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Amazonia, climate and biomass burning in a changing world

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AMAZON ECOSYSTEMS AT A GLANCE

AMAZON belongs to 7 Latin American countries

Maintenance of global carbon cycle

- 15% of global NPP and a key carbon sink for anthropogenic CO_2
- Stores between 100 to 130 billion ton of carbon in the biomass

Climate stabilization

- Key heat source for the atmosphere
- Annual rainfall = 2400 mm

Powerful hydrology

- 18% of fresh water flow into the global oceans
- Amazon river discharge of 220,000 m^3/s

Helps to maintain cultural and ethnic diversity

- Over 300 indigenous populations, language diversity

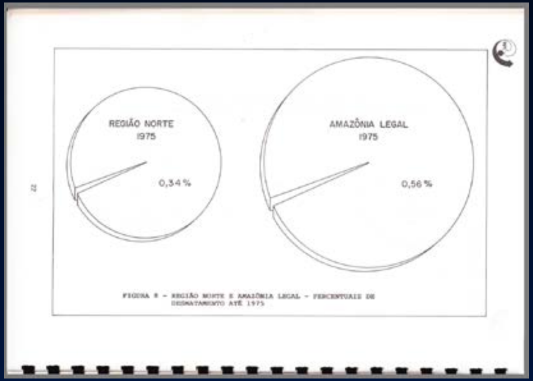
Biodiversity richness

- > 10% of species

Amazonia and Global Climate Change: a two-way process

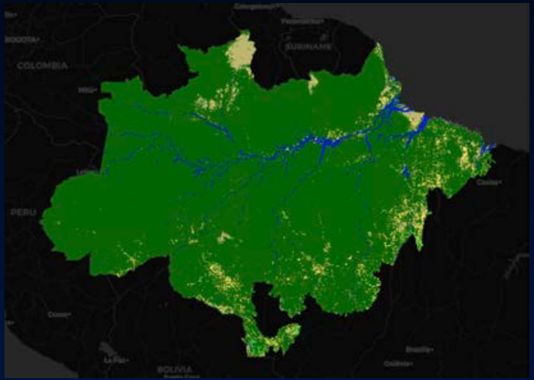
Deforestation versus global temperature increase

