

Airborne Dust Simulations and Forecasts

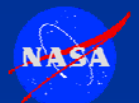
Pima Association of Governments Forum

June 22, 2007

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Dazhong Yin
University of Arizona
Department of Atmospheric
Sciences



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



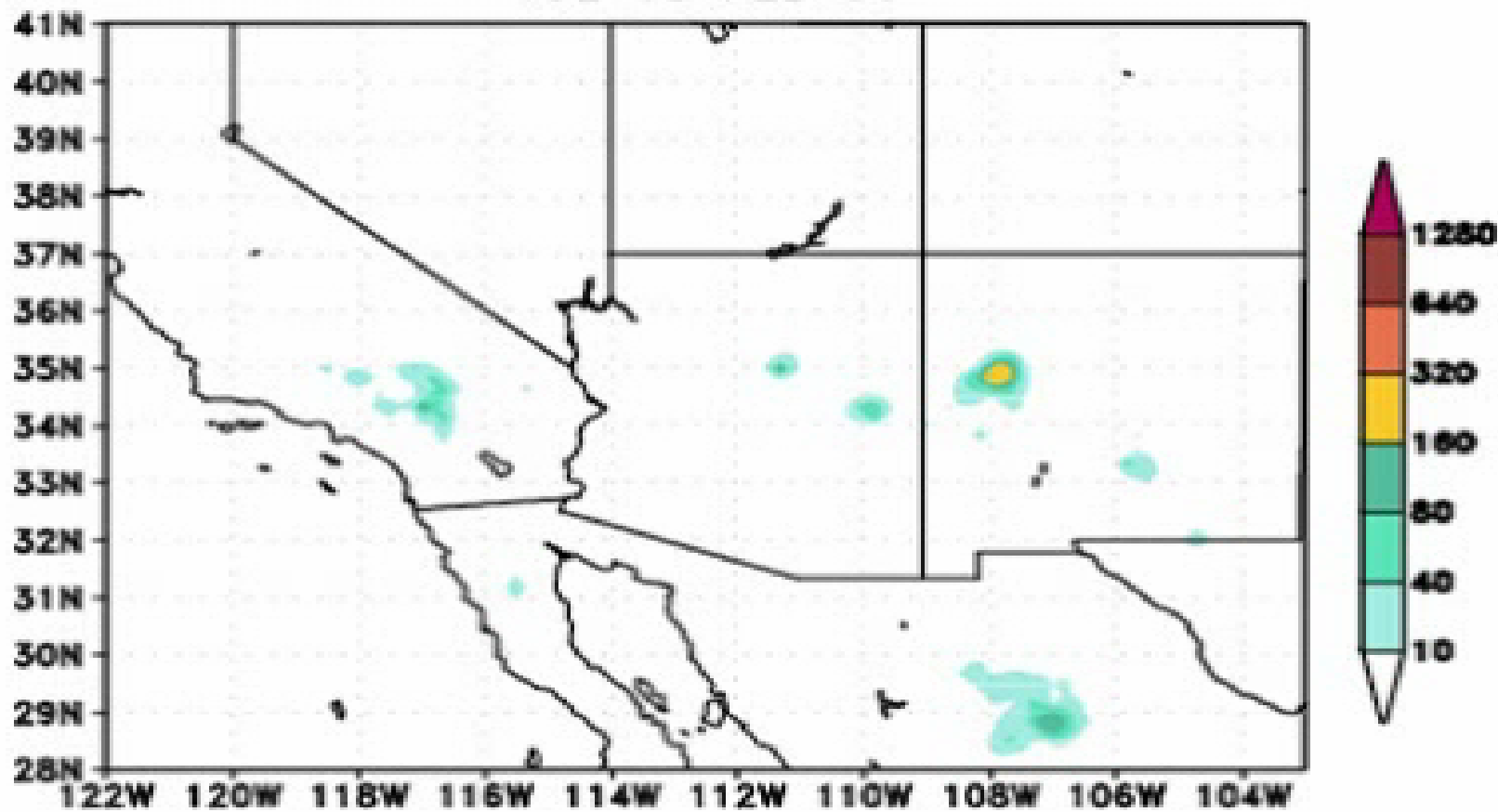
Four Dust Storms

- February 2006 - Arizona
- February 2007 – Texas
- January 2007 – California, Arizona to Texas
- December 2003 - New Mexico/Texas



Dust Concentration ($\mu\text{g}/\text{m}^3$)

13z 15 FEB 06



PM 10

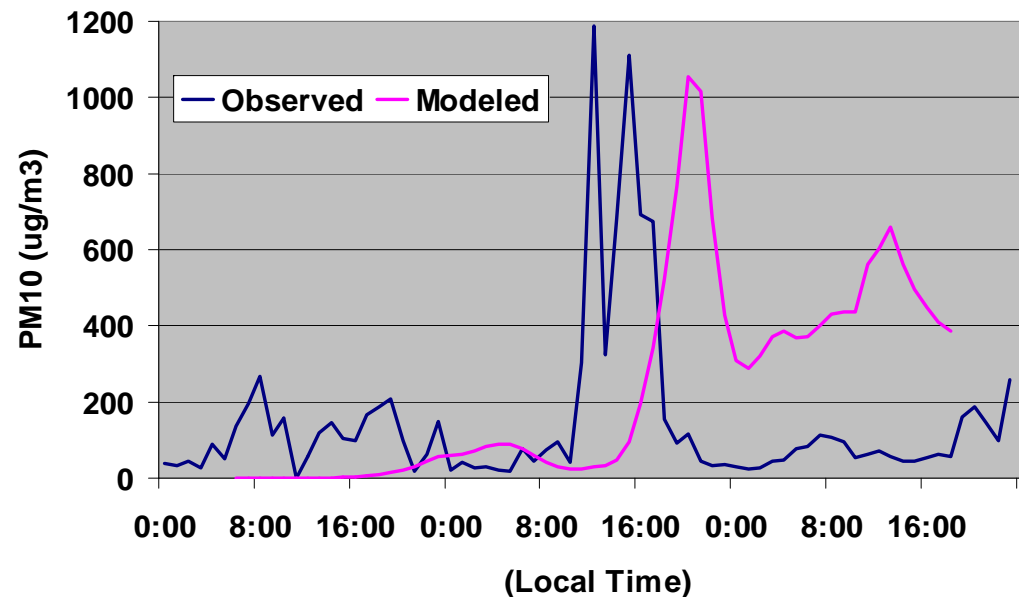


A cloud of dust on Interstate 8 south of Phoenix left two people dead and 13 others injured on 15 February 2006.



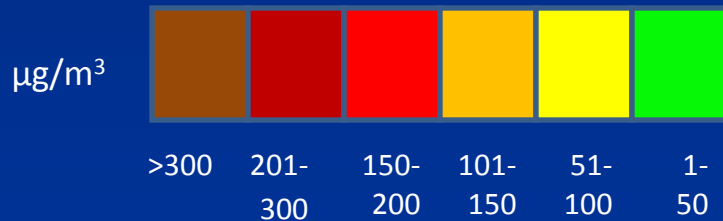
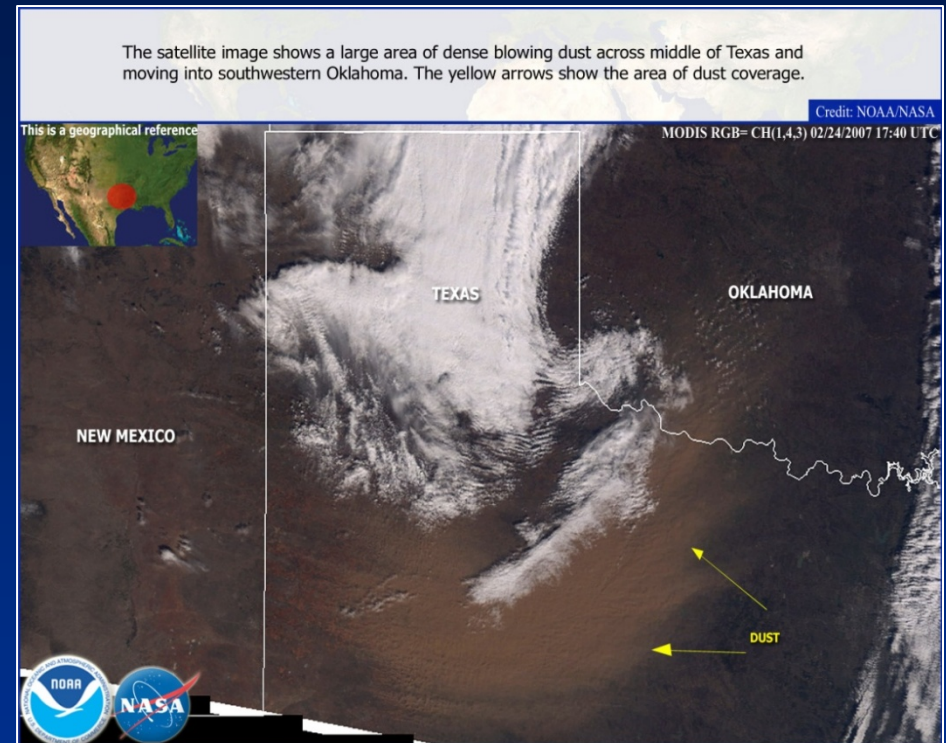
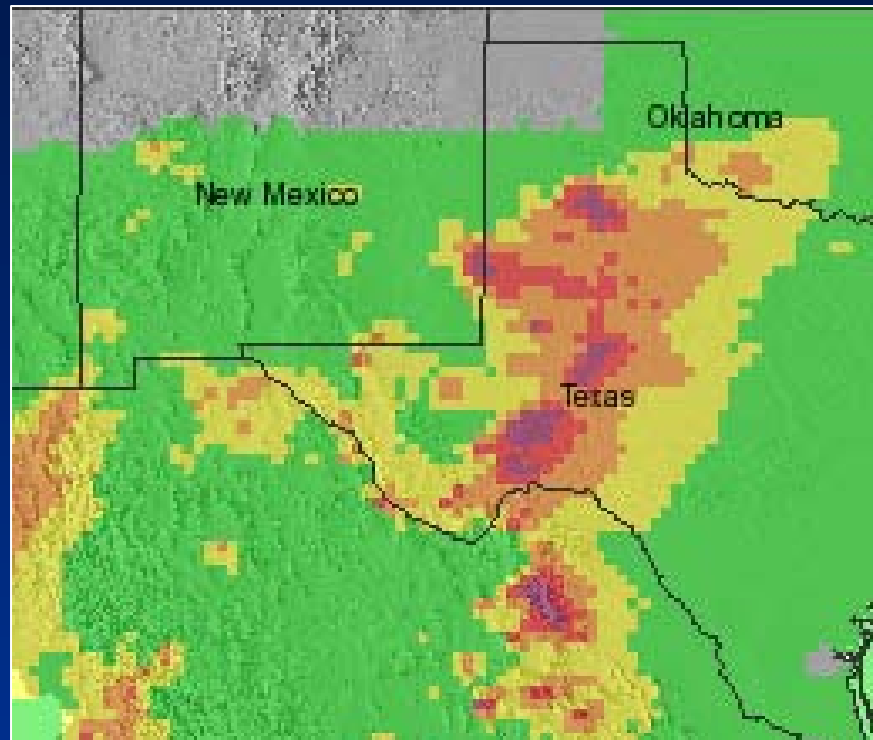
Pinal County Air Quality observed the dust event (in blue) at Stanfield, ~3 miles from the accident. The UofA 72-hr hindcast simulated the event (in red).

