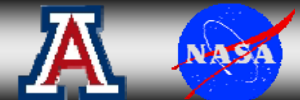




Environmental Surveillance for Public Health

Stan Morain & Amelia Budge
Earth Data Analysis Center
University of New Mexico





PHAIRS Research Team

- PI & Co-PI
 - S. Morain (UNM)
 - W. Sprigg (UA)
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 - K. Benedict (UNM)
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 - J. Speer (TTUHSC)
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 - Beena Chandy (UA)
 - Chris Cattrall (UA)
 - Patrick Shaw (UA)
- Public Health Partners
 - City of Lubbock Dept of Health
 - Pima County Dept of Environmental Quality
 - Arizona Dept of Health Services
 - NM Dept of Health
 - UNM Health Science Center
 - ARES Corporation
 - ABQ Air Quality Office

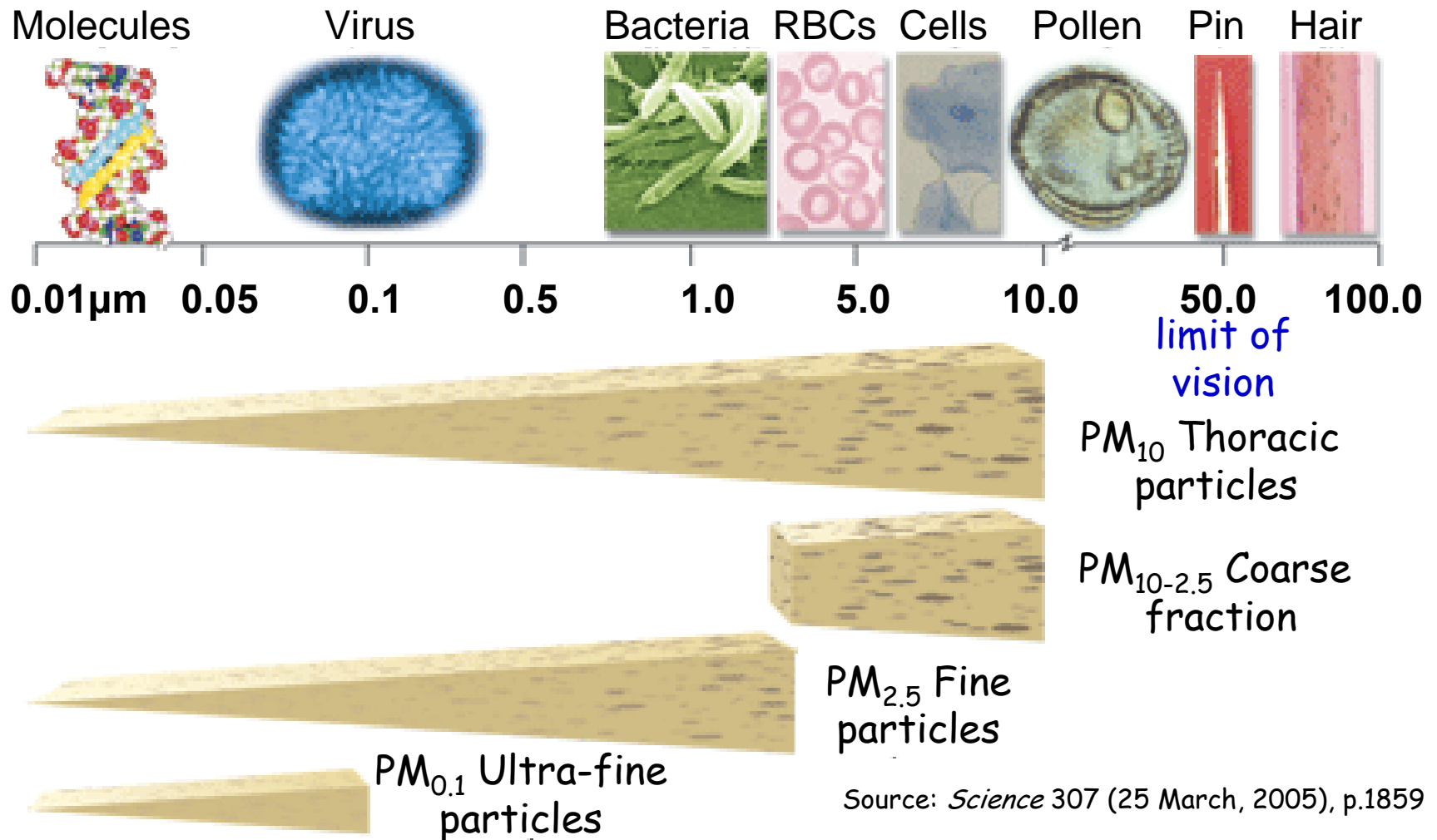


PHAIRS Aims and Goals

Addresses	Does Not Address
Quality of life	Lives saved
Public health	Individual health
Forecasting airborne dust episodes that could affect populations at risk	Forecasting public health <i>per se</i>
Syndromic surveillance (pre-diagnosis)	Disease diagnosis



