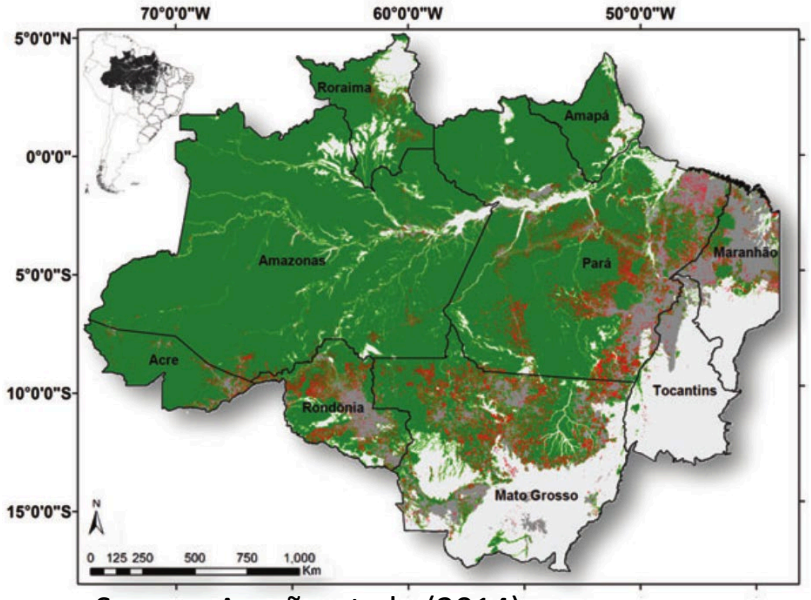
CO Measurements as a Biomass Burning

Carbon Emission Tracer at the Amazon Basin

Lucas Domingues
Luciana Gatti, Afonso Aquino, Caio Correia, Alber Sanches, Emanuel Gloor, John Miller, Wouter Peters, Jocelyn Turnbull, Luana Basso, Graciela Tejada, Henrique Cassol and Luciano Marani

July 2020

Introduction – Why study the Amazon?



Source: Aragão et al., (2014)

- It represents 50% of tropical forests in the world (Malhi et al.,2005);
- hosts the largest carbon pool (~200 PgC), comparable to half of the amount of atmospheric carbon on 18thcentury (Gloor et al., 2012);
- Amazon River drains into the ocean ~20% of the world's fresh water (Gloor et al., 2008);
- ~20% biodiversity of the globe (Houghton et al., 2001);

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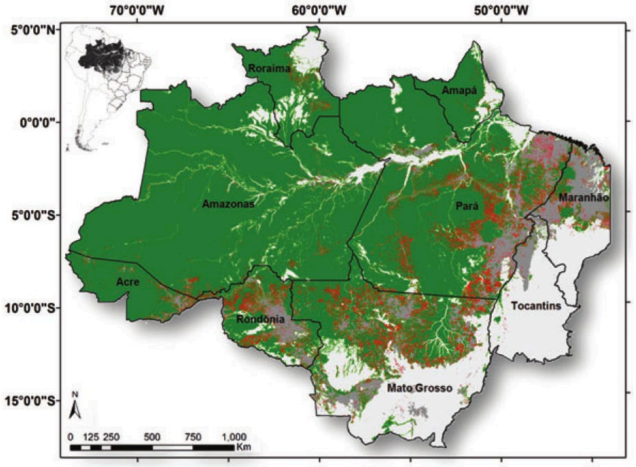
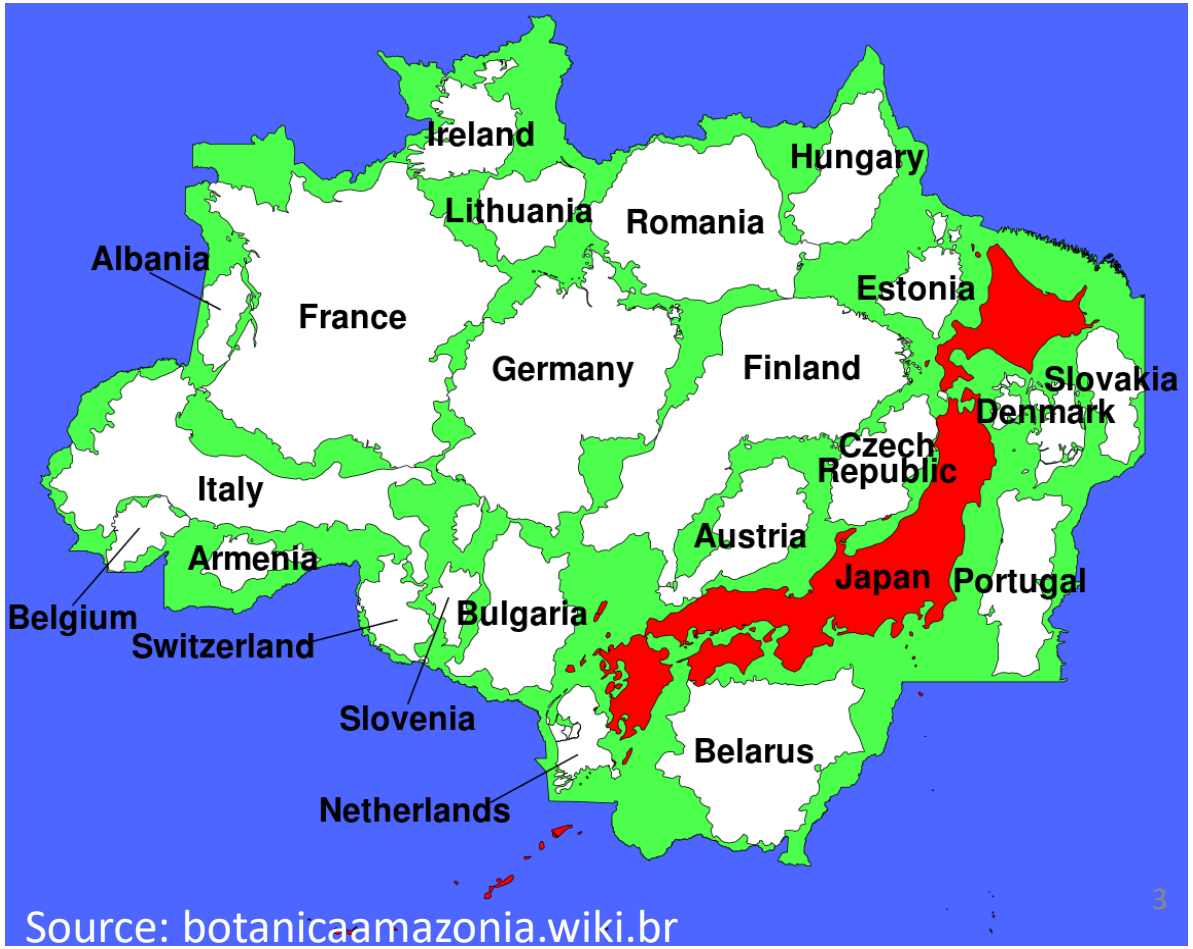


Source: Aragão et al., (2014)

- 5.000.000 Km^2

(Gloor et al, 2012)



Source: botanicaamazonia.wiki.br

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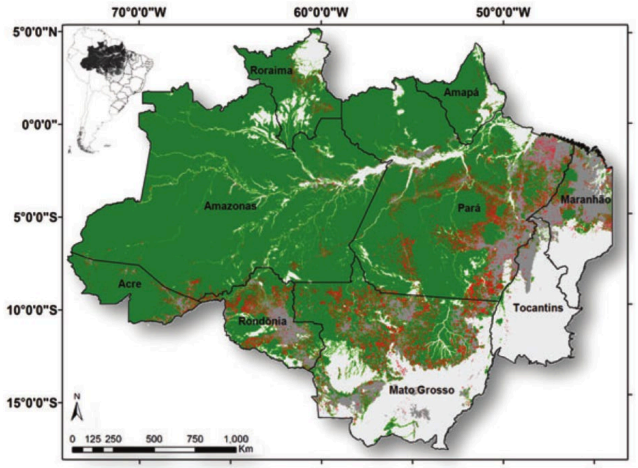

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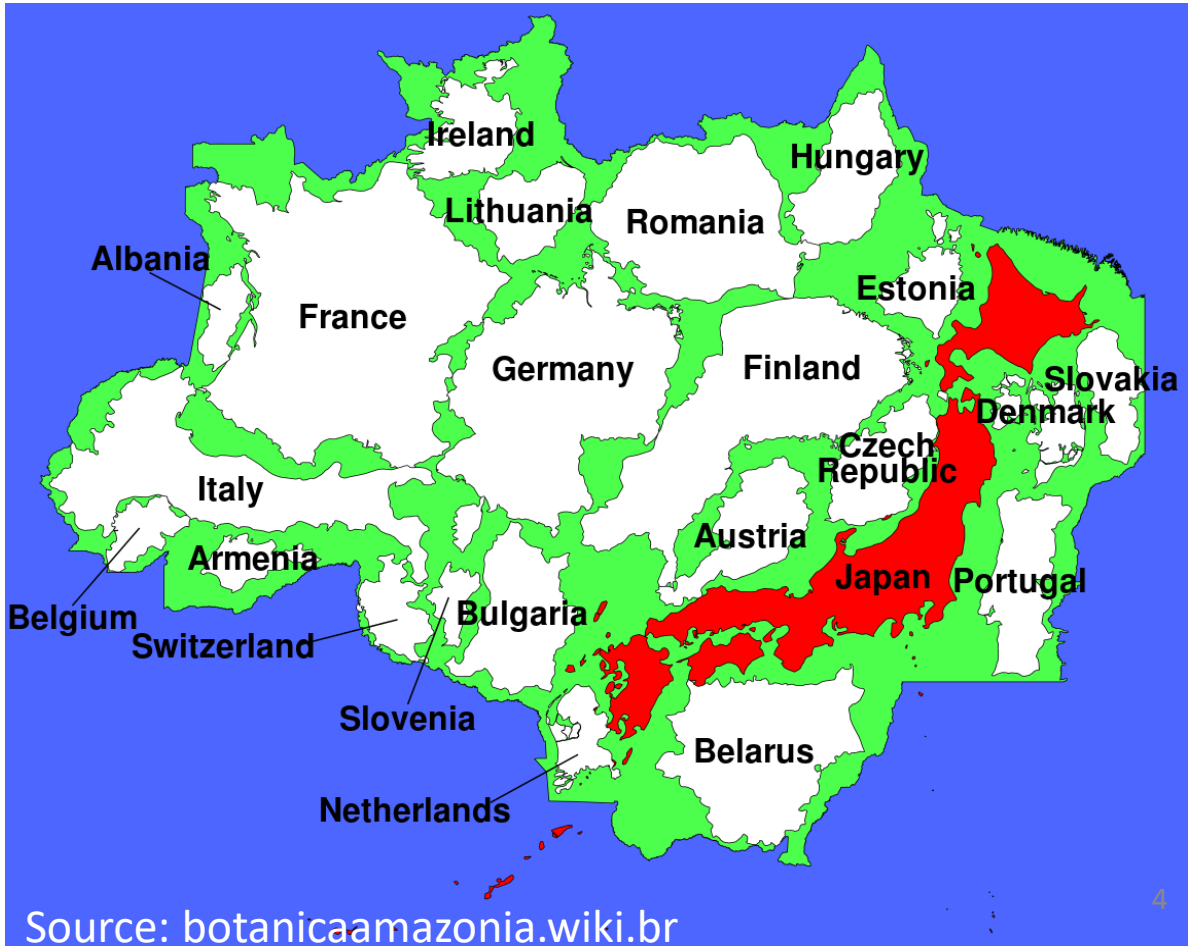
- 5.000.000 Km^2

(Gloor et al, 2012)

Under pressure by land use change (Aragão et al., 2018).



