State of the Climate for the Central Great Plains

Johannes Feddema
Department of Geography
University of Kansas

Adapting to a Changing Climate on the Central Great Plains Conference
Kansas State University, September 6, 2011

The Christian Science Monitor

Why has 2012 been the hottest year on record in the US?

More than 40,000 daily heat records have been broken around the country so far this year, according to the National Oceanic and Atmospheric Administration, compared with last year's 25,000 daily records set by this date.

By Douglas Main, *OurAmazingPlanet Staff Writer* / July 3, 2012

Beachgoers crowd the surf near the Balboa Pier in Newport Beach, Calif., on July 2.

Ana Venegas/The Orange County Register/AP

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Heat is beating records around the country: the first five months of 2012 have been the hottest on record in the contiguous United States. And that's not including June, when 164 all-time high temperature records were tied or broken around the country, according to government records.

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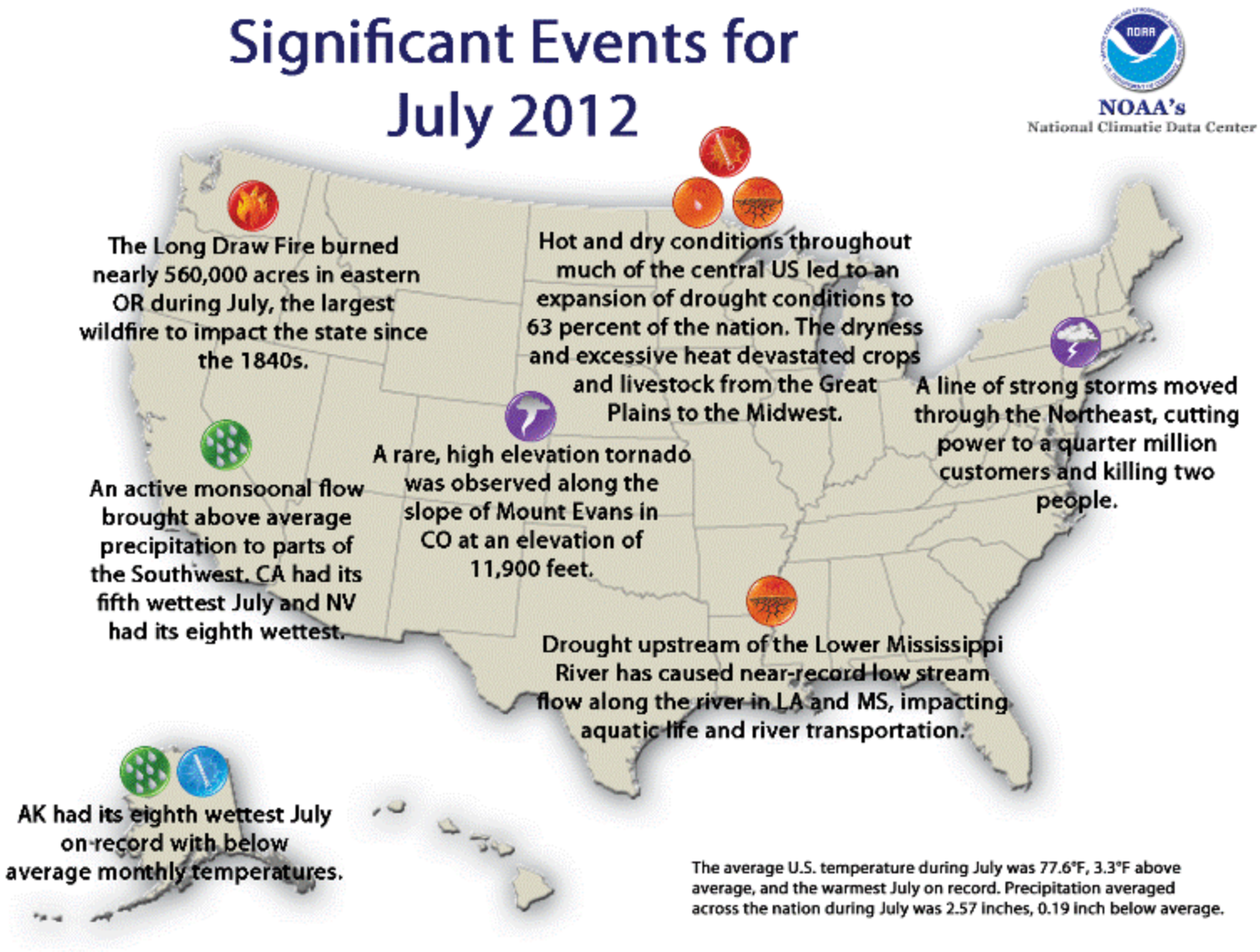
That's unusual, since the most intense heat usually comes in July and August for much of the country, said Jake Crouch, a climate scientist with National Climatic Data Center. For example, only 47 all-time high records were tied or broken in June of last year.

Also, more than 40,000 daily heat records have been broken around the country so far this year, according to the National Oceanic and Atmospheric Administration. Compare that with last year —the ninth warmest on record — when only 25,000 daily records had been set

State of Climate? Or weather?

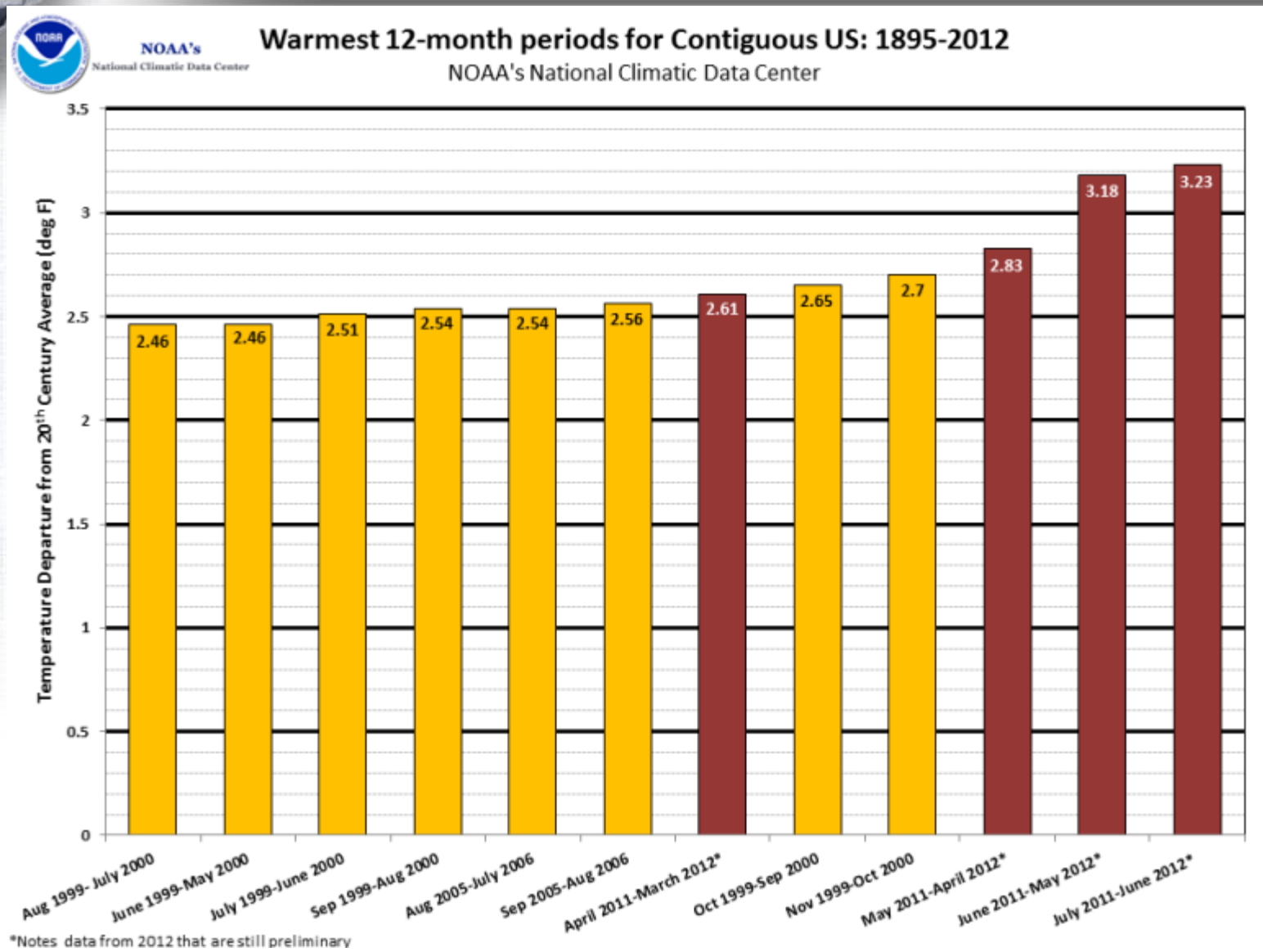


Things to think about

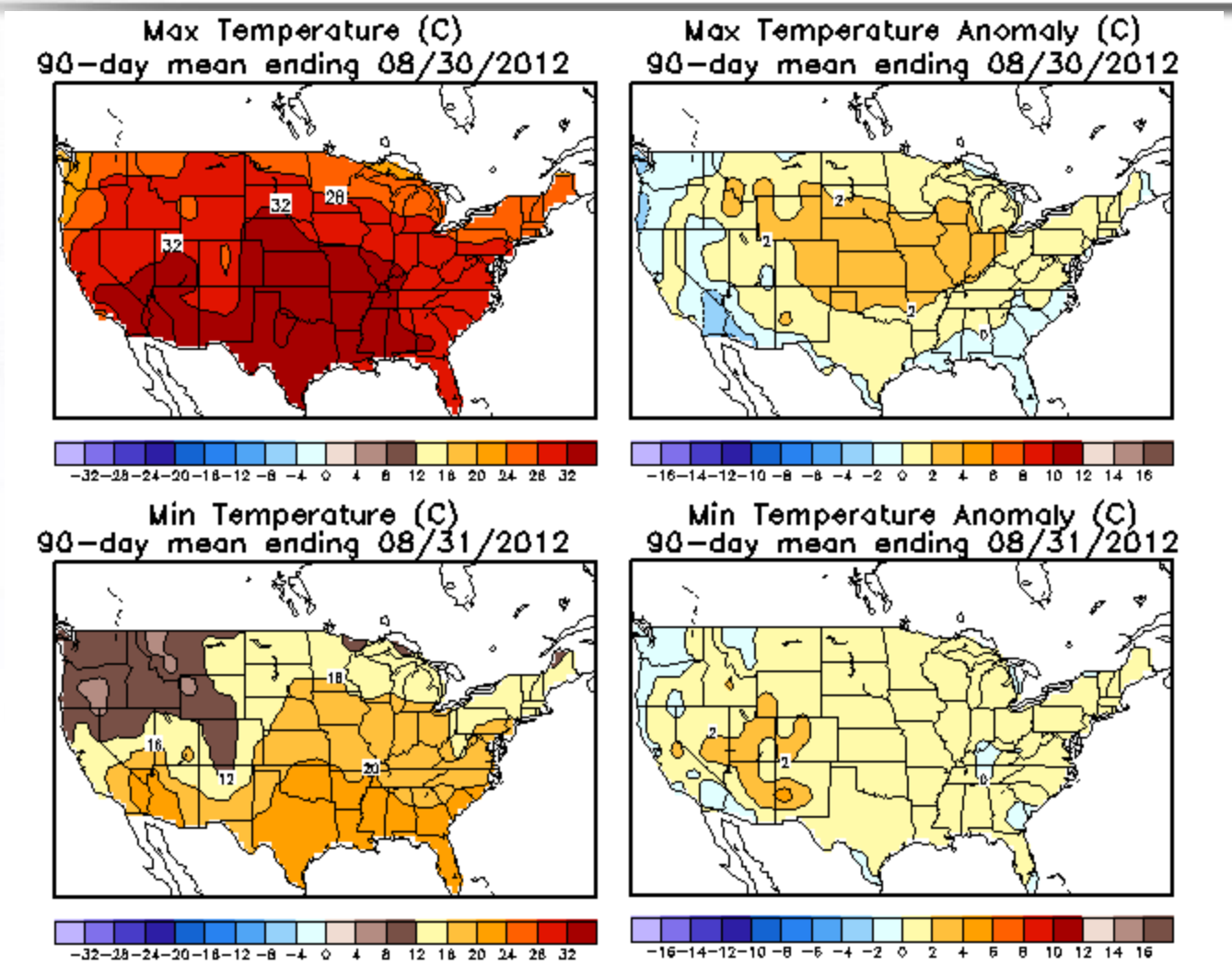
July marked the 36th consecutive July and 329th consecutive month with a global temperature above the 20th century average. The last below-average temperature July was July 1976 and the last below-average temperature month was February 1985.

The average temperature for the contiguous U.S. during July was 77.6°F, 3.3°F above the 20th century average, marking the warmest July and all-time warmest month on record for the nation in a period of record that dates back to 1895. The previous warmest July for the nation was July 1936, when the average U.S. temperature was 77.4°F.

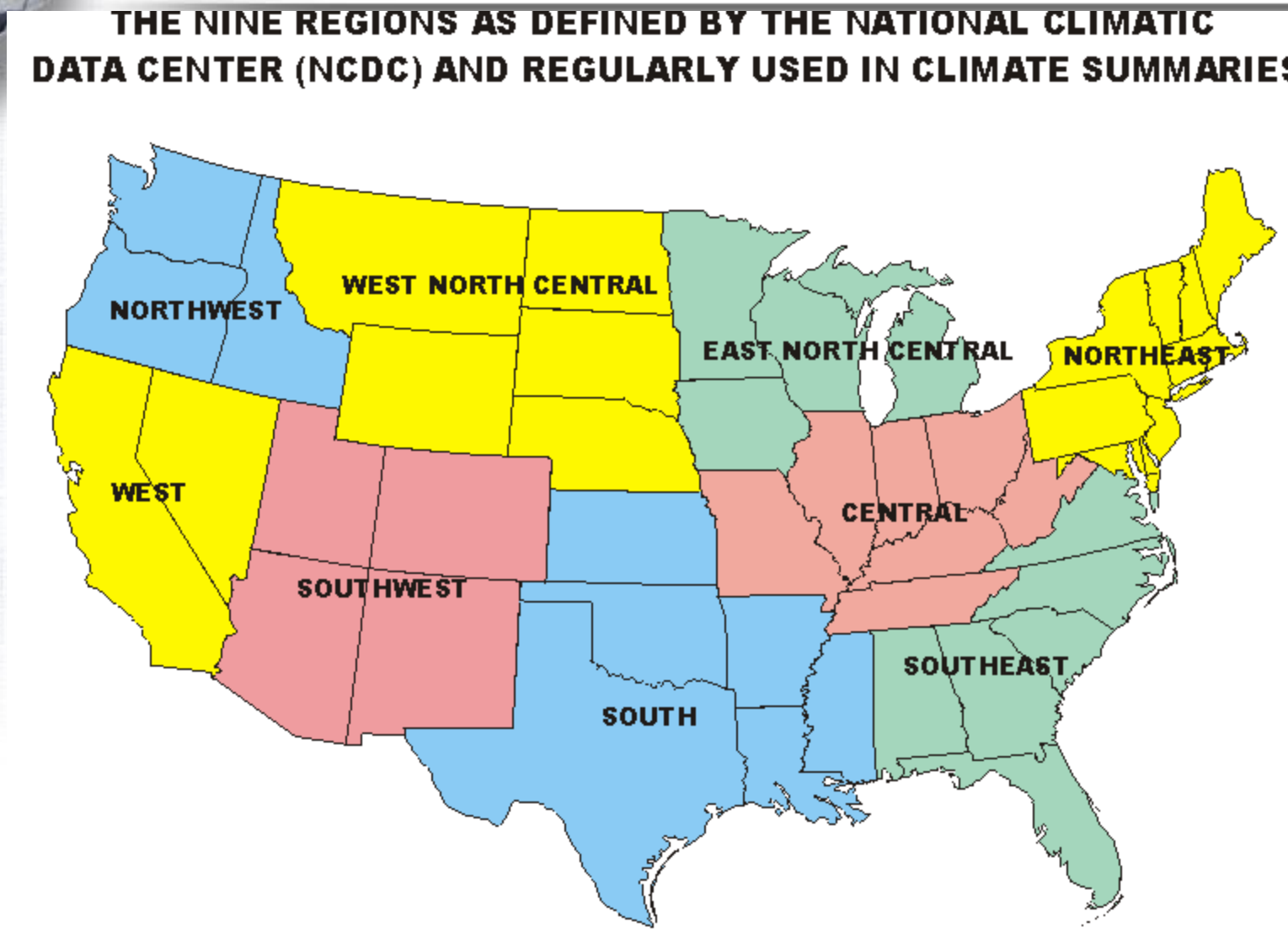
Setting more US temperature records



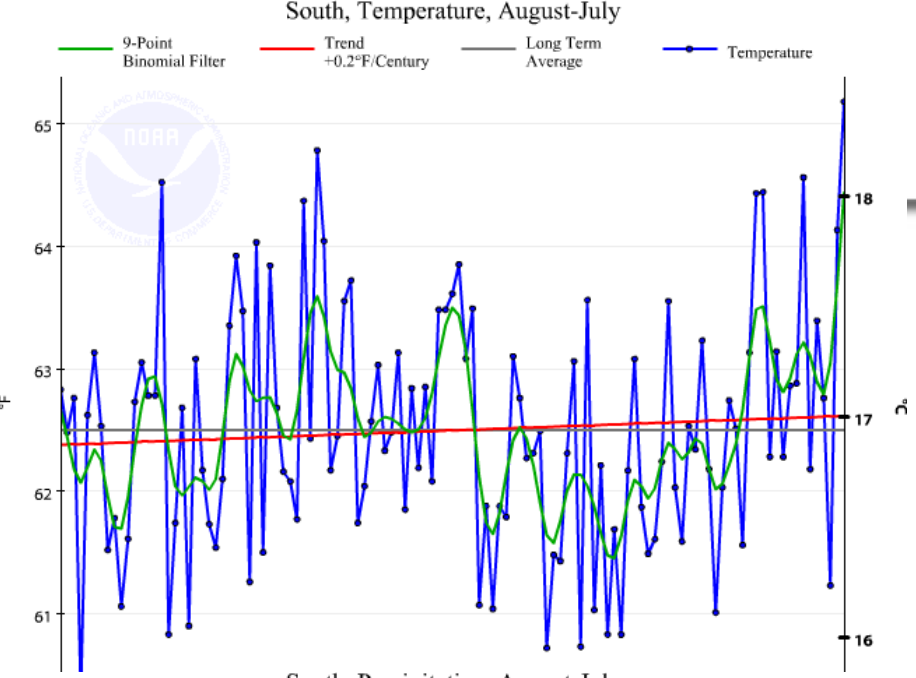
What happened this summer?

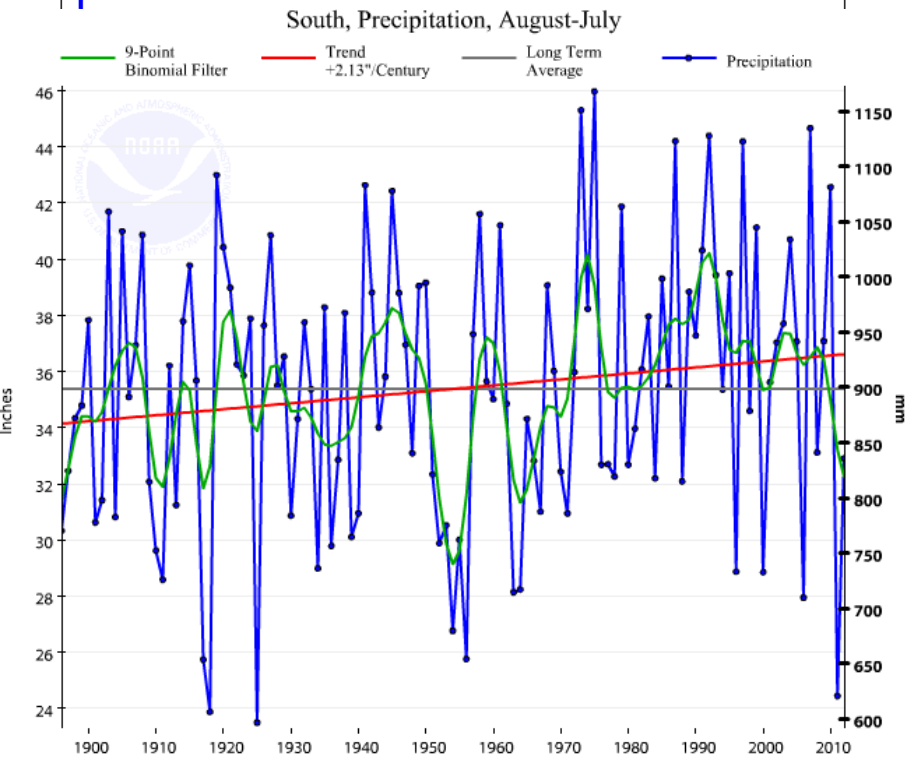


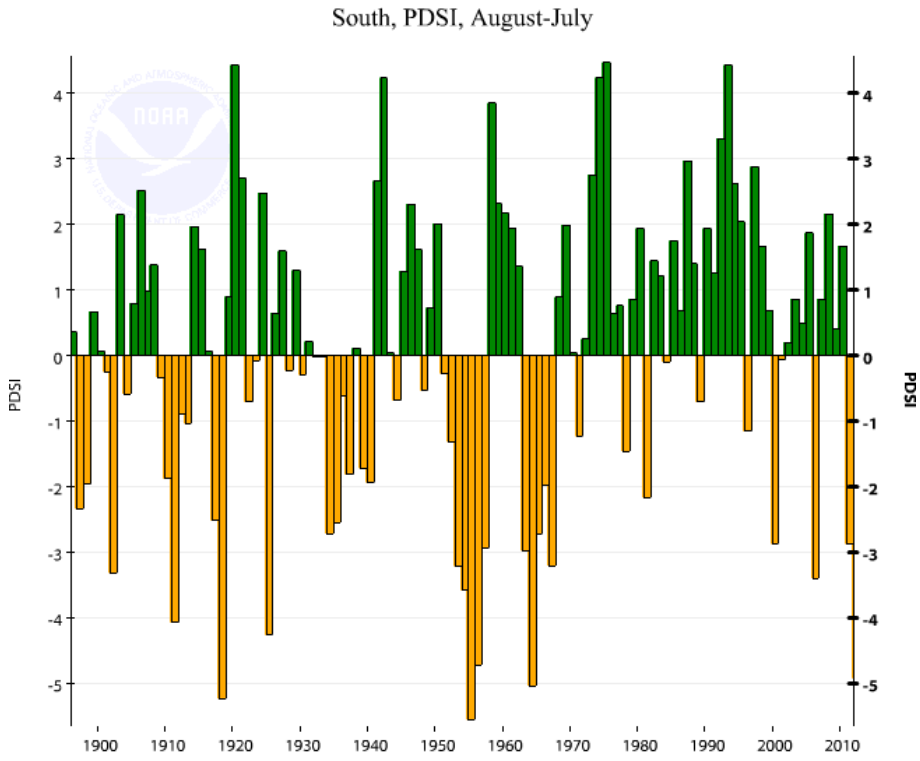
US climate Regions



South Region Climate Trends – August 1895-July 2012

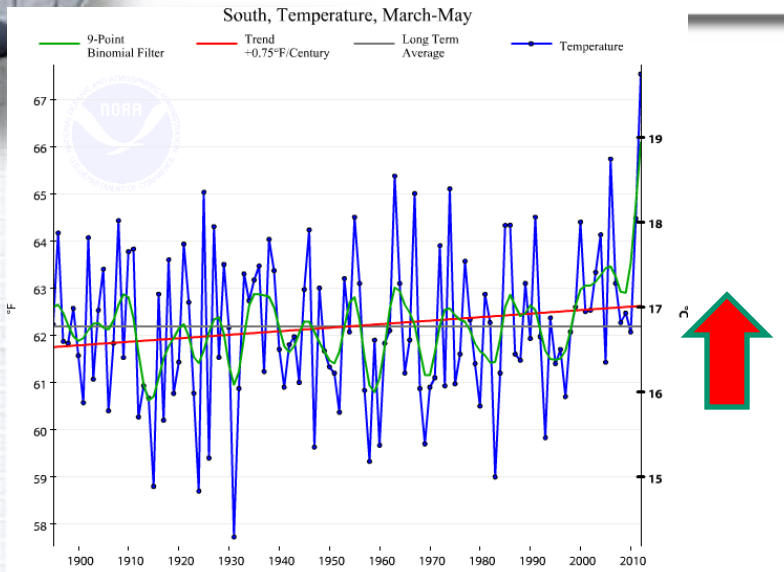


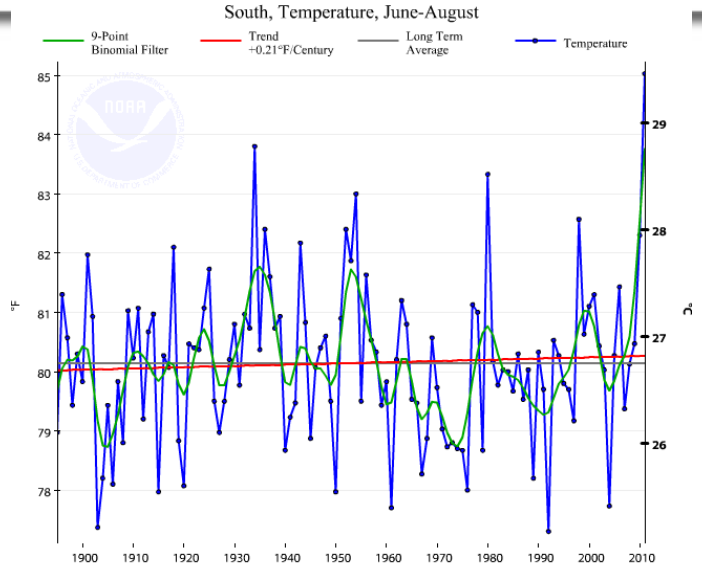


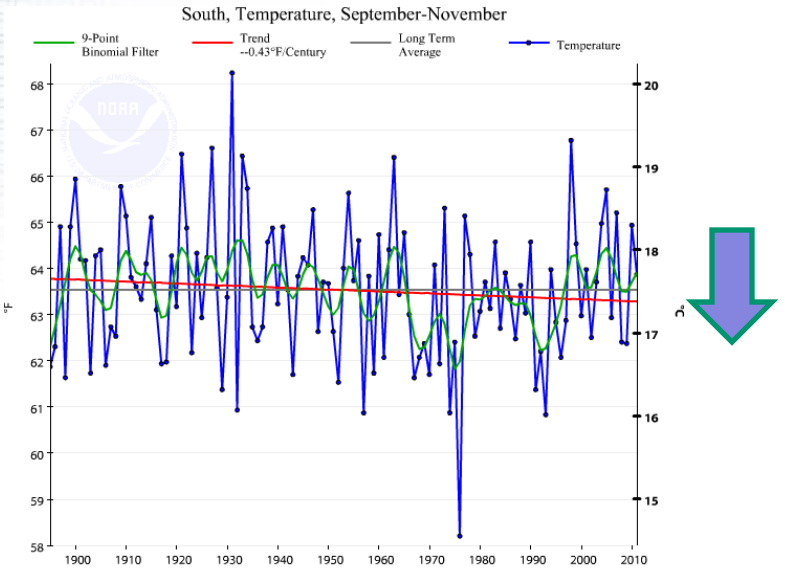


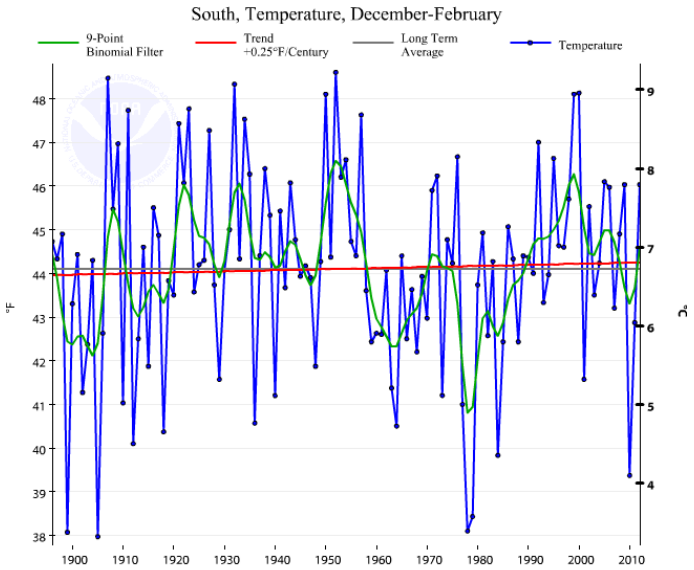
Source: NOAA/NCDC http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=tmp&month=5&year=2012&filter=3&state=106&div=0

