USGS
science for a changing world

Climate Change Science:
Exploring the Past, Observing the Present, Forecasting the Future

Climate change is an issue of increasing public concern, because of its potential effects on land, water, and biological resources. In the next several years, the United States and other nations will be challenged to make management and policy decisions as well as develop adaptation and mitigation strategies that will require anticipating the effects of a changing climate and its impacts on humans and ecosystems. These decisions and strategies will require accurate and robust science information, including predictive models and likely scenarios of impending short- and long-term changes and impacts.

The value of these models squarely rests upon the quality of the information that serves as their input, including understanding of physical, chemical, and biological processes that both drive climate change and are responsive to changing climate.

USGS Role in Climate Change

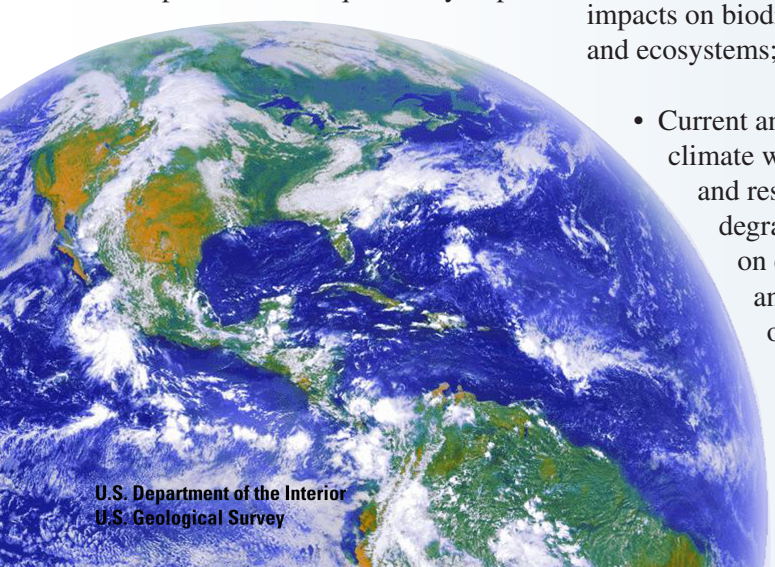
USGS has an extensive, well-regarded history in studying climate change and its impacts. Our unique ability to provide essential ground-truthing across multiple scientific disciplines in a wide variety of spatial and temporal scales enables the USGS to play a key role within the climate science community.

USGS provides on-the-ground science information from our numerous observation and monitoring networks and process-based research activities that span the biological, geological, geographical, and hydrological sciences. These observations and related research efforts are essential components for building climate models, especially those that deal with the physical causes of climate change and the impacts on the terrestrial, freshwater, and marine ecosystems from changing climate. USGS findings and data provide critical information to decision-makers regarding many important climate-related issues, such as

- Future availability of water for people and ecosystems in arid regions of the Western United States and populated areas of the country that have a high demand on water;

- Proliferation of invasive species and impacts on biodiversity, critical habitat and ecosystems;

- Current and future trends of climate warming in the Arctic and resultant permafrost degradation, and impacts on energy, transportation, and potential releases of greenhouse gas as a result of temperature change;



U.S. Department of the Interior
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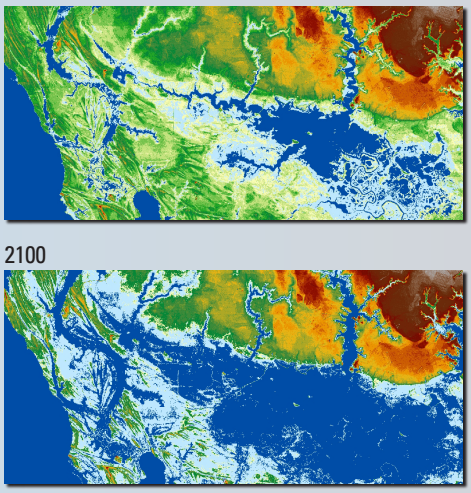


- Consequences of abrupt changes in climate including sea-level rise and impacts on low-lying coastal communities;

- Changing fire cycles; risks and responses in critical biomes.

