Drought and Climate Extremes Indices for the North American Drought Monitor and North America Climate Extremes Monitoring System

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DRI Precipitation and Drought Indices Workshop

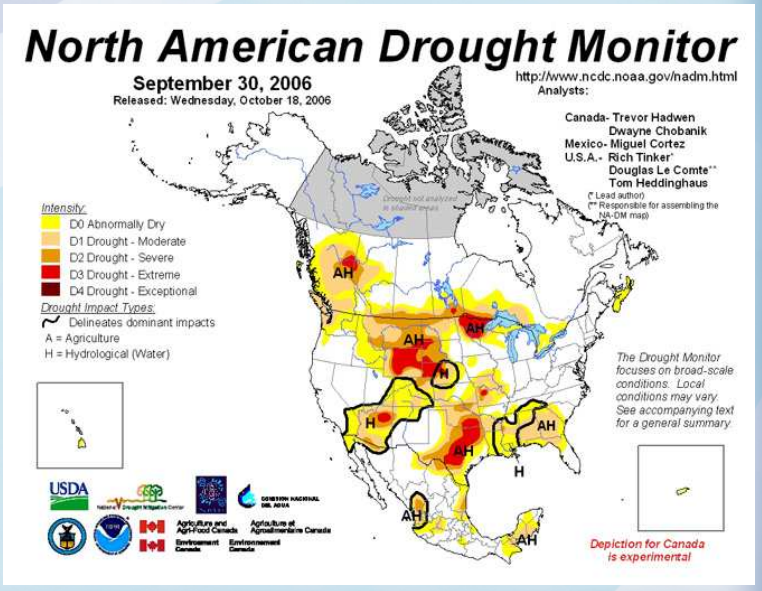
30 April 2009, Toronto, Ont., Canada

Outline

- ✓ Background of the North American Drought Monitor (NADM)
- ✓ Drought and precipitation indicators that support the NADM
- ✓ Background of the North America Climate Extremes Monitoring (NACEM) System
- ✓ Extremes indices utilized in the NACEM
- ✓ Background and components of the U.S. Climate Extremes Index (CEI)
- ✓ Snow Climatology indicators (if we have time)

North American Drought Monitor (NADM)

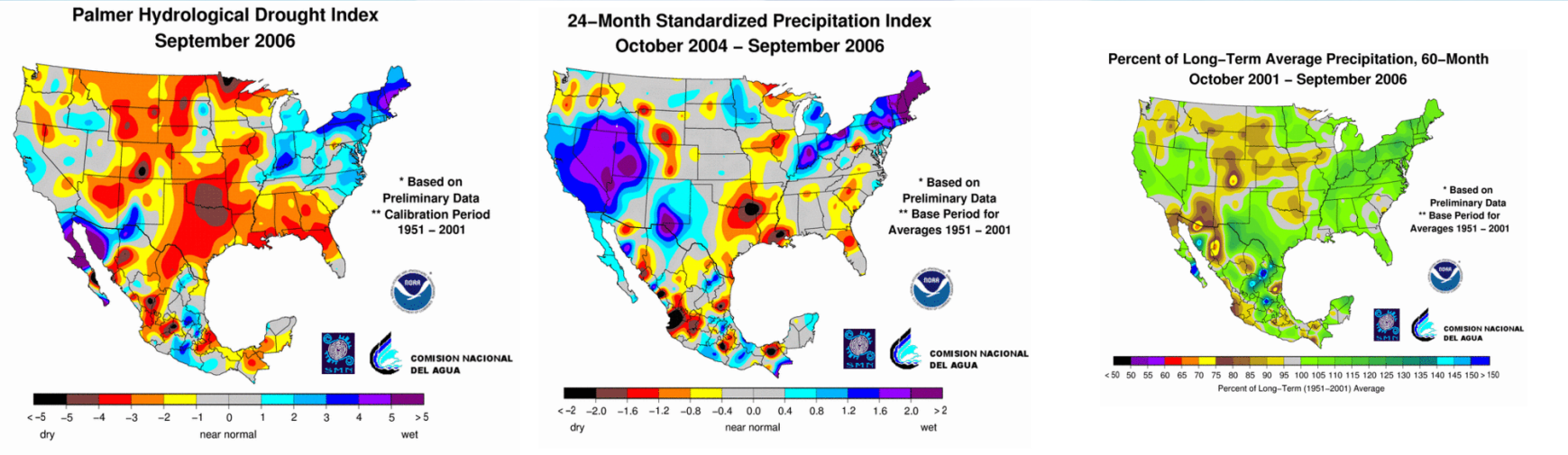
- ✓ **NADM is an operational product issued monthly that provides a general summary of current drought conditions across North America; first issued publicly in 2003.**
- ✓ **Drought conditions in each country determined by specialists in that country.**
  - The weekly U.S. Drought Monitor from the week closest to the end of the month is used in the U.S.
- ✓ Participants:
  - U.S. (most of the USDM authors):
    - NOAA (NCDC, CPC)
    - USDA / JAWF
    - NDMC
  - Canada:
    - Agriculture & Agri-food Canada
    - Meteorological Service of Canada
  - Mexico:
    - National Meteorological Service (SMN)
- ✓ NADM is an international partnership, a NOAA example of the implementation of GEOSS of the Americas



http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html

NADM Continental Drought Indicators

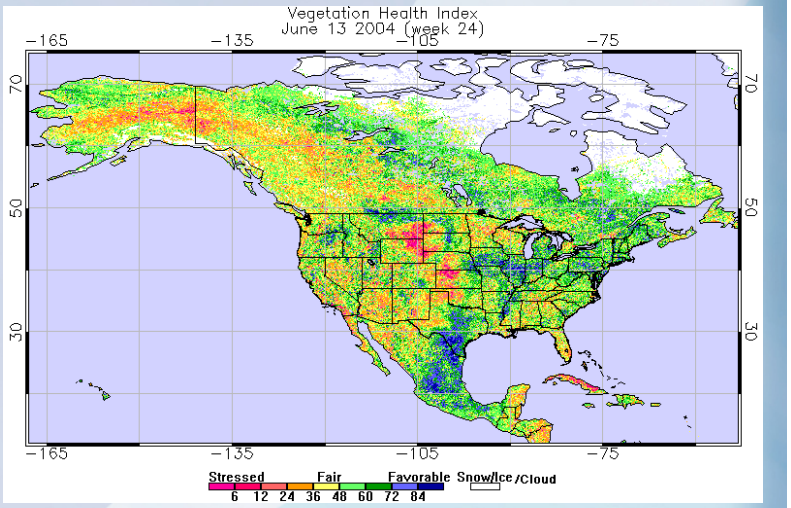
- ✓ Drought conditions in US, MX, CN are determined independently based on different data, indices, & analyses within each country by analysts in each country
- ✓ **Drought indices covering entire continent are needed**
  - **Same indices, same standardizing period (1951-2001), same methodologies**
  - **This consistency needed for depiction across international boundaries**
- ✓ Issues concerning the regional applicability of drought indices (e.g., Palmer Indices, SPI) – even definition of drought