South Region: Temperature Seasonal Trends



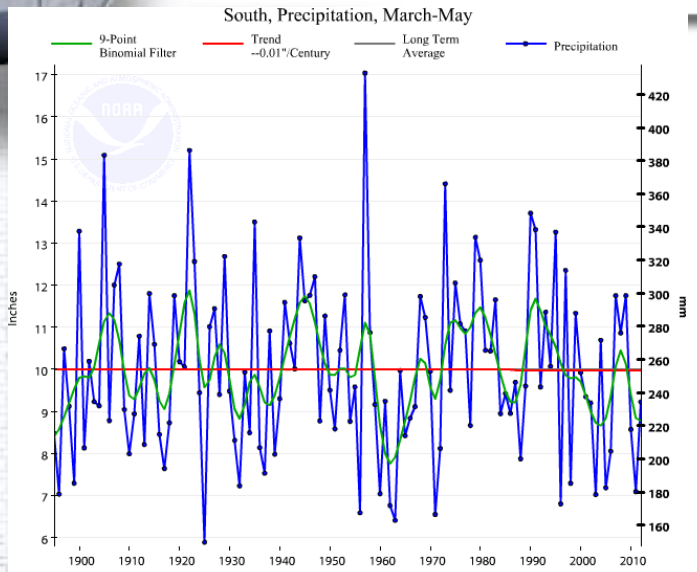


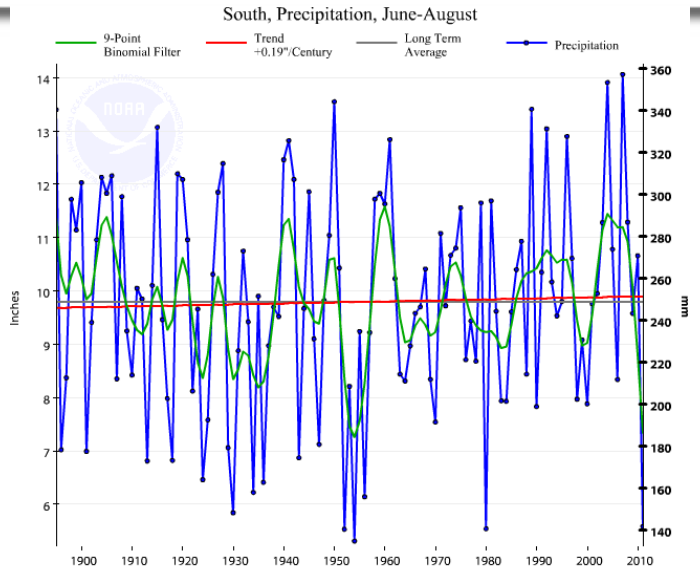


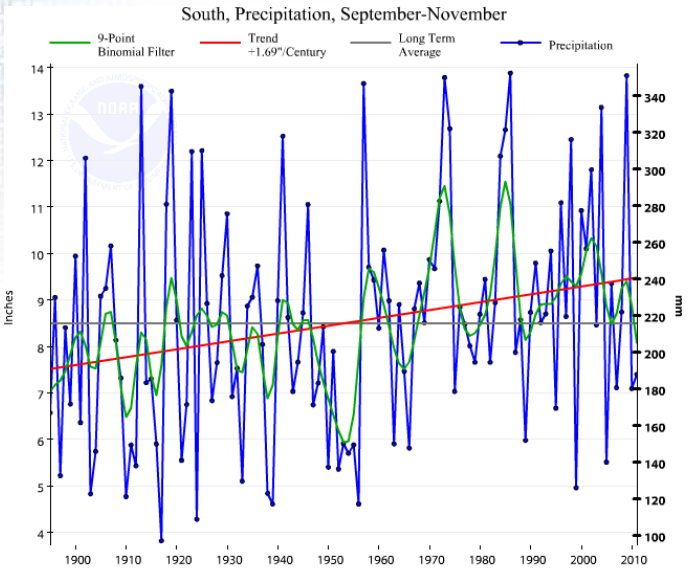


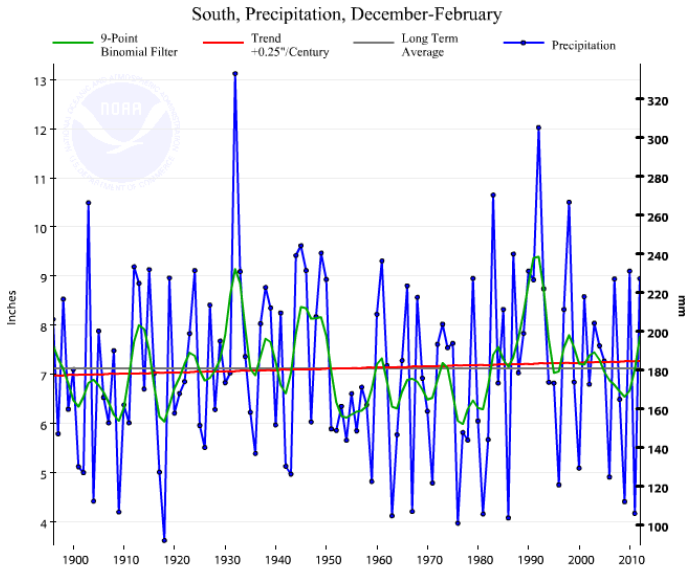
Source: NOAA/NCDC http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=tmp&month=5&year=2012&filter=3&state=1

South Region: Precipitation Seasonal Trends









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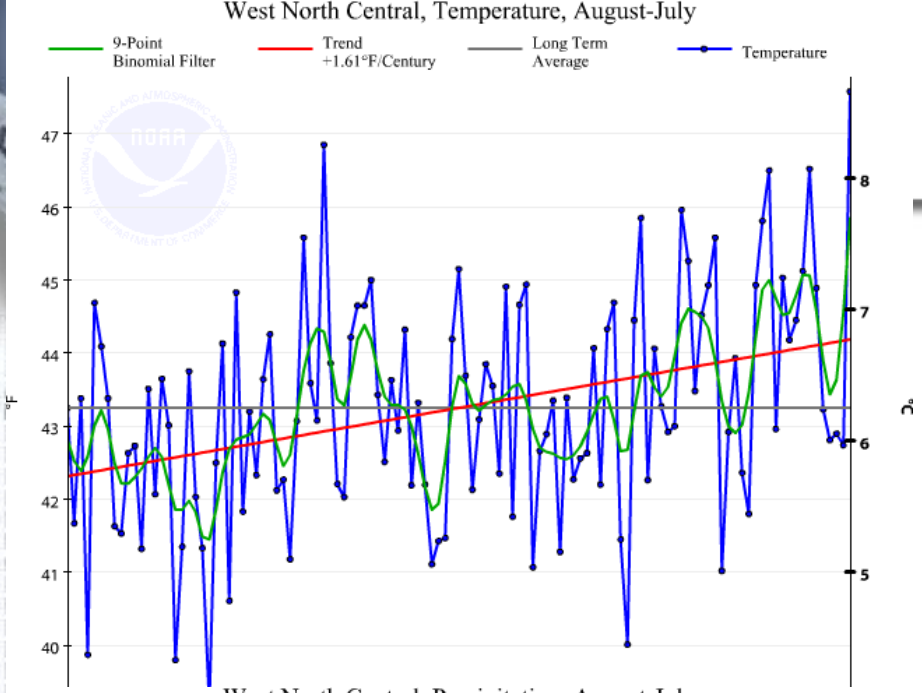
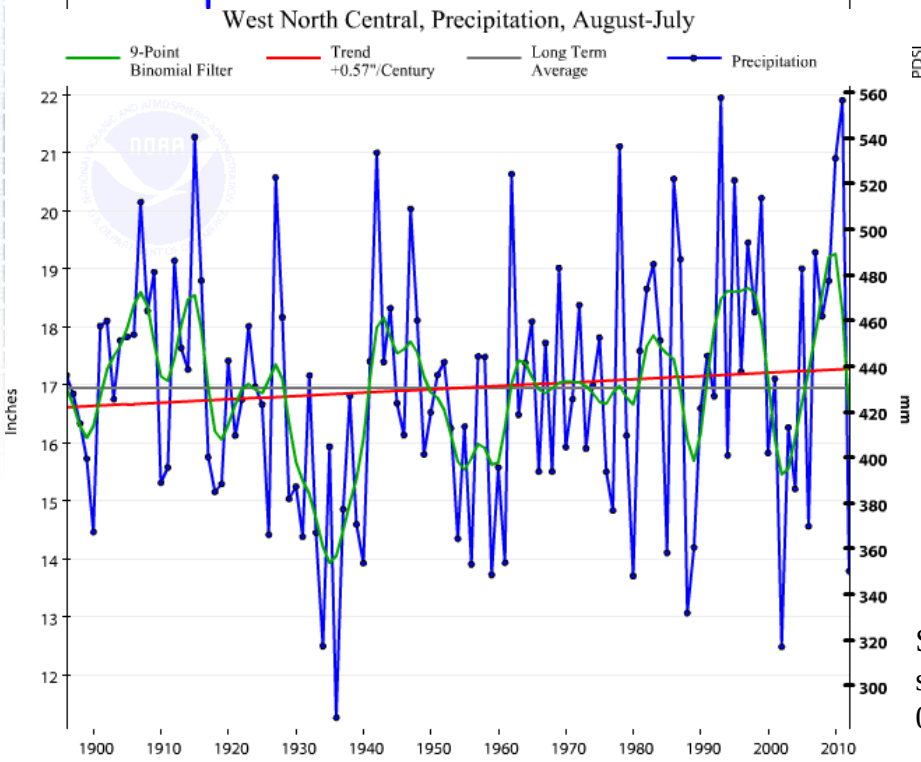
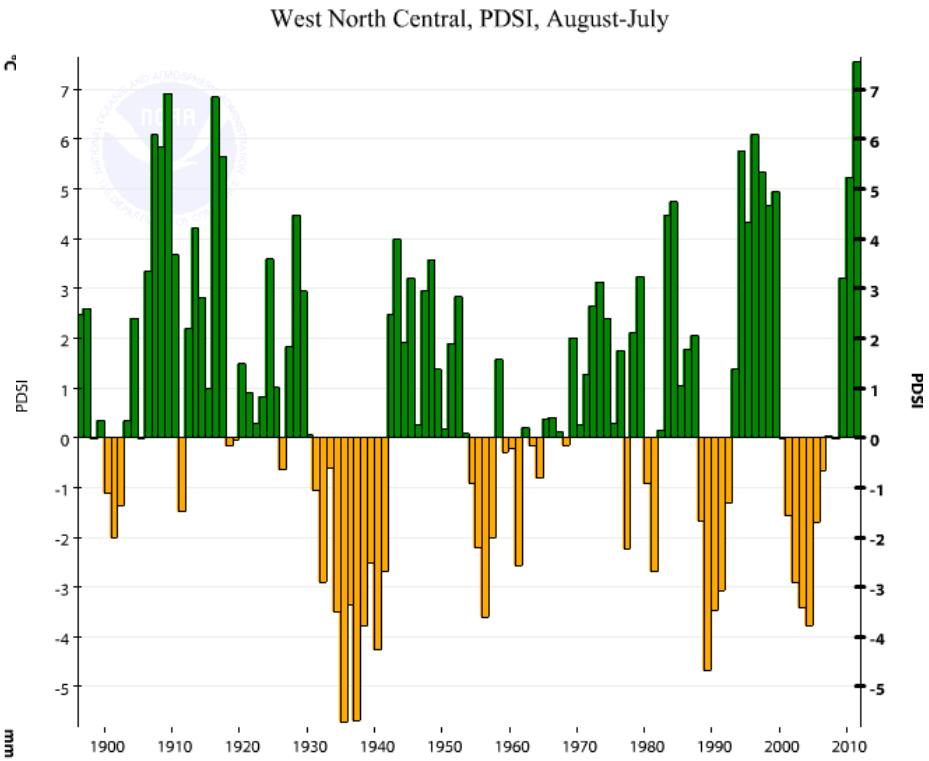
NWC Region Climate Trends – August 1895-July 2012

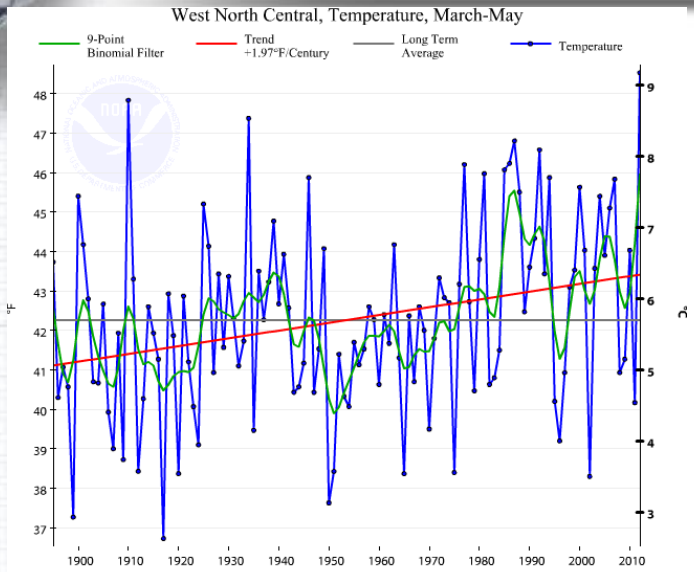


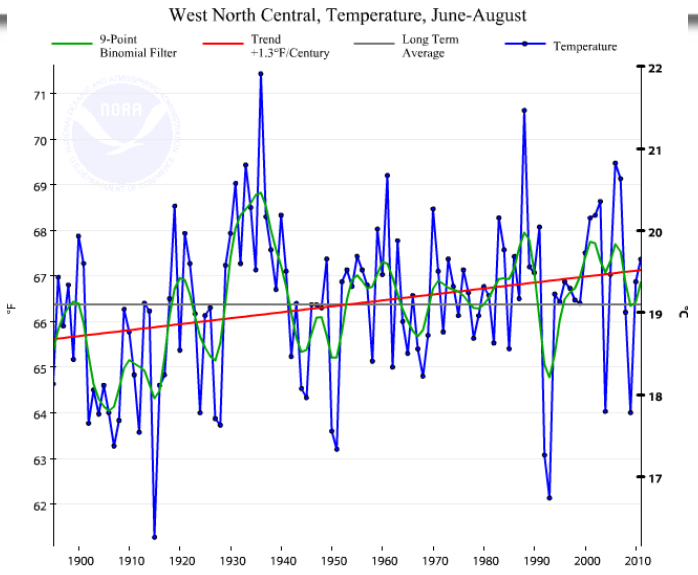


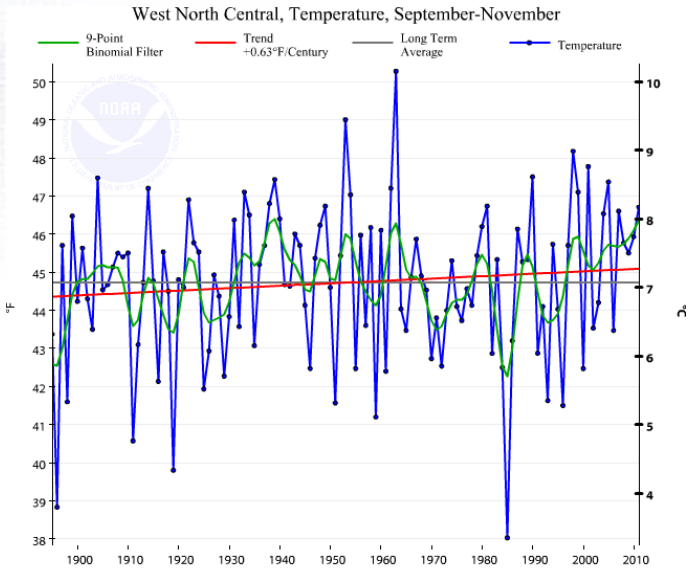


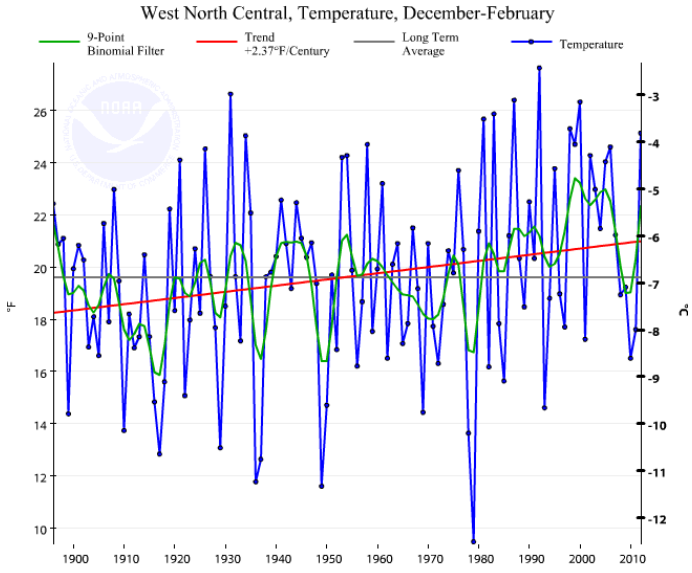
Source: NOAA/NCDC http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=tmp&month=5&year=2012&filter=3&state=106&div=0

NWC Region: Temperature Seasonal Trends









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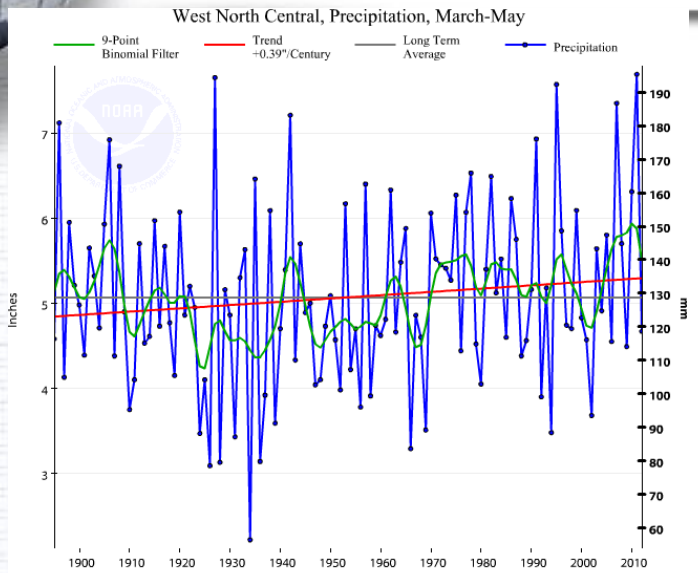
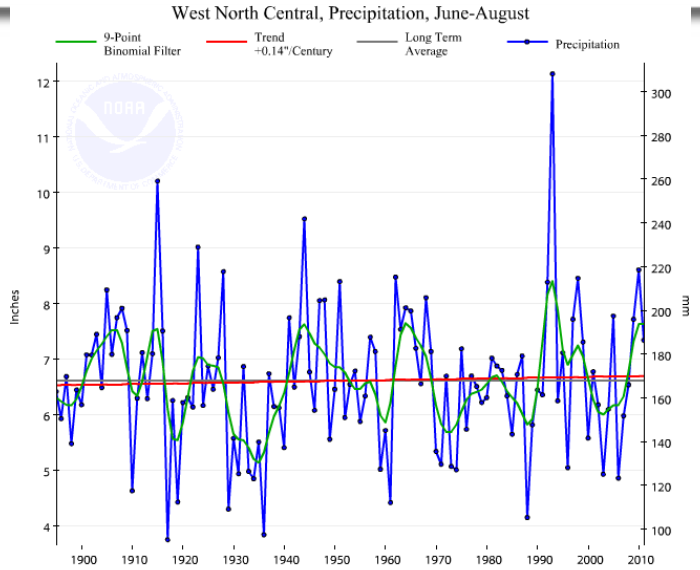
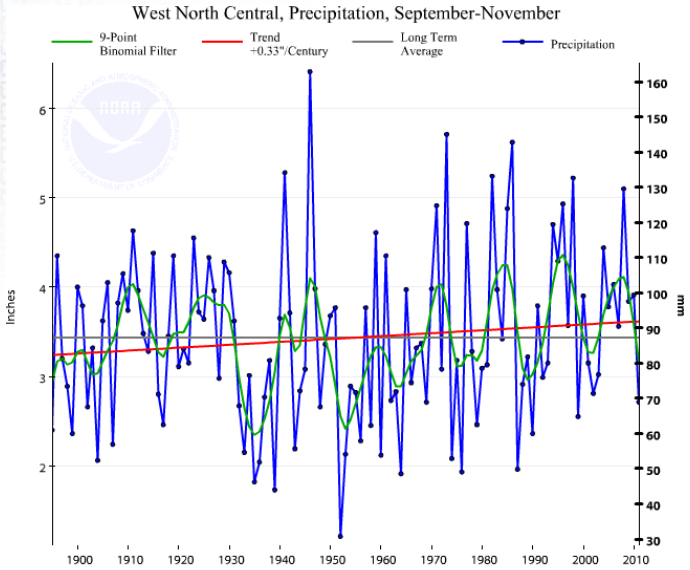
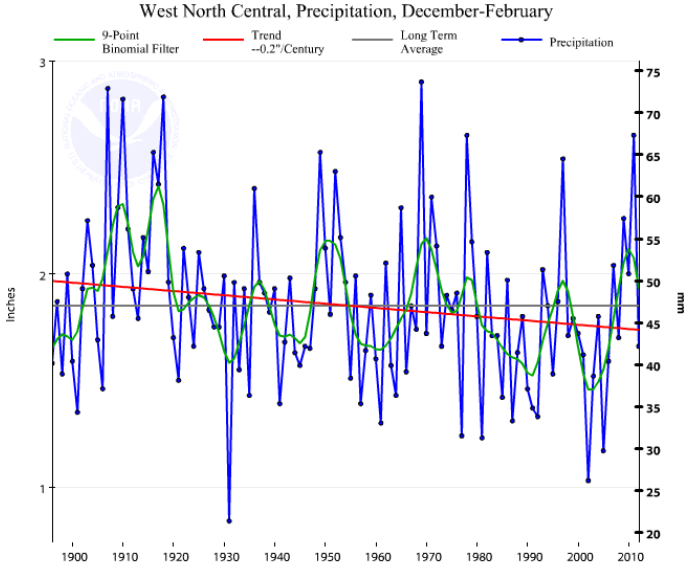
NWC Region: Precipitation Seasonal Trends



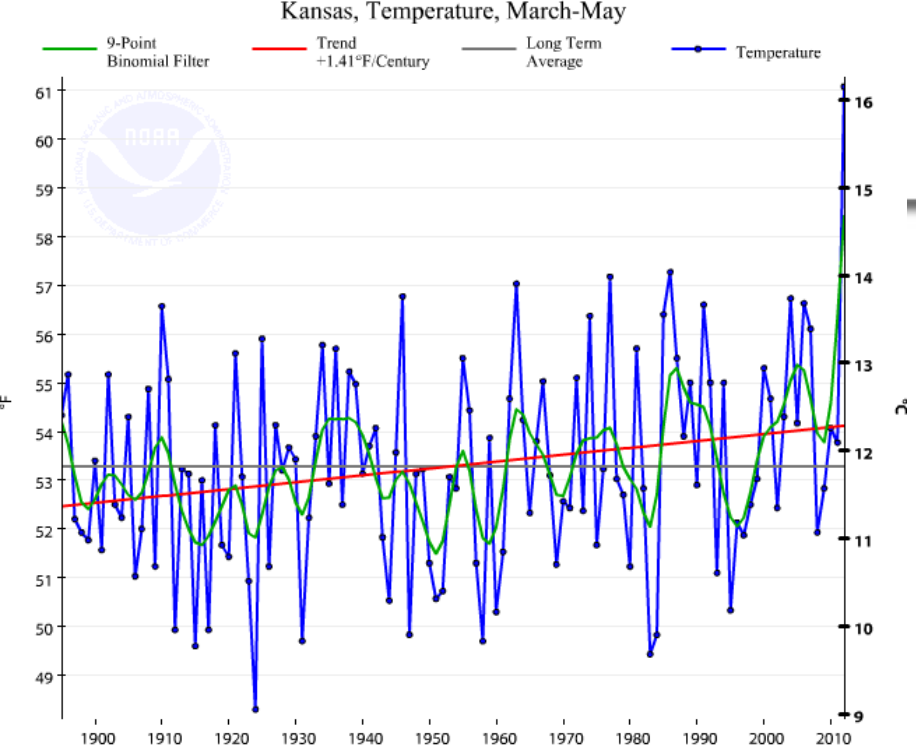


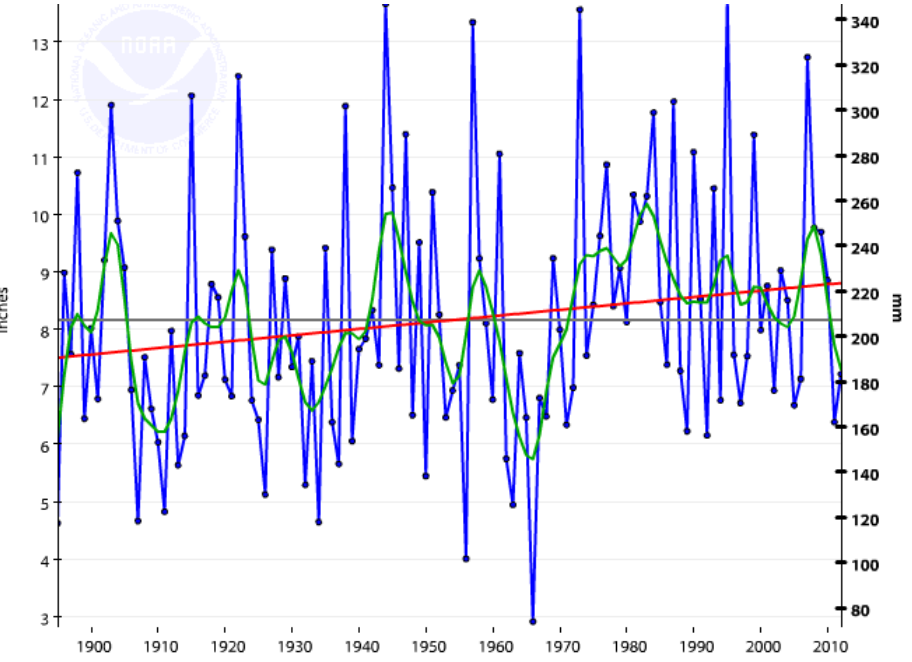


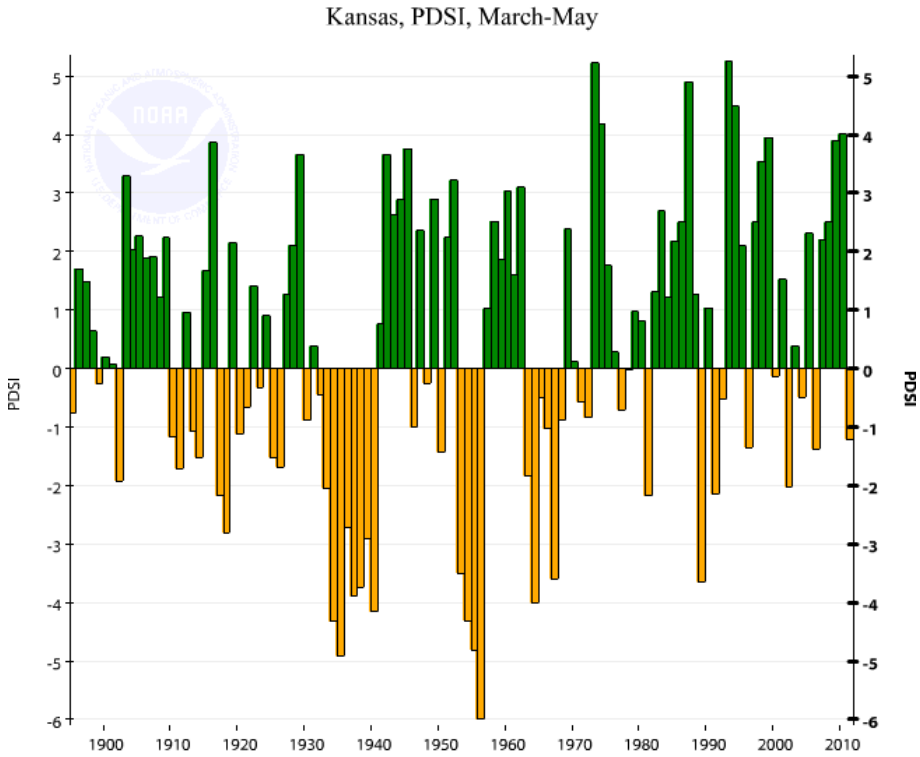


Source: NOAA/NCDC http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=tmp&month=5&year=2012&filter=3&state=1

Kansas in the Spring -- Winter Wheat!

