-	13	0
50-9793	4.64	1010	-38	1.20	-0.08	26	0
50-2350	4.64	1060	12	1.27	-0.01	41	0
50-0770	8.13	1268	220	1.24	-0.04	68	0
10-1291	15.98	1240	192	1.27	-0.01	19	0
80-0900	16.80	1520	472	1.31	0.03	13	13
10-0236	17.90	1225	177	1.21	-0.06	19	0
50-7977	21.00	889	-159	1.27	-0.01	11	0
50-2352	22.25	1125	77	1.18	-0.09	14	0
					n_{region}:	**224**	**13**
			Additional stations (black squares)				
80-2120	34.76	1000	-48	1.25	-0.03	14	13
50-8140	45.50	680	-368	1.34	0.06	21	0
Etc.							

Enter station ID for station you want to add/remove: <XX.XXXX>

Figure 4.6.1. An example of spatial plot with accompanying interactive table used to add or remove stations from a region for station Delta 6N (50-2339).

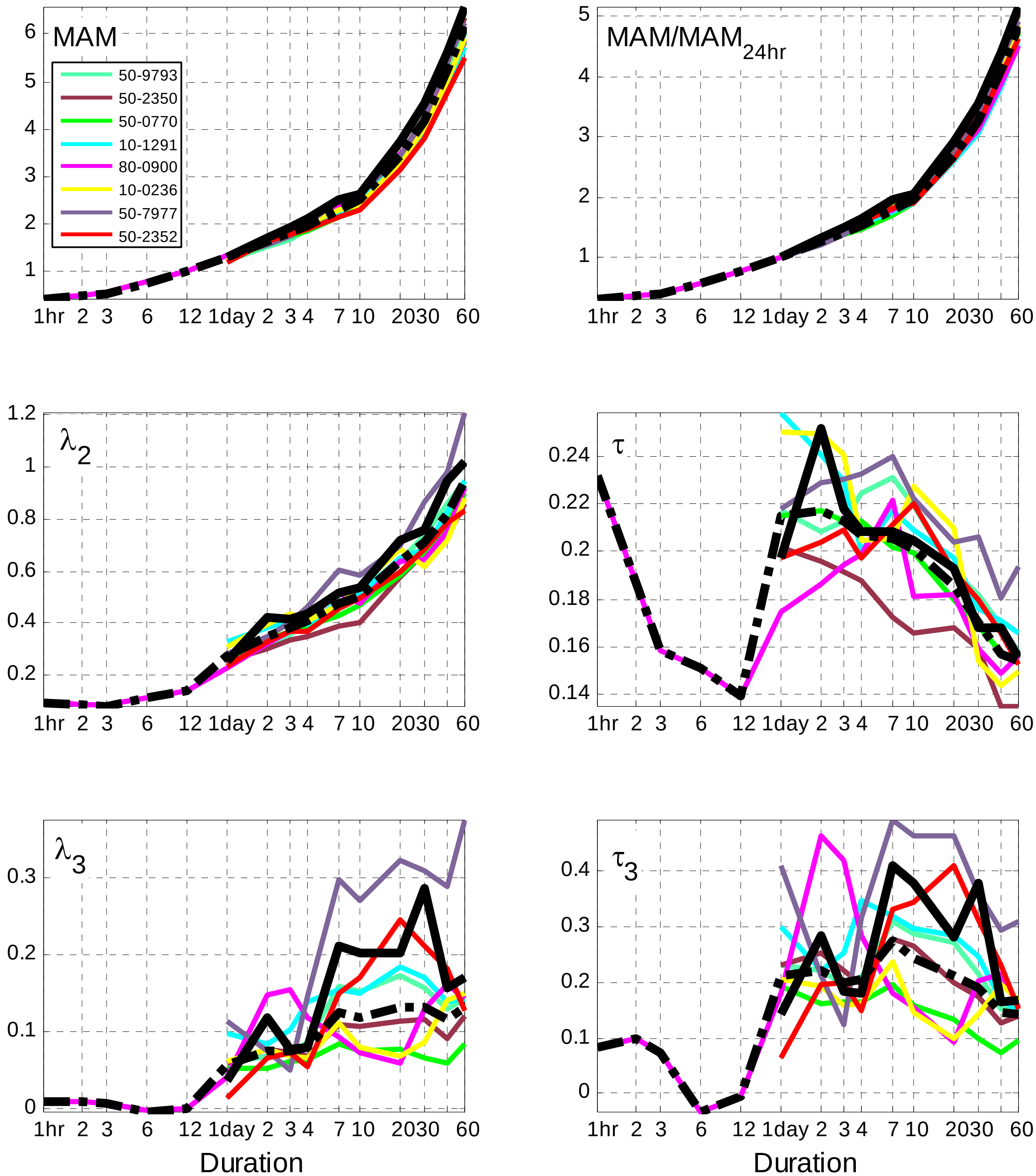


Figure 4.6.2. An example of plots of L-moments (left panels), MAM/MAM$_{1\text{-day}}$ and L-moment ratios (right panels) across durations for a region. Thick red lines show statistics for target station (station 50-2339); thin colored lines show statistics for other stations in the region; thick dashed red lines show corresponding regional estimates.

4.6.3. AMS-based estimates

Choice of distribution. A goodness-of-fit test based on L-moment statistics for 3-parameter distributions, as suggested by Hosking and Wallis (1997), was used to assess which of the 3-parameter distributions listed in Section 4.6.1 provide acceptable fit to the AMS data. Inspection of probability plots for 1-hour, 1-day and 10-day durations, like the one shown in Figure 4.6.3, and results of $\chi 2$-tests were also considered during distribution selection. The tests were inconclusive; there was not a single distribution that was consistently better than others. The decision was made to adopt the GEV distribution across all stations and for all durations for a number of reasons. GEV is a distribution generally recommended for analysis of extreme events. Based on the tests' results, GEV distribution provided an acceptable fit for most of the stations across a majority of durations. Finally, although it is not required to use the same type of distribution across all durations and/or regions, changes in distribution type for different durations or regions often lead to considerable discontinuities in frequency estimates across durations or between nearby locations, particularly at rarer frequencies.

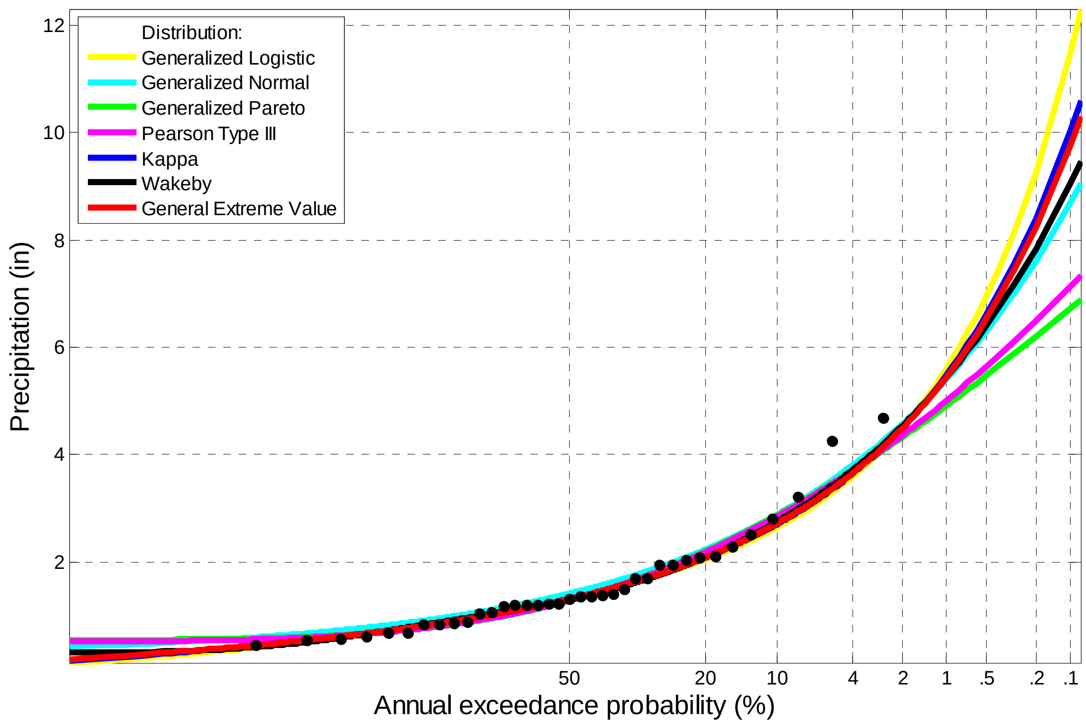


Figure 4.6.3. Probability plots for selected distributions for 1-day AMS at Chitina station (50-1824).

Frequency estimates for daily durations. For each station and for each duration 1-day and longer, regional L-moment statistics were used to calculate the parameters of the GEV distribution and to produce precipitation frequency estimates for the following annual exceedance probabilities (AEPs): 1/2 (50%), 1/5, 1/10, 1/25, 1/50, 1/100, 1/200, 1/500 and 1/1000. This calculation was repeated for all durations and for all stations. Since regional L-moments, and consequently, precipitation frequency estimates, were calculated independently for each duration, resulting depth-duration-frequency (DDF) curves did not always look smooth. Smoothing of L-moments by cubic spline functions improved the shape of DDF curves. Figure 4.6.4 illustrates precipitation depth-duration-frequency curves before and after smoothing of L-moments for Snettisham Power Plant station (50-8584). Appendix A.4 lists the final L-moments at each station for 1-day through 60-day durations.

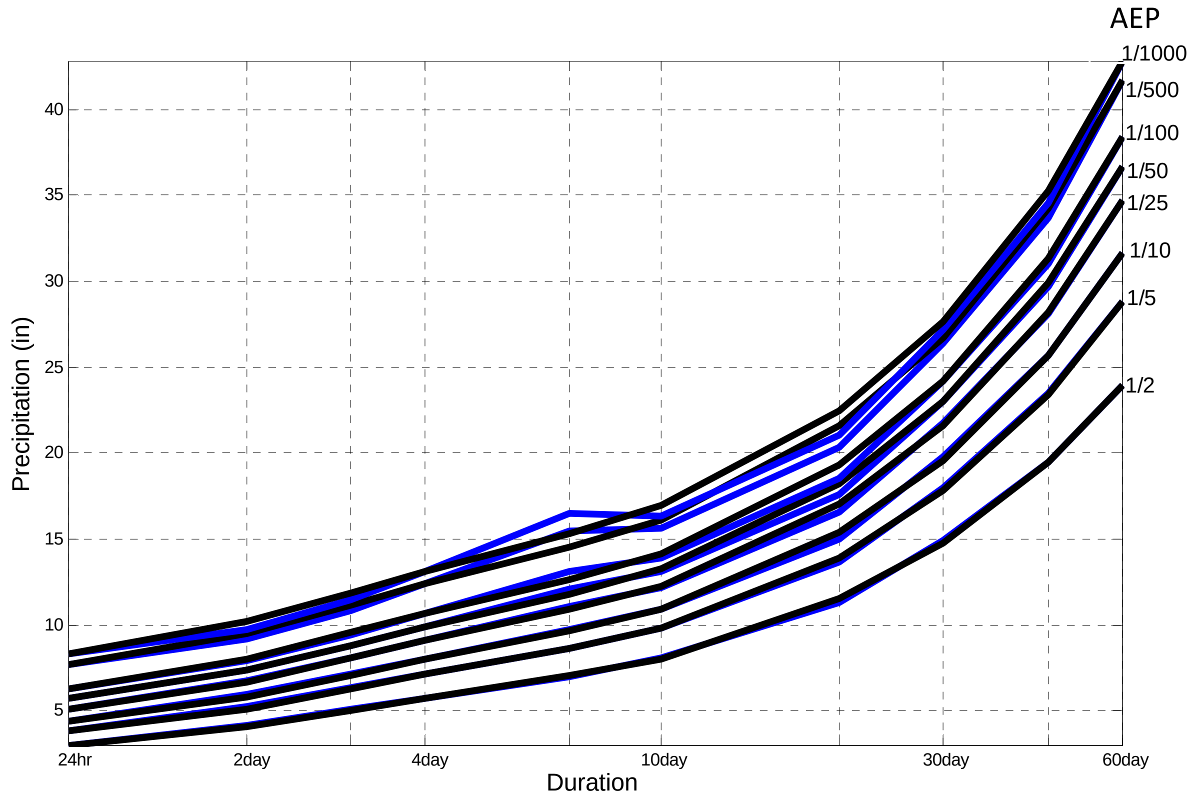


Figure 4.6.4. Precipitation frequency estimates for a range of durations for selected AEPs for station Snettisham Power Plant (50-8584). Blue lines represent original estimates; black lines represent estimates obtained after L-moments were smoothed across durations.

Frequency estimates for hourly durations. Regional L-moment statistics were used to calculate the parameters of the GEV distribution and to produce hourly precipitation frequency estimates for the same set of AEPs as for daily durations. This calculation was repeated for all hourly durations and for all stations. For a significant number of stations, it was observed that resulting precipitation frequency estimates were implausible and that the evolution of estimates across durations was frequently erratic, especially for AEPs of 1/100 (1%) or less. Further investigation indicated that in the majority of anomalous cases, small sample sizes resulted in unreliable higher order moments (especially λ_3) which consequently resulted in irrational variations in estimates across hourly durations. First order moments (i.e., mean annual maxima) were less affected by the sample size. An attempt to smooth L-moments using similar approaches as for daily durations failed. Finally, it was decided to use ratios of the relatively stable first order moments at hourly durations to first order 24-hour moments and apply them to 24-hour precipitation frequency estimates to develop hourly frequency estimates. In other words, an assumption was made that mean annual maxima (MAMs) vary across hourly durations, but that ratios of quantiles for different AEPs and corresponding MAMs remain constant.

Frequency estimates for sub-hourly durations. 5-minute, 10-minute, 15-minute and 30-minute estimates were calculated using scaling factors from 60-minute estimates. The scaling factors were developed through analysis of average ratios of n-minute annual maxima to corresponding unconstrained 60-minute annual maxima. N-minute annual maximum data for this analysis came from 36 NCDC n-minute stations that had records of monthly maxima data for durations from 5 minutes through 60 minutes (a list of n-minute stations is available in Table A.1.3 of Appendix A.1).

Given the relatively little available data and after reviewing the ratios by region, it was decided that the final scaling factors would be calculated by taking averages of quality controlled ratios from all stations in the project area. The scaling factors for the 5-minute, 10-minute, 15-minute, and 30-minute durations are given in Table 4.6.1.

Table 4.6.1. Scaling factors for n-minute durations.

Duration (minutes)	5	10	15	30
Scaling factor	0.35	0.47	0.55	0.73

4.6.4. PDS-based estimates

PDS-based precipitation frequency estimates were calculated indirectly from the Langbein's formula (Langbein, 1949) that transforms a PDS-based average recurrence interval (ARI) to an annual exceedance probability (AEP):

$$\mathrm{AEP} = 1 - \exp\left(-\frac{1}{\mathrm{ARI}}\right).$$

PDS-based frequency estimates were calculated for the same durations as AMS-based estimates for 1-, 2-, 5-, 10-, 25-, 50-, 100-, 200-, 500- and 1,000-year ARIs. Selected ARIs were first converted to AEPs using the above formula and then used to calculate precipitation frequency estimates for daily and hourly durations following the same regional approach and using the same L-moments that were used in the AMS analysis. For sub-hourly durations, PDS-based based frequency estimates were calculated using the same scaling factors that were used to estimate AMS-based frequency estimates.

4.6.5. Confidence limits

A Monte Carlo simulation procedure, as described in Hosking and Wallis (1997), was used to construct 90% confidence intervals (i.e., 5% and 95% confidence limits) on both AMS-based and PDS-based precipitation frequency curves. It should be noted that confidence intervals constructed through this approach account for uncertainties in distribution parameters, but not for other sources of uncertainties (for example, distribution selection), that could also significantly impact the total error, particularly at rarer frequencies.

Since the station dependence analysis (Section 4.6.2) indicated that for regions with more dense station network, AMS data from different stations could be correlated (especially for longer durations), the algorithm was adjusted to account for inter-station correlation. At each station, 1,000 simulated data sets per duration were used to generate precipitation quantiles. Estimates were sorted from smallest to largest and the 50^{th} value was selected as the lower confidence limit and the 950^{th} value was selected as the upper confidence limit.

Due to significant differences in record lengths across hourly and daily durations, it is expected that confidence intervals for hourly durations are much wider than corresponding intervals at daily durations. Because of very short records, similar to precipitation frequency estimates, confidence limits fluctuated a lot from duration to duration and confidence intervals were often wider than corresponding intervals for 24-hour duration. To address this, confidence limit estimates were smoothed across durations and restricted by the corresponding value at 24-hour duration.

4.7. Rainfall frequency estimates at stations

4.7.1. Background

Precipitation frequency estimates from Section 4.6 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. For example, rainfall is treated differently from snowfall in watershed modeling because of different runoff producing mechanisms - while rainfall generates runoff almost immediately, snowfall generally goes into storage until it melts and produces runoff at a later date.

In Alaska, due to geo-climatic conditions, the contribution of snowfall to the total yearly precipitation amount is significant. However, that does not necessarily translate to its significant participation in precipitation annual maximum series (AMS). To explore differences in total and liquid-only precipitation frequency estimates, concurrent rainfall and precipitation AMS were extracted at stations which had information useful for distinguishing the type of precipitation. Rainfall frequency analysis was done for durations up to 24 hours, which are of most interest to design projects relying on peak flows.

4.7.2. Extraction of rainfall data

Different methodologies were developed in order to segregate liquid from solid precipitation, depending on the type of data that was available in each dataset. More details on the type of data used for rainfall segregation for each dataset are given in Table 4.7.1. In the table, it is also indicated how many stations had at least 10 years of data which was the minimum number of years for a station to be considered for this analysis.

Table 4.7.1. Type of data used for segregation of liquid from total precipitation and number of stations per dataset.

Recording interval	Data source: dataset	Type of data available	Number of stations
1-day	Environment Canada	precipitation, rainfall	55
	NCDC: TD3200	precipitation, snowfall, air temperature	281
	UAF: Arctic LTER	warm season precipitation	0
	USDA: SNOTEL	precipitation, temperature	39
	USGS	precipitation, air temperature	2
1-hour	Environment Canada	precipitation, rainfall	12
	NCDC: TD3240 and ISH	precipitation, rainfall, air temperature at nearby daily NCDC station	4
	RAWS	precipitation, air temperature	78
	UAF: WERC – North Slope	warm season precipitation	0
	UAF: Bonanza Creek LTER	warm season precipitation	0
	UAF: Arctic LTER	warm season precipitation	0

Stations from datasets that provided precipitation measurements only during warm months were not used in this analysis (shaded gray in the table) since it was assumed that all precipitation at those stations was liquid precipitation. Simultaneous rainfall and precipitation data were available only in the Environment Canada datasets. NCDC ISH also included rainfall-only data but there were not enough annual maxima at these stations to be useful in the analysis. For the NCDC TD3200 dataset, which contained records of precipitation and snowfall, the following three methods for the extraction of rainfall were considered:

1. For days with zero or missing snowfall, precipitation was assumed to be rainfall; for days with recorded snowfall, all precipitation was assumed to be snowfall.

2. Recorded snowfall amounts were first converted to snow water equivalent using the 10 to 1 rule, which assumes that the density of the snow is 1/10 of the density of water. Rainfall amounts were then calculated as the difference between precipitation and snow water equivalent.
3. Recorded snowfall amounts were converted to snow water equivalent using the 10 to 1 rule. For days when the snow water equivalent was less than 1/3 of the total precipitation amount, total precipitation was treated as a rainfall; otherwise it was assumed to be snowfall.

For other datasets, average daily air temperature measured at that station or at the nearest station from a different dataset was used to assign the type of precipitation. During cold months, all precipitation was considered snowfall. During warm months, pre-determined average daily air temperature thresholds were used to differentiate snowfall from rainfall. Warm (wet) and cold (dry) seasons were defined for each climate region in Section 4.3. Table 4.7.2 lists temperature thresholds for each climate region.

Table 4.7.2. Average daily air temperature threshold values used to segregate rainfall values from total precipitation for each climate region.

Region	**Temperature threshold (ºF)**
Arctic	32
West Coast	33
Interior	33
Southwest Islands	35
Southwest Interior	34
Cook Inlet	34
South/Southeast Coast	36

4.7.3. Rainfall frequency estimation

Concurrent rainfall and total precipitation annual maximum series were extracted for stations that had at least 10 years of data for the following durations: 1-hour, 3-hour, 6-hour, 12-hour and 24-hour. Separate rainfall and precipitation frequency analyses were conducted using the Generalized Extreme Value (GEV) distribution with parameters estimated from L-moment statistics. For sub-daily durations, there was no real difference in frequency estimates between total and liquid precipitation. For the 24-hour duration, for about half of the stations, precipitation AMS were made up almost exclusively of rainfall (an example is shown in panel a) of Figure 4.7.1). For about 23% of stations, solid precipitation annual maxima were among the more frequent events in total precipitations AMS (panel b); for approximately 12% of stations, solid precipitation annual maxima were among the highest amounts in AMS (panel c); and for about 15% of stations, the majority of total precipitation AMS were from solid precipitation (panel d).

Ratios of rainfall and precipitation frequency estimates were typically higher than 0.96 suggesting little difference between the two. For the NCDC 3200 dataset, findings were similar regardless of the method of segregation used. Moreover, when ratios were plotted on a map for selected annual exceedance probabilities, no spatial patterns were observed. Unfortunately, only a handful of stations were available at higher altitudes (above 3,000 feet) - nine daily stations and no hourly stations. So, assessing the effect of elevation on differences between rainfall and total precipitation frequencies was not feasible.

In conclusion, given that there were very few high-altitude stations and that the analysis of all available stations showed minor differences between rainfall and precipitation frequency estimates, it was decided not to provide separate rainfall frequency estimates in NOAA Atlas 14 Volume 7.

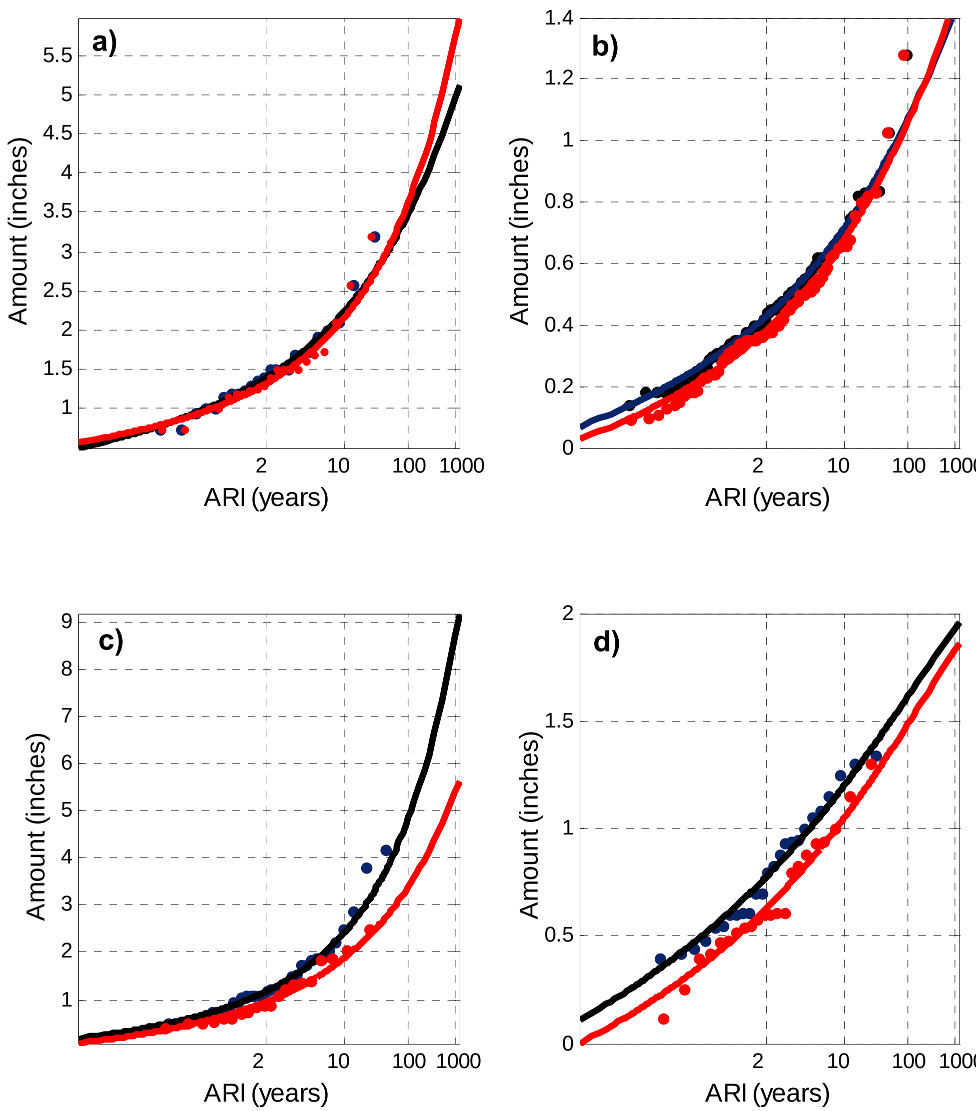


Figure 4.7.1. Probability distributions for the 24-hour precipitation and rainfall annual maximum series at stations (a) 50-1325, (b) 50-0546, (c) 50-1824, and (d) 50-1977. The red line and red circles indicate the rainfall distribution and AMS data and the black line and black circles indicate the total precipitation distribution and AMS data.

4.8. Derivation of grids

4.8.1. Mean annual maximum precipitation

Mean annual maximum (MAM) grids served as the basis for deriving gridded precipitation frequency estimates at different frequencies and durations. The station mean annual maximum values for the 15 selected durations between 60 minutes and 60 days were spatially interpolated to produce corresponding mean annual maximum grids at 30 arc-seconds (on average around 928 x 928 meters or 3,045 by 3,045 feet) resolution using a hybrid statistical-geographic approach for mapping climate data named Parameter-elevation Regressions on Independent Slopes Model (PRISM) developed by Oregon State University's PRISM Climate Group (e.g., Daly et al., 2002).

Intermediate review of mean annual maxima grids suggested that in a two areas of varied terrain, where the lack of stations unduly influenced expected spatial patterns, it was beneficial to add mean annual maximum estimates for selected locations to anchor the spatial interpolation. MAMs were estimated across durations at the two locations shown in Table 4.8.1. Additionally, MAMs of one or more durations were adjusted at fifteen locations where inspection of spatial patterns indicated that estimates were not consistent with estimates at nearby stations or with climatological expectations.

Table 4.8.1. Locations where mean annual maxima were estimated to anchor spatial interpolation.

Location ID	Location name	Latitude	Longitude	Elevation (ft)
99-9998	Big Port Walter Mountain	56.3966	-134.7627	3020
99-9999	Mount Isto	69.2003	-143.8019	2730

Appendix A.5 provides detailed information on the PRISM-based methodology for creating mean annual maxima grids. In summary, a unique regression function was developed for each target grid cell to derive mean annual maximum values for each duration that accounted for the difference between an observing station and the target cell's mean annual precipitation, topographic facet, coastal proximity, the distance of an observing station to the target cell, etc. Because of the limited number of stations recording at durations shorter than 1 day, sub-daily mean annual maximum data were developed for daily-only stations for 60-minute through 12-hour durations (see Appendix A.5 for more detail).

Jacknife cross-validation indicated that, for this project area, overall bias was less than 1 percent and the mean absolute error was less than 11 percent across all durations. However, given that so few stations were available in Alaska, and that cross-validation errors could be calculated only at stations, true interpolation errors in many parts of the state may be higher.

4.8.2. Precipitation frequency estimates with confidence limits

Estimates for 60-minute through 60-day durations. The HDSC-developed spatial interpolation technique termed 'CRAB' for the Cascade, Residual Add-Back (Parzybok and Yekta, 2003) which was used in previous NOAA Atlas 14 volumes to convert mean annual maximum grids into grids of AMS-based and PDS-based precipitation frequency estimates failed to produce spatial patterns in line with expected climatological patterns, especially for ARIs of 100-years or more. That was especially the case in areas with very few stations and/or near stations with relatively short periods of record. The major limitation that caused CRAB's failure is that residuals, which are calculated for each station to quantify the difference between at-station estimates and initial gridded estimates, were spread across vast areas.

For that reason, an alternative interpolation technique was developed for this project area. Similar to CRAB, this technique derives grids along the frequency dimension for a given duration. Hence, the evolution of frequency-dependent spatial patterns for a given duration is independent of other durations. Also, similar to the CRAB process, it utilizes the inherently strong linear relationship that exists between mean annual maxima and precipitation frequency estimates for the 2-year average recurrence interval (ARI), as well as between precipitation frequency estimates for consecutive ARIs. Figure 4.8.1 shows an example of the relationship between the 50-year and 100-year estimates for the entire project area for the 24-hour duration. The R^2 value here of 0.998 is very close to 1.0, which was common for all relationships. The slope coefficient of 1.0995 can be thought of as an average domain-wide ratio between 100-year and 50-year quantiles for 24-hour duration. In CRAB, this type of equation would be calculated using all stations in the project area and used to establish an initial grid of 100-year precipitation frequency estimates, which would then be adjusted using a grid of residuals. However, when individual ratios were calculated for stations in the project area and plotted on a map, the ratios clearly indicated regional patterns (see an example for 100-year 24-hour in Figure 4.8.2). The alternative interpolation technique used in this project is appropriate to interpolate such regional patterns.

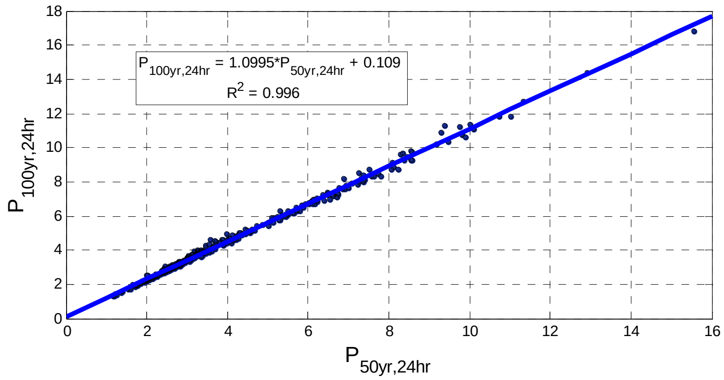


Figure 4.8.1. Scatter plot of 100-year versus 50-year precipitation frequency estimates based on 24-hour annual maximum series. Linear regression line is also shown.

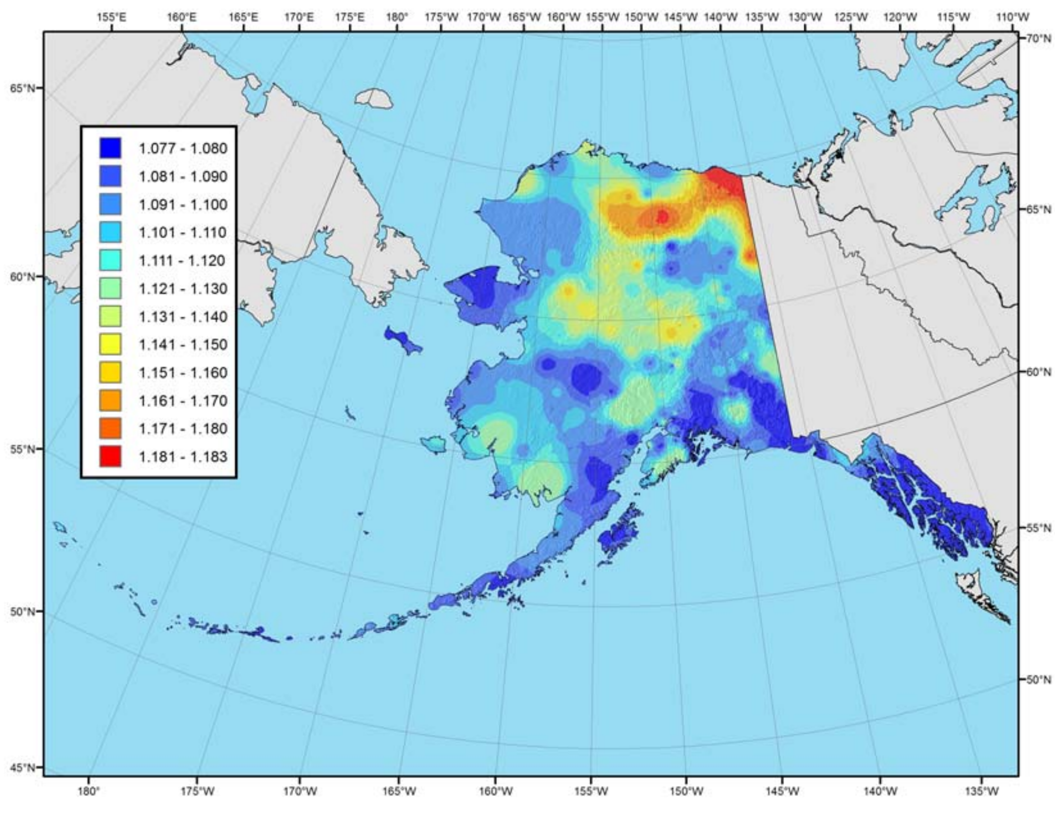


Figure 4.8.2. Spatially interpolated ratios used to calculate 24-hour 100-year precipitation frequency grid from the 50-year grid.

For each duration, the cascade began with the PRISM-derived mean annual maximum (MAM) grid as the initial predictor grid and the 2-year precipitation frequency estimates as the subsequent grid. Ratios between the 2-year estimates and corresponding MAM estimates for each station were spatially interpolated to a grid by applying an inverse-distance-weighting algorithm that uses the nine closest stations not more than 100 miles apart. Gridded MAM estimates were then multiplied by corresponding gridded ratios to create a grid of 2-year precipitation frequency estimates. In the subsequent run, ratios between the 5-year and 2-year estimates were interpolated and used to calculate 5-year precipitation grid from the 2-year grid, and so forth. 2-year precipitation frequency estimates were also used to create a grid of 1-year estimates.

To ensure consistency in grid cell values across all durations and frequencies, duration-based internal consistency checks were conducted (e.g., 24-hour estimate less than 12-hour estimate). For inconsistent cases, the longer duration grid cell value was adjusted by multiplying the shorter duration grid cell value by 1.01 to provide a 1% difference between the values. After grid cell consistency was ensured across durations, it was performed across frequencies to ensure that there were no frequency-based inconsistencies caused by the adjustment.

A jack-knife cross-validation technique (Shao and Tu, 1995) was used to evaluate the spatial interpolation technique's performance for interpolating precipitation frequency estimates. It was cost prohibitive to re-create the PRISM mean annual maximum grids for each cross-validation iteration. For this reason, the cross-validation results reflect the accuracy of the interpolation procedure based on the same mean annual maximum grids. Figure 4.8.3 shows validation results for 100-year, 24-hour estimates as a histogram representing the distribution of differences in 100-year 24-hour estimates with and without each station. For more than 86% of stations in the project area, differences were less than ±10%. Errors of more than ±20% occurred at several hourly stations scattered throughout the state. Given the vastness of the project area and the limited number of stations with relatively short periods of record, overall, the spatial interpolation technique adequately reproduced values. However, similar to the MAM interpolation, given that cross-validation errors could be calculated only at stations, true interpolation errors in many parts of the state may be even higher.

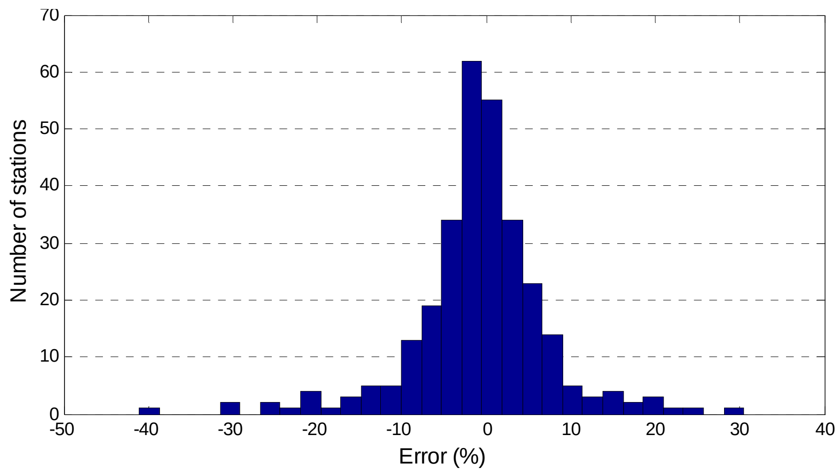


Figure 4.8.3. NOAA Atlas 14 Volume 7 jackknife cross-validation results for 100-year 24-hour estimates.

Estimates for sub-hourly durations. Precipitation frequency grids for sub-hourly durations were derived by multiplying the 60-minute precipitation frequency grids by corresponding scaling factors (see Table 4.6.1).

Confidence limits. Grids of upper and lower limits of the 90% confidence interval for the precipitation frequency estimates were derived using same procedures that were used to create grids of precipitation frequency estimates.

5. Precipitation Frequency Data Server

5.1. Introduction

NOAA Atlas 14 precipitation frequency estimates are delivered entirely in digital form in order to make the estimates more widely available and to provide them in various formats. The Precipitation Frequency Data Server (PFDS; http://hdsc.nws.noaa.gov/hdsc/pfds/) is a point-and-click interface developed as the primary web portal for precipitation frequency estimates and associated information.

5.2. Underlying data

The PFDS operates from a set of ASCII grids of precipitation frequency estimates and lower and upper bounds of the 90% confidence interval. The grids can be downloaded from the website and imported into a Geographical Information System (GIS). Table 5.2.1 shows the complete set of average recurrence intervals and durations for which PDS-based frequency estimates with 95% confidence limits are available from the PFDS for any location in the project area. Similarly, Table 5.2.2 shows the complete set of annual exceedance probabilities and durations for which AMS-based frequency estimates with confidence limits are available from the PFDS for any particular location.

The ASCII grids, which represent the official estimates, have the following pertinent metadata:

- Resolution: 30 arc-seconds (on average around 928 x 928 meters or 3,045 by 3,045 feet);
- Units: inches*1000 (integer);
- Projection: geographic (longitude/latitude);
- Datum: NAD 83.

Table 5.2.1. Average recurrence intervals and durations for which PDS-based precipitation frequency estimates with 90% confidence intervals are available from the PFDS.

Duration	**Average recurrence interval (ARI)**									
	1-yr	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**200-yr**	**500-yr**	**1,000-yr**
5-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
15-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
30-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
60-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
24-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
20-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
30-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
45-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
60-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5.2.2. Annual exceedance probabilities and durations for which AMS-based precipitation frequency estimates with 90% confidence intervals are available from the PFDS.

Duration	**Annual exceedance probability (AEP)**								
	1/2	**1/5**	**1/10**	**1/25**	**1/50**	**1/100**	**1/200**	**1/500**	**1/1000**
5-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
15-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
30-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
60-minute	✓	✓	✓	✓	✓	✓	✓	✓	✓
2-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
3-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
6-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
12-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
24-hour	✓	✓	✓	✓	✓	✓	✓	✓	✓
2-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
3-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
4-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
7-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
20-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
30-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
45-day	✓	✓	✓	✓	✓	✓	✓	✓	✓
60-day	✓	✓	✓	✓	✓	✓	✓	✓	✓

5.3. Products available on the Precipitation Frequency Data Server

The PFDS homepage (http://hdsc.nws.noaa.gov/hdsc/pfds/) has a clickable map of the United States. Upon clicking on Alaska or selecting the state name from the drop-down menu, an interactive map of Alaska and its surrounding area is displayed (see Figure 5.3.1). A location for which precipitation frequency estimates are needed can be selected by:

- Manually entering latitude and longitude coordinates in decimal degrees (negative numbers should be entered for southern hemisphere latitudes and for western hemisphere longitudes);
- Selecting a station from a pull-down list;
- Dragging the red cursor to a location on the map;
- Double clicking anywhere on the map;
- Clicking on an observing station on the map (after selecting "show stations on map" and zooming in).

From the menu at the top of the page, a user can select PDS-based or AMS-based precipitation frequency estimates, units and whether estimates should be displayed as precipitation depths or intensities.

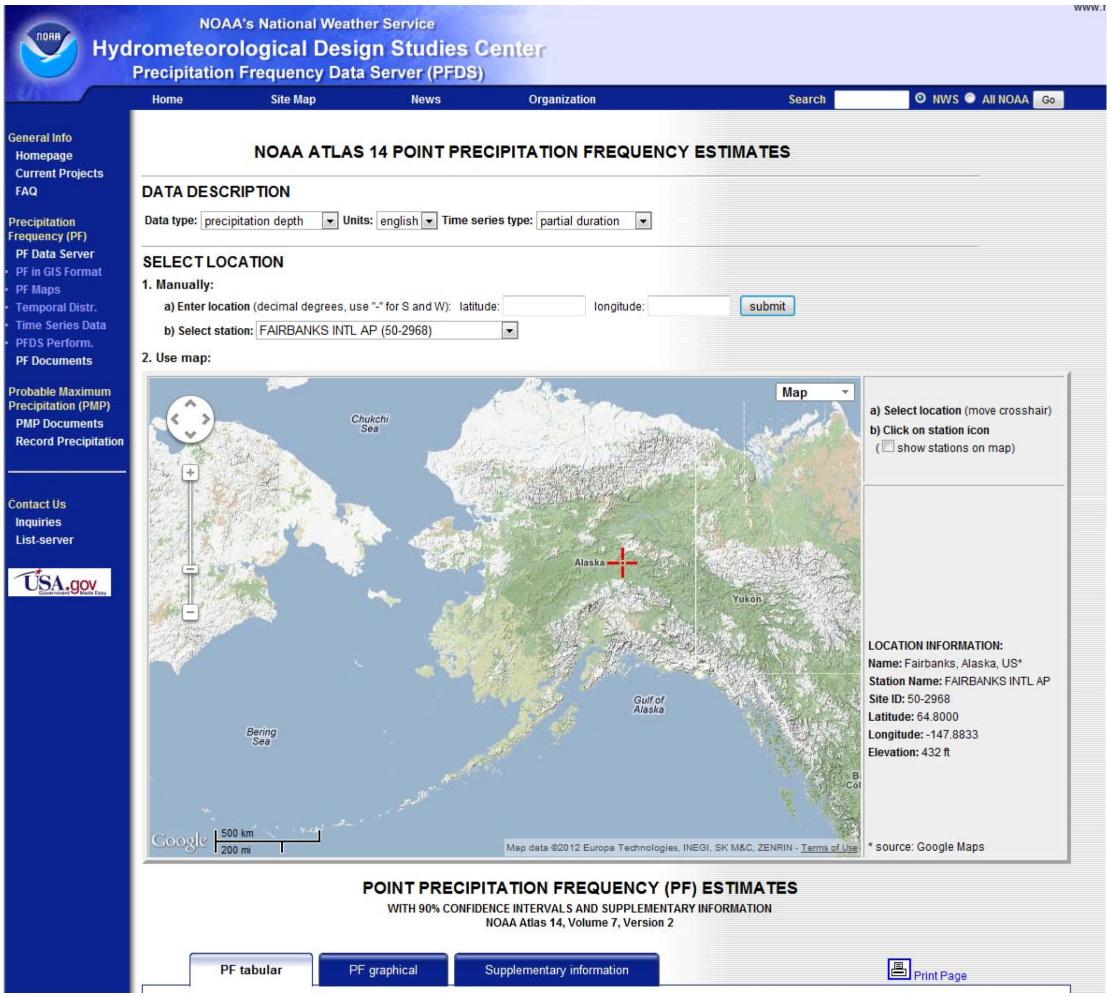


Figure 5.3.1. Initial view of the interactive map of Alaska.

After a location is selected, all precipitation frequency and confidence limit estimates from the underlying grids are extracted and the output is displayed directly below the map in three separate tabs: 'PF tabular', 'PF graphical' and 'Supplementary information'. A printer-friendly version of the precipitation frequency estimates with some supplementary information can be obtained by selecting the "Print Page" icon above the output display (see Figure 5.3.2). The printed page will include metadata information about the selected point in the header, tabular and graphical representations of the estimates, and maps of the location.

The 'PF tabular' tab provides data tables of the precipitation frequency depths (or intensities) showing also the lower and upper bounds of the 90% confidence interval. These data can be downloaded as comma-separated values (csv format) from a selection beneath the tables (see Figure 5.3.2).

