

# Progress in Earth System Modeling in Brazil

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WCRP Advisory Council Meeting  
Brasília, 27 May 2013

# Outline

- History of modeling efforts in Brazil
  - CPTEC & LBA
  - CATT/BRAMS
- Status Quo of
- Future actions needed

1950

1960

1970

1980

1990

2000

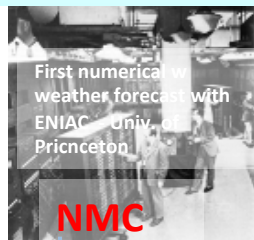
2010

2020



Very simple models of the atmosphere

Atmosphere

Atmosphere  
SurfaceAtmosphere  
Surface  
Ocean and ocean iceAtmosphere  
Surface  
Ocean and ocean ice  
Aerosol  
CarbonAtmosphere  
Surface  
Ocean and ocean ice  
Aerosol  
Carbon  
Vegetation Dynamics  
Atmospheric ChemistryEvolution of numerical  
Modelling  
componentsBeginning of  
assimilation of  
Satellite data in  
NWP

1950

1960

1970

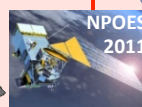
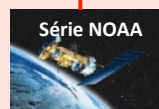
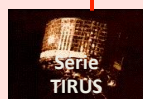
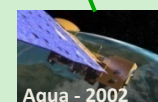
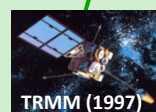
1980

1990

2000

2010

2020

Polar Orbit  
OperationalGeostationary  
OrbitPolar Orbit  
For research  
Used  
Operationally



June 26, 2012

Português English

Select One:

Home

Study

Training and Education

Communication and Outreach

Organization and Coordination

LBA-DIS

On-Line Products

Events

## ? About LBA

The Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) is an international research initiative led by Brazil. LBA is designed to create the new knowledge needed to understand the climatological, ecological, biogeochemical, and hydrological functioning of Amazonia, the impact of land use change on these functions, and the interactions between Amazonia and the Earth system.

## Training and Education

O êxito desse programa é, em grande parte, resultante da prioridade que o LBA sempre atribuiu à formação de novos pesquisadores e à excelência na qualificação de pesquisadores em níveis avançados. Antes mesmo que se iniciassem os trabalhos de campo do LBA, ainda nas etapas de planejamento do programa em 1995, foi criado o primeiro Comitê de Treinamento e Educação para definir os objetivos e planejar as metas de curto e longo prazo em treinamento e educação:

- melhorar a qualificação dos pesquisadores do LBA mediante a capacitação técnica e formação científica.
- expandir e fortalecer a comunidade científica em pesquisas ambientais e climáticas na Amazônia.

## Special Edition LBA

- » Acta Amazônica, v.35 (2), 2005.
- » Earth Interactions, v. 09. June-July 2005
- » Ecological Applications, v. 14, n. 4, Supplement, 2004
- » Philosophical Transactions of the Royal Society : "Tropical forests and global atmospheric change". Malhi & Phillips editors, 29 March 2004
- » Global Change Biology, v. 10, n. 5, 2004
- » Theoretical and Applied Climatology, v. 78, n. 1-3, 2004
- » Remote Sensing of Environment, v. 87, n. 4, 2003
- » Journal of Geophysical Research (Atmosphere), v. 107, n. D20, set., 2002.
- » Global Change Newsletter IGBP no. 45, 2001

## News

» **[07-16-09] - Caxiuanã sedia curso internacional sobre Ecologia e Biogeoquímica da Amazônia**  
Projeto LBA-ECO sedia curso internacional sobre Ecologia e Biogeoquímica da Amazônia na FLONA de Caxiuanã

» **[05-21-09] - Experimento LBA/BARCA estuda o balanço regional de carbono na Amazonia**  
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## Events



## On-line Systems



## RAINFOR News

### March 2012

*Esteban Alvarez and Alvaro Cogollo have been successful in their application to COLCIENCIAS*

### February 2012

*Oliver Phillips gave an invited research talk about Amazon research findings at the Universidad de Los Andes, Venezuela*

### July 2011

*'A Large and Persistent Carbon Sink in the World's Forests'*

### June 2011

*Workshop: "Environmental science in Amazonia:RAINFOR as a catalyst to integrate projects under a regional network,analyse data and develop manuscripts" was hosted at the Escola da Floresta, Brazil*

