Risk Management & Resiliency for Design Rainfall

NCTCOG Public Works Roundup May 21, 2019

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Overview

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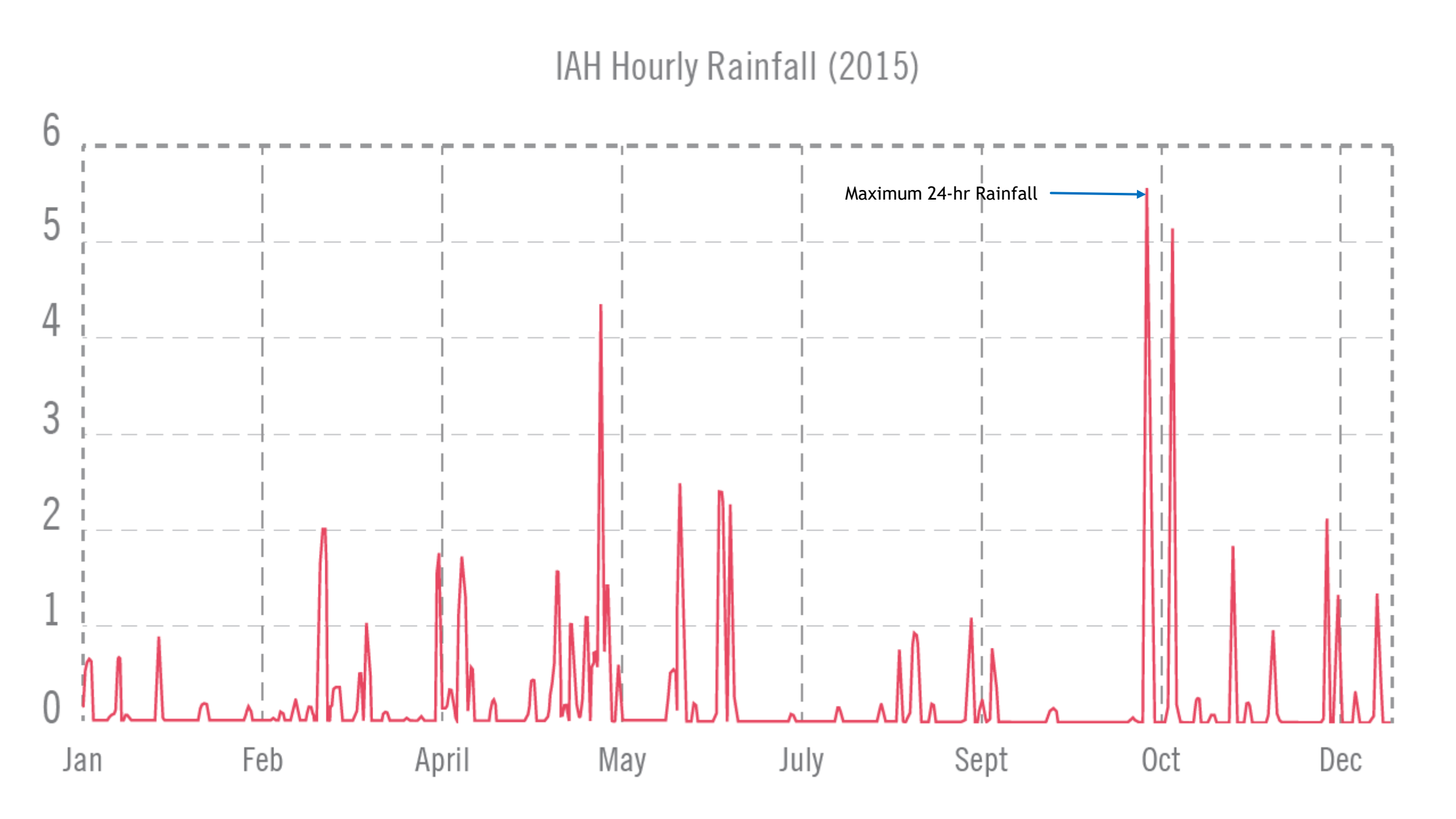
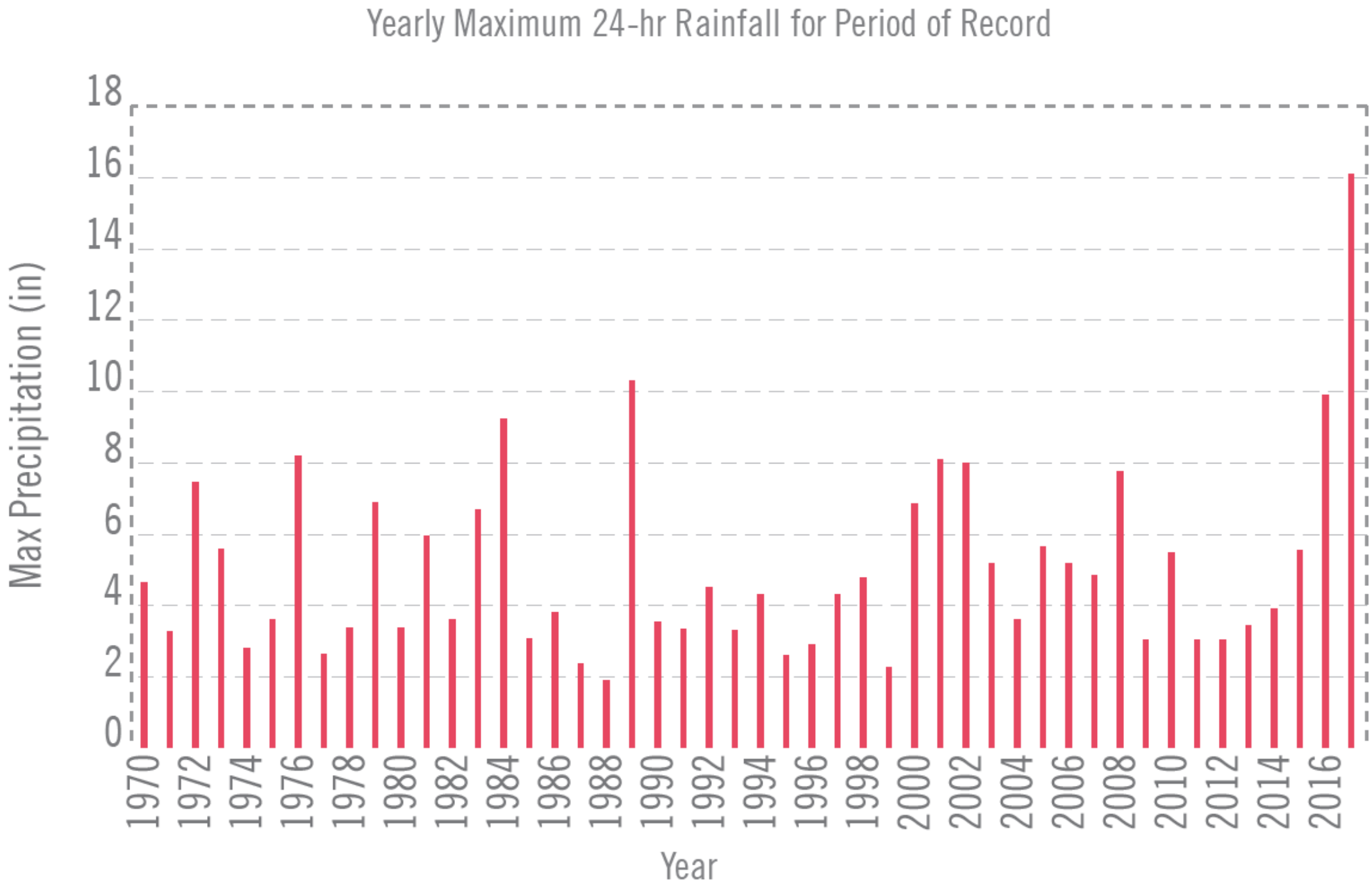
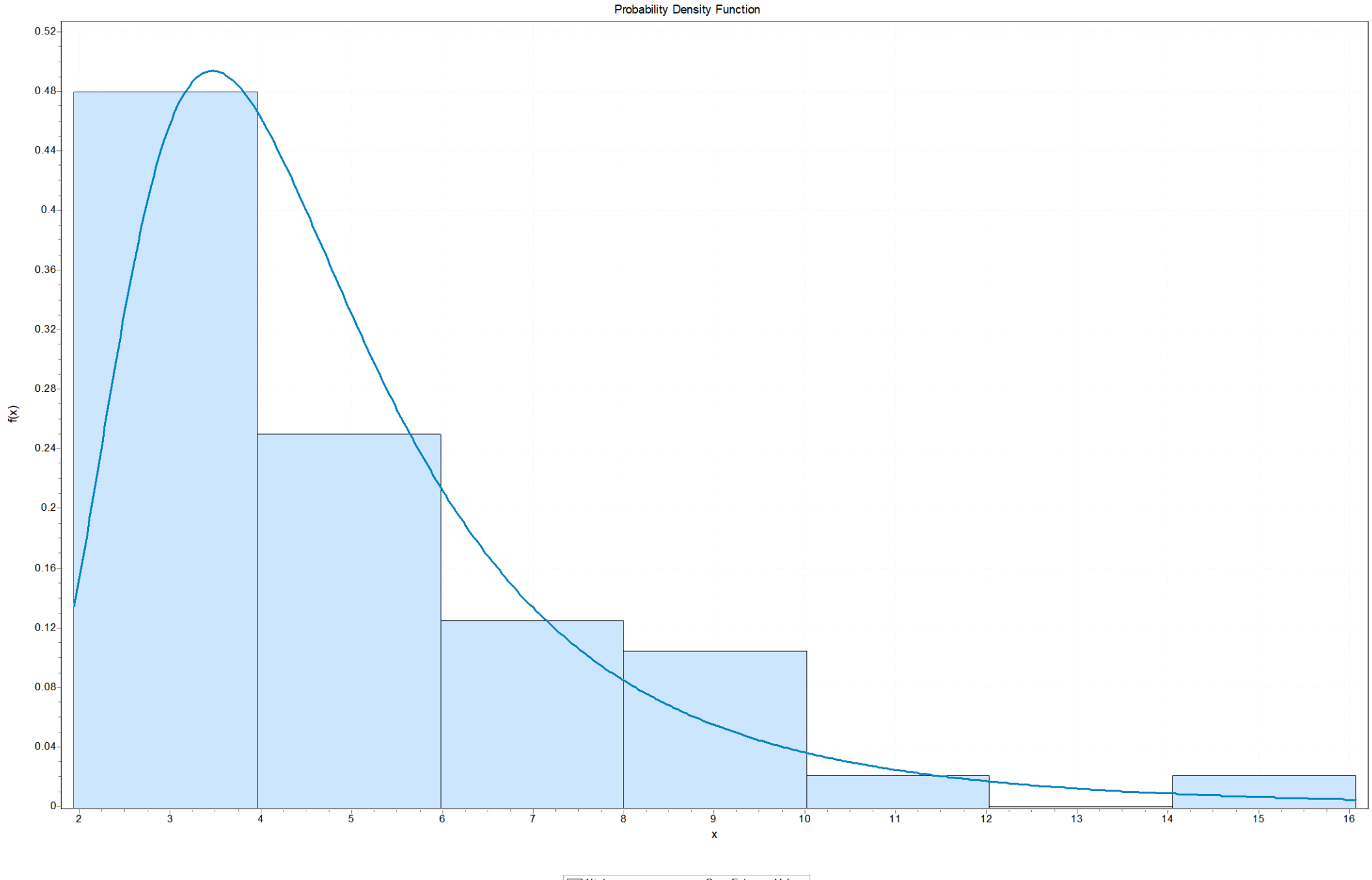
- Current Statistical Methods
- Uncertainty
- Why Resiliency
- Methods for Resiliency
- Moving Forward