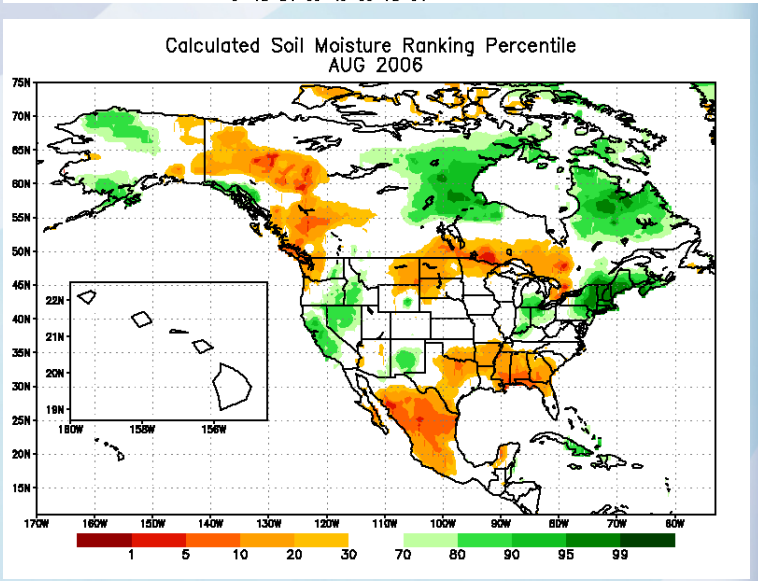


http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html

NADM Continental Drought Indicators

- ✓ Palmer Drought Index (PHDI, Z Index, modified PDSI [PMDI or PDI])
- ✓ Standardized Precipitation Index (SPI) (1-, 2-, 3-, 6-, 9-, 12-, 24-month)
- ✓ Percent of Long-Term Average Precipitation (PCTPCP, 1951-2001 base period)
- ✓ Satellite-based indices
  - Vegetation Health Index (VHI)
  - VegDRI (eventually)
- ✓ Modeled Soil Moisture (CPC Leaky Bucket Model)
- ✓ NADM Objective Blends (under development)





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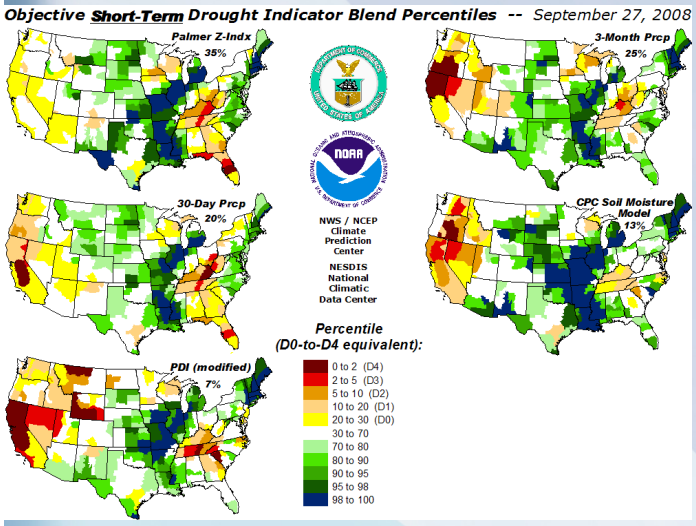
USDM & NADM Objective Blends

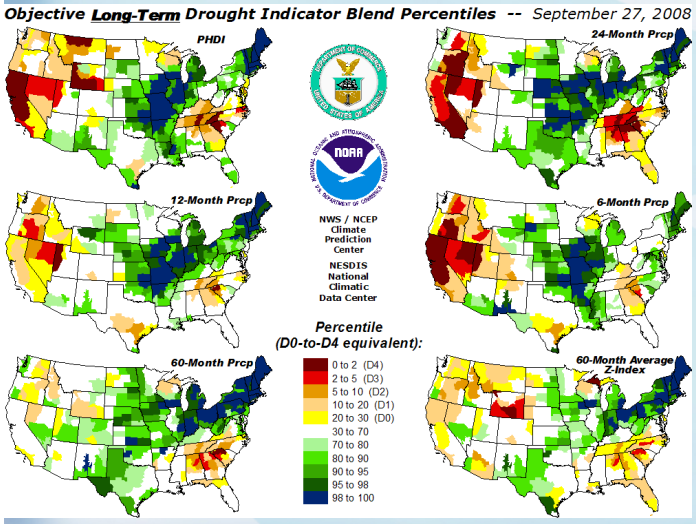
- ✓ Objective blends integrate multiple indicators into a product update using a percentile ranking method
- ✓ All parameters are first rendered as percentiles with respect to a standard period using a percent rank method
- ✓ The parameters (drought indicators) are then combined using a weighting scheme
- ✓ Short- and Long-Term Blends produced
- ✓ Need serially complete data

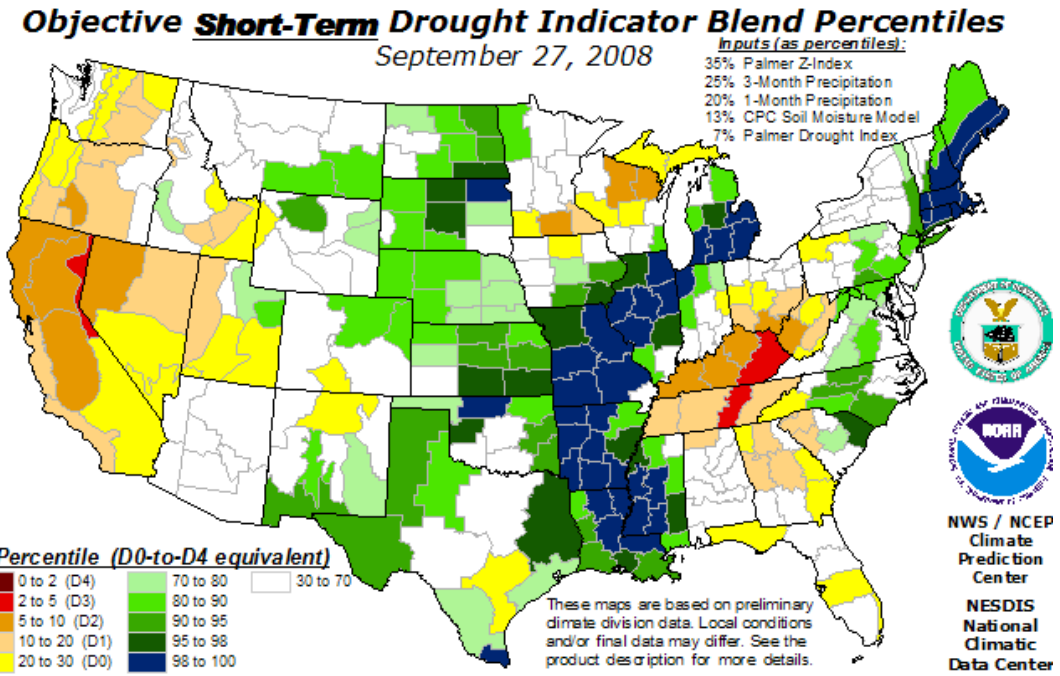
❖ Operationally produced weekly for USDM using NOAA/CPC's real-time daily and weekly climate division data and NOAA/NCDC's monthly archive of indices for 1932-2000

