

**Architecture and Functionality of the PHAiRS
(Public Health Applications in Remote Sensing)
Web Services**

William Hudspeth, Karl Benedict, Amy Budge
Earth Data Analysis Center
University of New Mexico
Albuquerque, New Mexico, USA

At-Risk Populations

Environmentally induced health risks to populations respiratory illnesses are a growing concern globally particular concern are dust and smoke particles in atmosphere.

PM_{2.5} – particles < 2.5 μm diameter

PM₁₀ – particles < 10 μm diameter

Syndromic Surveillance Systems

Many syndromic surveillance systems have been developed in recent years to provide electronic access to information on a variety of diseases and syndromes. A few have enhanced their tools with mapping and visualization technologies.

Rapid Syndrome Validation Project (RSVP)

Syndrome Reporting Information System (SYRIS)

Applications in Remote Sensing

Jointly developed by the Earth Data Analysis Center at University of New Mexico, and the Department of Atmospheric Sciences at the University of Arizona

Funded under NASA's REASoN program

A decision-support system aimed at providing public health officials with early detection and analysis of dust storms to enhance ability to warn populations at risk

Assimilates NASA data sets (MOD12) into the Dust Regional Atmospheric Model (DREAM) – Slobodan Nickovic et al. 2001

DREAM forecasts atmospheric concentration of both PM_{2.5} and PM₁₀ particle size classes

Project Goals

Development of technologies that streamline the ingestion of new environmental data into the system

Providing map data, image services, and analytical functions that can be accessed from and integrated into decision-support systems

Develop a free-standing, web-based interactive mapping environment as a demonstration of the web services provided by PHAiRS

PHAIRS Development Effort

Automate download of environmental data (NCEP, NOAA NOMADS) used in the DREAM model

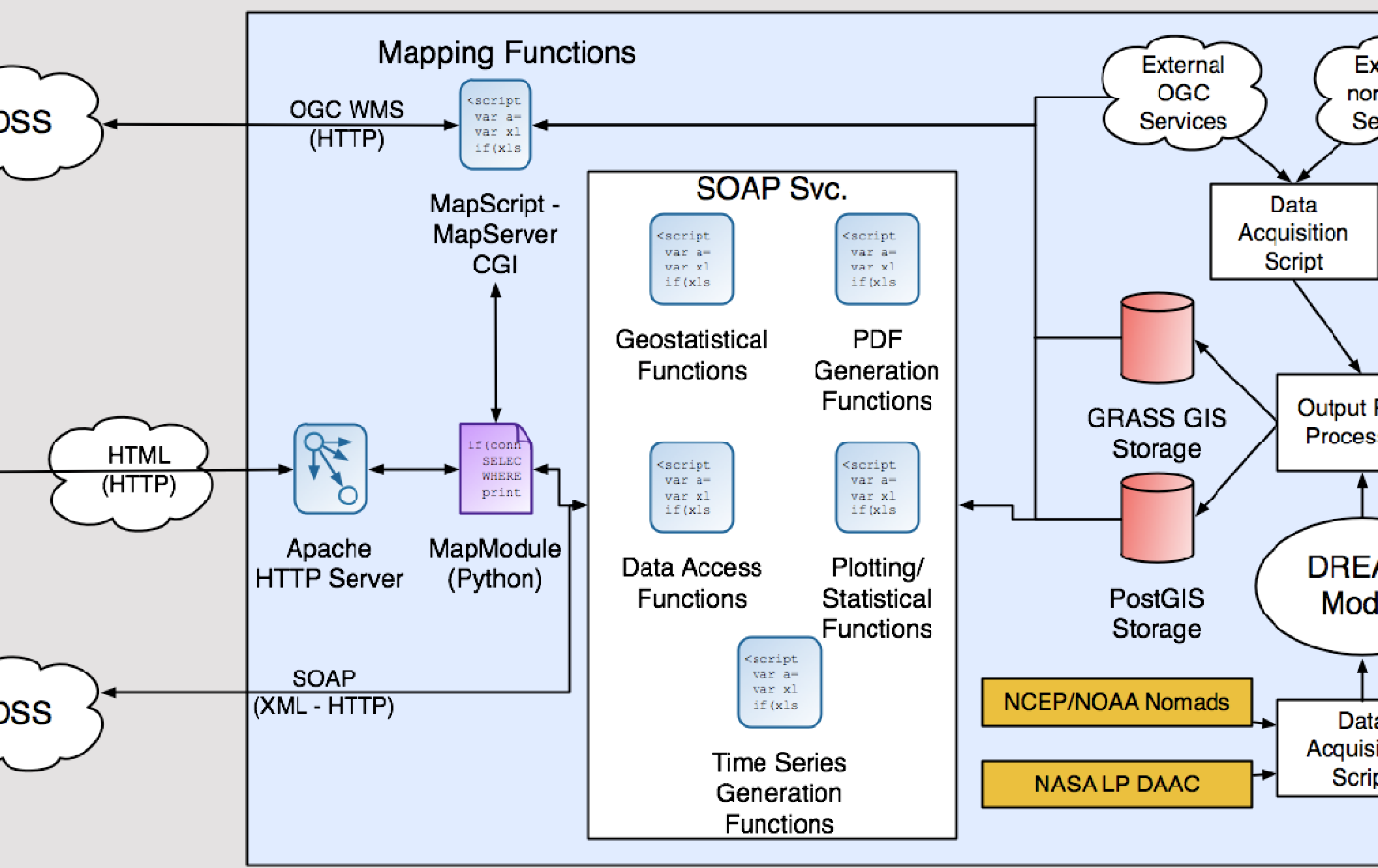
Automate download and archiving of EPA AIRNow particulate data for verification and validation of DREAM model outputs

