33rd WGNE Meeting, Tokyo, Japan
Oct 2018

Fixing systematic errors at CPTEC

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Thanks to P. Kubota, G. Pereira, D. Castilho, E. Ramirez, D. França, E. Vendrasco

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October 2018

Outline

→ Progress on regional modelling

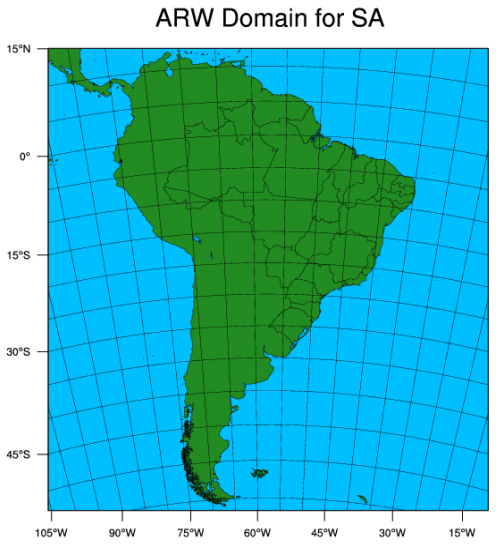
→ Progress on global modelling

New Operational Regional Model at CPTEC

www.cptec.inpe.br

- Model: WRF
- Dynamic Core: ARW
- Initial version: 3.9.1.1
- Resolution: 5km
- Levels: 42
- Vertical coordinate: Sigma
- Operational since June 1, 2018
- It runs twice a day (00 e 12Z)

Microphysics	Ferrier
PBL	YSU – Yonsei University
Surface	Noah
Surface Layer	Monin-Obukhov revised
Convection	New Tiedke
Radiation	RRTMG



BRAMS - Research regional model at CPTEC

www.cptec.inpe.br

BRAMS air quality (20km already in operation)

Improvements in the pre-processor tool

Improvements of 3BEM methodology – review of emission factors

FRP methodology (version 1.6)

Streets invetory for MARJ (version 1.5)

Improvement of urban emissions for MASP

***Improvements in the model* (only research)**

Implementation of Runge-Kutta time integration scheme (under tests)

Implementation of a new computational method on chemistry module

~70% more efficient

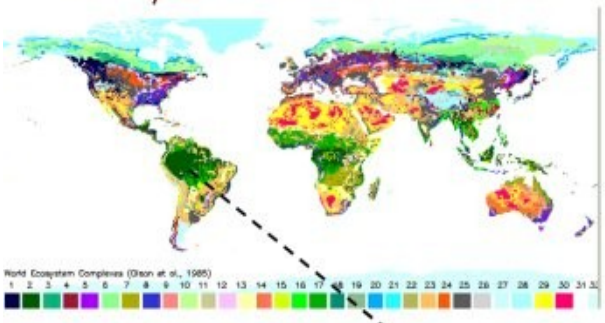
3BEM Model

www.cptec.inpe.br

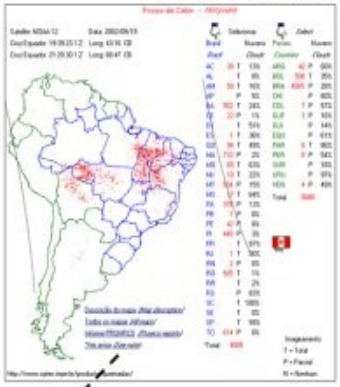
Biomass burning emissions inventory

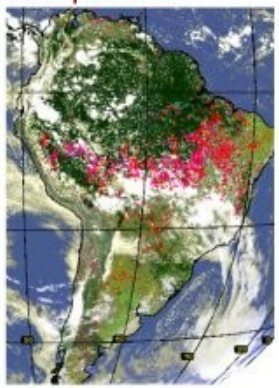
Brazilian Fire Emission Model: Regional scale – daily basis

density of carbon data



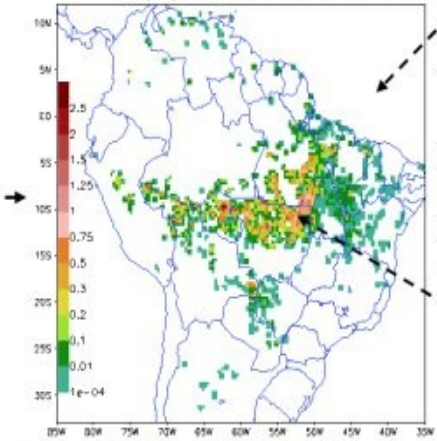
near real time fire product





land use data

CO Source Emission (ton[CO]/km^2 day) – 07SEP2002



emission & combustion factors

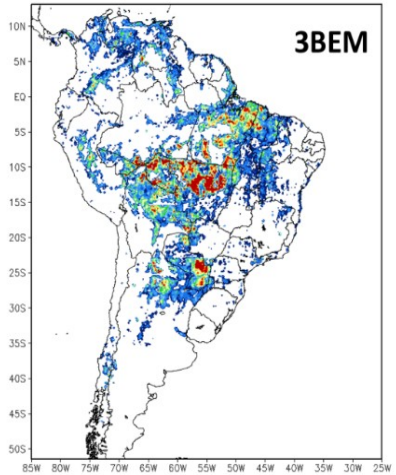
Biome category	Emission Factor for CO (g/kg)	Emission Factor for PM2.5 (g/kg)	Aboveground biomass density (α, kg/m^2)	Combustion factor (β, fraction)
Tropical forest[1]	110.	8.3	20.7	0.48
South America savanna[2]	63.	4.4	0.9	0.78
Pasture[3]	49.	2.1	0.7	1.00

[1] Average values for primary and second-growth tropical forests, [2] Average values for campo cerrado (C3) and cerrado sensu stricto (C4), [3] value for campo limpo (C1). All numbers are from Ward et al.,

mass estimation

$$M[\eta] = \alpha_{veg} \cdot \beta_{veg} \cdot E f_{veg}^{[\eta]} \cdot a_{fire}$$

CO source emission (kg m^{-2}day^{-1})