PM10 Concentrations at Stanfield, AZ
February 14-16, 2006

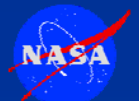


Dust PM 2.5 Concentration Forecast

February 24, 2007

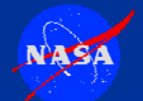
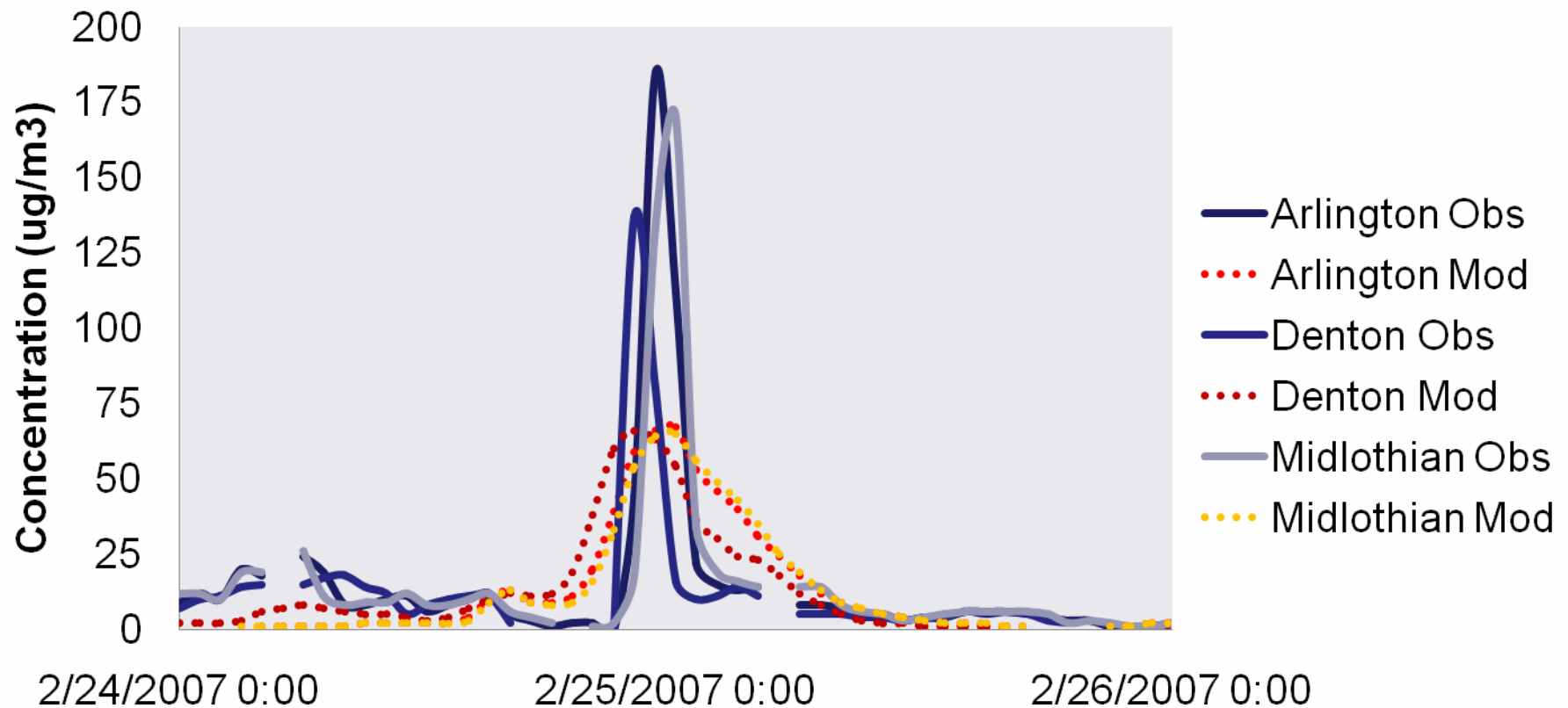


Model PM2.5 (left) and MODIS observed dust plumes (right) @ 18 UTC

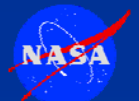
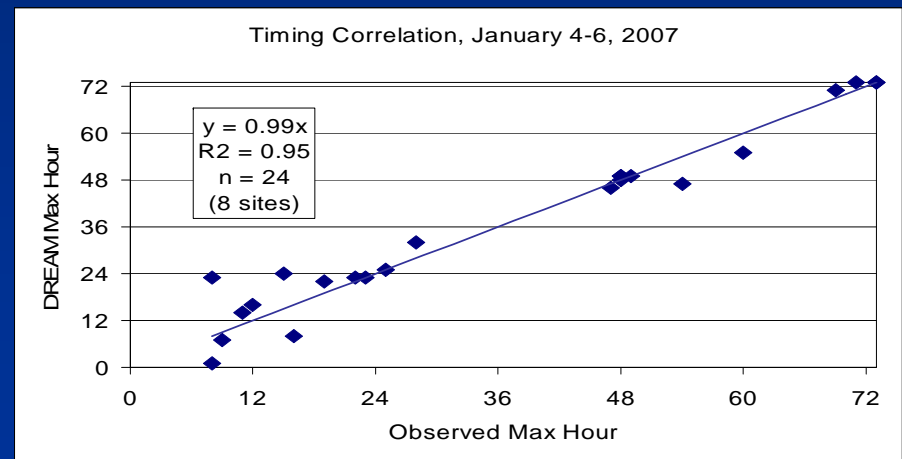
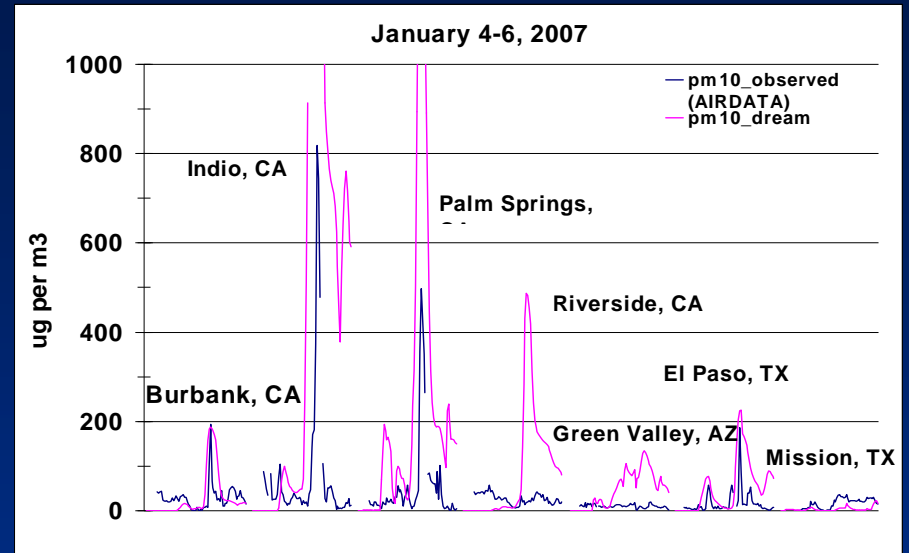
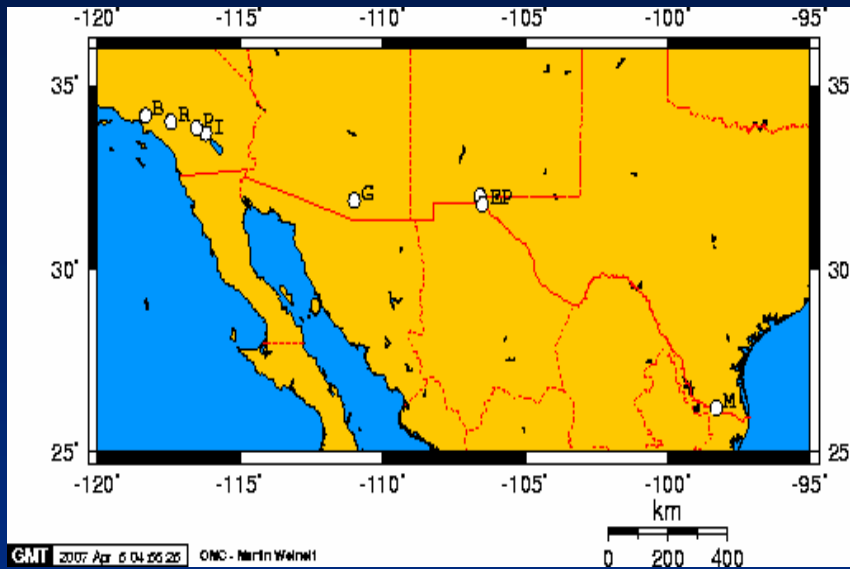


