TAMS: A Tracking, Classifying, and Variable-Assigning Algorithm for Mesoscale Convective Systems in Simulated and Satellite-Derived Datasets

This paper describes a novel tracking algorithm that was originally developed to track MCSs over Africa, and has been enhanced to a more general tool to track MCSs in large observational and model datasets. The manuscript is well-written and the tracking steps are easy to understand based on the figures presented. Another strength of the paper is that many specific examples are given which help the reader to set the technical features into a scientific context and better understand the implications of different tracking options. An outstanding feature of the TAMS algorithm is its capability to work with unstructured grids, which has become more and more important with the advent of global k-scale models. In addition, TAMS provides the possibility to combine tracked MCS features with any other variable or dataset, which is useful to better understand the processes of convective organization from multiple angles. The tracking tool should therefore be of high interest to the weather and climate research community. I recommend the publication of this manuscript after addressing and clarifying the following minor issues.

General comments:

- **Introduction:** While the introduction provides a thorough review on existing tracking algorithms, the motivation of why it is important and useful to track mesoscale convective systems in various datasets could be extended. Following the example applications that are mentioned later in the paper, you could, highlight the importance for both forecasting purposes as well as understanding fundamental climate processes such as interactions of weather systems at different spatial scales. Since TAMS focuses on tracking MCSs, it would also be useful to briefly define what an MCS is from a physical point of view (not in terms of cloud top temperature or precipitation thresholds). This can help readers that are not familiar with this weather system to better understand the choices of thresholds for the classifications lateron in the paper.
- **Background flow**: I am not sure I understand how the zonal projection of cloud elements based on the set background flow parameters is combined with the area-overlapping method. Is this only relevant when there are other overlapping cloud elements, but in the wrong direction? How can users make an informed decision of what background flow parameter to choose?
- **Grid-independence:** Can you define what is meant by grid-independent and what the limitations or minimum requirements are. In particular, it was not quite clear to me what the requirements for the datasets to be matched in the variable-assignment are. Is it only the time dimension that need to fit the timesteps of the track-input data + latitude and longitude information? Does this function also work with unstructured grids or 3D data?
- **Unstructured data:** The polygons in Figure 3 seem to suggest that there are almost no differences between the tracking based on the regridded MPAS data compared to the native-grid MPAS data. Since the reason to track on unstructured data rather than on a regridded version of it is to preserve more information, I am wondering if TAMS can make use of the fine-scale structures from the native grid? Do you expect larger differences in the tracked features when the resolution is even higher (say 4km) or if variables that are noisier than Tb are used as the main tracking field (e.g. precipitation)? A brief discussion of the advantages of tracking on native grids could be useful here.

Detailed comments

- L. 11 : remove “robustness” because we are only starting to understand how robust results from objective tracking actually are. And I think the more important point here is that the statistical analysis of MCSs itself has only become possible with the help of objective/automated tracking methods because you can enhance your analysis from case studies to more climatological analyses

- L. 18: Before introducing the overlapping technique as a method to link features over time, it would be useful to briefly explain the concept of feature/object detection. In addition, I suggest to already mention the polygon/convex hull-method that is essential for TAMS here.
- L. 33: Explain “graph node”
- L. 41: Explain TempestExtreme in some more detail, as its flexible design is similar to tobac, but the included algorithms differ. Has TempestExtreme been used to track MCSs?
- L. 58-59: Please provide the reference to the publicly available MCS datasets mentioned here.
- L. 74: Does the cold core only have to appear once during the MCS lifetime?
- L. 85: 3km -> 4km IR data?
- L. 141: Does the *tams.run* function also work with other datasets as precipitation or only if you do the variable-assignment separately?
- L. 143: Can a minimum area criterion be applied in the identification step or only in the classification step?
- L. 162: How is the Matlab function for unstructured grids embedded/implemented in the python framework?
- L. 187: The example cloud elements shown in Figure 4 and the discussion on which tracking parameters lead to a continuous MCS track for the example in the red box are very useful. Can you explain the reason why the setting with u= -15 m/s is needed and why the elements would otherwise not be connected even if they overlap at any point in time?
- Fig. 5: It is an interesting feature that the probability for any MCS area between 10e3 and 10e6 km2 is pretty constant for the default and looser Tb thresholds. In contrast, the stricter Tb threshold option (Tb - 15 K) results in a distinct peak. Are these characteristics a consequence of the convex hull method or how can these results be interpreted?
- Fig. 6: Although it is clear that darker colors represent higher frequencies, it would be useful to add a colorbar to this figure.
- L. 202: remove one “here”
- L. 201-204: Do you think there is a physical explanation for the different relationships between area and duration for different cold core thresholds or can this feature be attributed to the tracking technique?
- Section 2.3: Can the classes be modified or do you plan to enhance the package such that they can be in the future? It would be a useful tool to allow the users to set definitions for the classes themselves since these could be very dependent on the research questions asked.
- Section 3.3: Maybe you could specify a few examples on the posprocesssing and visualization functionalities that you can find (e.g., plotting spatial maps including the convex hull masks, identified CE numbers and track line overlaid with input data, which statistics can be derived quickly via high-level functions?)
- Section 2.4: In this section, it could be very useful to show an example figure of a contour overlaid with another dataset (e.g. precipitation).
- Section 3.2: Clarify that Yang and Slingo (2001) estimate the infrared brightness temperature which might be more directly related to IR radiances from geostationary satellites than the actual cloud top temperature. In this paragraph, I also suggest to motivate why this functionality is useful, i.e. comparing trackings in model data to satellite observations.

- L. 286-297: These are all great application examples. I suggest to add a subsection (e.g. “Applications”) before the summary since this is all new information and it deserves to be highlighted in the main body of the paper.