PF tabular | PF graphical | Supplementary information | Print Page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.093 (0.068-0.130)	0.123 (0.089-0.174)	0.174 (0.123-0.251)	0.216 (0.151-0.316)	0.274 (0.188-0.408)	0.319 (0.215-0.483)	0.364 (0.242-0.559)	0.430 (0.281-0.670)	0.518 (0.333-0.823)	0.584 (0.370-0.942)
10-min	0.125 (0.091-0.175)	0.165 (0.119-0.233)	0.234 (0.166-0.337)	0.290 (0.203-0.424)	0.368 (0.252-0.549)	0.428 (0.289-0.648)	0.488 (0.324-0.750)	0.578 (0.378-0.901)	0.695 (0.446-1.11)	0.784 (0.496-1.26)
15-min	0.146 (0.107-0.204)	0.194 (0.140-0.274)	0.273 (0.194-0.393)	0.340 (0.237-0.497)	0.431 (0.295-0.642)	0.501 (0.338-0.758)	0.571 (0.379-0.877)	0.676 (0.442-1.05)	0.813 (0.522-1.29)	0.918 (0.581-1.48)
30-min	0.194 (0.142-0.271)	0.257 (0.186-0.363)	0.363 (0.257-0.523)	0.451 (0.315-0.659)	0.572 (0.392-0.853)	0.665 (0.448-1.01)	0.758 (0.504-1.16)	0.897 (0.587-1.40)	1.08 (0.693-1.72)	1.22 (0.771-1.96)
60-min	0.266 (0.194-0.372)	0.352 (0.254-0.498)	0.497 (0.352-0.716)	0.618 (0.432-0.903)	0.783 (0.536-1.17)	0.911 (0.614-1.38)	1.04 (0.690-1.60)	1.23 (0.804-1.92)	1.48 (0.949-2.35)	1.67 (1.06-2.69)
2-hr	0.327 (0.239-0.457)	0.433 (0.313-0.612)	0.612 (0.434-0.881)	0.762 (0.532-1.11)	0.966 (0.661-1.44)	1.12 (0.757-1.70)	1.28 (0.849-1.96)	1.51 (0.989-2.36)	1.82 (1.17-2.89)	2.05 (1.30-3.31)
3-hr	0.363 (0.265-0.507)	0.480 (0.346-0.679)	0.680 (0.482-0.979)	0.846 (0.591-1.24)	1.07 (0.735-1.60)	1.25 (0.840-1.89)	1.42 (0.942-2.18)	1.68 (1.10-2.62)	2.02 (1.30-3.21)	2.28 (1.44-3.67)
6-hr	0.481 (0.351-0.672)	0.638 (0.461-0.902)	0.900 (0.638-1.30)	1.12 (0.781-1.63)	1.42 (0.971-2.11)	1.65 (1.11-2.50)	1.88 (1.25-2.89)	2.23 (1.46-3.47)	2.68 (1.72-4.26)	3.02 (1.91-4.88)
12-hr	0.634 (0.463-0.886)	0.841 (0.607-1.19)	1.17 (0.828-1.68)	1.44 (1.01-2.11)	1.84 (1.26-2.74)	2.15 (1.45-3.26)	2.49 (1.65-3.82)	2.94 (1.93-4.59)	3.55 (2.28-5.64)	4.00 (2.53-6.45)
24-hr	0.824 (0.748-0.918)	1.09 (0.978-1.23)	1.49 (1.31-1.72)	1.83 (1.58-2.14)	2.33 (1.96-2.79)	2.76 (2.28-3.37)	3.22 (2.62-4.00)	3.81 (3.05-4.82)	4.59 (3.59-5.93)	5.18 (3.99-6.81)
2-day	0.995 (0.903-1.11)	1.31 (1.18-1.48)	1.78 (1.56-2.05)	2.17 (1.87-2.55)	2.75 (2.32-3.30)	3.25 (2.69-3.97)	3.79 (3.08-4.70)	4.46 (3.56-5.63)	5.34 (4.17-6.90)	6.01 (4.62-7.89)
3-day	1.10 (0.999-1.23)	1.45 (1.30-1.63)	1.96 (1.72-2.26)	2.39 (2.06-2.80)	3.02 (2.54-3.62)	3.55 (2.93-4.33)	4.12 (3.35-5.12)	4.83 (3.86-6.11)	5.77 (4.51-7.46)	6.48 (4.99-8.52)
4-day	1.19 (1.08-1.32)	1.55 (1.39-1.75)	2.09 (1.84-2.41)	2.54 (2.19-2.98)	3.21 (2.70-3.85)	3.76 (3.11-4.59)	4.37 (3.55-5.43)	5.11 (4.09-6.46)	6.09 (4.77-7.87)	6.84 (5.26-8.98)
7-day	1.42 (1.29-1.58)	1.82 (1.63-2.05)	2.41 (2.12-2.78)	2.91 (2.51-3.41)	3.65 (3.07-4.38)	4.27 (3.53-5.22)	4.95 (4.03-6.15)	5.80 (4.64-7.34)	6.93 (5.42-8.95)	7.78 (5.98-10.2)
10-day	1.61 (1.46-1.79)	2.03 (1.82-2.29)	2.66 (2.33-3.06)	3.19 (2.75-3.74)	3.98 (3.35-4.77)	4.64 (3.84-5.67)	5.37 (4.37-6.67)	6.29 (5.02-7.94)	7.49 (5.86-9.68)	8.41 (6.47-11.0)
20-day	2.20 (2.00-2.45)	2.73 (2.44-3.08)	3.49 (3.06-4.03)	4.13 (3.56-4.84)	5.06 (4.26-6.07)	5.83 (4.83-7.12)	6.67 (5.42-8.28)	7.65 (6.11-9.66)	8.94 (6.99-11.5)	9.91 (7.62-13.0)
30-day	2.76 (2.50-3.07)	3.39 (3.04-3.83)	4.29 (3.76-4.94)	5.03 (4.33-5.89)	6.08 (5.12-7.29)	6.95 (5.75-8.48)	7.87 (6.40-9.78)	8.88 (7.10-11.2)	10.2 (7.98-13.2)	11.2 (8.62-14.7)
45-day	3.50 (3.18-3.90)	4.29 (3.84-4.84)	5.38 (4.72-6.20)	6.24 (5.37-7.31)	7.42 (6.25-8.91)	8.37 (6.92-10.2)	9.35 (7.60-11.6)	10.3 (8.26-13.1)	11.6 (9.10-15.0)	12.6 (9.70-16.6)
60-day	4.07 (3.69-4.53)	5.03 (4.51-5.68)	6.29 (5.52-7.25)	7.22 (6.23-8.47)	8.44 (7.11-10.1)	9.35 (7.74-11.4)	10.2 (8.33-12.7)	11.1 (8.89-14.0)	12.3 (9.59-15.9)	13.1 (10.1-17.3)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

CSV Estimates from the table in csv format: precipitation frequency estimates | Submit

Main Link Categories:
Home | OHD

Figure 5.3.2. Precipitation frequency data for a selected location in tabular format.

The 'PF graphical' tab has two sub-tabs. The first, 'Curves', shows two basic types of output based on the user's selection of data type: depth-duration-frequency (DDF) or intensity-duration-frequency (IDF) graphs. The PFDS provides DDF and IDF graphs in two different formats: with duration and with frequency on x-axis. An example of the DDF graph in both formats is given in Figure 5.3.3; an example of the IDF graph with duration on x-axis is shown in Figure 5.3.4. Both, DDF and IDF graphs can be built from either AMS or PDS data, depending on the user's selection of time series type. The second sub-tab, 'PF estimates with confidence intervals' shows plots of the precipitation magnitude-frequency curve with upper and lower confidence limits for a selected duration (see example in Figure 5.3.5).

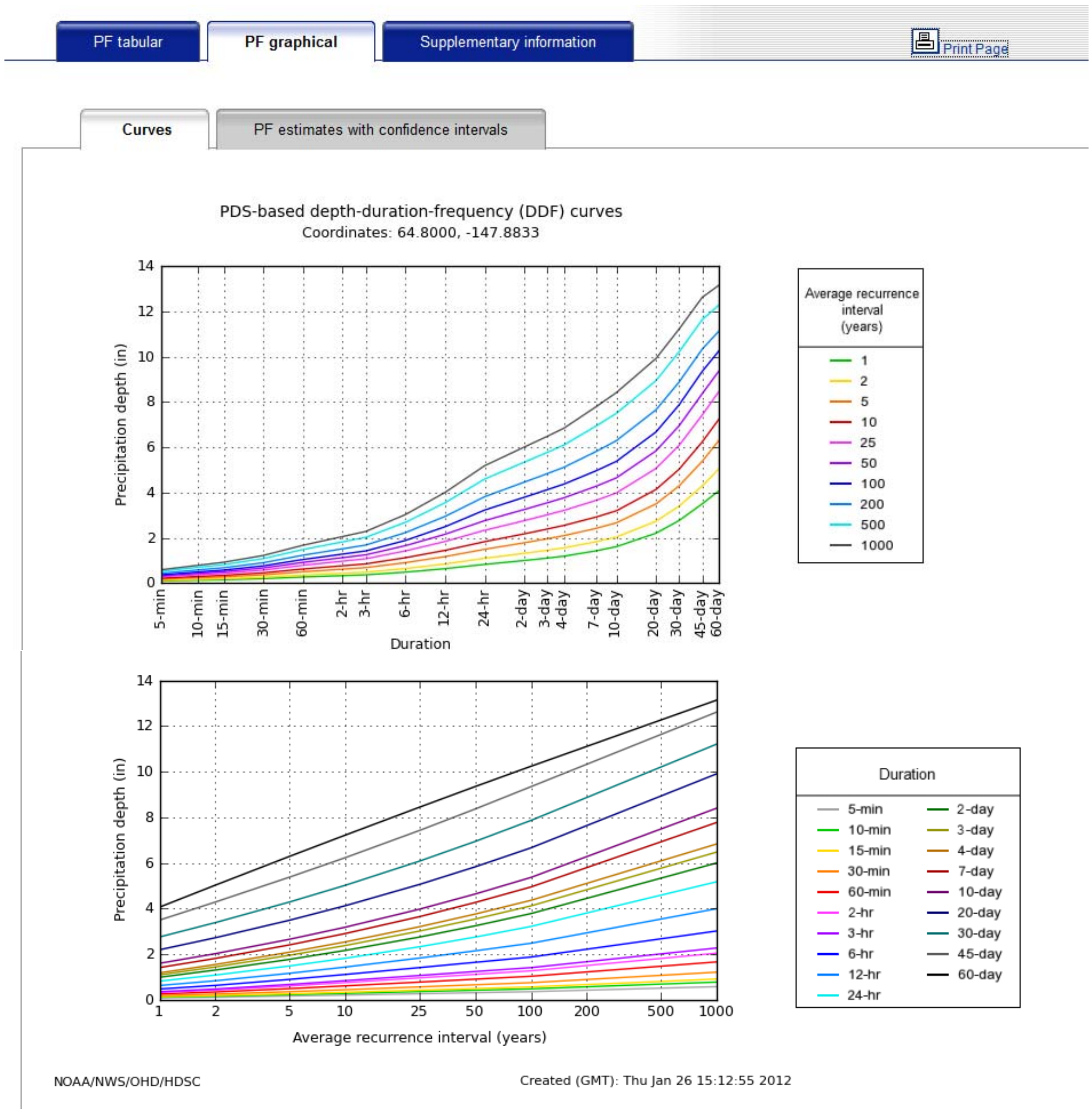


Figure 5.3.3. Sample depth-duration-frequency curves built from the PDS data with duration on the x-axis (top figure) and average recurrence interval on the x-axis (bottom figure).

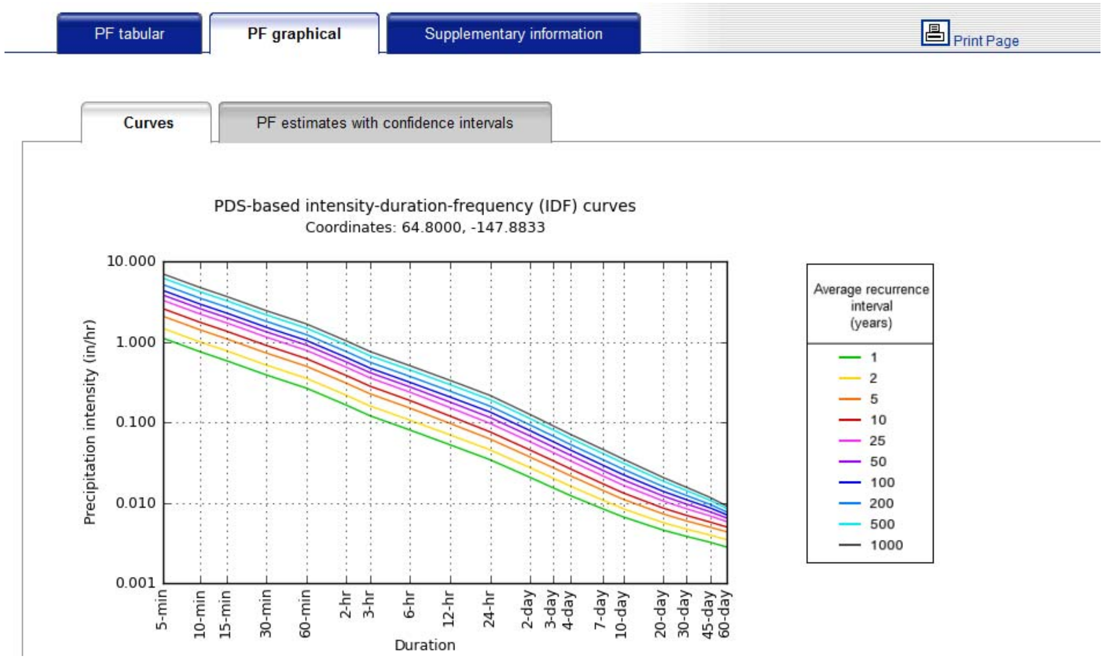


Figure 5.3.4. Sample intensity-duration-frequency (IDF) graph with duration on the x-axis.

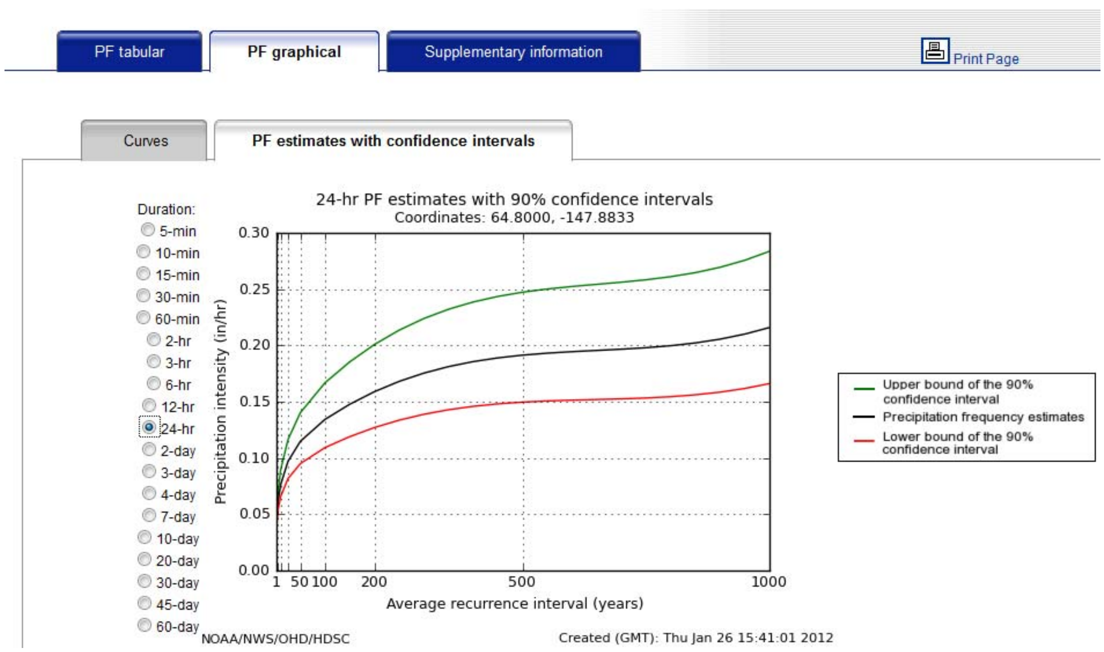


Figure 5.3.5. Sample of a magnitude-frequency plot with the upper and lower bounds of the 90% confidence interval for 24-hour duration.

Lastly, the 'Supplementary information' tab provides links to additional data and information for that location:

- **NOAA Atlas 14 Volume 7 document.**
- **Precipitation frequency grids in GIS compatible formats.** Grids are available for AMS- and PDS-based estimates for all combinations of durations and average recurrence intervals or annual exceedance probabilities, respectively (as shown in Tables 5.2.1 and 5.2.2). Users are advised to review the Federal Geographic Data Committee (FGDC) compliant metadata before using any of the GIS datasets (http://hdsc.nws.noaa.gov/hdsc/pfds/meta/na14_vol7_ak_grid_metadata.xml).
- **Cartographic maps of precipitation frequency estimates.** Cartographic maps show contour lines created from gridded PDS-based precipitation frequency estimates for selected durations and average recurrence intervals. Figure 5.3.6 shows an excerpt from a cartographic map. Maps were created to serve as visual aids and are not recommended for interpolating precipitation frequency estimates. Users are advised to retrieve point precipitation frequency values from the PFDS interface which accesses the gridded data directly.

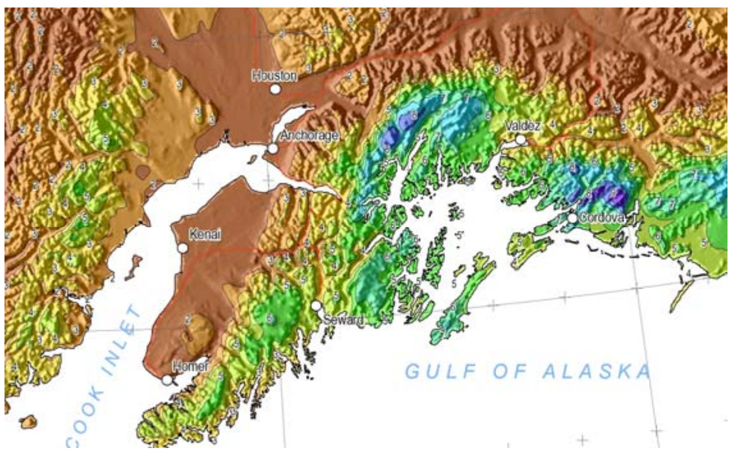


Figure 5.3.6. An excerpt of a cartographic map for 2-year ARI and 24-hour duration.

- **Temporal distributions.** Temporal distributions of precipitation amounts exceeding precipitation frequency estimates for the 2-year recurrence interval are provided for 6-hour, 12-hour, 24-hour, and 96-hour durations for delineated climate regions. The temporal distributions for the duration are expressed in probability terms as cumulative percentages of precipitation totals. To provide detailed information on the varying temporal distributions, separate temporal distributions were derived for four precipitation cases defined by the duration quartile in which the greatest percentage of the total precipitation occurred. Figure 5.3.7 shows as an example the regional temporal distribution curves of all precipitation cases for the 6-hour and 24-hour durations. See Appendix A.7 for more information.
- **Seasonality analysis.** The seasonality graphs (an example is shown in Figure 5.3.8) show the percentage of annual maxima for a given duration that exceeded the NOAA Atlas 14 precipitation frequency estimates for the duration and selected annual exceedance probabilities in each month for various climate regions. Results are provided for the 60-minute, 24-hour, 2-day, and 10-day durations and for annual exceedance probabilities of 1/2, 1/5, 1/10, 1/25, 1/50, and 1/100. Seasonality graphs are not intended to be used to derive seasonal precipitation frequency estimates. See Appendix A.8 for more information.

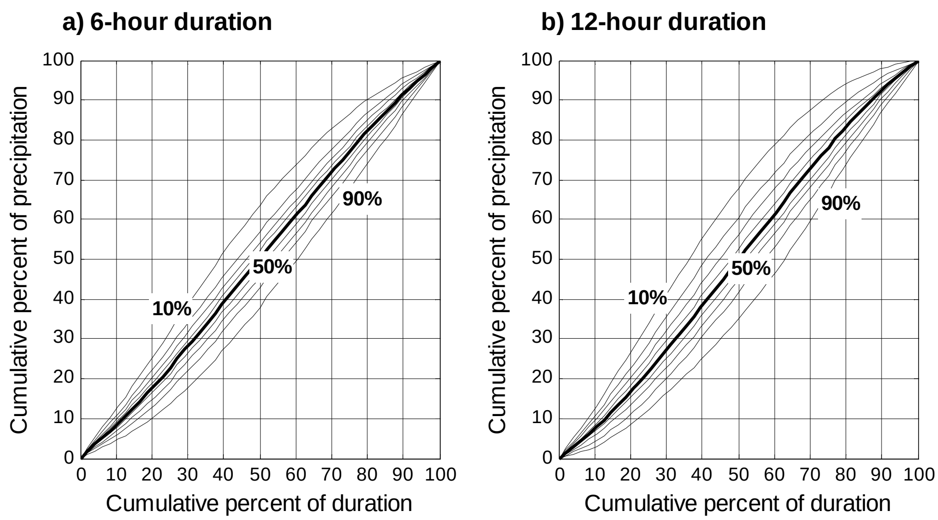


Figure 5.3.7. Sample temporal distribution curves for 6-hour (left panel) and 12-hour (right panel).

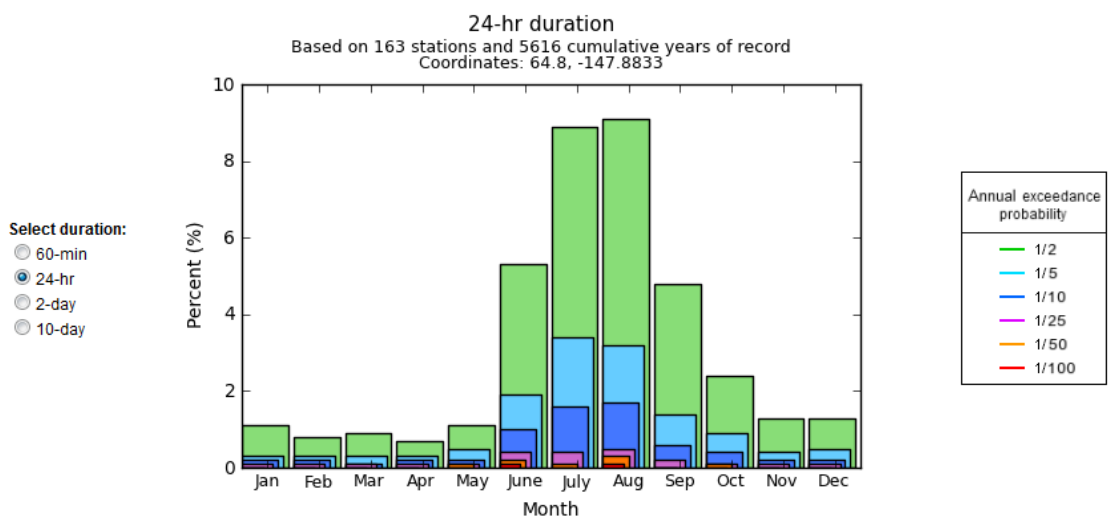


Figure 5.3.8. Sample 24-hour seasonal exceedance graph.

- **Rainfall frequency estimates.** Given that there were very few high-altitude stations and that the analysis of available stations showed only minor differences between rainfall and precipitation frequency estimates, it was decided not to provide separate rainfall frequency estimates in NOAA Atlas 14 Volume 7. See Section 4.7 for more information.
- **Time series data.** Annual maximum series precipitation data used in frequency analysis is available for gauged locations.
- **Information on nearby climate stations** (via NCDC).
- **Watershed information** (via the Environmental Protection Agency).

Some of the NOAA Atlas 14 data products can also be accessed through the left menu bar on the PFDS web page, including:

- ASCII grids of precipitation frequency estimates,
- cartographic maps,
- temporal distributions,
- annual maximum series datasets,
- associated documentation.

Answers to frequently asked questions (FAQ) are available via links on the PFDS web site. Inquiries regarding the use of the PFDS or its data can be addressed by emailing HDSC.Questions@noaa.gov.

6. Peer review

A peer review of the Alaska precipitation frequency project's preliminary results was carried out during a four week period starting on August 2, 2011. The request for review was sent via email to the members of the HDSC list-server from all over the United States and other interested parties in Alaska. Potential reviewers were asked to evaluate the reasonableness of point precipitation frequency estimates as well as their spatial patterns. The review included the following items:

a. List of all stations used in the analysis. The list included information on station name, state, source of data, assigned station identification number, latitude, longitude, elevation, and period of record. It also showed information if the station was merged with another station, if the station was co-located with another station with a different ID, and if metadata at the station were changed.
b. List of all stations that were received, but not considered in analysis. This list contained stations that were not used, either because there was another station with a longer period of record nearby, station data were not reliable, or the station period of record was not long enough and it was not a candidate for merging with any nearby station.
c. Spatially-interpolated mean annual maxima for 60-minute, 24-hour and 10-day durations.
d. Spatially-interpolated precipitation frequency estimates for 60-minute, 24-hour and 10-day durations and for 2-year and 100-year average recurrence intervals.
e. At-station depth-duration-frequency curves for 60-minute to 10-day durations and for 2-year to 100-year average recurrence intervals (ARI).

The reviews provided critical feedback that improved estimates. Reviewers' comments regarding station metadata, at-station precipitation frequency estimates and their spatial patterns, and supplemental information along with HDSC responses can be found in Appendix A.6.

7. Comparison with previous NOAA publications

The precipitation frequency estimates in NOAA Atlas 14 Volume 7 supersede the estimates for Alaska previously published in the following publications:

a. *Technical Paper No. 47, Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska for Areas to 400 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years* (Miller, 1963);
b. *Technical Paper No. 52, Two-to-Ten-Day Precipitation for Return Periods of 2 to 100 Years in Alaska* (Miller, 1965).

Precipitation frequency estimates at the 100-year average recurrence interval from NOAA Atlas 14 Volume 7 were examined in relation to corresponding estimates from Technical Paper No. 47 (TP47) for 60-minute and 24-hour durations. Corresponding TP47 paper maps (Figures 3-24 and 3-53, respectively) were geo-referenced. Isopluvial contours were digitized and converted to gridded format using standard spatial interpolation tools available in ArcGIS for the comparison.

The maps in Figures 7.1 and 7.2 illustrate the differences between new and old estimates. On average, 60-minute precipitation frequency estimates increased by 0.21 inches; at specific locations estimates changed between -0.72 and 1.26 inches. Differences in 100-year 24-hour precipitation frequency estimates ranged between -9.27 and 11.17 inches, but on average estimates changed very little (decreased by 0.18 inches).

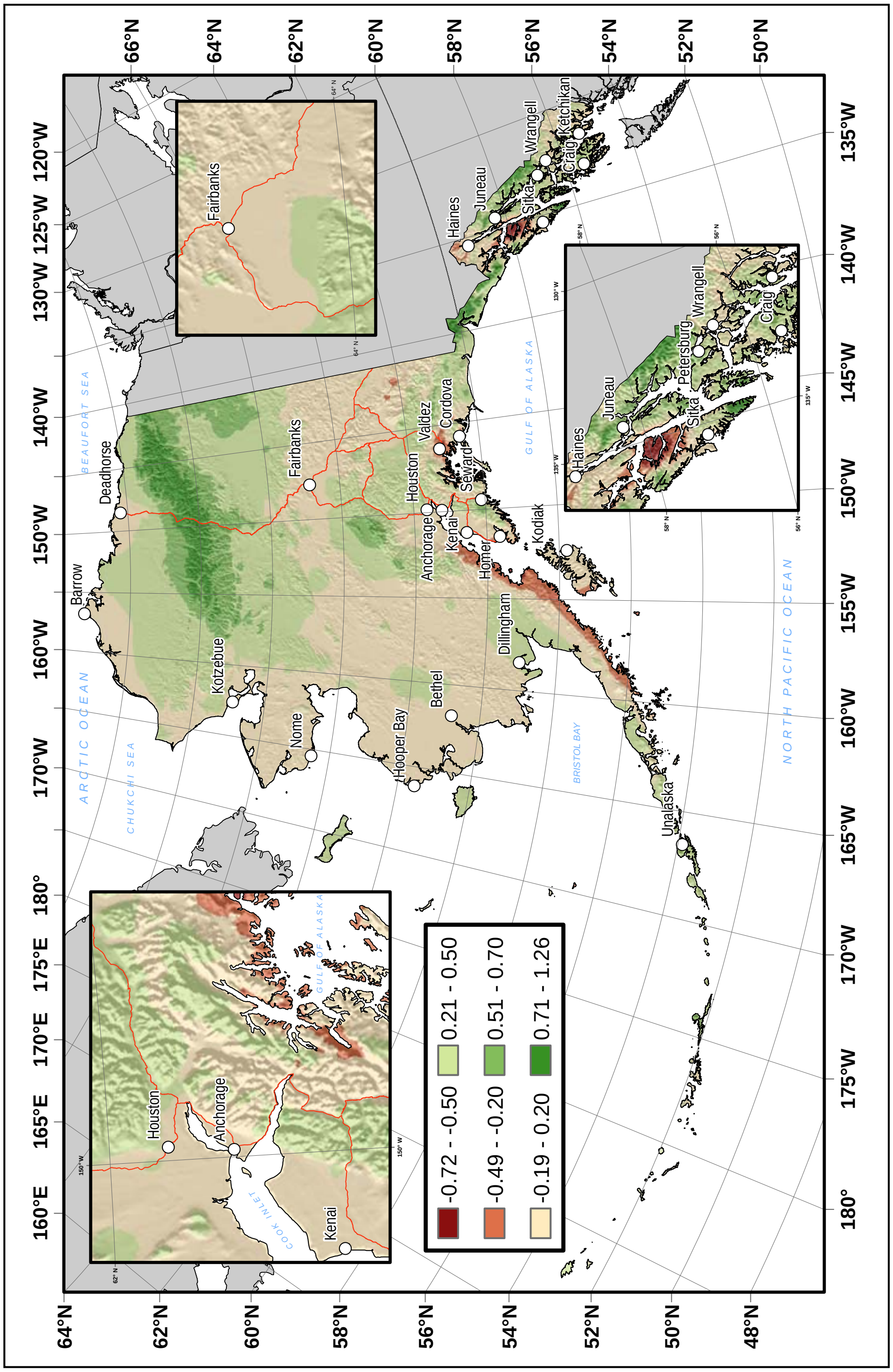


Figure 7.1. Differences in 100-year 60-minute estimates (in inches) between NOAA Atlas 14 and TP47.

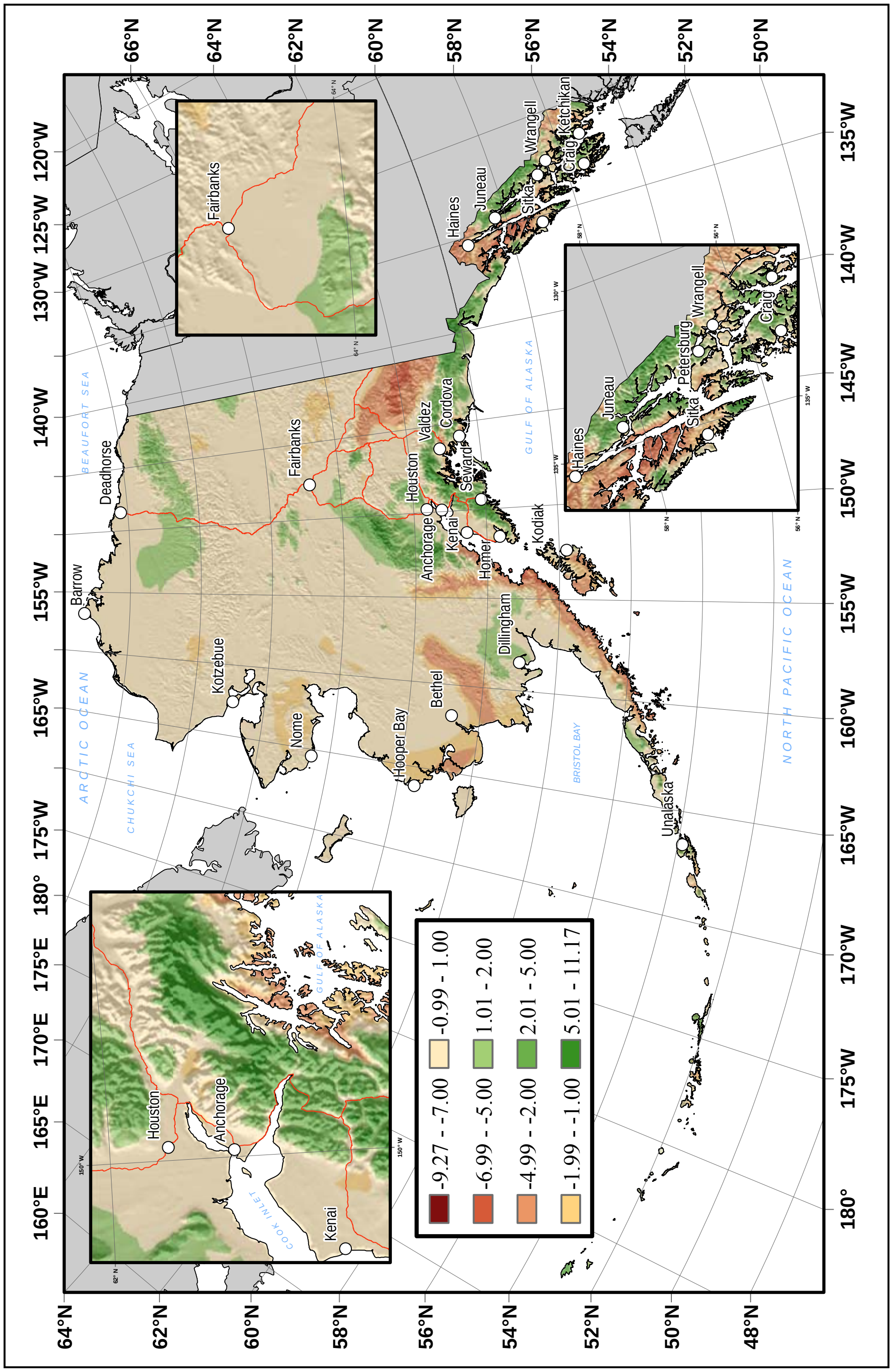


Figure 7.2. Differences in 100-year 24-hour estimates (in inches) between NOAA Atlas 14 and TP47.

The differences in estimates between the two publications are attributed to a number of factors, including errors in digitizing and converting contours to grids for TP47 estimates, improved frequency analysis approaches and interpolation techniques used in NOAA Atlas 14 (see Section 4), and above all, to the increase in the number of stations and periods of record across all durations used in frequency analysis.

Technical Paper No. 47 was published in 1963, so potentially about 50 additional data years were available at stations used in TP47 for the NOAA Atlas 14 analyses. For the 24-hour duration, a total of 211 stations with an average period of record of 18 years (ranging from 1 to 54 years) were used for frequency analysis in TP47, while in NOAA Atlas 14 Volume 7 a total of 396 stations with an average of 32 data years per station (9 to 103 years) were used. Figure 7.3 shows record lengths for daily stations used in each publication.

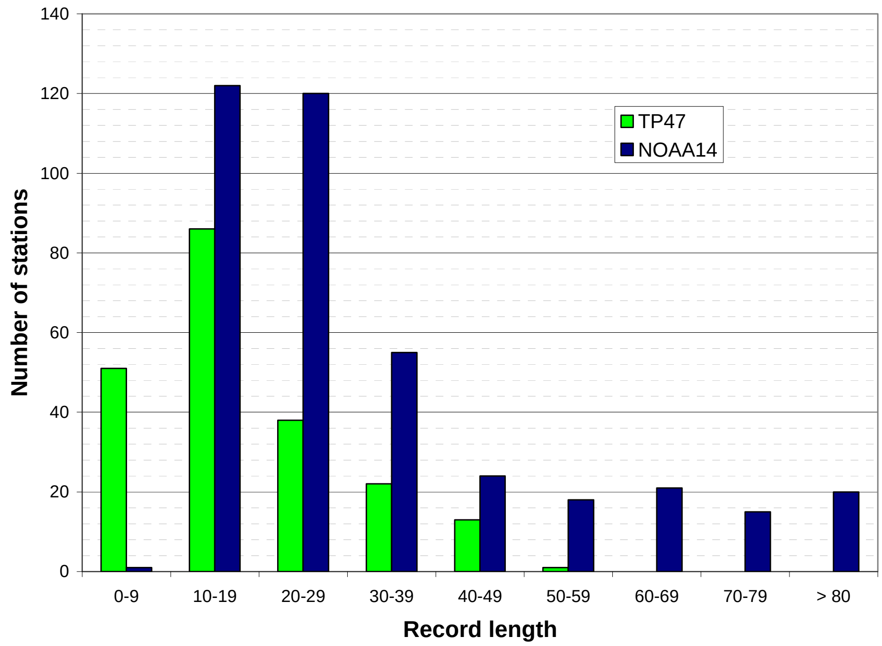


Figure 7.3. Number of daily stations used for precipitation frequency analysis versus record length shown as years of record for TP47 and data years for NOAA Atlas 14 Volume 7 (data years may be shorter than years of record due to missing data at stations).

Also, since 1963, stations have been added at higher elevations (Table 7.1). This is crucial since more than 50 percent of the land in Alaska lies at an elevation that is higher than 1,000 feet and about 20% of the land is above 3,000 feet.

Table 7.1. Number of daily stations used for precipitation frequency analysis for TP47 and NOAA Atlas 14 Volume 7 grouped by elevation.

Number of daily stations	**TP47**	**NOAA Atlas 14**
Total used in analysis	211	396
Above 1,000 ft	26	134
Above 3,000 ft	0	10

The difference in available data between the two studies is even more pronounced for hourly durations. In TP47, only 9 stations were available, with an average record length of less than 10 years (ranging from 1 to 20 years). For NOAA Atlas 14, 121 stations with an average of 18 years (rainging from 10 to 49 data years) were available. Figure 7.4 shows record lengths for hourly stations used in each publication. The maximum elevation of hourly stations in TP47 was 500 feet, while in NOAA Atlas 14 hourly stations were found as high as 3,000 feet.

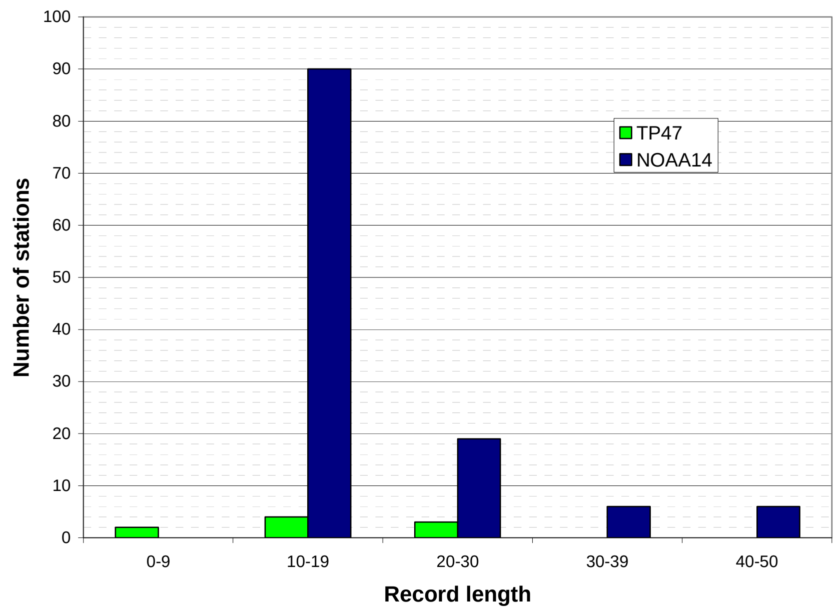


Figure 7.4. Number of hourly stations used for precipitation frequency analysis for TP47 (years of record) and NOAA Atlas 14 Volume 7 (data years).

Acknowledgments

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We acknowledge Martha Shulski, formerly with the Alaska Climate Research Center, who provided advice on where to get precipitation data for this project and the many colleagues who provided additional data beyond what was available from the NOAA’s National Climatic Data Center, including: Giselle Bramwell from the Meteorological Services of Canada, Environment Canada; Jessica Cherry and Jason Downing from the University of Alaska, Fairbanks; Daryl Herzmann of Iowa Environmental Mesonet, Iowa State University; Jim Laundre of the Marine Biological Laboratory, Woods Hole, Massachusetts; Nancy Westcott of the Midwestern Region Climate Center; and Jack Stickel from the Alaska Department of Transportation and Public Facilities.

Lastly, we acknowledge colleagues who provided feedback to improve the final product, including: Robin Beebee of HDR Alaska, Inc.; Crane Johnson of U.S. Army Corps of Engineers, Alaska District; Nicole L Shorney of U.S. Army Corps of Engineers, Omaha District; and Rick Thoman, NWS Weather Forecast Office, Fairbanks.

Appendix A.1 List of stations used to prepare precipitation frequency estimates

Table A.1.1. List of stations in the state of Alaska used in the analysis showing station name, station ID, post-merge station ID, co-located daily station ID, base duration, source of data, latitude, longitude, elevation, and period of record. Bold font in the latitude, longitude, and elevation fields indicates information that has been adjusted. Bold font in the 'Period of record' field indicates that the station data was extended using data from station that has the same ID in 'Post-merge station ID' column. Three 15-minute stations were not used directly in the analysis, but were used to extend records at hourly stations identified in the 'Post-merge station ID' column. For an hourly station co-located with a daily station with a different ID, the daily station's ID shown in the 'Co-located station ID' column should be used to locate the hourly station on the PFDS web page.

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
ADAK NAS	50-0026			1-day	NCDC	51.8833	-176.6500	17	10/1942-3/1996
ALASKA PACIFIC UNIV	50-0172	50-1220		1-day	NCDC	61.1833	-149.8000	220	7/1993-10/2004
ALCAN HWY	80-0100			1-hour	RAWS	62.8167	-141.4667	1800	6/1990-12/2010
ALLAKAKET	50-0230			1-day	NCDC	66.5667	-152.6500	400	7/1907-5/1998
ALPINE INN	50-0238	50-8915		1-day	NCDC	61.7167	-148.9000	459	10/1963-12/1971
ALYESKA	50-0243			1-day	NCDC	60.9667	-149.1167	272	11/1963-7/2010
AMBLER	50-0249			1-day	NCDC	67.0833	-157.8500	120	**12/1981-5/2011**
AMBLER WEST	50-0260	50-0249		1-day	NCDC	67.0833	-157.8667	120	12/1981-3/1992
ANCHORAGE 4 ESE	50-0288	50-0172		1-day	NCDC	61.2000	-149.7833	180	3/1957-10/1962
ANCHORAGE ELMENDORF AFB	50-2820			1-day	NCDC	61.2500	-149.8000	192	**2/1916-9/1997**
ANCHORAGE INTL AP	50-0280			1-day	NCDC	61.2000	-150.0000	132	4/1952-8/2010
ANCHORAGE INTL AP	50-0280			1-hour	NCDC	61.1689	-150.0277	132	10/1962-4/2010
ANCHORAGE MERRILL FLD	50-0285	50-2820		1-day	NCDC	61.2167	-149.8500	138	2/1916-10/1953
ANDERSON	50-0299	50-2005		1-day	NCDC	64.3500	-149.2000	510	7/1997-11/2001
ANGEL CREEK	80-0120			1-hour	RAWS	65.0200	-146.2281	1100	7/1999-12/2010
ANGOON	50-0310			1-day	NCDC	57.5000	-134.5833	10	**1/1882-7/2010**
ANIAK AP	50-0332			1-day	NCDC	61.5833	-159.5333	86	8/1920-3/1990
ANNETTE ISLAND AP	50-0352			1-day	NCDC	55.0500	-131.5667	109	**1/1893-8/2010**
ANNETTE WSO AP	50-0352			1-hour	NCDC	55.0389	-131.5786	109	9/1949-4/2010
ANNEX CREEK	50-0363			1-day	NCDC	58.3167	-134.1000	92	1/1917-7/2010
ATIGUN PASS	10-0957			1-day	SNOTEL	68.1304	-149.4781	4800	10/1981-9/2010
ATKA	50-0433			1-day	NCDC	**52.2171**	**-174.2076**	39	1/1882-10/1949
ATTU	50-0452			1-day	NCDC	52.8333	**-173.1833**	70	7/1917-8/1993
AUKE BAY	50-0464			1-day	NCDC	58.3833	-134.6500	42	2/1963-7/2010

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
BARANOF	50-0522			1-day	NCDC	**57.0816**	**-134.8330**	20	11/1936-3/1966
BARROW POST ROGERS AP	50-0546			1-day	NCDC	71.2833	-156.7667	31	9/1901-8/2010
BARTER ISLAND WSO AP	50-0558			1-day	NCDC	**70.1350**	**-143.5935**	39	5/1948-12/1988
BEAR MTN	80-0140			1-hour	RAWS	66.0594	-142.7694	1925	8/1990-7/2003
BEAVER	80-0160			1-hour	RAWS	66.2667	-146.5167	483	5/1990-12/2010
BEAVER FALLS	50-0657			1-day	NCDC	55.3833	-131.4667	35	5/1948-7/2010
BELL ISLAND	50-0676			1-day	NCDC	**55.9195**	**-131.5672**	10	10/1929-11/1952
BELUGA	50-0685			1-day	NCDC	61.1833	-151.0333	75	8/1973-6/1992
BEN CREEK	80-0200			1-hour	RAWS	**65.2872**	**-143.1060**	**1875**	5/1990-12/2010
BENS FARM	50-0707			1-day	NCDC	61.5667	-149.1333	150	5/1969-5/2002
BERING GLACIER	80-0220			1-hour	RAWS	60.1186	-143.2833	75	4/1998-12/2010
BETHEL AP	50-0754			1-day	NCDC	60.7833	-161.8333	102	8/1923-8/2010
BETHEL AP	50-0754			1-hour	NCDC	60.7850	-161.8291	102	**7/1950-5/2011**
BETTLES AP	50-0761			1-day	NCDC	66.9167	-151.5167	642	5/1951-8/2010
BETTY PINGO	40-1510			1-hour	WERC	70.2744	-148.8908	37	**4/1992-1/2010**
BIG DELTA AP	50-0770			1-day	NCDC	64.0000	-145.7167	1268	11/1919-8/2010
BIG LAKE	80-0240			1-hour	RAWS	61.5183	-149.9078	100	4/2000-12/2010
BIG RIVER LAKES	50-0788			1-day	NCDC	60.8167	-152.3000	40	1/1978-7/2010
BIRCH CREEK	80-0260			1-hour	RAWS	65.5847	-144.3636	850	7/1998-12/2010
BIRCH ROAD	50-0824	50-8025		1-day	NCDC	61.1333	-149.7667	459	10/1965-6/1972
BONANZA CREEK	10-0208			1-day	SNOTEL	64.7500	-148.3000	1150	**5/1989-9/2009**
BOOTH LAKE	80-0340			1-hour	RAWS	57.2678	-154.5650	171	7/1995-12/2010
BOUNDARY	50-0910			1-day	NCDC	64.0667	-141.1167	2601	10/1947-10/1957
CALDER	50-1201			1-day	NCDC	56.1667	-132.4500	20	4/1908-4/1932
CAMPBELL CREEK SCI CTR	50-1220			1-day	NCDC	61.1667	-149.7833	258	**3/1957-7/2010**
CANDLE	50-1230			1-day	NCDC	65.9333	-161.9167	23	1/1908-10/1950
CANNERY CREEK	50-1240			1-day	NCDC	61.0167	-147.5167	45	5/1979-7/2010
CANTWELL 2 E	50-1243			1-day	NCDC	63.4000	-148.9000	2149	11/1983-7/2009
CANYON ISLAND	50-1251			1-day	NCDC	58.5500	-133.6833	20	10/1935-3/2006
CAPE DECISION	50-1269			1-day	NCDC	**56.0017**	**-134.1362**	49	11/1940-8/1974
CAPE HINCHINBROOK	50-1308			1-day	NCDC	**60.2386**	**-146.6460**	185	5/1944-8/1974
CAPE LISBURNE	50-1312			1-day	NCDC	**68.8736**	**-166.1003**	45	1/1954-11/1984

