Frequency Distributions of Heavy Precipitation in Illinois: Updated Bulletin 70

Jim Angel and Momcilo Markus

Illinois State Water Survey

PRAIRIE RESEARCH INSTITUTE

ILLINOIS

Acknowledgments

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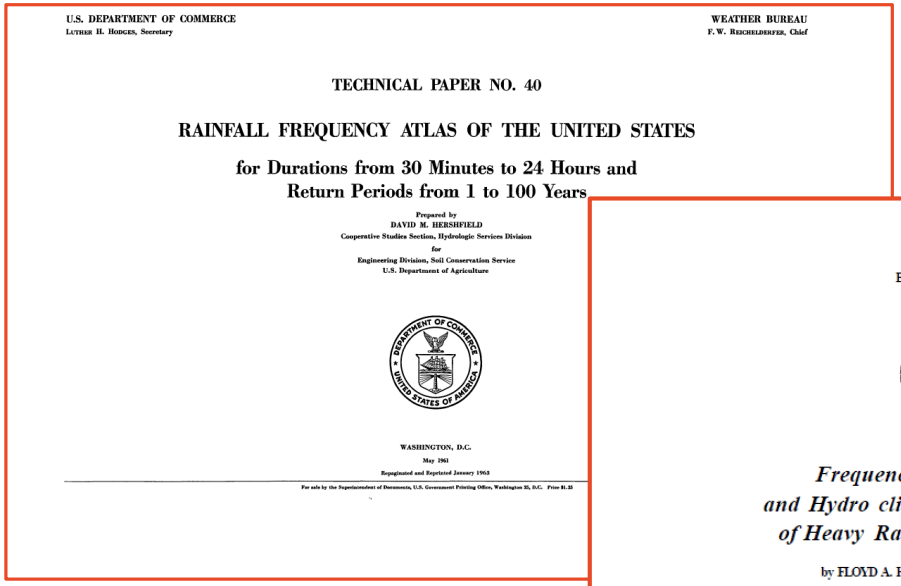
Coordinated with IDNR Office of Water Resources.

Sally McConkey, David Kristovich, Brian 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
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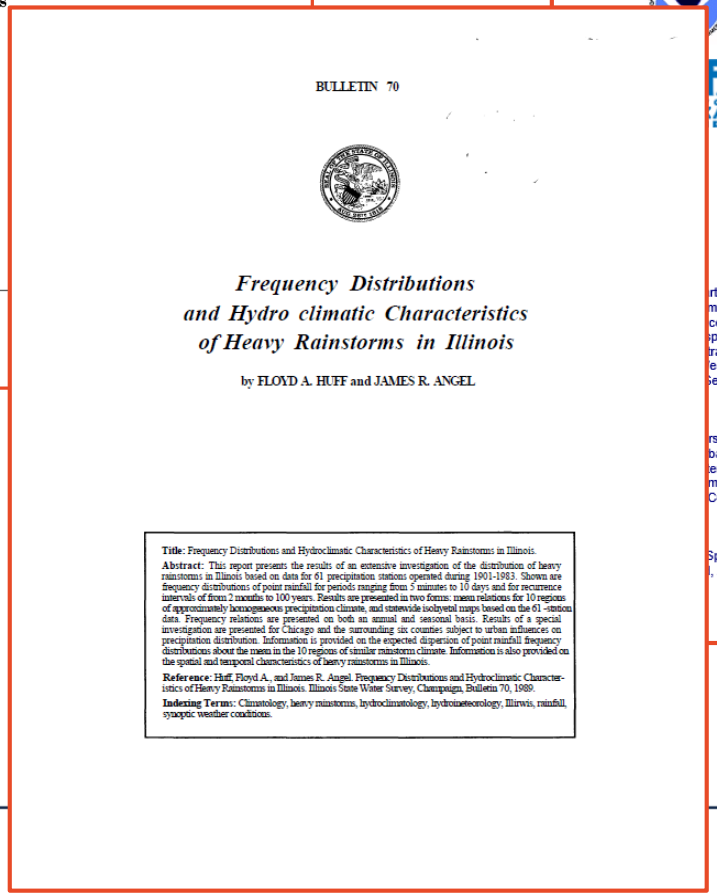
WASHINGTON, D.C.
May 1961
Reprinted and Reprinted January 1963



BULLETIN 70

Frequency Distributions
and Hydro climatic Characteristics
of Heavy Rainstorms in Illinois

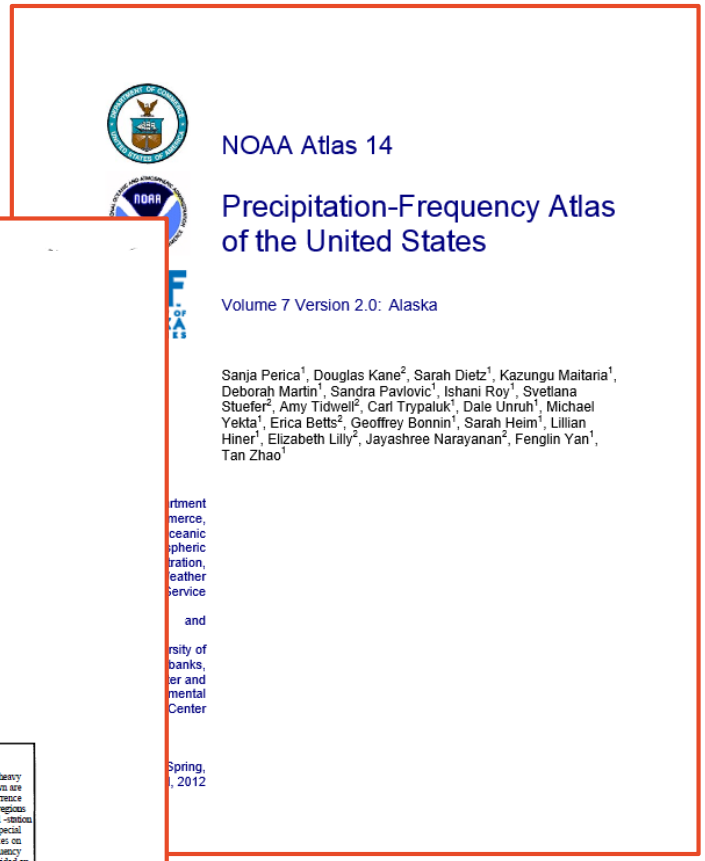
by FLOYD A. HUFF and JAMES R. ANGEL

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, hydrometeorology, Illinois, rainfall, synoptic weather conditions.



