U.S. Global Change Research Program

Fourth National Climate Assessment, Vol II — Impacts, Risks, and Adaptation in the United States

Chapter 21 | Midwest

Dr. Jim Angel

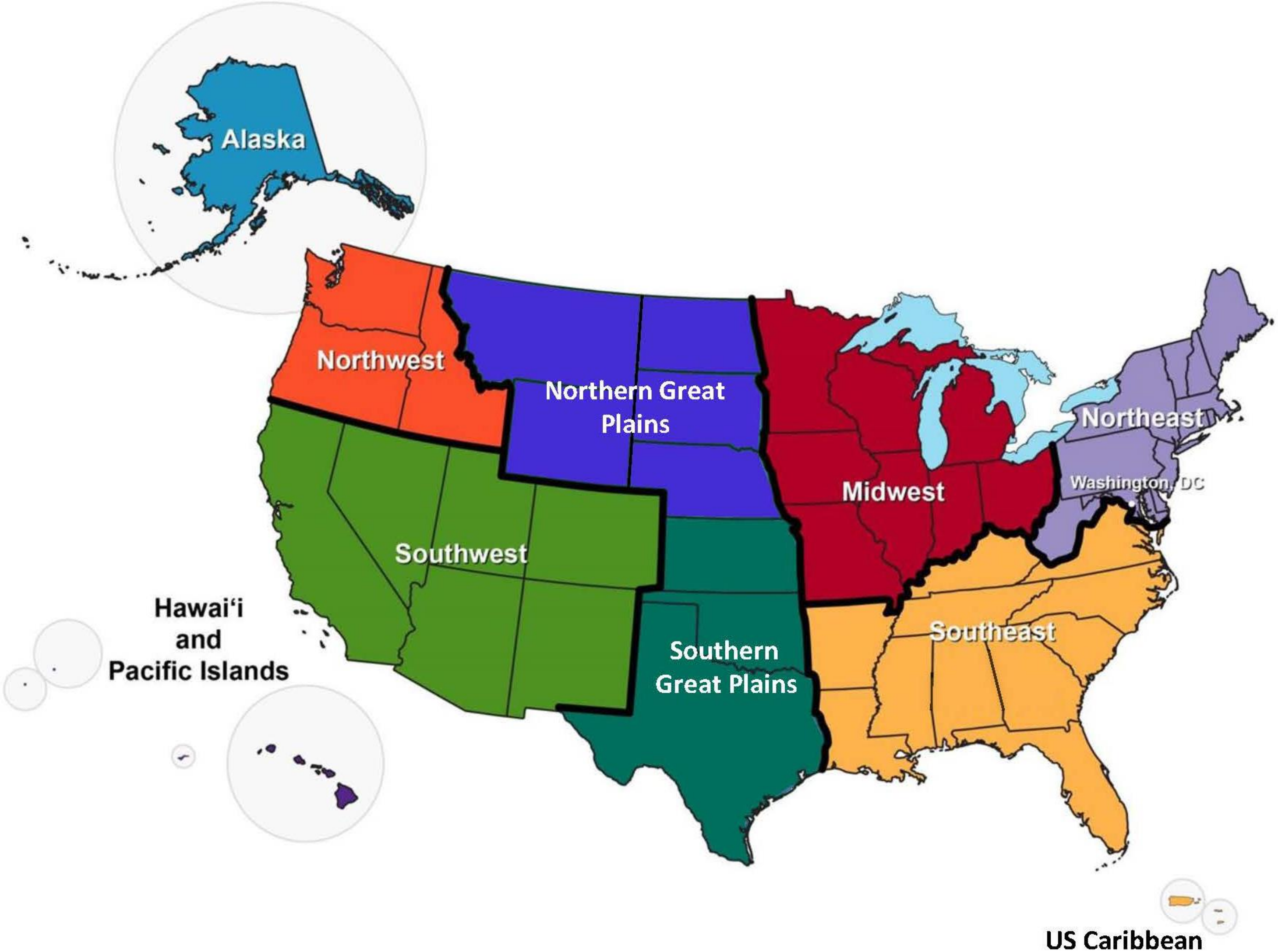
University of Illinois (retired)

https://nca2018.globalchange.gov/

Background

- Mandated Report to Congress Every Four Years
- 13 Federal Agencies
- 300 Authors
- Two Years of Writing and Reviews

NCA4 Regions

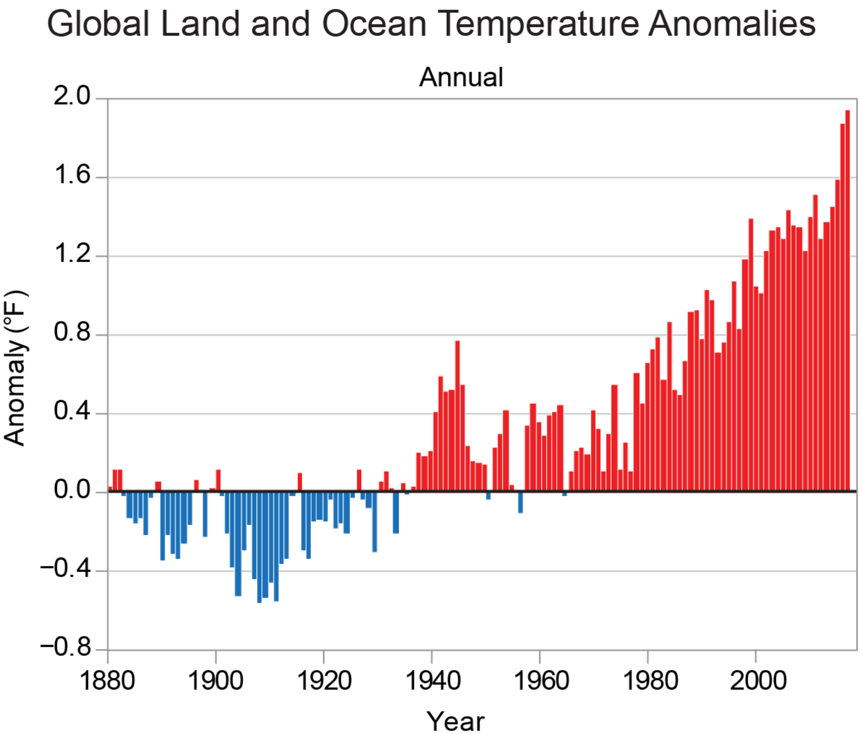


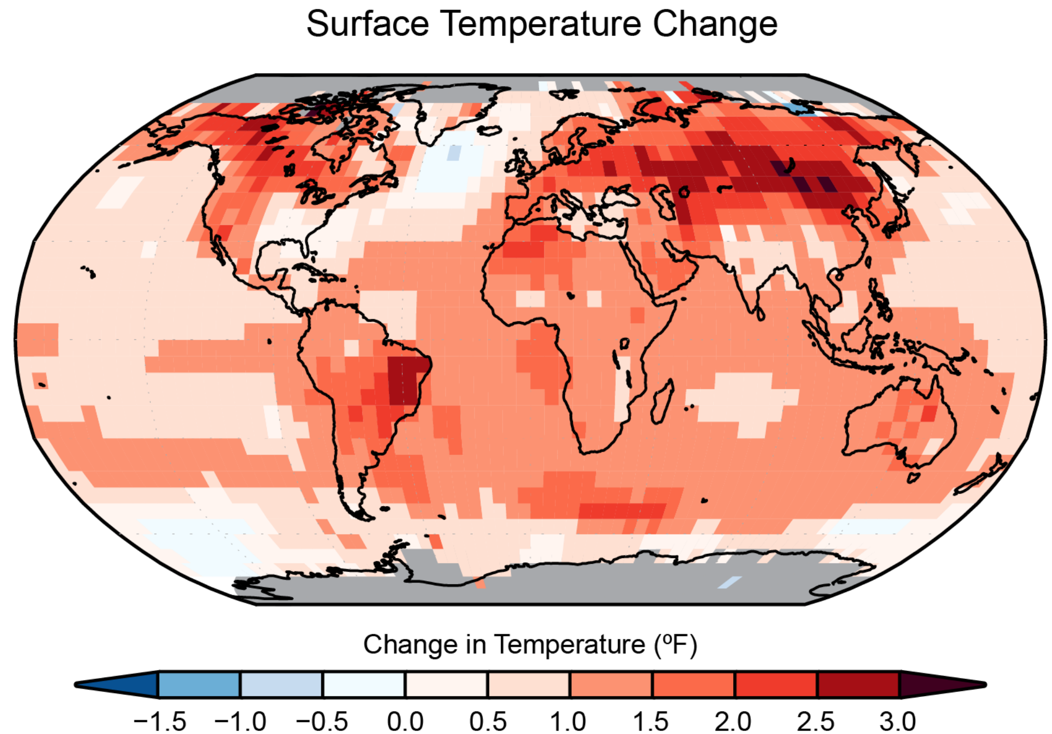
Contents

- Observed Climate Change and Impacts
- Potential Future Risks
- Examples of Adaptation Strategies

