

Use of NASA 3D-AQS Remote Sensing Data in Google Earth: a New Tool for Air Quality Forecasters

Amy K. Huff
Battelle Memorial Institute
huffa@battelle.org

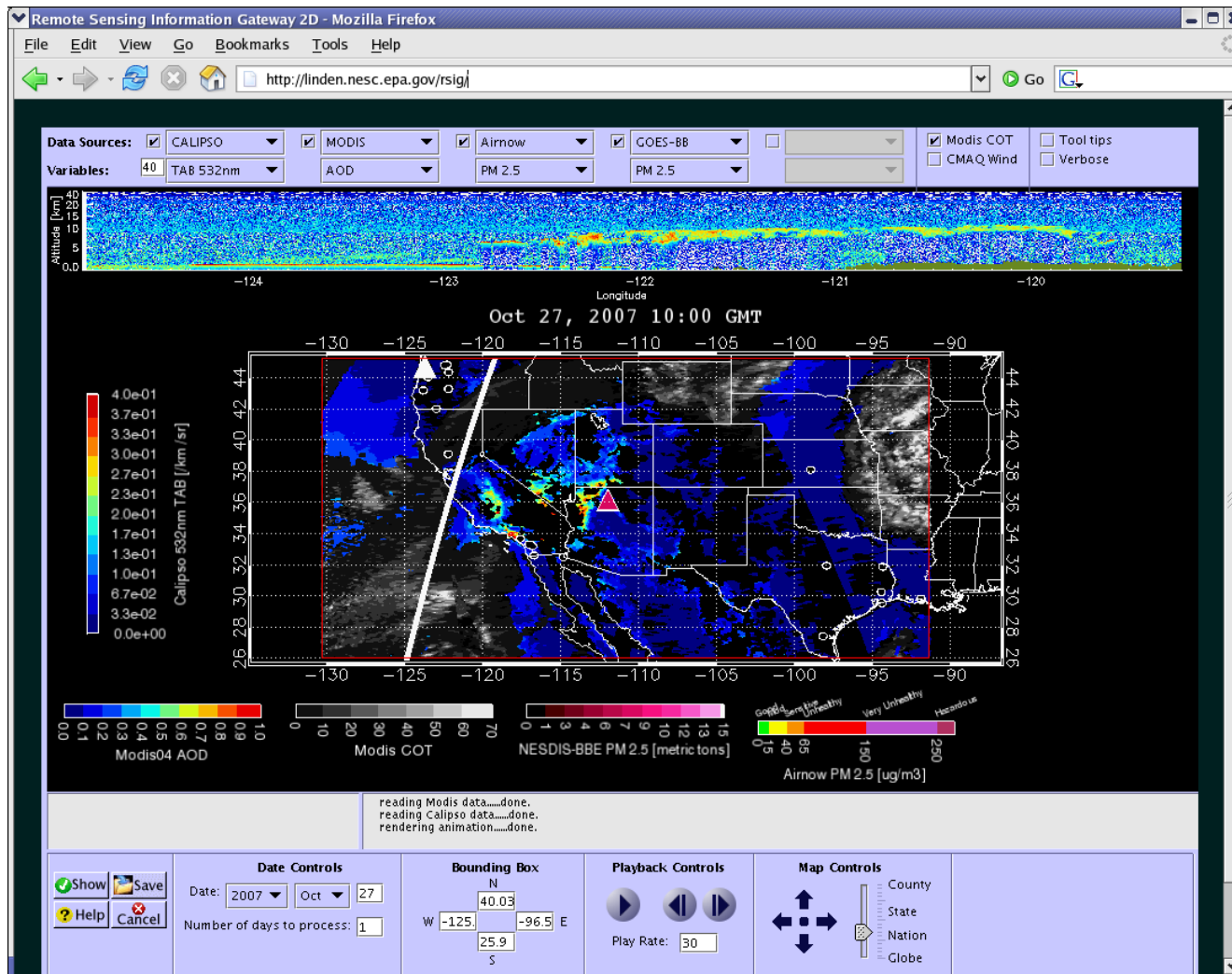
Update on the 3DAQS Project

- Goal: make NASA satellite data more accessible to the air quality community.
- AIRQuest datasets (2004-2008)*:
 - MODIS AOD matched to PM_{2.5} monitors
 - GASP AOD matched to PM_{2.5} monitors
 - MISR AOD matched to PM_{2.5} monitors
 - OMI NO₂ (GSFC “Standard Product”) matched to NO₂ data from EPA network
- RSIG datasets (2004-2008):
 - MODIS AOD gridded to 12×12 km² CMAQ grid
 - GASP AOD gridded to 12×12 km² CMAQ grid
 - Ground-based UMBC lidar

*EPA is working to find a permanent home for the
3DAQS data in AIRQuest

Remote Sensing Information Gateway (RSIG)


- RSIG allows users to visualize and download air quality data from many different sources.
- Visit the RSIG booth for more information!



IDEA

MODIS True Color, AOD Images and other Satellite Goodies

<http://www.star.nesdis.noaa.gov/smcd/spb/aq/>

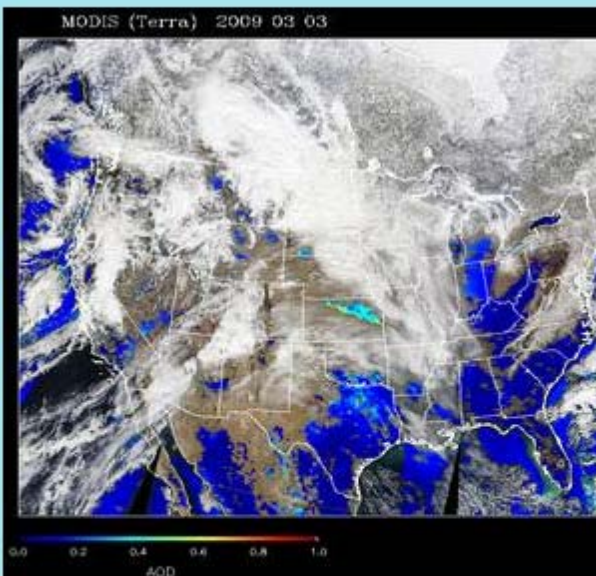


IDEA Infusing satellite Data into Environmental Applications

We value your feedback! Please send any comments or suggestions to the IDEA Team.

MODIS (Terra) MODIS (Aqua)

Regional plots of MODIS aerosol optical depth and cloud optical thickness

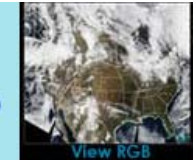


MODIS (Terra) 2009 03 03

0.0 0.2 0.4 0.6 0.8 1.0
AOD

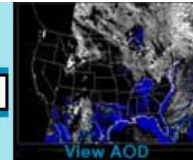
Select Region

Download US RGB Image (Terra)
Download US RGB Image (Aqua)



View RGB

Download US AOD Image (Terra)
Download US AOD Image (Aqua)



View AOD

PREVIOUS FORECAST DAY NEXT FORECAST DAY

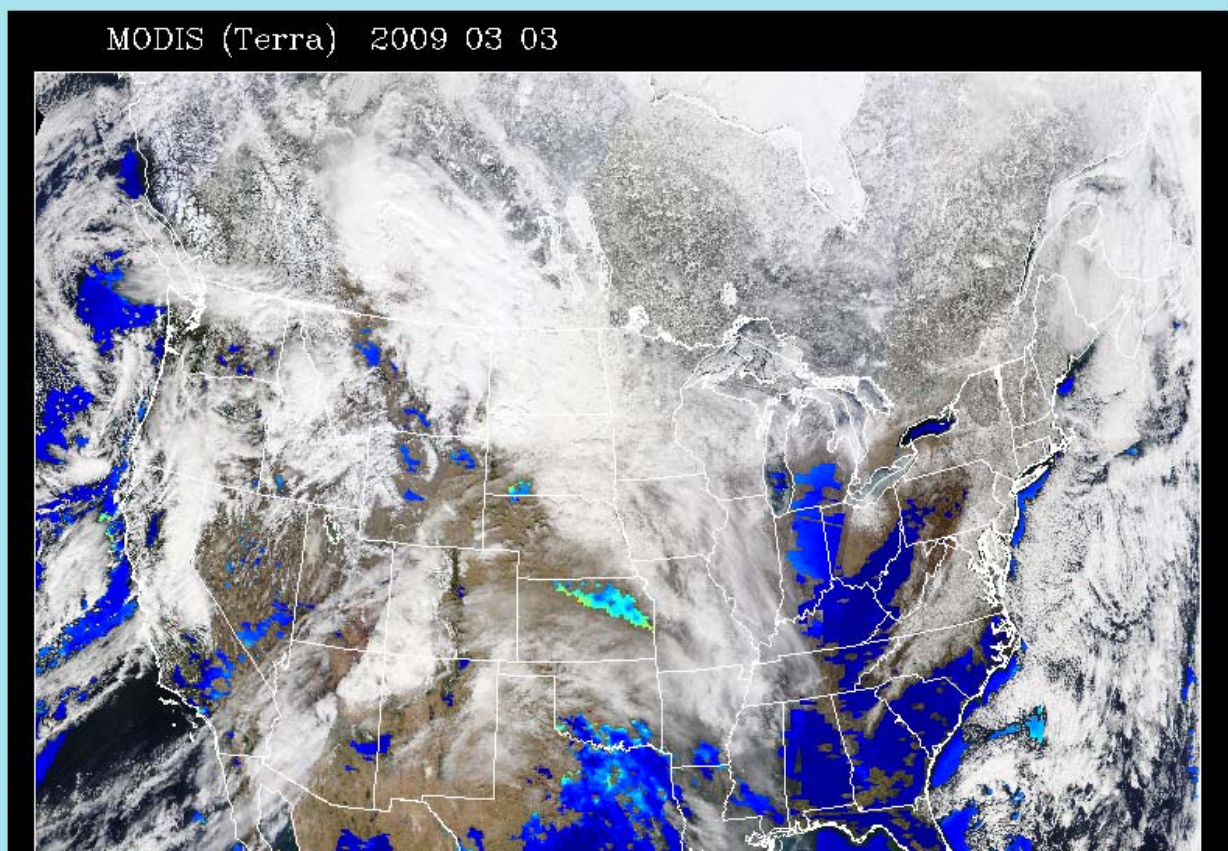
2009 March 03 1115 Go

Valid date ranges (20080101 to 20090303)