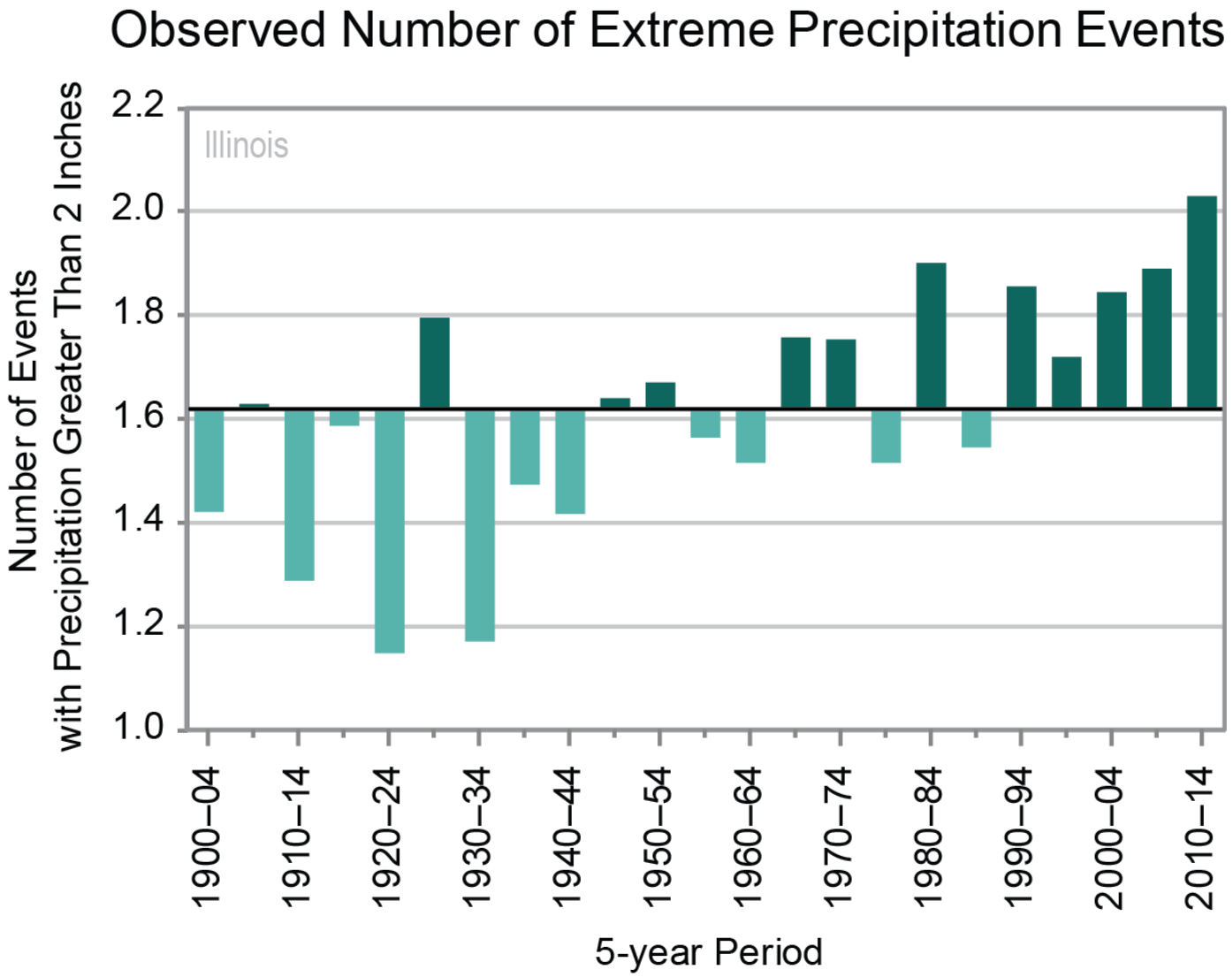
NOAA Atlas 14

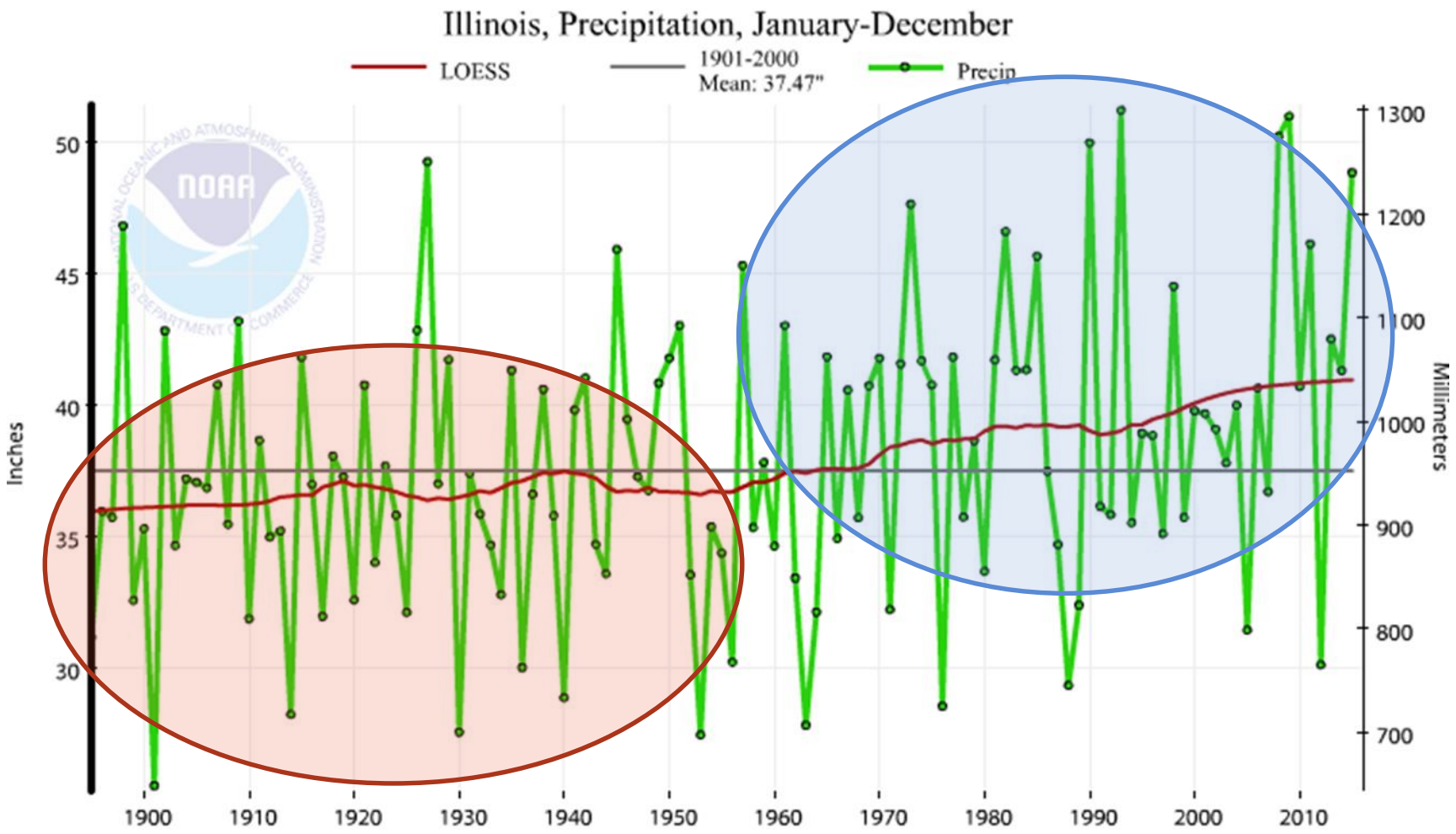
Precipitation-Frequency Atlas of the United States

