

GREENHOUSE GASES FROM FOSSIL FUELS AND THEIR IMPACT ON GLOBAL CHANGE

José Goldemberg

Universidade de São Paulo, Brazil

Keywords: greenhouse effect, global warming, greenhouse gases (GHG), anthropogenic sources of GHG, IPCC (Intergovernmental Panel on Climate Change), carbon dioxide emissions, deforestation.

Contents

1. Global Warming
 2. Fossil Fuels' Contribution to Greenhouse Warming
 3. The Contribution of Deforestation
 4. Conclusions
- Glossary
Bibliography
Biographical Sketch

Summary

A discussion is presented on the natural “greenhouse effect” of the atmosphere, which is responsible for the present temperature of Earth’s surface, and the increases in that temperature due to the anthropogenic production of additional quantities of greenhouse gases (GHG). The conclusions of the IPCC (Intergovernmental Panel of Climate Change) are also presented, followed by the main sources of GHG. Dominant among them is CO₂ (carbon dioxide) resulting from the burning of fossil fuels. The countries that contribute most significantly to these emissions are listed in this article. Finally, the contribution of deforestation to global warming is presented.

1. Global Warming

Earth’s atmosphere is almost completely transparent to incident solar radiation. A small fraction of this radiation (mostly visible light) is reflected into space but most of it hits Earth’s surface, where it is absorbed and re-emitted in all directions as thermal (infrared) radiation (Figure 1).

The atmosphere contains gases that are not transparent to thermal radiation; as a consequence the atmosphere gets warmer than it would in the absence of these “greenhouse gases” (GHG). They act as a blanket around Earth and warm it, in very much the same way as a greenhouse in the winter keeps the air inside it warm enough to enable the growing of out-of-season vegetables and flowers.

On the Moon, which does not have an atmosphere, temperatures are very high when the sun illuminates its surface, and very low when it does not. The existence of the atmosphere and its greenhouse gases allows life on Earth. They act as stabilizers against abrupt temperature changes between night and day. The amount of warming produced

depends on the concentration and radiative properties of each gas, and the length of time the gases remain in the atmosphere. Without greenhouse gases, it is estimated that the average temperature of Earth's surface would be some 15–20°C below zero.

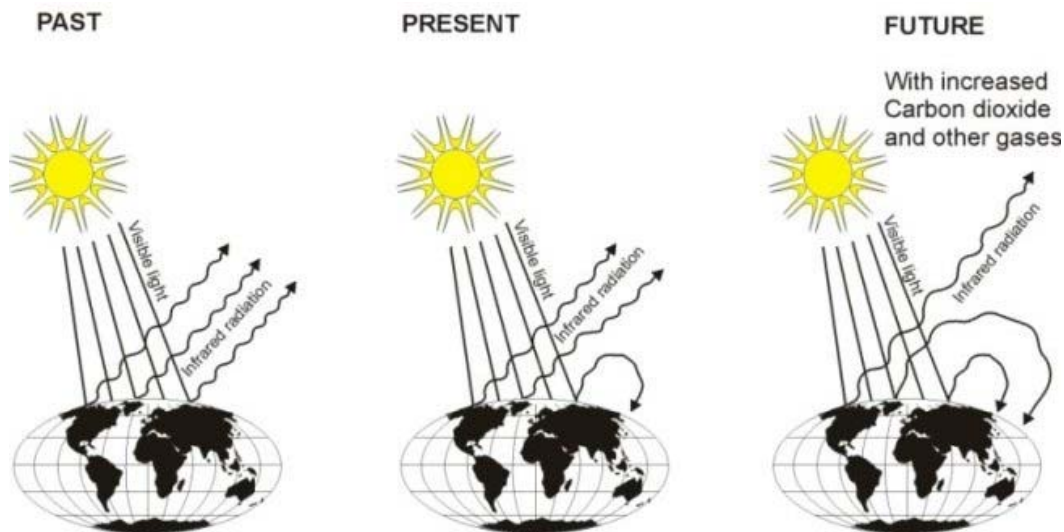


Figure 1. The greenhouse effect

Any human-made changes in the radiative balance of Earth, including those due to an increase in greenhouse gases or aerosols, will tend to alter atmospheric and oceanic temperatures, and the associated circulation and weather patterns. These changes are superimposed on variations in climate due to natural causes; to distinguish them, it is necessary to identify the human-made “signal” against the background “noise” of natural climate variability, which is not an easy task.

The most important greenhouse gases are CO₂ (carbon dioxide), CH₄ (methane) chlorofluorcarbons (mainly CF₁₁ and CF₁₂) and nitrous oxide (N₂O). The effectiveness of these gases in warming the atmosphere is different: one molecule of CF₁₁ is 3400 times more effective than a molecule of CO₂, one molecule of N₂O, is 270 times more effective, and one molecule of CH₄, is approximately 11 times more effective than CO₂. Therefore, even very small concentrations of these gases can contribute significantly to global warming.

Figure 2 shows the percentual contributions of different greenhouse gases to global warming.

