



IPCC TFI Expert Meeting on Use of Atmospheric Observation Data in Emission Inventories – 5 – 7 September 2022

Airborne Amazon Carbon budget and CH₄ emissions

Luciana V. Gatti

Coord. of Greenhouse Gas Laboratory
General Coordination of Earth Science
INPE – National Institute of Space Research





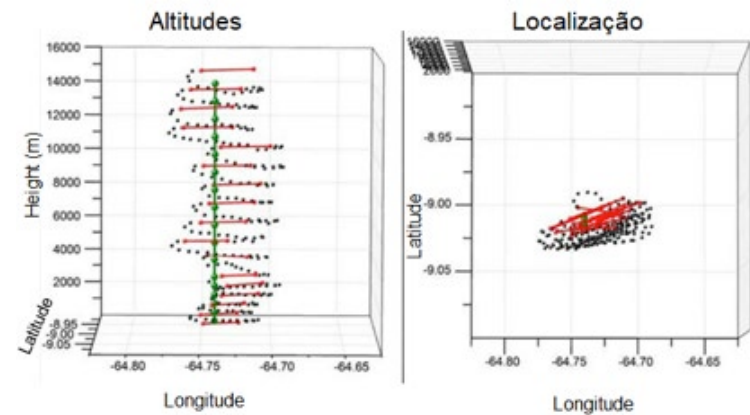
50% Global Tropical Forest

~ 120Pg above ground biomass

Amazon river discharge ~20% of
Global fresh water input to ocean

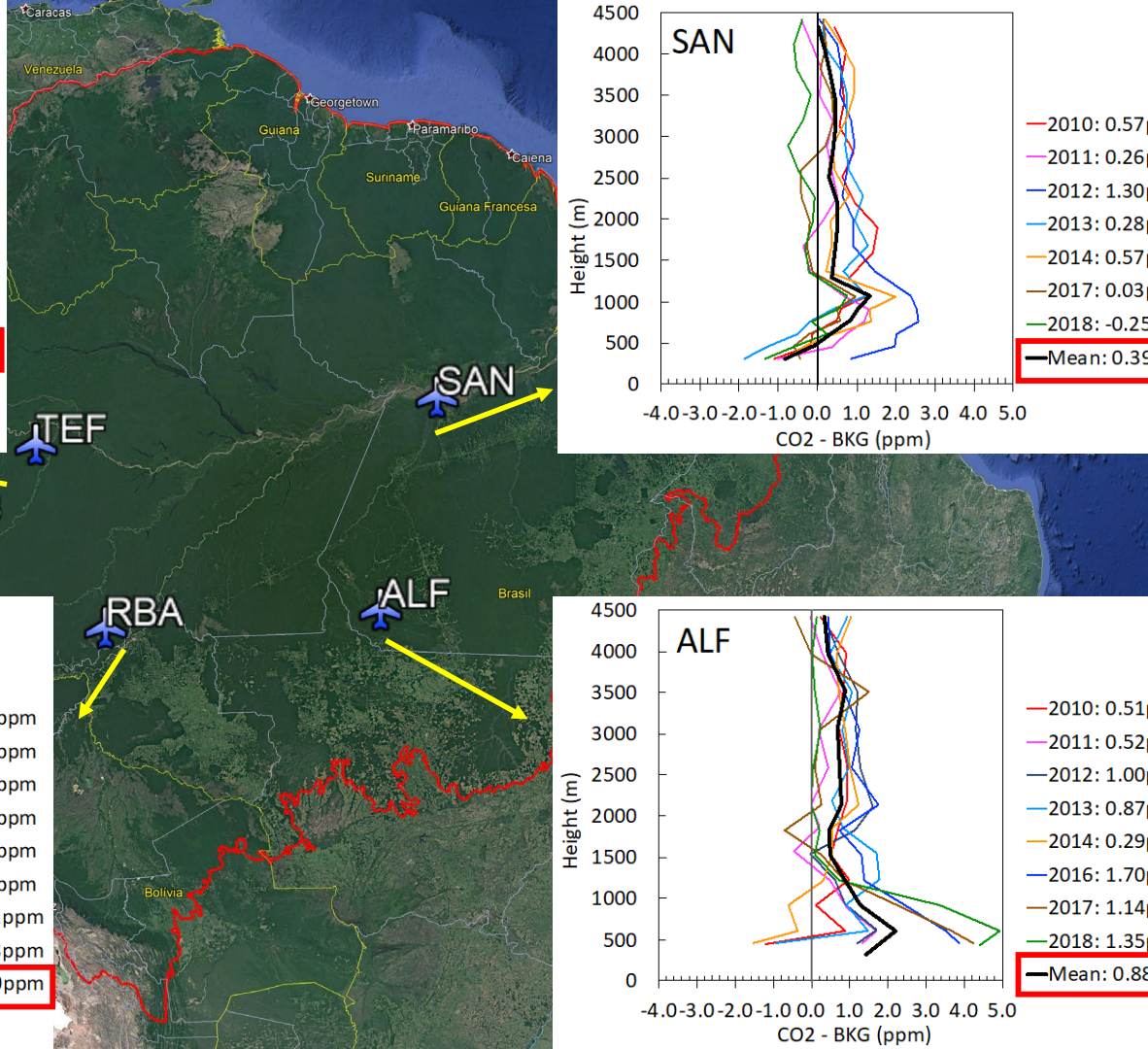
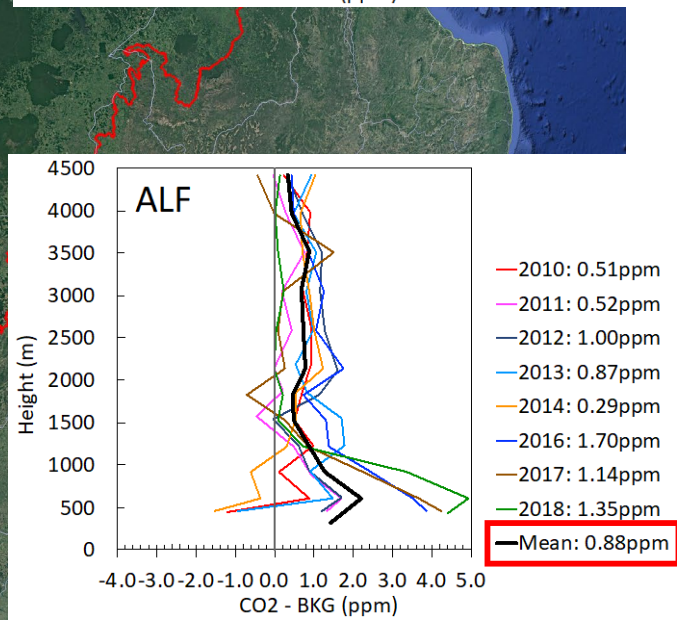
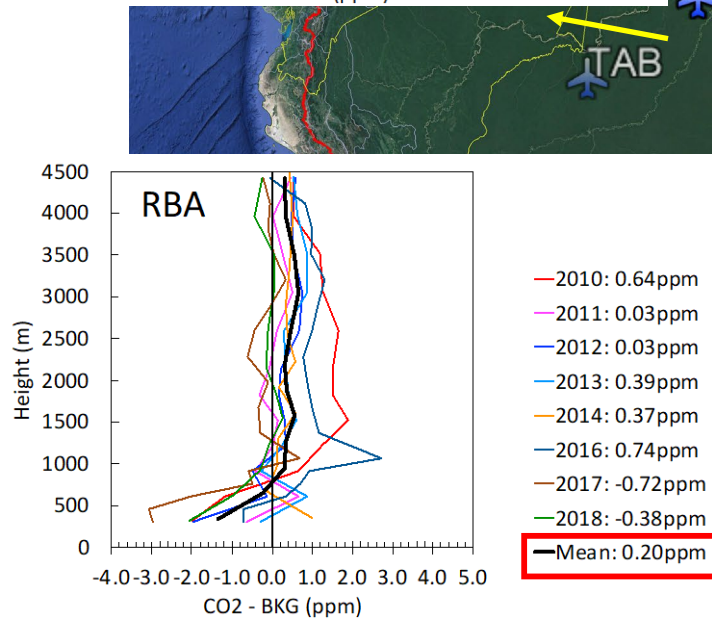
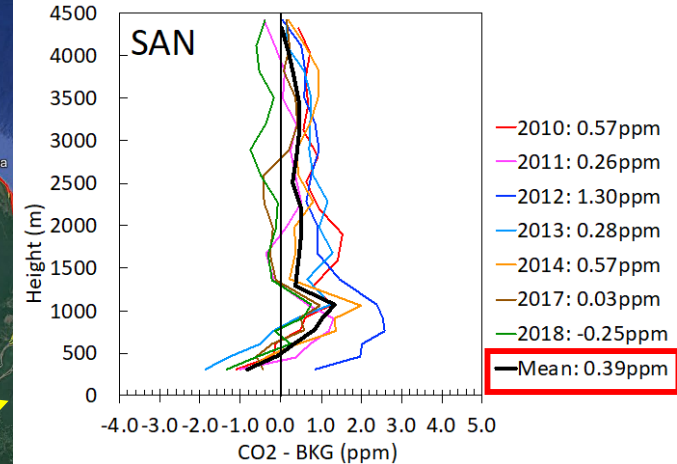
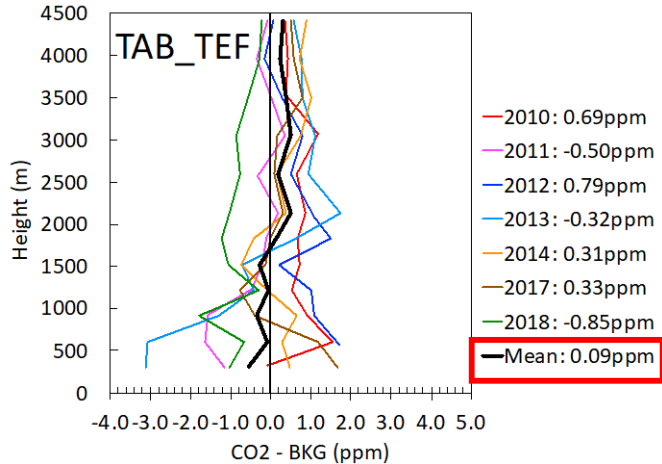
~20% Global biodiversity

