Introduction

The Earth's climate is changing. Temperatures are rising, snow and rainfall patterns are shifting, and more extreme climate events—like heavy rainstorms and record high temperatures—are already taking place. Scientists are highly confident that many of these observed changes can be linked to the climbing levels of carbon dioxide and other greenhouse gases in our atmosphere, which are caused by human activities.

The **climate change indicators** in this report look at the composition of the atmosphere, fundamental measures of climate, and the extent to which several climate-sensitive aspects of the oceans, snow and ice, human health, society, and ecosystems are changing. Together, these indicators present compelling evidence that climate change is happening now in the United States and around the world.

HOW IS THE CLIMATE CHANGING?

Since the Industrial Revolution began in the 1700s, people have added a significant amount of greenhouse gases into the atmosphere, largely by burning fossil fuels to generate electricity, heat and cool buildings, and power vehicles—as well as by clearing forests. The major greenhouse gases that people have added to the atmosphere are carbon dioxide, methane, nitrous oxide, and fluorinated gases. When these gases are emitted into the atmosphere, many remain there for long time periods, ranging from a decade to thousands of years. Past emissions affect our atmosphere in the present day; current and future emissions will continue to increase the levels of these gases in our atmosphere for the foreseeable future.

"Greenhouse gases" got their name because they trap heat (energy) in the lower part of the atmosphere (see "The Greenhouse Effect" on p. 4). As more of these gases are added to the atmosphere, more heat is trapped. This extra heat leads to higher air temperatures near the Earth's surface, alters weather patterns, and raises the temperature of the oceans.

These observed changes affect people and the environment in important ways. For example, sea levels are rising, glaciers are melting, and plant and animal life cycles are changing. These types of changes can bring about fundamental disruptions in ecosystems, affecting plant and animal populations, communities, and biodiversity. Such changes can also affect society and traditional ways of life for

WHY USE INDICATORS?

One important way to track and communicate the causes and effects of climate change is through the use of indicators. An indicator represents the state or trend of certain environmental or societal conditions over a given area and a specified period of time. For example, long-term measurements of temperature in the United States and globally are used as an indicator to track and better understand the effects of changes in the Earth's climate.

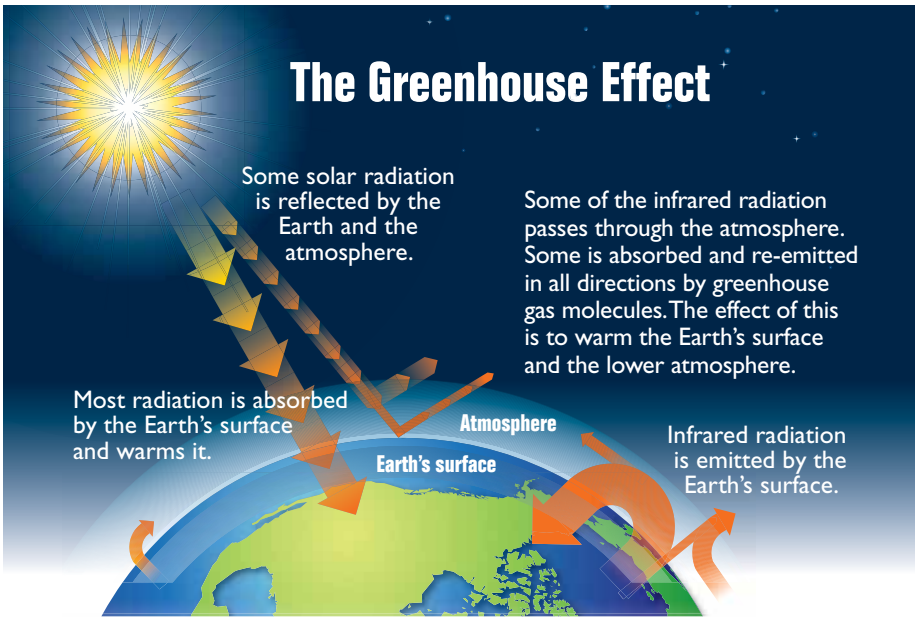
HOW DO THE INDICATORS RELATE TO CLIMATE CHANGE?

All of the indicators in this report relate to either the causes or effects of climate change. Some indicators show trends that can be more directly linked to human-induced climate change than others. Collectively, the trends depicted in these indicators provide important evidence of "what climate change looks like."

WHAT IS CLIMATE CHANGE?

Climate change refers to any substantial change in measures of climate (such as temperature or precipitation) lasting for an extended period (decades or longer). Climate change may result from natural factors and processes or from human activities.

Global warming is a term often used interchangeably with the term "climate change," but they are not entirely the same thing. Global warming refers to an average increase in the temperature of the atmosphere near the Earth's surface. Global warming is just one aspect of global climate change, though a very important one.



certain communities, including where people can live, what kinds of crops are most viable, and what kinds of businesses can thrive in certain areas.

Although the climate is continually changing, not every climate change indicator will show a smooth pattern of steady change. The Earth is a complex system, and there will always be natural variations from one year to the next—for example, a very warm year followed by a colder year. The Earth's climate also goes through other natural cycles that can play out over a period of several years or even decades. Individual years or even individual decades can deviate from the long-term trend.[1] Thus, EPA's indicators present trends for as many years as the underlying data allow.

