Atmos. Chem. Phys. Discuss., 4, S515–S517, 2004
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Refinements in the use of equivalent latitude for assimilating sporadic inhomogeneous stratospheric tracer observations, 1: Detecting transport of Pinatubo aerosol across a strong vortex edge" *by* P. Good and J. Pyle

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Received and published: 15 April 2004

Firstly, we would like to thank the reviewer for spending time to study our manuscript and for offering some insightful and helpful comments. Our responses to specific points are given below.

———referee comment

First, data are used from only six stations whose latitudes vary from 44.5 N to 78.9 N. The small number of stations would seem to make the analysis vulnerable to varia-

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tions in lidar instrument or technique masquerading as latitude variations. That is, even though the random error in R is estimated at 20 to 30 %, might there not be systematic errors in one or more stations which would skew the PDFs when all of the measurements are counted together? Are some of the apparent changes in time actually shifts in the number of measurements from one station compared with another? How difficult would it be to rule out this possibility, say by comparing different stations at similar equivalent latitudes?

———author response

Following the referee's comments, the data has been checked to discover whether systematic error in one or more stations is responsible for the temporal changes reported in the paper. This was done by examining the data from each station individually. It was found that the major changes reported in the paper (in particular, the poleward shift of the NUr=0.2 contour) can be detected in data from individual stations. Hence, the results are not due to systematic differences between stations. This will be reported in a revised manuscript.

———referee comment

Second, in Figure 6, the authors show that the equivalent latitude of the aerosol tracer shifts in time over the month of January. However, to show that cross-vortex transport has taken place, we need to be able to see the movement of the vortex edge itself. The reader can sort of see this in the spacing of the lines in Figure 6, but as the authors point out the width of the edge region obtained from these lines is terribly wide. It would perhaps be helpful to overlay (as an extra, gray line in the figure) the equivalent latitude S72 of the vortex edge as obtained from the meteorological analyses.

We agree that the evidence for volcanic aerosol inside the vortex at this level is not conclusive. This discussion illustrates the main point of the paper: that even when an unusually large degree of care is used, detecting transport across a strong vortex edge is very difficult. However, the shape of the PDFs does offer some support to

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our suggestion that cross-vortex volcanic aerosol has been detected. Specifically, the PDF for NUr(i)=0.2 and days 50-80 has a very different shape from that for earlier times. For EQ5 $>$ 71 degrees, the PDF is stretched poleward as far as EQ5=90. This different form of the EQ5 error statistics indicates that different dynamics are in play for NUr(i)=0.2. Secondly, the companion paper demonstrates transport of volcanic aerosol to the very highest equivalent latitudes (as opposed to simply entering the vortex core) starting just below 475K. Thus it seems likely that some transport into the vortex core occurred above 475K. Estimating the bounds of the real atmosphere polar vortex (as opposed to that in the analyses) with sufficient precision to add extra confidence to this result would be probably not be possible.

———referee comment

Third, it is not clear that the error in equivalent latitude, evaluated near the edge of the polar vortex, is necessarily the same as the error poleward or equatorward of the edge. After all, as different dynamics come into play, it is plausible that the PV values from which the equivalent latitudes are calculated might have different error statistics.

Indeed, the equivalent latitude error poleward or equatorward of the edge will be very different (much larger) from the value presented for the edge region. However, the aim here was to investigate the use of equivalent latitude in detecting transport across the vortex edge. For this purpose, only the equivalent latitude error in the edge region is important.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 635, 2004.