Product description

Choose plot type: MODIS (Terra) MODIS (Aqua) GASP animated GASP fixed frame

MODIS (Terra) 2009 03 03



U.S. Air Quality Weblog (“Smog Blog”)

Daily Summaries of Air Quality in the U.S. using Remote Sensing Products

<http://alg.umbc.edu/usaq/>

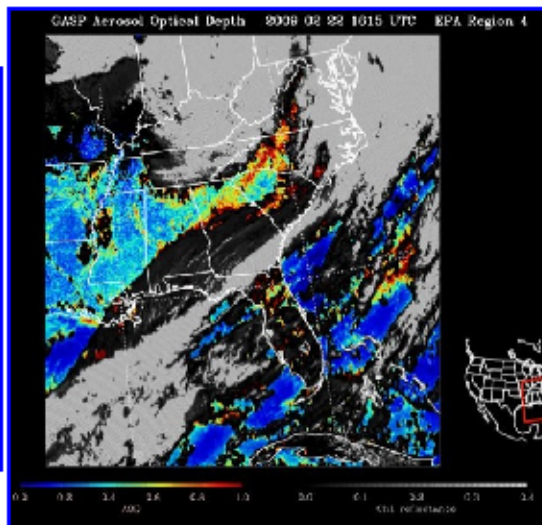
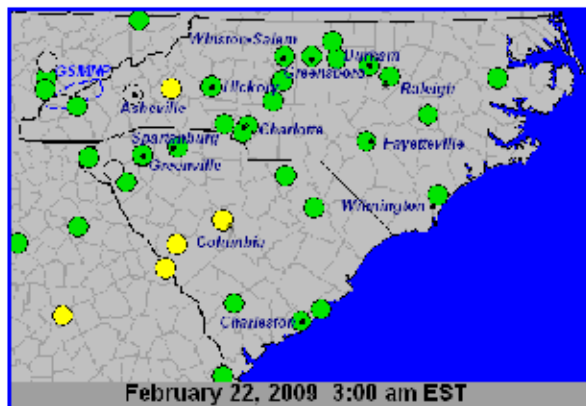
U.S. Air Quality

The Smog Blog

February 22, 2009

MODERATE AQ IN THE CAROLINAS; GOOD ELSEWHERE

It is a very good air quality day for the country with only elevated concentrations in **California's San Joaquin Valley** under heavy cloud cover and a few hours of moderate concentrations in the Carolinas (left) and GASP was able to catch that line of haze following frontal passage (right). The red line of nearly 1 AOD could not be confirmed on MODIS as the AOD product did not run on IDEA today (we're checking this out).



Main Data Sources

[UW MODIS Today USA Composite](#)

[NASA MODIS Rapidfire Browse / Subsets](#)

[EPA AirNow / ParticlesNow / \(KML\) / AirNowTech](#)

[NOAA IDEA \(operational product\)](#)

[NOAA NESDIS GASP / GASP-West / GASPER \(pw only\)](#)
[NOAA Air Quality Forecast Guidance](#)

[KNMI OMI Tropospheric NO2](#)

[NOAA Hazard Mapping System Fire and Smoke Product / Smoke Text](#)

[USDA MODIS Active Fire Maps](#)

[NOAA NWS KML/GIS Links](#)

What is Google Earth?

- It is a “virtual globe” program that allows you to “fly anywhere on Earth to view satellite imagery, maps, terrain, and 3D buildings, from galaxies in outer space to the canyons of the ocean.”
- It requires files in **kml** (keyhole markup language) or **kmz** (zipped kml) format.
- It is becoming extremely popular – more and more datasets are becoming available for use in Google Earth!



Why is Google Earth Useful for Air Quality?

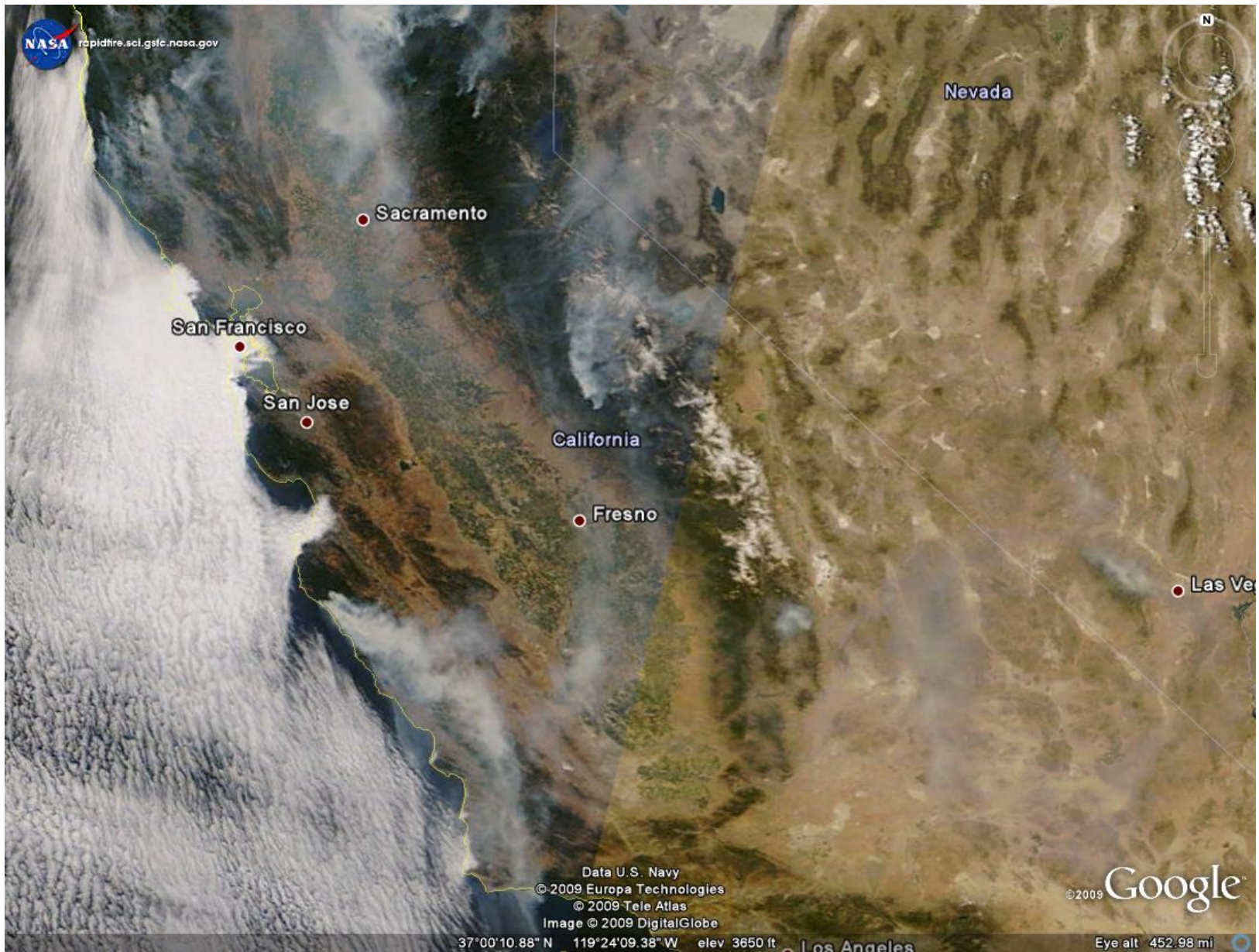
- Google Earth is **free** and **easy to use!**
- You can **overlay data sets** for more accurate interpretation.
- It gives **geographic reference** for data and images: see satellite images, AQIs, back/forward trajectories in reference to cities and state borders.
- Google Earth allows you to **zoom in/out of your area of interest**: you are no longer at the mercy of regional satellite subsets.
- It displays **3D datasets** (*i.e.*, CALIPSO).



MODIS Terra True Color Image

AERONET_Fresno Subset, June 23, 2008

[MODIS Rapid Response <http://rapidfire.sci.gsfc.nasa.gov/subsets/>]



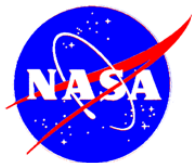
What Do You Need to Get Started?

- Download Google Earth: <http://earth.google.com/>
- Minimum System Requirements (PCs):
 - Operating System: Windows 2000, XP, or Vista
 - System Memory (RAM): 256 MB
 - Hard Disk: 400 MB free space
 - Network Speed: 128 Kbits/sec
 - Graphics Card: 3D-capable with 16 MB of VRAM
- Check with your IT department to make sure it is ok for you to download and use the free version of Google Earth at work.



