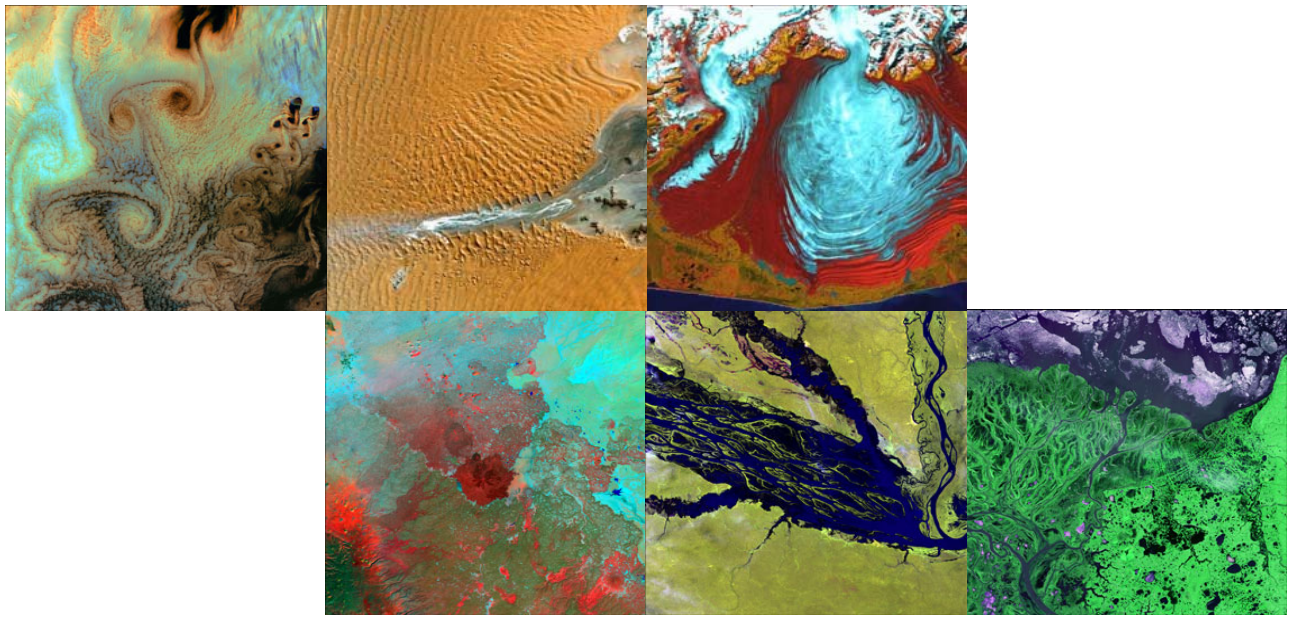
Use satellite data for modeling biomass burning emissions