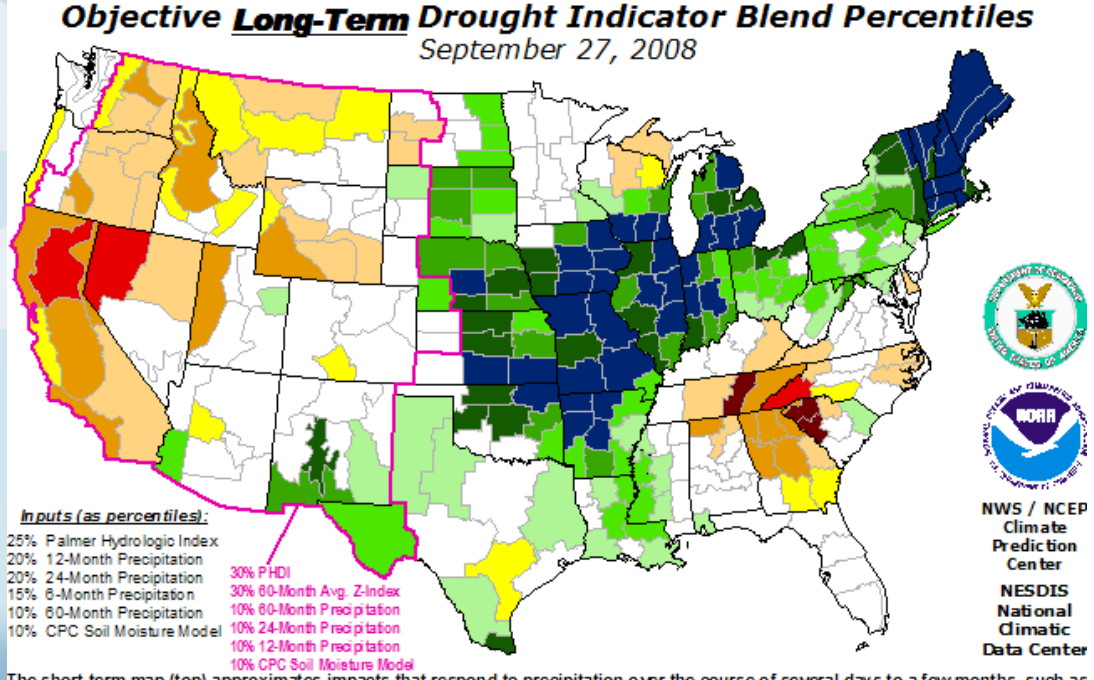
❖ Experimental for NADM; monthly; use gridded temperature, precipitation, & Palmer index fields for North America; 1895-2005

USDM Objective Blends



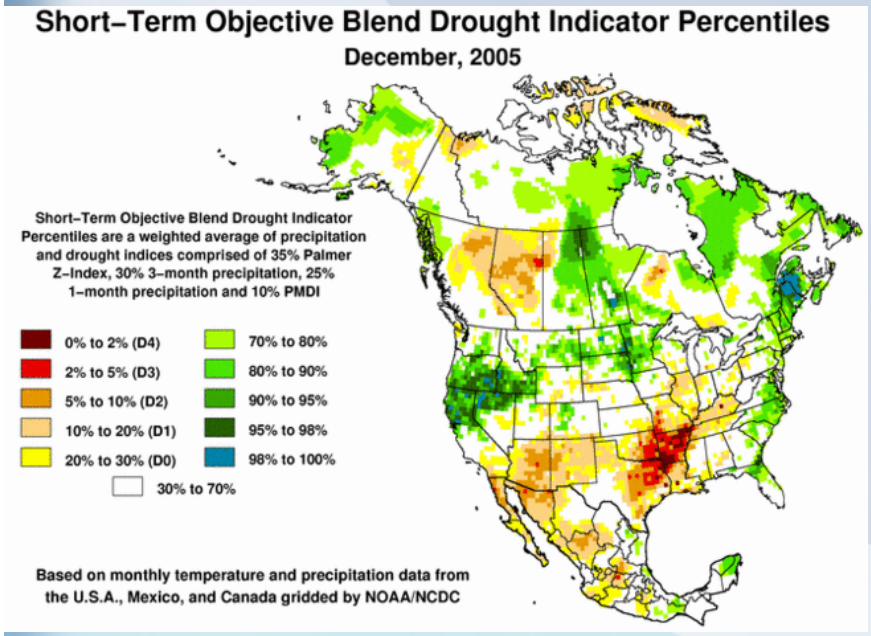






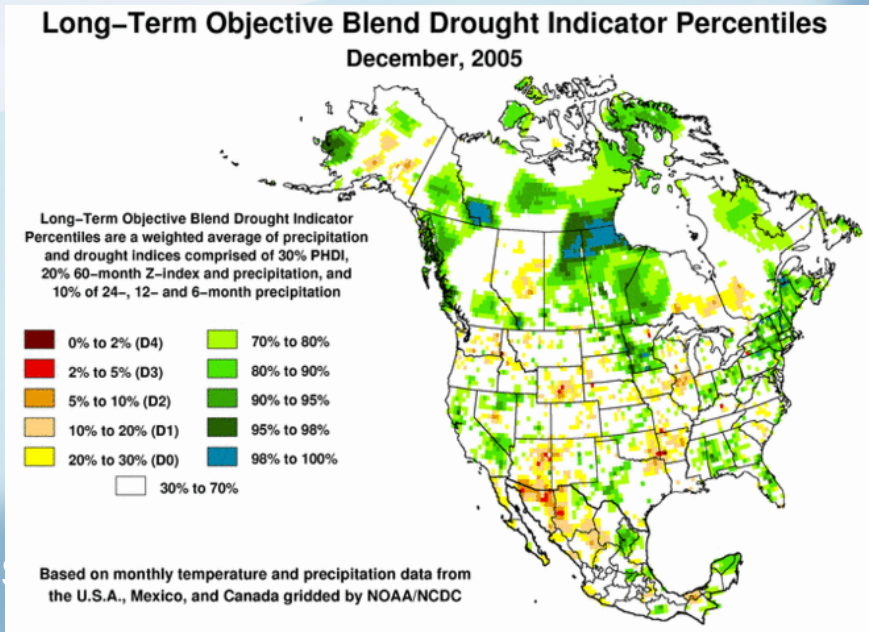
The short-term map (top) approximates impacts that respond to precipitation over the course of several days to a few months, such as agriculture, topsoil moisture, unregulated streamflows, and most aspects of wildfire danger. The long-term map (bottom) approximates impacts that respond to precipitation over the course of several months to a few years, such as reservoir content, groundwater depth, and lake levels. HOWEVER, the relationship between indicators and impacts can vary significantly with location and season. THIS IS PARTICULARLY TRUE OF WATER SUPPLIES, which are additionally affected by source, and management practices.

