Global Warming

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The term Global Warming refers to the observation that the atmosphere near the Earth's surface is warming, without any implications for the cause or magnitude. This warming is one of many kinds of climate change that the Earth has gone through in the past and will continue to go through in the future. Temperature increases will have significant impacts on human activities: where we can live, what food we can grow and how or where we can grow food, and where organisms we consider pests can thrive. To be prepared for the effects of these potential impacts we need to know how much the Earth is warming, for how long the Earth has been warming, and the cause of the warming. Answers to these questionsprovide us with a better basis for making decisions related to issues such as water resource management and agricultural planning.

What is the Greenhouse Effect?
How is it related to Greenhouse Warming and Global Warming?

The Greenhouse Effect is a termthat describes how water vapor, carbon dioxide, and other gases in the atmosphere help maintain the temperature at the Earth's surface. The atmosphere approximates the function of a greenhouse by first letting sunlight (solar or short wave radiation) pass through to warm the Earth, while absorbing much of the heat (thermal or long wave radiation) radiated up from the surface of the Earth and re-radiating it back to the surface.

Life on Earth would be very different without the Greenhouse Effect. The Greenhouse Effect serves to keep the long-term annual average temperature of the Earth approximately 32°C higher than the Earth's temperature would be without the Greenhouse Effect. It is reasonable to expect that the Earth should warm as concentrations of greenhouse gases in the atmosphere increase above natural levels, much like what happens when the windows of a greenhouse are closed on a warm,

sunny day. This additional warming is commonly referred to as Greenhouse Warming.

Greenhouse Warming is global warming due to increases in atmospheric greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, etc.), whereas Global Warming refers only to the observation that the Earth is warming, without any indication of what might be causing the warming. Global Warming is accepted as fact by most of the scientific community. However, Greenhouse Warming is more controversial because it implies that we know what is causing the Earth to warm. Although it is known for certain that atmospheric concentrations of these greenhouse gases are rising dramatically due to human activity, it is less well known exactly how increases in these greenhouse gases factor in the observed changes of the Earth's climate and global temperatures.

How is the ozone issue different?

The ozone issue and Greenhouse Warming are related yet distinct scientific issues. In the lower atmosphere (called the troposphere), the ozone does act as a greenhouse gas, trapping outgoing radiation that would otherwise escape into space. Compared to carbon dioxide, ozone is a minor greenhouse gas. The significance of tropospheric ozone may be increasing however, due to the burning of fossil fuel, which generates ozone (commonly recognized as a component of smog) into the lower atmosphere. Ozone also plays a very important, natural role in the upper atmosphere (called the stratosphere). In the upper atmosphere, ozone acts as a shield against harmful ultraviolet (UV) radiation from the sun. Reductions in stratospheric ozone result in the increase of harmful UV radiation reaching the Earth's surface. Ninety percent of the atmospheric ozone is concentrated 10 to 40 kilometers above the Earth's surface. The biggest destroyer of the ozone in the stratosphere is the set of human produced chemical compounds (chlorofluorocarbons - CFC's), which act as greenhouse gases in the lower atmosphere. Extremely cold stratospheric temperatures over the North and South Poles, combined with solar radiation and atmospheric circulation, amplify the impact of ozone destroying chemical reactions, resulting in "Ozone Holes" over the Antarctica and the Arctic.

Paleoclimatology

It is the study of past climate. The word is derived from the Greek root "paleo-," which means "ancient," and the term "climate." Paleoclimate is climate that existed before humans began collecting instrumental measurements of weather (e.g., temperature from a thermometer, precipitation from a rain gauge, sea level pressure from a barometer, wind speed and direction from an anemometer). Instead of instrumental measurements of weather and climate, paleoclimatologists use natural environmental (or "proxy") records to infer past climate conditions. Paleoclimatology not only includes the collection of evidence of past climate conditions, but the investigation of the climate processes underlying these conditions.

Climate variability, including changes in the frequency of climate extremes (like droughts, floods and storms), has always had a large impact on humans. A particularly severe El Nino, or relatively short drought, can cost people billions of dollars. For this reason, scientists study past climate variability and change to gain clues that will help them anticipate future climate change. This scientific information is then helps society plan for future climate change. Unfortunately, records of past climate change from satellites and human measurements (thermometers, rain gauges) are too short, generally less than 150 years, to examine the full range of climate variability. For this reason, it is critical to examine climate change going back hundreds and thousands of years using paleoclimate records from trees, coral, sediments, glaciers and other natural "proxy" sources. The study of paleoclimates has been particularly helpful in the discovery that the Earth's climate system can shift between dramatically different climate states in a matter of years and/or decades. Understanding "climate surprises" of the past is critical if we are to avoid being surprised in the future by abrupt climatic change.

The study of past climate change also helps us understand whether humans are effecting the Earth's climate system. The study of climate change over the last thousand years clearly shows that global warming of this century is for real; and that the recent record warm years are likely unprecedented in the last 1200 years. The paleoclimate record also allows us to examine the causes of past climate change, and

to help unravel the natural causes of past climate change (for example: volcanic eruptions and solar variability) can explain 20th century global warming.

Lastly, most state of the art climate prediction done in the world is accomplished using large sophisticated computer models of the climate system. There has been a great deal of research focused on ensuring that these models can simulate most aspects of the modern, present-day, climate, it is also important to know how these same models simulate climate change. This can only be accomplished by comparing modelled past climate change with changes that are observed using paleoclimate records. Thus, paleoclimatology helps us gain confidence that our computer model simulations of future climate are worth believing.

There are several ways that scientists study how the Earth's temperature is changing: satellites, instrumental records and proxy data. Some scientists look to satellites to reveal something about the Earth's changing climate. Although the satellite record is very short (ca. 20 years) and hard to interpret due to changes in instruments and orbits. The record of instrumental temperature measurements, extending back to the 19th century, provides data from thermometers, rain gauges, etc. since 1860. Paleoclimatologists also find clues in natural records-proxy data. Proxy data are natural clues to past climate that are buried in sediments at the bottom of the oceans, locked in coral reefs, frozen in glaciers and ice caps, or preserved in the rings of trees.

Good weather records extend back only about 125 years. In that time, the earth's global average temperature has increased by approximately 0.5 degrees centigrade. Scientists are trying to determine if this warming is a natural fluctuation, or a result of greenhouse warming. From paleo records, we know that the climate of the past million years has been dominated by the glacial cycle , a pattern of ice ages and glacial retreats lasting thousands of years. In the even more ancient past, changes in climate have been linked to the movement of continents and to the storage of vast amounts of carbon in oil and coal beds.

What can we predict about climate in the future?

Powerful computer models are used to try to predict the climate of the future. The 2001 best estimates of the Intergovernmental Panel on Climate Change (IPCC) are for global warming by approximately 1.5 to 6 °C by the end of the next century. It is also likely that there will be substantial climate variability over the next 100 years, quite possibly including shifts in the frequency of severe droughts, floods and El Ninos.

Climate Change
It's real.
Within the lifetime of our kids, climate change could really affect our health, our economy...our lives. Yes, climate change is about global warming. But it's more than that. It's also about changing rainfall, wind, clouds and extremes such as droughts, heat waves, severe storms and melting permafrost.

We've been doing an uncontrolled experiment with our atmosphere. The results are starting to come in, and they don't look very good.