My calculation of global warming due to direct CO_2 forcing

I have finally got around to carrying out my own calculation of how much of an increase in the near-ground global average temperature (GAT) arises from ***direct*** CO_2 forcing. I emphasise that this excludes feedback effects.

The full gory details are [here].

If you have a technical background you should be able to follow the whole calculation, though it is not trivial. My method includes a number of simplifying fudges.

The most important of these fudges is an assumption for how the change in global average temperature varies with altitude. I had not appreciated at the outset how sensitive the near-ground GAT would be to its variation with height. Nor had I appreciated initially that the stratosphere and the mesosphere have ***decreased*** in temperature over recent decades. It turns out that the more these high-altitude layers decrease in temperature, the more the troposphere needs to increase in temperature in order to maintain energy balance.

As a result, depending upon what model I assume for the variation with altitude, the near-ground GAT increase due to a 50% increase in CO_2 (i.e., from pre-industrial to 2023) ranges from 0.29 degC to 0.73 degC (based on my favoured method). The higher end of this range appears more likely as that corresponds to decreases in stratospheric / mesospheric temperatures. A broader range of results averages to 0.57 degC.

Popular or news accounts of the IPCC models are guilty of obscuring the fact that just less than half of the currently observed 1.2°C increase in GAT (since pre-industrial times) is, in those models, due to the direct effect of CO_2 increases – namely 0.54 degC. Whilst the large spread in my predictions is unfortunate, I tentatively conclude there is reasonable agreement with the IPCC models as regards the ***direct*** effect of CO_2.

The rest of the observed 1.2°C increase in GAT is claimed to be due to feedback effects. Whilst the occurrence of feedback effects is a very reasonable expectation, quantifying feedback effects is another matter. It's just too difficult. Arguably it is difficult even to predict, from basic physics, whether positive or negative feedbacks would win overall. The approach taken by IPCC modellers is to include tuneable parameters to account for feedback. Generally the dominant of these is water vapour.

Water vapour will increase due to rising temperature, and hence, being a greenhouse gas, will contribute to a positive feedback. On the other hand, rising water vapour levels would – to my naïve mind – tend to increase cloud cover. The Earth's albedo is very sensitive to cloud cover, and greater cloud cover will reflect more incoming radiation back into space. So I would expect this to provide a negative feedback. Oddly, the IPCC models appear to attribute positive feedback to cloud cover. I make no definitive statement about this. Indeed, my position is exactly that a definitive statement about the magnitude, and even the sign, of total feedback effects is extremely problematic…which is why IPCC modellers have recourse to fitting tuneable parameters instead.

That's fair enough. What isn't fair enough is to then claim that "the science is settled" (a claim which is intrinsically unscientific in any case). Nor is it valid, having had recourse to fitting against uncertain physics, to place too much reliance on the future predictions of models whose extrapolation to greater CO_2 concentrations is of uncertain foundation.

The delicacy of these calculations is illustrated by how little the energy balance would be upset due to a 50% increase in CO_2 (if temperatures did not change to compensate). At most this is 1%, and a lot less according to my favoured models (maybe 0.35%). This isn't surprising because 1.2^{o}C is only ~0.4% of the near-ground absolute temperature.

In Section 27 of my calculation, "Putting the Results in Context", I illustrate some further issues. I suggest that the percentage change in radiation emissions from the planet due to CO_2 increase might be a more important result than the increase in GAT. The reduction in radiant energy emissions due to the 50% increase in CO_2 (were temperatures not to increase to compensate) are only 0.2% to 1%. In absolute terms this is a decrease in infrared emissions into space of around 0.5 to 2.4 W/m2. How does this small change compare with other variabilities in the climate?

By using the GAT we have obviated discussion of the diurnal and seasonal variations in temperature, as well as the variations with latitude. These three variations might be roughly about 6%, 13% and 23% of the absolute temperature - vastly greater than the CO_2 induced changes in infrared emission. This calls into question whether working on the basis of a fictional uniform, average temperature, with static unvarying temperatures, may be misleading – or, at least, might induce an error which swamps the apparent signal.

Of even greater concern (to me, anyway) is cloud cover. Typically 67% of the Earth is covered by cloud. But this varies from day to day by around 30% (i.e., 52% to 82%). Averaging over a year causes the variation in annual averages to be much smaller, of course, but it is still around 3% (e.g., 66% - 69%). In absolute numbers this implies a variability in the (short wavelength) energy reflected off clouds of 3% of 79 W/m2, i.e., 2.4 W/m2. This is greater than, or at best equal to, the change in infrared emissions due to a 50% CO_2 increase. This does not mean that natural variations in cloud cover would prevent a GAT increase of around 1degC from being observable (clearly, it is observable), but it does mean that it could not be discerned from a single year. Rather, many years of data are required so that the random natural variations average to smaller percentages. However, what it does illustrate is that an increase in average cloud cover comparable to its annual variability (over the time required to increase CO_2 by around 50%, say some tens of years) would be sufficient to negate the effects of that CO_2 increase on GAT completely. In other words: just how confident can we possibly be that cloud cover increases would not negate GAT increases due to CO_2 completely, even if the latter were to double? In which case the observed increase in GAT would have to be due to something other than CO_2.

And then there are the range of issues affecting insolation, i.e., the Sun's radiant power.

These issues are why scientifically well-informed persons explore other avenues in addition to the politically obligatory "CO_2 is everything". I make no definite claims; I only point out that there is reasonable doubt about the causes of the whole of the observed GAT increase, and also substantial doubt about predictions of the future based on extrapolations of models which have fitted tuneable parameters without a secure basis in physics.