Public Health Applications in Remote Sensing

Addendum

PHAiRS Final Benchmark Report
Activities and Outputs
Mid-September 2008 to February 2009
NASA Agreement NNS04AA19A

Preface

This addendum is an up-date to the *PHAiRS Final Benchmark Report* submitted September 30, 2008. To complete the benchmark report on schedule, it was necessary to limit input to materials and activities completed by September 15, 2008. This addendum completes the inputs between that date and end of February 2009, the scheduled final review of PHAiRS.

Table of Contents

1.0 Third Quarterly Report (Oct-Dec) for Year 5

1.1 Modifications to PHAiRS Client

Work during the Oct-Dec quarter, 2008, focused on addressing bugs in the PHAiRS 4-bin infrastructure, databases, and client code base. These problems were uncovered in the main PHAiRS mapping client and the PHAiRS animation client. Tracking down errors in the execution of client python code revealed that many were associated with the insertion of records into the PHAiRS PostgreSQL/PostGIS database rather than the DREAM model. The database constitutes part of the post-processing functions that occur once a daily forecast has been completed. In particular, these relate to the insertion of records that note the location of GRASS rasters associated with each hour of a DREAM forecast.

Work began with the correction of a problem in the “build_grass_raster_records.py” file, which as part of the DREAM output post-processing scheme, writes DREAM output records stored as GRASS rasters into the project PostgreSQL/PostGIS database. Normally, post-processing of DREAM output data results in the creation of a collection of GRASS rasters for both the raw dust concentration data, as well as a reclassified version that mirrors the Air Quality Index values (AQI) employed by the EPA. This is true for each hour of the forecast, and for each of the particle size bins (including the derived proxies for PM2.5 and PM10). Once the entire day's collection of GRASS rasters has been created, a record for the file system path and location is recorded for each raster into the PostgreSQL/PostGIS database. Owing to a minor programming error, many of these path locations were not written into the database. As a consequence, requests to display these images, either singly via a WMS call, or as a sequence in the animation client, returned empty location results. In some cases, multiple records were recorded for each raster. Erroneous records were erased, and new entries were written into the database using the newly modified script.

Another significant problem with generating complete temporal sequences in the animation client was associated with those days when the DREAM model failed to generate a full series of data for each forecast. In such cases, only a partial subset of the output rasters was generated in the GRASS image archive. Incomplete model runs represented a relatively small output of DREAM records, but was instrumental in generating errors in the animation client. To address this problem, changes were made to the post-processing code to stop all output processing when incomplete forecasts were encountered. This was introduced at several points in the processing stream. First, the scripting in “build_grass_raster_records.py” (see above) was modified to verify that a complete daily record of GRASS rasters was present in each day's run before writing the raster file locations to the PostgreSQL/PostGIS database. An additional modification was made to the “dream2grass.py” file, such that an incomplete collection of raw DREAM output files would halt the post-processing programming stream.

Prior to enabling these changes to the post-processing stream, it was first necessary to drop all GRASS directories that contained an insufficient number of raster files to successfully run the PHAiRS animation client. In other words these directories contained data for those dates when the DREAM model did not generate a complete set of output files for the entire 48-hour forecast. The file “dump_grass_dream_directory.py” scans through all of the GRASS raster map sets in the image archive. Each map set is a subdirectory which contains raster images for an entire day's forecast, including representations of the raw data for each particle size bin, as well as representations of the AQI-reclassed output rasters for each particle size bin (including the PM2.5 and PM10 proxies). These directories were removed from the GRASS database. As such, it will be necessary to re-run these daily forecasts when time permits to create a temporally complete and continuous record of DREAM outputs.

To re-build the PostgreSQL/PostGIS database, all records were first erased, and then modifications to the “build_grass_raster_records.py” file were made such that the script would scan the entire existing archive of GRASS raster files, and write a new record into the database for each hour and particle size category in the daily map set locations. The newly re-written database was checked for errors, and found to be clean.

As a diagnostic tool, the web-formatted file named “the_count.py” collects and reports on the dates of all successful DREAM runs. Because of the processing steps changed above, it is not expected that dates without the requisite number of files will be reflected in this list. Certain sections of “the_count.py” were re-written so that all dates since the project data begin date (January 1, 2006) until the current date are written to the web site. Days that do not have enough data files to proceed to post-processing are marked with red. Karl Benedict has used the non-web portion of this script to generate a list of days that remain to be run. In that version, the output list is passed to a chronological job that takes the first date in the list, and passes it to the DREAM model for processing. Dates that fail at least twice are removed from the list, and placed in a new category that represents problem dates.

