WATER SUPPLY PLANNING AND MANAGEMENT:

CLIMATE VARIABILITY AND CHANGE

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IDNR/OWR **ISWS** **ISGS**

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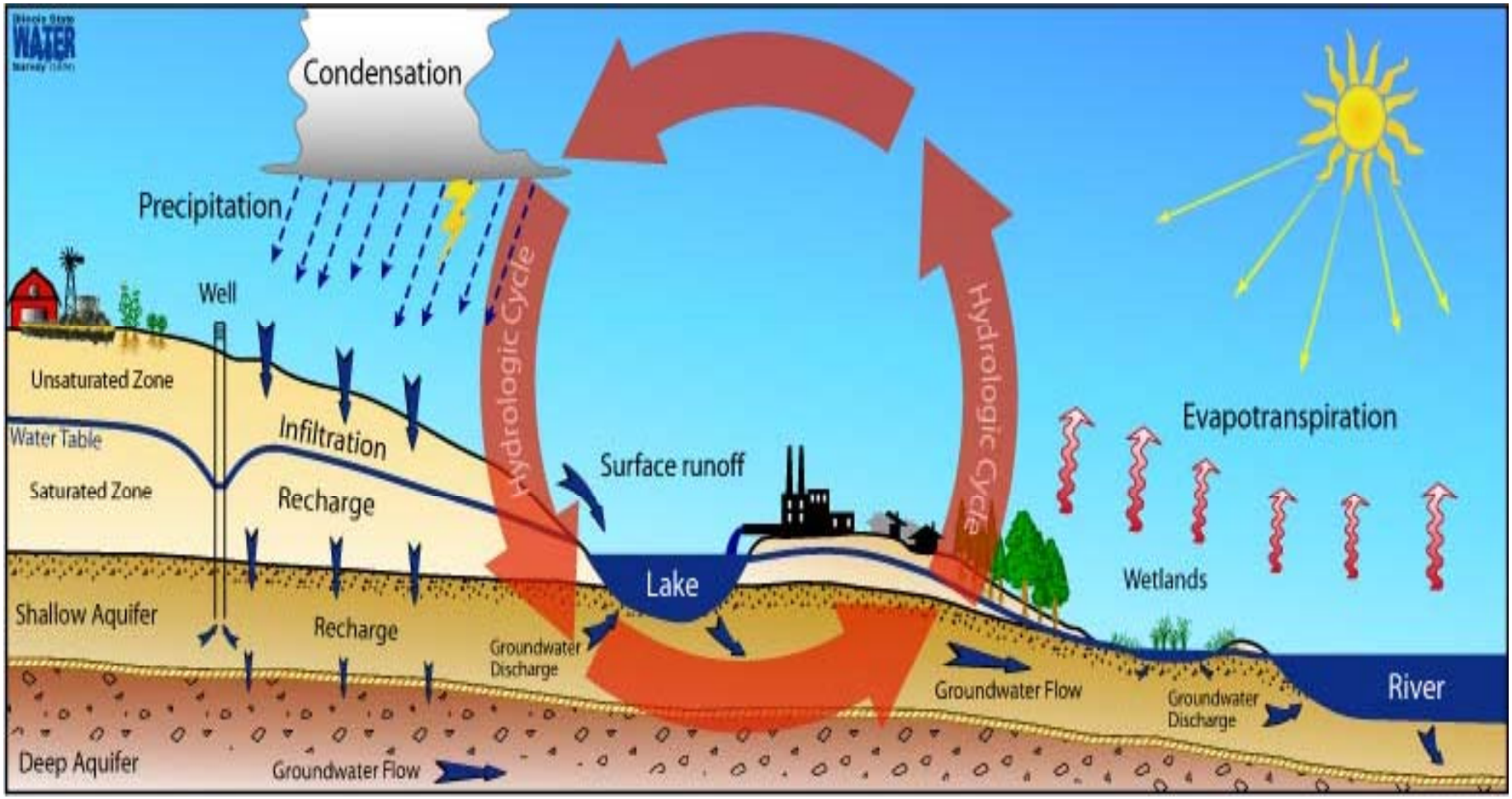
- UNCERTAINTY AND RISK IN WATER SUPPLY PLANNING

THE WATER CYCLE: CLIMATE, SURFACE WATER, and GROUNDWATER ARE LINKED



1. CLIMATE CONDITIONS ARE A MAJOR FACTOR IN WATER SUPPLY

2. LONG-RANGE WATER SUPPLY PLANNING REQUIRES CONSIDERATION OF CLIMATIC CONDITIONS TO 2050 AND PERHAPS BEYOND

3. FUTURE CLIMATIC CONDITIONS ARE HIGHLY UNCERTAIN

4. THE CHALLENGE IS HOW TO DEAL WITH UNCERTAINTIES AND ASSOCIATED RISKS

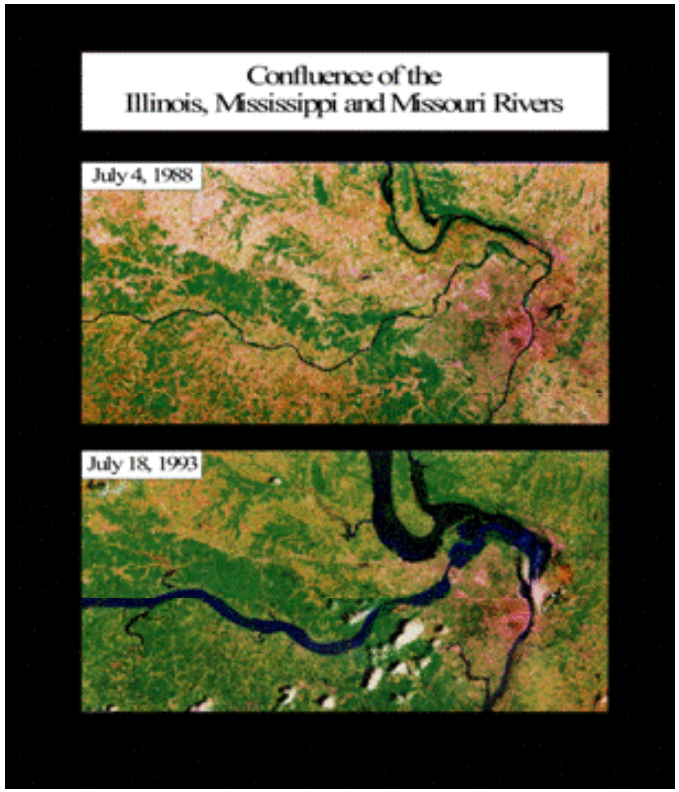
DEFINITION of CLIMATE

- The statistical aggregate of weather conditions over a period of time: temperature; precipitation; wind; cloudiness; storms; etc.
- Climate “normals” are set over 30 year periods: means; extremes; frequencies of occurrence etc.
- Current “normal” period is 1971-2000.
- This will change to 1981-2010 in 2011.

CLIMATE VARIABILITY
and
CLIMATE CHANGE

DEFINITION of CLIMATE VARIABILITY

- Variations (ups and downs) in climatic conditions on time scales of months, years, decades, centuries, and milenia. Includes droughts and floods.



DEFINITION of CLIMATE CHANGE

- A statistically significant change in climate characteristics over a long period of time.
  - From one 30-year period to another
  - From one century to another
  - From one millenium to another
- You can’t have climate change over less than a 30-year period.
- Climate change can be a change in the mean, a change in extremes, or change in frequencies.

