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Quantifying Aerosol influences on the Cloud Radiative Effect

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Although evidence of aerosol influences on the microphysical properties of shallow liquid cloud fields abounds, a rigorous assessment of aerosol effects on the *radiative properties* of these clouds has proved to be elusive because of adjustments in the evolving cloud system. We will demonstrate through large numbers of idealized large eddy simulation and 14 years of surface-based remote sensing at a continental US site that the existence of a detectable cloud microphysical response to aerosol perturbations is neither a necessary, nor a sufficient condition for detectability of a radiative response. We will use a new framework that focuses on the cloud field properties that most influence shortwave radiation, e.g., cloud fraction, albedo, and liquid water path. In this framework, scene albedo is shown to be a robust function of cloud fraction for a variety of cloud systems, and appears to be insensitive to averaging scale. The albedo-cloud fraction framework will be used to quantify the cloud radiative effect of shallow liquid clouds and to demonstrate (i) the primacy of cloud field properties such as cloud fraction and liquid water path for driving the cloud radiative effect; and (ii) that the co-variability between meteorological and aerosol drivers has a strong influence on the detectability of the cloud radiative effect, regardless of whether a microphysical response is detected. A broad methodology for systematically quantifying the cloud radiative effect will be presented.