Estimation of Effective Raindrop Shape Model from 35 GHz Attenuation and Differential Attenuation

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Rainfall measurements using polarimetric radar observables exploit their sensitivity to the shape-size dependence of raindrops. The equilibrium shape-size relationship of raindrops is well established. For radar applications raindrops are modeled as oblate spheroids with size dependent axial ratios. The relationship between size and axial ratio may be altered by oscillations. Furthermore, the drop shape projected on the plane perpendicular to the radar line-of-sight direction is also affected by drop canting. It is of interest to determine whether or not there is a deviation from the equilibrium shape-size model and to estimate an effective shape model for raindrops from measurements during a rainfall event. For this purpose we propose the use of specific attenuation A_h and specific differential attenuation $\Delta A = A_h - A_v$ at 35 GHz, where h and v denote horizontal and vertical polarization. It is shown that raindrop canting and oscillation affect A_h negligibly and ΔA significantly. Simulations using DSDs from ground based disdrometer measurements indicate that the relationship between A_h and ΔA is sensitive to the raindrop shape model used. For example, power law relationship of the form $A_h = a(\Delta A)^b$ (with both A_h and ΔA having units of dB/km) have the following coefficients for an equilibrium drop shape model ($a = 6.78$, $b = 0.889$) and two different oscillation models ($a = 8.25$, $b = 0.873$; and $a = 8.91$, $b = 0.887$). It is suggested that simultaneous measurements of A_h and ΔA could be used together with simulated A_h - ΔA relationships for determining the presence of drop oscillations and canting and for estimating an effective raindrop shape model during a given rainfall event.

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2. A new technique is presented for determining the presence of drop oscillations and canting and for estimating an effective raindrop shape model during a given rainfall event.
3. The proposed technique can have a significant impact on improving the estimates of rainfall rate using polarimetric radar measurements, which is a topic of current research interest.