Sent: Thursday, 4 June 2009
To: Economics, Committee (SEN)
Cc: Joyce, Barnaby (Senator)
Subject: Reject CPRS For Basic Science of CO2 Reasons
Attachments: BASIC SCIENCE CO2.doc

Carbon Pollution Reduction Scheme

The changes made by the Senate must not just delay any ETS but reject every ETS

outright because :

a. CO2 has already done its job in making the earth about 14 degrees warmer than
it would be without CO2, otherwise it would be uninhabitable.

b. ETS of any kind would therefore cost jobs, increase electricity bills,
and for the developing world they would increase poverty. BUT DO NOTHING ABOUT THE EARTH'S TEMPERATURE. THIS HAS ALREADY BEEN DONE.

The Senate must understand what CO2 can do, and what CO2 has already done before
finalising the economics.

The attached document explains in a simple way the basic physical processes of CO2 trapping energy. This is objective pure science based on accurate Infrared Spectroscopy data and was first done by mental arithmetic in an hour or so. It is not computer modelling. A computer has been used to draw the graphs, and make the document transferable electronically.

ABSTRACT

The literature available to the public such as newspaper articles and the IPCC 2007 report do not explain the how atmospheric CO2 traps the earth's outgoing infrared radiant energy. Using accurate infrared spectroscopy data, combined with basic high school physics it can be shown that CO2 has played a very important role in making the earth a habitable place by trapping almost as much
of this outgoing radiation as it can. CO2 can only trap infrared radiation in a
limited range of frequencies and is transparent at other infrared frequencies. Do not think of atmospheric CO2 as a blanket, but as a blanket with huge holes that always align and let most of the energy out.

Yours sincerely,

Dr Lance McCarthy,

The Basic Physical Science of Resonant Trapping of the Earth's outgoing Infrared Radiant Energy by Atmospheric CO_2

Dr Lance McCarthy

Honorary Research Fellow

Physics

Flinders University

10th June 2009

Abstract

The literature available to the public such as newspaper articles and the IPCC 2007 report do not explain how atmospheric CO_2 traps the earth's outgoing infrared radiant energy. Using accurate infrared spectroscopy data, combined with basic physics it is easy to show that CO_2 has played a very important role in making the earth a habitable place by trapping some of this outgoing radiation. But CO_2 can only trap infrared radiation in a limited range of frequencies and is transparent at other infrared frequencies. Do not think of atmospheric CO_2 as a blanket, but as a blanket with huge holes. Adding more CO_2 is like adding other blankets with holes that align, and this will still let most of the energy out. The current 380 ppm of CO_2 has contributed to a rise in the earth's temperature of about 14.4^0 C, compared with what it would be without any CO_2. Raising the CO_2 level to 760 ppm can only raise the temperature by a further 0.6^0 C. When we examine the temperature changes which were contributed to by CO_2 at lower levels, such as those in 1959 we see that the then 315 ppm would have contributed about 0.4^0C less than at present. The Vostok ice core data shows that as the CO_2 levels varied between 190 ppm and 270 ppm, temperatures varied by 10^0 C. The temperature variations calculated here, that relate to these levels are about 12.3^0 C (at190 ppm) and 13.7^0 C (at 270 ppm), just a 1.4^0 C change. This shows that other factors must have made contributions to the temperature variations, apart from those contributed by varying CO_2 levels. The temperature rise of 0.6^0 C that will occur if the CO_2 level increases to 760 ppm in 200 years represents only 0.03^0 C per decade. Increased CO_2 levels can only cause a small temperature rise. Emissions trading schemes would cause energy costs to rise, poverty to increase and would delay the recovery of the world's economy thus destroying jobs, but cannot play a major role in controlling the earth's temperature. The whole world must reject emissions trading schemes.

Footnote : There is just one page of text, followed by nine diagrams. Superscripts are used to indicate which diagrams will help people visualise what is happening, especially those who are not familiar with the basic science ; and give all readers access to some of the important infrared spectroscopy data..

The Basic Physical Science of Resonant Trapping of Energy by Atmospheric CO_2

The earth receives heat by electromagnetic radiation from the sun whose surface is ~ 6000^0 K, at frequencies in and near the visible spectrum[1]. Heat produced by humans is small. The earth can only lose energy by infrared radiation[1, 2], and has adjusted its temperature to about 17^0C (290^0K) so that its outgoing radiation is equal to that coming in from the sun. There is no conduction or convection to outer space. The outgoing radiation is in the frequency range 100-1800 conventional infrared units, with maximum output at frequency 600 units on a roughly bell shaped curve. When the energy trapped by the atmosphere (or that coming in from the sun) varies, the surface temperature varies to keep the balance. The outgoing radiant energy depends on the fourth power of the temperature in ^{O}K (Stefan's Law). So an increase of temperature 3^0 from 300^0K–303^0K (ie. by 1%), increases the energy radiated by 4%. Increasing temperature by 7.5^0 gives 10% more, & by 15^0 gives 20% more radiation.

An atmospheric carbon dioxide molecule consists of atoms O – C – O whose masses are connected by electric forces acting as springs. This creates a vibration-rotation system, which like a tuning fork, a bell or a radio receiver has resonant frequencies. The quantum nature of matter increases the number of resonances ; thermal velocity broadens them. The earth's outgoing radiation excites these resonances ; CO_2 does trap energy, otherwise we would be much colder. There are about 120 overlapping resonances forming an absorption band having frequencies between 585-750 units[3, 5]. For the rest of the earth's outgoing radiation spectrum, CO_2 is transparent[4]. Do not think of atmospheric CO_2 as a blanket, but as a blanket with huge holes. More CO_2 acts like another blanket with holes that align. Most of the energy still gets out.The maximum amount of the earth's total outgoing radiation that CO_2 can trap is about 20%, causing the temperature to be 5% or 15^0 higher than without any CO_2.