Evolution of deforestation in Amazonia 1975-2018



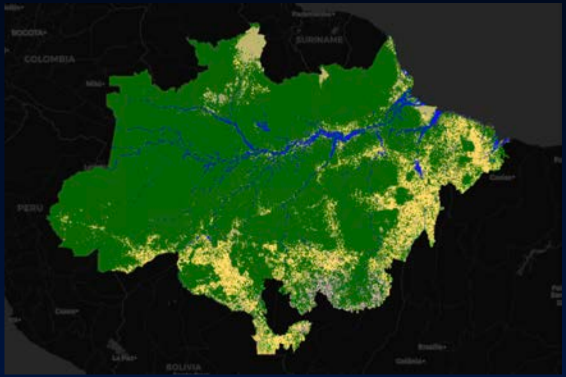
1975

0,5 %



1988

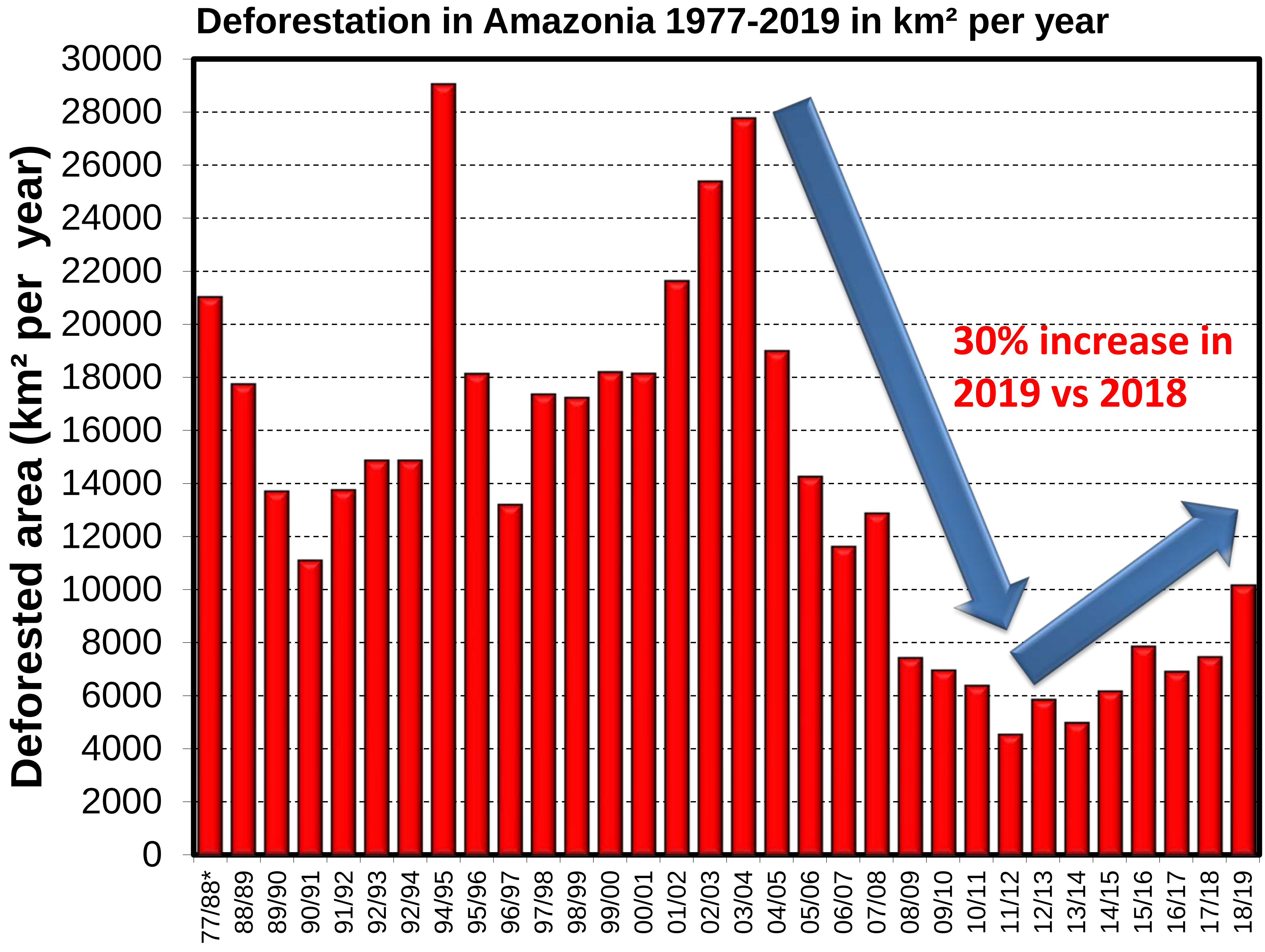
5,0 %



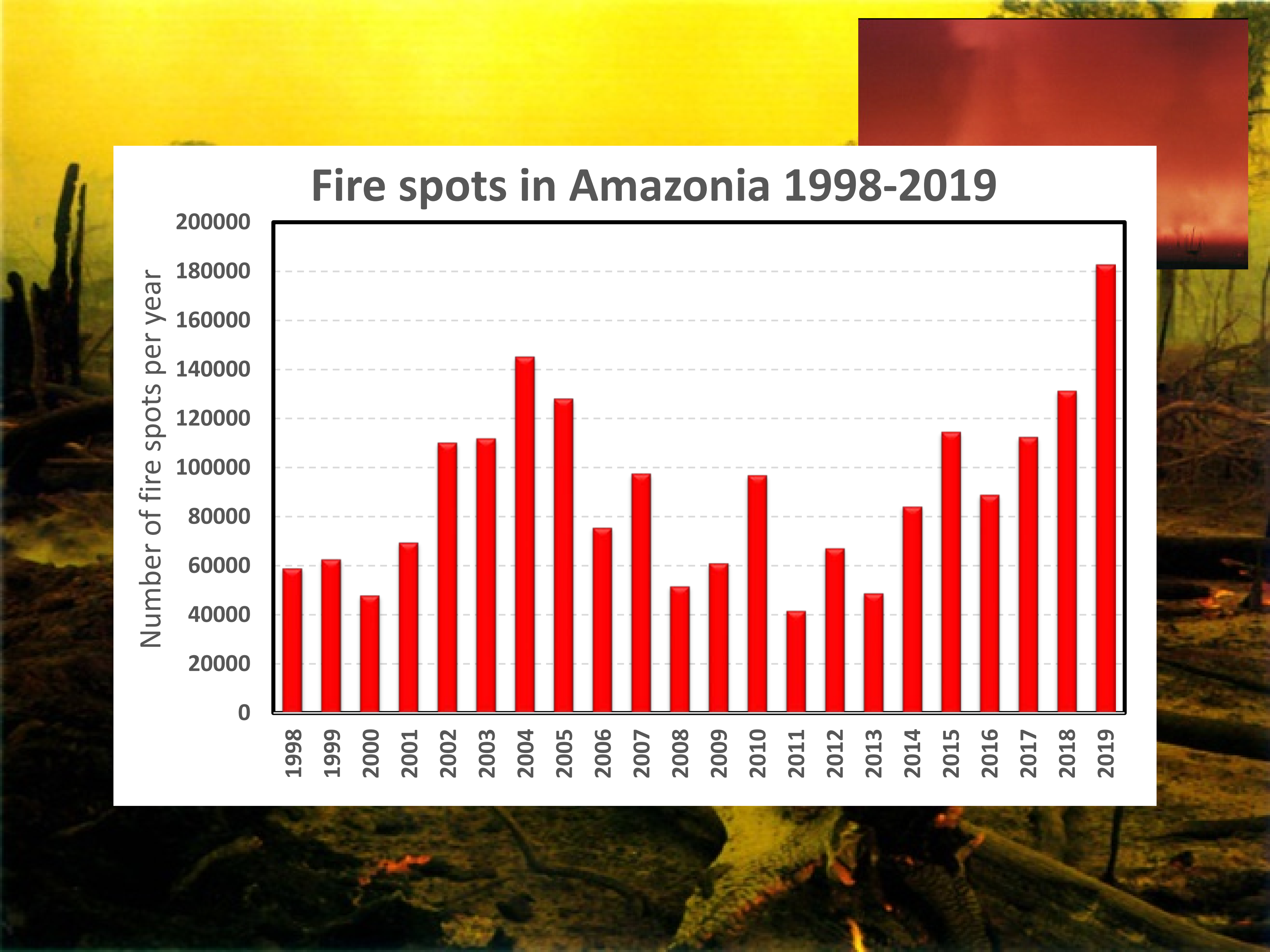
2018

19 %

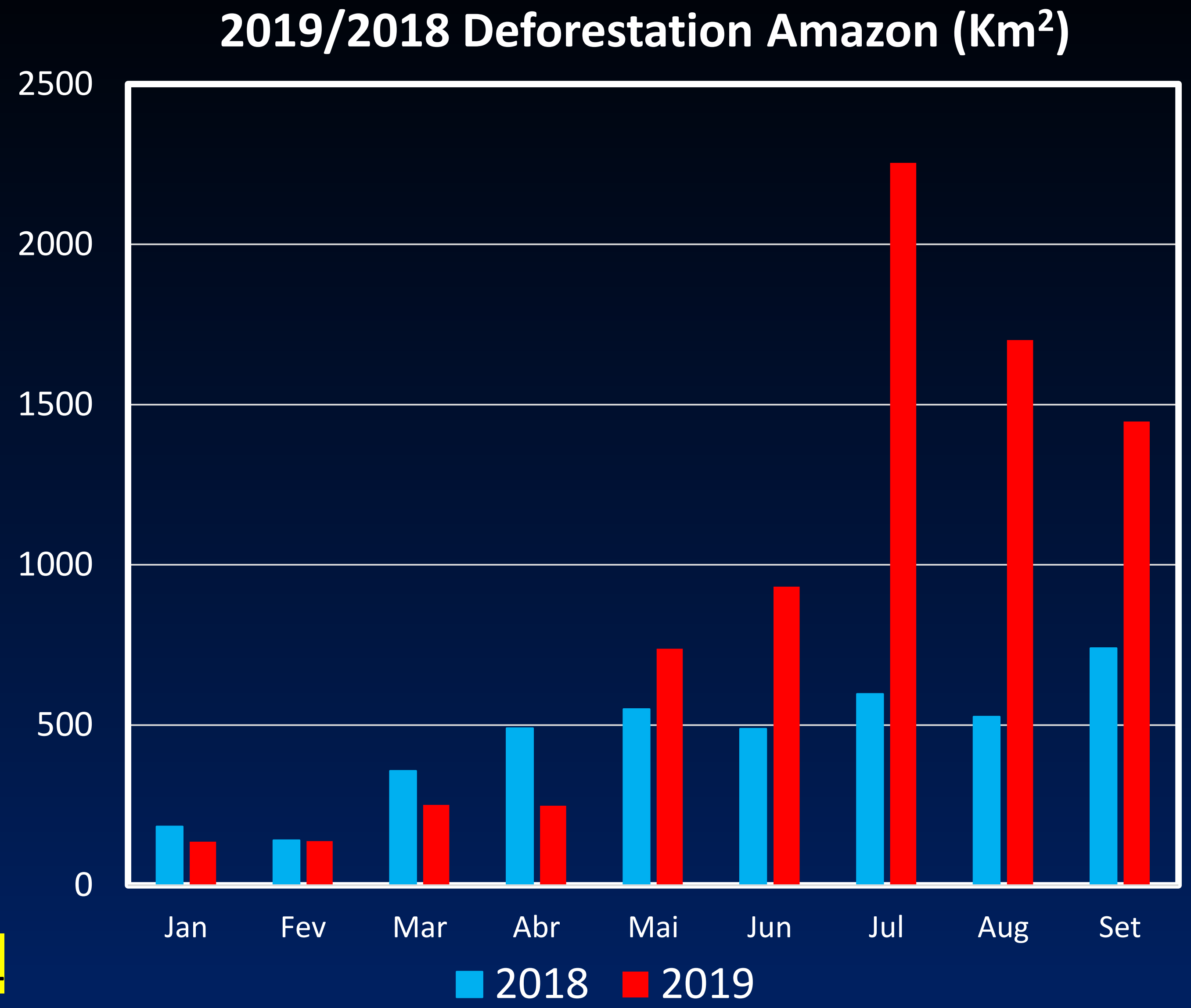
Souce: Prodes/INPE, MapBiomas



Deforestation in Amazonia 1977-2019 in km² per year
Deforested area (km² per year)
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
77/88*
88/89
89/90
90/91
91/92
92/93
92/94
94/95
95/96
96/97
97/98
98/99
99/00
00/01
01/02
02/03
03/04
04/05
05/06
06/07
07/08
08/09
09/10
10/11
11/12
12/13
13/14
14/15
15/16
16/17
17/18
18/19
30% increase in
2019 vs 2018


Fire spots in Amazonia 1998-2019
Number of fire spots per year
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

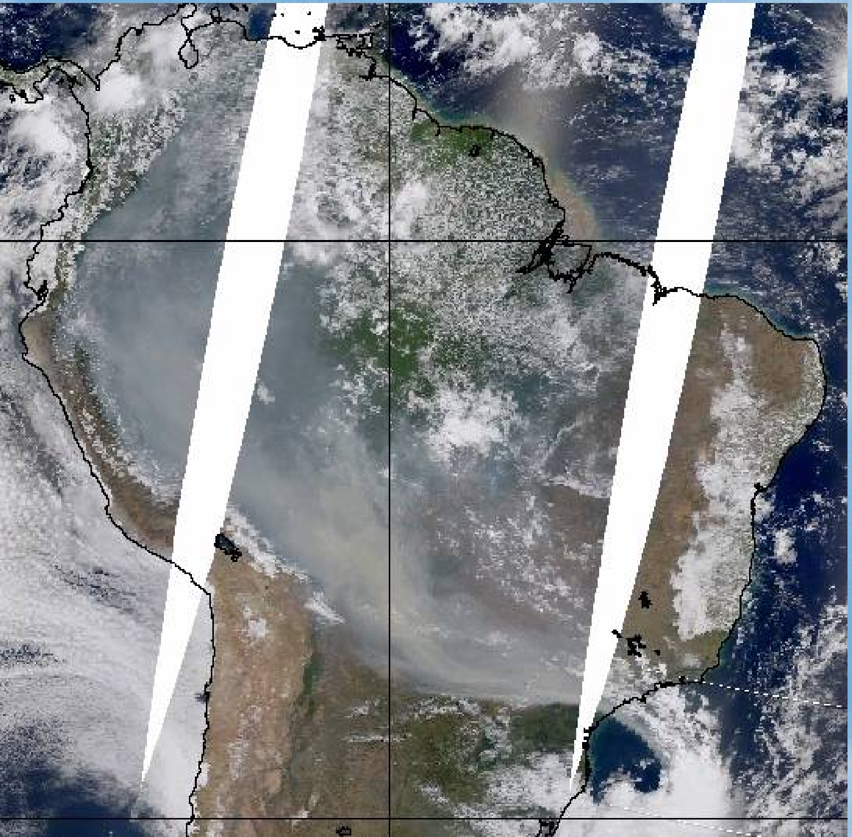
From jan-sept 2019 increase 93% Detection of deforestation alerts comparing with same period in 2018

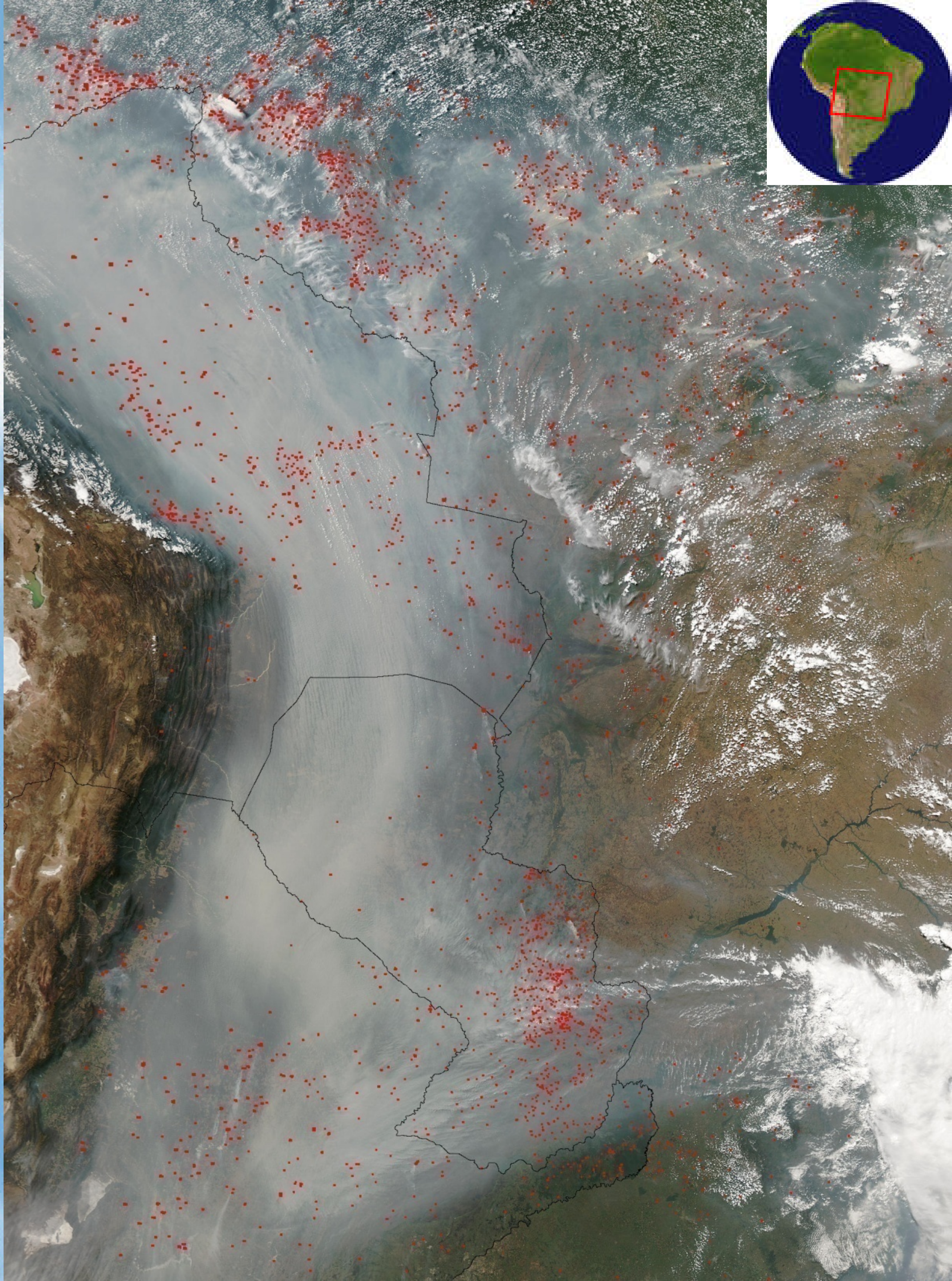


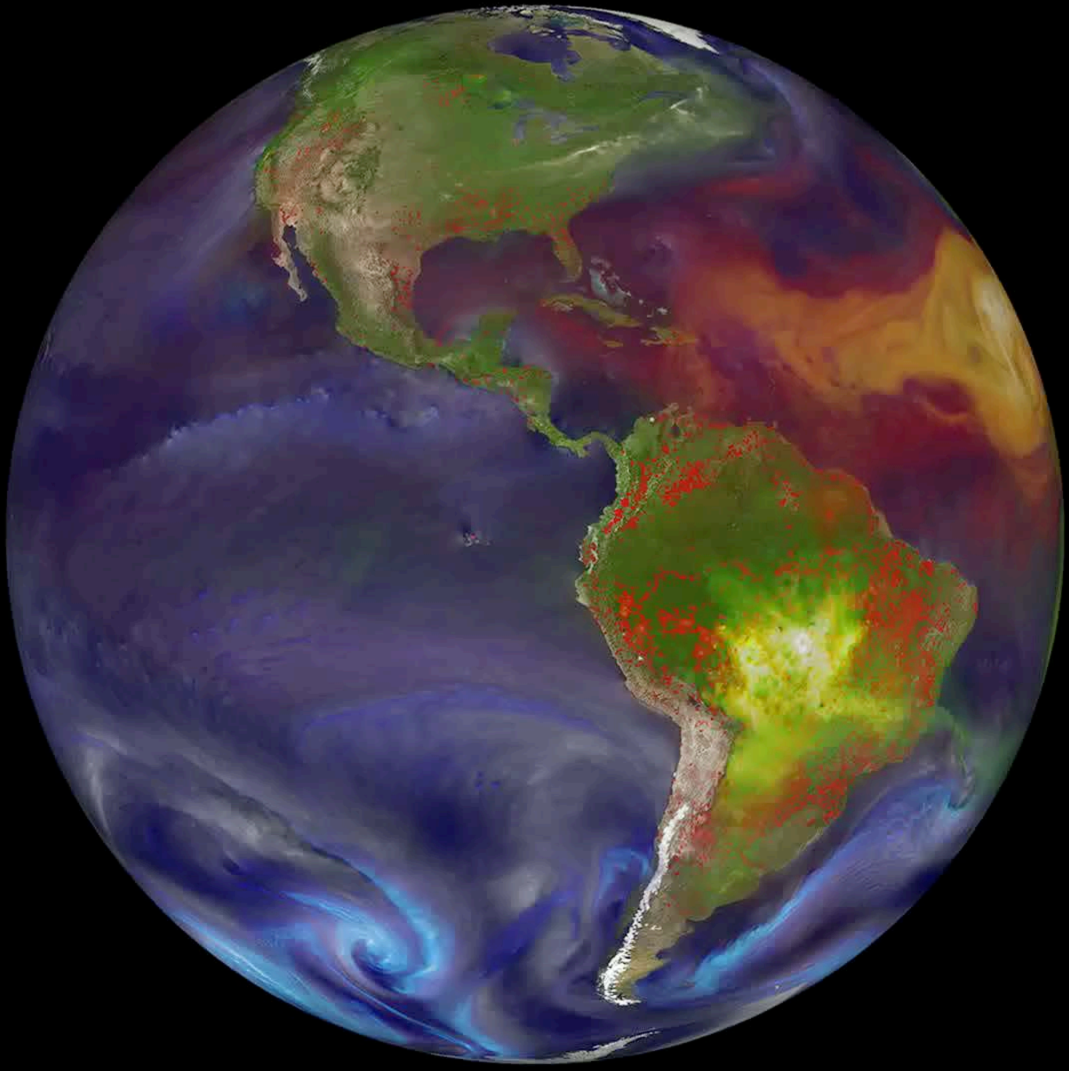
> 90% is ILLEGAL

Large scale aerosol distribution in Amazonia

- Severe health effects on the Amazonian population (about 20 million people)
- Climatic effects, with strong effects on cloud physics and radiation balance.
- Changes in carbon uptake and ecosystem functioning

