Exploring Snowfall in the United States

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October 9th, 2014 OSU Climate Change Webinar Series

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Outline

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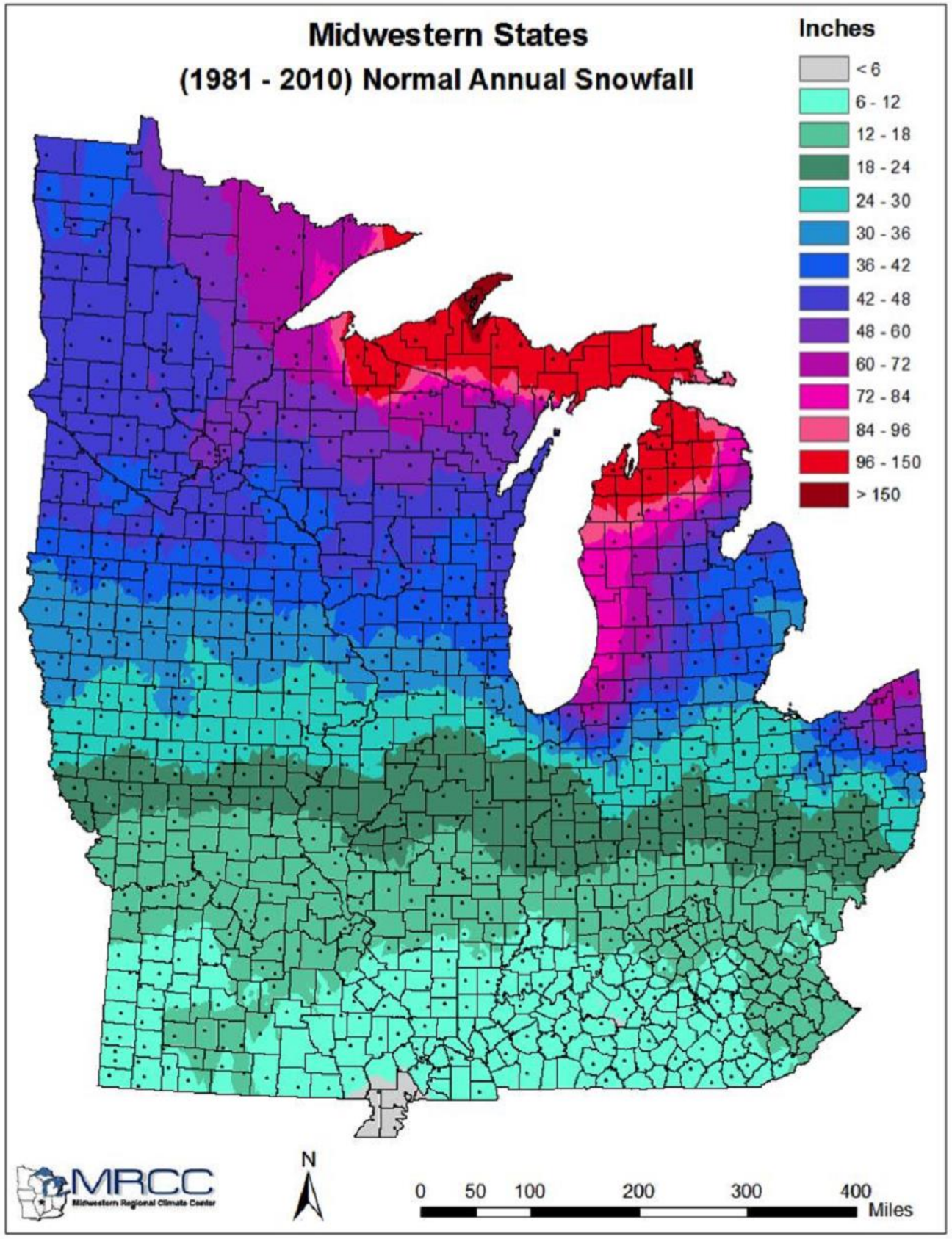
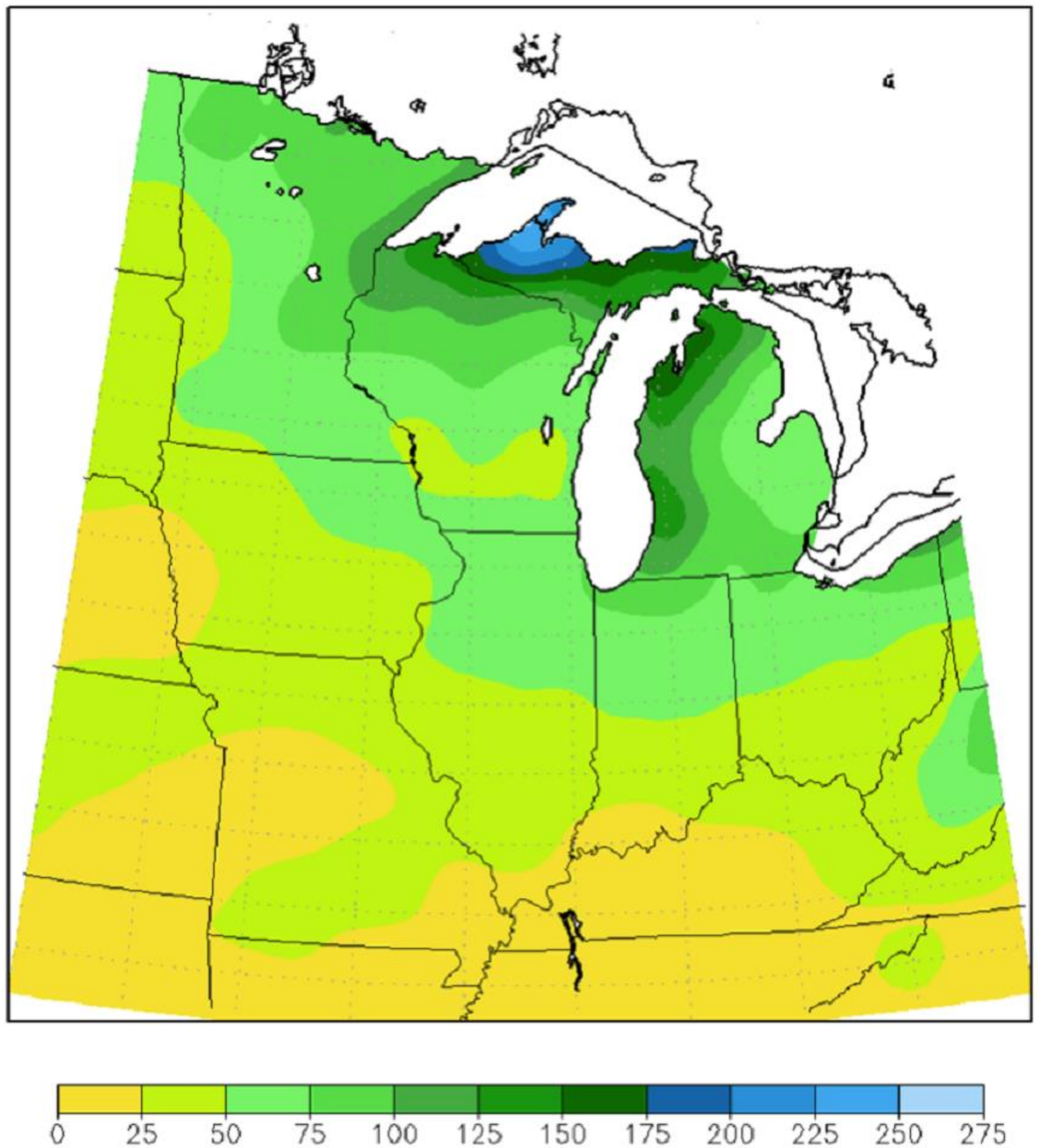
- Motivation – Why should we be interested in snowfall frequency?
- Snowfall Frequency Regionalization
- Trends in snowfall frequency by region
- Coming Soon – ORNL/CDIAC Snowfall Interface

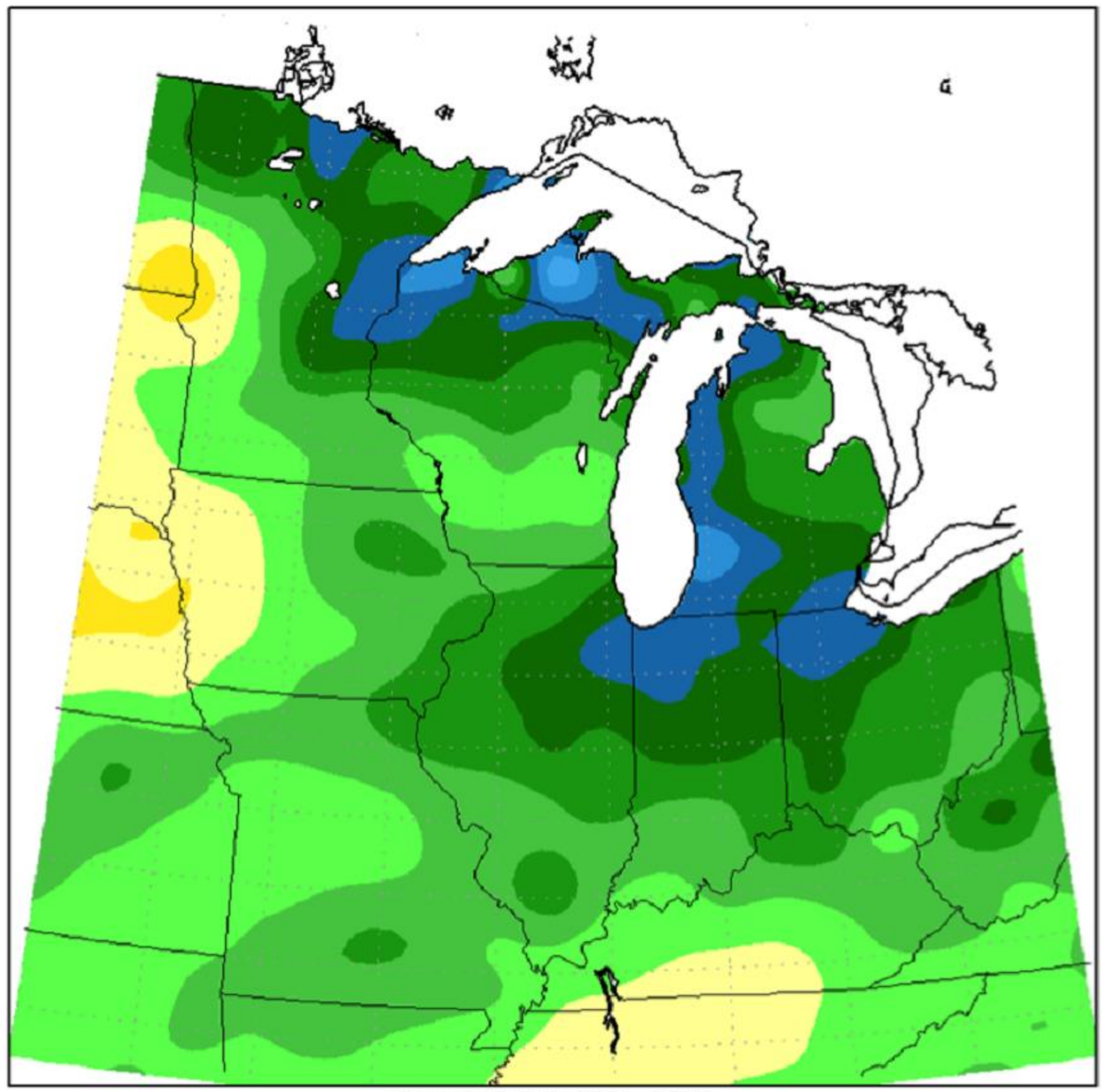

Midwestern States
(1981 - 2010) Normal Annual Snowfall
Inches
< 6
6 - 12
12 - 18
18 - 24
24 - 30
30 - 36
36 - 42
42 - 48
48 - 60
60 - 72
72 - 84
84 - 96
96 - 150
> 150
MRCC
Midwestern Regional Climate Center
N
0 50 100 200 300 400
Miles

Accumulated Snowfall (in)
July 1, 2013 to July 20, 2014



Midwestern Regional Climate Center
Illinois State Water Survey, Prairie Research Institute
University of Illinois at Urbana–Champaign

Accumulated Snowfall (in): Departure from Mean
July 1, 2013 to July 20, 2014



Mean period is 1981–2010.

Midwestern Regional Climate Center
Illinois State Water Survey, Prairie Research Institute
University of Illinois at Urbana–Champaign

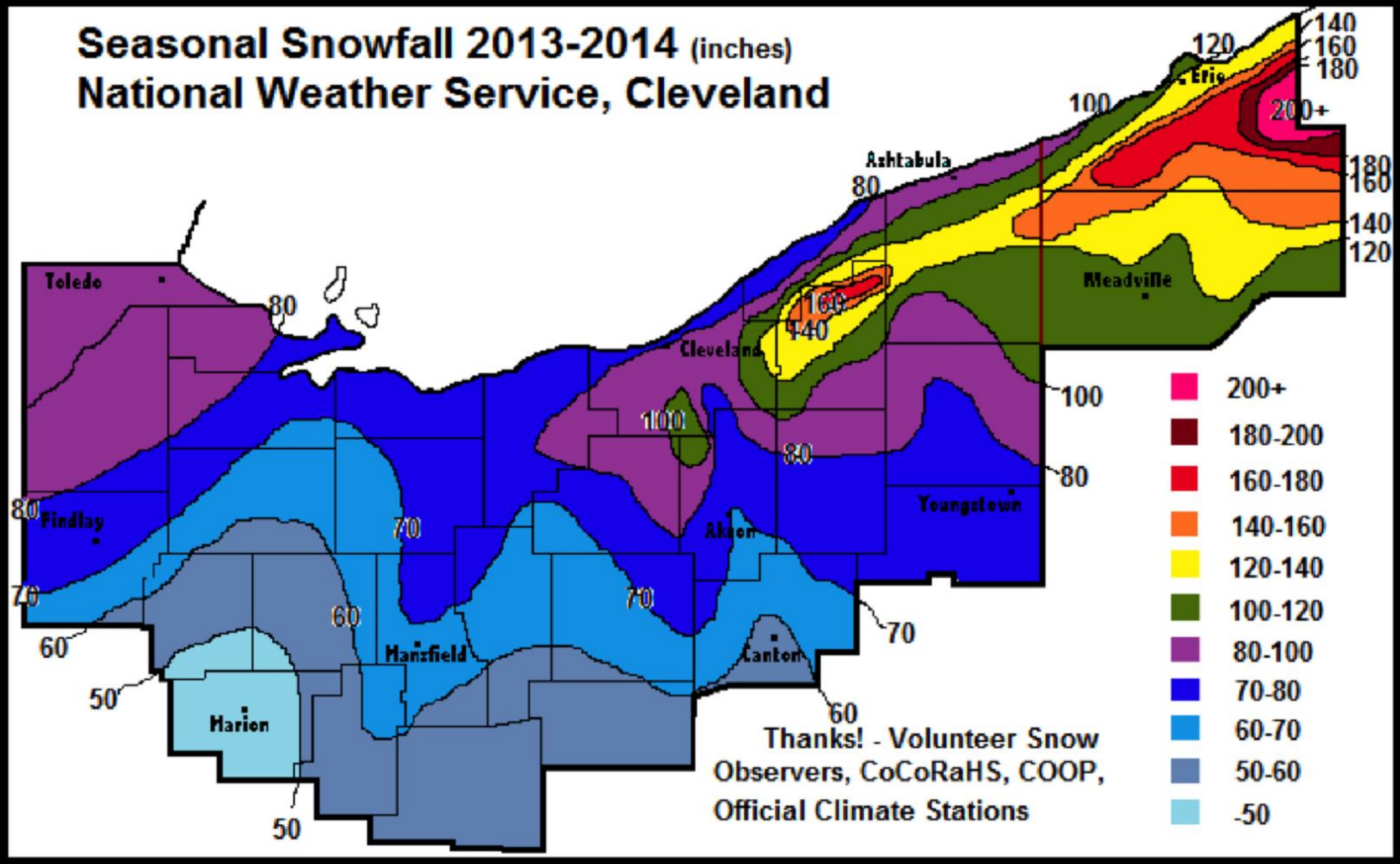


Image from the NWS office in Cleveland, Ohio

Motivation:

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Toledo area plows, February, 2014. Photo by The Blade/Andy Morrison

Motivation:

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One Large snowfall event

Time spent shoveling:

Cost of Salt:

Motivation:

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One Large snowfall event

Time spent shoveling:

Cost of Salt:

Motivation:

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One Large snowfall event

Time spent shoveling:

Cost of Salt:

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One Large snowfall event

Time spent shoveling:

Cost of Salt:

Motivation:

One Large snowfall event

Several smaller snowfall events

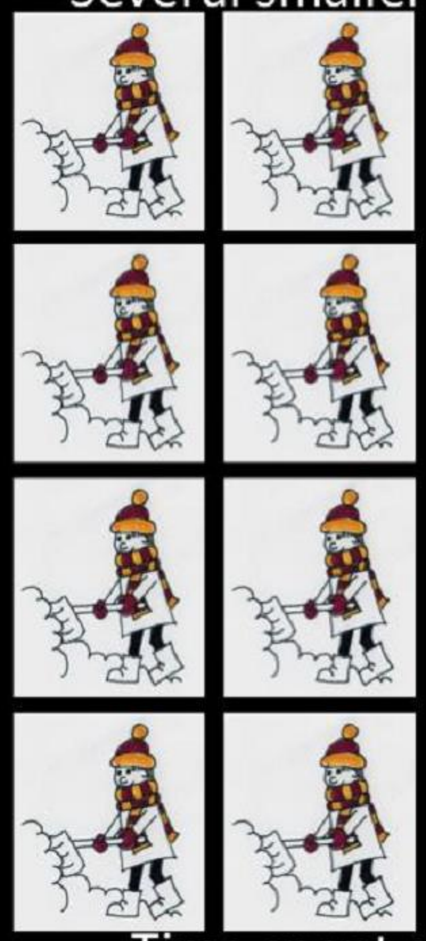
Time spent shoveling:

Cost of Salt:

Motivation:

One Large snowfall event

Several smaller snowfall events



Time spent shoveling:

Cost of Salt:

Time spent shoveling:

Cost of Salt:

Motivation:

