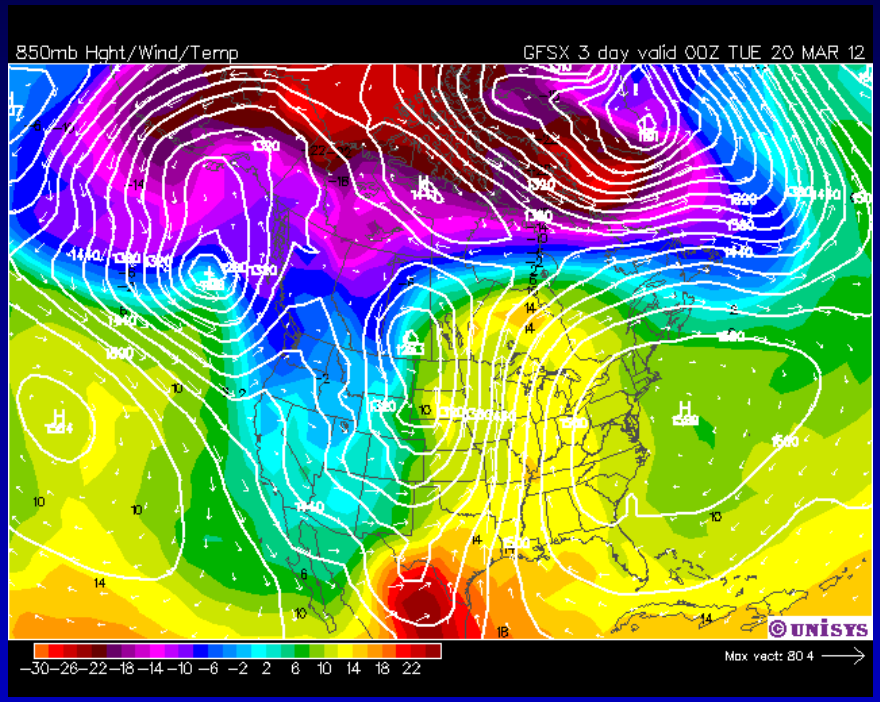
Reflections on a Growing Season of Extremes, Climate Trends, and Implications for Agriculture



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MICHIGAN STATE UNIVERSITY EXTENSION

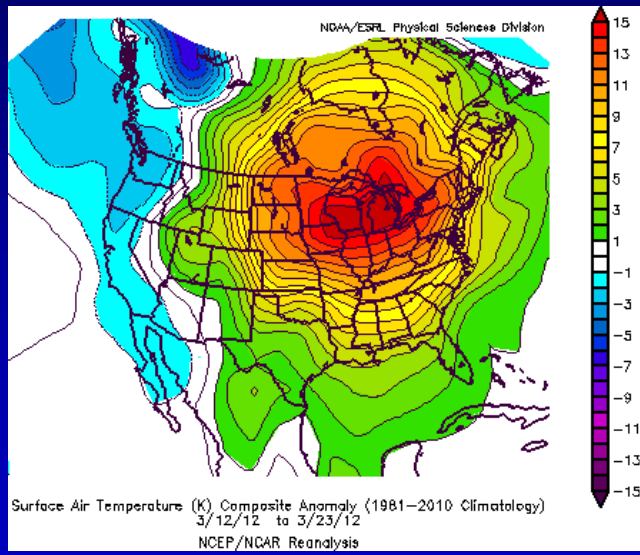
MICHIGAN STATE UNIVERSITY AgBioResearch

Outline

- Seasonal Highlights
- Historical Context, Trends
- Future Projections
- Near Future Outlook

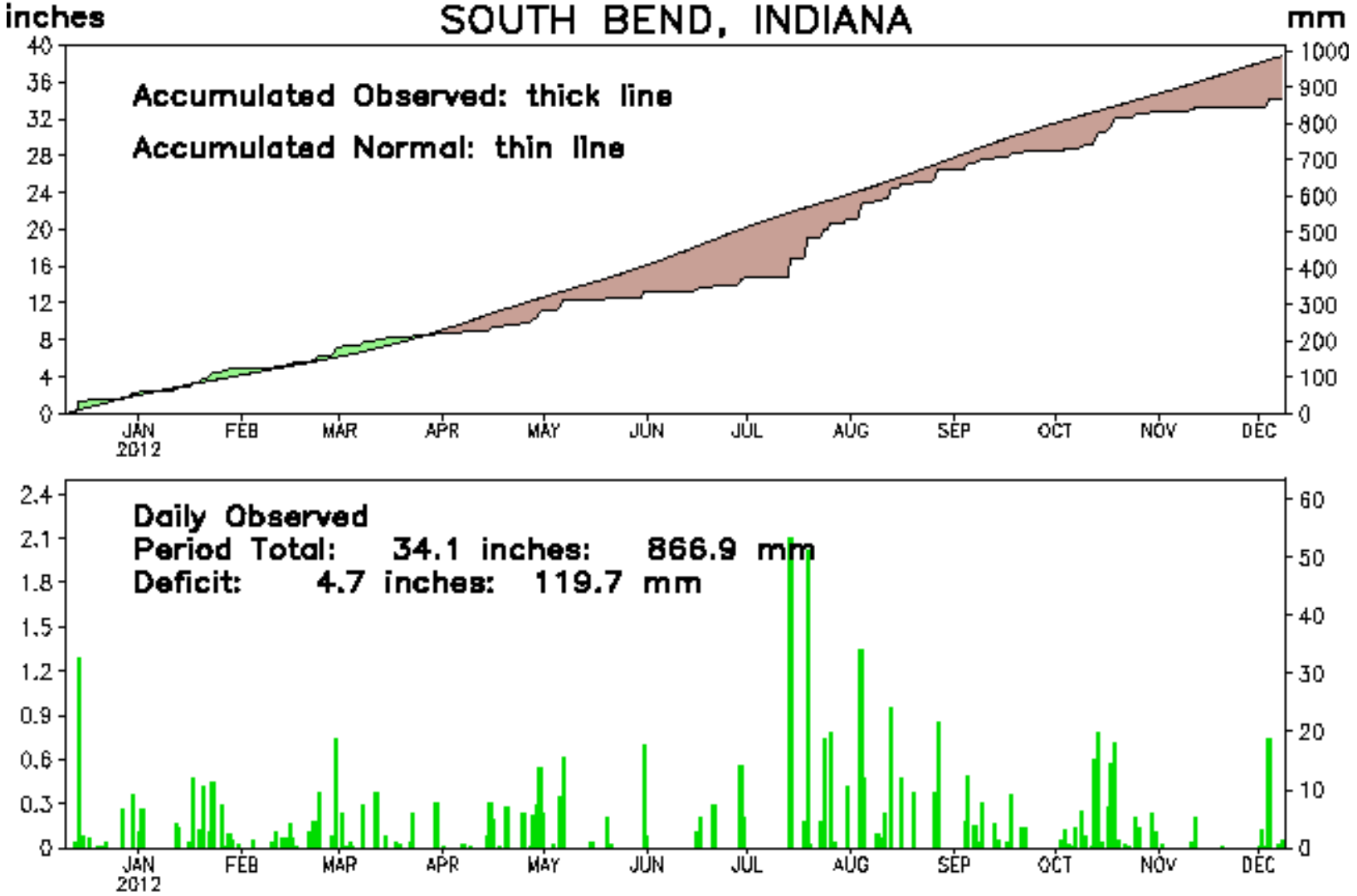
March 2012 Summary

- Nationally, mean March temperature was 10.6˚C, 4.8˚C above normal.
  - Departure was 0.3˚C warmer than previous all time warmest March (1910)
  - Only one month (JAN 2006) with a greater departure from normal
  - 15,292 warm temperature records broken (7,775 daytime, 7,517 nighttime)
  - Warmest March ever for 25 states
- In Michigan, mean March temperature was 6.9°C, which was 7.6˚C warmer than normal and 1.8˚C warmer than the previous record (1945)
  - A new all-time record for warmest temp ever in March, 32.2˚C at Lapeer on the 21st.
  - Individual days where mean temp was more than 20˚C above normal



Precipitation

SOUTH BEND, INDIANA



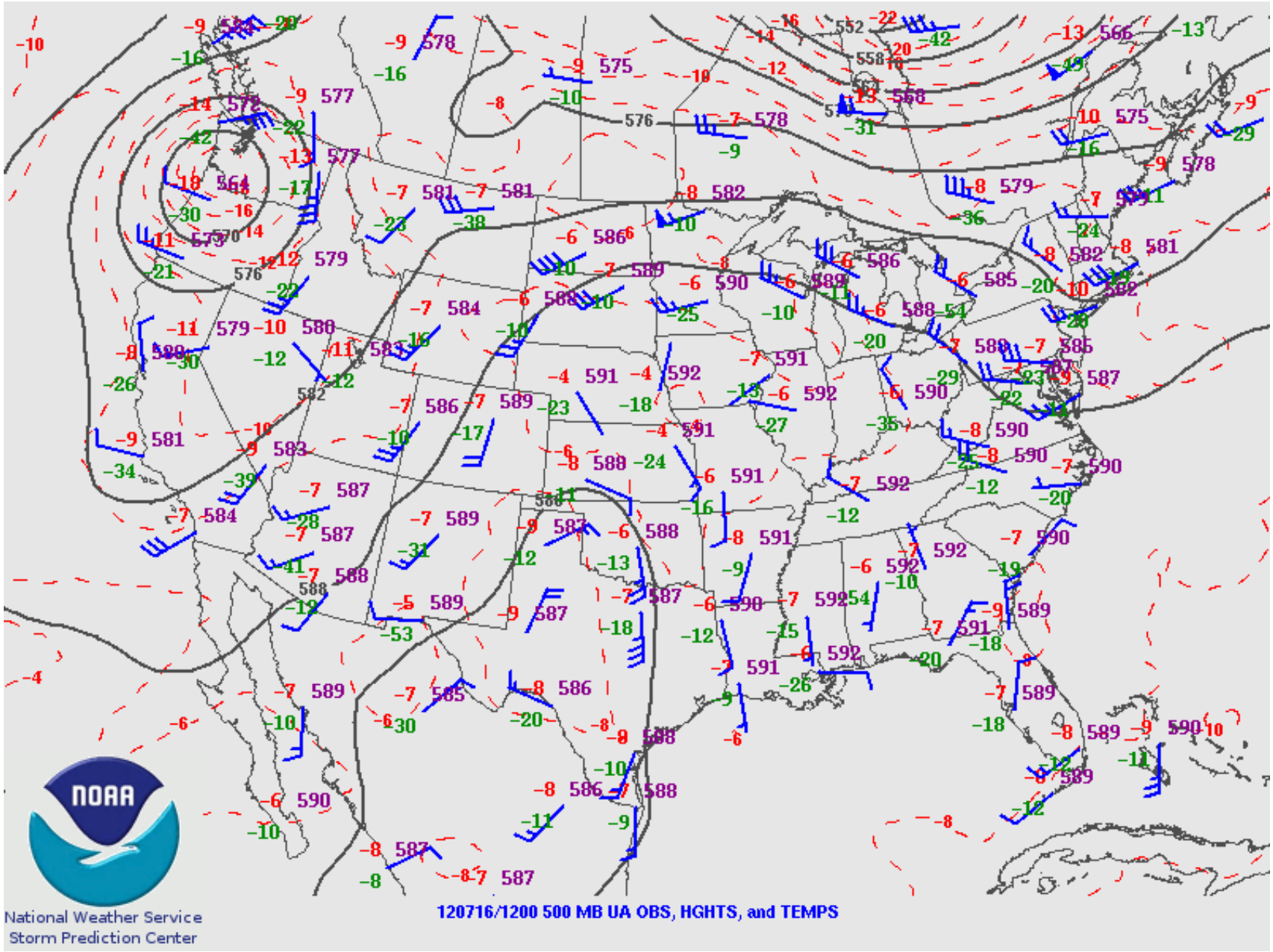
Data updated through 08 DEC 2012

CLIMATE PREDICTION CENTER/NCEP

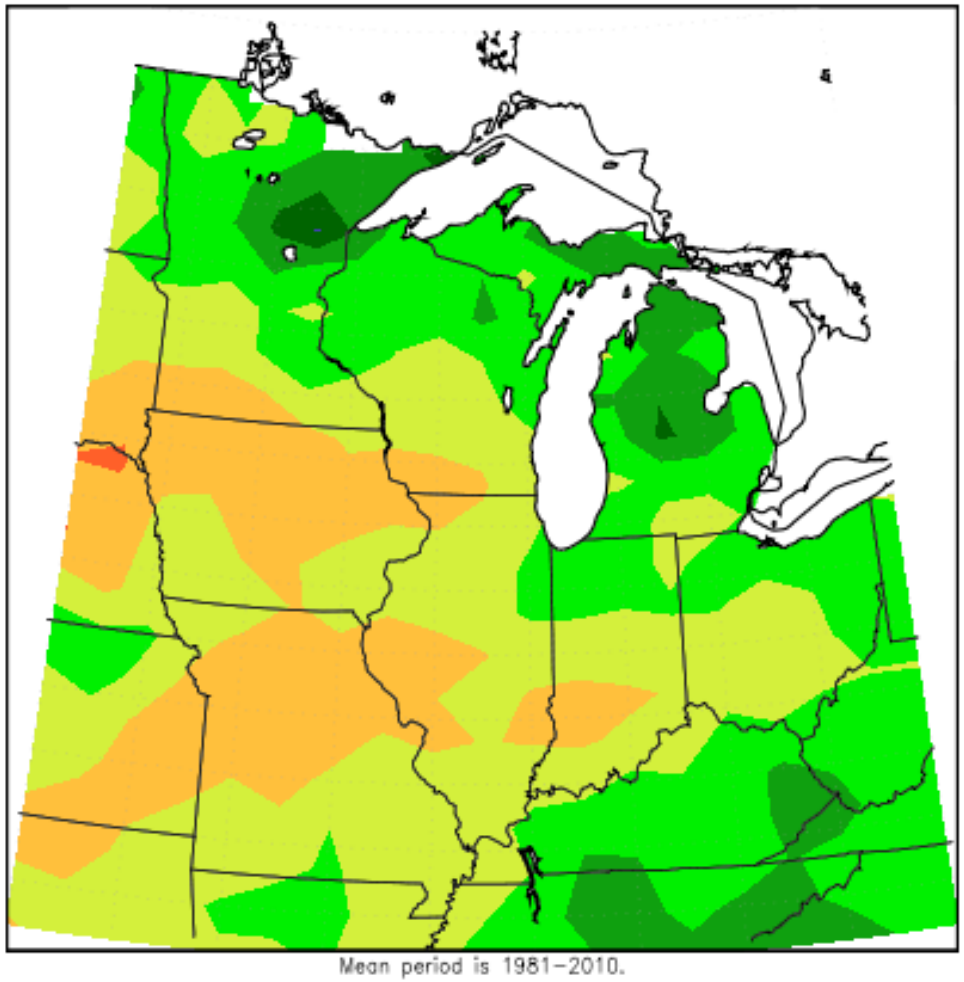
2012 Drought

- Due to prolonged dryness and much warmer than normal temperatures, drought conditions developed across large portions of the continental USA during the spring and early summer of 2012.
  - The drought was associated with a persistent upper air ridging pattern across central sections of the USA
  - As of July 16, 56.0 percent of the contiguous U.S. experienced drought conditions, the largest percentage since 1956.
  - Crop commodity prices rose rapidly to record or near record levels.
  - Preliminary damage estimates at $50 billion (on a national basis).
  - As of late August, the USDA has designated 1,297 counties across 29 states as federal disaster areas.

