



# **Satellite Data for Air Quality Forecasting and Near Real-Time Analysis**

**UN/Austria/ESA Symposium**

**"Space Tools and Solutions for Monitoring the Atmosphere in  
Support of Sustainable Development"  
Graz, Austria, 11 - 14 September 2007**

**Jill Engel-Cox  
Battelle Memorial Institute  
703-875-2144, [engelcoxj@battelle.org](mailto:engelcoxj@battelle.org)**

**Erica Zell, Stephanie Weber, Jen Zewatsky, Amy Huff, Battelle  
Ray Hoff, University of Maryland, Baltimore County**

**MODIS 6 September 2007  
Data from NASA GSFC**

# Overview

---

- Air quality forecasting for human health:
  - U.S. Case Study: AIRNow, IDEA, and GASP
  - News stories pilot project
- Near real-time analysis:
  - U.S. Air Quality: “The Smog Blog”
- Case examples:
  - Central American “Toxic Dust Cloud”
  - North American long-distance smoke
- A few thoughts on using satellites to study air quality in near real-time

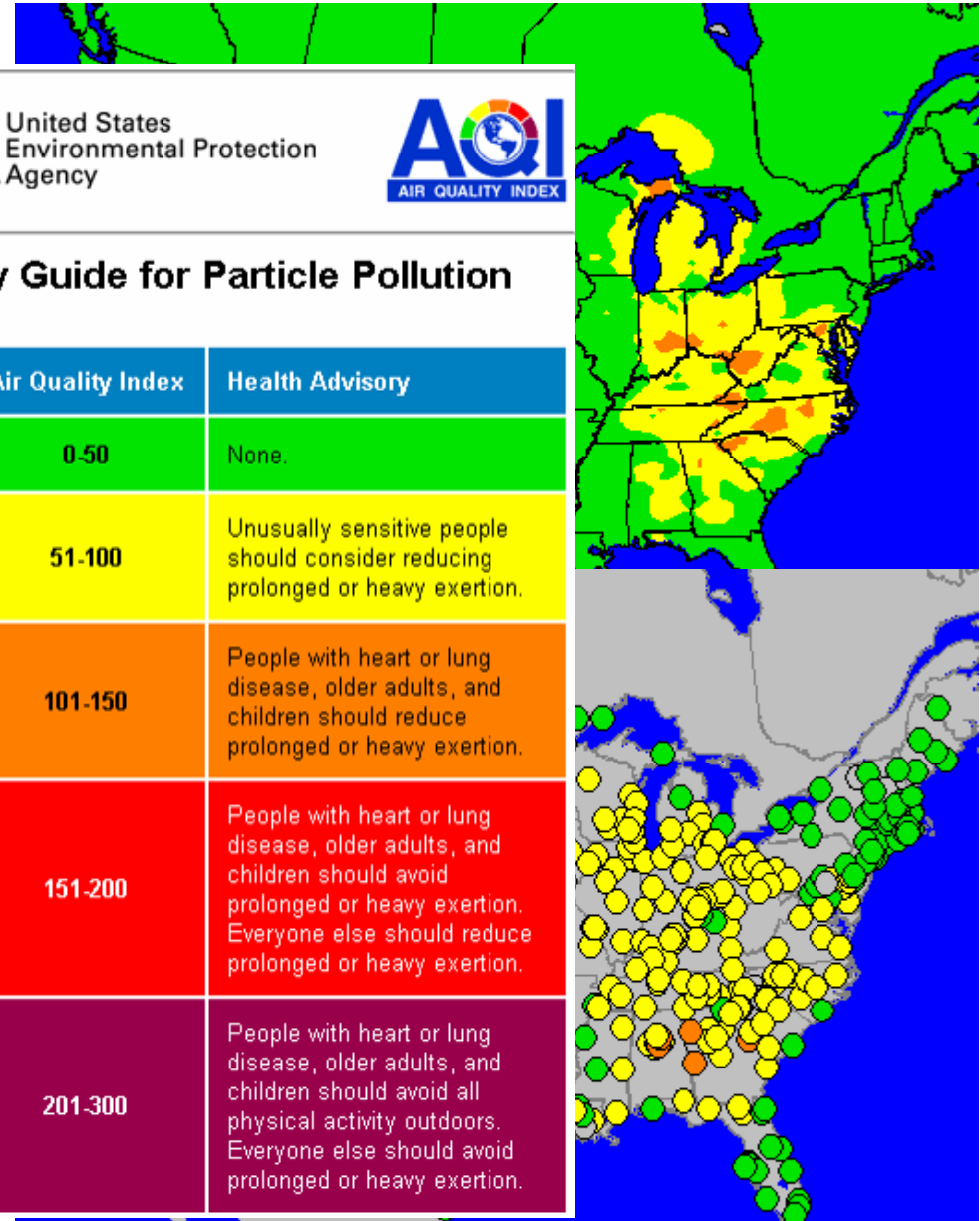
# U.S. Ambient Real-Time Air Monitoring

- Real-time Monitors
  - Hourly Ozone (ppb)
  - Hourly PM<sub>2.5</sub> (µg / m<sup>3</sup>)
- Converted to health-based air quality index (AQI)
- Available on U.S. Environmental Protection Agency's AIRNow website (<http://www.airnow.gov>)