EXAMPLES OF CLIMATE CHANGE

- Change in the annual mean

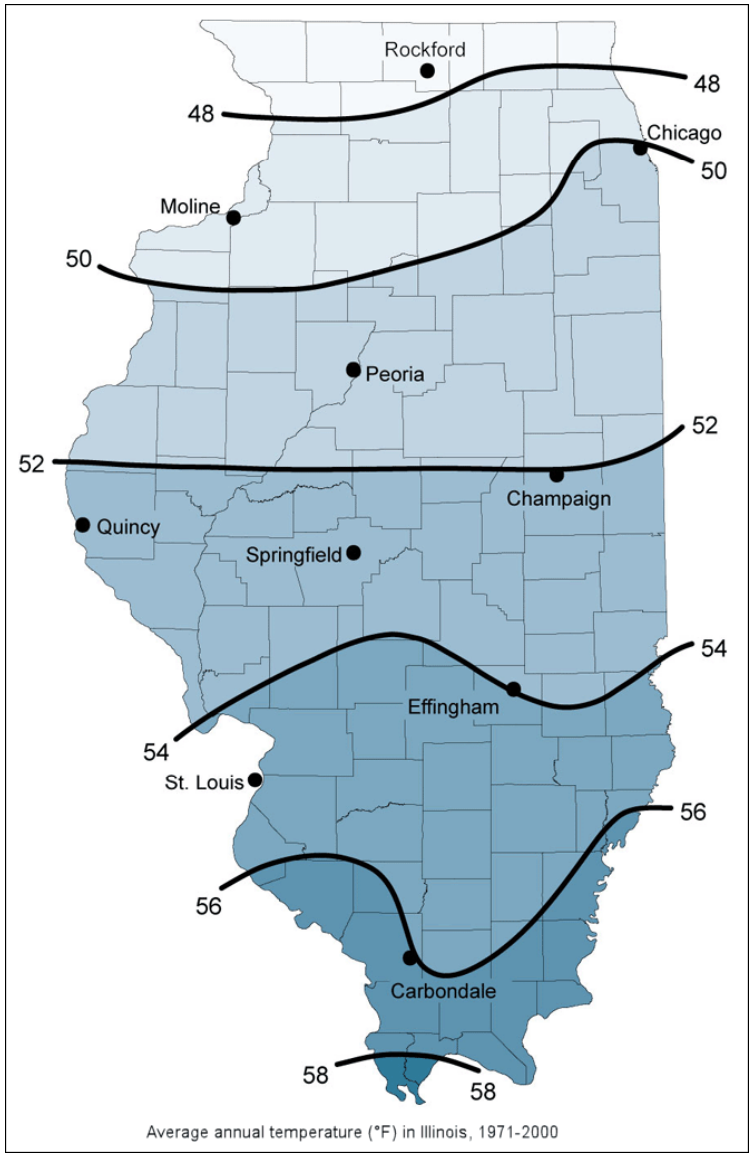
- Constant mean with change in extremes

- Constant mean with change in frequency of extremes

EFFECTS OF CLIMATE VARIABILITY AND CHANGE ON WATER SUPPLY

- **Droughts and lower precipitation reduce water availability**
- **Higher temperatures increase the loss of water and increase water demand**
- **Droughts and high temperatures combined have the largest impacts on water supply and demand**