- This period is now the warmest in the history of modern civilization.
- … human activities, especially emissions of greenhouse gases, are the dominant cause of the observed warming since the mid-20th century

https://science2017.globalchange.gov/



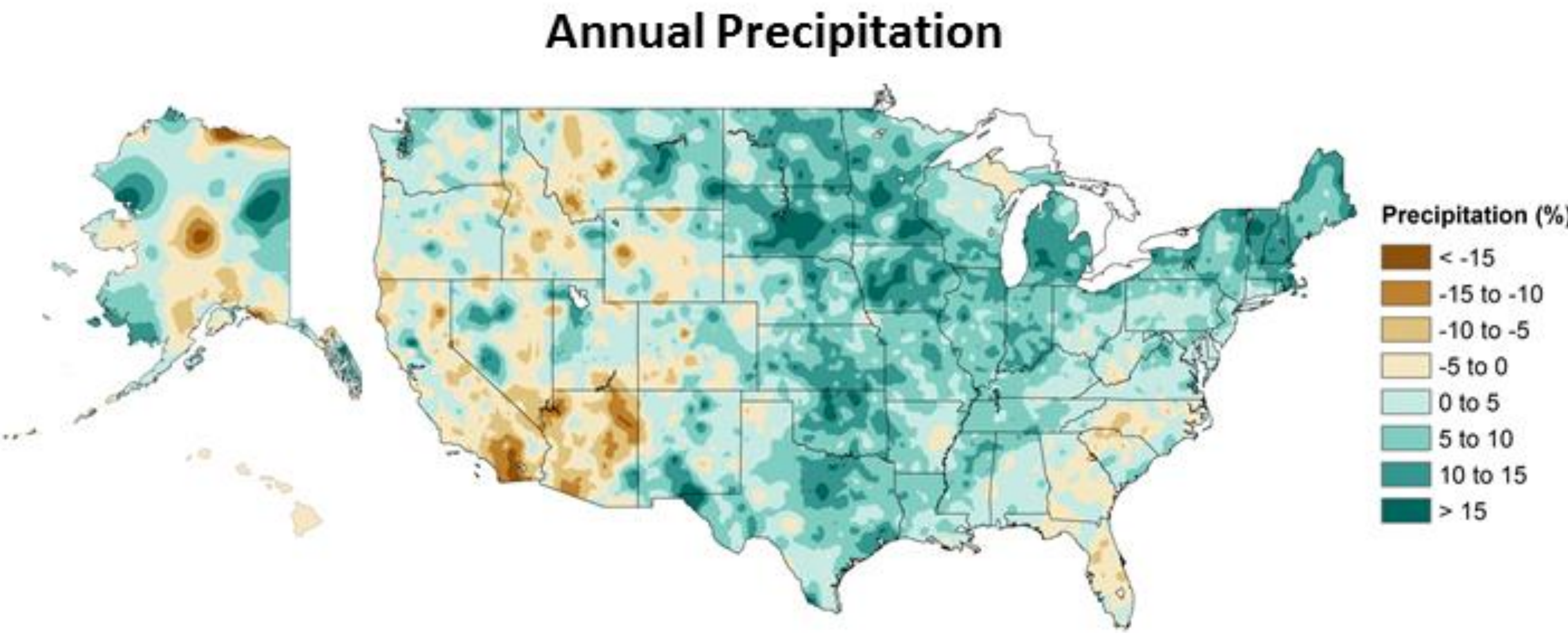


Caption: (left) Global annual average temperature has increased by more than 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960. Red bars show temperatures that were above the 1901–1960 average, and blue bars indicate temperatures below the average. (right) Surface temperature change (in °F) for the period 1986–2016 relative to 1901–1960. Gray indicates missing data. *From Figures 1.2. and 1.3 in Chapter 1.*

21 Key Messages

- Agriculture
- Forests
- Ecosystems
- Human Health
- Infrastructure
- Vulnerable Communities
- Case study of the Great Lakes region

