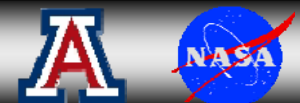




Verifying and Validating Dust Forecasts for Health Risks

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Earth Data Analysis Center,
University of New Mexico
USA





Program Elements

- PHAIRS
- SDSWAS
- NASA RPC - Pollen
- Interoperability
- SYRIS; Air Quality Authorities; Health Offices
- EPHTS & EPHTN
- EPA Workshop
- ICSU 2008 Grant Proposal



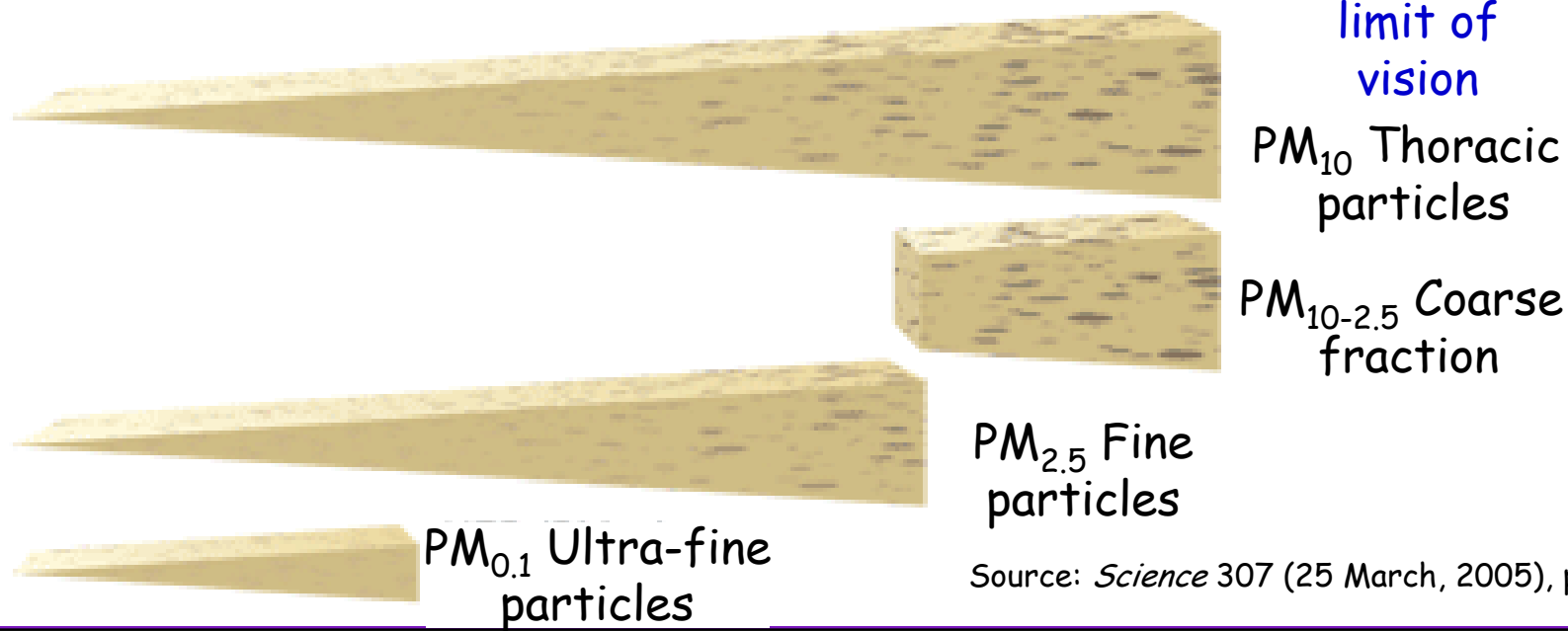
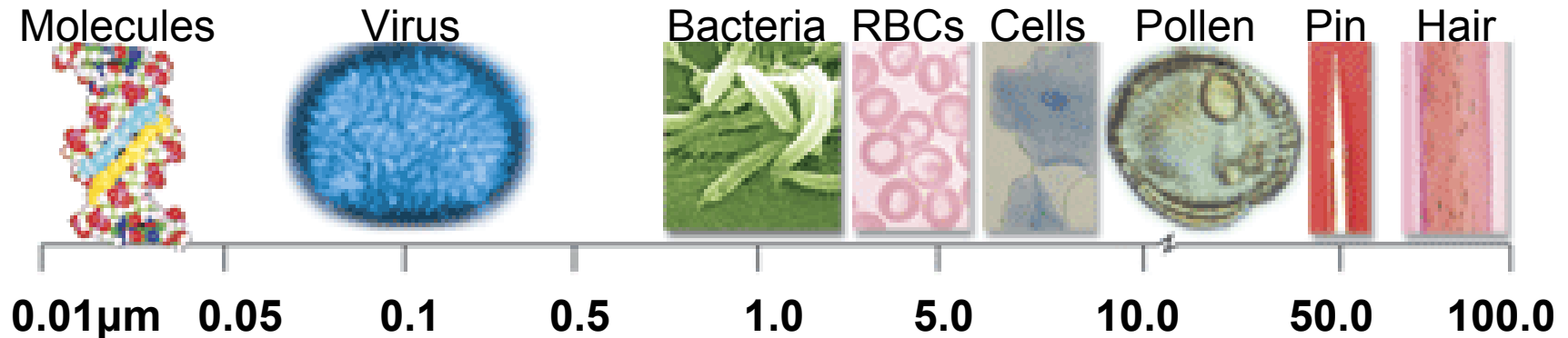
PHAIRS

Aims and Goals

- Focus on dust storm forecasting, disease surveillance, and respiratory health impacts
- 3 thrusts
 - Assimilate satellite data into DREAM and nest within the NCEP/Eta forecasting system
 - Measure incremental improvements to DREAM outputs and use them as inputs to health surveillance system
 - Create collaborations with public health authorities to validate relationships between dust episodes and respiratory diseases