February 2007 Forecast Verification

Texas February 2007 dust event PM2.5 airport comparisons



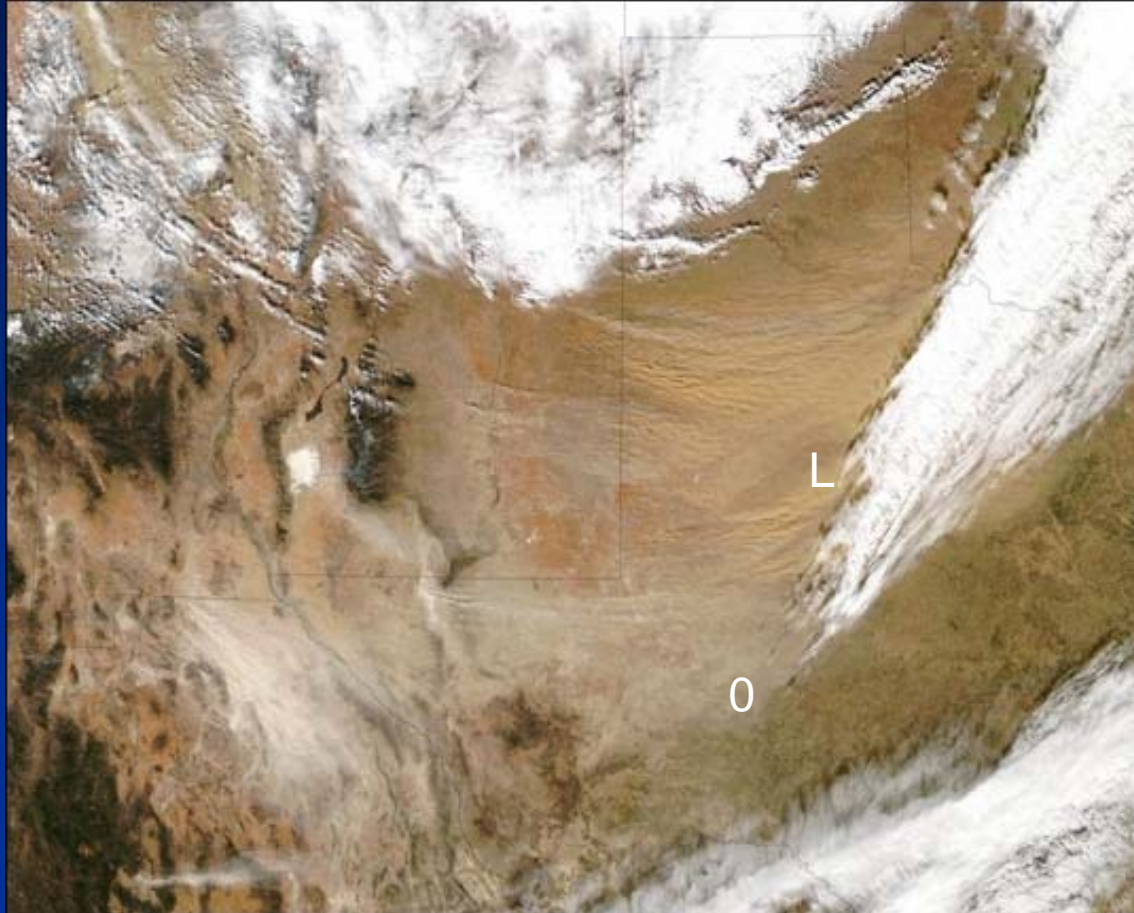
January 4-6, 2007 MODEL vs. EPA AIRDATA at 7 PM₁₀ Sites



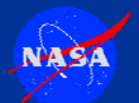
Dust Forecast Case

December 15-17, 2003

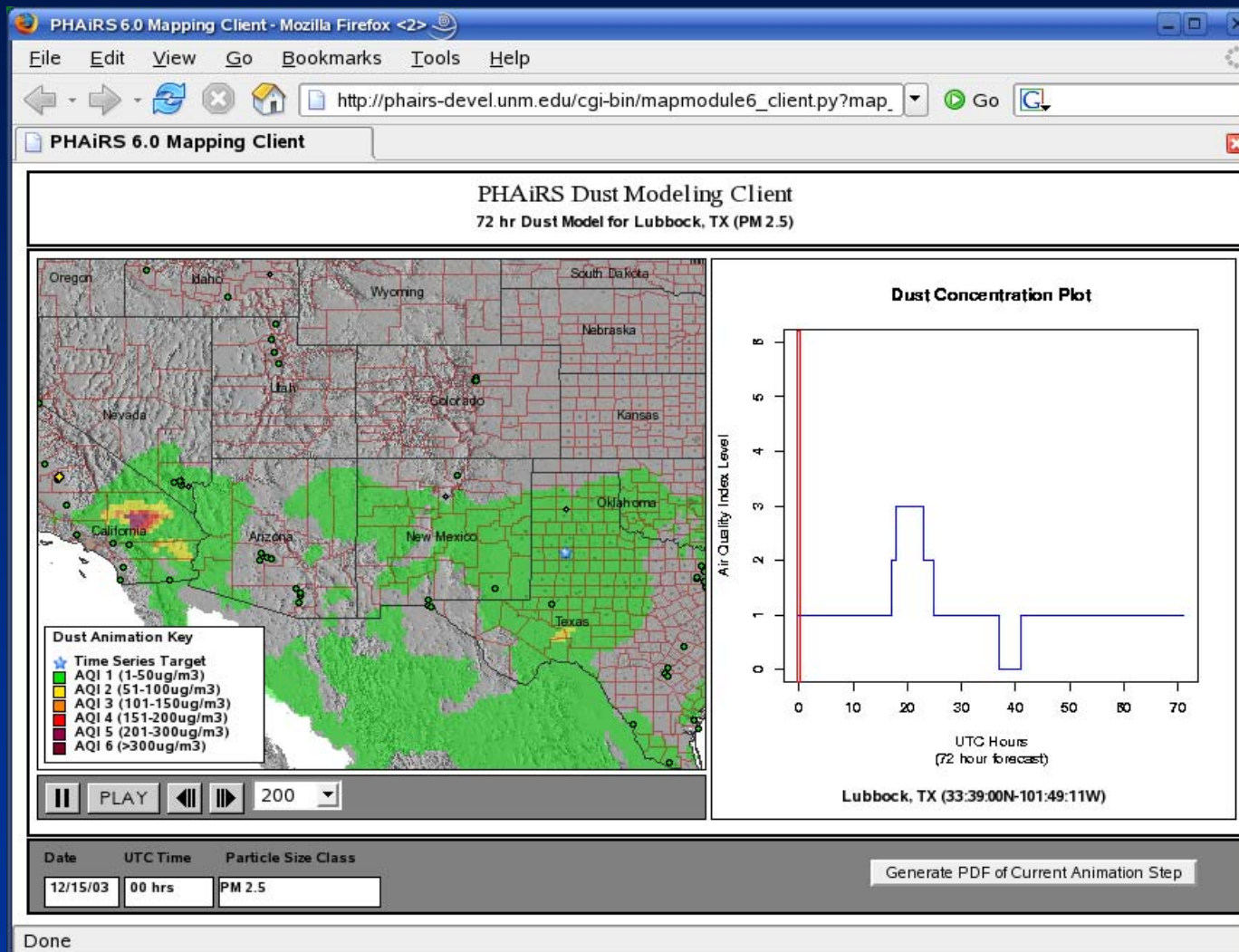
A FRONTAL SYSTEM SWEEP ACROSS NEW MEXICO, TEXAS AND NORTHERN MEXICO CREATING A SIGNIFICANT DUST STORM for Odessa (O) and Lubbock (L)



