Disdrometer-based C-Band Radar Quantitative

Precipitation Estimation (QPE) in a highly complex terrain region in tropical Colombia.

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Introduction

A realistic representation of the spatio-temporal variability of rainfall together with a skillful quantification of surface precipitation is critical for many practical applications.

Rain gauge networks do not fully capture the high spatio-temporal variability of precipitation: Weather radars provide an excellent source of data to characterize rainfall variability.

However, radars are not able to directly measure surface precipitation highlighting the need for Quantitative Precipitation Estimation techniques (QPE). It is also ideal to have a QPE methodology that allows to assess precipitation uncertainties.

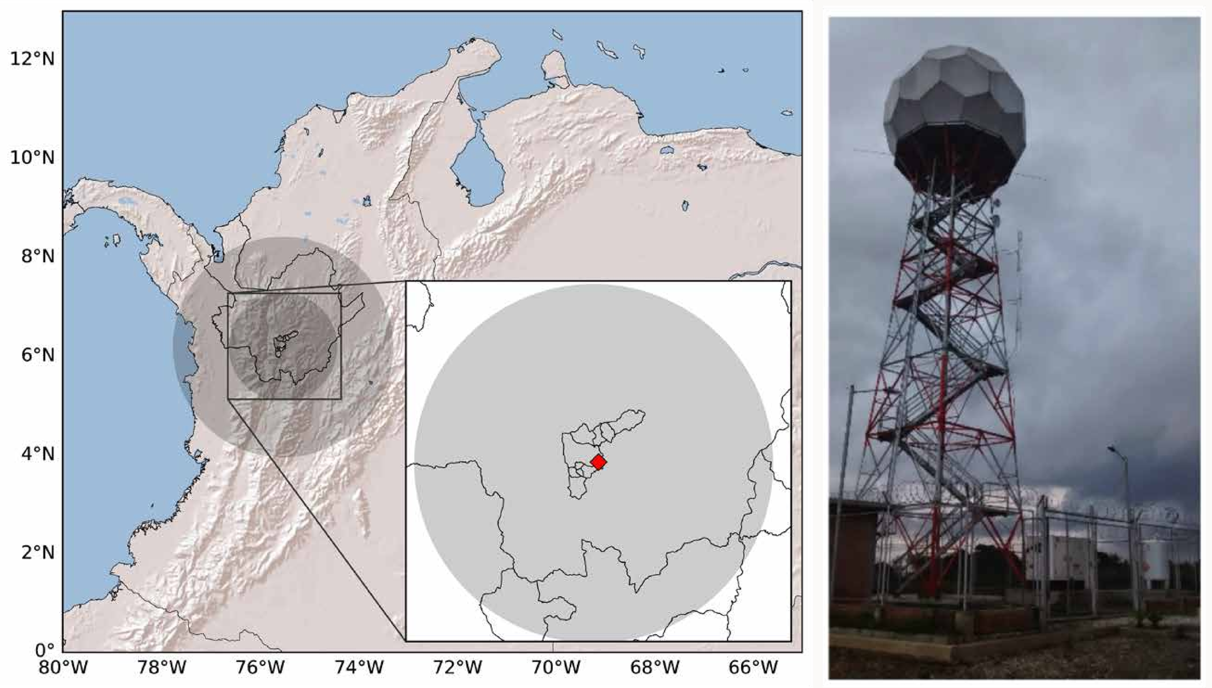

Figure 1. Radar location and study region.
Gray circles correspond to 120 and 240 km range radar seeps.

Data

The QPE algorithm proposed as part of this work uses C-Band radar information (1o elevation and 120 km of range sweeps). The radar is located 6.191oN, 75.5287oW and 2850.0 m a.s.l. (Fig 2). The analysis is performed using 1 year long radar datasets from October 2014 to October 2015 with a time resolution of 5 minutes, integrated with observed rainfall from rain gauges, meteorological stations and disdrometer.

