Types of Glaciers

Hanging glacier	A river of ice that protrudes over a rock lip.
Cirque glacier	A river of ice extending from an upland rock basin with steep-sided walls.
Mountain glacier	A river of ice developing in a high mountain region from ice fields covering several peaks.
Valley glacier	A river of ice occupying a valley.
Piedmont glacier	A river of ice that extends from a mountainous region onto flat plains, where it spreads out.
Tidewater glacier	A river of ice flowing from a valley into the sea.
Ablation glacier	A melting glacier.
Accumulation glacier	A growing glacier.
Temperate or warm glacier	A glacier in a temperate or warm region where ice is at or close to the pressure melting point temperature for most of the year.
Polar or cold glacier	A glacier in a polar region where temperatures are below the pressure melting point all year.

Source

Christopherson, Robert W. *Geosystems.* 4th ed. Upper Saddle River, NJ: Prentice Hall, 2002.

Global Warming

Global warming refers to the gradual increase in the average temperature of Earth's surface and its oceans. The phenomenon is related to, but not the same as, the greenhouse effect, which is a natural process that helps regulate the surface temperature of Earth.

Certain gases in Earth's atmosphere—commonly referred to as "greenhouse gases"—including water vapor, carbon dioxide (CO_2), and methane (CH_4)—are transparent to incoming short-wave solar radiation, but these same gases effectively absorb outgoing long-wave radiation emitted by Earth's surface. Some of the absorbed long-wave radiation is emitted downward toward Earth's surface, thereby warming it.

The concept of surface temperatures on Earth being raised because of heat-trapping gases in the atmosphere was first suggested in 1827 by the French mathematician Jean-Baptiste Fourier, who referred to *un effet de verre* ("an effect of glass"). In 1896 the Swedish chemist Svante Arrhenius compared such warming to that of a "hothouse." However, the physical process by which a greenhouse warms is somewhat different from that of the greenhouse effect on Earth's atmosphere. Without this natural greenhouse effect, Earth's average surface temperature would be about -19°C (-2°F), 34°C (61°F) cooler than its present value of approximately 15°C (59°F).

During the twentieth century, climate scientists began to focus increasing attention on the possibility of an enhanced greenhouse effect, resulting from an increase in greenhouse gas emissions attributed to anthropogenic, or human-induced, activities since the beginning of the Industrial Revolution. Specifically, the combustion of fossil fuels, such as coal, oil, and natural gas, has elevated the atmospheric concentration of CO_2 from 280 parts per million by volume (ppmv) prior to the Industrial Revolution to approximately 372 ppmv currently. As the concentration of CO_2 in Earth's atmosphere increases, the average altitude at which it releases energy to space is increasing as well. Because of the colder temperatures present at higher altitudes, the CO_2 is transmitting less radiation to space overall, resulting in a warming of the lower atmosphere.

According to a report issued in 2001 by the Intergovernmental Panel on Climate Change (IPCC), a multinational panel established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), "the global average surface temperature has increased by 0.6 ± 0.2°C since the late 19th century." The IPCC also concluded that "the 1990s was the warmest decade and 1998 the

warmest year in the instrumental record, since 1861." Subsequent data compiled by the University of East Anglia's Climatic Research Unit, the National Oceanic and Atmospheric Administration, and NASA's Goddard Institute for Space Studies indicate that 2005 ranked near or just above 1998 as the warmest year since instrumental records began.

Because of its potential effects on government policy, business infrastructure, the global economy, and the environment itself, global warming remains one of the most scrutinized of all contemporary scientific issues. Much of the debate centers on the uncertainties associated with the computer models used to simulate how various components of Earth's climate will change over time. The extent to which natural factors and human activities contribute to rising global temperatures and the effects of such warming on various regions pose some of the greatest challenges for scientists and policy makers. Despite these uncertainties, the IPCC reported in 2001, "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

Concern over the potential effects of global warming led to the introduction in 1997 of the Kyoto Protocol, an international agreement that requires industrialized countries to reduce greenhouse-gas emissions to pre-1990 levels by 2012. The agreement went into force on February 16, 2005, following ratification by Russia on November 18, 2004, but the Kyoto Protocol applies only to countries that formally ratified it.

As of the beginning of 2007, the United States, a signatory to the Kyoto Protocol, had not ratified the treaty. At the time the treaty was drafted, the Clinton Administration cited lack of participation by developing nations as a reason for not submitting the protocol to the Senate for ratification. More recently, President George W. Bush claimed that ratification of the Kyoto Protocol would hurt the U.S. economy and that its goals are unrealistic.

Sean Potter

Sources

Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2001: The Scientific Basis*. Ed. J.T. Houghton, et al. Cambridge, UK: Cambridge University Press, 2001.

National Aeronautics and Space Administration GISS Surface Temperature Analysis. http://data.giss.nasa.gov/gistemp.

National Research Council. *Climate Change Science: An Analysis of Some Key Questions.* Washington, DC: National Academy Press, 2001.

United Nations Framework Convention on Climate Change. http://unfccc.int/2860.php.

Godfrey, Thomas (1704–1749)

Thomas Godfrey, the inventor of the sextant, was born on January 10, 1704, at Bristol, Pennsylvania, to a farm family. His father died when Thomas was an infant, and his mother remarried.

As an adult, Thomas Godfrey worked as a glazier, setting the windows of the State House (Independence Hall) and the home of James Logan, the governor of Pennsylvania, among other buildings. While working at Governor Logan's house, he engaged the governor in conversation, revealing his knowledge of mathematics and astronomy. Logan, a mathematician, astronomer, and patron of science, encouraged Godfrey to act on his natural talents.

In 1727, Godfrey joined with Benjamin Franklin in establishing the Leather Apron Club of artisans engaged in thought and science. Franklin rented part of his house to Godfrey in Philadelphia. Godfrey did not have any formal education, but his inquisitiveness, intuition, and precise mind took him to the realm of mathematics, astronomy, and optics. Fondness for these subjects led Godfrey to read books such as Isaac Newton's *Principia,* for which he had to master Latin. He also calculated planetary positions for publication in Franklin's *Poor Richard's Almanack.*

Godfrey associated with sailors in the taverns of the Philadelphia waterfront, which led to many rounds of discussion about navigation. One of the problems faced by sailors was calculating the degree of latitude. The archaic backstaff method of determining a ship's latitude in relation to the North Star was not always accurate.

While Godfrey was glazing windows one day, a pane of glass fell to the ground; he noticed the double reflection from the glass in relation to the rays of the sun. The sun, he deduced, could be