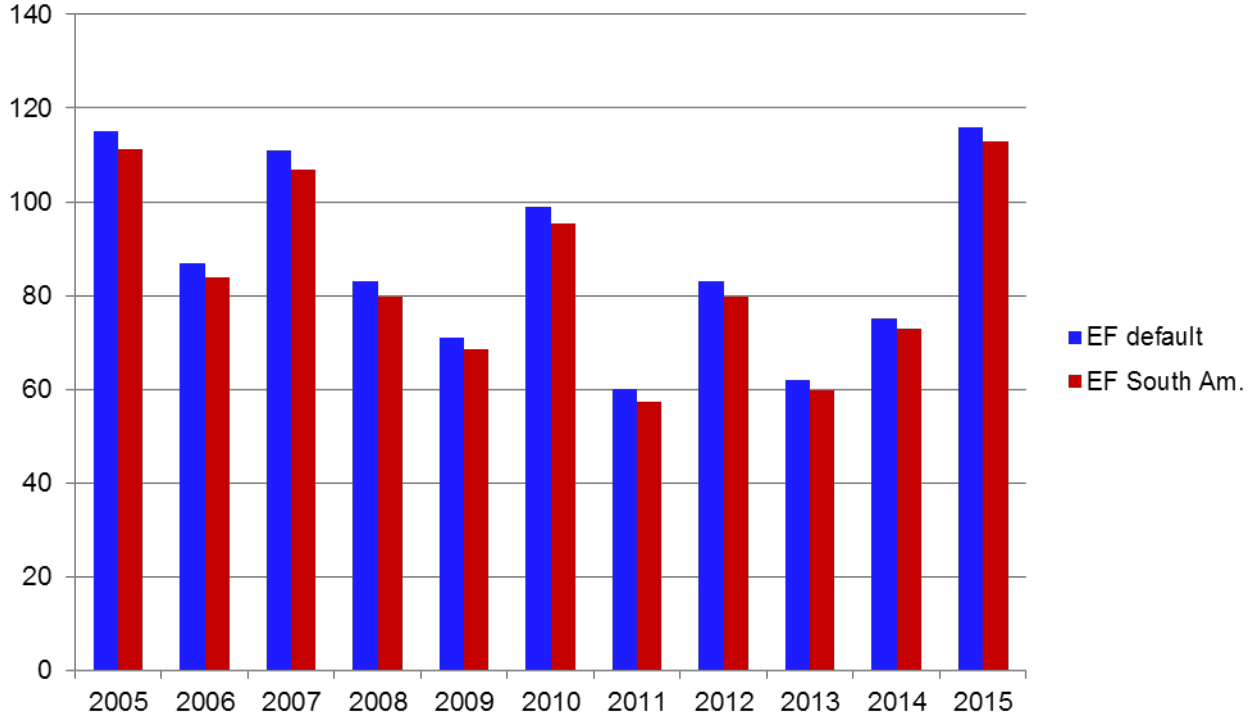


Longo et al, 2011

Courtesy G. Pereira and D. França

Emission factors updates

Annual Emissions of CO (Tg) from biomass burning in South America



- Emission inventories with 20 km x 20 km spatial resolution;
- PREP using fire counts;
- EFs updates based on Andreae e Merlet (2001), Andreae (personal comunication, 2016) and Yokelson et al. (2013).

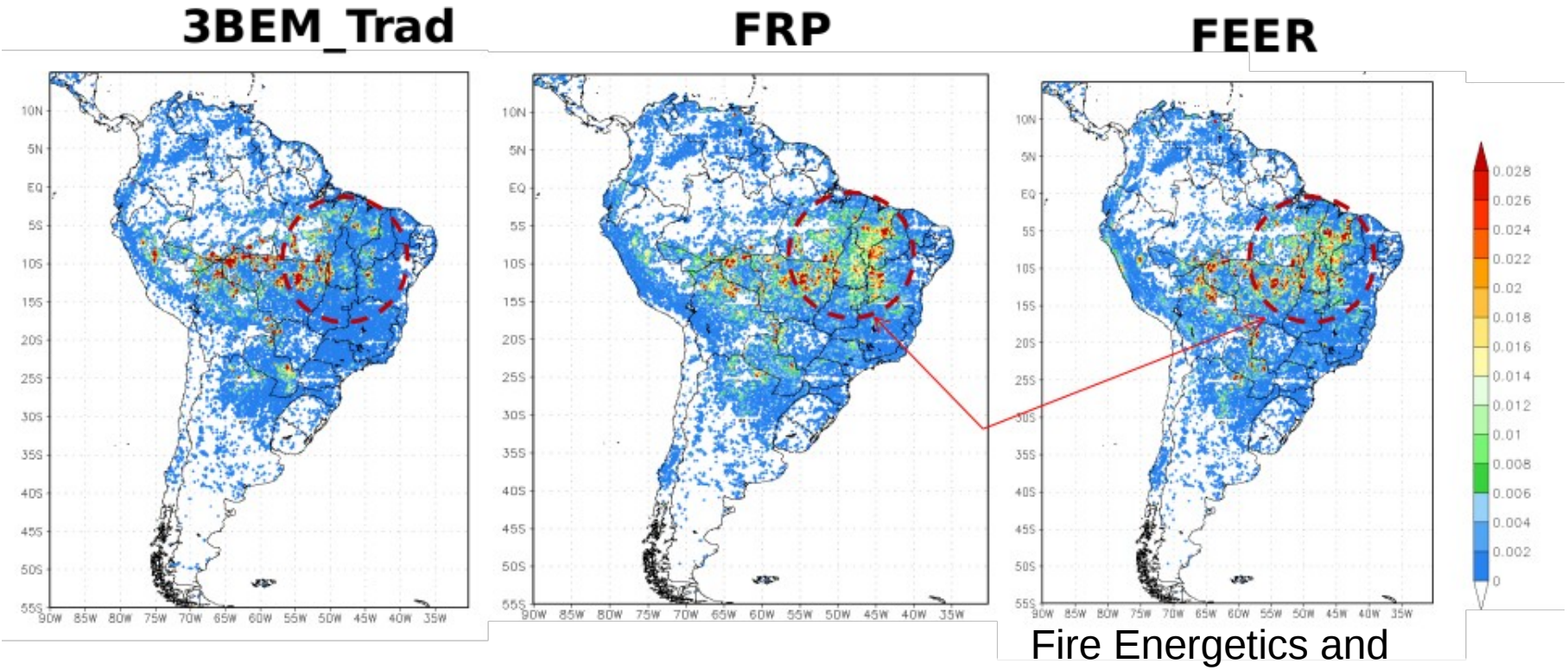
Courtesy G. Pereira and D. França

FRP implementation

www.cptec.inpe.br

Inventories evaluation

CO (Kg/m2)

