Updated Precipitation Frequency Estimates for Minnesota

Presenter:

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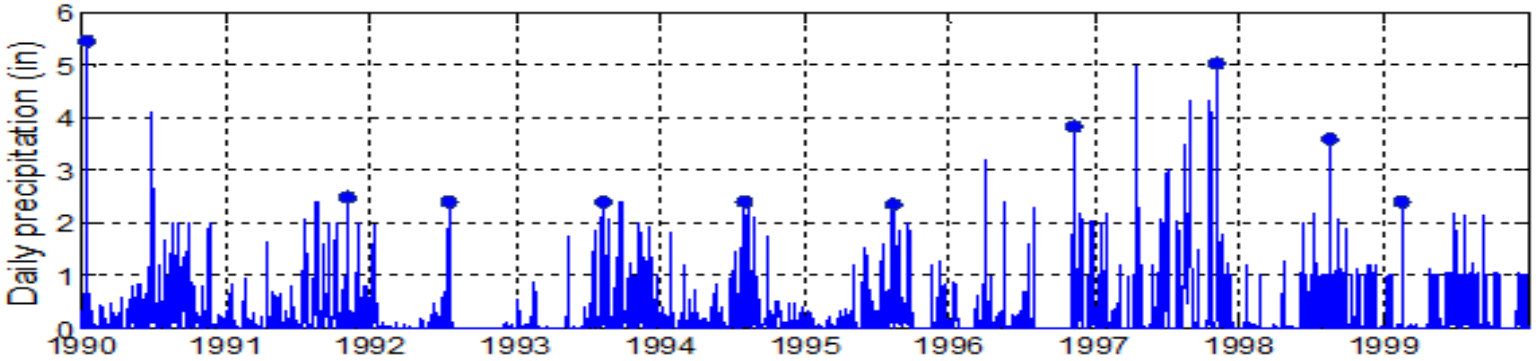
Annual Meeting of the City Engineers Association of Minnesota
January 30 – February 1, 2013

Topics

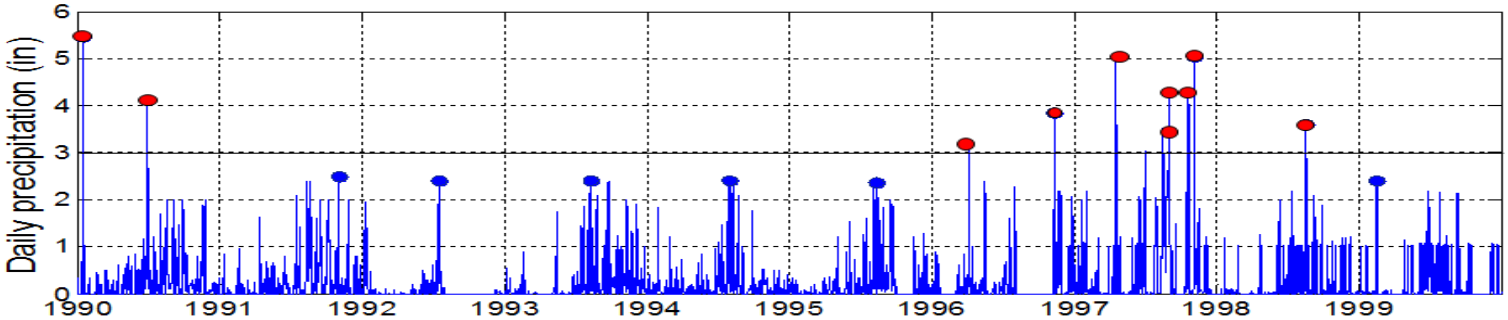
1. Background
2. Products
3. Methodology
4. Peer review and schedule

Annual maximum series (AMS) vs. partial duration series (PDS)

AMS



PDS



- ❑ AMS-based frequency analysis used in NOAA 14.

- ❑ PDS-based precipitation frequency estimates were calculated indirectly from Langbein's formula that transforms AMS-based frequencies (annual exceedance probabilities - AEPs) to PDS-based frequencies (average recurrence intervals - ARIs).

Precipitation frequency (PF) estimate - definition

- **Frequency**:
  - AMS: Annual exceedance probability – AEP
  - PDS: Average recurrence interval – ARI (return period – T)
  - For frequencies important for engineering design transformation is simple:

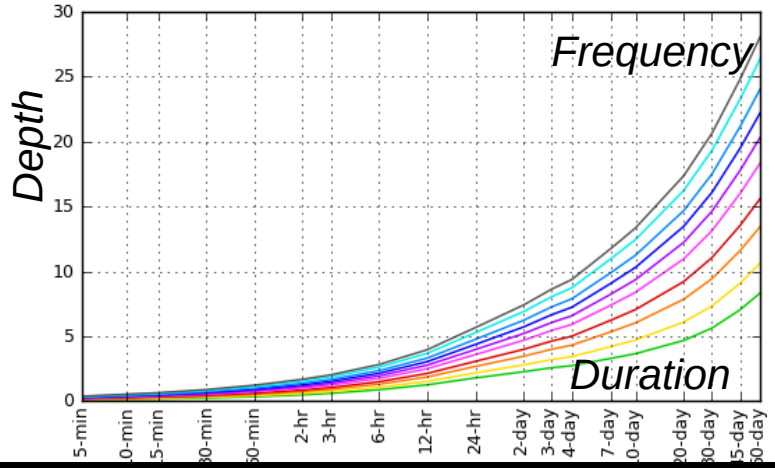
    ARI = 100/ AEP
  - Example: amount that has 1% chance of being exceeded in any given year (AEP = 1%), on average, will be exceeded only once in 100 years (ARI = 100yr)

- **PF estimate:**

  Precipitation **D**epth (or **I**ntensity) for a given **D**uration and **F**requency (ARI or AEP)

Depth -**D**uration-**F**requency (DDF) curves

Intensity -**D**uration-**F**requency (IDF) curves



Application: Estimating severity of historical events

NBC WASHINGTON

HOME > WEATHER > STORIES

1000-Year Rainfall in Ft. Belvoir

Duluth News Tribune

Published June 21, 2012, 12:00 AM

Rain was likely largest storm in Duluth history

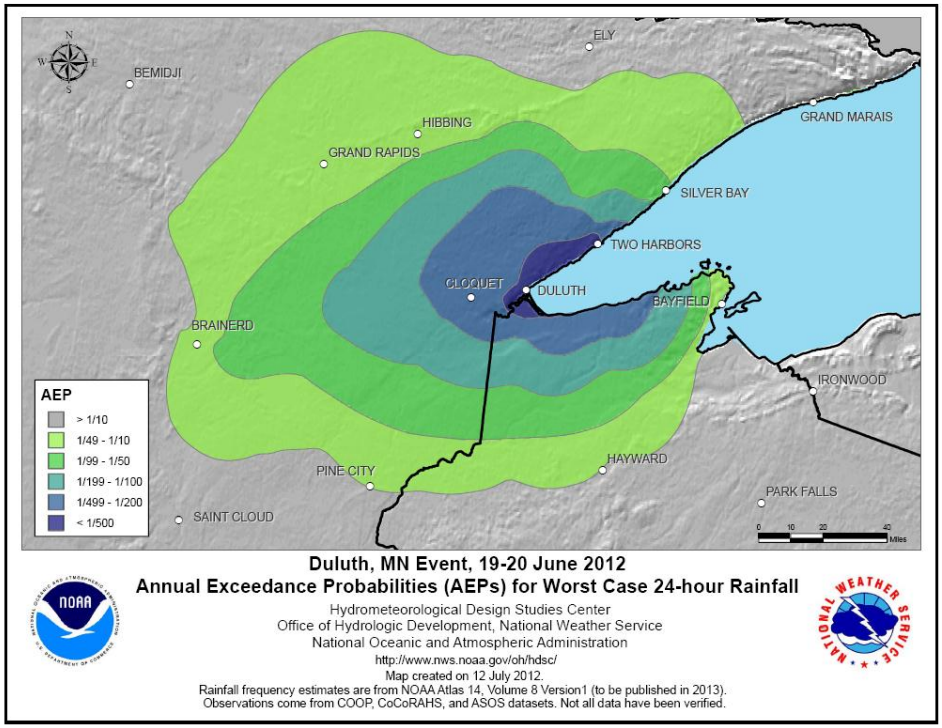
This week's rainstorm might well be the largest in Duluth's recorded history, dating back to the Miller, science and operations manager for the National Weather Service in Duluth.

By: John Myers, Duluth News Tribune

Greg Spoden, Minnesota state climatologist, said this was the region's "1 percent storm" or what old-timers used to call the 100-year flood.

"We really don't have enough years of data to compare these to, but this was a storm you would have about a 1 percent chance of seeing on any given year. And you got it across a pretty wide area up there," Spoden said.

The rainstorm also ranks among the larger in state history, Spoden said, but falls far short of the 16 inches received in 24 hours in August 2002 in Hokah in far southeastern Minnesota, which caused massive flash-flooding and millions of dollars of damage.



Application: Infrastructure design

- **How much water will be available?**

- **Examples:**

  - ***Control of water:*** Flood mitigation, land development and construction , storm water drainage (roads, parking lots, airports, land, roofs), culverts, bridges,...

  - ***Utilization of water for beneficial purposes:*** *w*ater supply, irrigation, navigation,hydrolectric-power development, ...

  - ***Water-quality management***

  - ***...***

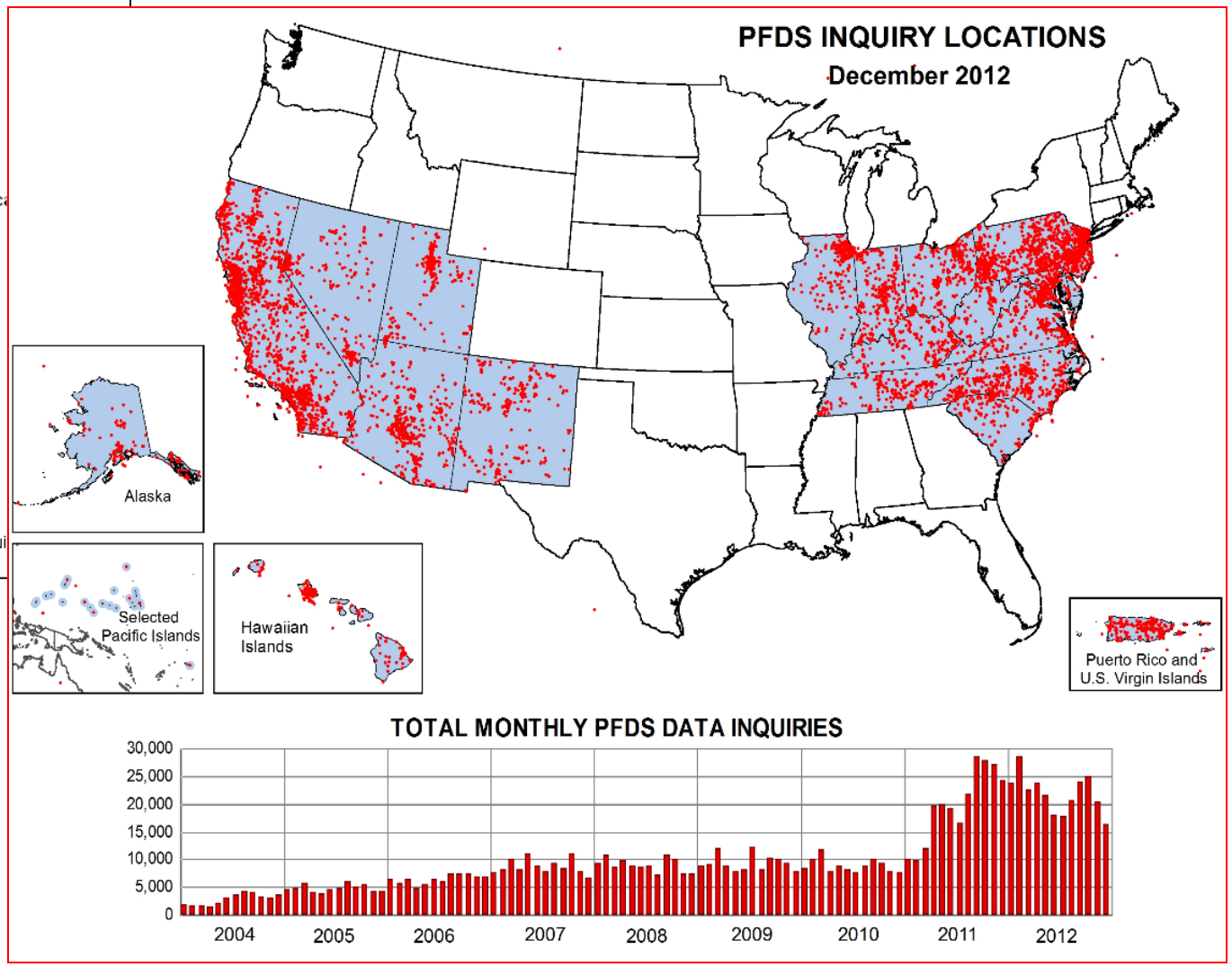
Type of structure	Return period (years)
Highway culverts	
Low traffic	5–10
Intermediate traffic	10–25
High traffic	50–100
Highway bridges	
Secondary system	10–50
Primary system	50–100
Farm drainage	
Culverts	5–50
Ditches	5–50
Urban drainage	
Storm sewers in small cities	2–25
Storm sewers in large cities	25–50
Airfields	
Low traffic	5–10
Intermediate traffic	10–25
High traffic	50–100
Levees	
On farms	2–50
Around cities	50–200
Dams with no likelihood of loss of life (low hazard)	50–100
Small dams	100 +

