

PRELIMINARY STUDY OF GREENHOUSE GASES NEAR TO SANTOS AND SÃO SEBASTIÃO PORTS

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Abstract

The carbon biogeochemical cycle in nature involves the atmosphere, ocean, terrestrial and marine biota, and mineral reservoirs, with major fluxes between the atmosphere and both terrestrial biota and ocean waters. Studies link the increase of CO₂ and CH₄ (GHG) to climate change and anthropogenic activities. Coastal zones have a significant impact on the carbon cycle. This study examines GHG concentrations in estuary systems close to port zones, focusing on Santos and São Sebastião ports in São Paulo, Brazil. Santos Port, the largest in Latin America, and São Sebastião Port, with a petroleum terminal, can be significant contributors of GEE. A preliminary campaign measured CO₂ and CH₄ for 27 hours using a portable GHG analyzer on the research vessel Albacora from the University of São Paulo's Oceanographic Institute. Results showed promising GHG concentrations, with CO₂ levels above 420 ppm near Santos and above 450 ppm near São Sebastião, for methane, the major concentration was ~3 ppm, but in short period of acquisitions, in the major part of trajectory the level was between ~1.8 - ~1.9 ppm.

Introduction

Coastal areas represent only 7% of the total ocean surface but play an important role in biogeochemical cycles among continents, atmosphere, and oceans [1]. In 2019, CO₂ concentrations detected were the highest recorded in at least 2 million years, and CH₄ concentrations were the highest in at least 800,000 years. Since 1750, increases in CO₂ and CH₄ concentrations far exceed those observed in natural atmospheric changes observed in glacial and interglacial periods [2]. Due to this increase in the concentration of these gasses and their high potential to interfere with radiative forcing during the last decade, GHG (greenhouse gas) dynamics have been further investigated in various environments, which also include coastal areas, making estuaries very promising regions for GHG studies [3]. The main purpose of this work is to study Greenhouse gasses (GHG), such as CO₂ and CH₄, on the waters of the coastal region of São Paulo. The data were collected in situ on a vessel provided by the Institute of Oceanography of São Paulo University (IOUSP). The campaign was conducted in early spring 2021 from the northern region to the south of the coast of São Paulo, traveling through cities with more and less anthropogenic impacts. For these in situ measurements a portable gas analyzer Microportable Greenhouse Gas Analyzers (LGR-ICOS™ GLA Series) - was used to detect the CO₂ and CH₄ spectra through the Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS) technique.

Methods

The Albacora I Campaign, which took place in an approximately 27-hour Journey along the Coast of São Paulo state, Brazil. The route crossed the coast of cities with greater anthropic impact such as the Baixada Santista Metropolitan Region and other regions of low anthropic impacts located in Litoral North and South of São Paulo state (Figure 1).

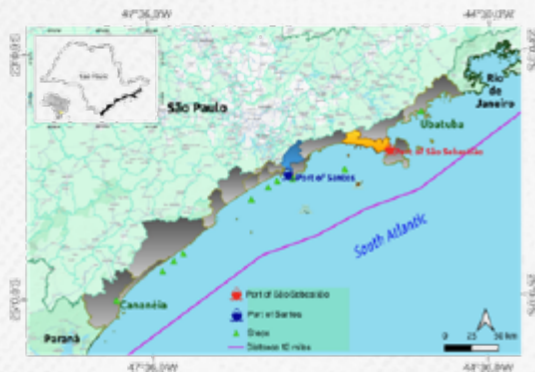


Figure 1: Map coast of São Paulo. It highlights the cities which located the São Sebastião and Santos Ports



Figure 2: Microportable Greenhouse Gas Analyzer LGR-ICOS™ GLA Series

For data collection, a portable gas analyzer - Microportable Greenhouse Gas Analyzer LGR-ICOS™ GLA Series - (see Figure 2) was used. This instrument has a high sensibility, resulting in a very fast gas flow response time (1 second) [4], it's based on the Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS), a technique that is widely utilized for gas detection due to its rapid response, high sensitivity, and stability [5], achieve obtain a precision of <0.9 ppb (1 second) for CO₂ and <350 ppb for CH₄ (1 second). A Teflon tube of ¼ was coupled to the INLET, which extended up to about 3 meters above sea level and was positioned above the cabin of the captain of the vessel at half ship. At the end of this tube a PFA 47-mm Savillex filter holder was attached, and inside this support a Zefluor membrane of 2.0 µm was used (Figure 3).



