2019 MWRC

EVALUATION OF 1-DAY, 100-YEAR RAINFALL DEPTHS IN MISSISSIPPI

Presented by :

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STATETECH ENGINEERING, LLC

About the Presenter

- **B.S.C.E (2008) Oklahoma State University**
- **Licensed TBPE (2013)**
- **StateTech Engineering (2013)**
- **Ph.D. (May 2018) Texas Tech University**
- **Over 10 years of experience as a practitioner**

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What is a 1-Day, 100-Year Rainfall Depth

- **99% Quantile from an Extreme Value Distribution (e.g. AMS)**
- **Used to Define Flood Risk (e.g. delineate flood plains)**

- **FEMA Flood plains (Mississippi):**
  - underwrites ~64,000 policies
  - ~$16M dollars worth of polices (9/30/2017 FEMA)
  - ~60,000 insurance claims, exceeding $3B dollars in claims since 1978

Outline

- **Review 5 Rainfall Studies between (1917-2013) in Mississippi: "brief synopsis of statistical methods and results"**
- **1-Day, 100-yr DDF ; Isopluvial Maps (Precipitation Contours Maps)**
- **Compare 1-Day, 100-yr DDF at County Centroids**

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Outline (Studies)

1. **Miami Conservancy District (1917), T.R. Part V "Storm Rainfall of Eastern United States", (MCD 1917)** [3]
2. **Floods, "Continuation of (MCD 1917)" (Switzer 1929)** [5]
3. **Rainfall Intensity-frequency Data, (USDA 1935)** [6]
4. **TP-40, (USWB 1963)** [1]
5. **Southern Region Climate Center, (SRCC 1997)** [7]
6. **NOAA Atlas 14, Vol 9, Ver 2.0 , (NOAA 2013)** [4]

(MCD 1917) $_3$

Miami Conservancy District, "Storm Rainfall of Eastern United States", Technical Report V (MCD 1917) :

- **First Extreme Rainfall study performed in the U.S.**
- **USWB Daily Rainfall Data (1850-1914) ; ~4,500 locations**
- **Excess Rainfall >=1 in/ Day (PDS)**
- **Aggregated records within 2 –(deg) grids to one overall record**
- **Utilized records >= 10 years**
- **Calculated probabilities base on % Ranking (eg. 100-yr Freq = 5th largest value in 500 samples)**

(MCD 1917) $_3$

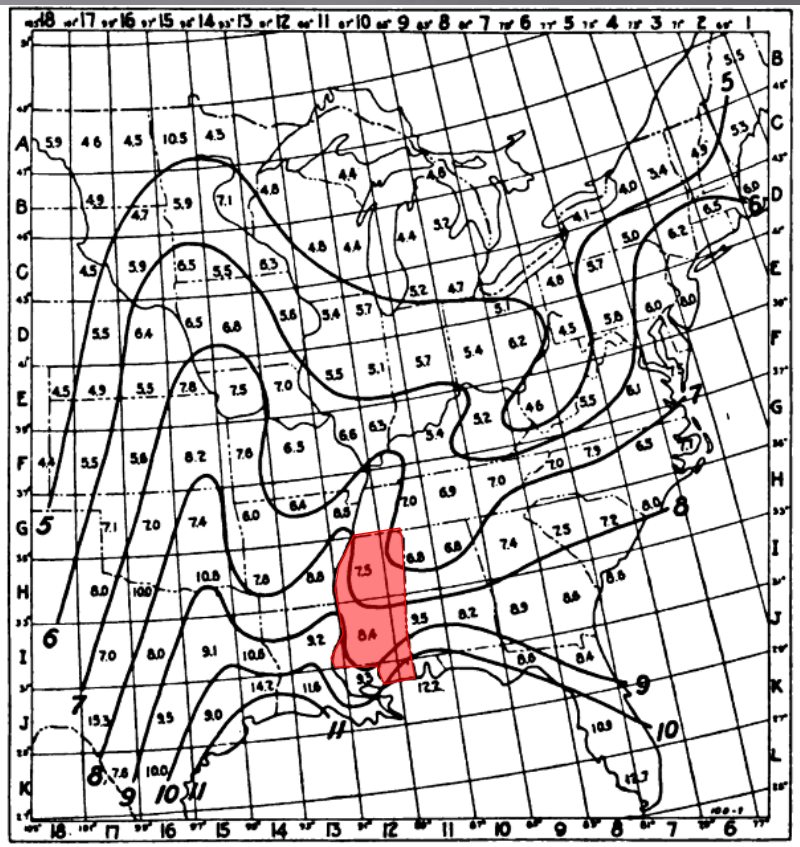

FIG. 31.—ISOPLUVIAL CHART FOR 100-YEAR PERIOD AND 1-DAY RAINFALL.

(Switzer 1929) [5]

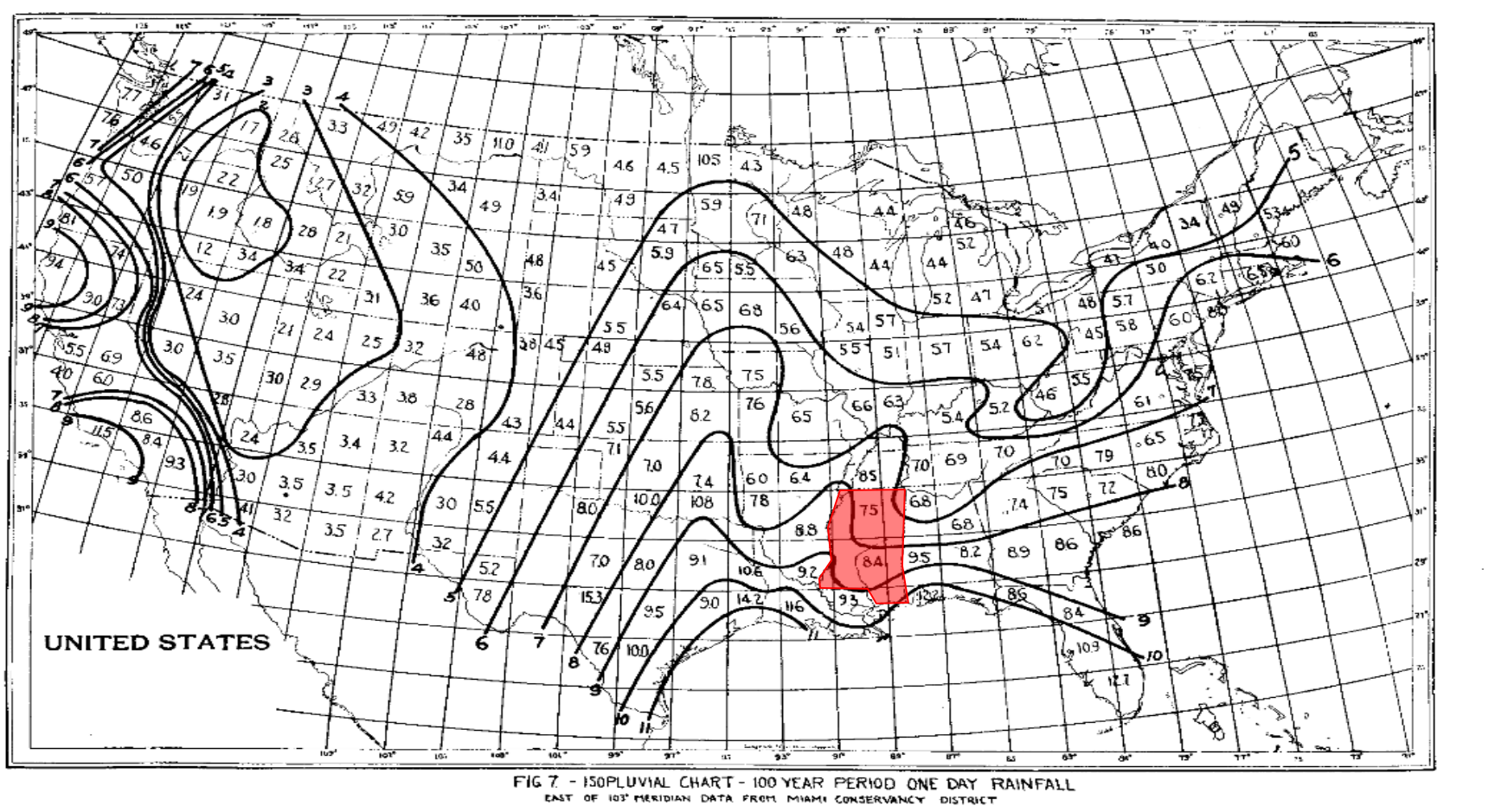

FIG 7 - ISOPLUVIAL CHART - 100 YEAR PERIOD ONE DAY RAINFALL
EAST OF 103° MERIDIAN DATA FROM MIAMI CONSERVANCY DISTRICT

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(USDA 1935) [6]

