# Biomass Burning aerosol emissions: A Proposal for AEROCOM BB Experiment

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Satellite AOD snapshots to constrain Biomass Burning Emissions *Source Strength*


124 Globally Distributed Cases
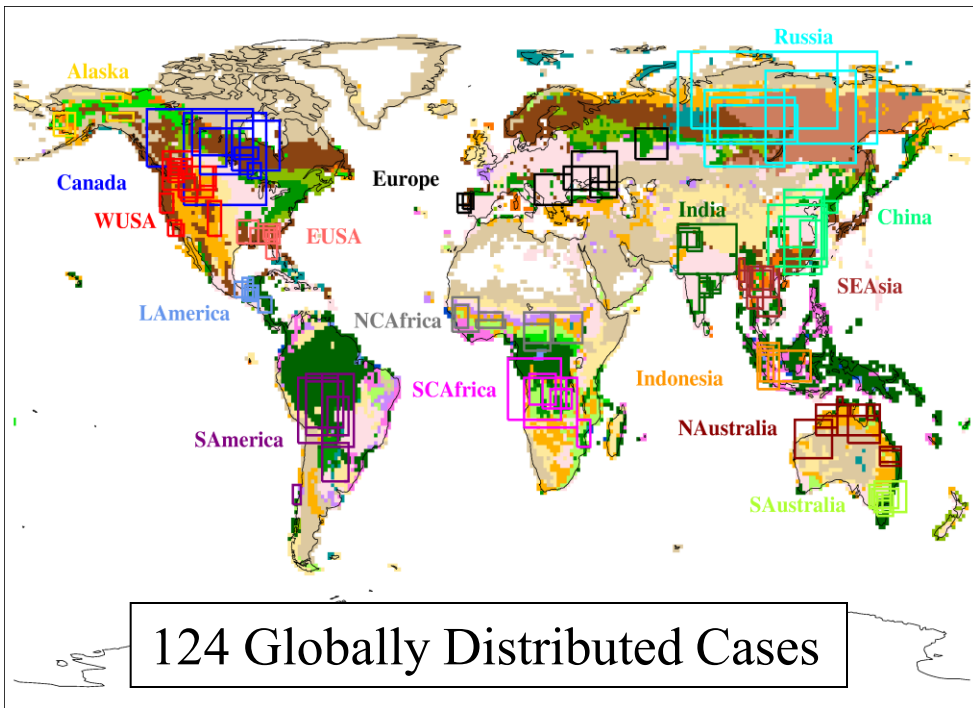
Land cover legend:
1 Tree cover, broadleaved, evergreen
2 Tree cover, broadleaved, deciduous, closed
3 Tree cover, broadleaved, open
4 Tree cover, needle-leaved, evergreen
5 Tree cover, needle-leaved, deciduous
6 Tree cover mixed leaf type
7 Tree cover, regularly flooded, fresh water
8 Tree cover, regularly flooded, saline water
9 Mosaic: tree cover / other natural vegetation
10 Undefined
11 Shrub cover, closed-open, evergreen
12 Shrub cover, closed-open, deciduous
13 Herbaceous cover, closed-open
14 Sparse herbaceous or sparse shrub cover
15 Regularly flooded shrub and/or herbaceous cover
16 Cultivated and managed areas
17 Mosaic:Cropland/Tree cover/other natural veg
18 Cropland/Shrub and/or grass cover

