

Climate Change on the Prairie: A Basic Guide to Climate Change in the High Plains Region - UPDATE

Global Climate Change

Why does the climate change?

The Earth's climate has changed throughout history and will continue to change in the future. Global climate change can be attributed to one of two causes, natural or anthropogenic (human-induced), and can occur on different time scales, both short-term and long-term.

A volcanic eruption is an example of natural short-term climate change. When ash is ejected high into the atmosphere, it temporarily blocks the sunlight and subsequently cools the Earth. El Niño is another example of natural short-term change. When the sea surface temperatures in the equatorial Pacific are warmer than normal, global wind patterns can change which affects temperature and precipitation patterns. Long-term climate change, on the order of thousands of years, is due to changes in solar radiation receipt, slight changes in the Earth's orbit, continental drift, formation or loss of ice sheets, and changing ocean currents.

Human activities can also influence climate. The human influence that is most responsible for recent changes in global temperature is the burning of fossil fuels which increases the levels of greenhouse gases in the atmosphere, such as carbon dioxide and methane. Increases in greenhouse gases contribute to a general warming of the Earth because as their concentrations increase so does the temperature.

As the Earth's climate changes, many different sectors will be impacted. The impacts on Earth's ecosystems are already apparent from the tundra to the tropical waters. For example, in the high northern latitudes, permafrost

is thawing which is increasing coastal erosion and damaging infrastructure of the towns which are built upon the permafrost. Rising sea temperatures already threaten the coral reefs of the world which is having an impact on tourism and fisheries.

What are the current trends and projections?

Surface temperature measurements of both the land and the ocean indicate a warming trend since the early 20th century and especially in the last 50 years (Figure 1).

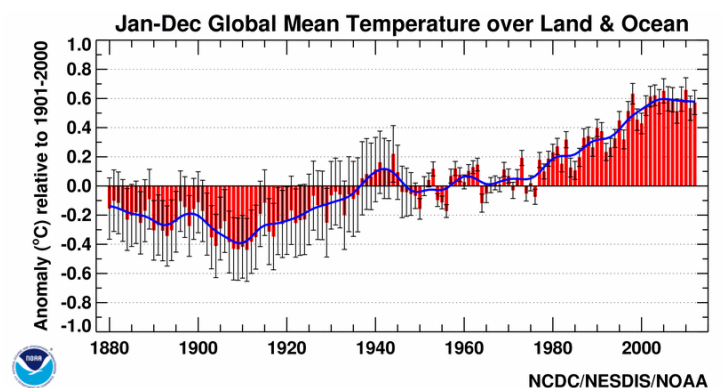


Figure 1: Departure from 1901-2000 average temperature. Figure courtesy National Climatic Data Center.

According to the U.S. Global Change Research Program (USGCRP), models which incorporate different greenhouse gas emission scenarios project global temperatures to increase by 2°F-11.5°F by 2100. If the rate of greenhouse gas emissions is reduced, the temperature increase is projected to be on the lower end of the range and if emission rates continue at or near current rates the temperature increase is projected to be at the higher end of the range.



Climate Change in the United States

Historical trends and projections - temperature

Overall, temperatures across the United States have been warming over the past 100 years and the average temperature has increased by 2°F in the past 50 years (USGCRP). The warming trend is occurring in both the daily maximum and minimum temperatures; however the minimum temperatures are increasing at a faster rate than maximum temperatures. Generally, Alaska, along with western and northern portions of the contiguous 48 states show the greatest warming. Areas of the southeast show a slight cooling over the past century, however, these areas have begun to show a warming trend over the past 30 years.

Climate models are projecting that temperatures will continue to increase now through 2100. Because of the residence time of greenhouse gases in the atmosphere, model projections of near future temperature changes do not vary much. However, by 2100, in the lower emissions scenarios, the increase could range from 4°F-6.5°F and in the higher emissions scenarios the increase could range from 7°F-11°F (USGCRP).

