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Interactive comment on "Tropical troposphere to stratosphere transport of carbon monoxide and long-lived trace species in the Chemical Lagrangian Model of the Stratosphere (CLaMS)" *by* R. Pommrich et al.

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We thank the reviewer for very helpful comments. In particular, we accept the recommendation to explain why it is important to present both the new formulation and the evaluation of this model concept in GMD. We have changed the paper to respond to these comments. Our detailed response to all the comments in the review is given below, with the reviewer comments shown in italics.

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Major comments

1. *There exist already several models that can simulate trace species in the considered domain. I recommend to describe explicitly what the main advantages are of CLaMS compared to other models.* In response to this comment, we have mainly changed the motivation given in the introduction. Here, we have focused on the main feature that distinguishes the CLaMS model from the other models mentioned, namely the very different (Lagrangian) representation of transport. This Lagrangian transport encompasses a mixing scheme (e.g., McKenna et al., 2002b; Konopka et al., 2005), i.e., is clearly goes beyond a trajectory calculation. We have also included a brief discussion of other, very recently published, model developments based on similar (Lagrangian) ideas (see also response to review three). We have added the following text to the paper: "In this way, the unique Lagrangian transport scheme of CLaMS, which is inherently non-diffusive and therefore particularly well suited for the simulation of strong trace gas gradients (e.g., McKenna et al., 2002b; Konopka et al., 2005), may be applied to studies of the upper troposphere and lowermost stratosphere. An alternative concept for a numerically efficient simulation of CO in the stratosphere, based on a representation of transport by trajectories and precalculated chemical tendencies from a chemical climate model has been recently presented by Wang et al. (2014)."

2. *It is important to have a good model, but even more important that there exist important research questions that can be assessed with the model. I recommend to mention such questions, in a rather specific way. Which questions are currently unresolved, that could be resolved with CLaMS, and why are these questions relevant? Both major comments are about why it is important to have (an evaluation of) this model.* We agree with this point. In response to the comment, we have added the following discussion to the paper (end of introduction): "The version of CLaMS presented here will allow addressing a variety of cur-

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rent research questions, which require an accurate and efficient representation of transport and chemical processes in the vicinity of the tropical and extratropical tropopause. Transport processes in this region are frequently problematic to simulate, because of strong gradients in trace species (e.g., CO, H_2O, HCN, O_3). Examples for such research questions are transport pathways through the Asian monsoon, intrusions of upper tropospheric tropical air masses into the lowermost extratropical stratosphere and of small scale (e.g., warm conveyor belts) transport pathways from the troposphere to the stratosphere".

Minor comments

1. *Why do you evaluate in Figures 2, 3 4, 7, 8, anomalies, rather than de signal itself? Wouldn't it interesting to evaluate the averages as well?*

   We agree that it would be interesting to evaluate the averages in addition to anomalies. However, we do not consider it straightforward that a model can achieve an accurate representation of the anomalies, which is why we have provided the respective tests in the paper. A comparison of the averages is an important next step, but introduces further complications, most notably the problem of biases in the satellite data themselves (e.g., Wang et al., 2014). Therefore, for the present paper, we have concentrated on the comparison in absolute values for the in situ data, for which we were able to conduct some analysis of possible biases (see in particular the appendix of the paper). But we agree with the reviewer that further analysis of the CLaMS CO fields against measurements should follow.

2. *p. 5111 l. 13-15: 'at comparatively low numerical cost' is mentioned twice in this sentence*: fixed.

3. *The panels in Figure 4 are, at least for me, too small for comparison purpose*: We agree. We have changed Figure 4 to make the panels larger and have combined

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the panels to reduce white space in the figure. Along these lines, we have also improved the quality of Figs. 10 and 11.

References

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Interactive comment on Geosci. Model Dev. Discuss., 7, 5087, 2014.