South American Biomass Burning Analysis (SAMBBA): UK Perspective

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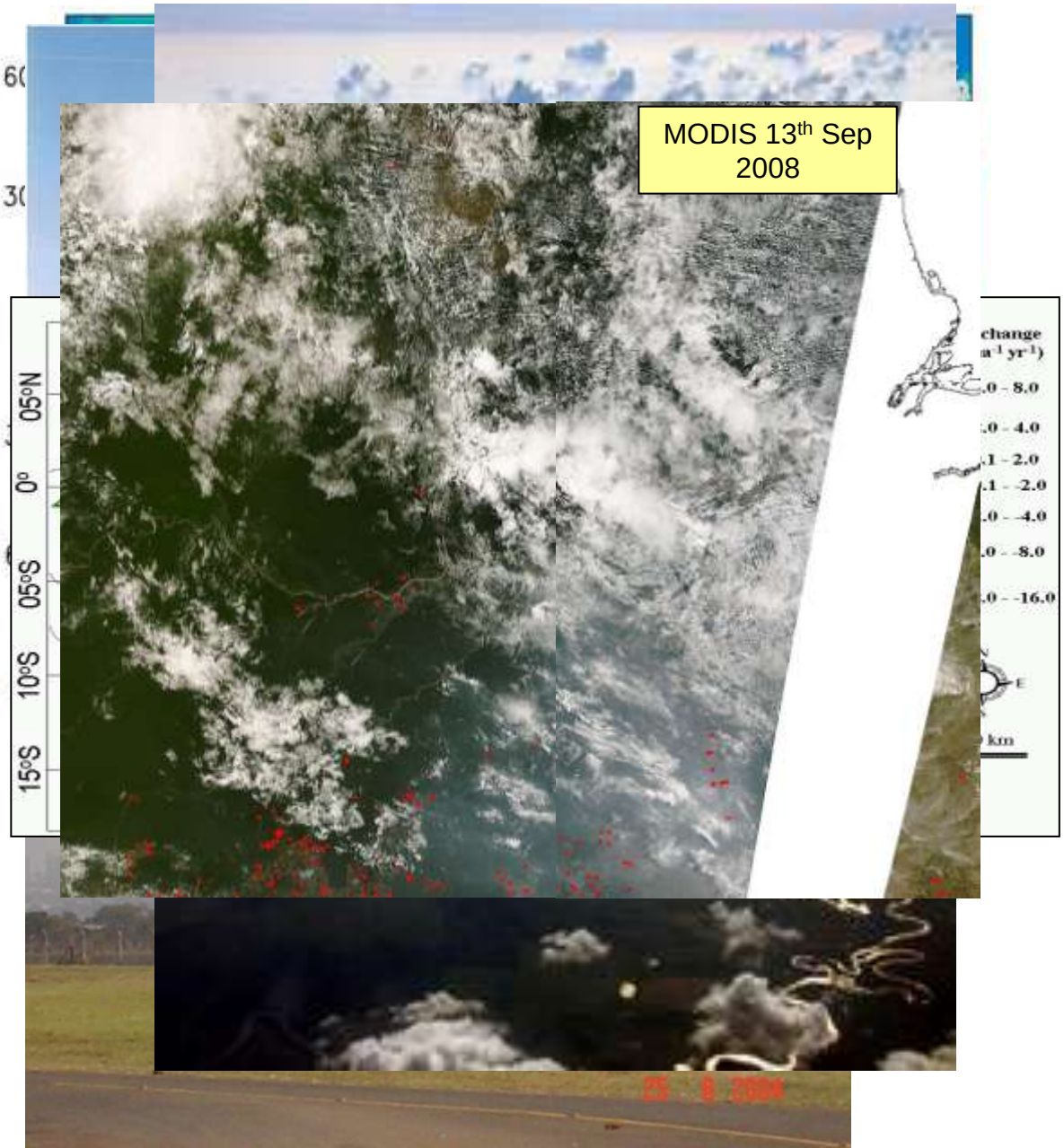
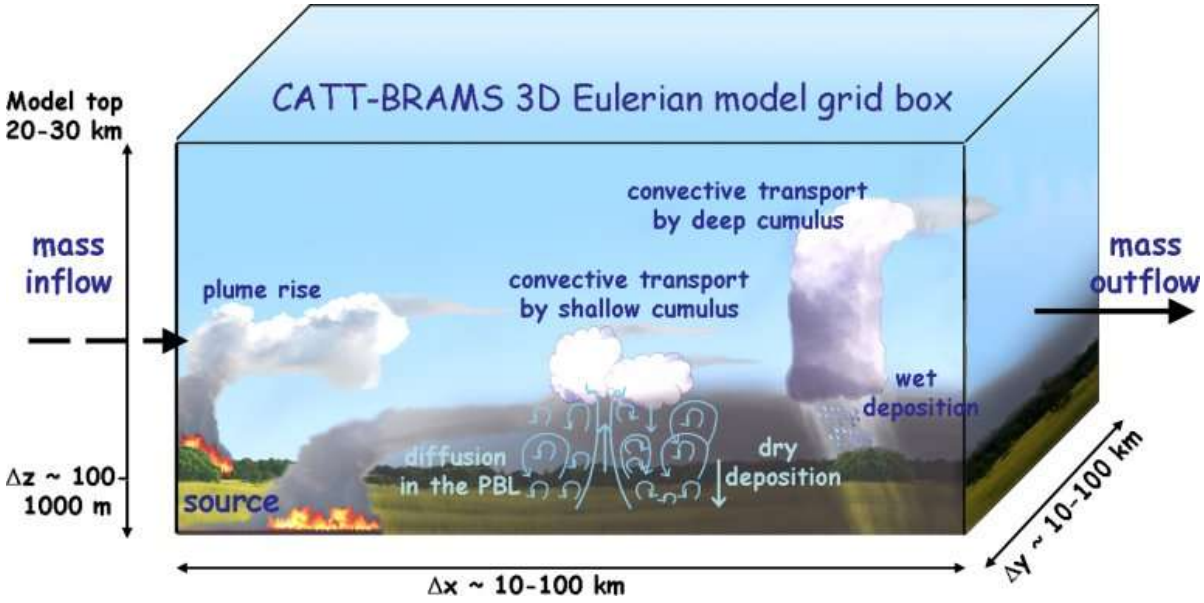
The Scientific Drivers

