Interactive comments on “The role of storm dynamics and scale in controlling urban flood response”

Reviewer 1:
The paper presents interesting data-driven analyses of rainfall-runoff processes for flood events using a unique dataset of stream gauges in combination with radar rainfall data.
The paper is well written and easily understood and my comments below are primarily suggestions to further analyses rather than criticism of the conducted work.
AR: we thank the reviewer for his positive comments and valuable suggestions to which we respond below.

1. Page 6 line 27 – page 7 line 9: Please provide information on the 15 min. radardata. Is this an average over 15 min or does it represent a “snaphot-value” in 15 min window? If it is an average over the 15 min I find it difficult to justify the resampling to 30 m resolution since the rainfall can have moved significantly during the 15 min. The must thus be a quite large uncertainty related to the time lag between rainfall and flow and the RWD. We did some studies on advection interpolation of “snapshot” radar data in order to increase the temporal resolution (Nielsen et al., 2014; Thorndahl et al., 2014) which gave much better rainfall estimates (doing mean field bias adjustment) than with the data with a lower temporal resolution. In this case we both resampled in time and space. Maybe this could also have been relevant here in order to reduce the aforementioned uncertainty.
AR: the 15 minute radar rainfall estimates are “snapshot-values”, i.e. the radar beam passes over the area once every 15 minutes. We will clarify this in the data description in section 2.1.
The reason we interpolate to 30 meters is in order to estimate variability in travel distances associated with topography and imperviousness, within the radar pixel. We are aware that the snapshots may not be representative of the entire 15 minute interval, especially for fast moving storms. However, we believe that it sufficiently captures the information for the purpose of our study, i.e. minimum, mean and maximum distance of storm relative to the outlet and movement of storms relative to the flowpath network.

2. I think it could be relevant to address the range of return periods of the analyzed events both in terms of rainfall over specific durations (and areas or fractional coverages) as well as return periods of the flood peaks.
AR: Thanks for this suggestion. We will report return periods for rainfall based on rainfall frequency distributions provided by NOAA for this area*. NOAA provides point rainfall frequency estimates; the closest we can compare to is maximum rainfall intensity values per radar pixel (1x1km2).
Maximum values for 15-min, 1x1 km2 rainfall intensities per event varied from 8.8. to 132 mm/h, associated with return intervals of less than 1 year up to 25 years.
* (https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=nc)

Based on Villarini et al (2009), who reported flood frequency distributions for LowerLittle Sugar Creek and for LHope Creek, flow peaks for our event catalog (max flow peaks per basin resp. 3.4 and 10.4 m3/s/km2) were associated with 100-year return periods in resp. 1990 and 1992, decreasing to 8 resp. 20 years in 2007, according to the Generalised Additive Model they fitted to annual flood peaks in these 2 basins.

3. The definition of flood is somewhat unclear. I guess that many of the events does not actually produce a flood (in the definition of inundation), but more high flows. Maybe it could be relevant to show an hydrograph example related to the definition in page 8

line 16-18.
AR: thanks for the suggestion. The term “flood response” is indeed used to refer to hydrological response associated with high flow events, in this case the top 5 flow peaks per year, on average. In the catchments that we investigated, it is hard to distinguish between bank-full flow and inundating flows, as channels and natural floodplains were heavily modified as a consequence of urbanisation. As a result, what used to be considered “bank-full” flow in a natural channel could be considered flooding (of private properties, gardens) in the urbanised context (Turner-Gillespie et al., 2003).

Reference:
Turner-Gillespie, D. F., Smith, J. A., & Bates, P. D. (2003). Attenuating reaches and the regional flood response of an urbanizing drainage basin. Advances in Water Resources, 26(6), 673-684.

4. One thing which also could be relevant to consider is the time between rainfall events or the time since the last rainfall event and how that affects the flood peaks. I could imagine that higher saturated soils (as a result of recent rainfall) would correlate well to the flow peaks
AR: This is indeed a relevant point that has been investigated in previous publications, incl a recent paper by Zhou et al. (in press, WRR). They did not find a clear relationship between watershed wetness (represented by antecedent rainfall and streamflow) and flow peaks. This is why we have chosen not to include this as a potential explanatory variable in our analysis.

5. The use of the empirical 25 mm/h threshold to represent high intensity rainfall could be reasoned better. Would it make any difference if this threshold was lower or higher.
AR: We chose the 25 mm/h threshold as it corresponds with the 1 inch threshold that is used by the flood hazard community, specifically the National Weather Service, as an index for potential flash flooding. It has also been used previously in the literature to investigate the influence of storm core versus overall rainfall (e.g. Syed et al., 2003).

Specific comments
Page2 line 10. Here it could be relevant also to cite Thorndahl et al. (2017)
AR: thanks for the suggestion, we will add the citation
Equation 2. The use of T is somewhat misleading since it is used twice in the equation.
AR: thanks for pointing this out, we will correct the equation to avoid confusion
Figure 2. I could be relevant to provide the number of events in each basin in the figure.
AR: the number of events per basin are provided in table 3. We prefer not to add the number of events in the figure in order not to crowd the plots. We can add the information in the figure caption.

References
Nielsen, J.E., Thorndahl, S., Rasmussen, M.R., 2014. Improving weather radar precipitation estimates by combining two types of radars. Atmospheric Research 139, 36–45. doi:10.1016/j.atmosres.2013.12.013
Thorndahl, S., Einfalt, T., Willems, P., Nielsen, J.E., ten Veldhuis, M.-C., Arnbjerg-Nielsen, K., Rasmussen, M.R., Molnar, P., 2017. Weather radar rainfall data in urban hydrology. Hydrology and Earth System Sciences 21, 1359–1380. doi:10.5194/hess-21-1359-2017
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