Air Quality-Related NRT kml/kmz Files

- MODIS true color images
- Current and Forecasted AQI Color Codes
- Current Fire Information
- OMI Tropospheric NO₂
- Backward and Forward Airmass Trajectories
- CALIPSO
- Meteorological Information (GOES, METARS)



NOAA

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

MODIS Today: USA Composite

Near Real-Time Terra and Aqua MODIS True Color Images for CONUS

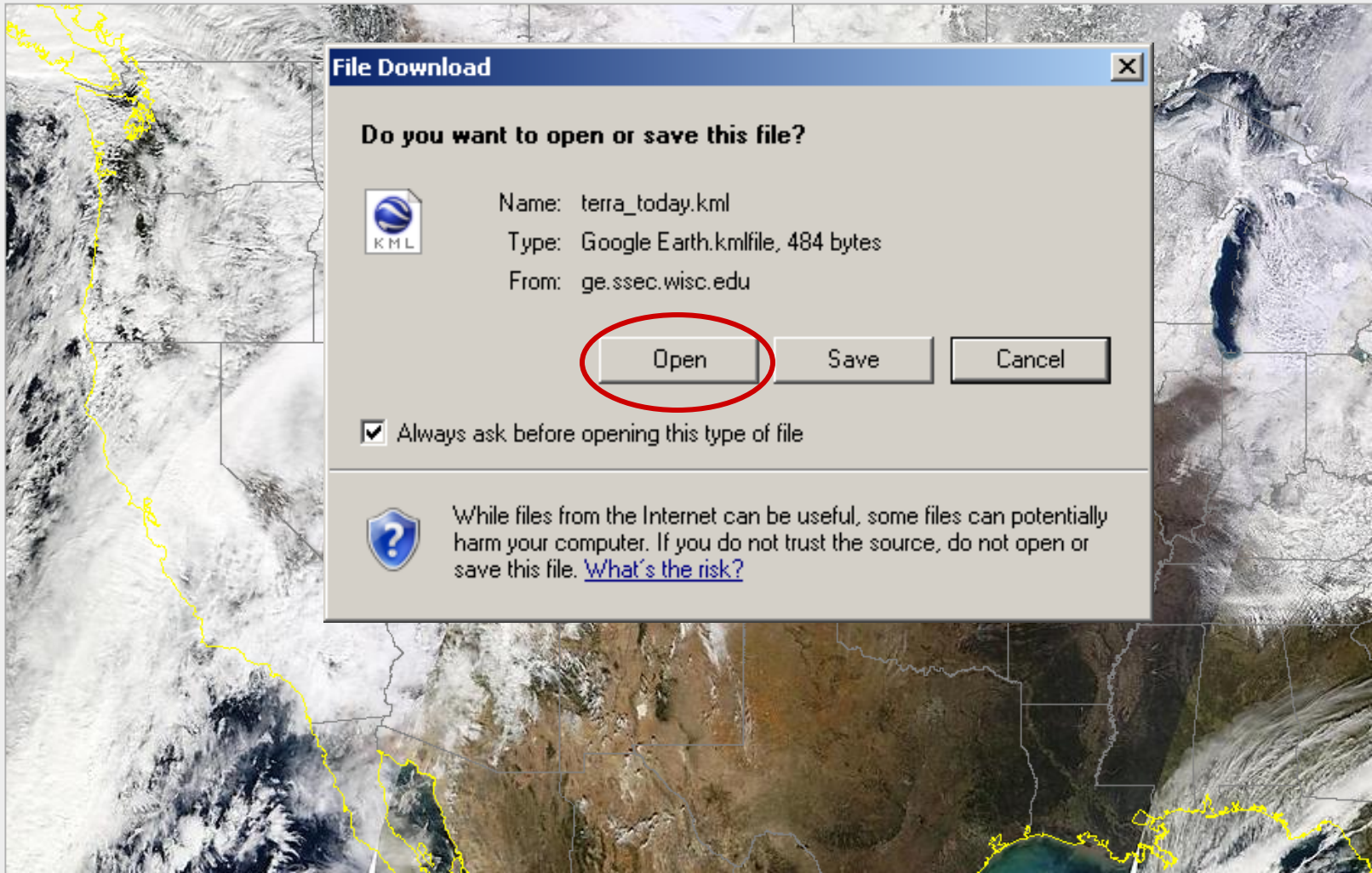
<http://ge.ssec.wisc.edu/modis-today/>

 **MODIS Today: USA Composite - February 22, 2009 (053)**

February 22, 2009 (053) Previous Day Next Day Show All Available Images

Terra Aqua | True Color False Color | Coastline State borders Sector borders | [Today's Terra Passes](#) [Open in Google Earth](#)

[Download this image](#) (Click on the image below to zoom in)



The image shows a screenshot of the Google Earth application window. The main window displays a 3D view of the Earth from space, with a yellow lightning bolt striking the North American continent. The interface includes a top menu bar (File, Edit, View, Tools, Add, Help), a search bar, and a 'Places' sidebar on the left. In the 'Places' sidebar, the 'Temporary Places' folder is expanded, showing two files: 't1_09057' and 'a1_09057'. A red rectangular box highlights two files: 'aqua_today[1].kml' and 'terra_today[1].kml', which are listed under a folder that is partially obscured but appears to be 'Air Quality from AIRNow'. The bottom of the window shows the Google logo, copyright information (© 2009 TerraMetrics, © 2009 Europa Technologies), and coordinates (48°44'09.20" N, 50°33'17.19" W) and altitude (Eye alt 6428.56 km).

- All new kml/kmz files open under “Temporary Places” in the “Places” sidebar.
- Save files by moving them (click and drag) to “My Places.”
- If you save “aqua_today” and “terra_today” in “My Places,” they will update automatically and be available every time you open Google Earth!

AQIs from AIRNow

Color-Coded Hourly AQI Values for USA

http://www.airnow.gov/index.cfm?action=google_earth.main

[Local Forecasts
& Conditions](#)

National Overview

[Forecast](#)
[Particles Now](#)
[Ozone Now](#)
[Action Days](#)
[Archives](#)
[International](#)

[AQI Summary](#)

[About AIRNow](#)

Partners

[For Partners](#)
[List of Partners](#)

Air Quality Basics

[Air Quality Index](#)
[Ozone](#)
[Particle Pollution](#)
[UV](#)

The AQI for...

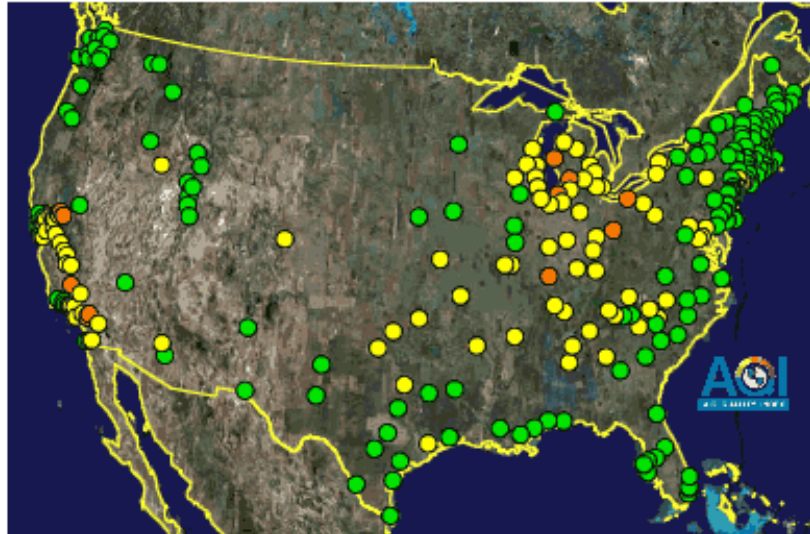
[Health Providers](#)
[Kids](#)
[Students](#)
[Older Adults](#)
[Teachers](#)
[Weathercasters](#)

Key Topics:

[Your Health](#)
[Smoke from Fires](#)

Air Quality Index (AQI) in Google Earth

Air Quality Index (AQI) forecasts and current conditions are now available in Keyhole Markup Language (KML) format. This allows for AIRNow data to be displayed in 3D viewers such as Google Earth. Follow the instructions below to install and run the AIRNow KML files in Google Earth.



Example of AIRNow forecasts in Google Earth

Instructions for Google Earth:

1. If you already have the Google Earth software installed, simply click [here](#) to download the AIRNow KML files.
2. Depending on how your software is configured, clicking the link will either download the files to your computer or automatically launch Google Earth with the AIRNow data in the program.
3. If you do not have Google Earth installed, you can download it free from Google on the following website: <http://earth.google.com/>. Once installed, follow steps 1 and 2 above.

Search

Fly To Find Businesses Directions

Fly to e.g., 1600 Pennsylvania Ave, 2000

▶ ■ ×

Places Add Content

- My Places
 - Air Quality from AIRNow
 - Current Conditions
 - Today's Forecast
 - Tomorrow's Forecast
 - aqua_today[1].kml
 - terra_today[1].kml
 - OMI clouds and nitrogendiox
The data displayed in this Google Earth file was
 - CONUS MODIS Fire Detection
This KML displays the following:
 - Spot Burn Sites
Wildfires in red.
 - METAR Observations
Individual files are large and may slow computer
 - CONUS Satellite Visible L...
 - WDSS-II Real-time Weath...
 - NORTHEAST_RADARONLY
 - Synoptic Weather Map F...
 - Global Tropical Storms
 - Temporary Places



- If you save these files in "My Places," they will update automatically and be available every time you open Google Earth!