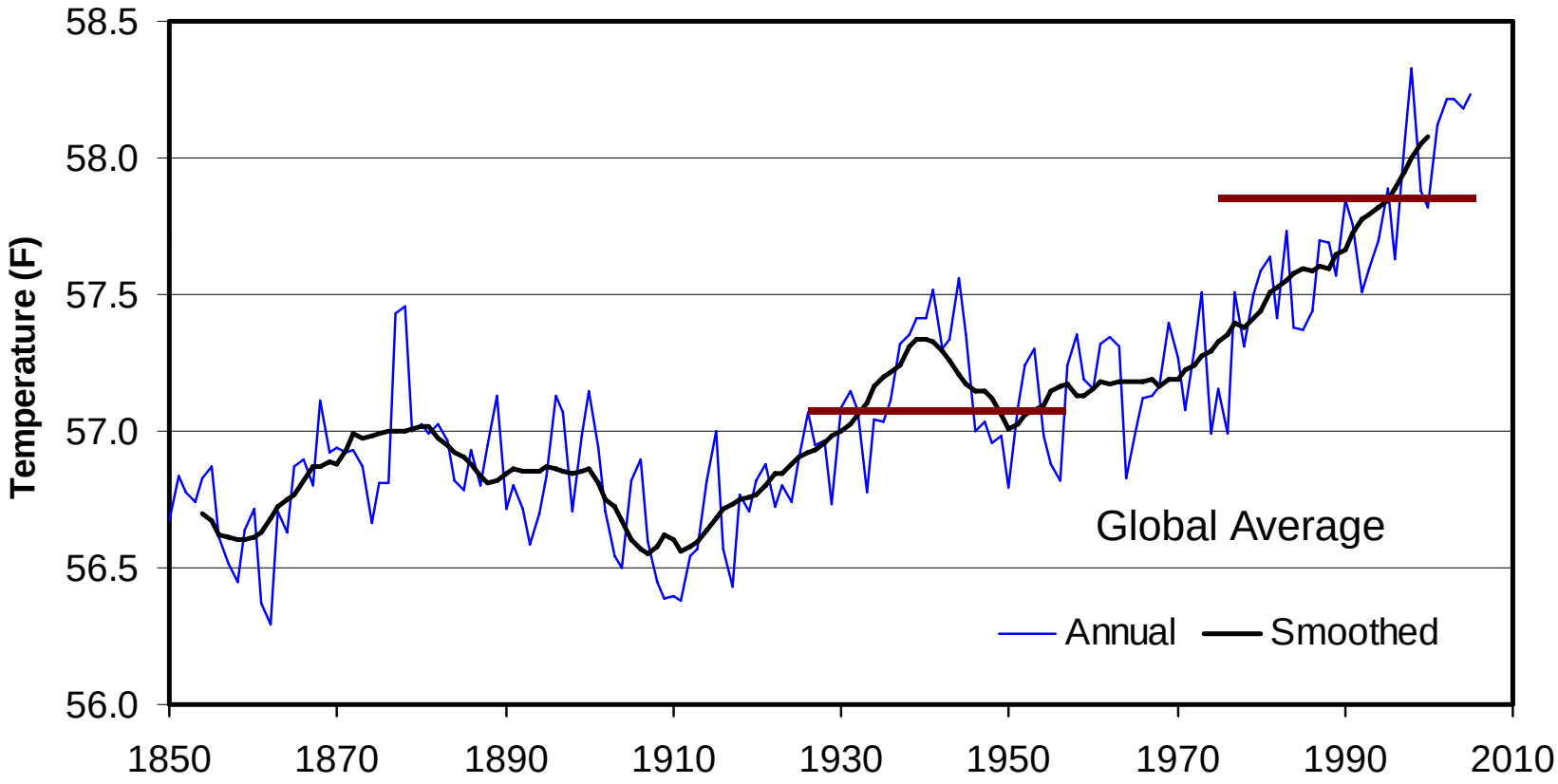
MEAN ANNUAL TEMPERATURE 1971-2000



Average annual temperature (°F) in Illinois, 1971-2000

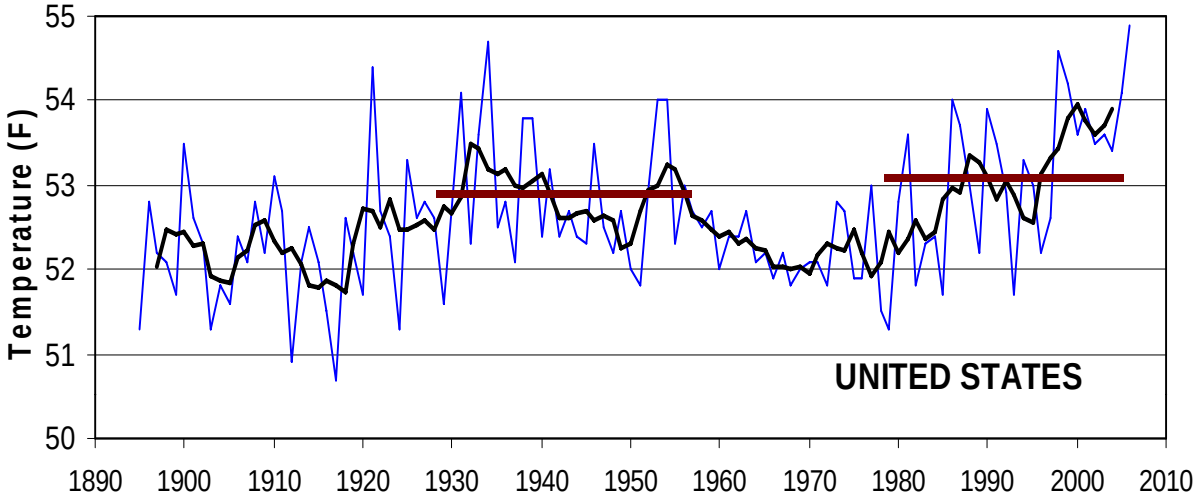
Global Warming

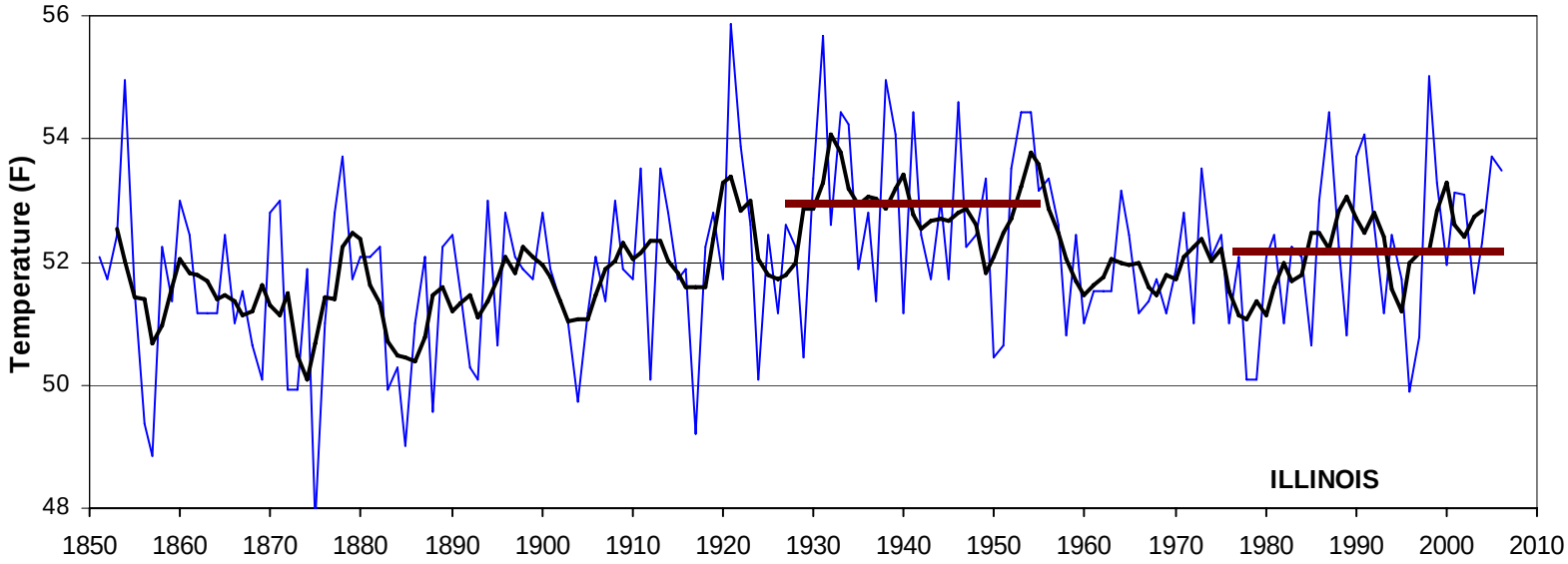
Source: Hadley Centre, UK



Temperature __ Annual _ Smoothed

Source: Jim Angel, Illinois State Water Survey





ANNUAL TEMPERATURE TRENDS

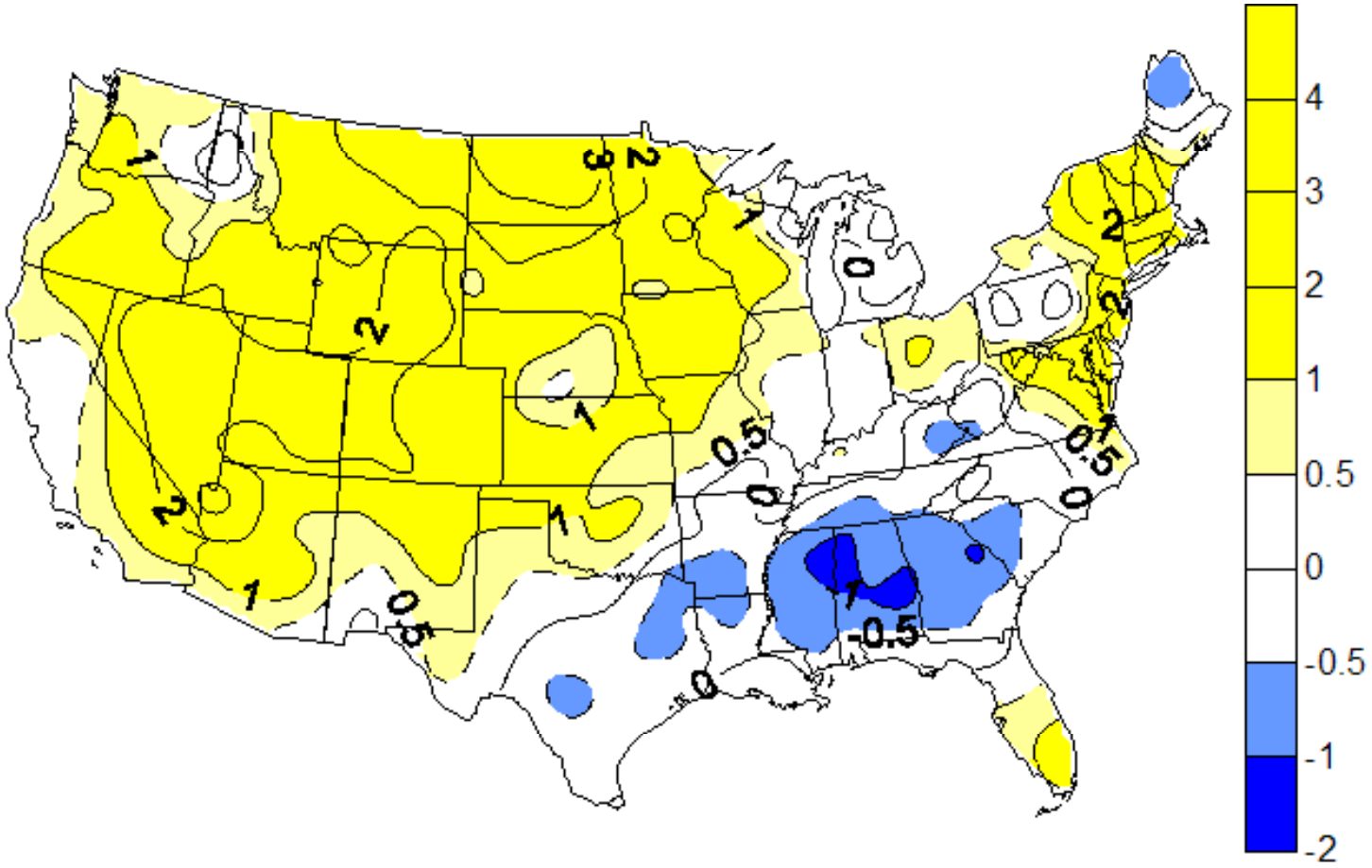
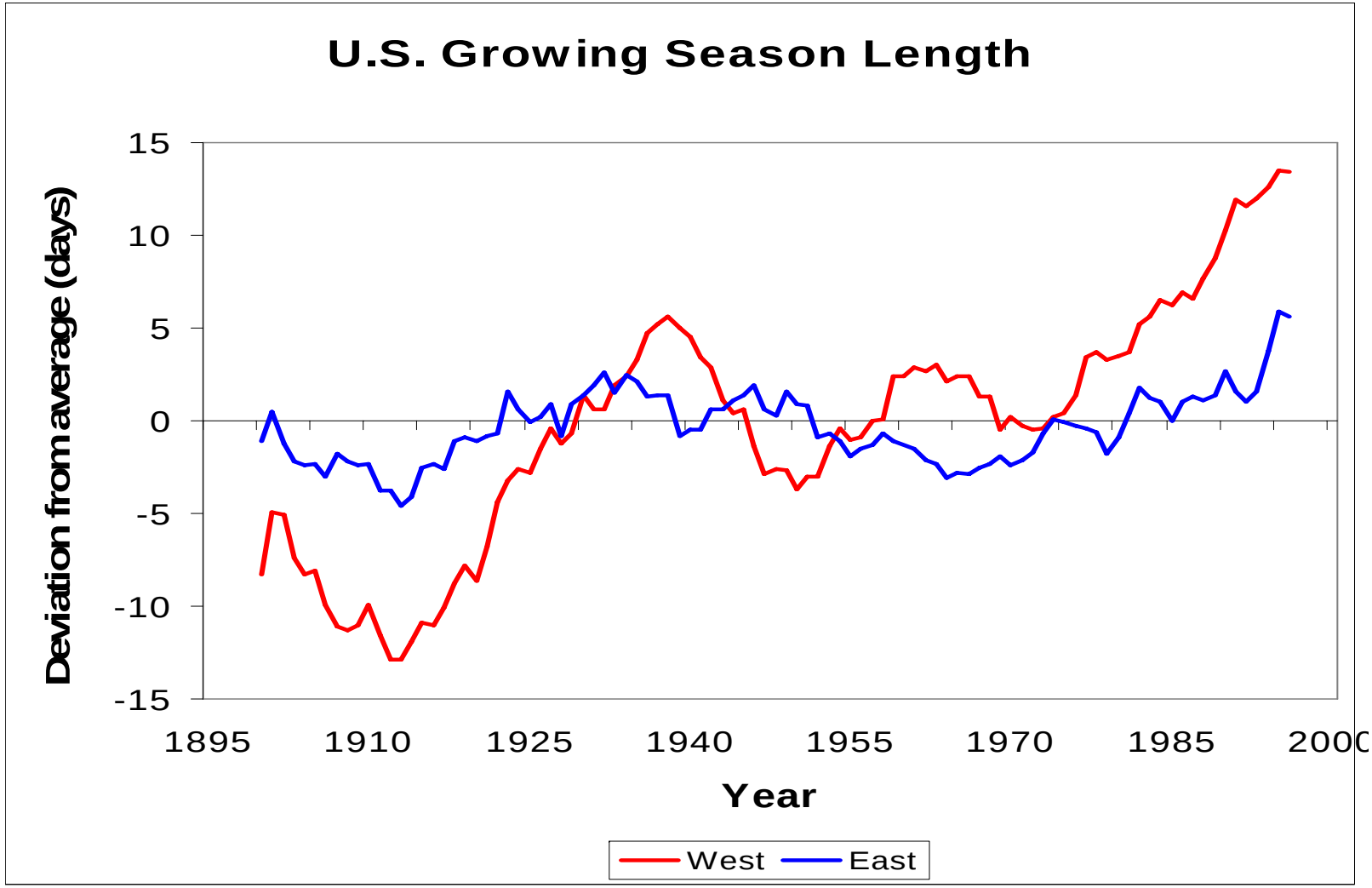
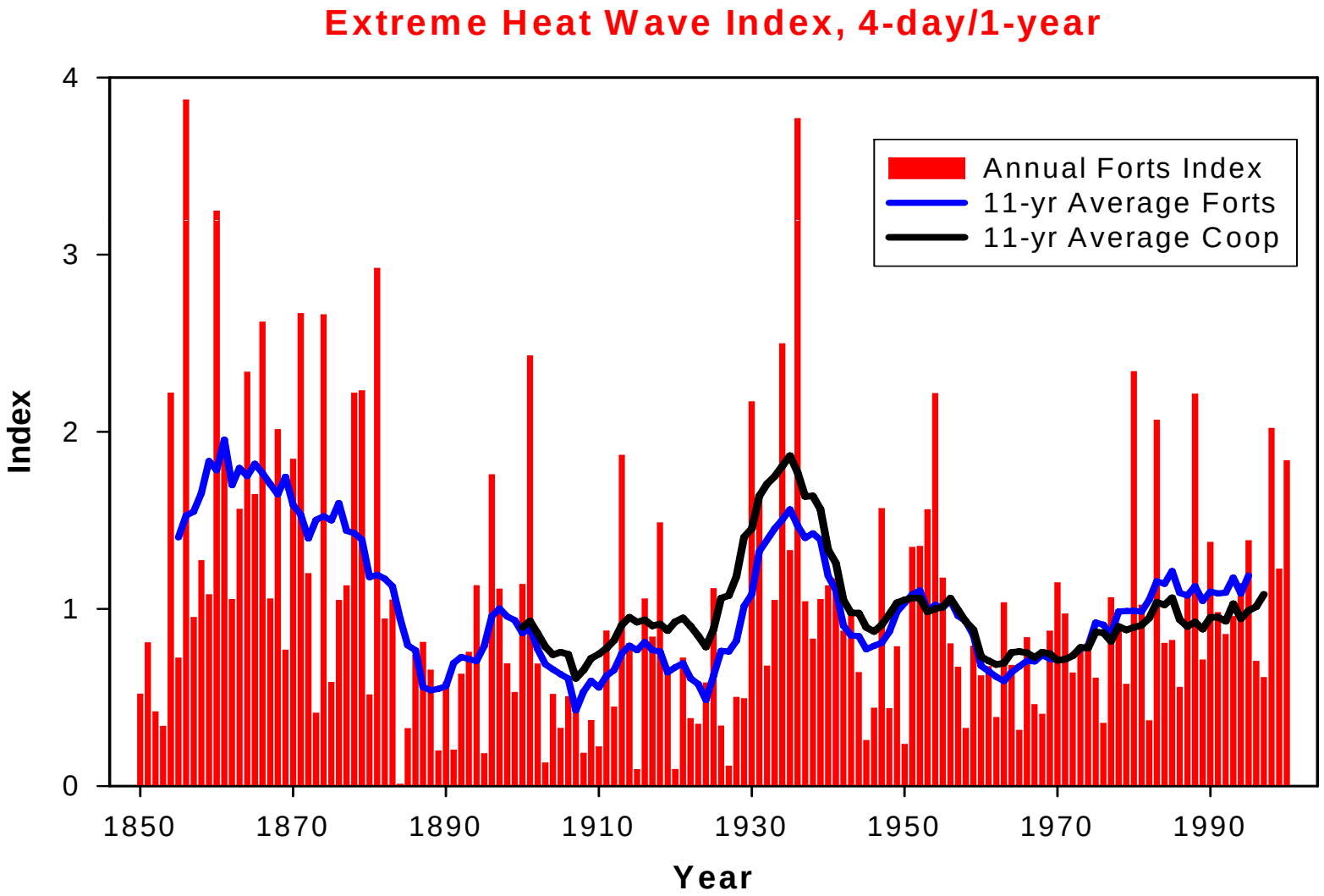