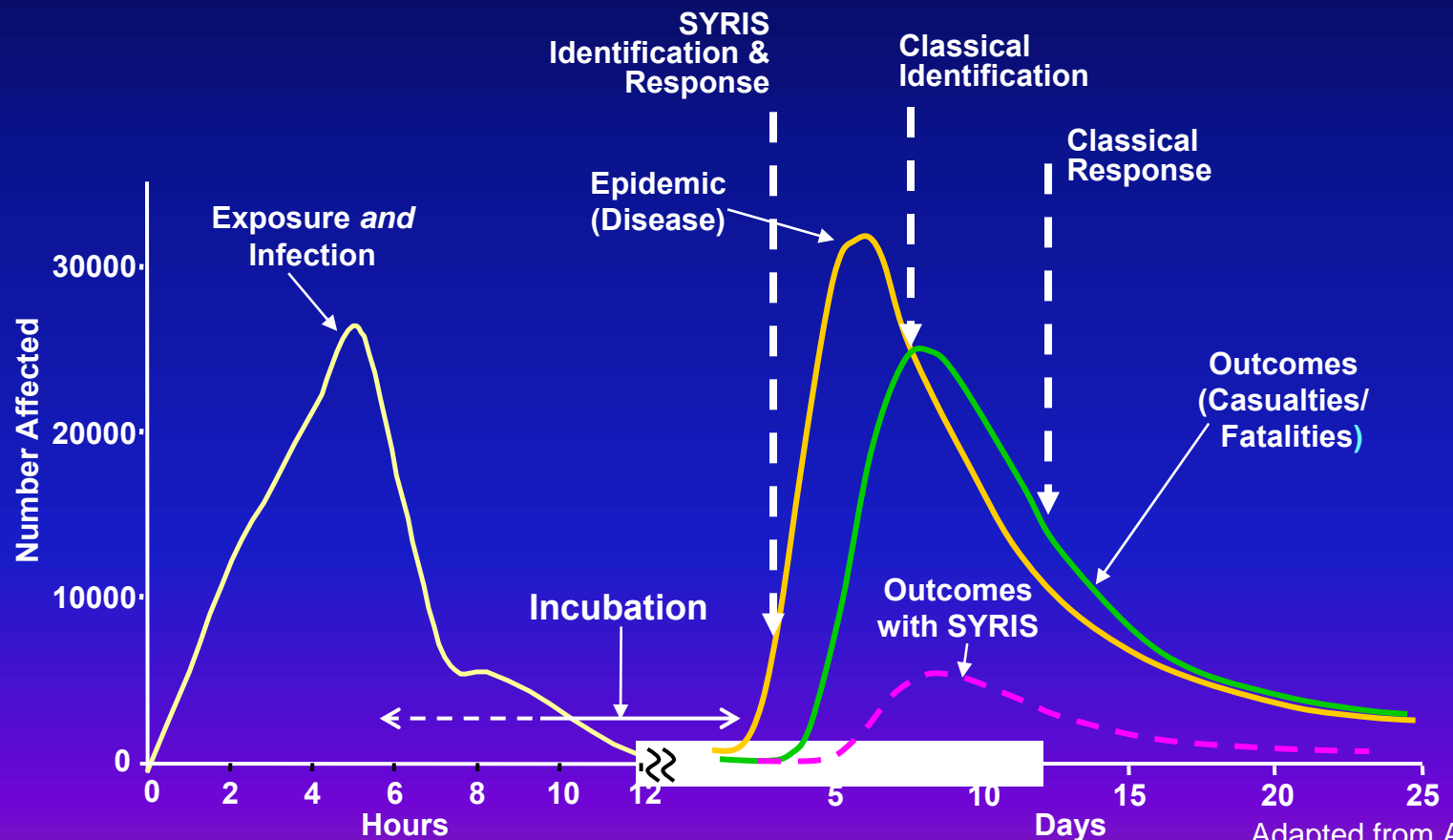
Particulate Matter Size Distribution & Related Biophysical Impacts



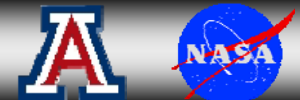


SYRIS = Earlier Detection and Immediate Response to Outbreaks

- Exposure: People/Animals are exposed to infectious agents
- Epidemic: People/Animals begin to show signs of infection
- Outcome: People/Animals begin to die or get very sick
- SYRIS Outcome: 80% fewer People/Animals get sick or die

