PUBLIC HEALTH APPLICATIONS IN REMOTE SENSING

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The University of Arizona

China Meteorological Administration Seminar

Beijing
9 July 2008

Beijing: 10:30AM 20 March 2002
(China News Agency photo)

Acknowledgements

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http://www.atmo.arizona.edu/faculty/research/dust/dust.html
http://phairs.unm.edu

Phoenix Arizona Dust Storm
7 June 2006

http://www.atmo.arizona.edu/faculty/research/dust/dust.html

Dust Storm Forecasting

- Why Do It?
- How Do We Try?
- What Limits Our Progress?
- What Is Possible?

Drought ⇒ Dust ⇒ Health

- Inhaled PM leads to heart failure, …"Ambient particulate matter accelerates coagulation…" Mutlu et al., 2007
- "Inhalation of fine, airborne particulate matter (PM) has serious chronic human health effects and is a major cause of premature death worldwide." Moreno et al., 2006
- "Coachella, California, residents' cardiovascular mortality and heart rate variability are elevated due to high airborne PM," Ostro et al., 2000

Valley Fever

- CAUSE: SOIL-DWELLING FUNGI
- FUNGUS RESPONDS TO WEATHER & CLIMATE
- INHALING SPORES MAY LEAD TO INFECTION
  - FLU=LIKE SYMPTOMS (fever, cough, etc.)
  - MAY MOVE FROM LUNGS TO OTHER PARTS OF BODY
- REGIONAL MORTALITY / MORBIDITY
  - 2004 SEVERE CASES: AZ = 3,665 USA = 6,056
  - DEATHS: 6-10% of reported cases (in AZ)

Adapted from A. Comrie

UA Valley Fever Center of Excellence

Valley Fever Endemic Zone

From A. Comrie, 2000

Hector and Laniado-Laborin, 2002

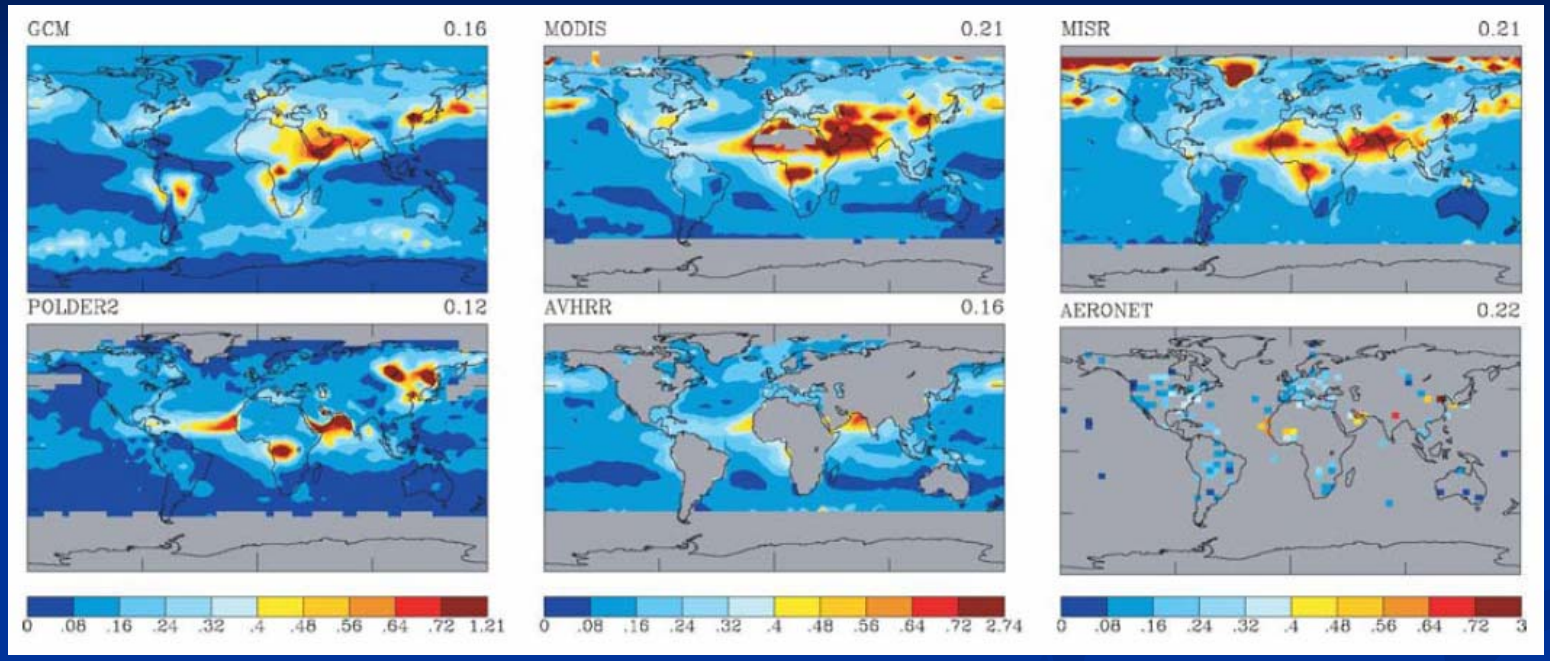
Transcontinental Transport

- Desert soils contain bacteria, fungi, viruses, plant pollen, heavy metals & unknown quantities of imported toxins [1]
- Tampa, Florida: airborne PM 0.3 - 1.0 concentrations during African dust event: 10X background [1]
- **Fungal Diseases of Crops** (e.g. sugarcane, bananas) appear in Caribbean within days of African outbreak, and Foot and Mouth Disease (endemic to the Sahel) may also [2]
- **Bacterial Pathogens of Rice & Beans, and Bacterial Bearers of Disease of Fruit & Trees** transported from Africa to the Caribbean [1,2]
- Paediatric Asthma emergency admissions on Trinidad linked to African dust [3]

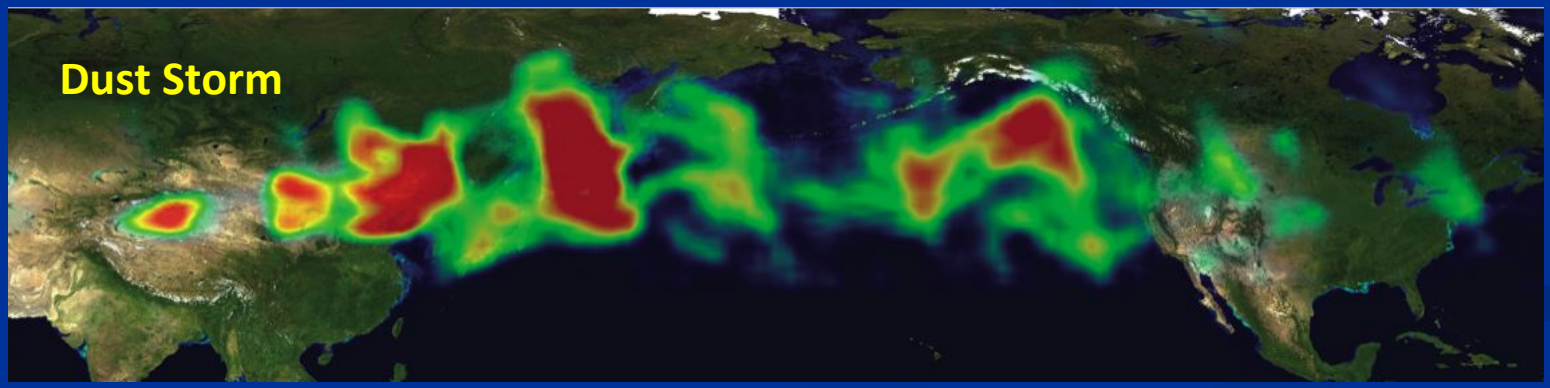
[1] Griffin, D.W. (2007); [2] Kellogg & Griffin (2005); [3] Gyan, K., et.al. (2005)

