STUDY OF LONG TERM SF_6 MOLE FRACTIONS IN AMAZON AND BRAZILIAN COAST

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1. Introduction

SF_6 is one of the most potent greenhouse gases known, having a very high global warming potential of 23,500 (relative to CO_2). Its surface fluxes include anthropogenic emissions from applications in industry and very minor uptake by the oceans. SF_6 is inert throughout the troposphere and stratosphere and is slowly photolyzed in the mesosphere, resulting in an estimated atmospheric lifetime of 3200 years, so its emissions accumulate in the atmosphere and can be estimated directly from its observed rate of increase[1]. Its global mole fraction was around 9.5 ppt in 2016, almost twice the level observed in the mid-1990s[2]. Since it is a very stable gas in the atmosphere, its annual growth rate has been relatively constant since the 1980s, and has been increasing in a very linear way[3]. Brazil is not an SF_6 producer, therefore, the emissions reported in the Brazilian inventory are due only to leaks in equipment installed in the country due to its maintenance or disposal.

2. Methodology

SF_6 atmospheric measurements were started with vertical profiles using small aircrafts, since 2000 in Santarém (SAN; 2.86ºS; 54.95ºW), 2010 in Rio Branco (RBA; 9.38ºS, 67.62ºW), Alta Floresta (ALF; 8.80ºS, 56.75ºW), Tabatinga (TAB; 5.96ºS, 70.06ºW) and Tefé (TEF; 3.31ºS, 65.8°W, which started in 2013 to replace TAB, results from these sites will be named TAB_TEF), all these sites located in Brazilian Amazon Basin. In 2006, we started flasks measurements at Arembepe (ABP, 12,75°S, 38,15°W; between 2006-2009) located at the Brazilian Atlantic coast, and since 2010 started two more locations, Salinópolis (SAL; 0.60°S, 47.37°W) and Natal (NAT; 5.48°S, 35.26°W). The samples from the Brazilian coast were collected weekly by using a pair of glass flasks (2.5L) and a portable sampler. At Amazon sites samples from vertical profiles were collected, generally fortnightly, using a semi-automatic sampling system, which consists of separate compressor and flask units, developed by ESRL/NOAA.

3. Results and Discussion

The SF_6 growth rate obtained for each study site are shown in Table 1, it was observed that in all sites SF_6 mole fractions showed an increase over the studied period, following the global growth rate. SAN results show that SF_6 mole fractions increased since 2000, by nearly 5.3 ppt between 2000 and 2018 (Figure 2), and by a mean increase rate of 0.28 ppt per year.

Figure 3 shows the results obtained during 2010 until 2018 in the four Amazon sampling sites, and the SF_6 global mean mole fractions for this period. It was observed during all these years that mole fractions at all our stations are generally similar to the global mean, with an annual growth ratio between 0.32 and 0.33 ppt/year. Can be observed an annual seasonality, with higher values between January to beginning of May. This seasonality can also be observed in SAL (located in the Brazilian coast). Examination of air parcel paths using HYSPLIT[4,5] for these periods confirmed that some air parcels arriving at these stations have travelled from the northern hemisphere to the sites. The mean position of Intertropical Convergence Zone (ITCZ) shows variation along the year. Between January and beginning of May the ITCZ is below SAL position, therefore the air masses for SAL and Amazon sites coming from north hemisphere. While in NAT and ABP cannot be observed this seasonality. The air masses back trajectories calculated for NAT and ABP show that the air masses arriving entirety from the South Atlantic Ocean (Figure 3).

4. Conclusions

Results of this long-term measurements showed that all sites had a continuous increase in concentrations, with an annual growth ratio between 0.32 and 0.33 ppt/year (2010-2018), that is similar to the global increase in this period (0.32 ppt/year using the NOAA data). Considering only the SAN measurements (2000-2018) the annual growth ratio is 0.28 ppt/year, the same observed for the global mean concentration during this period.

These results indicate that Amazon and Brazilian northeast coast do not have significant emissions of SF_6 and its mole fractions following the global growth ratio.

Acknowledgments

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Figure 1. Sample sites located in Brazilian Amazon and Brazilian coast

Table 1. SF_6 growth rate to Brazilian Amazon sites and Brazilian coast sites

	Brazilian Coast Sites	
Period	**Site**	**growth rate (ppt/year)**
2006-2009	ABP	0.27
2010-2016	SAL	0.32
2010-2018	NAT	0.33
	Brazilian Amazon Sites	
Period	**Site**	**growth rate (ppt/year)**
2000-2018	SAN	0.28
2010-2018	ALF	0.33
2010-2018	RBA	0.33
2010-2018	SAN	0.33
2010-2018	TAB_TEF	0.32