AQI AIR QUALITY INDEX

AIR QUALITY INFORMATION
Dallas-Fort Worth, TX

Current Conditions

Ozone **Good 37**

PM_{2.5} **Good 31**

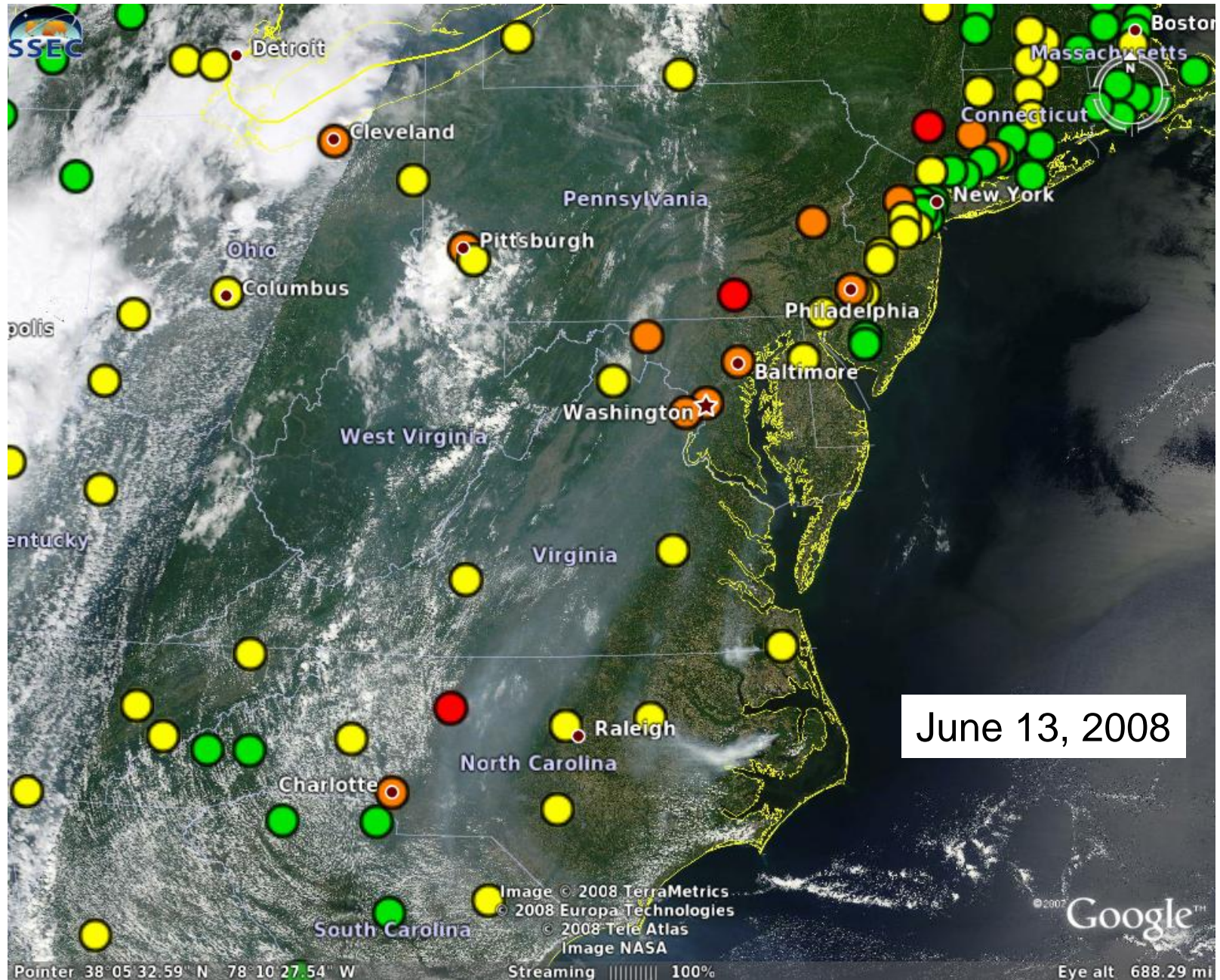
[National Air Quality](#)

Updated: Mon 02/23/2009 12:00 CST

© 2009 DMapas
© 2009 Europa Technologies

43°55'39.66" N 141°05'30.23" W Eye alt 6428.56 km

MODIS Terra True Color and AQIs: Regional View

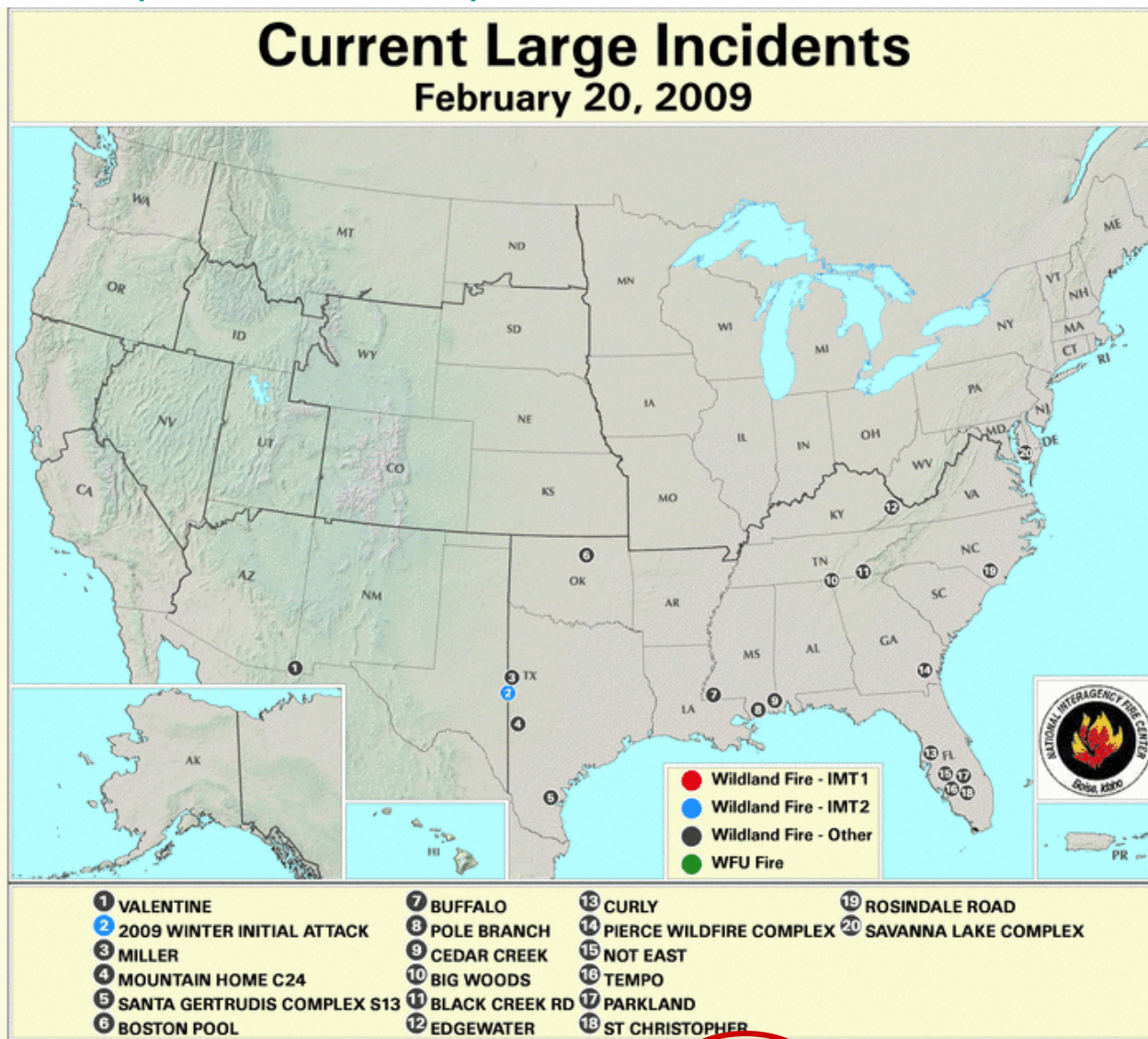


MODIS Active Fire Mapping Program

Fire Information from MODIS Compiled by USDA

<http://activefiremaps.fs.fed.us/>

- ▶ [Contact Us](#)
- ▶ [Programs and Services](#)
- ▶ [BAER](#)
- ▼ [Active Fire Maps](#)
 - [Current Large Fires](#)
 - [United States](#)
 - [Canada](#)
 - [Regional Maps](#)
 - [United States](#)
 - [Canada](#)
 - [ArcIMS Maps](#)
 - [CONUS](#)
 - [Alaska](#)
 - [Hawaii](#)
 - [Canada](#)
 - [MODIS Images](#)
 - [United States](#)
 - [Canada](#)
 - [Fire GIS Data](#)
 - [Google Earth and WMS Maps](#)
 - [Current Detections](#)
 - [United States](#)
 - [Canada](#)
 - [Other MODIS Products](#)
 - [Information](#)
 - [FAQs](#)
 - [NASA](#)
 - [MODIS](#)
 - [Related Links](#)
 - [Project Cooperators](#)
 - [RSAC](#)
 - [NASA GSFC RR](#)
 - [NASA GSFC DRL](#)
 - [NIFC](#)
 - [UMD](#)
 - [SSEC](#)
 - [GINA](#)
 - [CONABIO](#)

- 


[View Printable Map](#)