## Air Quality Guide for Particle Pollution

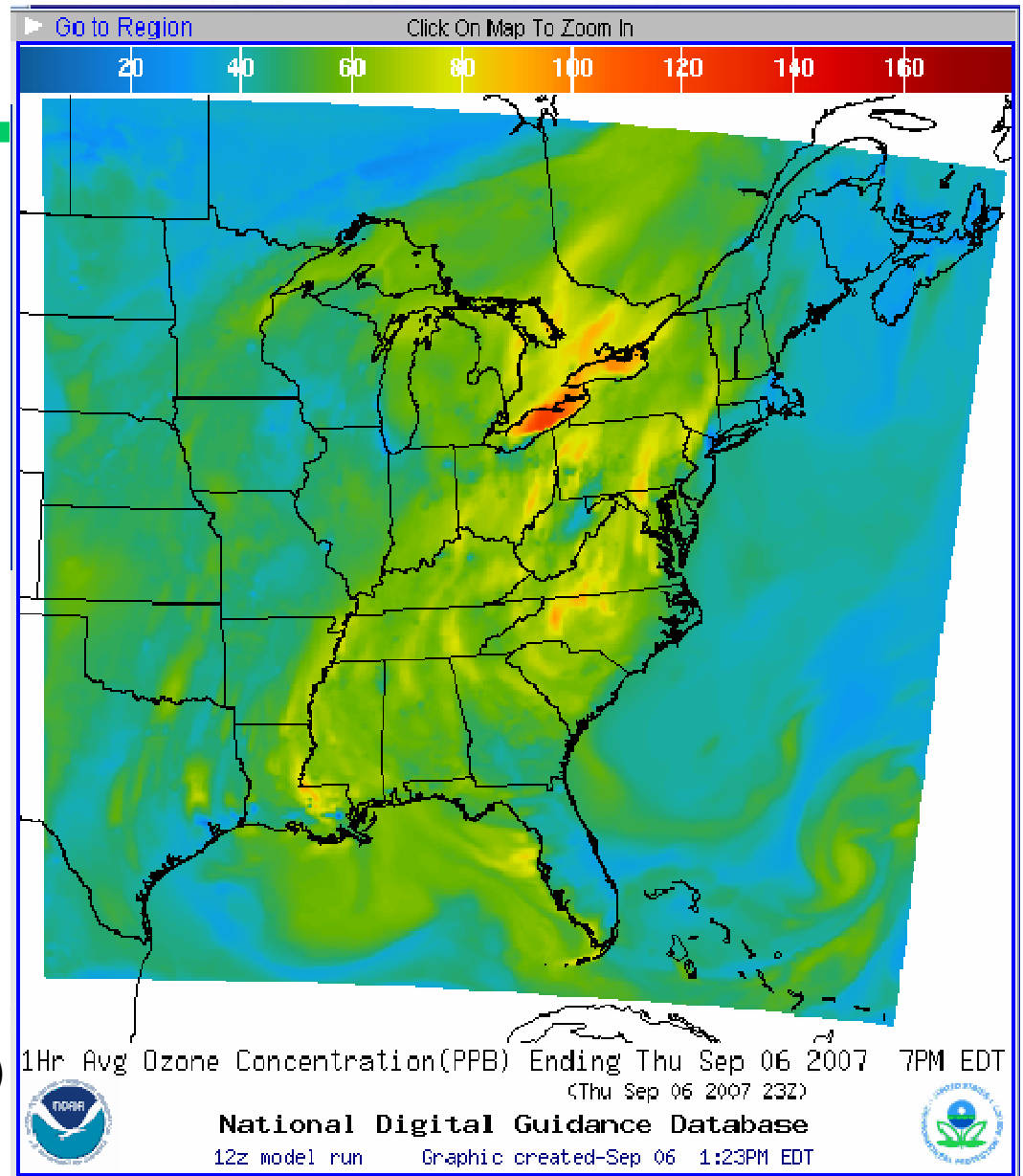
Air Quality	Air Quality Index	Health Advisory
Good	0-50	None.
Moderate	51-100	Unusually sensitive people should consider reducing prolonged or heavy exertion.
Unhealthy for Sensitive Groups	101-150	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
Unhealthy	151-200	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy (Alert)	201-300	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.



September 5, 2007 12:00 am EDT

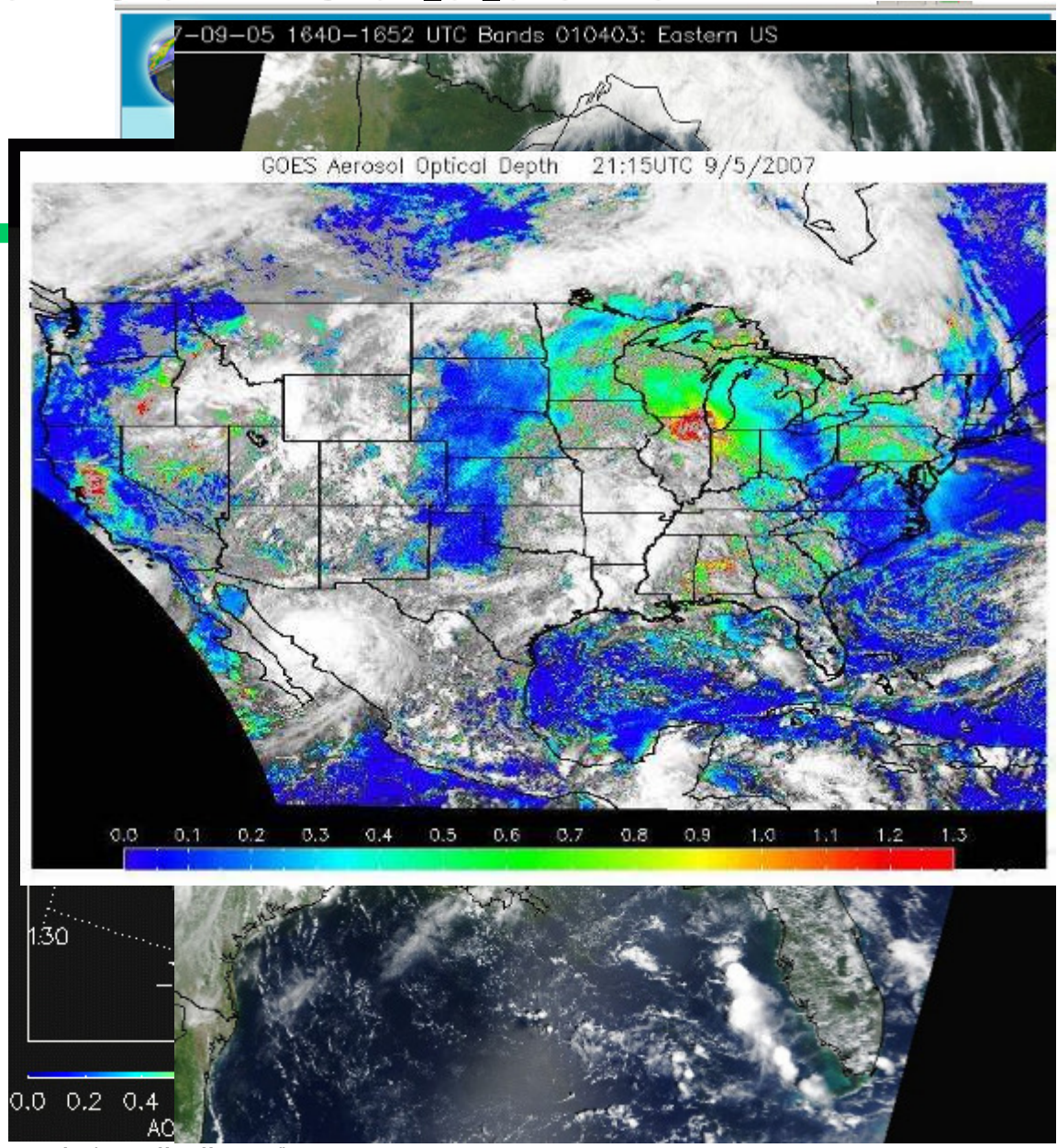
# U.S. Ambient Air Quality Forecasting

- Next Day Forecasts
  - Forecasts at city level
  - Alerts issued for bad pollution days
  - Coordinated by U.S.EPA
  - National forecast guidance being developed by National Weather Service
- Key sites are:
  - AIRNowTech (<http://www.airnowtech.org/>)
  - National Weather Service (<http://www.nws.noaa.gov/aq/>)