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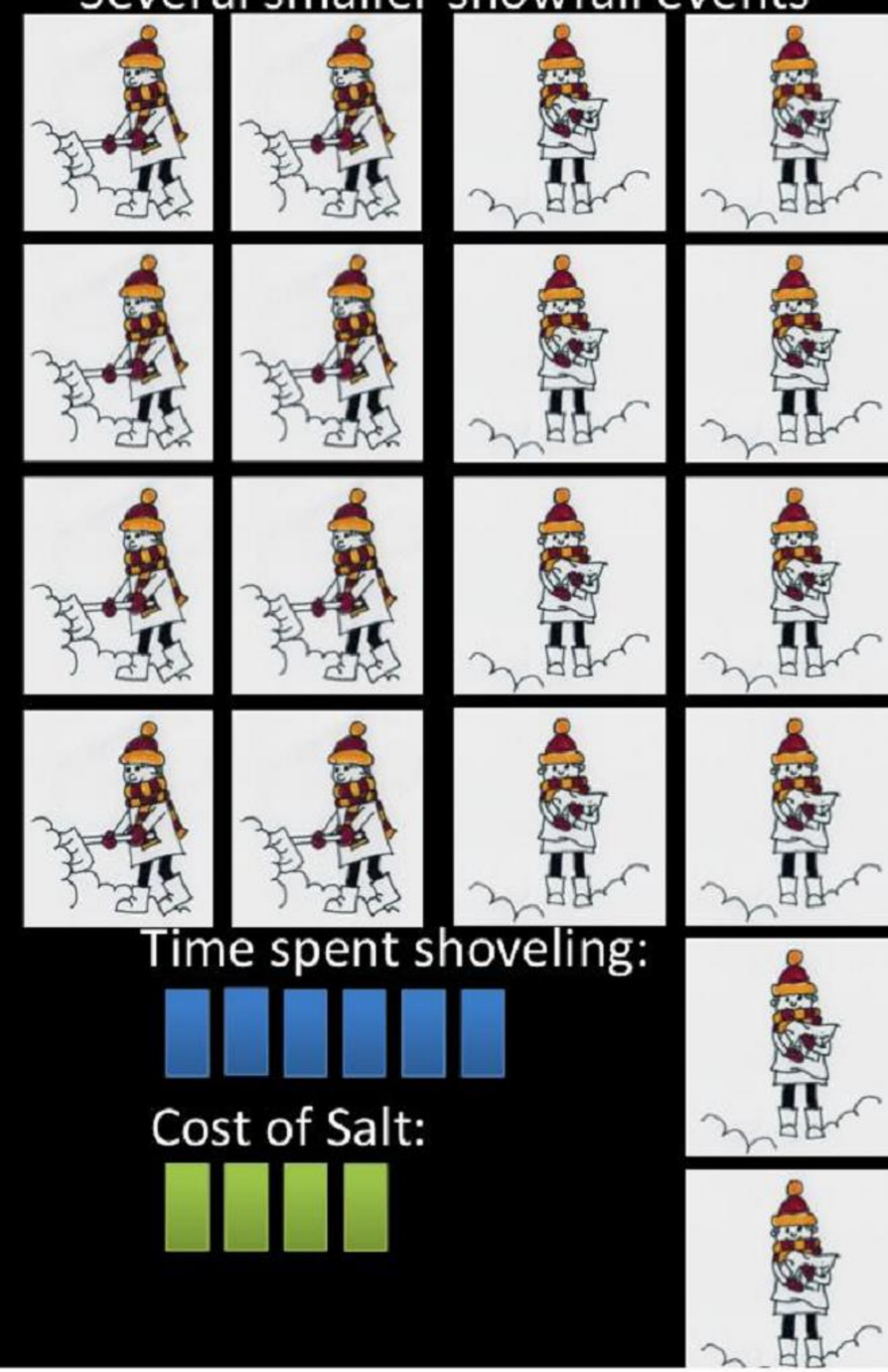
One Large snowfall event

Several smaller snowfall events



Time spent shoveling:

Cost of Salt:

Time spent shoveling:

Cost of Salt:

U.S. Snowfall Frequency Regionalization

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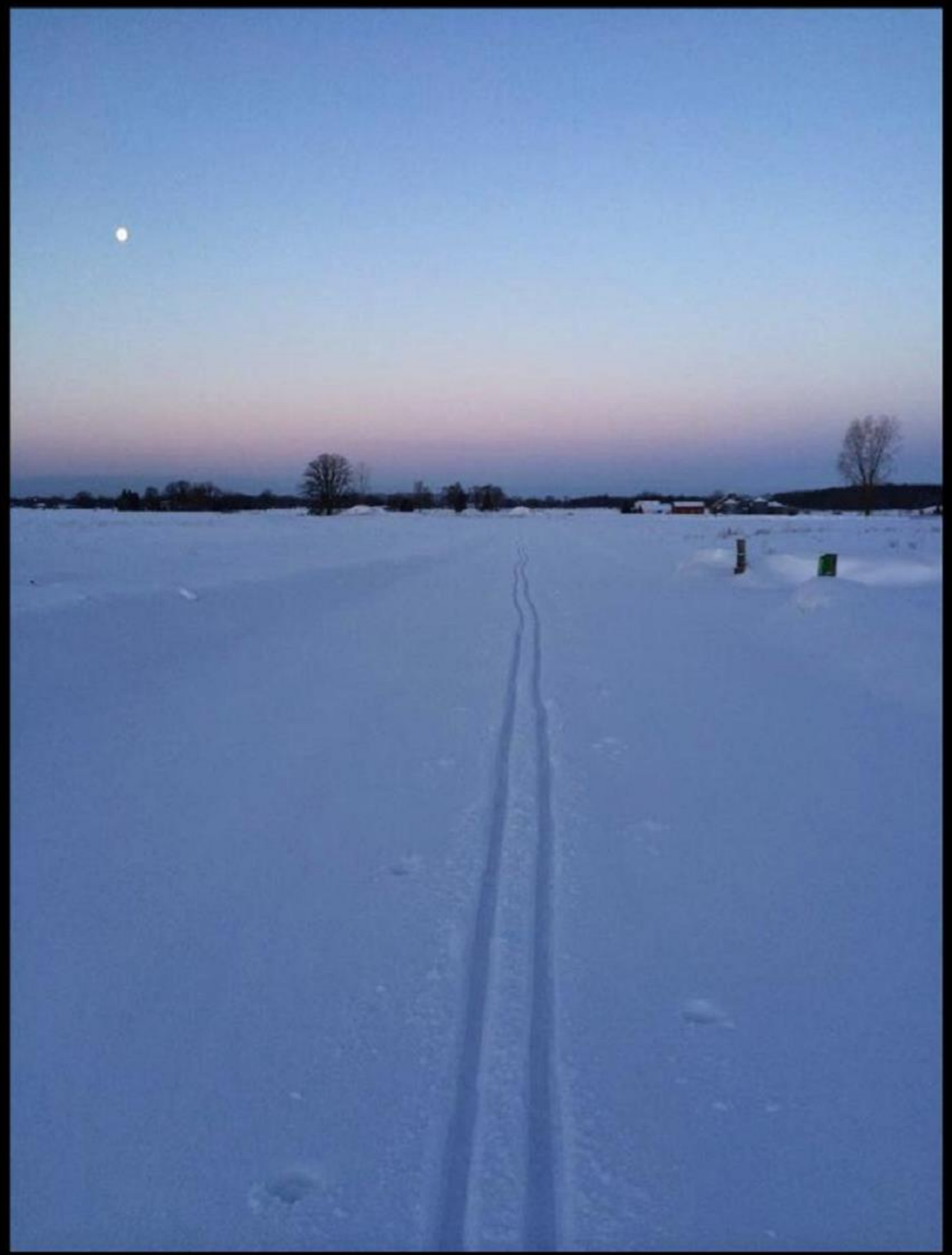
Goal: to create snowfall frequency regions and examine changes through time

Collaborator:

Dr. Daniel Leathers, Department of Geography, University of Delaware



Snowfall Data

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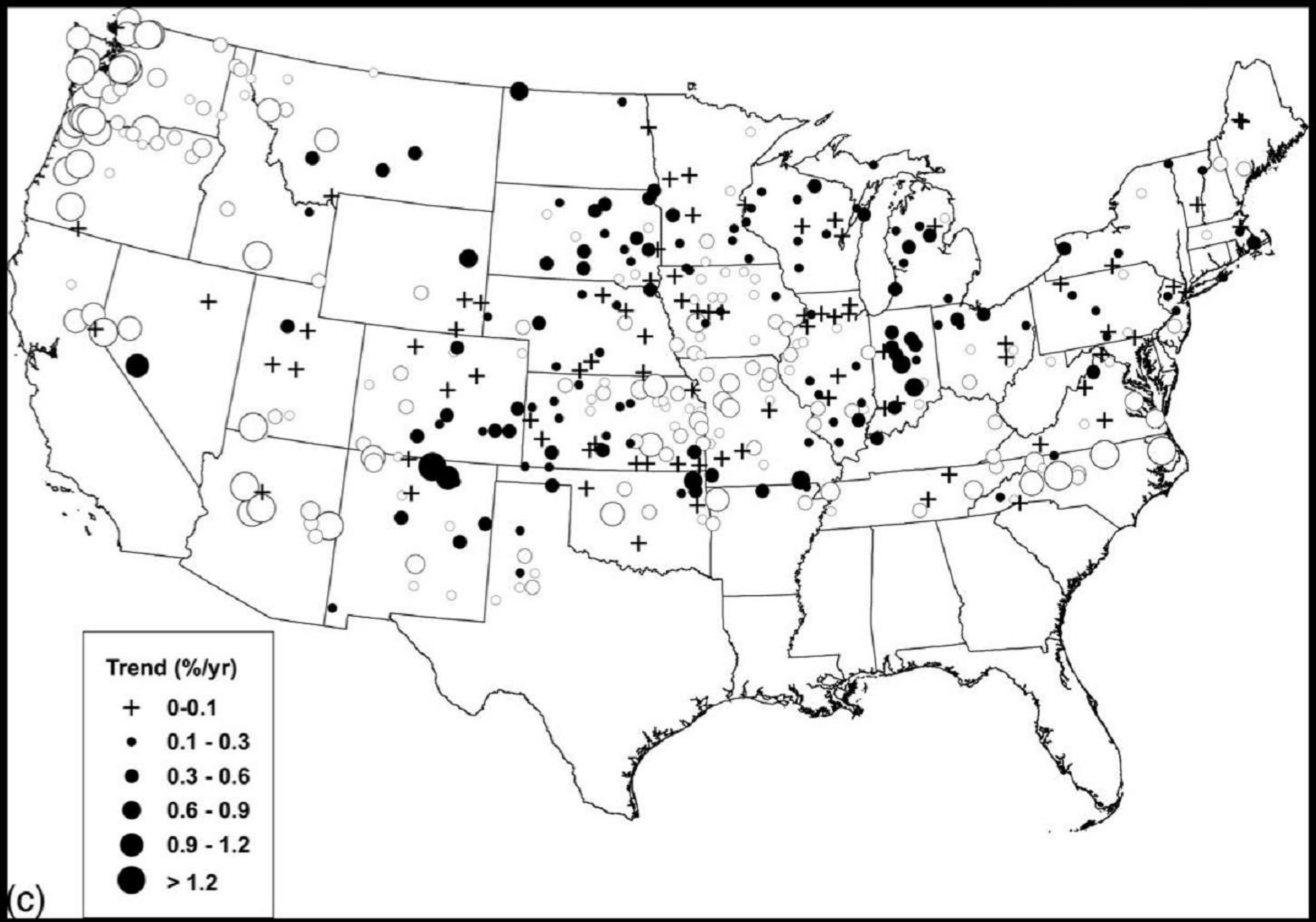
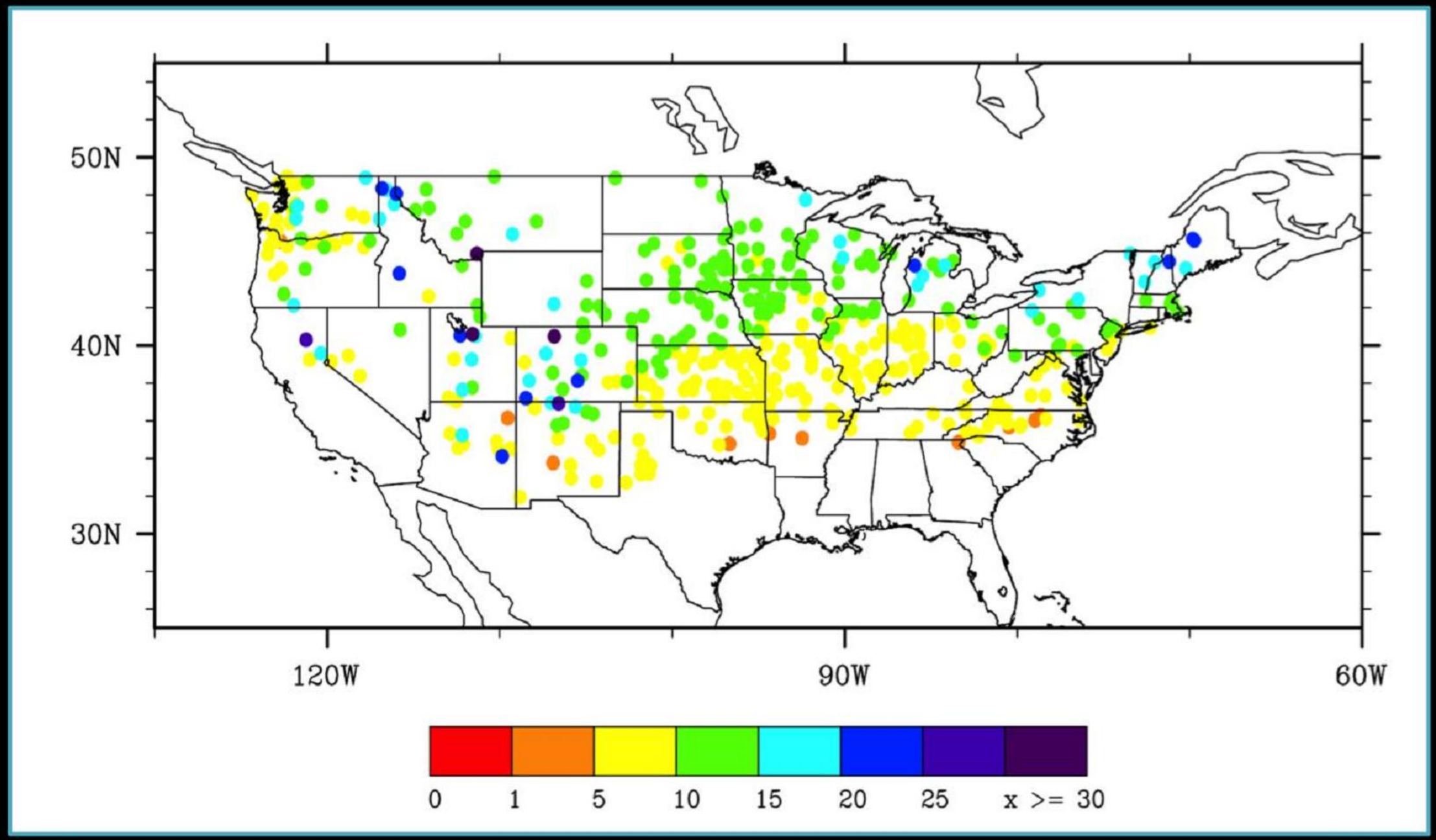
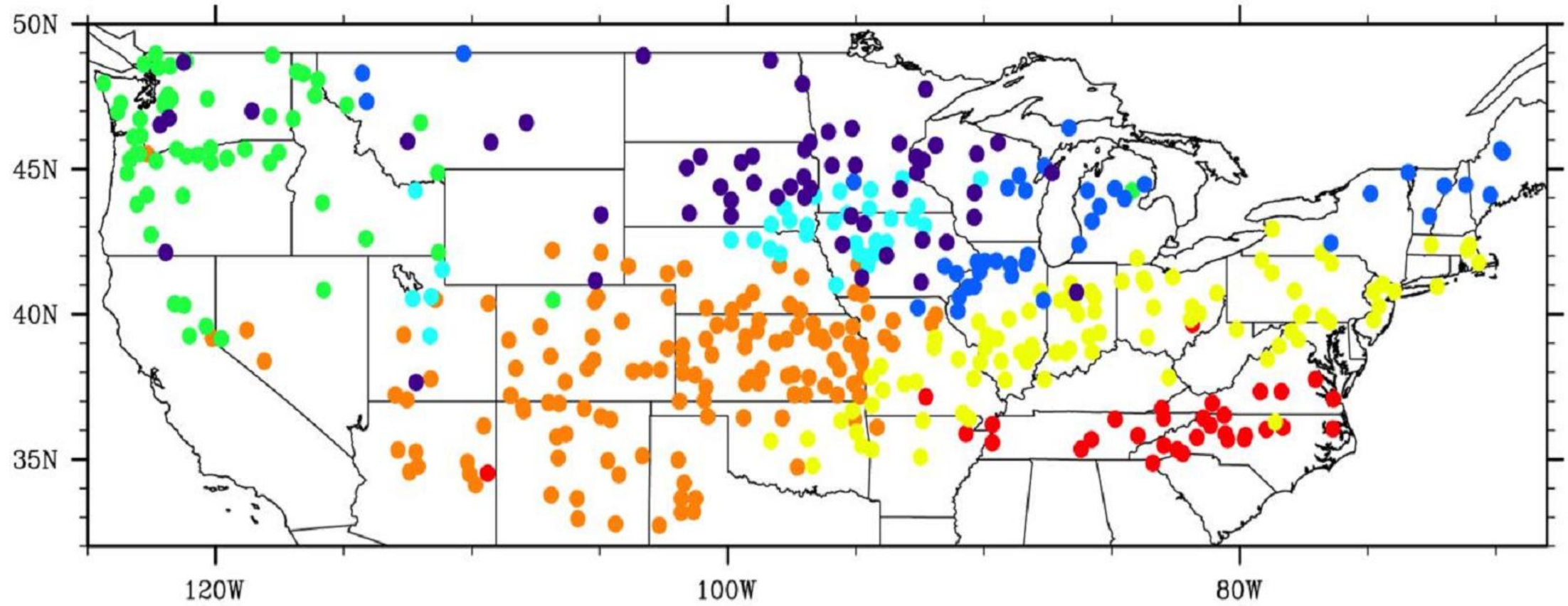


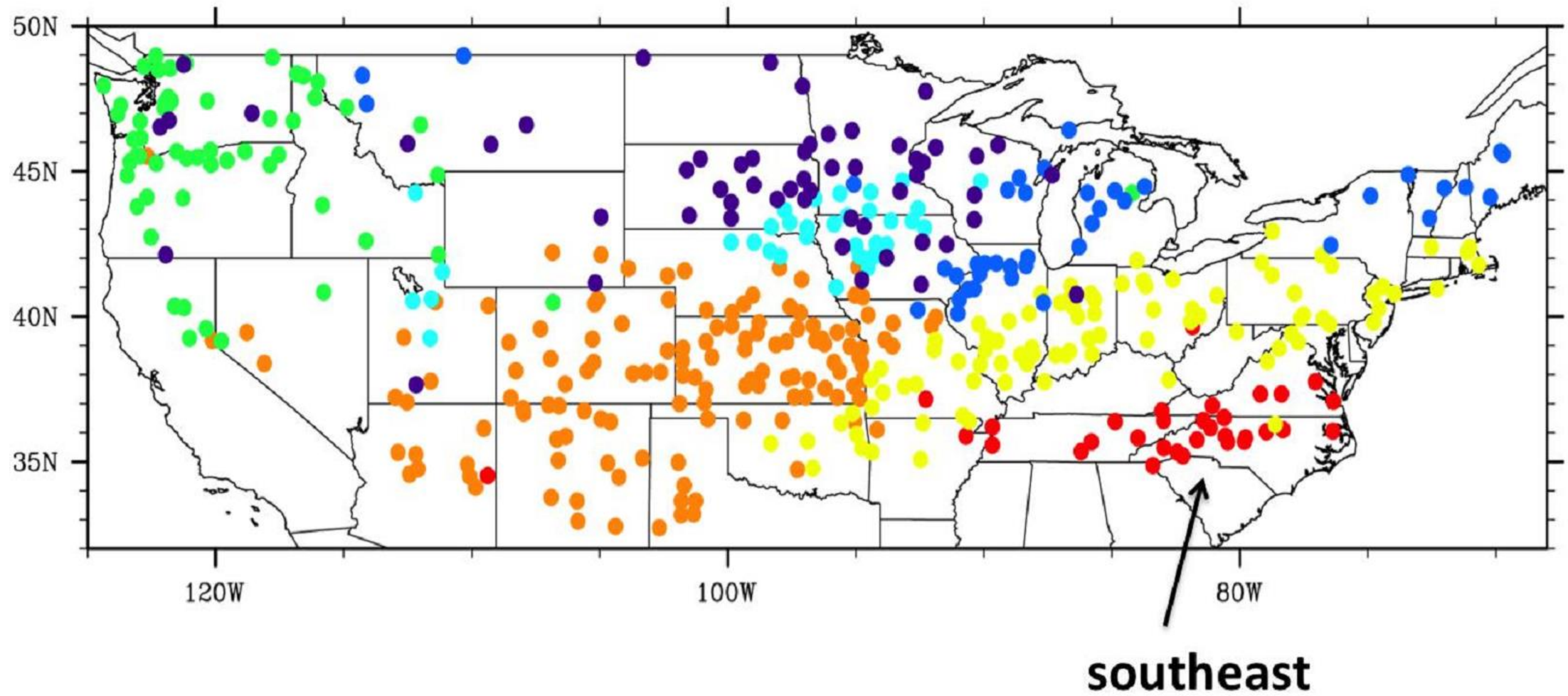
Figure 4c from Kunkel *et al.* (2009)