Volume 7 Version 2.0: Alaska

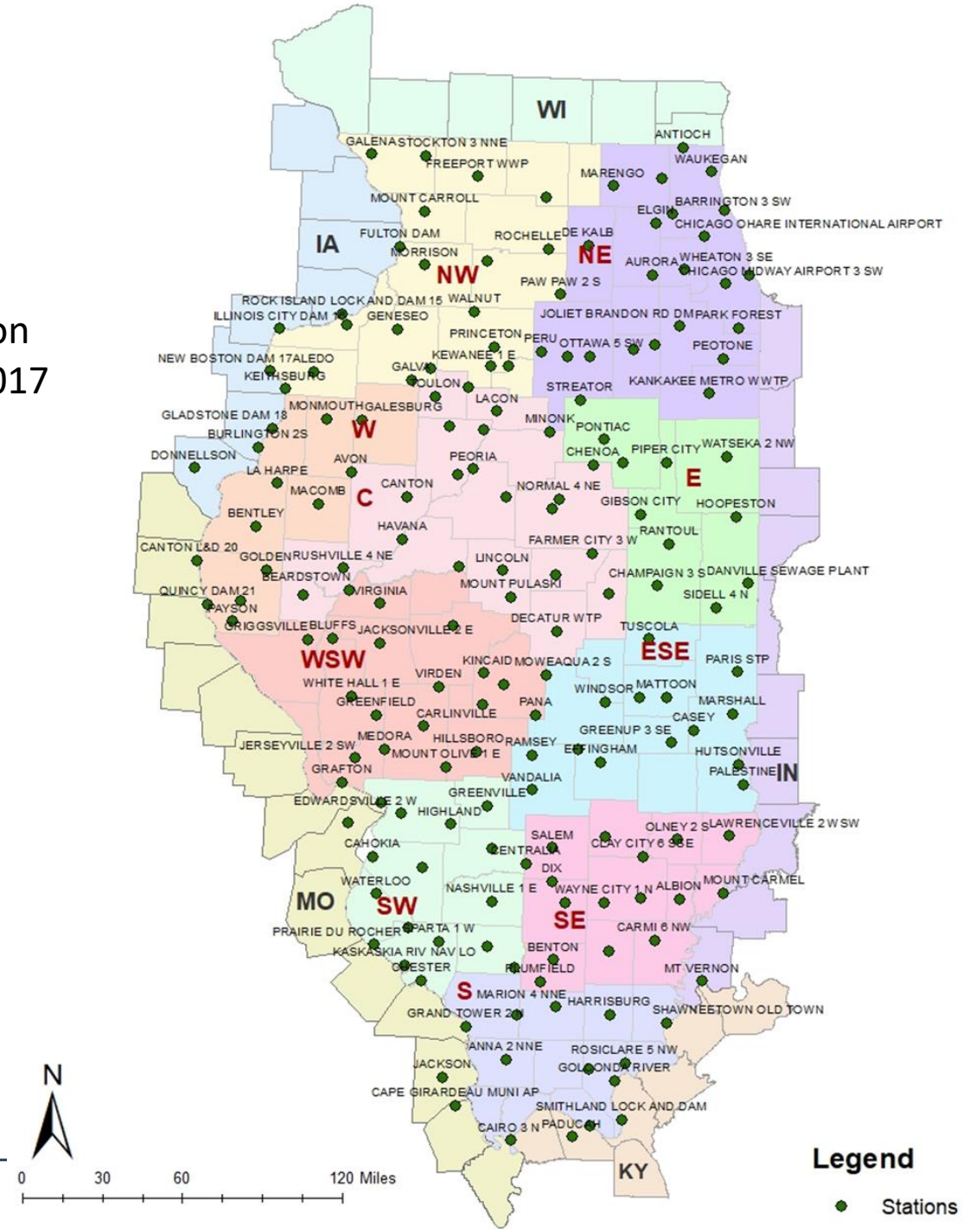
Sanja Perica[1], Douglas Kane[2], Sarah Dietz[1], Kazungu Maitaria[1], Deborah Martin[1], Sandra Pavlovic[1], Ishani Roy[1], Svetlana Stuefer[2], Amy Tidwell[2], Carl Trypaluk[1], Dale Unruh[1], Michael Yekta[1], Erica Betts[2], Geoffrey Bonnin[1], Sarah Heim[1], Lillian Hiner[1], Elizabeth Lilly[2],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

Illinois


Observed Number of Extreme Precipitation Events
Illinois
Number of Events with Precipitation Greater Than 2 Inches
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


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

Daily Precipitation
Stations 1948-2017



Our Solution to Observed Changes

- 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

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

The second report

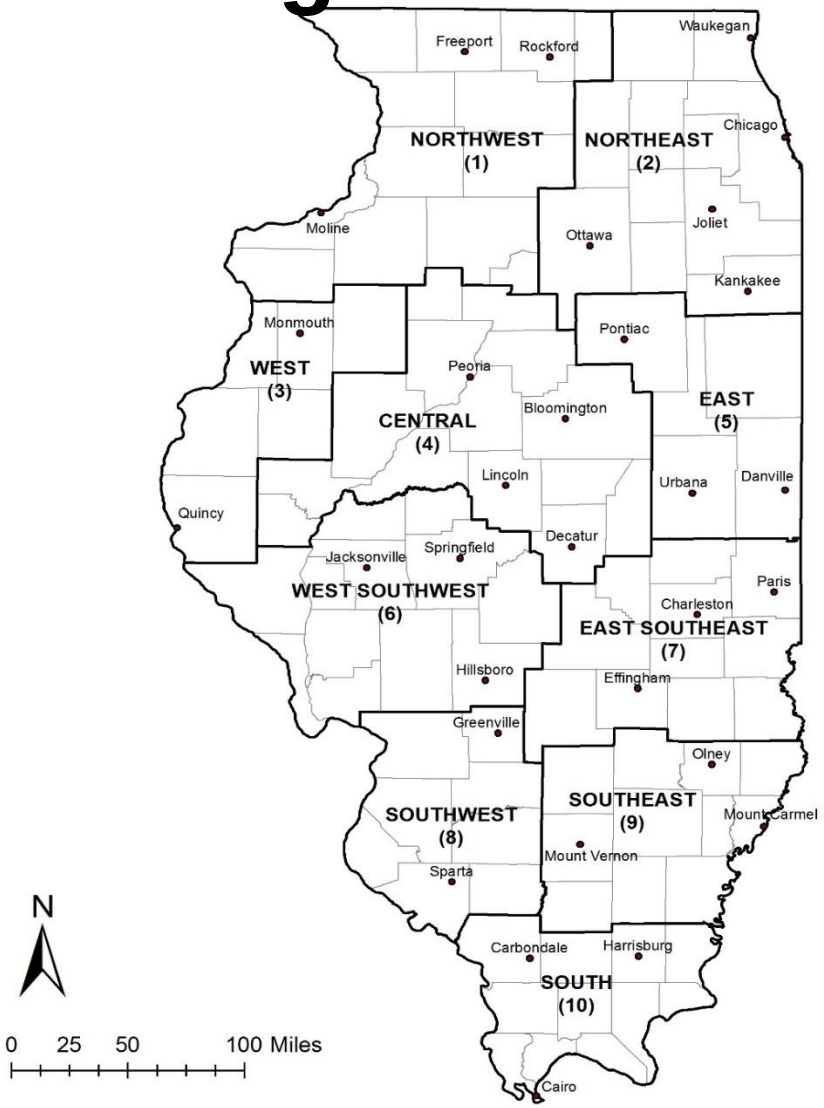
The second report, expected out in June 2019, will

1. Revisit the distribution of precipitation within the storm, also known as the Huff curves
2. The relationship between point and areal precipitation patterns out to 400 square miles
3. Comparative analysis between different methods to account for non-stationarity
   ("That is as far as the grant goes.")

Issues not addressed in the project:

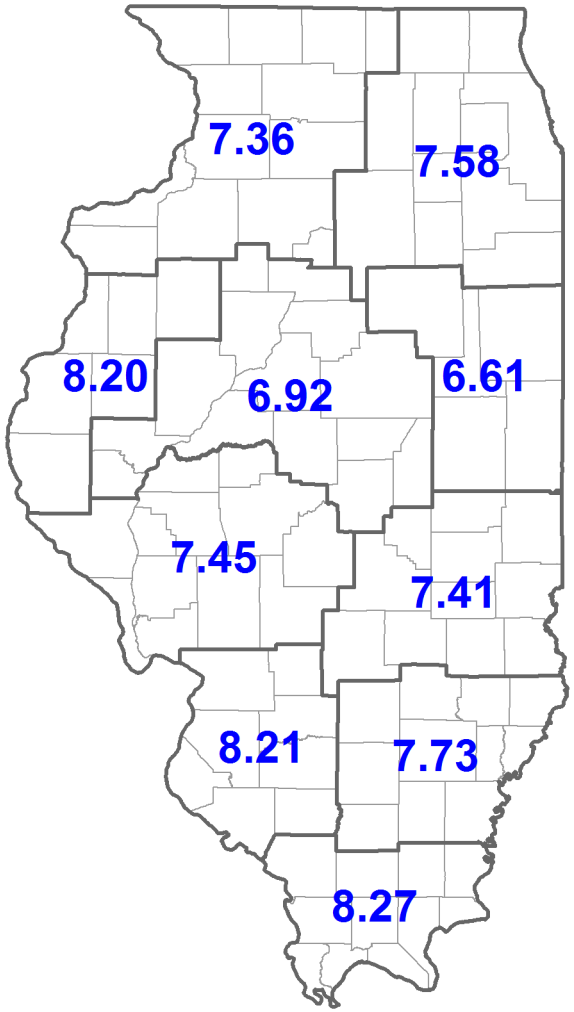
1. Return periods less than 2-year (e.g. 1-year, 6-month, 3-month)
2. Storm durations less than 1-hour (e.g. 30-min., 15-min., 5-min.)
3. Isohyetal maps

