BNL-73885-2005-AB

# GENERALIZED EXPRESSIONS FOR EFFECTIVE RADIUS, CLOUD RADIATIVE PROPERTIES AND THEIR APPLICATION TO STUDIES OF THE FIRST INDIRECT AEROSOL EFFECT

P. H. Daum and Y. Liu
Atmospheric Sciences Division
Brookhaven National Laboratory
Upton, NY 11973-5000

February 2005

For presentation at the
2005 ARM Science Team Meeting
Daytona Beach, FL
March 14-18, 2005

**ABSTRACT**

Radiative properties of clouds are often expressed as a function of effective radius re defined as the ratio of the third to the second moment of the cloud droplet size distribution, and the value of re in turn is parameterized as a "1/3" power-law: re = a(L/N)^1/3 where L is the cloud liquid water content, N is the cloud droplet number concentration and a is an increasing function of the relative dispersion of the cloud droplet size distribution.

We have recently shown that the relative dispersion of the cloud droplet size distribution increases concurrently with the droplet concentration leading to a dispersion effect that significantly diminishes the Twomey effect. However, evaluation of the relationship between the relative dispersion and droplet concentration from ambient data is highly uncertain because differences in cloud dynamics from cloud to cloud, as well as from point to point in a single cloud, cause variations in L as well as N. Here we seek to reduce the uncertainties in the parameterization of dispersion effect caused by cloud dynamics by showing that the parameter a is well represented by another power-law: a = b(L/N)^-c. A new power-law that has an exponent (1/3-c) < 1/3 due to the dispersion effect is then obtained for the effective radius. This new power-law, which has (L/N) as the independent variable, is then used to generalize various expressions for studying cloud radiative properties and the first indirect aerosol effect. These new expressions are used to estimate the effect of relative dispersion on the magnitude of the first indirect aerosol effect.

---

Research by BNL investigators was performed under the auspices of the U.S. Department of Energy under Contract No. DE-AC02-98CH10886.