NOAA Atlas 14 Precipitation-Frequency Atlas of the United States: Products and Methods

Presenter:

Sanja Perica, Director
Hydrometeorological Design Studies Center (HDSC),
Office of Hydrology, National Weather Service, NOAA
Email: Sanja.Perica@noaa.gov
Phone: 301-713-0640 (161)
Web: www.nws.noaa.gov/oh/hdsc

Co-authors
(for Volumes 8 and 9)

Geoffrey Bonnin, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St Laurent, Carl Trypaluk, Dale Unruh

Presentation for NRC and SOH/Extreme Storm Event Work Group
6/26/2013

Topics

1. Background

2. NA14 products

3. NA14 methods

   3.1. Current methods

   3.2. Enhancements

      - Accounting for non-stationarity (climate change)

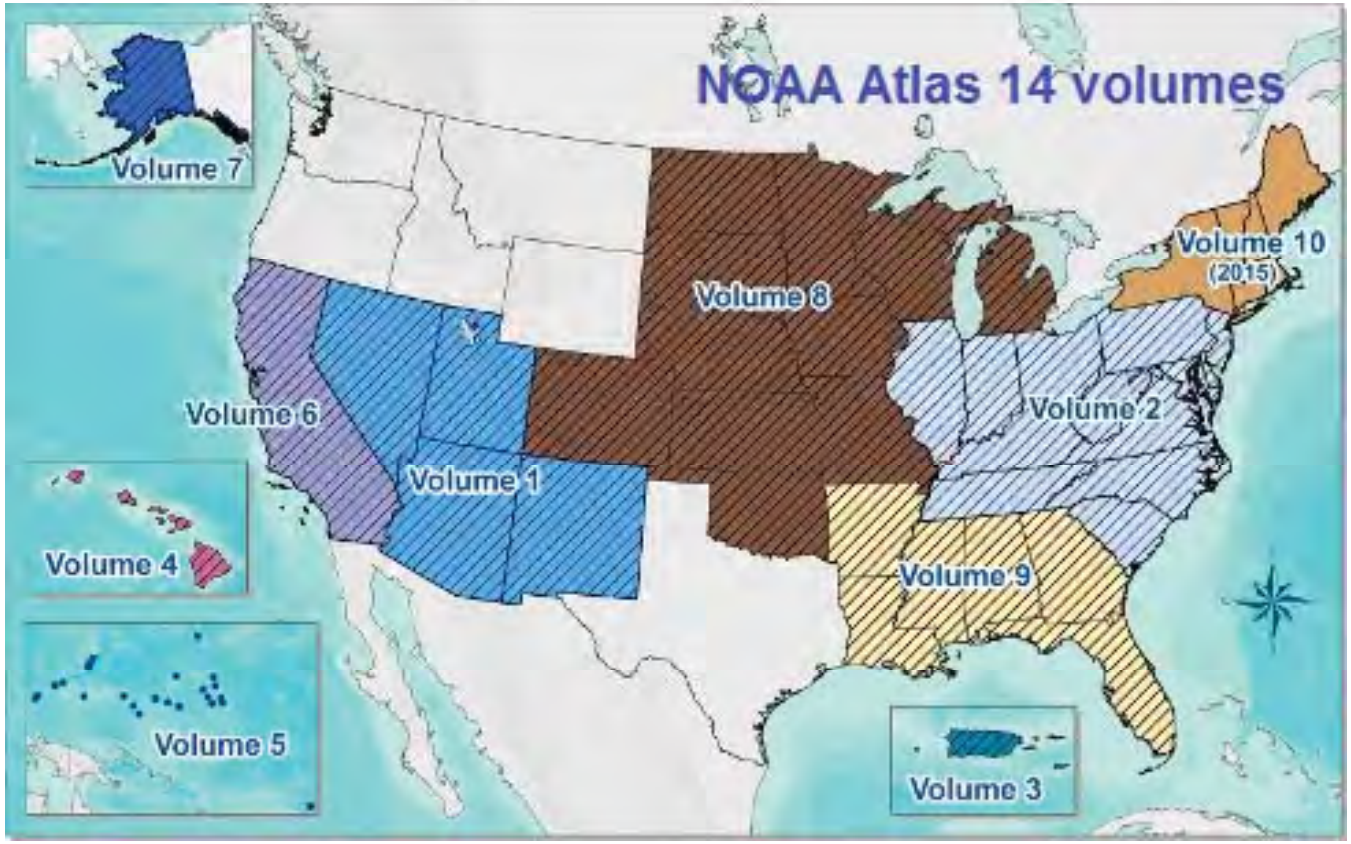
      - areal reduction factors

NOAA Atlas 14 Volumes

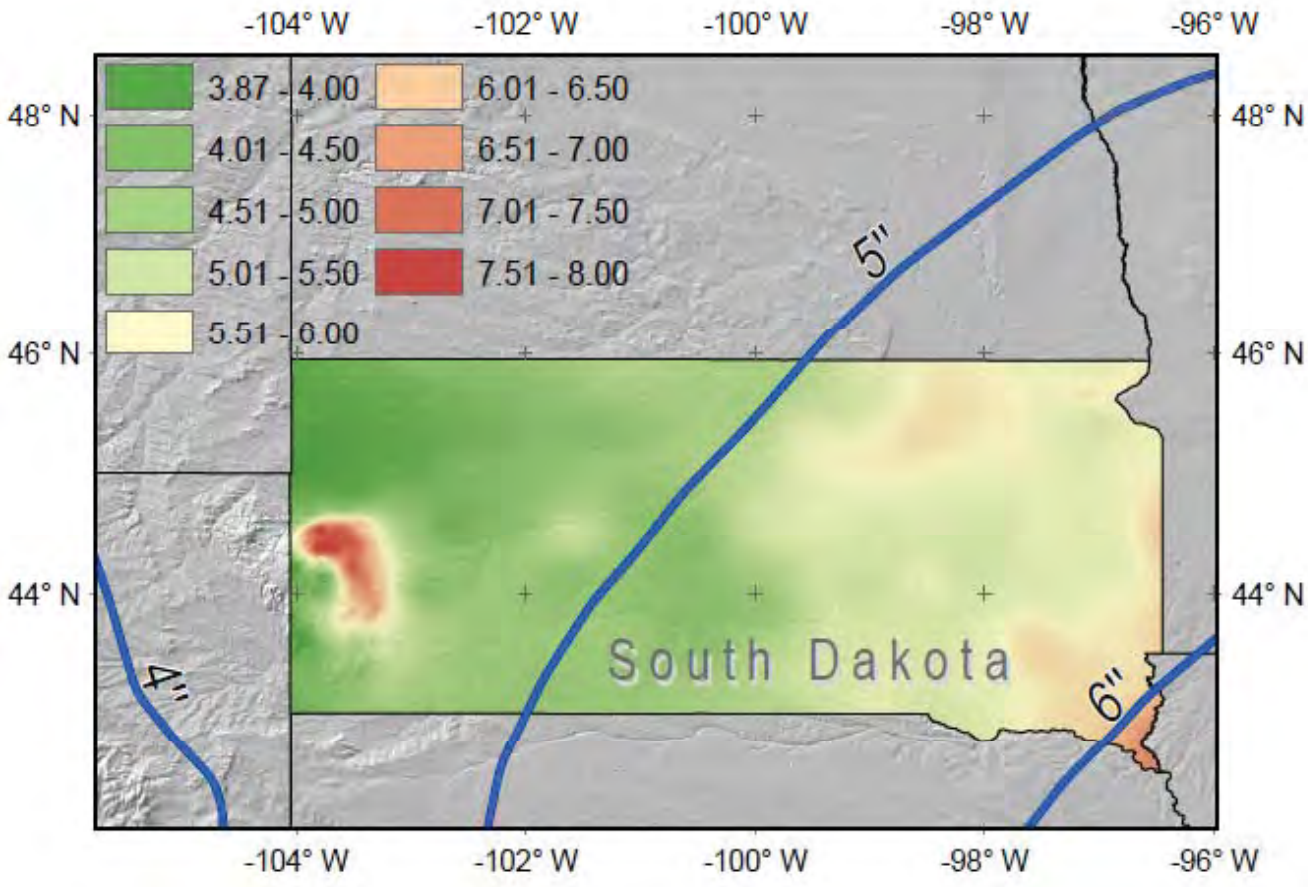
- NOAA/NWS/Hydrometeorological Design Studies Center (**HDSC**) is responsible for updating precipitation frequency estimates.

- **Methodology**: AMS-based region-of-influence regional frequency analysis approach based on L-moment statistics.

- Since 2004, updates are published as Volumes of **NOAA Atlas 14** (online).



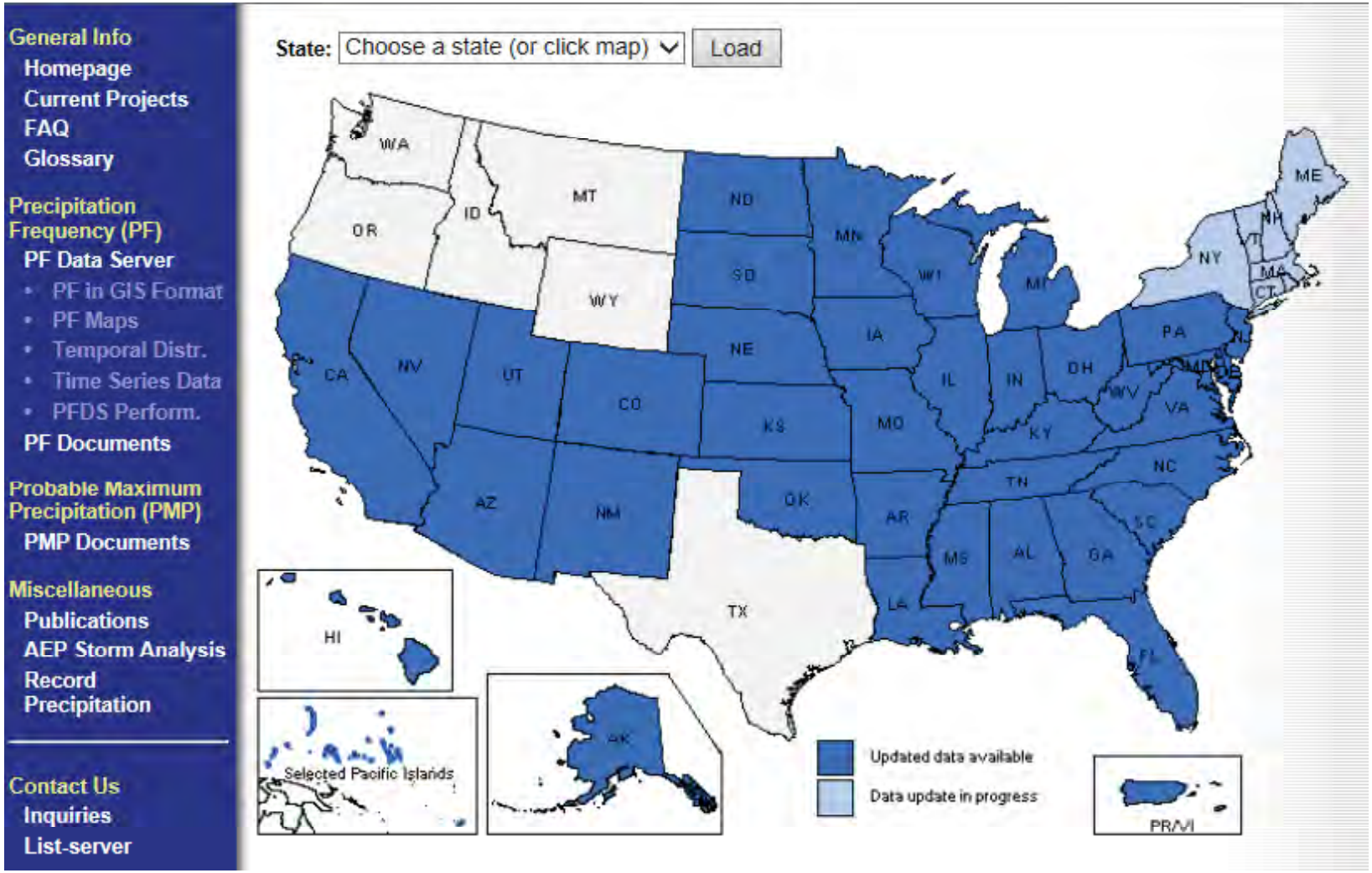
Old vs. new
NOAA Atlas 14 vs. TP40



NA14: 30 arc-sec gridded estimates with confidence intervals

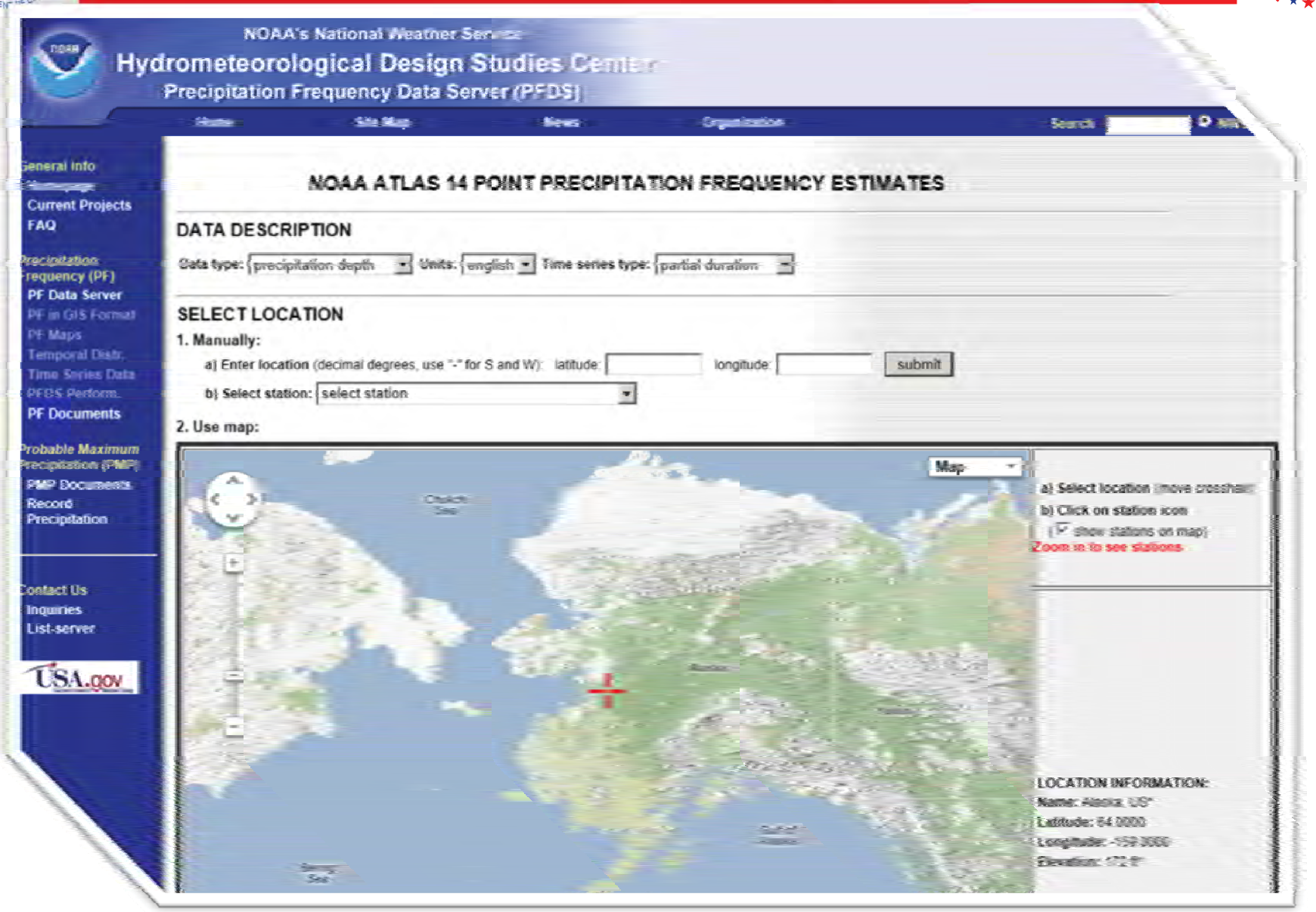
TP40: paper maps with isohyets

Where to go find NOAA Atlas 14 products?

