Comprehensive comparison of precipitation measurement systems for convective and non-convective events

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Introduction

During the field phase of Convective and Orographically-induced Precipitation Study (COPS) the Supersite "S" was equipped with several precipitation measuring devices (Fig. 1).
In this study we investigate precipitation measurements for selected IOPs during the COPS field phase. Precipitation data of collocated vertically pointing micro rain radar (MRR), optical disdrometer, and a weighing precipitation gauge are compared with scanning C-band weather radar covering the location of the supersite.

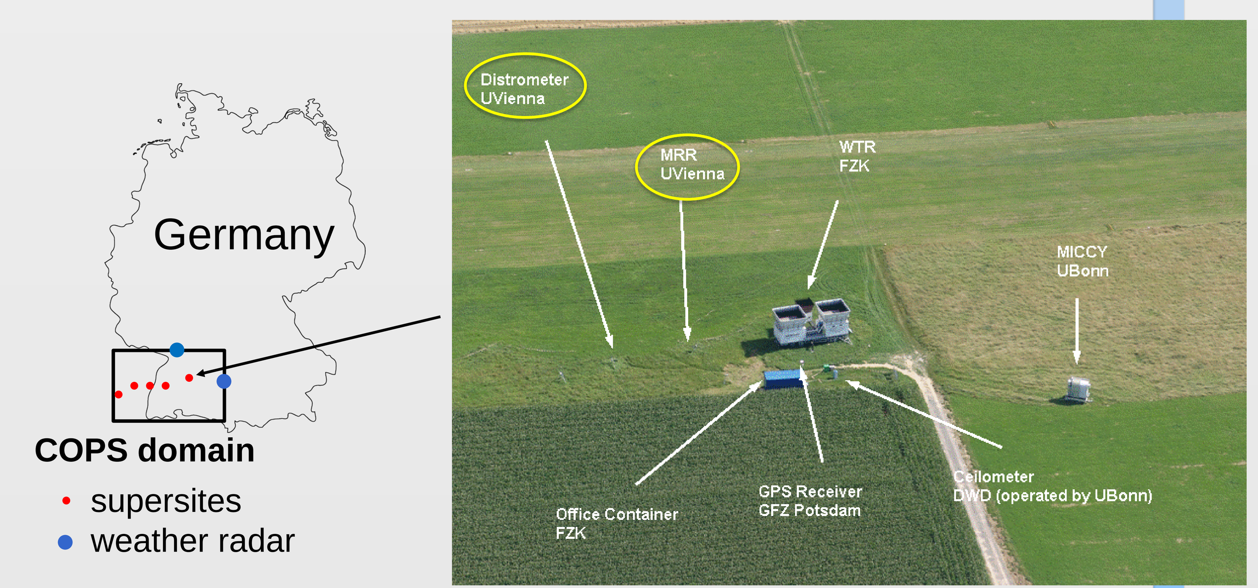


Fig. 1. Location within the COPS domain and aerial view of the supersite S. Some of the instruments used in this study are marked yellow. Weighing gauge was located some meters away from disdrometer.