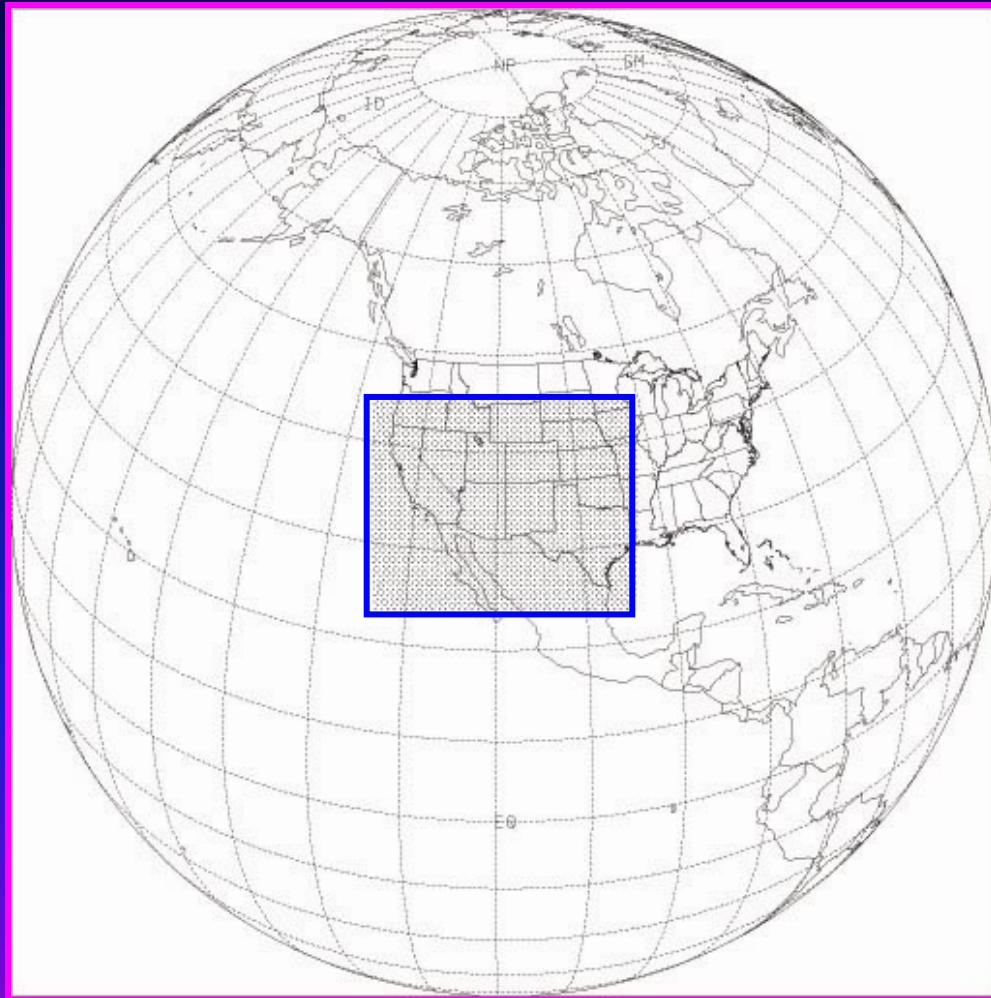
Particulate Matter Size Distribution & Their Related Biophysical Impacts



Source: *Science* 307 (25 March, 2005), p.1859



Model Domain

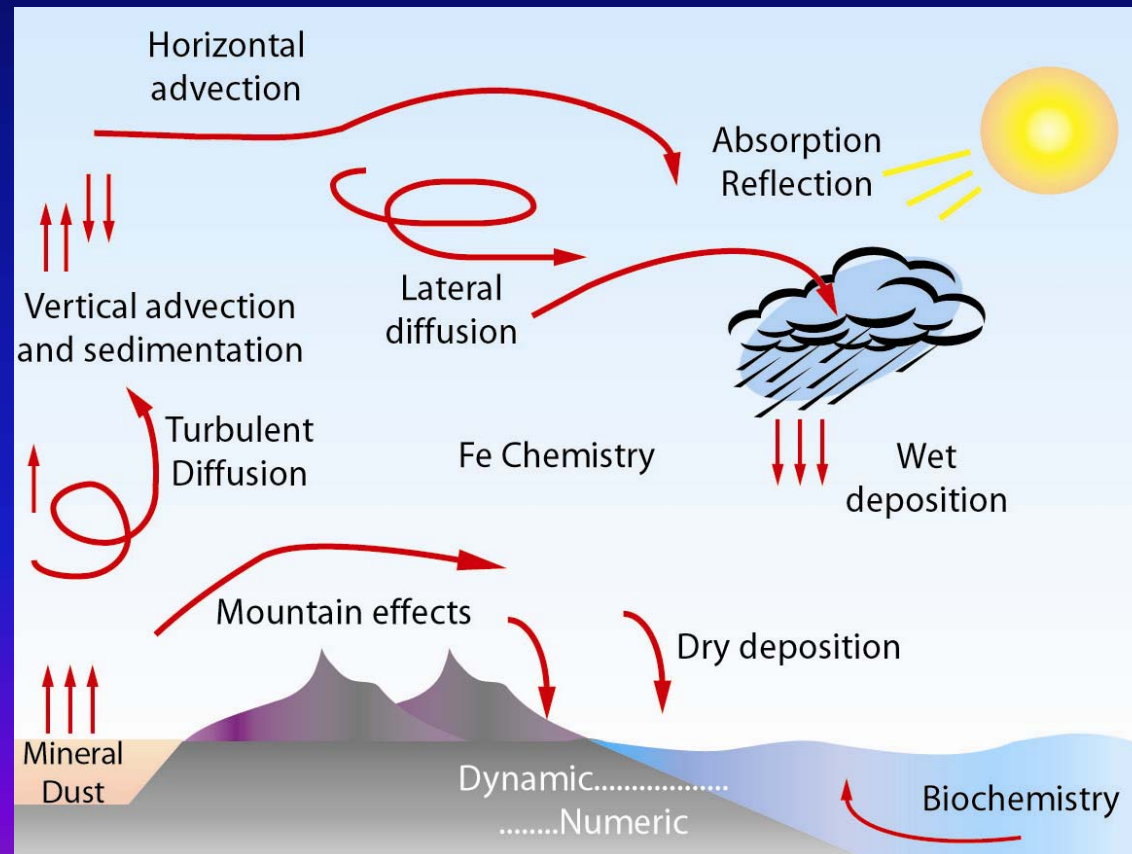


- Domain center at $(109^{\circ}\text{W}, 35^{\circ}\text{N})$
- Horizontal semi-staggered Arakawa E grid
- Horizontal grid spacing $1/3$ degree



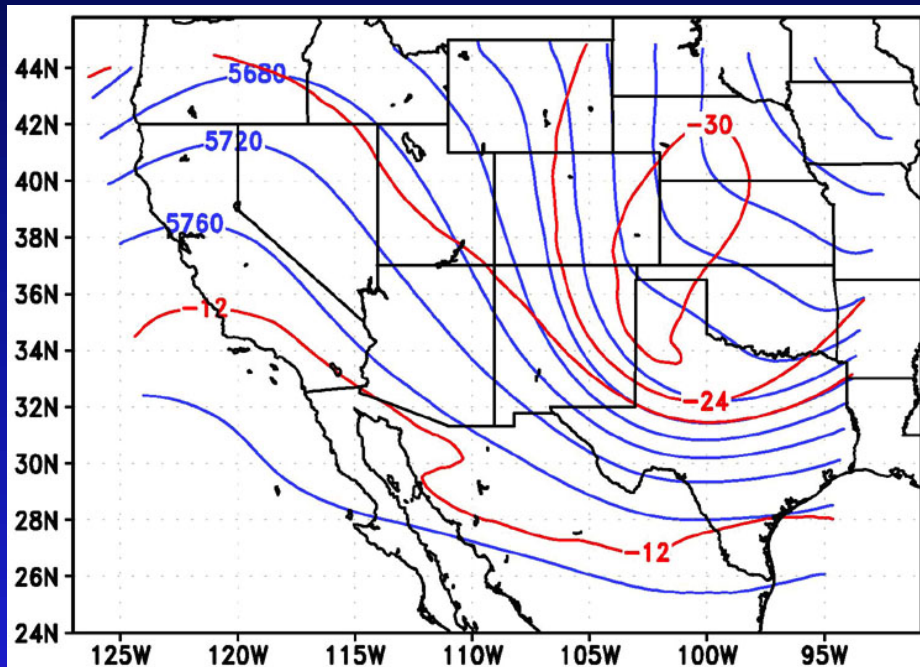
DREAM Equation

$$\frac{\partial C_k}{\partial t} = -u \frac{\partial C_k}{\partial x} - v \frac{\partial C_k}{\partial y} - (w - v_{gk}) \frac{\partial C_k}{\partial z} - \nabla \cdot (K_H \nabla C_k) - \frac{\partial}{\partial z} \left(K_Z \frac{\partial C_k}{\partial z} \right) + \left(\frac{\partial C_k}{\partial t} \right)_{SOURCE} - \left(\frac{\partial C_k}{\partial t} \right)_{SINK}$$