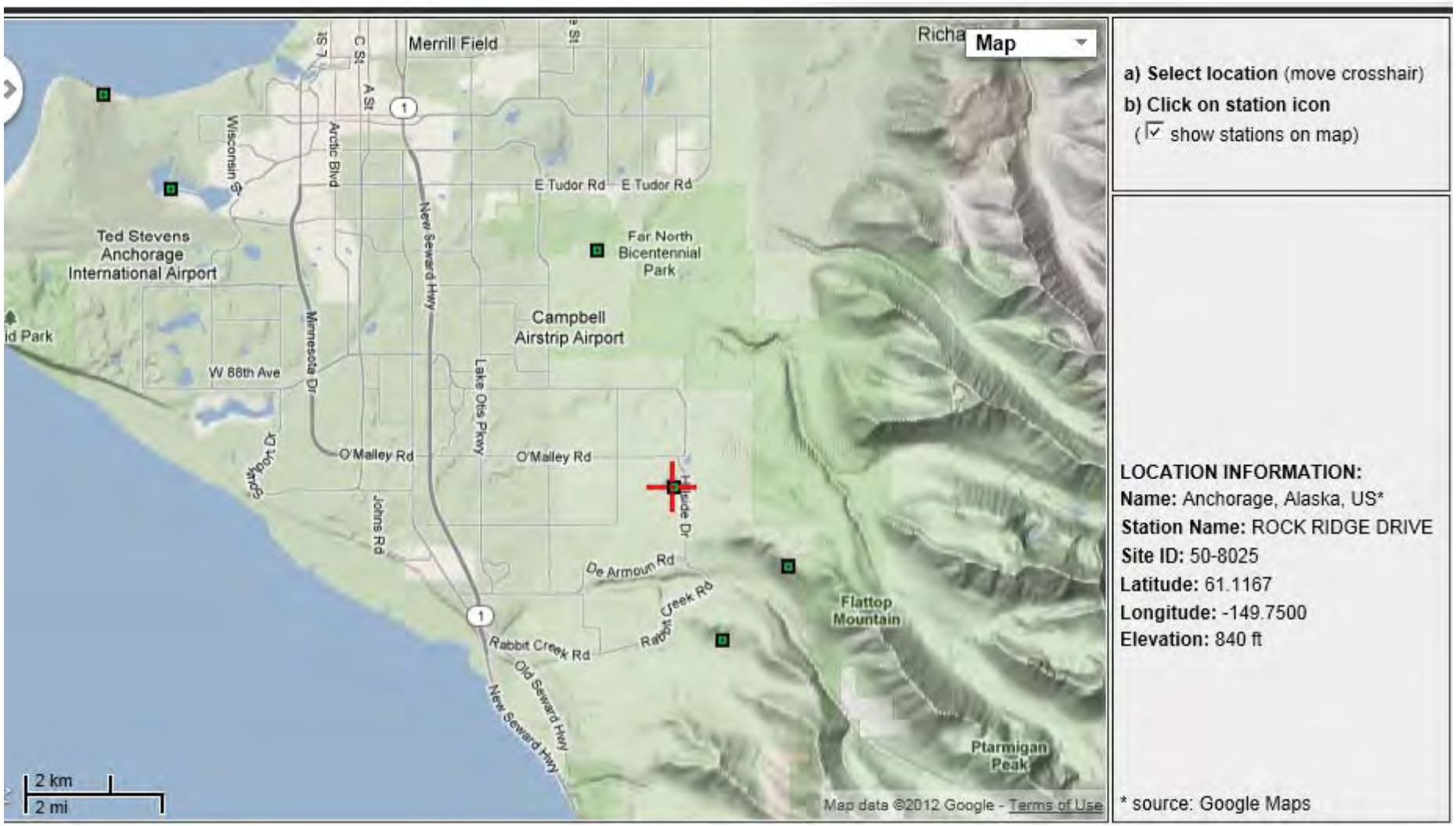


http://hdsc.nws.noaa.gov/hdsc/pfds/index.html

Retrieving PF estimates for location of interest
Initial display



Zooming in to location of interest...



...retrieve PF estimate (with confidence limits)

PF tabular | PF graphical | Supplementary information | Print Page

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

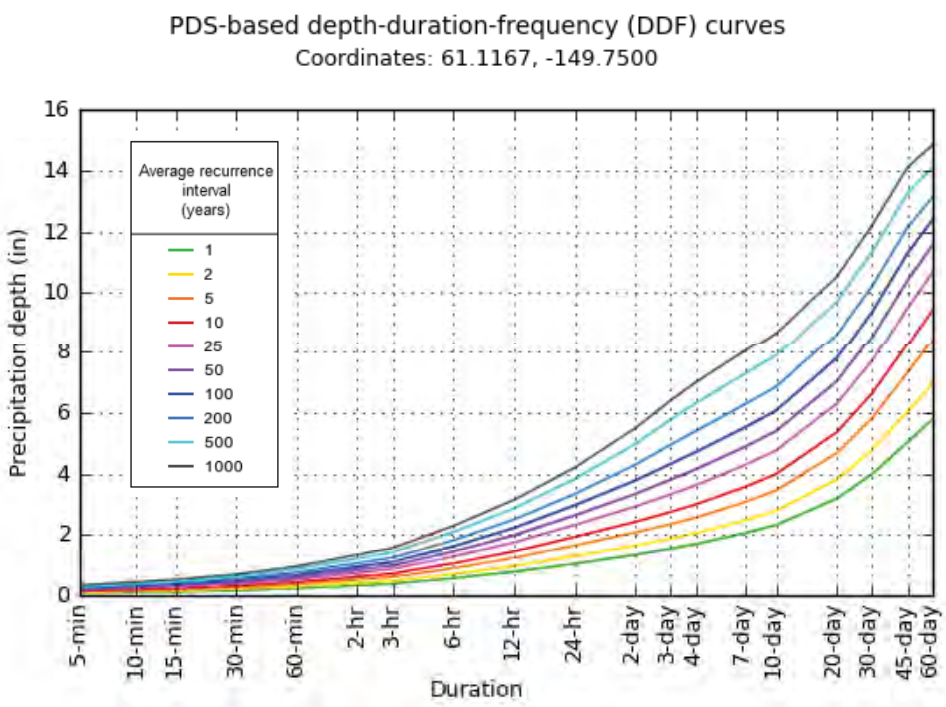
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.085 (0.065-0.113)	0.106 (0.080-0.143)	0.134 (0.100-0.184)	0.158 (0.116-0.220)	0.190 (0.137-0.270)	0.215 (0.152-0.310)	0.240 (0.167-0.351)	0.270 (0.186-0.401)	0.310 (0.209-0.470)	0.340 (0.226-0.522)
10-min	0.115 (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)	0.323 (0.225-0.473)	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)	0.378 (0.264-0.553)	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)	0.502 (0.350-0.735)	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)	0.687 (0.471-1.01)	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)	0.957 (0.667-1.40)	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)	1.12 (0.771-1.63)	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)	1.63 (1.1[illegible]-2.36)	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)	1.99 (1.4[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 (1.38-2.01)	1.94 (1.59-2.39)	2.33 (1.86-2.9[illegible])	(2.0[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)	(2.6[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)
4-day	1.71 (1.47-2.01)	2.06 (1.75-2.45)	2.57 (2.14-3.13)	3.00 (2.46-3.71)	3.63 (2.90-4.58)	4.15 (3.27-5.33)	4.71 (3.65-6.15)	5.40 (4.11-7.16)	6.30 (4.70-8.54)	6.99 (5.13-9.62)
7-day	2.06 (1.77-2.43)	2.48 (2.10-2.95)	3.08 (2.56-3.74)	3.57 (2.92-4.41)	4.29 (3.43-5.41)	4.88 (3.84-6.26)	5.51 (4.27-7.19)	6.27 (4.78-8.31)	7.27 (5.42-9.85)	8.02 (5.89-11.0)
10-day	2.33 (2.00-2.74)	2.79 (2.37-3.33)	3.45 (2.87-4.20)	3.99 (3.27-4.93)	4.76 (3.81-6.01)	5.39 (4.25-6.92)	6.06 (4.70-7.91)	6.84 (5.21-9.08)	7.88 (5.88-10.7)	8.66 (6.36-11.9)
20-day	3.19 (2.74-3.75)	3.82 (3.24-4.55)	4.68 (3.89-5.68)	5.35 (4.38-6.61)	6.29 (5.03-7.93)	7.02 (5.53-9.01)	7.78 (6.03-10.2)	8.60 (6.56-11.4)	9.69 (7.23-13.1)	10.5 (7.72-14.5)
30-day	3.99 (3.43-4.70)	4.78 (4.05-5.69)	5.83 (4.85-7.08)	6.63 (5.42-8.18)	7.70 (6.16-9.72)	8.53 (6.72-11.0)	9.37 (7.25-12.2)	10.2 (7.79-13.6)	11.3 (8.46-15.4)	12.2 (8.96-16.8)
45-day	5.03 (4.33-5.92)	6.03 (5.12-7.18)	7.32 (6.09-8.89)	8.26 (6.76-10.2)	9.49 (7.60-12.0)	10.4 (8.19-13.4)	11.3 (8.75-14.7)	12.1 (9.25-16.1)	13.3 (9.88-18.0)	14.1 (10.3-19.4)
60-day	5.78 (4.97-6.80)	6.96 (5.91-8.29)	8.41 (6.99-10.2)	9.43 (7.71-11.6)	10.7 (8.55-13.5)	11.6 (9.11-14.8)	12.4 (9.60-16.2)	13.1 (10.0-17.4)	14.1 (10.5-19.1)	14.8 (10.9-20.4)

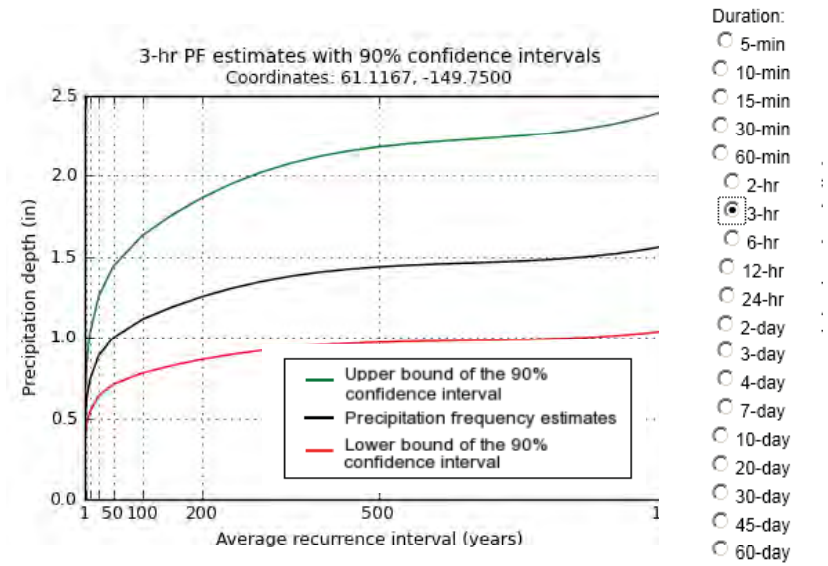
2.97
(2.30-3.88)

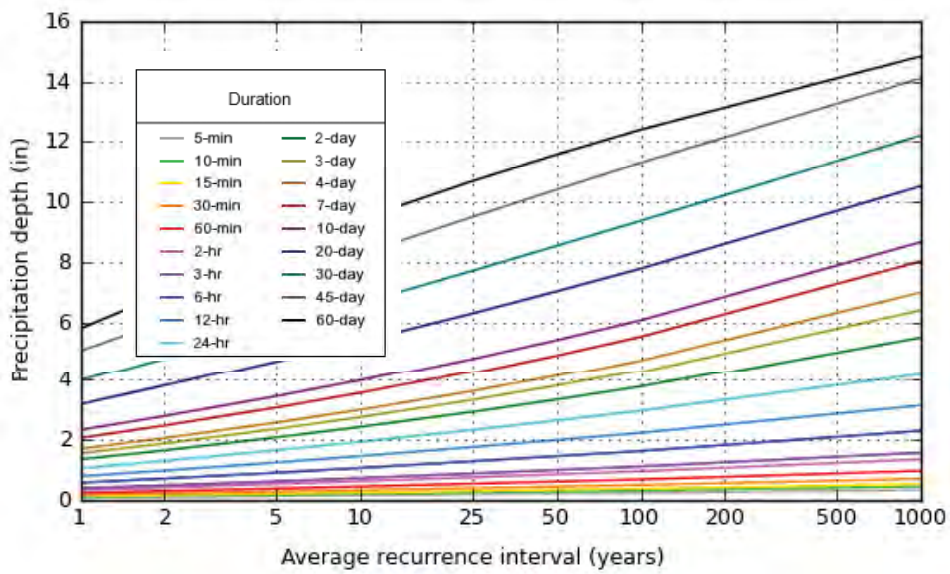
PF graphical: DDF curves, confidence intervals

PF tabular | PF graphical | Supplementary information

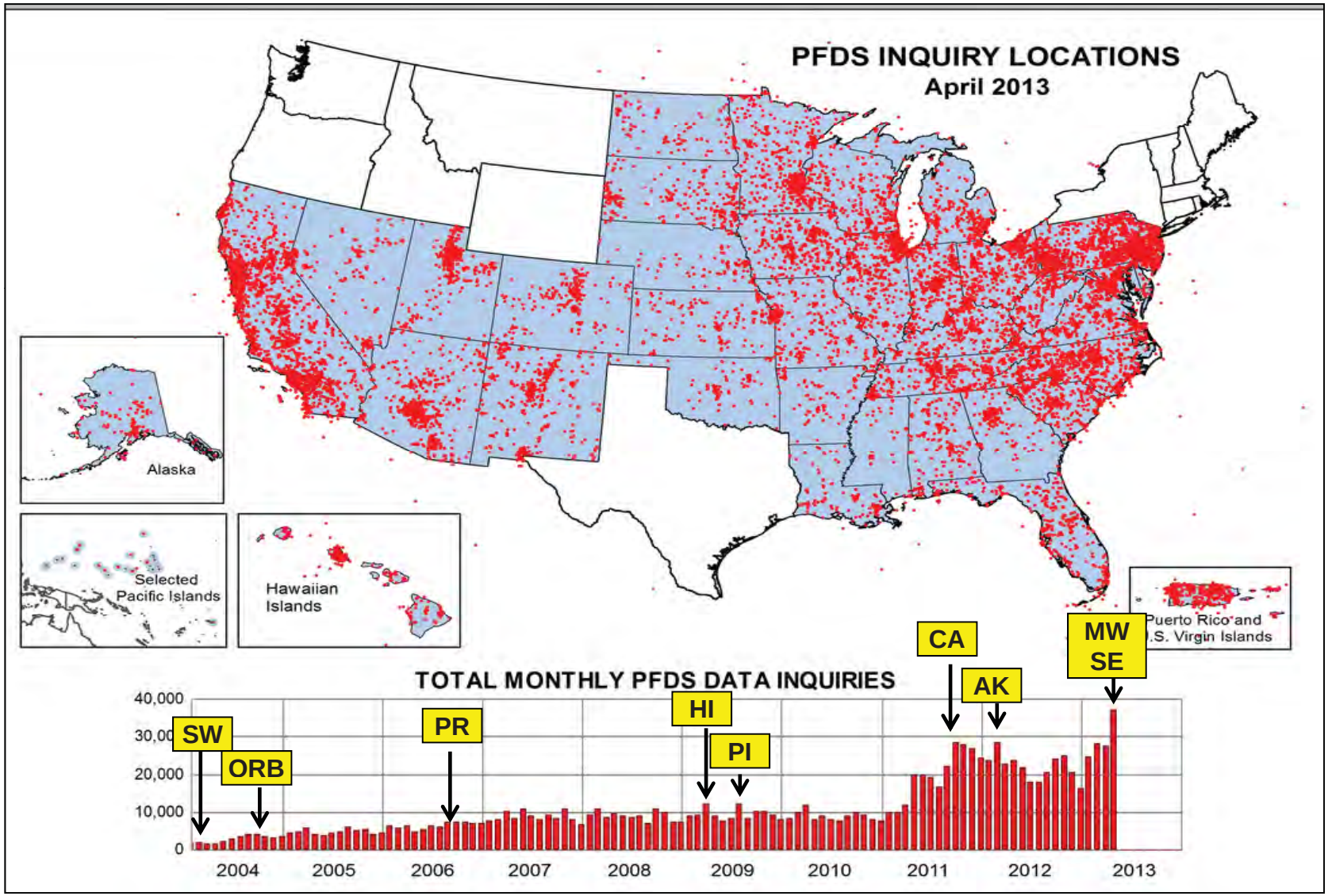
Curves | PF estimates with confidence intervals