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



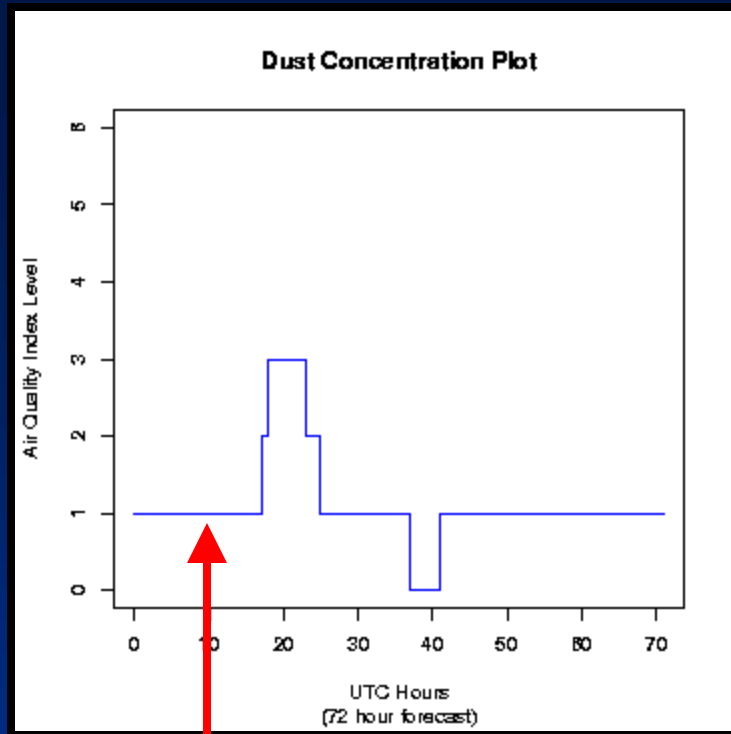
Sample Web-Available Product



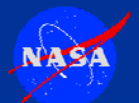
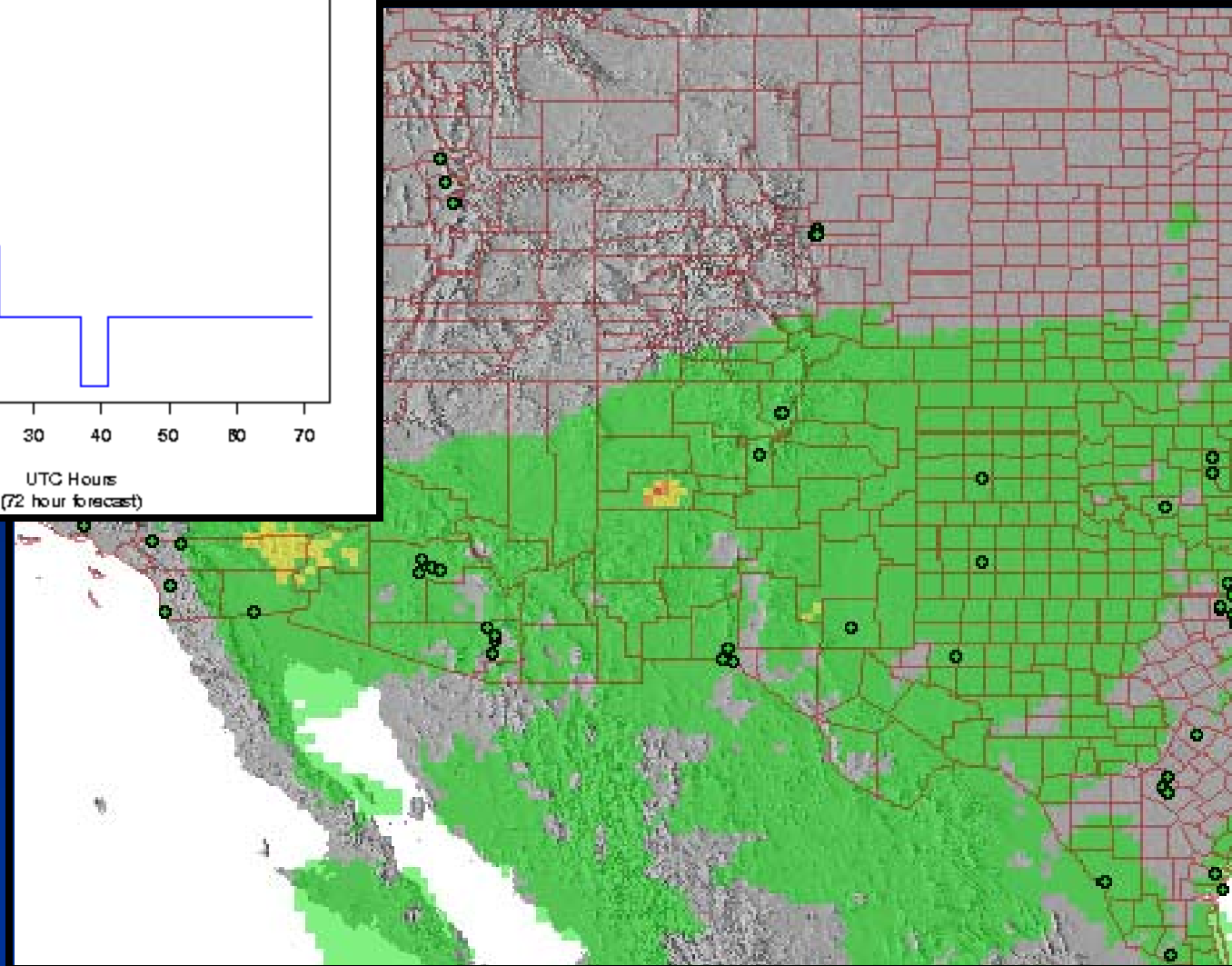
<http://phairs.unm.edu>



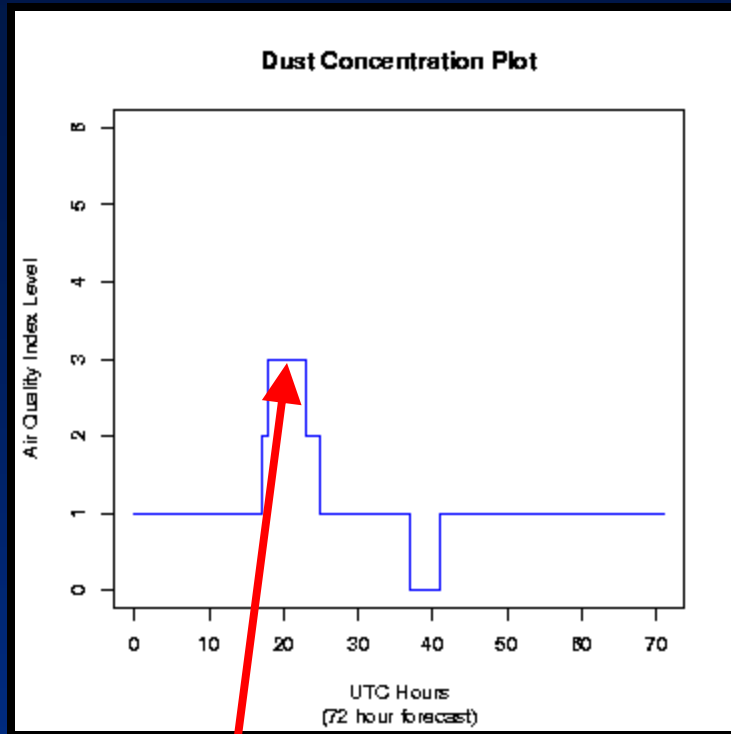
PM_{2.5} Lubbock, TX 12/15/03



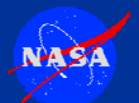
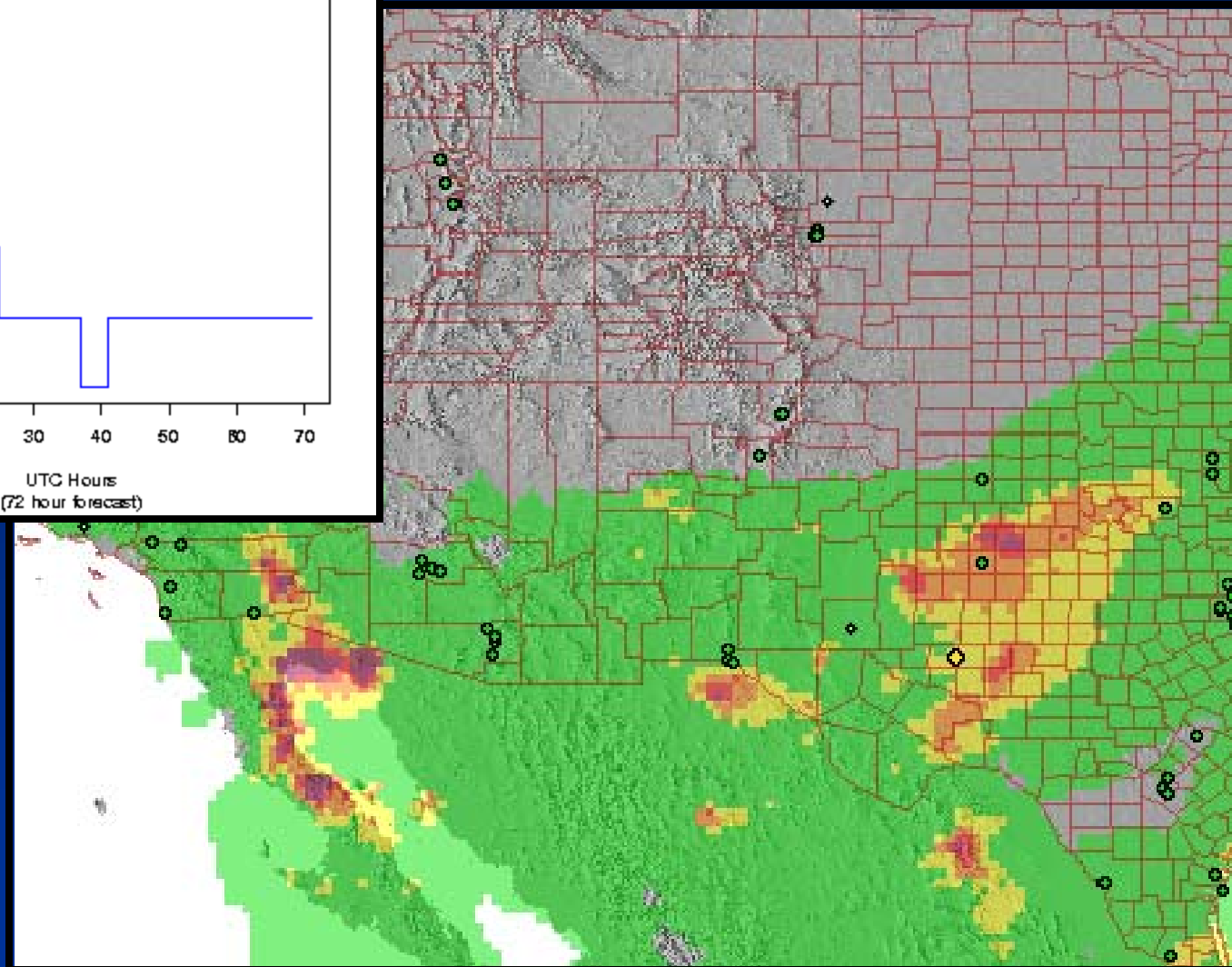
T = 10 hours



