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IMPORTANCE OF SPECTRAL SHAPE IN CLOUD PARAMETERIZATIONS AND INDIRECT AEROSOL EFFECTS

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ABSTRACT

This work expands on our previous studies on the role that the relative dispersion of the cloud droplet size distribution have in improving cloud parameterizations in climate models and evaluation of indirect aerosol effects. First we demonstrate the importance of the spectral shape in determining the effective radius and cloud radiative properties. Then we show that the relative dispersion of the cloud droplet size distribution changes when pre-cloud aerosol properties change. Especially, we present more observational evidence that an increase the droplet concentration caused by increased aerosol loading results in an increase in the relative dispersion, leading to a dispersion effect that negates the Twomey effect. The dispersion effect is further parameterized as a power-law function the ratio of the liquid water content and droplet number concentration, leading to a new formalism that generalizes the commonly used equations. It is found that the dispersion effect offsets the Twomey effect by (33 ± 8.7)% with a 95% confidence level, and increases proportionally with the Twomey effect in magnitude. These results suggest that consideration of the dispersion effect, which has been largely ignored, (partially) resolve two fundamental problems bewildering the study of indirect aerosol effects: the discrepancies between observations and those expected from the Twomey effect, and the large uncertainty in estimates of indirect aerosol effects. The effects of drizzle mode on the spectral shape and hence on the parameterization of cloud radiative properties are also discussed.

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