

Climate Change Resources

Northern Institute of Applied Climate Science
www.nrs.fs.fed.us/niacs

USDA Forest Service Climate Change Resource Center
www.fs.fed.us/ccrc/

USDA Forest Service Office of the Climate Change Advisor
www.fs.fed.us/climatechange/climate-update.shtml

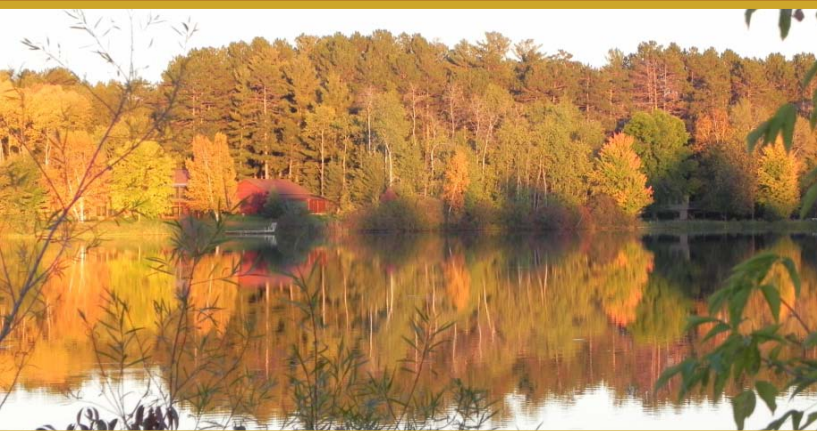
USDA Forest Service Climate Change
www.fs.fed.us/climatechange/

Intergovernmental Panel on Climate Change (IPCC)
www.ipcc.ch/

NASA Global Climate Change
<http://climate.nasa.gov/>

Pew Center on Global Climate Change
www.pewclimate.org/

Climate Change Atlas
www.nrs.fs.fed.us/atlas/



This display was designed by Tivoli Gough and Leslie Brandt. Funding for these panels were provided by the Northern Institute of Applied Climate Science (NIACS).

The *Climate Change in the Great Lakes* educational display is available on short-term loan for use in visitor centers, special exhibits, and other outreach events. Contact Patricia Butler at (906) 482-6303 ext. 12, or prbutler@mtu.edu to arrange to have the panels come to your location.

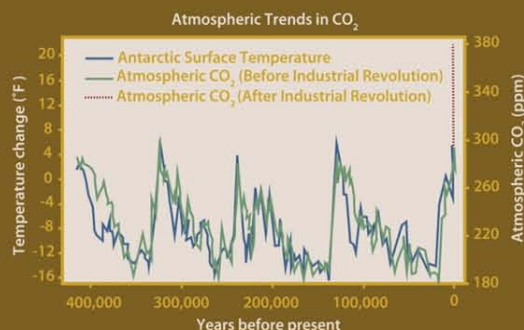


Climate Change and the Greenhouse Effect



Climate change signifies changes in measures of climate such as temperature, precipitation, wind, or storm frequency or intensity lasting for an extended period of time (decades or longer).

The Earth's climate has changed many times in the past million years, including events from ice ages to long warming periods. Many of these past changes were driven by natural factors such as changes in the Earth's orbit, volcanic emissions, and the amount of energy emitted by the Sun. In the late 18th century, human activities associated with the Industrial Revolution started to change the composition of heat-trapping gases in the atmosphere due to deforestation and the burning of fossil fuels, such as oil and coal.



What is the greenhouse effect? Our atmosphere contains gases such as water vapor and carbon dioxide that absorb and emit infrared radiation. These gases trap heat inside the atmosphere and warm the surface of the earth where we live. These gases are necessary for life; without them, the earth's temperature would be too cold to live. However, human activities have led to concentrations of these gases that are higher than they have been over the past 800,000 years, leading to increased global temperatures. In the past 200 years humans have increased carbon dioxide levels in the atmosphere by 35% compared to pre-industrial levels. Most climate scientists agree that this along with human emissions of other greenhouse gases has led to an increase in global temperatures. In fact, the eight warmest years on record have occurred since 1998. The amount of increase as a percentage of these gases is growing as well. Greenhouse gas emissions caused by human activities increased by 14% from 1990 to 2008. Carbon dioxide accounts for most of our nation's emissions. Electricity generation is the largest source of greenhouse gas emissions in the United States, followed by transportation. Globally, deforestation accounts for approximately one fifth of carbon dioxide emissions.



