The Editor
Letter in response to Neville Hughes
Imlay MagnetMick Harewood & Sue Norman 27.02.2011

Neville Hughes (Magnet letters 24 Feb 2011) does not seem to have an understanding of the physical basis of the atmospheric greenhouse effect. Most of the molecules in the atmosphere (nitrogen and oxygen) are transparent to visible light and to infrared light. They let in sunlight, which warms the earth s surface, and let heat escape in the form of infra-red radiation.

Greenhouse gases like CO2 and water vapour are transparent to visible light but relatively opaque to infra-red radiation. They prevent some of the heat escaping back to space, so the earth s surface is warm enough to be habitable. This is the so-called natural greenhouse effect.

Carbon dioxide has increased from about 280 parts per million (ppm), prior to the industrial revolution, to about 390 to 400 ppm today. This is the fastest rate of increase in CO2 concentration over the entire known record of the earth, measured by ice cores or coral cores or any other means.

There has been a corresponding increase in the average surface temperature of the earth over this time of about 0.8 to 1 degree C.

The relative abundance of water vapour and CO2 in the atmosphere raises the intriguing question of why increasing atmospheric CO2 is thought to be driving global warming but water vapour, an equally potent but far more abundant greenhouse gas, does not. The answer lies in the different physical properties of these two compounds.

CO2 can only exist as a gas at the temperatures and pressures that occur naturally on earth. As a solid (dry ice), it is unstable and sublimates directly into a gas at normal atmospheric pressures.

Water can exist as a solid, liquid or gas at natural temperatures and pressures. An increase in temperature will increase the proportion of water vapour that can remain in the air. At the lower temperatures and pressures in the higher atmosphere, water vapour turns into liquid droplets of colloidal size (clouds), which increase the amount of solar radiation reflected directly back into space. Therefore, water has the effect of both increasing and decreasing the greenhouse effect of a rise in atmospheric CO2.

Another effect of water is to transport heat from the earth s surface to the higher parts of the atmosphere through the heat-pump effect of changing phases. When water evaporates at the earth s surface, an extra amount of heat (called the latent heat of vaporisation) is absorbed by the molecules. When these same molecules condense to form clouds, this heat is released, much higher in the atmosphere. Therefore, a higher proportion of the heat will be radiated out into space.

Thus water vapour increases the greenhouse effect because it is a potent and relatively abundant greenhouse gas but it decreases the greenhouse effect by increasing the albedo (reflectivity) of the earth (from clouds or snow) and by transporting heat from the surface to the clouds.

Water vapour can be temporarily removed from the atmosphere by condensing or freezing. CO2 can only be removed from the atmosphere by chemical change, such as in photosynthesis or coral formation. The half-life of water vapour is estimated at about 8 days, whereas the half-life of CO2 is in decades.

Neville Hughes quotes costs of electricity from coal, gas, nuclear and renewables but does not mention the external costs of atmospheric pollution from fossil fuels, or the cost of secure storage of nuclear waste for about 280,000 years.

Australia is extremely vulnerable to global warming because we are starting with a relatively hot and dry continent with an erratic rainfall distribution and fire-prone vegetation. Earlier CSIRO modeling showed that doubling atmospheric CO2 would decrease the frequency of small rainfall events but increase the size and frequency of very large storm events.

It is in the interest of all Australians to encourage the successful negotiation of international agreements which reduce atmospheric greenhouse gas emissions. It is impossible to do this from a position of being the highest per capita greenhouse gas emitters in the developed world. Putting a price on greenhouse gas emissions encourages energy conservation and will stimulate investment in cleaner technologies for energy production and storage.

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