PFDS performance statistics
Infrastructure design locations

Precipitation Frequency Data Server Performance

Performance statistics for December 2012

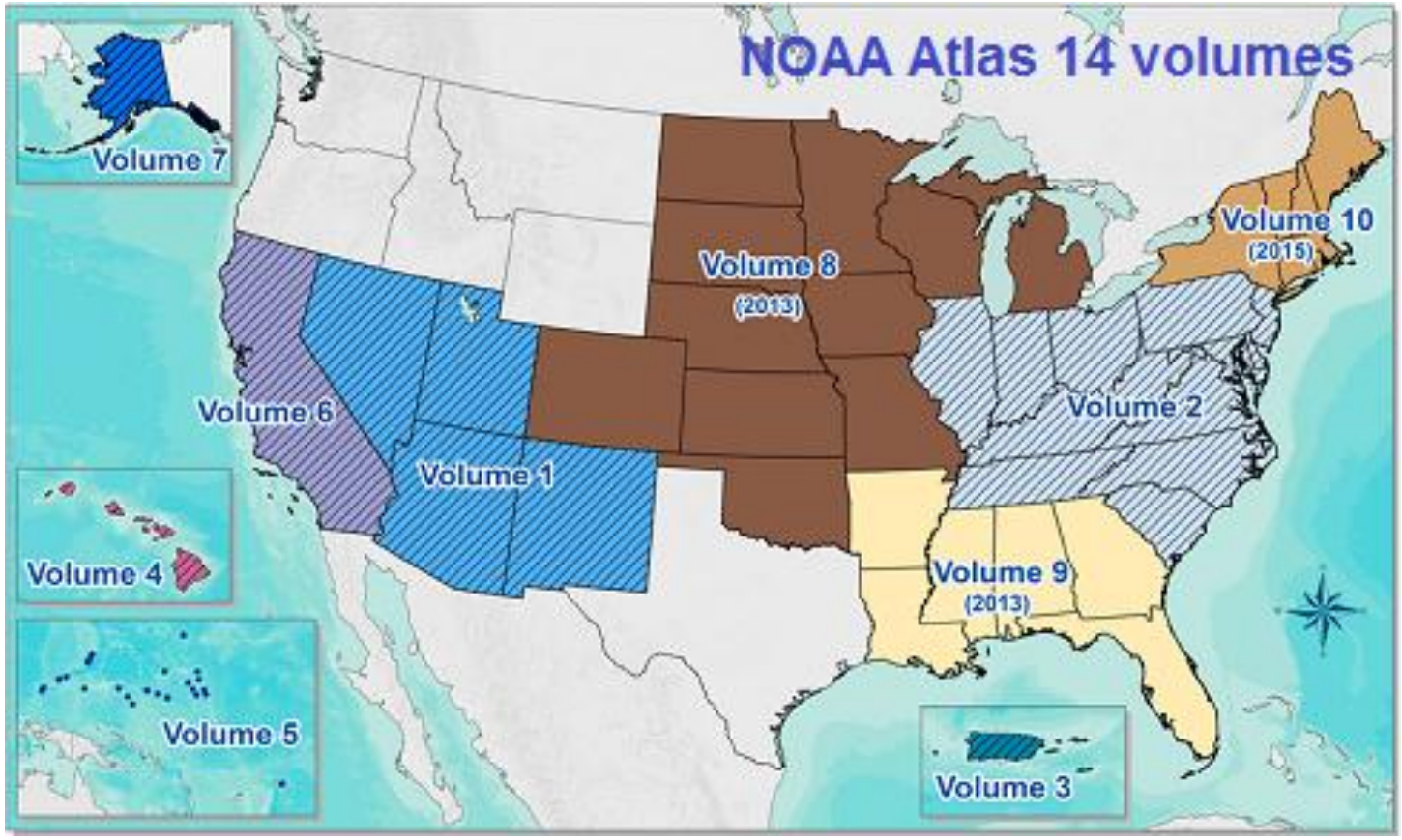
- **Total number of Inquiries processed*:** 16,206
- **Total number of inquiries processed for each series:**
  Partial duration (default): 15,532 (95.8%)
  Annual maximum: 674 (4.2%)
- **Total number of inquiries processed for each domain ca**
  .gov: 2,208 (7.0%)
  .com: 7,491 (23.7%)
  .edu: 1,323 (4.2%)
  .mil: 318 (1.0%)
  .net: 12,027 (38.0%)
  .org: 192 (0.6%)
  .other and/or unresolved: 8,051 (25.5%)
- **Total number of inquiries processed for each script:**
  precipitation frequency table*: 16,103
  curves plots: 2,662
  pf with confidence intervals plots: 267
  supplementary info: 2,722
  rainfall frequency table: 44
  seasonality plots: 90
  old webpage*: 103
  * Scripts with asterisk were used for total number of inqui



HDSC and NOAA Atlas 14

NOAA/NWS/Hydrometeorological Design Studies Center (**HDSC**) is responsible for updating precipitation frequency estimates.

Updates are published as Volumes of **NOAA Atlas 14.**



HDSC: http://www.nws.noaa.gov/oh/hdsc/index.html

NOAA's National Weather Service

Hydrometeorological Design Studies Center

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Precipitation Frequency (PF)
- PF Data Server
- PF Documents

Probable Maximum Precipitation (PMP)
- PMP Documents

Miscellaneous
- Publications
- AEP Storm Analysis
- Record Precipitation

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Available on PFDS

Precipitation frequency estimates

Hydrometeorological Design Studies Center (HDSC) is updating precipitation frequency estimates for various areas of the United States as Volumes of NOAA Atlas 14. Estimates in a variety of formats, together with related documentation and supplementary information are available from the Precipitation Frequency Data Server (PFDS). Publications for states not covered by Atlas 14 are also available. learn more >

Inquires about Precipitation Frequency Estimates for the United States

E-mail: HDSC.questions@noaa.gov

HDSC list-server

The list-server is not meant to serve as a discussion forum but a tool for HDSC to distribute information. Only HDSC personnel may send messages through the server. Address list is kept confidential.

To subscribe: send an e-mail to hdsc-subscribe@gateway2.nws.noaa.gov. The subject and the body of the email is not utilized.

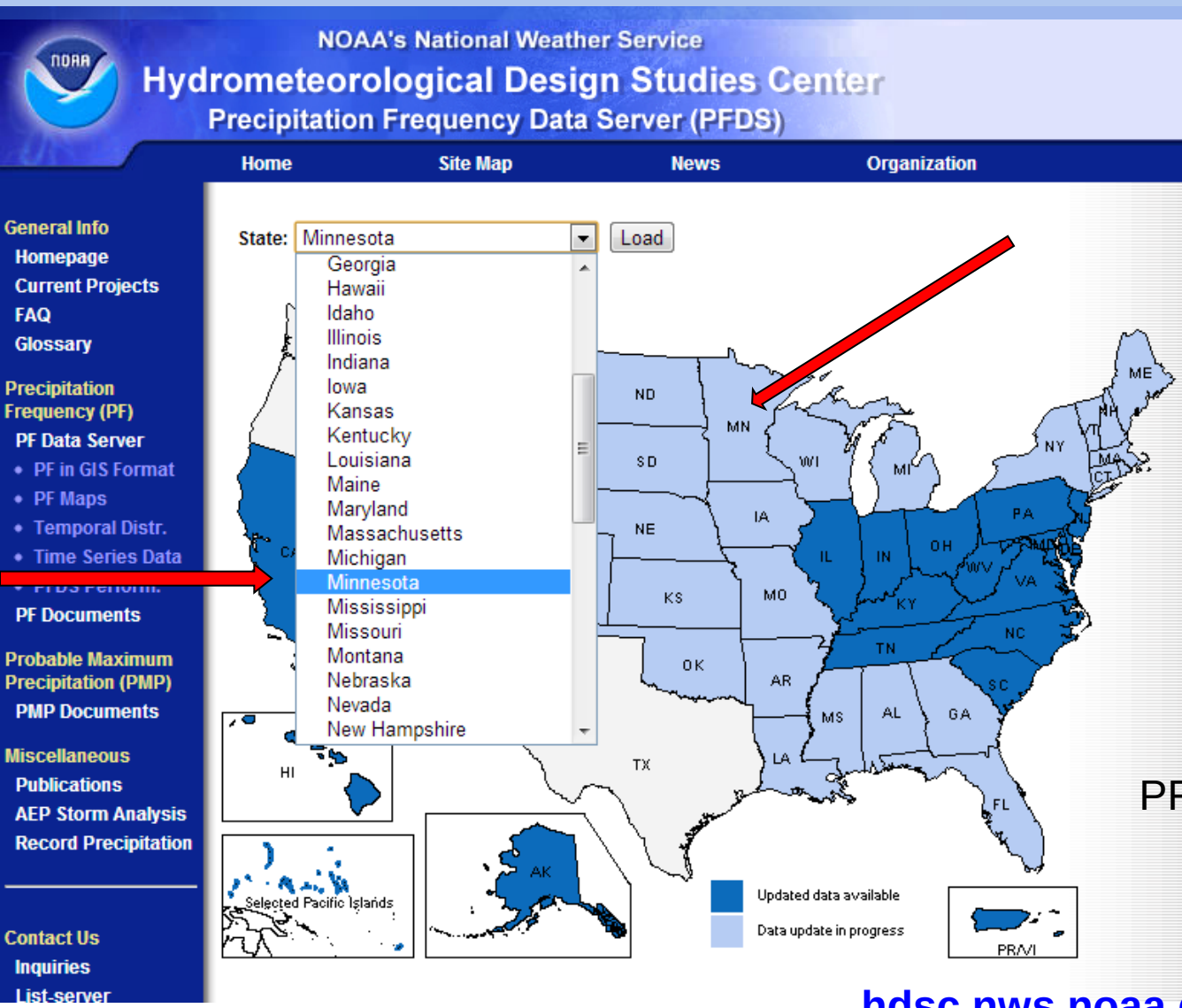
To unsubscribe: send an e-mail to hdsc-unsubscribe@gateway2.nws.noaa.gov.

Quarterly Progress Reports for Current HDSC Projects

FY 2013
- October - December 2012

FY 2012
- July - September 2012
- April - June 2012

PF estimates for Minnesota



PF products are available for download from the **Precipitation Frequency Data Server (PFDS):**

hdsc.nws.noaa.gov/hdsc/pfds/index.html

Current PF information for MN

Current Precipitation Frequency Information and Documents for MINNESOTA

'iewing the documents requires the Adobe Acrobat Reader (click here to download).

<=1 hour

- **Technical Memorandum NWS Hydro 35**, *Five to 60-minutes Precipitation Frequency for Eastern and Central United States* (1977). Precipitation-frequency values for the Central and Eastern United States for return periods from 2 to 100 years for durations of 5 minutes to 1 hour are provided in a series of maps and graphs. This material supersedes the similar material published in Technical Paper 40.

1 hour - 24 hour

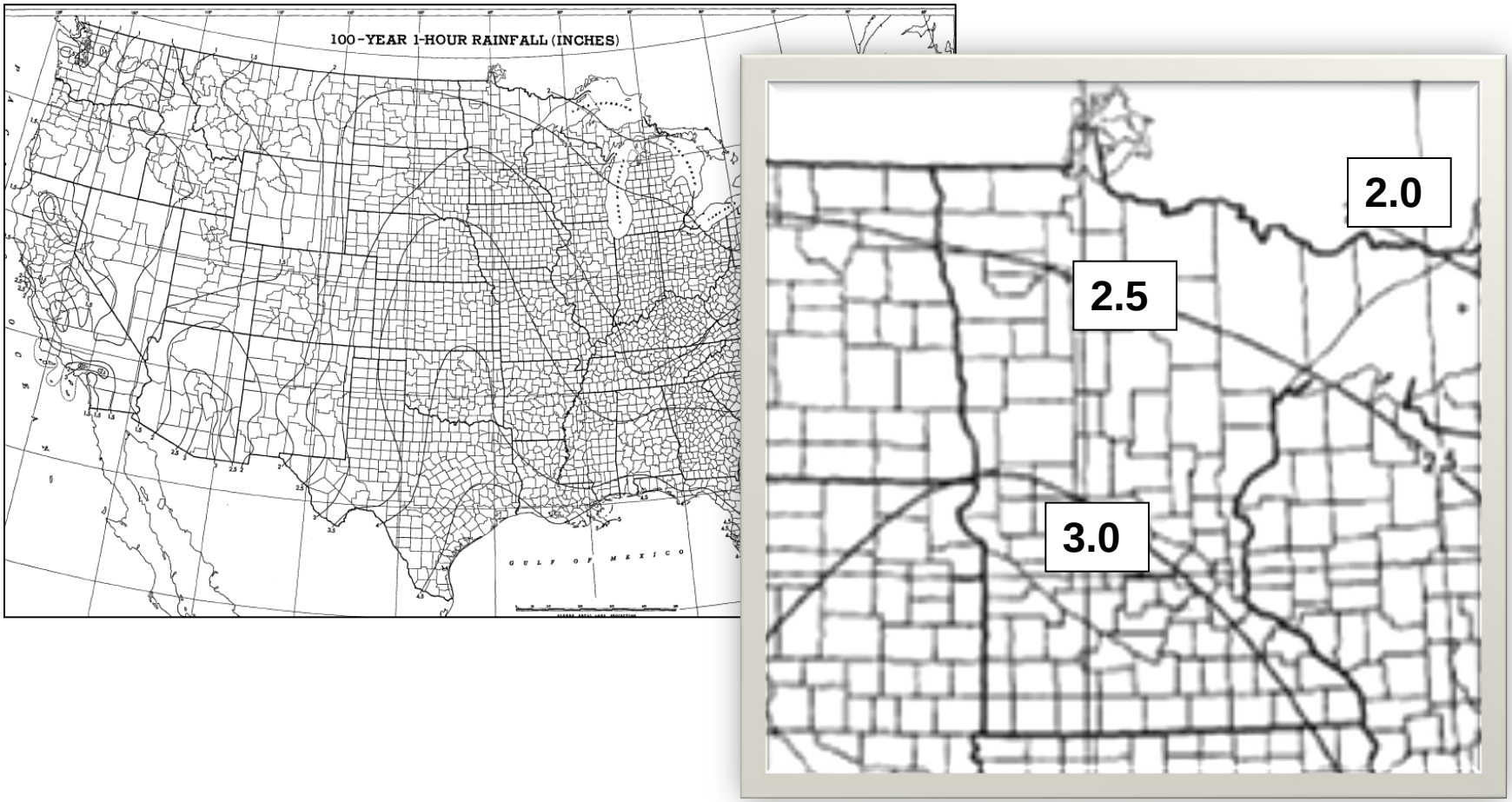
- **Technical Paper 40**, *Rainfall Frequency Atlas of the United States for Durations from 30 minutes to 24 Hours and Return Periods from 1 to 100 Years* (1961). Rainfall-frequency values for selected durations from 30 minutes to 24 hours and return periods of 1 to 100 years are given on a series of maps.