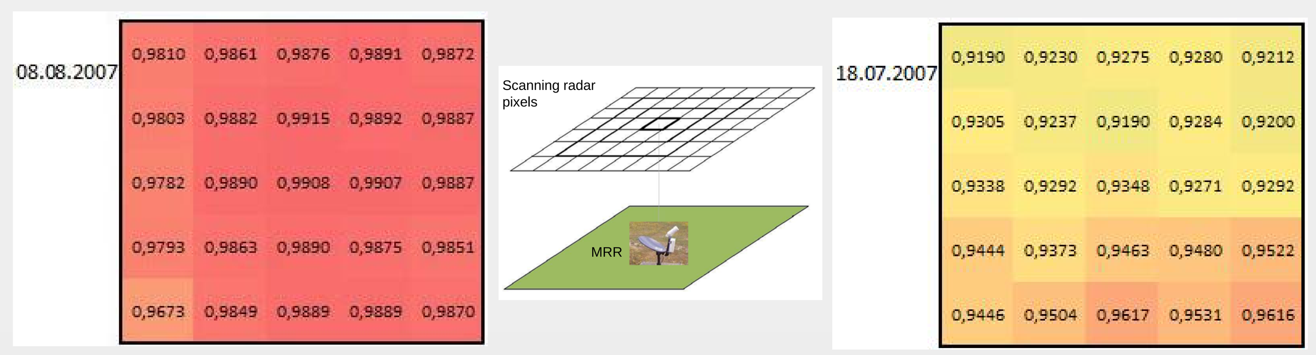
Data

Selected IOPs with precipitation are stratified into convective and non-convective events. Since the sampling characteristics (sample volume, sampling time) varies notably between the instruments used for comparison, appropriate matching of the temporal and spatial scale of the different observations was done with a particular attention given to the differences in the height of the measurements.

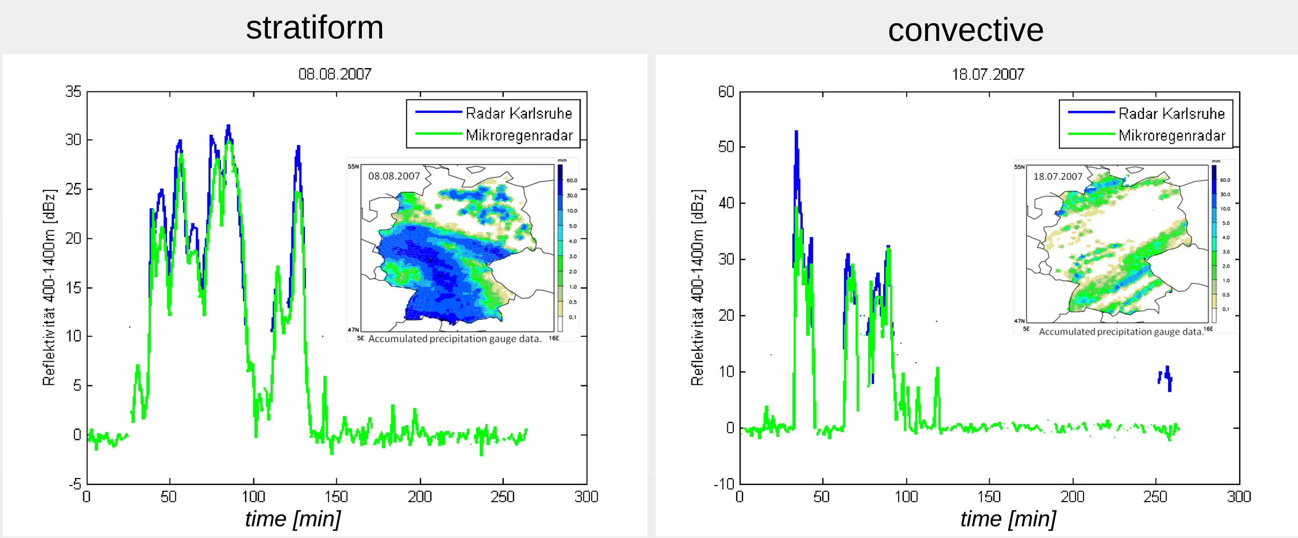
	IOP	Datum
convective	5b	20070702
	6	20070704
	7a	20070708
	9a	20070718
	15a	20070812
	17a	20070821
stratiform	**IOP**	**Datum**
	-	20070721
	14b	20070808
	14c	20070809

Instrument	Provider
scanning radar	KIT Karlsruhe
micro rain radar MRR	Uni Wien
disdrometer PARSIVEL	Uni Wien
rain gauge PLUVIO OTT	Uni Frankfurt

Scanning radar vs. Micro Rain Radar (MRR)

