

# State of the Climate: Recent Developments

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# NCDC Climate Monitoring Branch

<http://www.ncdc.noaa.gov/climate-monitoring>

- NCDC: Asheville, NC since 1951
- CMB est. 1998
  - Provides regular “State of the Climate” reports
  - Mission: “monitor and assess the state of the climate”
  - We deal in data – the *observed* climate. This approach complements, informs and draws from larger climate science (the *understood* climate)



# Two modes of Climate Monitoring



# Essential Climate Variables

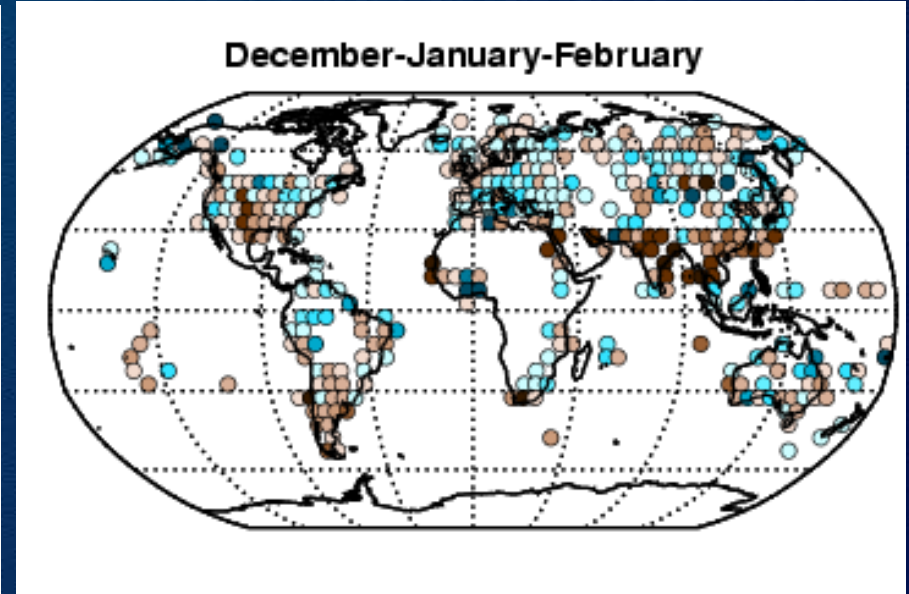
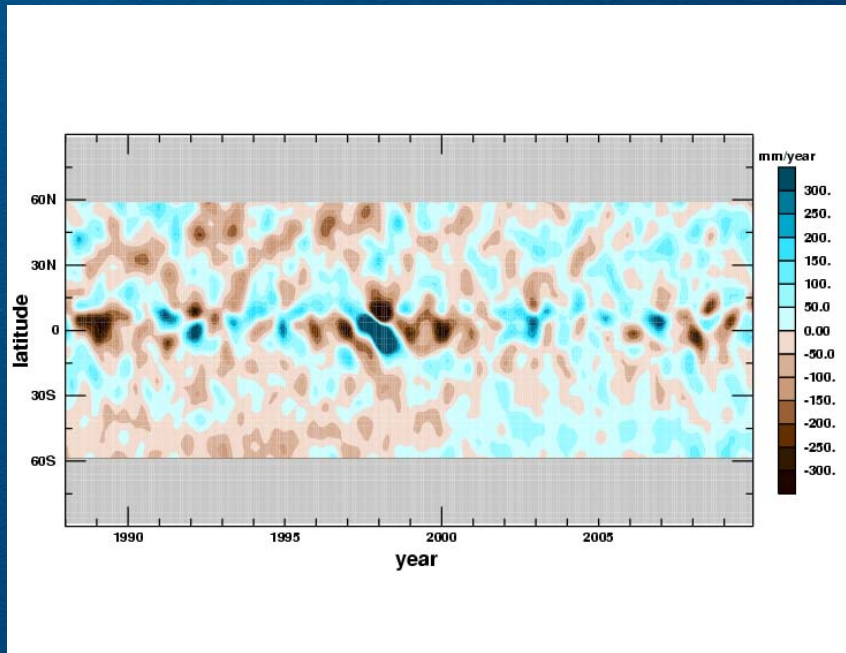
Atmosphere: Surface	Atmosphere: Upper-Air	Atmosphere: Composition	Ocean: Surface	Ocean: Subsurface	Terrestrial
Air Temperature	Earth Rad'n Budget	Carbon Dioxide	Temperature	Temperature	Soil Moisture
Precipitation	Temperature	Methane	Salinity	Salinity	Snow Cover
Air Pressure	Wind Speed & Dir	Ozone	Sea Level	Current	Permafrost + Seasonally Frozen
Sfc Rad'n Budget	Water Vapor	Nitrous Oxide	Sea State	Nutrients	Glaciers + Ice Caps
Wind Speed & Dir	Cloud Properties	CFCs	Sea Ice	Carbon	River Discharge
Water Vapor		Hydro CFCs	Current	Ocean Tracers	Water Use
		Hydrofluorocarbs	Ocean Color	Phytoplankton	Ground Water
		Sulfur Hexafluorides	CO <sub>2</sub> Partial Pressure		Lake Levels
		Perfluorocarbons			Albedo
		Aerosol Properties			Land Cover
					Percent Absorbed Photosynthetically Active Radiation
					Leaf Area Index
					Biomass
					Fire Disturbance



# Leveraging Relative Strengths

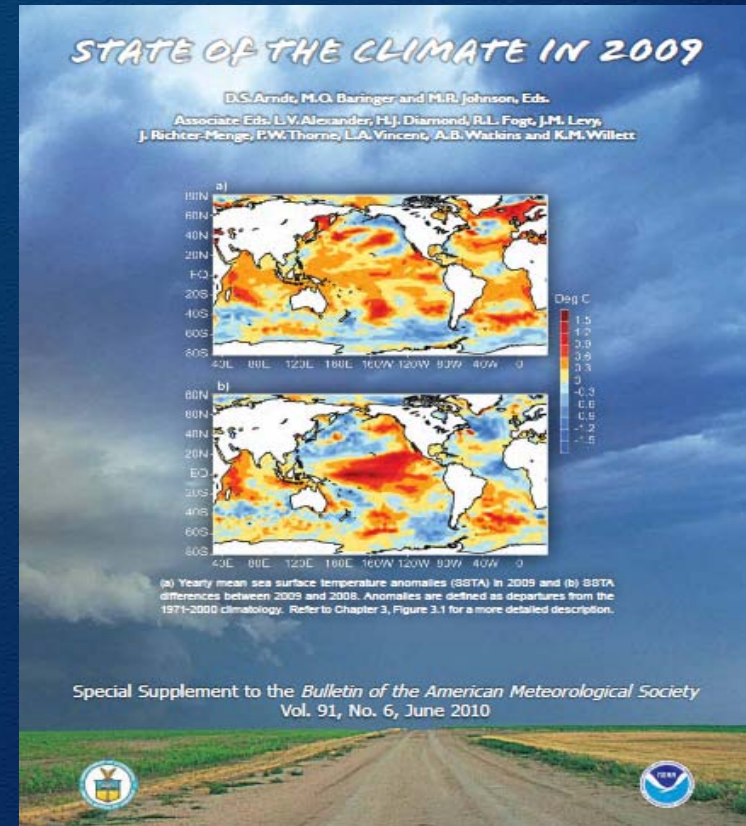
**Satellite-Derived**  
(breadth of coverage/sample)

**In-Situ**  
(depth of record)



# State of the Climate

- Some of the following taken from “State of the Climate in 2009”.
- “Annual physical” of the climate system
- 305 authors from 43 Nations