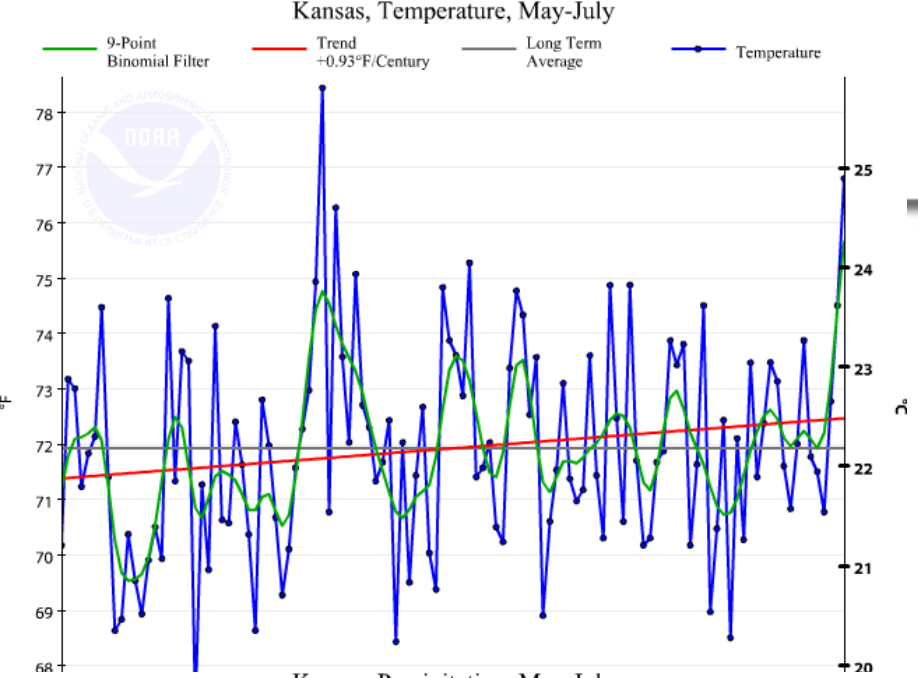


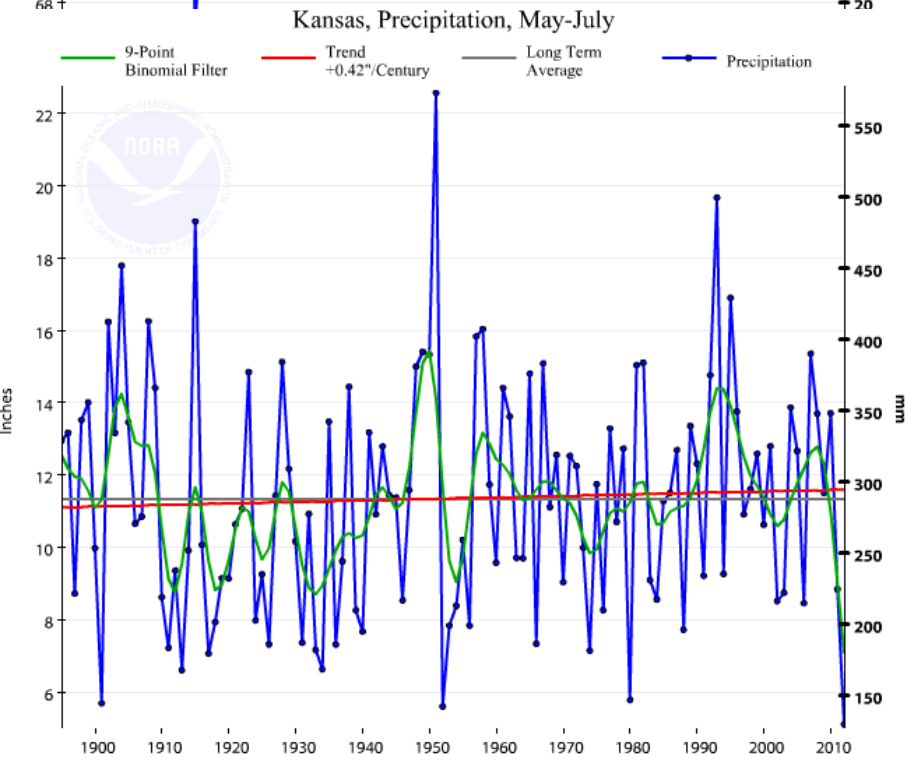


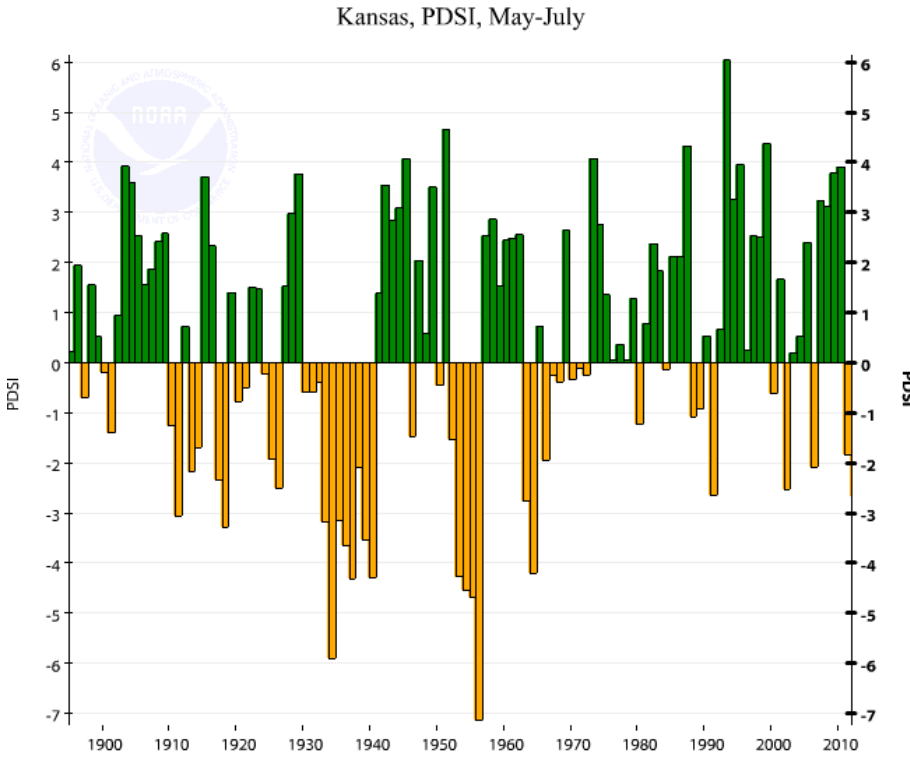


Source: NOAA/NCDC http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=pdsi&month=7&year=2012&filter=3&state=14&div=0

What About Kansas: Early Summer (May-July)

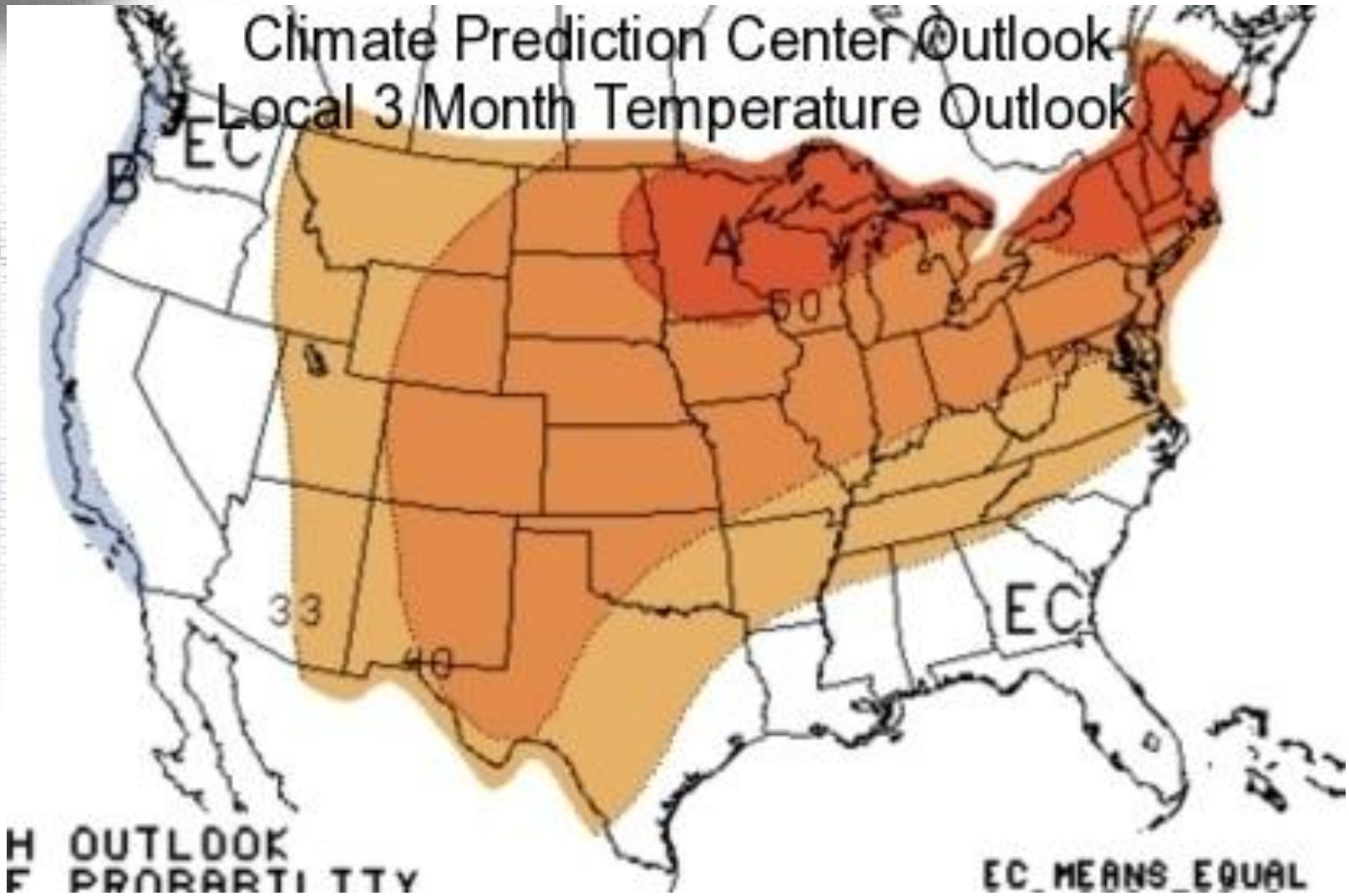






Source: NOAA/NCDC http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=pdsi&month=7&year=2012&filter=3&state=14&div=0

US Outlook for the next 3 months!



What about extremes?

How is the current warmth different from the past?

Figure 2. Areas of the Lower 48 States with Hot Daily High Temperatures, 1910–2008

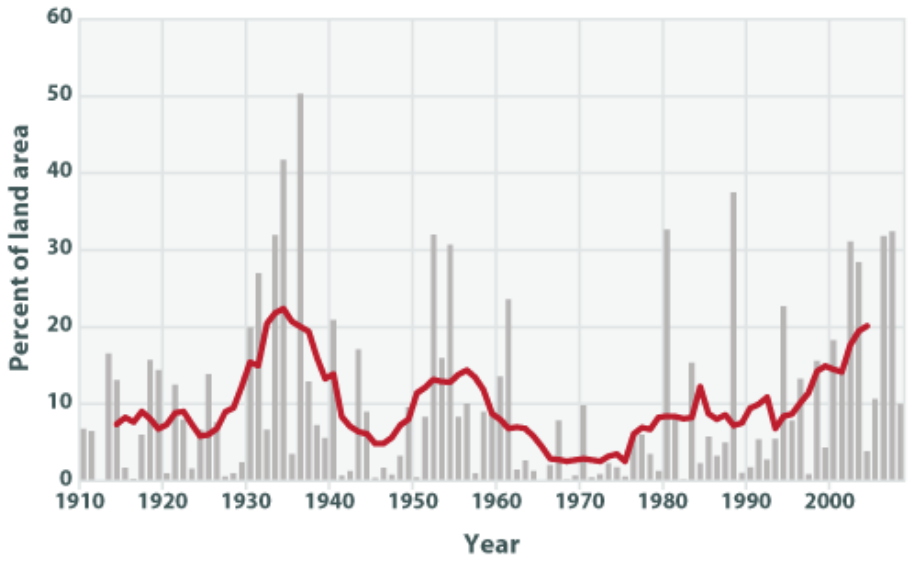
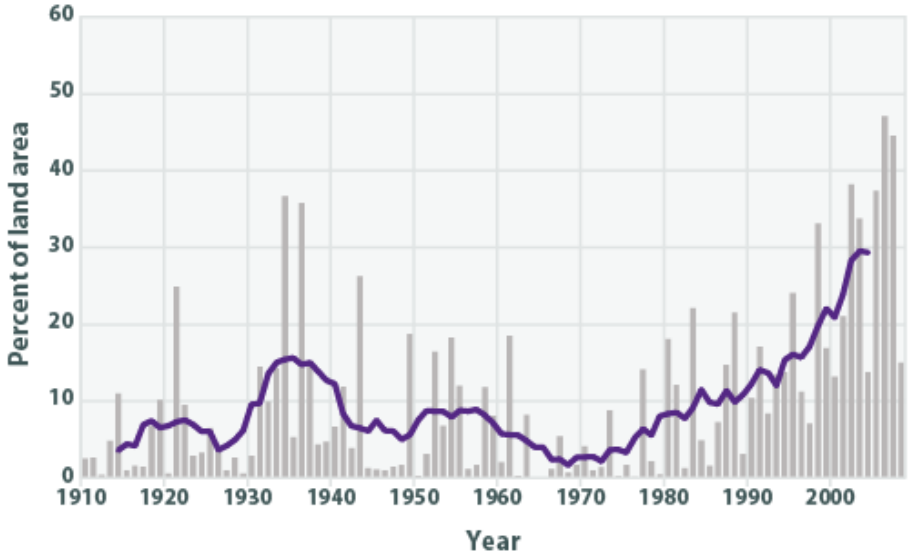
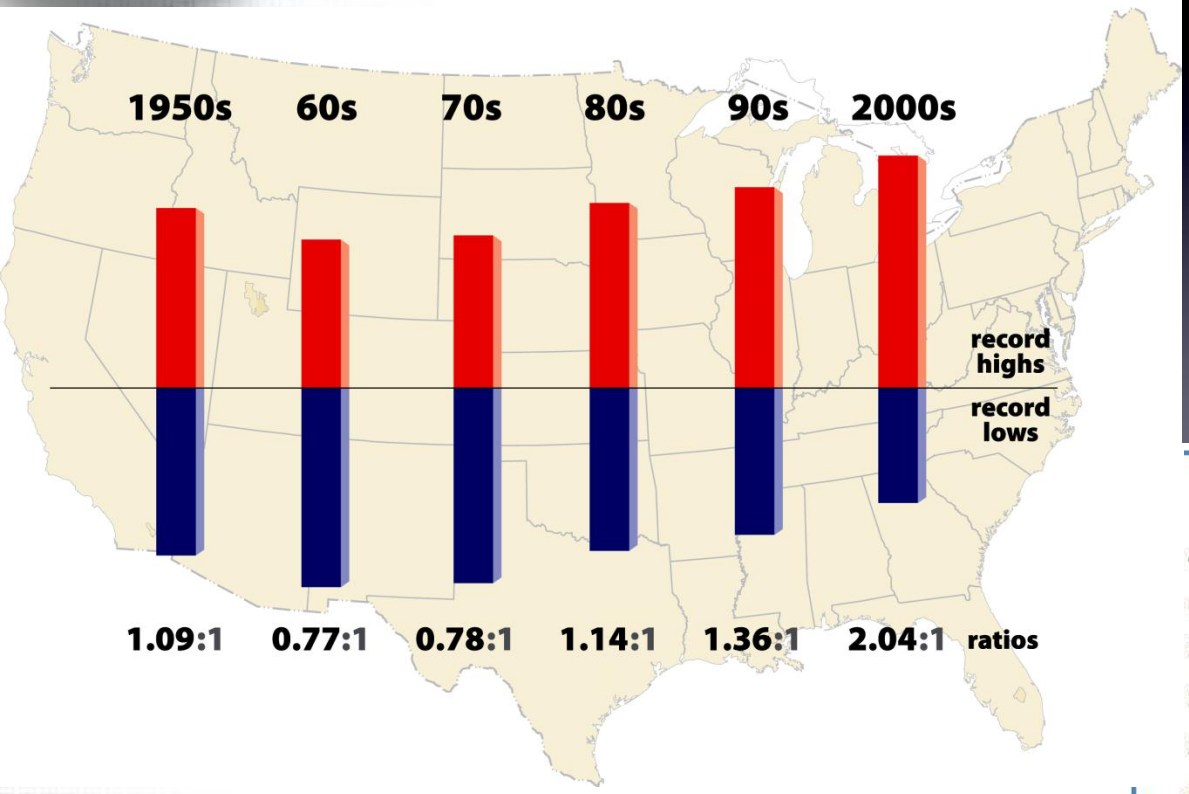


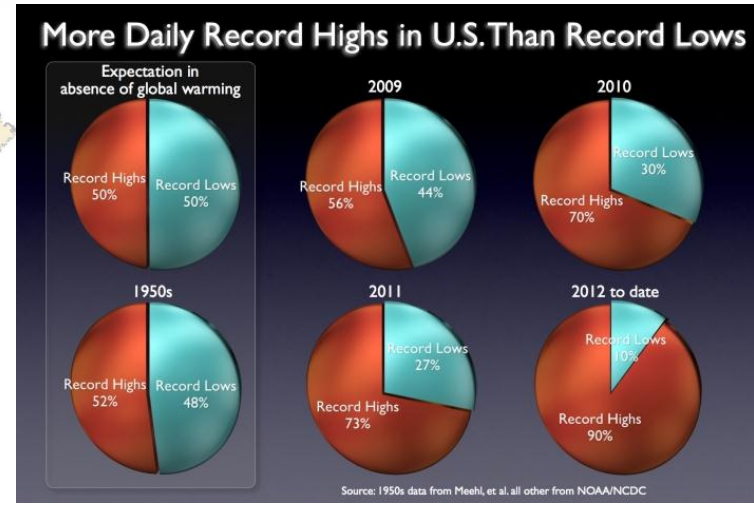
Figure 3. Areas of the Lower 48 States with Hot Daily Low Temperatures, 1910–2008

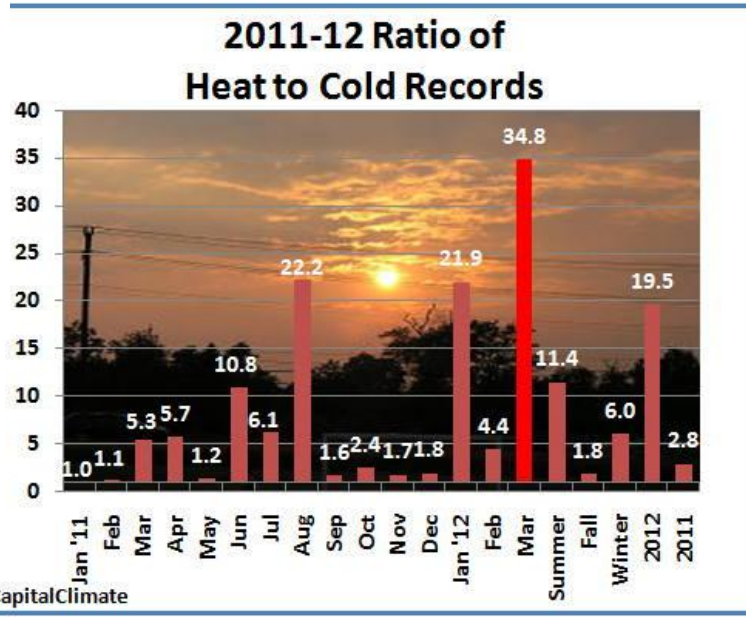


Source: EPA http://epa.gov/climatechange/science/indicators/weather-climate/heat-waves.html -- uses coop stations

Breaking records in the US

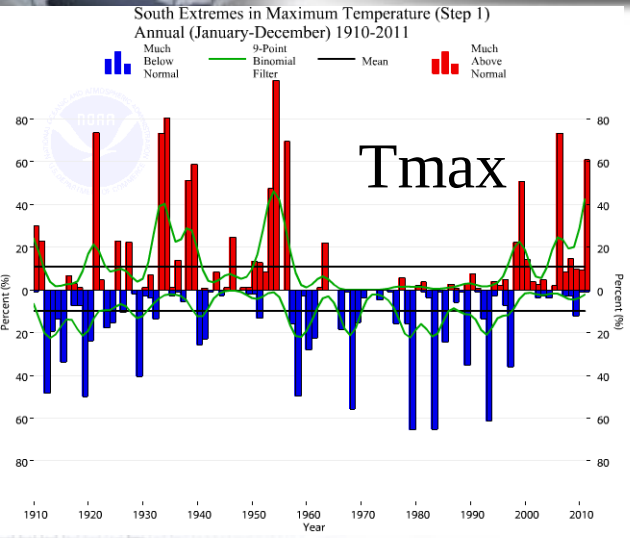


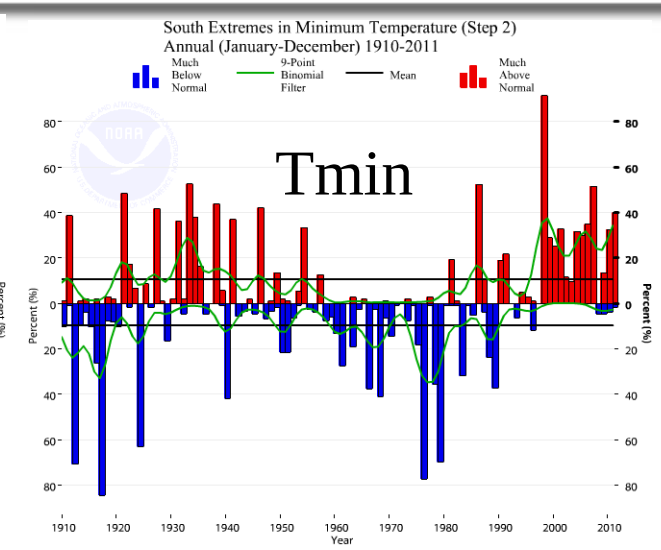


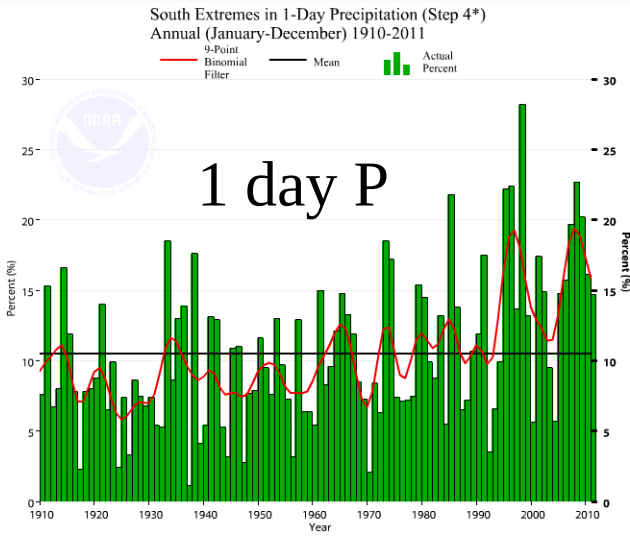


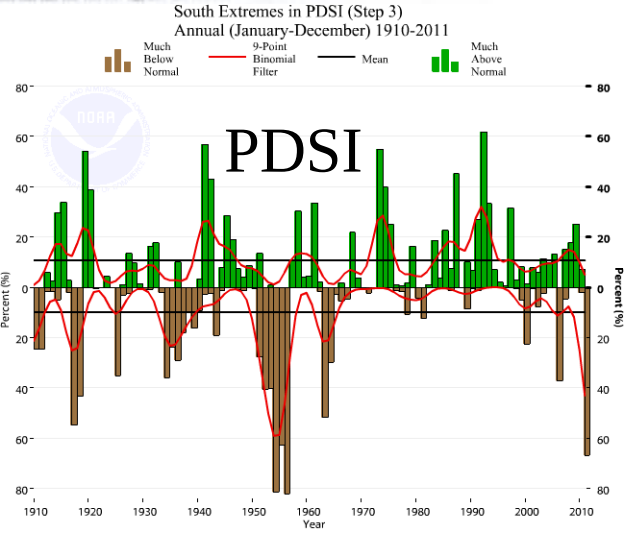
Sources: https://www2.ucar.edu/atmosnews/news/1036/record-high-temperatures-far-outpace-record-lows-across-us
Andrew Freeman Climate Central and Capital Climate

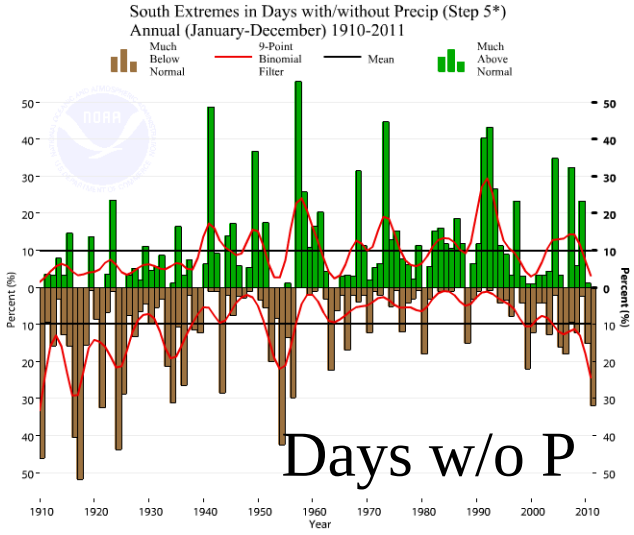
Extremes in the South region

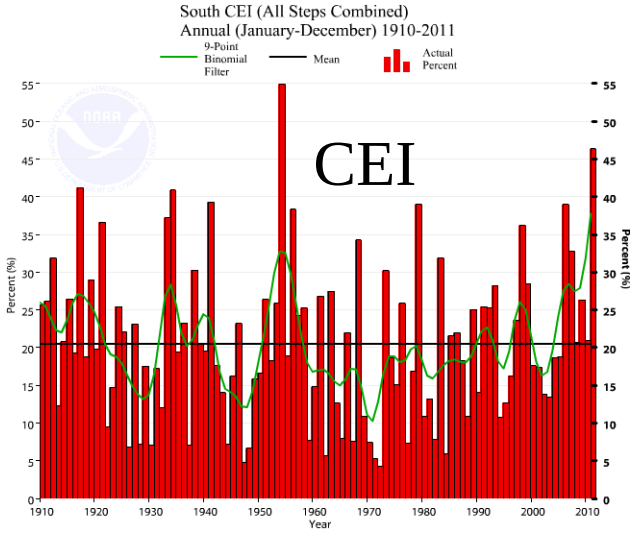








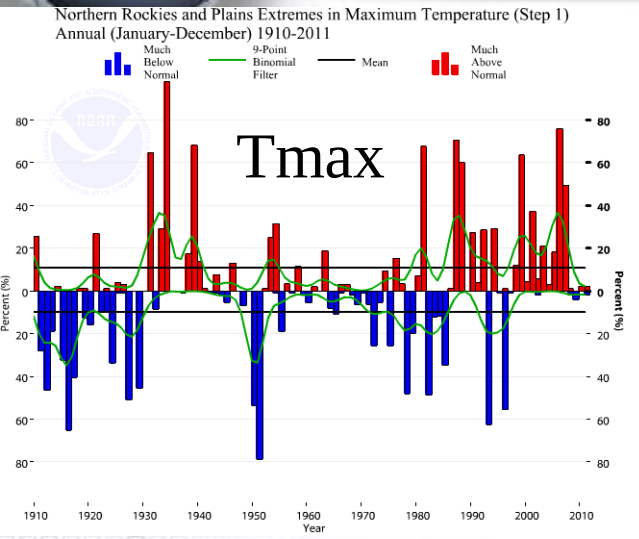


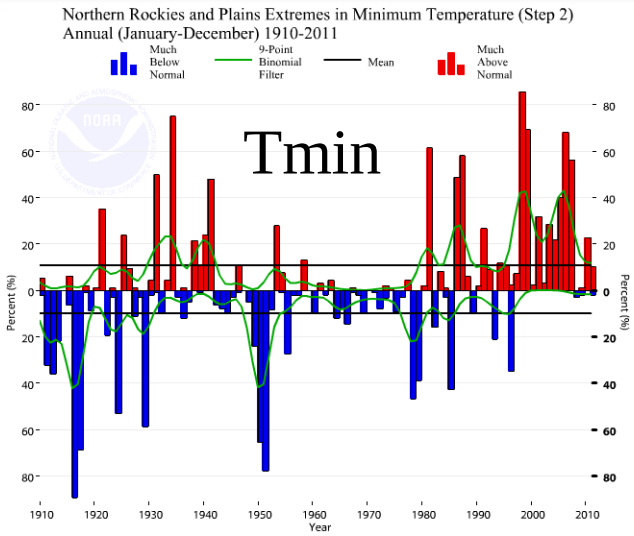


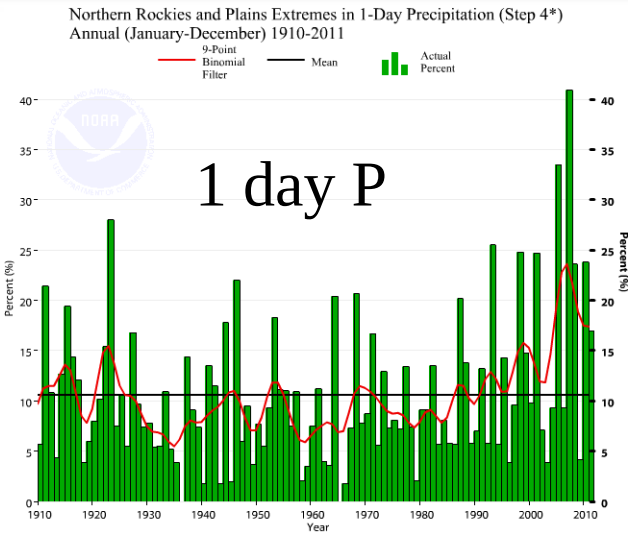
Y axis = percent area affected X axis annual from 1910 - 2011

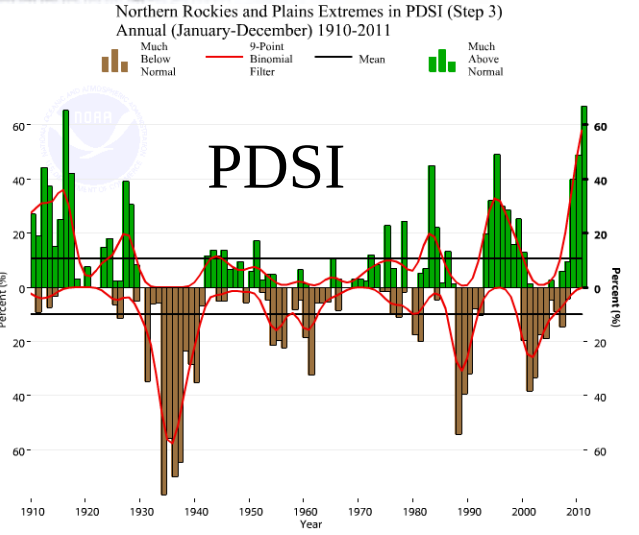
Source: NOAA/NCDC http://www.ncdc.noaa.gov/extremes/cei/regional_overview/ytd