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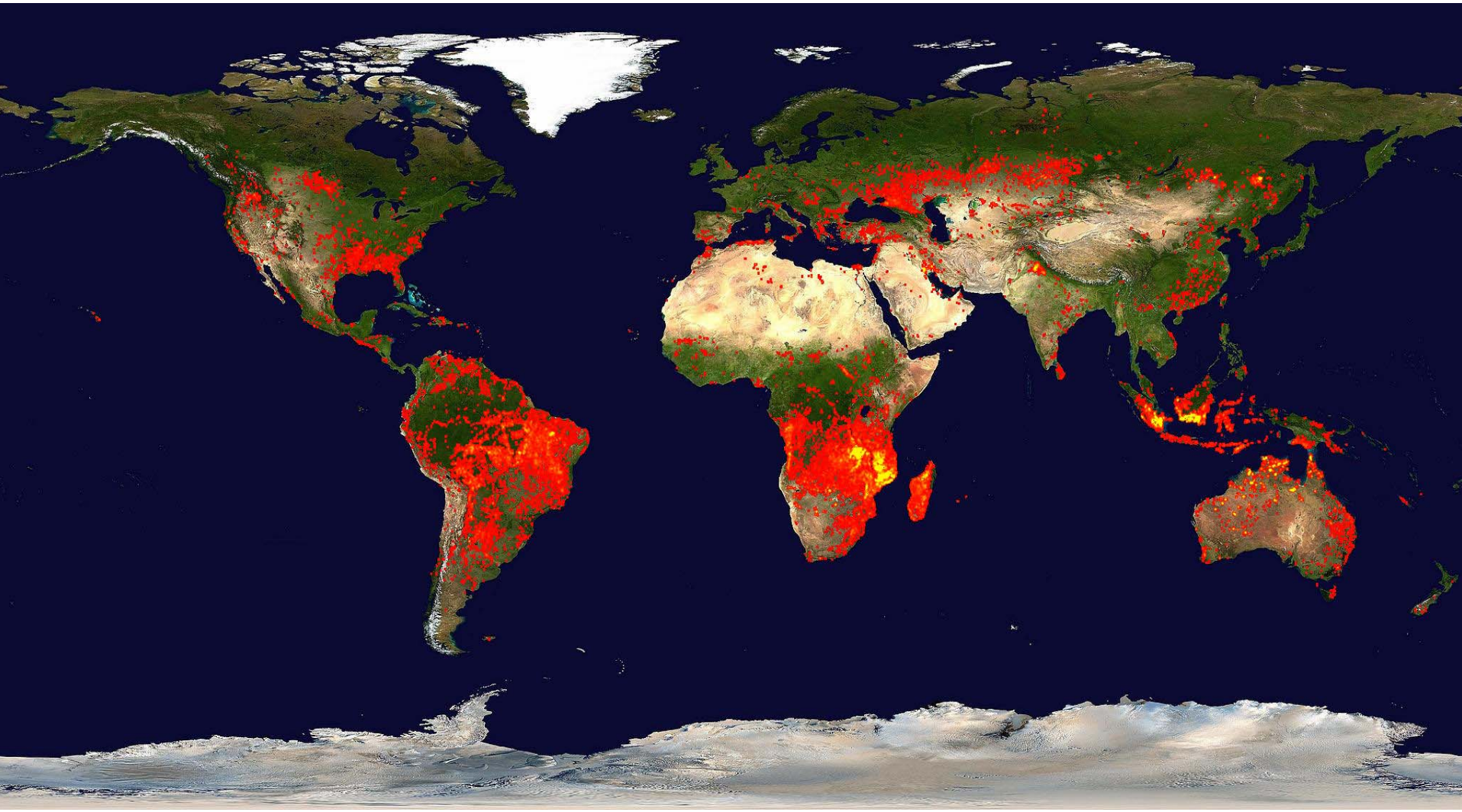
Introduction

- Biomass burning is one of the major source of aerosols, especially for BC
- Large spatial and temporal variation of biomass burning make emission estimation challenging
- Satellite fire data are the only means to detect biomass burning in the global/regional scale
- We explore the use of several different satellite fire data-based methods for calculating biomass burning emissions
- We compare model simulated aerosol optical thickness with MODIS and AERONET data and vertical extinction with lidar data

