(13-240327-A) **Dynamical Drivers of Free-Tropospheric Ozone Increases Over Equatorial Southeast Asia**

R.M. Stauffer[1], A.M. Thompson[1], D.E. Kollonige[1,2], N. Komala[3], H.K. Al-Ghazali, D.Y. Risdianto, A. Dindang, A.F.B. Jamaluddin, M.K. Sammathuria, N.B. Zakaria, B.J. Johnson[4], P.D. Cullis[4], and L.D. Oman[1]

[1]NASA Goddard Space Flight Center (GSFC), Atmospheric Chemistry and Dynamics Laboratory, Greenbelt, MD 20771; 301-614-5552, E-mail: ryan.m.stauffer@nasa.gov
[2]Science Systems and Applications, Inc. (SSAI), Lanham, MD 20706
[3]Indonesian Institute of Aeronautics and Space (LAPAN), Jakarta, Indonesia
[4]NOAA Global Monitoring Laboratory (GML), Boulder, CO 80305

Positive trends in tropical free-tropospheric (FT) ozone are frequently ascribed to emissions growth, but less is known about the effects of changing dynamics and the possible fingerprints of climate change. In an update of our previous work (Thompson et al., 2021; JGR; https://doi.org/10.1029/2021JD034691; "T21"), we re-examine Southern Hemisphere Additional Ozonesondes (SHADOZ) ozone trends over Equatorial Southeast Asia (ESEA), one of the most convectively active regions on Earth, now with 25 years of ozone profile data from 1998-2022. T21 posited that consistent, early-year positive FT ozone trends at several tropical SHADOZ stations may be related to decreases in convective activity. Our 25-year analysis of Kuala Lumpur and Watukosek (Java) SHADOZ stations finds that the +5 to +15% (+2 to +6 ppbv) per decade FT ozone trends from ~February-May are coincident with large increases in satellite IR brightness temperatures (T_b), outgoing longwave radiation (OLR), and velocity potential at 200 hPa (VP200). All demonstrate decreasing convection. Trends in ozone and dynamical indicators are generally weak throughout the rest of the year. These results suggest that dynamical influences, i.e., decreases in the intensity and frequency of convection, are a primary driver of FT ozone buildup in the early months of the year over ESEA, with waning convection suppressing the typical lofting and redistribution of low, near-surface ozone throughout the tropical FT. The decrease in convection likely also enables the accumulation of biomass burning emissions, as AIRS satellite FT carbon monoxide trends (2002-2022) also show a small peak in ~March-May. These results demonstrate the need for monthly or seasonally-resolved analyses, as opposed to annual means, for the robust attribution of observed ozone trends. Finally, we compare our results with those from simulations driven by MERRA-2 meteorology to test the ability of models to replicate the pattern in observed ESEA FT ozone trends.

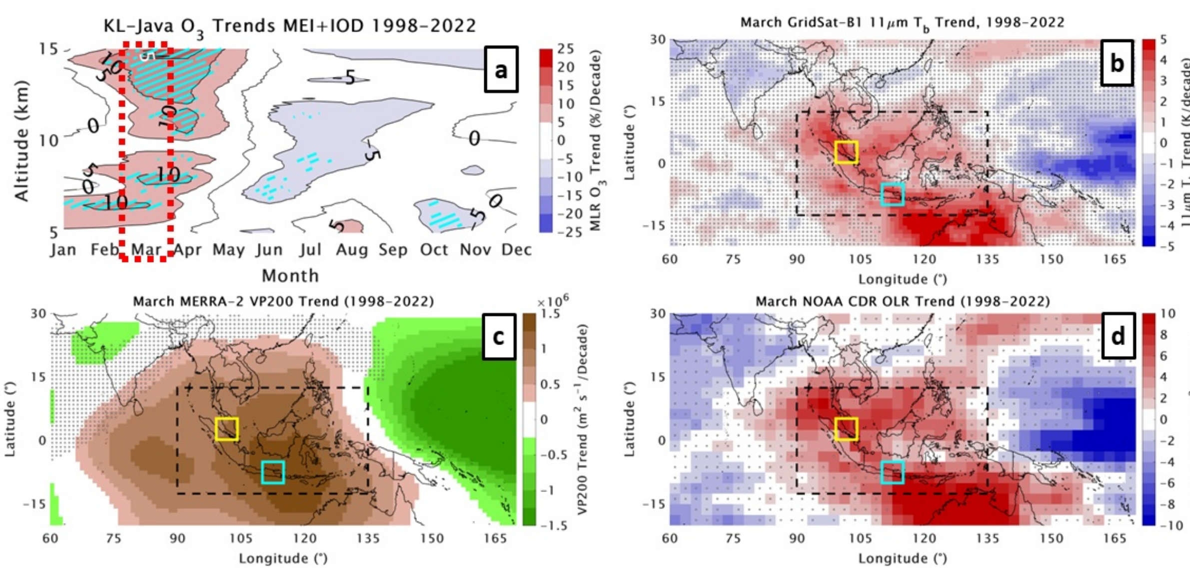

Figure 1. (a): Multiple linear regression ozone trends in percent per decade from 5-15 km (cyan hatching indicates 2-sigma statistical significance) from merged Kuala Lumpur-Watukosek (KL-Java) SHADOZ data. The month of March (*see panels b-d*) is highlighted by the red dashed box. (b): March GridSat-B1 11 micron IR brightness temperature (T_b) trends in K per decade. (c): March MERRA-2 velocity potential at 200 hPa (VP200) trends in m^2 s^{-1} per decade. (d) March outgoing longwave radiation (OLR) trends in W m^{-2} per decade. All panels show trends for 1998-2022. Stippling on panels b-d indicate *insignificant* trends. Yellow (Kuala Lumpur), blue (Watukosek), and black boxes on the panel b-d maps represent regions for which trends will be highlighted in our study.