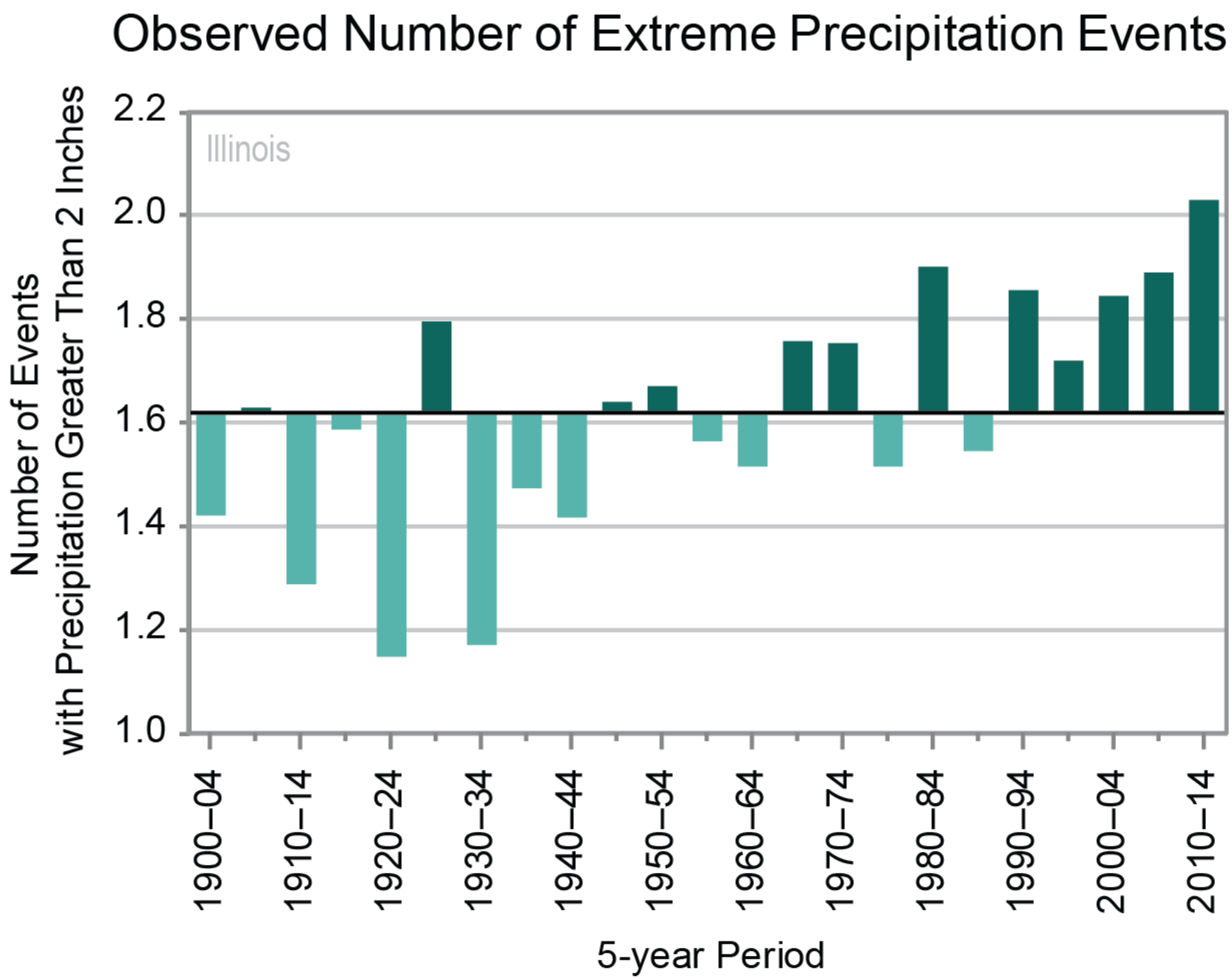
1986-2015 minus 1901-1960



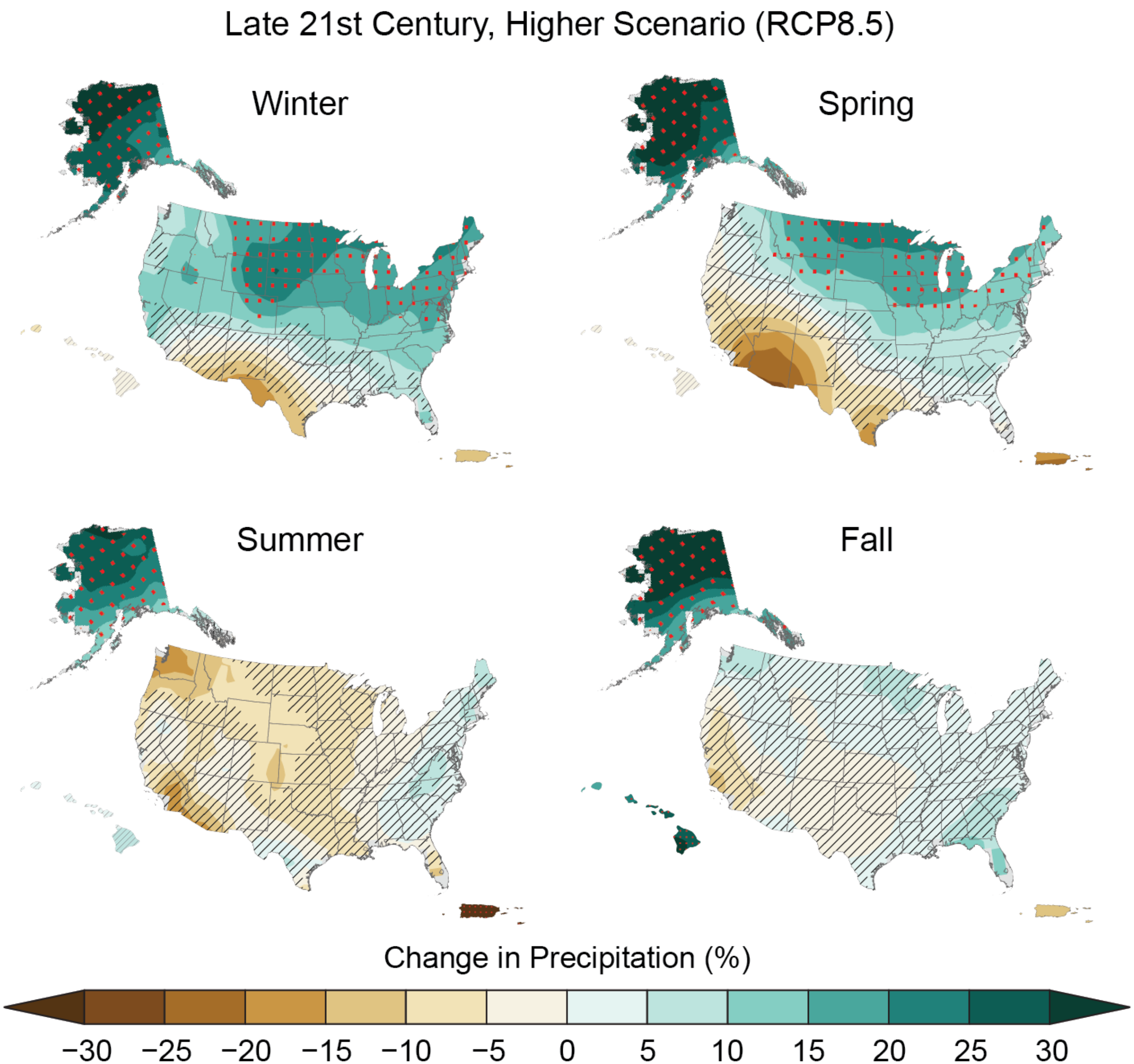
Increased Humidity

U.S. Global Change Research Program

Illinois



Observed Number of Extreme Precipitation Events
Number of Events
with Precipitation Greater Than 2 Inches
Illinois
2.2
2.0
1.8
1.6
1.4
1.2
1.0
1900–04
1910–14
1920–24
1930–34
1940–44
1950–54
1960–64
1970–74
1980–84
1990–94
2000–04
2010–14
5-year Period

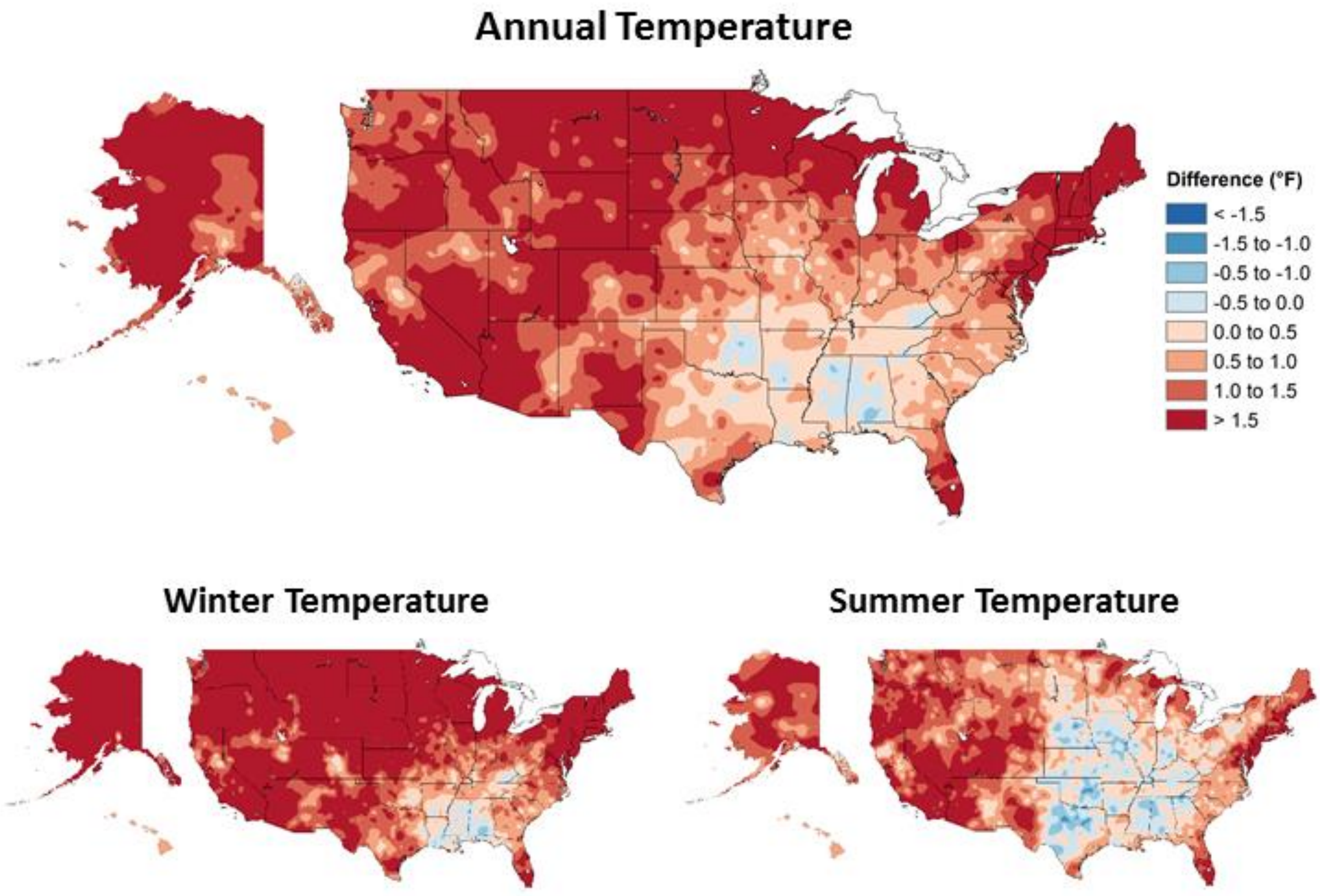


Late 21st Century, Higher Scenario (RCP8.5)
Winter
Spring
Summer
Fall
Change in Precipitation (%)
−30 −25 −20 −15 −10 −5 0 5 10 15 20 25 30

2070-2099

- Volume I of the NCA4
- Precipitation will continue to increase (medium confidence)
- Heavy precipitation events will increase in frequency and amounts (high confidence)

