



USGS ATLAS. BACKGROUND



1998. Asquith. DEPTH-DURATION FREQUENCY OF PRECIPITATION FOR TEXAS.

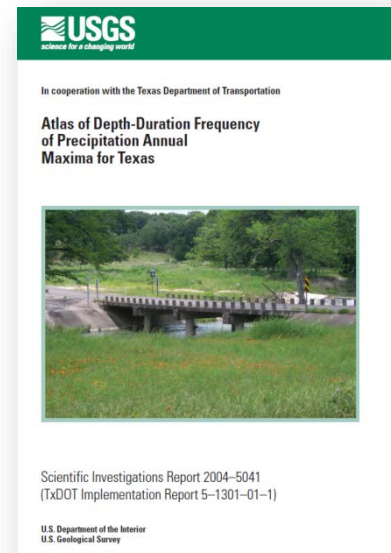
USGS Water-Resources Investigations Report 98–4044.

- *“Defines the depth-duration frequency (DDF) of rainfall annual maxima in Texas by providing an atlas of the parameters of probability distributions.”*
- *“Many TxDOT Design engineers have had greater-than-expected difficulty implementing the procedures ... The difficulty has delayed the implementation of the new precipitation data. develop a simple-to-use atlas of the updated precipitation depths in Texas for selected values of storm duration and frequency.” (From TxDOT Implementation Status, Project Summary Report 5-1301-01-S)*

2004. Asquith and Roussel. ATLAS OF DEPTH-DURATION FREQUENCY OF PRECIPITATION ANNUAL MAXIMA FOR TEXAS. USGS Scientific Investigations Report 2004–5041.

- *“Provides a directly interpretable atlas of DDF in Texas **on the basis of research results of Asquith (1998)**. The report contains 96 maps of the depth of rainfall for 12 storm durations and 8 annual nonexceedance probabilities (recurrence intervals).”*
- *GOALS: improve ease of use; resolve inconsistencies in estimates*
- *Data not updated for this project; in some areas regionalization done differently; at 1-day GEV replaced GLO.*

2006. Asquith, Roussel, Cleveland, Fang, and Thompson. Statistical characteristics of storm interevent time, depth, and duration for eastern New Mexico, Oklahoma, and Texas. USGS Professional Paper 1725.






- FINAL PRODUCTS
- UNDERLYING DATA
- FREQUENCY ANALYSIS TECHNIQUES

USGS
science for a changing world

In cooperation with the Texas Department of Transportation

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas



Scientific Investigations Report 2004-5041
(TxDOT Implementation Report 5-1301-01-1)

U.S. Department of the Interior
U.S. Geological Survey

Precipitation Frequency Data Server (PFDS)

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PF Documents

Probable Maximum Precipitation (PMP)
PMP Documents

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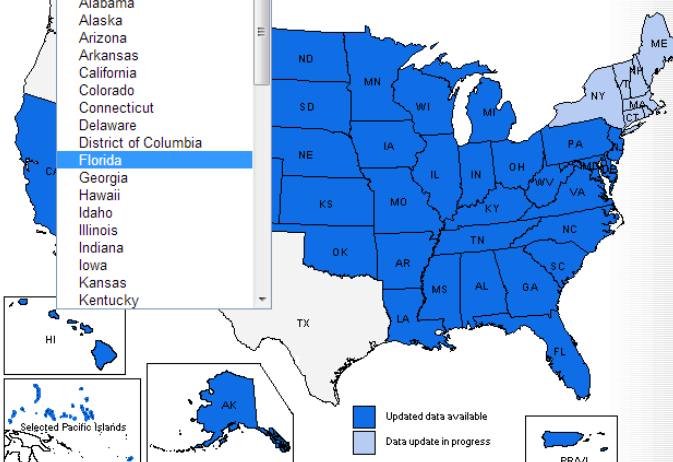
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State: Florida

Choose a state (or click map)

States

- Alabama
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- Delaware
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- Florida
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- Hawaii
- Idaho
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- Iowa
- Kansas
- Kentucky



Legend:
■ Updated data available
■ Data update in progress

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




1. AVAILABLE PRODUCTS

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In cooperation with the Texas Department of Transportation

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas



Scientific Investigations Report 2004-5041
(TxDOT Implementation Report 5-1301-01-1)

U.S. Department of the Interior
U.S. Geological Survey

Precipitation Frequency Data Server (PFDS)

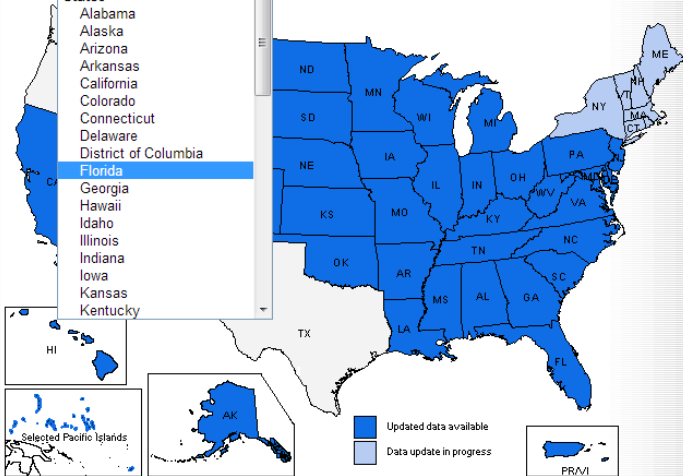
Home Site Map News Organization

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Choose a state (or click map)

States

- Alabama
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- Colorado
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- Delaware
- District of Columbia
- Florida**
- Georgia
- Hawaii
- Idaho
- Illinois
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- Kansas
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Updated data available
 Data update in progress

Selected Pacific Islands

AK HI PR/VI

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USGS ATLAS. Cartographic maps