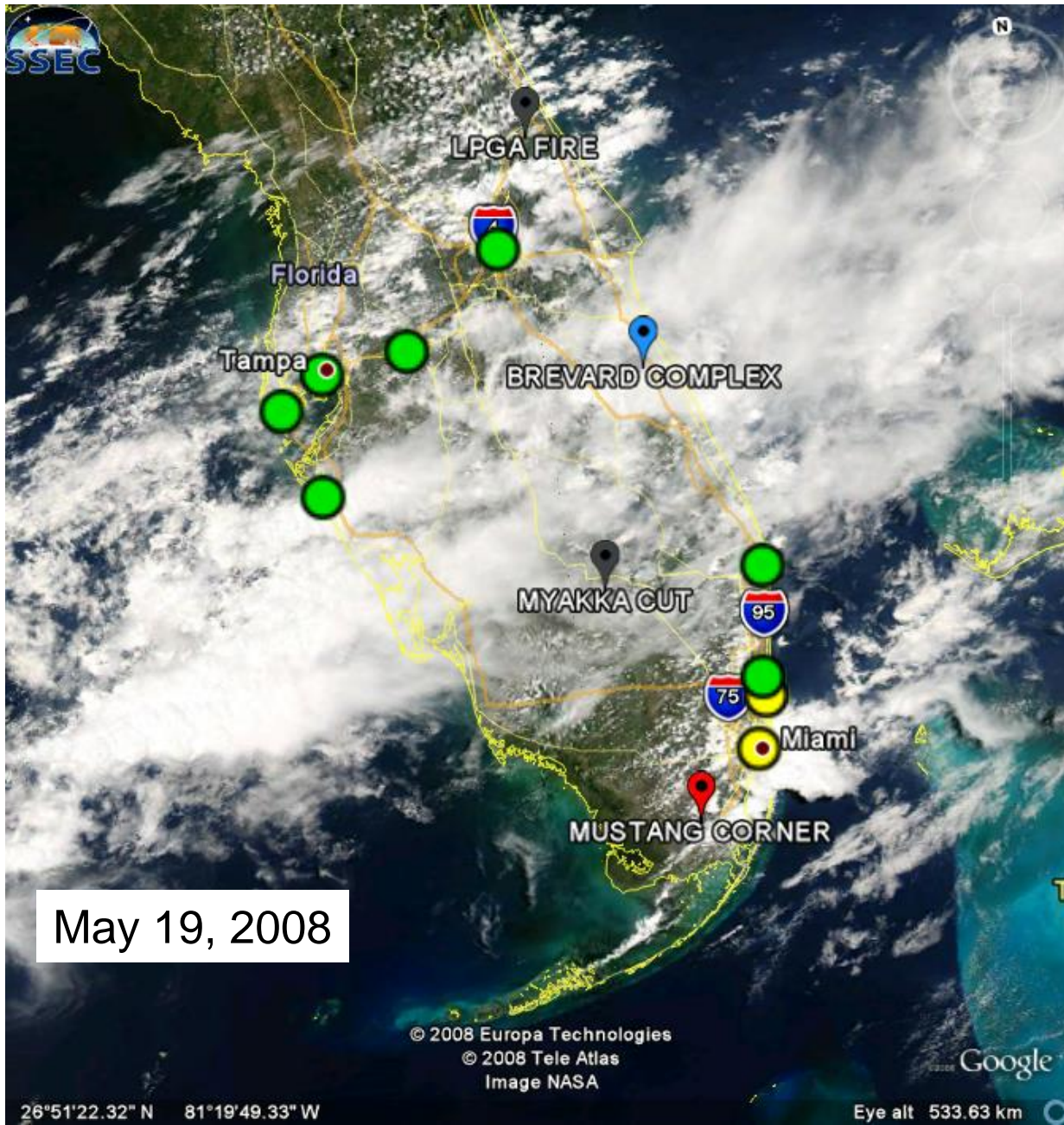
[View High Resolution Map](#)

[Definition of Map Terms](#)

[Download KMZ File](#)

Select a Fire

MODIS Terra True Color, AQIs, Major Fires



NOAA Hazard Mapping System Fire and Smoke Product

Fire Information from MODIS and GOES, Compiled by NOAA

<http://www.ssd.noaa.gov/PS/FIRE/hms.html>

HMS Keyhole Markup Language (KML) Files

The HMS
the Sate
polar (A
(MODIS
quality c

Last Update Thu Feb 26 15:17:07 UTC 2009

The m
throug

Relate

Most Recent

HMS KML

Files:

26 Feb 2009 -- [FIRE SMOKE](#)
25 Feb 2009 -- [FIRE SMOKE](#)

- S
- N

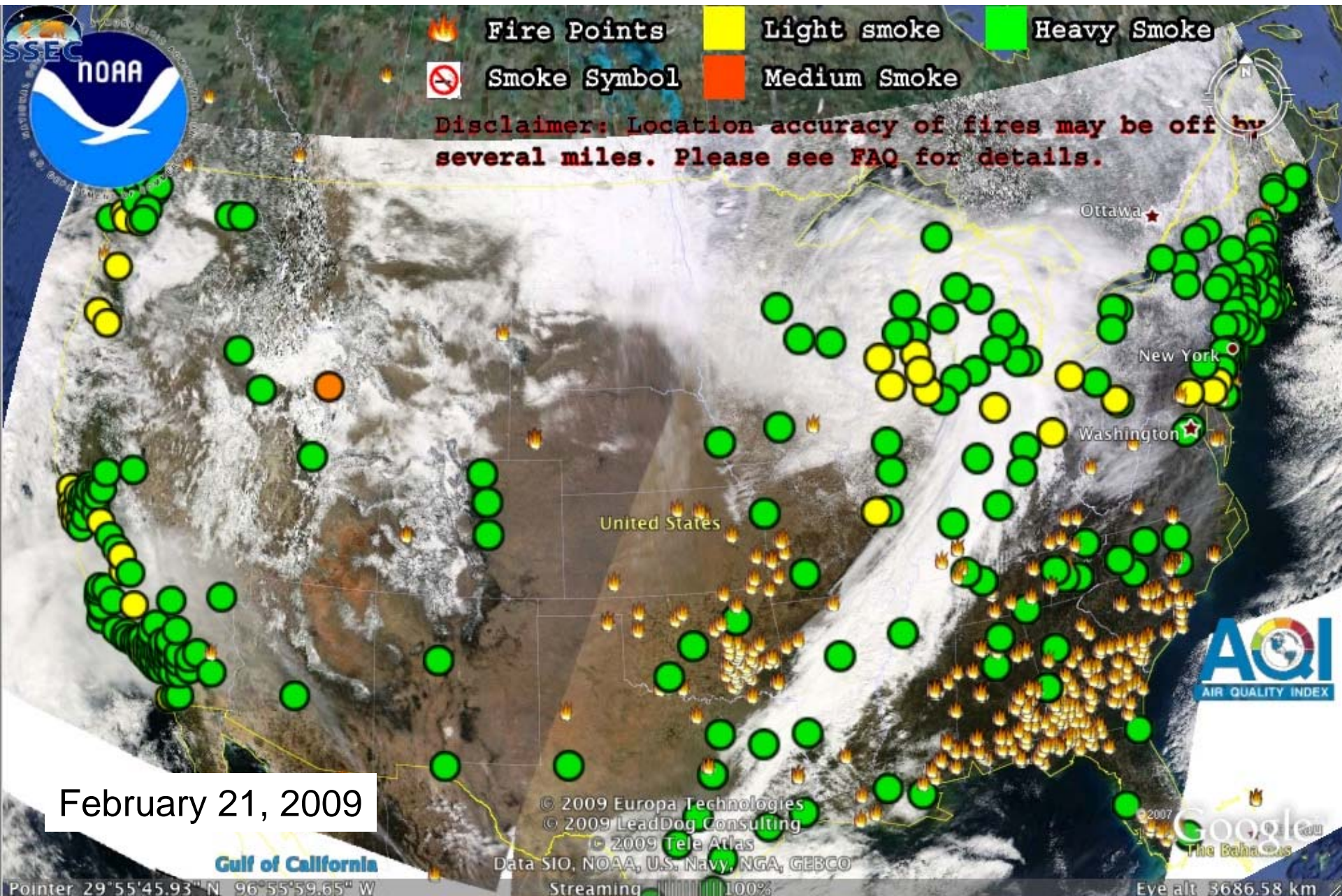
The mo

Analysis
Fires a
Smoke, v

For the m
smoke ex
Nacional
the other
analyze s
MODIS w

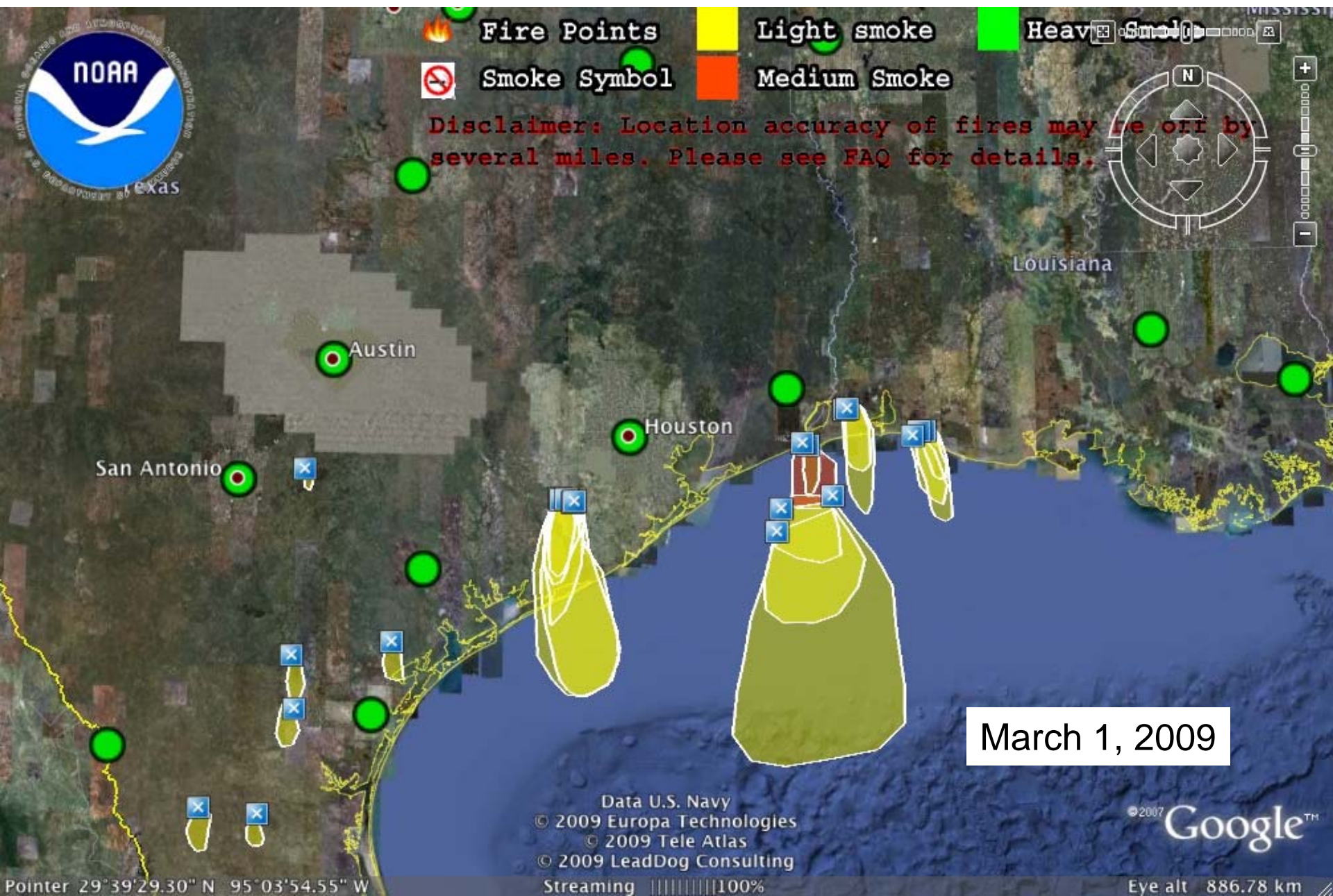
- 24 Feb 2009 -- [FIRE SMOKE](#)
- 23 Feb 2009 -- [FIRE SMOKE](#)
- 22 Feb 2009 -- [FIRE SMOKE](#)
- 21 Feb 2009 -- [FIRE SMOKE](#)
- 20 Feb 2009 -- [FIRE SMOKE](#)
- 19 Feb 2009 -- [FIRE SMOKE](#)
- 18 Feb 2009 -- [FIRE SMOKE](#)
- 17 Feb 2009 -- [FIRE SMOKE](#)
- 16 Feb 2009 -- [FIRE SMOKE](#)
- 15 Feb 2009 -- [FIRE SMOKE](#)
- 14 Feb 2009 -- [FIRE SMOKE](#)
- 13 Feb 2009 -- [FIRE SMOKE](#)
- 12 Feb 2009 -- [FIRE SMOKE](#)
- 11 Feb 2009 -- [FIRE SMOKE](#)
- 10 Feb 2009 -- [FIRE SMOKE](#)
- 09 Feb 2009 -- [FIRE SMOKE](#)
- 08 Feb 2009 -- [FIRE SMOKE](#)
- 07 Feb 2009 -- [FIRE SMOKE](#)
- 06 Feb 2009 -- [FIRE SMOKE](#)
- 05 Feb 2009 -- [FIRE SMOKE](#)

MODIS Aqua True Color, AQIs, HMS Fire Data



February 21, 2009

AQIs and HMS Smoke Plumes



OMI Tropospheric NO₂

Global Near Real-Time OMI NO₂ Tropospheric Column from KNMI

http://www.temis.nl/airpollution/no2col/no2regioomi_col3.php

Regional Tropospheric NO₂ columns from OMI



Tropospheric NO₂

[<-- previous day](#)
[<-- previous month](#)

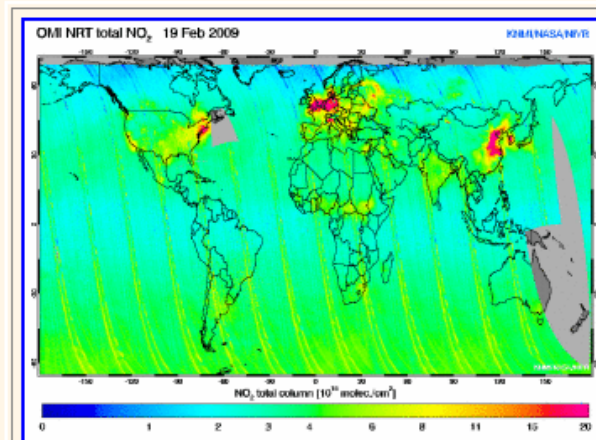
[next day -->](#)
[next month -->](#)

NO₂ observation for:

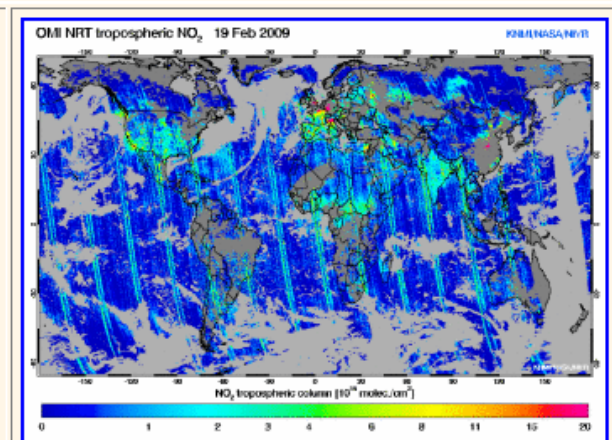
Region:
Year:
Month:
Day:

[Info on data anomalies](#)

Regional NO₂ of 19 February 2009



Total column



Tropospheric column

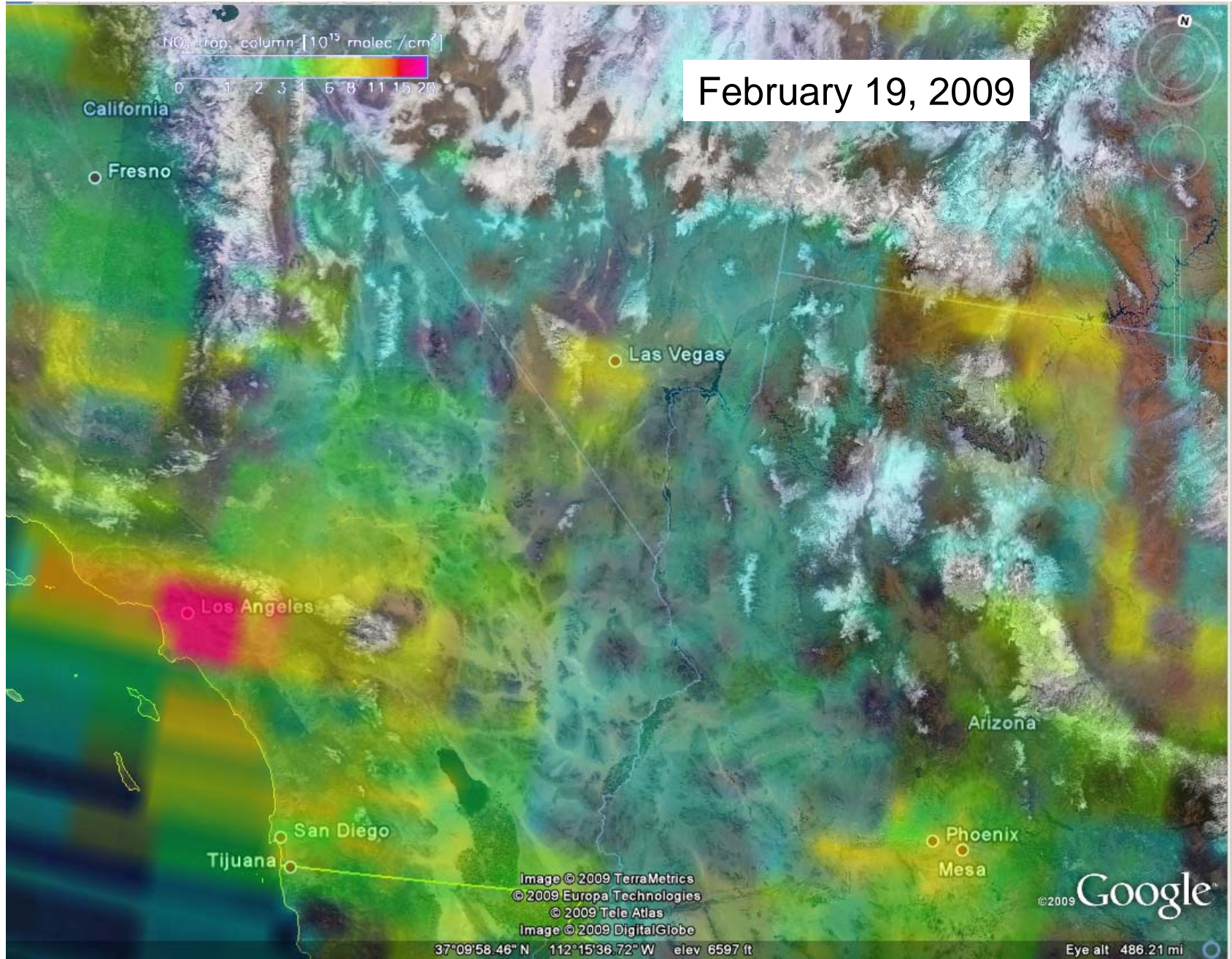
[NO₂ data file](#)

Profile data is not available

[Data file archive](#)

[Image in Google Earth](#)

MODIS Aqua True Color and OMI Tropospheric NO₂



HYSPLIT Airmass Trajectory Analysis

Forward and Backward Trajectories from the HYSPLIT Model

<http://www.ready.noaa.gov/ready/hysplit4.html>

HYSPLIT MODEL RESULTS FOR JOB NUMBER 379862

Plot proje
Vertical pl
units:
Label Inte
Plot color
Zoom fact
Create Ja
Animation
Graphic s
Distance
overlay:
GIS output
Create Po
Plot mete
field along
Dump me
data along

```
adding: logocon.gif (deflated 7%)
adding: HYSPLITtraj_379862_01.kml (deflated 92%)
Complete Trajplot
Started Trajectory Drawing (Version: February 2009)
Google Earth file creation for job 379862.
Complete Hysplit
Percent complete: 100.0
Percent complete: 95.8
```

