CMAQ Air Quality Forecasts during the Georgia Fires of 2007

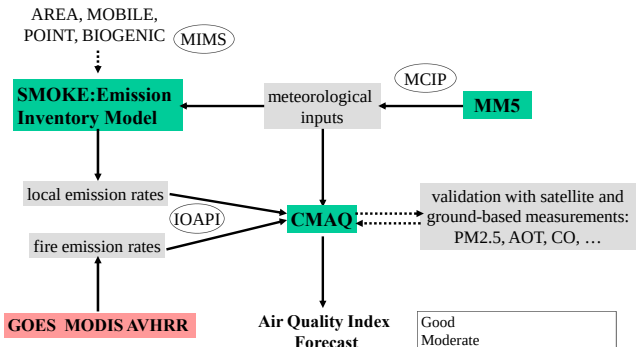
Eun-Su Yang[1], Sundar A. Christopher[1], and Shobha Kondragunta[2]

[1]Earth System Science Center, University of Alabama in Huntsville; [2]NOAA/NESDIS Center for Satellite Applications and Research

Motivation

- **Aerosols are highly variable spatially and temporally because of a relatively short residence time. Atmospheric transport of aerosols is important.**
- **A primary goal of this project is to estimate/forecast Air Quality Index (AQI) using the MM5/SMOKE/CMAQ modeling system. In particular, we are interested in smoke aerosols transported from fire sources.**
- **We propose a possible source of discrepancy between simulated and observed PM2.5 concentrations near fire sources.**

Modeling System



SMOKE: Sparse Matrix Operator Kernel Emissions
MCIP: Meteorology-Chemistry Interface Processor
MIMS: Multimedia Integrated Modeling System
I/O API: Input/Output Applications Programming Interface

Modeling Approaches

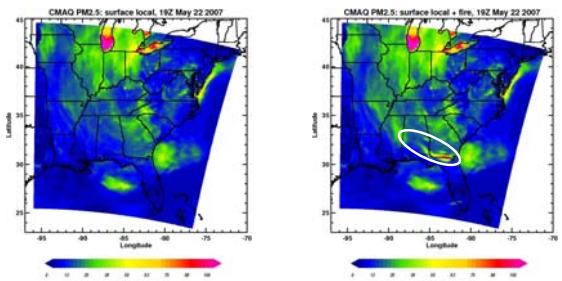
- ✓ Domains: Eastern United States (focused on Southeastern).
- ✓ 12-km horizontal grid.
- ✓ 20 vertical layers.
- ✓ CMAQ runs with EBI solver, cb4-ae4-aq mechanism.
- ✓ Separate runs with
  - — **local** emissions for April 1 – May 31.
  - — **local + fire** emissions for April 1 – May 31.
- ✓ Fire emissions injected uniformly from surface to mixing layer height.

Application to GA/FL fires in 2007

In May 2007, the abnormally dry conditions continued over Georgia and Florida. This drought exacerbated wildfire conditions, with 192,000 hectares in Georgia and 93,000 hectares in Florida burned.

PM2.5 Simulations

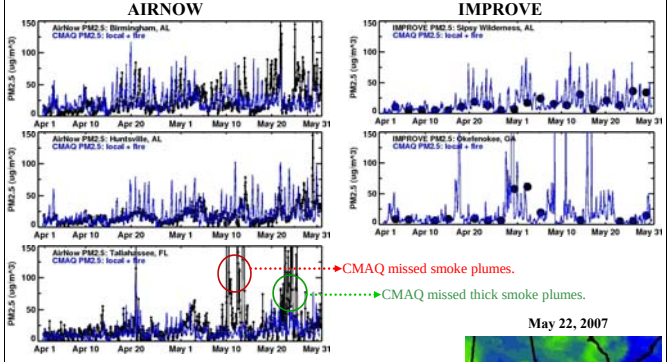
Without fire emissions **With fire emissions**



CMAQ PM2.5 concentrations: (left) CMAQ simulations with local emissions, and (right) CMAQ simulations adding fire emissions. Wildland fires enhance PM2.5 concentrations near and downwind of fire source regions.

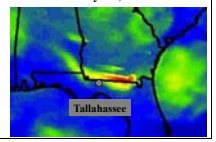
Comparison with Ground-Based Observations

AIRNOW **IMPROVE**

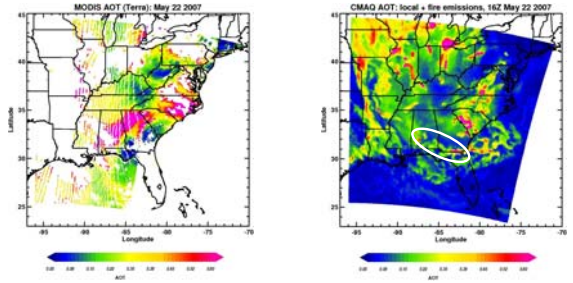


CMAQ simulations with local and fire emissions well reproduce overall PM2.5 concentration levels. However, CMAQ should have accurately located smoke plumes near the fire source regions.

May 22, 2007

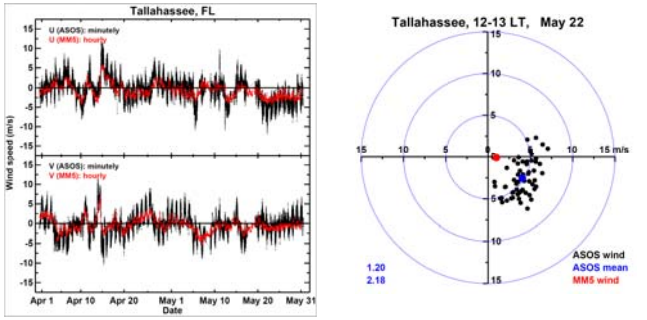


AOT Simulations



(left) MODIS AOT at 16Z, May 22 2007 and (right) CMAQ AOT simulations with local and fire emissions. Fire effects are dominant downwind of fire source regions (white ellipse).

Uncertainty in Transport Modeling



Comparison of MM5 winds with ASOS winds at Tallahassee. The sources of error in the simulation model could be (1) uncertainty in MM5 wind fields and (2) uncertainty in CMAQ treatments of turbulence.

Summary

- **CMAQ reasonably well reproduces PM2.5 and AOT.**
- **Local emissions contribute to air quality degradation even during fire season.**
- **Fire emissions are still dominant near and downwind of fire regions.**
- **Meteorological fields such as wind direction are important to precisely locate fire plumes → include uncertainty of winds into simulations.**
- **Initial conditions of fire emission rates need to be adjusted**

→ 1 x (emission rates) vs. 2 x (emission rates)
(injection within PBL) vs. (injection above PBL)

Email: yes@nsstc.uah.edu; sundar@nsstc.uah.edu; Shobha.Kondragunta@noaa.gov