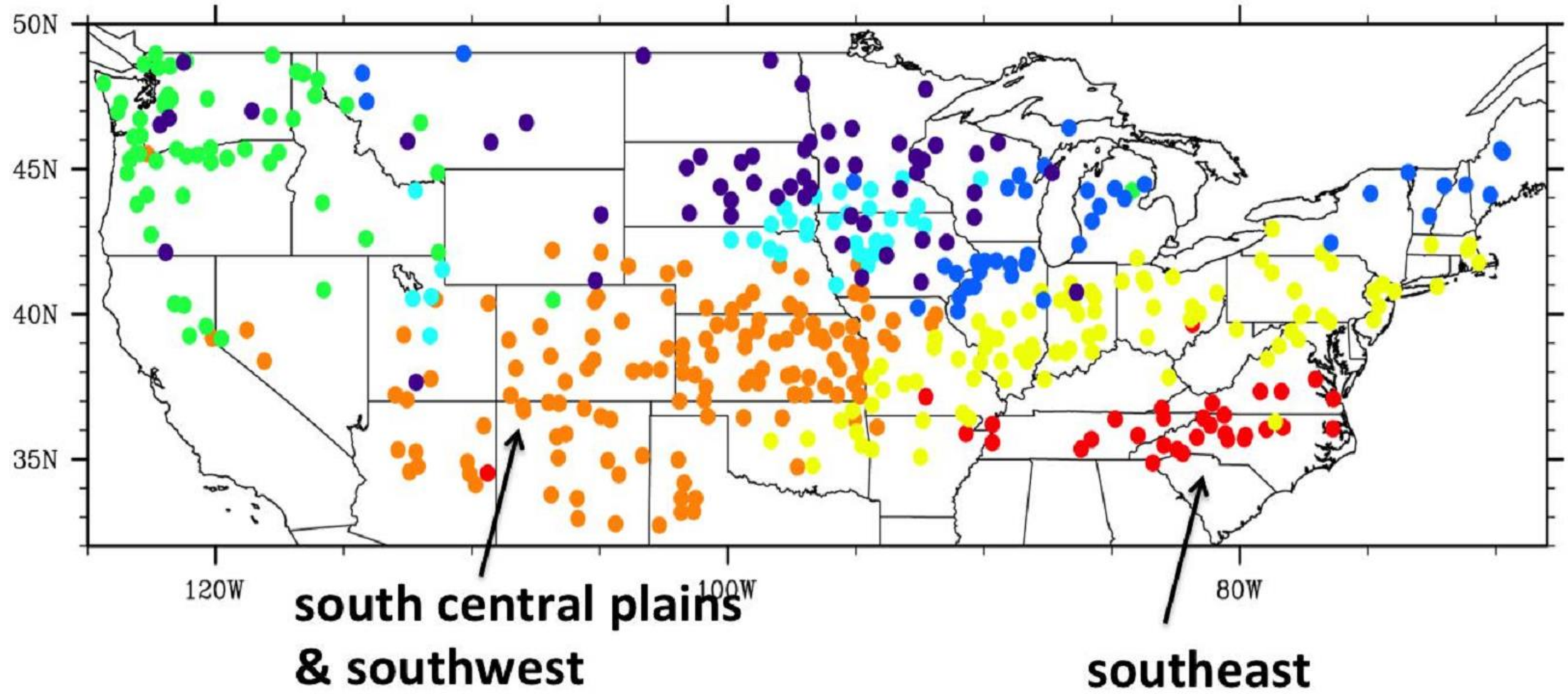
Snowfall Data

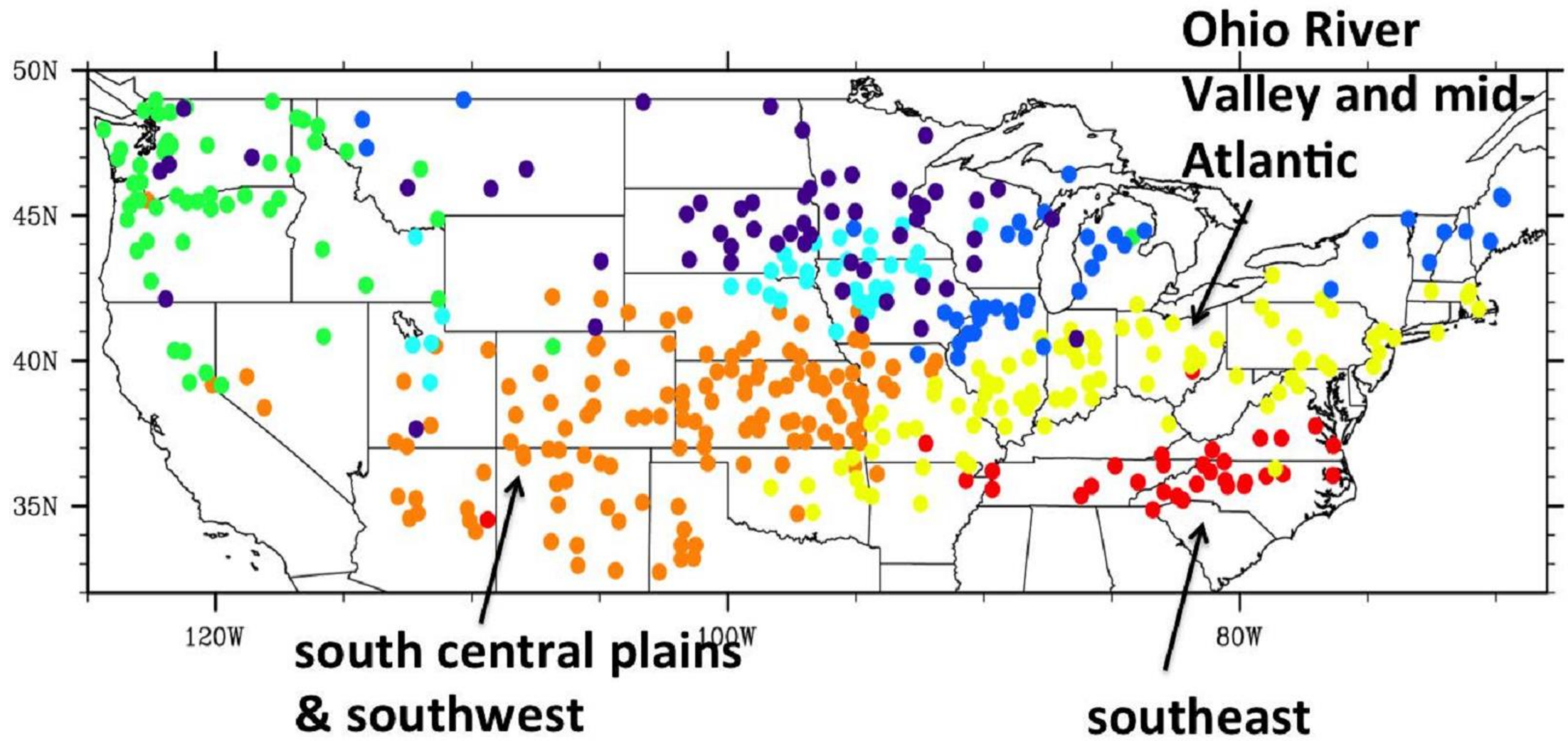


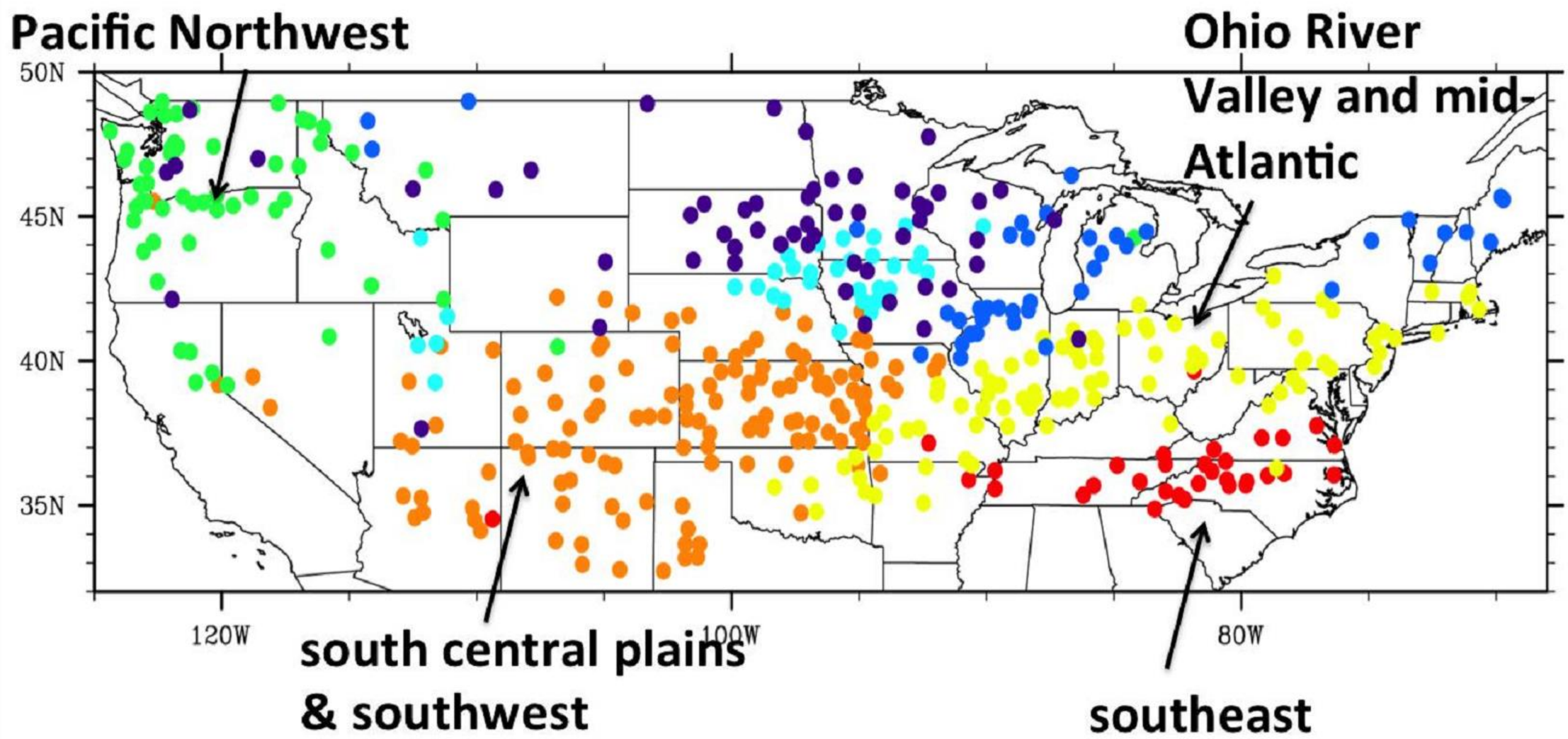
the average seasonal frequency of events greater than or equal to 2 inches.

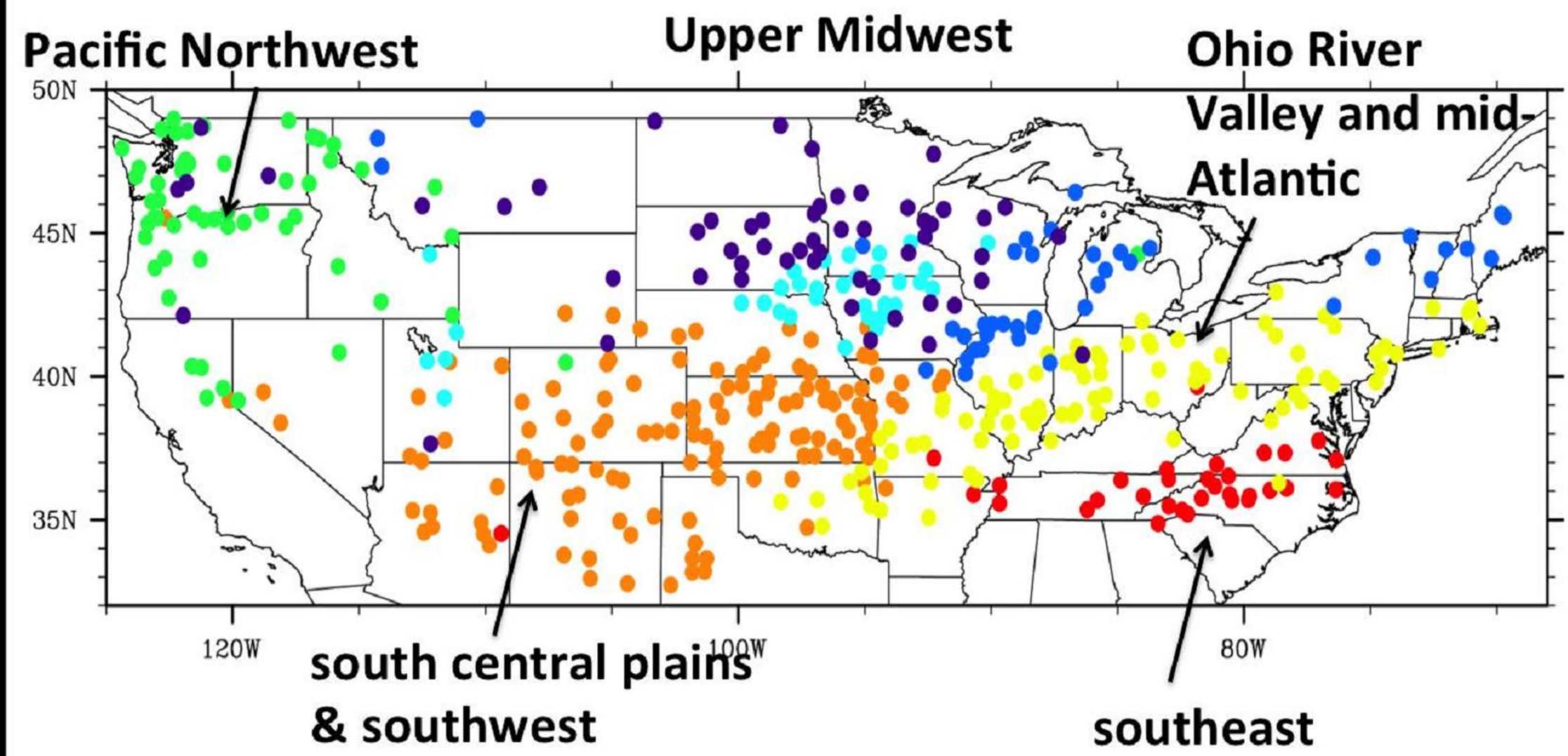

50N
45N
40N
35N
120W
100W
80W

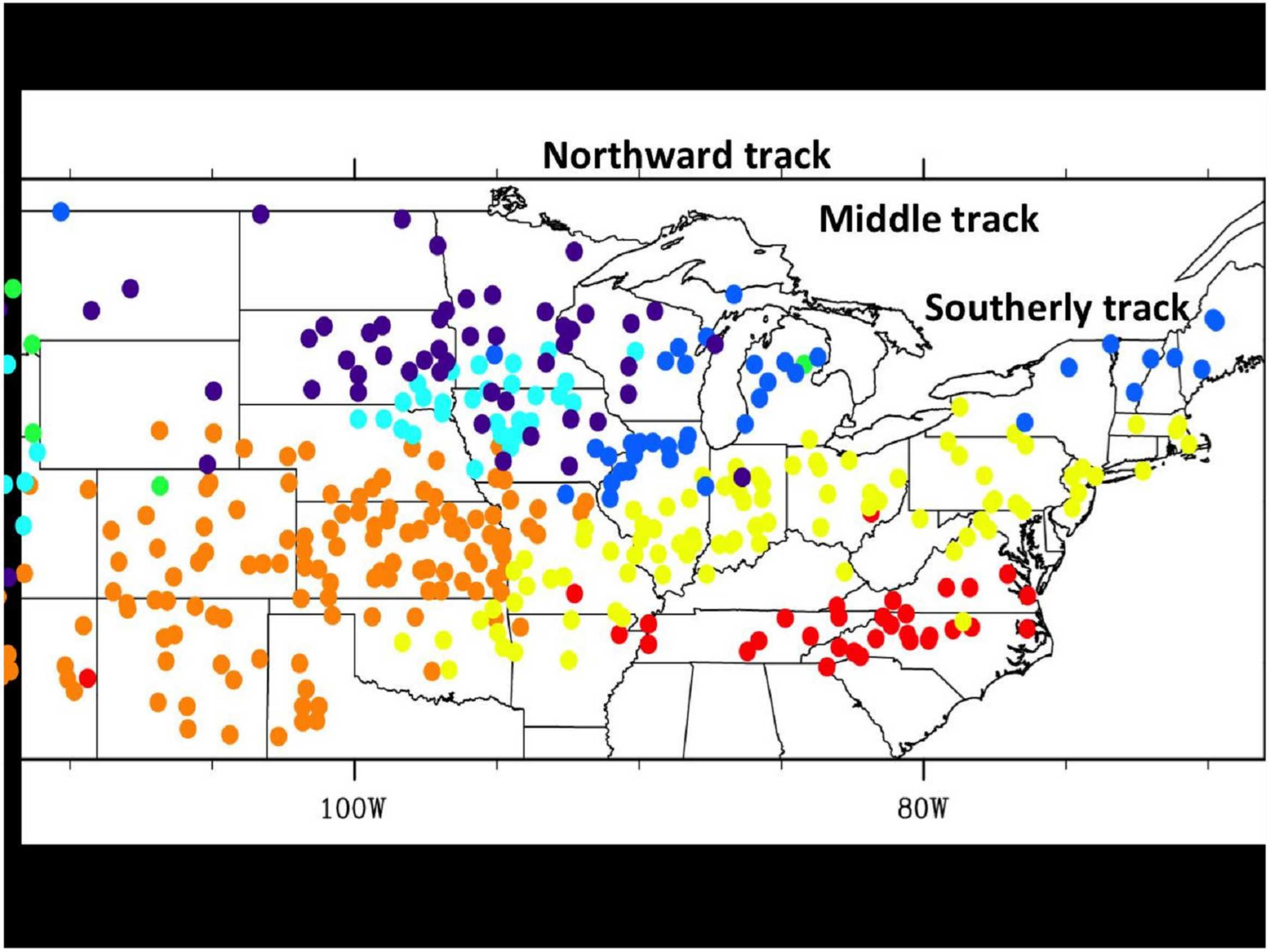

50N
45N
40N
35N
120W
100W
80W
southeast

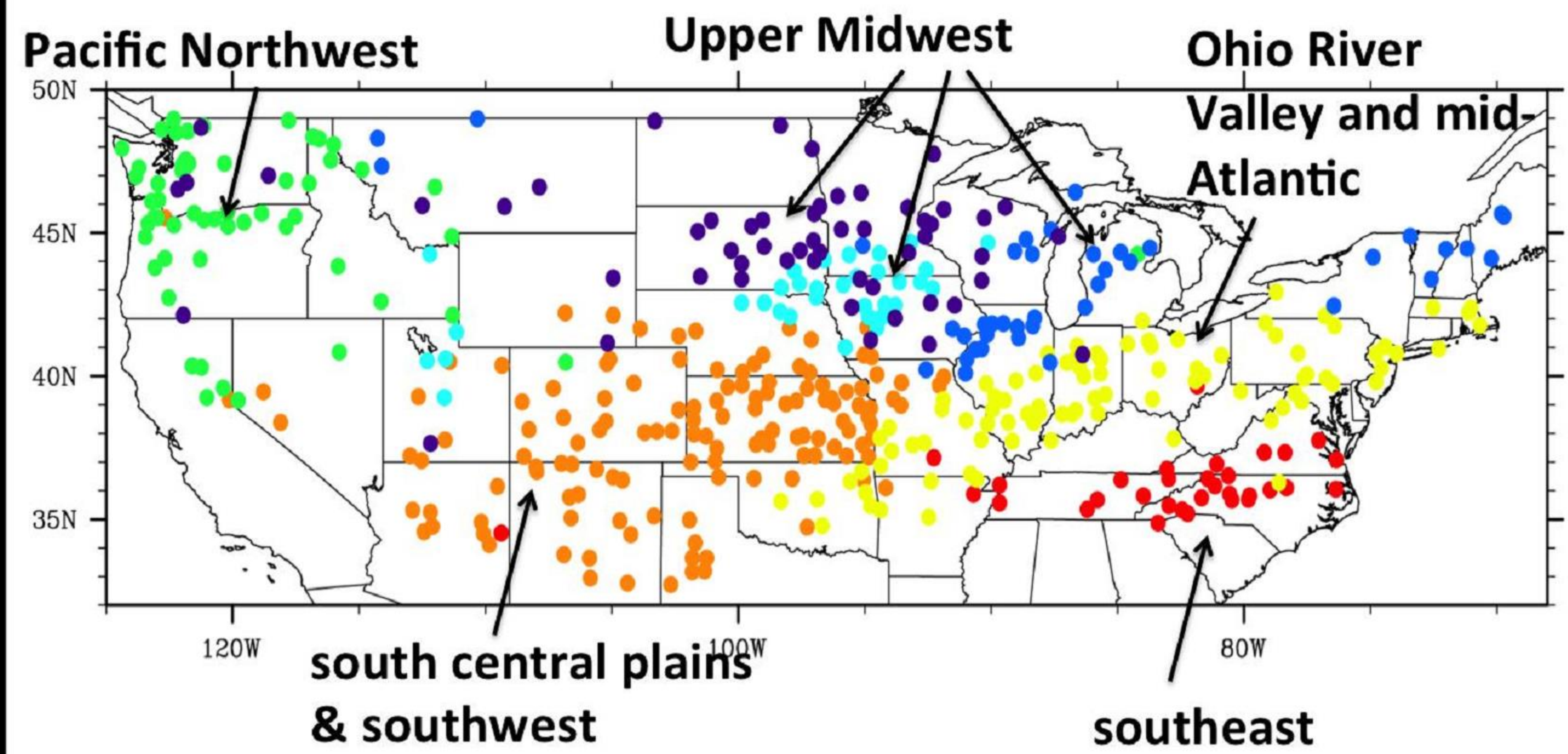

50N
45N
40N
35N
120W
100W
80W
south central plains
& southwest
southeast


Ohio River Valley and mid-Atlantic
50N
45N
40N
35N
120W
100W
80W
south central plains & southwest
southeast