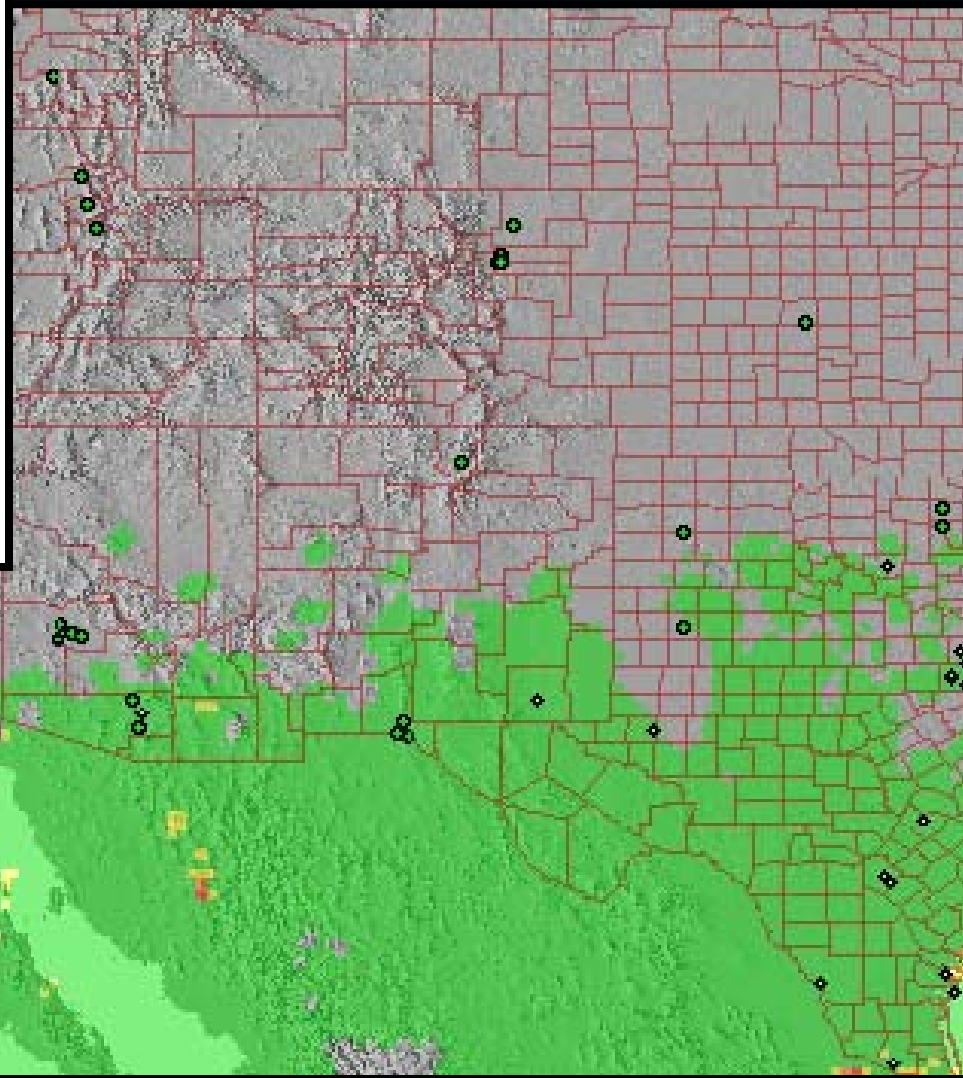
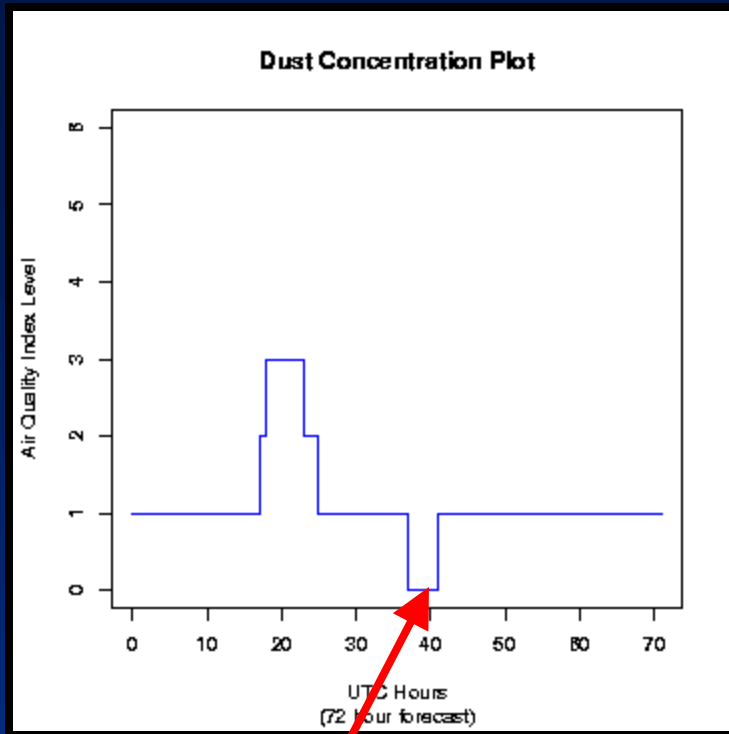
PM_{2.5} Lubbock, TX 12/15/03



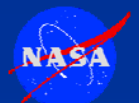
T = 20 hours



PM_{2.5} Lubbock, TX 12/15/03

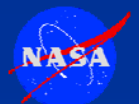


T = 40 hours

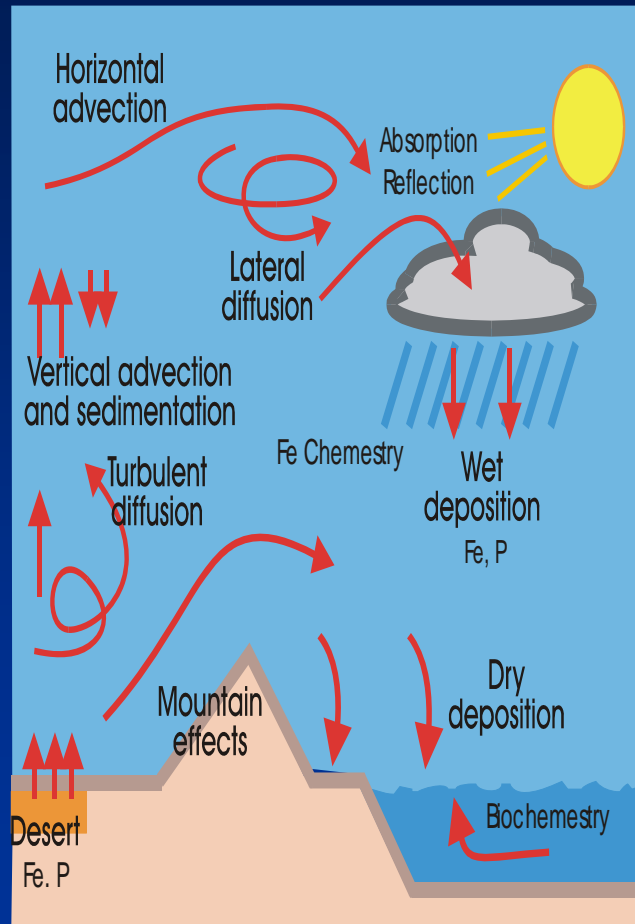


Public Health Applications in Remote Sensing ... and the UofA Aerosol Group

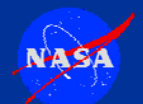
- **Objective:** an operational (dust) forecast system for *human health* decision support
- **Principles:**
 - Numerical models, for objectivity & multiple use
 - NWS models, for world-wide use & operational continuity
 - Satellite sensors, to cover the globe
 - High resolution, “at your ZIP code” for greater accuracy
 - International, for an intercontinental problem
 - *Public Health* Advisors, for practical design



Quasi-operational DREAM

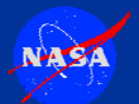


- Numerical, Dynamical Dust Generator 'DREAM'
- Driven In-Line by NWS Operational Model
- NASA - MODIS Dust Source Identification
- NASA Satellite Model Verification
- EPA AIRnow Network Model Verification
- Choice of PM Size Distribution
- Client Selects Product
- Simulations of Past Events & *Future Scenarios*
- Up to 72-hr Forecasts (time, amount, duration)
- Aiming for ZIP-code Resolution



Model Applications in AQ

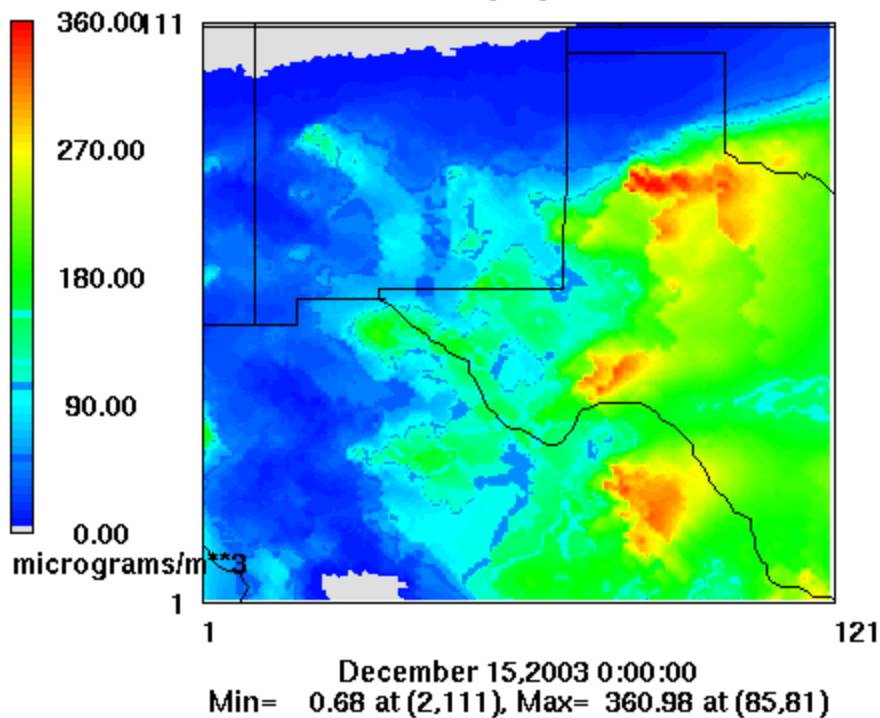
- Border AQ Issues
- Monitoring Regional AQ
- Evaluating Dust Control Policies
- Assessing AQ in Future Climates



HOW MUCH DUST IN THE U.S. ORIGINATES SOUTH OF THE BORDER?

