The AeroCom Biomass Burning Experiment

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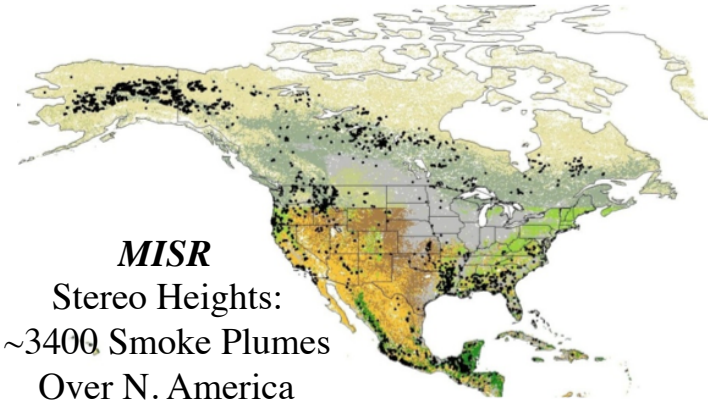
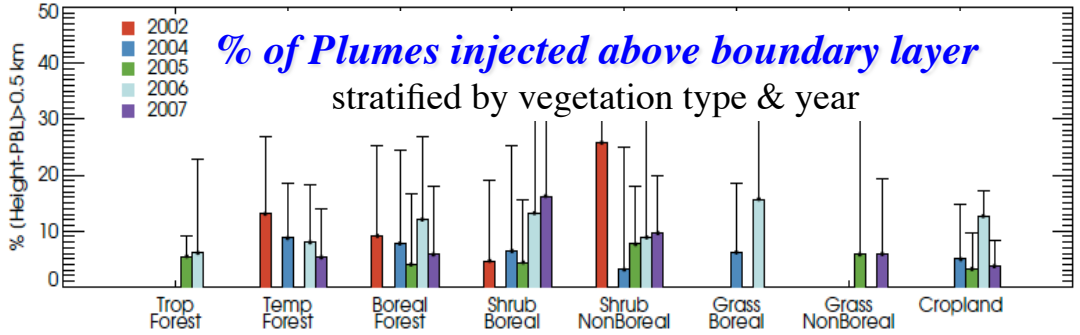
Wildfire Smoke *Injection Heights* & *Source Strengths*

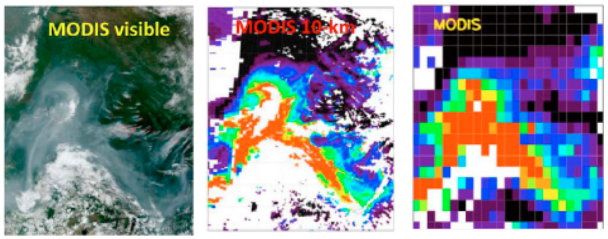


MISR
Stereo Heights:
~3400 Smoke Plumes
Over N. America

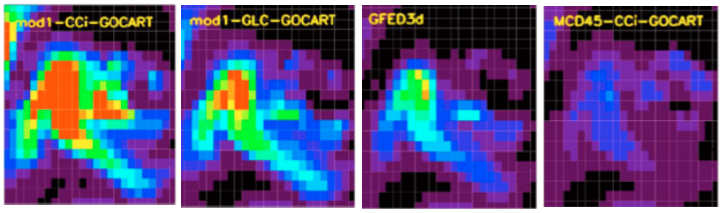


% of Plumes injected above boundary layer
stratified by vegetation type & year

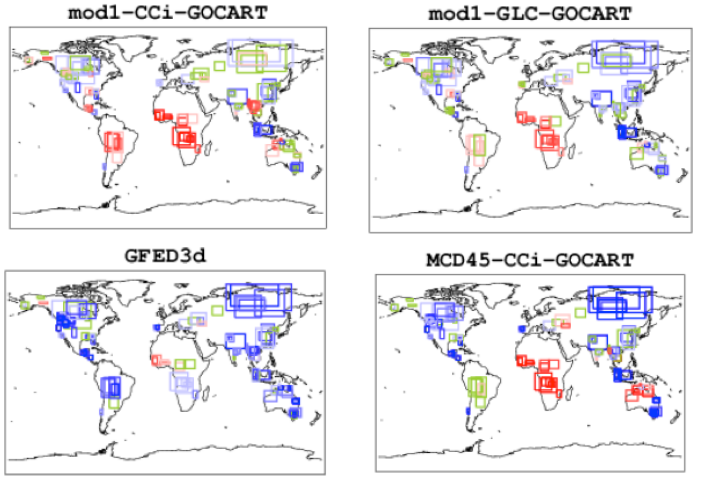
Val Martin et al. ACP 2010



MODIS Smoke Plume Image & Aerosol Amount Snapshots



GoCART Model-Simulated Aerosol Amount Snapshots
for *Different Assumed Source Strengths*



Different Techniques for *Assuming Model Source Strength*
Overestimate or ***Underestimate*** Observation
Systematically in Different Regions

Petrenko et al., JGR 2012

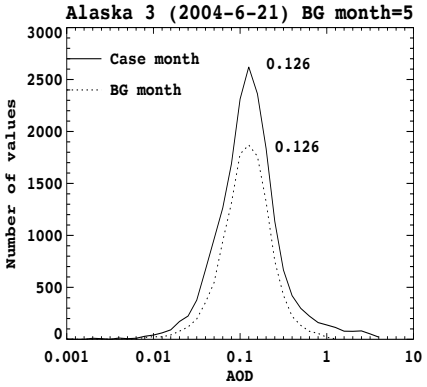
Source Strength
Refinements to the MODIS BB AOD Snapshot Dataset