Source: botanicaamazonia.wiki.br

Introduction

FAST RELEASE POTENTIAL !

Introduction

Source: Jonathan Barichivich

Objectives

The main objective is to determine the carbon emission from biomass burning using the CO as a tracer in the Amazon Basin in the period between 2010 and 2016 and the factors that influence the CO:CO_2 ratios.

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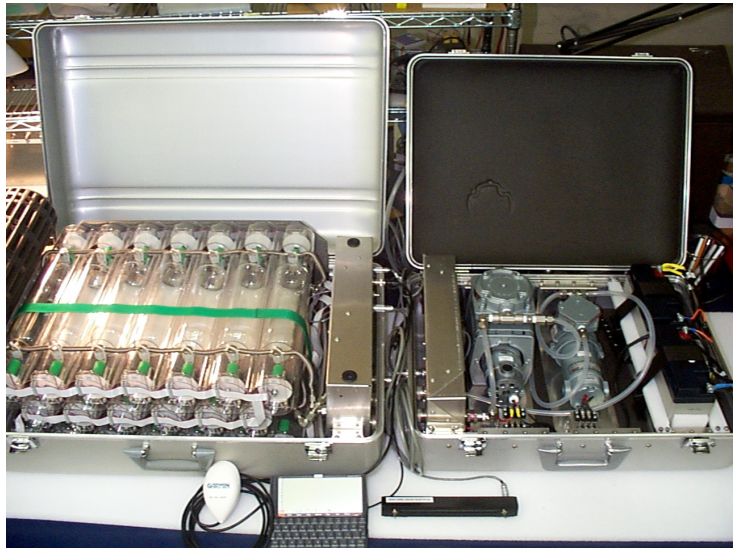
HOW

1. Bi-monthly sampling of CO_2, CO e SF_6.
2. Determine the BKG using SF6 as an air mass tracer.
3. Development of new methodology for the BKG determination.
4. The relation of climatological variables and C emissions .
5. CO:CO2 ratios.
6. Biomass burning Carbon emission.

Objectives

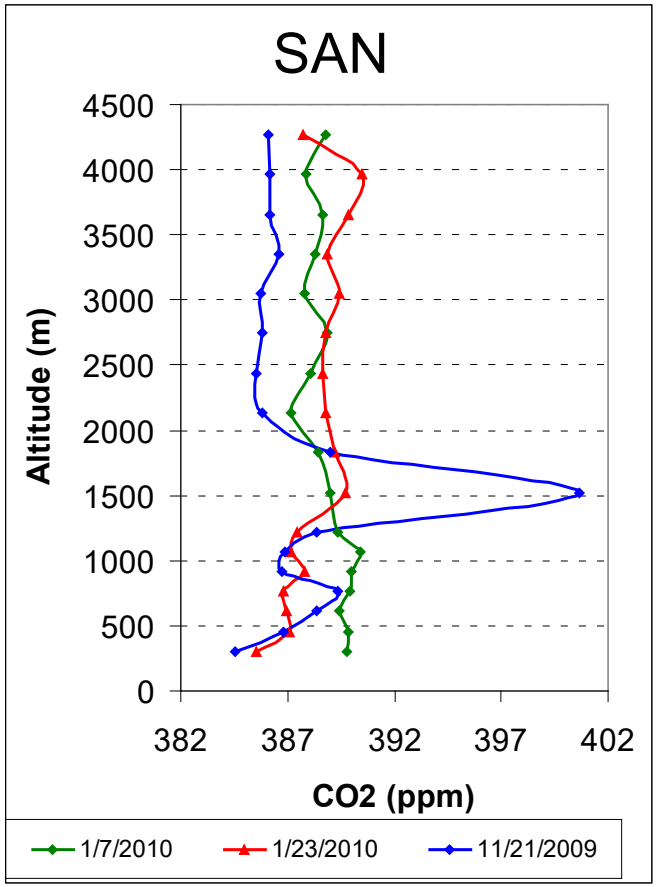
1. Bi-monthly sampling of CO_2, CO e SF_6.

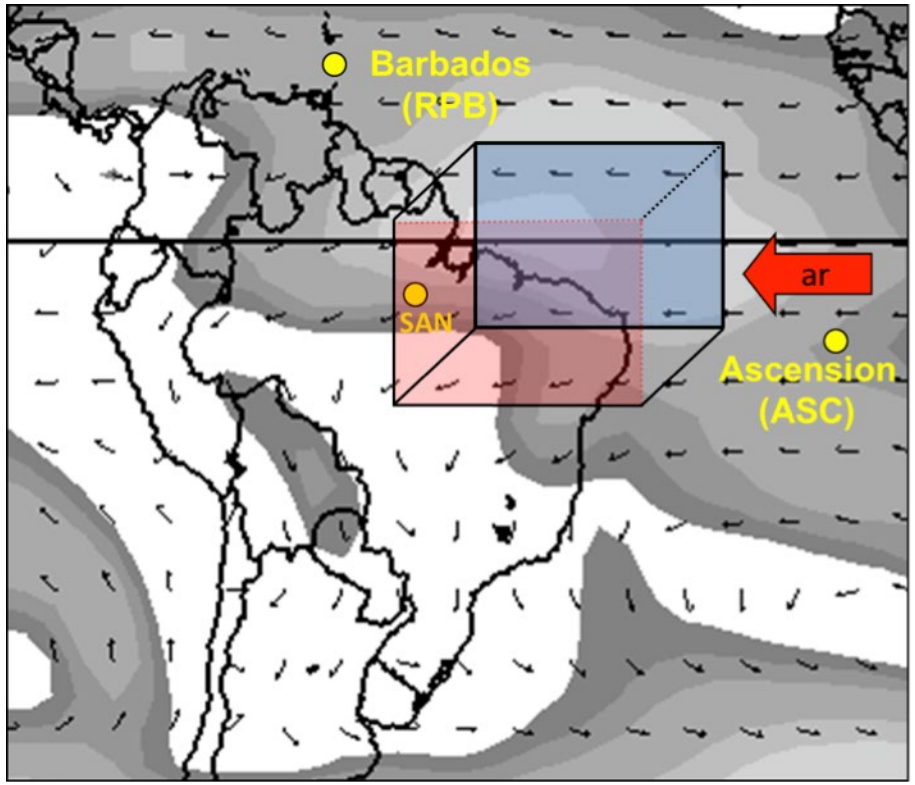
- ✓ Arround 500 profiles performed
- ✓ + 5000 samples