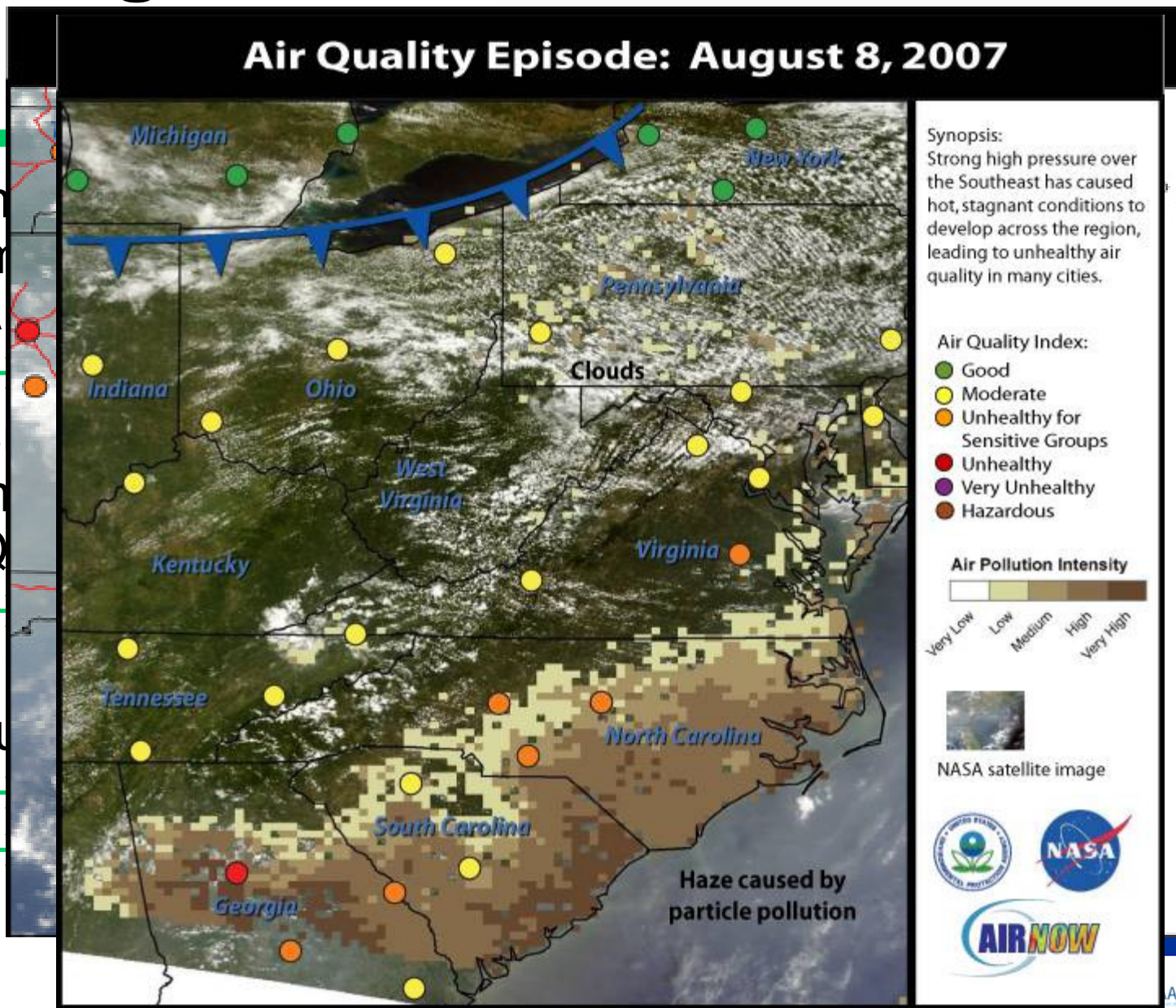
# Satellite Data Can Support Air Quality Forecasting

- Satellites can help
  - Show spatial extent
  - Indicate intensity
  - Track transport
- Requirements
  - Relevant to ground concentrations
  - Available by early afternoon
  - Visually similar
- Key systems are:
  - IDEA (<http://idea.ssec.wisc.edu/>)
  - MODIS Rapid Response (<http://rapidfire.sci.gsfc.nasa.gov/>)
  - MODIS Direct (<http://eosdb.ssec.wisc.edu/modisdirect/>)
  - GASP (<http://www.ssd.noaa.gov/PS/FIRE/GASP/gasp.html>)



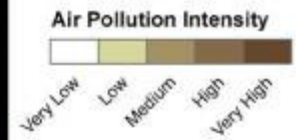
# “Smog Stories” / Air Quality News

● In  
im  
A  
● B  
m  
Q  
● P  
SU



Synopsis:  
Strong high pressure over the Southeast has caused hot, stagnant conditions to develop across the region, leading to unhealthy air quality in many cities.

- Air Quality Index:**
- Good
  - Moderate
  - Unhealthy for Sensitive Groups
  - Unhealthy
  - Very Unhealthy
  - Hazardous



NASA satellite image

Search:

## of Life

UMBC

About U.S. Air Quality

Useful Links

Recent Entries

Main Data Sources

Help Files

ies work together to report

# Near Real-Time Analysis

U.S. Air Quality

The Smog Blog

U.S. Air Quality (The Smog Blog), <http://alg.umbc.edu/usaq>

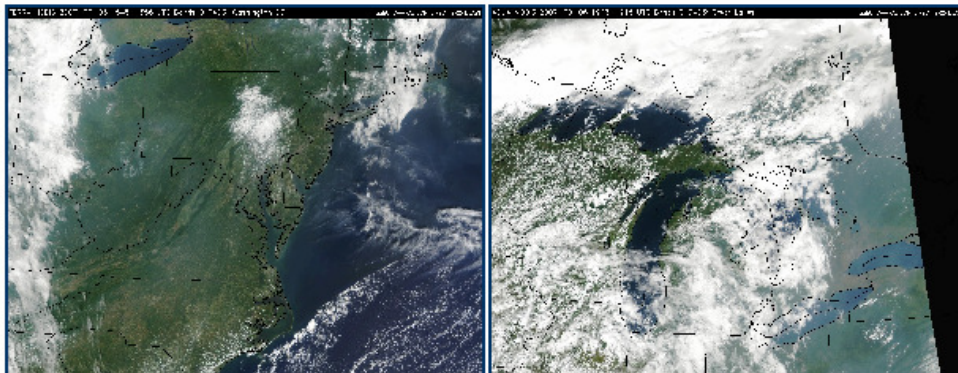


September 6, 2007

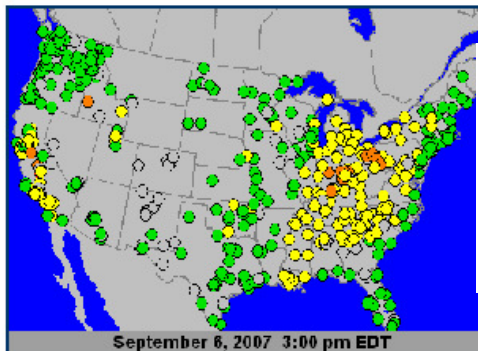
## HAZE IN THE GREAT LAKES AND CALIFORNIA

And perhaps even a little hazier today over the mid-west and midatlantic region. of Ohio and Kentucky were in the unhealthy range at 3EDT. The haze seems to be particularly intense over the Great Lakes and according to the [HMS](#) analysis there is haze over large parts of the upper midwest, and midatlantic region.

## Daily posts



PM<sub>2.5</sub> monitors in central California also reached the unhealthy range, possibly related to continued fires there. The RGB for California is not available yet, so check back later today.