10 Regions in Illinois

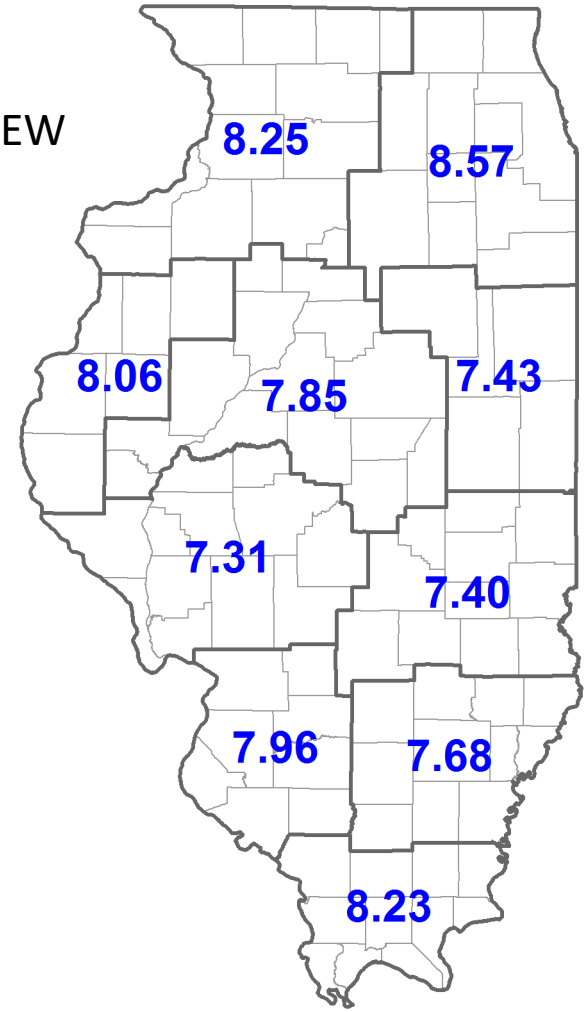


Old and New 100-Yr, 24-Hour Storm

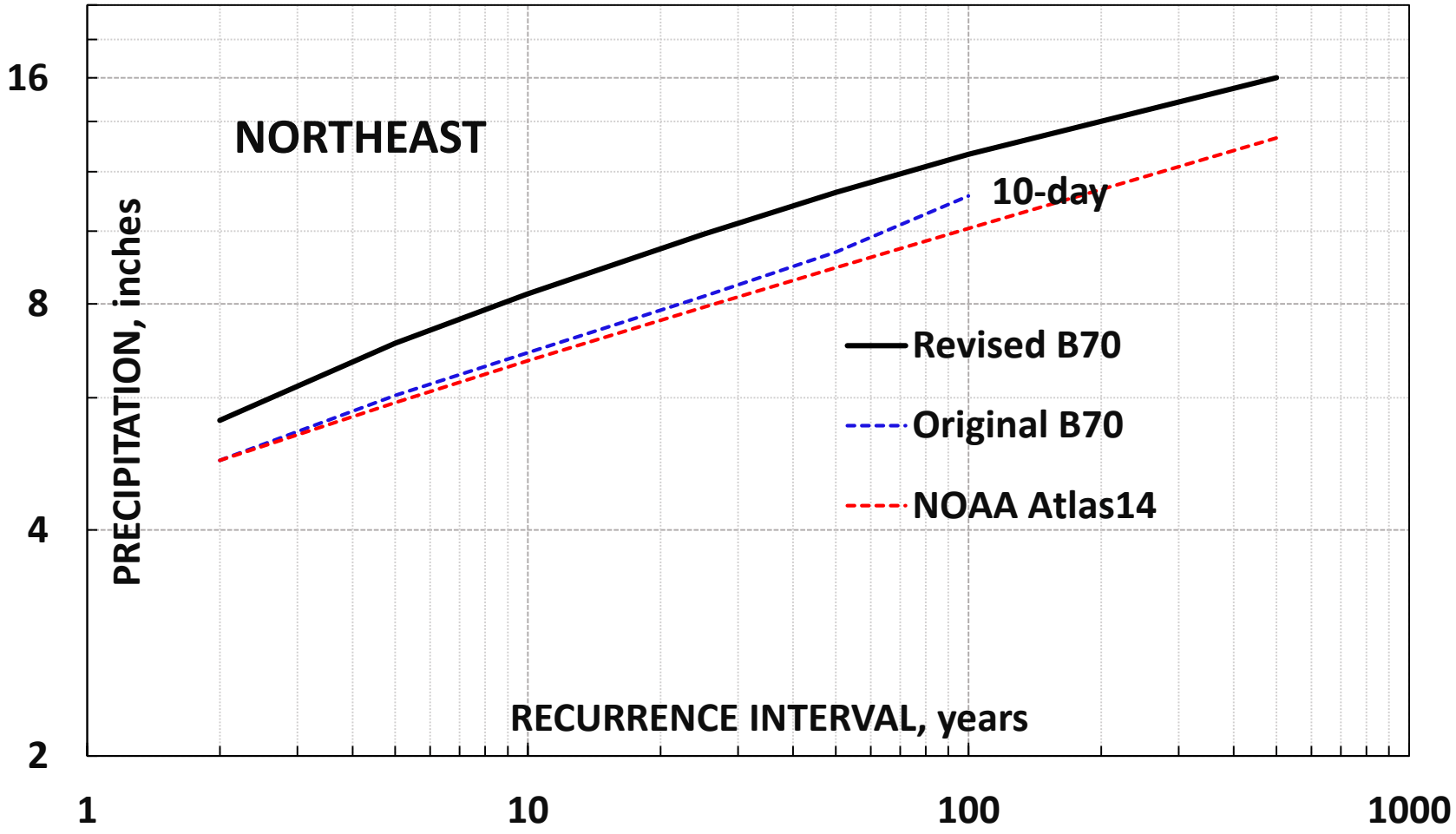
OLD



NEW



Issues/questions


NORTHEAST
10-day
Revised B70
Original B70
NOAA Atlas14
PRECIPITATION, inches
RECURRENCE INTERVAL, years
16
8
4
2
1
10
100
1000

Waukegan, IL

DRAFT Comparison of current WDO rainfall depths and Revised Bulletin 70 rainfall depths

	Storm Duration (hours)	Storm Recurrance Interval								Multiplier
		1 year	2 year	5 year	10 year	25 year	50 year	100 year	500 year	
WDO	240	3.45	4.12	5.00	5.70	6.98	8.09	9.56		1.47
Revised			5.60	7.09	8.25	9.90	11.26	12.65	16.00	
Difference			1.48	2.09	2.55	2.92	3.17	3.09		
%Increase			36%	42%	45%	42%	39%	32%		

For example:

Current 100-year, 240-hour rainfall amount is 9.56"

Revised 100-year, 240-hour rainfall amount is 12.65"

This is a 3.09" difference

This is about a 32% increase

DRAFT Comparison of current WDO rainfall depths and Revised Bulletin 70 rainfall depths

	Storm Duration (hours)	Storm Recurrance Interval								Multiplier
		1 year	2 year	5 year	10 year	25 year	50 year	100 year	500 year	
WDO	240	3.45	4.12	5.00	5.70	6.98	8.09	9.56		1.47
Revised			5.60	7.09	8.25	9.90	11.26	10.53	16.00	
Difference			1.48	2.09	2.55	2.92	3.17	0.97		
%Increase			36%	42%	45%	42%	39%	10%		

For example:

Current 100-year, 240-hour rainfall amount is 9.56"

Revised 100-year, 240-hour rainfall amount is 10.53"

