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Discussion

Comment on "Thermal pollution causes global warming", by B. Nordell [Global Planet. Change 38 (2003), 305–312]

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The recent paper "Thermal Pollution Causes Global Warming" (Nordell, 2003) reminds us that heat dissipation from nonrenewable energy sources has now become comparable to natural geothermal heat flow. This paper's conclusion, however, contradicts decades of research (beginning with Manabe and Stickler, 1964) and in our view is demonstrably wrong.

Nordell points out that the global average of thermal pollution is about 0.02 W m^{-2}. He compares this number with recent estimates of geothermal heat flow, about 0.09 W m^{-2}. But a more relevant number for comparison is the total radiative energy forcing created by the accumulation of carbon dioxide and other "greenhouse" gases in Earth's atmosphere as a result of fossil fuel burning and other human activities since the industrial revolution. This number is 2.4 W m^{-2} with about a 10% uncertainty (Ramaswamy et al., 2001). It is simply not credible that thermal pollution, more than two orders of magnitude smaller, would produce a greater climate response.

The radiative forcing quoted above is defined as the decrease in net tropopause energy flux from the climate system that would occur if the greenhouse gases increased without any change in atmospheric temperature, moisture, clouds, etc. Of course the real system begins to respond immediately to a change in energy flux, and in that sense radiative forcing is a hypothetical quantity, but it is well defined and firmly established by both spectroscopic observations and theory for CO_2 and other trace gases.

Nordell concludes from a simple model of radiative transfer that a 1.8 K increase in global mean surface temperature is to be expected eventually from thermal pollution. His model divides the atmosphere into a number of layers, each of which is assumed to radiate as a blackbody. Although such a model can be useful in qualitatively discussing Earth's climate (Goody and Walker, 1972), it neglects both atmospheric convection and the extreme variations in optical depth as a function of wavelength that the real atmosphere

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exhibits. Use of this model to precisely infer small (<0.1 W m^{-2}) changes in outgoing longwave radiation and thereby deduce equilibrium global warming is not appropriate.

To sum up, if 0.02 W m^{-2} from thermal pollution will eventually warm Earth's surface by 1.8 K, then anthropogenic greenhouse gas forcing to date (2.4 W m^{-2}) will eventually warm Earth's surface by ~200 K. Despite the thermal inertia of the oceans, etc., which as Nordell points out slows the warming, it seems obvious that the small (~0.6 K) warming observed to date rules out the author's theory. There are many good reasons for society to invest in renewable energy sources–including reducing the greenhouse effect of fossil fuel generated energy–but worry about global mean thermal pollution is not one of them. We hasten to add that local effects of thermal pollution can be significant and warrant further study.

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