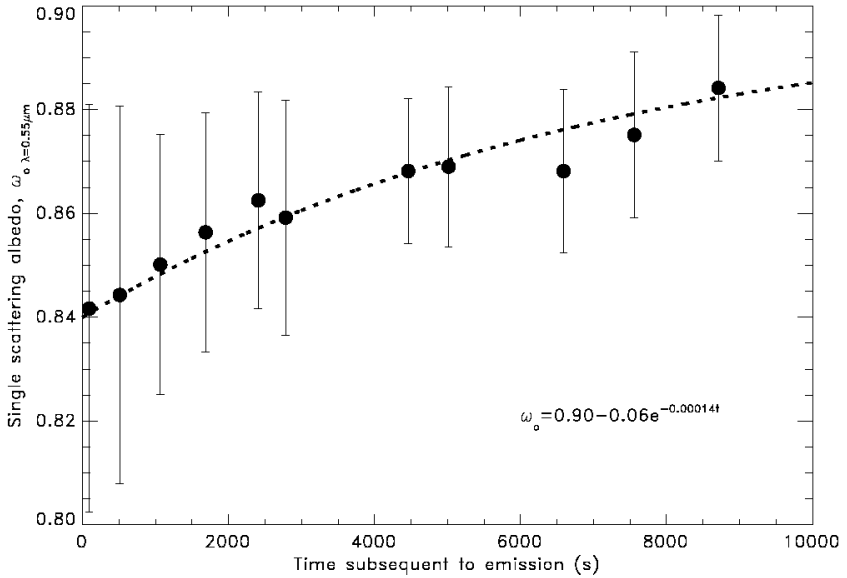
- Regional climate
- Global Climate
- Biosphere-carbon cycle interactions
- Numerical Weather Prediction
- Air Quality



Key Scientific Questions

- Emissions
- Chemical Ageing
- Vertical distribution
- Improved determination of optical properties
- Aerosol-cloud interactions
- Assessing radiative balance





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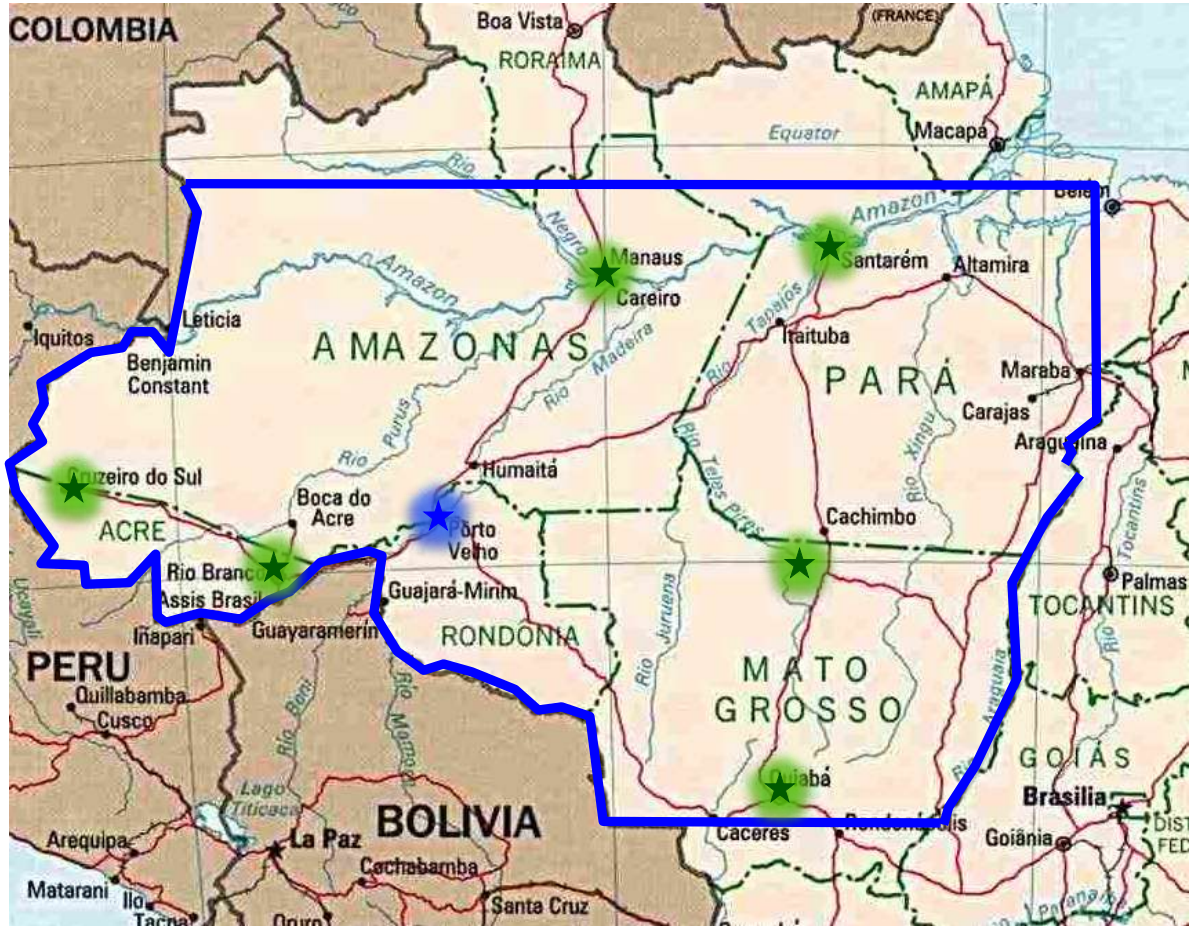
Where we want to fly



Proposed extent of BAe-146 operations
(bounded by Brazilian border on SW side)

- Experiment based at Porto Velho (blue stars).
- Various re-fuels options (green stars):

1. Manaus
2. Santarem
3. Alta Floresta
4. Cuiaba
5. Rio-Brancho
6. Cruzeiro do Sul

(others…?)

