An Unsettling Look at the Settled Science of Global Warming
Part 2: Layman's Discussion
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Introduction

This is the second of three papers on the impact of Carbon Dioxide (CO2) on climate. The first paper is a method of determining the total impact of CO2 on climate. This paper provides an overview of that work in terms that people without a strong scientific background can understand. If you are interested in the details surrounding what is being discussed in this paper, please refer to Part 1.

Note that these papers only consider whether increasing CO2 will change climate. No assertions about current or future temperatures are made. No assertions about the possible effects of climate change are made. No assertions about other gases impacting climate are made.

What these papers describe is the engineering method of determining radiant heat absorption by CO2 in an atmosphere (that is, the greenhouse effect). They show that this effect is practically at a maximum at around 200 ppm CO2.

Definitions

Although this is a simplified report, some technical terms need to be defined. Please note that these definitions are simplifications. Exact definitions require a level of scientific understanding that most normal people do not have. The exact definitions would also double the length of this paper.

Global Warming (GW) is a term for a change in climate. It means that the earth will get warmer.

Anthropogenic Global Warming (AGW) is a term for global warming, caused by human activity.

Greenhouse Effect is a term for an increase in the atmosphere's temperature due to heat being held in by various gases, rather than immediately radiating into space. (Note that the heat does radiate into space. It radiates from the gas, rather than the surface of the earth. As the gas warms, due to absorbing heat energy, it also radiates more heat energy).

Greenhouse Gas is a term for a gas that absorbs radiant heat and hence warms the atmosphere, thus causing the greenhouse effect.

Electromagnetic Radiation (EMR) describes a type of energy. Visible light is a small part of this energy. Other types of EMR are X-rays, radio waves and radiant heat.

Radiant Heat is a type of EMR energy. It has the same properties as light, differing only in wavelength (and the fact that our eyes cannot see it).

Kelvin is a temperature measure, similar to Fahrenheit or Celsius. One Kelvin degree is the same size as one Celsius degree. Zero degrees Kelvin (0 K) is called absolute 0 because temperature cannot get colder than this. Zero degrees Celsius (0° C) is equal to 273.15 K. Note that in proper notation, there is no degree sign (°) in Kelvin. For most scientific purposes, the Kelvin scale is used.

The Hypothesis

The greenhouse effect can be easily visualized by an analogy. Think of the atmosphere as a pane of glass and CO2 as a black marker. Light (and radiant heat is a type of light) can travel through the clean (no CO2) glass. An initial amount of CO2 in the atmosphere is like a mark on the pane of glass from the marker. Increasing the C02 is like adding another mark. As the number of marks increases, less and less light can get through the glass (and the glass gets warmer). Similarly, with the atmosphere, as more and more CO2 is added, less and less heat can escape to outer space. With the glass and marker, there will come a point when the entire glass has marker on it. Now if you make a mark, you do not change how much light gets through. The first paper in this series shows that this is also true of the atmosphere. Sooner or later, there will come a time when increasing CO2 no longer has any effect on temperatures and hence climate.

Put another way, there is a value for the atmospheric concentration of CO2 at which increasing the concentration of CO2 will no longer result in increased temperatures. The first paper in this series makes the case that this concentration is 200 ppm; that is, beyond 200 ppm, increasing CO2 will have no impact on climate.

It has been said that the marker analogy is flawed. The alternate hypothesis is that CO2 is like a blanket. The more there is in the atmosphere, the more it holds in the heat. This would be true if absorbance of CO2 followed the type of absorbance proposed by the IPCC. The first of these papers shows why the marker analogy is better than the blanket analogy and shows how the IPCC relationship is an oversimplification.

The Science

Please note that the following greatly simplifies many concepts. This is a broad and simple overview of a complicated issue, not a science course.

Everything in the universe has some positive temperature (in degrees Kelvin). Everything radiates electromagnetic energy, with the intensity of that radiation being directly tied to the temperature. So very cold things only radiate a little bit of EMR. As things get hotter, they begin to radiate at shorter and shorter wavelengths while also emitting all of the longer wavelengths as well. This is because as wavelength decreases, the energy in the wave increases. Eventually, the EMR wavelengths get to the point where we can see them with our eyes, that is, it becomes light. You see something hot glow red. As it continues to heat, it gets white hot. If the heating continues, the new EMR becomes invisible again, but is even more energetic.