Upper Air Pattern Associated with 2012 Drought



Accumulated Precipitation: Percent of Mean
June 1, 2012 to August 31, 2012

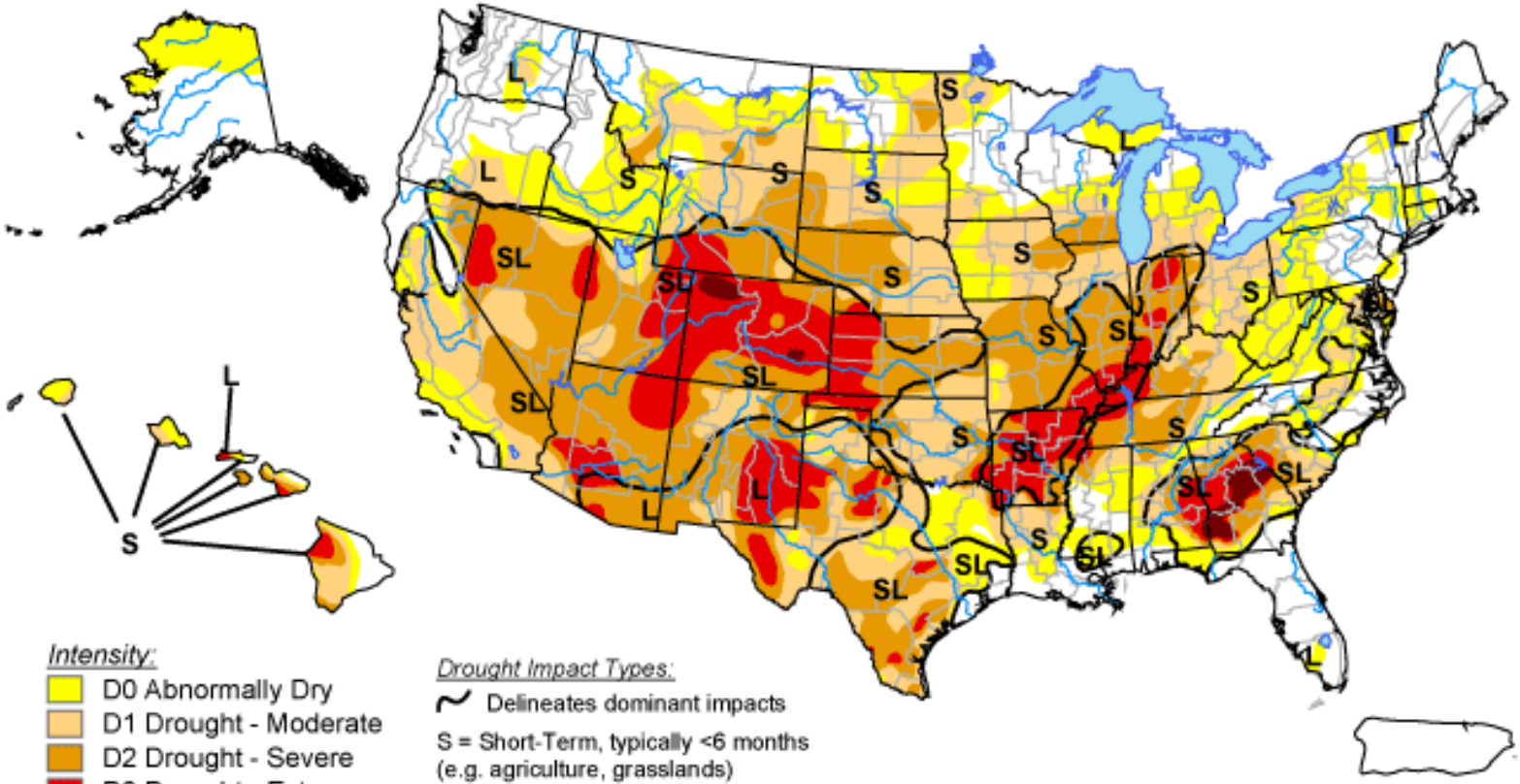


Mean period is 1981–2010.

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

U.S. Drought Monitor

July 10, 2012
Valid 7 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
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Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

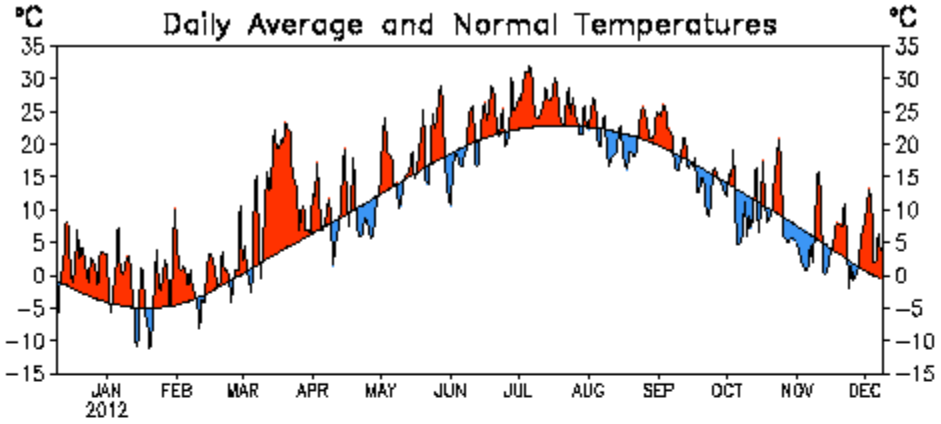
http://droughtmonitor.unl.edu/

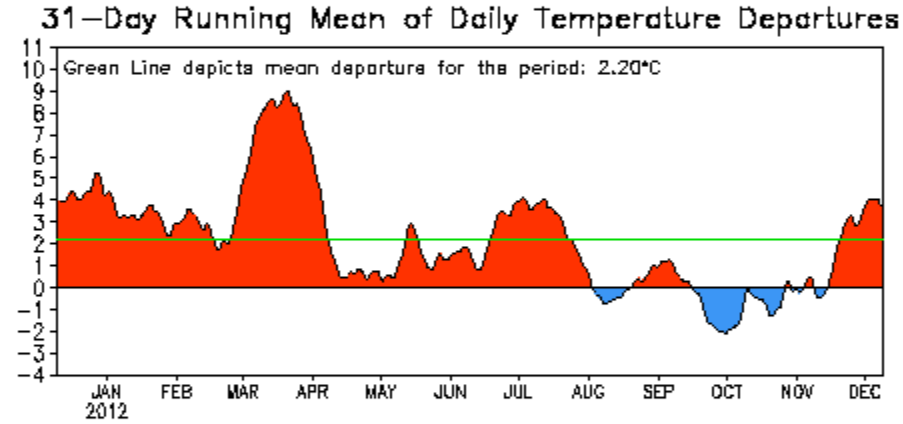
USDA | National Drought Mitigation Center