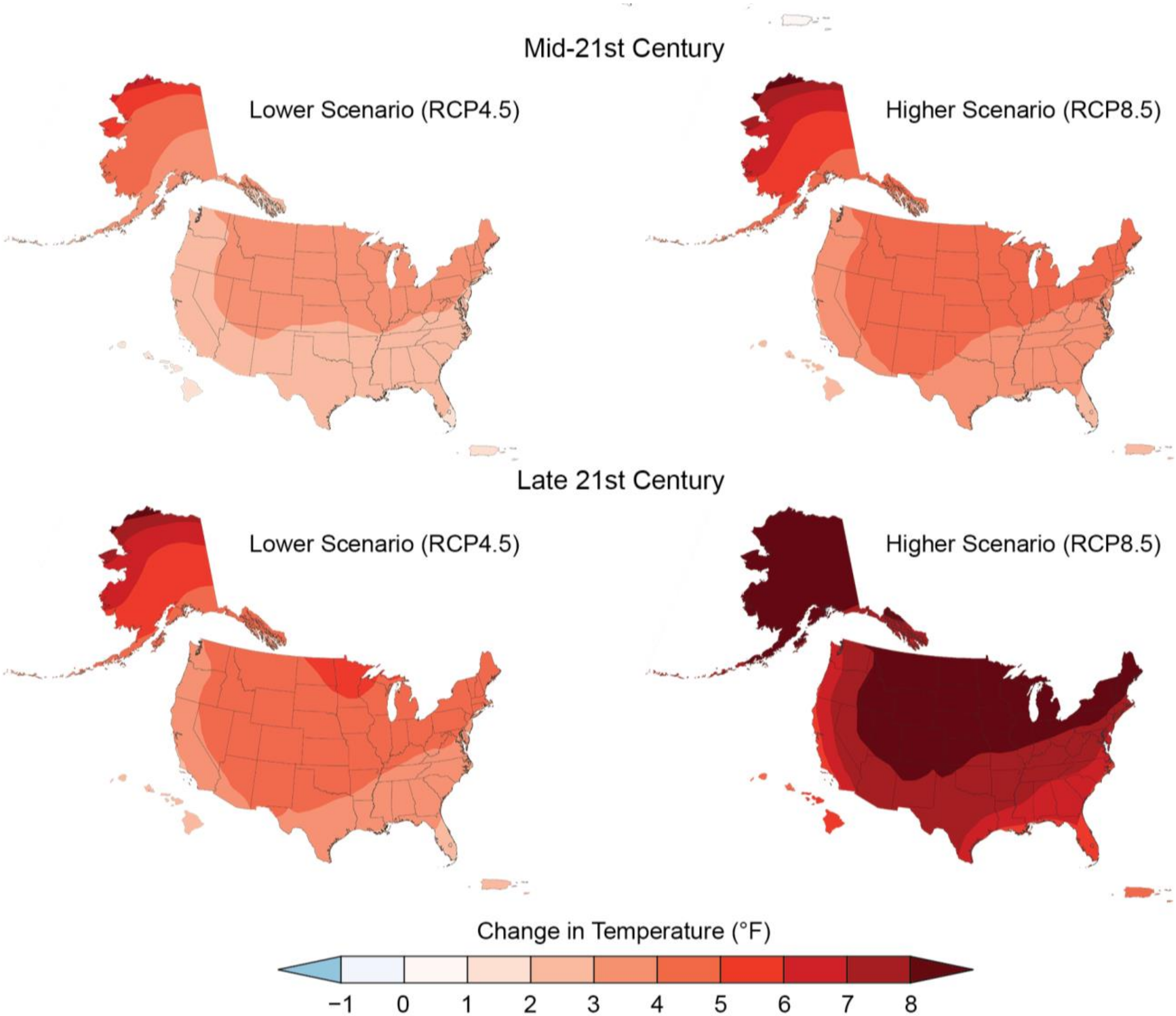
https://science2017.globalchange.gov/



Observed Warming

1986-2016 minus 1901-1960

Projected Change in Temperatures



21 Key Message #1

Agriculture

… Increases in warm-season absolute humidity and precipitation have eroded soils, created favorable conditions for pests and pathogens, and degraded the quality of stored grain.

Projected changes in precipitation, coupled with rising extreme temperatures before mid-century, will reduce Midwest agricultural productivity to levels of the 1980s without major technological advances.

21 Key Message #4

Human Health

Climate change is expected to worsen existing health conditions and introduce new health threats by increasing the frequency and intensity of:

- poor air quality days;
- extreme high temperature events and heavy rainfalls;
- extending pollen seasons;
- modifying the distribution of disease-carrying pests and insects.

High Cost of Heat

Labor Costs from High Heat Under the High Scenario

- By 2050, the annual costs in the Midwest would be $9.8 billion per year
- By 2090, the annual costs would be $33 billion per year

21 Key Message #5

Transportation and Infrastructure

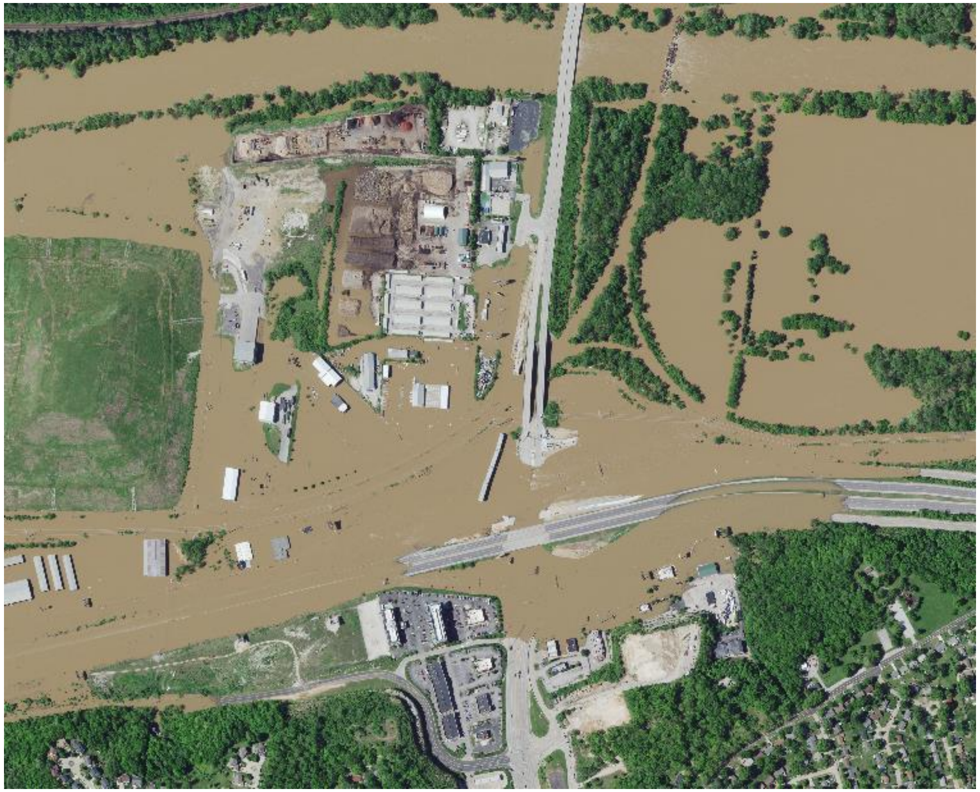
Storm water management systems, transportation networks, and other critical infrastructure are already experiencing impacts from changing precipitation patterns and elevated flood risks.

Green infrastructure is reducing some of the negative impacts by using plants and open space to absorb storm water.

The **annual** cost of adapting urban storm water systems to more frequent and severe storms is projected to exceed $500 million for the Midwest by the end of the century.

Fig. 21.11: Meramec River Flooding

This composite image shows portions of Interstate 44 near St. Louis that were closed by Meramec River flooding in both 2015 and 2017. The flooding shown here occurred in May 2017. *Image credit: Surdex Corporation.*



Summary

- Observed significant impacts in the Midwest, caused primary by a shift towards wetter conditions with more heavy rains
- Future challenges will include the arrival of increased temperatures and extreme heat
- Adaptation and mitigation efforts have begun but much more is needed

https://nca2018.globalchange.gov/chapter/21/

Frequency Distributions of Heavy Precipitation in Illinois: Updated Bulletin 70

Jim Angel and Momcilo Markus

Illinois State Water Survey
PRAIRIE RESEARCH INSTITUTE

ILLINOIS

Acknowledgments

Work supported by the Illinois Department of Commerce and Economic Opportunity under Grant No. 08-355061 and funded by the U.S. Department of Housing and Urban Development's Community Development Block Grants Award No. B-08-DI-17-0001.

Coordinated with IDNR Office of Water Resources.

Sally McConkey, David Kristovich, Bryan Kerschner, Mary Richardson, Wes Cattoor, Kexuan Arial Wang, Lu Jin, Shaoxuan Guo, Shailendra Singh, Tom Over, Annie Peiyong Qu, Francina Dominguez, Ryan Shriver, and Lisa Sheppard

Rainfall frequency sources
TP-40, ISWS Bulletin 70, NOAA Atlas 14

U.S. DEPARTMENT OF COMMERCE
LUTHER H. HODGES, Secretary

WEATHER BUREAU
F. W. REICHELDERFER, Chief

TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and
Return Periods from 1 to 100 Years

Prepared by
DAVID M. HERSHFIELD
Cooperative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

WASHINGTON, D.C.
May 1961
Repaginated and Reprinted January 1963

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $1.25

BULLETIN 70

Frequency Distributions and Hydro climatic Characteristics of Heavy Rainstorms in Illinois

by FLOYD A. HUFF and JAMES R. ANGEL

Title: Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois.

Abstract: This report presents the results of an extensive investigation of the distribution of heavy rainstorms in Illinois based on data for 61 precipitation stations operated during 1901-1983. Shown are frequency distributions of point rainfall for periods ranging from 5 minutes to 10 days and for recurrence intervals of from 2 months to 100 years. Results are presented in two forms: mean relations for 10 regions of approximately homogeneous precipitation climate, and statewide isohyetal maps based on the 61 -station data. Frequency relations are presented on both an annual and seasonal basis. Results of a special investigation are presented for Chicago and the surrounding six counties subject to urban influences on precipitation distribution. Information is provided on the expected dispersion of point rainfall frequency distributions about the mean in the 10 regions of similar rainstorm climate. Information is also provided on the spatial and temporal characteristics of heavy rainstorms in Illinois.

Reference: Huff, Floyd A., and James R. Angel. Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois. Illinois State Water Survey, Champaign, Bulletin 70, 1989.

Indexing Terms: Climatology, heavy rainstorms, hydroclimatology, hydroineteorology, Illirwis, rainfall, synoptic weather conditions.