Pacific Northwest
Ohio River Valley and mid-Atlantic
south central plains & southwest
southeast
50N
45N
40N
35N
120W
100W
80W


Pacific Northwest
Upper Midwest
Ohio River Valley and mid-Atlantic
south central plains & southwest
southeast
50N
45N
40N
35N
120W
100W
80W


Northward track
Middle track
Southerly track
100W
80W


Pacific Northwest
Upper Midwest
Ohio River Valley and mid-Atlantic
south central plains & southwest
southeast
50N
45N
40N
35N
120W
100W
80W

Trends in Snowfall Frequency by region

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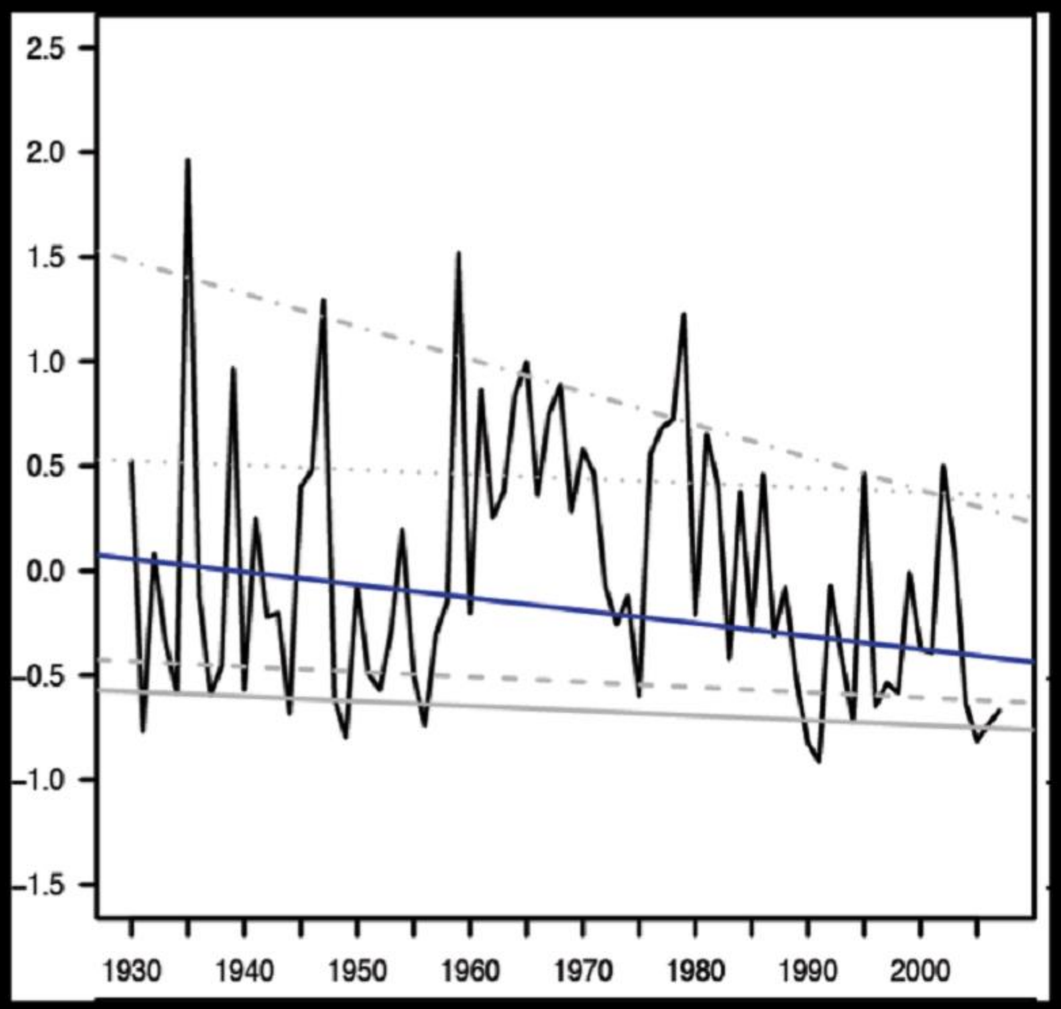
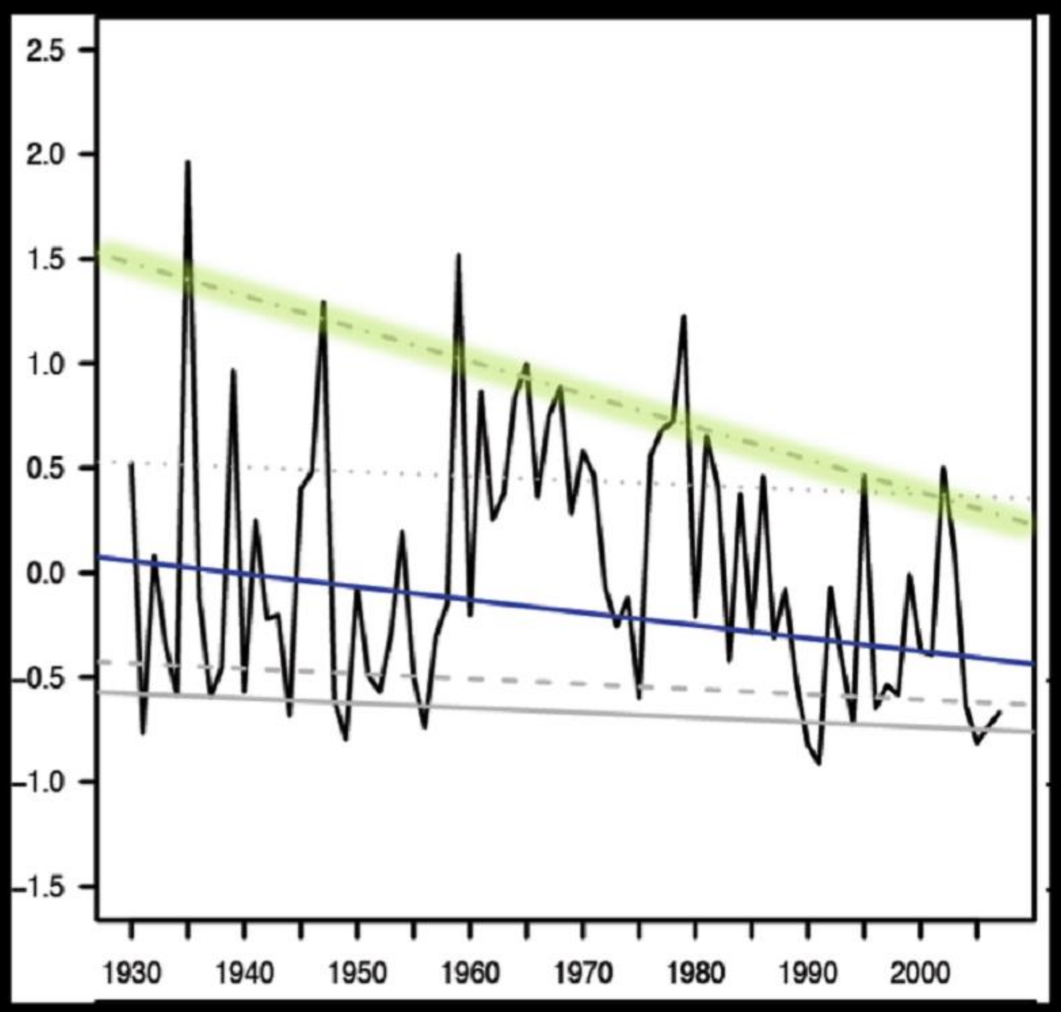
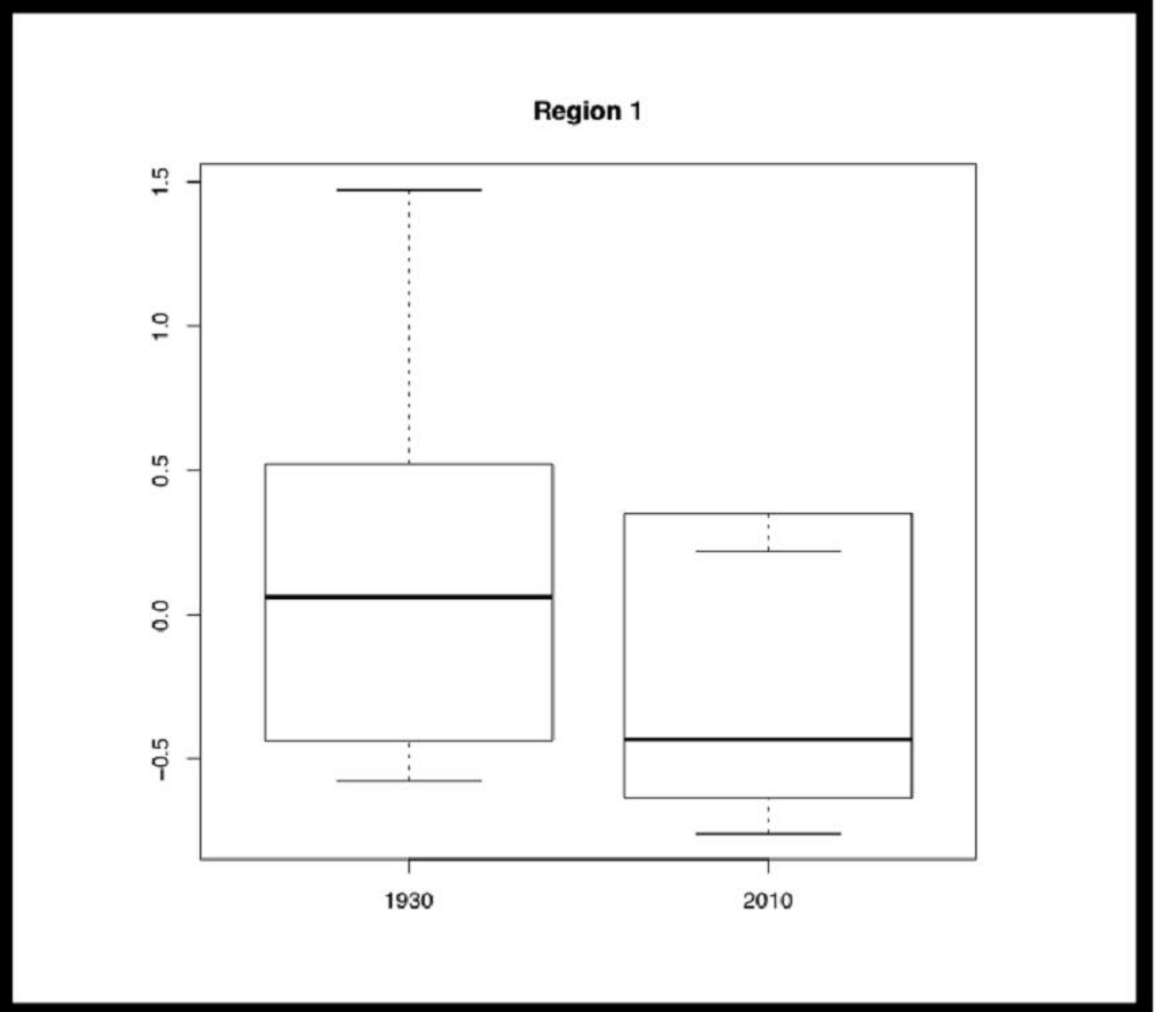
- Quantile regression to assess changes in the entire distribution
  - estimates for the 10th, 25th, 50th, 75th and 90th percentiles
  - Highlighted slopes statistically different from zero ($p<=0.05$)

Trends in Snowfall Frequency: Southeast



Trends in Snowfall Frequency: Southeast





Trends in Snowfall Frequency: Southeast

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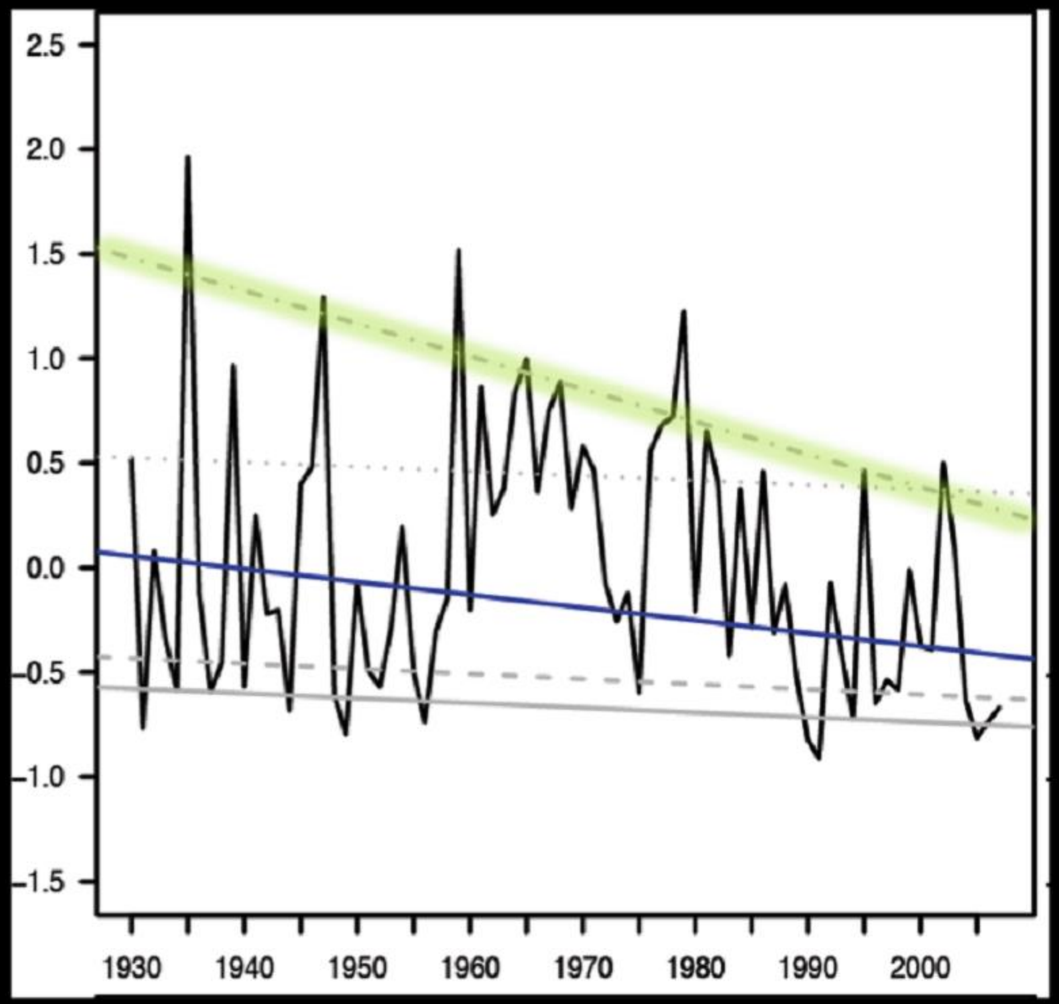