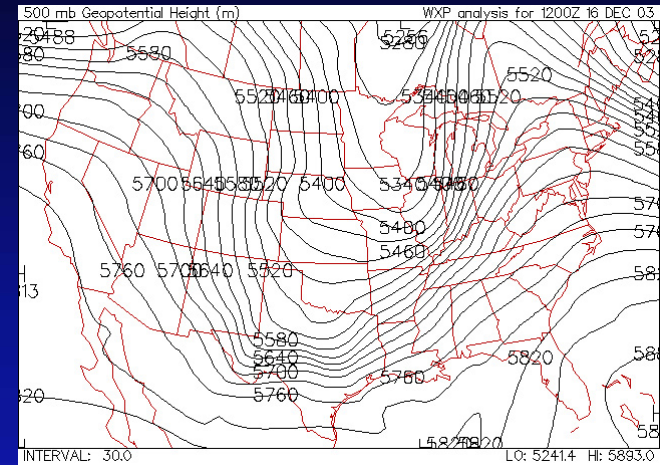




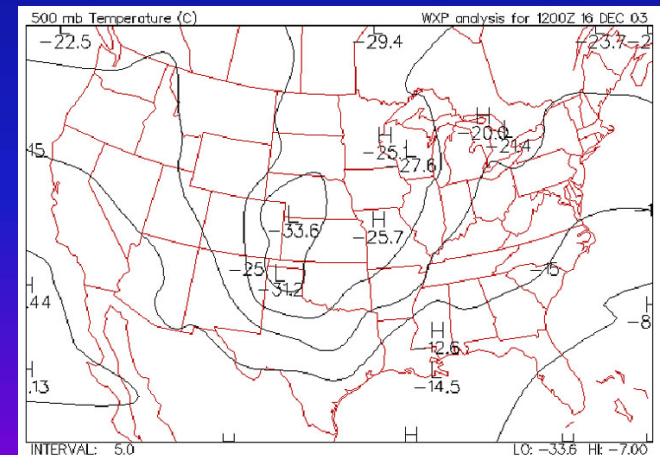
Modeled vs Observed Synoptic Patterns 12Z 16 Dec 03



DREAM Simulation
red isolines = temperature
blue isolines = geopotential height



Observed Geopotential Height



Observed Temperature

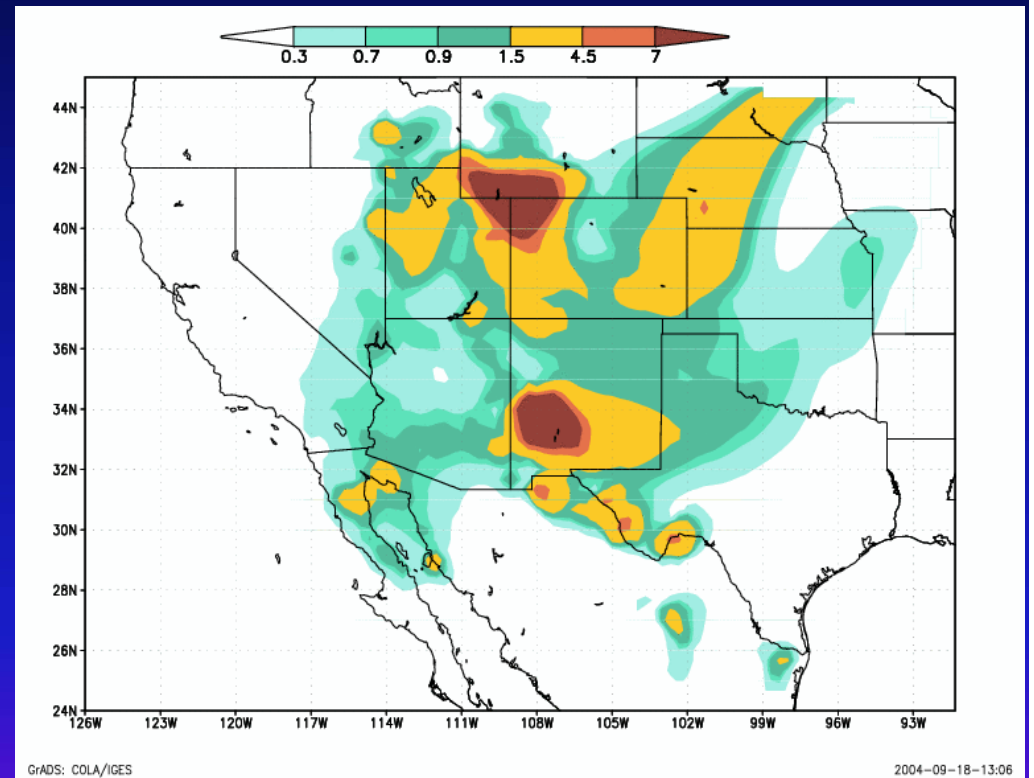


Observed Visibility vs. Modeled Dust Concentrations Dec. 15-16, 2003

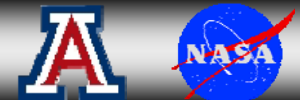


Texas

Continuous Air Monitoring Stations



DREAM Baseline (no EO data included)





Baseline and Replacement Parameters

Baseline DREAM Parameters	Function/Purpose	EO Replacement Parameters
ECWMF medium-range weather forecast model	Initial & boundary conditions; Res. = 1°	NCEP/eta global forecast model
Olsen World Ecosystems	Land cover; Res. = 10min.	MOD-12 Res. = 1km
USGS terrain data	Res. = 1km	SRTM-30 Res. = 1km
Aerodynamic roughness length: predicted using 12 SSiB land cover types	Estimate dust entrainment potential	Look-up table linked to MOD-12 land cover
Soil Moisture: simulated using a land surface model	Res. = 2min.; categories reduced to texture categories	AMSR-E