Asian Dust Transport - April 2001

Aerosol Optical Depth



Liu et al., 2005



- MODIS (Terra and Aqua)
- TOMS
- OMI
- AIRS
- METEOSAT

Composit by NASA

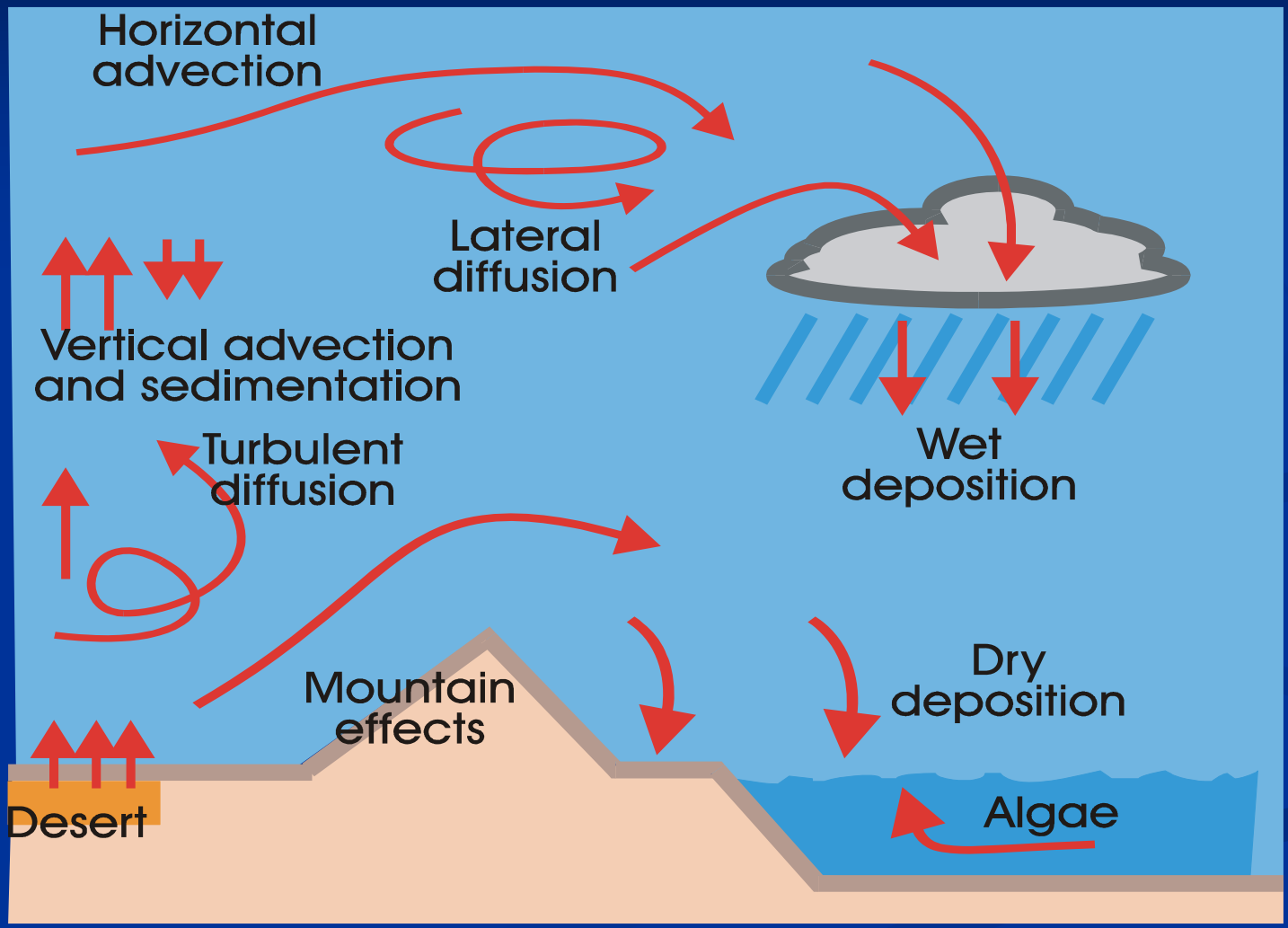
Public Health Applications in Remote Sensing -- PHAiRS

- **Objective:** operations-capable (dust) forecast system for human health decision support

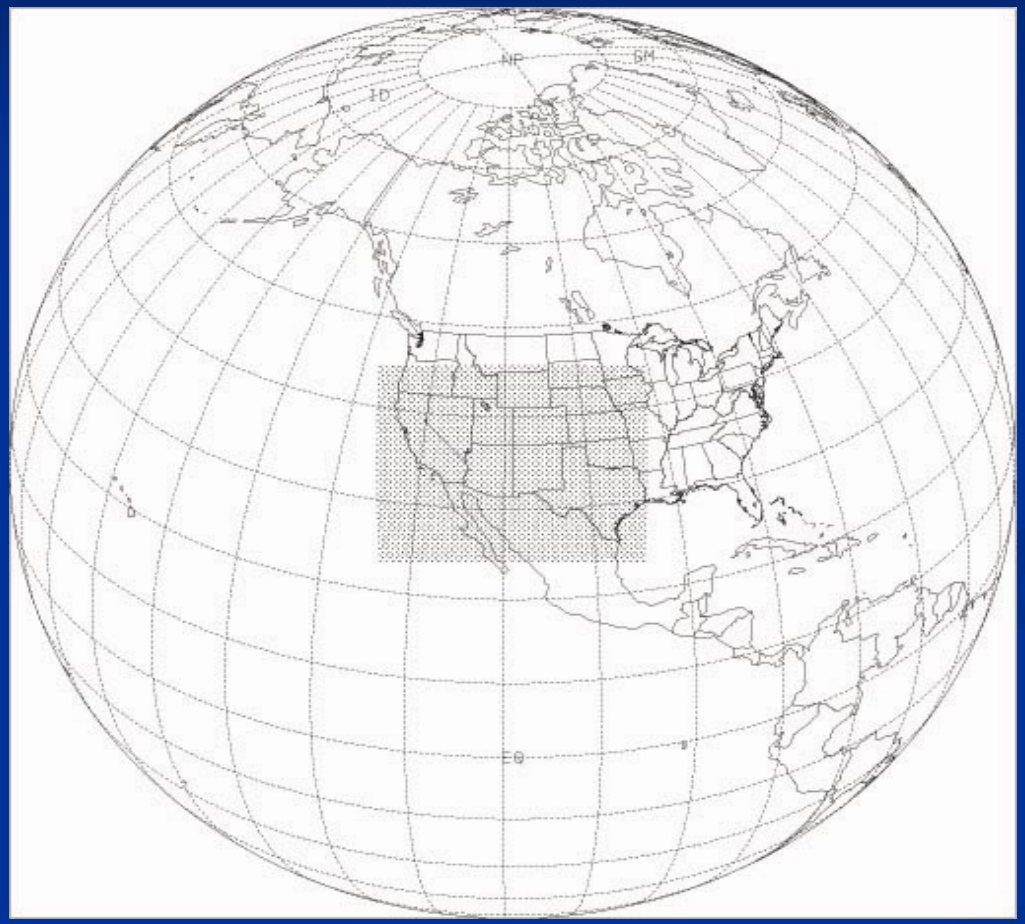
- **Principles:**
  - Numerical models: objective, adaptable & multiple use
  - NWS models: global reach, reputation & continuity
  - Model interoperability & supercomputing for globalocity
  - NASA Satellites: identifying/monitoring sources
  - High resolution, "at your ZIP code" for greater use
  - Client Selects Product
  - Public Health & AQ Advisors, for practical design

Dust Regional Atmospheric Model (DREAM)

Slobodan Nickovic



Model Setup



- Domain center at (109°W, 35°N)
- Horizontal grid: initial spacing 1/3 degree

MODEL SYSTEM

DREAM (in-line) driven by NCEP/Eta or NCEP/NMM

VARIABLE INPUT DATA

NCEP global weather (initial & boundary conditions)

(SEMI) PERMANENT INPUT DATA

soil and land cover

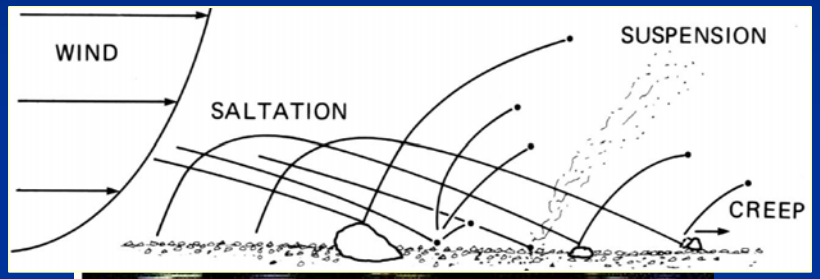
- Zobler soil texture – 1 deg – global
- FAO - 4 km – global
- NASA - MODIS

