MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

SOUTH AMERICAN BIOMASS BURNING ANALYSIS:
Brazilian perspectives

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Ricardo Siqueira, Madeleine Sanchez,
Fernando Cavalcante, Megan Bela, Márcia Yamosoe, Alexandre Correa

http://meioambiente.cptec.inpe.br

ciência para sustentabilidade

Grupo de Modelagem da Atmosfera e Interfaces
Modeling of the Atmosphere and its Interfaces Group

Ministério da Ciência, Tecnologia e Inovação

GOVERNO FEDERAL
BRASIL
PAÍS RICO É PAÍS SEM POBREZA

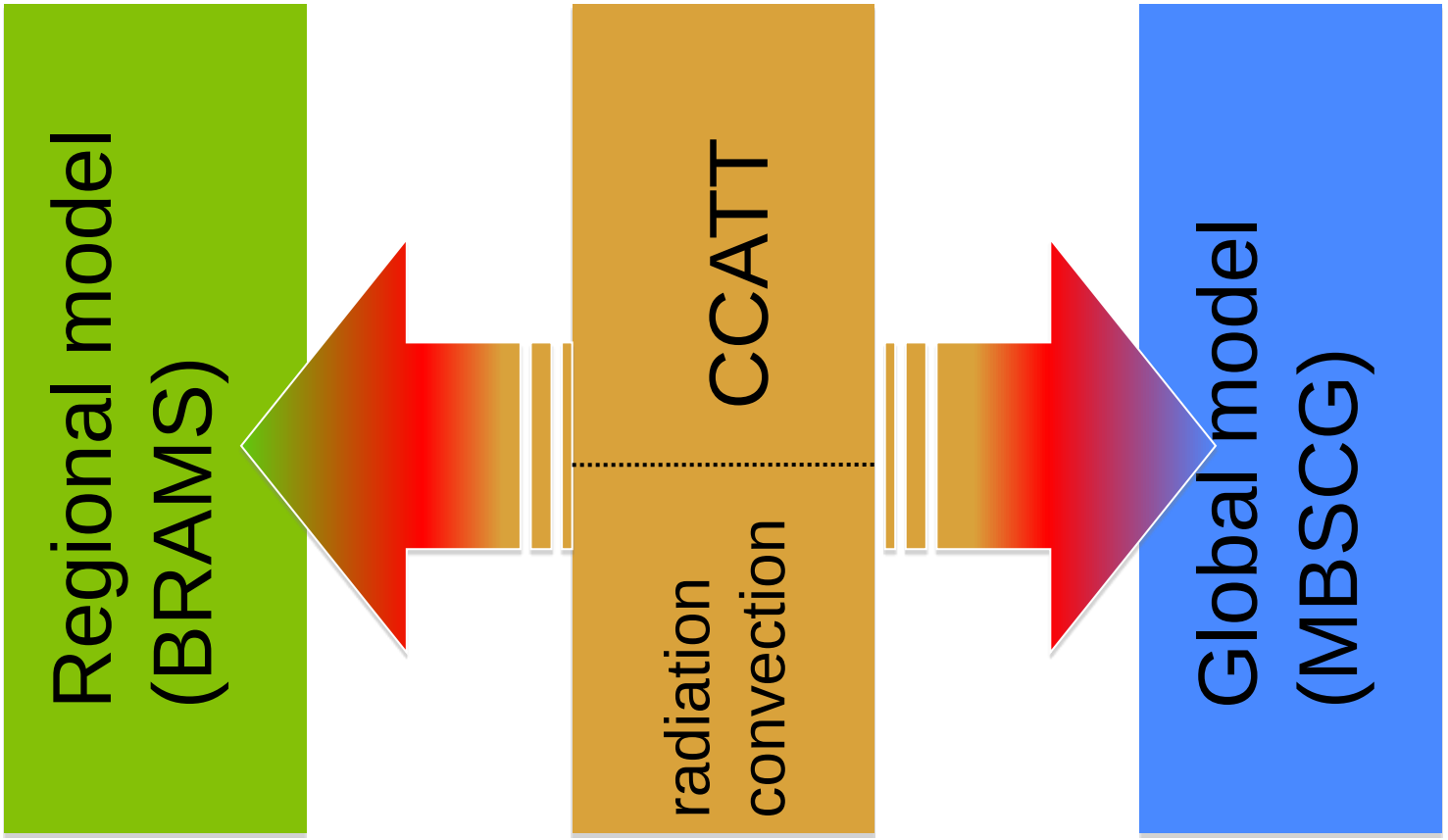
Main goals

Improve our understanding of the impact of biomass burning on the chemical composition of the atmosphere (aerosols/ gases), cloud formation and the energy balance of the atmosphere;

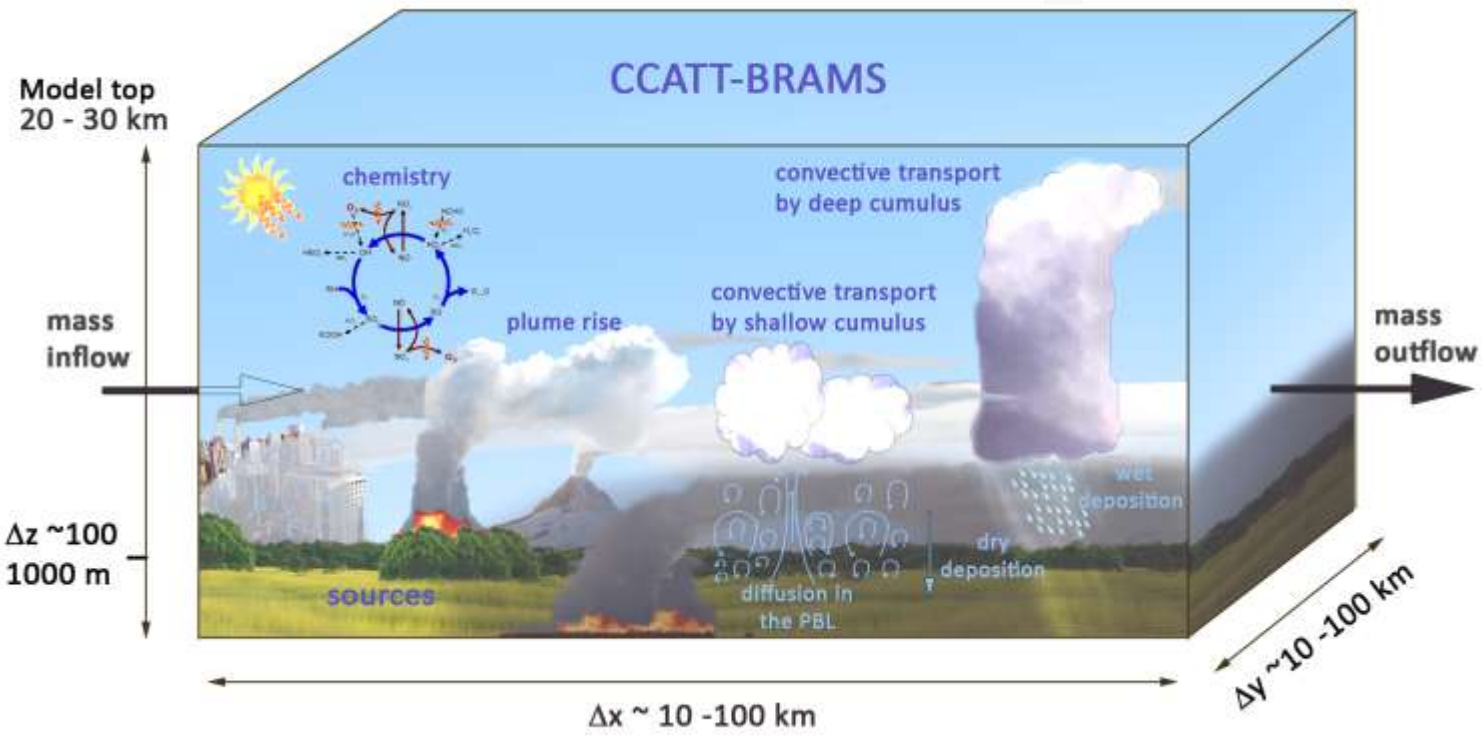
Development and evaluation of INPE's atmospheric chemistry transport models suitable for local, regional and global scales: **CCATT-BRAMS & MBSCG**

Assess the impact of burning emissions on air quality, weather and climate;

Common chemistry module for both regional (CCAAT-BRAMS) and global (MBSCG) models