82 Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

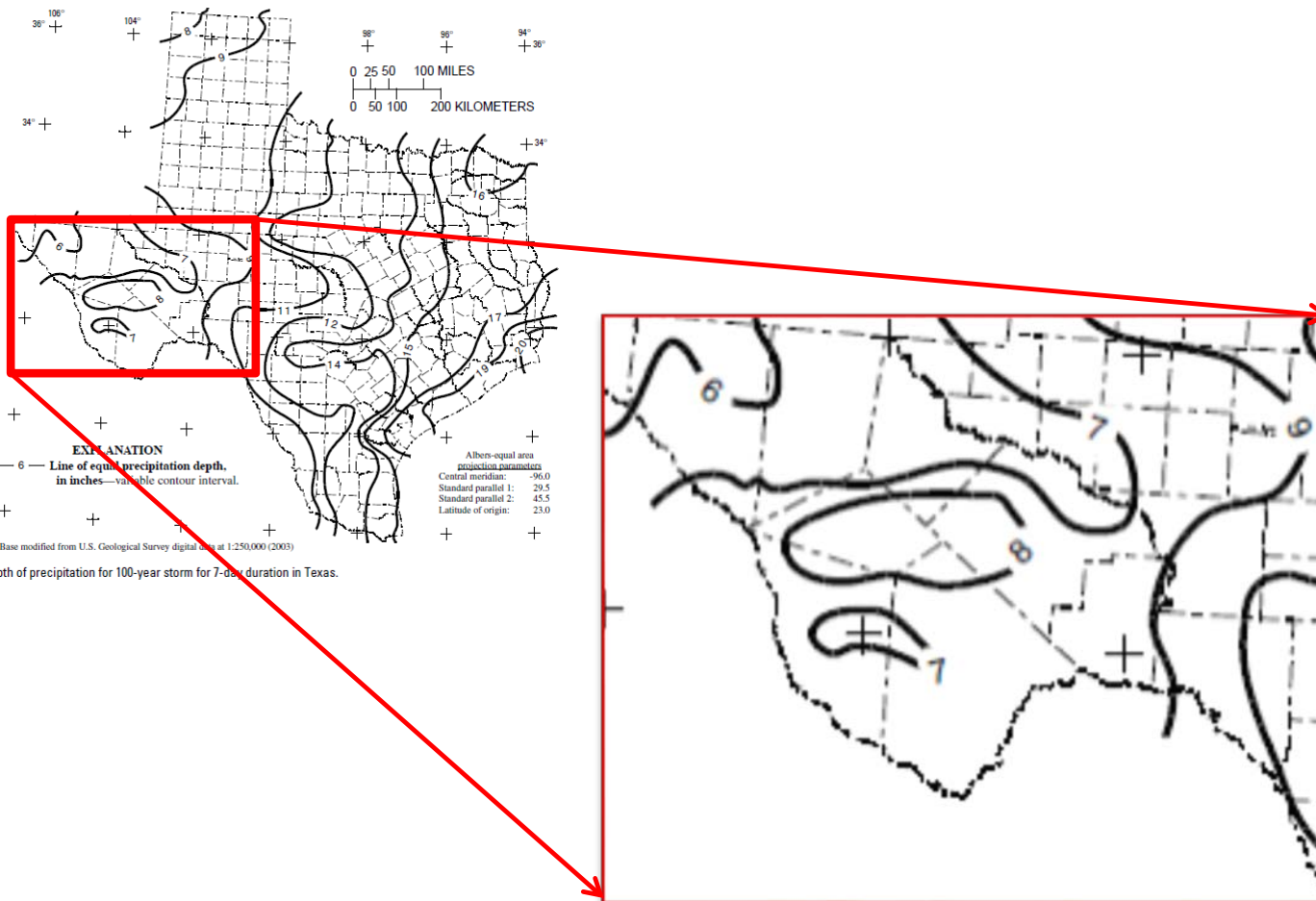


Figure 75. Depth of precipitation for 100-year storm for 7-day duration in Texas.

Figure 75. Depth of precipitation for 100-year storm for 7-day duration in Texas.



NA14. Cartographic maps



PF tabular

PF graphical

Supplementary information



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Precipitation

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Probable Maximum Precipitation (PMP)

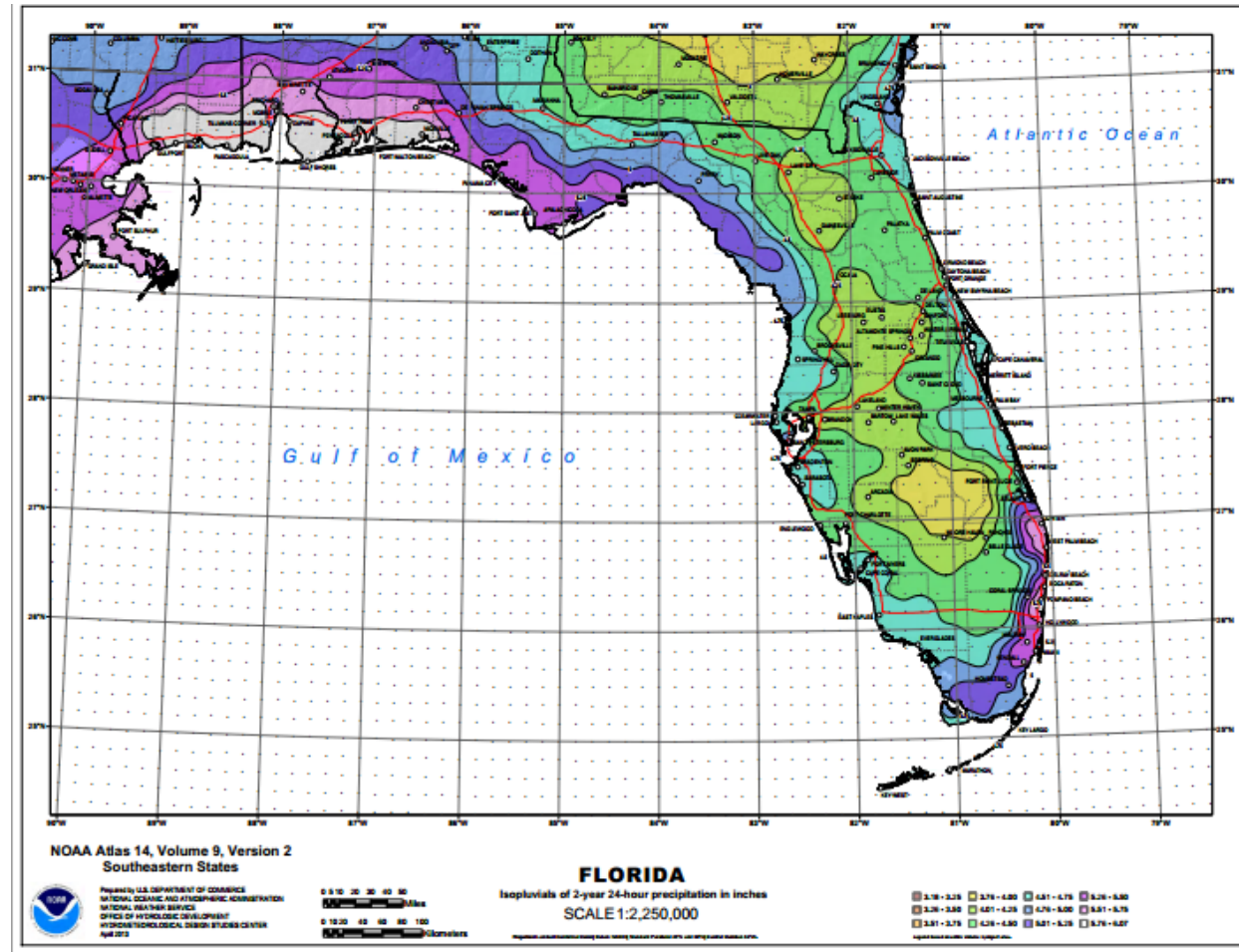
PMP Documents

Miscellaneous

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



NA 14. Underlying data



- ❑ PFDS operates from a set of ASCII grids (30-arc sec resolution)

**USGS
project
coverage**



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



NA14. Precipitation frequency estimates in GIS compatible format (30 arc-sec resolution)



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

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 7 (Alaska)

Type:

Precipitation frequency estimates

Series:

Partial duration series

Average recurrence interval:

2-year

Duration:

5-minute

NA 14. PF estimates for a single location



Initial display

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: FL

DATA DESCRIPTION

Data type: Units: Time series type:

SELECT LOCATION

1. Manually:
a) Enter location (decimal degrees, use "-" for S and W): latitude: longitude:
b) Select station (click here for a list of stations used in frequency analysis for FL):

2. Use map:

Map

a) Select location (move crosshair or double click)
b) Click on station icon (show stations on map)

LOCATION INFORMATION:
Name: Ocala, Florida, US*
Latitude: 29.1889
Longitude: -82.1403
Elevation: 71 ft*

* source: Google Maps



NA14. Zooming in...