Unites States Department of Agriculture-Misc Publication 24

“Rainfall-Intensity-Frequency Data (USDA 1935) :

- **USWB 5-Min Records (1893-1933) , 211 Locations**
- **Utilized locations with records >= 15 years**
- **Evaluated Storm Depths ~(28,000 storms)**
- **DDF for (5 min-24 hours) , (5-100 year Frequencies)**
- **Extreme Rainfall (PDS) NOT DESCRIBED IN REPORT**
- **Semi-log (curve fitting) for Frequency Predictions**

(USDA 1935) [6]

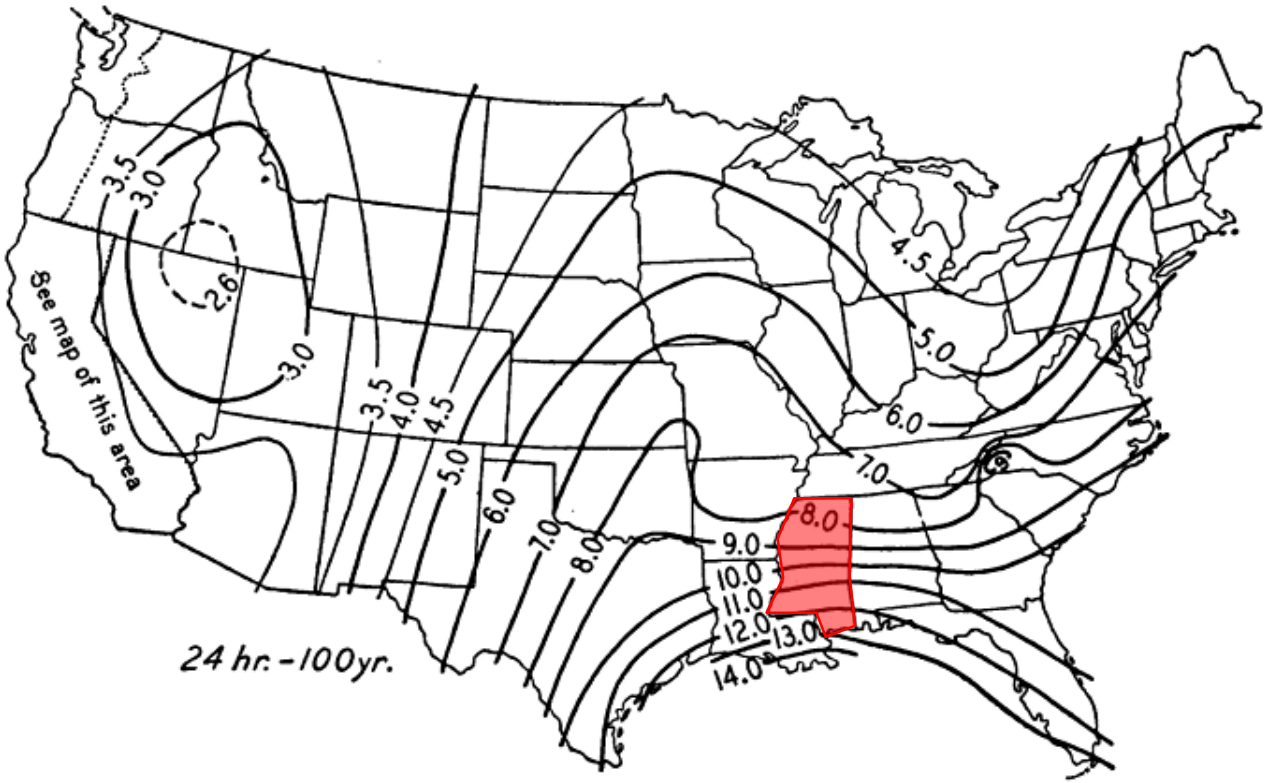


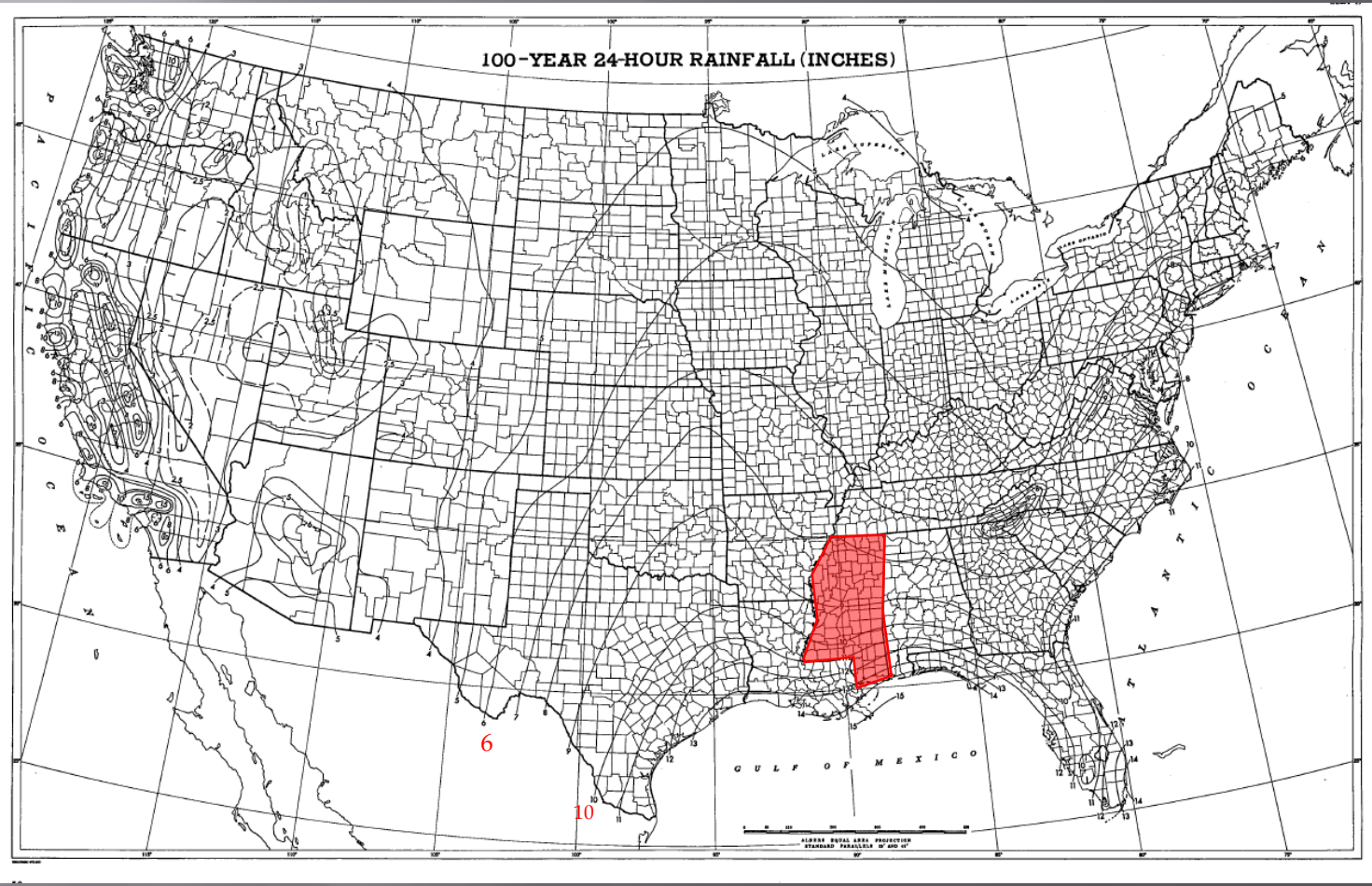
FIGURE 59.—Twenty-four-hour rainfall, in inches, to be expected once in 100 years. (Data for Pacific Coast area are given in fig. 62.)