(1) Expanded the ***Number of Fire Cases*** from 124 to over 900

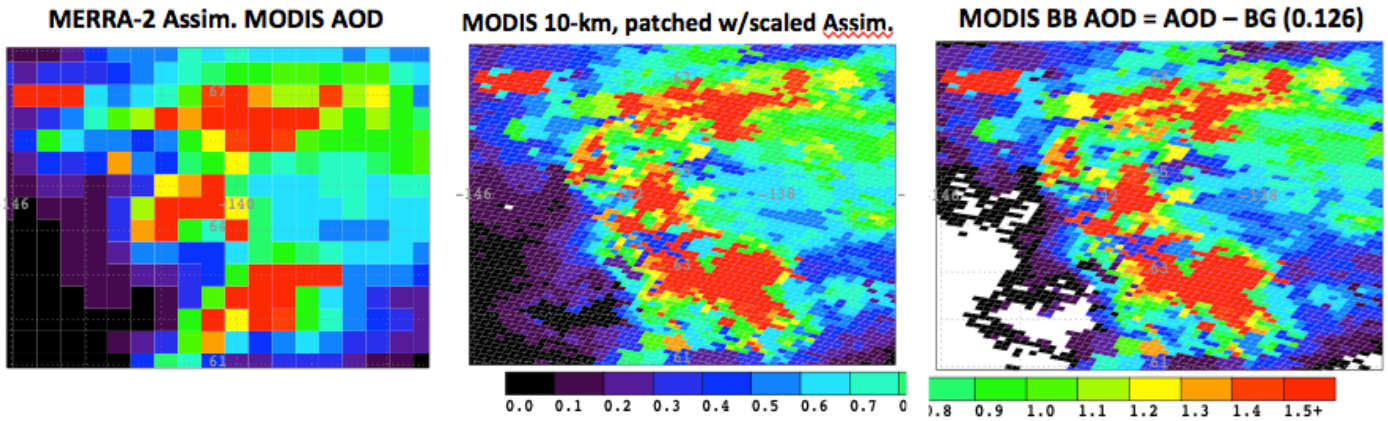
(2) Used scaled reanalysis-model simulations to ***Fill Missing AOD Retrievals*** in the MODIS observations

(3) ***Separated the BB Components*** of the total AOD from background aerosol in the near-source regions (*using pre-fire-season AOD statistics*)

(4) Included emissions from ***Small Fires*** that are not identified explicitly in the satellite observations (*GFED4.1s*)



Background AOD is the modal mean AOD for the month (BG month) at the beginning of, or just before, the burning season.



MODIS BB AOD = **Plume AOD_{tot} – AOD_{bkgnd}**

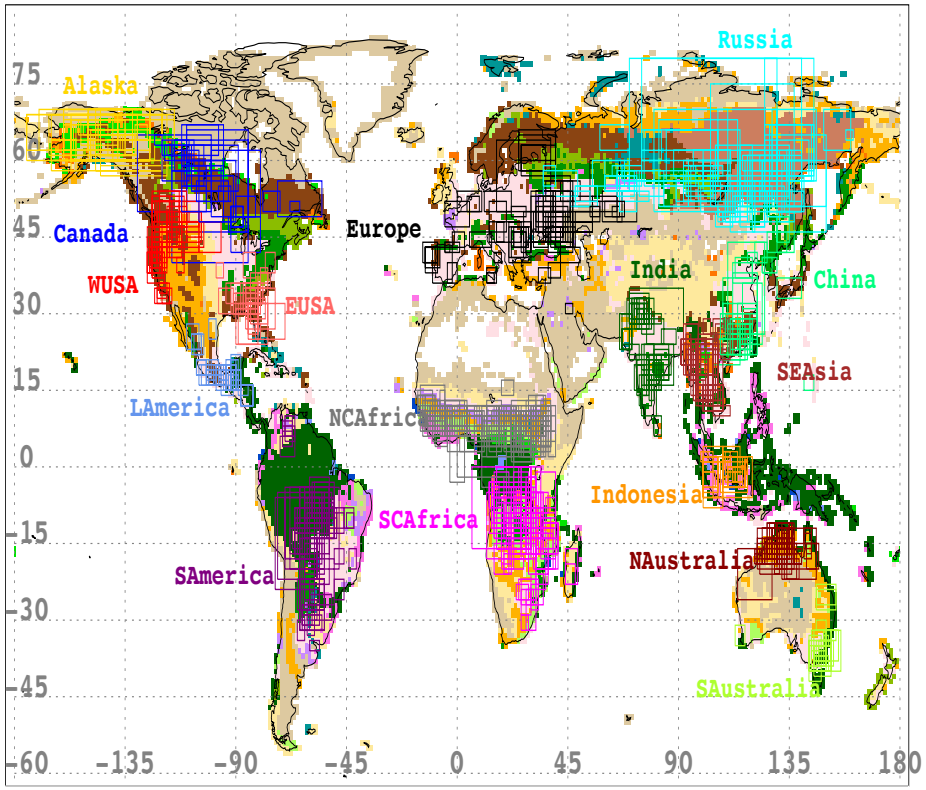
Petrenko et al., JGR 2017 in press

Source Strength

Satellite Reference Observational Dataset

2004, 2006-2008

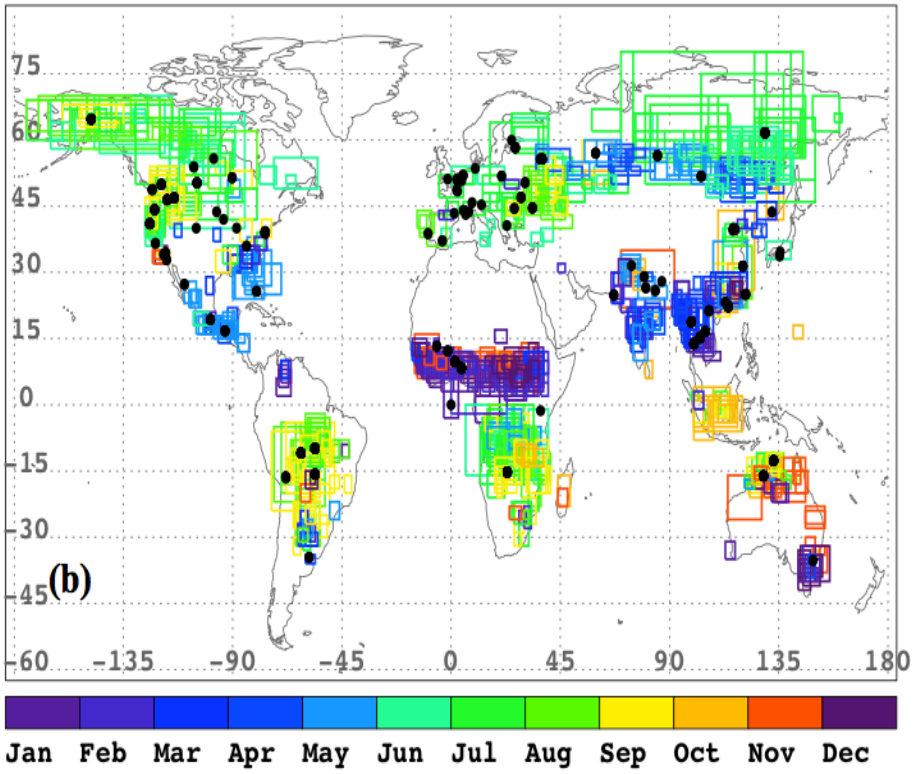
972 Cases in 16 Colored *Ecosystems* (497 in 2008)