This is a 0.97" difference

This is about a 10% increase

Annual rainfall (inches) for given recurrence interval

Storm code	Zone code	Station	2-month	3-month	4-month	6-month	9-month	1-year	2-year	5-year	10-year	25-year	50-year	100-year
1	1	Aledo	2.19	2.63	3.01	3.54	4.07	4.42	5.43	6.56	7.35	8.35	9.30	10.88
1	1	Dixon	2.04	2.45	2.80	3.30	3.79	4.12	5.02	5.95	6.85	8.40	9.70	11.60
1	1	Freeport	2.15	2.59	2.96	3.48	4.00	4.35	5.25	6.30	7.02	8.65	10.40	12.38
1	1	Galva	2.13	2.56	2.93	3.45	3.97	4.31	5.15	6.30	7.14	8.40	9.45	10.60
1	1	Moline	2.21	2.65	3.03	3.57	4.10	4.46	5.41	6.51	7.33	8.45	9.80	11.04
1	1	Morrison	2.14	2.57	2.96	3.49	4.01	4.36	5.15	6.20	7.09	8.40	9.80	11.66
1	1	Mt Carroll	2.19	2.63	3.03	3.57	4.10	4.46	5.25	6.25	7.09	8.35	9.40	10.60
1	1	Rockford	2.16	2.60	3.00	3.53	4.06	4.41	5.25	6.35	7.23	8.40	9.40	10.45
1	1	Walnut	2.16	2.60	3.00	3.53	4.06	4.41	5.19	6.30	7.20	8.45	9.50	10.61
1	2	Aurora	2.08	2.54	2.86	3.36	3.86	4.20	5.06	6.40	7.56	9.33	10.90	12.60
1	2	Chicago	1.93	2.33	2.65	3.11	3.58	3.89	4.78	5.70	6.41	7.70	9.16	11.07
1	2	DeKalb	2.11	2.54	2.92	3.44	3.96	4.30	5.14	6.30	7.05	8.19	9.19	10.78
1	2	Joliet	2.11	2.54	2.92	3.44	3.96	4.30	5.14	6.35	7.30	8.82	10.08	11.55
1	2	Kankakee	2.02	2.43	2.80	3.30	3.79	4.12	4.89	6.04	6.90	8.24	9.70	12.35
1	2	Marengo	1.98	2.38	2.75	3.23	3.72	4.04	4.78	5.70	6.41	7.40	8.29	10.03
1	2	Ottawa	2.06	2.48	2.86	3.36	3.86	4.20	4.99	5.99	6.83	8.19	9.45	10.92
1	2	Waukegan	1.93	2.32	2.68	3.15	3.62	3.94	4.78	5.81	6.67	7.77	8.71	9.56
1	3	La Harpe	2.34	2.82	3.25	3.82	4.40	4.78	5.83	7.20	8.19	9.50	10.75	12.98
1	3	Monmouth	2.16	2.62	3.00	3.53	4.06	4.41	5.41	6.70	7.72	9.24	10.50	11.76
1	3	Quincy	2.26	2.73	3.14	3.70	4.25	4.62	5.56	6.83	7.77	8.98	10.03	11.24
1	4	Bloomington	2.20	2.69	3.02	3.55	4.08	4.44	5.35	6.51	7.37	8.48	9.39	10.21
1	4	Decatur	2.22	2.67	3.05	3.59	4.13	4.49	5.50	6.97	7.93	8.99	9.70	10.60
1	4	Havana	2.03	2.44	2.82	3.31	3.81	4.14	4.90	5.96	6.82	7.95	8.90	10.00
1	4	Lincoln	2.08	2.54	2.88	3.39	3.90	4.24	5.05	6.21	7.02	8.08	8.84	10.01
1	4	Minonk	2.00	2.41	2.78	3.27	3.76	4.09	4.85	6.01	6.62	7.56	8.70	10.28
1	4	Peoria	2.03	2.44	2.82	3.31	3.81	4.14	4.90	5.96	6.82	8.24	9.14	10.31
1	4	Rushville	2.21	2.67	3.07	3.62	4.16	4.52	5.30	6.30	7.09	8.14	9.03	9.87
1	5	Danville	2.26	2.72	3.11	3.66	4.21	4.58	5.46	6.66	7.41	8.44	9.17	9.71
1	5	Hoopeston	2.17	2.63	3.01	3.54	4.08	4.43	5.15	6.18	7.06	8.29	9.27	10.30
1	5	Pontiac	2.02	2.44	2.81	3.30	3.80	4.13	4.99	6.13	7.01	8.20	9.17	10.20
1	5	Roberts	2.04	2.46	2.84	3.34	3.84	4.17	4.94	5.94	6.64	7.72	8.75	10.61
1	5	Urbana	2.19	2.63	3.03	3.57	4.10	4.46	5.20	6.13	6.75	7.57	8.14	8.76
1	6	Carlinville	2.25	2.71	3.09	3.63	4.18	4.54	5.45	6.62	7.57	8.89	10.25	12.24
1	6	Griggsville	2.14	2.58	2.95	3.47	3.99	4.34	5.35	6.72	7.72	8.94	9.85	11.37
1	6	Hillsboro	2.22	2.68	3.09	3.63	4.18	4.54	5.40	6.57	7.47	8.64	9.70	11.49
1	6	Jacksonville	2.17	2.64	3.01	3.54	4.07	4.42	5.25	6.60	7.52	8.69	10.10	11.38
1	6	Morrisonville	2.13	2.56	2.95	3.47	3.99	4.34	5.30	6.42	7.22	8.43	9.49	10.61
1	6	Pana	2.22	2.68	3.07	3.63	4.18	4.54	5.65	6.77	7.52	8.58	9.60	11.19
1	6	Springfield	2.00	2.41	2.77	3.26	3.75	4.08	4.95	6.21	7.12	8.59	9.80	11.11
1	6	White Hall	2.15	2.59	2.99	3.51	4.04	4.39	5.35	6.62	7.57	8.72	9.65	10.65
1	7	Charleston	2.30	2.77	3.16	3.71	4.27	4.64	5.51	6.63	7.39	8.36	9.18	10.10
1	7	Effingham	2.26	2.72	3.11	3.66	4.20	4.57	5.61	6.94	7.80	8.72	9.90	11.27
1	7	Palestine	2.37	2.86	3.29	3.87	4.45	4.84	5.66	6.58	7.24	8.06	9.10	10.38
1	7	Paris	2.20	2.65	3.05	3.59	4.13	4.49	5.51	6.84	7.80	9.03	10.00	11.02
1	7	Windsor	2.27	2.74	3.16	3.71	4.27	4.64	5.61	6.89	7.90	9.23	10.30	11.58
1	8	Belleville	2.20	2.64	3.02	3.55	4.08	4.44	5.30	6.60	7.70	9.25	10.70	13.25
1	8	DuQuoin	2.35	2.82	3.23	3.80	4.37	4.75	5.90	7.20	8.10	9.35	10.15	10.90
1	8	Greenville	2.18	2.62	3.02	3.55	4.08	4.44	5.45	6.67	7.47	8.69	9.85	11.11
1	8	Sparta	2.34	2.81	3.20	3.76	4.32	4.70	5.70	6.95	7.90	9.35	10.60	11.85
1	8	St Louis	2.15	2.59	2.99	3.51	4.04	4.39	5.35	6.72	7.83	9.29	11.00	12.93
1	9	Fairfield	2.32	2.79	3.19	3.75	4.31	4.69	5.71	7.09	8.16	9.64	10.81	12.04
1	9	Flora	2.29	2.76	3.16	3.71	4.27	4.64	5.61	6.89	7.80	9.33	10.60	11.83
1	9	McLeansboro	2.36	2.87	3.28	3.86	4.43	4.82	5.81	7.14	8.16	9.54	10.71	11.83
1	9	Mt Carmel	2.32	2.80	3.22	3.79	4.36	4.74	5.81	7.39	8.40	10.15	11.07	11.94
1	9	Mt Vernon	2.35	2.83	3.25	3.83	4.41	4.79	5.81	7.17	8.16	9.58	10.76	11.83
1	9	Olney	2.35	2.83	3.26	3.83	4.41	4.79	5.71	6.89	7.75	8.98	10.10	11.27
1	10	Anna	2.74	3.30	3.81	4.48	5.15	5.60	6.65	7.95	8.90	10.10	11.00	12.00
1	10	Cairo	2.57	3.10	3.54	4.16	4.78	5.20	6.25	7.75	8.75	10.20	11.50	12.50
1	10	Carbondale	2.50	3.01	3.43	4.04	4.65	5.05	6.35	7.80	8.75	9.80	10.60	11.30
1	10	Harrisburg	2.47	2.98	3.43	4.04	4.65	5.05	6.02	7.60	9.08	11.22	12.40	14.07
1	10	New Burnside	2.65	3.19	3.67	4.32	4.97	5.40	6.52	7.95	9.02	10.40	11.50	12.65