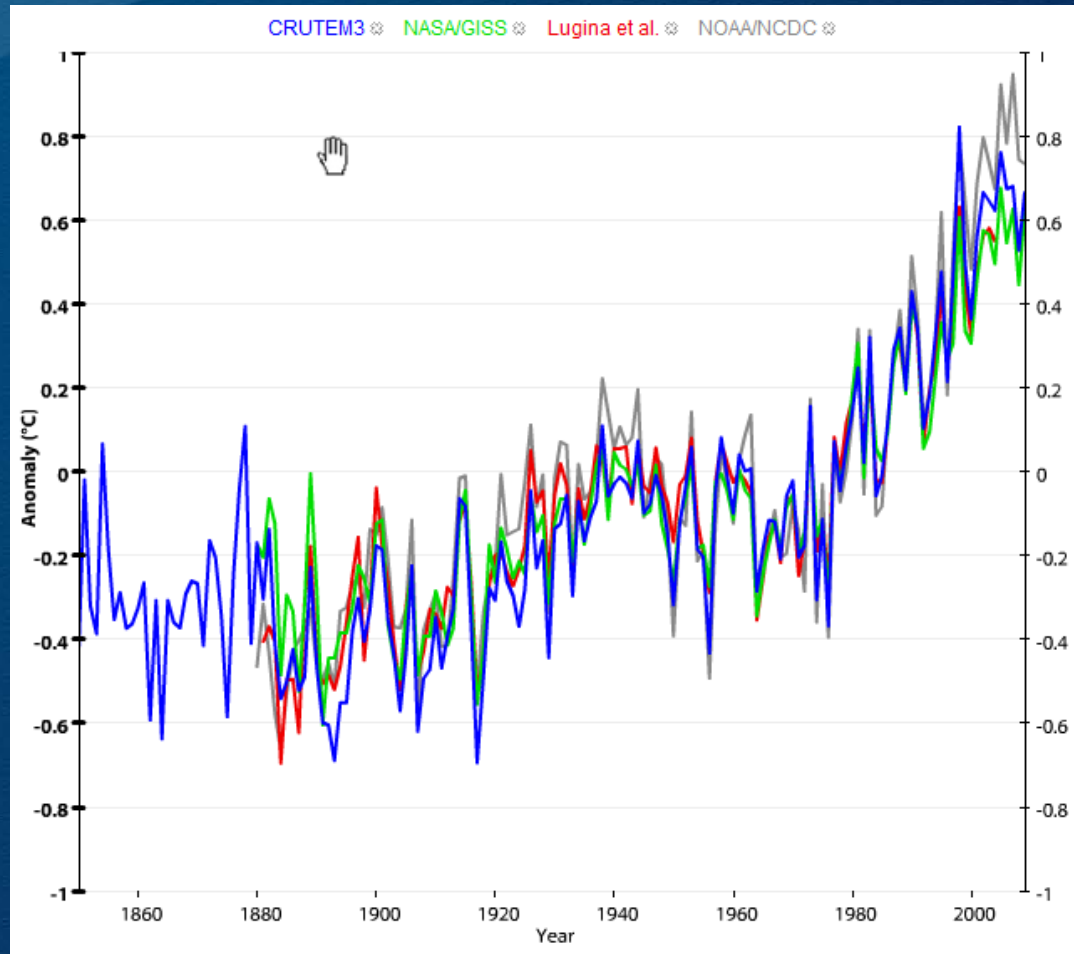


<http://www.ncdc.noaa.gov/bams-state-of-the-climate/2009.php>

# 11 companion indicators to $T_{\text{sfc}}$

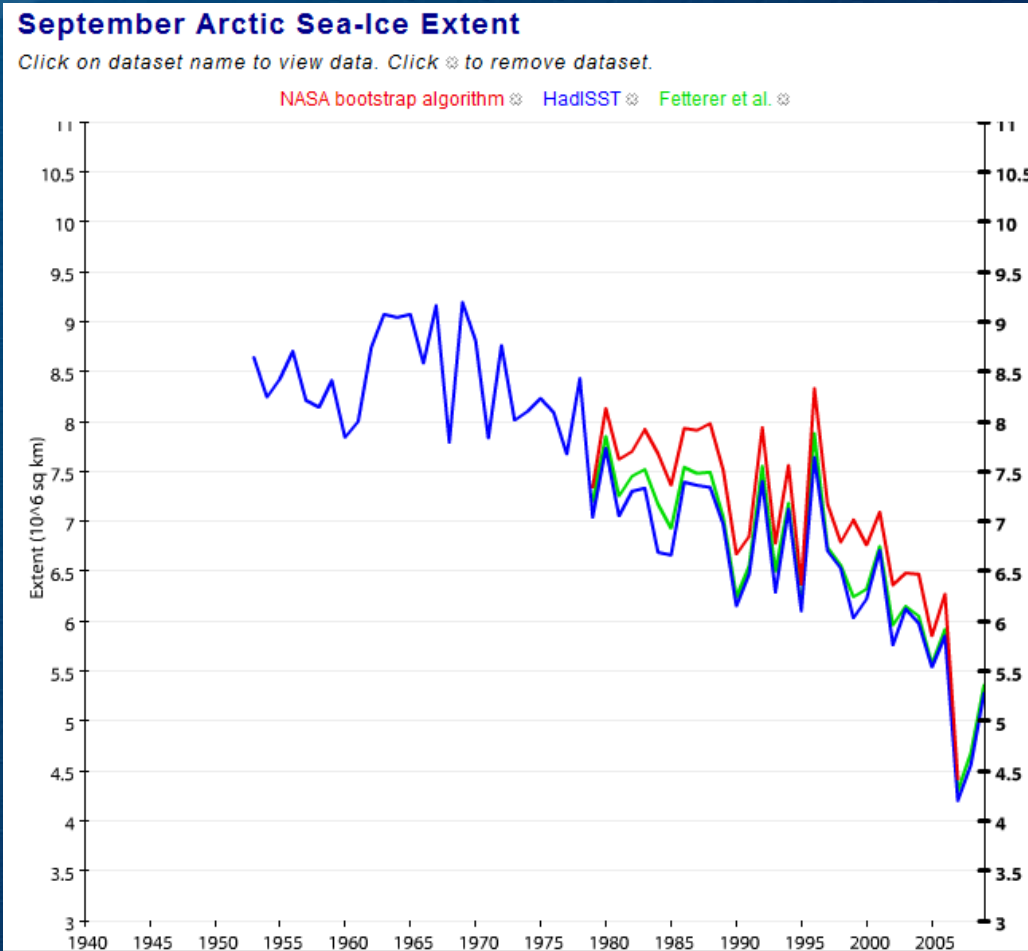
- Selected 11 indicators that would or would not reflect a warming world
  - Each built on >2 independent data sets
- In a warming world, based upon simple physical principles we would unambiguously expect ...
  - ... the following indicators to increase: land surface air temp, sea-surface temp, marine air temp, sea level, tropospheric temp, ocean heat content and specific humidity.
  - ... the following indicators to decline: snow cover, sea-ice extent, glacier mass, and stratospheric temp (also influenced by ozone depletion).

# Globally: Temperature over Land





# Northern Hemisphere Sea Ice



# Global-scale evidence: a warming world

## Ten Indicators of a Warming World

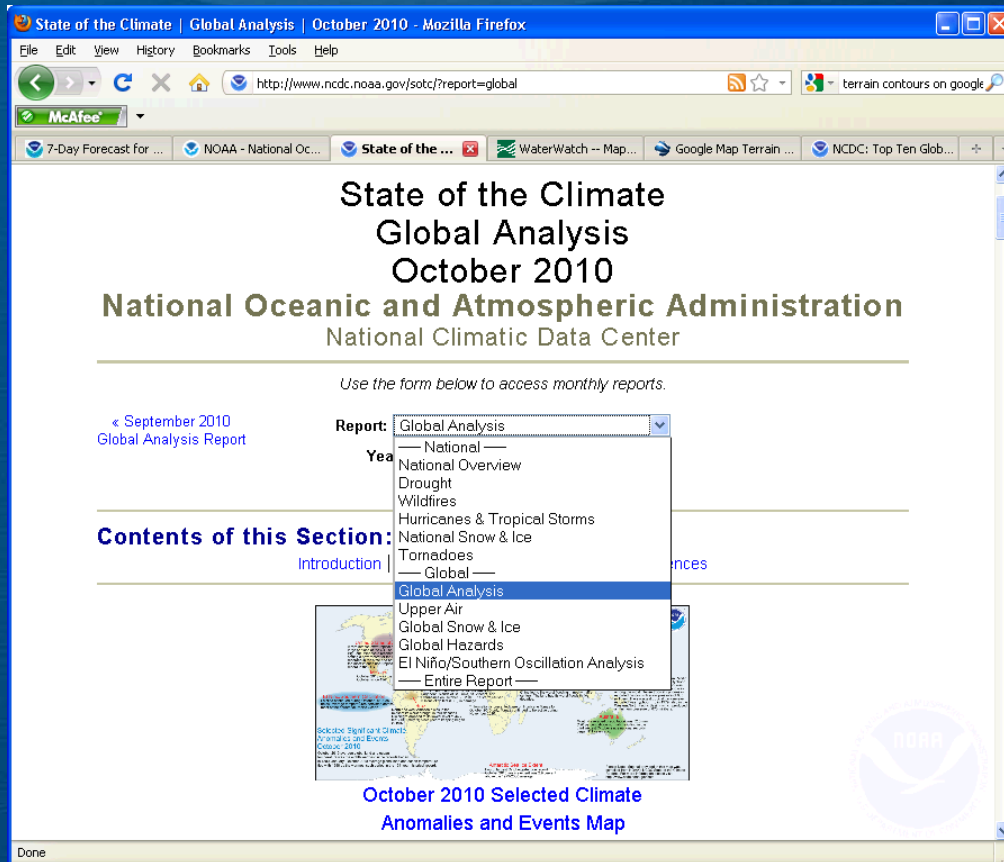


Seven of these indicators would be expected to increase in a warming world and observations show that they are, in fact, increasing. Three would be expected to decrease and they are, in fact, decreasing.