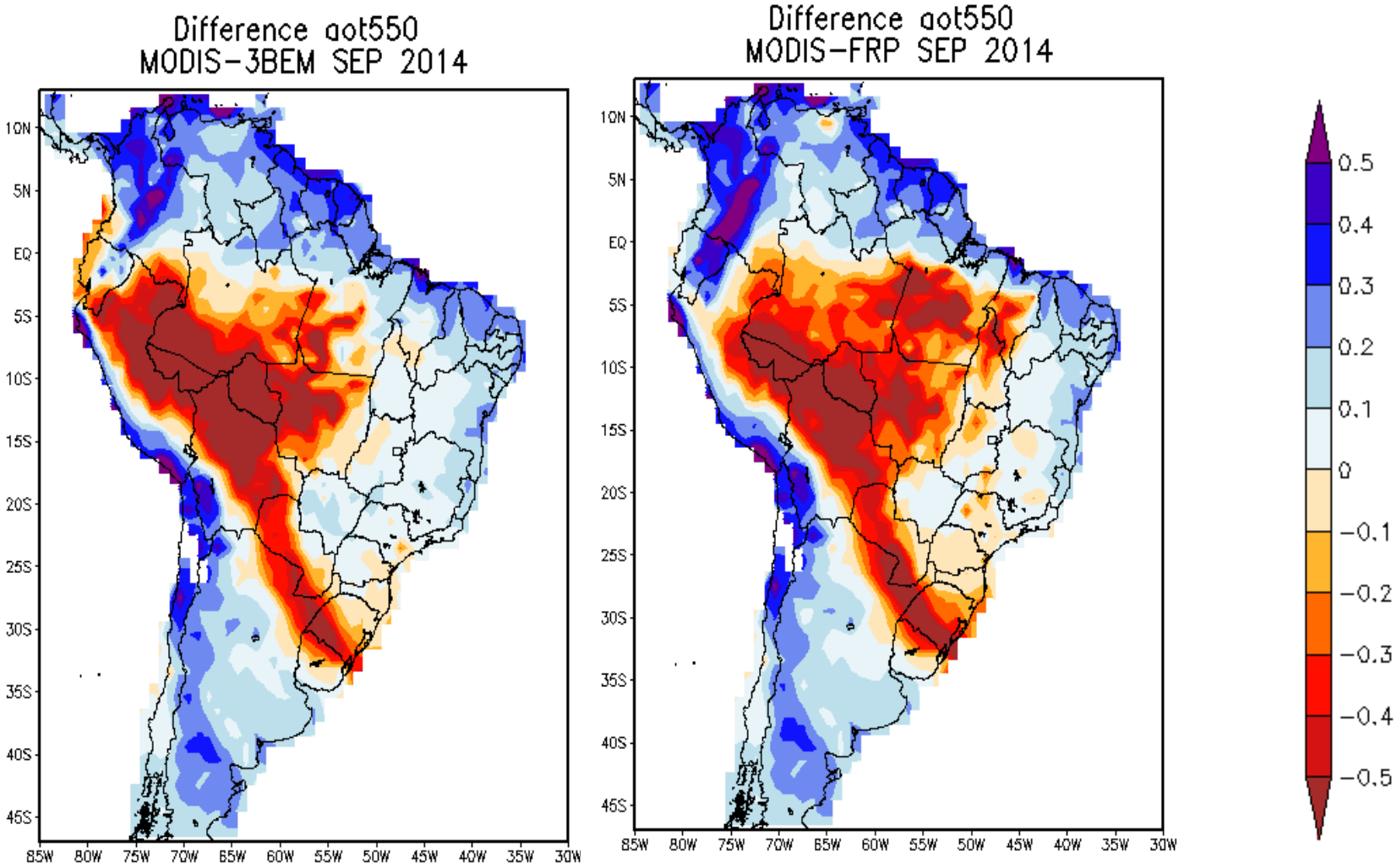


Courtesy: Gabriel Pereira

Fire Energetics and Emissions Research (FEER)

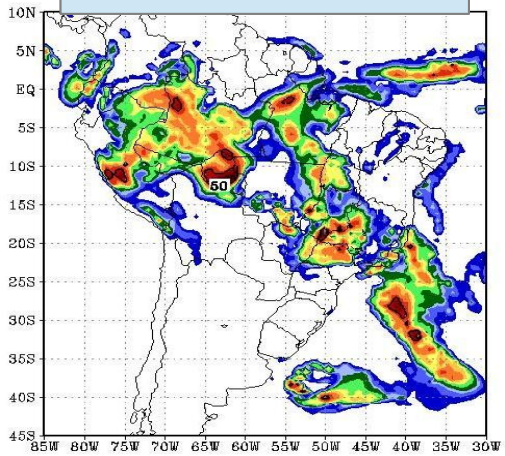
Towards the implementation of FRP at CPTEC/INPE

