Relation between Terminal Velocity and VHF Backscatter from Precipitation Particles

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Abstract

The backscatter from precipitation particles observed by the vertically pointed antenna beam of the Chung-Li VHF radar and the drop size distributions measured by a ground-based disdrometer located at the radar site are analyzed and studied in this article. We find that the main body of the drop size distribution can be approximated very well by a Gamma distribution $N_oD^\mu\exp(-\delta D)$. With this property and power-law approximation to the relation between fallspeed $V_T(D)$ and diameter D of the precipitation particle $V_T(D)=AD^B$, the theoretical relationship between terminal velocity V_D and range-corrected VHF backscatter P of the precipitation particles is derived and the result shows that their relation follows a power law in the form of $V_D=\alpha P^\beta$. With the help of asymptotic approximation of Gamma function, we analyze further the relation between α and β and find that their relation can be well approximated by an exponential expression in the form of $\alpha=Ae^{\xi\beta}$, where ξ is governed by radar parameters and the characteristics of the drop size distribution and independent of fallspeed-diameter relation of the precipitation particle. The exponential approximation to the $\alpha-\beta$ relation can be applied to the estimations of precipitation parameters, including rainfall rate and N_o in Gamma drop size distribution, and the data taken from the ground-based disdrometer and the Chung-Li VHF radar validate its applicability.