Complete through 2010

# END OF YEAR UPDATE

# State of the Climate Online

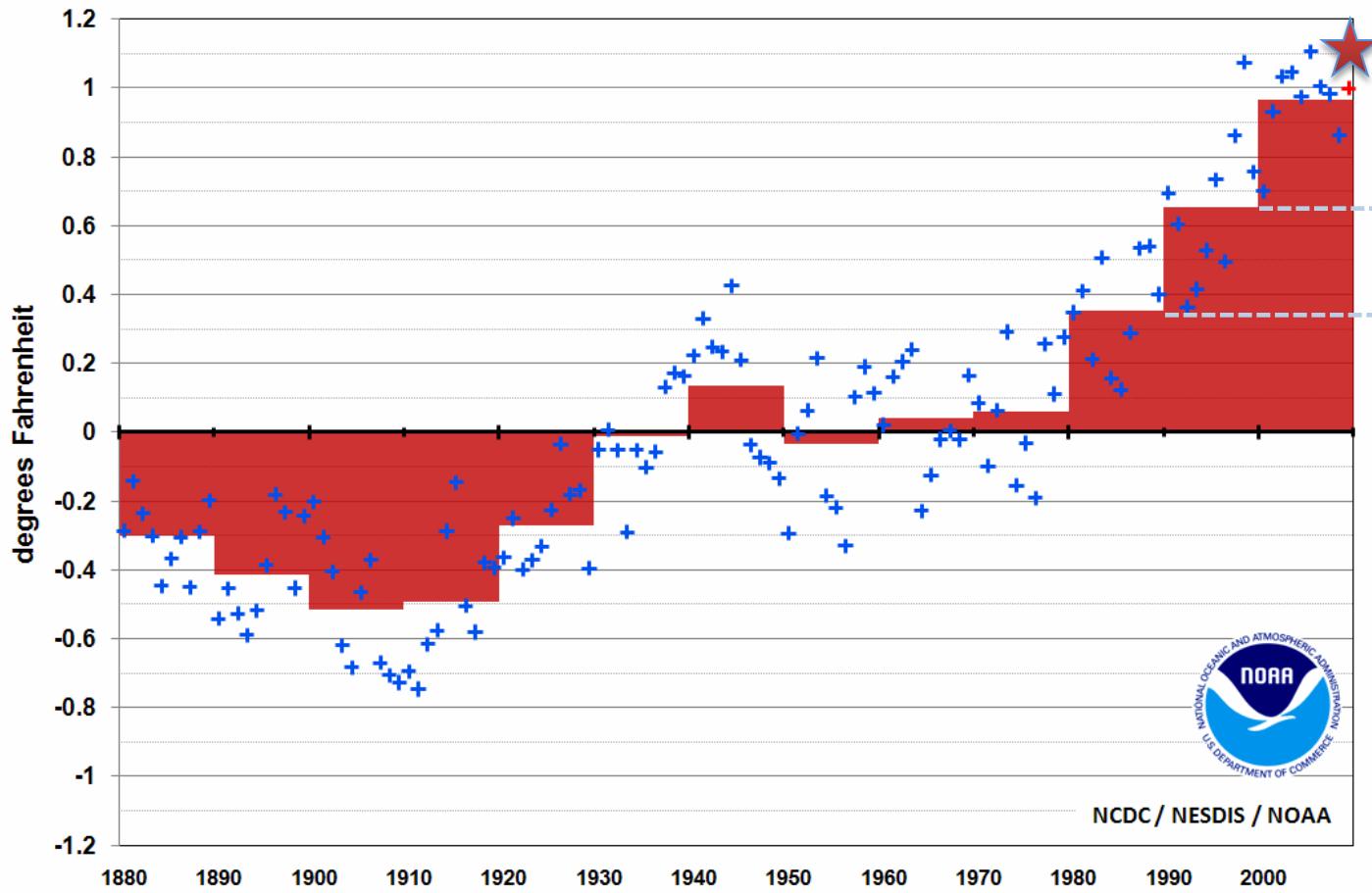


- Global:
  - Global Analysis (surface temp & precip)
  - Upper Air
  - Snow & Ice
  - Hazards (what happened)
  - El Nino / Southern Oscillation
- United States:
  - National Overview
  - Drought
  - Hurricanes & Tropical Storms
  - Snow & Ice
  - Tornadoes

<http://www.ncdc.noaa.gov/sotc>

# Annual Global Temperature

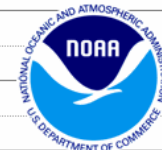
Annual Global (Land & Ocean) Temperature Anomaly  
relative to 1901-2000 base period



2010

1990s warmest decade at the time. Every year of 2000s warmer than 1990s average.

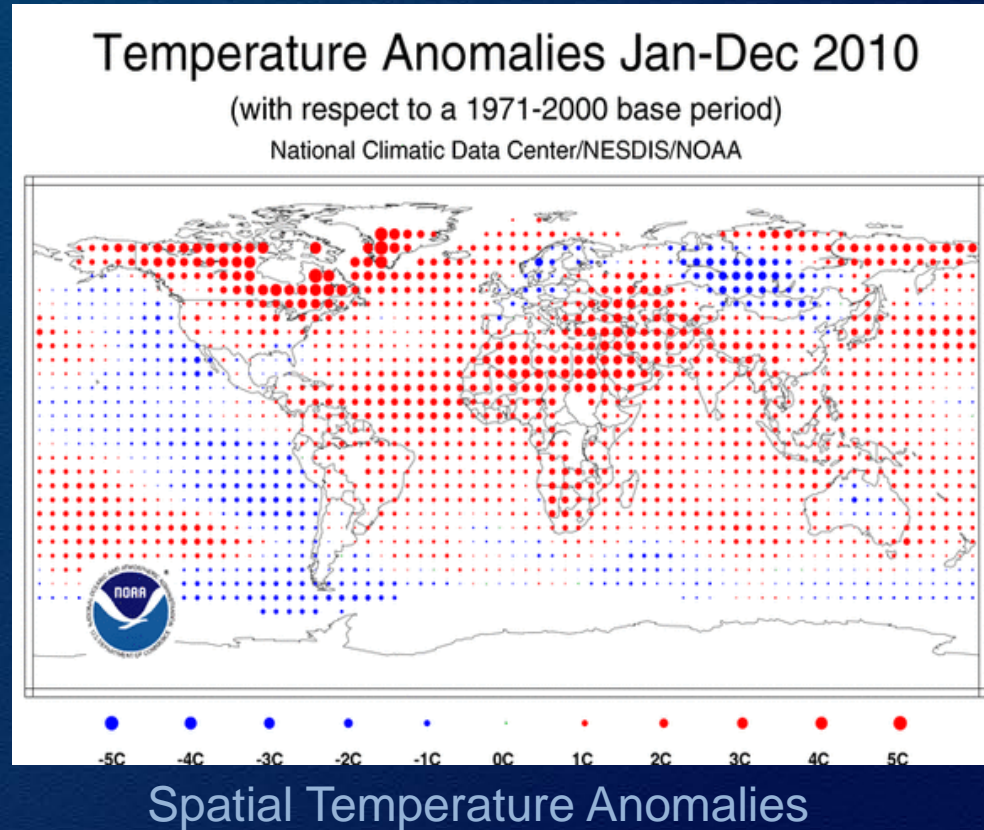
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NCDC / NESDIS / NOAA

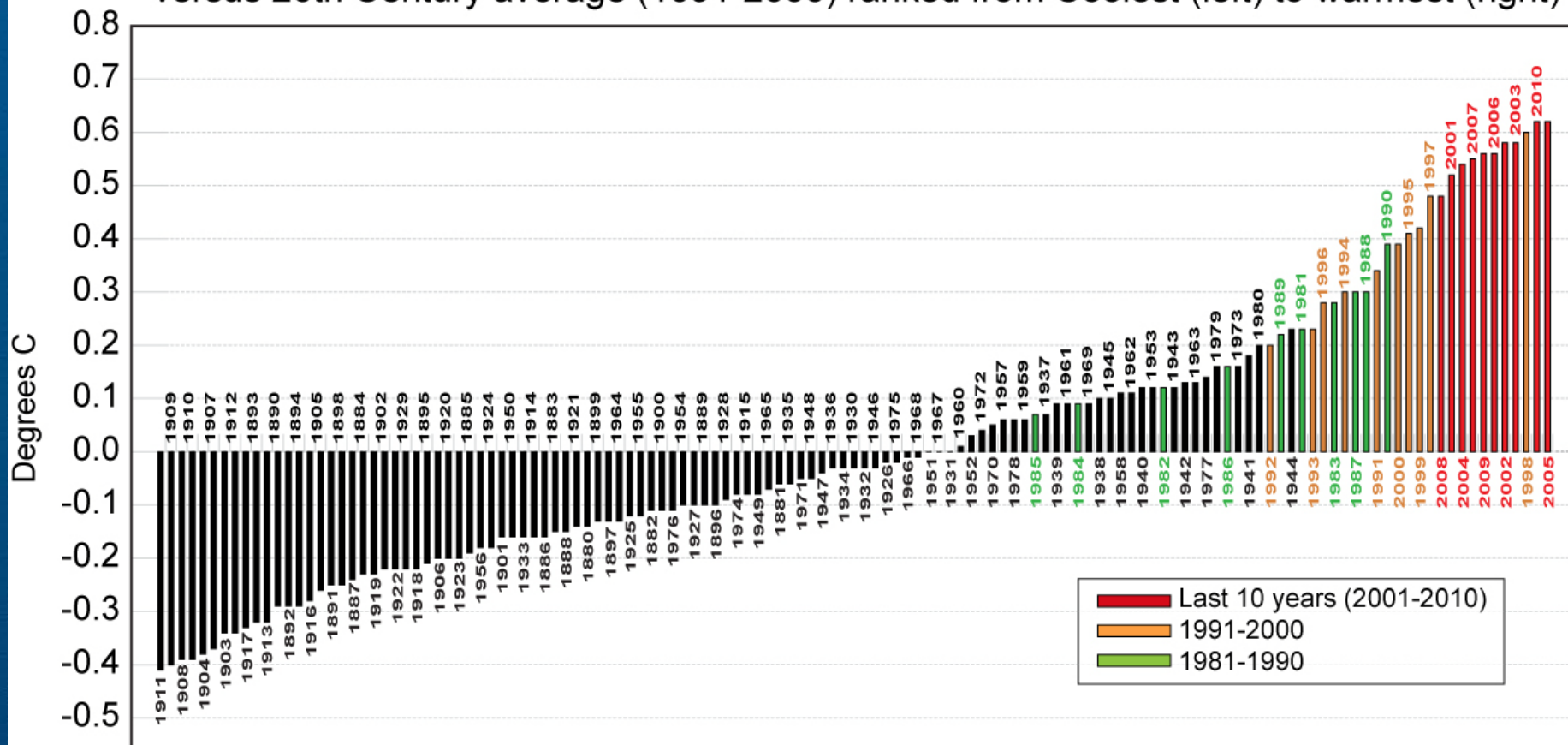
# 2010 at a Glance

- Transition from substantial El Nino to substantial La Nina during mid-2010
- Episodes of unusually strong NH meridional oscillation indices
- Wettest year on record (globally-averaged over land)



