UNIVERSITY OF ALABAMA IN HUNTSVILLE

Ozone Variability and Anomalies Observed during SENEX and SEAC⁴RS Campaigns

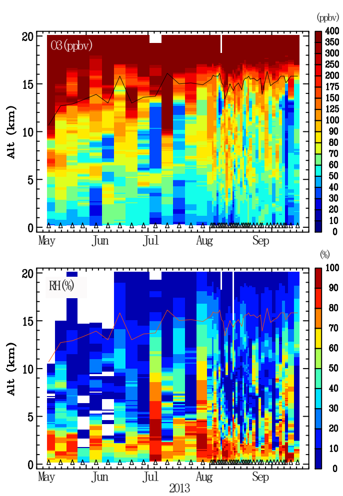
Shi Kuang[1], Mike Newchurch[1], Anne Thompson[2], Ryan Stauffer[23], Bryan Johnson[4], Lihua Wang[1], [1]UAH, [2]NASA/MSFC, [3]USRA, [4]NOAA/ESRL

1. Introduction

Ozone is a crucial tropospheric trace gas (also a secondary pollutant) that drives the complex oxidization chain by reacting with carbon monoxide, methane, hydrogen oxide radicals, nitrogen oxide radicals (NOx), and volatile organic compounds. Tropospheric ozone abundance and variability are regulated by stratosphere-to-troposphere transport (STT), industrial emissions, lightning-generated NOx, biomass burning, and tropospheric photochemistry. This work is to analyze tropospheric ozone variability and anomalies using the data measured at Huntsville during the SENEX [Warneke et al., 2016] and SEAC⁴RS [Toon et al., 2016] campaigns in 2013.

Huntsville is a near sea-level, mid-sized city located at the southern edge of the northern middle latitudes (34.725ºN and 86.645ºW) with a humid subtropical climate. The air quality of Huntsville can be largely considered as slightly polluted rural, given that ozone in the PBL at Huntsville is higher than unpolluted, background stations (e.g., Trinidad Head, Wallops Island), but lower than polluted metropolitan cities (e.g., Houston). Although industrial emissions in Huntsville are minor, this city is sometimes affected by pollution transport on various spatial scales.

2. Tropospheric Ozone Variability



Ozonesonde
Meas. range up to 35km
Vertical resolution ~ 100m
Rise rate ~ 5m/s
Precision better than ±5%
Accuracy better than ±10%
Vaisala RS80 or iMet

Figure 1. Ozone mixing ratio (upper) and RH (lower) from ozonesonde measurements in Huntsville, AL, from May to Sep. 2013. The solid line represents the WMO-defined thermal tropopause [WMO, 1986].

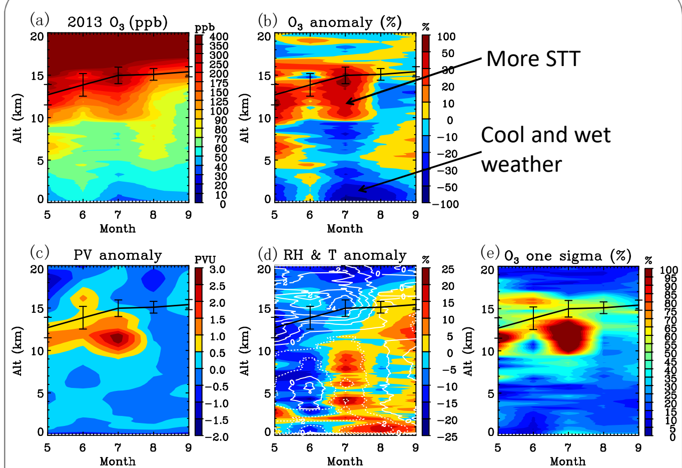


Figure 2. Ozonesonde measurements at Huntsville in 2013 compared to the climatology. (a) Monthly mean ozone and tropopause heights with their 1-σ. (b) Ozone anomaly. (c) PV anomaly computed from the global ERA-interim model [Dee et al., 2011]. (d) RH anomaly (colors) and temperature anomaly (white lines). (e) Monthly ozone 1-σ. The black solid line represents the thermal tropopause heights.