www.cptec.inpe.br

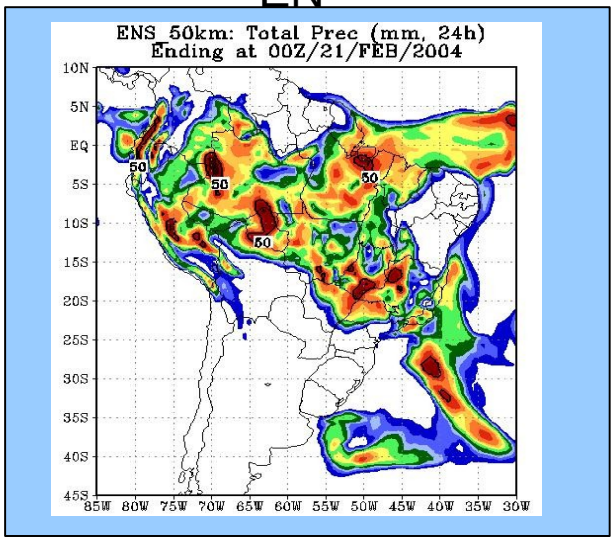


Applying an optimization method to improve convective parameterizations

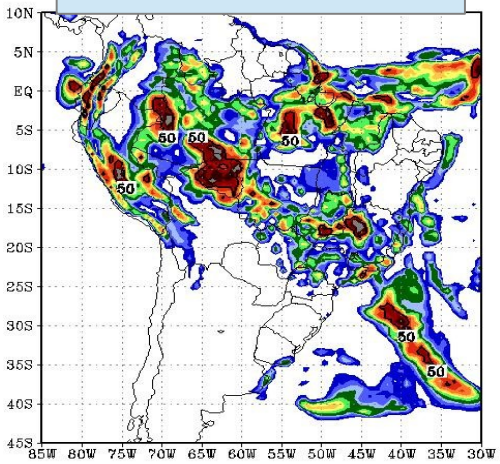
AS



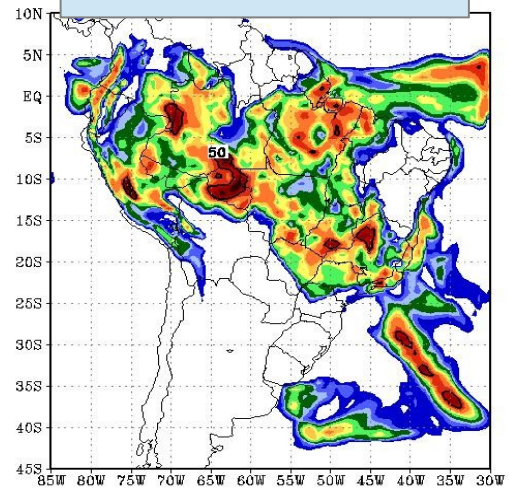
EN



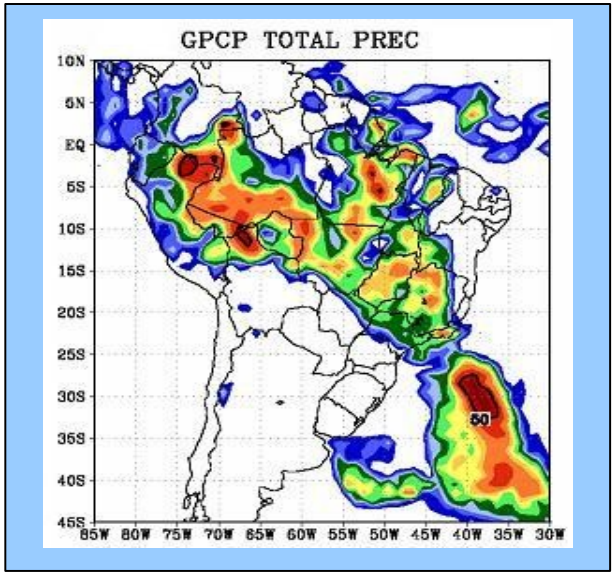
MC



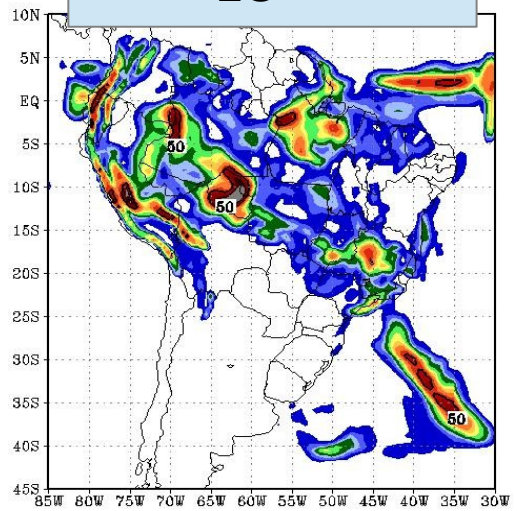
GR



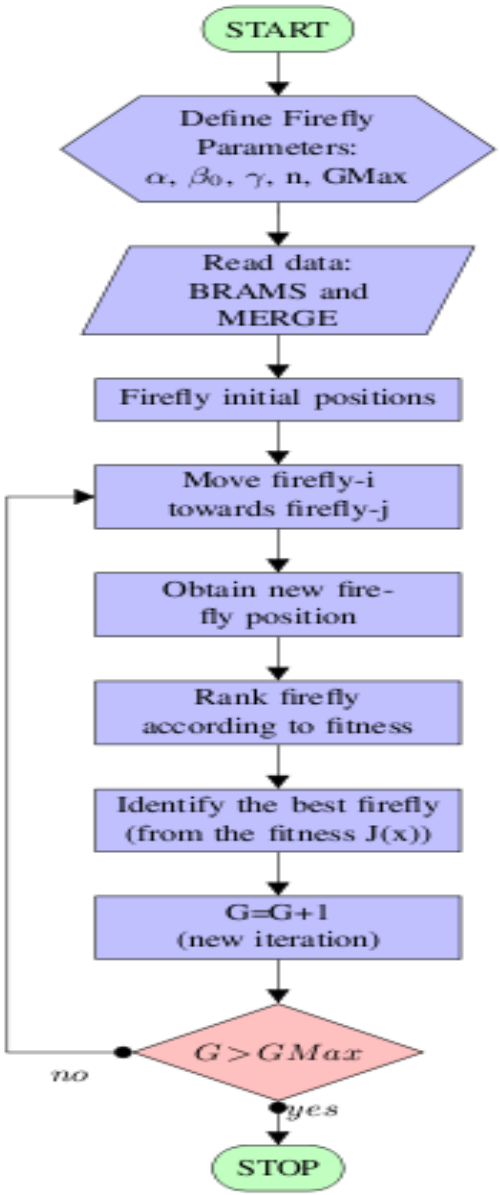
GPCP

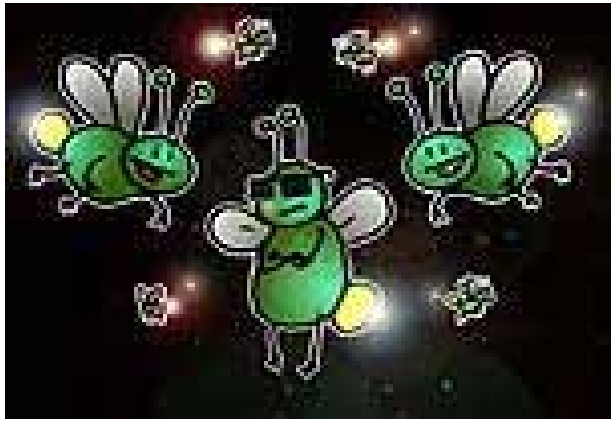


LO



Freitas et al, 2005b





$$\min \left\{ P_M - P_O \right\}$$

model obs

dos Santos et al. (2013)