13 Smoke Emission Estimates

Petrenko, Kahn, Chin, et al., JGR 2012
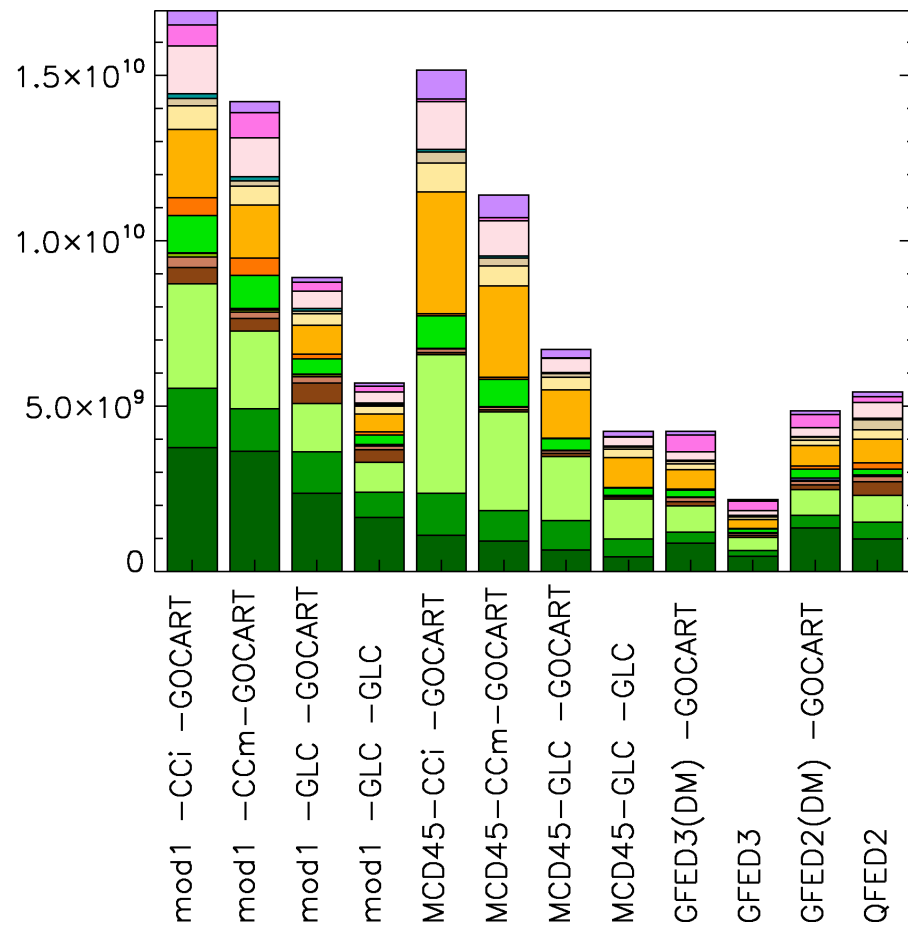
MODIS-GoCART Total Column AOD Comparisons
Sample Case: Siberia July 20 2006
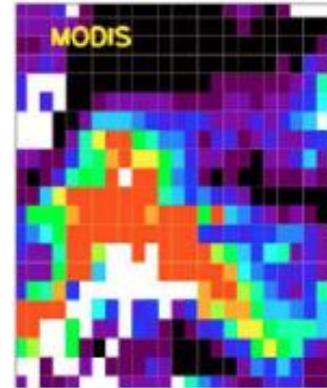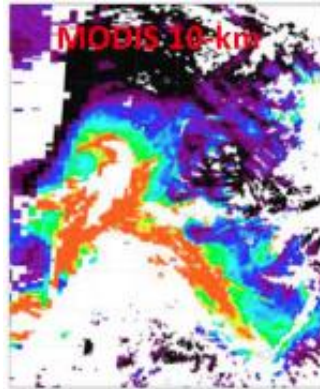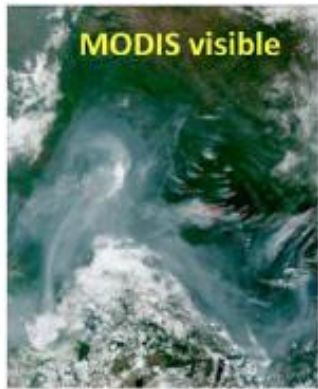
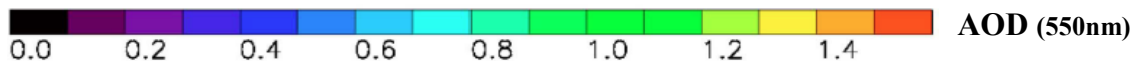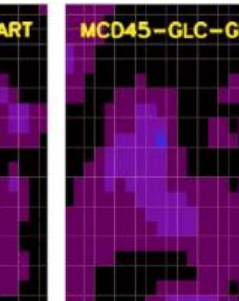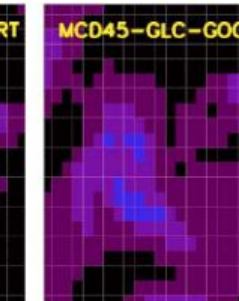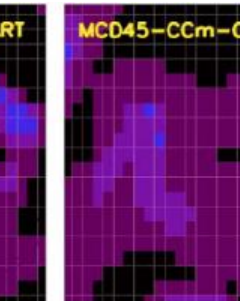**Goddard Chemistry Aerosol Radiation and Transport (GOCART) model runs**

