



Remote Sensing and Modeling of the Georgia 2007 Fires

**Eun-Su Yang, Sundar A. Christopher, Yuling Wu, Pawan Gupta,
Thomas Jones, and Udaysankar Nair**

Earth System Science Center
University of Alabama in Huntsville

Shobba Kondragunta

NOAA/NESDIS

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Mike Newchurch, Arastoo Biazar, Chuang Xu, and UAH AQ Team

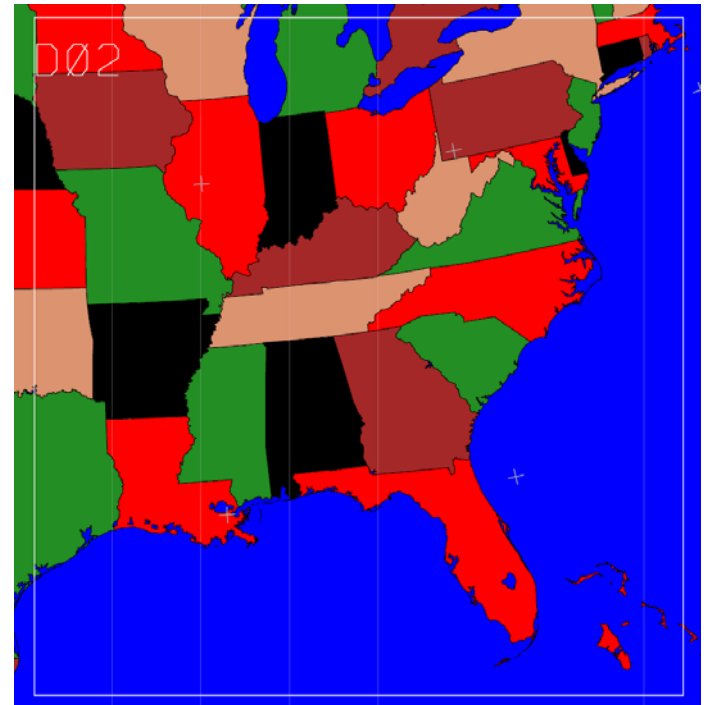
Outline

- **Motivation**
- **Remote sensing of fires and smoke**
- **AERO-RAMS**
- **MM5/SMOKE/CMAQ**
- **Evaluations (models & satellite data)**
- **Summary**

Motivation

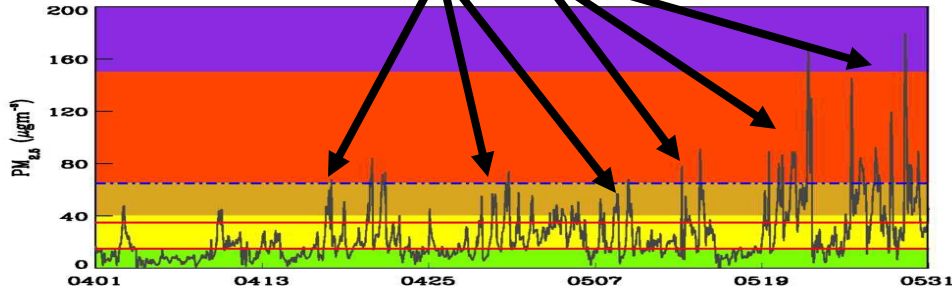
- Evaluate satellite remote sensing data sets and products with in-situ measurements.
- Use satellite derived fire emissions in mesoscale model to forecast PM_{2.5}.
- Use satellite derived fire emissions in CMAQ to forecast PM_{2.5}.
- Evaluate CMAQ and AERO-RAMS

Area of Study
May 2007



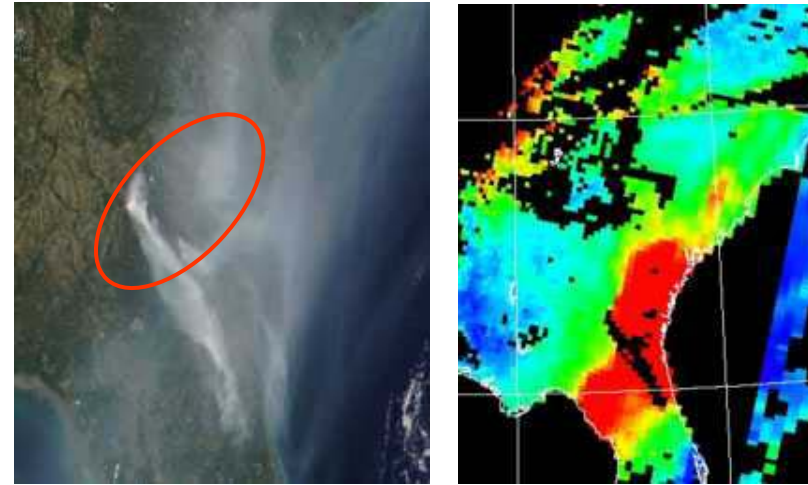
Georgia/Florida fires in May 2007

smoke plume? or local emission?