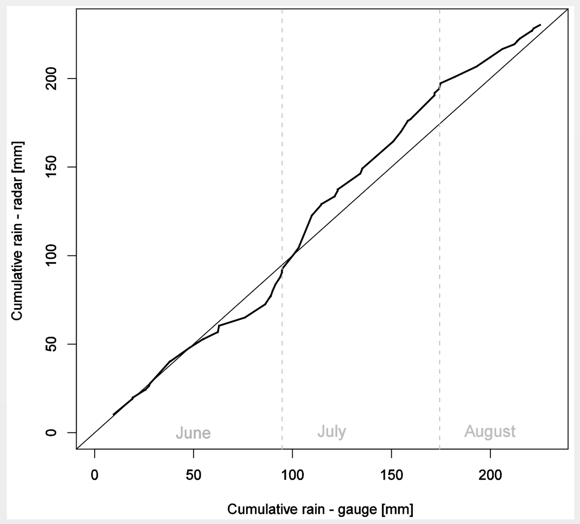


Correlation coefficient calculated between pixels of the scanning radar surrounding the location of MRR (central pixel) and MRR shows the influence of wind drift for convective case between the mean of the corresponding MRR-gates (400m – 1400m) and the height of radar scanning volume (ca. 1000m above MRR position).



Reflectivity time series of two selected precipitation events (stratiform and convective) of the scanning and vertically pointing micro rain radar show similar time evolution.

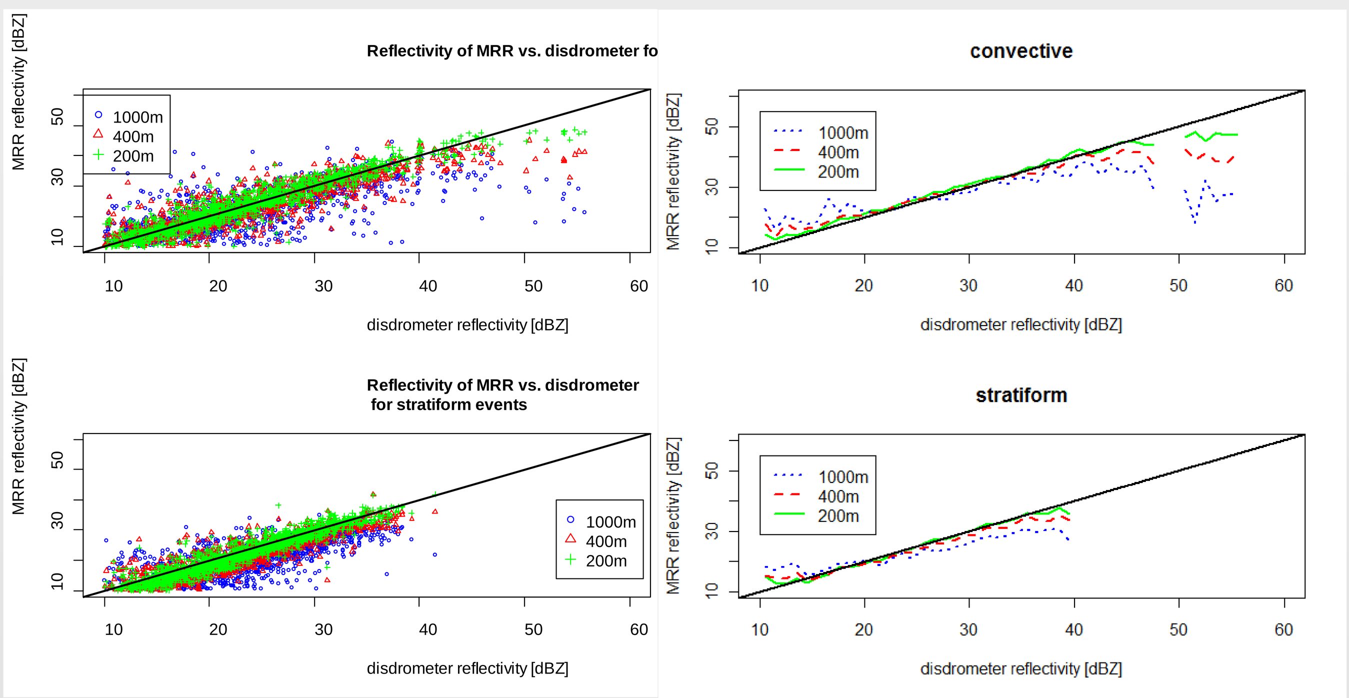
radar vs. gauge



$$B[dB] = 10 \cdot \log_{10}\left(\frac{\sum_i R_i}{\sum_i G_i}\right)$$

For daily precipitation sums including all events, mean bias B of ~30% towards radar precipitation is calculated.