Time Series Data

- PFDS Perform.
- PF Documents

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2. Use map:

Map

a) Select location
(move crosshair or double click)

b) Click on station icon
(show stations on map)

LOCATION INFORMATION:
Name: Tampa, Florida, US*
Latitude: 28.0319
Longitude: -82.5715
Elevation: 18 ft*

* source: Google Maps

Google 10 km 10 mi

Map data ©2013 Google - Terms of Use Report a map error

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 9, Version 2



NA14. ...retrieving PF estimate with confidence limits



PF tabular

PF graphical

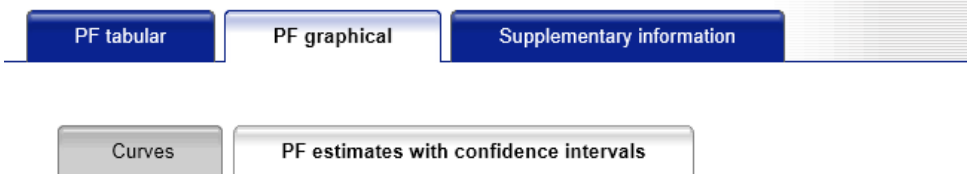
Supplementary information

Print Page

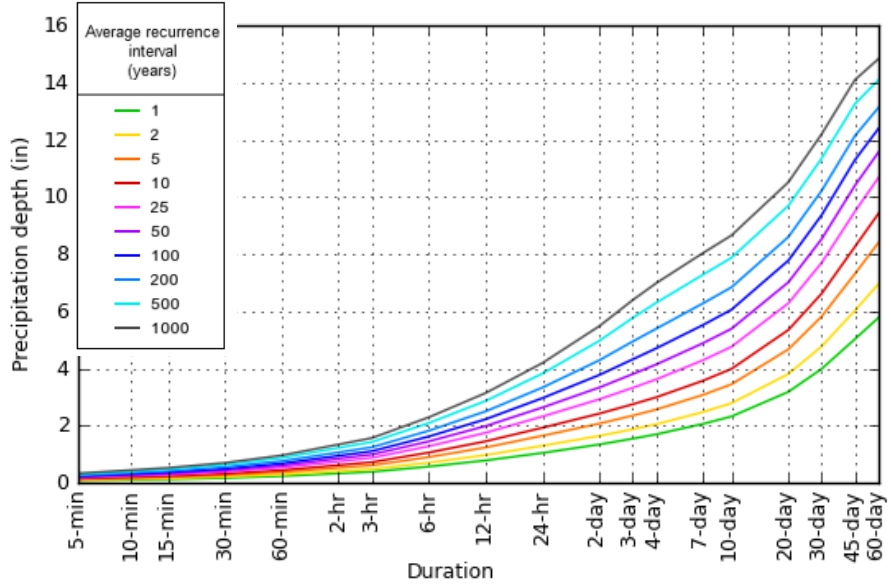
PDS-based precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.085 (0.065-0.113)	0.106 (0.080-0.143)	0.134 (0.100-0.184)	0.158 (0.116-0.220)	0.190 (0.137-0.270)	0.215 (0.152-0.310)	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 (0.229-0.473)	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 (0.269-0.553)	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 (0.359-0.735)	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 (0.479-1.01)	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)	0.967 (0.669-1.40)	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 (0.779-1.63)	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 (1.15-2.38)	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)	2.00 (1.45-2.80)	2.22 (1.61-3.05)	2.54 (1.81-3.53)	2.87 (1.94-4.35)	3.15 (2.09-4.84)
24-hr	1.06 (0.907-1.24)	1.31 (1.11-1.58)	1.66 (1.38-2.01)	1.91 (1.59-2.39)	2.23 (1.80-2.94)	2.54 (2.05-3.30)	2.97 (2.30-3.88)	3.25 (2.66-4.00)	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)	3.41 (2.76-4.30)	3.88 (3.15-5.00)	4.36 (3.57-5.66)	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)



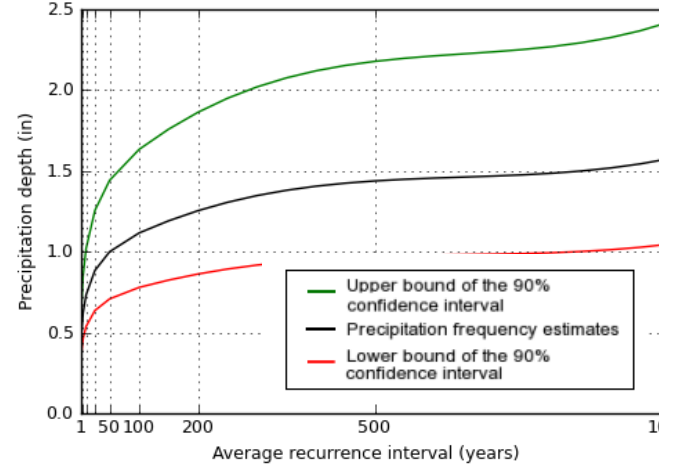
NA 14. DDF curves, confidence intervals plots



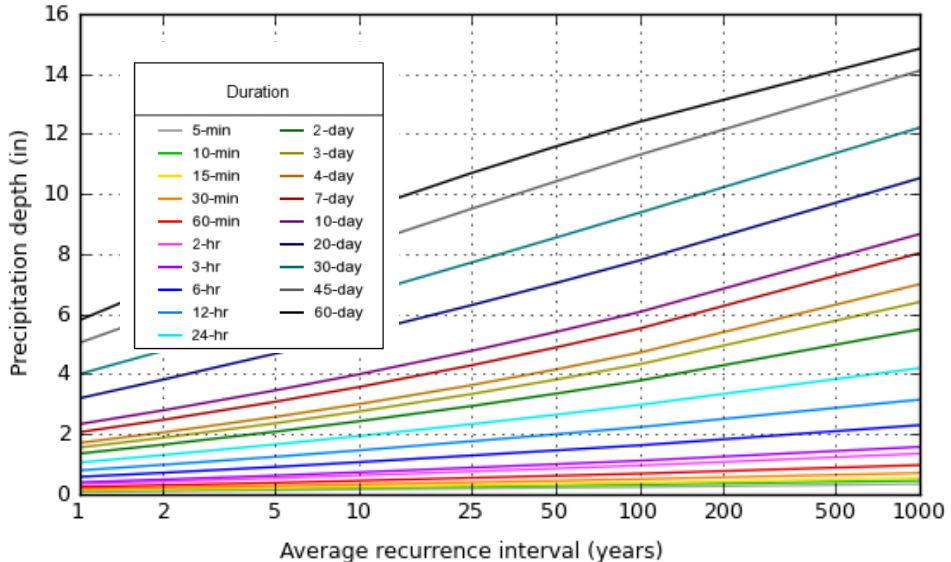
PDS-based depth-duration-frequency (DDF) curves
Coordinates: 61.1167, -149.7500



3-hr PF estimates with 90% confidence intervals
Coordinates: 61.1167, -149.7500



- 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





NA 14. Additional products



- Temporal distributions
- Seasonality analysis
- Rainfall (liquid precipitation) frequency estimates
- Annual maximum series data for a range of durations
- Related documentation
- Link to relevant NCDC climate data and EPA watershed information
- COMING SOON: Regional Areal-Reduction-Factors calculated on-fly for any delineated area




2. DATA

USGS
science for a changing world

In cooperation with the Texas Department of Transportation

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas



Scientific Investigations Report 2004-5041
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U.S. Department of the Interior
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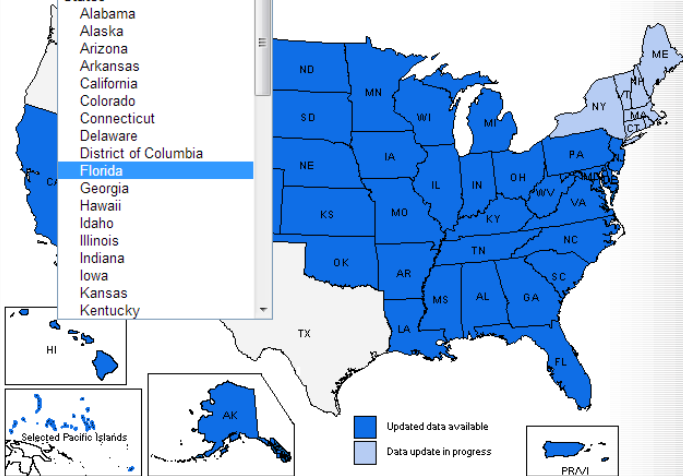
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Updated data available
 Data update in progress