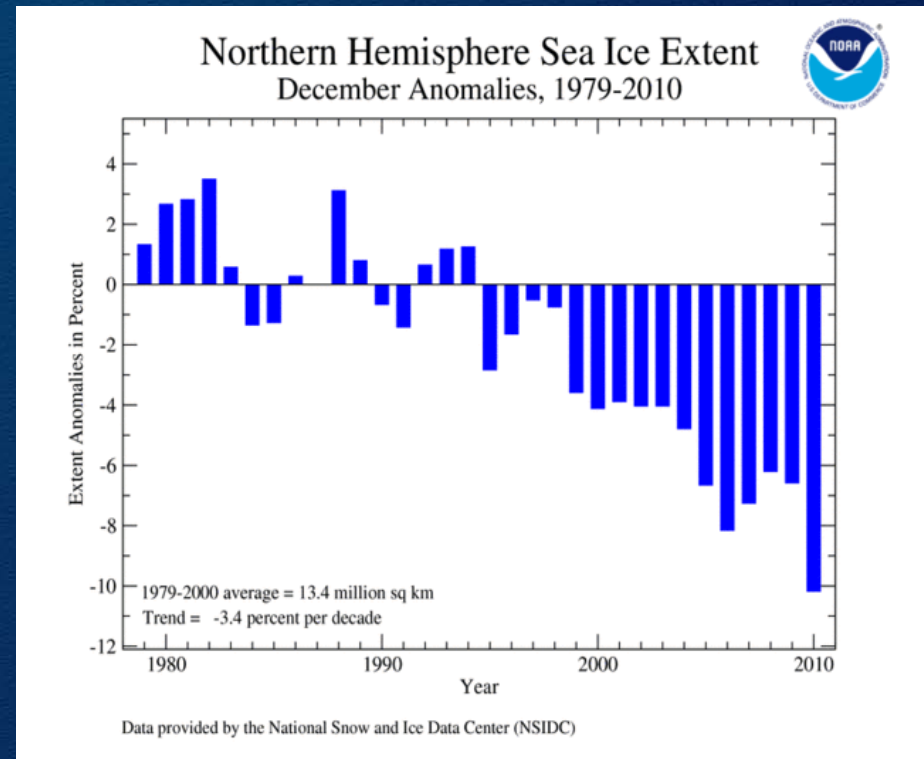
# Historical Perspective

Annual Global Temperature Anomalies  
versus 20th Century average (1091-2000) ranked from Coolest (left) to warmest (right)



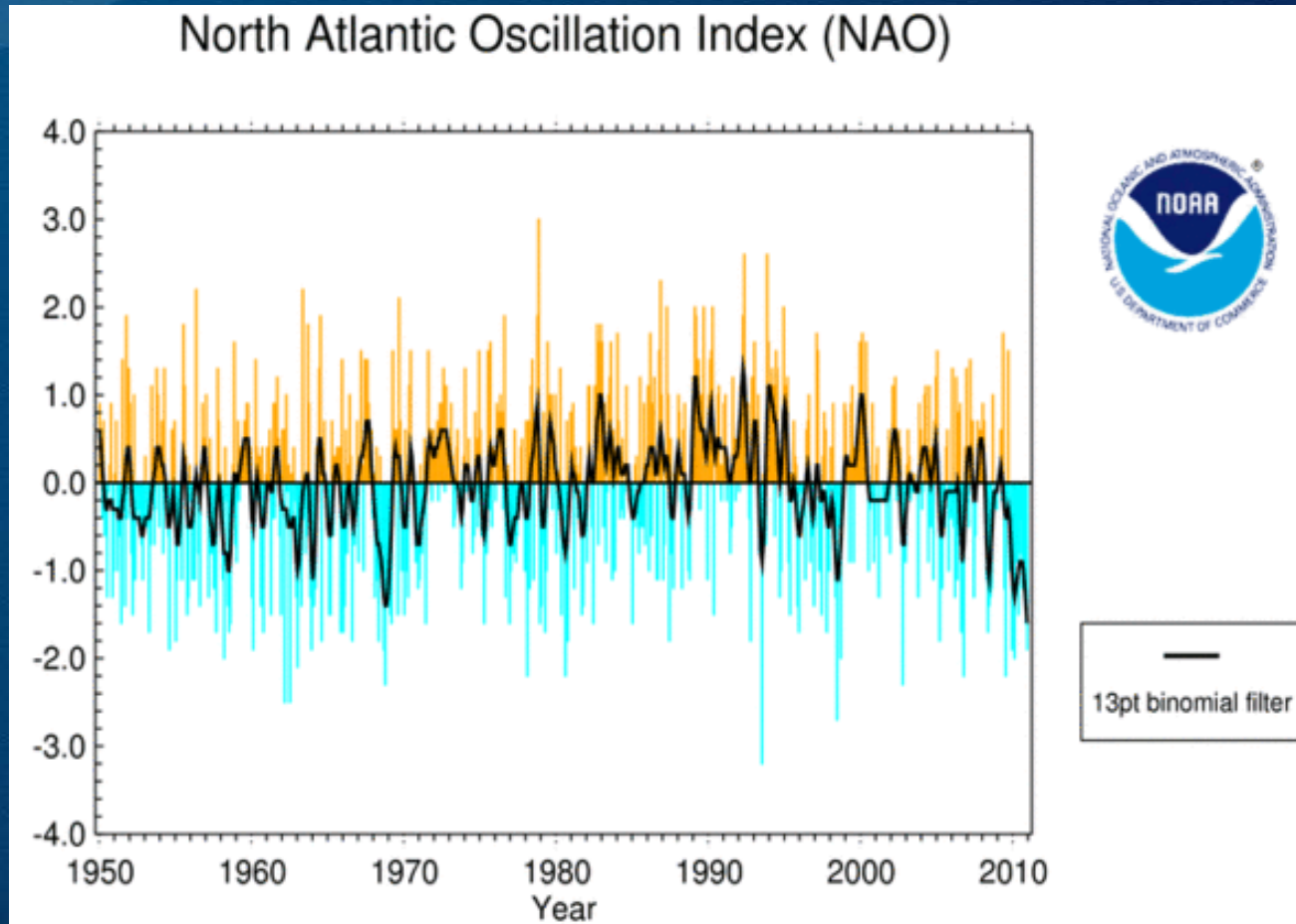
# Arctic Sea Ice Extent

- 3<sup>rd</sup> smallest annual minimum
  - Last 4 years are 4 smallest
- Below-average extent for all 12 months
  - Record smallest monthly extent for Jun and Dec (pictured →)
- Extended growth season
  - Sea ice extent approached the long-term average in late March
- Short melt season
  - March 31<sup>st</sup> spring maximum is latest start to the melt season on record





# An unusual recent relationship with the Arctic



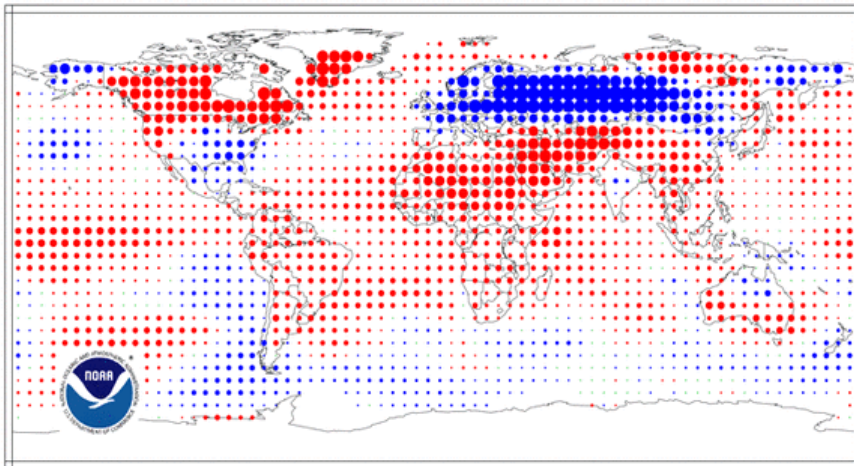
# Very Negative AO, with:

## El Nino

### Temperature Anomalies January 2010

(with respect to a 1971-2000 base period)

National Climatic Data Center/NESDIS/NOAA



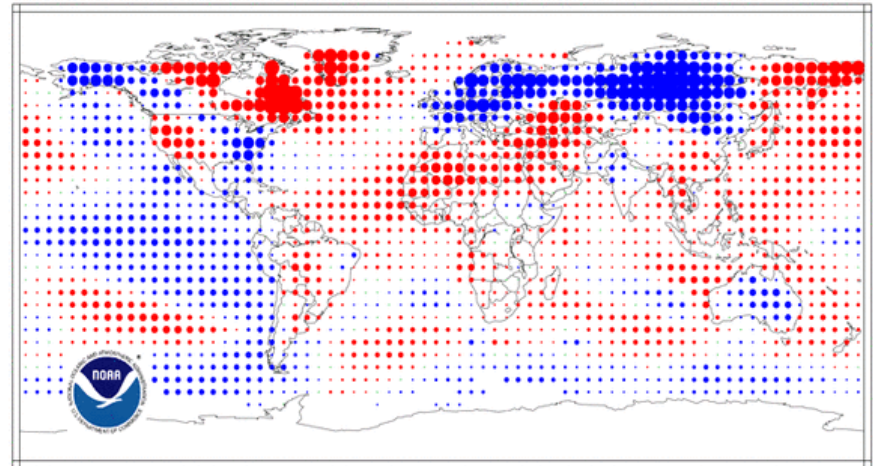
Degrees Celsius

## La Nina

### Temperature Anomalies December 2010

(with respect to a 1971-2000 base period)

National Climatic Data Center/NESDIS/NOAA



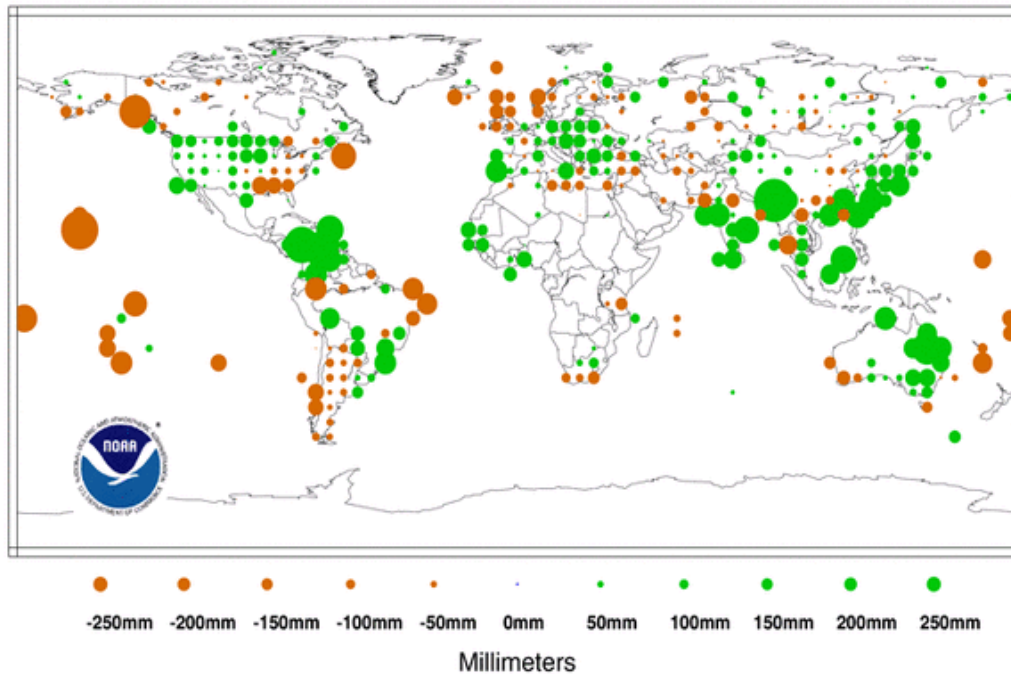
Degrees Celsius

# 2010: Wettest Year on Record

## Precipitation Anomalies Jan-Dec 2010

(with respect to a 1961-1990 base period)

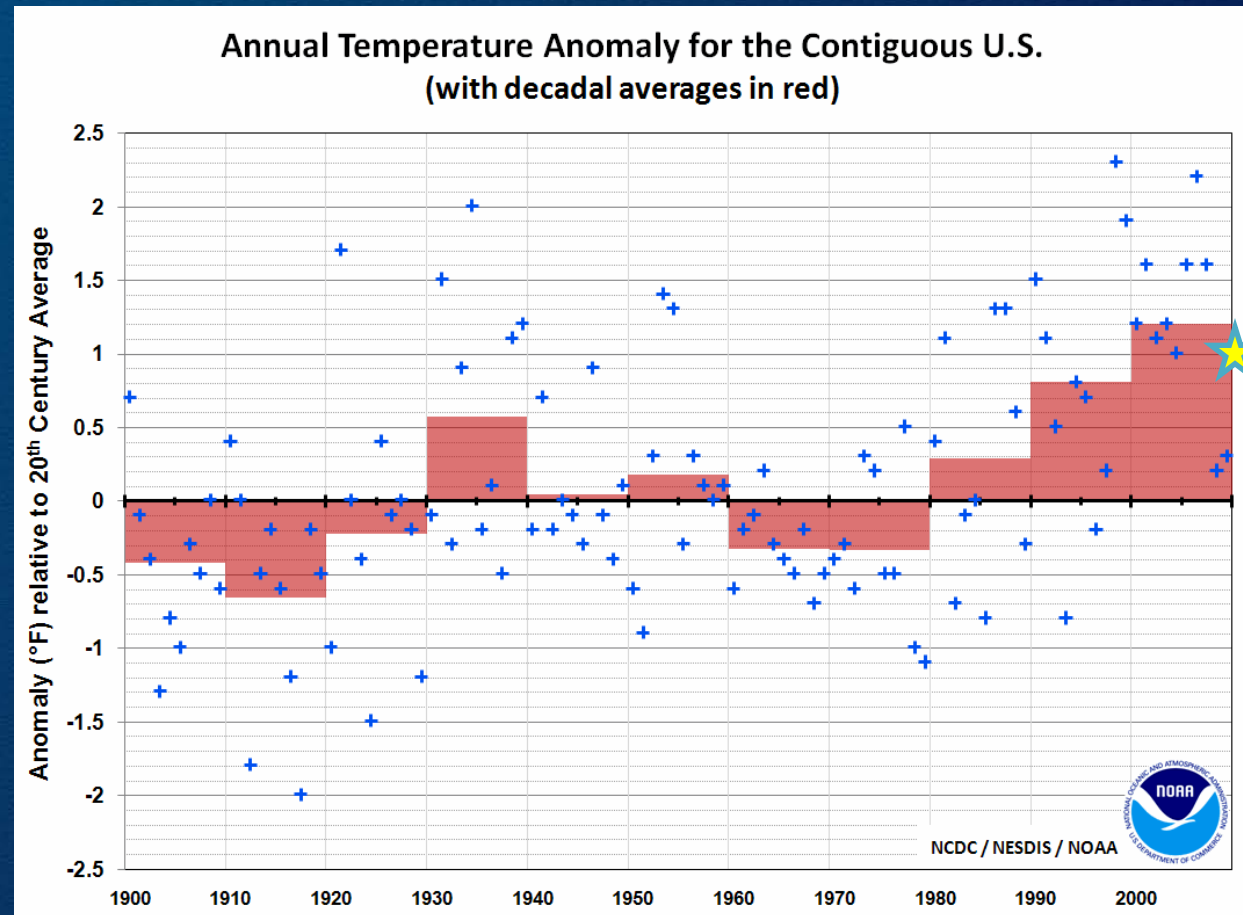
National Climatic Data Center/NESDIS/NOAA