Anything that gets in the way of EMR will absorb some of that EMR. The rest will either pass through (like light through a window) or reflect (like light off a mirror). Because we cannot create or destroy energy, the absorbed EMR energy must change into another type of energy. This is usually heat content, meaning that as something sits in light it will tend to warm up. As the thing that absorbs EMR warms up, it emits more EMR as well until a new equilibrium is reached and the temperature no longer changes.

In the case of the atmosphere, there are two sources of EMR. There is the EMR from the sun that warms things up. There is also the EMR from the earth that cools things down. Most of the EMR from the sun is very energetic and at short wavelengths. Most of the EMR from the earth is less energetic and at much longer wavelengths.

The atmosphere of the earth is sort of like a pair of coloured glasses. Some of the EMR can get through and some gets stopped by the atmosphere. In particular, most of the EMR that we can see with our eyes, that is, light, gets through. Some 'colours' do not get through particularly well. In particular, infrared or radiant heat, is absorbed by certain gases, such as carbon dioxide, water, methane and others. One gas, ozone, absorbs EMR in the range of ultraviolet (UV). This light causes sun burn and is linked to skin cancer (and vitamin D production, so do get a bit of sun every day!). The UV from the sun is absorbed by the ozone, stopping most of it from getting to the surface of the earth.

The amount of EMR that is absorbed by a gas depends on two things. First is the total distance the EMR goes through in the gas. Second is the concentration of the gas. This means that a short length of gas with a lot of the gas will absorb a similar amount of EMR compared to a long length of gas with a little gas. It is this product or the number you get by multiplying two numbers, which is important in determining how much EMR will be absorbed. This product is called 'path length'. Because the atmosphere is a pretty long length (for most calculations, it is enough to consider the first 42 kilometers), it does not take much of any particular gas for that gas to begin to have a noticeable effect.

There are at least two ways to figure out how much EMR will be absorbed by the atmosphere, and hence how much it will tend to warm up. Part 1 of this paper is a detailed description of the engineering method of doing this. The second is as performed by climate scientists.

Climate scientists quoted by the various assessment reports of the Intergovernmental Panel on Climate Change (IPCC) use an equation in their models of the atmosphere to account for variation of CO2. This equation is not used in any other field, producing incorrect values for the amount of radiant heat absorbed in an atmosphere.

The Engineering

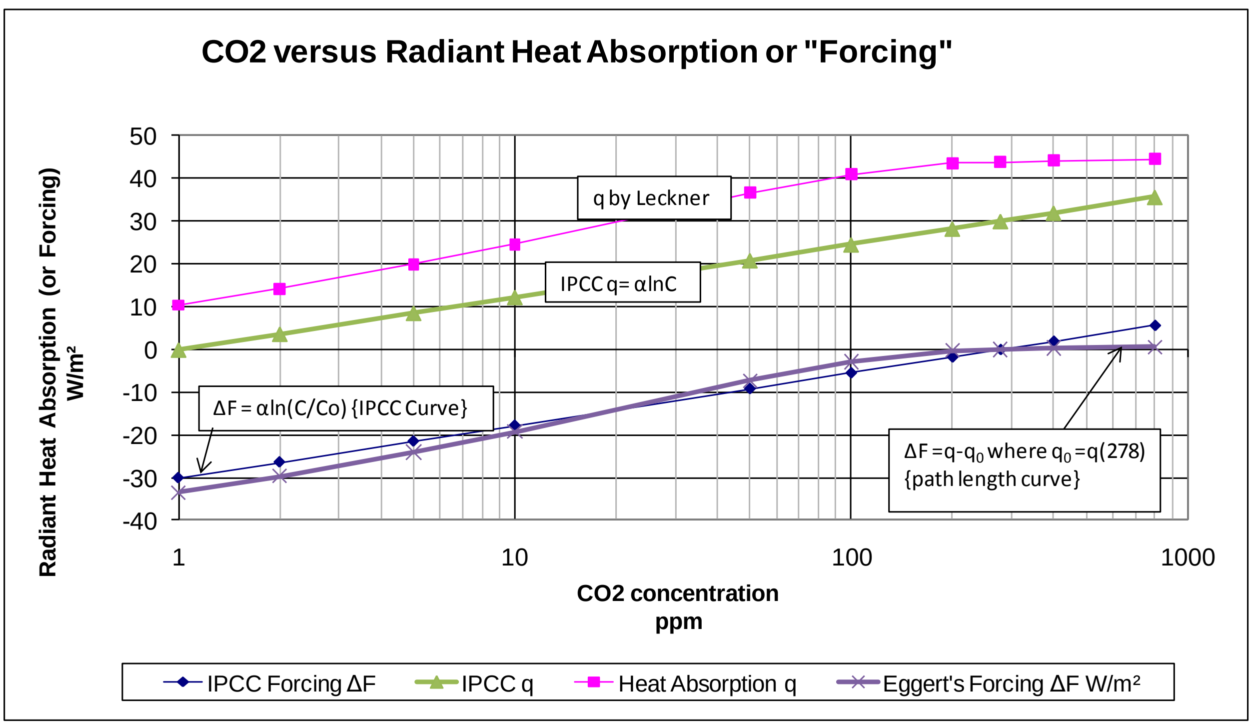
It is, in theory, possible to calculate how much radiant heat will travel through any particular path length of gas. These calculations are extremely complicated and have areas of uncertainty. Things such as re-radiation by the gas itself, atomic structure of the gas, etc., must be taken into account. The types of calculations for this are very important in a number of fields, including, but not limited to, climate science.