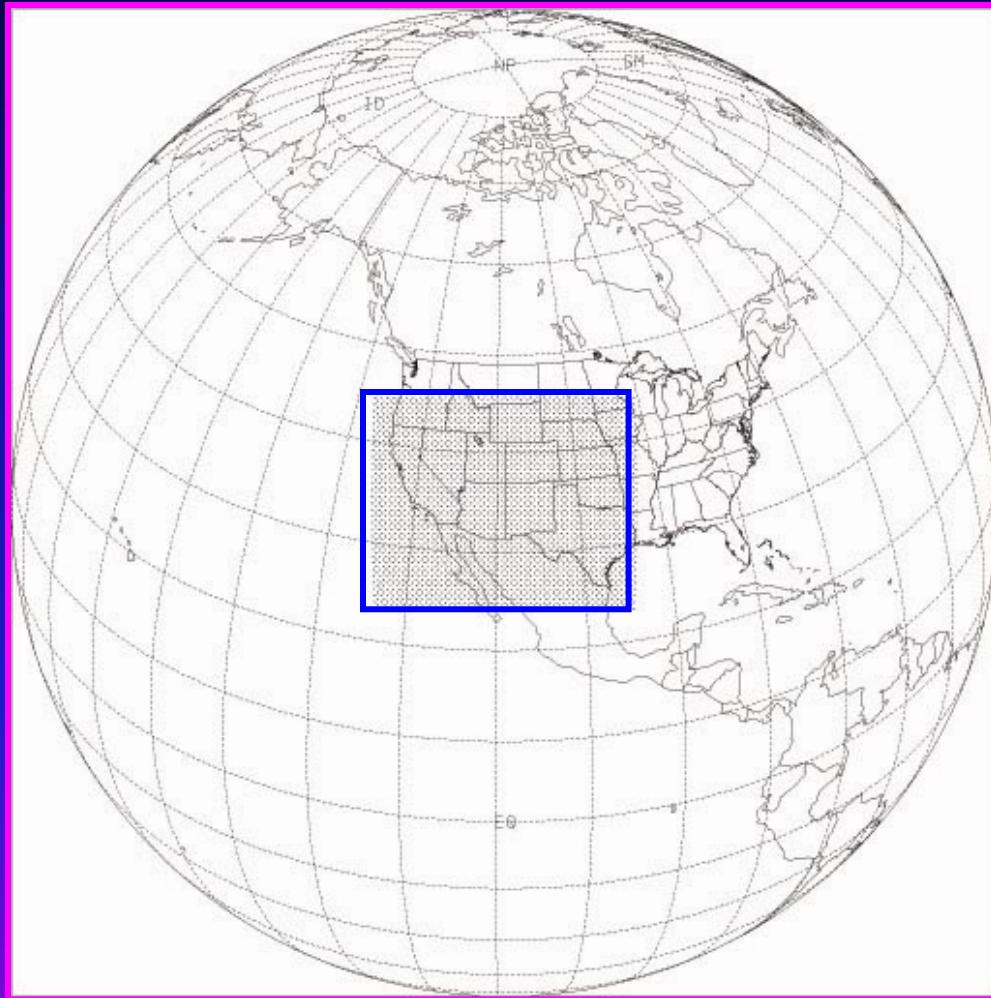


Adapted from ARES, 2007





Model Domain

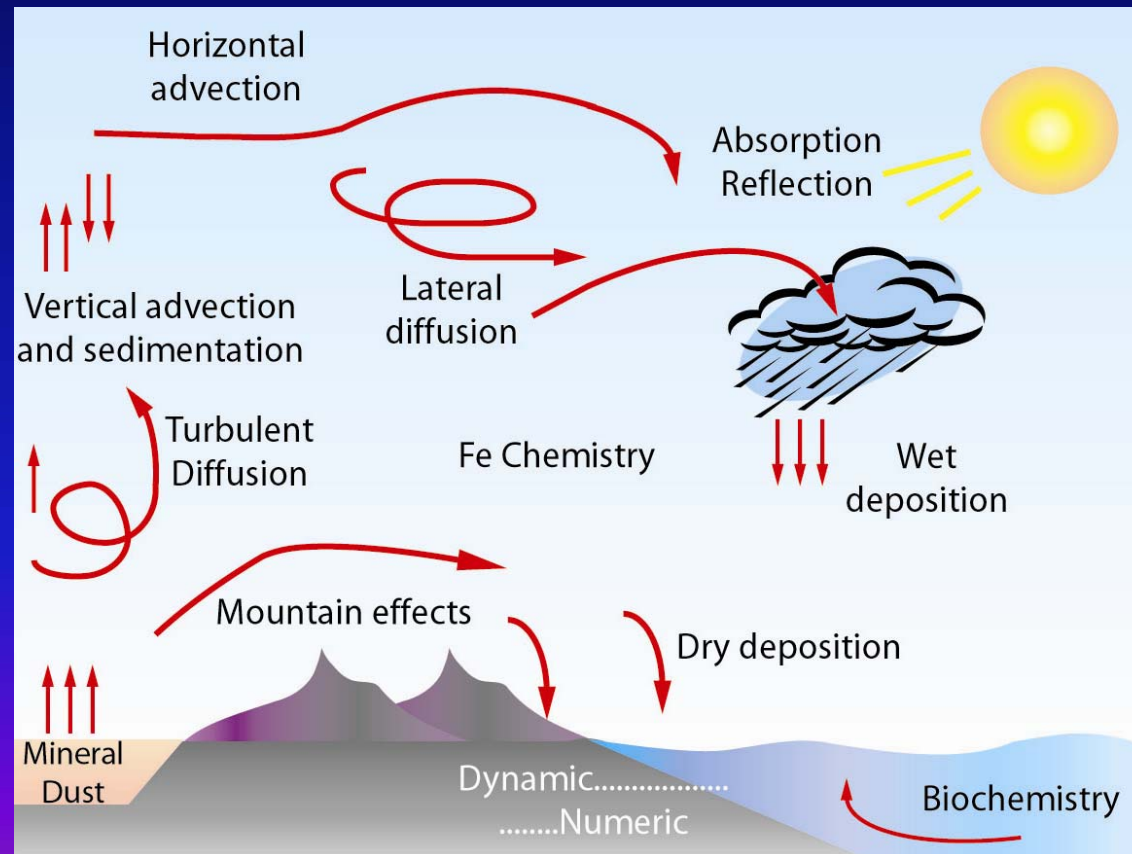


- Domain center at (109°W, 35°N)
- Horizontal semi-staggered Arakawa E grid
- Horizontal grid spacing 1/3 degree



