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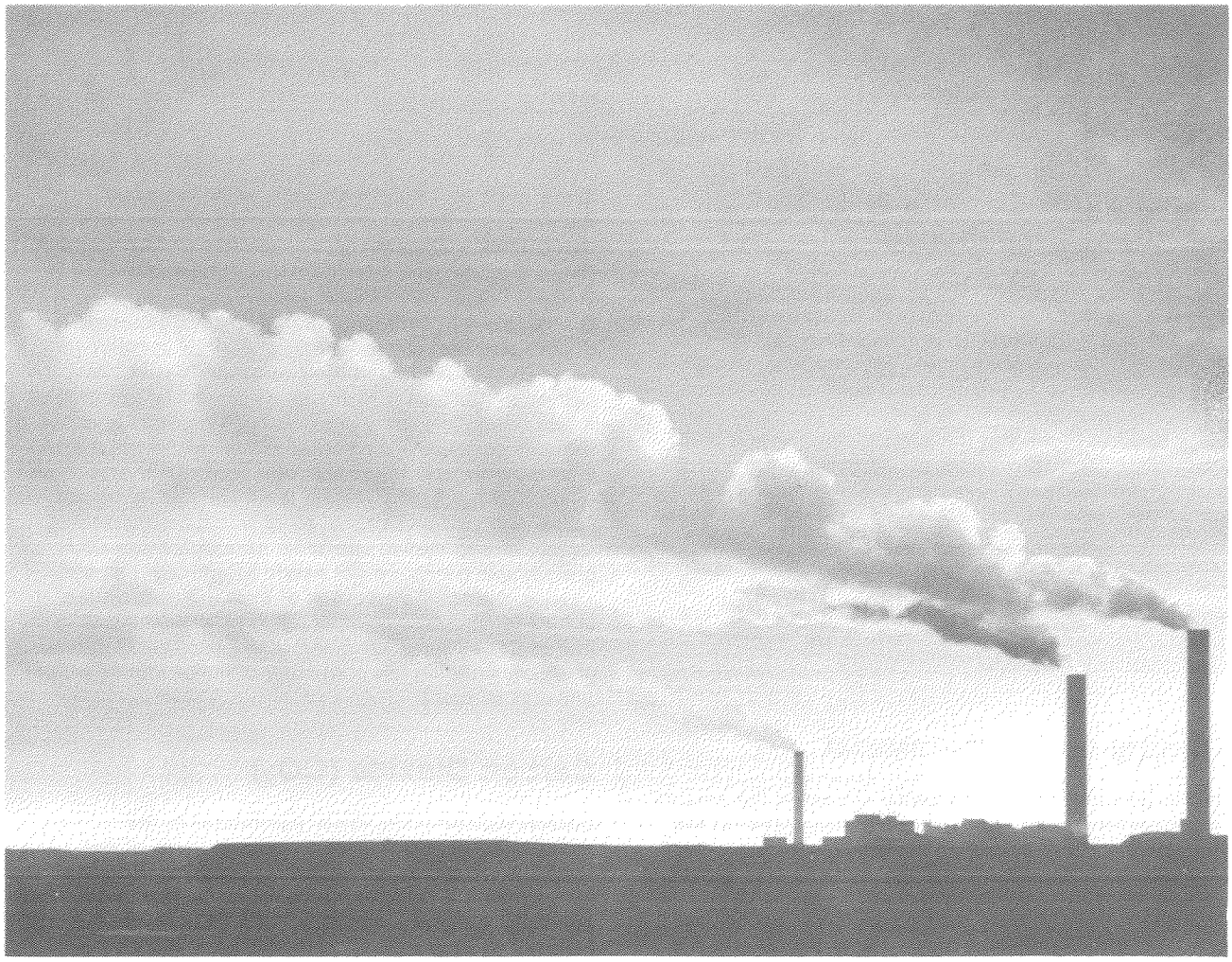
Fact Sheet