Column Budget Technique

$$F_{gás} = \frac{\int_{z=0}^{4km} [(C_{gás})_{SITE} - (C_{gás})_{bg}]dz}{t}$$





Objectives - Methodology

$$F_C^{\text{Fire}} = ratio_{CO^2:CO} \left(F_{CO} - F_{CO}^{Natural}\right)$$

Objectives - Methodology

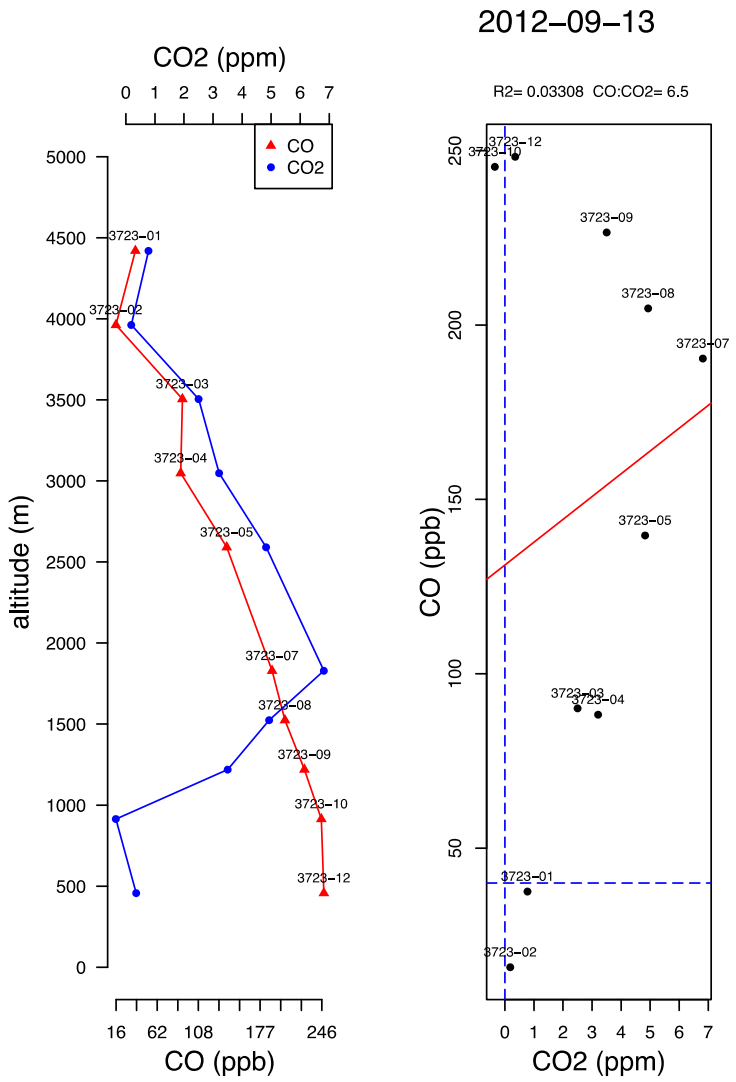
5. $CO:CO_2$ ratio

$$F_C^{Fire} = ratio_{CO^2:CO}(F_{CO} - F_{CO}^{Natural})$$

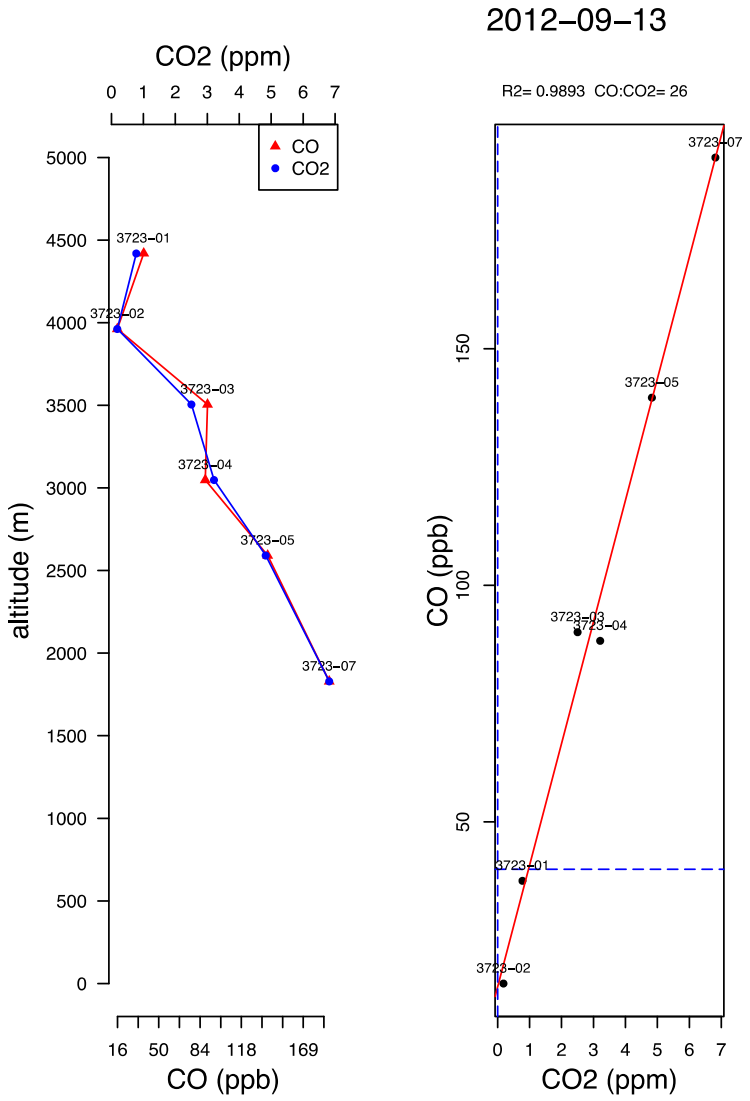
- ✓ Only profiles on dry season and above boundary layer (1500m height)
- ✓ Considers profiles with at least one flask with CO concentration above 100 ppb in relation to the Background.
- ✓ Comparative study performed between the profiles.

$CO:CO_2$ ratio

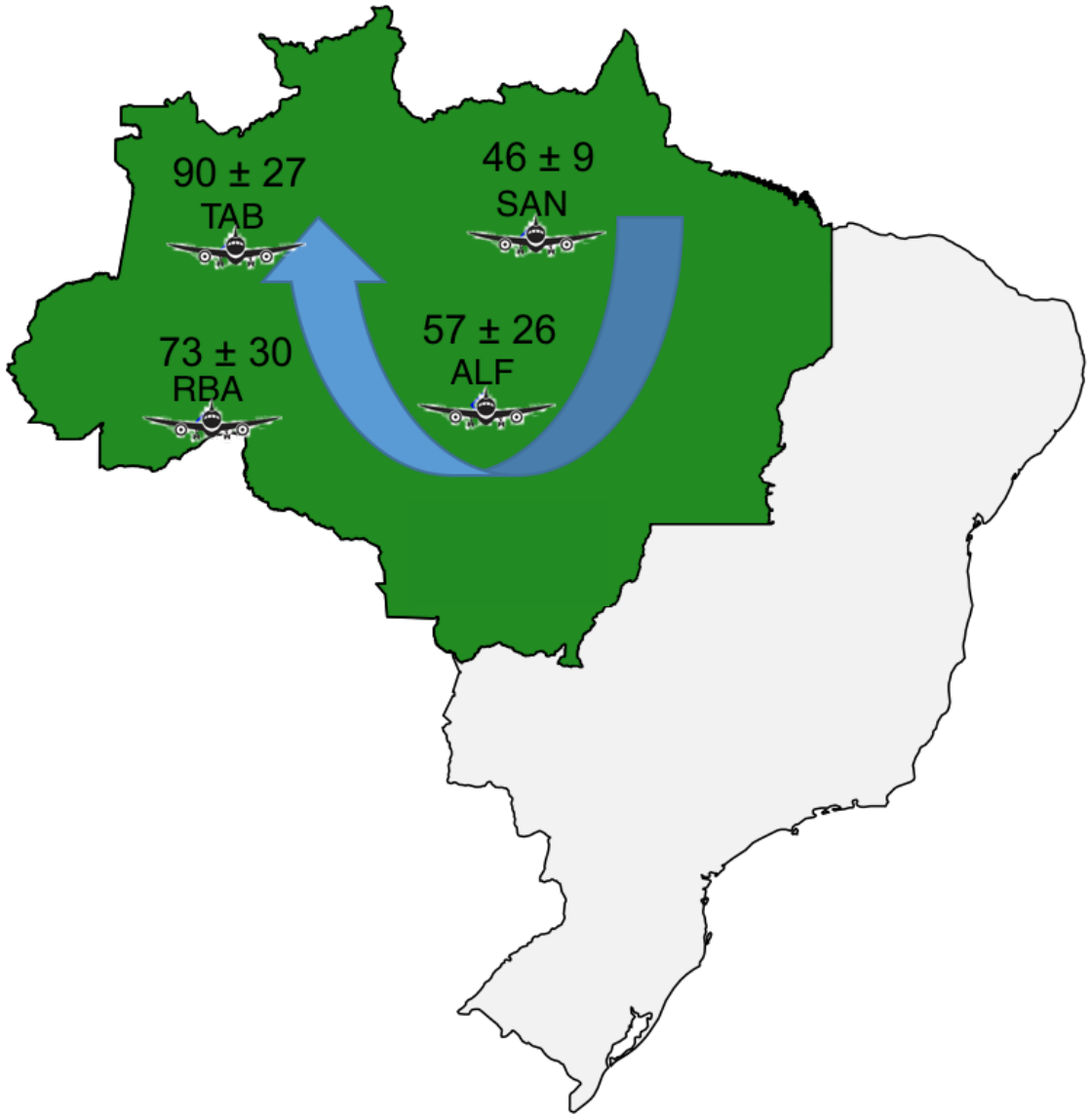
Pre-analysis



Post-analysis

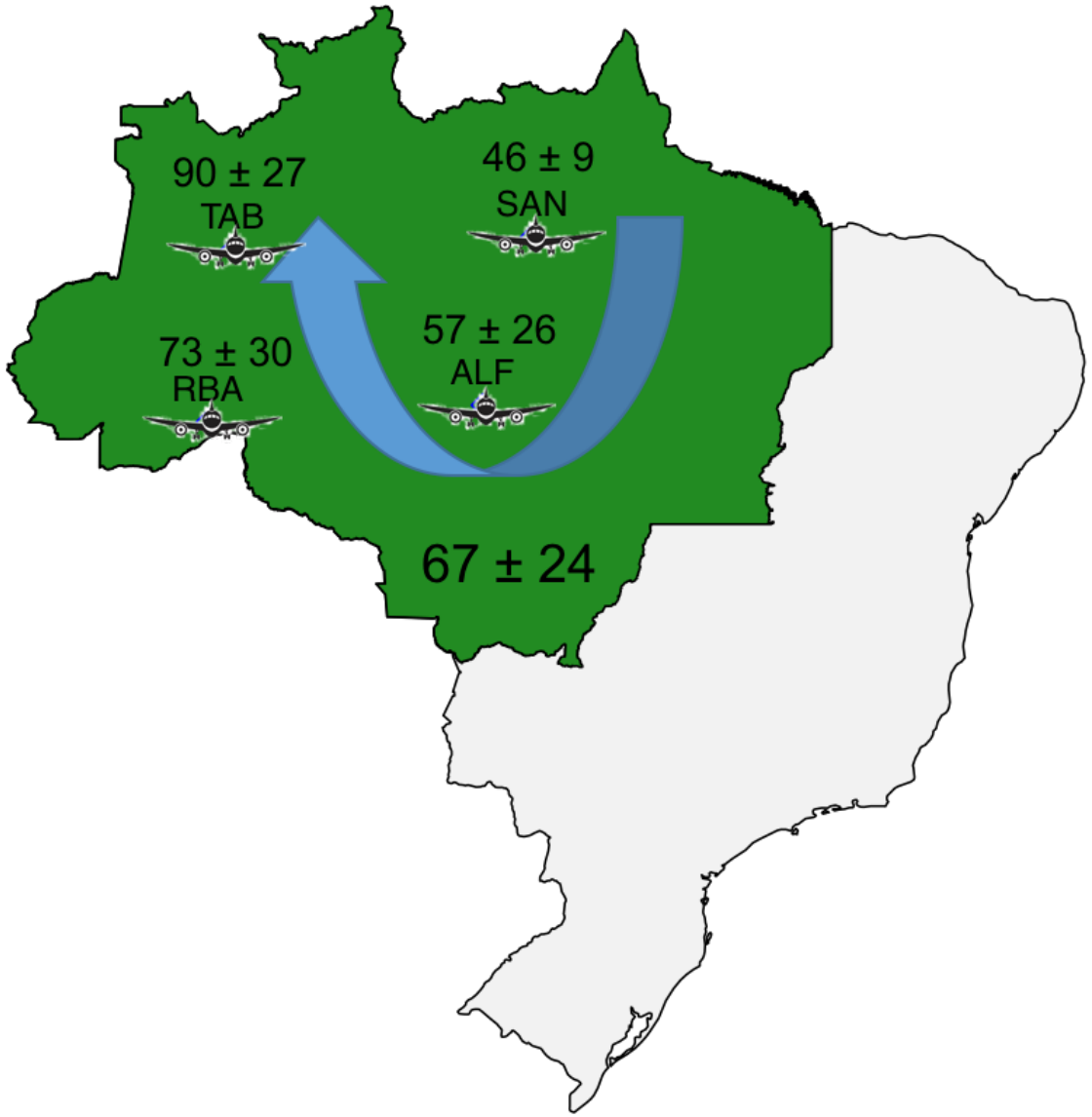


$CO:CO_2$ ratio



Domingues et al., (*in prep*)

$CO:CO_2$ ratio



Domingues et al., (*in prep*)

$CO:CO_2$ ratio - Literature

Table 2. Comparison of emission ratios $\Delta CO/\Delta CO_2$ measured during BARCA with literature data.