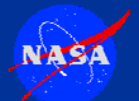
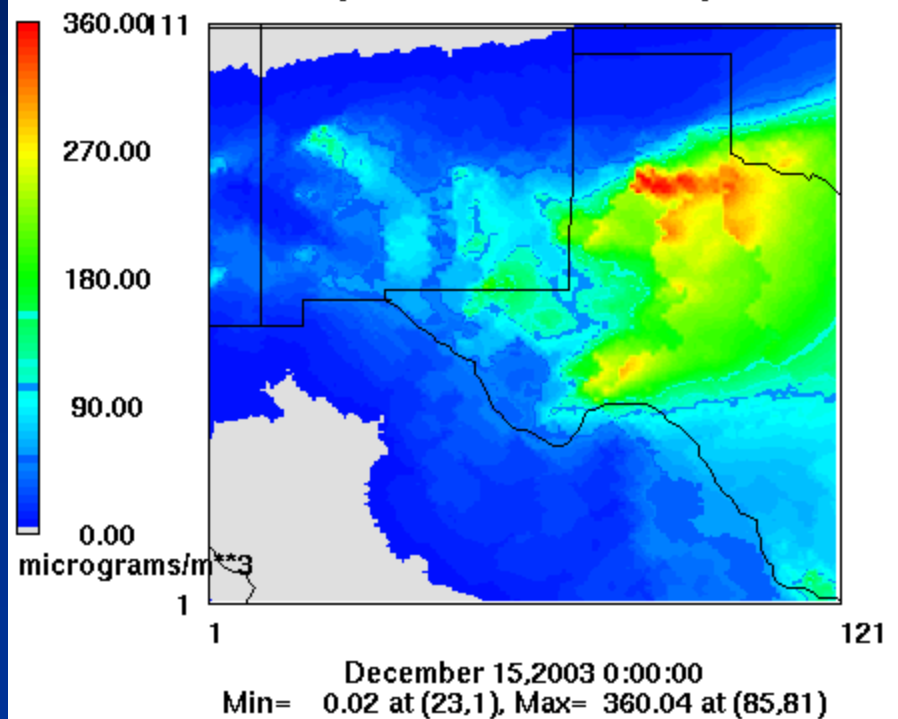
PM10

(all)



PM10

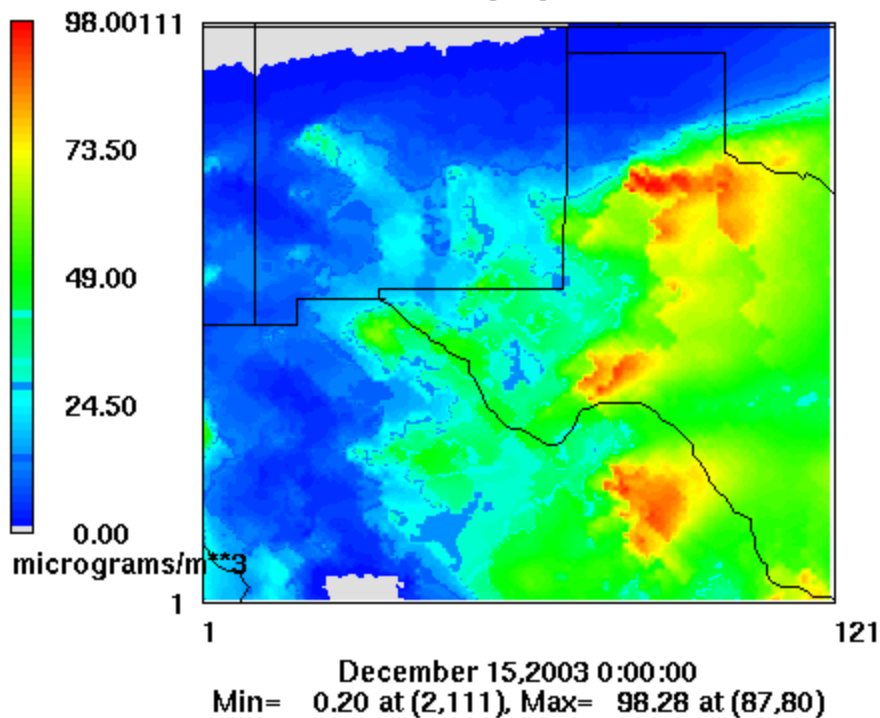
(no Mexican sources)



HOW MUCH DUST IN THE U.S. ORIGINATES SOUTH OF THE BORDER?

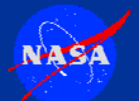
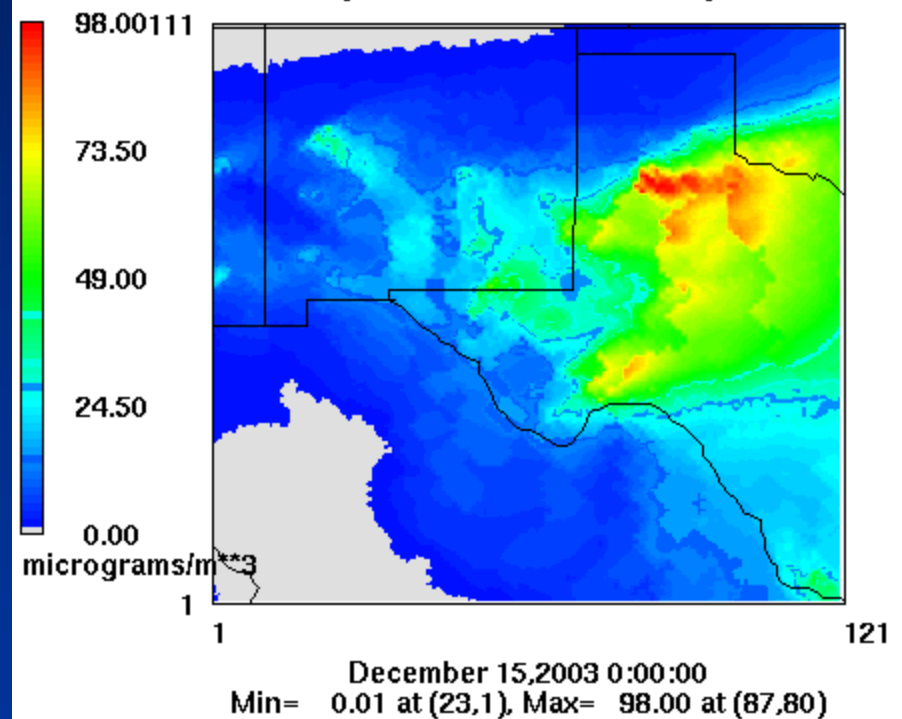
PM2.5

(all)



PM2.5

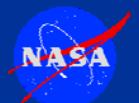
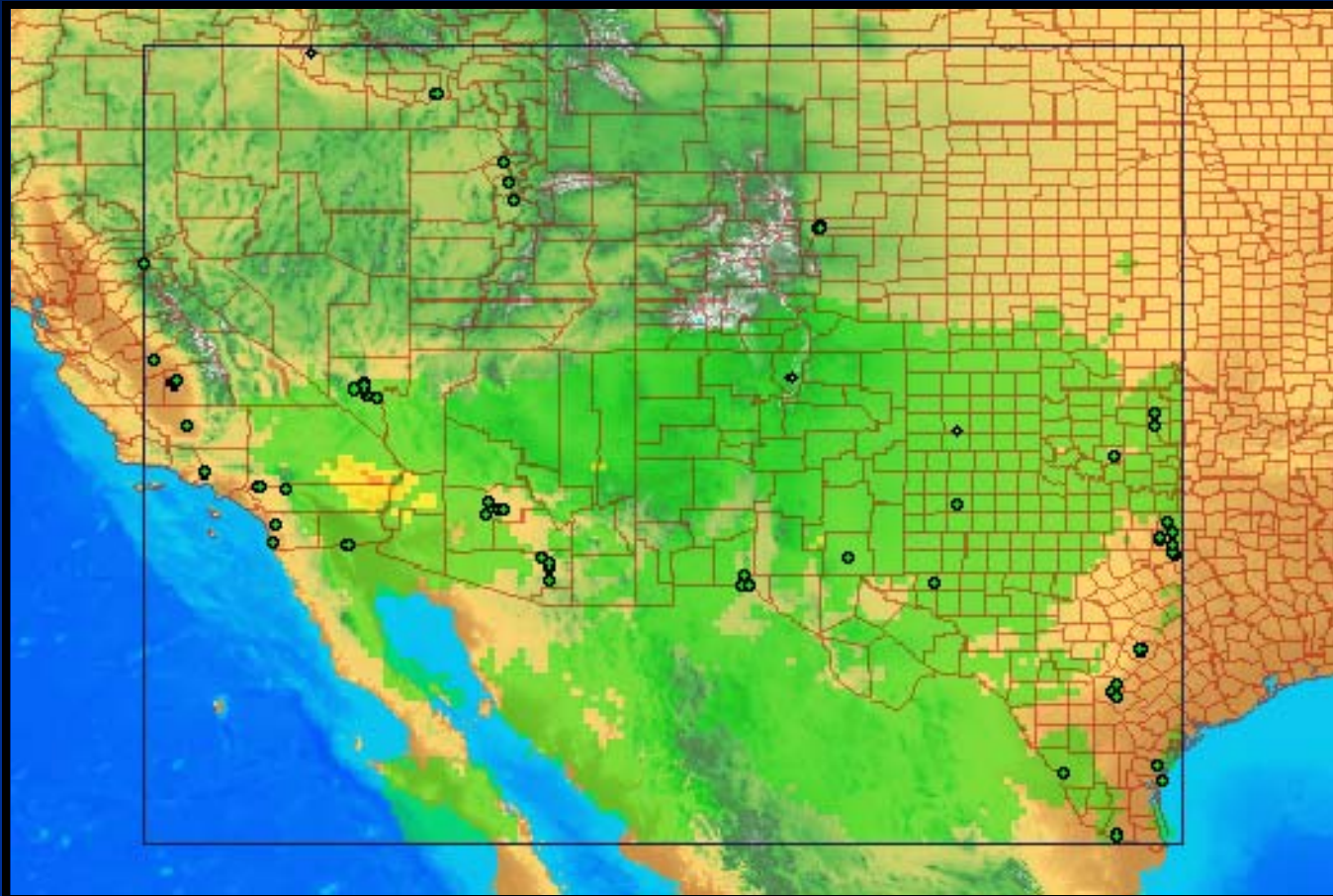
(no Mexican sources)