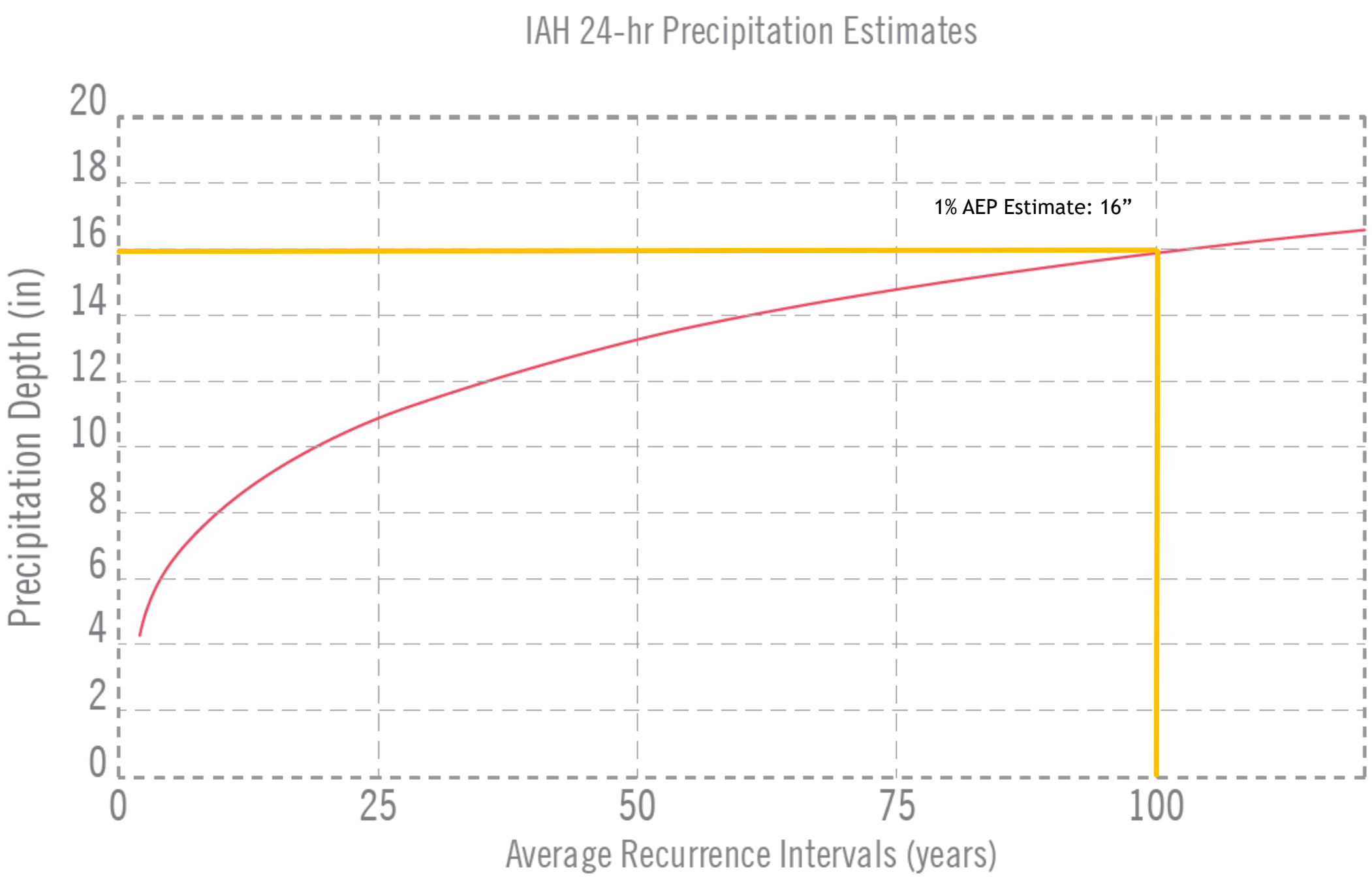
Determination of 1% AEP Storm Event

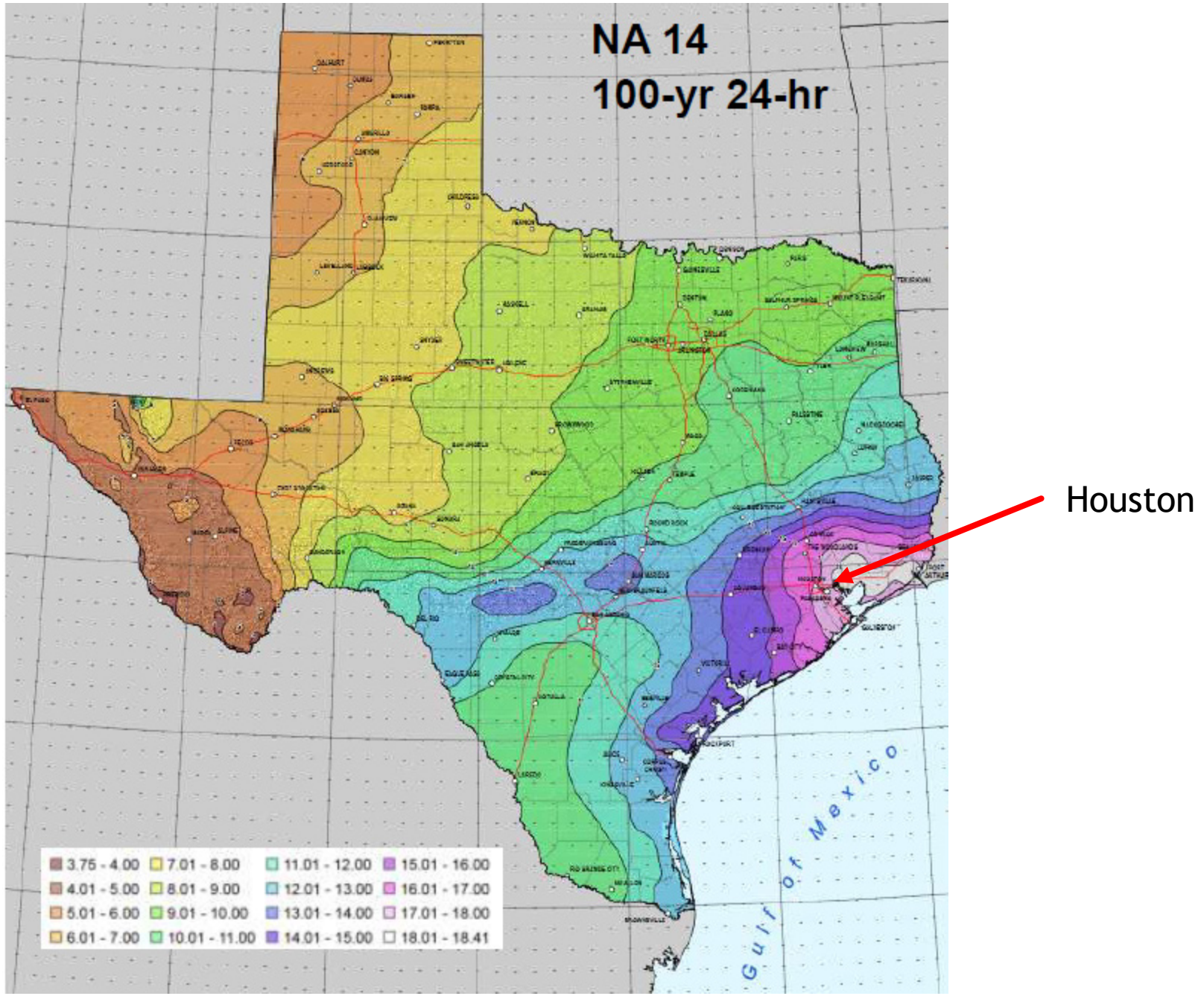
Houston Intercontinental Airport (IAH)


IAH Hourly Rainfall (2015)
Maximum 24-hr Rainfall
6
5
4
3
2
1
0
Jan
Feb
April
May
July
Sept
Oct
Dec


Yearly Maximum 24-hr Rainfall for Period of Record
Max Precipitation (in)
0
2
4
6
8
10
12
14
16
18
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year


Probability Density Function
f(x)
x
0.52
0.48
0.44
0.4
0.36
0.32
0.28
0.24
0.2
0.16
0.12
0.08
0.04
0
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Histogram
Gen. Extreme Value


IAH 24-hr Precipitation Estimates
1% AEP Estimate: 16”
Precipitation Depth (in)
20
18
16
14
12
10
8
6
4
2
0
0
25
50
75
100
Average Recurrence Intervals (years)

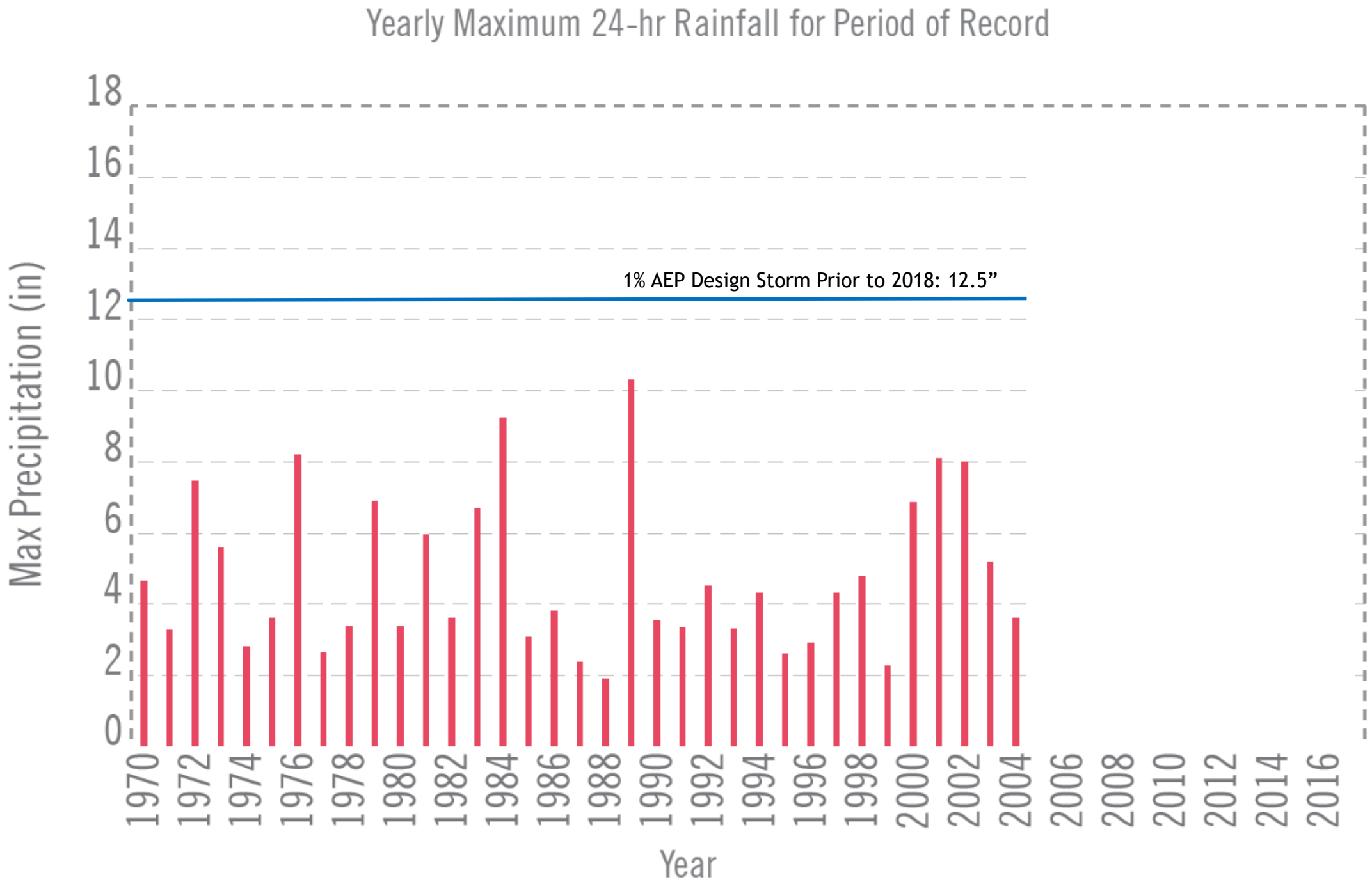

NA 14
100-yr 24-hr
Houston
3.75 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01 - 7.00
7.01 - 8.00
8.01 - 9.00
9.01 - 10.00
10.01 - 11.00
11.01 - 12.00
12.01 - 13.00
13.01 - 14.00
14.01 - 15.00
15.01 - 16.00
16.01 - 17.00
17.01 - 18.00
18.01 - 18.41
Gulf of Mexico

Uncertainty

Sample Size, Conditions, Location, Methods

Sample Size

Period of Record


Yearly Maximum 24-hr Rainfall for Period of Record
Max Precipitation (in)
18
16
14
12
10
8
6
4
2
0
1% AEP Design Storm Prior to 2018: 12.5”
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year

