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Estimating the vertical profiles of cloud water content in warm rain clouds

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The cloud water content (CWC) in rainy clouds is a crucial parameter to determine the onset and the growth rate of precipitation, and to quantify the associated latent heating rate. No direct retrieval of CWC in rainy cloud from satellite observations is reported due to the difficulties of separating cloud particles from precipitation sized particles. However, based on multiple cloud simulations from the Weather and Research Forecasting (WRF) model, we have found that the CWC profile in warm rains can be well determined by three macro-physical cloud properties of cloud water path (CWP), cloud top height (CTH), and cloud bottom height (CBH). The CBH can be estimated using CWP, CTH and near surface rain rate. We proposed an algorithm with a lookup table for estimating the CWC profile using CWP, CTH and near surface rain rate as inputs. The performance of this algorithm was tested with WRF model simulations and a real drizzle case observed by the CloudSat satellite. Testing verified that the algorithm can retrieve the vertical distribution of CWC correctly with few errors at different spatiotemporal scales. In addition, the algorithm is not confined to particular microphysics schemes and is valid for multiple cloud systems in different areas over the world. This algorithm is expected to improve current knowledge of cloud water content in rainy clouds.