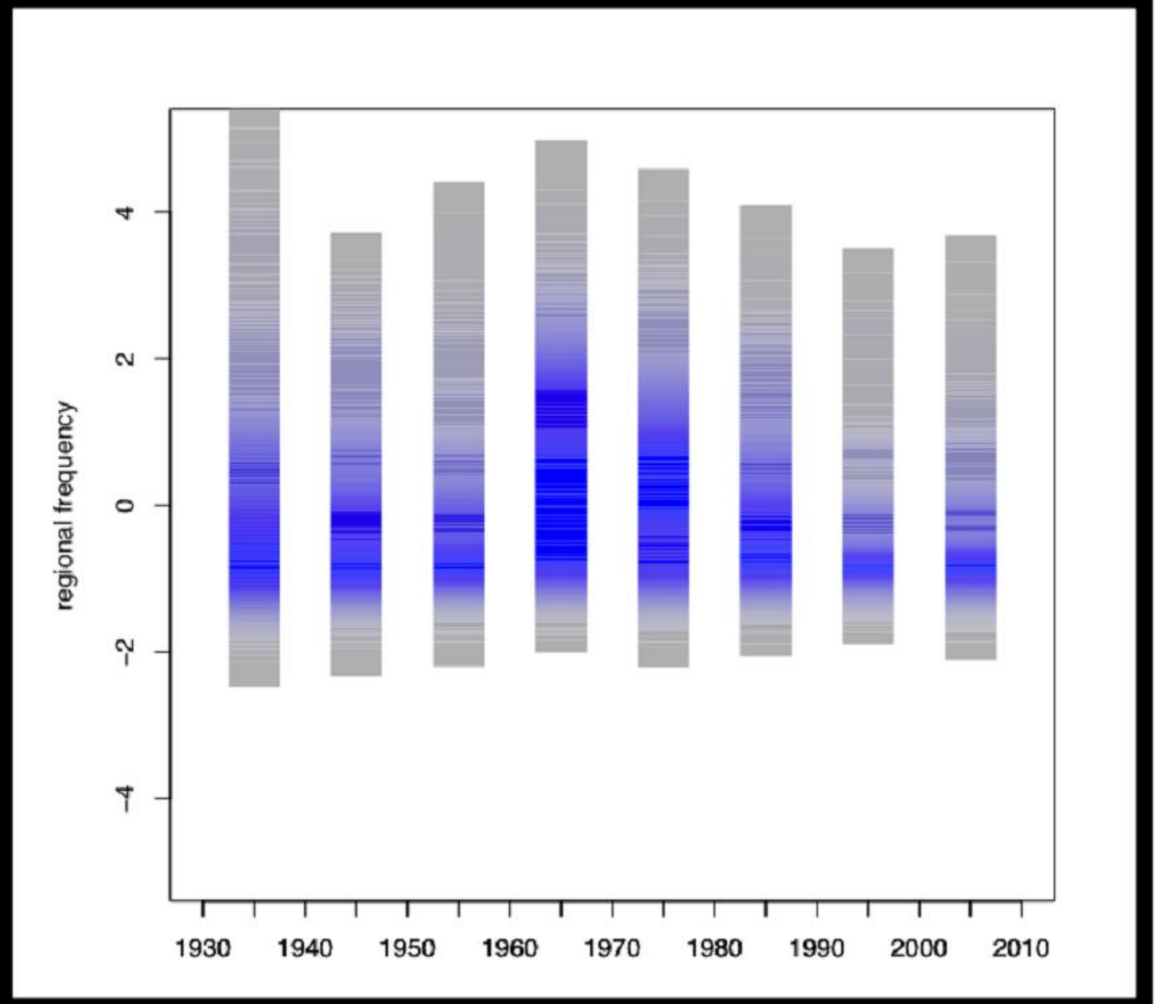

Trends in Snowfall Frequency: South Central Plains & Southwest

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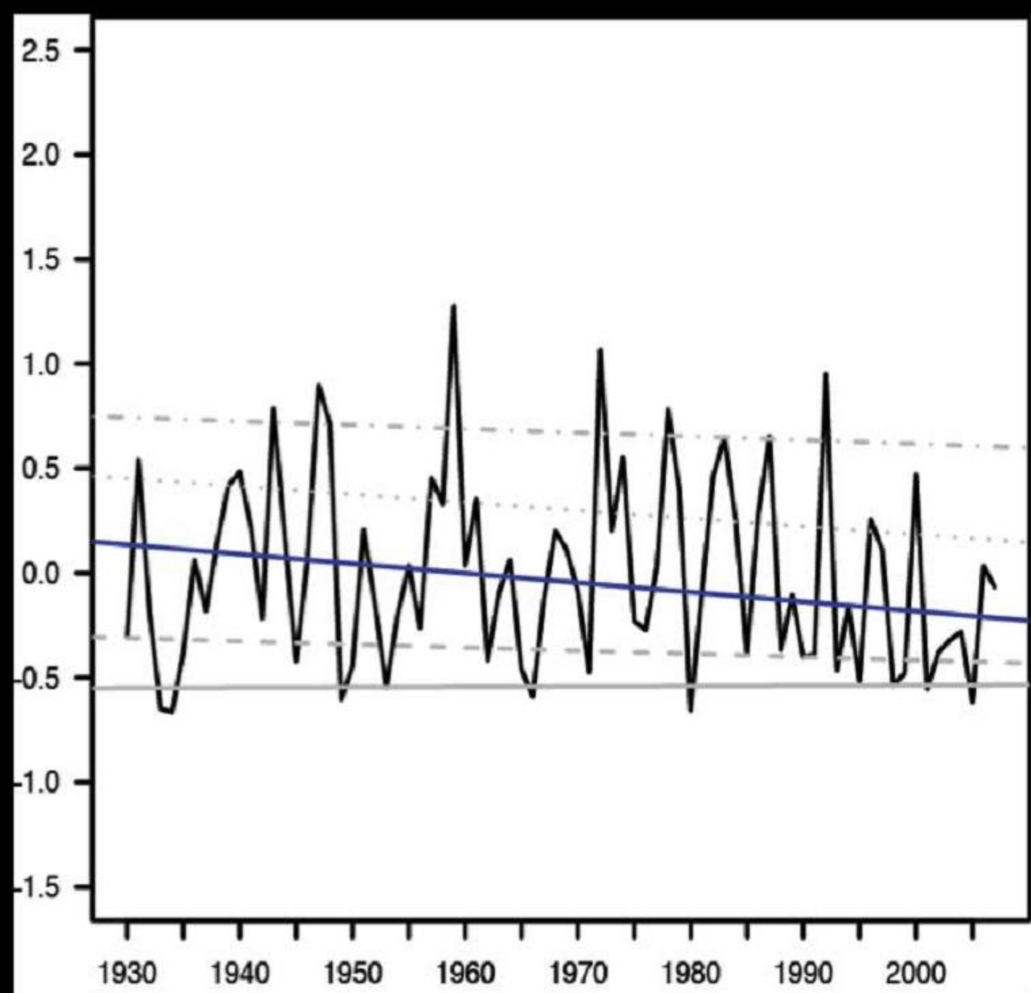

Trends in Snowfall Frequency: Ohio River Valley & mid-Atlantic

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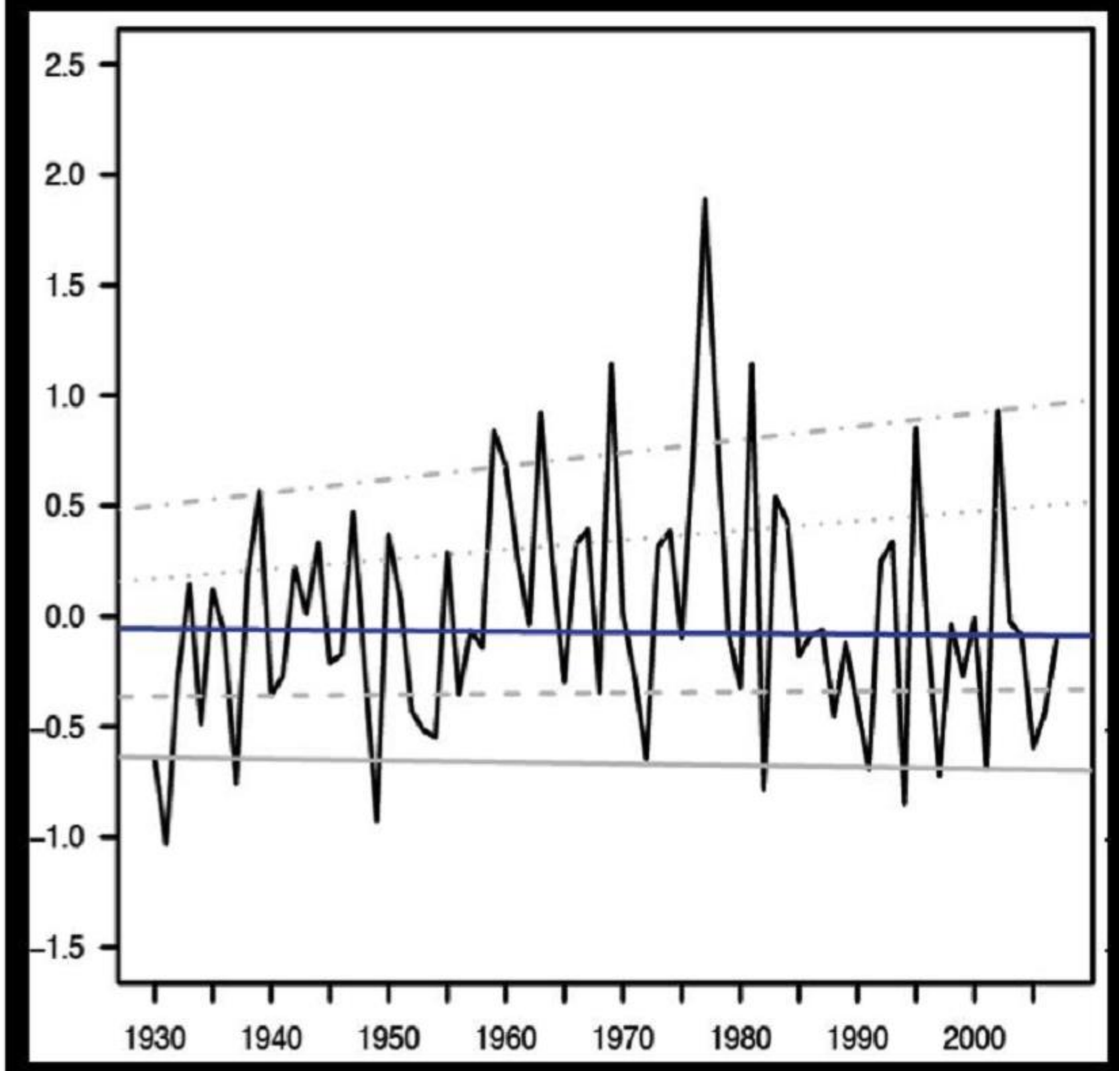

Trends in Snowfall Frequency: Pacific Northwest

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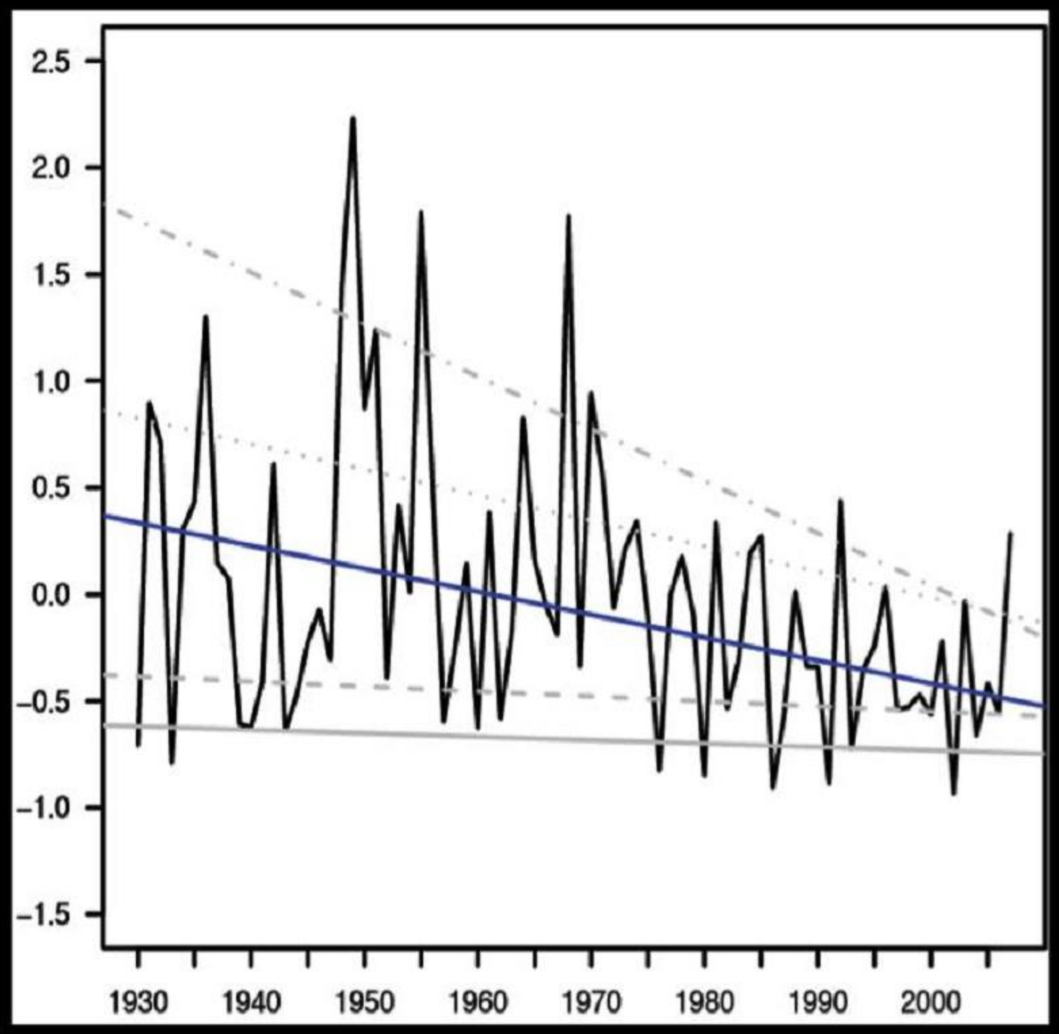

Trends in Snowfall Frequency: Pacific Northwest

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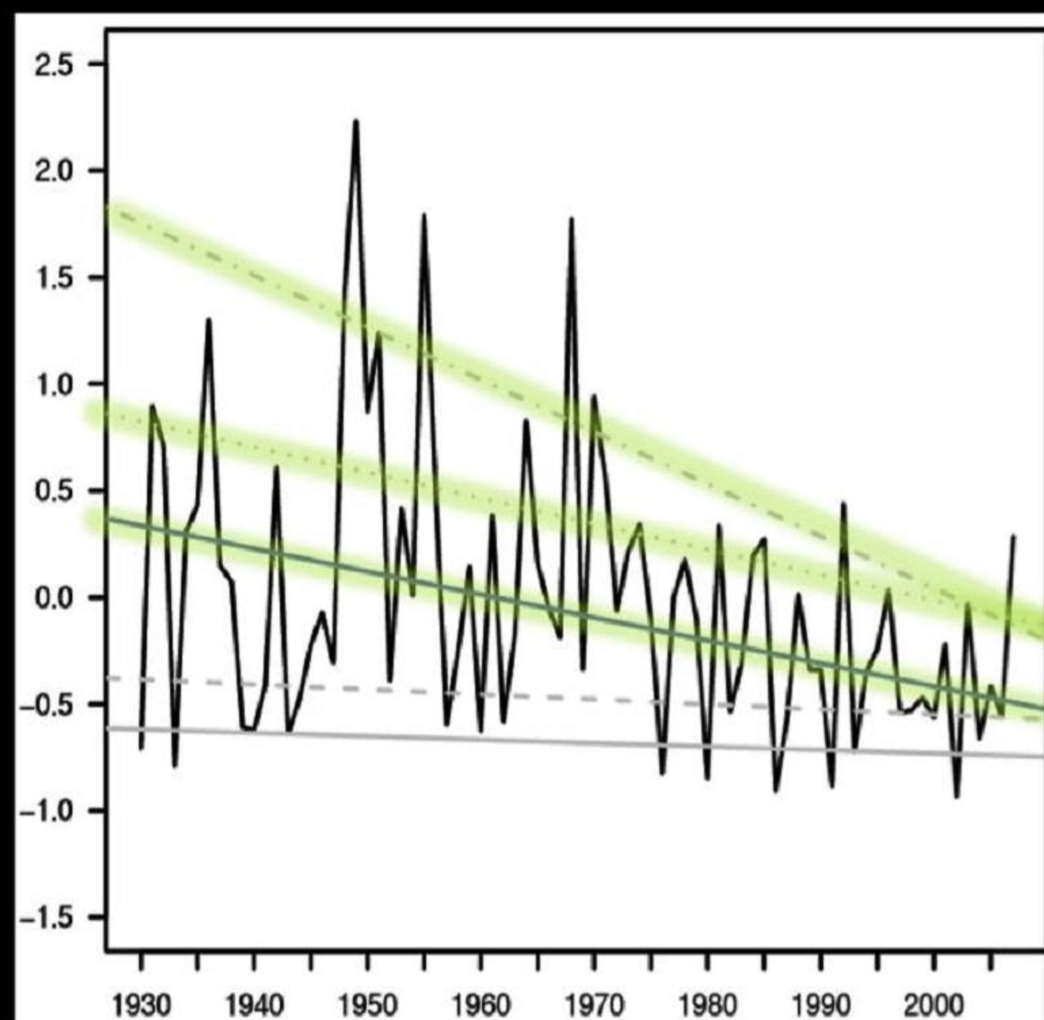

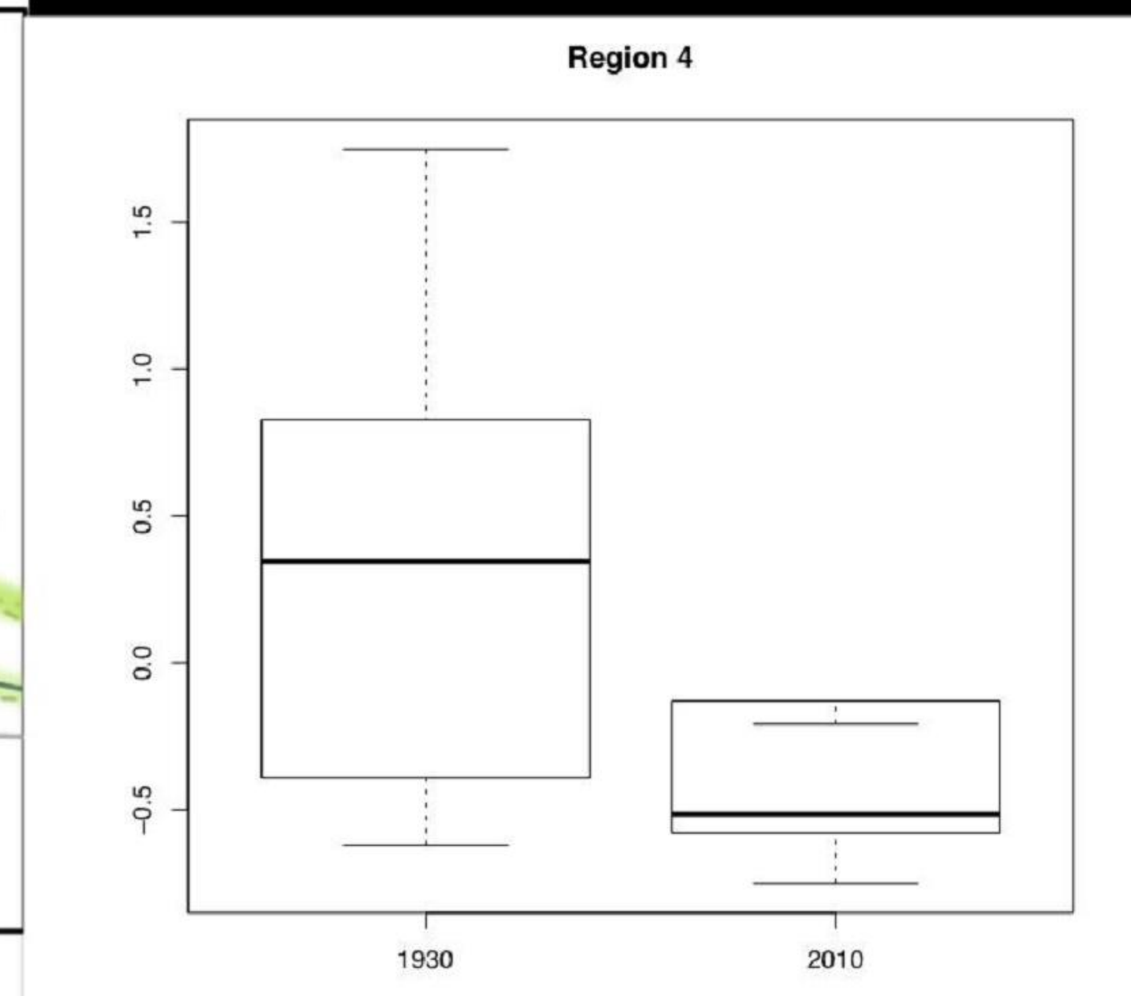

Trends in Snowfall Frequency: Pacific Northwest

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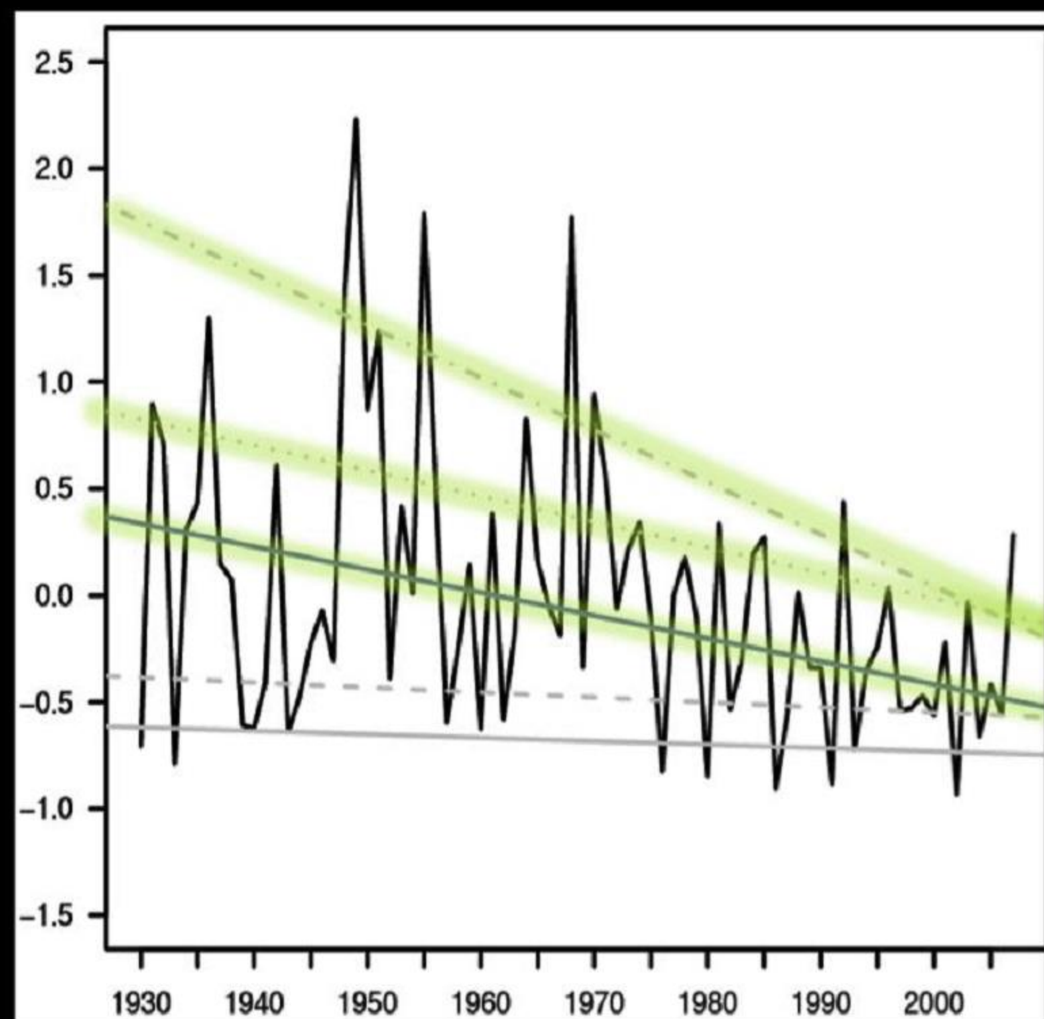