Climate Change in the Great Lakes Region

Signs of climate change have been detected in the Great Lakes region. The northern Midwest, including the upper Great Lakes region, has warmed by almost 4°F (2°C) in the 20th century. Scientists are virtually certain that in the next century the climate in the Great Lakes region will continue this dramatic warming trend. Changes in the climate have the potential to affect not only water and ecosystems but also the economy, outdoor recreation, and our communities.

- The average length of time lakes remain frozen in winter has decreased.
- Migratory birds are arriving earlier.
- Flowers are blooming earlier; the growing season is starting earlier.
- More extreme weather events including change in rain and snow patterns, heat waves, and droughts are taking place.
- Invasive species are moving northward which threaten native species.

Regional Examples



Wild Rice

In 2007, wild rice could not be harvested due to drought conditions likely caused by changing weather patterns associated with climate change. Low lake levels cause rice stalks to break under fruithead weight. Warmer spring temperatures bring competing drought-tolerant invasive species like purple loosestrife. Increased storm intensity introduces crop failure, germination delays, and uprooted wild rice plots.

Cold-Water Fish

Climate change is projected to shift fish distributions, moving the boundary that separates cool-water species like walleye from warm-water fish like bass northward by as much as 300 miles by 2050. Scientists predict Michigan, Wisconsin, and Minnesota may lose over half of their existing cool-water habitats as warmer temperature zones creep northward. Decreasing water levels from increased evaporation reduce access to marshes and vegetation, which provide shelter, food, and breeding habitats to over 30 species of fish.



Lake Ice

Spring ice break-up on lakes is coming earlier each year. Record high lake temperatures have caused ice cover to shrink by 20 percent in winter over the past 37 years. Ice is crucial in keeping water from evaporating and maintaining lake levels. Fewer ice-covered days also mean a shorter ice fishing season.



Forest Service Initiatives Conserving Natural Resources in a Changing Climate

The Forest Service has made responding to climate change an essential part of its mission. We strive to sustain healthy and functioning ecological, social, and economic systems as the climate changes. Research helps us make more informed decisions. Monitoring helps us detect changes and assess management effectiveness.

The FS is working to devise strategies and implement management practices now for adapting to altered local climates to help reduce potential impacts. Diverse, healthy ecosystems can better respond to disturbances caused by climate change. Restoring and maintaining healthy forests is also a great way to mitigate climate change by storing carbon in living trees and soil.



Here is just a sampling of ways the Forest Service is working to respond to a changing climate in the Great Lakes Region.

- 1 Minnesota:** Northern Research Station scientists and the Superior National Forest are working together to examine ways the Superior can expand its monitoring program to include indicators of climate change.
- 2 Wisconsin:** The Forest Service and outside partners are working together to develop a Climate Change Response Framework that will help us adapt forests to new and changing conditions, as well as mitigate greenhouse gas emissions responsibly for climate change.
- 3 Illinois:** The Midewin National Tallgrass Prairie is restoring former agricultural land to native tallgrass prairie, which stores carbon in the soil and provides habitat for native plant and bird species.
- 4 Indiana:** The Hoosier National forest has established a 120-acre native pollinator farm, which provides habitat to pollinators threatened by climate change and a source of native plant seeds for the future.
- 5 Ohio:** Scientists at the Northern Research Station's Delaware, OH office have developed the Climate Change Atlas, which maps potential suitable habitat for trees and birds under a changing climate.
- 6 Michigan:** Northern Research Station and Michigan Technological University scientists are studying the effects of climate variability on plants and carbon storage in boreal peatlands.
- 7 Pennsylvania:** The Allegheny National Forest has been collaborating with the Northern Research Station and state partners to develop disease-resistant strains of trees presently threatened by introduced insects and diseases in order to sustain diverse, healthy forests with greater resilience to the added stressors of a changing climate.
- 8 New York:** The Finger Lakes National Forest is working to improve grassland habitats, riparian corridors and aquatic passages. This effort to maximize the acreage of land treated for non-native invasive species, and riparian ecosystems will aid in the restoration of Lake Ontario and provide habitat for resident and migratory wildlife species.