MONITORING REGIONAL AQ

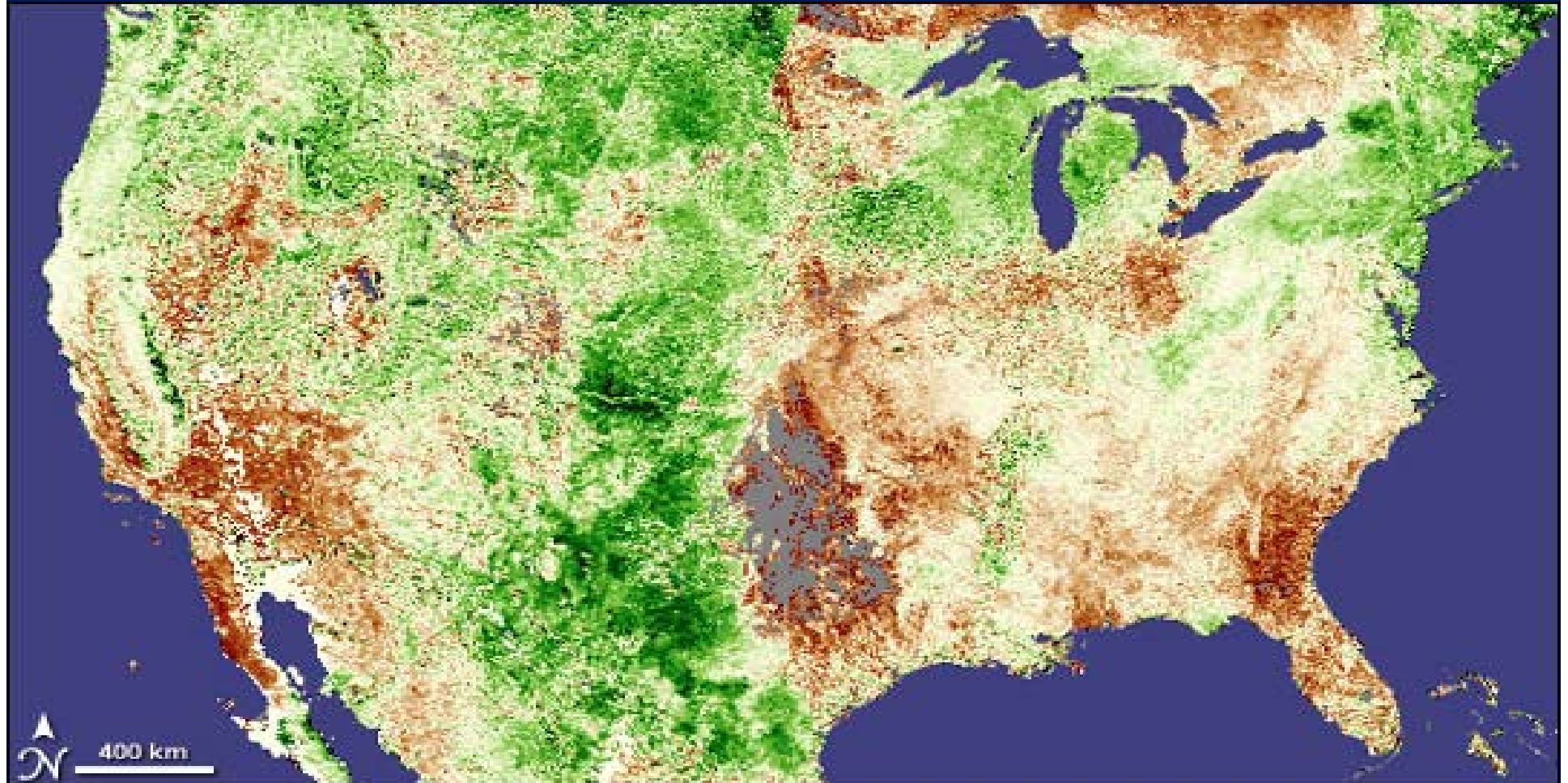
Model Simulations & Forecasts

Fill gaps in Monitoring Network



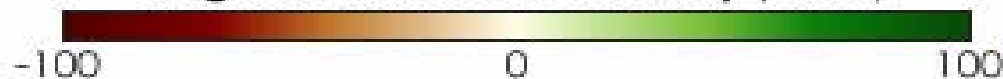
DROUGHT & CLIMATE CHANGE

Vegetation in May 2007 vs. average during same period from 2000 through 2006. Courtesy Global Inventory



May 21-31, 2007

Vegetation Percent Anomaly (NDVI)



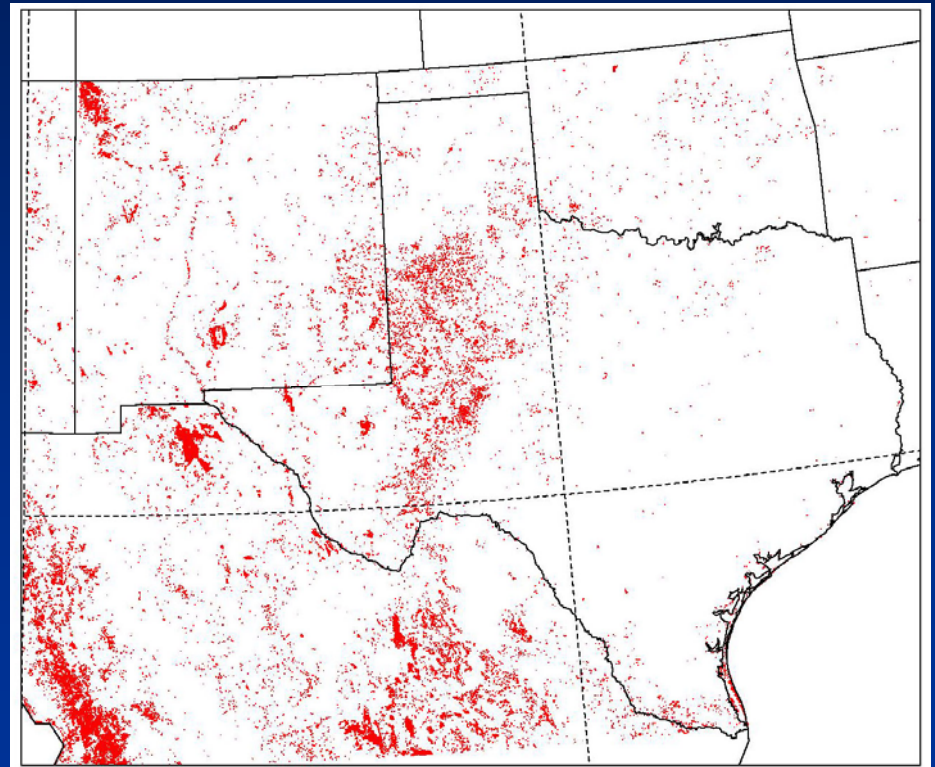
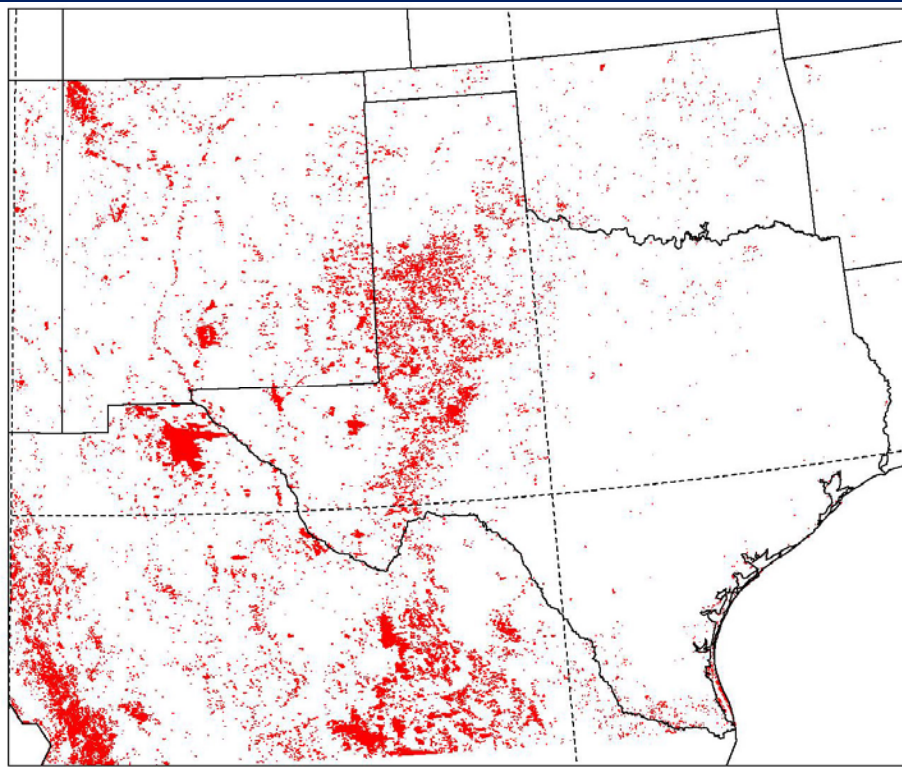
CLIMATE CHANGE & AIR QUALITY