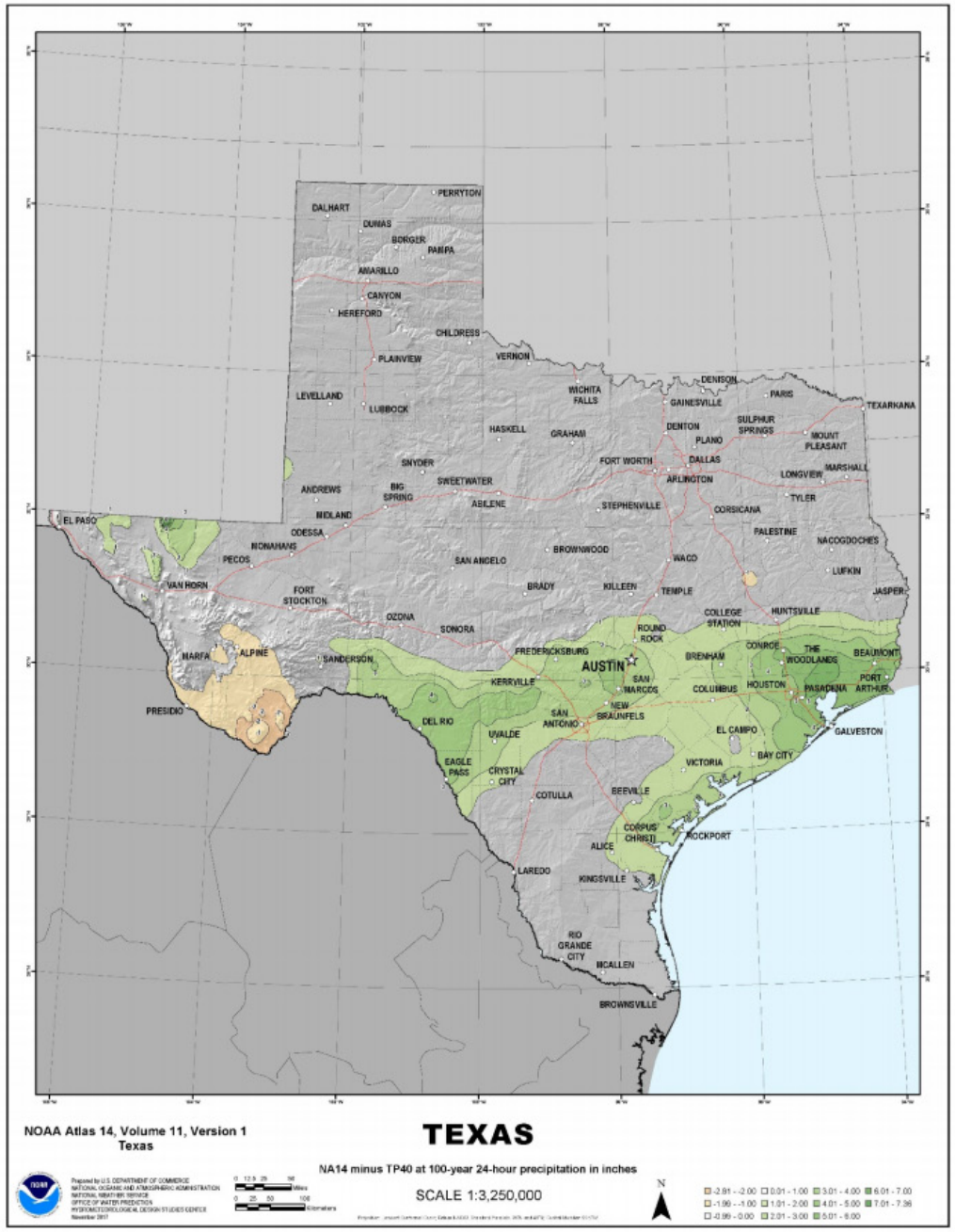
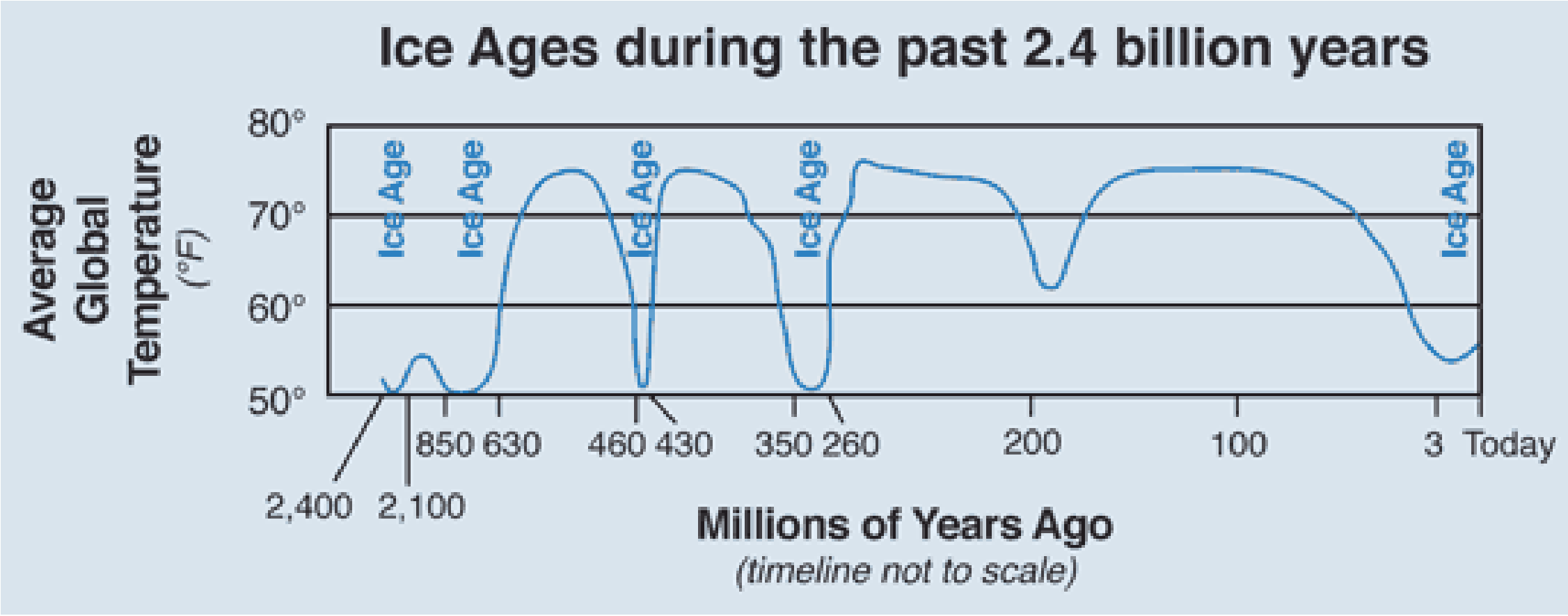


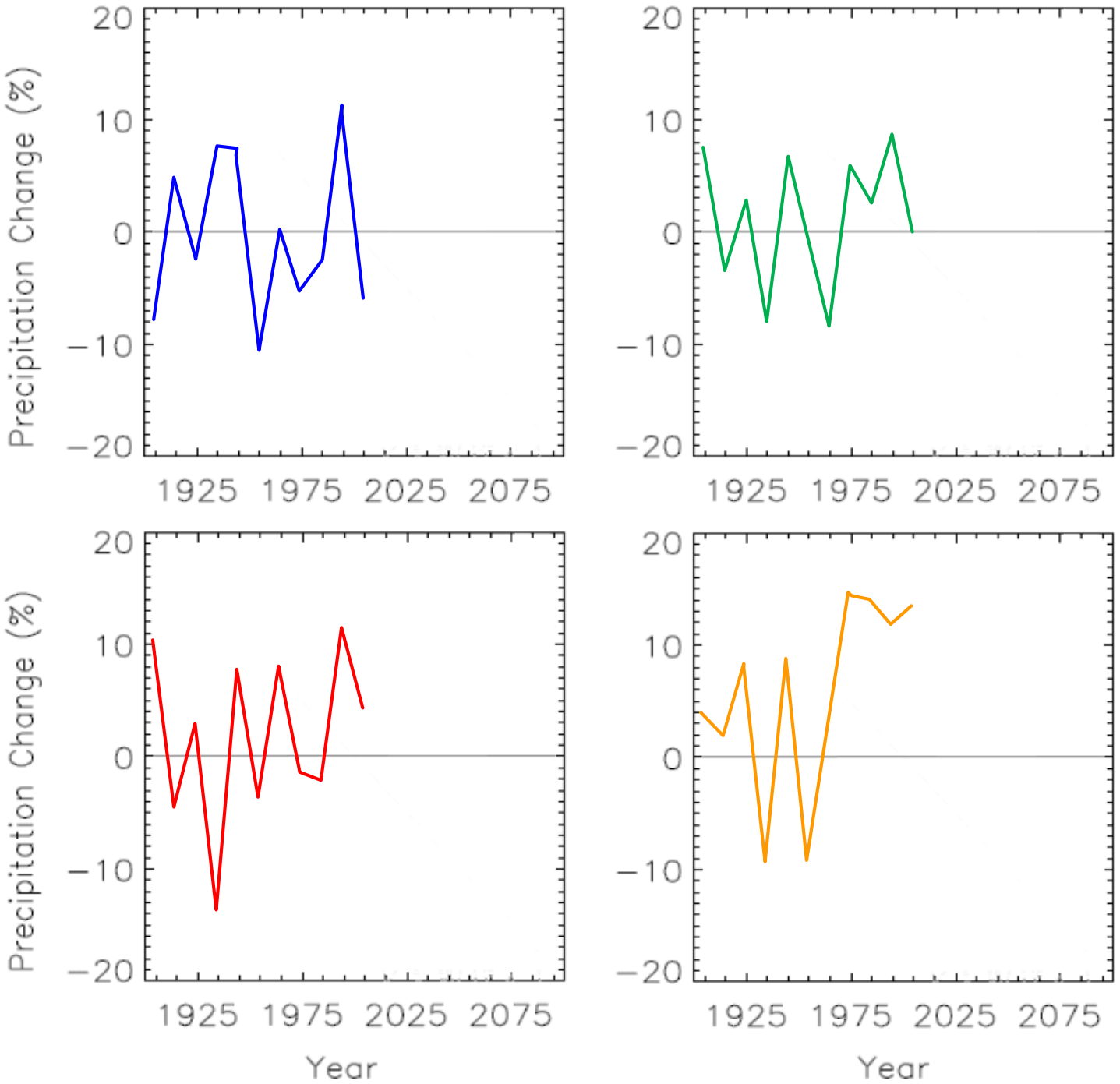
Figure 8. Map showing differences in 100-year 24-hour estimates (in inches) between NOAA Atlas 14 Volume 11 and TP-40.

Conditions

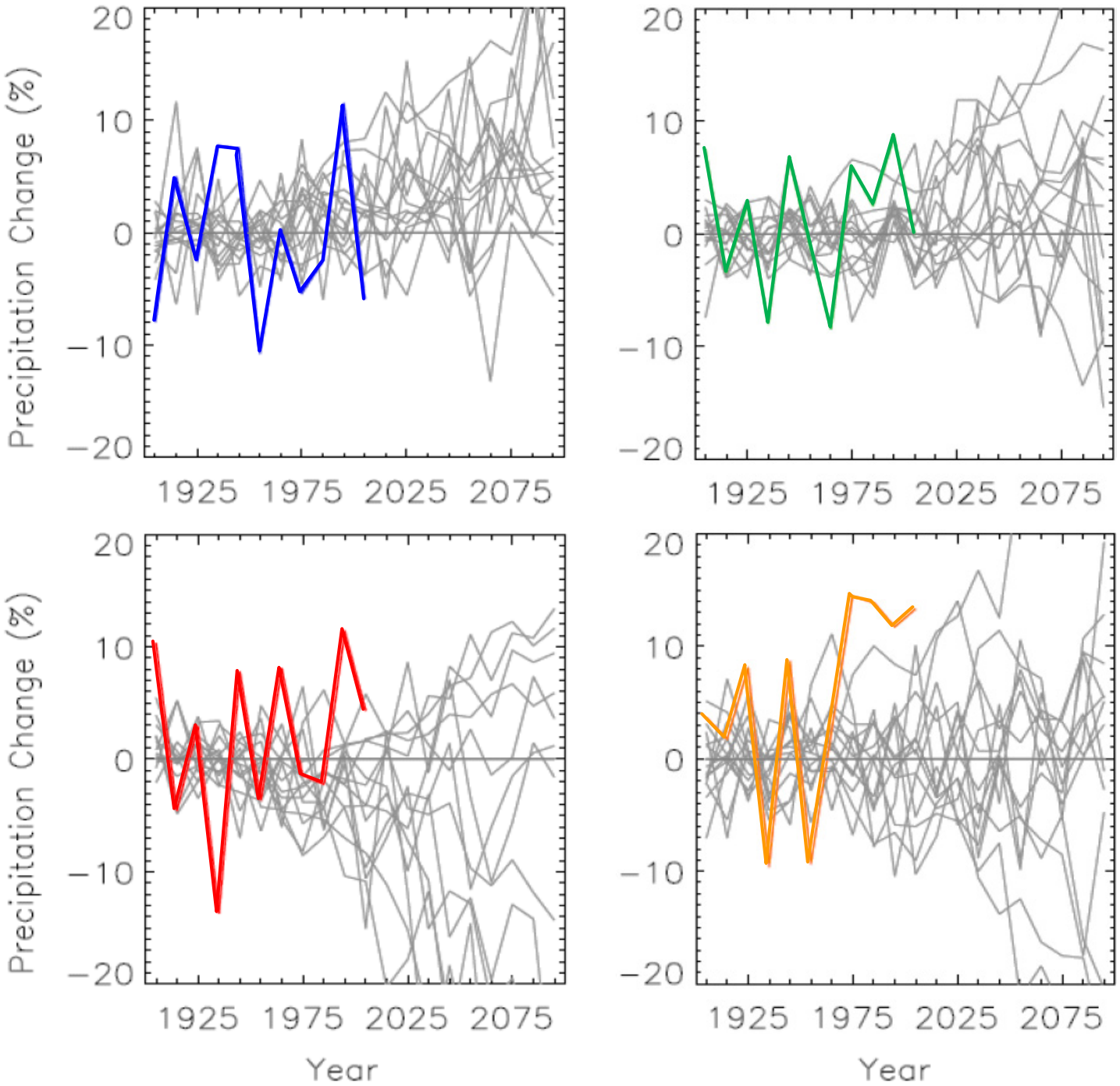
Climate Change



*Utah Geological Society (Modified from Gary Saltzman)