Selected Pacific Islands

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Data collection



USGS: NWS dataset

- NOAA, National Climatic Data Center (NCDC)

NA14: various sources

(40 agencies for MWSE; 24 agencies for NE)

- NOAA, National Climatic Data Center (NCDC)
- Boston Water and Sewer Commission
- Earth Networks
- Environment Canada
- Illinois State Water Survey: National Atmospheric Deposition Program (NADP)
- Mid-Atlantic River Forecast Center: Integrated Flood Observing and Warning System (IFLOWS) data
- Midwestern Region Climate Center (MRCC): 19th Century Forts and Voluntary Observers Database
- Automated Surface Observing Systems (ASOS)
- Colorado Climate Center: (CoCoRaHS)
- Mount Washington Observatory
- NCDC: U.S. Climate Reference Network (USCRN)
- National Resources Conservation Service (NRCS): Soil Climate Analysis Network (SCAN)
- New Hampshire Department of Transportation
- Office of the New Jersey State Climatologist at Rutgers University: NJ Mesonet
- U.S. Department of Agriculture: Agricultural Research Service (ARS)
- U.S. Forest Service: Remote Automated Weather Stations (RAWS) dataset
- USGS Water Science Centers
- U.S. Army Corps of Engineers local offices
- New York City Department of Environmental Protection (NYCDEP)
- ...



Record lengths

Record length

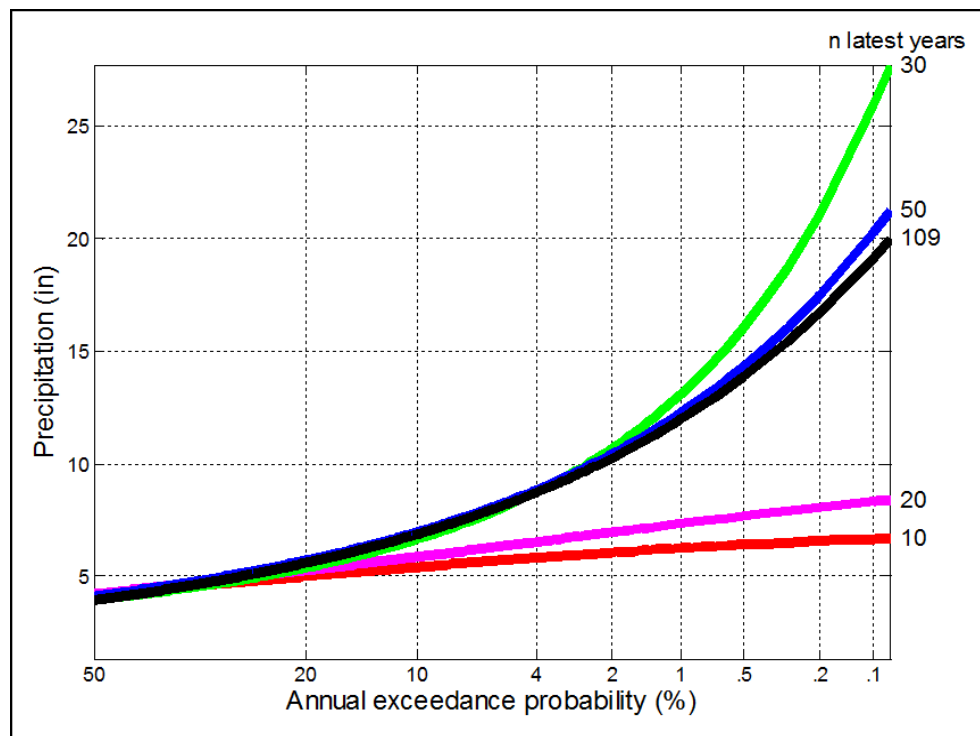
USGS: Data for 1998 USGS study go up to 1994.

NA14: Potentially more than 20 more years of data available at each station;
More stations pass minimum data years requirement

nyears criteria

USGS: nyears > 9

NA14: nyears > 29
(with some exceptions)



3. FREQUENCY ANALYSIS METHODS

In cooperation with the Texas Department of Transportation

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

Scientific Investigations Report 2004-5041
(TxDOT Implementation Report 5-1301-01-1)

U.S. Department of the Interior
U.S. Geological Survey

Precipitation Frequency Data Server (PFDS)

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Updated data available
Data update in progress
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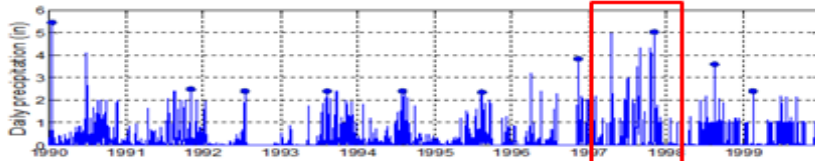
USGS: AMS-based regional frequency analysis approach based on L-moment statistics

NA14: AMS-based regional frequency analysis approach based on L-moment statistics

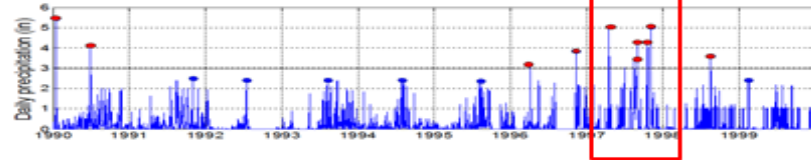
ARI vs AEP



AMS



PDS



AMS: Annual exceedance probability

PDS: Average recurrence interval (return period)

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 9, Version 2

PF tabular

PF graphical

Supplementary information

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AMS-based precipitation frequency estimates with 90% confidence intervals (in inches)¹

Duration	Annual exceedance probability (1/years)									
	1/2	1/5	1/10	1/25	1/50	1/100	1/200	1/500	1/1000	
24-hr	4.04 (3.46-4.74)	5.14 (4.39-6.06)	6.18 (5.23-7.32)	7.81 (6.47-9.92)	9.25 (7.41-11.9)	10.9 (8.33-14.4)	12.6 (9.24-17.3)	15.2 (10.6-21.6)	17.4 (11.7-24.8)	

