

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-424

Anonymous Referee #2

Referee comment on "A novel method for objective identification of 3-D potential vorticity anomalies" by Christoph Fischer et al., Geosci. Model Dev. Discuss.,
<https://doi.org/10.5194/gmd-2021-424-RC2>, 2022

Review of "A novel method for objective identification of 3-D potential vorticity anomalies"

GENERAL COMMENTS:

An automated technique to objectively identify potential vorticity (PV) anomalies in isentropic levels is presented, with the novelty that it can be extended to 3D. The development and testing are focused on the detection of dynamical tropopause anomalies, which are related to extreme weather events. Description vectors are computed to simplify further analysis. The advantages of the 3D analysis are highlighted.

The method is sound and useful. The 3D extension is original and valuable.

The manuscript is well written and the effort to keep it easy to understand is noteworthy. Still, I have doubts about several things.

SPECIFIC COMMENTS:

- The word anomaly can be misleading. In general, it is easy to understand what it means by the context, but not as much in the abstract.

- Abstract: "The generated feature descriptions are well suited ... for generation of climatologies of feature characteristics". Lines 534 to 536: "Further research is required

on certain aspects of this identification ... for climatologies, automated tracking techniques are required. Ideas for further work ..." I do not think the 3D algorithm is that well suited for climatologies in its current version, feature descriptions or not.

- Looks like the development and testing of this method was restricted to the detection of anomalies in the dynamical tropopause. However, both the title and the abstract suggest a more general use. This is not discussed anywhere. There is just a mention of the problem in the equator due to the projection (lines 165-166), but this doesn't affect the dynamical tropopause, which is not defined at the lower latitudes. Can the method be used in other heights (i.e. middle troposphere/stratosphere) as it is?

- Line 184: " $\hat{\sigma}(x_c, y_c)$ itself can be calculated from the latitude and longitude positions of the pole and its surrounding pixels" This should be explained.

- I have had a lot of problems with "visualizing" the 3D method. The representation of the PVA in Figure 11 b and c (for example) is confusing: it looks like the 3D surface is such that it encompasses a volume (and then Γ_1 and Γ_2 should be surfaces, too). But this is not possible if the represented surface is 2 PVU: how is the surface closed to make it look like the PVA represented in Figure 11c?. It took me some time to realize that the computed surface doesn't have a thickness, and thus Γ_1 and Γ_2 are lines. Even in the images in the left column of Figure 12, where the structure of the surface is better represented, it looks like the anomaly has a thickness, a volume. In summary: explain what you do to make the PVA look like that (and why) or use a more realistic surface.

- In the left column of Figure 12, it is difficult to see the yellow region as an anomaly, and the right column does not help much. It would be useful to see two cross-sections going through the anomaly (a horizontal one and a vertical one), at least for one of the rows. I know this means losing information but, if the sections are wisely chosen, it will also mean gaining perspective and understanding.