MEDIDAS DE ÓXIDO NITROSO SOBRE A BACIA AMAZÔNICA COM O USO DE AVIÕES DE PEQUENO PORTE – UM ESTUDO DE LONGO TEMPO

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1. Introduction

The Nitrous Oxide (N_2O) is the third most important natural greenhouse gas (GHG) on Earth, due to its atmospheric mixing ratio and global warming potential of around 300 times higher than the Carbon Dioxide (CO_2) in a hundred years scenario (WMO, 2016). The main sources of N_2O are the nitrification and denitrification processes in soil promoted by microorganisms; it is also emitted in oceans, in biomass burning processes and by industry. Around 40% of these emissions are from anthropogenic activities, two thirds of the soil emissions are originated in tropics and ~20% are from rainforest ecosystems, as the Amazon forest (WMO, 2016; Van Haren *et al*., 2005; Melillo *et al.* 2001). The Amazon rainforest has a total area of 8 millions square kilometers, which ~5 million km^2 are in Brazilian territory (58,74% of Brazil's total area) and hosts one quarter of global biodiversity (Malhi & Phillips, 2005). It's one of the main rainforests in the world, corresponding to 50% of the total of this biome, however, human extractive activities in Amazon has been destroying the forest by wood cutting activities, forest conversion, agricultural and other resources exploration. The greatest parts of GHG emissions in Brazil are from land use change, agricultural activities and biomass burning, these activities influence directly the N_2O emissions since they are its main sources.

Key Word: Nitrous Oxide, N_2O, Amazon and Greenhouse Gases.

2. Metodology:

In this study, natural air was sampled in glass flasks using small aircraft over four sites in the Brazilian Amazon Basin, as described in Gatti *et al.* 2014, in order to have a great

quadrant to better understand the whole area: Alta Floresta (ALF; 8.80ºS, 56.75ºW), Rio Branco (RBA; 9.38ºS, 64.8ºW), Santarém (SAN; 2.86ºS, 54.95ºW) and Tabatinga (TAB; 5.96ºS, 70.06ºW), ALF, RBA and TAB sites started in 2010 and we still perform sampling in these sites, the last one (TAB) changed to Tefé (TEF; 3.39°S, 65.6°W) in 2013 due to technical problems. During a short period (2013-2015) we performed flights over Salinópolis (SAH; 0.76°S, 47.84°W) for comparison with background mixing ratios, which are the ones found in the global stations of Ascencion Island (ASC; 7.9°S, 14.4°W), Barbados (RPB; 13.2°N, 59.4°W) and Cape Point (CPT; 34.3º S, 18.4º E). The reason to use the information obtained in these stations is that the studied region has an atmospheric air circulation pattern where the air entering at the Amazon basin is dominated by trade-wind easterlies coming from the tropical Atlantic Ocean (Miller *et al.*, 2007) in direction to Andes (West). The profiles are performed in a descendant helicoidally pattern in which a flask is sampled in a pre-determined altitude from top to bottom. The inlet was installed in the aircraft such the gases from its engine combustion wouldn't interfere in the sample, it was also installed a temperature and relative humidity sensor and also a GPS in order to register the conditions and positioning of each sample. The sampling system consists in two units, one containing two pumps and rechargeable batteries and another containing the glass flasks. It was chosen to sample between 12:00 and 13:00 local time because at this time of the day the troposphere is more stable, therefore providing a better repeatability of the atmospheric conditions. The analyses were performed by gas chromatography using an Electron Capture Detector (ECD), and a carrier gas containing 5% of methane in Argon, each glass flask is analyzed individually, the analysis system uses a reference standard tank with a known concentration of N_2O, each flask result is compared with two shots of reference gas, one before and one after the quantification, so any external factors influences are minimized to improve the precision. The measurements in SAN started in 2000 and the quantification was done by NOAA laboratories until 2003, after this year the analysis started to being performed by our laboratory. This data is very valuable and can be used to calculate regional fluxes and help in the better understanding of the Amazon Basin role in the global N_2O emissions.

3. Results and Discussions:

The N_2O mixing ratios had enhanced along the years in the studied region, these results are presented in the figure bellow (Figure 1). The dots represent the average concentration found in each vertical profile while the lines ate the smooth curves of the concentrations found in the global stations situated in the Atlantic Ocean.