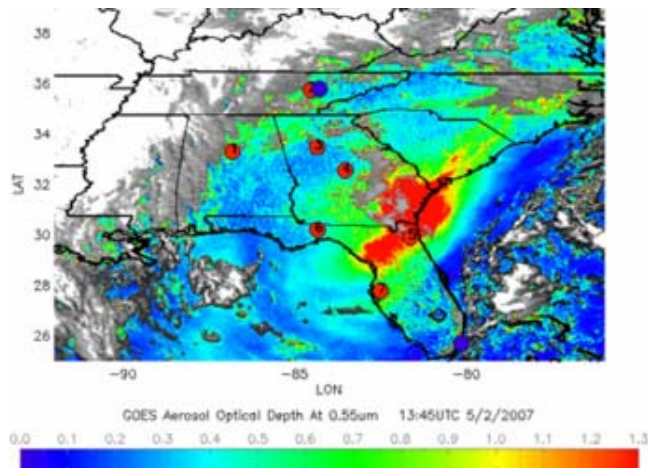


PM_{2.5} mass from one location in Birmingham, Alabama from April 1-May 31, 2007. The colors indicate various air quality categories ranging from Good to extremely unhealthy conditions.

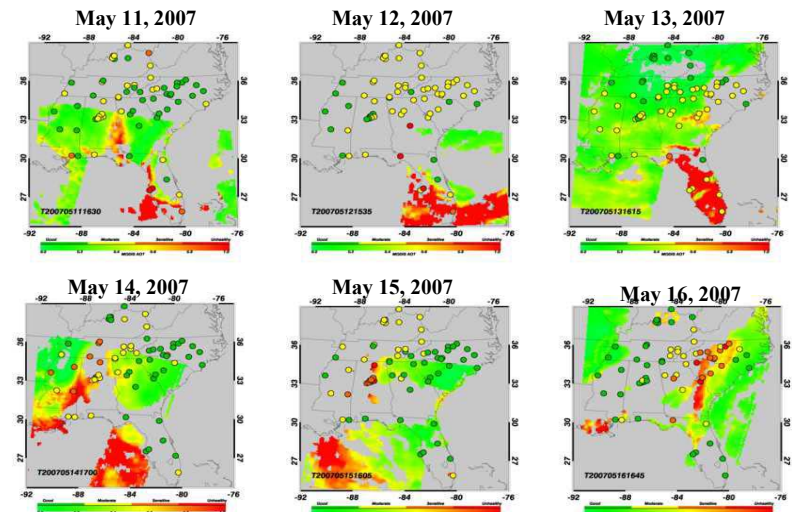
MODIS-Terra Images, May 2, 2007



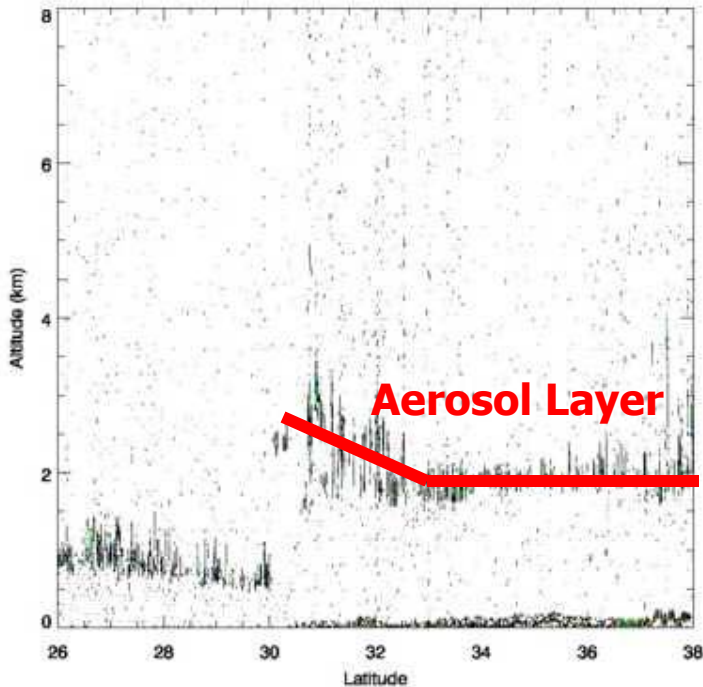
