

## ***Interactive comment on “Implications of Lagrangian transport for coupled chemistry-climate simulations” by A. Stenke et al.***

**A. Stenke et al.**

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### **General Comments:**

The reviewer is correct that we partly refer to the results of Stenke et al. (2008), especially with respect to stratospheric dynamics. We do this for two reasons: First, the results of Stenke et al. (2008) are based on the plain dynamic model E39 and it is not self-evident that the findings hold also for the fully coupled chemistry-climate model version. Second, we believe that discussing the changes in stratospheric dynamics is necessary for the analyses of stratospheric tracer distributions. We have tried to keep this section as short as possible. We have added a supplement to extend the discussion of stratospheric tracers.

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Concerning the second comment of the reviewer we'd like to point out that the intention of our paper is to present and evaluate the new model version E39C-A. A detailed discussion of the dynamical effects of the changed ozone field (yes, ozone is coupled to the dynamics) would require sensitivity studies in which the model's radiation code is forced by different ozone fields and chemical feedback is switched off. We believe that this kind of process studies are far beyond the scope of the present paper and should be published separately.

The possible reasons for a different or better performance of other models not applying a Lagrangian transport scheme are manifold, e.g. different model formulations, domain or resolution. Lagrangian transport works for E39C, but things might look different in other models. According to our opinion it is not possible to attribute the improvements to a single cause, especially not in a fully coupled model system.

### Specific Comments:

- Abbreviations: We have included a table describing the different model version used in our study. In the abstract we have tried to avoid the extensive use of abbreviations.
- See response to general comments.
- p18730/l-2: Reference added.
- p18733/l-31 and p18741/l-9: The problem of “empty grid boxes”, a required mapping and filling procedure as well as arising inconsistencies between Lagrangian space and grid point space have already been discussed in detail in Stenke et al. (2008). We think this discussion should not be repeated in the present paper. As the number of air parcels scales with pressure, we expect the applicability

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- of ATTILA to be limited for middle atmosphere models, at least in view of actual computer resources.
- p18735/I-9: The changes in the prescribed forcings like the additional radiative heating rates by volcanic aerosols have only minor effects on the overall dynamics. This is obvious from the time-series of the global mean temperatures in the lower stratosphere (see Fig. S1 in the supplement): The changes in the volcanic heating rates lead to a different stratospheric temperature response during max. 2 years after the volcanic eruption. After this time both model versions do not show any substantial differences.
  - p18736/I20-24: The calculation of the stream function in the 2d model is based on climatological zonal mean temperatures (Barnett and Corney, 1985) as a function of latitude and pressure for every month of the year, i.e. the model takes into account an annual cycle. The use of prescribed fields always means an underestimation of coupling effects. Feedback processes between transport and chemistry are rather complex, and we are not able to disentangle the size of each effect. According to our opinion the effect of inconsistent changes of the Brewer-Dobson-Circulation is minor.
  - p18739/I-22: We have included a short (and speculative) discussion of possible reasons for the different behaviour in NH and SH.
  - p18744/I-2: An upper boundary condition for the Cl<sub>x</sub> family similar to the introduced CH<sub>4</sub> upper boundary condition would require global observations for all chlorine compounds similar to HALOE CH<sub>4</sub> measurements. Even if such measurements would be available we would not expect a significant improvement of the results. As mentioned above we believe that the underestimation of feedback processes due to prescribed boundary conditions is negligible.
  - p18745/I-14: Our analyses include all seasons and geographical regions, not

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only winter and spring. In the paper we concentrate on the winter/spring polar stratosphere because we believe that's the region of most interest.

### Minor Comments:

- p-18728, l 5-9: sentence removed
- p-18735, l 9 >> done
- p-18740, l22: "so-called" removed

### Technical Corrections:

- Legend Fig. 7 >> done

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