Figure 1. ANNUAL temperature trends in the U.S. expressed as the total change over the period 1895-2006 in degrees F and derived from climate division data. Copyright 2007. Illinois State Water Survey.

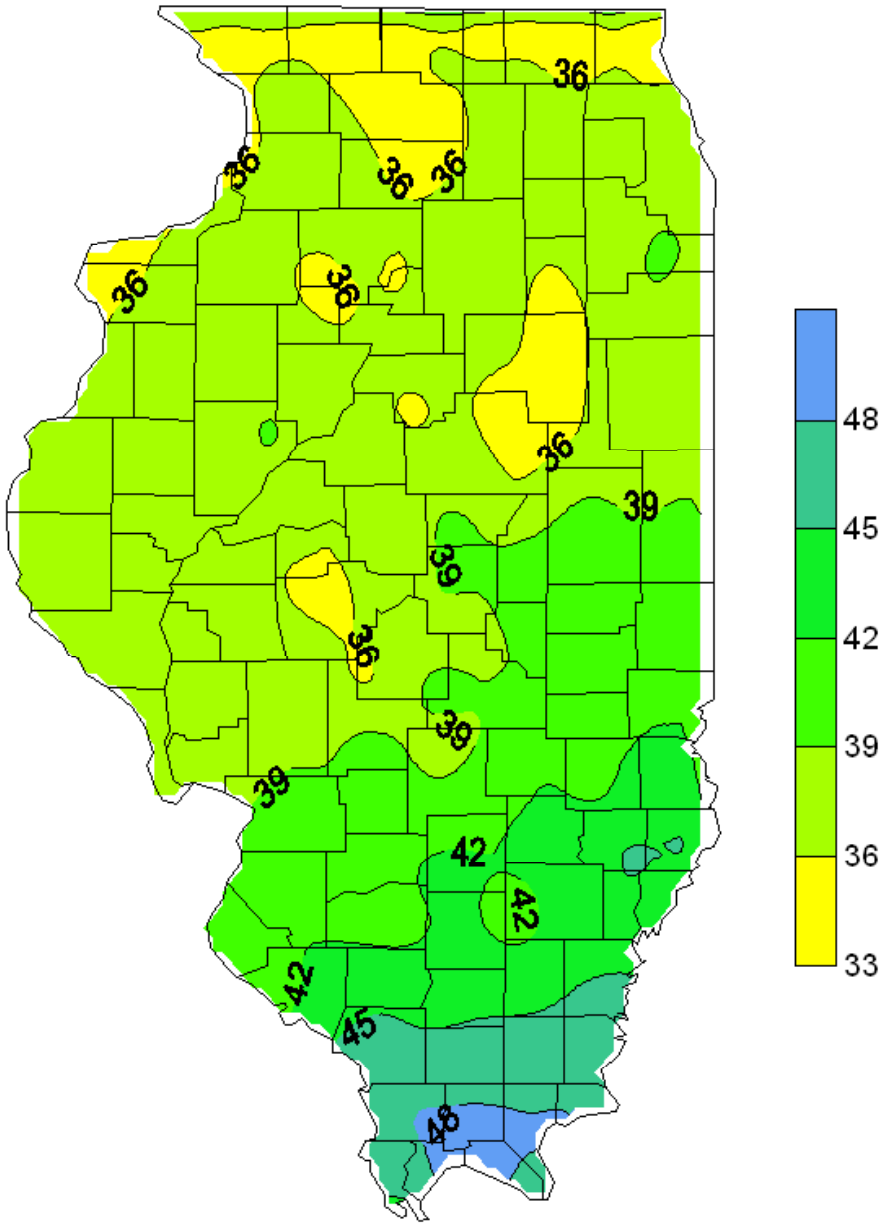
20+ DAYS INCREASE IN GROWING SEASON IN WEST. NOT MUCH CHANGE IN EAST (K. Kunkel)