Region	Vegetation	Platform	$\Delta CO/\Delta CO_2 \times 10^3$	Reference
Eastern & Central Amazon	Mostly rainforest	Aircraft	66 ± 23	This study
Southern Amazon	Rainforest and some pasture	Aircraft	61 ± 17	Guyon et al. (2005)
Manaus region	Unknown	Aircraft	77 ± 40	Kuhn et al. (2010)
Central Amazon	Mostly rainforest	Aircraft	85 ± 4	Andreae et al. (1988)
Amazon	Rainforest	Aircraft	103 ± 8	Ferek et al. (1998)
Southern Amazon	Rainforest	Aircraft	85 ± 29	Ward et al. (1991)
Yucatan	Rainforest	Aircraft	78 ± 13	Yokelson et al. (2009)
Southern Amazon	Rainforest and some pasture	Aircraft, RSC corrected	90 ± 25	Guyon et al. (2005)
Southern Amazon	Rainforest	Aircraft and ground	106	Yokelson et al. (2008)
Southern Amazon	Pasture maintenance	Aircraft and ground	159	Yokelson et al. (2008)
Amazon	Forest	Aircraft and ground	82	Babbitt et al. (1996)
Amazon	Rainforest	Ground	119	Greenberg et al. (1984)
Southern Amazon	Rainforest	Ground	110 ± 51	Soares Neto et al. (2009)
Eastern Amazon	Rainforest	Ground	126	Ward et al. (1992)
Eastern Amazon	Secondary forest	Ground	84	Ward et al. (1992)
India	Dry Tropical Forest	Ground	124	Prasad et al. (2000)
Literature survey	Tropical Forest		92 ± 26	Akagi et al. (2011)
Literature survey	Tropical Forest		99 ± 17	Andreae and Merlet (2001), updated 2011

Andreae, M. O. et all, 2012.

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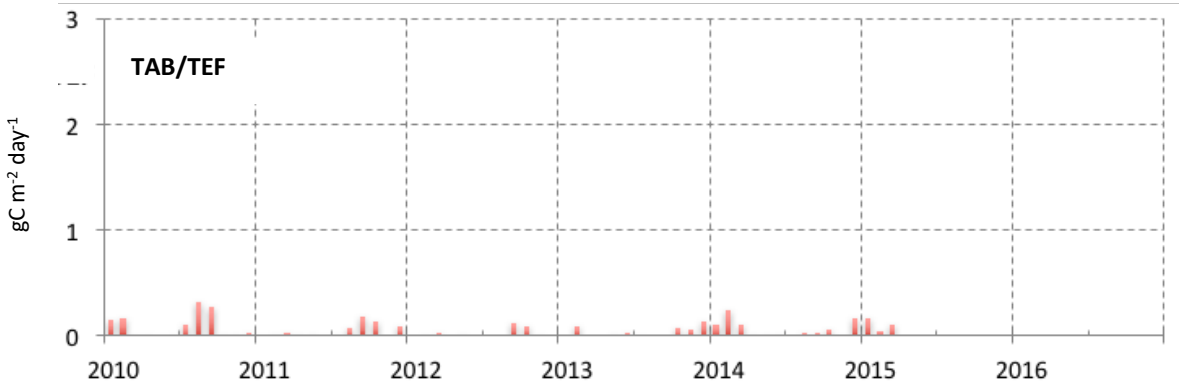
GLOBAL BIOGEOCHEMICAL CYCLES, VOL. 15, NO. 4, PAGES 955–966, DECEMBER 2001

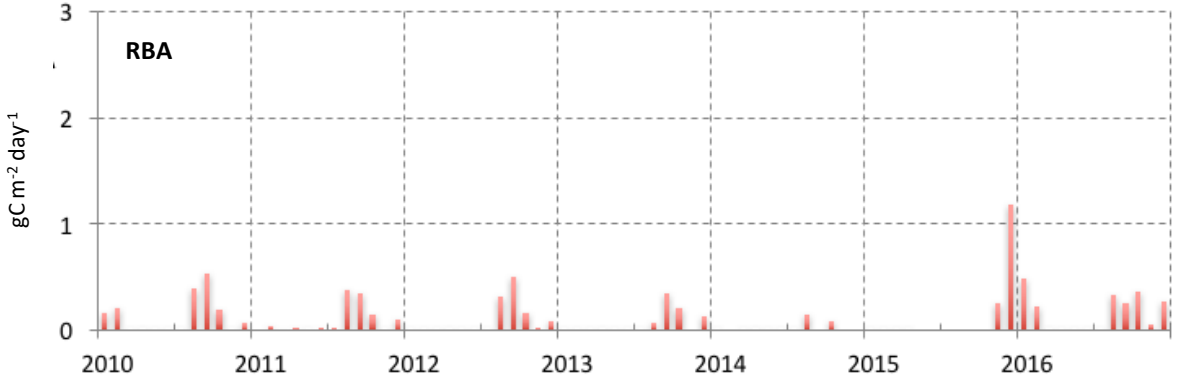
Emission of trace gases and aerosols from biomass burning

M. O. Andreae and P. Merlet
Biogeochemistry Department, Max Planck Institute for Chemistry, Mainz, Germany

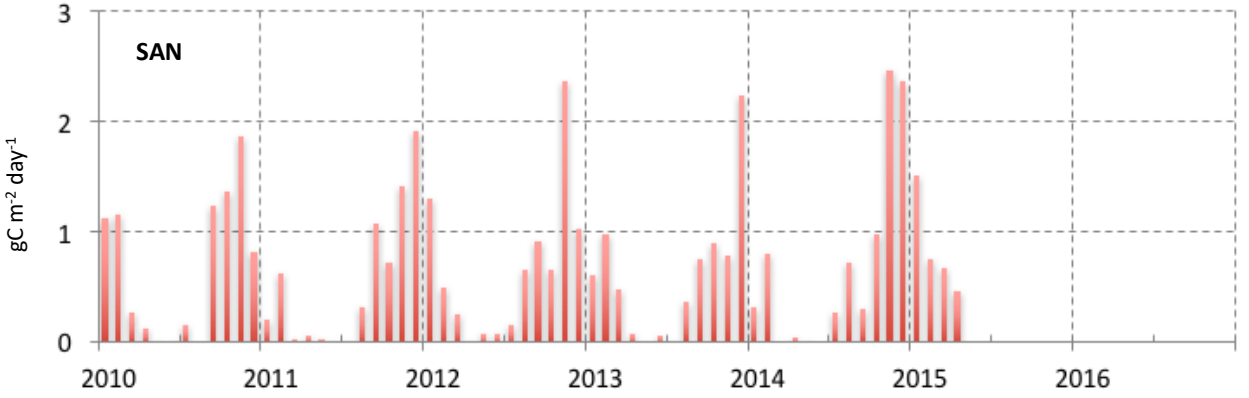
- ✓ + 2000 citations
- ✓ $CO:CO_2$ Ratio 103 ± 14 Tropical Forests