The worst case scenario[6] would be if the current 380 ppm is trapping half what CO_2 can, i.e. 10% of the total. This would require the earth's temperature to have risen to be 7.8^0 above what it would have been without any CO_2. Then doubling the CO_2 to 760ppm would trap a further 5% of the out-going radiated energy, increasing the temperature by another 4.1^0. If this increase of 4.1^0 took place over 200 years it would represent 0.2^0 per decade. Fortunately accurate infrared spectroscopy data proves this worst case scenario to be wrong. Yes, in science data can prove that something is wrong.

We look at accurate Infrared Standard Data[5]. A cell just 1 metre high, containing CO_2 at pressure $1/3800^{th}$ of an atmosphere (which is the equivalent of 260 ppm) traps 100% of the radiation between 667–670 units & 1%–50% of the rest in the resonance range between 585–750 units, the only range in which CO_2 can absorb. Going up in the atmosphere by 1000 metres with 260 ppm would increase the absorption for all frequencies between 575–750 units to over 90% at just 1000 m above the earth.

We can be sure that 380 ppm of CO_2 now traps more than 95% (~97%) of the outgoing radiant energy from the earth[7, 8] in the frequency range that CO_2 can, and has contributed to the earth's temperature being 14.4^0 C higher[9] than it would be without any CO_2. Increasing the CO_2 level to 760 ppm can increase the earth's temperature by a maximum of 0.6^0. If this takes 200 years it is 0.03^0 per decade. We have plenty of time to develop major safe clean sources of energy such as Plasma Fusion energy.

Water in the atmosphere does not consist only of isolated individual molecules but groups of very large numbers of molecules. Just as in a microwave oven, these molecules resonantly absorb electromagnetic energy and share it with their neighbours. For this reason H_2O is able to trap a much larger amount of the earth's outgoing radiation[3] than CO_2. Methane (CH_4) is a molecule with 5 atoms. Therefore methane has many more resonant modes and thus it can trap more energy than CO_2 can.

Burning coal causes particulate pollution which plays a role in reflecting energy coming in from the sun, and in trapping energy going out from the earth. In addition, particulate pollution may also be reducing rainfall. Reduction coal particulate pollution is also very important because in places like China this kills hundreds of thousands of people every year from lung problems. In the USA, estimates are that it kills more than 40,000 people per year. However energy, especially electrical energy is essential to produce our water, food, transport and to repair damage caused by naturally occuring changes to the environment, not human induced changes. Energy saves lives ; less energy means more poverty. Vast amounts more of energy will be needed for the survival of human beings.

Using simple basic physics and accurate infrared spectroscopy data we can understand how current atmospheric CO_2 is already trapping almost as much of the earth's outgoing radiation as CO_2 can. Increased CO_2 levels can only cause a small temperature rise. Emissions trading schemes would increase energy costs, increase poverty, delay the recovery of the world's economy and destroy jobs but cannot play a major role in controlling the earth's temperature. The whole world must reject ETS.

