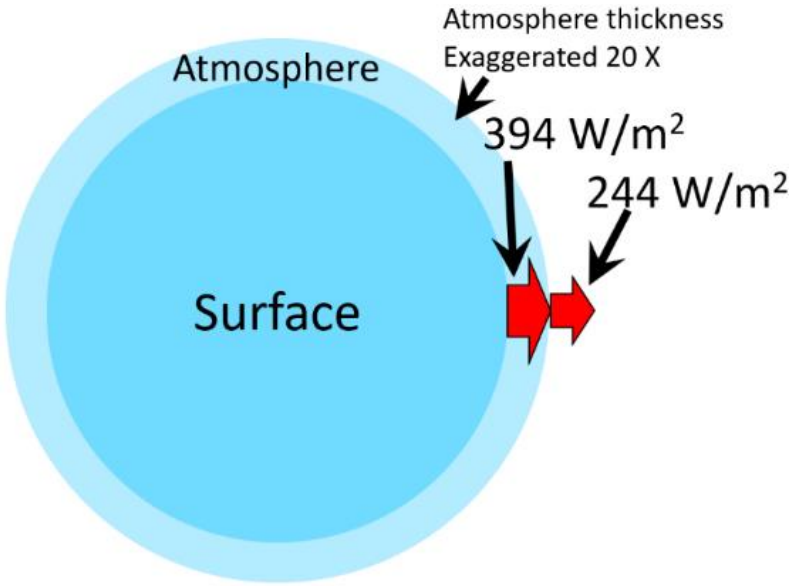
Comments on CO_2, IR, and Climate

It is hard to believe, when thinking of things as large as the earth, that people get bogged down in minutiae, staring at things through microscopes and not seeing the globe. This essay is about the big picture, and everything herein is based on well-known facts.

1. The solar intensity at the earth's orbit is 1368 W/m^2. The earth reflects 30% (approximately, and variably) of that, and the spherical average is 244 W/m^2. (Note that in all cases, we will be talking of averages over the spherical area of the earth.)
2. At equilibrium the earth radiates precisely that amount back into space: 244 W/m^2. (Minor disequilibria do occur frequently, but temporarily.)
3. The *surface* of the earth (at 288.4 K) radiates 394 W/m^2, as determined by the Stefan-Boltzmann radiation law.
4. In other words, the *surface* of the earth radiates 150 W/m^2 more than is radiated into space. That 150 W/m^2 is retained heat, and obviously the atmosphere is responsible.
5. If the atmosphere had no interaction with IR, but still reflected 30% of the sunlight, its temperature would be 255 K, which is 33 K (= 33ºC) colder that it is now.
6. The 150 W/m^2 of heat retention is responsible for that 33 ºC of warming,

Some people may say that the numbers are not quite accurate, but in what follows, it is unimportant whether the difference is 140 W/m^2 or 160 W/m^2. What matters is that the atmosphere has a net effect of reducing the surface radiation by about 150 W/m^2 to equal the net radiation to space. The surface radiation is calculable from the average surface temperature, and the radiation to space must equal the solar radiation absorbed by the earth.



Now it is time to start thinking about the atmosphere. IR leaves the surface, and less IR goes into space. Obviously, what matters is the interaction between IR and molecules in the atmosphere. **Whose expertise should one seek for information about this subject?** Most people have no idea, because the subject is so alien to their background. Physicists whose expertise is Atomic, Molecular, and Optical (AMO) physics, and chemists whose specialty is Molecular Spectroscopy may or may not know details of the relevant spectra (of CO_2, H_2O, CH_4, and other *greenhouse gases*, GHGs). Suffice it to say that these subjects are not to be found in curricula of Meteorology or Climatology Departments, let alone in Political

Science Departments or law schools. For a genuine expert, see Will Happer's recent essay at https://www.independent.org/issues/article.asp?id=13458&omhide=true.

Molecular dynamics involves not only IR absorption, but energy sharing through collisions. At high altitude, GHGs can absorb energy from collisions and then radiate IR to outer space. Things are not as simple as Mr. Gore pretends.

The CO_2 concentration is usually given (a bit too casually) in terms of *parts per million* (ppm), which chemists take to mean *by weight*. The known data, however, are expressed in units of *parts per million by volume* (ppmv), which is numerically the same as parts per million by the count of molecules.

Again, we need to concentrate on the big picture. Let us take the words of the experts about the effect of doubling CO_2 concentration.

7. The current estimate is that if CO_2 concentration is doubled, the additional IR amount that will be absorbed by atmospheric CO_2 is 3.5 W/m^2.
8. **That is, doubling the CO_2 concentration would increase the retained heat from 150 W/m^2 to 153.5 W/m^2.**
9. If 150 W/m^2 results in 33 ºC warming, what do you expect from 153.5 W/m^2?

Carbon dioxide has been singled out and demonized on the grounds that our consumption of fossil fuels will cause/is causing "climate change" (*nee* global warming). You can see from list item 8 that the claim is dicey at best, but it is useful to look into CO_2 a bit carefully.

10. At present, CO_2 (at ca. 400 ppmv) is responsible for about one-fifth, 30 W/m^2 of the total heat retention (150 W/m^2) of the atmosphere,

At very low concentrations (compared to the present low 400 ppmv), CO_2 is a very effective IR absorber in a certain region of the IR spectrum.