Another significant block of work this quarter was the creation of scripts and a database infrastructure to calculate and store basic descriptive statistics that summarize dust concentration values across New Mexico counties. To accomplish these tasks, the new python script “*poly_density.py*” processes this information as the final post-processing steps of a daily DREAM model run. For each hour of each particle size bin (PM2.5 or PM10) in a given 48-hour DREAM forecast, the *poly_hour()* function in this script uses the GRASS GIS *r. statistics* function to calculate a group of summary statistics by New Mexico county. The statistics include the mean, median, mode, maximum, minimum, standard variation, and variance. Hourly statistics are written into PostgreSQL tables (dust_county_pm25 for PM2.5 and dust_county_pm10 for PM10) that use the county FIPS code and a timestamp column for each unique record. Once hourly records have been amassed, the *poly_daily_stats()* function uses records from the hourly tables to calculate 24-hour means and variances for each of the above statistics, and writes them to the *dust_daily_county_pm25* and *dust_daily_county_pm10* PostgreSQL tables. The basic algorithm used be the script will allow similar summary statistics to be calculated for any polygon coverage desired, including census tracts, school districts, etc.

A primary reason for developing the ability to summarize basic statistics by county (or any other polygon feature), was to use these summaries to investigate the association of dust concentration in the atmosphere with the incidence of various respiratory outcomes, as measured in state hospitals, clinics, and schools. An important consumer of dust concentration summary data is the New Mexico Environmental and Public Health Tracking project (NMEPHT). The delivery of statistical data to NMEPHT would ideally be formatted around a 24-hour summary anchored to the local time-zone. Keep in mind that DREAM model output records for any given 48-hour forecast begin and end at midnight UTC (universal) time. Depending on the time of year (and whether or not local time in New Mexico is in synch with standard or daylight savings time), local time in New Mexico trails that of UTC time by 6-7 hours. To generate 24-means for New Mexico local times, a second script, *nm_epht_daily_dust.py*, was written to read from the hourly statistics files, and to write new daily summary records to a second set of tables named *nm_local_daily_county_pm2*5 and *nm_local_daily_county_pm10*, respectively. These 24-hour statistical summaries are now incorporated and viewable as thematic maps in the NMEPT Web Portal, currently undergoing development.

1.2 Seasonal Dust Masks from MOD13A2

During the last quarter the problem of the completeness of the barren class in the DREAM model was addressed again. Previously, attempts to improve the barren class consisted of replacing the MOD12Q1 barren class with a group of barren classes from the REGAP classification. Initial comparisons of the two model runs with the different barren classes showed little improvement in the output. Consequently, a different approach was tried.

1.2.1 Dust Mask Generation

MOD12Q1 represents a multi-temporal classification that describes land cover properties as observed during the year (12 months of input data, and last modified in 2002). For the agricultural class, this was interpreted to mean that pixels that had a crop at any time during the year would be called cropland, even if during part of the year the pixels might actually be bare of vegetation. If there were a way to account for the times that the cropland pixels were actually bare and transfer them to the barren class for that time frame, there might be an improvement in the DREAM model runs for specific times of year. To do this, the MOD13A2 16-day NDVI composites for a period in February 2008 and July 2008 were downloaded from the EOS Data Gateway. These two dates are good examples of a large barren ground category in winter compared to a large vegetated category in summer to see how the DREAM model reacted to these differences. The sequence of images below outlines the procedures used to generate a new barren class from the NDVI composites.

Figure 1 outlines the model steps used to generate the new barren class. The three symbols at the top of the figure define raster layers, or images, recode tables which allow the operator to change class numbers in an image, and a model function or process. Figure 2 shows the first two steps in the model run shown inside the green circles. These are recode steps which generate two separate images for the MOD12Q1 cropland and barren classes. Each class is renumbered as 1, and all other classes are renumbered as 0.

