



Climate Change

Discussion Series

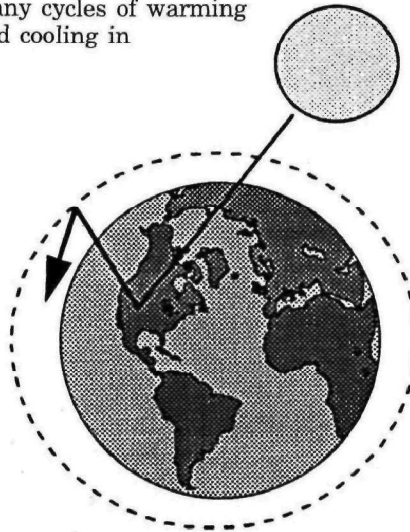
Global Climate Change

The greenhouse effect is a naturally occurring phenomenon. So called greenhouse gases act to warm the earth by absorbing infrared radiation that is given off from the earth's surface after sunlight strikes it.

The term global warming refers to an enhanced greenhouse effect resulting from human activities. Since the beginning of the industrial revolution, human activities have led to increased atmospheric concentrations of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs). Fossil fuel burning, which releases CO_2 , CO , N_2O and other pollutants, has increased at a rapid rate over the last century. More cattle and greater use of fertilizer have led to increased emissions of CH_4 and N_2O . Deforestation in many areas of the globe has contributed to increased CO_2 concentrations.

Atmospheric concentrations of CFCs and tropospheric ozone have also increased, primarily because of industrial activity.

The Earth's atmosphere has undergone many cycles of warming and cooling in



the past. However, two aspects of current greenhouse warming predictions differ from climate changes in the recent past. First, the temperature of the earth is expected to rise higher than the planet has experienced in the last 125,000 years. Second, past climate changes of comparable magnitude have occurred over thousands of years and have allowed for gradual ecosystem adjustments. We may now experience similar changes during the next century at a rate faster than many ecosystems can adapt.

A 1990 study by the Intergovernmental Panel on Climate Change (IPCC), involving several hundred scientists, concluded that a doubling of CO_2 levels would most likely lead to a 1.5 to 4.5 degrees C (3 to 8 degrees F) warming of the earth in the next 100 years. An increase in all greenhouse gases equivalent to a doubling of CO_2 emissions could occur as early as 2030.

Major Greenhouse Gases

Carbon Dioxide (CO_2): Currently responsible for approximately half to two-thirds* of humans' contribution to global warming, CO_2 's atmospheric concentration has risen 25 percent since the beginning of the Industrial Revolution. Combustion of fossil fuels and deforestation are the main sources of this increase. Because society's basic energy sources produce CO_2 , its atmospheric concentration is projected to continue to increase unless strong measures are taken to encourage energy conservation, alternative energy sources, and forest preservation.

Methane (CH_4): Although methane has a much lower atmospheric concentration than CO_2 , it is a more potent greenhouse gas and its concentration is increasing at a rate of 1 percent per year. Sources include rice paddies, cows, termites, natural gas leakage, biomass burning, landfills, and wetlands. Of the major greenhouse gases, CH_4 concentrations may be the easiest to stabilize with modest cuts in emissions.

Chlorofluorocarbons (CFCs): Invented in this century, CFCs have been implicated not only in chemical destruction of

stratospheric ozone, but also in greenhouse warming. Each CFC molecule has a direct warming effect several thousand times that of a CO_2 molecule. However, CFCs cause an indirect cooling effect by destroying ozone, another greenhouse gas. The extent to which the direct warming effect is offset by the indirect cooling effect has not yet been determined. CFCs are used in refrigerants, aerosol propellants, foam-blowing agents, and solvents. Their atmospheric concentration is increasing at a rate of 4 percent per year. Substitutes are being developed that are not as chemically stable and that therefore will not accumulate as fast in the atmosphere. The Montreal Protocol, an international agreement, and recent U.S. measures currently limit production of these gases, but further limits may be necessary.