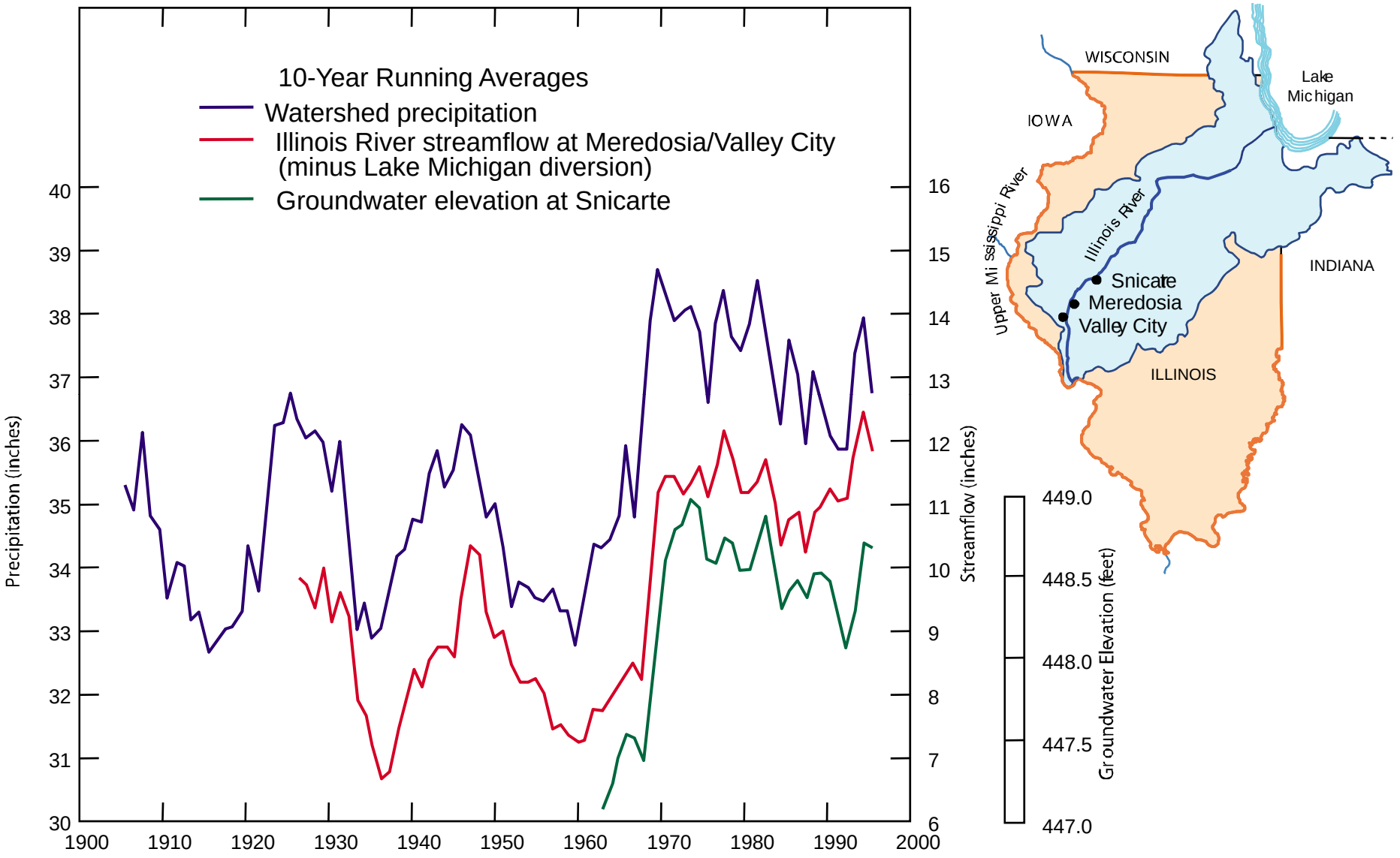
USA HEATWAVE INDEX
(K. Kunkel)



1971-2000 Normal Annual Precipitation (in)

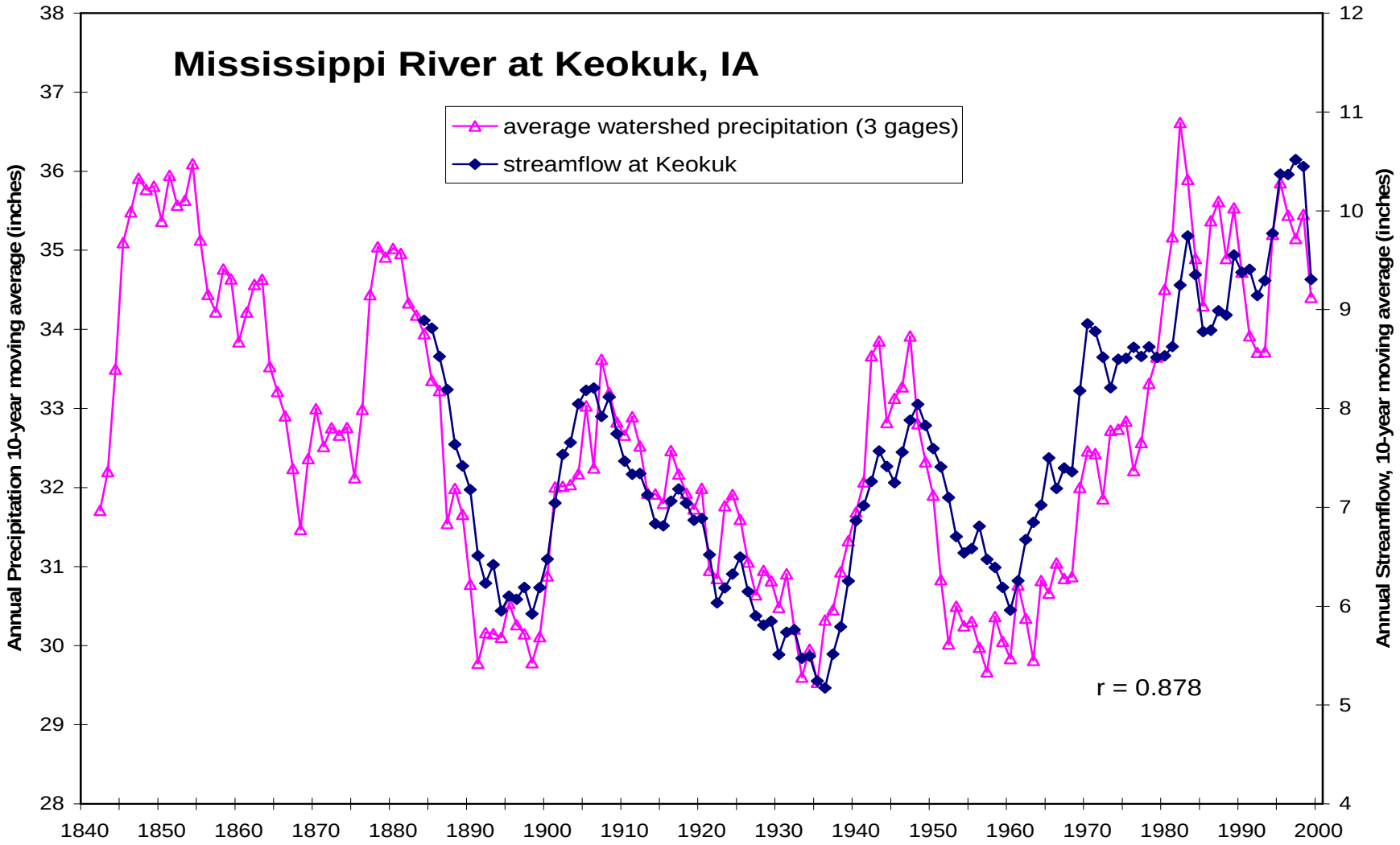


Illinois State Water Survey, Office of the State Climatologist

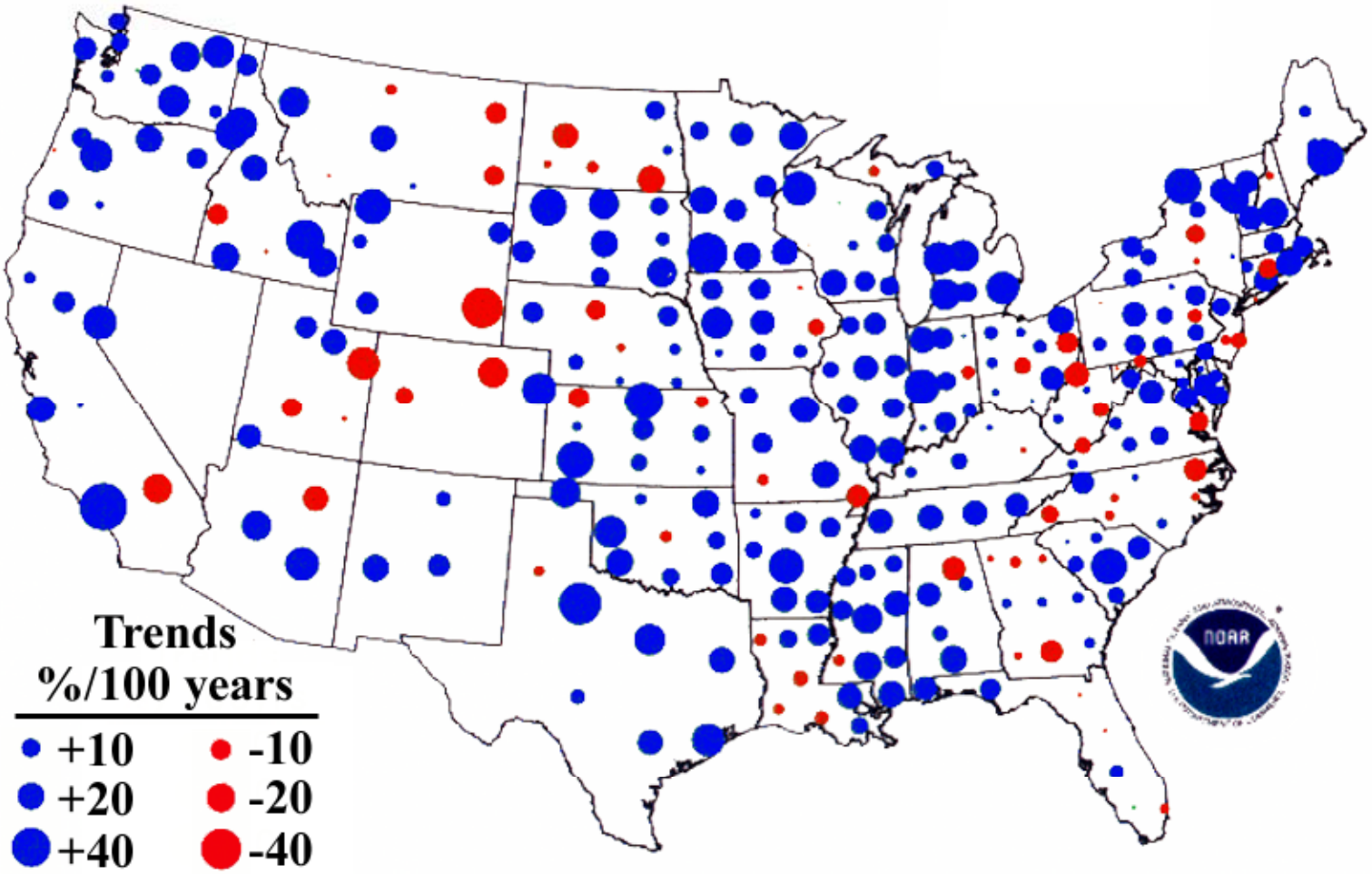


10-year running averages of Illinois River watershed precipitation, streamflow (minus Lake Michigan diversion), and groundwater elevation.