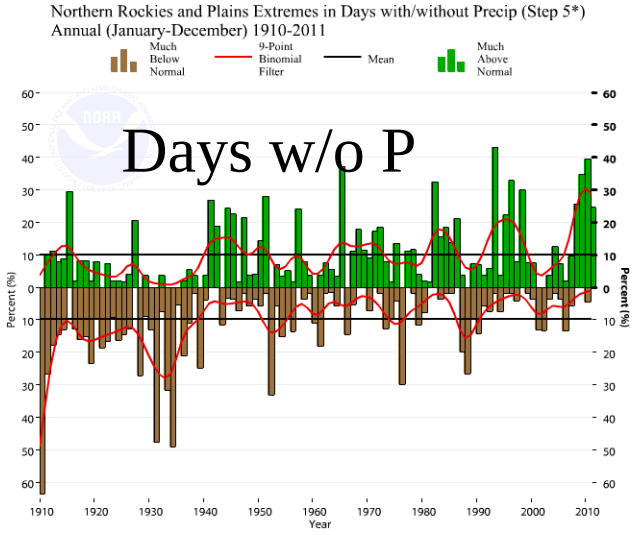
Extremes in the NWC region

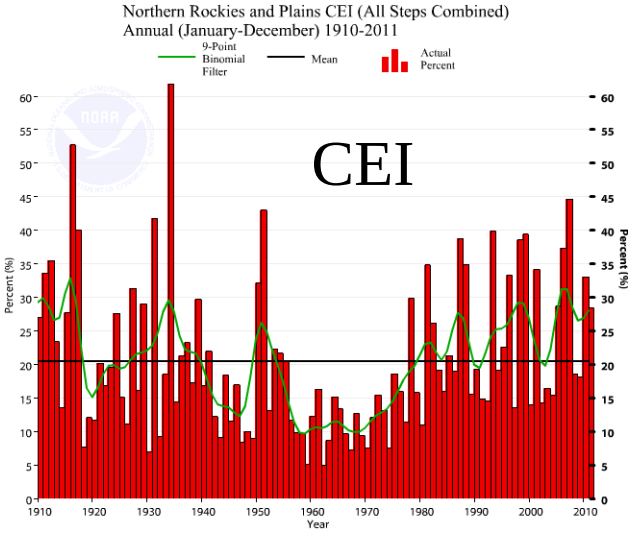












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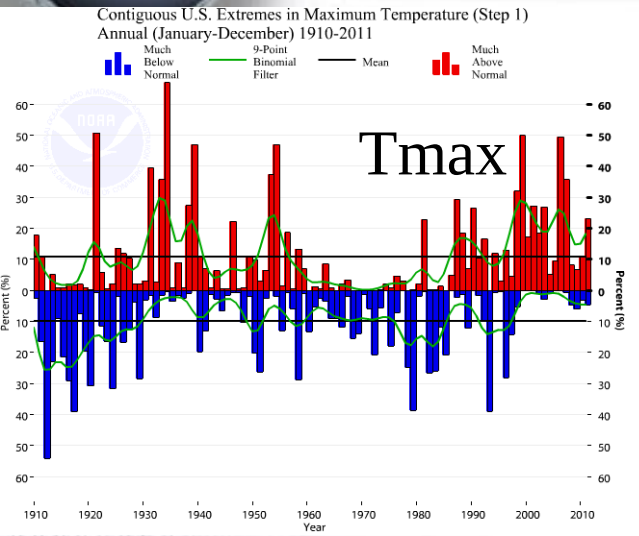
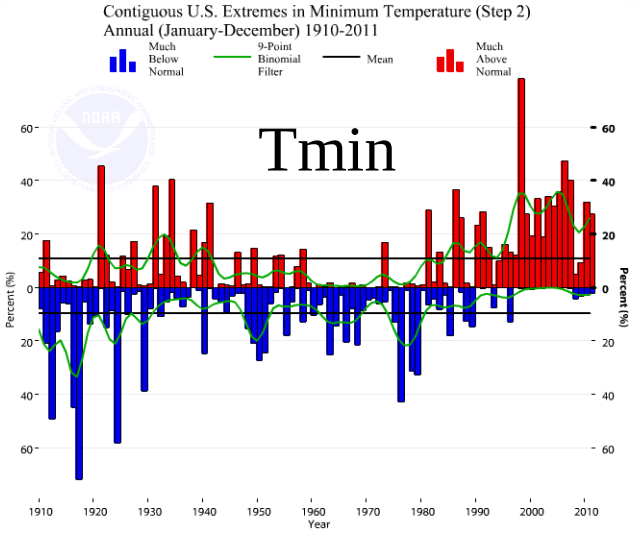
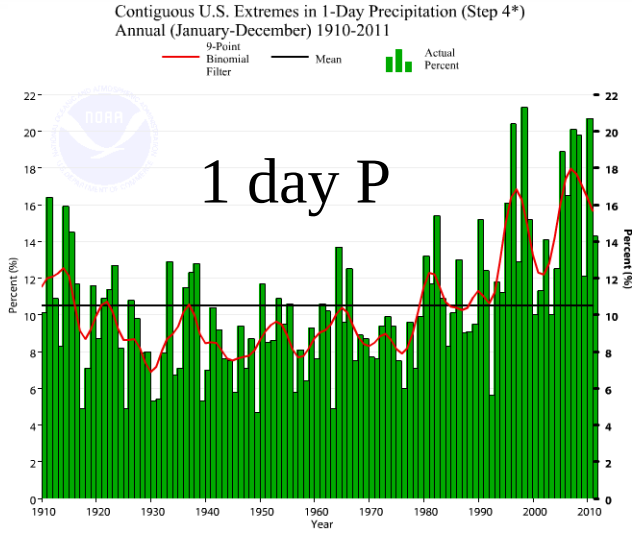
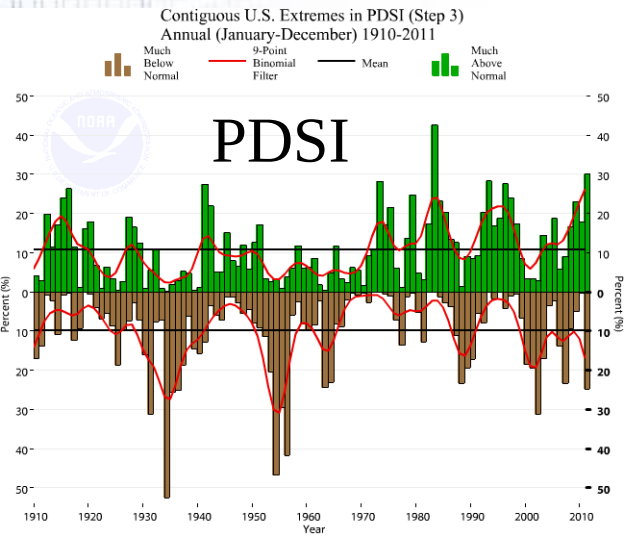
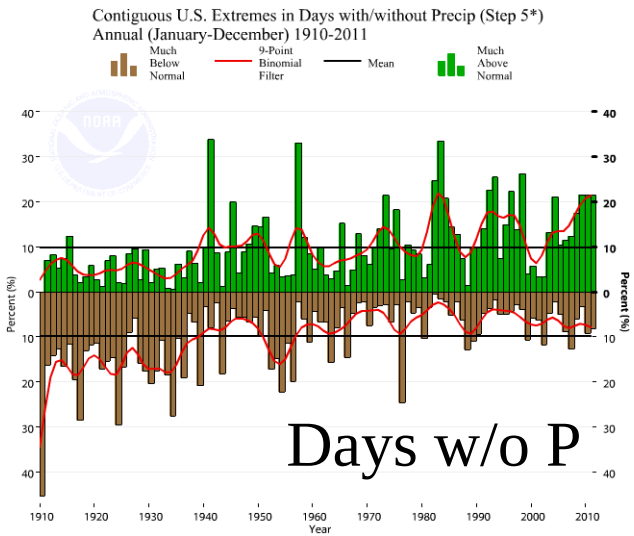
Extremes in the Contiguous US

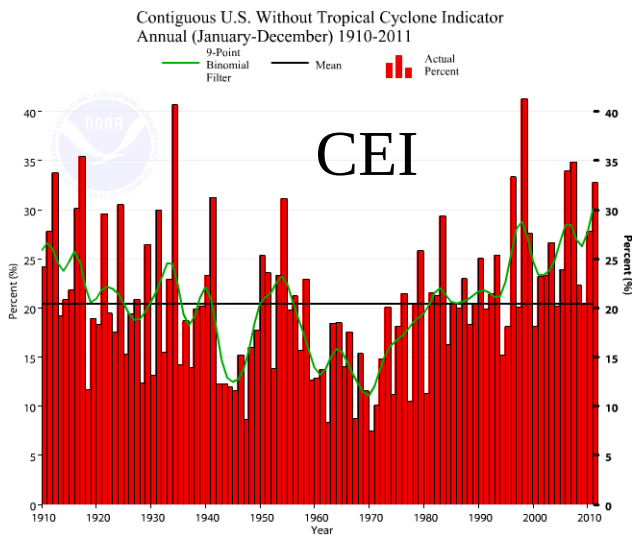








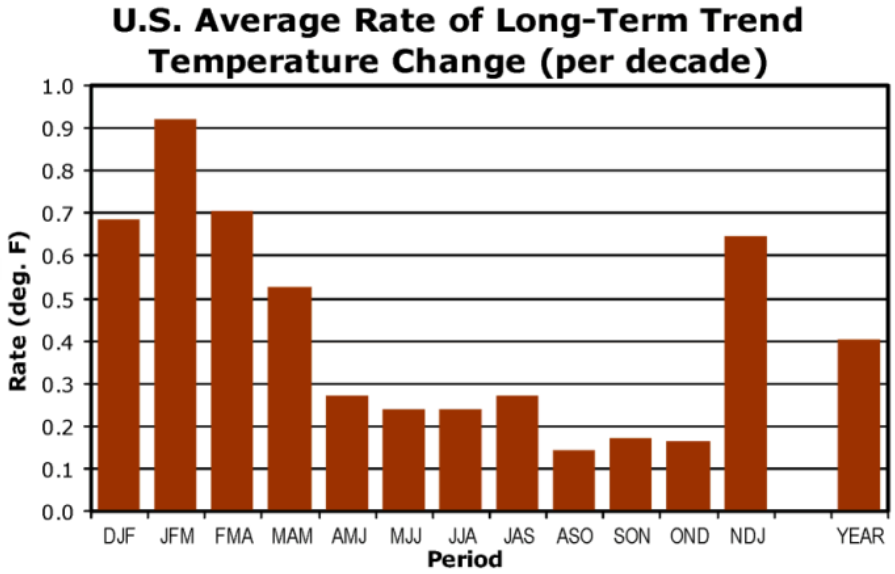


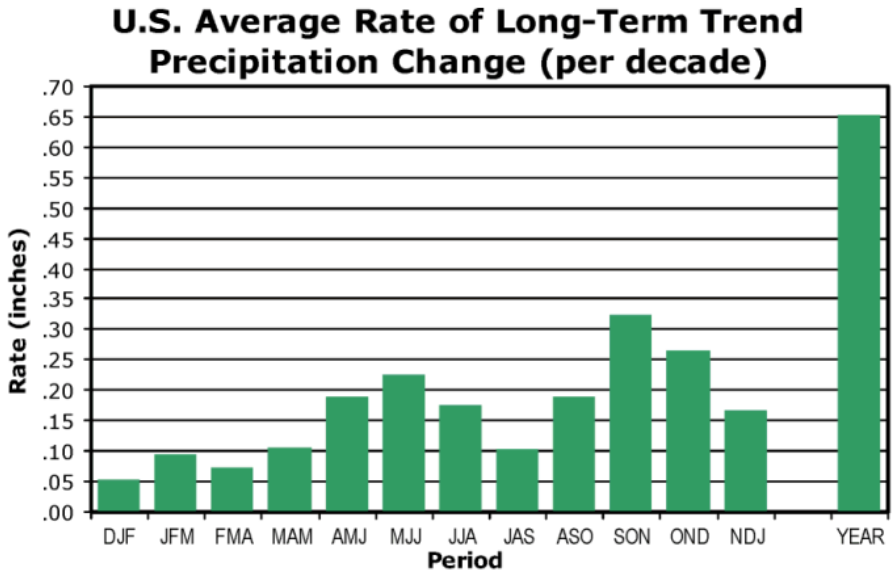


Y axis = percent area affected X axis annual from 1910 - 2011

Source: NOAA/NCDC http://www.ncdc.noaa.gov/extremes/cei/regional_overview/ytd

Changes by Season trend from 1976 to 2005

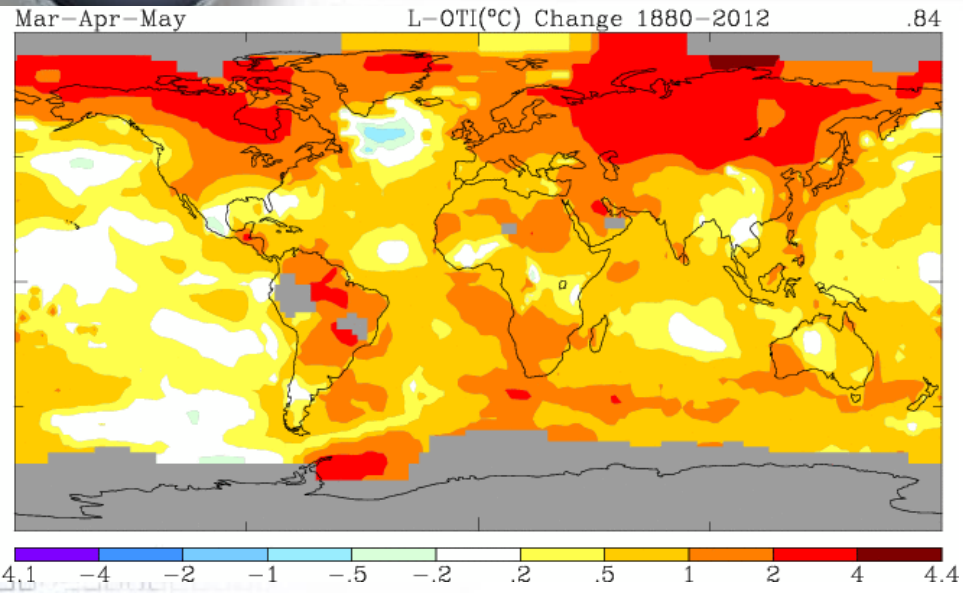


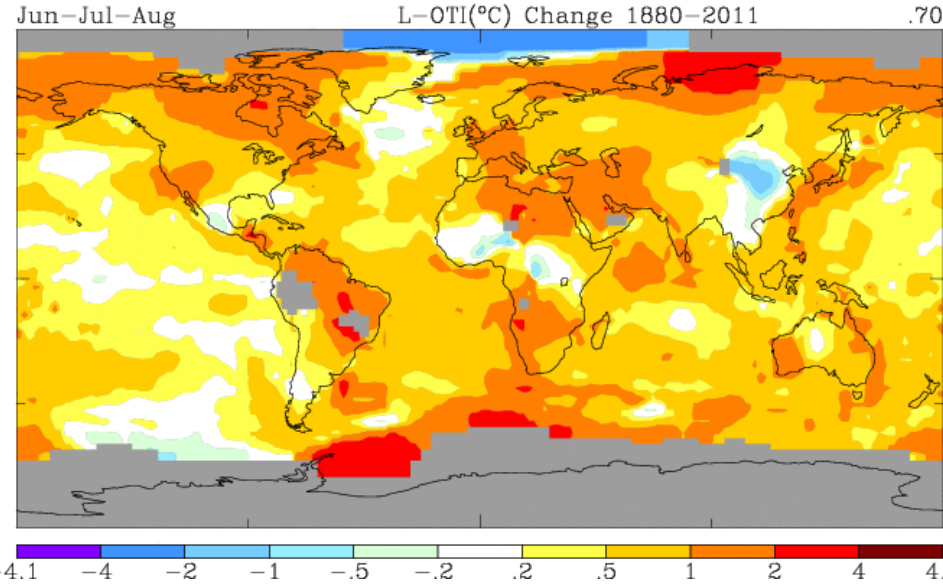


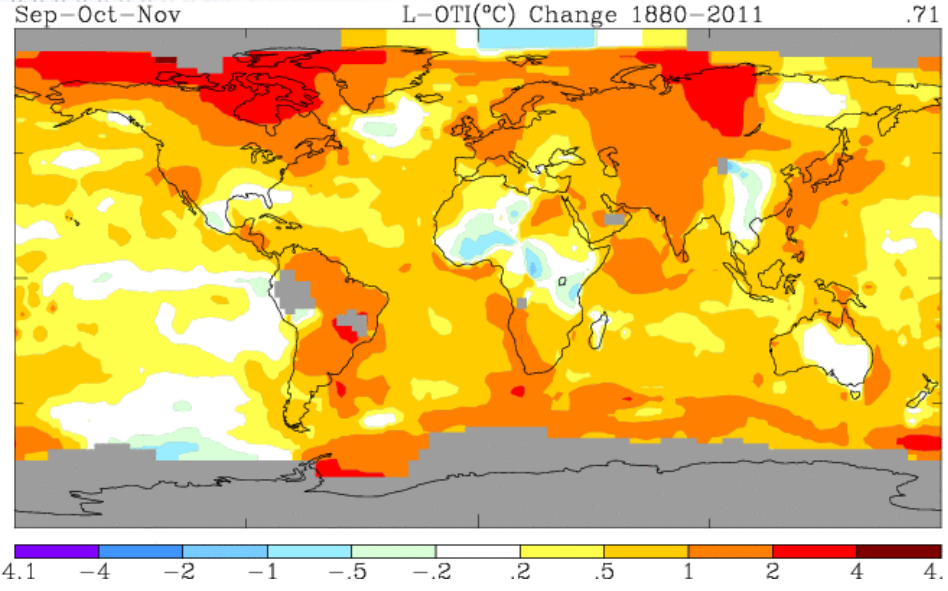
Source: NOAA/NCEP http://www.cpc.ncep.noaa.gov/trendusa.gif

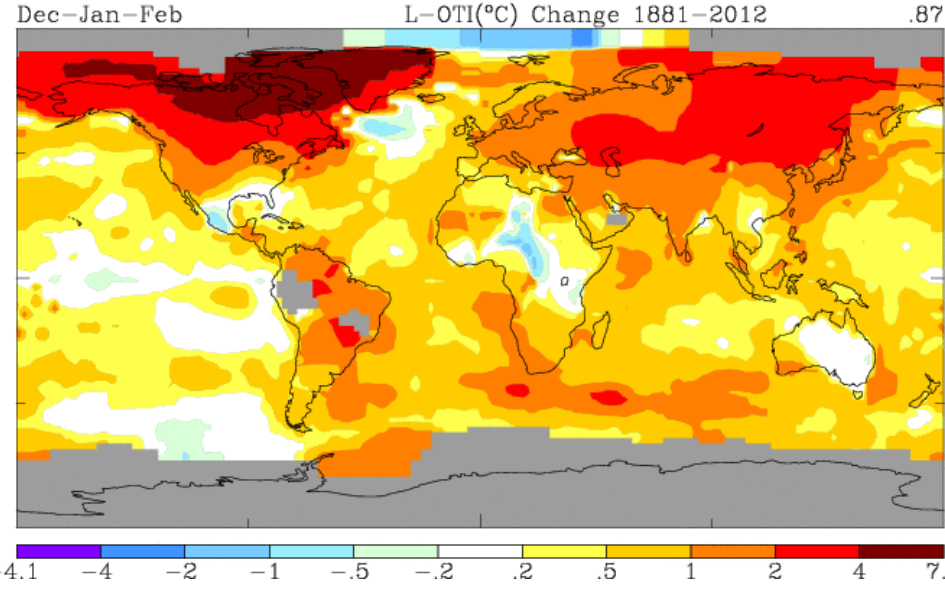
What about the global picture?

Global temperature change from 1880 to 2011

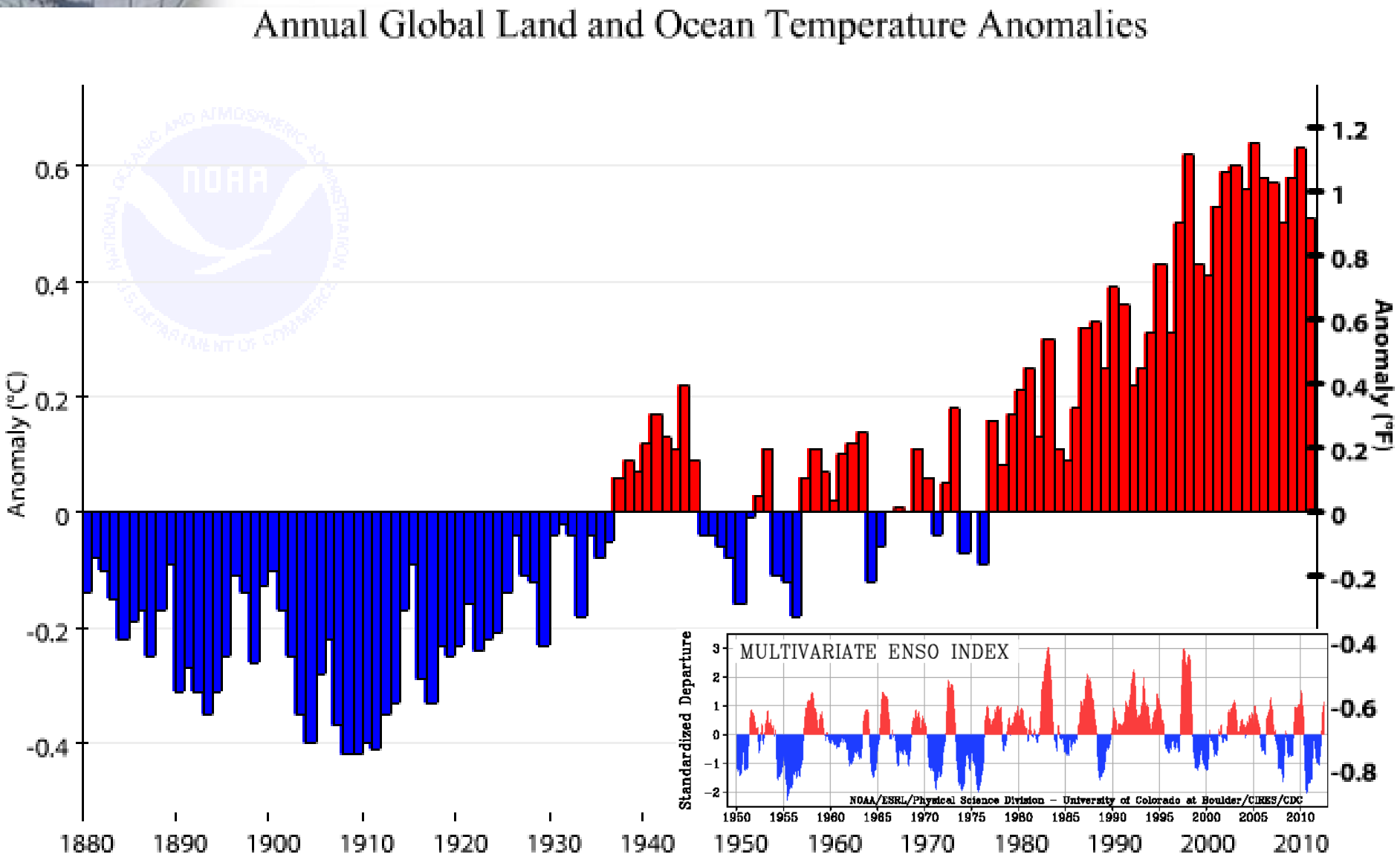




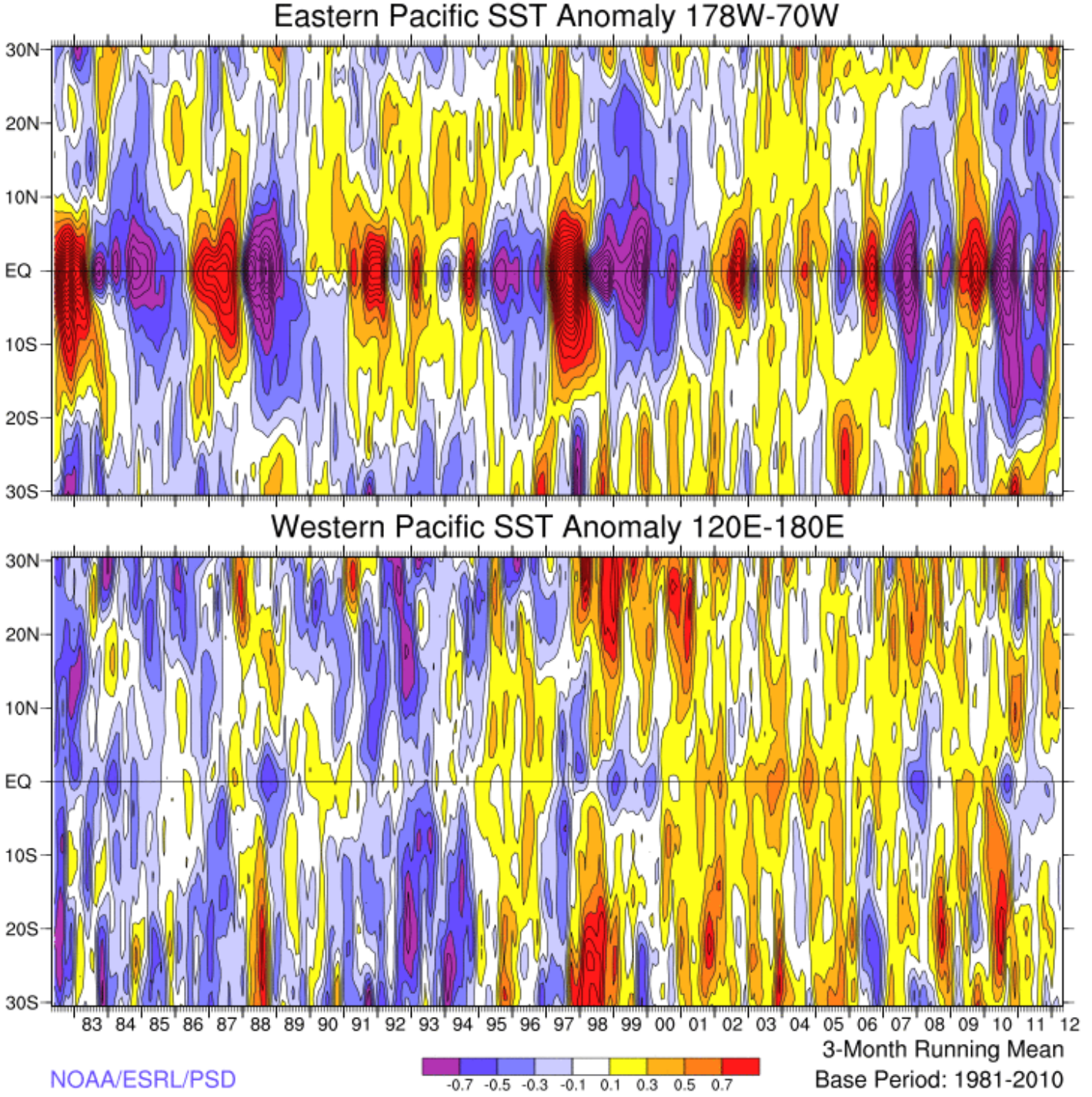




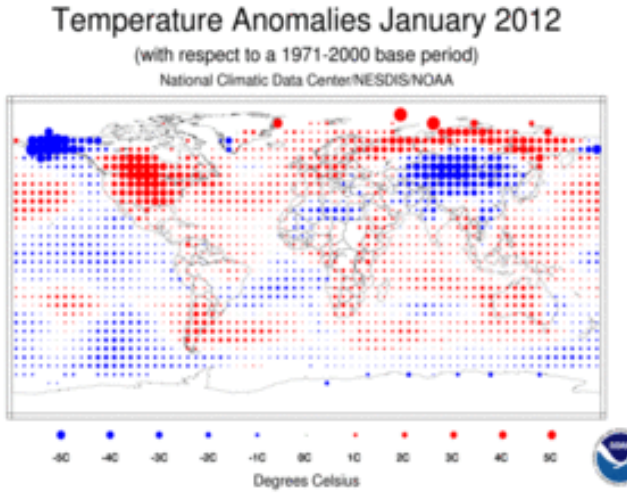
Global temperature trends and ENSO

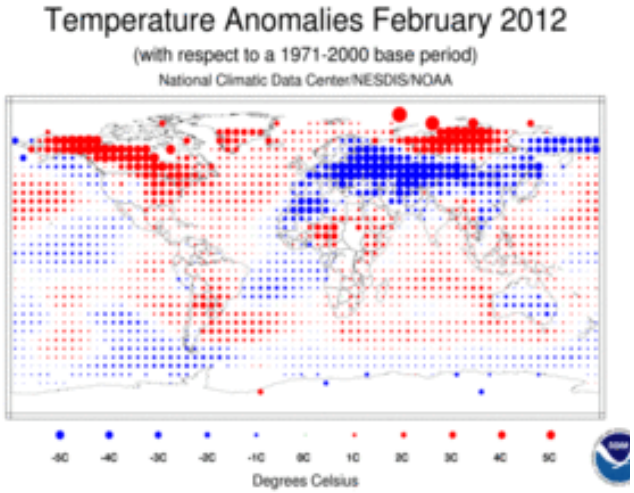


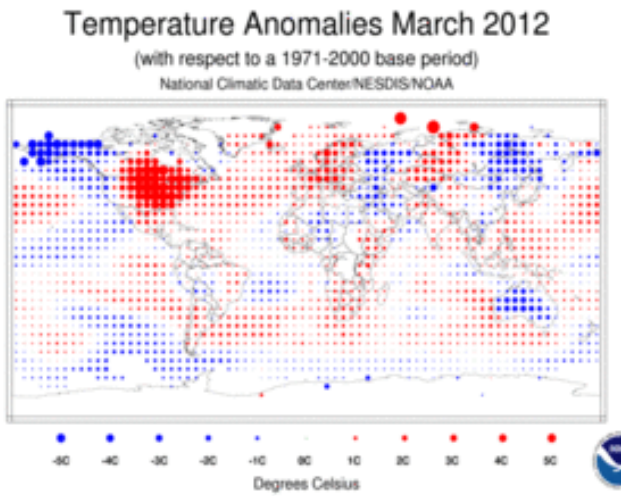
ENSO trends Pacific SSTs

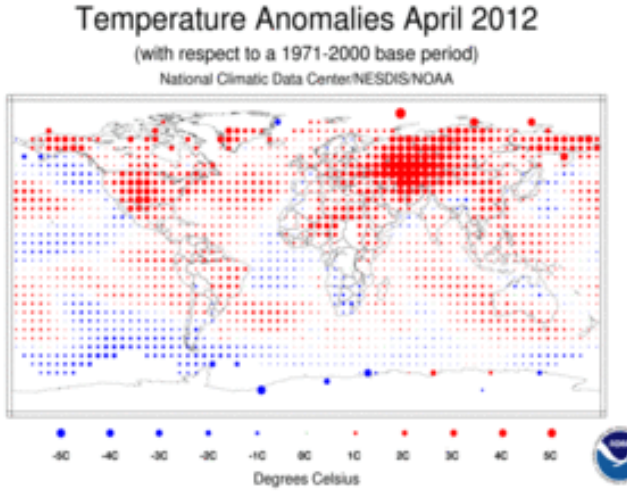


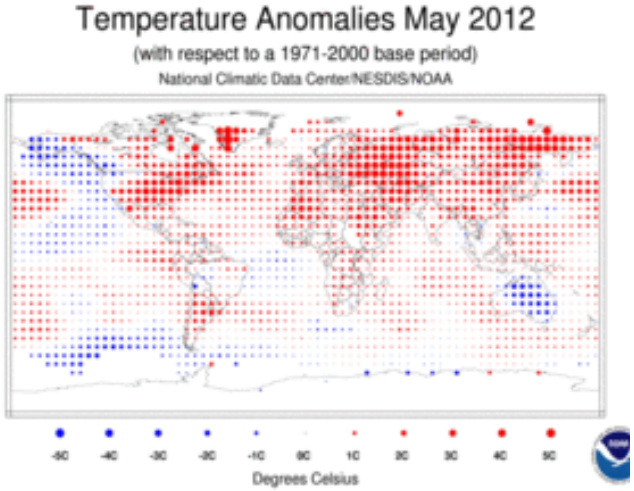
2012 Global Monthly Temperature Anomalies

