A Long-term Study of Aerosol–cloud Interactions and Their Radiative Effect at a Mid-latitude Continental Site Using Ground-based Measurements

E.T. Sena[1], A. McComiskey[2] and G. Feingold[3]

[1]Institute of Physics, University of São Paulo, São Paulo, Brazil; 55-11-30916925, E-mail: elisatsena@gmail.com
[2]NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO 80305
[3]NOAA Earth System Research Laboratory, Chemical Sciences Division (CSD), Boulder, CO 80305

Empirical estimates of the microphysical response of cloud droplet size distribution to aerosol perturbations are commonly used to constrain aerosol–cloud interactions in climate models. Instead of empirical microphysical estimates, here macroscopic variables are analyzed to address the influences of aerosol particles and meteorological descriptors on instantaneous cloud albedo and radiative effect of shallow liquid water clouds. Long-term ground-based measurements from the Atmospheric Radiation Measurement Program over the Southern Great Plains are used. A broad statistical analysis was performed on 14 years of coincident measurements of low clouds, aerosol, and meteorological properties. Two cases representing conflicting results regarding the relationship between the aerosol and the cloud radiative effect were selected and studied in greater detail. Microphysical estimates are shown to be very uncertain and to depend strongly on the methodology, retrieval technique, and averaging scale. For this continental site, the results indicate that the influence of aerosol on shallow cloud radiative effect and albedo is weak and that macroscopic cloud properties and dynamics play a much larger role in determining the instantaneous cloud radiative effect compared to microphysical effects.

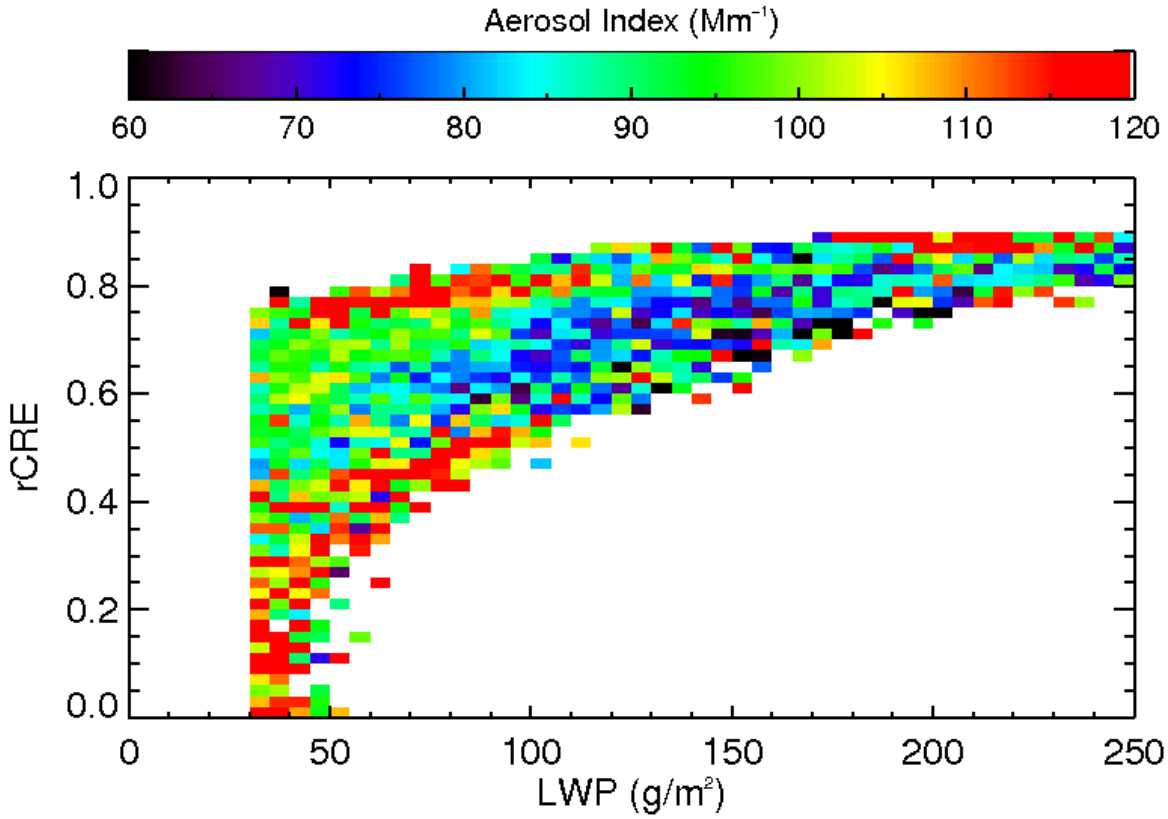

Figure 1. Relative cloud radiative effect (rCRE) as a function of liquid water path (LWP) colored by 14-year averaged aerosol index (A_i) observed for low clouds at the Southern Great Plains, Oklahoma.