(NOAA TP40 1963) [1]

NOAA –Technical Paper 40-"Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years", (TP40 1963):

- **5,000 stations across the U.S. (records >=40 years)**
- **Converted (AMS) to (PDS)**
- **Adjusted Daily Records by 1.13 factor (sample bias)**
- **Gumbel Extreme Value Distribution-nomographs**
- **Regional growth factors**

(NOAA TP40 1963) [1]



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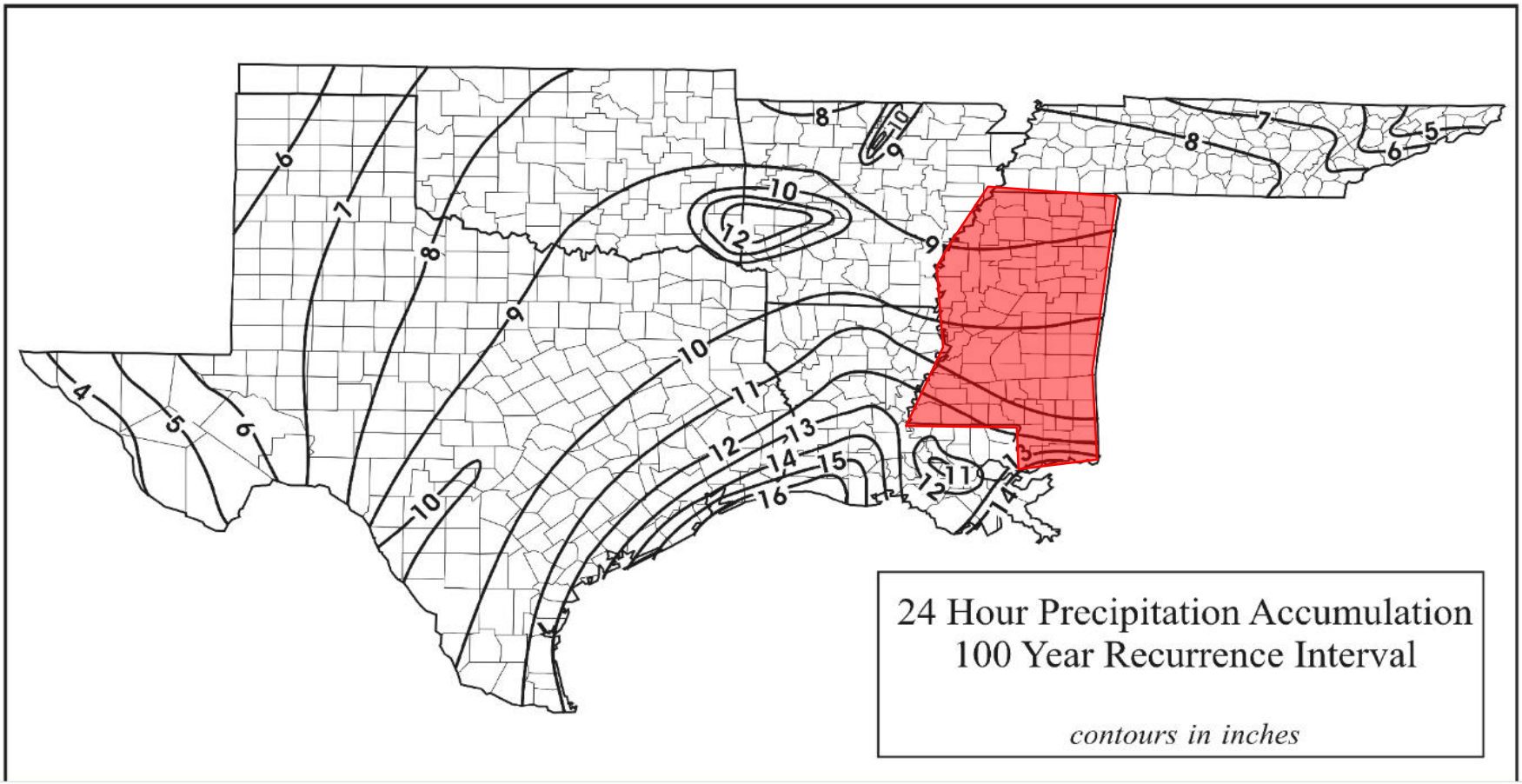
(SRCC1997) [7]

Rainfall Frequency/Magnitude Atlas for the South-Central United States

- 1st order stations , records >= 35 years; typical range was 1949-1991
- Adjusted Daily Records by 1.13 factor (sample bias)
- DDF (3-24 hr) and (2-100 year) frequencies (PDS)
- semi-log regression
- Manually drawn isohytes

(SRCC1997) [7]