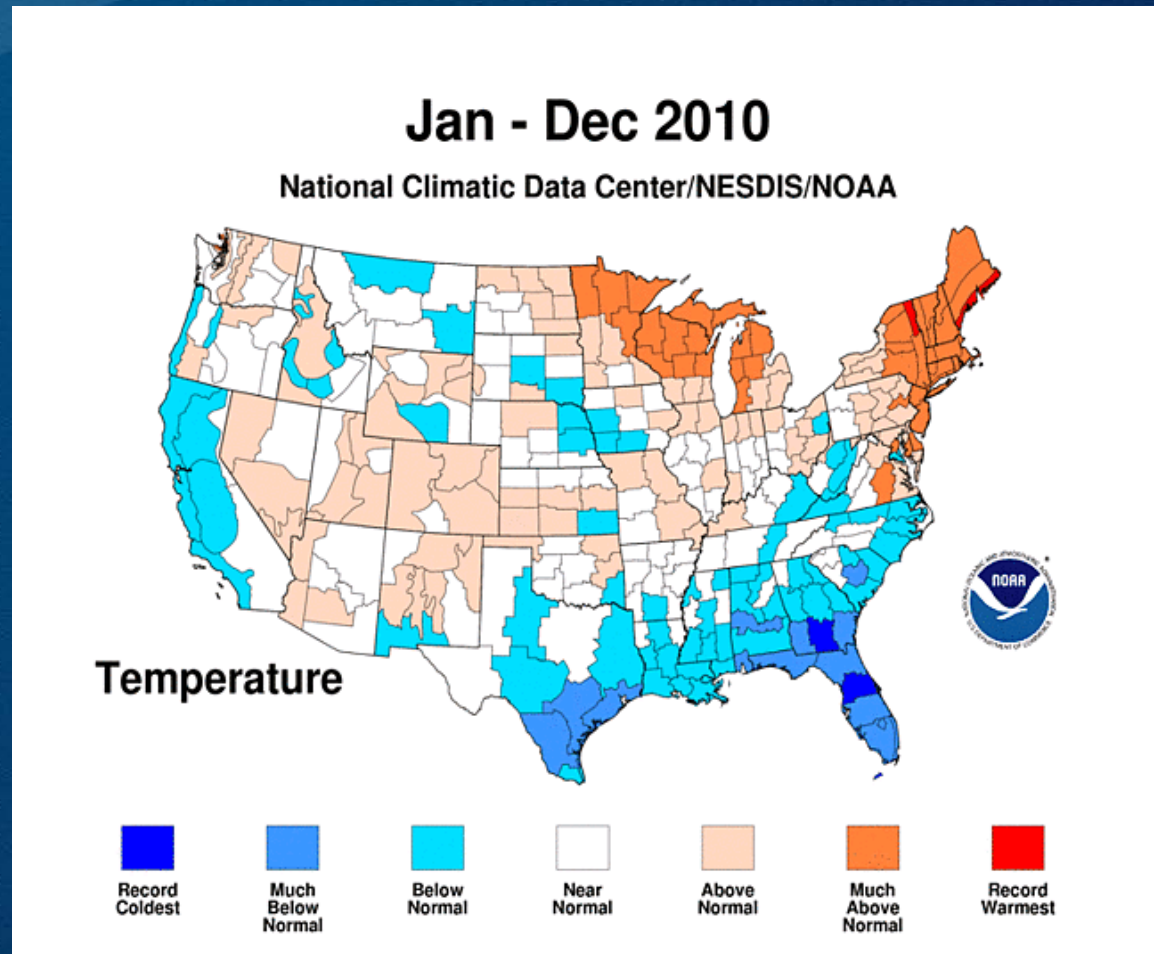
# STATE OF THE CLIMATE: IN THE U.S.

# Annual Average U.S. Temperature

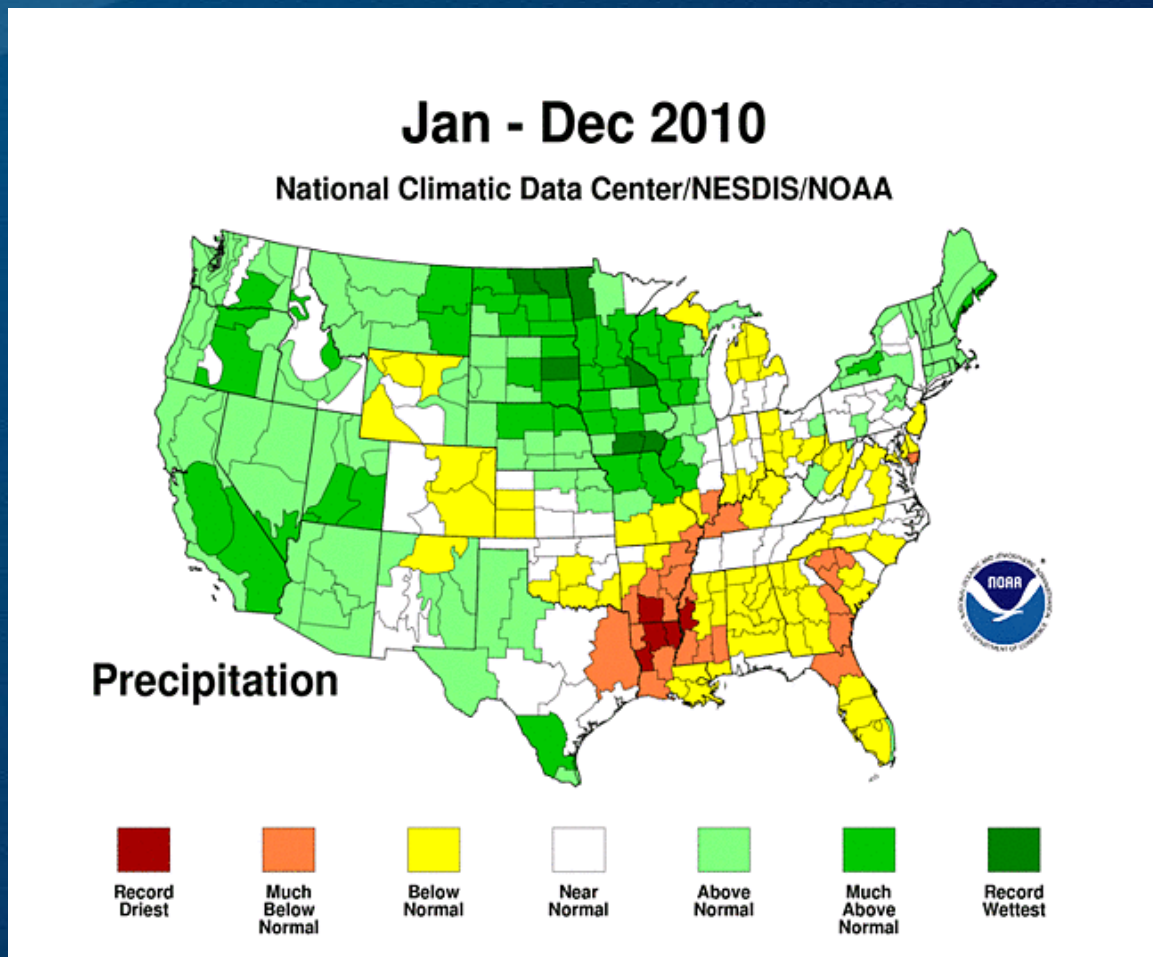
- Derived from 1,218 USHCN (v2) stations
- Warming since 1895 happens to be the same rate as the rest of the globe
- **2010**: 53.8F (1.0F above 20<sup>th</sup> C. average)



# 2010 Average Temperature: Ranks

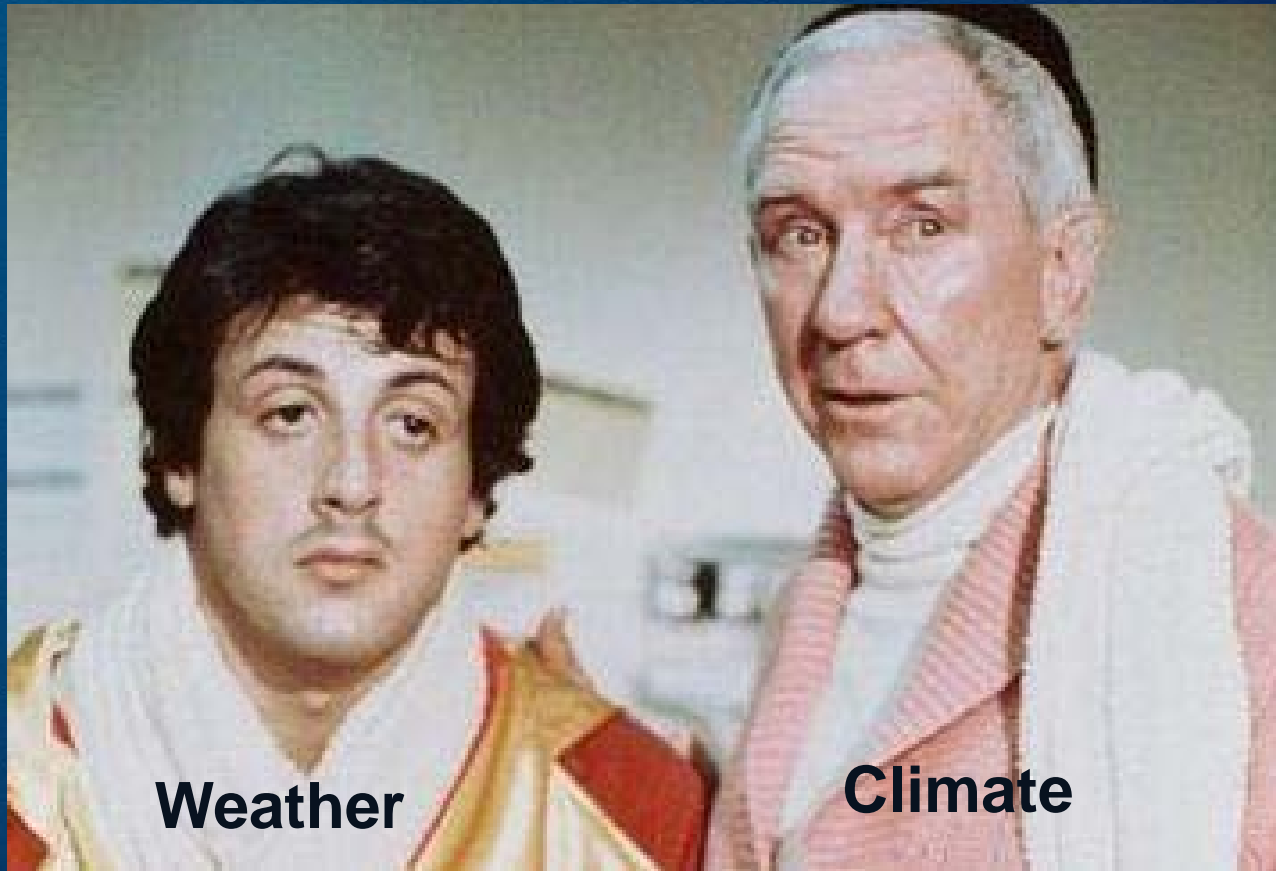


# 2010 Average Precipitation: Ranks



# Relationship between weather & climate

Literature Review: Stallone et al. (1976)



