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直接数値シミュレーションに基づいた積雲での乱流クラスタリングによる粒子性 Bragg 散乱の解析
Analysis of particulate Bragg scattering due to turbulent clustering in cumuli based on direct numerical simulations

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Radar observation is one of powerful tools to obtain data regarding the cloud physics. The radar observation data are analyzed based on the relation between the radar reflectivity factor and the cloud physical properties. In most cases, the relation derived assuming homogeneity and randomness of particle distributions is used. However, spatial correlations of cloud droplets cause particulate Bragg scattering, which increases the reflected microwave intensity in radar observations. The particulate Bragg scattering is assumed to be insignificant in clouds for a long time. However, the particulate Bragg scattering can be significant due to cloud turbulence. One of the turbulence effects in clouds is turbulent droplet clustering: cloud turbulence generates microscale clusters of cloud droplets due to centrifugal effects. The authors' group performed a three-dimensional direct numerical simulation (DNS) of particle-laden isotropic turbulence and revealed that the influence of turbulent clustering can be a cause of significant error in radar observation of clouds (Matsuda et al., J. Atmos. Sci., 2014). The DNS was performed under the conditions with monodispersed droplets: all droplets in a domain have the same size. This study aims to investigate the influence of turbulent clustering on the radar reflectivity factor for the case of polydispersed cloud droplets; i.e., droplet size distribution in cumulus clouds are considered in the DNS. In the DNS, an isotropic turbulence is generated by solving the Navier-Stokes equation without any turbulence model and a large number of droplet motions are tracked by the Lagrangian method. The clustering data are used to calculate the intensity of scattering microwave considering particulate Bragg scattering. The radar reflectivity factor is calculated from the scattering intensity. We will show the results of the radar reflectivity factor analysis comparing with the factor based on the turbulent clustering data for monodispersed droplets, and discuss the influence of turbulent clustering on radar cloud observations.

キーワード: 直接数値シミュレーション, 乱流クラスタリング, レーダ反射因子
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