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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Evolution of Zonally Asymmetric Austral Ozone in a Chemistry Climate Model" *by* Fraser Dennison et al.

Anonymous Referee #1

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General comments:

This paper provides a useful advance to the topic through demonstrating the use of elliptical diagnostics to investigate the distribution of ozone in the Southern Hemisphere stratosphere. The authors apply the method to reanalysis data (from ECMWF) and simulations from a particular chemistry-climate model (NIWA-UKCA), fitting an ellipse to the 300 DU contour in total column ozone for October average data to examine the asymmetry of the ozone distribution. They show that ozone depletion has a significant influence on the asymmetry of the ozone distribution over the Antarctic during October, confirming other earlier related work. The main advance is in applying the elliptical diagnostics to the assessment of the Antarctic ozone distribution.

I recommend that the manuscript be published subject to the authors addressing the

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Discussion paper

following specific comments.

Specific comments:

1. Are formal uncertainties obtained for the fitted parameters? The code in the supplement suggests that formal uncertainties are not calculated, but on reading Taubin (1991), it would seem that this should be possible. It would appear from Figure 3 that the uncertainty on the fitted central longitude is relatively small compared with the inter-annual variability, but it would be useful to make a statement on the accuracy of the fitting. This could be confirmed by fitting to simulated ellipses of known properties.

2. Related to 1 above, how well-fitted is the 300 DU contour to an ellipse? Not withstanding the reference to Waugh (1997), an ellipse seems rather an arbitrary function to apply to the total ozone column where overburdens and unburdens of ozone due to tilting of the vortex with height will tend to distort the shape of a particular contour. It would be useful to comment on how small and consistent is the difference in area between the 300 DU contour and the fitted ellipse. The authors should also comment on how the tilting of the vortex could influence the fitted parameters. The effect of tilting when the vortex becomes distorted could be checked by fitting to a suitably chosen contours for two partial columns (e.g. 100 hPa and 10 hPa).

3. What is the spatial resolution of the ECMWF data used? How does the spatial resolution of the gridded data influence the accuracy of the ellipse fitting? For example, if the model and reanalysis have different spatial resolutions, how would uncertainties (or spread) in fitted parameters be expected to compare. This could be checked by changing the spatial resolution of the reanalysis data and seeing how the fitted parameters differ compared with those for the original resolution of the reanalysis data.

4. I am unsure how the 2-sigma envelope in Figure 1c for the model ensemble can extend to what looks like 90 degrees south given that the authors state in line 8 of page 4 that they only use fits where the central latitude is north of 89 degrees south. Please clarify. I suggest use of percentiles rather than standard deviations as the

envelope you show is symmetrical about the mean but I would expect the true range to be asymmetric (as, for example, by your method you can't have a central latitude greater than 89 degrees south).

5. The timeseries in Figure 3 run from about 1960 to 2090 which makes me wonder if smoothing has been used (although this is not stated in the caption). Please clarify or indicate why the full time span has not been used.

6. In the discussion, an effort is made to compare with earlier work, and it is noted that the ellipse centre longitude shifts west in the period 1960-1999, while other studies (e.g Grytsai et al., 2007 using data from 1979 to 2005) show that the extratropical zonal ozone minimum shifted eastward in part of this period. However, the authors do not offer an explanation for these differences. Is it possible to reconcile these differences by considering the longitude of the ellipse fitted to the reanalysis data at its most equatorward latitude? From looking at Figure 1 of Grytsai et al. (2007) this would tend to correspond to the longitude of ozone minimum in their analysis, albeit at a somewhat variable latitude that would depend on the size of the vortex (noting that the shift noted by Grytsai et al. (2007) is more eastward towards the pole).

Technical corrections:

Page 2, line 30: its rather than it's

Page 2, line 33: show the position of ozone minima to differ. . .

Page 4, line 9: are rather than is

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