

Chemicals in Climate Forcing

Subject: Chemistry

Grade Level: 10th – 11th

Rational or Purpose: This lesson aims to help students to understand the chemicals that are affecting our climate today. Students will know the contributors of those chemicals and how these chemicals help warming up the Earth.

Materials:

Poster boards or Computers with Microsoft PowerPoint®

Lesson Duration: 90 minutes (2 lessons)

TEKS Objectives:

112.45 Chemistry (c) (3) (A) (B) (C)

Background Information:

News, media, and science magazines have often stress that the emission of carbon dioxide is causing a significant climate change in our human history. We know that the decreasing number of trees in forests causes more carbon dioxide to accumulate in the atmosphere (less photosynthesis occurs to convert carbon dioxide to oxygen). Let's take a look of the following diagram:

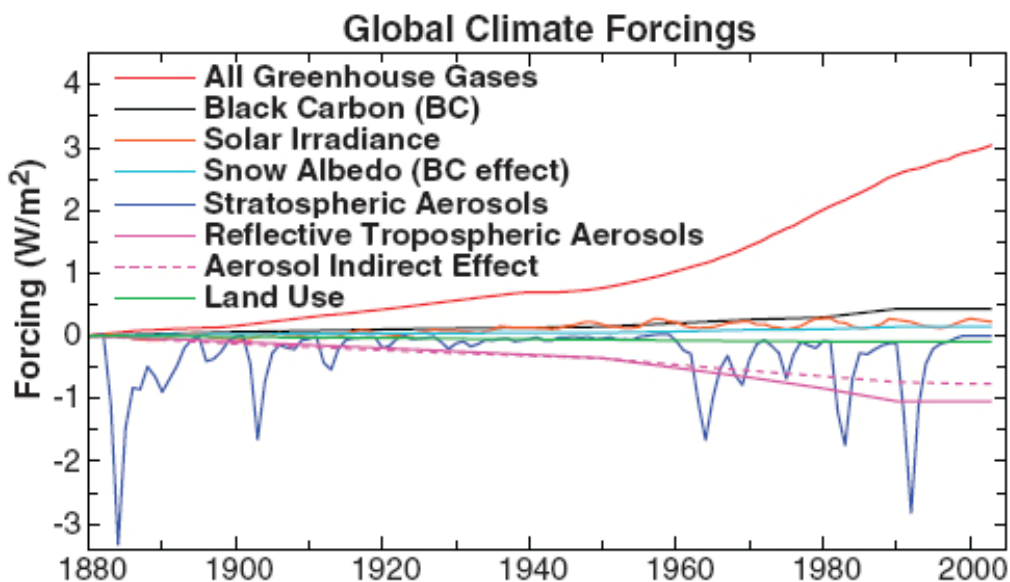


Fig. 1. Forcings used to drive global climate simulations.

Source: Hansen, J., et al., "Earth's Energy Imbalance: confirmation and Implication" *Science*, Vol. 308, 2005

This diagram shows us how different factors are affecting the climate. As you can see, the “All Greenhouse Gases” (red line) stand out among other factors. That means, carbon dioxide is not solely responsible for the climate change. There are some other gases, such as *methane* (CH_4), *nitrous oxide* (N_2O), *CFCs* (*chlorofluorocarbons*), and *ozone* (O_3).

For example, nitrous oxide, although it has less publicity than carbon dioxide, its potential to enhance global warming is far greater than CO_2 , as suggested in IPCC 2007 report. You can look at the following table (an excerpt from the original table) to compare carbon dioxide, methane and nitrous oxide:

Table 2.14. Lifetimes, radiative efficiencies and direct (except for CH_4) GWPs relative to CO_2 . For ozone-depleting substances and their replacements, data are taken from IPCC/TEAP (2005) unless otherwise indicated.

Industrial Designation or Common Name (years)	Chemical Formula	Lifetime (years)	Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$)	Global Warming Potential for Given Time Horizon			
				SAR† (100-yr)	20-yr	100-yr	500-yr
Carbon dioxide	CO_2	See below ^a	1.4×10^{-5}	1	1	1	1
Methane ^c	CH_4	12 ^c	3.7×10^{-4}	21	72	25	7.6
Nitrous oxide	N_2O	114	3.03×10^{-3}	310	289	298	153

If we look at the radiative efficiency, we shall see that the forcing done by nitrous oxide is about 300 times more than carbon dioxide, assuming the quantity of both gases are the same. Therefore, when we look at global warming, we should not focus only on carbon dioxide. There are many other factors that we must be aware of.

Activity

As introduced in the Background Information, there are several greenhouse gases that contribute to global warming. In this activity, students, in groups, will be assigned a greenhouse gas and spend a class period to research and organize information. The information must at least include:

- 1) Chemical structure of the greenhouse gas (Draw resonance state if it exists.)
- 2) Contributor(s) of the greenhouse gas;
- 3) Where it locates in the atmosphere;
- 4) Mechanism to cause global warming;
- 5) What we or others can do to decrease the amount of the greenhouse gas;
- 6) Fun facts about the greenhouse gas, if any (optional).

Teacher may either ask students to gather information on a poster board or PowerPoint presentation. In the second lesson, students will spend 10 – 15 minutes to make final modification before they present their greenhouse gases in the classroom.