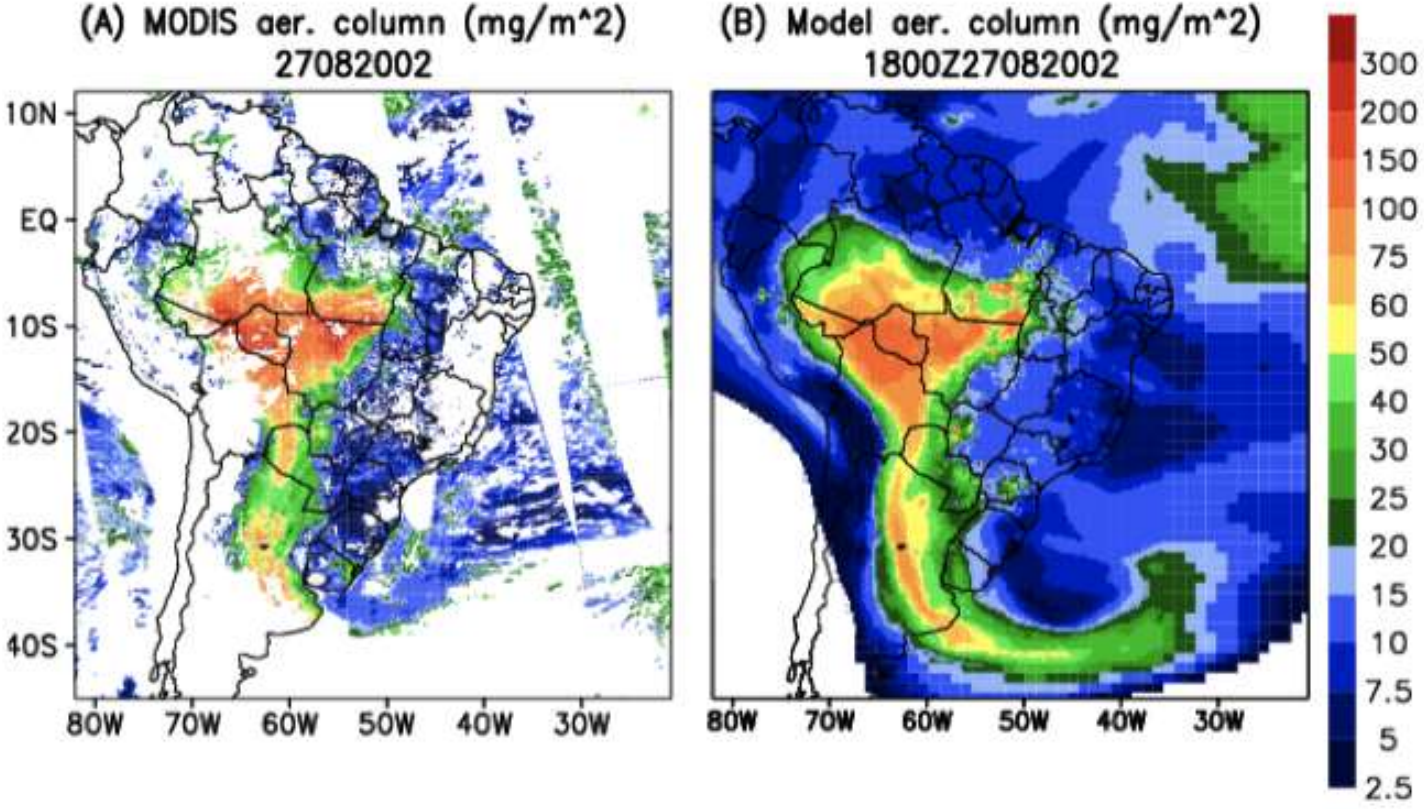


Numerical Developments

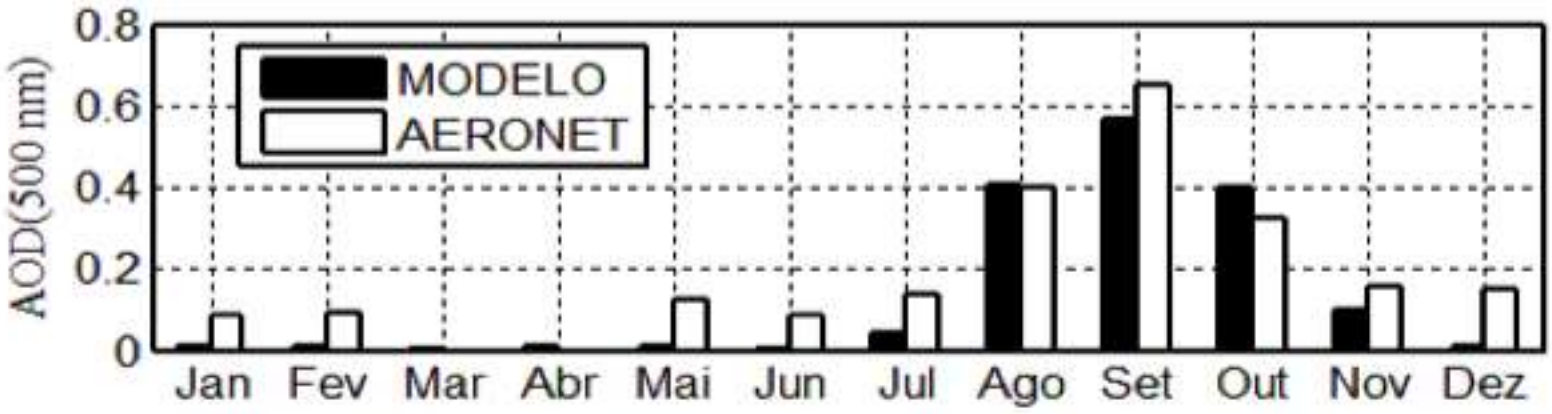


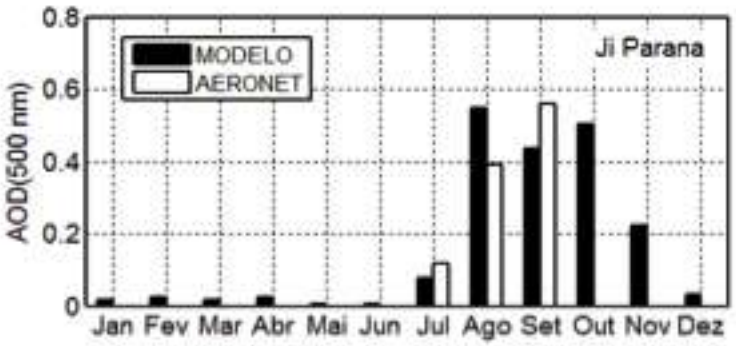
Coupled Chemistry-Aerosol-Tracer Transport model to the Brazilian developments on the RAMS: CCATT-BRAMS

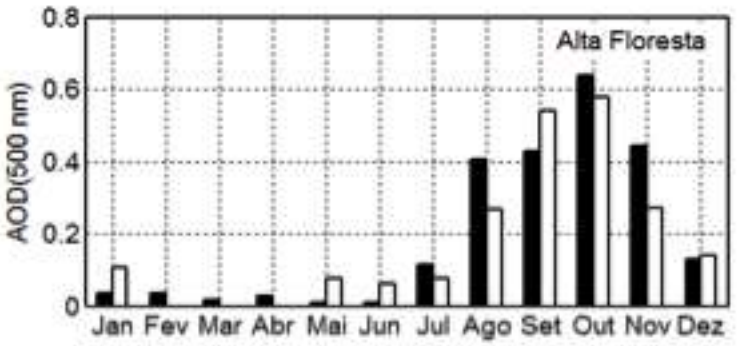
MODIS x model

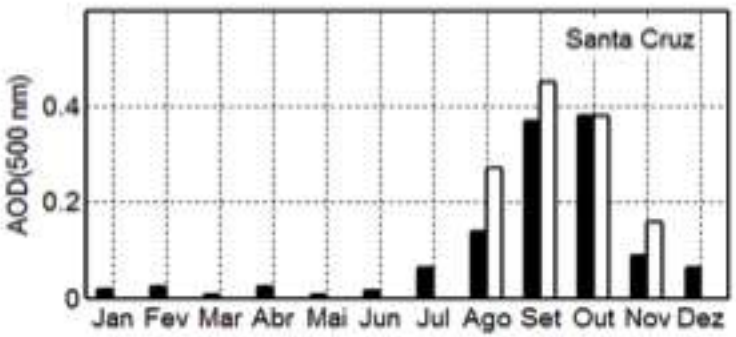


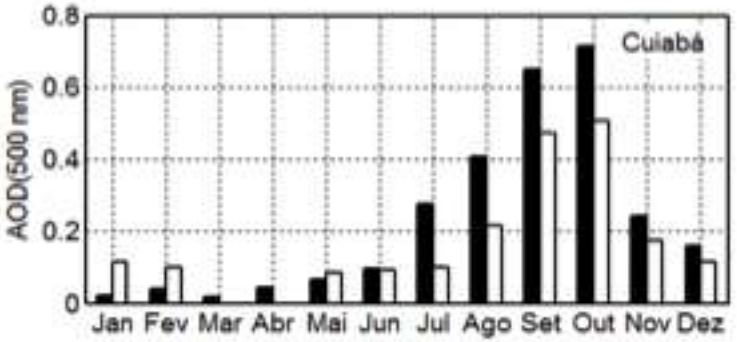
AERONET x model (2008)











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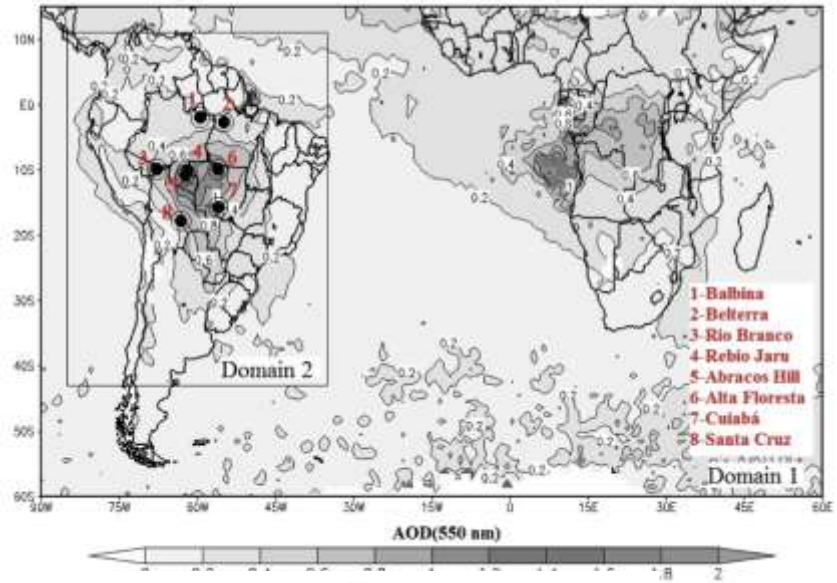
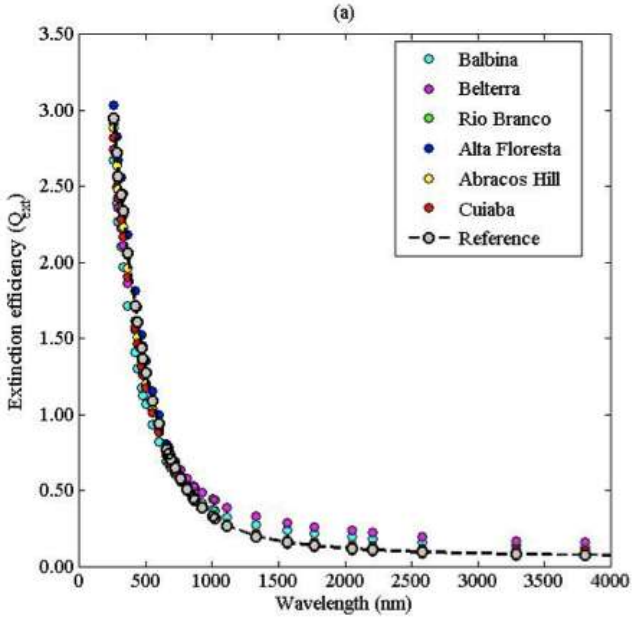
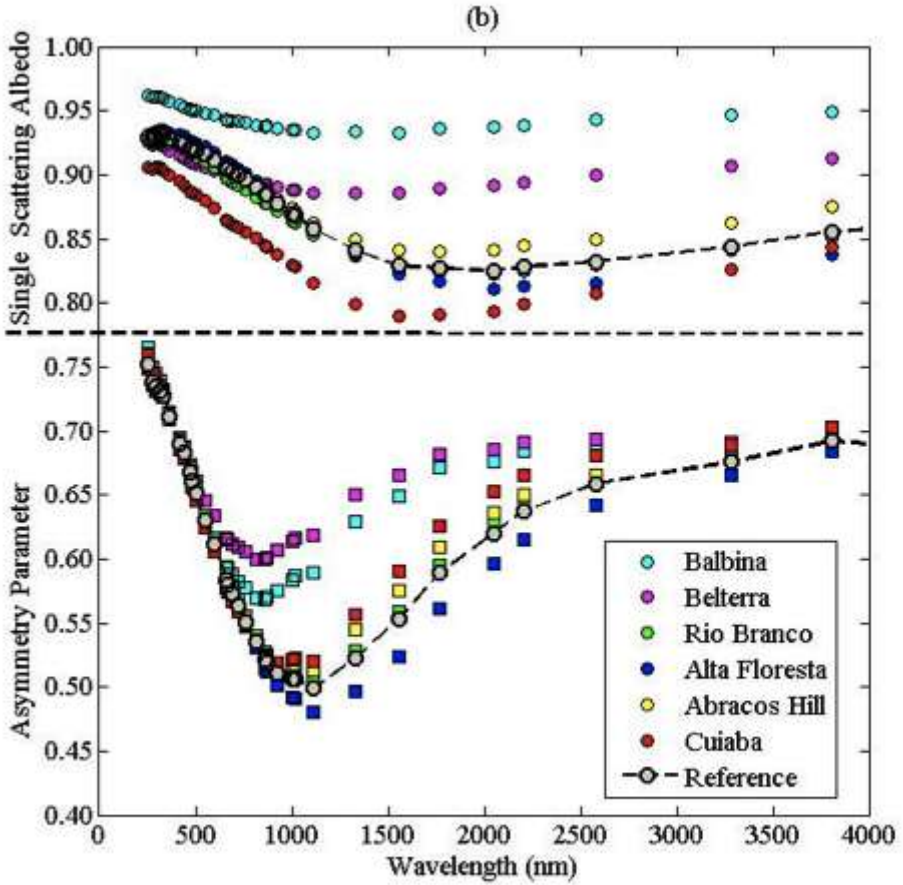
Aerosol optical properties in SA

