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Observations and Modeling of the Green Ocean Amazon: Sounding Enhancement Field Campaign Report

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Observations and Modeling of the Green Ocean Amazon: Sounding Enhancement Field Campaign Report

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Executive Summary

The goal of this campaign was to provide higher temporal sampling of the vertical structure of the atmosphere during the two intensive observational periods (IOPs) of the GoAmazon 2014/15 campaign. The U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility's first ARM Mobile Facility (AMF1) baseline launches for 2014 and 2015 was 4 sondes/day at 2 am, 8 am, 2 pm, and 8 pm local time (LT) (6, 12, 18 and 0 Coordinated Universal Time [UTC]). However, rapid changes in boundary layer and free tropospheric temperature, humidity, and wind profiles happen throughout the diurnal cycle over Manaus, Brazil's complex forest canopy with resulting responses in aerosol, cloud, and precipitation characteristics. This campaign increased sampling to 5 sondes/day for the 2014 wet and dry season IOPs by adding a launch at 11 am (15 UTC) to capture rapid changes in boundary layer properties and convective cloud growth during that time. The extra launch also corresponded to the time of day the ARM Gulfstream (G-1) and German HALO aircraft most often flew, thus providing useful measurements of the large-scale environment during the flights. In addition, the extra launch will significantly add to the quality of AMF1 instrument retrievals and variational analysis forcing data set during the IOPs.

Acronyms and Abbreviations

AEB	Agencia Espacial Brasileira
AGU	American Geophysical Union
AMF1	ARM Mobile Facility 1
AMS	American Meteorological Society
ARM	Atmospheric Radiation Measurement Climate Research Facility
ASR	Atmospheric System Research
CAPE	convective available potential energy
DFG	Deutsche Forschungsgesellschaft
DLR	German Aerospace Center
DNPq	Brazilian National Council for Scientific and Technological Development
DOE	U.S. Department of Energy
FAPESP	Fundacao de Amparo a Pesquisa do Estado de Sao Paulo
G-1	Gulfstream aircraft
GoAmazon 2014/15	Green Ocean Amazon 2014/15
INPA	Instituto Nacional de Pesquisas da Amazonia
INPE	Instituto Nacional de Perquisas Espaciais
IOP	intensive operational period
LBA	Large Scale Biosphere Atmosphere Experiment in Amazonia
LT	local time
UTC	Coordinated Universal Time

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1.0 Background

The focus of the enhanced sounding request was to provide higher temporal sampling of the vertical structure of the atmosphere during the two intensive observational periods (IOPs) of the Green Ocean Amazon field campaign (GoAmazon2014/5). The first ARM Mobile Facility (AMF1) at the T3 site in Manacapuru in the central Amazon was the location of the extra launches. The AMF1 baseline launches were made 4 times per day for all of 2014 and 2015 at 2 am, 8 am, 2 pm, and 8 pm LT (6, 12, 18 and 0 UTC). The extra launches supported by this field campaign occurred at 11 am LT (15 UTC) for 4 February-31 March 2014 and 15 August-14 October 2014. This extra launch allowed observations of rapid changes in boundary layer and free tropospheric temperature, humidity, and wind profiles that happen from morning to afternoon over Manaus' complex forest canopy with resulting responses in aerosol, cloud, and precipitation characteristics.

The enhanced sounding launches during the two GoAmazon 2014/15 IOPs will help explain diurnal variations in aerosol-cloud-precipitation interactions during two distinct climatological periods (i.e., the wet and transition seasons). These diurnal variations are especially relevant over the Brazilian Amazon as convection evolves from shallow and non-precipitating earlier in the day to deep and heavily precipitating later in the day, thus contributing to one of the ARM Facility's priorities of studying deep tropical convection over land in the Amazon Basin. Enhanced observations of the diurnal cycle will contribute to studies spanning the Aerosol Life Cycle, the Cloud Life Cycle, and Cloud-Aerosol-Precipitation Interactions and will support DOE's overall vision of obtaining a detailed, representative, and accurate description of Earth's atmosphere and the ability to model important processes in climate models (e.g., the inability to accurately simulate the diurnal cycle of convection over land is a notable deficiency in most global climate models).