Automate daily runs of the DREAM model, each providing a 48-hour concentration forecast for 6 particle size bins (4 bins and 2 derived proxies for PM_{2.5} and PM₁₀)

Post-processing of DREAM output data to create archive of raster images and dust concentration data for decision-support systems

Development of web services for mapping, data retrieval, and statistical analysis

PLATFORS Development Framework



Product Delivery

Data processing/
product generation

Data Storage/Provision

Data Acquisition

- Daily Retrieval
 - EPA AIRNow PM_{2.5} and PM₁₀ hourly data for 80+ EPA measurement locations within the model domain from [DataFed](#). Imported into PostgreSQL/PostGIS Database.
 - 72-hour NOAA Global Forecast (GFS) data for DREAM model initialization from two NOAA data sources. Stored in two separate directories on file system.

Model Execution

Initiated Daily Execution of DREAM model
beginning in early 2007

Verify availability of initialization parameters

Execute the DREAM model

DREAM output conversion from binary to ASCII

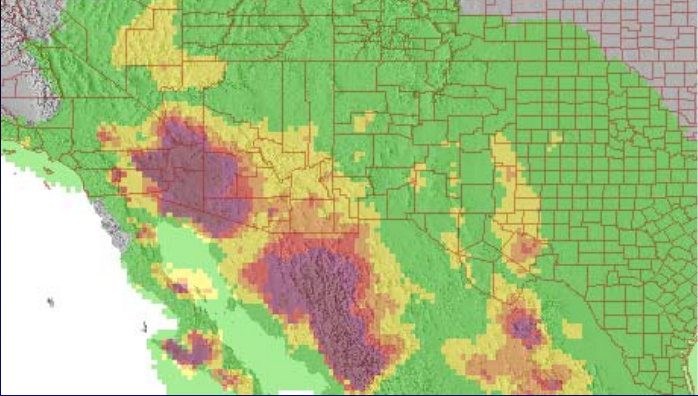
Import model output into GRASS raster database

Derivation of $PM_{2.5}$ and PM_{10} particle densities
from 4 size bins output by DREAM model