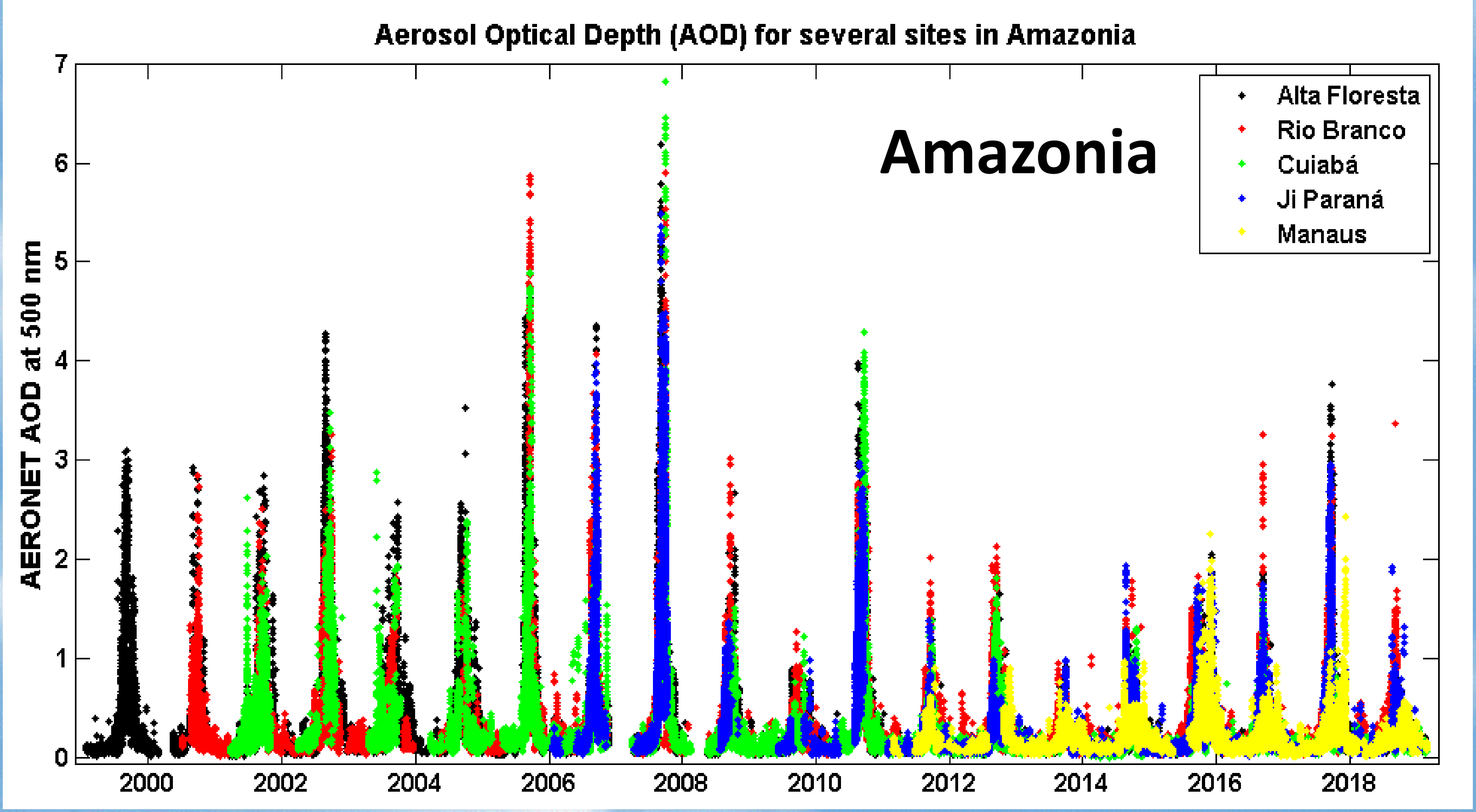




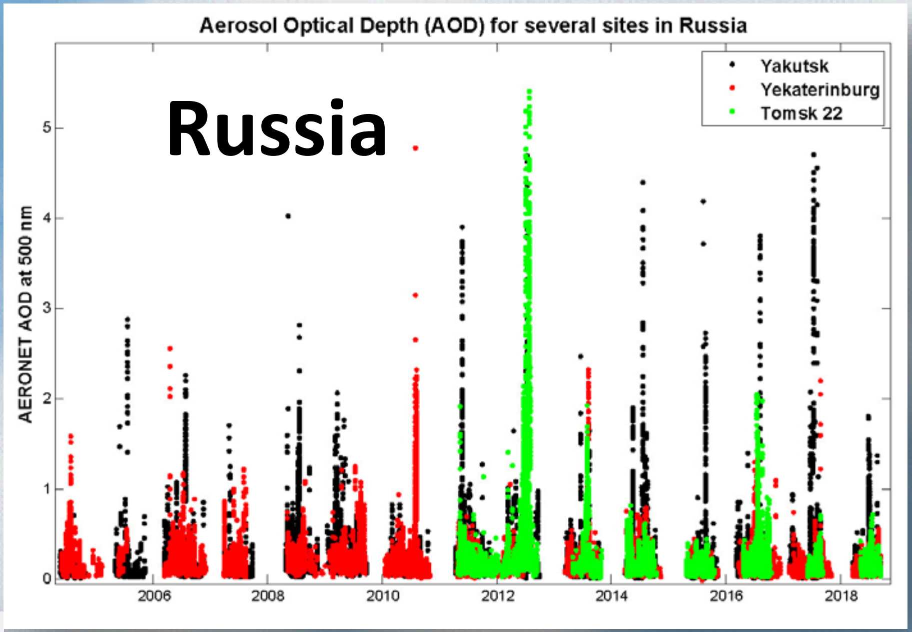


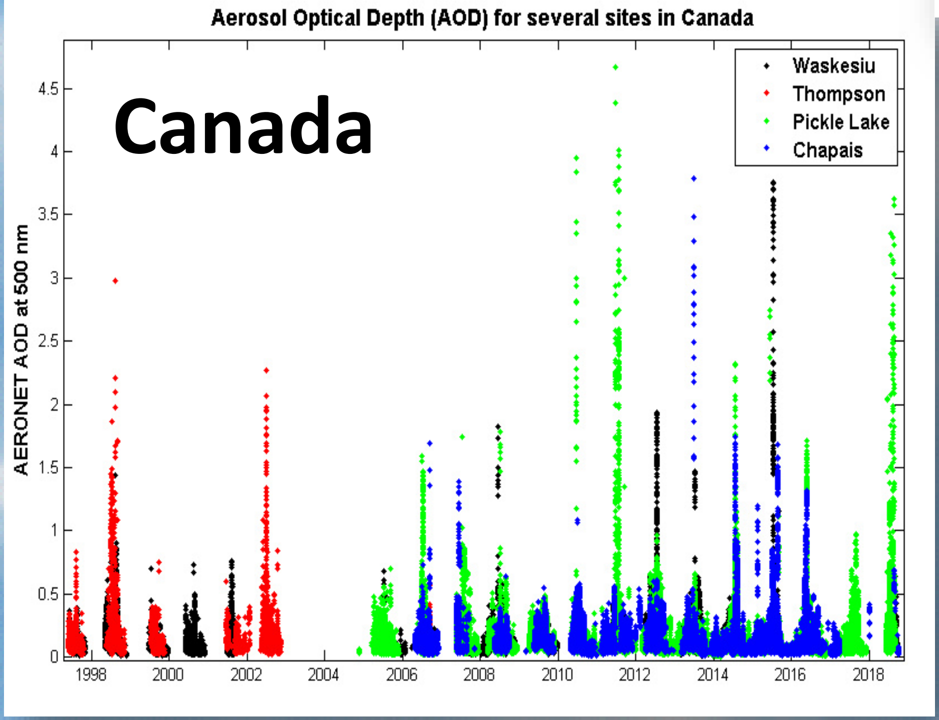
AIRS Carbon monoxide at 18000 ft

Biomass burning are the dominating source in both the boreal and tropical forest during the summer (May – September) and dry periods



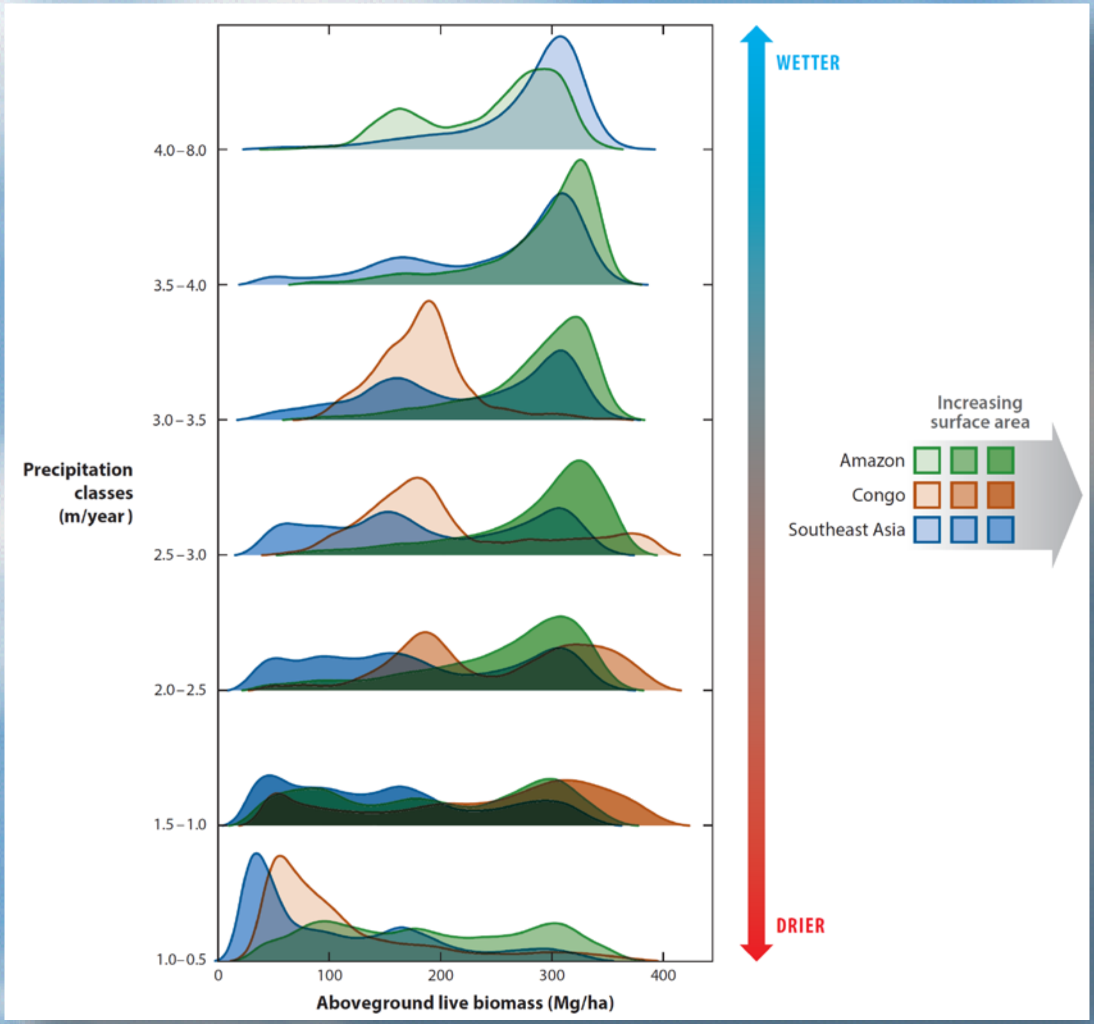
Biomass burning in the boreal forests: AOD time series