1 Tree cover, broadleaved, evergreen
2 Tree cover, broadleaved, deciduous, cl
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 wa
8 Tree cover, regularly flooded, saline w
9 Mosaic: tree cover/other natural veg
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 herb. cov
16 Cultivated and managed areas
17 Mosaic:Cropland/Tree cover/other veg
18 Cropland/Shrub and/or grass cover

The colored squares represent ecosystems

***Month* when case was observed by MODIS**



Petrenko et al., 2017 in press

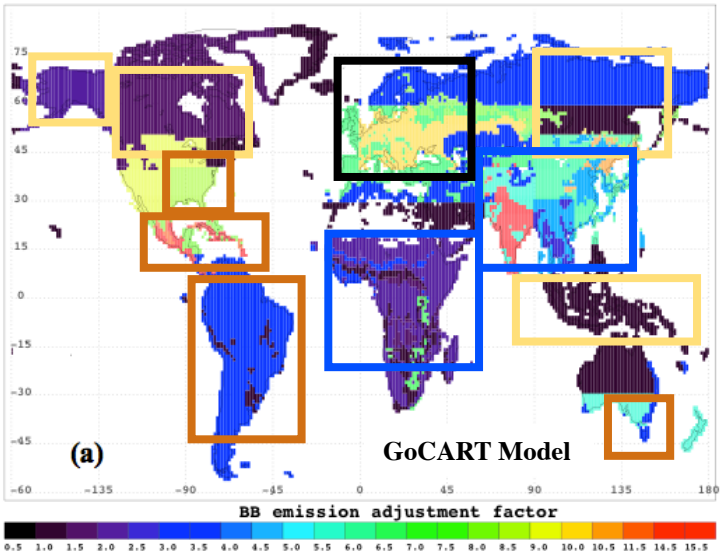
Source Strength
Adjustment Factor Situational Groupings

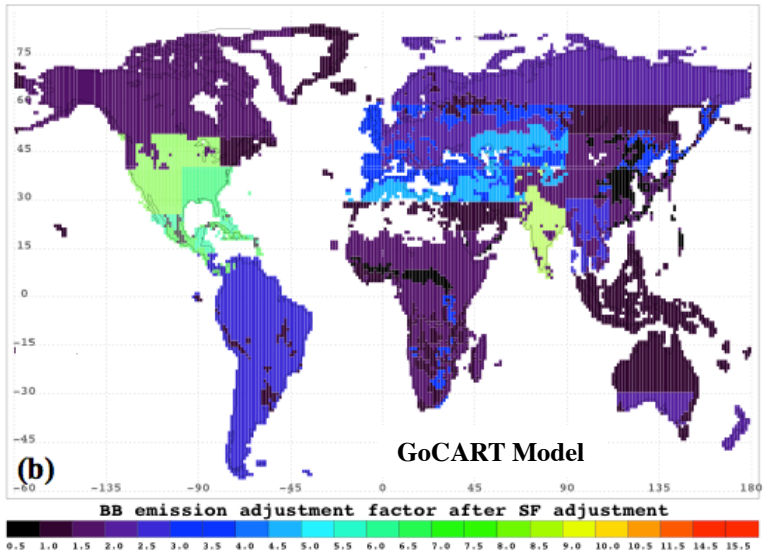
Group 1 –***Discrete, Strong Smoke Plumes*** dominate, minimal adjustment needed

Group 2 – Smoke source ***Adjustments Resolve most AOD Discrepancies***

Group 3 – ***Background AOD High & Comparable*** to or larger than smoke AOD

Group 4 – ***Background AOD Low but Comparable*** to smoke AOD





Petrenko et al., 2017 in press

Group 1 – ***Alaska, Canada, Indonesia, Eastern Siberia***

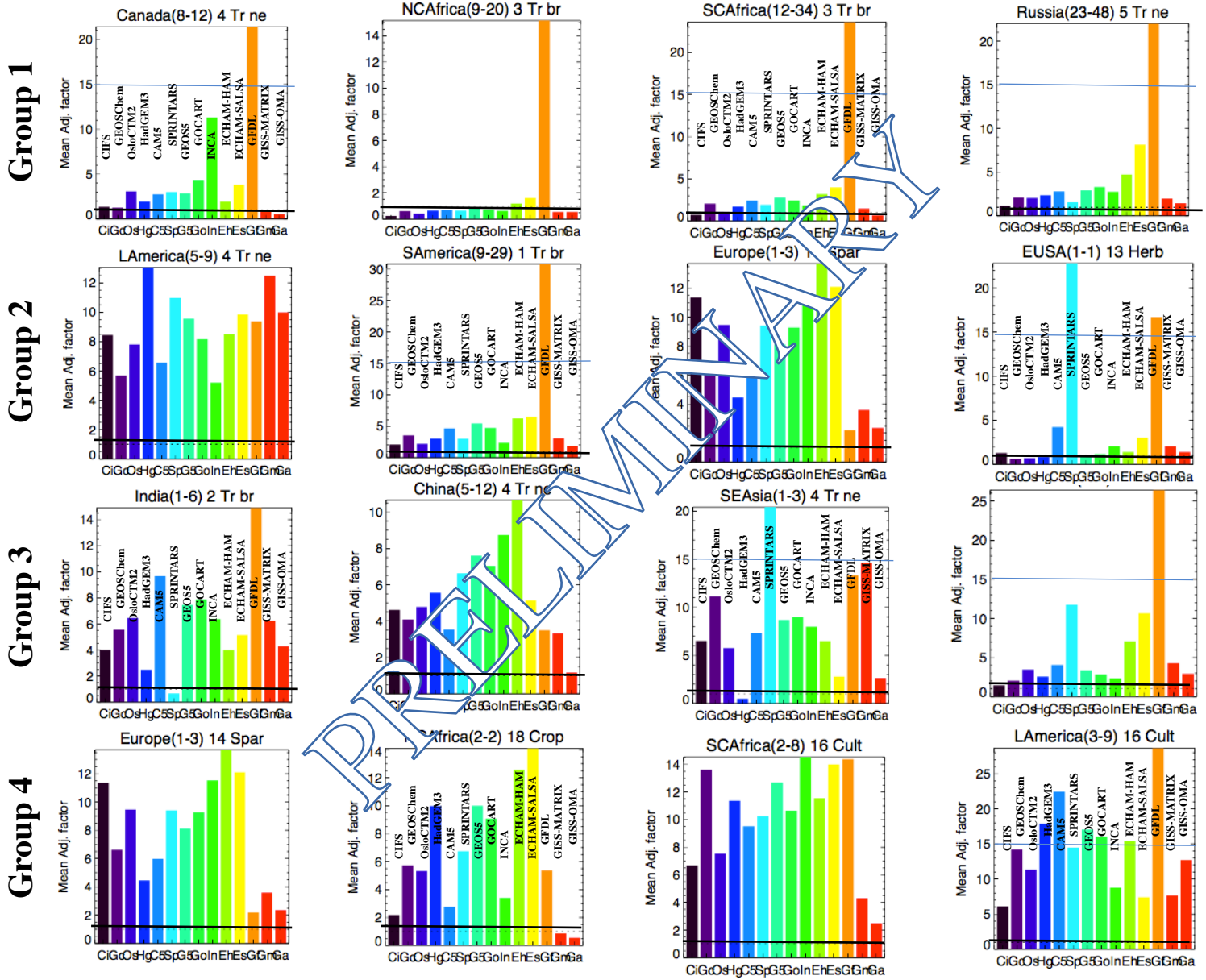
Group 2 – ***South Australia, Eastern USA, South America, Latin America*** *(with SF)*