PM sources in drier future vs sources in 2003

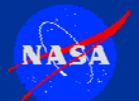
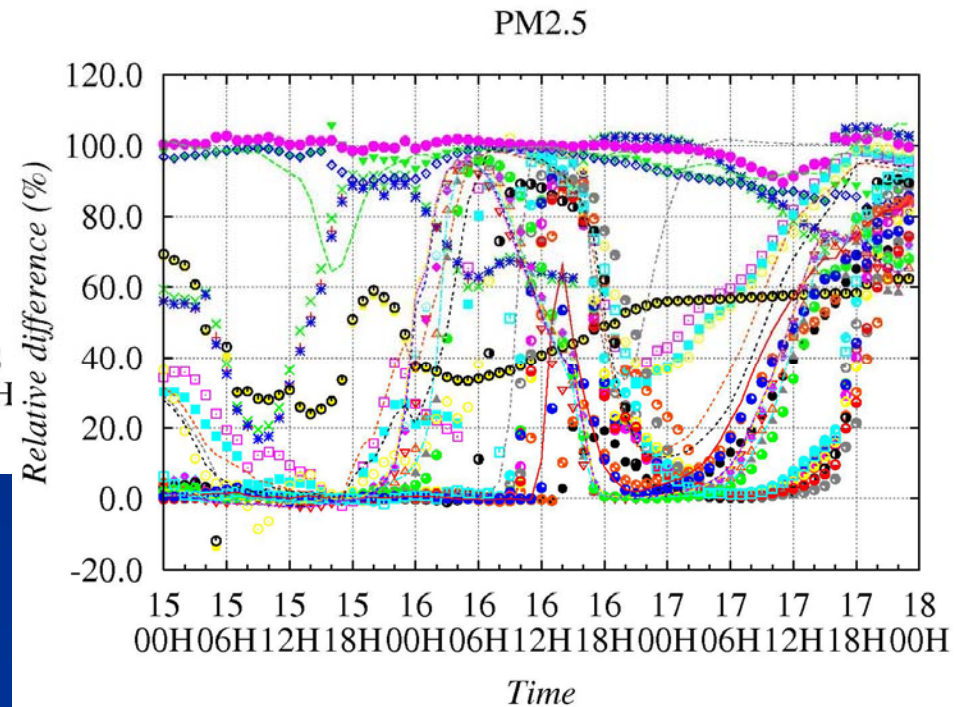
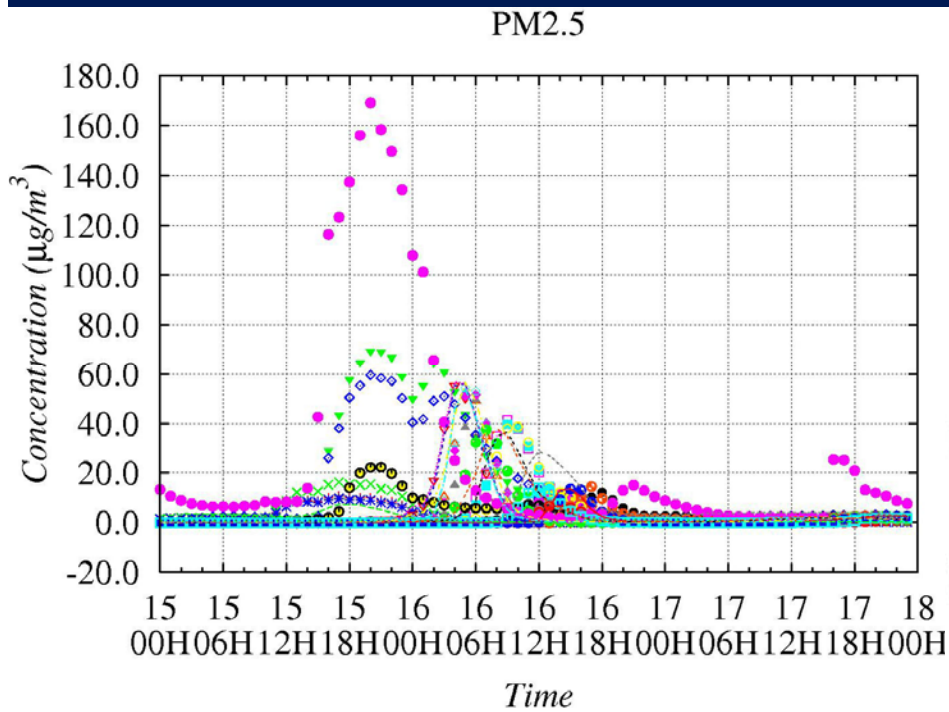
Scenario: The December 15-17, 2003 Storm

Drier future

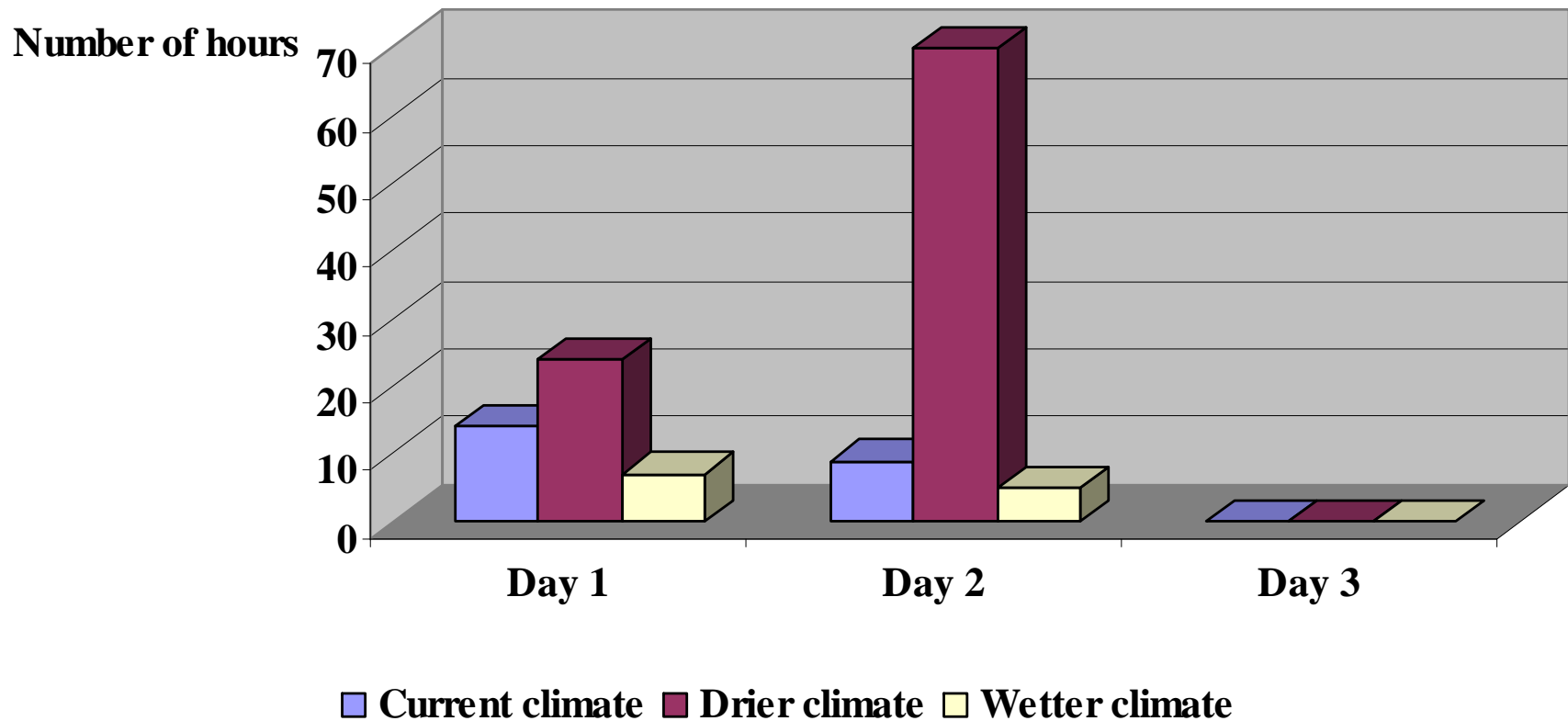
2003



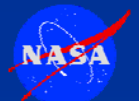
PM_{2.5} difference at 40 sites: drier future vs. 2003 (pink dots @ Channel View, TX)



Number of hours of PM_{2.5} exceeding daily standard (65 $\mu\text{g}/\text{m}^3$) among 40 sites.

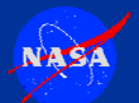


N.B. Effective Dec 17, 2006, standard is 35 mg/m³



CONCLUSIONS

- 3- day forecasts of when high PM levels will occur are accurate & ready for operational services
- Simulations of past or future PM AQ are realistic & ready for policy planning & assessments
- Research is improving PM concentration forecasts and simulations
- The proposed location in AZ of a U.N. Pan-Am Dust Centre would benefit local, State and regional AQ, health services, transportation safety, ... including responses to drought and anticipating the consequences of climate change



Acknowledgements

Modeling: Dazhong Yin, Slobodan Nickovic, Zavisla Janjic

Forecast Verification: Brian Barbaris, Kurt Thome, Anna-Britt Mahler, Patrick Shaw

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Health Applications: Susan Caskey, Chandra Bales, Shirley Baros, Mike Inglis, Alan Zelicoff

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Advisors: Beth Gorman, Wayne Byrd, Ken Komatsu, Len Flowers

Integration: Stan Morain, Amy Budge, Bill Sprigg

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