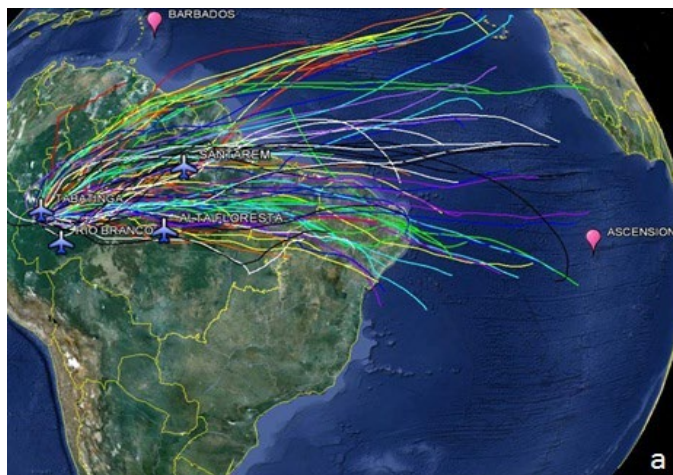
$7.25 \times 10^6 \text{ km}^2$

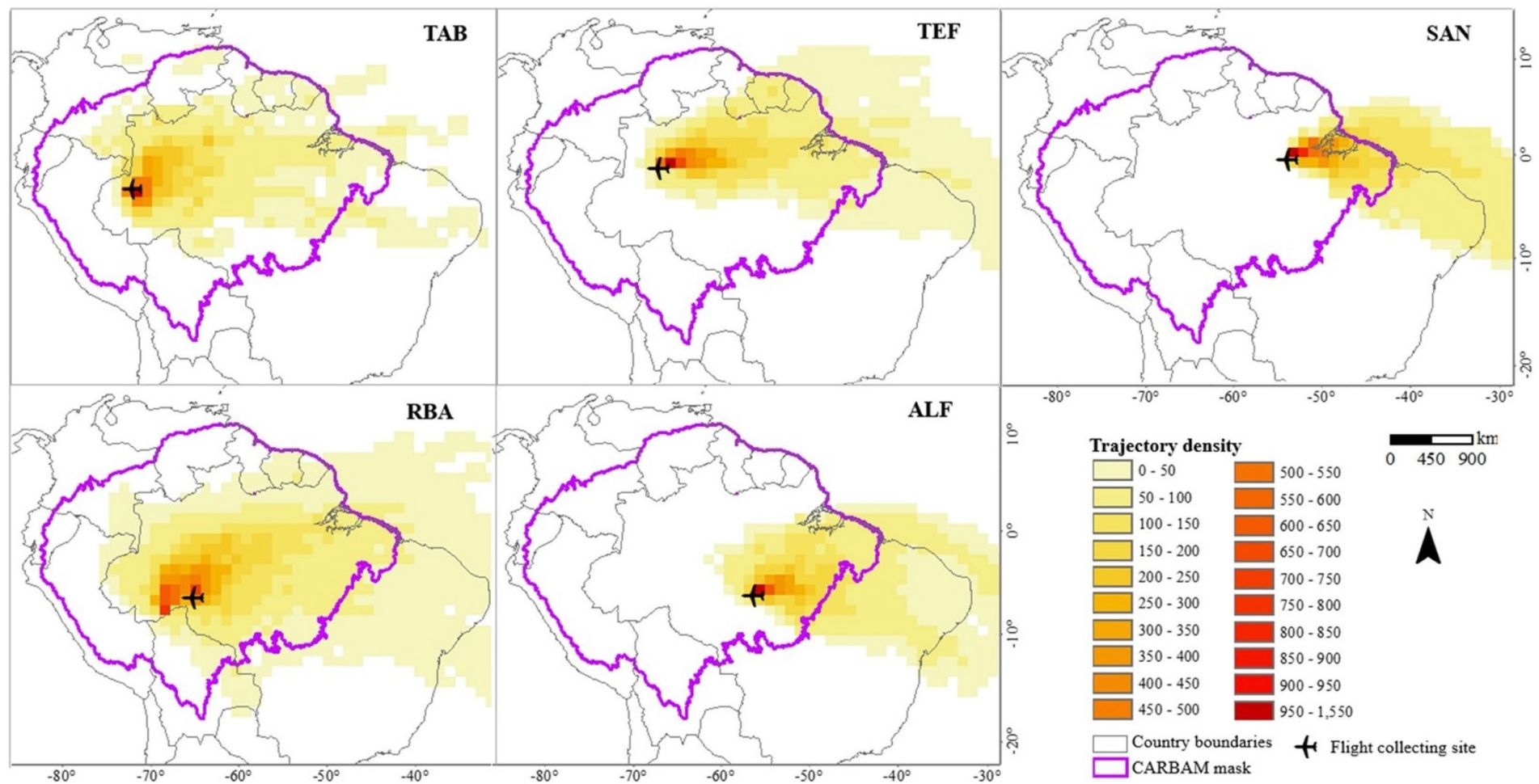


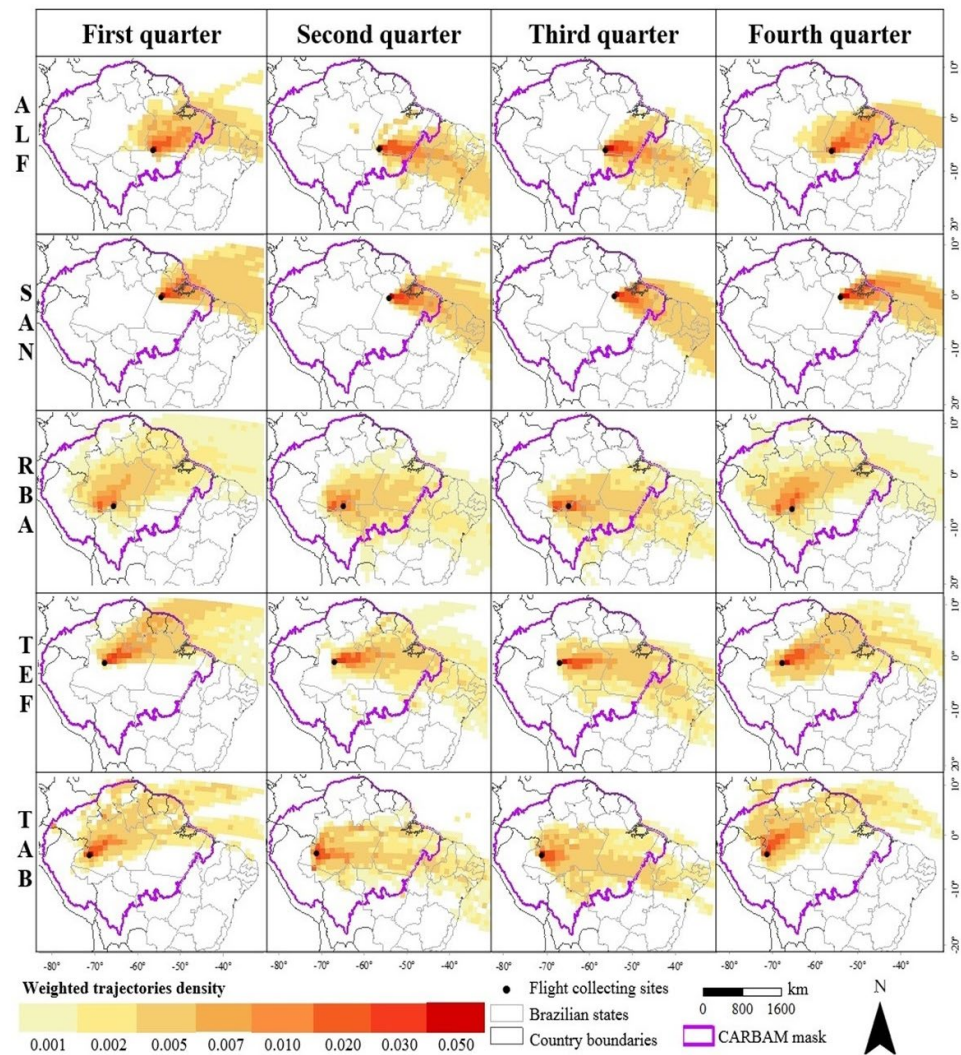
CO_2 , CH_4 , N_2O and CO



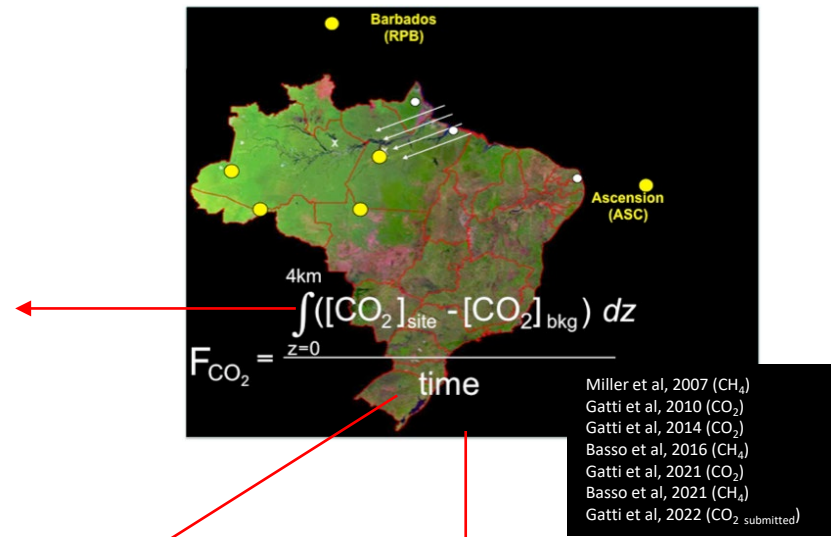
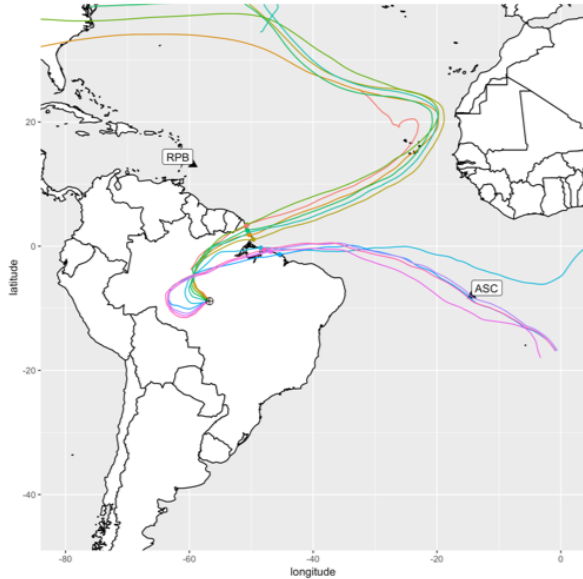
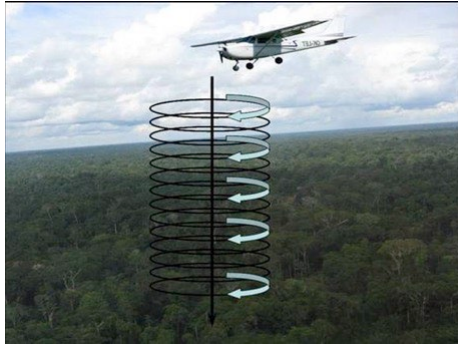




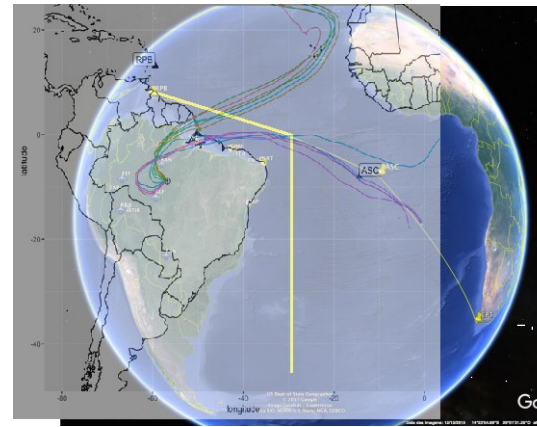


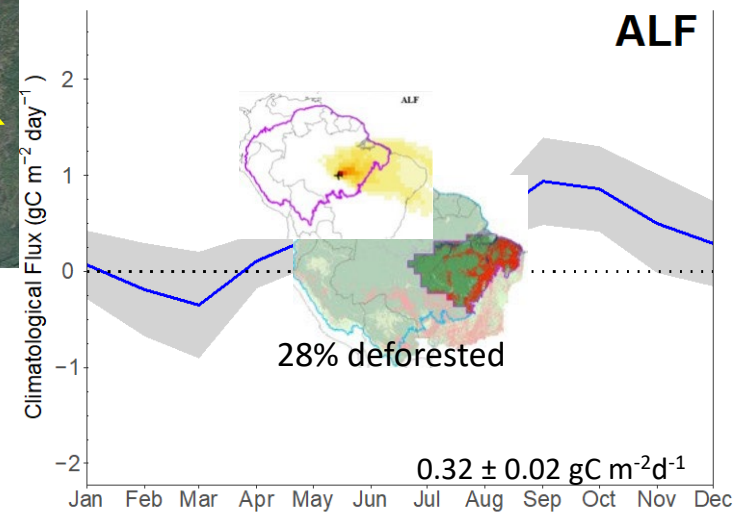
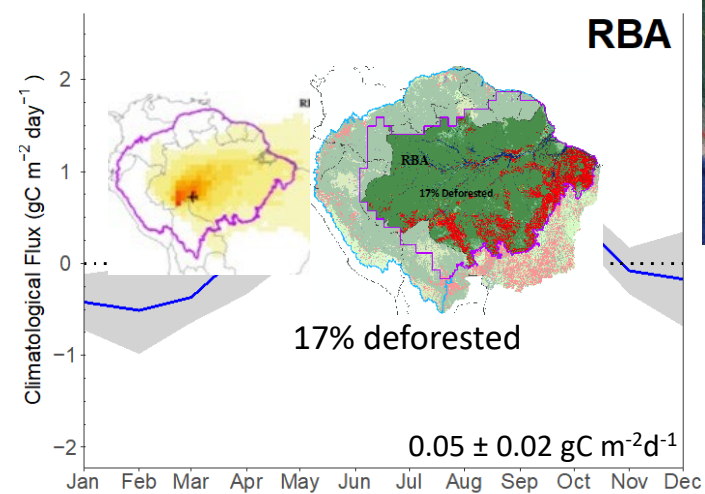
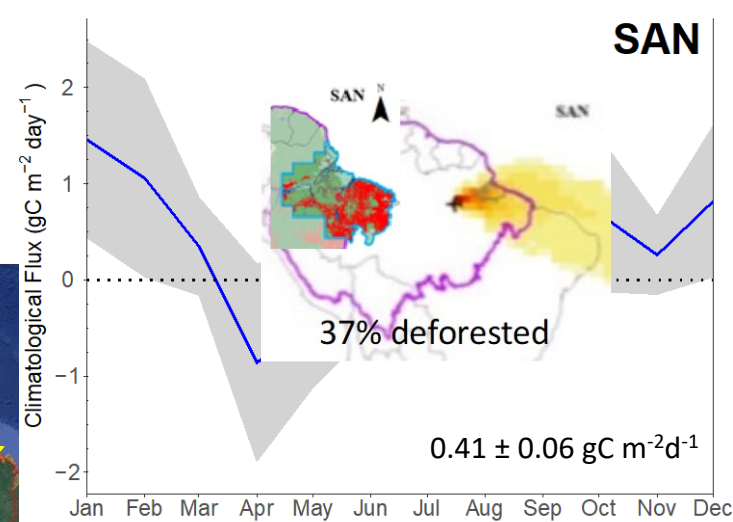
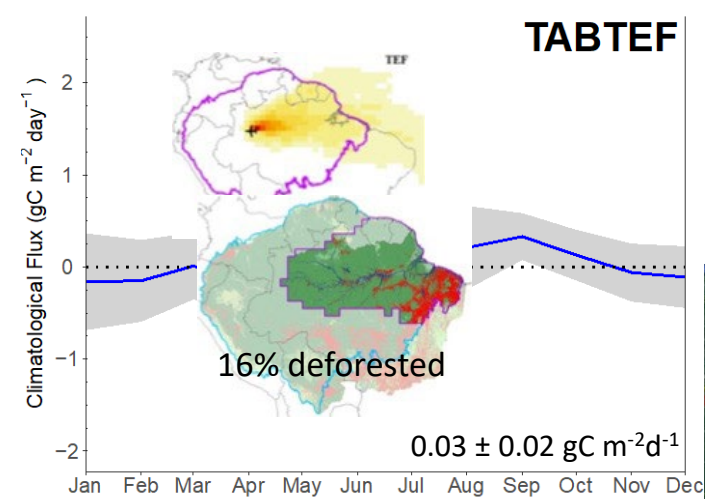


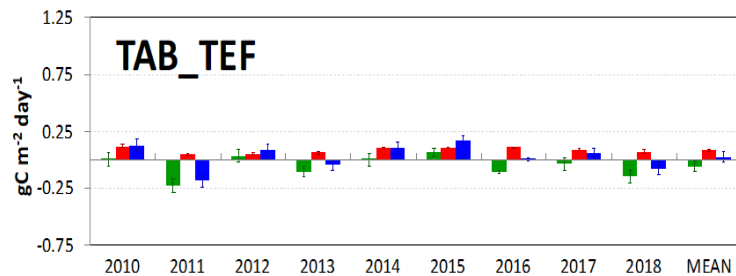
Flux from Column Budget Technique



Background

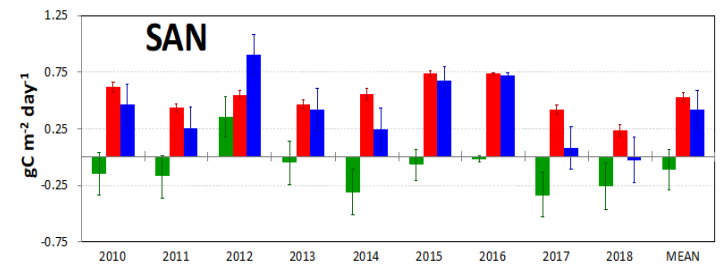






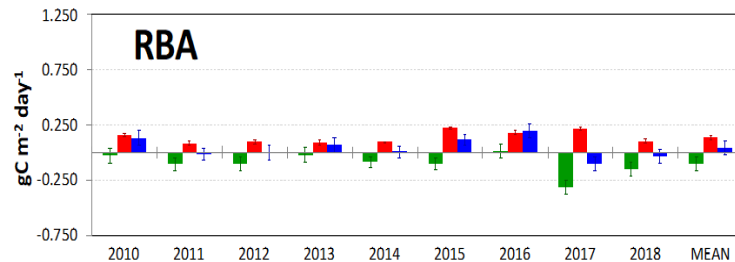
TAB_TEF Total C Flux: $0.03 \pm 0.02 \text{ gC.m}^{-2}.\text{day}^{-1}$
 Fire C Flux: $0.08 \pm 0.004 \text{ gC.m}^{-2}.\text{day}^{-1}$
 NBE C Flux: $-0.06 \pm 0.02 \text{ gC.m}^{-2}.\text{day}^{-1}$

