Author response to Anonymous Referee #1

Manuscript: *A dense rain-gauge observation framework for advection-consistency diagnosis of urban convective rainfall*

EGUsphere preprint: egusphere-2026-1314
Response to: RC2, Anonymous Referee #1, 5 July 2026

Dear Editor and Reviewer,

We thank Anonymous Referee #1 for recognizing the novelty and potential value of the method and for identifying where its interpretation, organization, evaluation, and reproducibility needed substantial improvement. We agree with the central criticism: the residual is motivated by a continuity-equation separation, but it is not a direct or unique measurement of convective physics. We have revised the manuscript accordingly and summarize the changes below.

1. Scope of the physical interpretation

We removed descriptions such as “physics-informed framework,” “physics-based foundation,” and “physics-based indicator.” The revised manuscript presents the method as an **advection-consistency diagnostic**. The continuity equation now provides kinematic motivation for comparing an observed gauge-derived rainfall field with an advection-only reference; it is not presented as proof that the residual is uniquely convective.

The residual is now defined strictly as the departure of the observed field from the estimated transport reference. Positive and negative values can be consistent with surface rainfall growth and weakening, respectively, but may also include non-stationary or deforming motion, optical-flow error, boundary effects, smoothing, and sparse or uneven gauge support. The manuscript states explicitly that growth and decay also occur in non-convective precipitation and that the residual is not a direct retrieval of cloud dynamics, updrafts, or microphysics.

2. Spatial and temporal scale, gauge density, and domain size

We agree that these scales control the meaning of the residual. The manuscript now reports the 71 by 57 computational grid, 1 km grid spacing, 15 min accumulation interval, median nearest-neighbour gauge spacing of approximately 1.5 km, Gaussian smoothing scale of 2.5 km, and truncated support radius of 7.5 km. A spatial-support figure identifies grid cells containing gauges, nearest-gauge distance, and cells outside the smoothing support.

We do not claim a universal minimum network density or domain size. Instead, the new transferability discussion requires the target rainfall features to be resolved by multiple gauges, unsupported cells to be masked, smoothing sensitivity to be tested, and the domain to include a displacement margin for the chosen time interval. The Bangkok parameter values are explicitly described as study-specific rather than defaults for other regions.

3. Circular reasoning and evaluation

We agree that the earlier presentation used residual-derived variables both to define and apparently evaluate the labels. This was circular. The revised manuscript now distinguishes three evidence roles:

1. peak residual area, event-integrated residual, peak residual sum, and strong-residual persistence are **classification inputs**;
2. their distributions are **descriptive consequences of the rule**, retained to make the thresholds and class composition transparent; and
3. rainfall intensity and seasonal–diurnal timing are not classification inputs and are reported only as **contextual plausibility checks**.

The manuscript no longer calls the residual feature-space separation independent validation. It also states that no independent radar, satellite, lightning, sounding, or expert convective labels were available, so the present study does not establish externally validated classification skill. Formal validation against such observations is identified as required future work.

4. Code and data availability

We agree that a new method should be inspectable and executable. The public GitHub repository, release `v1.0.0`, therefore provides the paper-specific Python processing scripts used for station-to-grid Gaussian reconstruction, Farneback optical flow, advection and residual calculation, frame- and storm-level residual metrics, final threshold labeling, threshold exploration, and residual-feature-space plotting. These are copies from the authors' paper-processing source tree, not a simplified reimplementation. The release also includes human-readable measured-rainfall and station-metadata templates, input-schema documentation, and an unrestricted synthetic-input generator. A thin command-line hook accepts exactly two required scientific inputs—one post-QA/QC event-window rainfall table and one station-metadata table—and directly invokes the released paper-processing scripts. The one-command demonstration creates synthetic versions of those same two inputs and passes them through that hook to the final operational label. It also produces a visual summary of the observed, advected, and residual rainfall fields and of the final threshold checks. It uses no restricted BMA observations. A visual quick-start guide documents the two inputs, processing stages, and outputs.