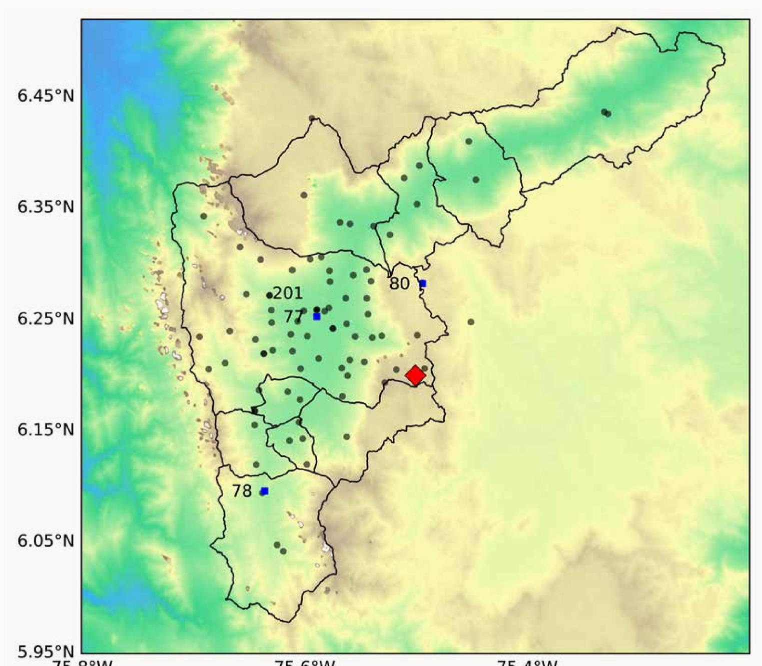

Figure 2. Study region zoom.
Radar (Red dot), disdrometers (Blue dots) and rain gauges (Gray dots) locations.