16% deforested



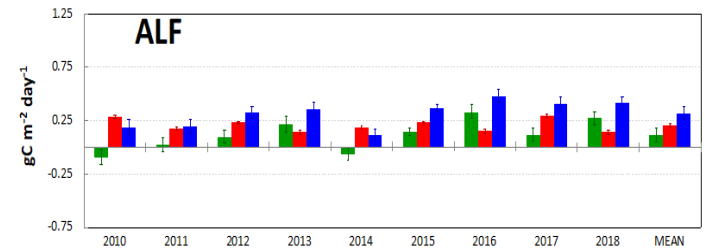
SAN Total C Flux: $0.41 \pm 0.06 \text{ gC.m}^{-2}.\text{day}^{-1}$
 Fire C Flux: $0.53 \pm 0.01 \text{ gC.m}^{-2}.\text{day}^{-1}$
 NBE C Flux: $-0.13 \pm 0.06 \text{ gC.m}^{-2}.\text{day}^{-1}$

37% deforested



RBA Total C Flux: $0.05 \pm 0.02 \text{ gC.m}^{-2}.\text{day}^{-1}$
 Fire C Flux: $0.14 \pm 0.01 \text{ gC.m}^{-2}.\text{day}^{-1}$
 NBE C Flux: $-0.10 \pm 0.02 \text{ gC.m}^{-2}.\text{day}^{-1}$

17% deforested



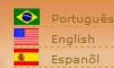
ALF Total C Flux: $0.32 \pm 0.02 \text{ gC.m}^{-2}.\text{day}^{-1}$
 Fire C Flux: $0.20 \pm 0.01 \text{ gC.m}^{-2}.\text{day}^{-1}$
 NBE C Flux: $+0.11 \pm 0.02 \text{ gC.m}^{-2}.\text{day}^{-1}$

29% deforested



Queimadas

Monitoramento de Focos



OST DPI

Parâmetros Básicos

Data Inicial (aaaa-mm-dd) GMT: 2010-08-01 00:00:00
Data Final (aaaa-mm-dd) GMT: 2010-10-01 23:59:59
País: BRASIL
Estado/Região (um ou mais): MA, MG, MS, MT
Município (opcional):
Satélite (um ou mais): TODOS, Satélite Referência, NOAA 15 Norte, NOAA 15 Sul
Bioma Brasileiro: Todos
Região (opcional):
Coordenada Específica (opcional):
Latitude: Longitude:
Consultar

Gráficos

Tipo: Político
Histograma

Focos nas Unidades de Conservação...

Acessórios

Coordenadas dos focos na projeção UTM, Polidônica, Menor, Albers...
Focos NOAA Antigos: 1992 A 1998
Ajuda
Veja Relatório enviado ontem às 23:30...
Relatórios-Resumo Diários de Focos
Receba um relatório resumido dos focos nas UCs em seu email. Inscreva-se...
Perguntas Frequentes...
Calculadora Geográfica...
Banco de fotos de campo

HOME QUEIMADAS

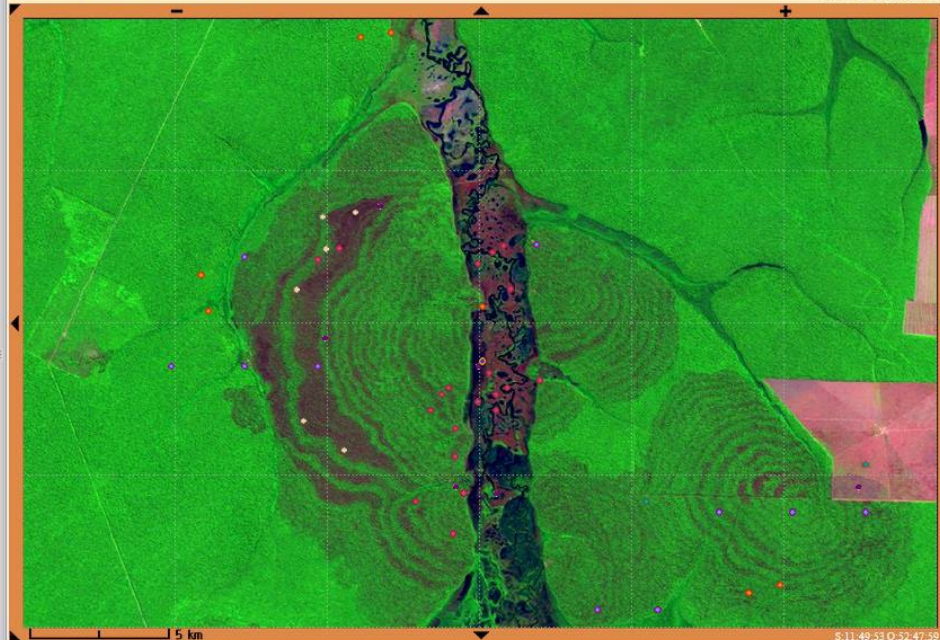
Dúvidas, comentários e sugestões:
queimadas@inpe.br

Atualizações Diárias:
04:30, 10:30, 13:30, 16:30, 19:30, 21:30 e 23:30 horário de Brasília/DF

4:13:58

Mosaico LandSat 2011 (AMZ)/Grade LandSat TM/

S11:40:00 O52:47:30



S11:50:00 O53:02:30

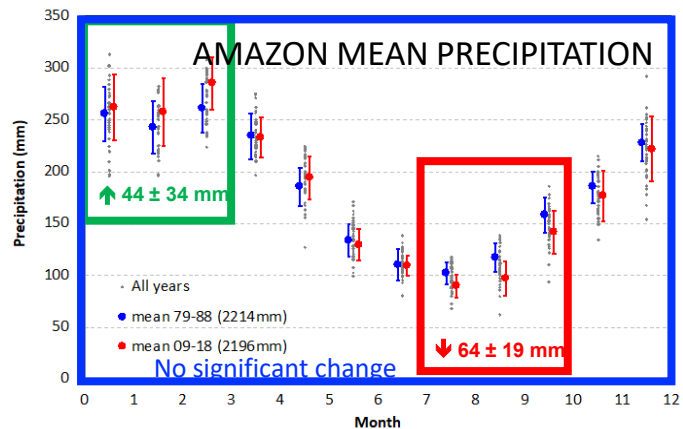
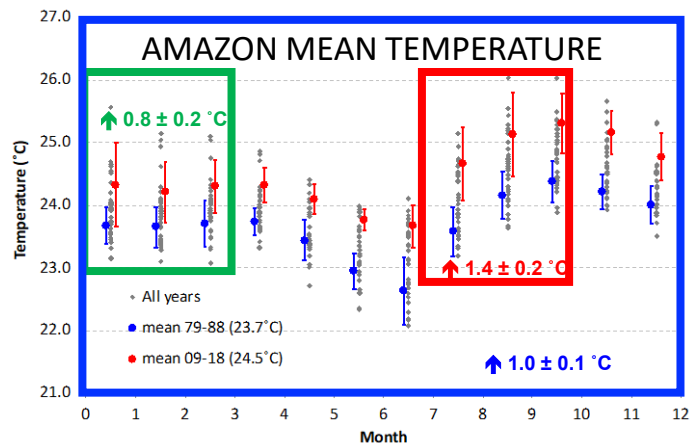
S11:49:53 O52:47:30

52 de 203228 Focos, nesta tela, entre 2010-08-01 00:00:00 - 2010-10-01 23:59:59 GMT
Obs: na tela só estão sendo mostrados 20000 focos
Em 22/agosto/2011, O CPTEC/INPE mudou o satélite de referência para contabilização das queimadas para o AQUA-UMD - Tarde, veja detalhes

- = NOAA-15; ● = NOAA-15D; ● = NOAA-12; ● = NOAA-12D; ● = NOAA-14;
- = NOAA-16; ● = NOAA-16N; ● = NOAA-17; ● = NOAA-18D; ● = NOAA-18;
- = NOAA-18D; ● = NOAA-18; ● = GOES-08; ● = GOES-10; ● = GOES-12;
- = GOES-13; ● = AQUA-T; ● = AQUA-M; ● = TERRA-T; ● = TERRA-M;
- = METEOSAT-02; ● = AQUA_M-M; ● = AQUA_M-T; ● = TERRA_M-M; ● = TERRA_M-T;
- = AQUA-MEX; ● = TERRA-MEX; ● = ATSR; ● = TRMM;

Exportar Focos: Tela/Screen/Print/Imagem (Hml) OK

<https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels-monthly-means?tab=form>



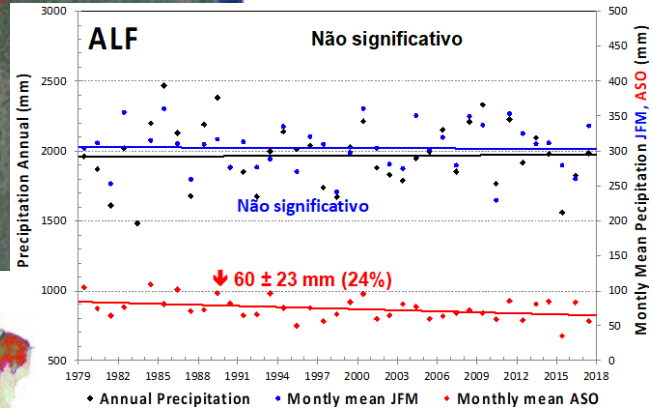
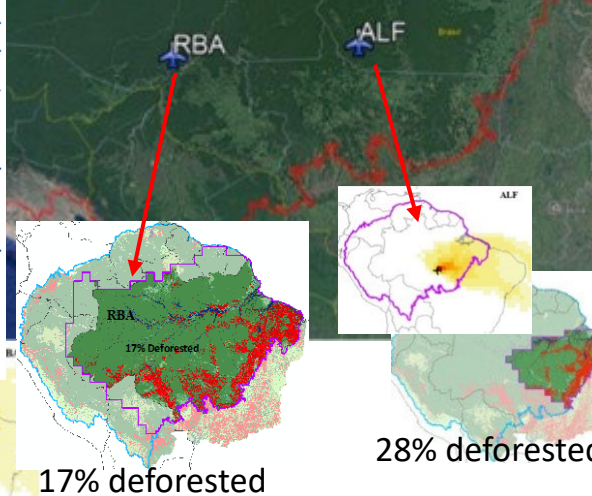
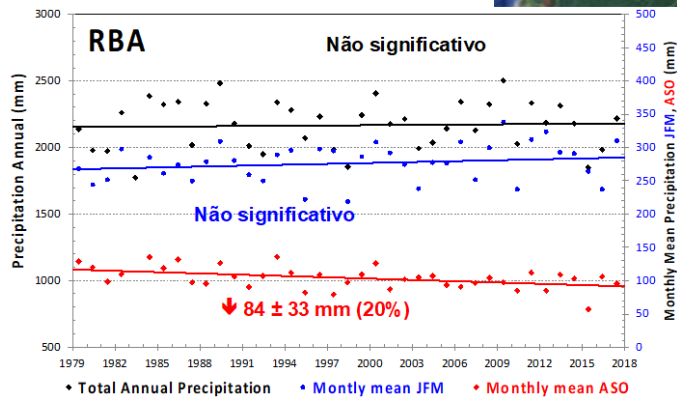
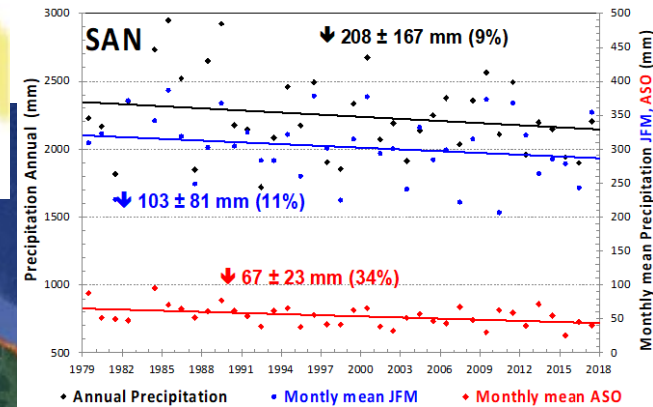
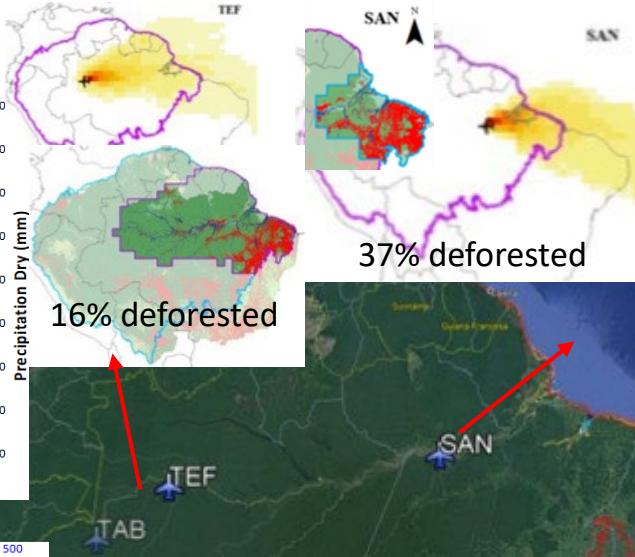
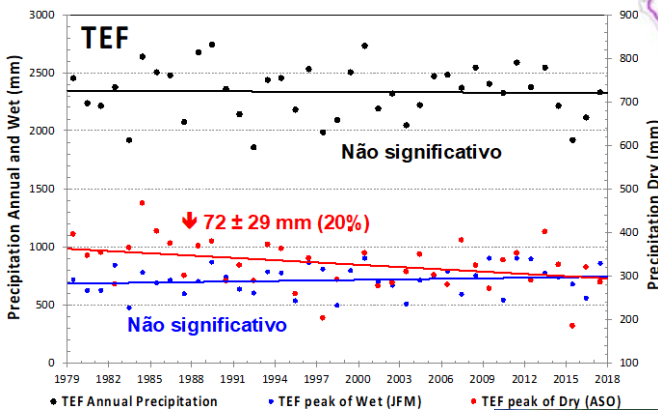
Amazon 7.25×10^6 km²