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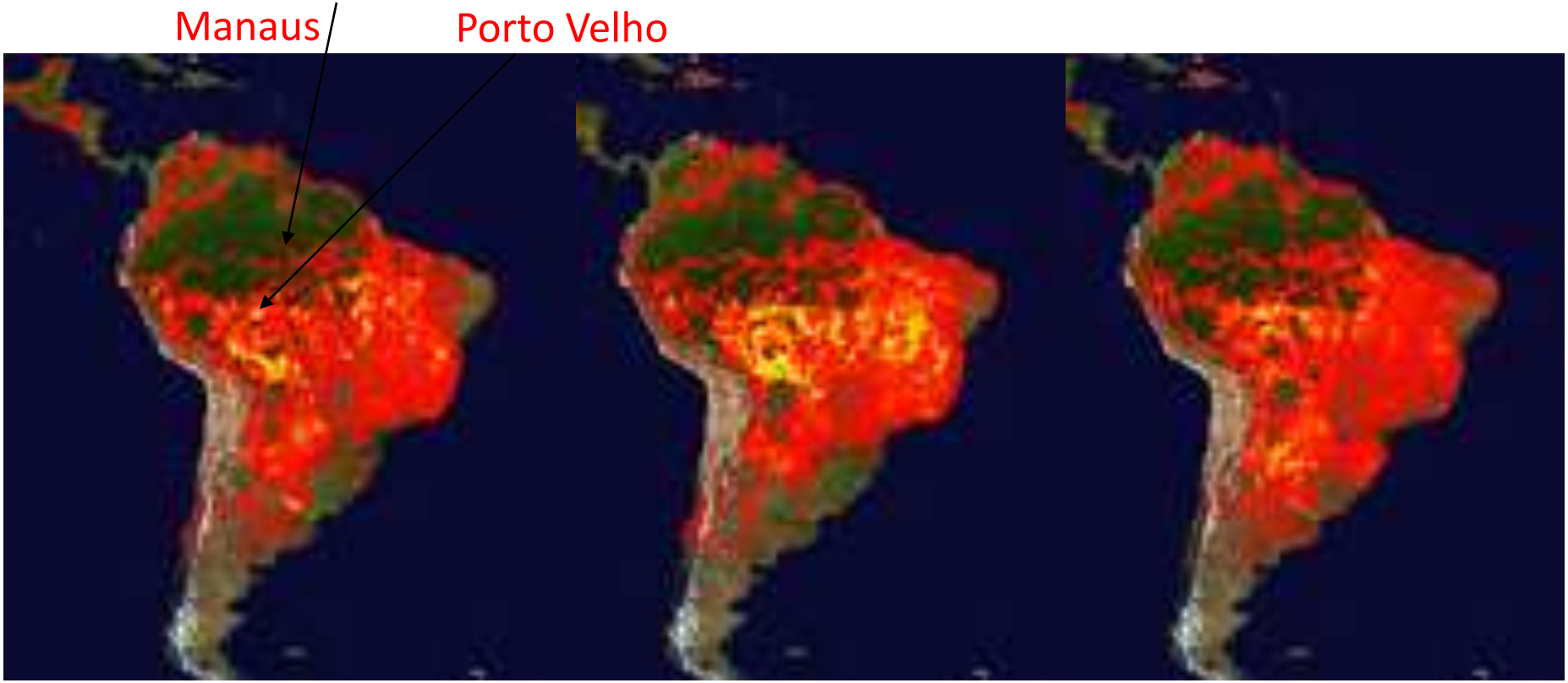
When we want to fly



Mid-September MODIS fire counts for years:

2008 2007 2006

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Facility for Airborne Atmospheric Measurement (FAAM)

Suite of in-situ and remote sensing instrumentation.

Detachment to Porto Velho in September 2012.
Aim is to fly approximately 70 hours.
15 -18 individual flights (double flights wherever possible)

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Inside FAAM

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Instrumentation

(www.faam.ac.uk/index.php/current-future-campaigns/171-sambba-south-american-biomass-burning-analysis)

- Basic meteorology, dropsondes, turbulence probe
- Aerosol size distributions (PCASP, VAAC, AMS, CAS, CDP, GRIMM OPC)
- Absorption / black carbon (PSAP, SP2)
- Aerosol chemistry (AMS, filters, VAAC)
- Hygroscopicity (wet nephelometer, CCN)
- Gaseous chemistry (O3, CO, NOx, PTRMS, GCMS, Fast GHG, PAN, FAGE, WAS bottles for GC analysis, bag samples and FTIR?)
- Cloud and precipitation properties (TWC & LWC sensors, CDP, CAPS, SID2, 2DS, CIP-15, CIP-100)
- SW radiation (BBRs, SWS+SHIMS)
- LIDAR Leosphere 355nm
- IR camera, video cameras

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SAMBBA core partners

MET OFFICE

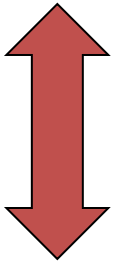
Ben Johnson

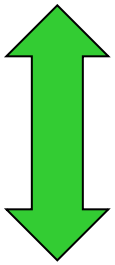
Jim Haywood

INPE

Karla Longo

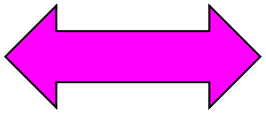
Saulo Freitas





NERC

Hugh Coe



USP

Paulo Artaxo

NERC SAMBBA consortium

PI: Coe (Manchester)

Investigators

Exeter:	Jim Haywood; Peter Cox; Stephen Sitch; Lina Mercado
Kings:	Martin Wooster;
Leeds:	Spracklen; Carslaw; Mann; Marsham; McQuaid; Parker;
Manchester:	McFiggans; Connolly; Gallagher; Allan; Williams;
Reading:	Highwood; Shaffrey; Ryder;
UEA:	Oram; Mills;
York:	Lewis; Hopkins; Purvis