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
CAPE NEWENHAM	50-1314			1-day	NCDC	**58.6445**	**-162.0635**	475	9/1953-11/1984
CAPE ROMANZOF	50-1318			1-day	NCDC	61.7667	-166.0500	434	5/1953-2/1985
CAPE SARICHEF	50-1325			1-day	NCDC	**54.5960**	**-164.9240**	177	3/1952-12/1980
CAPE SPENCER	50-1334			1-day	NCDC	**58.1988**	**-136.6402**	89	11/1936-8/1974
CAPE ST ELIAS	50-1321			1-day	NCDC	**59.7984**	**-144.5988**	49	7/1936-7/1974
Caribou Peak	80-0425			1-hour	RAWS	**65.1738**	**-147.4910**	**1564**	6/1990-12/2010
CENTRAL #2	50-1458	50-1466		1-day	NCDC	65.5833	-144.8000	869	5/1905-5/1954
CENTRAL #2	50-1466			1-day	NCDC	65.5667	-144.7667	920	**5/1905-7/2010**
CHALKYITSIK	80-0440			1-hour	RAWS	66.5906	-144.3411	450	6/1997-12/2010
CHANDALAR LAKE	50-1492			1-day	NCDC	67.5167	-148.5000	1895	**6/1963-7/2010**
CHANDALAR LAKE	50-5354	50-1492		1-day	NCDC	67.5000	-148.5000	1899	6/1963-5/1965
CHATANIKA	80-0460			1-hour	RAWS	**65.0191**	**-148.5800**	1450	5/1990-12/2010
CHENA HOT SPRINGS	50-1574			1-day	NCDC	65.0500	-146.0500	1201	8/1962-7/2010
CHICKEN	50-1684			1-day	NCDC	64.1000	-141.9167	1799	5/1911-7/2010
CHICKEN	80-0480		50-1684	1-hour	RAWS	**64.0857**	**-141.8775**	**2859**	9/1998-12/2010
CHINIAK	50-1763			1-day	NCDC	57.6167	-152.3667	157	**8/1928-12/2000**
CHISANA	80-0540			1-hour	RAWS	62.1333	-142.0833	3318	7/1988-12/2010
CHISTOCHIN	80-0560			1-hour	RAWS	**62.5682**	**-144.6538**	**1800**	6/2001-12/2010
CHITINA	50-1824			1-day	NCDC	61.5167	-144.4333	600	**3/1917-12/2010**
CHITNA	80-0600		50-1824	1-hour	RAWS	**61.5153**	**-144.4380**	**594**	10/1998-12/2010
CHULITNA RIVER	50-1926			1-day	NCDC	62.8333	-149.9167	1350	1/1971-7/2010
CIRCLE CITY	50-1977			1-day	NCDC	65.8333	-144.0667	598	7/1900-10/1999
CIRCLE HOT SPRINGS	50-1987			1-day	NCDC	65.4833	-144.6000	935	7/1935-7/2010
CLEAR 4 N	50-2005			1-day	NCDC	64.3500	-149.0500	495	**12/1965-11/2001**
CLEARWATER	50-2019	50-2350		1-day	NCDC	64.0500	-145.5167	1100	10/1964-8/1994
COLD BAY AP	50-2102			1-day	NCDC	55.2167	-162.7333	78	**6/1942-8/2010**
COLDFOOT	50-2104	10-0958		1-day	NCDC	67.2500	-150.1833	1050	9/1993-4/2000
COLDFOOT	10-0958			1-day	SNOTEL	67.2531	-150.1836	1040	**10/1970-9/2010**
COLDFOOT CAMP	50-2103	50-2104		1-day	NCDC	67.2667	-150.2333	1102	10/1970-5/1977
COLLEGE 5 NW	50-2112			1-day	NCDC	64.9333	-147.8833	950	8/1976-7/2010
COLLEGE OBSY	50-2107			1-day	NCDC	64.8667	-147.8333	621	5/1948-7/2010
COLVILLE VILLAGE	50-2126			1-day	NCDC	70.4333	-150.4167	5	12/1996-7/2010

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
COOPER LAKE	10-0959			1-day	SNOTEL	60.3902	-149.6935	1200	10/1981-9/2010
COOPER LAKE PROJECT	50-2144			1-day	NCDC	60.4000	-149.6667	505	7/1959-3/2004
COOPER LANDING KENAI R	50-2147			1-day	NCDC	60.5000	-149.8167	419	**9/1941-12/2010**
COPPER CTR	50-2156			1-day	NCDC	61.9667	-145.3167	1000	7/1902-4/1982
CORDOVA M K SMITH AP	50-2177			1-day	NCDC	60.4833	-145.4500	31	5/1909-8/2010
CORDOVA NORTH	50-2173			1-day	NCDC	**60.5576**	**-145.7528**	25	**9/1899-6/2010**
COTTONWOOD	80-0640			1-hour	RAWS	65.3458	-155.9361	1310	6/1991-9/2010
CRAB BAY	50-2222	50-7738		1-day	NCDC	60.0667	-147.9833	69	1/1975-4/1979
CRAIG	50-2227			1-day	NCDC	55.4833	-133.1500	13	10/1936-7/2010
CROOKED CREEK	50-2247			1-day	NCDC	61.8667	-158.2500	125	7/1911-10/1974
DELTA 5 NE	50-2350			1-day	NCDC	64.0833	-145.6167	1060	**10/1964-7/2010**
DELTA 6N	50-2339			1-day	NCDC	64.1167	-145.7500	1048	8/1996-7/2010
DELTA JUNCTION 20 SE	50-2352			1-day	NCDC	63.9667	-145.1000	1125	11/1980-7/2010
DILLINGHAM AP	50-2457			1-day	NCDC	59.0500	-158.5167	86	6/1919-5/2005
DRY CREEK	50-2568			1-day	NCDC	63.6833	-144.6000	1350	8/1996-7/2010
DUTCH HARBOR	50-2586	50-2587		1-day	NCDC	53.9167	-166.5000	50	6/1905-9/1920
DUTCH HARBOR	50-2587			1-day	NCDC	53.9000	-166.5333	13	**6/1905-7/2010**
EAGLE	50-2607			1-day	NCDC	64.7833	-141.2000	840	11/1901-7/2010
EAGLE	80-0720		50-2607	1-hour	RAWS	64.7761	-141.1619	880	**1/1976-12/2010**
EAGLE	50-2607	80-0720		1-hour	NCDC	64.7856	-141.2036	850	1/1976-6/2008
EIELSON FLD	50-2707			1-day	NCDC	64.6667	-147.1000	547	10/1946-7/2010
EKLUTNA	50-2717	50-5883		1-day	NCDC	**61.4657**	**-149.3410**	30	5/1941-2/1955
EKLUTNA LAKE	50-2725			1-day	NCDC	**61.4033**	**-149.1456**	879	6/1946-8/1976
EKLUTNA PROJECT	50-2730			1-day	NCDC	**61.4747**	**-149.1728**	38	1/1952-1/1998
EKLUTNA WTP	50-2737			1-day	NCDC	61.4500	-149.3167	640	**5/1941-7/2010**
ELDRED ROCK	50-2770			1-day	NCDC	**58.9715**	**-135.2212**	52	3/1941-7/1973
ELFIN COVE	50-2785			1-day	NCDC	**58.1950**	**-136.3528**	20	1/1975-7/2010
EMMONAK	50-2825			1-day	NCDC	62.7833	-164.4833	14	9/1977-1/1994
EUREKA	50-2952			1-day	NCDC	61.9500	-147.1667	3342	7/1953-9/1968
FAIRBANKS F.O.	10-0215			1-day	SNOTEL	64.8602	-147.7889	450	10/1982-9/2009
FAIRBANKS INTL AP	50-2968			1-day	NCDC	64.8000	-147.8833	432	7/1948-8/2010
FAIRBANKS INTL AP	50-2968			1-hour	NCDC	64.8039	-147.8761	432	**9/1949-4/2011**

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
FAIRBANKS INTL AP	50-2968	50-2968		15-min	NCDC	64.8000	-147.8833	432	1/2000-4/2011
FAREWELL	80-0780			1-hour	RAWS	**63.7368**	**-154.1420**	775	8/1996-12/2010
FAREWELL FAA AP	50-2988			1-day	NCDC	62.5167	-153.8833	1503	12/1941-12/1973
FAREWELL LAKE	50-3009			1-day	NCDC	62.5500	-153.6167	1060	4/1985-2/2009
FIVE FINGER LIGHT ST	50-3072			1-day	NCDC	**57.2704**	**-133.6314**	30	4/1941-7/1984
FIVE MILE	50-3082			1-day	NCDC	65.9333	-149.8333	502	**9/1970-1/2011**
FLAT	50-3085			1-day	NCDC	62.4500	-158.0000	325	2/1933-5/1961
FLAT	80-0820			1-hour	RAWS	62.8228	-156.6139	1480	8/1996-12/2010
FORT LISCUM	50-3162	50-9686		1-day	NCDC	61.1000	-146.4500	-999	6/1900-8/1916
FORT YUKON	10-0961			1-day	SNOTEL	66.5705	-145.2455	430	**1/1918-9/2010**
FORTMANN HATCHERY	50-3125	10-0241		1-day	NCDC	**55.6075**	**-131.3683**	131	3/1904-5/1927
FT KNOX MINE	50-3160			1-day	NCDC	65.0000	-147.3333	1621	12/1997-7/2010
FT RICHARDSON W.T.P.	50-3163			1-day	NCDC	61.2333	-149.6500	490	**1/1965-5/2010**
FT YUKON	50-3175	10-0961		1-day	NCDC	66.5667	-145.2667	440	1/1899-3/1990
FUNNY RIVER	50-3196			1-day	NCDC	60.4833	-150.8000	275	**9/1950-7/2010**
FUNTER BAY	50-3198			1-day	NCDC	**58.2548**	**-134.8987**	30	2/1980-6/1996
GAKONA 1 N	50-3205			1-day	NCDC	62.3000	-145.3000	1460	11/1971-4/1989
GALENA	50-3212			1-day	NCDC	64.7333	-156.8833	152	**10/1942-7/2010**
GALENA AP	50-3215	50-3212		1-day	NCDC	64.7333	-156.9333	120	10/1942-9/1993
GAMBELL	50-3226			1-day	NCDC	63.7833	-171.7500	30	6/1902-8/1997
GEORGE	80-0860			1-hour	RAWS	63.8375	-144.3503	1525	8/1999-12/2010
GILMORE CREEK	50-3275			1-day	NCDC	**64.9768**	**-147.5331**	970	2/1966-7/2010
GLACIER BAY	50-3294			1-day	NCDC	58.4500	-135.8833	50	1/1966-7/2010
GLEN ALPS	50-3299			1-day	NCDC	61.1000	-149.7000	2259	1/1971-7/2010
GOBBLERS KNOB	10-0962			1-day	SNOTEL	66.7449	-150.6677	2030	**10/1970-9/2010**
GOODPASTURE	80-0900			1-hour	RAWS	64.2381	-145.2669	1520	7/1996-12/2010
GRANDVIEW	10-0956			1-day	SNOTEL	60.6083	-149.0631	1100	10/1983-9/2010
GRANITE	80-0920			1-hour	RAWS	60.7275	-149.2869	512	5/1997-12/2010
GRANITE CRK PILLOW	10-1291			1-day	SNOTEL	63.9438	-145.3999	1240	10/1987-9/2010
GRAPHITE	80-0940			1-hour	RAWS	67.0333	-143.2833	850	6/1991-10/2010
GREEN CABIN LAKE	40-1250			1-hour	WERC	68.5335	-149.2310	2980	1/1996-1/2009
GROUSE CREEK DIVIDE	10-0964			1-day	SNOTEL	60.2597	-149.3423	700	10/1988-9/2010

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
GUARD ISLAND LIGHT STN	50-3454			1-day	NCDC	**55.4459**	**-131.8812**	20	11/1940-6/1969
GULKANA	90-0001			1-day	USGS	63.2667	-145.4167	4856	10/1967-9/2009
GULKANA AP	50-3465			1-day	NCDC	62.1667	-145.4500	1570	3/1909-8/2010
GUSTAVUS	50-3475			1-day	NCDC	58.4167	-135.7167	40	4/1923-7/2010
HAINES	50-3495	50-3490		1-day	NCDC	59.2167	-135.4333	257	9/1948-9/1953
HAINES 40 NW	50-3504			1-day	NCDC	59.4500	-136.3667	820	**6/1927-7/2010**
HAINES AP	50-3490			1-day	NCDC	59.2500	-135.5167	31	**1/1882-8/2010**
HAINES TERMINAL	50-3500			1-day	NCDC	59.2667	-135.4500	175	9/1957-7/1988
HALIBUT COVE	50-3530			1-day	NCDC	**59.5972**	**-151.2314**	30	9/1975-1/1998
HAYCOCK	80-1020			1-hour	RAWS	65.2017	-161.1550	177	5/1988-11/2010
HAYES RIVER	50-3573			1-day	NCDC	61.9833	-152.0833	1000	11/1980-7/2010
HEALY	50-3581	50-3585		1-day	NCDC	63.8500	-148.9500	1244	2/1920-4/1973
HEALY 2 NW	50-3585			1-day	NCDC	63.8833	-149.0167	1490	**2/1920-7/2010**
HELMUT	80-1060			1-hour	RAWS	**67.7465**	**-144.1640**	2800	9/1988-9/2010
HIDDEN FALLS HATCHERY	50-3605			1-day	NCDC	57.2167	-134.8667	22	10/1992-7/2010
HODZANA	80-1100			1-hour	RAWS	66.7417	-148.6767	1075	6/1991-12/2010
HOGATZA	80-1120			1-hour	RAWS	66.2167	-155.6667	685	5/1988-12/2010
HOLY CROSS	50-3655			1-day	NCDC	62.1833	-159.7667	20	4/1892-5/1975
HOMER	80-1140			1-hour	RAWS	59.7458	-151.2083	715	5/1998-12/2010
HOMER 5 NW	50-3670	50-9144		1-day	NCDC	59.6833	-151.6333	1132	3/1952-8/1973
HOMER 8 NW	50-3672			1-day	NCDC	**59.7460**	**-151.6375**	1080	10/1977-7/2010
HOMER 9 E	50-3682			1-day	NCDC	59.7167	-151.3333	512	**10/1973-7/2010**
HOMER AP	50-3665			1-day	NCDC	59.6500	-151.4833	64	9/1932-8/2010
HOMER RSCH CTR	50-3680	50-3682		1-day	NCDC	59.7000	-151.3167	279	10/1973-1/1979
HOONAH	50-3695			1-day	NCDC	58.1167	-135.4500	40	5/1941-7/2010
HOONAH	80-1180			1-hour	RAWS	**57.7867**	**-135.1665**	450	9/1989-12/2010
HOPE	50-3720			1-day	NCDC	60.9000	-149.6333	180	3/1979-7/2010
HUGHES	50-3765			1-day	NCDC	66.0667	-154.2333	545	3/1941-1/1970
ILIAMNA AP	50-3905			1-day	NCDC	59.7500	-154.9000	183	3/1920-8/2010
IMNAVIAT BASIN A	40-1100	40-1110		1-hour	WERC	68.6100	-149.3036	3048	5/1985-12/1993
IMNAVIAT BASIN B	40-1110		10-0968	1-hour	WERC	68.6163	-149.3036	3048	**5/1985-1/2010**
IMNAVIAT CREEK	10-0968			1-day	SNOTEL	68.6169	-149.3003	3050	10/1980-9/2010

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INDIAN MTN	50-3910			1-day	NCDC	65.9833	-153.6833	1220	8/1966-1/1985
INDIAN PASS	10-0946			1-day	SNOTEL	61.0677	-149.4795	2350	10/1979-9/2010
INNOKO	80-1220			1-hour	RAWS	**63.3817**	**-158.8220**	930	3/1988-12/2010
INTRICATE BAY	50-3933			1-day	NCDC	59.5500	-154.5000	120	8/1959-7/2006
JATAHMUND	80-1240			1-hour	RAWS	62.6000	-142.0833	2300	7/1990-12/2010
JUNEAU 9 NW	50-4110	50-4103		1-day	NCDC	58.4167	-134.5333	121	7/1965-6/1980
JUNEAU AP	50-4100			1-hour	NCDC	58.3567	-134.5638	**3**	**9/1949-5/2011**
JUNEAU DWTN	50-4092	50-4094		1-day	NCDC	**58.3021**	**-134.4196**	171	1/1890-6/1965
JUNEAU DWTN	50-4094			1-day	NCDC	58.3000	-134.4167	25	**1/1890-7/2010**
JUNEAU FORECAST OFFICE	50-4103			1-day	NCDC	58.4000	-134.5667	106	**7/1939-7/2010**
JUNEAU INTL AP	50-4100			1-day	NCDC	58.3500	-134.5833	12	9/1936-8/2010
KAIYUH	80-1280			1-hour	RAWS	64.4256	-158.1058	110	8/1997-10/2010
KAKE	50-4155			1-day	NCDC	56.9667	-133.9000	70	5/1919-4/1992
KAKE	80-1300			1-hour	RAWS	56.9739	-133.6600	400	9/1989-12/2010
KALSIN BAY	50-4161	50-1763		1-day	NCDC	57.5667	-152.4500	20	8/1928-6/1931
KANUTI	80-1320			1-hour	RAWS	66.0933	-152.1700	825	8/1990-12/2010
KASILOF 3 NW	50-4425			1-day	NCDC	**60.3699**	**-151.3669**	70	11/1925-10/1997
KAVET	80-1340			1-hour	RAWS	67.1386	-159.0436	235	5/1993-12/2010
KELLY	80-1360			1-hour	RAWS	67.9333	-162.3000	412	4/1990-12/2010
KENAI 9N	50-4550			1-day	NCDC	60.6667	-151.3167	126	**6/1967-4/2007**
KENAI LAKE	80-1380			1-hour	RAWS	**60.3628**	**-149.3864**	475	9/1989-12/2010
KENAI MOOSE PENS	10-0966			1-day	SNOTEL	60.7261	-150.4756	300	10/1983-9/2010
KENAI MUNI AP	50-4546			1-day	NCDC	60.5833	-151.2333	91	5/1899-8/2010
KENAI NWR	80-1400			1-hour	RAWS	60.5917	-150.3167	400	6/1988-12/2010
KENNECOTT	50-4555			1-day	NCDC	61.4833	-142.8833	2210	12/1916-8/1947
KETCHIKAN INTL AP	50-4590			1-day	NCDC	55.3500	-131.7167	76	9/1910-8/2010
KETCHIKAN INTL AP	50-4590	55-0073	55-0073	15-min	NCDC	55.3500	-131.7167	76	2/2005-4/2011
KEYSTONE RIDGE	50-4621			1-day	NCDC	64.9167	-148.2667	1600	8/1996-7/2010
KIANA	80-1420			1-hour	RAWS	66.9767	-160.4375	150	4/1988-12/2010
KILBUCK	80-1440			1-hour	RAWS	**60.3404**	**-160.1600**	1910	1/1992-12/2010
KILLISNOO	50-4689	50-0310		1-day	NCDC	57.4694	-134.5694	20	1/1893-2/1932
KING SALMON AP	50-4766			1-day	NCDC	58.6833	-156.6500	47	**6/1917-7/2010**

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KITOI BAY	50-4812			1-day	NCDC	58.1833	-152.3667	60	11/1954-7/2010
KLAWASI	80-1460			1-hour	RAWS	62.1472	-144.9281	3100	6/1992-12/2010
KLUKWAN	50-4929	50-5898		1-day	NCDC	59.4000	-135.9000	91	1/1908-2/1921
KOBUK	50-4964			1-day	NCDC	66.9000	-156.8667	140	8/1953-12/1979
KODIAK AP	50-4988			1-day	NCDC	57.7500	-152.4833	19	**1/1931-8/2010**
KODIAK AP	50-4988			1-hour	NCDC	57.7511	-152.4855	19	2/1984-4/2010
KODIAK AP USCG BASE	50-4986	50-4988		1-day	NCDC	57.7500	-152.5000	13	1/1931-1/1973
KODIAK NF	50-4984	50-4991		1-day	NCDC	57.8000	-152.4000	151	9/1913-12/1949
KODIAK WWTP	50-4991			1-day	NCDC	57.8000	-152.3500	45	**9/1913-7/2010**
KOTZEBUE RALPH WEIN AP	50-5076			1-day	NCDC	66.8833	-162.6000	10	8/1902-8/2010
KOUGAROK MET 2	41-2820	80-1980		1-hour	ATLAS	65.4283	-164.6435	361	4/1999-1/2009
KOYUKUK	80-1480			1-hour	RAWS	**66.0035**	**-157.5684**	**1256**	7/1990-12/2010
KUPARUK	50-5136			1-day	NCDC	70.3167	-149.5833	64	2/1983-7/2010
LADD AFB	50-5318			1-day	NCDC	64.8333	-147.6000	459	**7/1943-12/2010**
LAKE MINCH	80-1500		50-5881	1-hour	RAWS	63.8933	-152.3106	740	6/1992-12/2010
LAKE SUSITNA	50-5397			1-day	NCDC	62.4500	-146.6833	2374	5/1990-12/2003
LATOUCHE	50-5454			1-day	NCDC	60.0500	-147.9000	49	3/1917-11/1959
LAZY MTN	50-5464			1-day	NCDC	61.6333	-149.0333	728	9/1984-7/2010
LINCOLN ROCK LIGHT S	50-5499			1-day	NCDC	**56.0565**	**-132.6979**	26	6/1942-2/1968
LINGER LONGER	50-5506	50-3504		1-day	NCDC	59.4333	-136.2833	700	10/1959-4/1982
LITTLE CHENA RIDGE	10-0947			1-day	SNOTEL	65.1242	-146.7339	2000	10/1981-9/2010
LITTLE PORT WALTER	50-5519			1-day	NCDC	**56.3800**	**-134.6500**	14	7/1936-7/2010
LIVENGOOD	80-1540			1-hour	RAWS	65.4236	-148.7217	450	8/1998-12/2010
LIVENGOOD DOT	50-5534			1-day	NCDC	65.5167	-148.5500	425	**7/1933-12/2010**
LOWER KUPARUK	40-3000	40-1510		1-hour	WERC	70.2833	-148.9667	37	4/1992-1/1996
MAIN BAY	50-5604			1-day	NCDC	**60.5181**	**-148.0931**	57	10/1982-7/2010
MANKOMEN LAKE	50-5607			1-day	NCDC	62.9833	-144.4833	3024	7/1965-12/2008
MANLEY HOT SPRINGS	50-5644			1-day	NCDC	65.0000	-150.6500	275	6/1909-7/2010
MATANUSKA AG EXP STN	50-5733			1-day	NCDC	61.5667	-149.2500	172	7/1917-7/2010
MATANUSKA VALLEY 12	50-5731	50-6871		1-day	NCDC	61.6167	-149.1000	220	7/1941-10/1954
MATANUSKA VALLEY 16	50-5735	50-9759		1-day	NCDC	61.5333	-149.4333	49	7/1951-10/1954
MATANUSKA VALLEY 2	50-5721	50-6873		1-day	NCDC	61.5500	-149.0833	79	8/1941-6/1953

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MATANUSKA VALLEY 9	50-5728	50-6875		1-day	NCDC	61.6500	-149.2000	420	7/1941-10/1954
MAY CREEK	50-5810			1-day	NCDC	61.3500	-142.6833	1503	**11/1963-12/2010**
MAY CREEK	80-1600		50-5810	1-hour	RAWS	**61.3424**	**-142.6922**	1600	5/1990-12/2010
MC CARTHY 1 NE	50-5752	50-5754		1-day	NCDC	61.4333	-142.9167	1601	11/1919-9/1976
MC CARTHY 1 NE	50-5754	50-5757		1-day	NCDC	61.4333	-142.9000	1540	10/1976-2/1983
MCCARTHY 3 SW	50-5757			1-day	NCDC	61.4167	-143.0000	1250	**11/1919-7/2010**
MCGRATH AP	50-5769			1-day	NCDC	62.9500	-155.6000	333	4/1939-8/2010
MCGRATH AP	50-5769			1-hour	NCDC	62.9575	-155.6102	333	7/1950-4/2010
MCKINLEY PARK	50-5778			1-day	NCDC	63.7167	-148.9667	2069	1/1923-7/2010
MCNEIL CANYON	10-1003			1-day	SNOTEL	59.7452	-151.2598	1320	10/1986-9/2010
MENDENHALL	50-5851	50-4110		1-day	NCDC	58.4000	-134.5333	89	7/1939-4/1944
METLAKATLA	50-5853	50-0352		1-day	NCDC	55.0833	-131.5667	-999	1/1893-7/1894
MIDDLE FORK BRADLEY	10-1064			1-day	SNOTEL	**59.7595**	-150.7637	2300	10/1990-9/2010
MILE 39 STEESE	50-5873	50-5880		1-day	NCDC	65.1833	-147.2500	750	2/1998-3/2000
MILE 41 STEESE	50-5879	50-5880		1-day	NCDC	65.2000	-147.2000	879	9/1972-4/1977
MILE 42 STEESE	50-5880			1-day	NCDC	65.2167	-147.1667	1000	**9/1972-7/2010**
MINCHUMINA	50-5366	50-5881		1-day	NCDC	63.8833	-152.2833	702	1/1945-5/1967
MINCHUMINA	50-5881			1-day	NCDC	**63.9067**	**-152.2975**	**1025**	**1/1945-12/2010**
MINERAL LAKES	50-5882			1-day	NCDC	62.9500	-143.3833	2098	**8/1996-1/2011**
MIRROR LAKE SCOUT CAMP	50-5883	50-2737		1-day	NCDC	61.4333	-149.4000	405	11/1985-4/2004
MONAHAN FLAT	10-1094			1-day	SNOTEL	63.3050	-147.6489	2710	10/1983-9/2010
MONUMENT CREEK	10-0949			1-day	SNOTEL	65.0775	-145.8736	1850	10/1980-9/2010
MONUMENT CREEK	10-0949			1-hour	SNOTEL	**65.0775**	**-145.8736**	1850	7/1991-7/2009
MOOSE PASS 3 NW	50-5894			1-day	NCDC	60.5000	-149.4333	463	7/1941-10/2004
MOOSE RUN	50-5896	50-6769		1-day	NCDC	61.2500	-149.6667	394	1/1965-1/1971
MOOSE VALLEY	50-5898			1-day	NCDC	**59.4050**	**-135.8923**	400	**1/1908-3/1958**
MOSES POINT	50-6058			1-day	NCDC	64.7000	-162.0500	20	3/1943-7/1967
MT. RYAN	10-0948			1-day	SNOTEL	65.2506	-146.1524	2800	10/1981-9/2010
MUNSON RIDGE	10-0950			1-day	SNOTEL	64.8517	-146.2122	3100	10/1980-9/2010
MUNSON RIDGE	10-0950			1-hour	SNOTEL	**64.8517**	**-146.2122**	3100	7/1992-5/2010
NABESNA	50-6147			1-day	NCDC	62.4000	-143.0000	2899	10/1966-7/2010
NAKNEK	50-6166	50-4766		1-day	NCDC	58.6833	-156.6500	49	6/1917-7/1955

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NAKNEK	50-4766			1-hour	NCDC	58.6833	-156.6500	49	10/1962-4/2010
NAPTOWNE	50-6227	50-8727		1-day	NCDC	60.5333	-150.7500	249	9/1950-9/1954
NELCHINA HWY CAMP	50-6270			1-day	NCDC	61.9833	-146.8667	2485	**4/1969-5/1983**
NENANA MUNI AP	50-6309			1-day	NCDC	64.5500	-149.0667	360	**12/1916-5/2011**
NIKISKI TERMINAL	50-6403	50-4550		1-day	NCDC	60.6833	-151.3833	110	6/1967-1/1978
NINILCHIK	50-6441			1-day	NCDC	60.0500	-151.6667	121	**10/1940-1/2011**
NINILCHIK	80-1720		50-6441	1-hour	RAWS	60.0433	-151.6656	130	4/1995-1/2011
NOATAK	80-1740			1-hour	RAWS	68.0708	-158.7042	985	4/1990-1/2011
NOME MUNI AP	50-6496			1-day	NCDC	64.5167	-165.4500	13	8/1900-8/2010
NOME WSO AP	50-6496			1-hour	NCDC	64.5111	-165.4400	13	9/1949-4/2010
NORTH DUTCH ISLAND CAA	50-6562			1-day	NCDC	60.7667	-147.8000	39	8/1943-1/1957
NORTH POLE	50-6581			1-day	NCDC	64.7500	-147.3333	475	10/1968-7/2010
NORTHWAY AP	50-6586			1-day	NCDC	62.9667	-141.9333	1712	10/1942-8/2010
NORUTAK	80-1760			1-hour	RAWS	66.8333	-154.3333	800	5/1990-11/2010
NUKA GLACIER	10-1037			1-day	SNOTEL	59.6980	-150.7117	1250	**10/1985-9/2010**
NUKA RIVER	10-1488	10-1037		1-day	SNOTEL	59.6667	-150.6833	1300	10/1985-9/1990
NULATO	50-6656			1-day	NCDC	**64.7272**	**-158.0791**	**112**	8/1917-7/2004
NUNIVAK ISLAND	50-6727			1-day	NCDC	60.3833	-166.2000	52	9/1923-2/1973
NYAC	50-6760			1-day	NCDC	**60.9807**	**-159.9974**	449	10/1926-9/1963
OIL WELL ROAD E P	50-6769	50-3163		1-day	NCDC	61.2333	-149.7167	371	11/1967-7/1974
ORCA	50-6844	50-2173		1-day	NCDC	**60.5791**	**-145.7165**	**100**	9/1899-3/1908
OUZINKIE	50-6853			1-day	NCDC	57.9333	-152.5000	40	5/1989-8/2007
PAAQ PALMER MUNICIPAL	55-0112		50-6870	1-hour	ASOS	61.6000	-149.0800	233	1/1973-5/2011
PABE BETHEL AIRPORT	55-0016	50-0754		1-hour	ASOS	60.7800	-161.8000	151	1/1950-5/2011
PACV CORDOVA/MILE 13	55-0032		50-2177	1-hour	ASOS	60.5000	-145.5000	43	1/1950-5/2011
PAEN KENAI MUNICIPAL	55-0072		50-4546	1-hour	ASOS	60.5700	-151.2500	95	1/1950-5/2011
PAFM AMBLER	55-0004		50-0249	1-hour	ASOS	67.1000	-157.8500	289	2/1988-5/2011
PAGY SKAGWAY	55-0143		50-8525	1-hour	ASOS	59.4700	-135.3000	16	1/1973-5/2011
PAHN HAINES BOAT HARBOR	55-0055		50-3490	1-hour	ASOS	59.2300	-135.4300	33	1/1950-5/2011
PAHY HYDABURG SEAPLANE	55-0064			1-hour	ASOS	**55.2063**	**-132.8283**	0	7/1996-5/2011
PAIL ILIAMNA ARPT	55-0066		50-3905	1-hour	ASOS	59.7500	-154.9200	161	1/1998-5/2011
PAJN JUNEAU INTL AIRPORT	55-0068	50-4100		1-hour	ASOS	58.3700	-134.5800	23	1/1950-5/2011

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PAKT KETCHIKAN INTL ARPT	55-0073		50-4590	1-hour	ASOS	55.3500	-131.7000	95	**12/1996-5/2011**
PAKW KLAWOCK	55-0080			1-hour	ASOS	55.5800	-133.0800	49	12/1980-5/2011
PALH LAKE HOOD SEAPLANE	55-0087			1-hour	ASOS	61.1800	-149.9700	72	1/1994-5/2011
PALMER 1 N	50-6871	50-6875		1-day	NCDC	61.6167	-149.1000	220	11/1954-12/1977
PALMER 4 SE	50-6873	50-7352		1-day	NCDC	61.5333	-149.0833	102	6/1956-9/1960
PALMER 5 NW	50-6875			1-day	NCDC	61.6500	-149.2000	630	**7/1941-12/1977**
PALMER JOB CORPS	50-6870			1-day	NCDC	**61.5926**	**-149.1014**	220	11/1948-7/2010
PAMR MERRILL FIELD	55-0096			1-hour	ASOS	61.2200	-149.8500	138	1/1950-5/2011
PAOR NORTHWAY	55-0110		50-6586	1-hour	ASOS	62.9700	-141.9300	1722	1/2000-5/2011
PASD SAND POINT	55-0131		50-8183	1-hour	ASOS	55.3200	-160.5200	23	6/1980-5/2011
PASI SITKA/JAPONSKI ARPT	55-0142		50-8494	1-hour	ASOS	57.0700	-135.3500	66	12/1996-5/2011
PASO SELDOVIA	55-0135		50-8355	1-hour	ASOS	59.4500	-151.7000	33	6/1997-5/2011
PATA TANANA/CALHOUN MEM	55-0154		50-9014	1-hour	ASOS	65.1700	-152.1000	220	12/1999-5/2011
PATK TALKEETNA	55-0153		50-8976	1-hour	ASOS	62.3000	-150.1000	358	**1/1950-5/2011**
PAVL KIVALINA AIRPORT	55-0079			1-hour	ASOS	67.7300	-164.5400	10	8/1998-5/2011
PAWD SEWARD	55-0136		50-8371	1-hour	ASOS	60.1200	-149.4500	59	1/1973-5/2011
PAWI WAINWRIGHT AIRPORT	55-0164			1-hour	ASOS	70.6200	-159.8500	89	8/1957-5/2011
PAXSON	50-7095	50-7097		1-day	NCDC	**63.0321**	**-145.4975**	2696	8/1917-12/1967
PAXSON	50-7097			1-day	NCDC	63.0333	-145.5000	2699	**8/1917-1/2010**
PAXSON	80-1820		50-7105	1-hour	RAWS	62.9453	-145.5014	2670	8/1996-1/2011
PAXSON RIVER	50-7105			1-day	NCDC	62.9500	-145.5000	2752	10/1968-1/2011
PELICAN	50-7141			1-day	NCDC	**57.9568**	**-136.2220**	12	2/1967-7/2010
PETERSBURG	50-7233	50-7251		1-day	NCDC	**56.8128**	**-132.9539**	52	5/1924-8/1983
PETERSBURG 1	50-7251			1-day	NCDC	56.8000	-132.9500	107	**5/1924-7/2010**
PLANT MATERIALS CTR	50-7352			1-day	NCDC	61.5333	-149.0833	67	**8/1941-1/1994**
PLATINUM	50-7365			1-day	NCDC	59.0167	-161.7833	20	10/1939-6/1964
POINT HOPE	50-7431			1-day	NCDC	68.3500	-166.8000	10	3/1924-2/1982
POINT LAY	50-7442			1-day	NCDC	69.7500	-163.0500	13	9/1941-3/1958
POINT MACKENZIE	50-7444	10-1002		1-day	NCDC	61.4167	-150.0833	160	12/1980-10/2008
POINT MACKENZIE	10-1002			1-day	SNOTEL	61.3897	-150.0218	200	**10/1983-9/2010**
POINT RETREAT	50-7451			1-day	NCDC	**58.4114**	**-134.9550**	20	2/1945-7/1973
POORMAN	80-1900			1-hour	RAWS	**64.0847**	**-155.5680**	**930**	6/1988-1/2011

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PORCUPINE CREEK	50-7465	50-5506		1-day	NCDC	**59.3677**	**-136.2885**	1601	6/1927-9/1936
PORT ALEXANDER	50-7557			1-day	NCDC	56.2500	-134.6500	12	9/1949-7/2010
PORT ALSWO	80-1920		50-7570	1-hour	RAWS	60.1958	-154.3200	260	6/1992-1/2011
PORT ALSWORTH	50-7570			1-day	NCDC	60.2000	-154.3167	260	**4/1940-1/2011**
PORT HEIDEN	50-7700			1-day	NCDC	56.9500	-158.6167	92	10/1942-10/1988
PORT SAN JUAN	50-7738			1-day	NCDC	60.0500	-148.0667	40	**1/1975-7/2010**
PORTAGE	50-7486	50-7494		1-day	NCDC	60.8500	-148.9833	39	6/1936-10/1949
PORTAGE 1 S	50-7494			1-day	NCDC	60.8167	-148.9833	40	**6/1936-2/1995**
PREACHER	80-1940			1-hour	RAWS	65.9233	-145.0300	1038	8/1993-1/2011
PROSPECT CREEK	50-7778	10-0962		1-day	NCDC	66.8167	-150.6667	955	10/1970-4/2001
PUNTILLA	50-7783			1-day	NCDC	62.0833	-152.7333	1832	1/1942-7/2010
QUARTZ CRE	80-1980			1-hour	RAWS	65.4000	-164.6500	427	**5/1988-1/2011**
RABBIT CRE	80-2000			1-hour	RAWS	61.0844	-149.7283	1480	5/1993-1/2011
RADIOVILLE	50-7854			1-day	NCDC	57.6000	-136.1500	20	5/1936-10/1950
RAMPART	50-7891	50-7900		1-day	NCDC	65.5000	-150.2500	381	6/1905-8/1933
RAMPART 2	50-7900			1-day	NCDC	65.5000	-150.1333	400	**6/1905-7/1977**
RENEE	80-2040			1-hour	RAWS	62.7100	-146.6181	2600	6/1999-1/2011
RHOADS CREEK	10-0236			1-day	SNOTEL	63.9333	-145.3333	1225	10/1987-9/2009
RICHARDSON	50-7977			1-day	NCDC	64.2833	-146.3333	889	4/1917-7/1971
RIKAS LANDING	50-7989	50-9793		1-day	NCDC	64.1500	-145.8500	1268	6/1969-11/1982
ROCK RIDGE DRIVE	50-8025			1-day	NCDC	61.1167	-149.7500	840	**10/1965-10/1980**
ROUND LAKE	80-2080			1-hour	RAWS	64.6847	-153.9400	570	8/1992-1/2011
RUSSIAN MISSION	50-8054			1-day	NCDC	61.7833	-161.3167	50	7/1928-10/1987
SAGWON	10-0238			1-day	SNOTEL	69.4242	-148.6926	1000	**10/1982-10/2009**
SAGWON	40-1410		10-0238	1-hour	WERC	69.4262	-148.6909	902	10/1986-10/2009
SALCHA	50-8140			1-day	NCDC	64.5000	-146.9833	680	9/1975-6/2010
SALCHA	80-2120			1-hour	RAWS	64.5900	-146.1400	1000	12/1996-12/2010
SALMON CREEK BEACH	50-8168	50-4092		1-day	NCDC	58.3167	-134.4667	-999	1/1917-7/1921
SALMON TROUT	80-2140			1-hour	RAWS	66.8125	-141.6200	2210	7/1988-1/2011
SAND POINT	50-8183			1-day	NCDC	55.3167	-160.5167	22	**9/1941-5/2011**
SELAWIK	80-2160			1-hour	RAWS	66.6033	-159.1125	105	6/1991-1/2011
SELDOVIA	50-8350	50-8355		1-day	NCDC	59.4333	-151.7000	20	1/1918-6/1964

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SELDOVIA DOCK	50-8355			1-day	NCDC	59.4333	-151.7000	30	**1/1918-5/2011**
SEVEN MILE	80-2180		50-3082	1-hour	RAWS	65.9383	-149.8550	823	3/1988-1/2011
SEWARD	50-8371			1-day	NCDC	60.1167	-149.4500	30	2/1908-9/2008
SEWARD 19 N	50-8377			1-day	NCDC	60.3500	-149.3500	454	11/1986-7/2010
SEWARD 8 NW	50-8375			1-day	NCDC	60.1833	-149.6333	410	7/1983-3/2010
SHEEP MTN	50-8407	50-8945		1-day	NCDC	61.8000	-147.6833	2279	7/1943-5/1966
SHEEP MTN LODGE	50-8409			1-day	NCDC	61.8167	-147.5000	2799	**7/1943-7/2010**
SHEMYA AFB	50-8419			1-day	NCDC	52.7167	**-174.1000**	122	7/1943-3/1995
SHISHMAREF	50-8437			1-day	NCDC	**66.2506**	**-166.0821**	**10**	10/1919-10/1973
SITKA JAPONSKI AP	50-8494			1-day	NCDC	57.0500	-135.3667	14	9/1944-8/2010
SITKA MAGNETIC OBSY	50-8503			1-day	NCDC	57.0500	-135.3333	67	11/1867-12/1989
SITKINAK	50-8512			1-day	NCDC	56.5833	-153.9167	20	11/1960-1/1981
SKAGWAY	50-8525			1-day	NCDC	**59.4531**	**-135.3183**	**35**	**11/1898-8/2010**
SKAGWAY 1 NW	50-8532	50-8528		1-day	NCDC	**59.4680**	**-135.3193**	570	11/1972-8/1981
SKAGWAY AP	50-8528	50-8525		1-day	NCDC	59.4667	-135.3167	20	7/1965-8/2010
SKWENTNA	50-8536			1-day	NCDC	61.9667	-151.1833	150	7/1939-7/2010
SLANA	50-8547			1-day	NCDC	62.7167	-143.9833	2191	**4/1957-11/2007**
SLANA AP	50-8550	50-8547		1-day	NCDC	62.7167	-143.9167	2419	7/1974-10/1977
SLIDE MTN	50-8556	50-6270		1-day	NCDC	61.9833	-146.7833	2450	4/1969-10/1976
SNETTISHAM	10-0001	50-8584		1-day	SNOTEL	**58.1356**	**-133.7287**	25	10/1995-9/2009
SNETTISHAM PWR PLT	50-8584			1-day	NCDC	**58.1422**	**-133.7390**	20	**9/1964-7/2010**
SNOWSHOE LAKE	50-8594			1-day	NCDC	62.0333	-146.6667	2299	10/1963-7/2010
SOLOMAN GULCH	10-0240			1-day	SNOTEL	61.0830	**-146.3039**	30	10/1990-9/2008
SOURDOUGH 1 N	50-8625			1-day	NCDC	62.5333	-145.5167	1959	9/1971-9/1996
SPARREVOHN	50-8666			1-day	NCDC	61.1000	-155.5500	1580	5/1953-1/1985
ST MARYS	50-8105			1-day	NCDC	62.0500	-163.1667	311	**7/1967-5/2000**
ST MARYS AP	50-8107	50-8105		1-day	NCDC	62.0667	-163.3000	320	9/1980-6/1991
ST PAUL ISLAND AP	50-8118			1-day	NCDC	57.1667	-170.2167	35	9/1892-8/2010
ST PAUL ISLAND AP	50-8118			1-hour	NCDC	57.1594	-170.2222	35	10/1949-4/2010
STERLING	50-8727	50-3196		1-day	NCDC	60.5333	-150.7500	180	10/1954-4/1968
STONEY	80-2320			1-hour	RAWS	**61.0639**	**-153.8964**	1250	6/1992-1/2011
STONEY RIVER	80-2340			1-hour	RAWS	61.6467	-156.4333	265	9/1990-1/2011

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SUMMIT CREEK	10-0955			1-day	SNOTEL	60.6171	-149.5314	1400	10/1988-9/2010
SUMMIT WSO AP	50-8811			1-day	NCDC	63.3333	-149.1333	2410	8/1905-10/1976
SUSITNA	50-8882			1-day	NCDC	61.3333	-150.6667	**13**	7/1932-7/1947
SUSITNA VALLEY HIGH	10-0967			1-day	SNOTEL	62.1324	-150.0468	375	10/1987-9/2010
SUTTON 1 W	50-8915			1-day	NCDC	61.7167	-148.9167	550	**10/1963-7/2010**
SWAN LAKE	10-0241			1-day	SNOTEL	55.6167	**-131.3691**	50	**3/1904-9/2009**
SWANSON	80-2380			1-hour	RAWS	60.7278	-150.8722	280	5/1990-1/2011
T LAKE	80-2560			1-hour	RAWS	63.7533	-143.8167	2073	9/1990-10/2010
TAHNETA PASS	50-8945	50-8409		1-day	NCDC	**61.8039**	**-147.5517**	2619	4/1978-9/2000
TALKEETNA AP	50-8976			1-day	NCDC	62.3167	-150.1000	350	7/1918-8/2010
TALKEETNA AP	50-8976	55-0153	55-0153	15-min	NCDC	62.3167	-150.1000	350	1/2000-4/2001
TANACROSS CAA AP	50-8987			1-day	NCDC	63.3833	-143.3333	1503	5/1904-7/2003
TANALIAN POINT	50-9005	50-7570		1-day	NCDC	60.2167	-154.3667	308	4/1940-1/1959
TANANA CALHOUN MEM AP	50-9014			1-day	NCDC	65.1667	-152.1000	227	10/1902-8/2010
TATALINA	50-9035			1-day	NCDC	62.9000	-155.9667	964	7/1952-1/1985
TELIDA	80-2440			1-hour	RAWS	63.4400	-153.3567	650	5/1991-12/2010
TELLER	50-9102			1-day	NCDC	65.2667	-166.3667	10	8/1925-4/1997
TENAKEE SPRINGS	50-9121			1-day	NCDC	57.7833	-135.2333	20	7/1969-1/1983
TEUCHET CREEK	10-0951			1-day	SNOTEL	64.9469	-145.5205	1640	10/1981-9/2010
THE TICES	50-9144			1-day	NCDC	59.6833	-151.6500	902	**3/1952-4/1975**
THORNBROUGH	50-2102			1-hour	NCDC	55.2000	-162.7166	98	10/1962-4/2010
THORNBROUGH AFB	50-9153	50-2102		1-day	NCDC	55.2000	-162.7167	98	6/1942-12/1950
TIN CITY	50-9249			1-day	NCDC	65.5667	-167.9167	269	11/1953-11/1984
TOK	50-9313			1-day	NCDC	63.3500	-143.0500	1620	6/1954-7/2010
TOK RIVER	80-2520		50-5882	1-hour	RAWS	62.9572	-143.3467	2300	1/2000-1/2011
TONSINA	50-9385			1-day	NCDC	61.6500	-145.1667	1575	7/1907-7/2010
TOOLIK FIELD STATION MET	30-1100			1-day	ARCTIC LTER	68.6283	-149.5961	2384	**6/1988-10/2007**
TOOLIK MOIST ACIDIC TUSSO	30-1110			1-hour	LTER	68.6241	-149.6067	2493	6/1990-12/2006
TOTCHAKET PILLOW (DISCONT	10-1444			1-day	SNOTEL	64.7667	-149.4167	350	10/1979-9/1993
TREE POINT LT STN	50-9399			1-day	NCDC	**54.8027**	**-130.9339**	36	10/1929-1/1970
TRI NAL ACRES	50-9421			1-day	NCDC	60.5500	-150.5333	325	6/1971-10/1987
TRIMS CAMP	50-9410			1-day	NCDC	63.4333	-145.7667	2410	11/1953-11/1979

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TURNAGAIN PASS PILLOW	10-1449			1-day	SNOTEL	60.7805	-149.1831	1880	10/1982-9/2010
TUTKA BAY LAGOON	50-9460			1-day	NCDC	59.4333	-151.4167	63	8/1979-12/2003
TWO RIVERS	50-9489			1-day	NCDC	64.8667	-146.9500	605	12/1992-8/2009
UGANIK BAY	50-9511			1-day	NCDC	57.7167	-153.3167	49	8/1951-3/1965
UK EAST HEADWATERS	40-1220			1-hour	WERC	68.5849	-149.3063	2992	1/1996-1/2009
UMIAT AP	50-9539			1-day	NCDC	69.3667	-152.1333	266	4/1945-4/2001
UNALAKLEET FLD	50-9564			1-day	NCDC	63.8833	-160.8000	15	9/1941-10/1998
UNIVERSITY EXP STN	50-9641			1-day	NCDC	64.8500	-147.8667	475	9/1904-7/2010
UPPER CHENA	10-0952			1-day	SNOTEL	65.0985	-144.9332	2850	10/1983-9/2010
VALDEZ MUNI AP	50-9685	50-9686		1-day	NCDC	61.1333	-146.2500	105	9/1949-9/2009
VALDEZ WSO	50-9686			1-day	NCDC	61.1333	-146.3500	23	**6/1900-8/2010**
VIEW COVE	50-9702			1-day	NCDC	**55.0731**	**-133.0581**	10	4/1932-6/1946
VUNZIK LAKE	80-2620			1-hour	RAWS	66.7981	-146.7158	525	8/1994-9/2009
WALES	50-9739			1-day	NCDC	65.6167	-168.0500	9	10/1925-8/1995
WASILLA 2	50-9763	50-9765		1-day	NCDC	61.5833	-149.4500	351	7/1964-6/1968
WASILLA 2 NE	50-9765			1-day	NCDC	61.6167	-149.4000	500	**7/1964-5/1984**
WASILLA 3 S	50-9759			1-day	NCDC	61.5333	-149.4333	50	**11/1944-6/1999**
WEIN LAKE	80-2640			1-hour	RAWS	64.3150	-151.0833	1050	5/1988-1/2011
WEST FORK	50-9769	50-5534		1-day	NCDC	65.4667	-148.6667	430	8/1967-10/1973
WEST KUPARUK	40-1300			1-hour	WERC	69.4259	-150.3417	523	1/1994-12/2008
WHITES CROSSING	50-9790			1-day	NCDC	61.7000	-150.0000	270	1/1971-10/2009
WHITESTONE FARMS	50-9793			1-day	NCDC	64.1500	-145.8833	1010	**6/1969-7/2010**
WHITTIER	50-9829			1-day	NCDC	60.7833	-148.6833	60	3/1942-7/2010
WILLOW HWY CAMP	50-9864	50-9861		1-day	NCDC	61.7667	-150.0500	230	2/1977-10/1989
WILLOW WEST	50-9861			1-day	NCDC	61.7500	-150.0500	205	**5/1960-7/2010**
WISEMAN	50-9869			1-day	NCDC	67.4333	-150.2167	1289	11/1918-7/2010
WONDER LAKE	50-9883			1-day	NCDC	63.4833	-150.8667	2100	**3/1925-1/2011**
WONDER LAKE	80-2680		50-9883	1-hour	RAWS	63.4903	-150.8714	2120	7/1995-1/2011
WRANGELL AP	50-9919			1-day	NCDC	**56.4843**	**-132.3790**	**56**	11/1917-7/2010
YAKATAGA AP	50-9930			1-day	NCDC	60.0833	-142.5000	27	3/1943-5/1983
YAKUTAT AP	50-9941			1-hour	NCDC	59.5119	-139.6711	33	11/1949-4/2010
YAKUTAT STATE AP	50-9941			1-day	NCDC	59.5167	-139.6333	28	5/1917-8/2010

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
YETNA RIVER	10-9909			1-day	SNOTEL	62.9333	-158.4333	120	10/1983-9/2009
ZAREMBO	80-2700			1-hour	RAWS	56.3000	-132.8486	1100	9/1989-1/2011

Table A.1.2. List of stations in the buffer zone in Canada used in the analysis showing station name, station ID, post-merge station ID, co-located daily station ID, base duration, source of data, latitude, longitude, elevation, and period of record. Bold font in the latitude, longitude, and elevation fields indicates information that has been adjusted. Bold font in the 'Period of record' field indicates that the station data was extended using data from station that has the same ID in 'Post-merge station ID' column. For an hourly station co-located with a daily station with a different ID, the daily station's ID shown in the 'Co-located station ID' column should be used to locate the hourly station on the PFDS web page.