Group 3 – ***India, China, Southeast Asia, North & South-Central Africa***

Group 4 – ***Europe***, + ***Crop, Cultivated*** *ecosystems almost everywhere,* ***& some Shrub***

Source Strength

AOD_{BB} Ratio Multi-Model/MODIS (2008)



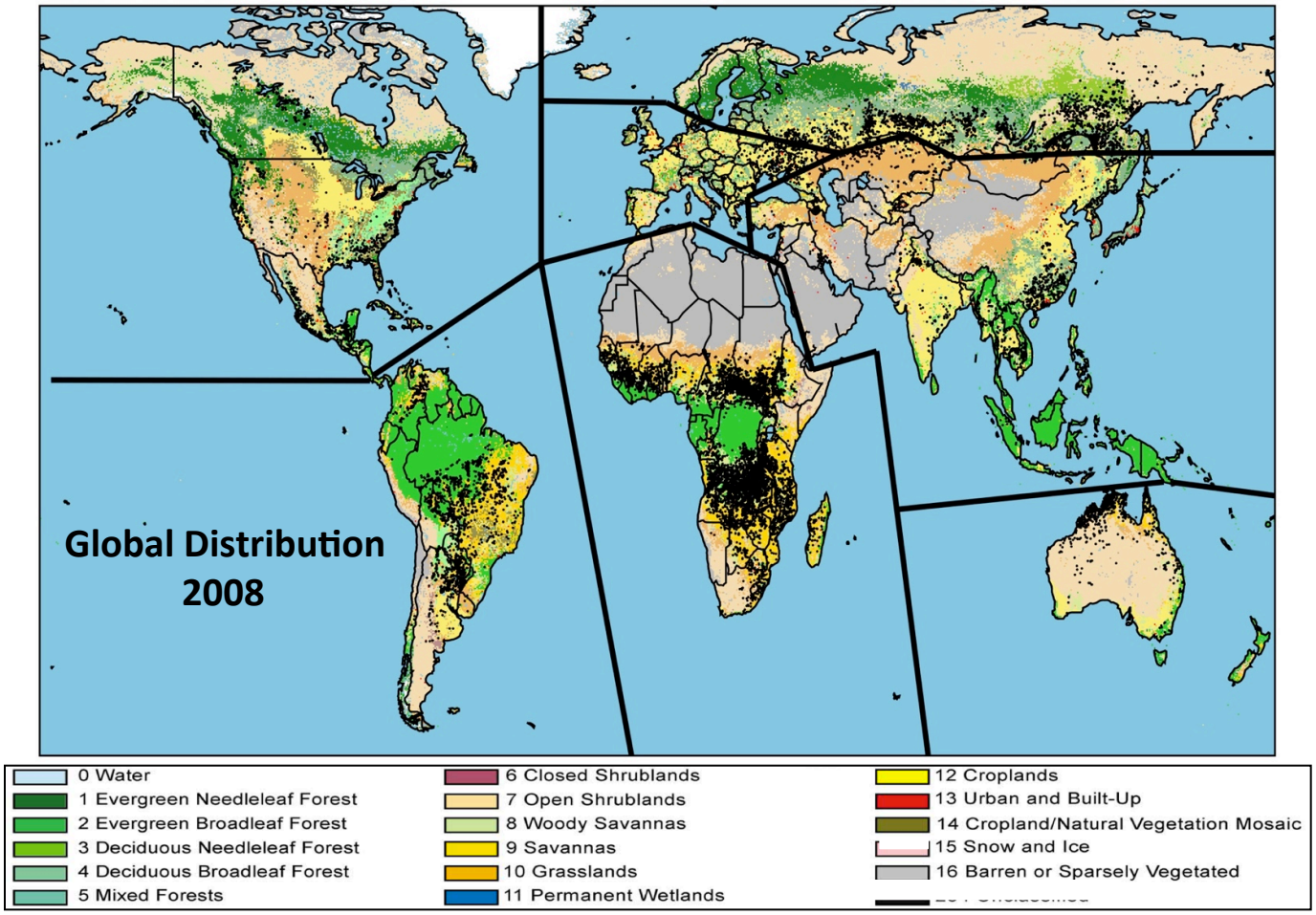
Organizing model runs into groups for which source-strength approach works differently, so we can:

- **Define adjustment factors** where they help
- Characterize **situations with large uncertainties**
- **Separate inventory from model-specific** issues

CAMS-GFED3-gd8b	GEOS5
GEOSCHEM-v902	GOCART
OsloCTM2	INCA
HadGEM3	ECHAM6.1-HAM2.2
CAM5	ECHAM6-SALSA
SPRINTARS	GFDL-AM3p10
	GISS-MATRIX
	GISS-OMA

Petrenko et al., 2017 in prep.