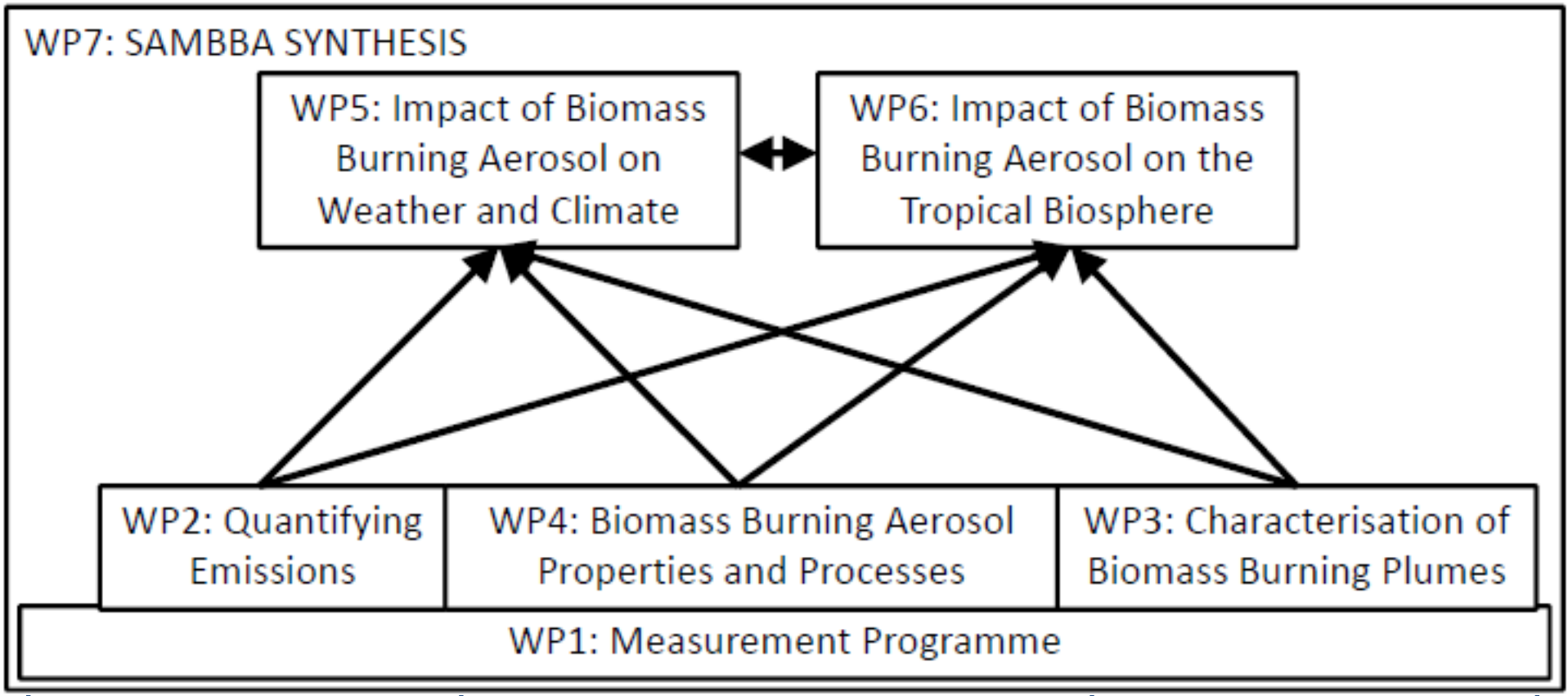
Partners

Met Office:	Ben Johnson; Paul Field; Sean Milton; Chris Jones
INPE:	Karla Longo and Saulo Freitas
University of Sao Paolo	Paulo Artaxo
ECMWF:	Adrian Simmons and Johannes Kaiser
Harvard and DOE:	Scot Martin
Brookhaven	Arthur Sedlacek