## Multi-sensor: Satellite images, ground-based monitors, etc.

Posted by Ana Prados at 6:15 PM

### About U.S. Air Quality

USAQ is a daily diary of air quality in the U.S. using information from NASA satellites, ground-based lidar, EPA monitoring networks, and other monitors. Interpretation and analysis is provided by the staff of the **University of Maryland, Baltimore County Atmospheric Lidar Group.**

Search

Search this site:

**Search**

### Recent Entries

- [Haze in the Great Lakes and California more hazy than yesterday](#)
- [Fires & Moderate PM](#)
- [Different day, same story](#)
- [Clear day](#)
- [Haze & Smoke is still here...](#)
- [Haze in southcentral U.S., smoke in Oregon and northwest](#)
- [Clouds and Haze in the Southeast](#)
- [Pa...](#)
- [Elk...](#)

## Index & Links

- [UW MODIS Direct](#)
- [NASA MODIS Rapidfire Browse / Subsets](#)
- [EPA AirNow / ParticlesNow / AirNowTech](#)
- [NASA-UW IDEA / NOAA IDEA Beta Test](#)
- [AA NESDIS GASP / GASP-West / GASPER \(pw only\)](#)
- [AA Air Quality Forecast Guidance](#)
- [SA OMI Tropospheric NO<sub>2</sub>](#)
- [AA Hazard Mapping System Fire and Smoke Product / oke Text](#)
- [DA MODIS Active Fire Maps](#)
- [an Air Partners Monitoring Sites MD-DC-NoVA](#)

## Image Interpretation Help Files

- [MODIS Red Green Blue Image \(MODIS Direct\)](#)
- [MODIS Red Green Blue Image \(Rapidfire\)](#)
- [MODIS Aerosol Optical Depth \(IDEA\)](#)

# Expand to Mesoamerica: SERVIR Air

- SERVIR is satellite visualization and monitoring system for Mesoamerica
- Focus on disasters, ecosystems, biodiversity, weather... *not air quality*
- Partner with 3D-AQS to bring air quality info into SERVIR
  - Case study
  - Mesoamerica air quality blog
  - Training & student exchange
  - Transfer of real-time systems
  - Improved ground monitors (EPA)
  - Communication & outreach

The screenshot displays the SERVIR website interface. At the top, the header reads "SERVIR The Mesoamerican Regional Visualization and Monitoring System" with the date "FRI, JUNE 15, 2007" and language options for "Español" and "English". A navigation bar includes links for "SERVIR Data", "Online Maps", "GEOSS Decision Support", and "3-D Visualizations".

The left sidebar contains a menu with "Home", "User's Manual", "Downloads", "In the News", "About SERVIR", "Gallery" (highlighted), "Directory", "Partners", "Library", and "Contact Us". Below this is a "NASA Earth Science Applications" section and a search box with a "Go" button.

The main content area features a green banner: "Your 'One Stop Shop' for Regional Data, Dynamic Maps, Decision Support, and Interactive Visualizations". Below this, it says "Mesoamerica Today, Friday, June 15, 2007" and provides links to "Go to SERVIR Realtime Image Viewer >>", "View GOES Images of A Specific Country", and "Make Your Own GOES Animation". A "Latest GOES image" is shown as a weather map of Mesoamerica dated "15 Jun 2007 20:15 UTC". A legend below the map identifies colors: black for "Cloud free, very warm surface temperatures", purple for "Weak, warm cloud tops, low altitude", and red for "Intense, cold cloud tops, high altitude". A link for "SERVIR Realtime Image Viewer >>" is provided.

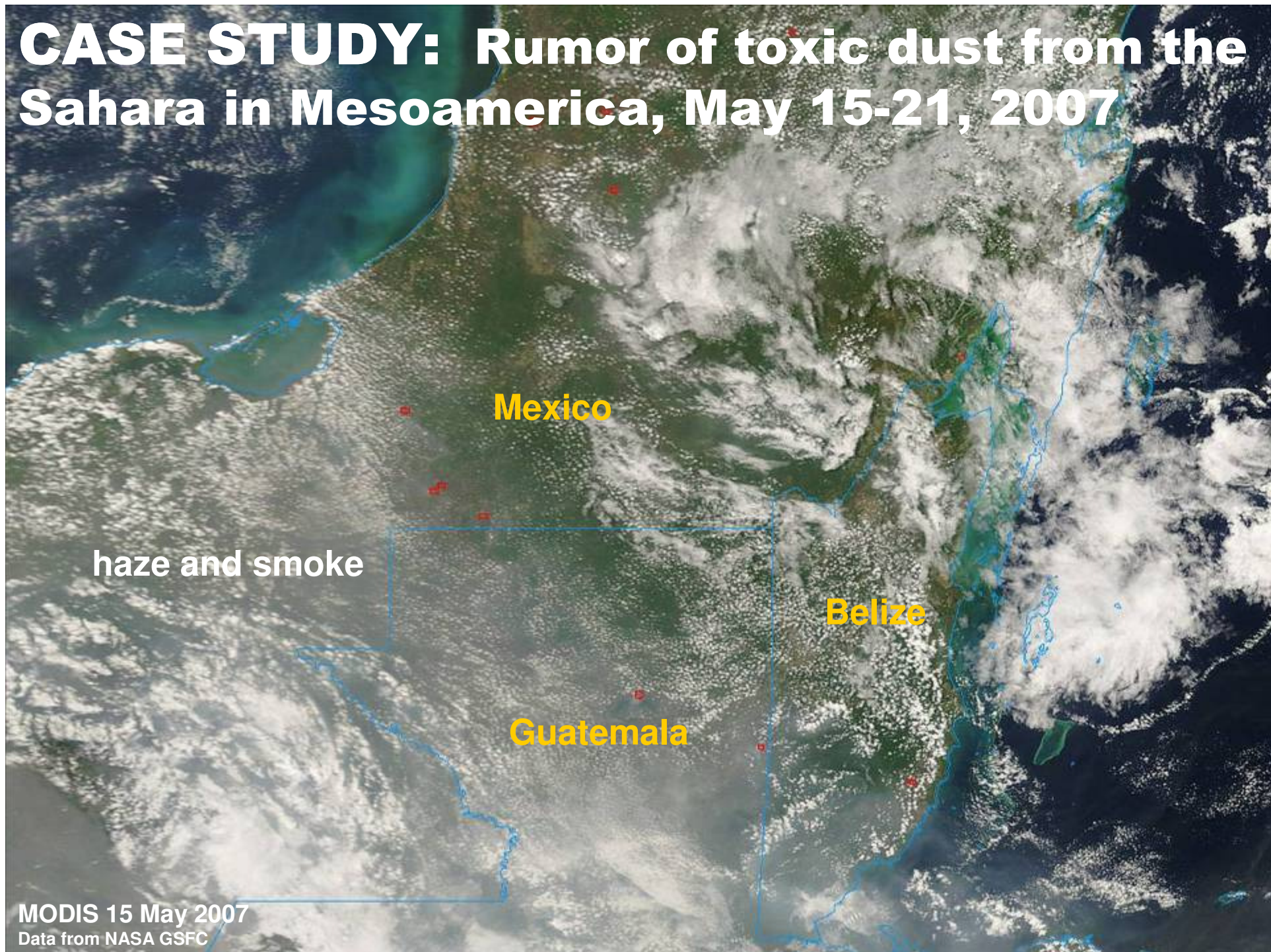
The right sidebar, titled "SERVIR Movies", lists "Click images to view movies" and includes thumbnails for "First 21 Named Storms of 2005 Atlantic Hurricane Season", "A Vision of the Future (18.2 MB)", "Video Tierra ceniza o bosques saludables", "Time Lapse of Fires (17.88 MB)", and "Fade from Day to Night (20 KB)".