DREAM Equation

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



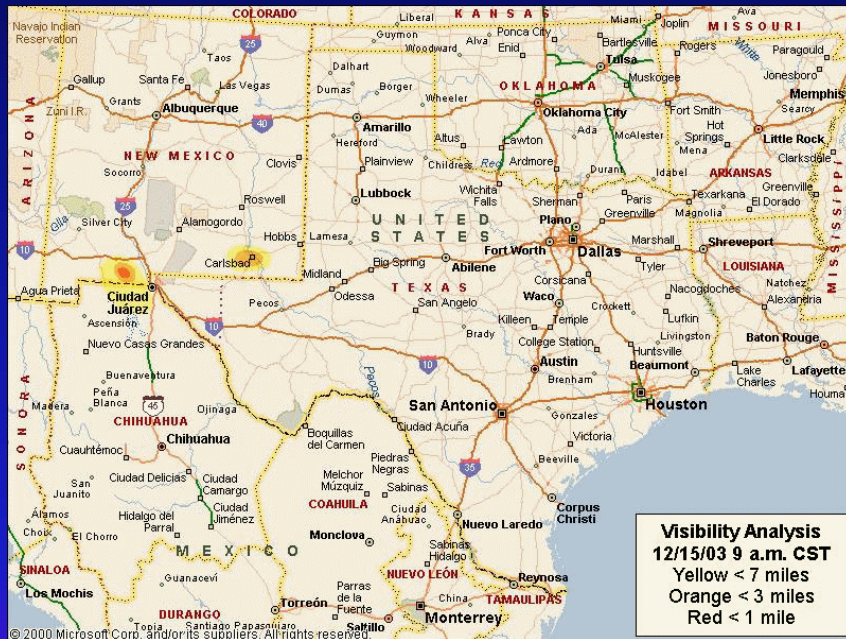


Baseline and Replacement Parameters

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

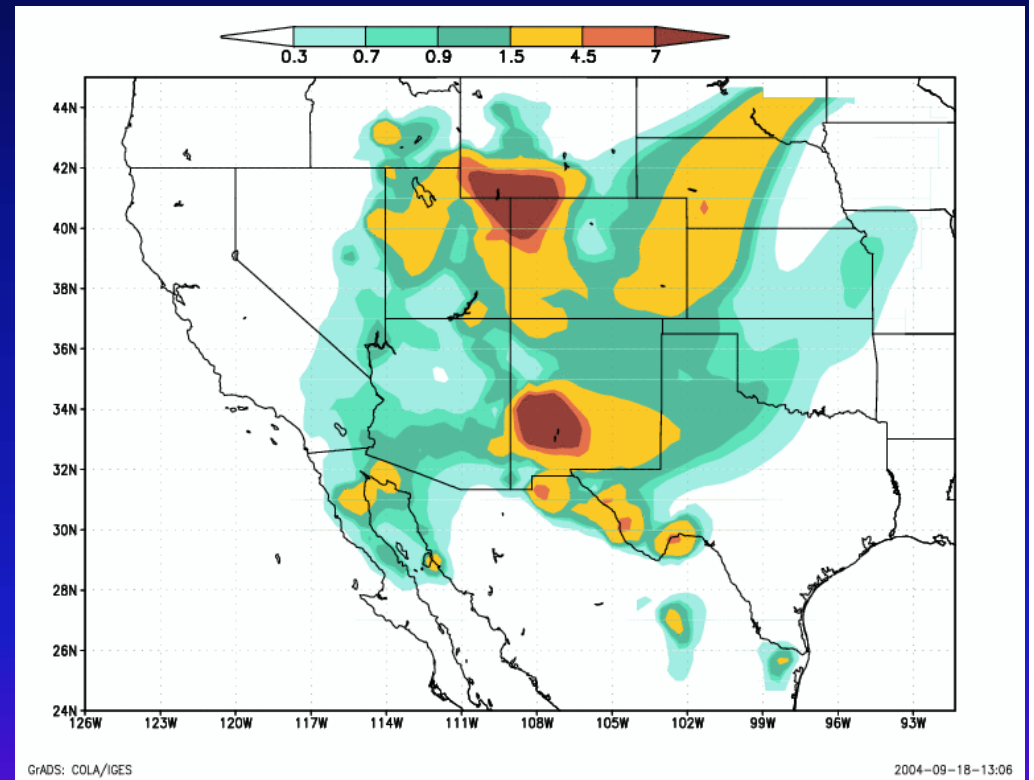


Observed Visibility vs. Modeled Dust Concentrations Dec. 15-16, 2003

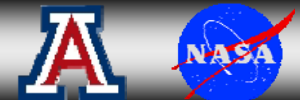


Texas

Continuous Air Monitoring Stations



DREAM Baseline (no EO data included)





Assimilation vs. Fusion

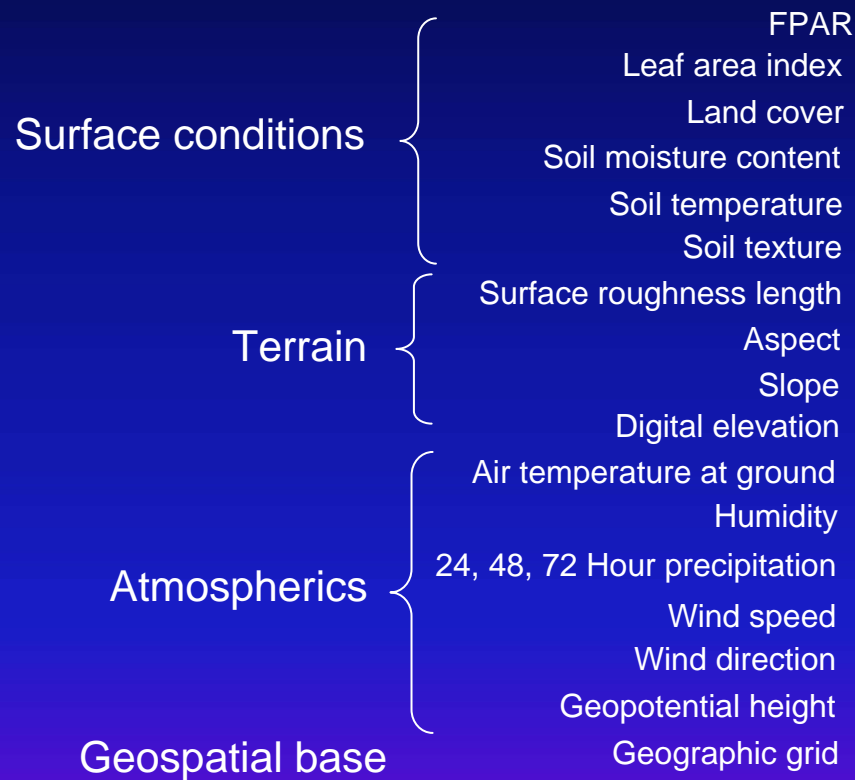
Assimilation: The process of replacing selected static parameters in an Earth system model with digital pixel values from Earth observation data sets to improve the model's performance and convert it into a more dynamic (forecasting) form without changing the model's intended purpose.

