Tribal Climate Change Webinar Series

June-July 2013

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Tribal Climate Change Webinar Series

- June 13: Climate Change—What it is and why it's important
- **June 18: Indicators of Climate Change**
- June 25: Climate Change Impacts on Tribes
- July 12: Climate Change Outreach and Education

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Climate Change Indicators in the United States, 2012

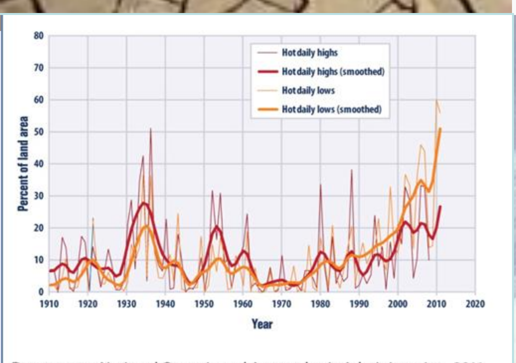
Tribal Climate Change Program Webinar Series
June 18, 2013

Lesley Jantarasami &
Mike Kolian

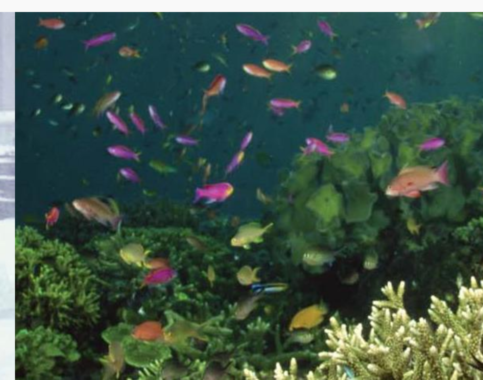
Office of Air & Radiation
Office of Atmospheric Programs
Climate Change Division

Outline


- Introduction to EPA’s climate change indicators report
- Discuss some key findings and messages
- Preview of several indicators in the report
- Explore the climate change indicators website
- Discussion: question and answer



Data source: National Oceanic and Atmospheric Administration, 2011.


Goals of the Report

- Communicate the causes and effects of climate change in an easy-to-understand way (*What is happening now? What does climate change look like?*).
- Highlight observed data with a focus on the U.S., with some regional and some global context; no future projections included.
- Show important trends that are relevant to society and the environment.
- Inform existing and future climate-related programs.

Drought conditions of U.S. lands

About the 2012 Report

- Updates the 2010 report (first edition).
- Consists of 26 indicators (57 figures).
  - Five chapters: Greenhouse Gases, Weather and Climate, Oceans, Snow and Ice, Society and Ecosystems.
  - Three **new** indicators (Snowfall, Streamflow, Ragweed Pollen Season).
  - Nearly all the indicators were updated with data that have become available since the last report and several were expanded with additional metrics.
- Relies on publicly-available and peer-reviewed data sets.
  - Includes data from government agencies (e.g. NOAA, NASA, USGS, and CDC) research institutions, universities, and NGOs.
  - The report underwent an independent, external peer review.

What is an indicator?

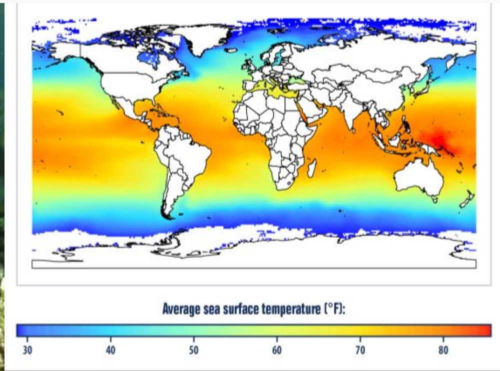
An indicator represents the state or trend of certain environmental conditions over a given area and a specific period of time.

What Makes a Good Indicator?

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

- Criteria used to select indicators:
  - Trends over time
  - Based on observed data
  - Broad geographic coverage
  - Published or peer-reviewed data
  - Usefulness
  - Relevance to climate change
  - Feasible to construct
  - Transparency, reproducibility, and objectivity
  - Ability to communicate to the public





Indicators in the 2012 Report

Greenhouse Gases

U.S. and Global GHG Emissions
Atmospheric GHG Concentrations
Climate (radiative) Forcing

Weather and Climate

U.S. and Global Temperature
U.S. and Global Precipitation
High and Low Temperatures
Drought
Heavy Precipitation
Tropical Cyclone Activity

Oceans

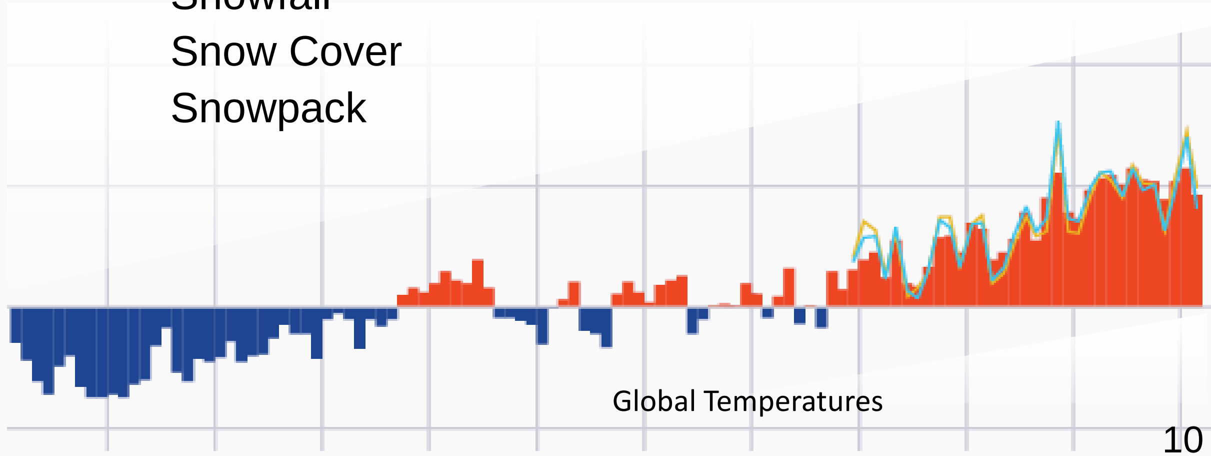
Ocean Heat Content
Sea Surface Temperature
Sea Level
Ocean Acidity

Snow and Ice

Arctic Sea Ice
Glaciers
Lake Ice
Snowfall
Snow Cover
Snowpack

Society and Ecosystems

Heat-Related Deaths
Length of Growing Season
Streamflow
Ragweed Pollen
Leaf and Bloom Dates
Bird Wintering Ranges



Global Temperatures

Some Key Findings





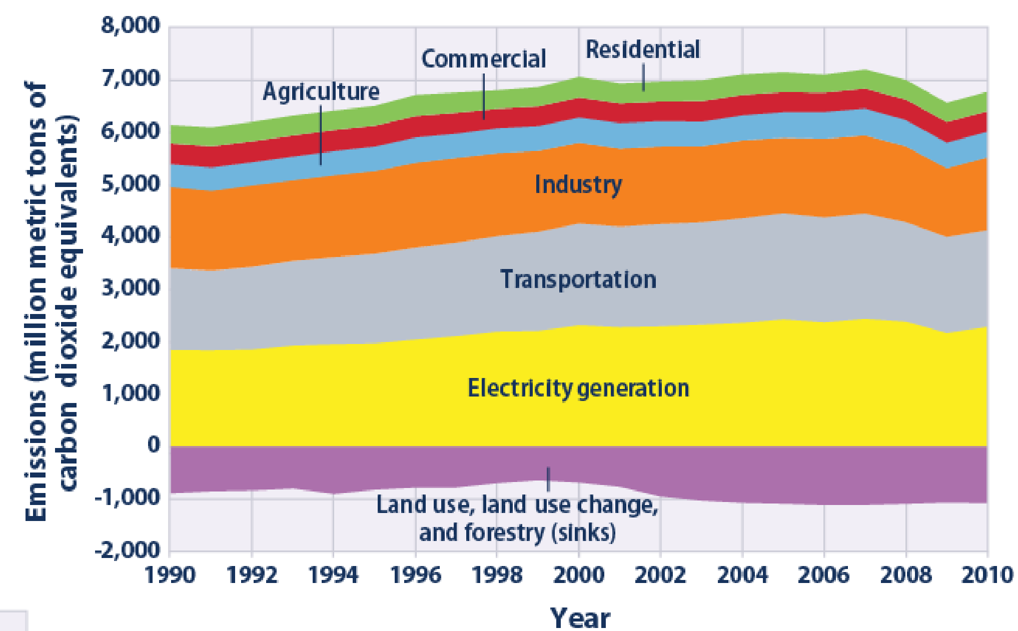
- Unusually hot summer temperatures have become more common, and daily record high temperatures now outnumber record low temperatures by 2 to 1.
- A higher percentage of U.S. is experiencing heavy precipitation in the form of intense, single day events.
- Relative sea level rose along much of the U.S. coastline over the past half century, particularly in the mid-Atlantic and Gulf coasts.
- The extent of Arctic sea ice has decreased markedly with 2012 being the lowest on record. Glaciers in the U.S. and world-wide melting faster and losing mass.
- The length of the growing season and ragweed pollen season are increasing, and bird wintering ranges have moved northward.

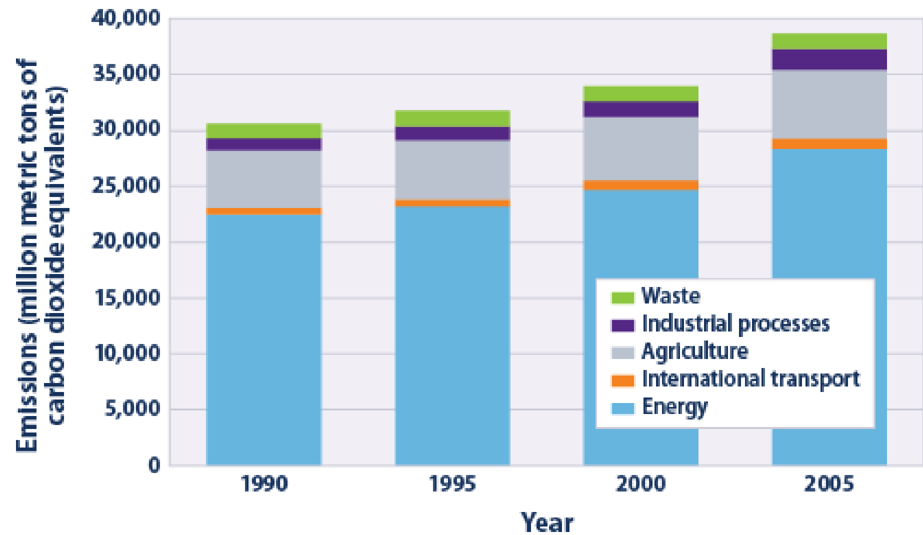
Greenhouse Gases

U.S. and Global Greenhouse Gas Emissions

Electricity generation is the largest U.S. GHG emissions source (32%). Transportation is the second-largest source (27%).