NOAA Atlas 14 Volumes – performance statistics



Supplementary information Documentation

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- FAQ

Precipitation Frequency (PF)
- PF Data Server
  - PF in GIS Format
  - PF Maps
  - Temporal Distr.
  - Time Series Data
  - PFDS Perform.
- PF Documents

Probable Maximum Precipitation (PMP)
- PMP Documents
- Record Precipitation

Contact Us
- Inquiries
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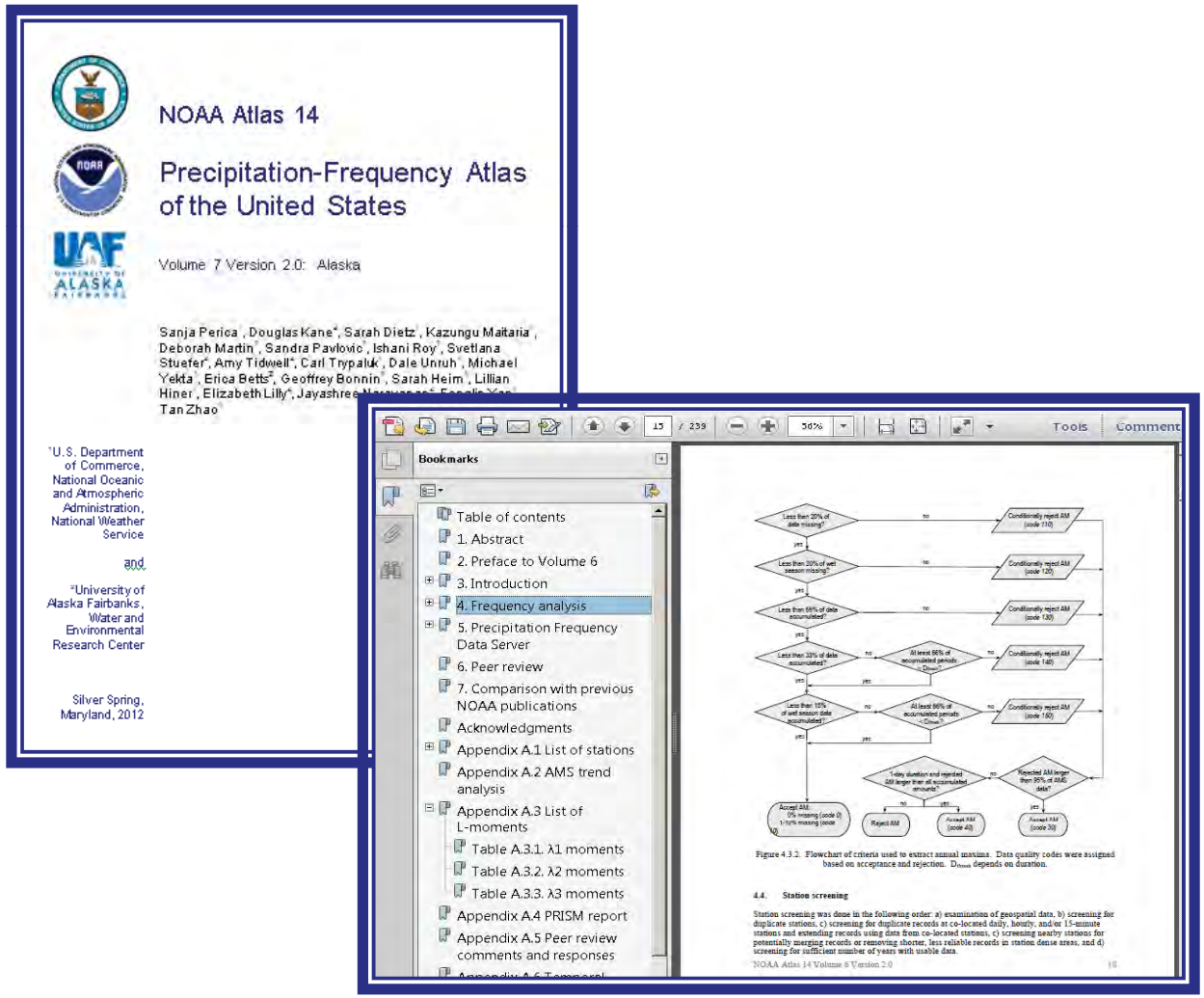

Cartographic maps

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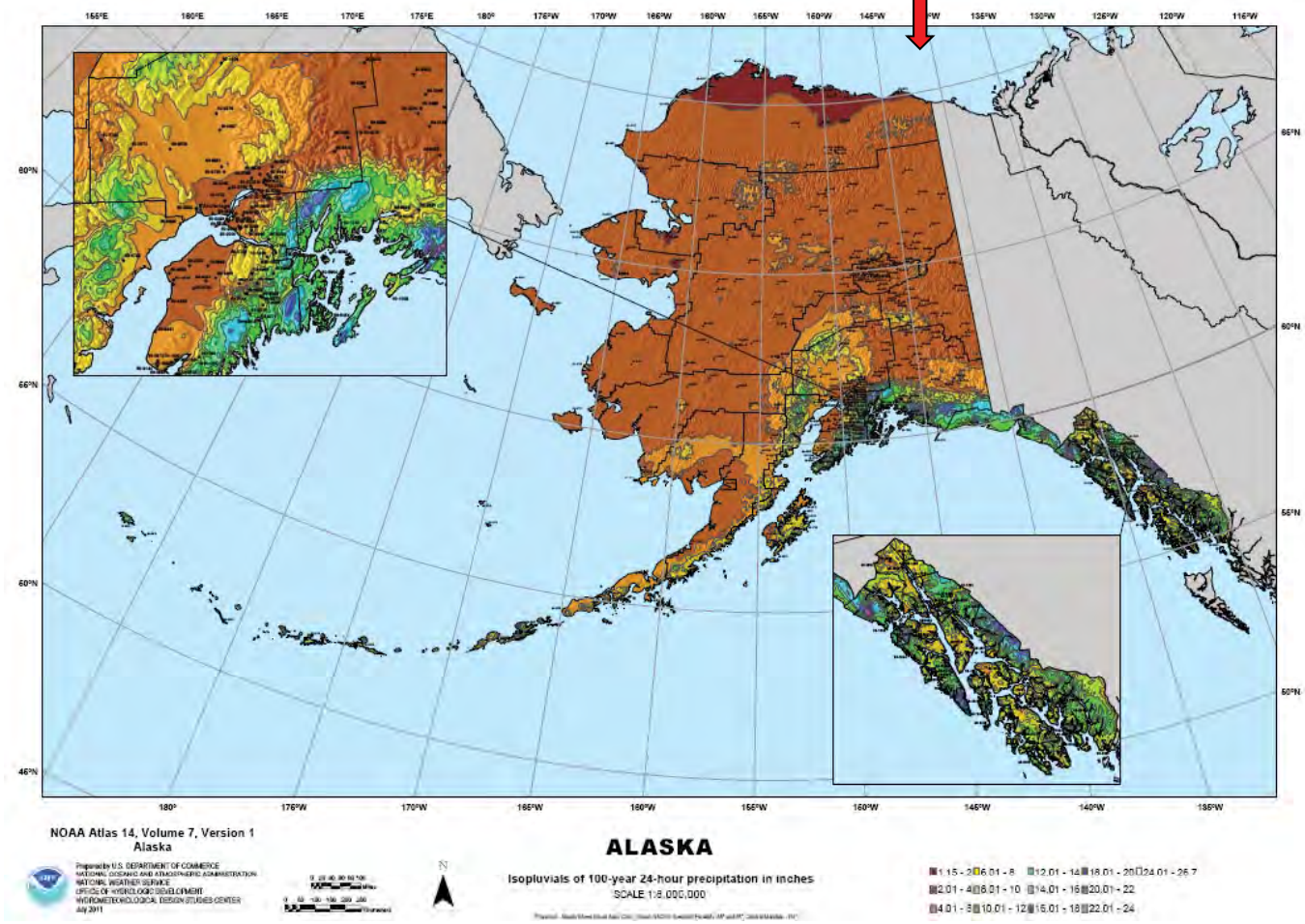


Maps were created to serve as visual aids and are not recommended for interpolating estimates.

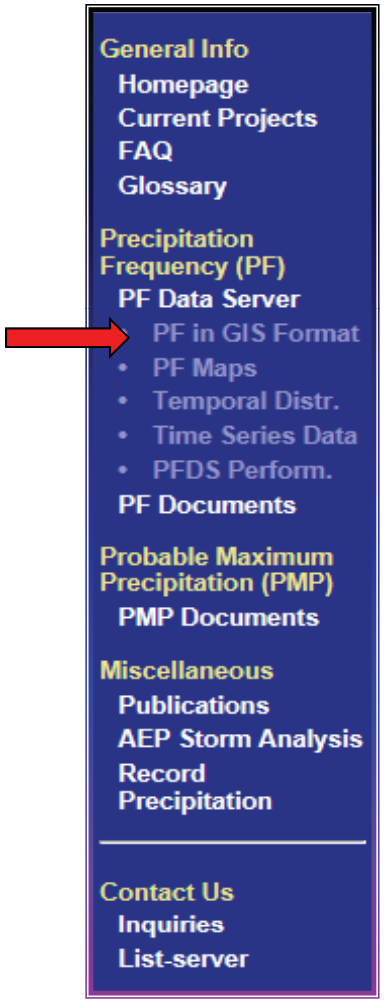
Underlying data

- 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.

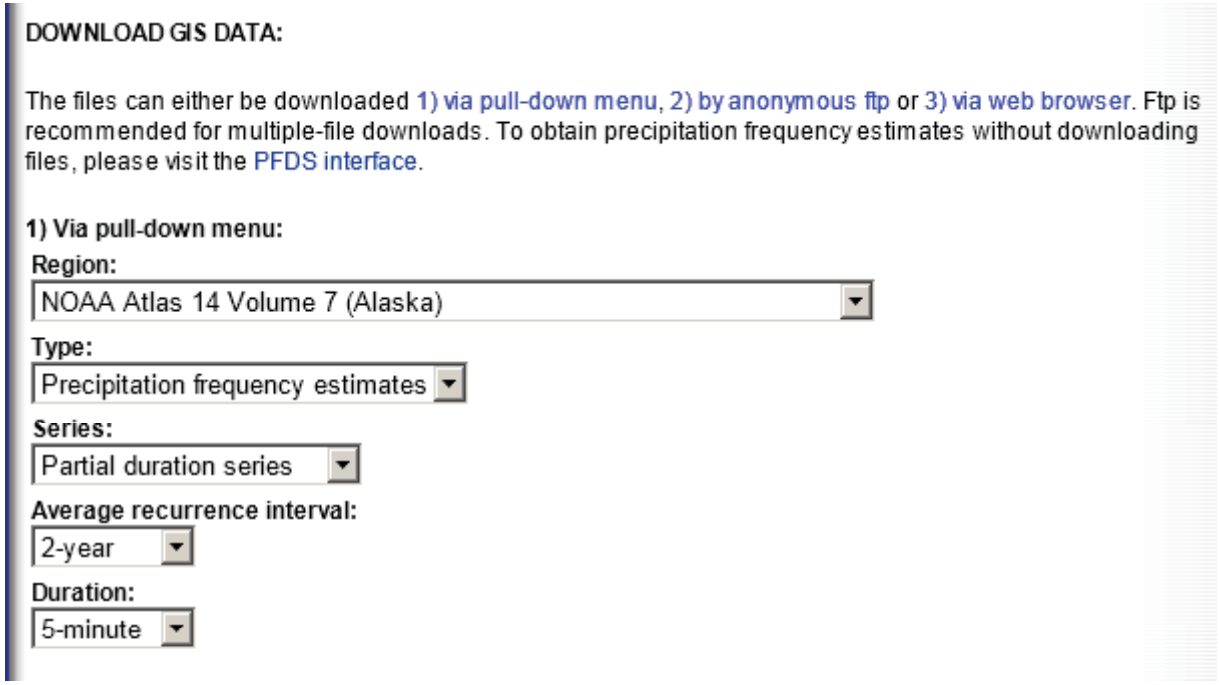
- Number of available grids:
  570 for PDS (190*3)
  513 for AMS (171*3)

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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

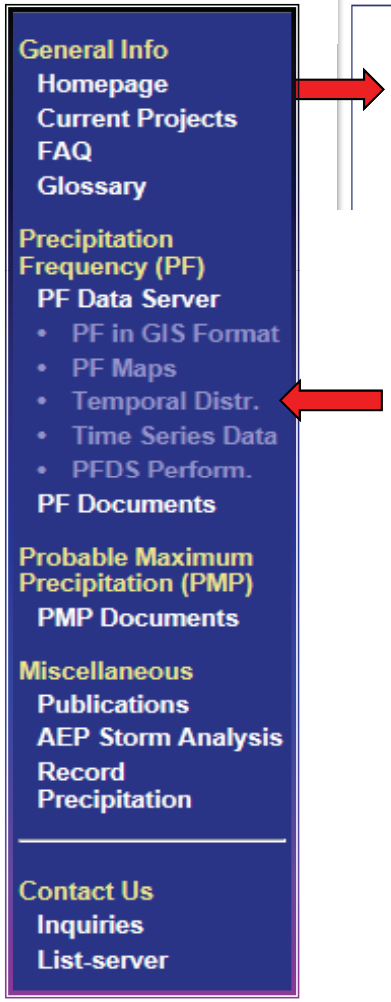
Precipitation frequency estimates in GIS compatible format (30 arc-sec resolution)

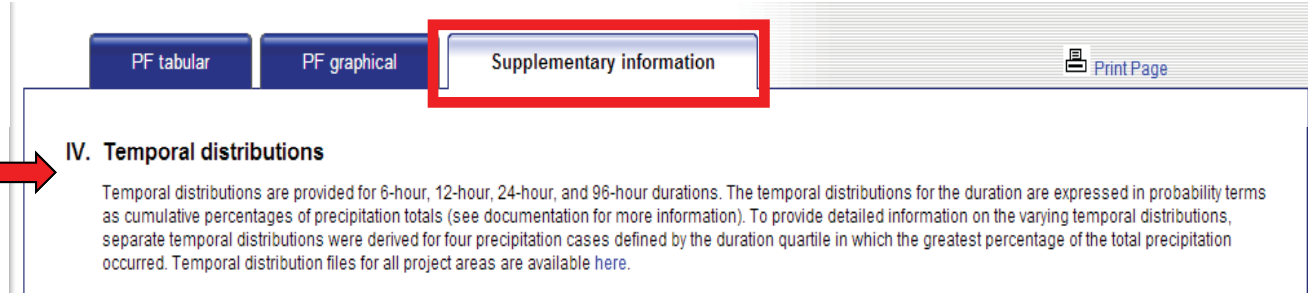


- ❑ ***PDS: 570 grids (190 quantile; 190 upper CL; 190 lower CL)***
- ❑ ***AMS: 513 grids (171 quantile; 171 upper CL; 171 lower CL)***



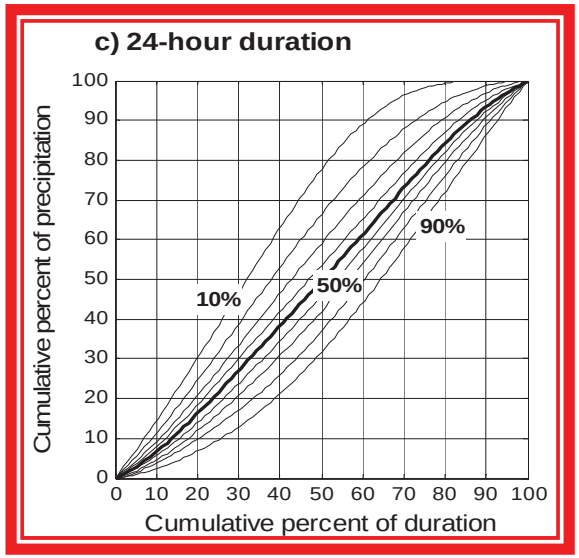
Supplementary information: Temporal distributions





- 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.