MODIS Rapid Response System Global Fire Maps

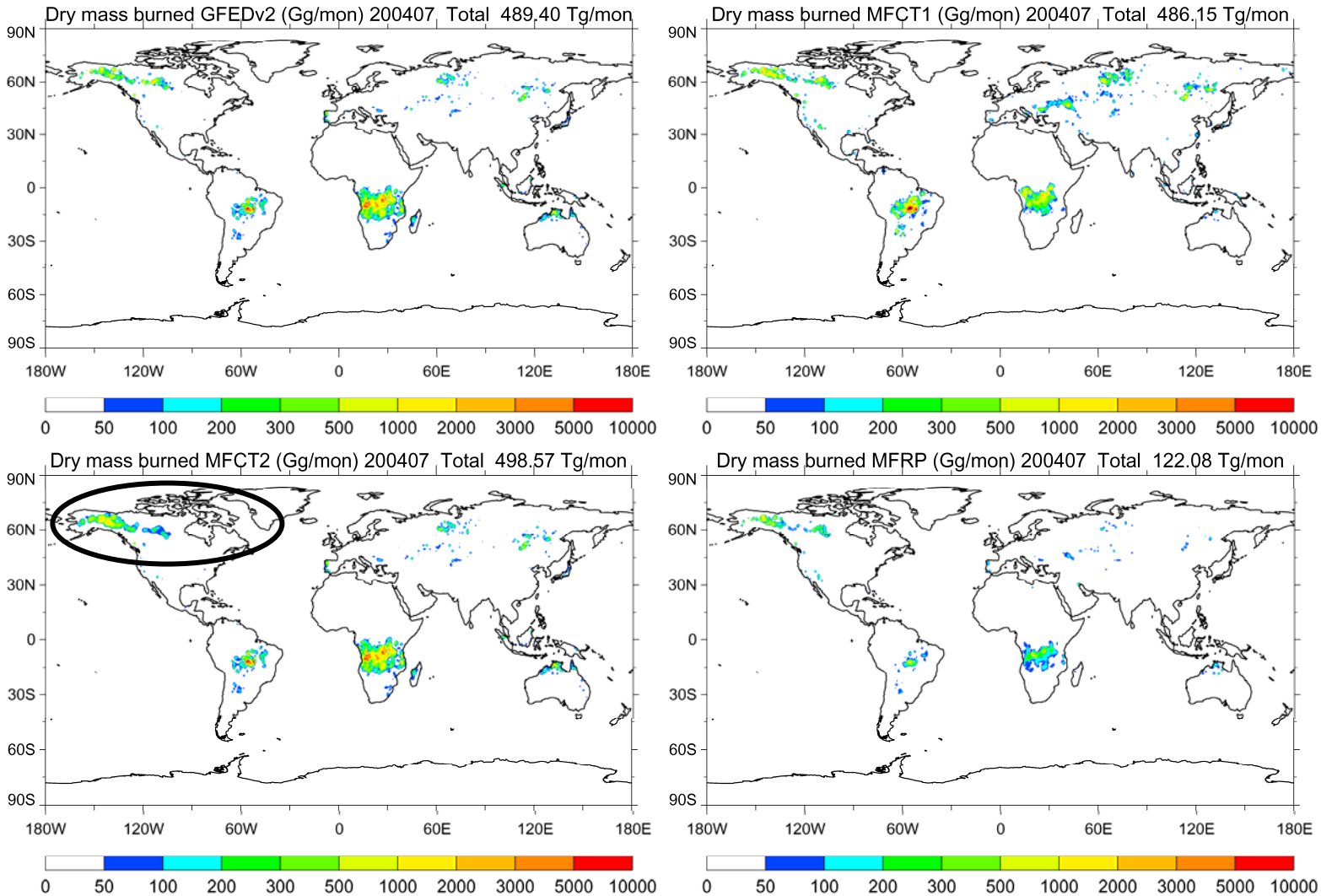


Satellite fire data-based estimation of biomass burning emissions

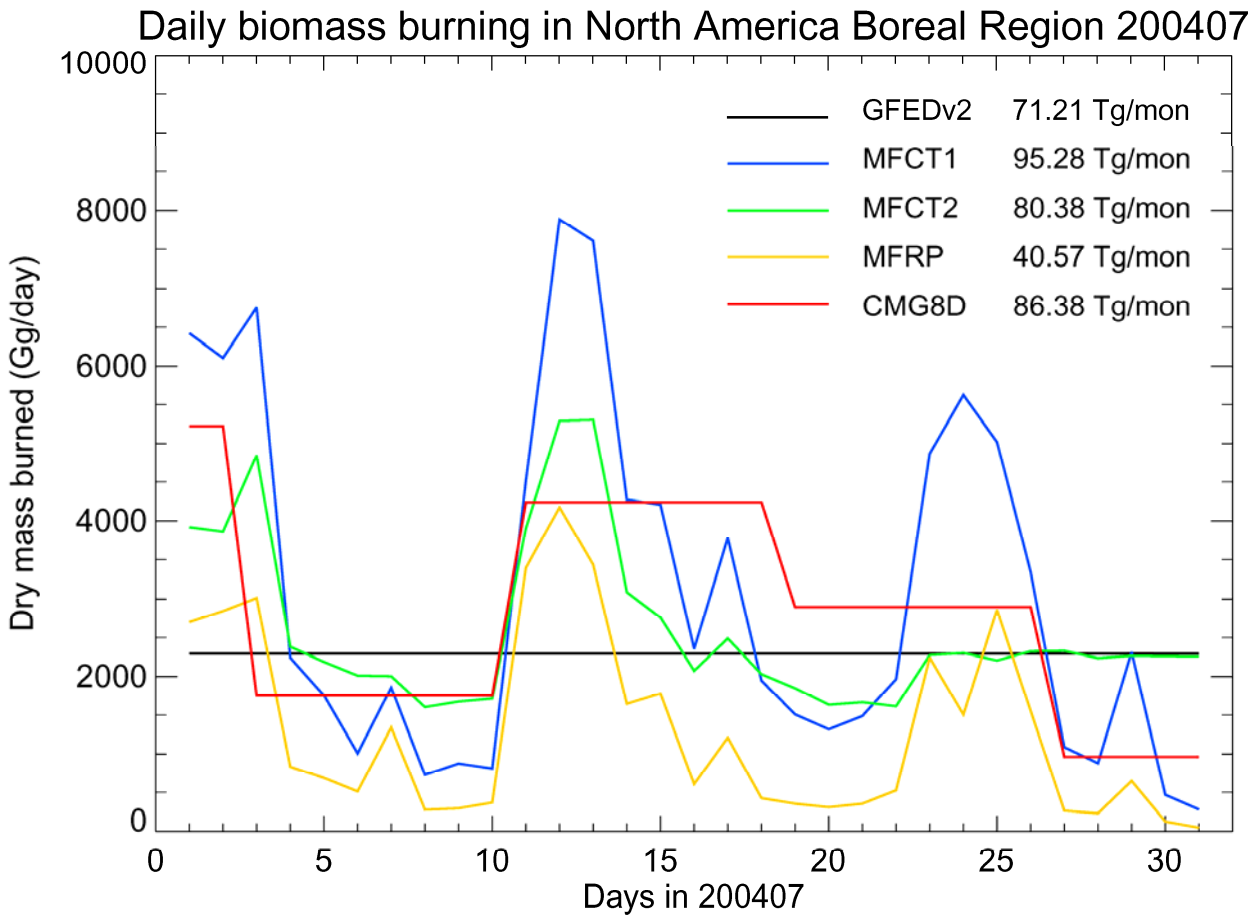
	Satellite data	*Other data/tools*	*Emission calculated*	*Time resolution*
Global Fire Emission Dataset (GFEDv2)	Terra-MODIS, TRMM-VIRS, ERS-ATSR	CASA biogeo-chemical model	E = ABCF	Monthly average
MODIS Fire Counts (MFC1)	Terra- and/or Aqua-MODIS	Biomass density, completeness of burning	E = ABCF	4-times/day (or pick one for daily avg)
MODIS Fire Counts (MFC2)	Terra- and/or Aqua-MODIS	Biomass density, fire severity (dep. on RH and T)	E = ABCF	4-times/day (or pick one for daily avg)