Carbon versus precipitation

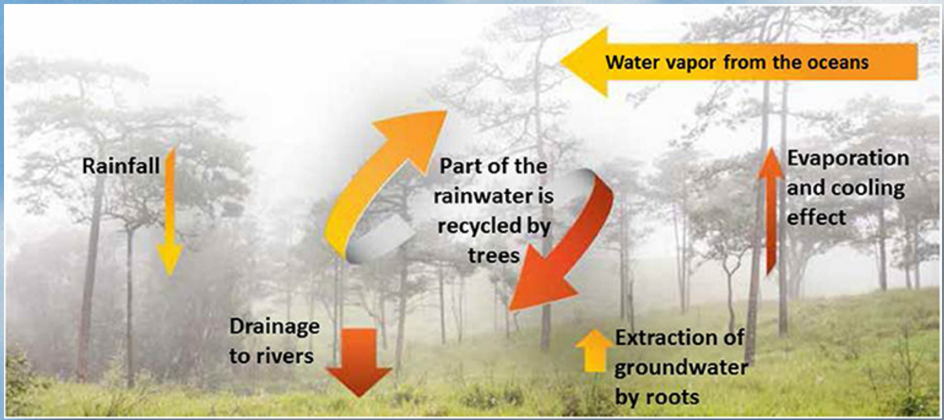
Amazon, Congo Basin, and Southeast Asia

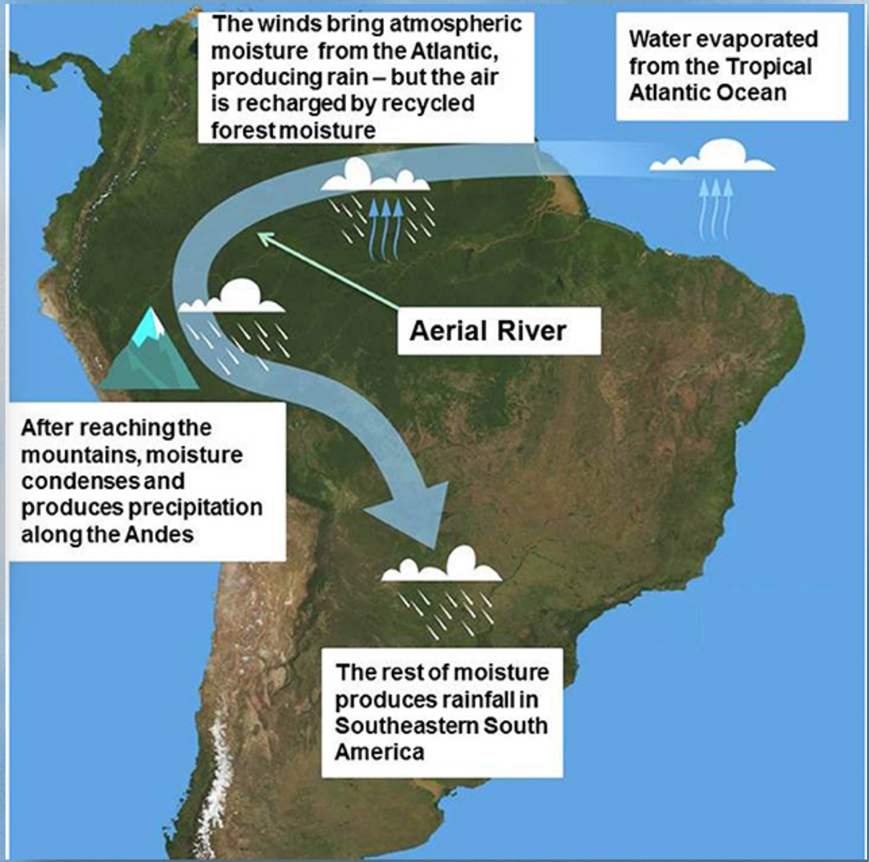


Paulo Brando et al., Annu. Rev. Earth Planet. Sci. 2019. 47:555–81

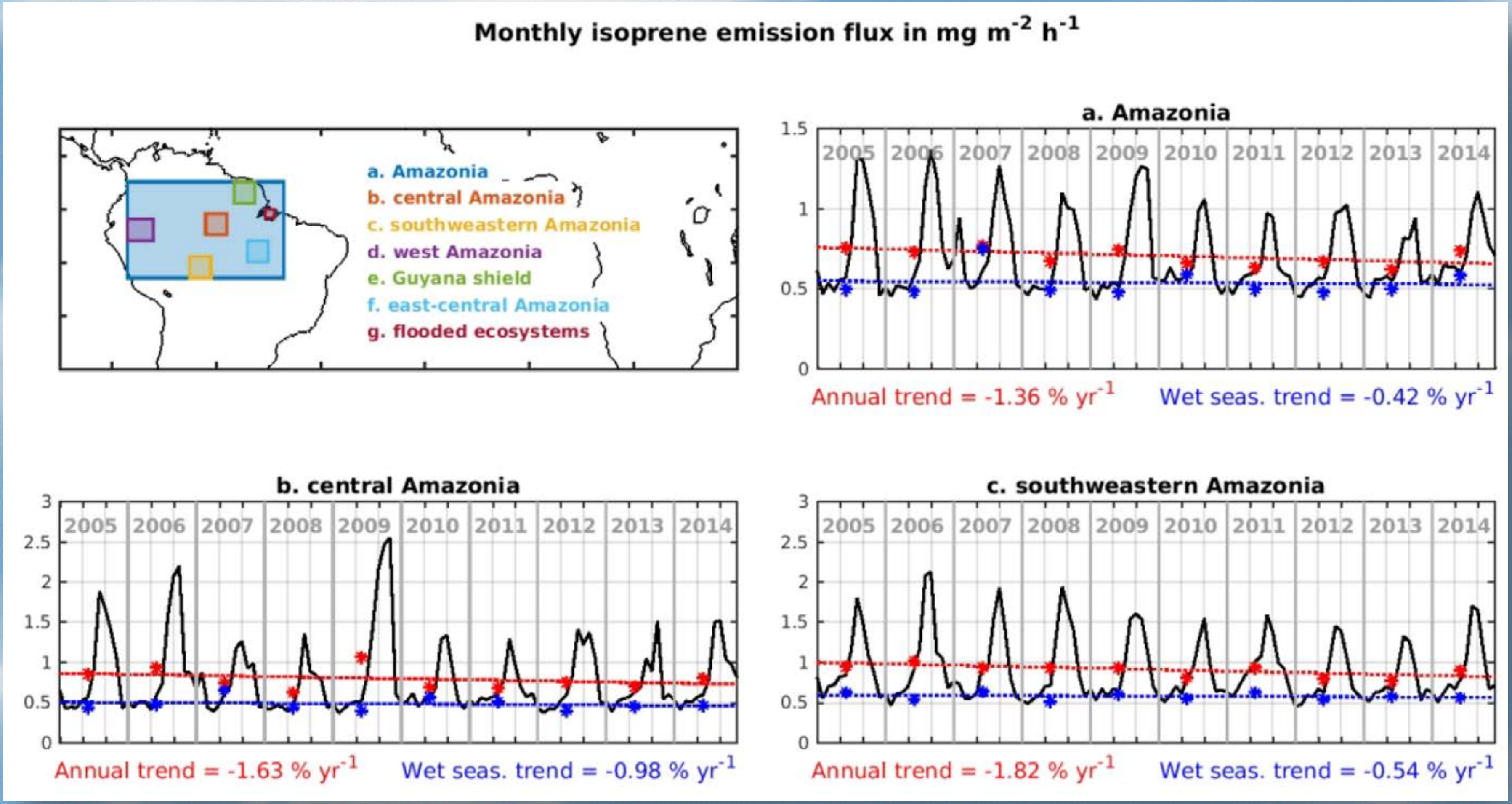
Carbon and hydrological cycles linked

Water vapor regional and large scale circulation



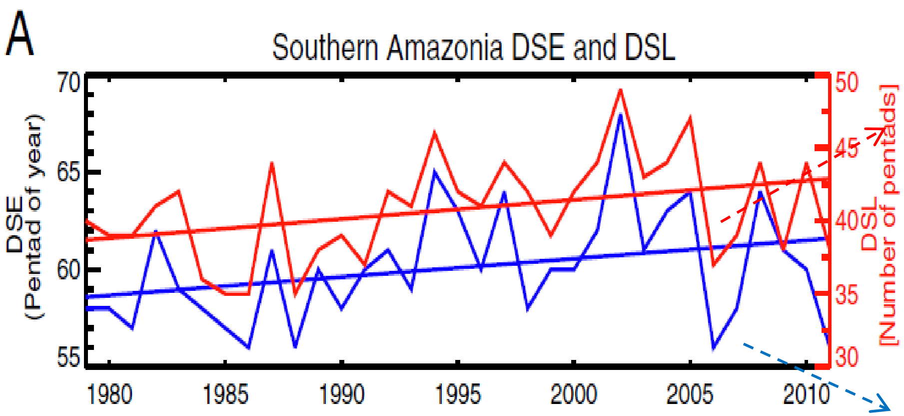


Trends in isoprene fluxes in Amazonia: Decreasing emissions



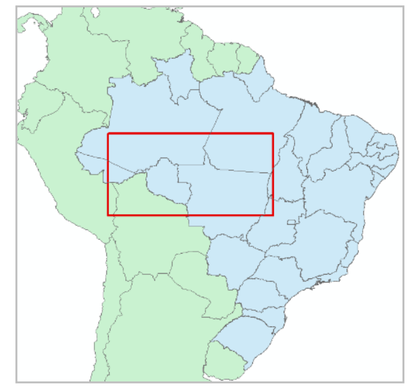
Yanez-Serrano, GCB 2020

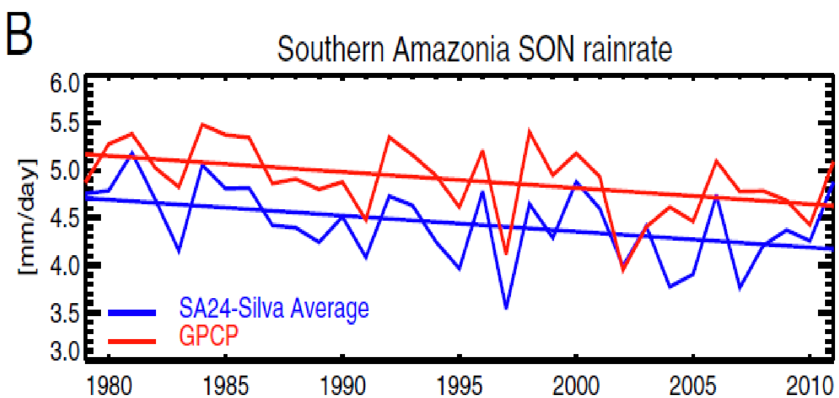
Dry season length is increasing in Amazonia



Annual time series of dry season length (DSL)

Annual time series of dry season END (DSE)

