Fact Sheet

Environment Canada / Environnement Canada

Atmospheric Environment Service / Service de l'environnement atmosphérique

Atmospheric Environment Service

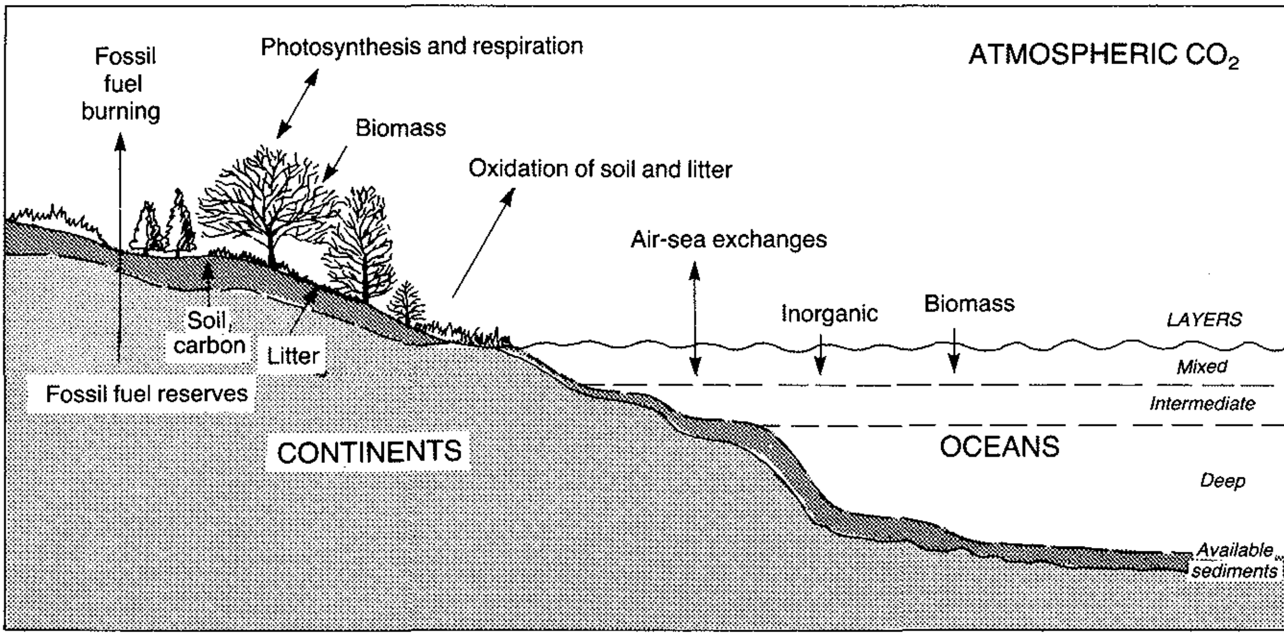
CLIMATE AND CARBON DIOXIDE

One source of CO_2.

There is growing concern about increasing concentrations of carbon dioxide (CO_2) in the atmosphere. If these concentrations continue to grow over the next five to ten decades, as projected, the world climate could undergo significant changes which, in turn, would have dramatic social, economic and political impacts. The following is a summary of the scientific basis for these concerns.

How the carbon cycle works

Carbon in the form of CO_2 and its derivatives are stored in three large natural reservoirs — the oceans, the land, and the atmosphere. It is constantly being transferred from one reservoir to the other.



The carbon cycle.

Carbon enters the atmosphere primarily as CO_2 by emission from ocean surfaces in the tropical regions and as a product of the decay of organic matter and the respiration of plants and animals. Volcanoes, forest and grass fires also contribute to this process. About the same amount of CO_2 is removed from the atmosphere by absorption into oceans in temperate and cold regions and by vegetation, which requires CO_2 for photosynthesis.

Since the start of the industrial revolution, the burning of fossil fuels has rapidly increased the amount of CO_2 entering the atmosphere. In 1980 alone, this source released 5 billion tonnes of carbon into the atmosphere. At the same time, the effectiveness of the land and the oceans in removing CO_2 from the atmosphere may also have changed. Recent research indicates that about 50-60% of CO_2 released by burning fossil fuels is retained by the atmosphere. The remainder probably is retained primarily by the oceans, although some might be assimilated in biomass. Recent shifts toward energy conservation have been influential in slowing the rate of increase, but if current trends in fossil fuel usage continue, and the oceans' ability to absorb portions of this excess CO_2 remain unchanged, CO_2 concentrations in the atmosphere will double from 1980 levels by the end of the 21st century.

Measuring CO_2 concentrations

The first reliable series of atmospheric CO_2 measurements, taken at the earth's surface, was started in Hawaii in 1958. In 1979 the mean global concentration of CO_2 in the atmosphere was about 335 parts per million. These records indicate that concentrations have been increasing at an average rate of about three percent per decade since 1958. Trends available from other surface stations in both the northern and southern hemispheres show that these increases are world-wide.