NADM Objective Blends



- ✓ NADM percentiles based on 1895-2005
- ✓ 0.5x0.5-degree gridded data base
- ✓ Short-term blend components:
  - Palmer Z Index (35%)
  - 3-month precipitation (30%)
  - 1-month precipitation (25%)
  - Palmer Drought Index (10%)

- ✓ Long-term blend components:
  - Palmer Hydrological Drought Index (30%)
  - 60-month Palmer Z Index (20%)
  - 60-month precipitation (20%)
  - 24-month precipitation (10%)
  - 12-month precipitation (10%)
  - 6-month precipitation (10%)



NOAA's

North America Climate Extremes Monitoring (NACEM) System

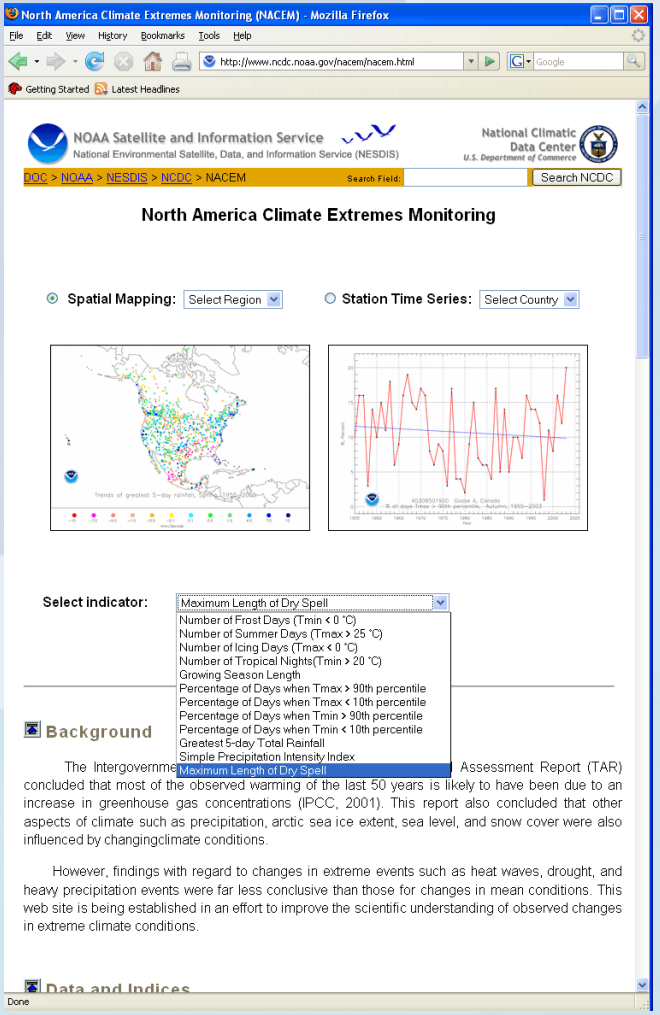
- ✓ **Purpose: Improve the scientific understanding of observed changes in extreme climate conditions**
- ✓ **From a set of 27 core climate extremes indices, a subset of 12 are being analyzed at this time**
  - Based on work of WMO Expert Team on Climate Change Detection Monitoring and Indices
- ✓ **Data Base consists of daily temperature and precipitation data from 1955-present for stations across Canada (210 stations), US (750), and Mexico (300)**

http://www.ncdc.noaa.gov/nacem/nacem.html

NACEM Web Page

✓ Products:

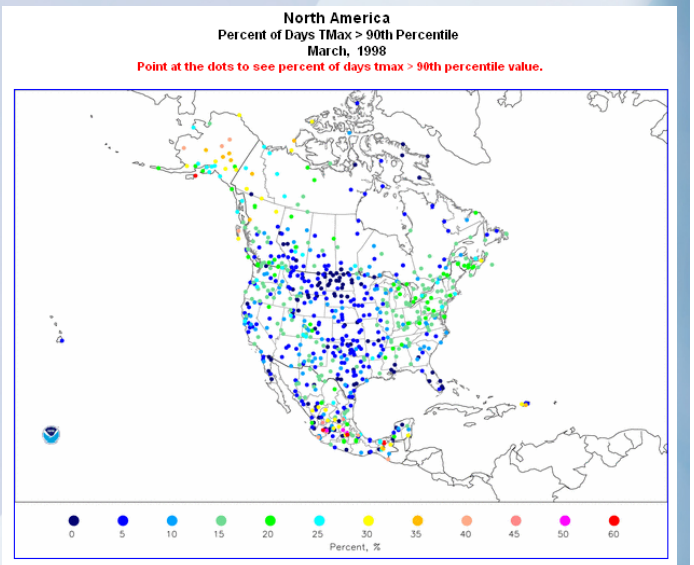
- Monthly/seasonal maps of trends and anomalies for North America or the 3 individual countries
  - ➢ Stations can be subsetted based on elevation, trend significance, percent of available data
- Time series graphs of individual station data

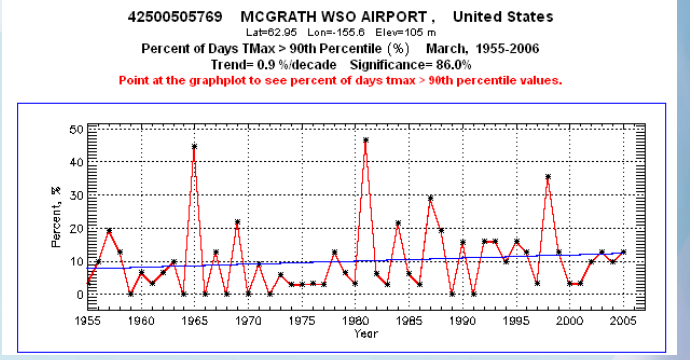


http://www.ncdc.noaa.gov/nacem/nacem.html

NACEM Indices

- ✓ Number of Frost Days (Tmin < 0 C)
- ✓ Number of Summer Days (Tmax > 25 C)
- ✓ Number of Icing Days (Tmax < 0 C)
- ✓ Number of Tropical Nights (Tmin > 20 C)
- ✓ Growing Season Length
- ✓ Percentage of Days when Tmax > 90th percentile
- ✓ Percentage of Days when Tmax < 10th percentile
- ✓ Percentage of Days when Tmin > 90th percentile
- ✓ Percentage of Days when Tmin < 10th percentile
- ✓ Greatest 5-day Total Precipitation
- ✓ Simple Precipitation Intensity Index
- ✓ Maximum Length of Dry Spell (Pcp < 1 mm)