Nitrous Oxide (N_2O): Nitrous oxide's concentration in the atmosphere is increasing at a rate of 0.25 percent per year. Although nitrous oxide is a more potent greenhouse gas than CO_2 , its contribution to global warming is lower because of its low concentration. Anthropogenic (human) sources include fossil fuel and biomass combustion, agricultural fertilizers, and land disturbances. The relative contribution of natural and anthropogenic sources of N_2O are not that well understood.

* Based on 1990 emission estimates and IPCC 1992 GWPs (global warming potential). CH_4 estimates include indirect effects.

NOTE: Climate Change refers to potential modification of the earth's climate resulting from increasing atmospheric concentrations of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs). Through a naturally occurring process known as the greenhouse effect, these gases act to warm the earth by trapping heat in the atmosphere. This process plays an important role in maintaining earth's current temperature and climate. By increasing concentrations of greenhouse gases, human activities are trapping more heat in the atmosphere and potentially changing the earth's climate.

Potential Impacts of Climate Change on the United States

Coastal Resources: Sea level rise could cause loss of wetlands and drylands along coastlines and could require costly measures to protect developed areas.

Water Resources: Changes in water flow and water quality could occur with the potential for more severe water shortages in some areas.

Agriculture: Yields could change (productivity could shift northward) and the range of agricultural pests and diseases could also move northward. Irrigation demands will likely increase in many regions.

Biodiversity: Ranges and populations of various species could be reduced. Some species could become extinct.

Electricity Demand: Electricity demand could rise in all but the northernmost regions of the United States as the use of air conditioning increases to compensate for higher temperatures.

Air Quality: Higher temperatures could increase air pollution in some regions.

Health: In addition to likely increases in heat-related deaths, the spread of insect-borne infectious diseases such as malaria and dengue fever could extend northward.

Options to Reduce Greenhouse Gas Emissions

- Increase energy efficiency and use of renewable energy sources.

Strengthen building and appliance efficiency standards. Encourage utilities to invest in conservation measures to reduce demand.

Promote renewable energy sources, such as solar, wind, hydro, and geothermal power.

Encourage transportation efficiency and alternative fuels.

Adopt carbon or fossil fuel taxes.

Accelerate phase-out of CFCs.

- Capture methane and recover energy from the various methane sources.

- Reduce deforestation and encourage tree planting programs.

- Reduce N₂O emissions from fertilizer use and other sources.

Options to Adapt to Climate Change

Sea Level Rise: Establish buffer zones to allow for inland migration of wetlands and to limit loss of structures; incorporate sea level rise into coastal management plans.

Agriculture: Maintain genetic diversity; develop specialized crop and livestock varieties; prepare for the potential introduction of new pests; improve irrigation efficiency; increase the use of conservation tillage and crop rotation practices.

Water Resources: Conserve; protect water quality and opportunities for future supplies; improve river basin and drought contingency planning.

Forests: Maintain diversity and extensiveness; prepare for episodes of increased mortality due to changes in fire and pest disturbances.

Natural Systems: Maintain species ranges; avoid barriers to migration and habitat fragmentation; establish migratory pathways.

Health: Recognize health-debilitating weather; improve disease surveillance systems.

Based on EPA's Report to Congress, *The Potential Effects of Global Climate Change on the United States*, Washington, D.C., 1989; EPA's Report to Congress, *Policy Options for Stabilizing Global Climate*, Washington, D.C., 1990; EPA's *Adapting to Climate Change: What Governments Can Do*, Washington, D.C., 1991; IPCC's *Policymakers' Summaries*, 1990; and the *Selected Summary of Current State Responses to Climate Change*, Washington, D.C., 1990.

EPA's State and Local Climate Change Outreach Program is designed to raise awareness about climate change and provide technical and financial support to state and local agencies and non-profit organizations in the analysis and development of cost-effective response strategies. For further information, contact Kitty Sibold at 202-260-8825.

Order additional sheets from the Climate Change Discussion Series: U.S. EPA, Climate Change Division (PM221), 401 M Street, SW, Washington, D.C. 20460, fax: 202-260-6405