>=2-day

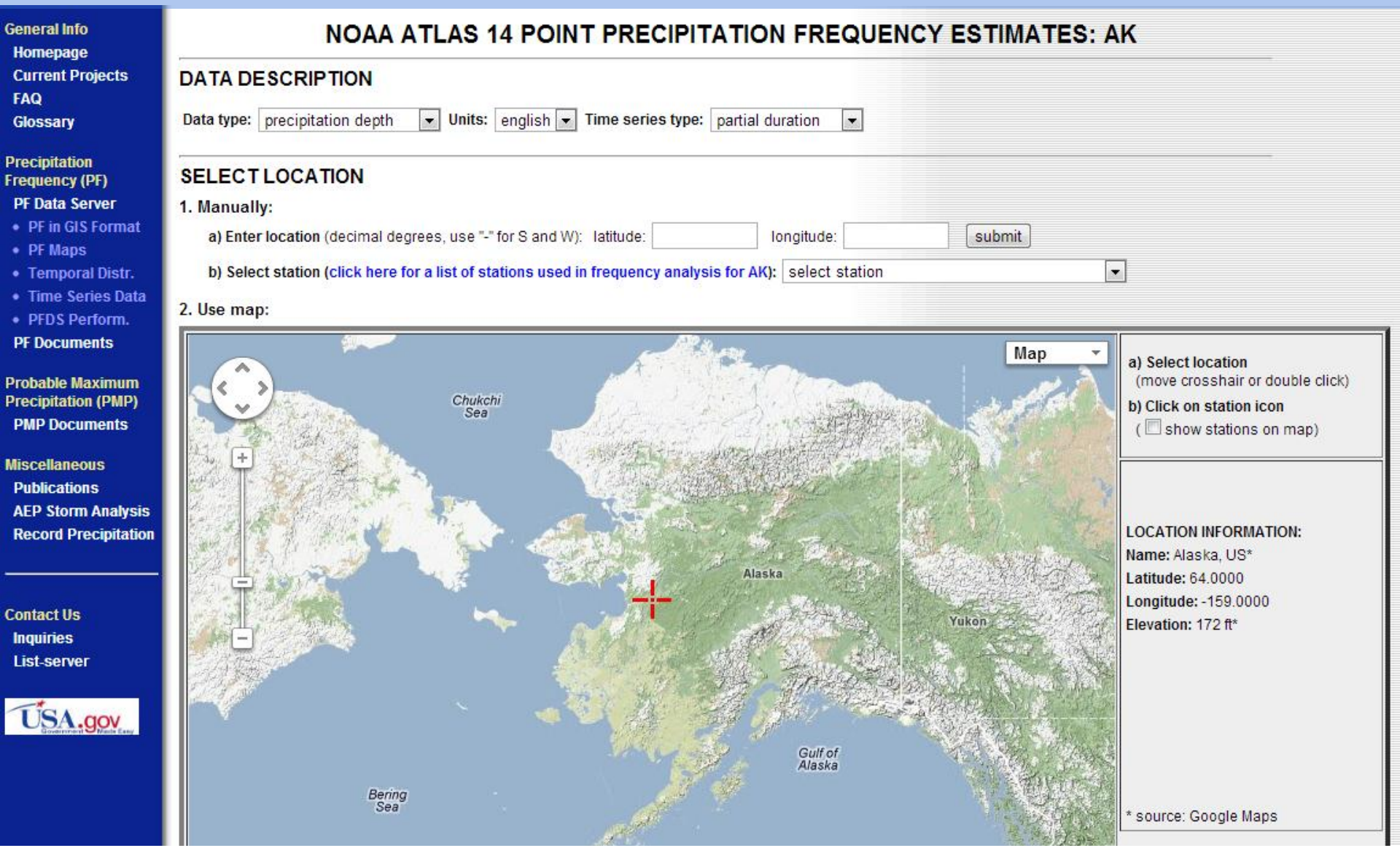
- **Technical Paper 49**, *Two-to-Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States* (1964)

Main Link Categories:
Home | OHD

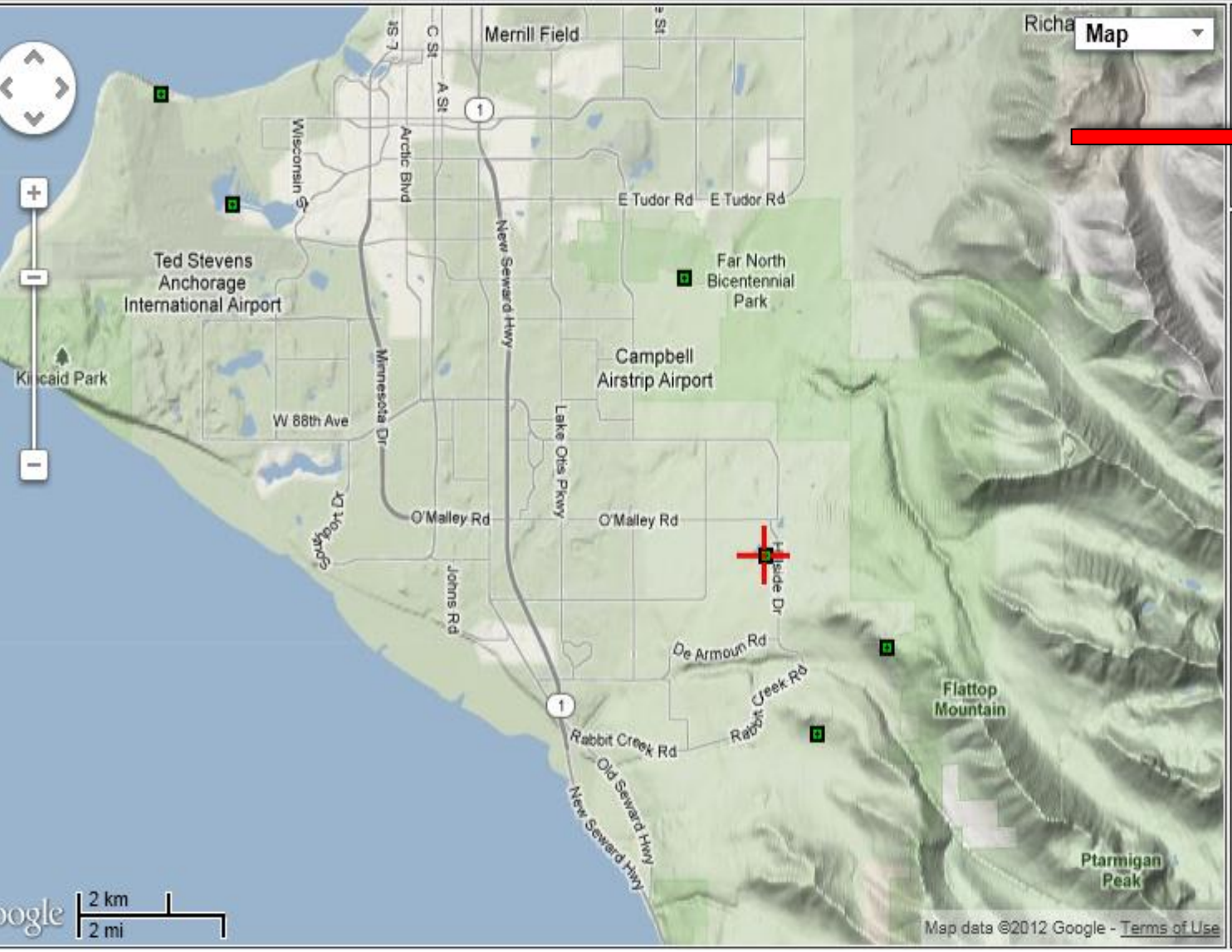
Current PF information for MN



NOAA Atlas 14 interactive web page (upper part)



NOAA Atlas 14 interactive web page



a) **Select location** (move crosshair)

b) **Click on station icon**

(☑ show stations on map)

LOCATION INFORMATION:

Name: Anchorage, Alaska, US*

Station Name: ROCK RIDGE DRIVE

Site ID: 50-8025

Latitude: 61.1167

Longitude: -149.7500

Elevation: 840 ft

* source: Google Maps

"PF tabular" tab (below map): PF estimates with confidence limits

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 7, Version 2

PF tabular | PF graphical | Supplementary information

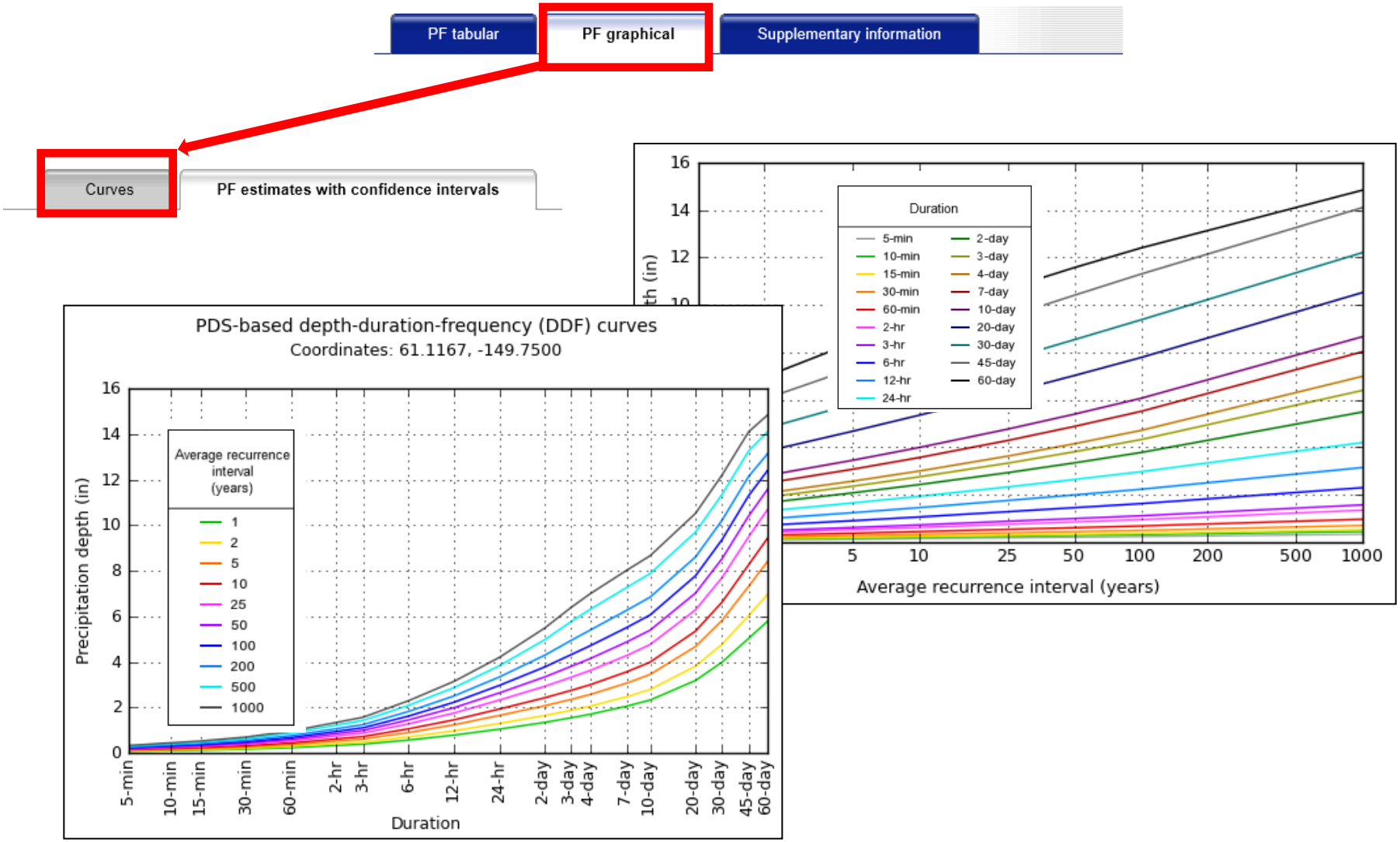
Print Page

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	0.085 (0.065-0.113)	0.106 (0.080-0.143)	0.134 (0.100-0.184)	0.158 (0.116-0.220)	0.190 (0.137-0.270)	0.215 (0.152-0.310)	[illegible] (0.167-0.351)	0.270 (0.186-0.401)	0.310 (0.209-0.470)	0.340 (0.226-0.522)
10-min	0.115 (0.088-0.153)	0.142 (0.108-0.191)	0.180 (0.134-0.247)	0.212 (0.156-0.295)	0.256 (0.184-0.364)	0.289 (0.205-0.417)	0.3[illegible] (0.225-[illegible]473)	0.363 (0.250-0.539)	0.416 (0.280-0.630)	0.456 (0.303-0.701)
15-min	0.134 (0.103-0.178)	0.166 (0.126-0.224)	0.211 (0.157-0.289)	0.248 (0.182-0.345)	0.299 (0.215-0.425)	0.338 (0.239-0.487)	0.3[illegible] (0.264-[illegible]553)	0.425 (0.292-0.631)	0.487 (0.328-0.738)	0.534 (0.355-0.820)
30-min	0.178 (0.136-0.237)	0.220 (0.167-0.296)	0.280 (0.208-0.384)	0.329 (0.241-0.458)	0.397 (0.285-0.564)	0.449 (0.318-0.647)	0.5[illegible] (0.350-[illegible]735)	0.564 (0.388-0.838)	0.646 (0.435-0.978)	0.708 (0.470-1.09)
60-min	0.244 (0.187-0.325)	0.302 (0.229-0.407)	0.383 (0.285-0.525)	0.451 (0.331-0.628)	0.544 (0.391-0.772)	0.615 (0.436-0.887)	0.6[illegible] (0.479-[illegible]01)	0.772 (0.531-1.15)	0.885 (0.597-1.34)	0.970 (0.644-1.49)
2-hr	0.340 (0.261-0.453)	0.420 (0.318-0.566)	0.534 (0.398-0.732)	0.628 (0.461-0.874)	0.758 (0.545-1.08)	0.858 (0.608-1.24)	0.9[illegible] (0.668-[illegible]40)	1.08 (0.740-1.60)	1.23 (0.831-1.87)	1.35 (0.898-2.08)
3-hr	0.396 (0.304-0.527)	0.490 (0.371-0.660)	0.622 (0.463-0.853)	0.732 (0.537-1.02)	0.884 (0.636-1.26)	1.00 (0.708-1.44)	1.[illegible] (0.779-[illegible]63)	1.25 (0.862-1.86)	1.44 (0.969-2.18)	1.58 (1.05-2.42)
6-hr	0.578 (0.443-0.770)	0.715 (0.542-0.963)	0.908 (0.676-1.25)	1.07 (0.783-1.49)	1.29 (0.926-1.83)	1.46 (1.03-2.10)	1.[illegible] (1.14-2.38)	1.83 (1.26-2.72)	2.10 (1.41-3.18)	2.30 (1.53-3.53)
12-hr	0.792 (0.607-1.05)	0.981 (0.744-1.32)	1.25 (0.928-1.71)	1.46 (1.07-2.03)	1.76 (1.27-2.50)	[illegible]	[illegible]	[illegible]	2.87 (1.94-4.35)	3.15 (2.09-4.84)
24-hr	1.06 (0.907-1.24)	1.31 (1.11-1.56)	1.66 (1.36-2.01)	1.94 (1.59-2.39)	2.33 (1.88-2.94)	[illegible]	[illegible]	[illegible]	3.83 (2.86-5.19)	4.20 (3.08-5.78)
2-day	1.35 (1.16-1.59)	1.65 (1.40-1.97)	2.08 (1.73-2.53)	2.43 (1.99-3.00)	2.93 (2.35-3.70)	[illegible]	[illegible]	[illegible]	4.97 (3.71-6.74)	5.49 (4.03-7.55)
3-day	1.55 (1.33-1.83)	1.88 (1.60-2.24)	2.36 (1.96-2.87)	2.76 (2.26-3.40)	3.33 (2.67-4.21)	3.81 (3.00-4.89)	4.33 (3.35-5.64)	4.95 (3.77-6.56)	5.77 (4.31-7.82)	6.40 (4.70-8.80)
[illegible]	1.71	2.06	2.57	3.00	3.63	4.15	4.71	5.40	6.30	6.99