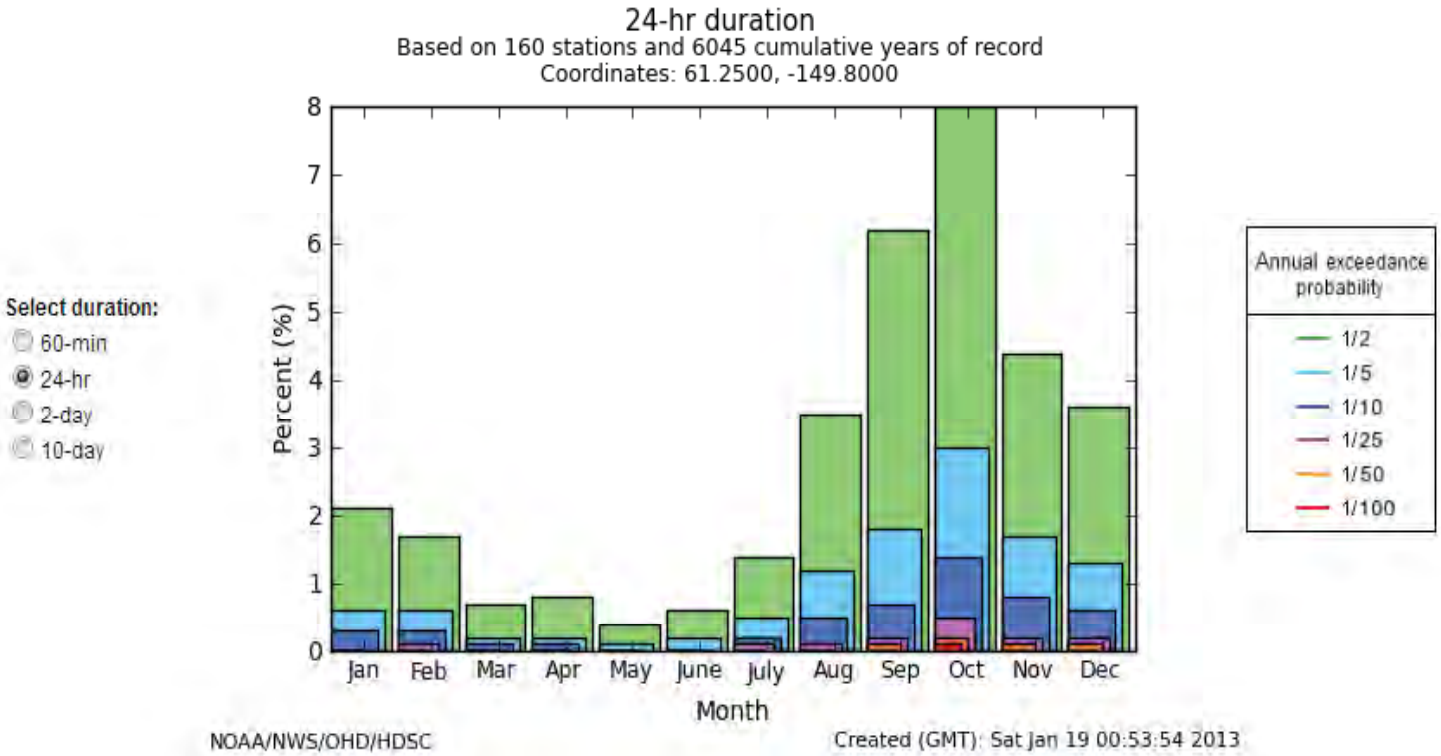


Supplementary information
Seasonality analysis

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.



Supplementary information
Rainfall freq. estimates

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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

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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.

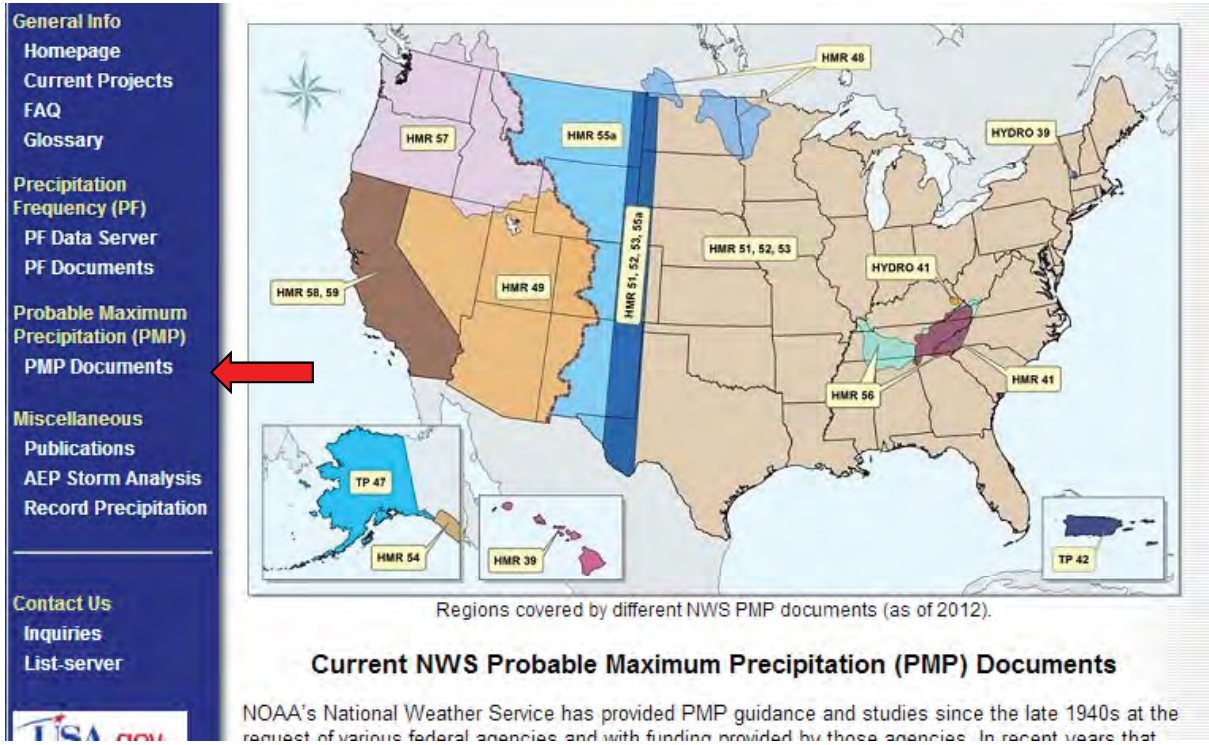
Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

+/-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.

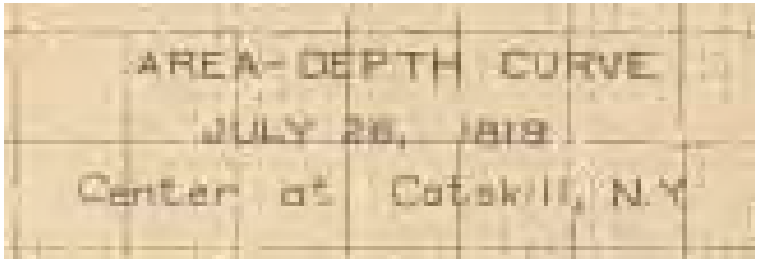
PMP Documents

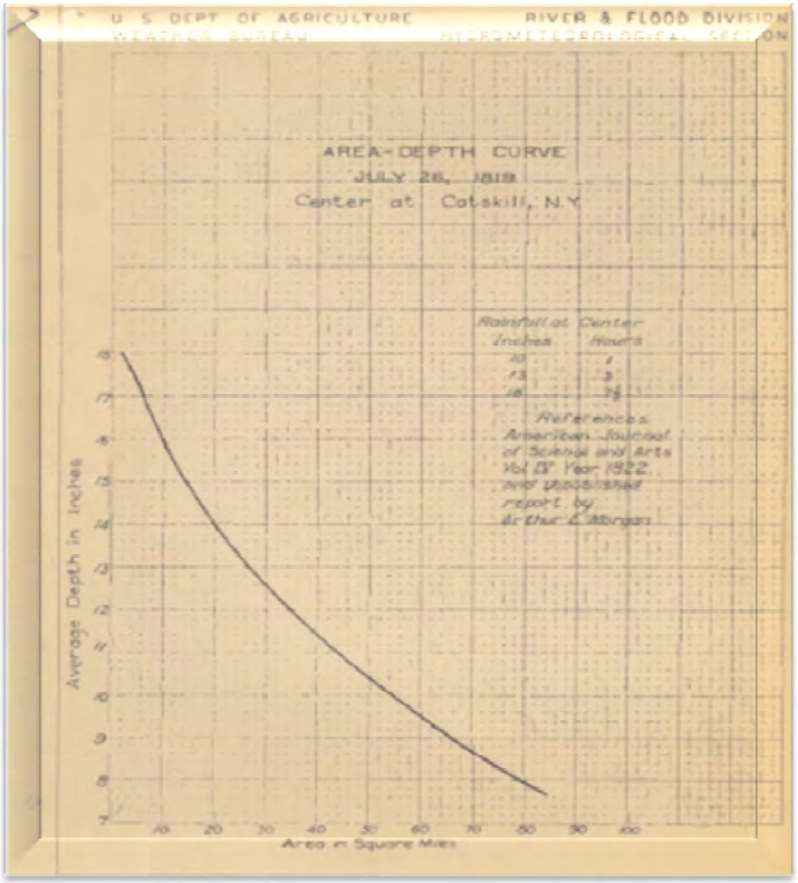


Document link	Title	Date	Size (MB)
Hydrometeorological Report No. 39	Probable Maximum Precipitation in the Hawaiian Islands	1963	3.4
Hydrometeorological Report No. 41	Probable Maximum and TVA Precipitation over the Tennessee River Basin above Chattanooga	1965	5.7
Hydrometeorological Report No. 46	Probable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

Storm data

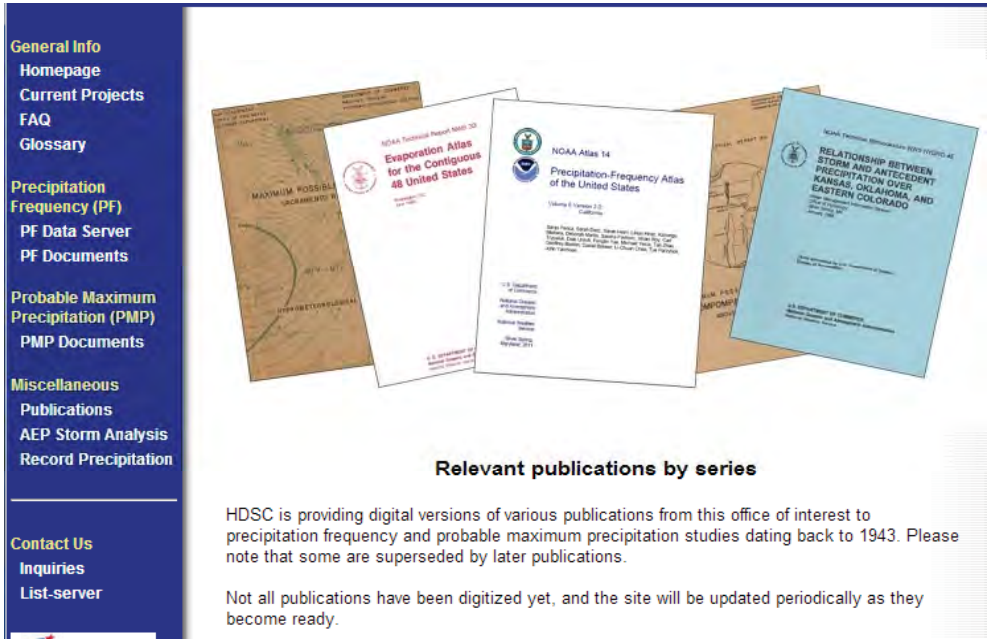
- Keep paper copies of old storm data going back to 1819





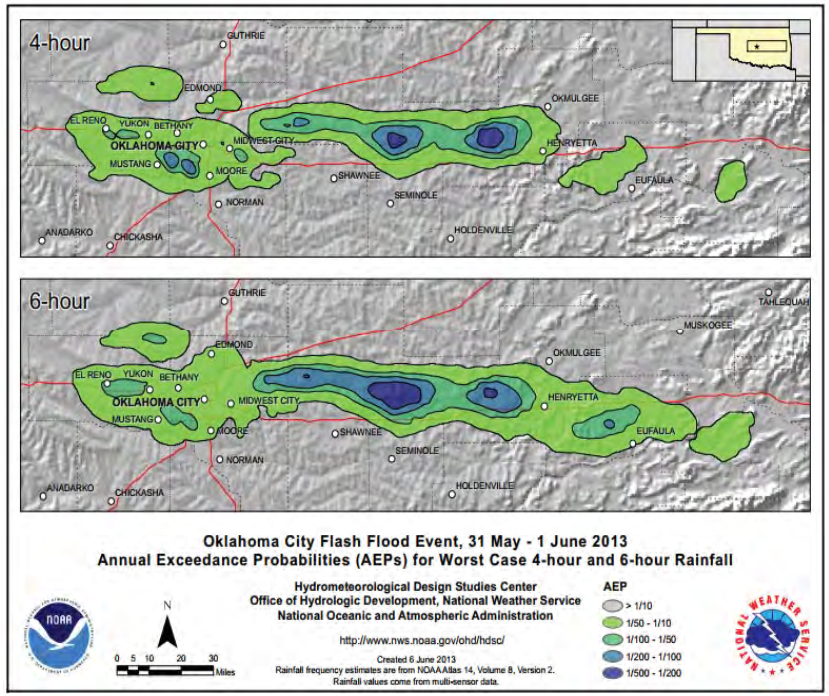
Relevant NWS publications

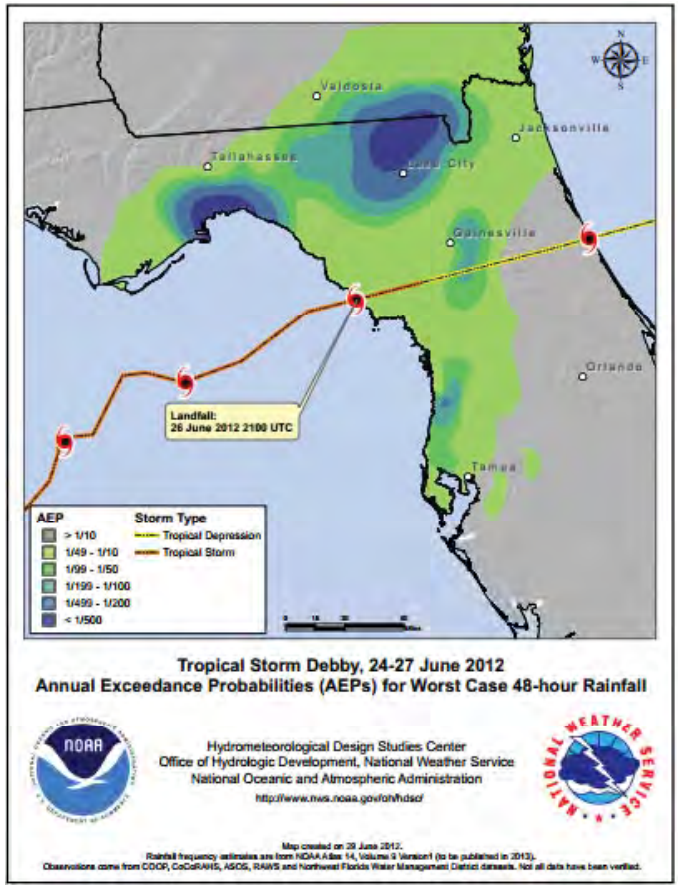
- U.S. Weather Bureau & NOAA Hydrometeorological Reports (1943 – 1999)
- Weather Bureau Technical Papers (1943 – 1966)
- Technical Reports (1967 - 1988)
  - ESSA TR Weather Bureau series (1967 - 1970)
  - NOAA TR NWS series (1971 - 1988)
- Technical Memoranda (1966 – 1995)
- NOAA Atlas 2 (1973)
- NOAA Atlas 14 (2004 – 2013)