Optimization method to improve convective parameterizations

Inverse problem: parameter estimation

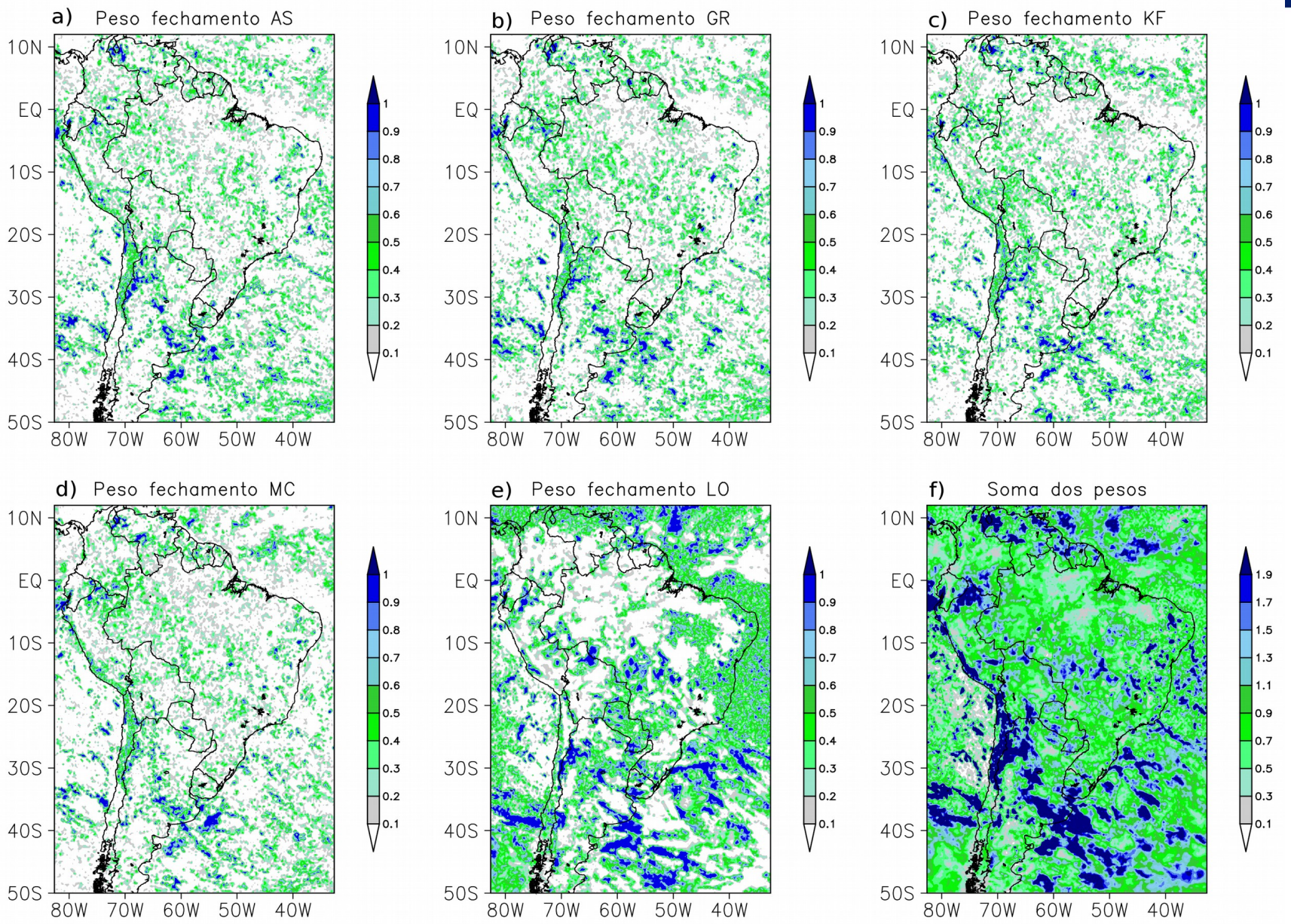
Inverse model

$$J(\overrightarrow{P}) = min||P_M(\overrightarrow{W}^T) - P_O||_2^2$$

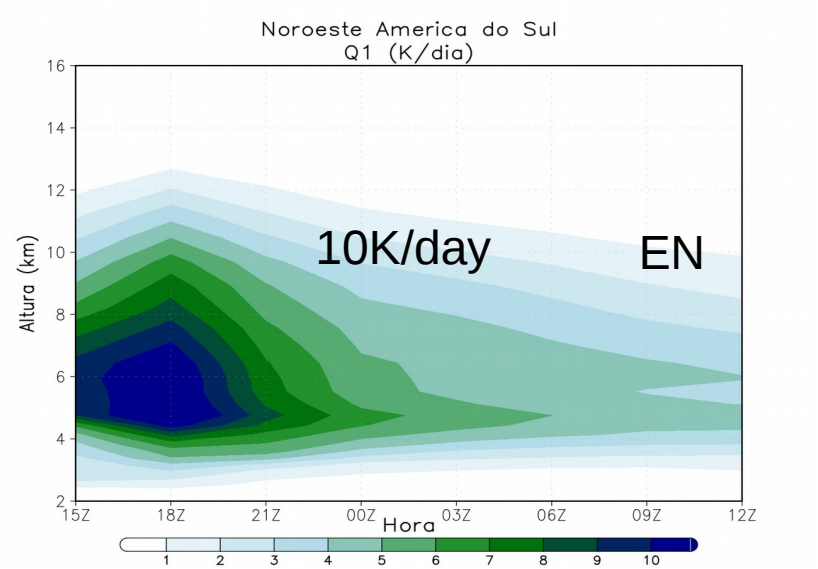
$$= \sum_{i=1}^{5}[P_M(w_i) - P_O]^2, \qquad P_M = \sum_{i=1}^{5} w_i P_i$$

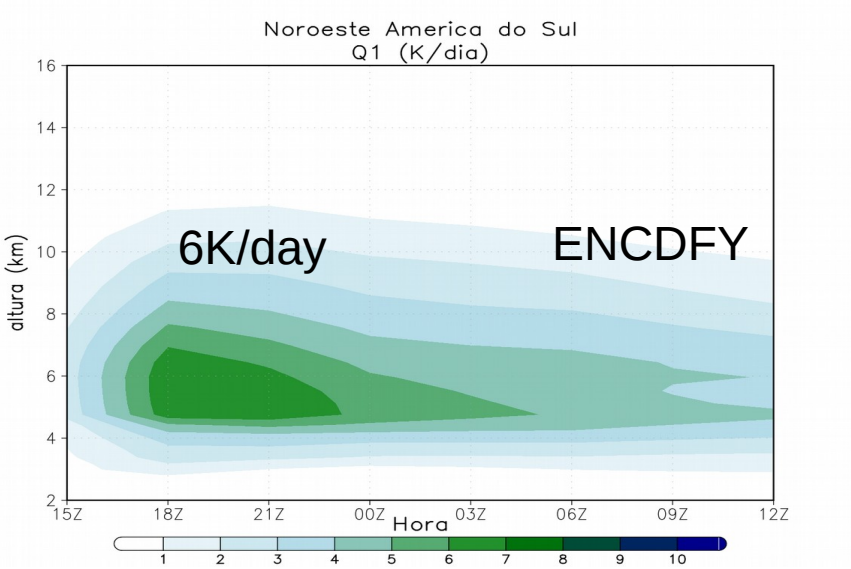
$$\overrightarrow{W}^T = [w_{GR}, w_{MC}, w_{LO}, w_{KF}, w_{AS}]$$