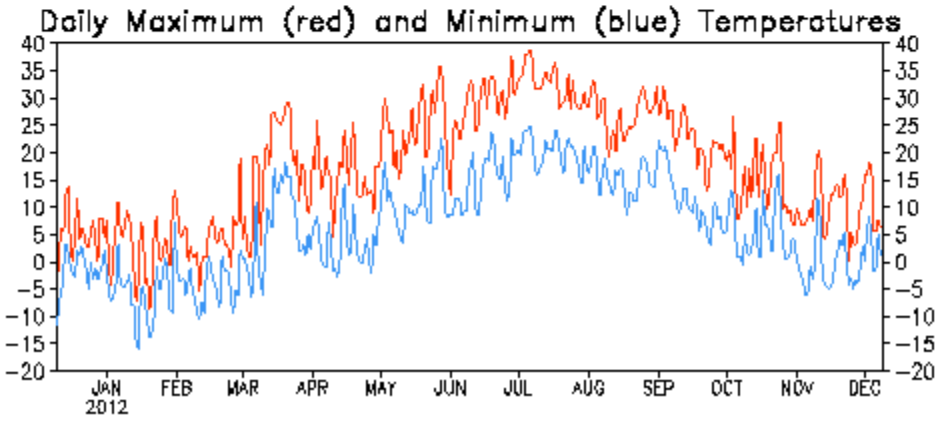
Released Thursday, July 12, 2012

Author: Rich Tinker, NOAA/NWS/NCEP/CPC

SOUTH BEND, INDIANA





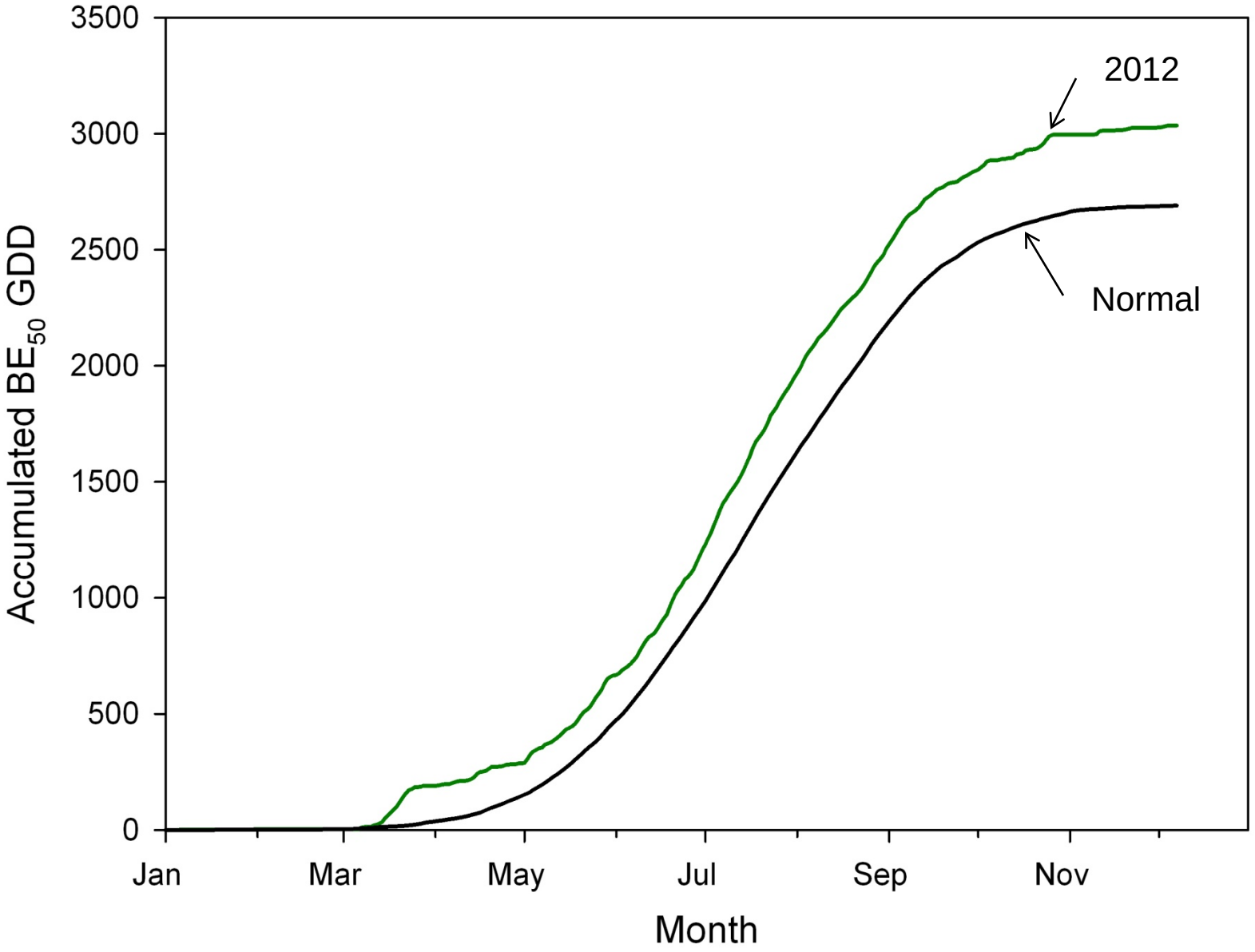


Data updated through 08 DEC 2012

CLIMATE PREDICTION CENTER/NCEP

Accumulated Base 50ºF GDDs

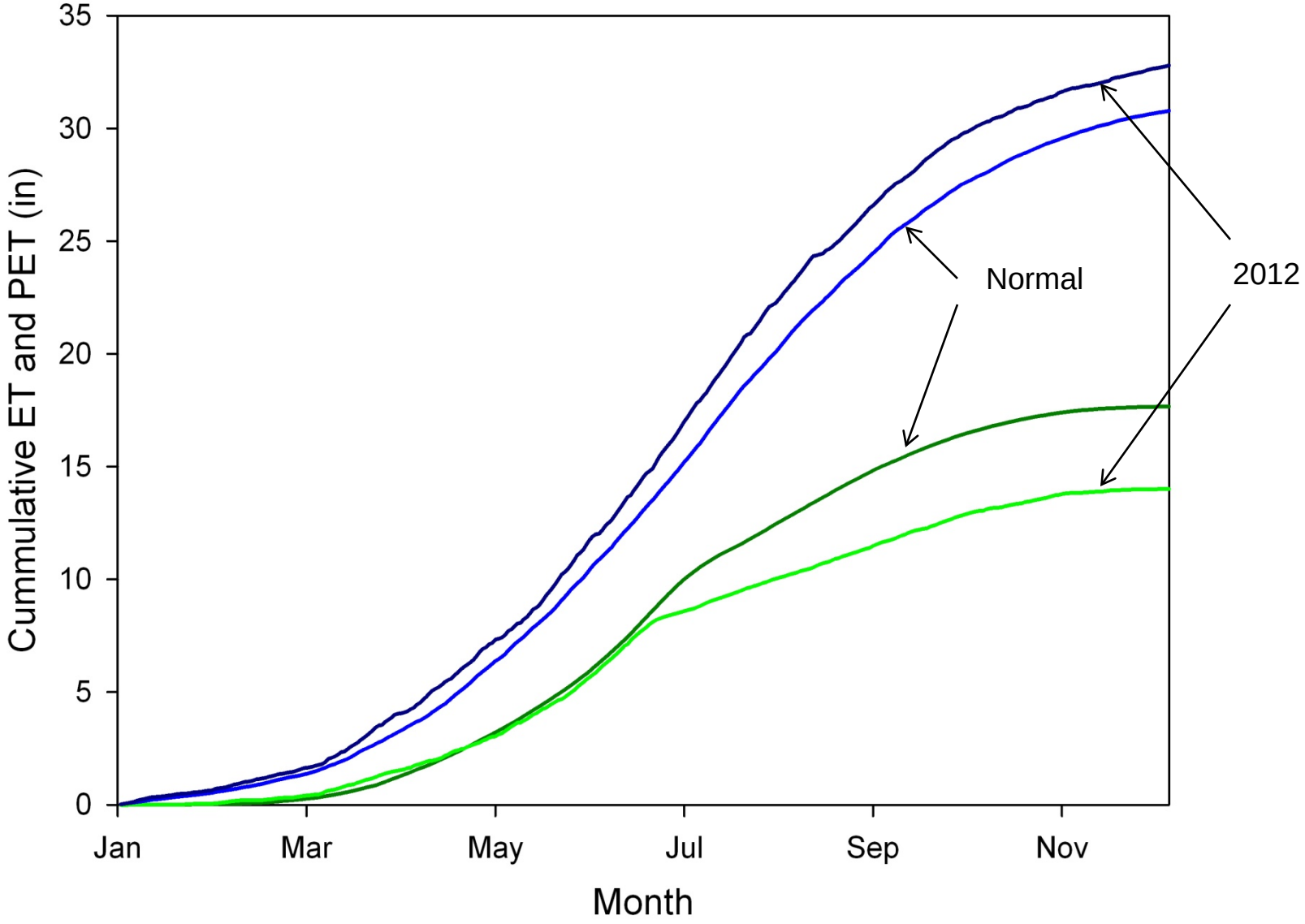
Lapeer, MI 2012



Accumulated ET, PET

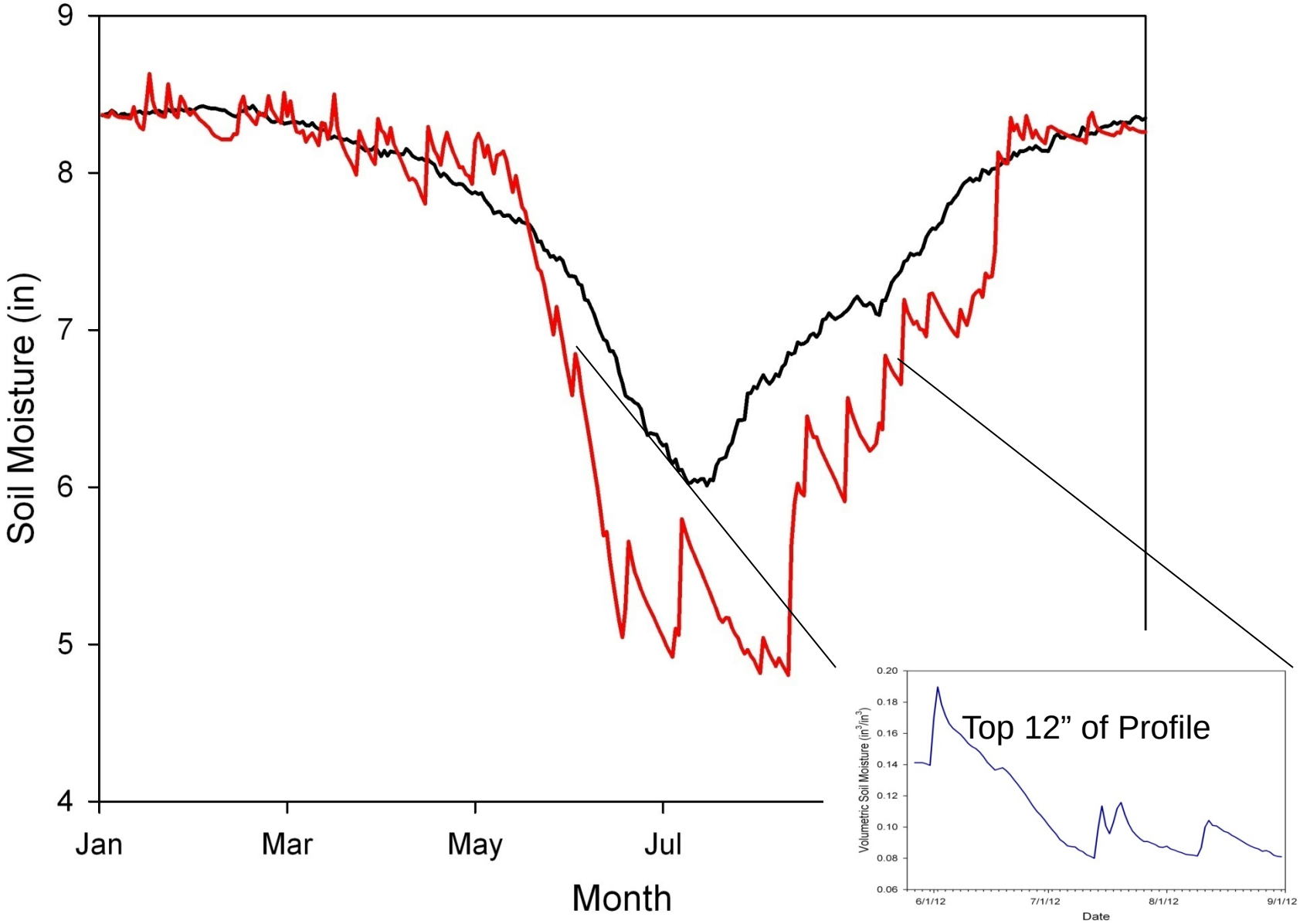
JAN 1 – NOV 30, 2012

East Lansing, MI



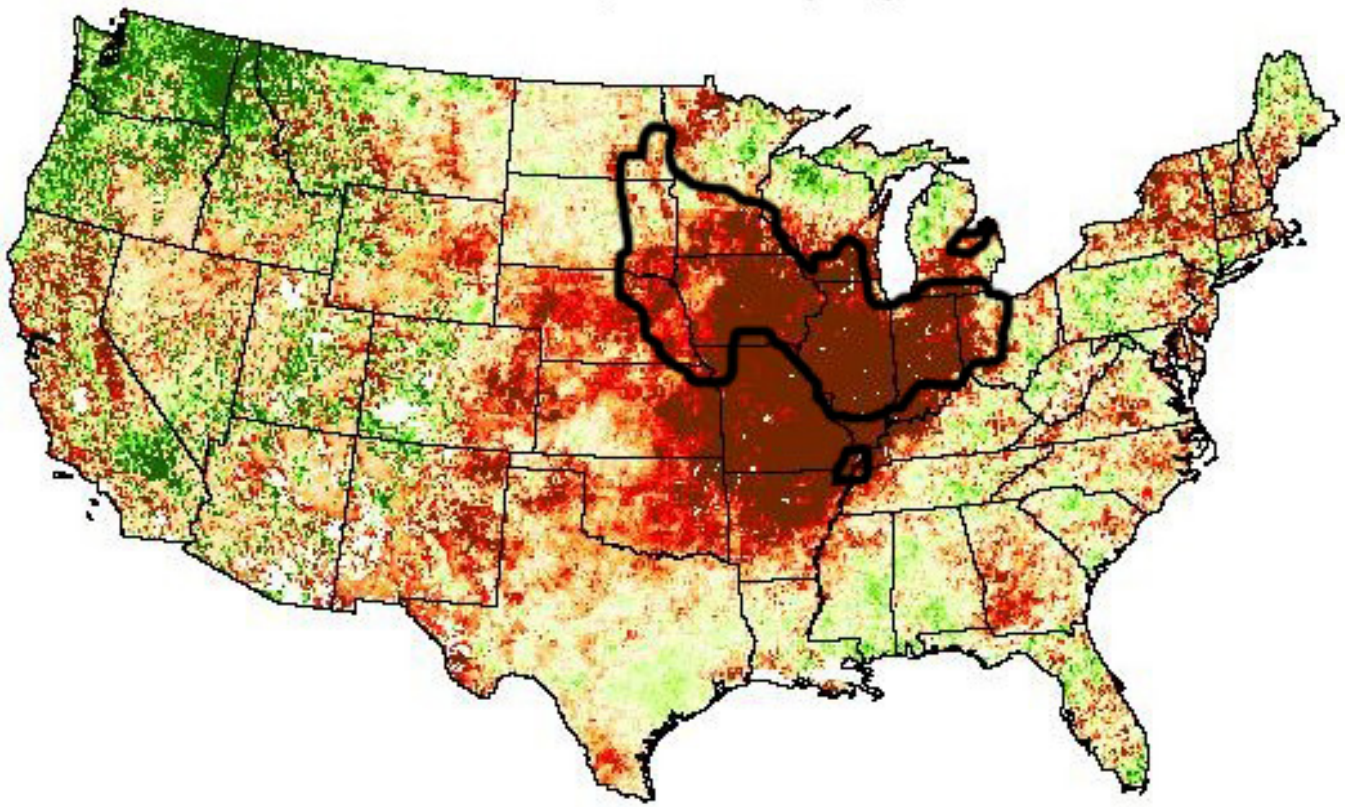
Plant Available Soil Moisture

Top 5 Feet, Silty Clay, E. Lansing, MI
JAN 1 – OCT 31, 2012



Evaporative Stress Index

1 month composite ending August 7, 2012

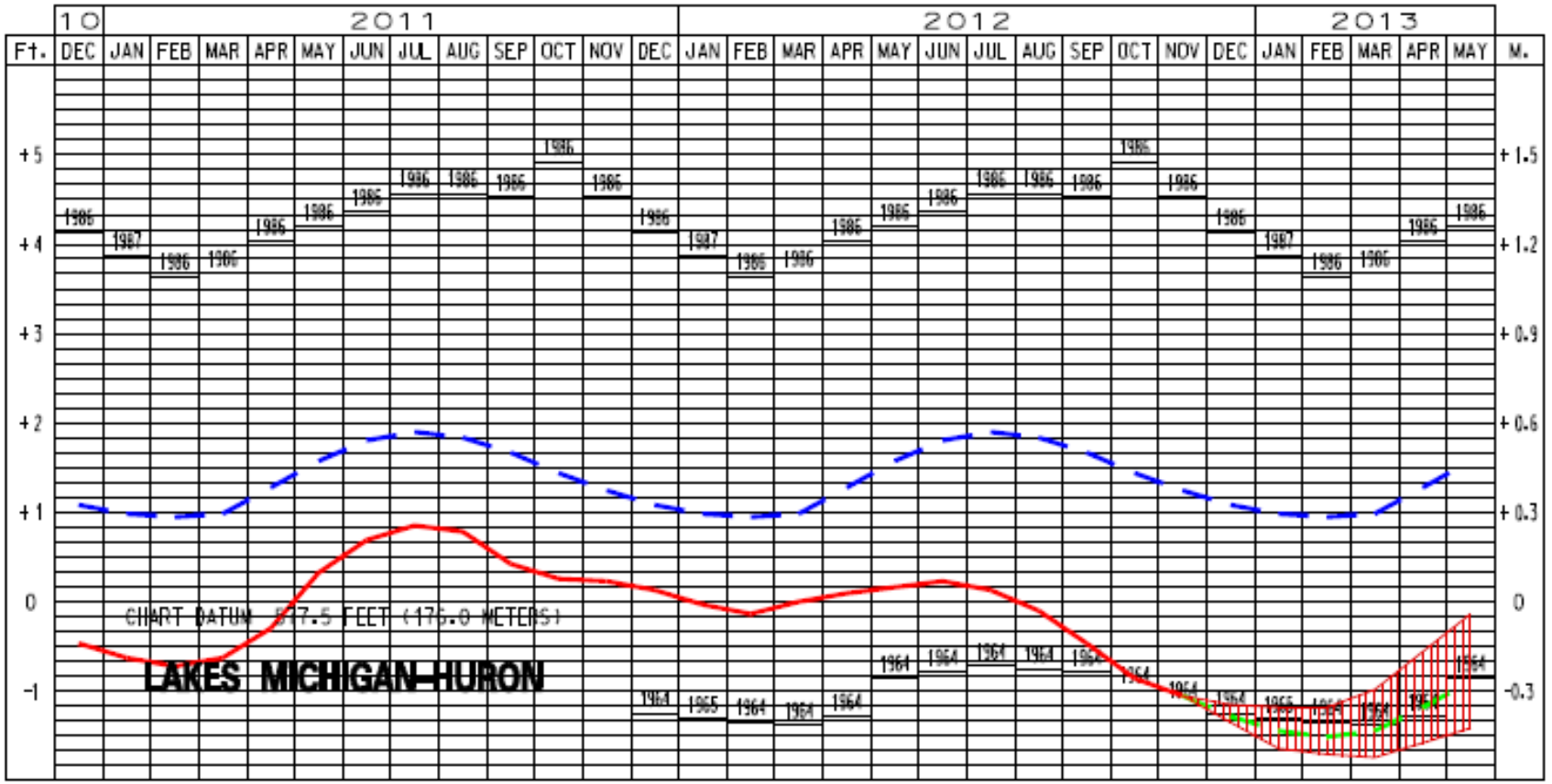


Standardized ET/PET anomalies

-2σ< -1σ 0 +1σ > +2σ

Historical and Projected Monthly Lake Levels

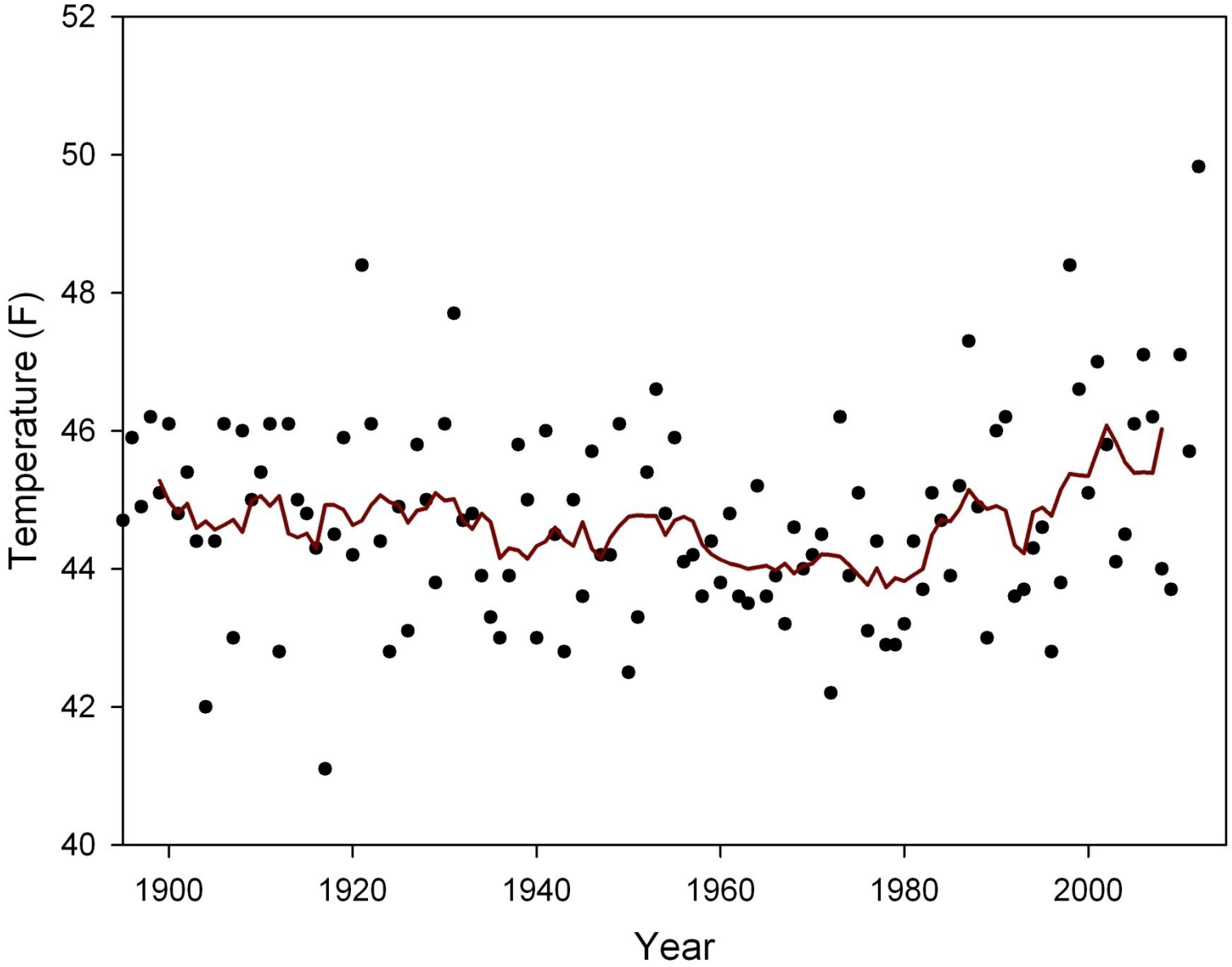
Lakes Michigan-Huron



USACE, 2012

Historical Trends

Mean Temperatures vs. Year, Michigan 1895-2012*

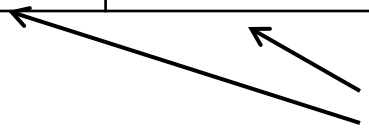


* Data through NOV 2012, assumes normal temperatures during DEC 2012

Seasonal Changes in Mean Temperature

1895-2010 (ºF/year)

State	Season				
	Annual	Winter	Spring	Summer	Fall
IA	0.009**	0.014	0.014**	0.004	0.001
IL	0.004	0.005	0.011*	-0.001	-0.001
IN	0.003	0.006	0.010*	-0.005	-0.001
MI	0.001	0.008	0.007	-0.006	-0.008
MN	0.014***	0.022*	0.015**	0.008*	0.006
MO	0.005	0.008	0.010*	0.002	-0.004
OH	0.008***	0.011	0.014***	0.002	0.003
WI	0.009***	0.019*	0.013*	0.002	0.002
Reg. Avg.	0.007	0.012	0.012	0.001	0.000