NOAA Atlas 14

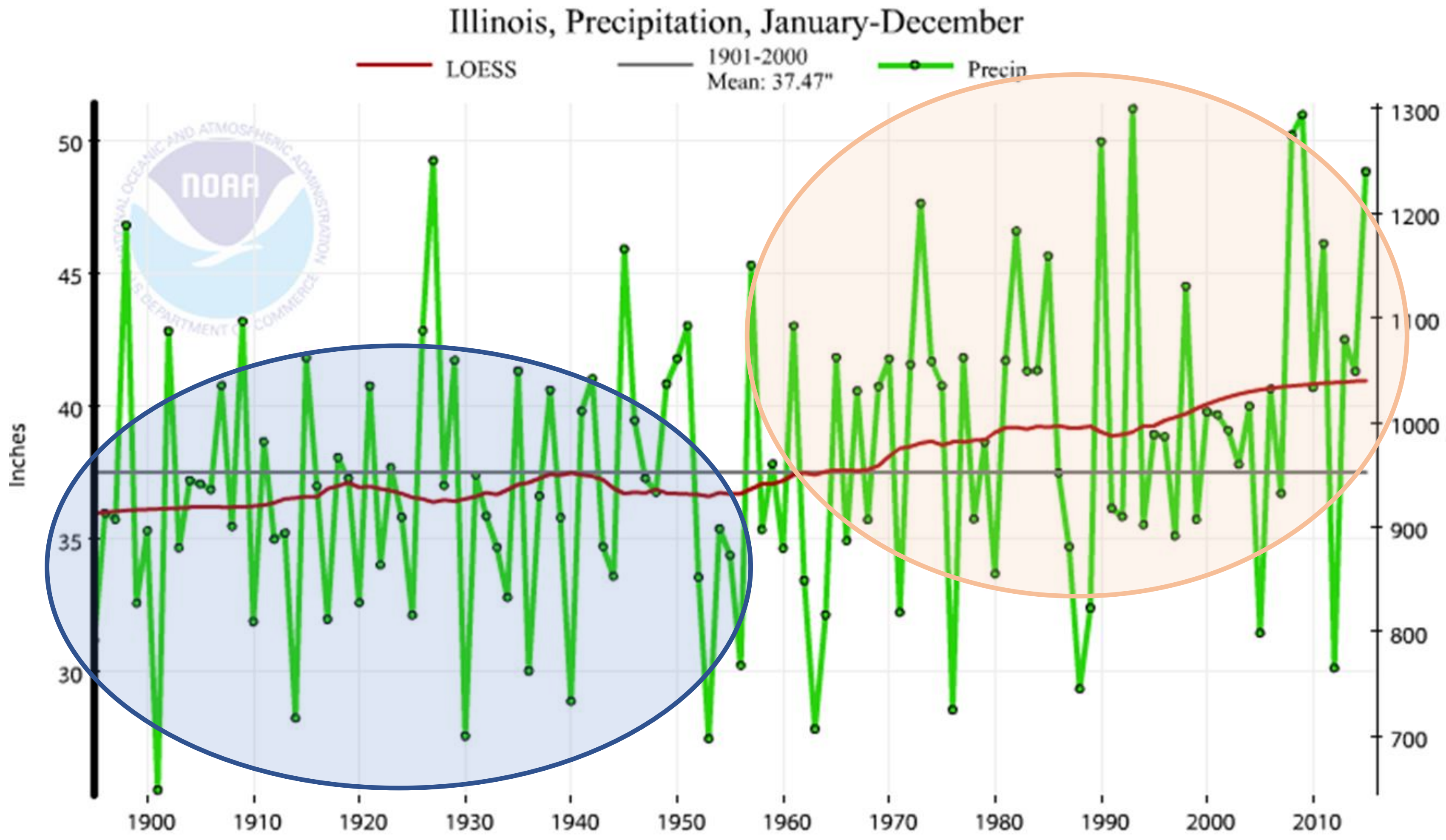
Precipitation-Frequency Atlas of the United States

Volume 7 Version 2.0: Alaska

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

rtment
merce,
ceanic
spheric
tration,
eather
Service
and
rsity of
banks,
er and
mental
Center

Spring,
, 2012



Illinois, Precipitation, January-December
LOESS
1901-2000
Mean: 37.47"
Precip
Inches
Millimeters
50
45
40
35
30
1300
1200
1100
1000
900
800