GOES, May 2, 2007



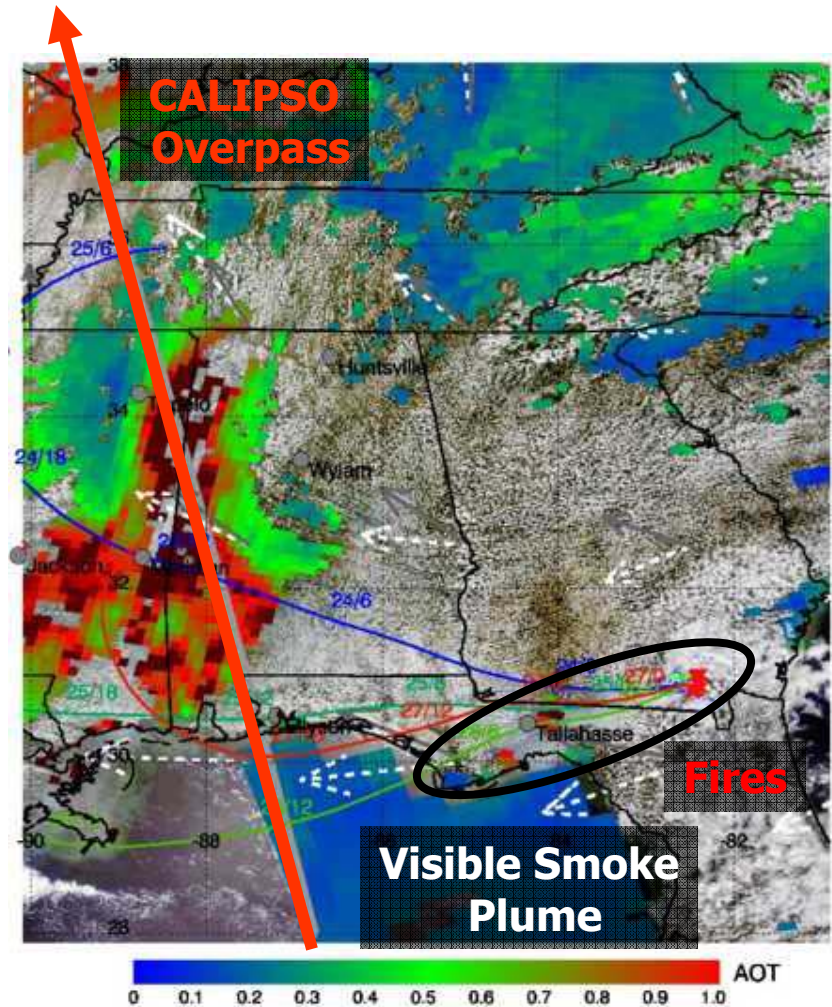
MODIS AOT



Data fusion: MODIS, wind, GOES, and CALIPSO



- No overpass directly over fires, one downstream at 19 UTC 24 May.
- **Aerosol layer present between 2 and 3 km ASL.**



Data Fusion: MODIS, wind, and GOES fire data combined from 24-25 May.