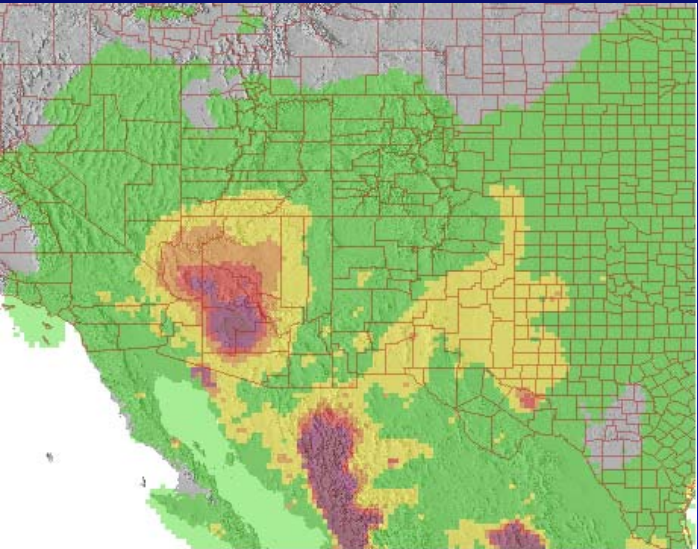
Reclassify GRASS rasters to reflect EPA AQI
values for visualization

Web Mapping Services

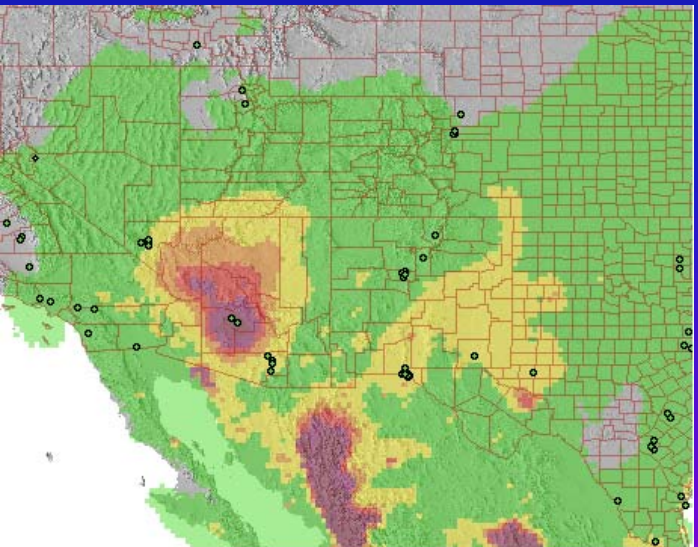
- Open Geospatial Consortium - Web Map Services (WMS)
 - Time enabled point map service for EPA AIRNow PM_{2.5} and PM₁₀ hourly data
 - Time enabled raster service for DREAM model output (in process)
 - Background datasets



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us_counties&TIME=2007-04-16T00



[http://phairs-devel.unm.edu:8080/cgi-
bin/mapserv?map=dream_animation_20070416_pm25](http://phairs-devel.unm.edu:8080/cgi-bin/mapserv?map=dream_animation_20070416_pm25)
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[http://phairs-devel.unm.edu:8080/cgi-
bin/mapserv?map=dream_animation_20070416_pm25](http://phairs-devel.unm.edu:8080/cgi-bin/mapserv?map=dream_animation_20070416_pm25)
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Layers=GRASS_SHADED_RELIEF,D041607_t20.pm2
us_counties,epa_AIRNow_complete&TIME=2007-04-16T20

Simple Object Access Protocol (SOAP)

Mapping services

Delivery of map images via WMS standard

Data delivery and download SOAP service

Extraction of values by EPA station location: DREAM model outputs, EPA AIRNow measurements

Output formatted either as HTML for inclusion in browser or CSV for download

Statistical Summary SOAP Service

Measures of central tendency and dispersion for DREAM and AIRNow data

Measures of association between DREAM output and AIRNow data

PHAIRS TOOLKIT

A set of free-standing, web-based, interactive mapping clients that demonstrate the functionality and integration of the PHAIRS web services.

