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Tropospheric Ozone Variability during LASIC Field Campaign Report

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Office of Science, Office of Biological and Environmental Research

Acronyms and Abbreviations

AEJ-S	African Easterly Jet-South
ARM	Atmospheric Radiation Measurement
BB	biomass burning
CLARIFY	Cloud-Aerosol-Radiation Interactions and Forcing
DOE	U.S. Department of Energy
LASIC	Layered Atlantic Smoke Interactions with Clouds
LNOx	lightning nitrogen oxides
NASA	National Aeronautics and Space Administration
SHADOZ	Southern Hemisphere Additional Ozonesondes
UK	United Kingdom
UTC	Coordinated Universal Time
WRF	Weather Research and Forecasting

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1.0 Summary

During the period of 17 August-5 October 2017, 20 ozonesondes were launched from Ascension Island as part of the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility's Layered Atlantic Smoke Interactions with Clouds (LASIC) field campaign. The primary goal of the measurements was to improve understanding of the evolution of the wave-one ozone maximum. The key objectives were

- Measure the variability of ozone mixing ratios associated with the African Easterly Jet (AEJ) on sub-synoptic time scales in which meteorology may play a role.
- In concert with weekly measurements from the Southern Hemisphere Additional Ozonesondes (SHADOZ) network, determine the vertical distribution of ozone and aerosols at Ascension Island.
- Determine from lidar measurements the locations of the biomass burning (BB layer) and its relationship to ozone mixing ratios.
- Determine the relative abundance of ozone in the BB layer relative to ozone mixing ratios at higher altitudes that may be associated with lightning nitrogen oxides (LNOx).
- Determine sources of high or low ozone mixing ratios through back trajectory models at Ascension Island.

The original plan of measurements from the last week in July through the first week in September were altered because of problems with the airport runway at Ascension Island. The transport to get to Ascension Island was arranged through a lift by the United Kingdom (UK) Cloud-Aerosol-Radiation Interactions and Forcing (CLARIFY) team. We arrived on 15 August and the first ozonesonde launch occurred on 17 August. Two members of the LASIC team, Bruno Cunha and Vagner Castro, assisted in setting up the antenna and preparing chemical mixtures needed for the launches prior to my arrival. During the field campaign, they help during the day of the launch in sending up the ozonesondes, which required two launches. There was also a public outreach day with the CLARIFY team, when I gave a description of how ozonesondes work and why tropospheric ozone is important to the climate system. I then launched an ozonesonde for the visitors with the help of Wagner.

The measurements went as planned with loss of data from two (night of 7 September) of the 22 ozonesondes and several time periods when the signal was lost during the ascent. The ozonesonde launches were typically carried out 1400 UTC unless there were clearance issues from Air Traffic Control. In addition, launches were planned during the CLARIFY flights which took O3, CO and CH4 measurements during their missions. The National Aeronautics and Space Administration (NASA) Lockheed P-3 Orion also coordinated flights with the CLARIFY team on August 23, 24, 25, and 26. Launches occurred on each of these days during the afternoon. The last CLARIFY flight occurred on 10 September, but launches were continued through 15 September. After this period, the LASIC team helped during the day of launch, which were the last five ozonesonde flights (25, 26, 29 September, 2 and 5 October). These late date flights provide insight on the ozone maximum when it is likely that ozone production from biomass burning in the low altitudes and lightning in the high altitudes contributes to large total column values.

I have completed the preliminary analysis; however, my return to the university during the fifth week of the fall semester did not allow for quality control of the data. The final quality-controlled product will be completed before 1 June 2018.

2.0 Results

- Low ozone mixing ratios were found in the marine boundary layer, but higher ozone mixing ratios above the inversion near 850 hPa, with peaks found in the 800-600 hPa layer. The highest O3 mixing ratios of 125 ppbv were found in this layer on 4 September and confirmed by aircraft measurements. High CO and aerosol concentrations were found in this layer. Ozone mixing ratios in the middle to upper troposphere continued to increase into the month of October (Figure 1).
- While ozone mixing ratios were quite variable, higher ozone mixing ratios were found when the winds were from the east (Africa). For the entire period there was a correlation of 0.83 for 800- 600 hPa winds and ozone mixing ratios. In contrast, the African Easterly Jet-South (AEJ-S) was not present as often as suspected during high ozone episodes with a correlation of 0.28 for 800-600 hPa wind speeds and ozone mixing ratios.

