The AeroCom Biomass Burning Experiment
Mariya Petrenko, Maria Val Martin, Ralph Kahn, Mian Chin

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.

\[
\text{MODIS BB AOD} = \text{Plume AOD}_{\text{tot}} - \text{AOD}_{\text{bkgnd}}
\]
Source Strength
Satellite Reference Observational Dataset
2004, 2006-2008

972 Cases in 16 Colored Ecosystems (497 in 2008)

Month when case was observed by MODIS

The colored squares represent ecosystems

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

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**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**
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

Petrenko et al., 2017 in prep.
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/](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**

**Plumes by Month**
(total plumes = 15,857)

- January: 1411
- February: 796
- March: 719
- April: 1511
- May: 1630
- June: 1531
- July: 1649
- August: 1615
- September: 978
- October: 1136
- November: 885
- December: 0

**Plumes by Geographic Region**

- Africa: 6939 (~44% of total)
- Australia: 1073
- Southwest Eurasia: 1093
- North America: 1329
- Boreal Eurasia: 1448
- South America: 1990
- South Asia: 1985

**Plumes by Biome**

- 53% of total #

**Equivalent Plumes by Max Height and Band**
(total Good + Fair plumes = 5391)

- Mode of red band max ht ~ = 700 m
- Mode of blue band max ht ~ = 1050 m

*Val Martin et al., 2017 in prep.*
Conclusion:
When the injection height is above the PBL in regions with significant wind shear, MINX-initiated simulations better represent satellite observations.

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