Fusion: The process of including EO image products (at any of several levels of processing) into a GIS architecture in such a way that the datasets, both vector and raster, are geospatially registered at a specified scale. This usually requires sub-setting, re-projection and rescaling of fused data.



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.



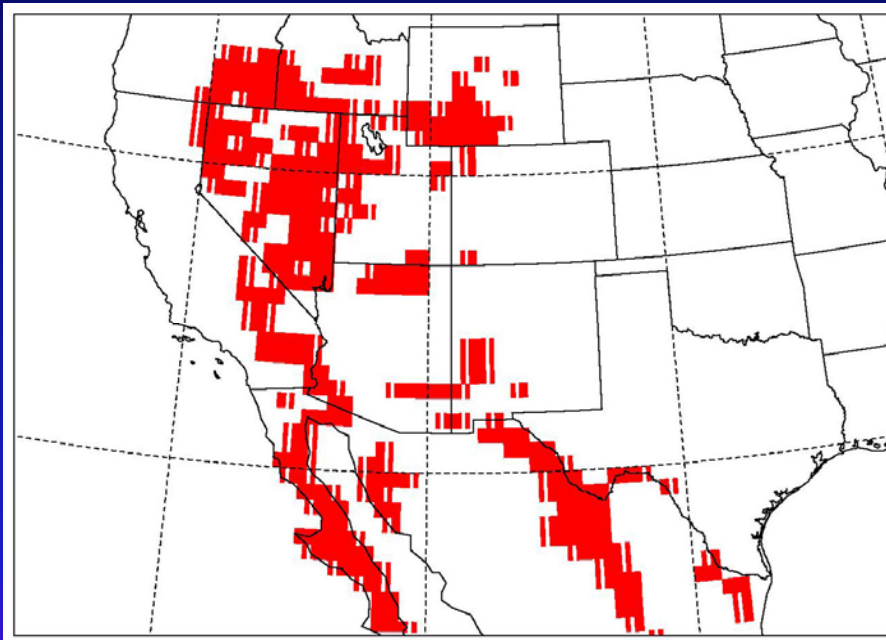


Steps in Assimilation

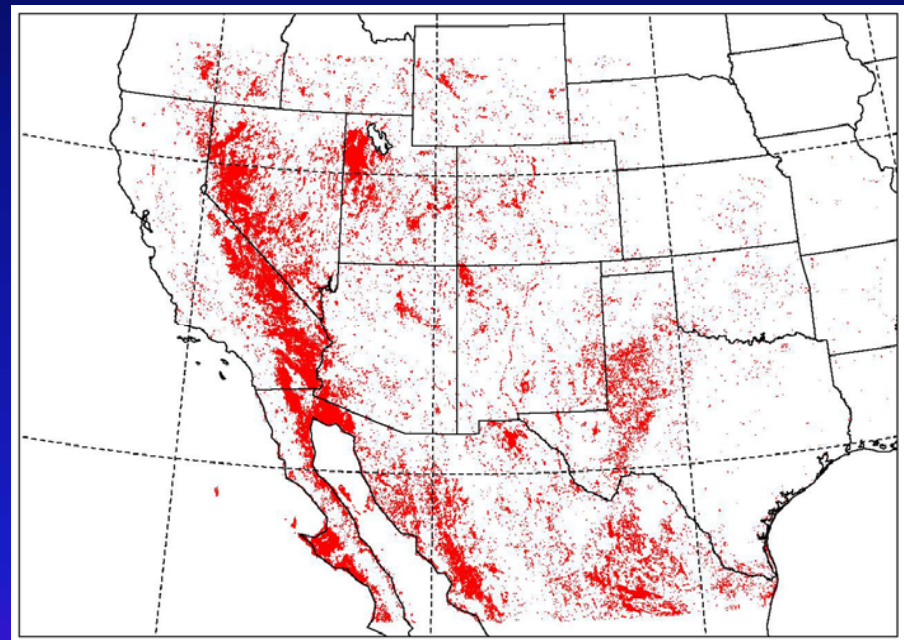
- Assess metadata & attributes of current model inputs and of possible EO inputs
 - Measurement units
 - x,y,z Resolution
 - Temporal frequency
 - Projection
 - File formats
 - Validity & accuracy
 - Error & error propagation
- Select EO inputs based on highest perceived benefit for enhancing model output
- Replace model input with EO data and compare model outputs
- Iterate with successive EO inputs
- Measure improvements at each stage and document overall performance improvements



Barren Ground (Potential Dust Sources)