2.97
(2.30-3.88)

“PF Graphical/Curves” tab: DDF or IDF curves

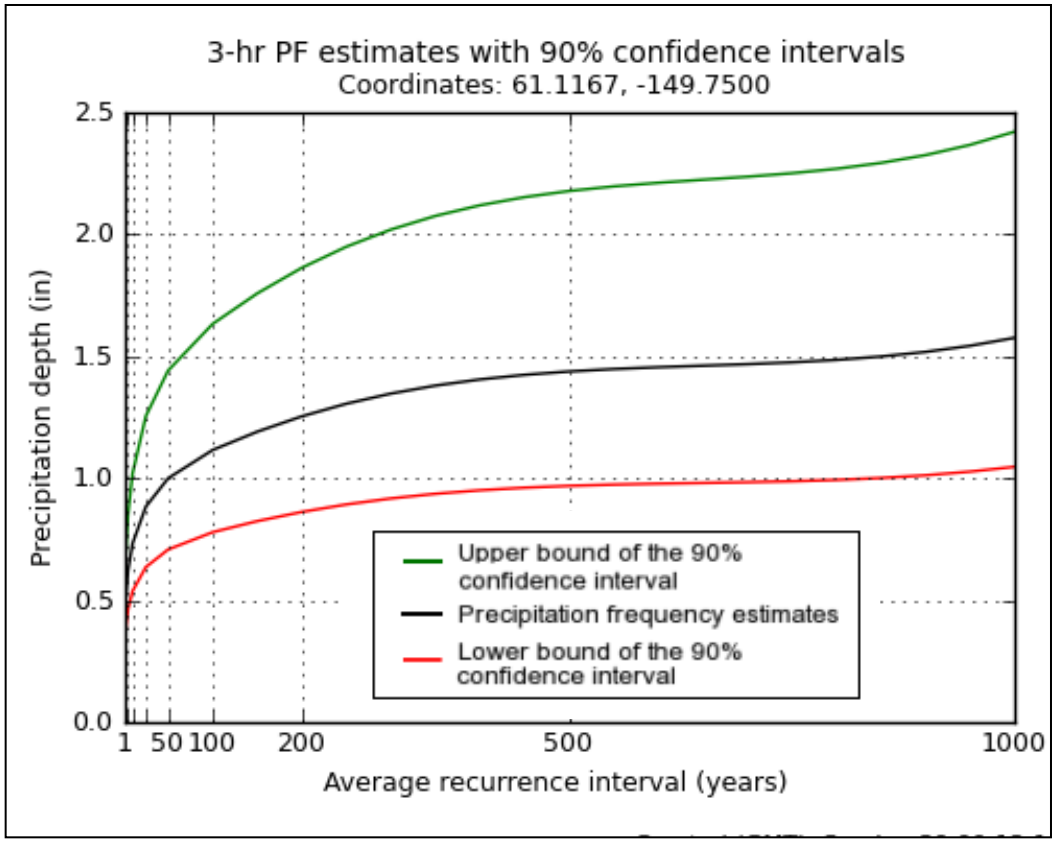


“PF Graphical/PF estimates with confidence intervals”

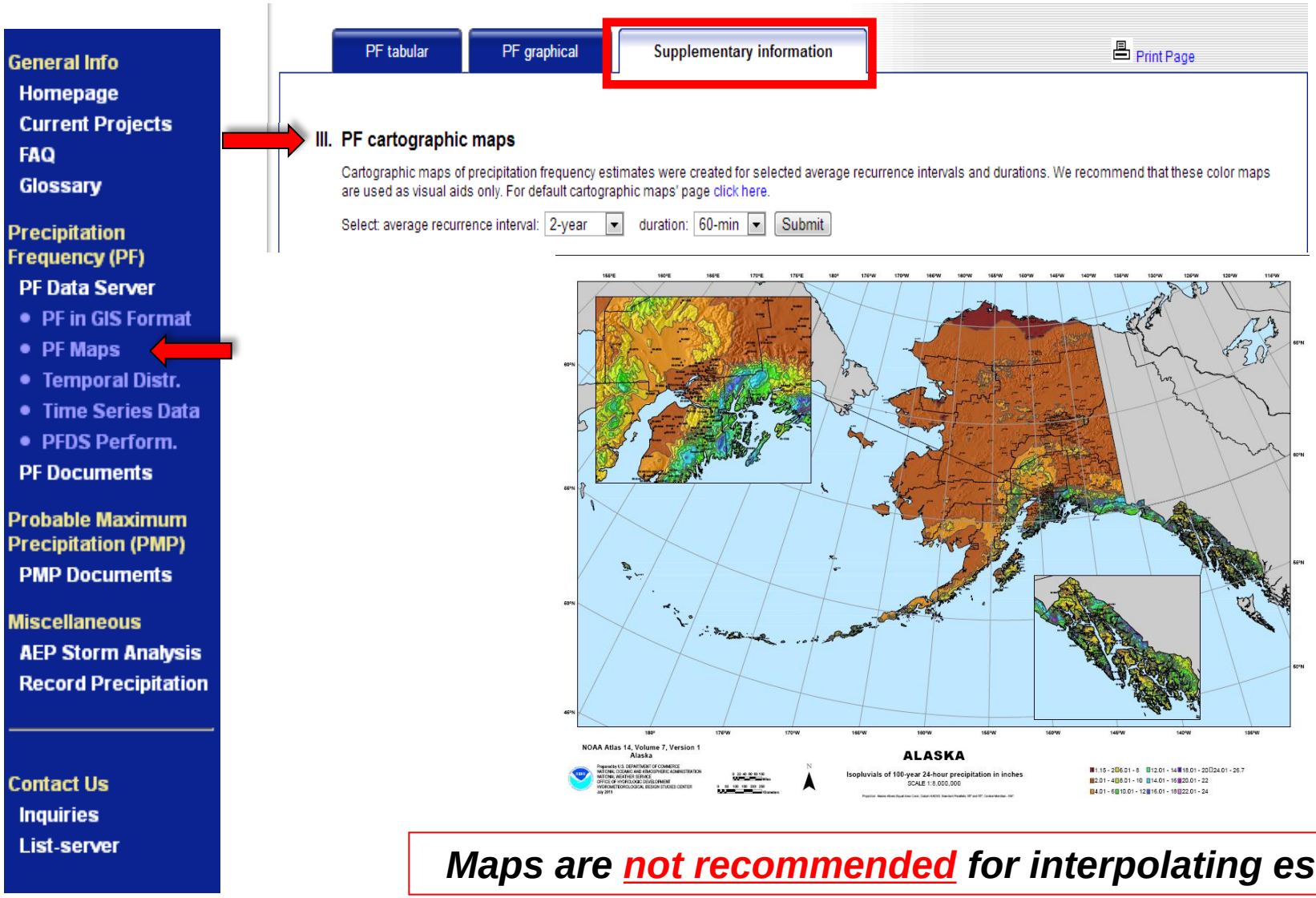
PF tabular | PF graphical | Supplementary information

Curves | PF estimates with confidence intervals

Duration:
- 5-min
- 10-min
- 15-min
- 30-min
- 60-min
- 2-hr
- 3-hr
- 6-hr
- 12-hr
- 24-hr
- 2-day
- 3-day
- 4-day
- 7-day
- 10-day
- 20-day
- 30-day
- 45-day
- 60-day



“Supplementary information”: Cartographic maps



Maps are <u>not recommended</u> for interpolating estimates.

Underlying data

- PFDS operates from a set of ASCII grids (30-arc sec resolution) of PDS-based and AMS-based precipitation frequency estimates and corresponding lower and upper bounds of the 90% confidence interval.

- Number of available grids:
  570 for PDS (190*3)
  513 for AMS (171*3)

- Grids of liquid precipitation may also be available.

Duration	Average recurrence interval (ARI)									
	1	2	5	10	25	50	100	200	500	1,000
5-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
15-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
30-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
60-min	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

"Supplementary information": PF grids in GIS format

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I. Document

Click here for this volume's document.

II. PF in GIS format

Spatially interpolated precipitation frequency estimates (with upper and lower bounds of the 90% confidence interval) area available in GIS compatible format (ascii file).
For default download page click here.

DOWNLOAD GIS DATA:

The files can either be downloaded 1) via pull-down menu, 2) by anonymous ftp or 3) via web browser. Ftp is recommended for multiple-file downloads. To obtain precipitation frequency estimates without downloading files, please visit the PFDS interface.

1) Via pull-down menu:

Region:
NOAA Atlas 14 Volume 1 (Semiarid Southwest)

Type:
Precipitation frequency estimates

Series:
Partial duration series

Average recurrence interval:
2-year

Duration:
5-minute

“Supplementary information”: 1. Document

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NOAA Atlas 14

Precipitation-Frequency Atlas of the United States

15 / 239 56% Tools Comment

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- 7. Comparison with previous NOAA publications
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- Appendix A.2 AMS trend analysis
- Appendix A.3 List of L-moments
  - Table A.3.1. λ1 moments
  - Table A.3.2. λ2 moments
  - Table A.3.3. λ3 moments
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- Appendix A.5 Peer review comments and responses

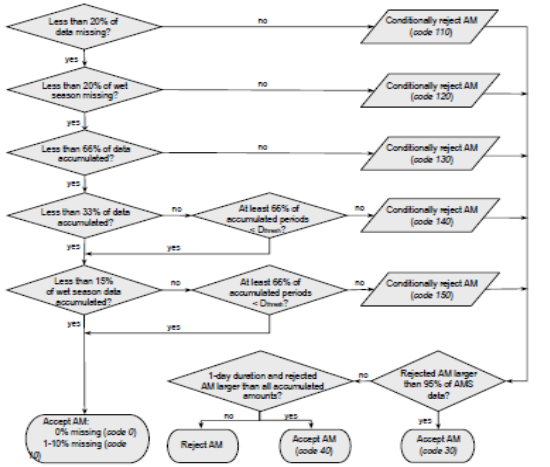


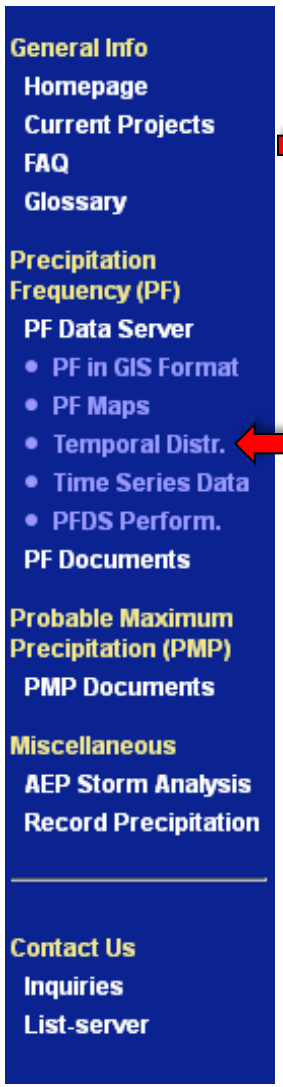
Figure 4.3.2. Flowchart of criteria used to extract annual maxima. Data quality codes were assigned based on acceptance and rejection. D_{dmax} depends on duration.

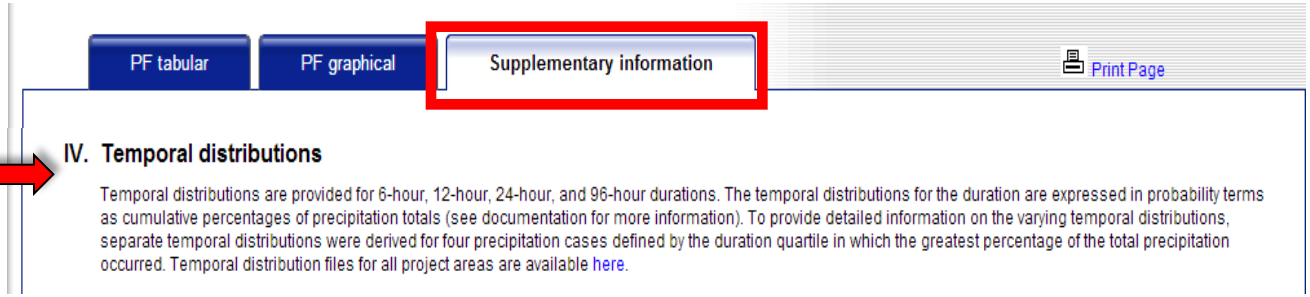
4.4. Station screening

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.

NOAA Atlas 14 Volume 6 Version 2.0 10

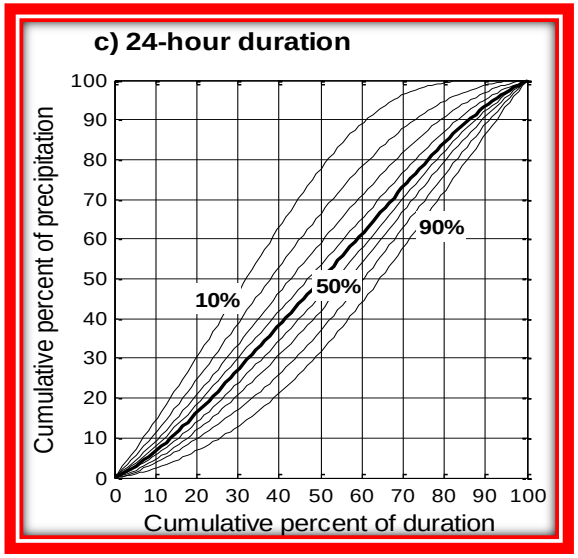
"Supplementary information": Temporal distributions





- ❑ Temporal distributions of amounts exceeding 2-year magnitudes provided for 6-hour, 12-hour, 24-hour, and 96-hour durations for delineated climate regions.