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
AIYANSH	21-0150	24-5384		1-day	ENV CANADA	55.2333	-129.0167	750	1/1924-9/1971
ALICE ARM	21-0330			1-day	ENV CANADA	**55.6819**	**-129.5053**	1031	1/1948-9/1964
ANNIE LAKE ROBINSON	21-0115			1-day	ENV CANADA	60.4667	-134.8333	2690	**9/1976-5/2006**
ANYOX	21-0446			1-day	ENV CANADA	55.4167	-129.8167	370	5/1916-6/1935
ATLIN	21-0560			1-day	ENV CANADA	59.5667	-133.7000	2209	3/1899-5/2009
ATLIN	21-0560			1-hour	ENV CANADA	59.5667	-133.7000	2209	5/1963-10/2005
BEAVER CREEK A	21-0160			1-day	ENV CANADA	62.4103	-140.8675	2129	11/1968-2/2006
BLANCHARD RIVER	21-0163			1-day	ENV CANADA	**60.0026**	**-136.8541**	2742	11/1986-2/2007
BOB QUINN AGS	21-1050			1-day	ENV CANADA	56.9668	-130.2500	2001	12/1977-4/1994
BRONSON CREEK	21-1086			1-day	ENV CANADA	**56.6817**	**-131.0850**	351	5/1989-9/1999
BURWASH A	21-0182			1-day	ENV CANADA	61.3667	-139.0500	2646	10/1966-2/2007
BURWASH A	21-0182			1-hour	ENV CANADA	61.3667	-139.0500	2646	7/1974-5/1989
CARCROSS	21-0200			1-day	ENV CANADA	60.1743	-134.6978	2165	2/1907-2/2007
CASSIAR	21-1440			1-day	ENV CANADA	59.2833	-129.8333	3534	3/1954-8/1996
DAWSON A	21-0402			1-day	ENV CANADA	64.0431	-139.1278	1215	2/1976-2/2007
DAWSON A	21-0402			1-hour	ENV CANADA	64.0431	-139.1278	1215	5/1976-11/2002
DEASE LAKE	21-2340			1-day	ENV CANADA	58.4283	-130.0106	2646	9/1944-2/2007
DEASE LAKE	21-2340			1-hour	ENV CANADA	58.4283	-130.0106	2646	10/1972-11/2005
EAGLE PLAINS	21-0468			1-day	ENV CANADA	66.3694	-136.7177	2034	10/1979-2/2007

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
FRASER CAMP	21-8036			1-day	ENV CANADA	59.7164	-135.0450	2850	8/1980-2/2007
GOOD HOPE LAKE	21-3245			1-day	ENV CANADA	59.3000	-129.2833	2524	8/1973-6/1986
GRAHAM INLET	21-3255			1-day	ENV CANADA	59.6000	-134.1833	2164	7/1973-2/2007
GREEN ISLAND	21-3298			1-day	ENV CANADA	54.5686	-130.7083	39	10/1978-5/2009
HAINES APPS NO 2	21-3315			1-day	ENV CANADA	**59.5139**	**-136.4750**	1310	2/1956-6/1974
HAINES JUNCTION	21-0630			1-day	ENV CANADA	60.7725	-137.5803	1953	10/1944-5/2009
ISKUT RANCH	21-3672			1-day	ENV CANADA	57.8667	-130.0167	2801	6/1976-5/1994
KLONDIKE	21-0679			1-day	ENV CANADA	64.4539	-138.2156	3190	6/1966-2/2007
KOMAKUK BEACH A	21-0685			1-day	ENV CANADA	69.5833	-140.1833	24	8/1958-6/1993
LANGARA	21-4500			1-day	ENV CANADA	54.2553	-133.0581	133	7/1936-6/2009
LANGARA	21-4500			1-hour	ENV CANADA	54.2553	-133.0581	133	5/1982-7/2006
MASSET AIRPORT	21-4920			1-day	ENV CANADA	54.0275	-132.1253	25	**6/1897-2/2007**
MASSET CFS	21-4945	21-4955		1-day	ENV CANADA	54.0333	-132.0667	40	11/1971-2/1981
MASSET TOW HILL	21-4955	21-4920		1-day	ENV CANADA	54.0333	-131.9667	7	9/1981-5/1986
MILL BAY	21-5130			1-day	ENV CANADA	55.0000	-129.7500	10	1/1915-3/1959
MULE CREEK	21-5248			1-day	ENV CANADA	59.7833	-136.6000	2899	9/1970-10/1986
NAAS HARBOUR	21-5275			1-day	ENV CANADA	54.9333	-129.9333	20	2/1900-8/1929
NASS CAMP	21-5384			1-day	ENV CANADA	55.2375	-129.0294	951	**1/1924-2/2007**
OGILVIE RIVER	21-0794			1-day	ENV CANADA	65.3603	-138.3053	1959	5/1971-2/2007
OLD CROW A	21-0800	21-0805		1-day	ENV CANADA	67.5706	-139.8392	824	9/1951-2/2007
OLD CROW RCS	21-0805			1-day	ENV CANADA	67.5706	-139.8392	824	**9/1951-5/2009**
PLEASANT CAMP	21-6197	50-3504		1-day	ENV CANADA	59.4500	-136.3667	900	5/1974-5/2009
PORT SIMPSON	21-6336			1-day	ENV CANADA	54.5667	-130.4333	26	6/1886-6/1910
PORTER CREEK WAHL	21-0907			1-day	ENV CANADA	60.7667	-135.1167	2339	11/1989-1/2005
PREMIER	21-6420			1-day	ENV CANADA	**56.0505**	**-130.0219**	1345	1/1926-9/1996
PRINCE RUPERT	21-6480	21-6481		1-day	ENV CANADA	54.2833	-130.3833	170	8/1908-12/1962
PRINCE RUPERT A	21-6481	21-6483		1-day	ENV CANADA	54.2925	-130.4447	116	5/1962-3/2006
PRINCE RUPERT A	21-6481		21-6483	1-hour	ENV CANADA	54.2925	-130.4447	116	10/1969-2/2005
PRINCE RUPERT AWOS	21-6483			1-day	ENV CANADA	54.2861	-130.4447	116	**8/1908-5/2009**
PRINCE RUPERT MONT CIRC	21-6488			1-day	ENV CANADA	54.3203	-130.2900	197	8/1959-5/2009
PRINCE RUPERT R PARK	21-6492			1-day	ENV CANADA	54.3000	-130.3333	298	8/1959-9/1997
PRINCE RUPERT SHAWATLANS	21-6493			1-day	ENV CANADA	54.3333	-130.2500	36	7/1966-6/1999

Station name	Station ID	Post-merge station ID	Co-located station ID	Base duration	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
ROCK RIVER	21-0935			1-hour	ENV CANADA	66.9811	-136.2181	2398	9/1974-12/1988
SNAG A	21-1000			1-day	ENV CANADA	62.3667	-140.4000	1924	8/1943-9/1966
STEWART	21-7740	21-7745		1-day	ENV CANADA	55.9500	-129.9833	15	9/1910-4/1967
STEWART A	21-7742			1-day	ENV CANADA	55.9361	-129.9850	24	**9/1910-2/2007**
STEWART BCHPA	21-7745	21-7742		1-day	ENV CANADA	55.9500	-129.9833	40	10/1967-5/1976
STEWART RIVER	21-1033			1-day	ENV CANADA	63.3167	-139.4333	1175	4/1976-9/1993
SWEDE CREEK	21-1070			1-day	ENV CANADA	**64.0233**	**-139.5623**	1050	7/1918-1/1929
TELEGRAPH CREEK	21-8040			1-day	ENV CANADA	57.9000	-131.1667	600	**7/1942-9/1999**
TELEGRAPH CREEK	21-8041			1-day	ENV CANADA	57.9000	-131.3333	820	5/1979-6/2000
TELEGRAPH CREEK	21-8041			1-hour	ENV CANADA	**57.9073**	**-131.1640**	820	5/1979-9/1999
TODAGIN RANCH	21-8202			1-day	ENV CANADA	57.6000	-130.0667	2949	8/1973-3/1992
TODAGIN RANCH	21-8202			1-hour	ENV CANADA	57.6000	-130.0667	2949	6/1975-10/1991
TRIPLE ISLAND	21-8250			1-day	ENV CANADA	54.2947	-130.8803	68	6/1989-5/2009
UNUK RIVER ESKAY CREEK	21-8535			1-day	ENV CANADA	56.6525	-130.4461	2909	9/1989-2/2007
WHITEHORSE	21-1290	21-1300		1-day	ENV CANADA	60.7167	-135.0500	2086	11/1904-3/1942
WHITEHORSE A	21-1300			1-day	ENV CANADA	60.7100	-135.0683	2316	**11/1904-5/2009**
WHITEHORSE A	21-1300			1-hour	ENV CANADA	60.7100	-135.0683	2316	5/1960-9/2002
WHITEHORSE RIVERDALE	21-1400			1-day	ENV CANADA	60.7100	-135.0272	2099	9/1969-5/2009
WOLF CREEK	21-1601	21-0115		1-day	ENV CANADA	60.5000	-134.9500	2499	6/1985-5/1989

Table A.1.3. List of stations used in the analysis for constrained to unconstrained observation correction factors (see Section 4.5.2) and n-minute scaling factors (see Section 4.6.3) showing station name, state, station ID, source of data, latitude, longitude, elevation, and period of record.

Name	Station ID	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
ANCHORAGE INTL AP	50-0280	NCDC	61.1689	-150.0278	132	1/1973-12/2009
ANCHORAGE LAKE HOOD AP	50-0277	NCDC	61.1781	-149.9664	90	3/2005-12/2009
ANNETTE WSO AP	50-0352	NCDC	55.0389	-131.5786	109	1/1973-12/2009
BARROW WSO AP	50-0546	NCDC	71.2833	-156.7814	31	1/1984-12/2009
BARTER ISLAND WSO AP	50-0558	NCDC	70.1333	-143.6333	39	1/1984-1/1990
BETHEL AP	50-0754	NCDC	60.7850	-161.8292	102	1/1984-12/2009
BETTLES AP	50-0761	NCDC	66.9161	-151.5089	642	1/1984-12/2009
BIG DELTA FAA/AMOS AP	50-0770	NCDC	63.9950	-145.7183	1268	1/1984-12/2009
COLD BAY AP	50-2102	NCDC	55.2208	-162.7325	78	1/1973-12/2009
CORDOVA AP	50-2177	NCDC	60.4914	-145.4511	31	1/1984-12/2009
DEADHORSE	50-2316	NCDC	70.1917	-148.4772	61	3/2005-12/2009
FAIRBANKS INTL AP	50-2968	NCDC	64.8039	-147.8761	432	1/1973-12/2009
GULKANA AP	50-3465	NCDC	62.1603	-145.4569	1571	1/1984-12/2009
HAINES AP	50-3490	NCDC	59.2433	-135.5094	15	2/2005-12/2009
HOMER AP	50-3665	NCDC	59.6428	-151.4872	64	1/1984-12/2009
ILIAMNA AP	50-3905	NCDC	59.7539	-154.9069	183	2/2005-12/2009
JUNEAU AP	50-4100	NCDC	58.3567	-134.5639	-999	1/1973-12/2009
KENAI AP	50-4546	NCDC	60.5797	-151.2392	91	1/1984-12/2009
KETCHIKAN	50-4590	NCDC	55.3567	-131.7117	76	2/2005-12/2009
KING SALMON AP	50-4766	NCDC	58.6828	-156.6564	47	1/1973-12/2009
KLAWOCK AP	50-4901	NCDC	55.5800	-133.0750	12	3/2005-12/2009
KODIAK AP	50-4988	NCDC	57.7511	-152.4856	19	1/2000-12/2009
KODIAK NAVY AIR STN	50-4986	NCDC	57.7500	-152.5000	13	1/1984-5/1997
KOTZEBUE WSO AP	50-5076	NCDC	66.8850	-162.5967	10	1/1984-12/2009
MCGRATH AP	50-5769	NCDC	62.9575	-155.6103	333	1/1973-12/2009
NOME WSO AP	50-6496	NCDC	64.5111	-165.4400	13	1/1984-12/2009
NORTHWAY AP	50-6586	NCDC	62.9614	-141.9292	1713	1/1984-12/2009
PALMER AP	50-6867	NCDC	61.5961	-149.0917	230	2/2005-12/2009
SITKA JAPONSKI AP	50-8494	NCDC	57.0483	-135.3600	14	1/1984-12/2009
SKAGWAY AP	50-8528	NCDC	59.4556	-135.3239	20	2/2005-12/2009
ST PAUL ISLAND AP	50-8118	NCDC	57.1594	-170.2222	35	1/1973-12/2009

Name	Station ID	Source of data	Latitude	Longitude	Elevation (ft)	Period of record
TALKEETNA AP	50-8976	NCDC	62.3200	-150.0950	350	1/1984-12/2009
TANANA AP	50-9014	NCDC	65.1744	-152.1069	227	1/1984-12/2009
UNALAKLEET WSO AP	50-9564	NCDC	63.8833	-160.8000	18	1/1984-5/1997
VALDEZ MUNI AP	50-9685	NCDC	61.1314	-146.2433	105	1/1984-5/1997
YAKUTAT AP	50-9941	NCDC	59.5119	-139.6711	33	1/1973-12/2009

Appendix A.2 Bias correction report
(report was formatted by HDSC)

Alaskan Precipitation Bias Corrections

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Our goal was to make bias corrections for undercatch to all Alaskan precipitation data used in this study, including Canadian precipitation data along the eastern Alaskan border. Because of the sparse data network in Alaska, we used all acceptable precipitation data regardless of the collecting party and gauge type in our frequency estimation. A large majority of the instruments were the standard 8-inch National Weather Service (NWS) orifice gauge, but not all. Another challenge was determining when during their life span (especially for older stations of long duration) that Alter shields were added to the 8-inch NWS orifice gauges.

The best designed gauges do not collect 100% of falling precipitation, and gauges of different designs have different catch efficiencies; for example those of the United States and Canada. It is also clear that gauges where the top of the gauge is flush with the ground, with surrounding vegetation, or with some mechanical device like a wind shield, will catch more precipitation than those lacking such features.

The three most significant reasons for gauge undercatch are surface wetting, evaporation and wind. For precipitation intensity/duration/frequency (IDF) studies, wind is the most important variable to consider. The World Meteorological Organization (WMO) Solid Precipitation Measurement Intercomparison study (Goodison et al., 1998) was initiated at 26 sites in 13 countries in the northern hemisphere winter of 1986/1987. Several other published papers (Yang et al., 1998; Yang et al., 1999; Yang et al., 2000; and others) followed up on this study and reported on related results, such as equations for correcting undercatch of liquid precipitation for the 8-inch NWS orifice gauge.

The final outcome of the WMO study was a set of equations to correct for the undercatch of daily precipitation for the various gauges used in these 13 countries. As one might expect, there is considerable difference in the design, shape, size, construction materials, wind shield design and orifice height of each gauge type used (Sevruk and Klemm, 1989). All the studied gauges were compared against the Double Fence Intercomparison Reference (DFIR), a shielded Tretyakov gauge at 3 meters in height with an octagonal vertical double-fence shield. It was acknowledged that a gauge situated in a natural bush shelter provided the best estimate of "ground true" precipitation, but since bushes are not available in all climatic regions, an artificial shield was selected. Researchers also conceded that this gauge comes closest to the "true ground precipitation" when compared against other gauges, but the DFIR is still not an ideal gauge and therefore still suffers from undercatch. The equations for undercatch corrections require only one variable, wind; these equations, though, were only derived to correct 24 hour precipitation. All gauges used in the WMO study performed better for rainfall precipitation than for solid precipitation.

Ideally, we would identify the type of gauge used at each station in the Alaskan analysis and make bias corrections based on the results reported in the WMO Report No. 67 (Goodison, et al., 1998) for solid precipitation and in Yang et al. (1998) for liquid precipitation, but a number of discrepancies exist between the WMO methodologies and the historical data available to our study.

Numerous types of precipitation gauges used over the years in Alaska have been identified (8-inch NWS orifice standard rain gauge, Wyoming gauge system, 4-inch diameter plastic gauge, 12-inch diameter gauge; in addition, some of these have been fitted at some point with wind or Alter shields). In the WMO study, only national gauges were evaluated; therefore just the 8-inch orifice gauge and the

Wyoming system were evaluated for the United States. Further complicating the problem was that Canada has its own type of precipitation gauge (AES Type B for rain, Nipher gauge for snow). As indicated earlier, each gauge type has different catch efficiency and clearly the performance is enhanced if the gauge has a wind shield.

In effect, if we had a hypothetical true precipitation event of 1 inch in 24 hours, each measurement gauge would yield a different value, and all would report less than the original 1 inch of precipitation. We planned to make bias corrections to the precipitation data so that each gauge type would report close to the same value, even though all would still report less than the 1 inch hypothetical value since all gauges are imperfect. According to the results of the WMO study (Yang et al., 1998), for a 3 m/s wind speed, a standard 8-inch NWS precipitation gauge equipped with an Alter shield will undercatch the amount of liquid precipitation by 8.3% (21.8 % for solid precipitation); for a non-shielded gauge, the undercatch is 11.1% (45.2 % for solid precipitation).

So that the user of this report can grasp the possible magnitude of change at an actual station with an 8-inch NWS orifice shielded gauge, we calculated undercatch of the annual maximum 24 hour event at Annette, a small village in southeast Alaska, for a 25 year period (1984-2008). The average wind speed for these storms was 20.2 feet/sec (6.2 meters/sec) and the average undercatch of the annual maximum over this period was estimated to be 15.1%. These annual maximums are rain events that mostly occur in September and October. As this station is near the coast, it is likely to be a windier environment than non-coastal stations; therefore the percentage of undercatch would be greater than for less windy non-coastal areas.

For this study, to make the desired daily bias corrections at each site, we need good historical data on the type of gauge, when a wind shield was added and daily wind data. The plan was to make bias corrections for undercatch at all stations where the collected data is used; clearly, making corrections for a fraction of the stations is not acceptable. However, while we know the type of gauge (with a few exceptions), for most sites we do not know when wind shields were added as very little information on this event is recorded. While information such as moving gauges and installing new gauges were recorded, seldom was it noted when an Alter shield was added to a site. In addition, for many of the remote daily weather stations, we also lack wind data as it is not recorded. Also, a limitation of the WMO study is that the authors only derived equations for correcting daily precipitation, not for other durations (such as hourly). Because of this lack of information and data inconsistency over the whole study period, we were unable to make precipitation gauge undercatch corrections to the precipitation data used in this study.

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Appendix A.3 Annual maximum series trend analysis

1. Selection of statistical tests for detection of trends in AMS

Precipitation frequency analysis methods used in NOAA Atlas 14 volumes are based on the assumption of stationary climate over the period of observation (and application). To meet the stationarity criterion, the annual maximum series data must be free from trends during the observation period. A number of parametric and non-parametric statistical tests are available for the detection and/or quantification of trends. Selection of an appropriate statistical test requires consideration of the data tested and the limitations of the test.

Annual maximum series (AMS) were first graphed for each station in the project area to examine the time series and to observe general types of trends in the data. Visual inspection of time series plots indicated that there were no abrupt changes or apparent cycles in the AMS, but suggested the possibility of slight trends at some locations. Changes appeared to be gradual and approximately linear.

The null hypothesis that there are no trends in annual maximum series was tested on 1-hour and 1-day AMS data at each station in the project area with at least 40 years of data. The hypothesis was tested at each station separately and for the state as a whole at the level of significance α = 5%. At-station trends were inspected using the parametric *t*-test and non-parametric Mann-Kendall test (Maidment, 1993). Both tests are extensively used for trend analysis in environmental sciences and are appropriate for records that have undergone a gradual change. The tests are fairly robust, readily available, and easy to use and interpret. Since each test is based on different assumptions and different test statistics, the rationale was that if both tests have similar outcomes there can be more confidence about the results. If the outcomes were different, it would provide an opportunity to investigate reasons for discrepancies.

Parametric tests in general have been shown to be more powerful than non-parametric tests when the data are approximately normally distributed and when the assumption of homoscedasticity (homogeneous variance) holds (Hirsch et al., 1991), but are less reliable when those assumptions do not hold. The parametric *t*-test for trend detection is based on linear regression, and therefore checks only for a linear trend in data. A linear trend assumption seemed adequate here, since, time series plots indicated if any, monotonic, linear changes in AMS. The Pearson correlation coefficient (r) was used as a measure of linear association between annual maximum series data and time for the *t*-test. The hypothesis that the data are not dependent on time (and also that they are independent and normally distributed values) was tested using the test statistic t that follows Student's distribution as defined as:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

where n is the record length of the AMS. The hypothesis is rejected when the absolute value of the computed *t*-statistic is greater than the critical value obtained from Student's distribution with (n - 2) degrees of freedom and exceedance probability of $\alpha/2$ %, where α is the significance level. The sign of the *t*-statistic defines the direction of the trend, positive or negative.

Non-parametric tests have advantages over parametric tests since they make no assumption of probability distribution and are performed without specifying whether trend is linear or nonlinear. They are also more resilient to outliers in data because they do not operate on data directly. One of the disadvantages of non-parametric tests is that they do not account for the magnitude of the data. The Mann-Kendall test was selected among various non-parametric tests because it can accommodate missing values in a time series, which was a frequent occurrence in the AMS data. The Mann-

Kendall test compares the relative magnitudes of annual maximum data. If annual maximum values are indexed based on time, and x_i is the annual maximum value that corresponds to year t_i, then the Mann-Kendall statistic is given by:

$$S = \sum_{k=1}^{n-1} \sum_{i=k+1}^{n} sign(x_i - x_k)$$

The test statistic Z is then computed using a normal approximation and standardization of the statistic S. The null hypothesis that there is no trend in the data is rejected at significance level α if the computed Z value is greater, in absolute terms, than the critical value obtained from standard normal distribution that has probability of exceedance of α/2 %. The sign of the statistic defines the direction of the trend, positive or negative.

In addition to an at-station trend analysis, the relative magnitude of any trend in AMS for the state as a whole was assessed by linear regression techniques. 1-hour and 1-day station-specific AMS for stations with at least 40 years of data were rescaled by corresponding mean annual maximum values and then regressed against time, where time was defined as year of occurrence minus 1900. The regression results from all stations were tested against a null hypothesis of zero serial correlation (zero regression slopes).

2. Trend analysis results and conclusion

The null hypothesis that there are no trends in annual maximum series was tested on 1-hour and 1-day AMS data at each station in the project area with at least 40 years of data. For the 1-hour duration, 12 stations satisfied the record length criterion; for the 1-day duration, the number of stations was 154. The *t*-test and Mann-Kendall test for trends were applied to test the hypothesis. Results from both tests were very similar. Both tests indicated no statistically-significant trends at any station in the 1-hour data, and in about 85% of stations with 1-day data (details in Table A.3.1). In the 1-day dataset, positive trends were detected in about 8% of stations, and negative trends in about 7% of stations. The spatial distribution of the Mann-Kendall and *t*-test trend analysis results for 1-day AMS are shown in Figure A.3.1.

Table A.3.1. Trend analysis results based on *t*-test and Mann-Kendall (M-K) test for 1-hour and 1-day AMS data.

Number of stations	**1-hour**		**1-day**	
	***t*-test**	**M-K test**	***t*-test**	**M-K test**
no trend	12	12	130	132
positive trend	0	0	13	13
negative trend	0	0	11	9
Total	12	12	154	154

Results from the regional trend analysis also indicated that the null hypothesis that there are no trends in AMS in the state of Alaska as a whole could not be rejected at 5% significance level. Because tests at both the 1-hour and 1-day durations indicated no statistically-significant trends in the data, the assumption of stationary climate was accepted for this project area and no adjustment to AMS data was recommended.

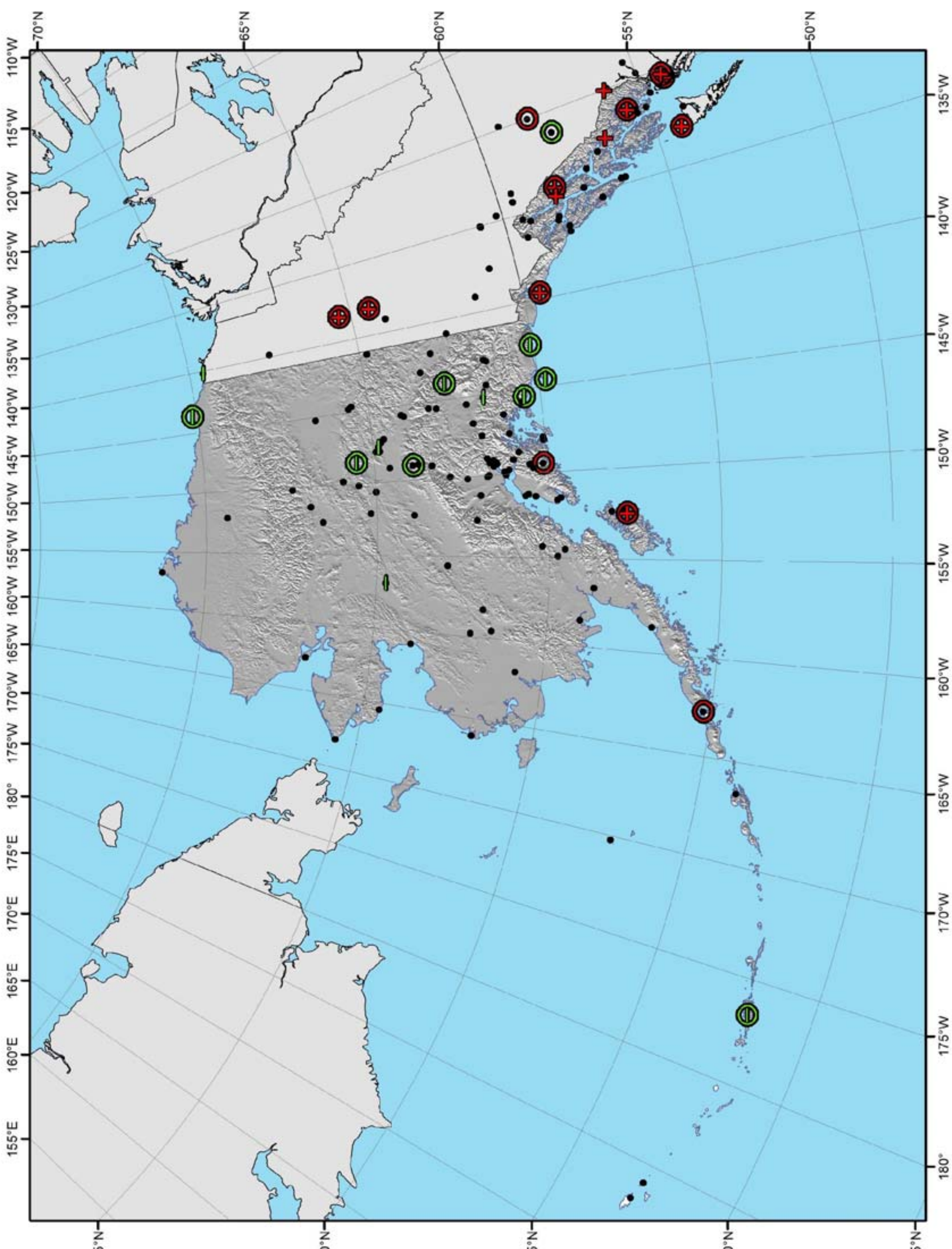

Figure A.2.1. Spatial distribution of Mann-Kendall test and *t*-test trend results for 1-day AMS. Red plus signs indicate locations where the Mann-Kendal test detected positive trends in AMS data and green negative signs indicate locations with negative trends. Similarly, red circles indicate locations where *t*-test indicated positive trends and green circles locations with negative trends.

Appendix A.4 List of L-moments (λ_1, λ_2, λ_3) for 1-day through 60-day durations

Table A.4.1. λ_1 moments.

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
10-0208	1.327	1.614	1.870	2.069	2.456	2.747	3.646	4.435	5.542	6.605
10-0215	1.106	1.323	1.517	1.669	1.959	2.182	2.914	3.583	4.495	5.290
10-0236	1.229	1.540	1.811	1.989	2.231	2.405	3.147	3.915	4.991	5.889
10-0238	0.768	0.923	1.062	1.171	1.385	1.548	2.091	2.587	3.231	3.730
10-0240	3.085	4.018	4.879	5.618	7.381	8.737	12.118	14.783	18.409	22.015
10-0241	4.498	6.170	7.713	9.036	12.111	14.626	22.100	28.679	38.116	47.578
10-0946	2.528	3.099	3.624	4.072	5.111	5.931	8.182	10.058	12.692	15.337
10-0947	1.535	1.844	2.125	2.355	2.848	3.234	4.408	5.442	6.833	8.051
10-0948	1.270	1.613	1.921	2.164	2.642	3.009	4.208	5.298	6.709	7.808
10-0949	1.363	1.824	2.236	2.556	3.177	3.639	5.054	6.283	7.981	9.572
10-0950	1.634	2.125	2.561	2.890	3.491	3.934	5.335	6.572	8.338	10.088
10-0951	1.095	1.360	1.603	1.805	2.247	2.606	3.756	4.809	6.207	7.355
10-0952	1.446	1.821	2.162	2.438	3.023	3.470	4.761	5.857	7.350	8.735
10-0955	1.949	2.368	2.753	3.078	3.827	4.407	5.964	7.243	8.936	10.466
10-0956	3.966	4.926	5.797	6.508	8.017	9.194	12.791	15.961	20.207	23.883
10-0957	1.318	1.651	1.959	2.223	2.830	3.330	4.882	6.284	8.170	9.779
10-0958	1.227	1.540	1.816	2.019	2.368	2.628	3.571	4.471	5.661	6.592
10-0959	2.818	3.541	4.189	4.691	5.669	6.393	8.548	10.389	12.963	15.468
10-0961	0.677	0.801	0.911	0.995	1.155	1.273	1.644	1.971	2.427	2.859
10-0962	1.266	1.576	1.850	2.052	2.399	2.656	3.547	4.373	5.530	6.579
10-0964	3.289	4.309	5.239	6.009	7.713	9.010	12.656	15.721	19.343	21.847
10-0966	1.299	1.527	1.745	1.950	2.533	3.004	4.035	4.810	5.814	6.769
10-0967	1.939	2.304	2.644	2.942	3.672	4.262	5.876	7.232	8.997	10.505
10-0968	1.299	1.506	1.695	1.853	2.200	2.488	3.475	4.421	5.714	6.798
10-1002	1.342	1.599	1.839	2.050	2.576	2.997	4.079	4.955	6.166	7.380
10-1003	1.772	2.094	2.390	2.640	3.211	3.667	5.005	6.167	7.717	9.062
10-1037	4.120	5.744	7.201	8.347	10.606	12.332	17.979	23.112	29.515	34.098
10-1064	3.219	4.128	4.947	5.604	6.952	7.992	11.314	14.304	17.965	20.501
10-1094	1.170	1.491	1.784	2.027	2.555	2.972	4.240	5.358	6.867	8.192
10-1291	1.255	1.553	1.812	1.988	2.243	2.427	3.157	3.884	4.916	5.827
10-1444	1.053	1.271	1.464	1.608	1.860	2.054	2.770	3.468	4.464	5.371
10-1449	3.333	4.250	5.086	5.781	7.319	8.512	11.887	14.736	18.603	22.185
10-9909	1.210	1.562	1.882	2.141	2.687	3.115	4.461	5.668	7.304	8.731
21-0115	0.836	0.990	1.128	1.237	1.456	1.623	2.132	2.576	3.211	3.843
21-0160	1.208	1.523	1.803	2.012	2.377	2.662	3.770	4.888	6.438	7.727
21-0163	1.394	1.704	1.980	2.186	2.547	2.824	3.848	4.848	6.259	7.511
21-0182	1.092	1.312	1.508	1.653	1.904	2.100	2.859	3.624	4.688	5.577
21-0200	0.889	1.009	1.118	1.206	1.385	1.526	1.993	2.424	2.995	3.456
21-0330	3.184	4.305	5.328	6.178	8.044	9.525	14.004	17.949	23.397	28.435
21-0402	0.839	0.996	1.138	1.252	1.479	1.659	2.288	2.887	3.702	4.381
21-0446	3.757	4.894	5.933	6.798	8.699	10.218	14.892	19.057	24.758	29.878
21-0468	1.241	1.432	1.609	1.761	2.114	2.409	3.346	4.206	5.371	6.364
21-0560	0.967	1.120	1.258	1.370	1.607	1.792	2.365	2.875	3.588	4.258
21-0630	1.137	1.309	1.462	1.578	1.792	1.949	2.439	2.867	3.476	4.075
21-0679	1.031	1.213	1.381	1.524	1.857	2.132	2.986	3.758	4.847	5.877
21-0685	0.686	0.814	0.928	1.017	1.193	1.328	1.756	2.141	2.661	3.115
21-0794	0.994	1.170	1.330	1.462	1.745	1.971	2.670	3.294	4.182	5.044
21-0805	0.921	1.087	1.234	1.343	1.536	1.684	2.241	2.788	3.540	4.164
21-0907	0.842	0.972	1.091	1.187	1.383	1.543	2.110	2.661	3.457	4.208
21-0935	1.261	1.436	1.597	1.733	2.036	2.282	3.027	3.687	4.640	5.600
21-1000	1.237	1.448	1.638	1.790	2.091	2.332	3.182	3.997	5.104	6.014

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
21-1033	1.000	1.219	1.412	1.552	1.787	1.957	2.546	3.090	3.786	4.305
21-1050	1.749	2.259	2.707	3.022	3.529	3.884	5.070	6.131	7.578	8.864
21-1070	0.705	0.853	0.988	1.098	1.331	1.508	2.019	2.453	3.031	3.543
21-1086	3.137	3.948	4.703	5.369	7.021	8.357	11.917	14.860	18.952	23.014
21-1300	0.812	0.960	1.093	1.197	1.394	1.548	2.082	2.588	3.274	3.847
21-1400	0.913	1.070	1.208	1.305	1.451	1.563	2.059	2.594	3.352	3.980
21-1440	1.471	1.714	1.942	2.145	2.650	3.073	4.295	5.360	6.845	8.257
21-2340	1.102	1.267	1.419	1.551	1.859	2.117	2.920	3.651	4.684	5.661
21-3245	1.323	1.683	2.001	2.233	2.643	2.923	3.713	4.352	5.247	6.167
21-3255	0.909	1.100	1.272	1.409	1.685	1.895	2.525	3.071	3.801	4.440
21-3298	3.779	4.777	5.688	6.445	8.079	9.418	13.841	17.975	23.789	29.103
21-3315	2.858	3.564	4.215	4.771	6.057	7.092	10.100	12.704	16.287	19.624
21-3672	1.048	1.270	1.473	1.645	2.032	2.344	3.311	4.179	5.259	6.040
21-4500	2.230	2.800	3.340	3.835	5.126	6.256	9.622	12.650	17.016	21.360
21-4920	1.969	2.432	2.874	3.284	4.377	5.336	8.122	10.595	14.098	17.493
21-5130	3.438	4.554	5.565	6.384	8.086	9.431	13.702	17.564	23.100	28.519
21-5248	1.854	2.154	2.435	2.685	3.319	3.833	5.191	6.310	7.817	9.223
21-5275	3.439	4.580	5.616	6.465	8.277	9.696	13.953	17.670	22.997	28.360
21-5384	2.313	2.973	3.565	4.032	4.962	5.668	7.837	9.737	12.409	14.987
21-6336	3.180	4.416	5.532	6.429	8.259	9.703	14.378	18.649	24.743	30.602
21-6420	3.668	4.612	5.507	6.322	8.455	10.268	15.315	19.650	25.718	31.616
21-6483	3.535	4.521	5.431	6.211	8.002	9.492	14.223	18.564	24.625	30.154
21-6488	5.016	6.251	7.401	8.411	10.867	12.900	18.803	23.955	31.028	37.542
21-6492	4.232	5.499	6.667	7.670	9.992	11.901	17.777	23.060	30.175	36.296
21-6493	4.716	5.965	7.123	8.132	10.548	12.532	18.289	23.297	30.256	36.846
21-7742	3.424	4.481	5.453	6.278	8.171	9.684	14.046	17.796	23.060	28.209
21-8036	2.087	2.673	3.201	3.624	4.482	5.154	7.341	9.339	12.038	14.340
21-8040	1.030	1.201	1.354	1.469	1.681	1.843	2.409	2.943	3.619	4.098
21-8041	1.221	1.460	1.672	1.830	2.113	2.316	2.943	3.485	4.235	4.949
21-8202	1.127	1.336	1.528	1.692	2.071	2.371	3.209	3.917	4.887	5.806
21-8250	1.962	2.334	2.696	3.043	4.047	4.936	7.298	9.299	12.162	15.110
21-8535	3.372	4.405	5.348	6.132	7.861	9.211	13.086	16.385	21.014	25.574
30-1100	1.217	1.434	1.634	1.805	2.201	2.520	3.429	4.207	5.309	6.412
30-1110	1.218	1.435	1.636	1.807	2.204	2.522	3.430	4.208	5.310	6.412
40-1220	1.247	1.422	1.587	1.736	2.113	2.437	3.406	4.274	5.524	6.768
40-1250	1.146	1.311	1.466	1.603	1.936	2.226	3.179	4.082	5.316	6.356
40-1300	0.718	0.809	0.891	0.959	1.099	1.218	1.682	2.162	2.779	3.196
40-1510	0.553	0.626	0.696	0.761	0.938	1.088	1.488	1.823	2.280	2.708
50-0026	2.618	3.106	3.558	3.948	4.846	5.622	8.312	10.936	14.556	17.610
50-0230	1.071	1.264	1.439	1.583	1.889	2.127	2.851	3.486	4.343	5.100
50-0243	4.011	5.121	6.122	6.922	8.568	9.811	13.474	16.607	20.848	24.707
50-0249	1.386	1.703	1.994	2.243	2.816	3.273	4.634	5.827	7.235	8.158
50-0280	1.357	1.585	1.797	1.982	2.433	2.790	3.720	4.477	5.510	6.514
50-0310	1.896	2.420	2.901	3.305	4.199	4.931	7.295	9.475	12.489	15.171
50-0332	1.411	1.778	2.109	2.374	2.917	3.334	4.640	5.801	7.332	8.604
50-0352	3.878	4.907	5.868	6.719	8.805	10.565	15.806	20.468	27.104	33.591
50-0363	3.966	5.290	6.503	7.527	9.823	11.692	17.533	22.813	30.071	36.560
50-0433	2.976	3.342	3.702	4.054	5.093	6.046	8.703	11.037	14.447	18.003
50-0452	3.201	3.820	4.388	4.866	5.925	6.802	9.682	12.374	16.133	19.518
50-0464	2.531	3.186	3.792	4.318	5.556	6.591	9.783	12.671	16.739	20.576
50-0522	4.922	6.672	8.298	9.720	13.123	15.970	24.632	32.411	43.113	52.761
50-0546	0.517	0.606	0.686	0.751	0.886	0.990	1.299	1.567	1.932	2.266
50-0558	0.719	0.847	0.960	1.043	1.180	1.281	1.634	1.962	2.390	2.725
50-0657	5.537	7.080	8.506	9.737	12.605	15.001	22.525	29.398	39.020	47.890
50-0676	3.974	5.232	6.394	7.397	9.749	11.684	17.459	22.562	29.822	36.947

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-0685	1.999	2.418	2.805	3.137	3.918	4.542	6.270	7.724	9.743	11.711
50-0707	1.252	1.475	1.676	1.835	2.147	2.391	3.219	3.991	5.018	5.845
50-0754	1.152	1.425	1.674	1.879	2.322	2.678	3.821	4.866	6.265	7.436
50-0761	1.044	1.252	1.445	1.612	2.014	2.332	3.176	3.867	4.810	5.716
50-0770	1.246	1.485	1.698	1.861	2.163	2.396	3.217	3.997	5.057	5.944
50-0788	3.046	4.046	4.952	5.685	7.250	8.411	11.515	14.022	17.465	20.872
50-0910	1.110	1.342	1.551	1.717	2.048	2.310	3.188	4.007	5.188	6.328
50-1201	3.938	5.153	6.300	7.344	10.033	12.357	19.255	25.426	33.905	41.559
50-1220	1.320	1.586	1.827	2.024	2.442	2.766	3.740	4.589	5.727	6.725
50-1230	0.684	0.802	0.908	0.988	1.136	1.249	1.631	1.984	2.504	3.036
50-1240	4.843	6.648	8.306	9.710	12.950	15.461	22.204	27.744	35.092	41.760
50-1243	1.400	1.728	2.021	2.244	2.659	2.975	4.055	5.059	6.434	7.624
50-1251	3.038	3.955	4.803	5.531	7.279	8.616	11.859	14.368	17.882	21.635
50-1269	2.860	3.616	4.311	4.904	6.249	7.371	11.010	14.394	19.091	23.276
50-1308	3.829	5.394	6.795	7.883	9.992	11.571	16.432	20.675	26.682	32.579
50-1312	1.158	1.504	1.806	2.011	2.314	2.524	3.283	3.988	4.926	5.685
50-1314	2.071	2.672	3.207	3.615	4.366	4.944	6.991	8.939	11.593	13.817
50-1318	1.707	2.184	2.618	2.971	3.726	4.311	6.036	7.522	9.614	11.666
50-1321	3.423	4.666	5.789	6.693	8.541	10.001	14.788	19.189	25.258	30.640
50-1325	1.701	2.129	2.516	2.825	3.462	3.948	5.426	6.718	8.376	9.692
50-1334	4.548	6.014	7.345	8.432	10.740	12.552	18.065	22.919	29.912	36.984
50-1466	0.980	1.181	1.361	1.501	1.773	1.984	2.700	3.368	4.288	5.092
50-1492	0.962	1.103	1.231	1.336	1.560	1.737	2.295	2.797	3.472	4.052
50-1574	1.342	1.681	1.983	2.214	2.652	2.976	3.967	4.824	6.064	7.345
50-1684	1.288	1.510	1.711	1.877	2.232	2.514	3.394	4.183	5.216	6.050
50-1763	3.896	4.991	5.989	6.812	8.618	10.007	13.802	16.924	21.635	27.171
50-1824	1.586	1.853	2.091	2.272	2.623	2.862	3.438	3.868	4.484	5.197
50-1926	2.405	3.110	3.742	4.232	5.180	5.889	8.090	10.023	12.654	15.023
50-1977	0.903	1.026	1.137	1.225	1.401	1.536	1.968	2.356	2.907	3.438
50-1987	1.028	1.267	1.476	1.623	1.852	2.018	2.644	3.250	4.084	4.790
50-2005	1.262	1.530	1.772	1.967	2.369	2.673	3.564	4.325	5.308	6.115
50-2102	2.135	2.513	2.860	3.155	3.825	4.373	6.063	7.581	9.717	11.737
50-2107	1.091	1.314	1.513	1.668	1.968	2.195	2.939	3.614	4.526	5.308
50-2112	1.123	1.351	1.555	1.714	2.019	2.255	3.043	3.772	4.765	5.623
50-2126	0.522	0.600	0.674	0.746	0.957	1.136	1.554	1.882	2.342	2.827
50-2144	2.412	3.106	3.731	4.227	5.243	5.986	8.032	9.707	11.891	13.812
50-2147	1.939	2.307	2.630	2.865	3.258	3.546	4.560	5.507	6.878	8.213
50-2156	1.241	1.370	1.489	1.591	1.821	2.010	2.615	3.171	3.901	4.483
50-2173	6.810	9.194	11.349	13.084	16.681	19.456	28.048	35.653	45.547	53.555
50-2177	4.825	6.362	7.760	8.908	11.378	13.309	19.091	24.134	30.994	37.193
50-2227	3.827	4.829	5.772	6.623	8.786	10.635	16.044	20.827	27.577	34.090
50-2247	0.993	1.203	1.395	1.555	1.905	2.192	3.125	3.990	5.172	6.197
50-2339	1.270	1.580	1.852	2.046	2.357	2.588	3.476	4.350	5.536	6.492
50-2350	1.270	1.515	1.734	1.903	2.220	2.469	3.374	4.254	5.449	6.427
50-2352	1.192	1.469	1.710	1.874	2.107	2.277	3.003	3.757	4.766	5.517
50-2457	1.425	1.780	2.101	2.359	2.884	3.299	4.673	5.943	7.665	9.129
50-2568	1.319	1.642	1.925	2.126	2.442	2.678	3.600	4.519	5.825	6.980
50-2587	3.186	4.130	4.972	5.618	6.835	7.750	10.727	13.411	17.096	20.396
50-2607	1.037	1.190	1.331	1.448	1.703	1.913	2.616	3.280	4.197	4.995
50-2707	1.175	1.450	1.693	1.873	2.188	2.424	3.245	4.013	5.086	6.051
50-2725	0.978	1.133	1.274	1.394	1.663	1.880	2.546	3.141	3.940	4.630
50-2730	1.403	1.658	1.886	2.064	2.408	2.679	3.637	4.556	5.825	6.912
50-2737	1.243	1.475	1.686	1.858	2.219	2.503	3.392	4.188	5.322	6.428
50-2770	2.691	3.531	4.293	4.916	6.248	7.276	10.309	12.926	16.393	19.388
50-2785	4.197	5.218	6.185	7.066	9.367	11.330	16.822	21.554	28.349	35.296