*Research Agreement with SERNANP*

### May 2011

*Research Agreement with La Comunidad de Monte Grande*

### September 2010

*Research Agreement with IBIF and UAB*

### July 2010

*'Saber Amazónico' (IIAP-2009) - Video showing RAINFOR work in Peru*

## Welcome to the RAINFOR Website

The Amazon Forest Inventory Network is an international network that has been established to understand the biomass and dynamics of Amazonian forests. Since 2000 we have established a systematic framework for long-term monitoring of this region, which holds more biodiversity, water, and vegetation carbon, than any other region of the planet. RAINFOR has worked step-by-step with partners across the nations of Amazon, taking account of the potentially strong modulating role of environmental variables like soil nutrition, and the need to help develop a new generation of Amazon ecologists. RAINFOR is currently supported by the Andes and Amazon Initiative of the Gordon and Betty Moore Foundation and by NERC as part of the AMAZONICA consortium.



English | [Español](#) | [Português](#)



Newsletters



FORESTPLOTS.NET

















04 10 2002 14:20





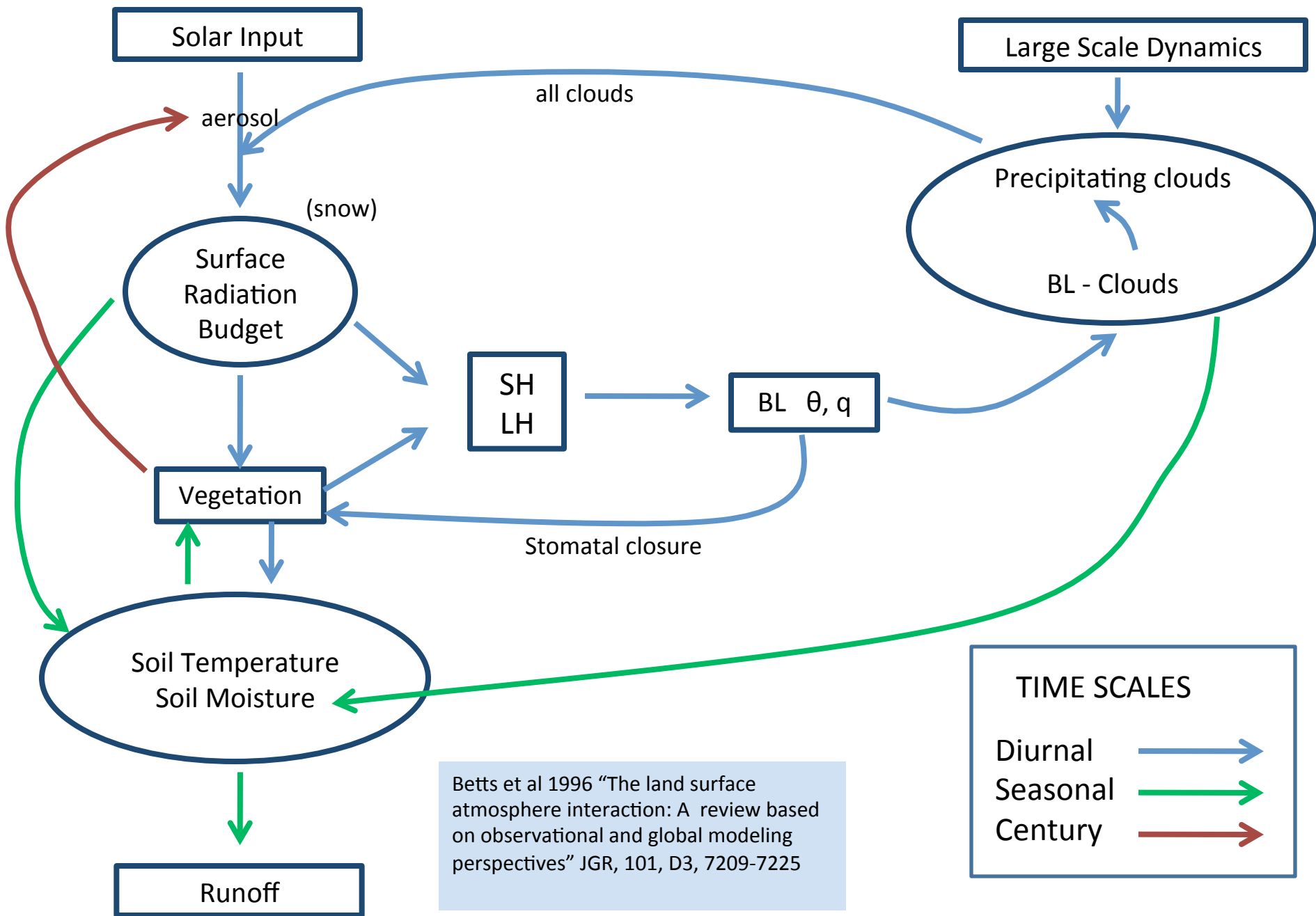
# GOES-10 26-27 April 2007

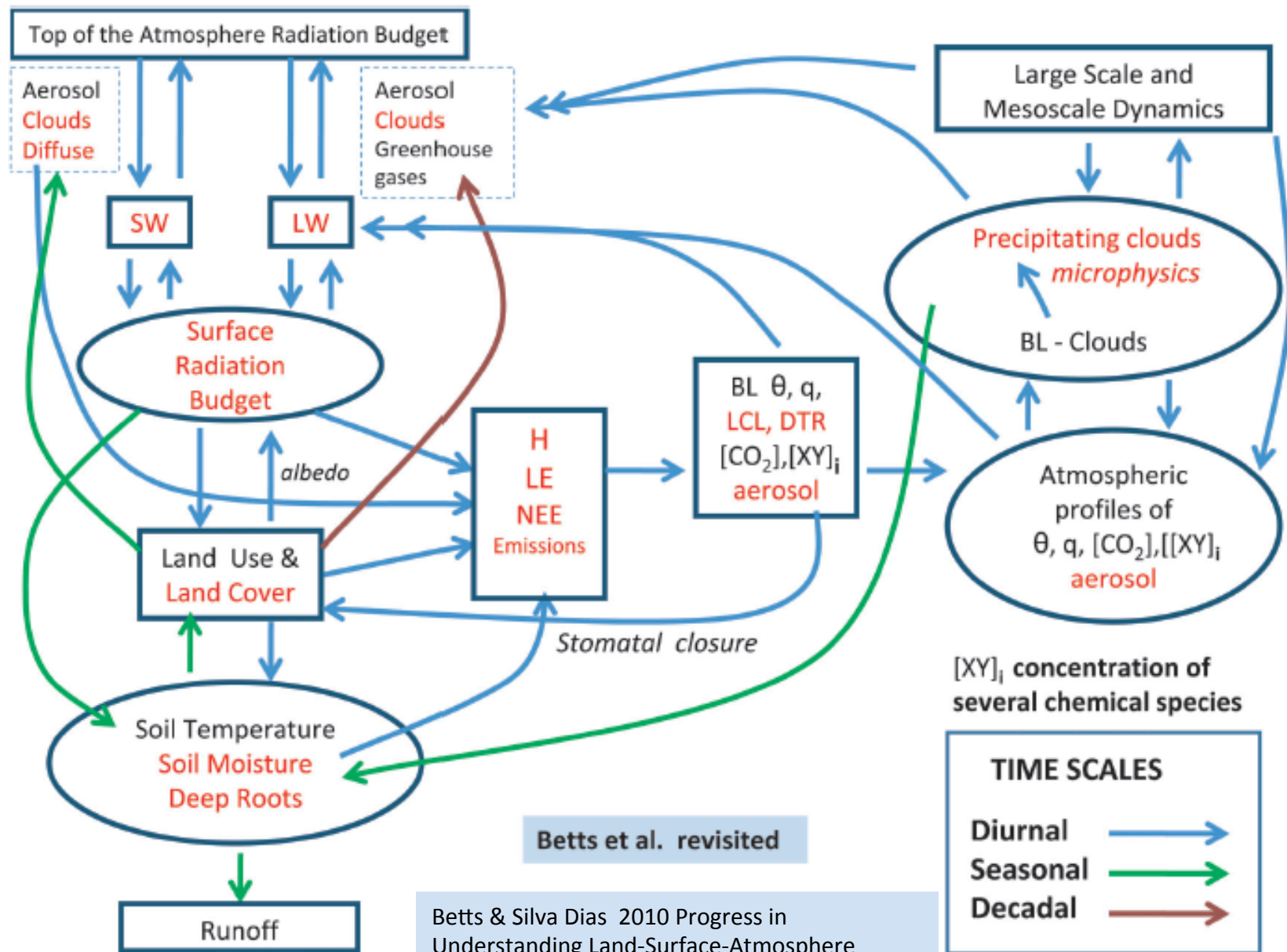


# Ten year perspective from LBA

- **Many coupled processes**
- Shortwave and longwave fluxes: clouds
  - Coupling of  $LW_{\text{net}}$  to diurnal temperature range
- Aerosols
  - role of fires in vertical transport
  - cloud microphysics & precipitation
- Partition of moisture convergence into column water vapor, cloud & precipitation
- Surface-cloud-boundary layer coupling







