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Geoscientific Model Development Discussions

Interactive comment on "Detection, tracking and event localization of interesting features in 4-D atmospheric data" *by* S. Limbach et al.

Anonymous Referee #1

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The article presents an interdisciplinary work combining the fields of atmospheric science and computer science. As such, it is an important contribution to advance the transfer of computer science knowledge into the atmospheric domain. The paper documents a valuable study on automatically detecting and tracking time varying flow features in numerical atmospheric simulations, which as a data analysis method is well suited for publication in GMD. In particular the method's ability to locate events in the feature's temporal evolution in grid point space appears useful. The presented case study of detecting locations where jet stream merging and splitting takes place illustrates the abilities of the method.

However, the manuscript has potential for improvements before final publication. In particular, I suggest to improve

- how the presented method is put into the context of related work and how the authors' contribution is indicated,

- the authors' rationale for using region growing as segmentation method,

- presented information on the efficiency of the method, and,

- in some parts sentence structure and grammar.

These issues are detailed below. Addressing them will make the paper a nicely documented study illustrating how algorithmic approaches successful in other domains can be transferred and adapted to the atmospheric sciences. Thus, I recommend the paper for publication subject to the authors addressing the suggested revisions.

== General comments ==

1) The authors do a good job in presenting literature that in the atmospheric domain has appeared on feature detection. In other domains, however, significantly more literature has been published on the topic. In my opinion, the developed algorithm is not sufficiently put into the context of existing algorithms for similar purposes. In particular in flow visualisation, a number of studies have been published on feature extraction and tracking, including 4D flow data. I acknowledge you have cited the work of Reinders (3016/15). To name a few others, I refer to the overview by Post et al. (2003) and, more specifically, to the works of Samtaney (1994), Ji et al. (2003), Fuchs et al. (2008), Muelder and Ma (2009) and references therein. I suggest to complete the literature review in Sect. 1 (3016/5ff.) and, in particular, to detail on how the content of Sects. 2 and 3 relates to these works.

2) Please clarify your contribution. The three points mentioned in 3016/16-23 misleadingly suggest to the reader that are no other algorithms that operate on time series of 3D data and that are able to track more than a single feature. In Sects. 2 and 3, it is not clear to me which parts of the algorithm are similar to existing methods and what is new. As a suggestion, you could put your contribution to event tracking in grid point

space into the centre of the manuscript and stress which kind of atmospheric studies it enables.

3) Your rationale for using region growing as segmentation strategy is not clear to me as well. In 3016/9ff you state that your development was inspired by the work of Siegesmund (2006). Please elaborate on why his approach was favourable to you over other segmentation methods. Which other segmentation methods would have been an alternative? Are there types of atmospheric flow features that are not detectable with region growing? In 3016/7 you mention that there are different variations of region growing. I suggest to motivate your approach in Sects. 2 and 3 in the context of these variations.

4) You claim your algorithm to be efficient (e.g. 3014/2, 3016/16, 3026/9). However, the only paragraph providing vague information on the computational performance is 3033/24-29. I suggest to add supporting facts and statements to the manuscript (e.g. information on the run-time, properties of the used data structures).

5) Language: I have listed a number of suggestions to improve the manuscript below. Nevertheless, I recommend you to recheck the correctness of the text. Some complicated sentences could be written in a more concise manner to make them better understandable, and a number of redundant words (e.g. "so-called") should be removed.

== Specific comments ==

Title

I recommend changing the title of the paper to "Detection, tracking and event localization of jet stream features in 4-D atmospheric data". This much better reflects the actual content of the paper. Alternatively, at least the word "interesting" should be removed from the title (and any other parts of the manuscript), as it in my opinion is a too vague adjective: what is "interesting"? I suggest to rather explain in the text why the

detected features are interesting.

Abstract

- Take care to use consistent time (e.g. "we extended", "we compare", etc.)

- 3014/2 I suggest to remove "interesting" (see title)

- 3014/5 change "we extended the basic idea", to "we extend the method ..."

- 3014/9 remove "so-called", I suggest to state explicitly what an event graph is (e.g. "a directed acyclic graph containing..")

- 3014/13 "tested" sounds odd. I suggest "we present a case study of"

- 3014/16 change "previous" to "a climatology from a previous study"

Sect. 1

- 3015/1 remove "Therefore, " and add a paragraph break. This increases the strength of the argument in the following sentence

- 3015/3 remove "so-called"

- 3015/8 remove "s" in "considers"

- 3015/10 remove "In addition, the"

- 3015/25-27 check grammar

- 3016/1 change "of this study was" to "of these studies were"

- 3016/5-24 This paragraph should be revised (cf. general comments 1-3)

- 3016/25-26 The sentence suggests that the ozone hole segmentation is also part of this paper. I suggest to not mention the ozone hole study at all (this also applies to Sect. 5), as it appears confusing. Why do you not present any results from that study? Alternatively, is there a citable reference in which results from the ozone hole study

were used? Could you include any results?

- 3017/4 What do you mean by “objects”?

Sect. 2.1

- 3018/23 insert “have”, “we have worked”

- 3018/23 Is your algorithm able to handle grid topologies other than regular lat/lon as well?

Sect. 2.2

- Please put the definitions in this section in the context of related work (general comment 1). For instance, the event graph terminology has also been used by Reinders et al. (2001); Samtaney et al. (1994) describe feature evolution by means of a directed acyclic graph.

- 3019/24 remove “so-called”

- 3020/12 I assume “small and fast moving” depends on grid and time resolution, you might want to state this

- 3020/12 I suggest to refer to the literature to indicate what more involved techniques could be

Sect. 2.3

- 3022/10 It is not clear to me on which literature this paragraph is based. What are “many traditional .. methods”?

