

Clouds and radiatively induced circulations (Invited Chapter for the AGU Geophysical Monograph Series “Cloud Physics and Dynamics: Showers and Shade from Earth’s Atmosphere”)

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Abstract

In the atmosphere, there is an intimate relationship between clouds, atmospheric radiative cooling/heating, and radiatively induced circulations at various temporal and spatial scales. This coupling remains not well understood, which contributes to limiting our ability to model and predict clouds and climate accurately. Cloud liquid and ice particles interact with both shortwave (SW) and longwave (LW) radiation, leading to cloud radiative effect (CRE). The CRE includes perturbations of the radiative fluxes at the top of the atmosphere (TOA) and the surface, as well as perturbations of the radiative cooling profile within the atmosphere. The effect of clouds that results in atmospheric radiative heating or cooling that is distinct from the clear-sky radiative cooling profile will be termed the CRE on atmospheric heating, or CRE-AH. The CRE-AH can significantly modify the horizontal and vertical gradients of the diabatic heating profile, inducing circulations at various scales in the atmosphere. In turn, circulations govern cloud formation and evolution processes and therefore the properties and distribution of clouds.