24 Hour Precipitation Accumulation
100 Year Recurrence Interval
contours in inches

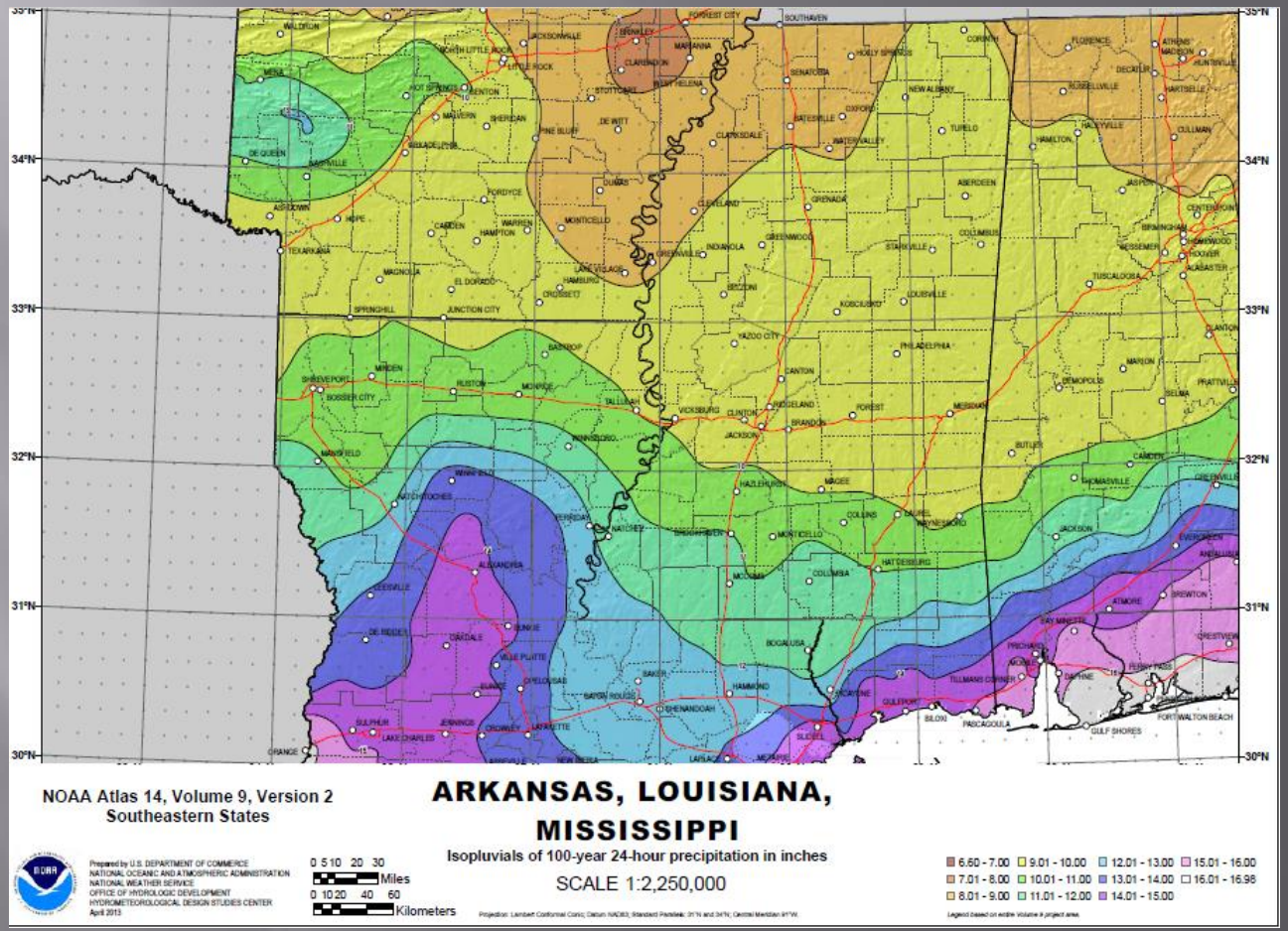
(NOAA Atlas 14, Vol 8, Ver. 2.0) $_4$

NOAA Atlas 14 Vol 8 Ver 2.0 for Mississippi

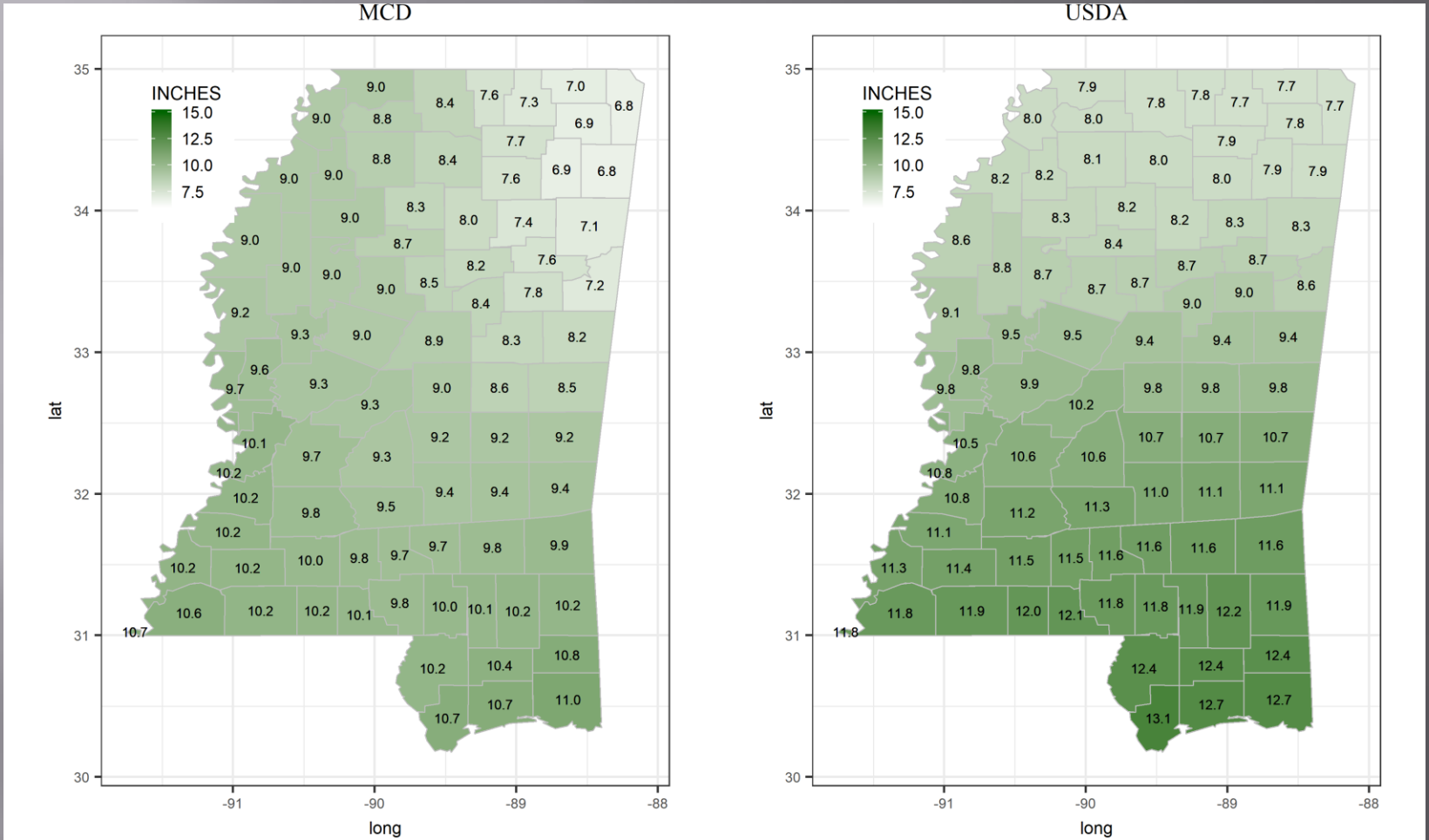
http://hdsc.nws.noaa.gov/hdsc/pfds/

- **Data up to 2012, records >= 15 years**
- **DDF(5-min to 60 Day) , (1-1,000) Year) , 90% Confidence intervals**
- **Adjusted Daily Records by 1.13 factor (sample bias)**
- **L-moment statistics, GEV distribution**
- **Geospatial statistics using PRISM (MAR) correlation to 30-(arcsec) grids (~0.25 sqm) or (0.5 X 0.5) miles ; ~250,000 cells**

(NOAA Atlas 14, Vol 8, Ver. 2.0) $_4$



Mississippi 1-Day, 1% Depths



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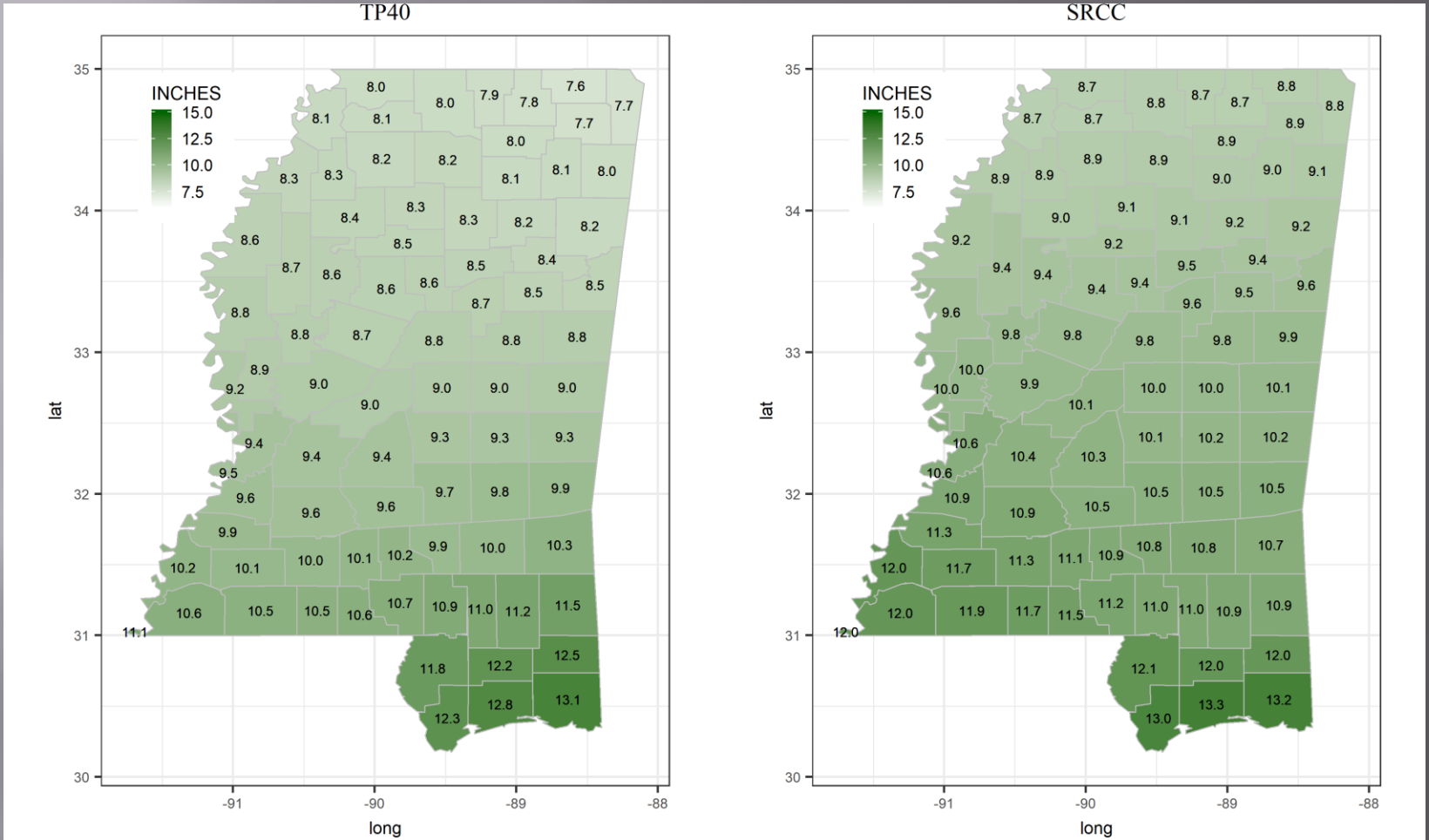
Mississippi 1-Day, 1% Depths