3-hourly output

Resolution: 1°(lat) x 1.25°(lon) x 30 vert. layers

Meteorological fields GEOS DAS Version 4

Emissions include: dust, sea salt, anthropogenic, sulfate & precursors, BB

13 BB emission options in separate model runs

Study period: June 2006-June 2007

Petrenko et al., JGR, 2012
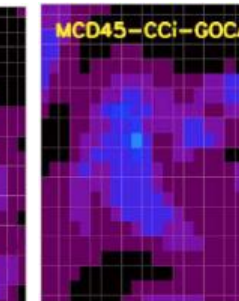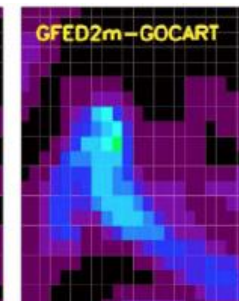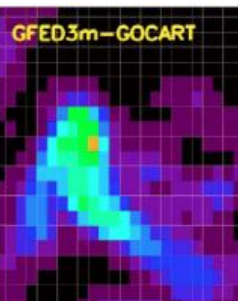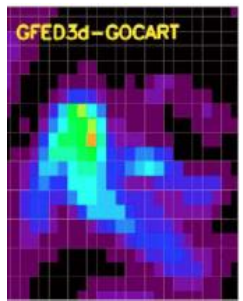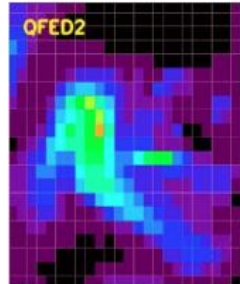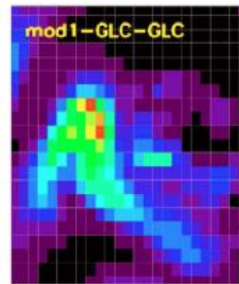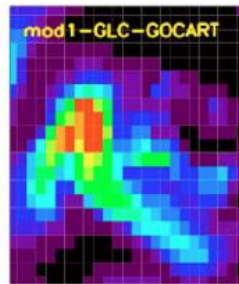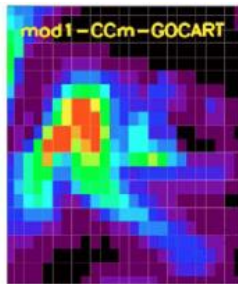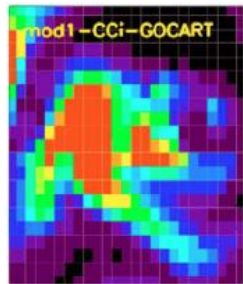
Ratio of GOCART to MODIS average AOD
For each case, for 12 emission estimates
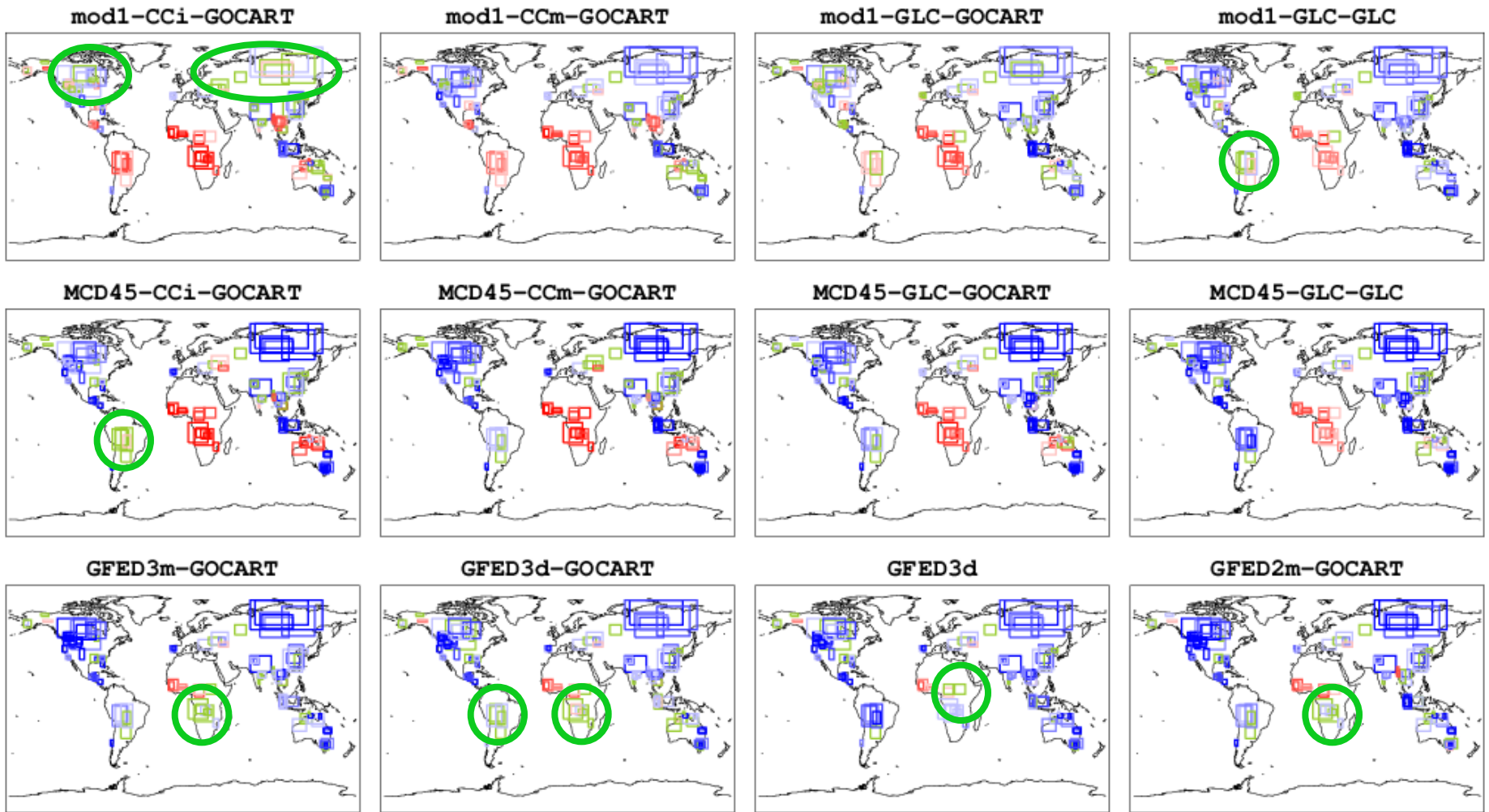
Systematic regional patterns; some emissions work better in certain regions