Weights

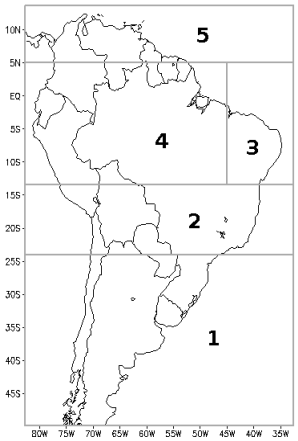

a) Peso fechamento AS
b) Peso fechamento GR
c) Peso fechamento KF
d) Peso fechamento MC
e) Peso fechamento LO
f) Soma dos pesos
10N
EQ
10S
20S
30S
40S
50S
80W
70W
60W
50W
40W
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
1.9
1.7
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1

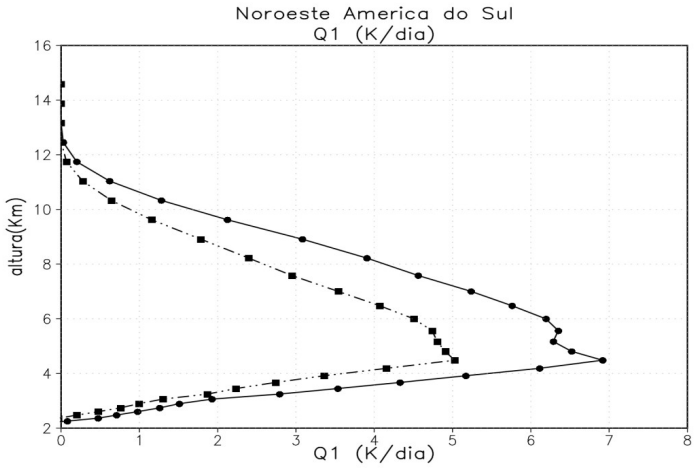
Heating rate (Q1) Northwest South America