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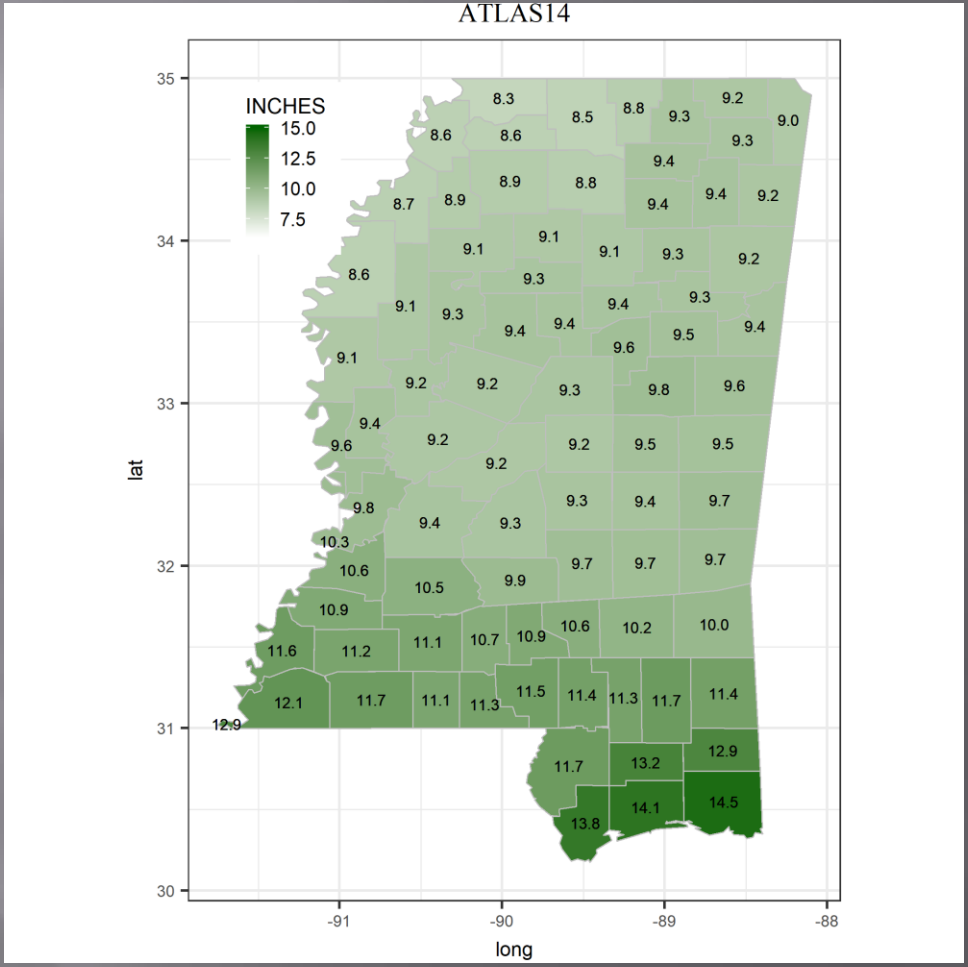
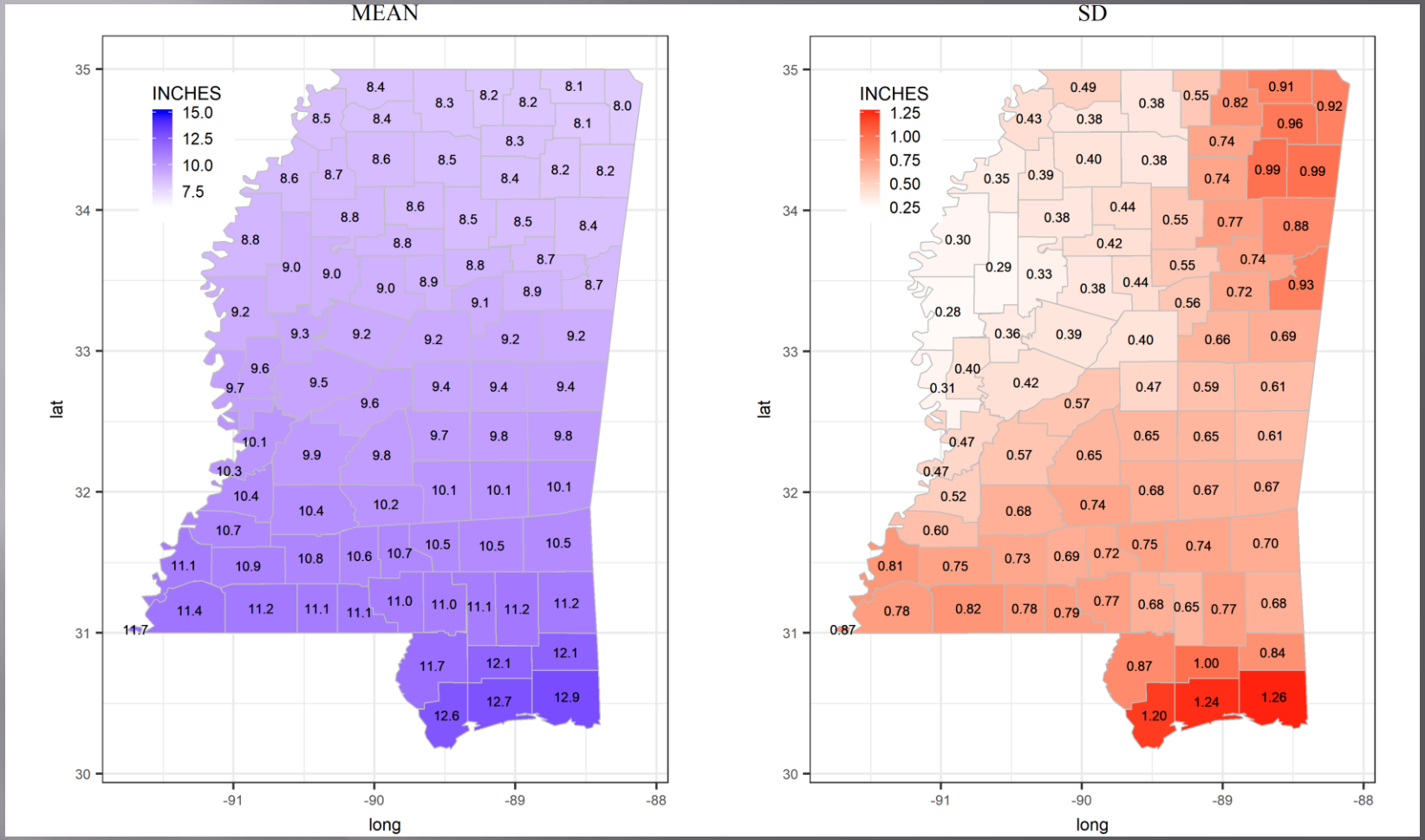
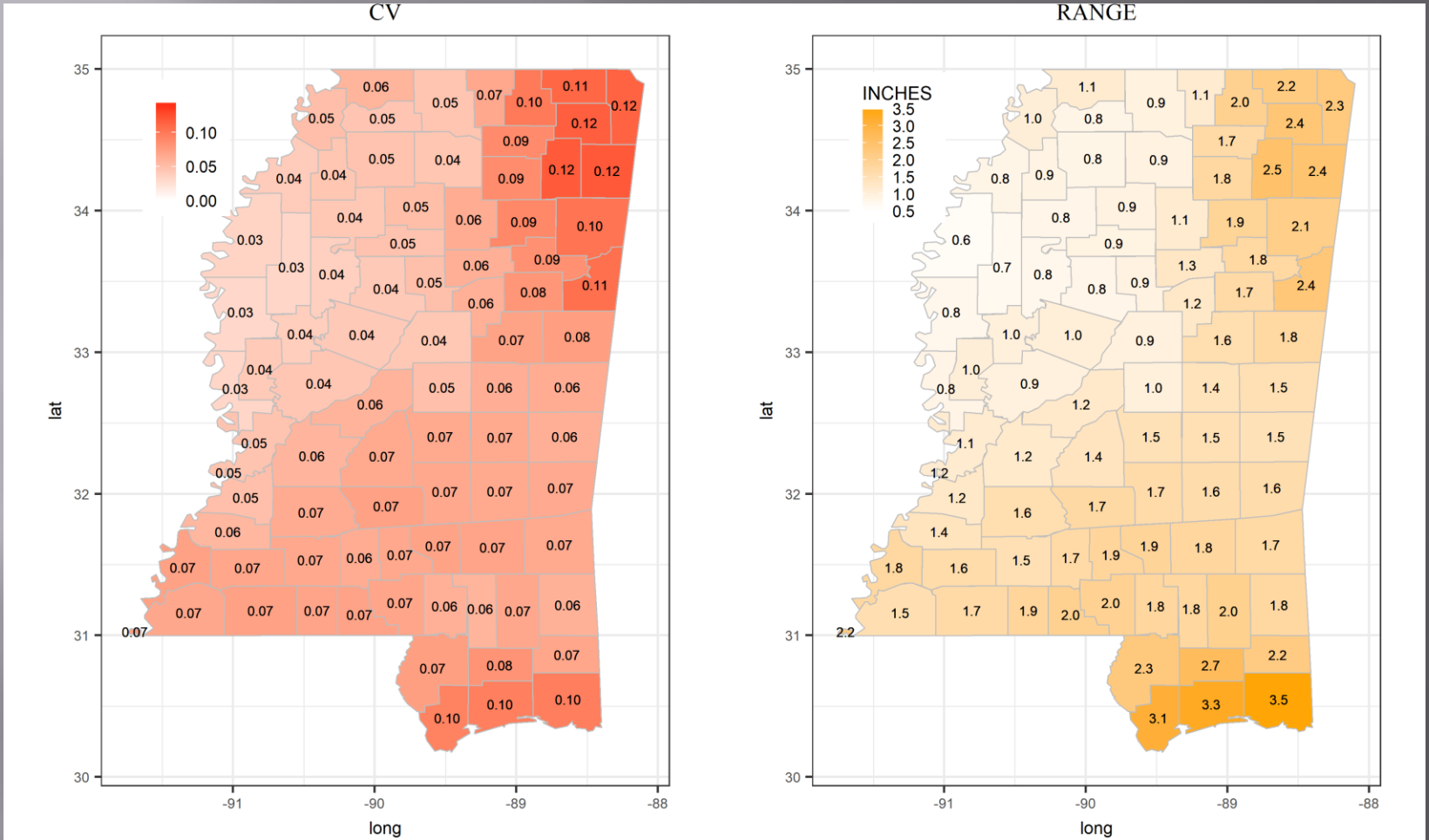
Mississippi 1-Day, 1% Depths