The Atmospheric Environment Service (AES) of Environment Canada collects air samples at Alert, NWT and Sable Island NS which are then analyzed for CO_2 concentrations by Fisheries and Oceans Canada. Samples are also being obtained for analysis from ships crossing the Pacific Ocean and from three west coast lighthouses.

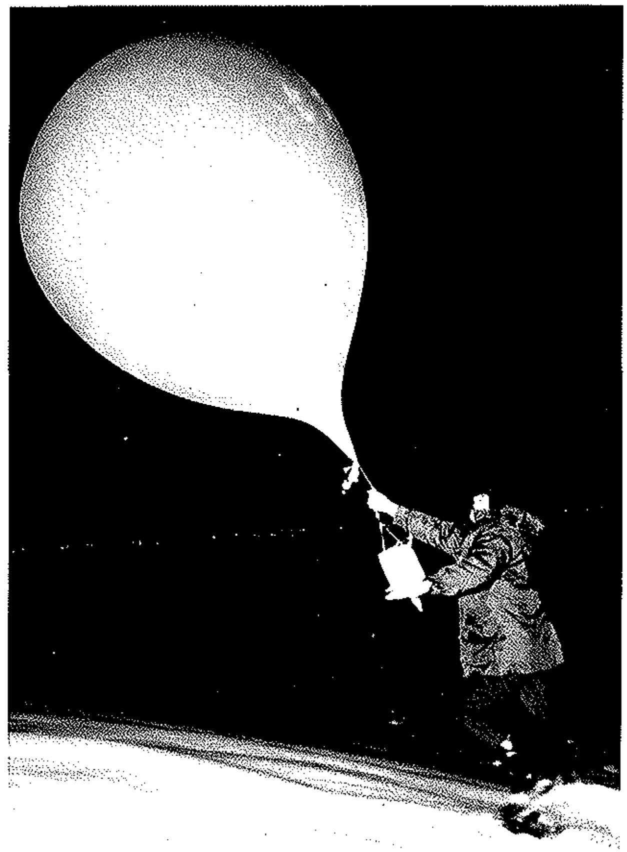
Rising CO_2 concentrations and the climate

Scientists are concerned about the type of climate that could result from increasing levels of CO_2. The climate system (involving the atmosphere, ocean and lands) acts like a giant engine which converts some of the solar energy into air and ocean currents and distributes the rest around the globe as heat. The earth's surface and atmosphere constantly emit energy into space, keeping the climate system in thermal balance. As concentrations of CO_2 increase, more of the energy from the earth would be "trapped" by the lower atmosphere causing the earth's surface to warm. This warming, commonly known as the "greenhouse effect", would increase the amount of water evaporated from the oceans, which in turn would "trap" even more of the earth's emitted energy and warm the surface still further. This is not a runaway process, however, since, as the atmosphere becomes more moist and more clouds form, more solar energy would be reflected back into space thus tending to cool the earth's surface.

The balancing mechanisms described involve complex interactions between the energy flow, the motions of the air and sea, the earth's topography and the conditions of the earth's surface. Further, changes in other climate elements, such as precipitation, may be much more important than temperature. To investigate these questions, scientists use intricate computer models known as general circulation models, to simulate the total behaviour of the climate system. Such models, though still primitive have been used to make estimates of the potential climate changes due to increasing CO_2.

According to the most advanced model available, the average global temperature at the surface would rise 2°C if the mean global CO_2 concentration doubled. The model also indicates that warmings at more northern latitudes would be larger than those near the equator. In Arctic regions the annual average increase in temperature would be about 4°C. Because of the oceans' ability to store heat, it could take 30 to 40 years for this warming to be completed after the CO_2 has doubled.

There are many gaps in our knowledge of the climate system and, thus, it is necessary for scientists to continually reexamine the scientific basis for these estimates. For this reason, the AES has developed an advanced computer model of the climate system which will be used to investigate the effects of CO_2 with the aim of decreasing the scientific uncertainties.

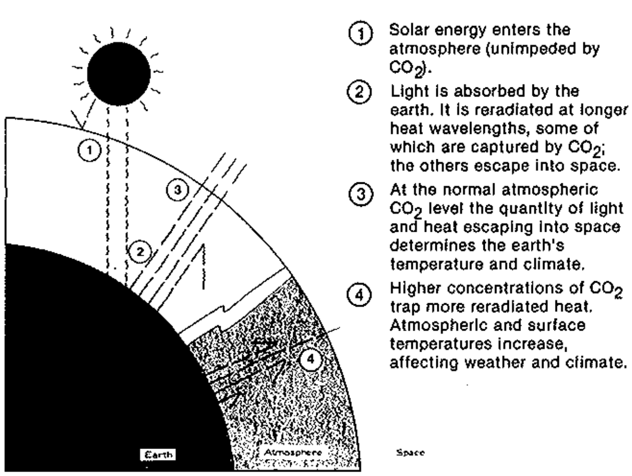


Radiosonde being released to measure pressure, temperature and humidity in the atmosphere.

