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Green Ocean Amazon 2014/15 High-Volume Filter Sampling: Atmospheric Particulate Matter of an Amazon Tropical City and its Relationship to Population Health
Field Campaign Report

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CLIMATE RESEARCH FACILITY

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Acronyms and Abbreviations

ARM	Atmospheric Radiation Measurement Climate Research Facility
CONAMA	Brazilian National Council of the Environment
CNPq	Brazilian National Council for Scientific and Technological Development
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
GoAmazon	Green Ocean Amazon 2014/15 field campaign
INPA	Instituto Nacional de Pesquisas da Amazonia
LBA	Central Office of the Large Scale Biosphere Atmosphere Experiment in Amazonia
PAH	polycyclic aromatic hydrocarbon
PM	particulate matter
TSP	total suspended particulate
UEA	Universidade do Estado do Amazonia
UFAM	Federal University of Amazonas
WHO	World Health Organization

Contents

Figures

.

1.0 Summary

Manaus, the capital of the Brazilian state of Amazonas, is developing very rapidly. Its pollution plume contains aerosols from fossil fuel combustion mainly due to vehicular emission, industrial activity, and a thermal power plant. Soil resuspension is probably a secondary source of atmospheric particles. The plume transports from Manaus to the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility ARM site at Manacapuru urban pollutants as well as pollutants from pottery factories along the route of the plume. Considering the effects of particulate matter on health, atmospheric particulate matter was evaluated at this site as part of the ARM Facility's Green Ocean Amazon 2014/15 (GoAmazon 2014/15) field campaign.

Aerosol or particulate matter (PM) is typically defined by size, with the smaller particles having more health impact. Total suspended particulate (TSP) are particles smaller than 100 μm; particles smaller than 2.5 μm are called $PM_{2.5}$.

In this work, the $PM_{2.5}$ levels were obtained from March to December of 2015, totaling 34 samples and TSP levels from October to December of 2015, totaling 17 samples. Sampling was conducted with $PM_{2.5}$ and TSP high-volume samplers using quartz filters (Figure 1). Filters were stored during 24 hours in a room with temperature (21,1ºC) and humidity (44,3 %) control, in order to do gravimetric analyses by weighing before and after sampling. This procedure followed the recommendations of the Brazilian Association for Technical Standards local norm (NBR 9547:1997). Mass concentrations of particulate matter were obtained from the ratio between the weighted sample and the volume of air collected. Defining a relationship between particulate matter ($PM_{2.5}$ and TSP) and respiratory diseases of the local population is an important goal of this project, since no information exists on that topic.

Figure 1: High-volume samplers ($PM_{2.5}$ and TSP) at the ARM site in Manacapuru, Amazonas.

Further chemical analyses (metals and polycyclic aromatic hydrocarbon [PAH]) will be done on these samples in order to identify major pollutants and to investigate the sources of these particles.

This project was supported by the National Council for Scientific and Technological Development (CNPq), whose funds were used to purchase equipment, and the Amazonas Research Foundation, which supported GOAmazon Campaign Science and students' fellowships. The campaign was carried out by

graduate and post-graduate students of the Chemistry Department of the Federal University of Amazonas (UFAM). We also had transport logistic support from UFAM throughout the sampling period at the ARM site.

This work contributed to the technical and scientific development of the Amazon region, and to the development of support for quality of life and environmental preservation.

2.0 Results

The results presented here are concerned with levels of particulate matter PM2.5 and TSP collected during the ARM GoAmazon field campaign. The range of PM2.5 concentration, 4,25 – 71,18 µg m-3, was higher in 70 % of samples than the World Health Organization (WHO) recommendation (25 µg m-3 24-hour mean). Considering limits stated by the U.S. Environmental Protection Agency (EPA), PM2.5 levels were higher in 52% of samples. TSP levels varied from 22,69 to 92,00 µg m-3 during the period. Based on the Brazilian regulatory standard from the National Council of Environment (CONAMA), these concentrations were 82% lower than limits expected for TSP (Figure 2). In comparison to mean concentration obtained in the Manaus urban area, PM2,5 and TSP mean levels were 120% and 59% higher, respectively.