MODIS Fire Radiative Power (MFRP)	Terra- and/or Aqua-MODIS		E = kPF (k = 0.368 – 4.37)	4-times/day (or pick one for daily avg)
MODIS CMG-8day (CMG8D)	Terra- and/or Aqua-MODIS	Biomass density, completeness of burning	E = ABCF	8-day average

E = emission rate, A = area burned, B = biomass density, C = Completeness of burning, F = emission factor, k = constant converting emission rate to fire radiative power

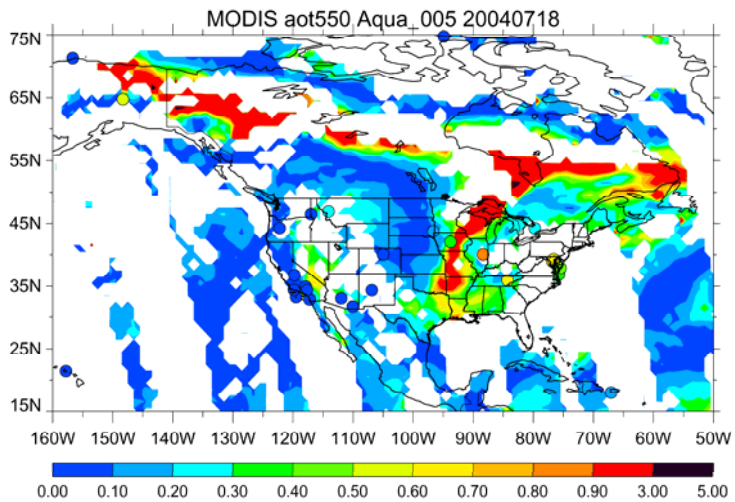
Comparison with estimated dry mass burned from different methods for 200407, global