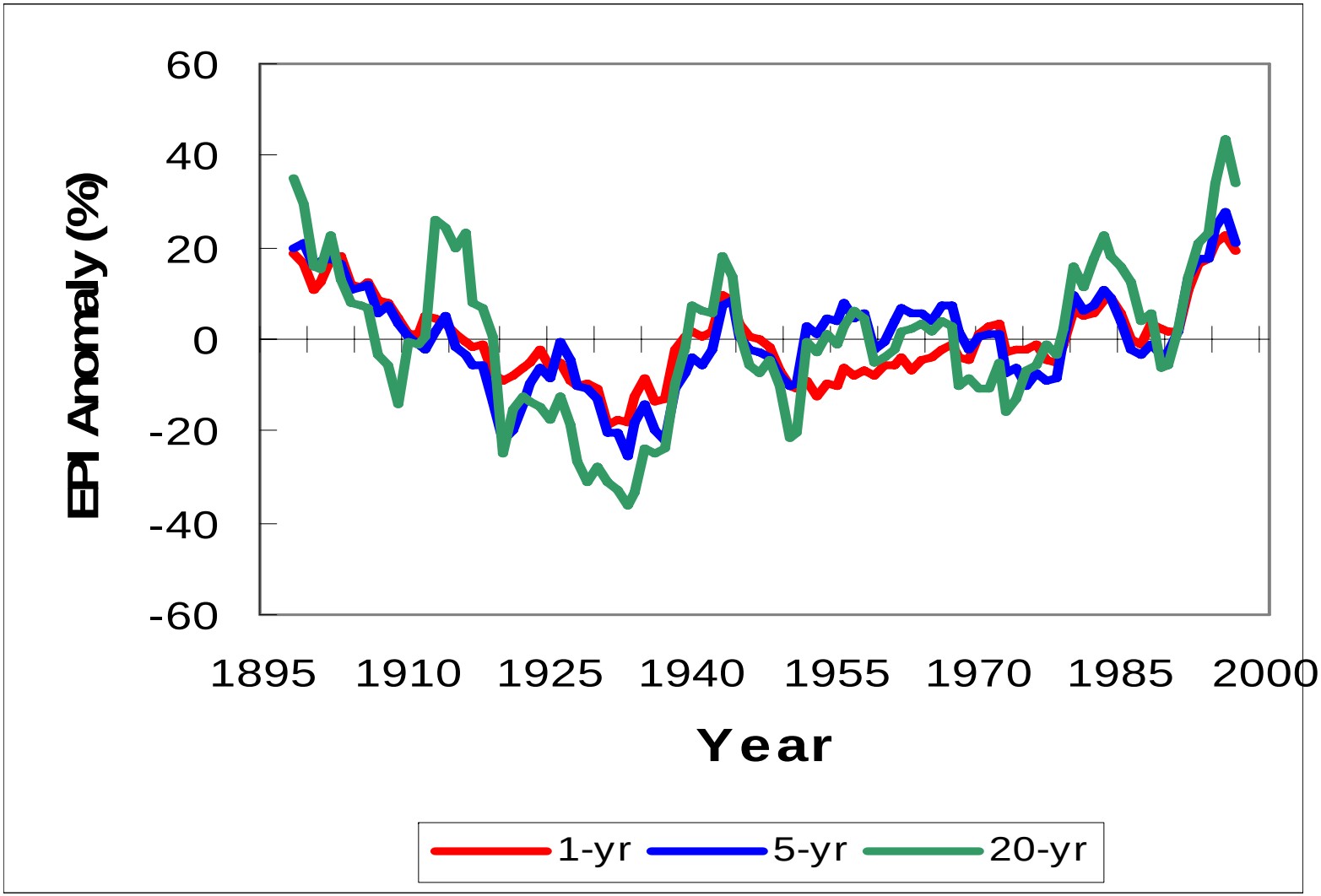
Vern Knapp in Winstanley et al. (2006), ISWS IEM 2006-02



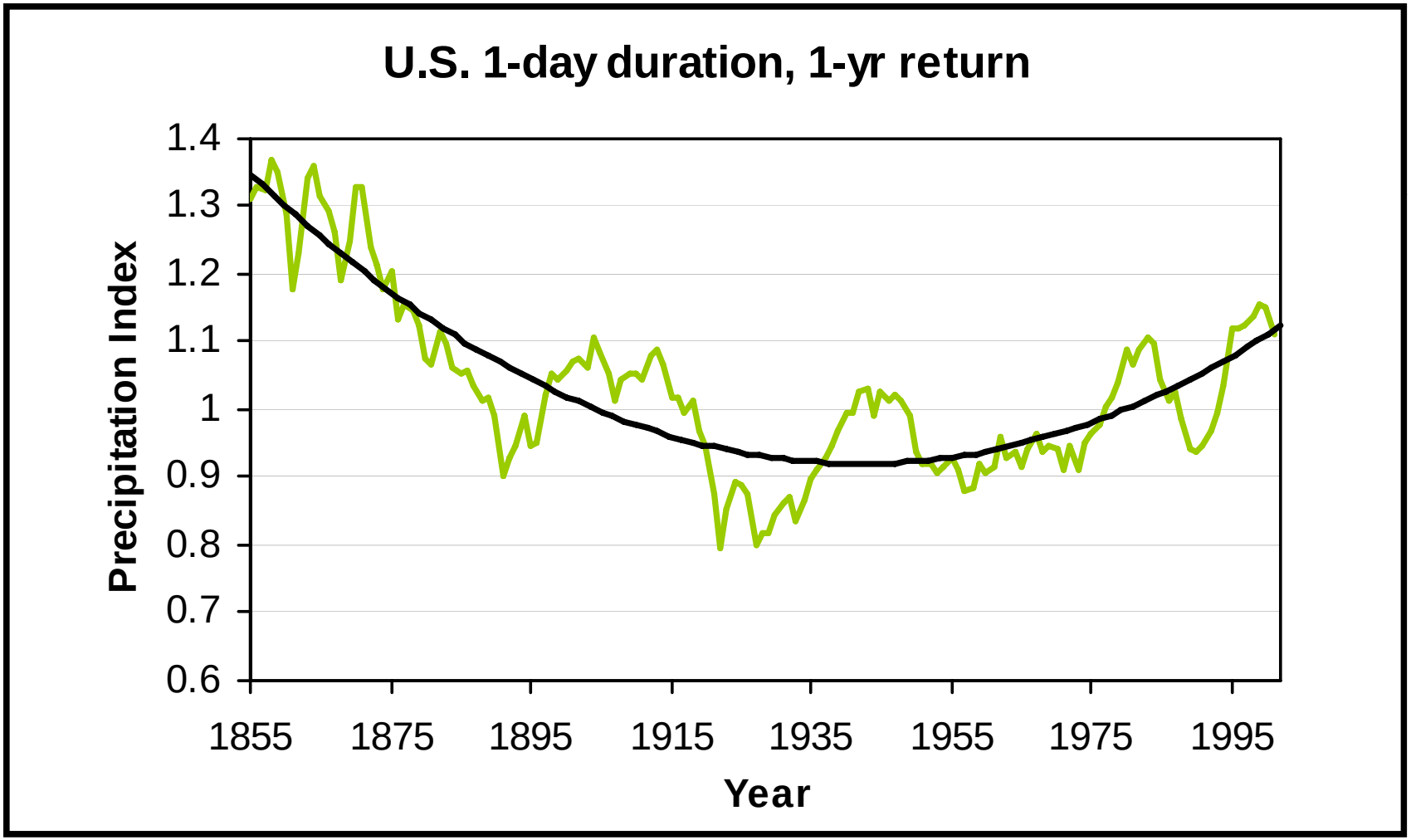
USA 20th CENTURY PRECIPITATION TRENDS



Trends in Heavy Precipitation Events Across USA (K. Kunkel)



Trends in Precipitation Events Across USA (M. Palecki)