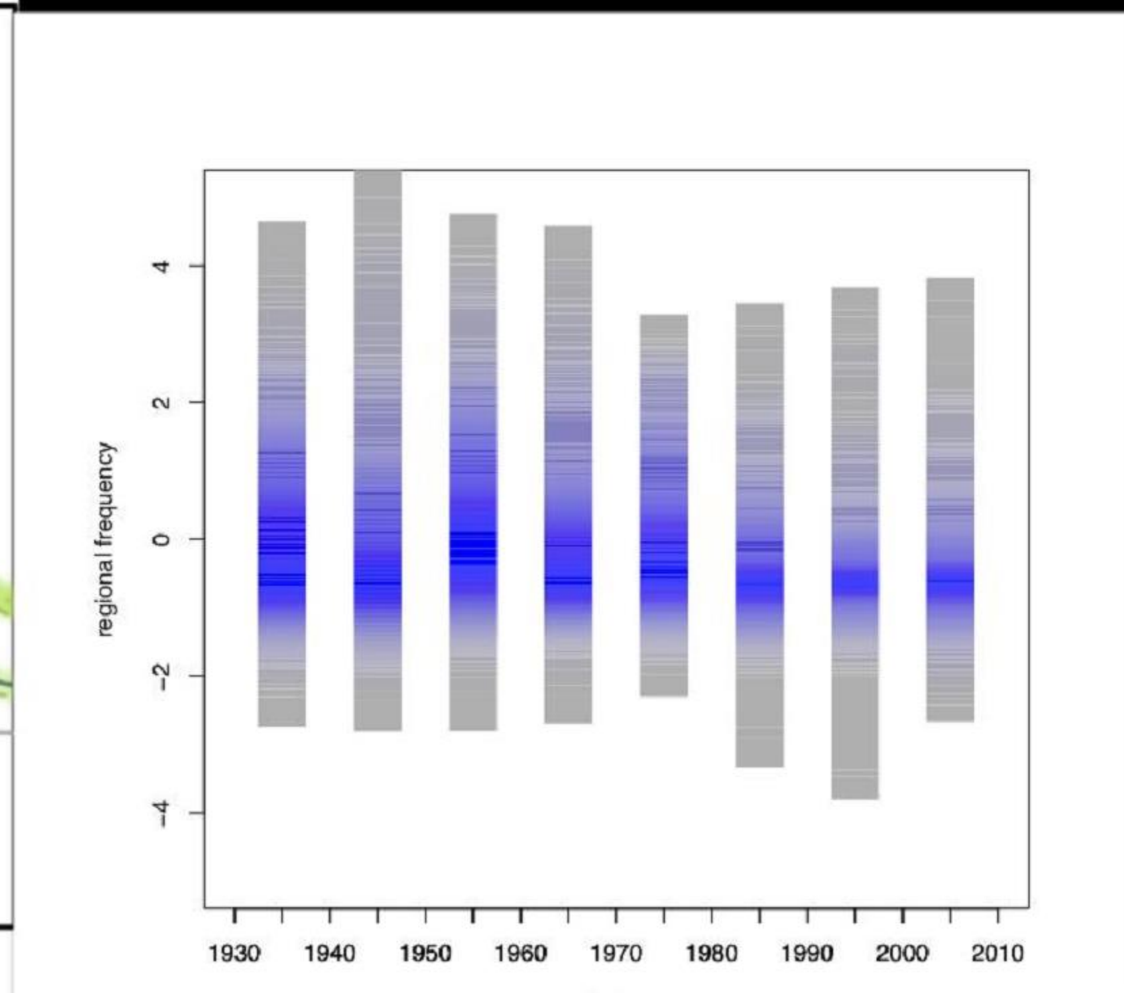

Trends in Snowfall Frequency: Midwest, middle track

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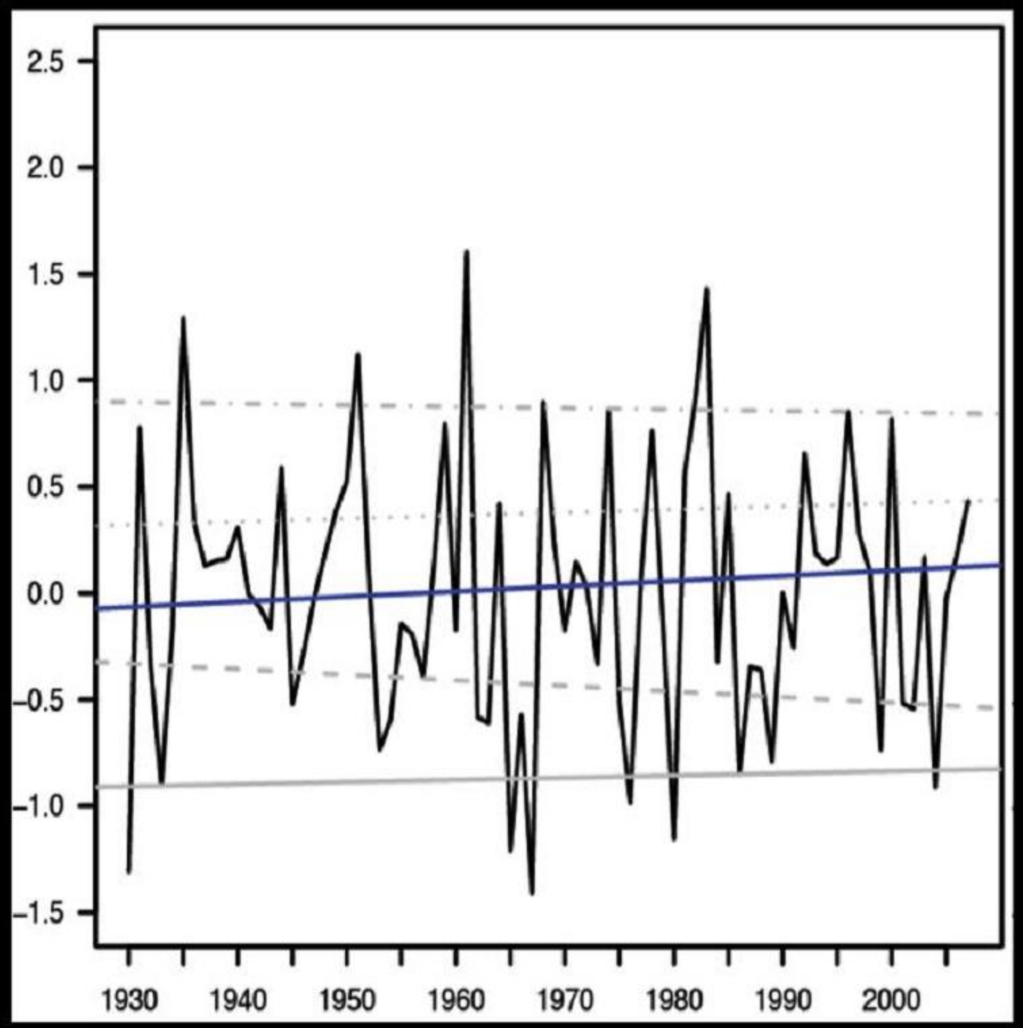

Trends in Snowfall Frequency: Midwest, southern track

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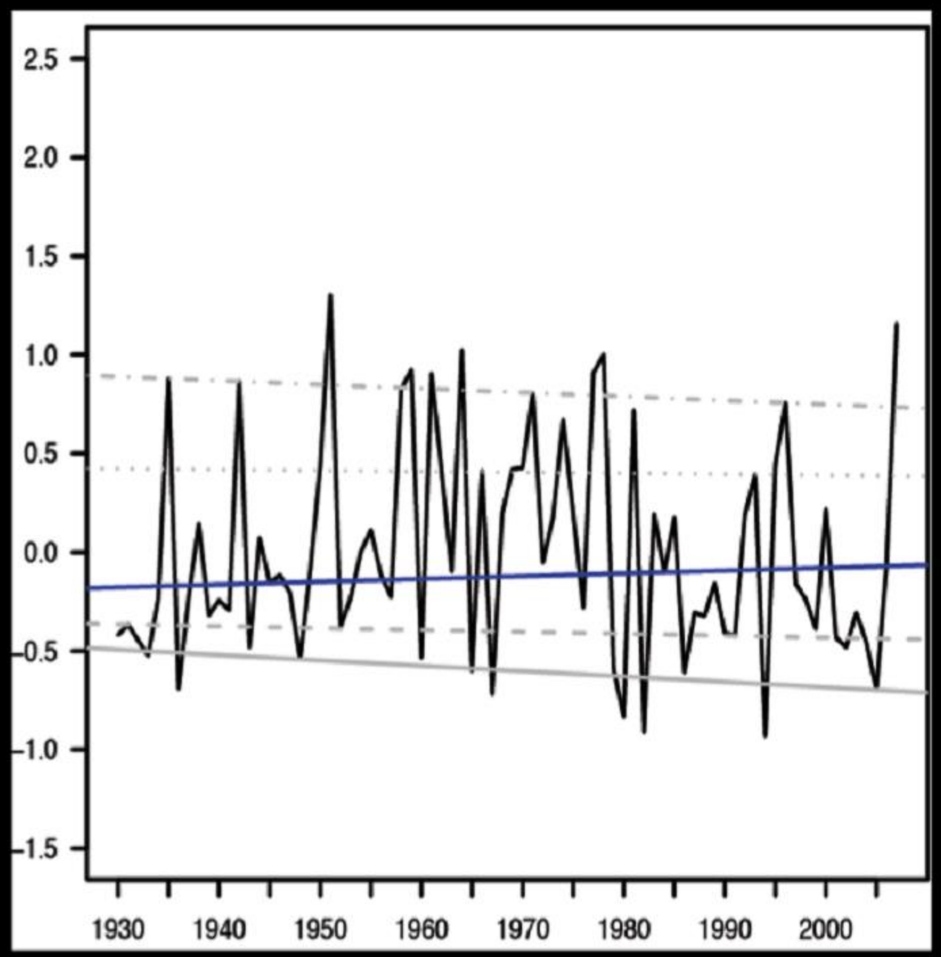

Trends in Snowfall Frequency: Midwest, northern track

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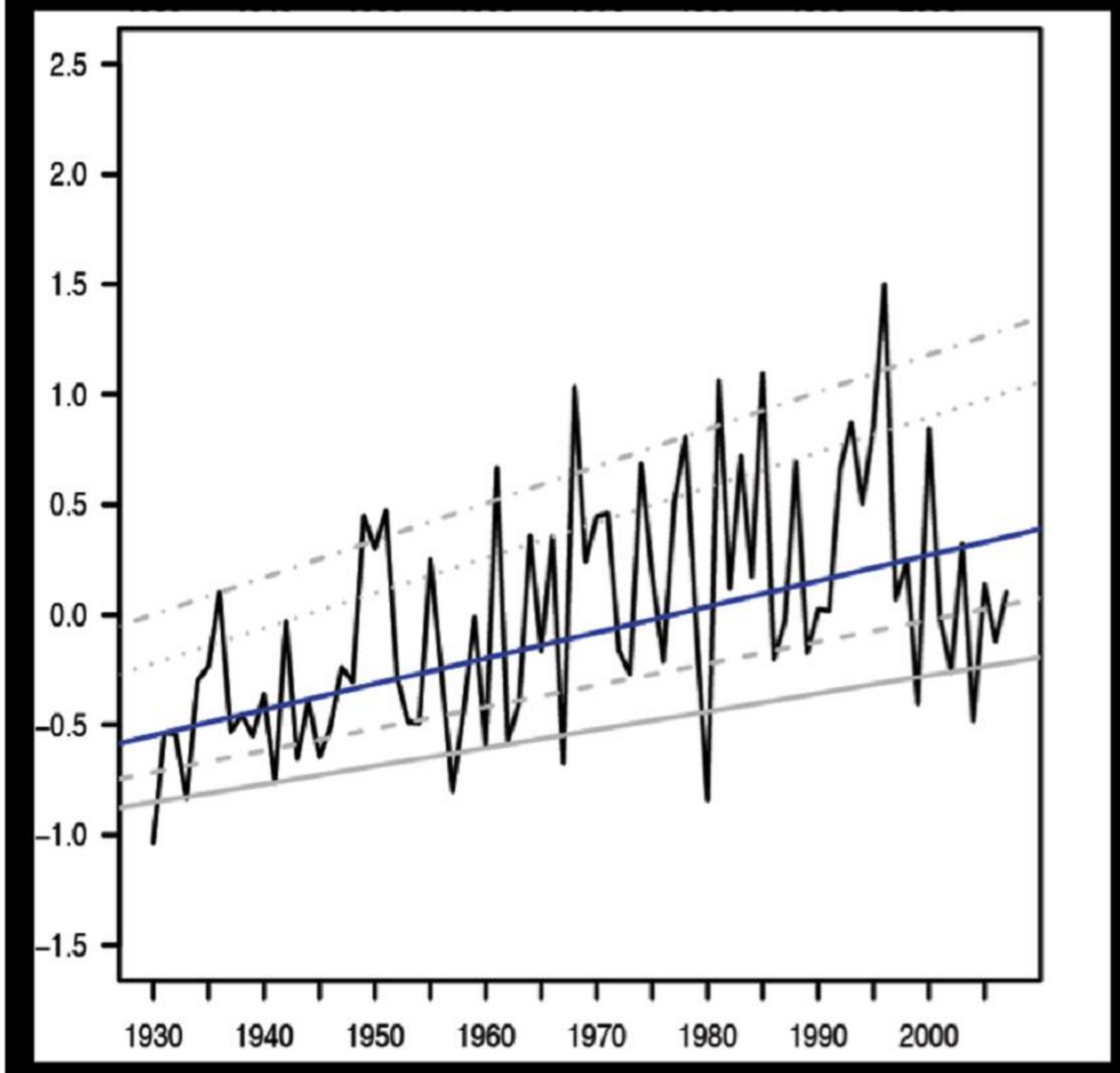

Trends in Snowfall Frequency: Midwest, northern track

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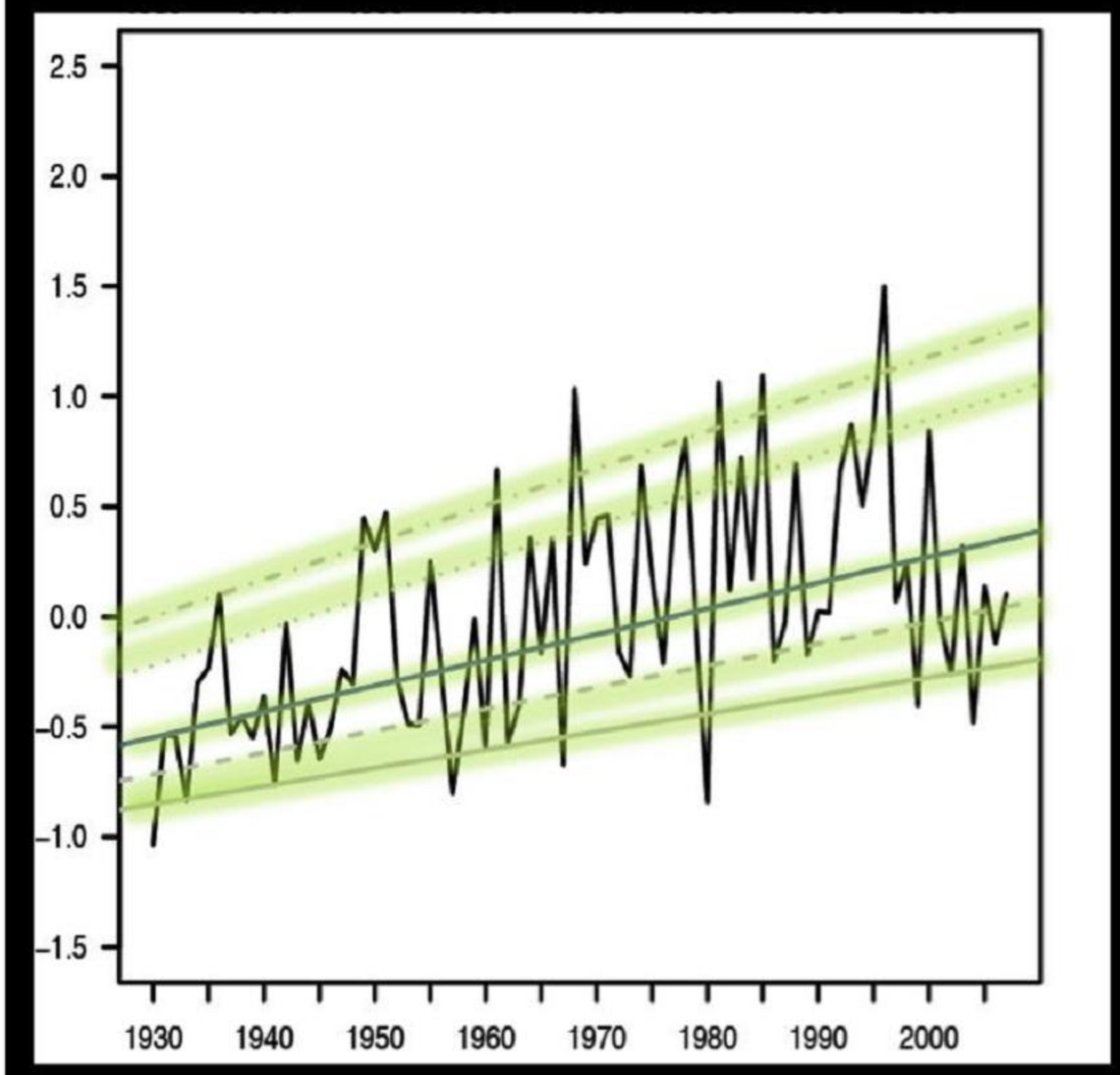

