ANL/ER/PP-855343

LONGWAVE RADIATIVE FORCING BY AQUEOUS AEROSOLS

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Submitted to Nature

January 1995

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This work was performed for the United States Department of Energy, Office of Energy Research, Office of Health and Environmental Research Atmospheric Chemistry Program, under Contract W-31-109-ENG-38. This work was performed at Argonne National Laboratory.

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Sir:

Recently, a great deal of interest has been focussed on the role of aerosols in climatic change because of their potential cooling impacts due to light scattering.¹⁻⁴

Wigley⁴ has suggested that unless the effects of aerosols are included in projections of climatic change, our estimates may contain large errors in radiative balance and in some cases may have the wrong sign. In addition, K.E. Taylor and J.E. Penner reported in their letter of June 1994³ that, the climate response (or sensitivity) to longwave CO₂-induced forcing may differ from the response to shortwave aerosol forcing due to light scattering and therefore may not be directly additive. We wish to point out there is an equally important climatic balance arising from the longwave absorption of the aerosol species themselves which has been neglected.⁵⁻⁷.

Recent advances in infrared spectroscopy using cylindrical internal reflectance have allowed the longwave absorption of dissolved aerosol species and the associated liquid water to be accurately determined and evaluated⁵⁻⁶. Experimental measurements using these techniques have shown that dissolved sulfate, nitrate, and numerous other aerosol species will act to cause greenhouse effects. That is they will actively absorb infrared radiation in the troposphere as well as scatter incoming radiation.¹⁻⁴ Their absorption bands are located in the atmospheric window region where the major

greenhouse gases (e.g. CO_2 , CH_4 , etc.) do not absorb and thus, their impact is maximized. In addition, their absorption bands are very broad (240 cm^{-1} for sulfate) compared to those for the trace greenhouse gasses ($40 - 80 \text{ cm}^{-1}$) for the chlorofluorocarbons (CFC's) with integrated intensities an order of magnitude higher.⁵

Our preliminary calculations indicate that the longwave climate forcing (i.e., heating)⁵ for sulfate aerosol will be comparable in magnitude to the cooling effect produced by light scattering.¹⁻⁴ However, more detailed modelling will clearly be needed to address the impact of the longwave forcing due to aerosols as a function of atmospheric height and composition. Our work has shown that aerosol composition will be important in determining longwave forcing,⁵ while shortwave forcing will be more related to the physical size of the aerosol droplets.¹⁻⁴ On the basis of these studies, it is increasingly apparent that aerosols, fogs, and clouds play a key role in determining the radiative balance of our atmosphere and in controlling regional and global climates. As our understanding of the climate system increases, the factors affecting our projections of climate forcing become ever more complicated and the results become farther removed from those obtained for CO_2 forcing alone. However, unless an attempt is made to include these competing factors in climate change calculations, the modelling will never come close to predicting the overall response of the climate system to

anthropogenic emissions.

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