Some areas that also need to perform such calculations are heating design, greenhouse design, blast furnace design, and so on. Note the repetition of the word 'design'. This implies the application of science to come up with something that works, or more commonly – engineering.

In order to be able to perform calculations for designing many different types of things that must account for radiant heat loss in the atmosphere, H. C. Hottell at MIT performed thousands of measurements of heat as it went through various concentrations of CO2 at various lengths of gas. He then generated a number of graphs that are used by engineers in designing a huge range of applications. In the 1970's, B. Leckner further refined these curves. The premise of these papers is that these graphs and methods for determining radiant heat absorption in the atmosphere are applicable to determining radiant heat absorption in the . . . atmosphere.

The challenge in using these curves to estimate how much energy is absorbed by the atmosphere, and hence how big the greenhouse gas effect will be, is calculating the atmosphere 'path length'. Part one of this paper details a method for doing this. Once this 'path length' is known for CO2, it is possible to figure out what the effect of changing CO2 will be.

This was done for concentrations from 1 ppm CO2 to 800 ppm CO2. The IPCC equation assumes a 0 for 'forcing' at 278 ppm CO2. Although this is entirely arbitrary and without any use, other than as an illustration, the effect can be duplicated by taking the absolute numbers generated using path length calculations and subtracting the value at 278. This was done. In addition, it is possible to reverse this process on the IPCC results and come up with an absolute value for heat absorbed. The result was: For concentrations up to about 100 ppm CO2, the prediction of the impact of CO2 on heat in the atmosphere is (within reasonable limits) equal. At somewhere between 100 to 200 ppm, the results begin to separate. Beyond 200 ppm, the difference becomes significant. The following graph illustrates this. The source data for this graph is below the graph.



						Path	http://www.esrl.noaa.gov/gmd/agg i/

Atmospheric CO2 ppm	IPCC Forcing ΔF W/m²	IPCC q W/m²	Path Length Bar-cm	Leckner ε	Heat Absorption q W/m²	Length Forcing ΔF W/m²	see also AR4 **$\Delta F = \alpha \ln(C/Co)$** Co= 278 α= 5.35	**IPCC $q = \alpha \ln C$** ppm CO2 W/m²
1	**-30.11**	**0.00**	0.67	0.033	**10.42**	**-33.46**		
2	**-26.40**	**3.71**	1.3	0.045	**14.20**	**-29.67**	**$q=\varepsilon\sigma(T^4)$**	W/m²
5	**-21.50**	**8.61**	3.4	0.063	**19.89**	**-23.99**	σ= 5.67E-08	SB constant
10	**-17.79**	**12.32**	6.7	0.078	**24.62**	**-19.25**	T= 273.15	Kelvin
50	**-9.18**	**20.93**	33.5	0.116	**36.62**	**-7.26**		
100	**-5.47**	**24.64**	67.0	0.130	**41.03**	**-2.84**		
200	**-1.76**	**28.35**	134.0	0.138	**43.56**	**-0.32**		
278	**0.00**	**30.11**	186.3	0.139	**43.88**	**0.00**	Note that in both cases, ΔF is	
400	**1.95**	**32.05**	268.1	0.140	**44.19**	**0.32**	equal to $q-q_0$ where q_0 is	
800	**5.65**	**35.76**	536.1	0.141	**44.51**	**0.63**	at CO2=278	

Note that the "path length" method works for calculations that would duplicate massively higher levels of CO2 in the atmosphere than are likely. That is, this method is valid for amounts of CO2 far in excess of what will be caused by humans burning fossil fuels.

The IPCC curve shows a continual increase in the effect of CO2. There is an absolute and constant value for 'forcing' for every doubling of CO2 concentration. The path length method shows the effect flattening out, and becoming 0 at about 800 ppm. That is, from 0 ppm to about 100 ppm the path length method shows a similar value for doubling compared to the IPCC method. The table below summarizes this.