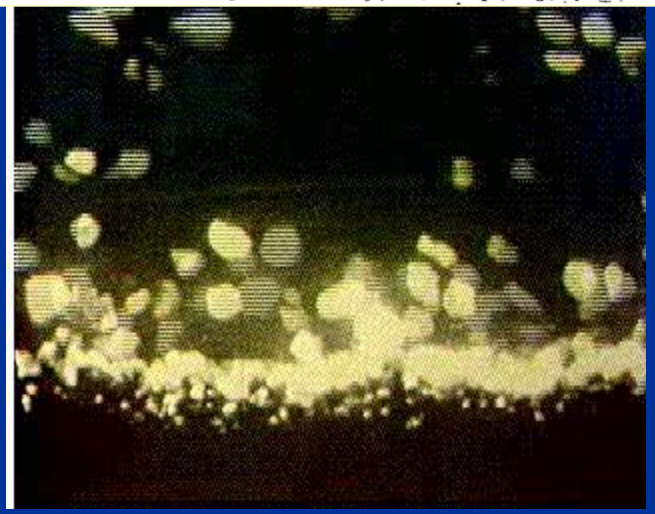
DUST PRODUCTION FACTORS:

soil structure	vegetation cover
soil moisture	atmospheric turbulence

Wind Erosion Modeling

Adapted from Betterton ppt





Saltating particles in wind tunnel

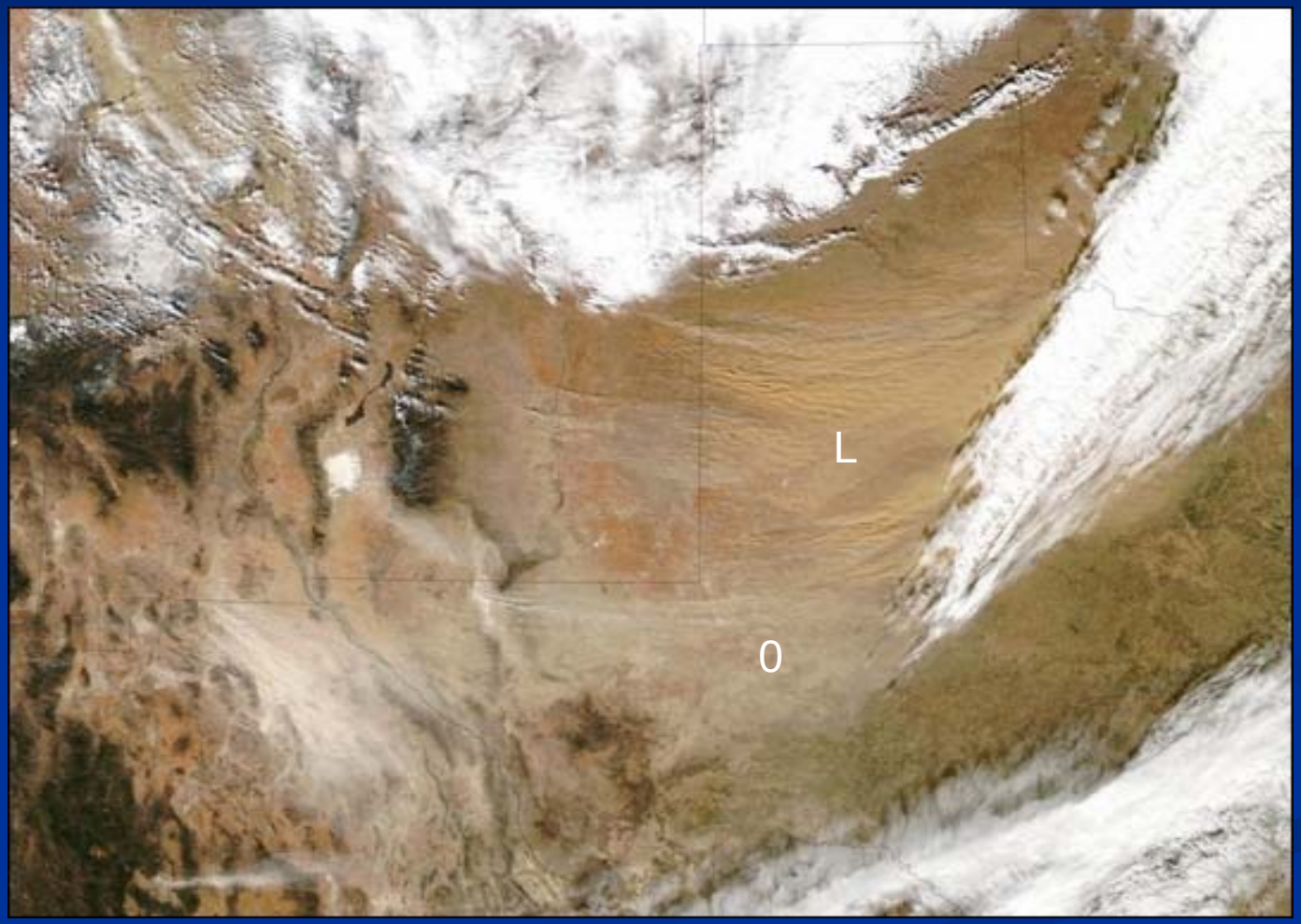
Mass flux:

- Creep (rolling): 800-2000 μm D
- Saltation (hopping): 100-800 μm D
- Suspension (wind blown dust): <100 μm D

Research of
Laboratory of Blown Sand Physics
Cold & Arid Regions Environmental & Engineering Research Institute, CAS
Lanzhou
… protects 1,000 Km of railroad in western China

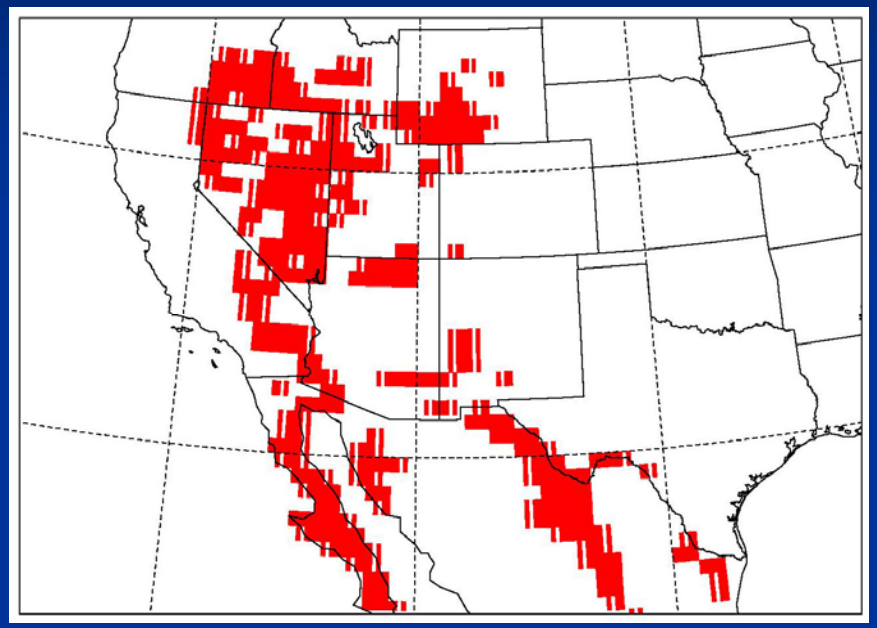
Typical SW Problem

December 15-17, 2003: A FRONTAL SYSTEM SWEPT ACROSS NEW MEXICO, TEXAS AND NORTHERN MEXICO: A DUST PROBLEM for Odessa (O) and Lubbock (L) Texas

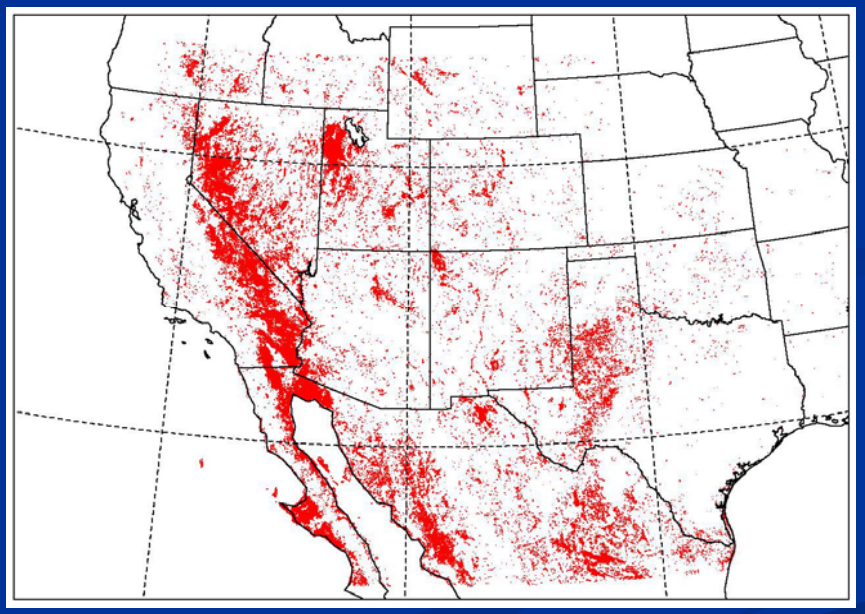


GOES 12 Vis/IR Composite, 12/15/03 @ 1426 CST

A Possible Solution?