Ratio of GOCART average AOD to MODIS average AOD

0.00 0.33 0.50 0.625 0.83 1.20 1.60 2.00 3.00 10.65

N. America Plume *Injection Height* Climatology
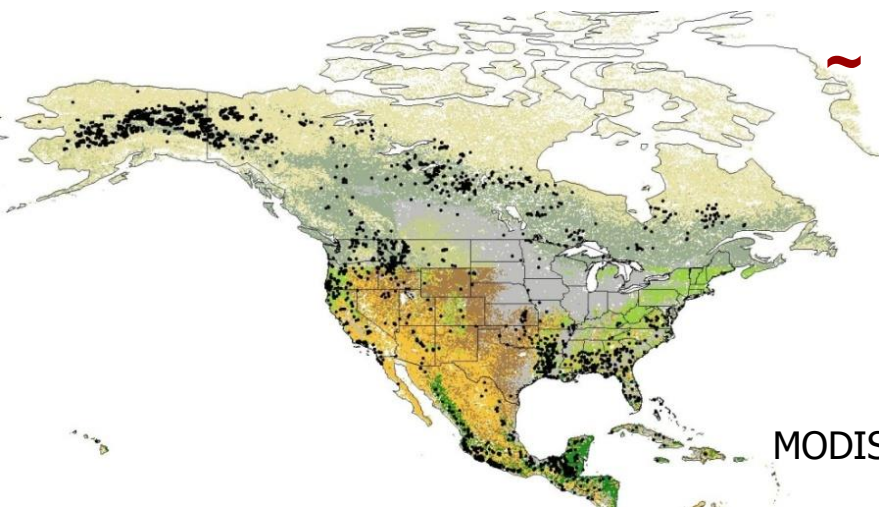
~ 3400 plumes digitized over North America for 2002, 2004-2007

MODIS IGBP land cover map
(1x1 Km res)

- Tropical Forest
- Temperate Forest
- Boreal Forest
- Boreal Shrubland
- Non-Boreal Shrubland
- Boreal Grassland
- Non-Boreal Grassland
- Cropland
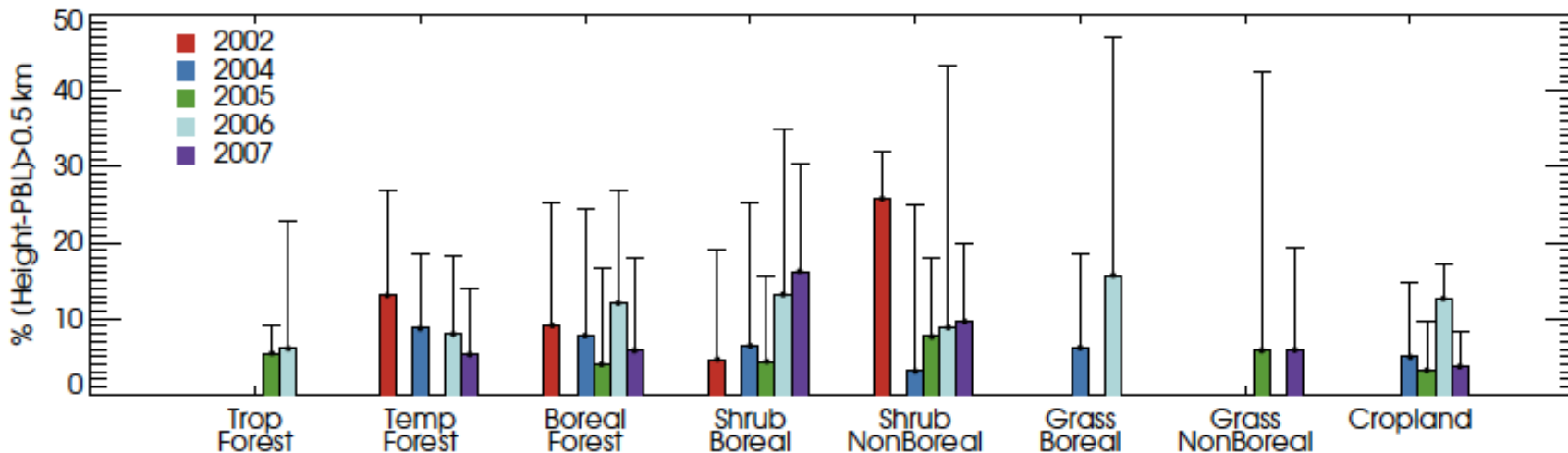
Percent of plumes >0.5 km *above BL*, stratified by year and vegetation type