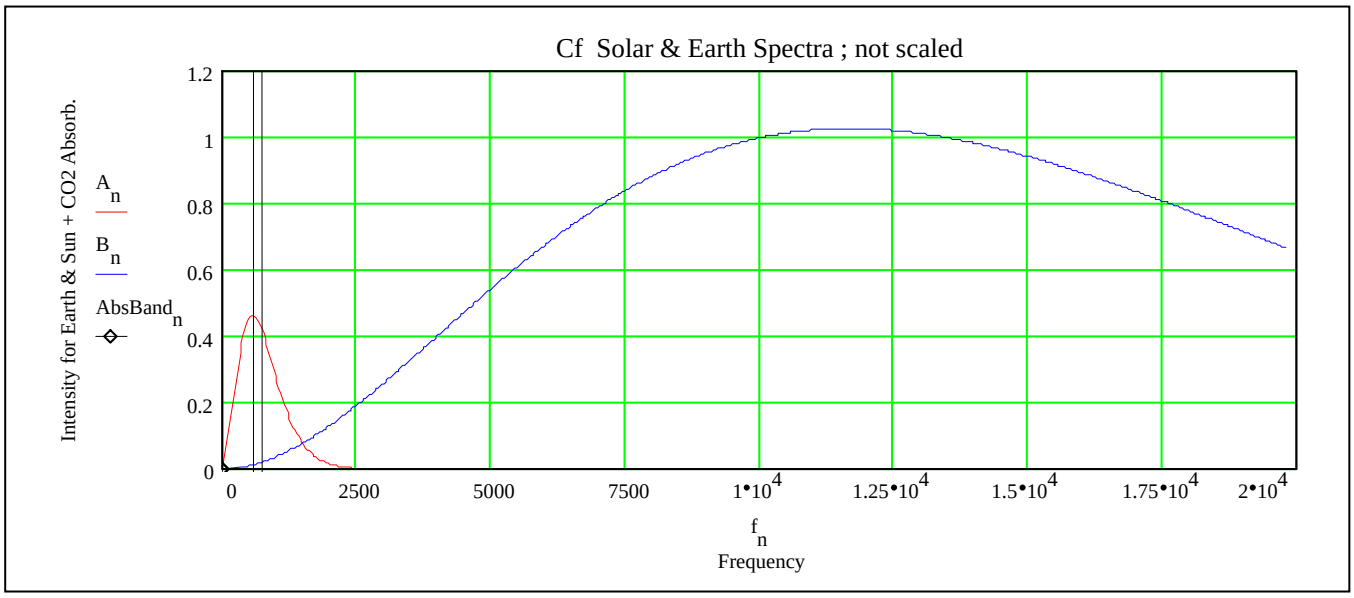

Fig. 1 **General description of the Sun's radiation spectrum** which covers almost all the frequency range on the graph, **compared with the Earth's infrared radiation spectrum** at the left. The vertical scales are arbitrary, with the Earth's intensity magnified so that the frequency range can be seen. The frequency units are standard infrared units (cm^{-1}) ; thus at the point 1.25 x 10^4 the wavelenth is about 0.66 microns at the red end of the visible spectrum. The two vertical lines around 650 units define the spectral range in which CO_2 can resonantly absorb the Earth's outgoing infrared radiation.

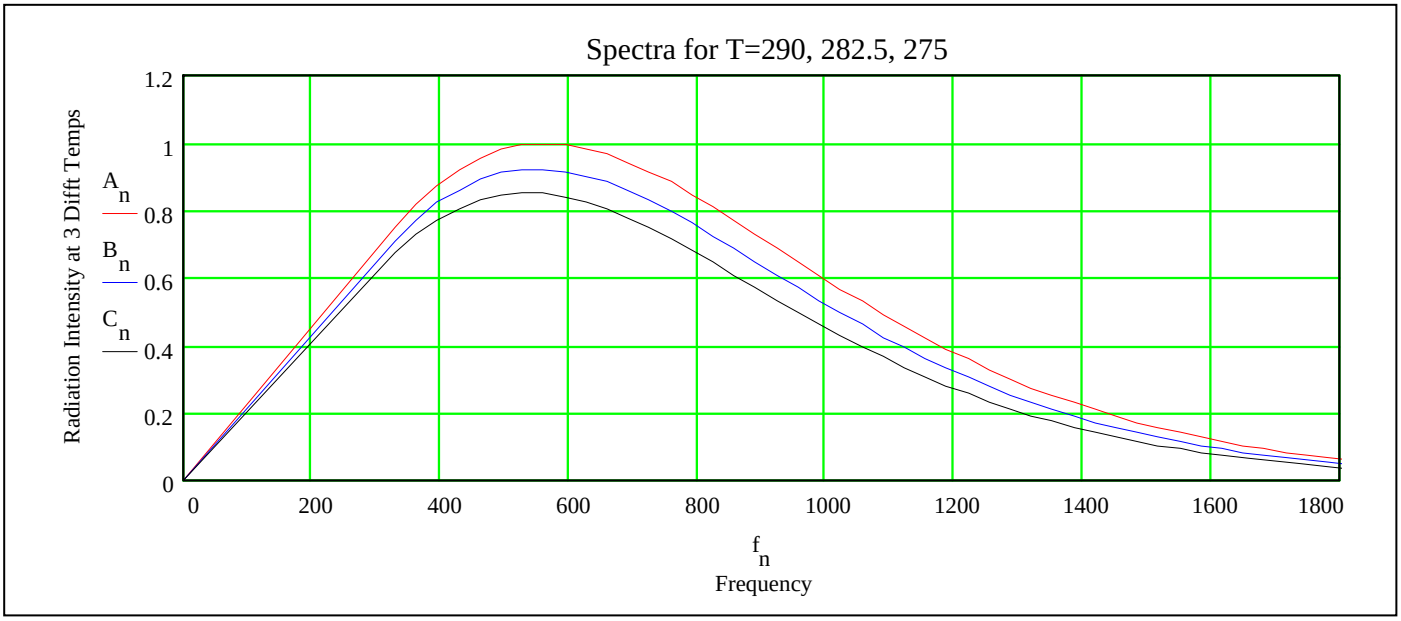

Fig. 2 **Expanded view of the Earth's outgoing infrared radiation** at 3 different temperatures, which for the calculations made using Stefan's Law are in degrees K.
290 K = 17 C ; 282.5 K = 9.5 C and 275 K = 2 C.
The area under each curve is a measure of the total radiated power at that temperature. For the decrease in temperature by 15 C from 17 C to 2 C, which is 15 degrees or approximately 5% of 290 K, calculating the area under the curves shows that the radiated power decreases by almost 20%. This means that if the Earth's temperature was 2 C without CO_2, and the current added CO_2 was the principle means for trapping the earth's outgoing energy, it would have to trap 20% of that energy to bring the temperature up by 15 C to the current 17 C.