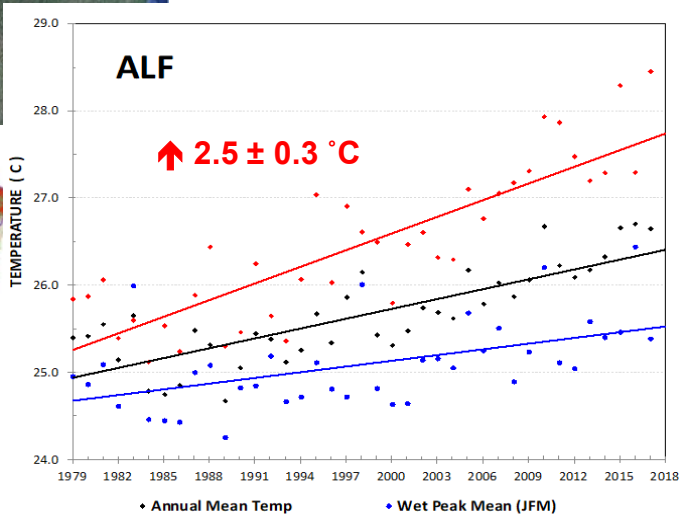
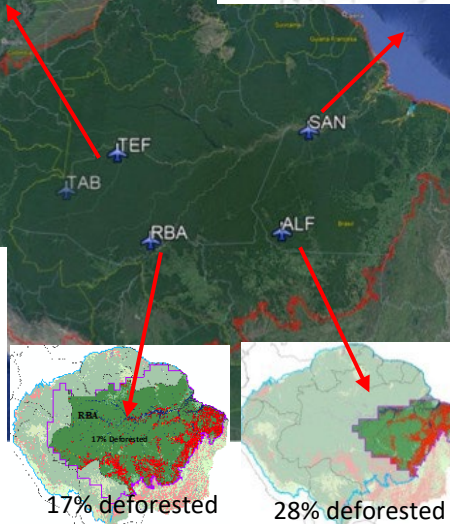
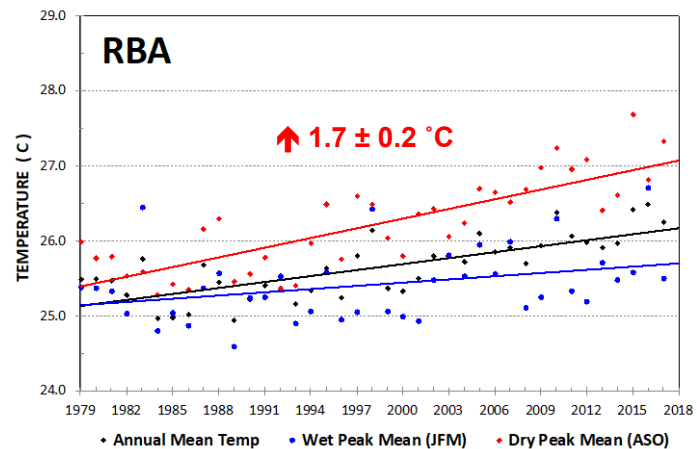
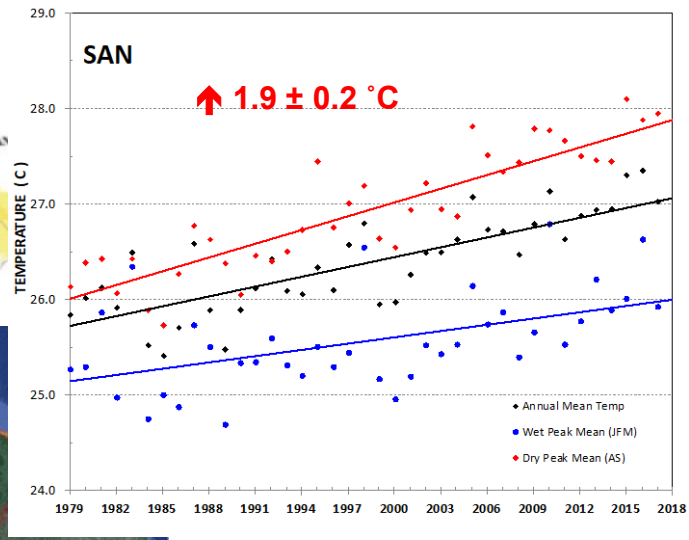
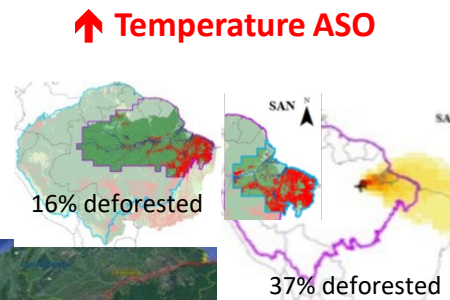
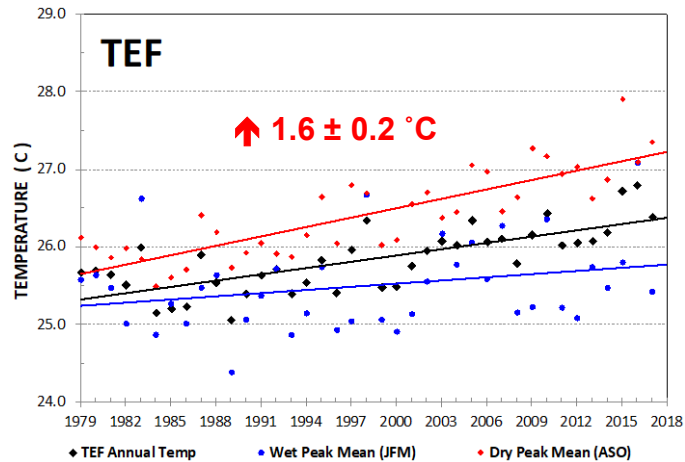


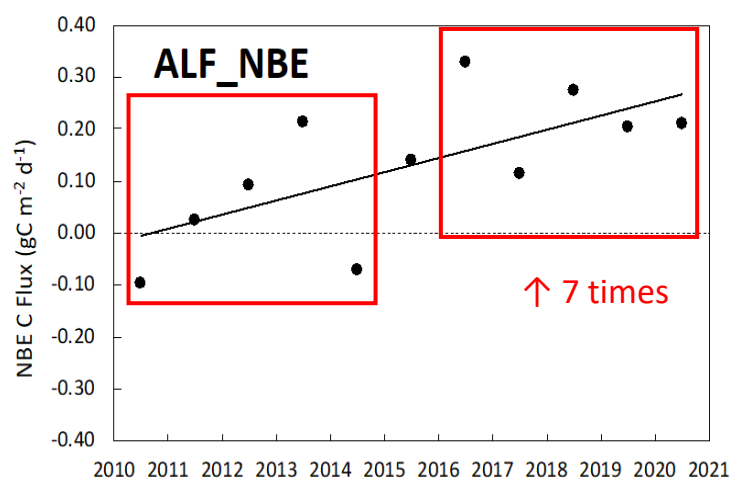
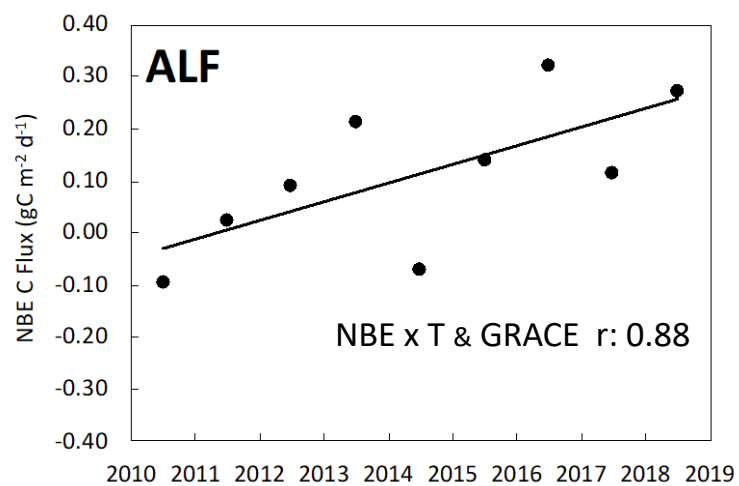
17% deforest until dez 2018

<https://climatedataguide.ucar.edu/climate-data/gpcp-monthly-global-precipitation-climatology-project>