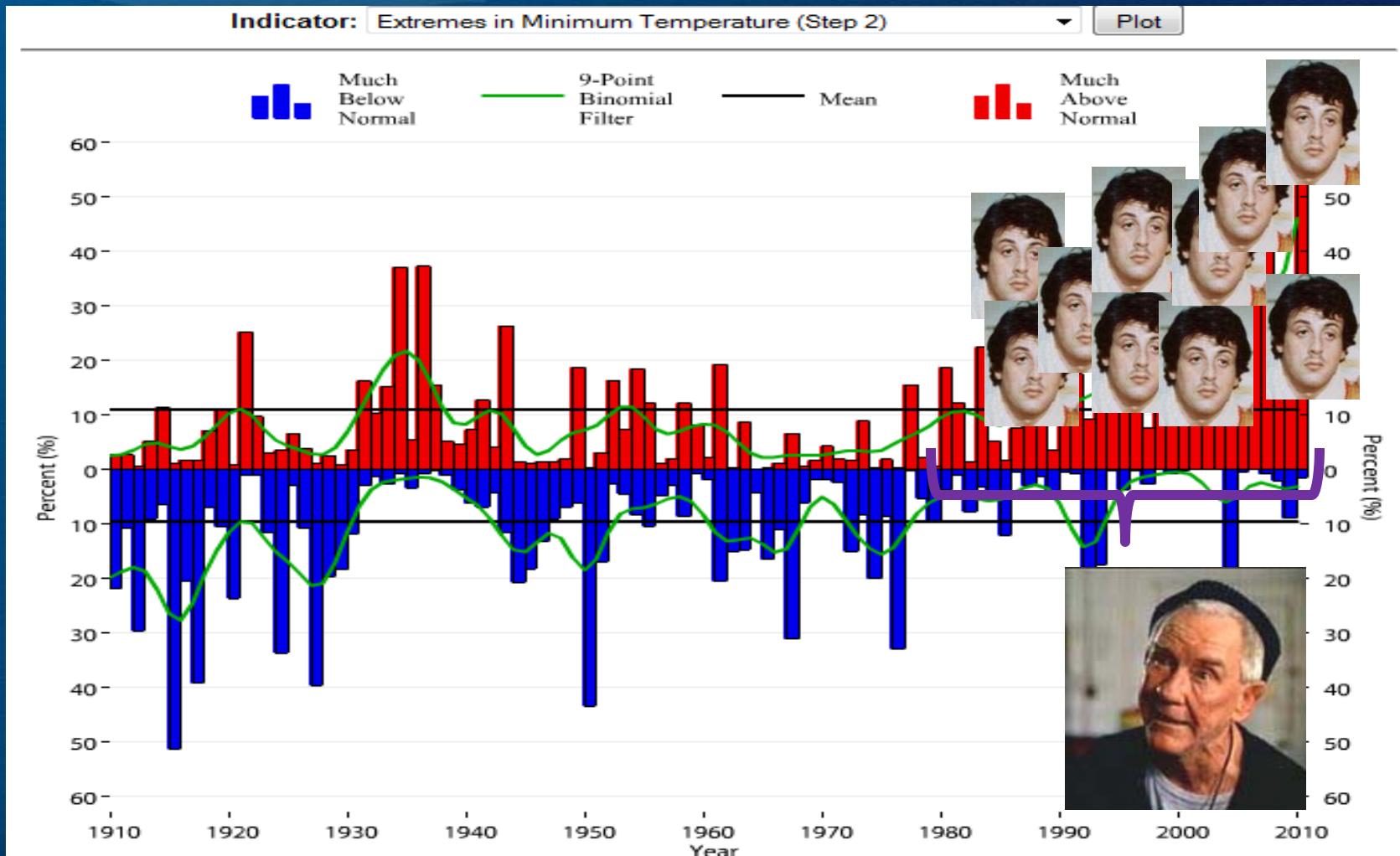
**Weather**

**Climate**



# US Climate Extremes

## summer minimum temperatures

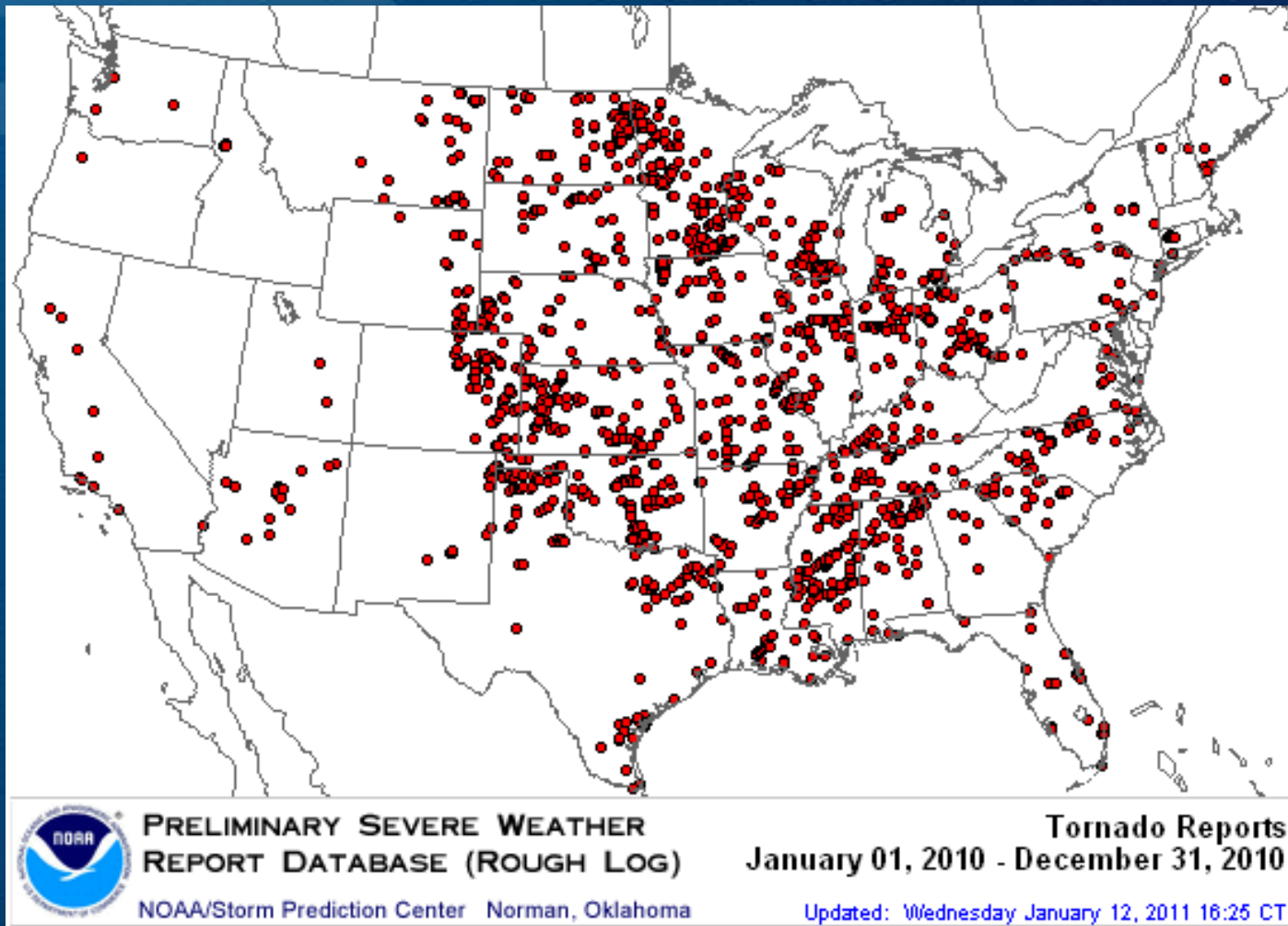


# 2010 State Monthly Climate Extremes

Month	Records by State	Season	Records by State
Jan		Winter (DJF)	
Feb		1 <sup>st</sup> Qtr (JFM)	NH VT ME FL MA RI MI
Mar	MA NJ RI	Spring (MAM)	MI NJ NY CT RI MA VT NH ME
Apr	CT IL ME NJ RI	2 <sup>nd</sup> Qtr (AMJ)	LA NC VA MD DE NJ CT RI MA NH ME
May	LA RI	Jan-Jun	ME NH RI VT
Jun	LA NC VA MD DE NJ RI IA MI	Summer (JJA)	MS AL GA FL TN SC NC VA MD DE NJ RI WI
Jul	DE RI	3 <sup>rd</sup> Qtr (JAS)	FL MA WI
Aug	LA FL	Warm (Mar-Sep)	LA FL SC NC TN KY IN OH VA WV MD DE NJ CT RI MA NH VT ME
Sep	NM MN	Autumn (SON)	
Oct	NV FL	4 <sup>th</sup> Qtr (OND)	NV FL
Nov		Jul-Dec	
Dec	GA FL NV UT	Annual	NH RI

KEY: **WARMEST** **COOLEST** **WETTEST** **DRIEST**

# Tornadoes in the US: 2010



# July 23, 2010: Vivian, SD



New National Record for:  
Hailstone diameter: 8.0"  
Hailstone weight: 1.9375 lb.