CO_2 induced climate change — potential impacts

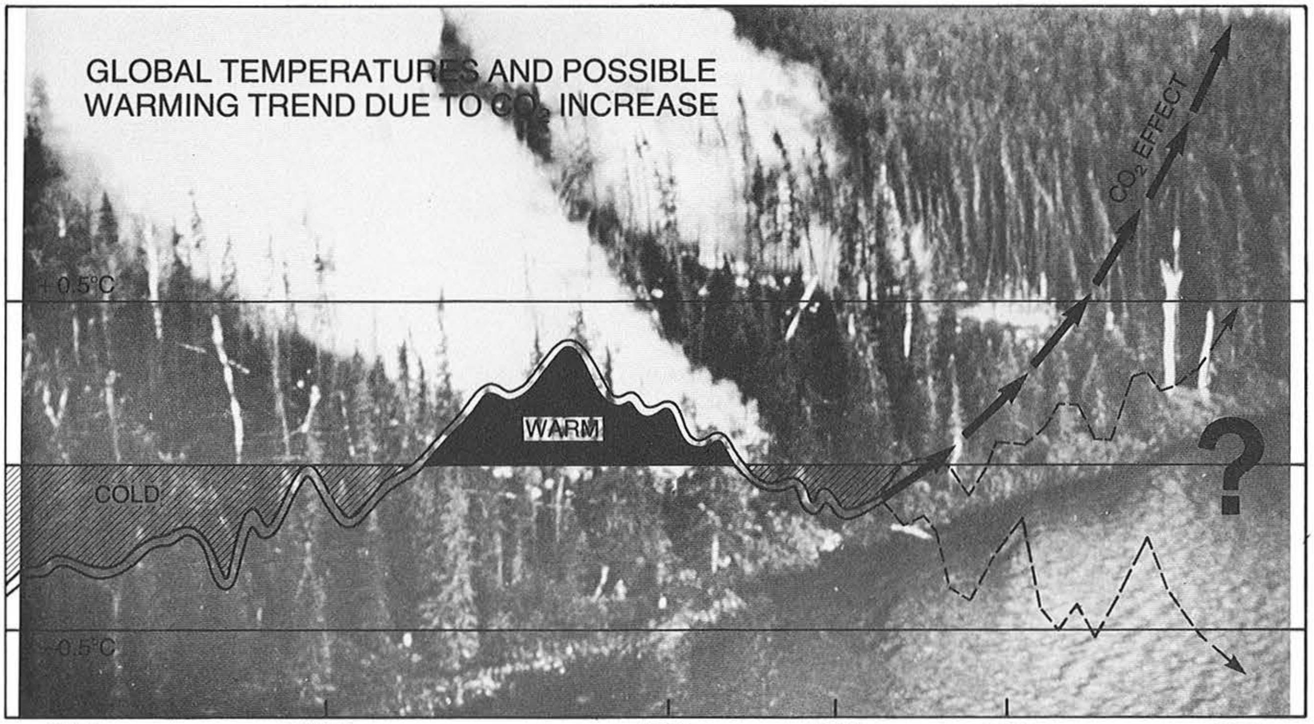
Although scientists are still debating the timing and magnitude of temperature changes due to CO_2, they generally agree that, during the 21st century, increased concentrations of CO_2 in the atmosphere will produce a global warming larger than any observed in the past 1000 years. However, the CO_2 effect may be moderated by cooling produced by natural phenomena.

A change of one or two degrees in the average global temperature will mean much larger changes in regional temperatures and alterations to the circulation pattern. Although it is not possible to define these changes precisely, experts have suggested some likely outcomes: the extra warming at northern latitudes will probably weaken the west-east circulation in the latitude belt between the 30 to 60°N. Increased temperatures will extend the growing season in northern latitudes and increase the ice-free season in polar seas. Globally, the warming would create more deserts in some areas and improve water supplies in others. Such climate changes could have major social and economic consequences. A warmer atmosphere and altered precipitation patterns could reduce the capability of global agricultural sector to provide food for the growing populations.



The "Greenhouse Effect".

Canada might benefit from a warmer climate. The climatic conditions for farming northern lands would improve. Studies suggest increased CO_2 concentrations would boost agricultural and forest biomass yields by enhancing photosynthesis. Warmer temperatures could also lead to reductions in the amount of ice in Arctic and inland waters aiding northern navigation and oil exploration. In addition, less heating fuel would be required during the winter months. On the other hand there would be lower agricultural yields if the Prairies experience increased aridity. These projections are speculative At this time we must await the results of further studies to assess or plan adaptive strategies.



Rising temperatures in northern latitudes can increase forest fire risk.

For further information
on CO_2-related activities and the effects of
CO_2 on climate contact:
The Canadian Climate Centre
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For further information
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Issued under the authority of the
Minister of the Environment
Atmospheric Environment
Services

Catalogue No. En 57-24/2-1982E
ISSN 0715-0040
ISBN 0-662-12130-9