- ❑ Four precipitation cases; defined by the duration quartile in which the greatest percentage of the total precipitation occurred.



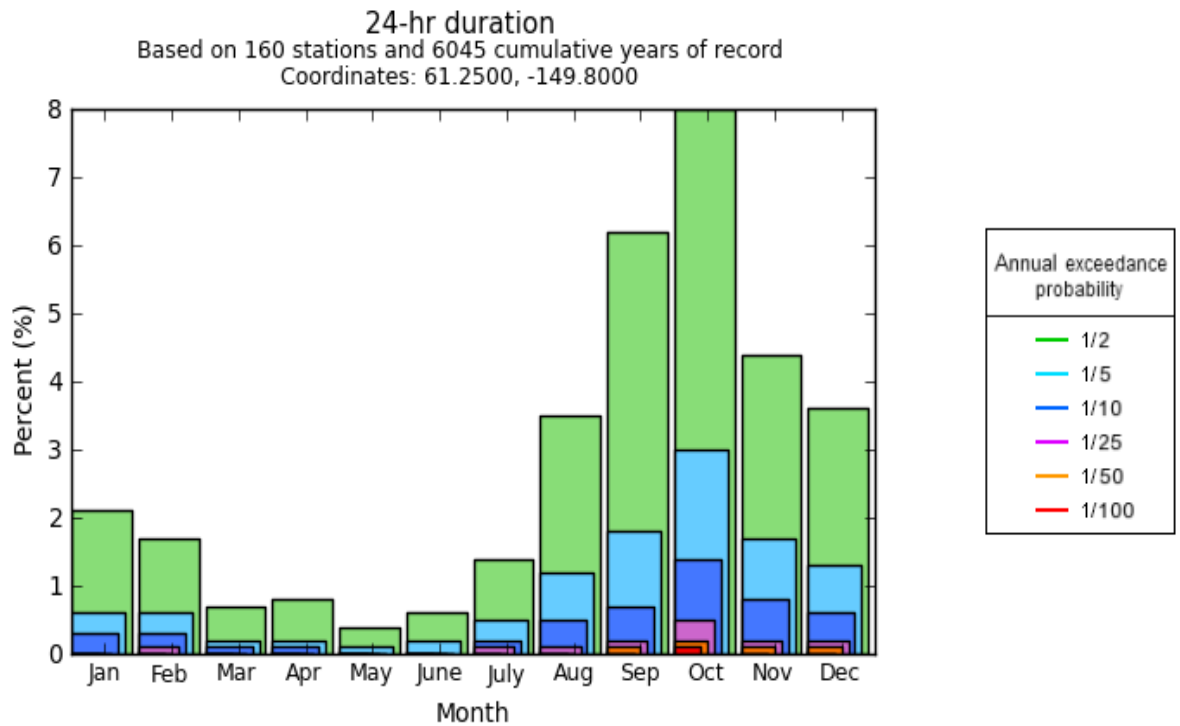
“Supplementary information”: Seasonality analysis

PF tabular | PF graphical | Supplementary information | Print Page

V. Seasonality analysis

The seasonality graphs show the percentage of precipitation totals for a given duration that exceeded the precipitation frequency estimates for the duration and selected annual exceedance probabilities in each month for each region. The precipitation frequency estimates were derived from annual maximum series at each station in the region (as described in documentation). Results are provided for 60-min, 24-hr, 2-day, and 10-day durations and for annual exceedance probabilities of 1/2 (or 1-in-2), 1/5, 1/10, 1/25, 1/50, and 1/100. Seasonality graphs should not be used to derive seasonal precipitation frequency estimates.

Select duration:
- 60-min
- 24-hr
- 2-day
- 10-day



"Supplementary information": Rainfall freq. estimates

PF tabular | PF graphical | Supplementary information | Print Page

VI. Rainfall frequency estimates

Rainfall (liquid precipitation only) frequency estimates are provided for durations between 1 and 24 hours in addition to precipitation frequency estimates. Please refer to NOAA Atlast 14 document for more information.

PDS-based rainfall frequency (RF) estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
60-min	0.509 (0.439-0.596)	0.658 (0.567-0.770)	0.863 (0.741-1.01)	1.04 (0.884-1.24)	1.29 (1.06-1.60)	1.50 (1.19-1.91)	1.73 (1.33-2.27)	1.97 (1.47-2.68)	2.33 (1.65-3.33)	2.63 (1.78-3.91)
2-hr	0.757 (0.653-0.884)	0.956 (0.826-1.12)	1.24 (1.07-1.46)	1.49 (1.26-1.77)	1.84 (1.50-2.28)	2.13 (1.69-2.71)	2.45 (1.89-3.21)	2.79 (2.08-3.79)	3.29 (2.33-4.70)	3.71 (2.52-5.53)
3-hr	0.947 (0.818-1.10)	1.19 (1.03-1.39)	1.53 (1.31-1.79)	1.82 (1.55-2.17)	2.25 (1.83-2.79)	2.60 (2.07-3.31)	2.98 (2.29-3.91)	3.39 (2.52-4.60)	3.99 (2.82-5.70)	4.49 (3.05-6.69)
6-hr	1.39 (1.21-1.63)	1.73 (1.50-2.03)	2.23 (1.91-2.61)	2.66 (2.26-3.16)	3.26 (2.66-4.04)	3.76 (2.98-4.78)	4.29 (3.30-5.62)	4.87 (3.62-6.60)	5.70 (4.03-8.14)	6.39 (4.34-9.52)
12-hr	2.04 (1.77-2.39)	2.59 (2.24-3.03)	3.37 (2.90-3.96)	4.06 (3.46-4.82)	5.01 (4.09-6.19)	5.78 (4.59-7.35)	6.58 (5.07-8.63)	7.44 (5.54-10.1)	8.68 (6.14-12.4)	9.69 (6.57-14.4)
24-hr	2.28 (2.03-2.61)	3.01 (2.68-3.46)	4.14 (3.67-4.77)	5.18 (4.56-6.00)	6.59 (5.65-7.85)	7.78 (6.56-9.41)	9.03 (7.47-11.1)	10.4 (8.38-13.1)	12.4 (9.71-16.2)	14.1 (10.7-18.9)

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

Numbers in parenthesis are RF estimates at lower and upper bounds of the 90% confidence interval. The probability that rainfall 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: Rainfall frequency estimates Submit

“Supplementary information”:Time series data

PF tabular | PF graphical | **Supplementary information** | Print Page

VII. Time series data

Precipitation frequency analysis methods used in NOAA Atlas 14 volumes are based on the analysis of annual maximum series data. This volume uses water year (October - September). The partial duration series (PDS) is a listing of the N (period of record) greatest observed precipitation depths for a given duration at a station, regardless of how many occurred in the same year. PDS-based frequency estimates were derived from AMS data.

Please note that PDS time series are only available for Volumes 1-3. This station's AMS time series can be found here.

ftp://hdsc.nws.noaa.gov/pub/hdsc/data/_TimeSeries_stations/AK_50-2820_ams.txt

```
Precipitation annual maximum series (inches)
Station ID: 50-2820
Station name: ANCHORAGE ELMENDORF AFB
State: AK
Latitude (decimal degrees): 61.2500
Longitude (decimal degrees): -149.8000
Elevation (feet): 192

Duration: 1 day
10/08/1916    2.10
09/09/1917    0.64
08/15/1918    0.62
12/26/1919    0.80
01/01/1920    0.90
10/10/1921    1.07
07/15/1922    0.74
10/16/1923    0.82
09/19/1924    1.38
09/05/1925    0.84
08/19/1926    0.52
09/18/1927    1.50
11/24/1928    0.76
03/16/1930    0.80
09/20/1931    0.80
09/28/1932    1.55
```

Supplementary information: NCDC and EPA info

PF tabular | PF graphical | Supplementary information

Print Page

VIII. Climate data source

Precipitation frequency results are based on data from a variety of sources, but largely from NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to NOAA Atlas 14 Document.

Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of the selected location. Digital ASCII data can be obtained directly from the NCDC site.

IX. Watershed information

Click here to get the watershed information for this location from the U.S. Environmental Protection Agency's (EPA) site.

PMP Documents

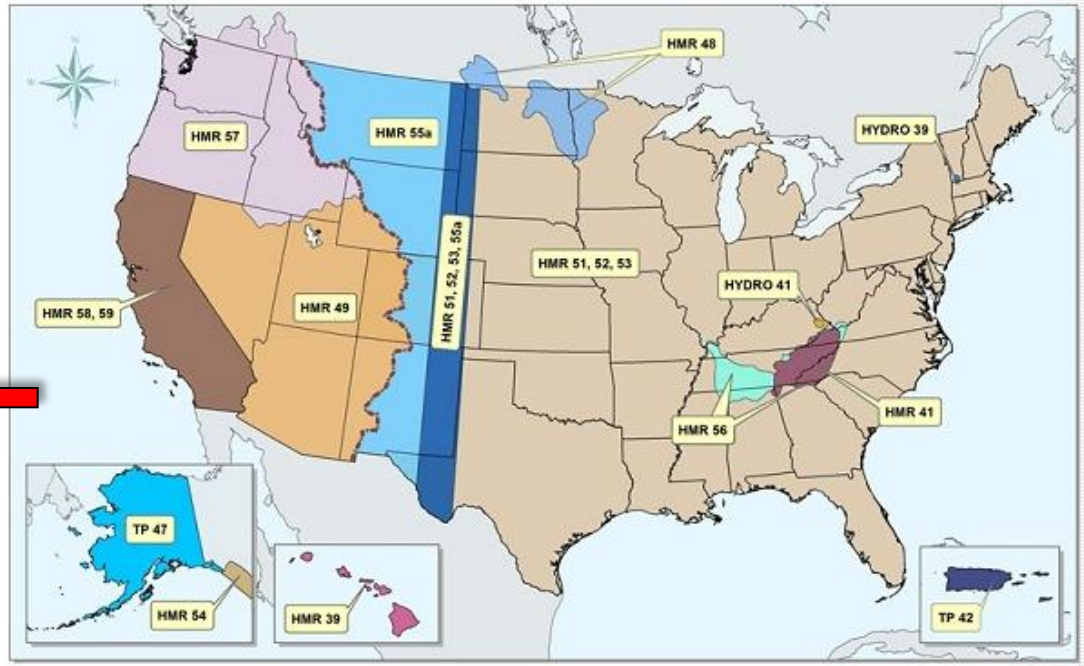
General Info
Homepage
Current Projects
FAQ
Glossary

Precipitation Frequency (PF)
PF Data Server
PF Documents

Probable Maximum Precipitation (PMP)
PMP Documents

Miscellaneous
Publications
AEP Storm Analysis
Record Precipitation

Contact Us
Inquiries
List-server



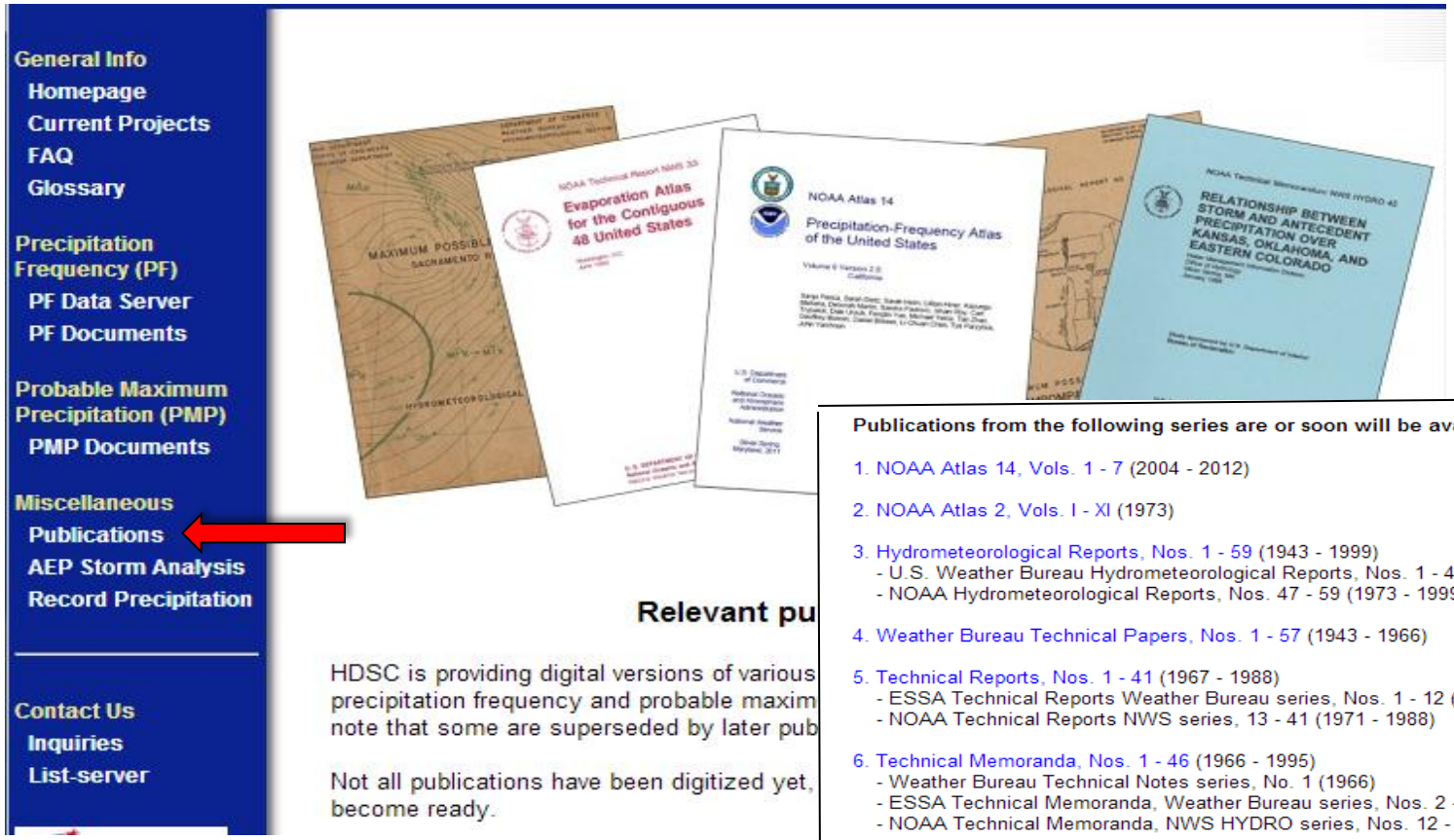
Regions covered by different NWS PMP documents (as of 2012).

