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Downward Transport of Ozone due to Convection Near Manaus, Brazil

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Introduction

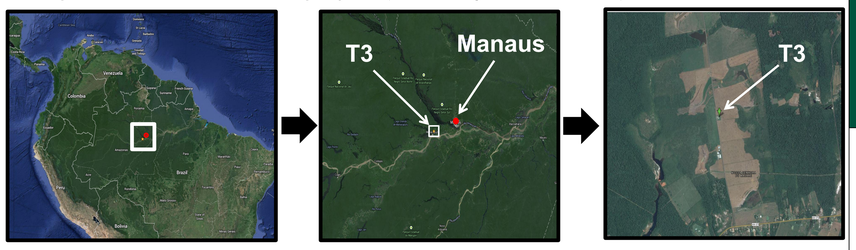
- Ozone (O_3) is a greenhouse gas and is an important oxidant. It can drive a plethora of chemical reactions. In elevated mixing ratios (>80 parts per billion, ppb) ozone is harmful to human and plant health.
- In convective-type storms, ozone can be transported (along with other trace gasses) throughout the troposphere[12]. The downwardly transported ozone to the surface is not yet broadly investigated. Yet, its redistribution in the troposphere is crucial as ozone can drive chemical reactions, forming free radicals that serve as a primary sink for gases such methane and hydrocarbons. Enhanced sink for ozone and methane can impact the greenhouse effect.

Objectives

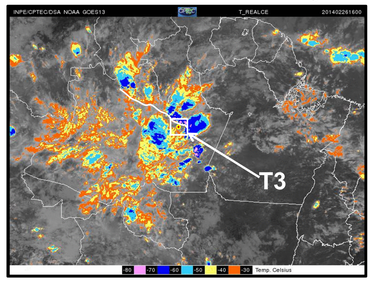
- Determine the magnitude of ozone increases associated with mesoscale convective systems (MCSs) near Manus, Brazil.
- Estimate the magnitude of ozone enhancement as a function of both spatial extent and storm organization.

Methods

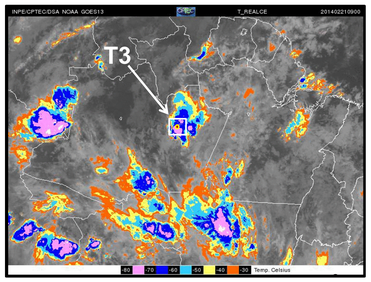
- Data were collected at a site located southwest from the city Manaus, Brazil as part of the GOAmazon project (February-March 2014).



- Classifications: Days are first classified between mesoscale convective storm (MCS) days and no MCS days. From the existing MCS days more classifications are chosen: large or small, squall or individual.

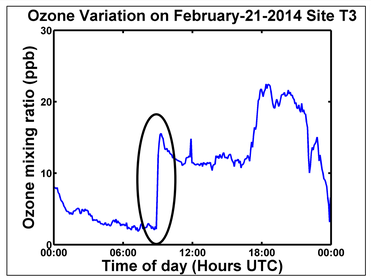


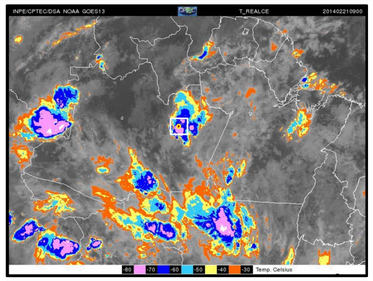
Small and squall

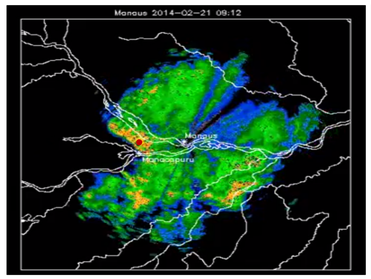


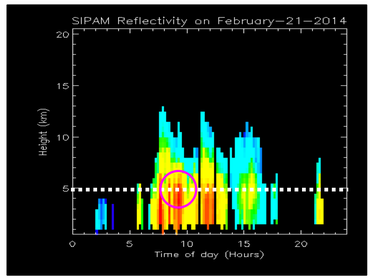
Large and individual

Case Study



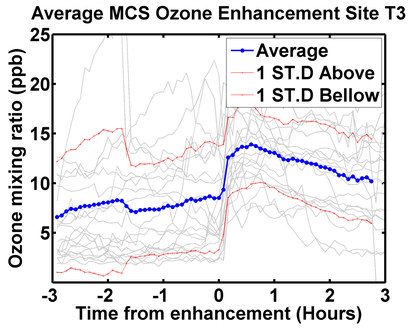






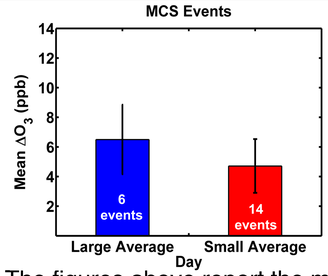
- 21 February 2014 is the best case of ozone enhancement for the two-month period.
- Convective downdrafts on 21 Feb 2014 increased ground-level ozone by 11 ppb and the ozone-rich air mass originated from ~5km above the surface.

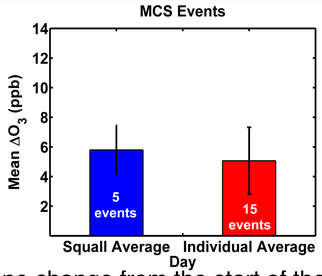
Average MCS Ozone Enhancement



- There are a total of 20 MCS classified events.
- The 20 events are taken 3 hours before and after the main enhancement to find the average ozone enhancement caused by MCSs.
- The average ozone change from just before the storm to peak ozone is ~4 ppb, with a minimum of 2 ppb and a maximum of 11 ppb.

Experiment Classifications





- The figures above report the mean ozone change from the start of the storm to the peak enhancement.
- The left figure shows average ozone enhancement for the large and small classifications. Large MCSs contribute more ozone on average (7 ppb), but with a p-value of .0806 the difference between the two is not significant. With larger MCSs, stronger convective regimes might be present, leading to stronger convective downdrafts and more ozone transport.
- The right figure shows average ozone enhancement for the squall line and individual MCS classifications. Squall line type MCSs contribute a larger amount of ozone to the surface (6 ppb). With a p-value of .5136 there is no significant difference between the two categories.

Conclusions

- On average mesoscale convective systems contributed to ground-level ozone enhancements of 4 ppb, and ranged from 2 to 11 ppb.
- Results from two sample t-tests on the secondary classifications are not statistically significant, thus we cannot conclude that there is a significant difference in the amount of ozone transported to the surface between large and small type storms, as well as individual MCSs and squall line MCSs.
- A better understanding is now known of the magnitude of ozone transported to the surface in Manaus, Brazil. This will assist in the development of more accurate predictions of the changing climate.

Acknowledgments

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References:

[1]Bertram, T. H., Perring, A. E., Wooldridge, P. J., Crounse, J. D., Kwan, A. J., Wennberg, P. O., et al. (2007). Direct Measurements of the Convective Recycling of the Upper Troposphere. *Science*, 816-820.

[2]Betts, A. K., Gatti, L. V., Cordova, A., Silva Dias, M. A., & Fuentes, J. D. (2002). Transport of ozone to the surface by convective. *journal of geophsyical research*.