Relatively greater changes in winter, spring

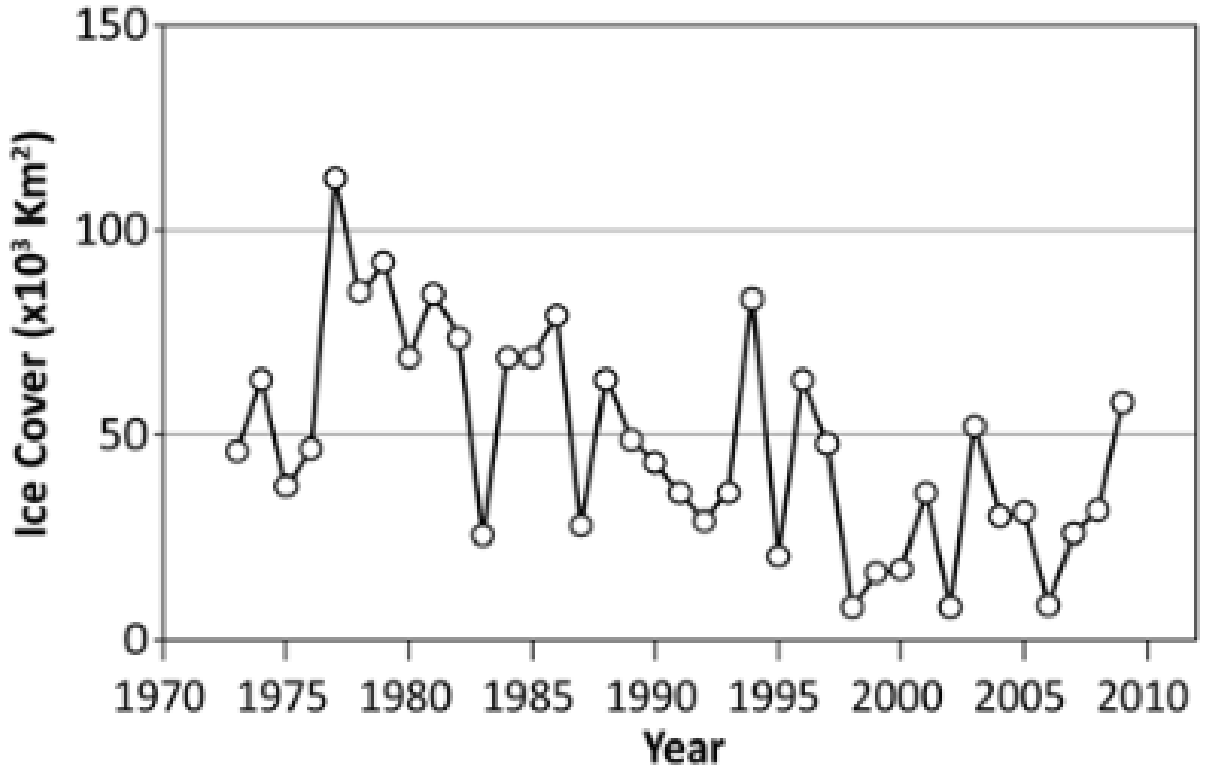
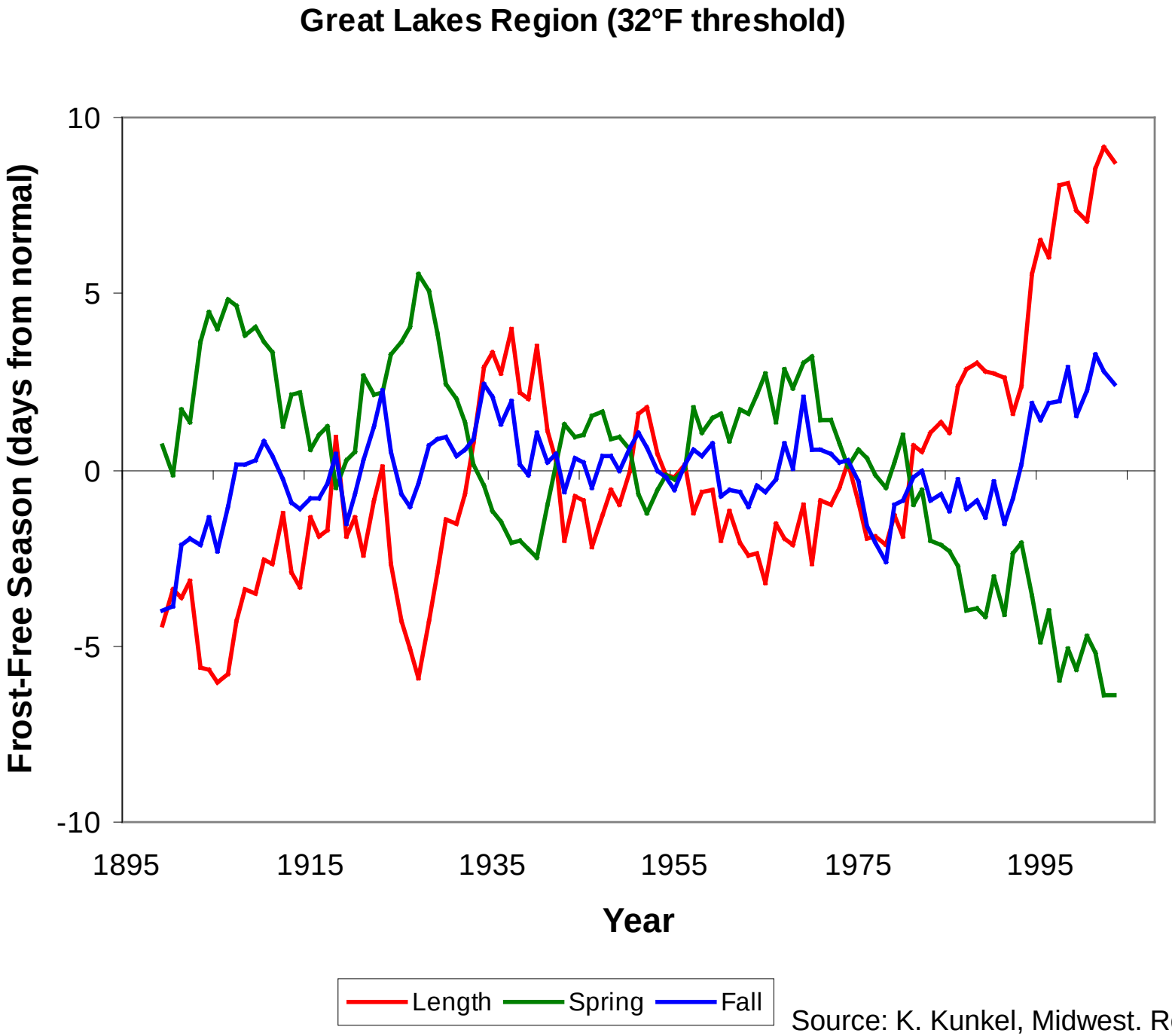
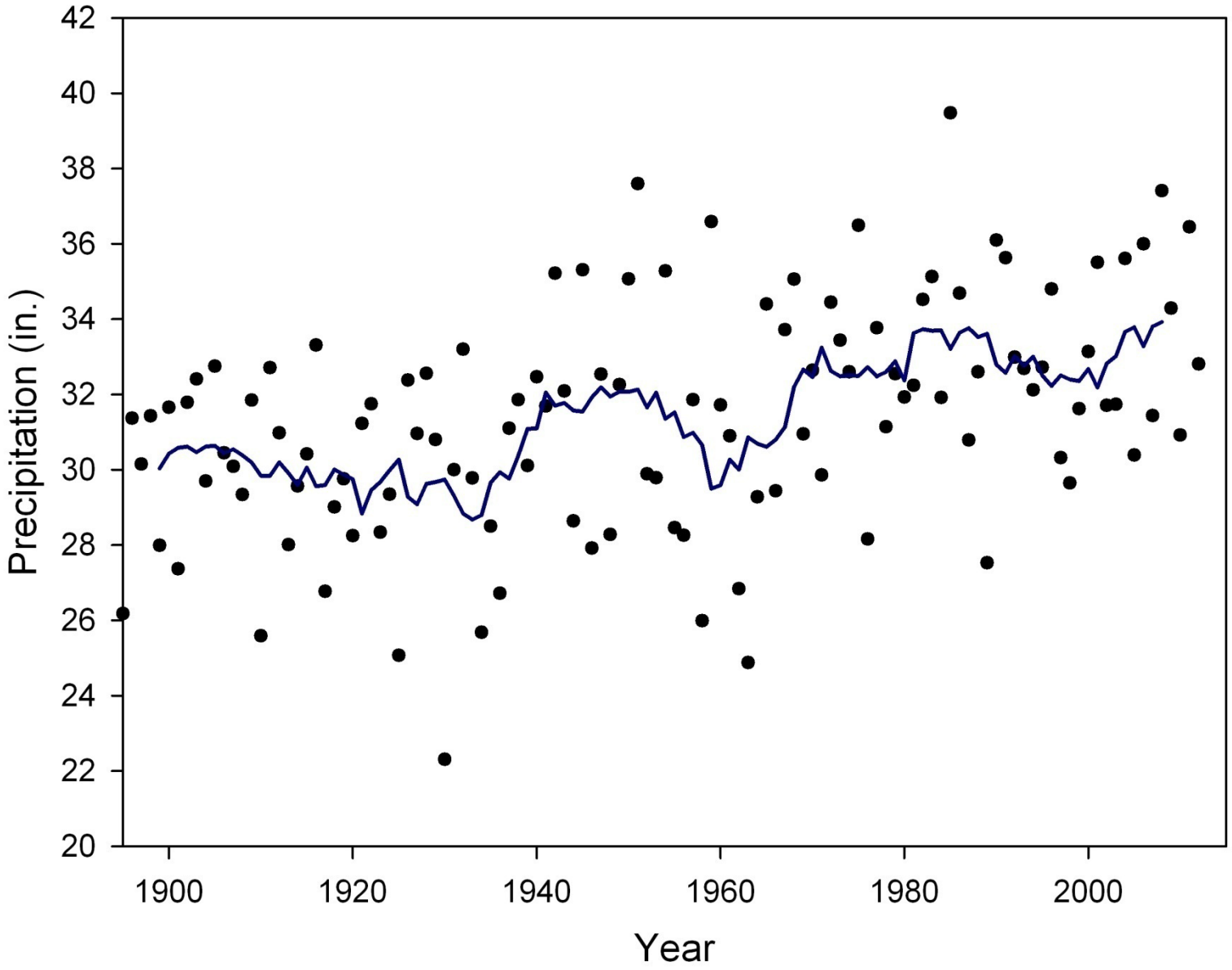


Figure 10. Time series of annual averaged ice area for the Great Lakes. From Wang et al. (2010).



Source: K. Kunkel, Midwest. Reg. Clim. Center

Annual Precipitation vs. Year, Michigan 1895-2012*

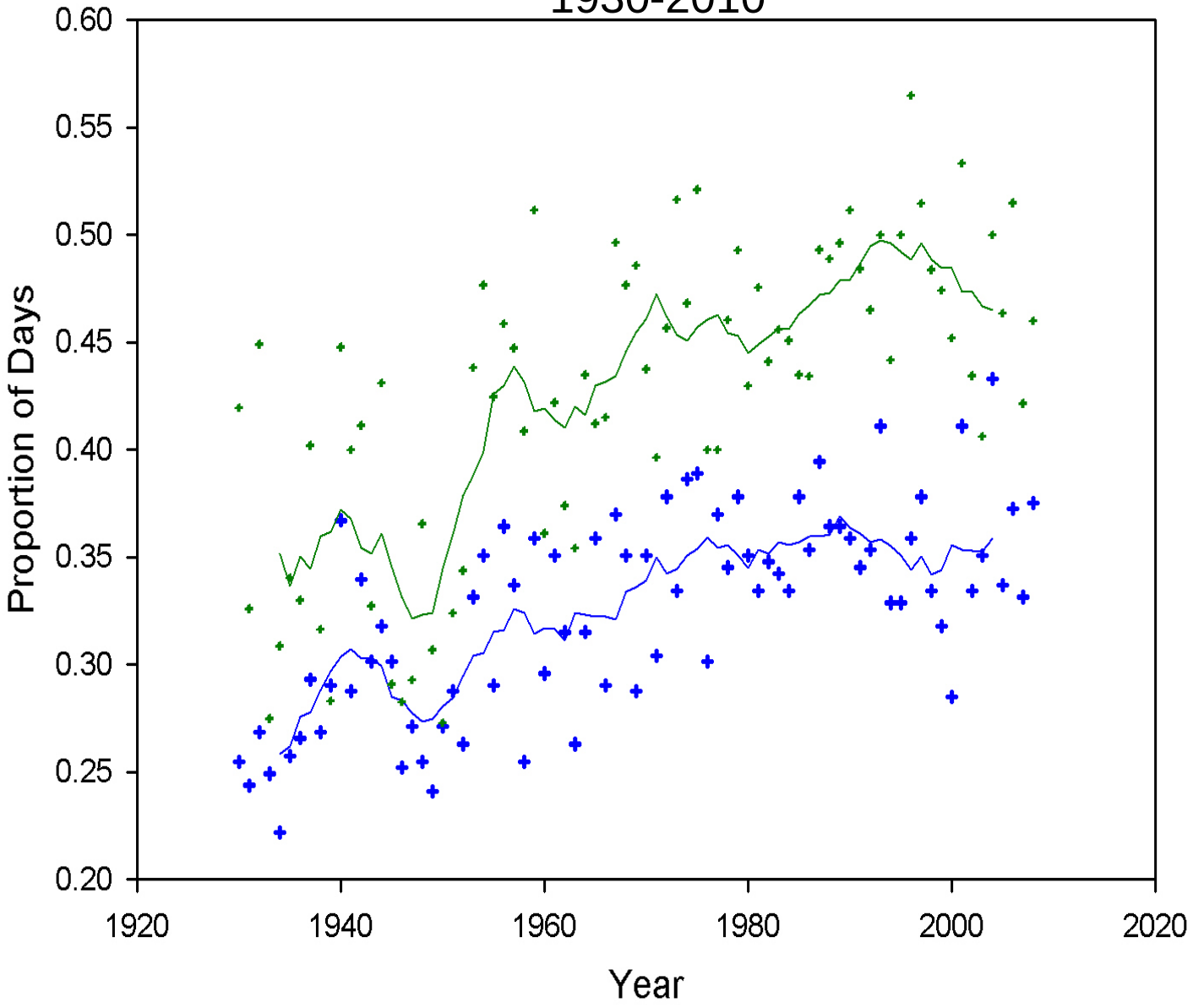


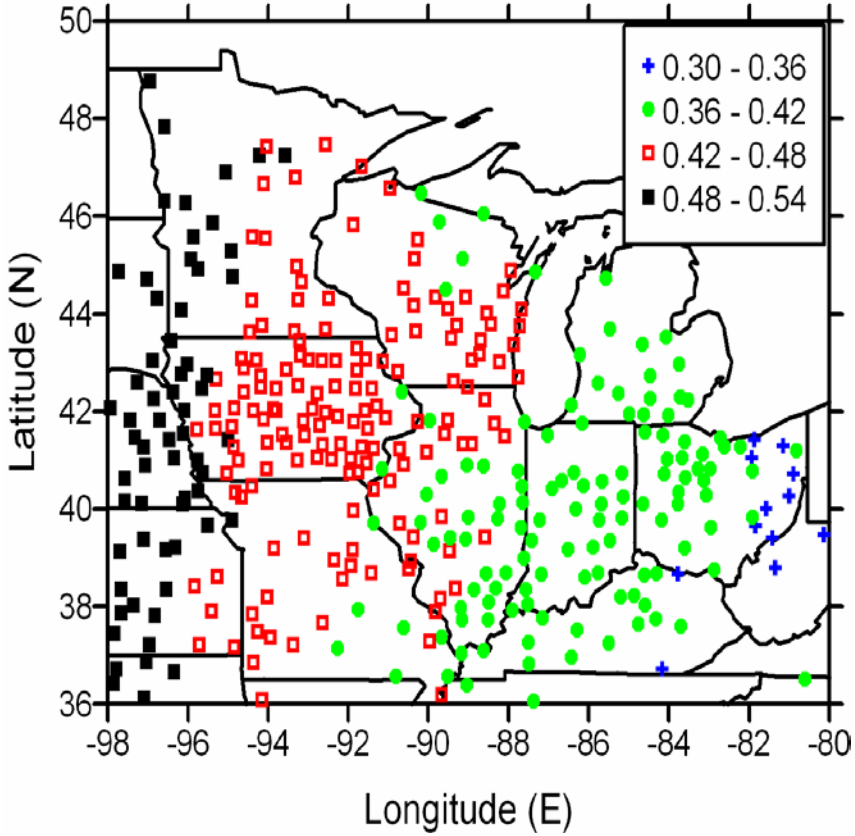
* Data through NOV 2012, assumes normal total during DEC 2012