↓ Precipitation ASO

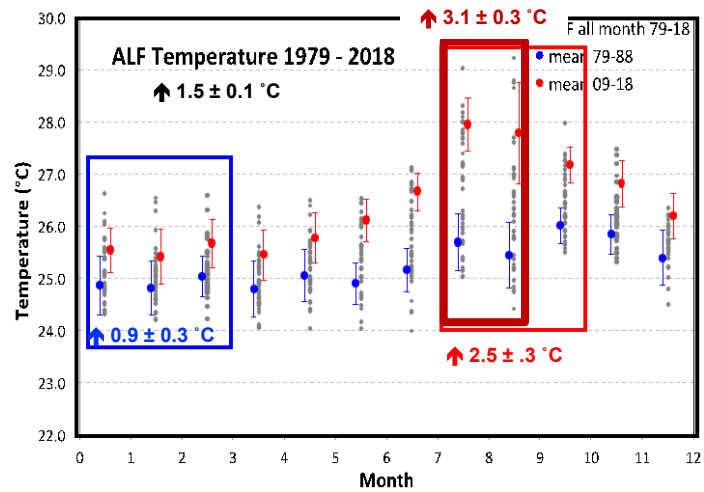




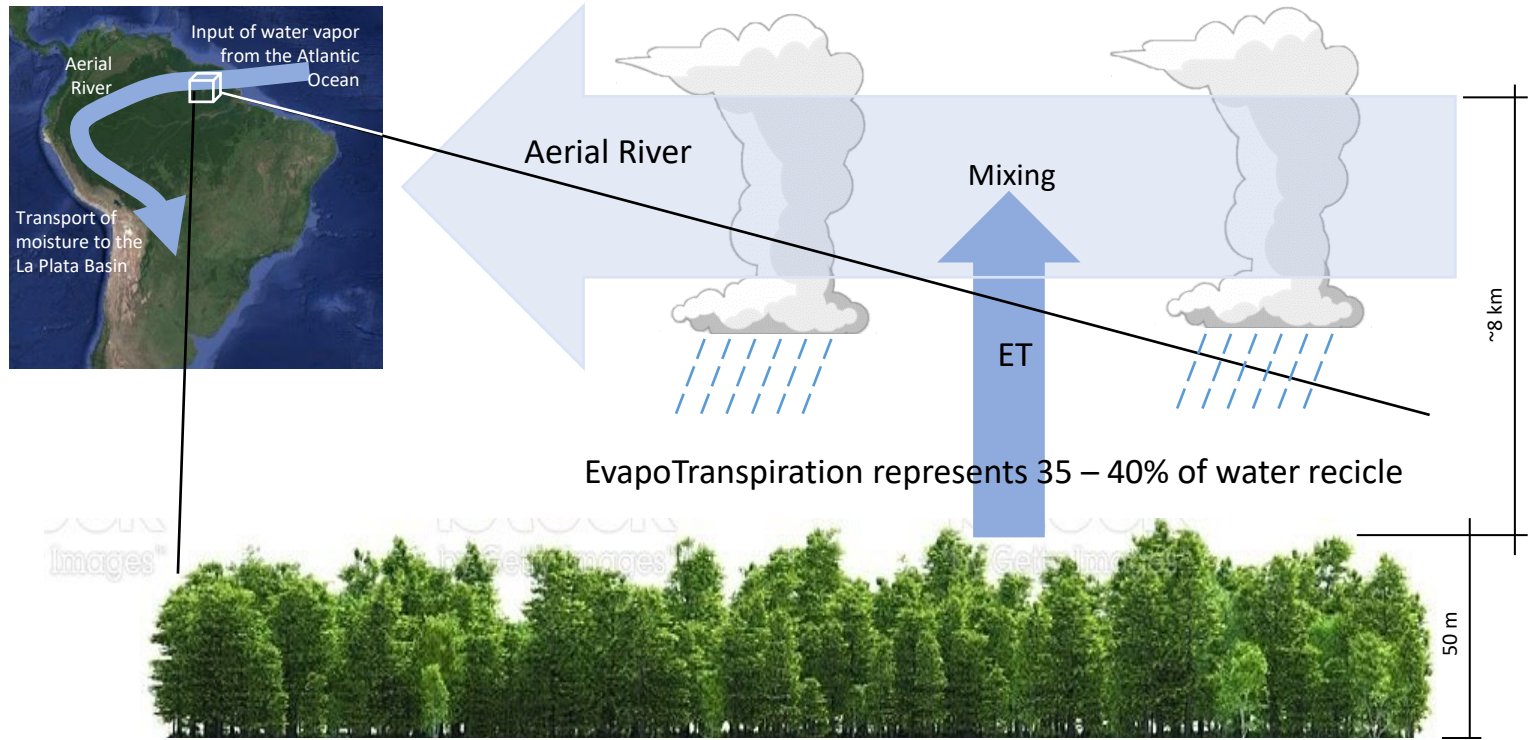


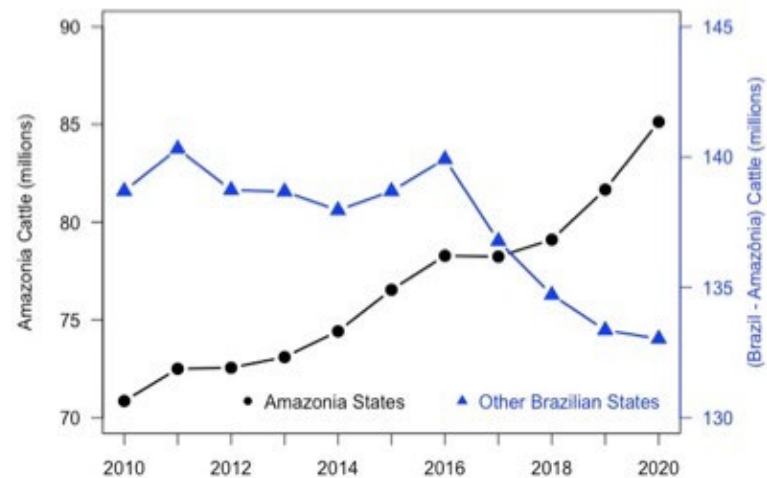
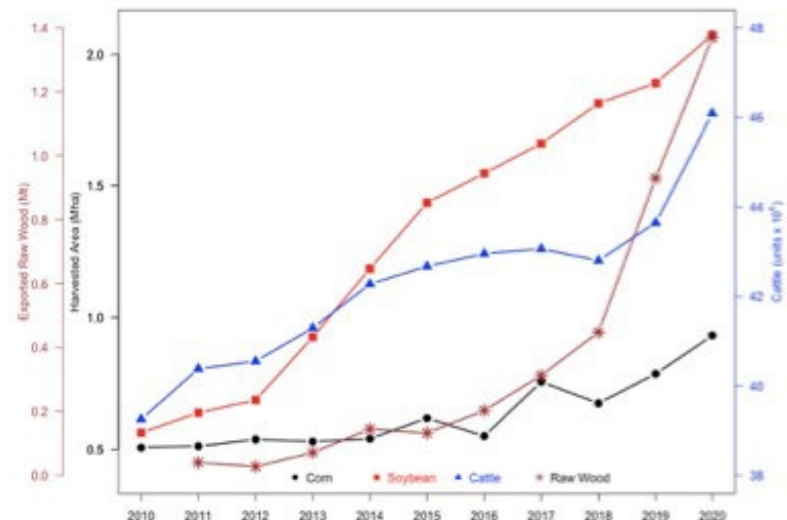
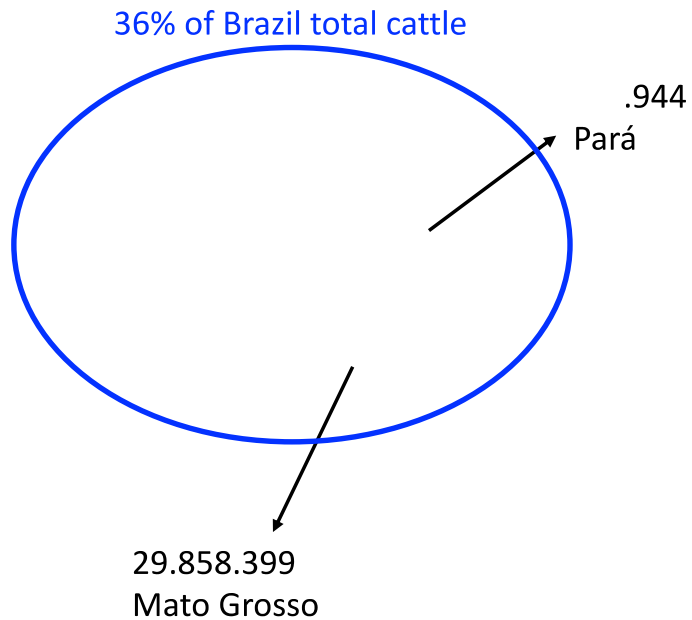
New results

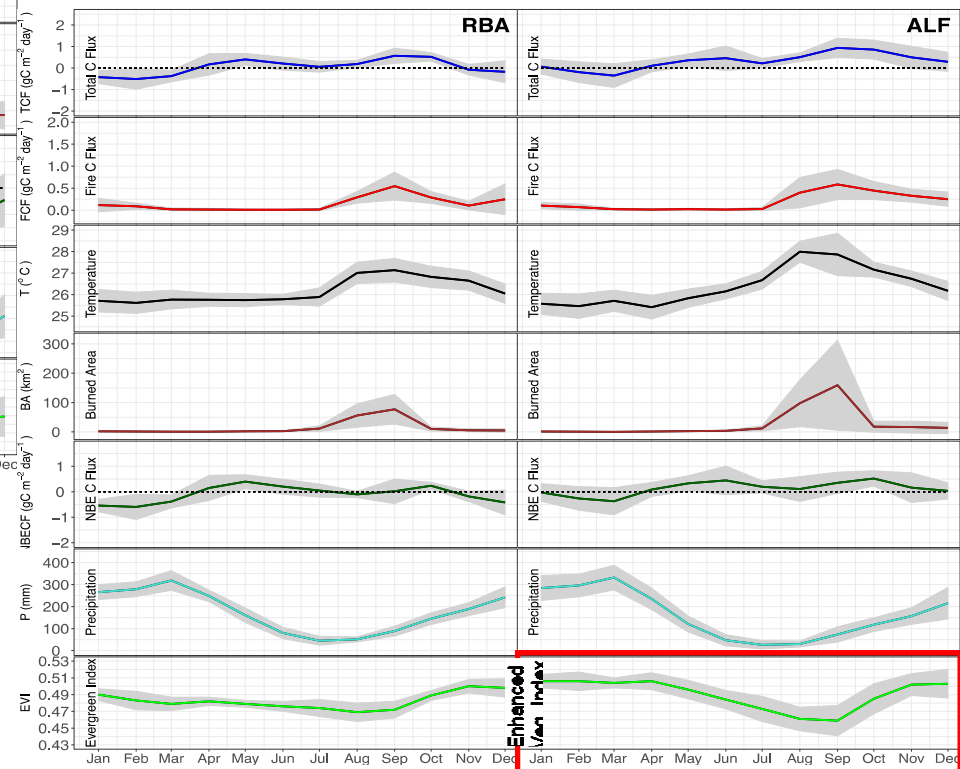
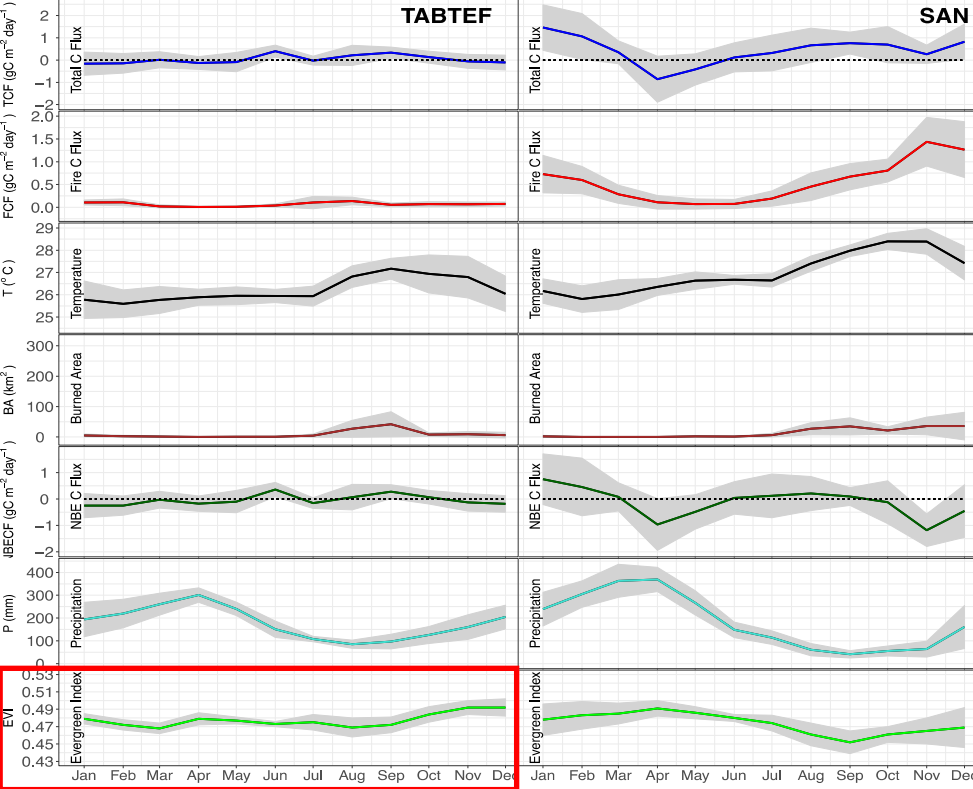
Temperature and water in the soil have a significant impact

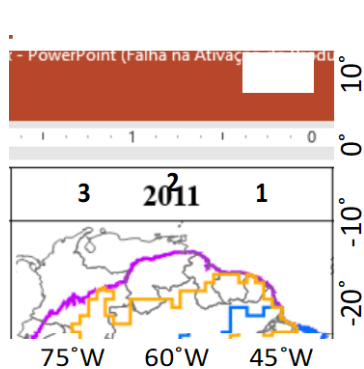


	NBE	C FIRE	Total C Flux
2010-2014	0.03	0.20	0.24
2016-2020	0.23	0.21	0.44





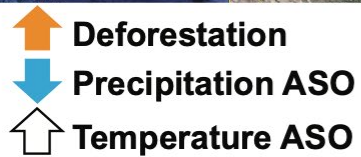
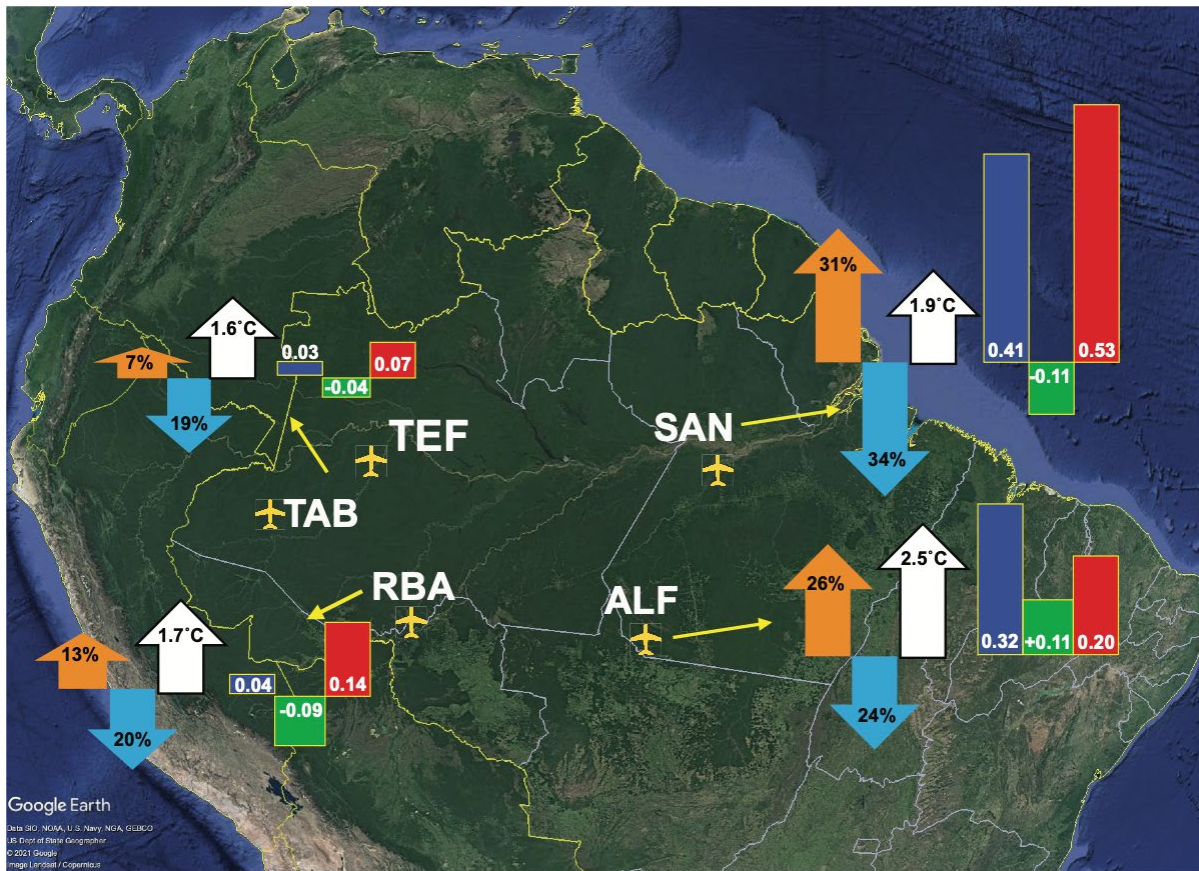




11% deforested 27% deforested

gC/m ² /dia	Amazon Total Region	West side Amazon (2,3)	East side Amazon (1)
Total	0.11±0.16	0.04±0.12	0.35±0.22
NBE	-0.04±0.15	-0.07±0.12	0.04±0.21
Fire	0.15±0.07	0.11±0.05	0.31±0.10

Amazon Carbon Balance (7,256,362 km ²)	Amazon Forest total Area
Total C Balance (PgC y ⁻¹)	0.29 ± 0.08
Fire C Balance (PgC y ⁻¹)	0.41 ± 0.02
NBE C Balance (PgC y ⁻¹)	-0.13 ± 0.08



Total C Flux (gC m⁻² d⁻¹)
 NBE C Flux (gC m⁻² d⁻¹)
 FIRE C Flux (gC m⁻² d⁻¹)

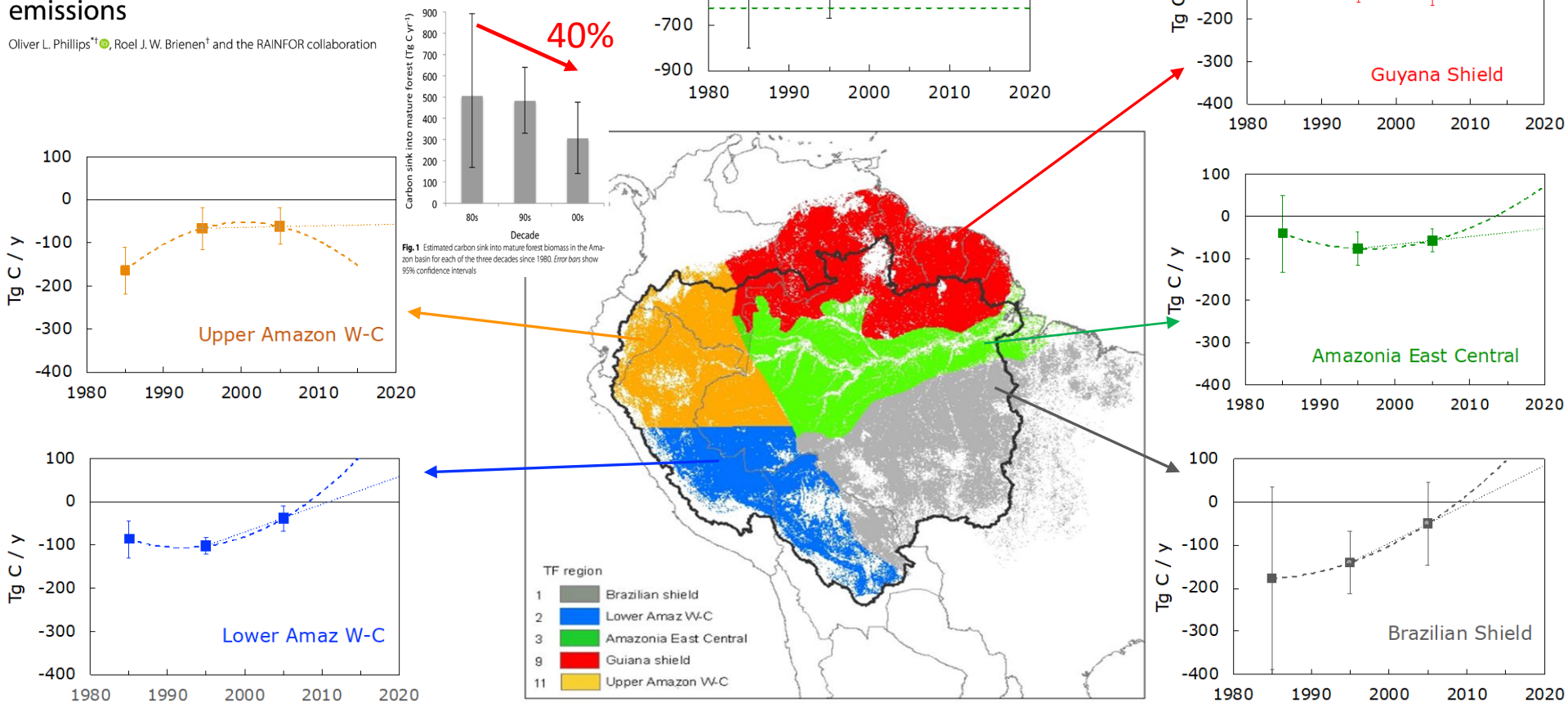
RESEARCH

Open Access



Carbon uptake by mature Amazon forests has mitigated Amazon nations' carbon emissions

