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Chemistry-transport modeling of the satellite observed distribution of tropical troposheric ozone

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Abstract. We have compared the 14-year record of satellite derived tropical tropospheric ozone columns (TTOC) from the NIMBUS--7 Total Ozone Mapping Spectrometer (TOMS) to TTOC calculated by achemistry-transport model (CTM). An objective measure of error, based on the zonal distribution of TTOC in the tropics, is applied to perform this comparison systematically. In addition, the sensitivity of the model to several key processes in the tropics is quantified to select directions for future improvements. The comparisons indicate a widespread, systematic (20%) discrepancy over the tropical Atlantic Ocean, which maximizes during austral Spring. Although independent evidence from ozonesondes shows that some of the disagreement is due to satellite overestimate of TTOC, the Atlantic mismatch is largely due to a misrepresentation of seasonally recurring processes in the model. Only minor differences between the model and observations over the Pacific occur, mostly due to interannual variability not captured by the model. Although chemical processes determine the TTOC extent, dynamical processes dominate the TTOC distribution, as the use of actual meteorology pertaining to the year of observations always leads to a better agreement with TTOC observations than using a random year or a climatology. The modeled TTOC is remarkably insensitive to many model parameters due to efficient feedbacks in the ozone budget. Nevertheless, the simulations would profit from an improved biomass burning calendar, as well as from an increase in NO_x abundances in free tropospheric biomass burning plumes. The model showed the largest response to lightning NO_x emissions, but systematic improvements could not be found. The use of multi-year satellite derived tropospheric data to systematically test and improve a CTM is a promising new addition to existing methods of model validation, and is a first step to integrating tropospheric satellite observations into global ozone modeling studies. Conversely, the CTM may suggest improvements to evolving satellite retrievals for tropospheric ozone.

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