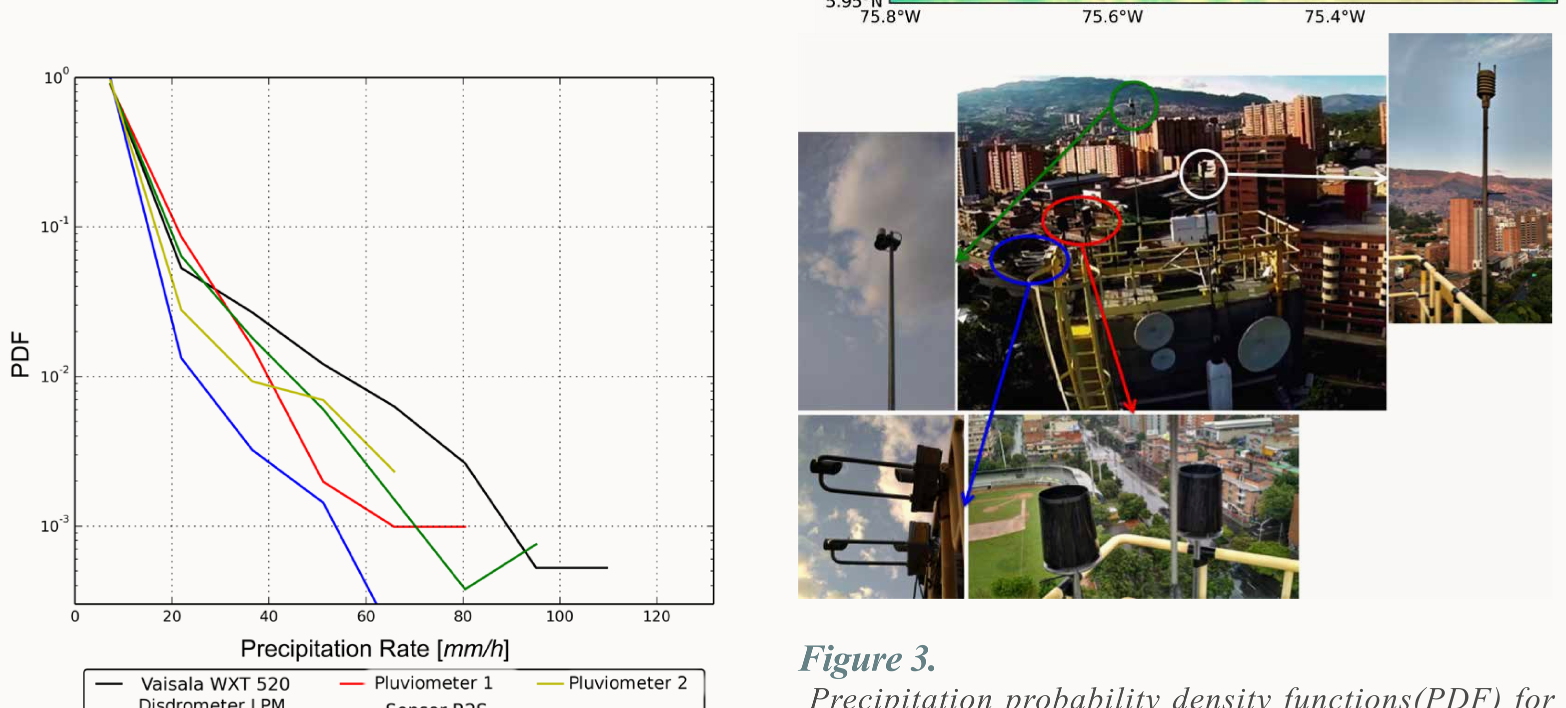

Figure 3.
Precipitation probability density functions(PDF) for different sensors located in same site.

Experimental Methodology

Traditional Methods: ZR Relationship

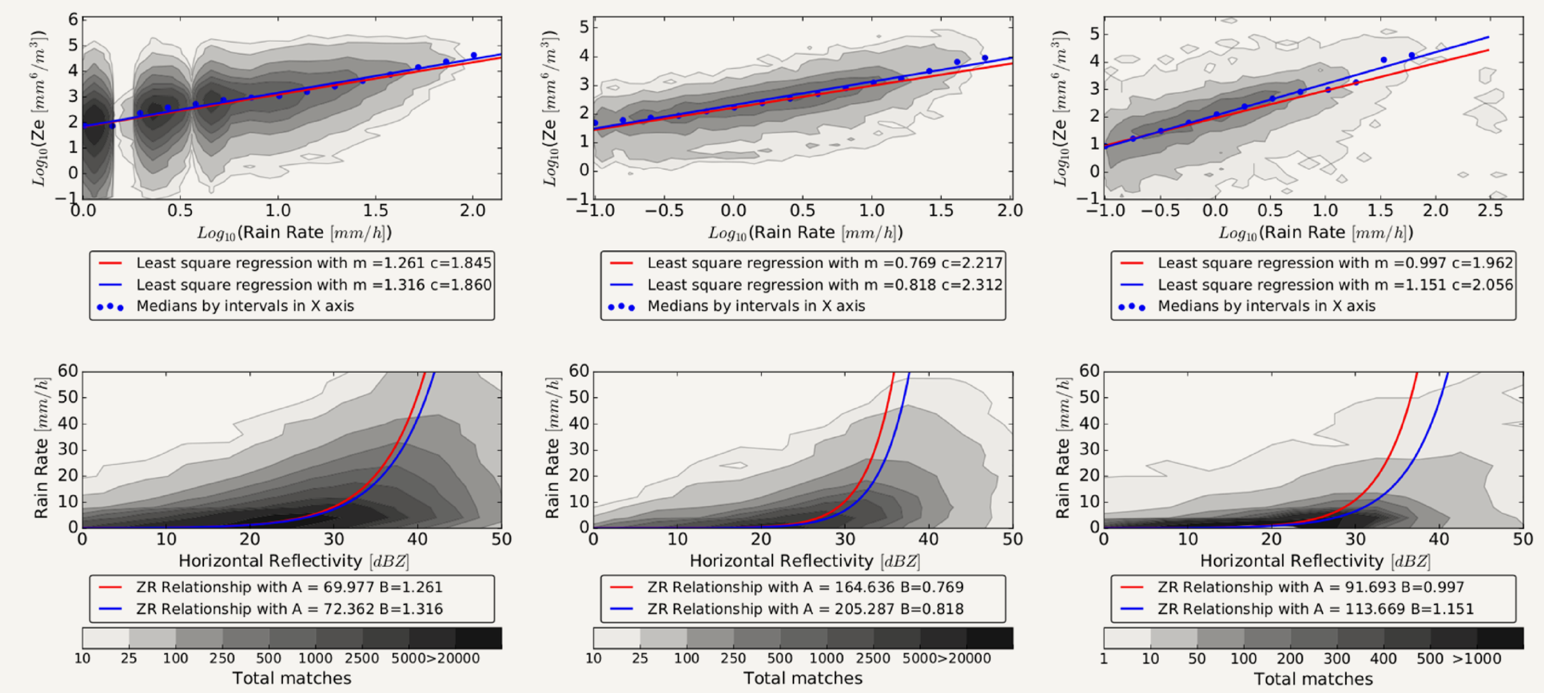

Figure 4.
Fit ZR relationship with data to scale time of 15 minutes.