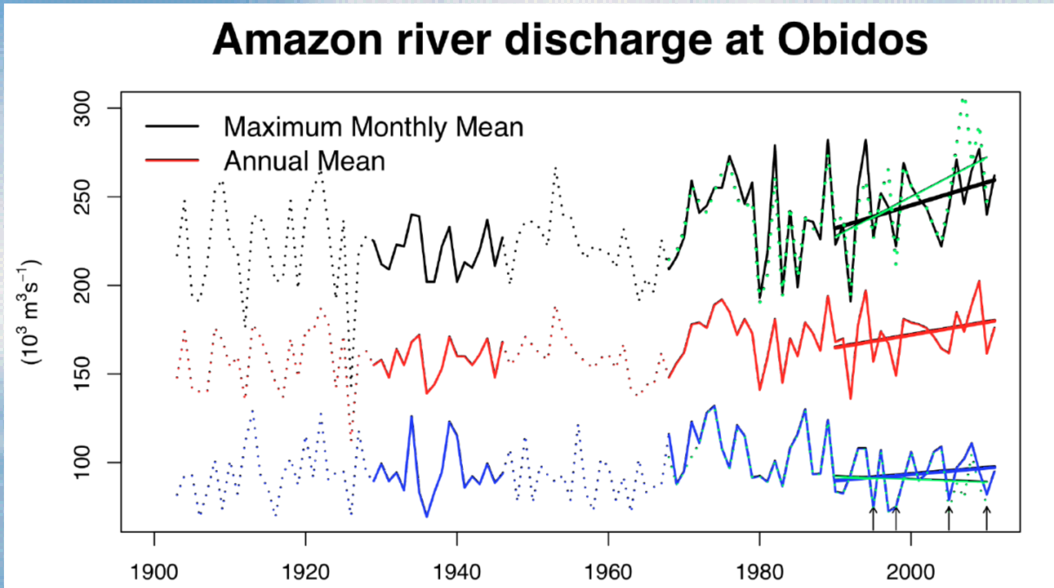


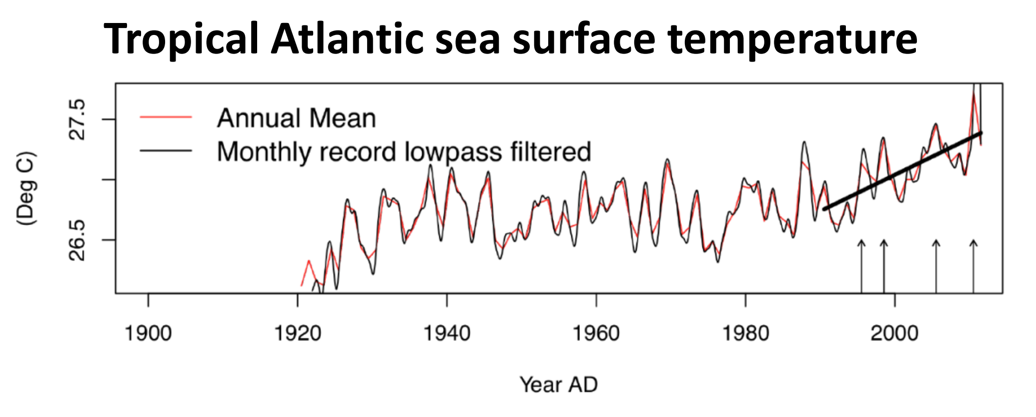


Dry season length has increased by **6.5±2.5** days/decade;

Fu et al. 2013 (PNAS)

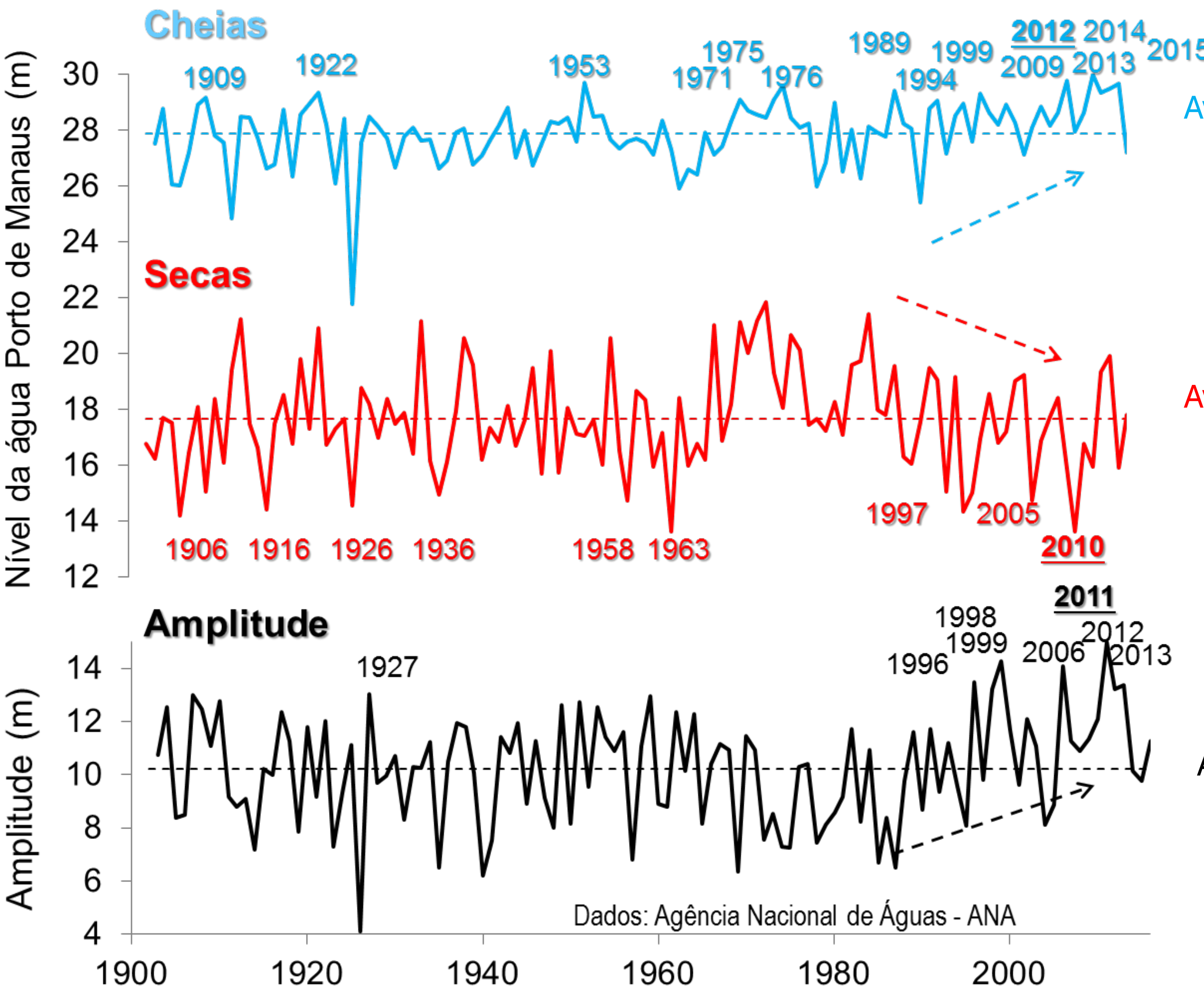
The Amazonian hydrological cycle is intensifying





Gloor et al. 2013

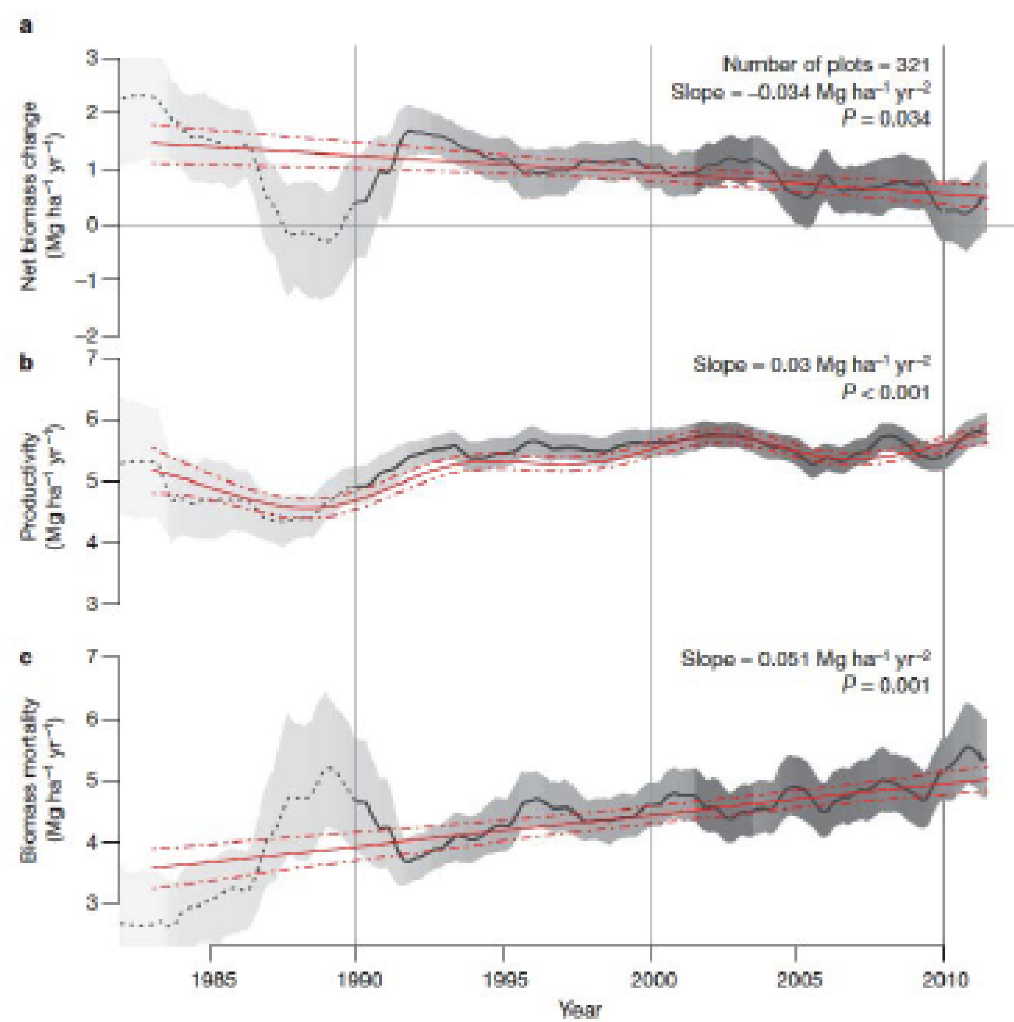
Water levels at the Manaus Port (1903-2016)



Jochen Schöngart et al., 2017

Carbon cycling: Amazonia stores about 120 Tg C

How tropical forests processes affects carbon, water and energy fluxes?

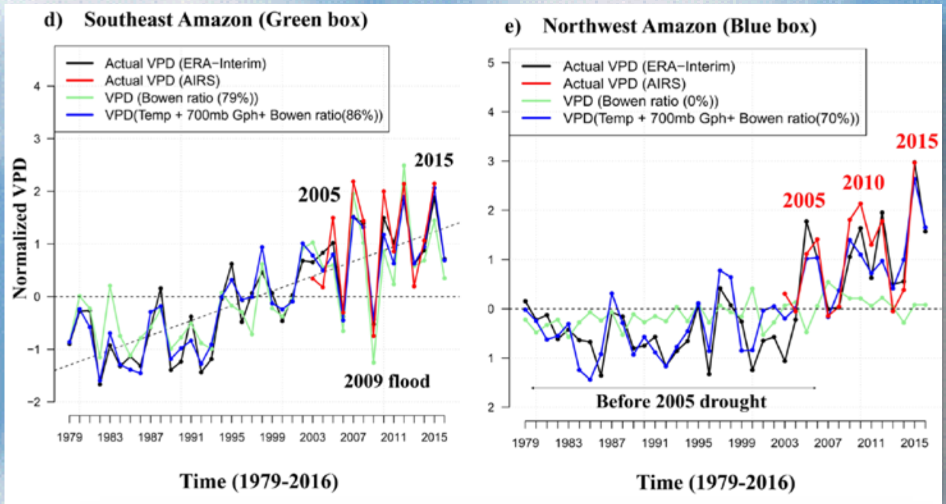


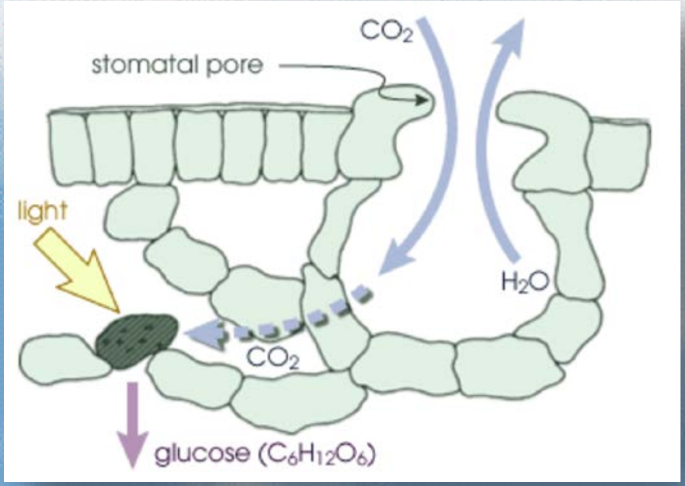
(Brienen et al., 2015)