Current NWS Probable Maximum Precipitation (PMP) Documents

NOAA's National Weathe
request of various federal

Document link	Title	Date	Size (MB)
Hydrometeorological Report No. 39	Probable Maximum Precipitation in the Hawaiian Islands	1963	3.4
Hydrometeorological Report No. 41	Probable Maximum and TVA Precipitation over the Tennessee River Basin above Chattanooga	1965	5.7
Hydrometeorological Report No. 46	Probable Maximum Precipitation, Mekong River Basin	1970	16.2

Misc. information: Relevant publications



Publications from the following series are or soon will be available:

1. NOAA Atlas 14, Vols. 1 - 7 (2004 - 2012)

2. NOAA Atlas 2, Vols. I - XI (1973)

3. Hydrometeorological Reports, Nos. 1 - 59 (1943 - 1999)
   - U.S. Weather Bureau Hydrometeorological Reports, Nos. 1 - 46 (1943 - 1970)
   - NOAA Hydrometeorological Reports, Nos. 47 - 59 (1973 - 1999)

4. Weather Bureau Technical Papers, Nos. 1 - 57 (1943 - 1966)

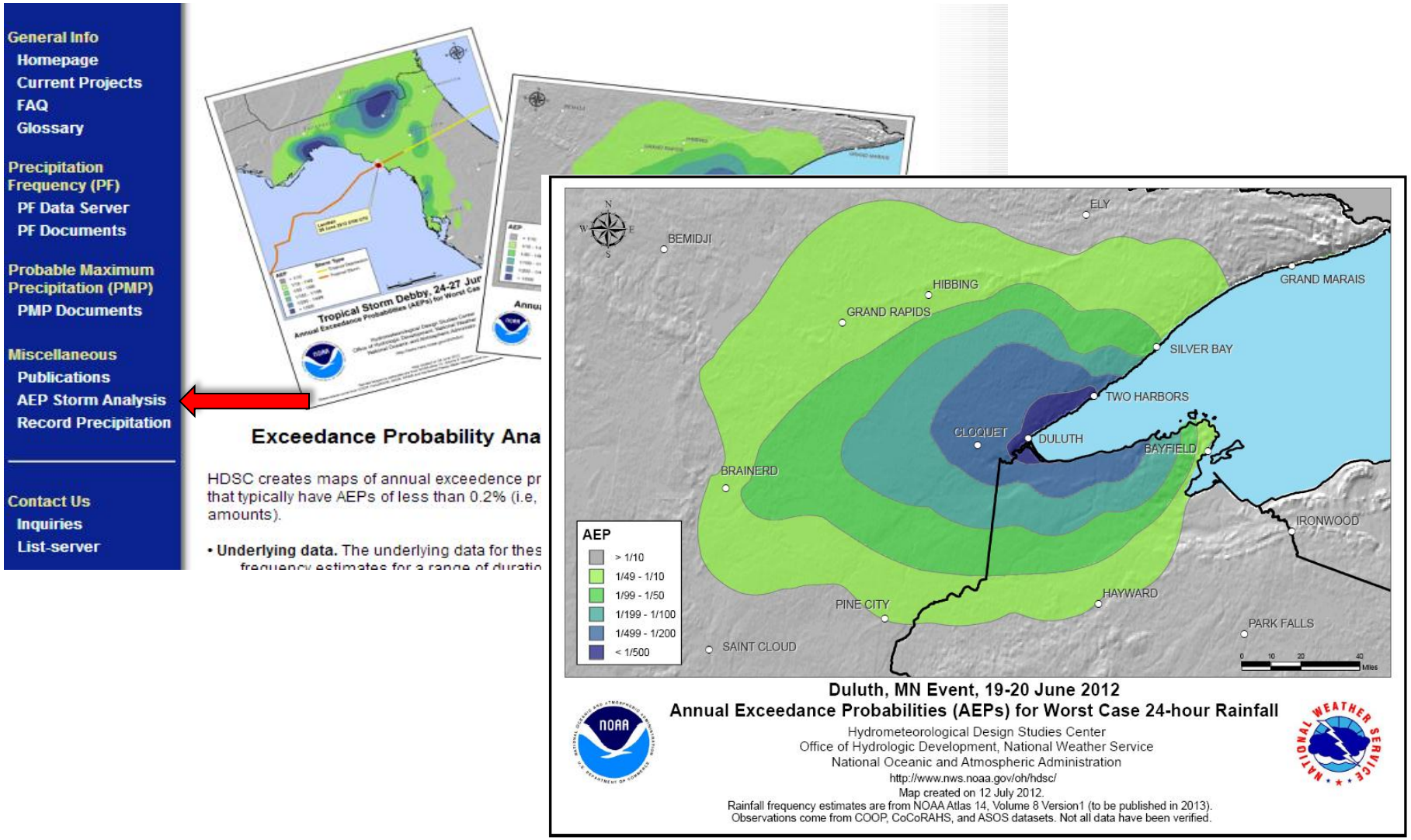
5. Technical Reports, Nos. 1 - 41 (1967 - 1988)
   - ESSA Technical Reports Weather Bureau series, Nos. 1 - 12 (1967 - 1970)
   - NOAA Technical Reports NWS series, 13 - 41 (1971 - 1988)

6. Technical Memoranda, Nos. 1 - 46 (1966 - 1995)
   - Weather Bureau Technical Notes series, No. 1 (1966)
   - ESSA Technical Memoranda, Weather Bureau series, Nos. 2 - 11 (1967 - 1970)
   - NOAA Technical Memoranda, NWS HYDRO series, Nos. 12 - 46 (1971 - 1995)

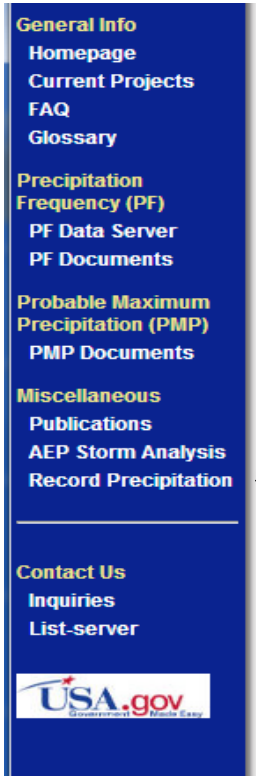
1. NOAA Atlas 14, Vols. 1 - 7 (2004 - 2012)

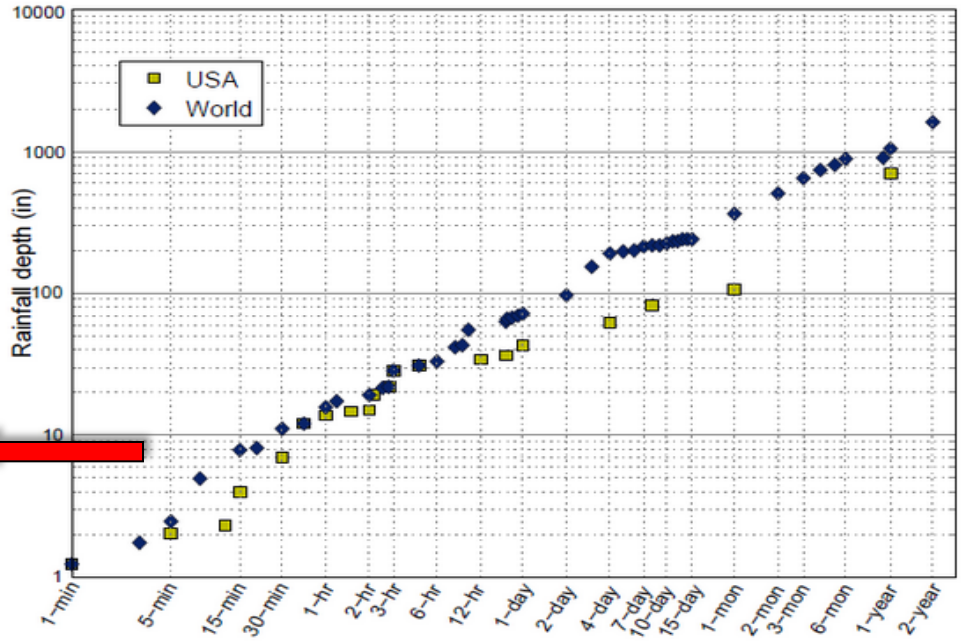
Vol.	Title	Publication year	Size (MB)	Comments
1	Precipitation-Frequency Atlas of the United States, Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah)	2004 revised 2006 Addendum 2011	6.9	SE California superseded by NA14 Vol6
	Precipitation-Frequency Atlas of the United States, Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New	2004		

Misc. information: AEP storm analysis

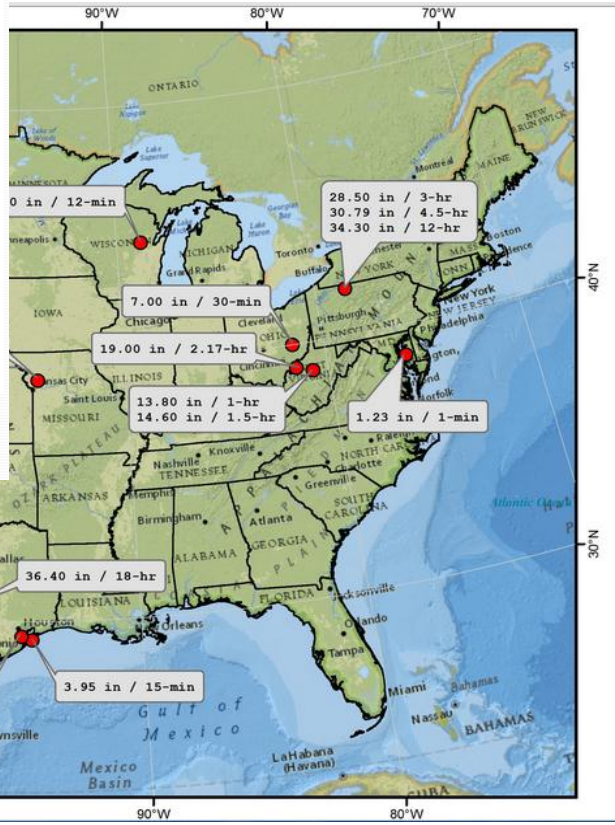


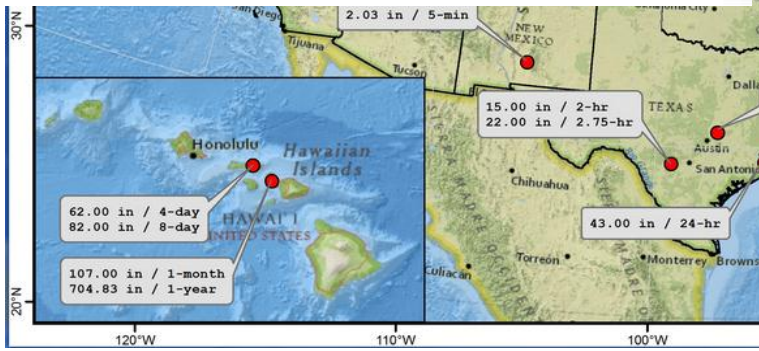
Misc. information: World and USA record prcp.





Record point precipitation measurements for the world and the USA





Major tasks

1. Data collection, formatting

- Data collected and formatted for 25,695 stations maintained by 40 agencies
- 1,091 stations in MN

2. Examination of geospatial data and station cleanup

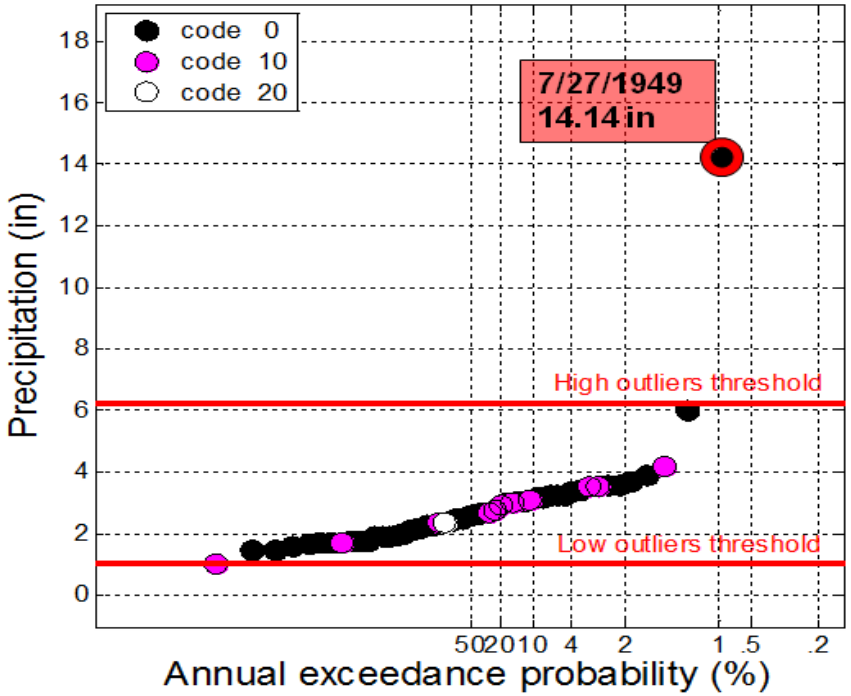
- Confirming latitude, longitude and elevation data
- Screening for duplicate stations from different databases and duplicate records at co-located stations
- Extending records at longer-duration stations using data from co-located stations
- Screening nearby stations for potentially merging records
- Removing shorter, less reliable records in station dense areas
- Screening for sufficient number of years with usable data (≥ 30)
- 7603 stations retained for frequency analysis

