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DISPERSION BIAS, DISPERSION EFFECT, AND AEROSOL-CLOUD CONUNDRUM

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ABSTRACT

Recent studies have shown that relative dispersion (ratio of the standard deviation to the mean radius of the cloud droplet size distribution) significantly affects effective radius, and that anthropogenic aerosols increase not only cloud droplet number concentration but also relative dispersion, leading to a warming dispersion effect that acts to offset the cooling from the Twomey effect. This work extends the previous studies by further examining the effect of relative dispersion on cloud albedo and cloud radiative forcing, deriving an analytical formulation, and presenting a new approach for representing relative dispersion in climate models. Further analyses show that unrealistic representation of relative dispersion in parameterization of cloud radiative properties in general and evaluation of aerosol indirect effects in particular is at least in part responsible for several outstanding puzzles of the aerosol-cloud conundrum, e.g., overestimation of cloud radiative cooling by climate models compared to satellite observations, large uncertainty and discrepancy in estimates of the aerosol indirect effect, and the lack of difference in cloud albedo between the northern and southern hemispheres. Application of the new formulation to remote sensing spectral shape of the cloud droplet size distribution is also explored.
