![ProRADAR]

RADARSAT for Amazonia:
Results of ProRADAR Investigations

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Can RADARSAT improve methane emission estimations in tropical floodplains and reservoirs: Tucuruí Reservoir and Lago Grande, Amazon?

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Abstract

Because wetlands are regarded as significant natural sources of CH_4 in the last two decades there have been several attempts to quantify their contribution to the global carbon budget. In the Amazon floodplains and reservoirs, where fluxes are high, the main focus of these studies was to measure methane fluxes in three different environments: open water, macrophyte beds and flooded forests. However, there is still little information about the extension of these environments. Since the early eighties there were some attempts to quantify the area of these habitats through remote sensing techniques. Cloud cover and the seasonal variability of these environments made difficult to produce accurate numbers on the proportion of each habitat in the floodplain and reservoirs. The availability of RADARSAT data made it possible to acquire multi temporal data over Tucuruí reservoir and Lago Grande. The objective of this study is to present a methodology of integrating radar data and methane ground measurements to produce more accurate methane estimation of these ecosystems to the global carbon budget. For that, during 1996, as part of the ADRO project, water and gas samples for methane concentration determination were collected concurrently with the RADARSAT acquisition.

1- INTRODUCTION

Methane is a greenhouse gas with concentration in the atmosphere increasing at a rate of 1.5 to 2.0 % per year (Kbalil and Rasmussen, 1989; Staufer et alii, 1988). Because wetlands are regarded as significant natural sources of methane, in the last two decades, there have been several attempts to quantify their contribution to the global carbon budget (Bartlett et alii, 1990; Crill et alii, 1988; Devol et alii, 1994). In the Amazon floodplains and reservoirs, where fluxes are high, the main focus of these studies was to measure methane fluxes in three different environments: open water, macrophyte beds and flooded forests. According to these studies methane flux vary in a range between less than 0.1 to 1600 mg $CH4.m^2.d^{-1}$ (Bartlett et al., 1990; Devol et al., 1990; Crill et al., 1988; Richey et al., 1988).

The wide range of these fluxes is the consequence of large temporal and spatial variability in the environmental conditions of the Amazon floodplain habitats. These studies provided enough information on the magnitude of the fluxes. However, the contribution of these environments to the global carbon budget is still poorly understood due to the lack of information on their areal extension (Mathew and Fung, 1989) and the detailed seasonal variation of the fluxes.

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The availability of multitemporal RADARSAT data made it possible to acquire multitemporal data over Tucuruí reservoir and Lago Grande. The objetive of this study is to present a methodology for integrating radar data and methane ground measurements to produce more accurate methane estimation of

these ecosystems to the global carbon budget. This paper has the purpose to present the results from the first ADRO campaign (May, 1996) in Tucuruí reservoir and Lago Grande de Monte Alegre.

2- METHODOLOGY

From May 19 to June 2 of 1996 water and gas samples for methane concentration determination were collected concurrently with the RADARSAT acquisition for three different environments: open water, macrophyte beds and flooded forest at Tucuruí and Lago Grande (Para, Brazil). Figure 1 presents the location of study sites, respectively, as well as the ground sampling habitats. The experimental design and the methodology for processing remote sensing data can be found elsewhere in this volume (Costa et lii, 1997).

A Van Dom bottle was sub-sampled for measurements of : pH, total carbon dioxide and dissolved methane. Dissolved oxygen and water temperature were determinate *in situ* using a oxygen meter YSI model 58 (data not presented here). Initially after collection, water samples for dissolved methane were submitted to the multiple fase equilibration (McAuliff, 1974) for gas extraction and head-space methods. Gas samples were returned to the laboratory , and analyzed for CH_4 in a gas chromatograph equiped with flame ionizatior detector, using a CG- 370 Porapak N column and the externai standard method.

Methane fluxes to the atmosphere were determined by changes in the concentrations of floating chambers placed over the vegetated surface. This method provides an estimation of the total flux at the water-atmosphere interface. The chamber were dome-shaped, built with inert plastic material and covered a total area of 0.152 em^i and a volume of 0.0213 m^i . Floating collars were placed over the chamber to keep an internai height of 10 em over the water column. To minimize the temperature effect, the chambers were covered with a thin reflective layer. After placement on a surface, 60 ml of the air enclosed in the chamber was withdrawn into plastic syringes every 5 minutes over a 20 minutes sampling period. Methane fluxes to the troposphere were calculated from the slope of linear regression between the concentration change in the chamber and the experimentation time. These values were normalized for the chamber volume and area. Data are presented as means ± 1 SD, unless otherwise noted.