SAMBBA NERC Work Packages

Emissions

Regional climate

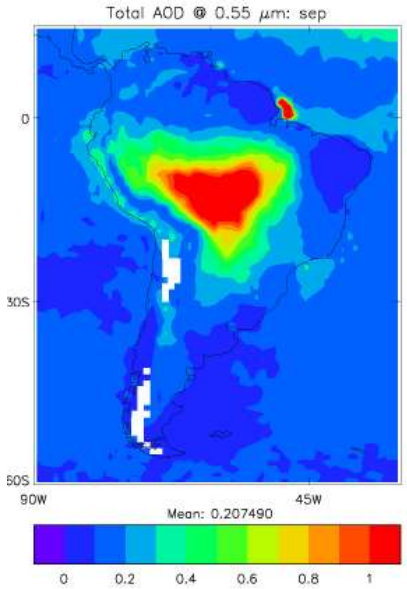


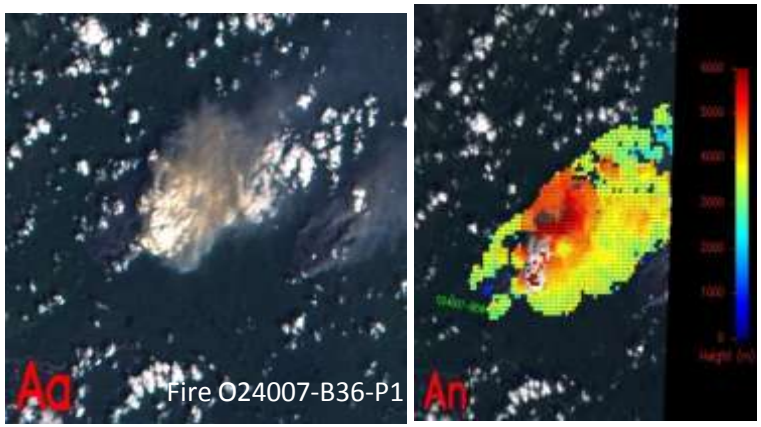
Assessing radiative balance

Air Quality

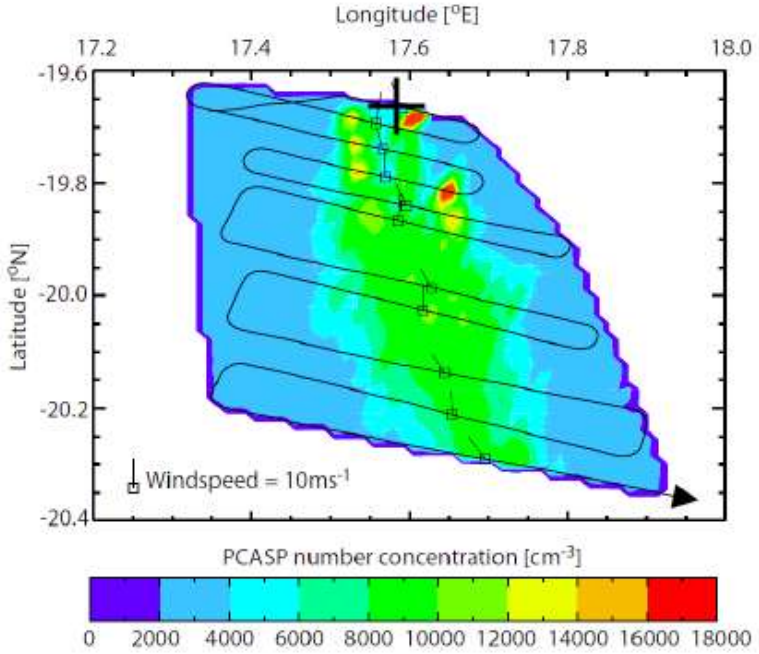
WP1: Experimental Strategy

- Ground Based Measurements





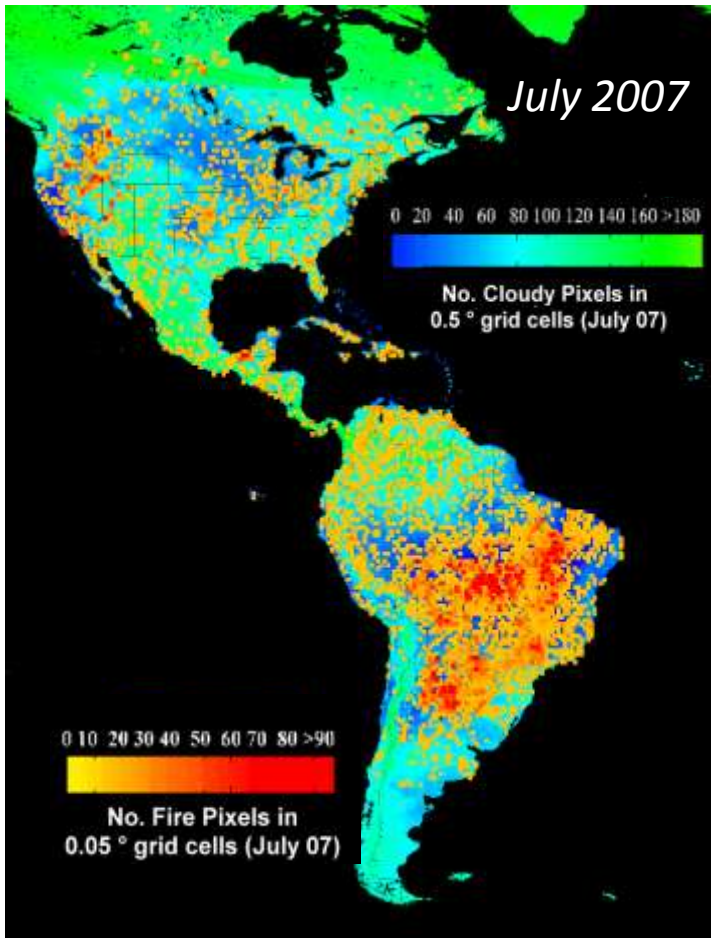
- Satellite Measurements



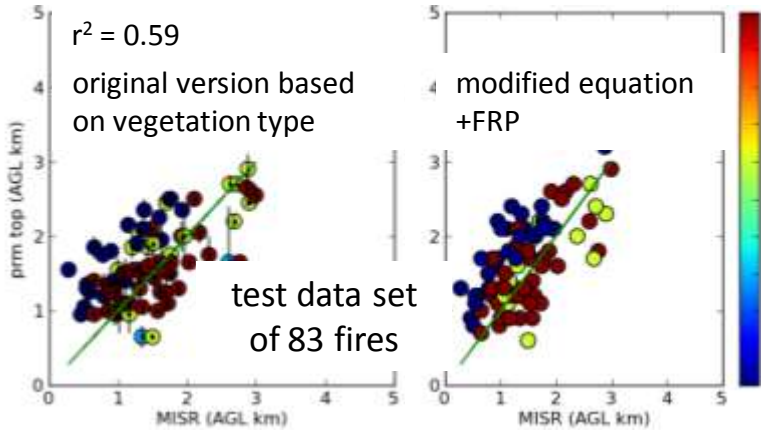
- Airborne experiment

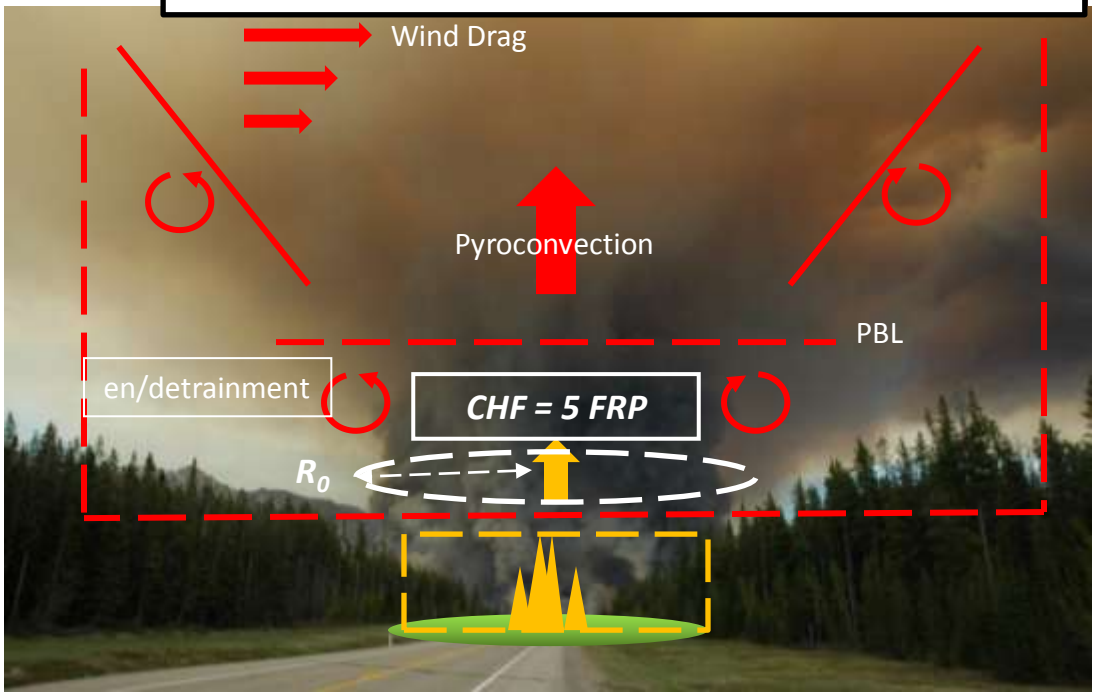
WP2: Quantifying Emissions

- Fire Radiative Power as an approach to capturing fuel consumption
- Emissions ratio measurements (ground and air)
- Plume rise mode verification and testing