Bulletin 70

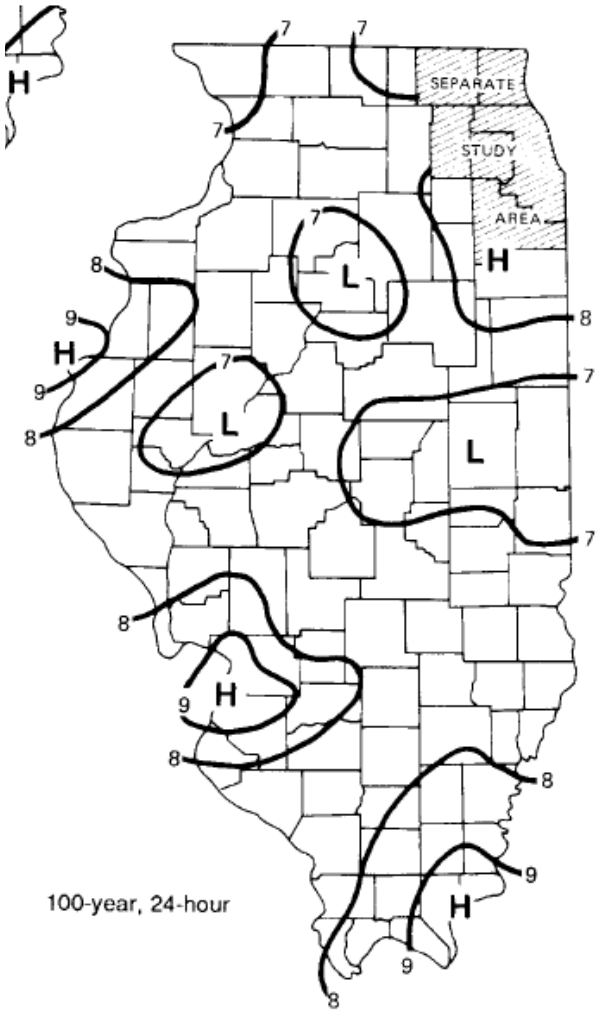


Figure 15. Concluded

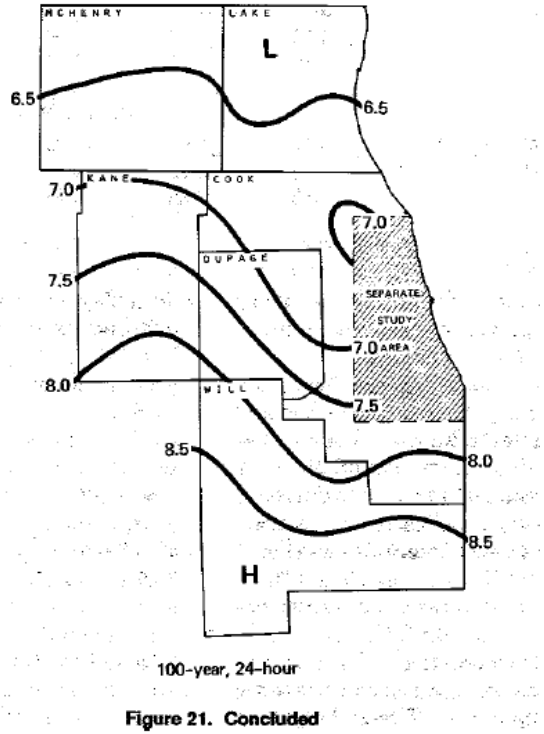
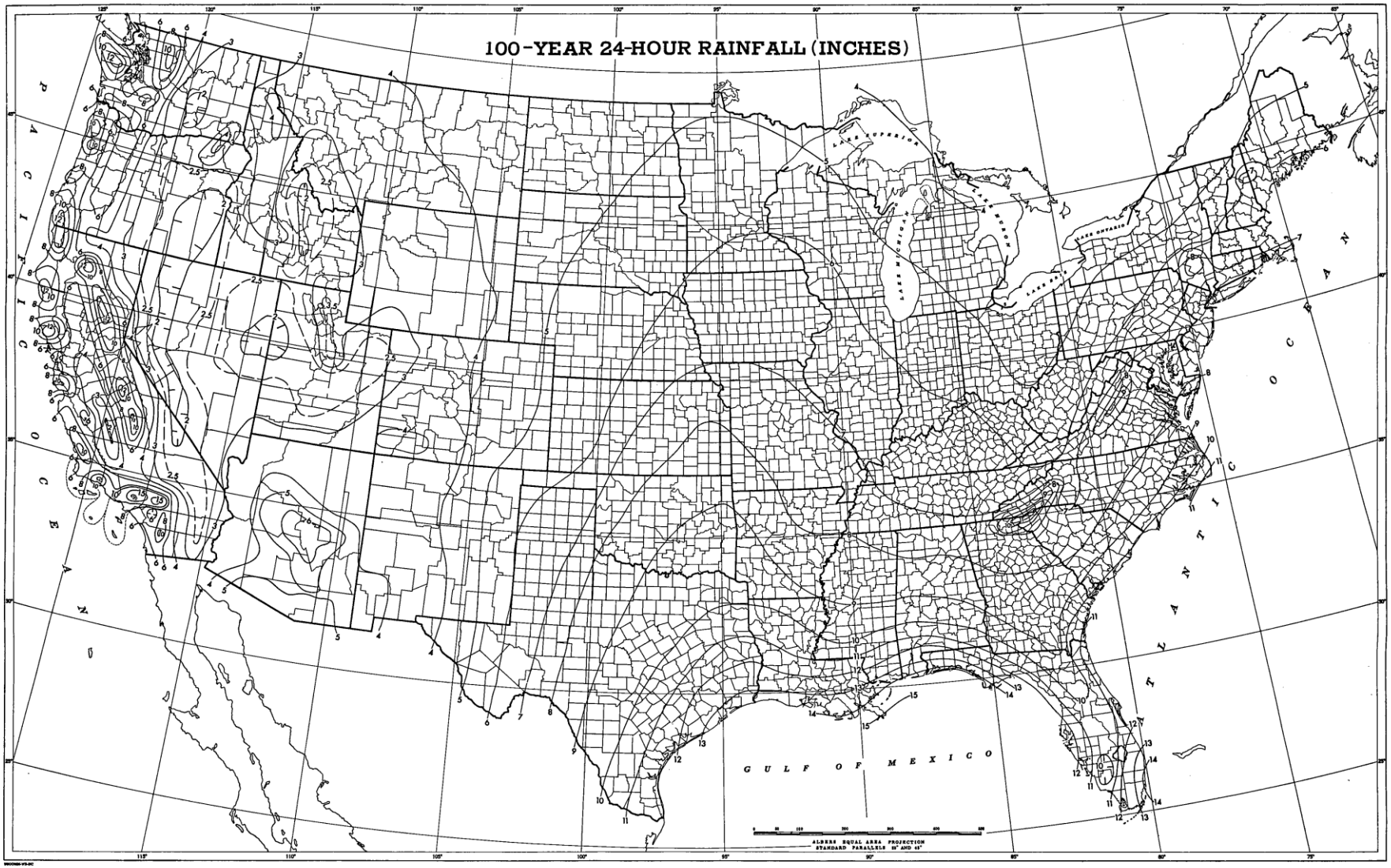
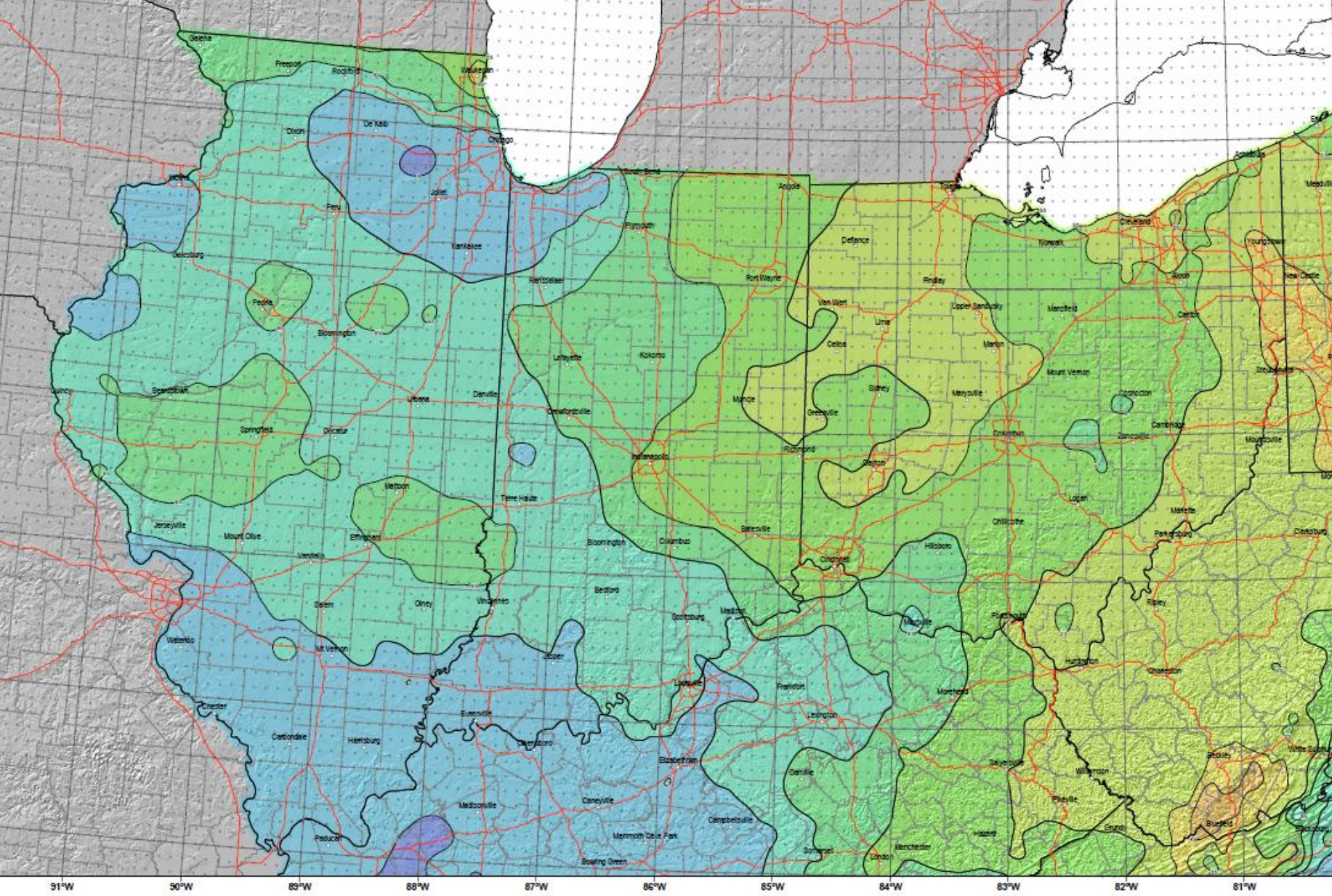