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-2820	1.227	1.459	1.671	1.848	2.243	2.555	3.475	4.273	5.359	6.345
50-2825	1.144	1.391	1.618	1.810	2.253	2.602	3.588	4.423	5.563	6.631
50-2952	1.352	1.658	1.930	2.135	2.511	2.789	3.681	4.474	5.592	6.660
50-2968	1.096	1.268	1.423	1.550	1.819	2.031	2.699	3.298	4.116	4.838
50-2988	1.407	1.733	2.027	2.266	2.767	3.153	4.301	5.293	6.722	8.193
50-3009	1.390	1.593	1.784	1.956	2.393	2.763	3.850	4.812	6.053	7.042
50-3072	2.308	2.973	3.586	4.111	5.319	6.307	9.332	12.041	15.690	18.845
50-3082	0.909	0.985	1.058	1.129	1.331	1.511	2.005	2.434	3.029	3.596
50-3085	1.148	1.415	1.662	1.874	2.372	2.779	4.002	5.086	6.559	7.870
50-3160	1.410	1.867	2.271	2.565	3.062	3.422	4.649	5.769	7.283	8.573
50-3163	1.274	1.513	1.732	1.915	2.326	2.650	3.584	4.386	5.464	6.430
50-3196	1.206	1.430	1.635	1.805	2.173	2.469	3.381	4.195	5.380	6.587
50-3198	2.594	3.400	4.131	4.726	5.979	6.975	10.231	13.226	17.087	20.037
50-3205	1.000	1.214	1.404	1.547	1.806	2.001	2.642	3.223	4.134	5.206
50-3212	1.052	1.196	1.330	1.447	1.722	1.954	2.693	3.376	4.317	5.149
50-3226	1.374	1.562	1.736	1.888	2.262	2.559	3.341	3.981	4.830	5.605
50-3275	1.323	1.630	1.906	2.121	2.537	2.854	3.893	4.836	6.074	7.068
50-3294	2.621	3.521	4.352	5.065	6.736	8.074	11.827	15.008	19.453	23.814
50-3299	1.735	2.138	2.497	2.769	3.264	3.638	4.897	6.057	7.739	9.399
50-3454	2.386	3.084	3.732	4.299	5.662	6.782	9.956	12.679	16.661	20.905
50-3465	1.012	1.188	1.345	1.468	1.703	1.885	2.506	3.086	3.873	4.540
50-3475	2.402	3.058	3.666	4.192	5.441	6.460	9.393	11.926	15.507	19.047
50-3490	2.891	3.753	4.539	5.193	6.639	7.763	10.946	13.634	17.361	20.970
50-3500	2.586	3.346	4.040	4.615	5.889	6.872	9.588	11.844	15.040	18.322
50-3504	2.870	3.545	4.165	4.692	5.903	6.868	9.619	11.966	15.235	18.397
50-3530	2.498	3.071	3.592	4.020	4.943	5.660	7.784	9.623	12.077	14.222
50-3573	2.254	2.839	3.356	3.734	4.376	4.851	6.563	8.188	10.369	12.140
50-3585	1.312	1.607	1.871	2.075	2.466	2.760	3.679	4.491	5.642	6.767
50-3605	4.051	5.397	6.659	7.785	10.593	12.975	20.014	26.258	35.111	43.711
50-3655	1.347	1.612	1.854	2.052	2.472	2.814	3.955	5.026	6.500	7.778
50-3665	1.589	1.899	2.185	2.429	2.996	3.451	4.763	5.892	7.480	9.035
50-3672	1.707	2.072	2.408	2.693	3.348	3.875	5.430	6.788	8.666	10.420
50-3682	1.534	1.814	2.071	2.291	2.795	3.205	4.456	5.571	7.067	8.352
50-3695	2.541	3.242	3.887	4.433	5.674	6.677	9.661	12.279	15.998	19.658
50-3720	1.896	2.176	2.425	2.612	2.941	3.203	4.283	5.417	7.023	8.380
50-3765	1.658	1.955	2.217	2.406	2.721	2.944	3.690	4.358	5.243	5.976
50-3905	1.852	2.205	2.529	2.802	3.411	3.904	5.433	6.807	8.689	10.368
50-3910	1.584	2.118	2.578	2.869	3.225	3.469	4.512	5.570	6.928	7.858
50-3933	2.099	2.566	2.992	3.345	4.121	4.724	6.450	7.917	9.904	11.726
50-4094	3.486	4.519	5.462	6.248	7.966	9.361	13.850	17.970	23.655	28.716
50-4100	2.397	3.066	3.679	4.195	5.348	6.277	9.089	11.577	15.131	18.644
50-4103	3.321	4.274	5.152	5.902	7.605	9.031	13.708	18.088	24.140	29.451
50-4155	2.326	3.001	3.632	4.192	5.600	6.732	9.685	12.102	15.262	18.058
50-4425	1.323	1.595	1.843	2.046	2.488	2.830	3.807	4.634	5.786	6.904
50-4546	1.348	1.626	1.879	2.085	2.522	2.867	3.943	4.907	6.246	7.484
50-4550	1.559	1.899	2.204	2.442	2.900	3.250	4.368	5.372	6.825	8.286
50-4555	1.782	2.168	2.509	2.761	3.198	3.524	4.669	5.744	7.243	8.582
50-4590	5.826	7.552	9.133	10.458	13.392	15.771	23.230	29.975	39.382	48.060
50-4621	1.320	1.658	1.963	2.206	2.704	3.073	4.094	4.929	6.175	7.611
50-4766	1.169	1.409	1.629	1.814	2.224	2.565	3.693	4.754	6.236	7.564
50-4812	2.418	3.083	3.691	4.200	5.318	6.235	9.230	12.010	15.821	19.132
50-4964	1.491	1.900	2.262	2.528	2.994	3.326	4.357	5.249	6.454	7.537
50-4988	3.186	4.008	4.750	5.345	6.561	7.514	10.571	13.342	17.226	20.841
50-4991	2.853	3.619	4.312	4.875	6.063	6.978	9.679	12.004	15.275	18.482
50-5076	0.857	1.043	1.211	1.345	1.615	1.823	2.486	3.083	3.845	4.428

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-5136	0.614	0.694	0.767	0.828	0.964	1.074	1.423	1.739	2.110	2.338
50-5318	1.188	1.364	1.524	1.658	1.950	2.188	2.943	3.633	4.594	5.472
50-5397	1.145	1.292	1.428	1.543	1.801	2.017	2.759	3.470	4.422	5.182
50-5454	5.196	7.204	9.044	10.590	14.025	16.833	25.923	34.308	45.314	54.040
50-5464	1.392	1.691	1.958	2.165	2.554	2.854	3.877	4.832	6.159	7.341
50-5499	2.328	3.046	3.705	4.261	5.503	6.523	9.824	12.875	16.940	20.273
50-5519	8.932	11.376	13.644	15.619	20.347	24.239	35.580	45.477	59.275	72.402
50-5534	1.019	1.202	1.370	1.513	1.839	2.102	2.897	3.600	4.549	5.382
50-5604	6.364	8.870	11.150	13.022	17.025	20.208	30.165	39.107	51.608	63.273
50-5607	1.485	1.934	2.339	2.663	3.321	3.834	5.510	7.042	9.094	10.811
50-5644	1.429	1.696	1.940	2.143	2.592	2.942	3.943	4.795	5.939	6.971
50-5733	1.230	1.477	1.700	1.877	2.232	2.508	3.404	4.220	5.354	6.383
50-5757	1.543	1.877	2.172	2.388	2.762	3.039	4.031	4.969	6.219	7.224
50-5769	1.208	1.428	1.629	1.797	2.163	2.461	3.421	4.302	5.540	6.685
50-5778	1.575	1.874	2.141	2.350	2.760	3.067	4.006	4.822	5.967	7.072
50-5810	1.331	1.563	1.776	1.955	2.361	2.677	3.578	4.343	5.308	6.067
50-5880	1.332	1.671	1.975	2.212	2.676	3.028	4.138	5.125	6.504	7.801
50-5881	1.167	1.349	1.516	1.659	1.985	2.256	3.113	3.898	5.022	6.107
50-5882	1.376	1.628	1.854	2.030	2.370	2.632	3.496	4.287	5.350	6.245
50-5894	2.216	2.739	3.223	3.637	4.635	5.383	7.132	8.461	10.189	11.819
50-5898	2.422	3.064	3.647	4.123	5.149	5.929	8.077	9.847	12.418	15.208
50-6058	1.479	1.778	2.053	2.286	2.822	3.246	4.471	5.526	6.849	7.868
50-6147	1.171	1.477	1.747	1.945	2.287	2.537	3.410	4.221	5.254	6.017
50-6270	1.147	1.338	1.512	1.659	1.988	2.254	3.063	3.783	4.780	5.698
50-6309	1.247	1.477	1.684	1.848	2.187	2.439	3.159	3.763	4.582	5.345
50-6441	1.698	1.992	2.262	2.487	2.992	3.385	4.489	5.417	6.720	8.021
50-6496	1.231	1.532	1.803	2.019	2.459	2.798	3.873	4.836	6.111	7.168
50-6562	4.875	6.305	7.623	8.749	11.369	13.467	19.490	24.663	31.624	37.856
50-6581	1.110	1.287	1.448	1.580	1.860	2.081	2.772	3.392	4.209	4.881
50-6586	1.252	1.422	1.576	1.703	1.971	2.191	2.973	3.734	4.741	5.514
50-6656	1.150	1.386	1.605	1.795	2.251	2.617	3.635	4.498	5.594	6.474
50-6727	1.106	1.298	1.468	1.591	1.793	1.953	2.644	3.389	4.459	5.370
50-6760	1.613	1.912	2.195	2.454	3.135	3.718	5.385	6.843	8.767	10.395
50-6853	3.262	4.181	5.017	5.704	7.189	8.347	11.792	14.783	18.871	22.617
50-6870	1.266	1.516	1.741	1.917	2.263	2.531	3.407	4.206	5.297	6.250
50-6875	1.525	1.823	2.096	2.327	2.856	3.271	4.431	5.407	6.723	7.932
50-7097	1.385	1.724	2.026	2.260	2.701	3.043	4.248	5.395	6.924	8.145
50-7105	1.202	1.436	1.651	1.834	2.248	2.588	3.684	4.694	5.938	6.792
50-7141	5.937	8.015	9.942	11.617	15.653	18.892	27.764	35.201	45.276	54.644
50-7251	4.078	5.312	6.451	7.430	9.713	11.575	17.043	21.818	28.676	35.611
50-7352	1.313	1.525	1.717	1.875	2.211	2.480	3.343	4.130	5.222	6.211
50-7365	1.504	1.795	2.058	2.269	2.694	3.039	4.292	5.519	7.150	8.407
50-7431	0.892	1.054	1.198	1.310	1.522	1.686	2.247	2.773	3.510	4.178
50-7442	0.742	0.874	1.001	1.119	1.450	1.720	2.383	2.919	3.482	3.793
50-7451	3.188	4.260	5.216	5.944	7.285	8.309	11.820	15.098	19.810	24.325
50-7494	2.980	4.123	5.150	5.960	7.568	8.794	12.695	16.186	20.786	24.571
50-7557	5.797	7.283	8.657	9.843	12.584	14.916	22.648	29.971	40.233	49.427
50-7570	1.379	1.660	1.915	2.121	2.552	2.887	3.908	4.805	6.102	7.425
50-7700	1.417	1.647	1.851	2.002	2.262	2.463	3.253	4.054	5.191	6.185
50-7738	4.625	6.038	7.367	8.564	11.618	14.193	21.592	28.052	36.533	43.628
50-7783	1.314	1.607	1.867	2.064	2.428	2.701	3.625	4.476	5.581	6.436
50-7854	3.974	5.307	6.524	7.538	9.756	11.554	17.268	22.477	29.827	36.736
50-7900	0.958	1.143	1.307	1.432	1.668	1.841	2.376	2.840	3.494	4.132
50-7977	1.279	1.555	1.803	1.996	2.375	2.662	3.589	4.424	5.508	6.367
50-8025	1.326	1.626	1.895	2.105	2.517	2.827	3.786	4.626	5.780	6.836

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-8054	1.214	1.452	1.676	1.879	2.411	2.848	3.994	4.940	6.180	7.275
50-8105	1.106	1.384	1.636	1.840	2.264	2.600	3.711	4.738	6.044	7.006
50-8118	1.231	1.410	1.582	1.742	2.170	2.555	3.739	4.832	6.384	7.848
50-8140	1.337	1.612	1.856	2.039	2.367	2.615	3.494	4.326	5.456	6.403
50-8183	2.010	2.469	2.890	3.243	4.047	4.673	6.408	7.858	9.822	11.651
50-8355	2.646	3.217	3.743	4.193	5.251	6.082	8.344	10.225	12.660	14.734
50-8371	3.955	5.061	6.070	6.909	8.774	10.213	14.249	17.639	22.074	25.904
50-8375	4.353	5.683	6.878	7.817	9.707	11.089	14.927	18.073	22.495	27.019
50-8377	3.639	4.390	5.074	5.637	6.871	7.810	10.426	12.608	15.444	17.877
50-8409	1.351	1.625	1.867	2.040	2.320	2.530	3.355	4.177	5.273	6.105
50-8419	1.677	1.941	2.186	2.396	2.882	3.292	4.613	5.841	7.616	9.341
50-8437	0.850	0.950	1.042	1.121	1.301	1.455	2.006	2.550	3.251	3.749
50-8494	3.790	4.830	5.788	6.602	8.454	9.971	14.655	18.869	24.776	30.312
50-8503	3.935	4.979	5.944	6.774	8.714	10.312	15.129	19.412	25.461	31.279
50-8512	2.656	3.150	3.596	3.957	4.684	5.284	7.516	9.750	12.850	15.443
50-8525	2.320	2.894	3.412	3.826	4.674	5.312	7.161	8.729	10.852	12.806
50-8536	1.934	2.377	2.776	3.096	3.755	4.256	5.734	7.000	8.755	10.428
50-8547	1.483	1.753	1.998	2.196	2.614	2.932	3.854	4.638	5.733	6.806
50-8584	5.574	7.850	9.939	11.704	15.733	18.914	27.783	35.233	46.024	57.499
50-8594	1.059	1.252	1.424	1.555	1.792	1.978	2.677	3.370	4.348	5.209
50-8625	1.069	1.318	1.541	1.717	2.065	2.333	3.221	4.035	5.143	6.096
50-8666	1.575	1.891	2.186	2.446	3.088	3.611	5.032	6.221	7.878	9.514
50-8811	1.502	1.833	2.130	2.364	2.832	3.188	4.290	5.260	6.612	7.885
50-8882	1.790	2.304	2.765	3.125	3.822	4.356	6.107	7.704	9.854	11.680
50-8915	1.409	1.767	2.083	2.317	2.724	3.023	4.016	4.916	6.181	7.368
50-8976	1.964	2.444	2.879	3.232	3.976	4.548	6.229	7.673	9.676	11.588
50-8987	1.554	1.803	2.024	2.190	2.499	2.719	3.379	3.939	4.669	5.289
50-9014	1.147	1.356	1.549	1.714	2.091	2.396	3.294	4.077	5.148	6.124
50-9035	1.126	1.382	1.618	1.820	2.289	2.655	3.616	4.394	5.516	6.735
50-9102	1.082	1.303	1.500	1.649	1.918	2.122	2.833	3.501	4.389	5.104
50-9121	2.870	3.908	4.862	5.668	7.522	8.957	12.829	16.016	20.233	24.031
50-9144	1.579	1.845	2.093	2.310	2.836	3.278	4.629	5.847	7.535	9.077
50-9249	1.176	1.464	1.724	1.932	2.356	2.684	3.725	4.661	5.897	6.920
50-9313	1.268	1.478	1.663	1.793	1.995	2.145	2.711	3.267	4.080	4.866
50-9385	1.269	1.478	1.661	1.792	2.006	2.164	2.742	3.297	4.074	4.762
50-9399	3.122	4.131	5.067	5.883	7.823	9.452	14.488	19.056	25.380	31.110
50-9410	2.584	3.159	3.678	4.096	4.967	5.631	7.579	9.246	11.588	13.893
50-9421	1.019	1.221	1.403	1.548	1.837	2.069	2.889	3.678	4.729	5.556
50-9460	4.059	5.075	5.992	6.729	8.246	9.413	13.017	16.198	20.443	24.083
50-9489	1.299	1.612	1.895	2.124	2.606	2.972	4.008	4.875	6.122	7.428
50-9511	3.119	3.856	4.523	5.060	6.168	7.029	9.685	12.033	15.431	18.890
50-9539	0.972	1.108	1.227	1.307	1.422	1.501	1.790	2.061	2.431	2.749
50-9564	1.160	1.452	1.713	1.919	2.322	2.632	3.646	4.570	5.818	6.883
50-9641	1.096	1.306	1.495	1.644	1.942	2.171	2.901	3.557	4.437	5.185
50-9686	3.103	4.158	5.119	5.913	7.671	9.003	12.567	15.465	19.448	23.371
50-9702	4.743	6.011	7.226	8.361	11.440	14.159	22.044	29.050	38.807	47.918
50-9739	1.090	1.345	1.573	1.749	2.086	2.341	3.167	3.913	4.935	5.847
50-9759	1.292	1.595	1.866	2.076	2.473	2.776	3.779	4.697	5.968	7.110
50-9765	1.320	1.706	2.050	2.311	2.793	3.152	4.312	5.352	6.771	8.029
50-9790	1.843	2.230	2.580	2.860	3.442	3.876	5.083	6.079	7.486	8.927
50-9793	1.216	1.479	1.714	1.891	2.216	2.462	3.312	4.106	5.193	6.127
50-9829	6.683	9.554	12.152	14.253	18.667	22.047	31.878	40.254	52.308	64.809
50-9861	1.883	2.191	2.471	2.702	3.204	3.597	4.769	5.790	7.148	8.319
50-9869	1.235	1.517	1.765	1.945	2.248	2.468	3.221	3.913	4.867	5.718
50-9883	1.869	2.074	2.270	2.453	2.942	3.386	4.828	6.201	8.033	9.495

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-9919	3.212	4.135	4.988	5.723	7.444	8.864	13.139	16.941	22.324	27.531
50-9930	4.027	5.232	6.341	7.284	9.431	11.189	16.622	21.512	28.287	34.475
50-9941	5.381	6.938	8.371	9.593	12.386	14.684	21.837	28.311	37.229	45.240
55-0064	4.384	5.570	6.656	7.570	9.601	11.264	16.638	21.595	28.236	33.750
55-0079	0.898	1.043	1.178	1.294	1.571	1.790	2.350	2.798	3.501	4.414
55-0080	3.240	4.038	4.786	5.455	7.108	8.540	13.061	17.248	22.998	28.023
55-0087	1.375	1.589	1.792	1.977	2.472	2.866	3.757	4.431	5.363	6.354
55-0096	1.244	1.426	1.599	1.758	2.188	2.543	3.441	4.167	5.156	6.113
55-0164	0.587	0.646	0.702	0.752	0.878	0.986	1.315	1.612	2.014	2.362
80-0100	1.402	1.575	1.735	1.874	2.195	2.463	3.327	4.126	5.166	5.972
80-0120	1.382	1.629	1.852	2.032	2.398	2.686	3.596	4.416	5.648	6.985
80-0140	1.015	1.129	1.238	1.336	1.588	1.807	2.482	3.098	3.946	4.700
80-0160	0.884	0.983	1.076	1.156	1.352	1.512	1.957	2.334	2.875	3.434
80-0200	1.132	1.301	1.456	1.588	1.887	2.133	2.908	3.613	4.576	5.417
80-0220	4.803	5.980	7.091	8.096	10.662	12.871	19.437	25.308	33.476	41.048
80-0240	1.467	1.679	1.894	2.112	2.847	3.466	4.624	5.433	6.575	7.934
80-0260	0.978	1.124	1.259	1.375	1.644	1.864	2.539	3.144	3.942	4.602
80-0340	1.517	1.758	1.984	2.190	2.710	3.171	4.670	6.090	8.022	9.640
80-0425	1.468	1.775	2.054	2.285	2.797	3.187	4.241	5.103	6.306	7.519
80-0440	0.880	0.995	1.102	1.195	1.412	1.589	2.112	2.573	3.156	3.604
80-0460	1.432	1.770	2.065	2.269	2.577	2.798	3.612	4.389	5.559	6.781
80-0540	1.071	1.302	1.503	1.642	1.848	2.001	2.663	3.359	4.283	4.947
80-0560	1.563	1.830	2.068	2.253	2.609	2.877	3.713	4.449	5.532	6.677
80-0640	1.304	1.605	1.870	2.061	2.371	2.605	3.517	4.427	5.694	6.761
80-0780	1.357	1.727	2.050	2.277	2.626	2.877	3.787	4.647	5.900	7.128
80-0820	1.567	1.857	2.127	2.366	2.950	3.438	4.950	6.322	7.862	8.712
80-0860	1.603	1.892	2.146	2.328	2.623	2.844	3.717	4.592	5.785	6.739
80-0900	1.310	1.632	1.915	2.113	2.426	2.647	3.406	4.099	5.050	5.891
80-0920	3.479	4.186	4.811	5.273	6.099	6.667	8.255	9.539	11.262	12.888
80-0940	0.935	1.081	1.213	1.320	1.542	1.709	2.174	2.557	3.101	3.664
80-1020	0.946	1.152	1.337	1.482	1.768	1.988	2.694	3.329	4.221	5.056
80-1060	0.838	0.948	1.050	1.137	1.338	1.503	2.004	2.450	3.082	3.691
80-1100	0.948	1.040	1.128	1.211	1.438	1.636	2.188	2.666	3.331	3.965
80-1120	1.432	1.653	1.858	2.040	2.499	2.856	3.705	4.361	5.240	6.103
80-1140	1.903	2.229	2.522	2.752	3.209	3.554	4.613	5.539	6.787	7.890
80-1180	3.003	3.881	4.702	5.429	7.241	8.724	12.817	16.284	20.841	24.781
80-1220	1.280	1.460	1.633	1.794	2.229	2.605	3.650	4.552	5.757	6.813
80-1240	1.637	1.864	2.074	2.254	2.666	3.009	4.126	5.164	6.516	7.563
80-1280	1.018	1.222	1.406	1.548	1.822	2.034	2.742	3.397	4.357	5.327
80-1300	2.844	3.561	4.224	4.797	6.143	7.249	10.519	13.392	17.541	21.763
80-1320	1.037	1.091	1.146	1.203	1.387	1.572	2.139	2.680	3.481	4.285
80-1340	1.133	1.302	1.466	1.619	2.056	2.414	3.238	3.874	4.708	5.495
80-1360	1.068	1.343	1.589	1.779	2.143	2.417	3.295	4.080	5.163	6.144
80-1380	3.656	4.296	4.880	5.364	6.448	7.254	9.272	10.850	13.010	15.203
80-1400	1.459	1.656	1.834	1.977	2.269	2.495	3.184	3.789	4.687	5.659
80-1420	1.242	1.442	1.623	1.771	2.086	2.329	3.045	3.660	4.535	5.410
80-1440	1.190	1.379	1.566	1.749	2.300	2.796	4.155	5.336	6.769	7.781
80-1460	1.064	1.233	1.389	1.521	1.819	2.065	2.844	3.556	4.542	5.433
80-1480	1.109	1.327	1.527	1.692	2.053	2.341	3.258	4.090	5.172	6.027
80-1540	0.821	0.963	1.095	1.212	1.499	1.736	2.417	3.008	3.745	4.299
80-1740	0.950	1.032	1.116	1.202	1.480	1.742	2.430	3.021	3.825	4.560
80-1760	1.182	1.419	1.636	1.816	2.218	2.528	3.391	4.111	5.102	6.055
80-1900	1.086	1.267	1.432	1.567	1.859	2.087	2.759	3.341	4.126	4.827
80-1940	1.088	1.187	1.285	1.380	1.662	1.921	2.655	3.308	4.163	4.866
80-1980	0.913	1.049	1.172	1.270	1.464	1.618	2.145	2.640	3.299	3.827

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
80-2000	1.705	2.024	2.309	2.530	2.953	3.279	4.386	5.416	6.877	8.239
80-2040	1.357	1.562	1.760	1.946	2.471	2.928	4.187	5.273	6.650	7.730
80-2080	1.147	1.494	1.796	1.997	2.279	2.477	3.255	4.016	5.001	5.715
80-2120	1.266	1.492	1.703	1.888	2.340	2.703	3.662	4.448	5.599	6.877
80-2140	1.269	1.506	1.723	1.904	2.305	2.622	3.575	4.411	5.507	6.416
80-2160	1.123	1.314	1.486	1.626	1.913	2.141	2.905	3.615	4.548	5.280
80-2320	1.593	1.855	2.091	2.281	2.664	2.966	3.955	4.864	6.150	7.360
80-2340	1.454	1.698	1.919	2.094	2.439	2.719	3.760	4.797	6.255	7.522
80-2380	1.322	1.536	1.731	1.890	2.225	2.493	3.359	4.154	5.296	6.410
80-2440	1.149	1.428	1.674	1.853	2.158	2.385	3.195	3.963	5.028	5.959
80-2560	1.127	1.306	1.469	1.603	1.888	2.113	2.810	3.433	4.284	5.049
80-2620	0.804	0.956	1.089	1.181	1.320	1.419	1.759	2.070	2.567	3.173
80-2640	1.207	1.368	1.516	1.641	1.921	2.160	2.987	3.790	4.968	6.109
80-2700	3.679	4.588	5.433	6.175	7.947	9.467	14.429	19.097	25.402	30.637
90-0001	2.327	3.142	3.867	4.414	5.412	6.155	8.634	10.892	13.921	16.467

Table A.4.2. λ_2 moments.

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
10-0208	0.297	0.373	0.438	0.481	0.542	0.582	0.714	0.829	1.014	1.251
10-0215	0.252	0.303	0.348	0.377	0.416	0.444	0.560	0.678	0.845	0.988
10-0236	0.265	0.324	0.375	0.408	0.452	0.480	0.575	0.658	0.776	0.893
10-0238	0.277	0.306	0.331	0.351	0.388	0.415	0.501	0.577	0.691	0.819
10-0240	0.433	0.607	0.761	0.876	1.083	1.229	1.646	1.987	2.496	3.078
10-0241	0.634	0.829	1.006	1.154	1.475	1.734	2.535	3.253	4.275	5.267
10-0946	0.498	0.578	0.652	0.714	0.855	0.965	1.259	1.500	1.842	2.203
10-0947	0.337	0.400	0.455	0.497	0.574	0.630	0.801	0.949	1.154	1.346
10-0948	0.280	0.347	0.406	0.445	0.500	0.538	0.681	0.818	1.011	1.186
10-0949	0.314	0.411	0.495	0.552	0.639	0.698	0.885	1.046	1.282	1.532
10-0950	0.368	0.467	0.553	0.608	0.676	0.723	0.905	1.081	1.354	1.655
10-0951	0.246	0.299	0.345	0.379	0.436	0.479	0.637	0.790	1.008	1.207
10-0952	0.324	0.399	0.464	0.506	0.563	0.602	0.750	0.892	1.113	1.358
10-0955	0.464	0.546	0.621	0.682	0.811	0.907	1.171	1.388	1.665	1.897
10-0956	0.867	1.052	1.214	1.334	1.532	1.686	2.332	3.006	3.844	4.361
10-0957	0.292	0.345	0.396	0.442	0.571	0.672	0.888	1.048	1.257	1.465
10-0958	0.273	0.322	0.365	0.398	0.462	0.510	0.678	0.835	1.046	1.218
10-0959	0.687	0.819	0.937	1.027	1.196	1.317	1.670	1.964	2.368	2.757
10-0961	0.169	0.188	0.206	0.221	0.255	0.281	0.349	0.403	0.482	0.571
10-0962	0.267	0.324	0.374	0.411	0.473	0.519	0.684	0.840	1.061	1.263
10-0964	0.746	0.933	1.102	1.238	1.520	1.737	2.443	3.084	3.782	4.136
10-0966	0.251	0.293	0.333	0.372	0.485	0.568	0.701	0.787	0.892	0.999
10-0967	0.415	0.489	0.558	0.615	0.745	0.843	1.088	1.281	1.536	1.775
10-0968	0.388	0.435	0.474	0.496	0.514	0.527	0.636	0.792	1.001	1.119
10-1002	0.274	0.313	0.350	0.384	0.474	0.547	0.723	0.862	1.054	1.251
10-1003	0.357	0.411	0.459	0.497	0.571	0.630	0.836	1.032	1.283	1.466
10-1037	0.878	1.154	1.400	1.586	1.920	2.182	3.232	4.301	5.551	6.219
10-1064	0.686	0.832	0.963	1.065	1.259	1.414	2.031	2.660	3.379	3.739
10-1094	0.240	0.304	0.360	0.402	0.477	0.531	0.705	0.858	1.084	1.324
10-1291	0.270	0.327	0.376	0.408	0.454	0.484	0.576	0.653	0.765	0.883
10-1444	0.239	0.289	0.334	0.366	0.420	0.460	0.608	0.750	0.962	1.175
10-1449	0.638	0.791	0.928	1.034	1.235	1.392	1.950	2.483	3.138	3.565
10-9909	0.245	0.309	0.366	0.409	0.489	0.549	0.744	0.920	1.166	1.392
21-0115	0.168	0.196	0.220	0.239	0.275	0.300	0.379	0.446	0.536	0.616
21-0160	0.275	0.344	0.405	0.449	0.520	0.575	0.806	1.047	1.351	1.544

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
21-0163	0.310	0.369	0.420	0.457	0.521	0.568	0.739	0.902	1.130	1.336
21-0182	0.223	0.261	0.294	0.321	0.373	0.414	0.548	0.671	0.826	0.939
21-0200	0.179	0.200	0.218	0.233	0.261	0.282	0.354	0.420	0.500	0.554
21-0330	0.533	0.714	0.875	0.997	1.222	1.389	1.941	2.441	3.108	3.665
21-0402	0.155	0.175	0.194	0.211	0.257	0.295	0.385	0.457	0.549	0.629
21-0446	0.629	0.812	0.975	1.098	1.322	1.490	2.062	2.590	3.288	3.851
21-0468	0.295	0.335	0.371	0.400	0.458	0.504	0.665	0.818	0.997	1.102
21-0560	0.192	0.210	0.227	0.242	0.277	0.306	0.391	0.467	0.561	0.628
21-0630	0.274	0.315	0.350	0.376	0.420	0.449	0.527	0.589	0.677	0.775
21-0679	0.191	0.215	0.237	0.257	0.308	0.350	0.468	0.570	0.706	0.827
21-0685	0.200	0.240	0.276	0.300	0.338	0.364	0.450	0.525	0.618	0.684
21-0794	0.186	0.213	0.238	0.258	0.305	0.340	0.438	0.520	0.623	0.703
21-0805	0.234	0.270	0.303	0.328	0.377	0.412	0.518	0.609	0.717	0.790
21-0907	0.172	0.205	0.233	0.253	0.288	0.313	0.407	0.499	0.617	0.706
21-0935	0.338	0.382	0.421	0.453	0.516	0.562	0.684	0.782	0.917	1.053
21-1000	0.306	0.350	0.390	0.420	0.476	0.520	0.684	0.845	1.064	1.241
21-1033	0.193	0.222	0.248	0.270	0.317	0.352	0.438	0.505	0.585	0.646
21-1050	0.341	0.440	0.525	0.577	0.634	0.673	0.829	0.984	1.192	1.358
21-1070	0.130	0.150	0.168	0.185	0.232	0.268	0.338	0.387	0.449	0.509
21-1086	0.539	0.645	0.742	0.826	1.029	1.187	1.596	1.926	2.372	2.800
21-1300	0.166	0.202	0.234	0.257	0.292	0.316	0.404	0.485	0.593	0.679
21-1400	0.186	0.225	0.259	0.280	0.303	0.319	0.398	0.485	0.607	0.702
21-1440	0.252	0.309	0.359	0.394	0.447	0.484	0.618	0.743	0.923	1.094
21-2340	0.184	0.225	0.260	0.285	0.324	0.351	0.444	0.527	0.656	0.802
21-3245	0.226	0.305	0.373	0.410	0.442	0.460	0.535	0.604	0.708	0.817
21-3255	0.183	0.217	0.248	0.272	0.318	0.351	0.449	0.532	0.635	0.711
21-3298	0.560	0.714	0.851	0.952	1.127	1.257	1.701	2.112	2.663	3.119
21-3315	0.683	0.797	0.904	1.001	1.250	1.453	1.980	2.410	2.999	3.575
21-3672	0.184	0.230	0.270	0.298	0.341	0.372	0.486	0.593	0.728	0.819
21-4500	0.336	0.390	0.444	0.496	0.653	0.790	1.116	1.373	1.775	2.297
21-4920	0.296	0.339	0.382	0.424	0.557	0.674	0.942	1.150	1.471	1.881
21-5130	0.510	0.728	0.917	1.045	1.227	1.355	1.835	2.295	2.943	3.527
21-5248	0.431	0.490	0.545	0.595	0.724	0.825	1.051	1.221	1.446	1.666
21-5275	0.515	0.695	0.854	0.970	1.168	1.309	1.757	2.149	2.687	3.183
21-5384	0.420	0.579	0.719	0.821	1.001	1.122	1.455	1.720	2.085	2.450
21-6336	0.471	0.661	0.829	0.949	1.151	1.295	1.769	2.193	2.769	3.280
21-6420	0.630	0.753	0.869	0.973	1.239	1.459	2.051	2.546	3.219	3.847
21-6483	0.542	0.689	0.822	0.925	1.129	1.283	1.764	2.189	2.749	3.217
21-6488	0.744	0.935	1.106	1.242	1.517	1.721	2.316	2.819	3.473	4.024
21-6492	0.627	0.823	0.997	1.133	1.394	1.588	2.188	2.713	3.377	3.890
21-6493	0.699	0.892	1.065	1.201	1.472	1.672	2.252	2.742	3.386	3.949
21-7742	0.583	0.732	0.866	0.974	1.200	1.369	1.843	2.236	2.788	3.342
21-8036	0.433	0.541	0.637	0.713	0.862	0.976	1.338	1.662	2.108	2.512
21-8040	0.218	0.266	0.307	0.331	0.357	0.375	0.459	0.548	0.659	0.725
21-8041	0.258	0.324	0.379	0.413	0.448	0.471	0.563	0.650	0.771	0.875
21-8202	0.196	0.243	0.285	0.314	0.364	0.397	0.497	0.580	0.700	0.825
21-8250	0.298	0.349	0.397	0.441	0.558	0.654	0.896	1.092	1.358	1.615
21-8535	0.552	0.677	0.792	0.889	1.113	1.282	1.708	2.043	2.503	2.967
30-1100	0.364	0.414	0.457	0.483	0.513	0.534	0.641	0.762	0.930	1.056
30-1110	0.350	0.407	0.455	0.484	0.514	0.534	0.641	0.763	0.930	1.055
40-1220	0.373	0.410	0.443	0.465	0.494	0.516	0.634	0.773	0.968	1.114
40-1250	0.342	0.378	0.409	0.429	0.453	0.471	0.587	0.736	0.931	1.046
40-1300	0.166	0.181	0.194	0.206	0.228	0.248	0.322	0.397	0.509	0.616
40-1510	0.138	0.149	0.159	0.169	0.196	0.219	0.272	0.313	0.386	0.504
50-0026	0.550	0.598	0.642	0.677	0.747	0.809	1.082	1.392	1.850	2.256

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-0230	0.234	0.257	0.279	0.300	0.359	0.410	0.540	0.646	0.793	0.937
50-0243	0.722	0.918	1.092	1.220	1.444	1.614	2.258	2.889	3.664	4.155
50-0249	0.304	0.371	0.434	0.486	0.609	0.703	0.962	1.178	1.435	1.617
50-0280	0.375	0.406	0.435	0.462	0.536	0.597	0.751	0.876	1.043	1.199
50-0310	0.318	0.393	0.463	0.522	0.658	0.768	1.097	1.386	1.791	2.179
50-0332	0.298	0.358	0.412	0.455	0.540	0.603	0.797	0.965	1.179	1.349
50-0352	0.568	0.711	0.841	0.948	1.175	1.354	1.903	2.389	3.066	3.701
50-0363	0.613	0.769	0.912	1.033	1.306	1.529	2.204	2.805	3.708	4.697
50-0433	0.625	0.647	0.671	0.696	0.781	0.870	1.146	1.415	1.836	2.307
50-0452	0.795	0.920	1.036	1.136	1.375	1.565	2.081	2.508	3.097	3.668
50-0464	0.393	0.470	0.542	0.603	0.745	0.864	1.232	1.567	2.081	2.660
50-0522	0.781	0.978	1.158	1.308	1.631	1.902	2.878	3.839	5.119	6.103
50-0546	0.118	0.133	0.146	0.156	0.179	0.197	0.253	0.302	0.373	0.442
50-0558	0.209	0.247	0.279	0.299	0.323	0.338	0.400	0.460	0.538	0.598
50-0657	0.784	0.973	1.144	1.284	1.577	1.812	2.594	3.322	4.338	5.252
50-0676	0.596	0.734	0.859	0.962	1.187	1.367	1.934	2.446	3.164	3.831
50-0685	0.410	0.492	0.567	0.631	0.787	0.904	1.169	1.366	1.646	1.965
50-0707	0.255	0.293	0.328	0.354	0.401	0.437	0.565	0.687	0.846	0.966
50-0754	0.247	0.298	0.345	0.381	0.450	0.504	0.686	0.857	1.078	1.248
50-0761	0.228	0.256	0.283	0.310	0.387	0.452	0.604	0.723	0.887	1.057
50-0770	0.268	0.313	0.352	0.382	0.439	0.478	0.585	0.670	0.787	0.901
50-0788	0.586	0.740	0.886	1.019	1.384	1.651	2.120	2.426	2.871	3.470
50-0910	0.218	0.254	0.287	0.315	0.383	0.436	0.581	0.701	0.865	1.019
50-1201	0.603	0.706	0.811	0.916	1.253	1.561	2.332	2.973	3.811	4.541
50-1220	0.269	0.309	0.346	0.377	0.441	0.492	0.650	0.792	0.979	1.134
50-1230	0.145	0.167	0.186	0.200	0.223	0.240	0.307	0.375	0.479	0.587
50-1240	0.681	1.000	1.284	1.503	1.922	2.234	3.230	4.117	5.288	6.265
50-1243	0.317	0.375	0.426	0.462	0.519	0.561	0.719	0.873	1.104	1.339
50-1251	0.480	0.585	0.681	0.763	0.956	1.105	1.479	1.772	2.221	2.784
50-1269	0.453	0.531	0.602	0.662	0.794	0.906	1.276	1.626	2.152	2.703
50-1308	0.652	0.895	1.111	1.275	1.576	1.802	2.561	3.256	4.229	5.126
50-1312	0.249	0.328	0.396	0.442	0.505	0.549	0.708	0.858	1.055	1.213
50-1314	0.400	0.515	0.615	0.685	0.792	0.870	1.169	1.462	1.866	2.204
50-1318	0.338	0.429	0.510	0.574	0.701	0.797	1.098	1.365	1.725	2.041
50-1321	0.661	0.842	1.008	1.145	1.443	1.683	2.469	3.195	4.131	4.844
50-1325	0.321	0.401	0.472	0.529	0.648	0.733	0.955	1.132	1.345	1.508
50-1334	0.746	0.957	1.146	1.292	1.576	1.791	2.472	3.079	3.960	4.855
50-1466	0.227	0.268	0.305	0.332	0.378	0.412	0.540	0.664	0.821	0.932
50-1492	0.203	0.228	0.252	0.270	0.307	0.336	0.438	0.535	0.667	0.774
50-1574	0.298	0.371	0.435	0.477	0.539	0.580	0.712	0.824	0.994	1.184
50-1684	0.290	0.324	0.355	0.380	0.435	0.479	0.625	0.761	0.932	1.054
50-1763	0.635	0.819	0.982	1.099	1.293	1.430	1.864	2.240	2.816	3.488
50-1824	0.380	0.464	0.538	0.585	0.656	0.692	0.749	0.782	0.826	0.886
50-1926	0.494	0.630	0.750	0.839	1.001	1.113	1.427	1.681	2.040	2.415
50-1977	0.202	0.226	0.246	0.262	0.288	0.308	0.381	0.451	0.541	0.609
50-1987	0.243	0.293	0.337	0.364	0.394	0.415	0.516	0.629	0.779	0.885
50-2005	0.385	0.446	0.501	0.541	0.618	0.672	0.836	0.974	1.166	1.351
50-2102	0.403	0.473	0.537	0.591	0.716	0.812	1.068	1.278	1.560	1.827
50-2107	0.244	0.296	0.341	0.372	0.415	0.446	0.560	0.669	0.826	0.973
50-2112	0.251	0.304	0.351	0.382	0.426	0.458	0.579	0.698	0.870	1.031
50-2126	0.123	0.131	0.141	0.150	0.188	0.221	0.282	0.324	0.394	0.509
50-2144	0.581	0.720	0.843	0.938	1.119	1.249	1.639	1.971	2.375	2.670
50-2147	0.473	0.534	0.588	0.627	0.686	0.729	0.896	1.061	1.294	1.502
50-2156	0.285	0.308	0.328	0.344	0.374	0.397	0.475	0.547	0.643	0.723
50-2173	1.174	1.581	1.946	2.228	2.775	3.184	4.458	5.580	7.032	8.197

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-2177	0.845	1.109	1.346	1.533	1.908	2.191	3.048	3.793	4.803	5.713
50-2227	0.592	0.717	0.834	0.940	1.210	1.435	2.039	2.544	3.255	3.971
50-2247	0.203	0.238	0.269	0.293	0.337	0.371	0.498	0.622	0.797	0.953
50-2339	0.274	0.334	0.386	0.423	0.481	0.519	0.636	0.734	0.868	0.998
50-2350	0.274	0.320	0.362	0.393	0.453	0.496	0.617	0.717	0.855	0.988
50-2352	0.253	0.304	0.349	0.378	0.419	0.446	0.543	0.631	0.749	0.846
50-2457	0.260	0.332	0.396	0.441	0.511	0.563	0.762	0.958	1.229	1.460
50-2568	0.291	0.346	0.394	0.431	0.499	0.548	0.699	0.829	1.007	1.173
50-2587	0.601	0.777	0.933	1.052	1.278	1.438	1.890	2.260	2.745	3.174
50-2607	0.199	0.219	0.238	0.253	0.289	0.319	0.416	0.506	0.626	0.727
50-2707	0.270	0.342	0.404	0.441	0.481	0.508	0.631	0.760	0.944	1.101
50-2725	0.184	0.207	0.228	0.246	0.283	0.313	0.408	0.496	0.612	0.708
50-2730	0.266	0.303	0.336	0.362	0.412	0.452	0.592	0.728	0.914	1.074
50-2737	0.234	0.270	0.302	0.328	0.378	0.416	0.544	0.661	0.826	0.982
50-2770	0.569	0.749	0.910	1.036	1.286	1.470	2.004	2.454	3.036	3.527
50-2785	0.727	0.844	0.956	1.059	1.333	1.570	2.250	2.848	3.676	4.449
50-2820	0.250	0.285	0.317	0.344	0.405	0.454	0.604	0.738	0.916	1.070
50-2825	0.233	0.276	0.314	0.346	0.417	0.473	0.643	0.793	0.990	1.151
50-2952	0.290	0.340	0.384	0.416	0.474	0.517	0.653	0.775	0.952	1.135
50-2968	0.296	0.338	0.375	0.400	0.439	0.466	0.566	0.660	0.802	0.951
50-2988	0.293	0.346	0.393	0.431	0.509	0.569	0.745	0.896	1.128	1.406
50-3009	0.308	0.339	0.368	0.395	0.469	0.533	0.708	0.859	1.060	1.240
50-3072	0.384	0.458	0.527	0.585	0.718	0.829	1.190	1.526	1.979	2.356
50-3082	0.203	0.220	0.236	0.251	0.293	0.329	0.421	0.497	0.607	0.723
50-3085	0.230	0.278	0.321	0.356	0.426	0.481	0.649	0.798	1.008	1.209
50-3160	0.318	0.418	0.504	0.558	0.626	0.671	0.855	1.037	1.293	1.521
50-3163	0.264	0.292	0.318	0.343	0.415	0.477	0.642	0.782	0.964	1.120
50-3196	0.233	0.274	0.312	0.344	0.415	0.467	0.593	0.690	0.825	0.972
50-3198	0.392	0.492	0.581	0.650	0.782	0.886	1.262	1.627	2.134	2.569
50-3205	0.211	0.242	0.269	0.290	0.324	0.350	0.431	0.502	0.625	0.801
50-3212	0.226	0.246	0.264	0.280	0.317	0.351	0.478	0.609	0.790	0.935
50-3226	0.315	0.346	0.375	0.401	0.464	0.516	0.675	0.819	1.003	1.146
50-3275	0.295	0.365	0.426	0.468	0.528	0.570	0.727	0.876	1.085	1.270
50-3294	0.405	0.524	0.633	0.723	0.918	1.071	1.516	1.899	2.444	2.997
50-3299	0.353	0.416	0.473	0.515	0.590	0.646	0.850	1.044	1.323	1.585
50-3454	0.343	0.427	0.504	0.569	0.716	0.833	1.168	1.454	1.867	2.296
50-3465	0.215	0.239	0.260	0.276	0.306	0.330	0.409	0.483	0.589	0.688
50-3475	0.372	0.457	0.534	0.598	0.737	0.847	1.179	1.470	1.904	2.375
50-3490	0.609	0.770	0.917	1.038	1.302	1.502	2.044	2.488	3.099	3.698
50-3500	0.545	0.687	0.816	0.922	1.155	1.329	1.791	2.162	2.685	3.231
50-3504	0.596	0.724	0.842	0.940	1.163	1.335	1.799	2.181	2.713	3.249
50-3530	0.483	0.575	0.658	0.726	0.868	0.980	1.336	1.658	2.062	2.357
50-3573	0.518	0.640	0.746	0.816	0.910	0.975	1.241	1.506	1.865	2.151
50-3585	0.298	0.359	0.413	0.451	0.512	0.556	0.699	0.827	1.020	1.232
50-3605	0.634	0.774	0.906	1.025	1.328	1.591	2.420	3.187	4.200	5.010
50-3655	0.286	0.331	0.370	0.400	0.450	0.490	0.645	0.804	1.025	1.208
50-3665	0.312	0.362	0.406	0.442	0.515	0.574	0.772	0.958	1.214	1.436
50-3672	0.334	0.394	0.449	0.493	0.582	0.653	0.892	1.116	1.414	1.658
50-3682	0.302	0.345	0.385	0.417	0.481	0.533	0.721	0.905	1.147	1.327
50-3695	0.399	0.500	0.590	0.662	0.800	0.908	1.265	1.595	2.076	2.557
50-3720	0.388	0.432	0.471	0.500	0.551	0.591	0.763	0.946	1.203	1.411
50-3765	0.383	0.424	0.461	0.492	0.561	0.614	0.758	0.877	1.027	1.149
50-3905	0.344	0.419	0.486	0.534	0.614	0.674	0.901	1.122	1.411	1.625
50-3910	0.364	0.456	0.536	0.592	0.675	0.733	0.937	1.124	1.352	1.505
50-3933	0.381	0.473	0.555	0.616	0.725	0.805	1.071	1.312	1.628	1.884