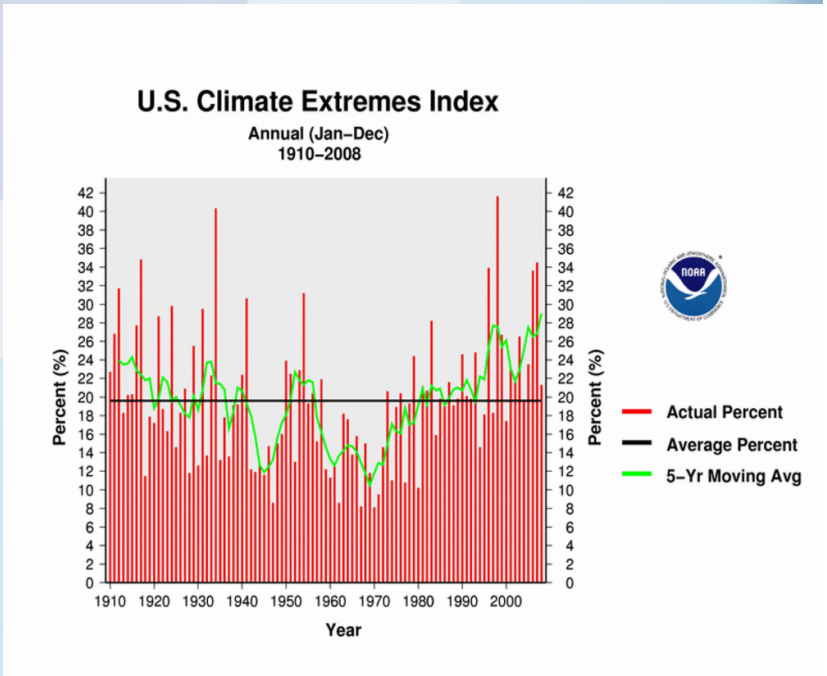
http://www.ncdc.noaa.gov/nacem/nacem.html

U.S. Climate Extremes Index (CEI)

- ✓ Integrates several climate components into a standardized national index to monitor & analyze climate extremes in the U.S.. Components:
  - Monthly max & min temperature
  - Daily precipitation
  - Monthly PDSI
  - Landfalling tropical storm & hurricane wind velocity *(experimental)*

Period of record: 1910-present

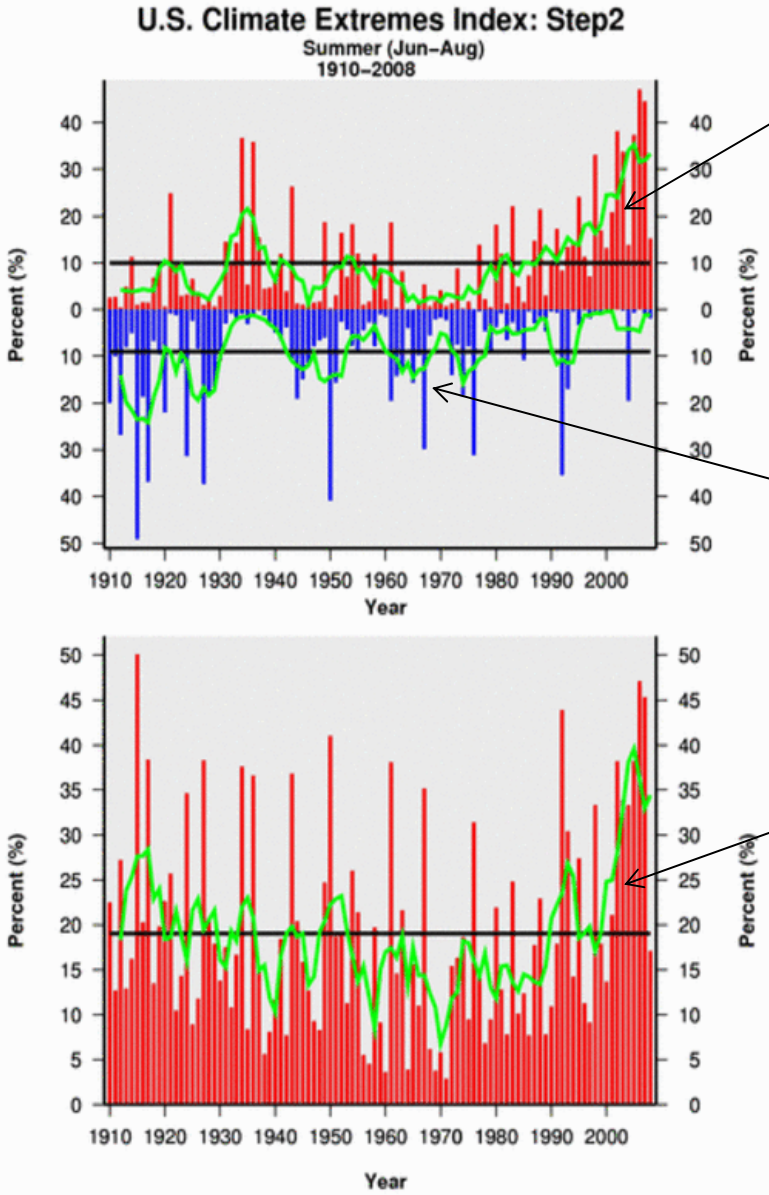
- ✓ Data:
  - USHCN v2 stations (temp & precip) supplemented with TD3200
  - Climate divisions (monthly PDSI)
  - HURDAT (tropical cyclone wind velocity)
- ✓ The components are converted to percentiles
- ✓ Upper & lower tenth percentile threshold
- ✓ Percent area of the country with each component exceeding the threshold



http://www.ncdc.noaa.gov/oa/climate/research/cei/cei.html

CEI Components

"Step 2" (component 2): percent area of the U.S. with **minimum temperatures** above and below the tenth percentile



Percent area above 90th percentile (warm nights)

Much Above Normal Percent

Much Below Normal Percent

Average Percent

5–Yr Moving Avg

Percent area below 10th percentile (cold nights)