Evaluation of a 1D plume-rise model:
Towards a parameterization of smoke *injection heights*

To Constrain models:
Need to assess the
Parameterizations
actually used

Heat Flux Options

Active Fire Area Options
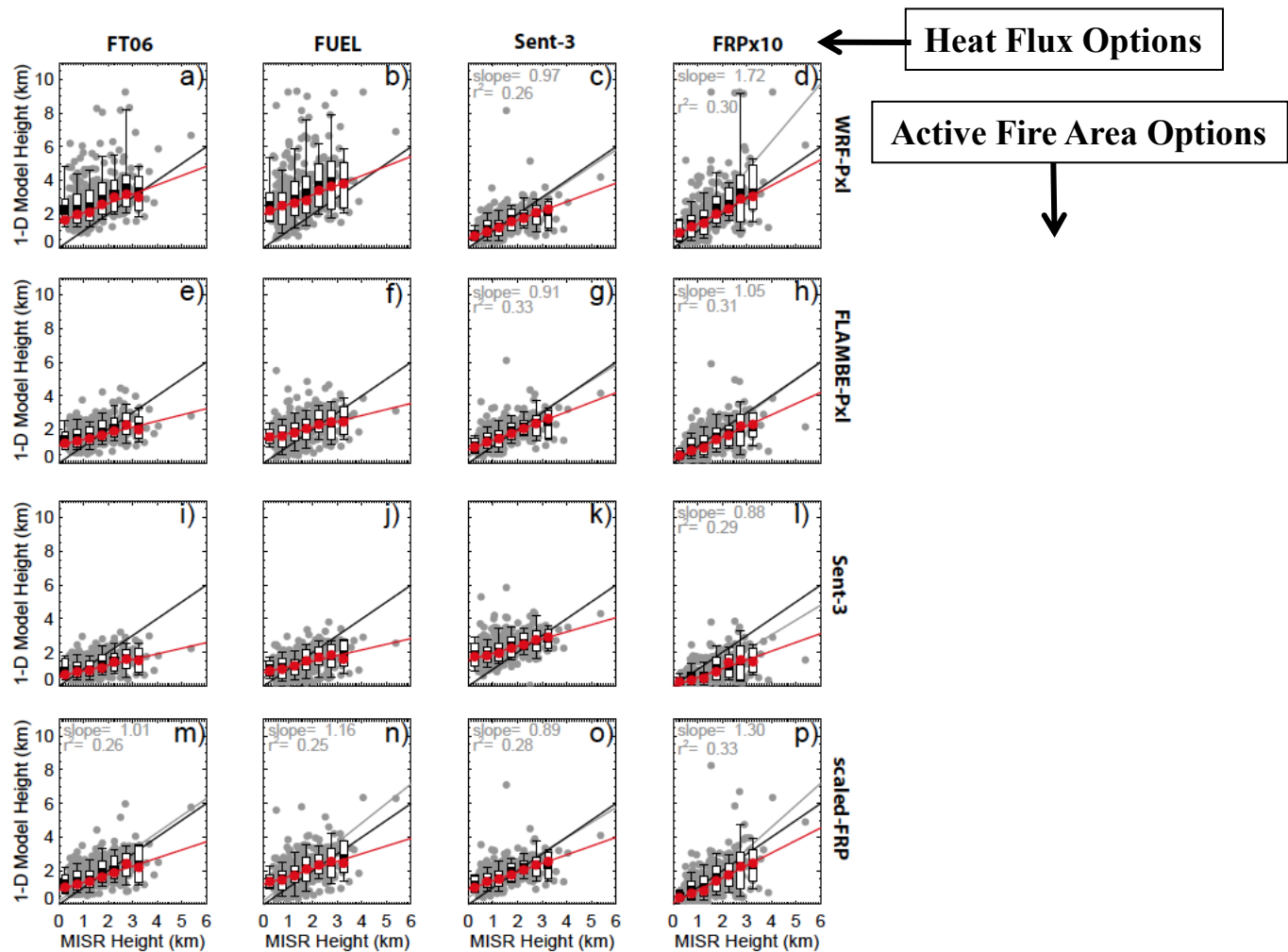
1-D Plume-rise model heights vs. **MISR-observed max. plume heights**
-- Plume-rise calculations have *lower dynamic range than observed*, but very variable