Mississippi 1-Day, 1% Depths



Mississippi 1-Day, 1% Depths



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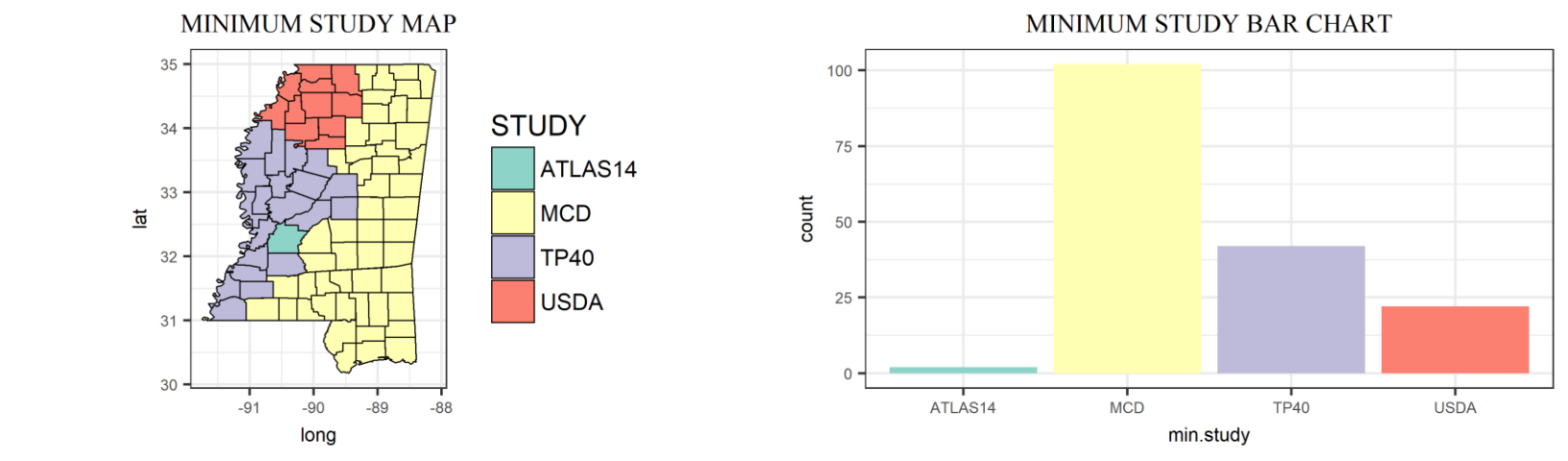
Mississippi 1-Day, 1% Depths

Statistic	sd (in)	cv -	range (in)
mean	0.64	0.07	1.56
sd	0.22	0.02	0.60
cv	0.34	0.32	0.39
2.5%	0.30	0.03	0.75
16%	0.39	0.04	0.91
50%	0.67	0.07	1.56
84%	0.84	0.09	2.12
97.5%	1.20	0.12	3.14