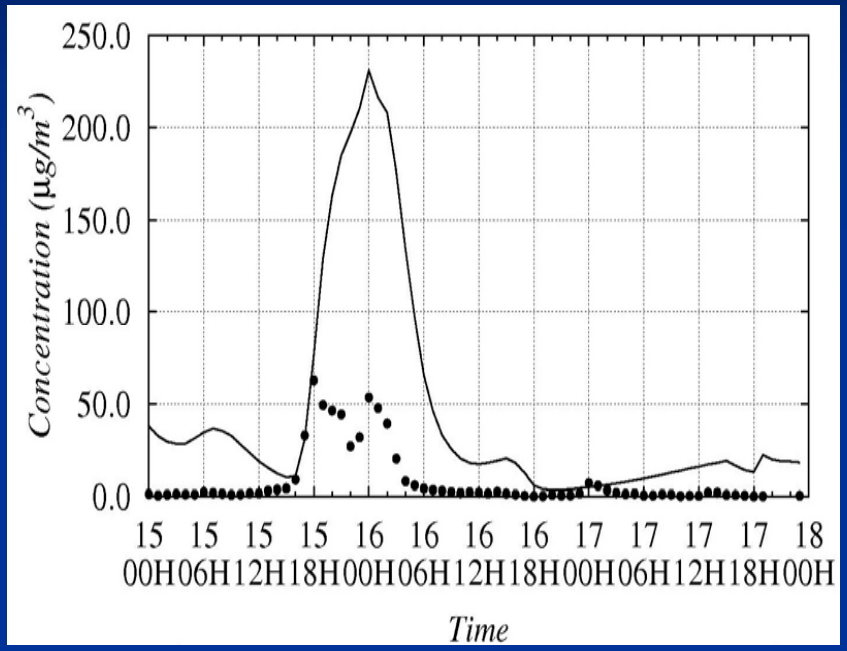


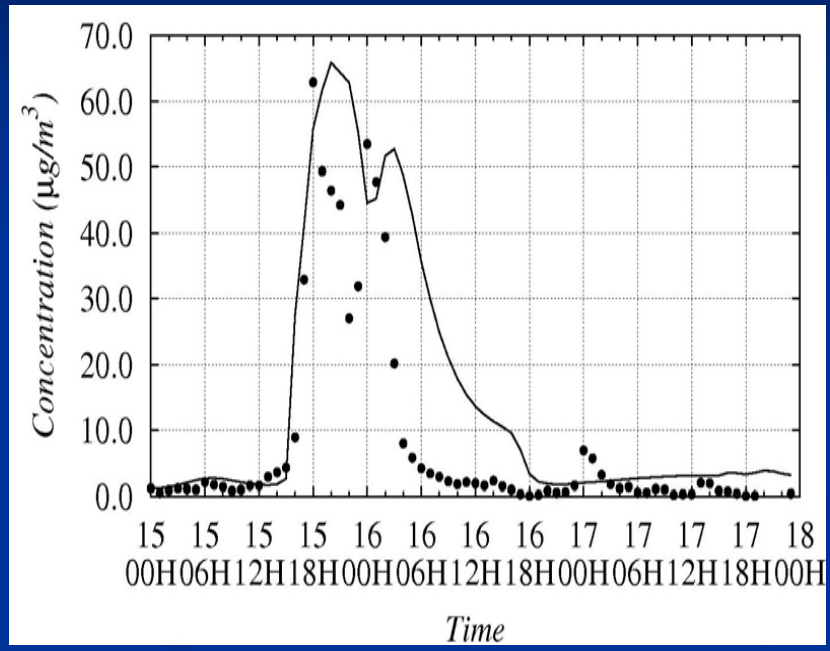
Bare ground class from Olson World Ecosystem Land Cover



And from NASA MODIS MOD12 product

Modeled and Measured PM2.5 Concentrations at Odessa, Texas, Dec. 15, 2003



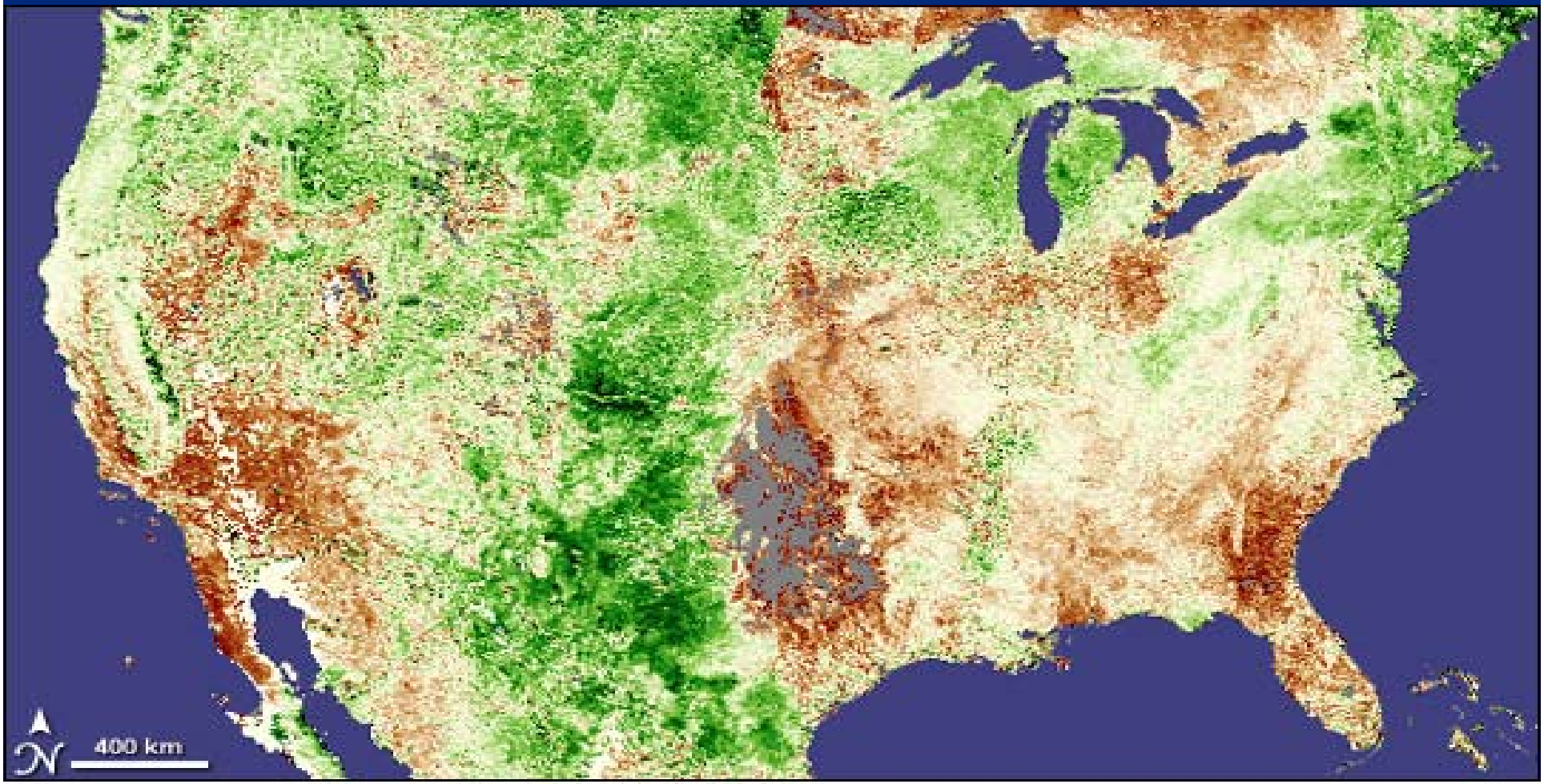


(L) with Olsen land surface data; (R) with NASA MODIS land data: measured (dots) modeled (solid lines) N.B. different scales

But, sources change

Vegetation: May 2007 vs. average May 2000 - 2006 Courtesy:

Global Inventory Modeling & Mapping Studies Group NASA GSFC

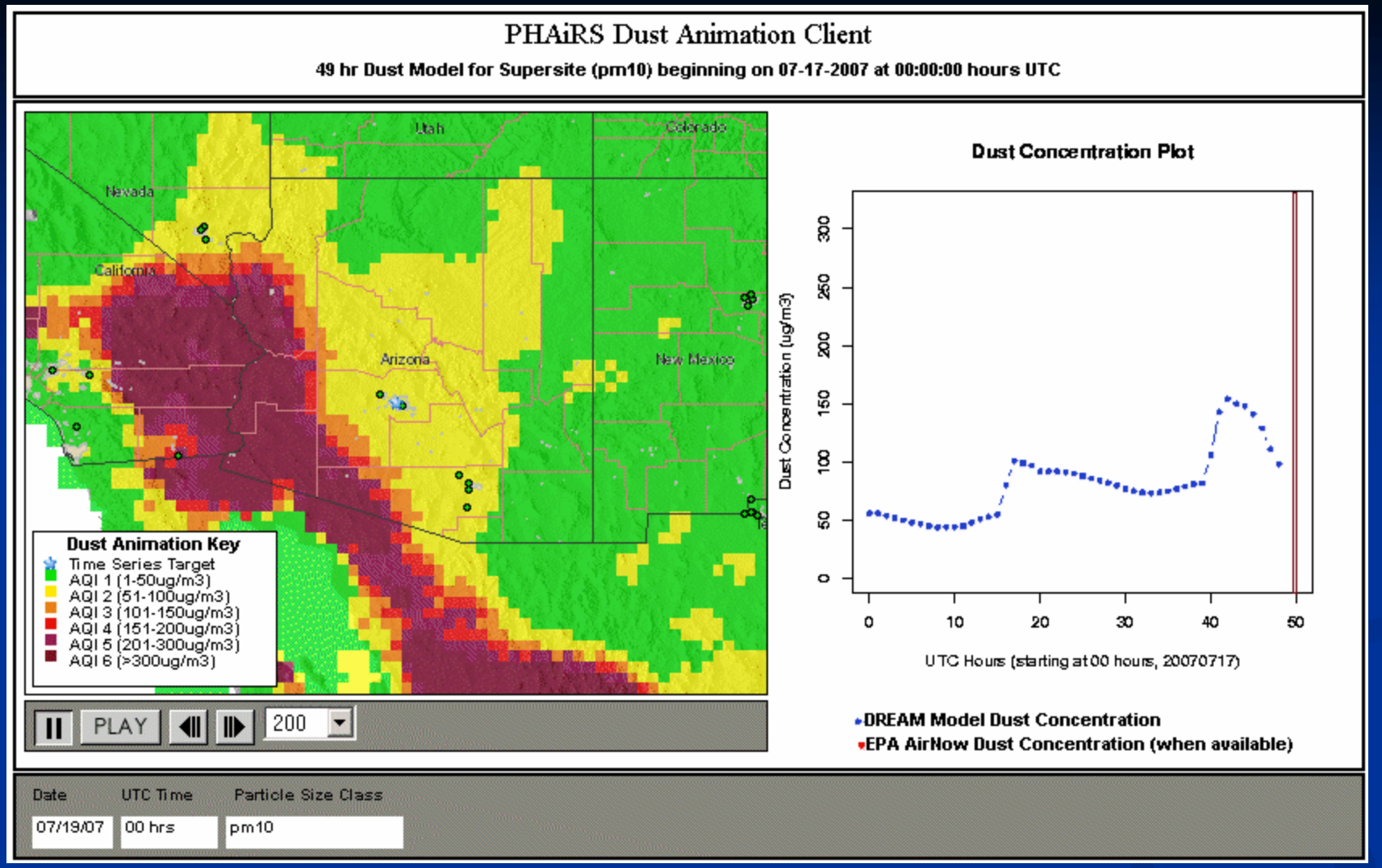


Experimental Mineral Dust Source Monitoring
US Geological Survey

- MODIS; Southern California & Arizona USA
- 1 January – 27 December 2005; Week Time Steps

Phoenix, Arizona -- July 17, 2007

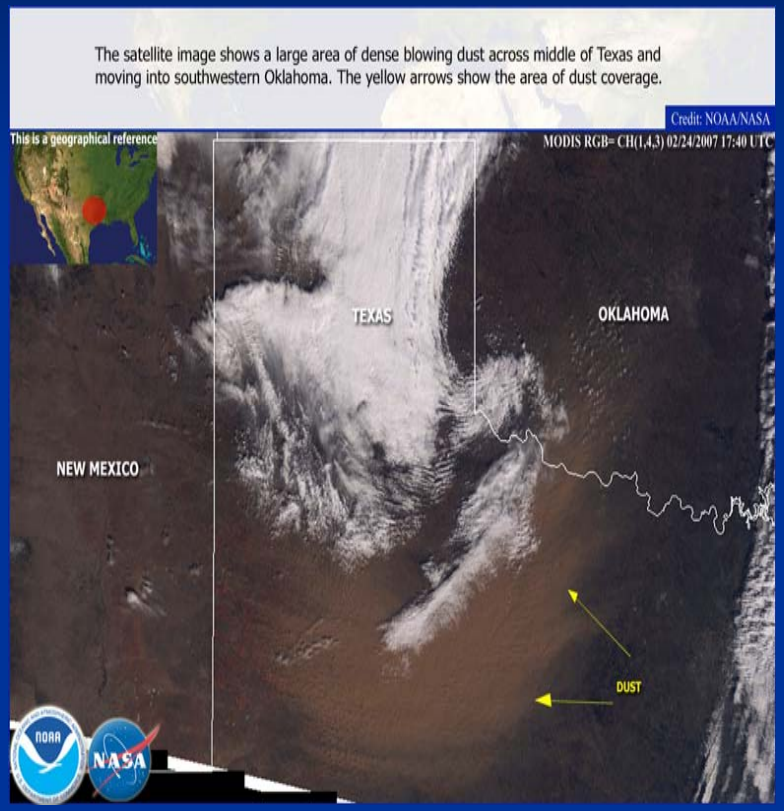
http://www.atmo.arizona.edu/research/dust/dustmovie.html

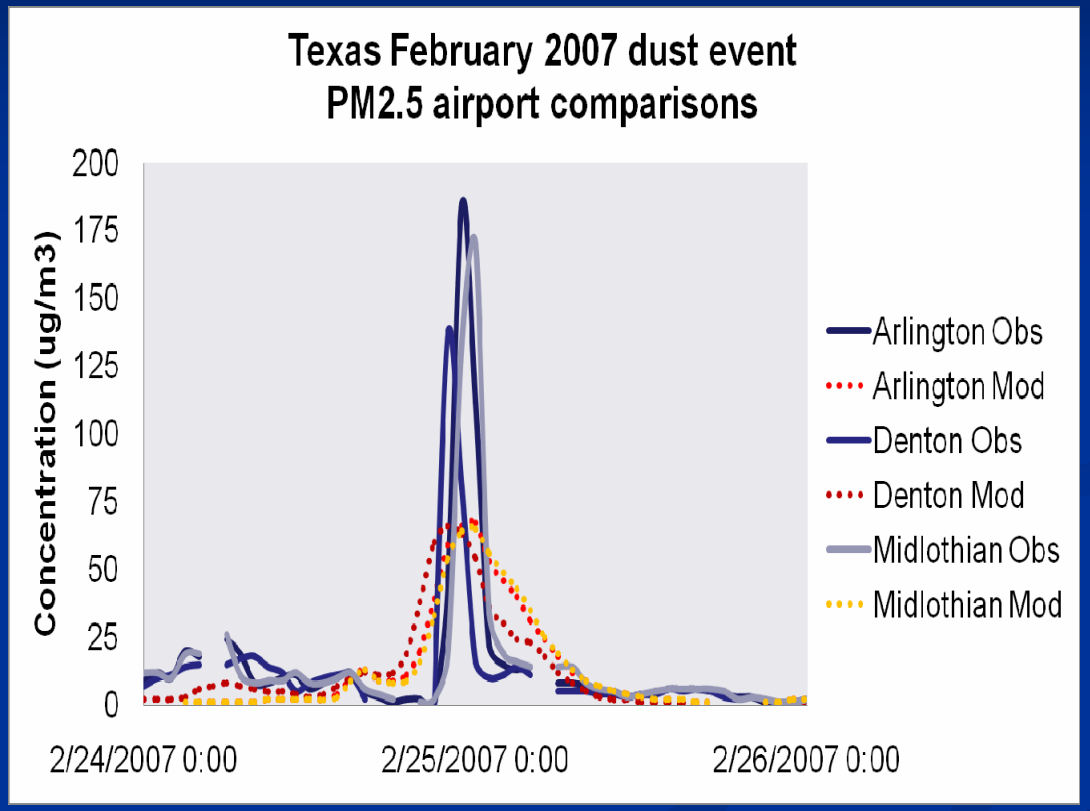


PM 10 DREAM (1:8,000,000 scale) Display (W. Hudspeth)
48-Hour Animation begins July 17, 2007, 00 hours UTC
Supersite (EPA AIRNOW Station), Phoenix, Arizona (33:30:00N, 112:05:59W)
EPA AIRNOW data unavailable