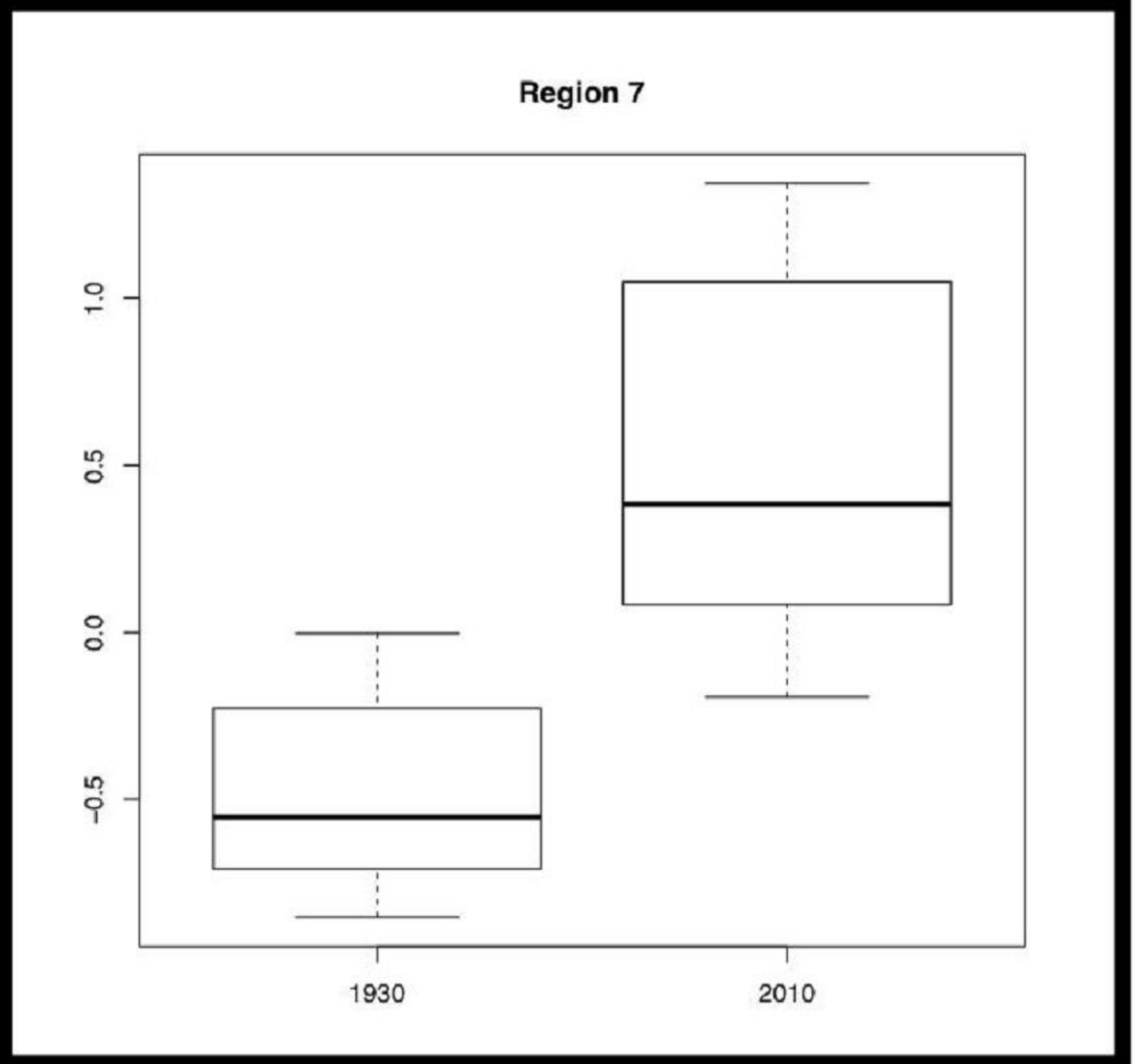

Trends in Snowfall Frequency: Midwest, northern track

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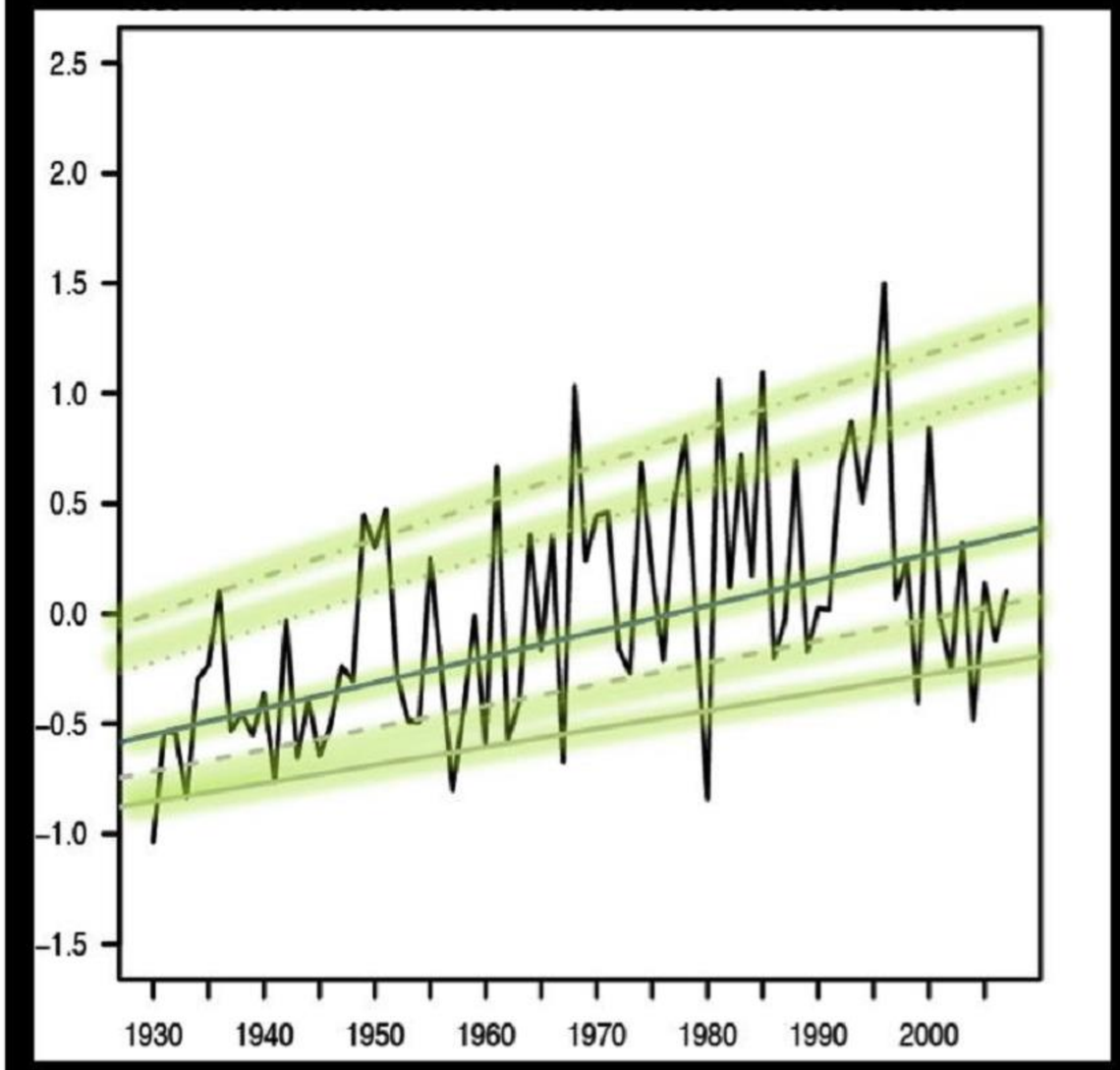

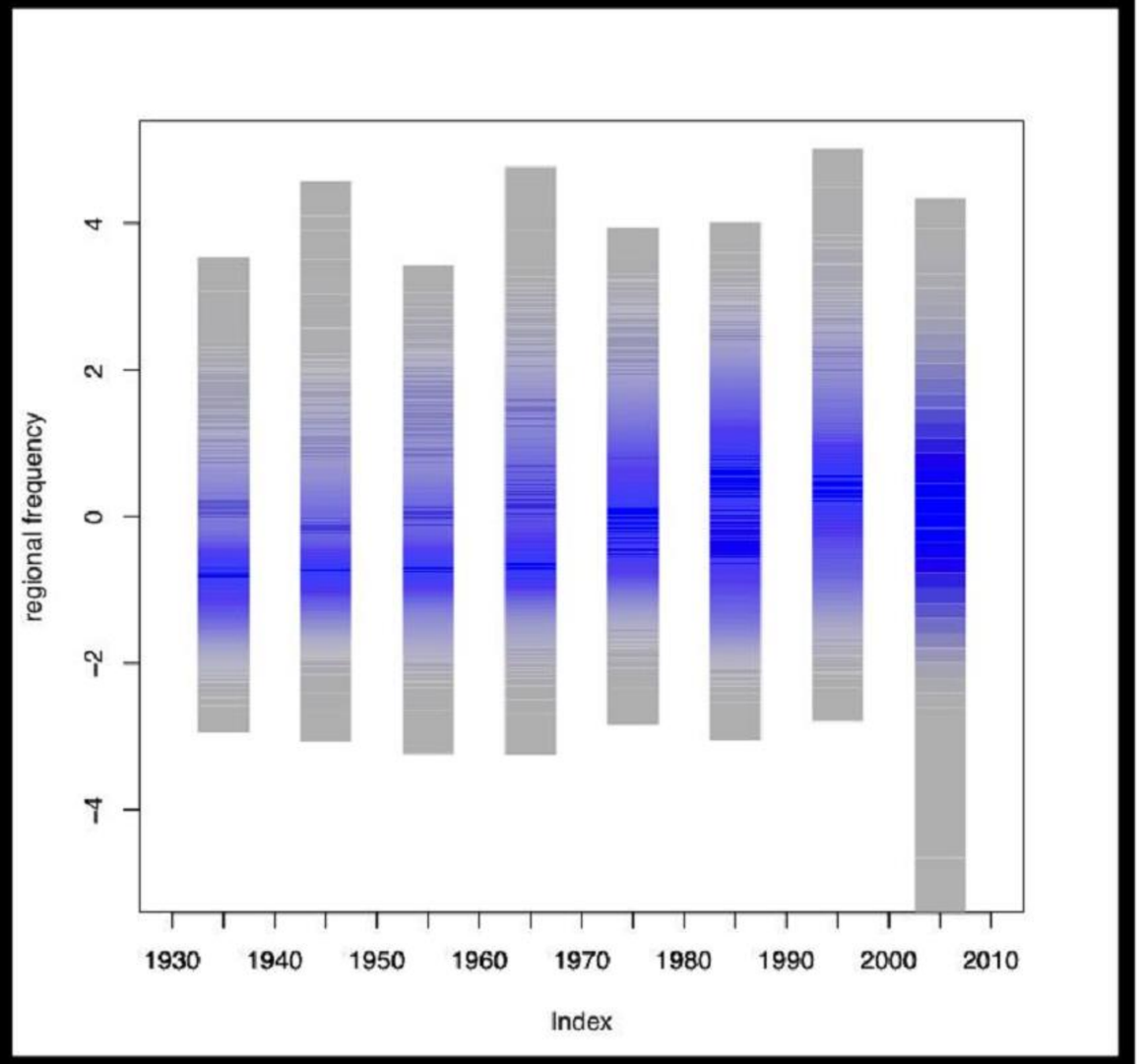

Snow Data Interface

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OAK RIDGE NATIONAL LABORATORY

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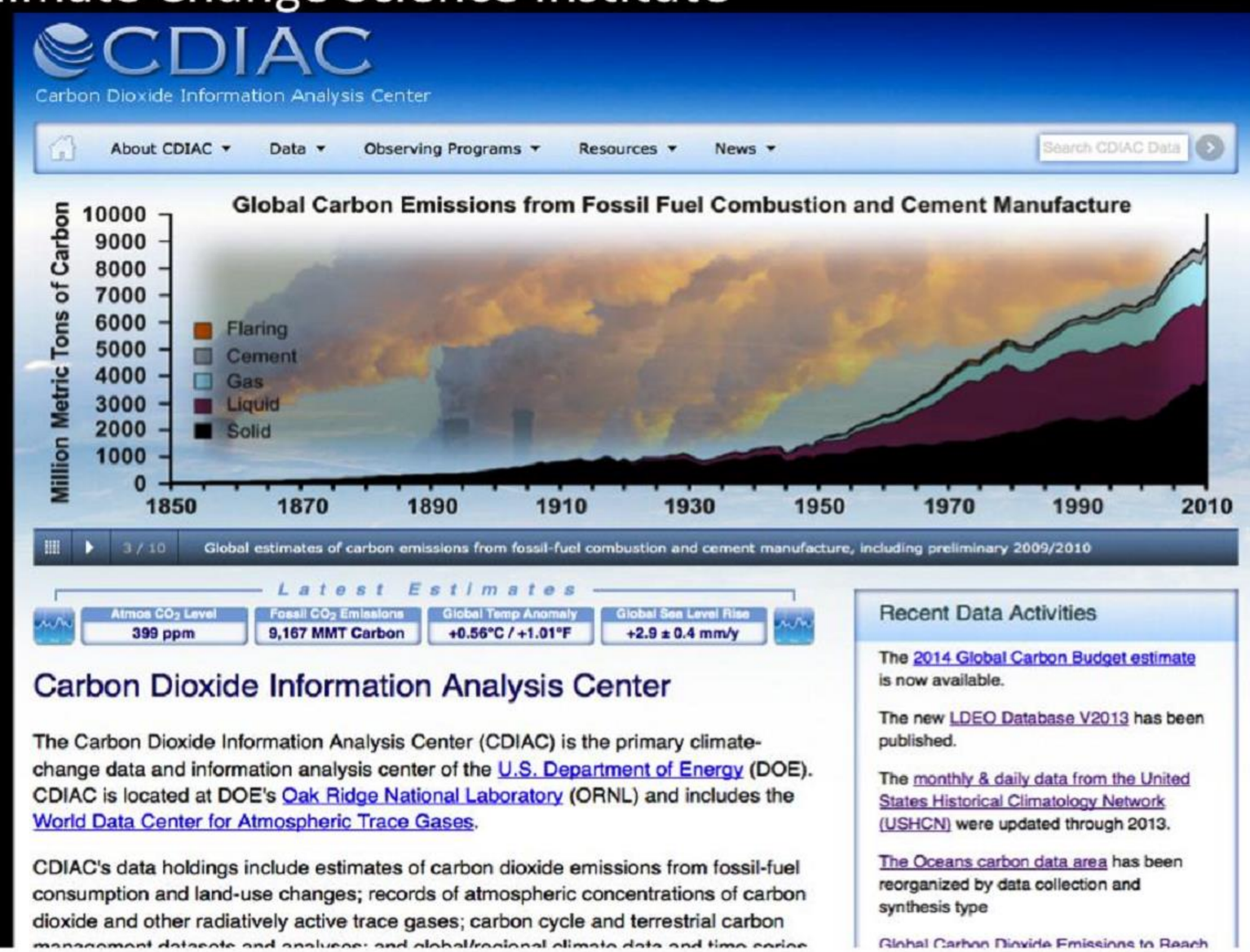
Goal: Create a Snow Data Interface that is easily accessible by the public

Collaborators:

Dale Kaiser, and Kefa Lu

Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory
Climate Change Science Institute

cdiac.ornl.gov



Snow Data Interface

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Snow Data Interface

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Snow Data Interface

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DayRec: United States Record-Maximum/Minimum Daily Temperatures

(Please read about DayRec data and methods before using these data.)

Select a state or the entire U.S. from the pulldown list and click 'Map Sites' to display station locations. Select a station from the map or the station list to pop-up a description of the station. Click on the "Get Data" link to access its data.

Note: *Due to stringent data completeness requirements, six states do not have stations at this time.*

Select:

United States

Map Sites | Clear Map

Gravette, AR (032930)
Newport, AR (035186)
Pocahontas 1, AR (035820)
Prescott 2 NNW, AR (035908)
Subiaco, AR (036928)
Davis 2 WSW Exp Farm, CA (042294)
Lemon Cove, CA (044890)
Livermore, CA (044997)
Orland, CA (046506)
Pasadena, CA (046719)
Paso Robles, CA (046730)
Redlands, CA (047306)
Tahoe City, CA (048758)
Cheesman, CO (051528)
Cheyenne Wells, CO (051564)
Dillon 1 E, CO (052281)
Ft Collins, CO (053005)
Las Animas, CO (054834)
Montrose #2, CO (055722)
Rocky Ford 2 SE, CO (057167)
Saint Leo, FL (087851)

Snow Data Interface

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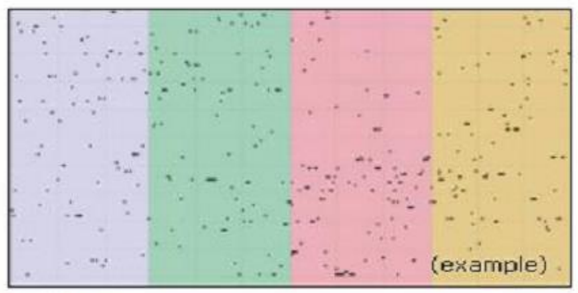
US HCN

DayRec: United States Record-Maximum/Minimum Daily Temperatures[1]

URBANA, Illinois, station 118740.

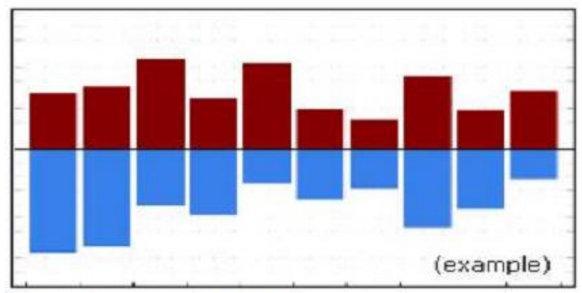
Years That Daily Temperature Records Were Set[2]



Variable: Hot Tmax | Get Plot | Get Data

Hot Tmax
Cool Tmax
Warm Tmin
Cold Tmin

Number of Record Temperatures Set per Decade[3]



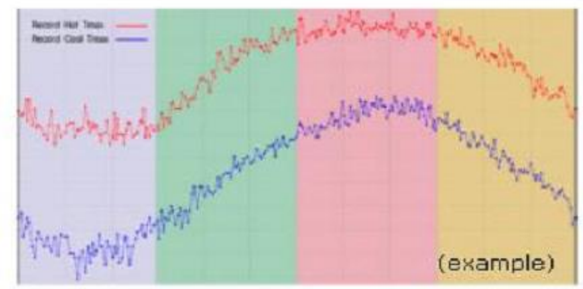
Variable: Hot Tmax | Season: Winter (DJF) | Get Plot

Variable: Hot Tmax | Season: Winter (DJF) | Get Data

Hot Tmax & Cold Tmin together: Get Plot

Hot Tmax & Cold Tmin together: Get Data

Record Temperature Values for Each Day of the Year



Variable: Hot/Cool Tmax | Get Plot

Hot/Cool Tmax | Get Data

All Daily Tmax/Tmin Data, 1911-2010

Variable: Tmax | Data Structure: Serial Daily | Get Data

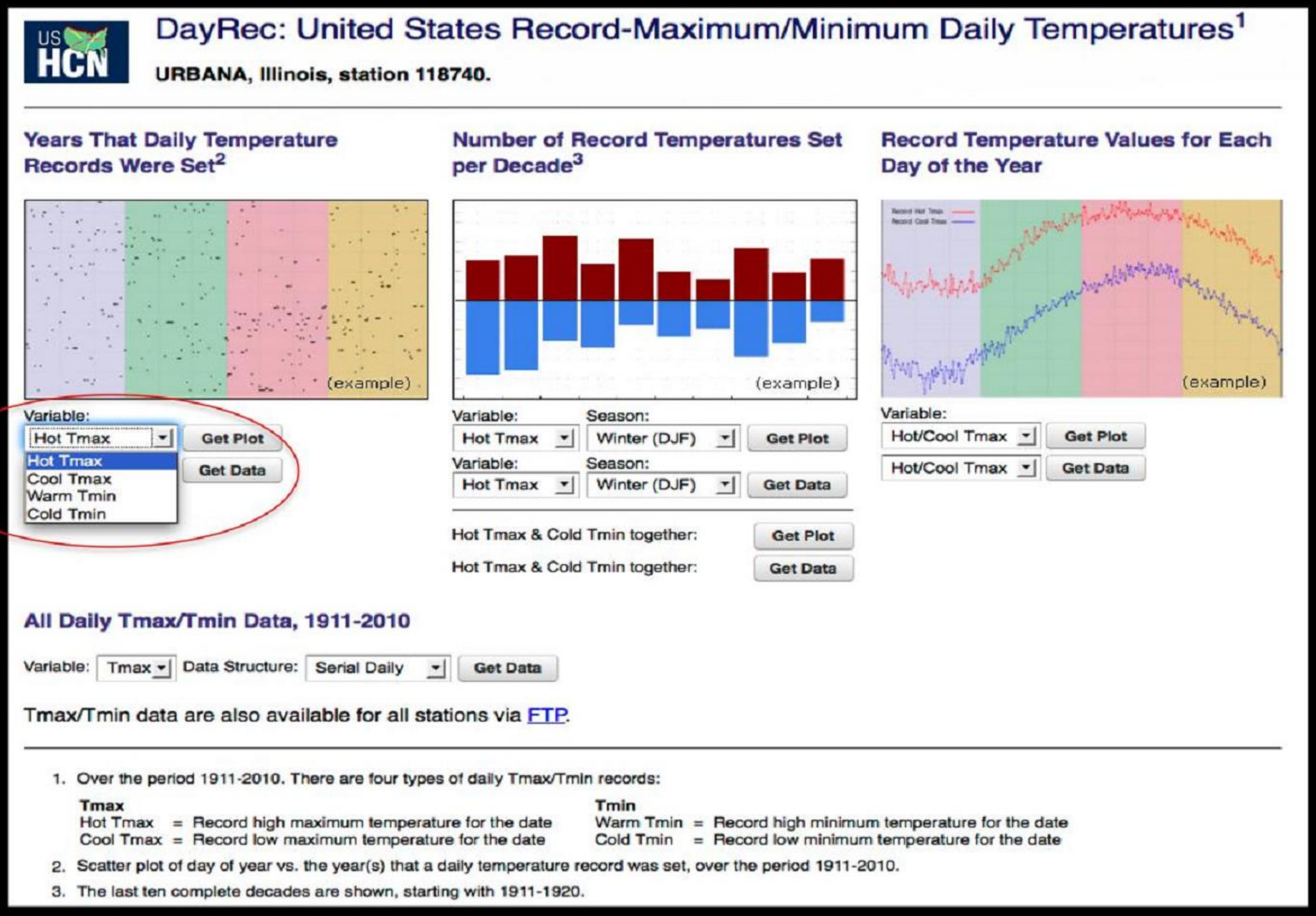
Tmax/Tmin data are also available for all stations via FTP.

