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A Possible Explanation for the $Z - R$ Parameter Inconsistency when Comparing Stratiform and Convective Rainfall

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The well-known $Z - R$ power law $Z = AR^b$ uses two parameters, A and b, in order to relate rainfall rate R to measured weather radar reflectivity Z. A common method used by researchers is to compute Z and R from disdrometer data and then extract the $A - b$parameter pair from a log-linear line fit to a scatter plot of $Z - R$ pairs. Even though it may seem far more truthful to extract the parameter pair from a fit of radar Z_R versus gauge rainfall rate R_G, the extreme difference in spatial and temporal sampling volumes between radar and rain gauge creates a slew of problems that can generally only be solved by using rain gauge arrays and long sampling averages. Disdrometer derived $A - b$ parameters are easily obtained and can provide information for the study of stratiform versus convective rainfall. However, an inconsistency appears when comparing averaged $A - b$ pairs from various researchers. Values of b range from 1.26 to 1.51 for both stratiform and convective events. Paradoxically the values of Afall into three groups: 150 to 200 for convective; 200 to 400 for stratiform; and 400 to 500 again for convective. This apparent inconsistency can be explained by computing the $A - b$ pair using the gamma DSD coupled with a modified drop terminal velocity model, $v(D) = \alpha D^{\beta} - w$, where w is a somewhat artificial constant vertical velocity of the air above the disdrometer. This model predicts three regions of A, corresponding to $w < 0$, $w = 0$, and $w > 0$, which approximately matches observed data.