Reviewer #2:

This is a welcome contribution to the literature on atmospheric rivers as triggers of compound flooding. However, it is unclear if sufficient work has been undertaken at this stage to justify publication now.

The authors note that: "If common landfalling locations shift significantly under future warming scenarios, this could explain the difficulty in establishing a statistically robust relationship between ARs and CIF events in later warming periods, as such shifts are not explicitly accounted for in the current methodology. This highlights the need for further research to reduce uncertainties in modeling AR dynamics."

The authors are to be commended for admitting in the conclusions that: "The results carry considerable uncertainty, primarily due to internal climate variability, the exclusion of dynamic factors, sample size limitations, and AR detection methods. Future studies can improve the methodology by focusing on more characteristics of ARs."

For those involved in flood risk decision-making, the paper in its present form is much less informative and useful than it might be if further research would be undertaken to address some of the key uncertainties identified by the authors themselves.

Response:

We sincerely thank the reviewer for the constructive feedback. We organized our response around the main criticisms raised as follows:

(a) Justification of the study's contributions
(b) Clarification of the uncertainties acknowledged in the current manuscript

(a) Justifying the contributions

This study contributes to the field of research substantially by being the first to quantify AR driven inland compound flooding under climate change using large ensembles. To date, only two studies have explicitly addressed compound effects: one focusing on coastal flooding along the Dutch coast (Ridder et al., 2018), and the other on temporal compounding of atmospheric rivers in California (Bowers et al., 2024). Further, to our knowledge, no prior research has investigated inland compound flooding driven by atmospheric rivers, nor examined the combined influence of externally forced climate change and internal climate variability arising from natural variability of climate and large-scale climate patterns.

(b) Clarification of uncertainties

The uncertainties identified during this study are inherent to the problem being studied and we explicitly acknowledge them to highlight future research opportunities. Fully resolving the range of uncertainties identified would require separate in depth studies because of their complexity. The current body of literature highlights the extent of differences caused by the existence of different atmospheric river detection techniques (Ralph et al., 2019; Rutz et al., 2019). Internal climate variability is a known irreducible source of error, and numerous studies have examined

its influence on modeling various phenomena. This study specifically quantifies and discusses the implication of uncertainty from internal variability as a key objective. The results in the submitted work can support future research specifically targeting the relationship between internal variability and AR-driven activity, an important direction underscored by the strong link we identified between compound events and AR-related flooding.

In response to the comments on ensemble size, although a large ensemble may increase the accuracy of the results, the ensemble size used in this work aligns with prior large scale studies and yields consistent results (Hagos et al., 2016; Michaelis et al., 2022; Tseng et al., 2022).

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