700
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

Our Solution …

- Use 1948-2017 data to better represent the current, wetter climate
- Three times as many stations are available from 1948 onward
- Include a Bulletin 70 style adjustment by giving more weight to the second half of the record

L-Moments Software

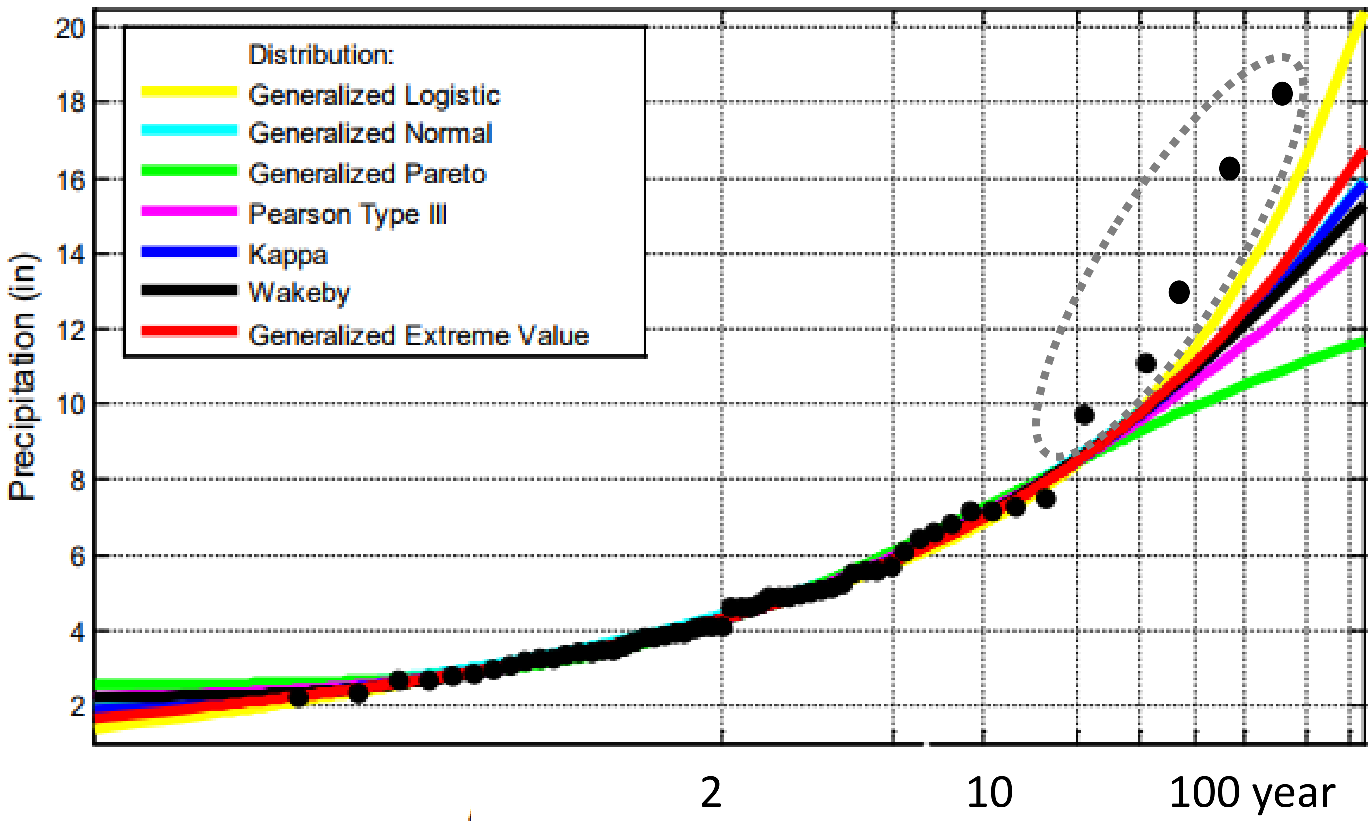
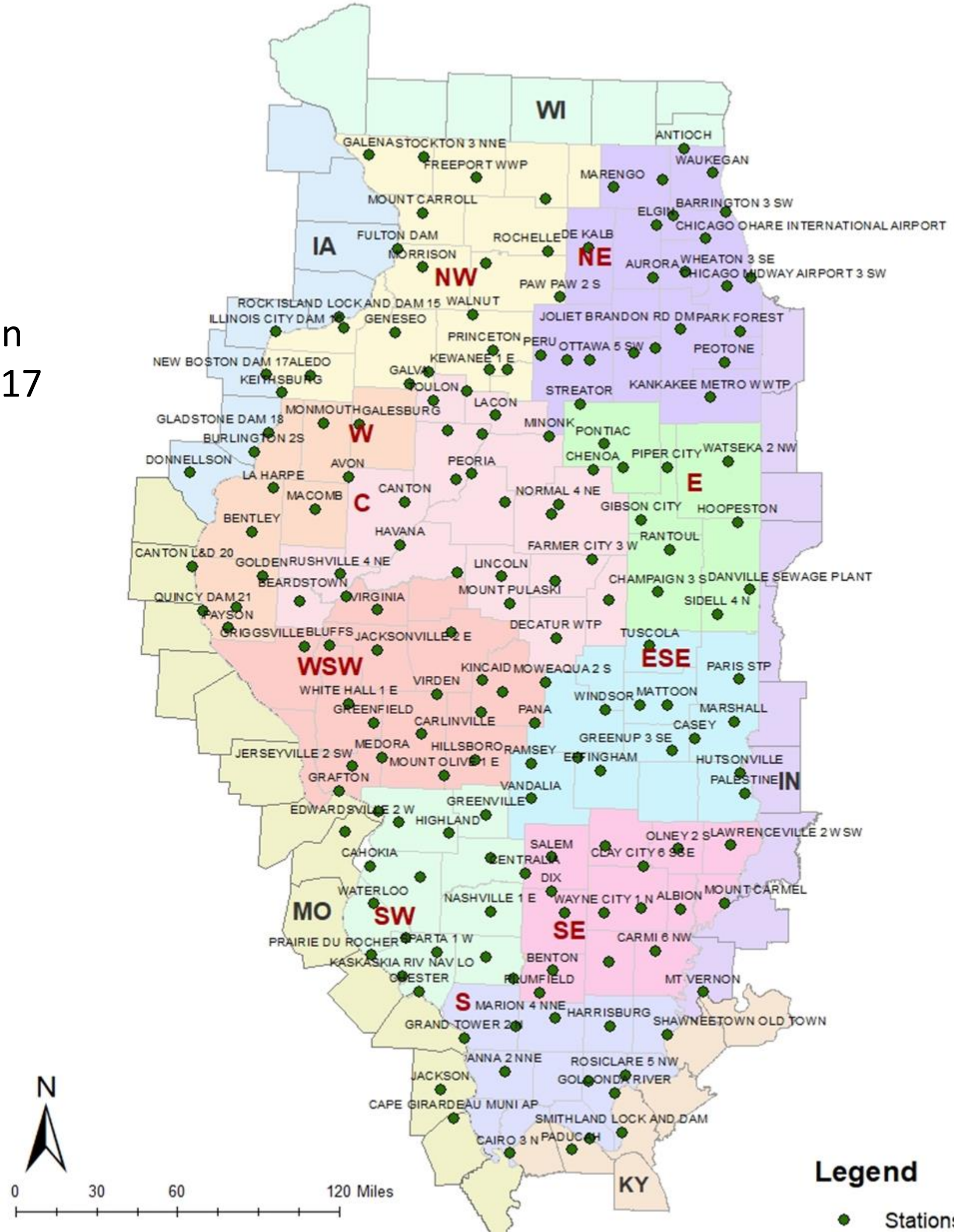
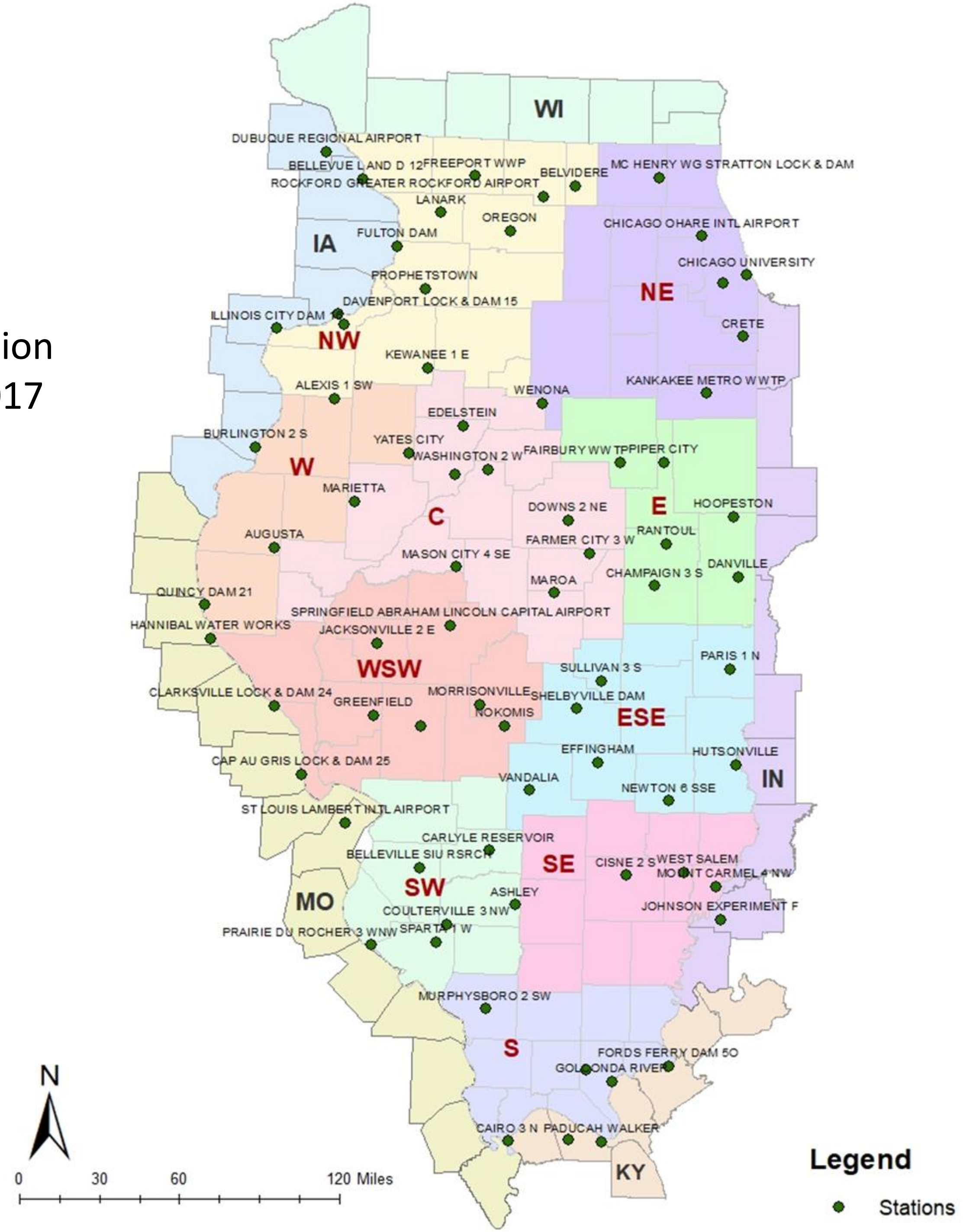


