Amazonian squall line downdrafts and ozone transport

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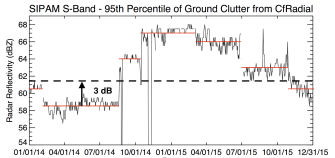
Introduction

This poster will first describe the Brazilian Army's SIPAM S-band radar data set that has been processed for the entire 2-year GoAmazon2014/5 period. The next objective is to illustrate the concept of the descending arm, which represents the variability of the radar 3-D reflectivity in a 22 km x 22 km box. High variability is argued to indicate coincident strong up and downdrafts, which occur at the leading edge of convective storms. Chemical tracers, such as ozone, have been shown to be transported downward by these strong convective events over the Amazon, which is supported by the SIPAM descending arm analysis and vertical velocity and spectrum width retrievals from the radar wind profiler at the T3 site. Ozone can also be transported horizontally at the surface in cold pools.

SIPAM S-band radar quality control

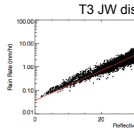
- Calibration corrections of -5.5 to +3.0 dB were applied to the 240 km radial SIPAM data from Jan 2014 to Dec 2015 using TRMM and GPM space-borne radars for absolute calibration and clutter monitoring for relative changes during the 2-year period.

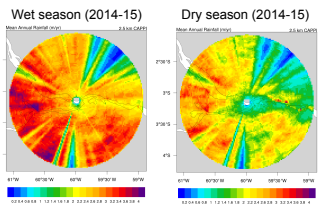


- SIPAM data was also processed to remove ground clutter and AP, although some still remains. Volume scans typically have 17 elevation angles, which were gridded to 2 km horizontal and 0.5 km vertical resolution. However, some volumes are missing upper level scans thus degrading gridded values aloft and retrievals of echo tops. 3-D CAPPI files of reflectivity and radial velocity are available on the ARM website.

SIPAM precipitation products

- A single Z-R relation based on J-W disdrometer observations at T3 was used to calculate rain maps every 12 min at the 2.5 km CAPPI level.
- While there are regions of blockage at 0.9°, higher elevation angles can mitigate this closer to the radar. We recommend using only the 110 km radius for rain and 3-D radar retrievals.
- Echo-top height and convective-stratiform rain type products are also available.

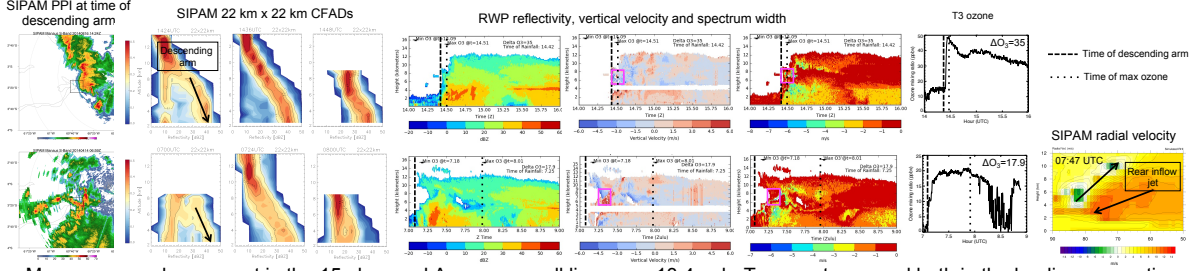




Downdrafts and ozone transport in Amazonian convection

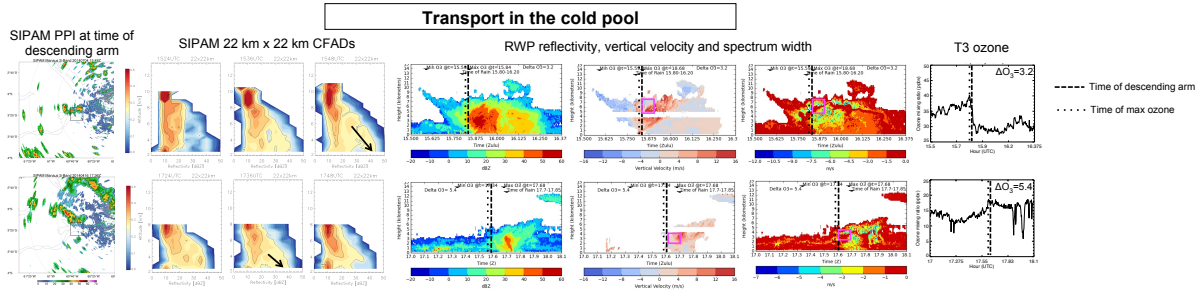
Twenty five cases of enhanced surface ozone at T3 between April and September 2014 have been analyzed with SIPAM and RWP observations. About half of the cases occurred within squall lines while the other events occurred before or after surface rain was present.

Transport within the squall line



- Mean ozone enhancement in the 15 observed Amazon squall lines was 13.4 ppb. Transport occurred both in the leading convective lines and trailing stratiform regions, where the rear inflow jet can play a role. Descending arms, downdraft maxima, and spectrum width perturbations generally began around 6-9 km in height, making this the likely ozone source region in these cases.

Transport in the cold pool



- Mean ozone enhancement in the 10 cases where ozone maxima occurred before or after the convective system was 8.4 ppb. Transport in these cases is assumed to occur in the gust front outflow from the observed convection or nearby storms. Descending arms, downdraft maxima, and spectrum width perturbations began around 3-6 km in height and convection tended to be shallower.

Conclusions

- Two years (2014-2015) of continuous 3-D reflectivity and radial velocities are available from a Brazilian S-band scanning radar in the vicinity of Manaus. Data is available from ARM and images and further information is at: http://atmo.tamu.edu/goamazon-sband-radar
- CFADs from relatively small boxes (~20-30 km) can indicate the occurrence of collocated strong up and downdrafts at the leading edge of convective storms. Next steps are to determine the strength and height of the downdrafts using the descending arm framework and to link the downdraft characteristics to cold pools and ozone transport across the radar domain, expanding upon Gerken et al. (2016).
- Ozone enhancement at the surface associated with convective storms can occur 1) directly in the convective downdraft, 2) in the rear inflow jet in stratiform rain regions, and 3) via horizontal advection in the cold pool. Next steps will be to quantify the relative importance of each mechanism to surface ozone during GoAmazon2014/5.