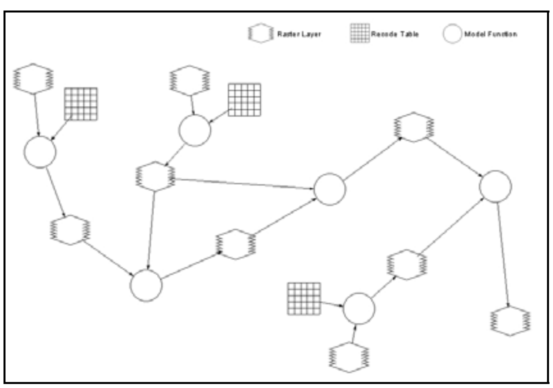


Figure 1. NDVI/Barren class model.

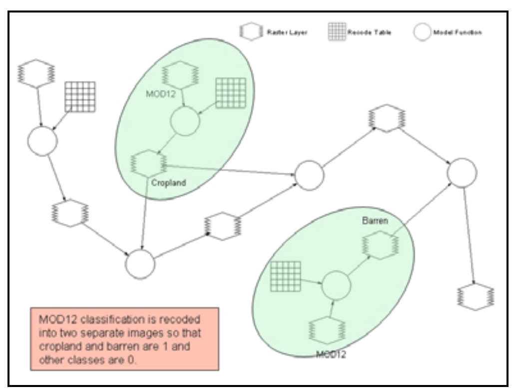


Figure 2. Recoding of the Cropland and Barren Classes.

Figure 3 shows both of these images superimposed on the same image with cropland as yellow and barren as red. Once this step has been performed for the first time, the same images would be used for all NDVI dates so they would not have to be regenerated each time. At this point in the process, an NDVI image composite for February 18 thru March 4 was obtained and examined (Figure 4). This image was examined and it was determined that the density value of 2500 was a good boundary between irrigated vegetation and barren fields. The image was then recoded so that all values below 2500 were eliminated (changed to zero). Figure 5 shows the February NDVI and Figure 6 shows the resulting recoded image.

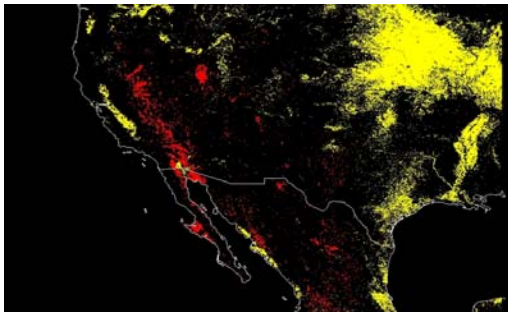


Figure 3. MOD12 cropland class (yellow) and barren class (red).

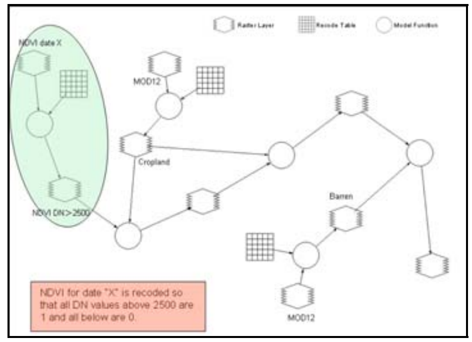


Figure 4. Recoding original NDVI image, eliminating all values below 2500.

Figure 5. Original NDVI image for February.

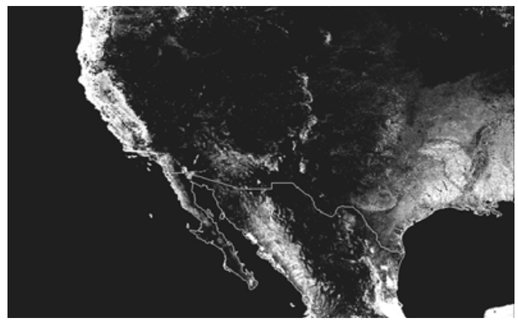


Figure 6. NDVI image with all values below 2500 recoded to zero.

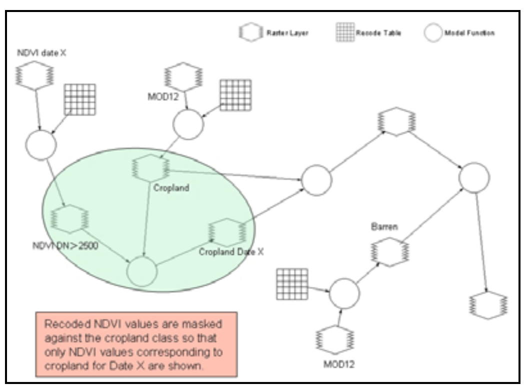


Figure 7. Model segment showing masking of NDVI values with cropland class.