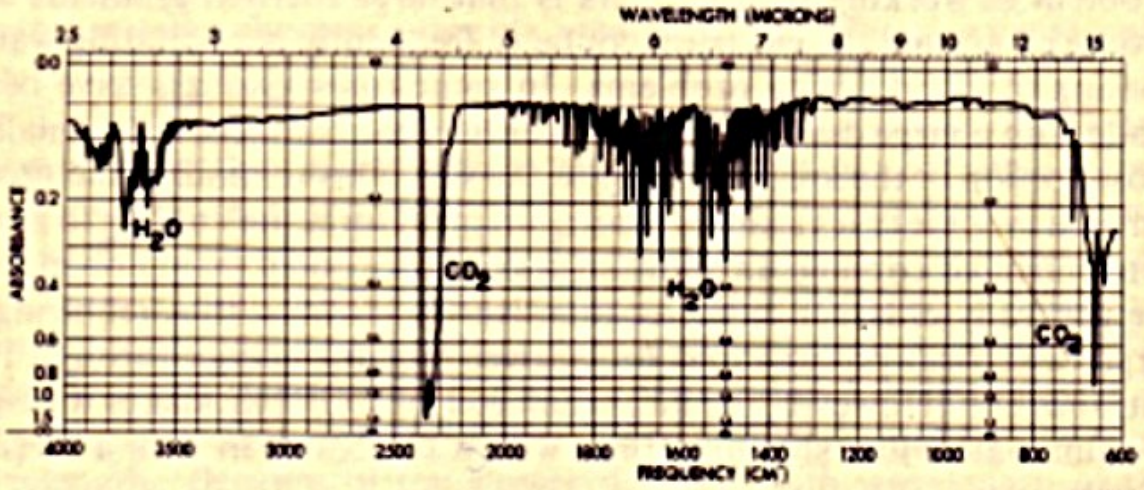

Figure 2-7. Atmospheric absorption bands.

both before and after the sample spectrum. Care must be exercised in regions where there are atmospheric absorption bands. Depending on the accuracy desired, it may be necessary to purge the optical path of water vapor and CO_2 in order to do quantitative analyses. In fact, even for qualitative analyses on moderate- or high-resolution instruments, it may be necessary to purge the optical path, unless the analyst can work in spectral regions free from atmospheric bands. Figure 2-7 shows the absorption spectrum of air of roughly one-meter path length. The regions most troublesome because of atmospheric absorption are: 3740 cm^{-1} (2.67 μ; H_2O), 2350 cm^{-1} (4.25 μ; CO_2), 1820–1330 cm^{-1} (5.5–7.5 μ; H_2O), and 670 cm^{-1} (14.98 μ; CO_2).

Fig 3 Atmospheric absorption bands in Infrared Spectroscopy

Fig 2-7 from "IR Theory and Practice of Infrared Spectroscopy" by Alpert, Keiser & Szymanski, Plenum Press (New York 1970).

Note especially that :

1. "Fig 2-7 shows the absorption spectrum of air of roughly **<u>one metre path length</u>**."
2. Here for the range of frequencies between ~ 600 and ~ 2000 (cm^{-1}, which is the standard IR freq. unit), there is absorption in CO_2 only in the region around 580 – 760 units. As seen in Fig 2, the Earth's outgoing infrared radiation is in the range about 100 – 1800 units. The absorption in CO_2 in the region around 580 – 760 units is shown in more detail in Fig. 5.
3. There is a much broader absorption band for water (H_2O) between 1300 – 2000 units.
4. The strong absorption band for CO_2 between 2200 – 2400 units does not overlap with the Earth's outgoing infrared radiation spectrum, so this cannot trap the earth's outgoing radiant energy, and therefore it does not need to be considered for the temperature variations.

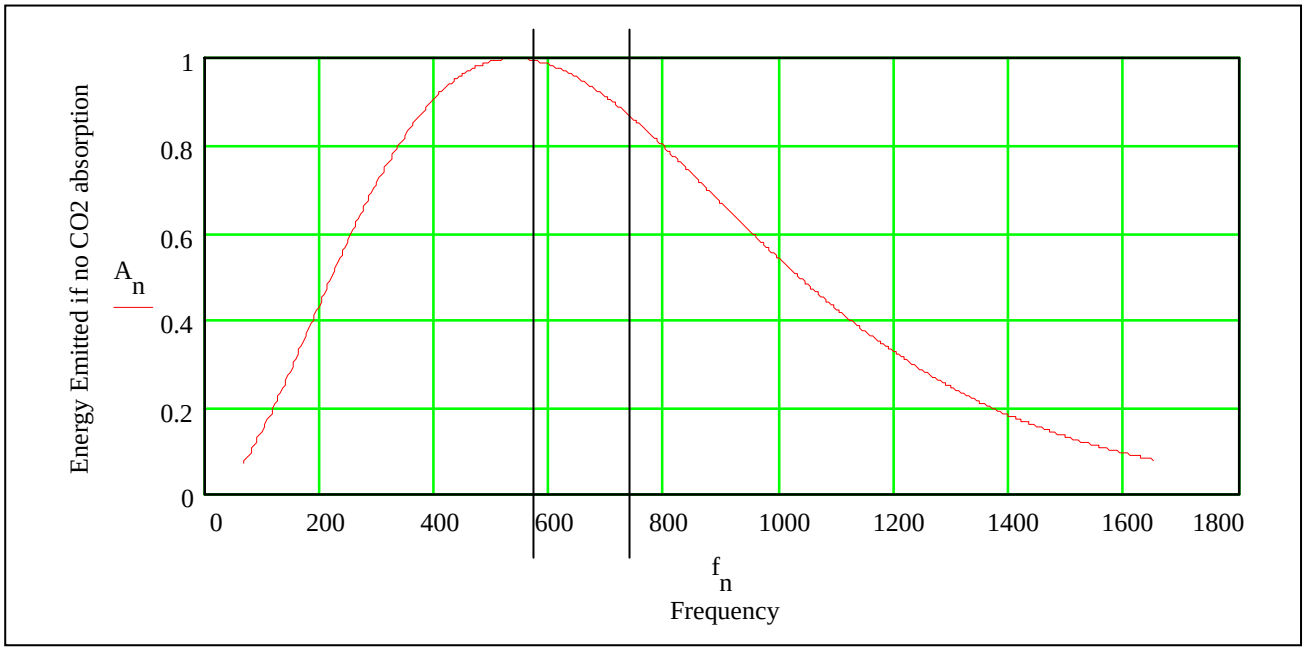

Fig 4. The character of the spectrum of the earth's outgoing infrared radiation for a surface at 27^0 C, plotting the intensity as a function of frequency in standard infrared units cm^{-1}. **Vertical lines define frequencies where CO_2 traps.**

