Overview of the ACRF Deployment in the Amazon Basin

MegaCity Outflow in the Tropics: Manaus, Brazil

Presented by Scot Martin, ASR Science Meeting, 29 March 2011
The deployment site is situated such that it experiences the extremes of:

(i) a pristine atmosphere when the Manaus pollution plume meanders; and
(ii) heavy pollution and the interactions of that pollution with the natural environment when the plume regularly intersects the site.

The city of Manaus uses high-sulfur oil as its primary source of electricity. The city is also an industrial zone of several million people and has high emissions of soot.
Cont’d

Particle number and mass concentrations are 10 to 100 times greater in the pollution plume compared to the times when pristine conditions prevail.

The deployment will enable the study of how aerosol and cloud life cycles, including cloud-aerosol-precipitation interactions, are influenced by pollutant outflow from a tropical megacity.

AMF Operations: Jan - Dec 2014 (Manacapuru)

AAF Operations: Feb/Mar & Sep/Oct 2014 (Manaus)
A Brief Orientation to Mesoscale Features of the Amazon Basin
Prevailing Patterns of Wind, Water, and Energy Flows in the Amazon Basin
Ten-Day Back-Trajectories during AMAZE-08


Red: 200 m
Blue: 4000 m
7 Feb - 14 Mar 2008
Outgoing Longwave Radiation (W m$^{-2}$)

Dec-Jan-Feb

Jun-Jul-Aug

Adapted from Andreae, “Correlation between cloud condensation nuclei concentration and aerosol optical thickness in remote and polluted regions,” *Atmos. Chem. Phys.*, 2009, 9, 543–556.
Amazon Particles Dominated by Organic Components

AMAZE-08: A Major Result: Dominance of Secondary Organic Material in Submicron Particles

1. SEM
2. AMS  
   O:C of 0.4 to 0.5, consistent with chamber SOA particles
3. CCN  
   Measured CCN activity accurately predicted using $\kappa_{\text{organic,SOA}}$ from lab results
4. AMS  
   Similarity of measured mass spectra to those chamber SOA particles
5. AMS  
   Absence of features for PBAPs
Aspects of Cloud Development over this Continental Region are Similar to That over Oceans

Adapted from Andreae, M. O.; Rosenfeld, D.; Artaxo, P.; Costa, A. A.; Frank, G. P.; Longo, K. M.; Silva-Dias, M. A. F. Science 2004, 303, 1337.
Amazon Basin: Aerosol and water cycling over the pristine rainforest. SOA formed by photo-oxidation of volatile organic compounds (VOC) and PBA emitted from biota in the rainforest (plants and microorganisms) serve as biogenic nuclei for CCN and IN, which induce warm or cold rain formation, precipitation, and wet deposition.


How will these aerosol and cloud life cycles, including cloud-aerosol-precipitation interactions, be influenced by pollutant outflow from the tropical megacity of Manaus?
ACRF Site Location
Site Location
Site Location: AAA Site Near Manacapuru

Large Pasture Site (LPS)

111 by 60.8 km represented by this box. Wind speeds at 1 km altitude are typically 10 to 30 kph.
Large Point Source of Pollution in Manaus:  
High-Sulfur Diesel for Electricity
Outflow from Manaus first Crosses River: 2 to 10 km wide
Manaus Outflow Continues Across 60 km Forest
Arrival at AAA Large Pasture Site:

Location of ACRF Deployment
ACRF Instrumentation
The ARM Aerial Facility in Brazil

Beat Schmid, Technical Director
Pacific Northwest National Laboratory
Richland, WA
ARM Mobile Facility One - Typical Deployment
### AMF1 – 7 x 20’ sea containers
1 full-time on-site technician

