Biomass Burning Aerosol (BBA) Processes: Integrating ARM Field & Laboratory Studies (via WRF-MOSAIC/PartMC) to Inform E3SM-MAM4 Parameterizations

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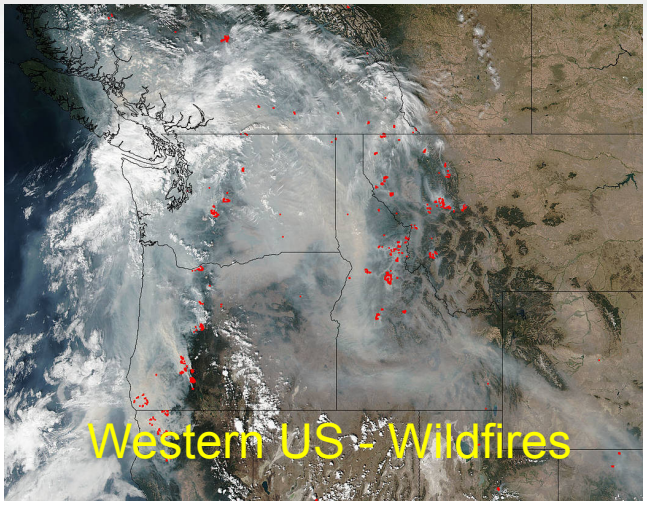