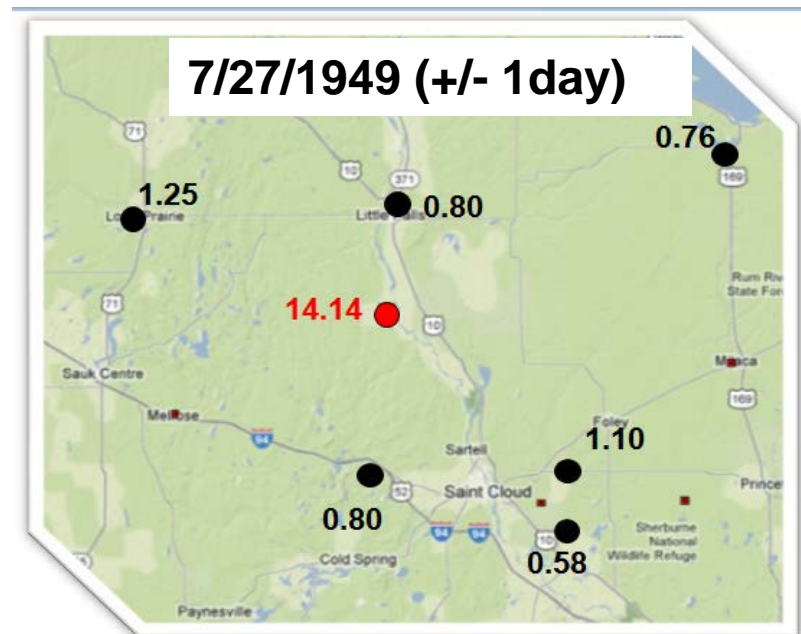
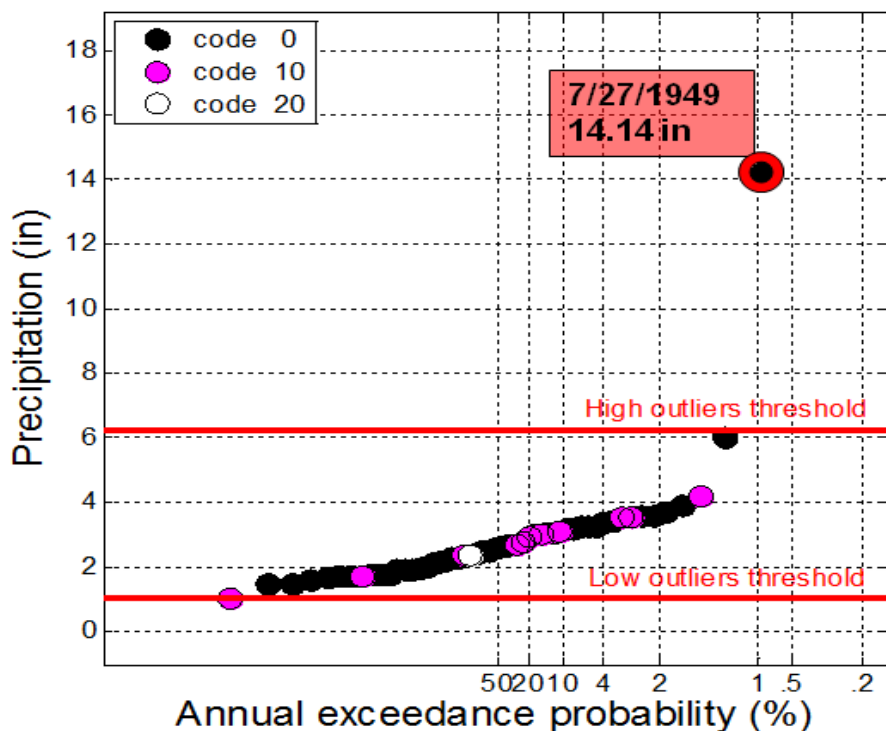
USGS

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
24-hr	3.81 (3.26-4.46)	4.30 (3.68-5.05)	5.28 (4.50-6.22)	6.26 (5.30-7.42)	7.85 (6.51-9.99)	9.27 (7.43-11.9)	10.9 (8.34-14.4)	12.6 (9.24-17.3)	15.2 (10.6-21.6)	17.4 (11.7-24.8)

NA14

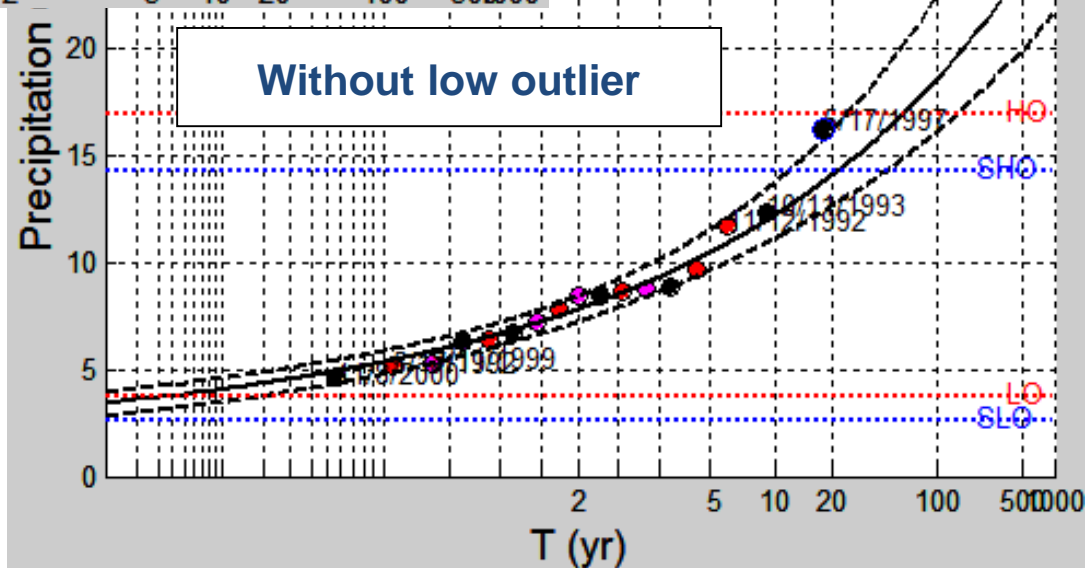
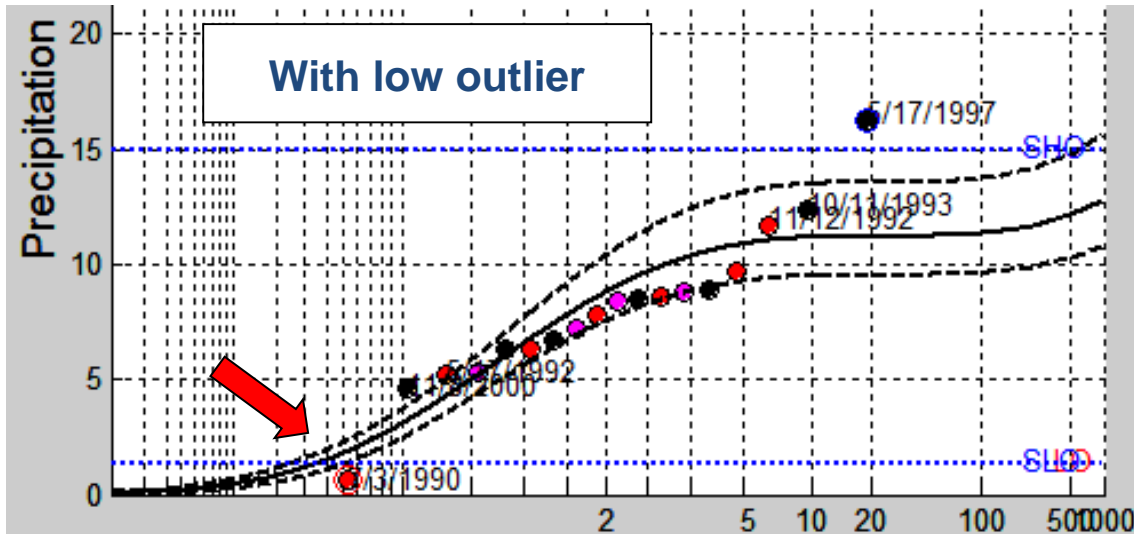
- USGS?
- NA14: QC done for all durations; high and low outliers



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



AMS QC - Low outlier example

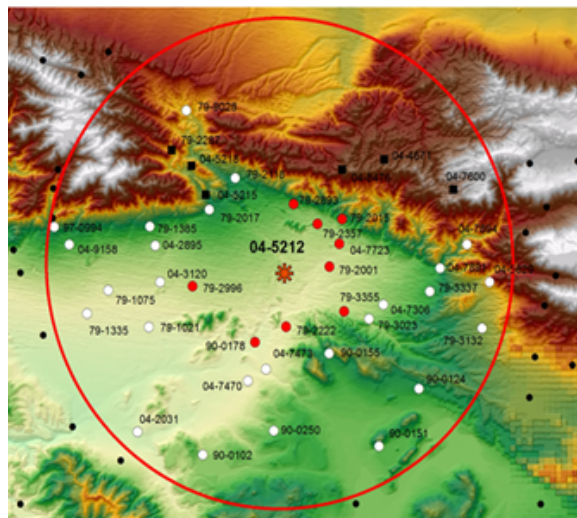


Precipitation frequency estimate for ARI (T):	With low outlier	Without low outlier
100 years	12 in	18 in
1000 years	13 in	26 in