Atmospheric CO2 ppm	IPCC q W/m²	Doubling IPCC Δq W/m²	Heat Absorption q W/m²	Doubling Heat Absorption Δq W/m²	
1	0.00		10.41657		
2	3.71	3.71	14.20442	3.79	From 1 to 2
5	8.61		19.88618		
10	12.32	3.71	24.62099	4.73	From 5 to 10
50	20.93		36.61583		
100	24.64	3.71	41.03498	4.42	From 50 to 100
200	28.35	3.71	43.56021	2.53	From 100 to 200
400	32.05	3.71	44.19152	0.63	From 200 to 400
800	35.76	3.71	44.50717	0.32	From 400 to 800

This table shows that at levels of CO2 above 200 ppm, the effect drops by an order of magnitude. It is approaching 0 and is, practically speaking, negligible or more simply, zero.

The path length method shows an impact due to CO2 increasing from 278 ppm to 400 ppm to be about the same as an increase from 400 ppm to 800 ppm. That is, what has happened over the last 100 years would require a doubling of CO2 for the same effect. The best estimates given to date are a change of somewhere between 1 to 3 degrees Celsius over the past 100 years, assuming the data as reported by the IPCC is representative of the actual ‘global mean temperature’. Note that this is a highly controversial assumption at this time.

The Copenhagen consensus discussed a change of no more than 2 degrees Celsius. Thus it is clear that no action on reducing CO_2 is required to meet the Copenhagen consensus.

What It Means

The short summary of what it means is: CO_2 increases will not increase the greenhouse effect. Full stop. That is it. CO_2 is not a pollutant, it will not change the weather or climate. There is no basis whatsoever for trying to control the amount of CO_2 in the atmosphere.

The IPCC equation assumes a “logarithmic” or log relation between forcing and CO_2. The path length curve more closely resembles a ‘log log’ relation between forcing and CO_2. That is the IPCC model is an oversimplification that results in overestimating the impact of CO_2 at higher concentrations. The IPCC reports discuss the impact on forcing of doubling CO_2. This is because they believe the relation is logarithmic. Indeed for most of the range of CO_2 concentrations, it does resemble this.

The doubling table above shows that there is a strong case to be made that this doubling does not continue for all concentrations of gas. This effect is not seen in other fields that calculate radiant heat loss in the atmosphere. It is a precept of science that the laws of science that hold in one area are the same everywhere. Thus, radiant heat absorption in climate science will behave the same way as radiant heat in engineering. Utilizing the climate science model for calculating radiant heat absorption results in inaccurate values for radiant heat absorption at higher levels of CO_2. As atmospheric CO_2 increases, this error increases as well.

Misconceptions

“The Green House effect violates the second law of thermodynamics”.
The second law of thermodynamics states that net heat flow can only move from hot to cold. All bodies radiate energy. If there is a warm body next to a cooler body, both radiate heat. The warm body will radiate more heat than the cooler body, hence there will be a net flow from warm to cold, hence there is no violation of the second law. As it can be shown that all bodies radiate heat, were it true that this fact violated the second law of thermodynamics, then the second law would be wrong, not the (provable) fact that all bodies radiate heat. Seeing as no one is contesting the validity of the second law, it is safe to say there is no violation.

“There is too little CO_2 in the atmosphere to impact climate”.
As this series of papers illustrates, the level of CO_2 in the atmosphere, though seemingly small, is enough that further additions of CO_2 no longer impact on climate. That is, from a climate point of view, there is a lot of CO_2 in the atmosphere. The irony of this misconception is that if there were indeed “too little” CO_2 in the atmosphere, small changes would have a drastic effect. This is why methane is such an important greenhouse gas (but that is a topic for another paper).

“The effect of water is so large that the effect of CO_2 cannot be noticed”.

While water is the main reason that there are noticeable differences in day to day greenhouse effects, the impact of CO_2 is additive. The massive effect of water on the greenhouse effect is seen by everyone on a humid summer night when the temperature hardly drops after the sun sets. Or on a very dry summer night when it starts to get cool even before sunset. The effect of CO_2 adds to this, but CO_2 does not vary as much as water does. The impact of CO_2 is also less, but by no means trivial. If there were no CO_2 in the atmosphere, the planet would be colder. At low levels of CO_2 (lower than any the earth has likely ever seen), increases in CO_2 would have a very noticeable effect on temperature, no matter how much water was presen