Mapping services

Data download services

Statistical analysis services

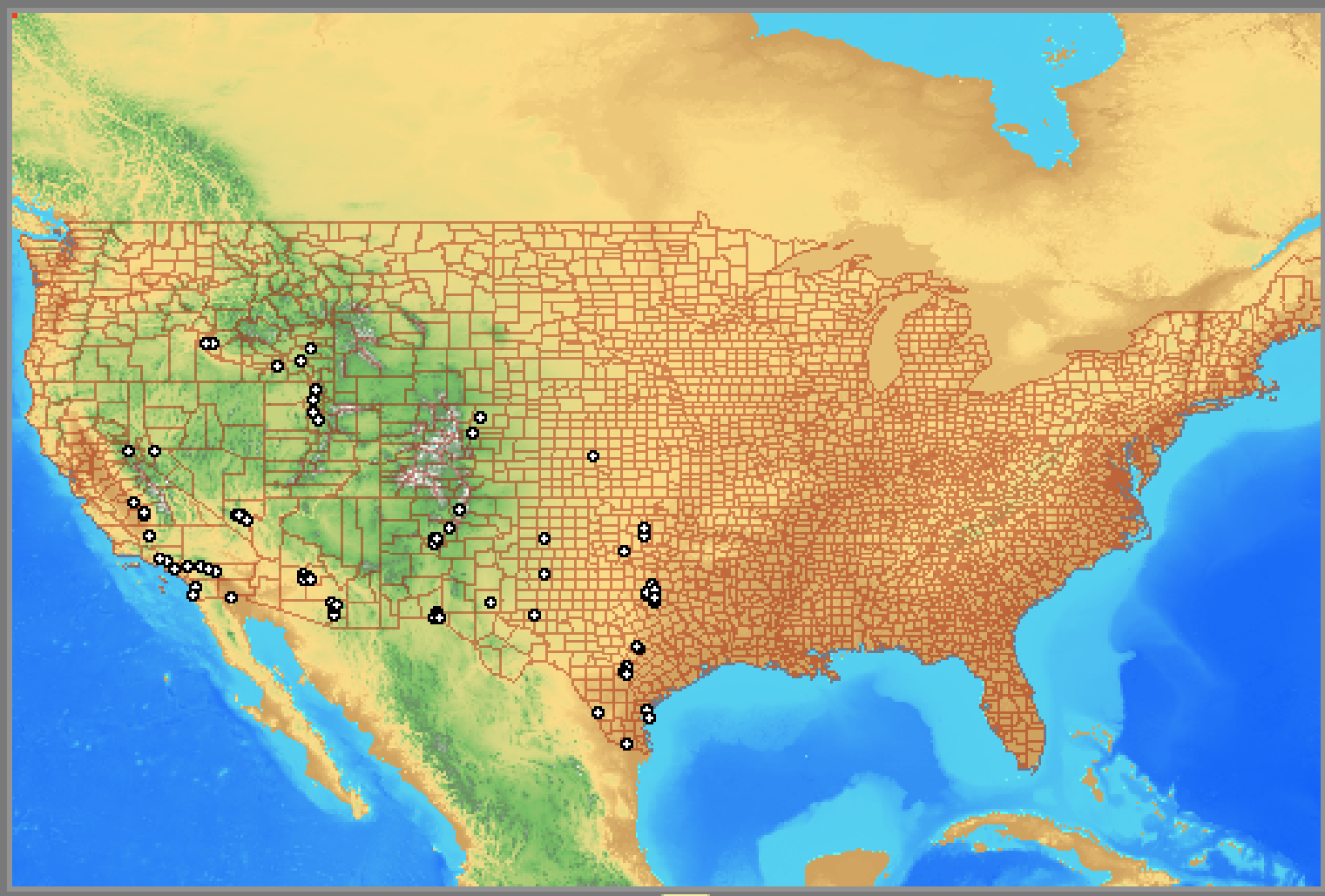
Interactive Mapping Client

- Standard capabilities: pan, zoom, layer selection
- Display of time-enabled data: EPA AIRNow ground observations, DREAM output
- Summarization over specified regions: DREAM model output over irregular regions (e.g. County)
- Time series tool with plot and animation