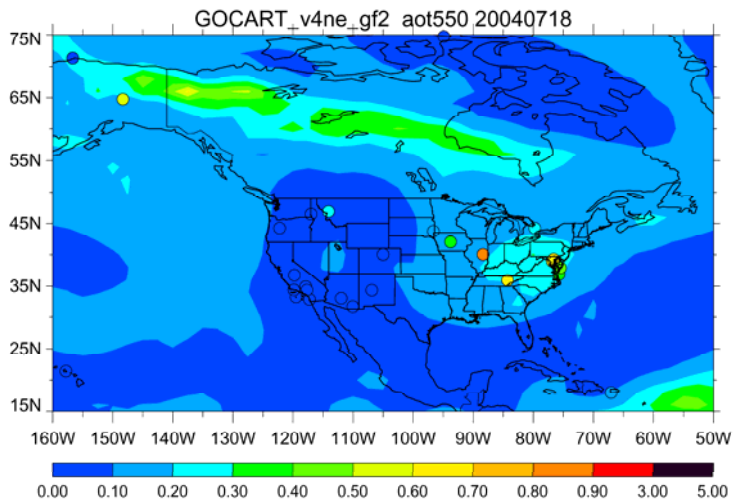


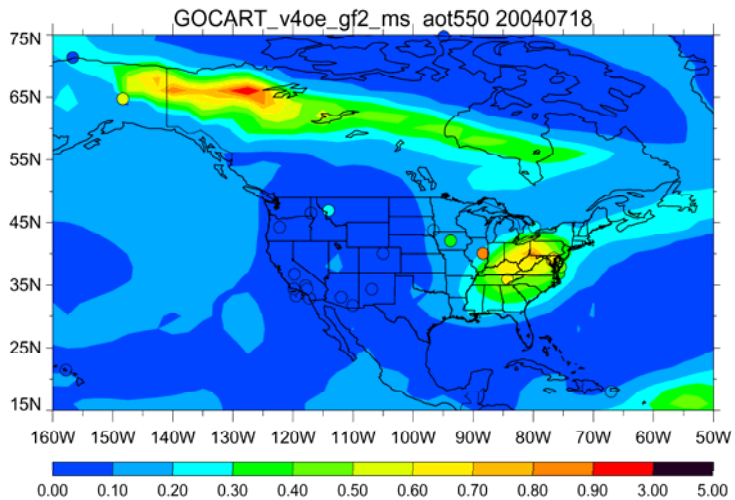
Comparison with estimated dry mass burned from different methods for 200407, North America

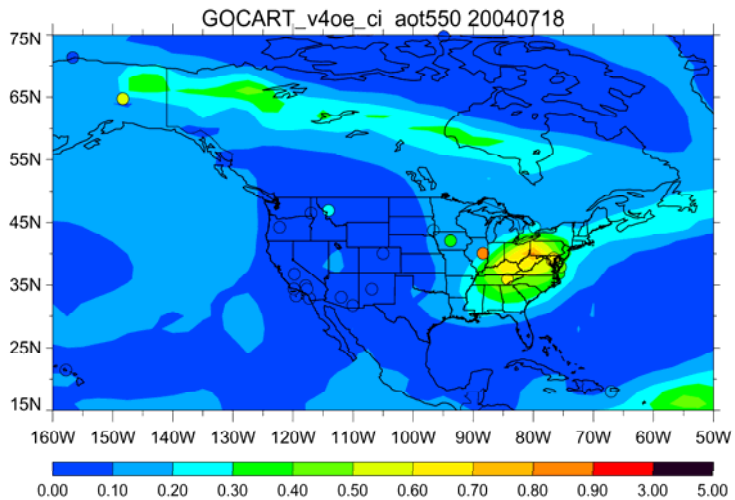


AOT: Comparison with MODIS (7/18/04)