Betts & Silva Dias 2010 Progress in  
 Understanding Land-Surface-Atmosphere  
 Coupling from LBA Research. Journal of  
 Advances in Modeling Earth Systems. , v.2, 1-20

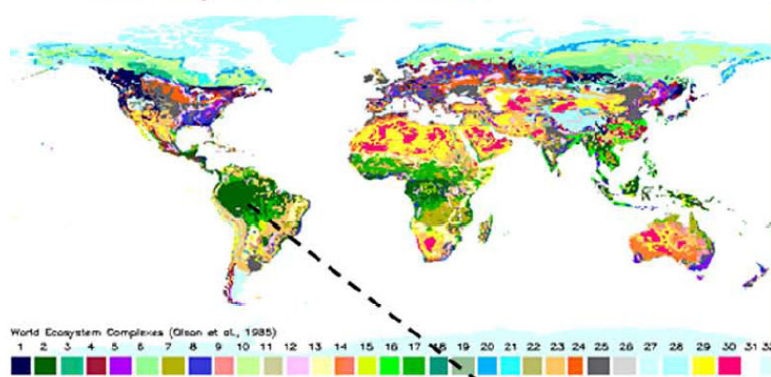


# Coupled Aerosol and Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS)

- Freitas, S. R., Longo, K. M., Silva Dias, M. A. F., Chatfield, R., Silva Dias, P., Artaxo, P., Andreae, M. O., Grell, G., Rodrigues, L. F., Fazenda, A., Panetta, J.. **2009**. The Coupled Aerosol and Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS). Part 1: Model description and evaluation In Atmospheric Chemistry and Physics v.9, 2843-2861
- Longo, K M ; Freitas, S. R. ; Andreae, M. O. ; Setzer, A. W. ; Prins, E. ; Artaxo, P.E. . The Coupled Aerosol and Tracer Transport Model to the Brazilian Development on the Regional Atmospheric Modeling System (CATT-BRAMS) Part 2: Model Sensitivity to the Biomass Burning Inventories. Atmospheric Chemistry and Physics (Online), v. 10, p. 5785-5795, **2010**
- Freitas, S. R., Longo, K. M., Chatfield, R., Latham, D., Silva Dias, M.A.F., Andreae, M. O, Prins, E., SantosJ C, Gielow, R., Carvalho JR, J A. **2007**. Including the sub-grid scale plume rise of vegetation fires in low resolution atmospheric transport models In Atmospheric Chemistry and Physics , v.7, 3385-3398
- Freitas, S. R. ; Longo, K M ; Alonso, M. F. ; M. Pirre ; Marécal, V. ; Grell, G. ; Stockler, R. ; R. ; Sánchez Gácita, M. . PREP-CHEM-SRC - 1.0: a preprocessor of trace gas and aerosol emission fields for regional and global atmospheric chemistry models. Geoscientific Model Development, v. 4, p. 419-433, **2011**.
- Freitas, S. R. ; Longo, K M ; Trentman, J. ; Latham, D. . Technical Note: Sensitivity of 1-D smoke plume rise models to the inclusion of environmental wind drag. Atmospheric Chemistry and Physics, v. 10, p. 585-594, **2010**.
- Vendraasco, E.P. ; Silva Dias, P.L. ; Freitas, E.D. . A case study of the direct radiative effect of biomass burning aerosols on precipitation in the Eastern Amazon. Atmospheric Research , v. 94, p. 409-421, **2009**.