AERONET sites

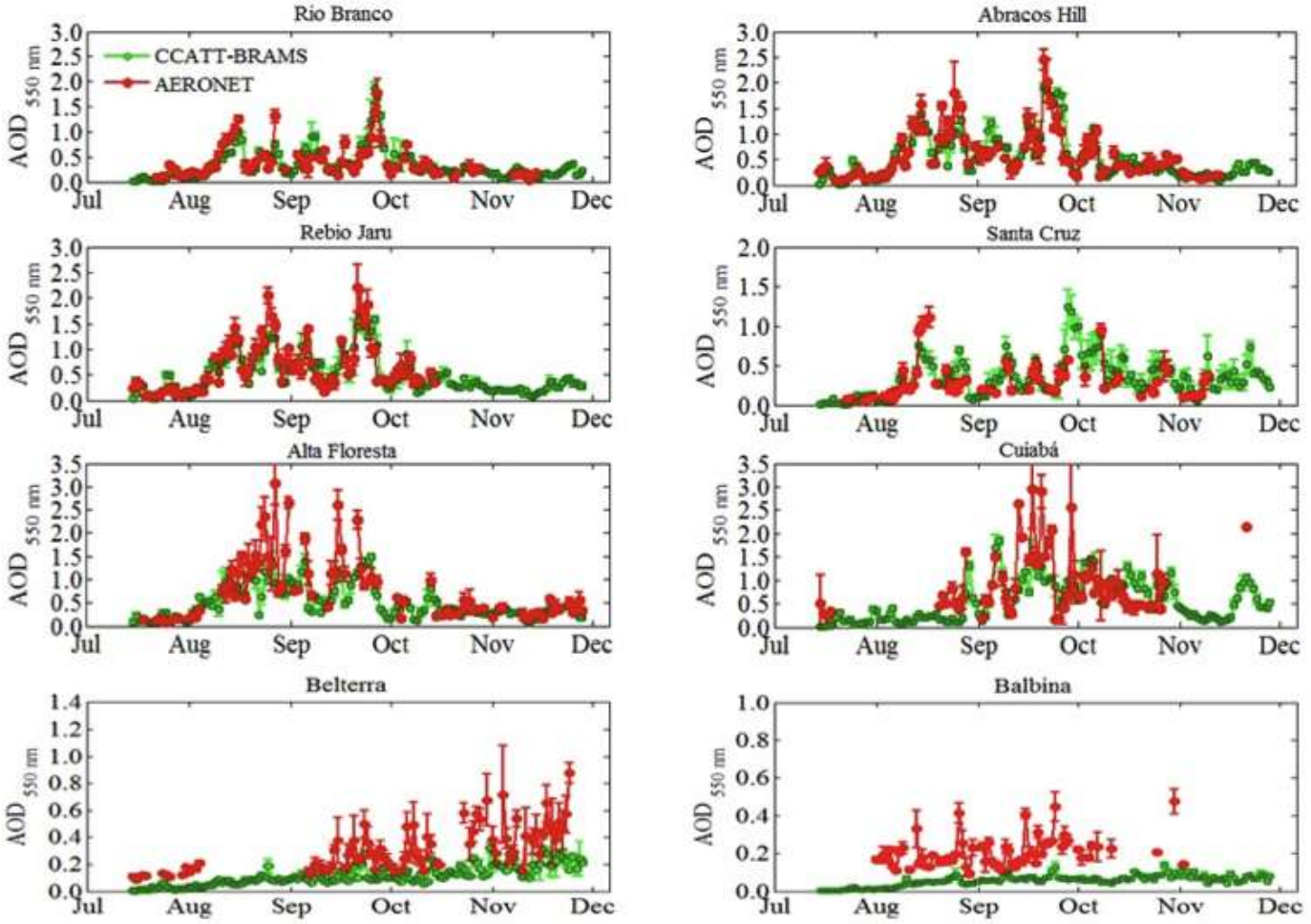




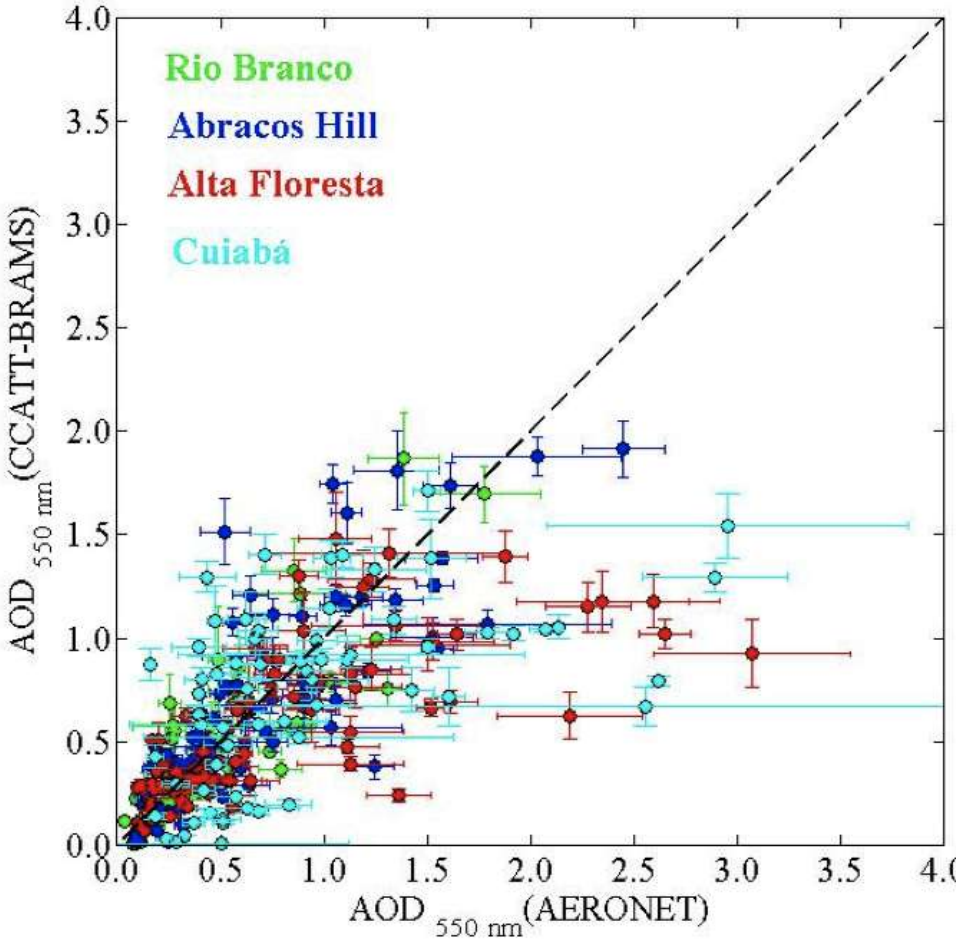


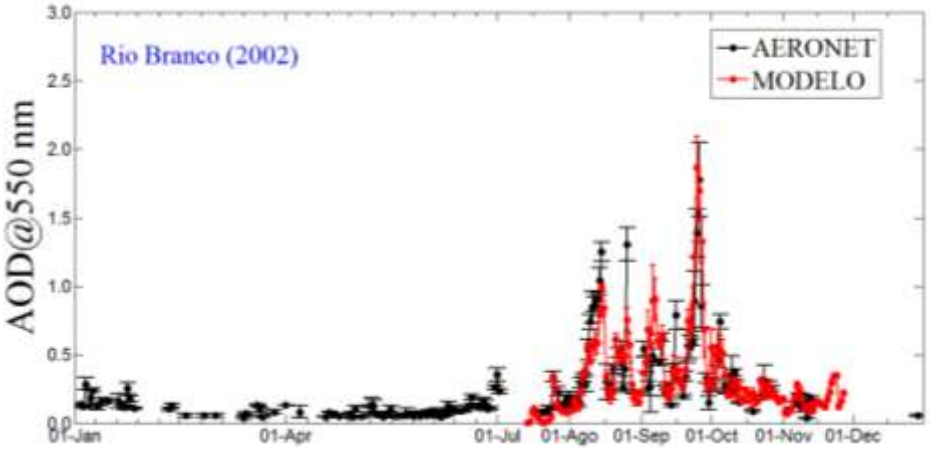
Rosário et al., ACPD, 2012.

