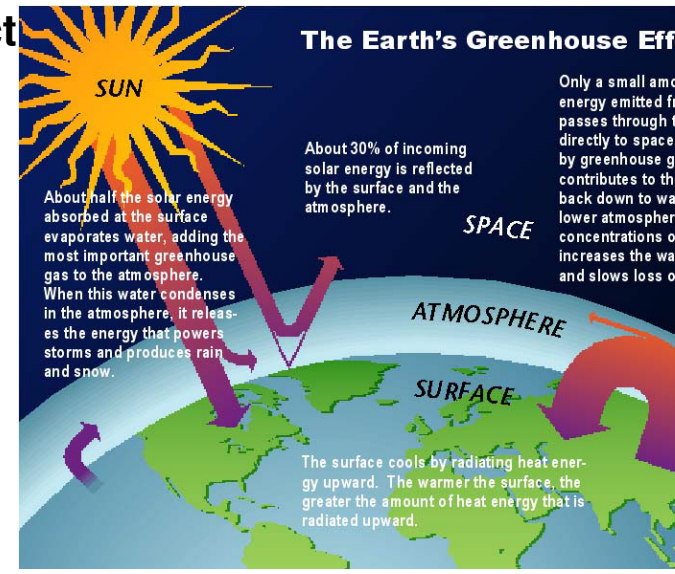
Climate and the Greenhouse Effect



Earth's climate is determined by complex interactions between the sun, oceans, atmosphere, land, and living things. The composition of the atmosphere is particularly important because certain gases (including water vapor, carbon dioxide, methane, halocarbons, ozone, and nitrous oxide) absorb heat radiated from the Earth's surface. As the atmosphere warms, it in turn radiates heat back to the surface, to create what is commonly called the "greenhouse effect." Changes in the composition of the atmosphere alter the intensity of the greenhouse effect. Such changes, which have occurred many times in the planet's history, have helped determine past climates and will affect the future climate as well.

Human Activities Alter the Balance

Humans are exerting a major and growing influence on some of the key factors that govern climate by changing the composition of the atmosphere and by modifying the land surface. The human impact on these factors is clear. The concentration of carbon dioxide (CO2) has risen about 30% since the late 1800s. The concentration of CO2 is now higher than it has been in at least the last 400,000 years. This increase has resulted from the burning of coal, oil, and natural gas, and the destruction of forests around the world to provide space for agriculture and other human activities. Rising concentrations of CO_2 and other greenhouse gases are intensifying Earth's natural greenhouse effect. Global projections of population growth and assumptions about energy use indicate that the CO2 concentration will continue to rise, likely reaching between two and three times its late-19th-century level by 2100. This dramatic doubling or tripling will occur in the space of about 200 years, a brief moment in geological history.

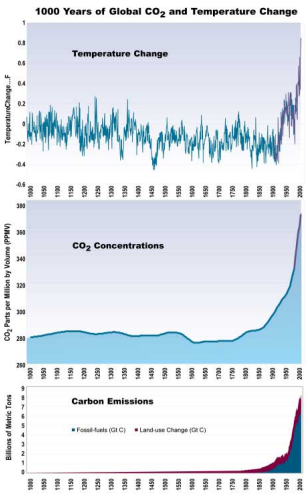
The Climate Is Changing

As we add more CO_2 and other heat-trapping gases to the atmosphere, the world is becoming warmer (which changes other aspects of climate as well). Historical records of temperature and precipitation have been extensively analyzed in many scientific studies. These studies demonstrate that the global average surface temperature has increased by over 1°F (0.6 °C) during the 20th century. About half this rise has occurred since the late 1970s. Seventeen of the eighteen warmest years in the 20th century occurred since 1980. In 1998, the global temperature set a new record by a wide margin, exceeding that of the previous record year, 1997, by about 0.3 °F (0.2 °C). Higher latitudes have warmed more than equatorial regions, and nighttime temperatures have risen more than daytime temperatures.

As the Earth warms, more water evaporates from the oceans and lakes, eventually to fall as rain or snow. During the 20th century, annual precipitation has increased about 10% in the mid- and high-latitudes. The warming is also causing permafrost to thaw, and is melting sea ice, snow cover, and mountain glaciers. Global sea level rose 4 to 8 inches (10-20 cm) during the 20th century because ocean water expands as it warms and because melting glaciers are adding water to the oceans.

According to the Intergovernmental Panel on Climate Change (IPCC), scientific evidence confirms that human activities are a discernible cause of a substantial part of the warming experienced over the 20th century. New studies indicate that temperatures in recent decades are higher than at any time in at least the past 1,000 years. It is very unlikely that these unusually high temperatures can be explained solely by natural climate variations. The intensity and pattern of temperature changes within the atmosphere implicates human activities as a cause.

The relevant question is not whether the increase in greenhouse gases is contributing to warming, but rather, what will be the amount and rate of future warming and associated climate changes, and what impacts will those changes have on human and natural systems.



Records of Northern Hemisphere surface temperatures, CO_2 concentrations, and carbon emissions show a close correlation.

Temperature Change: reconstruction of annual-average Northern Hemisphere surface air temperatures derived from historical records, tree rings, and corals (blue), and air temperatures directly measured (purple). CO_2 Concentrations: record of global CO

2

concentration for the last 1000 years, derived from measurements of CO

2

concentration in air bubbles in the layered ice cores drilled in Antarctica (blue line) and from atmospheric measurements since 1957. Carbon Emissions: reconstruction of past emissions of CO

2

as a result of land clearing and fossil fuel combustion since about 1750 (in billions of metric tons of carbon per year).