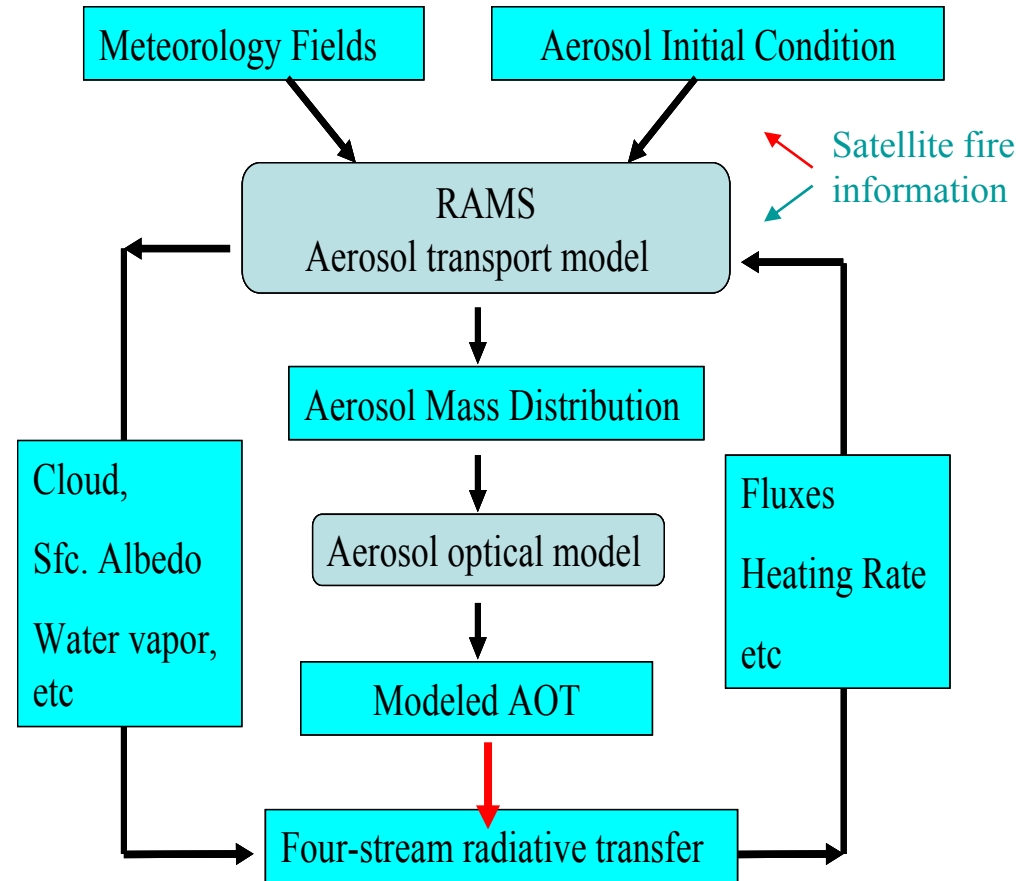
AERO-RAMS

Regional Atmospheric Modeling System – coupled with an aerosol module (AERO-RAMS)

- ✓ Transport/Dispersion module
- ✓ Deposition: Zhang et al., 2001; Slinn, 1984
- ✓ Radiative Transfer
- ✓ Aerosol (emission) assimilation scheme

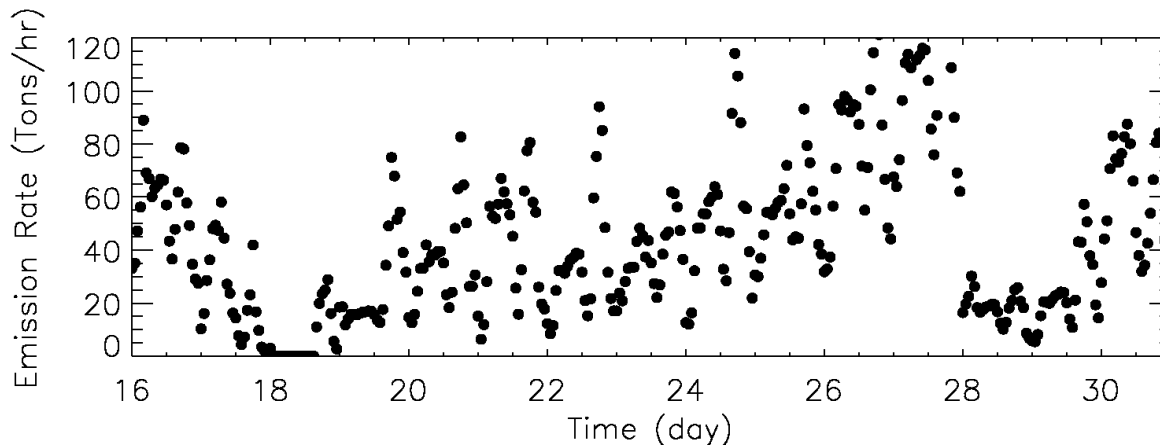
Limitations

- ✓ No simulation of background
- ✓ No chemistry process



AERO-RAMS Fire emission

Smoke emission rates derived from GOES by NOAA/NESDIS averaged for $0.5^\circ \times 0.5^\circ$ fire area in South Georgia



Emissions = f (burned area, fuel load, emissions factors, fuel consumed)

- GOES and MODIS underestimate burned area.
- Large uncertainties are expected in emission factors.