DREAM Performance Before & After EO Data Assimilation

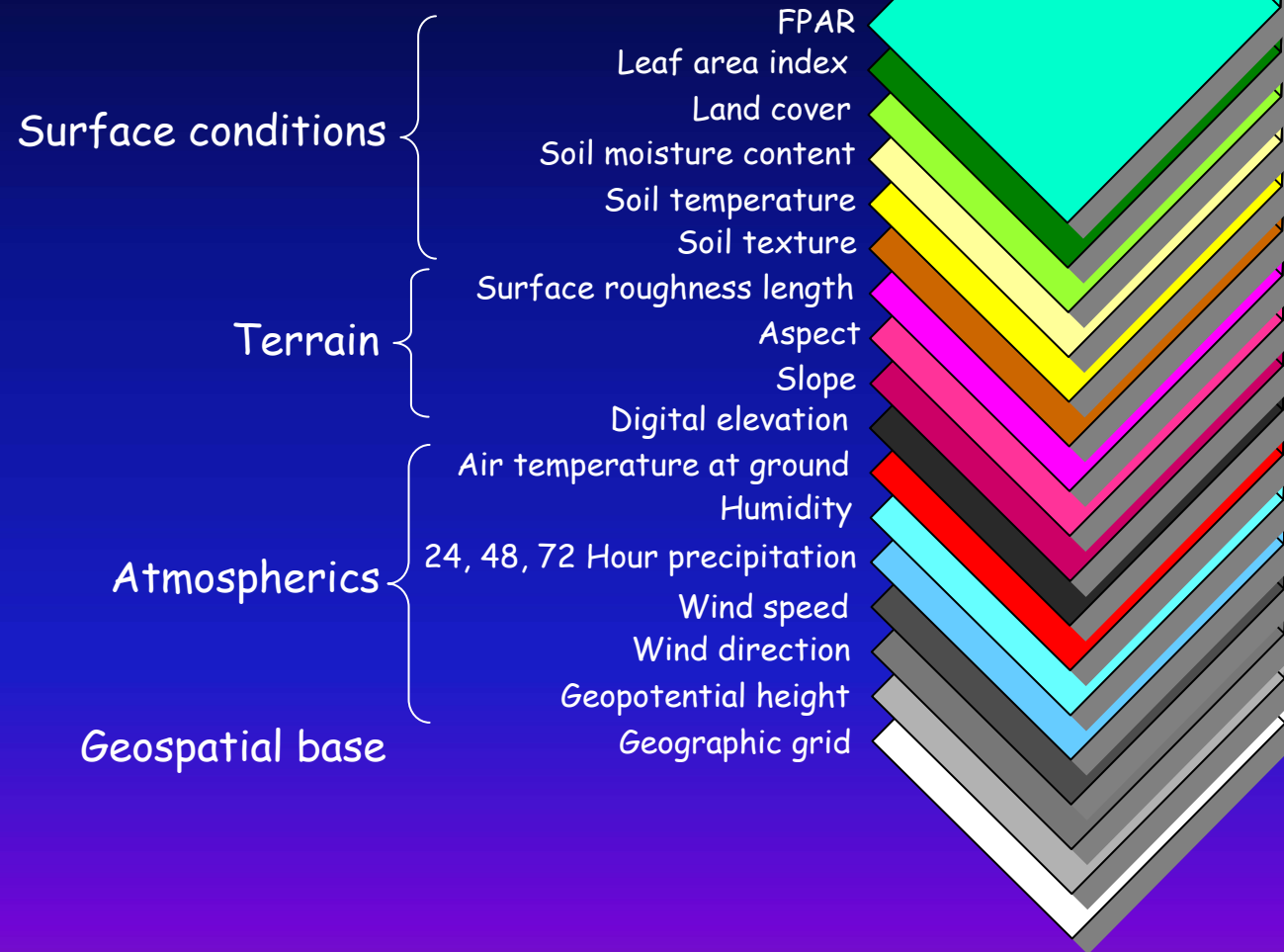
Metrics	Wind Speed (m/s)	Wind Direction (°)	Temp. (K)	Definition (M = modeled; O = observed)
Mean observed	5.53	231.40	276.74	$\frac{1}{N} \sum_{i=1}^N O_i$
Mean modeled	4.65 4.37	226.60 230.38	275.56 277.48	$\frac{1}{N} \sum_{i=1}^N M_i$
Mean bias	-0.88 -1.16	-4.80 -1.02	-1.20 0.72	$\frac{1}{N} \sum_{i=1}^N (M_i - O_i)$
Mean error	1.97 2.03	51.76 47.85	4.09 2.67	$\frac{1}{N} \sum_{i=1}^N M_i - O_i $
Agreement index	0.74 0.75	0.74 0.76	0.71 0.95	$1 - \frac{\sum_{i=1}^N (M_i - O_i)^2}{\sum_{i=1}^N (M_i - \bar{O} + O_i - \bar{O})}$