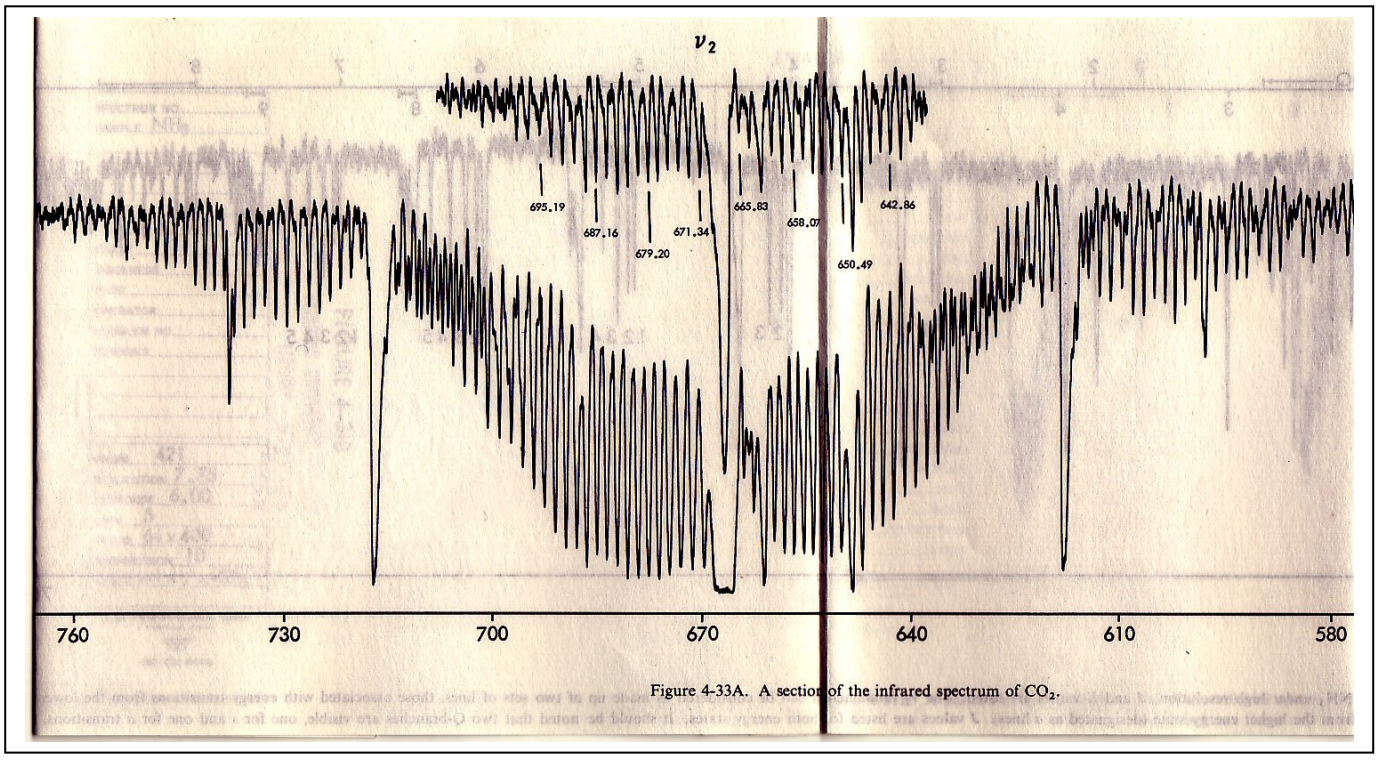

Fig 5. Part of the CO_2 absorption spectrum as published in "Theory and Practice of Infrared Spectroscopy" by Alpert, Keiser & Szymanski in 1964.
Note : 1. There is no vertical scale. 2. There is no information on "cell size" or pressure of CO_2 in the cell.
3. Resolution is not stated

The important pieces of information to be gained from this graph are :

(a). This section with freq in the range ~ 585 – 750 (cm^{-1}) is the only part overlapping with infrared radiation from the earth at ~ 290^0K that CO_2 can absorb.
(b) in the lower trace the pressure that was used appears to completely absorb the radiation at ~ 667 – 670, (c) in the upper trace, presumably taken at lower pressure ($1/5^{th}$?), the absorption from about 610 – 740 is of the order of 15% of that at 667 – 670, so increasing the density of CO_2 increases the absorption by about 5 times to about 75%.

A more detailed 1986 book "Handbuch of Infrared Standards" Guelachvili G & Rao KN, takes several pages to present this part of the absorption spectrum with high resolution and shows that in just 1 metre, 0.2 Torr = $1/3800^{th}$ atmosphere (equiv to 260 ppm) of CO2 traps ~ 100 % between 667 – 670 ; 40% between 616-618 and 50% at 721. Combining this information with the graph above we can see that 380 ppm of CO_2 in the <u>whole</u> atmosphere (not just 1m) would trap almost all the outgoing energy that CO_2 can, therefore increasing the atmospheric CO_2 levels cannot have a further large effect on the earth's temperature, only ~ 0.6^{0}.