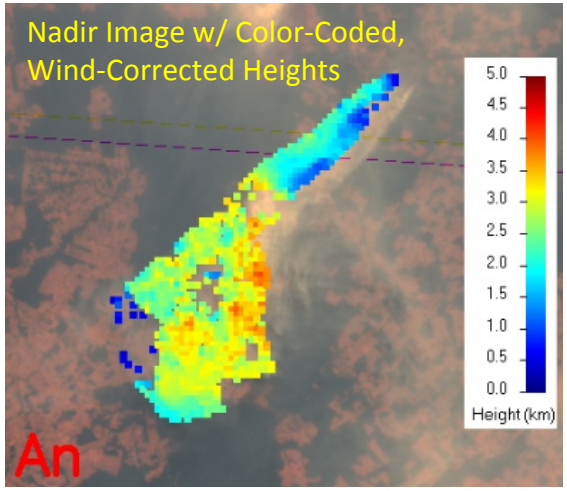
Biomass Burning Experiment *PHASE 2*:
Fire Emission ***Injection Heights***

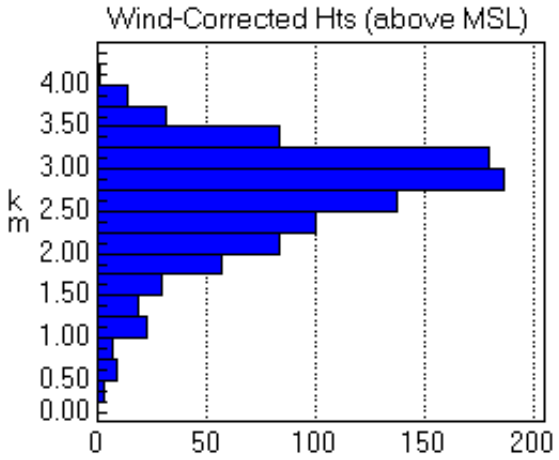


- About ***50,000 smoke plumes*** digitized 2008-2010 (~16,000 for 2008)
- Each plume is Operator-Processed using ***MINXv4.0***, and Quality Controlled
- For N America, about ***18% - 20%*** of plumes are injected above the PBL
- Raw, graphics and summary files, and documentation are ***available on-line:***

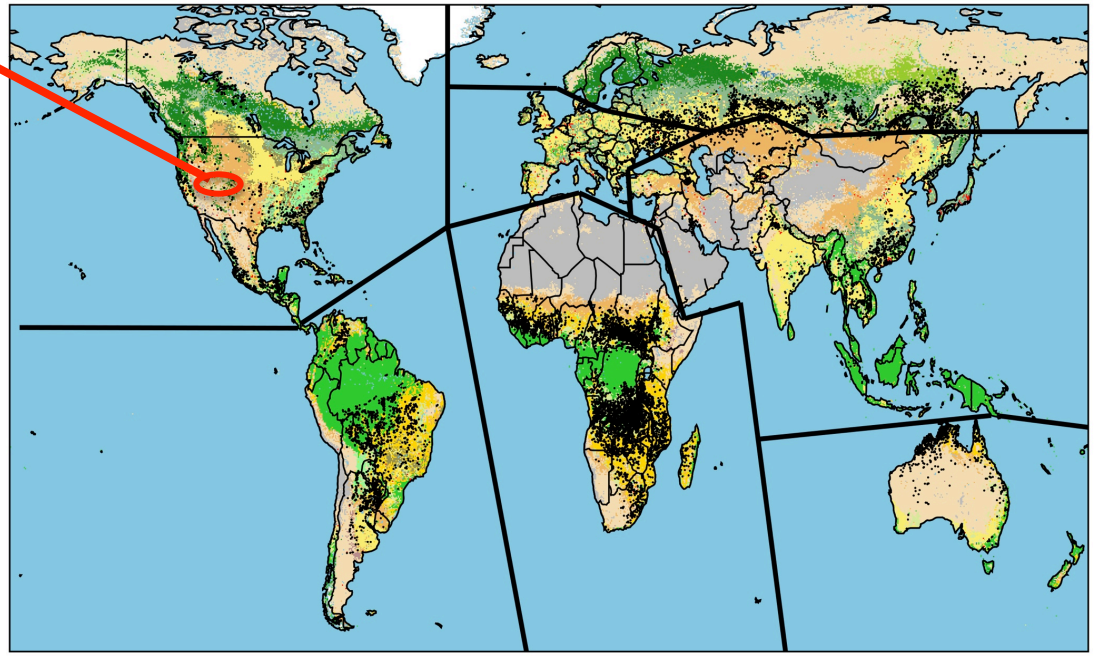
https://misr.jpl.nasa.gov/getData/accessData/MisrMinxPlumes2/ *Val Martin et al., 2017 in prep.*

Biomass Burning Experiment *PHASE 2*: *Fire Emission Injection Heights*



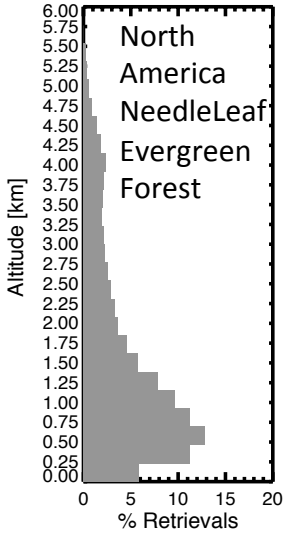


- Heights at ***1.1 km Horizontal*** res., ***~250-500 m Vertical*** res.
- Keyed to the ***Elevation of Maximum Spatial Contrast***
- Parallax is corrected for proper motion (***Wind Correction***)
- Height histogram gives some ***Indication of Vertical Extent***