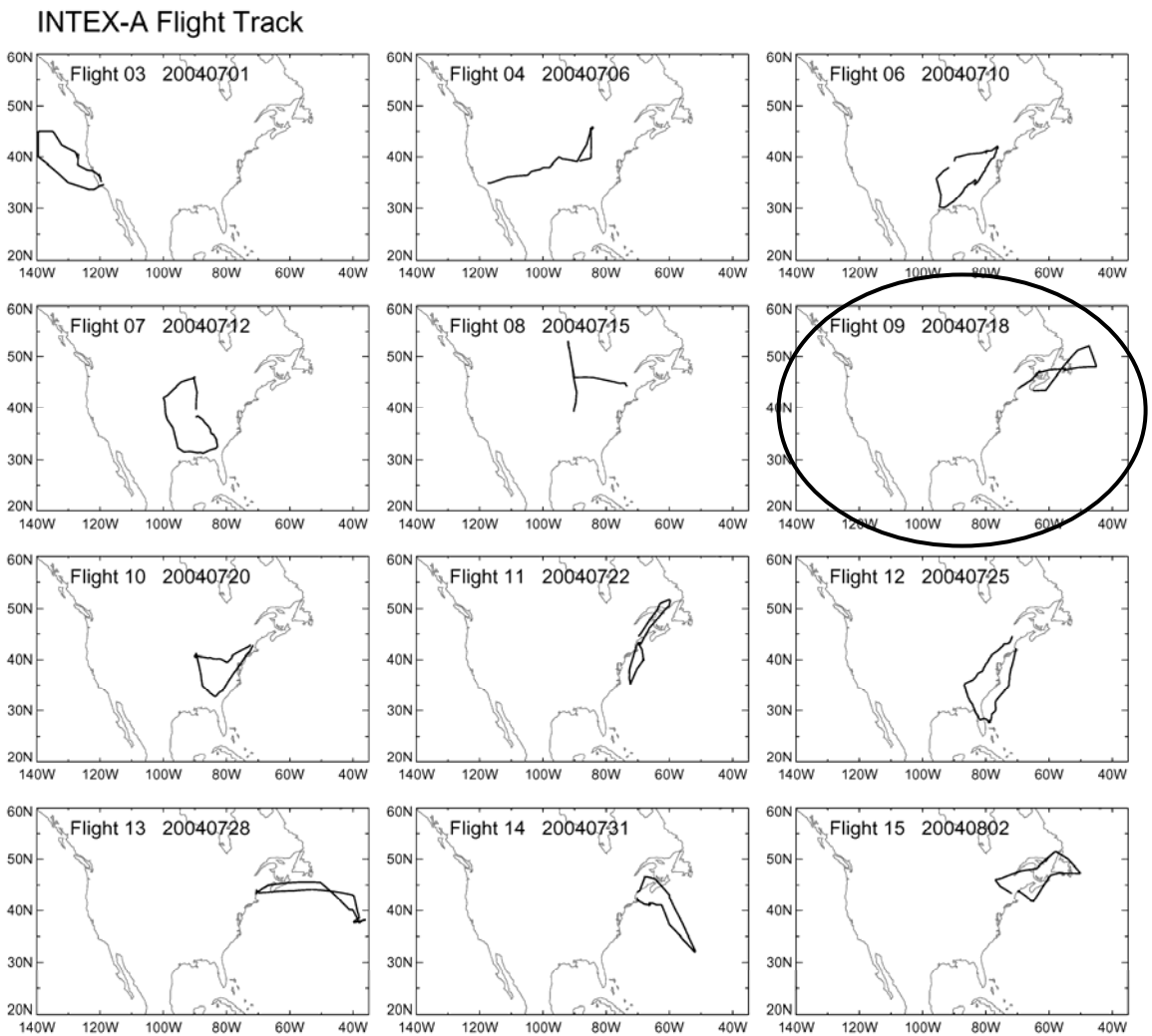




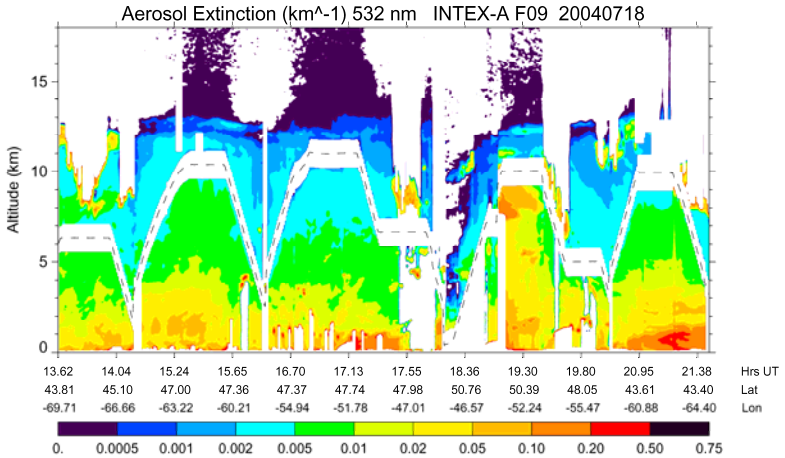


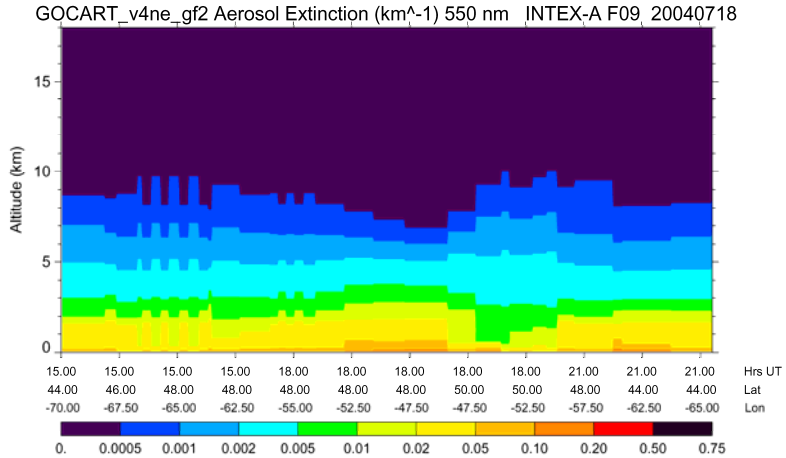


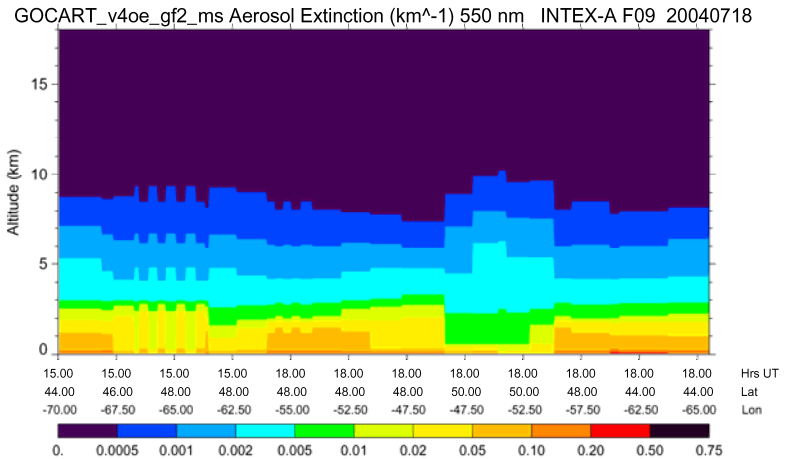