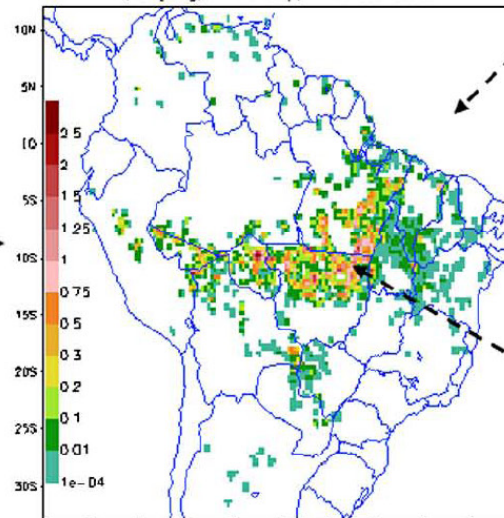
# Biomass Burning – CATT-BRAMS

density of carbon data



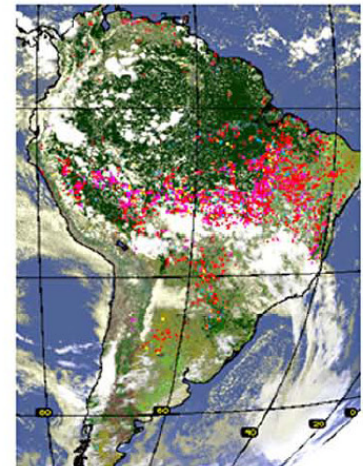
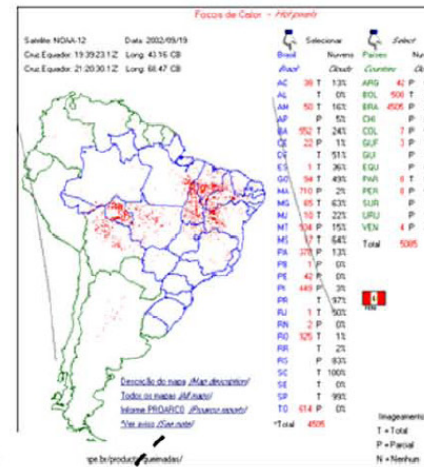
CO Source Emission  
(ton[CO]/km<sup>2</sup> day) – 07SEP2002

land use data



CO source emission (kg m<sup>-2</sup> day<sup>-1</sup>)