Frequency of Wet Days and Wet/Wet Days

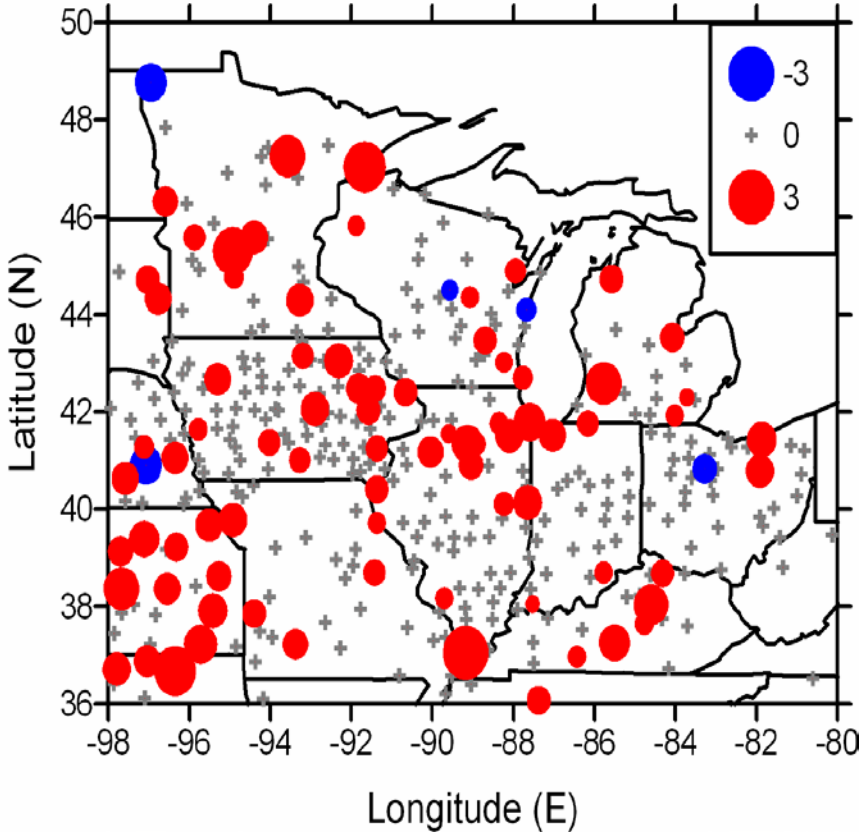
Caro, MI

1930-2010





Mean fraction of annual precipitation derived from10 wettest days
1971-2000

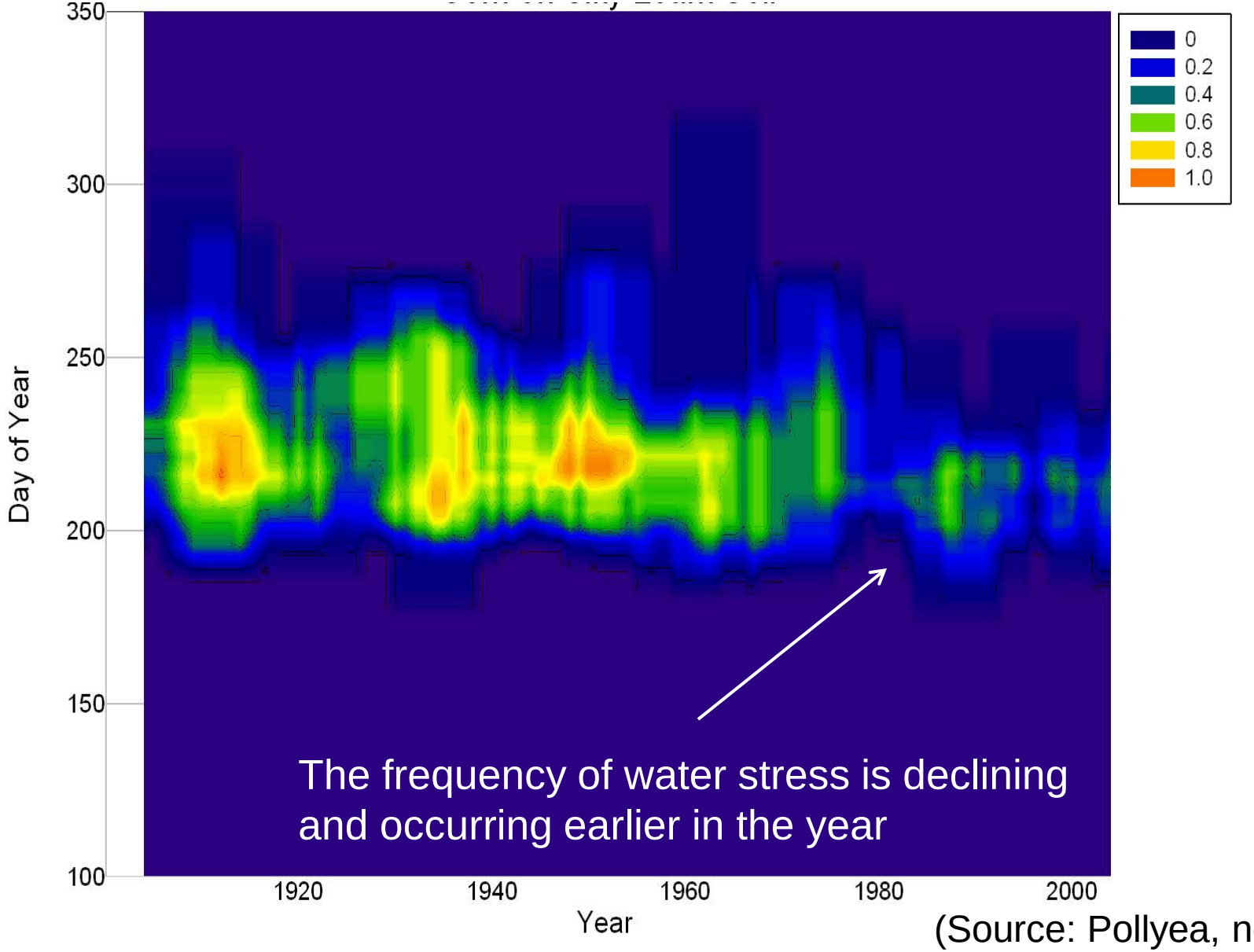


Trend in sum of the top-10 wettest days in a year (%/decade)
1901-2000

(Pryor et al., 2009)

Frequency of Days PAW_{150} < 0.50 Potential PAW_{150}

Ann Arbor, MI, Silt Loam, 1900-2009

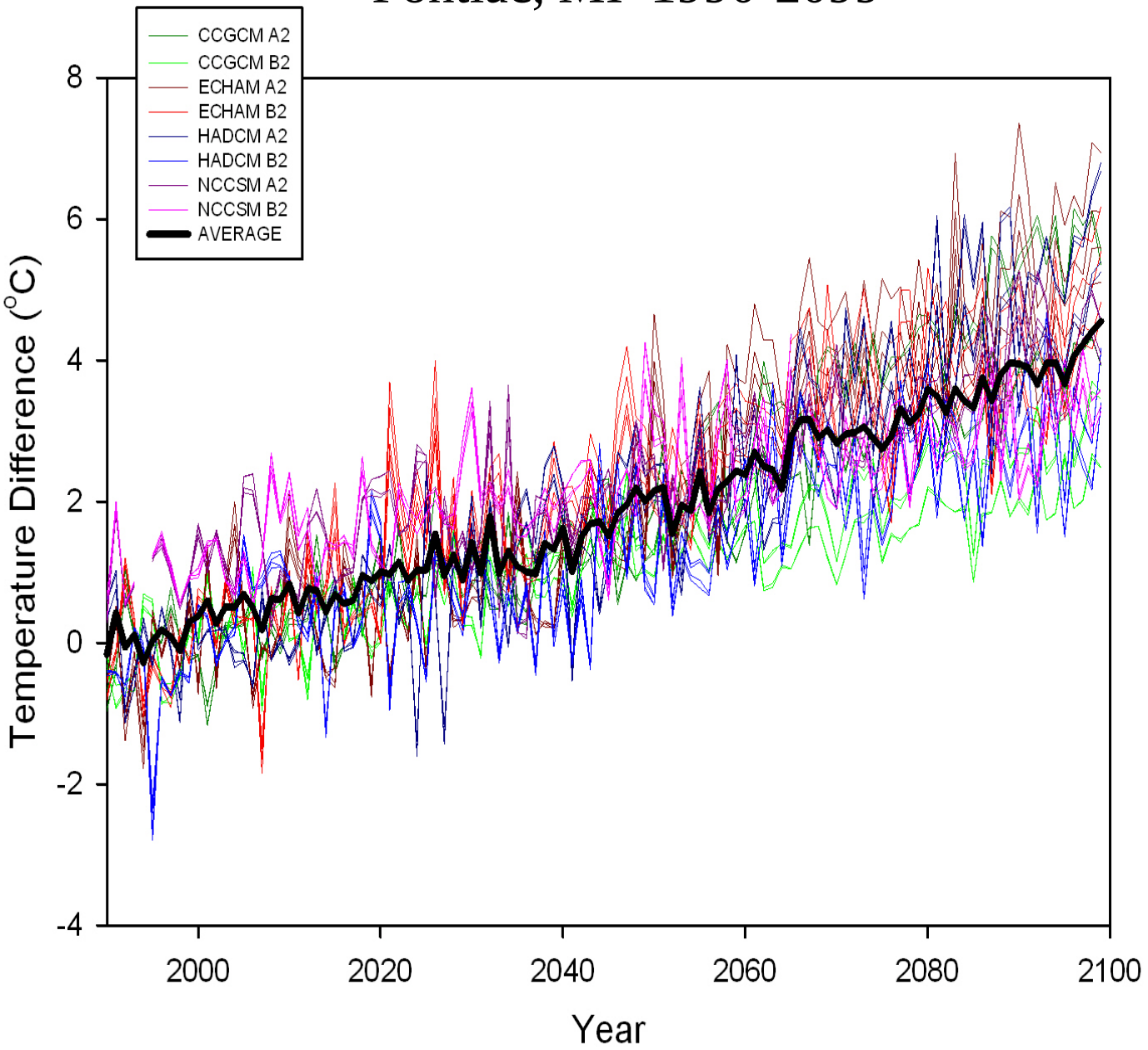


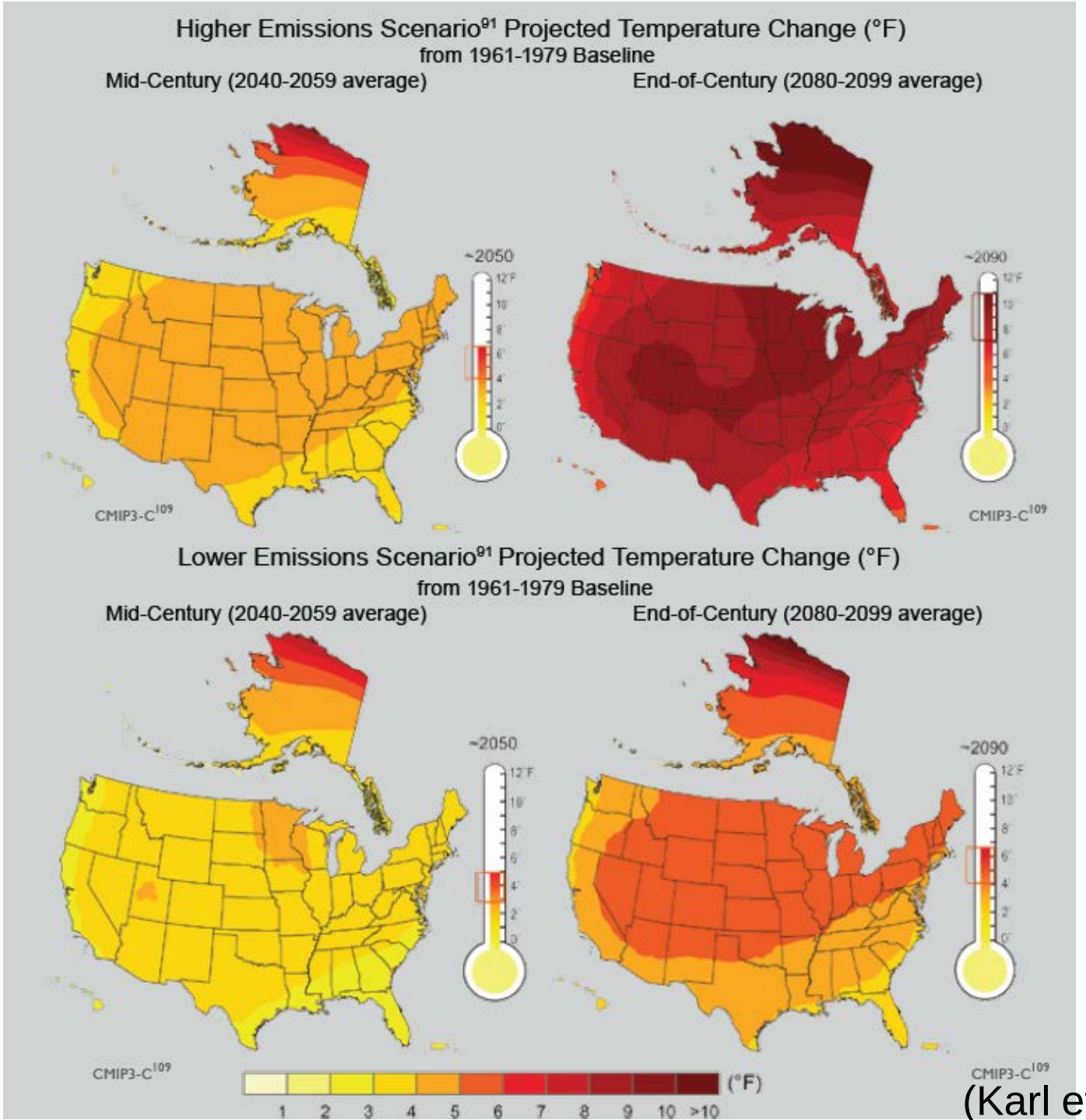
(Source: Pollyea, no date)

