Impact of merging methods on radar based nowcasting of rainfall.

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1 Motivation and Objectives

- Tracking rainfall storms from radar data is commonly used for rainfall nowcasting at the required resolution for urban models.
- Conditional Merging (CM)[1] combining radar and gauge data has been proven efficient to improve radar estimates.

→ How does this method impact the forecast algorithm results?

→ How suitable is the method for forecasting urban pluvial floods?

2 Study Area and Data

- **Study area :** Hannover Radar, Germany (R ≈128km^2)
- **Gauge data :** 80 stations
- **Radar Data :** raw data (RR), conditional merged (CM)
- **Resolution** : 1 km^2 , 5min
- **Events :** 2 convective, 1 stratiform

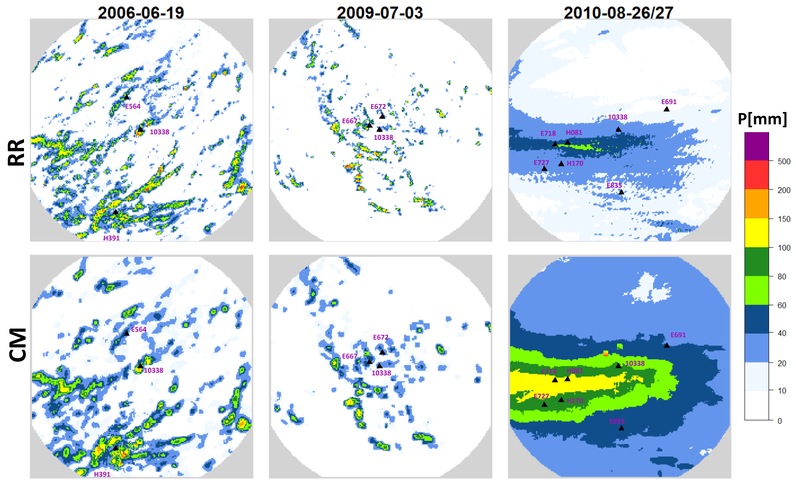

Figure 1: Daily rainfall sum of the selected three events over the study area: upper row – raw radar data (RR) and lower row– conditionally merged data (CM).

- **Forecast algorithm :** HyRaTrac[2]
- **Forecast time: :** 5 min
- **Update Frequency :** 15 min
- **Lead Time :** 30 min

References:
[1]Berndt, C.,Rabiei, E., Haberlandt, U., 2014. Geostatistical merging of rain gauge and radar data for high temporal resolutions and various station density scenarios. Journal of Hydrology, 508: 88-101.
[2] Krämer, S., Fuchs, L., and Verworn. H-R., 2007. Aspects of radar rainfall forecasts and their effectiveness for real time control – the example of the city of Vienna. Water Practice and Technology, 2 (2). Doi:10.2166/wpt.2007.042

3 Performance Assessment

Quantitative Criteria

Stations with P[mm/h] T>20 [a]

$$RMSE[\frac{mm}{5min}] = \sqrt{\frac{\sum_{j=1}^{J}(Z_{i,j}^{*} - Z_{i,j})^2}{J}}$$

$$VOL.ERROR[\%] = 100 \cdot \frac{\sum_{j=1}^{J}(Z_{i,j}^{*}) - \sum_{j=1}^{J}(Z_{i,j})}{\sum_{j=1}^{J}(Z_{i,j})}$$

where: n – no. of stations, J – no. of time steps per event

Categorical Criteria

Alarms: P[mm/h]T>20 [a]