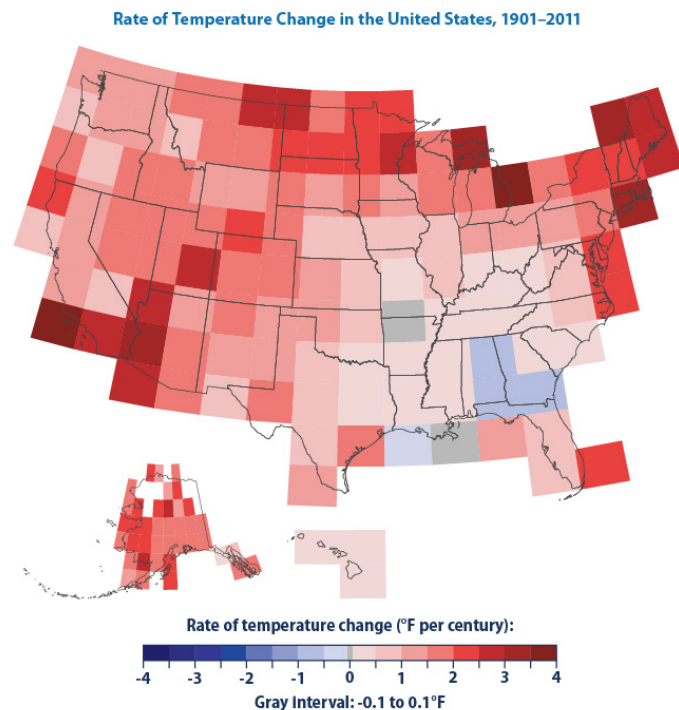


Figure 2: Annual Temperature Trends 1901-2011. Figure courtesy United States Environmental Protection Agency.

Historical trends and projections - precipitation

According to the USGCRP, shifts in global precipitation patterns are already occurring and have resulted in increases in precipitation in some areas and decreases in others. Here in the United States, the total annual precipitation has increased by 5% over the past 50 years (USGCRP). This increase has occurred for the most part due to an increase in the frequency and intensity of heavy downpours. All areas of the United States have shown to have an increase in heavy downpours over the last 50 years, but the areas with the highest increases are the Northeast and the Midwest.

While precipitation changes are much more difficult to predict than temperature changes in the long term, climate models do show indications that northern areas of the United States will become wetter, particularly in the winter and spring, and areas of the south and west will become drier. Models are also projecting an increase in heavy downpours and a decrease in light precipitation over the next 100 years (USGCRP).

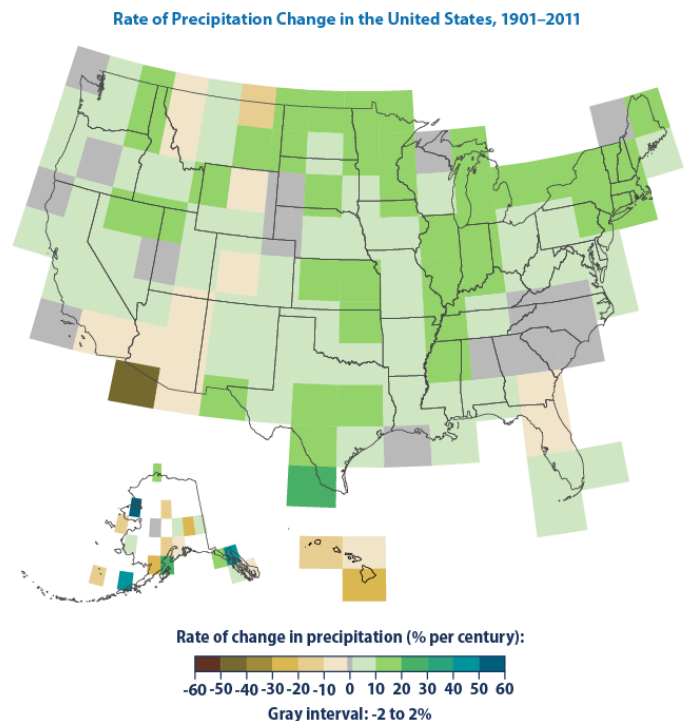


Figure 3: Annual Precipitation Trends 1901-2011. Figure courtesy United States Environmental Protection Agency.