Vertical profile: Comparison with lidar data during INTEX-A (7/18/04)

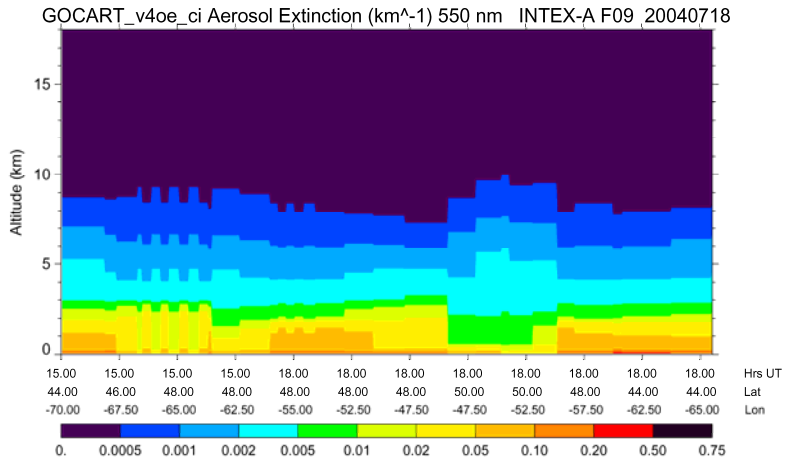


Vertical profile: Comparison with lidar data during INTEX-A (7/18/04)

