N_2O AND CO_2 FLUXES USING A TUNABLE DIODE LASER TRACE GAS ANALYZER (TGA) AT THE BRAZILIAN CERRADO – PRELIMINARY RESULTS

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ABSTRACT: This study presents the first results obtained using a tunable diode laser trace gas analyser (TGA) measuring N_2O and CO_2 fluxes at the Brazilian *cerrado* region. Measurements were performed at a crop-livestock integration system area, in Santo Antonio de Goiás, GO. Initial measurement results are presented, indicating a large variability of the N_2O fluxes and the predominance of CO_2 sequestration at the studied areas.

KEYWORDS: TGA, greenhouse gases, micrometeorological methods

FLUXOS DE N_2O E CO_2 UTILIZANDO UM ANALISADOR DE GASES TRAÇO POR LASER DE DIODO AJUSTÁVEL (TGA) NO CERRADO BRASILEIRO – RESULTADOS PRELIMINARES

RESUMO: Este trabalho apresenta os primeiros resultados obtidos com o uso de um analisador de gases traço por laser de diodo ajustável (TGA) na medição dos fluxos de N_2O e CO_2 na região do cerrado brasileiro. As medições foram feitas em uma área com o sistema de integração lavoura-pecuária, em Santo Antônio de Goiás, GO. Os resultados iniciais das medições são apresentados, indicando uma grande variabilidade do fluxo de N_2O e a predominância do sequestro de CO_2 nas áreas estudadas.

PALAVRAS-CHAVE: TGA, gases do efeito estufa, métodos micrometeorológicos

INTRODUCTION

The emission of greenhouse gases (GHG) by agricultural activities is significant when total anthropogenic emissions are accounted (HOUGHTON et al., 2001). The *cerrado* biome occupies an important place in the Brazilian production of grains and livestock. Recent changes in soil use have been studied during the last few years as an increased source of GHG, mainly when not followed by conservationist practices, as the integrated crop-livestock-forest system, for example (VILELA et al., 2008).

Brazilian estimates of GHG emissions are obtained by means of chamber measurements (SIQUEIRA NETO et al., 2011; CRUVINEL et al., 2011), or calculations based on total

biomass changes (FEARNSIDE et al., 2009). The use of micrometeorological techniques to estimate GHG fluxes allows continuous measurements, and a better understanding of the temporal dynamics of the gaseous fluxes. The tunable diode laser trace gas analyzer (TGA) used along with the flux gradient method has been used to obtain reliable estimates of N_2O fluxes (MAGGIOTTO et al., 2000, GLENN et al., 2012).

The objective of this is study is to present the first period of flux measurements of N_2O and CO_2 using the TGA in Brazil, in a *cerrado* area in Santo Antônio de Goiás, and report these measurements along with other environment measurements.

MATERIAL AND METHODS

In Santo Antônio de Goiás, GO (lat. 16° 29' S, long. 49° 17' W), concentrations of N_2O and CO_2 were measured at two heights above the pasture using a tunable diode laser trace gas analyzer (TGA200, Campbell Sci.), from October 2012 to April 2013. Two 7 ha fields were studied: a 1-year-old pasture (P1) and a 3-years-old pasture (P3). These fields are part of the experimental area of Embrapa Arroz e Feijão (CNPAF), where an integrated crop-livestock-forest system (ICLF) is conducted. According to the Brazilian soil classification system, the soil at the site is a *Latossolo Vermelho Acriférrico Típico* (EMBRAPA, 2006), and the climate is Aw, according to Köppen classification, with well-defined rainy (Oct-Apr) and dry (May-Sept) seasons (IBGE, 1978).

Fluxes at each field were calculated every 30 min using the flux gradient method: $F = -K\ \partial C/\partial z$, where K is the eddy diffusivity ($m^2\ s^{-1}$), and $\partial C/\partial z$ is the concentration gradient of the gas. The concentration gradient was estimated using a concentration difference (ΔC) occurring over a vertical distance (Δz). Data were collected and stored by a CR3000 datalogger (Campbell Sci.).

Sonic anemometer data were obtained at the area using a CSAT3 (Campbell Sci.), and meteorological data were obtained from the SIMEHGO (*Sistema de Meteorologia e Hidrologia do Estado de Goiás*) weather station located in Santo Antônio de Goiás. Soil water tension was monitored starting on Jan 16 2013, by using six tensiometers installed in each field, at three depths (20, 40 and 80 cm). Animals were allotted in both experimental fields at different periods throughout the measurements.