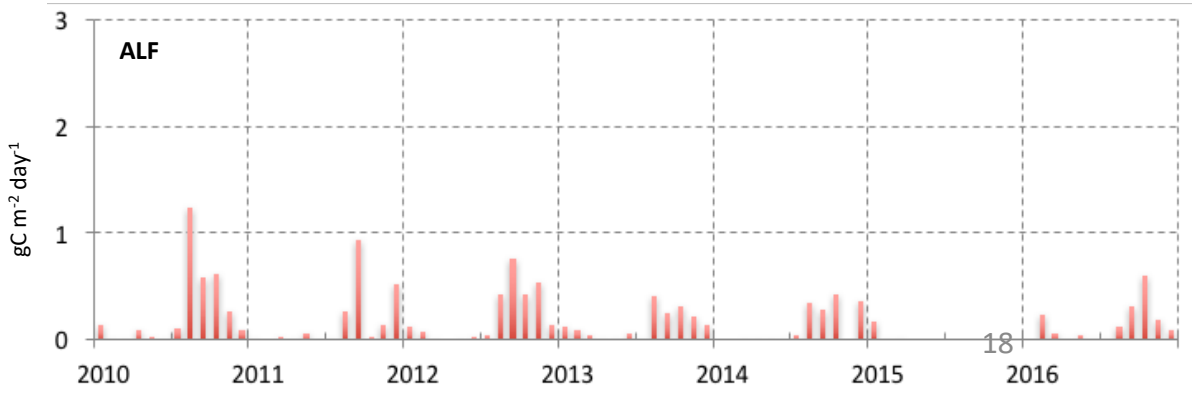
Carbon Flux


TAB/TEF
gC m-2 day-1
3
2
1
0
2010
2011
2012
2013
2014
2015
2016

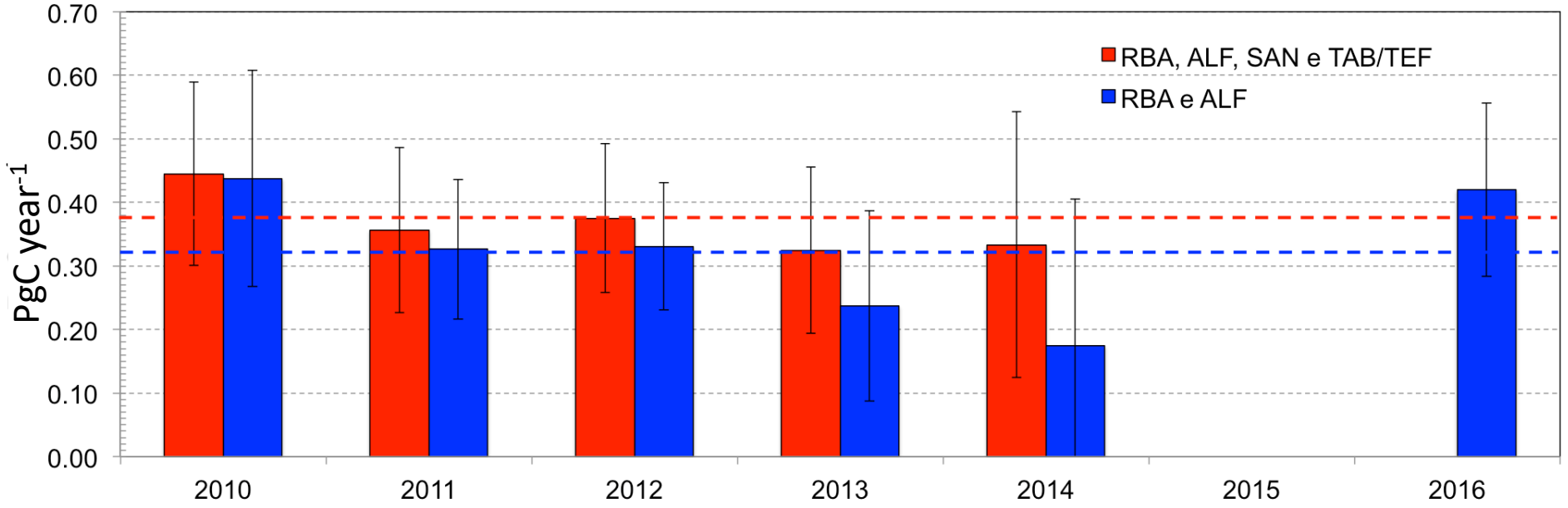

RBA
gC m-2 day-1
3
2
1
0
2010
2011
2012
2013
2014
2015
2016


SAH
SAL
CAM
SAN
TEF
TAB
NAT
RBA
ALF
ABP


SAN
gC m-2 day-1
3
2
1
0
2010
2011
2012
2013
2014
2015
2016

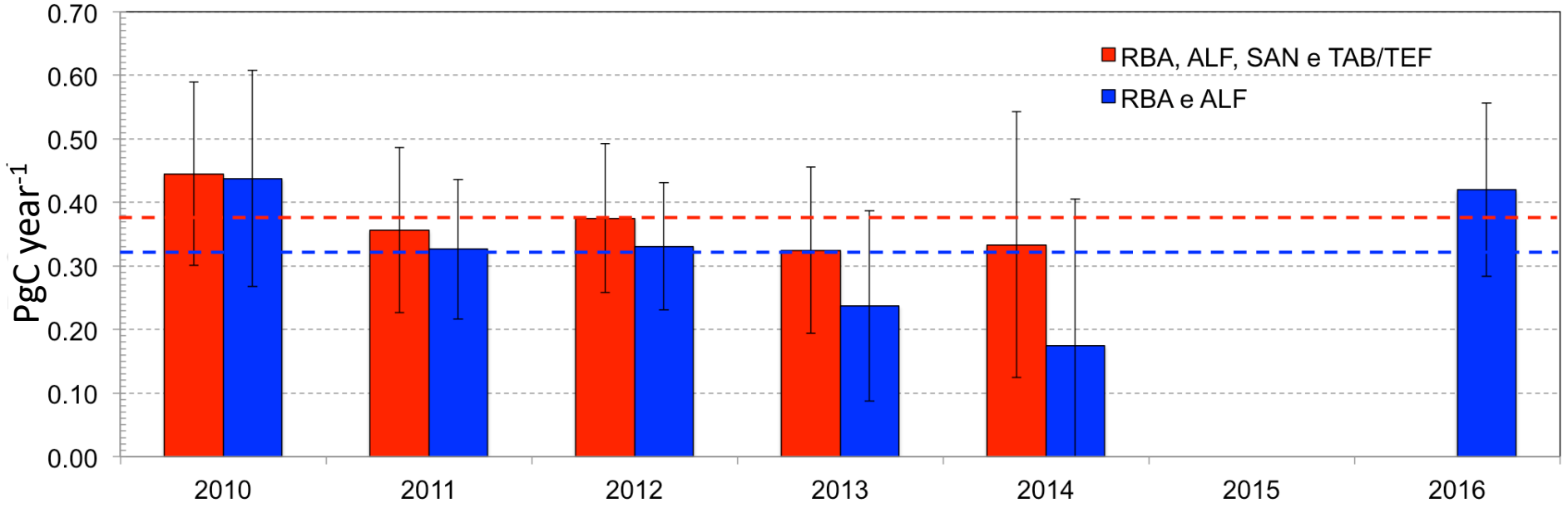

ALF
gC m-2 day-1
3
2
1
0
2010
2011
2012
2013
2014
2015
2016

Scaled Carbon Flux



	2010	2011	2012	2013	2014	2015	2016
PgC year^{-1}	0.44 ± 0.14	0.36 ± 0.13	0.37 ± 0.12	0.32 ± 0.13	0.33 ± 0.21	-	-
PgC year^{-1}	0.44 ± 0.17	0.33 ± 0.11	0.33 ± 0.1	0.24 ± 0.15	0.17 ± 0.23	-	0.42 ± 0.14

Scaled Carbon Flux



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PgC year^{-1}	0.44 ± 0.14	0.36 ± 0.13	0.37 ± 0.12	0.32 ± 0.13	0.33 ± 0.21	-	-
PgC year^{-1}	0.44 ± 0.17	0.33 ± 0.11	0.33 ± 0.1	0.24 ± 0.15	0.17 ± 0.23	-	0.42 ± 0.14

0,37 ± 0,15 GtC year^{-1} 0,32 ± 0,15 GtC year^{-1}

Conclusions

9%

~ 1.2 GtC year^{-1}

Source: CDIAC; NOAA-ESRL; Houghton et al 2012; Giglio et al 2013; Le Quéré et al 2016; Global Carbon Budget 2016

Conclusions

9%

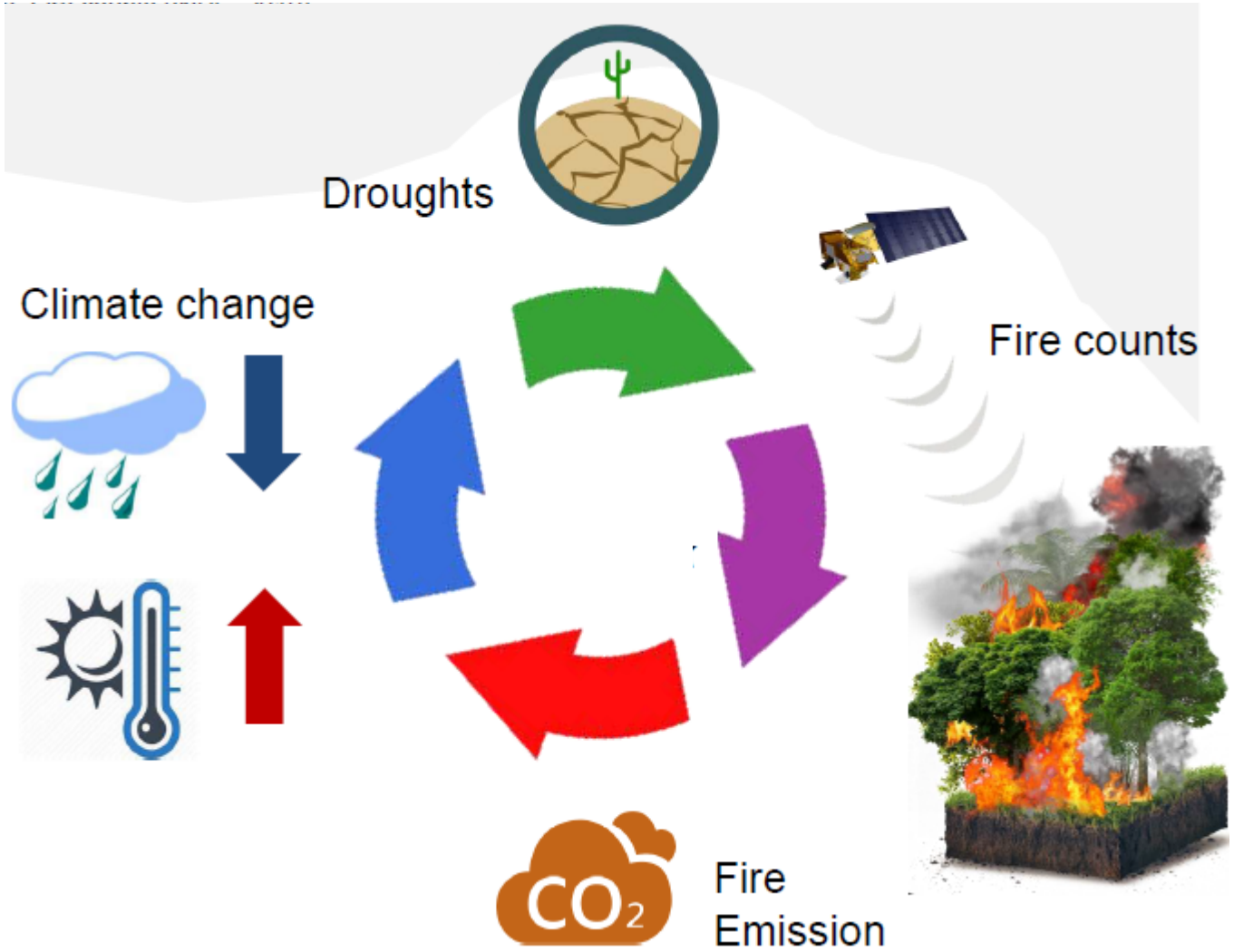
~ 1.2 GtC year^{-1}

- The Amazon Carbon emission from biomass burning could contribute up to 1/3 of global land use change emissions.