Two general ZR relationships were developed using Linear Least Square Regression (LLSR). For the First methodology, ZR relationships were estimated using pairs of radar reflectivity and in-situ precipitation rate data (red line). The second methodology (LLSR based) is used to fit medians by intervals of reflectivity (Blue line).

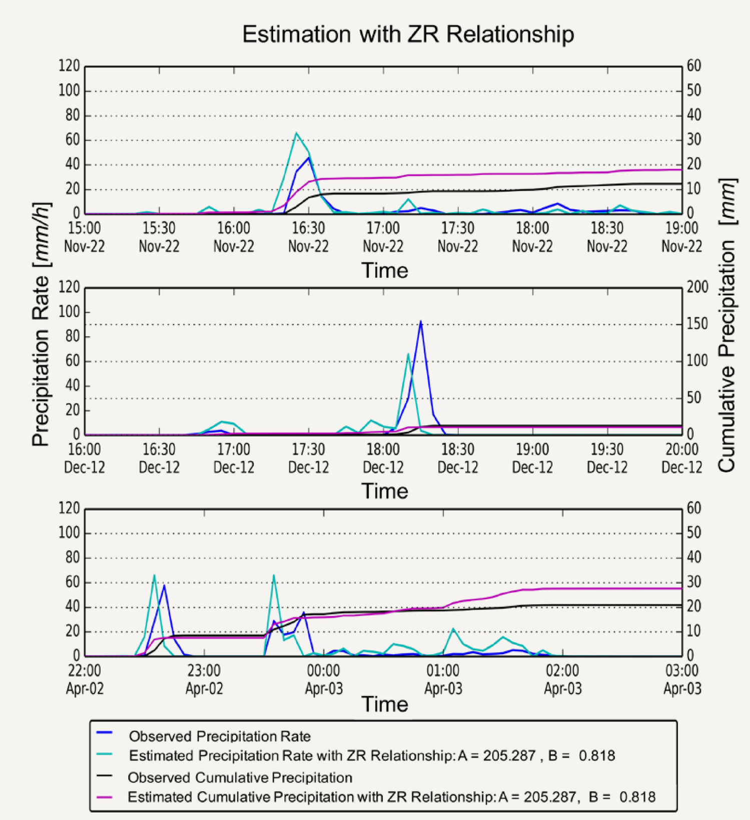

Figure 5.
Cumulative precipitation values estimates with a 15 minutes ZR relationship from meteorological stations data

Multi-Stage Model for QPE

The QPE developed in this work significantly improves over the general ZR relationships. The QPE methodology is a new disdrometer-based multi-stage technique that uses radar reflectivity and disdrometer precipitation spectra in order to estimate precipitation.

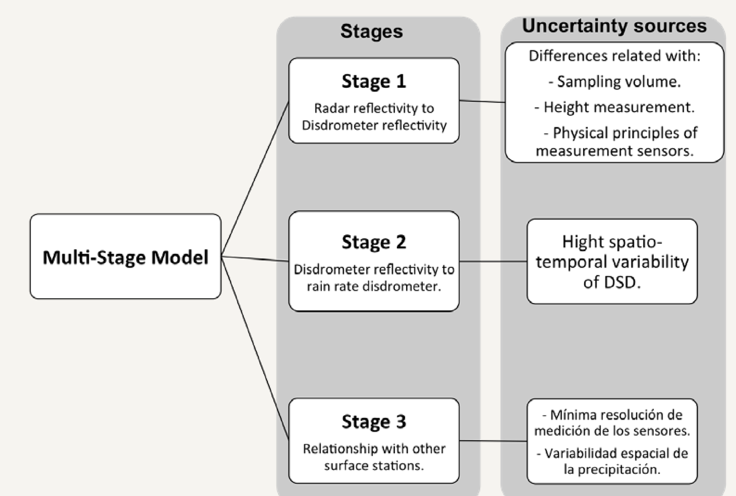

Figure 6.
scheme multi-stage model.

The main advantage of using the multi-stage model compared with traditional models is the possibility of estimating uncertainty for each step of the process.