ATLAS14	MCD	TP40	USDA
2	102	42	22
1%	61%	25%	13%

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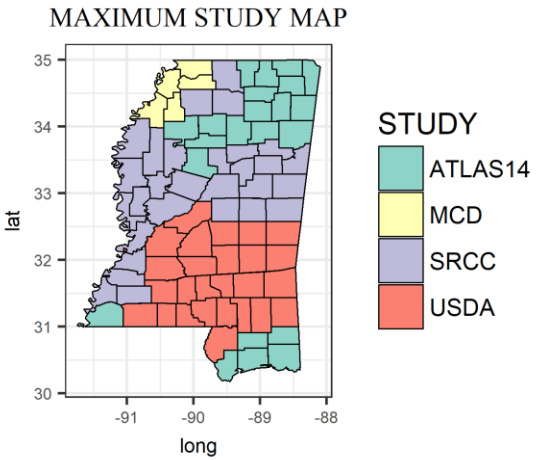
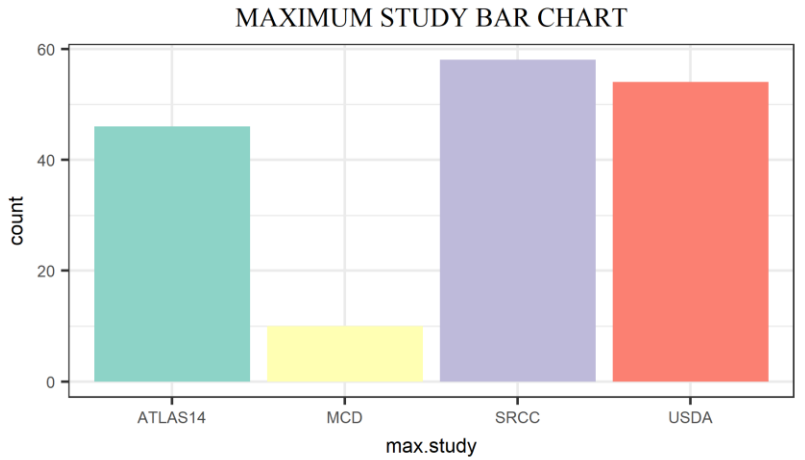
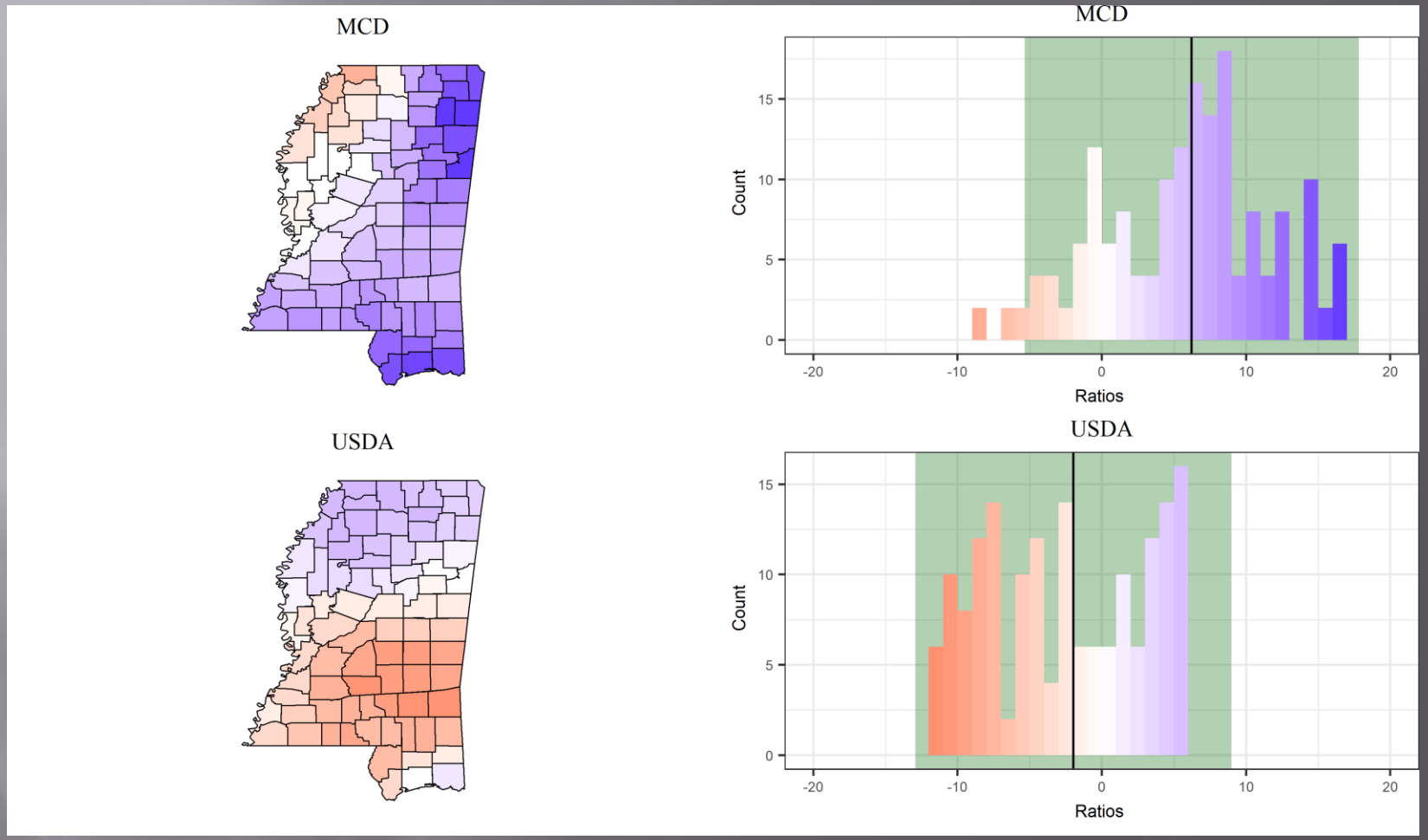


