A comment on "Ozone sonde cell current measurements and implications for observations of near-zero ozone concentrations in the tropical upper troposphere", by H. Vomel and K. Diaz

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This is an interesting paper which suggests that near-zero measurements from ozonesondes as reported by previous studies are not correct. In a recent study, *Ziemke et al.* [2009] used Aura OMI satellite measurements of ozone for scenes involving deep convective clouds (radiative cloud fractions greater than 80% for OMI) and found a large contrast in ozone concentrations inside thick clouds between the Pacific and Atlantic regions. The ozone measured in these thick clouds in the remote Pacific Ocean region was found to be very small (to a few ppbv on average) in contrast to large concentrations (> 60 bbpv) inside thick clouds over the landmasses of Africa and South America (see **Figure 1** below). The conceptual idea was that much of the ozone measured in thick clouds is a manifestation of ozone in the lower troposphere/boundary layer that is injected upwards into these clouds from deep convection.

The purpose of this short commentary is to note a fundamental difference between ozonesonde measurements and the OMI satellite measurements; the latter represent extreme conditions of deep convection whereas the former represent conditions that are largely clear sky and definitely not associated in situ with deep convective clouds. The ozonesonde measurements will not represent ozone concentrations inside deep convective clouds unless there is upper level outflow of air from the clouds followed by transport and under conditions of low mixing of air.

There are currently few measurements of ozone inside deep convective cloud systems other than those obtained from satellite remote sensing. The recent Tropical Composition, Cloud and Climate Coupling (TC4) mission in Central America could have accomplished many measurements of ozone in thick clouds but mechanical damage to the NASA WB 57 aircraft shortly before mission thwarted the effort. There was only one flight (with a DC 8) during the TC4 mission which measured ozone concentrations in thick clouds. None of those ozone values were smaller than about 20 ppbv, but this is still consistent with in-cloud ozone averaging about 30 ppbv from OMI for the Central American region (see **Figure 1** below). It would be of interest to have more in situ measurements of ozone inside deep convective clouds, especially in the Pacific where the satellite retrievals indicate small concentrations. Deep convective clouds in the tropics brings to light a complexity of cloud physics and photochemistry which involves large solar UVB radiation and destruction of ozone (O3 + UVB --> O2 + O(1D)) and deep

multiple scattering within the thick clouds including Mie scattering from H2O water droplets to ice particles.

Reference for OMI satellite measurements of in-cloud ozone:

Ziemke, J. R., J. Joiner, S. Chandra, P. K. Bhartia, A. Vasilkov, et al., Ozone mixing ratios inside tropical deep convective clouds from OMI satellite measurements, *Atmos. Chem. Phys., 9*, 573-583, 2009.

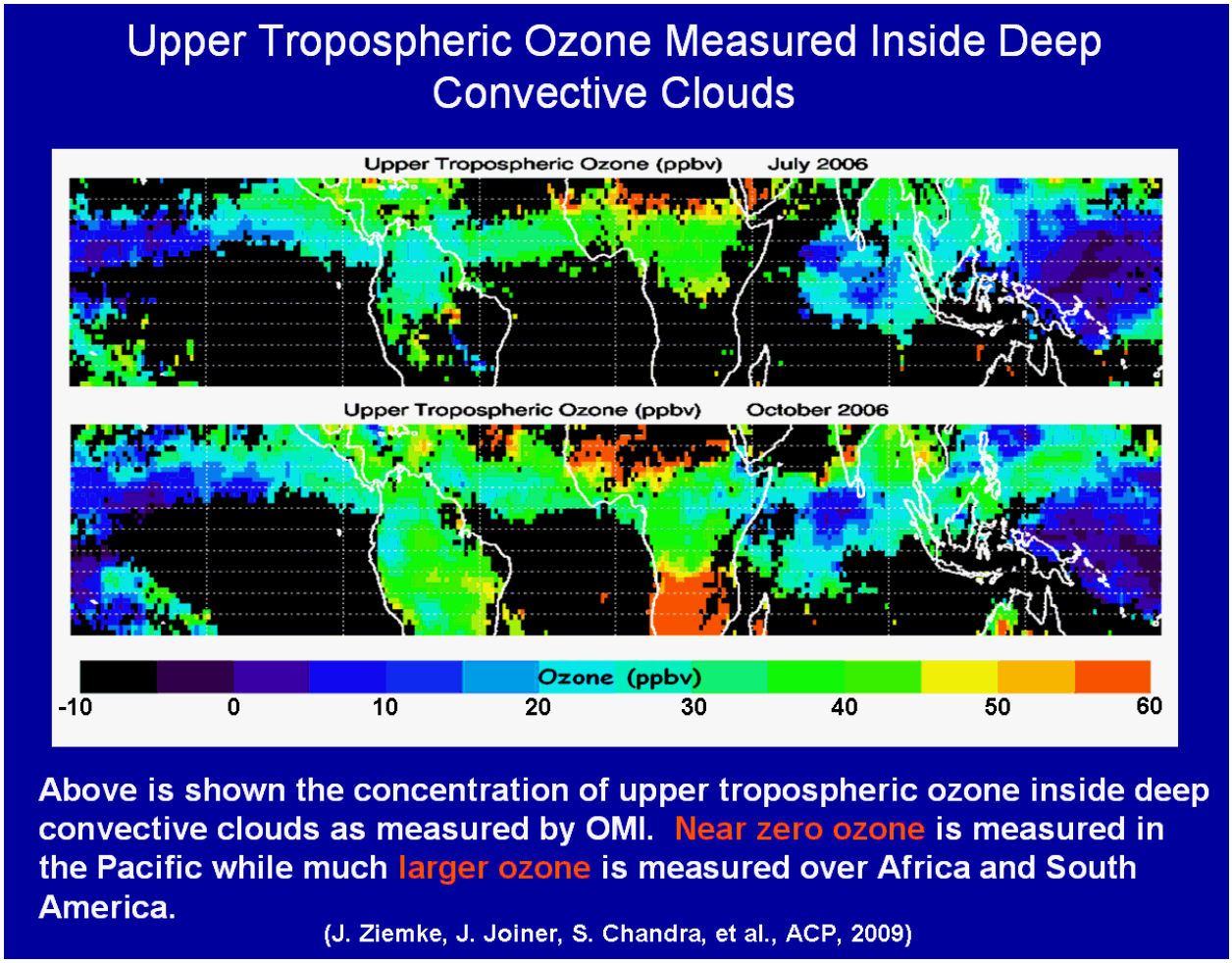

Figure 1. Estimated mean upper tropospheric O_3 volume mixing ratio (VMR, in units ppbv) for July 2006 (top) and October 2006 (bottom). Optical Centroid Cloud Pressure (OCCP) values from OMI were constrained to lie between 250 hPa and 550 hPa. The derived VMR data were binned to 1^o latitude × 1.25^o longitude and include a 3-point running average smoothing along longitude and latitude. Black pixel regions indicate no bright clouds in these regions for the entire month. Note that there exist some pixels in the Pacific with negative VMR of a few ppbv which could be explained by as yet unresolved measurement/calibration differences between OMI and MLS for bright cloud scenes.