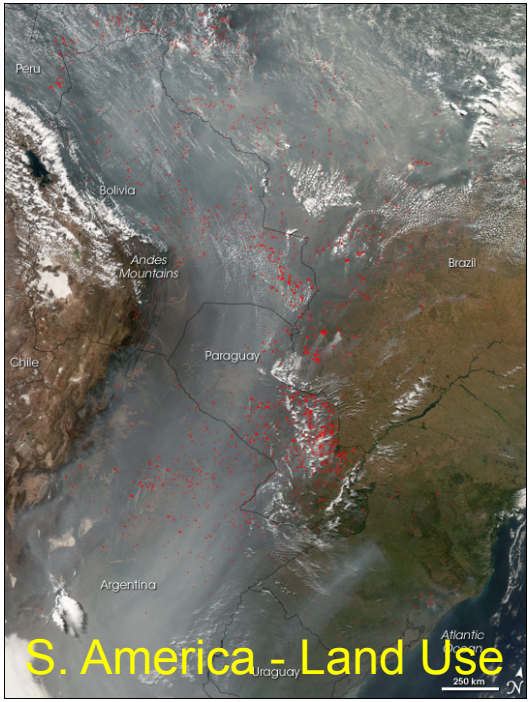

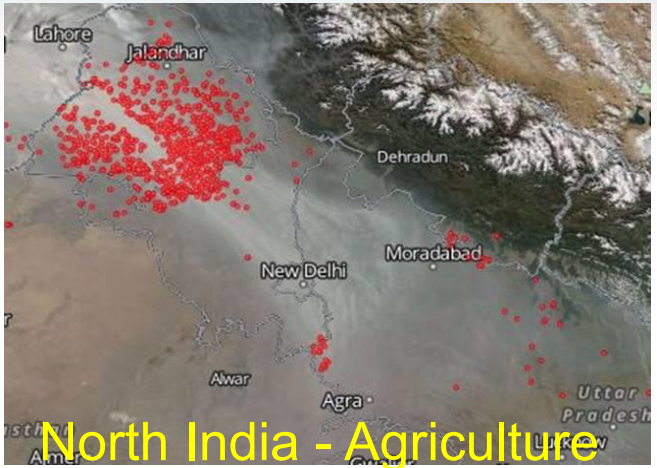

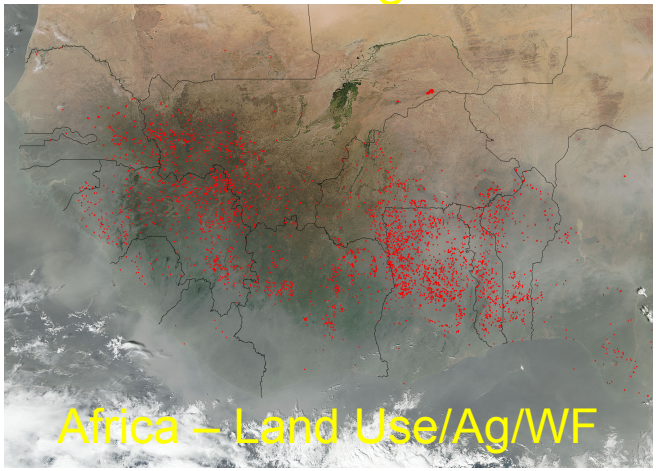

DOE ASR/ARM
Science Team Meeting
Wed. 3/21/18 1.30-3.3 PM

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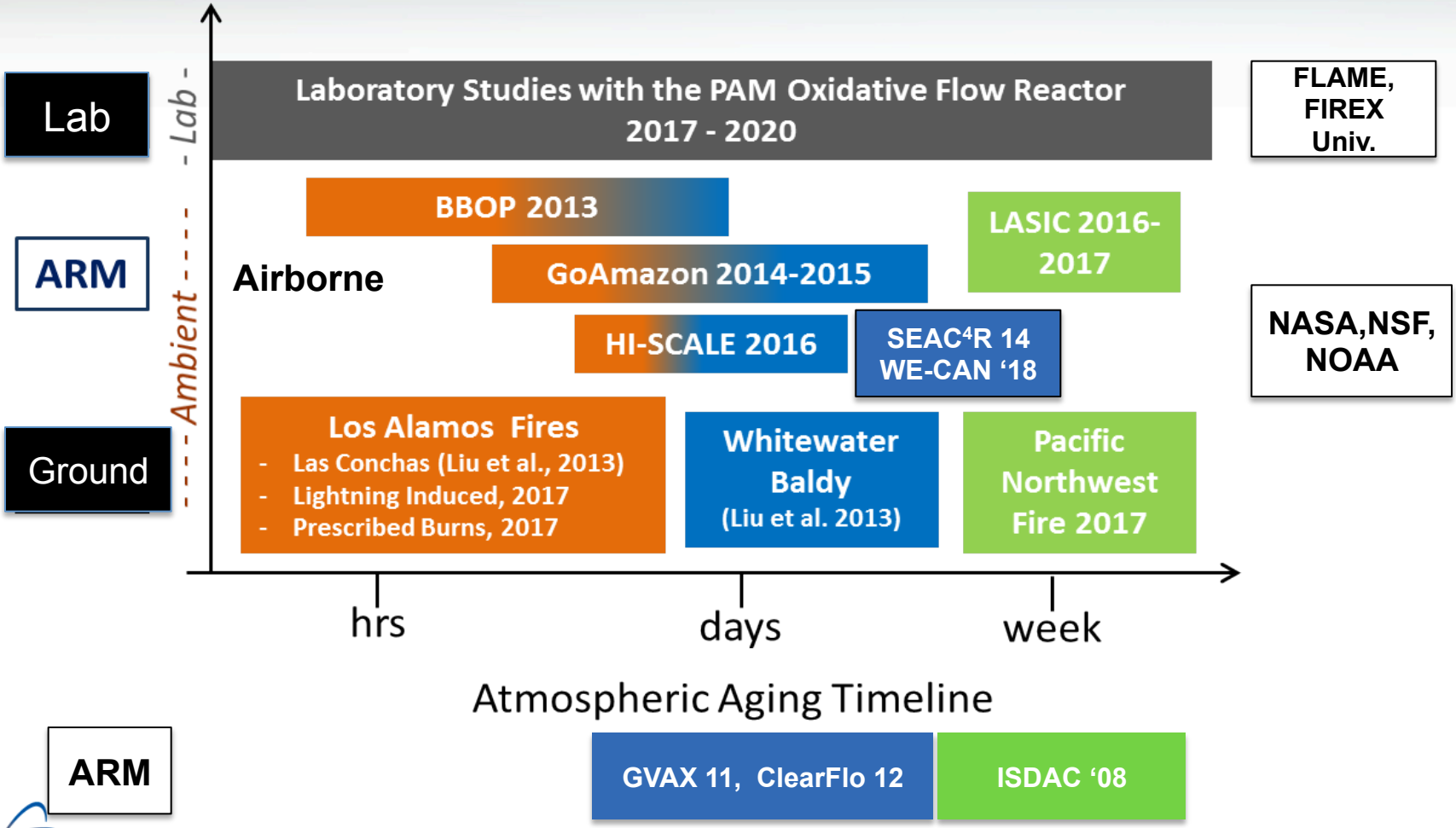
ASR Atmospheric System Research