Total percent area above 90th percentile & below 10th percentile

Combined Percent

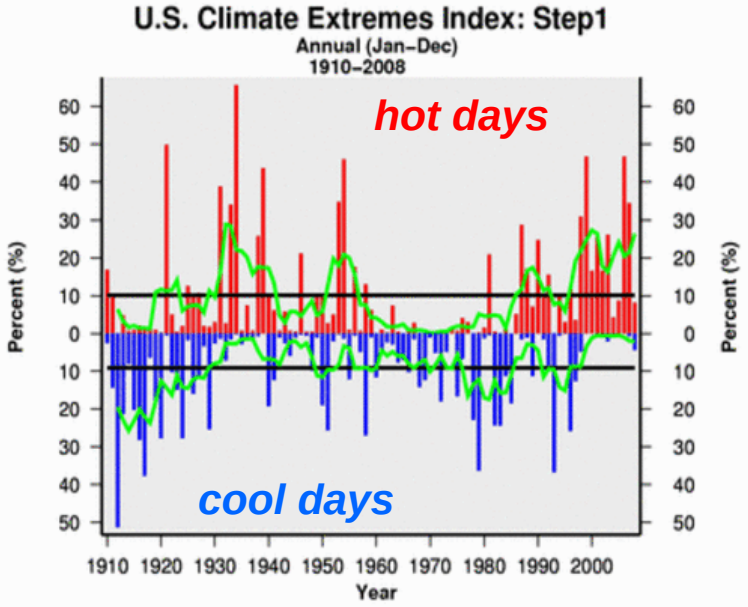
Average Percent

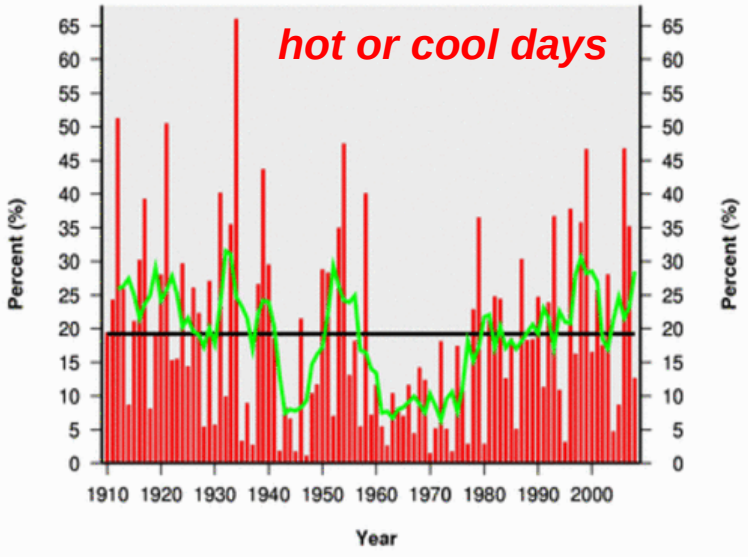
5–Yr Moving Avg

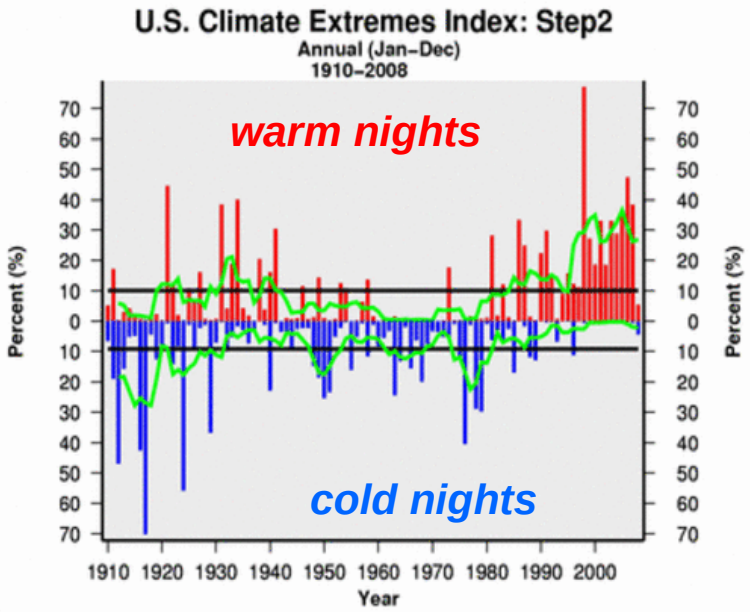
Annual CEI Components

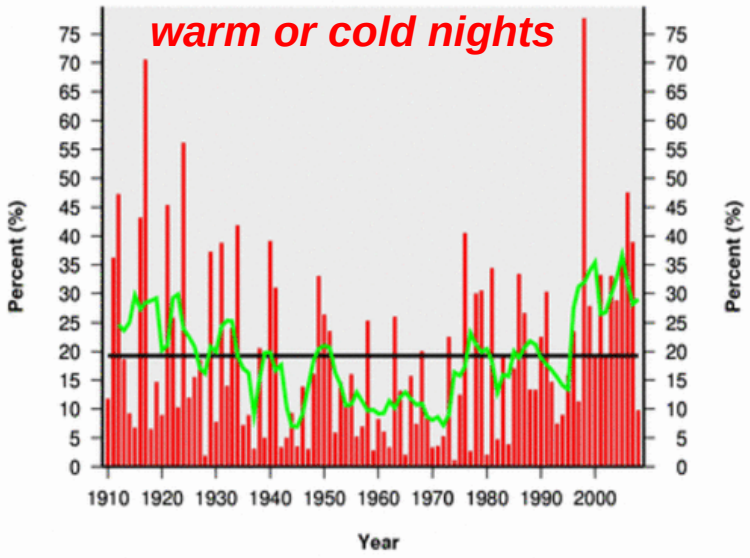
Tmax

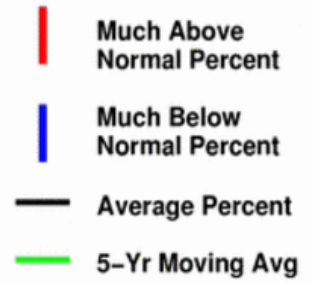
Tmin

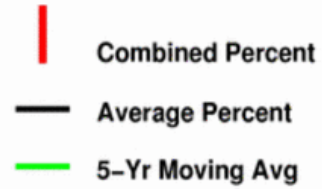