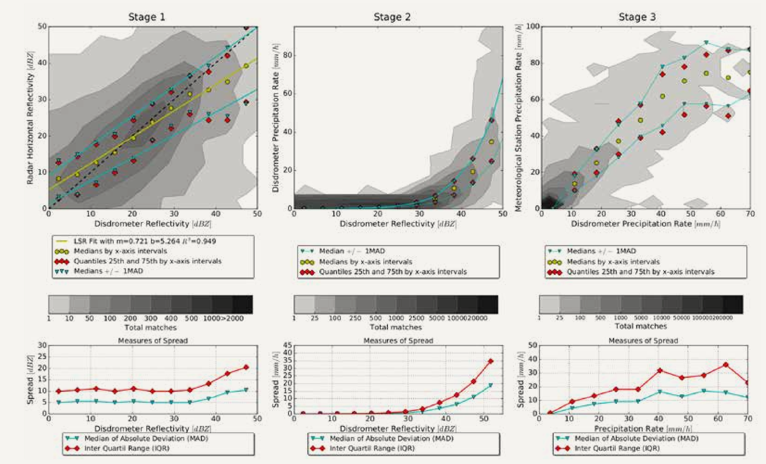

Figure 7.
Multi-stage model with MAD confidence bands

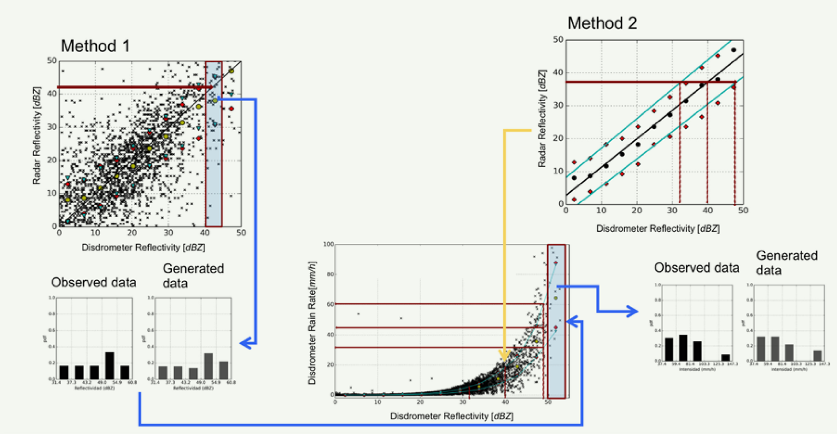

Figure 8.
Estimation of uncertainty using monte-carlos method in stages 2 and 3 of the multi-stage model.

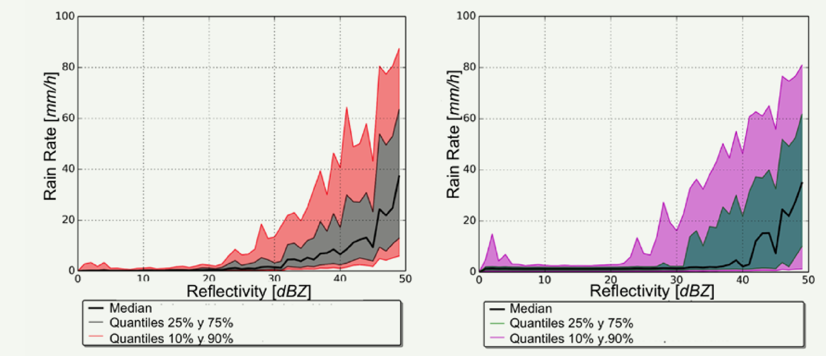

Figure 9.
Scheme of quantification of the uncertainty models.

Two methodologies were used for uncertainty quantification.

Results

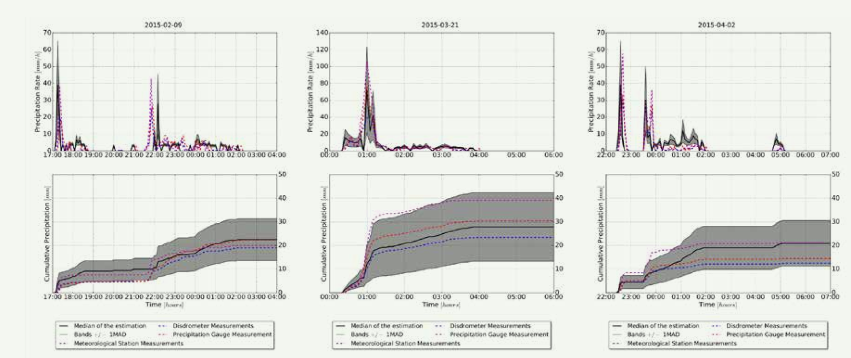

Figure 10.
Results of estimation with multi-stage model.Blue line is the disdrometer precipitation data, pluviometer data (red line), magenta line is the meteorological station records and continuous black line is the estimated precipitation.