- 3022/10-20 The terminology in this paragraph confuses me. Why do you add samples to a segment (“S”) instead of a feature, as defined in Def. 3? Or does S denote a set of samples, as line 19 suggests? In line 13, do you mean eight neighbouring samples for a TWO-dimensional case (four-dimensional would be more, I assume)?

- 3022/Def.11 Similar definitions for a homogeneity criterion are used in the literature

as well (e.g. Pal and Pal, 1993)

- 3022/26 “typical” in which respect?

- 3023/5 “common approach” in which respect?

Sect. 3

- 3023/17 I suggest rephrasing the sentence to “The region growing methods introduced by XYZ require one or more..”

- 3023/23 replace “applicable” by “practical” or “feasible”

- 3023/23-25 What is an “automatic search” in this context? Why is it inefficient?

- 3023/26 I do not understand what exactly you mean by “only require one sequential iteration”. The text suggests that your algorithm differs in this respect from the approaches used by other authors. How does it differ, for instance, from Muelder and Ma (2009), who at any timestep iterate through all unsegmented grid points to detect any new features (Sect 2.3 in their paper)?

- 3023/26 “efficiency considerations”: can you support this by numbers? What speed-up can be achieved?

- 3024/23-25 This is an important statement. I suggest to put more emphasis on it and to support it by examples of how the predicates could look like.

Sect. 3.1

- 3025/5 replace “previous algorithm outline” by “Algorithm 1”; sentence can be split into two

- 3025/7 “On the way” sounds unscientific, I suggest “During execution”

- 3025/8 “later” is redundant

- 3025/12 “any .. any”: I suggest to rephrase this in a more concise manner; what is

“any candidate feature”?

- 3025/13 rephrase “we look at all”

- 3025/19 What is an “appropriate data structure”? Please specify.

Sect. 3.2

- 3026/3-4 “many possible approaches”: Please be more specific. Which types of objects can be imagined, which approaches are suitable? I suggest to refer to the literature.

- 3026/8-19 It is unclear to me why checks for spatial overlapping and feature size are sufficient. For which types of features do they work? What happens if the time step of the available dataset is too large to allow for spatial overlap of the features? Are alternative checks mentioned in the literature?

- 3026/9 I might have missed this, do you explain the details of the data structure that is extended?

- 3026/11 rephrase “finish the association”, e.g. “associate a sample..”

- 3026/14-15 sentence sounds odd, rephrase

Sect. 3.3

- I suggest you emphasize your contribution described in this section, as it is the basis for the results presented in Sect. 4: Why is it particularly interesting for atmospheric applications to determine the locations of the events? What is new compared to existing approaches (e.g. the boundary growing approach of Muelder and Ma, 2009)?

- 3027/1 – 3028/4 This part is difficult to understand. You provide a very good illustration of the process in Fig. 3. I suggest to first describe the localization of a merging event in the 2D case by means of Fig. 3, then generalize the concept to three dimensions. You might also want to state at the beginning of the paragraph that (and why)

in order determine the grid points at which merging has taken place, a region growing processes composed of two stages is suitable. Then describe the details.

- 3027/1 “The basic idea behind ..” is redundant, e.g. “Localization of .. is based on a search ..”

- 3027/2-5 Difficult to understand, “steps on the lattice”, “grow” and “touch” are unclear.

- 3027/8-9 Difficult to understand, reads as if the feature (instead of the merging event) is identified by the edges.

- 3027/17ff. You might want to point out that this region growing process is separate from the feature detection phase

- 3027/24ff Why is the second growing phase necessary? How do you determine the number of steps? What do you mean by “fuzziness” in this context?

Sect. 4

- 3028/6-9 It would strengthen the manuscript if you would state for which types of phenomena the algorithm has been tested and why the jet stream case representative (cf. the comment to the ozone hole case in Sect. 1).

Sect. 4.2

- 3030/18 Why did you choose 10m/s to be added to the value of Koch et al. (2006)? Can you provide any information on the sensitivity of the result on this parameter? Is it important?

- 3030/20-21 (“We do not state..”) Fine for this case study. However, as you have introduced these criteria in Sects. 2 and 3, it would strengthen the manuscript if you provided an alternative example of how they could be used.

Sect. 4.3

- 3032/15-18 The sentence “If now, looking..” sounds odd, rephrase

- 3032/20-29 You are using a uniform lat/lon grid. Thus, the actual area represented by each grid point is not uniform (depends on latitude). Have you considered this when using the number of grid points of a segment as size indicator for the analysis?

Sect. 5

- I suggest to more strongly emphasize the contribution of the paper and the new results obtained from the case study.

- 3033/5 cf. comment on the ozone hole case in Sect. 1

- 3033/12-13 Smaller than what? Faster than what?

- 3033/17-23 What about prediction-correction methods such as presented by Muelder and Ma (2009) and approaches that include time information in the feature detection process (e.g. Ji et al., 2003, and Fuchs et al., 2008)?

- 3033/24-29 I suggest to move any information on performance and efficiency of the method into another section (cf. general comment 4).

Figures

- Fig 1: I suggest to add coastlines and/or a graticule for better readability of the figure. Rephrase the caption to “showing all detected three-dimensional features at a single time step”.

- Fig 5: The colour bar extent includes values below 40m/s, although these (according to the text) are not included in the segments. As the earth is depicted in blue, this is confusing. I suggest to have the colour bar only show values above 40m/s.

- Fig 6 and Fig 7: I suggest to add a graticule, similar to the figures in Koch et al. (2006), to improve readability.

- Fig 8: What are the units of the colour bar? What are the units of “cos-weighted gridpoints”?

== References ==

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