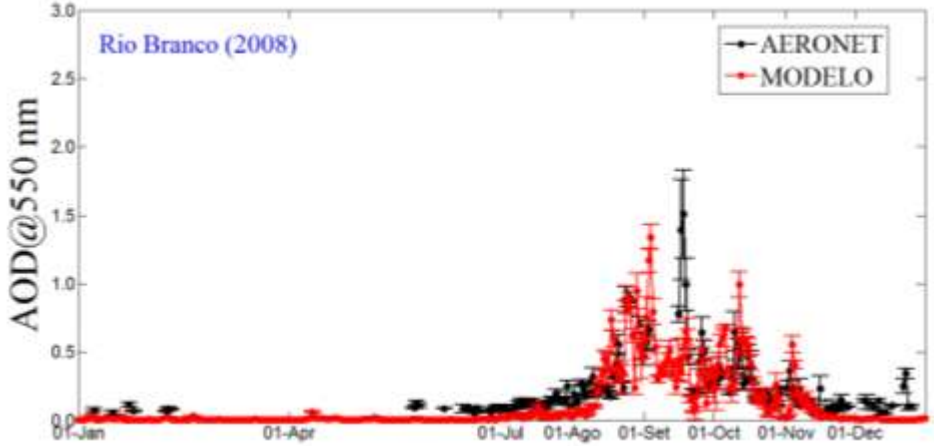
Aerosol optical thickness (model x AERONET)



AERONET x model







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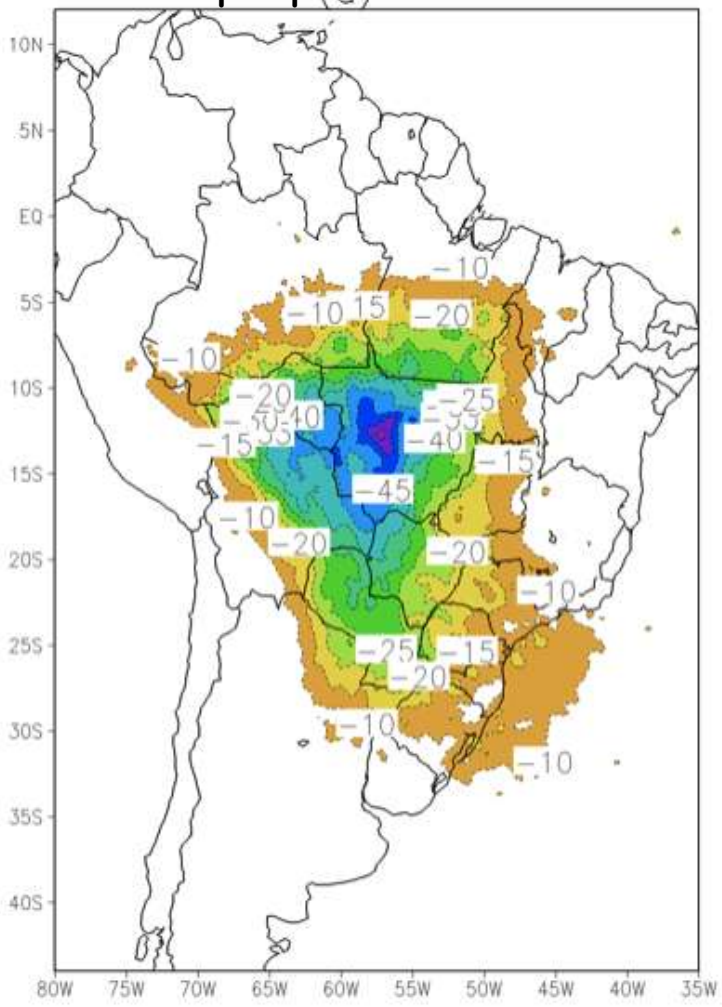
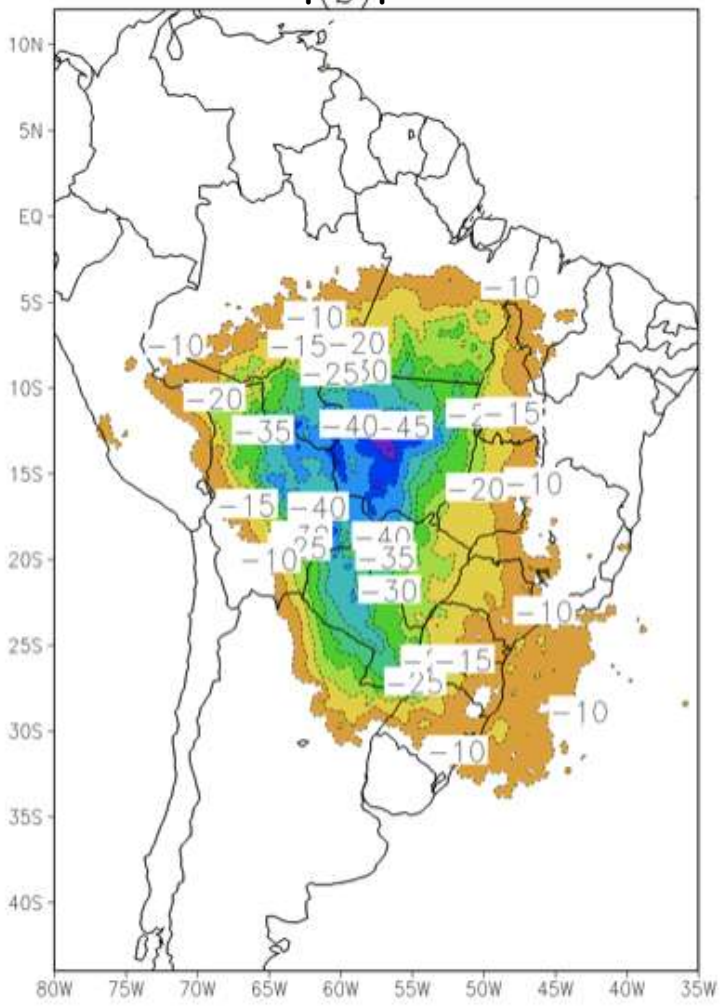
Burning season 24 h – surf. radiative forcing: difference between downward surface solar irradiance including and excluding aerosol direct radiative effect.

Static aerosol optical properties



Spatial varying aerosol optical properties



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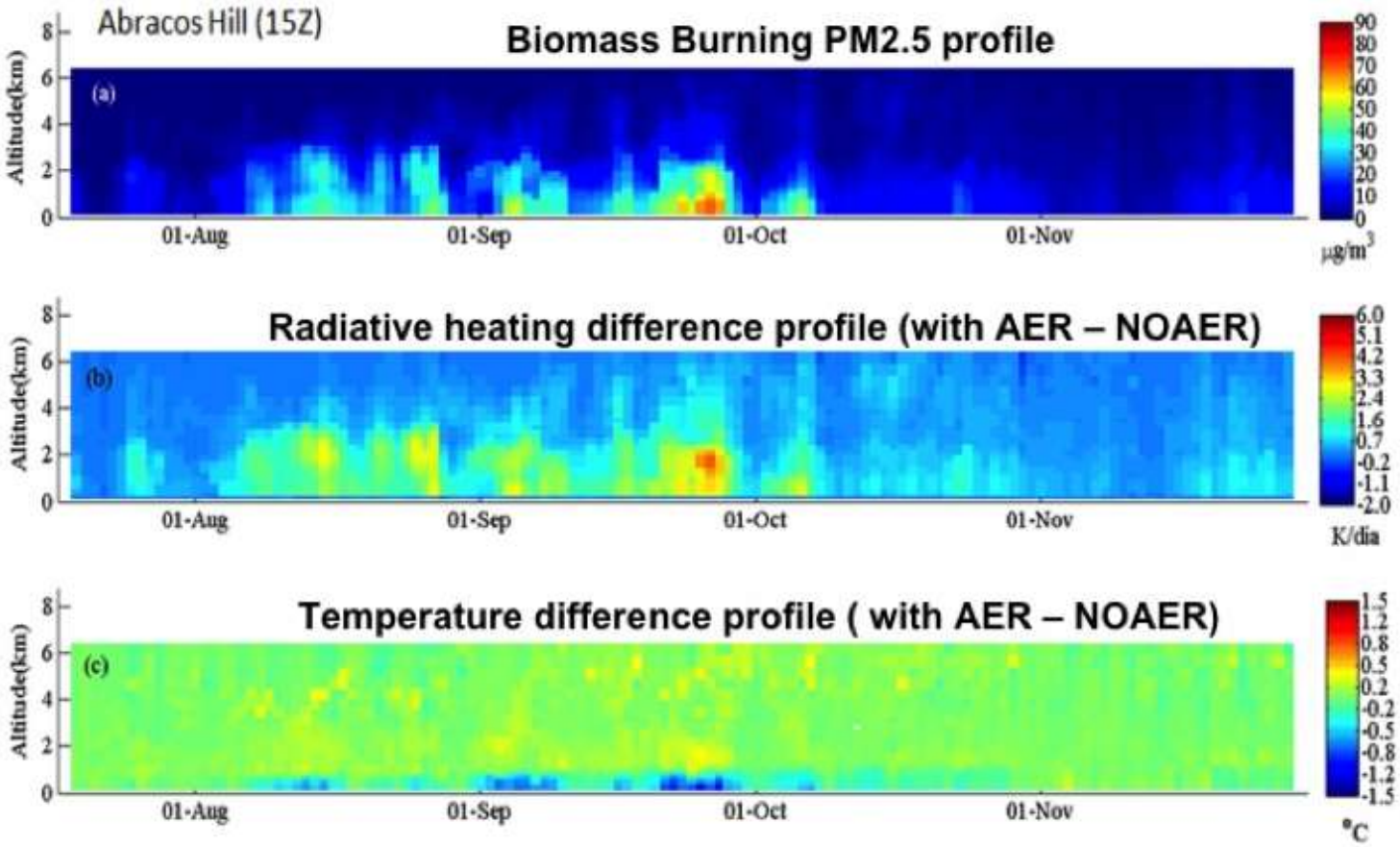
Semi-direct radiative effect