Future Projections

Model-Projected Mean Temperature Differences

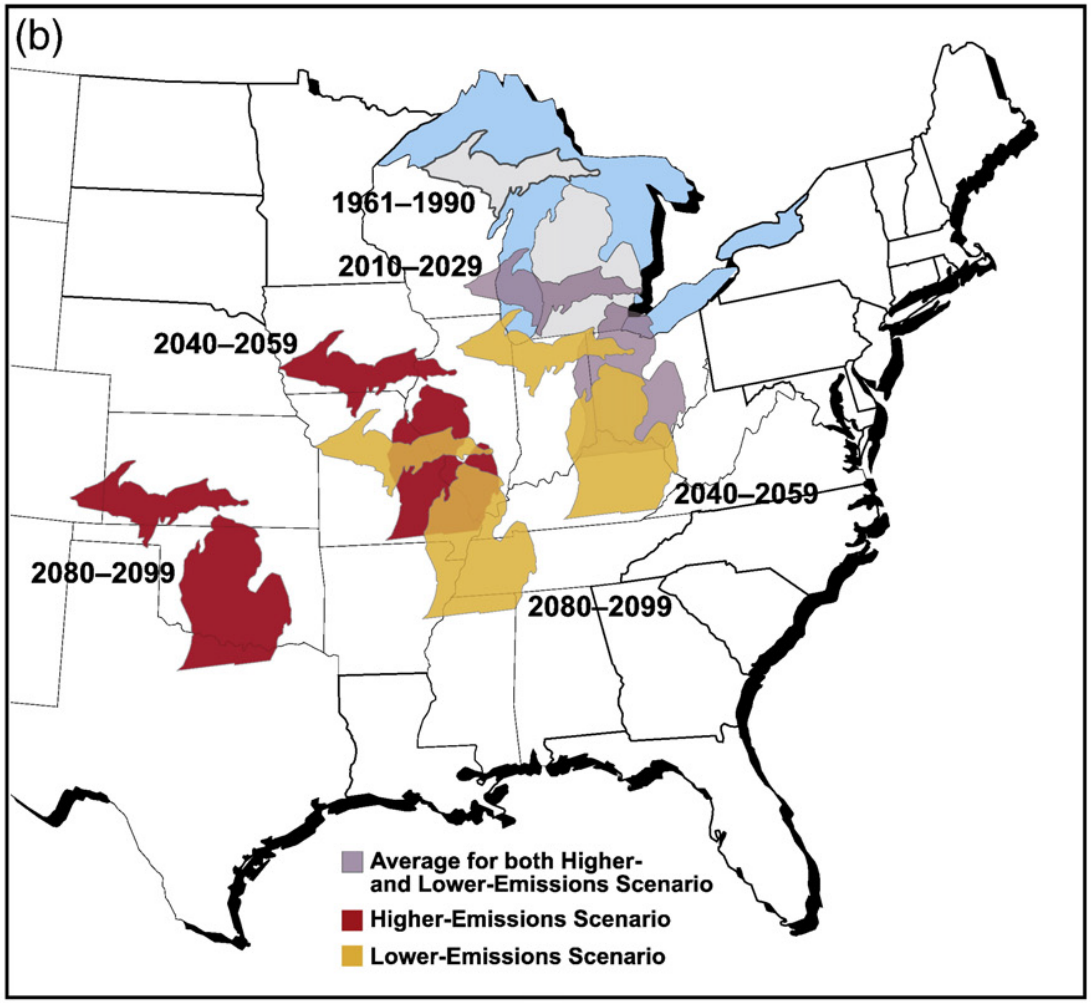
Pontiac, MI 1990-2099





(Karl et al., 2009)

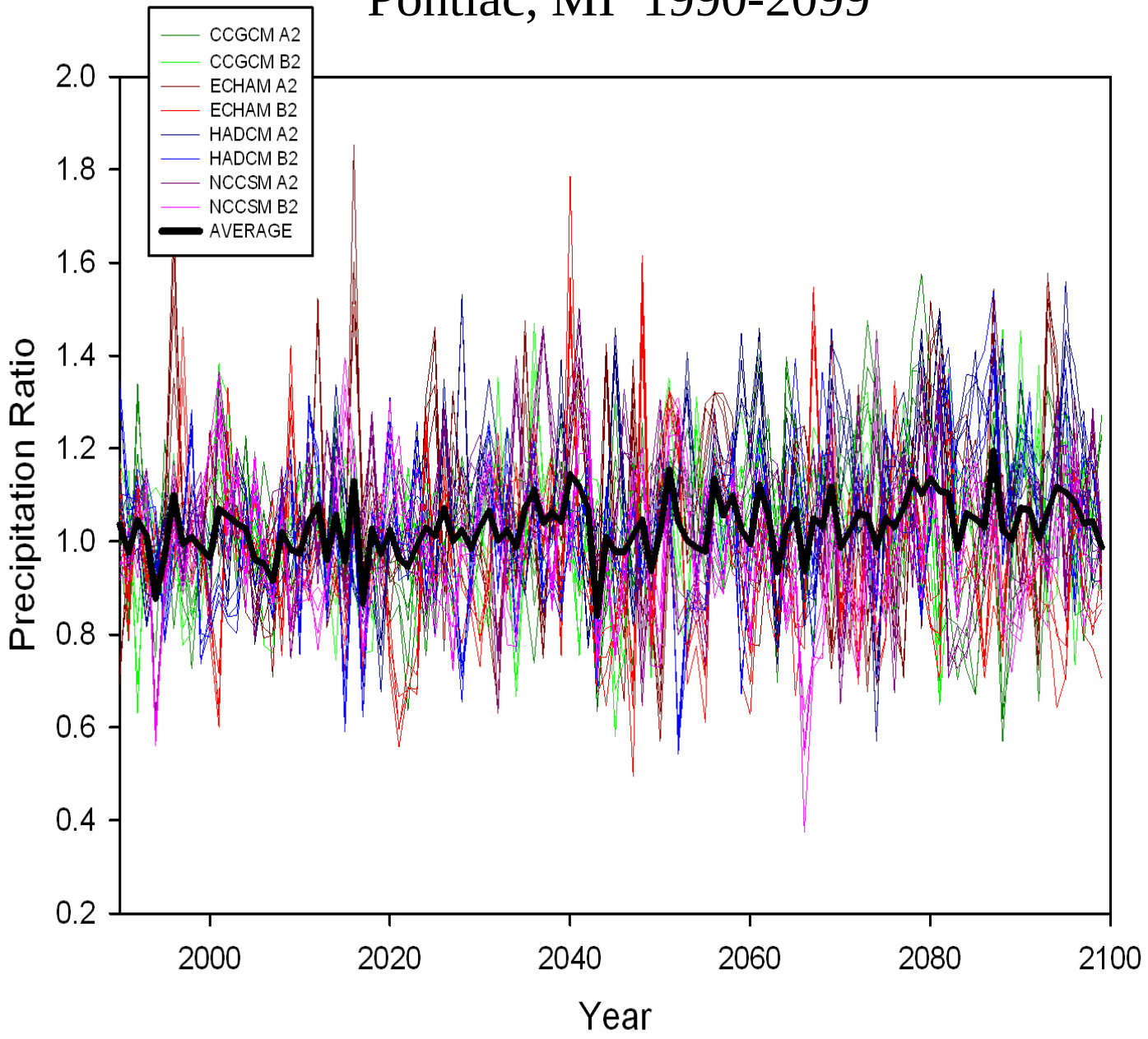
Projected Temperature Changes



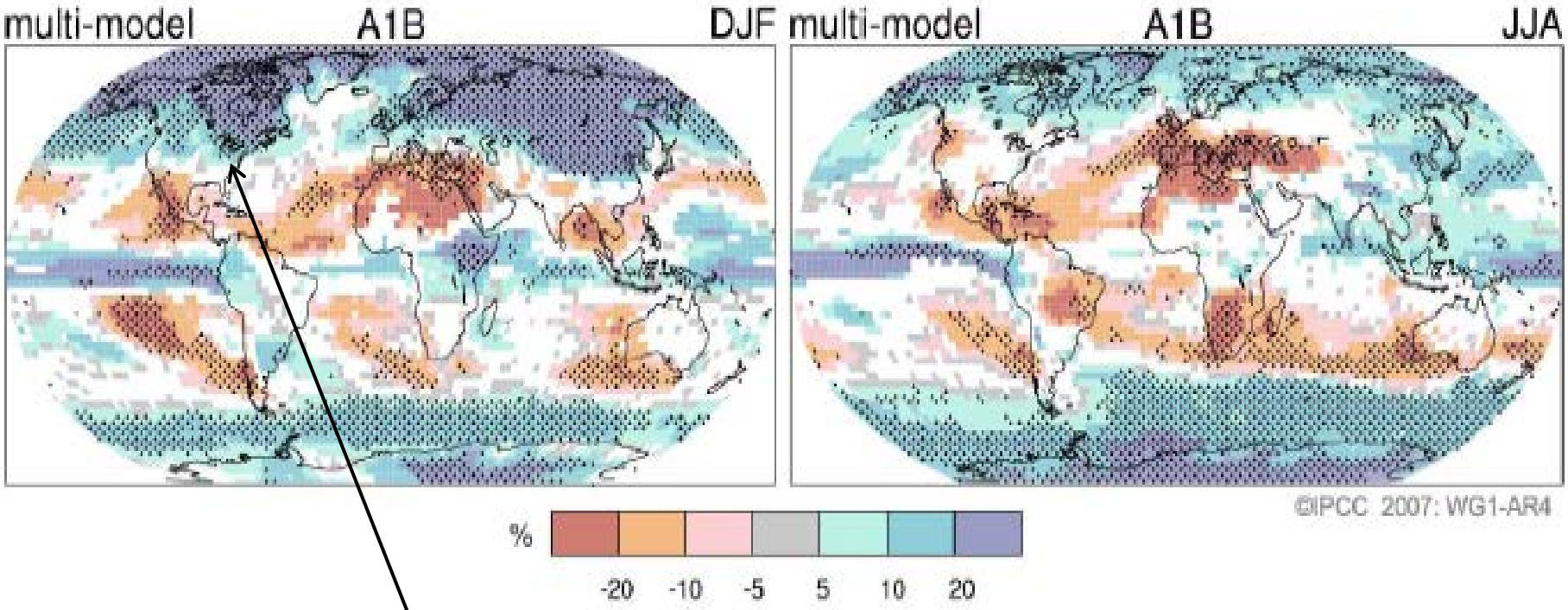
Hayhoe et al (2010)

Model-Projected Precipitation Ratios

Pontiac, MI 1990-2099

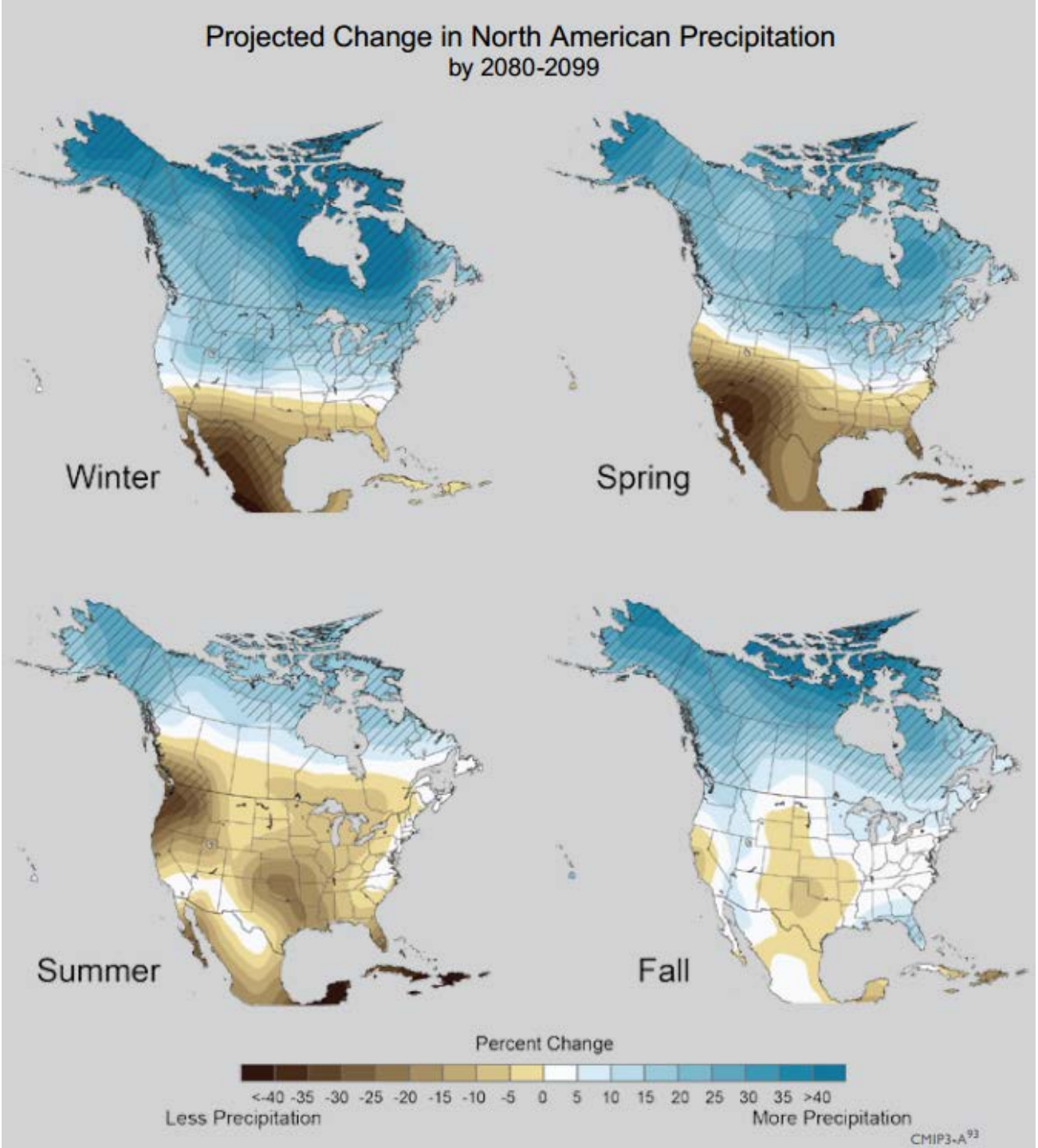


Projected Patterns of Precipitation Changes



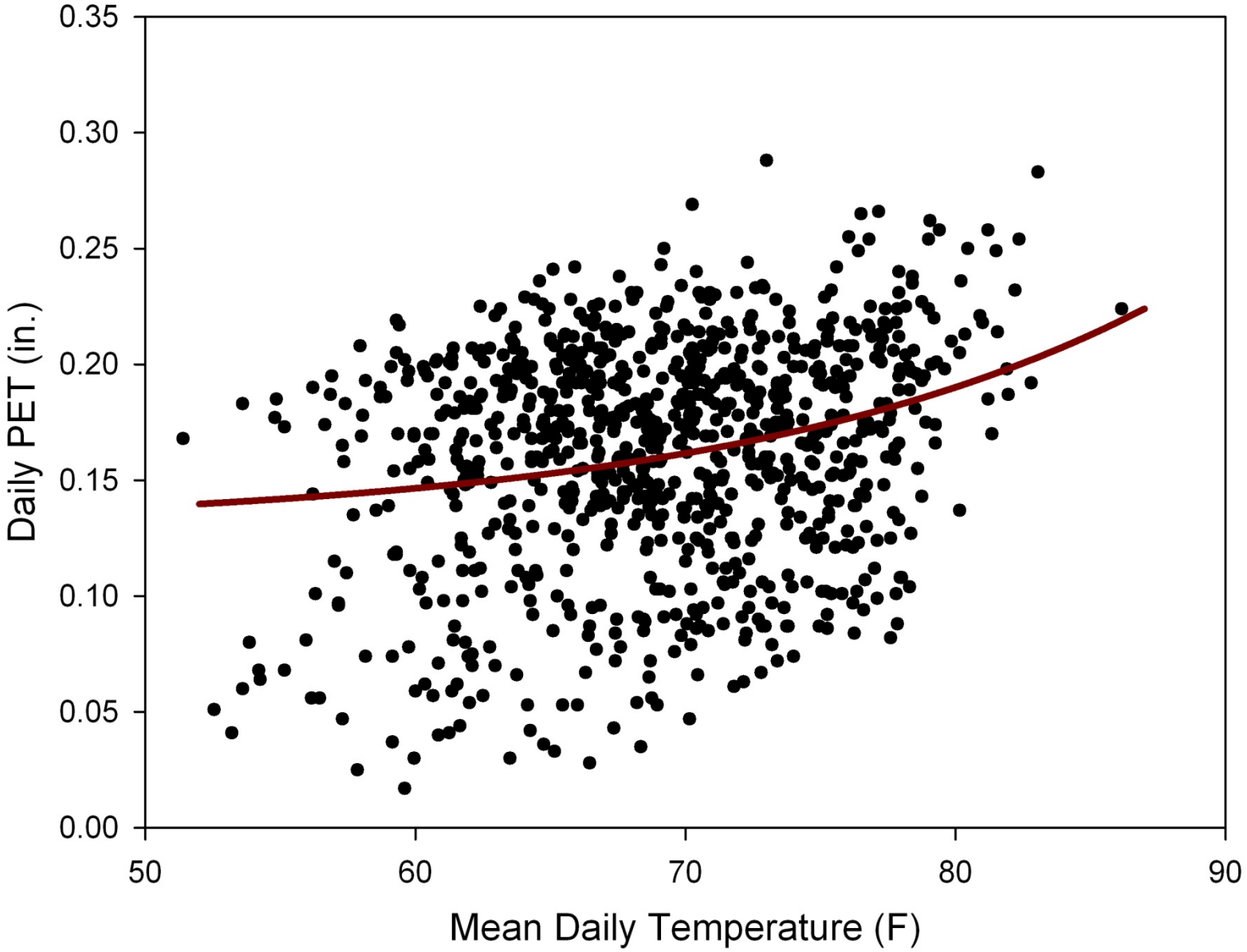
Region projected to become wetter, largely as a result of increasing cold season precipitation