Val Martin et al., JGR 2012

Evaluation of a 1D plume-rise model:
Towards a parameterization of smoke *injection heights*
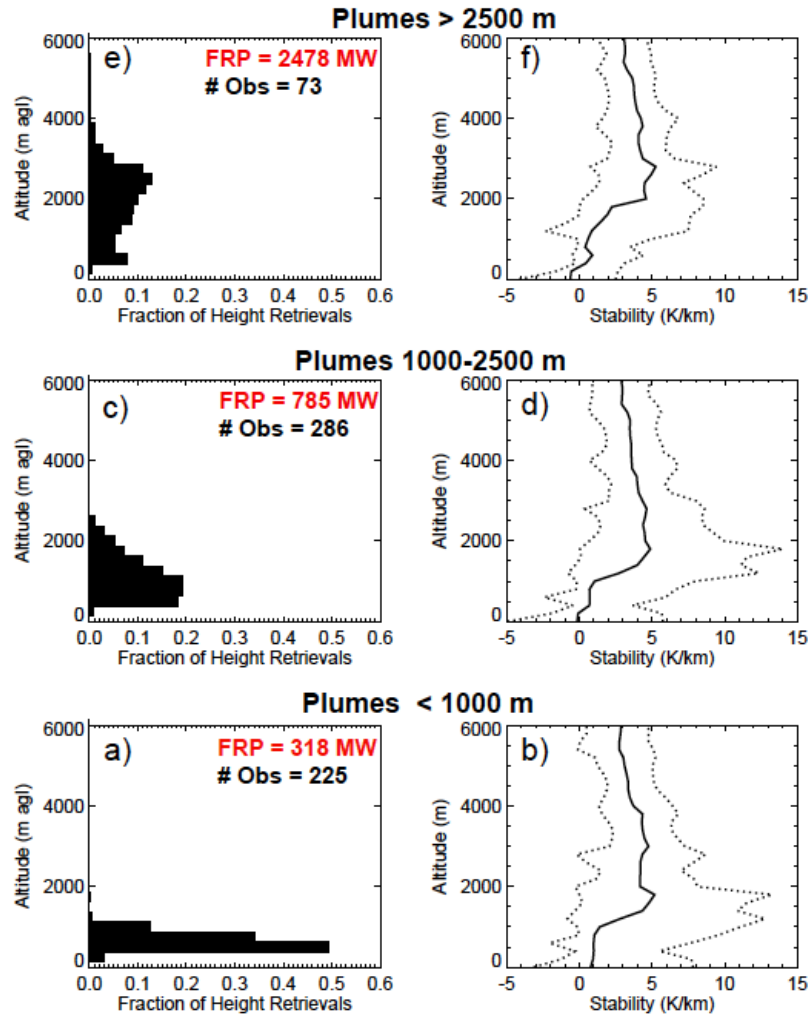
The key factors:

- *Fire Energy* (fire area; heat flux, FRP)
- *Atmospheric Stability*
- *Entrainment*

Plume height increases systematically as *FRP* increases and *Atmospheric Stability* decreases

Val Martin et al., JGR 2012

Motivation for the AeroCom BB Experiment AOD
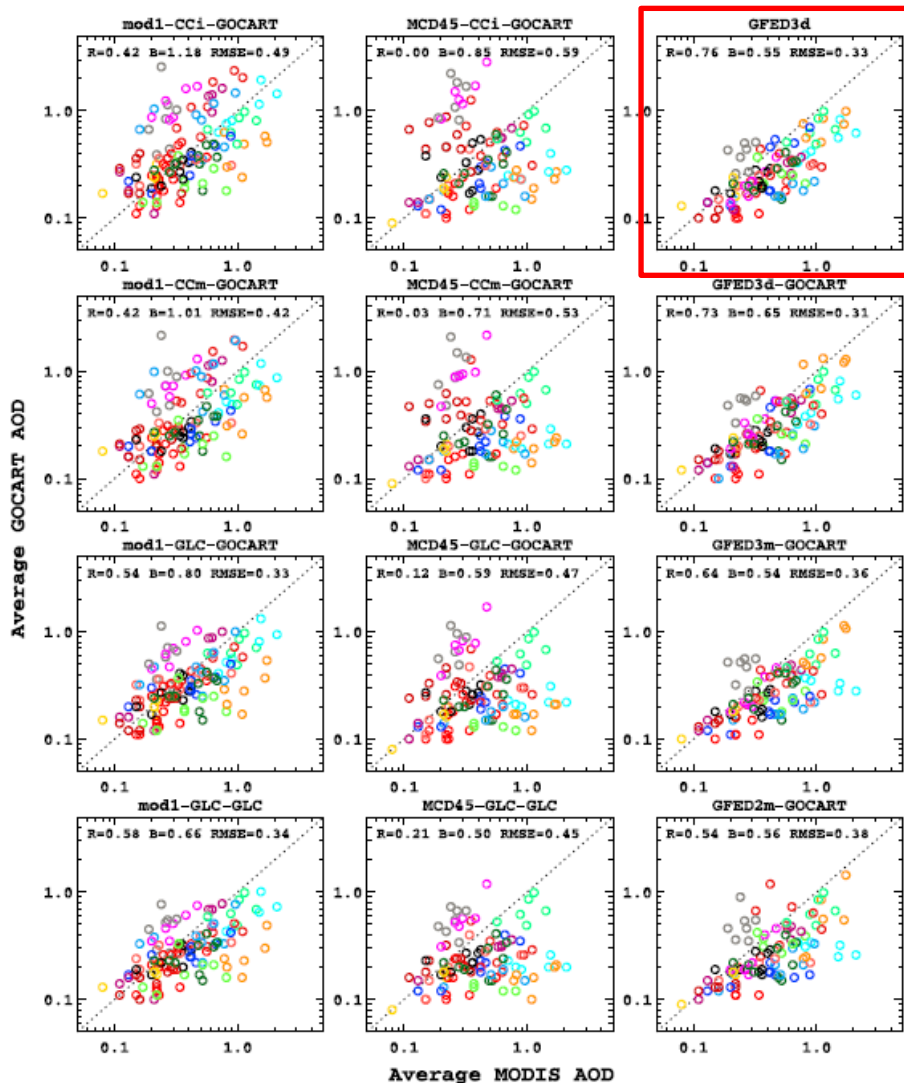
- We have a substantial set of **satellite wildfire plume AOD snapshots and injection heights** to help calibrate model/inventory performance