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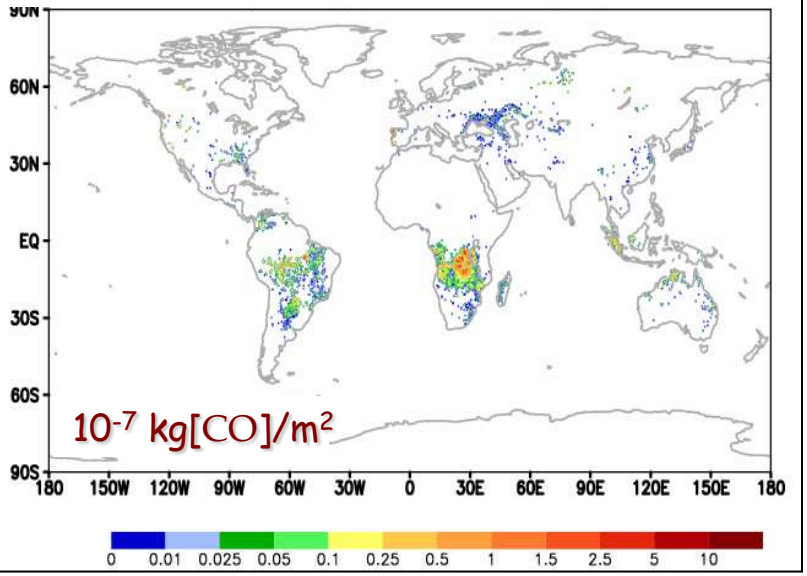
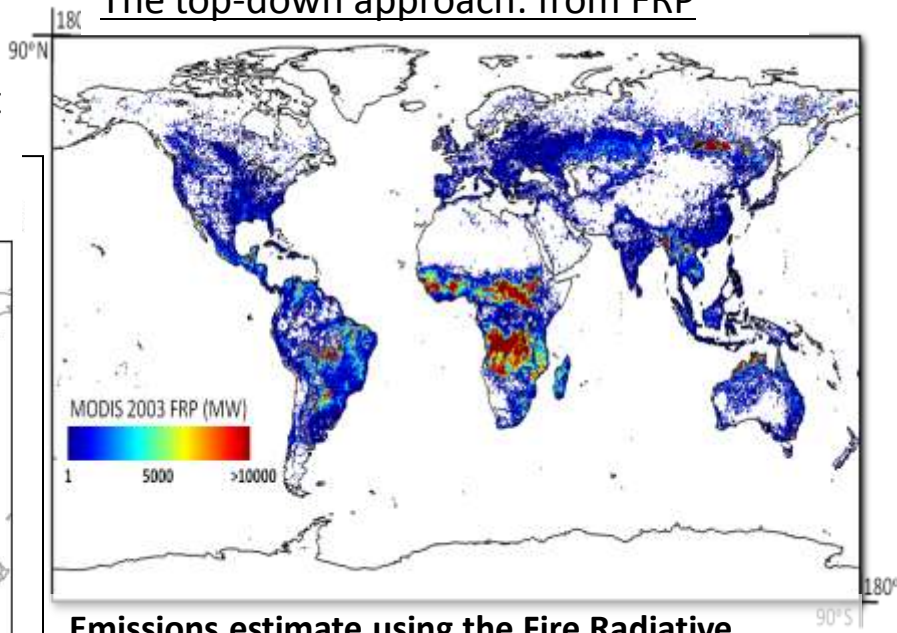
Biomass Burning Emissions Estimation

Brazilian Biomass Burning Emission Model (3BEM): 2 approaches

The bottom-up approach: fire size/burnt area, carbon density, emission and combustion factors.



The top-down approach: from FRP

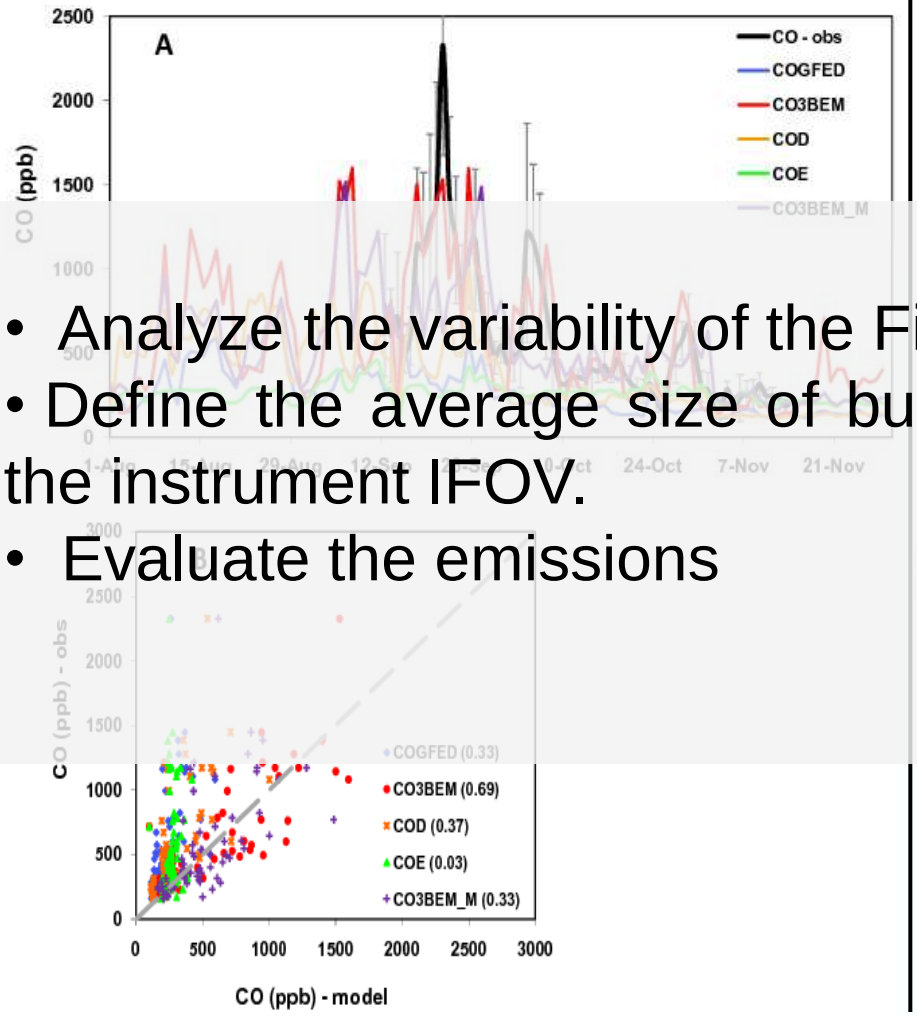


Emissions estimate using the Fire Radiative Energy (FRP) from MODIS, GOES and SEVIRI sensors.

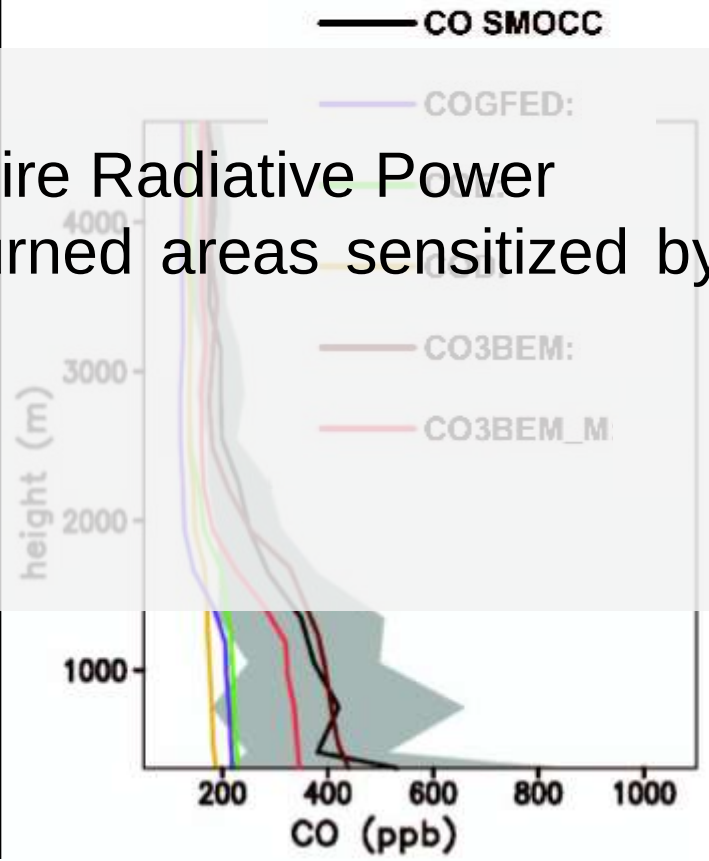
Intercomparison between 4 biomass burning inventories

EDGAR, GFEDv2, D2003, 3BEM

Model evaluation with SMOCC/RaCCI 2002 using near surface measurements



Model evaluation with SMOCC/RaCCI 2002 with airborne measurements (CO)



- Analyze the variability of the Fire Radiative Power
- Define the average size of burned areas sensitized by the instrument IFOV.
- Evaluate the emissions

Longo et al., ACP 2011.