The released scope deliberately excludes raw-data acquisition, the BMA event tables themselves, cache contents, batch/performance orchestration, machine-specific paths, logs, and unrelated project code. The intermediate metric-extraction script contains a low-threshold processing/QC label; the final 157-storm manuscript labels were produced separately by the released threshold-application script in strict mode, using the documented primary-area plus supporting-criterion rule. The authors inspected and executed the released processing chain and remain responsible for its scientific content; AI-assisted drafting does not replace author verification. Exact regeneration of the Bangkok results still requires the restricted observations and the authors' event-window definitions, so we do not claim data-complete replication.

The station-level observations are owned by the Bangkok Metropolitan Administration (BMA). The authors cannot redistribute them or grant access; requests must be directed to BMA and remain subject to the provider's permission and data-sharing policies. The manuscript code- and data-availability statements now make both boundaries explicit.

5. Re-parameterization for another study area

The Discussion now gives an explicit adaptation sequence. A new application should jointly select grid spacing and smoothing from the local nearest-neighbour-distance distribution; verify short-lag rainfall-field and motion consistency; mask cells outside observational support; choose a domain with an appropriate displacement margin; and recalibrate event-linking, residual-cell, footprint, accumulation, and persistence thresholds for the local network and rainfall climatology. Calibration against independent convective labels is preferred. Without such labels, the output should retain an explicitly operational "high-residual" interpretation.

6. Organization and repetition

The manuscript has been reorganized into a more conventional sequence: Literature review, Data and study area, Methods, Results, Discussion, and Conclusions. Rainfall-field reconstruction and smoothing now precede optical flow and residual calculation. Repeated stand-alone sections that reintroduced the advection and residual equations inside the classification workflow were removed. The Results section no longer begins by repeating the method.

We also removed repeated temporal-alignment wording, harmonized the motion-field notation as $\mathbf{V} = (u, v)$, integrated the late background motivation into the Introduction, corrected tense inconsistencies, and removed the cited verbatim repetitions.

For traceability, the reviewer's location-specific editorial comments were implemented individually. The material at original lines 27–35 was moved after the paragraph introducing existing convective-identification methods and was rewritten as introductory context. The unsupported general claim at original lines 196–197 about the adequacy of the 1 km resolution was not retained merely by adding a citation; it was replaced by a narrower statement that the 1 km spacing is a computational lattice, supported by the measured station-spacing and smoothing-support diagnostics. The material around original lines 456–459 was merged with the residual interpretation, the repetition at original lines 521–522 was removed, and the motivation at original lines 630–631 was integrated into the Introduction.

7. Literature-review focus

Consistent with both public reviews, the literature review is now restricted to four topics directly needed by the study: convective/stratiform identification, cell tracking, advection-based rainfall-field evolution, and statistical or gauge-based rainfall analysis. Prediction literature not needed to position the diagnostic was removed or reduced.

8. Quality control, smoothing, and ungauged areas

The revised QA/QC description gives the notebook-documented rules explicitly: negative values and values exceeding 500 mm in one 15 min record were flagged and converted to missing; gaps of up to six slots were time-interpolated; 7–10-slot gaps were forward-filled from the preceding value, with backward fill used only when no preceding value was available; and longer gaps remained missing. The 500 mm value is identified as a legacy operational screening bound, not a climatologically calibrated Bangkok threshold.

The normalized Gaussian weighting equation, 2.5 km scale, and 7.5 km truncation radius are now given before the motion method. Cells outside this radius are marked as having no smoothing support, and cells without a gauge in the same grid cell are described as having limited direct observational support. A three-storm sensitivity test over smoothing scales of 1.0–5.0 km is reported as a limited subset analysis, not a complete robustness assessment.

9. Advected convection and residual interpretation

The revised Discussion states explicitly that the method can miss a convective cell transported through the domain without strong within-domain positive departures. The method therefore detects neither all convection nor a unique convective process. It is most defensible over short intervals with adequate gauge support and field coherence. The manuscript also states that boundary entry, motion non-stationarity, deformation, and reconstruction error can contribute to residuals and must not be labelled automatically as physical growth or decay.

10. Summary

The revision now presents a narrower and more defensible contribution: an operational, transport-relative surface-rainfall diagnostic for dense gauge networks. It does not claim direct observation of precipitation physics or independent validation that the available data cannot provide. We appreciate the reviewer's comments, which materially improved the scope, organization, transparency, and transferability of the manuscript.