- We are: (1) adding **more fire source-strength cases**, (2) using MISR to **improve the AOD constraints** and (3) adding **2008 global injection heights**

- We selected **GFED3-daily** due to good overall source strength performance, but **any inventory can be tested**

- Need a joint effort, to **test multiple, global models** to draw robust BB injection height & emission strength conclusions

Objectives

- Inter-compare & quantify **model BB AOD accuracy and diversity**

- Propose **regional emission corrections**
  -- improve the widely used GFEDv3 emissions

- Test global model smoke **injection height – emission intensity relationships**

We are offering:
Satellite-based smoke plume AOD and injection height climatologies

Satellite Constraints

- Benchmark year: *2008*

- MODIS ***AOD for pre-selected smoke plumes*** in different biomass burning regions

- MISR ***2008 global BB plume height*** currently being retrieved at JPL and GSFC

Model Study period:

January 1 – December 31 2008, preceded by a few months spin-up.

Experiment Design

Exp.	BB emission Option 1	BB emission Option 2	Injection height
BB0	--	--	*No BB emission*
BB1	**GFED v3**	GFED v3	Boundary layer
BB2	**GFED v3 x 0.7**	GFED v3 x 0.5	Boundary layer
BB3	**GFED v3 x 5**	GFED v3 x 2	Boundary layer
BB6	--	GFED v3 x 4	Boundary layer
BB4	**GFED v3**	GFED v3 x 0.5	Val Martin
BB5	**GFED v3 x 5**	GFED v3 x 2	Val Martin
BB7	--	GFED v3 x 4	Val Martin

Control ⟶ BB1

Requested output:

2-D, 3-hourly, instantaneous

- Total column *550 nm AOD*
- *Biomass burning AOD*, if available (or AOD's of individual aerosol species)
- *Wind speeds* in the middle of emission injection height
  [e.g., if all smoke is distributed within PBL, output mid-PBL winds]
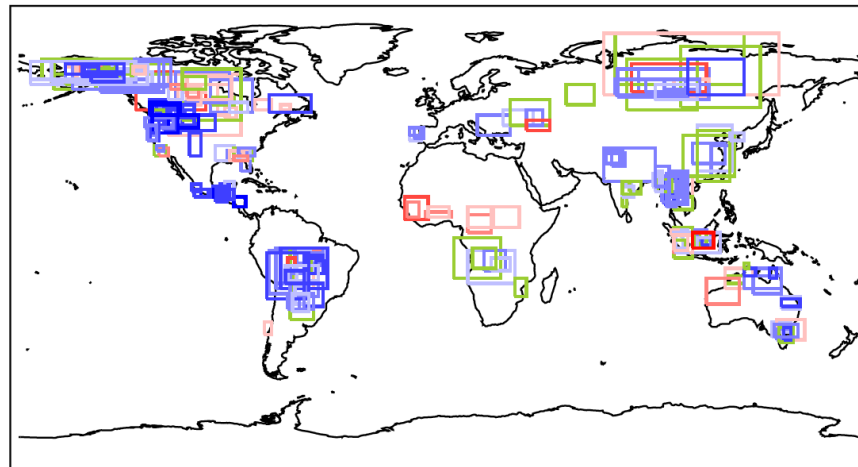- **PBL height**

3-D [3-hourly]