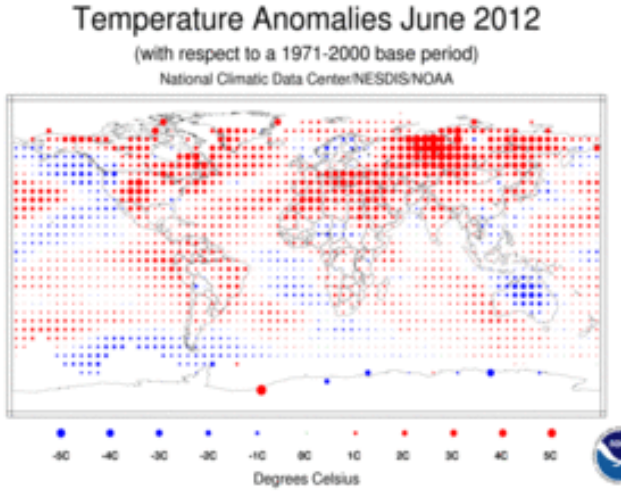










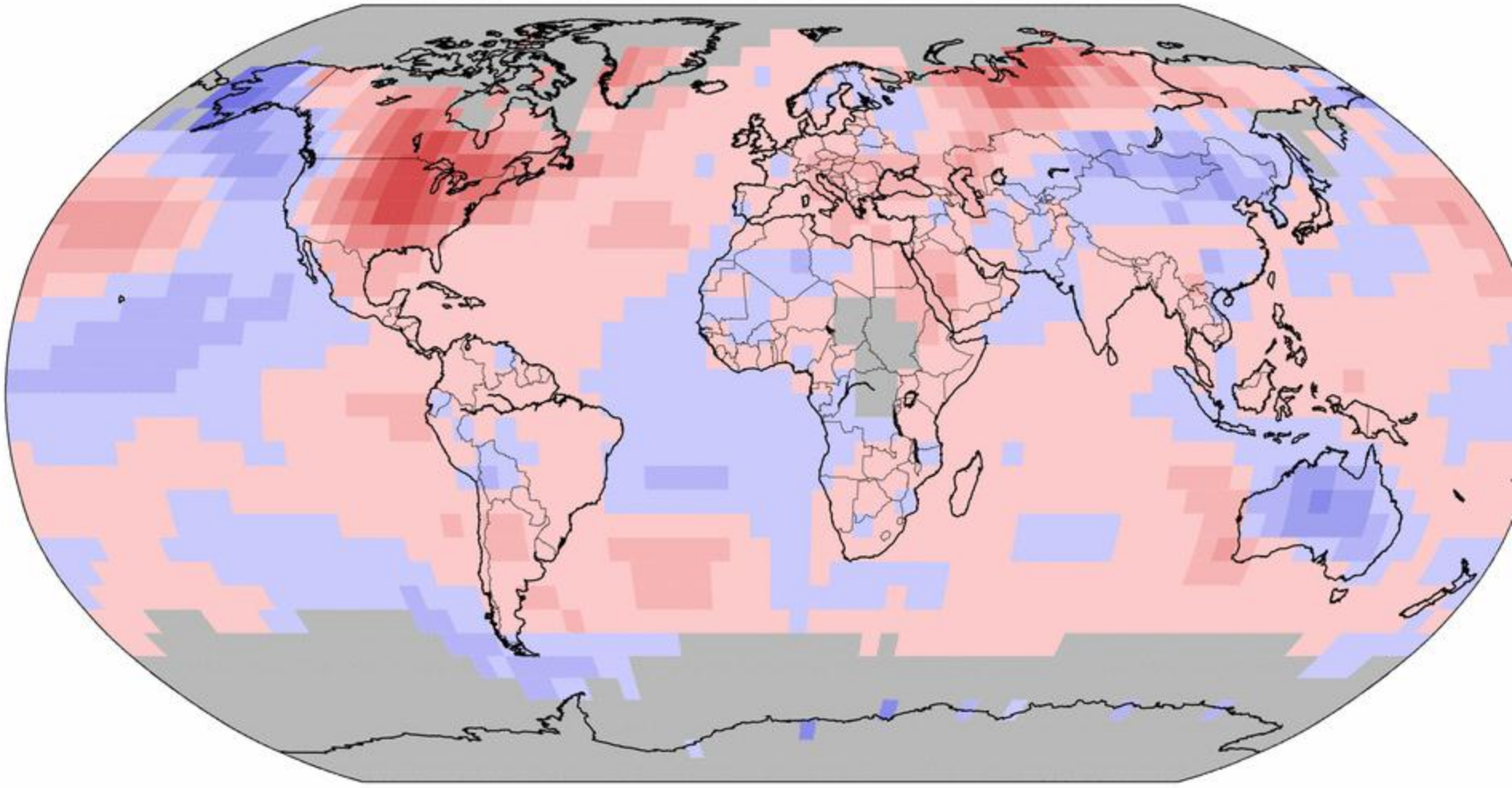


Source: NOAA/NCDC http://www.ncdc.noaa.gov/sotc/global/

Land & Ocean Temperature Anomalies Jan–Jul 2012

(with respect to a 1981–2010 base period)

Data Source: GHCN–M version 3.1.0 & ERSST version 3b



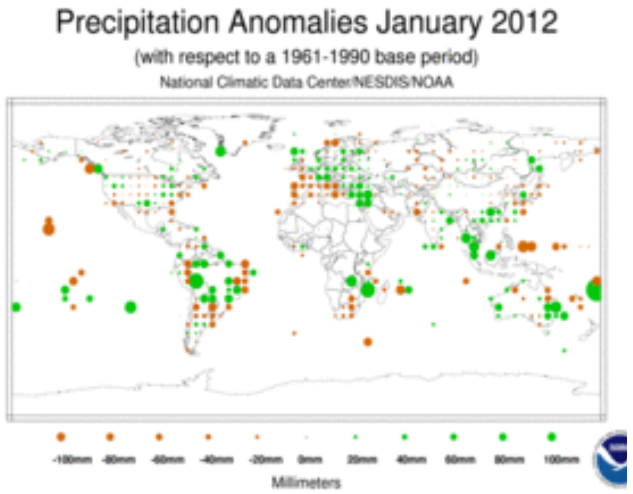
−5 −4 −3 −2 −1 0 1 2 3 4 5

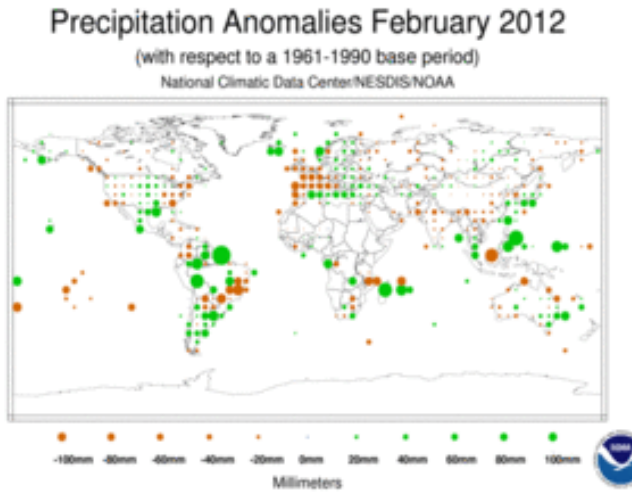
Degrees Celsius

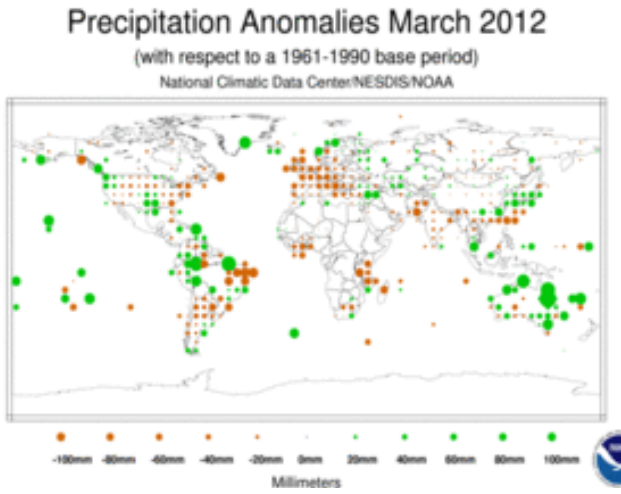
NOAA's National Climatic Data Center

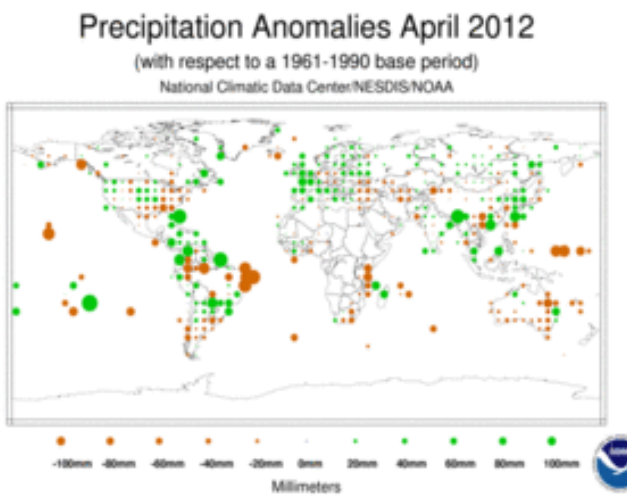
Please Note: Gray areas represent missing da

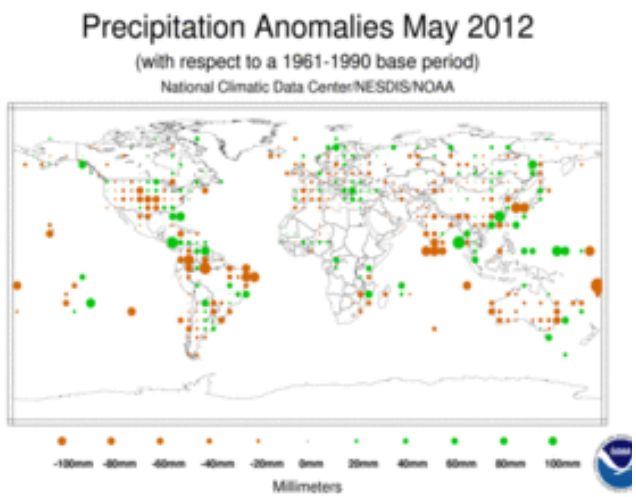
2012 Global Monthly Precipitation Anomalies

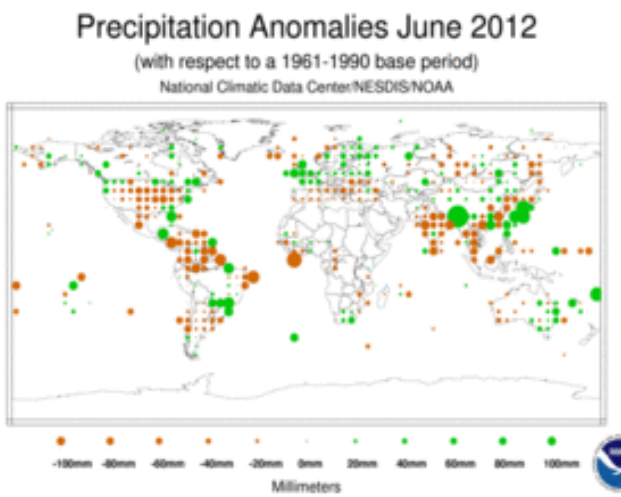












Source: NOAA/NCDC http://www.ncdc.noaa.gov/sotc/global/

Changes in Global Extreme Temperatures

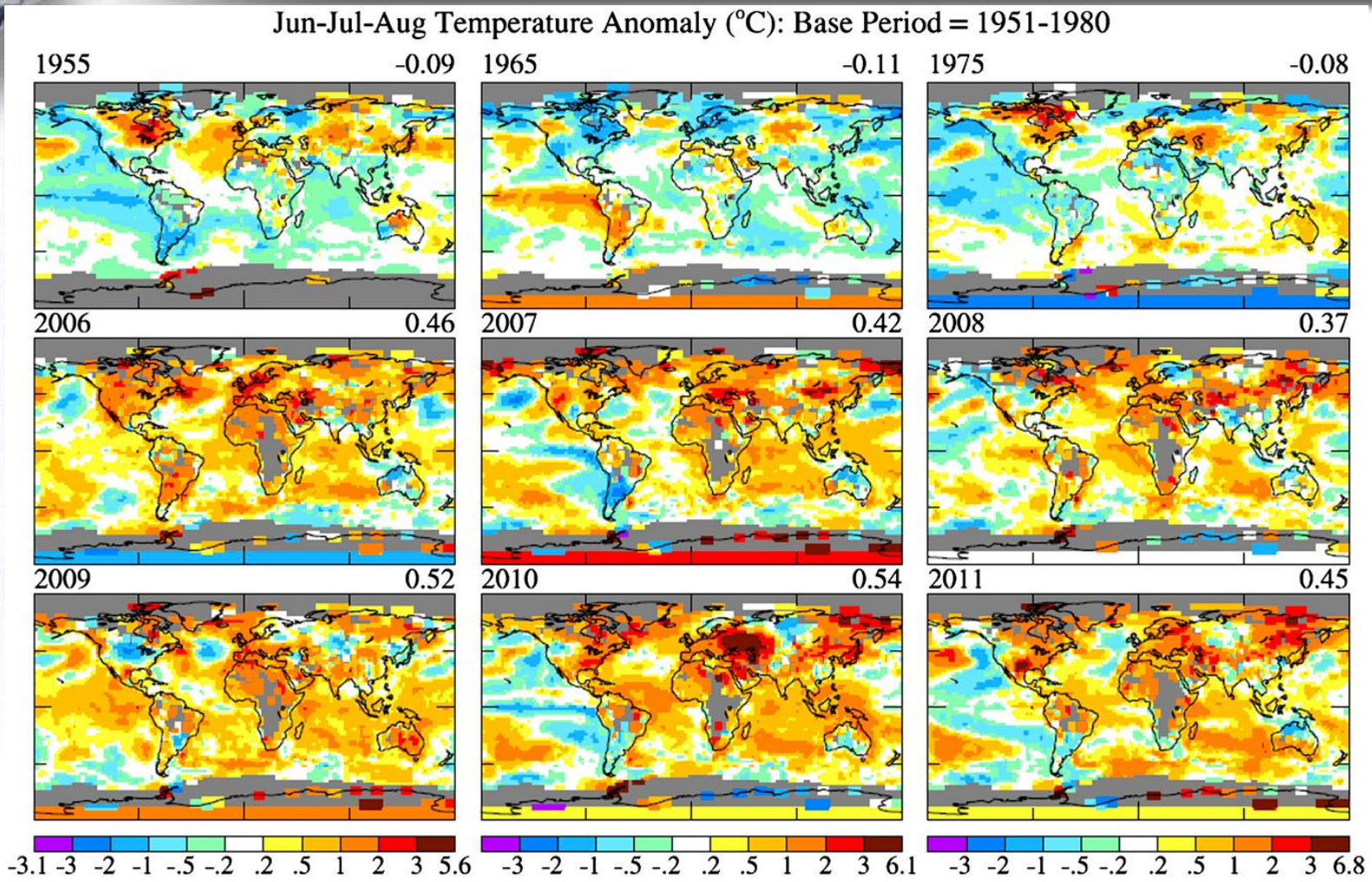
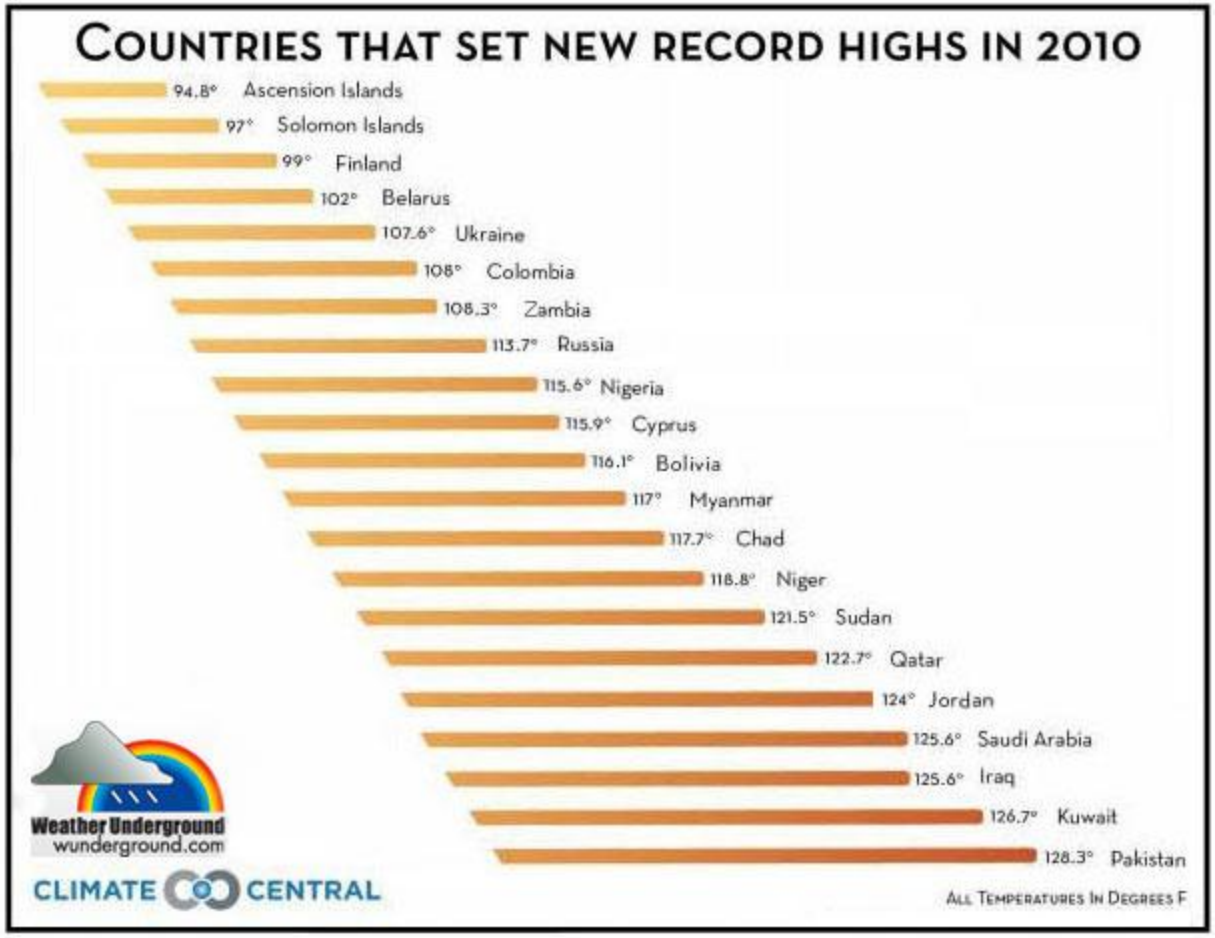


Fig. 1. June–July–August surface temperature anomalies in 1955, 1965, 1975, and the past 6 y relative to the 1951–1980 mean. Number on Upper Right is the global mean (average over all area with data).

Extremes are not just this year!



Changes in Global Extreme Temperatures

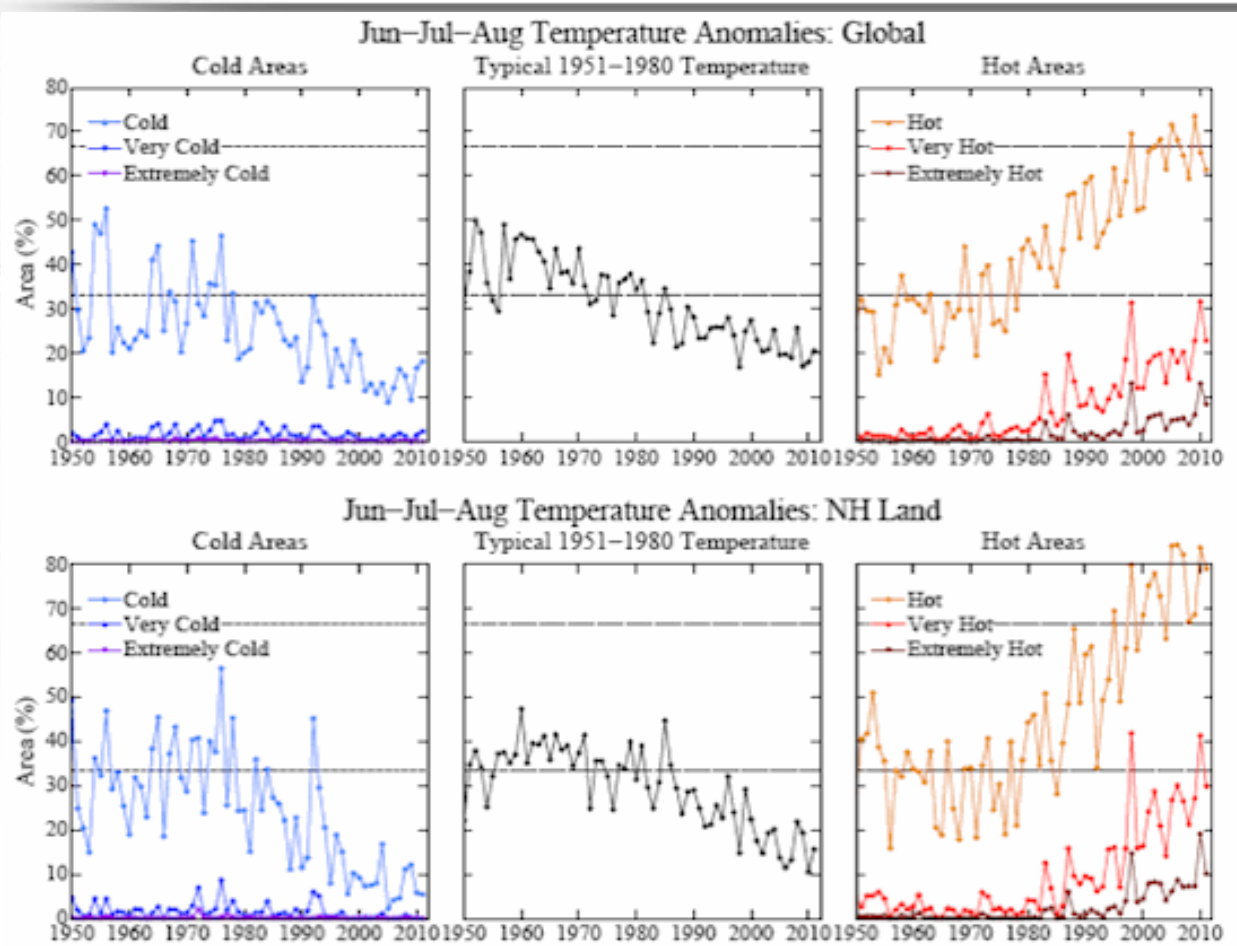


Fig. 5. Area of the world covered by temperature anomalies in the categories defined as hot (> 0.43σ), very hot (> 2σ), and extremely hot (> 3σ), with analogous divisions for cold anomalies.

Source: Hansen, Satoa and Ruedyb **Perception of climate change** *PNAS August 6, 2012*

Changes in Global Extreme Temperatures

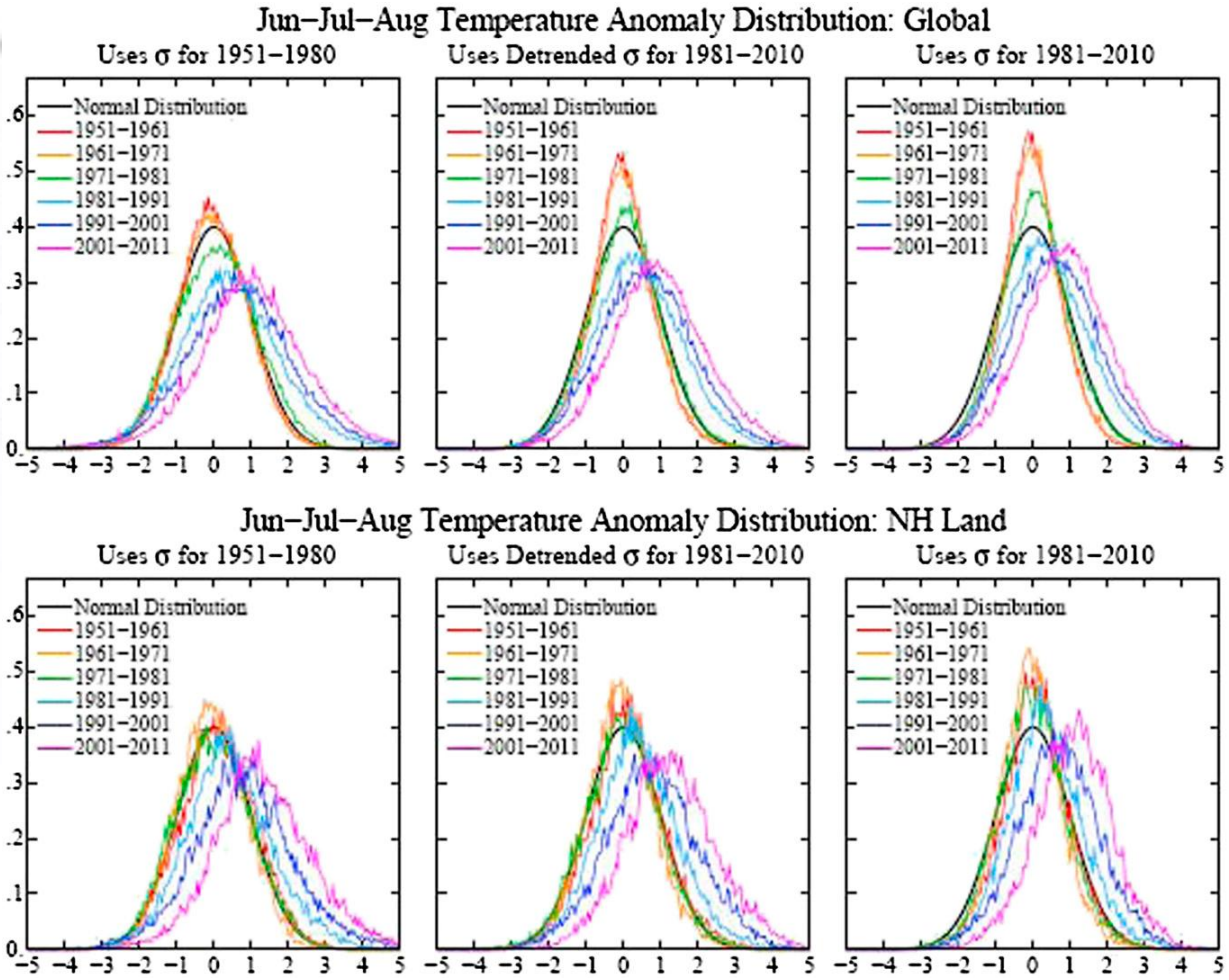
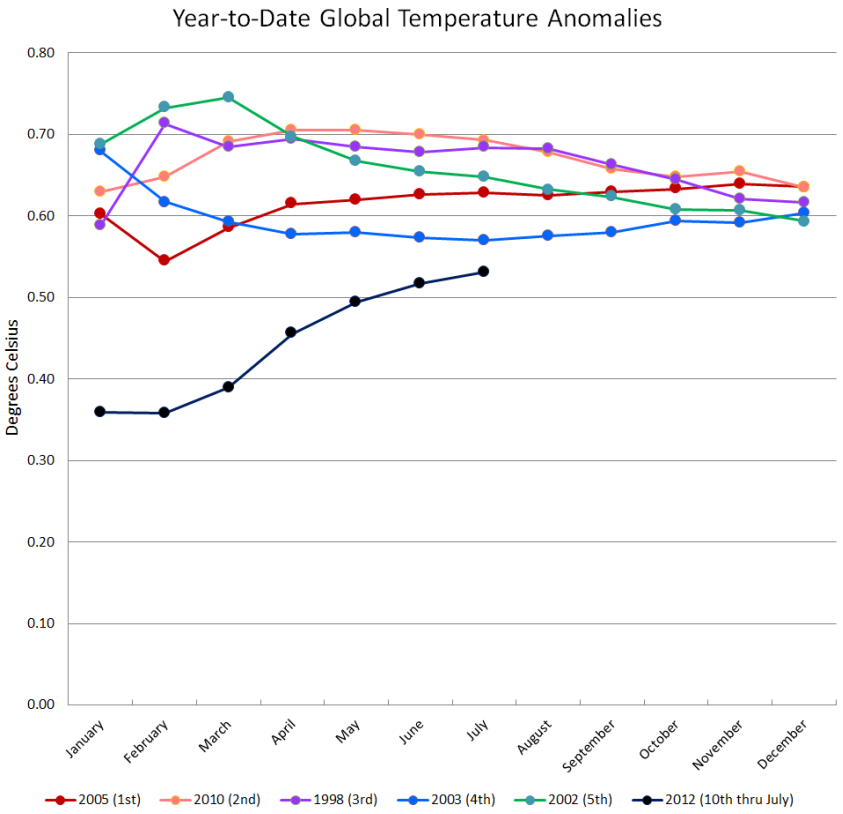


Fig. 4. Frequency of occurrence (y axis) of local temperature anomalies (relative to 1951–1980 mean) divided by local standard deviation (x axis) obtained by counting gridboxes with anomalies in each 0.05 interval. Area under each curve is unity.

