DOES THE ENHANCED GREENHOUSE EFFECT THREATEN OUR FUTURE?

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The world is warming up. It is widely assumed that we understand the causes, that the warming will have catastrophic consequences unless it is halted, and that we must immediately start to tackle this problem. However, when the facts are examined closely it seems there may be less justification than one might think for making some of these assumptions. This argument is summarised by Robert C. Balling Jnr. in The True State of The Planet, (The Free Press, 1995).

The earth and the moon are the same distance from the sun and each receives the same amount of heat per square metre of surface. The average surface temperature of the earth is 15^{o}C, the average surface temperature of the moon is minus 18^{o}C. The temperature difference is explained by the earth's atmosphere - the blanket of gases that surrounds our planet and that produces the greenhouse effect. The moon has no atmosphere.

The greenhouse effect works as follows. The sun radiates energy substantially as visible light of wavelength 0.4 to 0.7 micrometres (millionths of a metre). Our atmosphere is transparent to visible light and to the shortest wavelength infrared radiation from the sun which reaches and heats the surface of the earth. The earth radiates the heat energy back into the atmosphere in the form of longer wavelength (4-100 micrometre) infrared radiation. Some of this outgoing infrared radiation is absorbed in the atmosphere. Water vapour and carbon dioxide (CO_2), normal constituents of the atmosphere, strongly absorb infrared radiation, which warms the lower atmosphere and keeps the earth's surface hotter than it would otherwise be. Increasing the concentration of greenhouse gases intensifies the warming effect. Since 1850, human activities, mainly burning of fossil fuel and deforestation, have increased the atmospheric concentration of CO_2 by 25% - from about 285 parts per million (ppm) to 356 ppm.

Over the past 100 years many other gases that produce greenhouse warming have also been added to the atmosphere. Methane concentration has increased from 0.75 ppm in 1800, to 1.7 ppm today, mainly due to agricultural activities (principally from rice paddies and farting cattle). Nitrous oxide concentration increased from 285 parts per billion (ppb) in 1850 to 310 ppb in 1990. Chloroflourocarbons (CFCs) are also being released to the atmosphere in low concentration but are powerful greenhouse gases.

The overall effect of the several greenhouse gases may be approximated by calculating the 'equivalent carbon dioxide' value, i.e. how much CO_2 alone would be required to produce the same effect as all the greenhouse gases found in the atmosphere. Equivalent CO_2 levels increased from about 290 ppm in 1850 to 440 ppm in 1994.

Many scientists predict that the equivalent CO_2 value will double by the middle of the next century, compared to 1850 values. Scientists use computer models of the atmosphere to predict the resulting climate changes. These complex models push the largest computers to the limit. Despite efforts to-date however, many scientists admit that their models are still fairly primitive. It is also sensible to be wary of weather predictions for the year 2100 considering the known unreliability of weather predictions for next week.

A global warming is now predicted by the year 2100 by an amount in the range 1^{o}C to 3.5^{o}C, with a 'best' estimate of about 2^{o}C. A 2^{o}C warming would raise sea-levels by about 50 cm over

1850 levels and this would place about 10 million people at risk from flooding. The models also predict increased global rainfall, but soil moisture levels will decrease in many areas as the warming will increase evaporation. Climate predictions about wildfires, droughts, and storms are also derived from the model results.

According to Balling, the models contain many weaknesses, for example the role of oceans in absorbing CO_2 and storing and transporting heat is not adequately included. Also, clouds play a vital role in maintaining the energy balance of the earth, and cloud factors are particularly questionable in the models. The models don't adequately handle the effect of non-greenhouse gases that are also being added to the atmosphere and that have strong local and regional cooling effects. The models are improving all the time but the outputs from future models may look different from today's results.

Measurements have shown that the mean annual temperature of the earth has increased by $0.54^{o}C$ since 1881, and we know that equivalent CO_2 levels rose by 40% over that period. When the warming trend is analysed it is noted that nearly 70% of the warming occurred in the first half of the record, while the bulk of the greenhouse gas build up clearly occurred in the second half of the record. An obvious test of the computer models is to see if they can accurately simulate the observed temperature rise since 1881 when the 40% CO_2 increase is factored in. Until very recently the computer models were off by a factor of 2, concluding that we should have had a warming of at least $1^{o}C$ over the period 1881 to 1993.

But is the observed increase in temperature of $0.54^{o}C$ over the last 100 years really attributable to increased greenhouse gas emissions? Balling argues that factors such as volcanic dust in the atmosphere and the effects of a variable sun can account for much of the temperature increase. Furthermore, satellite-based lower atmosphere monthly temperature measurements are available for the period 1979 to the present. These data reveal a cooling of $0.13^{o}C$ over this period. However, it was only recently realised that the satellite measurements were not corrected for the fact that the satellites are slowly falling back to Earth. The application of these corrections will probably eliminate the previously measured cooling effect.

Measures have been proposed to restrict greenhouse gas emissions, including moving to lower-carbon-based fuels, improving energy-efficiency, reversing deforestation, etc. But Balling argues that even with these controls in place, the models still predict 65% of the temperature increase that would occur in the absence of controls.

Balling presents enough evidence to demonstrate that much that has been said about the enhanced greenhouse effect is over-stated. However, his bottom line appears to be that until we know more we should say little and we should refrain from taking action because it will be ineffectual. I cannot agree. CO_2 and other greenhouse gases are building up in the atmosphere and the world is warming up. At least some of this warming is attributable to the greenhouse gases and probably more of it than Balling suspects - remember the satellite temperature data. Therefore, let us take measures to reverse the buildup of greenhouse gases, but let us stop waving placards declaring 'The End is Nigh'.

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