Attenuation Correction for Polarimetric Radar Observations at X-, Ku-, and Ka-band Frequencies

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In recent years, dual-polarization radars operating at high frequencies such as X- and K-bands are becoming more popular due to the cost efficiency and portability. However, compared to the traditional S-band radars that are used for weather sensing by National Weather Service (NWS), observations at such frequencies severely suffer from attenuation along the propagation paths due to precipitation. Therefore, for any quantitative applications that use reflectivity and/or differential reflectivity, radar observations should be corrected for attenuation.

Since Hitchfeld and Borden proposed the attenuation correction technique based on empirical relationship between reflectivity and specific attenuation, a number of attenuation correction methodologies have been developed based on reflectivity observations. However, the reflectivity-only based correction algorithms are severely affected by radar measurement errors and system biases. Dual-polarization-based attenuation correction methods have been fairly successful and used widely in the recent years. For example, many operational systems have implemented differential phase-based attenuation correction.

This paper studies the attenuation cause by propagation in rain. A robust attenuation correction methodology based on dual-polarization radar measurements are developed to correct reflectivity and differential reflectivity profiles. The proposed attenuation correction methodology has been implemented and evaluated with CSU-CHILL X-band radar observations, as well as the Ku/Ka-band observations from the National Aeronautics and Space Administration (NASA) Dual-frequency Dual-polarization Doppler Radar (D3R). Cross-comparison between the attenuation corrected measurements and simultaneous S-band observations shows that the retrieved reflectivity and differential reflectivity provide an improvement over the conventional differential phase-based attenuation correction technique, especially for differential reflectivity correction.