Including plume rise sub-grid scale transport trough the *"super-parameterization"* concept

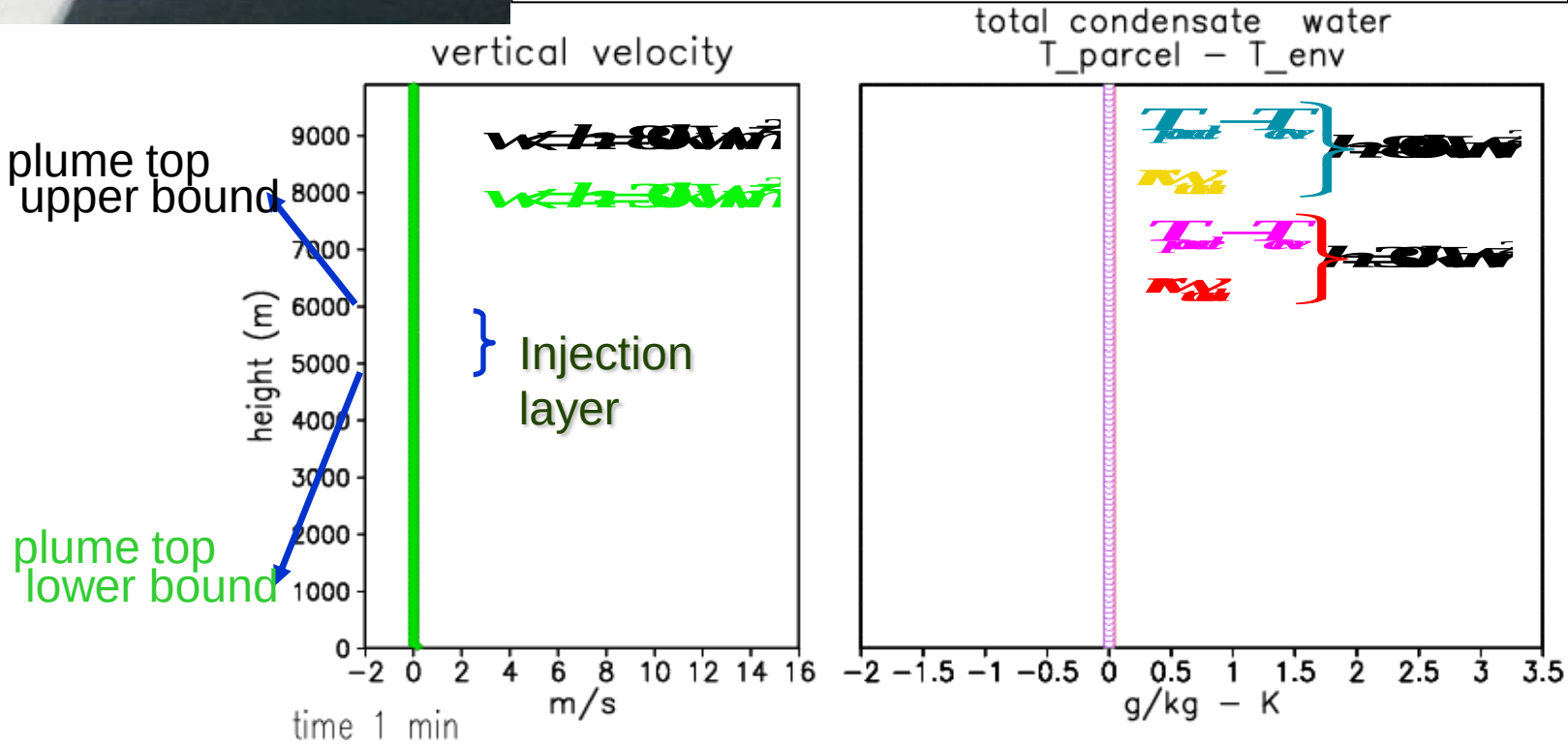
1D plume-rise model for vegetation fires

Biome: Forest

Time duration: 50 mn

Fire size: 20 ha

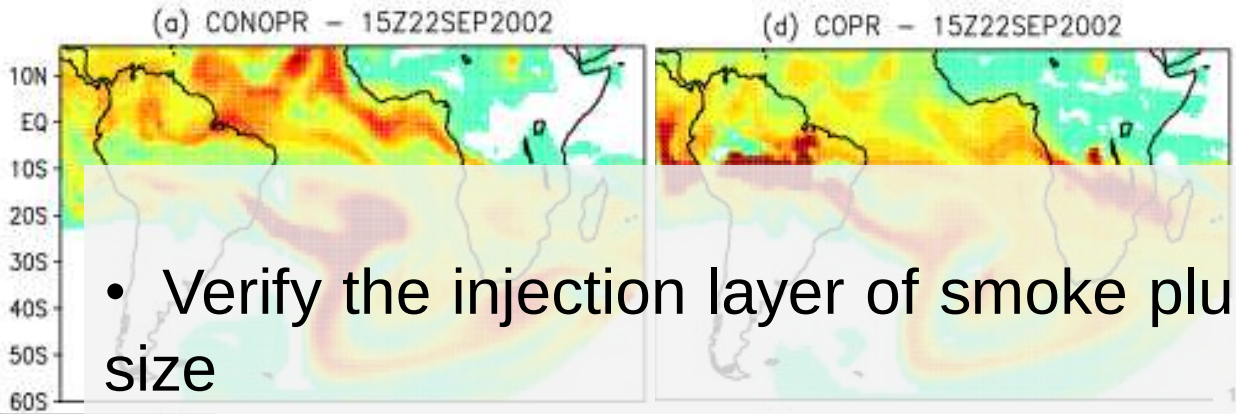
Heat flux: 80 kWm^{-2} / 30 kWm^{-2}

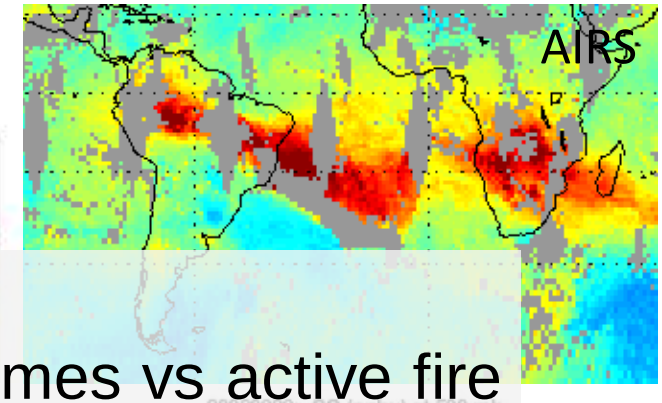


Freitas et al., ACP, 2010.

