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USE OF MICROPHYSICAL RELATIONSHIPS TO DISCERN GROWTH/DECAY MECHANISMS OF CLOUD DROPLETS

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ABSTRACT

A cloud droplet size distribution ---- hence the key microphysical quantities of climate importance (e.g., the total droplet concentration, liquid water content, relative dispersion, mean-volume radius, and effective radius) are determined by different physical mechanisms such as pre-cloud aerosols, cloud updraft and turbulent entrainment-mixing processes. Therefore, the relationships among these microphysical properties are expected to behave differently in response to aerosols, cloud updrafts and turbulent entrainment-mixing processes. For example, an increase in updraft velocity likely leads to an increase in droplet concentration but a decrease in relative dispersion whereas an increase in aerosol loading likely results in increases of relative dispersion and droplet concentration. The effect of entrainment-mixing processes is more complex, with different entrainment-mixing processes leading to different microphysical relationships. Identifying and quantifying the influences on these microphysical relationships of the various mechanisms is critical for accurately representing cloud microphysics in climate models and for reducing the uncertainty in estimates of aerosol indirect effects.

This study seeks to first dissect the effects on the cloud droplet size distribution from aerosols, updraft, and different turbulent entrainment-mixing processes by analyzing the characteristics of the relationships between the relative dispersion, droplet concentration, liquid water content, mean-volume radius, and effective radius calculated from in-situ measurements of cloud droplet size distributions. These relationships are further examined to establish a quantitative expression that relates effective radius to properties of pre-cloud aerosols, updraft and intensity of turbulence for use in cloud parameterizations and in evaluation of the aerosol indirect effect. Measurements taken from different projects with varying aerosol and dynamical properties and at different locations/times of clouds ranging from cloud adiabatic cores to cloud tops are analyzed to cover as many scenarios as possible.