http://phairs.unm.edu

Airport Safety
$PM_{2.5}$ Forecast vs Observation

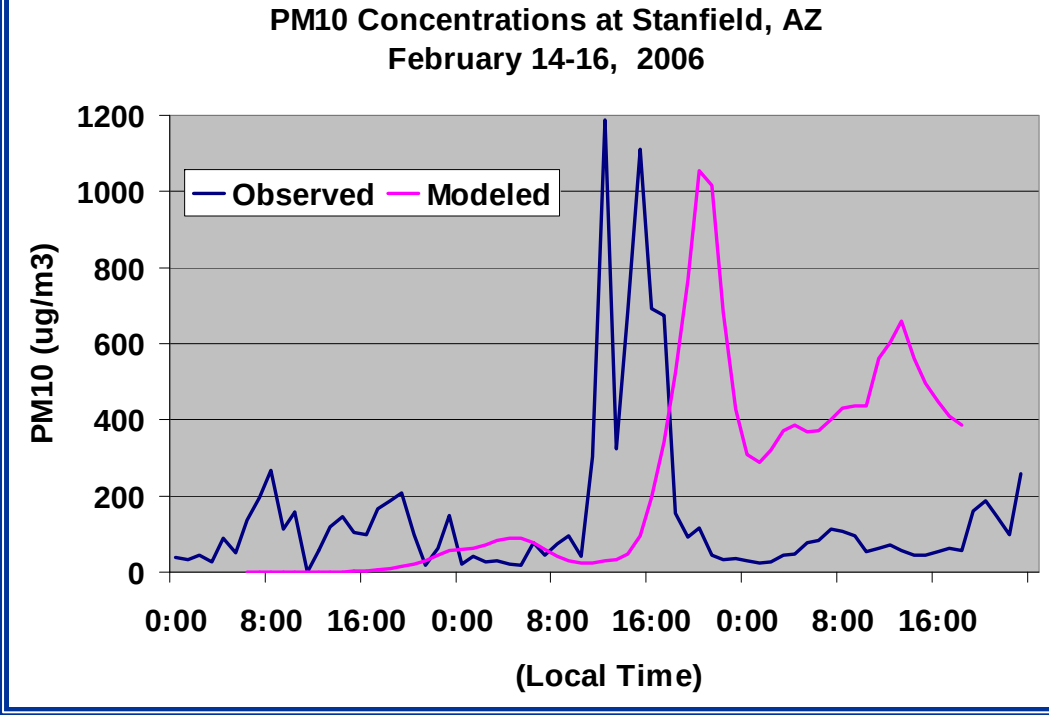




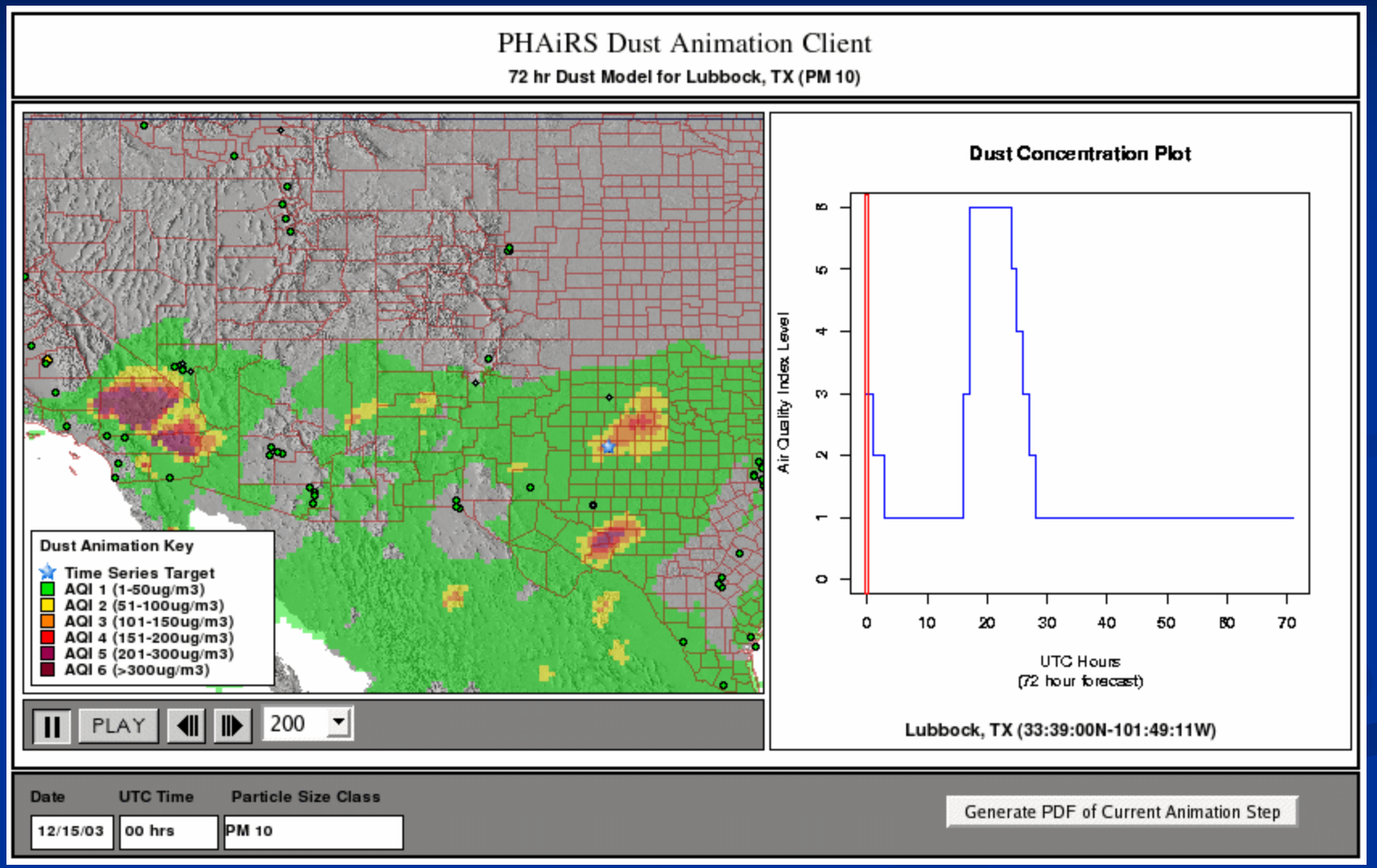
Highway Safety

A dust storm on Highway 8 south of Phoenix left two people dead and 13 others injured on 15 February 2006.

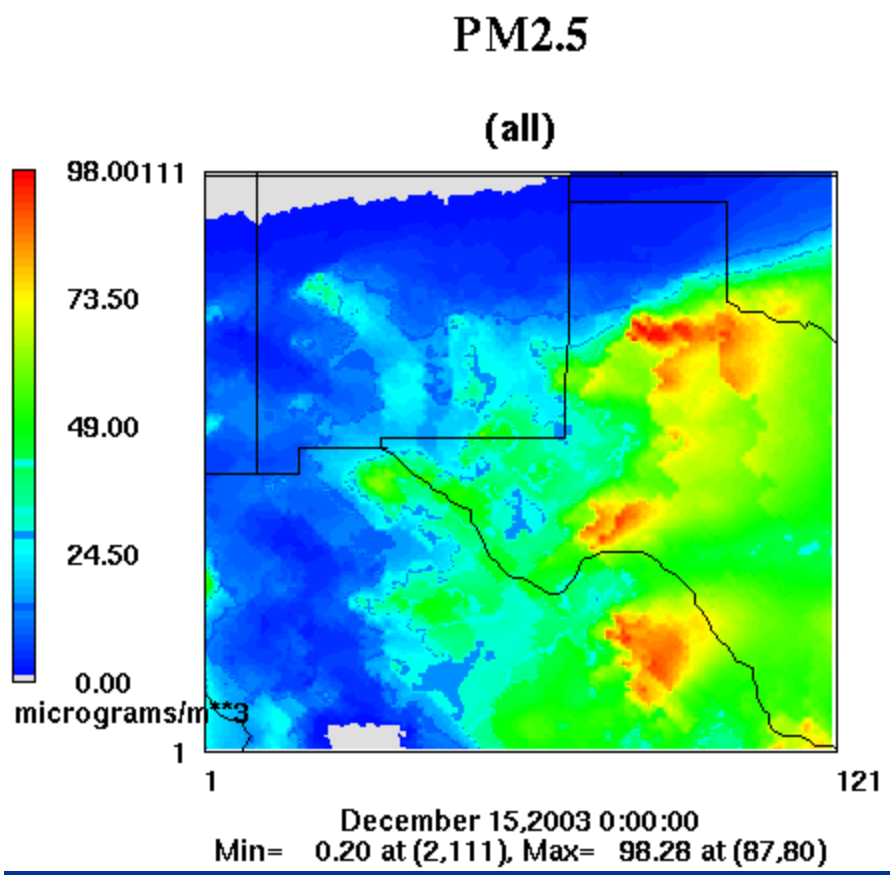
Pinal County Air Quality detected the event (in blue) at Stanfield, ~5 Km from the accident. A 72-hr hindcast simulated the event (in red).