Figure 3: Vessel IOUSP, in highlight the position inlet of portable gas analyzer

Results

As a result of this first experiment we obtained the following results. The campaign lasted about 27 hours. The initial data acquisition began at 6 pm (UTC) in the research base "Clarimundo de Jesus" in Ubatuba's city, which belongs to Institute Oceanography of University of São Paulo. The GHG analyzer maintained continuous measures until the final destination around 8 pm (UTC) in the research base "Dr. João de Paiva Carvalho" - Cananéia city (see Figure 1) also of the Institute Oceanography of University of São Paulo.

We obtained the following findings based on the dataset values in this sampling. The data archive for the line graphs (Figures 4 and 5) was averaged every 180 seconds from the raw data, which was initially measured at 1-second intervals.

This preliminary examination reveals that concentrations of both gasses, CH₄ and CO₂, showed some peaks than ran commonly accepted background levels by 1,87 ppm for CH₄ and 415 ppm for CO₂ in 2020 [6], but almost all the time the concentrations, mainly the methane are accordingly the background.

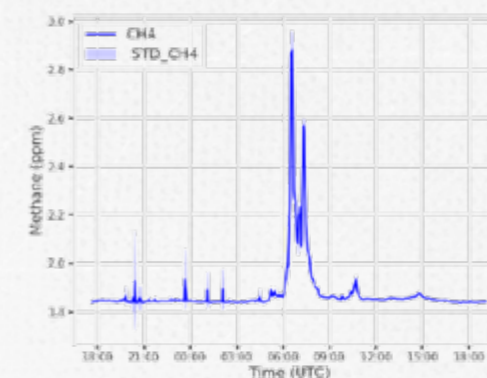


Figure 4: Illustrates the concentration of methane along the coast of São Paulo in Campaign Albacora I

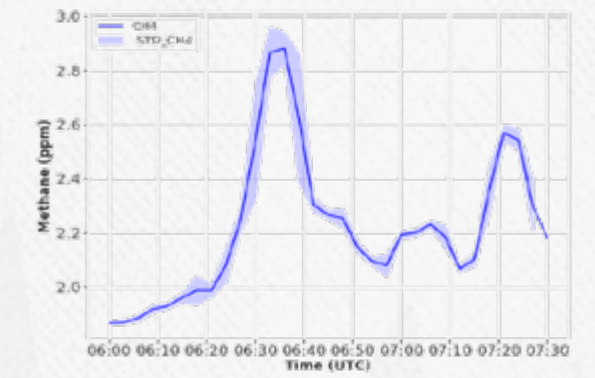
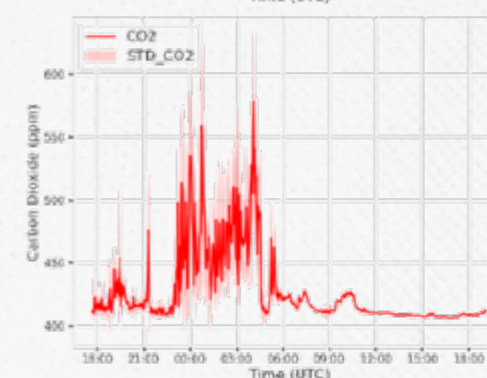


Figure 5: Displays the concentration of methane and carbon dioxide during two moments: 6 am to 7:30 am for methane and 11 pm at 6 am for carbon dioxide



As we can observe the data of CH₄ there was a greater increase in concentration between 6 - 7 am (UTC-time) with peaks of approximately 3 ppm. When we look at the CO₂ data the variability is higher, with peaks ranging between -415 and -575 ppm, it is observed that the data set that presents more these values were between 11 pm to 6 am (UTC-time).

Figure 5 shows the two moments cited above, when the concentrations of CH₄ and CO₂ obtained were higher. For the concentrations for methane the vessel steps near a Port of Santos for approximately

two hours, the point of step is indicated in the map on Figure 1 with the symbol blue. In the case of CO₂ the data show higher concentrations (above 420 ppm in more longer time period (around 8 hours). The vessel in this period crosses the traject between the two ports (São Sebastião and Santos), see Figure 1, where there is much traffic of vessels.

Conclusion

The data presented here, as previously mentioned, is data from a first campaign that aimed to explore a coastal region and verify the concentrations of CO₂ and CH₄ along the coast of the State of São Paulo with a portable GHG analyzer. Although it was a first use of this equipment for this purpose, the results were promising, because they detected results that define well the regions covered, mainly as the that in more populous cities and close to the ports of São Sebastião and Santos showed a greater concentration of this gas. Despite the promising results, it is important to stress that some aspects have to be taken into account in future work, it is necessary that some parameters are taken into account, such as wind direction, which would help to identify where the highest peaks of concentration of these gasses in each region come from, it would also be interesting to have a more comprehensive sampling with more days of measurements in the same regions and in different seasons, for better analysis of results.

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Keywords: Pantanal biome; Lidar System; atmospheric studies.

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