Oliver L. Phillips[†], Roel J. W. Brien[†] and the RAINFOR collaboration



Tree mode of death and mortality risk factors across Amazon forests

Adriane Esquivel-Muelbert  et al.[#]

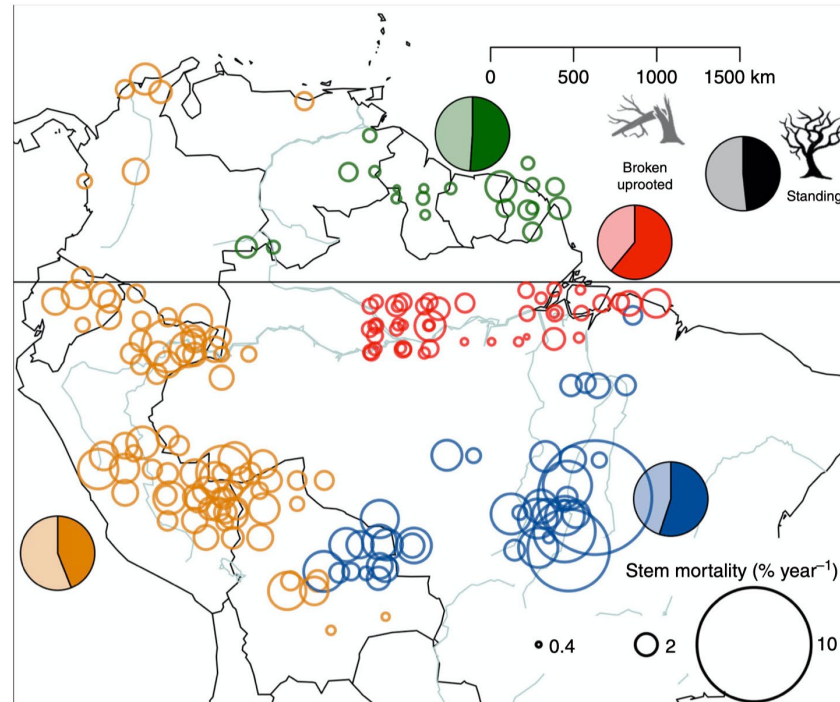
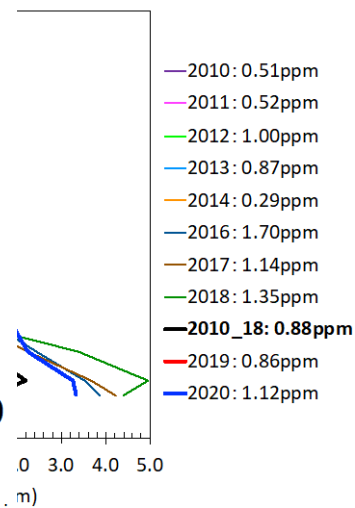
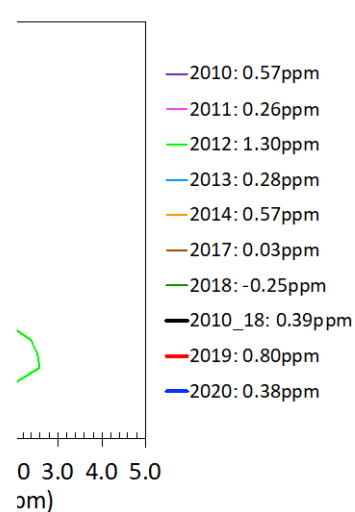
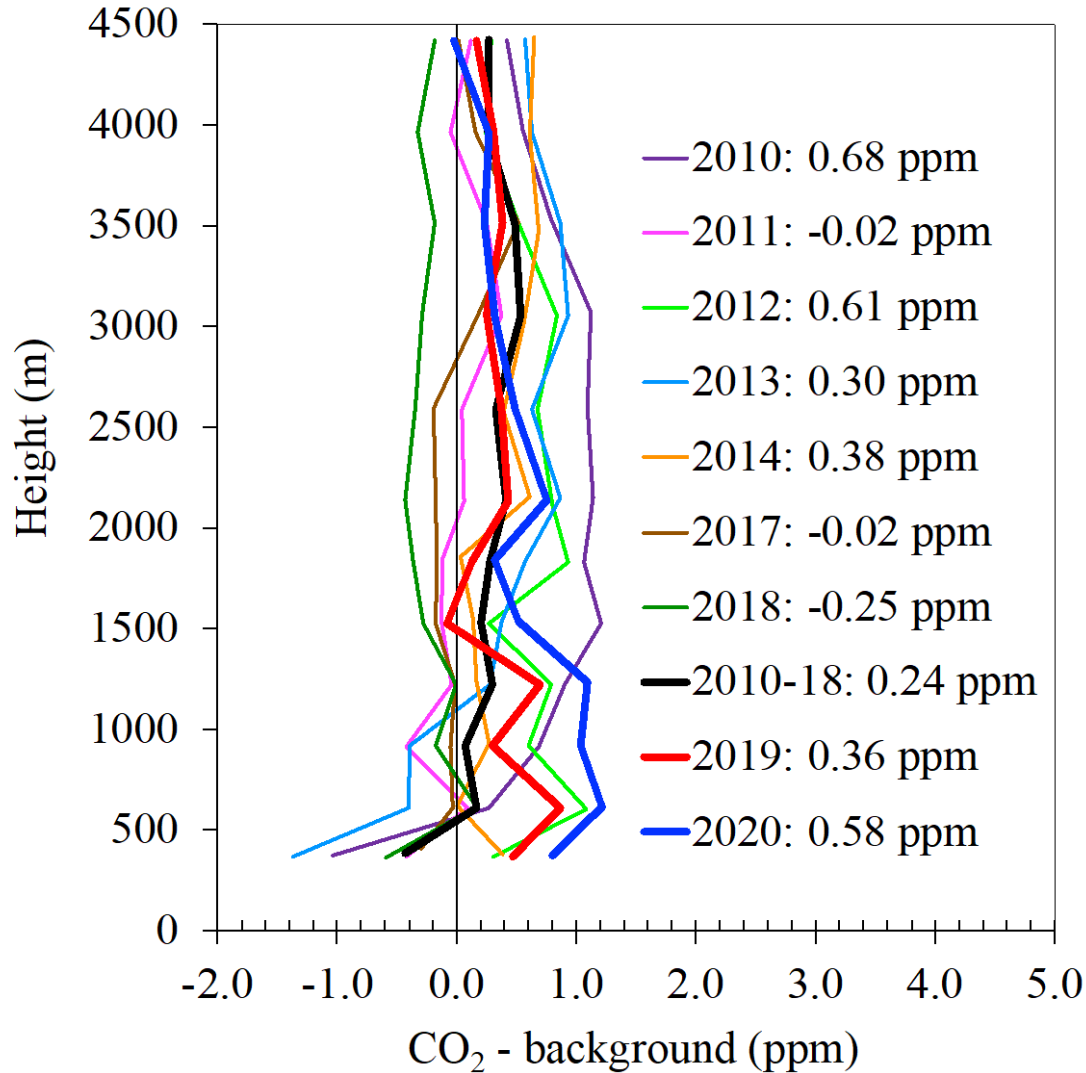
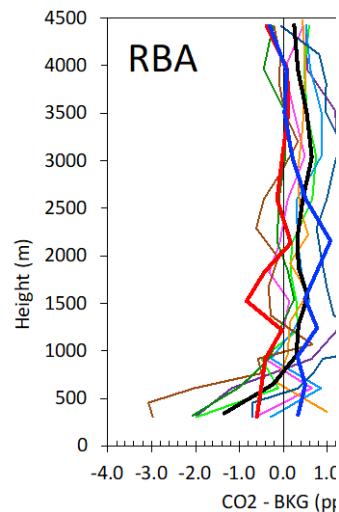
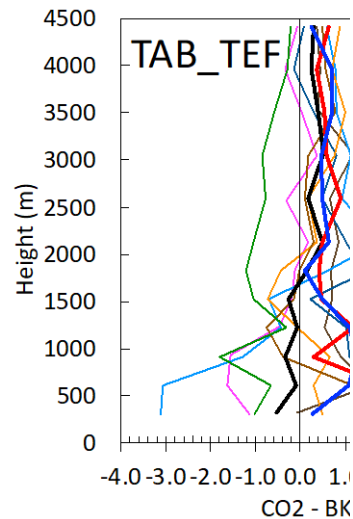
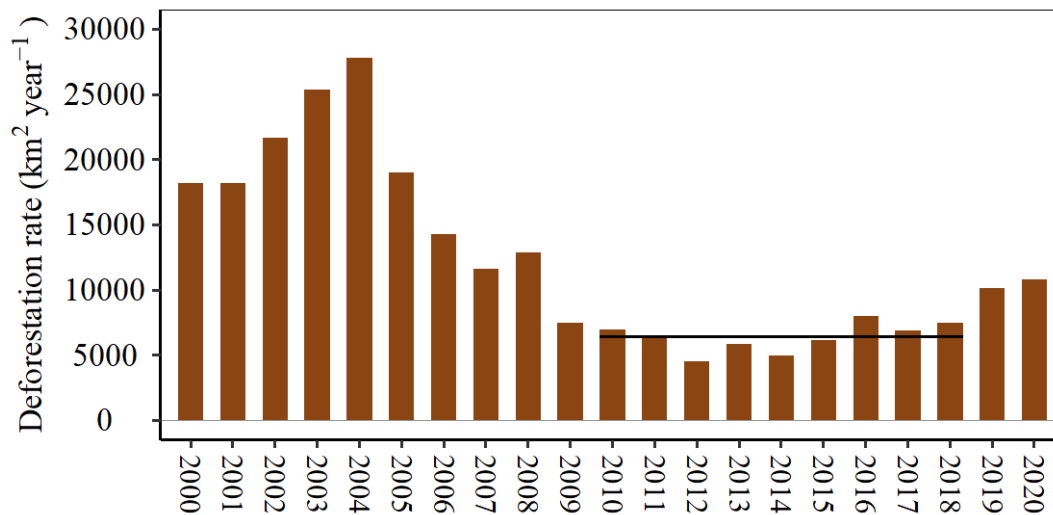


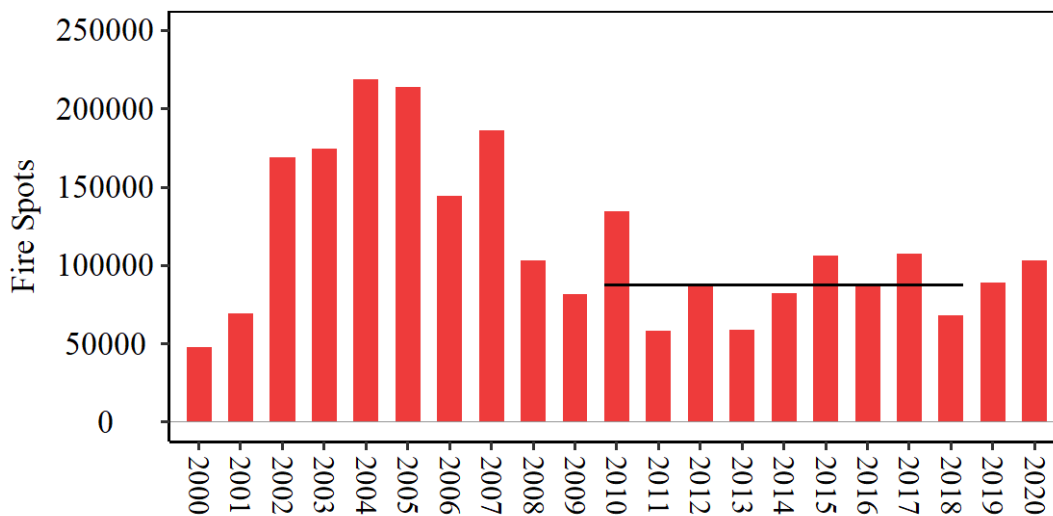
Fig. 1 Tree mortality rates and mode of death across Amazonia and adjacent lowland forests. Circles show the mean mortality rate across the entire time series available for each plot ($\% \text{ year}^{-1}$). Pie charts show the proportion of dead trees found standing (darker shading) and broken/uprooted (paler shading). Different colours represent the four geological regions: Northern (green), East-Central (red), Western (yellow) and Southern (blue). Mortality rates per plot were calculated as the mean value across all censuses weighted by the census-interval length.





