Dear Reviewer(s) and Editor,

We would like to thank once again the reviewers for their feedback that has improved the manuscript. Following their comments, the following changes were done in the updated version of the manuscript:

- The Title of the manuscript was changed to: "Improving radar-based rainfall nowcast by a nearest neighbour approach: Part I – Storm Characteristics"
- The introduction to the topic and the literature review has been updated to fulfil the comments from two reviewers to:
    - to have a better introduction on the topic: the value of the rainfall forecasting, and why specifically the use of the radar-based nowcasting (Line 34 -59)
    - to give a better overview of the radar based nowcast (both field-based and object based), and the choice of object based is justified (Lines 60-73)
    - to discuss more about the life cycle characteristics of convective storms (Lines 102-112)
    - to discuss the analogous approach implemented in the field based nowcast is and the novelty of the proposed methodology (Lines 128-138)
    - to discuss the main focus of the proposed methodology (Lines 141-151)
- Figure 2 was updated to include more information about the location of the study area in Germany (Figure 2-a), and better representing the study area in Figure 2-b. The description was also updated to meet the comments of the reviewers.
- More information is given about the merging method between radar and rain gauge done prior to the investigation following the comments of reviewer 1 (Lines 170-173).
- More information is given about the selection of the events that form the database following the comments of reviewer 1 (Lines 174-181).
- Figure 3 was introduced in the manuscript to explain the main concepts in this study, the concept of the "leave-one-event-out" cross-validations, and to illustrate the work flow in this study (together with potential sources of information leakage), following mainly the comments from the reviewer 3.
- Describing shortly the choice of the low identification thresholds for the storms following the comments of reviewer 2 (Lines 189-191).
- Describing better the tracking algorithm, and the obtained characteristics from the database (Lines 203-306 and Lines 212-216).
- Figure 4 has been updated, so all information is visible, the intensities are updated to maximum observed as mm/h, the merges are as well included.
- The previous limiting value of 0.5 for selecting the neighbours has been removed, and all the results now include all the neighbours that are closer to the "to-be-nowcasted" storm (previously line 261).
- The description of the Partial Information Correlation has been improved (Lines 285,295).
- How the ensemble members are chosen is discussed in Lines 233-234.
- The mean absolute error (MAE) instead of the average error was used for the optimization and for the assessment of the deterministic nowcast following the comments of Reviewer 2 and 1 (Line 417). The respective Figures 7-10 are changed accordingly.
- Following the comments from reviewer 2, the performance criteria are computed as averages per event (instead of averages for storm groups). This affects the Figure 7-13. The Equation 8, 9 and 10 were updated accordingly together with their description. **Please notice that the Figures are new (updated from the response to the reviewers) as the performance is now calculated for each event first and then the median over all events is taken.** In The figures 7-

13 we show only the median over the events, thus avoiding the confusion between mean and median (as stated by the three reviewers from the first version of the manuscript).

- The Continuous Rank Probability Score (CRPS) was introduced to asses the performance of the probabilistic nowcast (to enable also the direct comparison with the deterministic one) following the suggestion of Reviewer 2 and comments of Reviewer 1 (Lines 382-289). Figures 11-13 were updated accordingly.
- Appendix 8.1 and 8.2 were added to the manuscript to explain better how the results of the predictors weights were achieved (Line 401). Additionally, the Lines 303-308 were added to explain better how the predictors weights were calculated (following the comments of the reviewer 2 and 3).
- The information leakage on the computation weights is discussed in Lines 452-465 and Appendix 8.3 was added to the manuscript following the comments of reviewer 3.
- The new Figure 8 regarding the optimization of the deterministic k-NN, and the following description and choice of k was updated (Lines 472-488). Additionally, Table 4 is added.
- The information leakage in the optimization of the deterministic k-NN is discussed in Lines 488-495 (following the comments of reviewer 3).
- Table 5 is added in the result section of the deterministic k-NN to explain better where the number (%) in the text are coming from (following the comments of reviewer 2).
- As the Figures 9-10, have been updated to visualise the MAE per event, the discussion of the deterministic 4-NN results has been updated accordingly.
- Section 4.4 showing the results of the probabilistic 30NNs nowcast has been changed entirely since the performance criteria have been changed to the CRPS. A comparison with the deterministic 4-NNs is also shown here to understand which application is better suited for the nowcast of storm characteristics. An outlook paragraph is included in this section to discuss the advantages of the probabilistic approach, and the possible integration of the 30NNs with the Lagrangian persistence following the comments of mainly reviewer 2(Lines 636-645).
- Section 4.5 was introduced together with the Figures 14 and 15 to discuss the role of the unmatched storms in an operational nowcast, and how well the proposed methodology can forecast these storms, following the comments of reviewer 1 (Lines 662-674).
- The choice of other physical predictors was discussed in the outlook of the manuscript and will be subjected to future works, following the comments of reviewer 2 (Lines 731-736).
- The benefit of nowcasting storm characteristics and the future continuation of this work were discussed in Lines 646-660 and Lines 736-741 following the comments of reviewer 3.
- The benefit of the probabilistic nowcast was discussed in Lines 719-726 following the comments of reviewer 3.
- Throughout the text the “death” term was substituted with “dissipation term”, “birth” with “initialization”, “training” with “optimization”, and only the term “nowcast time” was used to refer the time when the nowcast was issued in reference to the storm initiation. Moreover, the term “object-based” instead of “object-oriented” was used in the manuscript to avoid confusion with the programming term (introduced so at Line 59).
- In the respective Figures, the grey lines are a bit darker (for better visualization) and the labels size in the graphs has been increased so it is better distinguishable (following the comments of reviewer 1).
- The problem with the term “optimization of the k” number for the nearest neighbour” is addressed in Lines 488-492 following the comments of reviewer 3. Moreover, since the nearest neighbour is not a proper learner as an artificial neural network (for instance), the term learning has been avoided in the manuscript.

Some of your suggestions or comments that have not been included directly in the manuscript are:

1. Visualization of an extreme event from reviewer1. It was not included because the nearest neighbour is not in its final form. The storm characteristics predictions are still to be integrated with the rainfall structure at fine temporal and spatial scales (1km$^2$ and 5min). Moreover, all the events selected are not normal ones, as they have been selected for urban flood purposes. Also, reviewer 2 recommended to explain better the limitations of the k-NN methods for predicting extreme behaviour and how this behaviour is underestimated in case of extreme events (and how the sample size is affecting this prediction). But this is already indirectly included in the calculation of the results, as the dataset is based on extreme events. Lastly, the paper is already too long, and we would like to include this example in the follow up paper. However, if the reviewers think this is very relevant to the study, we could include a small section 4.6 discussion a very extreme event and the data size influence on the performance of the probabilistic 30NNs.
2. No comments were made inside the manuscript about the size of the database, and the processing time, because, as already said, the kNN method its still not introduced in the final form. I would prefer to discuss these technical issues once the full kNN is operational, and also to mention what are the running time and memory depending on different cases: for instance, if a single storm or many storms are simultaneously present in the radar image.
3. The database and the script for the kNN methods are not yet publish. I will do my best to prepare everything and upload them before ***(only if)*** the paper is published.

with kind regards,
Bora Shehu