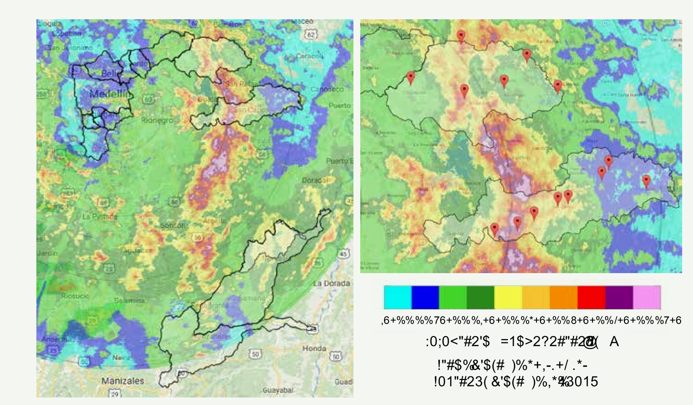

Figure 11.
QPE using the proposed multi-stage model.

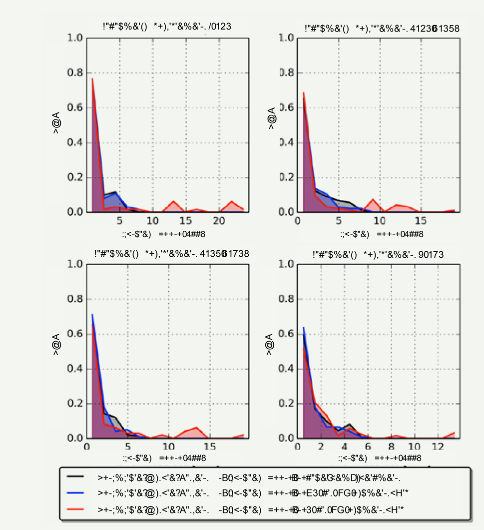

Figure 12.
PDFs of Absolute Error Estimations.

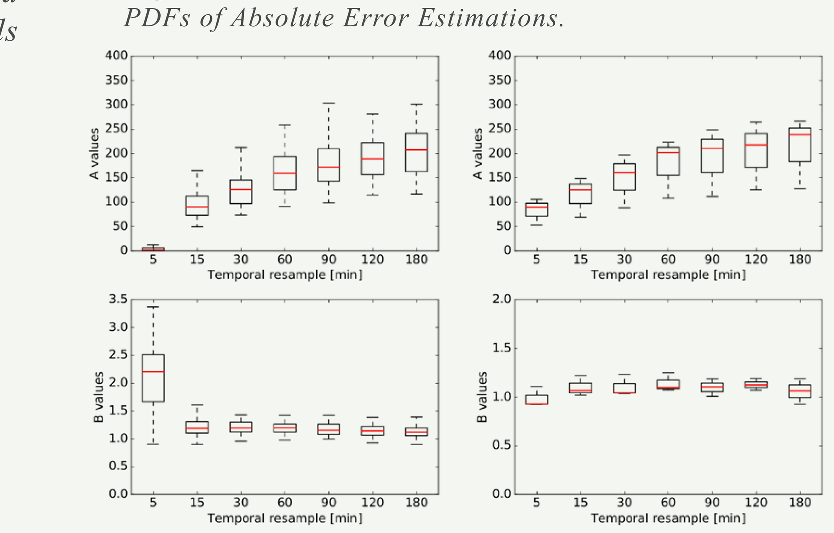

Figure 13.
Behavior of the coefficients A and B for different integration times.

Conclusions

- Precipitation estimates derived from radar variables should always include information about uncertainty (PDF) rather than being presented as deterministic values. Lack of microphysics understanding and rapid drop size variations are the primary source of QPE uncertainty.
- Quantitative precipitation estimates obtained using the proposed disdrometer-based multi-stage model are considerably more skillful than classical ZR methods when compared to observed data.

Bibliography

G. Lee and I. Zawadzki. Radar calibration by gage, disdrometer, and polarimetry: Theoretical limit caused by the variability of drop size distribution and application to fast scanning operational radar data. Journal of Hydrology, 2006.

Acknowledgements

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