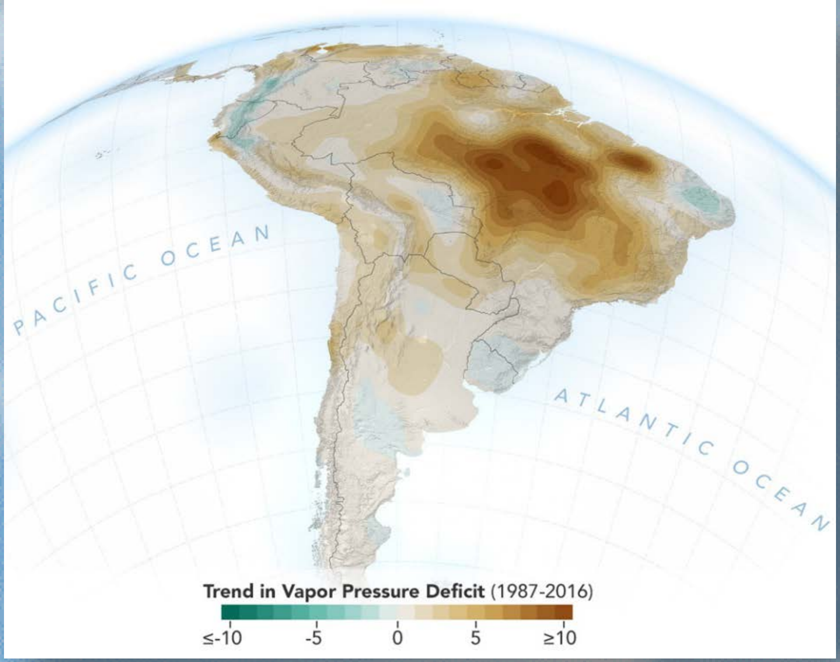
Net carbon flux today: ZERO

Tree mortality: significant INCREASE

Increase in the Vapor Pressure Deficit: Decrease in evapotranspiration in Amazonia







O déficit da pressão de vapor ou VPD é a diferença entre a quantidade de umidade no ar e quanta umidade o ar pode conter quando está saturado

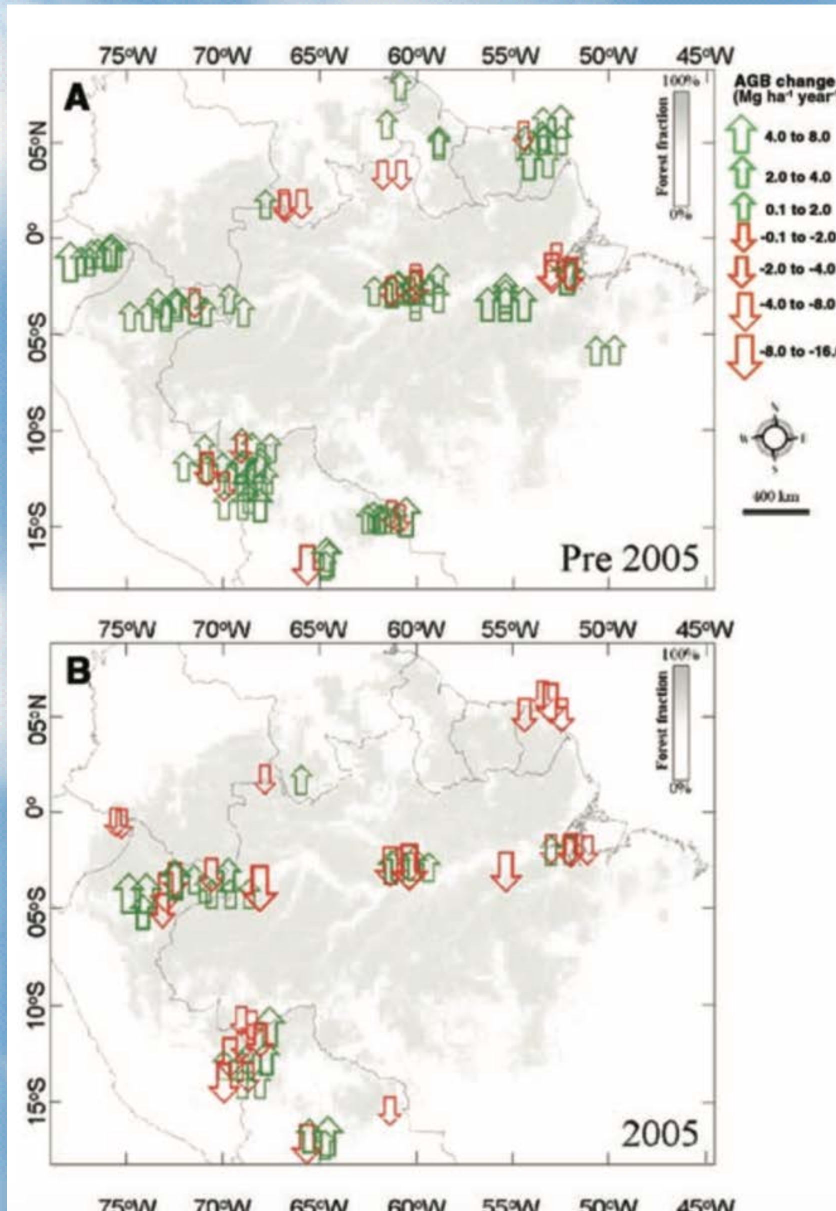
O aumento da VPD combinado com o decréscimo da fração evaporativa são as primeiras indicações de mecanismos de feedback positivos na Amazônia.

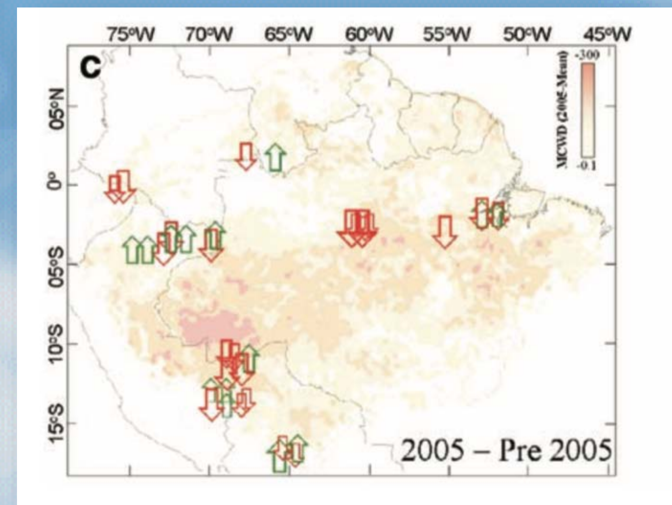
Nature Scientific Reports, Nov 2019

Above ground biomass and drought sensitivity (2005)

ABG Change Pre 2005

ABG Change in 2005

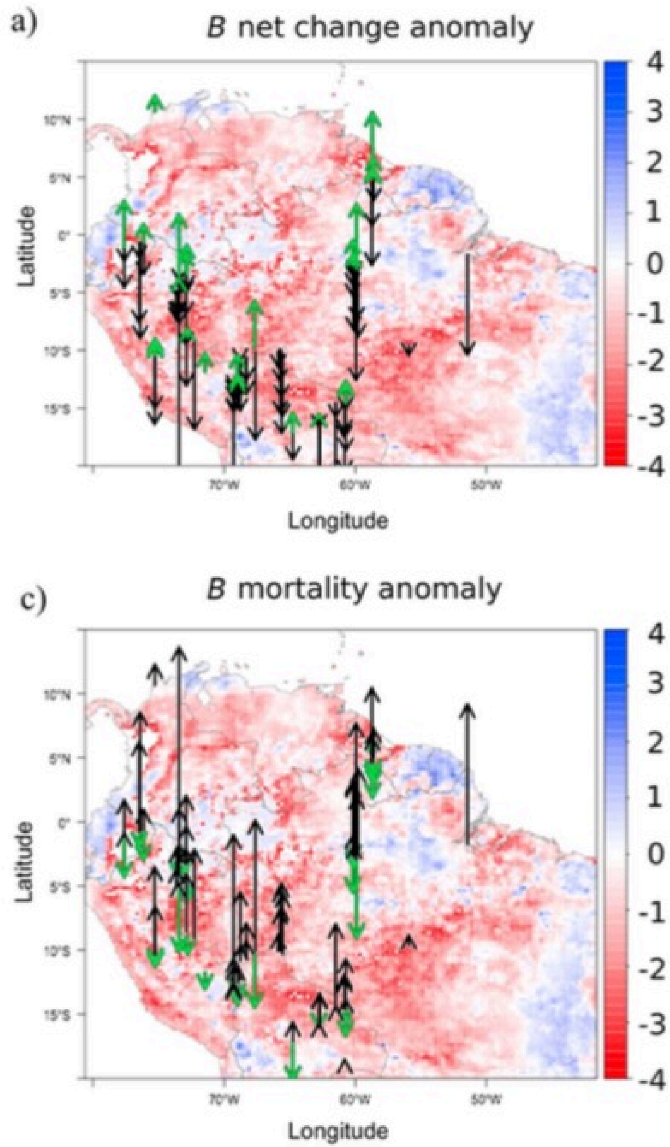




2005 – Pre 2005

Phillips et al., 2009, Science

Above ground biomass and drought sensitivity (2010)