NNSA

Questions: BBA Processes to Parameterizations

- How do emissions, dilution, photo-chemistry and humidity interact to control BBA evolution & their properties?
- What instrumental and observational gaps limit our ability to quantify BBA processes? How can we fill them “effectively”?
- How do all these processes effect the direct and indirect radiative forcing by BBAs?
- How do BBCA climate relevant properties scale with region (ecosystem), time (age) and size (large vs. small) of fire?
- What sub-grid scale processes and properties are uncertain or missing in current models (WRF-MOSAIC)? How to add them as scale-aware parameterizations (E3SM-MAM4)?
  - Detailed mechanism from lab. that are validated by field data
  - Reduced mechanism for use in climate models

Harness ARM Observation: Biomass Burning Field and Laboratory Data to Elucidate BBA processes



Agenda

1.30-1.35 *M. Dubey and S. Jathar*: Objectives and Outcome

1.35-1.45 *M. Shrivastava*, Constraining BB SOA in models: Uncertainties in Measurements and modeling parameters

1.45-1.55 *Jose Jimenez*, Net SOA formation from BB plumes in field studies, comparison to lab studies, and implications for global models

1.55-3.05 Highlight DOE Measurement & Model Results & Activities (5 min, 1-2 slides each)

R. Chakravarty, BB C-Aerosol Lab. Observations: Insights into Processes Parameterizations
C. Mazzoleni, Tar Ball from BB: SEM morphological studies
A. Sedlacek, Formation & evolution of Tar Balls & their optical & volatility properties
L. Kleinman, BBOP analysis: Process level results
P. Zuidema/A. Aiken, Status of LASIC single-scattering-albedo measurement assessment
M. Dubey/C. Cappa, Water uptake by BB smoke: Competing Lifetime & Absorption Effects
L. Fierce, Particle resolved analysis of BB
Y. Feng, Representation of aerosol absorption from BB in CAM5
A. Zelenyuk, Physicochemical BB aerosol properties: shape, density, composition & volatility
Qi Zhang, Formation & aging of BB organic aerosols: Results from field observation
T. Onasch, Field and laboratory measurements of biomass burning from BBOP to FIREX
S. Jathar/C. Cappa, Results from FIREX: Links to DOE ASR/ARM data & activities
R. Wernis/A. Goldstein/M. Shrivastava, Emissions/Variability of SVOCs from BB
M. Shirawa/D. Knoff, Modeling OH/NO_3 heterogeneous reactions of levoglucosan

3.05-3.30 Discussion, Path Forward and Write-up (ARM report and draft for publication)

Summary:

- Top down comparisons show E3SM BBA AODs are lower than MODIS data by x2-5 over S. America/Africa, suggesting POA emissions are low or SOA production could be missing in models but has not been observed in field.
- Bottom up *in situ* field measured ΔOA/ΔCO is constant with age and implies that any potential SOA production would need to be balanced by POA loss.
- New BBA laboratory studies observe SOA production, but further model analysis of wall effects is necessary to quantify this
- BBA processes/properties are much more complex than models assume.
  - Enhanced abs. by mixed-BC & dynamic BrC (bleaching, cloud/RH effect)
  - TBs are 40% mass, their dynamic optical properties uncertain (abs.)
  - TB could be linked by BBOA-3 and constrain transformation timescales
  - Need to resolve ΔOA/ΔCO and increase in OOA with mechanism
  - Aged African BBA have low SSA and AAE suggests BC
  - BBA H_2O uptake stresses need to measure BC-RH abs. effect
- Coordinate lab, field & model analysis to resolve these issues.

Strategy for "Effective" BBA Process Discovery and Insertion into Earth System Models (ASR)