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-4094	0.547	0.661	0.765	0.852	1.045	1.204	1.722	2.205	2.933	3.707
50-4100	0.376	0.449	0.516	0.572	0.701	0.807	1.132	1.423	1.876	2.407
50-4103	0.529	0.633	0.729	0.812	1.005	1.171	1.723	2.251	3.037	3.839
50-4155	0.387	0.463	0.534	0.596	0.755	0.885	1.239	1.537	1.925	2.258
50-4425	0.259	0.311	0.358	0.396	0.479	0.537	0.670	0.770	0.899	1.025
50-4546	0.366	0.419	0.467	0.506	0.590	0.652	0.809	0.932	1.092	1.236
50-4550	0.304	0.367	0.424	0.469	0.561	0.625	0.784	0.905	1.072	1.252
50-4555	0.380	0.482	0.570	0.630	0.718	0.780	1.018	1.249	1.543	1.752
50-4590	0.846	1.046	1.226	1.372	1.670	1.906	2.676	3.381	4.365	5.264
50-4621	0.295	0.377	0.450	0.501	0.589	0.648	0.812	0.942	1.154	1.455
50-4766	0.217	0.267	0.311	0.343	0.399	0.442	0.612	0.783	1.020	1.216
50-4812	0.395	0.510	0.610	0.681	0.789	0.870	1.191	1.516	1.973	2.363
50-4964	0.318	0.404	0.480	0.536	0.635	0.704	0.903	1.069	1.288	1.485
50-4988	0.520	0.662	0.786	0.867	0.973	1.048	1.362	1.682	2.148	2.574
50-4991	0.466	0.598	0.714	0.790	0.898	0.973	1.252	1.518	1.905	2.283
50-5076	0.173	0.212	0.246	0.272	0.321	0.359	0.486	0.605	0.765	0.898
50-5136	0.144	0.152	0.159	0.167	0.189	0.209	0.258	0.297	0.355	0.421
50-5318	0.267	0.310	0.348	0.375	0.418	0.449	0.564	0.674	0.837	1.000
50-5397	0.232	0.245	0.256	0.268	0.299	0.329	0.430	0.532	0.681	0.823
50-5454	0.669	0.919	1.146	1.331	1.713	2.034	3.300	4.608	6.266	7.349
50-5464	0.267	0.316	0.359	0.392	0.447	0.489	0.638	0.780	0.973	1.137
50-5499	0.363	0.430	0.494	0.552	0.699	0.823	1.176	1.483	1.891	2.241
50-5519	1.425	1.656	1.867	2.041	2.406	2.711	3.801	4.874	6.426	7.873
50-5534	0.223	0.258	0.291	0.318	0.381	0.430	0.554	0.653	0.802	0.985
50-5604	0.821	1.159	1.461	1.693	2.121	2.466	3.830	5.231	7.192	8.831
50-5607	0.275	0.359	0.434	0.496	0.624	0.722	1.008	1.252	1.595	1.933
50-5644	0.334	0.385	0.432	0.472	0.566	0.639	0.836	0.997	1.210	1.401
50-5733	0.241	0.281	0.317	0.344	0.394	0.433	0.570	0.700	0.876	1.022
50-5757	0.288	0.360	0.423	0.467	0.536	0.587	0.797	1.012	1.274	1.433
50-5769	0.236	0.263	0.289	0.311	0.367	0.415	0.554	0.676	0.858	1.053
50-5778	0.348	0.402	0.449	0.482	0.532	0.566	0.684	0.789	0.960	1.179
50-5810	0.248	0.299	0.345	0.382	0.458	0.517	0.709	0.886	1.088	1.204
50-5880	0.298	0.360	0.416	0.456	0.527	0.577	0.726	0.852	1.043	1.266
50-5881	0.287	0.317	0.346	0.372	0.436	0.491	0.652	0.794	0.999	1.203
50-5882	0.302	0.347	0.388	0.418	0.470	0.510	0.665	0.818	1.020	1.169
50-5894	0.535	0.639	0.732	0.808	0.973	1.093	1.396	1.636	1.933	2.179
50-5898	0.503	0.626	0.737	0.827	1.014	1.152	1.511	1.796	2.211	2.686
50-6058	0.285	0.332	0.375	0.411	0.494	0.560	0.753	0.919	1.138	1.326
50-6147	0.268	0.334	0.392	0.432	0.495	0.540	0.712	0.878	1.062	1.152
50-6270	0.252	0.277	0.301	0.321	0.367	0.405	0.526	0.638	0.805	0.983
50-6309	0.294	0.356	0.411	0.451	0.521	0.570	0.716	0.840	1.014	1.191
50-6441	0.330	0.377	0.420	0.455	0.528	0.585	0.753	0.898	1.094	1.271
50-6496	0.268	0.324	0.374	0.412	0.483	0.537	0.733	0.921	1.173	1.375
50-6562	0.644	0.835	1.009	1.152	1.453	1.702	2.584	3.443	4.560	5.386
50-6581	0.253	0.297	0.335	0.362	0.402	0.431	0.539	0.642	0.784	0.903
50-6586	0.294	0.331	0.365	0.392	0.446	0.489	0.648	0.804	1.004	1.144
50-6656	0.236	0.275	0.311	0.341	0.407	0.461	0.631	0.786	0.994	1.169
50-6727	0.257	0.301	0.338	0.360	0.379	0.392	0.480	0.592	0.755	0.879
50-6760	0.344	0.391	0.436	0.479	0.596	0.695	0.956	1.175	1.449	1.667
50-6853	0.535	0.695	0.834	0.929	1.067	1.164	1.518	1.851	2.323	2.759
50-6870	0.251	0.293	0.331	0.359	0.409	0.446	0.578	0.704	0.873	1.012
50-6875	0.405	0.456	0.502	0.542	0.636	0.708	0.899	1.054	1.260	1.446
50-7097	0.255	0.312	0.363	0.404	0.486	0.550	0.755	0.942	1.188	1.389
50-7105	0.219	0.255	0.289	0.319	0.391	0.451	0.623	0.774	0.962	1.104
50-7141	1.023	1.298	1.553	1.773	2.298	2.715	3.857	4.811	6.038	7.062

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-7251	0.646	0.762	0.873	0.979	1.284	1.545	2.201	2.735	3.483	4.244
50-7352	0.257	0.289	0.318	0.342	0.392	0.432	0.562	0.683	0.849	0.998
50-7365	0.292	0.349	0.399	0.434	0.488	0.529	0.709	0.901	1.163	1.362
50-7431	0.197	0.236	0.270	0.293	0.328	0.354	0.462	0.574	0.734	0.874
50-7442	0.144	0.183	0.219	0.251	0.332	0.390	0.512	0.600	0.694	0.756
50-7451	0.500	0.642	0.766	0.853	0.988	1.089	1.480	1.873	2.469	3.081
50-7494	0.582	0.789	0.975	1.119	1.396	1.610	2.352	3.050	3.885	4.403
50-7557	0.909	1.050	1.178	1.282	1.494	1.678	2.434	3.249	4.451	5.540
50-7570	0.270	0.337	0.396	0.437	0.500	0.545	0.702	0.849	1.050	1.223
50-7700	0.278	0.321	0.359	0.381	0.405	0.422	0.514	0.623	0.789	0.943
50-7738	0.588	0.771	0.936	1.072	1.352	1.590	2.532	3.512	4.822	5.788
50-7783	0.421	0.478	0.527	0.561	0.613	0.651	0.792	0.929	1.106	1.235
50-7854	0.686	0.833	0.967	1.074	1.289	1.468	2.149	2.843	3.787	4.533
50-7900	0.287	0.320	0.350	0.374	0.423	0.459	0.557	0.637	0.750	0.870
50-7977	0.276	0.343	0.402	0.443	0.509	0.552	0.678	0.782	0.917	1.035
50-8025	0.270	0.317	0.359	0.392	0.455	0.502	0.658	0.798	0.988	1.153
50-8054	0.256	0.293	0.328	0.360	0.446	0.515	0.686	0.822	0.994	1.140
50-8105	0.233	0.281	0.326	0.362	0.437	0.496	0.681	0.847	1.042	1.164
50-8118	0.193	0.233	0.270	0.300	0.366	0.418	0.572	0.706	0.894	1.074
50-8140	0.310	0.382	0.444	0.482	0.526	0.556	0.691	0.832	1.029	1.191
50-8183	0.392	0.480	0.562	0.634	0.815	0.949	1.229	1.431	1.693	1.954
50-8355	0.500	0.586	0.666	0.736	0.904	1.040	1.421	1.747	2.149	2.450
50-8371	0.877	1.056	1.217	1.341	1.571	1.754	2.474	3.207	4.113	4.681
50-8375	0.964	1.191	1.393	1.541	1.801	1.994	2.664	3.289	4.132	4.833
50-8377	0.828	0.953	1.066	1.157	1.339	1.481	1.960	2.404	2.945	3.303
50-8409	0.309	0.363	0.412	0.447	0.508	0.553	0.713	0.862	1.048	1.177
50-8419	0.417	0.468	0.516	0.559	0.668	0.758	0.992	1.185	1.462	1.756
50-8437	0.182	0.195	0.208	0.220	0.256	0.289	0.392	0.487	0.614	0.716
50-8494	0.615	0.725	0.826	0.911	1.098	1.255	1.812	2.356	3.085	3.656
50-8503	0.638	0.748	0.849	0.935	1.131	1.298	1.871	2.424	3.170	3.773
50-8512	0.510	0.595	0.669	0.714	0.764	0.801	1.019	1.290	1.683	1.992
50-8525	0.488	0.594	0.690	0.765	0.916	1.027	1.338	1.593	1.937	2.258
50-8536	0.416	0.505	0.583	0.643	0.756	0.836	1.063	1.250	1.513	1.782
50-8547	0.280	0.325	0.366	0.400	0.474	0.532	0.701	0.847	1.040	1.211
50-8584	0.853	1.130	1.383	1.594	2.062	2.429	3.454	4.313	5.654	7.321
50-8594	0.233	0.259	0.283	0.301	0.331	0.355	0.457	0.566	0.732	0.899
50-8625	0.211	0.244	0.273	0.297	0.348	0.388	0.509	0.616	0.780	0.973
50-8666	0.313	0.375	0.432	0.477	0.573	0.645	0.853	1.028	1.265	1.484
50-8811	0.332	0.390	0.440	0.476	0.531	0.572	0.721	0.864	1.081	1.305
50-8882	0.361	0.451	0.532	0.595	0.720	0.814	1.093	1.332	1.662	1.974
50-8915	0.286	0.348	0.403	0.441	0.499	0.540	0.688	0.828	1.023	1.196
50-8976	0.417	0.517	0.607	0.679	0.826	0.932	1.200	1.407	1.706	2.040
50-8987	0.461	0.501	0.536	0.563	0.613	0.649	0.762	0.862	0.991	1.098
50-9014	0.298	0.337	0.373	0.406	0.489	0.557	0.738	0.889	1.090	1.275
50-9035	0.221	0.261	0.298	0.328	0.393	0.443	0.581	0.696	0.872	1.088
50-9102	0.226	0.268	0.305	0.330	0.367	0.394	0.515	0.643	0.816	0.943
50-9121	0.490	0.629	0.755	0.859	1.084	1.260	1.789	2.253	2.852	3.336
50-9144	0.307	0.348	0.386	0.420	0.504	0.577	0.807	1.022	1.304	1.530
50-9249	0.262	0.315	0.363	0.401	0.476	0.535	0.742	0.938	1.198	1.404
50-9313	0.295	0.329	0.358	0.379	0.410	0.433	0.529	0.630	0.779	0.918
50-9385	0.300	0.342	0.378	0.401	0.426	0.444	0.512	0.579	0.679	0.779
50-9399	0.444	0.602	0.744	0.857	1.088	1.265	1.815	2.301	2.946	3.494
50-9410	0.537	0.635	0.725	0.801	0.975	1.104	1.409	1.640	1.967	2.333
50-9421	0.198	0.234	0.267	0.295	0.354	0.398	0.515	0.610	0.730	0.830
50-9460	0.812	0.978	1.128	1.245	1.478	1.657	2.253	2.800	3.497	4.018

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-9489	0.293	0.366	0.430	0.475	0.545	0.593	0.749	0.885	1.092	1.323
50-9511	0.527	0.651	0.759	0.832	0.935	1.009	1.303	1.595	2.027	2.447
50-9539	0.399	0.424	0.445	0.455	0.459	0.461	0.483	0.517	0.573	0.631
50-9564	0.232	0.275	0.313	0.342	0.398	0.442	0.608	0.773	0.996	1.171
50-9641	0.346	0.395	0.437	0.466	0.508	0.538	0.650	0.758	0.912	1.054
50-9686	0.460	0.640	0.799	0.914	1.114	1.254	1.671	2.020	2.532	3.085
50-9702	0.688	0.837	0.978	1.106	1.433	1.713	2.536	3.267	4.254	5.121
50-9739	0.237	0.286	0.330	0.363	0.420	0.465	0.626	0.782	0.998	1.183
50-9759	0.254	0.306	0.351	0.385	0.442	0.485	0.639	0.785	0.984	1.148
50-9765	0.259	0.325	0.384	0.427	0.504	0.559	0.744	0.910	1.129	1.306
50-9790	0.365	0.438	0.503	0.555	0.659	0.735	0.935	1.095	1.318	1.548
50-9793	0.262	0.311	0.355	0.388	0.449	0.491	0.602	0.689	0.808	0.929
50-9829	0.937	1.334	1.691	1.976	2.541	2.997	4.670	6.316	8.505	10.188
50-9861	0.385	0.448	0.506	0.552	0.645	0.714	0.907	1.067	1.283	1.485
50-9869	0.260	0.312	0.357	0.389	0.443	0.482	0.621	0.751	0.933	1.097
50-9883	0.432	0.459	0.486	0.512	0.584	0.651	0.864	1.067	1.358	1.629
50-9919	0.506	0.581	0.655	0.729	0.961	1.170	1.691	2.122	2.699	3.231
50-9930	0.692	0.841	0.978	1.095	1.362	1.584	2.313	2.995	3.863	4.497
50-9941	0.976	1.157	1.326	1.475	1.832	2.137	3.133	4.067	5.261	6.139
55-0064	0.636	0.798	0.943	1.057	1.278	1.450	2.050	2.618	3.334	3.841
55-0079	0.186	0.219	0.249	0.273	0.327	0.368	0.488	0.589	0.741	0.914
55-0080	0.462	0.565	0.661	0.745	0.950	1.120	1.620	2.059	2.629	3.095
55-0087	0.279	0.307	0.334	0.361	0.442	0.510	0.657	0.768	0.918	1.072
55-0096	0.254	0.277	0.299	0.321	0.390	0.451	0.597	0.715	0.873	1.027
55-0164	0.134	0.145	0.156	0.165	0.188	0.208	0.278	0.347	0.434	0.494
80-0100	0.381	0.417	0.450	0.478	0.537	0.586	0.752	0.910	1.124	1.304
80-0120	0.307	0.355	0.398	0.427	0.472	0.504	0.619	0.727	0.904	1.128
80-0140	0.231	0.253	0.272	0.289	0.328	0.361	0.477	0.589	0.735	0.841
80-0160	0.211	0.224	0.238	0.251	0.293	0.330	0.415	0.482	0.583	0.707
80-0200	0.247	0.273	0.297	0.318	0.365	0.403	0.524	0.634	0.780	0.898
80-0220	0.976	1.132	1.286	1.435	1.868	2.264	3.399	4.413	5.747	6.844
80-0240	0.297	0.327	0.359	0.393	0.519	0.628	0.815	0.941	1.118	1.328
80-0260	0.226	0.256	0.282	0.304	0.350	0.387	0.508	0.620	0.755	0.842
80-0340	0.258	0.302	0.340	0.368	0.410	0.443	0.590	0.752	0.979	1.164
80-0425	0.327	0.400	0.465	0.511	0.593	0.648	0.797	0.915	1.094	1.317
80-0440	0.215	0.234	0.251	0.267	0.310	0.345	0.437	0.511	0.607	0.687
80-0460	0.320	0.403	0.473	0.516	0.561	0.590	0.713	0.835	1.039	1.297
80-0540	0.196	0.236	0.272	0.299	0.345	0.380	0.520	0.658	0.809	0.875
80-0560	0.315	0.343	0.368	0.389	0.437	0.475	0.583	0.676	0.823	1.010
80-0640	0.284	0.326	0.362	0.387	0.426	0.456	0.606	0.780	1.020	1.199
80-0780	0.304	0.370	0.427	0.465	0.517	0.555	0.703	0.850	1.072	1.296
80-0820	0.299	0.343	0.383	0.415	0.479	0.530	0.710	0.881	1.097	1.248
80-0860	0.348	0.394	0.435	0.465	0.520	0.561	0.690	0.805	0.959	1.091
80-0900	0.282	0.343	0.397	0.434	0.492	0.528	0.620	0.689	0.786	0.893
80-0920	0.697	0.829	0.945	1.024	1.144	1.226	1.524	1.800	2.124	2.320
80-0940	0.227	0.249	0.270	0.288	0.331	0.364	0.445	0.509	0.600	0.702
80-1020	0.184	0.217	0.247	0.269	0.309	0.339	0.445	0.545	0.690	0.830
80-1060	0.210	0.226	0.242	0.258	0.301	0.338	0.430	0.504	0.614	0.738
80-1100	0.212	0.231	0.249	0.266	0.318	0.363	0.463	0.541	0.649	0.762
80-1120	0.330	0.365	0.398	0.430	0.525	0.598	0.736	0.831	0.961	1.108
80-1140	0.383	0.439	0.488	0.524	0.584	0.628	0.787	0.938	1.130	1.269
80-1180	0.503	0.627	0.742	0.841	1.070	1.257	1.820	2.318	2.964	3.484
80-1220	0.257	0.285	0.310	0.334	0.394	0.446	0.596	0.727	0.912	1.089
80-1240	0.372	0.421	0.466	0.503	0.584	0.650	0.883	1.107	1.367	1.511
80-1280	0.204	0.233	0.259	0.278	0.311	0.337	0.450	0.574	0.759	0.929

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
80-1300	0.463	0.537	0.607	0.669	0.825	0.956	1.336	1.670	2.150	2.637
80-1320	0.243	0.243	0.243	0.244	0.275	0.322	0.432	0.530	0.672	0.812
80-1340	0.246	0.275	0.302	0.328	0.401	0.464	0.625	0.757	0.936	1.100
80-1360	0.217	0.272	0.320	0.357	0.427	0.479	0.644	0.791	1.006	1.230
80-1380	0.830	0.933	1.028	1.105	1.271	1.399	1.783	2.118	2.544	2.878
80-1400	0.285	0.320	0.353	0.379	0.438	0.480	0.573	0.640	0.737	0.855
80-1420	0.266	0.299	0.330	0.354	0.405	0.446	0.586	0.719	0.914	1.105
80-1440	0.243	0.279	0.314	0.348	0.452	0.540	0.753	0.925	1.117	1.241
80-1460	0.216	0.229	0.243	0.256	0.293	0.328	0.428	0.518	0.663	0.843
80-1480	0.253	0.284	0.313	0.338	0.398	0.448	0.609	0.759	0.940	1.060
80-1540	0.184	0.215	0.243	0.267	0.320	0.361	0.469	0.558	0.677	0.790
80-1740	0.202	0.223	0.244	0.263	0.318	0.366	0.489	0.592	0.736	0.884
80-1760	0.261	0.285	0.308	0.333	0.416	0.490	0.653	0.780	0.953	1.133
80-1900	0.224	0.244	0.263	0.278	0.315	0.346	0.451	0.552	0.692	0.813
80-1940	0.259	0.274	0.290	0.306	0.358	0.406	0.536	0.649	0.792	0.905
80-1980	0.177	0.198	0.217	0.232	0.261	0.284	0.366	0.444	0.554	0.653
80-2000	0.347	0.395	0.438	0.471	0.533	0.583	0.761	0.934	1.176	1.389
80-2040	0.267	0.302	0.336	0.367	0.458	0.535	0.726	0.880	1.092	1.303
80-2080	0.281	0.340	0.390	0.424	0.469	0.502	0.641	0.786	0.967	1.082
80-2120	0.277	0.340	0.396	0.440	0.529	0.591	0.731	0.833	0.987	1.190
80-2140	0.320	0.372	0.420	0.460	0.552	0.621	0.805	0.956	1.133	1.256
80-2160	0.252	0.288	0.320	0.344	0.387	0.421	0.564	0.717	0.927	1.091
80-2320	0.304	0.363	0.415	0.450	0.502	0.540	0.681	0.818	1.009	1.177
80-2340	0.302	0.344	0.381	0.404	0.435	0.459	0.586	0.740	0.958	1.123
80-2380	0.255	0.295	0.331	0.360	0.425	0.472	0.591	0.684	0.812	0.946
80-2440	0.260	0.311	0.355	0.386	0.437	0.473	0.596	0.707	0.873	1.046
80-2560	0.241	0.272	0.301	0.325	0.379	0.420	0.522	0.602	0.709	0.812
80-2620	0.198	0.223	0.246	0.263	0.292	0.313	0.376	0.429	0.518	0.652
80-2640	0.294	0.321	0.346	0.369	0.427	0.479	0.643	0.796	1.017	1.230
80-2700	0.565	0.630	0.696	0.764	0.985	1.194	1.753	2.240	2.848	3.305
90-0001	0.424	0.588	0.733	0.839	1.021	1.152	1.568	1.933	2.452	2.963

Table A.4.3. λ_3 moments.

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
10-0208	0.096	0.114	0.129	0.140	0.164	0.177	0.194	0.205	0.216	0.229
10-0215	0.070	0.082	0.093	0.100	0.114	0.122	0.134	0.141	0.152	0.168
10-0236	0.054	0.063	0.071	0.078	0.100	0.113	0.118	0.120	0.123	0.129
10-0238	0.060	0.062	0.063	0.065	0.071	0.075	0.077	0.079	0.080	0.082
10-0240	0.110	0.124	0.138	0.152	0.203	0.244	0.300	0.333	0.387	0.478
10-0241	0.130	0.161	0.189	0.213	0.274	0.316	0.396	0.452	0.503	0.528
10-0946	0.125	0.129	0.135	0.142	0.185	0.220	0.236	0.244	0.256	0.286
10-0947	0.087	0.095	0.101	0.105	0.109	0.110	0.112	0.113	0.115	0.120
10-0948	0.070	0.077	0.082	0.085	0.089	0.090	0.092	0.093	0.094	0.098
10-0949	0.069	0.076	0.083	0.090	0.110	0.123	0.136	0.144	0.149	0.151
10-0950	0.092	0.092	0.092	0.092	0.102	0.116	0.136	0.150	0.165	0.174
10-0951	0.050	0.056	0.062	0.066	0.072	0.077	0.093	0.109	0.123	0.127
10-0952	0.078	0.079	0.080	0.082	0.093	0.104	0.118	0.127	0.138	0.151
10-0955	0.102	0.107	0.113	0.120	0.148	0.172	0.206	0.228	0.254	0.280
10-0956	0.200	0.213	0.230	0.250	0.355	0.450	0.566	0.638	0.720	0.800
10-0957	0.100	0.104	0.107	0.110	0.119	0.125	0.130	0.132	0.135	0.140
10-0958	0.075	0.089	0.101	0.109	0.122	0.129	0.145	0.155	0.169	0.183
10-0959	0.159	0.166	0.173	0.180	0.207	0.230	0.268	0.294	0.330	0.379

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
10-0961	0.035	0.040	0.044	0.047	0.054	0.057	0.059	0.060	0.062	0.066
10-0962	0.064	0.080	0.094	0.103	0.117	0.125	0.141	0.152	0.165	0.177
10-0964	0.203	0.230	0.254	0.274	0.313	0.346	0.478	0.615	0.766	0.831
10-0966	0.054	0.066	0.076	0.085	0.107	0.120	0.129	0.134	0.140	0.150
10-0967	0.110	0.125	0.139	0.149	0.170	0.180	0.189	0.194	0.200	0.211
10-0968	0.133	0.146	0.158	0.164	0.168	0.171	0.186	0.202	0.215	0.215
10-1002	0.090	0.101	0.110	0.117	0.130	0.136	0.144	0.148	0.155	0.169
10-1003	0.099	0.115	0.130	0.140	0.158	0.172	0.216	0.256	0.312	0.366
10-1037	0.265	0.318	0.367	0.411	0.521	0.602	0.773	0.896	1.045	1.176
10-1064	0.207	0.230	0.253	0.276	0.347	0.400	0.480	0.531	0.600	0.690
10-1094	0.051	0.071	0.089	0.100	0.115	0.124	0.148	0.166	0.186	0.200
10-1291	0.058	0.072	0.083	0.092	0.107	0.114	0.115	0.116	0.117	0.122
10-1444	0.072	0.081	0.090	0.096	0.109	0.118	0.147	0.172	0.203	0.226
10-1449	0.152	0.177	0.199	0.219	0.268	0.305	0.400	0.478	0.546	0.568
10-9909	0.053	0.063	0.071	0.076	0.086	0.091	0.102	0.109	0.118	0.126
21-0115	0.038	0.039	0.040	0.041	0.046	0.050	0.054	0.056	0.060	0.067
21-0160	0.064	0.071	0.079	0.085	0.103	0.114	0.130	0.139	0.150	0.160
21-0163	0.069	0.077	0.085	0.091	0.108	0.120	0.140	0.152	0.171	0.196
21-0182	0.034	0.041	0.048	0.053	0.064	0.070	0.075	0.077	0.080	0.084
21-0200	0.050	0.058	0.064	0.069	0.079	0.084	0.089	0.092	0.095	0.100
21-0330	0.125	0.160	0.190	0.211	0.243	0.261	0.296	0.319	0.351	0.391
21-0402	0.027	0.027	0.028	0.029	0.035	0.040	0.044	0.047	0.050	0.053
21-0446	0.145	0.174	0.203	0.232	0.331	0.400	0.458	0.488	0.530	0.600
21-0468	0.097	0.107	0.115	0.121	0.136	0.143	0.146	0.148	0.150	0.157
21-0560	0.041	0.042	0.042	0.043	0.045	0.046	0.048	0.050	0.052	0.055
21-0630	0.072	0.080	0.087	0.092	0.099	0.103	0.108	0.111	0.115	0.120
21-0679	0.050	0.053	0.056	0.059	0.072	0.080	0.083	0.084	0.085	0.088
21-0685	0.080	0.088	0.095	0.100	0.107	0.110	0.115	0.118	0.120	0.121
21-0794	0.043	0.049	0.054	0.057	0.064	0.067	0.072	0.074	0.077	0.080
21-0805	0.092	0.096	0.100	0.103	0.114	0.120	0.124	0.126	0.127	0.128
21-0907	0.043	0.047	0.050	0.053	0.061	0.066	0.074	0.077	0.084	0.098
21-0935	0.151	0.165	0.178	0.185	0.194	0.198	0.198	0.198	0.198	0.198
21-1000	0.089	0.096	0.102	0.106	0.115	0.120	0.130	0.137	0.145	0.151
21-1033	0.036	0.038	0.040	0.042	0.050	0.055	0.055	0.054	0.054	0.056
21-1050	0.066	0.083	0.097	0.105	0.115	0.118	0.120	0.120	0.121	0.121
21-1070	0.030	0.032	0.034	0.035	0.038	0.039	0.041	0.041	0.042	0.043
21-1086	0.108	0.133	0.156	0.173	0.210	0.231	0.257	0.275	0.284	0.284
21-1300	0.040	0.043	0.047	0.050	0.061	0.069	0.076	0.079	0.086	0.103
21-1400	0.045	0.052	0.059	0.064	0.074	0.080	0.087	0.091	0.098	0.114
21-1440	0.068	0.076	0.082	0.085	0.089	0.090	0.091	0.091	0.091	0.091
21-2340	0.060	0.068	0.075	0.081	0.098	0.108	0.111	0.113	0.115	0.117
21-3245	0.053	0.064	0.074	0.080	0.087	0.090	0.099	0.106	0.112	0.115
21-3255	0.041	0.043	0.045	0.047	0.053	0.058	0.062	0.064	0.067	0.070
21-3298	0.110	0.128	0.145	0.160	0.201	0.228	0.274	0.303	0.336	0.363
21-3315	0.209	0.229	0.248	0.264	0.300	0.329	0.418	0.497	0.573	0.600
21-3672	0.041	0.053	0.064	0.070	0.077	0.080	0.084	0.086	0.088	0.090
21-4500	0.067	0.078	0.087	0.096	0.124	0.142	0.165	0.177	0.198	0.240
21-4920	0.085	0.102	0.117	0.130	0.161	0.180	0.206	0.221	0.240	0.263
21-5130	0.117	0.144	0.167	0.184	0.214	0.229	0.251	0.264	0.280	0.301
21-5248	0.120	0.130	0.139	0.146	0.159	0.169	0.196	0.219	0.247	0.266
21-5275	0.110	0.133	0.154	0.170	0.204	0.225	0.270	0.302	0.330	0.341
21-5384	0.120	0.149	0.175	0.193	0.227	0.247	0.280	0.302	0.320	0.329
21-6336	0.130	0.195	0.250	0.280	0.307	0.320	0.345	0.361	0.380	0.400
21-6420	0.127	0.156	0.182	0.204	0.253	0.283	0.332	0.366	0.385	0.385
21-6483	0.095	0.121	0.145	0.163	0.198	0.222	0.276	0.315	0.372	0.441

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
21-6488	0.123	0.161	0.193	0.209	0.219	0.226	0.293	0.389	0.473	0.473
21-6492	0.104	0.137	0.166	0.191	0.246	0.283	0.362	0.422	0.460	0.460
21-6493	0.156	0.182	0.207	0.230	0.296	0.340	0.393	0.424	0.460	0.500
21-7742	0.130	0.175	0.215	0.241	0.281	0.300	0.323	0.337	0.350	0.362
21-8036	0.094	0.110	0.123	0.133	0.150	0.160	0.188	0.208	0.243	0.300
21-8040	0.053	0.065	0.076	0.082	0.091	0.095	0.105	0.111	0.120	0.130
21-8041	0.054	0.058	0.062	0.065	0.074	0.080	0.087	0.092	0.096	0.100
21-8202	0.037	0.043	0.049	0.054	0.070	0.080	0.088	0.092	0.096	0.100
21-8250	0.045	0.058	0.068	0.075	0.083	0.089	0.121	0.157	0.198	0.212
21-8535	0.117	0.139	0.157	0.169	0.184	0.193	0.214	0.230	0.247	0.259
30-1100	0.124	0.139	0.152	0.160	0.169	0.173	0.180	0.184	0.190	0.200
30-1110	0.104	0.116	0.127	0.135	0.149	0.156	0.163	0.166	0.171	0.178
40-1220	0.127	0.138	0.147	0.154	0.163	0.168	0.174	0.178	0.180	0.180
40-1250	0.117	0.127	0.136	0.142	0.149	0.153	0.164	0.173	0.180	0.181
40-1300	0.035	0.042	0.047	0.050	0.052	0.053	0.053	0.053	0.053	0.053
40-1510	0.020	0.022	0.024	0.026	0.030	0.033	0.041	0.047	0.054	0.060
50-0026	0.106	0.111	0.117	0.122	0.138	0.150	0.167	0.178	0.192	0.214
50-0230	0.066	0.074	0.081	0.085	0.088	0.089	0.098	0.109	0.130	0.160
50-0243	0.132	0.156	0.179	0.200	0.255	0.300	0.424	0.530	0.640	0.696
50-0249	0.064	0.080	0.094	0.106	0.129	0.145	0.186	0.218	0.251	0.270
50-0280	0.070	0.089	0.106	0.115	0.124	0.128	0.134	0.137	0.142	0.150
50-0310	0.047	0.068	0.085	0.097	0.116	0.125	0.143	0.154	0.168	0.180
50-0332	0.073	0.101	0.124	0.135	0.141	0.144	0.152	0.158	0.165	0.170
50-0352	0.097	0.157	0.211	0.250	0.326	0.370	0.446	0.495	0.550	0.600
50-0363	0.115	0.137	0.155	0.164	0.170	0.174	0.203	0.242	0.312	0.398
50-0433	0.112	0.121	0.129	0.135	0.150	0.159	0.177	0.188	0.200	0.208
50-0452	0.176	0.198	0.217	0.230	0.249	0.260	0.287	0.305	0.336	0.386
50-0464	0.083	0.090	0.097	0.101	0.108	0.113	0.140	0.172	0.226	0.291
50-0522	0.075	0.111	0.141	0.159	0.179	0.191	0.232	0.266	0.312	0.353
50-0546	0.035	0.038	0.040	0.042	0.045	0.047	0.056	0.064	0.074	0.080
50-0558	0.074	0.082	0.090	0.096	0.108	0.115	0.128	0.137	0.145	0.150
50-0657	0.154	0.193	0.227	0.253	0.305	0.336	0.398	0.444	0.472	0.472
50-0676	0.089	0.121	0.148	0.165	0.189	0.200	0.217	0.228	0.234	0.219
50-0685	0.099	0.128	0.154	0.172	0.205	0.222	0.245	0.258	0.271	0.280
50-0707	0.054	0.062	0.070	0.077	0.092	0.100	0.105	0.107	0.110	0.115
50-0754	0.080	0.088	0.095	0.100	0.111	0.120	0.146	0.169	0.195	0.210
50-0761	0.075	0.085	0.094	0.100	0.112	0.120	0.136	0.148	0.160	0.168
50-0770	0.055	0.063	0.071	0.076	0.085	0.090	0.098	0.103	0.108	0.112
50-0788	0.090	0.117	0.142	0.166	0.239	0.285	0.316	0.331	0.350	0.380
50-0910	0.046	0.049	0.052	0.056	0.071	0.082	0.097	0.105	0.117	0.131
50-1201	0.111	0.126	0.138	0.146	0.156	0.162	0.175	0.185	0.191	0.191
50-1220	0.058	0.073	0.086	0.095	0.108	0.115	0.123	0.128	0.131	0.131
50-1230	0.027	0.028	0.028	0.028	0.029	0.031	0.036	0.042	0.050	0.058
50-1240	0.108	0.133	0.157	0.179	0.244	0.303	0.478	0.638	0.854	1.041
50-1243	0.105	0.107	0.108	0.109	0.110	0.110	0.113	0.115	0.119	0.121
50-1251	0.097	0.104	0.109	0.113	0.119	0.123	0.143	0.163	0.190	0.209
50-1269	0.089	0.097	0.105	0.113	0.141	0.160	0.181	0.194	0.206	0.216
50-1308	0.152	0.191	0.226	0.258	0.343	0.400	0.486	0.541	0.600	0.650
50-1312	0.060	0.068	0.077	0.084	0.106	0.120	0.136	0.145	0.157	0.174
50-1314	0.077	0.106	0.131	0.147	0.168	0.181	0.211	0.232	0.263	0.300
50-1318	0.067	0.081	0.093	0.100	0.108	0.114	0.148	0.188	0.237	0.262
50-1321	0.152	0.189	0.222	0.247	0.295	0.330	0.427	0.506	0.632	0.798
50-1325	0.072	0.095	0.116	0.133	0.169	0.190	0.211	0.222	0.235	0.249
50-1334	0.168	0.222	0.268	0.295	0.322	0.340	0.436	0.543	0.650	0.680
50-1466	0.059	0.071	0.082	0.090	0.105	0.115	0.136	0.150	0.165	0.173

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-1492	0.034	0.042	0.049	0.053	0.060	0.064	0.073	0.080	0.087	0.090
50-1574	0.077	0.087	0.096	0.100	0.104	0.105	0.107	0.108	0.110	0.116
50-1684	0.077	0.092	0.106	0.116	0.134	0.148	0.188	0.223	0.267	0.300
50-1763	0.114	0.130	0.144	0.154	0.167	0.176	0.203	0.225	0.255	0.280
50-1824	0.120	0.150	0.176	0.190	0.204	0.210	0.218	0.223	0.225	0.225
50-1926	0.129	0.137	0.144	0.152	0.180	0.200	0.222	0.234	0.250	0.273
50-1977	0.042	0.050	0.056	0.061	0.068	0.073	0.084	0.092	0.099	0.100
50-1987	0.069	0.082	0.092	0.098	0.105	0.108	0.121	0.133	0.143	0.146
50-2005	0.109	0.131	0.149	0.160	0.172	0.178	0.191	0.201	0.214	0.230
50-2102	0.090	0.107	0.123	0.137	0.169	0.191	0.230	0.255	0.285	0.311
50-2107	0.076	0.088	0.098	0.106	0.119	0.127	0.141	0.151	0.160	0.165
50-2112	0.068	0.070	0.073	0.076	0.094	0.110	0.129	0.141	0.155	0.168
50-2126	0.026	0.028	0.030	0.032	0.039	0.043	0.043	0.044	0.044	0.045
50-2144	0.136	0.141	0.147	0.153	0.178	0.204	0.292	0.382	0.463	0.480
50-2147	0.114	0.124	0.132	0.140	0.162	0.177	0.191	0.199	0.210	0.227
50-2156	0.070	0.075	0.079	0.082	0.085	0.087	0.090	0.092	0.095	0.100
50-2173	0.254	0.329	0.397	0.452	0.578	0.659	0.798	0.883	1.015	1.218
50-2177	0.178	0.227	0.272	0.309	0.395	0.457	0.612	0.734	0.850	0.900
50-2227	0.107	0.134	0.159	0.180	0.231	0.262	0.308	0.339	0.356	0.356
50-2247	0.044	0.044	0.045	0.046	0.047	0.048	0.052	0.055	0.061	0.071
50-2339	0.058	0.070	0.080	0.087	0.101	0.108	0.115	0.119	0.126	0.142
50-2350	0.058	0.071	0.082	0.091	0.112	0.122	0.124	0.126	0.127	0.131
50-2352	0.054	0.061	0.067	0.072	0.087	0.095	0.100	0.102	0.105	0.110
50-2457	0.110	0.127	0.142	0.151	0.162	0.167	0.181	0.191	0.198	0.199
50-2568	0.062	0.066	0.070	0.073	0.080	0.086	0.097	0.104	0.117	0.136
50-2587	0.150	0.189	0.222	0.244	0.275	0.292	0.333	0.361	0.397	0.431
50-2607	0.040	0.045	0.050	0.053	0.058	0.060	0.062	0.064	0.065	0.065
50-2707	0.089	0.108	0.124	0.135	0.152	0.160	0.174	0.182	0.190	0.195
50-2725	0.040	0.041	0.043	0.044	0.050	0.054	0.057	0.059	0.061	0.063
50-2730	0.045	0.051	0.057	0.060	0.063	0.064	0.070	0.076	0.082	0.086
50-2737	0.038	0.042	0.046	0.049	0.055	0.058	0.066	0.070	0.077	0.088
50-2770	0.132	0.176	0.214	0.243	0.297	0.327	0.368	0.390	0.426	0.494
50-2785	0.173	0.206	0.234	0.249	0.260	0.267	0.293	0.318	0.361	0.422
50-2820	0.064	0.080	0.093	0.100	0.107	0.110	0.115	0.119	0.123	0.128
50-2825	0.049	0.055	0.060	0.065	0.075	0.082	0.097	0.108	0.124	0.145
50-2952	0.045	0.048	0.050	0.052	0.056	0.058	0.064	0.068	0.073	0.078
50-2968	0.079	0.088	0.096	0.103	0.116	0.123	0.133	0.140	0.146	0.150
50-2988	0.054	0.056	0.058	0.060	0.065	0.068	0.073	0.076	0.080	0.086
50-3009	0.060	0.061	0.061	0.062	0.064	0.065	0.068	0.069	0.072	0.076
50-3072	0.070	0.104	0.133	0.153	0.182	0.200	0.253	0.295	0.350	0.400
50-3082	0.051	0.054	0.057	0.060	0.071	0.078	0.085	0.088	0.093	0.104
50-3085	0.056	0.059	0.062	0.064	0.068	0.071	0.078	0.083	0.088	0.090
50-3160	0.092	0.106	0.119	0.128	0.144	0.154	0.175	0.190	0.206	0.218
50-3163	0.049	0.059	0.067	0.073	0.084	0.090	0.095	0.098	0.102	0.109
50-3196	0.050	0.061	0.070	0.076	0.085	0.089	0.096	0.100	0.105	0.113
50-3198	0.076	0.081	0.085	0.087	0.088	0.089	0.102	0.124	0.157	0.182
50-3205	0.050	0.051	0.051	0.052	0.054	0.055	0.056	0.057	0.058	0.060
50-3212	0.068	0.073	0.077	0.080	0.086	0.090	0.095	0.097	0.101	0.109
50-3226	0.054	0.064	0.072	0.079	0.098	0.110	0.133	0.150	0.164	0.170
50-3275	0.100	0.113	0.125	0.134	0.152	0.161	0.166	0.168	0.170	0.171
50-3294	0.082	0.094	0.104	0.111	0.121	0.126	0.133	0.137	0.144	0.159
50-3299	0.077	0.094	0.109	0.120	0.140	0.151	0.164	0.172	0.177	0.179
50-3454	0.076	0.087	0.098	0.109	0.140	0.161	0.188	0.205	0.218	0.223
50-3465	0.040	0.041	0.042	0.043	0.046	0.048	0.049	0.049	0.050	0.052
50-3475	0.074	0.077	0.081	0.085	0.100	0.110	0.114	0.116	0.118	0.120

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-3490	0.134	0.159	0.181	0.198	0.231	0.253	0.304	0.339	0.403	0.526
50-3500	0.120	0.142	0.161	0.176	0.205	0.224	0.268	0.299	0.349	0.425
50-3504	0.127	0.150	0.170	0.184	0.204	0.217	0.253	0.281	0.326	0.386
50-3530	0.113	0.145	0.172	0.189	0.208	0.221	0.290	0.368	0.453	0.485
50-3573	0.158	0.174	0.189	0.200	0.222	0.236	0.256	0.269	0.288	0.320
50-3585	0.073	0.087	0.100	0.107	0.113	0.117	0.130	0.141	0.157	0.171
50-3605	0.059	0.089	0.115	0.130	0.142	0.150	0.179	0.206	0.255	0.332
50-3655	0.069	0.087	0.102	0.110	0.117	0.120	0.126	0.130	0.135	0.141
50-3665	0.075	0.094	0.111	0.122	0.140	0.152	0.195	0.236	0.279	0.300
50-3672	0.079	0.101	0.121	0.137	0.175	0.200	0.244	0.274	0.305	0.327
50-3682	0.073	0.089	0.104	0.115	0.137	0.153	0.188	0.215	0.254	0.304
50-3695	0.083	0.095	0.105	0.109	0.110	0.111	0.112	0.114	0.117	0.138
50-3720	0.102	0.110	0.117	0.122	0.130	0.136	0.149	0.158	0.171	0.185
50-3765	0.106	0.115	0.124	0.130	0.142	0.150	0.163	0.171	0.184	0.203
50-3905	0.063	0.089	0.111	0.123	0.135	0.142	0.166	0.186	0.219	0.261
50-3910	0.106	0.130	0.152	0.166	0.188	0.200	0.225	0.241	0.262	0.284
50-3933	0.072	0.100	0.124	0.140	0.167	0.182	0.210	0.227	0.255	0.300
50-4094	0.106	0.111	0.117	0.124	0.151	0.175	0.212	0.238	0.269	0.300
50-4100	0.091	0.103	0.114	0.125	0.154	0.175	0.208	0.229	0.253	0.276
50-4103	0.150	0.175	0.198	0.220	0.281	0.330	0.452	0.550	0.650	0.700
50-4155	0.052	0.070	0.085	0.094	0.105	0.110	0.118	0.122	0.130	0.148
50-4425	0.055	0.069	0.082	0.089	0.100	0.105	0.109	0.112	0.114	0.116
50-4546	0.094	0.099	0.103	0.106	0.112	0.115	0.117	0.118	0.120	0.123
50-4550	0.090	0.107	0.122	0.130	0.137	0.140	0.143	0.145	0.146	0.115
50-4555	0.062	0.088	0.111	0.128	0.162	0.182	0.215	0.236	0.261	0.288
50-4590	0.170	0.249	0.317	0.362	0.436	0.470	0.498	0.511	0.527	0.547
50-4621	0.084	0.103	0.119	0.130	0.147	0.157	0.180	0.197	0.216	0.229
50-4766	0.046	0.062	0.077	0.089	0.114	0.130	0.156	0.174	0.190	0.200
50-4812	0.096	0.108	0.119	0.128	0.147	0.158	0.169	0.175	0.184	0.200
50-4964	0.074	0.101	0.124	0.142	0.178	0.200	0.238	0.262	0.290	0.315
50-4988	0.140	0.152	0.163	0.170	0.183	0.190	0.206	0.215	0.230	0.250
50-4991	0.113	0.129	0.142	0.151	0.164	0.171	0.183	0.190	0.200	0.216
50-5076	0.035	0.041	0.046	0.051	0.065	0.075	0.092	0.104	0.116	0.125
50-5136	0.031	0.033	0.034	0.036	0.039	0.041	0.044	0.047	0.050	0.054
50-5318	0.085	0.092	0.098	0.103	0.114	0.122	0.136	0.146	0.158	0.168
50-5397	0.049	0.050	0.051	0.052	0.056	0.058	0.060	0.061	0.062	0.064
50-5454	0.130	0.140	0.151	0.163	0.203	0.243	0.360	0.468	0.600	0.690
50-5464	0.056	0.061	0.066	0.069	0.073	0.075	0.078	0.079	0.082	0.085
50-5499	0.069	0.076	0.084	0.091	0.119	0.140	0.165	0.180	0.200	0.229
50-5519	0.214	0.224	0.236	0.250	0.315	0.370	0.434	0.475	0.510	0.530
50-5534	0.058	0.063	0.069	0.074	0.086	0.095	0.111	0.121	0.133	0.143
50-5604	0.190	0.201	0.218	0.238	0.367	0.497	0.693	0.827	0.977	1.100
50-5607	0.072	0.087	0.101	0.114	0.153	0.184	0.258	0.317	0.370	0.389
50-5644	0.087	0.096	0.104	0.111	0.123	0.132	0.161	0.187	0.215	0.232
50-5733	0.046	0.049	0.052	0.055	0.063	0.069	0.080	0.088	0.096	0.100
50-5757	0.036	0.047	0.056	0.064	0.082	0.095	0.128	0.155	0.179	0.186
50-5769	0.030	0.031	0.031	0.032	0.034	0.036	0.036	0.037	0.037	0.038
50-5778	0.077	0.079	0.081	0.083	0.091	0.098	0.105	0.108	0.113	0.122
50-5810	0.051	0.059	0.066	0.073	0.089	0.100	0.124	0.142	0.160	0.170
50-5880	0.080	0.082	0.083	0.085	0.091	0.096	0.100	0.102	0.105	0.110
50-5881	0.080	0.078	0.077	0.077	0.081	0.089	0.106	0.122	0.144	0.161
50-5882	0.057	0.061	0.064	0.066	0.072	0.076	0.084	0.090	0.100	0.125
50-5894	0.130	0.132	0.134	0.137	0.156	0.178	0.232	0.280	0.334	0.366
50-5898	0.107	0.130	0.149	0.161	0.177	0.187	0.212	0.229	0.265	0.359
50-6058	0.063	0.070	0.075	0.078	0.076	0.075	0.089	0.117	0.144	0.144