The recoded NDVI image in Figure 6 was then masked against the cropland class that was shown in Figure 3 as yellow. This process is shown in Figure 7, and the resulting image is shown in Figure 8. The yellow pixels show the areas in February that had respiring vegetation (crops) on them. The next step was to subtract the yellow pixels in Figure 8 from the MOD12Q1 yellow pixels shown in Figure 3. The resulting image yields MOD12Q1 cropland pixels that were actually barren in February. Figure 9 shows the model segment for this step in the process and Figure 10 shows the result, which is MOD12Q1 cropland, now barren in February.

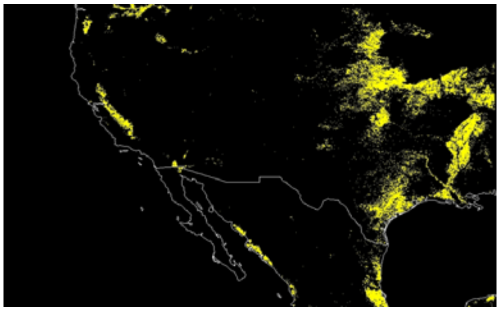


Figure 8. February cropland with green cover.

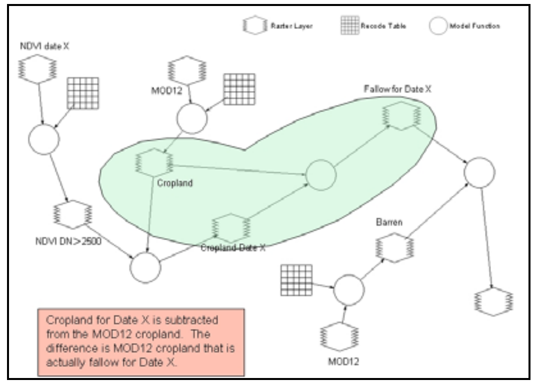


Figure 9. Model segment showing subtraction of February cropland from MOD12Q1 cropland

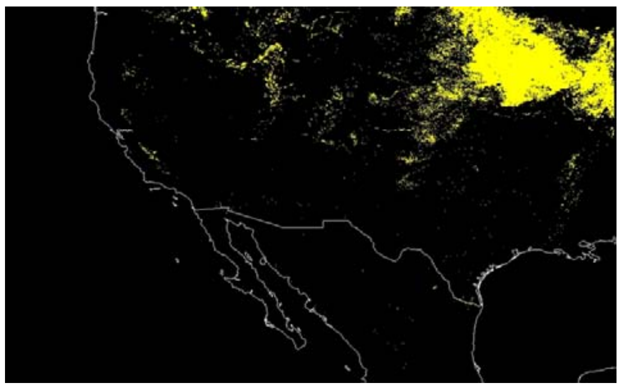


Figure 10. MOD12Q1 cropland that was barren in February

The final step in the process, shown in Figure 11, is to add the February MOD12Q1 barren class to the original MOD12 barren class (red class in Figure 3) to create a new barren class to be added to the DREAM model run. Figure 11 shows this last step in the model, and Figure 12 shows the original barren class in red and the February barren class added to it. One remaining question is how to handle the effect on snow cover on the NDVI images. Figure 13 shows the February NDVI image with snow cover highlighted in the red and yellow polygon.