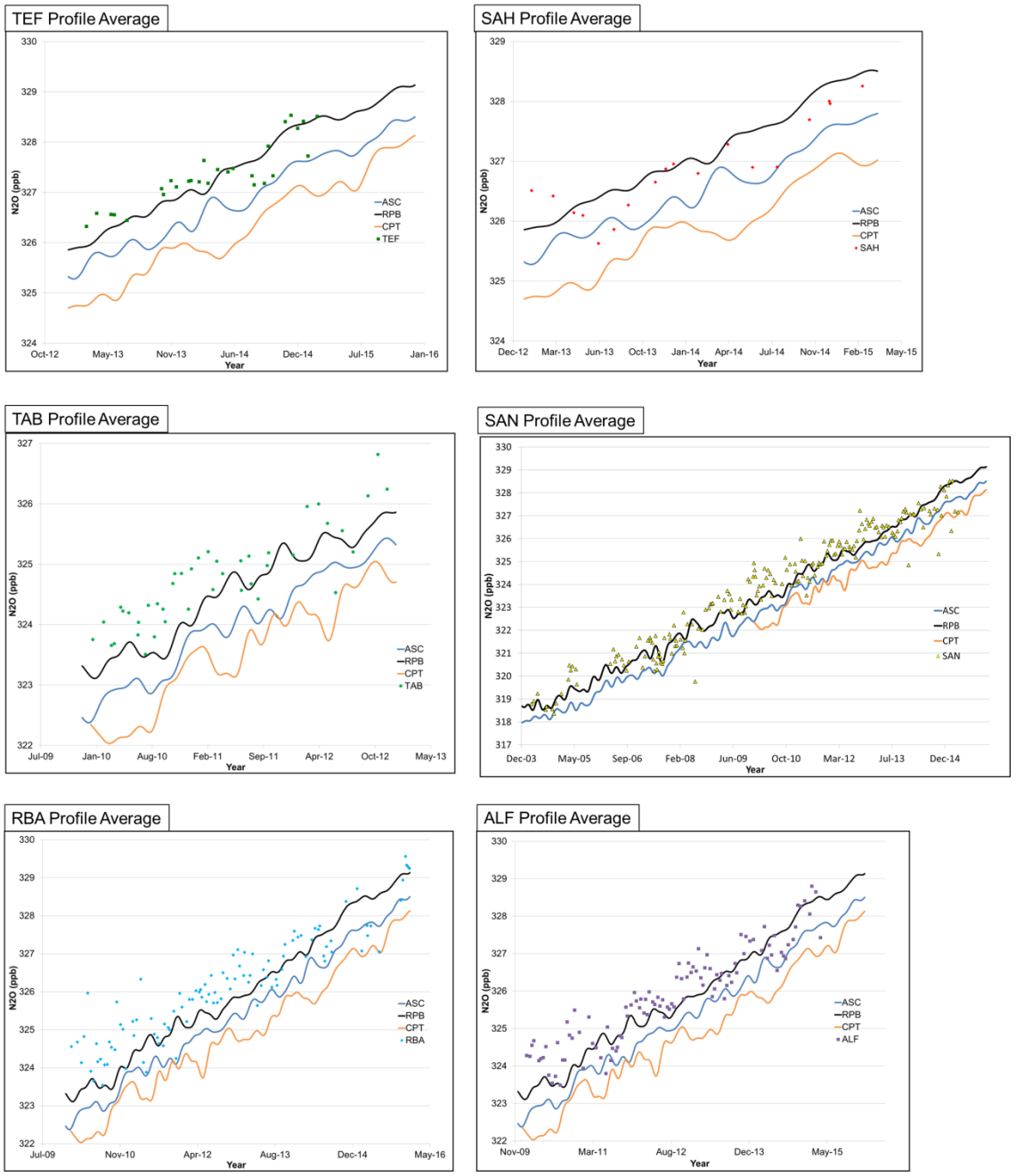

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Figure 1- N_2O mixing ratios distributed by site per year. The dots represent the average mixing ratios found in each profile and the lines represent the smoothed mixing ratios of the global stations used for comparison for the whole period of study.