Source: (IPCC, 2007)


Projected Change in North American Precipitation
by 2080-2099
Winter
Spring
Summer
Fall
Percent Change
<-40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 >40
Less Precipitation
More Precipitation
CMIP3-A93

Mean Air Temperature vs. PET

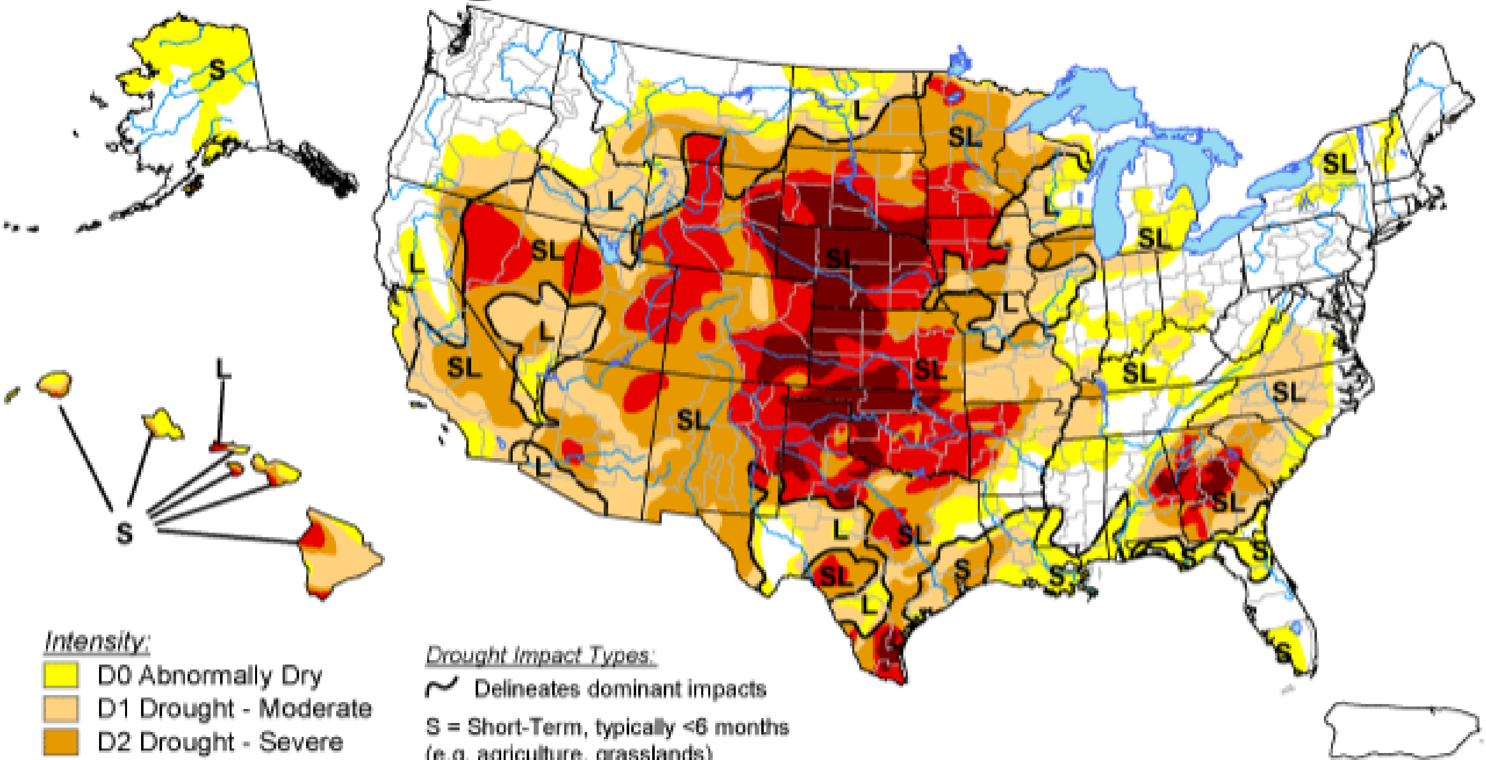
East Lansing, MI June-August, 2002-2011



Near Future Outlook

U.S. Drought Monitor

December 4, 2012
Valid 7 a.m. EST



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
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- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

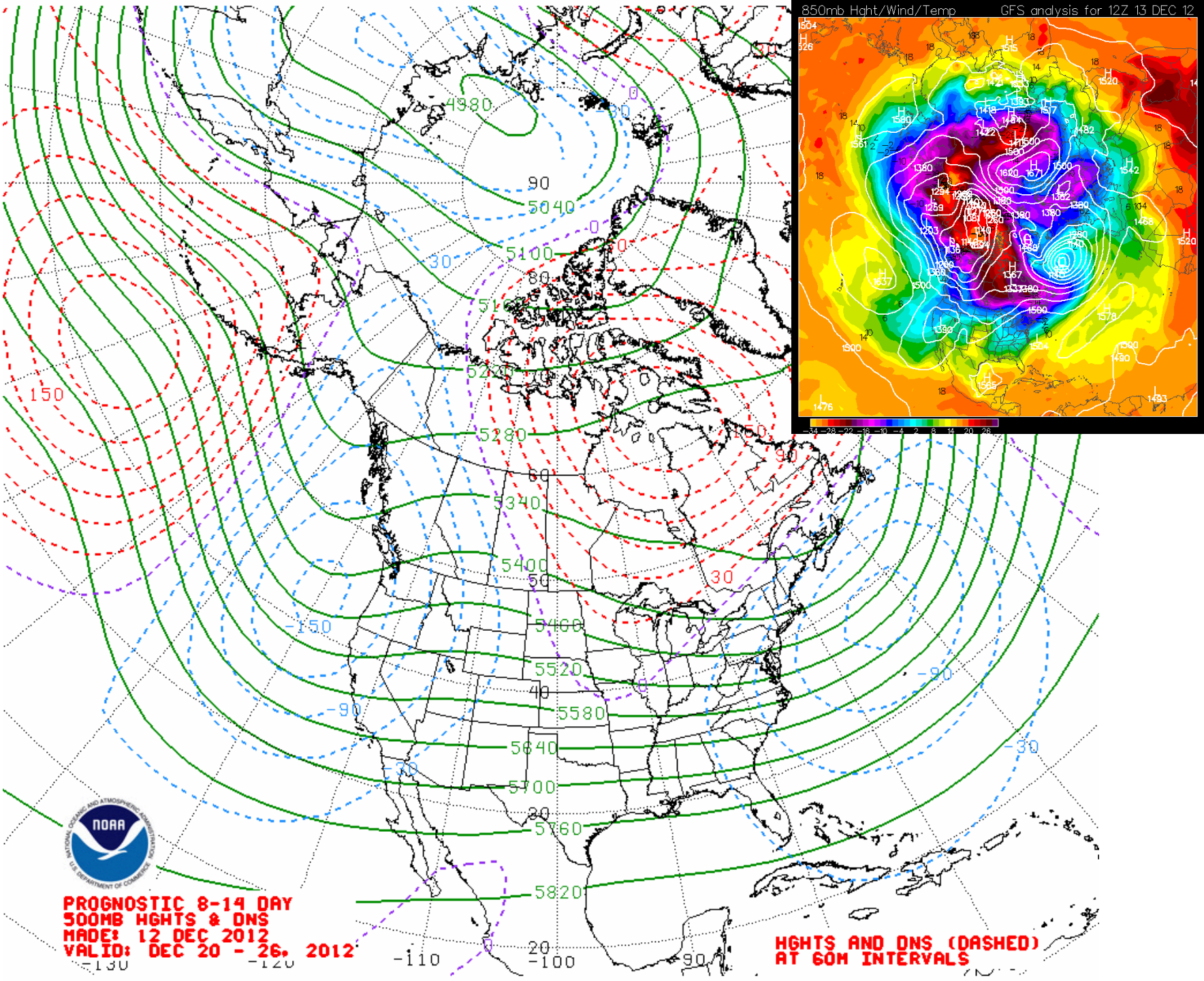
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

USDA National Drought Mitigation Center

Released Thursday, December 6, 2012

Author: Rich Tinker, NOAA/NWS/NCEP/CPC


850mb Hght/Wind/Temp
GFS analysis for 12Z 13 DEC 12
PROGNOSTIC 8-14 DAY
500MB HGHTS & DNS
MADE: 12 DEC 2012
VALID: DEC 20 - 26, 2012
HGHTS AND DNS (DASHED)
AT 60M INTERVALS
NOAA

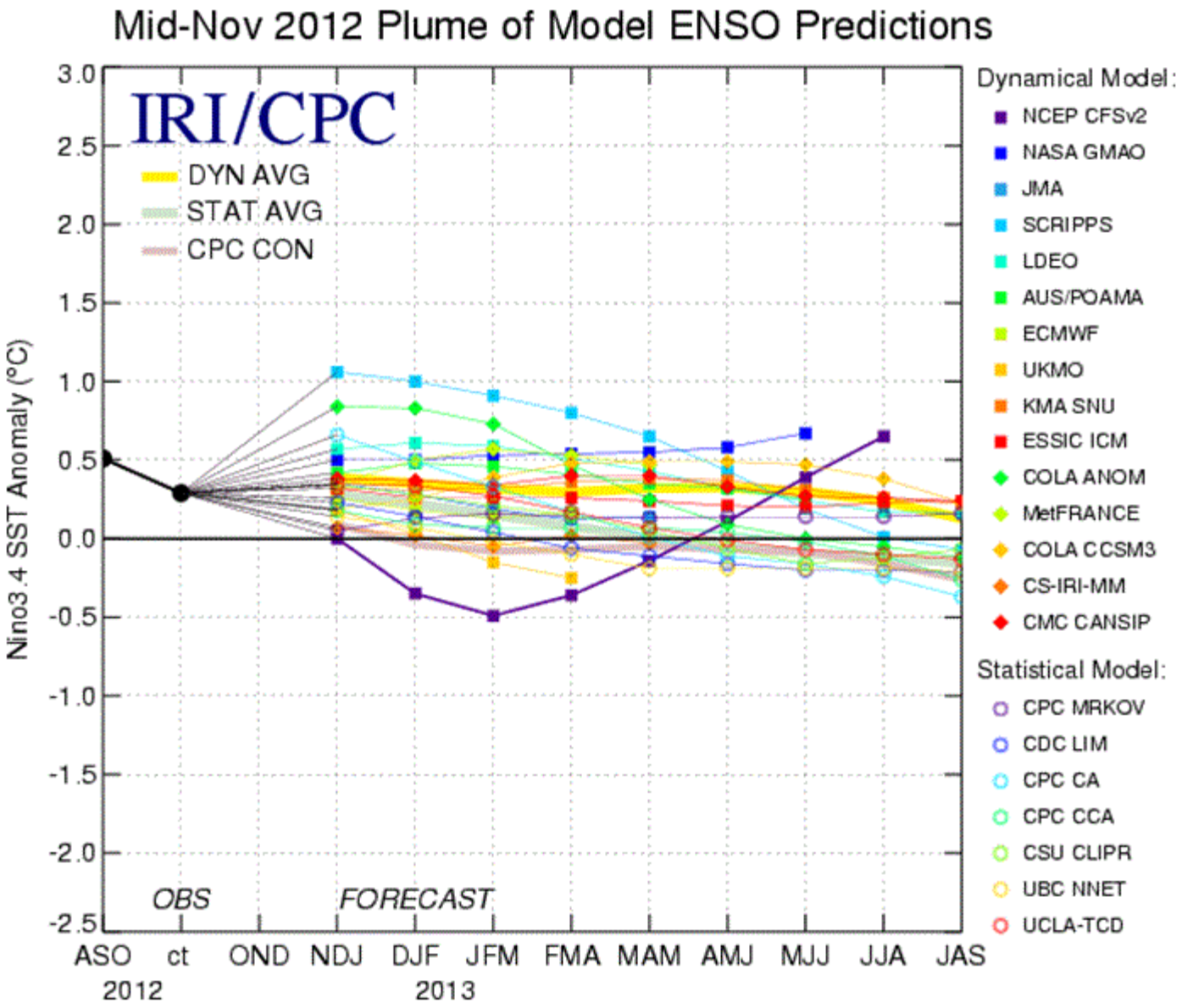
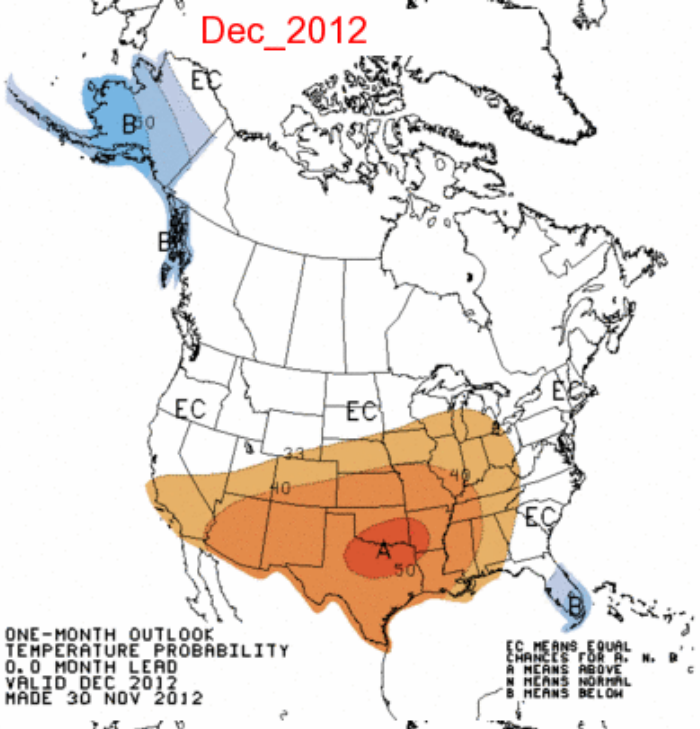
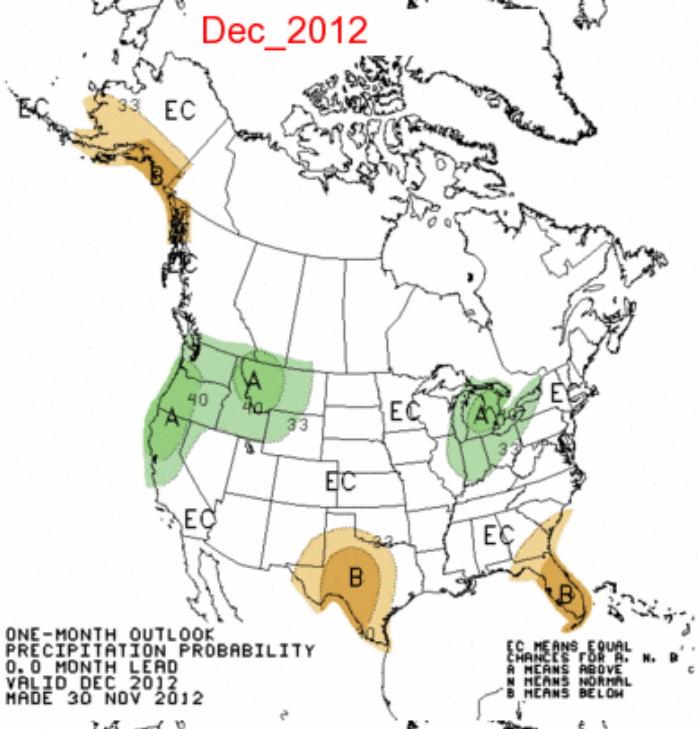


Figure 6. Forecasts of sea surface temperature (SST) anomalies for the Niño 3.4 region (5°N-5°S, 120°W-170°W). Figure courtesy of the International Research Institute (IRI) for Climate and Society. Figure updated 13 November 2012.