Plume Rise Model (Freitas *et al.*, 2007; 2010)





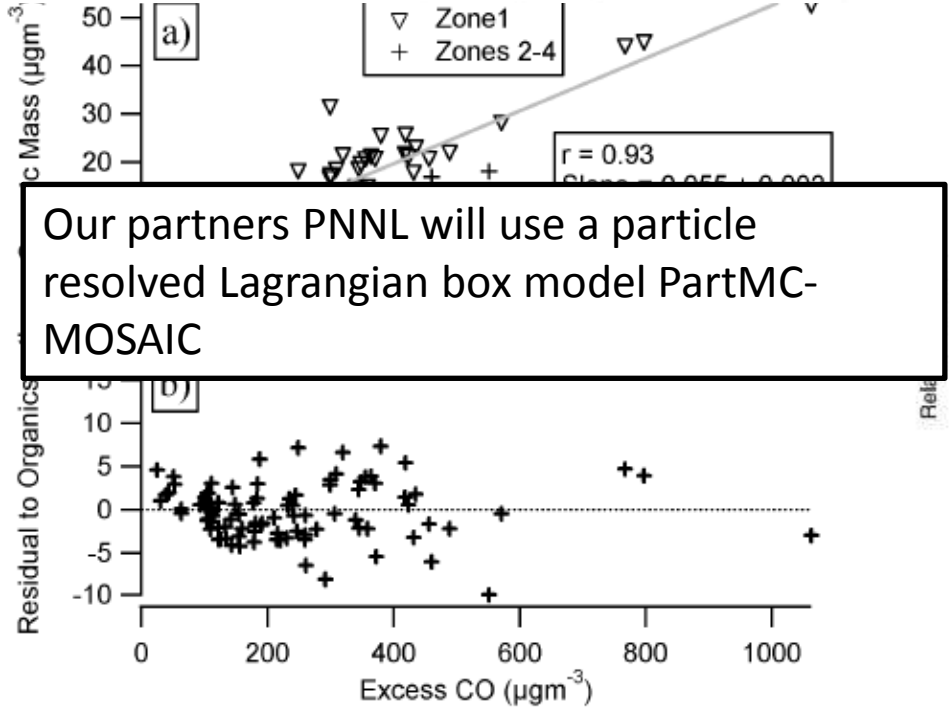
WP3: Transformations in Plumes

- Assessment of transformation rates in plumes
- Determination of key processes in plumes

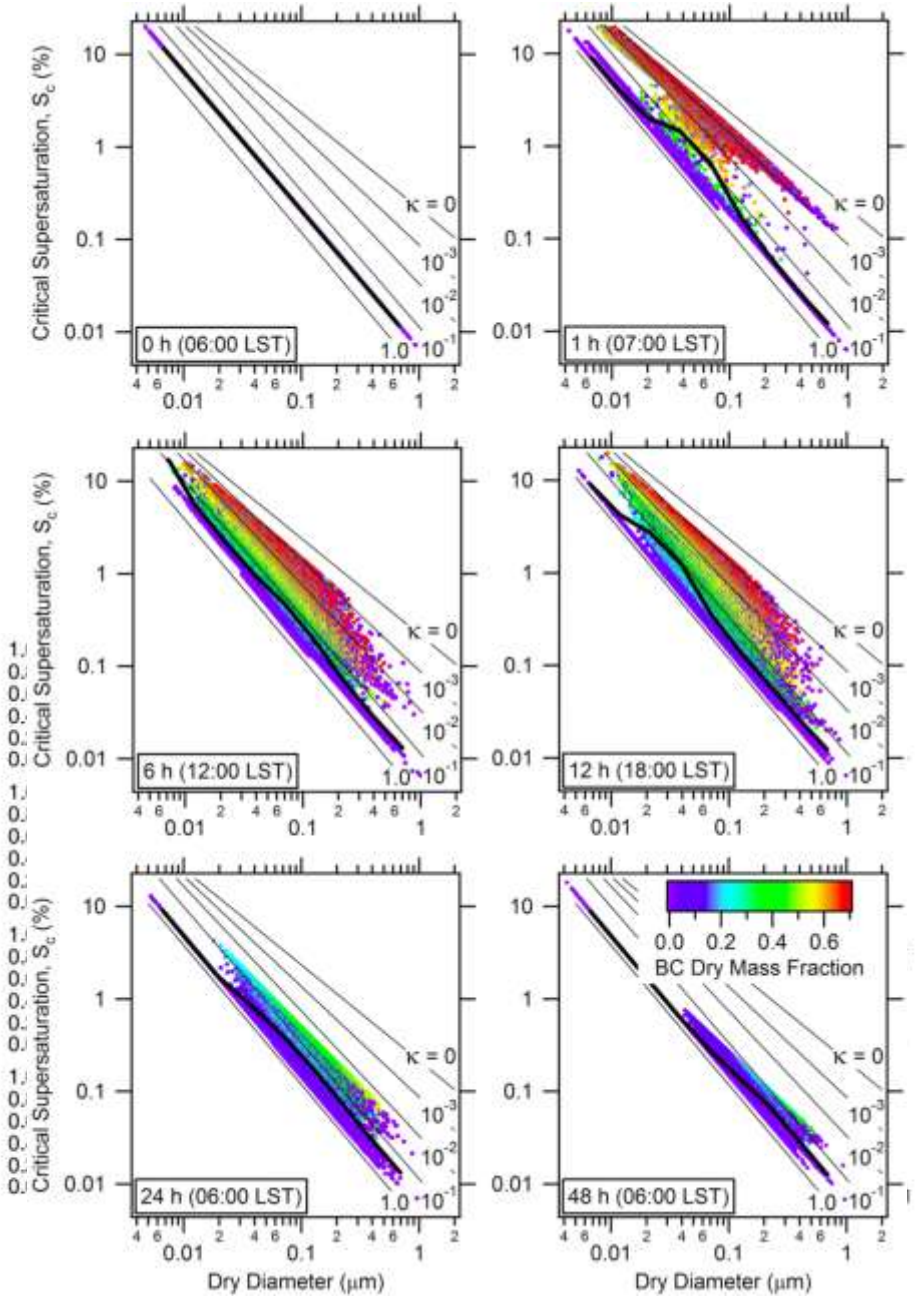
Particle-resolved simulation of aerosol size, composition, mixing state, and the associated optical and cloud condensation nuclei activation properties in an evolving urban plume