Table 1 presents the number of sampling station for each habitat. The smaller number of samples for Tucuruí reservoir is a consequence of logistic problems during this campaign.

Table 1 - Number of sampling station for each habitat at Tucuruí Reservoir and Lago Grande.

HabitatlLocation	Tucuruí Reservoir	Lago Grande
Open Water	-	08
Macrophytes beds	06	06
Flooded Forest	02	04

The detailed description on the methodology for image calibration and classification can be found elsewhere in this volume (Costa et alii, 1997).

3- RESULTS and DISCUSSION

Methane fluxes to the troposphere at Tucuruí Reservoir and Lago Grande (Table 2) were similar to those reported for the Amazon region (Bartlett et alii, 1990; Devol et alii, 1994; Richey et alii, 1988). The average methane emissions at Lago Grande and Tucuruí Reservoir were
similar for each habitat, with fluxes slightly higher at Lago Grande. The observed differences between the two systems is the result of differences in methane production, consumption and emission mechanisms, which seems to occur at different rates in each lake.
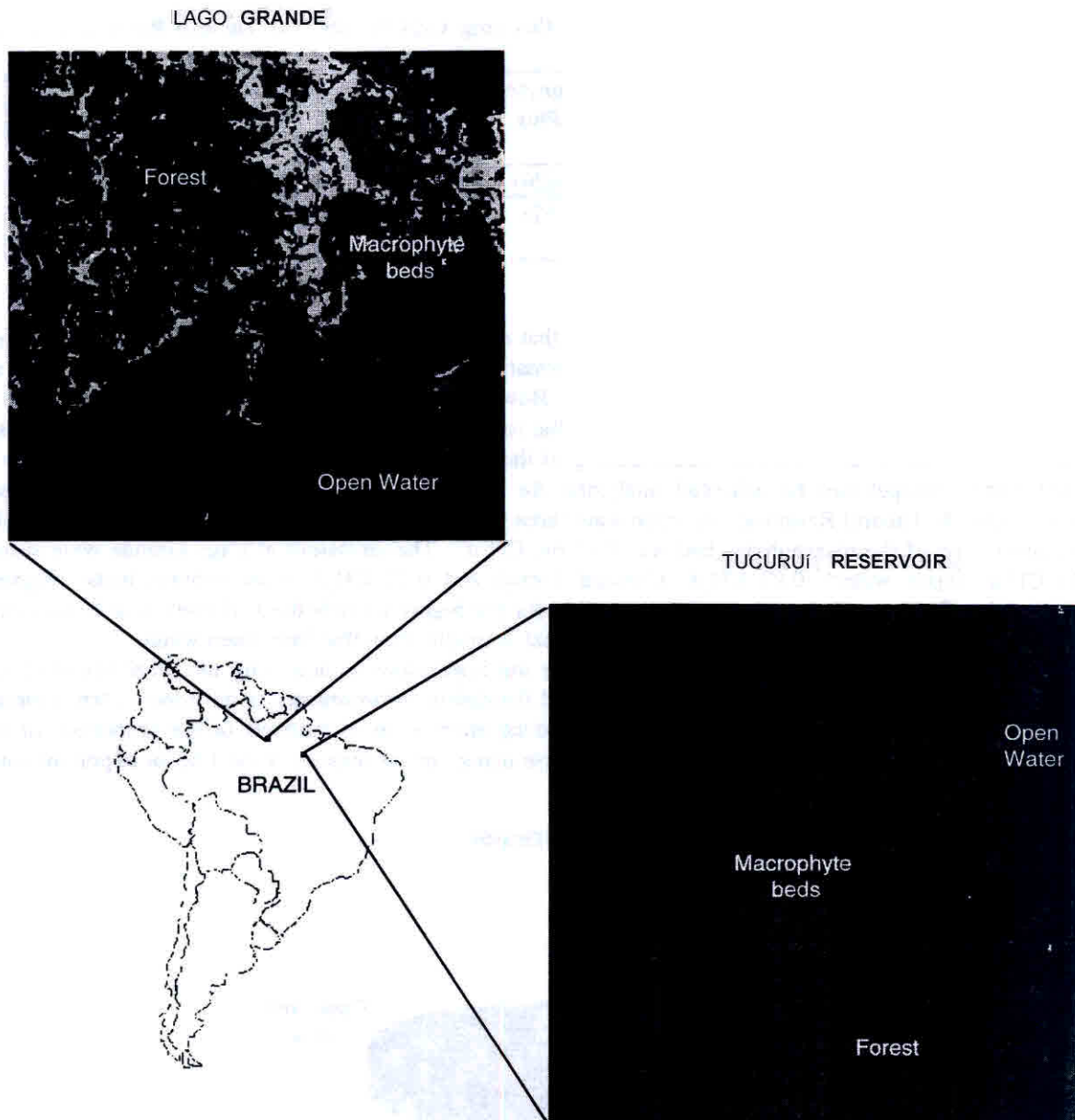
Figure I - Location of Tucuruí reservoir, Lago Grande and sampling habitats.