U.S.GHG Emissions and Sinks by Economic Sector (1990-2010)





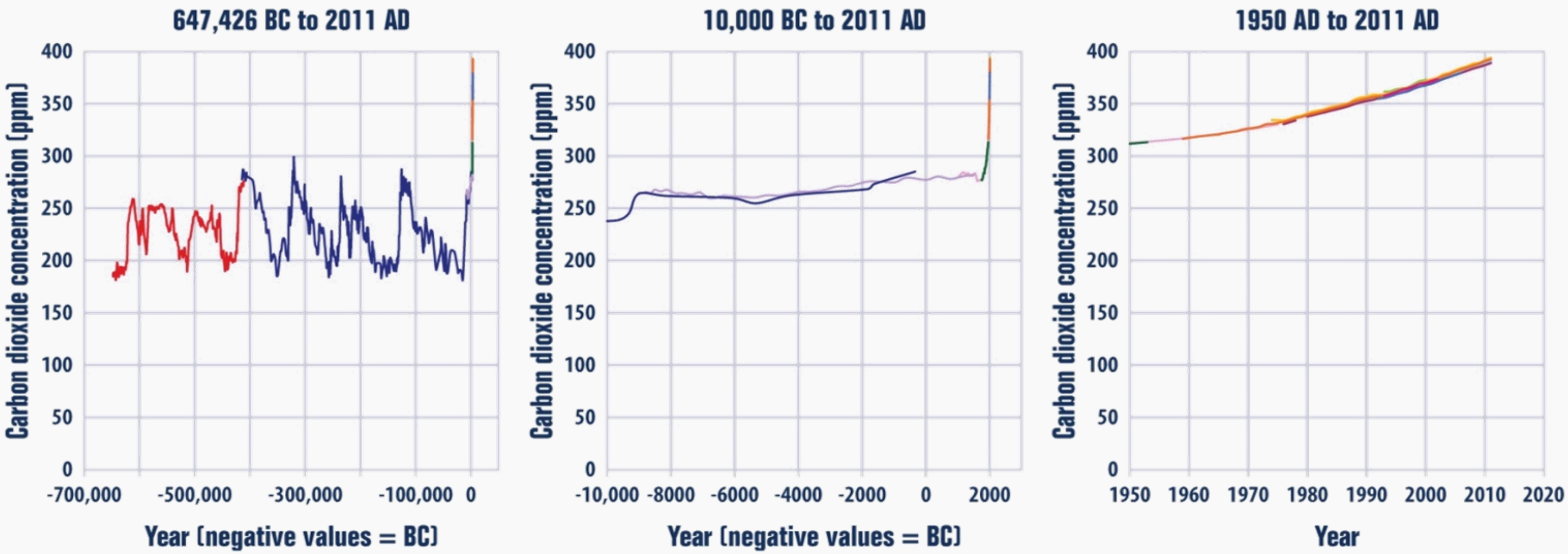
Global GHG Emissions by Economic Sector (1990-2005)

Energy production and use (including energy used by vehicles) represent the largest source of GHG emissions worldwide (about 73%), followed by agriculture (16 -17%)

Data sources: WRI, 2012; U.S. EPA, 2012

Atmospheric Concentrations of GHGs

Global Atmospheric Concentrations of Carbon Dioxide Over Time

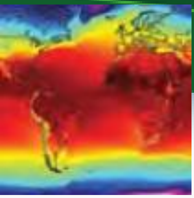


Data source: Various studies

- Current global atmospheric concentrations of carbon dioxide are at unprecedented levels compared with the past 650,000 years.

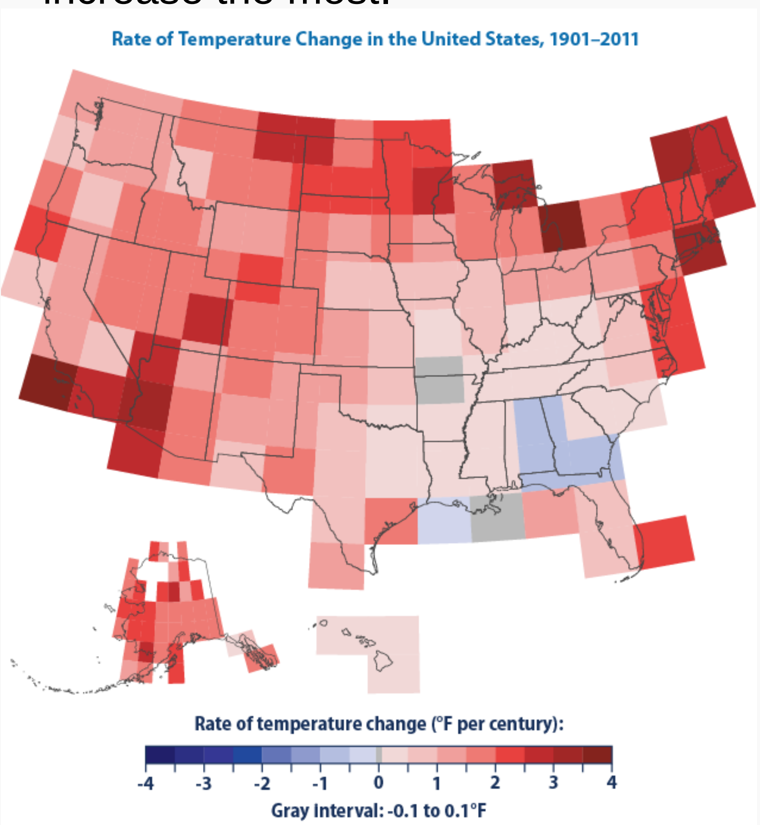
Weather and Climate

U.S. and Global Temperatures



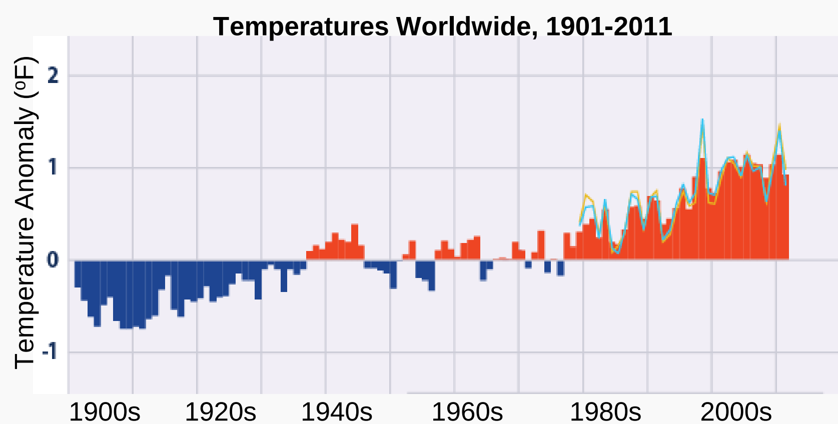
Rate of Temperature Change in the U.S., 1901-2011

- Average surface temperature across the contiguous 48 states has risen at an average rate of 0.13°F per decade since 1901.
- The North, the West, and Alaska have seen temperatures increase the most.



Temperatures Worldwide, 1901-2011

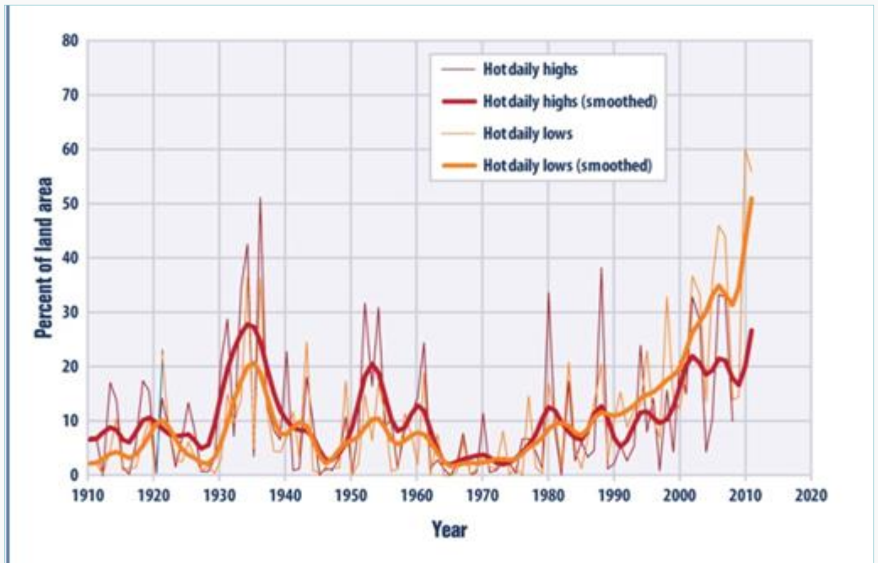
- Worldwide, 2001–2010 was the warmest decade on record since thermometer-based observations began.



Data sources: NOAA-NCDC, 2012

Area of the Contiguous 48 States With Unusually Hot Summer Temperatures, 1910-2012

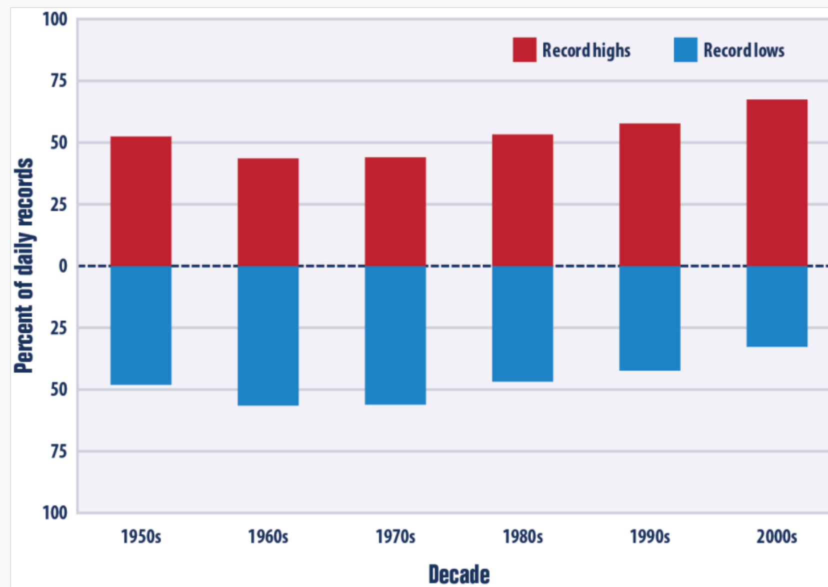
Since the 1970s, unusually hot summer temperatures have become more common. The occurrence of unusually hot summer nights (lows) has increased at an even faster rate. This trend indicates less "cooling off" at night.



Data source: National Oceanic and Atmospheric Administration, 2011.