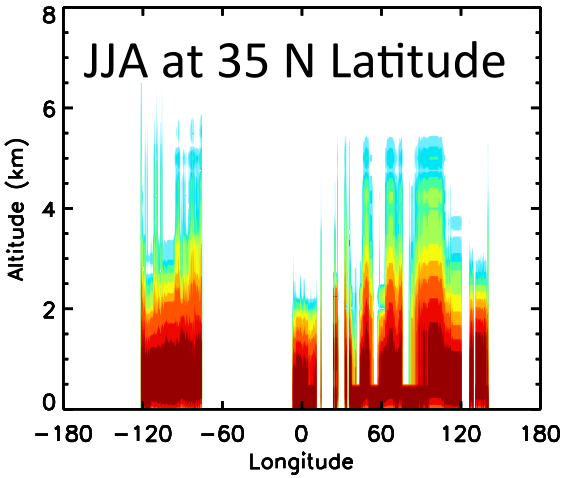


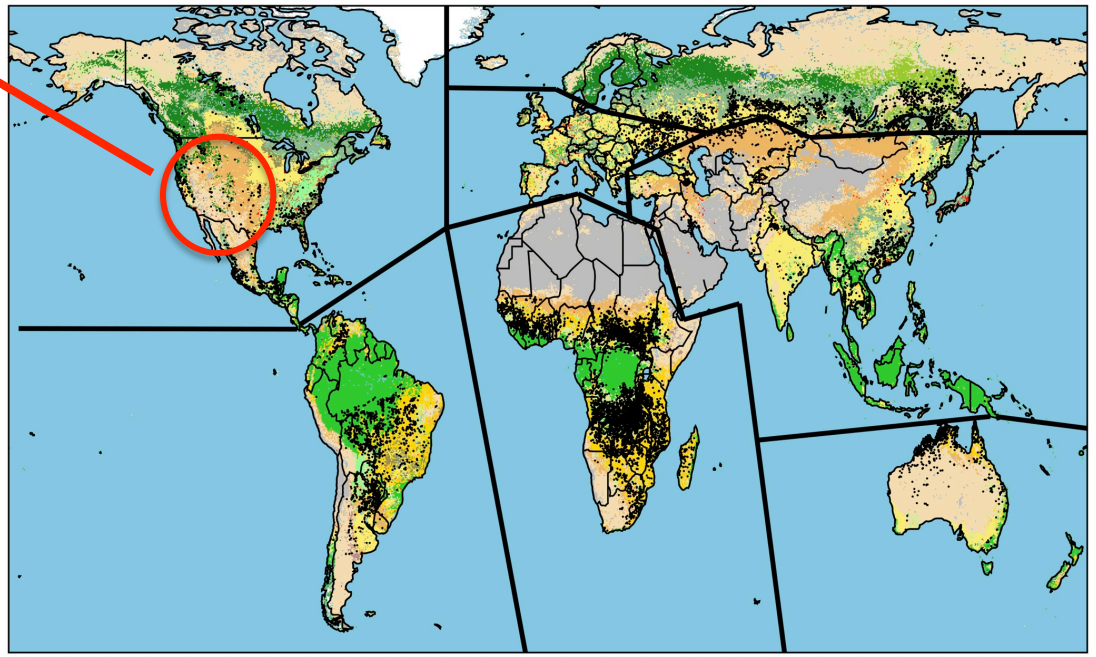
Val Martin et al., 2017 in prep.

Biomass Burning Experiment *PHASE 2*: *Fire Emission Injection Heights*



- Fire emissions are ***Stratified by Altitude***, ***Region***, ***Ecosystem***, & ***Season***
- Inter-annual and/or sub-seasonal ***temporal resolution*** might be required in some cases
- The cases in each stratum are ***Averaged*** to produce a statistical summary

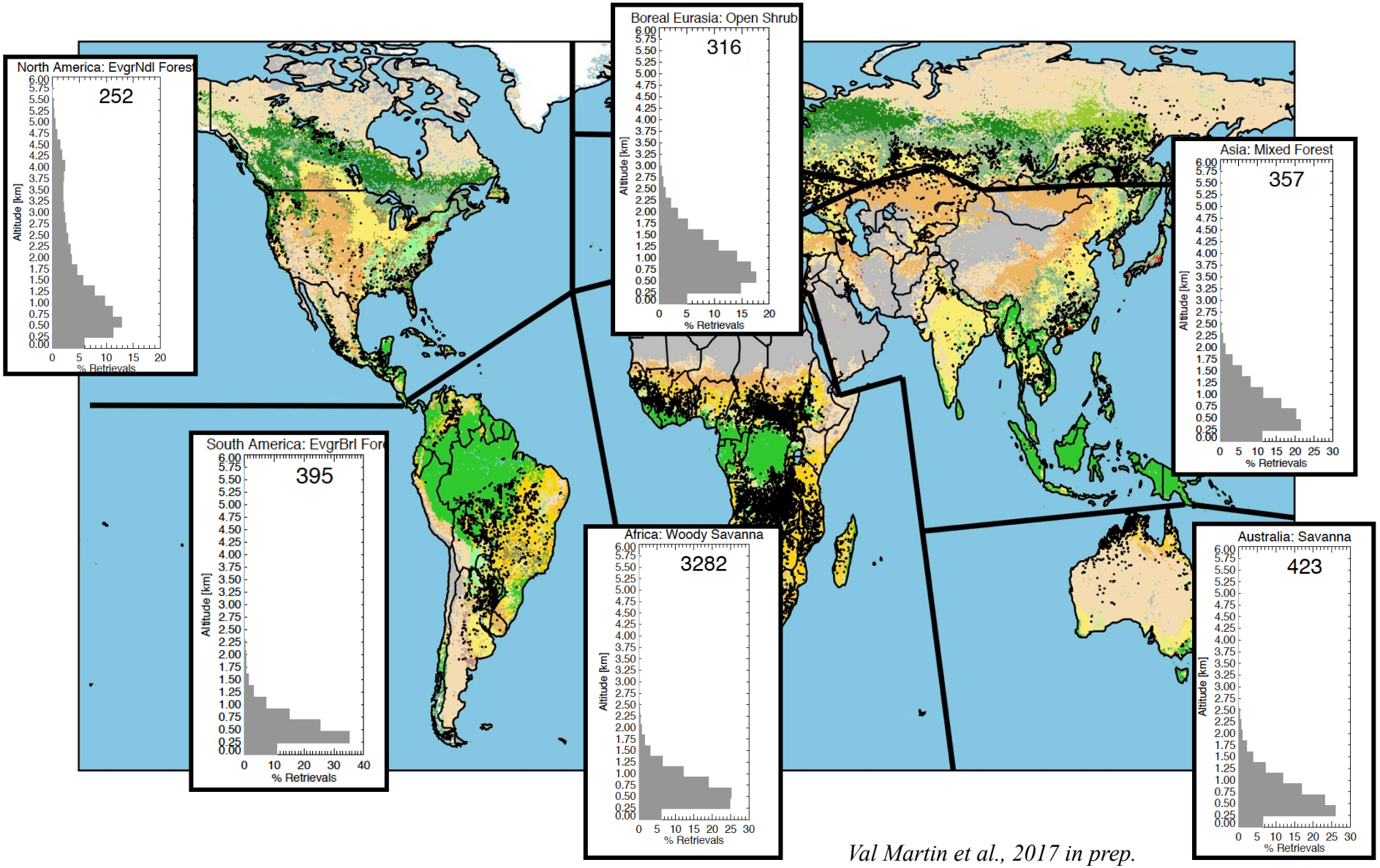




Val Martin et al., 2017 in prep.