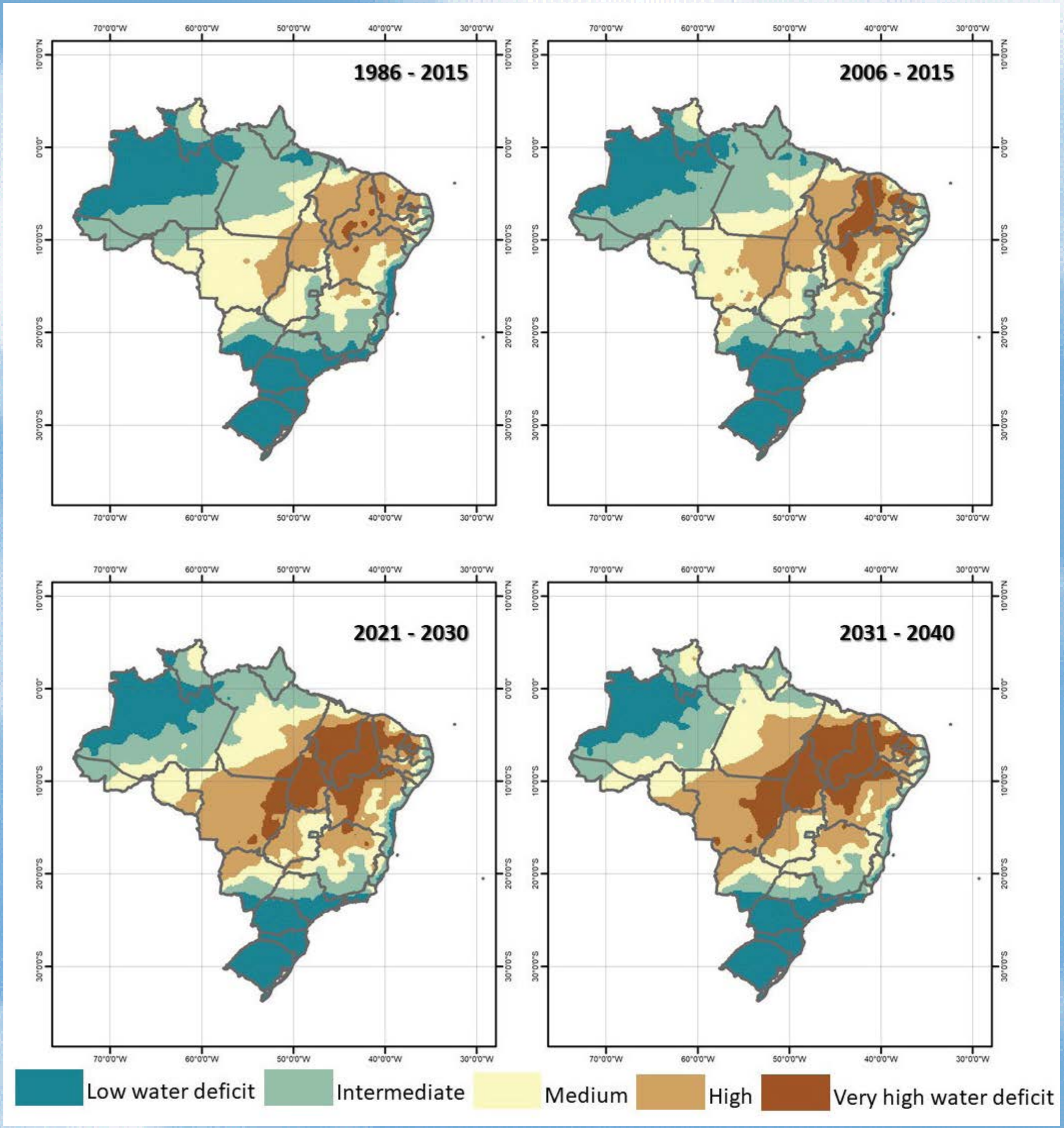


2010

Feldpausch et al. 2016, *Global Biogeochemical Cycles*

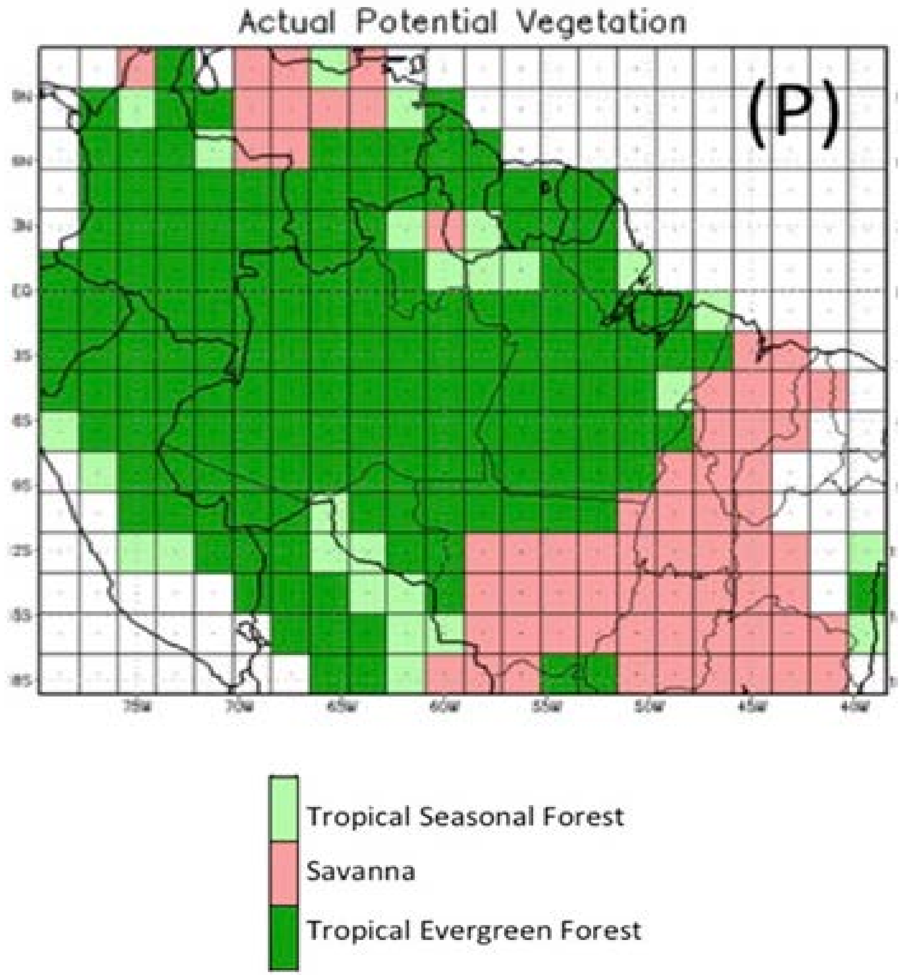
Water deficit in Brazil 1986-2040

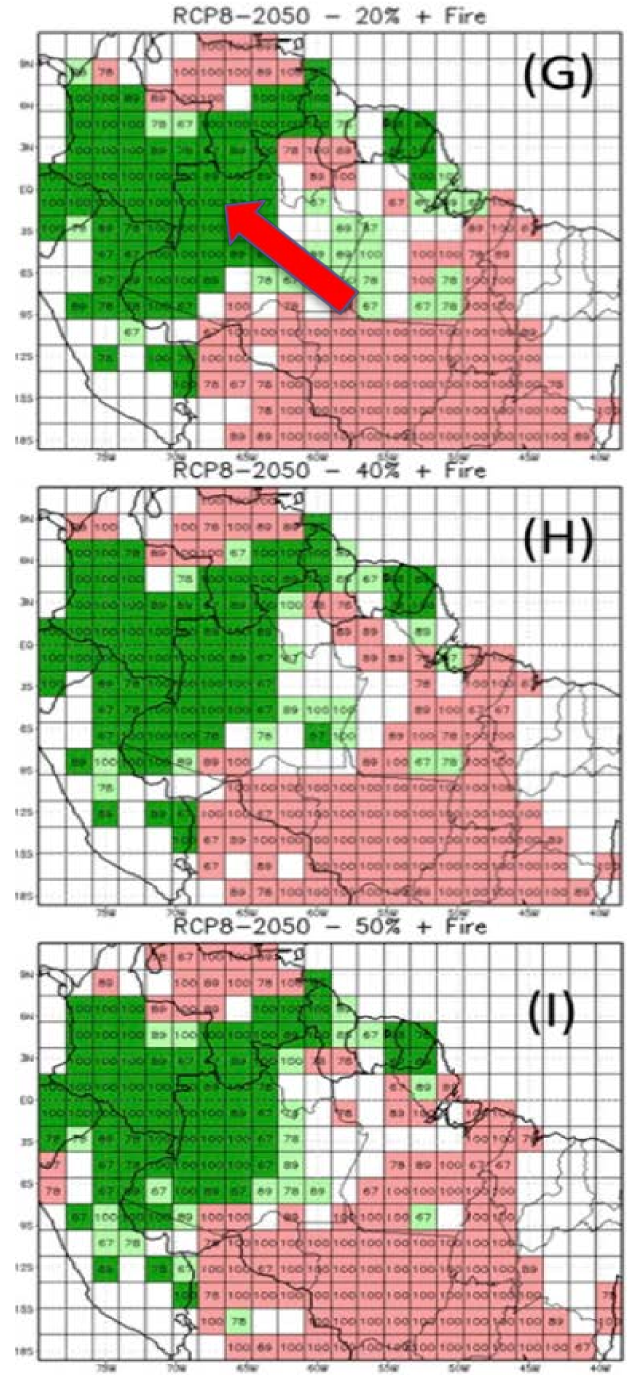
Brazil is already becoming a dryer area



Embrapa Informática Agropecuária, 2019

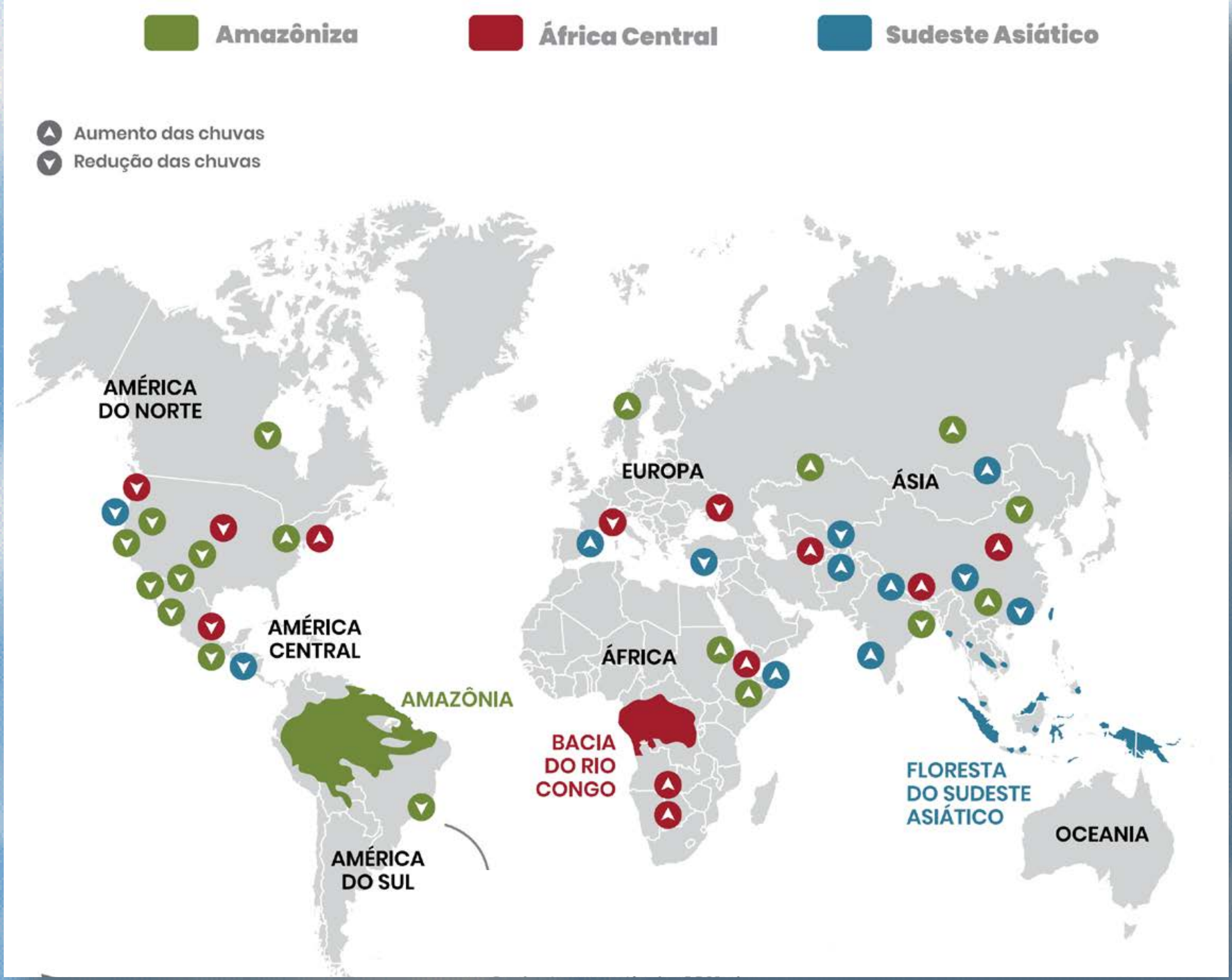
Projected distribution of natural biomes in South America





Nobre et al., PNAS, 2016

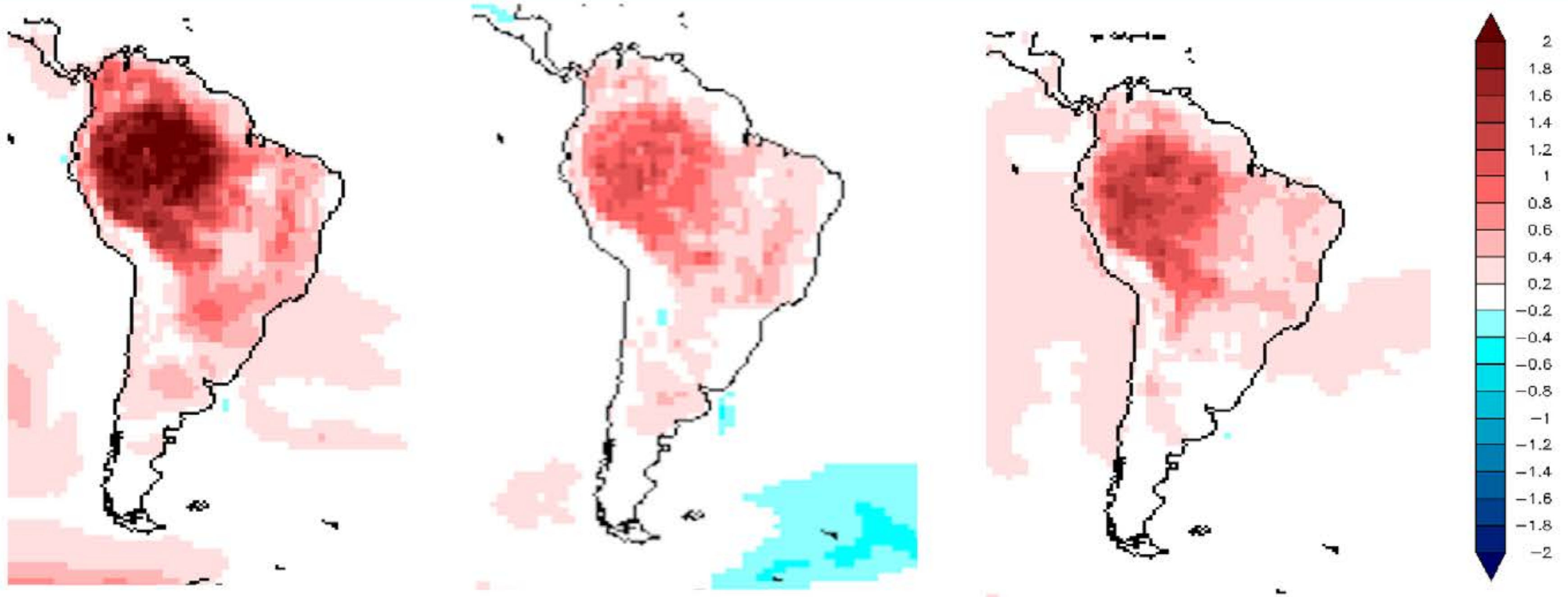
A world without tropical forests



Marengo and Souza, 2019, Lawrence and Vandecar 2015

The world without Amazonia in 2050...