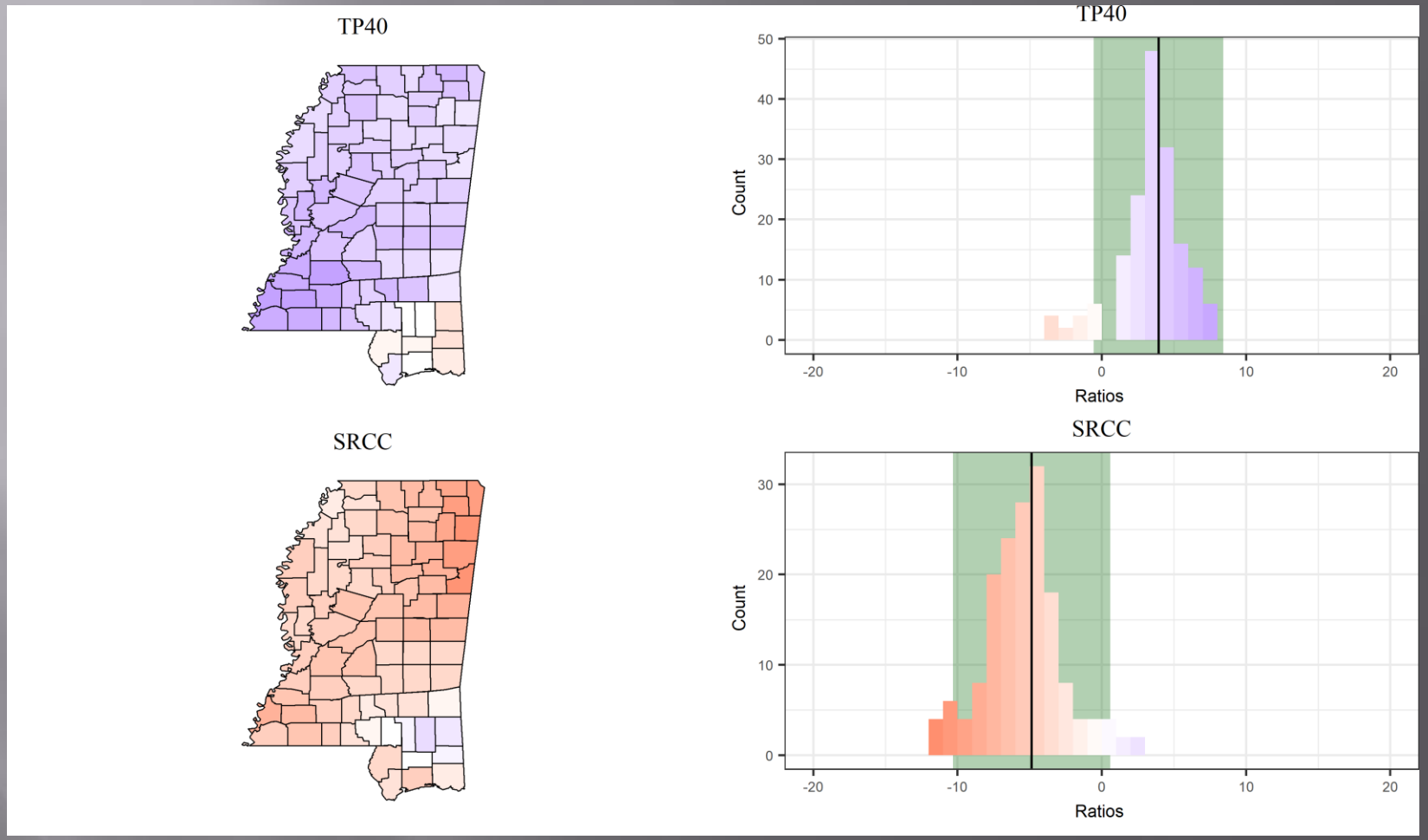


ATLAS14	MCD	SRCC	USDA
46	10	58	54
27%	6%	35%	32%

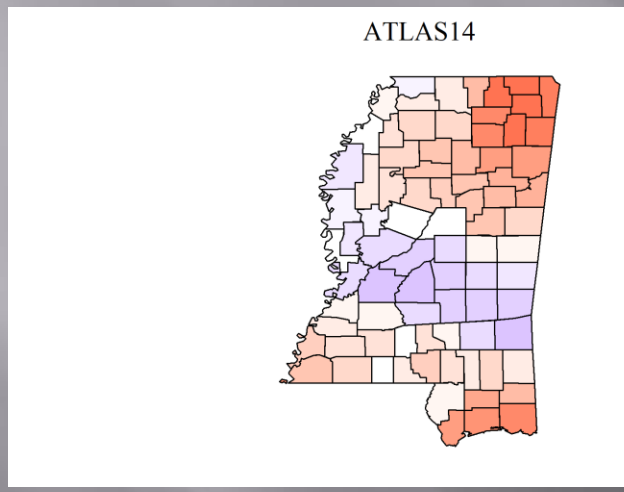
Comparison to the Mean

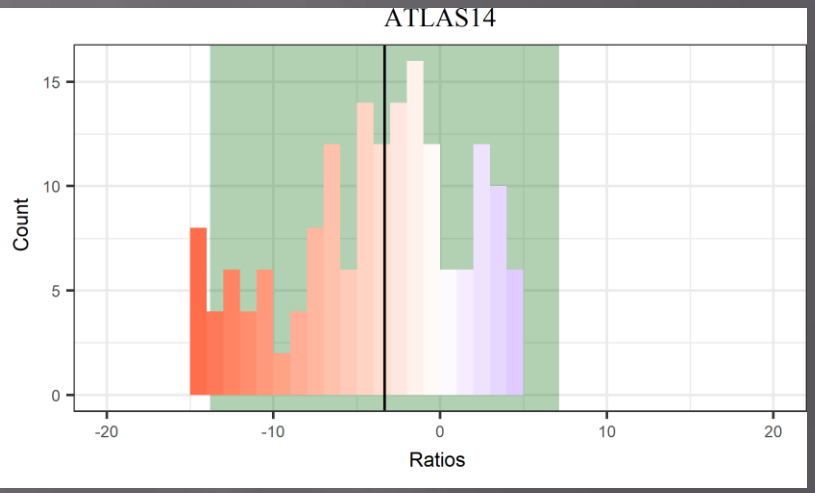


Comparison to the Mean

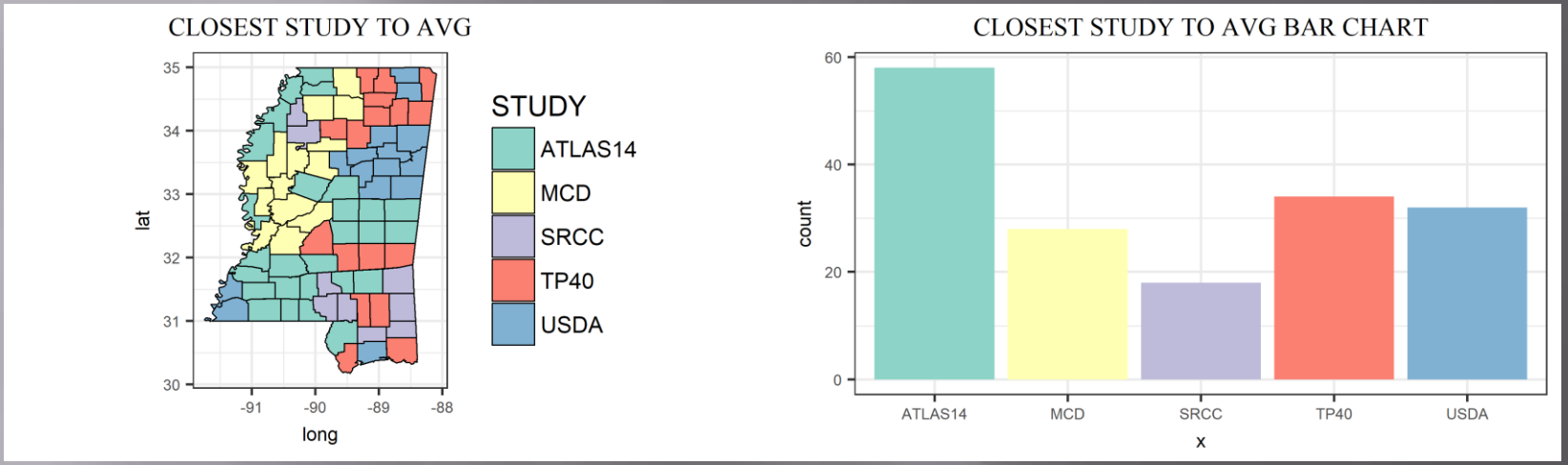


Comparison to the Mean





Comparison to the Mean



ATLAS14	MCD	SRCC	TP40	USDA
56	28	18	34	32
33%	17%	11%	20%	19%

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Comparison to the Mean

	5	3	4	1	2
STATISTIC	**MCD**	**USDA**	**TP40**	**SRCC**	**ATLAS14**
mean	6	-2	4	-5	-3
sd	6	5	2	3	5
cv	1	-3	1	-1	-2
2.5%	-5	-11	-2	-10	-14
16%	0	-8	2	-7	-10
50%	7	-2	4	-5	-3
84%	12	5	6	-3	3
97.5%	17	6	8	1	5

SUMMARY

- **SRCC is generally the largest of the studies**
- **MCD is generally the smallest of the studies**
- **ATLAS 14 is generally the most central of the studies**

SUMMARY

- All (5) studies are <6% different on average
  - Doctoral Research : Texas <6%
- Estimates have an average: SD of 0.64-in, CV of 0.07, and range of 1.56-in
  - Doctoral Research : Texas SD of 0.56-in
- Atlas 14 (uncertainty)
  - AVG 90% CI of +/- 2.3-in, or 23%
  - AVG RMSE of 1.4-in, or 14%
  - Doctoral Research : Texas AVG RMSE of 2-in, or 20%
- More certainty in estimates being alike than the estimates themselves (indistinguishable)

References

1) Hershfield, D. M. (1963);“Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and return Periods from 1 to 100 Years”; United States Weather Bureau.

2) Kite, G. (1977); “Frequency and Risk Analyses in Hydrology”; Water Resources Publications.

3) Morgan, A. (1917); “Storm Rainfall of Eastern United States, Technical Report Part “;The State of Ohio Miami Conservancy District.

4) Perica, S. ; et al. (2013); “Precipitation-Frequency Atlas , NOAA Atlas 14”; NOAA: Vol 9, Version 2.0

5) Switzer, F. (1929); “Floods”; Sibley Journal of Engineering, 362-366.

6) Yarnell, D. (1935); “Rainfall Intensity Frequency Data”. United States Department of Agriculture

7) Faiers, G.E.; Keim, B.D.; Muller, R.A.; “Rainfall Frequency/Magnitude Atlas for the South-Central United States”, SRCC Technical Paper;(1997)

Questions?