Record Daily High and Low Temperatures in the Contiguous 48 States, 1950–2009

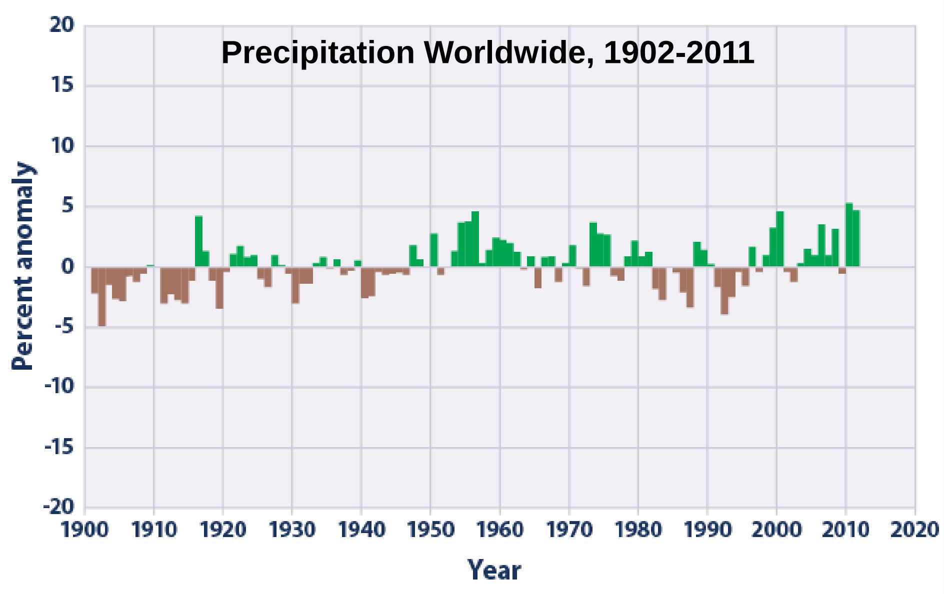
Since the 1970s, record setting daily high temperatures have become more common than record lows across the United States. The most recent decade had twice as many record highs as record lows.

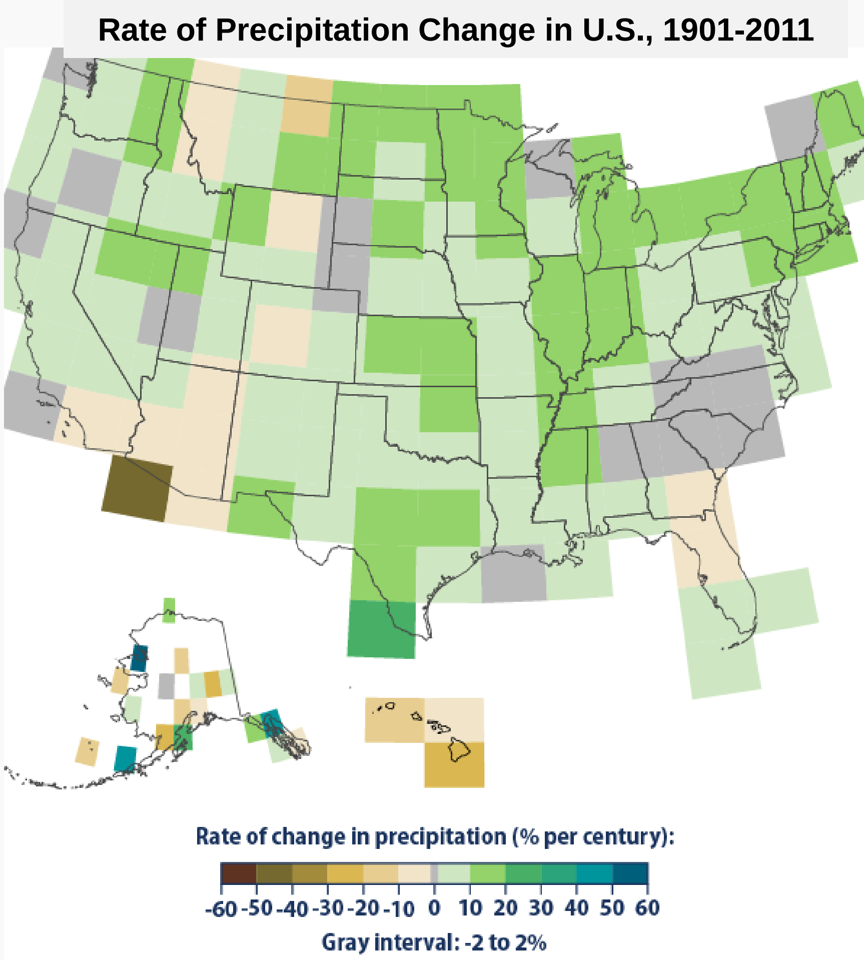


Data sources: NOAA, 2011; Meehl et al., 2009

U.S. and Global Precipitation

- On average, total annual precipitation has increased over land areas in the United States and worldwide.
- Some parts of the United States have experienced greater increases in precipitation than others.





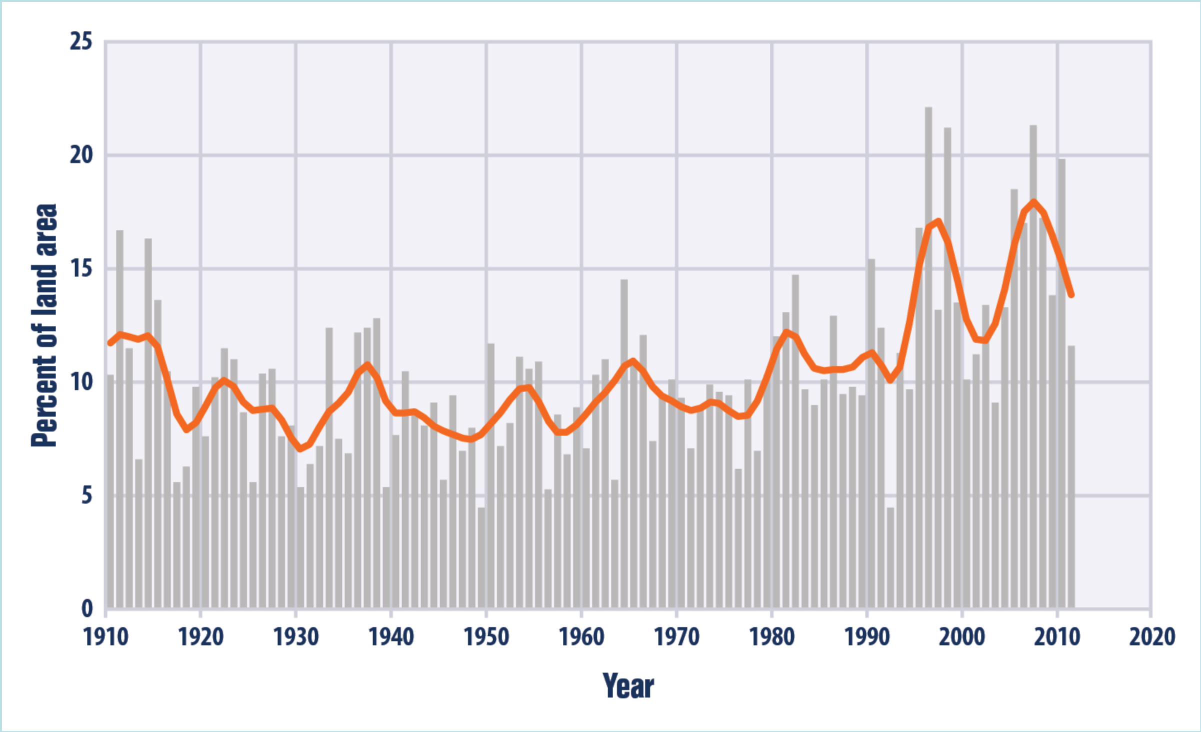
Data source: NOAA, 2012

Heavy Precipitation

In recent years, a larger percentage of precipitation has come in the form of intense single day events.

Eight of the top 10 years for extreme one-day events have occurred since 1990.

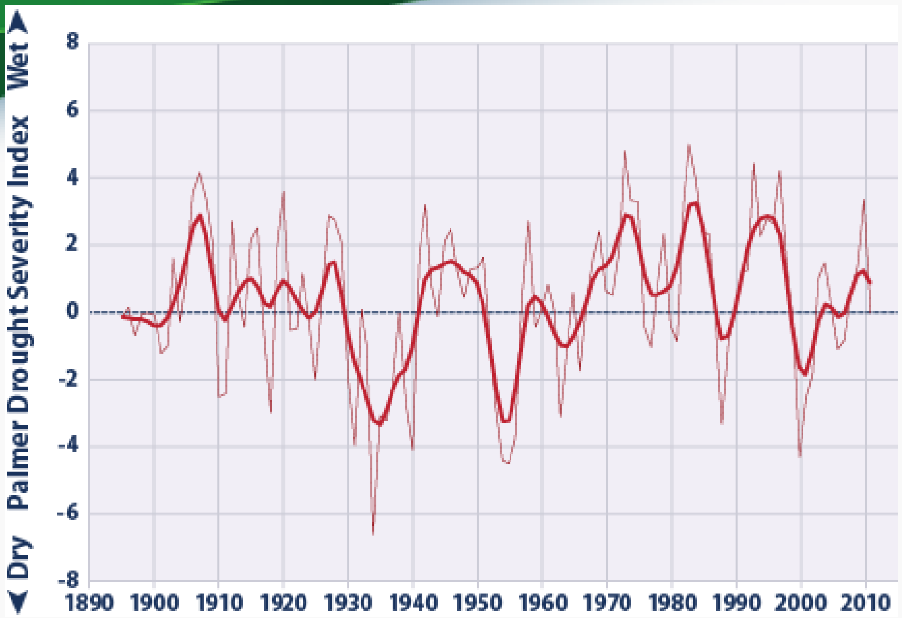
Extreme One-Day Precipitation Events in the Contiguous 48 States, 1910-2011



Data source: NOAA, 2012

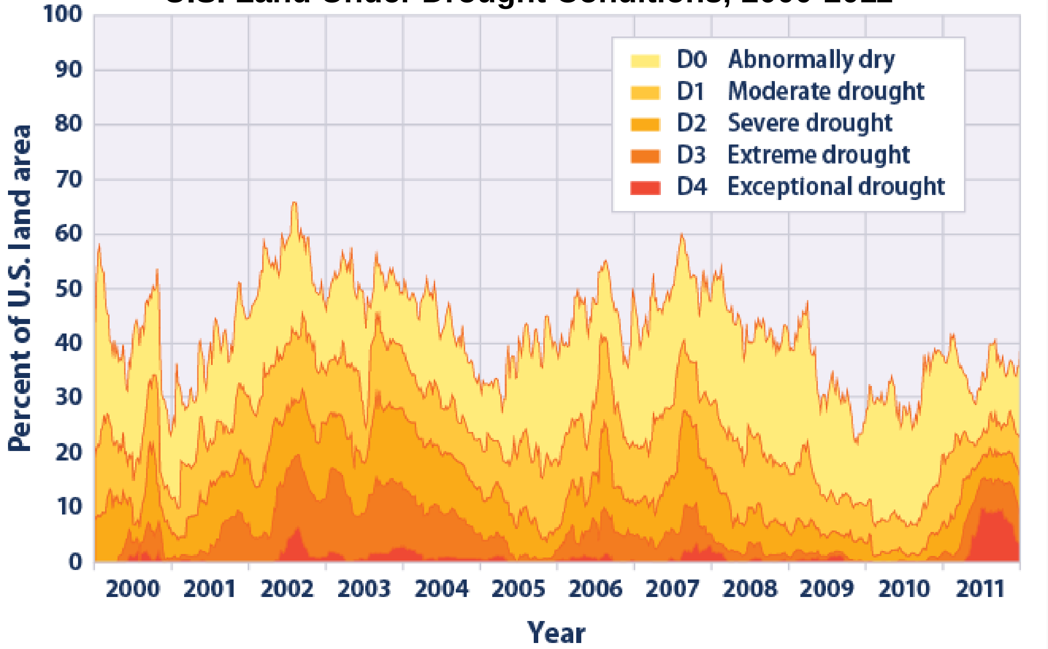
Drought

Average drought conditions across the nation have varied since records began in 1895.