Average fluxes at the three habitats (open water, macrophytes beds and flooded forest) fluctuated from 17 to 75 mg $CH4.m^{o2}.dai$. The wide range in the magnitude of the CH_4 emissions probably results from the large temporal and spatial variability in the environmental conditions at the floodplain habitats.

We observed significant differences among the three sampled habitats as sources of methane to the troposphere. Higher and more variable emissions were obtained from floating aquatic vegetation than from flooded forest and open water (Table 2). This distribution among habitats is similar to that presented in previous studies for the Amazon floodplain environments (Barttlet et al., 1990).

Table 2. Areal extent of each (krn') and methane flux (mg CH4.m"2.day"')at Tucuruí Resrvoir and Lago Grande

	Open WaterFlux	Open Water Area	Macrophytes beds Flux	Macrophytes beds Area	Flooded Forest Flux	Flooded Forest Area
Tucuruí	-	-	63,4(±26)	64.05	29.4(±41)*	45.2
Lago Grande	17(±5)	165.8	75(±32)	56.6	27(±7)	29.8

* Paliteiro - permanent flooded forest

In the last two decades, most of the studies that estimated methane emission to the troposphere from the Amazon river floodplain provided detailed information on the magnitude of the fluxes (Barttlet et alii, 1990; Crill et alii, 1988; 1990; Devol et alii, 1994). However, the contribution of these environments to the global carbon budget is still poorly understood due to the lack of information on their areal extension (Mathew and Fung, 1989). A better understanding of the contribution of the floodplain environments to the global carbon budget can be achieved analyzing the fluxes normalized for the areal extent of each environment.. At Tucuruí Reservoir, the open water area was responsible for a flux of 0.13 mg CH.d''', while the contribution of the macrophytes bed was 0.41 mg CH.d'''·. The emissions at Lago Grande were similar, 0.28 CH.d'', (open water), 0.08 CH.d''' (flooded forest) and 0.42 CH.d''! (macrophytes beds). Figure 2 indicates that floating meadows are still responsible for the higher contributions. However, at Lago Grande due to its little extent, the contribution of flooded forest is smaller than that from open water.

The results presented in this study indicate the importance of accessing the areal extent of each environment to fully comprehend the role of tropical floodplain environments as an importantant source of green house gases. The use of RADARSAT to produce more accurate numbers of the proportion of each habitat in the floodplain (Costa et alii, 1997) than those using optical sensors, would be an important source of information to achieve it.

Lago Grande

Flooded Forest 10%

Open water 36%

Macr. 54%
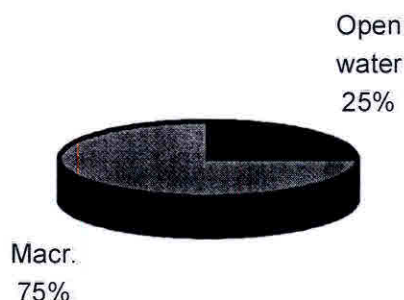
Tucuruí Reservoir

Open
water
25%

Macr.
75%
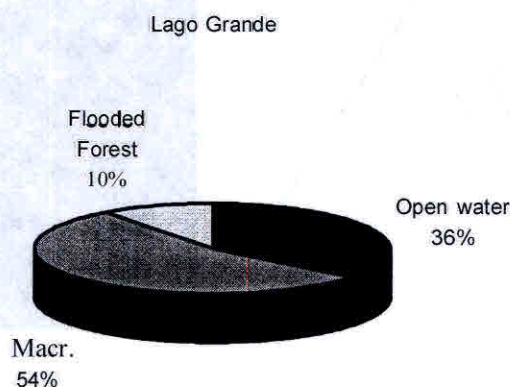
Figure 2. Contribution of each habitat to the total methane flux at each aquatic ecosystem.

4- CONCLUSION

First results indicate that the information provided by RADARSAT data can be an important source for a better understanding of the contribution of tropical floodplain habitats to the global carbon budget.

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