Source: CDIAC; NOAA-ESRL; Houghton et al 2012; Giglio et al 2013; Le Quéré et al 2016; Global Carbon Budget 2016

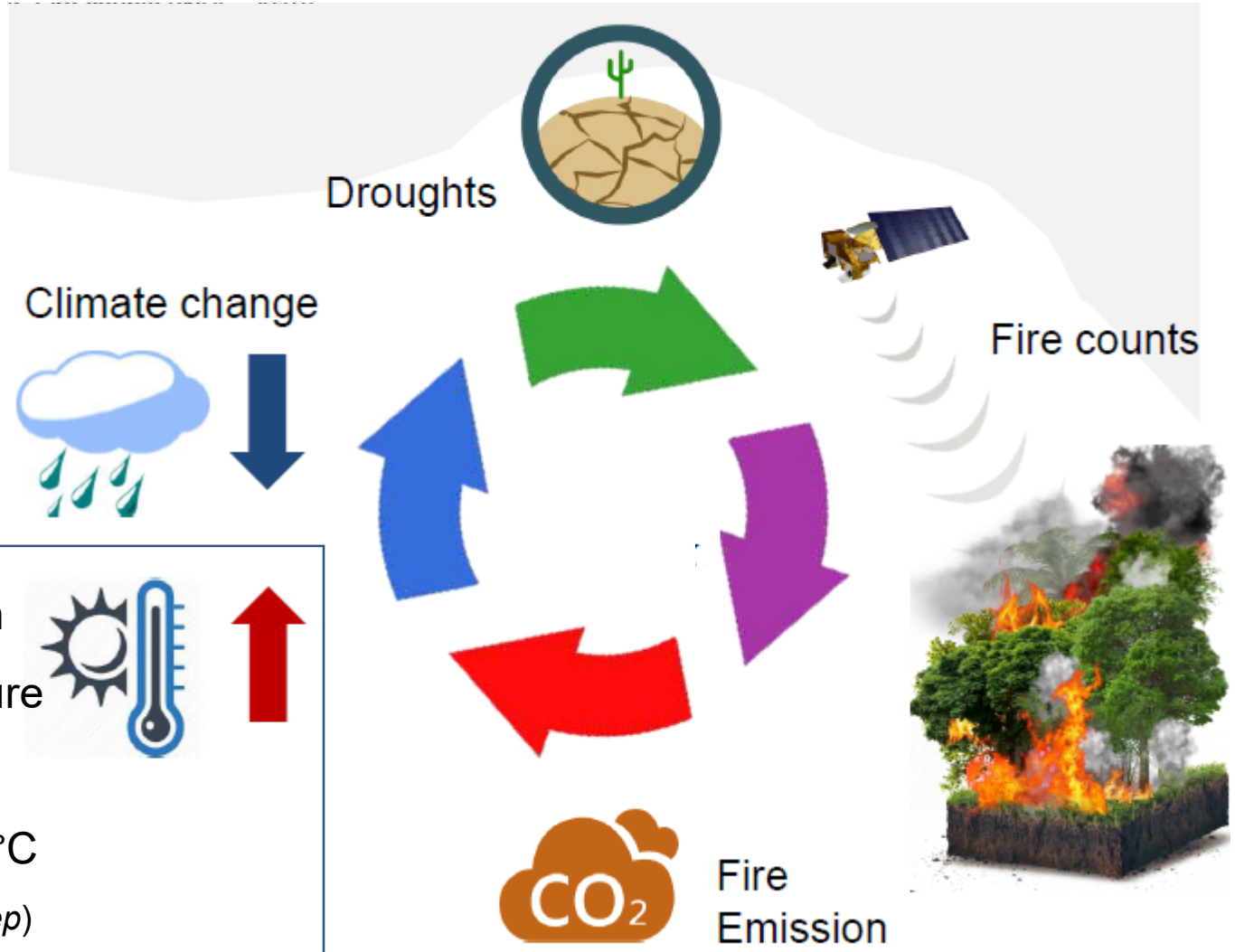
Conclusions

Amazon vicious cycle



Conclusions

Amazon vicious cycle



- The mean temperature increased around 1 °C

Gatti et al (*in prep*)

Conclusions

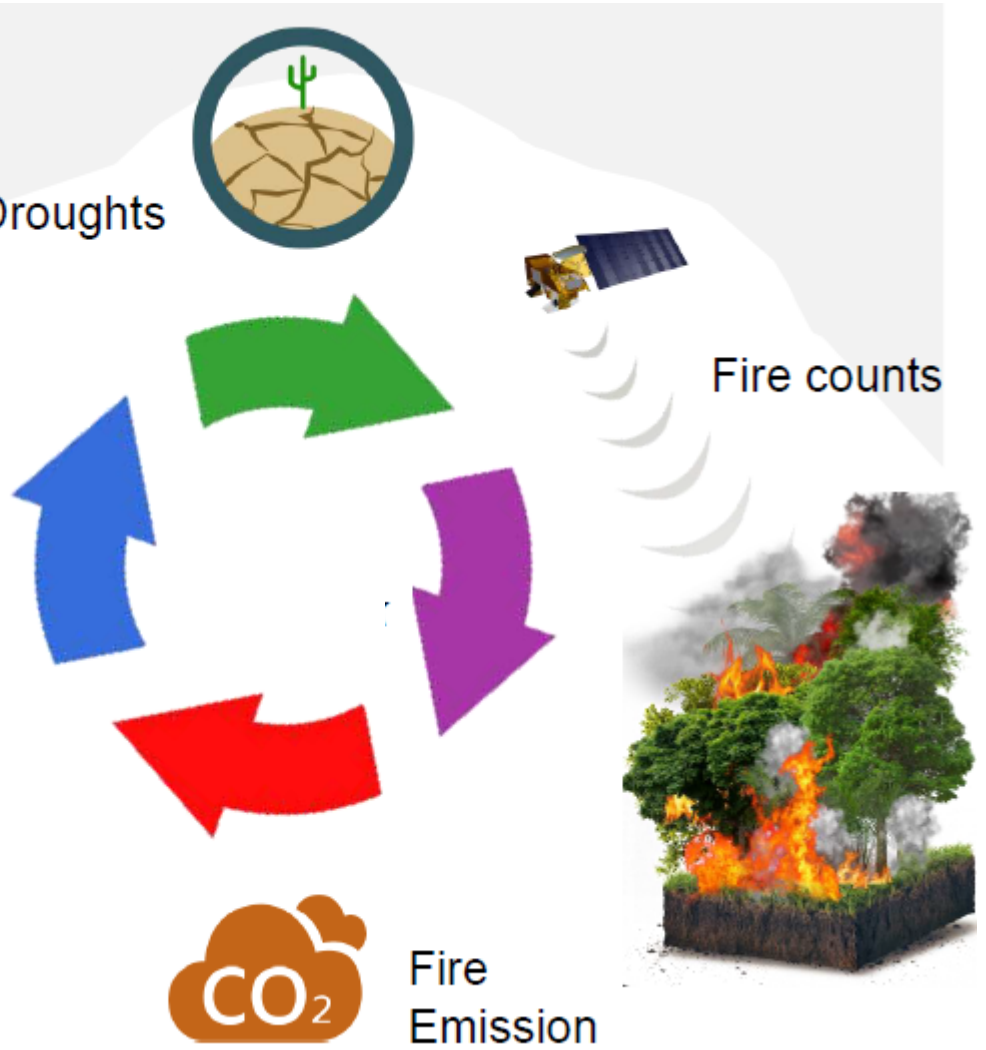
Amazon vicious cycle

- precipitation decrease in the dry season.

Climate change

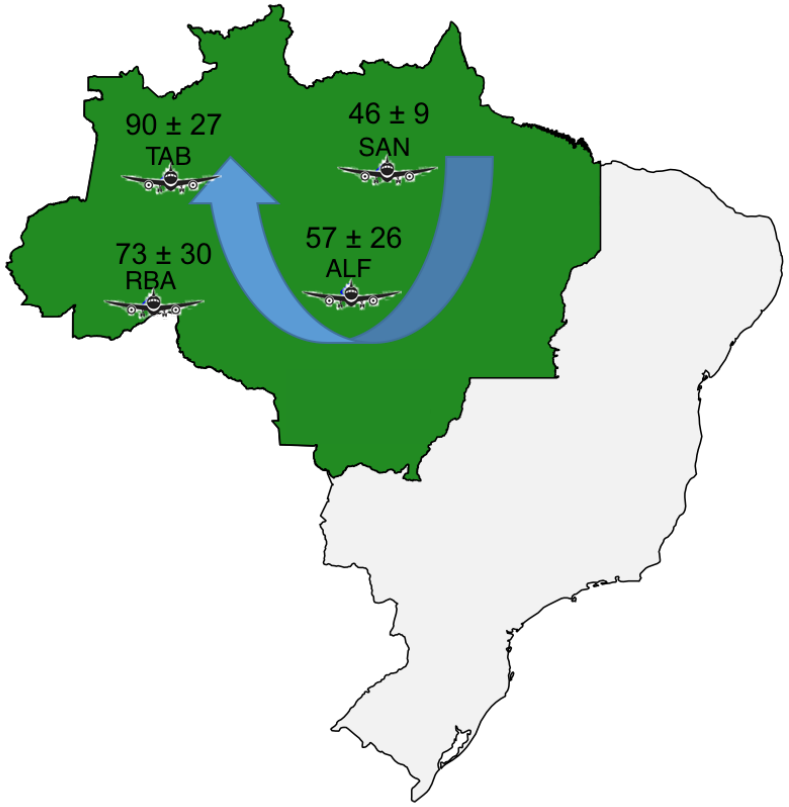
- The mean temperature increased around 1 °C

Gatti et al (*in prep*)