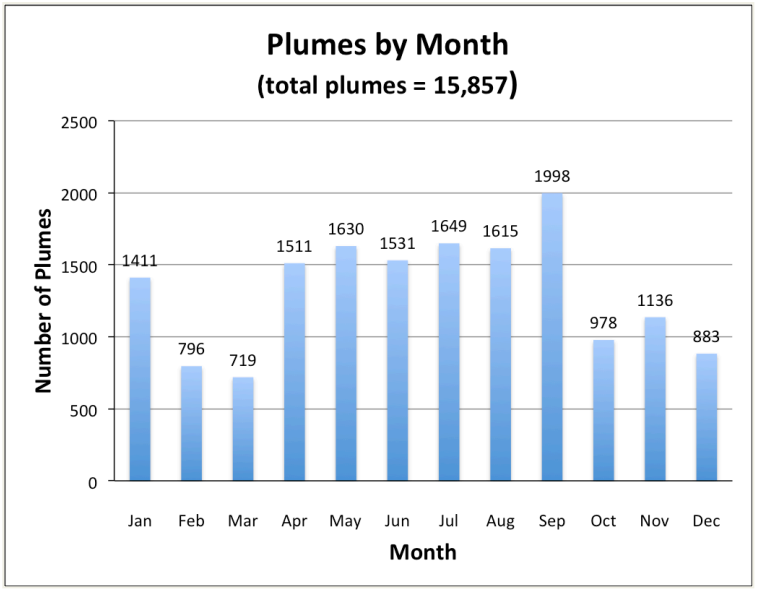
Example *Injection Height Vertical Distributions*

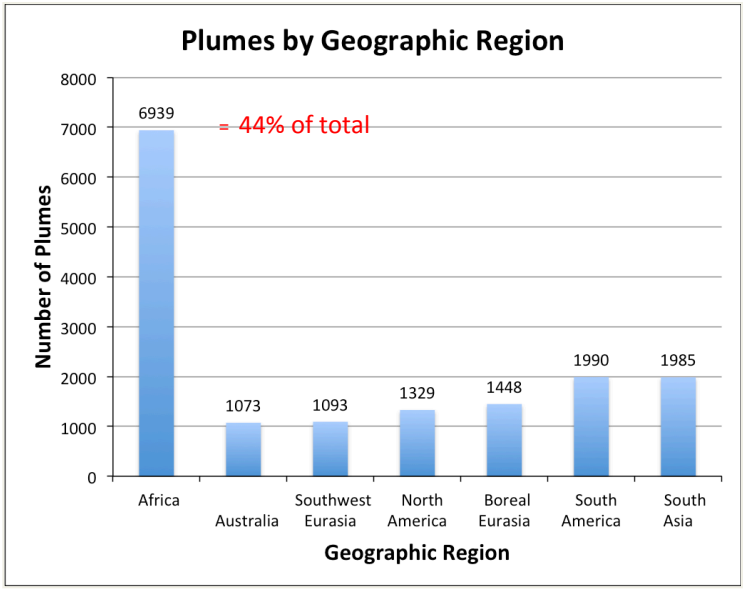
Stratified by Region and Biome

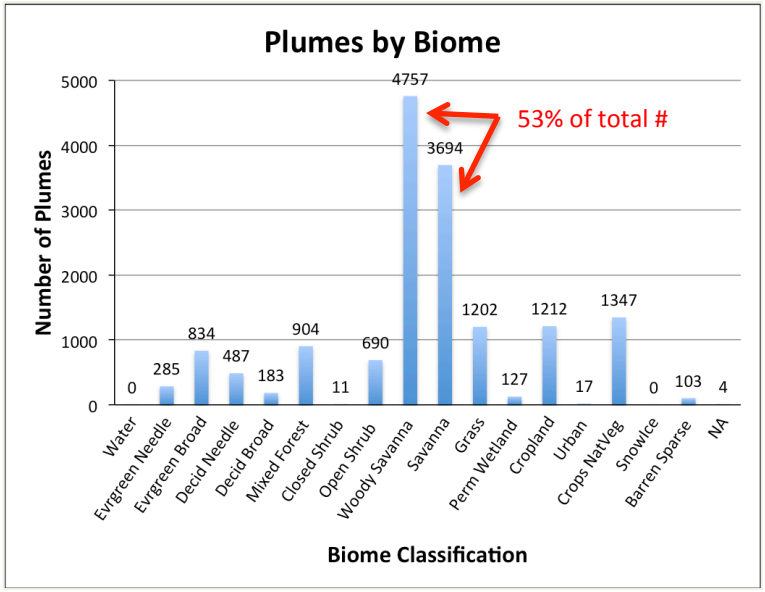


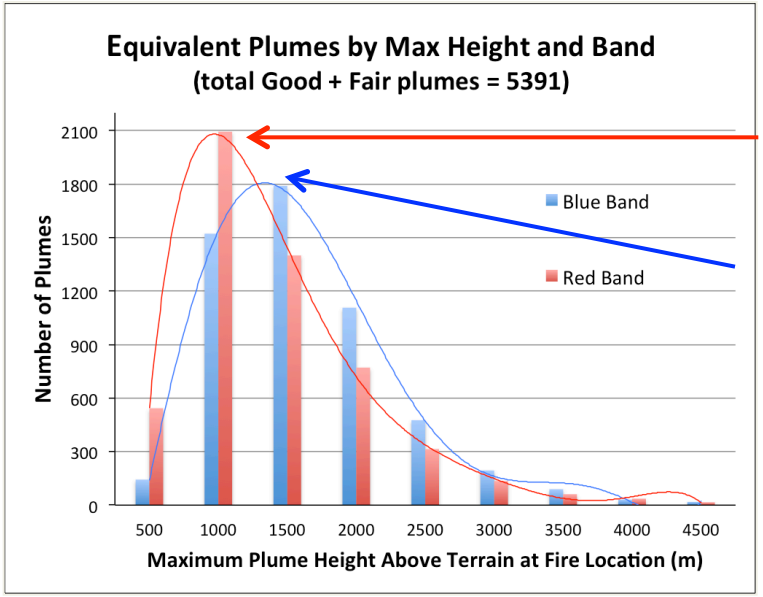
Val Martin et al., 2017 in prep.