Derivation of regional L-moments

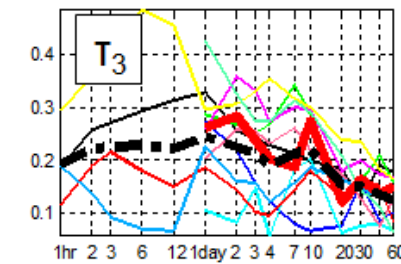
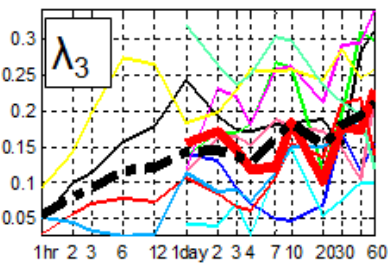
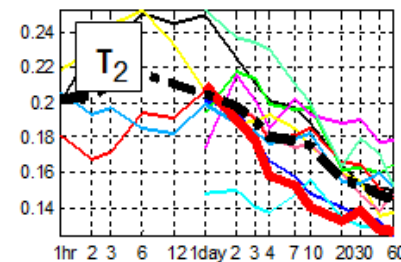
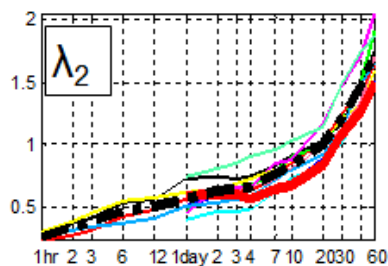
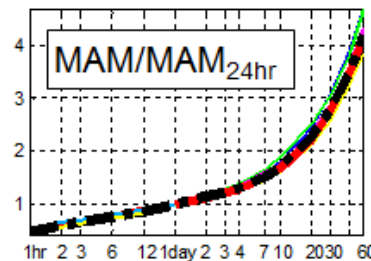
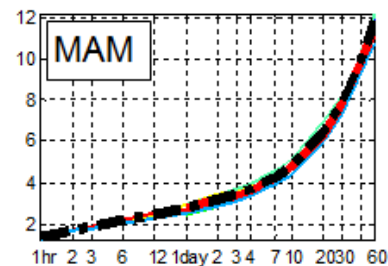
USGS: 5 (closest?) stations

NA14:



Enter stations you want to add or remove from the 04-5212 region: _____

Station ID	Distance (mi)	Elev (ft)	Elev difference (ft)	MAM (in)	MAM difference (in)	Daily	Monthly
Suggested stations (diamond for target station; red circles for stations in its region)							
04-5212	-	1160	-	2.36	-	61	0
79-2001	3.84	1047	-113	1.88	-0.48	51	51
79-2222	4.96	945	-215	1.72	-0.64	44	44
79-2357	5.33	1288	128	2.74	0.39	31	30
04-7723	5.37	1140	-20	2.39	0.04	105	30
79-3355	6.13	1193	33	1.70	-0.66	26	26
79-2893	6.42	1525	365	2.78	0.42	27	27
90-0178	6.84	800	-360	1.86	-0.49	45	45
79-2015	6.97	1747	587	2.84	0.49	46	46
79-2996	7.81	1115	-45	2.27	-0.09	32	33
Region:						468	333
Additional stations in 2-mile radius that passed geographic criteria (white circles)							
79-3023	8.28	1285	125	2.01	-0.34	45	46
Etc.							



Duration

Duration



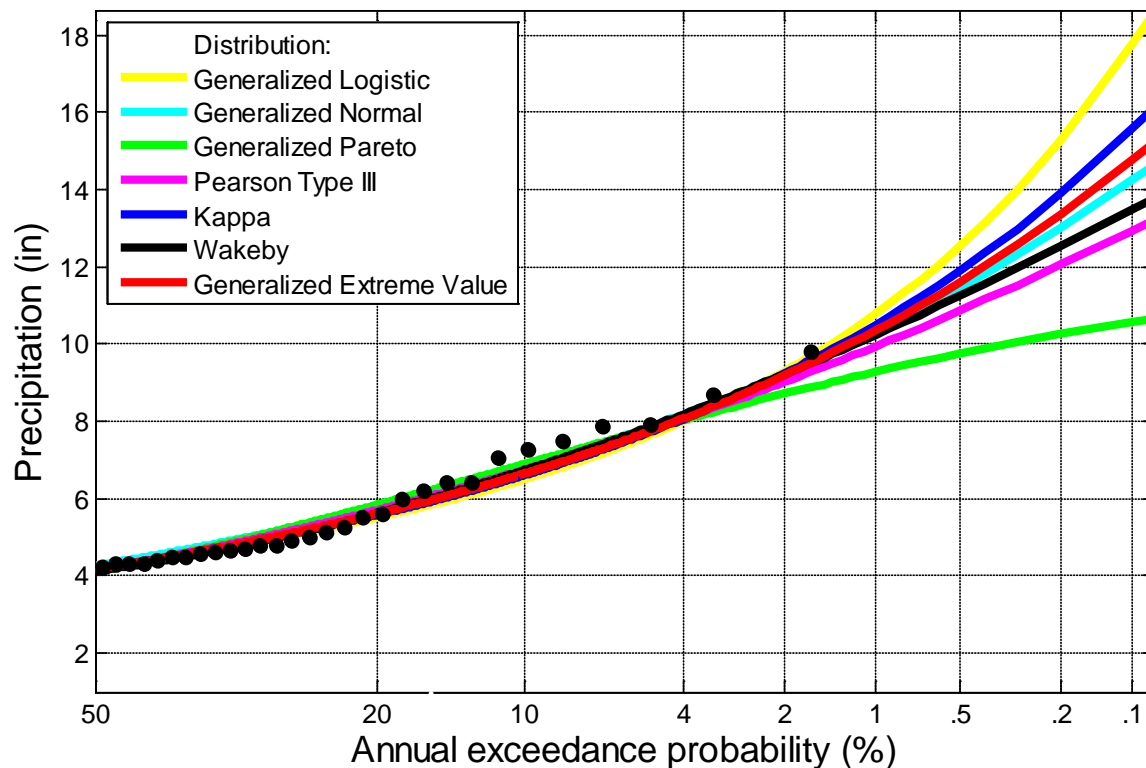
Distribution selection and fitting



USGS: GLO for 15min – 24hr; GEV for 1day – 7 day (1998)

GLO for 15min – 12hr; GEV for other durations (2004)