- Precision Spectral Pyranometer (PSP) \(\times 2\)
- Precision Infrared Radiometer (PIR) \(\times 2\)
- Shaded Black & White Pyranometer (B/W)
- Shaded Precision Infrared Pyrgeometer (PIR)
- Normal Incidence Pyrheliometer (NIP)
- Infrared Thermometer (IRT) \(\times 2\)
- Multi-Filter Rotating Shadowband Radiometer (MFRSR)
- Narrow Field of View Zenith Radiometer (NFOV)
- Optical Rain Gauge (ORG)
- Anemometers (WND)
- Temperature/Relative Humidity Sensor (T/RH)
- Barometer (BAR)
- Present Weather Detector (PWD)
- Eddy Correlation Flux Measurement System (ECOR)
- Shortwave Array Spectrometer (SAS-He, SAS-Ze)
- Microwave Radiometer (MWR)
- Microwave Radiometer Profiler (MWRP)
- Microwave Radiometer 90/150 (MWR-HF)
- Doppler Lidar (DL)
- Ceilometer (CEIL)
- Balloon Borne Sounding System (BBSS)
- W-band ARM Cloud Radar - 95GHz (WACR)
- Ka-W Scanning ARM Cloud Radar (SACR)
- Atmospheric Emitted Radiance Interferometer (AERI)
- Total Sky Imager (TSI)
- Aerosol Observation System (AOS)
  - CCNC
  - PSAP
  - Nephelometers \(\times 2\)
- Radar Wind Profiler – 1290MHz (RWP)
- Cimel Sunphotometer (CSPHOT)
Mobile Aerosol Observing System (MAOS) – 2 x 20’ sea containers (MAOS-A & MAOS-C)
2 x full time post-docs (supplied by ARM)
Guest operational personnel (approx. 5)

- SOnic Detection And Ranging (SODAR) System (1000 to 4000 Hz)
- Ultra-High Sensitivity Aerosol Spectrometer (enhanced)
- Dual Column Cloud Condensation Nuclei Counter (CCN)
- Single Particle Soot Photometer (SP2)
- Scanning Mobility Particle Sizer (SMPS)
- Photo-Acoustic Soot Spectrometer (PASS), 3 Wavelength
- Humidigraph (3 Relative Humidities with 3 single wavelength nephelometers)
- Humidigraph (Scanning Relative Humidity with 3 single wavelength nephelometers)
- Trace Gas Instrument System (Research-Grade)
- Particle Into Liquid Sampler-Ion Chromatography-Water Soluble Organic Carbon (PILS-IC-WSOC)
- Particle Soot Absorption Photometer (PSAP), 3 Wavelength
- Nephelometer, 3 Wavelength
- Condensation Particle Counter (CPC), 10 nm to >3000 nm particle size range
- Condensation Particle Counter (CPC), 2.5 nm to >3000 nm particle size range
- Hygroscopic Tandem Differential Mobility Analyzer (HTDMA)
- Proton Transfer Mass Spectrometer (PTRMS)
- 7-Wavelength Aethelometer
- Weather Transmitter (WXT-520)
- Aerosol Chemistry Speciation Monitor (ACSM)
Introduction to What is Already Known about Manaus Outflow
Impact of Manaus City on the Amazon Green Ocean atmosphere: ozone production, precursor sensitivity and aerosol load

U. Kuhn1,⁎, L. Ganzeveld2,⁎⁎, A. Thielmann1,⁎⁎⁎, T. Dindorf1, G. Schebeske1, M. Welling1, J. Sciare1,⁎⁎⁎⁎, G. Roberts1,⁎⁎⁎⁎, F. X. Meixner1,⁎, J. Kesselmeier1, J. Lelieveld2, O. Kolle3, P. Ciccioli4, J. Lloyd5, J. Trentmann6,⁎⁎⁎⁎, P. Artaxo7, and M. O. Andreae1

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Interests for ACRF Deployment in Amazon Basin: Megacity Outflow in the Tropics: Climate and Pollution Effects

What to Accomplish in Break Out Session: *Spinning Up Scientific Planning ($$)*
Adapted from Fig. 1 of Barth et al., *BAMS*, 86, 1738-1742, 2005.
<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Presenter(s)</th>
</tr>
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<tbody>
<tr>
<td>1:30-1:50</td>
<td>Overview of the ACRF deployment in the Amazon basin, including reports from recent scouting trips</td>
<td>Scot Martin</td>
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<tr>
<td>1:50-2:10</td>
<td>Background and scientific objectives: Aerosol Life Cycle</td>
<td>Jian Wang and Larry Kleinman</td>
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<tr>
<td>2:10-2:30</td>
<td>Background and scientific objectives: Cloud Life Cycle</td>
<td>Tom Ackerman and Mark Miller</td>
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<tr>
<td>2:30-2:50</td>
<td>Background and scientific objectives: Cloud-Aerosol-Precipitation Interactions</td>
<td>Graham Feingold and Jiwen Fan</td>
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<td>2:50-3:30</td>
<td>Discussions, including further involvement of the scientific community and potential support from other agencies</td>
<td></td>
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Join the google group: [http://groups.google.com/group/acrfmanaus2014](http://groups.google.com/group/acrfmanaus2014)
STOP
Cloud Droplet Number Concentration (CDNC): Sensitivity to Pollution in Pristine Regions