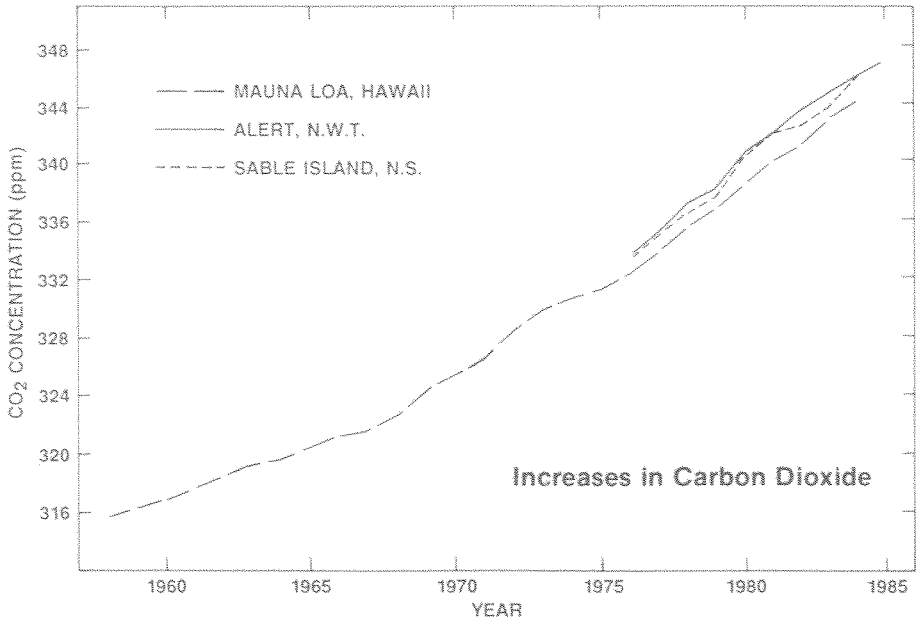
Atmospheric Environment Service

THE GREENHOUSE GASES



The burning of fossil fuels releases large quantities of carbon dioxide — a "greenhouse" gas — into the atmosphere. Such gases are expected to cause major changes in global climate.

The composition of the earth's atmosphere is undergoing a major global change. Human activities, such as air pollution, deforestation, the burning of fossil fuels, and even agricultural practices are now starting to alter the balance of gases in our atmosphere. There is widespread concern that this may cause major changes in world climate. Temperatures may rise. Rainfall patterns may shift. The effects on our society could be immense. The primary concern centres on a phenomenon often described as the greenhouse effect.



Carbon dioxide is increasing rapidly in the global atmosphere.

Planet Earth: A Natural Greenhouse

The sun heats the earth, providing the warmth and energy to sustain life on our planet. But the heating of the earth is not as simple as one might first assume. Certain gases in the atmosphere act somewhat like a blanket, keeping the surface of the earth warm. Without these atmospheric gases, the surface of the earth could be as barren and cold as the surface of the moon. This effect is similar in some ways to the glass in a greenhouse. The sun's rays pass through the earth's atmosphere relatively unaffected by its constituent gases. The rays are absorbed by the earth's surface, which heats up and radiates this energy back to space. Much of this radiated heat energy is now captured by atmospheric "greenhouse" gases, such as carbon dioxide, and partly returned to earth, thus "trapping" heat close to the surface.

Turning up the thermostat

Human activities have significantly increased the amount of carbon dioxide and other "greenhouse gases" in the atmosphere. These gases are expected to enhance the natural greenhouse effect and substantially alter global climate. Such changes could exceed anything experienced in human history, possibly as early as the year 2030. Carbon dioxide, produced by the burning of fossil fuels such as coal, oil and natural gas, is the major concern.

Studies of future climate, based on complex computer calculations, indicate that average world temperatures could increase between 1.5 and 4.5°C if global carbon dioxide is doubled. Warming in Arctic regions would be 2 — 3 times greater than the tropics, causing a change in global heat distribution. Major alterations in global wind patterns and rainfall distribution would result. A generally dryer climate is predicted for mid-latitude areas, such as southern Canada, while increased moisture is expected in the Arctic regions and possibly the Tropics. Global sea levels may rise as much as one metre. Studies of warmer climates in past eras tend to support these conclusions.

Global levels of carbon dioxide (CO_2) are expected to double over that of pre-industrial periods sometime between the middle and the end of the 21st century, (although it is becoming increasingly difficult to predict future trends in energy use). But carbon dioxide is not the only concern. Recent studies have shown that up to 20 other atmospheric gases contribute to the greenhouse effect. The most significant of these are CFCs, nitrous oxide, methane and ozone, all of which are increasing rapidly due to human activities. Although these other greenhouse gases are not nearly as abundant as carbon dioxide, the combined effect of their increase on the earth's temperature is expected to be almost equal to that of CO_2. This will accelerate the anticipated climatic changes, bringing the possibility of major effects within the next 50 years.

Carbon Dioxide (CO_2)

Carbon dioxide is the major contributor to the greenhouse effect. Scientific measurements of this atmospheric gas reveal an unmistakable, world-wide increase that is rapid and escalating. Concentrations are presently rising at a rate of 3 — 4% per decade and are believed to have already increased by about 25% over the past 200 years. The primary cause is the rapid rise in the use of oil, gas and coal to satisfy the energy demands of today's society. At present, the burning of these fossil fuels releases close to 5 billion tonnes of carbon, as gaseous carbon dioxide, into the atmosphere each year.

