Greenhouse effect? It's a misleading phrase

By Tim Ball

A lot of people talk about the greenhouse effect, but few understand what it means — and that includes most scientists. Developed to explain atmospheric processes, the term has become part of our language and is unlikely to disappear, even though it is a poor analogy. For most, it means global warming resulting from human activities. In reality, it also refers to cooling, and has been around since the formation of the atmosphere.

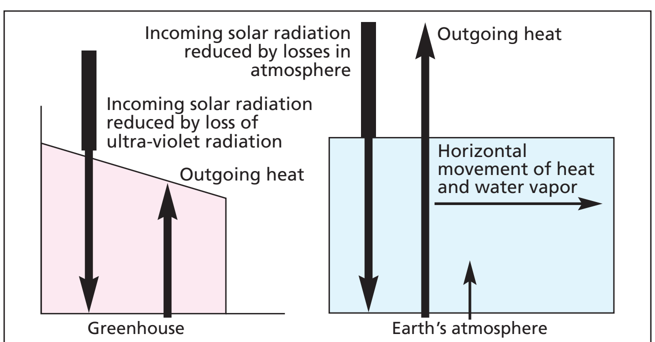
Picture your typical greenhouse. The sun provides heat and light, called incoming solar radiation (insolation) or shortwave energy. Glass acts as a filter, allowing insolation to get through, but blocking 100% of the ultraviolet radiation (you cannot get a sunburn through glass). The remainder is absorbed by surfaces inside the greenhouse and reradiated as sensible heat (heat you can feel) or longwave energy, which cannot pass through glass.

As long as sun shines and the greenhouse is sealed, heat builds up and the temperature inside rises. To reduce the temperature, you must block the sun or open vents to let heat escape. Energy entering must equal energy leaving to maintain a steady temperature; any change in this balance will cause warming or cooling.

Unlike greenhouse glass, the earth's atmosphere filters 95% of the ultraviolet radiation, which is absorbed by ozone; 5% reaches the surface. Clouds reflect 30% of sunlight back into space. Dust and water vapor absorb 19%, which directly heats the atmosphere. Only 51% of the sun's energy reaches the surface.

Theoretically, this energy is radiated up, but is prevented from escaping into space by so-called greenhouse gases, including water vapor, carbon dioxide and methane, which act as one-way valves. This trapped energy is called counter-radiation. Unlike greenhouse glass, which blocks escape, the gases only delay the escape.

In a greenhouse, heat radiates directly to the air; the earth's atmosphere is heated differently. Energy from the sun is used to evaporate water and heat the ground. Evaporated water carries the stored energy, which is released into the air when condensation occurs (which explains why temperatures rise with rain or snow). Air in contact with the ground is heated and transports heat energy upward by convection. The earth's atmosphere is mostly heated by this transported energy.



Heat energy is trapped in the greenhouse at left, while it gradually escapes to space in the earth system

Greenhouse gases delay heat escaping to space with different efficiencies. Water vapor, the most important, is over 2% of the atmospheric gas. Carbon dioxide is more effective, but accounts for only 0.035%. Methane is more effective again, but makes up a mere 0.0001%. Increase in these gases supposedly traps more heat, causing temperatures to rise.

The current global temperature is 15°C — an average of all temperatures around the globe for a year. Nobody knows what it would be without the blanket effect of the gases. Computer model estimates range from a low of –18°C to –22°C to a high of 33°C to 37°C. Problem is, all global warming predictions are based solely on these models.

Insolation is assumed to be constant; it isn't. Water vapor is assumed to be constant; it isn't. Satellites show cloud cover has increased in the past 30 years. Some even argue that carbon dioxide is not an efficient greenhouse gas. We have virtually no data for the upper atmosphere, nor do we know how much heat is actually arriving or leaving. Geothermal heat from volcanoes is not included at all.

The greenhouse effect is an annual estimate of energy balance, but energy is stored for varying periods of time. Oceans store energy for thousands of years as it circulates through the deep. Vegetation uses solar energy for photosynthesis; coal is a form of insolation stored millions of years ago.

Nature reacts to changes, but we understand very few of the adjustments. We know plants grow better in carbon dioxide-enriched atmospheres. Fuels produced from vegetable oils make good sense because they create a more natural balance between fuels burned and gases absorbed.

Carbon dioxide is the focus of attention because it is produced from burning fossil fuels. Ice from Antarctica, which has bubbles of gas trapped over the past 160,000 years, is used as the strongest argument for carbon dioxide as a warming greenhouse gas. However, indications are that temperature changed before carbon dioxide levels, not the other way around. Ice 160,000 years old is so compressed you need 8 meters to yield one reading, and 8 meters represents at least 10,000 years. Half of Canada was still under a huge ice sheet 10,000 years ago — other parts were under huge glacial lakes. In other words, it keeps scientists guessing.

Since we don't live in a typical greenhouse, the term "greenhouse effect" is a poor analogy. Ironically, in this age of information and certainty, we have few facts and limited understanding concerning this particular issue. You can, however, take some small comfort knowing that science doesn't know much more than you do.

Tim Ball, retired professor of climatology, lives in Victoria, B.C. He has a special interest in the impact of our changing climate