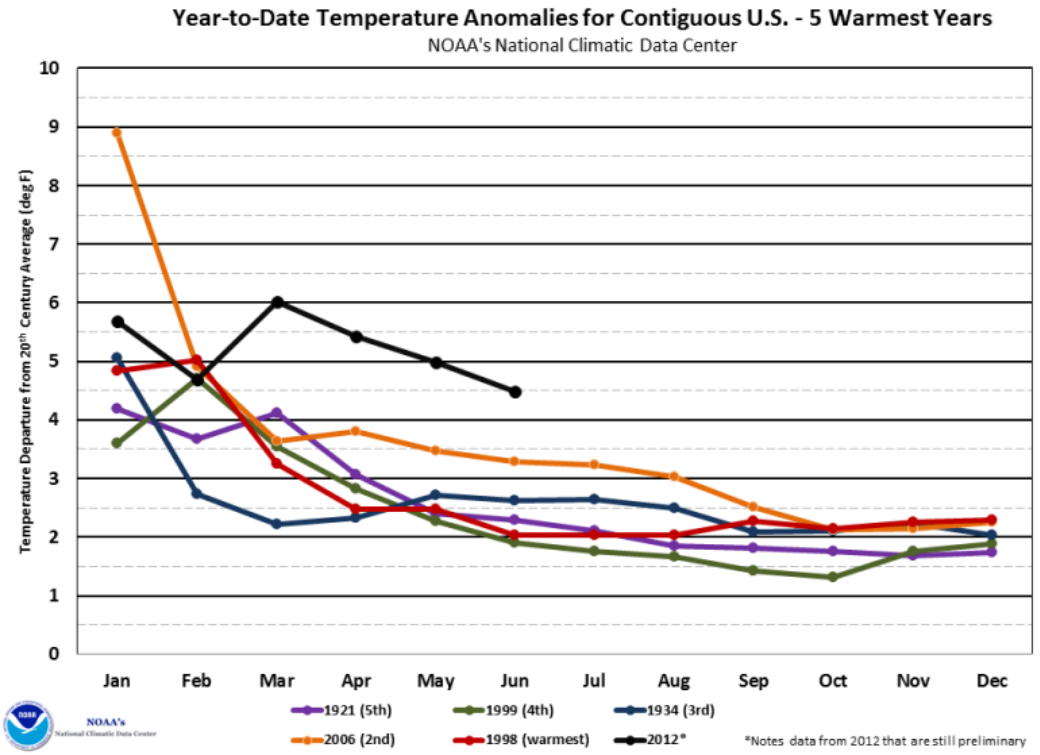
Source: Hansen, Satoa and Ruedyb **Perception of climate change** *PNAS August 6, 2012*

Global and US 5 warmest years and 2012



2010
2005
1998
2003
2002
2012 – tenth through July

2012 (through July)
1998
2006
1934
1999
1921



Changes in NH, US and SH Extreme Temperatures

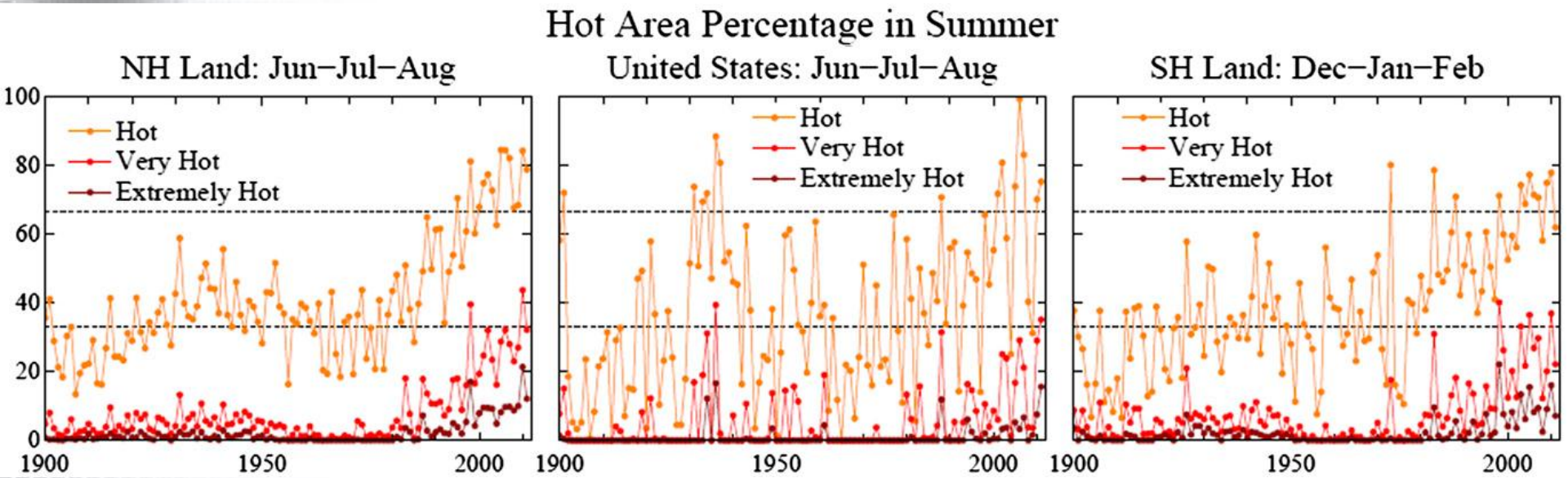
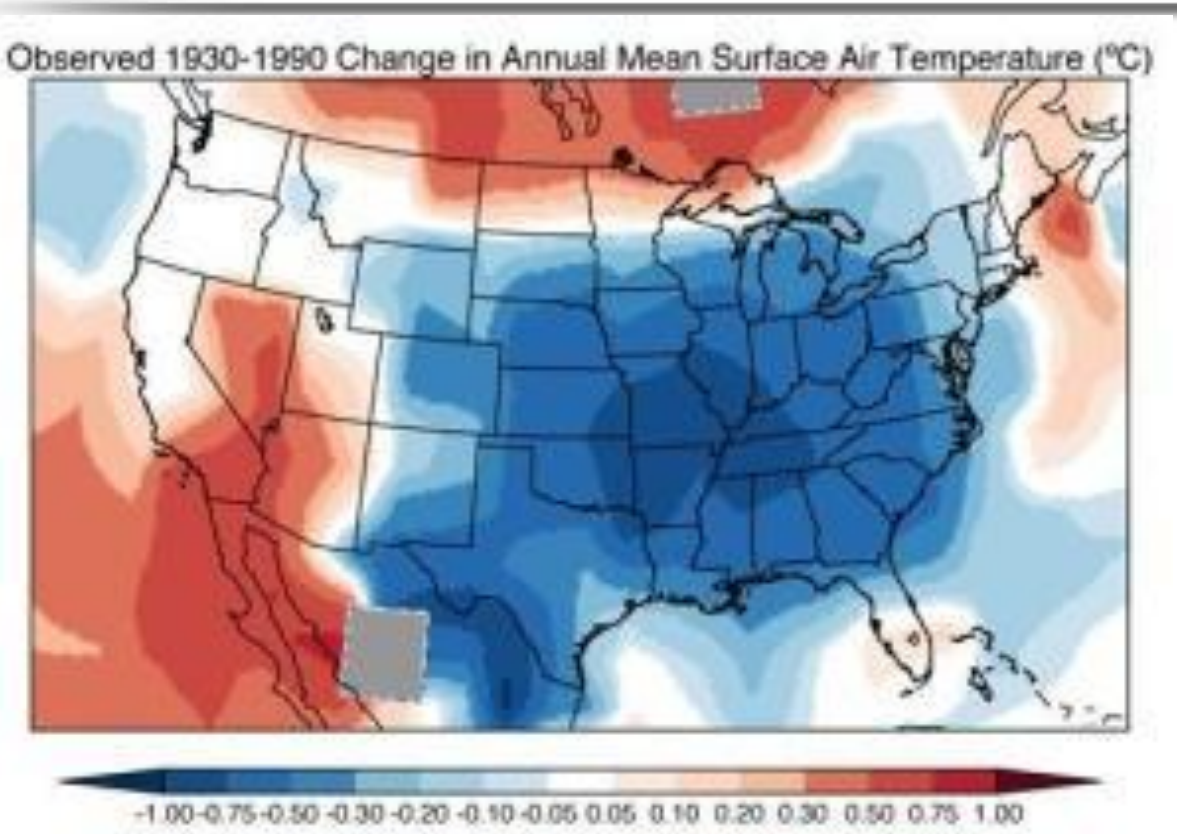


Fig. 7. Percent area covered by temperature anomalies in categories defined as hot (>0.43σ), very hot (>2σ), and extremely hot (>3σ). Anomalies are relative to 1951–1980 base period; σ is from 1951–1980 data.

Source: Hansen, Satoa and Ruedyb **Perception of climate change** *PNAS August 6, 2012*

What are some causes of the patterns we see in the United States?

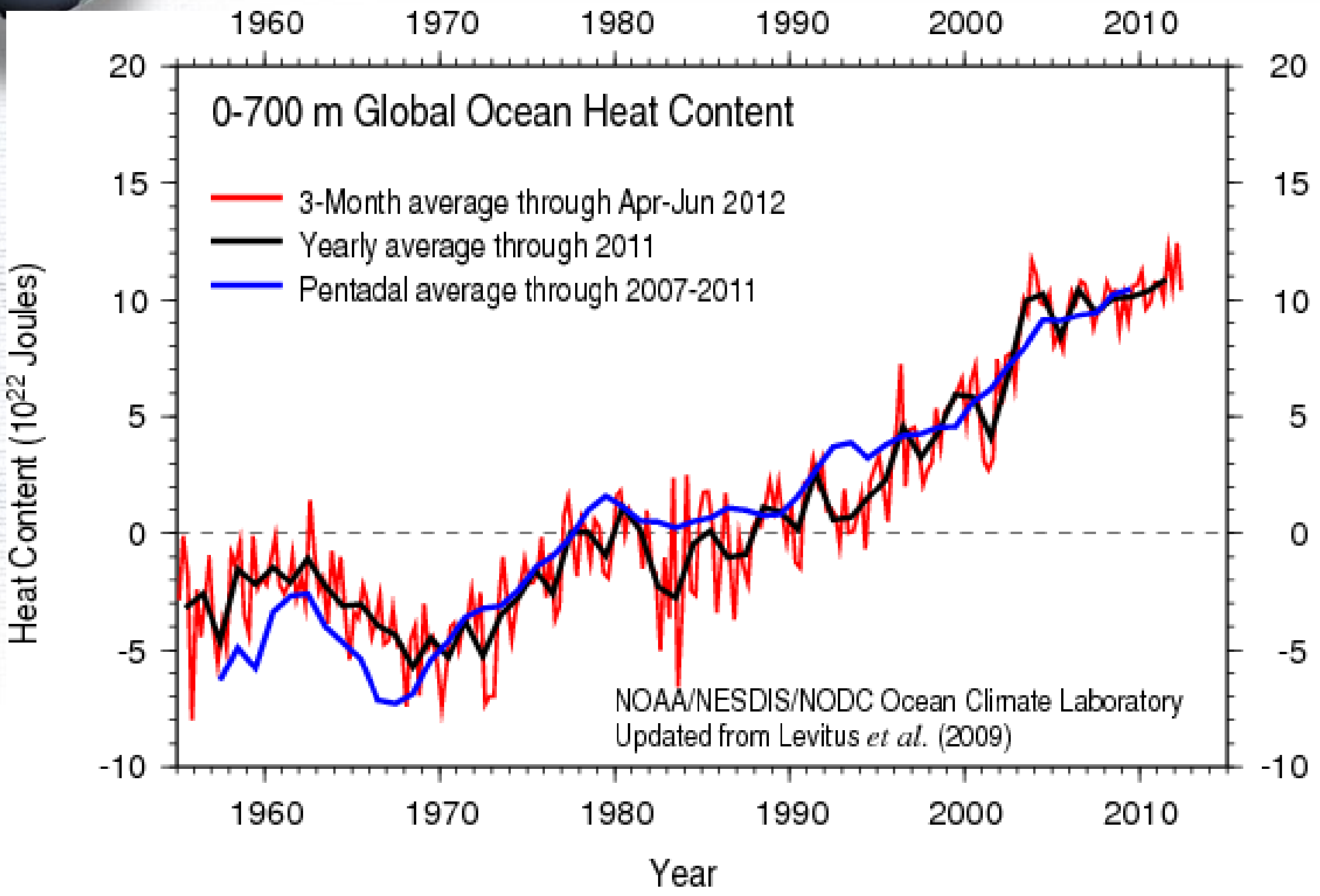
Observed Warming hole



Observed change in surface air temperature between **1930** and **1990**. Observations are from the NASA GISS Surface Temperature Analysis. (Credit: Image courtesy of Eric Leibensperger)

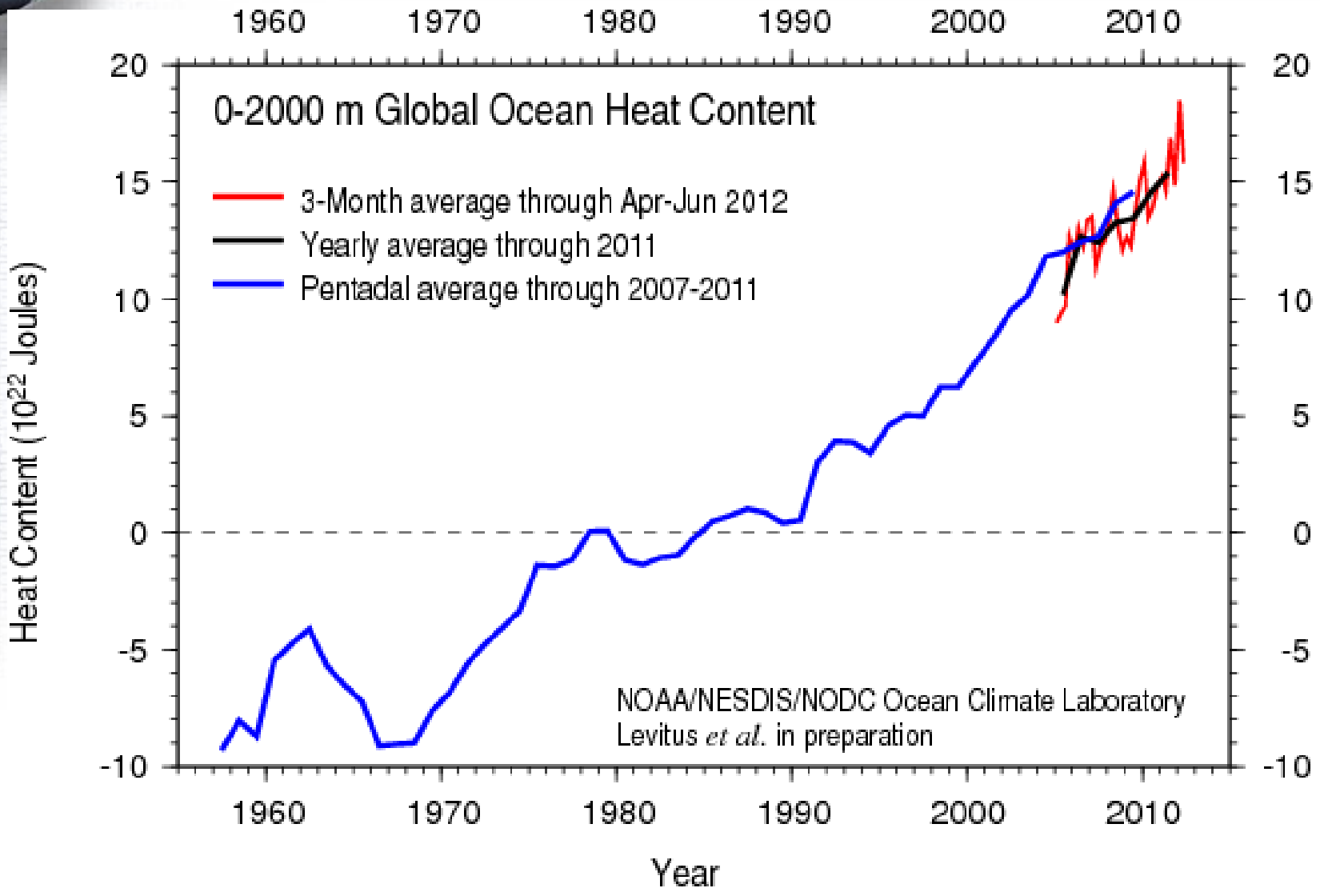
Source: http://www.sciencedaily.com/releases/2012/04/120426155117.htm

It's the Ocean. Stupid! – 700m Heat content



Source: NOAA http://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/

It's the Ocean. Stupid! – 2000m Heat content



Causes: Changes in Snow Climatology: Change between the last two climate periods

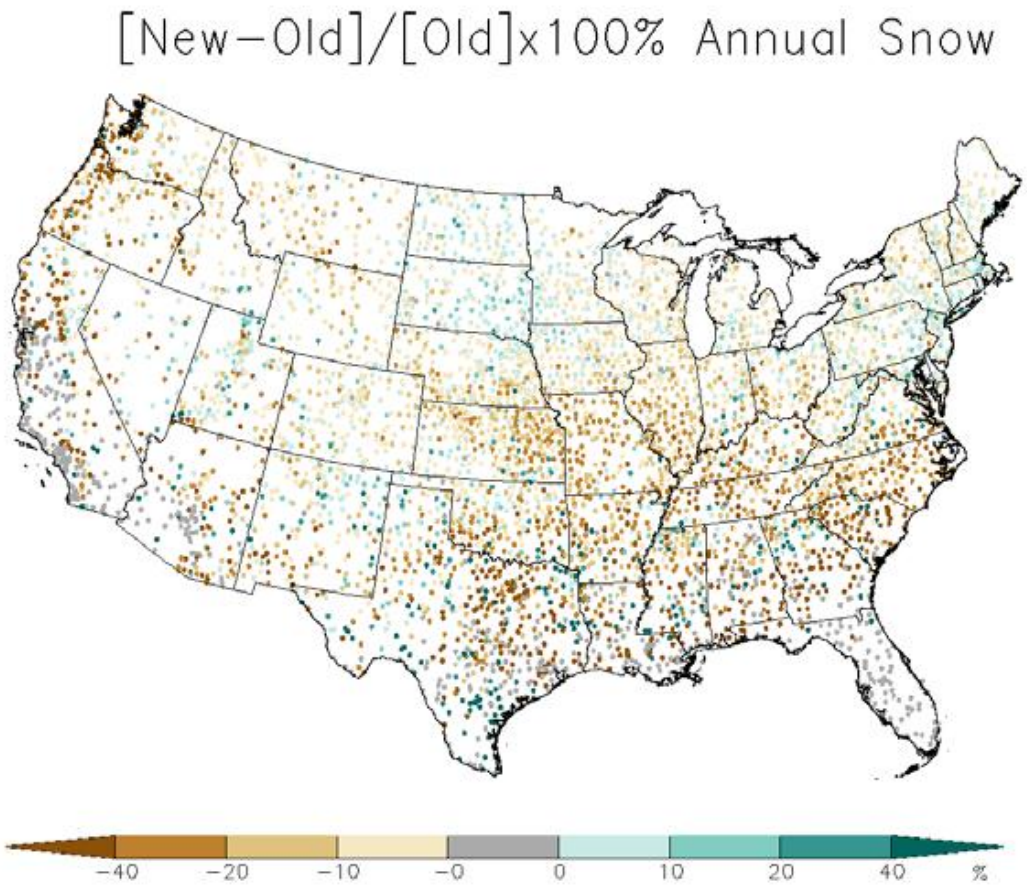
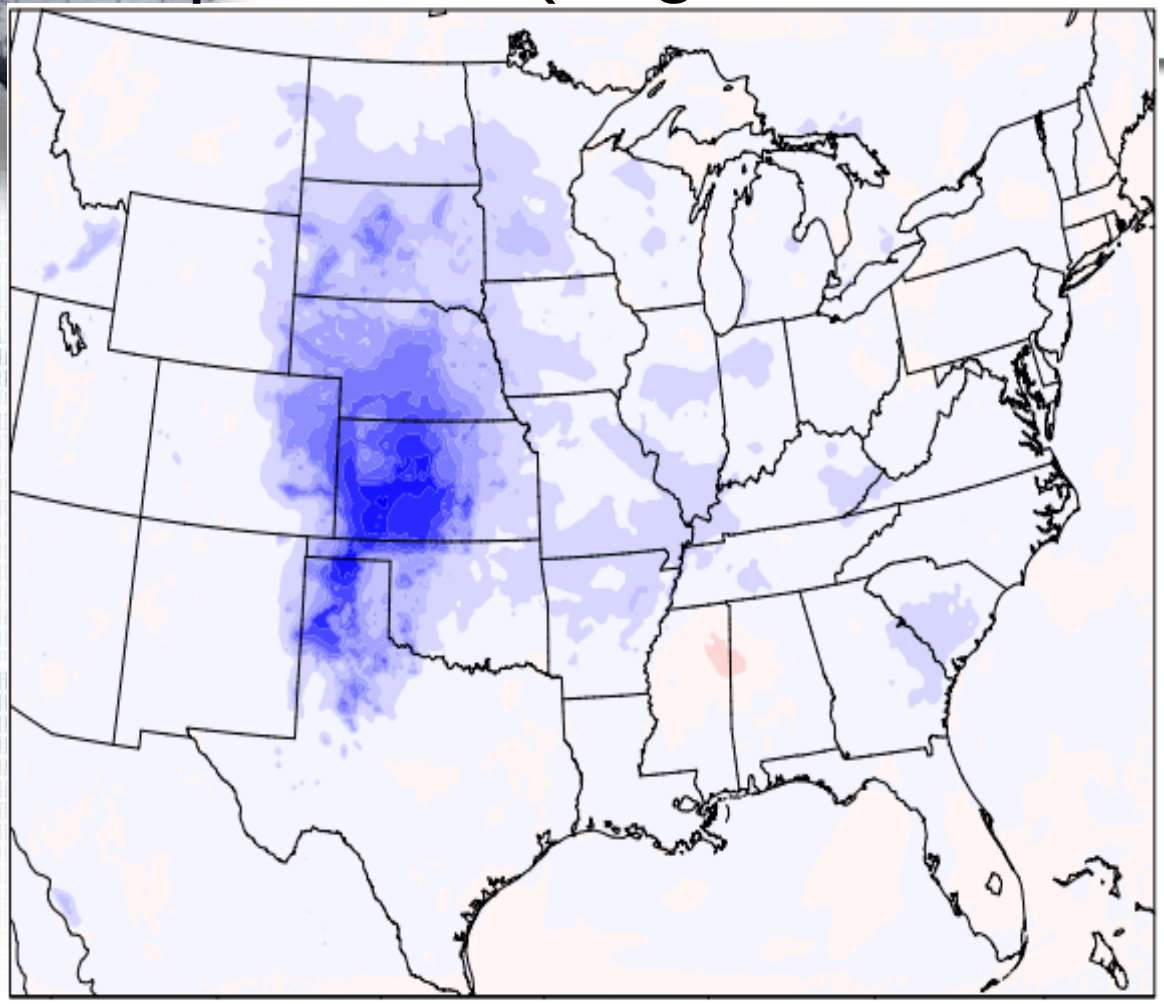
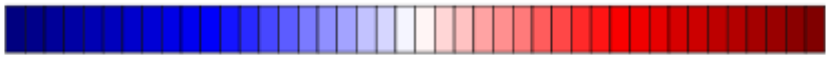


Figure 1: Percent difference between the 1981-2010 and 1971-2000 average annual snowfall totals across the contiguous United States. Both sets of averages are computed from GHCN-Daily using the methods employed for the 1981-2010 normals. At each location, the percent difference is calculated as the difference between the 1981-2010 and 1971-2000 normals, divided by the 1971-2000 normal. A positive difference indicates that the 1981-2010 snowfall normal is greater than the 1971-2000 normal at the same location.

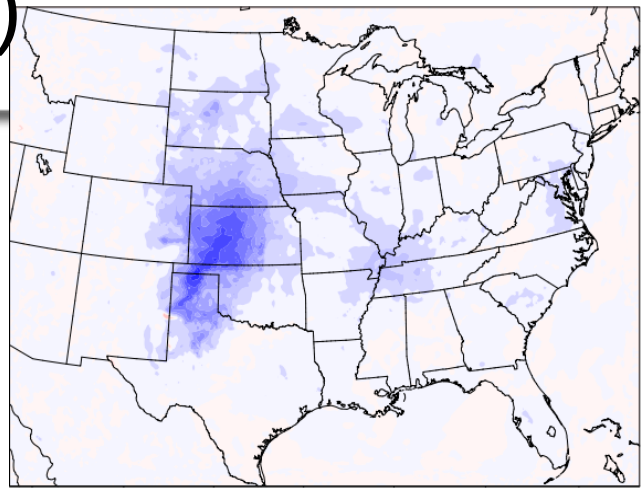
Source: WHAT'S NEW FOR SNOW IN NOAA'S 1981-2010 U.S. CLIMATE NORMALS? Durre, Squires, Vose, Arguez, Applequist, and Yin. NOAA NESDIS National Climatic Data Center, Asheville, North Carolina

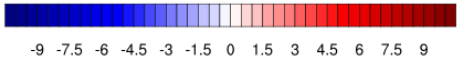
Temperature (irrigated – control)



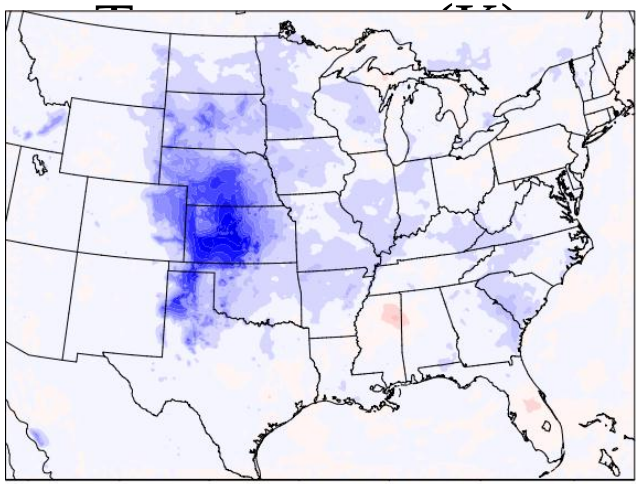


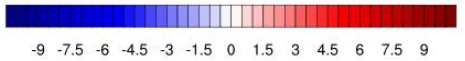
Average Temperature (K)





Minimum

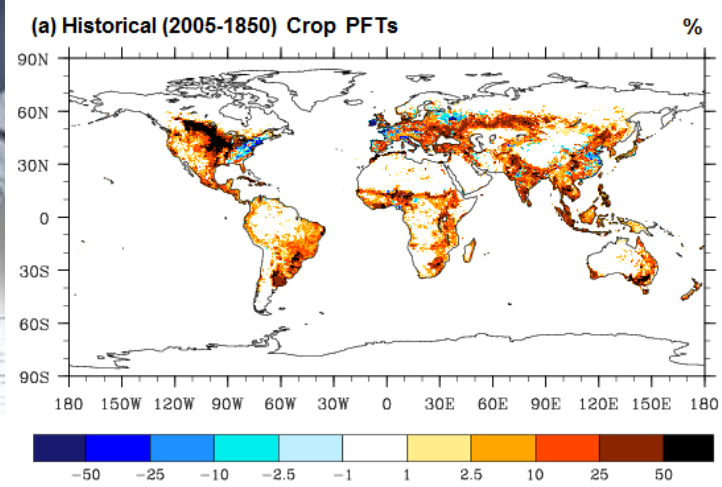


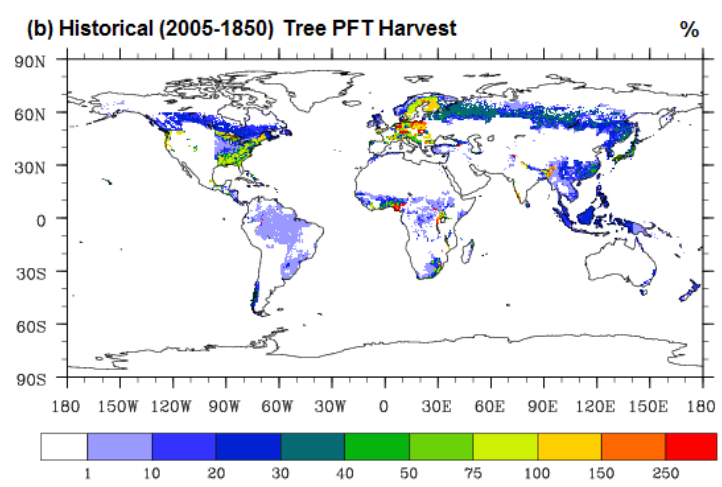


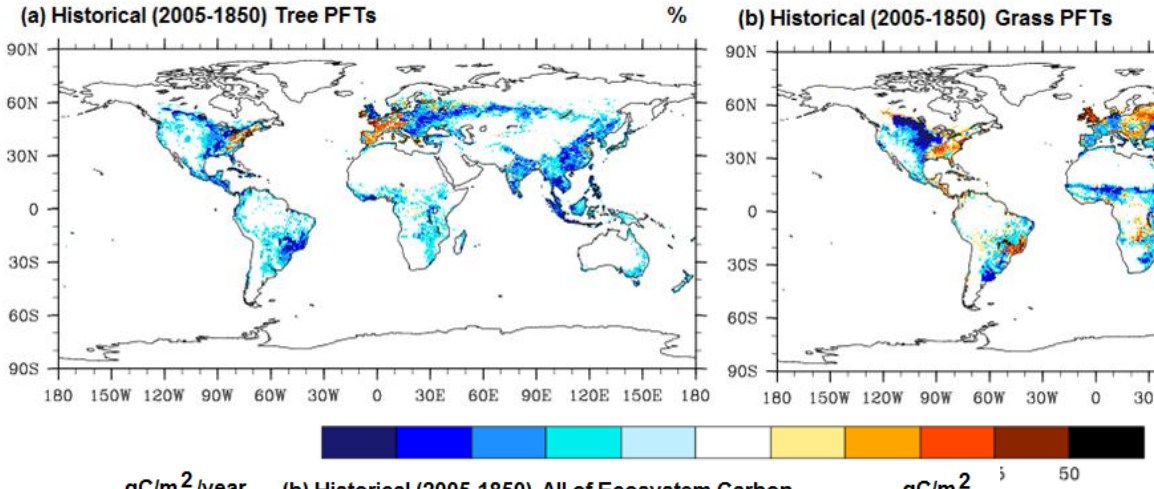
Max Temperature (K)

