ANALYSIS OF THE INFLUENCE OF CO_2 CONCENTRATION AND OTHERS EXTERNAL FACTORS ON THE N_2O QUANTIFICATION

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1. Introduction

Nitrous oxide (N_2O) is the third greenhouse gas with higher global warming potential and its lifetime is about 120 years (IPCC, 2007).

N_2O can be emitted into the atmosphere from natural and anthropogenic sources, including the oceans, soil, combustion of fuels, biomass burning, use of fertilizer and various industrial processes (WMO, 2013). On the other hand, the major sink of this gas is the stratosphere, since it is involved in the destruction of stratospheric ozone (Houghton, 1996). Thus, the N_2O anthropogenic sources should be controlled in order avoid increasing the concentration of this gas into the troposphere and consequently to prevent the reduction of stratospheric ozone.

All the N_2O studies are reliant upon the accurate quantification of atmospheric N_2O concentration, which is very limited in precision and accuracy. The kind of technology applied, the type of carrier gas as well as external factors as CO_2 concentration in the laboratory room, for example, can affect the stability and sensitivity in the N_2O concentration measurements.

The focus of this study is to show how the CO_2 concentration in the laboratory room can influence the N_2O measurements.

2. Methodology

The N_2O measurement was made by gas chromatography (GC) using the Electron Capture Detector (ECD), which is considered as an extremely sensitive technique when compared to the Flame Ionization Detector (FID). The carrier gas used in the system is Ar-CH_4 (5%) and 74 mL.min^{-1} flow rate. This carrier gas can provide higher ECD sensitivity than N_2 or Ar gases (Wang et al., 2010). The pre-column and column are HaysepQ 100/120 mesh, 183cm length, 3/16" ED. Loop with 15mL volume and oven with constant temperature of 70ºC were used. The N_2O measurement system is showed in the Figure 1.

Figure 1 - GEE Analytical System of LQA / IPEN. 1: Chromatograph HP 6890 plus / ECD (Electron Capture Detector) 2: Gas flow controller; 3: Sample and system select valve; 4: Vacuum measurer and samples receiver; 5: Cromatograph´s interface

To evaluate how the CO_2 concentration in the laboratory room can influence the N_2O measurements, firstly four people stayed in the laboratory during half an hour and left the laboratory after that time. Once the system has stabilized, 150 grams of dry ice was placed in laboratory room to evaluate the interference of CO_2 higher concentrations.

All the CO_2 concentrations were monitored using the Q-Trak™ Plus IAQ monitor. The N_2O concentrations were determined simultaneously by CG-ECD for the data correlation.

3. Results and Discussion

The influence of CO_2 concentration was correlated with the N_2O quantification. Results demonstrated that ECD signals of N_2O were significantly altered by increasing the CO_2 concentration. Results are showed in the Figure 2.

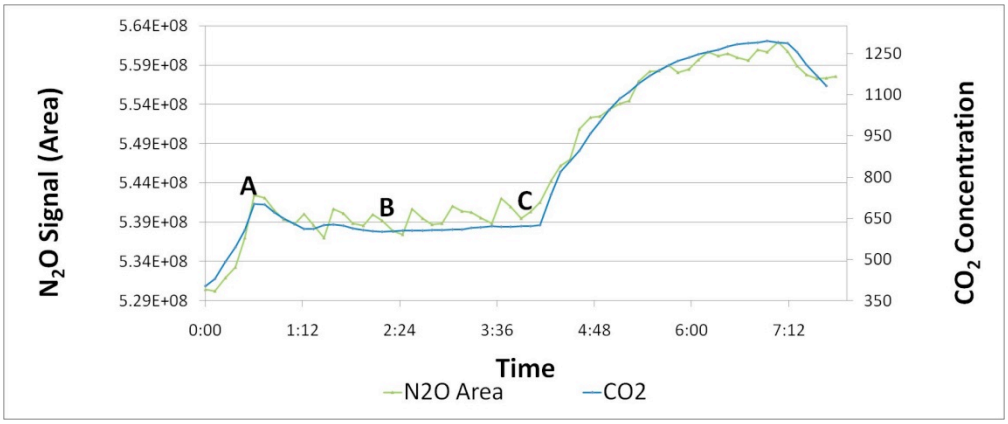

Figure 2 - GC-ECD - N_2O signals peak area in response to the CO_2 concentration. A: influence of four people in the laboratory room; B: stable level; C: influence of 150 g of dry ice in the laboratory room

The linear data for the correlation between N_2O signal peak area and CO_2 concentration is showed in the Fig. 3. The correlation coefficient (R) for the data is 0.991 indicating that N_2O signals (peak area) are very sensitive when CO_2 concentration is changed.

