

1. Amazing carbon dioxide

Why is a trace gas, such as carbon dioxide, (only 0.04% of air) referred to as the control knob of the Earth's thermostat? How can a small change in carbon dioxide (CO₂) content make a critical difference to the actual global surface temperature of the Earth? Nitrogen and oxygen comprise the bulk of the atmosphere but do not absorb the earth's heat radiation. Although water vapour and clouds together absorb 75% of the Earth's heat radiation¹ they cannot determine the temperature of the atmosphere. Water vapour and clouds depend on temperature and air circulation in ways that CO₂ does not. They condense and cannot maintain a *temperature structure* for the atmosphere. CO₂ accounts for 80% of the non-condensing gases that maintain the temperature structure of the Earth and acts as the control knob of the Earth's thermostat. It controls the amount of water vapour and clouds.

CO₂ absorption is strong as it absorbs in the frequency range where the Earth's heat emission (Planck field) is strongest. The instant *doubling* of CO₂ content (e.g. from pre-industrial 280 ppm to 560 ppm) would reduce the Earth's emission of heat radiation to space by about 4 Watts for every square metre of the Earth's surface. CO₂ absorption is that strong. The atmospheric temperature must be raised to radiate an extra 4 Watts per square metre to restore the Earth's energy balance. The increased surface temperature of 1.2°C from the instant doubling of CO₂ content allows an increased water vapour content by maintaining a constant relative humidity. The extra water vapour increases the overall absorption by water vapour itself raising the surface temperature further by about 1.2°C. The total increase is about **3°C** when all feedbacks are included.

Although the temperature of Mars, Earth and Venus are affected by their distance from the Sun and by the sunlight they reflect to space, their surface temperature is strongly determined by their atmospheric density of carbon dioxide and water vapour as shown in the table:

	Mars	Earth	Venus
CO₂ density	very low	Significant	extremely high
Water vapour	little (0.03%)	global average 0.4%	little left (0.002%)
Average surface temp.	minus 50°C	15°C	460°C
Greenhouse effect	minus (5C°)	significant (+33C°)	“runaway” (+400C°)

Table 1 - Surface temperature is strongly determined by the atmospheric density of carbon dioxide and water vapour

Figure 1 gives the climate impact for increasing concentrations of CO₂:

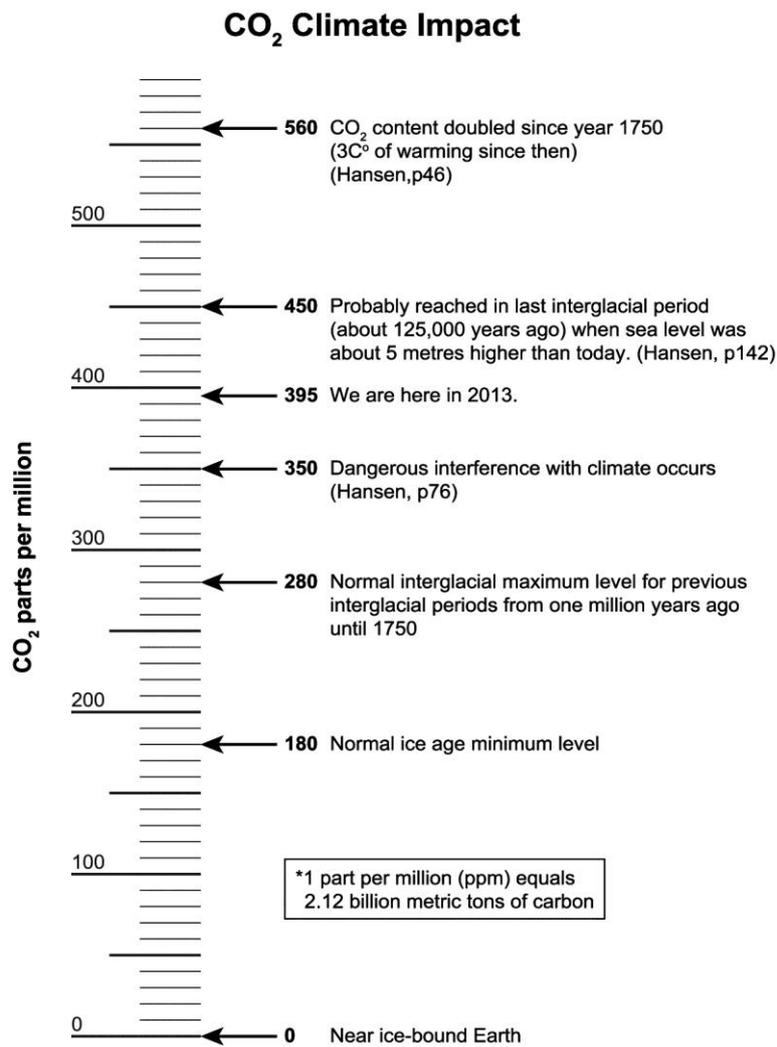


Figure 1 – Climate impact for increasing concentrations of CO₂

5. References

1. Lacis, A. A., G. A. Schmidt, D. Rind, and R. A. Ruedy, 2010: *Atmospheric CO₂: Principal control knob governing Earth's temperature*, **330**, 356-359, doi: 10.1126/science.1190653
2. Lenton, T. M., (2000). Land and ocean cycle feedback effect on global warming in a simple Earth system model, *Tellus*(2000), 52B, p1169.
3. Intergovernmental Panel on Climate Change (IPCC) (2001) *Third Assessment Report – Climate Change 2001: The Scientific Basis*, Chapter 6, Section 6.3.5 Simplified Expressions, Table 6.2, Cambridge Univ. Press, New York.
4. Chamberlain, Joseph W. (1978). *Theory of Planetary Atmospheres*, Academic Press, New York, p11.
5. Hansen, James, (2009). *Storms of My Grandchildren*, Bloomsbury Publishing, London, pp46-47.
6. Myhre, G., et al, (1998) *New estimates of radiative forcing due to well mixed greenhouse gases*, *Geophysical Research Letters*, Vol. 25, No.14, p2717.

Document created: 27/03/2013

Last modified: 17/07/2013

Author: Robert Ellis, *BSc(Hons)*

Key phrases: global warming, climate change, global warming articles, greenhouse ,greenhouse effect, what is global warming, effects, causes of global warming, effects of global warming, ipcc results, storms, tropical storms, severe thunderstorms, extreme weather, change climate global, temperature increase co2 ,carbon dioxide emissions, equation, formula, for students ,global warming equation/formula derived , global temperature and storm power increase calculated, global warming debunked, causes, effects, facts are given.