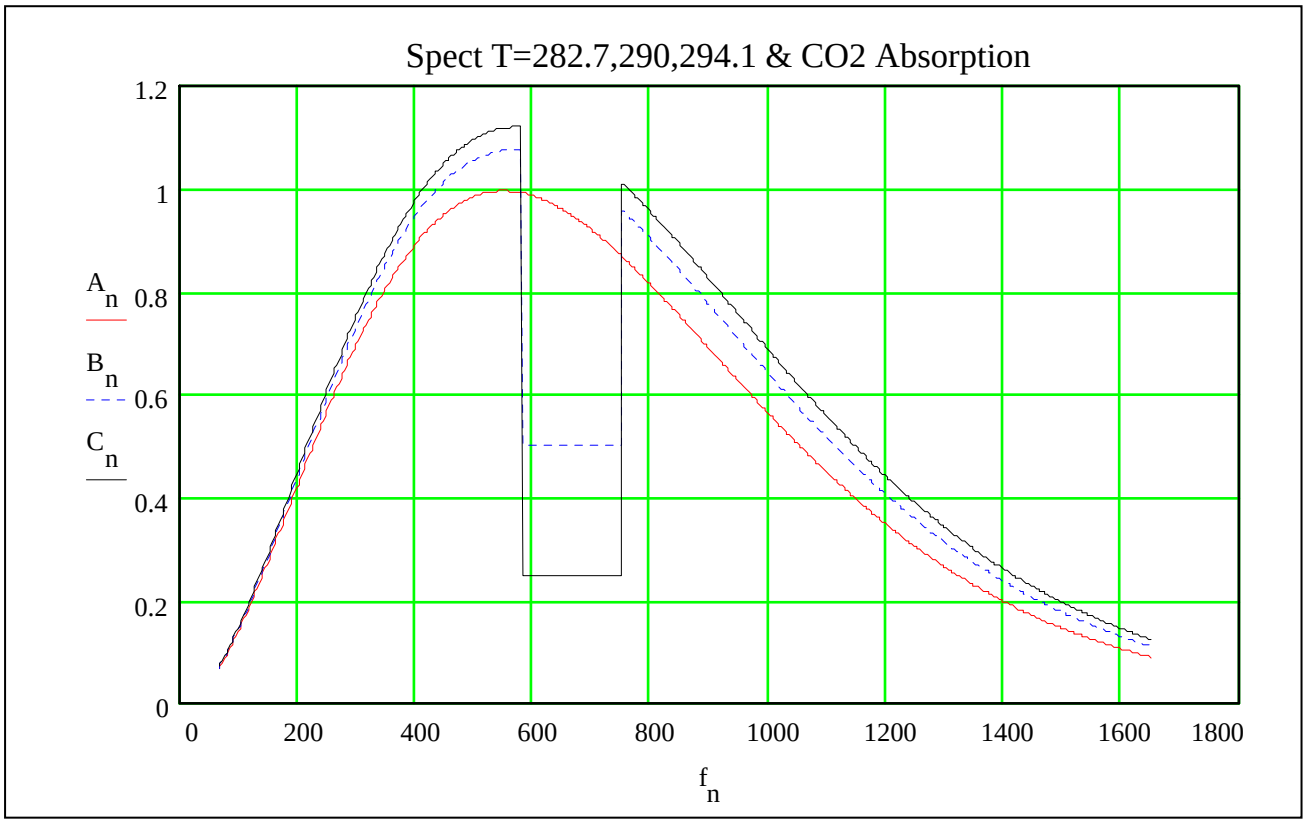

Fig 6. The worst case scenario is if the current 380ppm of CO_2 traps 50% of the energy that CO_2 can Comparisons of Black body radiation :

A. At 9.75^0 C (282.75^0 K) with no CO_2

B. At 17^0 C (290^0 K) if 380 ppm of CO_2 traps 50% of what it can in its absorption band

C. At 21^0 C (294^0 K) if an extra 380 ppm of CO_2 traps a further 50% of what remains, that is 75% of what CO_2 can trap in its absorption band.

In each case the total radiated energy is the same and in balance with the sun's incoming energy.

We see that for this worst case scenario the extra 380 ppm would cause a temperature rise of 4^0C, and that the temperature would be 7.25^0 lower if we did not have CO_2 trap energy.

