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Re: Minor revisions of manuscript EGUSPHERE-2023-592

Dear Reviewer,

Thank you sincerely for your valuable suggestions and kind words of appreciation. My co-authors and I highly appreciate the importance and insights provided in your comments. We have made genuine efforts to address each of your suggestions in the revised manuscript.

Below, you will find a point-by-point response outlining our approach to your suggestions and comments. Additionally, we have introduced a new section within the response letter, emphasizing the major revisions that have been executed in response to all reviewers' recommendations. Once the editor approves these responses, we would submit a revised version of the manuscript as per the *Geoscientific Model Development* guidelines.

Once again, we extend our gratitude for your thorough review and constructive feedback. Please do not hesitate to convey any further concerns or suggestions you may have; your input is crucial in enhancing the quality and rigor of our work.

Sincerely,
Arjun Babu Nellikkattil

Contents

1 Recommendation

SCAFET is a significant advance over the traditional absolute thresholding methods currently used by climate practitioners. With some minor revisions, see below, I recommend the manuscript for publication.

2 Revision Highlights

1. An additional appendix section has been included to provide a discussion and demonstration of the detection of three-dimensional structures within embedded 3D scalar fields.

2. An additional supplementary section has been added, presenting the sensitivity analysis of various parameters in the detection and characteristics of Atmospheric Rivers. The primary objective of this section is to illustrate the stability and reliability of the diverse parameters employed in SCAFET.

3. An extra supplementary section has been incorporated, offering a comparison of the identified characteristics of Atmospheric Rivers. Additionally, the computational aspects of SCAFET are contrasted with those of other detection algorithms.

4. The manuscript has been further refined to enhance grammar and comprehension.

3 Point-by-point Response

1. My main comment or question is related to how sensitive feature identification is to SCAFET parameters. You have shown that it is possible to identify weather features with SCAFET, which is great, but there is no discussion on how sensitive the results are. For example, how sensitive is the detection of ARs in Figure 4 to the parameters used in Table 1? On the one hand, it is intuitive to identify ARs as long, narrow shapes with (relatively) high IVT and precipitation. But concrete numbers must be used to implement that intuition. If you slightly change the SI threshold for Ridges, or the minimum length, or angle coherence, etc. does this totally change the kind of objects identified so that they no longer resemble ARs (I wouldn't think so, but perhaps), or does it slightly change the details of ARs detected? If it is the latter case, how did you decide on the exact values used in Table 1 for the best identification of ARs? I see there is one sentence, "The quantitative values for the properties are obtained from a consensus of previous studies referenced within each section." but I think this requires more elaboration.

We appreciate your comment and concur that a more in-depth discussion regarding the sensitivity of the employed parameters for feature extraction is indeed essential. Given the length constraints of the manuscript, we have integrated this discussion as a new supplementary section.

This section focuses on exploring the sensitivity of various parameters in detecting Atmospheric Rivers (ARs) using SCAFET. Specifically, we examine how modifications in the detection pa-

rameters influence key AR characteristics such as mean frequency, size, and count of ARs. Furthermore, the section incorporates a brief discussion explaining the observed sensitivity.

To facilitate readers' access to this supplementary section, an additional sentence has been introduced in Section 3.1, directing them to this content.

2. My second question is, what are we supposed to take away from Section 4.1 on Jet Streams? It shows some proof-of-concept that the method can be applied, in principle, to 3D data. To my eye, I don't see a clear jet stream identified by SCAFET in (b), (d), and (f) of Figure 7. So while the method can be applied to 3D data, it is not clear that it is successful in identifying features in 3D data.

In response to the feedback from Reviewer 2, the authors have made improvements to address this issue. We have added a new appendix section to showcase the identification of 3D cylinders embedded in simple scalar fields. This approach is analogous to the simpler examples demonstrated for 1D and 2D feature detection in Appendix A. The principal intent of this section is to underscore SCAFET's adeptness in accurately recognizing 3D structures.

The authors acknowledge the potential challenge in interpreting the presentation of 3D feature identification. They posit that this complexity stems from the intricacies inherent in effectively plotting and visualizing three-dimensional fields. To rectify this, we have made modifications to Figure 7. Specifically, they have chosen to focus on just one of the upper level jets, which could potentially make it easier to discern and evaluate the effectiveness of the SCAFET in identifying jet streams.

3. Third, while I think SCAFET is indeed a significant advance, I believe there are some statements made in the paper which are not justified, or I have misunderstood what you are trying to say.

    (a) Around line 40 there is discussion of dataset pre-processing, such as computing IVT fields for AR detection, and how this becomes infeasible for high resolutions and large ensembles. At first I read this as implying pre-processing as a downside of traditional methods, but something that SCAFET would bypass. However, SCAFET itself uses these pre-processed fields in the identification of ARs and cyclones.

    The reviewer is correct in pointing out the potential issues with making such sweeping statements. We intended to highlight the process of deriving thresholds from the input dataset during the segmentation procedure. Consequently, the entire dataset, especially for the considered period, has to undergo preprocessing to calculate thresholds. In contrast, SCAFET operates on a per-timestep basis, and although standard processes like smoothing are involved, there is no need to preprocess the **entire dataset**. The advantage of this approach is that we avoid the need to recalculate thresholds depending on the time-period or dataset under consideration. In simple terms, SCAFET can identify features using just a single timestep, while many conventional methods would necessitate threshold derivation following the preprocessing of extensive representative datasets.

    The sentence has been revised to emphasize this distinction more clearly.

(b) Starting at the end of line 327, there is the sentence "Due to its design, SCAFET does not require a priori climate information to identify features." I am not sure what is meant by this sentence. In the work presented, the shape-based component is only one piece of the full pipeline to identify weather features. Most obvious, the shapes are extracted from pre-processed fields IVT and RV, which are created from "climate information". Even knowing what generic shapes are appropriate for particular weather features I see as climate information.

Yet another sweeping statement. Thank you for pointing it out. The sentence has been modified now.

4. Finally, the writing and grammar etc. of the paper need to be cleaned up. Below are some instances I found during my reading:

   (a) line 15: "… and value (5Vs) of climate data (REFs) of climate data."

   (b) starting in line 162: "In the current study, a simple radius is defined and the closest object within the given radius to each object at time n is clustered and identified from time n+1 as the same object in motion." I get the general idea of what you are saying here, but I found this sentence hard to parse.

   (c) line 186-187: "… derive this threshold from dataset directly, …"

   (d) line 204-205: "… each object is used as to filter …"

   (e) line 274: "…, SSTFs are not tracked as ocean fronts are stationary rather than…"

   (f) in the middle of the Figure 6 caption, "In the next step, ridges, caps, and domes are extracted from (b) and weak and small…", do you mean for this to be (a) instead of (b)?

   (g) line 293-294: "Since the scope of this section is limited to the validation of the detection method, we have only shown jet detection in three selected time steps." I'm not fully sure what you are trying to say here. Do you mean that filtering and tracking steps have not been performed here?

   (h) Figure 7 caption: "The 3D jet streams extracted for the corresponding time period is show in …"

   (i) line 362-363: "change of direction of a along the curve."

   (j) In Figure A2, please adjust the legend so it can be read more clearly

All the suggestions have been implemented. The manuscript has undergone further refinement to eliminate such grammatical errors. We appreciate your thorough review and attention to detail.