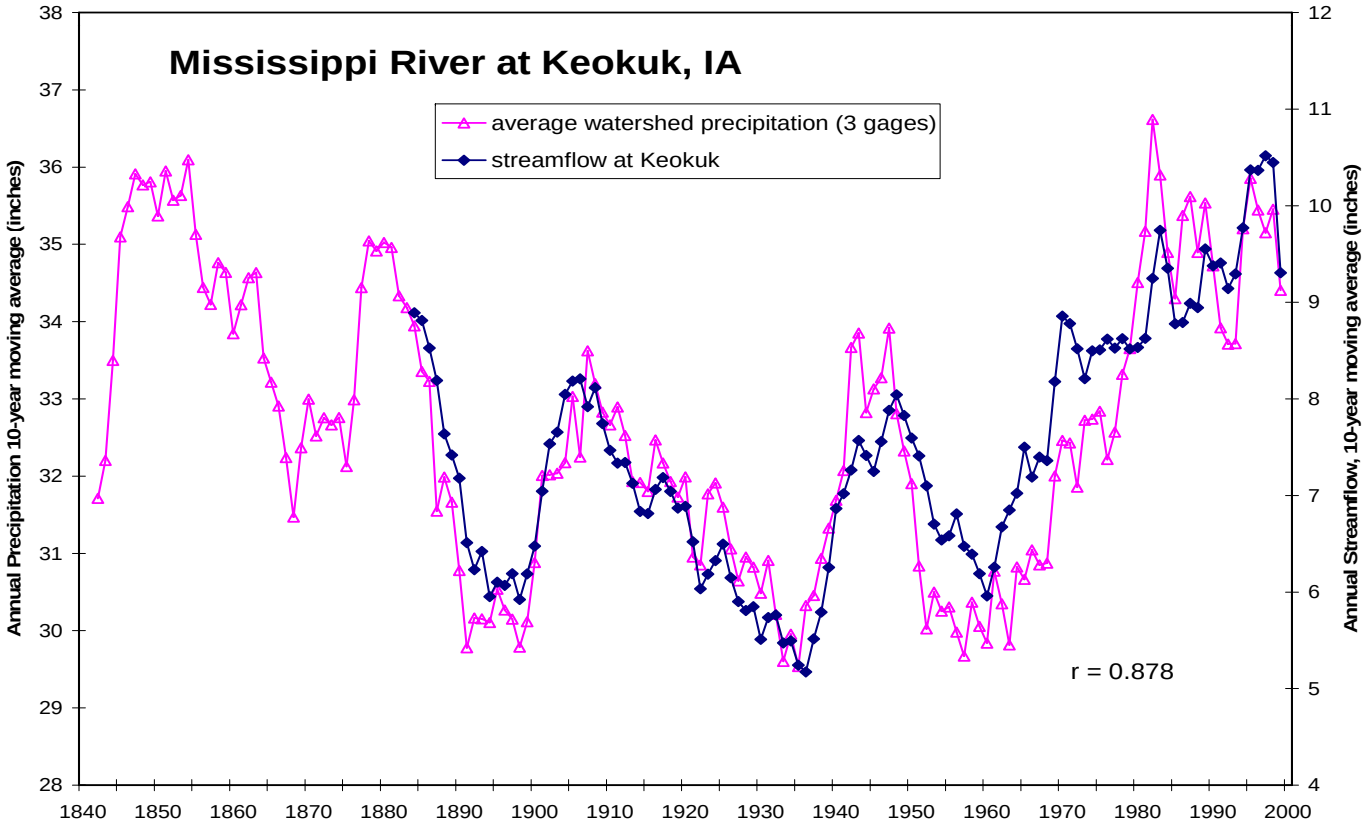
FUTURE CLIMATE

- **Future climate will be influenced by natural processes and human influences.**

- **There are 2 guides to possible future climatic conditions:-**
  - **The past record (what has occurred can occur again)**
  - **Climate modeling**

QUESTION: **IF THE INCREASE IN PRECIPITATION SINCE 1900 IS DUE TO THE INCREASING GREENHOUSE EFFECT, WHAT CAUSED EQUALLY HIGH PRECIPITATION IN THE 19th CENTURY AND A DECREASE IN PRECIPITATION THROUGH THE FIRST HALF OF THE 20th CENTURY?**

ANSWER: **UNEXPLAINED NATURAL VARIABILITY.**



WEAKNESS of GCMs in SIMULATING PRECIPITATION (Wigley, 2004)

