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Nonlinear Processes in Geophysics Discussions

Interactive comment on "Detecting and tracking eddies in oceanic flow fields: A vorticity based Euler-Lagrangian method" *by* R. Vortmeyer-Kley et al.

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Several typographical errors to correct: 1) Overall, many missing commas. When starting a sentence with a prepositional phrase, separate it from the sentence with a comma. Page/Line 1/13 - For this reason, 7/11 - For the Lagrangian descriptor M_v, 7/16 - ... in a flow, 9/26 - For M_v, 14/4 - However, nowadays, 14/12 - However,

In some cases, there are commas that are unnecessary, page 5 line 8: "...dynamical evolution yield" (no comma).

Do a re-read of the paper and look for these prepositional phrases and clearly separate them grammatically.

2) At times, the papers language is too conversational. In general, the tone of the paper is scientific, and it should remain so throughout the paper. From above, "nowadays" is an example. Page/Line 3/15 - "Anyhow" can simply be removed. 7/6 - remove "Again".

Do a re-read and it helps to read it out loud so that you can catch the conversational tone when it comes up. That said, the language is outstanding for a non-English native speaker!

3) Several words can be removed as they are unnecessary. In some cases, words need to be added or changed. Page/Line 1/14 - change "e.g. marine biology." to "marine biology for instance." 2/21 - "...but have been recently..." 4/31 - change on to of 5/10 - Change: "Manifold trajectories on both sides of the manifold have different behaviors compared..." 8/6 - change "distinction" to "distinguishing between ... and the identification " 9/2 - change "We use its" to "We use the feature" 14/3 - Change "non" to "none"

Technical issue

4) Check your formulae: Page/Line 5/3 - equation #3 - make sure the velocity is squared and the dt is not under the sqrt

Overall technical comments:

My main problem with this paper is that it asserts things that it does not support directly in the text. At times, there are conflicting statements about what the newly proposed Euler-Lagrangian descriptor can and cannot do. These discrepancies need to resolved in the text so that the reader is not confused or led astray. Also, in the beginning of the paper, the use of oceanographic data is discussed, but the paper is essentially about toy-models. I understand the need to verify a new metric by using toy-models, however, if you suggest that this metric is useful for geo-physical flows, then you need to demonstrate that in this paper, or put a disclaimer early within the text, that you intend to follow-up this paper with another paper demonstrating the metric on actual geo-physical flows obtained from either satellite data or well-understood simulated oceanographic models such as CCSM4 or a variant of ROMS that is well-accepted as a good representation of historical data (flows). Finally, when you compare your new metric to existing metrics, then state they your metric is better, you need to clearly state the differences and exactly HOW your metric out performs another. That is simply now done well in the text as it currently stands.

From my understanding of M_v, you state its superiority over the M-value mainly because it maximizes when a fluid packet is part of gyre. In this case, for the duration of its stay within the gyre, the vorticity is high so the M_v will be maximal. For the M-value, the center of the gyre will be a minimum, such that the M_v can distinguish an elliptical point as well as a hyperbolic point, whereas, the M-value shows both types as minima. That is the main difference you quote in their behavior.

First, you state that your metric has excellent time resolution when seeking the beginning of a gyres formation as well as its lifetime, because you can measure when the gyre dies off. In both of these measurements, you depend on the value of tau. You make a cases in figure 6 that the best value for tau is 0.15 times the lifetime of the gyre. This is a circular definition. You need to know the lifetime in order to determine tau if it is to be based on a percentage of that lifetime. Furthermore, you can only find a gyre once you vorticity values are maximized, meaning that you need a particle to have already been inside of a gyre long enough for the M_v to become maximal. This means that there is a lead-in time where you do not know whether you are in a gyre or not as the trajectory has not had enough time to sample to gyre. The problem is that in order to find the gyre in the first place, you need an initial value for tau simply to compute the M_v. So, do you propose to constantly be computing M_v for a range of tau values until you find a gyre - THEN you can adjust tau to be 0.15 the lifetime of the gyre? But wait, you need to know the end of the gyre as well to know the lifetime, so you cannot determine an optimal tau to find a gyre until it has formed and gone away. This suggests that an oceanographer will need to be computing M_v over a range of

tau values constantly simply to see when/if a gyre has formed. Of course, this is also true for the M-value.

Figure 3 needs to be larger and with a better color contrast in order to show the manifold structure.

Page 5, lines 6-15. At the beginning of the paragraph, you state that the M-value can distinguish between stable and unstable manifolds as well as hyperbolic and elliptic regions. On line 14, you state that the M-value cannot distinguish between elliptic and hyperbolic points.

Page 7, figure 2. It is implied in the previous literature as well as your own figures, that the M-value is good at finding the radius of the elliptic regions BECAUSE it has a minimum as the center, so that the contour of M-value maximizes as it moves away from the center and then decays as it moves far away - such that the maxima of M-values could be used to estimate the radii of elliptic regions. This is not explained in your paper, yet, you regularly refer to needing to use both the M_v and M-value to extract useful gyre information. Page 9, lines 3 and 4 - refer to using the M_v in combination with the M-value. Pages 15-17 also make it unclear in all of the figures which M function is used to extract the gyre location AND SIZE. In the figures, is it stated M and M_v. Why both?

Page 8, lines 6-10. This paragraph asserts that M_v is the best of four metric because it can discern between stable and unstable manifold lines - which can be used to get more insight into the size of the eddies. HOW exactly? I feel like a paragraph explaining this statement is missing. Perhaps it would precede this paragraph. Can M_v distinguigh between stable and unstable manifold lines? If so, how? For that matter, in Figure 2, you show the four convective cell case, where M_v maximizes at the center. As tau increases, the maxima form a flatter and flatter plane centered on the gyre. Doesn't this make you less sensitive to the size of the gyre, not more sensitive? How does M_v determine the radius of a gyre. I'd like to know based on the text provided.

Page 11, figure 6. The resolution shown for this figure does not convince me that 0.15*lifetime is the optimal tau value. It could be any value from 0.06 up to 0.21*lifetime. There should be many more points to determine the best value.

Finally, in the beginning, I thought I was going to see this metric applied to an oceanographic data set. By the end, I did not find it. Please show me something geo-physical or tell me that it is coming in a later publication.

Conclusion:

I do find the approach taken opens up a path to many Eulerian-Lagrangian metric to be devised. This paper could serve as a warning to others about the nuances required to create and utilize such a metric. There is something new here, however, the case currently is weakened by gaps in the presentation that lead to more questions in the readers mind. I look forward to the authors filling in these gaps and then publishing!

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