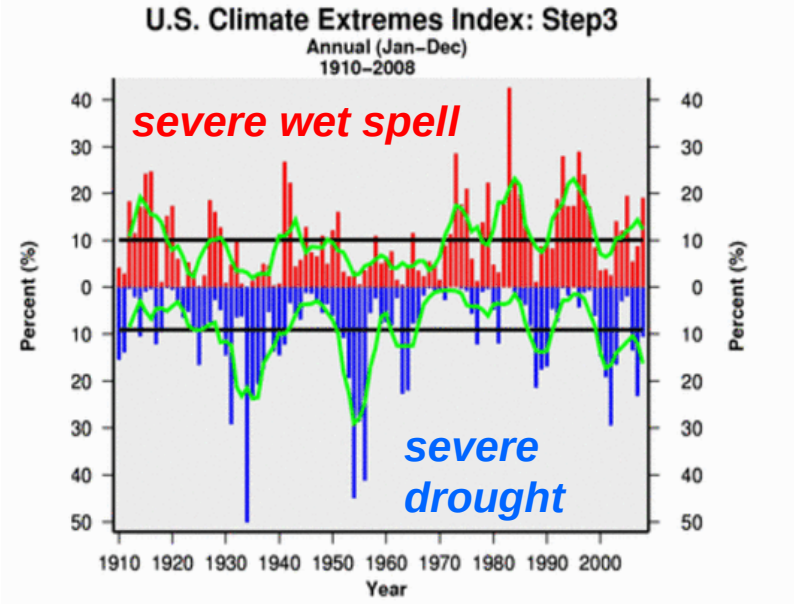


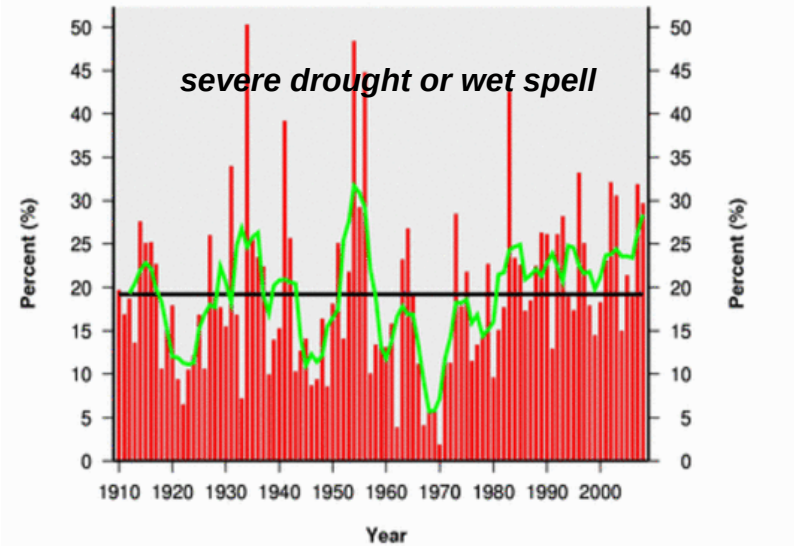


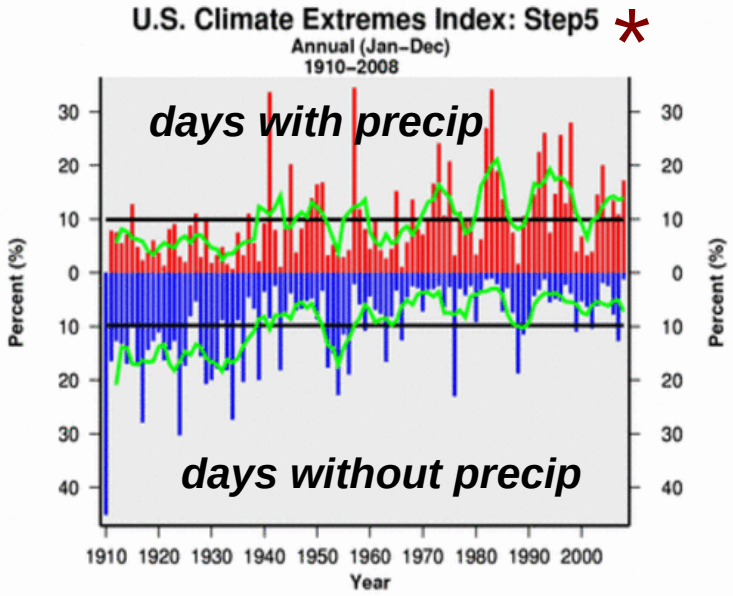


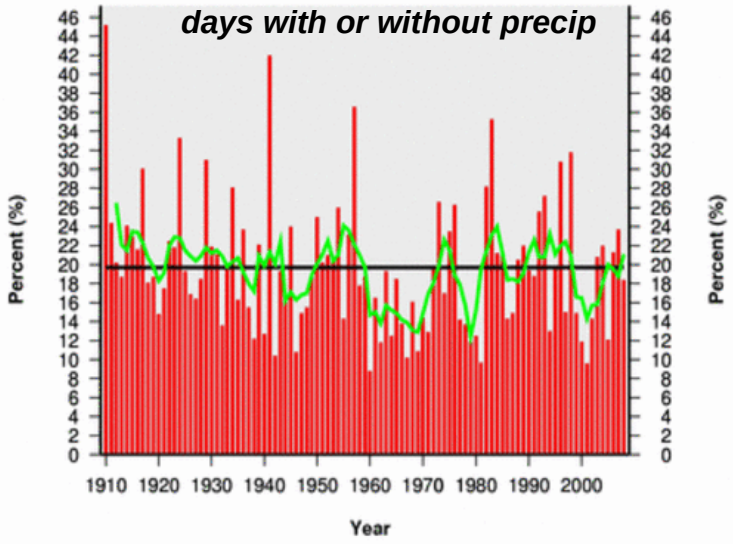
Annual CEI Components

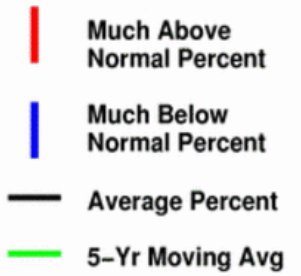
* Component 5: % area with much greater than normal number of days with precipitation (top) & % area with much greater than normal number of days without precipitation (bottom)