Image courtesy Aberdeen, SD WFO

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**THANK YOU FOR YOUR TIME**

# Ten Significant Global Wx/Cx Events

Rank	Event
1	Euro-Russo-Asian Heat Waves (& accompanying drought)
2	2010 Global Temperature
3	Pakistani Flooding
4	ENSO Transition (huge swing in intra-year measures)
5	Negative AO* (voters only considered Jan/Feb episode)
6	Brazilian Drought (record low streamflow at Rio Negro / Rio Amazon)
7	Historically Inactive Pacific Hurricane Season
7	Record NH Snow retreat (from near-largest in Jan to smallest by May)
9	Arctic Sea Ice Extent
10	Chinese Drought

- Not considered due to timing:
  - Late year Australian / Worldwide Flooding
  - December AO reprise

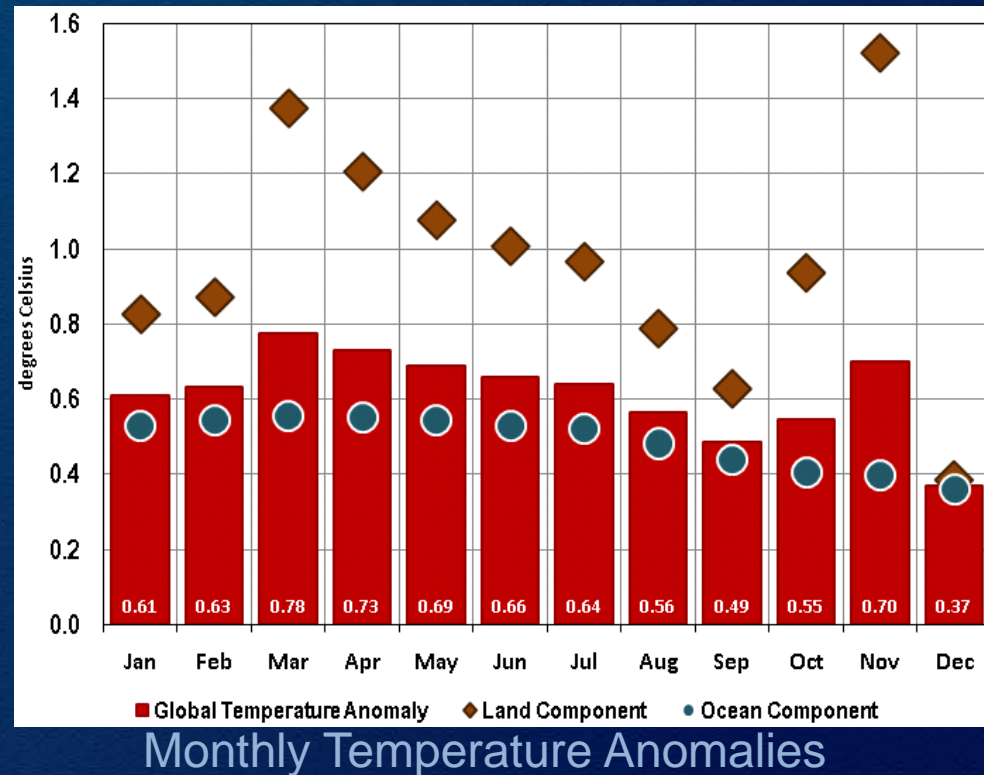
# Ten Significant US Climate Events

Rank	Event
1	Extreme Snow Season / Consecutive Snowstorms (“Snowmagedon”, etc.)
2	May Flooding in Central Tennessee (Nashville)
3	Extremely Warm Summer in Eastern U.S.
3	Midwest U.S. “Superstorm” Extra-tropical Cyclone
5	Historic Drought in Hawaii
6	No Hurricanes Made U.S. Landfall despite Active Atlantic
7	Near-Eradication of CONUS Drought in Mid-Year
8	National Record Hailstone, Vivian, SD: 8.0” diameter; 1 lb., 15 oz.
9	New England Flooding: Late Winter and Early Spring
10	Upper Midwest Tornadoes – Minnesota as #1 Tornado State of 2010 (?)

- Not considered due to timing:
  - Late year California/Western Flooding
  - December AO reprise

# 2010 Global Temps at a Glance

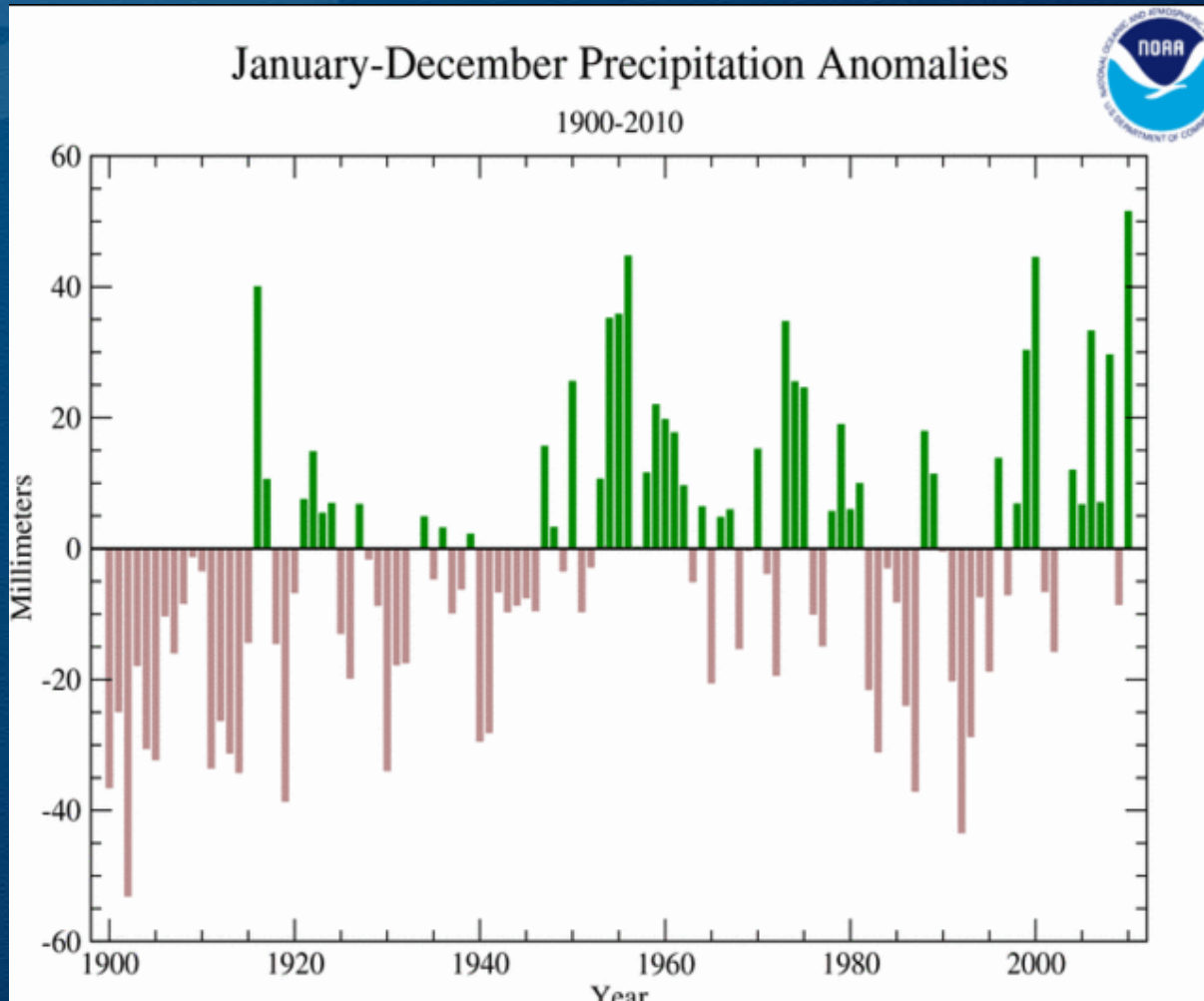
- Global Temp Anomaly\* :  
+0.62C / +1.12F
  - Tied 2005 for warmest
- Ocean Temp Anomaly:  
+0.49C / +0.88F
  - Tied 2005 for 3<sup>rd</sup> warmest
- Land Temp Anomaly:  
+0.96C / +1.73F
  - Tied 2005 for 2<sup>nd</sup> warmest



\* vs. 20<sup>th</sup> Century (1901-2000) average



# 2010: Wettest Year on Record



Based on globally-averaged GHCN (land-based) precipitation