Figure 21. Concluded

NOAA TP40 (1961)





A Atlas 14, Volume 2, Version 3
ver Basin and Surrounding States

repared by U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
FFICE OF HYDROLOGIC DEVELOPMENT

SCALE 1:2,000,000 (when printed/viewed at ANSI C size)
0 10 20 30 40 50
Miles
0 5 10 20 30 40 50 60 70

ILLINOIS, INDIANA, OHIO

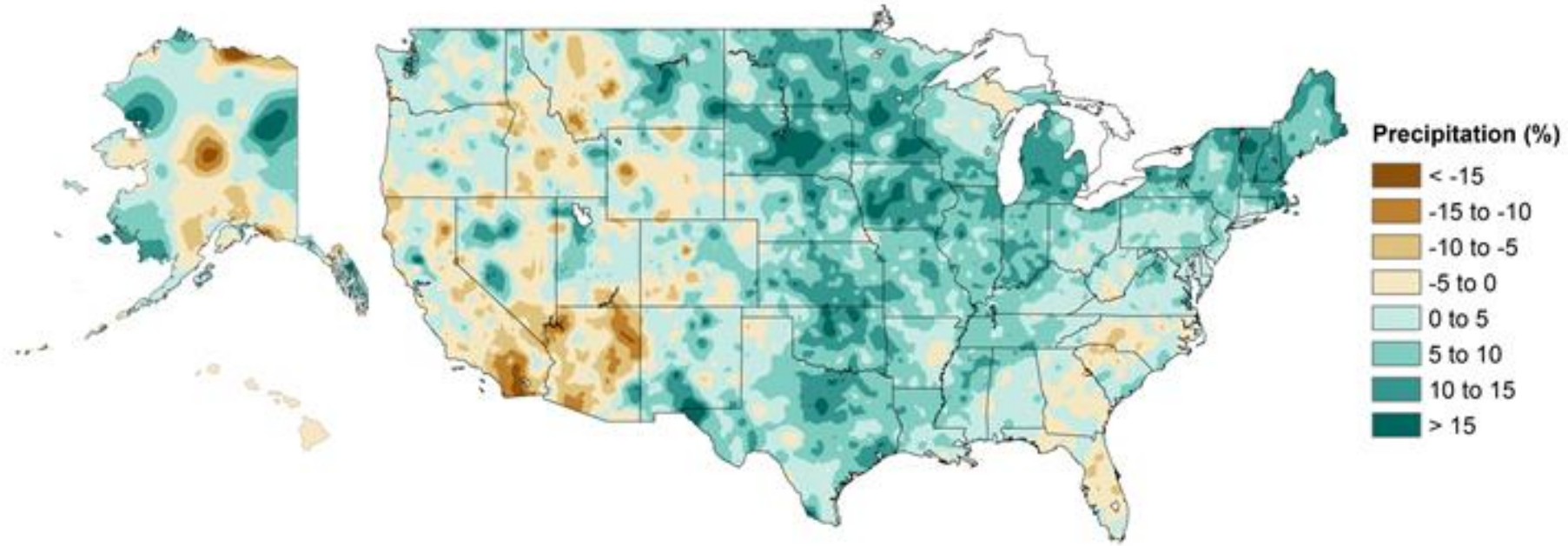
Isopluvials of 24 hour precipitation (inches)
with Average Recurrence Interval of 100 years

N

Inches

4.16 - 4.20	4.81 - 5.00	6.51 - 7.00	10.01 - 11.00
4.21 - 4.40	5.01 - 5.50	7.01 - 8.00	11.01 - 12.00
4.41 - 4.60	5.51 - 6.00	8.01 - 9.00	12.01 - 13.00

1986-2015 minus 1901-1960



The South-North decreasing gradient

Is the gradient “real” (physically or climatologically justifiable)?

Perhaps, the slope is not naturally present but occurs as a result of the data selection (spatial randomness in a short sample)?

Is it just an artifact of the way we do analysis (e.g. select regions/data)?