near real time fire product



emission & combustion factors

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

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

mass estimation

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

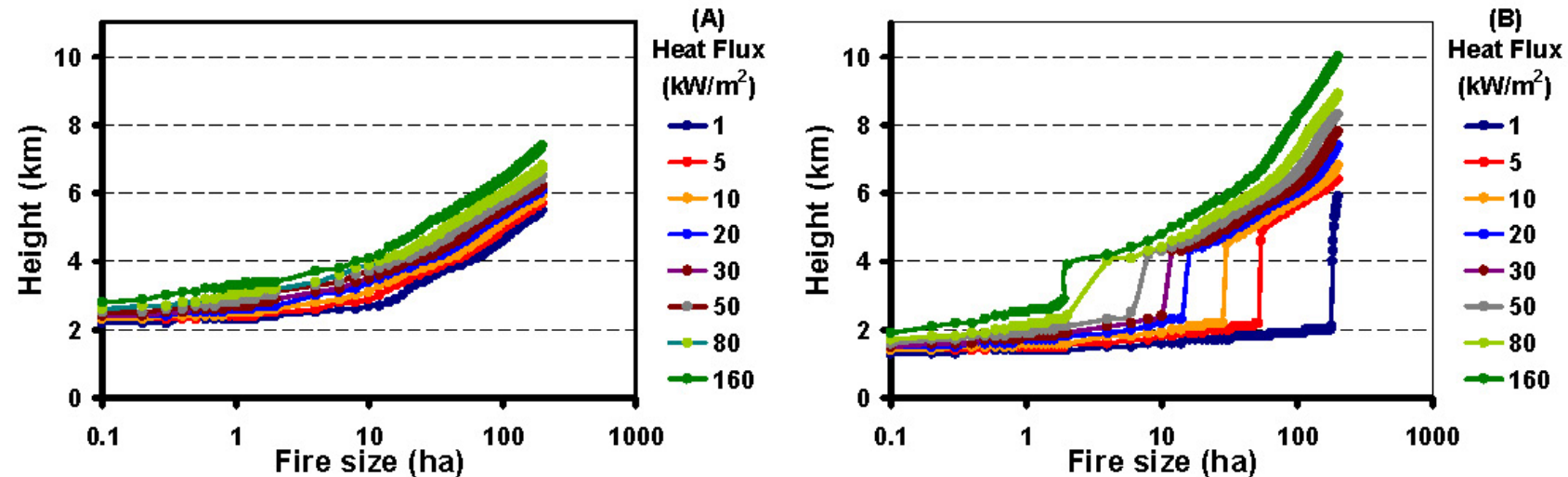


# Plume Rise of Vegetation Fires

S. R. Freitas et al.: Including the plume rise of vegetation fires

SMOCC 'Dry': 20 Sept. 2002

'Wet': 27 Sept. 2002



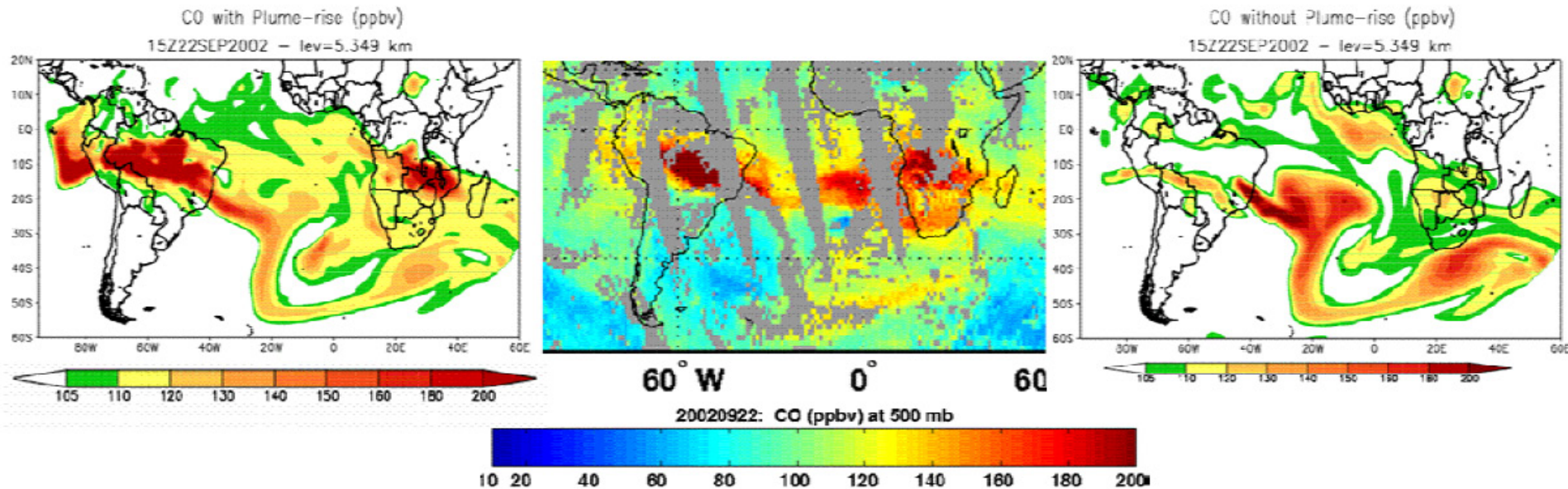
- Heat flux: Forest: 30-80kWm<sup>-2</sup>;  
Savannah: 5-25 kWm<sup>-2</sup>
- Fire size distribution broad: 13 ( $\pm 15$ )ha  
- fire plume reaches 4-8km

# 1-D plume model, driven by Fire Emission model & coupled to 3-D CATT-BRAMS gives realistic dispersion

**CO (ppbv) from  
model at ~5.5 km height  
with plume-rise**

**CO (ppbv) from  
AIRS at 500 mb  
22 SEP 2002**

**CO (ppbv) from  
model at ~5.5 km height  
without plume-rise**



- Mid-tropospheric CO matches AIRS much better with sub-grid 1-D plume rise model



<http://meioambiente.cptec.inpe.br/index.php?lang=en>



<http://brams.cptec.inpe.br/>

# Status quo of Modeling the Earth System in Brazil

- Operational demand:
  - Transport biomass burning
  - Urban air pollution
  - Ocean-atmosphere interaction in coastal processes
  - Nowcasting and short range forecasting of rainfall leading to flooding and landslides
- Research & Development (~ 50 people)
  - Modeling surface, soil, boundary layer ~ 40%
  - Modeling the ocean dynamics, carbon, coastal ~ 25%
  - Modeling air pollution ~ 10%
  - Modeling clouds, aerosol and interactions ~ 15%
  - Multi-scaling analysis theoretical, numerical ~ 5 %



# Future: what can be done to build up the modeling focus in Brazil

- Expand the earth system modeling community by attracting people from the Applied Mathematics community: multi-scaling and numerical methods
- Graduate programs with *specific focus* in earth system modeling