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-6147	0.045	0.056	0.065	0.072	0.086	0.096	0.112	0.122	0.136	0.152
50-6270	0.046	0.044	0.042	0.041	0.042	0.042	0.044	0.048	0.050	0.050
50-6309	0.095	0.114	0.131	0.143	0.164	0.177	0.201	0.217	0.239	0.271
50-6441	0.081	0.093	0.102	0.109	0.120	0.127	0.146	0.160	0.184	0.221
50-6496	0.054	0.060	0.066	0.073	0.096	0.112	0.132	0.145	0.156	0.160
50-6562	0.086	0.095	0.106	0.118	0.161	0.210	0.373	0.541	0.768	0.942
50-6581	0.072	0.084	0.095	0.102	0.114	0.120	0.130	0.136	0.144	0.156
50-6586	0.080	0.083	0.087	0.090	0.102	0.110	0.121	0.127	0.134	0.142
50-6656	0.064	0.069	0.074	0.079	0.092	0.100	0.107	0.111	0.114	0.118
50-6727	0.062	0.065	0.067	0.069	0.077	0.082	0.086	0.088	0.090	0.092
50-6760	0.081	0.086	0.091	0.097	0.122	0.144	0.178	0.201	0.226	0.243
50-6853	0.139	0.152	0.163	0.172	0.190	0.200	0.209	0.213	0.220	0.240
50-6870	0.048	0.058	0.066	0.072	0.082	0.087	0.092	0.095	0.100	0.110
50-6875	0.120	0.128	0.135	0.140	0.146	0.150	0.164	0.176	0.190	0.200
50-7097	0.067	0.074	0.080	0.086	0.104	0.118	0.154	0.183	0.214	0.234
50-7105	0.057	0.060	0.062	0.065	0.076	0.086	0.114	0.138	0.163	0.173
50-7141	0.232	0.307	0.370	0.399	0.410	0.416	0.453	0.497	0.575	0.683
50-7251	0.120	0.140	0.158	0.166	0.167	0.168	0.188	0.223	0.269	0.288
50-7352	0.050	0.058	0.065	0.071	0.089	0.100	0.109	0.113	0.120	0.136
50-7365	0.067	0.087	0.105	0.117	0.137	0.148	0.167	0.180	0.195	0.209
50-7431	0.035	0.048	0.059	0.065	0.070	0.073	0.086	0.100	0.117	0.129
50-7442	0.050	0.057	0.064	0.070	0.082	0.090	0.105	0.115	0.125	0.130
50-7451	0.099	0.111	0.121	0.128	0.140	0.147	0.164	0.176	0.191	0.203
50-7494	0.142	0.177	0.210	0.240	0.318	0.382	0.551	0.694	0.840	0.910
50-7557	0.120	0.133	0.146	0.160	0.213	0.250	0.280	0.296	0.316	0.342
50-7570	0.055	0.082	0.105	0.119	0.134	0.141	0.148	0.152	0.156	0.161
50-7700	0.063	0.074	0.084	0.090	0.097	0.100	0.104	0.106	0.110	0.120
50-7738	0.120	0.125	0.132	0.140	0.180	0.223	0.325	0.412	0.513	0.580
50-7783	0.150	0.179	0.203	0.220	0.246	0.260	0.286	0.304	0.320	0.330
50-7854	0.127	0.141	0.154	0.166	0.196	0.220	0.283	0.337	0.381	0.390
50-7900	0.078	0.084	0.089	0.093	0.098	0.102	0.106	0.109	0.114	0.128
50-7977	0.063	0.082	0.098	0.109	0.128	0.137	0.139	0.139	0.141	0.147
50-8025	0.059	0.075	0.090	0.099	0.111	0.117	0.125	0.130	0.133	0.133
50-8054	0.063	0.065	0.068	0.071	0.085	0.097	0.114	0.125	0.139	0.152
50-8105	0.052	0.059	0.066	0.071	0.080	0.087	0.100	0.109	0.122	0.137
50-8118	0.035	0.047	0.057	0.065	0.083	0.093	0.101	0.104	0.110	0.120
50-8140	0.087	0.102	0.116	0.127	0.150	0.164	0.183	0.195	0.207	0.216
50-8183	0.068	0.107	0.142	0.163	0.194	0.210	0.239	0.257	0.281	0.312
50-8355	0.121	0.152	0.179	0.197	0.225	0.244	0.314	0.381	0.471	0.547
50-8371	0.300	0.364	0.421	0.465	0.548	0.602	0.729	0.823	0.935	1.027
50-8375	0.256	0.289	0.319	0.347	0.420	0.476	0.607	0.709	0.827	0.915
50-8377	0.221	0.230	0.238	0.246	0.264	0.282	0.369	0.473	0.597	0.657
50-8409	0.046	0.067	0.085	0.095	0.108	0.114	0.120	0.124	0.126	0.126
50-8419	0.124	0.130	0.136	0.141	0.156	0.165	0.173	0.177	0.180	0.182
50-8437	0.029	0.031	0.034	0.035	0.039	0.041	0.047	0.051	0.055	0.055
50-8494	0.076	0.091	0.103	0.112	0.128	0.137	0.153	0.161	0.178	0.218
50-8503	0.069	0.087	0.103	0.115	0.137	0.151	0.178	0.196	0.220	0.246
50-8512	0.119	0.123	0.126	0.130	0.141	0.150	0.162	0.170	0.181	0.200
50-8525	0.108	0.123	0.136	0.146	0.163	0.173	0.199	0.217	0.252	0.321
50-8536	0.133	0.152	0.169	0.177	0.181	0.183	0.188	0.192	0.197	0.200
50-8547	0.045	0.056	0.067	0.075	0.097	0.110	0.128	0.139	0.148	0.152
50-8584	0.161	0.198	0.230	0.251	0.280	0.298	0.352	0.395	0.446	0.483
50-8594	0.038	0.038	0.039	0.039	0.040	0.041	0.043	0.043	0.045	0.046
50-8625	0.048	0.052	0.056	0.059	0.067	0.072	0.080	0.084	0.090	0.097
50-8666	0.070	0.077	0.083	0.089	0.109	0.120	0.120	0.120	0.121	0.121

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
50-8811	0.060	0.068	0.075	0.080	0.092	0.098	0.102	0.103	0.105	0.106
50-8882	0.083	0.121	0.154	0.172	0.186	0.192	0.206	0.215	0.229	0.257
50-8915	0.060	0.069	0.077	0.084	0.101	0.110	0.115	0.117	0.120	0.125
50-8976	0.114	0.142	0.166	0.180	0.198	0.206	0.223	0.232	0.248	0.272
50-8987	0.110	0.128	0.144	0.155	0.172	0.181	0.205	0.222	0.240	0.250
50-9014	0.075	0.088	0.100	0.110	0.134	0.150	0.176	0.194	0.210	0.220
50-9035	0.043	0.044	0.045	0.047	0.051	0.054	0.058	0.060	0.064	0.077
50-9102	0.045	0.050	0.056	0.060	0.074	0.082	0.090	0.095	0.100	0.108
50-9121	0.088	0.102	0.115	0.126	0.154	0.170	0.183	0.190	0.200	0.220
50-9144	0.077	0.092	0.105	0.115	0.130	0.141	0.196	0.257	0.313	0.322
50-9249	0.049	0.066	0.080	0.090	0.102	0.110	0.133	0.153	0.170	0.176
50-9313	0.057	0.061	0.065	0.067	0.073	0.078	0.095	0.111	0.129	0.137
50-9385	0.078	0.080	0.081	0.082	0.082	0.082	0.082	0.083	0.084	0.085
50-9399	0.082	0.110	0.136	0.153	0.179	0.197	0.286	0.381	0.456	0.456
50-9410	0.117	0.132	0.146	0.159	0.198	0.224	0.255	0.273	0.296	0.328
50-9421	0.037	0.046	0.054	0.060	0.080	0.090	0.093	0.095	0.097	0.101
50-9460	0.210	0.266	0.313	0.343	0.380	0.405	0.525	0.653	0.798	0.865
50-9489	0.088	0.101	0.112	0.121	0.144	0.156	0.168	0.174	0.180	0.185
50-9511	0.100	0.107	0.113	0.120	0.145	0.163	0.180	0.190	0.200	0.210
50-9539	0.107	0.107	0.108	0.108	0.109	0.109	0.110	0.110	0.110	0.110
50-9564	0.061	0.065	0.068	0.070	0.077	0.083	0.095	0.105	0.115	0.120
50-9641	0.088	0.099	0.108	0.114	0.125	0.131	0.139	0.144	0.150	0.157
50-9686	0.102	0.123	0.142	0.159	0.207	0.238	0.275	0.296	0.326	0.374
50-9702	0.125	0.156	0.185	0.210	0.277	0.317	0.356	0.380	0.395	0.400
50-9739	0.054	0.061	0.068	0.074	0.089	0.100	0.117	0.129	0.141	0.151
50-9759	0.047	0.060	0.072	0.079	0.089	0.095	0.105	0.111	0.118	0.123
50-9765	0.060	0.072	0.083	0.091	0.108	0.117	0.126	0.132	0.137	0.141
50-9790	0.073	0.097	0.117	0.129	0.143	0.151	0.168	0.179	0.195	0.214
50-9793	0.053	0.067	0.079	0.088	0.106	0.115	0.118	0.118	0.120	0.124
50-9829	0.137	0.159	0.182	0.206	0.288	0.365	0.566	0.741	0.900	0.950
50-9861	0.086	0.103	0.117	0.127	0.141	0.148	0.158	0.163	0.170	0.180
50-9869	0.063	0.077	0.090	0.097	0.105	0.110	0.123	0.133	0.145	0.154
50-9883	0.085	0.086	0.088	0.089	0.094	0.097	0.100	0.102	0.104	0.105
50-9919	0.088	0.099	0.109	0.114	0.115	0.115	0.118	0.122	0.129	0.137
50-9930	0.123	0.157	0.189	0.218	0.297	0.356	0.471	0.553	0.653	0.747
50-9941	0.167	0.200	0.231	0.255	0.301	0.340	0.506	0.686	0.946	1.165
55-0064	0.100	0.143	0.182	0.210	0.267	0.300	0.359	0.398	0.436	0.459
55-0079	0.028	0.033	0.037	0.041	0.049	0.055	0.076	0.096	0.124	0.151
55-0080	0.098	0.125	0.149	0.171	0.226	0.266	0.351	0.418	0.460	0.460
55-0087	0.055	0.072	0.086	0.095	0.106	0.111	0.120	0.126	0.129	0.129
55-0096	0.051	0.064	0.075	0.083	0.097	0.103	0.111	0.116	0.118	0.118
55-0164	0.024	0.028	0.031	0.033	0.037	0.040	0.045	0.048	0.050	0.050
80-0100	0.126	0.128	0.130	0.133	0.144	0.152	0.165	0.173	0.182	0.188
80-0120	0.074	0.080	0.086	0.091	0.103	0.110	0.112	0.113	0.115	0.120
80-0140	0.052	0.058	0.064	0.069	0.080	0.088	0.104	0.116	0.127	0.133
80-0160	0.043	0.050	0.055	0.058	0.061	0.062	0.069	0.076	0.087	0.096
80-0200	0.053	0.056	0.059	0.062	0.073	0.081	0.093	0.100	0.110	0.120
80-0220	0.229	0.247	0.267	0.289	0.374	0.454	0.607	0.714	0.903	1.232
80-0240	0.064	0.082	0.098	0.110	0.133	0.145	0.154	0.158	0.167	0.189
80-0260	0.050	0.063	0.074	0.081	0.092	0.099	0.120	0.139	0.152	0.152
80-0340	0.053	0.063	0.072	0.076	0.080	0.082	0.084	0.086	0.088	0.094
80-0425	0.095	0.113	0.128	0.136	0.143	0.147	0.156	0.163	0.168	0.170
80-0440	0.041	0.046	0.049	0.052	0.057	0.061	0.068	0.072	0.078	0.084
80-0460	0.091	0.109	0.124	0.134	0.152	0.163	0.190	0.211	0.234	0.252
80-0540	0.025	0.029	0.033	0.036	0.046	0.053	0.060	0.063	0.071	0.098

Station ID	1day	2day	3day	4day	7day	10day	20day	30day	45day	60day
80-0560	0.050	0.053	0.056	0.058	0.062	0.064	0.067	0.069	0.072	0.079
80-0640	0.090	0.097	0.103	0.107	0.114	0.118	0.126	0.131	0.139	0.151
80-0780	0.063	0.072	0.079	0.083	0.086	0.087	0.089	0.090	0.092	0.095
80-0820	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
80-0860	0.076	0.077	0.079	0.082	0.097	0.109	0.116	0.119	0.123	0.132
80-0900	0.057	0.074	0.088	0.097	0.109	0.114	0.116	0.116	0.118	0.119
80-0920	0.126	0.141	0.155	0.168	0.202	0.230	0.305	0.367	0.439	0.486
80-0940	0.043	0.048	0.052	0.055	0.059	0.062	0.067	0.070	0.075	0.086
80-1020	0.048	0.059	0.069	0.076	0.089	0.096	0.111	0.121	0.133	0.143
80-1060	0.049	0.051	0.053	0.055	0.059	0.061	0.066	0.069	0.072	0.073
80-1100	0.038	0.044	0.049	0.053	0.064	0.072	0.085	0.093	0.104	0.120
80-1120	0.082	0.098	0.113	0.123	0.138	0.147	0.167	0.182	0.200	0.218
80-1140	0.098	0.107	0.116	0.123	0.137	0.148	0.174	0.194	0.223	0.256
80-1180	0.087	0.103	0.117	0.126	0.137	0.143	0.154	0.161	0.173	0.200
80-1220	0.045	0.049	0.053	0.055	0.059	0.062	0.072	0.081	0.093	0.106
80-1240	0.072	0.080	0.088	0.095	0.121	0.138	0.150	0.158	0.162	0.162
80-1280	0.052	0.057	0.062	0.064	0.070	0.072	0.074	0.074	0.076	0.080
80-1300	0.071	0.087	0.100	0.105	0.102	0.098	0.102	0.111	0.131	0.178
80-1320	0.058	0.067	0.074	0.080	0.093	0.100	0.109	0.113	0.120	0.130
80-1340	0.060	0.076	0.090	0.100	0.119	0.130	0.152	0.168	0.180	0.183
80-1360	0.031	0.034	0.038	0.041	0.050	0.059	0.089	0.118	0.157	0.185
80-1380	0.226	0.232	0.238	0.244	0.261	0.279	0.346	0.420	0.515	0.578
80-1400	0.050	0.054	0.057	0.060	0.066	0.070	0.074	0.076	0.080	0.088
80-1420	0.057	0.066	0.074	0.081	0.099	0.110	0.126	0.136	0.147	0.157
80-1440	0.054	0.058	0.063	0.068	0.088	0.105	0.135	0.157	0.171	0.171
80-1460	0.040	0.041	0.042	0.042	0.043	0.043	0.043	0.044	0.044	0.044
80-1480	0.081	0.092	0.101	0.107	0.116	0.122	0.143	0.163	0.187	0.205
80-1540	0.051	0.060	0.068	0.073	0.084	0.090	0.099	0.104	0.111	0.119
80-1740	0.038	0.044	0.049	0.054	0.067	0.077	0.093	0.103	0.120	0.153
80-1760	0.079	0.086	0.093	0.099	0.114	0.124	0.140	0.149	0.166	0.201
80-1900	0.051	0.052	0.053	0.054	0.057	0.060	0.069	0.078	0.090	0.100
80-1940	0.070	0.075	0.081	0.085	0.097	0.105	0.113	0.117	0.122	0.129
80-1980	0.033	0.036	0.039	0.041	0.052	0.059	0.065	0.068	0.072	0.078
80-2000	0.075	0.088	0.100	0.109	0.126	0.136	0.147	0.154	0.158	0.158
80-2040	0.061	0.069	0.077	0.085	0.110	0.131	0.170	0.199	0.223	0.233
80-2080	0.082	0.086	0.089	0.092	0.099	0.104	0.113	0.118	0.123	0.125
80-2120	0.073	0.086	0.097	0.106	0.125	0.136	0.146	0.151	0.159	0.171
80-2140	0.112	0.125	0.137	0.144	0.154	0.158	0.163	0.166	0.170	0.180
80-2160	0.056	0.061	0.065	0.070	0.086	0.100	0.132	0.158	0.180	0.186
80-2320	0.065	0.076	0.085	0.090	0.097	0.100	0.104	0.106	0.110	0.120
80-2340	0.076	0.081	0.084	0.087	0.091	0.093	0.094	0.094	0.095	0.100
80-2380	0.055	0.069	0.082	0.090	0.104	0.110	0.115	0.116	0.120	0.130
80-2440	0.056	0.058	0.059	0.060	0.062	0.064	0.071	0.079	0.090	0.100
80-2560	0.051	0.056	0.061	0.065	0.075	0.080	0.087	0.090	0.095	0.104
80-2620	0.042	0.045	0.047	0.050	0.058	0.063	0.067	0.070	0.072	0.072
80-2640	0.077	0.080	0.082	0.084	0.092	0.099	0.116	0.131	0.151	0.169
80-2700	0.094	0.100	0.106	0.110	0.117	0.120	0.122	0.122	0.123	0.129
90-0001	0.103	0.147	0.186	0.216	0.277	0.319	0.430	0.520	0.606	0.644

Appendix A.5 PRISM report
(report was formatted by HDSC)

Final Report

**Production of Precipitation Frequency Grids for Alaska
Using a Specifically Optimized PRISM System**

Prepared for
National Weather Service, Hydrologic Design Service Center
Silver Spring, Maryland

Prepared by
Christopher Daly
PRISM Climate Group
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December 2011

1. Project Goal

The Hydrometeorological Design Studies Center (HDSC) within the Office of Hydrologic Development of NOAA's National Weather Service is updating precipitation frequency estimates for Alaska. In order to complete the spatial interpolation of point estimates, HDSC requires spatially interpolated grids of MAM (Mean Annual Maximum) precipitation. The contractor, the PRISM Climate Group at Oregon State University (OSU), was tasked with producing a series of grids for precipitation frequency estimation using an optimized system based on the Parameter-elevation Regressions on Independent Slopes Model (PRISM) and HDSC-calculated point estimates for the state of Alaska.

2. Background

HDSC used L-moment based regional frequency analysis approach to estimate precipitation frequencies. In this approach, the mean of the underlying precipitation frequency distribution is estimated at point locations with a sufficient history of observations. The form of the distribution and its parameters are estimated regionally. Once the form of the distribution has been selected and its parameters have been estimated, precipitation frequency estimates can be computed from grids of the MAM. The grids that are the subject of this report are spatially interpolated grids of the point estimates of the MAM for various precipitation durations. The point estimates of the MAM were provided by HDSC. HDSC selected an appropriate precipitation frequency distribution along with regionally estimated parameters and used this information with the grids of the MAM to derive grids of precipitation frequency estimates.

The PRISM Climate Group has previously performed similar work to produce spatially interpolated MAM grids for updates of precipitation frequency estimates in the Semiarid Southwest United States, the Ohio River Basin and Surrounding States, Puerto Rico/US Virgin Islands, Hawaiian Islands and Alaska study areas.

3. Report

This report describes tasks performed to produce draft mean annual maximum (MAM) grids for 15 precipitation durations: 1, 2, 3, 6, and 12 hours; and 1, 2, 3, 4, 7, 10, 20, 30, 45, and 60 days for AK. The tasks described were not necessarily performed in the order described, nor were they performed just once. The process was dynamic and had numerous feedbacks.

3.1. Adapting the PRISM system

The PRISM modeling system was adapted for use in this project after a small investigation was performed for the Semiarid Southwest United States, and subsequently used in the Ohio River Basin and Surrounding States, Puerto Rico/Virgin Islands, Hawaiian Islands, and Alaska study areas. This investigation and adaptation procedure is summarized below.

PRISM is a knowledge-based system that uses point data, a digital elevation model (DEM), and many other geographic data sets to generate gridded estimates of climatic parameters (Daly et al. 1994, 2002, 2003, 2006, 2008) at monthly to daily time scales. Originally developed for precipitation estimation, PRISM has been generalized and applied successfully to temperature, among other parameters. PRISM has been used extensively to map precipitation, dew point, and minimum and maximum temperature over the United States, Canada, China, and other countries. Details on PRISM formulation can be found in Daly et al. (2002, 2003, 2008), which are available from http://prism.oregonstate.edu/docs/.

Adapting the PRISM system for mapping precipitation frequencies required an approach slightly different than the standard modeling procedure. The amount of station data available to HDSC for precipitation frequency was much less than that available for high-quality precipitation maps, such as the peer-reviewed PRISM 1971-2000 mean precipitation maps (Daly et al. 2008). Data sources suitable for long-term mean precipitation but not for precipitation frequency included snow courses, short-term COOP stations, remote storage gauges, and others. In addition, data for precipitation durations of less than 24 hours were available from hourly precipitation stations only. This meant that mapping precipitation frequency using HDSC stations would sacrifice a significant amount of the spatial detail present in the 1971-2000 mean precipitation maps.

A pilot project to identify ways of capturing more spatial detail in the precipitation frequency maps was undertaken. Early tests showed that mean annual precipitation (MAP) was an excellent predictor of precipitation frequency in a local area, much better than elevation, which is typically used as the underlying, gridded predictor variable in PRISM applications. In these initial tests, the DEM, the predictor grid in PRISM, was replaced by the official USDA digital map of MAP for the lower 48 states (USDA-NRCS 1998, Daly et al. 2000). Detailed information on the creation of the USDA PRISM precipitation grids is available from Daly and Johnson (1999). MAP was found to have superior predictive capability over the DEM for locations in the southwestern US. The relationships between MAP and precipitation frequency were strong because many of the effects of various physiographic features on mean precipitation patterns had already been incorporated into the MAP grid from PRISM. Preliminary PRISM maps of 2-year and 100-year, 24-hour precipitation were made for the Semiarid Southwest and compared to hand-drawn HDSC maps of the same statistics. Differences were minimal, and mostly related to differences in station data used.

Further investigation found that the square-root transformation of MAP produced somewhat more linear, tighter and cleaner regression functions, and hence, more stable predictions, than the untransformed values; this transformation was incorporated into subsequent model applications. Square-root MAP was a good local predictor of not only longer-duration precipitation frequency statistics, but for short-duration statistics, as well. Therefore, it was determined that a modified PRISM system that used square-root MAP as the predictive grid was suitable for producing high-quality precipitation frequency maps for this project.

For this study, an updated official USDA grid of MAP for AK (1971-2000 average) was used (Figure 1). This grid was developed under funding from the USDOI National Park Service (Daly et al. 2009).

3.2. PRISM configuration and operation for Alaska

In general, PRISM interpolation consists of a local moving-window regression function between a predictor grid and station values of the element to be interpolated. The regression function is guided by an encoded knowledge base and inference engine (Daly et al., 2002, 2008). This knowledge base/inference engine is a series of rules, decisions and calculations that set weights for the station data points entering the regression function. In general, a weighting function contains knowledge about an important relationship between the climate field and a geographic or meteorological factor. The inference engine sets values for input parameters by using default values, or it may use the regression function to infer grid cell-specific parameter settings for the situation at hand. PRISM acquires knowledge through assimilation of station data, spatial data sets such as MAP and others, and a control file containing parameter settings.

The other center of knowledge and inference is that of the user. The user accesses literature, previously published maps, spatial data sets, and a graphical user interface to guide the model application. One of the most important roles of the user is to form expectations for the modeled climatic patterns, i.e., what is deemed “reasonable.” Based on knowledgeable expectations, the user selects the station weighting algorithms to be used and determines whether any parameters should be changed from their default values. Through the graphical user interface, the user can click on any grid cell, run the model with a given set of algorithms and parameter settings, view the results graphically, and access a traceback of the decisions and calculations leading to the model prediction.

For each grid cell, the moving-window regression function for MAM vs. MAP took the form

$$\text{MAM value} = \beta_1 * \text{sqrt(MAP)} + \beta_0 \qquad (1)$$

where β_1 is the slope and β_0 is the intercept of the regression equation, and MAP is the grid cell value of mean annual precipitation.

Upon entering the regression function, each station was assigned a weight that is based on several factors. For PRISM MAP mapping (used as the predictor grid in this study), the combined weight of a station was a function of distance, elevation, cluster, vertical layer, topographic facet, coastal proximity, and effective terrain weights, respectively. A full discussion of the general PRISM station weighting functions is available from Daly et al. (2008).

Given that the MAP grid incorporated detailed information about the complex spatial patterns of precipitation, only a subset of these weighting functions was needed for this study. For Alaska, the combined weight of a station was a function of distance and clustering, respectively. A station is down-weighted when it is relatively from the target grid cell, or when it is clustered with other stations (which can lead to over-representation).

The moving-window regression function was populated by station data provided by the HDSC. A PRISM GUI snapshot of the moving-window relationship between MAP and 24-hour MAM in southern Alaska is shown in Figure 2.

There were relatively few stations with data for durations of 12 hours or less from which to perform the interpolation. In addition, it was clear that the spatial patterns of durations of 12 hours or less could be very different than those of durations of 24 hours or more. This issue was encountered in a previous study for Puerto Rico. During that study the following procedure was developed, and adopted here:

(1) Convert available ≤ 12-hour station values to an MAM/24-hr MAM ratio (termed R24) by dividing by the 24-hour values;

(2) using the station R24 data in (1), interpolate R24 values for each ≤ 12-hour duration using PRISM;

(3) using bi-linear interpolation from the cells in the R24 grids from (2), estimate R24 at the location of each station having data for ≥ 24-hour durations only;

(4) multiply the estimated R24 values from (3) by the 24-hour value at each ≥ 24-hour station to obtain estimated ≤ 12-hour values;

(5) append the estimated stations from (4) to the ≤ 12-hour station list to generate a station list that matches the density of that for ≥ 24 hours; and

(6) interpolate MAM values for ≤ 12-hour durations with PRISM, using MAP as the predictor grid.

The interpolation of R24 values using PRISM (step 2 above) is normally performed with PRISM in inverse-distance weighting (IDW) mode. However, in Alaska, a lack of station data and strong spatial gradients in R24 made it difficult for the IDW parameterization to produce an adequate field of in R24 values, especially along coastal areas in southern Alaska. R24 values are typically lower along the coast than inland. Coastal areas receive high total precipitation amounts, but intensities at short durations, as a proportion of the 24-hour values, are less than in the drier, inland areas.

Experimentation with more sophisticated parameterizations of PRISM showed that there was a useful relationship between MAP and R24 that could be used to add skill to the R24 interpolation process. Further testing indicated that the cube root of the MAP provided the most linear fit. Therefore, the moving-window regression function for R24 vs. MAP took the form

$$R24 = \beta_1 * (MAP)^{1/3} + \beta_0 \qquad (2)$$

A PRISM GUI snapshot of a moving-window relationship between cube root MAP and 12-hour R24 in southern Alaska is shown in Figure 3.

Relevant PRISM parameters for applications to 60-minute R24 and 24-hour MAM statistics are listed in Tables 1 and 2, respectively. Further explanations of these parameters and associated equations are available in Daly et al. (2002, 2008).

The values of radius of influence (*R*), the minimum number of total (s_t) stations required in the regression were based on information from user assessment via the PRISM graphical user interface, and on a jackknife cross-validation exercise, in which each station was deleted from the data set one at a time, a prediction made in its absence, and mean absolute error statistics compiled (see Results section).

The input parameter that changed readily among the various durations was the default slope (β_{1d}) of the regression function. Slopes are expressed in units that are normalized by the average observed value of the precipitation in the regression data set for the target cell. Evidence gathered during PRISM model development indicates that this method of expression is relatively stable in both space and time (Daly et al. 1994).

Bounds are put on the slopes to minimize unreasonable slopes that might occasionally be generated due to local station data patterns; if the slope is out of bounds and cannot be brought within bounds by the PRISM outlier deletion algorithm, the default slope is invoked (Daly et al., 2002). The maximum slope bound was set to a uniformly high value of 30.0, to accommodate a large range of valid slopes. Lower slope bounds were generally not needed to handle extreme values, because values were within reasonable ranges. The exception was the shortest durations, where slightly negative slopes occasionally occurred; these were accommodated by setting the lower slope bound slightly below zero (Table 3). Slope default values were based on PRISM diagnostics that provided information on the distribution of slopes across the modeling region. The default value was set to approximate the average regression slope calculated by PRISM. For these applications, default slopes typically increased with increasing duration (Table 3). In general, the longer the duration, the larger the slope. This is primarily a result of higher precipitation amounts at the longer durations, and the tendency for longer-duration MAM statistics to bear a stronger and steeper relationship with MAP than shorter-duration statistics.

3.3. Preparation and review of draft grids

Draft grids for the 60-minute, 24-hour and 10-day durations were produced and made available to HDSC for evaluation. All of the necessary station data were provided by HDSC. The process began with a careful scrutiny of the station data and PRISM behavior. A version of PRISM which predicts for stations locations in the absence of each station (termed jackknifing) was run, and stations that were difficult for PRISM to predict for were identified, and sent to HDSC for review. HDSC removed the stations, modified their values, or determined that the stations were accurate as-is. This process was performed iteratively, until an acceptable station data set was produced. The draft PRISM grids were subsequently completed and submitted to HDSC for review.

3.4. Final grids

Having found the revised draft grids acceptable, HDSC requested that grids for all durations be completed. Before delivering the final grids to HDSC, the PRISM Climate Group checked them for internal consistency. In other words, the value of the MAM at each grid point for each duration must be greater than the value for shorter durations at the same grid point. If an inconsistency of this nature occurs, the current convention is to start with the 24 duration as a baseline, and set longer durations to slightly higher values and shorter durations to slightly lower values. Small consistency adjustments were needed at a few scattered locations around the state. Most were in remote areas, but two were at station locations, revealing inconsistencies in the station values. The data were corrected and the model re-run.

The final delivered grids inherited the spatial resolution of the latest 1971-2000 PRISM mean annual precipitation grids for Alaska, which is 30 arc-seconds (~800 meters). The grid cell units are in mm*100. Final MAM grids delivered to HDSC are as follows:

60-minute
2-hour
3-hour
6-hour
12-hour
24-hour
48-hour
3-day
4-day
7-day
10-day
20-day
30-day
45-day
60-day

Total: 15

3.5. Performance evaluation

PRISM cross-validation statistics for 60-minute/24-hour MAM ratio and the 60-minute, 24-hour, 10-day, and 60-day MAM intensities were compiled and summarized in Table 4. These errors were estimated using an omit-one jackknife method, where each station is omitted from the data set, estimated in its absence, then replaced. Since the 60-minute/24-hour MAM ratio was expressed as a percent, the percent bias and mean absolute error are the given as the bias and MAE in the original percent units (not as a percentage of the percent).

For the 60-minute/24-hour MAM ratio, the overall bias was less than one percent and the mean absolute error (MAE) about 3 percent. For the 60-minute, 24-hour, 10-day, and 60-day MAM intensities, biases were about 2 percent. MAEs for the 60-munite, 24-hour, 10-day, and 60-day durations were mostly in the 10-11 percent range. Given that so few stations are available in Alaska, and that cross-validation errors can be calculated only at stations, there is little doubt that the true interpolation errors in many parts of the state are higher than those shown in Table 4.

Table 1. Values of relevant PRISM parameters for interpolation of 60-minute/24-hour mean annual maximum ratio (60-minute R24) for Alaska. See Daly et al. (2002) for details on PRISM parameters.

Name	Description	Value
Regression Function		
R	Radius of influence	10 km*
s_t	Minimum number of total stations desired in regression	10 stations
β_{1m}	Minimum valid regression slope	-1.5^+
β_{1x}	Maximum valid regression slope	0.0^+
β_{1d}	Default valid regression slope	-0.05^+
Distance Weighting		
A	Distance weighting exponent	2.0
F_d	Importance factor for distance weighting	0.5
D_m	Minimum allowable distance	0.0 km
Elevation Weighting		
B	MAP weighting exponent	1.0
F_z	Importance factor for MAP weighting	0.5
Δ□z_m	Minimum station-grid cell MAP difference below which MAP weighting is maximum	10% of MAP
Δz_x	Maximum station-grid cell MAP difference above which MAP weight is minimal	50% of MAP upwards, 20% downwards

* Expands to encompass minimum number of total stations desired in regression (s_t).

$^+$ Slopes are expressed in units that are normalized by the average observed value of the precipitation in the regression data set for the target cell. Units here are 1/[cuberoot(MAP(mm))*1000].

Table 2. Values of relevant PRISM parameters for modeling of 24-hour mean annual maximum statistics for Alaska. See Daly et al. (2002) for details on PRISM parameters.

Name	Description	Value
<u>Regression Function</u>		
R	Radius of influence	10 km*
s_t	Minimum number of total stations desired in regression	45 stations
β_{1m}	Minimum valid regression slope	0.0^{+}
β_{1x}	Maximum valid regression slope	30.0^{+}
β_{1d}	Default valid regression slope	2.8^{+}
<u>Distance Weighting</u>		
A	Distance weighting exponent	2.0
F_d	Importance factor for distance weighting	1.0
D_m	Minimum allowable distance	0.0 km
<u>Elevation Weighting</u>		
B	Elevation weighting exponent	0.0
F_z	Importance factor for elev weighting	0.0
Δ□z_m	Minimum station-grid cell elev difference below which MAP weighting is maximum	NA
Δz_x	Maximum station-grid cell elevation difference above which station is given minimal weighting	50 m upwards, 5000 m downwards

* Expands to encompass minimum number of total stations desired in regression (s_t).

$^{+}$ Slopes are expressed in units that are normalized by the average observed value of the precipitation in the regression data set for the target cell. Units here are 1/[sqrt(MAP(mm))*1000].

Table 3. Values of PRISM slope parameters for modeling of MAM statistics for Alaska for all durations. For durations of 12 hours and below, station data were expressed as the ratio of the given duration's MAM value to the 24-hour MAM value, and interpolated; this was followed by an interpolation of the actual MAM values. See text for details. See Table 1 for definitions of parameters.

	Alaska		
Duration	β_{1m}	β_{1x}	β_{1d}
1h/24h ratio	-1.5	0.0	-0.05
2h/24h ratio	-1.5	0.0	-0.05
3h/24h ratio	-1.5	0.0	-0.05
6h/24h ratio	-1.5	0.0	-0.05
12h/24h ratio	-1.5	0.0	-0.05
1 hour MAM	-0.5	30.0	2.3
2 hour MAM	-0.5	30.0	2.3
3 hour MAM	-0.3	30.0	2.4
6 hour MAM	-0.2	30.0	2.5
12 hour MAM	0.0	30.0	2.7
24 hour MAM	0.0	30.0	2.8
48 hour MAM	0.0	30.0	3.0
3 day MAM	0.0	30.0	3.1
4 day MAM	0.0	30.0	3.2
7 day MAM	0.0	30.0	3.6
10 day MAM	0.0	30.0	3.8
20 day MAM	0.0	30.0	4.2
30 day MAM	0.0	30.0	4.5
45 day MAM	0.0	30.0	4.6
60 day MAM	0.0	30.0	4.8

Table 4. PRISM cross-validation errors for 60-minute/24-hour MAM ratio and 24-hour, 10-day, and 60-day MAM applications to Alaska. Since the 60-minute/24-hour MAM ratio was expressed as a percent, the percent bias and mean absolute error are the given as the bias and MAE in the original percent units (not as a percentage of the percent).

Statistic	N	% Bias	% MAE
60-min/24-hr MAM ratio	123	0.13	3.15
60-minute MAM	353	1.62	10.31
24-hour MAM	353	1.95	9.86
10-day MAM	352	2.28	11.20
60-day MAM	352	2.11	10.92

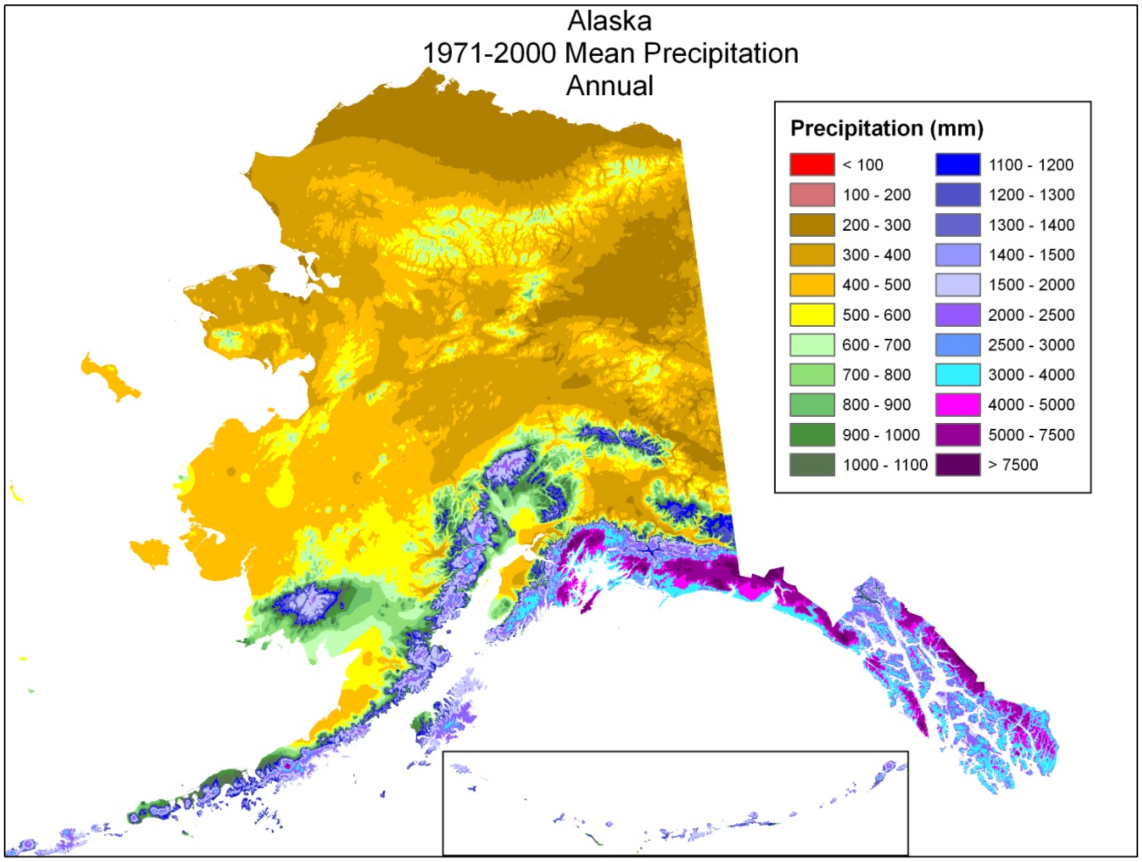

Figure 1. PRISM 1971-2000 mean annual precipitation (MAP) grid for Alaska.

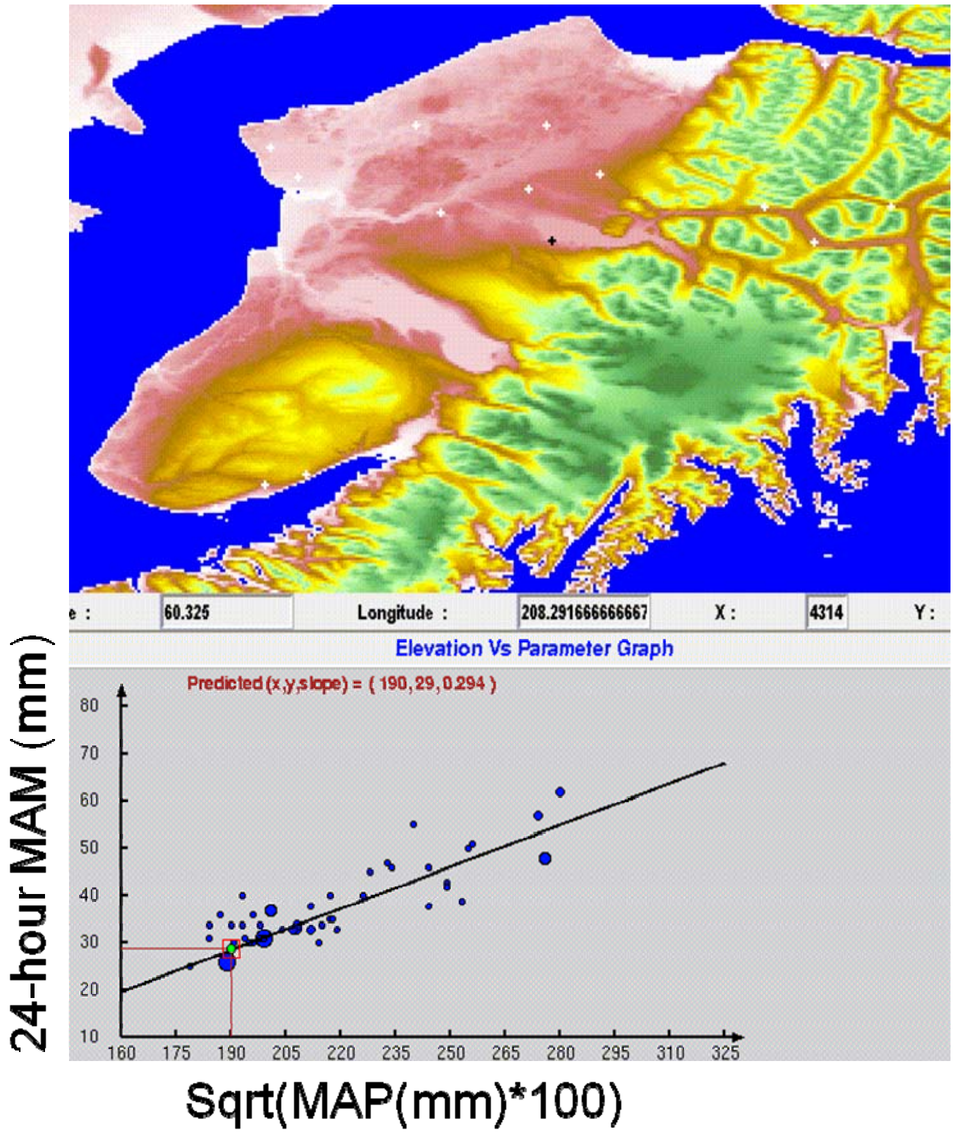

Figure 2. PRISM GUI snapshot of the moving-window weighted regression between the square root of mean annual precipitation and 24-hour mean annual maximum precipitation (MAM) in south-central Alaska. Regression is for the pixel marked with the black "+". Stations are shown with a white "+".