Both the mixing ratios found by our measurements and the ones measured in the global stations are increasing along the time, this shows the relevance of the study of the N_2O emissions to better understand it since it's an important GHG and directly affected by human activities.

It can be observed in Figure 1 the ranges and values vary along the sites and years, although, the growth rate found wasn't so discrepant. This can be observed in Table 1.

TABLE 1 – N_2O emissions Growth Rate for each site and the average for the whole Amazon Basin

Site	**Growth Rate (ppb yr^{-1})**
ALF	0.49
RBA	0.58
SAH	1.07
SAN	0.92
TAB	0.77
TEF	1.00
Average (2010-2015)	0.81
Global (WMO, 2016)	0.89

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In Figure 2 it's presented, as examples, two time series of all flasks of each vertical profile sampled both in ALF and RBA. The ranges are from red (bottom of the profile) to blue (top of the profile). In this figure it's possible to observe that in general the lower part of the profile (red dots) shows higher mixing ratios which indicates local emissions since the higher in altitude the sample is the farthest it represents. This too shows the relevance of this region in global N_2O emissions contribution. In another words, the bottom part of the profile represents smaller regions *i.e.* closer to the sampling site, while the top of the profile represents a greater region, less influenced locally because of atmospheric dynamics itself.

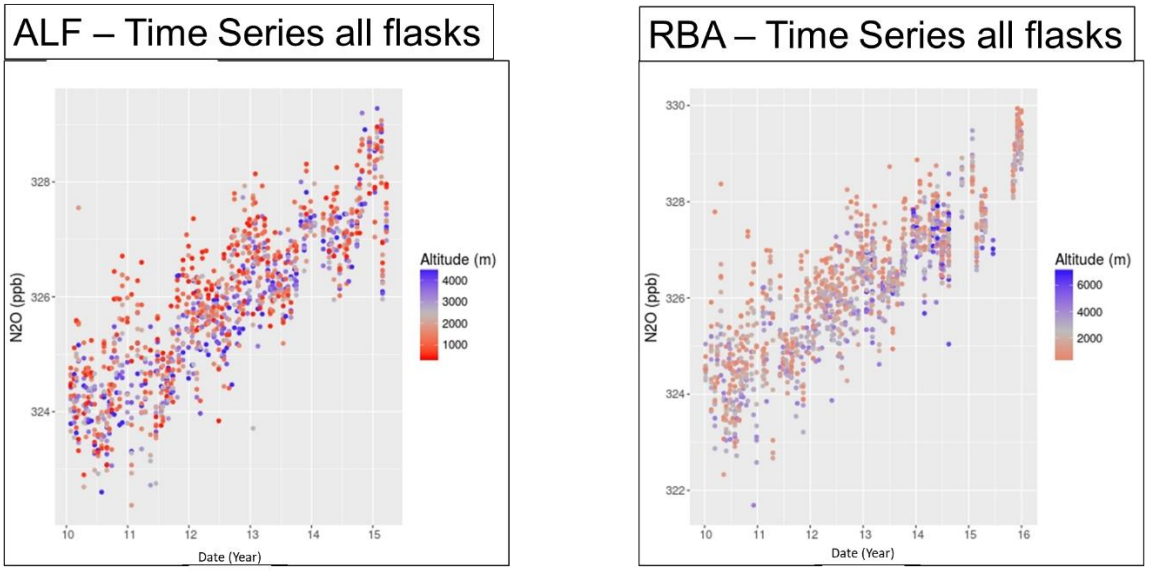

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Figure 2 – N_2O mixing ratios found for each flask for each profile divided by altitude ranging from red (bottom portion of the profile) to blue (highest portion)

4. Conclusions:

The mixing ratios in all the studied stations have presented an increase along the years, varying from ~316 ppb in 2000 (not presented in this work) to ~330 ppb in the present data, *i.e.* a mean growth rate of ~0.81 ppb yr^{-1}, which is consistent with the global data available, where the growth rate for the past 10 years is around 0.89 ppm yr^{-1} (WMO, 2016). This data can be used to calculate fluxes to better understand the role of the Amazon Basin in N_2O budget. More studies are needed in order to have a longer time series and then perceive what influence this gas emissions.

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