$$Accuracy = \frac{Hit\ Alarms + No-\ Alarms}{Total\ Observed}$$

$$Prob.of\ Detection = \frac{Hit\ Alarms}{Observed\ Alarms}$$

$$Prob.of\ False\ Alarm = \frac{False\ Alarms}{Observed\ No-Alarms}$$

4 Results – Part I

- Comparing time series of forecasted RR and CM radar data

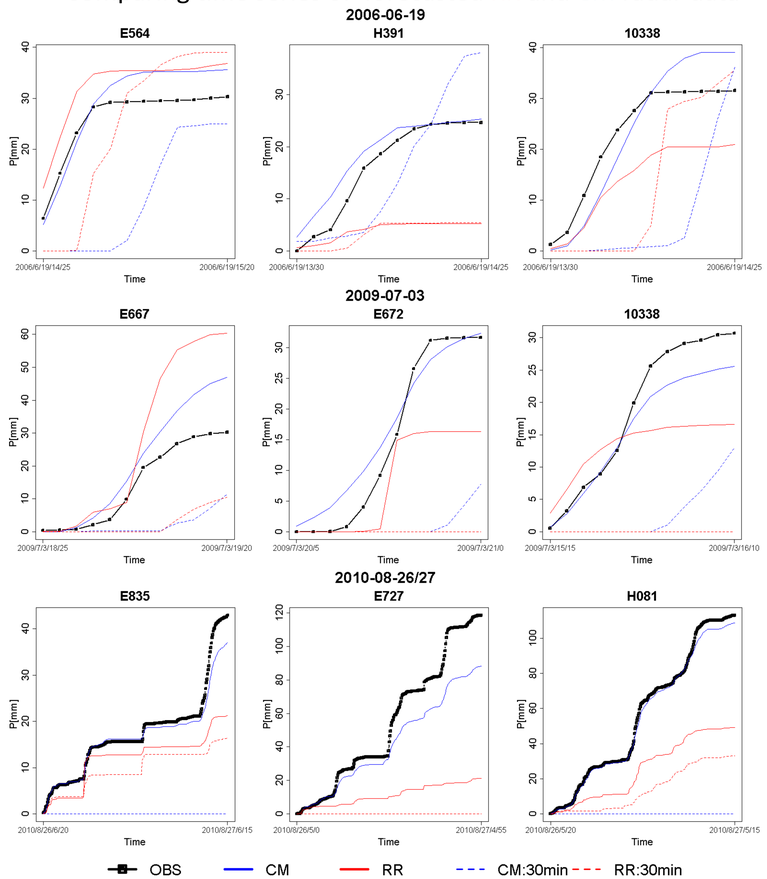

Figure 2: Comparison of the observed cumulative rainfall (solid black line) with the raw radar (solid red line) and CM (solid blue line) radar estimation and the respective forecast rainfall sums with 30 min lead time (CM data - dashed blue line and raw data - dashed red line) for the stations with rainfall sum higher than T=20 years.

4 Results – Part II

Table 1: The volume error and the RMSE for each of the stations and events using raw radar data (RR) and conditional merged data (CM) to estimate the performance of a) radar data compare to station data (rad2obs), b) forecast data with respect to input radar data (for2rad) and c) forecast data compared with observed station data (for2obs).

		VOL.ERROR [%]						RMSE[mm/5min]					
		rad2obs		for2rad		for2obs		rad2obs		for2rad		for2obs	
		RR	CM	RR	CM	RR	CM	RR	CM	RR	CM	RR	CM
1	E564	21.6	17.6	5.9	-30.0	28.8	-17.6	1.84	1.29	7.22	5.65	6.07	5.88
	H391	-78.8	2.7	3.3	50.5	-78.1	54.6	2.36	1.43	0.87	4.19	2.24	4.05
	10338	-33.6	23.7	69.7	-7.6	12.7	14.3	1.64	2.23	6.68	6.76	7.62	6.96
2	E667	99.5	55.0	-82.7	-75.9	-65.5	-62.7	5.53	1.95	8.07	4.32	3.52	3.75
	E672	-48.4	2.2	-100	-76.1	-100.0	-75.5	4.14	1.94	4.19	3.15	1.26	4.47
	10338	-45.9	-16.6	-100	-49.4	-100.0	-57.8	2.67	1.14	1.95	2.80	3.32	3.52
3	E835	-50.5	-13.7	-22.8	-100	-61.8	-100	0.47	0.13	0.34	0.26	0.36	0.34
	E727	-82.2	-25.7	-100	-100	-100	-100	0.85	0.51	0.22	0.47	0.90	0.90
	H081	-56.6	-3.9	-32.8	-100	-70.8	-100	0.53	0.25	0.33	0.53	0.59	0.69

Figure 3: The categorical criteria for each of the events based on alarms forecasted by raw radar (red) and CM data (blue) and alarms observed from the 80 stations within the radar range. Red lines indicate the criteria of the alarms issued by radar data compared to observed data, and black line the alarms forecasted compared to radar data.

5 Conclusion

- The implementation of CM on radar data doesn't necessarily improve the forecast.
- The forecast algorithm performs better with RR data. However the high errors in the RR data cause high overall errors when comparing forecast to observed data.
- The benefit of using CM towards RR is higher in convective events. While for the stratiform event, the forecast was unable to satisfactory predict movements from very smoothed CM data.
- Overall for issuing alarm, the forecast algorithm tends to favour more the use of RR data.
- Adaption of the tracking method to the CM data is necessary to improve the forecast.

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