EPA AIRNOW Ground Stations



Public Health Applications in Remote Sensing



Legend

- Denotes Time-Sensitive Layer
- Wilderness Areas
- Urban Areas
- Waterbodies

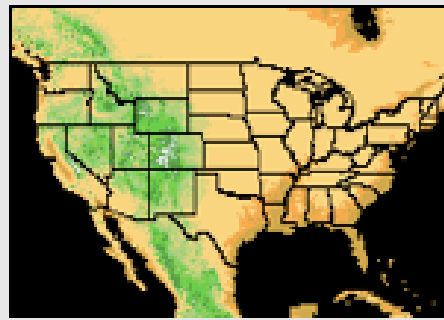
Background Layers

GTOPO 30 Meter DEM

Settings for Time-Sensitive Layer

2003-01-01 00:00:00
Date and Time

Refresh Map



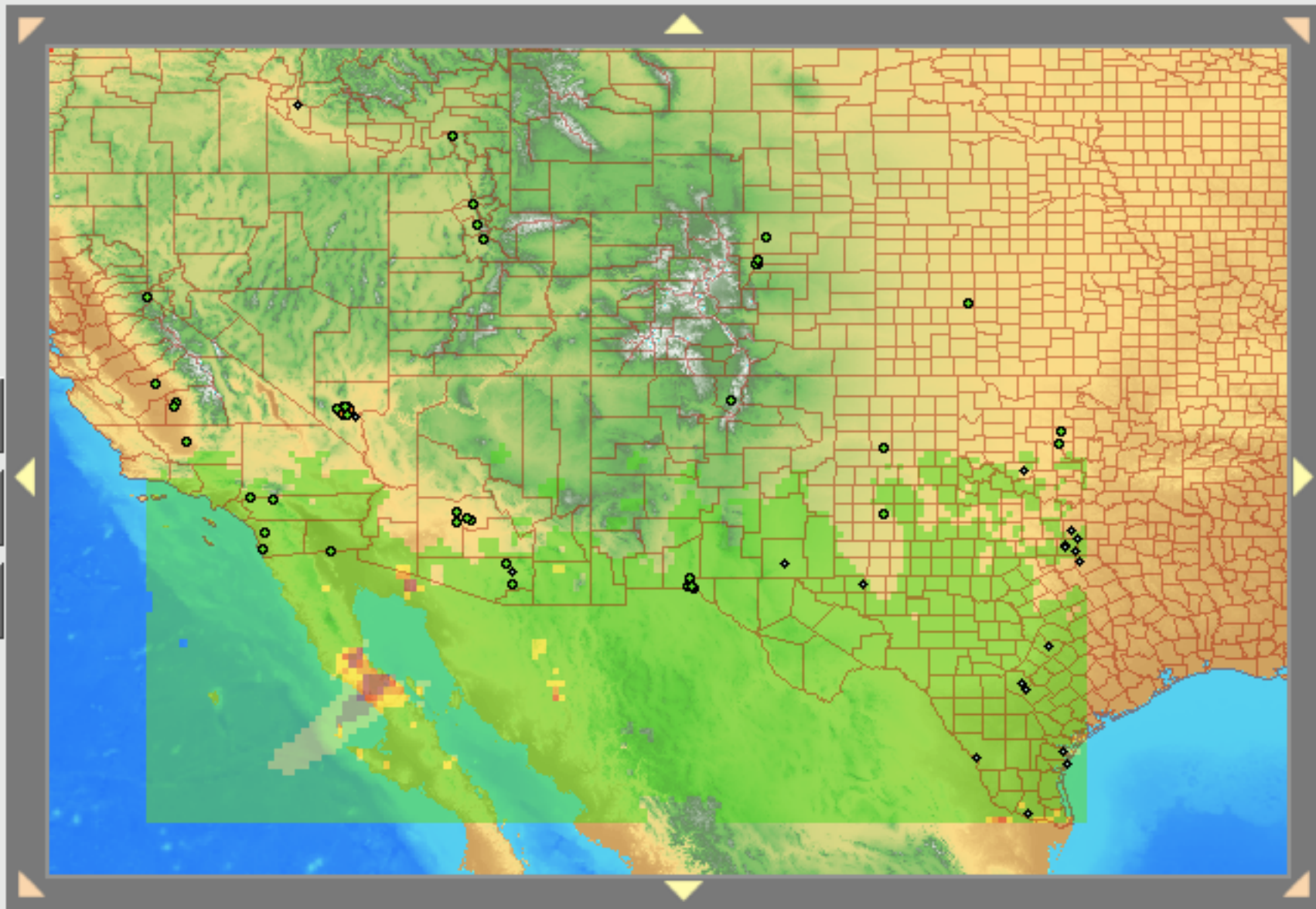
Northing Easting

Map Size Scale 1:35203902

Generate PDF of Current Map View



Public Health Applications in Remote Sensing



Legend

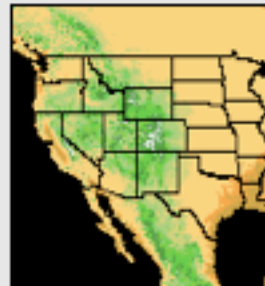
- EPA AirNow F
- ◆ Clear
- AQI 1
- ◆ AQI 2
- AQI 3
- AQI 4
- AQI 5