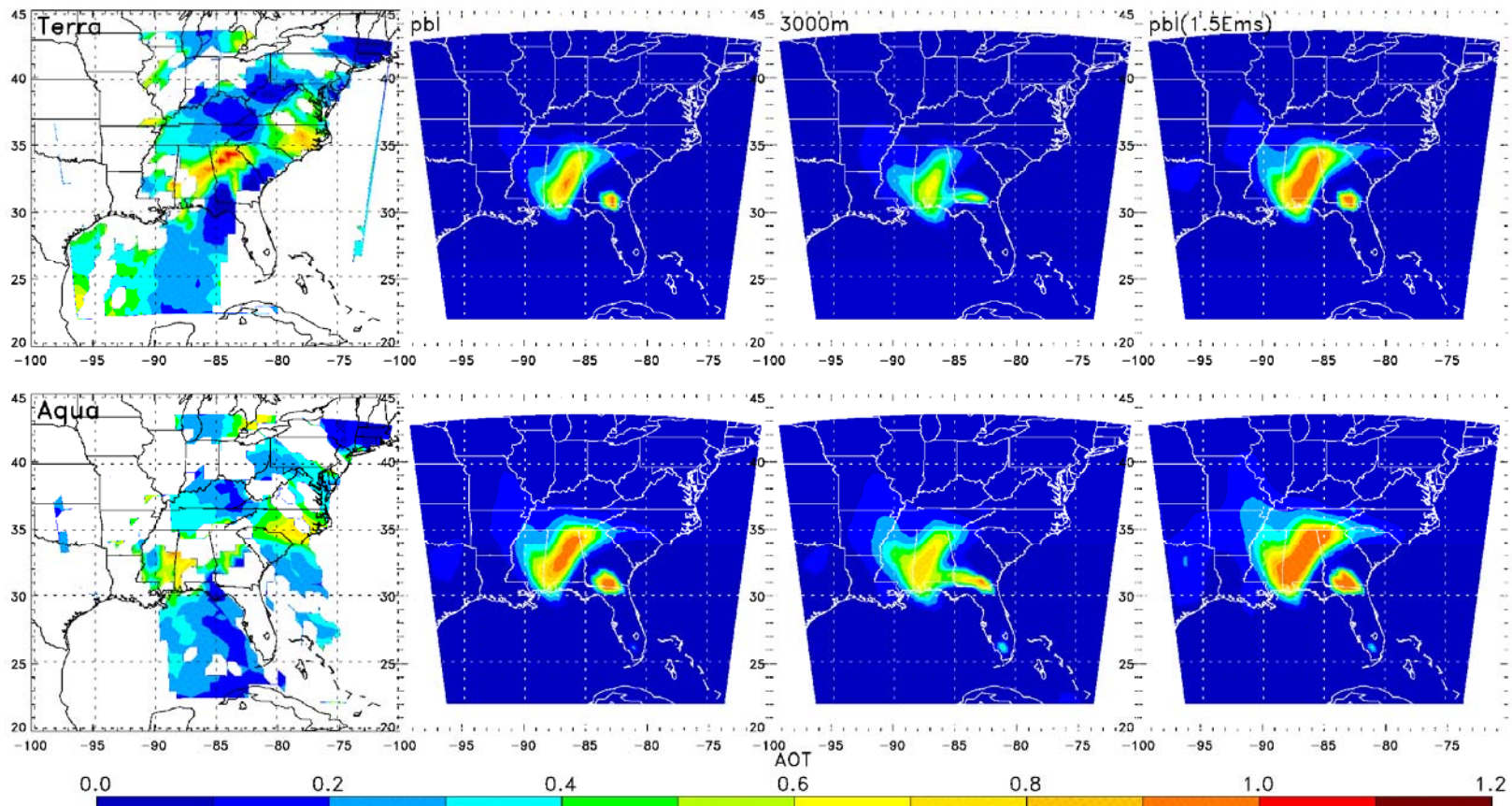
Result – Satellite Obs. Vs Model in Columnar AOT