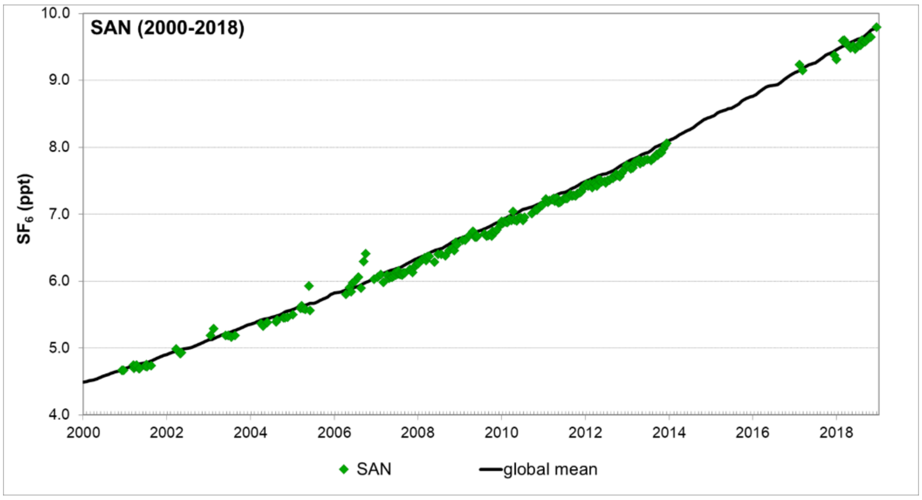

Figure 2. Temporal series of SF_6 measurements for SAN region (green) and SF_6 global mean mole fractions (black line) from NOAA, between 2000-2018.

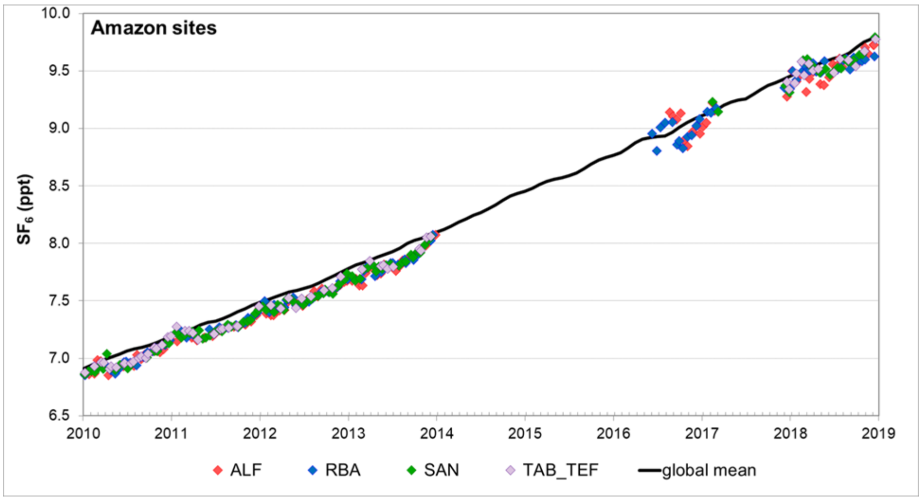

Figure 3. Temporal series of SF_6 measurements for Amazon sites (ALF, RBA, SAN, TAB_TEF) and SF_6 global mean mole fractions (black line) from NOAA, between 2010-2018

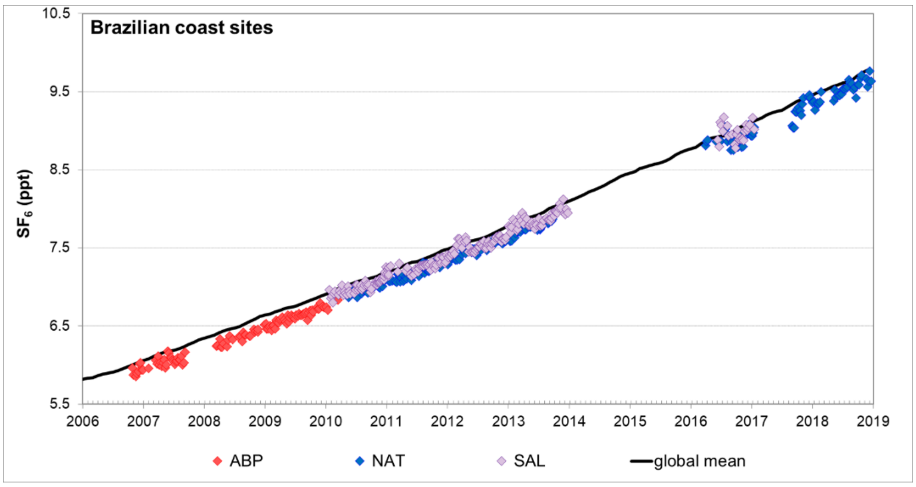

Figure 4. Temporal series of SF_6 measurements for Brazilian Northeast coast sites (ABP, NAT, SAL) and SF_6 global mean mole fractions (black line) from NOAA, between 2006-2018