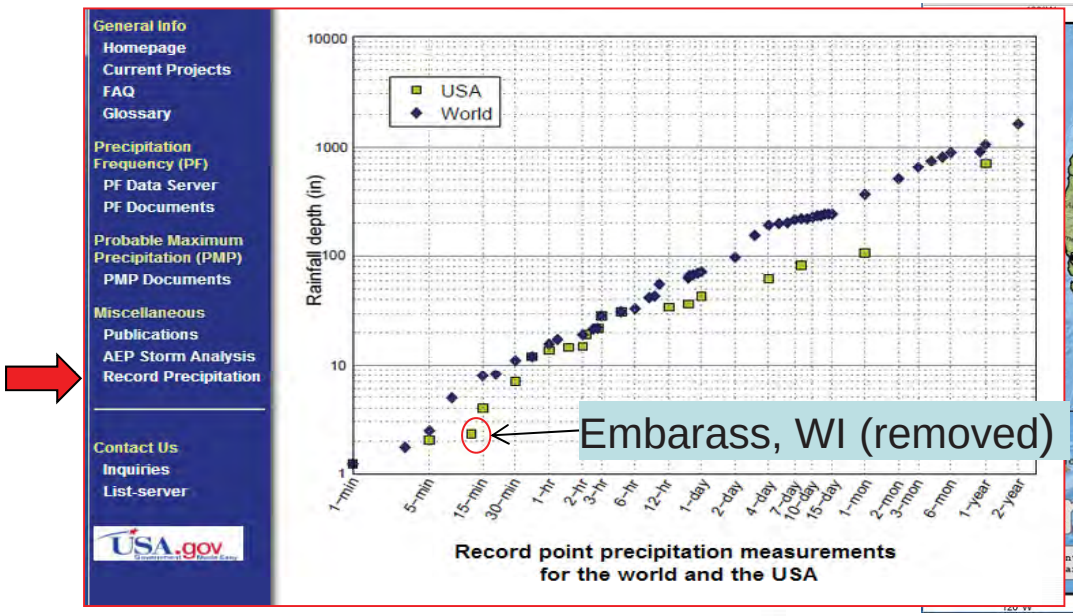
Prob. analysis for selected historical storm events

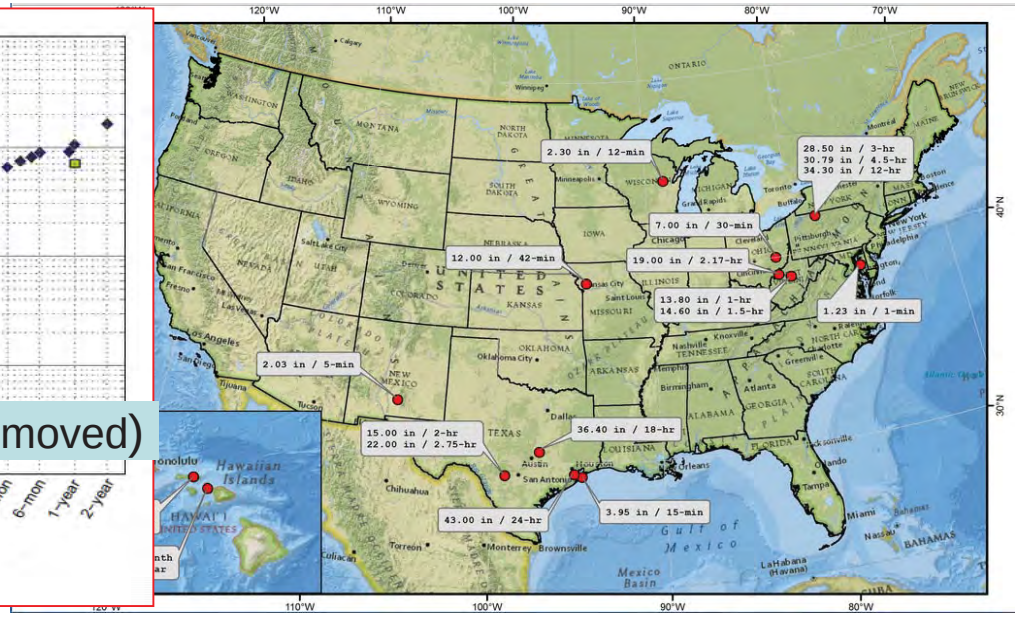
- Tennessee, 1-2 May 2010
- Duluth, Minnesota, 19-20 June 2012
- Tropical storm Debby, 24-27 June 2012
- Ohio Valley, 23-27 March 1913
- Oklahoma City, 31 May 2013
- San Antonio, 25 May 2013





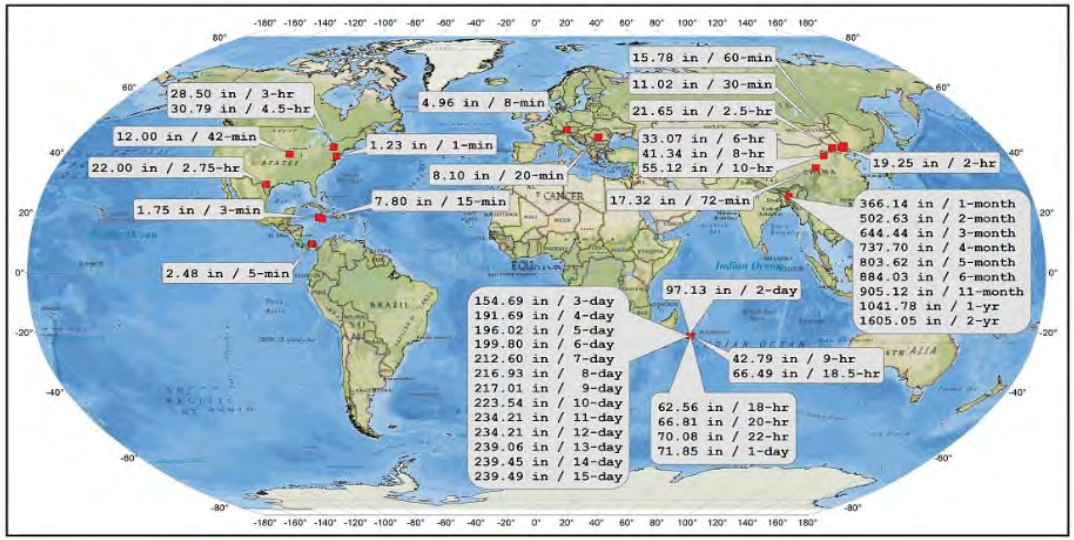
World and USA record precipitation





USA record point precipitation measurements

Duration	Amount (in)	Amount (mm)	Location	Lat (deg)	Lon (deg)	Start date	Ref
1-min	1.23	31	Unionville, Maryland	39.0	-76.133	4 Jul 1956	3,4,5
5-min	2.03	52	Alamogordo Creek, New Mexico	34.661	-104.387	5 Jun 1960	5
15-min	3.95	100	Galveston, Texas	29.29	-94.79	4 Jun 1871	5
30-min	7	178	Cambridge, Ohio	40.001	-81.578	16 Jul 1914	5



References (see web page)

1. National Climatic Data Center. *Climates of the World.*
2. Rapporteur on Climate Extremes, WMO.
3. Ohio Weather Library.

Additional information

General Info
- Homepage
- Current Projects
- FAQ
- Glossary

Precipitation Frequency (PF)
- PF Data Server
  - PF in GIS Format
  - PF Maps
  - Temporal Distr.
  - Time Series Data
  - PFDS Perform.
- PF Documents

Probable Maximum Precipitation (PMP)
- PMP Documents

Miscellaneous
- Publications
- AEP Storm Analysis
- Record Precipitation

Contact Us
- Inquiries
- List-server

Quarterly Progress Reports for Current HDSC Projects

FY 2013

- January - March 2013
- October - December 2012

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.

Major tasks

Data collection, formatting

- *For MW and SE projects, data collected and formatted for 25,695 stations maintained by 40 agencies*

Examination of geospatial data and station cleanup

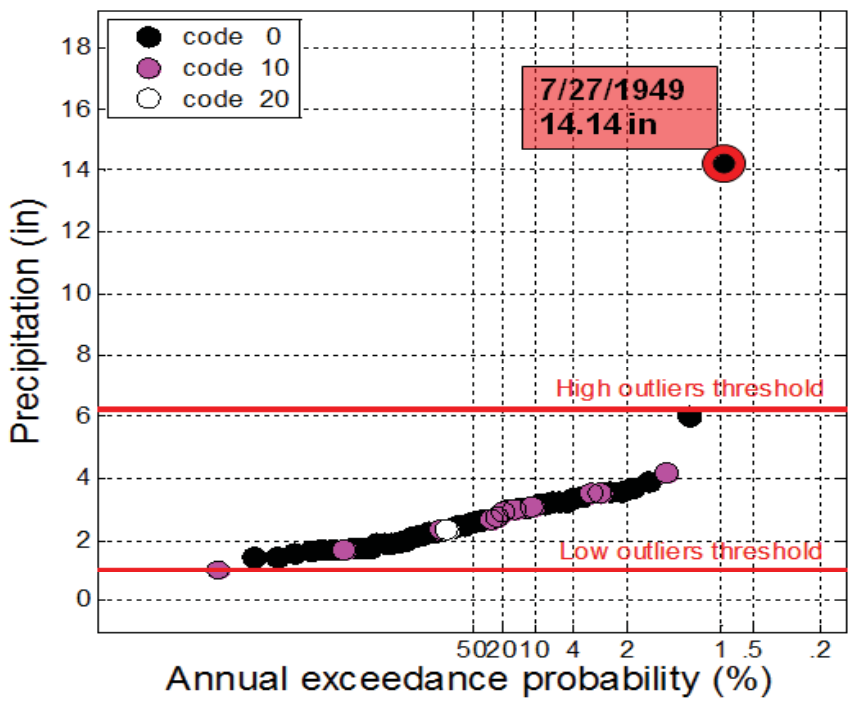
- *Confirming latitude, longitude and elevation data*
- *Screening for duplicate stations from different databases and duplicate records at co-located stations*
- *Extending records at longer-duration stations using data from co-located stations*
- *Screening nearby stations for potentially merging records*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

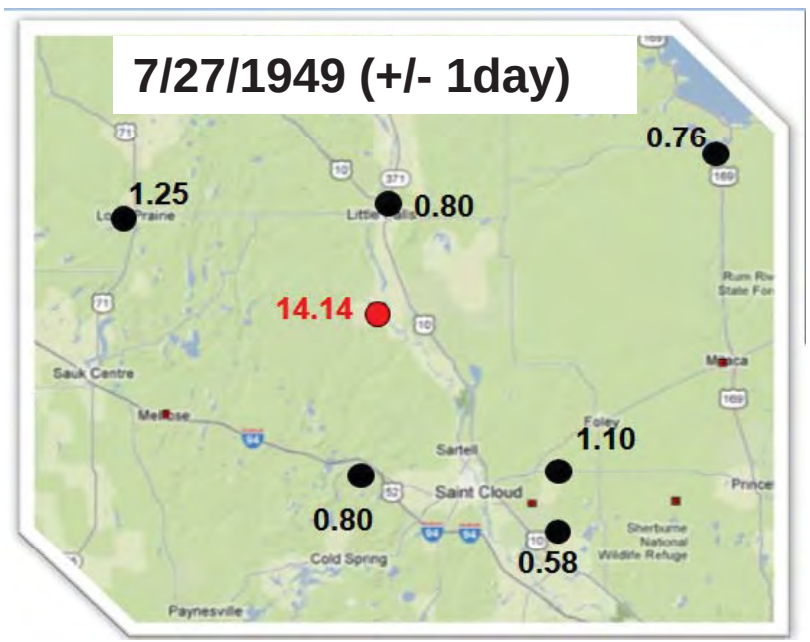
Major tasks:
AMS extraction and quality control

