Response to the thread SC C5268 through SC C6350 (C5268, C5297, C5303, C5331, C5334, C5343, C5346, C5361, C5394, C5406, C5408, C5410, C5416, C5389, C5991, C6073, C6079, C6101, C6103, C6293, C6298, C6330, C6346, C6350) and two others that belong in that thread (C5377, C6662)

These 26 Comments include 10 Comments by Nabil Swedan and 16 Comments by Tony Banton, Jack Dale, Charles Holley, Ray Siemankowski, Michel de Rougemont, and Harry ten Brink.

Comments of the latter six authors help correct misconceptions of Swedan about atmospheric radiation and do not require a response from us. In addition to their comments, we point out that the fundamentals of atmospheric radiation have been understood for centuries. A textbook with a good description of atmospheric radiation is provided at the end of this response.

Perhaps the most insightful description of the greenhouse effect in recent years is in the "CO_2 as a control knob" papers by Andrew Lacis and collaborators, also listed at the end of this response.

The most compelling evidence for the global impact of the greenhouse effect is the paleoclimate evidence for global temperature change over the past 800,000 years. Fig. 25a in our ACPD paper, below, shows just how tight the CO_2 control knob is. On millennial time scales Earth must be in near energy balance with space. Our precise knowledge of CO_2 over that period, and reasonable knowledge of global mean temperature change (about half of the Antarctic change) provides knowledge of the equilibrium global temperature response to a CO_2 change, as noted in the footnote in the paper repeated below. This empirical approach incorporates all processes occurring in the real world. The climate sensitivity includes the "slow" ice sheet response.

Keeping our modern world close to the Holocene temperature range does not necessarily require moving CO_2 back to 280 ppm, because humans are causing other forcings, e.g., by changing surface albedo and various activities (not just fossil fuel burning) that kick up atmospheric aerosols. With other things unchanged from today, atmospheric CO_2 would need to be reduced to about 350 ppm to restore Earth's energy balance.

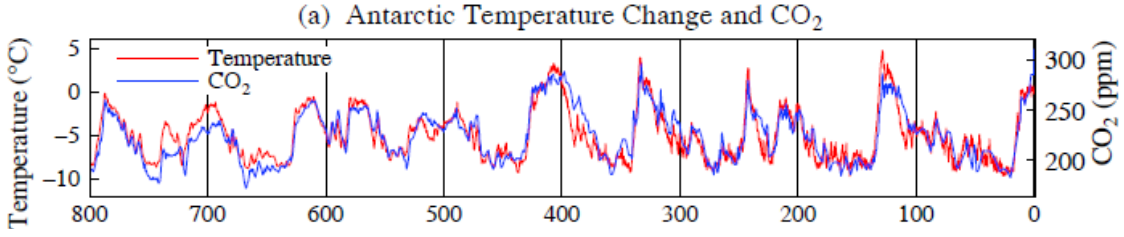

Fig. 25a. Antarctic (Dome C) temperature relative to last 10 ky (Jouzel et al., 2007) on AICC2012 time scale and CO_2 amount (Luthi et al., 2008). Temperature scale is such that standard deviation of T and CO_2 are equal, yielding ΔT (°C) = 0.114 ΔCO_2 (ppm). References provided in our ACPD paper.

The tight fit of CO_2 and Antarctic temperature (Fig. 25a) implies an equilibrium Antarctic sensitivity 20°C for 2×CO_2 (4 W/m^2) forcing (200 → 300 ppm forcing is ~2.3 W/m^2, Table 1 of Hansen et al., 2000), thus 10°C global climate sensitivity (Antarctic temperature change is ~ twice global change) with CO_2 taken as the ultimate control knob, i.e., if snow/ice area and other GHGs are taken to be slaves to CO_2-driven climate change. This implies a conventional climate sensitivity of 4°C for 2×CO_2, as GHG and albedo forcings are similar for glacial-to-interglacial

climate change and non-CO_2 GHGs account for ~20% of the GHG forcing. The inferred sensitivity is reduced to 2.5-3°C for 2×CO_2 if, as some studies suggest, global mean glacial-interglacial temperature change is only about one-third of the Antarctic temperature change (Palaeosens, 2012; Hansen et al., 2013b).

References:

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