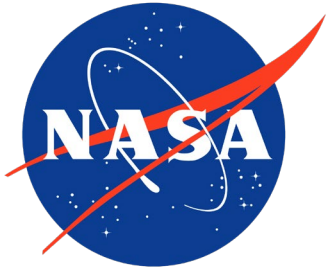


Conclusions

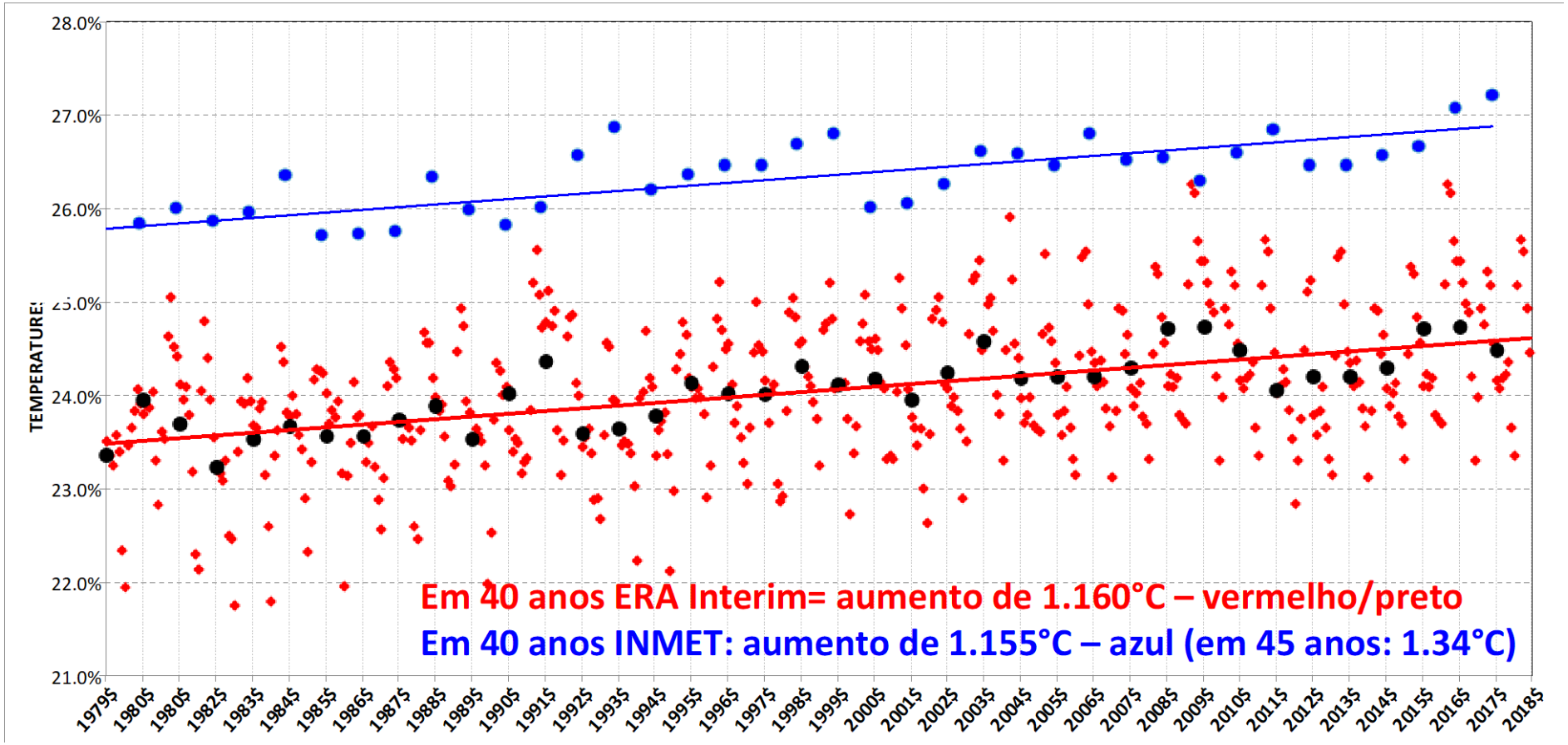
- The East part of Amazon showed CO:CO2 ratios comparable with the ones commonly found in Savannas, which corroborates with the hypothesis that this region may have lost it ability to sink carbon.



Acknowledgements

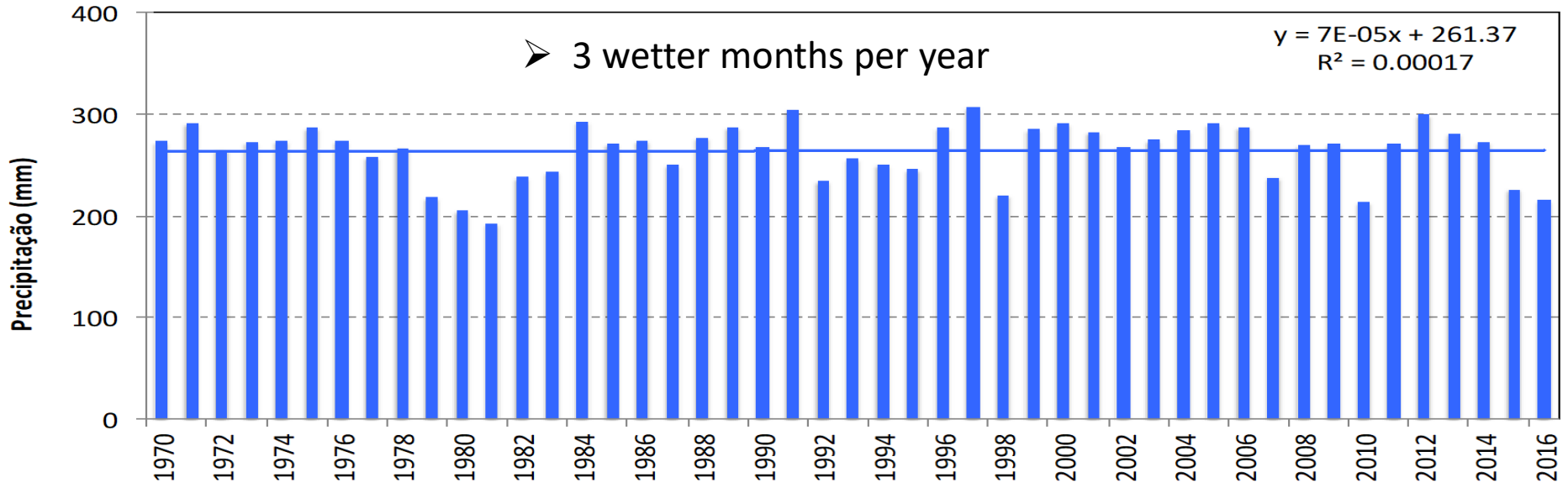


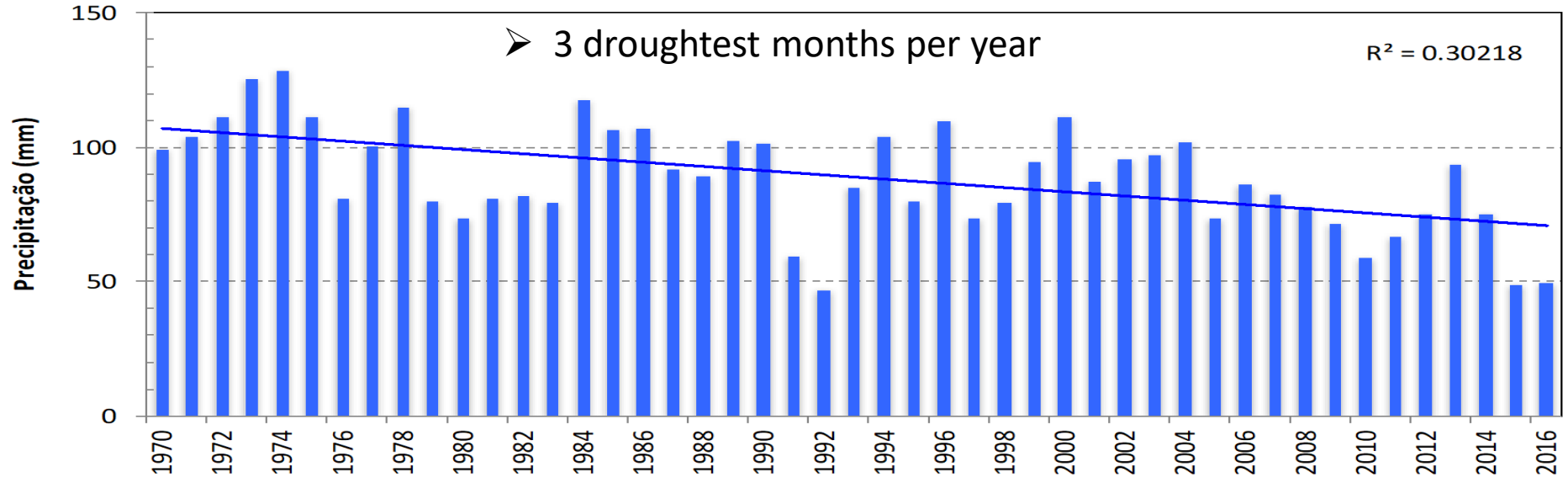
Temperature INMET and ERA Interim



Gatti et al., 2019 (in. prep)