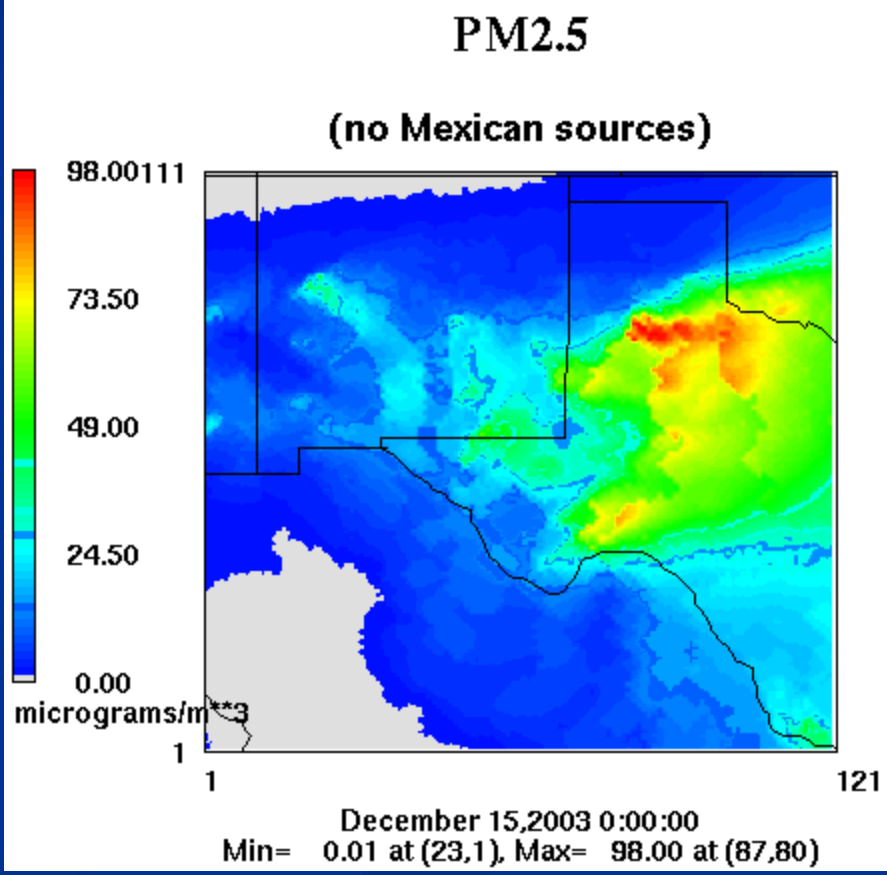


Do You Remember the December '03 Storm? A test product for public health agencies …

