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LETTER TO THE EDITOR

An assessment of the impact of pollution on global cloud albedo: comment

By J. HEINTZENBERG and J. A. OGREN, *Department of Meteorology, University of Stockholm, S-10691 Stockholm, Sweden*

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1. Introduction

Recently, Twomey et al. (1984) have made an attempt to assess the impact of light absorbing and cloud-forming particles on global cloud albedo. We welcome the approach of analysing the overall effect of an increasing atmospheric aerosol burden which, in principle, may lead to either increase or decrease of the planetary albedo. Moreover, the problem of the "dirty cloud", concerning the possible enhancement or damping of aerosol light absorption after incorporation of the absorbing particles into cloud elements, deserves continued attention, which may be stimulated by studies such as presented by Twomey et al. (1984). However, the paper has a number of shortcomings which affect the conclusions that can be drawn from the results.

2. Data base

As a means to determine the absorption properties of the aerosol, Twomey et al. (1984) collected particles (a) with an impactor having 50% collection efficiency at 0.8 μm radius (presuming their particle size parameter is the radius); (b) on unspecified Nuclepore filters. They were to some extent aware of the inadequacy of their samplers but greatly underestimated the possible systematic error in their absorption results. A number of studies in urban air (Countess et al., 1981; Heintzenberg, 1982b; Heintzenberg and Covert, 1984; Heintzenberg and Winkler, 1984) consistently yielded mass median radii between 0.1 and 0.2 μm for the light-absorbing particles. During atmospheric conditions with little total aerosol surface available for diffusional collection of the primary carbon particles, up to 70% of the light absorbing mass was found below 0.15 μm (Heintzenberg and Winkler, 1984).

In arctic haze, which can be compared to remote continental aerosols, the same mass medians were found (Heintzenberg, 1982a). Only in the extremely clean arctic summer, with aerosols with absorption coefficients of about 3×10^{-8} m^{-1}, were mass medians up to 0.4 μm measured (Heintzenberg, 1982a). Hence, a systematic underestimation by at least 90% appears realistic as compared to about 30% as estimated by Twomey et al. (1984).

Further support for the contention that Twomey et al. (1984) underestimated absorption levels is provided by similar measurements at a remote site near Flagstaff, Arizona, reported by Waggoner et al. (1981). The aerosol scattering coefficients observed by Waggoner et al. (1981) were very similar to those reported by Twomey et al. (1984) (mean value 1.9×10^{-5} m^{-1}). However, the mean absorption coefficient measured by Waggoner et al. (1981) was 1.2×10^{-6} m^{-1}, roughly an order of magnitude larger than what Twomey et al. (1984) observed at Mt. Lemmon, Arizona. As a result, the mean single-scattering albedo of 0.94 reported by Waggoner et al., (1981) is substantially lower than the value used by Twomey et al., (1984).

Finally, Twomey et al. (1984) quote Ogren and Charlson (1983) to support the argument that their impactor samples were representative. While it is possible to pick a set of parameters from Table 1 of Ogren and Charlson (1983) which yields most of

the elemental carbon in the size range larger 0.1 μm, it is also possible to select a set of parameters which yields the opposite result. It is much more reasonable to estimate the size distribution of the absorbing particles from the measurements quoted above than to use a table of values that were simply input values to a sensitivity study.

3. Discussion of results

The failure of Twomey et al. (1984) to correctly measure aerosol absorption makes an interpretation of their Fig. 4 tenuous at best. It is easy to envision a limit line with a much steeper slope than that used by Twomey et al. (1984). It would be a valuable exercise to test the effect on their conclusions of changes in the slope as well as intercept of the line defining the relationship between absorption coefficient and cloud condensation nucleus concentration. In general, it would have been more valuable to explore the problem at hand by means of extensive model calculations with varying aerosol and cloud properties instead of to present inconclusive results based on poor atmospheric data.

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