Historical Climate Trends in the High Plains Region

Temperature

Climate records in the High Plains date back well over 100 years, into the 19th century. A look into these historical datasets reveals the variability and trends in climate over time.

The trend in average annual temperature for the six-state region shows a warming trend of 1.9°F over the 118-year period analyzed. Temperatures show cooler than average conditions early in the record, followed by significant warmth during the 1930's dustbowl era, and generally warmer than average conditions since the 1970's, especially since the year 2000. The greatest amount of warming on an annual basis is found in North Dakota (2.9°F), while the least amount of warming is in Kansas and Nebraska (1.3°F). 2012 was the warmest year on record for the Region since records began, with an average temperature of 50.9°F for the High Plains Region.

Regionally, the annual warming trend is greater for nighttime low temperatures than for the daytime high temperatures (2.2°F vs. 1.6°F). This is the case for much of the globe with lows warming more than highs. One reason for this difference is thought to be an increase in the amount of moisture in the air, which affect minimum temperatures much more than maximum temperatures. If average temperature trends are broken down by season, the warming is strongest in winter (2.9°F) and weakest in autumn (0.7°F) for the Region. This seasonal variability is similar to observed global trends, particularly for land masses in the Northern Hemisphere.

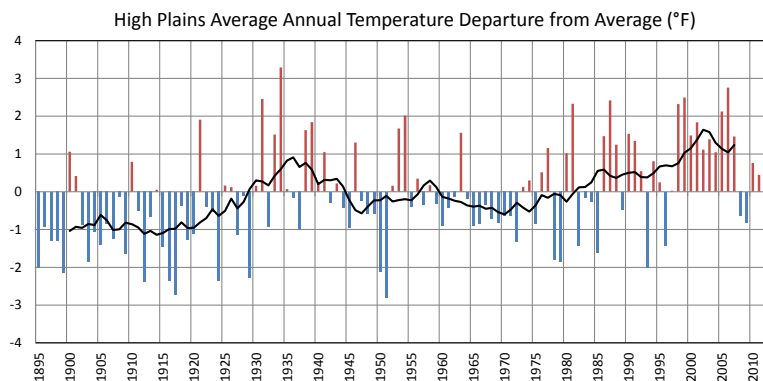


Figure 4: Average Annual Temperature Departure from the 118-Year Long-term Average (°F) in the High Plains Region. Data courtesy National Climatic Data Center.

Climate Change Quick Facts:

According to the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center's 2012 State of the Climate Report:

- Globally, each year since 1976 has been warmer than the long-term average temperature.
- 2012 ranked in the top 10 warmest globally, but was the warmest year on record in the U.S.
- Arctic temperatures are warming about two times faster than the rest of the world.
- CO₂ concentrations topped 400 ppm for the first time in the spring of 2012.

Statewide Average Temperature Change by Season (1895-2012)

Temperature in degrees F

State	Spring	Summer	Autumn	Winter
North Dakota	2.6	2.0	1.5	5.5
South Dakota	2.2	1.8	1.1	4.2
Nebraska	1.8	1.0	0.0	2.0
Kansas	1.7	1.0	-0.1	2.2
Wyoming	3.0	2.5	1.0	1.3
Colorado	2.0	1.1	0.4	1.9
Average	2.2	1.6	0.7	2.9



Historical Climate Trends in the High Plains Region

Precipitation

Overall, precipitation trends are weaker than temperature, with only a 1.3% increase in precipitation over the High Plains Region. There is high year-to-year variability throughout the period of record, which is typical for the continental type climate of the Region.

The dry years of the 1930's and 1950's stand out in the record with periods of below average rainfall. The past several decades have been part of a wet period for the Region, though 2012 stands out as one of the driest on record. Wyoming is typically the driest state, while Kansas is the wettest on an annual basis. Aside from Wyoming (with a 13% decrease), annual trends are fairly weak on a state by state basis. There are however, seasonal differences in the precipitation pattern with most states experiencing drier conditions during winter (8% decrease on average) and wetter conditions during autumn (12% increase). The overall trends for spring and summer are on average small.