The best available information on global climate change is the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC), sponsored jointly by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP). In 1990 the IPCC published its first Report that was an authoritative statement of the views of the international scientific community at that time. Several hundred scientists from 25 countries participated and an additional 200 scientists have been involved in a peer review. It was followed by a supplement in 1992, which updated, but did not substantially change its results. The original Report was again updated in 1995 in a process, which involved more than 2000 scientists.

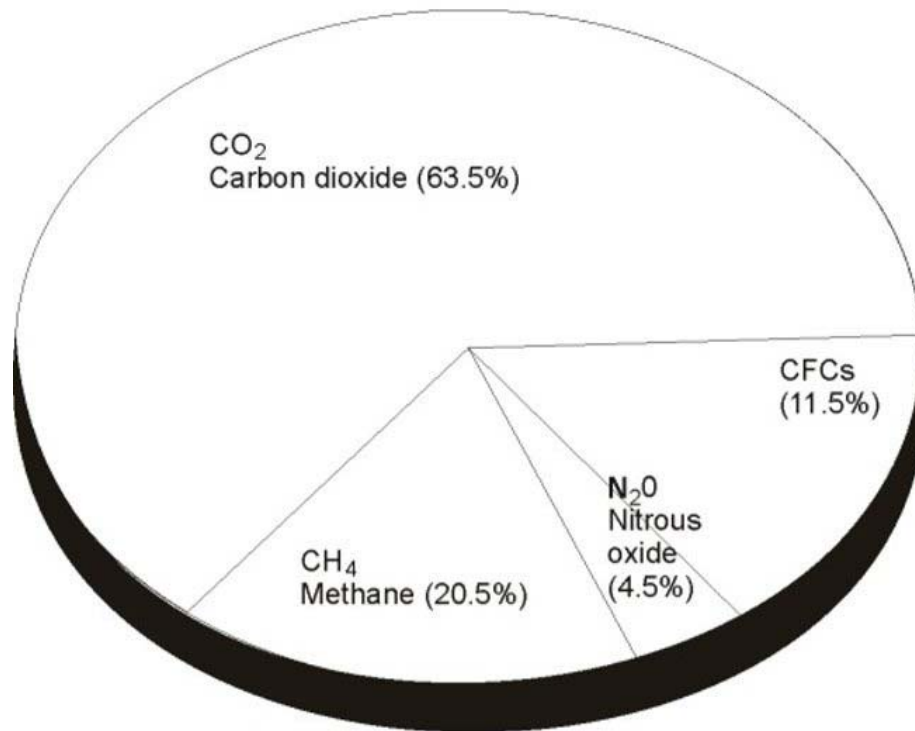


Figure 2. Contributions to climate change from anthropogenic sources

The major conclusions of this Report are:

- Greenhouse gas concentrations, mainly carbon dioxide (CO₂) and methane (CH₄), have grown significantly since pre-industrial times. Since the eighteenth century, the atmospheric concentration of CO₂ has risen from 280 to 360 parts per million by volume (ppmv), and that of CH₄ has risen from 700 to 1720 (parts per billion by volume ppb).
- These increases in greenhouse gas concentration have perturbed the energy balance of the Earth-Atmosphere system, tending to warm Earth's surface and to produce climate changes.
- The world surface temperature rose by 0.3°C to 0.6°C within the last 100 years.
- Global sea level has risen by between 10 cm and 25 cm over the past 100 years, and much of the rise may be related to the increase in the global mean temperature. Doubling the CO₂ concentration in the atmosphere will raise sea level 0.2 to 0.8 meters excluding melting of the polar caps.
- Climate is expected to continue to change in the future. The expected temperature increases by the year 2100 in different scenarios range from 1°C to 3.5°C. Such a rapid rise has been unprecedented in the last 10 000 years.

Figure 3 shows observed global mean temperature changes for the period 1861–1989 compared with predicted values from highly simplified climate models, which indicates the range of uncertainties of predictions of present models.

-
-
-

TO ACCESS ALL THE 8 PAGES OF THIS CHAPTER,
Visit: <http://www.eolss.net/Eolss-sampleAllChapter.aspx>

Bibliography

Austin D., Goldemberg J., and Parker G. (1998). *Are Conventional Metrics Misleading the Debate?* World Resources Institute, Climate Notes.

Carbon Dioxide Information Analysis Center (1993). *Trends 93 - A Compendium of Data on Global Change*. Tennessee, Oak Ridge: National Laboratory Oak Ridge.

IPCC (1995 update). *Climate Change. The IPCC Scientific Assessment*. Cambridge, UK: Cambridge University Press.

Biographical Sketch

Professor José Goldemberg earned his Ph.D. in Physical Science from Universidade de São Paulo of which he is former Rector and Full Professor. He has served as the President of Brazilian Association for the Advancement of Science and as the Secretary of State for Science and Technology, Secretary of the Environment and Minister of State of Education of the Federal Government of Brazil until August 1992. He has authored many technical papers and books on Nuclear Physics, Environment and Energy.