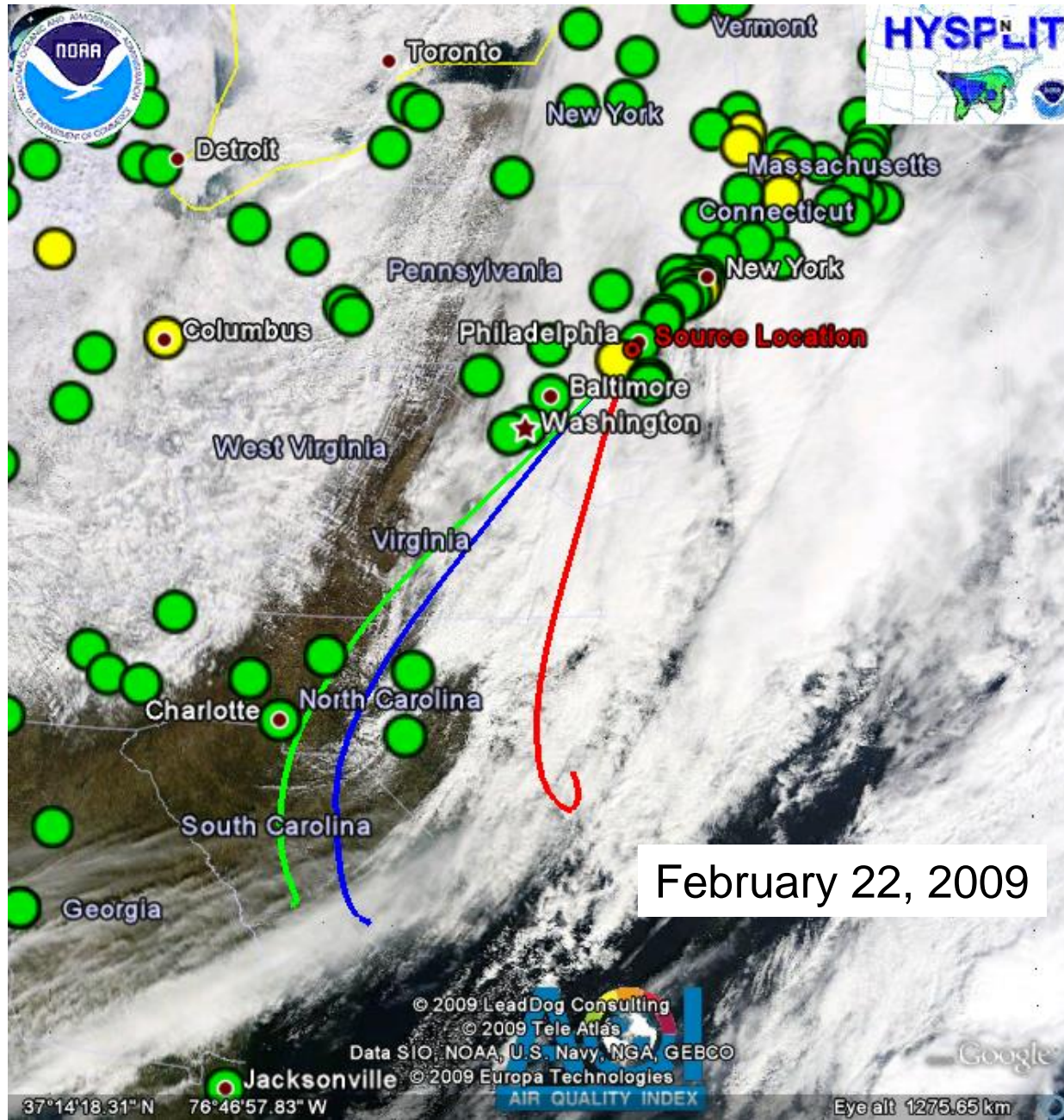
Your plot(s) are now available, but will be deleted in 6 hours:

Non-Javascript users click here for alternate links.

- Your Trajectory plot
 - How to read the trajectory maps.
- **Google Earth File (kmz)**
- Trajectory endpoints file.
 - Trajectory endpoints format help.
- Modify the trajectory plot without rerunning the model.
- **NEW** Rerun the model with user entered defaults.
- Modify trajectory number # (if available)....
1 2 3 4 5 6 7 8 9

elow

MODIS Terra True Color, AQIs, HYSPLIT



CALIPSO Expedited Browse Images

Vertical Profiles of Particulate Backscatter from the CALIPSO Satellite

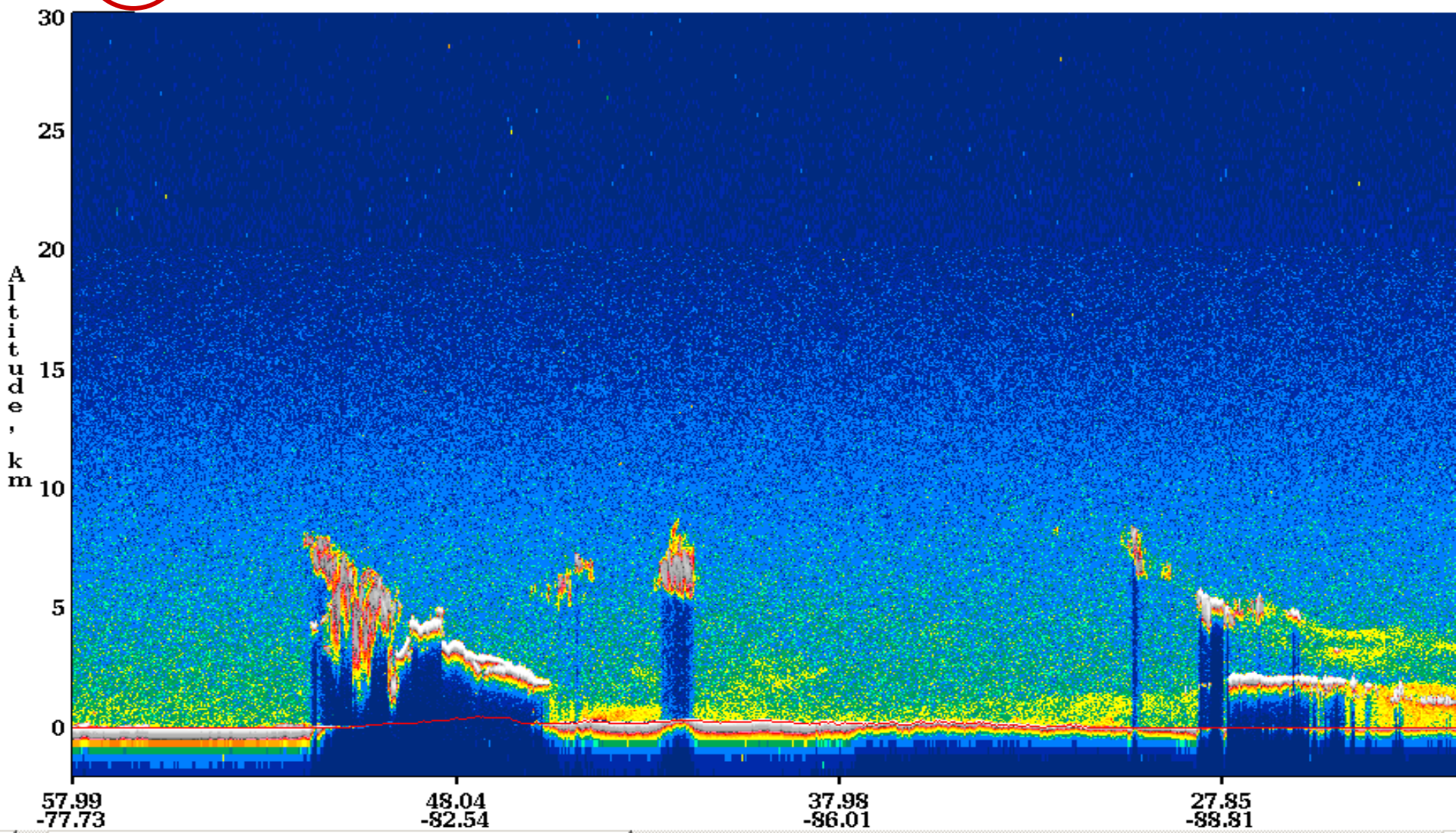
http://www-calipso.larc.nasa.gov/products/lidar/browse_images/show_calendar.php