Biomass Burning Experiment *PHASE 2*:
Global Statistics for 2008









Mode of red band max ht ~= 700 m

Mode of blue band max ht ~= 1050 m

Val Martin et al., 2017 in prep.

Eyjafjallajokull Volcano, Iceland

May 07, 2010 Eruption NOAA HySPLIT Model

Baseline HYSPLIT Simulation

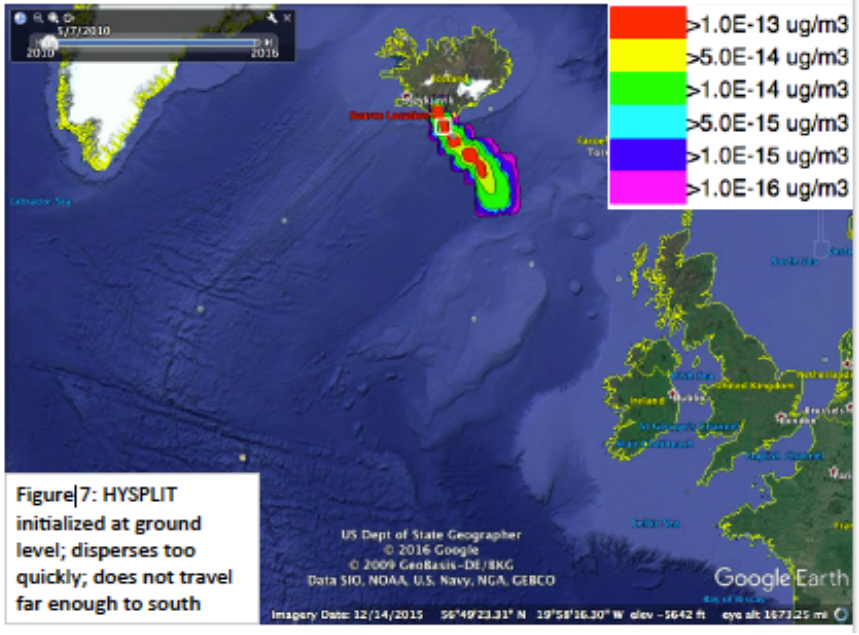


Figure 7: HYSPLIT initialized at ground level; disperses too quickly; does not travel far enough to south

MINX-Initialized Simulation

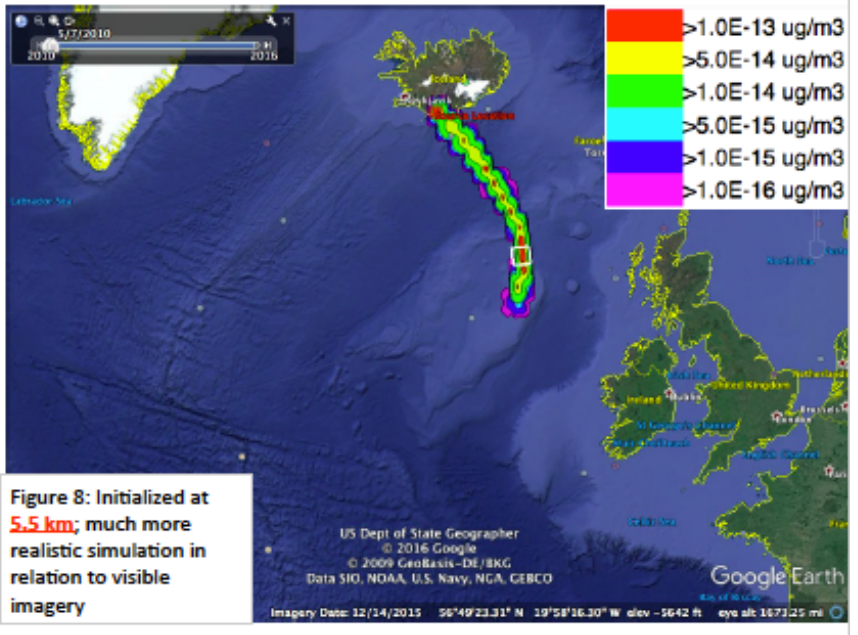


Figure 8: Initialized at 5.5 km; much more realistic simulation in relation to visible imagery

Conclusion:

When the injection height is above the PBL in regions with significant wind shear, MINX-initiated simulations better represent satellite observations.

Eyjafjallajokull (May 7, 2010 12:35 UTC)

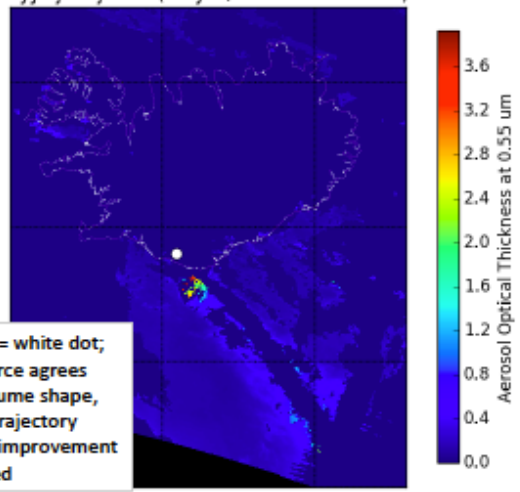


Figure 9: Source = white dot; AOD right at source agrees with baseline; plume shape, dispersion, and trajectory show significant improvement in MINX-initialized

We invite AeroCom participants to run their models considering these injection-height constraints.

How these data might be applied in models would be a topic for discussion at AeroCom, and as the study progresses

CJ Vernon et al., UMD Senior Project 2017