Olson World Ecosystems



MOD12Q1 Land cover
reduced to binary format

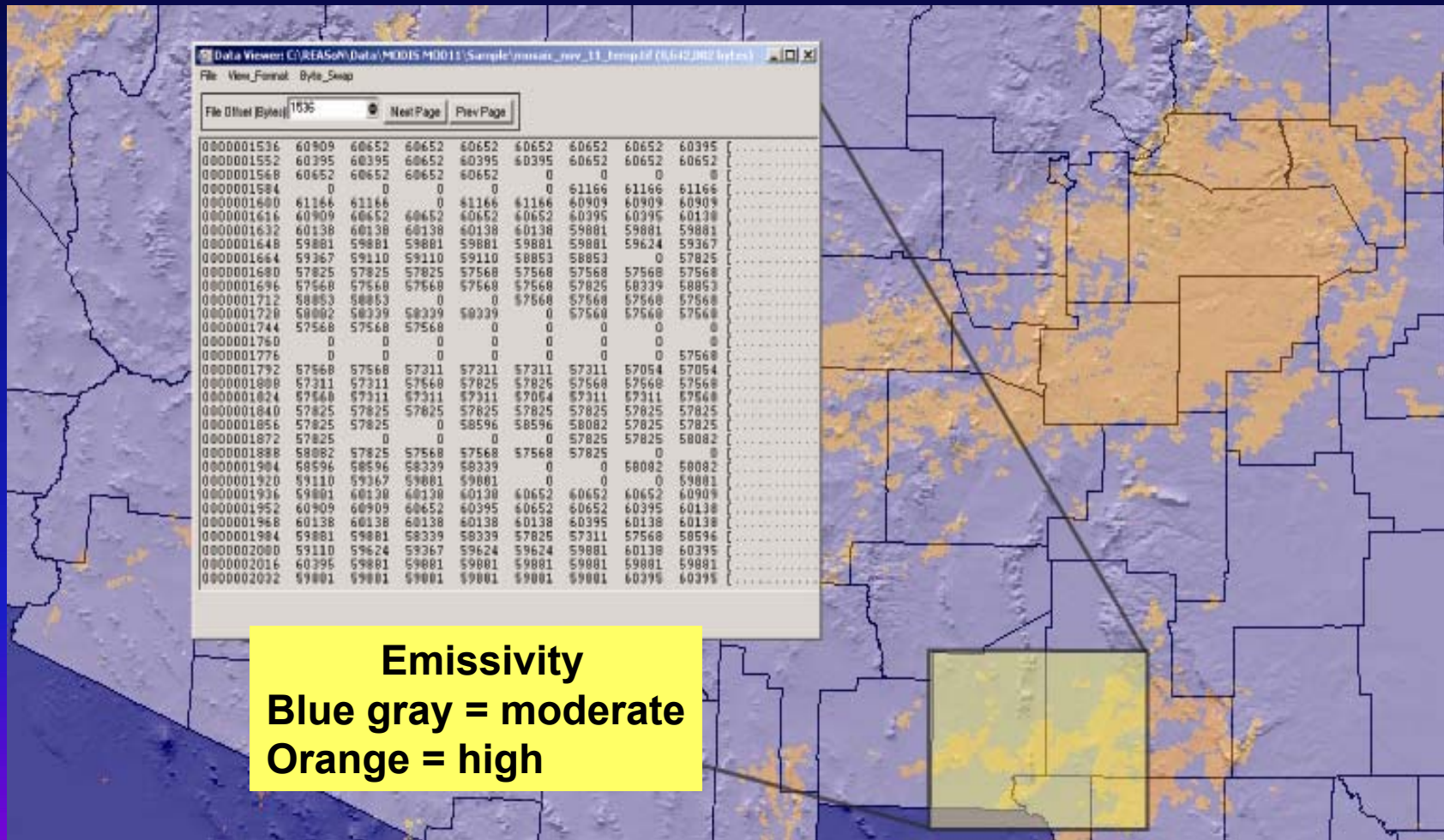


Aerodynamic Surface Roughness (z_0) Controls Dust Entrainment

<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



TERRA/MODIS MOD11A1 Land Surface Temperature/Emissivity-Daily 1-km





Sample Model Runs of NCEP/eta + DREAM with and w/o Assimilated EO Data

<i>Run #</i>	<i>MOD12</i>	<i>SRTM</i>	<i>Surface roughness length</i>	<i>FPAR</i>	<i>AMSR-E</i>
<i>Run 1a</i>					
<i>Run 2c</i>	Y				
<i>Run 4a</i>	Y	Y			
<i>Run 5a</i>	Y	Y	Y		
<i>Run 5b</i>	Y	Y	Y		
<i>Run 6a</i>	Y			Y	
<i>Run 15a</i>	Y				Y
<i>Run 10a</i>	Y	Y	Y		Y



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	$1 - \frac{\sum_{i=1}^N (M_i - O_i)^2}{\sum_{i=1}^N (M_i - \bar{O} + O_i - \bar{O})}$

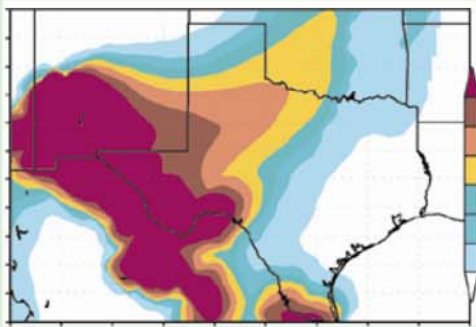
Blue = before EO Data Assimilation

Red = after EO Data Assimilation



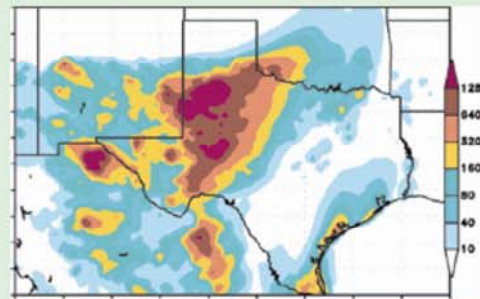
Incremental Improvements to Model Performance

Baseline Model Performance



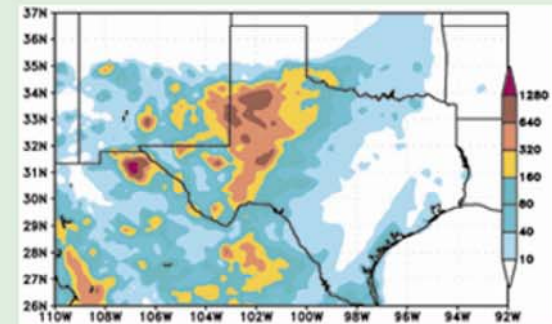
University of Malta
University of New Mexico
University of Arizona

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



Enhancing DSS & Surveillance Tools



Help

Login Public Health Alerts Contact Information

Fever with Skin Rash

Raw Report Count

Local Map of Syndrome

Reports Per Day

PHAIRS 7.0 Mapping Client - Netscape

http://phairs-devel.unm.edu:8080/cgi-bin/mapmodule7_client.py?map_size=smallayer+us_cen...