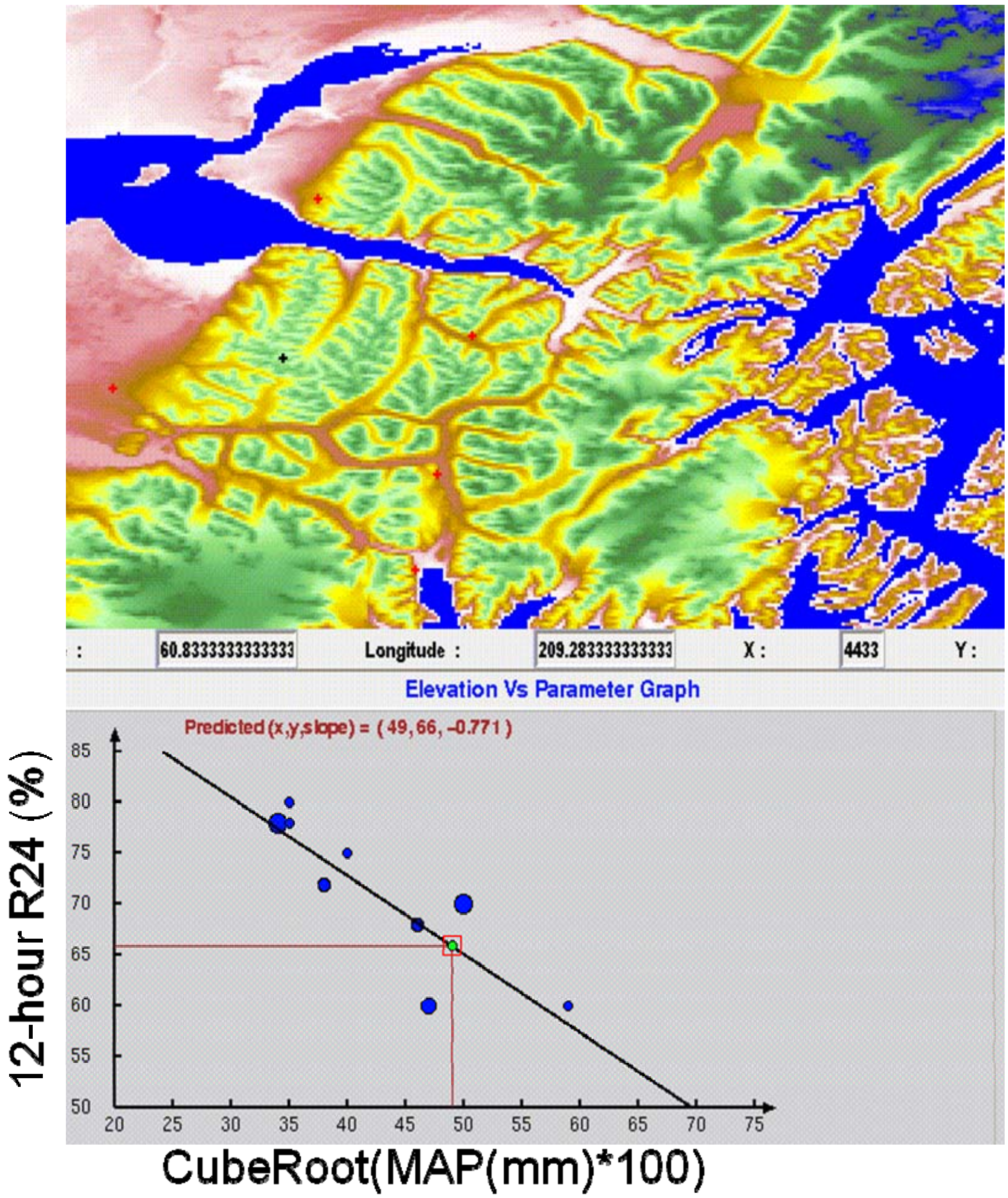

Figure 3. PRISM GUI snapshot of the moving-window weighted regression between the cube root of mean annual precipitation and 12-hour R24 (ratio of 12-hour to 24-hour MAM, expressed in percent) in south-central Alaska. Regression is for the pixel marked with the black "+". Stations are shown with a red "+".

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Appendix A.6 Peer review comments and responses

A peer review of preliminary results for the Alaska precipitation frequency project was carried out during a four week period starting on August 2, 2011. The request for review was sent via email to the over 600 members of the HDSC list-server from all over the United States and other interested parties in Alaska. Potential reviewers were asked to evaluate the reasonableness of point precipitation frequency estimates as well as their spatial patterns. The review included the following items:

1. List of all stations used in the analysis. The list included information on station name, state, name of agency that provided data, assigned station ID, latitude, longitude, elevation, and period of record. It also showed information if the station was merged with another station, if the station was co-located with another station with a different ID, and if metadata at the station were changed.
2. List of all stations that were received by HDSC, but not considered in analysis. This list contained stations that were not used, either because there was another station with a longer period of record nearby, station data were not reliable, or the station period of record was not long enough and it was not a candidate for merging with any nearby station.
3. Spatially-interpolated estimates of mean annual maxima for 60-minute, 24-hour and 10-day durations.
4. Spatially-interpolated precipitation frequency estimates for 60-minute, 24-hour and 10-day durations and for 2-year and 100-year ARIs.
5. At-station depth-duration-frequency curves for 60-minute to 10-day durations and for 2-year to 100-year average recurrence intervals (ARI).

Four reviews were received. All reviewers' comments and HDSC's responses are shown below. The comments and their respective HDSC responses have been divided in four categories:

1. Station metadata;
2. At-station precipitation frequency estimates;
3. Precipitation frequency grids/maps;
4. Additional and supplementary information.

1. Comments pertaining to station metadata

1.1 List of stations used in analysis: elevation of Chistochina appears to be in error – reads 180 and should be 1800.

HDSC response: Elevation of Chistochina station was changed to 1800 feet.

2. Comments pertaining to at-station precipitation frequency estimates

2.1 Station Amchitka is labeled Attuhitka on the DDF curve. As an aside, this station also has surprisingly low rainfall compared to nearby Aleutian stations.

HDSC response: The station name in our records is Amchitka and was mislabeled on the curve for the peer review. Annual maximum series at Amchitka station were revisited and a decision *was made not to use this station's data in the analysis. The station's period of record was relatively short with long spans of missing data. The station recorded data during relatively dry periods causing estimates to be much lower than corresponding estimates at nearby stations.*

2.2 Why are so many fewer stations shown on the 2-yr 60-minute map, when all stations have data for 2-yr 1-hr on the frequency curves?

HDSC response: On the 60-minute map we showed only locations of stations that have measurements at hourly durations (stations recording at 15-minute and/or 1-hour intervals). The contour lines on the map were created from gridded PDS-based precipitation frequency estimates that were obtained through spatial interpolation of at-station precipitation frequency estimates. These gridded hourly estimates were used to display depth-duration-frequency curves at each station.

2.3 Short duration precip maxima in Interior Alaska are completely a function of summer convection. It is therefore somewhat disconcerting to see that hourly precipitation data from a number of SNOTEL sites (e.g. MSOA2, EAGA2, MTRA2) equipped with tipping bucket gauges were not used in the construction of the products.

HDSC response: During the initial quality control effort, it was decided to exclude stations from hourly SNOTEL dataset due to their short periods of record and significant number of missing data. In addition, aggregated amounts at 24-hour duration were frequently considerably lower than corresponding 1-day amounts obtained from co-located daily SNOTEL stations. However, after further review of the dataset that was prompted by this comment, a decision was made to include two hourly SNOTEL stations that have reasonable records relative to their co-located daily stations.

3. Comments pertaining to precipitation frequency grids/maps

3.1 I reviewed approximately 40 at-station frequency estimates (Kenai Peninsula, Seward Peninsula, Fairbanks Area and North Slope of Alaska) and the estimates appear to match my local knowledge and seem to be representative. The frequency contour maps seem reasonable and the spatial distribution matches my limited local knowledge of the entire state. The two extreme locations in SE Alaska are interesting considering that there are no station data within the extreme isopluvials. These two areas seem to match up with similar areas shown in HR. No. 54.

HDSC response: Estimates in areas with no stations were developed through spatial interpolation of at-station estimates using hybrid statistical-geographic techniques for mapping climate (described in Section 4.8 of this document) and are influenced, among other factors, by terrain.

3.2 Smoothing and interpolation generally appear consistent with measurements and terrain. There are a few places where isolines are drawn around isolated stations, because the station measurements are higher/lower than the surrounding interpolated areas. These would indicate islands of higher/lower rainfall where there isn't enough data to determine that this is really true. I only list the ones below that do not have an apparent terrain influence that would support showing them as different than the surrounding area.

- Willow West – this station is shown as an "island" on the 2-yr/24-hr map, despite not having any apparent topographic isolation from surrounding areas. The isoline (2 inches) seems to be right at the 2-yr/24hr estimate for the station.
- Holy Cross and Cape Romanzof on the 10-day MAM map both are in their own "islands" without apparent topographic reasons
- On 2-year 10-day map, there are separate "islands" around Gulkana and Gakona, while the curves suggest that the isoline might be drawn around Gulkana, Gakona, and Klawasi to distinguish that area of lower precip.

HDSC response: A single contour line around an isolated station can occur frequently and is typically of little concern. Although it may appear from a cartographic map that an at-station estimate is much higher/lower than surrounding estimates, when the actual gridded estimates that were used to create the map are compared, the differences are typically minor. However, there can be cases where at-station estimates are very different from nearby interpolated values (resulting in several contour lines around a station); an effort was made to scrutinize such cases. After the peer review, an alternative interpolation technique was developed for this project area to address the inability of the interpolation technique used in the peer review (and in previous studies) to produce spatial patterns in line with expected climatological patterns, especially for ARIs of 100-years or more and in areas with very few stations (see Section 4.8 for more details). Therefore, estimates in areas surrounding the locations singled out in this comment have changed. The resulting spatial patterns were improved.

3.3 It looks to me like the maximum one hour precip in Interior Alaska are too low. In the area of maximum convection (Yukon-Tanana uplands), two year return period amounts should at least 0.50" inches and 10 year returns should be something near or a little below one inch. This seems to be supported on the "MEAN ANNUAL MAXIMUM PRECIPITATION FOR 60-MINUTES DURATION" map that shows a number "bulleyes" near stations that were used in the analysis.

HDSC response: Please see response to comment 3.2. As a result of the updated interpolation approach, estimates across interior Alaska changed and are more in line with expectations. Mean annual maximum (MAM) estimates for hourly durations were adjusted at locations where they appeared to be low, but the range of MAMs in this area remains the same (0.40 to 0.50 inches), which is consistent with observed data.

3.4 The map of isopluvials with 100 year return period seems much too low over some portions of the uplands north and west of Fairbanks, though here the "bullseyes" seem to be on the low side. It is meteorologically unreasonable that the 100 return period of one hour precip would be higher over the Tanana Flats, south of Fairbanks, than over the higher terrain to the north.

HDSC response: After the peer review, several unreliable stations in this region with short records were deleted. The new estimates are more in-line with expectations.

4. Comments pertaining to additional and supplementary information

4.1 Suggestion I have would be to add a column to the "Gages not used" table explaining why some gages were excluded from analysis. For most locations the reasons are obvious (not a long enough period of record or duplicate gage). But some locations, such as the Fort Greeley/Allen A gage (70-2670), were unclear as to why they were excluded.

HDSC response: In Section 4.4 of this document we provide a description of the screening process and why stations may not be used in the frequency analysis; we do not provide information on individual stations not retained. Hourly station 70-2670 was deleted because the station was missing about 97% of the precipitation observations during its period of record.

4.2 It would be useful for future planning purposes to include a flag in the 'Stations Not Included' data file that describes why a station was not used in the analysis (reliability, proximity, short record, etc.). This could aid in coordinating future precipitation data collection throughout the state.

HDSC response: Please see response to comment 4.1; this suggestion will be considered for future peer reviews.

4.3. Suggest selectively including intermediate isopluvials in the Central, Western and Northern portions of the state to add more detail to these areas.

HDSC response: We purposefully keep the contour intervals on cartographic maps constant. Please keep in mind that cartographic maps were created to serve only as visual aids. Users are advised to take advantage of the PFDS interface or the underlying ASCII grids for obtaining precipitation frequency estimates. Additionally, a user can contour the grids specifically for their area of interest.

4.4 Suggest that a temporal analysis (similar to HI Atlas 14 update) and comparison to previous precipitation estimates be included in the final report.

HDSC response: The temporal analysis and comparison of new and previous estimates are not part of the peer review process, but are included in the final publication. The temporal analysis is described in the Appendix A.7, and temporal distributions are available from the PFDS web page when any point is selected in the project area. The comparison of updated and previous estimates (from Technical Paper No. 47) is available in Section 7.

Appendix A.7 Temporal distributions of heavy precipitation

1. Introduction

Temporal distributions of precipitation amounts exceeding precipitation frequency estimates for the 2-year recurrence interval are provided for 6-, 12-, 24-, and 96-hour durations. The temporal distributions are expressed in probability terms as cumulative percentages of precipitation totals at various time steps. To provide detailed information on the varying temporal distributions, separate temporal distributions were also derived for four precipitation cases defined by the duration quartile in which the greatest percentage of the total precipitation occurred. To increase sample sizes, stations from the Arctic, Interior, West Coast and Southwest Interior climate regions were grouped in the Northern Region and Southwest Islands, Cook Inlet, and South/Southeast Coast regions into the Southern Region (see Section 4.1 and Figure 4.1.2).

2. Methodology and results

The methodology used to produce the temporal distributions is similar to the one developed by Huff (1967) except in the definition of precipitation cases. In accordance with the way a precipitation case ('event') was defined for the precipitation frequency analysis, a precipitation case for the temporal distribution analysis was computed as the total accumulation over a specific duration (6-, 12-, 24-, or 96-hours). As a result, it may contain parts of one or more storms. Because of that, temporal distribution curves presented here may be different from corresponding temporal distribution curves obtained from the analysis of single storms.

Also, precipitation cases for this project always start with precipitation but do not necessarily end with precipitation, resulting in potentially more front-loaded cases when compared with distributions derived from the single storm approach. Cases were selected from all events of a given duration that exceeded the 2-year average recurrence interval at each station. Table A.7.1 shows the total number of precipitation cases and number of cases in each quartile for each region and duration.

For each precipitation case, cumulative precipitation amounts were converted into percentages of the total precipitation amount at one hour time increments. All cases for a specific duration were then combined and probabilities of occurrence of precipitation totals were computed at each hour. The temporal distribution curves for nine deciles (10% to 90%) were smoothed using linear programming method (Bonta and Rao, 1988) and plotted in the same graph. Figure A.7.1 shows as an example of temporal distribution curves computed from all cases for the four selected durations for the Southern Region; time steps were converted into percentages of durations for easier comparison.

The cases were further divided into four categories by the quartile in which the greatest percentage of the total precipitation occurred. Table A.7.1 shows the numbers and proportion of precipitation cases used to derive the temporal distributions in each quartile. Unlike the cases of 12-, 24-, and 96-hour durations in which the number of data points can be equally divided by four, the cases of 6-hour duration contain only six data points and they cannot be evenly distributed into four quartiles. Therefore, in this analysis, for the 6-hour duration, the first quartile contains precipitation cases where the most precipitation occurred in the first hour, the second quartile contains precipitation cases where the most precipitation occurred in the second and third hours, the third quartile contains precipitation cases where the most precipitation occurred in the fourth hour, and the fourth quartile contains precipitation cases where the most precipitation occurred in the fifth and sixth hours. This uneven distribution affects the number of cases contained in each quartile for the 6-hour duration. Figures A.7.2 through A.7.5 show the Southern Region's temporal distribution curves for the four quartile cases for 6-hour, 12-hour, 24-hour and 96-hour durations, respectively.

Table A.7.1. Total number of precipitation cases and number (and percent) of cases in each quartile for selected durations for each climate region.

Duration	Region	All cases	First-quartile cases	Second-quartile cases	Third-quartile cases	Fourth-quartile cases
6-hour	Northern Region	785	273 (35%)	247 (31%)	186 (24%)	79 (10%)
	Southern Region	363	60 (16%)	130 (36%)	101 (28%)	72 (20%)
12-hour	Northern Region	825	292 (36%)	233 (28%)	200 (24%)	100 (12%)
	Southern Region	391	69 (18%)	133 (34%)	129 (33%)	60 (15%)
24-hour	Northern Region	680	242 (36%)	186 (27%)	153 (22%)	99 (15%)
	Southern Region	324	53 (16%)	113 (35%)	109 (34%)	49 (15%)
96-hour	Northern Region	688	299 (43%)	145 (21%)	129 (19%)	115 (17%)
	Southern Region	301	114 (38%)	64 (21%)	54 (18%)	69 (23%)

From the Precipitation Frequency Data Server, regional temporal distribution data are available in a tabular form for a selected location under the 'Supplementary information' tab or through the temporal distribution web page (http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_temporal.html). For 6-, 12- and 24-hour durations, temporal distribution data are provided in 0.5-hour increments and for 96-hour duration in hourly increments.

3. Interpretation

Figure A.7.1 shows as an example the temporal distribution curves of all precipitation cases in the Southern Region for the 6-, 12-, 24-, and 96-hour durations. Time steps were converted into percentages of total durations for easier comparison. Figures A.7.2 through A.7.5 show temporal distribution curves for first-, second-, third-, and fourth-quartile cases for 6-hour, 12-hour, 24-hour and 96-hour durations, respectively. First-quartile plots show temporal distribution curves for cases where the greatest percentage of the total precipitation fell during the first quarter of the duration (e.g., the first 3 hours of a 12-hour duration). The second, third, and fourth quartile plots are similarly for cases where the most precipitation fell in the second, third, or fourth quarter of the duration.

The temporal distribution curves represent the averages of many cases and illustrate the temporal distribution patterns with 10% to 90% occurrence probabilities in 10% increments. For example, the 10% curve in any figure indicates that 10% of the corresponding precipitation cases had distributions that fell above and to the left of the curve. Similarly, 10% of the cases had temporal distribution falling to the right and below the 90% curve. The 50% curve represents the median temporal distribution.

The following is an example of how to interpret the results using the figure (a) in the upper left panel of Figure A.7.4 for 24-hour first-quartile cases in the Southern Region.

- In 10% of the first-quartile cases, 50% of the total precipitation fell in the first 4.3 hours (18% of duration) and 90% of the total precipitation fell by 10.7 hours (44.8% of duration).
- A median case of this type will drop half of the precipitation (50% on the y-axis) in approximately 8.1 hours.
- In 90% of the cases, 50% of the total precipitation fell by 12.4 hours (52% of duration) and 90% of precipitation fell by 22.3 hours (94% of duration).

Temporal distribution curves are provided in order to show the range of possibilities. Care should be taken in the interpretation and use of temporal distribution curves. For example, the use of different temporal distribution data in hydrologic models may result in very different peak flow estimates. Therefore, they should be selected and used in a way to reflect users' objectives.

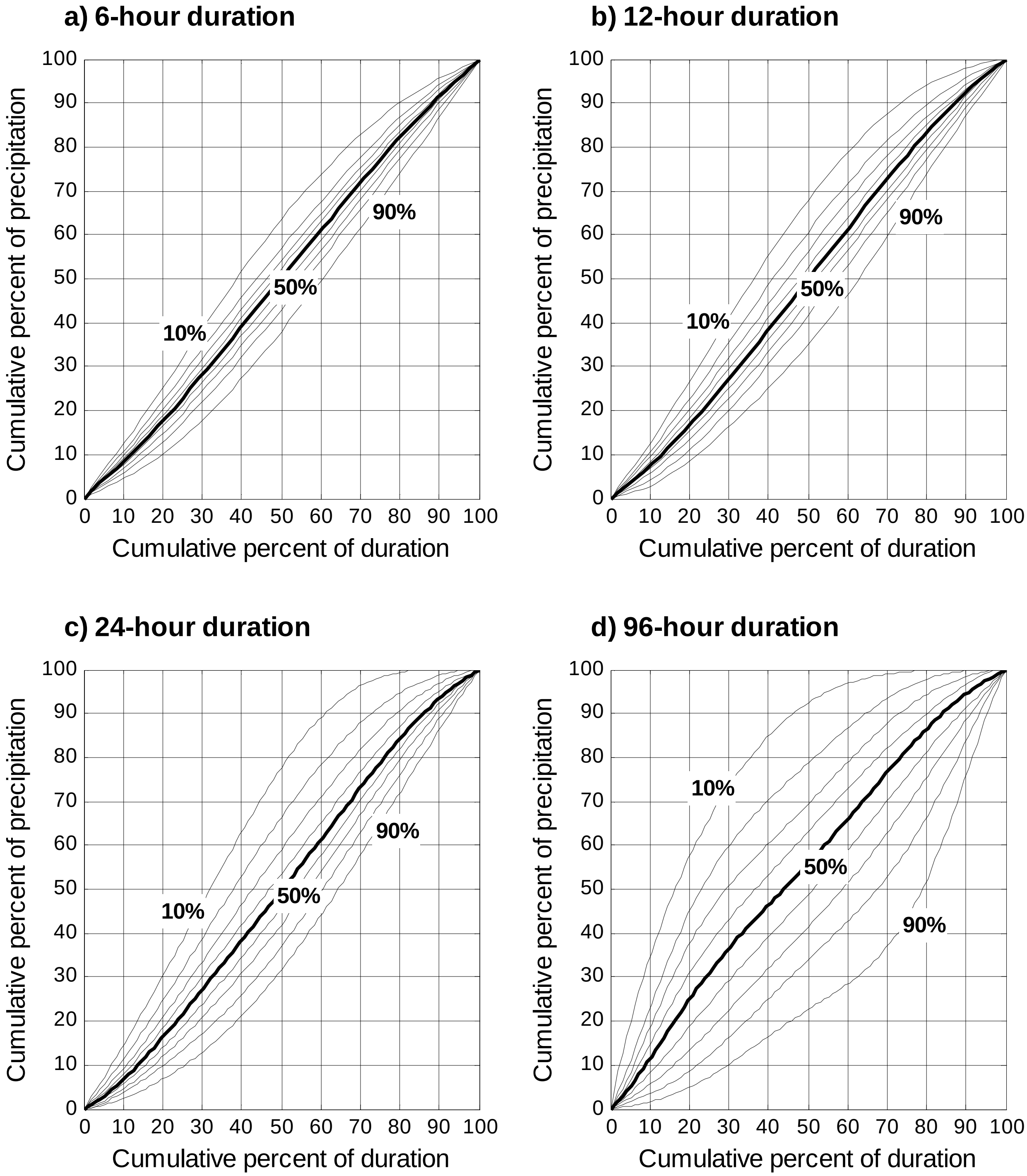

Figure A.7.1. Temporal distribution curves for the Southern Region all cases for: a) 6-hour, b) 12-hour, c) 24-hour, and d) 96-hour durations.

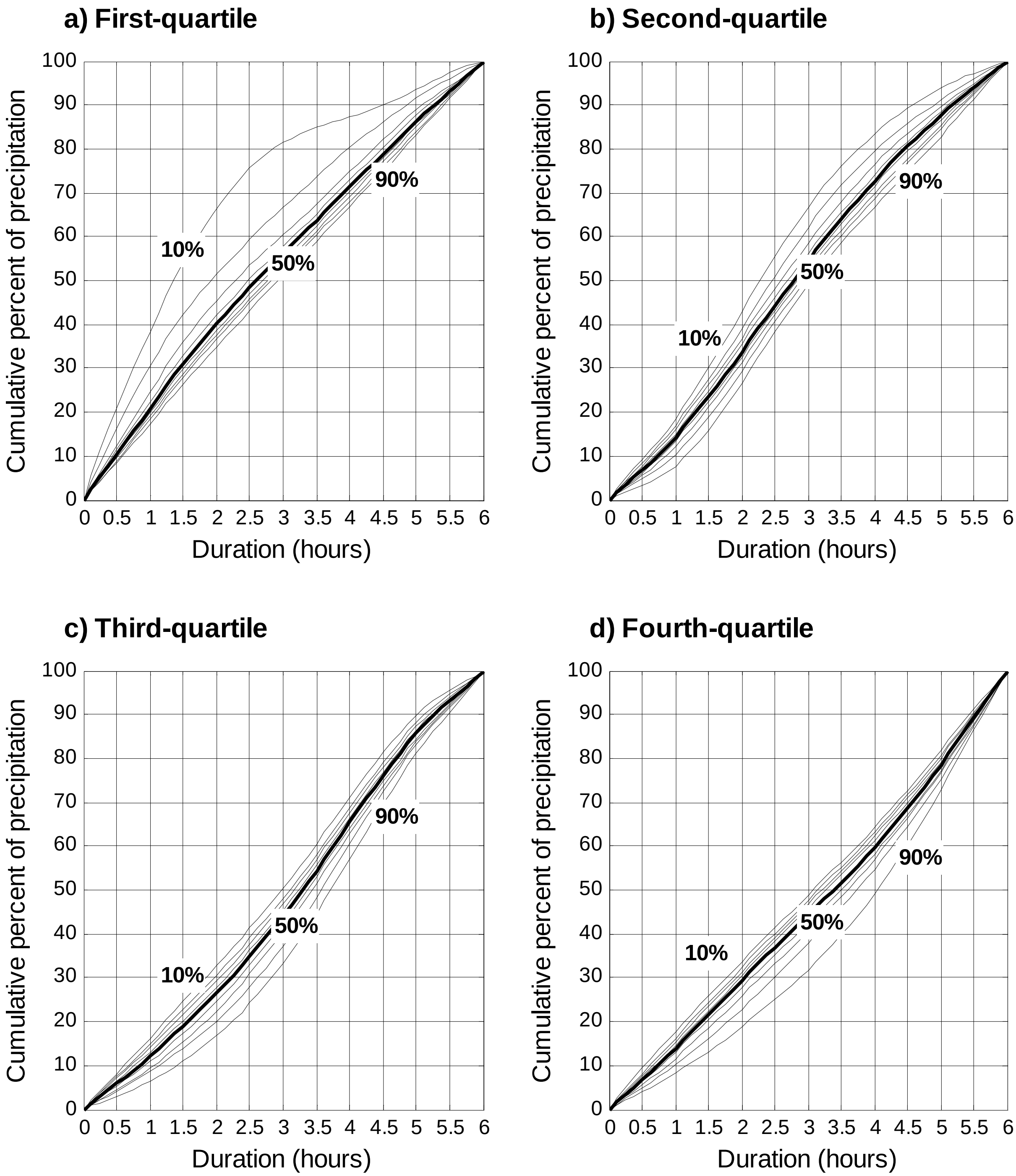

Figure A.7.2. 6-hour temporal distribution curves for the Southern Region: a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

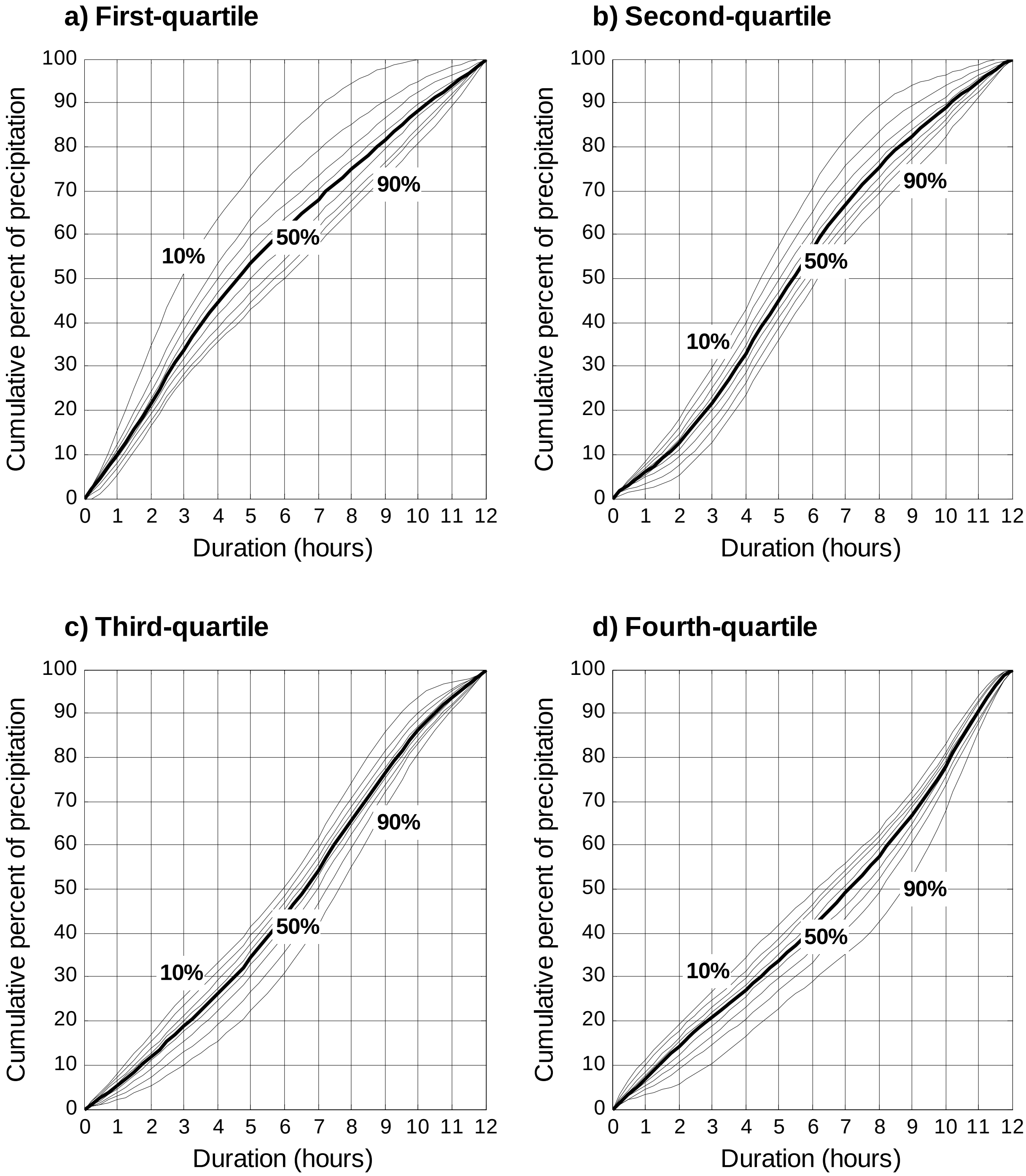

Figure A.7.3. 12-hour temporal distribution curves for the Southern Region: a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

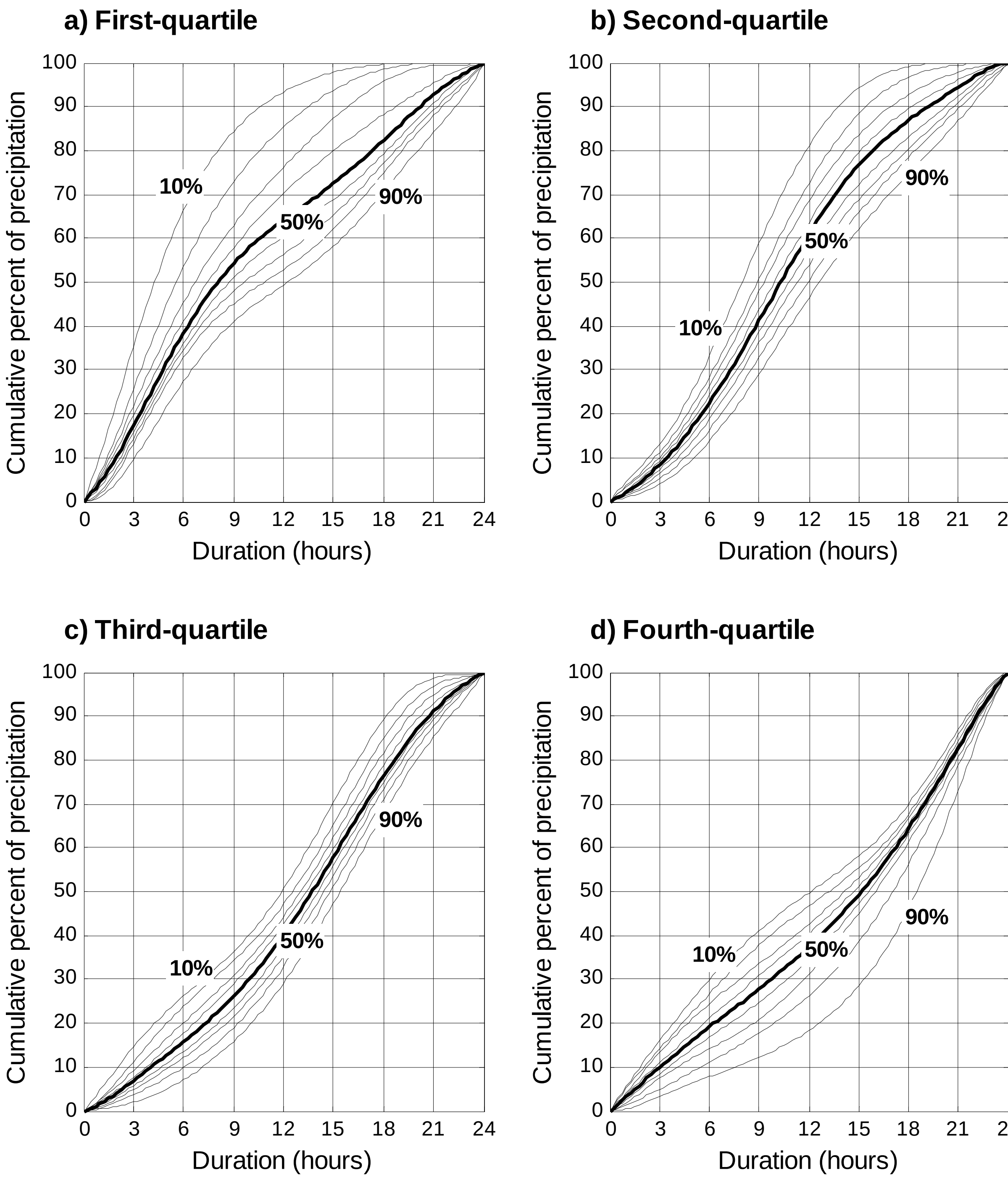

Figure A.7.4. 24-hour temporal distribution curves for the Southern Region: a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

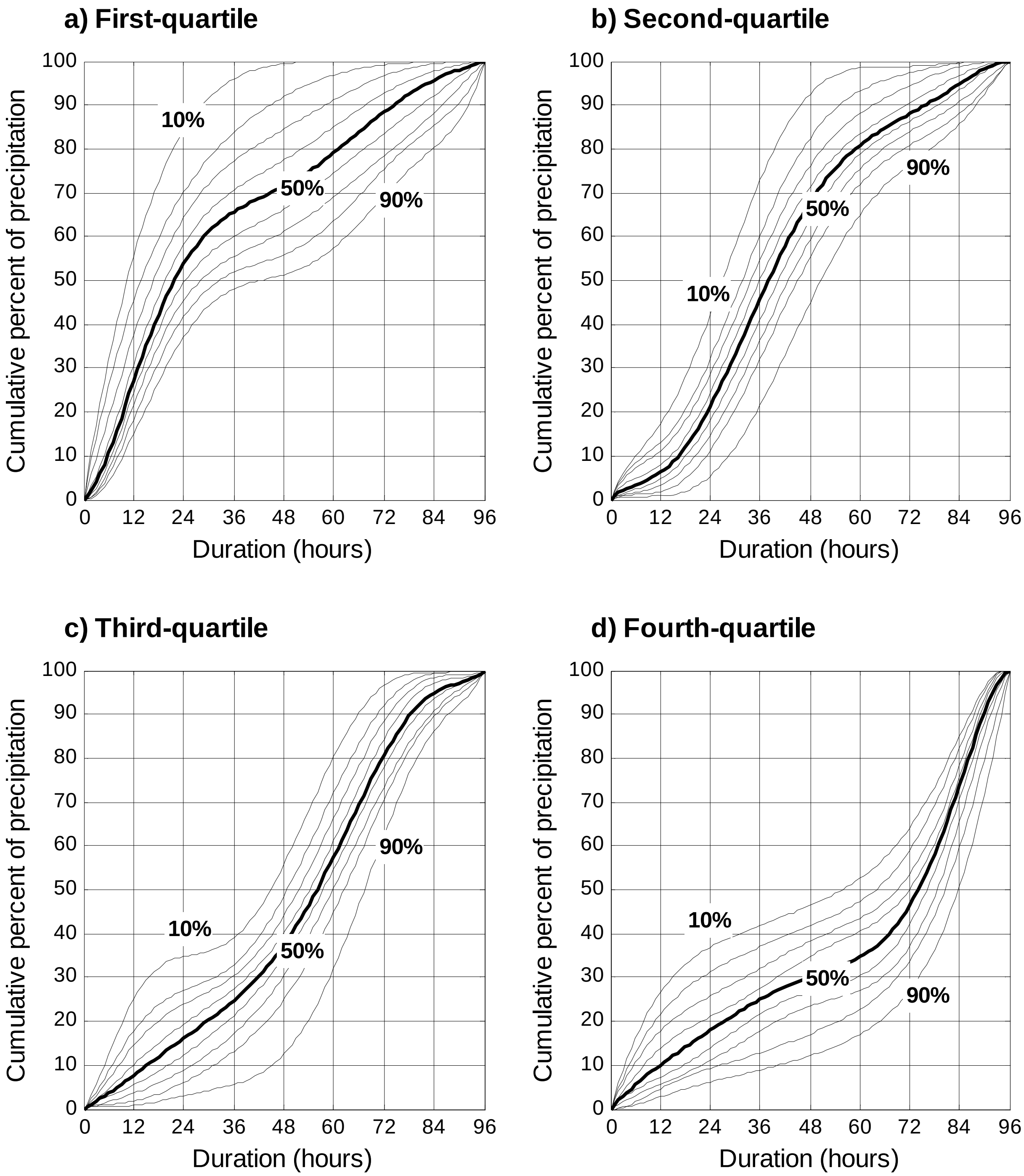

Figure A.7.5. 96-hour temporal distribution curves for the Southern Region: a) first-quartile, b) second-quartile, third-quartile, and d) fourth-quartile cases.

Appendix A.8 Seasonality

1. Introduction

To portray the seasonality of extreme precipitation throughout the project area, annual maxima that exceeded precipitation frequency estimates (quantiles) with selected annual exceedance probabilities (AEPs) for chosen durations were examined for the Northern and Southern climate regions described in Section 4.1. Graphs showing the monthly variation of the exceedances for a region are provided for each location in the project area via the Precipitation Frequency Data Server (PFDS) at http://hdsc.nws.noaa.gov/hdsc/pfds/. For a selected location, seasonal exceedance graphs can be viewed by selecting 'V. Seasonality analysis' of the 'Supplementary information' tab on the output page.

2. Method

Separate seasonal exceedance graphs were created for the Northern and Southern climate regions. They show the percentage of annual maxima for a given duration from all stations in a region that exceeded corresponding precipitation frequency estimates at selected AEP levels in each month. Results are provided for unconstrained 60-minute, 24-hour, 2-day, and 10-day durations and for AEPs of 1/2, 1/5, 1/10, 1/25, 1/50, and 1/100.

To prepare the graphs, first, the number of annual maxima exceeding the precipitation frequency estimate at a station for a given AEP was tabulated for each duration. Those numbers were then combined for all stations in a given region, sorted by month, normalized by the total number of data years in the region, and finally plotted via the PFDS.

3. Results

The exceedance graphs for a selected location (see an example for a location in the Northern Region in Figure A.8.1) indicate percent of annual maxima exceeding the quantiles with selected AEPs for various durations. The percentages are based on regional statistics. On average, 1 % of annual maxima for a given duration in a year (i.e., the sum of percentages of all twelve months) are expected to exceed the 1/100 AEP quantile, 4% is expected to exceed the 1/25 AEP quantile, etc.

Note that seasonality graphs are not intended to be used to derive seasonal precipitation frequency estimates.

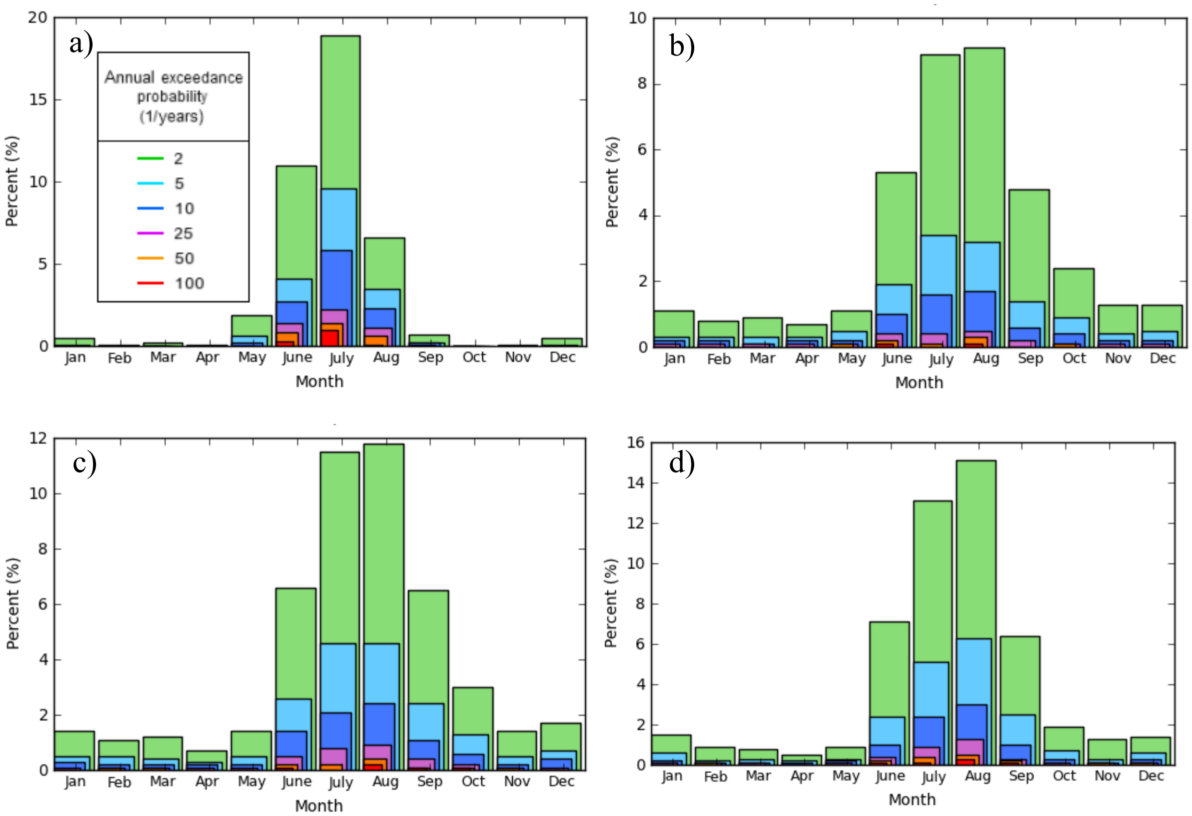

Figure A.8.1. Example of seasonal exceedance graphs for the Northern climate region for the: a) 60-minute, b) 24-hour, c) 2-day, and d) 10-day durations.

Glossary

(All definitions are given relative to precipitation frequency analyses in NOAA Atlas 14 Volume 7)

ANNUAL EXCEEDANCE PROBABILITY (AEP) – The probability associated with exceeding a given amount in any given year once or more than once; the inverse of AEP provides a measure of the average time between years (and not events) in which a particular value is exceeded at least once; the term is associated with analysis of annual maximum series (see also AVERAGE RECCURENCE INTERVAL).

ANNUAL MAXIMUM SERIES (AMS) – Time series of the largest precipitation amounts in a continuous 12-month period (calendar or water year) for a specified duration at a given station.

ASCII GRID – Grid format with a 6-line header, which provides location and size of the grid and precedes the actual grid data. The grid is written as a series of rows, which contain one ASCII integer or floating point value per column in the grid. The first element of the grid corresponds to the upper-left corner of the grid.

AVERAGE RECURRENCE INTERVAL (ARI; a.k.a. RETURN PERIOD, AVERAGE RETURN PERIOD) – Average time between *cases of a particular precipitation magnitude* for a specified duration and at a given location; the term is associated with the analysis of partial duration series. However, ARI is frequently calculated as the inverse of AEP for the annual maximum series; in this case it represents the average period between years in which a given precipitation magnitude is exceeded at least once.

CASCADE, RESIDUAL ADD-BACK (CRAB) – The HDSC-developed spatial interpolation procedure for deriving grids of precipitation frequency estimates from grids of mean annual maxima and point precipitation frequency estimates for a given duration.

CONSTRAINED OBSERVATION – A precipitation measurement or observation bound by clock hours and occurring in regular intervals. This observation requires conversion to an unconstrained value (see UNCONSTRAINED OBSERVATION) because maximum 60-minute or 24-hour amounts seldom fall within a single hourly or daily observation period.

DATA YEARS – See RECORD LENGTH.

DEPTH-DURATION-FREQUENCY (DDF) CURVE – Graphical depiction of precipitation frequency estimates in terms of depth, duration and frequency (ARI or AEP).

DISTRIBUTION FUNCTION (CUMULATIVE DISTRIBUTION FUNCTION) – Mathematical description that completely describes frequency distribution of a random variable, here precipitation. Distribution functions commonly used to describe precipitation data include 3-parameter distributions such as Generalized Extreme Value (GEV), Generalized Normal, Generalized Pareto, Generalized Logistic and Pearson type III, the 4-parameter Kappa distribution, and the 5-parameter Wakeby distribution.

FEDERAL GEOGRAPHIC DATA COMMITTEE (FGDC) COMPLIANT METADATA – A document that describes the content, quality, condition, and other characteristics of data and follows the guidelines set forth by the FGDC; metadata is "data about data."

FREQUENCY – General term for specifying the average recurrence interval or annual exceedance probability associated with specific precipitation magnitude for a given duration.

FREQUENCY ANALYSIS – Process of derivation of a mathematical model that represents the relationship between precipitation magnitudes and their frequencies.

FREQUENCY ESTIMATE – Precipitation magnitude associated with specific average recurrence interval or annual exceedance probability for a given duration.

HEAVY PRECIPITATION – Precipitation with an average recurrence interval roughly between 1 year and 1,000 years for a given duration.

INTENSITY-DURATION-FREQUENCY (IDF) CURVE – Graphical depiction of precipitation frequency estimates in terms of intensity, duration and frequency.

INTERNAL CONSISTENCY – Term used to describe the required behavior of the precipitation frequency estimates from one duration to the next or from one frequency to the next. For instance, it is required that the 100-year 3-hour precipitation frequency estimates be greater than (or at least equal to) corresponding 100-year 2-hour estimates.

L-MOMENTS – L-moments are summary statistics for probability distributions and data samples. They are analogous to ordinary moments, providing measures of location, dispersion, skewness, kurtosis, and other aspects of the shape of probability distributions or data samples, but are computed from linear combinations of the ordered data values (hence the prefix L).

MEAN ANNUAL PRECIPITATION (MAP) – The average precipitation for a year (usually calendar) based on the whole period of record or for a selected period (usually 30 year period such as 1971-2000).

PARTIAL DURATION SERIES (PDS) – Time series that includes all precipitation amounts for a specified duration at a given station above a pre-defined threshold regardless of year; it can include more than one event in any particular year.

PRECIPITATION FREQUENCY DATA SERVER (PFDS) – The on-line portal for all NOAA Atlas 14 deliverables, documentation, and information; http://hdsc.nws.noaa.gov/hdsc/pfds/.

PARAMETER-ELEVATION REGRESSIONS ON INDEPENDENT SLOPES MODEL (PRISM) – Hybrid statistical-geographic approach to mapping climate data developed by Oregon State University's PRISM Climate Group.

QUANTILE – Generic term to indicate the precipitation frequency estimate associated with either ARI or AEP.

RECORD LENGTH – Number of years in which enough precipitation data existed to extract meaningful annual maxima in a station's period of record (or data years).

UNCONSTRAINED OBSERVATION – A precipitation measurement or observation for a defined duration. However the observation is not made at a specific repeating time, rather the duration is a moveable window through time.

WATER YEAR – Any 12-month period, usually selected to begin and end during a relatively dry season. In NOAA Atlas 14 Volume 7, it is defined as the calendar year (January 1 to December 31).

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