7

Aerosols

Mitchell, J.F.B, Johns, T.C., Gregory J.M., *et al.* (1995). Climate response to increasing levels of greenhouse gases and sulfate aerosols. *Nature*, **376** (6540), 501–504.

Of the human-caused changes to climate forcing, greenhouse gases warm the planet, while aerosols, tiny suspended particles or droplets in the atmosphere, tend to cool. Haze in the air scatters sunlight, allowing some of it to be lost to space without ever depositing its energy at the surface in the Earth system, increasing the albedo of the planet and cooling it down. Aerosols differ from greenhouse gases, especially CO_2 and nitrous oxide N_2O, in that their lifetime in the atmosphere is short, only a few weeks, before they settle or wash out (as acid rain, for the aerosols resulting from sulfur emissions). The cooling influence from aerosols is therefore regional rather than global for the gases. Another difference is that the amount of climate forcing from the aerosols is much less well constrained than the warming impact of the gases. Aerosols scatter sunlight, but they also apparently influence the microphysics of cloud formation, leading to more numerous, smaller, and longer-lived cloud droplets than one would find in the cleanest air. This so-called indirect effect may be as important as the direct scattering of the bare aerosols, but it is difficult to know how the clouds would be different in the clean air, or even how clean the air would be without human intervention.

The potential cooling impact of aerosols is the kernel of truth at the heart of the "scientists claimed global cooling in the 1970's" myth that survives in popular perceptions of climate change science. It was quickly realized, however, that greenhouse gases are stronger than aerosols, so warming wins. Another piece of the story is the observation from sediment cores that interglacial periods such as our own do not last forever, and that our current interglacial has lasted about as long as the last interglacial period did, which could imply that a new ice age might start sometime in the next few millennia. This is of course an entirely different time scale than the threat of human-induced warming, and as it turns out the interglacial most analogous to ours, when the Earth's orbit around the sun was nearly circular as it is today, took place about 400 000 years ago, and lasted for 50 000 years, suggesting that the next ice age might have been tens of thousands of years in the future even in the absence of human releases of CO_2.

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