Estimation of Attenuation at X-band Using Propagation Phase and Differential Reflectivity

Wei-Yu Chang
Department of Atmospheric Sciences and Institute of Atmospheric
National Central University, Taiwan

Abstract

A X-band radar is relatively smaller, compact and offers finer spatial resolution when compared to a S-band radar but X-band radar measurements are more susceptible to attenuation. Intervening precipitation medium between radar and measurement volume causes attenuation. X-band reflectivity (Z_{HH}) and differential reflectivity (Z_{DR}) are usually underestimated due to the attenuation of radar signal as it propagates through precipitation. It is essential to correct the attenuation effects before any further application.

An attenuation estimation method that uses both differential reflectivity (Z_{DR}) and propagation phase (Φ_{DP}) concurrently is described. The attenuation method is based on variational algorithm. The majority of the attenuation estimation methods use Φ_{DP} only. A detailed observing system simulation experiment (OSSE) was used to evaluate performance of the variational-based method and Φ_{DP}-based methods for attenuation estimation. The variational-based method always estimated more accurate attenuation than Φ_{DP}-based method. Practical utility of the variational-based method attenuation correction was demonstrated using radar field measurements from TEAM-R (Taiwan Experimental Atmospheric Mobile - Radar) during SoWMEX/TiMREX 2008. Accuracy of attenuation corrected X-band measurements in actual field measurements were evaluated by comparing them with collocated NCAR S-band radar measurements. It was shown that the variational-based method is relatively less sensitive to measurement noise in radar observations. There were instances where large artifacts in Z_{DR} and Φ_{DP} due to steep gradients in storm intensity limited usefulness of the variational-based method, Φ_{DP}-based method is used as an alternate. Variational corrected Z_{HH} and Z_{DR} from attenuation corrected X-band radar measurements is also compared with disdrometer observations.