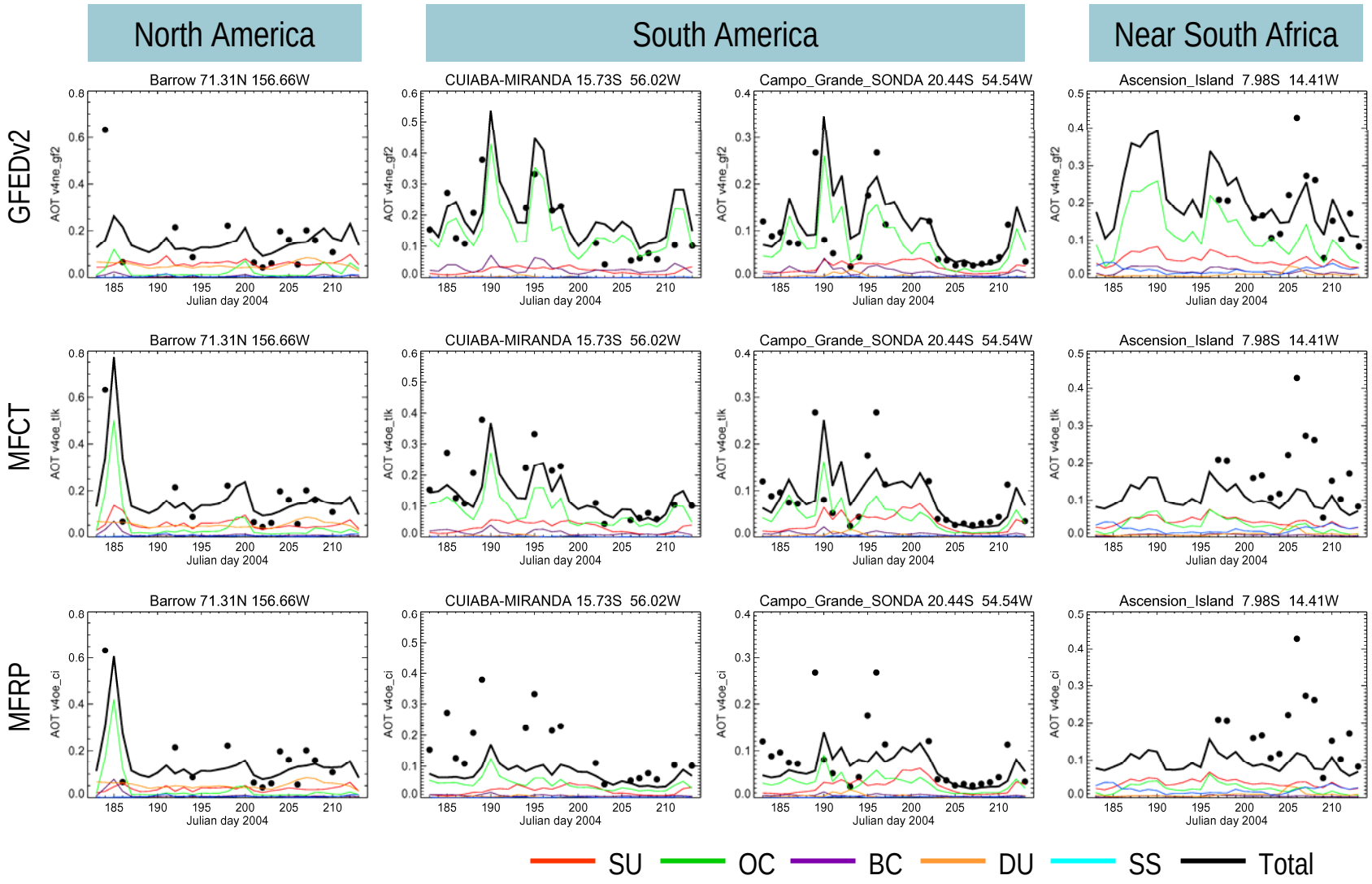








AOT: Comparison with AERONET



Conclusions

- There are many possibilities for calculating biomass burning emissions using satellite data
  - Firecounts x k = burned area:
    - data are readily available, but A would have large errors and daily data have gaps
    - Thorough retrieval of A: A is more accurate, but products are far behind real time and currently can only do monthly avg
  - MODIS fire radiative power: DM burned = FRP x k:
    - Avoid dealing with A and B and C
    - Published k varies by a factor of > 10 (0.368 – 4.37) – choose any values in between!

Conclusion (2)

- Monthly avg emission is not adequate for capturing large variations of aerosol near the source region, but seems not problematic for places where emission is always there (e.g., South America and Africa) during the burning season, and for places away from sources

Other Issues

- There are other parameters modelers can play with:
  - Injection height (MISR and CALIPSO can help!)
  - Emission factors (data needed!)
  - Fire severity (testing in progress)
  - Separate flaming and smothering stage (difficult, but worth assuming something)

Observation-based emissions:

- MODIS FRP + MODIS AOT based estimation of PM emission (Ichoku & Kaufman)
- MODIS AOT + AERONET AOT based inverse modeling (Dubovik et al.)
- Accuracy is totally dependent on the qualities of observed AOT and/or model processes