Average Drought Conditions in Lower 48 States, 1895-2011

U.S. Land Under Drought Conditions, 2000-2011

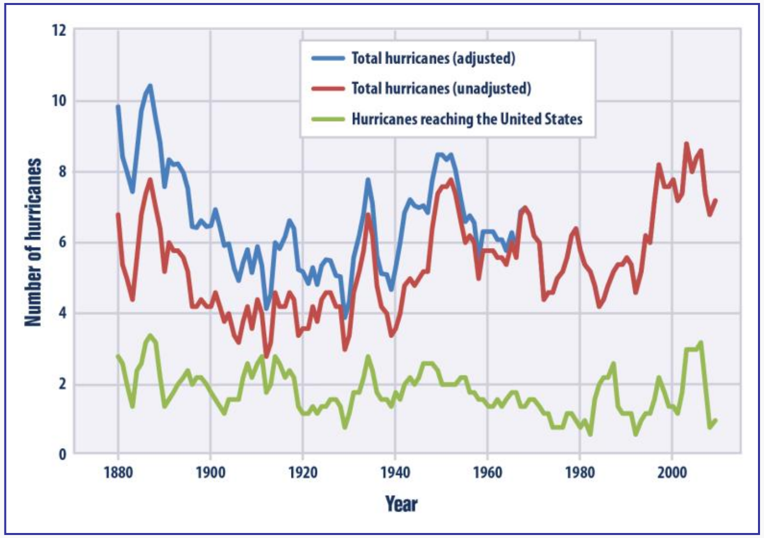


From 2000 through 2011, roughly 30-60% of U.S. land area experienced conditions that were at least abnormally dry at any given time.

Data sources: NOAA, 2012; National Drought Mitigation Center, 2012

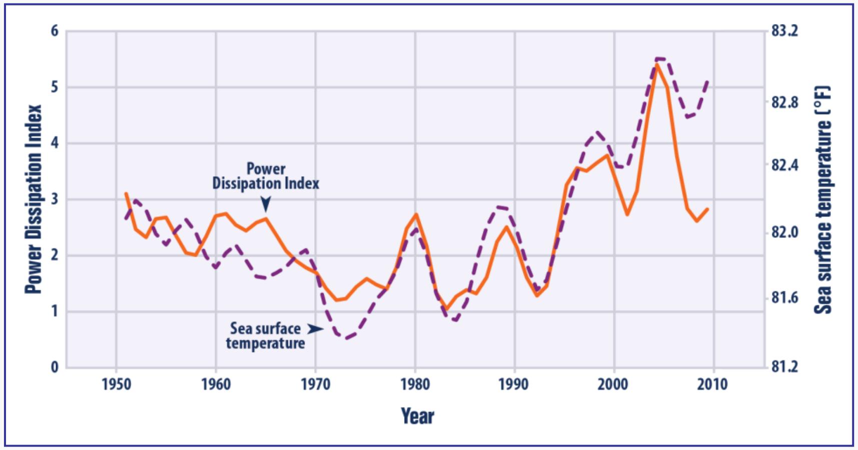
Tropical Cyclone Activity

Number of Hurricanes in the North Atlantic, 1878-2011



Data Source: NOAA, 2012

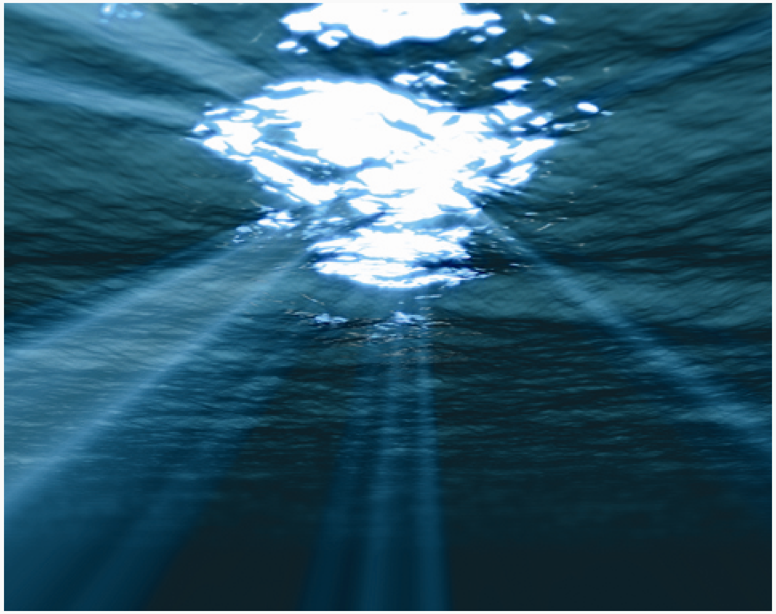
North Atlantic Tropical Cyclone Activity, 1949-2011



Data Source: Emmanuel 2012

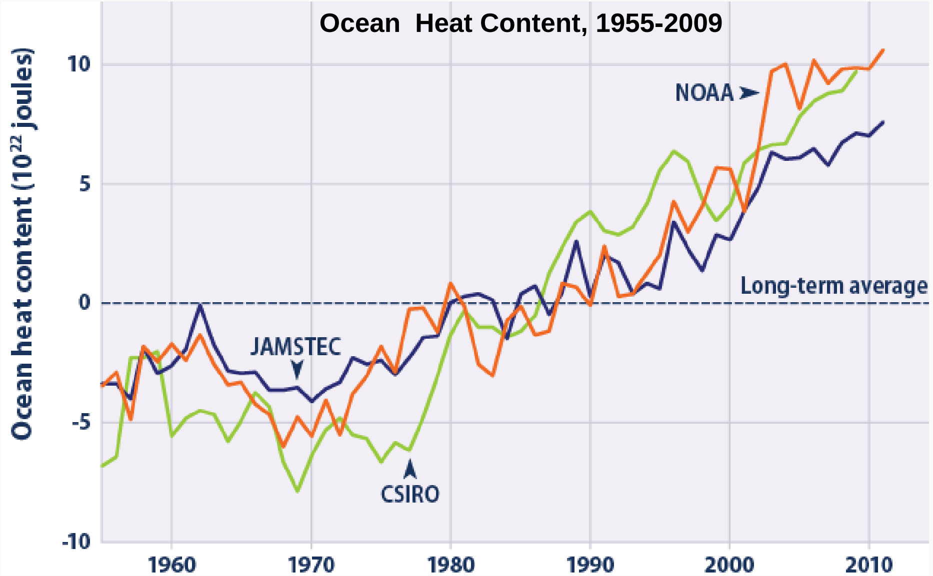
- Since 1878, about 6-7 hurricanes have formed in the North Atlantic every year.
- The Power Dissipation Index shows fluctuating cyclone intensity for most of the mid- to late 20th century, followed by a noticeable increase since 1995.

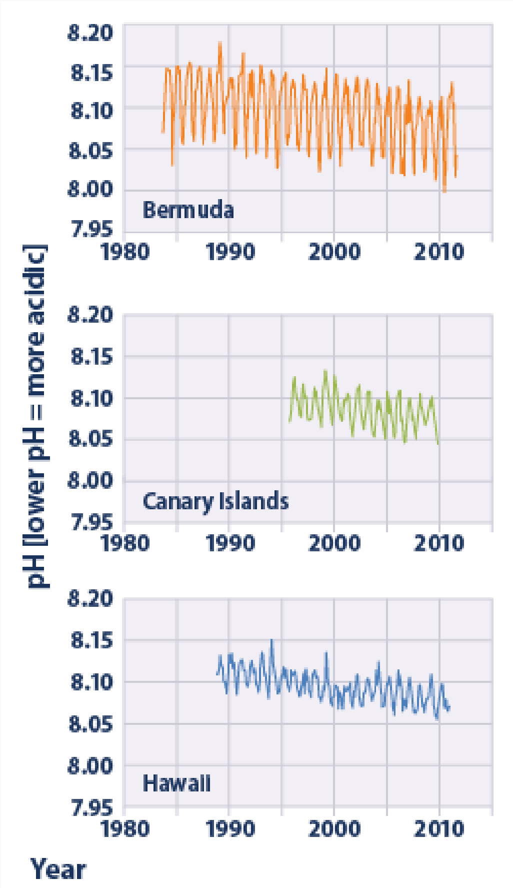
Oceans



Ocean Heat and Acidity

Oceans have become warmer since 1955, though the rate of change can vary from year to year

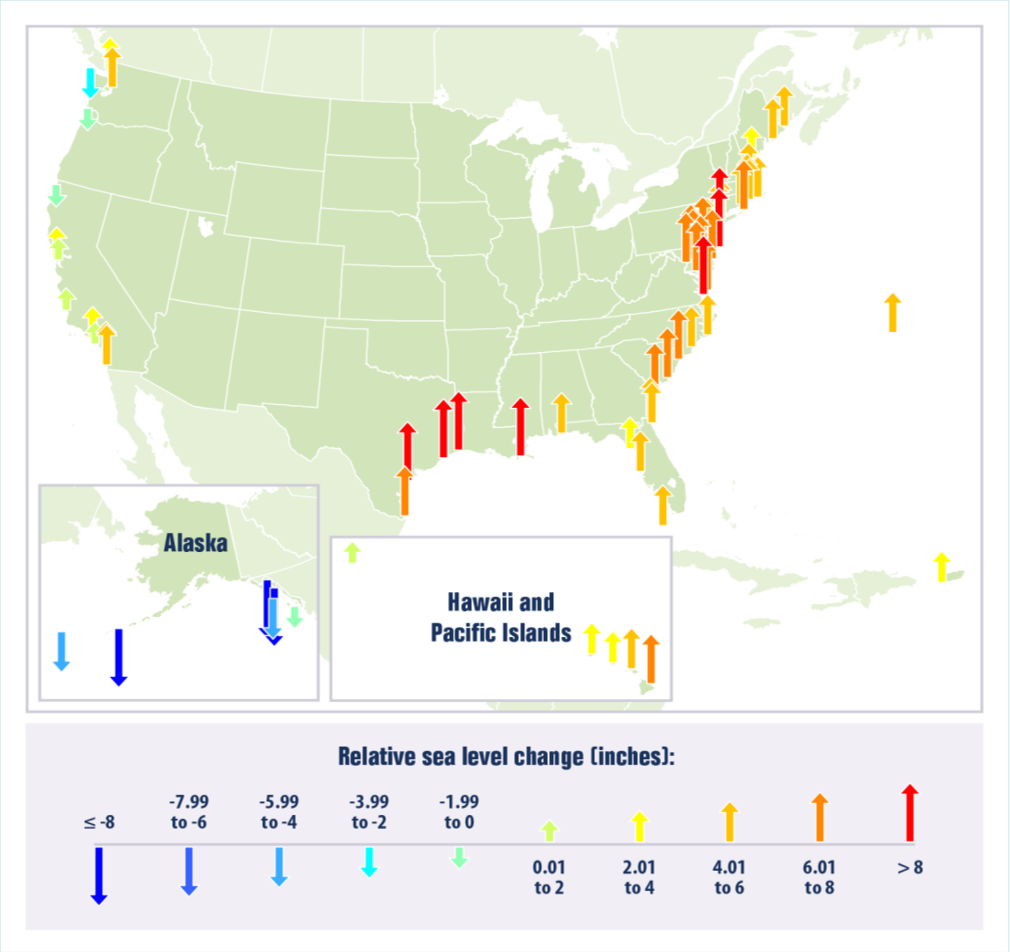




Ocean Acidity, 1983-2011

Ocean carbon dioxide levels have risen in response to increased carbon dioxide in the atmosphere, leading to an increase in acidity (that is, a decrease in pH)