Blue = before EO Data Assimilation

Red = after EO Data Assimilation



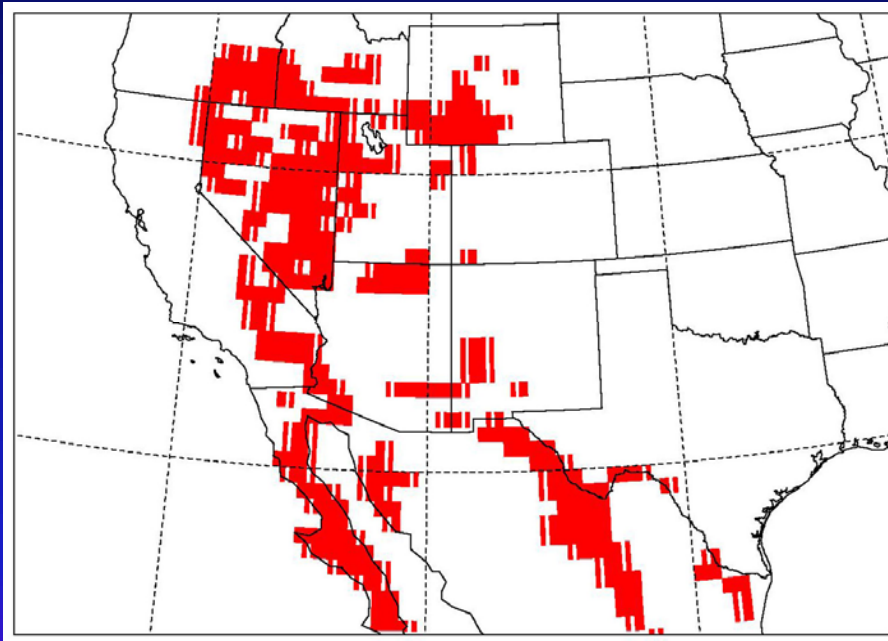
The Baker's Rack



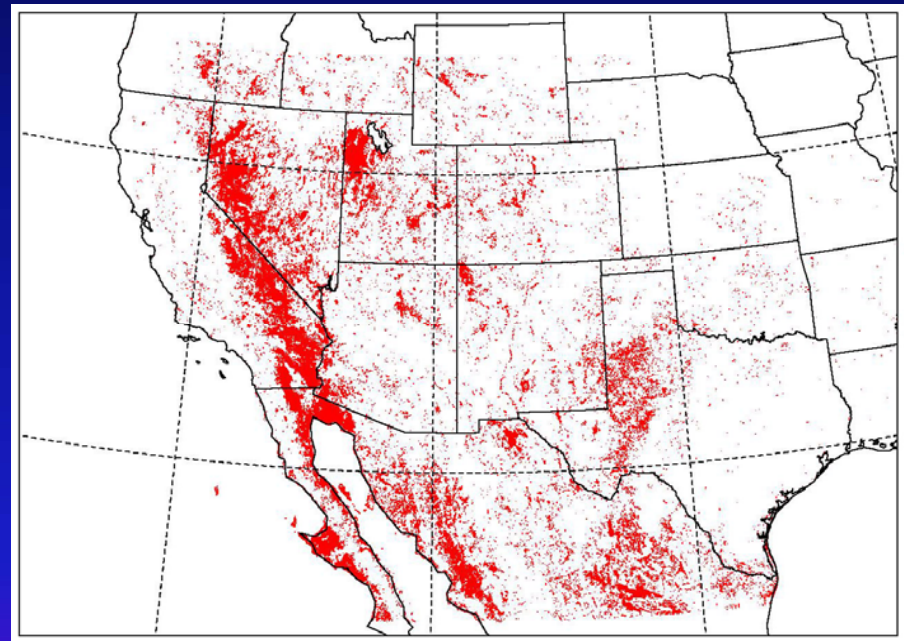
Aims are to: (1) replace selected trays in the rack with regularly refreshed EO digital data from the "terrain," "surface conditions," and "atmospheric" parameters that drive DREAM; (2) improve model output without altering the validity of the model's original function; and (3) convert the model to a more dynamic forecast.



Barren Ground (Potential Dust Sources)



Olson World Ecosystems



MOD12Q1 Land cover
reduced to binary format



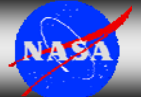
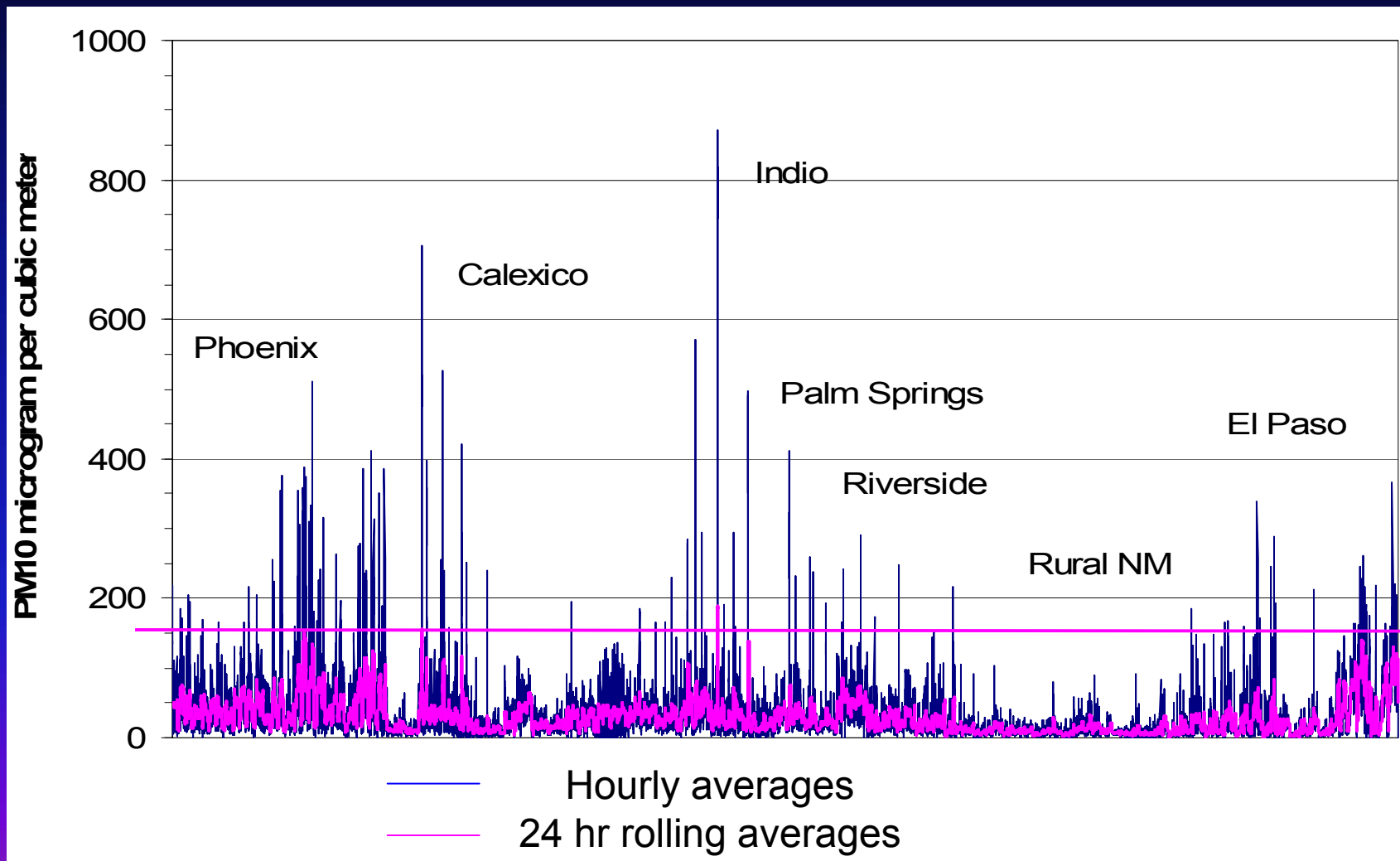
Aerodynamic Surface Roughness (z_0) Controls Dust Entrainment

<i>DN</i>	<i>Land Cover Category</i>	<i>z_0 Range (m)</i>	<i>Default z_0</i>
8	Woody Savanna	0.10-0.20	0.15
9	Savanna	0.03-0.10	0.06
10	Grassland	0.03-0.07	0.05
12	Cropland	0.04-0.18	0.11
14	Crops/Natural Mosaic	0.10-0.30	0.20
16	Barren/Sparse	0.00-0.01	0.01
253	Fill	0.00	0.00