- Aerosol *species concentrations*
- Aerosol 550 nm *extinction*

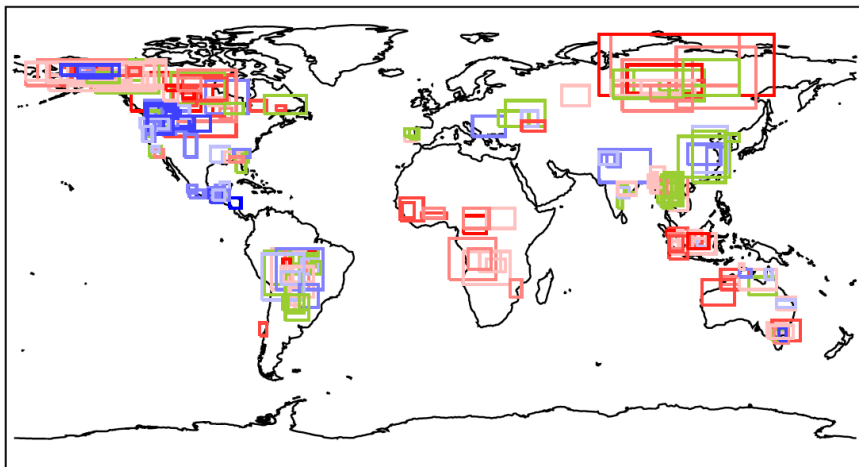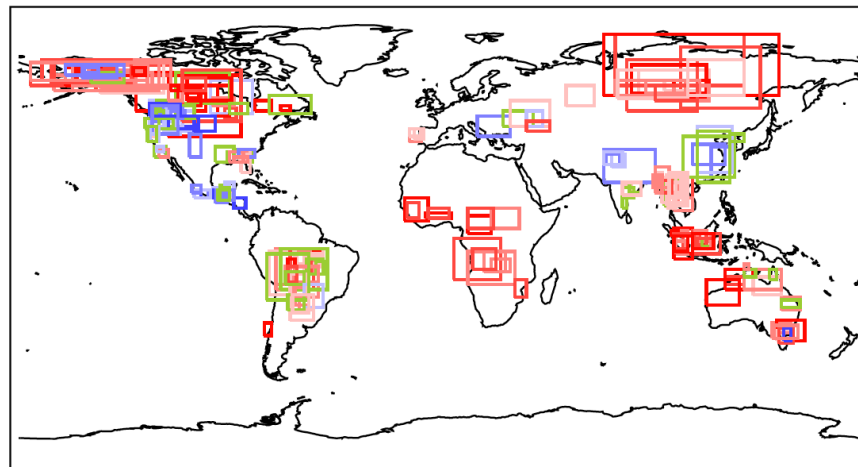# With *Source Strength* Perturbation Factors: 0.7, 1, 3 & 5
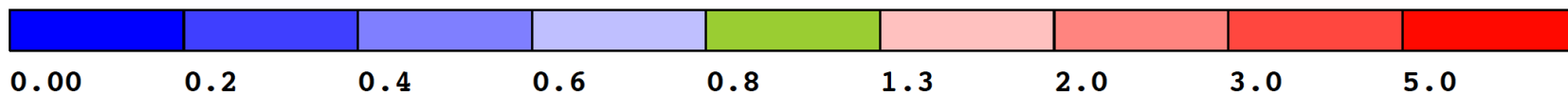

GOCART GFED3x0.7
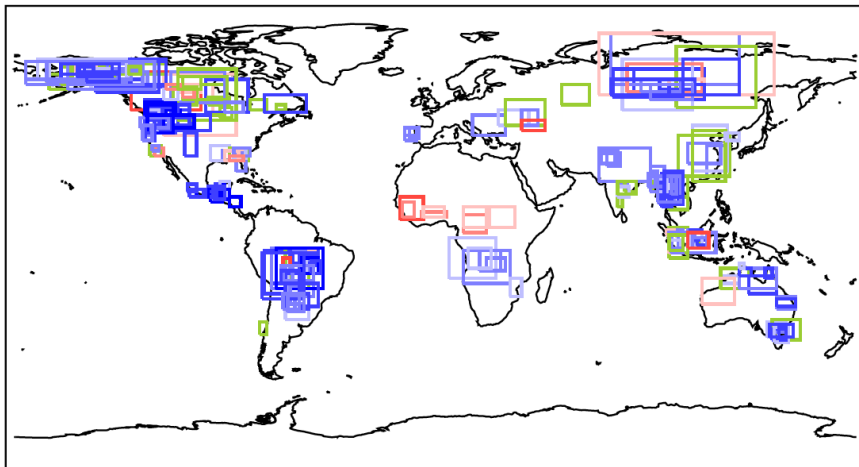
GOCART GFED3

GOCART GFED3x3

GOCART GFED3x5

Ratio of GOCART average AOD to MODIS average AOD

0.00   0.2   0.4   0.6   0.8   1.3   2.0   3.0   5.0

General Timeline

- ***AeroCom Meeting****:* Discuss & refine experiment plan

- ***Early 2014****:* Finalizing reference datasets

- ***Early 2014****:* Set up model simulations

- ***30 June 2014****:* Submit model outputs

- ***July-September 2014****:* Preliminary model analysis

- ***Fall 2014****: AeroCom* presentation & feedback

- ***Mid-2015****:* Finalize analysis, manuscript preparation