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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of near-tropopause ozone distributions in the Global Modeling Initiative combined stratosphere/troposphere model with ozonesondedata" *by* D. B. Considine et al.

D. B. Considine et al.

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General Comments:

We would like to thank the referee for the time spent reviewing this paper. The comments of all the referees have been very useful, and have helped us to produce an improved revised version which will be submitted to the journal shortly.

We have responded to most of the comments and suggestions included in the reviews, though some of the suggested modifications and additions were infeasible at this time. Below we list in italics the comments of Referee 2 to which we have responded, fol-

lowed by our response in regular font.

Specific Comments:

"The discussion on what we could learn from the different averaging approach is weak."

We have revised this discussion in the summary and conclusions section, and hope that the revised discussion is clearer. The basic conclusion is that pressure averaging can obscure model/measurement discrepancies. In particular, the sharp transition between tropospheric and stratospheric ozone values seen in daily sonde profiles are better preserved in monthly averages with RTT averaging. RTT averages are therefore more representative of the daily sondes than are pressure averages.

"On the other hand, when the 2.x2.5 run showed worsened high bias in modeled ozone, the authors suggest that this is due to not enough horizontal diffusion when denser grid points are used."

We did not mean to imply that the 4x5 simulation was better because it had more horizontal diffusion. Rather, the increase in resolution removed an error which was obscuring another error, which we feel is likely to be due to too coarse vertical resolution in the model. Our discussion of this point was modified for clarity in the revised version.

"The abstract in particular could use some improvement to make the take home massage [sic] stand out better."

We have modified the abstract for increased clarity in the revised version, particularly in regard to the differences between RTT and pressure averaging.

"Since the model has a coarser vertical resolution than the sondes, it is important to state in the paper how tropopause heights are derived in the model data."

We now include a brief discussion of how tropopause heights are determined in the model. The vertical model temperature profile is first interpolated to a 0.1 km grid using cubic spline interpolation, and then the WMO criteria is used to determine tropopause

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height. (We also tried linear interpolation to a 0.1 km grid, and found little difference in our results.)

"In addition, the variations of monthly tropopause pressure, as indicated by the vertical bars in figure 4, are unrealistically small. Take a mid latitude station, Wallops Island for example, the tropopause there often jump between the tropical and polar altitude depending on which side of the jet stream it is at, especially during Spring and Fall. It is hard to believe that the standard deviation of the mean is within 25 hPa. How much model data went in the tropopause height calculations? As many as the days with available ozonesonde data?"

We have revised this figure to include standard error bars for the observations as well as the model result. Note that the error bars are standard error rather than standard deviation, because we are interested in the precision with which mean and median tropopause heights are known, rather than quantifying the variability of the tropopause height. Although model and observed variability is comparable, model standard error is typically substantially smaller than observed because we are averaging daily model values over 5 model years, or 150 days in a 30-day month. This will result in over a factor of 12 reduction in the standard deviations, and accounts for the apparent smallness of the error bars. Though we use up to 15 years' data in the ozonesonde climatology, the number of observed values is usually smaller so observed standard errors are larger. We have included an explanation of these differences in the revised version of the paper.

"The issues discussed in the previous point suggest that in many ways the tropopause ozone may not be the best choice as an indicator of how the model is doing."

We understand that tropopause ozone is not the only metric of model behavior in the NTR, but feel that it is worth considering. Only three of the figures in this paper explicitly examine tropopause ozone (Figs. 5, 6, and 7). The rest consider profiles, examining ozone values both above and below the tropopause. We also consider three different

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ways of averaging and comparing near-tropopause ozone (pressure averaging and two different ways of comparing relative-to-tropopause averages.) We feel that this produces a balanced evaluation of model near-tropopause ozone distributions using ozonesondes.

"The comparisons focused too much on the mean, not enough on the variability. Although the standard deviations are given in several figures, they appear to be unrealistically small or inconsistent. Take figure 4 as an example, the standard deviations for the model tropopause is given without mentioning how the statistical set is formed.... Another example is figure 11. Without error bars, it is not clear how the 3 sets of statistics relate to each other."

As we have discussed above, we include standard error bars, not standard deviation bars on the figures, which is why they appear smaller than the referee expects. We use standard error instead of standard deviation because we are interested in how precisely monthly mean and median values in the sonde climatologies and model averages are defined. We find that they are defined well enough so that differences between the modeled and observed values are significant, allowing an evaluation of the accuracy with which the model reproduces the observations. To enhance this analysis we have added standard error bars to the data in Fig. 4, and explicitly discuss the implications of differences between the model and observed error bars. Figure 11 did include standard error bars for both the observed RTT-averaged profile and the model RTT-averaged profile. We hove now added error limits to the RTT-averaged profile compared at the same fraction of tropopause pressure. In addition, we have modified the figure to show standard deviations of the profiles so they can be compared. We have revised the text to comment on the differences between modeled and observed variability. We now also indicate standard error in Fig. 12.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 1589, 2008.

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