Rahul A. Zaveri,[1] James C. Barnard,[1] Richard C. Easter,[1] Nicole Riemer,[2] and Matthew West[3]

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 115, D17210, doi:10.1029/2009JD013616, 2010

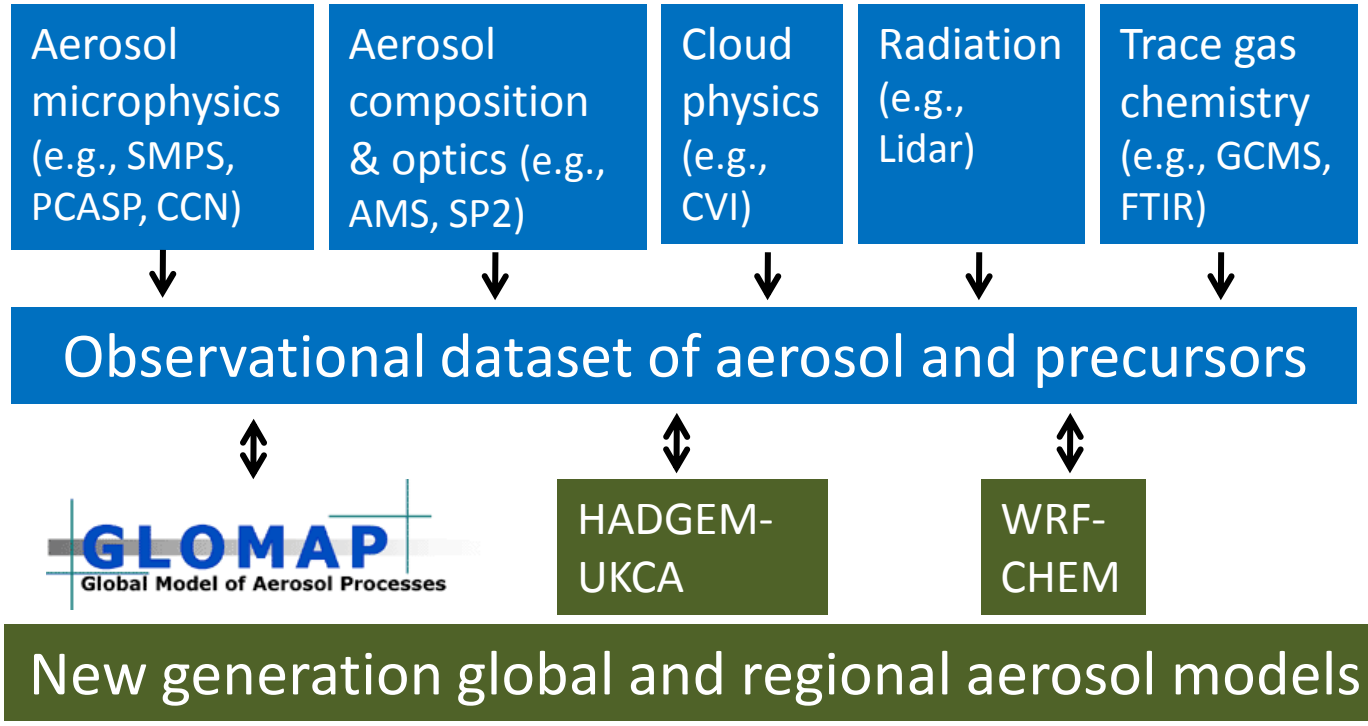


Our partners PNNL will use a particle resolved Lagrangian box model PartMC-MOSAIC



WP4: BBA Properties and Processes

Quantifying impacts of BBA requires understanding of the physical, chemical and optical properties of the aerosol.



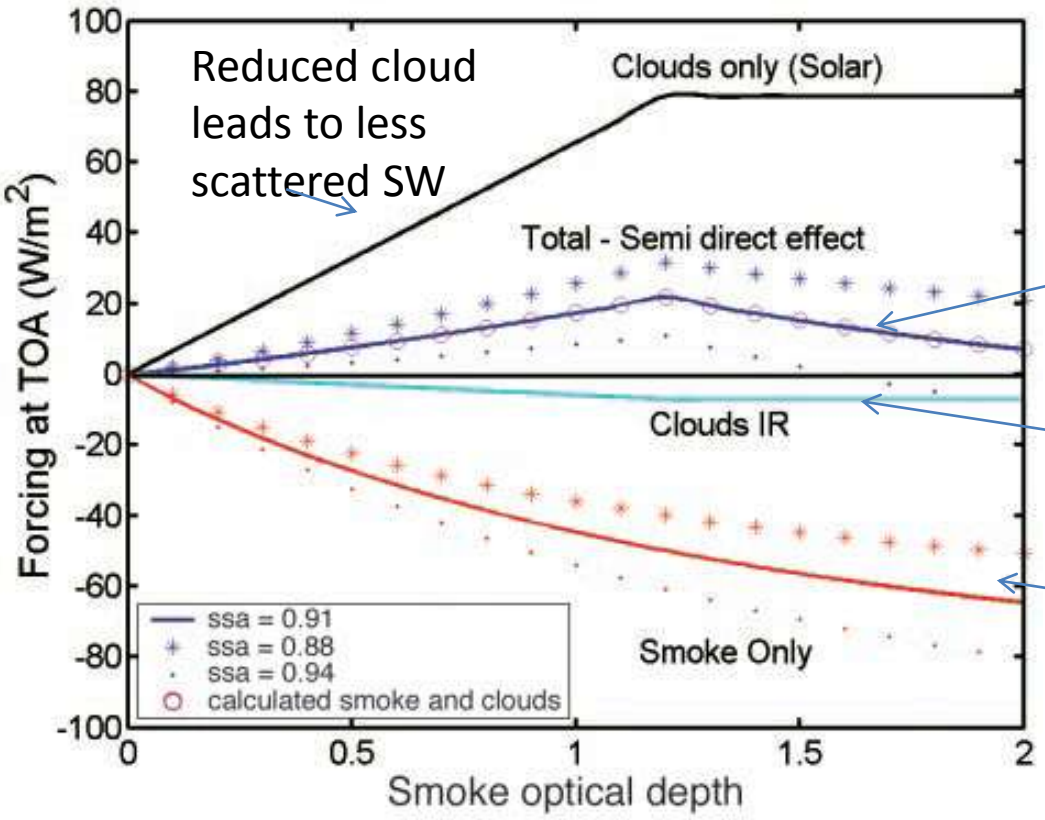
We will synthesise a detailed observational dataset of BBA to confront and test a new generation aerosol and climate models.