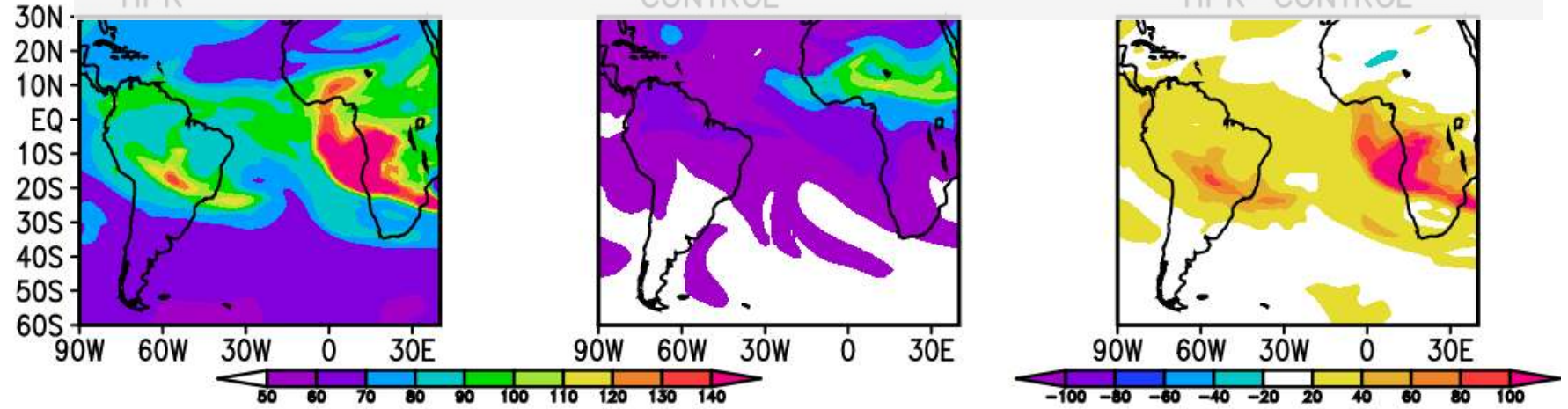
Model x AIRS

CCATT-BRAMS



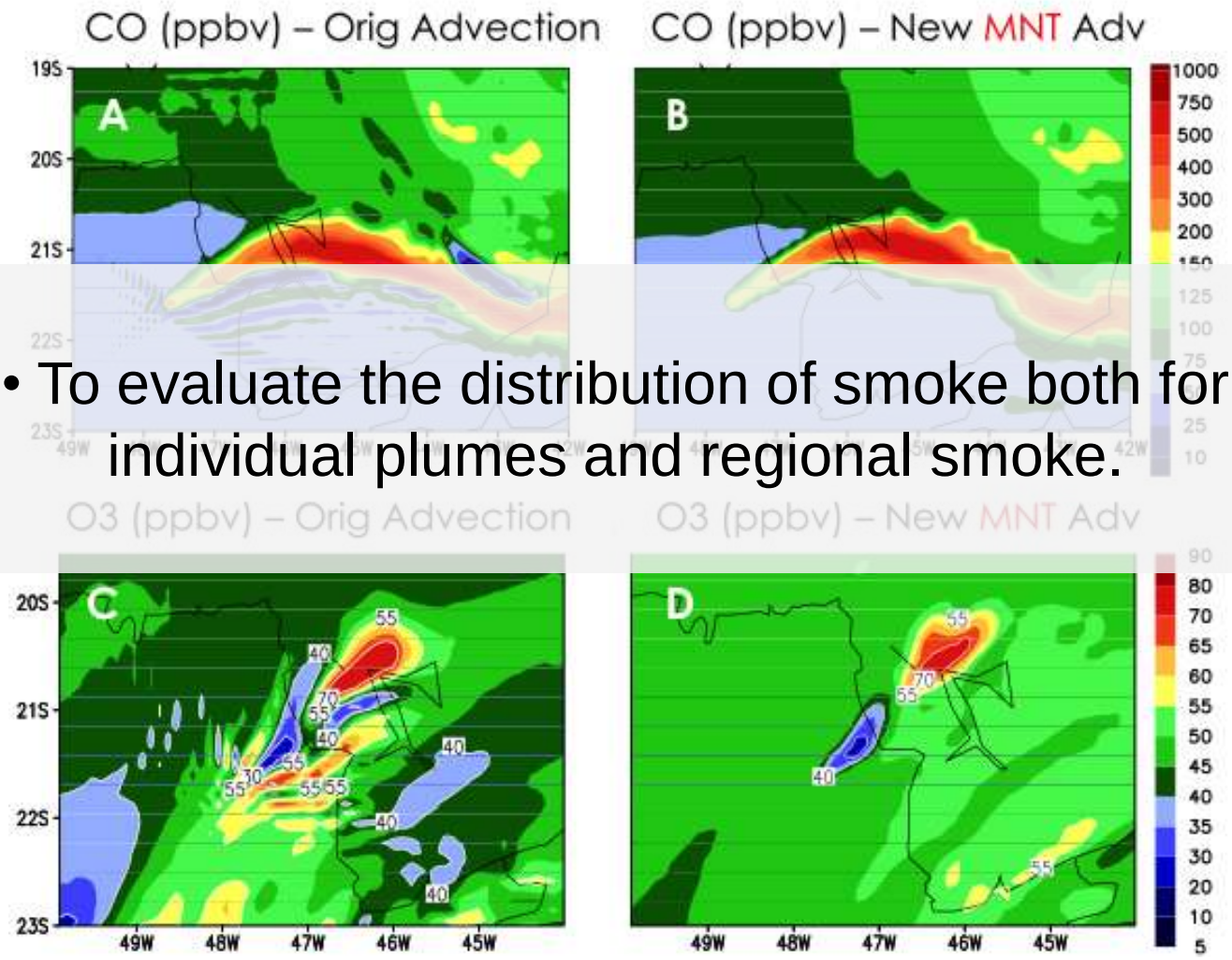


- Verify the injection layer of smoke plumes vs active fire size



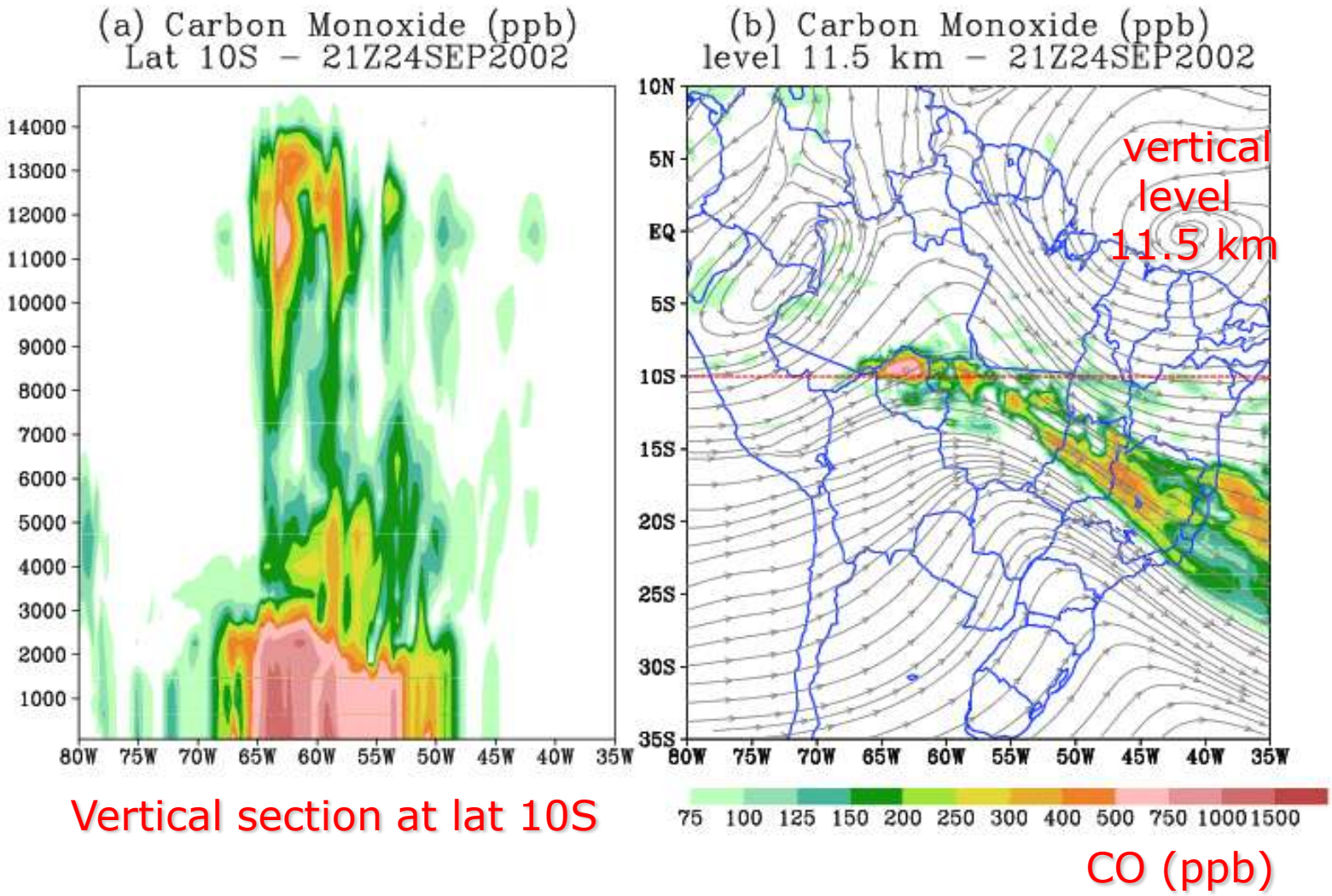
New advection scheme

Biomass burning plume of carbon monoxide (ppbv)



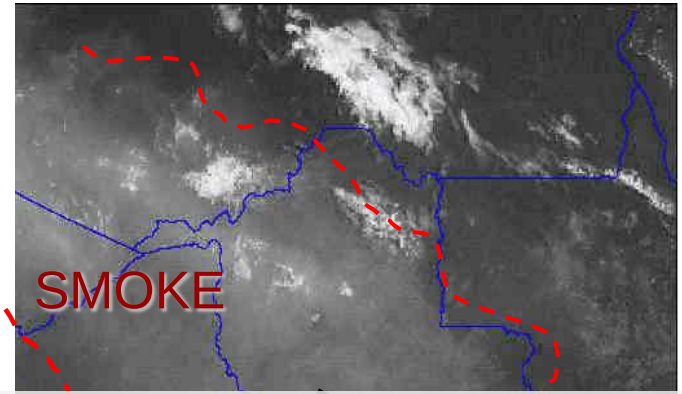
- To evaluate the distribution of smoke both for individual plumes and regional smoke.

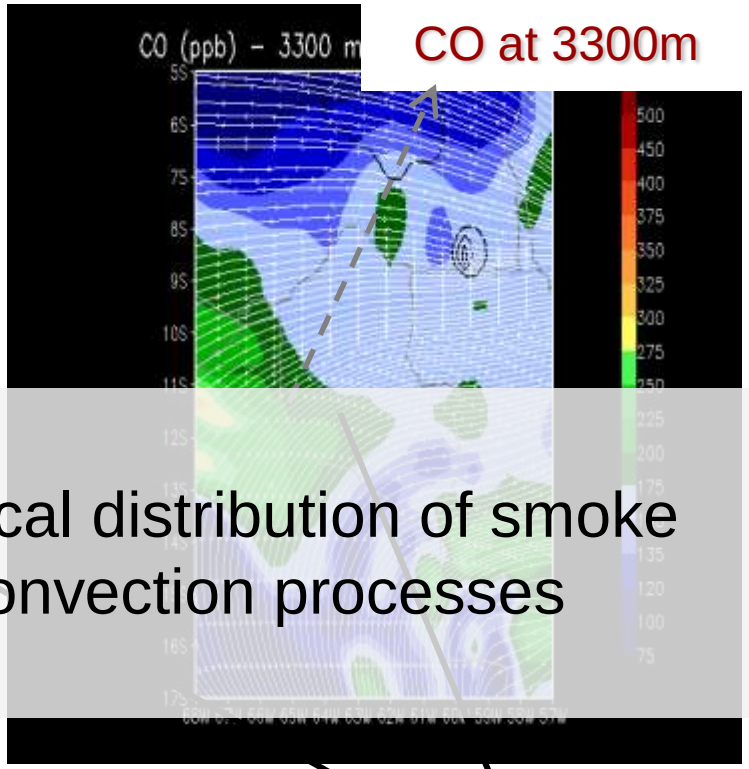
Deep Convective Transport of CO: 21Z 24 Sep 2002 – simulation with CCATT-BRAMS model



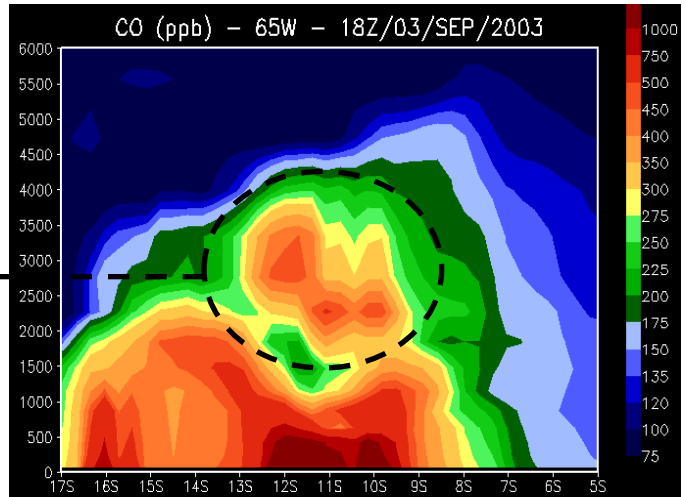
Vertical section at lat 10S

Shallow convective transport
Model simulation for 14-17Z03092003





- To evaluate the vertical distribution of smoke associated with convection processes



shallow cumulus

Low troposphere CO

PBL

Ongoing thesis work

•Aerosol indirect effect on cloud microphysics and cumulus convection
Ricardo Almeida, PhD at INPE, with Saulo Freitas and Karla Longo

•Nitrogen budget over South America: organic fraction of Nr
Madeleine Gácita (PhD at INPE, with Karla Longo, Scot Martin)

•Biogenic emission in South America: oxidative capacity of the Amazonian atmosphere
Fernando Cavalcante (PhD at INPE, with Karla Longo and Alex Guenther)

•Chemistry associated with convective clouds
Megan Bela (PhD at University of Colorado, with Mary Barth and Brian Toon)

Ongoing work

- Implementation of MATRIX in CCATT-BRAMS
  Karla Longo, Nilton Rosário, Luiz Flávio Rodrigues and Saulo Freitas

- New cumulus scheme for nearly cloud resolving resolutions (G3d)
  Saulo Freitas and Georg Grell)

- Implementation of the radiation scheme from UK-MO in CCATT-BRAMS
  Nilton Rosário, Karla Longo, Luiz Flávio Rodrigues and Saulo Freitas

Prescribed fires – FAPESP project (João Andrade)

Google earth

quilômetros 800

km 1000

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Remote Sensing of Cloud Microphysics: The FAPESP SeReNA Project

PI: Alexandre L. Correia <acorreia@if.usp.br> - Institute of Physics, University of Sao Paulo

Project timeframe: June 2011 – May 2013

.Key project goals:

a) infer from radiometric measurements the vertical profile of effective radii and thermodynamic phase of water and ice particles in clouds;

b) get large statistics to infer the aerosol influence on cloud microphysics, by performing measurements under different aerosol and meteorological conditions;

Measurements: imaging the reflected and emitted radiance on cloud sides with scientific cameras, at the wavelengths of 0.67, 2.10, 2.25 and 11um.