At the bottom, a footer lists various site resources: "Home | User's Manual | Downloads | In the News | About SERVIR | Gallery | Directory | Partners | Library | Presentations | Scientific Papers | Posters | Workshops | Contact Us | MesoStor | SERVIR Data Portal | Realtime Image Viewer | SERVIR Interactive Map Maker | SERVIR Map Maker Studio | Ecoregional Assessments | GEOSS Decision Support Products | Disasters | Ecology | Weather | Climate | Oceans | Water | Agriculture | Human Health | Energy | SERVIR-VIZ | Anaglyphs | Skyline | Google Earth".

<http://servir.nsstc.nasa.gov>

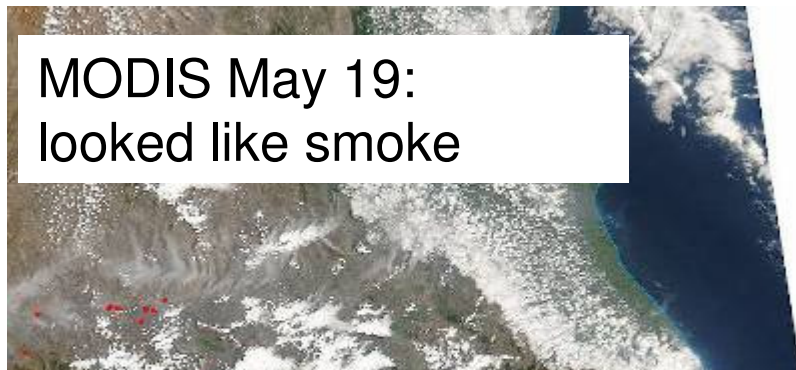


# CASE STUDY: Rumor of toxic dust from the Sahara in Mesoamerica, May 15-21, 2007



MODIS 15 May 2007  
Data from NASA GSFC

MODIS May 19:  
looked like smoke



NOAA Satellite and Information Service  
National Environmental Satellite, Data, and Information Service (NESDIS)

Satellite Fire Detections  
National Geophysical Data Center

NOAA HAZMAPPING SYSTEM

Legend

- Analyzed Smoke
- HMS
- AVHRR Analysis
- AVHRR NOAA-15
- AVHRR NOAA-16
- AVHRR NOAA-17
- GOES Analysis
- GOES-EAST
- GOES-WEST
- MODIS Analysis
- MODIS AQUA
- MODIS TERRA
- States

NOAA HYSPLIT MODEL  
Backward trajectory ending at 00 UTC 20 May 07  
GDAS Meteorological Data

Source: 15.77 N 91.06 W

Meters AGL

Job ID: 392632 Job Start: Fri Jun 1 20:56:56 GMT 2007  
Source 1: lat.: 15.77 lon.: -91.06 height: 500 m AGL  
Trajectory Direction: Backward Duration: 72 hrs Meteor Data: GDAS1  
Vertical Motion Calculation Method: Model Vertical Velocity  
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

May 18 2007  
May 20 2007  
Custom Range

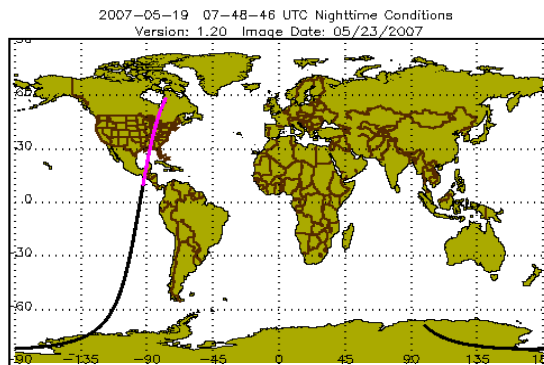
The screenshot displays the NOAA Hazard Mapping System interface. The main map shows satellite fire detections over a coastal region, with various colored squares representing different satellite analyses. A legend on the right lists the data sources. An inset window shows a HYSPLIT backward trajectory plot for a smoke plume ending at 00 UTC on May 20, 2007, at 15.77 N, 91.06 W. The plot shows the trajectory starting from the coast and moving inland. Below the plot is a vertical profile showing the smoke's height in meters above ground level (AGL) over time. The interface includes navigation tools, a toolbar, and date selection options.