22 May, 2007

AERO-RAMS

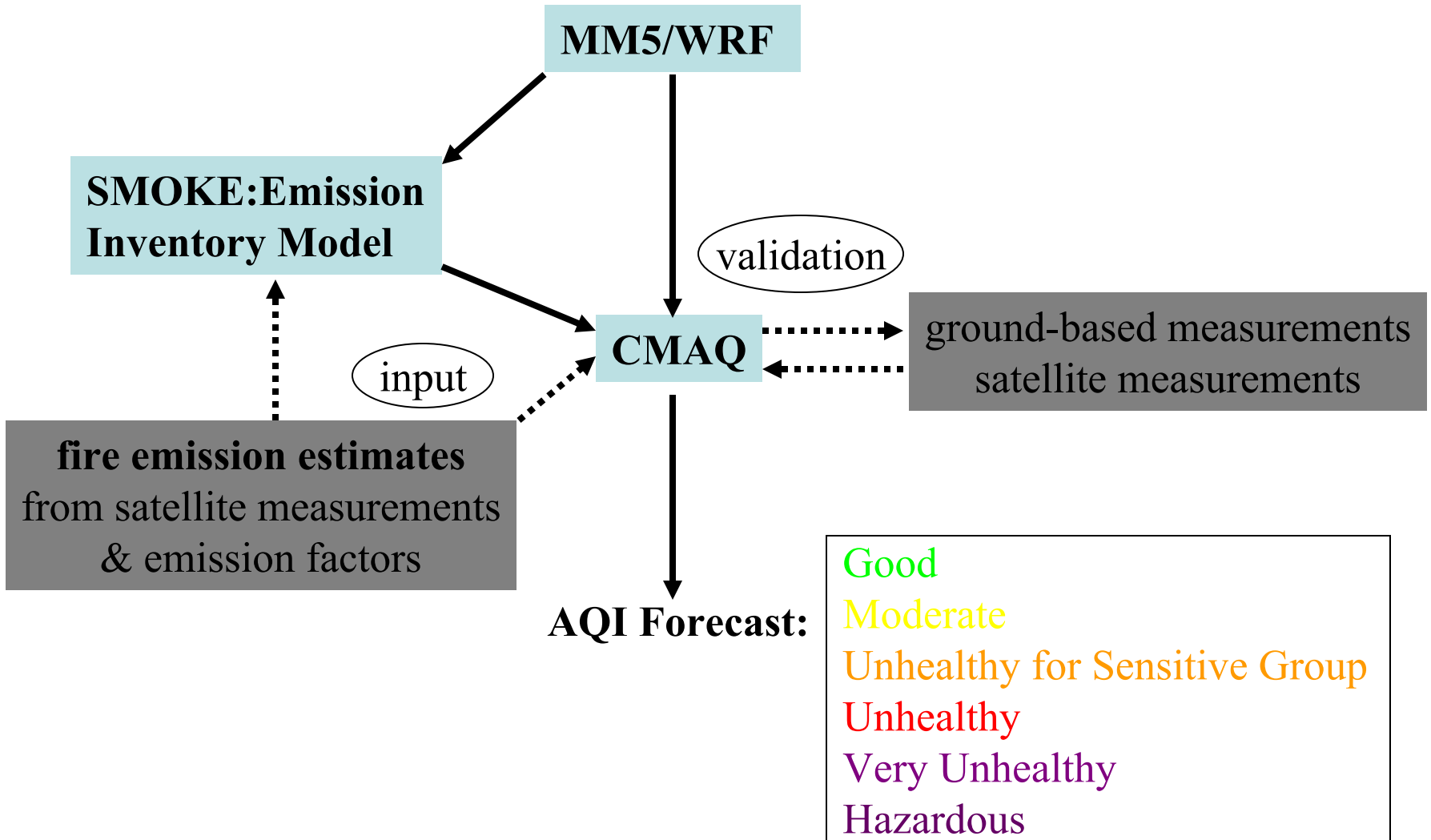
$h_{inj} > PBL$

+50% Emissions

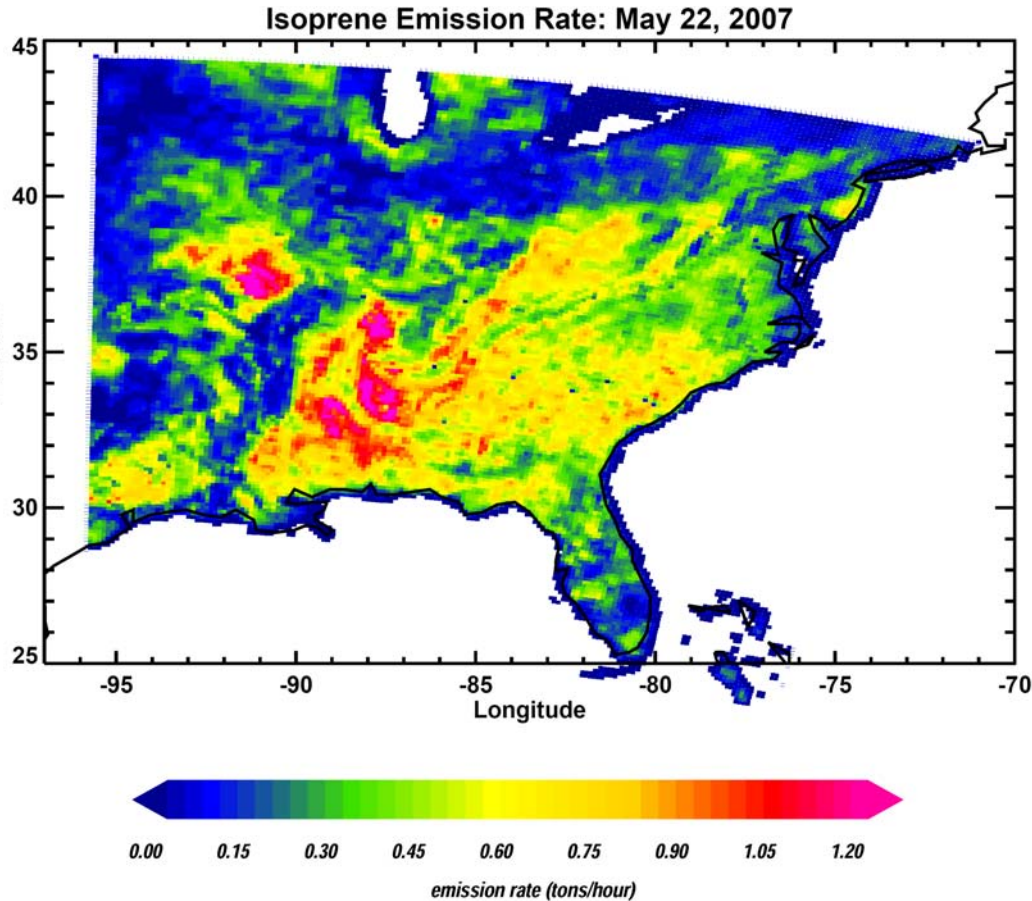


Background emissions and formation of secondary organic aerosols (SOA) should be included to explain MODIS AOT.

MM5/SMOKE/CMAQ



