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Interactive comment on "Bifurcation of potential vorticity gradients across the Southern Hemisphere stratospheric polar vortex" *by* Jonathan Conway et al.

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The method described by Serra et al (2017) is an interesting addition to the suite of methods used to determine the approximate location of the vortex edge, a task that is commonly useful and/or necessary. It will be interesting in the future to see this method validated, since Serra et al show only one 12-day period in the NH winter during a dynamical regime when any reasonable definition of the vortex edge would give satisfactory results for the vast majority of studies, and since they did not present any quantitative evidence that it corresponds better with the location of the transport barrier than other methods. It will also be interesting to see it applied to the vortex in the SH,

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Discussion paper

where (as Conway et al, as well as previous work, have clearly demonstrated) the vortex and its "edge" have a very different character than in the NH. It may be appropriate for Conway et al to cite Serra et al, for example, in the introduction where they mention numerous methods of defining the vortex edge, including other Lagrangian methods, and/or in the discussion where they mention the desirability of exploring how the bifurcation of the PV gradients in the vortex edge region relates to mixing diagnostics and other Lagrangian methods. However:

(1) The focus of Conway et al, as I read it – and in my opinion the thing that makes their work valuable and unique – is not on determining a single vortex edge by any method, but on describing and understanding the structure of the flow in the whole "vortex edge region", of which PV and its gradients provide a physically-based description. Any work, such as that of Serra et al, that focuses purely on defining a single vortex edge, is really peripheral to the main points of Conway et al, so I don't see it as essential to add any further discussion of relationships to any of the numerous possible vortex edge definitions that have been developed, even those that have already been shown to be useful in practical studies and/or have been validated in relation to the transport barriers; in fact such discussion might distract from the main points of the paper.

(2) Many, if not most, studies where a single vortex edge definition / contour is needed require that value to be computed for many years and many levels in both hemispheres – studies of, e.g., approximately 40 years of reanalysis data or hundreds of years of climate model data, on many levels throughout the stratosphere – they must thus use a method that allows the vortex edge to be calculated quickly and efficiently for such vast volumes of data. Therefore, methods such as that of Serra et al, and other methods based on, e.g., Lagrangian descriptors or other computationally-intensive mixing diagnostics, are not expected to be the ones widely used in most practical applications, although they may prove to be very useful in evaluating these more simple and practical methods. The exploration by Conway et al. of how one of those practical/efficient methods might be modified to describe the bifurcated SH vortex edge more accurately

is therefore much more to the point of developing a practical diagnostic that more accurately describes the vortex edge region in the SH.

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