Sea Level



Data Source: NOAA, 2012

Relative Sea Level Changes Along US Coasts, 1960-2011

Relative sea level rose along much of the U.S. coastline between 1960 and 2011, particularly the Mid-Atlantic coast and parts of the Gulf coast, where some stations registered increases of more than 8 inches.

Snow and Ice

Arctic Sea Ice

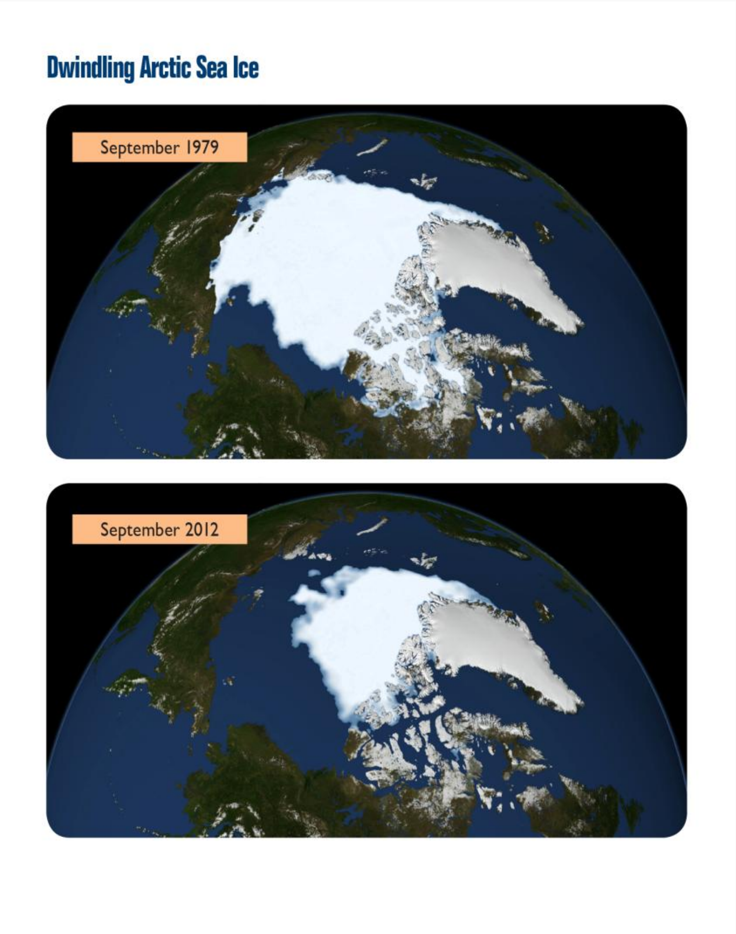
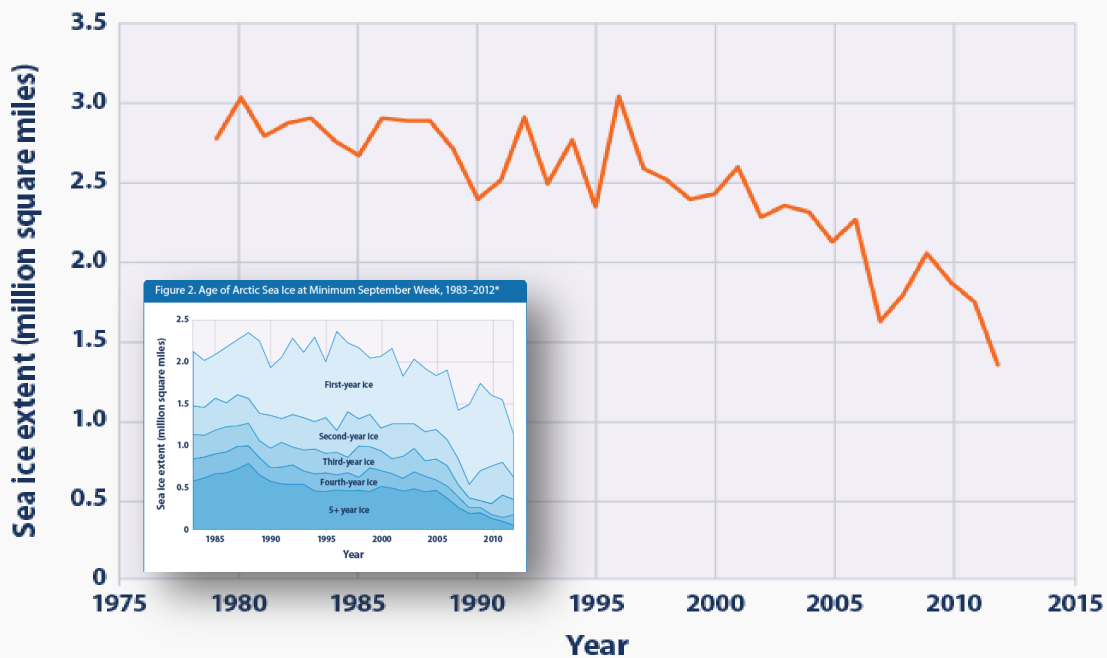


Image Source: NASA, 2011

September Average Arctic Sea Ice Extent, 1979-2012

September 2012 had the lowest sea ice extent on record.

The 2012 record low sea ice extent was 1.3 million square miles (an area five times the size of Texas) or 49% less than the historical 1979-2000 average.

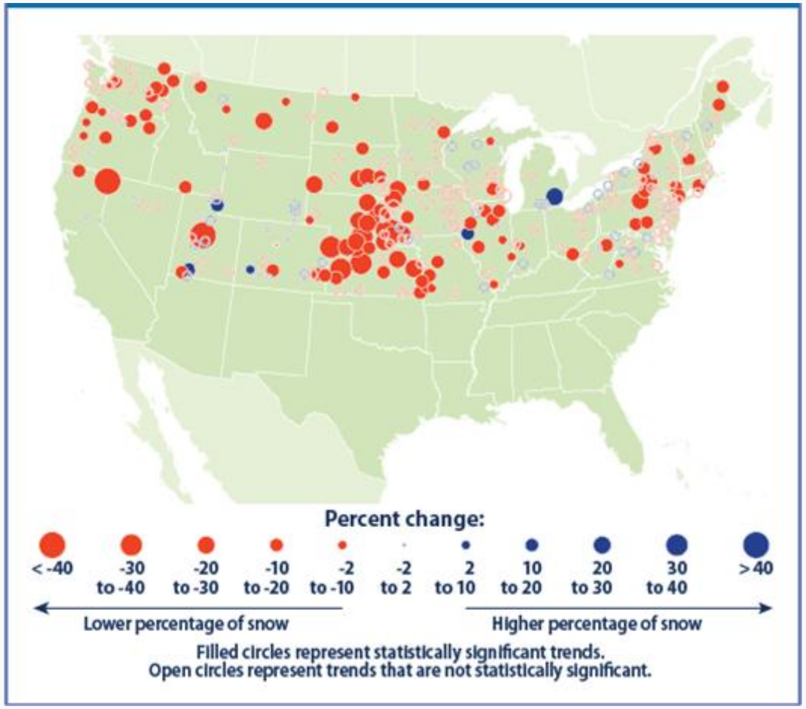


Data source: NSIDC, 2012

Snowfall "NEW"

Climate change can also lead to changes in the type and amount of precipitation.

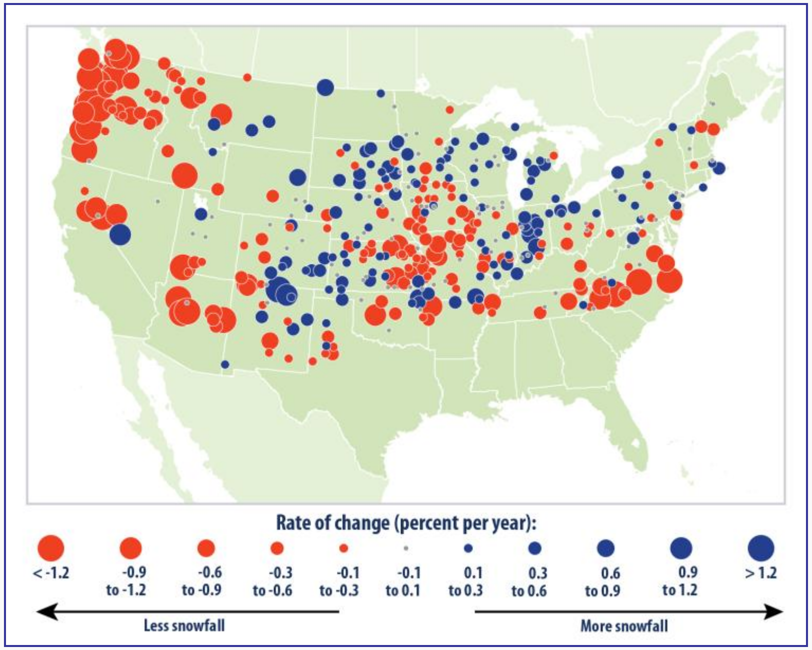
Change in Snow-to-Precipitation Ratio, 1949-2011



More than three-fourths of the stations across the contiguous 48 states have experienced a decrease in the proportion of precipitation falling as snow.

