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THREE-DIMENSIONAL TOMOGRAPHY OF CLOUD MICROPHYSICS BY COMBINING MICROWAVE RADAR AND RADIOMETER MEASUREMENTS

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ABSTRACT

Three-dimensional (3D) imaging of the cloudy atmosphere relies mainly on either cloud radars or microwave radiometers. These instruments are actually complementary in nature as microwave radiometers measure path-integrated water content while cloud radars provide range-resolved reflectivity. Combining these active and passive measurements enables us to relax or even eliminate some of the assumptions underlying the retrieval algorithms, and offers the promise for obtaining more cloud properties than using each sensor in isolation. In this work, we first describe the use of radar data to constrain a passive cloud tomography retrieval: either to derive cloud boundaries (single-frequency radar) or to derive initial estimates of the cloud liquid water content field (dual-frequency radar). The simulation experiments show that adding radar data to microwave cloud tomography substantially improves the retrieval accuracy. The use of radar data allows two radiometers to achieve the same retrieval accuracy as eight radiometers without radar data. We then show that it is no longer necessary to assume a constant drop number concentration to retrieve effective radius when combining microwave cloud tomography and radar measurements. We will also explore the potential to obtain 3D distributions of cloud liquid water content, drop number concentration, and effective radius by the combined radiometer-radar technique.