

Answer to Referee #2:

We thank the reviewer very much for the helpful comments on our manuscript. All comments were taken into account in the revised version and we feel that the manuscript has improved substantially through these revisions. Below, we reply point-by-point to the referee comments:

1. You have stated the importance of simulating the transport barriers and tropical pipe in the introduction (P 1761, Para, 2-3), as a motivation for the implementation of the transport module in the EMAC model. However, you present only the discussion on the polar barriers (Arctic and Antarctic vortices). Since EMAC is a climate model, it is also good to present a discussion on the subtropical barriers. You can use either age of air or any tracer simulations (N₂O/CH₄) for this and please make a comparison with measurements.

Answer: As suggested, we included additional age of air diagnostics in Figure 2 in the revised version of the paper. The new plots show simulated age of air profiles in the tropics and mid-latitudes (extending the discussion focussed on the polar region in the submitted version) and provide a comparison to measurements. The difference between the tropical and the mid-latitude profile shown in Fig. 2 gives an insight into the strength of the subtropical transport barrier in the model described here. However, the position and strength of the subtropical transport barrier shows high seasonal variability. Thus, a more extensive discussion of the subtropical transport barriers is a complex topic which is beyond the scope of this paper. Therefore we suggest to shift this discussion to a future publication of this model. For further discussion of age of air see also our answer to Referee #1, point 2.

2. As you have already pointed out the significance of the accurate simulation of H₂O in the climate models (P 1761, L 6; P1762, L 18-20,), I would also like to see the performance of EMAC/CLAMS on this. Please discuss the representation of the taperecorder in your model. You could compare that with the MLS measurements.

Answer: We agree that the water vapor tape recorder is an important model diagnostic. However, modelling water vapor involves complex micro-physical processes. In the current version of the EMAC/CLaMS model system, only a very simplified version of cirrus cloud formation is included, such that the current model version is not suitable for a detailed study of water vapor. The improvement of the representation of water vapor is an important further step in the future development of the model system.

3. Temperature is one of the important parameters to look at as far as the validation of a model is concerned. In addition, temperature has a seasonal cycle in the high latitudes, and you are presenting the polar vortex as an example of transport process in the model, so it is necessary to discuss the simulated temperature in the model. As shown by the SPARC (2010) report, some models show bias in the polar temperature. Therefore, please present a comparison of the modeled and measured/or reanalyzed (e.g. ERI) temperature.

Answer: We agree with the reviewer that the feedback to temperature is an important topic. However, in the model run that we show in this paper, the feedback from the trace gases to the radiation and model dynamics is not yet implemented. Thus the temperature is the same with both transport schemes.

Minor points

P1760, L15-16, example for what ? Please specify.

The edge of the polar vortex is an example for a region with strong transport barriers. Text changed in the paper.

P1761, L10: jet and tropopause
changed

P1761, L24: simulating or maintaining (transport barriers)? [also at P1763, L13 and in abstract] (e.g. maintaining a vortex in summer?)
changed

P1763, L2: "simulations of"
changed

P1769, L5-10: Yes, you can present that in a separate publication. However, you also need to present some comparisons for this study too (e.g. When this article is read, the reader should get a clear idea about the transport/dynamics of the model, if this is the goal of your article.)

In this article here we made a compromise in this respect. We extended the discussion about age of air in this article, which gives more insight in the dynamics. This model description paper mainly focusses on the description of the new model system (main focus). See also our answer to point 1.

P1771, Sect. 3.2: Please present a contour plot of the age of air distribution (latitude versus altitude), prior to the comparison at a particular altitude.
See also our answer to point 1.

P1772, L2: Hoffmann et al. (2004) is not published yet. So the readers do not know their comparison details. Therefore, please add more information on this.

Answer: The article by Hoffmann et. al. is now published in *Atm. Chem. Phys. Discuss.* We changed the paragraph in the following way:

Zonal mean trace gas climatologies from EMAC/CLaMS were also used to derive the relative lifetime of CFC-11 and CFC-12 (Hoffmann et al. 2014). The results compare very well with lifetimes derived independently from various satellite climatologies. The lifetime ratio of CFC-11 and CFC-12 from the EMAC/CLaMS simulation yields 0.48 (0.40-0.55). The satellite climatologies Hoffmann et al. (2014) deduce lifetime ratios ranging from 0.46 (0.39-0.54) to 0.47 (0.39-0.54). The good agreement between the model deduced and observationally deduced lifetimes provides further confidence in the representation of transport and chemistry of long-lived tracers in the EMAC/CLaMS model system. The results also correspond very well with the recommendations for the lifetimes of CFCs by SPARC 2013 which provide a lifetime ratio of CFC-11 and CFC-12 of 0.51 (0.35-0.76).