THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

Dr. Aloïs Tilloy
Associate Editor
Natural Hazards and Earth Systems Science

March 30, 2026

Dear Dr. Tilloy,

On behalf of my co-authors, I am pleased to re-submit our manuscript "Covariance-informed spatiotemporal clustering improves the detection of hazardous weather events" by H. Quintal, A. Sebastian, M. Serre, W. Jäger and M.C. de Ruiter for consideration in the Special Issue on "Methodological innovations for the analysis and management of compound risk and multi-risk, including climate-related and geophysical hazards" in *Natural Hazards and Earth Systems Science.*

We have carefully considered the reviewers' comments and have revised the manuscript accordingly. Following their suggestions, we significantly revised the Case Study application within the manuscript. Our major changes include:

- We revised the calculation of experimental covariance (Section 3.3) to use hourly heat index and precipitation aggregated within daily windows and restricted to land, eliminating potential biases introduced by rolling sums and issues over open water. This change reduces artificial temporal autocorrelation and results in more physically consistent space-time metrics than in the original version of the manuscript, which in turn improved clustering and interpretation of spatiotemporal variability (in Section 4).
- We replaced impact-based thresholds with statistically derived return-period thresholds (Section 3.4), computing 2-, 5-, 10- and 25-year extremes directly from ERA5 using extreme value analysis. This modification produces spatially consistent and scale-appropriate thresholds and avoids several of the issues, particularly related to heat index, presented in the previous version of the manuscript.
- We expanded the resampling framework (Sections 4.2-4.4) to include both space-time metrics derived from multiple covariance formulations and two interpolation strategies (maximum nearest neighbor and bilinear). This broader design demonstrated that model performance varies systematically with both resampling method and metric choice, strengthening the conclusion that covariance-informed resampling can yield statistically significant differences in skill (Section 4.5).
- We replaced the NOAA Storm Events Database with the Iowa Environmental Mesonet weather warnings dataset for validation (Section 4.5), which provides finer spatial resolution and more consistent reporting across counties from 2002-2023. This update reduces validation biases and results in more reliable performance estimates, particularly for precipitation events.
- We revised the performance evaluation (Section 4.5) to use the F1 score instead of recall, explicitly incorporating both precision and false positives. Although this led to lower absolute skill scores, it yielded a more realistic assessment of model performance.

To facilitate the review processes, we have addressed the reviewers' comments point-by-point and included our responses as a separate attachment to this letter. In addition, we have provided a version of the manuscript which includes tracked changes, as well as a final, clean version of the manuscript and supplementary materials.

All authors have read and approved the revised manuscript. The manuscript has not been submitted for consideration elsewhere. A.S. and M.C.R. are Associate Editors of the Special Issue on "Methodological innovations for the analysis and management of compound risk and multi-risk, including climate-related and geophysical hazards" in *Natural Hazards and Earth System Sciences*. A.S. and M.C.R. were not involved in the journal's review of, or decisions related to, this manuscript. The authors declare no other competing financial or non-financial interests.

Thank you for your thoughtful and constructive feedback provided on our manuscript. We believe the recommended changes have strengthened the manuscript. We look forward to receiving further feedback.

Sincerely,

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