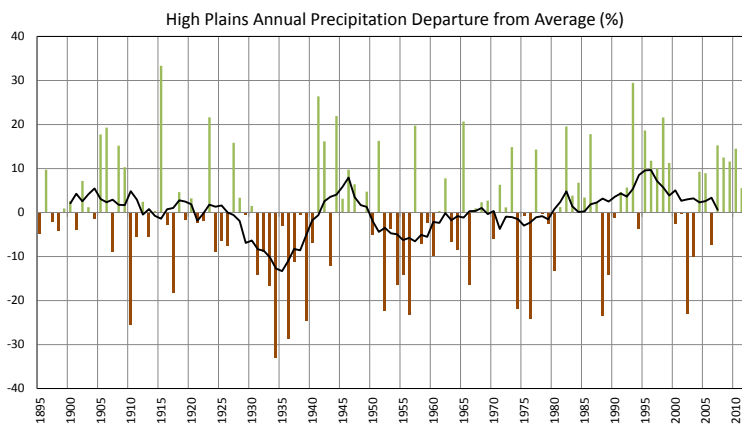


Figure 5: Average Annual Precipitation Departure from the 118-Year Long-term Average (%) in the High Plains Region. Data courtesy National Climatic Data Center.

Statewide Annual Climate Trends (1895-2012)				
Temperature in degrees F, Precipitation in percent				
State	Average Temperature	Maximum Temperature	Minimum Temperature	Precipitation
North Dakota	2.9	2.5	3.4	6%
South Dakota	2.4	1.6	3.2	3%
Nebraska	1.3	0.6	1.9	2%
Kansas	1.3	0.9	1.7	5%
Wyoming	2.0	2.7	1.3	-13%
Colorado	1.5	1.5	1.4	-1%
Average	1.9	1.6	2.2	1%

High Plains Region Update: 2010-2012

Three years of extremes

In the three years since the original release of this climate change guide, the High Plains Region has experienced a wide range of extreme conditions. Many of the statistics included in this document have changed quite a bit since the original release simply because the last three years have been so extreme. One of the most interesting examples of the extremes is the major flooding in 2011 followed by drought in 2012.

The winter of 2010-2011 brought record breaking snowfall to areas of Wyoming and Montana. This, coupled with a warm spring and additional heavy precipitation, spurred major flooding on the Missouri River and its tributaries which lasted much of the summer of 2011. Just the following year, the Region experienced its warmest spring on record followed by one of the warmest and driest summers on record. This set the stage for a widespread expansion of drought which caused impacts to many sectors including agriculture (both crops and livestock), water resources, and wildlife.



Notable Events:

- North Dakota had its wettest year on record in 2010.
- A new national hail record for diameter and weight was set on July 23, 2010 in Vivian, South Dakota.
- 2011 was a year of flooding for many of the major rivers including the Missouri, Souris, and Red.
- In 2012, Nebraska and Wyoming had both their warmest and driest year on record.
- Although drought conditions peaked in the summer of 2012, areas near the Colorado/Kansas border have been impacted by drought since 2010.
- The two most destructive fires in Colorado history occurred in 2012 and 2013 (in terms of structures burned: the Waldo Canyon Fire and the Black Forest Fire, respectively).

New Tool: Climate Impact Reporter

Impact	Sub-Impact	Title	Area Affected	Dates
Water Resources	water supply	Shutoff Order for Junior Priority Date Water Rights Upstream of Angostura Dam	South Dakota, River Basin-Cheyenne	2013-03-06 ongoing
Ecosystem	other	2012 Upland Bird Regional Forecast - Southcentral	Kansas, County-Harvey	2012-01-01 2013-01-31

Interested in looking at climate-related impacts in your local area? Need a place to archive impacts you know about? If so, you should check out HPRCC's new tool: the Climate Impact Reporter.

The Climate Impact Reporter was developed to document climate impacts over a variety of sectors in the High Plains Region. Users can browse for impacts within a specific area (i.e. river basin, state, county) or sector (agriculture, ecosystems, energy, human health, society, transportation, and water resources) using a simple mapping interface. Or, users can log their own impacts. Tutorials for using the Climate Impact Reporter and for logging reports are available on the website.

This tool will hopefully increase the understanding of impacts to extreme events by sector and as a result, will provide critical information for improved decision-making and adaptation strategies.