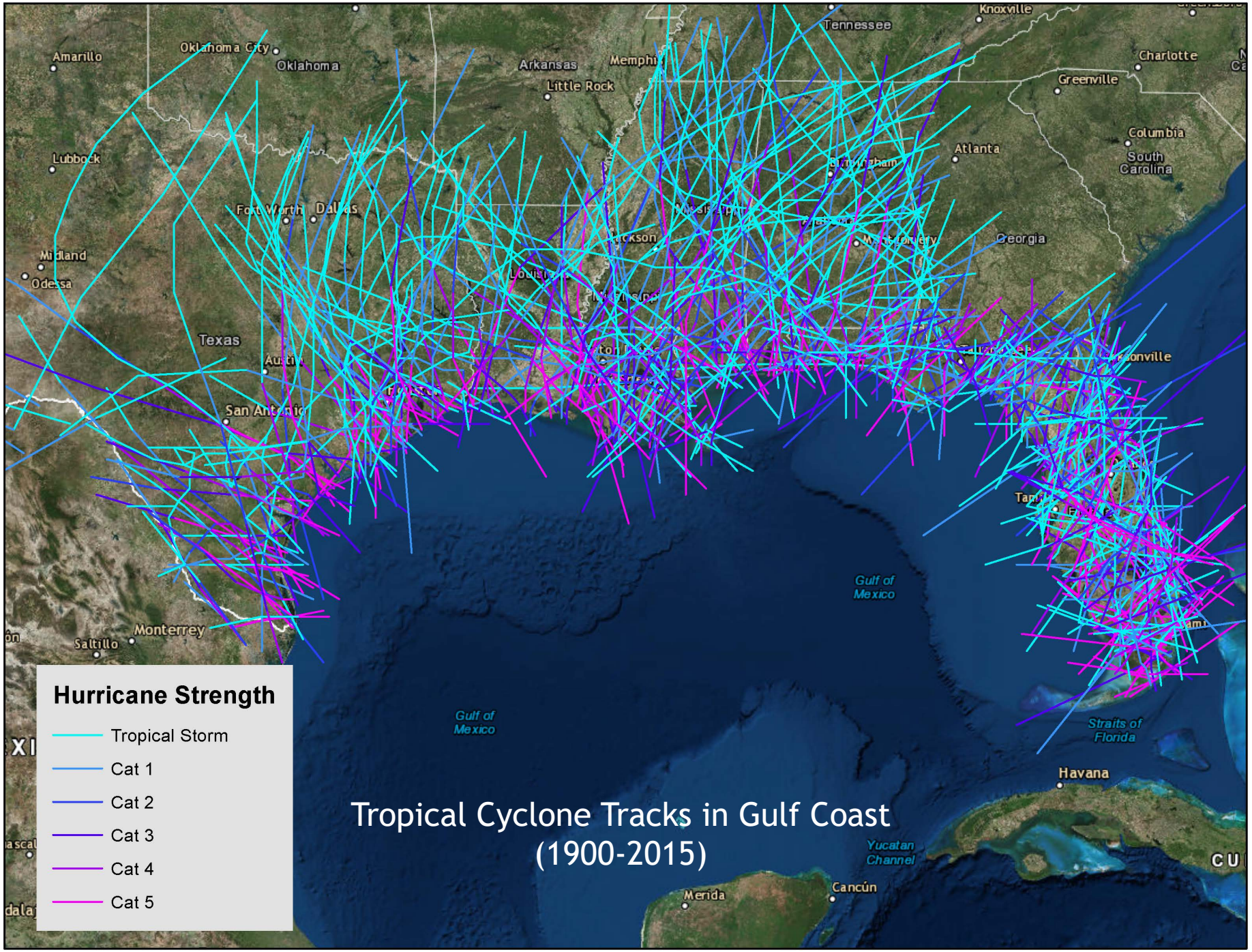
Winter, Spring,
Summer, Fall
Climate Predictions



Winter, Spring,
Summer, Fall
Climate Predictions

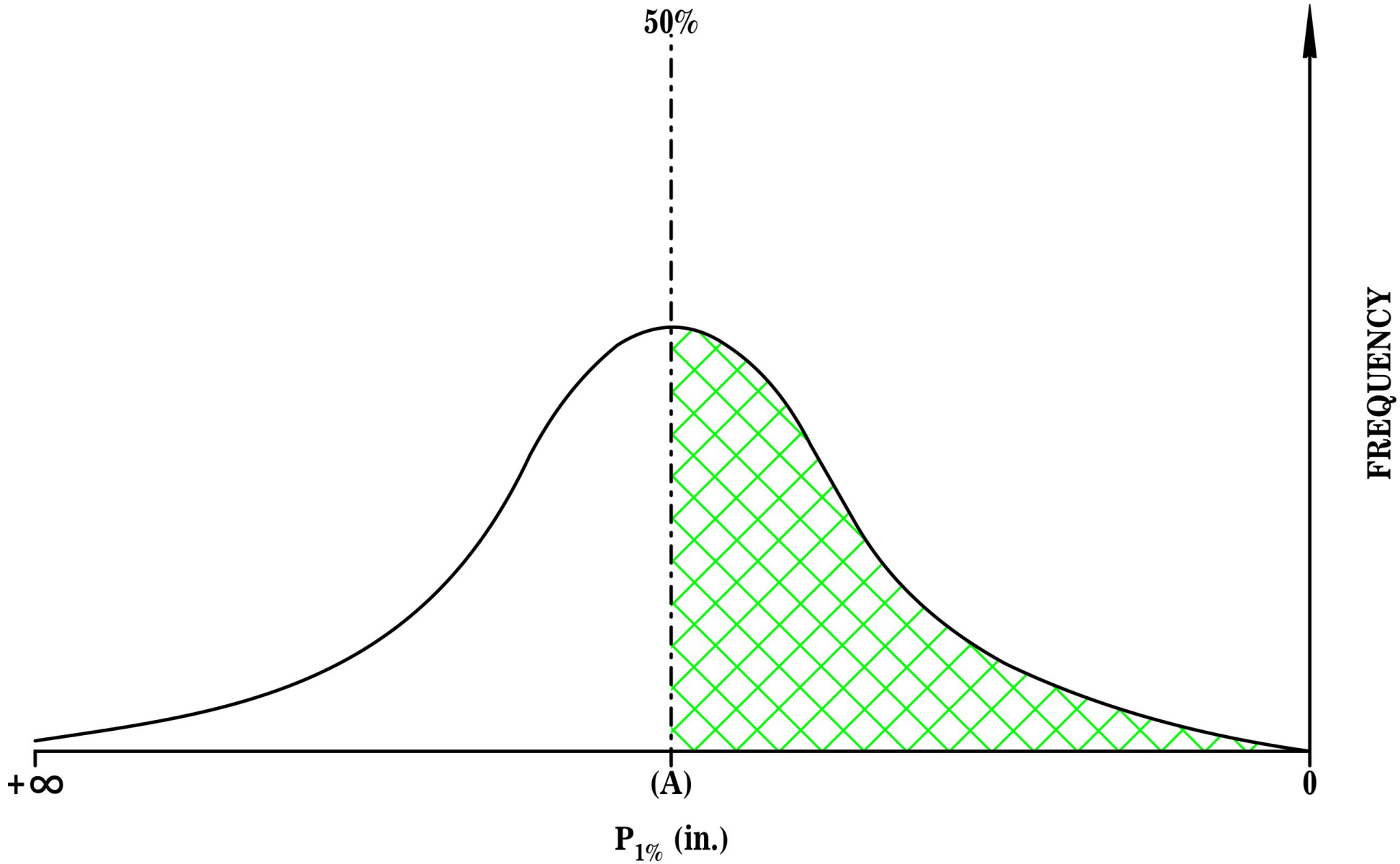
Location

Risk of Getting Hit


Hurricane Strength
Tropical Storm
Cat 1
Cat 2
Cat 3
Cat 4
Cat 5
Tropical Cyclone Tracks in Gulf Coast
(1900-2015)
Gulf of Mexico
Straits of Florida
Yucatan Channel
Havana
Cancún
Merida
Monterrey
Saltillo
San Antonio
Texas
Dallas
Fort Worth
Houston
Atlanta
Charlotte
Tennessee
Knoxville
Greenville
Columbia
South Carolina
Georgia
Jacksonville
Tampa
Oklahoma City
Oklahoma
Arkansas
Little Rock
Memphis
Amarillo
Lubbock
Midland
Odessa

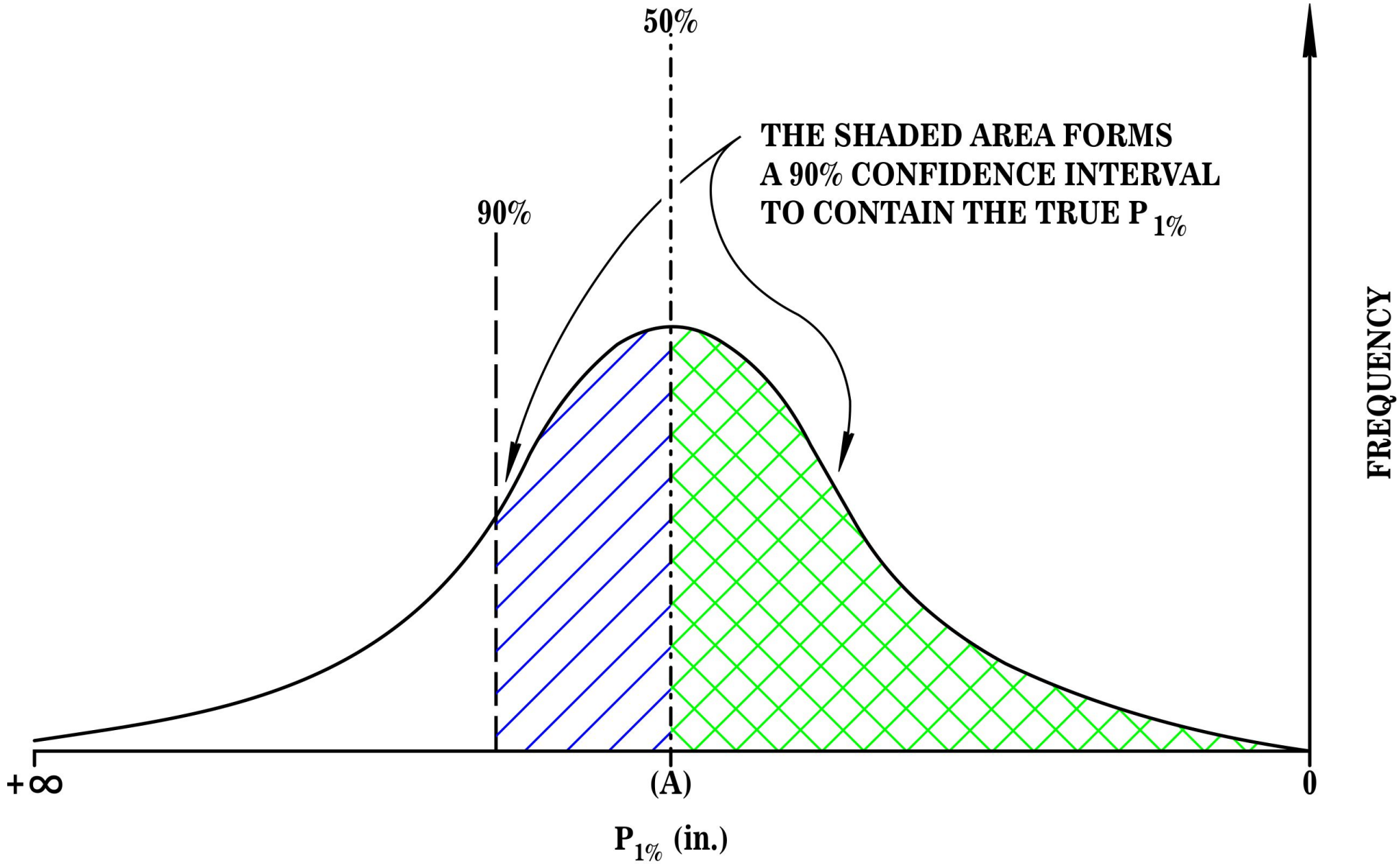
Methods

Statistical Uncertainty



FREQUENCY DISTRIBUTION OF $P_{1\%}$ VALUES

(VARIATION IN $P_{1\%}$ VALUES DUE TO SAMPLING ERROR)