Data Source: Feng, 2012

Change in Total Snowfall, 1930-2007



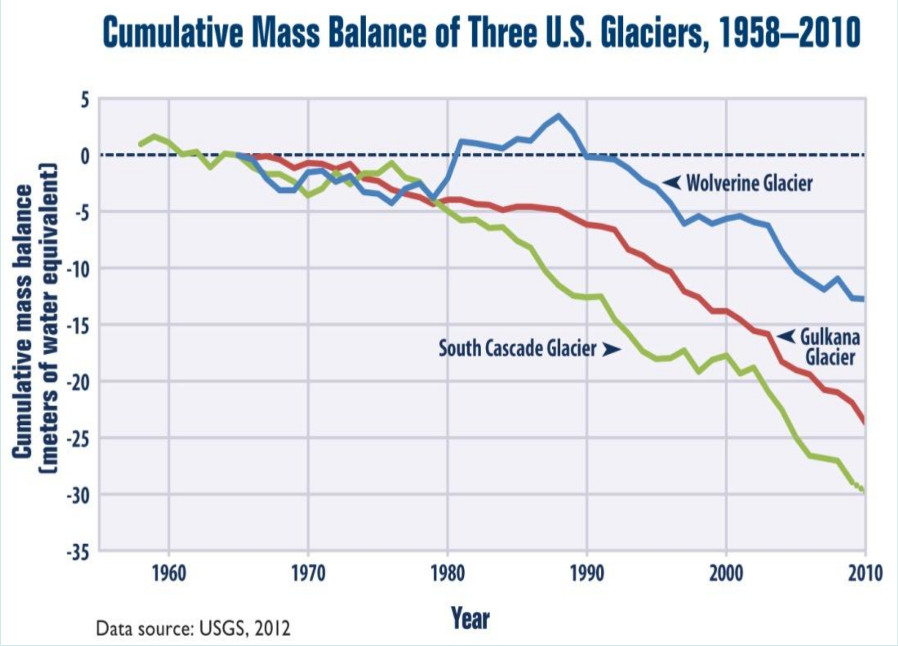
Snowfall amount varies greatly by region, with 57% of the stations have seen a decline in total snowfall.

Data Source: Kunkel et al., 2009

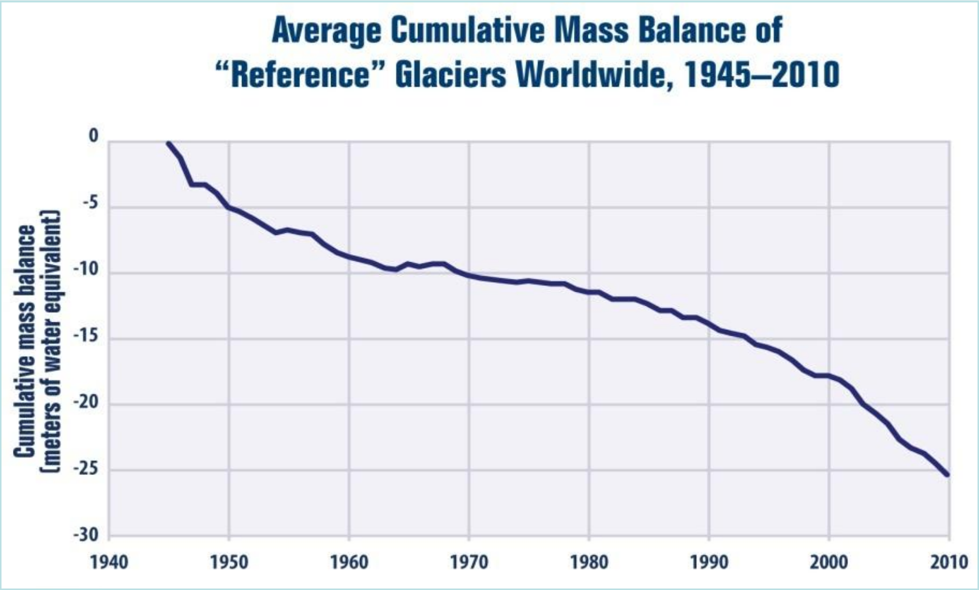
Glaciers

All three U.S. benchmark glaciers have shown an overall decline in mass balance since the 1960s and an accelerated rate of decline in recent years.

These trends are consistent with glaciers observed throughout the western U.S. , Alaska, and other parts of the world.



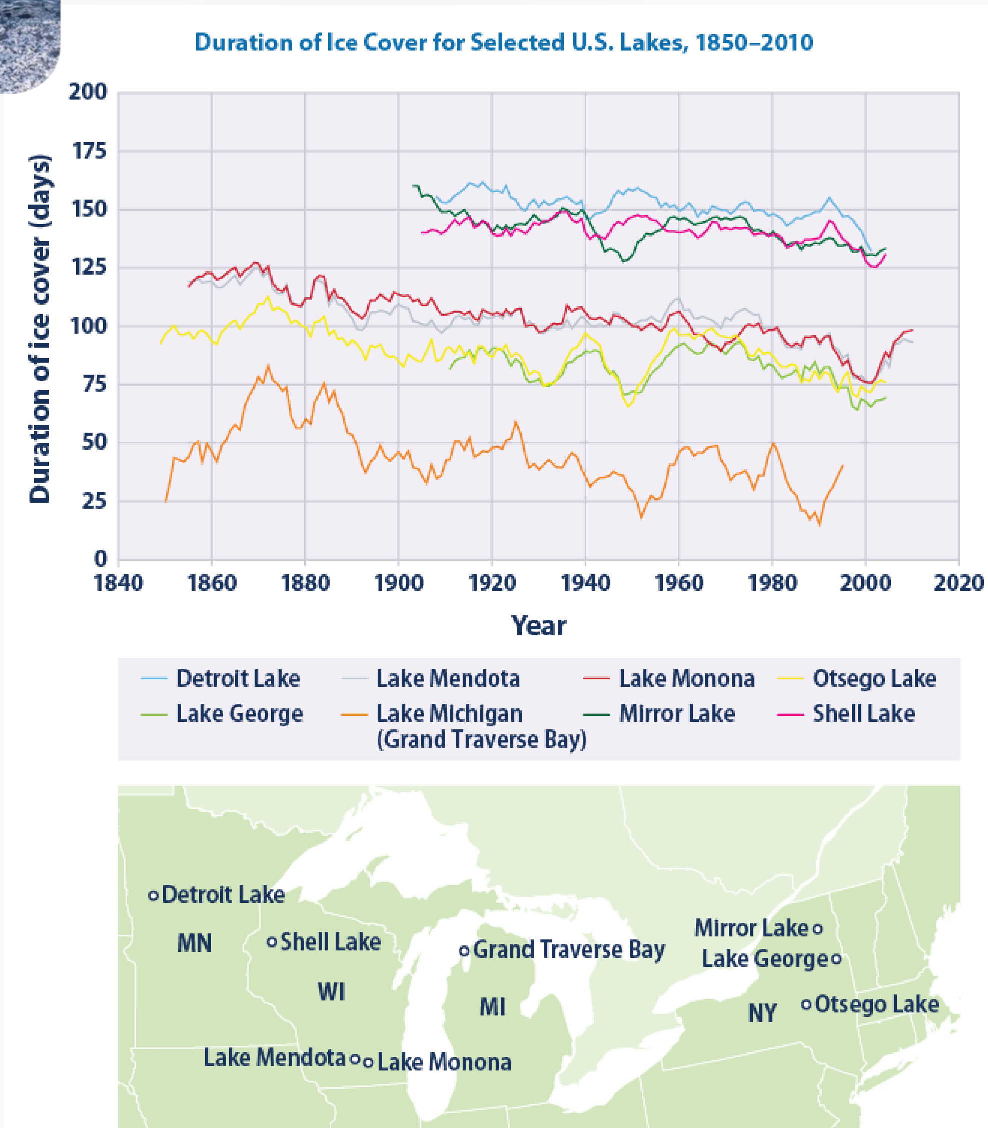
Data source: USGS, 2012



Data source: WGMS, 2012

On average, glaciers worldwide have been losing mass since at least the 1970s, which in turn has contributed to observed changes in sea level.

Lake Ice



Duration of Ice Cover for Selected U.S. Lakes, 1850-2010

The time lakes stay frozen has generally decreased since the mid-1800s.

For most of the lakes in this indicator, the duration of ice cover has decreased at an average rate of one to two days per decade.

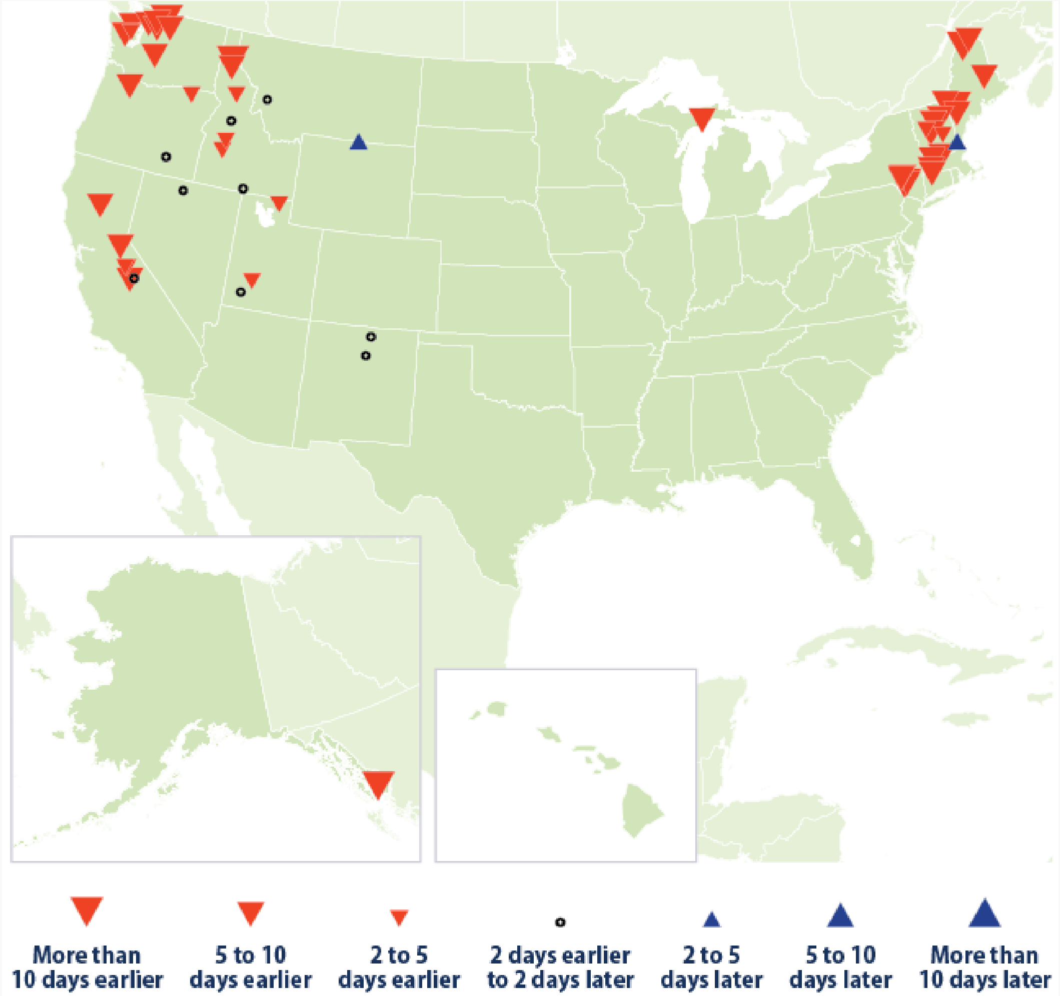
Data source: NSIDC, 2011

Society and Ecosystems

Streamflow “NEW”

Includes 3 metrics - high, low streamflow and….