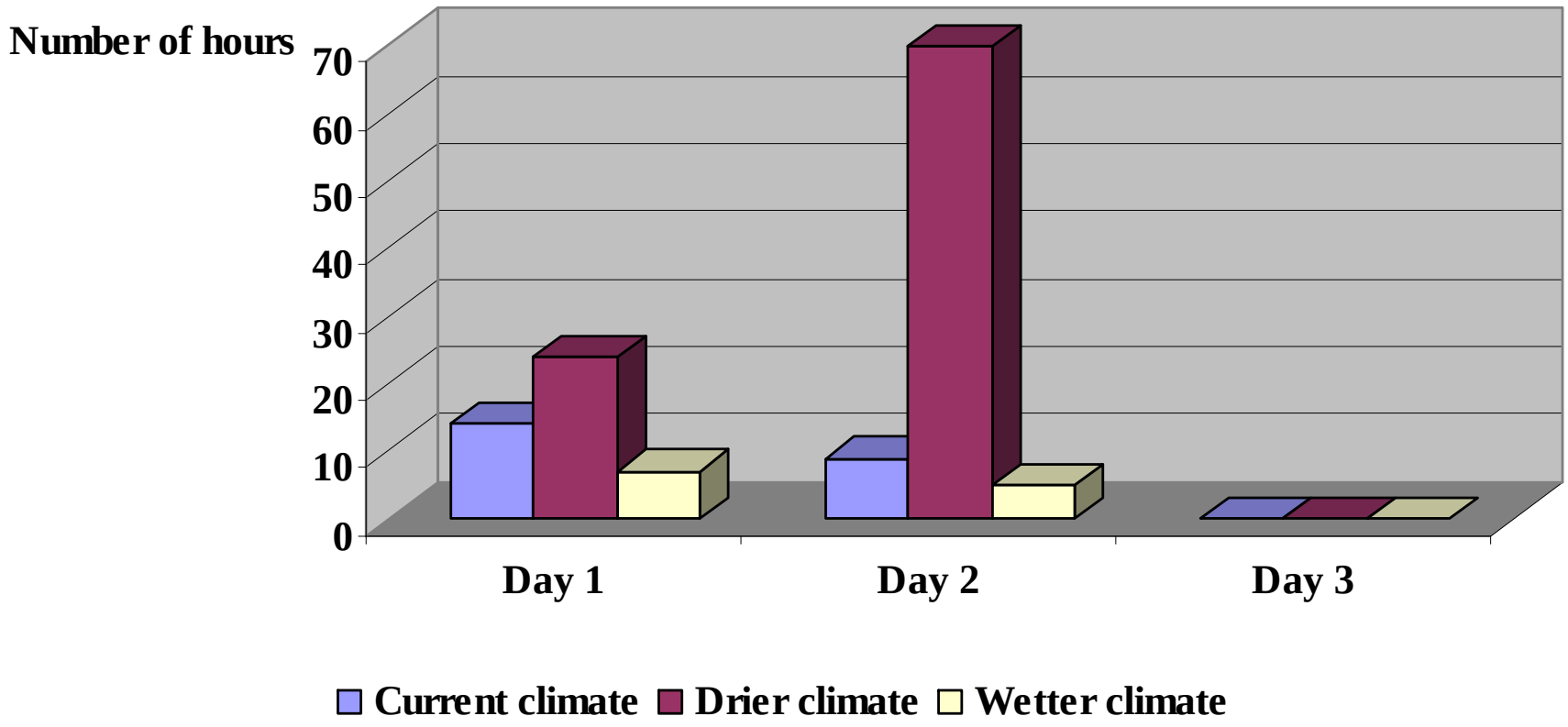


ISOLATE DUST SOURCE IN MODEL TO ASSESS SOURCE CONTRIBUTIONS





Hours of PM2.5 exceeding daily standard (65 μg/m^3)
40 sites 15-17 December 2003



N.B. Effective Dec 17, 2006, standard is 35 mg/m3

Research and Operations Together

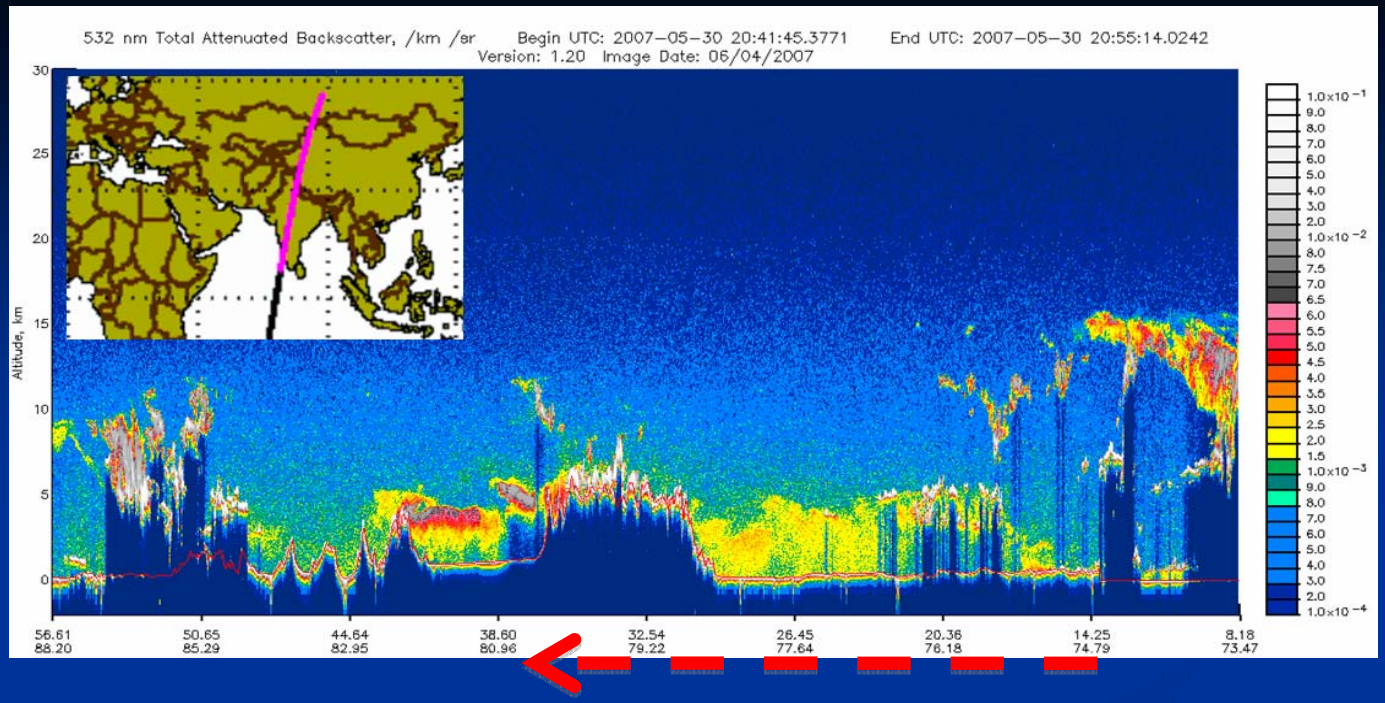
- **Airborne Dust Model Validation**

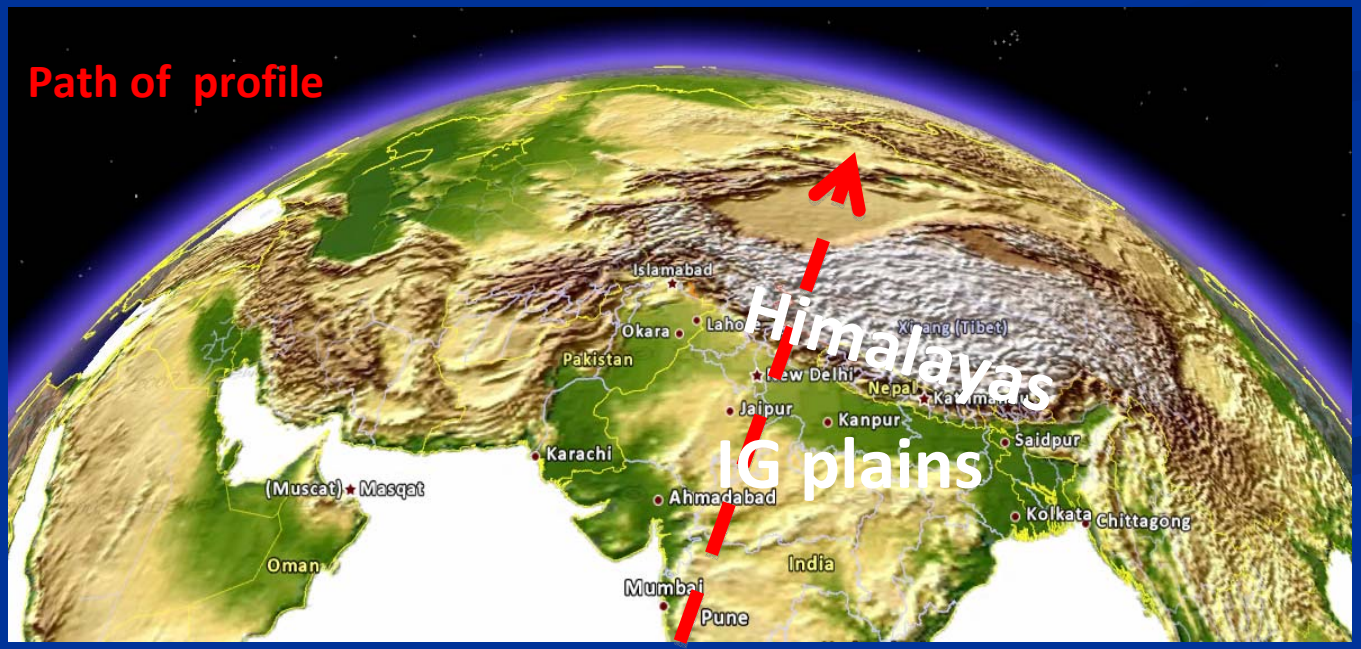
via

Measurements & Monitoring

- AERONET
- LIDAR
- AQ Sampling Networks -- PM10 and PM2.5
- CALIPSO*

The A-Train's CALIPSO (vertical profile)



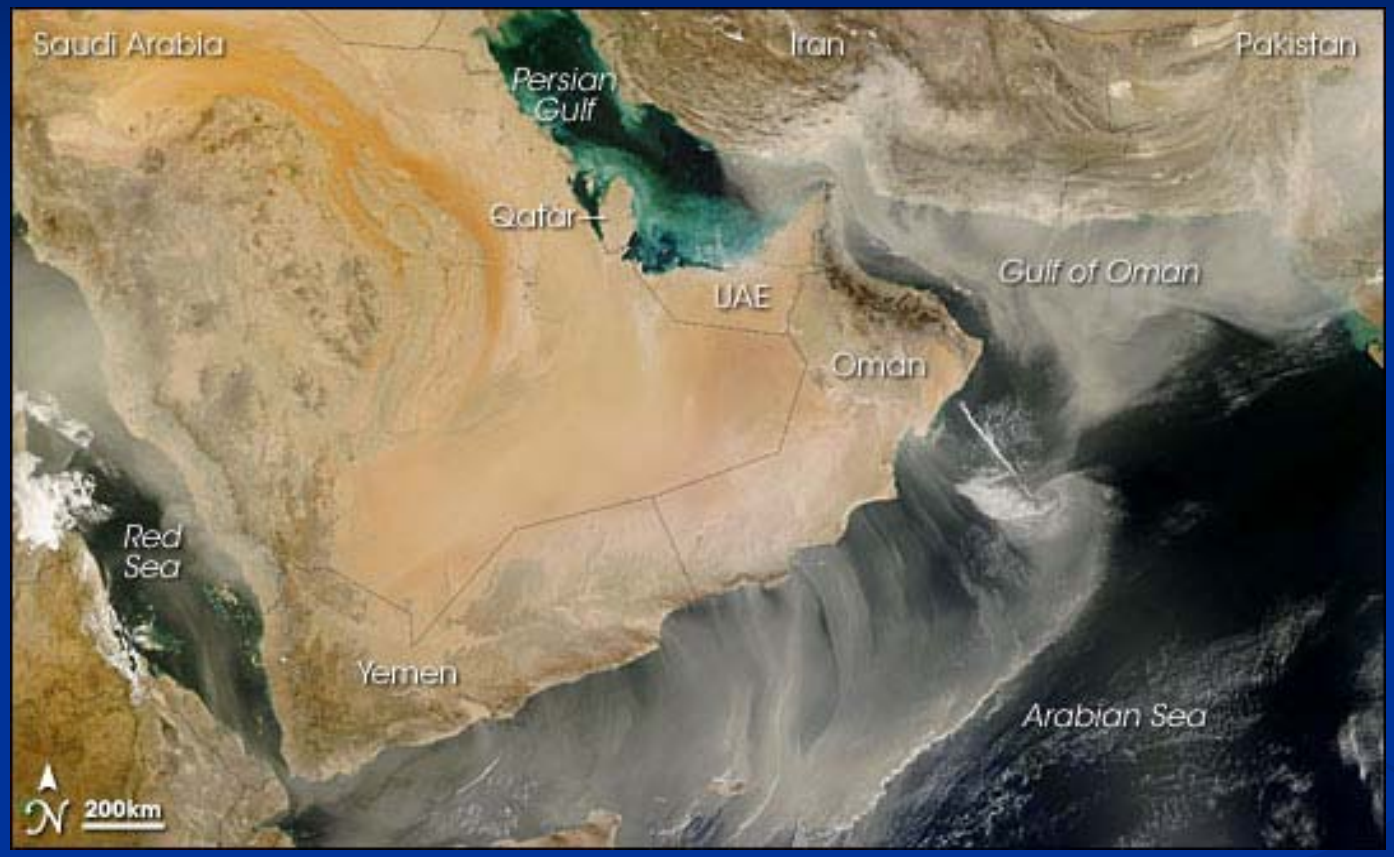


Research and Operations Together

- Sand & Dust Storm Detection
  - Satellite (e.g. CMA and NASA's *Natural Hazards* *)

Dust Plumes from Pakistan, Iran, Oman and Yemen 22 February 2008

.. from MODIS on NASA's Terra satellite



250 meters per pixel

Moderate Resolution Imaging Spectroradiometer

http://naturalhazards.nasa.gov

Courtesy Jeff Schmaltz, MODIS Rapid Response team

Information Access, Delivery & Dissemination

- **SERVIR – Systema Regional de Visualizacion y Monitoreo**
  - (http://servir.nsstc.nasa.gov/about.html)
- **PHAiRS**
  - (http://phairs.unm.edu)

SERVIR

- Geospatial Datasets
  • Search, browse, and download geospatial data and metadata from the SERVIR Data Portal http://servir.nasa.cathalac.org/portal.html

- Interactive Online Maps
  • View live maps from SERVIR Data Portal and the SERVIR GeoIntegrator
  • View, animate, and download near real-time satellite feeds of regional weather and ecological conditions on SERVIR Realtime Image Viewer

- Thematic Decision Support Tools
  • Receive real-time and near real time updates on environmental conditions
  • Browse customized regional climate change, land cover, and ecological data products

- 3D Interactive Visualizations
  • Compare real-time visualizations of weather and other phenomenon with framework data layers using the SERVIR-VIZ– a free, downloadable 3D Earth Viewer

Headquarters: Water Center for the Humid Tropics of Latin America and the Caribbean, Republic of Panama.

Test bed: NASA Marshall Space Flight Center, Huntsville, Alabama, USA

THANK YOU!