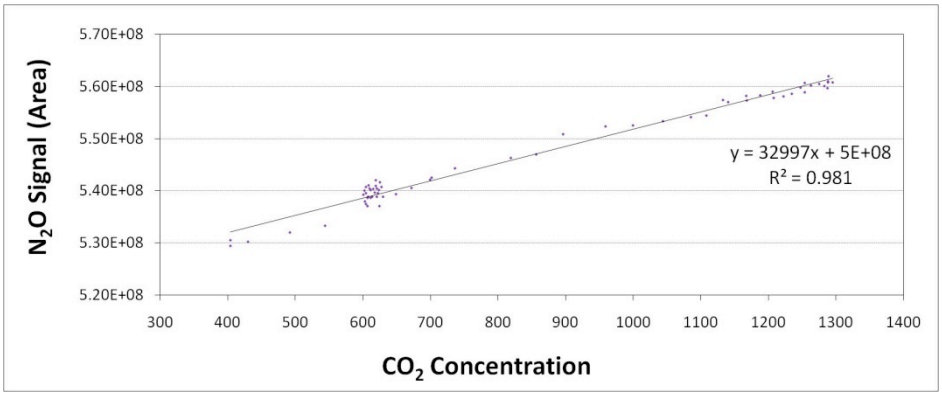

Figure 3 - Nitrous oxide (N_2O) signals peak area in response to the CO_2 concentration

To improve the precision in N_2O analysis LQA/IPEN started to made triplicate analysis for all measurements since 2012. The standard deviations results for the 1223 samples in triplicate are showed in the Figure 4. According to Figure 4, the standard deviations of 95.96% of all samples were below 1.50.

The time series for the tank calibration of the tank CA04533 is showed in the Figure 5. According to Figure 5, our system demonstrated the long-term repeatability.

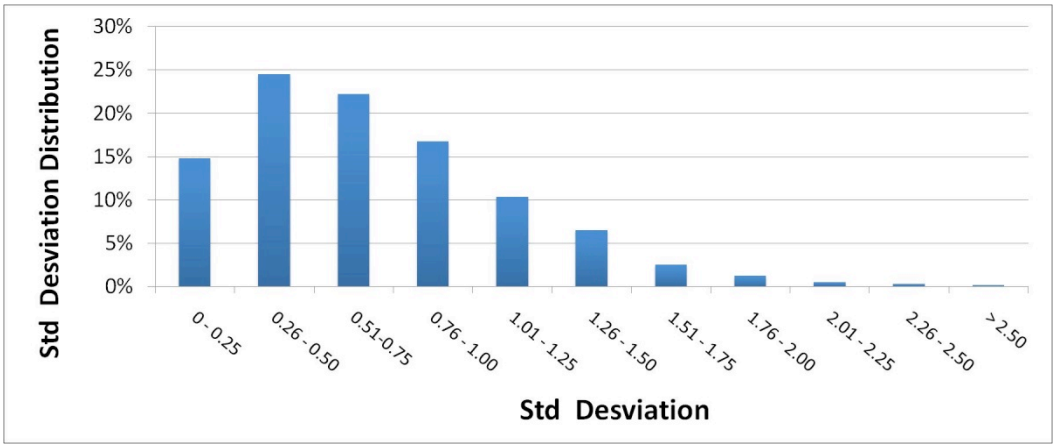

Figure 4 - Standard deviation distribution for the N_2O triplicates analysis

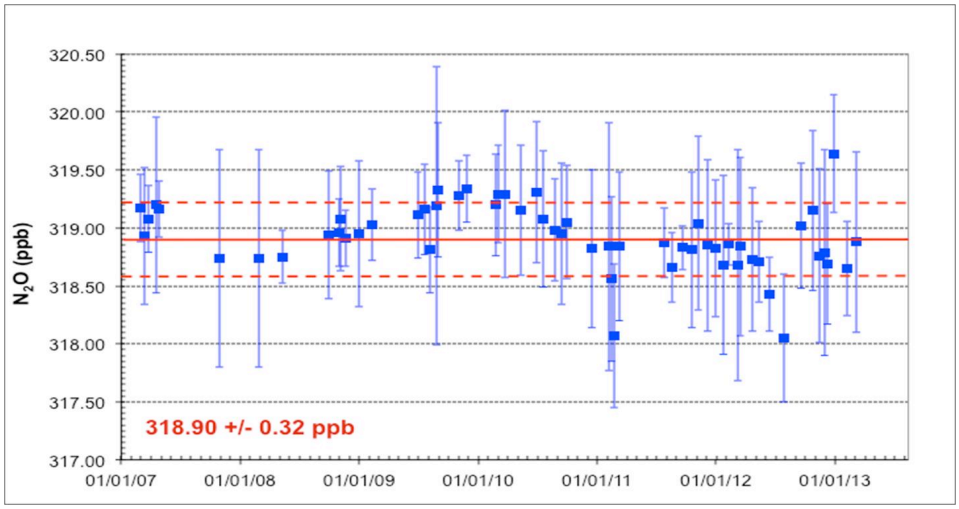

Figure 5 - Time series for the tank CA04533. Each point represents the mean of 20 aliquots by tank calibration; the error bars represent the standard deviation of the 20 analyses. The repeatability is the standard deviation of the results of all tank calibrations (2007–2013). The stability of tank, specially demonstrates the long-term repeatability of our system

4. Conclusions

Results demonstrated that ECD signals of N_2O were significantly altered by increasing the CO_2 concentration in the laboratory room. The influence of CO_2 concentration was correlated with the N_2O quantification and presented a correlation coefficient (R) of 0.991 for the data.

External factors how CO concentration and air relative humidity were correlated with N_2O ECD signals and both of them do not present an influence in the measurements. Since de CO_2 concentration can influence the N_2O determination, the chromatograph of LQA/IPEN laboratory will be isolated with a glove box in order to improve the measurements.

The N_2O concentrations should be as accurate as possible, since its gas concentration data are used for modelling climate change.

References

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