Timing of Winter-Spring Runoff in the U.S., 1940-2009



This streamflow metric shows changes in the timing of peak spring flow for rivers and streams, based on the long-term rate of change from 1940 to 2009.

Sixty percent of the streams measured show winter-spring runoff happening more than five days earlier than it did in the past.

Data source: USGS, 2012

Length of the Growing Season

The average length of the growing season in the lower 48 states has increased by about two weeks since the beginning of the 20th century.

Figure 1. Length of Growing Season in the Contiguous 48 States, 1895–2011

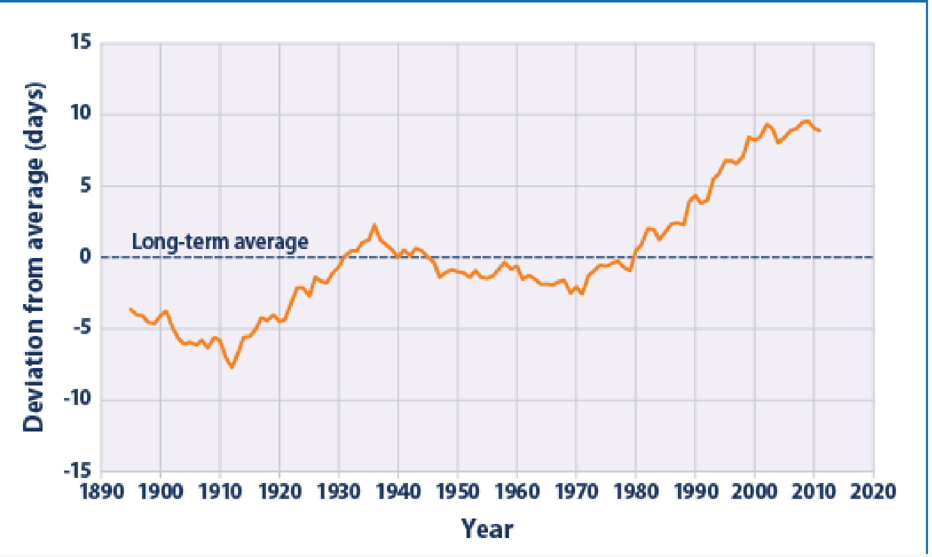
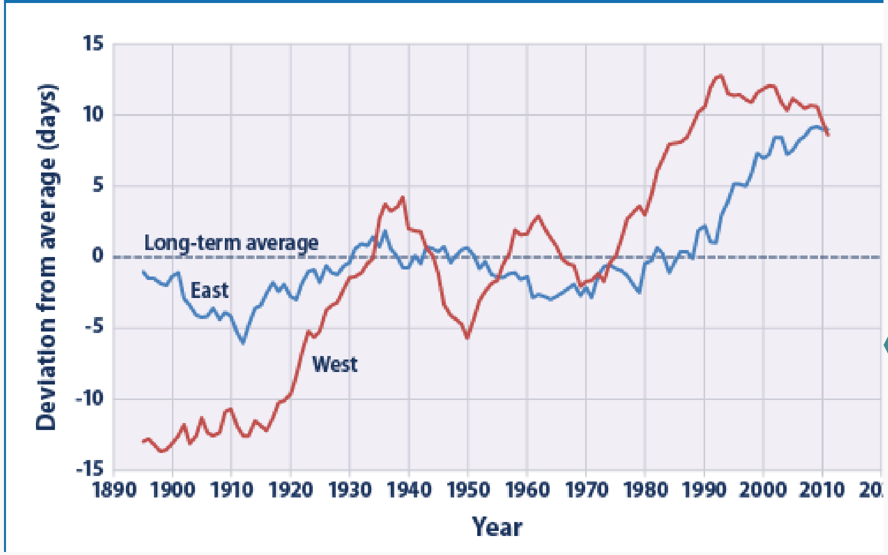


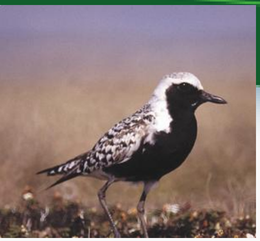
Figure 2. Length of Growing Season in the Contiguous 48 States, 1895–2011: West Versus East



The length of the growing season has increased more rapidly in the West than in the East.

Data source: Kunkel, 2012

Bird Wintering Ranges



Among 305 widespread North American bird species, the average ‘center of abundance’ moved northward and further from the coast between 1966 and 2005.

The species’ average shifted northward by 35 miles during this period. Bird wintering ranges are also moving further inland.

These trends are closely related to winter temperatures.

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

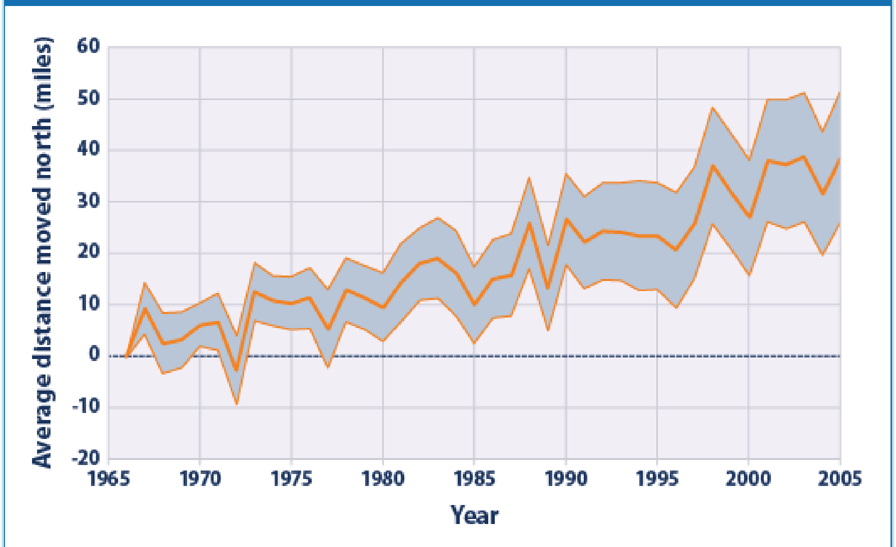
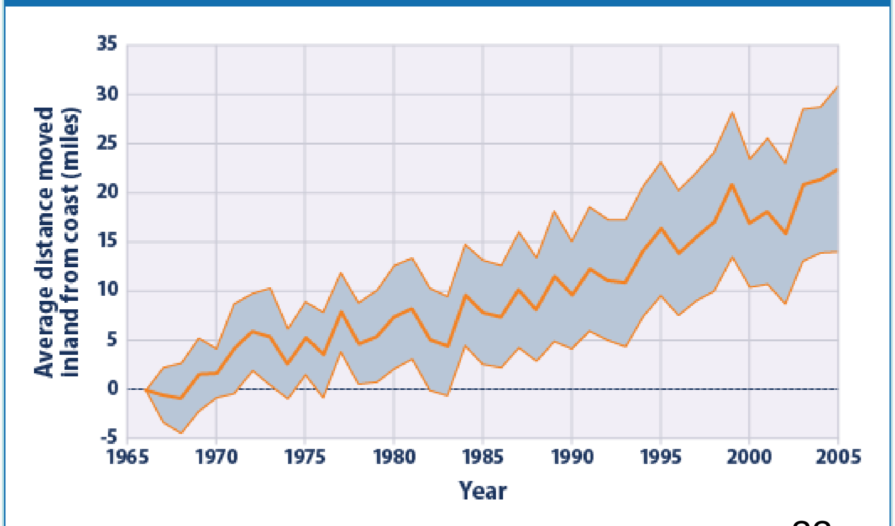


Figure 2. Change in Distance to Coast of Bird Center of Abundance, 1966–2005



Data source: National Audubon Society, 2009

Ragweed Pollen Season "NEW"

Data source: Ziska et al., 2012

Change in Ragweed Pollen Season, 1995-2011

Since 1995, ragweed pollen season has grown longer at eight of the 10 locations studied.

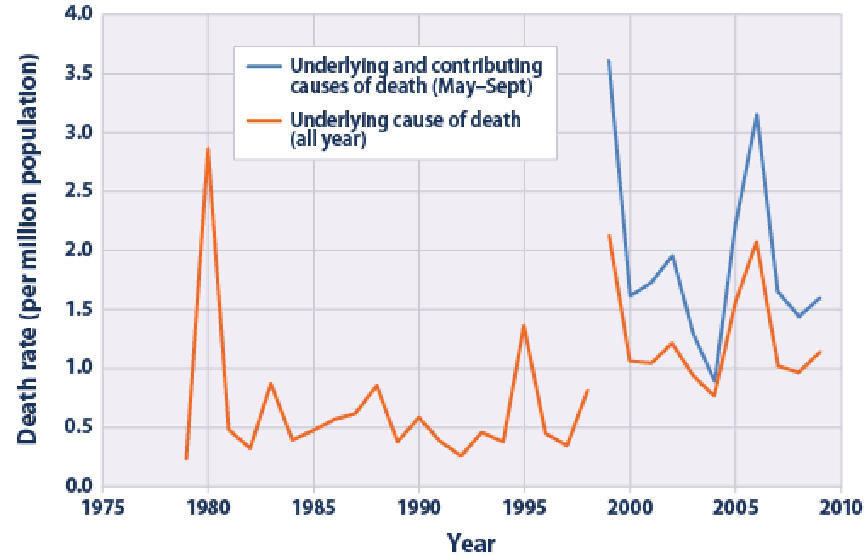
The increase in ragweed season length becomes more pronounced from south to north.

The trends are strongly related to changes in the length of the frost-free season and the timing of the first fall frost.

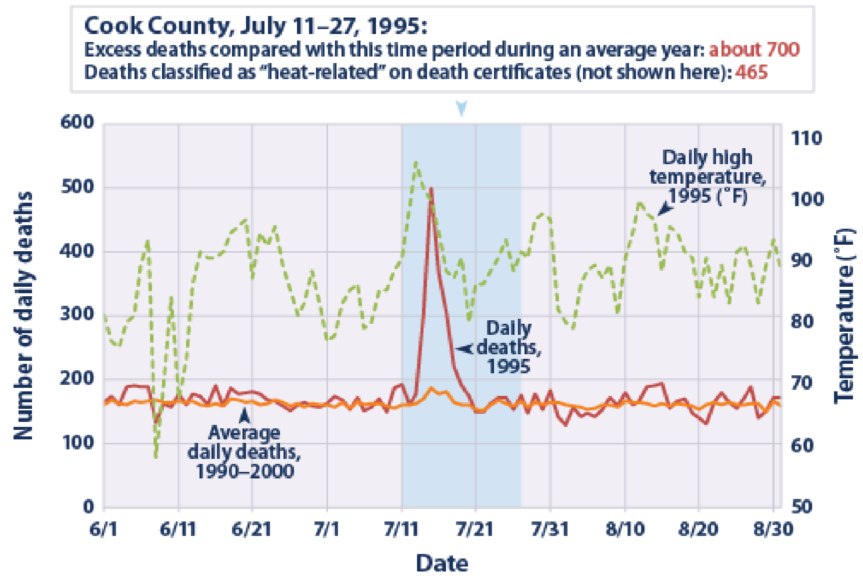
Heat-Related Deaths

- Over the past three decades, more than 7,000 Americans were reported to have died as a direct result of heat-related illnesses.
- From 1979-2009, the death rate as a direct result of exposure to heat was around 0.5 deaths per million population, with spikes in certain years.
- Studies of the 1995 heat wave event in Chicago suggest that there were hundreds more deaths than were actually reported as “heat-related” on death certificates.