RESULTS AND DISCUSSION

Daily mean air temperature, total precipitation and soil water potential at 20 cm depth during the measurement period are presented in Figure 1. The beginning of fluxes measurements coincided with the beginning of the rainy season at the region (Fig. 1B). Soil water potential indicates that during a relatively drier period (from Feb 20 2013 to Mar 19 2013 – Fig. 1C), soil potential was higher than field capacity (330 hPa), favoring aerobic soil processes. On the other hand, during wetter periods (from Jan 16 2013 to Feb 14 2013, and from Mar 21 2013 to

Apr 18 2013 – Fig. 1C), the anaerobic soil processes were favored, and probably affecting soil gaseous emissions.

Fluxes of N-N_2O and C-CO_2 are presented in Figure 2. There were few periods without flux data due to technical problems at the experimental site (power failures). Mean daily N_2O fluxes were generally higher in P3 than in P1 (Fig. 2A), and the averages for the entire measurement period were 31.8 (±7.4) and 64.1 (±7.7) µg N-N_2O m^{-2} h^{-1} for P1 and P3, respectively. There was a large variability of the fluxes throughout the period.

In general, daily means of CO_2 fluxes were negative (Fig. 2B), indicating that both pastures worked as sinks for atmospheric CO_2. Carbon sequestration in P1 was higher than in P3, with average fluxes of -670.2 (±74.1) and -514.6 (±72.4) mg C-CO_2 m^{-2} h^{-1} for P1 and P3, respectively. Differences observed between the fluxes in P3 and P1 were probably due to the more degraded stage of the older pasture, P3.