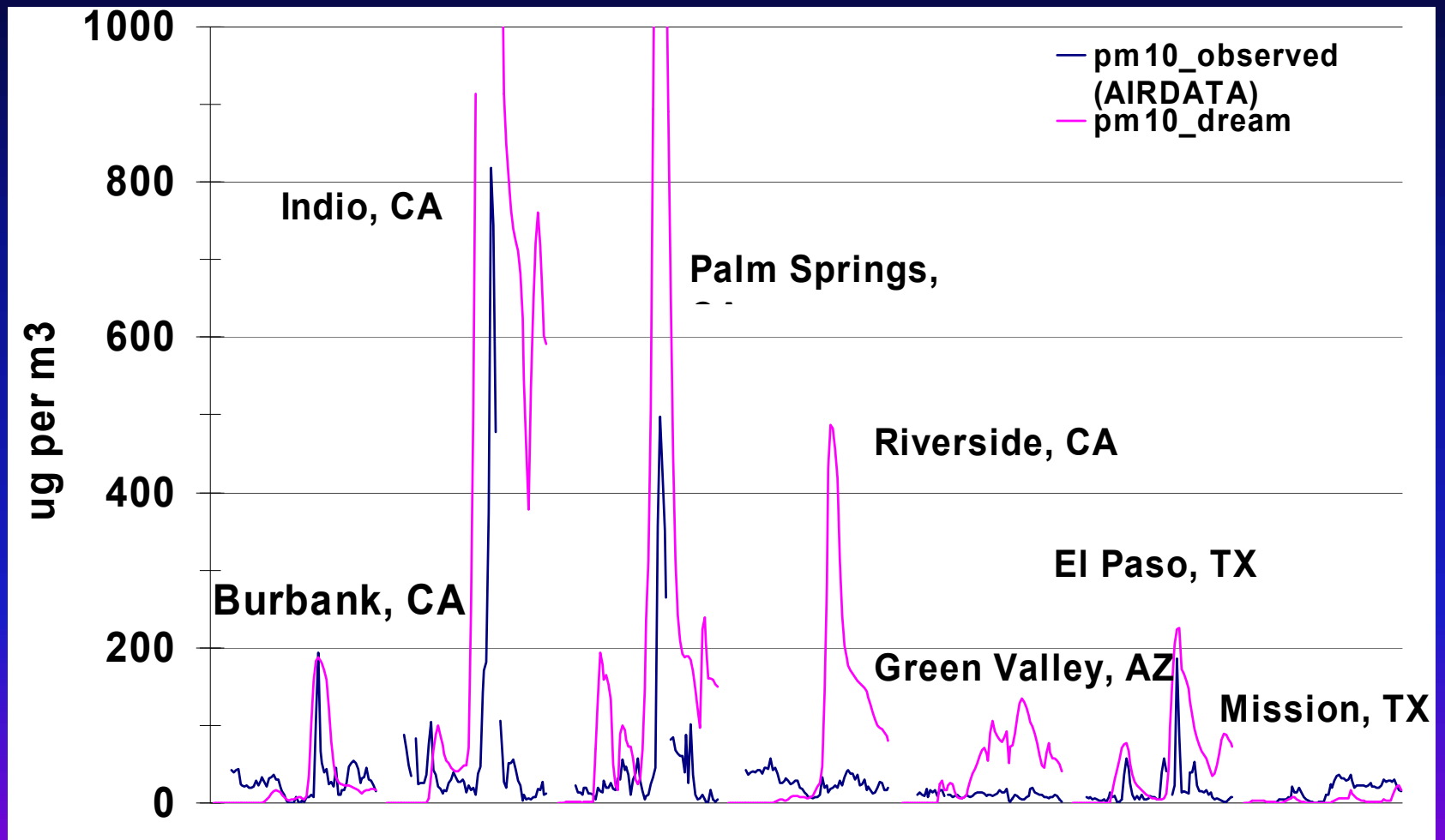
January 2007 AIRNow Data

N ≈ 29K data points from 40 sites in the model domain



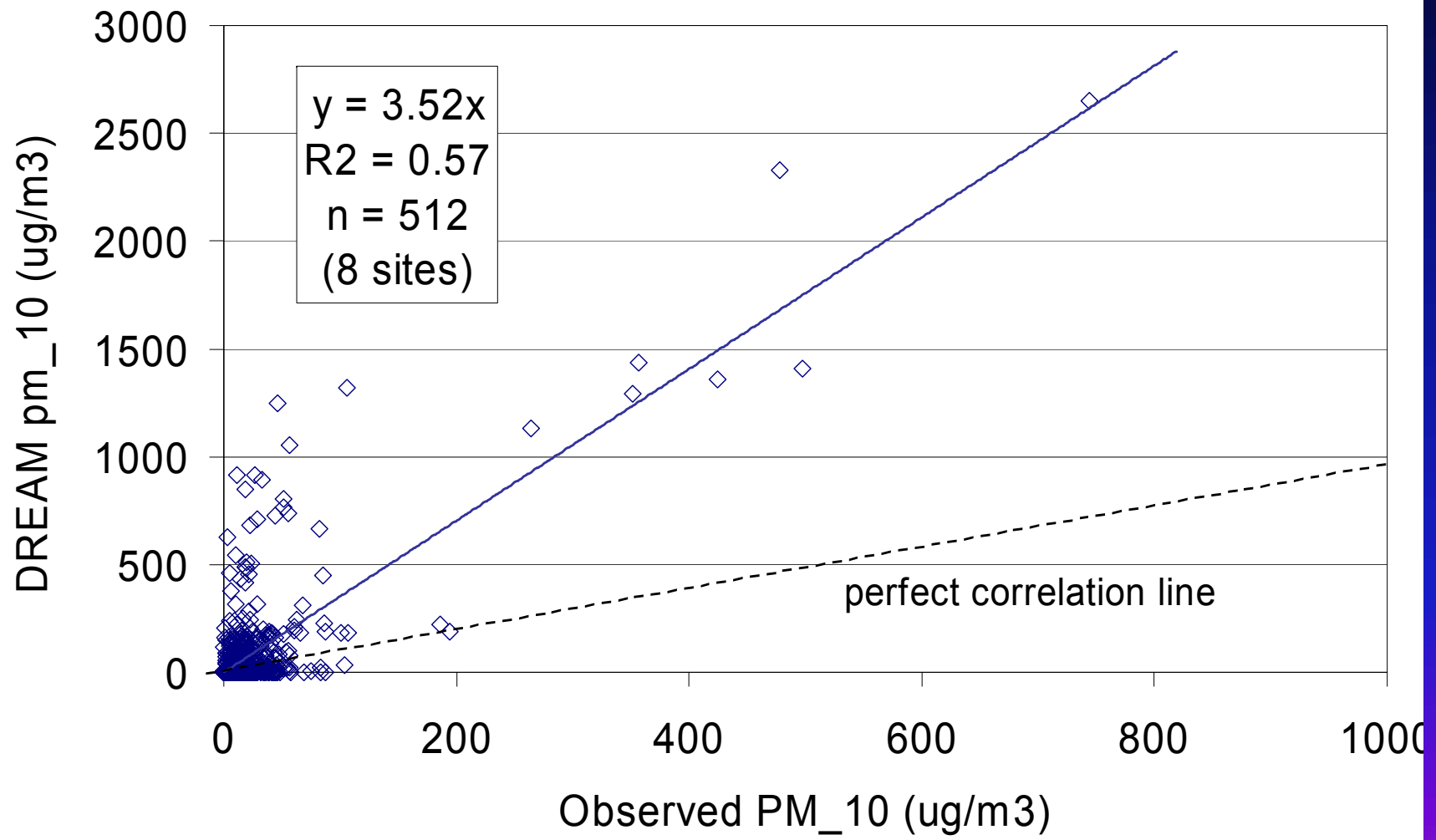


Dust Storm of January 4-6, 2007



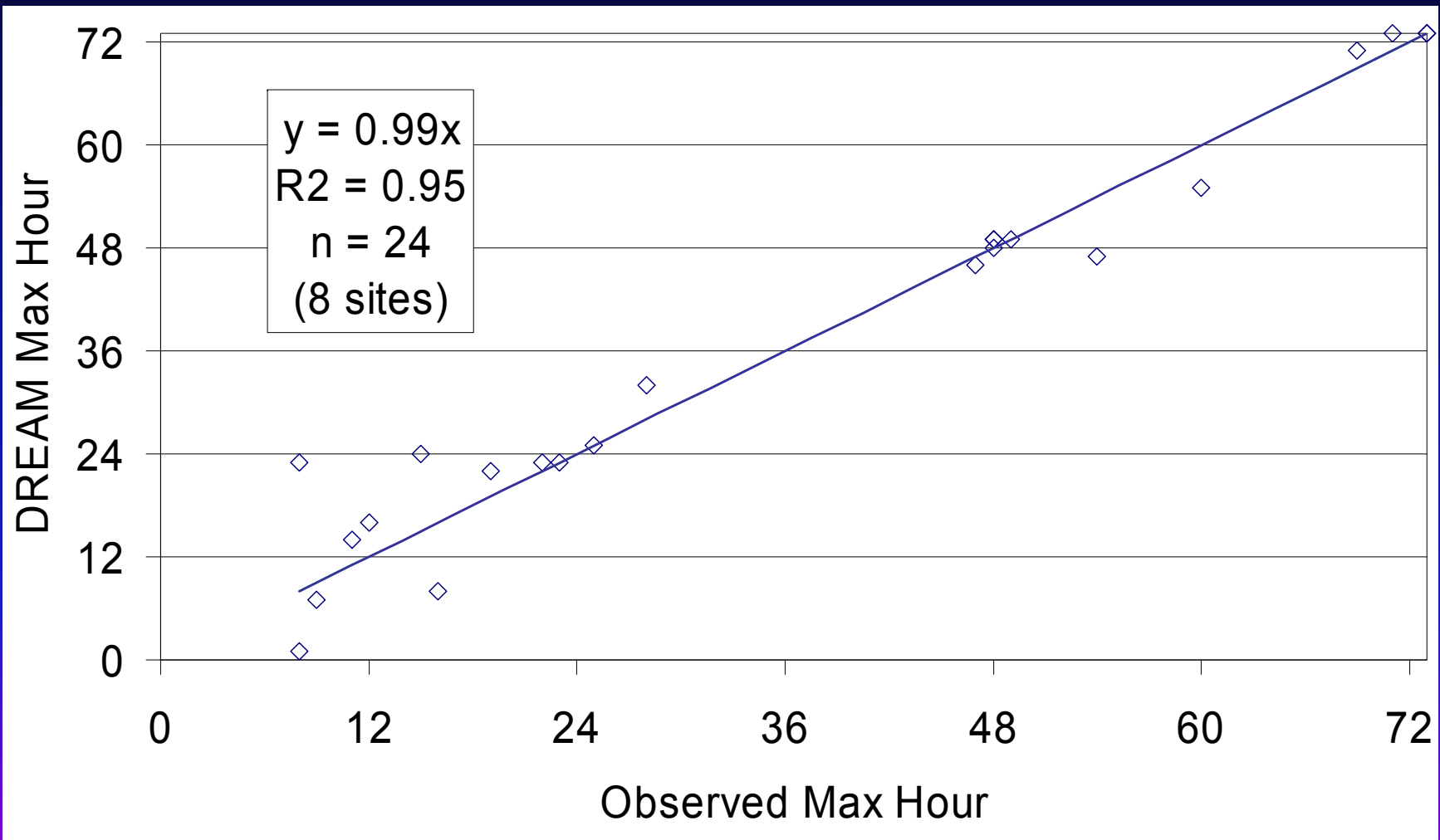


Magnitude Correlation - Jan 4-6, 2007



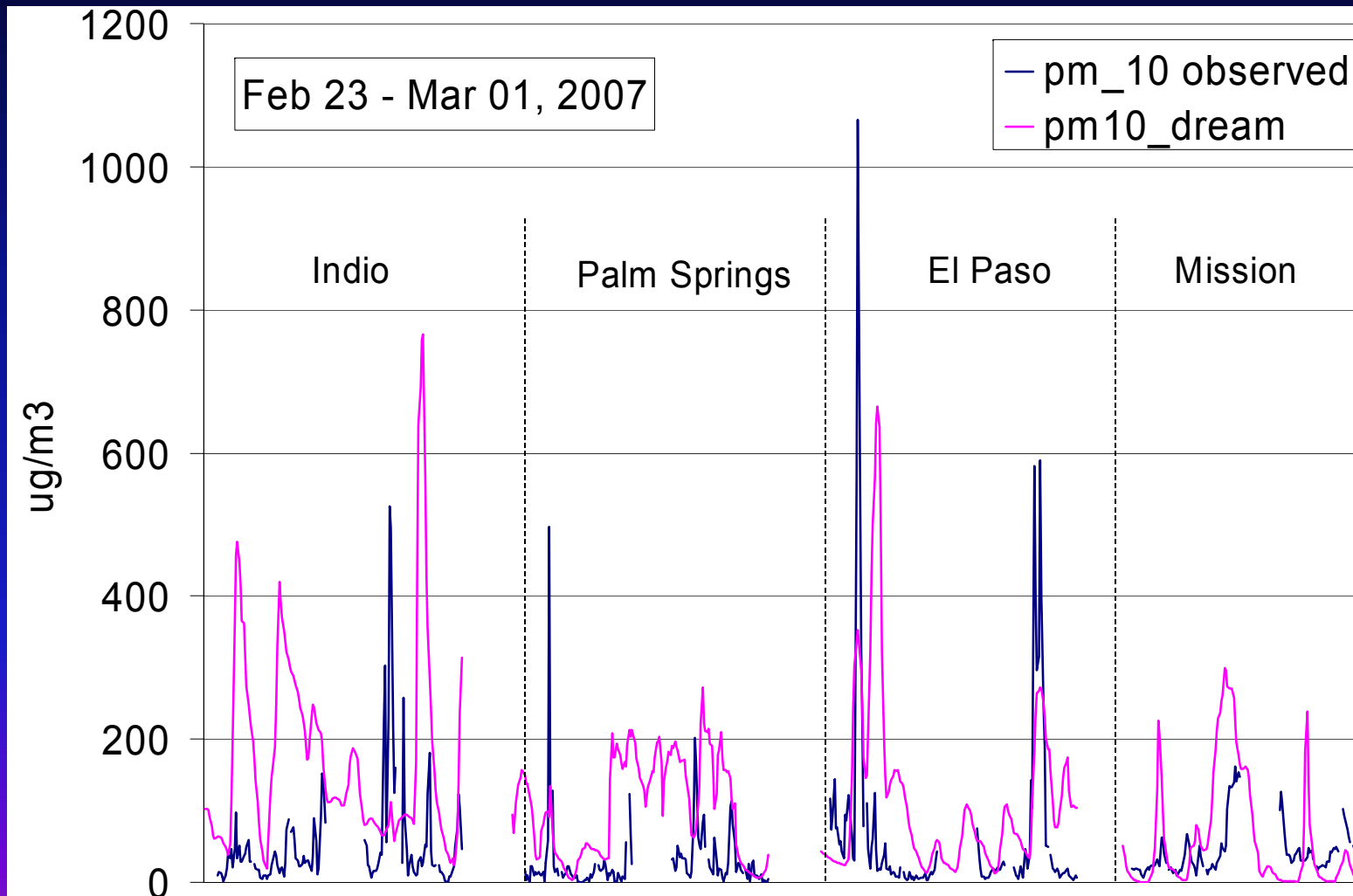


Timing Correlation - Jan 4-6, 2007





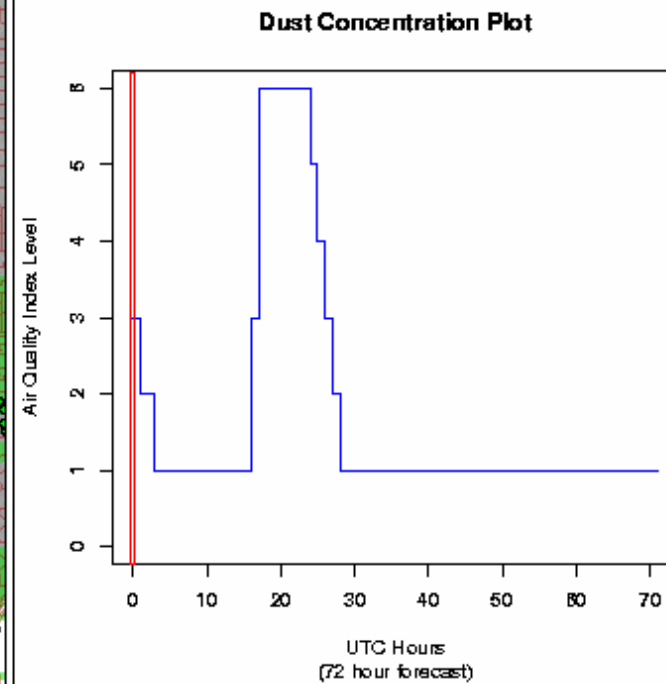
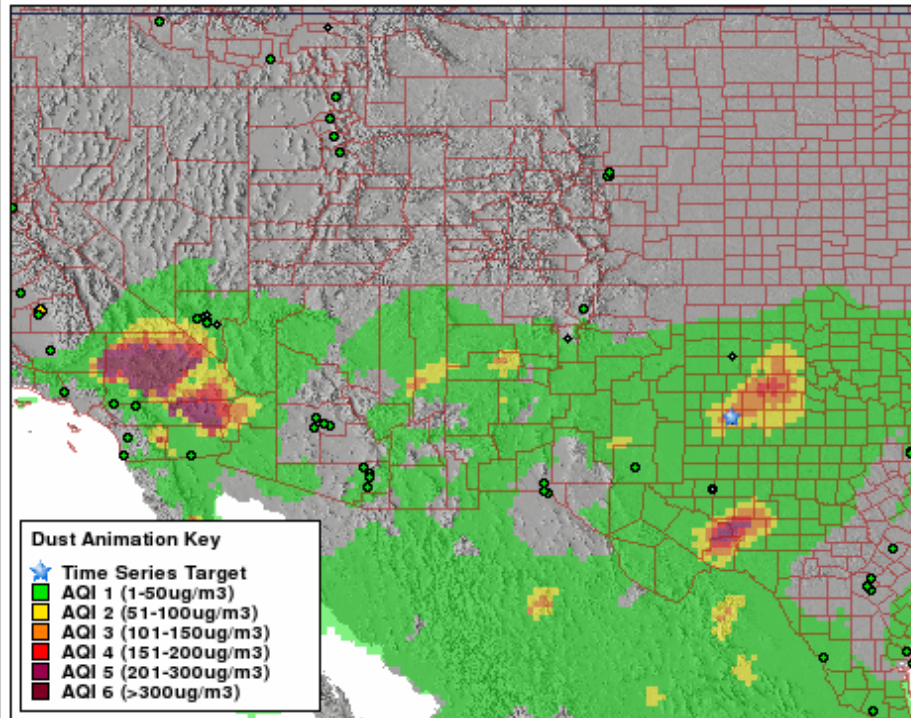