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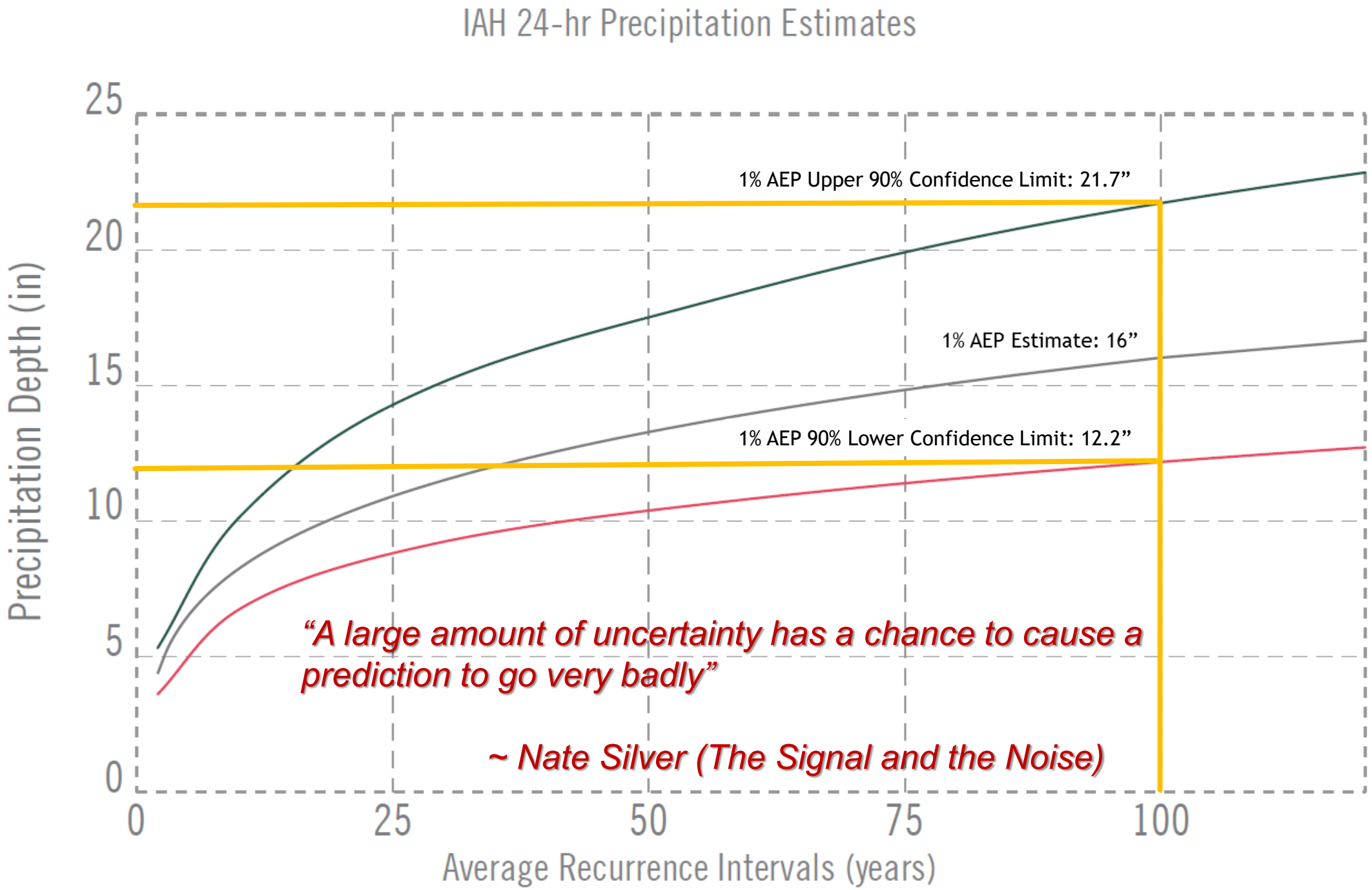
IAH 24-hr Precipitation Estimates
Precipitation Depth (in)
25
20
15
10
5
0
0
25
50
75
100
Average Recurrence Intervals (years)
1% AEP Upper 90% Confidence Limit: 21.7”
1% AEP Estimate: 16”
1% AEP 90% Lower Confidence Limit: 12.2”
“A large amount of uncertainty has a chance to cause a prediction to go very badly”
~ Nate Silver (The Signal and the Noise)

Why Resiliency?

2001
TS Allison, San Antonio, Central Texas

2003
Hurricane Claudette, Brownsville

2005
Hurricane Rita

2008
Hurricane Ike, Wichita Falls

2010
South Texas, New Braunfels

2015-2017
Inland floods

2016
Tax Day Flood

2001
Inland Floods

2002
Central & South Texas, TS Fay

2004
North Central Texas

2007
Hurricane Humberto, Marble Falls, North Texas

2014
Travis County

2015
Memorial Day Flood

2017
Hurricane Harvey

Resilience Model

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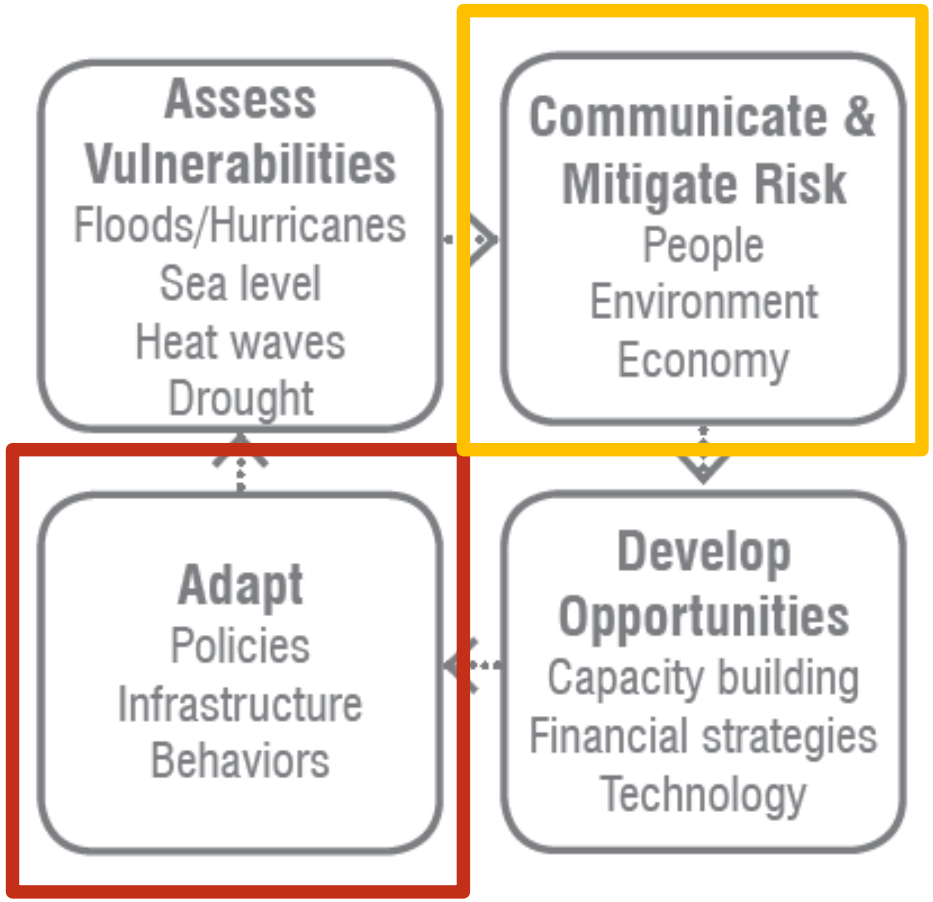
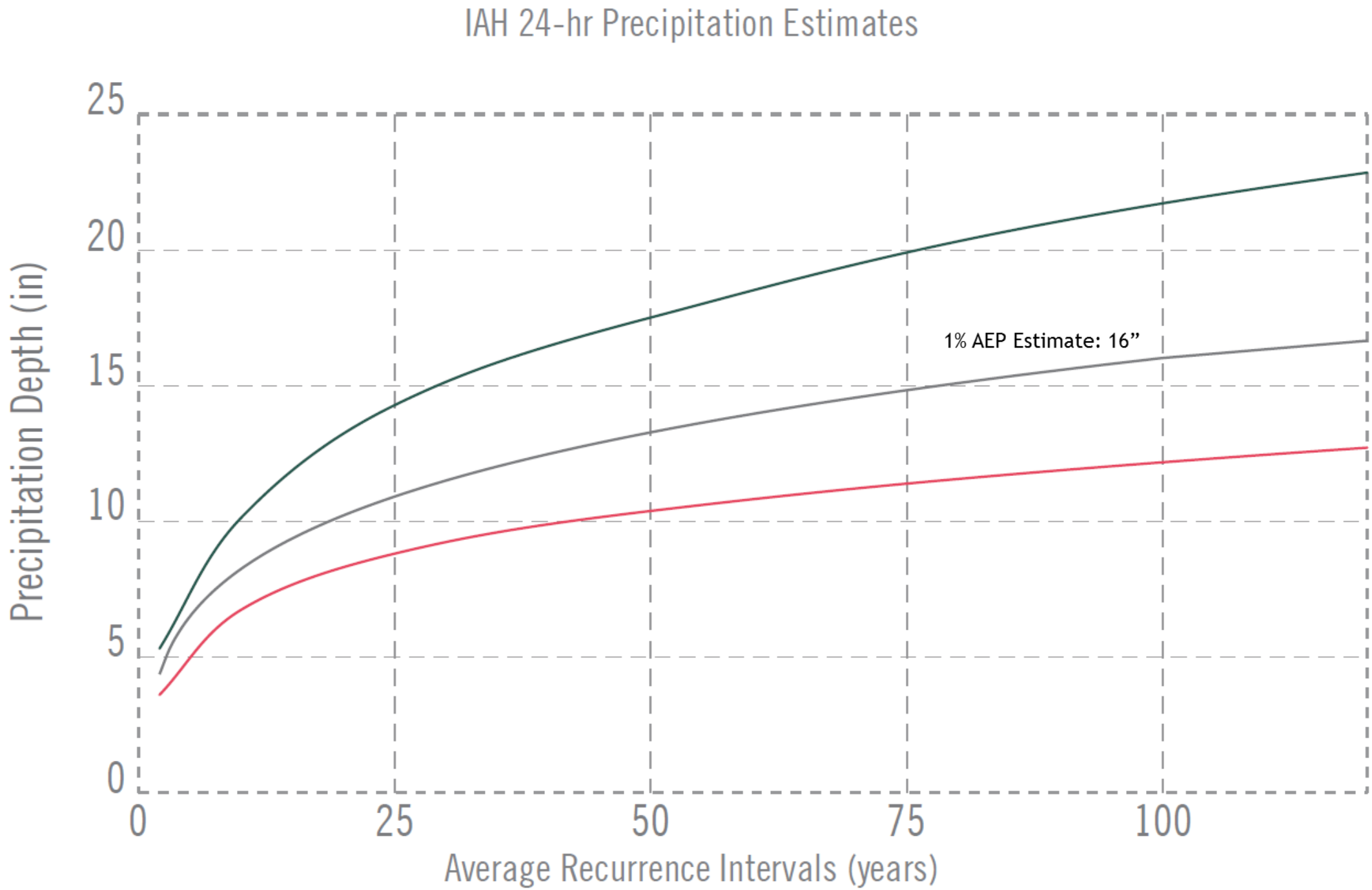
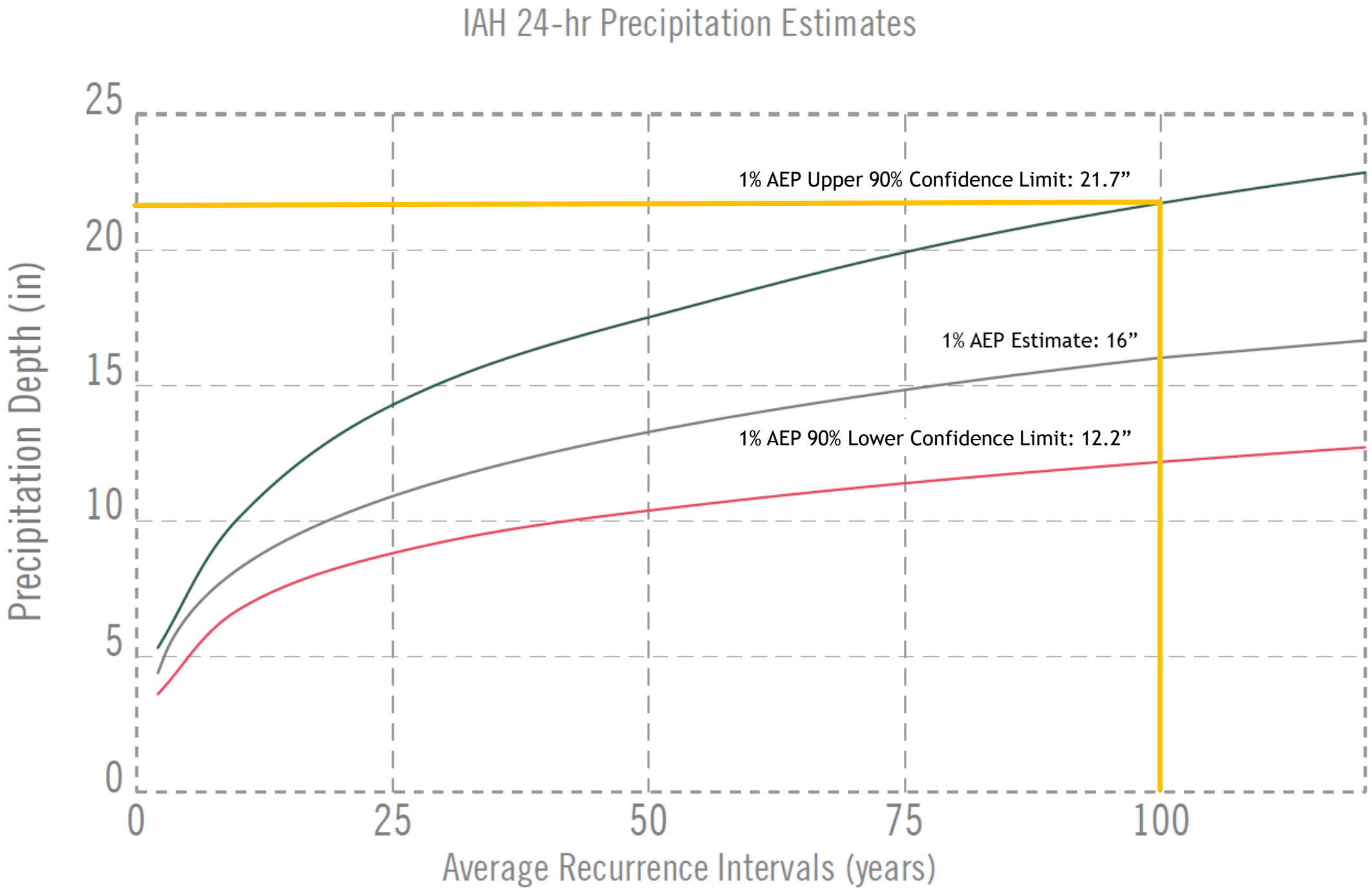