MM5/SMOKE --- CMAQ results



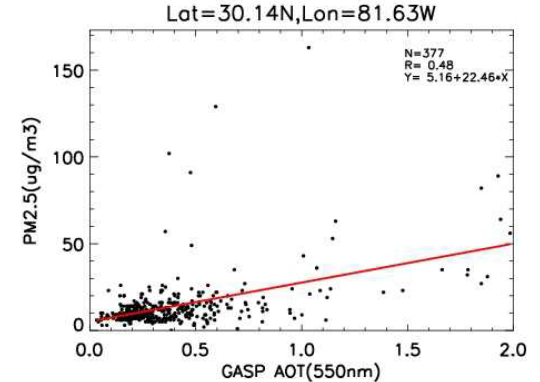
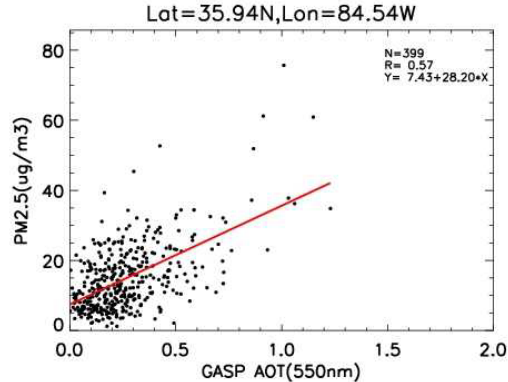
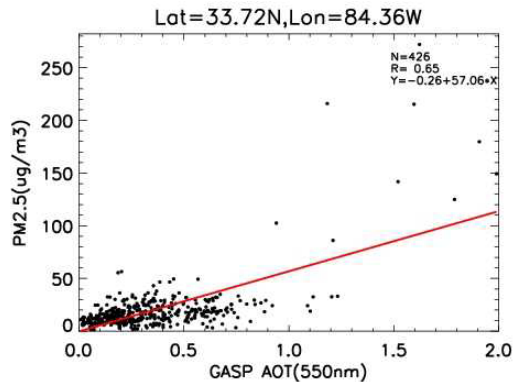
- ✓ MM5
- ✓ SMOKE
- ❖ CMAQ: not yet

Figure: Background Isoprene emission rate estimated from SMOKE biogenic process (BEIS3).