PHAIRS 7.0 Mapping Client - Netscape

http://phairs-devel.unm.edu:8080/cgi-bin/mapmodule7_client.py?map_size=smallayer+us_cen...

Detailed Inform

5/5/05: Cases of fever with skin rash have been reported which appear to be related to the "Fever with Skin Rash" syndrome. Please report all cases of fever with skin rash to the PHAIRS team.

Jul 15, 2005 11:48:

PHAIRS 7.0 Mapping Client - Netscape

PHAIRS 7.0 Mapping Client - Netscape

PHAIRS Dust Modeling Client

72 hr Dust Model for Albuquerque, NM (PM 2.5)

Dust Concentration Plot

Alt. Quality Index Level

UTC Hours (22 hr Interval)

Albuquerque, NM (35:06:00N 106:36:00W)

Dust Animation Key

- Time Series Target
- AGI 1 (1-500 ug/m3)
- AGI 2 (51-1000 ug/m3)
- AGI 3 (101-1500 ug/m3)
- AGI 4 (151-2000 ug/m3)
- AGI 5 (201-2500 ug/m3)
- AGI 6 (2500 ug/m3)

Date: 12/15/03 UTC Time: 12 hrs Particle Size Class: PM 2.5

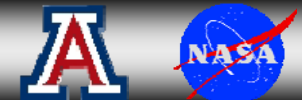
Generate PDF of Current Animation Step

Return to Syndrome Overview

DREAM Model Output

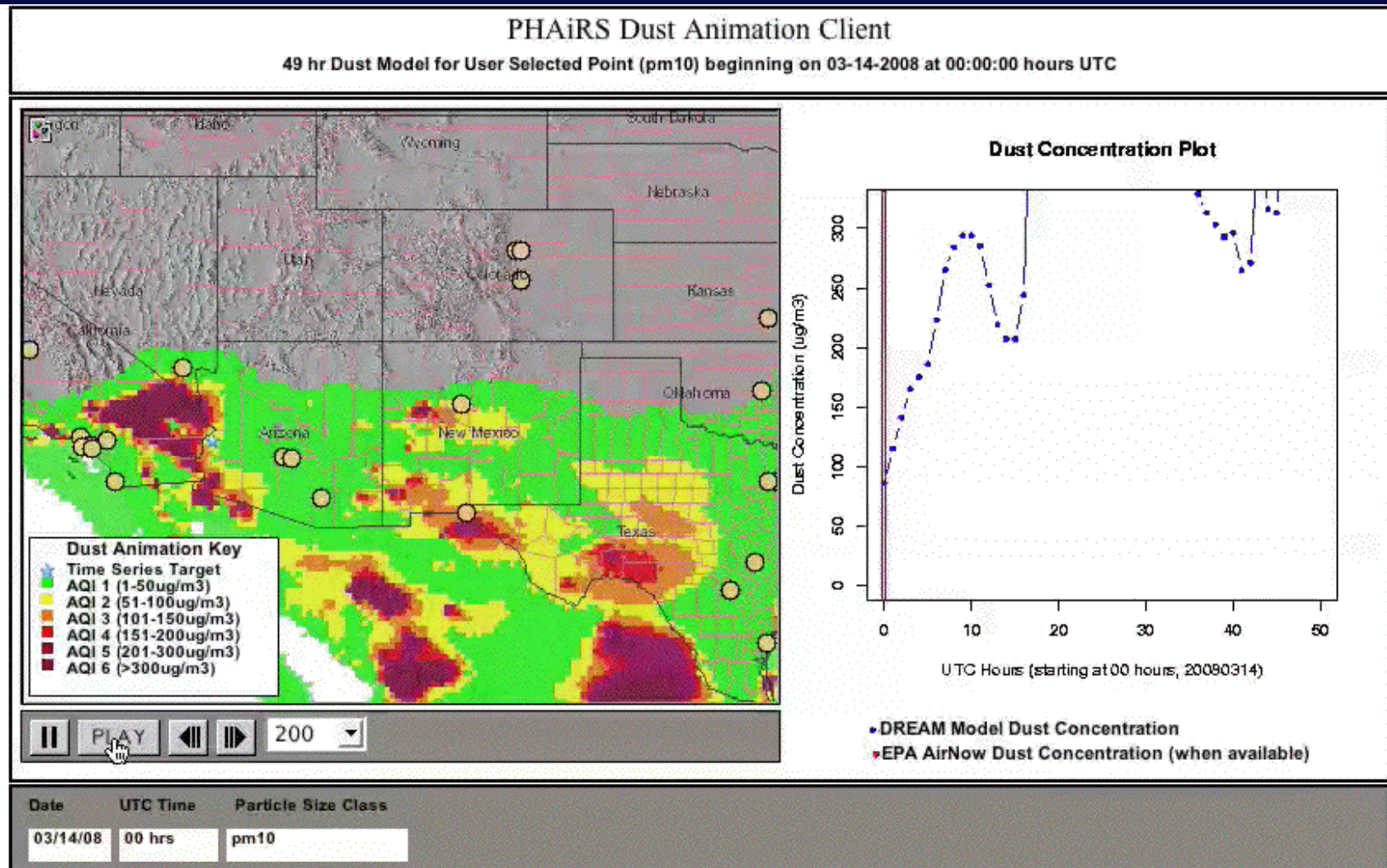
Jul 15, 2005 11:48:36 AM

Report Syndrome Log Out





Dust Storm Animation (PM-10) 49 Hr Outlook for Yuma, AZ (14 Mar 08)





DREAM Data Access and Statistical Wizard

Data Access

Download EPA PM2.5 Data (returns all data for all sites within the DREAM domain area)

Begin Date (YYYYMMDD) End Date (YYYYMMDD)
 [Download PM2.5 File](#) [Clear Date Fields](#)