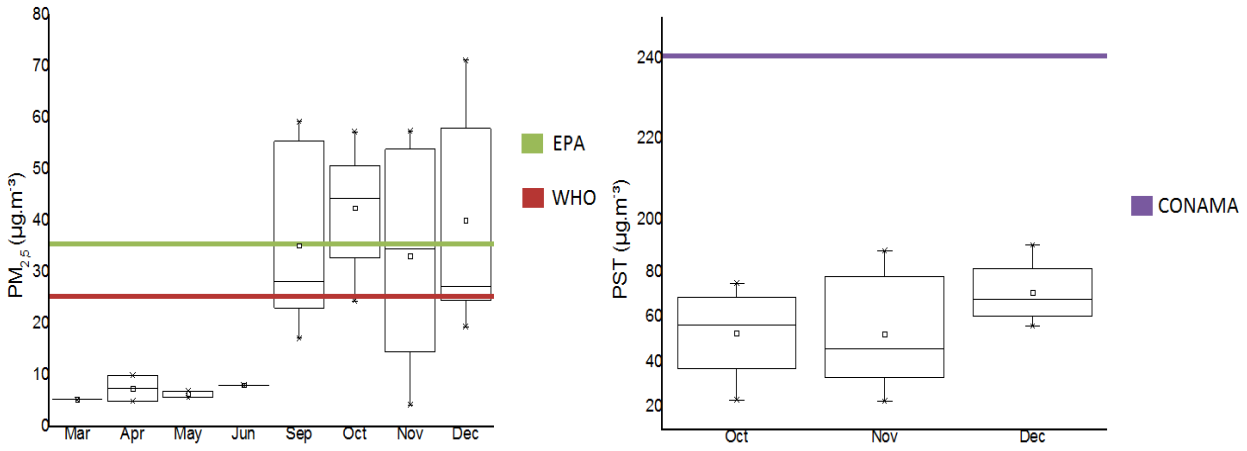

Figure 2: $PM_{2.5}$ and TSP levels obtained at the ARM GoAmazon campaign site in Manacapuru from March to December 2015. WHO and EPA limits of $PM_{2.5}$ concentration and the CONAMA limit of TSP level are shown for comparison.

Some of the samples showed $PM_{2.5}$ levels similar to those found in São Paulo, a city very different than Manacapuru in respect to population and source of particulate matter. It became clear that seasonality influences particle concentration, once the rainy season exhibited low levels of $PM_{2.5,}$ while during the dry season concentrations were about 3-5 times higher. The effects of El Niño contributed to an increase in vegetation fires (up to 2.000 from July through December) and to prolonging the dry season until December. It should be highlighted that in October the temperature inversion contributed to stagnation of the atmosphere, preventing the dispersion of pollutants.

Correlations between precipitation/vegetation fires and particulate matter have not been significant, indicating that others factors like continuous local sources and a low dispersion of pollutants during the dry season could have a great influence on particle levels.

Given the damage to human health caused by $PM_{2.5}$, especially in the elderly, children, and people with chronic respiratory diseases, we evaluated the relationship between the number of admissions due to respiratory ailments and the concentrations of $MP_{2.5}$. The results showed no significant correlations, suggesting that other factors may be causing these human health problems.

For now, the results are insufficient to establish a clear relationship between sources of particles and the atmospheric pollution at the Manacapuru ARM site, or to identify the major influences in its concentration. This is also true in relation to the effects of $PM_{2.5}$ on the health of the local population. In consequence, we will continue this project in the Manaus urban area to acquire data and learn more about these issues.

The opportunity provided by the GoAmazon campaign was very important to start our work in this initial stage of atmospheric research in the Amazon region. We expect to collaborate with the ARM team again.

3.0 Publications and References

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