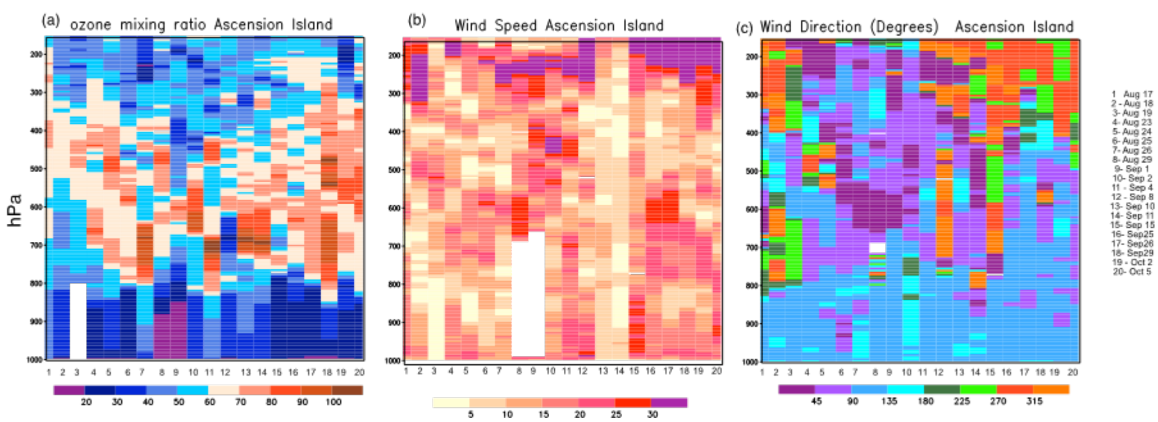

Figure 1. Vertical profiles of ozone, winds speeds, and wind directions during the LASIC field campaign.

- During the next few months, a synthesis manuscript will be written and several Weather Research and Forecasting (WRF) simulations will be undertaken to determine how aerosols and ozone might have been transported to specific altitudes. We will also compute the longwave radiative forcing associated with the profiles over Ascension Island.

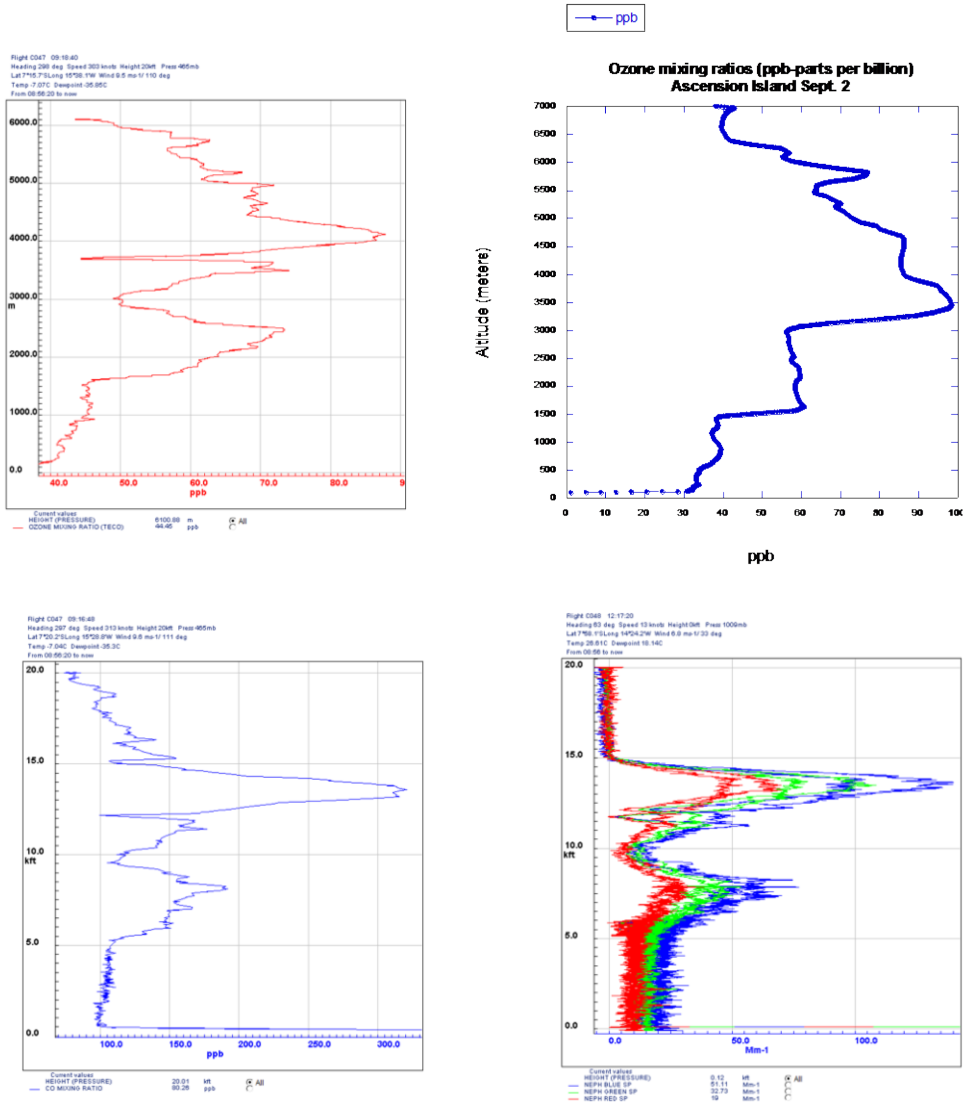

Figure 2. Top: Aircraft ozone mixing and ground-based ozone mixing ratios; Bottom: Aircraft CO mixing ratios and aerosol measurements.

3.0 Publications and References

Jenkins, GS, W Castro, and B Cunha. 2018. "Ozone mixing ratio variability at Ascension Island during the 2017 LASIC field campaign." Manuscript in preparation for *Geophysical Research Letters*.

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