Download EPA PM2.5 Data for a Single Site Within the DREAM Domain Area

Begin Date (YYYYMMDD) End Date (YYYYMMDD) Station ID-Name
 4013401

Download EPA PM10 Data (returns all data for all sites within the DREAM domain area)

Begin Date (YYYYMMDD) End Date (YYYYMMDD)

Download EPA PM10 Data for a Single Site Within the DREAM Domain Area

Begin Date (YYYYMMDD) End Date (YYYYMMDD) Station ID-Name
 4013401

View a Table of Observed and Modelled Data for a Single Station

Date (MM-DD-YYYY) Time (HH:MM:SS)
 01-01-2006 00:00:00 UTC

View a Table of Observed and Modelled Data for a Single Station

Date (MM-DD-YYYY) Particle Size
 01-01-2006 PM 2.5

View a Table of Observed and Modelled Data for a Single Station Run

Date (MM-DD-YYYY) Station ID-Name
 01-01-2006 40134010-DYSART

View a Table of Observed and Modelled Data for a Single Station Run

Begin (MM-DD-YYYY) End (MM-DD-YYYY) Station ID-Name
 01-01-2006 01-01-2006 40134010-DYSART

Statistical Functions

Generate Statistics for a Single Station for a Single Run

Date (MM-DD-YYYY) Station ID-Name
 01-01-2006 40134010-DYSART

Generate Statistics for a Single Station for a Single Run

Begin (MM-DD-YYYY) End (MM-DD-YYYY) Station ID-Name
 01-01-2006 01-01-2006 40134010-DYSART

Table of Observed and Predicted (DREAM) PM25 Values for the 48-hour period beginning 04/15/2007 (Station No. 350011013 / North Valley)

To save as a CSV file, right click on the link below, select 'Save Link As', and then provide a new filename with a .csv extension in the dialog box

[Download CSV File](#)

Station ID	Station Name	Latitude	Longitude	EPA Observed (ug/m3)	DREAM Model Value (ug/m3)	Datetime (YYYY-MM-DD"TT"HH:00:00)
350011013	North Valley	35.1878	-106.604	9.0	1.0075000279	2007-04-15T00:00:00
350011013	North Valley	35.1878	-106.604	7.0	0.9468014626	2007-04-15T01:00:00
350011013	North Valley	35.1878	-106.604	8.0	0.9998162003	2007-04-15T02:00:00
350011013	North Valley	35.1878	-106.604	10.0	1.063272094	2007-04-15T03:00:00
350011013	North Valley	35.1878	-106.604	10.0	1.1059926713	2007-04-15T04:00:00
350011013	North Valley	35.1878	-106.604	10.0	1.1227573542	2007-04-15T05:00:00
350011013	North Valley	35.1878	-106.604	9.0	1.1235294097	2007-04-15T06:00:00
350011013	North Valley	35.1878	-106.604	8.0	1.14150731	2007-04-15T07:00:00
350011013	North Valley	35.1878	-106.604	7.0	1.2136764386	2007-04-15T08:00:00
350011013	North Valley	35.1878	-106.604	7.0	1.3928309083	2007-04-15T09:00:00
350011013	North Valley	35.1878	-106.604	7.0	1.6509559225	2007-04-15T10:00:00
350011013	North Valley	35.1878	-106.604	8.0	1.9005882389	2007-04-15T11:00:00
350011013	North Valley	35.1878	-106.604	9.0	2.1024263957	2007-04-15T12:00:00
350011013	North Valley	35.1878	-106.604	8.0	2.2592646234	2007-04-15T13:00:00
350011013	North Valley	35.1878	-106.604	7.0	2.2293381831	2007-04-15T14:00:00
350011013	North Valley	35.1878	-106.604	8.0	2.0158823799	2007-04-15T15:00:00
350011013	North Valley	35.1878	-106.604	8.0	1.9149264869	2007-04-15T16:00:00
350011013	North Valley	35.1878	-106.604	7.0	4.448529552	2007-04-15T17:00:00
350011013	North Valley	35.1878	-106.604	6.0	6.8639706163	2007-04-15T18:00:00
350011013	North Valley	35.1878	-106.604	6.0	12.3272054336	2007-04-15T19:00:00
350011013	North Valley	35.1878	-106.604	6.0	20.8937504712	2007-04-15T20:00:00
350011013	North Valley	35.1878	-106.604	2.0	27.4044121013	2007-04-15T21:00:00
350011013	North Valley	35.1878	-106.604	4.0	30.1459564882	2007-04-15T22:00:00
350011013	North Valley	35.19	-106.6	missing	30.1911774804	2007-04-15T23:00:00
350011013	North Valley	35.1878	-106.604	6.0	31.2290444094	2007-04-16T00:00:00
350011013	North Valley	35.1878	-106.604	7.0	32.4169130886	2007-04-16T01:00:00
350011013	North Valley	35.1878	-106.604	8.0	30.877940795	2007-04-16T02:00:00
350011013	North Valley	35.1878	-106.604	7.0	29.4794110691	2007-04-16T03:00:00
350011013	North Valley	35.1878	-106.604	6.0	28.7514714634	2007-04-16T04:00:00

Data Access & Statistics





New Directions

- Particle speciation of PM_{2.5} using A-Train
- High Performance Computing-model runs
- Dust source updates – e.g. seasonal
- Vertical profile verification



Future Program Activities

- SDSWAS - WMO
- Rapid Prototyping for Pollen – MSFC, UA, UNM
- Interoperability – UA, UNM, GMU, GSFC
- SYRIS - AZ, NM, TX AQ Authorities & HSCs
- EPHTS & EPHTN – NMDOH, UNM, UA CDC
- EPA Workshop – Proposal stage, topic TBD
- ICSU 2008 Grant Proposal – ISPRS, UNM