Global deforestation is also a major cause of this increase. Carbon dioxide in the atmosphere is part of a natural cycle. Plants and animals release CO_2 as they breath. Decaying organic matter, volcanoes, and forest and

grass fires also contribute to the CO_2 in the atmosphere. However, these natural sources are kept in balance by processes which remove the gas from the atmosphere. One such important process is photosynthesis, by which forests and other vegetation remove CO_2 from the atmosphere and store it as carbon in their tissues and wood fibres. In tropical areas, huge tracts of forest are burned to clear the land for development. Such burning suddenly releases vast quantities of carbon stored in the trees for many years. Estimates suggest that deforestation may be adding as much as 1 — 2 billion tons of additional carbon to the atmosphere each year.

The ocean also plays a major role in the balance of CO_2 in the atmosphere. It serves as a huge reservoir for carbon, acting both to absorb and release large amounts of carbon dioxide. However, these mechanisms are extremely complex and still poorly understood.

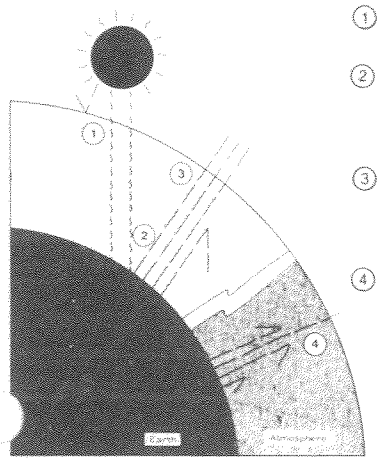
The ocean and other components of the ecosystem currently remove approximately one half of the excess CO_2 released into the atmosphere by human activities. The increase in global atmospheric CO_2 is caused by the half that remains.

CFCs

A group of industrial chemicals, known as CFCs (chlorofluorocarbons) or freon gases, are also major contributors to the greenhouse effect. Although CFCs are far less abundant than CO_2, their effect on climate, molecule for molecule, is about 10,000 more powerful. In a recent landmark environmental agreement in Montreal, CFCs have become the first greenhouse gas to be regulated worldwide.

The amount of CFCs in the atmosphere has increased sharply in recent years, as their industrial use grows. CFCs are used as the blowing agent in the manufacture of foam insulation and padding, as spray can propellants, as coolants in refrigerators and air conditioners and as solvents for cleaning microchips and other electronic equipment.

The "Greenhouse Effect"



1. Solar energy enters the atmosphere (unimpeded by CO_2).
2. Light is absorbed by the earth. It is reradiated at longer heat wavelengths, some of which are captured by CO_2; the others escape into space.
3. At the normal atmospheric CO_2 level the quantity of light and heat escaping into space determines the earth's temperature and climate.
4. Higher concentrations of CO_2 trap more reradiated heat. Atmospheric and surface temperatures increase, affecting weather and climate.

Since the early 1970s, CFCs have received considerable attention because of their threat to the ozone layer in the upper atmosphere. (This layer protects life on earth from the harmful effects of the sun's ultraviolet rays.) As a result, certain countries, including Canada and the United States, introduced restrictions on the use of these chemicals in spray cans in the late 1970s.

However, the reduction in CFC use caused by this action was quickly offset by increases in non-propellant uses. By the early 1980s, global levels of CFCs in the atmosphere were increasing at an alarming rate of 5-6% per year.

In Septemnber 1987, the world met in Montreal to sign an agreement to reduce global levels of CFCs. In the first accord of its kind, 24 nations, including Canada, pledged to reduce the use of these chemicals by 50% by 1999. The agreement, known as the Montreal Protocol, was developed under the United Nations Environment Program and signed as an addition to the 1985 Vienna convention for the Protection of the Ozone Layer.

Methane (CH_4)

Methane is a naturally-occurring greenhouse gas which has increased sharply due to human activities. In fact, the increase of global methane has virtually kept pace with the rise of world population.

Methane gas can be produced through a variety of processes, generally involving the break-down of vegetation, either through burning, digestion or rotting without the presence of oxygen. Large quantities of methane are believed to be released by rice paddies, where vegetation rots in the water-logged soils. Cattle and other grazing livestock are also another major source, where methane is produced in the animal's digestive system. It is estimated that the large global cattle population and increasing land areas covered by rice paddies now account for almost 50% of the global release of methane.

Roughly another 20% of global methane is produced by the burning of wood and other vegetation. Wood is burned extensively as a fuel and for industrial use in the third world, while large tracts of tropical forests are burned to clear land for agriculture.

Lesser amounts of methane are produced by the mining of coal and natural gas, which releases the methane gas trapped with these deposits. Natural sources, such as swamps and marshes, also contribute small amounts of this gas.

Nitrous Oxide (N_2O)

Like methane, nitrous oxide is also a naturally-occurring gas which has increased significantly in recent years due to human activities. At present, roughly 1/3 of the global atmospheric nitrous oxide is of human origin, resulting mainly from the use of chemical fertilizers and the burning of fossil fuels.

