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Interactive Comment

Interactive comment on "Impact of mixing and chemical change on ozone-tracer relations in the polar vortex" *by* R. Müller et al.

R. Müller et al.

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We thank Neil Harris for his comments. All his points are valid and have been taken into account in the revised version of the manuscript.

1. We agree, the distinction is to be made between Chemistry climate models (CCMs) and chemical transport models (CTMs) and we have changed the title of subsections 2.2.1 and 2.2.2 accordingly. Further, we have included a discussion of the representation of tracer relationships in Eulerian models (SLIMCAT and NCAR CTM) as suggested. The following text has been added to the paper: *The ozone-tracer relation in Eulerian chemical transport models has not been studied extensively. However, its has been shown that compact tracer-tracer rela-*

tions can be simulated for the polar vortex by Eulerian chemical transport models Plumb et al. (2000). Recently Robinson et al. (2005) reported simulations with the SLIMCAT model, showing compact ozone/CFC-11 relations in agreement with balloon-borne measurements.

2. The focus of the paper is on tracer-tracer relations within the vortex. There is a strong transport barrier at the vortex edge and very different tracer-tracer relations prevail inside and outside of the vortex. An extension of our arguments to other situations where mixing impacts tracer relationships (Hoor et al., 2004; Khosrawi et al.,2004) is therefore not straightforward. Of course, our arguments regarding mixing across the vortex edge apply to other tracer relationships than just those of ozone with a long-lived tracer, that are the focus of the present work. Nonetheless, the impact of mixing across the vortex edge on tracer relations will be rather different for relations with a shape different from ozone/tracer (like e.g. the NO_y/N_2O relationship) so that for example we would have to redo many CLaMS model runs. We feel that such an extension is beyond the scope of the paper.

3. More perturbed dynamical conditions, such as a minor warming, will indeed lead to enhanced mixing in CLaMS. However, *enhanced mixing* means here that more mixing events are triggered in CLaMS; the actual mixing parameters of the CLaMS mixing algorithm (from which the effective diffusivity is calculated) remain unchanged (Konopka et al., 2005b). For example, the standard mixing parameterisation of CLaMS was used successfully to simulate the stratospheric warming in the Antarctic in September 2002 (Konopka et al., 2005a) . Even for these rather perturbed conditions, the "surviving" part of the Antarctic vortex remained rather isolated. The Eulerian parametrisation of mixing in the model by Plumb et al. (2000) is different from the Lagrangian concept used in CLaMS, where the mixing intensity is proportional to the gradient of the wind rather than to the wind itself as it is the case in Eulerian models. Thus, the way that the model is set up

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means that the rather large diffusion coefficients K are effective at every timestep of the model run. In contrast, in CLaMS, during quiescent periods only very few mixing events would be triggered. In summary, we stand by our statement that the Plumb et al. (2000) model overestimates diffusion at the vortex edge. The following text has been added to the paper to clarify this point: *The diffusivities in the CLaMS model are the same for studies addressing rather different problems such as reproducing observed filamentary tracer structures (e.g., Khosrawi et al., 2005; Konopka et al., 2005b) or simulating the stratospheric warming in the Antarctic in September 2002 (Konopka et al., 2005a). Note that the Eulerian parametrisation of mixing in the model by Plumb et al., (2000) is different from the Lagrangian concept used in CLaMS, where the mixing intensity is proportional to the gradient of the wind rather than to the wind itself as it is the case in Eulerian models.*

Minor comments

We thank the reviewer for raising these points. We have followed the recommendations. We have also reduced the use of the nickname TRAC, although we have not completely eliminated it.

Additional References

- Hoor, P., Gurk, C., Brunner, D., Hegglin, M. I., Wernli, H., and Fischer, H.: Seasonality and extent of extratropical TST derived from in-situ CO measurements during SPURT, Atmos. Chem. Phys. Discuss., *4*, 1691–1726, 2004.

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