Figure 4.6.3. Probability plots for selected distributions for 1-day AMS at station Nowata (34-6485) in Oklahoma.

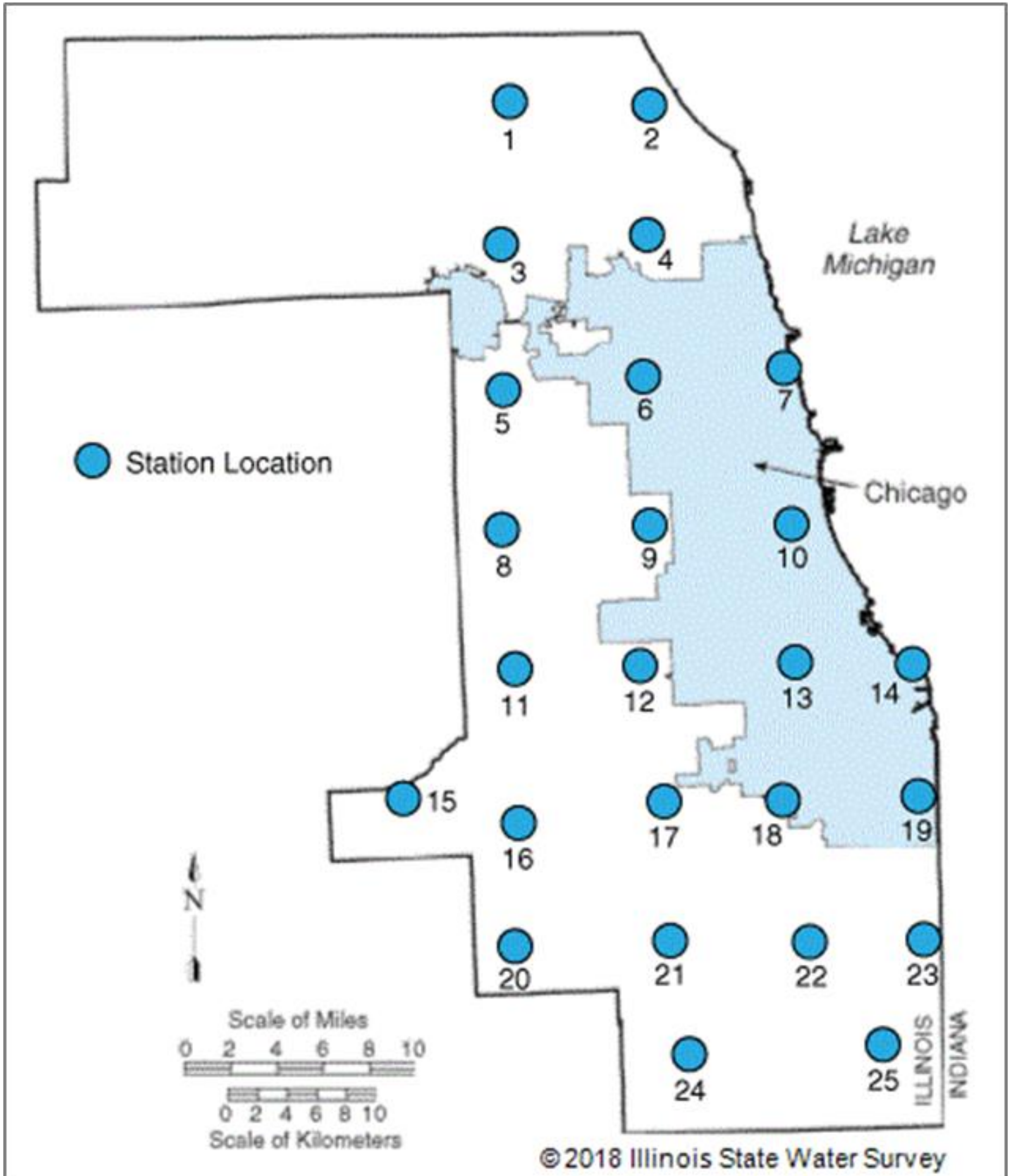
Daily Precipitation
Stations 1948-2017



Hourly Precipitation Stations 1948-2017



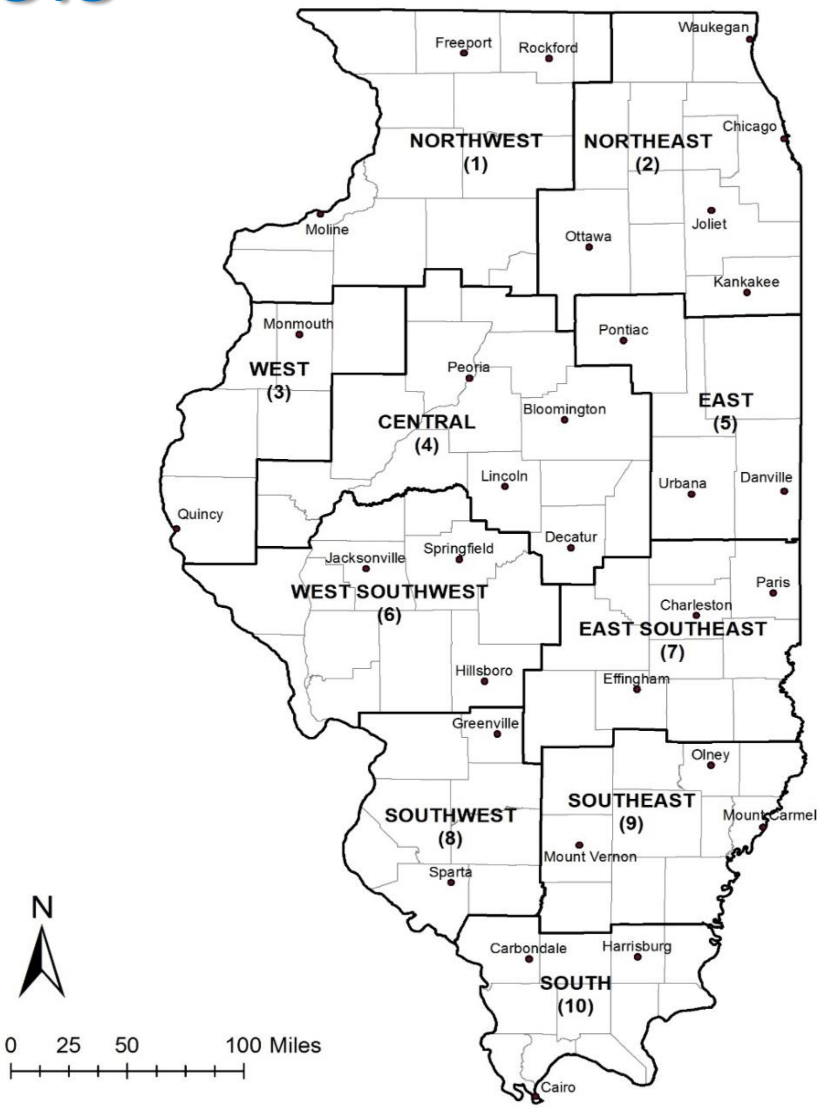
Cook County Precipitation Network 1989-2016



Similar to Bulletin 70

- Same 10 regions
- Return Period from 2 years to 500 years
- Durations of 1 hour to 10 days
- Designed to take into account **observed** climate change

10 Regions in Illinois



Process

- Obtained and QC'd the data
- Selected stations based on availability and length of record
- Calculated the expected precipitation at selected return period for 1 to 10 days using L-moments

Process

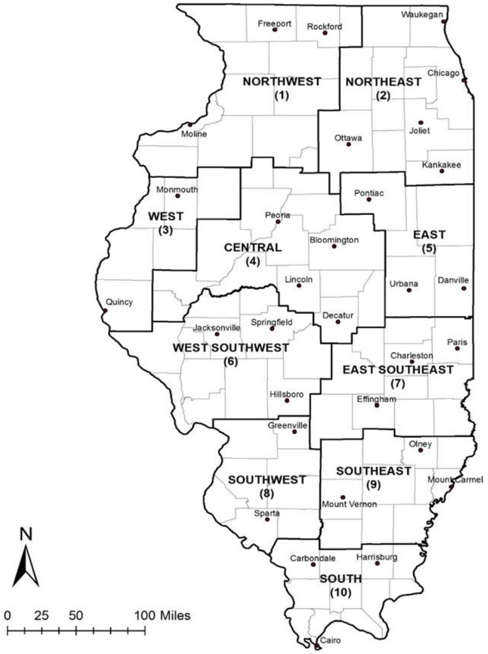
- Adjusted the results from the annual maximum series into a partial duration series using a standard approach (Langbein's equation, 1949)
- Converted the constrained to unconstrained using standard conversions

Table 1 Conversion from Constrained to Unconstrained Precipitation Adopted in this Study

From	1 day	2 days	3 days	5 days	10 days
To	24 hours	48 hours	72 hours	120 hours	240 hours
Conversion factor	1.13	1.04	1.02	1.01	1.00

Process …

- Averaged the station frequency values into a regional frequency analysis (RFA)



Process

- Calculate the less than 24 hour durations using conversion factors due to limitations of hourly data

Table 2 X-hr:24-hr Ratios

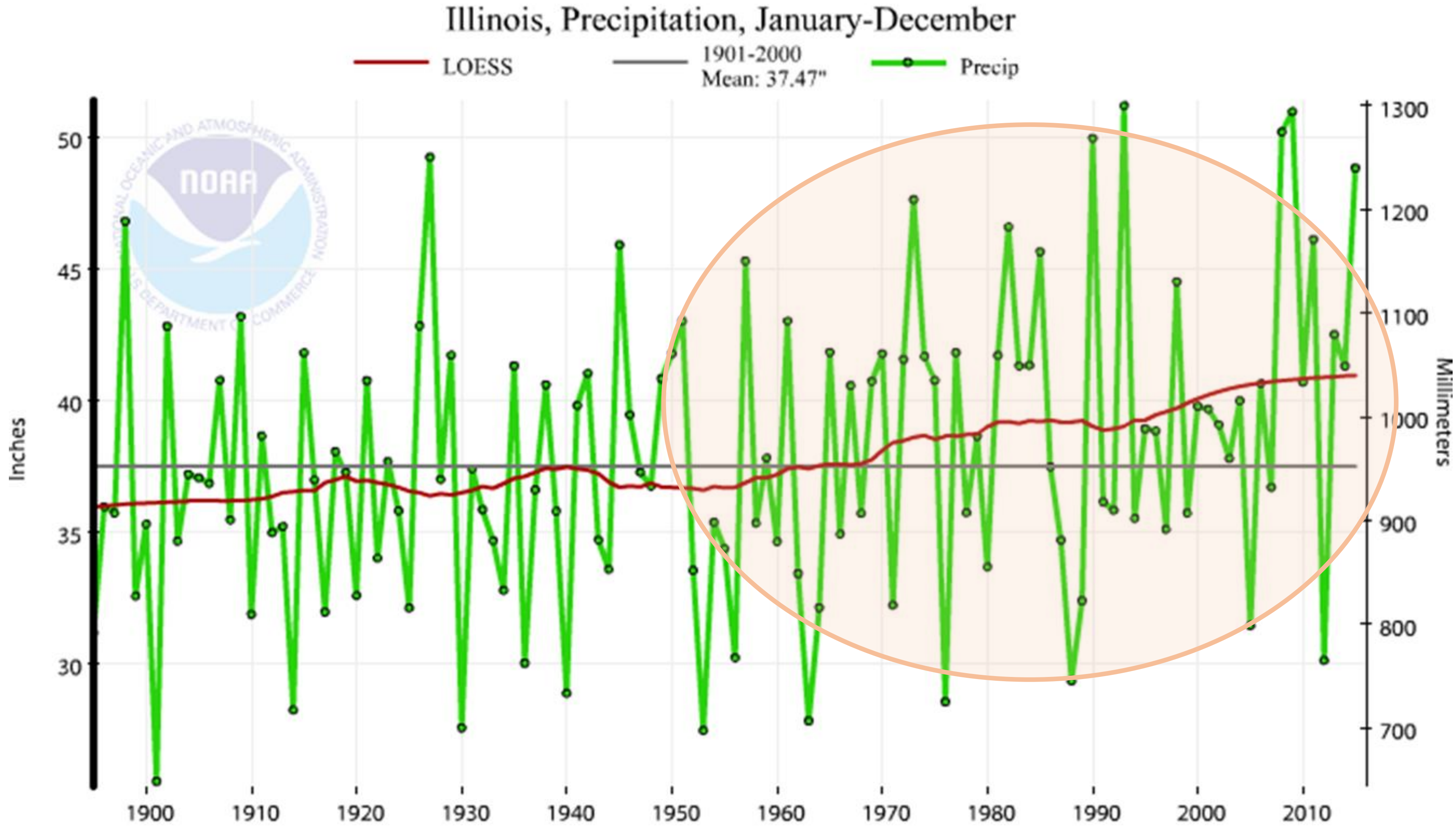
Storm Duration (hours)	RFA 1948-2017	Bulletin 70	Atlas 14	Adopted
1	0.42	0.47	0.47	0.47
2	0.56	0.58	0.57	0.58
3	0.64	0.64	0.63	0.64
6	0.76	0.75	0.75	0.75
12	0.87	0.87	0.86	0.87
18	0.94	0.94	N/A	0.94

