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Interactive Comment

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

Anonymous Referee #1

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General comments.

In this paper the authors attempt to quantify the errors in the equivalent latitude derived from potential vorticity analysis, using the lidar aerosol measurements in the lower stratosphere. Focusing on the vortex edge region, where the scatter between the aerosol and equivalent latitude is likely due to the error in the latter instead of the former, they come up with a pdf-based method to determine the best estimate for the "true" equivalent latitude as well as its error bars.

This is one of few papers that address the error in equivalent latitude by way of comparing observed data and model-assisted analysis. The material will be useful to those who study chemistry-transport modeling or chemical data assimilation for the stratosphere; I deem it appropriate for publication. However, there are a few points, both scientific and presentational, that need to be substantiated as outlined below.

Specific comments.

1. The authors are probably correct in their assessment of the relative contribution to the aerosol-equivalent latitude scatter in the vortex edge regions: the scatter is most likely due to error in the equivalent latitude and not to the measurement errors or chemistry or sedimentation. What is not clear is the extent to which the error estimate in this narrow region of the stratosphere based on single assimilation (UKMO) is representative. Allen and Nakamura (2003) show that equivalent latitude is most sensitive to the driving wind, and that the sensitivity on the wind varies with region and season. In fact, their analysis suggests that the equivalent latitude errors are probably minimal in the edge region where winds are smooth (and hence well modeled) and all tracers are strongly slaved to the wind. If this is true, the 2.6 degree estimate that the authors obtain is perhaps close to the lower bound of errors. I understand that this paper is primarily about the method and not about an exhaustive analysis, but at least some discussion seems necessary on this point.

2. The authors calculate equivalent latitude by integrating SLIMCAT model for 5 days from an observed potential vorticity distribution. It is argued that the effect of transport is to "randomize" errors, making it more Gaussian. First of all, if the model were run longer, does the gaussianity improve further? It seems to me that the method is chosen for practical reasons with two assumptions: a) the equivalent latitude of analyzed potential vorticity is reasonably close to the true equivalent latitude and hence provides a good initial condition; b) 5 days is sufficiently long to achieve gaussianity in errors but sufficiently short so as not to cause computational burden. Is this correct? I think it is important to clarify the role of potential vorticity and the subsequent transport calcula-

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tions. An alternative way of obtaining equivalent latitude may be to solve a long-term advection-diffusion problem to numerically generate PV-like tracer (Haynes and Shuckburgh 2000; Allen and Nakamura 2003). This way the equivalent latitude is decoupled from the analyzed PV, and error is likely to be well randomized. (These authors report that the obtained tracer is very similar to PV).

3. Since I believe most readers are new to the pdf method described herein, some tutorial would be helpful in the discussion. For example, it would be helpful to point out that what Fig.2 shows is a "cumulative" pdf, and that if there were no errors in the equivalent latitude and in the measurements, the curves would be step functions: the slope is introduced by the uncertainty in the equivalent latitude.

Technical points

p.2 col.1 L.1 Maybe phi_e = arcsine(1 - 2*A(chi)) [since A=0 should be at the pole]? p.4 col.2 last para. nu_i does not seem to be defined. Is it different from nu_R(i) ? p.5 col.1 sec. 3.3 L.5 due *to* early microphysical evolution... p.6 col.1 L.11 that the (the) sparse observation...

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