Mean





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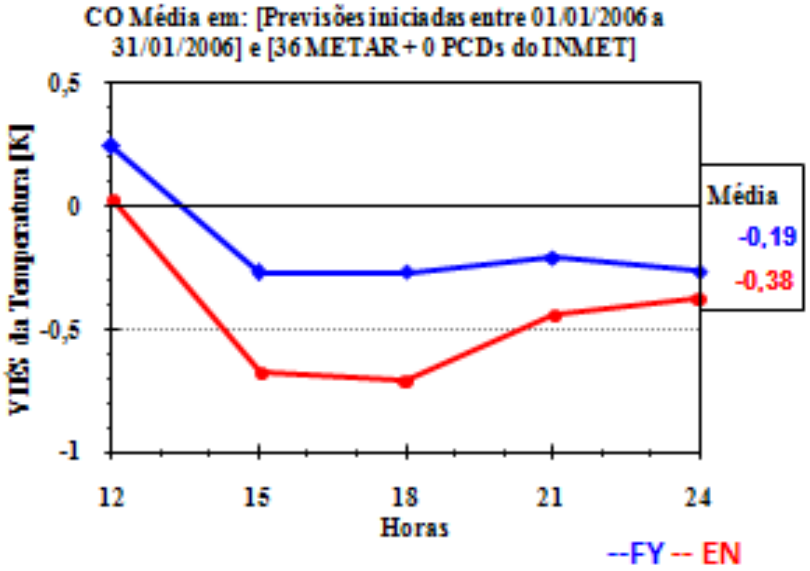
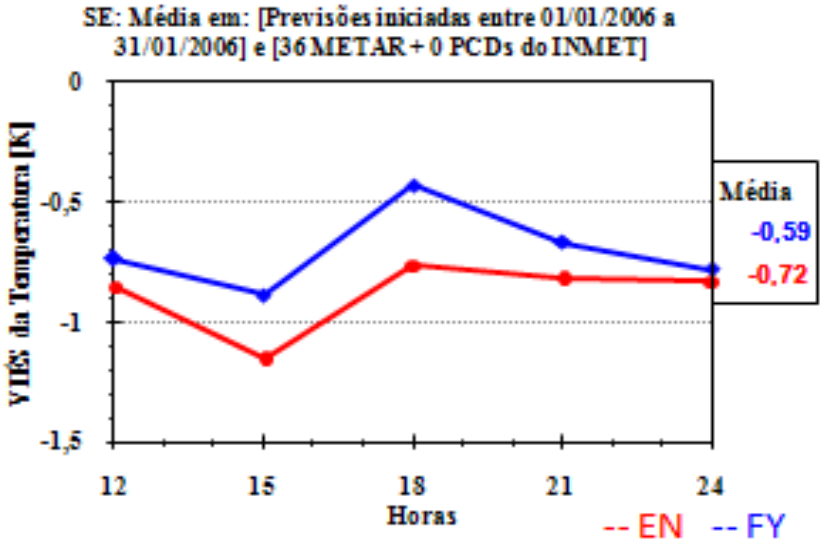
— EN

Bias 2-meter temperature





– FY

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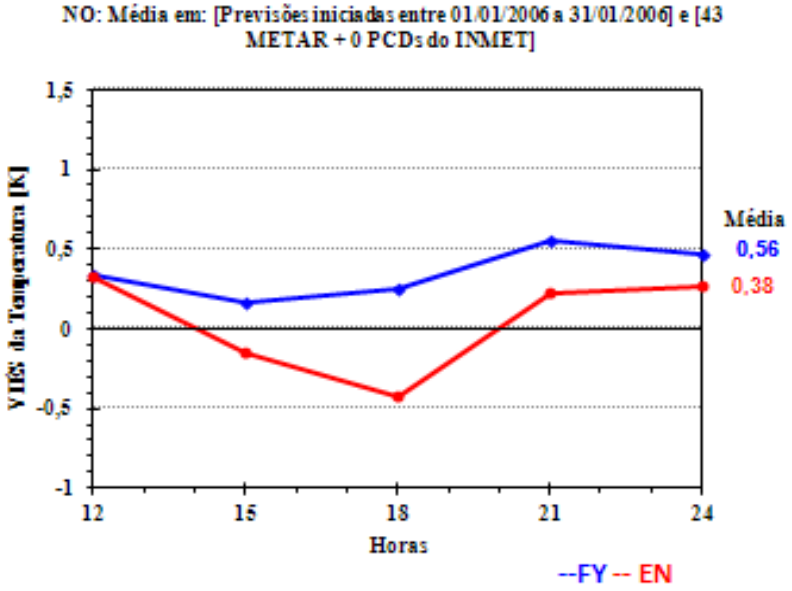
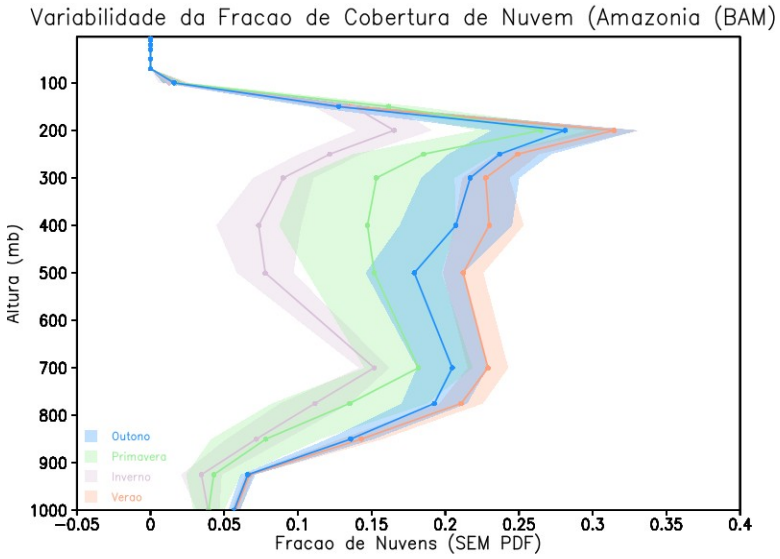


