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Evaluation of near-tropopause ozone distributions in the Global Modeling Initiative combined stratosphere/troposphere model with ozonesonde data

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Abstract. The NASA Global Modeling Initiative has developed a combined stratosphere/troposphere chemistry and transport model which fully represents the processes governing atmospheric composition near the tropopause. We evaluate model ozone distributions near the tropopause, using two high vertical resolution monthly mean ozone profile climatologies constructed with ozonesonde data, one by averaging on pressure levels and the other relative to the thermal tropopause. At the tropopause, model ozone is high-biased in the SH tropics and NH midlatitudes by ~45% in a 4° latitude ×5° longitude model simulation. Doubling the resolution to 2°×2.5° increases the NH high bias to ~60%, and reduces the tropical bias to ~30%, apparently due to decreased horizontal transport between the tropics and extratropics in the higher-resolution simulation. These ozone biases do not appear to be due to an overly vigorous residual circulation, insufficient convection, or excessive stratosphere/troposphere exchange, and so may be due to insufficient vertical resolution or excessive vertical diffusion near the tropopause. In the upper troposphere and lower stratosphere, model/measurement intercomparisons are strongly affected by the averaging technique.

Compared to the pressure-averaged climatology, NH and tropical mean model lower stratospheric biases are >20%. In the upper troposphere, the 2°×2.5° simulation shows mean high biases of ~20% and ~35% during April in the tropics and NH midlatitudes, respectively. This apparently good model/measurement agreement degrades when relative-to-tropopause averages are considered, with upper troposphere high biases of ~30% and 70% in the tropics and NH midlatitudes. This occurs because relative-to-tropopause averaging better preserves the larger cross-tropopause O_3 gradients which are seen in the daily sonde data, but not in daily model profiles. Relative-to-tropopause averages therefore more accurately reveal model/measurement discrepancies. The relative annual cycle of ozone near the tropopause is reproduced very well in the model Northern Hemisphere midlatitudes. In the tropics, the model amplitude of the near-tropopause annual cycle is weak. This is likely due to the annual amplitude of mean vertical upwelling near the tropopause, which analysis suggests is ~30% weaker than in the real atmosphere.

Final Revised Paper (PDF, 876 KB) Discussion Paper (ACPD)

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