2019 ↑ 58%

2020 ↑ 69%



2019 - %

2020 ↑ 17%

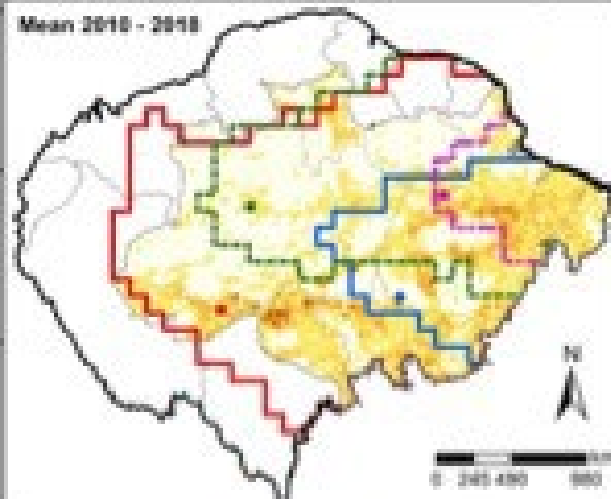
Latitude
0°0'0" S
5°0'0" S
10°0'0" S

70°0'0" W

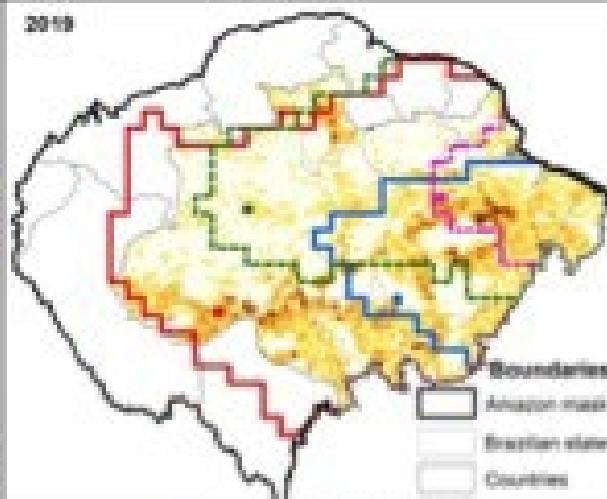
60°0'0" W

50°0'0" W

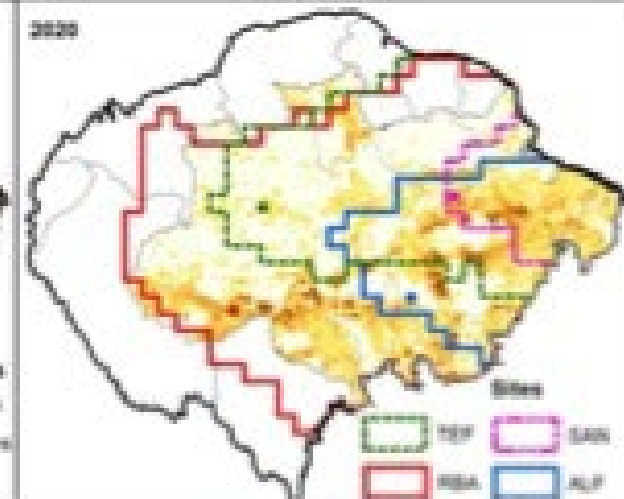
Mean 2010 - 2018



2019



2020



Boundaries

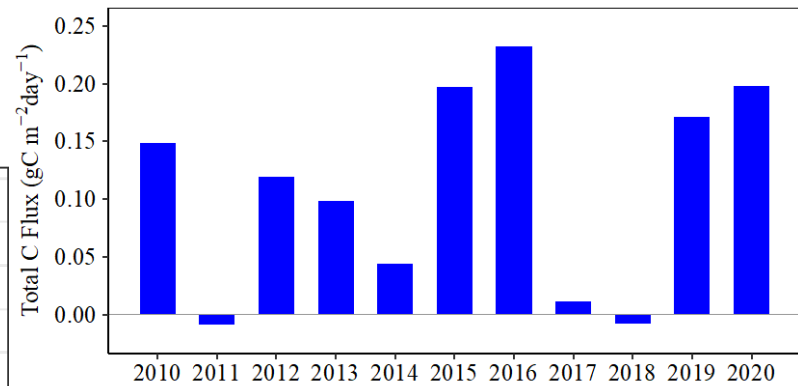
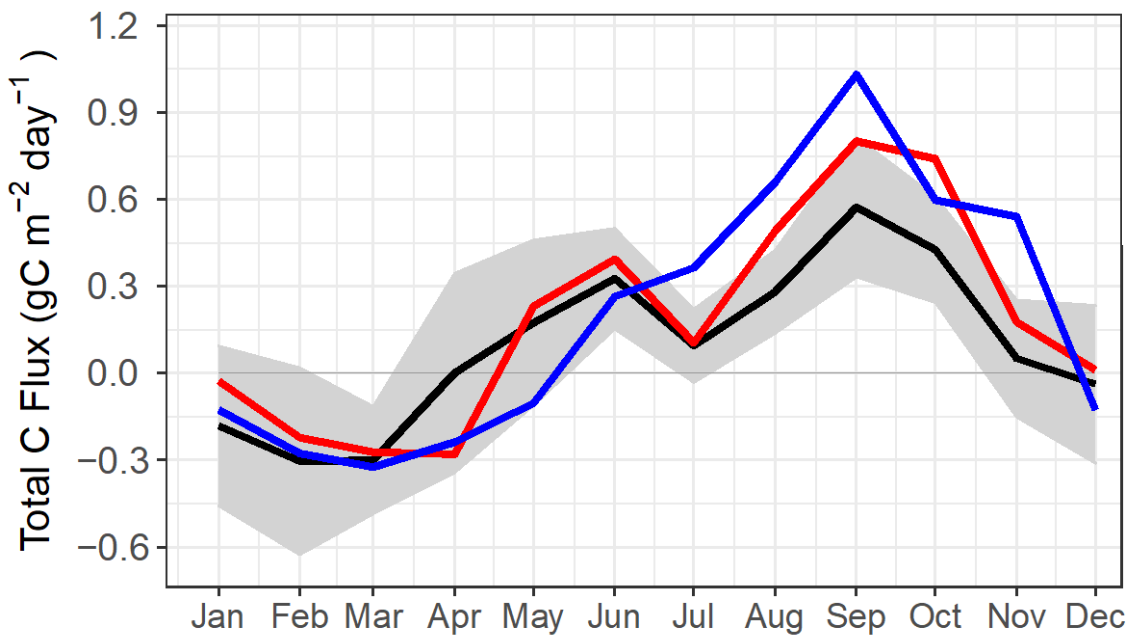
- Amazon mask
- Brazilian states
- Countries

Sites

- IGP
- SAO
- MSA
- ALP

Deforestation (km²)





2010-18			
gC/m ² /dia	Amazonia	2019	2020
Total	0.09	0.17 (84%)	0.20 (120%)
NBE	-0.06	+ 0.01	+ 0.05
Fire	0.15	0.16	0.16

Pg C / y	Amazonia	2019	2020
Total	0.25	0.44	0.52
NBE	-0.15	0.02	0.12
Fire	0.40	0.41	0.40

Amazon annual mean emission 2010-2018 ($\text{TgCH}_4 \text{ y}^{-1}$)

8% of global total emissions →

$$F_{\text{CH}_4}: 46,2 \pm 10,3$$

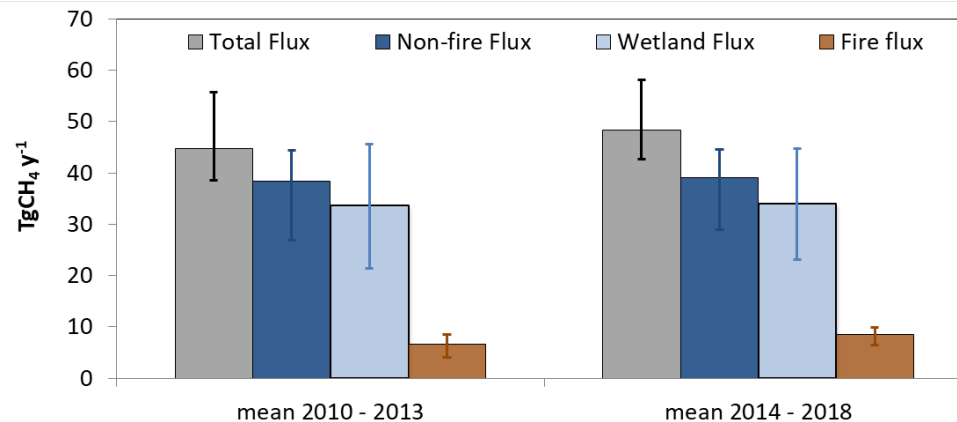
$$F_{\text{NON-FIRE_CH}_4}: 38,8 \pm 10,7$$

23% of global wetland emissions →

$$F_{\text{WET_CH}_4}: 33,8 \pm 7,6$$

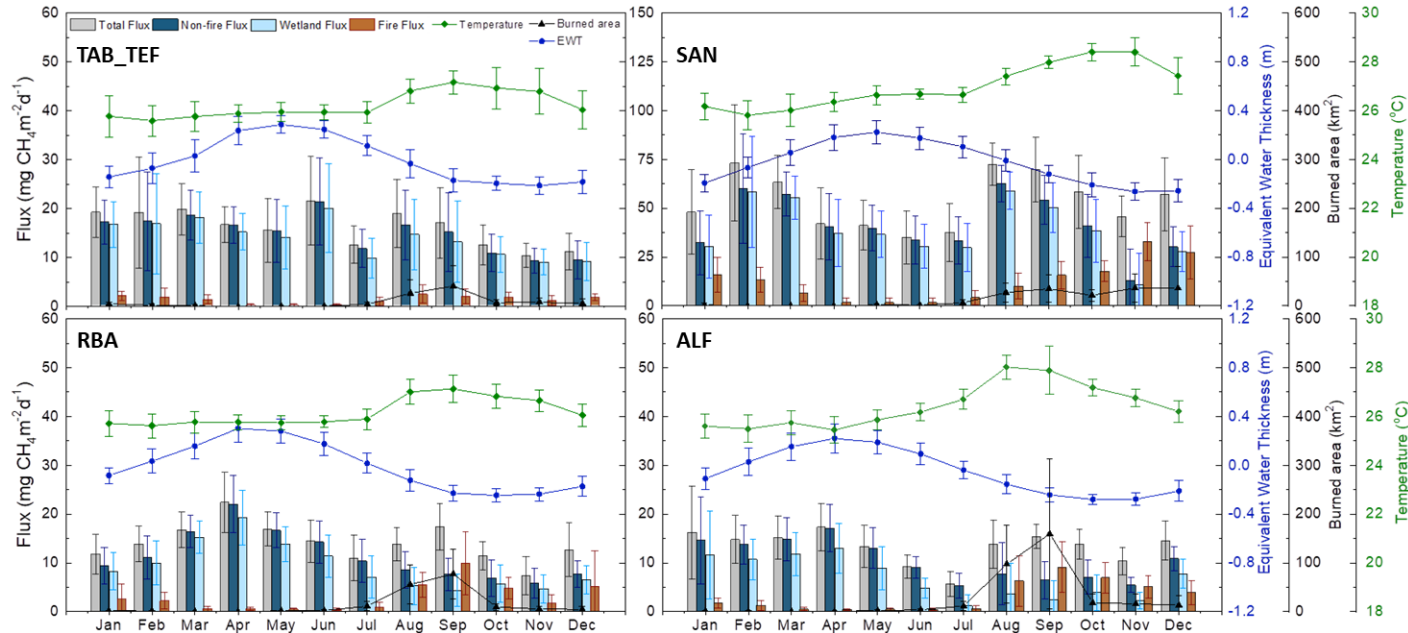
45% of biomass burning global emissions →

$$F_{\text{FIRE_CH}_4}: 7,7 \pm 1,6$$



- Non-fire sources – mainly wetlands - dominate emissions (biomass burning contribution ~17%)
- No significant emission trend over the period from 2010-2018 based on vertical profile data (Profile data 2021)

Comparison of magnitude and seasonality of fluxes



- northwest-central region: nearly a-seasonal consistent with weak precipitation seasonality
- southern regions: strongly seasonal synchronously with equivalent water thickness
- northeast region: double-peak emissions - causes unclear
- Distinct east-west contrast with an emission peak in the northeast
 - cause not fully understood

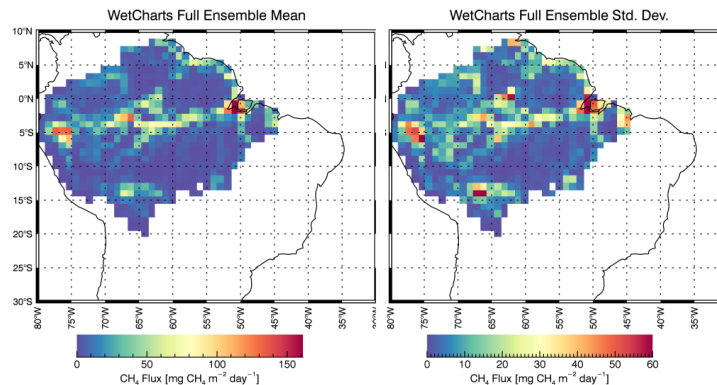
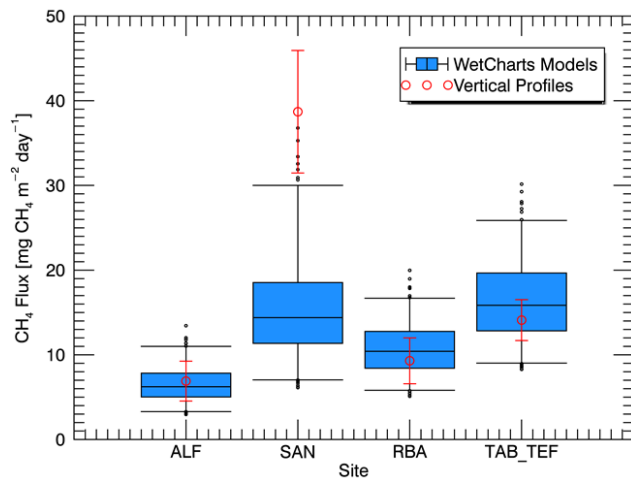
Comparison with wetland model predictions

A global wetland methane emissions and uncertainty dataset for atmospheric chemical transport models (WetCHARTs version 1.0)

A. Anthony Bloom¹, Kevin W. Bowman¹, Meemong Lee¹, Alexander J. Turner², Ronny Schroeder³, John R. Worden¹, Richard Weidner¹, Kyle C. McDonald^{1,3}, and Daniel J. Jacob²

For Amazon area (7.2 millions km²)

- annual WetCharts wetland emissions: $39.4 \pm 10.3 \text{ TgCH}_4 \text{ y}^{-1}$
- our data-based approach $33.8 \pm 12.7 \text{ TgCH}_4 \text{ y}^{-1}$



- Our wetland estimates were similar to fluxes from the WetCharts wetland model ensemble:
 - except for the SAN region:
 - WetCharts does show substantial emissions, but still just 40% of our estimates;

N_2O emissions in $\text{TgN}_2\text{O year}^{-1}$

	EPA, 2010 (Global)	Davidson & Kanter, 2014 (Global)	INPE(Amazon) Average	%
Total	18,8	18,9	2,43	13%
Natural	12,1	10,1	1,95 (BIO)	16 a 30%
Anthropic	6,7	8,8	0,47 (FIRE)	7 a 15%

