The urban effect on precipitation investigated by a 20-year C-band radar dataset

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The urban effect on the precipitation has been investigated by numerical modeling and satellite observation, but seldomly by ground-based radar measurement. Because the impacting distances of urban effect reported by other researchers are within radar coverage, radar measurement should have great potential to investigate the urban effect on precipitation. Stuttgart city is located in one of the largest metropolitan areas in Germany, and a long-term C-band radar 60km away from the Stuttgart is available from 1997 to 2018, with the dual-polarization feature starting from 2013.

To quantitatively depict the spatiotemporal variability of precipitation, we calculate the hourly mean precipitation rate, monthly precipitation, frequency of heavy precipitation, number of convective storms, and also determine morphology of convective storms from radar image. Besides, some of the statistics are compared to their counterparts based on the rainfall measurement of Germany Weather Service (DWD) rain gauge network. According to the Radar-rain gauge (R-G) comparison, our C-band data suffers from attenuation, but the variability of precipitation estimated from radar are consistent and comparable with rain gauge measurements.

We further evaluate C-band radar data by examining the expected orographic effect owing to the unique topographic features in the Stuttgart metropolitan region. After ensuring the viability of C-band radar precipitation measurement, the precipitation pattern unexplained by orographic effect can be attributed to the urban effect.

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