- 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

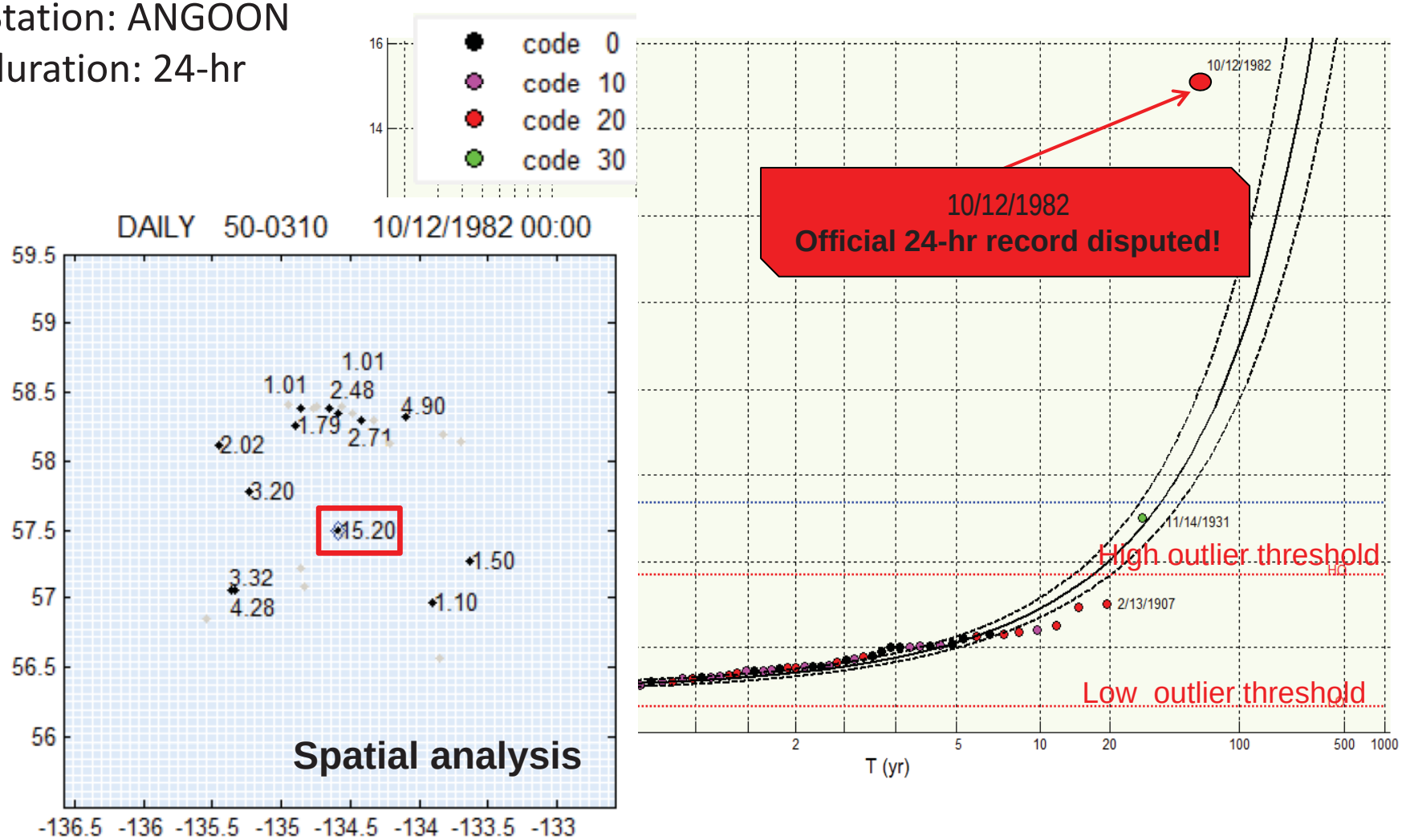
Example: Royalton 5W (21-7157), 1-day



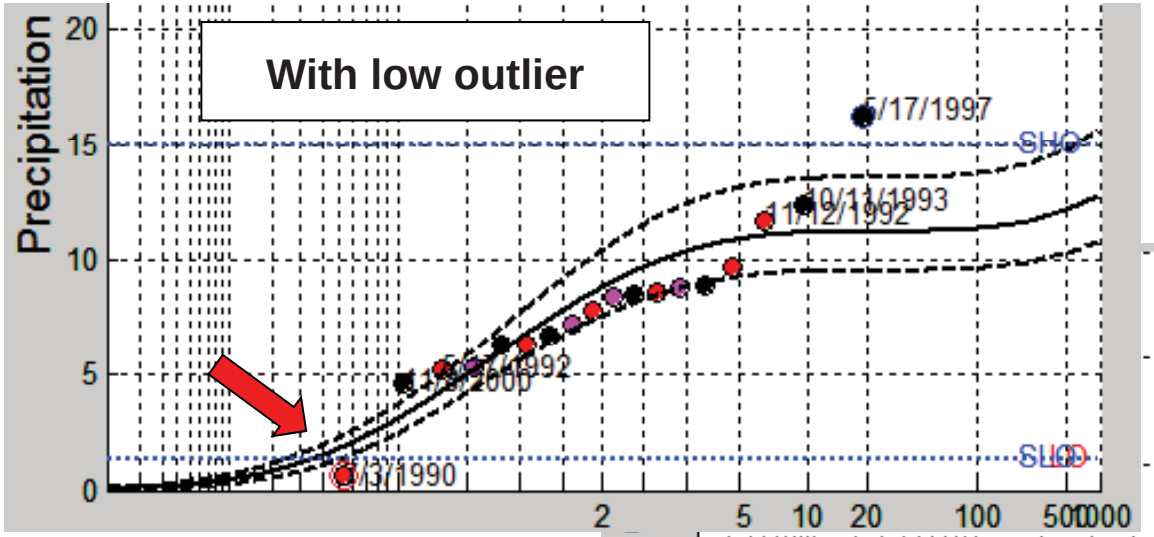


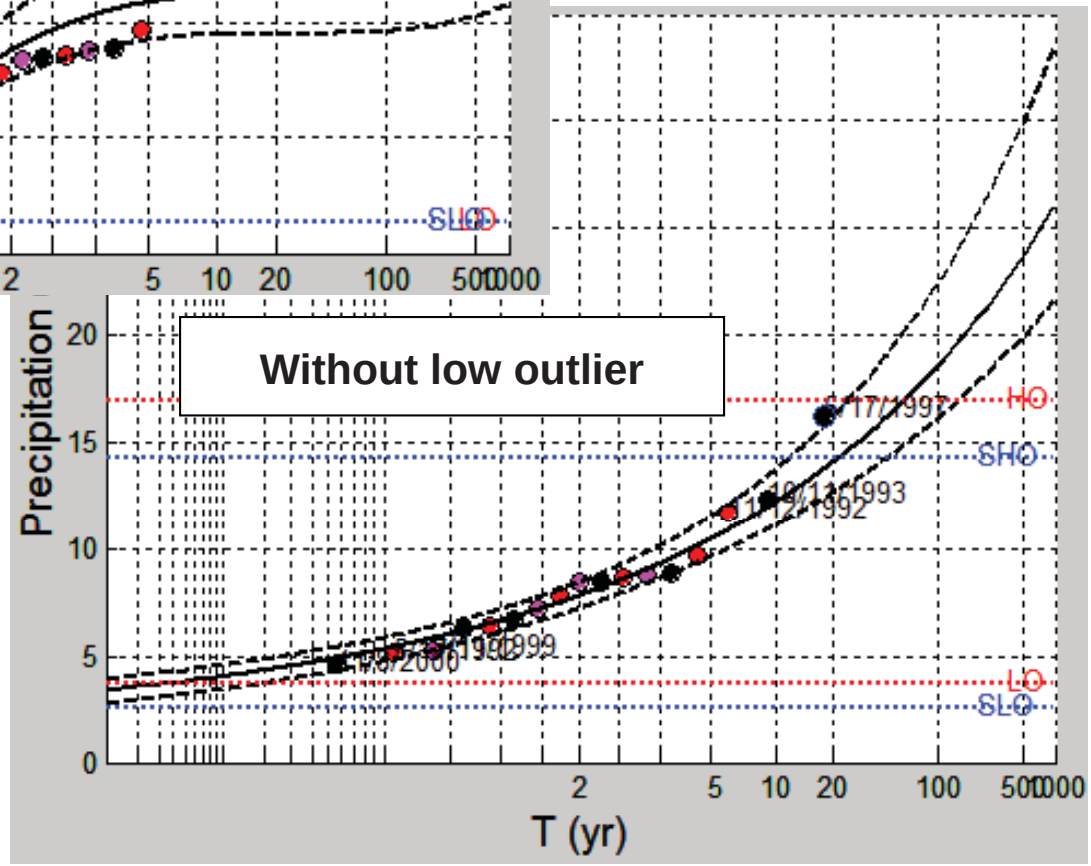
Major tasks:
AMS extraction and quality control

Station: ANGOON
duration: 24-hr



Major tasks:
AMS extraction and QC - Low outlier example





Precipitation frequency estimate for ARI (T):	With low outlier	Without low outlier
100 years	**12 in**	**18 in**
1000 years	**13 in**	**26 in**

Major tasks
Testing main assumptions

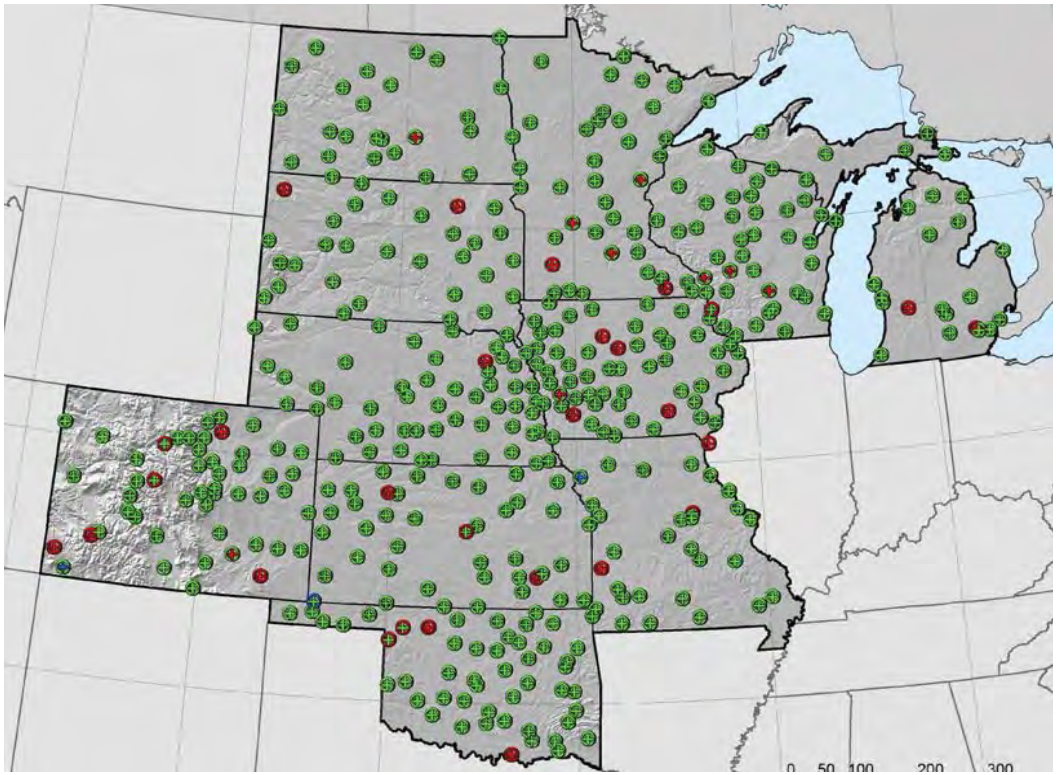
❑ NOAA 14 methods are based on the assumption of **spatial independence** and **stationarity** of AMS statistics over the period of observation (and application).

❑ **At-station analysis**

- Tests for trends in mean: parametric t-test, non-parametric Mann-Kendal test
- Levene's test for variance homogeneity
- Investigate spatial patterns

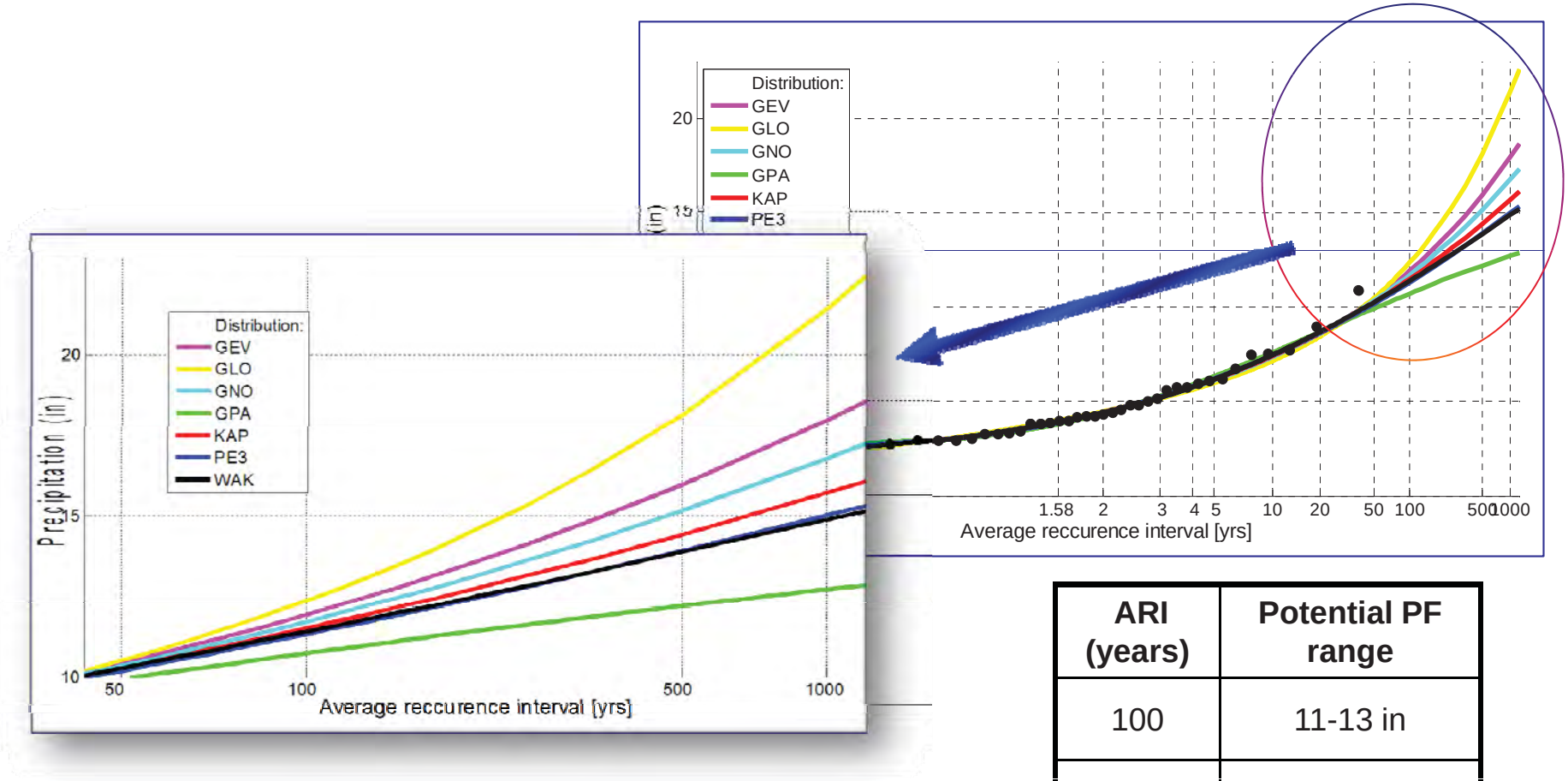
❑ **Regional analysis:**

- Normalize all AMS in a region
- Regress against time.
- Test H_0 : no serial correlation



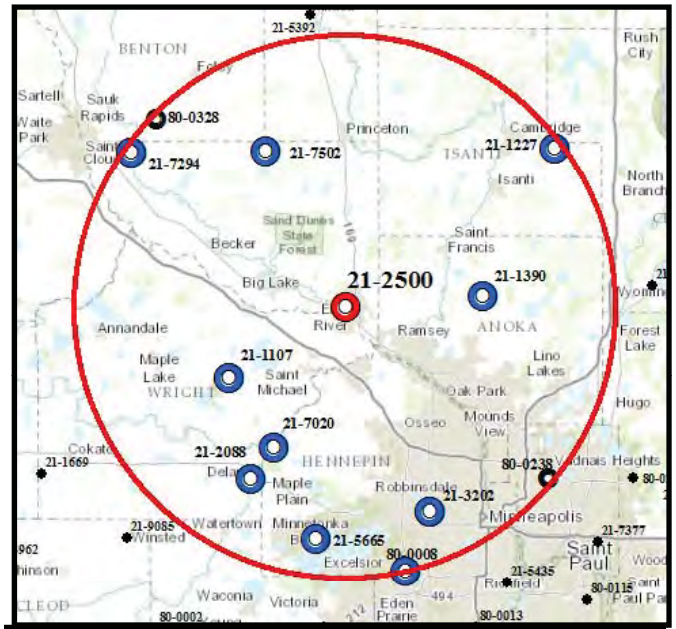
Major tasks
Distribution selection

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



ARI (years)	Potential PF range
100	11-13 in
1000	13 -22 in
10000	14 - 38 in

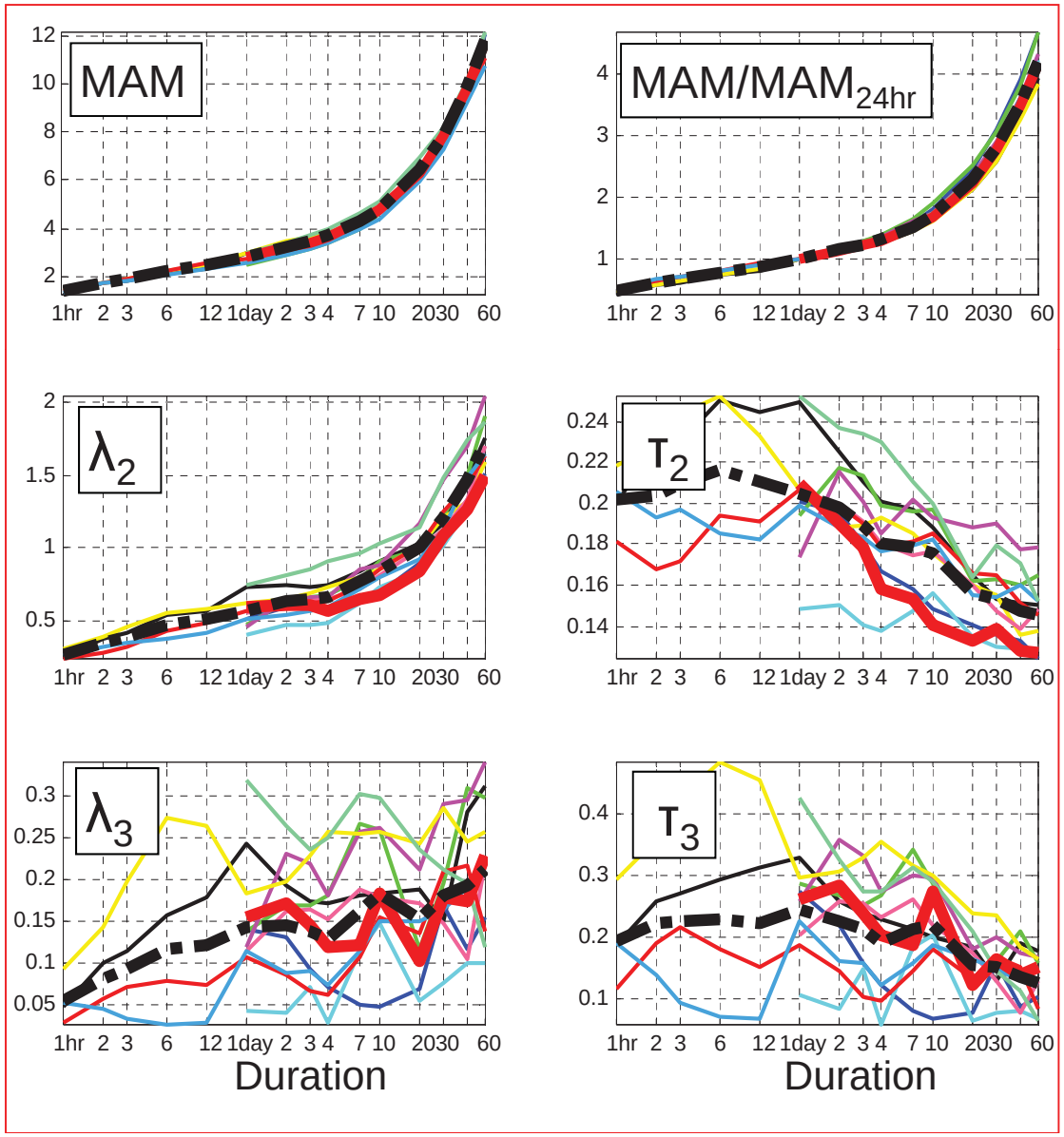
Major tasks
Derivation of regional L-moments