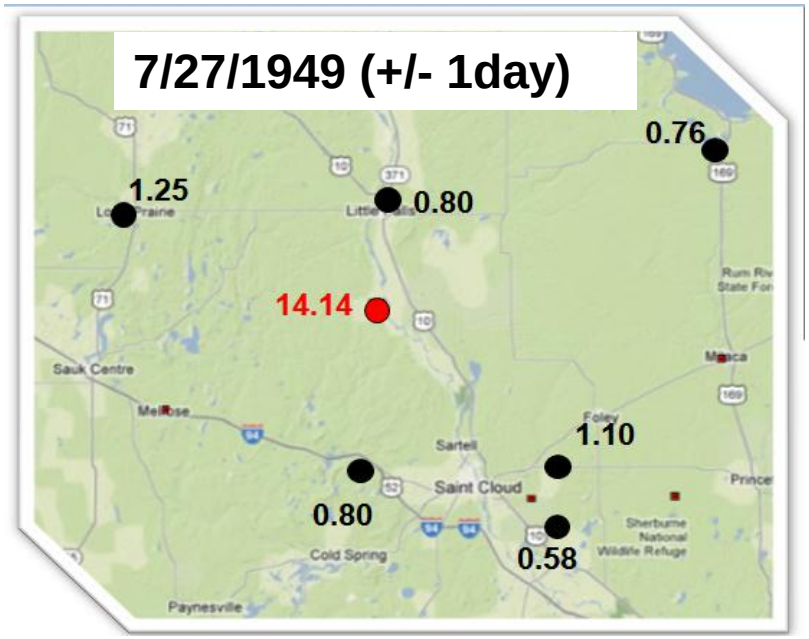
Major tasks

3. AMS extraction and quality control

- AMS extracted for (up to) 17 durations: 15- and 30-min; 1-, 2-, 3-, 6-, 12-hr; 1-, 2-, 3-, 4-, 7-, 10-, 20-, 30-, 45- and 60-day.
- AMS quality control: removing high and low outliers

Example: Royalton 5W (21-7157), 1-day





Major tasks

4. Data reliability tests: AMS trends (non-stationarity), spatial correlation, consistency

❑NOAA 14 methods are based on the assumption of a stationary AMS statistics

❑At-station analysis

-Data: 1-hr , 1-day, 10-day, 60-day AMS at stations with at least 50 years of data

-Tests for trends:

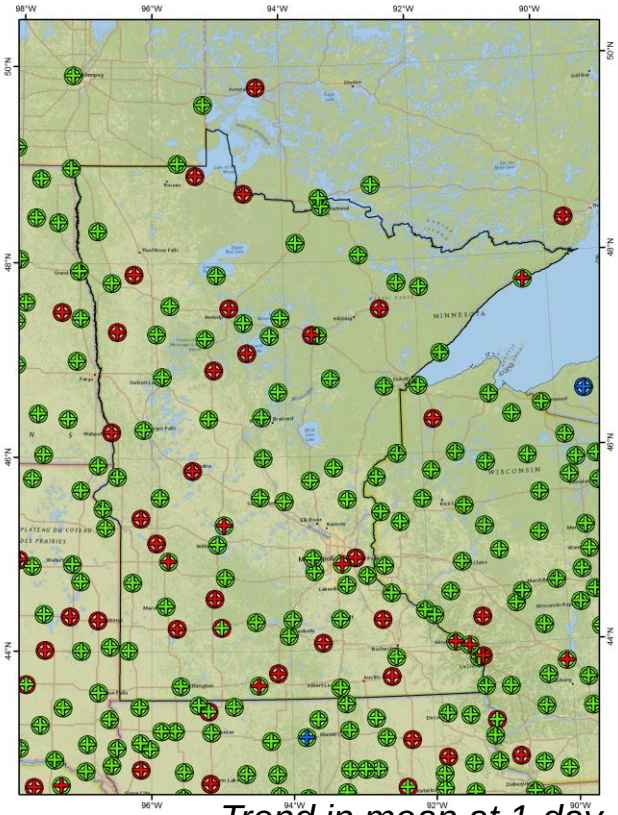
- parametric *t*-test (mean)
- non-parametric Mann-Kendal (mean)
- Levene test (variance)

-Investigated spatial patterns in test results

❑Regional analysis:

-Normalized AMS and regressed against time.

-Tested H_0 : no serial correlation at 5% level

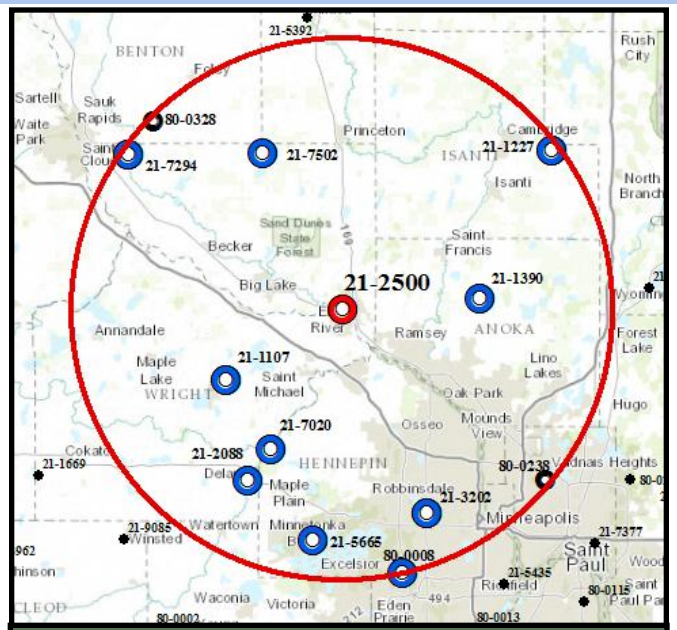


Trend in mean at 1-day

red – positive; green-none; blue - negative

Major tasks

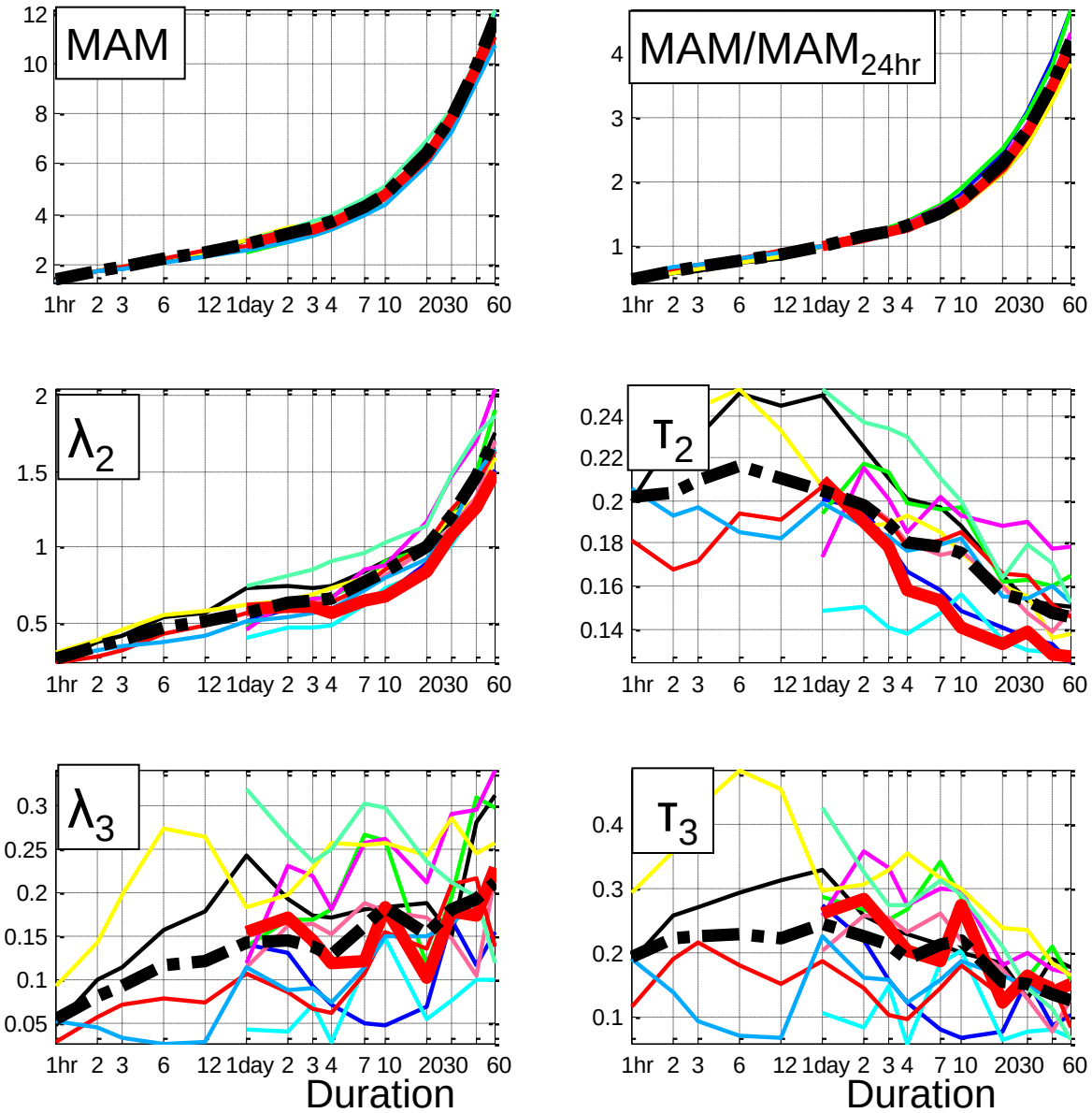
5. Derivation of regional L-moments



REGIONAL ANALYSIS FOR ELK RIVER (21-2500)

id	distance (mi)	elev (ft)	mam_{24hr} (in)	max_{24hr} (in)	n_{24hr}	n_{1hr}
Selected stations:						
21-2500	0.00	910	2.82	7.39	66	0
21-1107	14.54	992	2.96	7.11	61	48
21-1390	14.66	907	2.57	5.32	41	0
		...				
Backup stations:						
21-5392	31.19	1064	2.65	6.03	98	0
		...				
Deleted stations:						
80-0328	28.40	1099	2.81	5.26	31	0
		...				
Total number of years for selected stations:					651	180

Enter station ID you want to add/remove:____



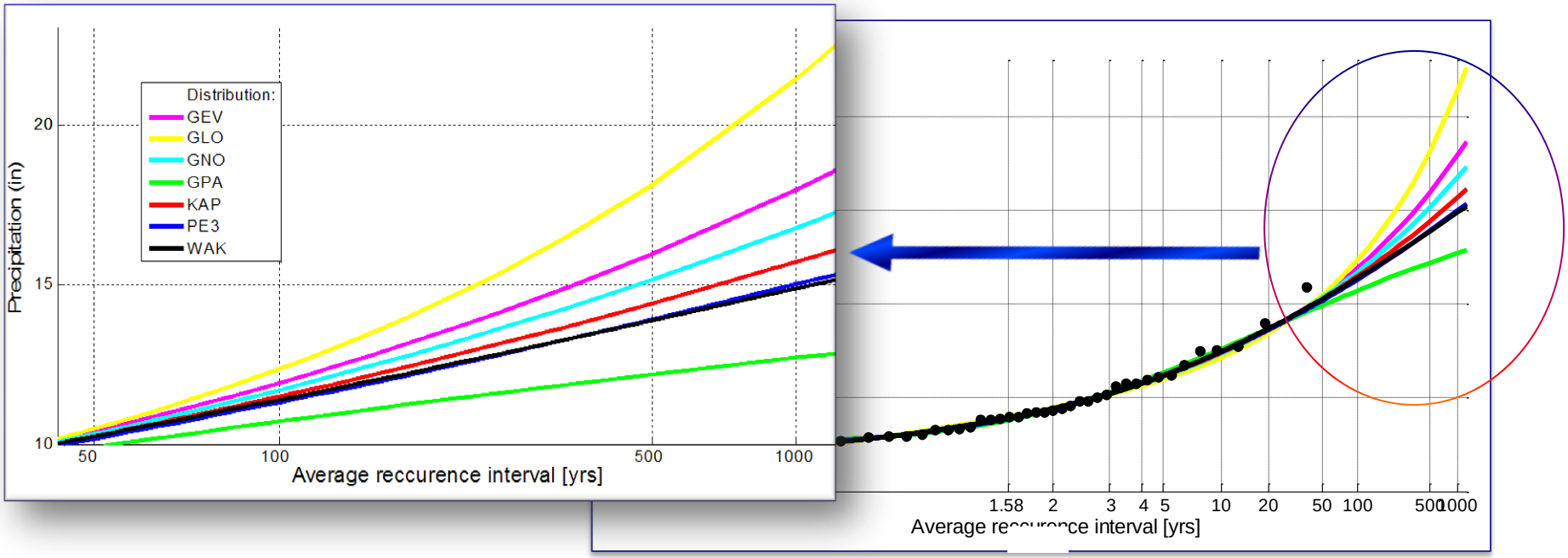
Major tasks

Task 6. Distribution selection

- Tested 7 distributions

- Estimates very sensitive to distribution selection for ARI > 100 years

ARI (years)	Potential PF range
100	11-13 in
1000	13 -22 in



Example: *station with ~50 years of data; all distributions passed statistical tests.*

Major tasks

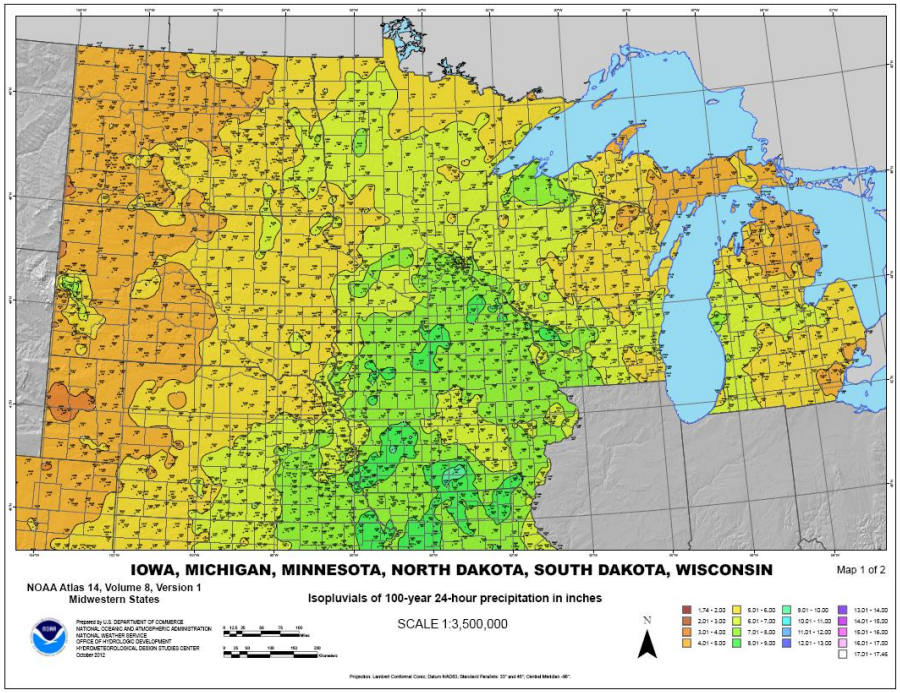
Task 7. Derivation of PF grids

- ❑ Mean annual maximum (MAM) precipitation grids at 30 arc-seconds (~800 meters, 2,600 feet) are basis for deriving PF grids. PRISM statistical-geographic approach for mapping climate data used to derive MAM grids for 15-min to 60-day durations.

