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EVOLUTION OF DROPLET SIZE DISTRIBUTION AND AUTOCONVERSION PARAMETERIZATION IN TURBULENT CLOUDS

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ABSTRACT

Effects from turbulence-induced fluctuations in water vapor saturation on cloud droplet growth are examined using a Brownian diffusion model [McGraw and Liu, 2006]. The model predicts diffusive broadening of the droplet size distribution, tempered by enhanced evaporation-induced drift of droplets to smaller size from vapor depletion, and approach to a stationary condition (Weibull distribution) determined by the balance between diffusion and drift. Monte Carlo simulations of the approach to the stationary limit and of the distribution itself are presented and compared favorably with observation. A key turbulence parameter required by the kinetic potential (KP) theory of drizzle formation is estimated using the new results. The KP theory, in turn, provides new scientific foundation for the critical radius (rc) used in parameterizations for modeling autoconversion. In particular, the KP theoretical determination of rc is used to obtain a systematic generalization of the Sundqvist-type threshold function and a new expression for autoconversion rate [Liu, et al., 2006]. Liu, Y., P. H. Daum, R. McGraw, and R. Wood (2006), "Parameterization of the Autoconversion process. Part II: Generalization of Sundqvist-type parameterizations", J. Atmos. Sci., accepted for publication. McGraw, R. and Y. Liu (2006), "Brownian drift-diffusion model for evolution of droplet size distributions in turbulent clouds", GRL, accepted for publication.
