Two Underlying Climate Simplicities

In my undying quest to make things so simple that even I can understand them, I have "discovered" two simplicities about climate that result in one simple, all-inclusive equation. There is, of course, nothing new about the discoveries; they are things that you already know.

The first one is that—*at equilibrium*—all planets absorb heat from the sun (the amount depending upon solar intensity and the albedo of the planet) and radiate that amount into space: $I_{in} = I_{out}$. Remember that the IPCC is always promoting the concept of the "equilibrium climate sensitivity," defined as the average temperature rise of the surface *at equilibrium* occasioned by the doubling of CO_2 concentration. In keeping with the IPCC, we will be averaging over the sphere in all cases.

The second simplicity is that the atmosphere, one way or another, reduces the radiation from the amount emitted by the surface to the amount emitted to space. There are *many* things that happen in the atmosphere, including IR absorption be GHGs, collisions that dissipate that absorbed energy, collisions that excite GHGs to radiate IR, reflection from bottoms of clouds to return IR to the surface where it is absorbed, as well as non-IR processes such as the motions of the atmosphere and of the oceans. All such complications aside, we will let the "greenhouse effect" (a.k.a., the atmospheric effect, the *net* absorption of IR, the *net* blockage of IR, etc.) be represented by G (as done, finally, in *AR6*). We have $G = I_{surf} - I_{out}$.

Now, we will bring in the Stefan-Boltzmann radiation law: $I = \sigma T^4$ and apply it to the surface of the earth. We combine the two simplicities into one equation applicable to all planets at equilibrium:

$$G = \sigma T_{surf}^4 - \frac{I_{sun}}{4}(1-\alpha) \tag{1}$$

Separating changes in G into the part caused by CO_2 and the part due to other causes, we find the differential of Eq. 1:

$$dG_{CO2} = 4\sigma T^3 dT - \frac{dI_{sun}}{4} + \frac{I_{sun}}{4} d\alpha - dG_{other} \tag{2}$$

Take a moment to study Equations 1 and 2, posing some what-ifs. Suppose that the solar intensity and the albedo α remain constant. If G increases, there will be an increase in surface temperature, and it is calculable from the equation. Alternatively, if there is an increase in surface temperature, then there *must be* an increase in the greenhouse (atmospheric) effect G to absorb the increasing infrared radiation.

Imagine in Eq. 1 that the composition of the atmosphere remains the same, and the solar intensity remains constant, then an increase in albedo must result in a decrease in temperature. Or, if there is a temperature increase, then the albedo must decrease.

We will now use IPCC-accepted numbers: I_{sun} = 1366 W/m^2; I_{in} = 239 W/m^2; α = 0.3; T_{surf} = 289 K; I_{surf} = 398 W/m^2; G = 159 W/m^2. You may have minor disagreements with some or all of the numbers. Please apply your own numbers to see whether they have any effect on the argument.

The IPCC uses a quantity called *radiative forcing* ΔF to apply to any increase (or decrease) in the greenhouse effect, failing to note that ΔF is nothing more and nothing less than an increment dG to G. Since the 2001 *Third Assessment Report*, IPCC has used $\Delta F = 5.35 \frac{\mathrm{W}}{\mathrm{m}^2} \ln\left(\frac{C}{C_0}\right)$ for the "forcing" due to an increase in CO_2 concentration from C_0 to C. For CO_2 doubling, $\Delta F_{CO2} = dG_{CO2}$ = 3.7 W/m^2.

I will consider only one IPCC conclusion, namely that the equilibrium climate sensitivity is 3 ºC (often regarded as their best estimate). Assuming constant sun, constant albedo, and CO_2 doubling, Eq. 2 says

$$3.7 = 16.5 - dG_{other} \left(\frac{\mathrm{W}}{\mathrm{m}^2}\right) \tag{3}$$

Whence the greenhouse effect from causes other that CO_2 must increase by 12.8 W/m^2 to balance the equation. Alternatively, if we assume that the only "forcing" comes from CO_2, we can calculate the change in albedo that can accommodate the increase in surface emission. In that case, the albedo must decrease by 0.037 (a 12.5% decrease).

IPCC, failing to apply the Stefan-Boltzmann equation to the surface, fails to notice the huge discrepancy between 3.7 W/m^2 and 16.5 W/m^2, and attributes the lion's share of the warming to CO_2, and says that the albedo is likely to increase, rather than decrease.

Go figure!

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