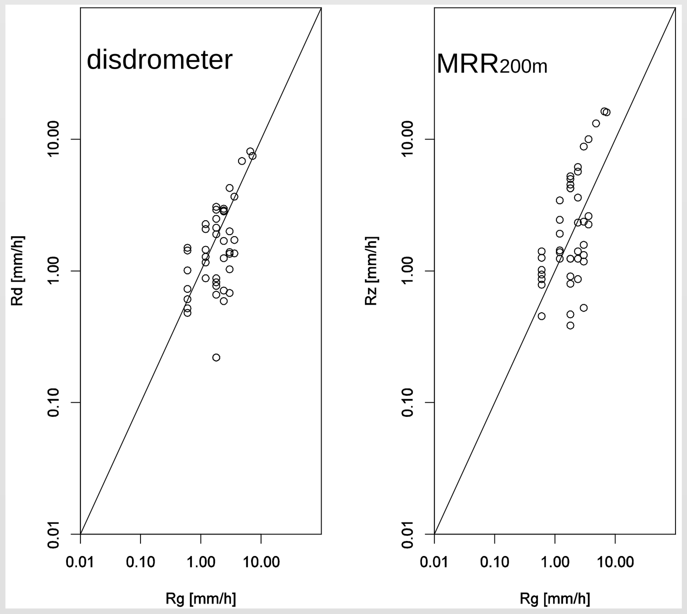
MRR vs. disdrometer

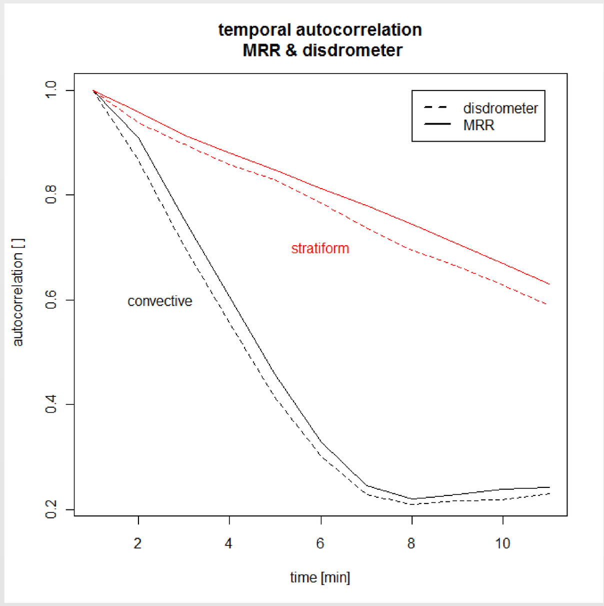


The lowest usable MRR gate (the second gate at 200m) and the lowest range gate that is observable by scanning radar (400m) show reasonable agreement with disdrometer, particularly for the reflectivity range between 20-40 dBZ. The range gate in the overlapping volume with scanning radar shows larger bias for high reflectivity occurrences.

Reflectivity- and height-dependent difference between MRR and disdrometer is detected for both, convective and stratiform events. In stratiform cases this bias towards higher disdrometer reflectivity measurements is even more pronounced.

Close agreement between disdrometer and gauge, and disdrometer and MRR legitimate its use to adjust or calibrate the Z-R relationship of the MRR as vertical extension towards routinely available radar precipitation estimation.