Adjustment for Non-Stationarity

- Ratio of the 1983-2017 RFA divided by the 1948-1982 RFA

Table 3 Temporal Trend Adjustment Factors for 10 Sections

	Climatic section	24 hrs	48 hrs	72 hrs	120 hrs	240 hrs	Average
1	Northwest	1.07	1.07	1.03	1.05	1.12	1.07
2	Northeast	1.06	1.12	1.13	1.18	1.21	1.14
3	West	1.00	0.96	0.91	0.92	1.02	0.96
4	Central	1.02	0.94	0.94	0.97	1.08	0.99
5	East	0.99	0.94	0.92	0.96	1.02	0.97
6	West Southwest	0.99	0.97	0.98	1.02	1.10	1.01
7	East Southeast	1.05	0.97	1.02	1.01	1.12	1.03
8	Southwest	1.11	1.09	1.10	1.13	1.26	1.14
9	Southeast	1.07	1.09	1.04	1.03	1.09	1.06
10	South	0.96	1.02	1.06	1.03	0.99	1.01


Illinois, Precipitation, January-December
LOESS
1901-2000
Mean: 37.47"
Precip
Inches
Millimeters
50
45
40
35
30
1300
1200
1100
1000
900
800
700
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

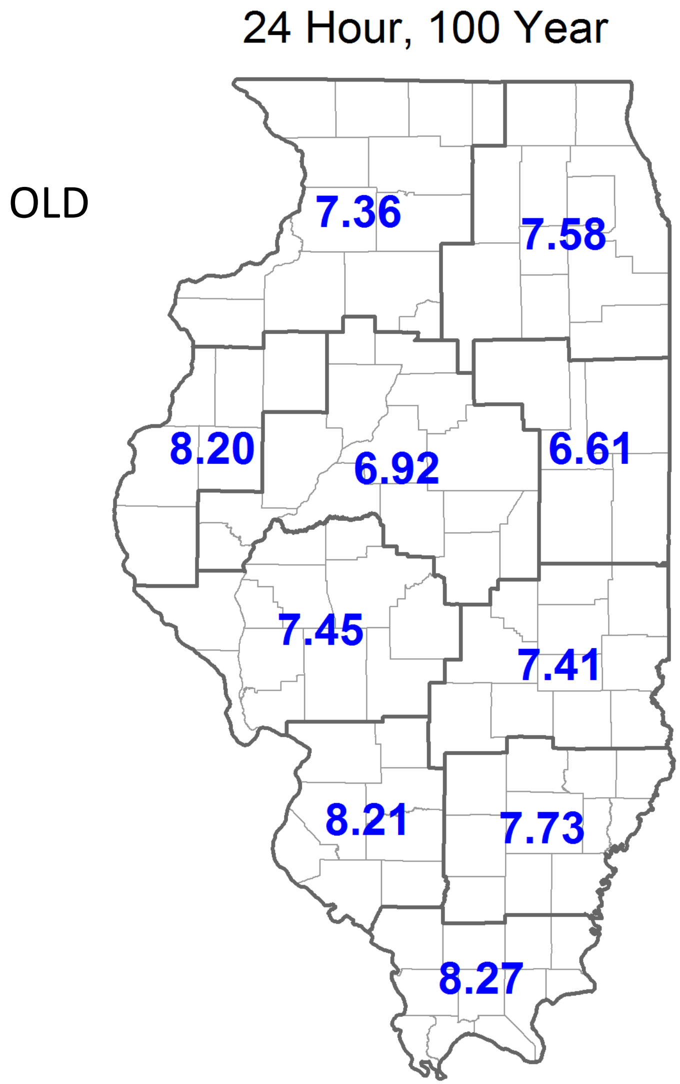
New Tables

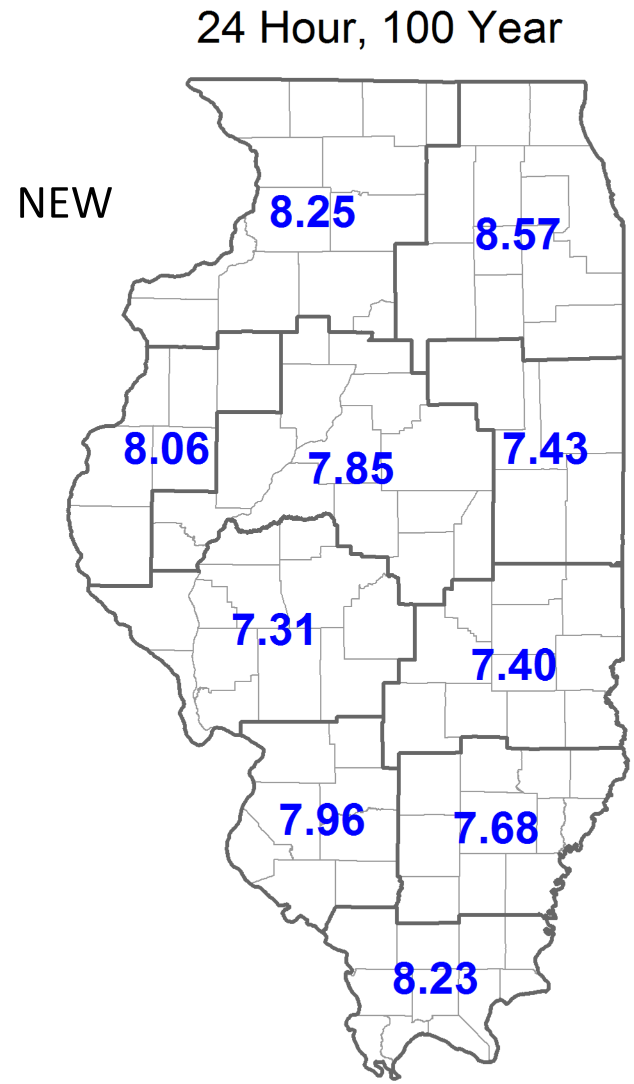
Table 5 Rainfall Frequencies

		Rainfall (inches) for given recurrence interval						
Storm code	*Section code*	*2-year*	*5-year*	*10-year*	*25-year*	*50-year*	*100-year*	*500-year*
1	1	5.48	6.86	7.98	9.55	10.84	12.14	15.65
1	2	5.60	7.09	8.25	9.90	11.26	12.65	16.00
1	3	5.62	7.00	8.10	9.60	10.65	11.64	13.99
1	4	5.46	6.87	8.04	9.53	10.55	11.50	13.65
1	5	5.50	6.84	7.90	9.35	10.45	11.55	13.96
1	6	6.00	7.38	8.47	9.95	10.99	11.95	14.08
1	7	6.57	7.86	8.90	10.20	11.20	12.06	13.95
1	8	6.75	8.18	9.30	10.80	11.95	13.10	15.95
1	9	7.06	8.30	9.22	10.37	11.21	11.96	13.75
1	10	6.36	7.65	8.76	10.40	11.66	12.96	16.20

Sample of the 240 hour (10-day) storm

Old and New 100-Yr, 24-Hour Storm

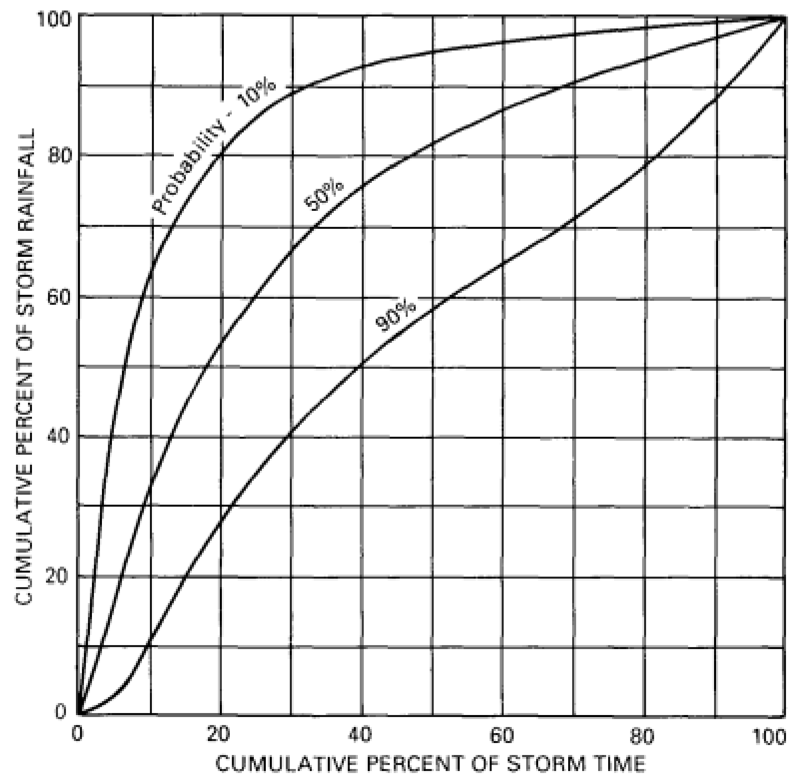




Volume 2

- Revisit the Huff curves (time distribution within the storm), using the Cook County Precipitation Network (CCPN)
- Area Reduction Factors

Figure 9. Time distribution of point rainfall in first-quartile storms



ISWS Contract Report 2019-05

http://hdl.handle.net/2142/103172

NBC News (2019)