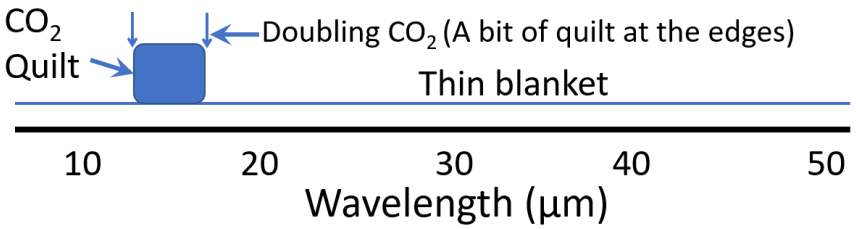
11. The first 200 parts per million of CO_2 are responsible for about 26.5 W/m^2. The *next* 200 ppmv—taking us from 200 ppmv to our present 400 ppmv—raised CO_2's total to 30 W/m^2, and the next doubling—400 ppmv to 800 ppmv—will raise CO_2's total to 33.5 W/m^2.

The very strong GHG property of CO_2 at extremely low concentration is likely responsible for the current demonization of CO_2.

The Blanket Model

The effect of GHGs is often described as covering the earth with a blanket, and adding CO_2 is described as adding more thickness. A more apt analogy is shown below as a thin blanket covering a large part of the IR spectrum, and the effect of our present CO_2 as a thick quilt covering a much smaller part of the spectrum. Overall the combination has a net warming effect of 150 W/m^2, and the quilt part of that total is 30 W/m^2.

Doubling the CO_2 concentration has the effect of *widening* the spectral range of the quilt a bit, in the amount necessary to add 3.5 W/m^2. Slightly more IR is absorbed at the quilt, but with the increased warming, slightly more IR is radiated across the rest of the spectrum.



Feedback

But wait! There's More! What about positive feedback from melting of snow and increasing water vapor content? If snow melts and exposes soil beneath it, the albedo (reflectivity) of the earth decreases. If the oceans warm, they will put more H_2O into the air, and enhance the greenhouse effect.

A 1% change in the absorbed solar radiation (244 W/m^2) would amount to a change of 2.44 W/m^2 reaching the surface, which is comparable with the doubling (or halving) of the CO_2 concentration. The climate models assume—one and all—that the albedo does not change.

Increasing H_2O concentration in the air has the triple effect of absorbing more IR, reflecting more with increased cloudiness, and *radiating* more IR to outer space.

The feedback mechanisms in the climate models involve many things (never underestimate the creativity of a determined computer programmer), but there is one thing they do *not* include: any feedback from CO_2 itself. In other words, doubling CO_2 concentration causes 3.5 W/m^2 of heat retention, but *other things* contribute to (catastrophic!) global warming.

The flaw in this argument is transparent: if those positive feedback mechanisms can lead to catastrophe because of 3.5 W/m^2 caused by CO_2, they would do the same if there were 3.5 W/m^2 heat retention from any cause whatsoever. It would have happened eons ago, and we would not be here talking about it.

Other variables

The earth's climate has varied greatly with no help from mankind and will continue to do so. What causes the changes?

Overall, the temperature of the earth for the last half-billion years has remained within plus or minus perhaps 10 ºC, a small fraction of the nominal 300 K temperature.

There is a 150-million year periodicity, wherein the earth goes through protracted ice ages. Israeli astrophysicist Nir Shaviv has shown that the ice ages occur when the earth is within an arm of the Milky Way. He identifies the reason as the greater flux of cosmic rays (due to proximity), causing greater ionization in the atmosphere, causing greater water condensation, causing more cloudiness, causing lower temperature.

We can infer past dates (for the last few thousand years) by counting tree rings or by carbon dating. The two do not agree. There is nothing wrong with the ring-counting process. The variable is the production rate of the C-14 isotope. The isotope is produced by cosmic rays interacting with atmospheric nitrogen, so the variability is due to variability in the cosmic ray flux. Over that period of time, it is unlikely that the sources of cosmic rays have varied, but more likely that the flux diverted by the magnetic fields (of sun and earth) have varied.

I can't pretend to be an expert in solar physics, but I do know that Cepheid variables have periods ranging from short to decades. Is there some long range (say, 1500-year) cycle that we can't see because of our short time frame of measurement?

Ocean currents vary with periods ranging from a few years to thousands of years, winds vary, the polar vortices vary, volcanoes happen, cloudiness changes, the water content of the air changes, the Andes are rising, the Isthmus of Panama rose out of the ocean a million years ago, vegetation changes, fertility of the soil changes and so on. Whatever the causes, there has been no shortage of natural climate variability.

Nuclear Power

There is no doubt that switching from fossil fuels to nuclear power would decrease our emissions of CO_2. There is also no doubt that nuclear power is the safest of all energy options.

There *is* doubt—*profound* doubt—that reducing CO_2 emissions would have measurable effect on the climate.

As I have done for the last several decades, I strongly recommend nuclear power and strongly recommend *against* basing the pro-nuclear case on the dubious claim that CO_2 is causing a "climate crisis."

NEVER TRY TO BUILD A STRONG CASE ON WEAK ARGUMENTS!

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