<http://cir.unl.edu>

Climate Change Projections and Possible Impacts

Through the use of climate models, scientists have the ability to project future climate based on scenarios of anthropogenic and natural forcings. One of the primary forcings is enhanced greenhouse gas emissions, which alters the amount of radiation we receive and influences temperature. Several research groups across the globe run models using scenarios to simulate future climate, both at the global and regional scale. A composite of the various climate models projects a warming in the High Plains Region of about 4°F by 2050 and 8°F or higher by 2090. The individual models show a range of temperature increases, although they all point to a warming. Model projections of changes in precipitation vary by season, showing a general drying in summer and autumn with wetter conditions in winter. Spring is projected to be wetter in the northern part of the Region and drier in the south. The summer drying trend is compounded by increased evaporation rates due to the projected warming. With approximately 70% of the land in the High Plains Region being used for agricultural or rangeland purposes, this Region is acutely sensitive to these types of changes.

Updated 08/2013



High Plains Regional
Climate Center

Climate Change Projections and Possible Impacts

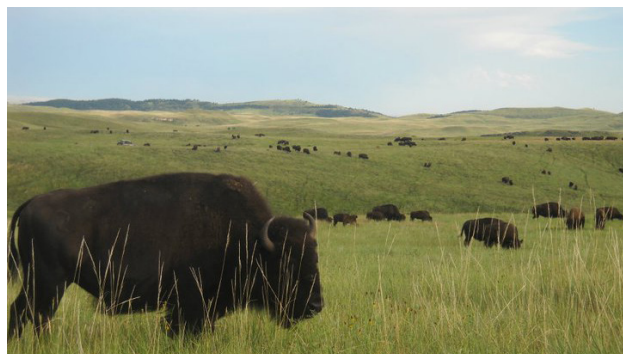
Key climate change impacts in this Region include the following:

- **Water Resources:** An increase in temperature, especially in the summer months, can lead to an increase in evapotranspiration and decrease in soil moisture. This can lead to an increase in irrigation demands, which is heavily relied upon to avoid plant water stress. Increased water use is already putting a strain on water resources in the Region, such as the Ogallala Aquifer.

“Warming of the climate system is unequivocal.”

Fourth Assessment of the Intergovernmental Panel on Climate Change

- **Extreme Events:** There are expected to be changes in the frequency and severity of extreme events in a warmer climate. This includes more days with heavy precipitation, extreme cold, and growing season frosts. These can affect urban and rural landscapes alike, and often the extreme events have a significant and immediate economic and social impact.
- **Ecosystems:** The likelihood of invasive species and pests is expected to increase in a warmer climate with associated shifts in temperature and precipitation patterns. Productivity and yields of agricultural land will be impacted by such a change. Adding in human-caused stress factors, such as fragmentation of habitat, native species will also become more vulnerable to climate change.

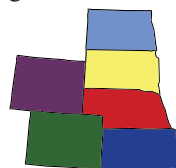


Custer State Park, South Dakota

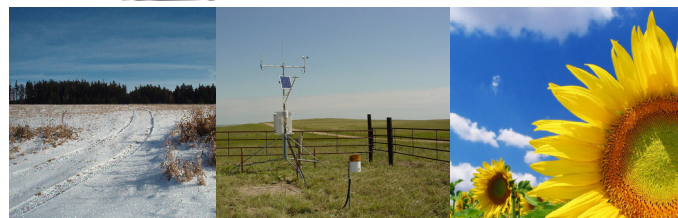
- **Demographics:** Current population trends in the Region are toward the growth of urban areas and a depopulation of the rural areas. This demographic trend brings a corresponding shift in the needed services and economic base. As such, rural areas are expected to have an increase in vulnerability to climate change. In addition, those living on or near tribal lands are particularly vulnerable to climate change stresses, such as those on water resources, which are expected to increase further in a changing climate.

* Projections and impacts information courtesy of the U.S. Global Change Research Program

For more information, please contact the High Plains Regional Climate Center:



High Plains Regional Climate Center



Providing Timely Climate Data and Information to the Public for Cost Effective Decision Making

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