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Interactive comment on "Insights on the three-dimensional Lagrangian geometry of the Antarctic Polar Vortex" *by* Jezabel Curbelo et al.

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Summary

In "Insights on the three-dimensional Lagrangian geometry of the Antarctic Polar Vortex" the authors analyze the full 3D Stratospheric Polar Vortex as it weakened during the southern spring of 1979. The analysis was performed using a the M function. The M function is defined as

$$M(\mathbf{x}_0, t_0, \tau) = \int_{t_0-\tau}^{t_0+\tau} ||\mathbf{v}(\mathbf{x}(t; \mathbf{x}_0), t)||dt,$$

where $\mathbf{v}$ is the velocity vector and $||\cdot||$ gives the magnitude of the vector. The M function gives the arc length of the trajectory of the point $\mathbf{x}_0 = \mathbf{x}(t_0)$ over the time interval $(t_0 - \tau, t_0 + \tau)$. High values of M correspond to large displacements in

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Discussion paper

fluid particles over the integration time, while low values of M correspond to small displacements. Sharp changes in the M field are indicative of stable and unstable manifolds. The velocity field for this study came from the ERA-Interim Reanalysis dataset published by the European Center for Medium-Range Weather Forecasts. This study is notable for its use of a fully 3D velocity field. Previous studies using the M function had mostly focused on 2D flows.

The authors found that the M function was able to accurately detect the Stratospheric Polar Vortex in the full 3D velocity field. The M function was also able to show the weakening of the polar vortex over the observed period. Furthermore, using the M function the authors were able to identify lobes surrounding the polar vortex. The M function was also able to depict the qualitative differences between the stratosphere, dominated by the polar vortex, and the troposphere, dominated by more turbulent and hyperbolic features. The authors conclude that this method can offer accurate insights into the behavior of 3D fluid flows.

Issues

The claim is that structures are identified in a 3D flow. But I would expect to see some extracted 2D structures, as was done in the cited paper du Toit, P. C. and Marsden, J. E. (2010). However, this is not the case. We merely see cross-sections of what are presumably 2D structures in the 3D flow.

How to identify elliptical LCS from the M function should be stated more clearly.

The use of the term algorithm in this paper is a bit confusing. Usually one expects to see a set of step by step instructions or a flow chart associated with an

algorithm.

Compliments

This paper was very well written.

The naming of the software tools and commands that were used in this was very helpful.

Pointing out the effect that terrain can have on stratospheric phenomena was a nice touch.

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