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EFFECTS OF SPECTRAL DISPERSION OF CLOUD DROPLET SIZE DISTRIBUTIONS ON RADIATIVE PROPERTIES OF CLOUDS

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Radiative properties of clouds are often expressed as a function of effective radius (defined as the ratio of the third to second moment of the cloud droplet size distribution and denoted by r_e). The value of r_e in turn needs to be parameterized, and the most commonly used parameterization is $r_e = \alpha(L/N)^{1/3}$, where L is the cloud liquid water content, N is the total droplet concentration and α is the prefactor. The principal distinction between existing parameterizations lies in the specification of αas a function of the spectral dispersion (d) of the cloud droplet size distribution. Our previous studies have shown that different treatments of the dependence of α on d in the commonly used parameterizations can result in significant uncertainties in the derived values of r_e. and the uncertainties in parameterized values of r_e increase with increasing d. This study further investigates the effects of $\alpha(d)$ on the evaluation of the radiative properties of clouds, e.g., cloud optical depth, cloud albedo and susceptibility. We first derive the equations that relate these radiative properties to $\alpha(d)$. Uncertainties in these radiative properties estimated from different parameterizations of r_e are then evaluated by applying these equations to different microphysical data sets. These data were collected in continental stratocumulus clouds over the Southern Great Plain (SGP) site of the Atmospheric Radiation Measurements (ARM) program during two recent field projects, and in marine stratus and stratocumulus clouds over the North Atlantic Ocean off the southern tip of Nova Scotia during the 1993 North Atlantic Regional Experiment (NARE). Analysis of comparison reveals the most accurate functional dependence of α on d. Sensitivities of cloud radiative properties to d are studied using this relationship. The importance of d relative to L and N is evaluated in determining these radiative properties of the clouds examined. The results of this study are useful for improving cloud representation in climate models and for remote sensing of cloud properties.

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