Methods for Resiliency

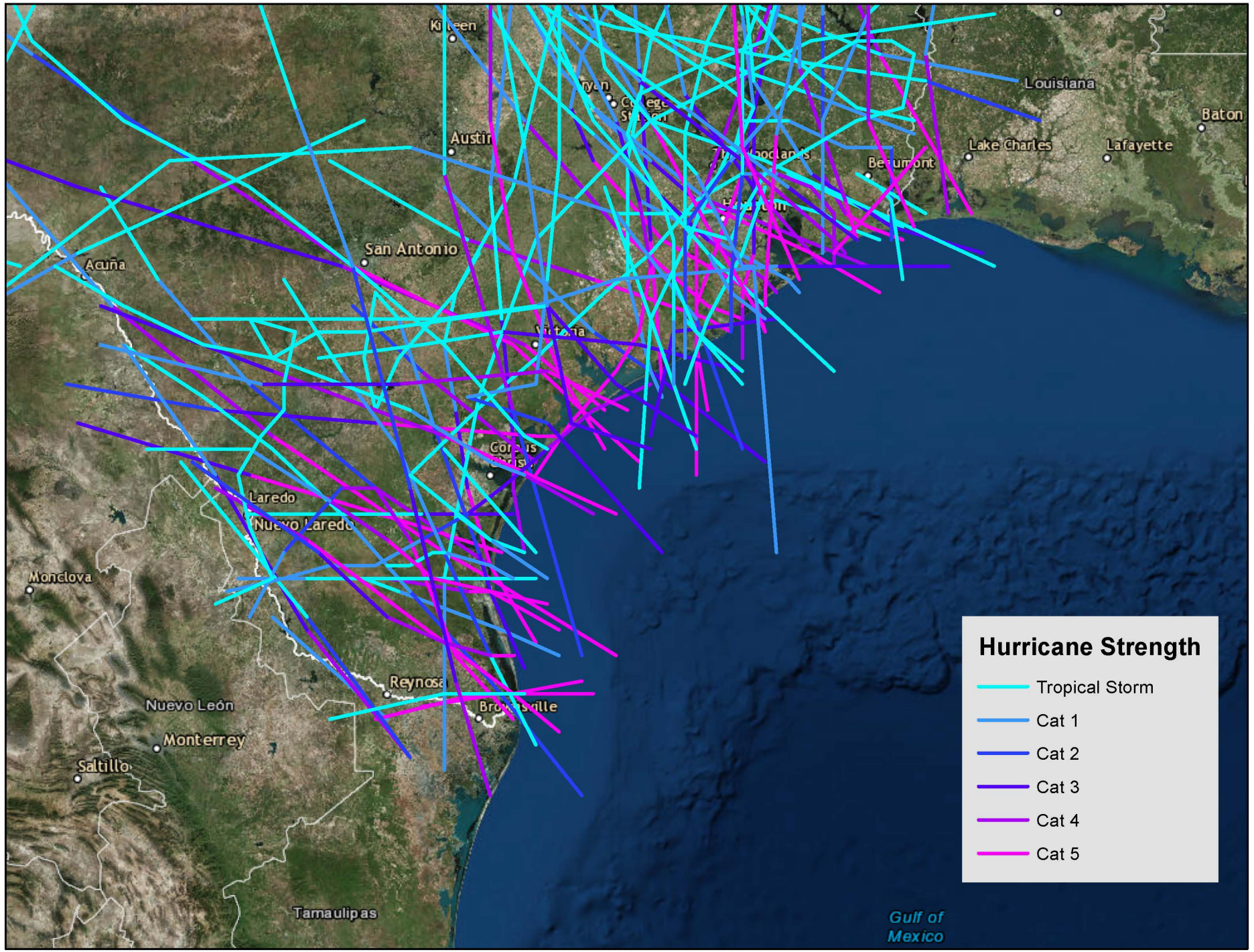
Upper Confidence Intervals, Higher Standards

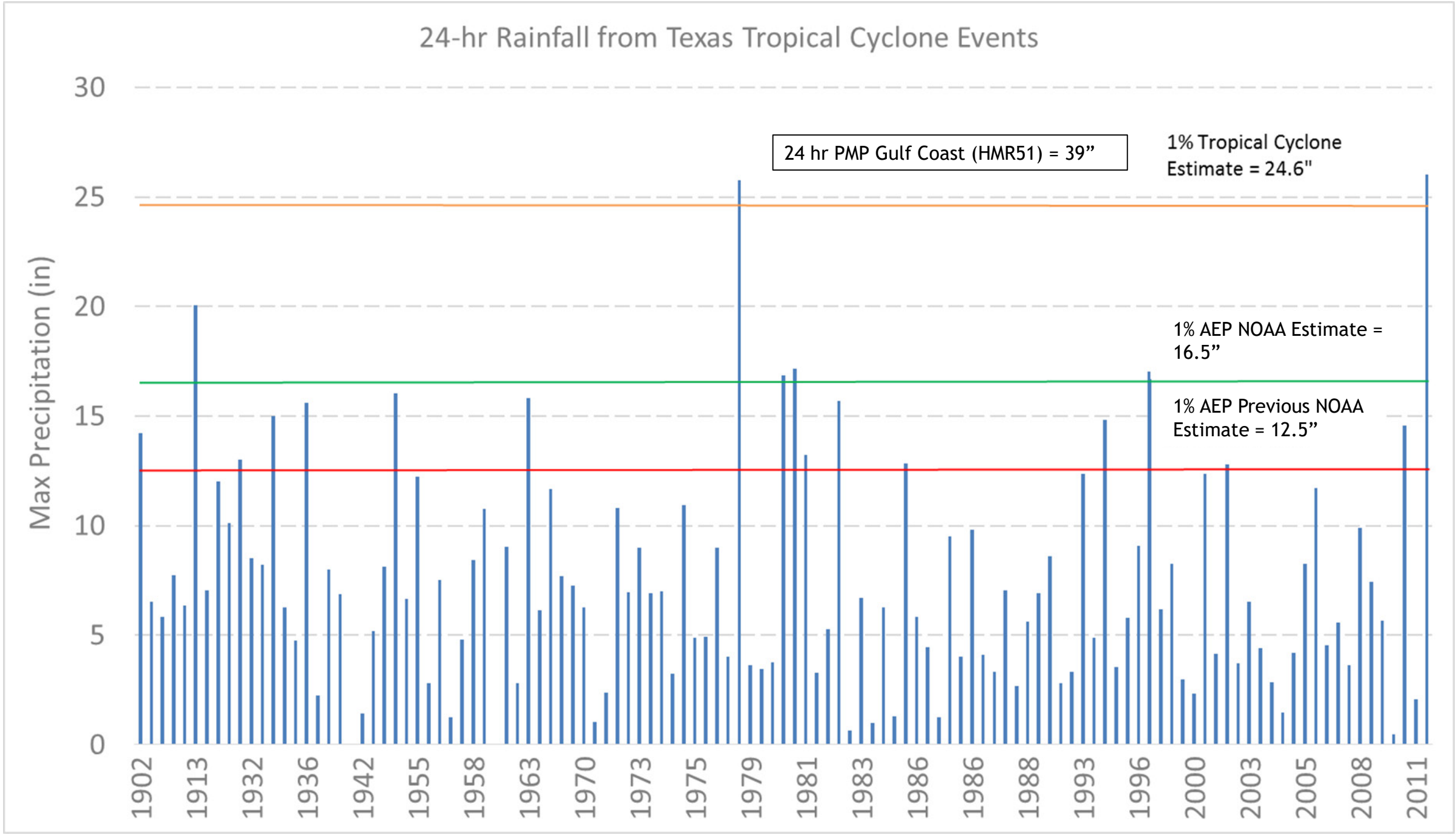
Upper Confidence Intervals


IAH 24-hr Precipitation Estimates
Precipitation Depth (in)
25
20
15
10
5
0
0
25
50
75
100
Average Recurrence Intervals (years)
1% AEP Estimate: 16”

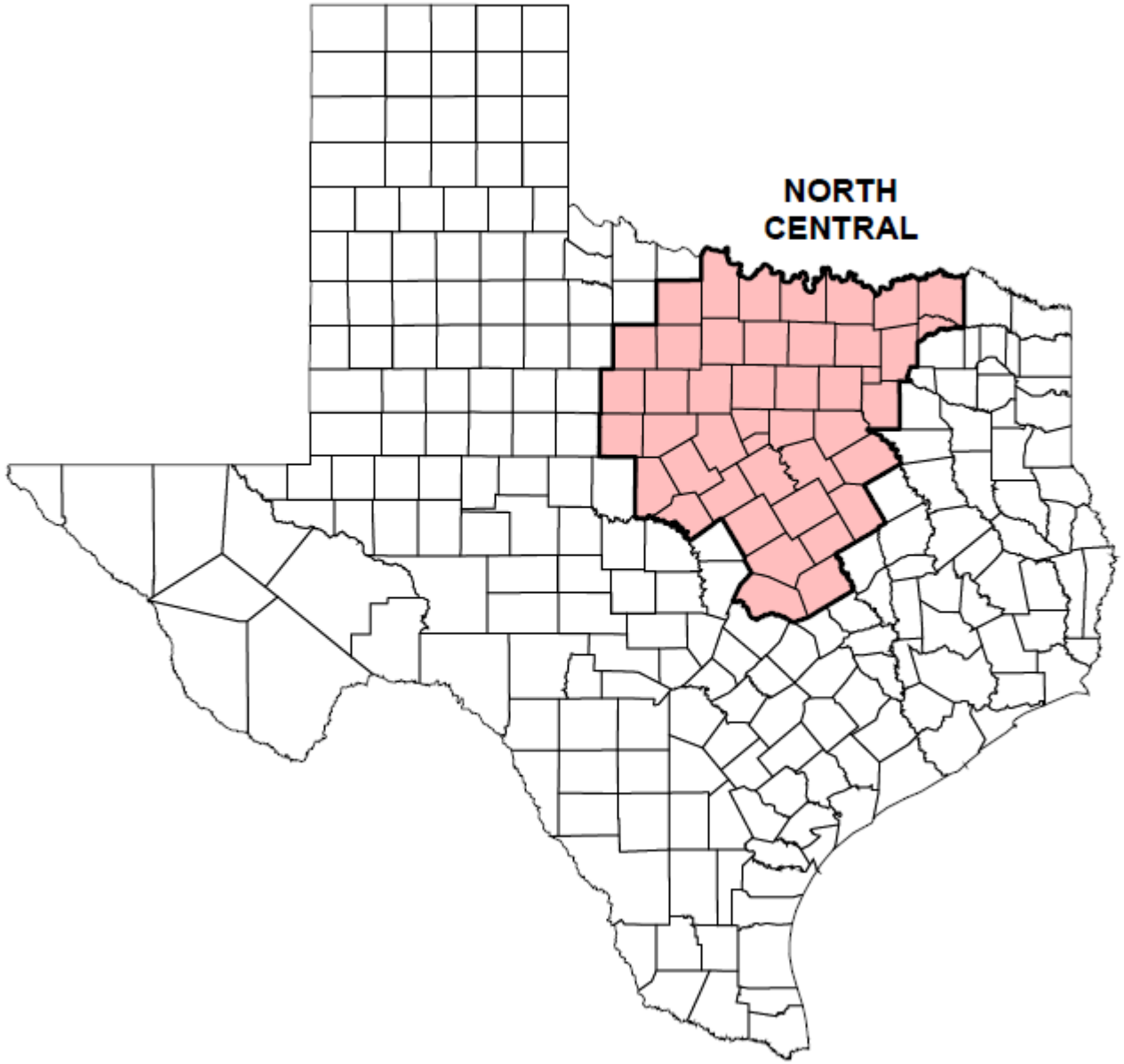

IAH 24-hr Precipitation Estimates
Precipitation Depth (in)
25
20
15
10
5
0
0
25
50
75
100
Average Recurrence Intervals (years)
1% AEP Upper 90% Confidence Limit: 21.7”
1% AEP Estimate: 16”
1% AEP 90% Lower Confidence Limit: 12.2”