NOAA Hazard  
Mapping System:  
indicated smoke on  
May 18-20

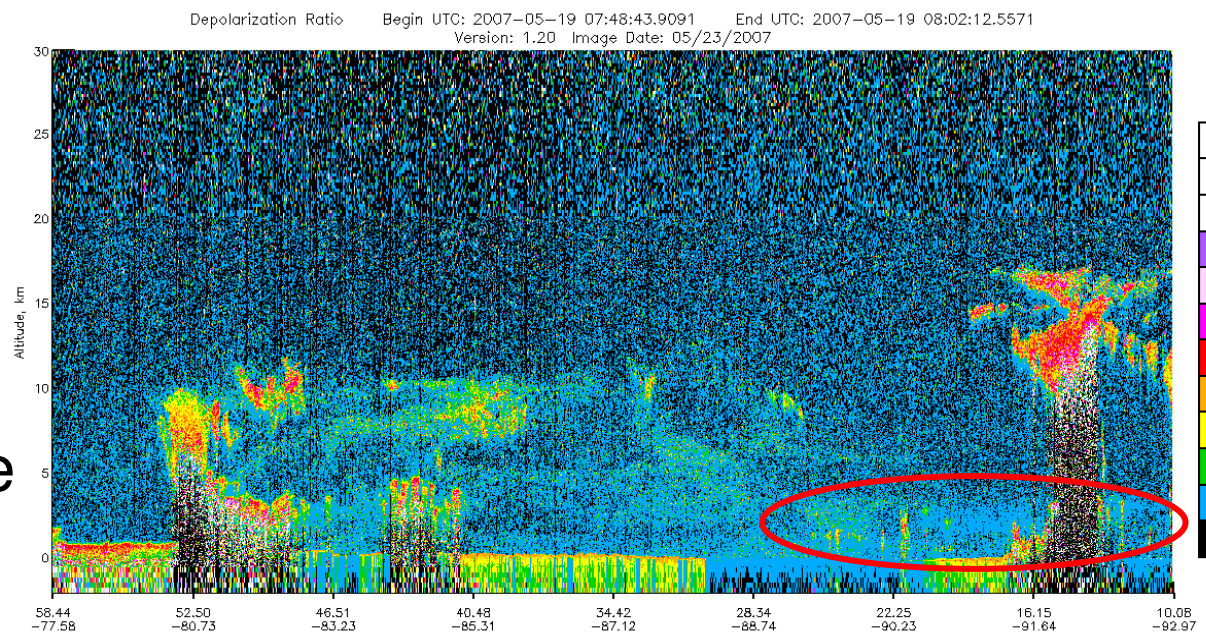
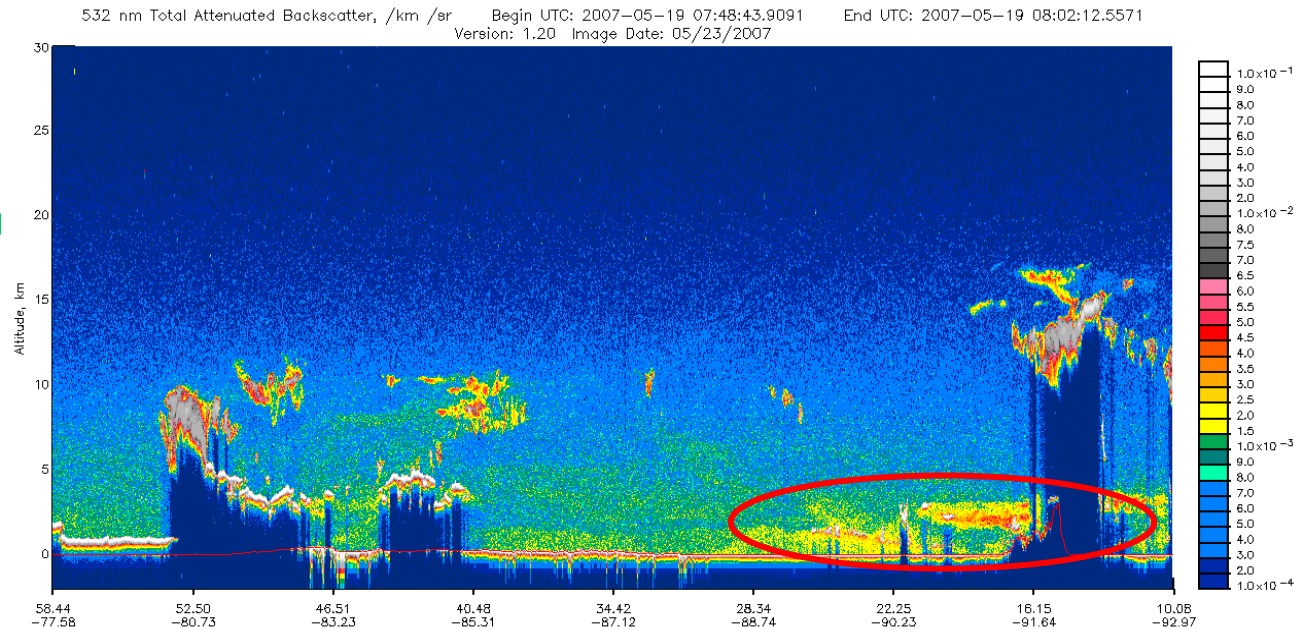
NOAA HYSPLIT:  
pointed to local sources

# And in the 3D view...

- CALIPSO images from May 18 over Costa Rica and Nicaragua

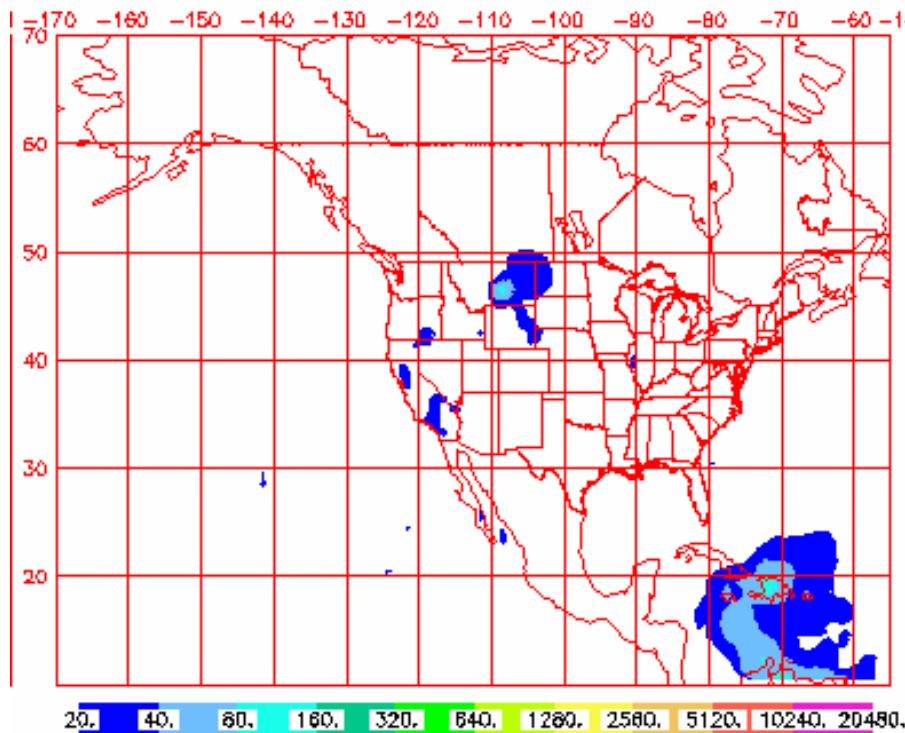


- Depolarization ratio supports case for smoke



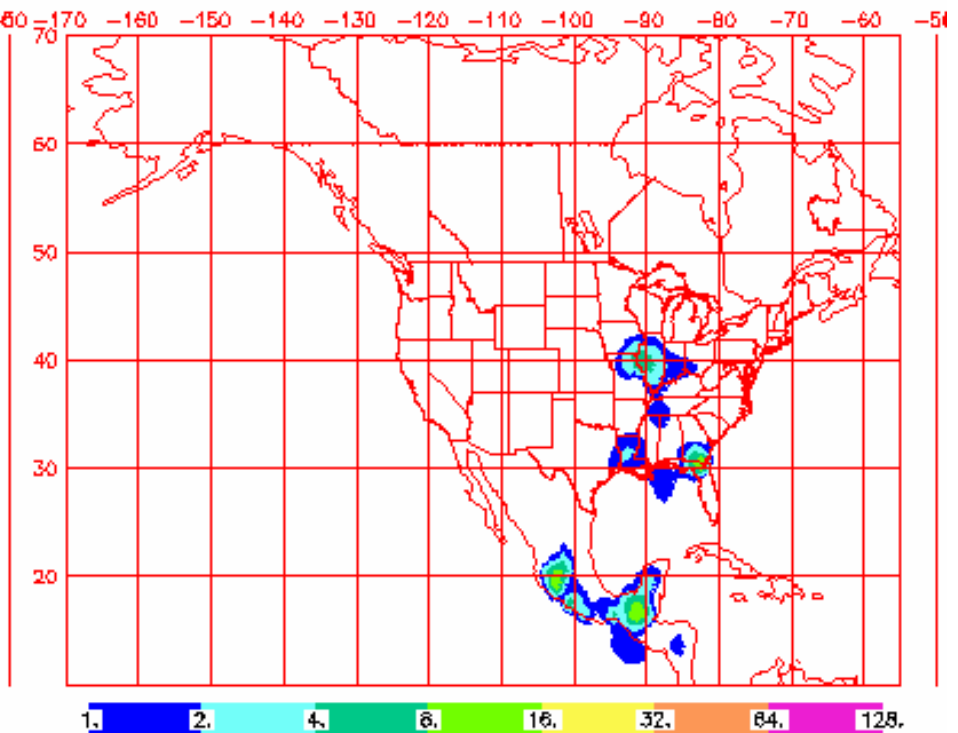
# What about the rumors of Saharan dust?