NA14: GEV for all durations



ARI (years)	Potential PF range
100	9.5 - 11 in
1000	10.5 - 18 in

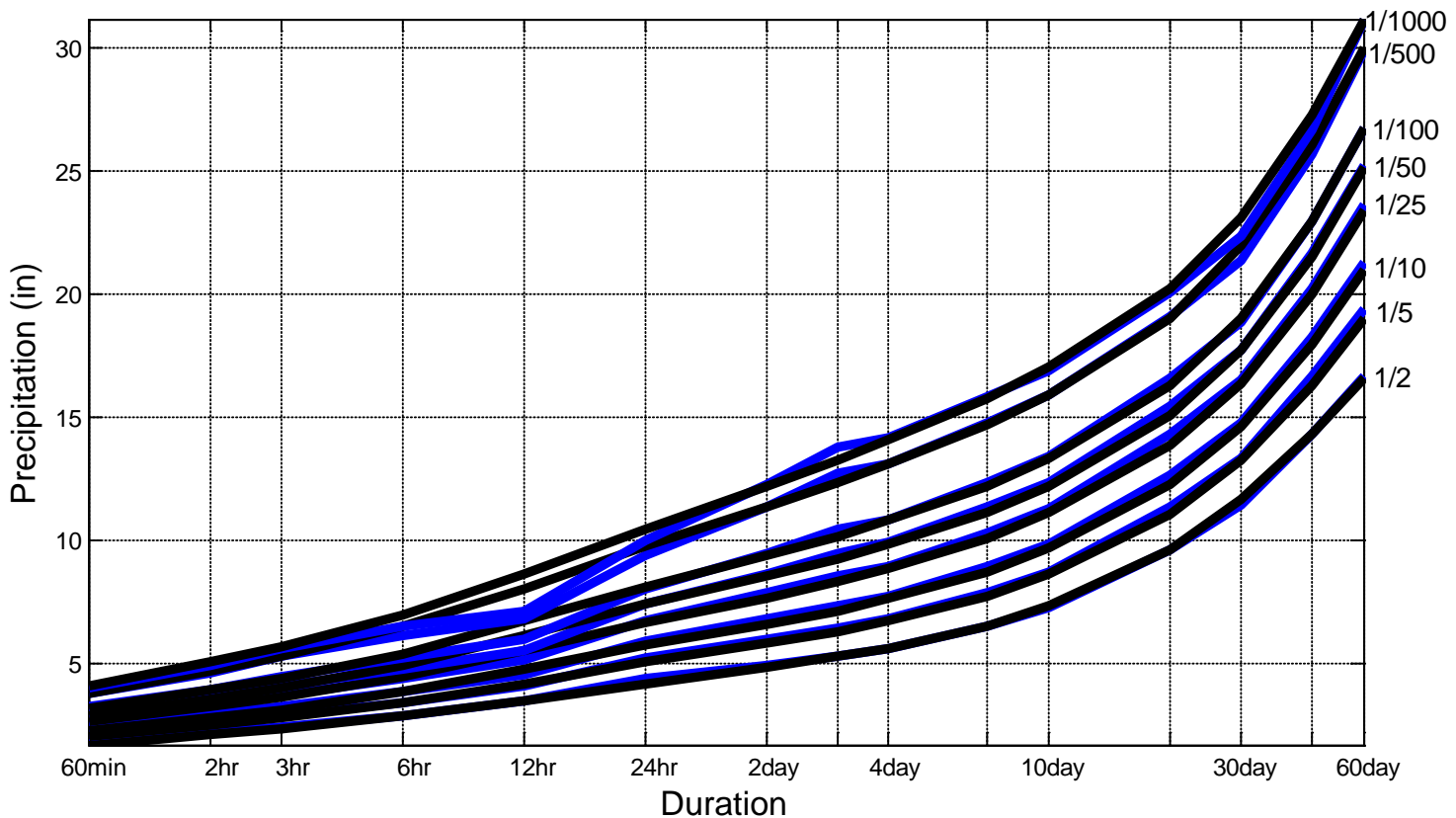


At-station DDF curves – consistency check



USGS: consistency checked in 2004 study

NA14: constrained optimization used to adjust inconsistencies





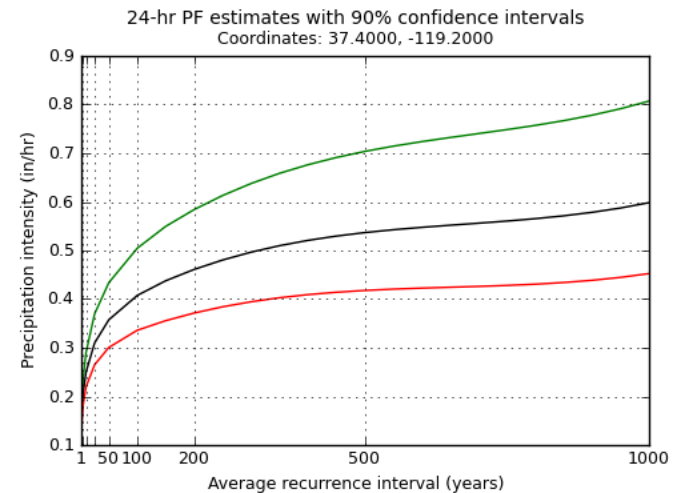
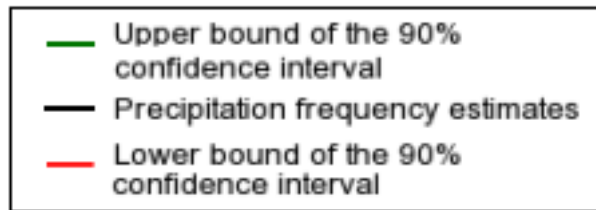
Confidence limits



USGS: not provided

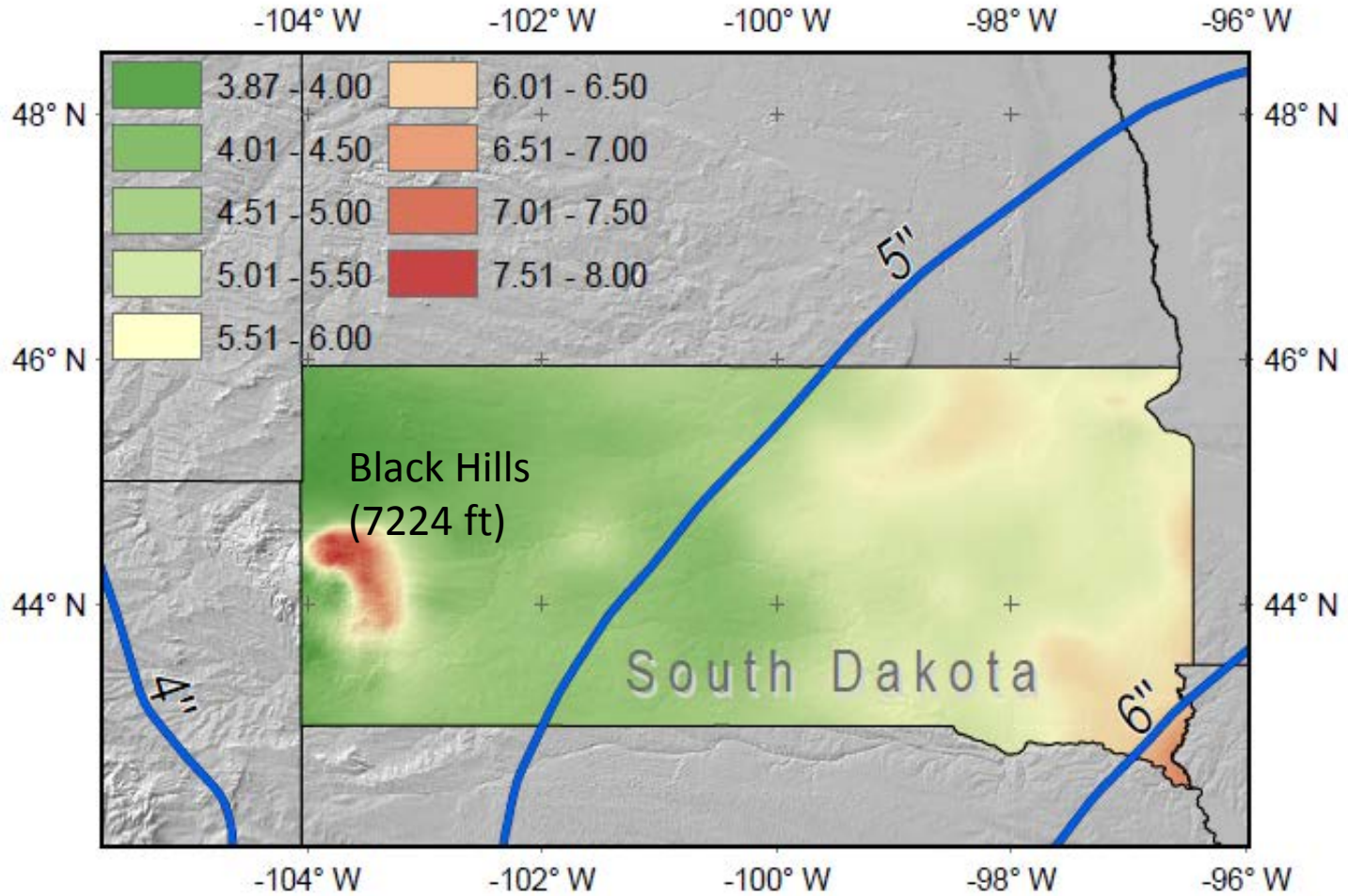
NA14:

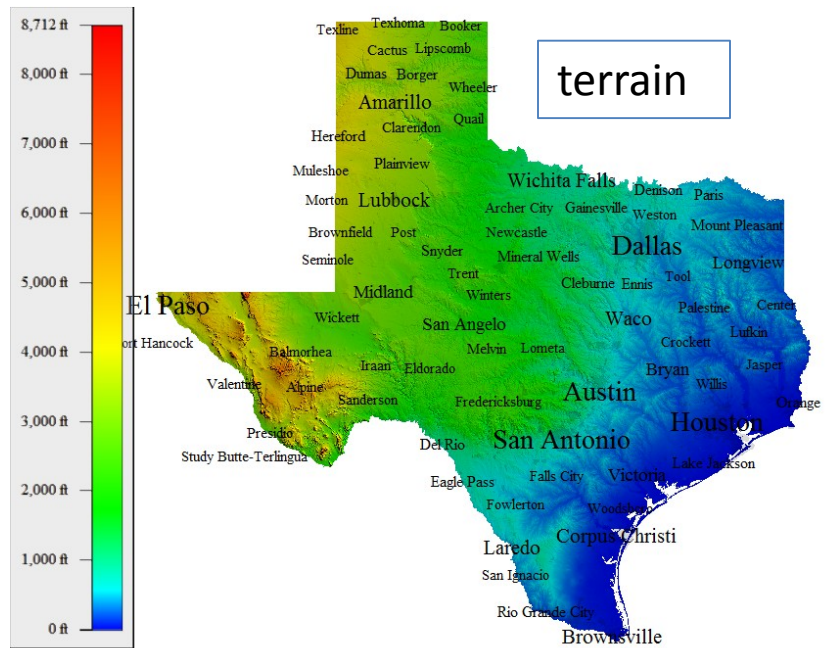
90% confidence intervals (i.e., 5% and 95% confidence limits)
algorithm was adjusted to account for inter-station correlation





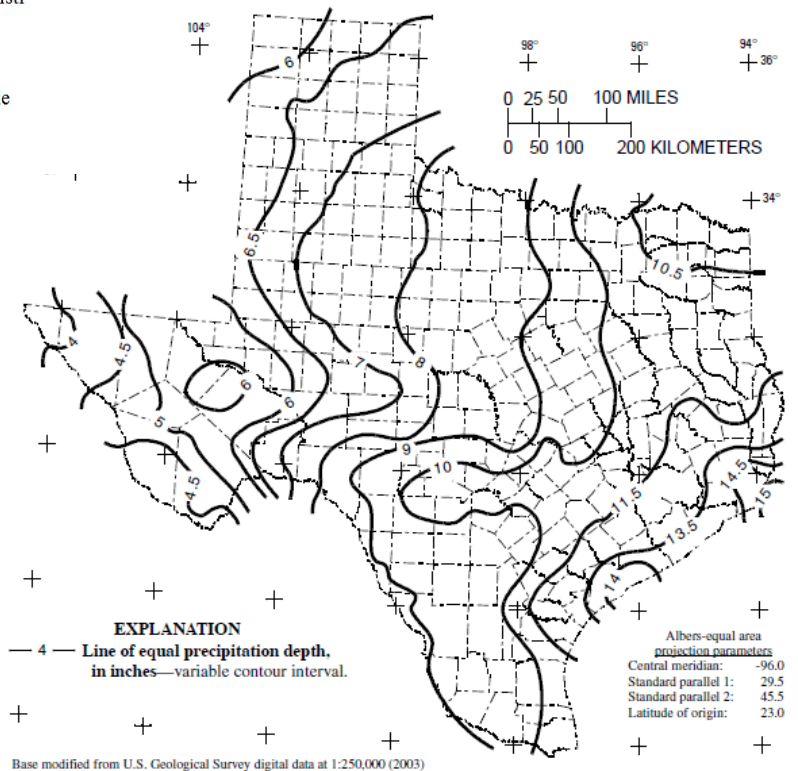
24-hr 100-yr NA14 vs. TP40



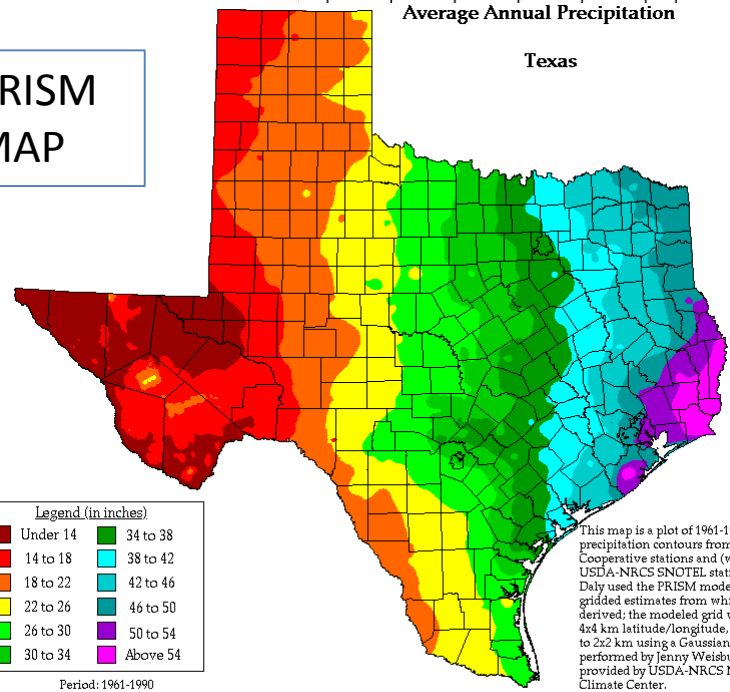


terrain

100-yr 1-day PF



PRISM MAP



Legend (in inches)

Under 14	34 to 38
14 to 18	38 to 42
18 to 22	42 to 46
22 to 26	46 to 50
26 to 30	50 to 54
30 to 34	Above 54

Period: 1961-1990

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4.4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.

EXPLANATION
 — 4 — Line of equal precipitation depth, in inches—variable contour interval.

Albers-equal area projection parameters
 Central meridian: -96.0
 Standard parallel 1: 29.5
 Standard parallel 2: 45.5
 Latitude of origin: 23.0

Base modified from U.S. Geological Survey digital data at 1:250,000 (2003)

ure 71. Depth of precipitation for 100-year storm for 1-day duration in Texas.



Summary



PRODUCTS

- 30-arc sec grids vs cartographic maps
- interactive Google map for DDF at selected location
- confidence intervals
- additional information (temporal, ARF)

UNDERLYING DATA

- additional data sources
- additional 20 years of data at NCDC stations
- hourly and 15-min data used for all duration

FREQUENCY ANALYSIS TECHNIQUES

- quality control
- regionalization
- interpolation