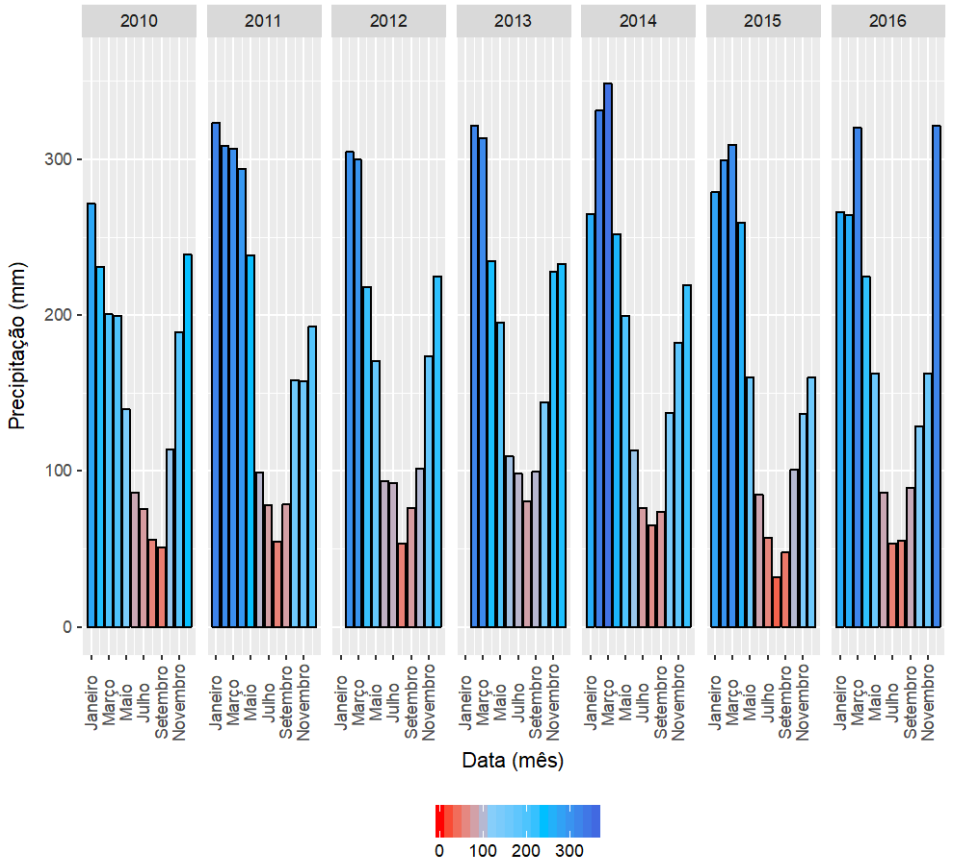
Precipitation



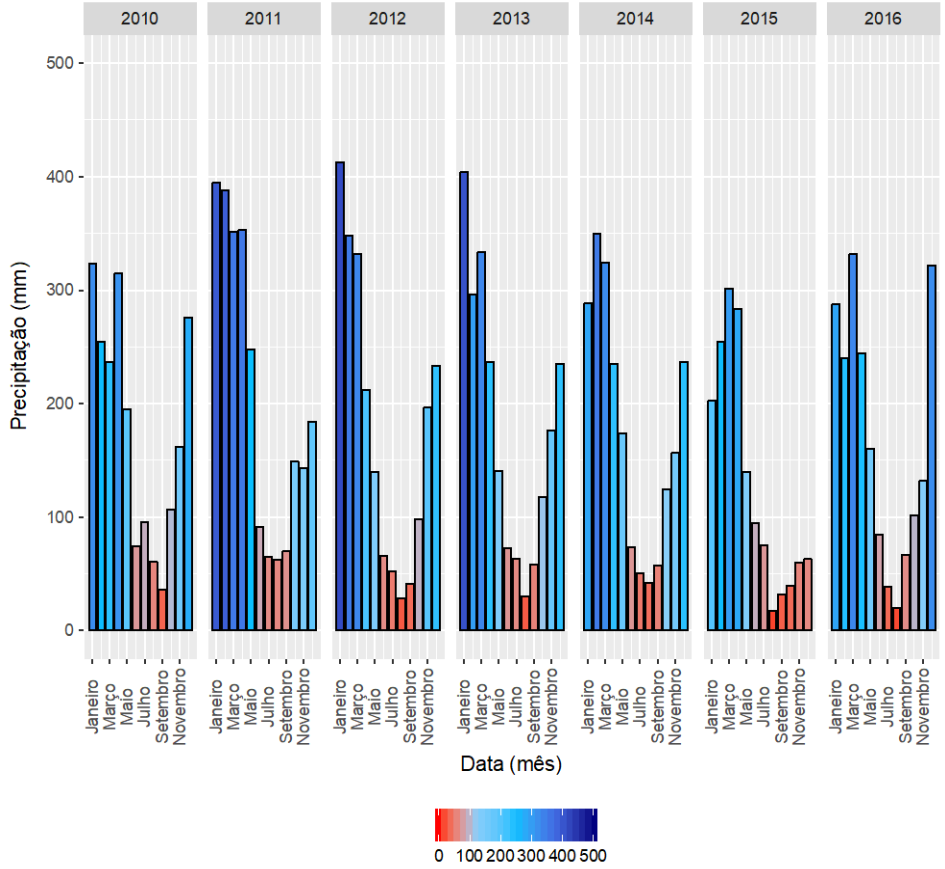


Precipitation and Influence Area

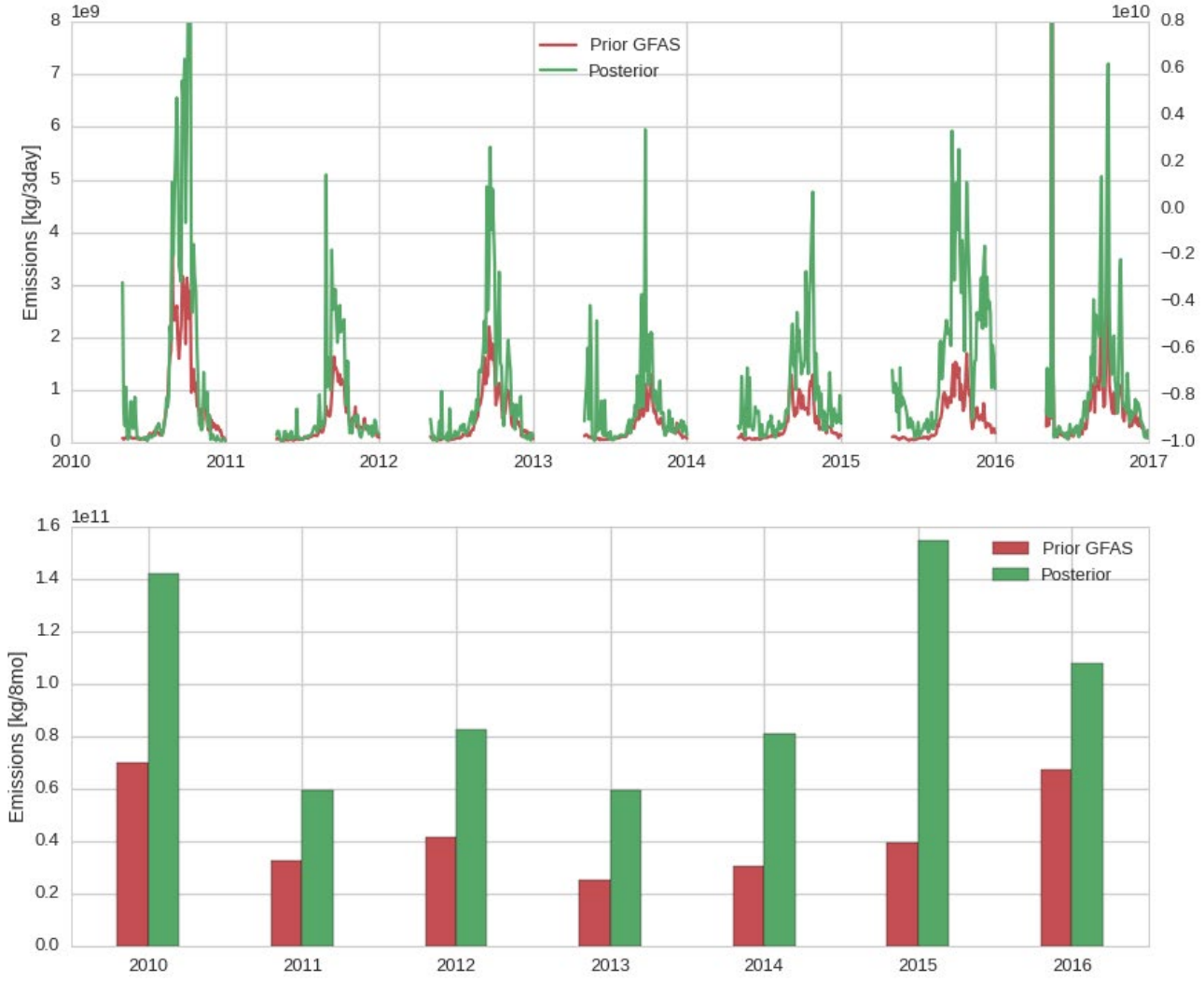
Amazon Basin



ALF Influence area

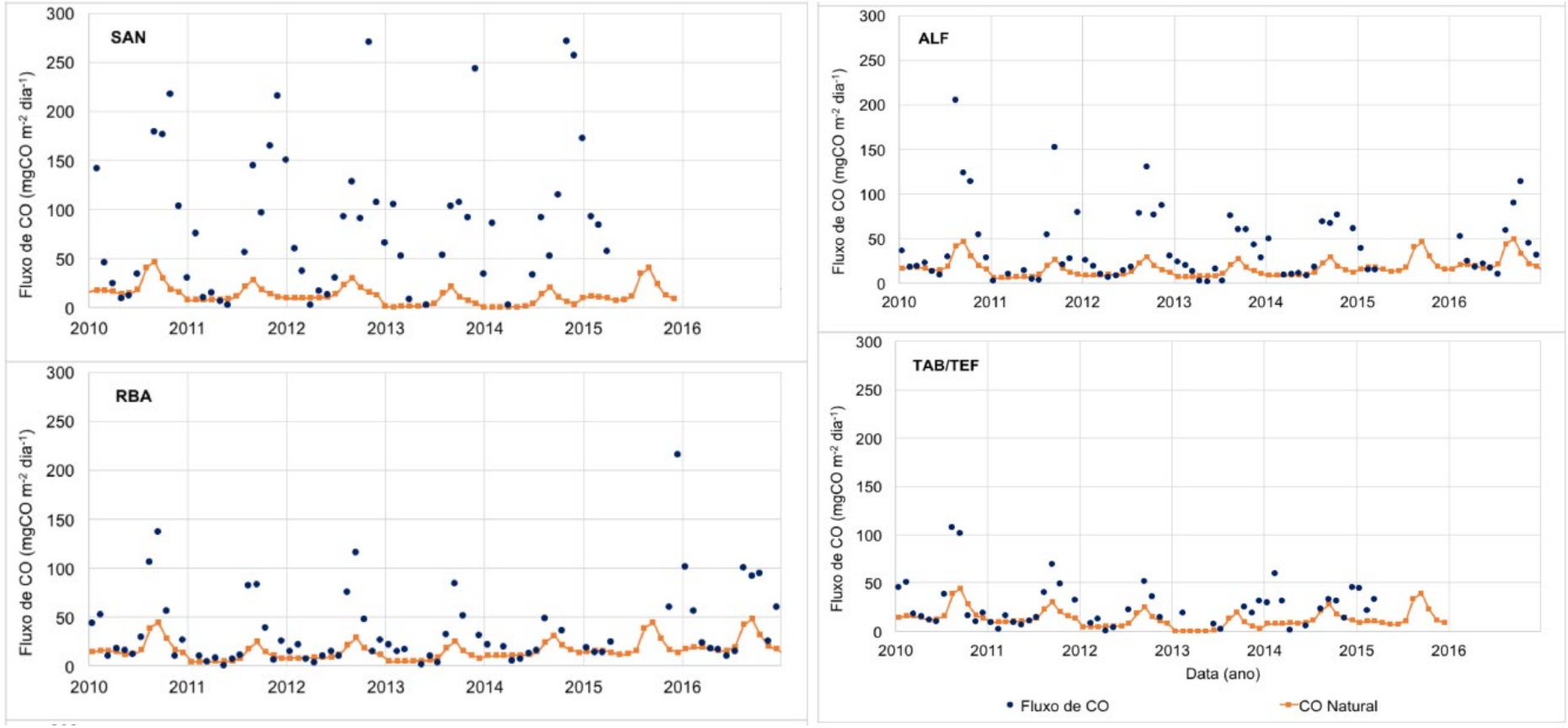


TM5 CO modeling



Naus, S. et al., 2019 (in. prep)

TM5 CO modeling



IMAGESv2 – Dr. John Miller and Sourish Basu

CO mixing ratios