Polarimetric Retrieval of Precipitation Rate in Cold Season using data from ICE-POP 2018

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There have been various radar reflectivity (Z)-based relationships for liquid water equivalent snowfall rate (S) in many studies (Gunn and Marshall 1958; Sekhon and Srivatava 1970; Huang et al. 2010; Szyrmer and Zawadzki 2010; Huang et al. 2015; von Lerber et al. 2017; Bukovcic et al. 2018). Recently, Bukovcic et al. (2018) proposed a new method to retrieve S as a function of specific differential phase (K_{DP}) as well as Z at S-band, and have shown that this relationship may be used universally while the coefficient of Z-S is highly variable in space and time as snowfall characteristics. Moreover, Ryzhkov et al. (2018) showed ice water content (IWC) retrieval method using polarimetric variable (radar reflectivity difference, Z_{DP}) and Z. This also can be used to estimate snowfall rate by considering the linear relationship between IWC and snowfall rate (Bukovcic et al. 2018). The benefit of polarimetric approach is that it is less sensitive to variability of particle size distribution and particle shape. This study compares polarimetric-based precipitation rates using ICE-POP 2018 (International Collaborative Experiments for Pyeongchang 2018 Olympic & Paralympic winter games) dataset with radar reflectivity-based precipitation rates.
The ICE-POP 2018 project has dense networks of radars and microphysical instruments to understand the winter precipitation over complex terrain in Pyeongchang region. Four S-band, 3 C-band, 3 X-band, and Ku- and Ka-band radars cover the region and 19 microphysical sites were deployed during the project. The main supersite of this project, MayHills Supersite (MHS), has 2 weighing gauges, three (W-, K-, and X-band) vertical pointing radars, Doppler lidar, 5 distrometers, and a snowflake camera with a DFIR (Double Fence Inter-comparison Reference).
Polarimetric relationships in the study are the one from Bukovcic et al. (2018) at Ku-band, and a relationship which is a combination of IWC(Z, Z_{DP}) of Ryzhkov et al. (2018) and S(IWC) of Bukovcic et al. (2018). For polarimetric variables, Ku-band of D3R (Dual-frequency, Dual-polarized, Doppler radar; Vega et al. 2014) radar is used. On the other hand, for radar reflectivity, operational S-band radar is used due to a strong attenuation by precipitation at Ku-band. The snowfall rate is retrieved at dendritic growth layer (DGL, at -15 ^{o}C altitude) where good polarimetric signatures appear. The mass changes by snow sublimation and depositional growth calculated from sounding data which is launched at the site near (~2 km) MHS are taken into account for impacts from surrounding environment between DGL and ground. Estimated precipitation rate at ground is compared with that of Pluvio in DFIR at MHS. In the most intensive event of ICE-POP 2018, polarimetric-based retrievals show better performance (correlation of 0.63 and 0.86, respectively) compared to radar reflectivity-based retrievals (correlation of 0.30). We will present the performance of the retrievals for other ICE-POP 2018 events as well.

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