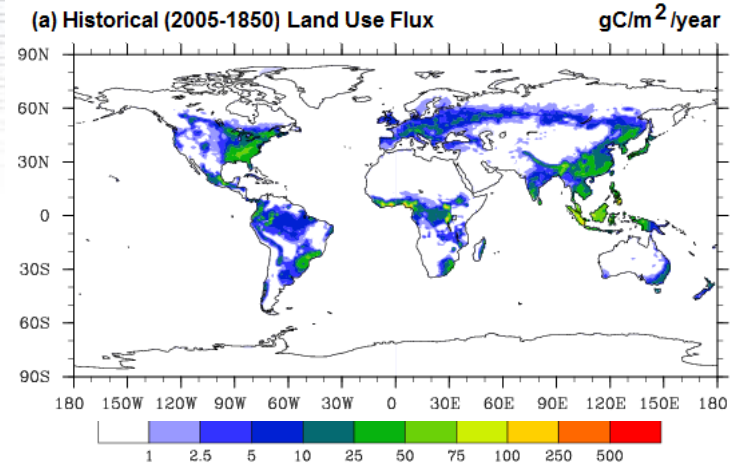
Source: Huber and Mechem Univ of Kansas

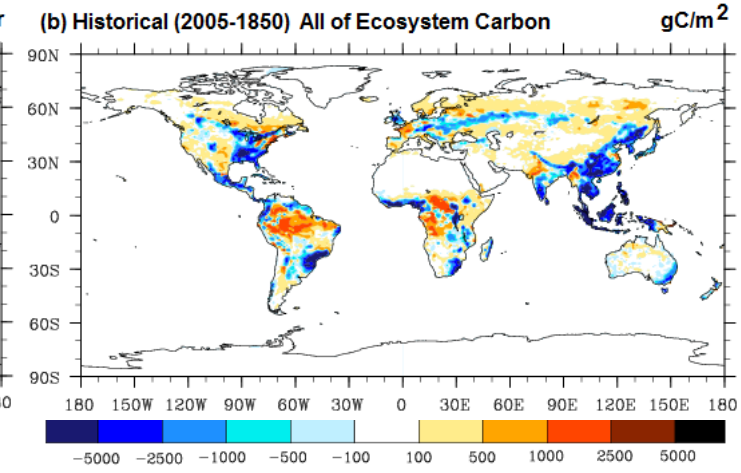
Historical
2005 - 1850





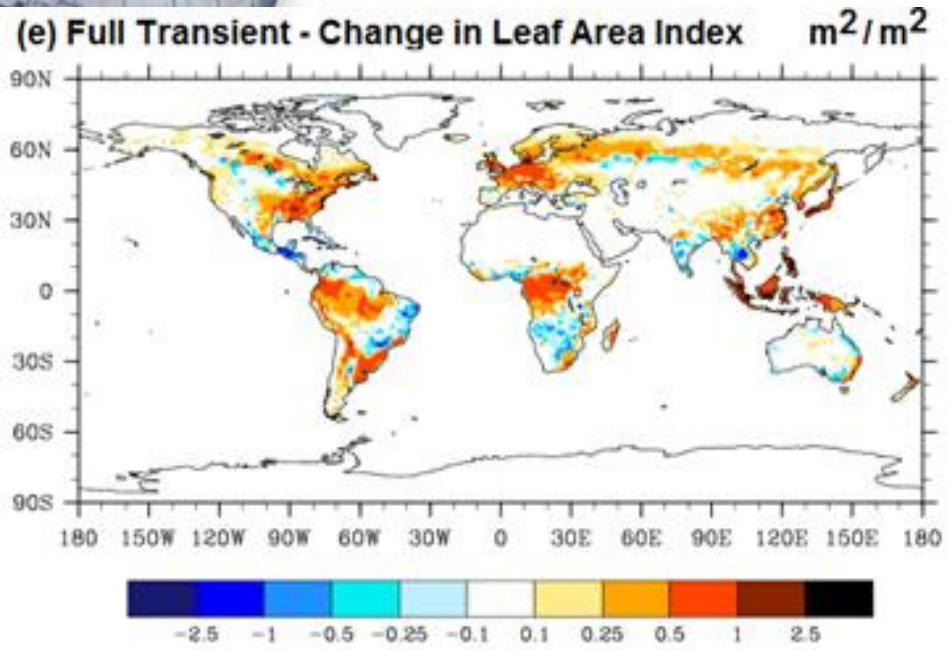


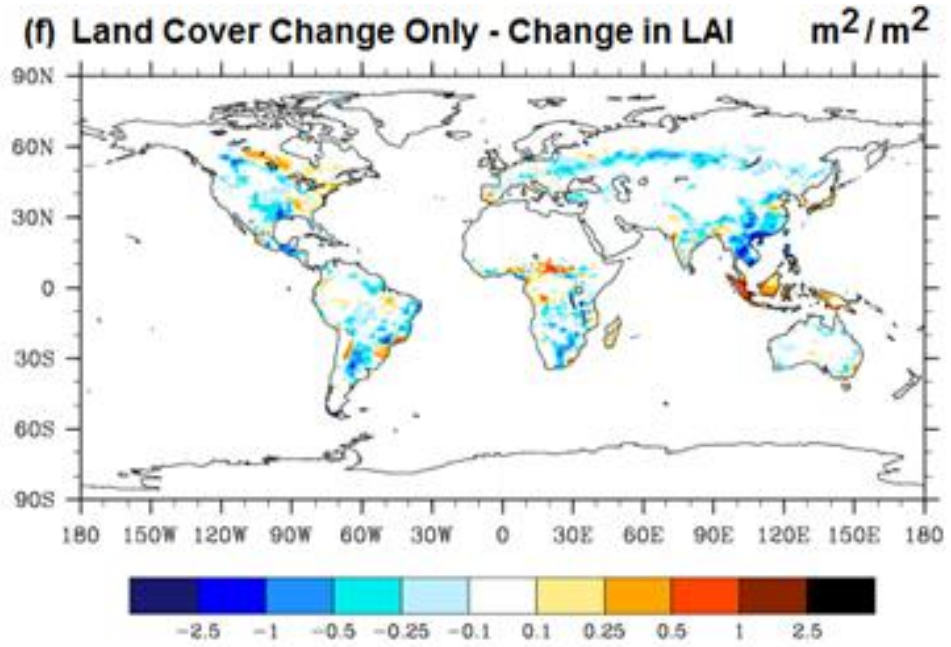


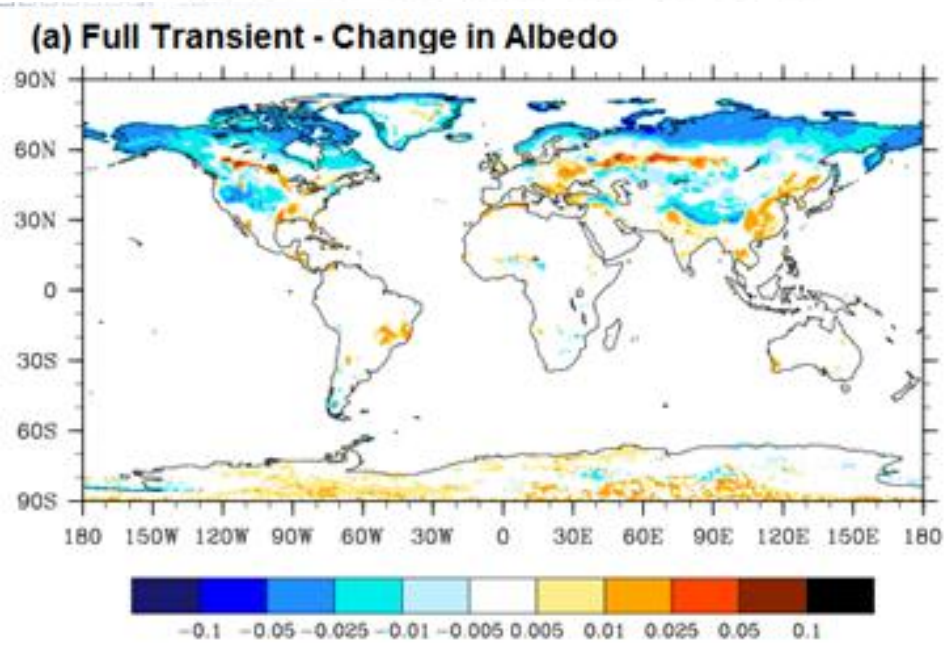


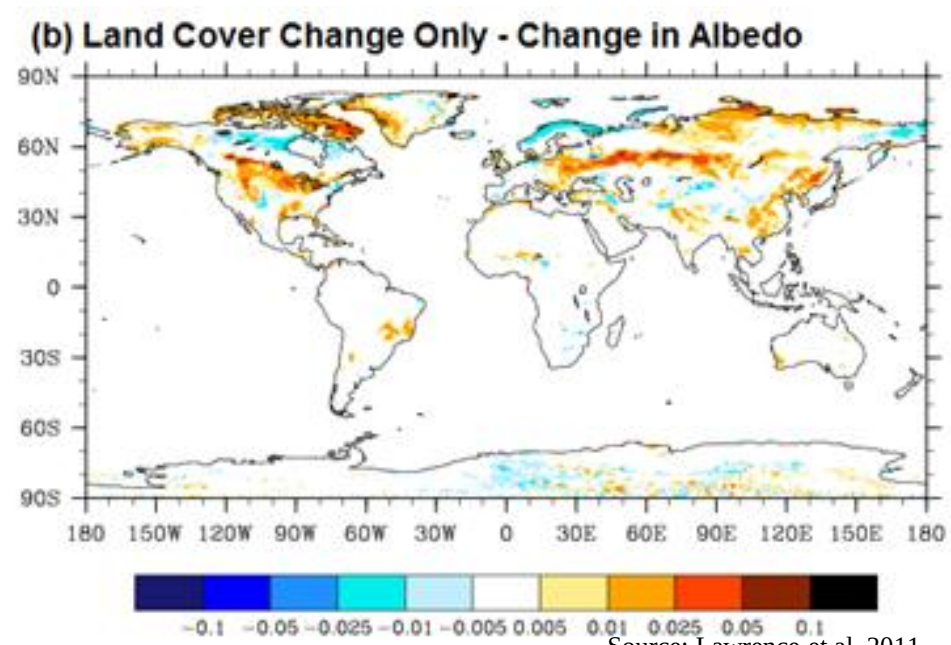
Source: Lawrence et al, 2011

Historical responses: Fully coupled vs Land cover only



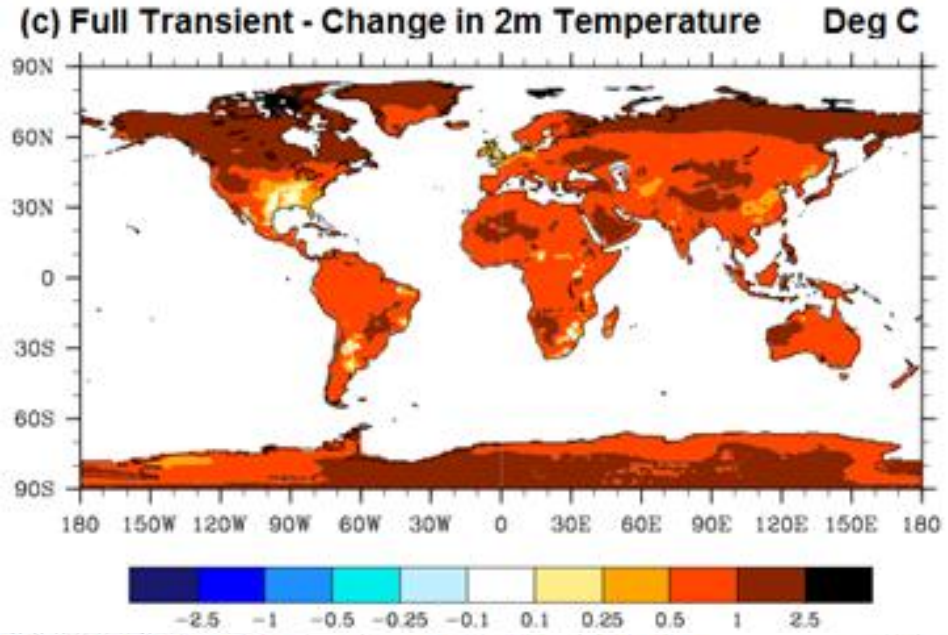


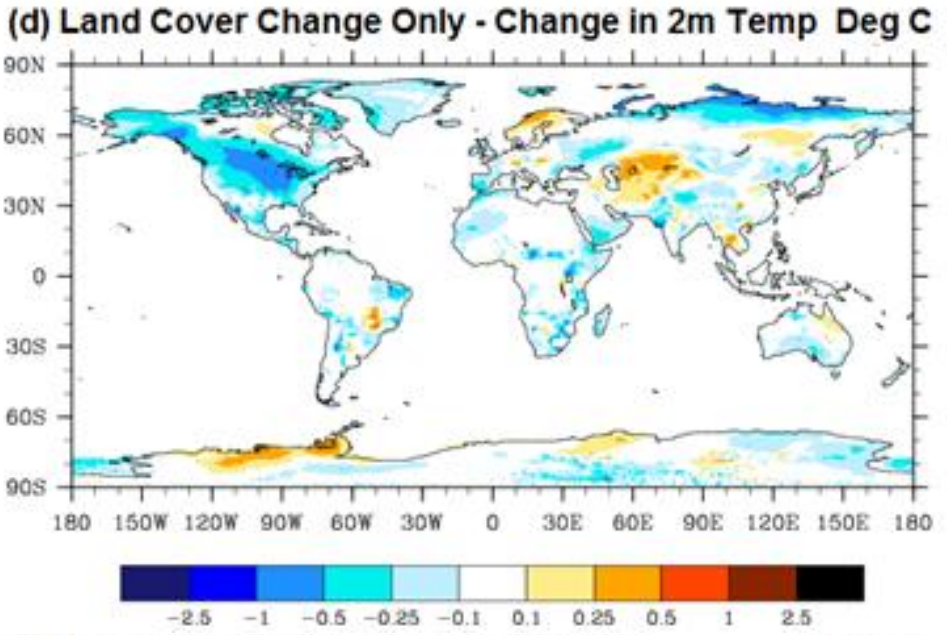


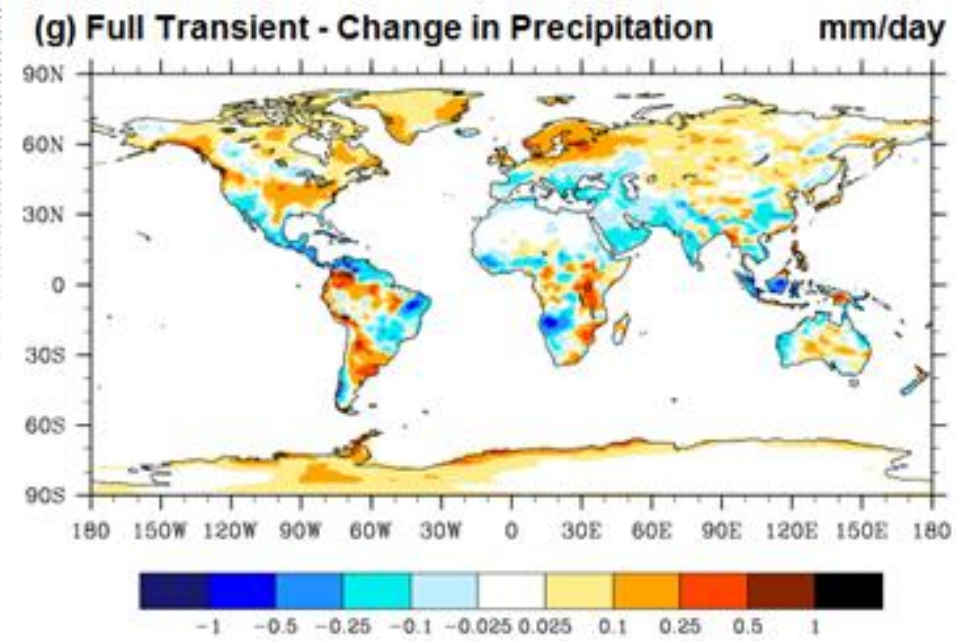


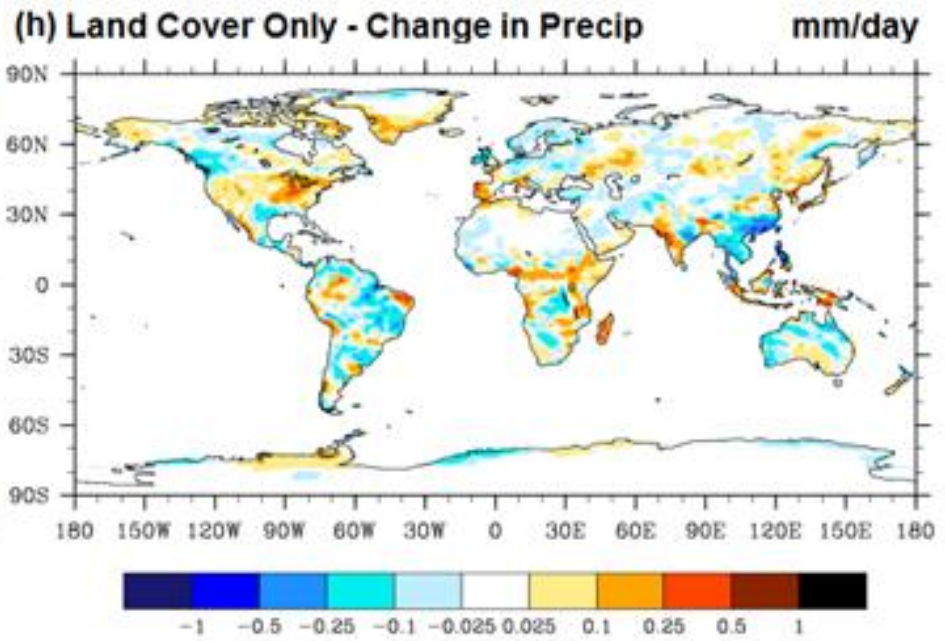
Source: Lawrence et al, 2011

Historical responses: Fully coupled vs Land cover only



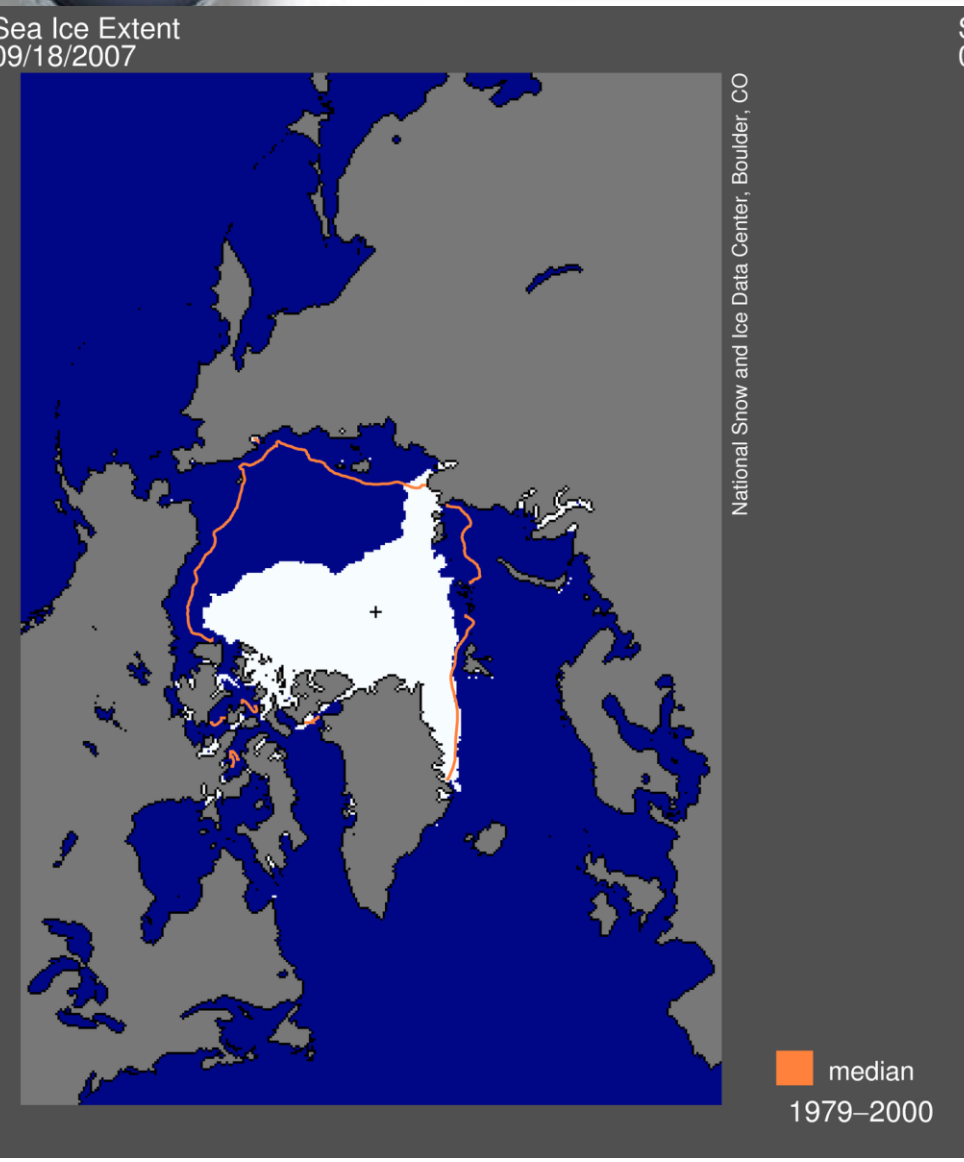


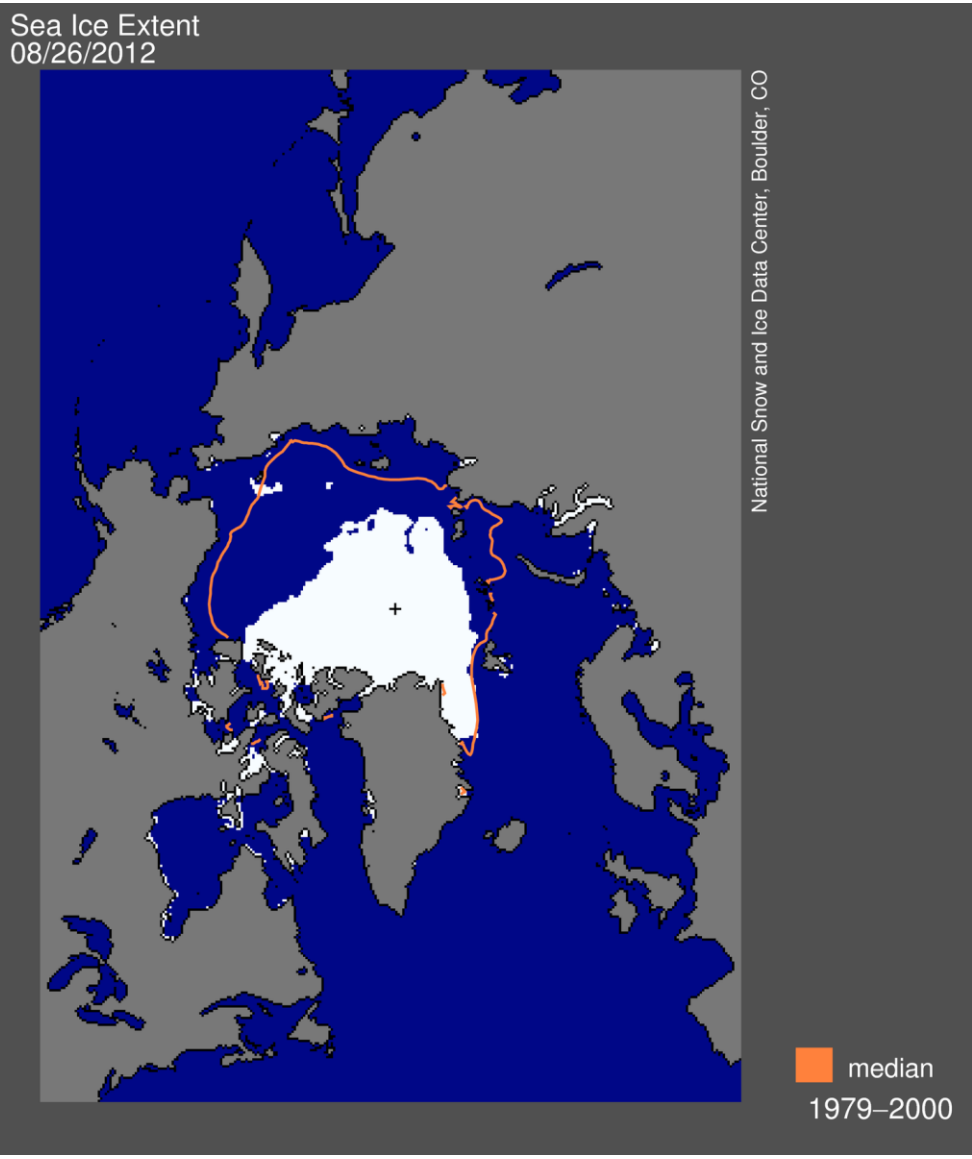




Source: Lawrence et al, 2011

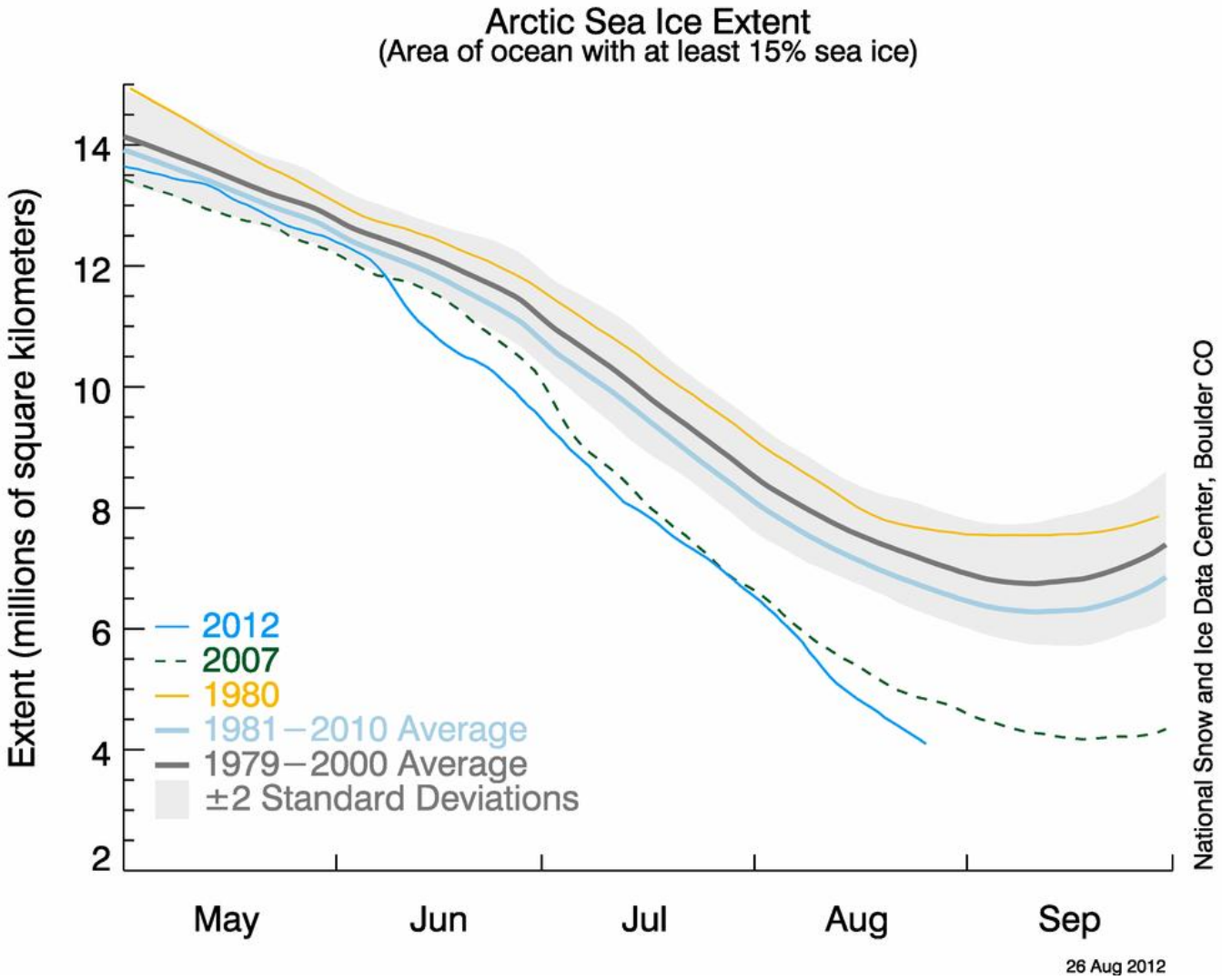
Arctic Sea Ice Extent 2007 vs 2012





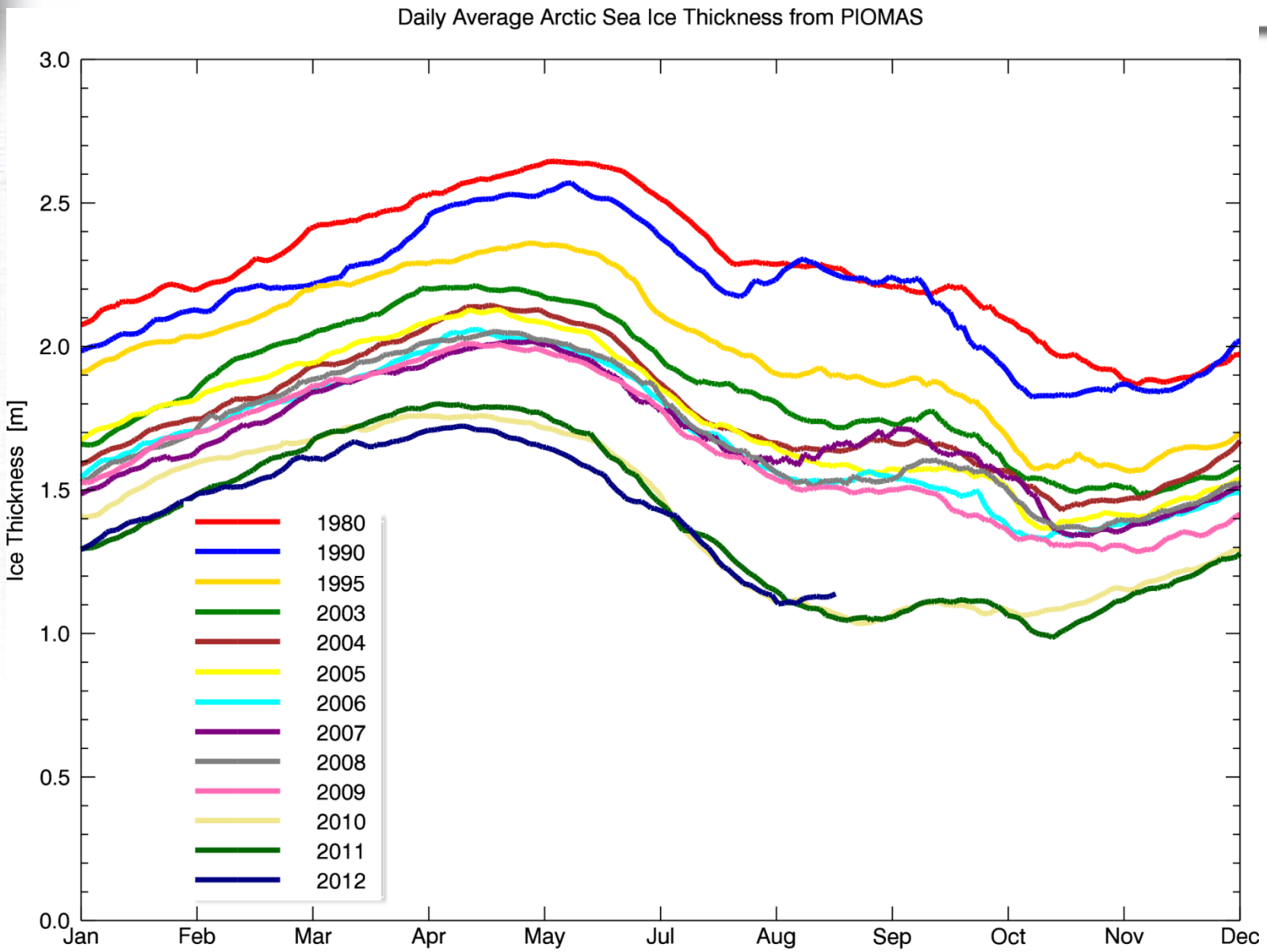
Source: NSIDC http://nsidc.org/arcticseaicenews/

Arctic Sea Ice AREA



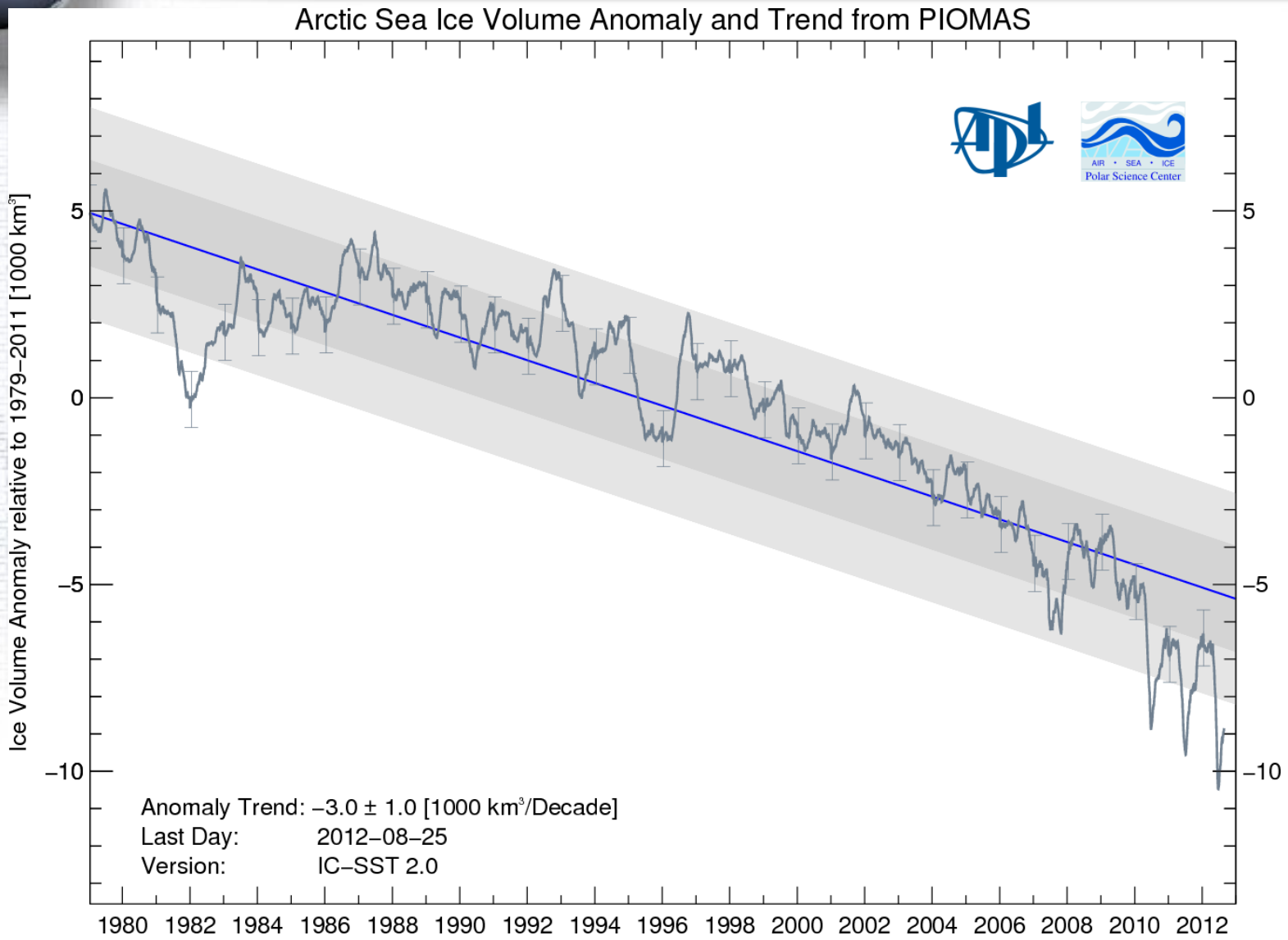
Source: NSIDC http://nsidc.org/arcticseaicenews/

Arctic Sea ice THICKNESS



Source: http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly/

Arctic sea ice VOLUME

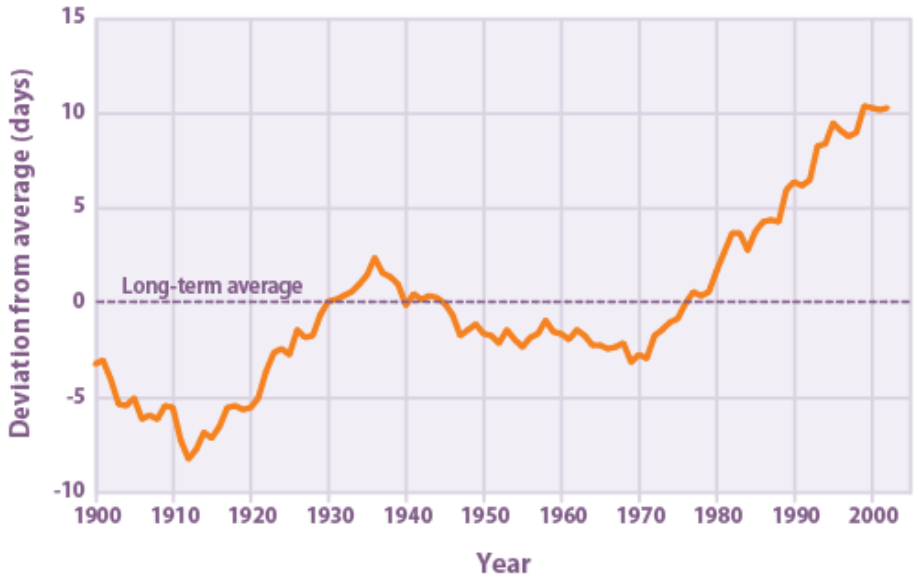


Source: http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly/

If you are not convinced?