3. Correlation among Ozone, Water Vapor, and Temperature

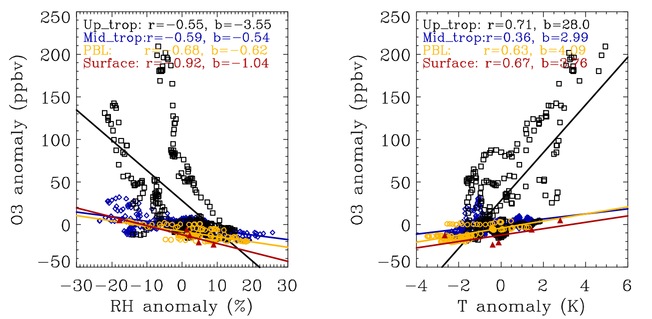


Figure 3. Correlation (a) between ozone anomaly and RH, and (b) between ozone anomaly and temperature for surface (red triangle), PBL (yellow circle), mid-troposphere (blue diamond), and upper-troposphere (black square) calculated from the monthly averaged ozonesonde data from May to September 2013.

4. Ozone Layers

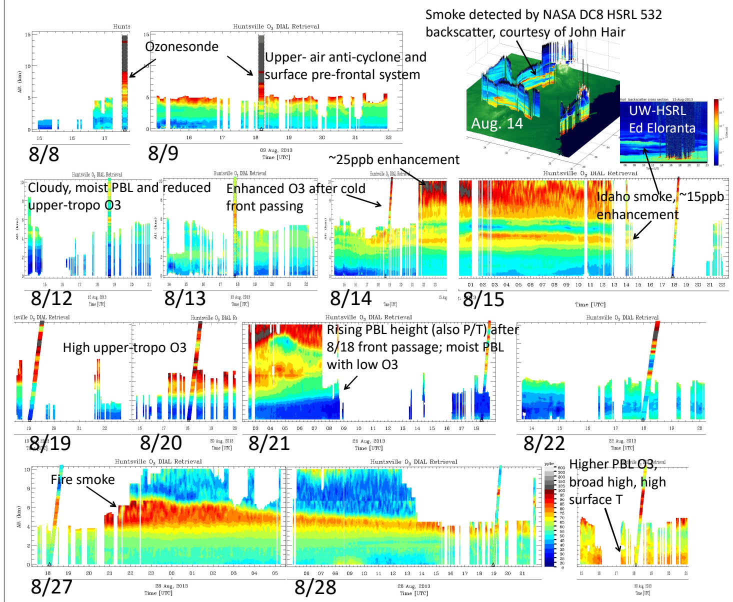


Figure 4. UAH ozone lidar observations in Aug. 2013 showing enhanced upper-tropospheric ozone and reduced PBL ozone.

5. Conclusions

From May to Sep. in 2013, ozone in the PBL measured at Huntsville was significantly lower than the climatological average, especially in July and August when the SEUS experienced unusually cool and wet weather.

Tropospheric ozone anomalies are anti-correlated (or correlated) with water vapor (or temperature) with a correlation coefficient about 0.6. The regression slopes between ozone and temperature anomalies for surface, PBL, and mid-troposphere are within 3.0-4.1 ppbv·K^{-1}. The stratospheric influence on free-tropospheric ozone could be significant during early summer.

Acknowledgements: *We thank the funding support from the TOLNet and SEAC⁴RS programs. We also thank the UAH students who made the ozonesonde measurements.*

Reference: *Kuang, S., Newchurch, M. J., Thompson, A. M., Stauffer, R. M., Johnson, B. J., & Wang, L. (2017). Ozone variability and anomalies observed during SENEX and SEAC4RS campaigns in 2013. J. Geophys. Res., 122, 11,227-11,241.*

Kuang, S., M.J. Newchurch, M. S. Johnson, L. Wang, J. Burris, R. B. Pierce, E. W. Eloranta, I. B. Pollack, M. Graus, J. de Gouw, C. Warneke, T. B. Ryerson, M. Z. Markovic, J. S. Holloway, A. Pour-Biazar, G. Huang, X. Liu, and N. Feng (2017). Summertime tropospheric ozone enhancement associated with a cold front passage due to stratosphere-to-troposphere transport and biomass burning: Simultaneous ground-based lidar and airborne measurements. J. Geophys. Res., 122(2), 1293-1311.

kuang@nsstc.uah.edu