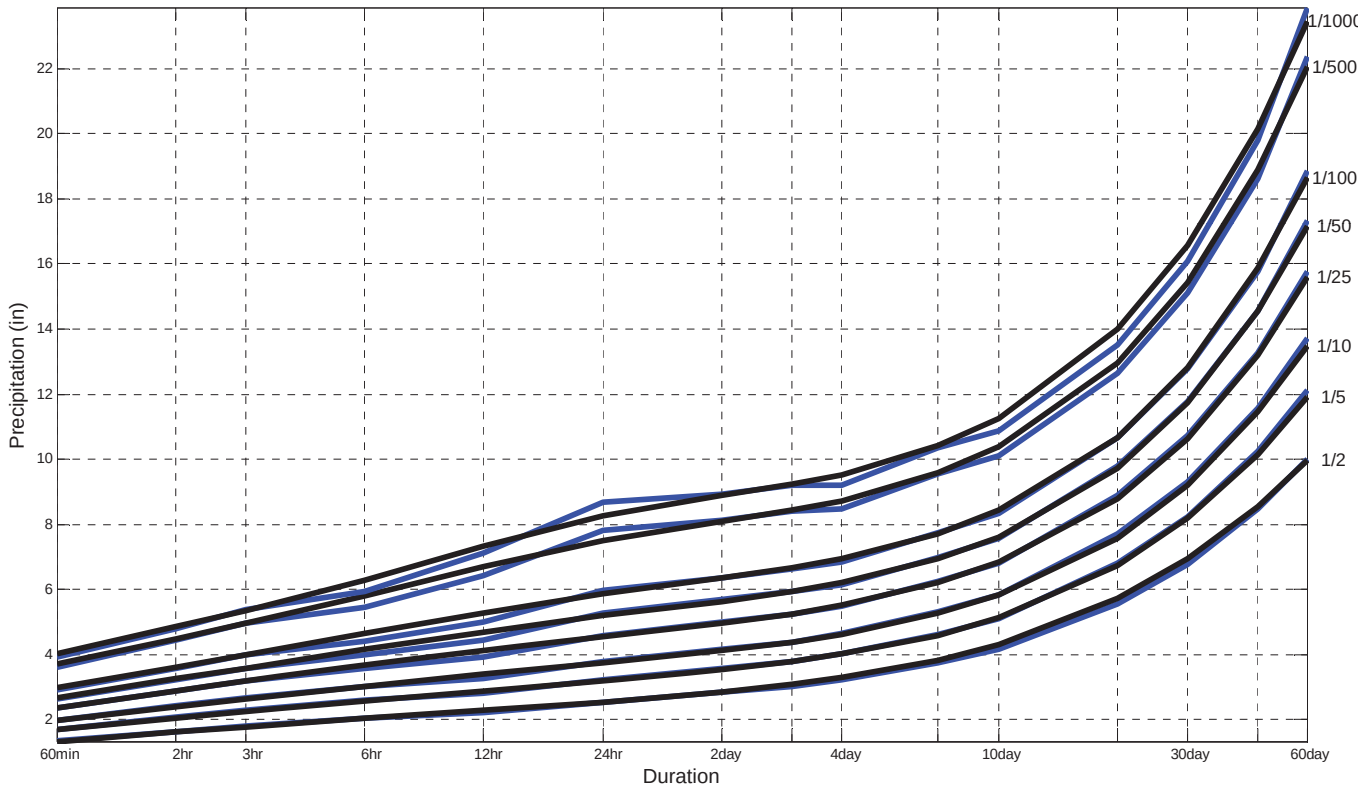
REGIONAL ANALYSIS FOR ELK RIVER (21-2500)

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:____



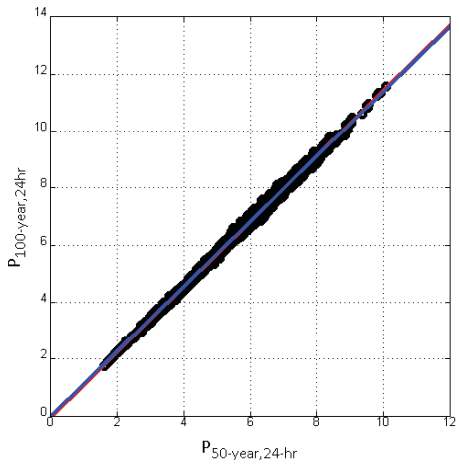
Major tasks:
At-station DDF curves – consistency checks

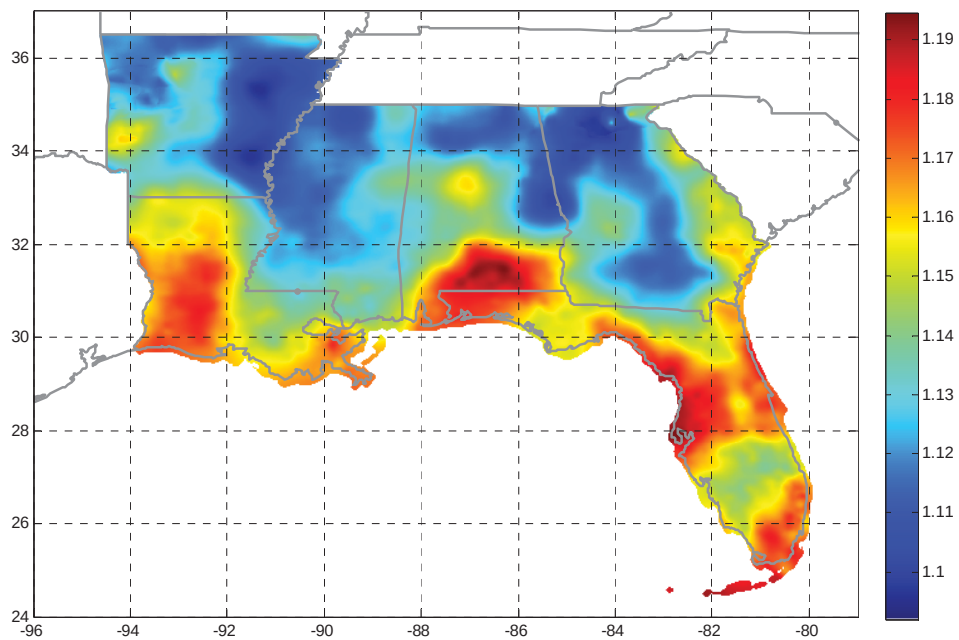


Major tasks:
PF interpolation at 30 arc-seconds resolution

- ❑ Mean annual maximum (MAM) precipitation grids 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.
- ❑ Evolution of frequency-dependent spatial patterns is independent for each duration
- ❑Process utilizes spatially interpolated ratios of precipitation frequency estimates for consecutive ARIs (natural neighbor interpolation - Delauney triangulation)

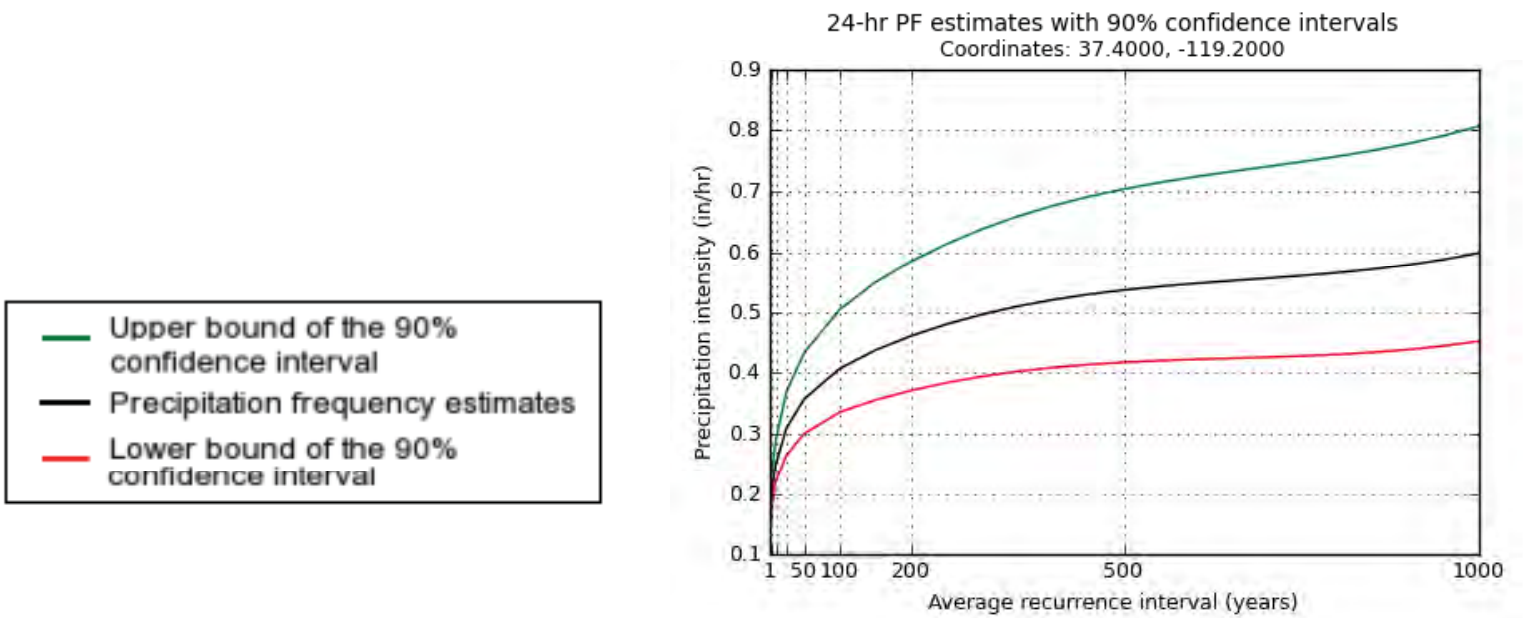
Example:
100-yr 24-hr
vs
50-yr 24-hr





Major tasks:
Confidence intervals

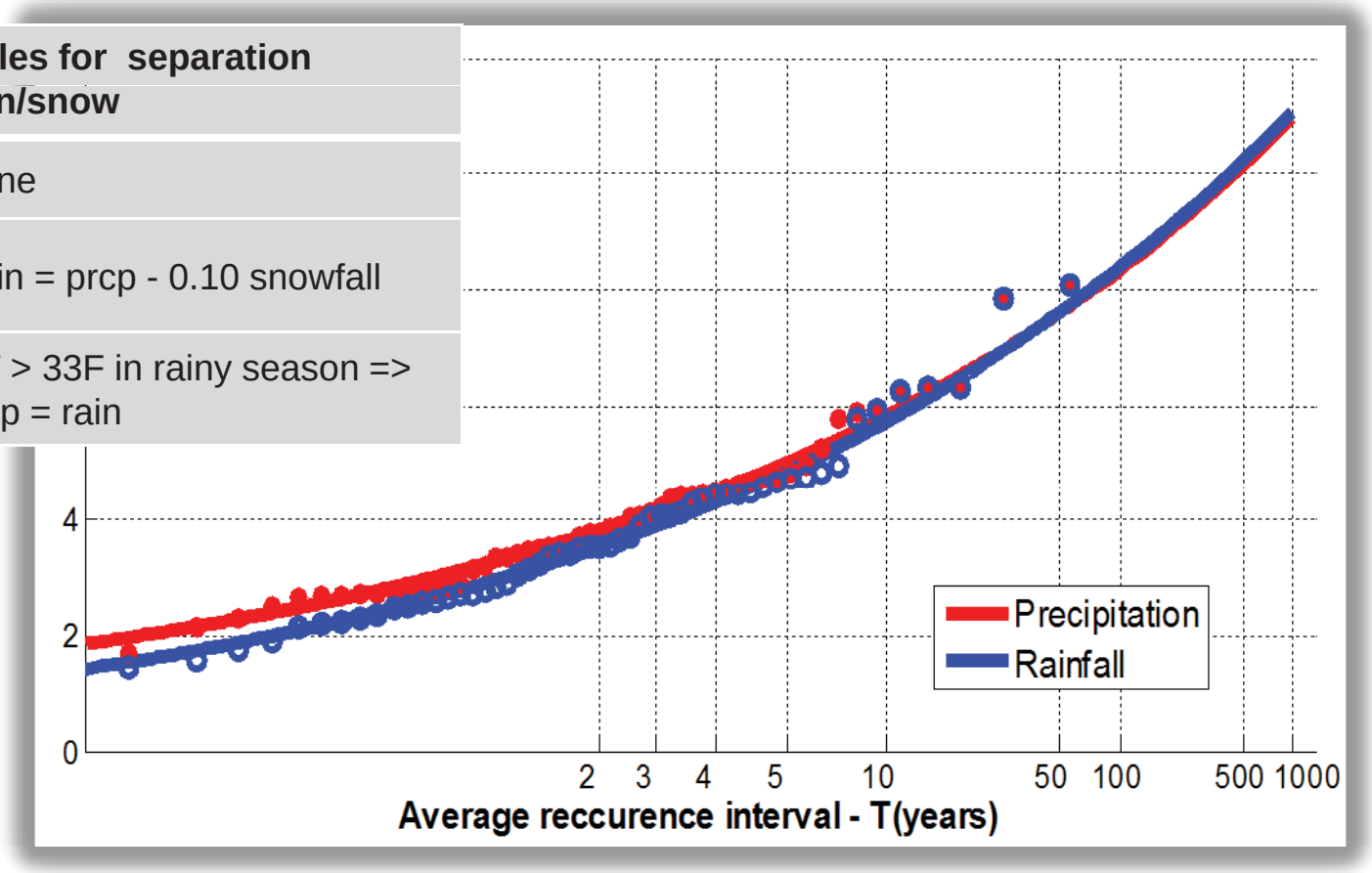
- ❑ Simulation used to construct 90% confidence intervals (i.e., 5% and 95% confidence limits) at stations.
- ❑ Algorithm adjusted to account for inter-station correlation.
- ❑ Estimates interpolated on 30 arc-sec grid.



