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**Geoscientific
Model Development
Discussions**

Interactive comment on "Quantifying atmospheric transport, chemistry, and mixing using a new trajectory-box model and a global atmospheric-chemistry GCM" *by* H. Riede et al.

Anonymous Referee #1

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This paper describes a modeling system that can be used for quantifying contributions from transport, chemistry and mixing along atmospheric trajectories. The model hierarchy consists of an atmospheric box model that is highly consistent to a 3D atmospheric chemistry model. Through comparison of results from the two models along atmospheric trajectories a separation of transport, chemistry and mixing can be achieved.

This paper is very well written, the tools and techniques generally clearly described and benefits and shortcomings of the method fairly well documented. The pesented method is new to me and I especially encourage the concept of "running trajectories through model output" which is a very useful tool in support of analysis of observations

and models.

I have one major comment/question. As mentioned on page 480, line 10, the 3D model results are also impacted by the secondary effects of mixing on chemistry, in contrast to the box model results. Thus, the definitions of chemistry and mixing become more nebulous the higher the degree of non-linearity in chemistry of the tracer species. This makes it less valuable for the analysis of such tracer observations where the actual chemistry contribution, i.e. chemistry occurring in the presence of diluted concentrations, is of interest. For CO with a fairly linear chemistry, the impact can be expected to be rather small, but what about species with a more non-linear chemistry such as ozone? Related to this I wonder, what are the advantages of your method compared to applying atmospheric trajectories along model output of mass diagnostics from the 3D model. Many modeling system do allow for output of fluxes and chemical rates for each grid box that can be used to quantify the individual contributions and thus allow for information about the actual chemistry component rather than a "pure" undiluted chemistry contribution.

One other question. I cannot quite follow the calculation of J-rates in the trajectory model. One page 461, line 29 you mention that for trajectory-box model calculations, the cloud fraction and cloud water content is set to zero. Then in the following paragraph you mention external J-rates replacing information about clouds and aerosols. What are the "external" J-rates and how exactly are J-rates derived in the box model and the influence from clouds and aerosols considered?

Interactive comment on Geosci. Model Dev. Discuss., 2, 455, 2009.