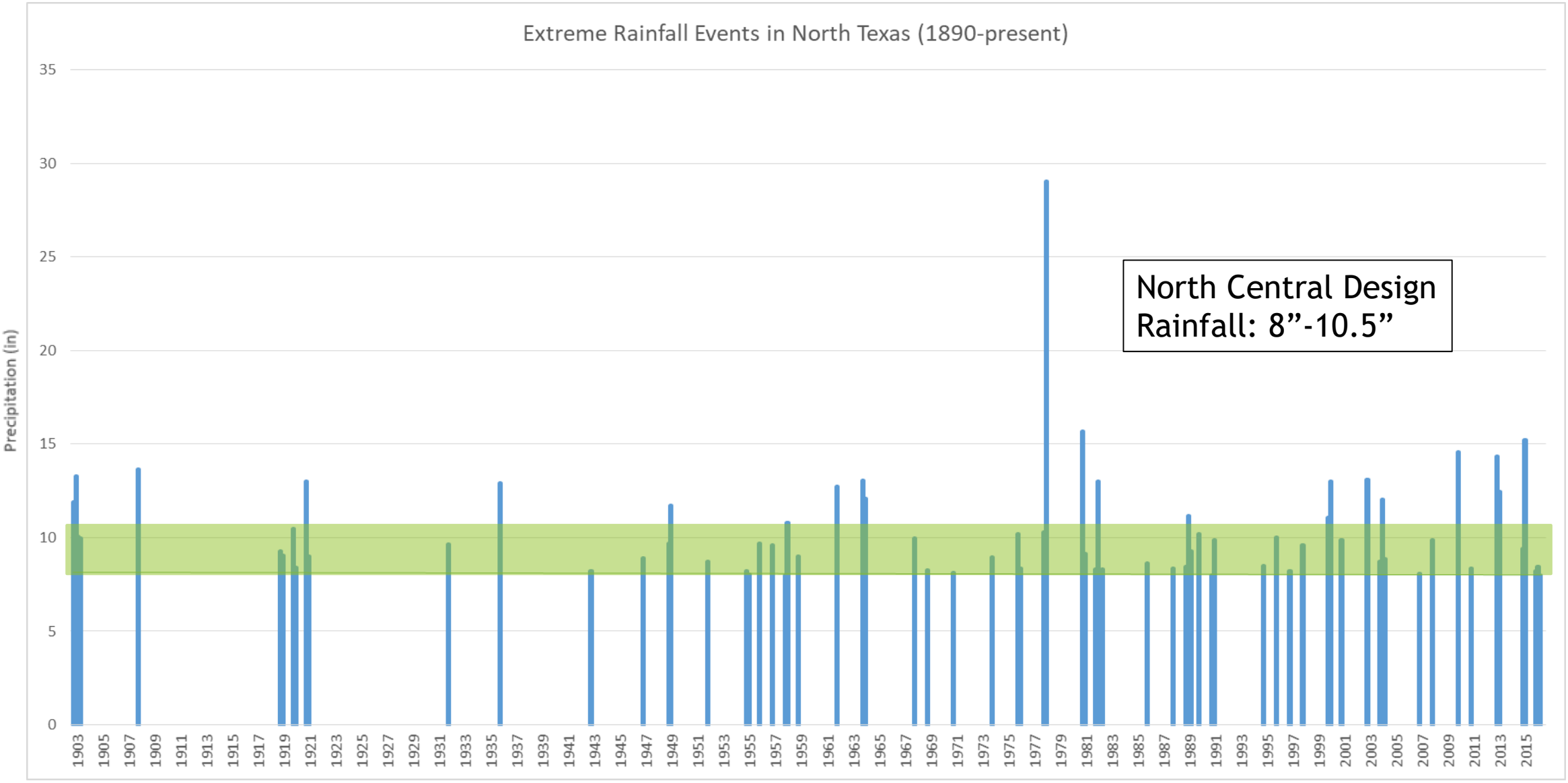
Extreme Event Analysis


Louisiana
Baton
Lake Charles
Lafayette
Austin
San Antonio
Acuña
Laredo
Monclova
Reynosa
Nuevo León
Monterrey
Saltillo
Tamaulipas
Gulf of Mexico
Hurricane Strength
Tropical Storm
Cat 1
Cat 2
Cat 3
Cat 4
Cat 5


24-hr Rainfall from Texas Tropical Cyclone Events
Max Precipitation (in)
30
25
20
15
10
5
0
24 hr PMP Gulf Coast (HMR51) = 39”
1% Tropical Cyclone Estimate = 24.6"
1% AEP NOAA Estimate = 16.5”
1% AEP Previous NOAA Estimate = 12.5”
1902
1913
1932
1936
1942
1955
1958
1963
1970
1973
1975
1979
1981
1983
1986
1986
1988
1993
1996
2000
2003
2005
2008
2011

Storms in North Central Texas


NORTH
CENTRAL


Extreme Rainfall Events in North Texas (1890-present)
Precipitation (in)
0
5
10
15
20
25
30
35
1903
1905
1907
1909
1911
1913
1915
1917
1919
1921
1923
1925
1927
1929
1931
1933
1935
1937
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1941
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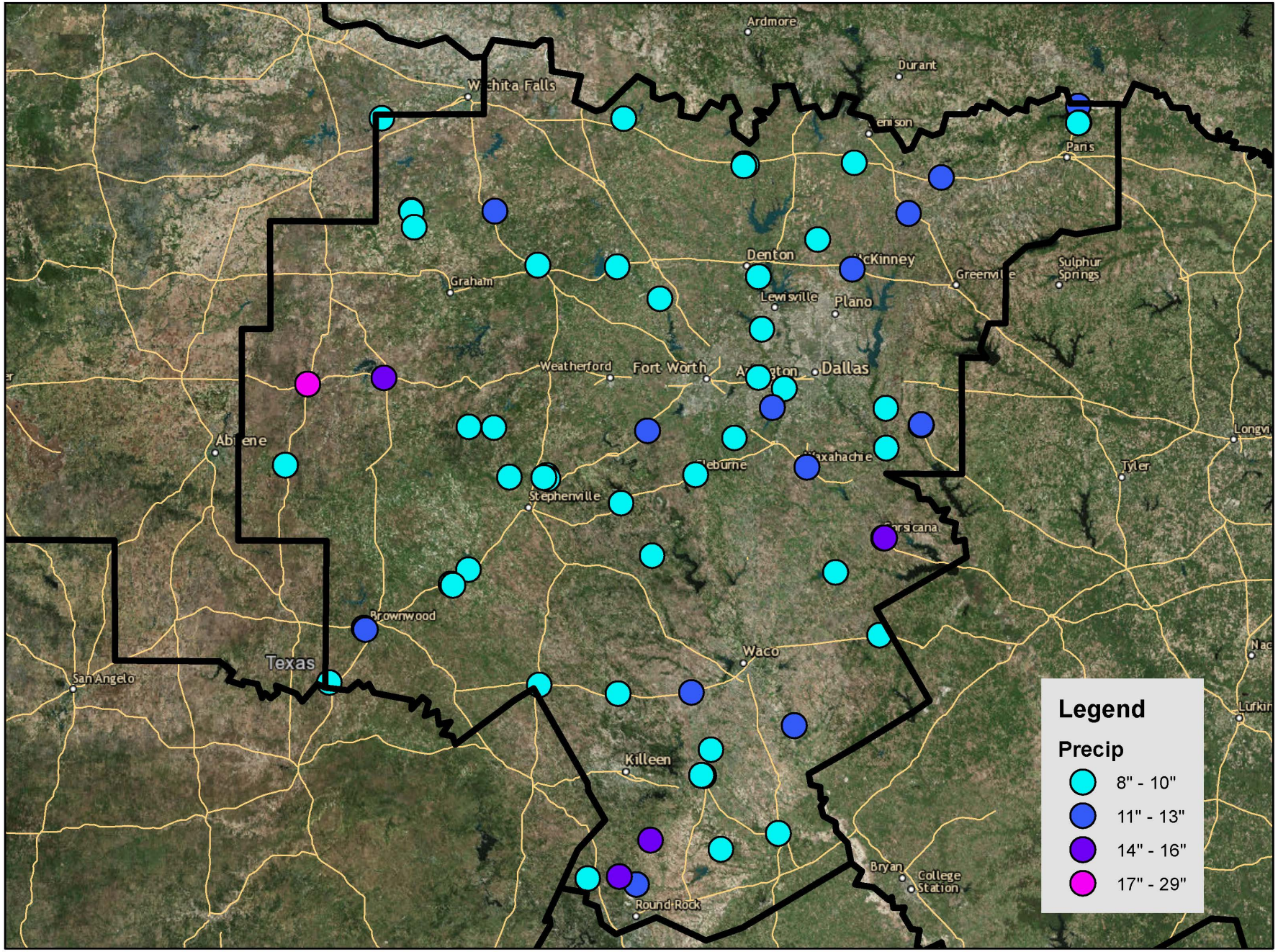
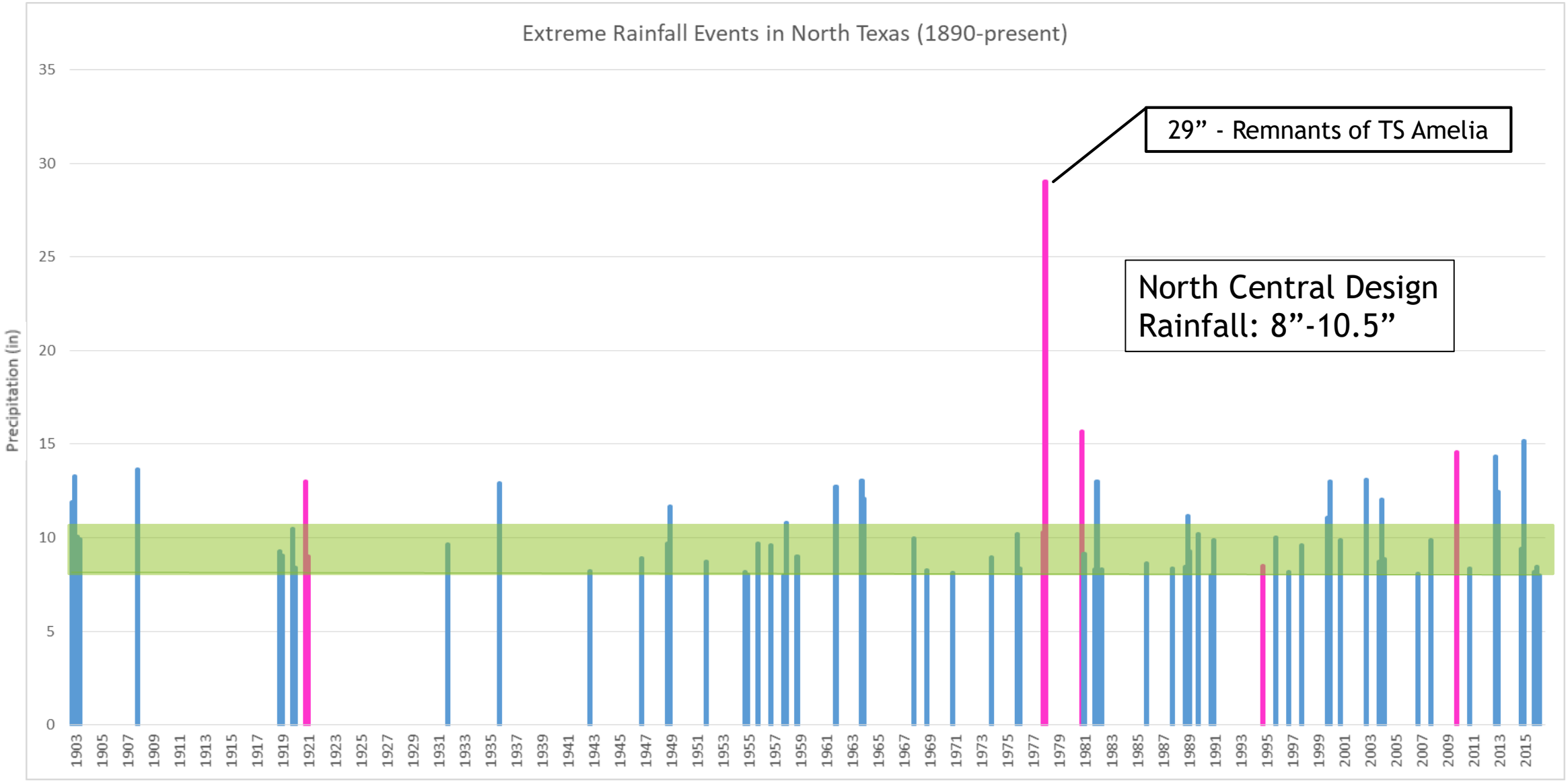
2001
2003
2005
2007
2009
2011
2013
2015
North Central Design Rainfall: 8”-10.5”

