Reply to Referee #1:

We would like to thank referee #1 for detailed comments that helped us to improve the manuscript. We have carefully considered each of the reviewer's comments in our revision. Our responses are provided below (the reviewer's comments are shown inline in italics).

Specific Comments: Line 42: CO has been used in transport studies in global models much farther back in time than indicated by the references used here. The Allen et al. (1996, JGR) should be included here.

Reply: Revised as suggested.

Section 2.2: The two models are driven by the same meteorology and have a number of similarities. The authors need to highlight the major differences between the two models, as this is sort of lost in the test. Perhaps highlight the model differences in a table. This is important because one of the major aspects of the paper is illustrating the difference in the CO results between models.

Reply: Thanks for this helpful comment. We have added one sub-section "2.2.3 Differences between GMI and GEOS-Chem" and one table (Table 1), together with Table 2 (original "Table 1") to highlight the major differences between the two models. The added section is as follows:

"To highlight the differences between the GMI and GEOS-Chem model run, we summarize their major differences in Table 1. In addition, we calculate the annual mean values and interannual standard deviations of CO budget (including biofuel and fossil fuel emissions, biomass burning emissions, tropospheric chemical production, tropospheric methane oxidation, loss with tropospheric OH, and net transport from troposphere to stratosphere) for GMI and GEOS-Chem during the period 2004–2012, and the results are provided in Table 2. In general, CO emissions from fuel combustion and biomass burning are mostly the same, but the chemical production and loss rates of CO in the troposphere are quite different between the two models. Specifically, GEOS-Chem is 40%, 16% and 15% higher than GMI in tropospheric chemical production Of CO, tropospheric CH4 oxidation and CO loss with tropospheric OH, respectively. For the net CO transport from troposphere to stratosphere, GEOS-Chem is ~9.5% larger than GMI."

Line 164: NCAR convection scheme. Is this correct? If so, what scheme is this? Is there a reference? Rain, cloud, land-water-ice all come from MERRA. They are not calculated in GMI as implied by this sentence.

Reply: We have revised this sentence to "Convective transport of trace gases is parameterized using a modified CONV_TRAN routine contained in the NCAR CCM3 physics package (Kiehl et al., 1998)."

Kiehl, J. T., Hack, J. J., Bonan, G. B., Boville, B. A., Williamson, D. L., and Rasch, P. J.: The National Center for Atmospheric Research Community Climate Model: CCM3, J. Clim., 11(6), 1131–1149, 1998.

Line 167: Need another sentence here: …. hindcast spinup period. Therefore, the GMI simulation used in this analysis is for 2004 through 2012.

Reply: Revised as suggested.

Lines 218-219: Is it the monthly means that are archived?

Reply: Yes, they are monthly mean data.

Line 241: The headings in Table 2 are incorrect. "Minimum" should be "Maximum" and vice versa. What is meant by "peak" here? Is it the maximum of the grid cell values of monthly means?

Reply: The "Minimum" and "Maximum" refer to the absolute percentage differences between models and MLS observations, we have exchanged them and renamed to "Minimum difference" and "Maximum difference". The "peak" is the maximum grid cell value of seasonal means, we have changed to "peaks of simulated CO concentrations" to avoid confusion.

Line 254: Need to point out that this maximum is not as broad as in the MLS data.

Reply: Revised as "However, this maximum in model simulations is not as broad as in the MLS observations. In addition, both models underestimate CO concentrations poleward of 50°."

Line 270: …local maxima and minima…

Reply: Revised as suggested.

Line 271: …underestimation of CO extremes from GMI….

Reply: Revised as suggested.

Line 294: The underestimate over and downwind of North America should also be mentioned.

Reply: Revised as: "This is mainly due to the underestimated CO over South Asia and East Asia, as well as East US and downwind region as shown in Figure 1."

Line 323: At 147 hPa (not shown)….

Reply: Revised as suggested.

Line 347: 20 hPa

Reply: Revised to "…the same altitude (~50 hPa or 20 km)".

Line 378: It is unclear as to whether the underestimates listed here are for a particular month or an average over the years.

Reply: It is for a month (averaged over 8 years). We have revised to "The largest underestimation for a month by GMI…" to avoid confusion.

Lines 392-393: The peak in both models is a month later than MLS in East Asia also.

Reply: We have revised as: "Over the other three regions, simulated seasonal variations are not consistent with MLS. For example, MLS shows CO peaks in July for East Asia and in August for South Asia (Figs. 12d and 12e), but the peaks in both models lag MLS by one month."

Line 404: Note that the seasonal cycle is not correct in North Africa and South Asia.

Reply: We added one sentence: "…but large discrepancies exist over northern Africa and South Asia (Figs. 13c and 13e)."

Line 419: "largest at 215 hPa" This is not true for four regions in DJF and MAM where the difference maximizes at 100 hPa.

Reply: Thanks for pointing out this. We have checked the differences and revised as: "In general, the differences between GMI and GEOS-Chem are largest at 215 hPa (up to 19%) during DJF, whereas the differences reach maximum at 100 hPa (up to 13%) during JJA."

Line 466: "....which is also captured in the GMI simulation, but not in the GEOS-Chem simulation."

Reply: Revised as suggested.

Lines 474-475: I would say it is more pronounced at 215 than at 147 hPa.

Reply: Revised as suggested.

Lines 514-516: Is there any explanation for this poor behavior by the models?

Reply: The inconsistency over East Asia and South Asia between models and MLS observation may result from several reasons, including low biases in direct surface emission, the fraction of CO emissions released above the boundary layer, biogenic NMVOC oxidation, horizontal advection of CO, and model parameterizations of convective transport.

Lines 534-537: I don't think this conclusion is mentioned anywhere else in the paper.

Reply: We have revised as: "The UTLS transport of CO from East Asia across the Pacific to North America in MAM and JJA is shown in the two models' simulation, but the CO concentrations are much lower than observed by MLS."

Lines 591-593: This conclusion supports the need to have a table that clearly shows the differences between the two models, especially with respect to these topics.

Reply: We agree to this comment and please see our reply to the 2nd comment above.

Line 627: V4 CO is slightly more realistic

Reply: Revised as suggested.

Table 2: There needs to be an overall heading over the nine columns to the right of the correlations. It should say "Model Biases (%)".

Reply: Revised as suggested.