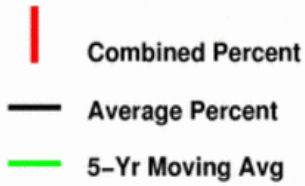








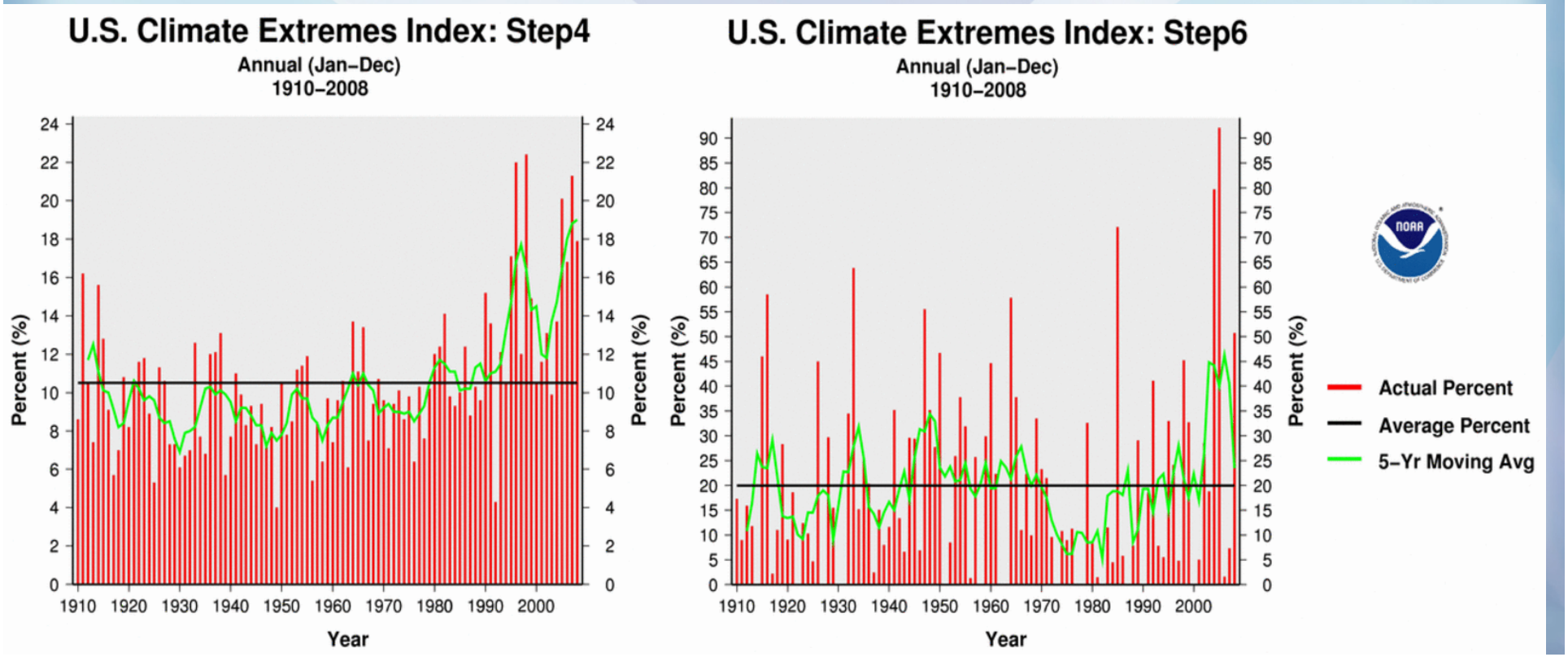




Annual CEI Components

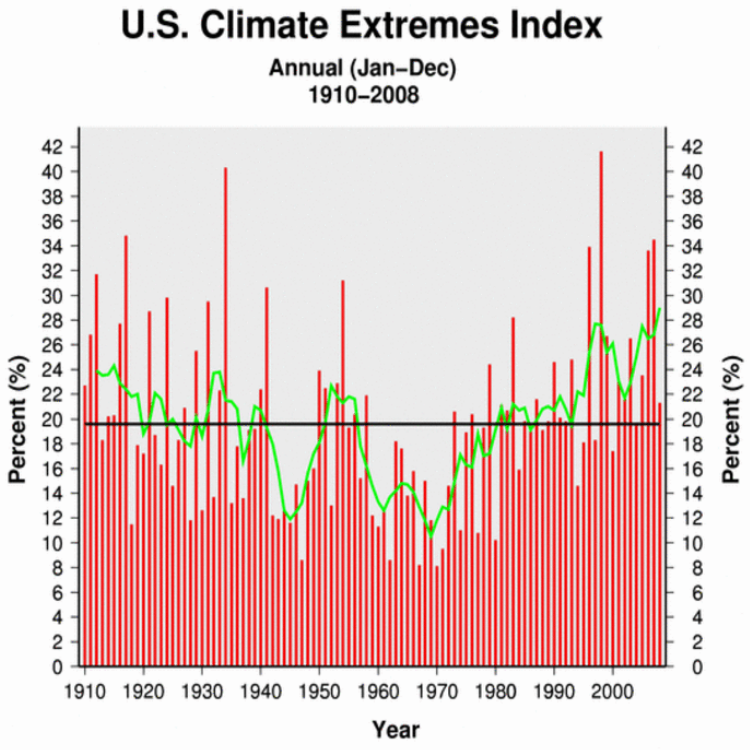
Component 4: twice the percent of the U.S. with much greater than normal proportion of precipitation derived from extreme (> 90th percentile) 1-day precipitation events (wet days).

Component 6 (experimental): sum of squares of U.S. landfalling tropical storm and hurricane wind velocities scaled to the mean of the first 5 indicators.

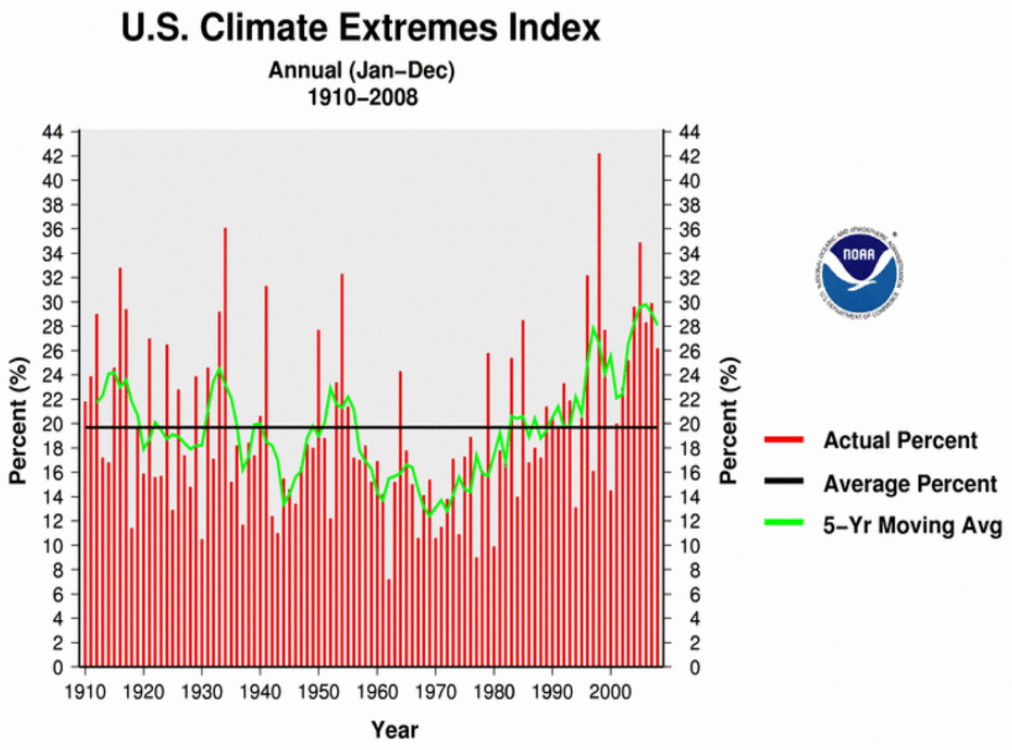


Annual CEI

Without component 6 (tropical storm & hurricane wind velocities):



With component 6 (tropical storm & hurricane wind velocities):



(time check)

Thank-You!

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http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html

http://www.ncdc.noaa.gov/nacem/

http://www.ncdc.noaa.gov/oa/climate/research/cei/cei.html

http://www.ncdc.noaa.gov/ussc/

http://drought.unl.edu/dm/monitor.html

http://drought.gov

http://www.ncdc.noaa.gov/oa/climate/research/monitoring.html

U.S. Snow Climatology Indices

- ✓ **Purpose: Create a snow climatology for Cooperative Network stations to support NOAA National Weather Service operations & FEMA snow disaster declaration activities**
- ✓ **Period of record daily snowfall & snow depth data were analyzed**
- ✓ **Daily & monthly climatologies were computed**
- ✓ **Station History metadata and Quality Control & Inventory (QCI) statistics were compiled to assist the user in evaluation of station quality and for station selection**

http://www.ncdc.noaa.gov/ussc/

U.S. Snow Climatology – Snow Indices

- Monthly & seasonal total snowfall
- Daily & multiple-day periods extreme snowfall
- Number of days (& multi-day periods) with snowfall >= various thresholds
- Number of consecutive days with snowfall (>= 0.1 in. & >= 1.0 in.)
- Monthly probability of receiving snowfall
- Daily probability of receiving snowfall beyond various thresholds
- Earliest, latest, & median dates with snowfall beyond various thresholds (snow season length)
- Extreme (1-day, 2-day, 3-day) snowfall corresponding to 4 return periods (10-yr, 25-yr, 50-yr, 100-yr)
- Median and extreme daily snow cover (snow depth [SD])
- Number of days with snow cover (SD beyond various thresholds)
- Number of consecutive days with snow cover (SD >= 1 in.)
- Daily probability of having snow depth beyond various thresholds

U.S. Snow Climatology – Statistics

- Mean
- Median
- Extremes (minimum, maximum, top 10 smallest, top 10 greatest)
- Quartiles
- Daily & monthly probabilities
- Frequencies
- Number of years with non-missing data

Thank-You!

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http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html

http://www.ncdc.noaa.gov/nacem/

http://www.ncdc.noaa.gov/oa/climate/research/cei/cei.html

http://www.ncdc.noaa.gov/ussc/

http://drought.unl.edu/dm/monitor.html

http://drought.gov

http://www.ncdc.noaa.gov/oa/climate/research/monitoring.html