ABOUT THIS REPORT

EPA publishes this report to communicate information about the science and impacts of climate change, assess trends in environmental quality, and inform decision-making. *Climate Change Indicators in the United States, 2014*, is the third edition of a report first published by the U.S. Environmental Protection Agency (EPA) in 2010 and updated in 2012. This report presents 30 indicators to help readers understand observed long-term trends related to the causes and effects of climate change, the significance of these changes, and their possible consequences for people, the environment, and society. Although each indicator has a connection to climate change, this report is not intended to identify the extent to which a certain indicator is driving climate change, nor the relative role of climate change in *causing* a trend in an observed indicator. Connections between human activities, climate change, and observed indicators are explored in more detail elsewhere in the scientific literature.

This report and the accompanying detailed technical documentation have been designed to ensure that the science and underlying peer-reviewed data supporting the indicators are presented and documented transparently. This report consists of peer-reviewed, publicly available data from a number of government agencies, academic institutions, and other organizations. EPA also received feedback from scientists, researchers, and communications experts in nongovernmental and private sectors. This feedback helped to inform the content and new features of this 2014 report. The entire report, including its technical support document, was peer-reviewed by independent technical experts.

About the Indicators in This Report

The indicators in this report were chosen using a set of criteria that considered usefulness, data quality, and relevance to climate change. The report is a compilation of key data sets for communication purposes; in addition to being published here, these data sets have been published in the scientific literature and in other government or academic reports.

Trends relevant to climate change are best viewed at broad geographic scales and over long time horizons, rather than at localized scales or over a few years or a season. The indicators in this report are based on historical records that go back in time as far as possible without sacrificing data quality. Most of the indicators in this report focus on the United States. However, some include global trends to provide context or a basis for comparison, or because they are intrinsically global in nature, such as atmospheric concentrations of greenhouse gases, which are influenced by global activities. The geographic extent and timeframe that each indicator represents largely depend on data availability and the nature of what is being measured.

All of the indicators discussed in this report relate to either the causes or effects of climate change. Some indicators are directly linked to human activities that cause climate change, such as Global Greenhouse Gas Emissions. Changes depicted by other indicators, such as U.S. and Global Temperature, have been confidently linked with the increase in greenhouse gases caused by human activity. Some of the trends in other indicators, such as Wildfires, although consistent with what one would expect in a warming climate, cannot yet be firmly attributed to human-induced climate change for various reasons (for example, limitations in the historical data, or other factors in addition to climate change that may influence the trend). A few indicators do not yet show any significant trend over the period for which data are available.

A Roadmap to the Report

The indicators are divided into six chapters: Greenhouse Gases, Weather and Climate, Oceans, Snow and Ice, Health and Society, and Ecosystems. Some chapters also include a "Community Connection" or "A Closer Look" feature that highlights a specific region, data record, or area of interest. Each indicator features five elements:

- One or more graphics depicting changes over time. Some indicators consist of a single metric, while others present multiple metrics (for example, the Drought indicator shows two different ways of calculating drought).
- Key points about what the indicator shows.
- Background on how the indicator relates to climate change.
- Information about how the indicator was developed.
- Important notes concerning interpretation of the indicator.

EPA has compiled an accompanying **technical support document** containing more detailed information about each indicator, including data sources, data collection methods, calculations, statistical considerations, and sources of uncertainty. This document also describes EPA's approach and criteria for selecting indicators for the report. This information is available on EPA's website at: www.epa.gov/climatechange/indicators.

Additional resources that can provide readers with more information appear at the end of the report (see Climate Change Resources on p. 98).

WHO IS THIS REPORT FOR?

Climate Change Indicators in the United States, 2014, is written with the primary goal of informing readers' understanding of climate change. It is also designed to be useful for the public, scientists, analysts, decision-makers, educators, and others who can use climate change indicators as a tool for:

- Effectively communicating relevant climate science information in a sound, transparent, and easy-to-understand way.
- Assessing trends in environmental quality, factors that influence the environment, and effects on ecosystems and society.
- Informing science-based decision-making.

LOOKING AHEAD

Indicators of climate change are expected to become even more numerous and to depict even clearer trends in the future. EPA will continue to work in partnership with coordinating bodies, such as the U.S. Global Change Research Program, and with other agencies, organizations, and individuals to collect and communicate useful data and to inform policies and programs based on this knowledge. As new and more comprehensive indicator data become available, EPA will continually update the indicators presented in this report.

WHAT'S NEW IN 2014?

The 2014 report reflects the following new features and changes:

- **Four new indicators: Heating and Cooling Degree Days, Lyme Disease, Wildfires**, and **Great Lakes Water Levels and Temperatures**. These additions provide further evidence of climate change and its effects on people, society, and ecosystems.
- **Expanded indicators: Atmospheric Concentrations of Greenhouse Gases** was expanded to cover global concentrations of ozone, and **Climate Forcing** was expanded to show the influence of ozone and other short-lived climate forcers. New metrics were added to the **High and Low Temperatures** and **Streamflow** indicators. Maps were added to **Sea Surface Temperature** and **Leaf and Bloom Dates** to show how changes over time vary by region.
- **Updated indicators:** Nearly all indicators have been updated with additional years of data that have become available since the last report.
- **"Community Connection" and "A Closer Look" content:** Four chapters highlight observed data for particular areas to provide a local or regional perspective on relevant topics. The data for these features meet the same data quality criteria as EPA's national indicators, but are focused on highlighting specific, more localized areas or topics of interest.