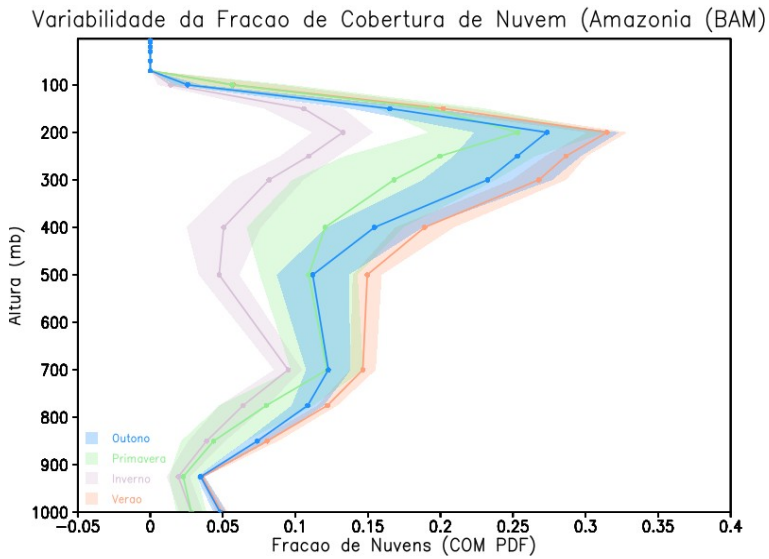
BAM - Global Model configuration

	Figueroa et al., 2016
Dynamics	Spectral EU or SL semi-implicit model, with hydrostatic approximation, sigma vertical coordinate
Cloud microphysics	Double-moment microphysics scheme (Morrison et al. 2009)
SW and LW radiation *Implement. optical properties*	CLIRAD; Chou and Suarez (1999) and modified by Tarasova and Fomin (2000)
Deep convection *Improvements on the scheme*	Simplified version of Arakawa
Shallow convection	UW shallow convection (Park and Bretherton 2009)
Vertical diffusion	Modified Mellor and Yamada (1982) scheme
Land surface processes *New eq. to compute surface albedo* *Seasonal variability of LAI*	Dynamic vegetation model, IBIS

Brazilian global Atmospheric Model

Implementation of a new cloud parameterization



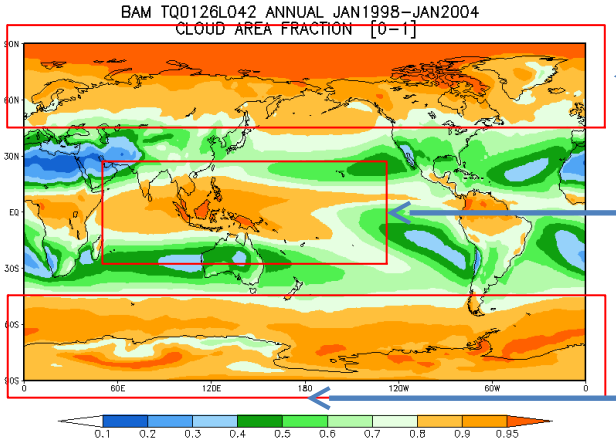


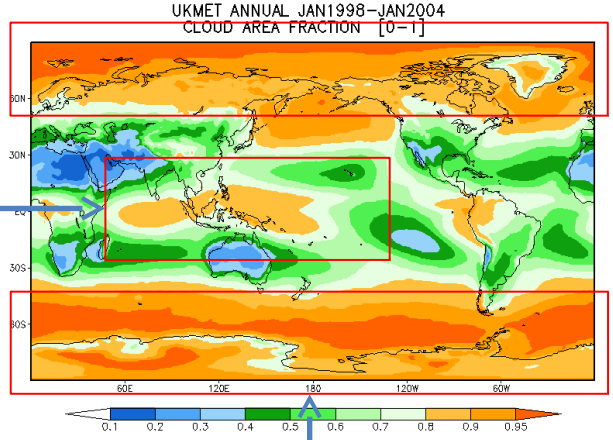
Without PDF(a) and with BAM PDF (1998-2008) cloud cover over Amazon for winter (purple), spring (green), fall (blue), summer (orange)

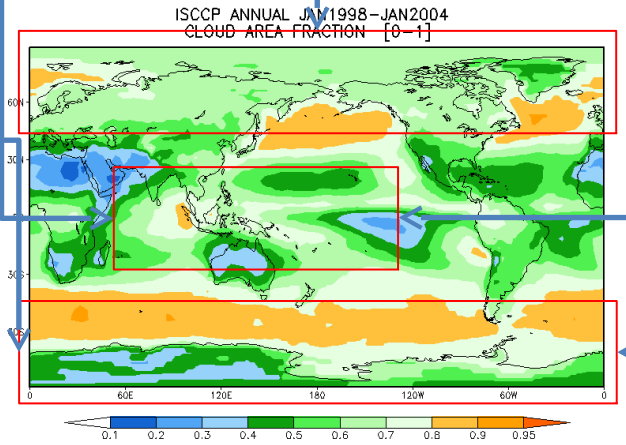
Courtesy Dayana Castilho

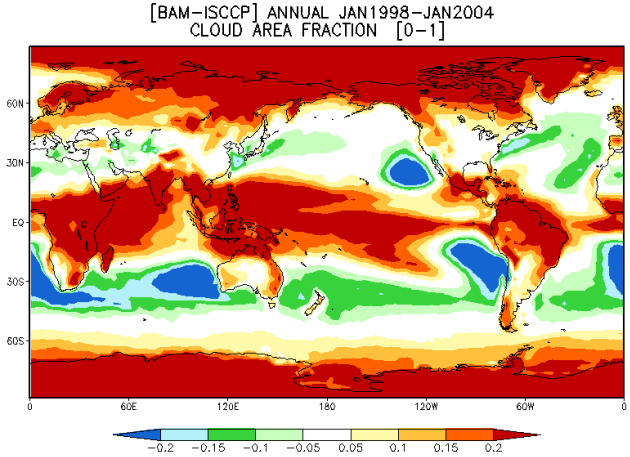
The Climate Science for Service Partnership Brazil

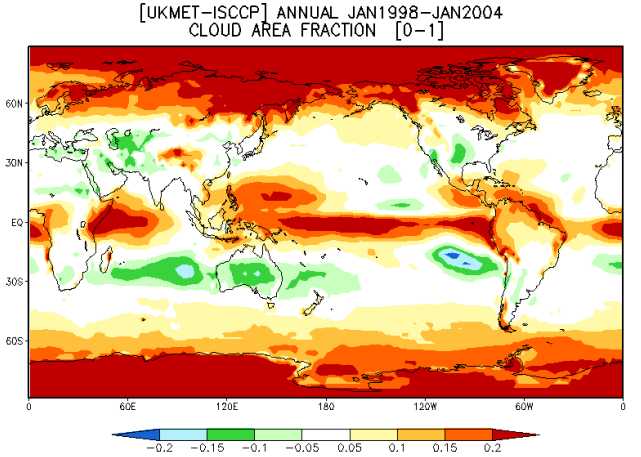
www.cptec.inpe.br











Courtesy Dayana Castilho

Thanks for your attention!