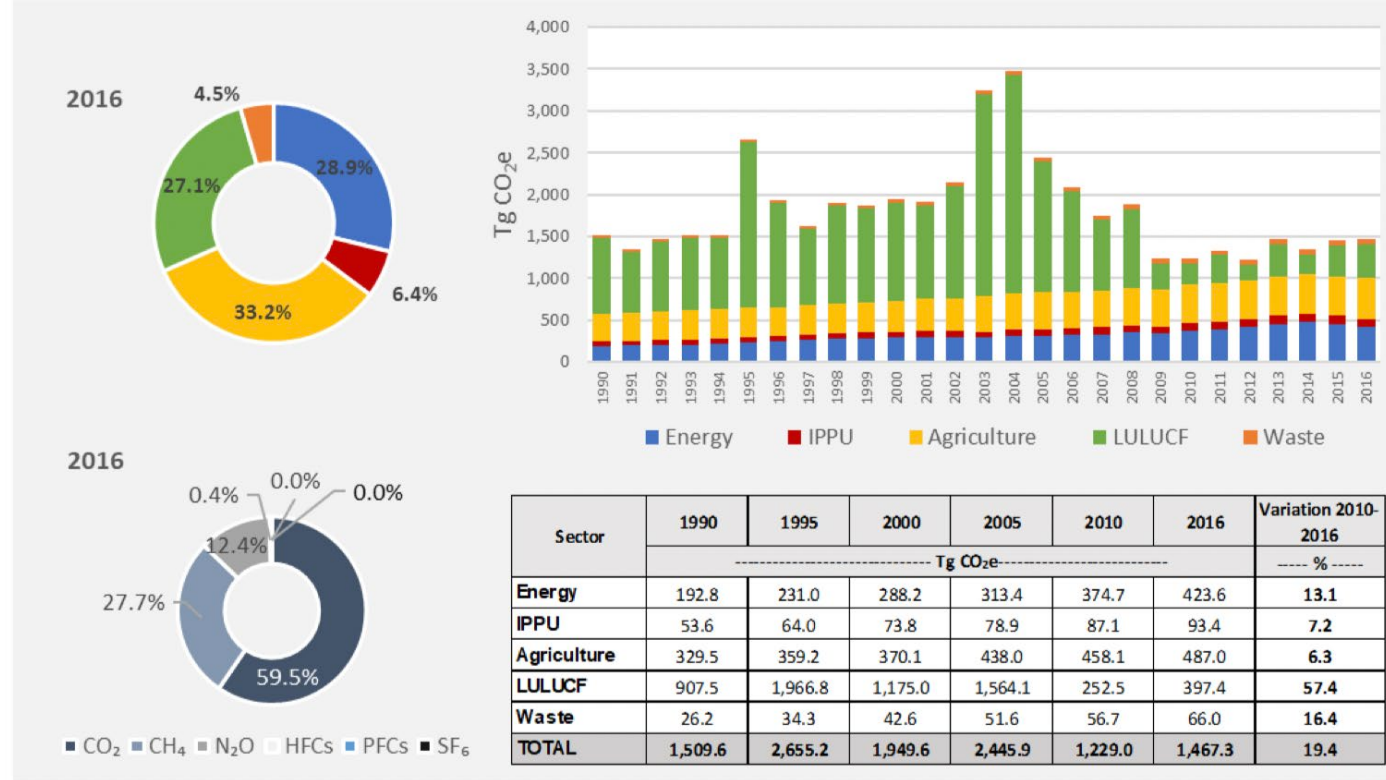
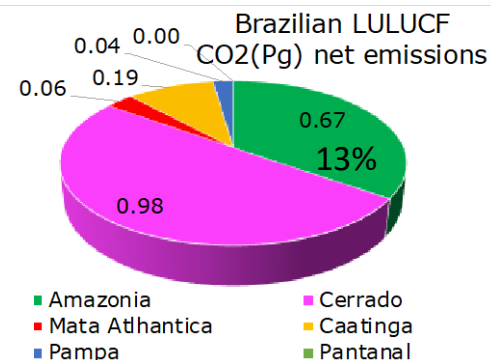
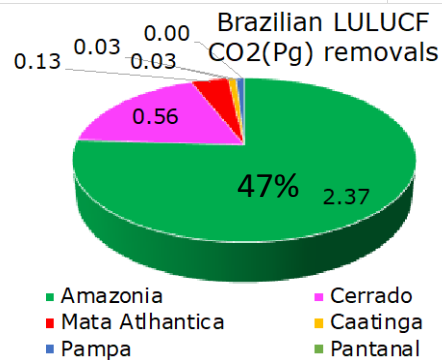
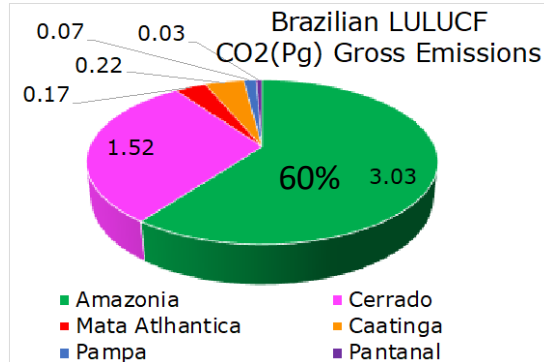
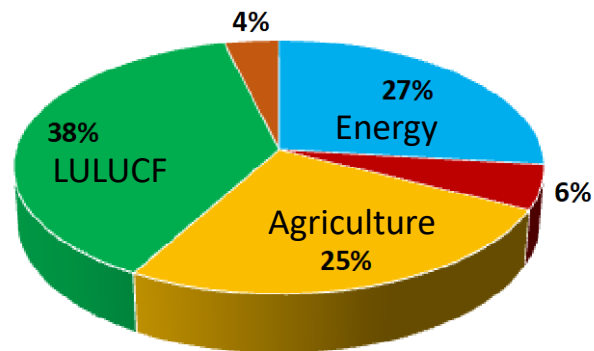


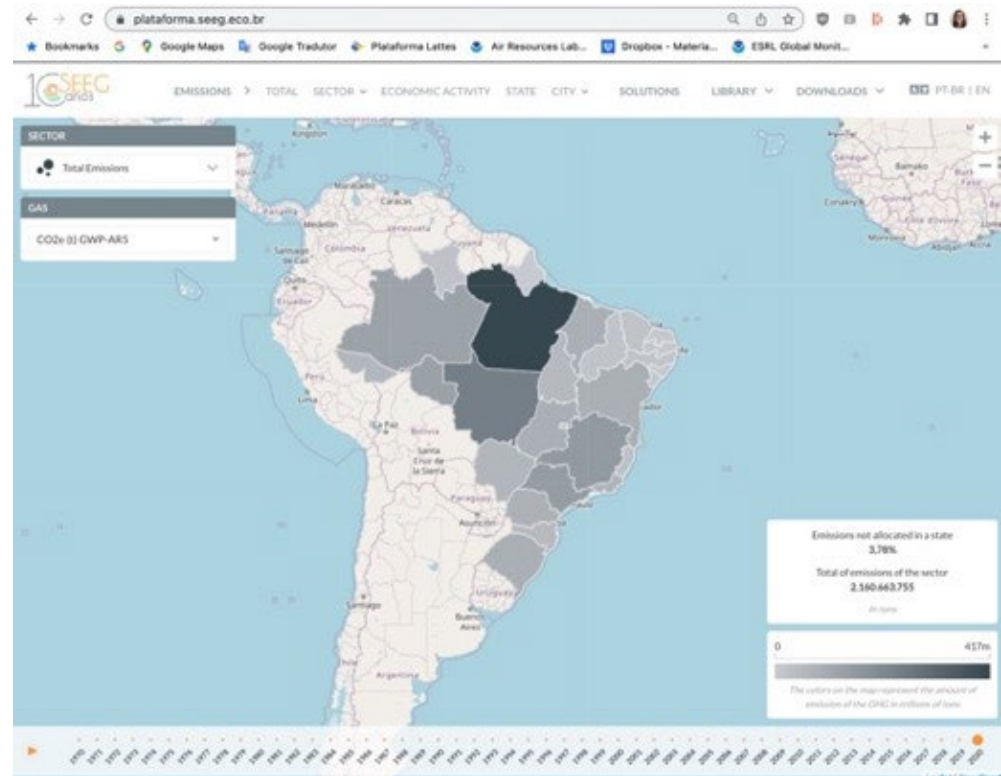
Figure 2.4. Total GHG emissions from 1990 to 2016 in Tg of CO₂e

In 2016, Brazilian emissions were 873,272 Gg CO₂; 19,333.2 Gg CH₄, and 586.09 Gg N₂O, which represented 59.5%, 27.7%, and 12.4% of the total Inventory in CO₂e. Between 2010 and 2016, total CO₂, CH₄, and N₂O emissions increased by 30.3%, 3.8%, and 10.7%, respectively.

IV National Communication from Brazil - Inventory (2010-2016)



Pg CO2/y	IV Braz. Inv.	LaGEE/INPE	SEEG (Pg CO2 eq)
2010-2016	0.674	0.915	0.508
2016-2020		0.926	0.646
2010		0.964	0.407
2011		0.132	0.417
2012		1.082	0.414
2013		0.876	0.510
2014		0.335	0.502
2015		1.481	0.598
2016		1.535	0.705
2017		0.327	0.526
2018		0.219	0.570
2019		1.164	0.647
2020		1.387	0.783



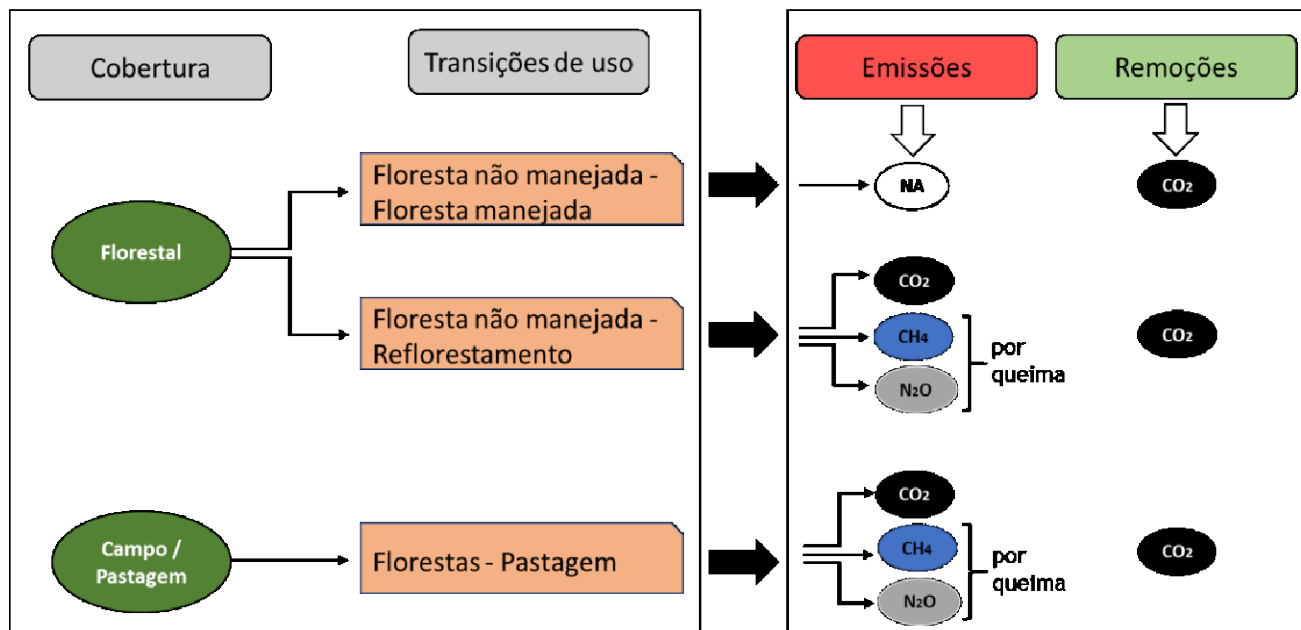


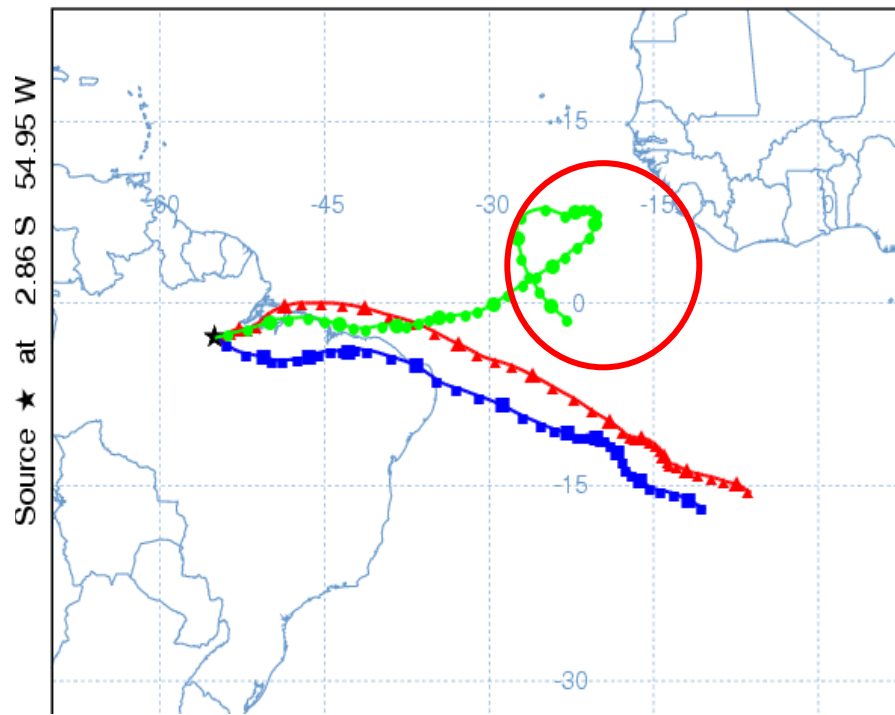
Figura 7. Exemplos de categorias, subcategorias e gases de GEE emitidos no setor LULUCF.

Conclusions

- The Amazon was and could continue to be our Climate Protection
 - Carbon Sink
 - Produce precipitation
 - Reduce temperature
- Deforesting the Amazon it becomes an acceleration of climate change
 - Carbon Source
 - Reduce dry season precipitation and and makes it longer
 - Increase temperature

Thank you <http://www.ccst.inpe.br/lagee/>

NOAA HYSPLIT MODEL
Backward trajectories ending at 1600 UTC 21 Aug 09
GDAS Meteorological Data



ACKNOWLEDGEMENTS

MINISTÉRIO DA
CIÊNCIA, TECNOLOGIA,
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