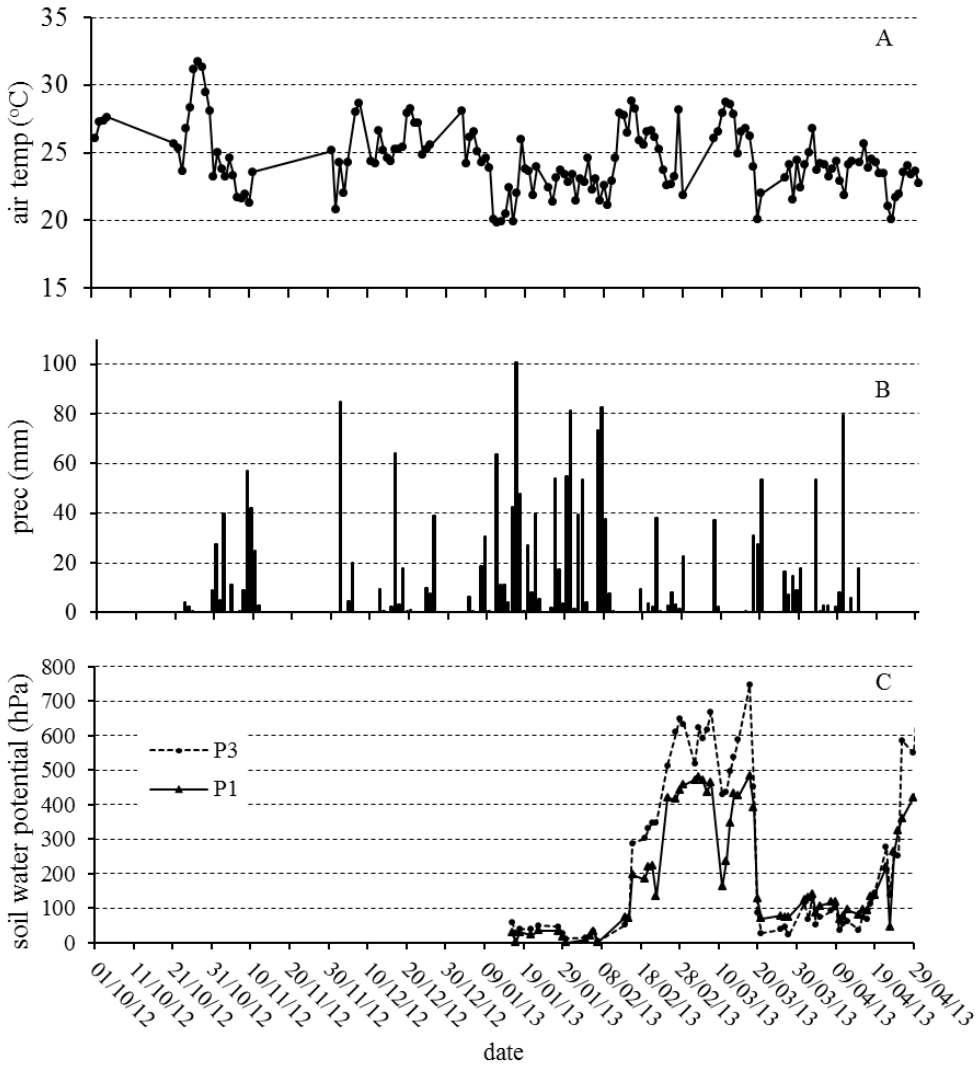

Figure 1. Weather and soil data for the experimental period in Santo Antônio de Goiás: (A) Average daily air temperature (°C), (B) Total daily precipitation (mm), (C) Soil water potential at 20 cm (kPa), starting on Jan 16 2013.

Fluctuations of CO_2 flux could be related to precipitation occurrences, as well as with the regrowth of the pasture and subsequent increase of the pastures leaf area index. On the other hand, the presence of animals could be related to a relative decrease in the fluxes.

Fluxes of both gases were evaluated for daytime and nighttime periods separately (data not shown). For N_2O flux, there was a trend of increasing fluxes during daytime, along with increasing air temperature and solar radiation reaching the surface. As expected, fluxes of CO_2 were negative during daytime due to prevailing sequestration by photosynthesis while during nighttime fluxes were positive, as a result of the plant respiration.

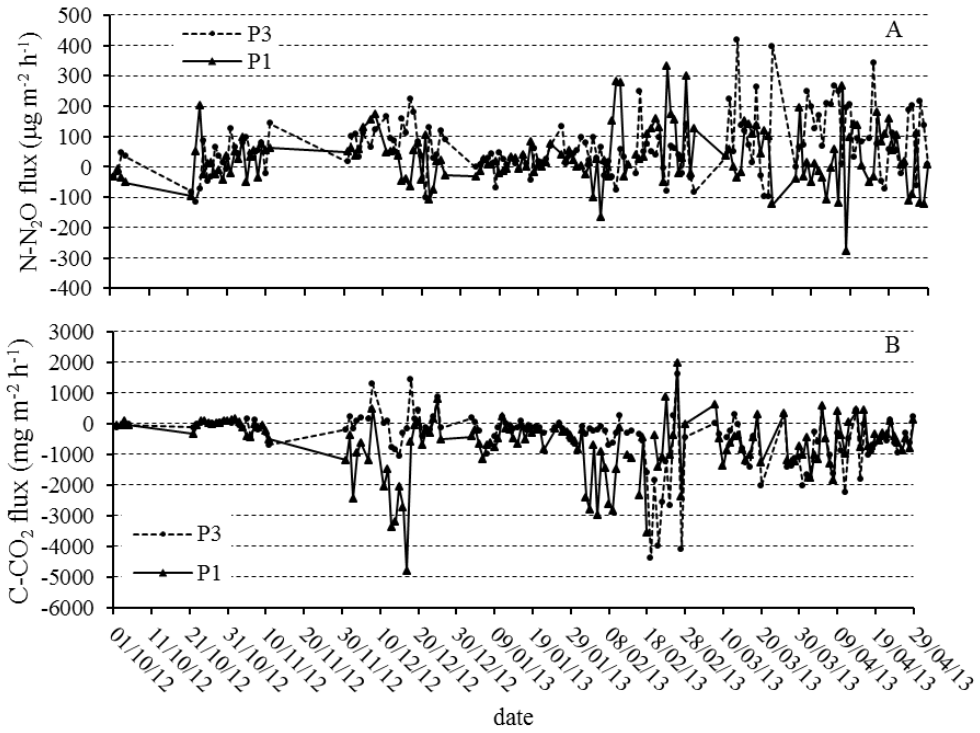

Figure 2. Daily averages fluxes measured at Santo Antônio de Goiás: (A) N_2O flux (µg N-N_2O m^{-2} h^{-1}), and (B) CO_2 flux (mg C-CO_2 m^{-2} h^{-1}).

CONCLUSIONS

Micrometeorological measurements of N_2O and CO_2 using the TGA allowed the continuous calculation of both gaseous fluxes at a crop-livestock-forest integration system in the Brazilian *cerrado*. The older of the two pasture areas studied presented a higher N_2O emission and lower CO_2 sequestration, indication of a more advanced degradation stage. This methodology will be useful to a better knowledge of the dynamics of gaseous emissions.

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