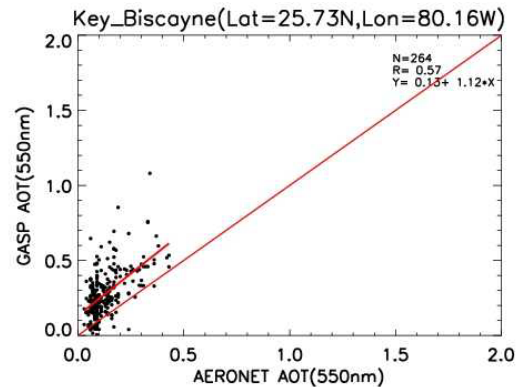
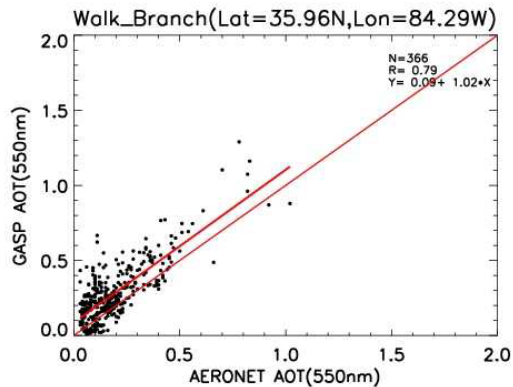
Local emissions differ from area to area (e.g., biogenic and mobile sources).

Validation of satellite AOT measurements

GASP vs. PM2.5



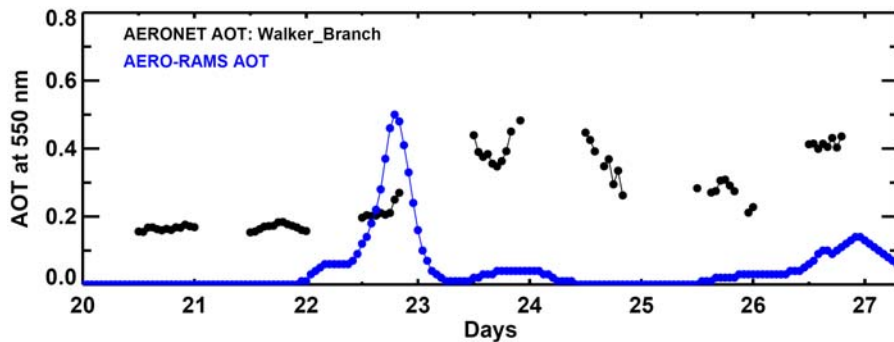
AERONET vs. GASP



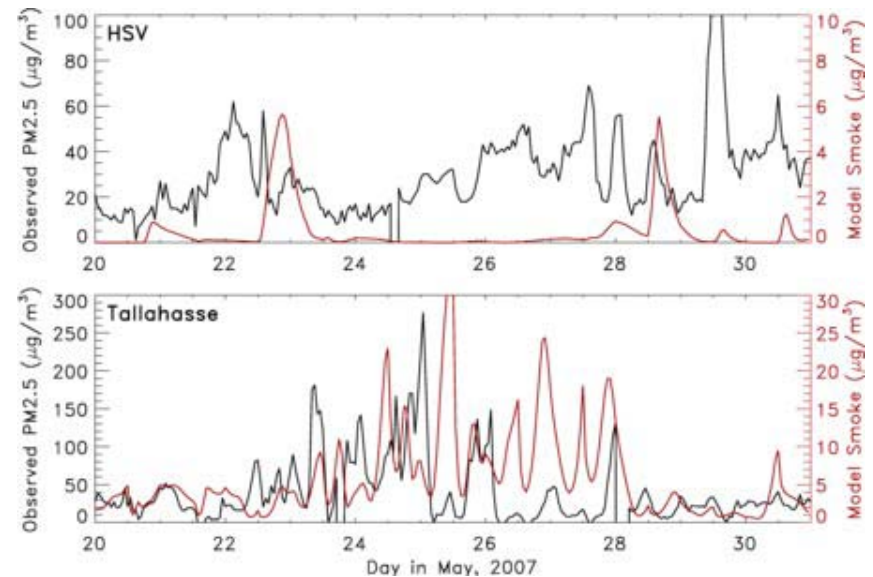
GOES aerosol products well correlate with ground-based aerosol measurements.

Model Evaluations

AERONET vs. AERO-RAMS (36N, 84W)



PM_{2.5} vs. AERO-RAMS



AERO-RAMS underestimates AOT and PM_{2.5}.

* AERONET station is far downstream of fire sources.

** PM_{2.5} stations are located near cities.

Summary

- **Satellite aerosol measurements are useful for compensating the spatial limitation of ground-based measurements.**
- **Fire emissions can be estimated from satellite measurements and emissions factors.**
- **AERO-RAMS underestimates aerosols transported from fire source regions.**
- **Local emissions and formation of SOA are important, especially for the study of transport of fire smoke plumes.**
- **MM5 (WRF)/SMOKE/CMAQ modeling system should simulate transport of fire smoke and formation of SOA.**