- 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/

Contract Report 2017-05
December 2017

Impacts of Potential Future Climate Change on the Expected Frequency of Extreme Rainfall Events in Cook, DuPage, Lake and Will Counties in Northeastern Illinois

Momcilo Markus, James Angel, Kexuan Wang, Gregory Byard, Sally McConkey, Zoe Zaloudek

ILLINOIS
Illinois State Water Survey
PRAIRIE RESEARCH INSTITUTE

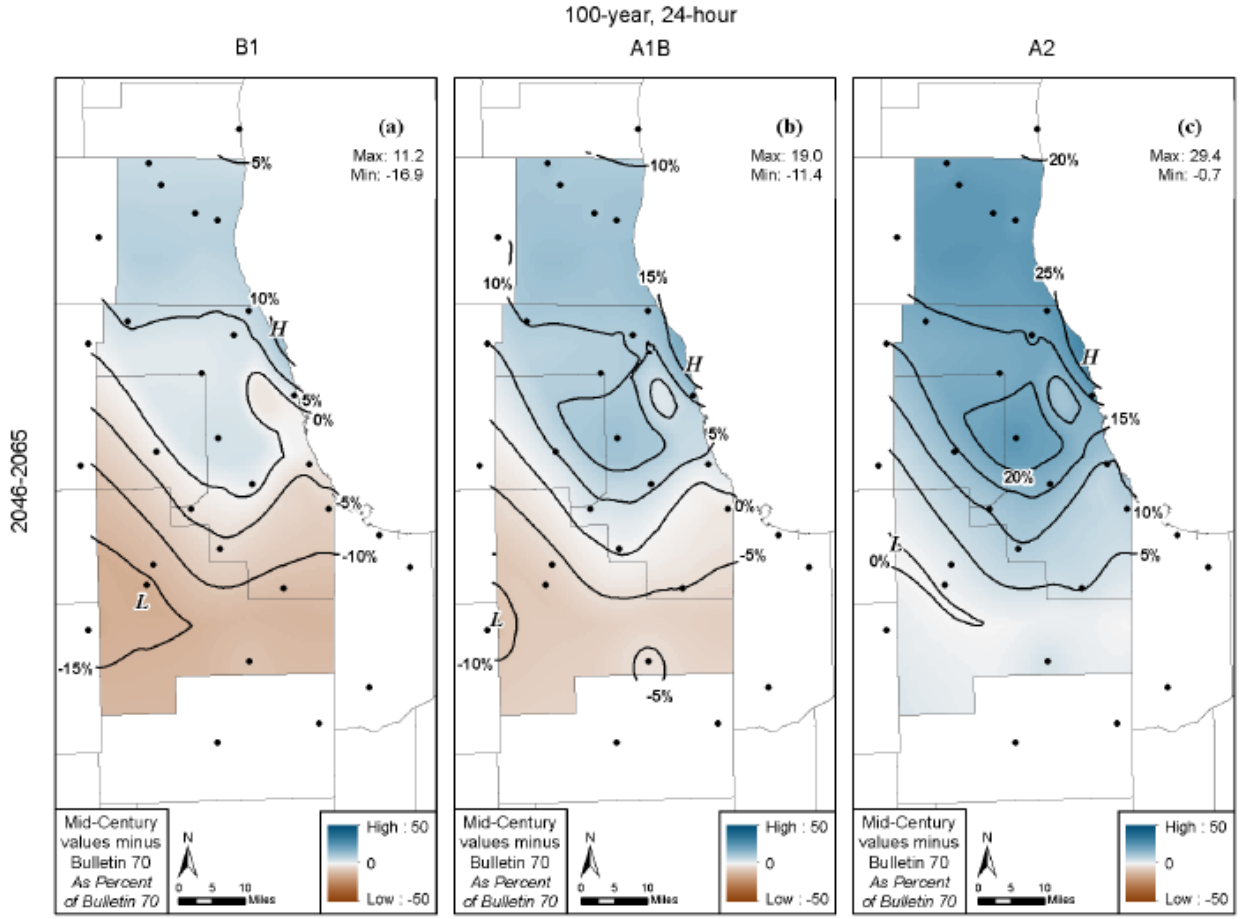


Figure B1.4. Percent differences between projected 100-year 24-hour projected values for mid-21st century based on CMIP3 UW data and Bulletin 70

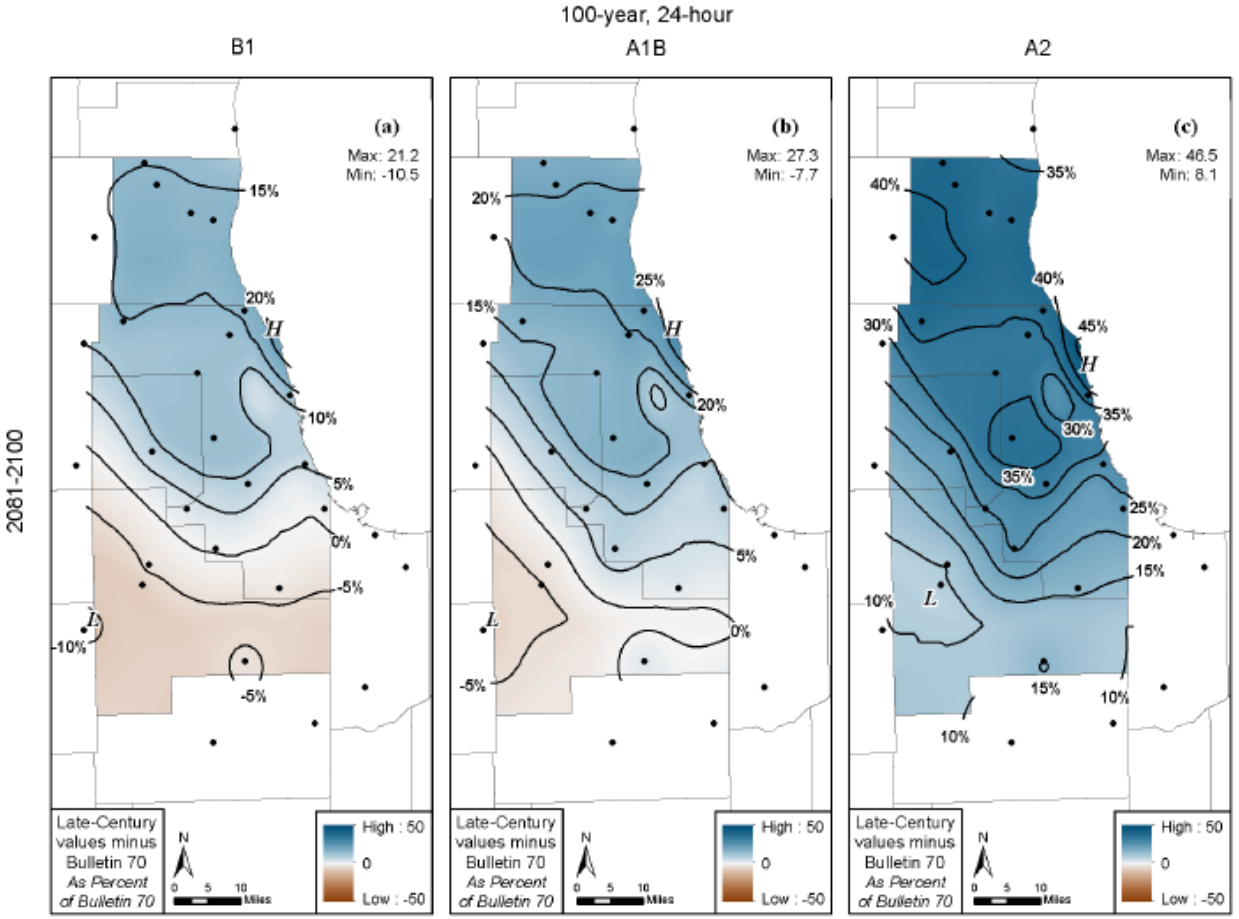


Figure B2.4. Percent differences between projected 100-year 24-hour projected values for late 21st century based on CMIP3 UW data and Bulletin 70

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