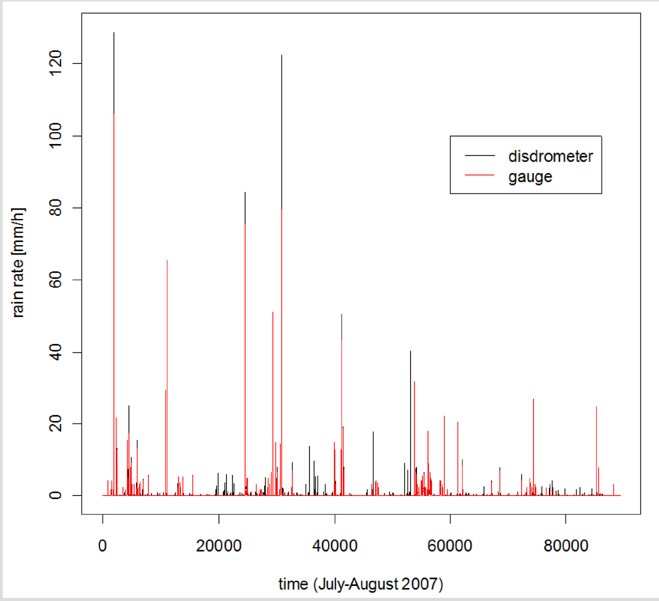




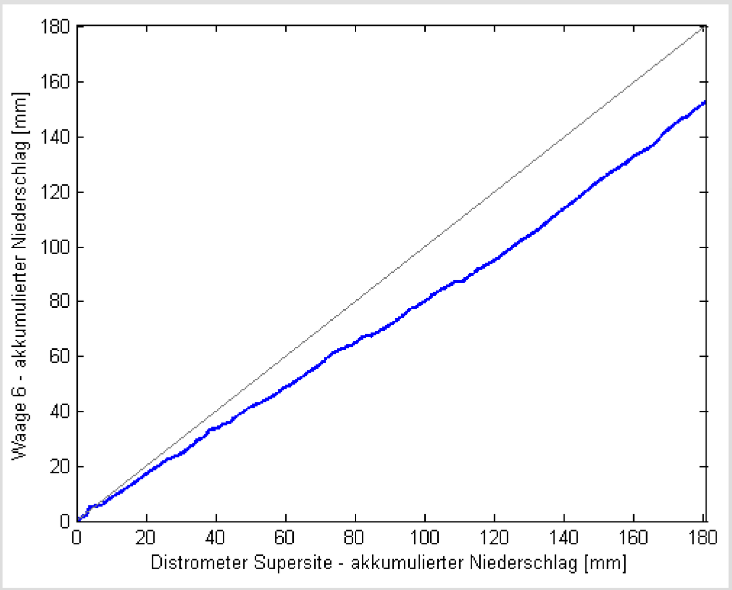
Temporal autocorrelation for selected IOPs (9a and 14b) shows expected behaviour: stratiform precipitation being more persistent in time than convective precipitation.
Both MRR and disdrometer are well correlated for sampling intervals up to 5 minutes.

Rain gauge vs. disdrometer

Timing of precipitation seems to be in good agreement between the gauge and disdrometer. During strong precipitation events, the spikes in disdrometer measurements are larger than those by the gauge, apparently because of the measuring inertia of the weighing gauge.



For the three months of observation (June – August) it comes out that disdrometer detected ~15% more precipitation than the rain gauge. Thorough data quality check should be done because of the sensitivity of disdrometer to report precipitation during clear air situations.



Conclusions

From the elevation of scanning radar over the vertical profiling of a micro rain radar down to the disdrometer and rain gauges on the ground, a whole chain of different precipitation measuring techniques is involved. Analyses of temporal and spatial correlation of precipitation data regarding comparison with scanning radar data show that the time averaging is less a problem than the spatial averaging. Errors due to the wind drift are a limiting factor, particularly for high resolution data.

Between the MRR and disdrometer, there is a reflectivity- and height- dependent bias towards higher disdrometer reflectivity values, increasing with higher range gates of MRR. This bias arises due to the variation of drop size distribution with the height. Therefore, for calibration purposes with MRR only lower range gates should be used and preferably not at very large reflectivity occurrences. Disdrometer seem to be more sensitive for precipitation occurrence but also are more error-prone (precipitation signal in clear air).

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