We acknowledge the support from the Central Office of the Large Scale Biosphere Atmosphere Experiment in Amazonia (LBA), the Instituto Nacional de Pesquisas da Amazonia (INPA), the Instituto Nacional de Pesquisas Espaciais (INPE), the Agencia Espacial Brasileira (AEB), the Max Planck Society, the Deutsche Forschungsgesellschaft (DFG), and the German Aerospace Center (DLR). The work was conducted under 2009/15235-8 of the Fundacao de Amparo a Pesquisa do Estado de Sao Paulo (FAPESP) and 00254/2013-9 of the Brazilian National Council for Scientific and Technological Development (DNPq).

2.0 Notable Events or Highlights

Figure 1 shows an example of the rapid change in atmospheric properties that can occur between 11 and 17 UTC (i.e., 8 am to 2 pm LT). In particular, note the strong surface warming, increase in convective available potential energy (CAPE) and dramatic wind shift from 8 am to 11 am, just before convection occurs over the area (as indicated by the saturated sounding at 2 pm). These changes would not be nearly as well captured without an intermediate sounding at 11 am LT.

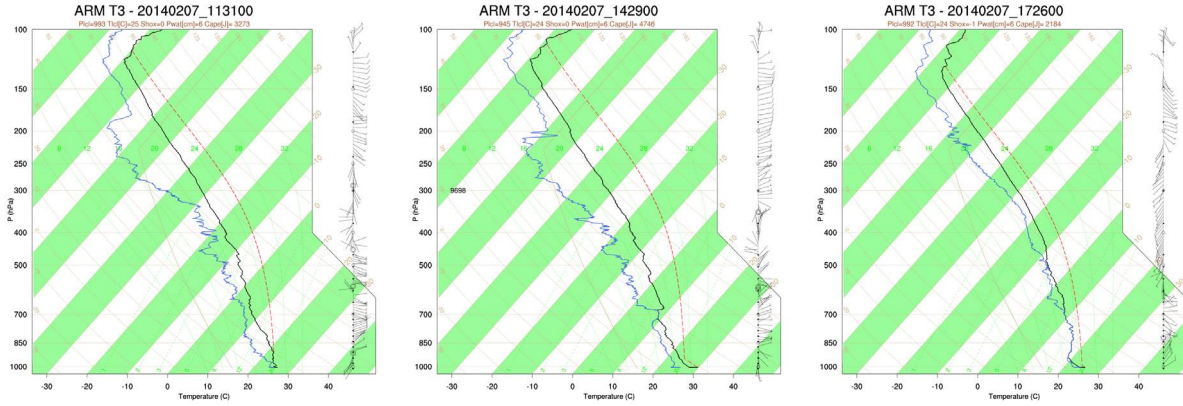


Figure 1. AMF1 soundings at 11, 14, and 17 UTC from 7 February 2014.

3.0 Lessons Learned

Launches were successful at a high rate.

4.0 Results

Figures 2 and 3 show the two-month average sounding for each IOP at the time of the special 11 am LT (14 UTC) launch and the two launches three hours before and after. Because of the large time averaging, the transition from time to time is not as distinct as for the single event in Figure 1. However, significant differences still exist between each time of day in terms of when the nocturnal stable layers erodes, the evolution of the magnitude of CAPE, and the direction of near-surface winds, all of which impact cloud growth and interaction with the Manaus plume.