Changes in the growing season

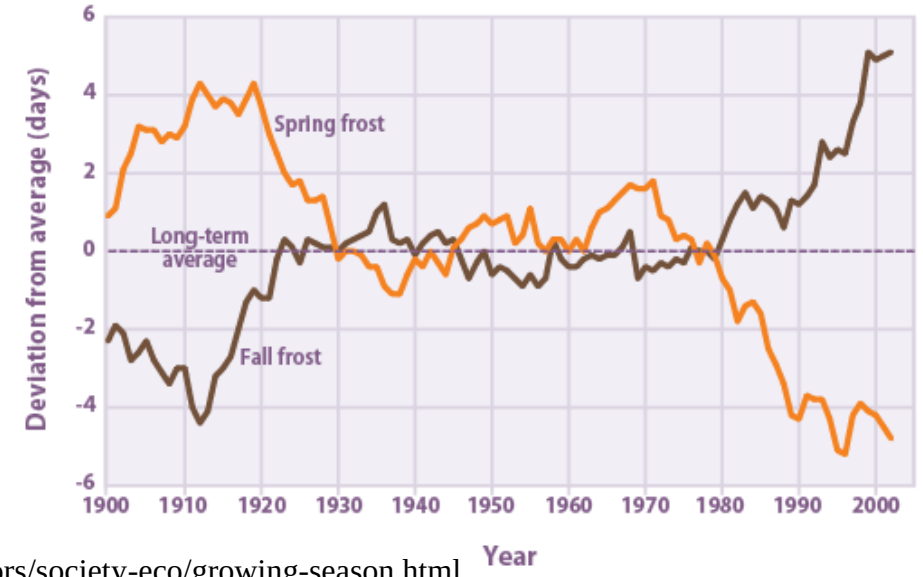
Figure 1. Length of Growing Season in the Lower 48 States, 1900–2002



Length of the growing season in the lower 48 states compared with a long-term average. For each year, the line represents the number of days shorter or longer than average. The trend line was smoothed using an 11-year moving average. Choosing a different long-term average for comparison would not change the shape of the trend

Timing of the last spring frost and the first fall frost in the lower 48 states compared with a long-term average. Positive values indicate that the frost occurred later in the year, and negative values indicate that the frost occurred earlier in the year. The trend lines were smoothed using an 11-year moving average.

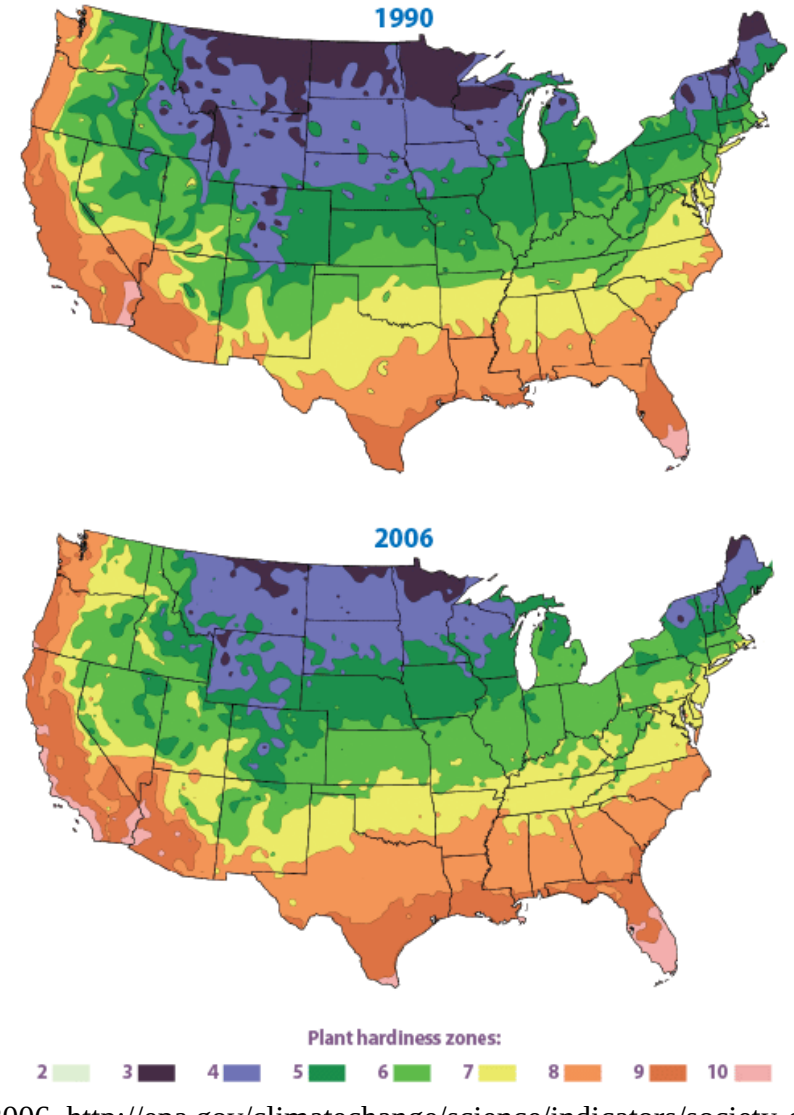
Figure 3. Timing of Last Spring Frost and First Fall Frost in the Lower 48 States, 1900–2002



Source: EPA: Kunkel, 2009 http://epa.gov/climatechange/science/indicators/society-eco/growing-season.html

Plant Hardiness

Figure 1. United States Plant Hardiness Zones, 1990 and 2006



Source: EPA : Arbor Day Foundation 2006 http://epa.gov/climatechange/science/indicators/society-eco/plant-zones.html

US Plant Phenology

Modeled trends in lilac and honeysuckle bloom dates across the lower 48 states, using the 1961 to 1990 average as a baseline. Positive values indicate that blooming occurred later in the year, and negative values indicate that blooming occurred earlier. The thicker line was smoothed using a nine-year weighted average. Choosing a different long-term average for comparison would not change the shape of the trend

Figure 1. First Leaf Dates in the Lower 48 States, 1900–2008

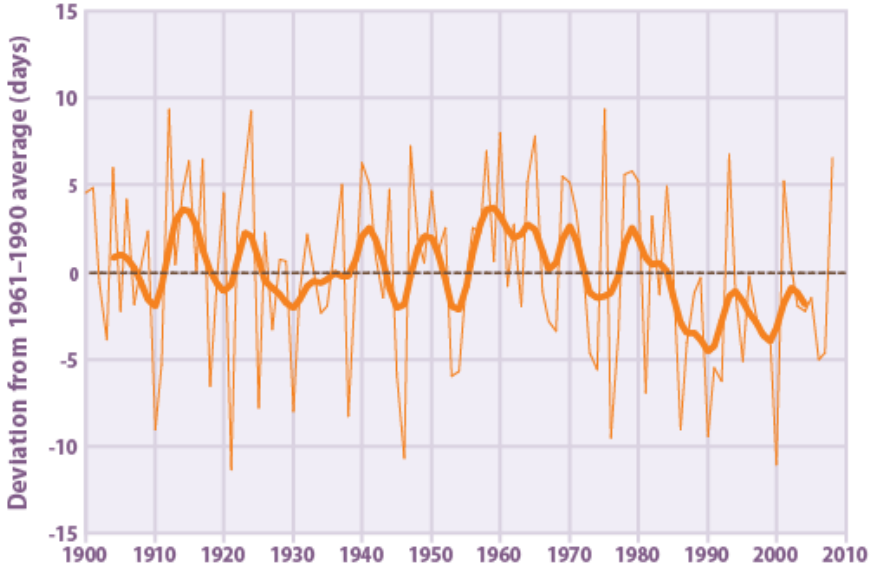
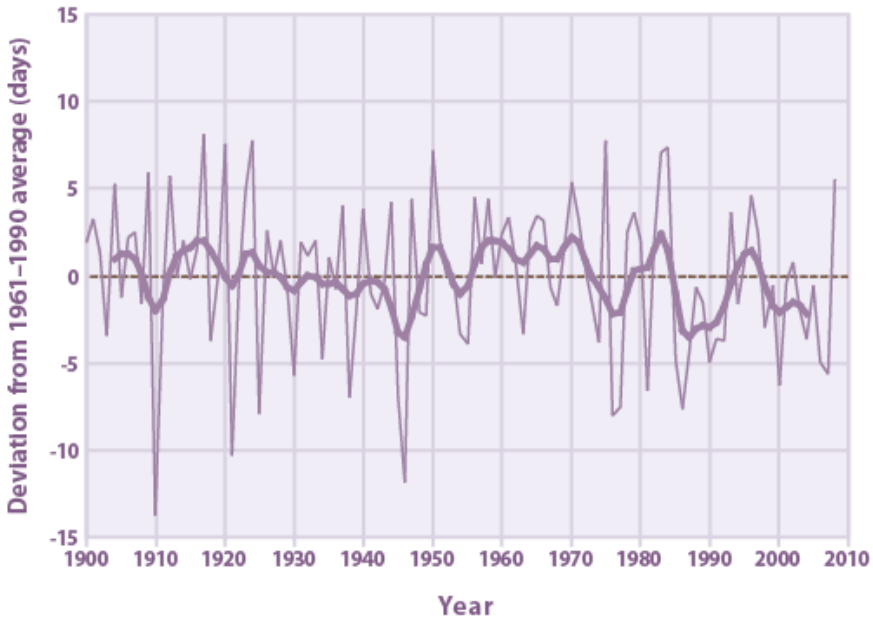


Figure 2. First Bloom Dates in the Lower 48 States, 1900–2008

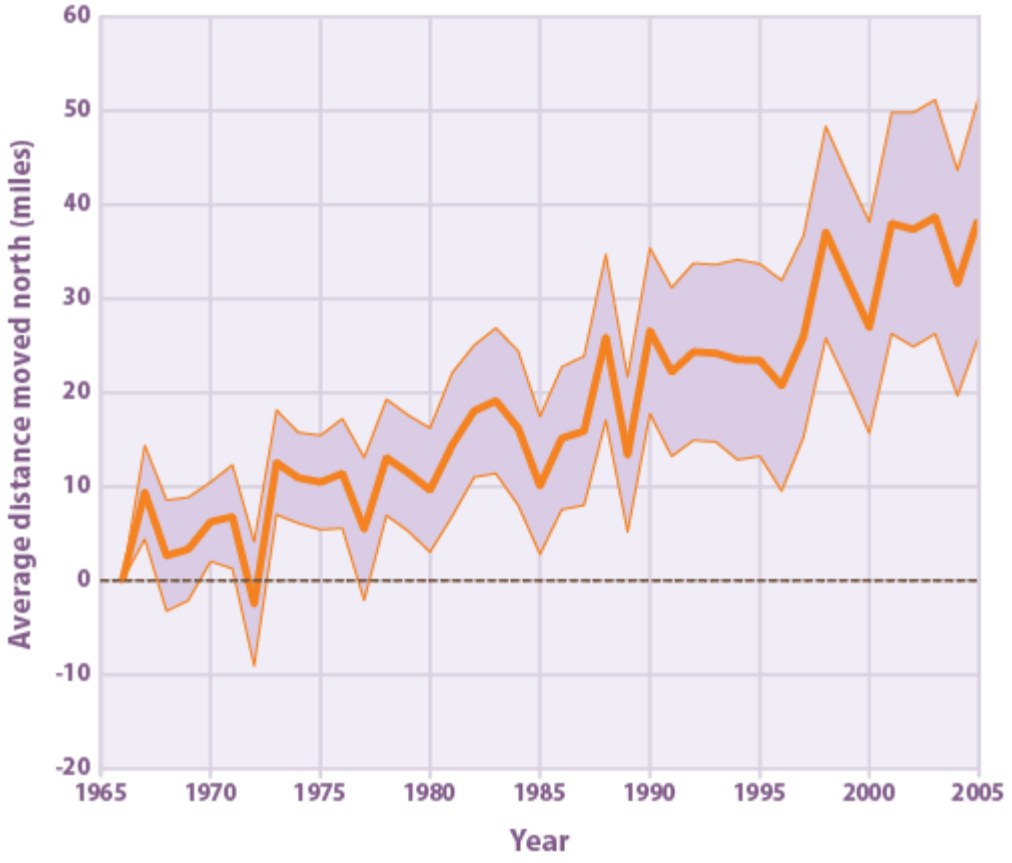


Source: EPA*:* Schwartz, 2009 http://epa.gov/climatechange/science/indicators/society-eco/leaf-bloom-dates.html

Changes in Bird Ranges 1966 to 2005

Annual change in latitude of bird center of abundance for 305 widespread bird species in North America from 1966 to 2005. Each winter is represented by the year in which it began (for example, winter 2005–2006 is shown as 2005). The shaded band shows the likely range of values, based on the number of measurements collected and the precision of the methods used.

Figure 1. Change in Latitude of Bird Center of Abundance, 1966–2005

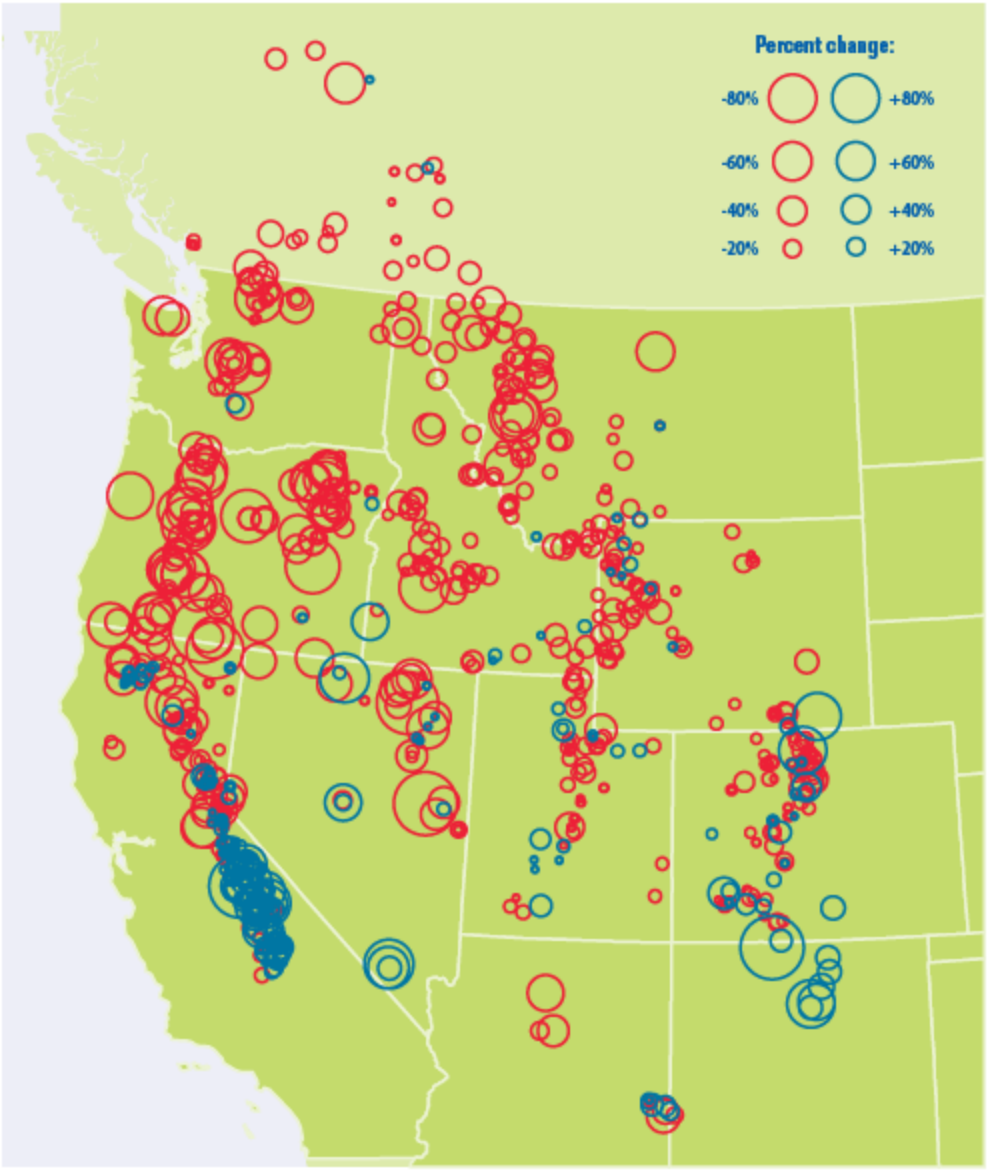


Source EPA: National Audubon Society, 2009 http://epa.gov/climatechange/science/indicators/society-eco/bird-ranges.html

Snow Pack

Trends in snow water equivalent in the western United States and part of Canada. Negative trends are shown by red circles and positive trends by blue.

Figure 1. Trends in April Snowpack in the Western United States and Canada, 1950–2000

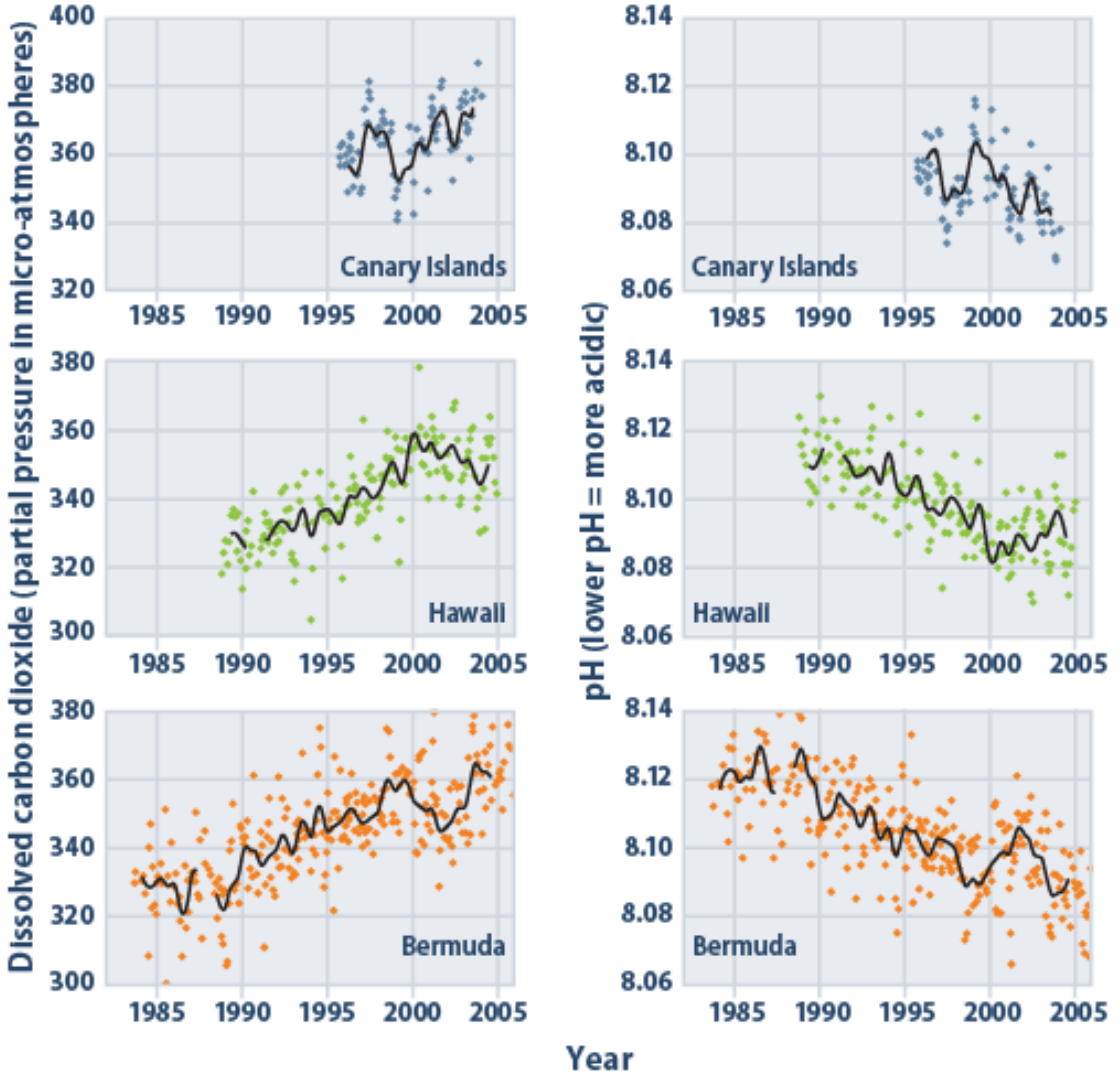


Source EPA: Mote, 2009 http://epa.gov/climatechange/science/indicators/snow-ice/snowpack.html

CO2 and Ocean acidity

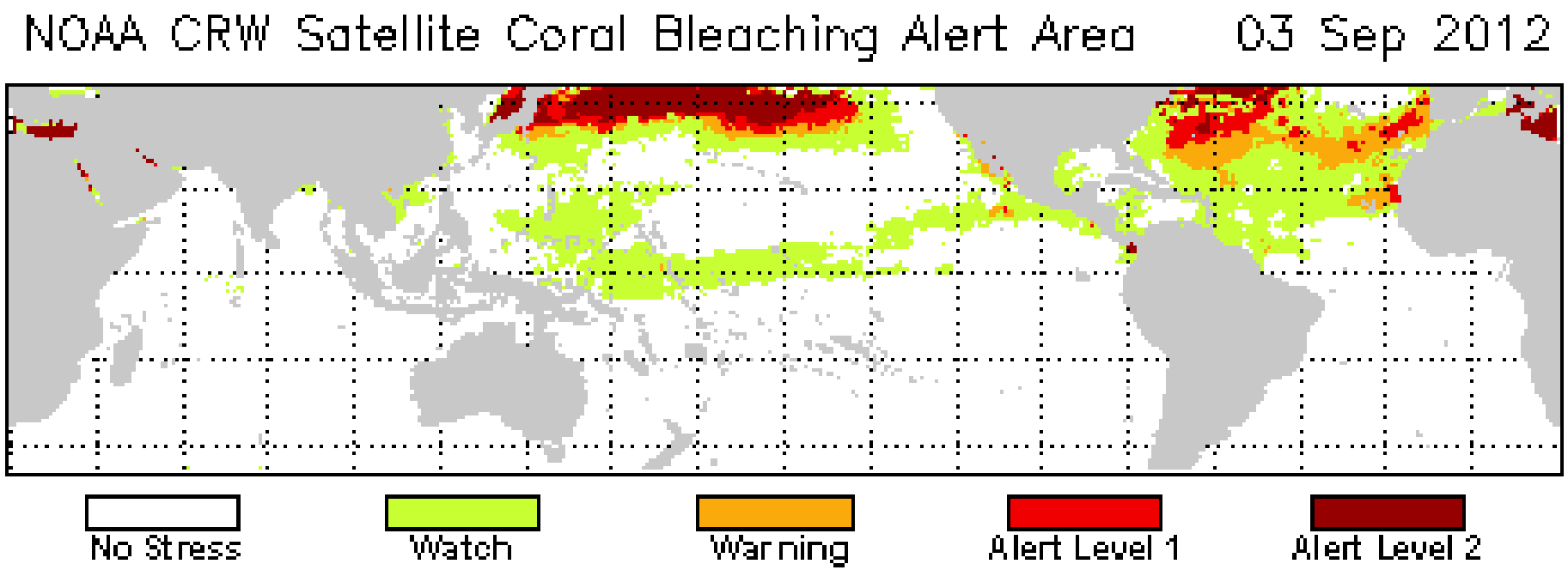
Changes in ocean carbon dioxide levels (measured as a partial pressure) and acidity (measured as pH). The data come from two observation stations in the North Atlantic Ocean (Canary Islands and Bermuda) and one in the Pacific (Hawaii). Dots represent individual measurements, while the lines represent smoothed trends.

Figure 1. Ocean Carbon Dioxide Levels and Acidity, 1983–2005



Source EPA: Bindoff et al, 2007 http://epa.gov/climatechange/science/indicators/snow-ice/snowpack.html

Now what!?


NOAA CRW Satellite Coral Bleaching Alert Area
03 Sep 2012
No Stress
Watch
Warning
Alert Level 1
Alert Level 2

Some last thoughts?

Implications of 2012?

Why 2013 will be a year of crisis

By **David Frum**, CNN Contributor
updated 11:01 AM EDT, Mon September 3, 2012

Rotting corn was damaged by severe drought on a farm near Bruceville, Indiana.

STORY HIGHLIGHTS

- David Frum: The drought in the U.S., Russia and Australia is driving up food prices
- He says sharp rises in prices have long been tied to unrest among the world's poor
- High prices have been cited as a cause of last year's upheaval in Egypt and Tunisia, he says
- Frum: The winner of November election in U.S. will have to deal with the consequences

Editor's note: *David Frum is a contributing editor at Newsweek and The Daily Beast and a CNN contributor. He is the author of seven books, including a new novel, "Patriots."*

(CNN) -- Prediction: 2013 will be a year of serious global crisis. That crisis is predictable, and in fact has already begun. It will inescapably confront the next president of the United States. Yet this emerging crisis got not a mention at the Republican National Convention in Tampa. We'll see if the Democrats do better.

The crisis originates in this summer's extreme weather. Almost 80% of the continental United States experienced drought conditions. Russia and Australia experienced drought as well.

The drought has ruined key crops. The corn harvest is expected to drop to the lowest level since 1995. In just July, prices for corn and wheat jumped about 25% each, prices for soybeans about 17%.

David Frum

These higher grain prices will flow through to higher food prices. For consumers in developed countries, higher food prices are a burden -- but in almost all cases, a manageable burden.

Americans spend only about 10% of their after-tax incomes on food of all kinds, including restaurant meals and prepackaged foods. Surveys for Gallup find that the typical American family is spending one-third less on food

Part of complete coverage on
Opinion on the news

What Democrats need to do in Charlotte
updated 8:51 AM EDT, Mon September 3, 2012

Julian Zelizer says it's not enough for President Obama to criticize Romney's stands or blame Bush; he needs to defend his record.

Politics of Clint Eastwood's empty chair
updated 10:42 AM EDT, Mon September 3, 2012

John Avlon says the empty chair was a symbol of everything that's wrong with the presidential campaigns.

Why 2013 will be a year of crisis
updated 11:01 AM EDT, Mon September 3, 2012

David Frum says the drought is driving up world food prices and history suggests that is likely to produce unrest within poor nations.

Romney and the politics of pandering
updated 10:20 PM EDT, Sat September 1, 2012

Mitt Romney is doing in 2012 what Barack Obama did four years ago -- pandering to voters to seek election -- but

Holcomb?