Background Layers

GOTOPO 30 Meter DEM

Settings for Time-Series

2003-12
Date and

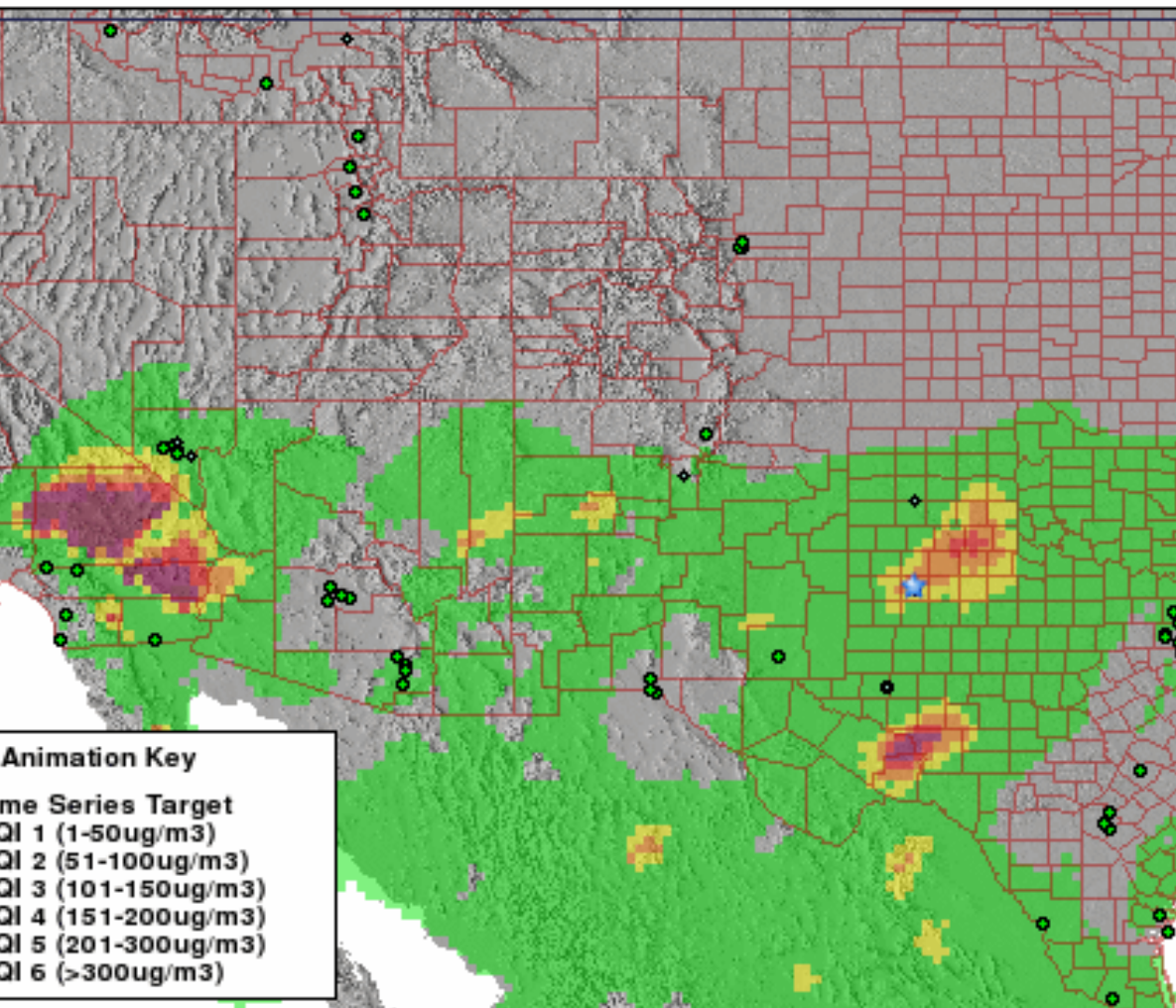


Northing Easting
 Map Size Scale

Time Series Tool

PHAIRS Dust Animation Client

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

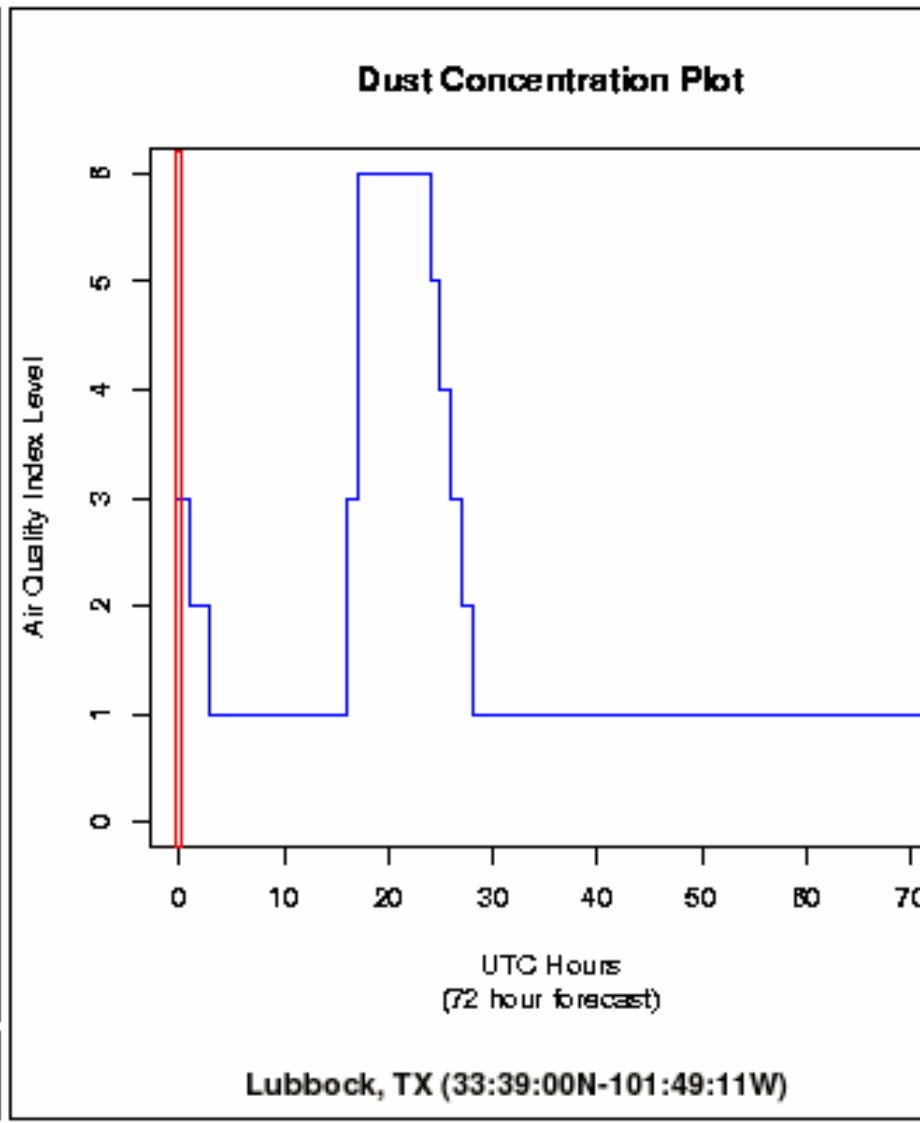


Animation Key

Time Series Target

- QI 1 (1-50ug/m3)
- QI 2 (51-100ug/m3)
- QI 3 (101-150ug/m3)
- QI 4 (151-200ug/m3)
- QI 5 (201-300ug/m3)
- QI 6 (>300ug/m3)

PLAY [Left Arrow] [Right Arrow] 200 [Dropdown Arrow]



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

Generate PDF of Current Animation Step

Services

EPA AIRNow data

- View and download
- Summary statistics

Paired DREAM and EPA AIRNow values

- View and download
- Summary statistics
- Measures of association

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
 40134010-DYSART [Download PM2.5 File](#) [Clear Date Fields](#)