- ❑ Spline interpolation used to interpolate ratios of consecutive quantiles.

- ❑ Consistency checked across types, durations and frequencies.

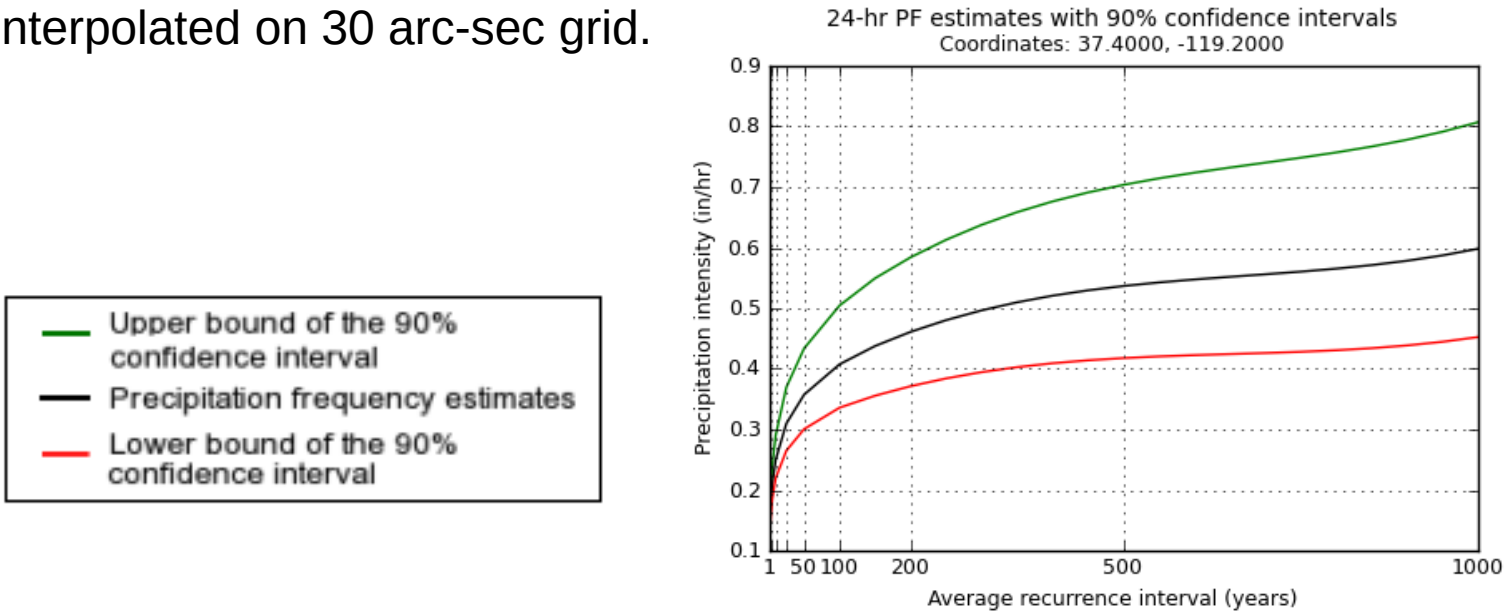
- ❑ N-minute estimates calculated using scaling factors from 15-minute and 60-minute estimates.



Major tasks

Task 8. Confidence intervals

- ❑ Simulation used to construct 90% confidence intervals (i.e., 5% and 95% confidence limits) at stations.
- ❑ Algorithm adjusted to account for inter-station correlation.
- ❑ Estimates interpolated on 30 arc-sec grid.



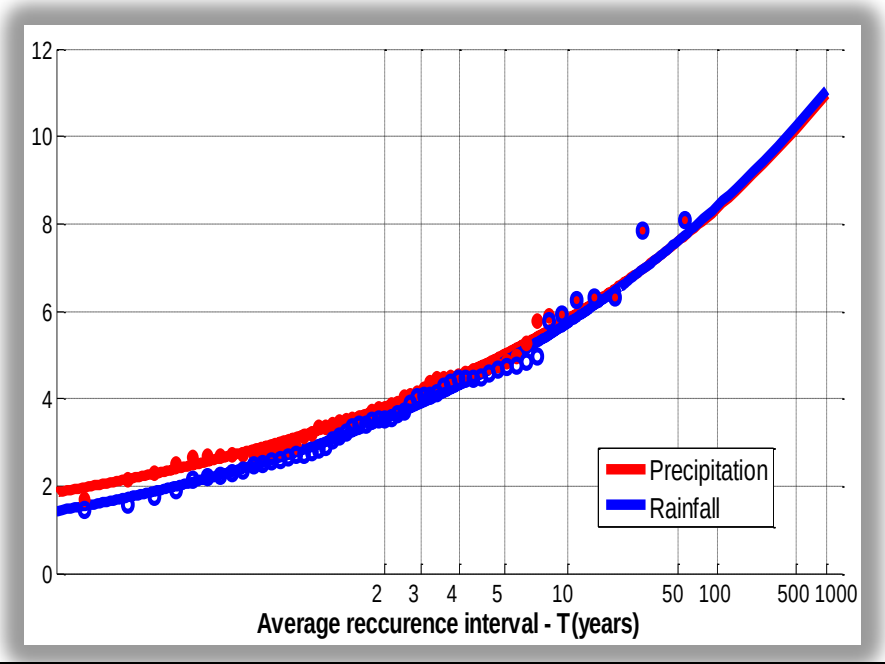
Major tasks

Task 9. Rainfall (liquid precipitation) frequency analysis

- Precipitation and rainfall AMS extracted for 1, 6,12, 24 hours
- Estimates for ARI = 2 - 1000 years
- Empirical relations developed for regions where estimates differ:

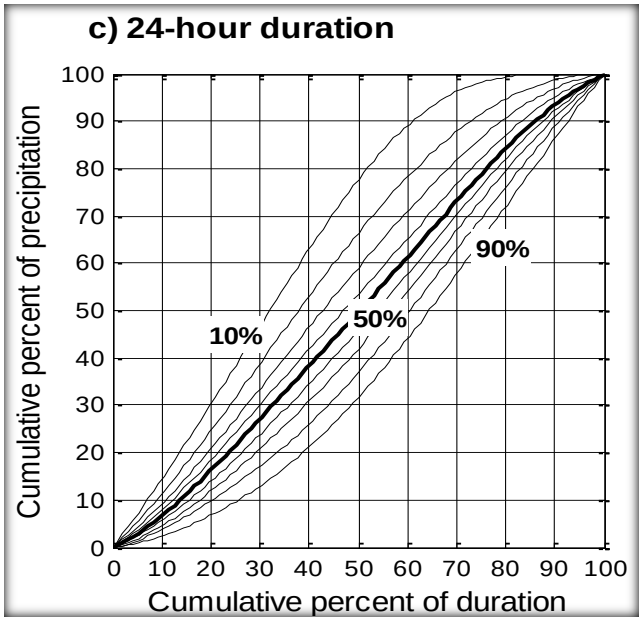
$$Rainfall_{\,frequency,\ duration} = a + b\ Precipitation_{\,frequency,\ duration}$$

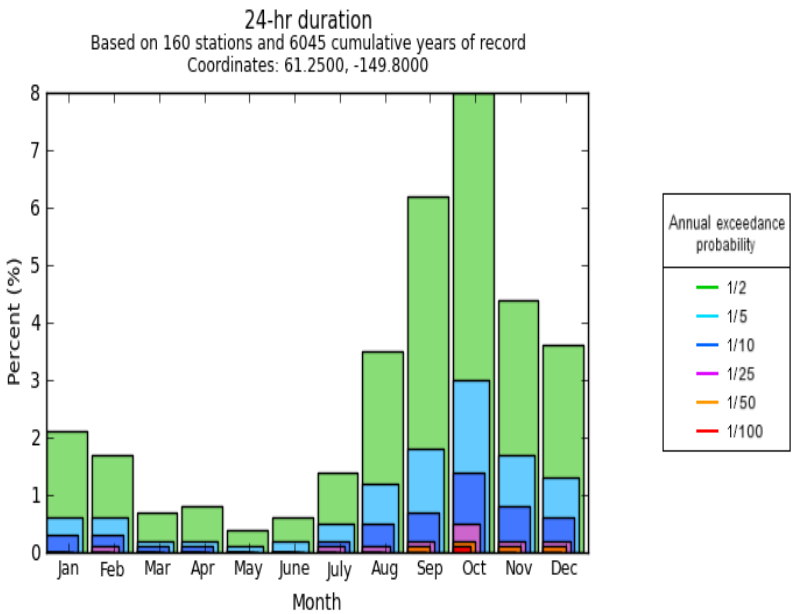
Data available	Rules for 24-hour
Prcp, rain	None
Prcp, snowfall	Rain = prcp - 0.10 snowfall
Prcp, temp	If T > 33F in rainy season => prcp = rain



Major tasks

Task 10. Seasonality analysis





Task 11. Temporal distributions

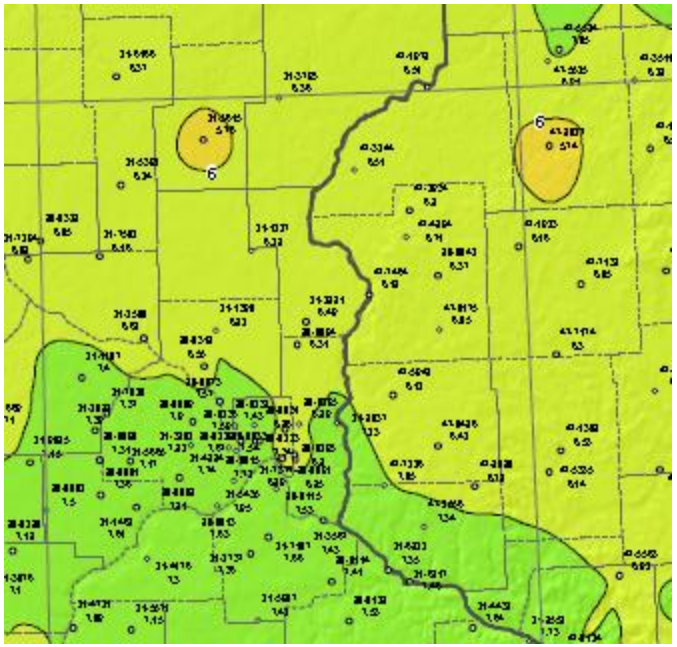
Peer review

- Request for review sent via email to the over 750 subscribers to the HDSC list-server as well as other interested parties.

- Potential reviewers asked to review:
  - station metadata
  - reasonableness of point precipitation frequency estimates
  - spatial patterns

- Review started on October 11th; received ~45 reviews

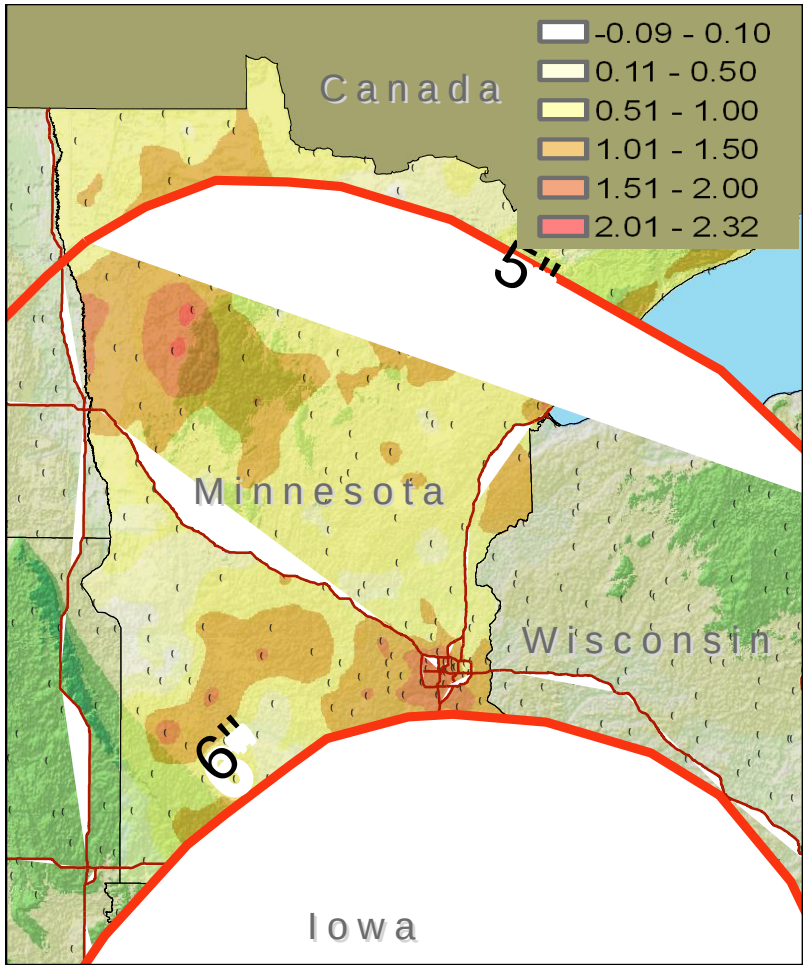
- Comments/questions
  - method and delivery of the estimates
  - station metadata
  - unsmooth contours and bulls' eyes
  - spatial patterns



Peer review

TP 40 vs
NOAA Atlas 14 Ver 1 (peer review)

- ❑ Some differences are due to digitization of TP40 paper maps and bulls eyes in NOAA 14 that will be filtered in final product
- ❑ Twin Cities metro area network of raingauges cleaned to reduce biases
- ❑ Other specific areas of concern still under investigation



Differences between NOAA Atlas 14 Ver. 1 and TP40 1day 100-yr

Product delivery

- On or around March 31st

  - Interactive web pages
  - GIS grids
  - temporal distribution
  - seasonality

- On or around April 30th
  - documentation
  - cartographic maps

- Announcement will be send out via email to list-server subscribers when estimates are ready: http://www.nws.noaa.gov/oh/hdsc/listserver.html

- Notice on publishing dates/delays will be put on the HDSC page (http://www.nws.noaa.gov/oh/hdsc/) and on the PFDS page (http://hdsc.nws.noaa.gov/hdsc/pfds/index.html) around March 25th.