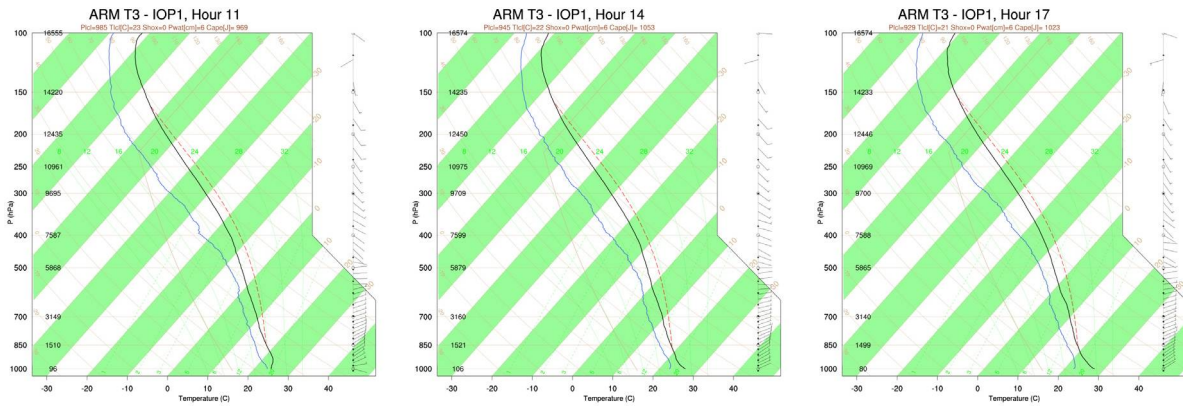


Figure 2. AMF1 mean IOP1 soundings at 11, 14, and 17 UTC.

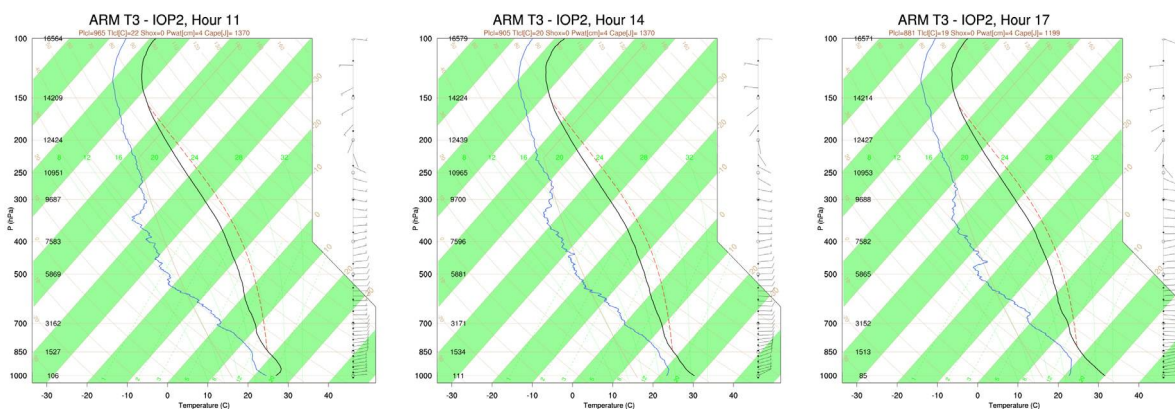


Figure 3. AMF1 mean IOP2 soundings at 11, 14, and 17 UTC.

The enhanced sounding data is being used in a variety of GoAmazon studies relating aerosols, clouds, and precipitation to the large-scale atmosphere. In addition, the variational analysis data set is currently being created for both IOPs using the extra sonde launches as an important observational constraint. The variational analysis is an important link to any model studies being done for GoAmazon.

5.0 Public Outreach

Not applicable.

6.0 GoAmazon 2014/15 Publications

6.1 Journal Articles/Manuscripts

A number of manuscripts using the enhanced sounding data are in preparation or have recently been submitted to various journals.

6.2 Meeting Abstracts/Presentations/Posters

The enhanced sounding data have been used in studies presented at American Geophysical Union (AGU) and American Meteorological Society (AMS) special sessions, as well as DOE Atmospheric System Research (ASR) science team and working group meetings and the recent GoAmazon 2014/15 Harvard University meeting.

7.0 References

Not applicable.



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