Download EPA PM10 Data (returns all data for all sites within the DREAM domain area)
Begin Date (YYYYMMDD) End Date (YYYYMMDD)
 [Download PM10 File](#) [Clear Date Fields](#)

Download EPA PM10 Data for a Single Site Within the DREAM Domain Area Under Development
Begin Date (YYYYMMDD) End Date (YYYYMMDD) Station ID-Name
 40134010-DYSART [Download PM10 File](#) [Clear Date Fields](#)

View a Table of Observed and Modelled Dust Concentration Values for a Specific Date, Hour, and Size Category (all domain stations)
Date (MM-DD-YYYY) Time (HH:00:00) Particle Size Category
 [View Table](#)

View a Table of Observed and Modelled Dust Concentration Values for a 48-hour DREAM Model Run (all domain stations)
Date (MM-DD-YYYY) Particle Size Category
 [View Table](#)

View a Table of Observed and Modelled Dust Concentration Values at a Single Station for a 48-hour DREAM Model Run
Date (MM-DD-YYYY) Station ID-Name Particle Size Category
 [View Table](#)

View a Table of Observed and Modelled Dust Concentration Values at a Single Station for User-Defined Time Range
Begin (MM-DD-YYYY) End (MM-DD-YYYY) Station ID-Name Particle Size
 [View Table](#)

Statistical Functions

Generate Statistics for a Single Station for a 48-hour DREAM Model Run
Date (MM-DD-YYYY) Station ID-Name Particle Size Category
 [Select Statistical Tests](#)

Generate Statistics for a Single Station for a User-Defined Date Range
Begin (MM-DD-YYYY) End (MM-DD-YYYY) Station ID-Name Particle Size
 [Select Statistical Tests](#)

Data Download and Statistics

DREAM Output Data

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"T"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

of Paired EPA and DREAM Output

```
station_id,station_name,latitude,longitude,pm25_observed,pm25_dream,utc_datetime
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350011013,North Valley,35.1878,-106.604,7.0,1.3928309083,2007-04-15T09:00:00
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350011013,North Valley,35.1878,-106.604,8.0,1.9005882389,2007-04-15T11:00:00
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350011013,North Valley,35.19,-106.6,missing,60.5588230782,2007-04-17T00:00:00
```

Descriptive Statistics

Selection of Measures of Central Tendency and Dispersion

Statistics for the 48-hour period beginning 04/15/2007 (Station No. 350011013 / North Valley)

Statistical Tests Desired and Click on Submit

- | | | | |
|-----------------------------------|--|--|--|
| <input type="checkbox"/> Modeled | <input type="checkbox"/> Normalized Mean Bias | <input type="checkbox"/> Index of Agreement | <input type="checkbox"/> Centered Root Mean Square (RMS) |
| <input type="checkbox"/> Observed | <input type="checkbox"/> Normalized Mean Error | <input type="checkbox"/> Standard Deviation (observed) | |
| | <input type="checkbox"/> Fractional Bias | <input type="checkbox"/> Standard Deviation (modeled) | |
| | <input type="checkbox"/> Fractional Error | <input type="checkbox"/> Correlation Coefficient (R) | |

Statistics

Clear All Checkboxes

Modeled and Observed Dust Values

Table of Statistical Tests for the 48-hour period beginning 04/15/2007 (Station No. 350011013 / North Va

A complete 48-hour DREAM run will normally generate 49 hourly records (e.g. n=49). Sample sizes less than this result from incomplete EPA

Statistic	Value	n
mean_modeled	27.9876930284	49
mean_observed	6.97826086957	46
mean_bias	19.8149753625	46
mean_error	24.9176016382	46
norm_mean_bias	283.952917968	46
norm_mean_error	357.074665221	46
ac_bias	-0.180382774372	46
ac_error	90.7423624214	46
index_agreement	0.0426630447359	46
std_dev_obs	1.84731450719	46
std_dev_mod	27.2584238933	49
correlation_coeff	-0.195921555962	46
std_dev_bias	27.9532198019	46

Validation and Verification

Statistical tests permit assessment of DREAM model performance in forecasting dust as NASA data of higher spatial and temporal resolution are used as input parameters.

Thank you.

<http://phairs.unm.edu>