Anthropogenic Greenhouse Gases Only Cause Global Cooling

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Abstract

We use fundamental notions of thermodynamic equilibrium, atmospheric physics and theory of radiation to demonstrate that atmospheric greenhouse gases may only produce global cooling.

Introduction

Computer models of climate endorsed by IPCC variously predict global warming ranging from 2 ºC to 5 ºC and recently up to 7 ºC, due to future doubling of the atmospheric carbon dioxide (CO_2), as compared to its pre-industrial values, estimated at 280 ppm. These predictions look *a priori* doubtful, as in 2018 we reached 407 ppm CO_2, going almost half way from 280 ppm to 560 ppm, whereas global warming has been stalling at 0.8 ºC for 20 years, notwithstanding the continuing growth of CO_2.

Discussion

We shall therefore leave alone the IPCC model predictions, and focus on physics of the atmosphere, with the aim to estimate the climate effect of the greenhouse gases theoretically. The temperature distribution in the atmosphere is described by the so-called lapse rate Γ_d, the derivative of temperature on height, given in dry atmosphere by the expression [1]:

$$\Gamma_d = -\frac{dT}{dz} = \frac{g}{C_p} = 9.8\,^{o}\text{C/km}\,, \qquad (1)$$

where $g = 9.81$ m/s^2 is the Earth's gravitational acceleration and $C_p = 1003.5$ J/(kg K) is the specific heat of dry air at constant pressure. Eq. (1) describes the temperature decreasing with height linearly and is valid for the troposphere. It will be sufficient for our purposes, demonstrating that there exists a direct relation between the temperature at the Earth's surface, and in the entire troposphere, established primarily by convection.

The energy exchange between Sun, Earth and outer space occurs in the form of radiation; see Fig. 1 that shows the energy fluxes most important for our discussion. The radiative flux F comes from the Sun, mostly as visible radiation. The radiative flux F_s is emitted by the surface in the form of infrared (IR) emission and escapes into outer space, and F_a is the IR radiative flux emitted by the atmosphere into the outer space. F_u and F_d describe the energy exchange between the surface and the atmosphere, occurring partly by radiation, and partly by convection, and establishing the atmospheric lapse rate. The essential condition here is:

$$F = F_s + F_a, \tag{2}$$

which is satisfied with very high precision – all of the energy received from the Sun has to be dissipated into the outer space, either by the atmosphere, or by the surface, as the long-term global temperature variations (0.8 ºC in over 100 years) are very small and slow compared to the daily (20 ºC in hours) and yearly (3 ºC in months) variations.

Let us now assume an instant *doubling* of the atmospheric CO_2. Due to additional CO_2 that absorbs IR radiation, the atmosphere will warm up, making the surface also warmer due to the lapse rate (maintained by F_u and F_d). However, now both F_s and F_a became larger than before [2], due to higher surface and atmospheric temperatures T_s and T_a, upsetting the equilibrium condition of Eq. (2). Thus, both atmosphere and surface will cool down, until reaching a new state of equilibrium, with Eq. (2) once more satisfied. What is the difference between the new and the old equilibrium? The new atmosphere has more CO_2, and thus absorbs IR better, but it also emits IR better, according to Einstein [3]. With the atmosphere more emissive, the same total flux of energy $F = F_s + F_a$ will be achieved already at lower temperatures, therefore the average temperature T of Earth surface and atmosphere will be *lower* after CO_2 doubling. This conclusion is robust, and independent on the details of the IR absorption spectrum of CO_2 and/or other greenhouse gases. Stronger atmospheric IR absorption will always cause stronger atmospheric IR emission [3], leading to a *lower* average temperature T.

However, we also need to evaluate the effect of the additional 280 ppm of CO_2 on the atmospheric lapse rate, as it would affect the surface temperature. We shall use the dry-air Eq. (1) for our estimates, as humidity reduces the effect of CO_2 on the lapse rate. Our upper estimate for this effect is –42 ppm of the lapse rate for 280 ppm of extra CO_2, as estimated at 20 ºC using handbook values for the gases involved. According to Eq. (1), *lower* C_p due to extra CO_2 corresponds to a *higher* lapse rate Γ_d. Thus, assuming a 100 ºC difference between the atmospheric temperature T_a at the height where IR radiation comes from, and the surface temperature T_s, we obtain that the temperature difference will become *higher* by ΔT = 42 ppm × 100 ºC = 0.0042 ºC. Thus, increased C_p, leaving the average temperature unchanged, will reduce T_a and increase T_s, as illustrated in Fig. 2. This increase of T_s will never exceed 0.0042 ºC, which is clearly insignificant compared to daily and yearly temperature changes. The same conclusion remains true even at much higher CO_2 concentrations and with other greenhouse gases present in comparable amounts. As we noted before, the atmospheric temperature T_a goes down due to increased atmospheric emissivity in the infrared range, caused by extra greenhouse gases [3].

Conclusion

We therefore conclude that the IPCC climate models are incorrect in predicting strong warming where only cooling is to be expected, according to our simple theoretical analysis.

References

1. Lapse rate, *Wikipedia*, https://en.wikipedia.org/wiki/Lapse_rate

2. Stefan-Boltzmann Law, Wikipedia, https://en.wikipedia.org/wiki/Stefan-Boltzmann_law

3. Einstein coefficients, *Wikipedia*, https://en.wikipedia.org/wiki/Einstein_coefficients

Figure captions

Figure 1. Energy exchange in the Surface + Atmosphere system.

Figure 2. Doubling CO_2: the effects of the increased emissivity and of the increased lapse rate on the atmospheric temperature T_a and the surface temperature T_s. Note that combining the two effects, the T_s growth will never exceed 0.0042 ºC.

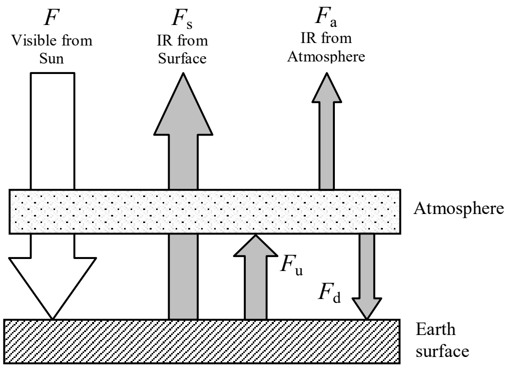

Fig. 1

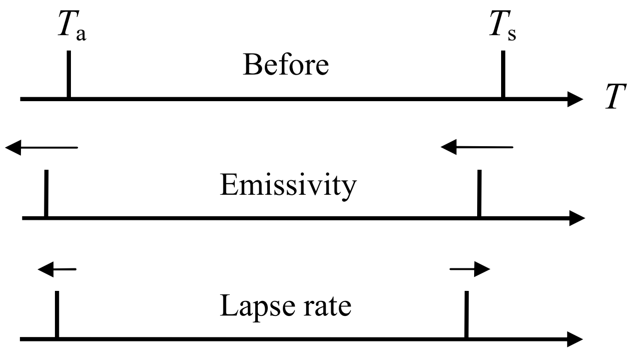

Fig. 2