Nitrous oxide is produced naturally by microbes in the soil and bodies of water. The nitrogen in this gas acts as a natural fertilizer, encouraging plant growth. The agricultural industry produces large quantities of chemical nitrogen for use as fertilizers. Once added to

the soil, some of this nitrogen is converted to nitrous oxide and released into the atmosphere.

The burning of fossil fuels and wood also releases large amounts of nitrous oxide into the atmosphere. The burning of wood for fuel and to clear forests for agriculture occurs primarily in the tropics, while fossil fuel combustion is characteristic of more industrialized areas.

Ozone (O_3)

Ozone is formed as a result of the energy of the sun's rays breaking up and reforming various atmospheric gases. Ozone, which is a specialized form of oxygen, is of great benefit in the upper atmosphere, where it shields us from the harmful ultraviolet rays of the sun. This upper level ozone is formed primarily from naturally-occurring chemicals.

However, in the lower atmosphere, ozone can be a major component of urban smog — damaging crops and aggravating respiratory problems. This low-level ozone is formed primarily by chemical reactions among a variety of air pollutants. In addition to its direct effect on plant life and health, ozone is also a powerful greenhouse gas.

Ozone in the lower atmosphere is a highly unstable compound, constantly breaking down and reforming as air pollutants mix together. Thus the amount of ozone in an urban area may vary considerably. However, the average concentration of this gas is rising steadily as urban air pollution increases. Roughly 75% of these ozone-forming pollutants come from automobile exhaust, with the remainder originating mainly from coal-burning plants.

Environment Canada's Role

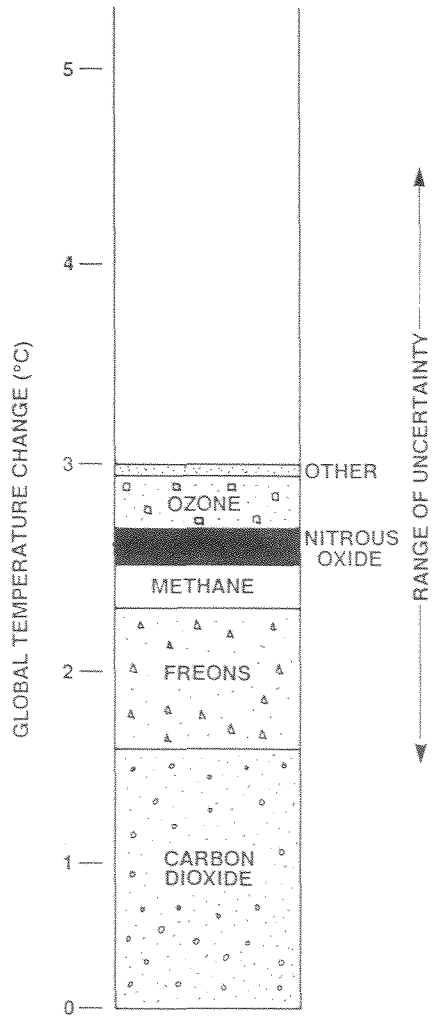
Concerted efforts are now underway to more fully understand the greenhouse effect and the roles played by the various greenhouse gases. Environment Canada research programs are keeping track of the rising levels of the most important greenhouse gases in the atmosphere. Studies are also being carried out on how these gases could change our climate and the potential impacts of these changes on our society. The Canadian Climate Program, initiated by Environment Canada, is co-ordinating the related research efforts of government, industry and universities across the country.

The greenhouse effect is a global concern, and Environment Canada is also participating in international efforts to further understanding and action on this complex problem. Environment Canada played a key role in the development of the historic Montreal Protocol, the first global agreement to protect the atmosphere. The protocol, which will reduce the use of CFCs, was signed at a diplomatic conference hosted by Environment Canada in Montreal.

In June 1988, Environment Canada organized a major global conference in Toronto on "The Changing Atmosphere: Implications for global security". Participants from around the world issued a strong statement calling for immediate action to reduce the greenhouse gases, including further restrictions on CFCs and a 20% reduction in CO_2 by the year 2005. Environment Canada is now developing strategies to pursue such actions.

Global Warming

Global temperature may rise an average of 3 °C by the year 2030. The major contributors to this warming are expected to be carbon dioxide and CFCs, with the other greenhouse gases having lesser effects, as indicated (based on current rates of emission).



Part of a series of fact sheets on climate change. Other titles are:

- Climate Change and Variability
- Impacts of Global Warming

For more information contact:

Environment Canada
Atmospheric Environment Service
Canadian Climate Centre
4905 Dufferin Street
Downsview, Ontario M3H 5T4

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