NAAPS Surface Concentration ( $\mu\text{g}\cdot\text{m}^{-3}$ )  
for 06:00Z 21 May 2007 Dust



2.000E+01: 2.048E+04 [ 1.163E-25, 0.088E+01, 5.480E+00] NIKRO-C<sub>1</sub>/M<sup>3</sup>

NAAPS Surface Concentration ( $\mu\text{g}\cdot\text{m}^{-3}$ )  
for 06:00Z 21 May 2007 Smoke



1.000E+00: 1.280E+02 [ 4.753E-20, 1.888E+01, 2.085E-01] NIKRO-C<sub>1</sub>/M<sup>3</sup>

NRL model says there's smoke, and maybe dust to the east..

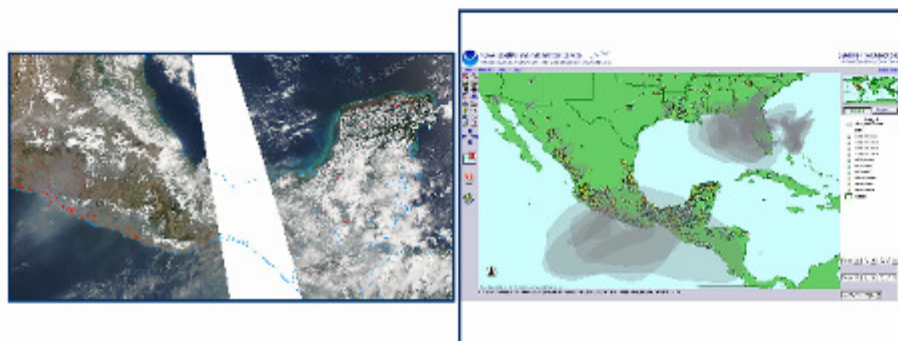
« Still Smokey in the southeast and possible African dust | [Main](#) | Still hazy in the southeast »

May 21, 2007

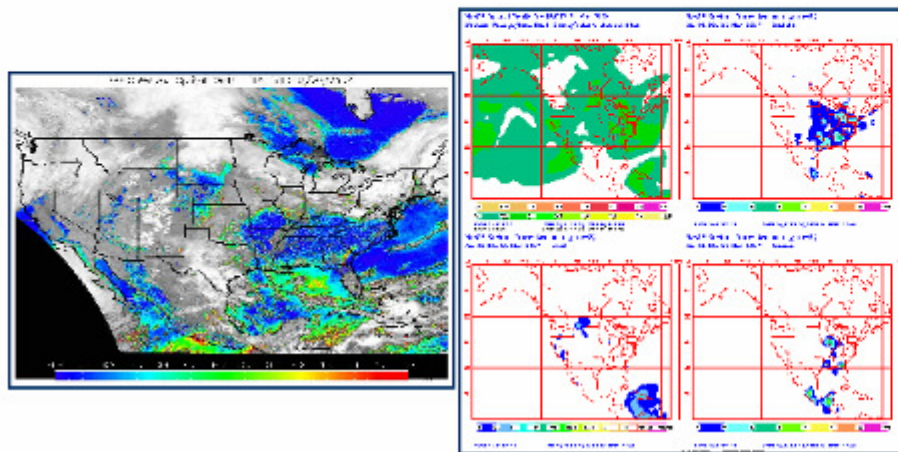
## SPECIAL FEATURE: FIRES AND SMOKE IN MESOAMERICA

On May 21, we received an email from colleagues with questions about air pollution that parts of MesoAmerica (specifically, Honduras, Costa Rica and Nicaragua) were experiencing, starting on Friday May 18. There was concern about toxics and about the possibility of Saharan dust crossing the Atlantic. We'd been watching the northern Gulf of Mexico pretty closely, since it had been very smoky from the fires in Florida. So, we looked a little further south to see if we could figure out what was happening.

MODIS true color images told us there were many fires in Central America that entire week; for example, on [May 15](#) and [May 16](#). The MODIS image from May 19 showed significant smoke and clouds in the entire northern part of the region (left image below). This is confirmed by the NOAA NESDIS smoke and fire detection Hazard Mapping System (right).