Major tasks
Rainfall (liquid precipitation) frequency analysis

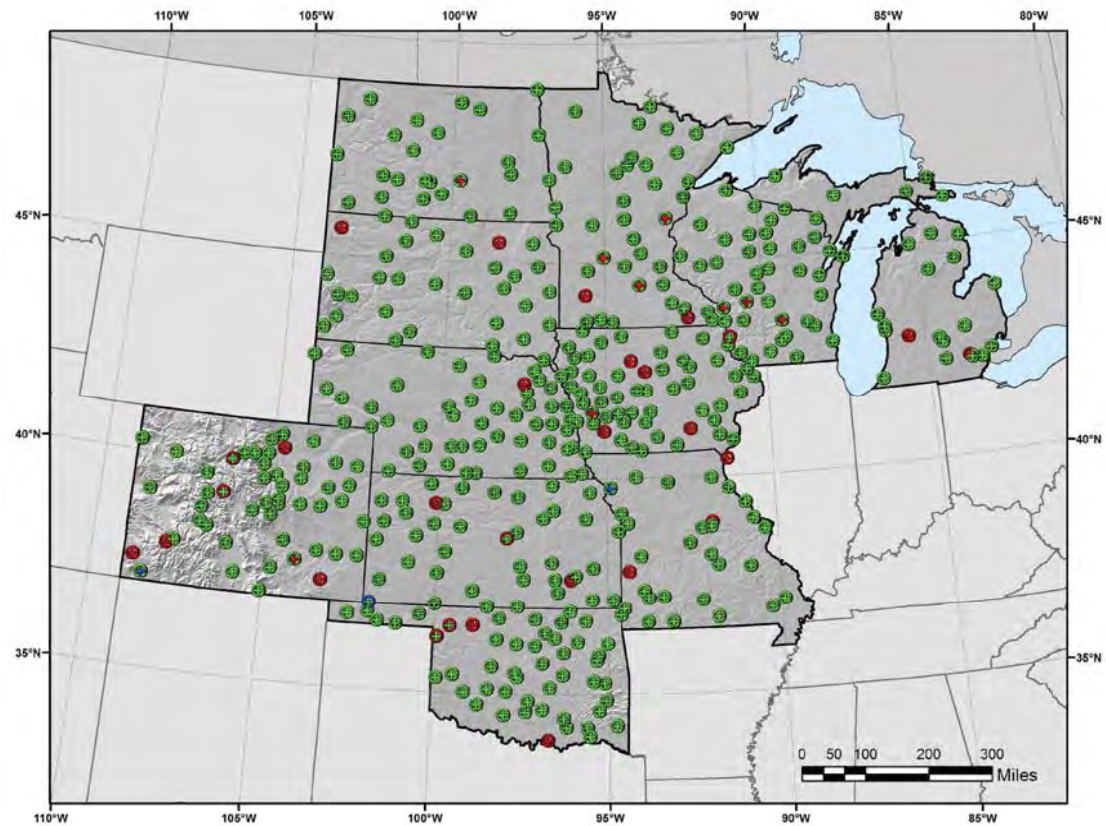
- Precipitation and rainfall AMS extracted for 1, 6,12, 24 hours
- Estimates for ARI = 2 - 1000 years
- Empirical relations developed for regions where estimates differ:

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

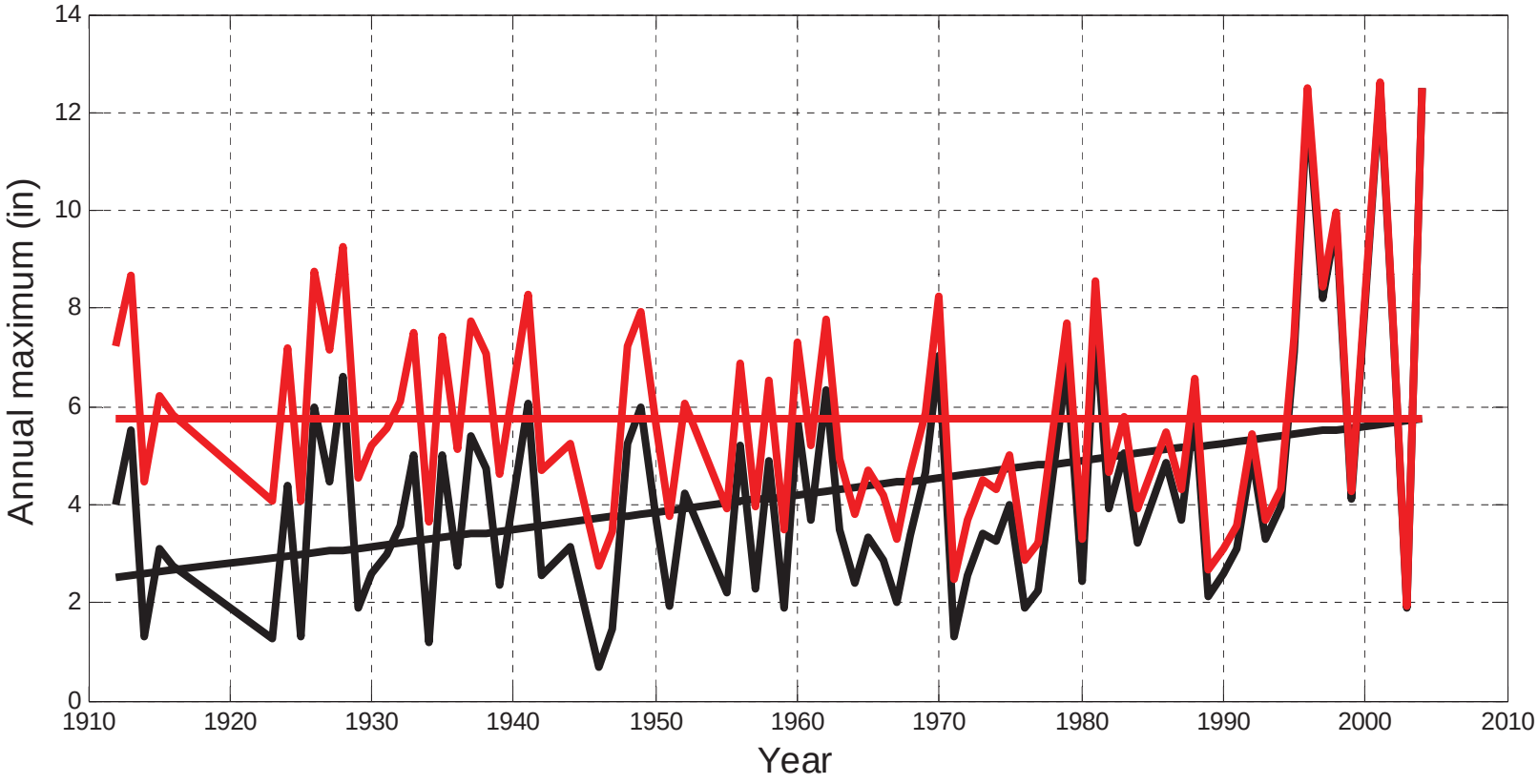


Accounting for non-stationarity using current approaches (AMS + MOM/PWM/MLE)

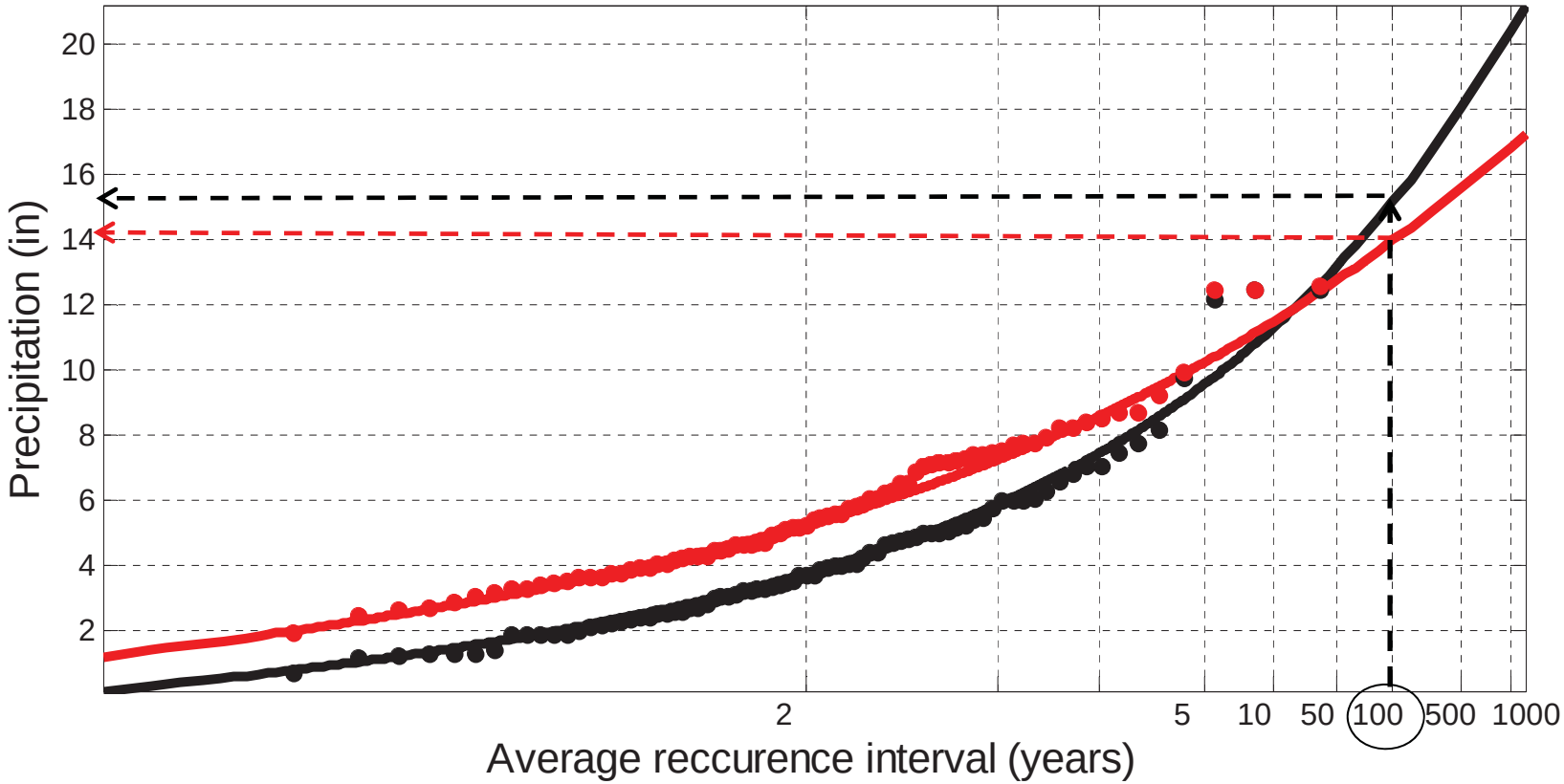
1. Should we adjust for trends in AMS at stations with trends, if no regional consistency?



Accounting for non-stationarity using current approaches
At-station analysis (AMS + MOM/PWM/MLE)



Accounting for non-stationarity using current approaches
At-station analysis (AMS + MOM/PWM/MLE)



Should we adjust? NO!

Accounting for non-stationarity in AMS
Incorporating trends

- **What approach to use?**
  - MOM and LMOM - cannot be generalized to incorporate trend
  - MLE approach – straightforward

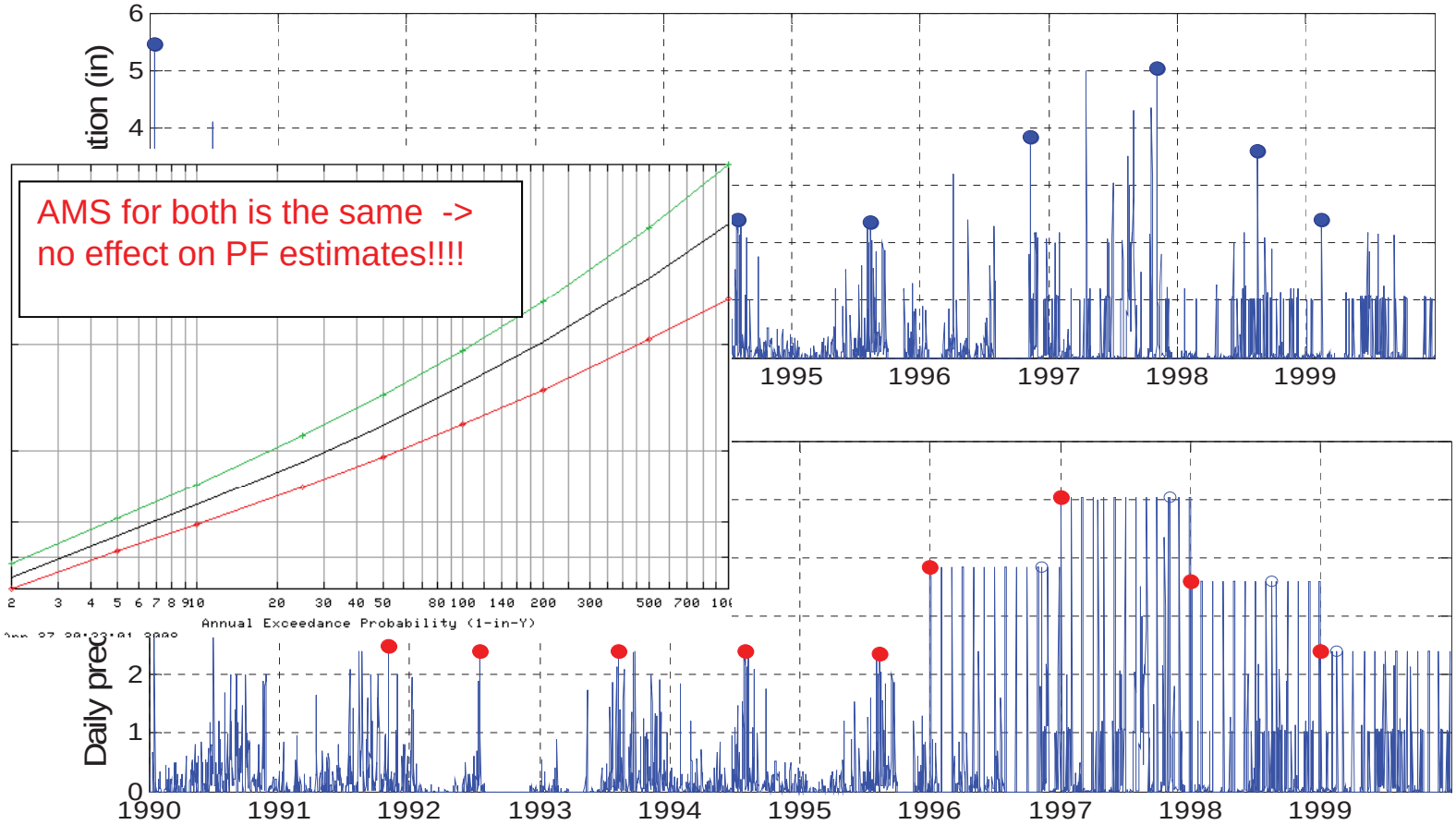
- **GEV distribution + MLE(t)**
  - build non-stationarity in mean only (scale and shape constant across the years)
  - build non-stationarity in all three parameters

- **Examples:** 100-year 24-hour estimates (inches) for stations with positive trends

LMOM	MLE	MLE(t)
13.0	13.5	13.7
15.0	20.0	20.7
17.1	16.6	16.8
14.6	17.3	17.6

- **Comparing effect of (non)-accounting for non-stationarity with other sources of uncertainty**
  - frequency analysis approach, distribution selection, parameter estimation method, gage undercatch, constrained observations, interpolation

Accounting for changes in magnitudes and frequencies



- **Solution: PDS +MLE$_t$?**

Areal reduction factors project
Methodology

- **Fixed-area and AM-center approaches**; not using storm-center approach applicable for PMP studies

- **3 types of methods tested**
  - method based on reconstruction of spatial correlation structures of rainfall within the Gaussian copula framework
  - method based on concepts of dynamic scaling and statistical self-affinity
  - method based on GEV distribution, where parameters defined as a function of area and duration.

Areal reduction factors project current status and future plans

- **Method comparison:**
  - Investigating uncertainties in ARF and sensitivity to parameters change
  - Input data: raingage data only vs. merged radar+gages grids
  - Testing basin: Ohio; plan to expand to all states covered in NA14

- **Enhancing interactive PFDS web page:**
  - Select outlet point on PFDS.
    Automatically delineate area and/or allow users to delineate area?
  - Calculate and display areal estimate for a given ARI and duration