

Interactive comment on “Observationally derived transport diagnostics for the lowermost stratosphere and their application to the GMI chemistry and transport model” by S. E. Strahan et al.

Anonymous Referee #1

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General comments:

This paper presents a set of diagnostics for the GMI chemistry transport model, with an emphasis on the transport in the lowermost stratosphere. A range of observations, including both satellite and aircraft in situ, are used to derive the diagnostics. The results and the methods presented contribute nicely to the ongoing community effort of process-oriented validation of chemistry -climate models. The topic is within the scope of ACP. The results are significant. The current version of the paper, however, has several weaknesses and needs improvement before publication. My comments and

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suggestions are given below. Some of the changes required are not minor.

Specific comments:

1. The introduction needs improvement

The first 3 paragraphs of the paper are lengthy and scattered. Please consider condensing them into one paragraph. The main points you made here are to introduce the concept of LMS and the relevant transport pathways. These are well-established concepts and can be stated in a more succinct fashion with a reference to Holton et al., 1995.

2. Clarity and efficiency of the figures (Figure 3, 4, 6)

Suggest using white background in figure 3&4. The black background does not add to the readability.

The white line and dots in Figure 3 are ambiguous. Suggest change into black thin lines with error bar indicating the scatter of the data. In case of the ER-2 data, I do not understand how the seasonal means appear to be scatters that show a spread. Enlarge the figure by a factor of 2 would improve the readability.

In figure 6, using scatters on top of each other is not the best choice. Suggest using lines and error bars, at least for one of them, maybe for both. The quantitative information will be more apparent.

3. Figure 5 and related discussions

This is an interesting comparison, but the presentation right now is very qualitative. Maybe a 3rd column can be added to show an overlay of the model and data contours in two colors without the fill.

The model result for the Fall doesn't support the authors' statement "N₂O isopleths clearly follow the dynamical tropopause and PV contours". Need to qualify that statement.

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4. Figure 7 and related discussions - some major issues here

This diagnostic is not as well designed as others in this paper. The figure is very vague and the comparisons with the data made in the discussion are too hand waving. Suggest to overlay SPURT data statistics on top of the model scatter, at least to show if they occupy the same tracer space.

The interpretation of the figure is somewhat flawed. It is difficult to see the tracer space the points in each color occupy, but a clear seasonal difference is shown by the upward extension of the blue points in Spring case. These upward extensions, or the fact that mixing lines are partially blue, suggest that, the mixing region involves the air mass below -10K level in Spring. This is in contradiction to the conclusion that the mixing layer is nearly constant in season (page 1461, line 20-24).

5. Figure 8 and related discussions

The curves in this figure are poorly defined. How the “modeled CO₂ cycle” is produced is not explained. What range of data that made the “Upper trop” curve, for example, is not explained in the text nor the caption. Similar to the previous figure, the comparison with the data is too hand-waving. You almost have to have H2004 side by side with this paper to understand the discussion. Overlay of SPURT data statistics should help.

6. Inadequate references

Reference of TTL and its lower boundary to Schoeberl et al., 2006 is not appropriate. This part of the introduction is only loosely relevant. If decide to keep, please reference Highwood and Hoskins [1998], Sherwood and Dessler [2000] for TTL and reference Folkins [2002], Gettelman and Forster [2002] for the lower boundary.

Page 1452, line 8, add at least one reference. e.g., Eyring et al., 2005.

For CO lifetime, transport signature, and distribution, need to reference some earlier papers, in the least MOPITT related papers, e.g. Edwards et al., 2004, 2006.

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For CO-O3 correlation, need to add Zahn et al. 2000; Zahn and Brenninkmeijer [2003]

Technical comments:

It will help the readers very much if the X-labels of figures 2, 6, and 8 are given in month, rather than every 100 days. It will make it a lot easier to follow the discussions in the text in terms of seasons if only labeling 4 points in the two year repeated cycle (Jan and Jul).

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