Exploring the Past

The past is the key to the future. In order to understand future climate change and its impacts, USGS scientists are studying the geologic record, which when fully unlocked will provide a wealth of scientific information about the length and intensity of past climate trends as well as the causes and mechanisms of climate change, including abrupt changes in climate cycles, and the ecological and physical impacts caused by climate changes.

We know that climate change has occurred many times on this planet over millions of years. Although climate change is a natural, continuous, inevitable Earth process, it is also significantly influenced by human forces, including human-induced greenhouse gas emissions (water vapor, carbon dioxide, methane, and nitrous oxide are the major gases contributed by humans to the atmosphere), and land cover changes and land use practices, which are having a significant effect on current climate. These forces will also play a major role in future climate change as well.

By studying various indicators of climate change in the geologic record, such as tree rings, ice cores, and fossil pollen records, scientists at USGS and elsewhere have been able to develop detailed evidence of climate change, including changes in temperature, hydrologic conditions, vegetation, and atmospheric greenhouse gas concentrations over the last several hundred thousand years. This record shows that natural climate change predates human influence and is generally cyclical in nature, with long-term periods of global cooling and glaciation punctuated by shorter-term periods of global warming and deglaciation. Human influences are significant in that they are in addition to any natural changes already occurring, and may be the key factors in changing the natural balance of the climate system. In other words, human factors may be additional drivers of potentially significant physical and ecological consequences of climate change.

Observing the Present

Long-term monitoring of climate change and its impacts is a cornerstone of USGS climate research. Information gathered from monitoring feeds directly into process-based research, climate models, and other models designed to assess ecological, physical, and human responses to changing climate. USGS currently conducts a wide variety of monitoring activities that provide insight to climate change issues, such as monitoring

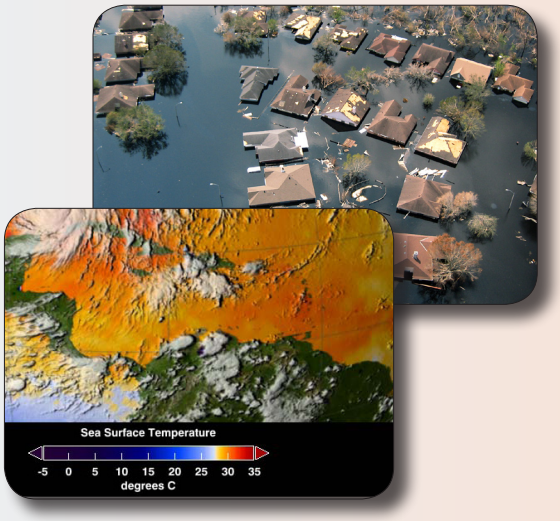
- Streamflow and ground-water levels in order to assess drought, flooding, and water use;
- Thawing permafrost in the sub-arctic and arctic regions of Alaska,
- Migration of plant communities and proliferation of invasive species in response to climate change;
- Changes in snowpack and stream runoff;
- Retreat of alpine glaciers;
- Coastal wetland change related to subsidence and sea-level rise;
- The interplay between land use, land-cover change, and climate;
- Changing distribution and impact of human and animal diseases.

Forecasting the Future

There is still much to be done to better understand the long-term climate future for our planet. For example, we need to enhance our ability to

- Forecast climate-related changes to physical and biological systems at local and regional scales and link these processes to global-scale models;
- Forecast precipitation changes as a consequence of changing climate, at geographic scales useful to resource managers;
- Understand how processes that regulate climate, like ocean circulation, will be affected by the range of temperature change predicted by most models, as well as by abrupt climate change events;
- Determine how global warming may affect the frequency, intensity, and paths of strong storms, including hurricanes;
- Understand the effects of climate change on ecosystems, including complex interactions, feedbacks and predicting adaptations in ecological systems;
- Simulate future climate change and levels of uncertainty so that policy-makers can make informed decisions;
- Consult with decision-makers in the development of useful products, including geospatial tools, user-friendly databases, and decision support systems.

USGS is ready to take a leadership role in carrying out these additional monitoring and research efforts. Our ability to conduct national, regional, and local research across private and public lands and to provide necessary science information across multiple scientific disciplines, times, and scales gives the USGS an important niche in the climate science community that no other public or private science agency can fill.



Satellite-based thermal image of sea-surface temperature and Hurricane Katrina, and its consequences on coastal communities.

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