Indio, Palm Springs, El Paso, Mission AIRNow and DREAM Data





Dust Animation (PM-10) 72 Hr Outlook for Lubbock, TX

PHAIRS Dust Animation Client
72 hr Dust Model for Lubbock, TX (PM 10)

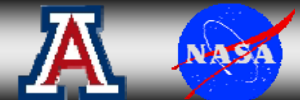


Lubbock, TX (33:39:00N-101:49:11W)

PLAY 200

Date: 12/15/03
UTC Time: 00 hrs
Particle Size Class: PM 10

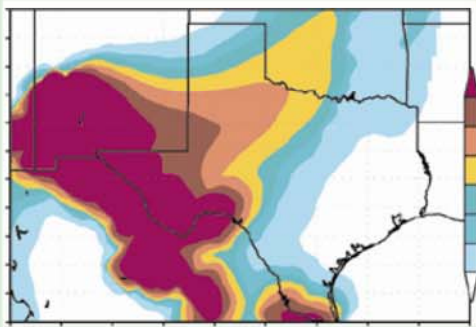
Generate PDF of Current Animation Step





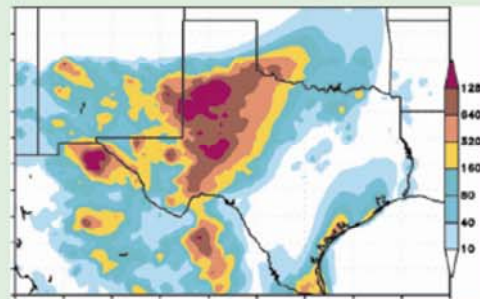
Incremental Improvements to Model Performance

Baseline Model Performance



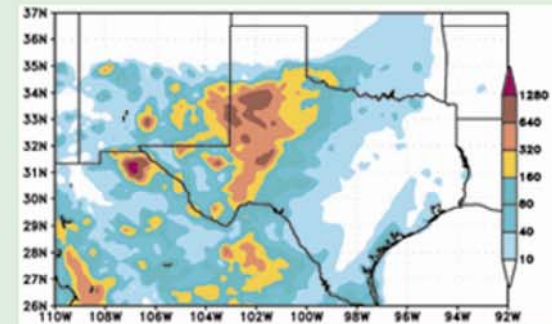
University of Malta
University of New Mexico
University of Arizona

Model Performance After
Assimilating Earth Observation Data



NASA / University of New Mexico
University of Arizona
World Meteorological Organization

Model Performance Using
NCEP/NMM Weather Forecast Model



NASA / University of New Mexico
University of Arizona
World Meteorological Organization



Thank You

<http://phairs.unm.edu>