Changes in surface temperature, °C



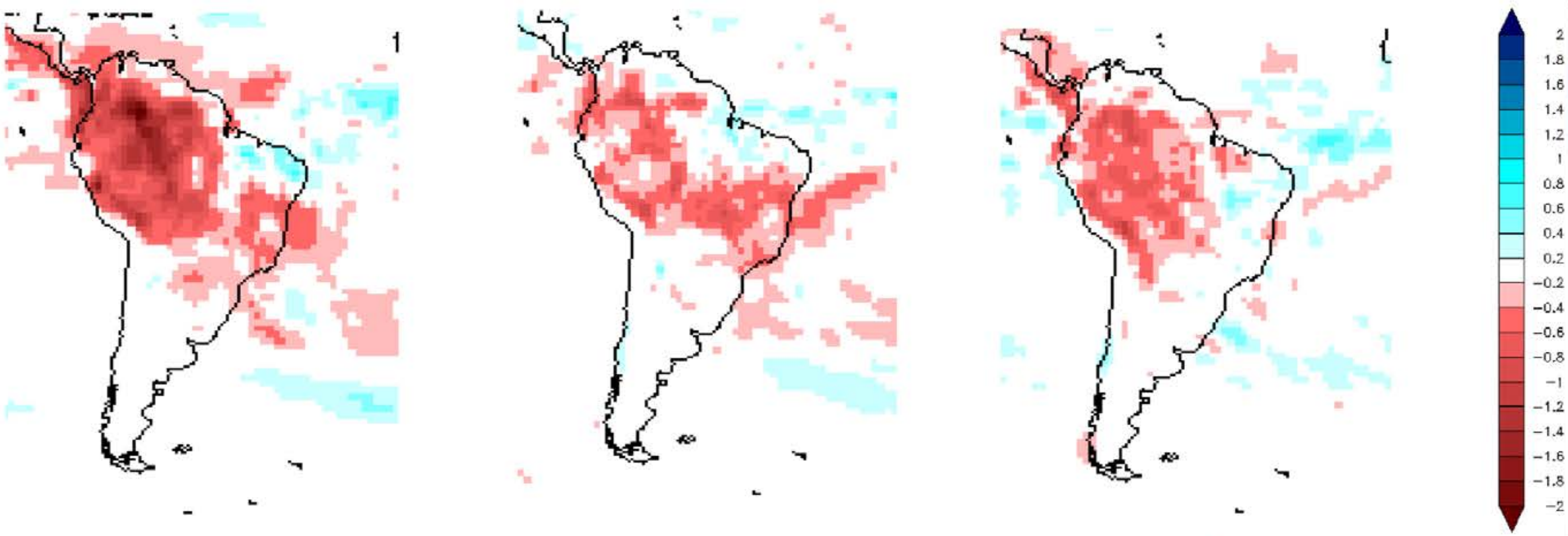
SSP1, 100% SSP1, 50% SSP5, 50%

Simulations GFDL – 50% and 100% deforestation and SSP1 SSP5

Shevliakova and Pacala - Exploring a World Without the Amazon 2019

The world without Amazonia in 2050...

Changes in precipitation, mm/day



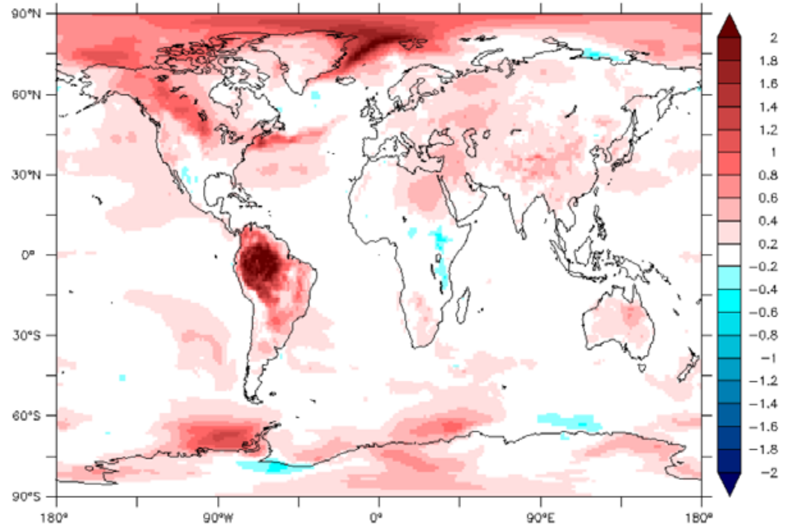
SSP1, 100% SSP1, 50% SSP5, 50%

Shevliakova and Pacala - Exploring a World Without the Amazon 2019

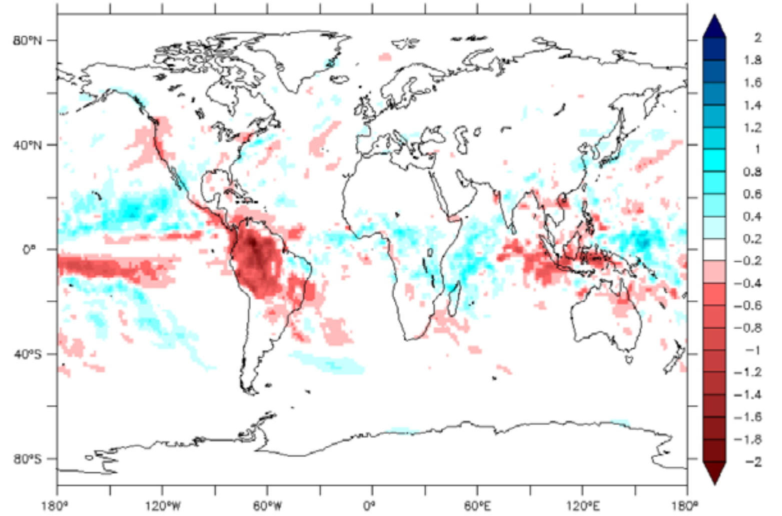
The world without Amazonia in 2050…

Global effect under the ambitious pathway (100%)

Temperature change



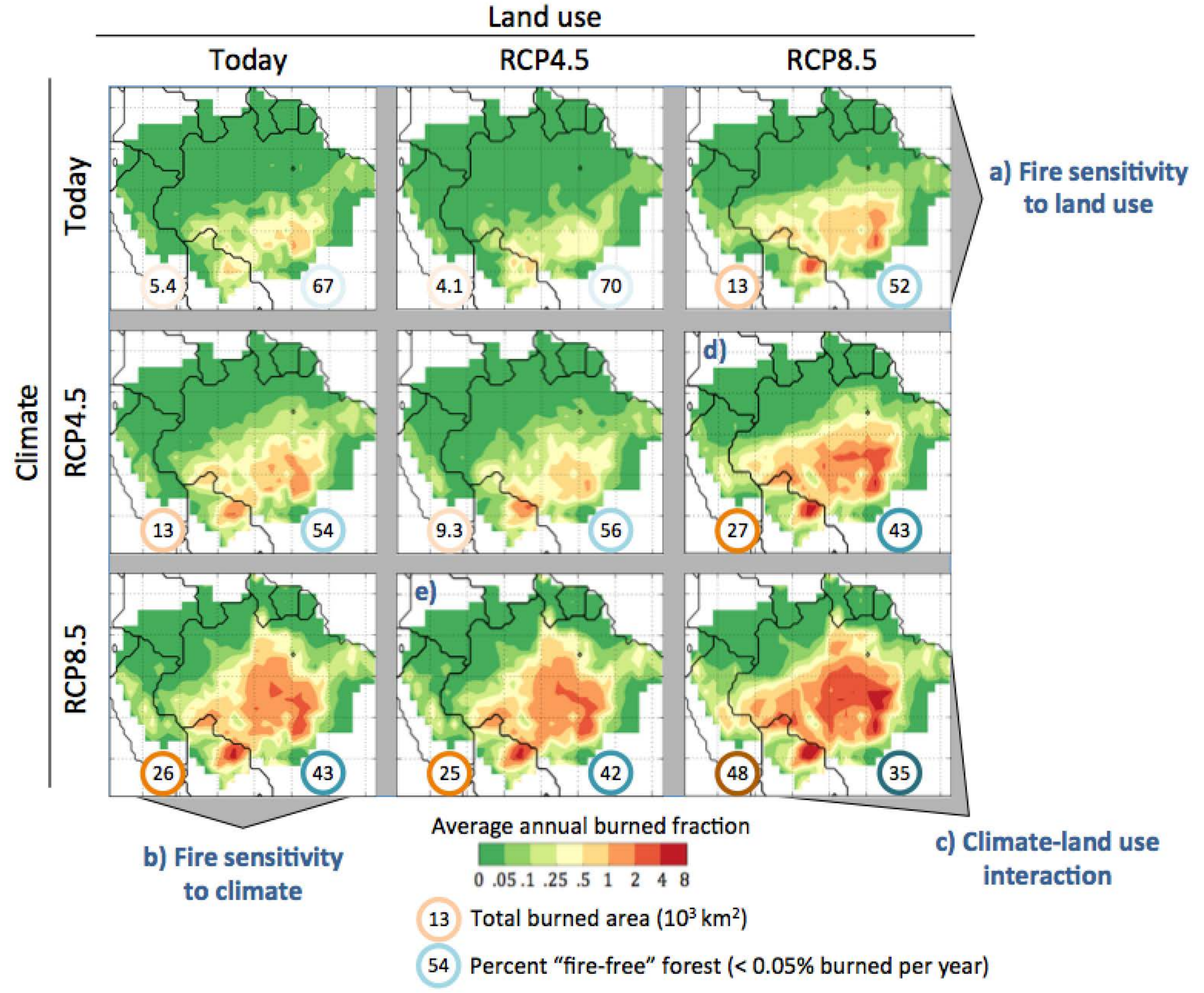
Precipitation change



ΔT increase: 0.25 C, Δ CO_2: 30 ppm

Shevliakova and Pacala - Exploring a World Without the Amazon 2019

Fire sensitivity to Climate and Land Use



Alone, restricting further deforestation will not protect Amazon forests from greater fire risk in coming decades.

Le Page et al., 2017

Amazonia is key to global sustainability

Thanks!!!

This work was supported by the National Institute of Science and Technology for Climate Change Phase 2 under CNPq Grant 465501/2014-1, and FAPESP Grants 2014/50848-9 and the CAPES Grant 88887.136402/2017-00.

Amazonia and other forests are critically important to our global climate…

Thanks for the attention!!!

This work was supported by the National Institute of Science and Technology for Climate Change Phase 2 under CNPq Grant 465501/2014-1, and FAPESP Grants 2014/50848-9 and the National Coordination for High Level Education and Training (CAPES) Grant 88887.136402/2017-00.