532 nm Total Attenuated Backscatter, /km /sr

Version: 2.02



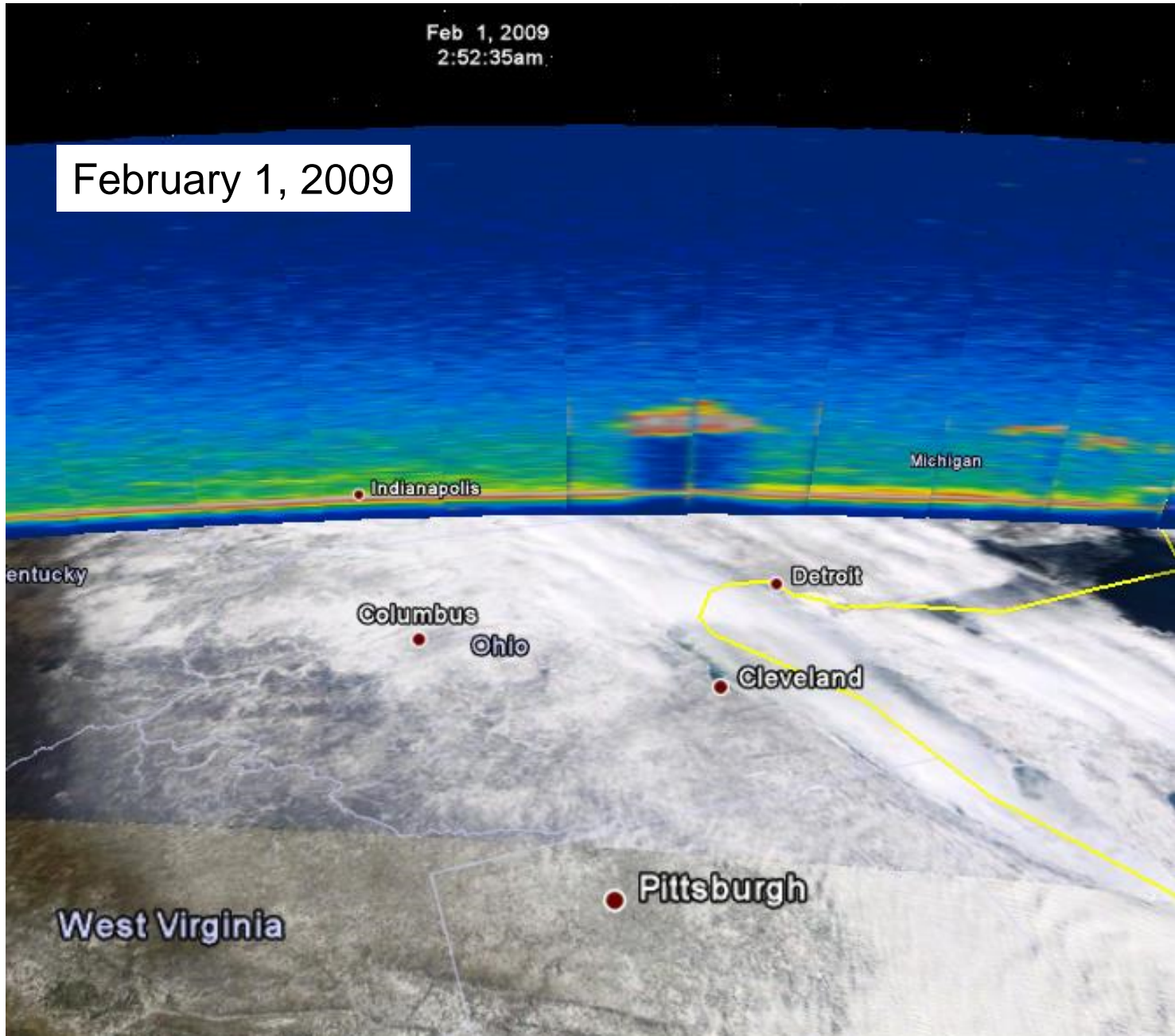
Click to download KMZ file



MODIS Terra True Color and CALIPSO

Feb 1, 2009
2:52:35am

February 1, 2009



National Weather Service Data

Current, Past, Fire, and Forecasted Weather Files from NWS

<http://www.srh.noaa.gov/gis/kml/>

Current Weather	Forecasts	Past Weather
Watches & Warnings Current Weather Warnings Flash Flooding - Basins and Streams	Your Local Weather Forecast Your Local Weather Graphical Forecast	Doppler Radar NWS Radar archive data
Doppler Radar Real Time Radar Radar Locations	MOS Guidance GFS Meteograms	Normals, Means, Extremes NCDC Climate Atlas of the United States NCDC GIS Portal
Surface Observations Metar Obs RAWS Obs APRSWXNET Obs MesoWest Obs Other Surface Obs	GOES Sounding Skew-T Tulsa area: Max Min POP River Gage Forecasts	Severe Weather Storm Reports: Tornado, Wind and Hail 1950-2006 Database of Tornado, Large Hail, and Damaging Wind Reports
Satellite Infrared Loop Visible Loop Water Vapor Loop		Rain/Snowfall CoCoRaHS Observations NOHRSC Snow Data
Remote Gages River Gages: Observed Snow Gages: w/ labels w/o labels		Hurricanes Past Atlantic Storm Tracks Past East Pacific Storm Tracks
Great Lakes Wave Height Ice Water Temperature	Fire Weather Current Spot Forecast Sites Fire Weather Categorized Observations MODIS fires IMET Locations	Additional Info Coastal Estuarine Bathymetry nowCOAST web mapping portal
Surface Fronts Past and Present Synoptic Features		



Not working



MODIS Terra True Color, AQIs, Fires, METAR Winds

0 10 20 30 40 50 60 70 80 90 100+

SSEC

January 24, 2009

Nashville

Tennessee

Atlanta

© 2009 Europa Technologies
© 2009 LeadDog Consulting
Image © 2009 TerraMetrics
© 2009 Tele Atlas

Google

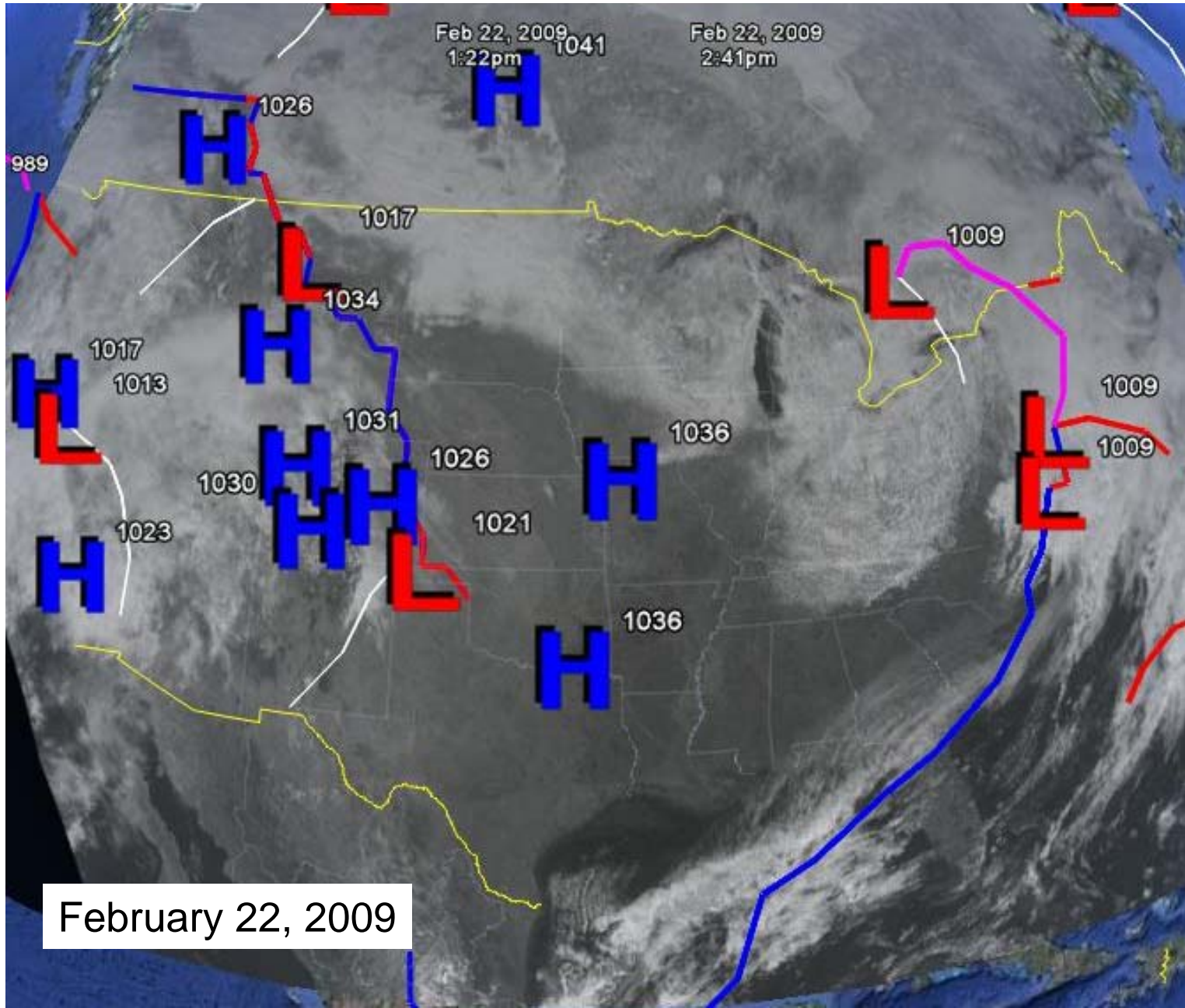


Pointers 34° 47' 46.35" N 82° 51' 24.35" W

Streaming 100%

Eye alt 539.10 km

Visible Satellite Imagery and Synoptic Analysis



Near Real-Time AOD Files for Google Earth

- Currently, there are no near real-time AOD files available for Google Earth.
- 3D-AQS and NASA are working on it, and we hope to have a link from IDEA soon for AOD kmz files.
- AOD kmz files are available from Giovanni for *retrospective* analysis.



Take Home Messages

- Google Earth is **free and easy to use**, which is good for air quality forecasters and analysts!
- It's "**one-stop shopping**" for visualization of many useful air quality-related datasets – just open Google Earth, and the most current images are automatically available.
- There are **A LOT of data sets available in Google Earth format** – more and more everyday – keep an eye open for them!
- Google Earth is the "**future**" of visualization – it's not going away anytime soon.

NYTimes: "Google Earth Fills Its Watery Gaps," February 3, 2009
<http://www.nytimes.com/2009/02/03/science/earth/03oceans.html?ref=science>

Acknowledgements

- Ray Hoff, Ana Prados, and the 3D-AQS team
- Shobha Kondragunta, Hai Zhang, and NOAA NESDIS
- Jim Szykman and the RSIG team
- NASA Applied Sciences



NOAA

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE