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Hemispheric Asymmetries in the Annual Cycle of Tropical Lower Stratospheric Ozone: Implications for Transport

O. Tweedy (1), D.W. Waugh (1), R.S. Stolarski (1,2), L.D. Oman (2), N.A. Kramarova (2,3)

(1) Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, Maryland, United States (otweedy1@jhu.edu), (2) Atmospheric Chemistry and Dynamics Laboratory, NASA Goddard Space Flight Center, Greenbelt, Maryland, United States, (3) Science Systems and Applications Inc., Lanham, MD, United States

The distribution of ozone in the tropical lower stratosphere is strongly influenced by transport processes such as vertical advection by the residual circulation and quasi-horizontal (isentropic) mixing. Previous studies quantified the relative role of these processes based on tropics-wide average characteristics under common assumption of "well-mixed" tropics. Multiple instruments provide us with evidence that show significant differences in the seasonal cycle of ozone between the northern and southern tropics (NT and ST respectively). Thus, latitudinal variations within the tropics have to be considered in order to understand the balance between upwelling and quasi-horizontal mixing in the tropical lower stratosphere. In this study we investigate the differences in ozone seasonality and transport processes affecting tracer's annual cycle amplitude in the Southern (0-20S) and Northern (0-20N) tropical lower stratosphere using observations from the Microwave Limb Sounder (MLS) on the Aura satellite and the Ozone Mapping and Profiler Suite (OMPS) on the Suomi National Polar-orbiting Partnership satellite together with simulations from Goddard Earth Observing System Chemistry Climate Model (GEOSCCM). Ozone budgets in the model are analyzed based on the Transformed Eulerian Mean (TEM) framework. TEM approach allows quantifying the relative importance of transport processes on tracer concentration. In agreement with observations, we detect the observed contrast between the ST and NT in GEOSCCM: annual cycle in ozone in the NT is larger than in the ST but opposite is true for the annual cycle in vertical advection. Thus, upwelling by the residual circulation alone cannot explain the differences between the ST and NT seasonality; quasi-horizontal mixing plays a major role in determining the NT ozone distribution and behavior. Analysis of zonal variations in the NT and ST ozone annual cycles suggests important role of North American and Asian Summer Monsoons (associated with strong isentropic mixing) on the lower stratospheric ozone in the NT.