Dec_2012
EC
B
A
33
40
50
ONE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
0.0 MONTH LEAD
VALID DEC 2012
MADE 30 NOV 2012
EC MEANS EQUAL CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW


Dec_2012
EC
A
B
33
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ONE-MONTH OUTLOOK
PRECIPITATION PROBABILITY
0.0 MONTH LEAD
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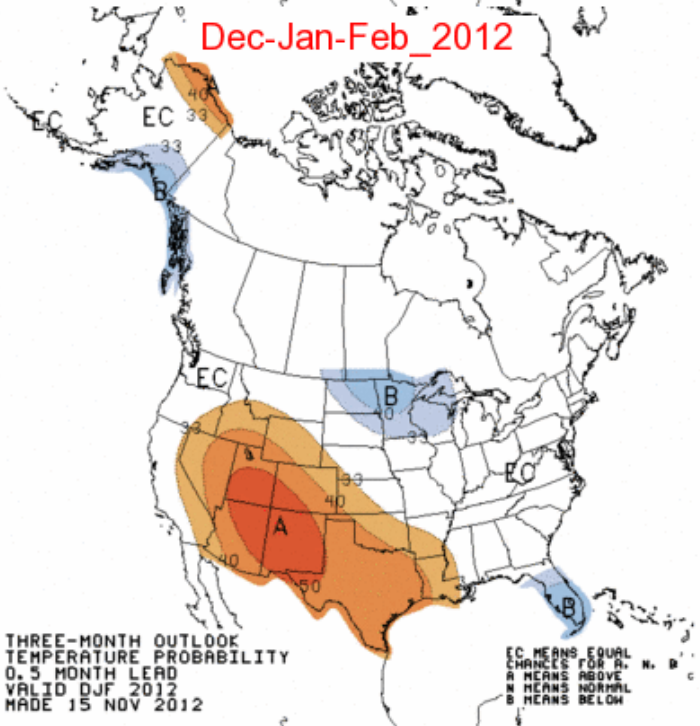
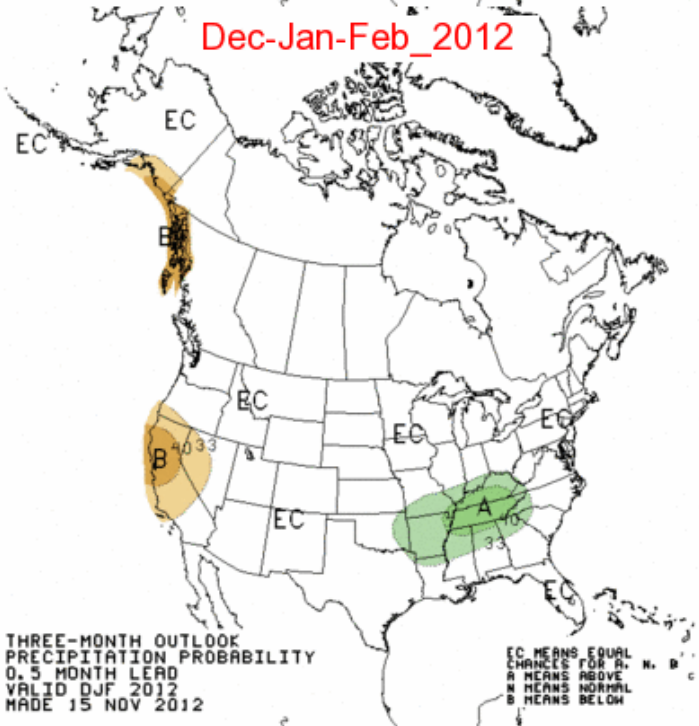

Dec-Jan-Feb_2012
EC
B
A
33
40
50
THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
0.5 MONTH LEAD
VALID DJF 2012
MADE 15 NOV 2012
EC MEANS EQUAL CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW


Dec-Jan-Feb_2012
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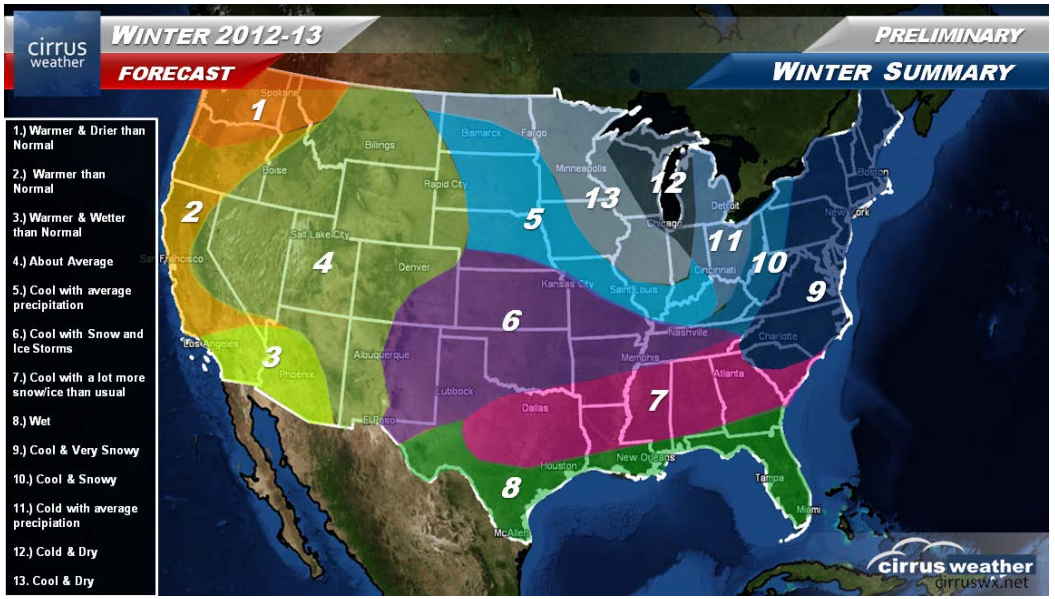
Other Winter Weather Outlooks

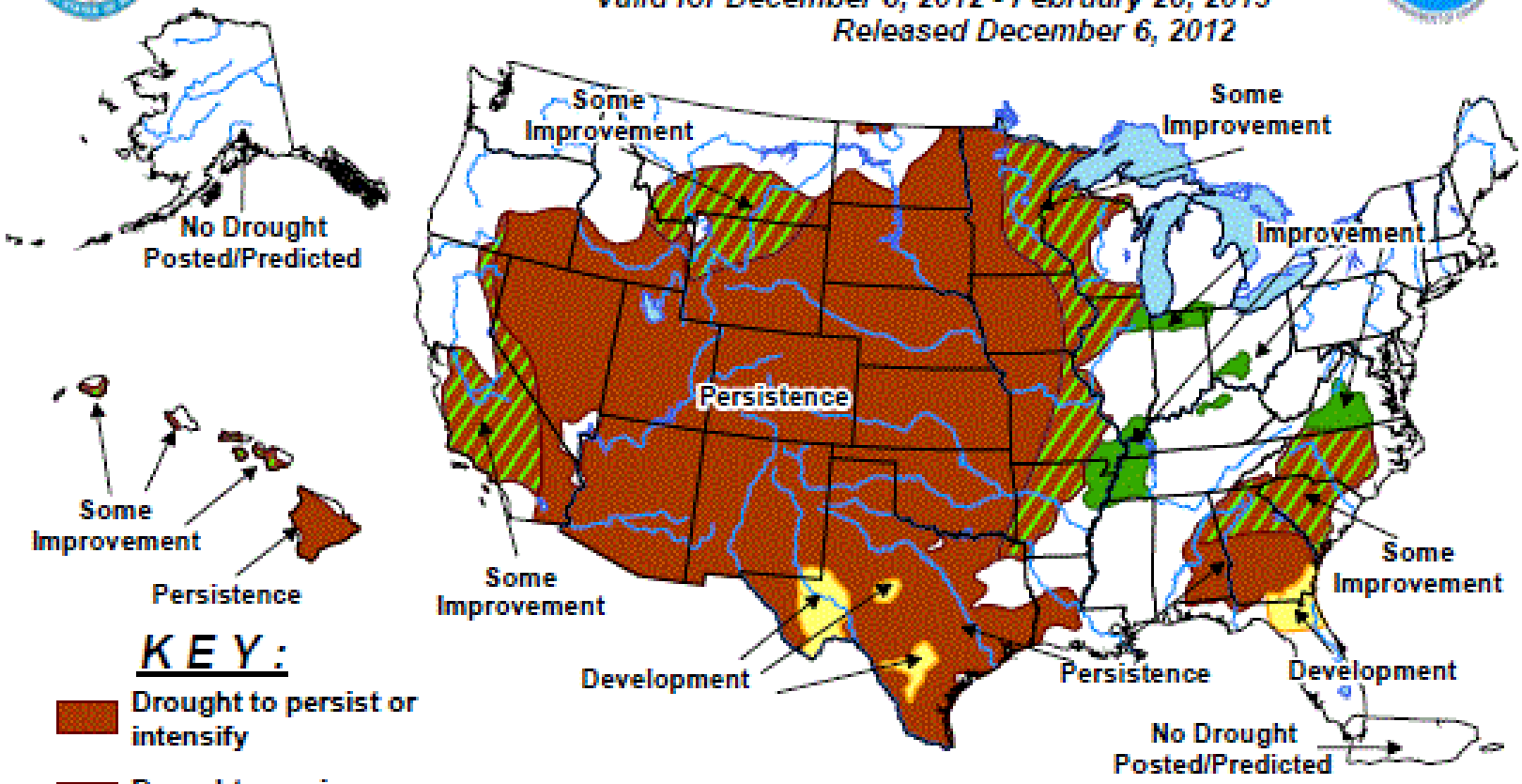


U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for December 6, 2012 - February 28, 2013

Released December 6, 2012

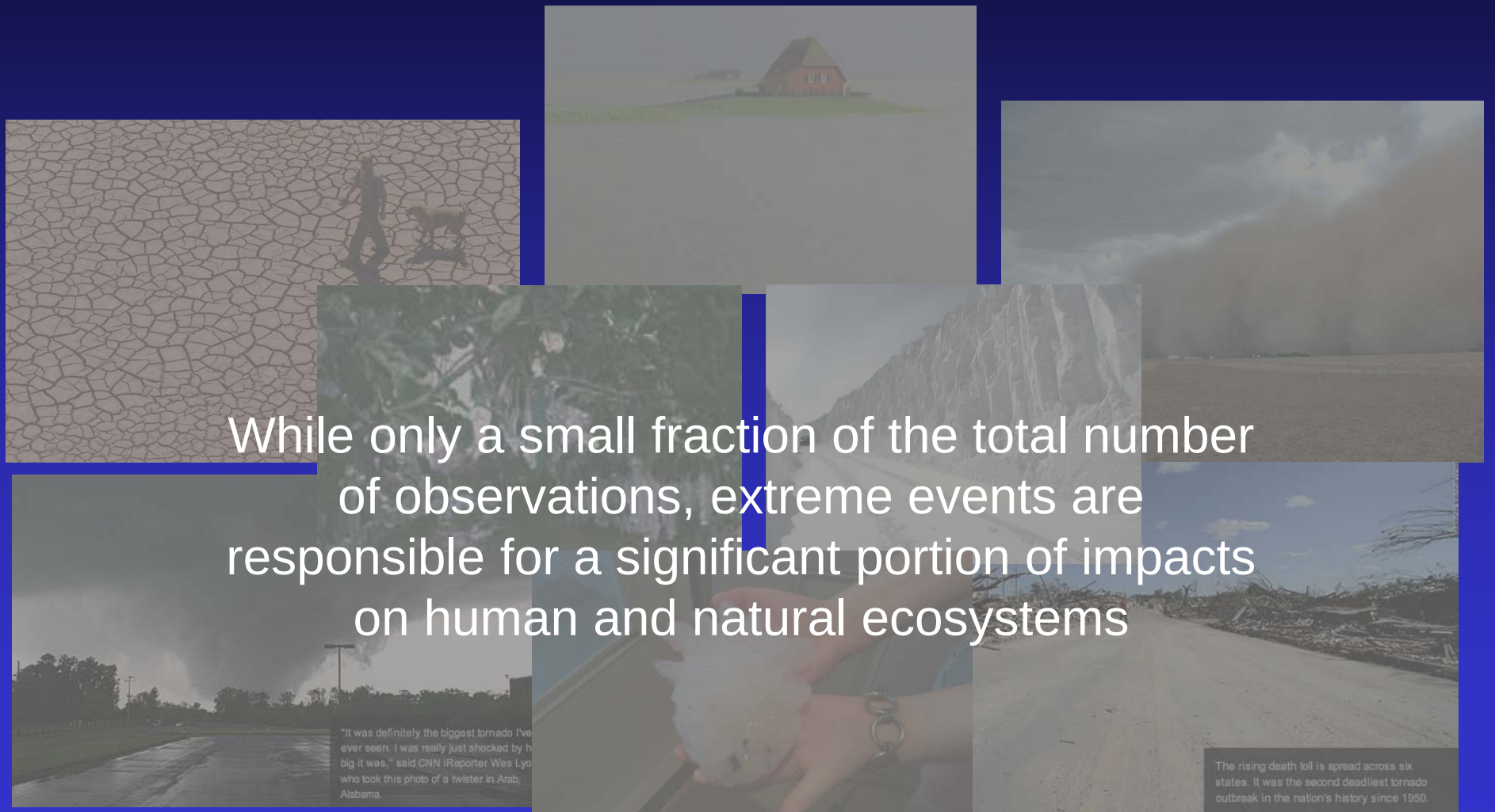


KEY:

- Drought to persist or intensify
- Drought ongoing, some improvement
- Drought likely to improve, impacts ease
- Drought development likely

Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

Impacts of Climatic Variability



While only a small fraction of the total number of observations, extreme events are responsible for a significant portion of impacts on human and natural ecosystems

Weather Anomaly or Climate Change?

- It is very difficult to distinguish anthropogenic signal from natural variability
- Ultimately, the physical processes and mechanisms responsible for weather and climate are the same
- Changes in the frequency of some extremes are consistent with long term trends
- Recent extremes are also generally consistent with future climate projections
- The recent weather extremes and climate change are likely not mutually exclusive: "…Although global warming is likely playing a role in this event, it probably did not play a major one. Meteorology, not climate change, is the main ingredient in the March 2012 U.S. extreme warmth". Of climate change, he said, ". . . its contribution to the magnitude of current conditions (+30°F departures [from average]) is quite small (but not zero) indeed." *Marty Hoerling (NOAA ESRL)*

Summary

- Extreme weather conditions during 2012 were consistent with some historical trends (e.g. warmer spring temperatures) while differing from others (summer drought).
- Overall, Michigan has become warmer and wetter during the past few decades, with warming of about 2.0ºF has occurred between 1980 and the present.
- Much of the recent warming has occurred during the cold season, leading to less ice cover on the Great Lakes and an earlier spring warm-up.
- Annual precipitation rates increased from the 1930's through the present, due to both more wet days and more heavy precipitation events.
- Most recent GCM simulations of the Great Lakes region suggest a warmer and wetter climate in the distant future, with much of the additional precipitation coming during the cold season months.
- With warming temperatures, PET and crop water needs will likely increase with time.


Questions?