Extreme 24 Hour Rainfall Depth North Central Texas




Extreme Rainfall Events in North Texas (1890-present)
Precipitation (in)
35
30
25
20
15
10
5
0
1903
1905
1907
1909
1911
1913
1915
1917
1919
1921
1923
1925
1927
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1931
1933
1935
1937
1939
1941
1943
1945
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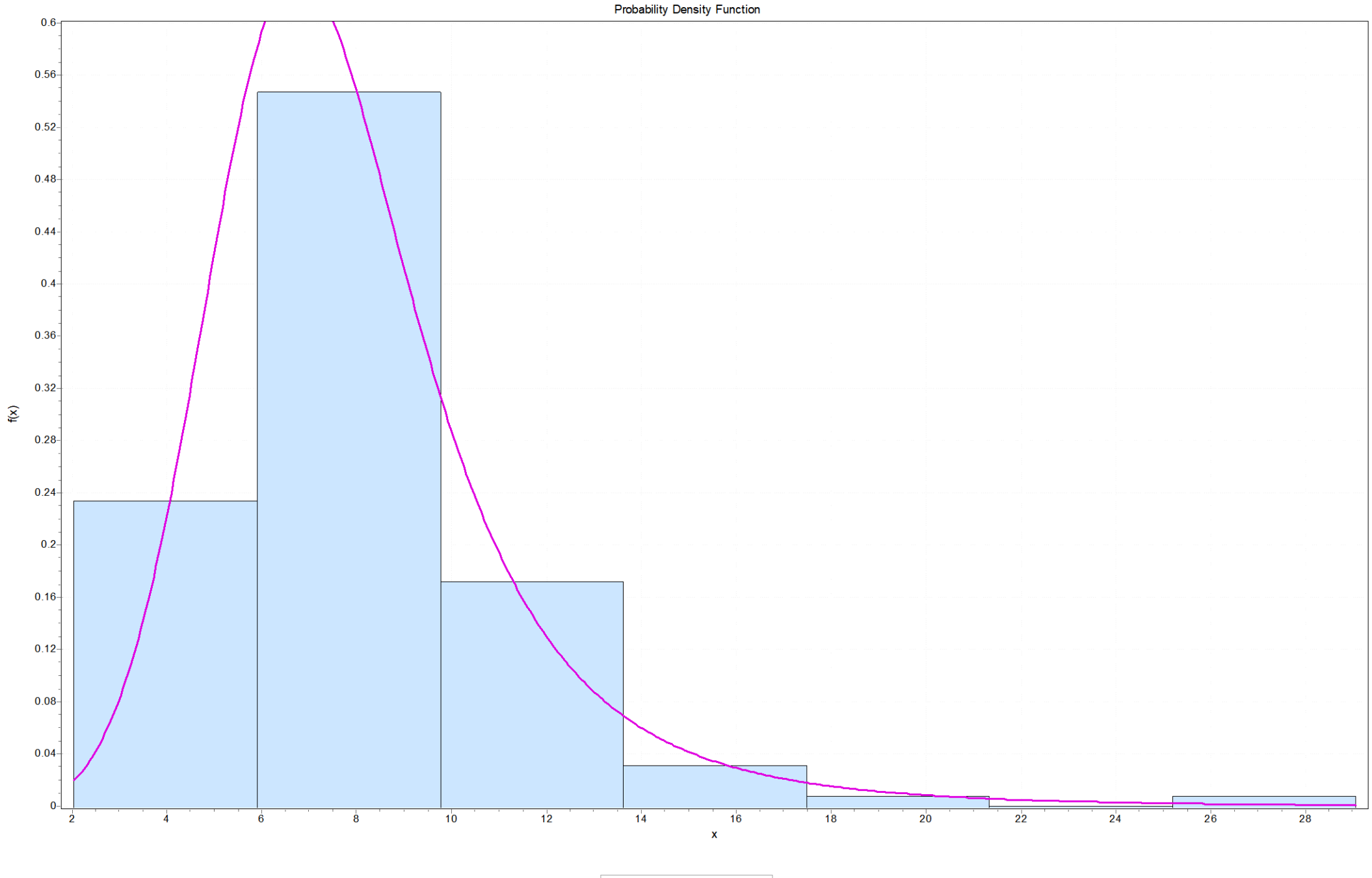
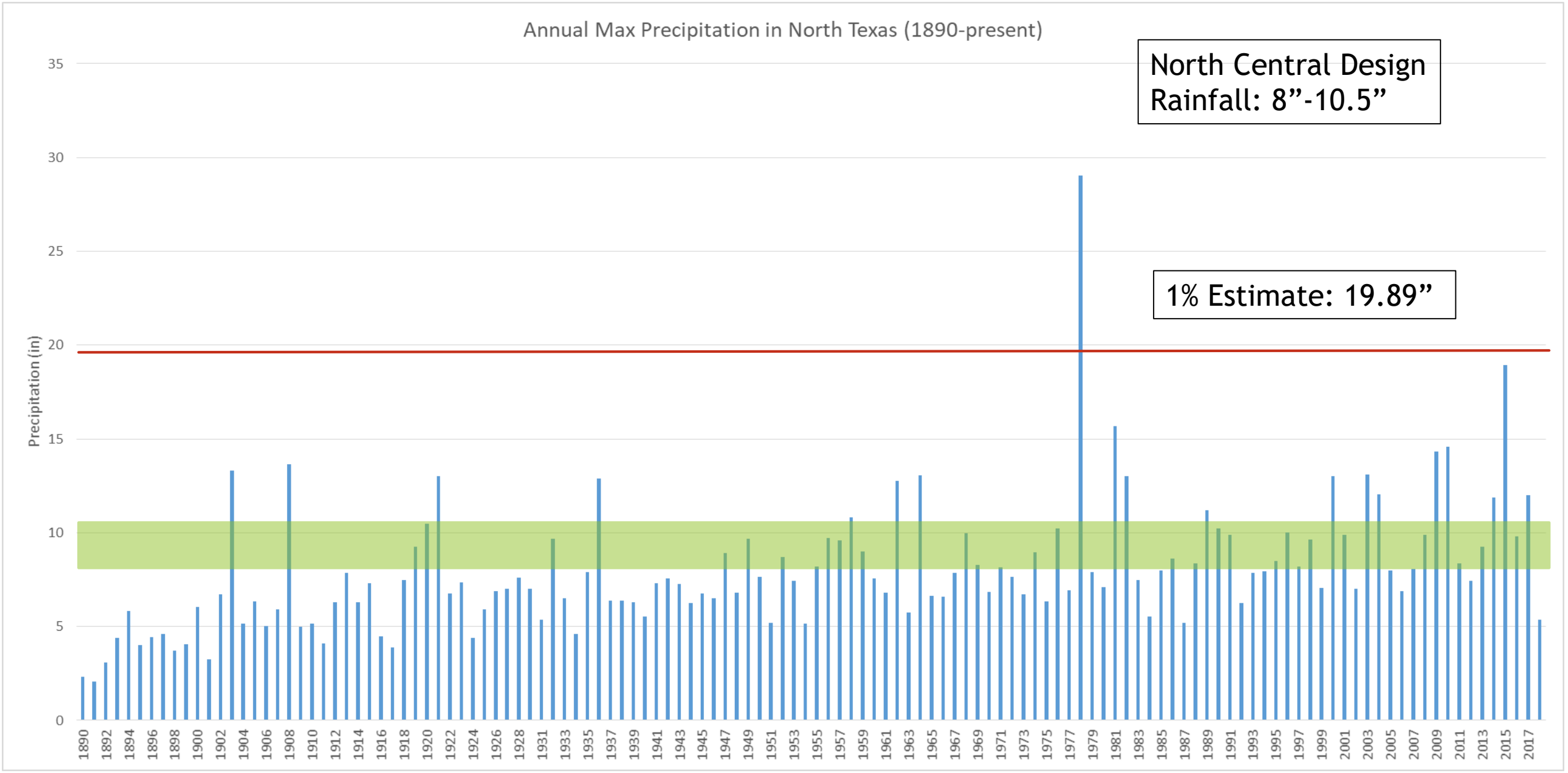
2001
2003
2005
2007
2009
2011
2013
2015
29” - Remnants of TS Amelia
North Central Design Rainfall: 8”-10.5”


Probability Density Function
f(x)
0.6
0.56
0.52
0.48
0.44
0.4
0.36
0.32
0.28
0.24
0.2
0.16
0.12
0.08
0.04
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
x
Histogram
Gen. Logistic


Annual Max Precipitation in North Texas (1890-present)
North Central Design Rainfall: 8”-10.5”
1% Estimate: 19.89”
Precipitation (in)
0
5
10
15
20
25
30
35
1890
1892
1894
1896
1898
1900
1902
1904
1906
1908
1910
1912
1914
1916
1918
1920
1922
1924
1926
1928
1931
1933
1935
1937
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1941
1943
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2001
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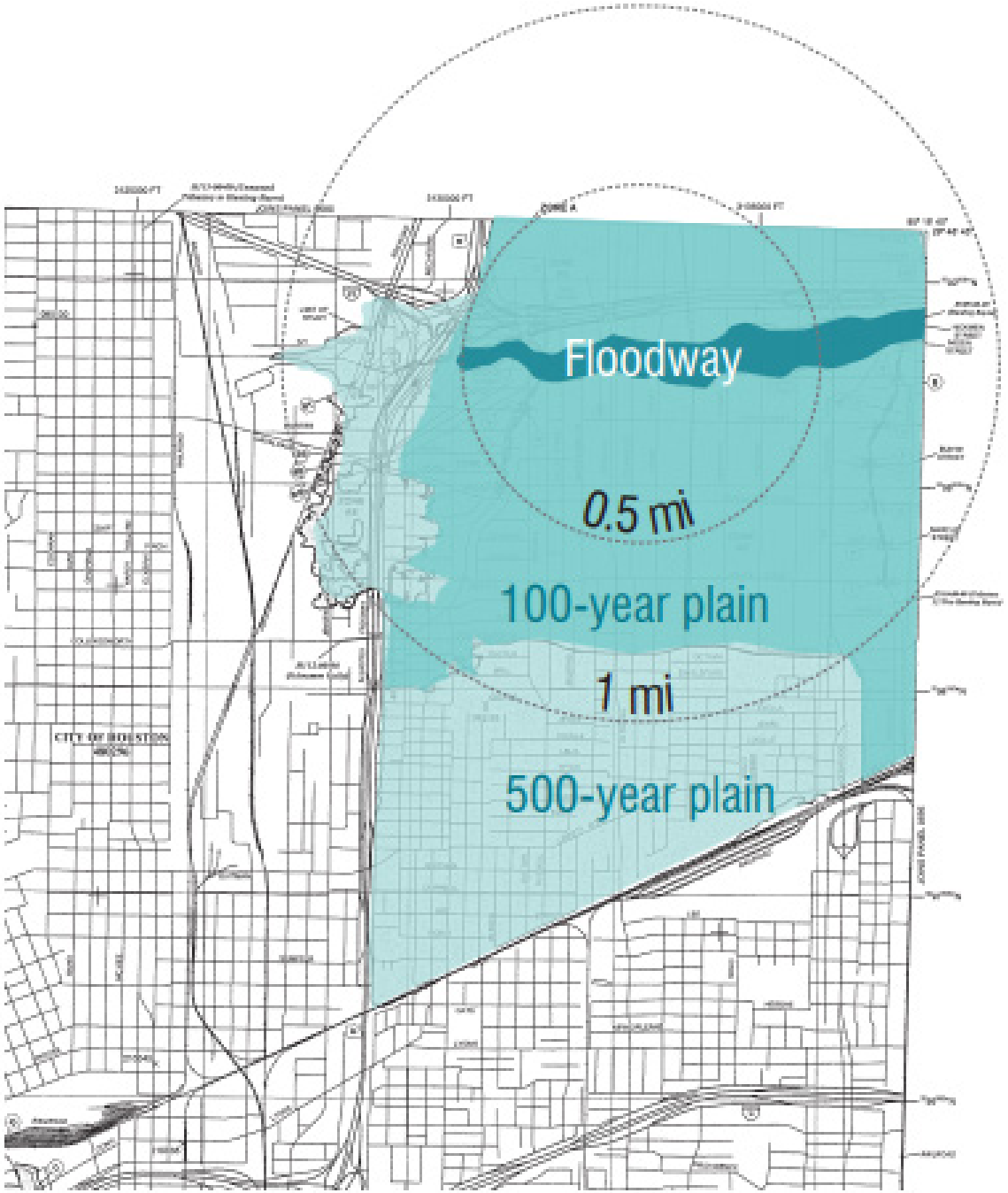
2005
2007
2009
2011
2013
2015
2017

Moving Forward



Fact Sheet #1

What is a floodplain?

Fact Sheet #4

How are floodplains designated?

Fact Sheet

How does rainfall drain away?

Fact Sheet

What is Resilience?

Briefing Document

FLOOD REGULATIONS

Are Policy Changes Needed?

- Current Approach
- Risk Analysis
  - Upper Confidence Interval
  - Up to 1% Tropical Cyclone/Extreme Rainfall Event
    - Emergency Services
    - Major Thoroughfares
    - Major Flood Infrastructure
    - Critical Facilities
- Communicate Risk to Public

Questions

HUITT-ZOLLARS

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