Platform: INPE's Bandeirante or another unpressurized aircraft (e.g. rented at the airport), flying over regions with contrasting pollution regimes, like Porto Velho and Manaus.

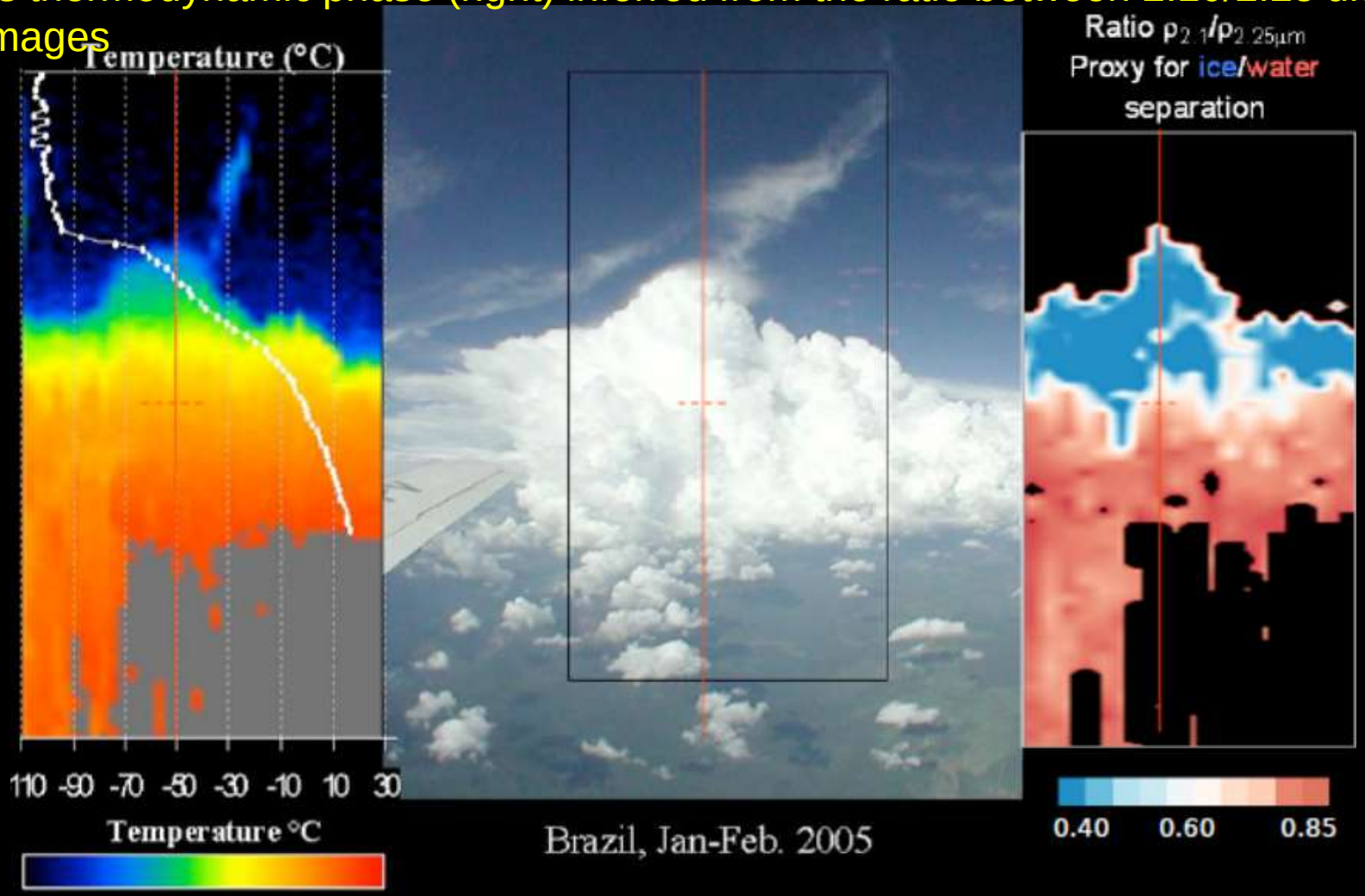
Funds: the SeReNA project is fully funded by FAPESP, including per diem for the PI and one student during the SAMBBA campaign, funds to cover aircraft fuel and pilot fees.

Synergy with SAMBBA: the SeReNA project can provide independent assessments of cloud microphysics, including thermodynamic phase, and can simultaneously benefit from the SAMBBA results. For that we need a set of overlapping measurements from SAMBBA and SeReNA over the same region or under similar aerosol / meteorology conditions.

Background and previous results: Martins et al. Atmos. Chem. Phys., 11, 9485–9501, 2011

Paper available for download at: http://bit.ly/martinspaper

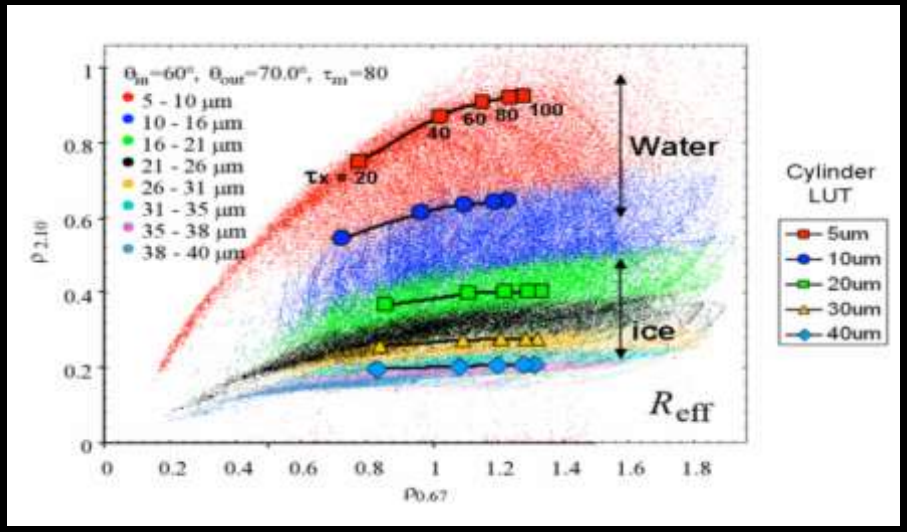
Example over Brazil: brightness temperature map (left) of a convective cloud and its thermodynamic phase (right) inferred from the ratio between 2.10/2.25 um images

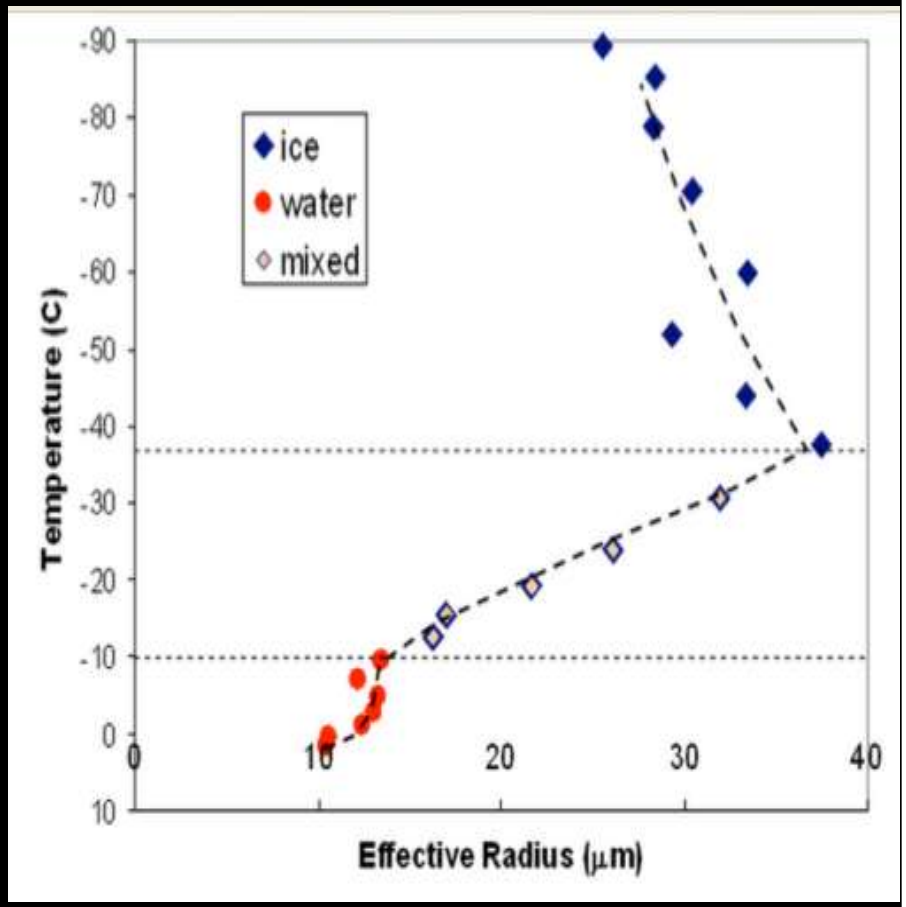


Background and previous results: Martins et al. Atmos. Chem. Phys., 11, 9485–9501, 2011

Paper available for download at: http://bit.ly/martinspaper

From the same example: the measured cloud reflectances in 0.67 and 2.10um in a given vertical profile are used in a look-up table to retrieve particle size (left). Combining this result with the brightness temperature and the thermodynamic phase, one builds the microphysical profile on the right. Many profiles can be retrieved and averaged for a single cloud, allowing for statistical robustness.





General flight planning

- Clouds properties (coordinate SAMBBA and SeReNA)
- Individual fires and plumes (coordinate with prescribed fires ground measurements)
- Fire characterization - statistical survey (coordinate with satellite)
- Regional scale characterization (smoke aging)
- Boundary layer studies

Modeling workshop planning: ~17/Sep