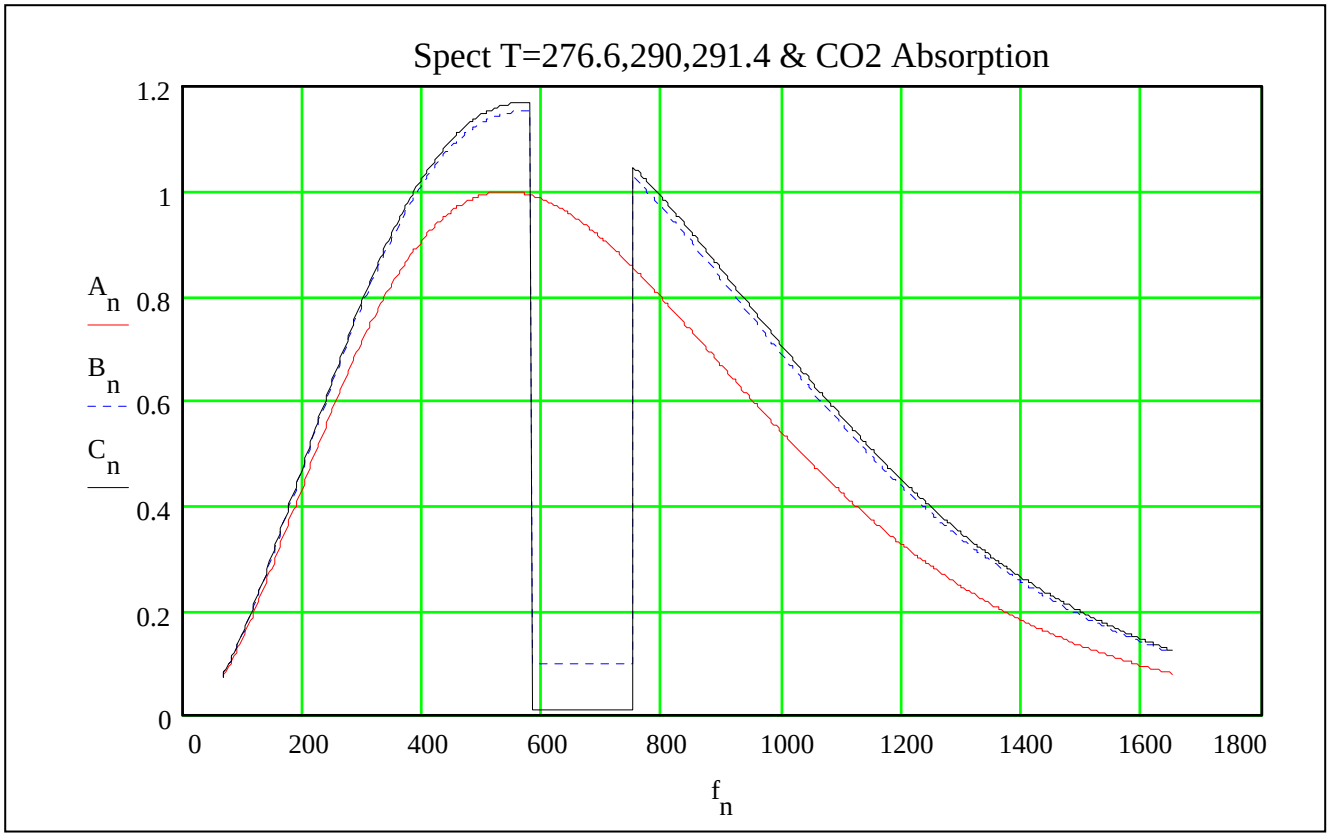

Fig 7 The temperatures if 380 ppm CO_2 traps only 90% ; and then 760 ppm would trap trap 99%
(a). No CO_2, T = 3.6 degrees C (276.6 K) ; (b). CO_2 380 ppm T = 17 degrees C (290 K)
(c). CO_2, 760 ppm T = 18.6 degrees C (291.6 K).