- D4.1 Detailed characterization of BB and background aerosol
- D4.2 Assess radiative closure
- D4.3 Quantify local impact of BBA on radiative budget and cloud

WP5: Impacts on Weather & Climate

- **Quantify the direct, semi-direct and indirect effect of BBA from Amazonia** (e.g. inform future IPCC reports, characterise uncertainties in forcing)
- **Assess the sensitivity of BBA impacts on regional weather patterns to model resolution and complexity**

Hierarchy of models with a range of resolution and complexity, constrained and informed by measurements from WP1



Total effect – dependent on SSA

Reduced cloud increases OLR

Smoke scatters SW radiation

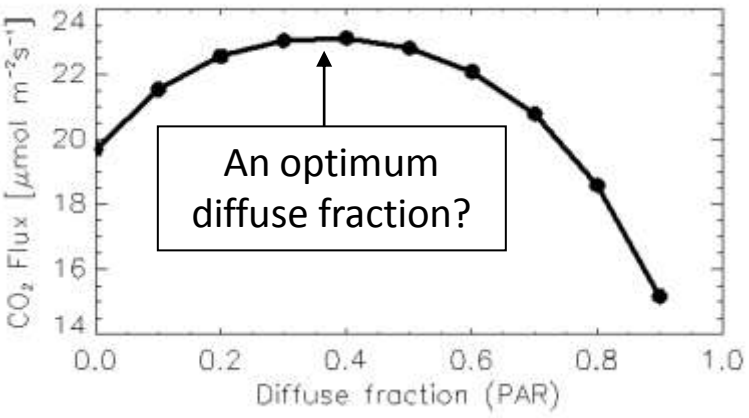
Annotated figure from Koren et al., Science, 2004

WP6: Impact of BBA on the Biosphere

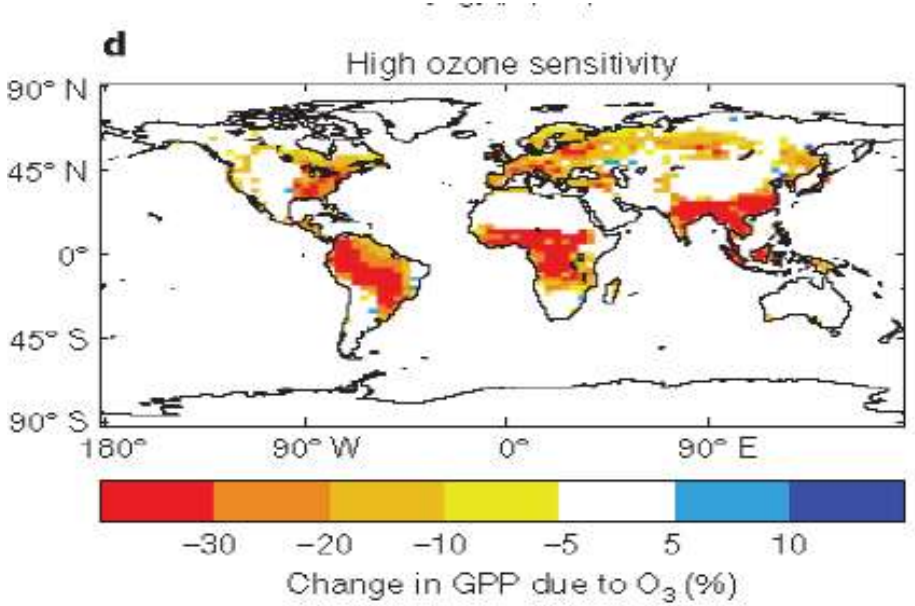
Climate feedback mechanisms, particularly the interaction with the terrestrial biosphere, are of fundamental importance in understanding future climate change scenarios and impacts on the health of the Amazonian rainforest.

WP6 will assess the impacts on the biosphere of:

- increased atmospheric CO_2 on the biosphere
- smoke on direct/diffuse radiation and photosynthesis
- ozone as a result of biomass burning



Mercado et al., 2009



Sitch et al., Nature, 2007

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WP7: Synthesis

- SAMBBA Database
- Synthesis of Amazonian aerosol composition and properties
- Quantification of relative importance of BC from BBA compared to that from other anthropogenic sources
- Assessment of impact of inclusion of biogeochemical feedbacks on climate metrics

Pathways to Impact

Beneficiaries

- Scientific Community

- Operational Forecasters in the UK, Europe and Brazil
- General public/media
- Policymakers

http://thebarometer.podbean.com/

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Distinct sortie types / sortie elements

1. Single fire/smoke plume studies (including prescribed burns) [WP2, WP3, WP4]
2. Radiative closure [WP4, WP5, WP6, MO]
3. Shallow cumulus sampling [MO / WP5]
4. Intensive BL studies [WP5]
5. Regional scale in-situ characterization of aerosol [WP3, WP4, WP5]
6. High altitude remote sensing (FRP / satellite validation) [WP2, WP4]

Summary

- SAMBBA aims to characterise the life cycle of biomass burning aerosol in South America and elucidate its impacts.
- Combination of ground, airborne and space-borne instrumentation; uses both in-situ and remote sensing measurements.