1. Over the period 1911-2010. There are four types of daily Tmax/Tmin records:

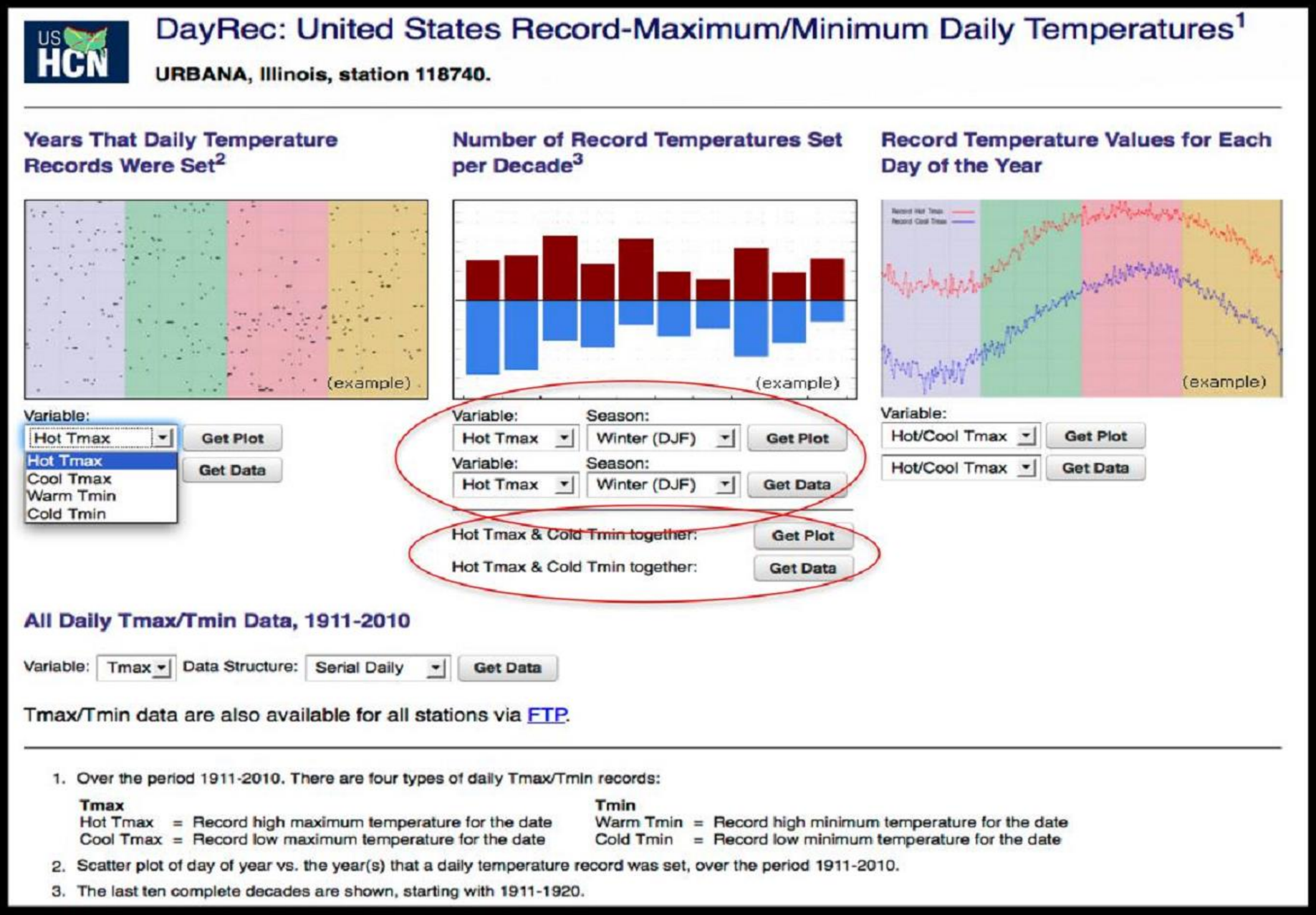
Tmax			Tmin		
Hot Tmax	=	Record high maximum temperature for the date	Warm Tmin	=	Record high minimum temperature for the date
Cool Tmax	=	Record low maximum temperature for the date	Cold Tmin	=	Record low minimum temperature for the date

2. Scatter plot of day of year vs. the year(s) that a daily temperature record was set, over the period 1911-2010.
3. The last ten complete decades are shown, starting with 1911-1920.

- DayRec interface (record-setting U.S. daily max/min temperatures)



- DayRec interface (record-setting U.S. daily max/min temperatures)



CDIAC

Carbon Dioxide Information Analysis Center

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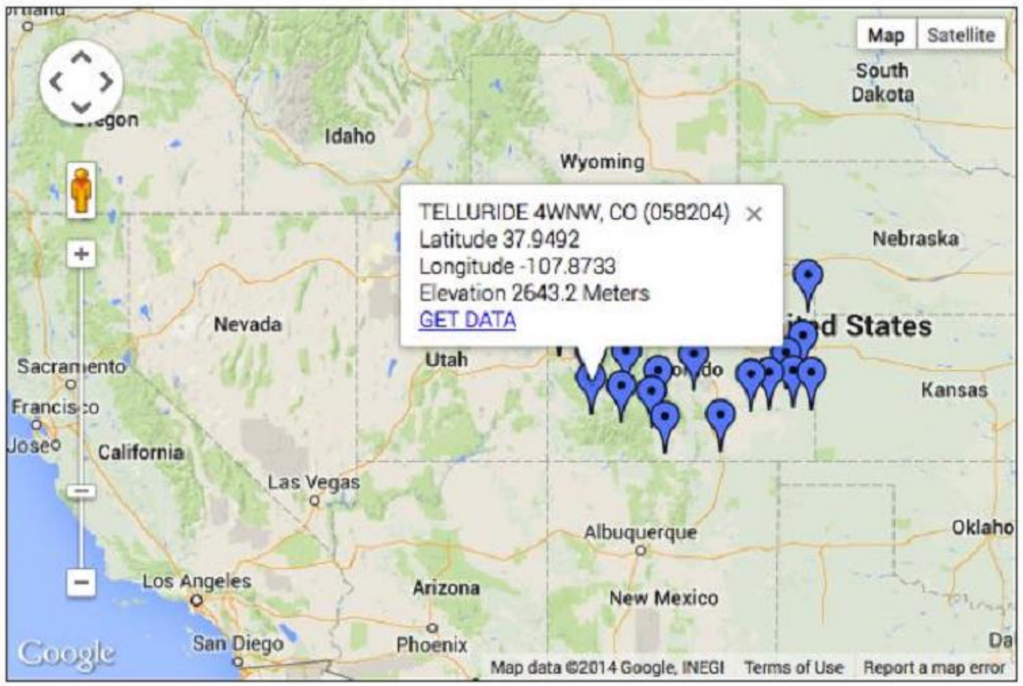
United States Historical Climatology Network (USHCN) Snowfall and Snow Depth

(Please read about USHCN snowfall and snow depth before using these data.)

Select a state or the entire U.S. from the pulldown list and click 'Map Sites' to display station locations. Select a station from the map or the station list to pop-up a description of the station and click on the "Get Data" link to access its data.



Select:

Colorado

Map Sites | Clear Map

BOULDER, CO (050848)
CANON CITY, CO (051294)
CHEESMAN, CO (051528)
CHEYENNE WELLS, CO (051564)
COLLBRAN, CO (051741)
DEL NORTE 2E, CO (052184)
DILLON 1 E, CO (052281)
EADS, CO (052446)
FT COLLINS, CO (053005)
FT MORGAN, CO (053038)
FRUITA, CO (053146)
GUNNISON 3SW, CO (053662)
HERMIT 7 ESE, CO (053951)
HOLLY, CO (054076)
LAMAR, CO (054770)
LAS ANIMAS, CO (054834)
MANASSA, CO (055322)
MONTROSE #2, CO (055722)
ROCKY FORD 2 SE, CO (057167)
SAGUACHE, CO (057337)
STEAMBOAT SPRINGS, CO (057936)
TELLURIDE 4WNW, CO (058204)
TRINIDAD, CO (058429)
WRAY, CO (059243)

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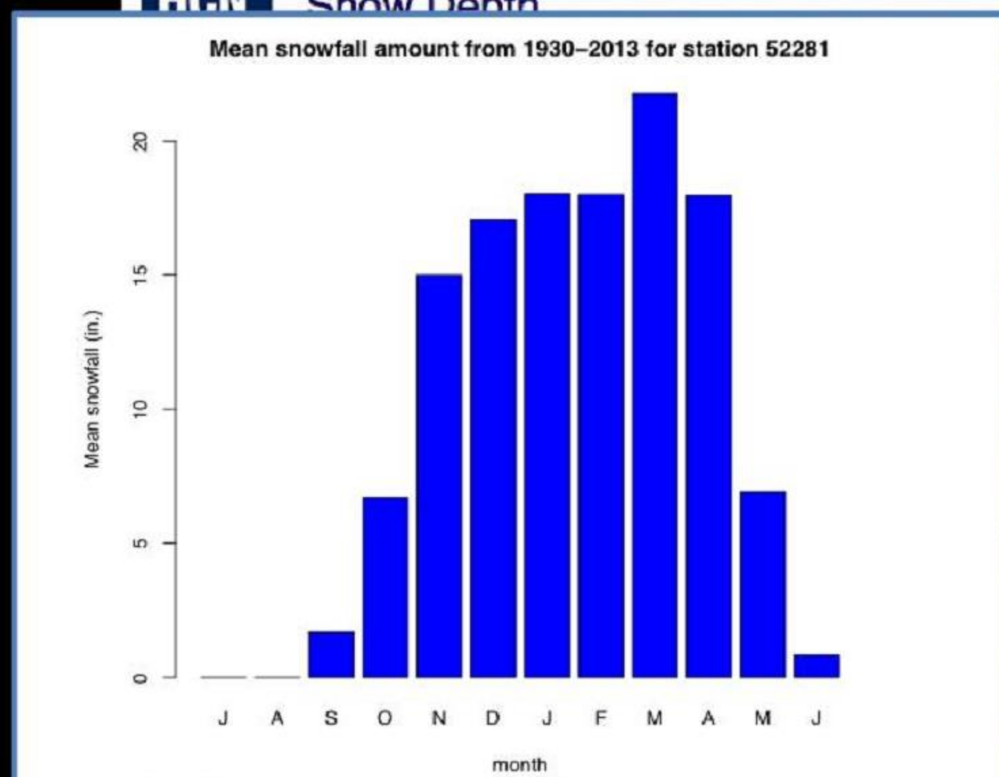

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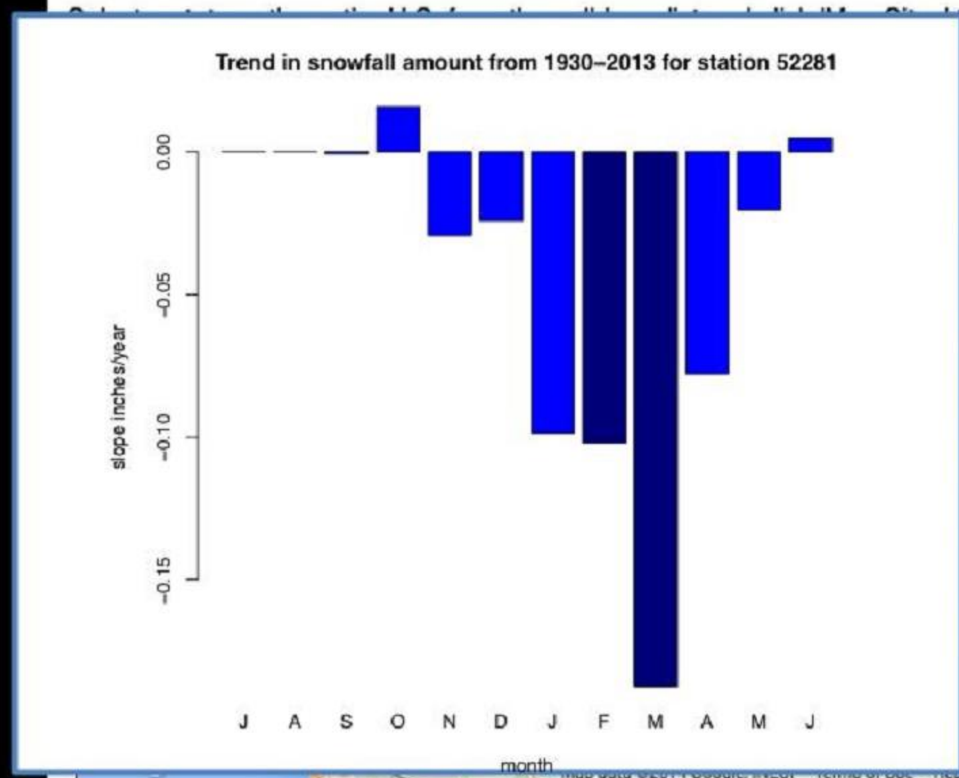

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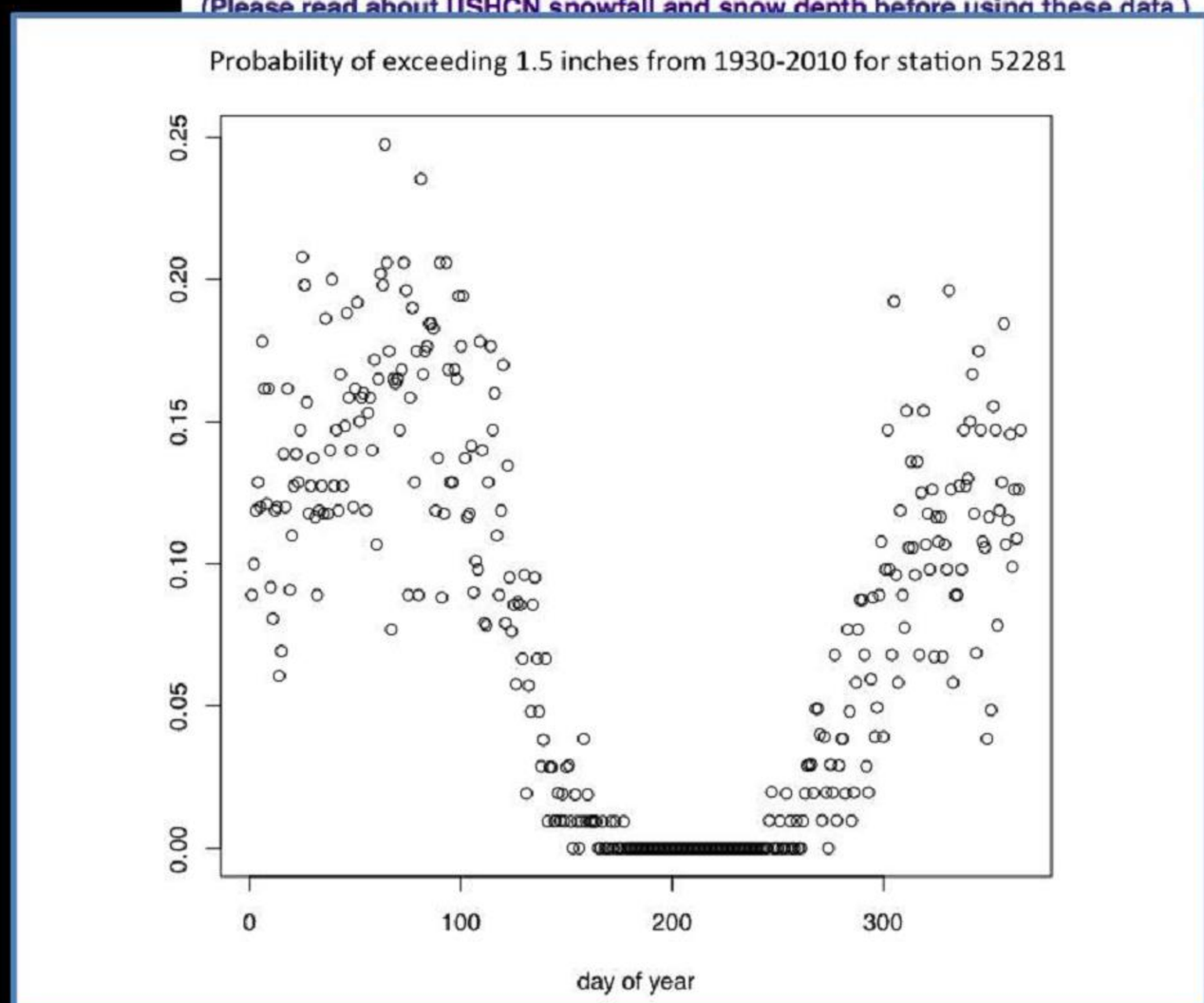

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Conclusions

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- A regionalization based on snowfall frequency results in seven regions which resemble common storm tracks
- Regional trends in snowfall frequency show
  - The southeast is experiencing a decreasing trend in very large snowfall frequency years.
  - The Pacific Northwest is experiencing declines in median and higher snowfall frequency years.
  - The Midwest, northern track is experiencing increases in all quantiles of the snow frequency distribution
- Monthly total and trend plots could be very useful for planning purposes.
- A new snow interface is under development at CDIAC which will allow users access to snowfall and snow depth data and plots. This includes daily and monthly variables as well as probabilities.

Thank you for participating in this Webinar

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Department of Earth & Atmospheric Sciences

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