On the link between carbon dioxide and particulate matter mortality

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Greenhouse gases and particle soot have been linked to enhanced sea-level, snowmelt, disease, heat stress, severe weather, and ocean acidification, but the effect of carbon dioxide (CO_2) alone on air pollution mortality has not been examined or quantified. Here, it is shown that increased temperatures from higher CO_2 increase particulate matter and ozone and their resulting health effects. A high-resolution global-regional nested model found that CO_2 may increase U.S. annual air pollution deaths by about 1000 (350-1800) and cancers by 20-30 per 1 K rise in CO_2-induced temperature. About 40% of the additional deaths may be due to ozone and the rest, to particles, which increase due to CO_2-enhanced stability, humidity, and biogenic particle mass. An extrapolation by population could render 21,600 (7400-39,000) excess CO_2-caused annual pollution deaths worldwide, more than those from CO_2-enhanced storminess. The study also found that higher carbon dioxide increases air pollution the most in locations where the pollution is already bad. Thus, for example, although it has only 12% of the U.S. population, more than 30% of the increased deaths found in the U.S. occurred in California, which has 6 of the top 10 polluted U.S. cities. The results here provide a basis for regulators to control carbon dioxide based on particle and ozone health grounds.

Application of ladderane lipids as a proxy for past anammox activity

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Anaerobic ammonium oxidation (anammox), performed by bacteria belonging to deep-branching members of the *Planctomycetales* [1, 2], has been recognized as an important process converting fixed inorganic nitrogen to N_2 in many marine environments, therefore having a major influence on the present-day marine nitrogen cycle. Ladderane lipids [3] are unique membrane lipids of anammox bacteria, and consist of up to five linearly concatenated cyclobutane rings, which is unprecedented in nature. In this study, we analyzed the distribution of fossil ladderane lipids in a sediment core from the northern Arabian Sea, which is located in the present-day oxygen minimum zone (OMZ). Concentrations of ladderane lipids varied between 0.3 and 5.3 ng/g sediment during the past 140 kyr, with high values observed during the Holocene, several interstadials during the last glacial as well as during the Eemian warm period. Maxima in ladderane lipid abundances correlate well with high TOC (6-9%) and $\delta^{15}N$ (>8‰) values indicating enhanced anammox activity in the water column during periods of an intense OMZ. Our data suggest that anammox constituted an important sink for fixed inorganic nitrogen in the Arabian Sea over the last glacial cycle, thereby having a substantial impact on the past oceanic nitrogen budget, which was so far attributed to heterotrophic denitrification.

[1] Van de Graaf *et al.* (1997) *Microbiology* **143**, 2415-2421. [2] Strous *et al.* (1999) *Nature* **400**, 446-449. [3] Sinninghe Damsté *et al.* (2002) *Nature* **419**, 708-712.