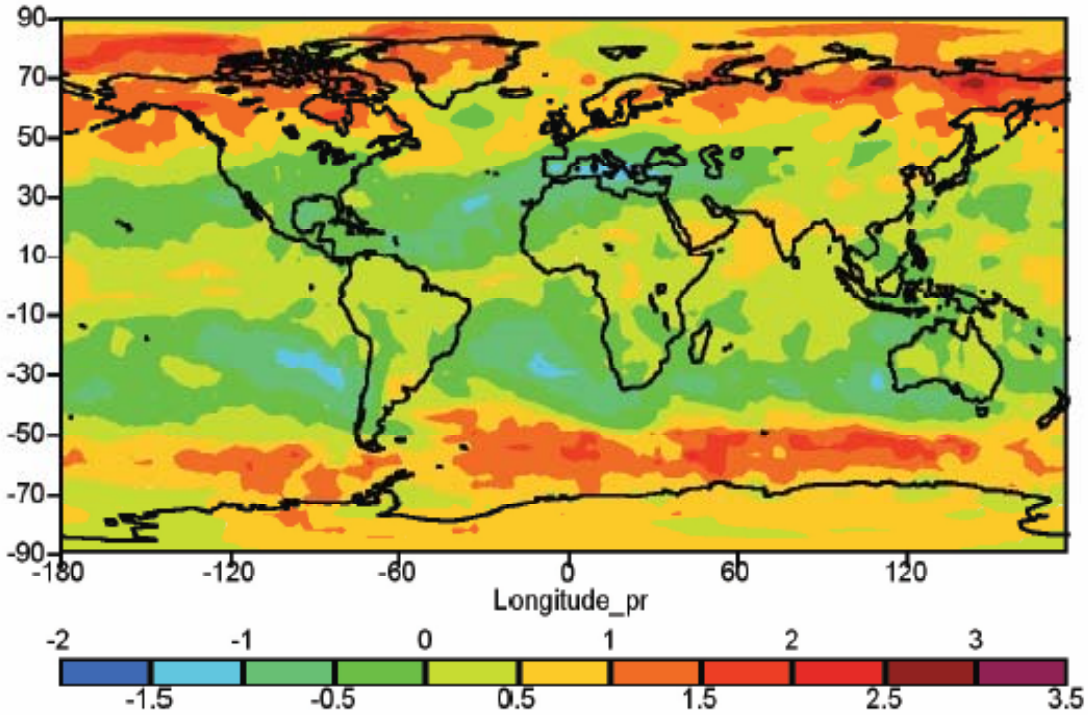
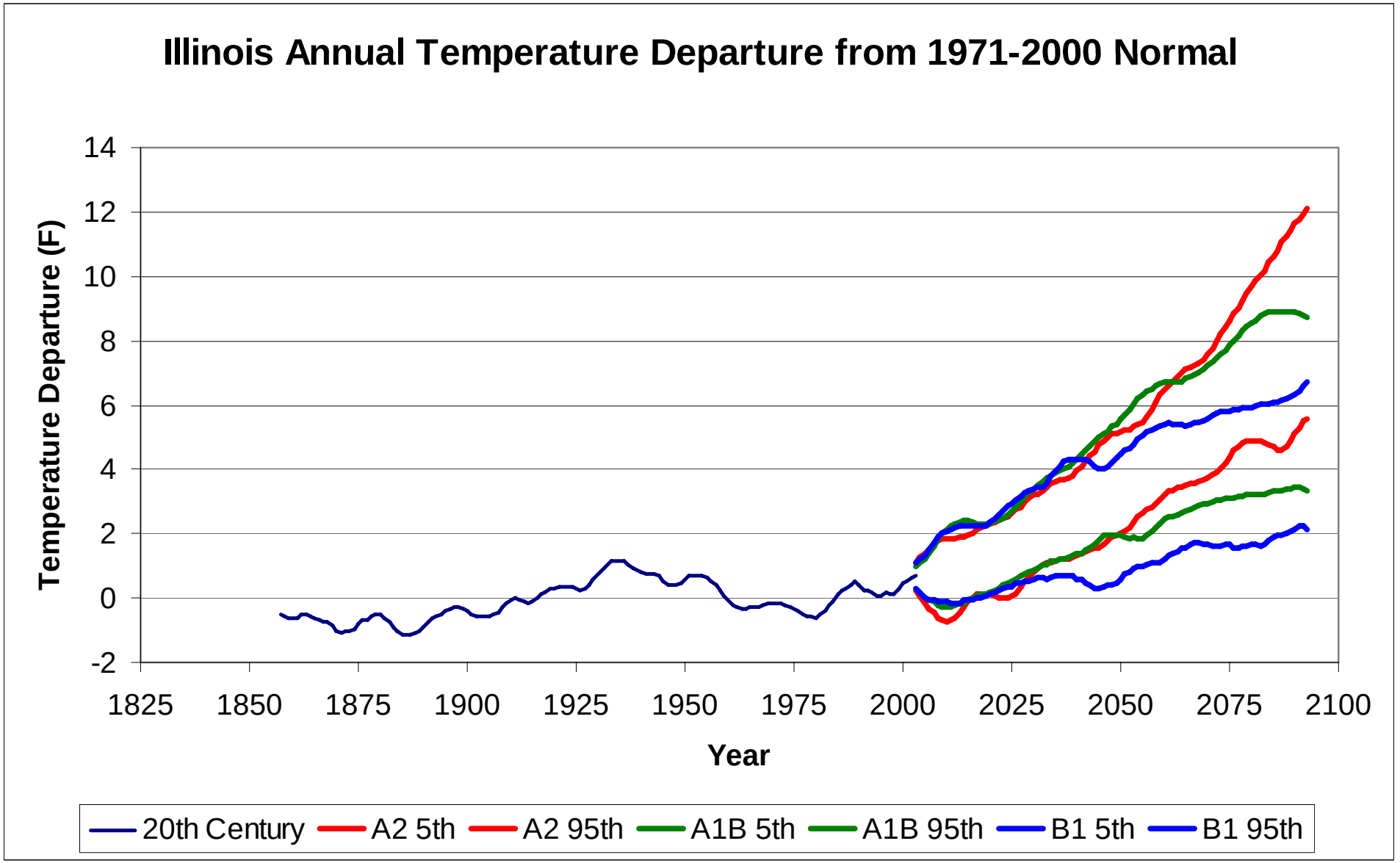
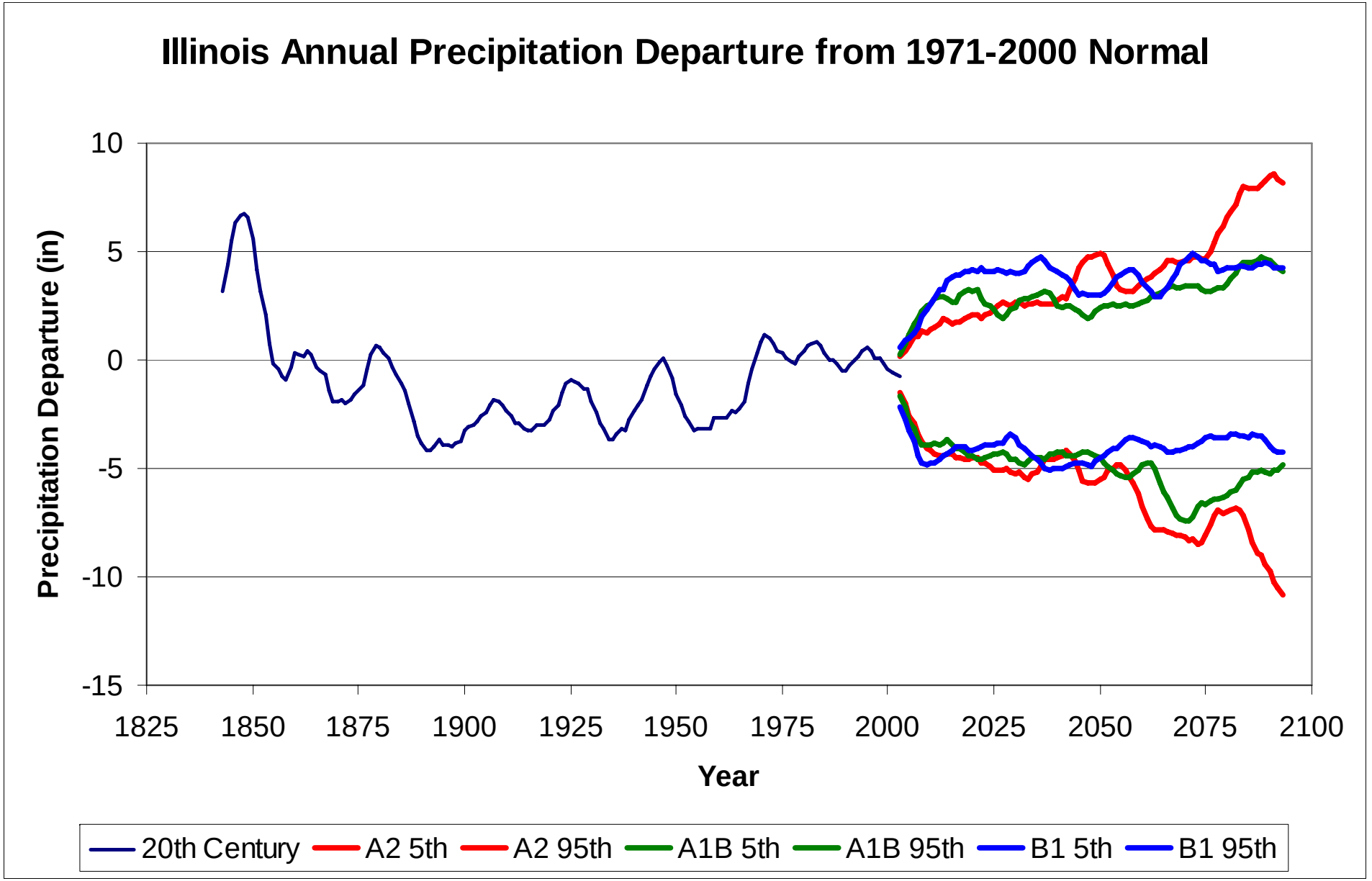


Figure 21. Inter-model signal-to-noise ratios for annual-mean precipitation (mean precipitation change per 1°C global-mean warming, averaged over 17 AOGCMs, divided by the inter-model standard deviation). This is a measure of both the sign and strength of the expected precipitation change and the level of agreement between models. Values between –1 and +1 indicate considerable uncertainty in the expected change.


Illinois Annual Temperature Departure from 1971-2000 Normal
Temperature Departure (F)
14
12
10
8
6
4
2
0
-2
1825
1850
1875
1900
1925
1950
1975
2000
2025
2050
2075
2100
Year
20th Century
A2 5th
A2 95th
A1B 5th
A1B 95th
B1 5th
B1 95th

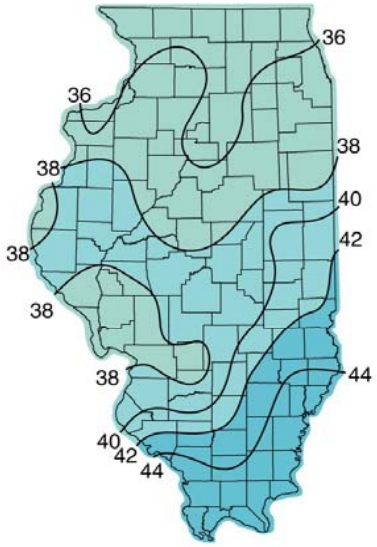

Illinois Annual Precipitation Departure from 1971-2000 Normal
Precipitation Departure (in)
10
5
0
-5
-10
-15
1825
1850
1875
1900
1925
1950
1975
2000
2025
2050
2075
2100
Year
20th Century
A2 5th
A2 95th
A1B 5th
A1B 95th
B1 5th
B1 95th

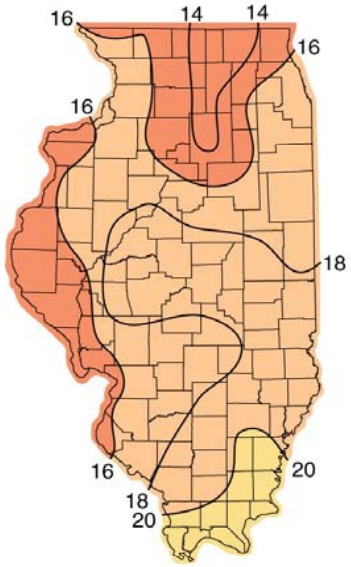
1 in 200 YEAR DROUGHT

The Water Cycle and Water Budgets in Illinois:
A Framework for Drought and Water-Supply Planning

Derek Winstanley, James R. Angel, Stanley A. Changnon, H. Vernon Knapp,
Kenneth E. Kunkel, Michael A. Palecki, Robert W. Scott, and H. Allen Wehrmann

ARE WE PREPARED...





...FOR SEVERE DROUGHT?

UNCERTAINTY AND RISK

- **WILL THE RWSPC RECOMMEND HOW TO DEAL WITH DROUGHT AND POSSIBLE CLIMATE CHANGE?**

- **WITH A HOT+ DRY CLIMATE SCENARIO DROUGHT FREQUENCY AND MAGNITUDE LIKELY WOULD BE DISASTEROUS, BUT WE CAN NOT PUT A PROBABILITY OF OCCURRENCE ON SUCH A SCENARIO.**

- **ONE APPROACH WOULD BE TO ANALYZE AND BE PREPARED TO AT LEAST DEAL WITH RECURRENCE OF SEVERE DROUGHTS THAT HAVE OCCURRED IN FIRST HALF OF 20th CENTURY. PLAN FOR 1 in 200 YEAR DROUGHT?**

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THANK YOU!