Figure 1. Deaths Classified as “Heat-Related” in the United States, 1979–2009



Example: Examining Heat-Related Deaths During the 1995 Chicago Heat Wave*



Data sources: CDC, 2012

SAMPLE PAGE

Heavy Precipitation

This indicator tracks the frequency of heavy precipitation events in the United States.

Key points on the trend

Background

"Heavy precipitation" refers to instances during which the amount of precipitation experienced in a location substantially exceeds what is normal. What constitutes a period of heavy precipitation varies according to location and season.

Climate change can affect the intensity and frequency of precipitation. Warmer oceans increase the amount of water that evaporates into the air. When more moisture-laden air moves over land or converges into a storm system, it can produce more intense precipitation—for example, heavier rain and snow storms.[17] The potential impacts of heavy precipitation include crop damage, soil erosion, and an increase in flood risk due to heavy rains. In addition, runoff from precipitation can impair water quality as pollutants deposited on land wash into water bodies.

Heavy precipitation does not necessarily mean the total amount of precipitation at a location has increased—just that precipitation is occurring in more intense events. However, changes in the intensity of precipitation, when combined with changes in the interval between precipitation events, can also lead to changes in overall precipitation totals.

About the Indicator

Heavy precipitation events can be measured by tracking their frequency, examining their return period (the chance that the event will be equaled or exceeded in a given year), or directly measuring the amount of precipitation in a certain period.

One way to track heavy precipitation is by calculating what percentage of a particular location's total precipitation in a given year has come in the form of extreme one-day events—or, in other words, what percentage of precipitation is arriving in short, intense bursts. Figure 1 of this indicator looks at the prevalence of extreme single-day precipitation events over time.

(Continued on page 31)

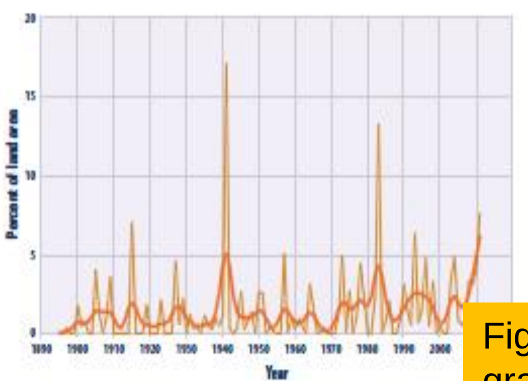
Background on the indicator

Figure 1. Extreme One-Day Precipitation Events in the Contiguous 48 States, 1910–2011

This figure shows the percentage of the land area of the contiguous 48 states where a much greater than normal portion of total annual precipitation has come from extreme single-day precipitation events. The bars represent individual years, while the line is a nine-year weighted average.

Figure 2. Unusually High Annual Precipitation in the Contiguous 48 States, 1895–2011

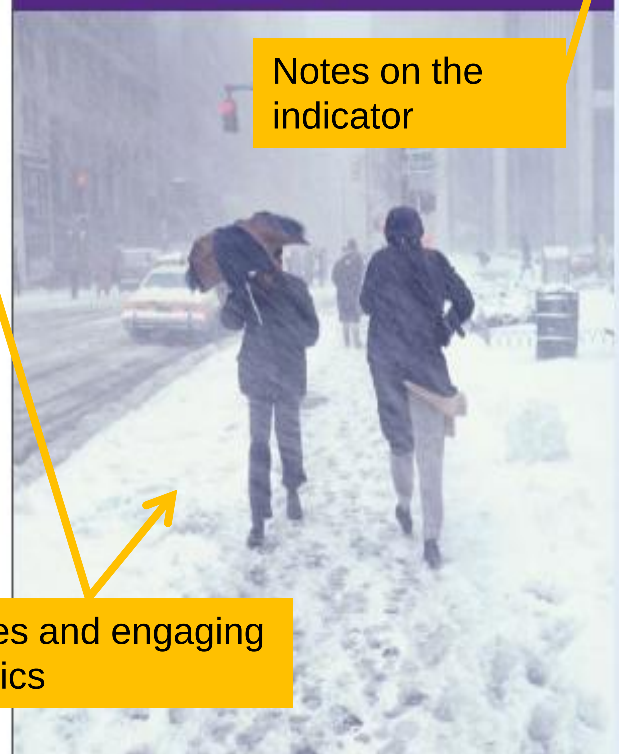
This figure shows the percentage of the land area of the contiguous 48 states that experienced much greater than normal precipitation in any given year, which means it scored 2.0 or above on the annual Standardized Precipitation Index (SPI). The thicker orange line shows a nine-year weighted average that smoothes out some of the year-to-year fluctuations.



Data source: NOAA, 2012[8]

Key Points

- In recent years, a larger percentage of precipitation has come in the form of intense single-day events. Eight of the top 10 years for extreme one-day precipitation events have occurred since 1990 (see Figure 1).
- The prevalence of extreme single-day precipitation events remained fairly steady between 1910 and the 1980s, but has risen substantially since then. Over the entire period from 1910 to 2011, the portion of the country experiencing extreme single-day precipitation events increased at a rate of about half a percentage point per decade (5 percentage points per century) (see Figure 1).
- The percentage of land area experiencing much greater than normal yearly precipitation totals increased between 1895 and 2011. However, there has been much year-to-year variability. In some years there were no abnormally wet areas, while a few others had abnormally high precipitation totals over 10 percent or more of the contiguous 48 states' land area (see Figure 2). For example, 1941 was extremely wet in the West, while 1982 was very wet nationwide.[20]
- Figures 1 and 2 are both consistent with other studies that have found an increase in heavy precipitation over timeframes ranging from single days to 90-day periods to whole years.[21] For more information on trends in overall precipitation levels, see the U.S. and Global Precipitation indicator on p. 28.



Notes on the indicator

Figures and engaging graphics

For ad... the occ... yearly p... at the S... (SPI). W... tation t... totals ... specif... If a lo... experiences less precipitation than normal during a particular period, it will receive a negative SPI score, while a period with more precipitation than normal will receive a positive score. The more precipitation (compared with normal), the higher the SPI score. The SPI is a useful way to look at precipitation totals because it allows comparison of different locations and different seasons on a standard scale. Figure 2 shows what percentage of the total area of the contiguous 48 states had an annual SPI score of 2.0 or above (well above normal) in any given year.

Indicator Notes

Weather monitoring stations tend to be closer together in the eastern and central states than in the western states. In areas with fewer monitoring stations, heavy precipitation indicators are less likely to reflect local conditions accurately.

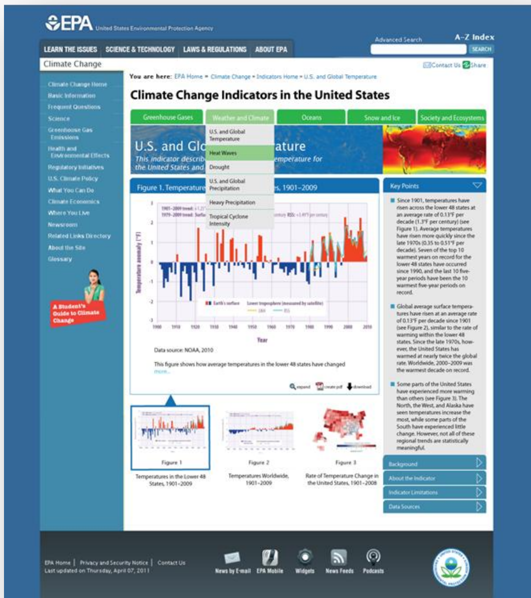
Data Sources

The data used for this indicator come from a large national network of weather stations and were provided by the National Oceanic and Atmospheric Administration's National Climatic Data Center. Figure 1 is based on Step #4 of the National Oceanic and Atmospheric Administration's U.S. Climate Extremes Index; for data and a description of the index, see: www.ncdc.noaa.gov/extremes/cei.html. Figure 2 is based on the U.S. SPI, which is shown in a variety of maps available online at: www.ncdc.noaa.gov/oa/climate/research/prelim/drought/spi.html. The data used to construct these maps are available from the National Oceanic and Atmospheric Administration at: ftp://ftp.ncdc.noaa.gov/pub/data/cirs.

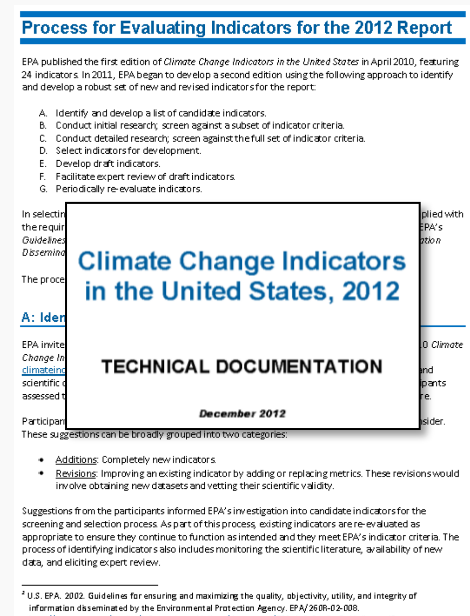
Data sources and links

Enhanced Online Presence

www.epa.gov/climatechange/indicators



- ✓ Printer-friendly PDFs of all text and figures
- ✓ Downloadable figures and graphics



- ✓ Details on methods/data for each indicator provided in technical documentation

- ✓ Highlights Brochure

How EPA Indicators Are Being Used

- Tribal requests for hard copies:
  - Confederated Salish & Kootenai Tribes
  - La Jolla Band of Luiseño Indians
  - Pechanga Band of Luiseño Indians
  - Sac & Fox Nation of Missouri in Kansas & Nebraska
- Reported uses by tribes:
  - For lending, public outreach, and education
  - Featured at Earth Day events highlighting climate change, to explain local climate impacts and what people can do
  - To inform tribal management
- Additional uses by other organizations:
  - Informing development of local Climate Health Adaptation Plan
  - Assist in developing monitoring strategies for climate change

What's Next for EPA Indicators?

- Plans underway to continue update and expand upon the current set of indicators.
- More regional indicators may be developed or highlighted (e.g., highlight issue(s) in a particular region).
- Continue to engage with other important indicators efforts (e.g., indicator system being developed by U.S. Global Change Research Program).

EPA's Climate Change Indicators in the United States

www.epa.gov/climatechange/indicators

Questions and comments can be sent to U.S. EPA's Climate Change Division at:
climateindicators@epa.gov

Thank You!