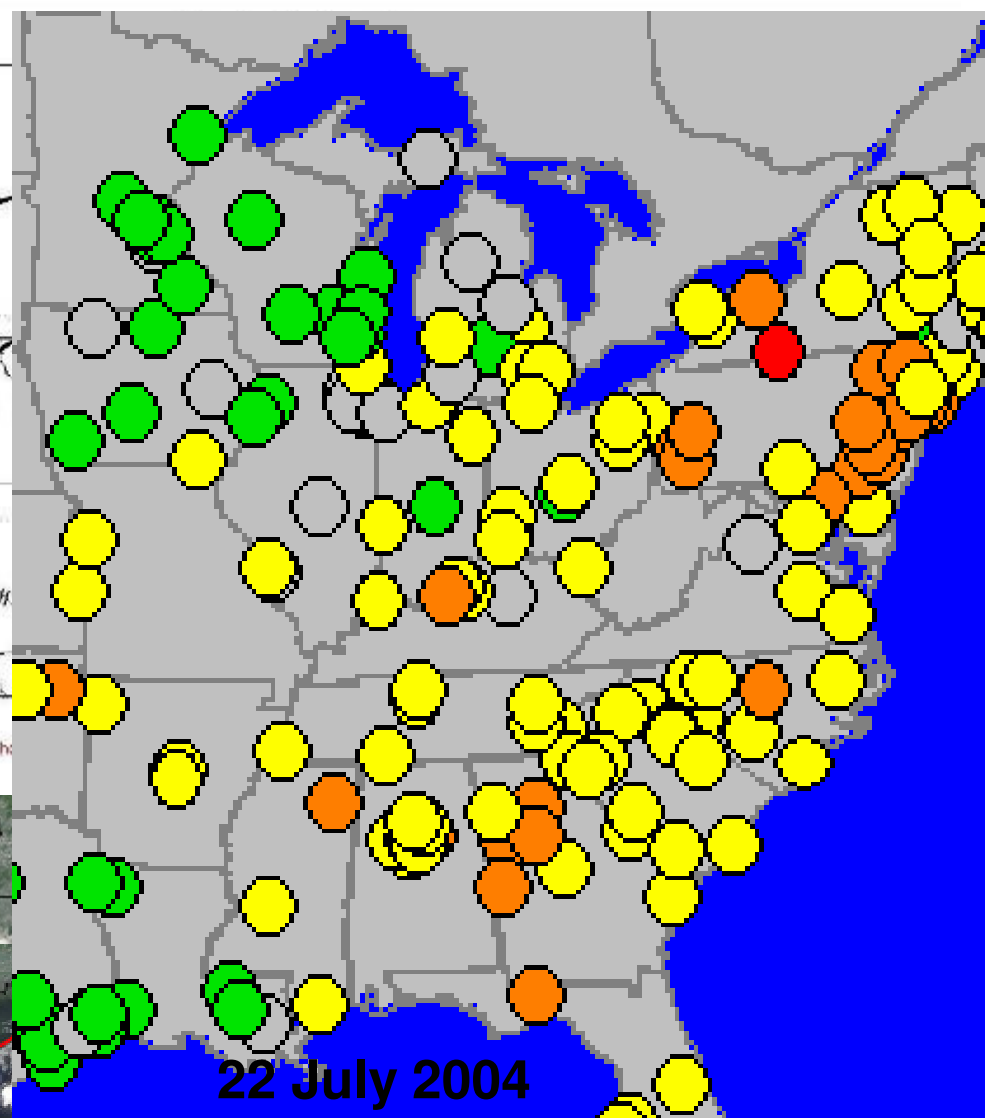
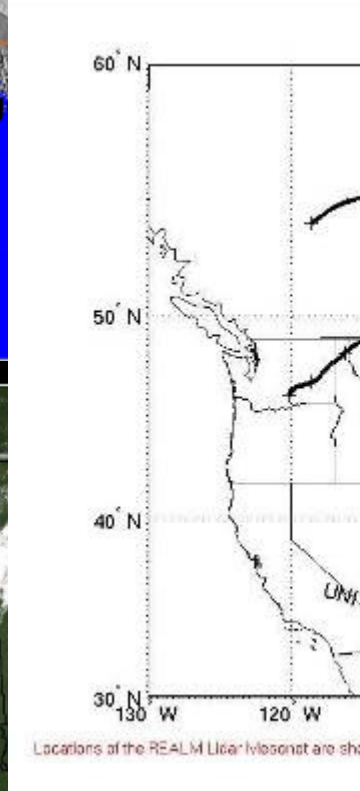
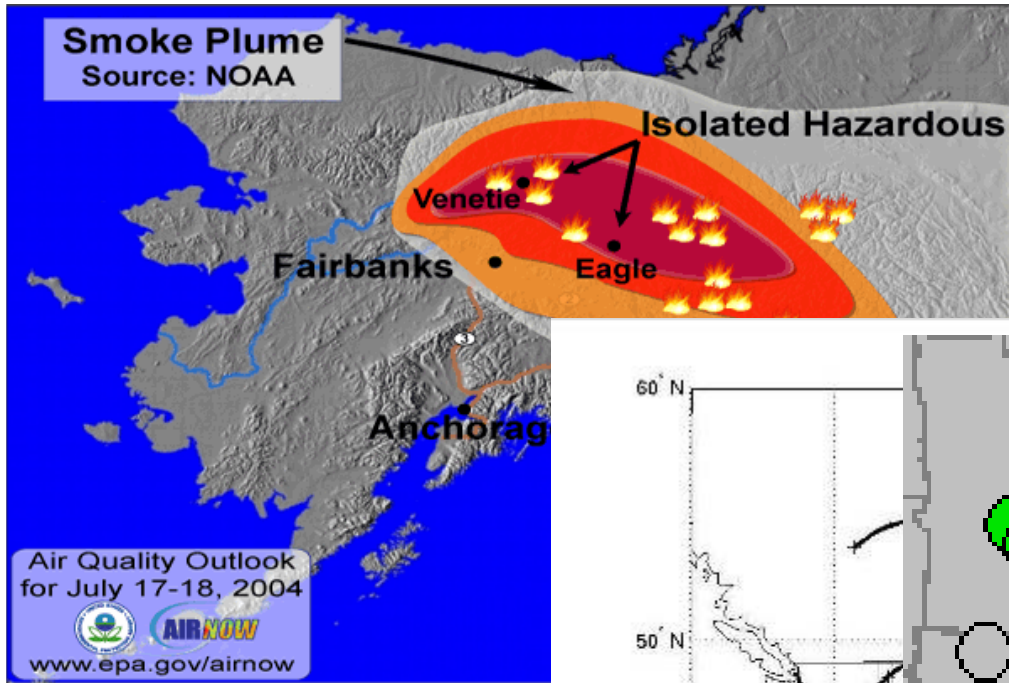
The GOES aerosol optical depth images from May 20 showed quite a bit of smoke and haze across the Gulf of Mexico, Caribbean Sea, and off Pacific coast (left image). The NRL model indicated smoke on May 21 (right image, bottom right panel). The back trajectories varied depending on start time and location, but 72 hours runs pointed to mostly local sources (e.g., see HYSPLIT for [May 19](#) and [May 20](#)). NASA's Earth Observatory did a story on these [fires in Mexico and Central America](#), including an image of the fires on May 21.



## Conclusion:

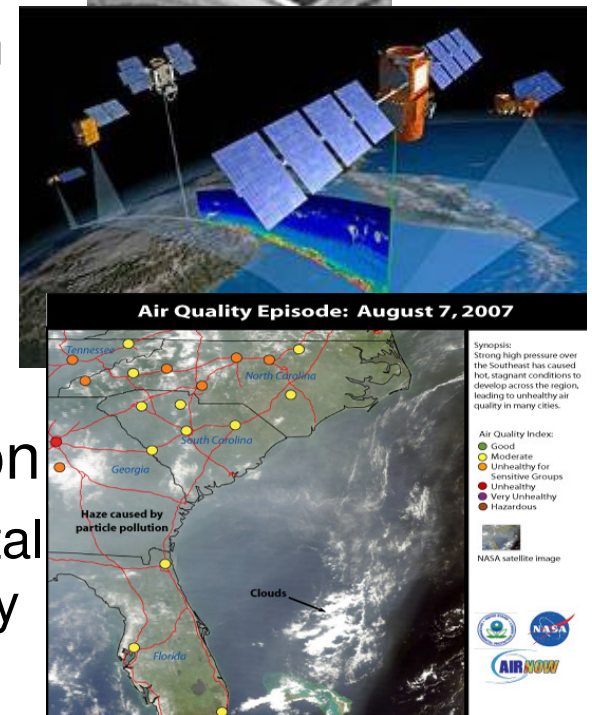
Air pollution in Mesoamerica May 18-21 was dominated by locally generated smoke

# Case Example: North America Smoke Transport



# A few thoughts on satellites and air quality near real-time analysis

- Pay attention at least a little every day
- Apply basic rules:
  - Occam's razor: All things being equal, the simplest solution tends to be the best one
  - Value of multiple sensors greater than their sum
- A picture is worth 1000 words
  - But a few words can really help explain what you're looking at
- Tell a story: be timely and relevant
- Share data, techniques, images, information
  - More people using and demanding environmental information = greater understanding of air quality



**Questions?**