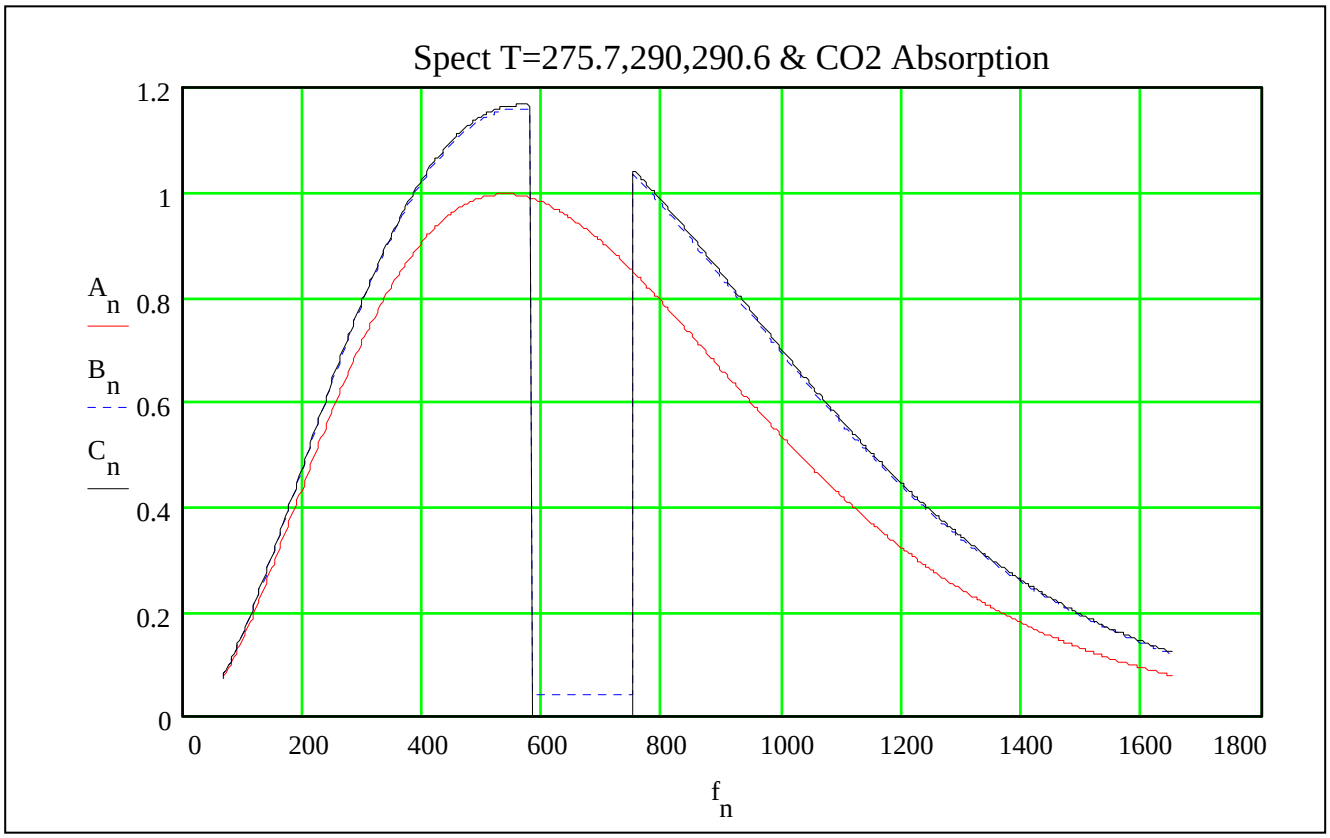

Fig 8. The realistic situation. 380 ppm CO_2 traps 96% ; then 760 ppm would trap trap 99.84 % (a). With no CO_2 : T = 2.7 degrees C (275.7 K) ; (b). with 380 ppm CO_2 : T = 17 degrees C (290 K) ; (c). with 760 ppm CO_2 : T = 17.6 degrees C (290.6 K). This gives a 0.6 degree rise in temperature from the present, in order to keep the outgoing radiant energy the same.

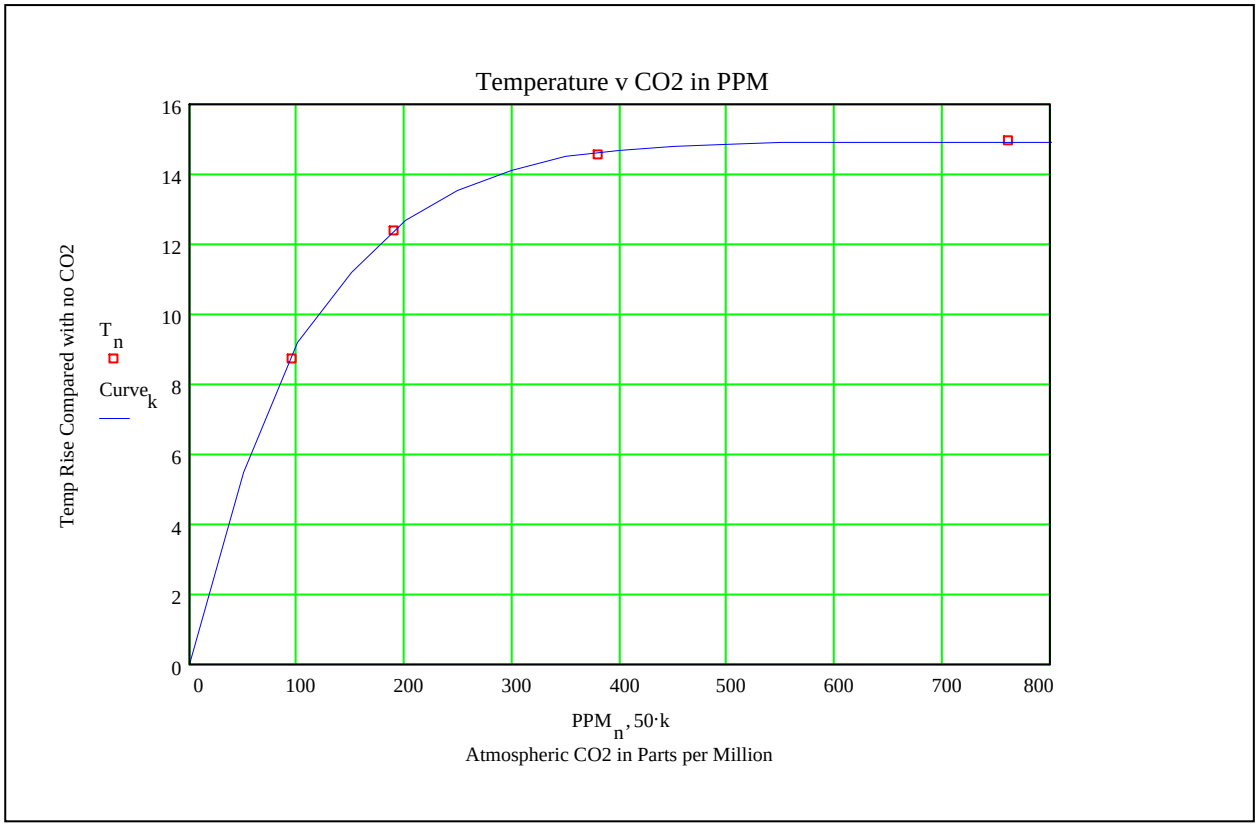

Fig. 9 Calculations of the relationship between the temperature rise from that with no CO_2 through a range of CO_2 levels. The calculations show :

(a) The current 380 ppm is contributing a rise of about 14.3^0 C

(b) With an increase by 380 ppm to 760 ppm of CO_2 the contribution will be about 0.6^0 C

(c) The 315 ppm recorded in 1959 would have contributed a rise of 13.9^0 C from that with no CO_2 making the temperature difference from the present caused by increased CO_2 to be an increase of 0.4^0 C.