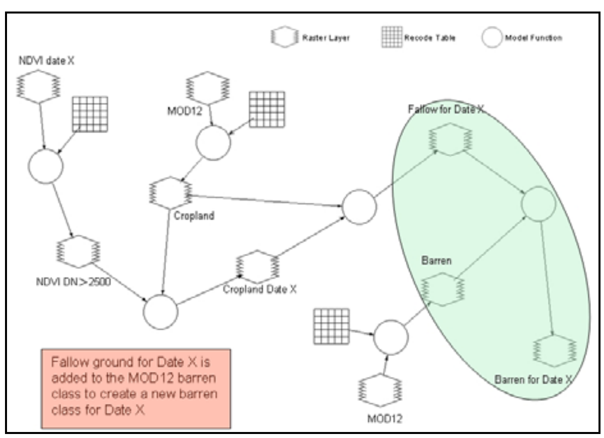
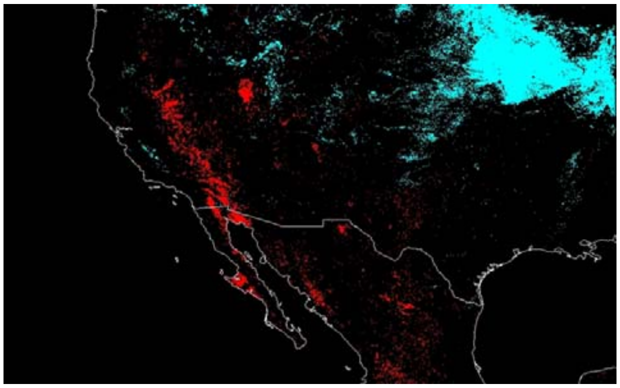


Figure 11. Model segment showing the addition of February barren category to the original MOD12Q1 barren class.



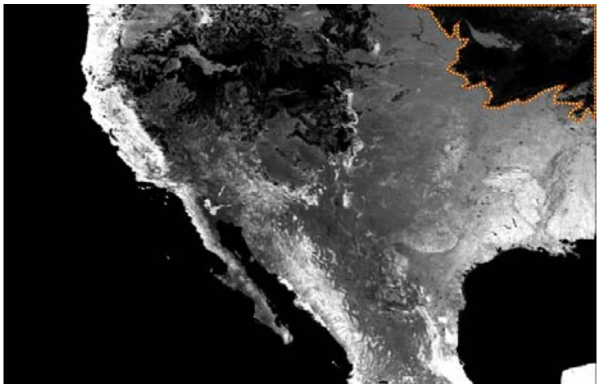


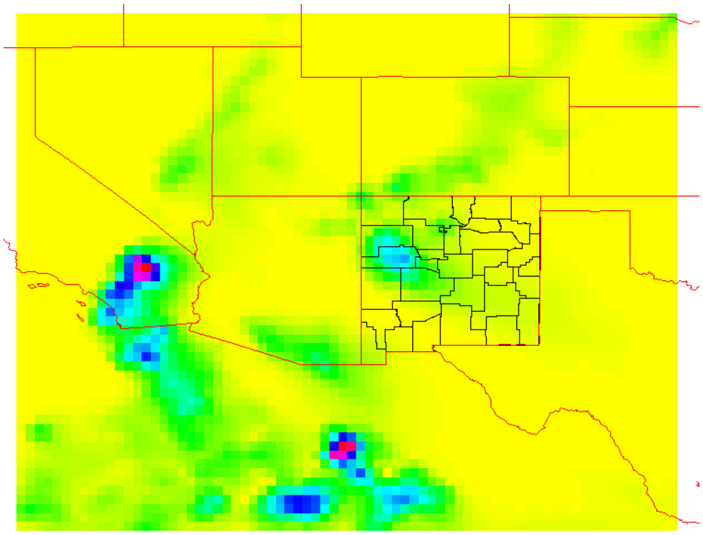
Figure 12. Resulting model image showing original barren class in red and the addition of February barren land in blue.

Figure 13. February NDVI image with snow cover highlighted by red and yellow polygon

Snow cover could incorrectly imply to the DREAM model that the barren snow is a potential source of dust. Test runs will be made using the snow cover as barren and also running it with the snow cover masked out as zero to see what effect the two have on the results.

1.2.2 Eight-Bin Particle Separation

Bill Hudspeth completed the basic processing script that extracts a user-specified layer from the DREAM 8-bin GRIB-formatted output files. Using wgrib, a text file is extracted for a unique particle size bin. The values are then parsed, and written into an ArcAscii grid in which the projection information and grid parameters are already included in a header. The file is then imported into the GRASS GIS system. Dates available for this service begin at 2008-01-06T00:00:00, and proceed in 3-hour intervals for a total of 72 hours. Example: 2008-01-06T03:00:00Z, 2008-01-06T06:00:00Z, 2008-01-06T09:00:00Z. To look at different particle size bins, change Layers=dream8_nmm7_rec to dream8_nmm1_rec, dream8_nmm2_rec, etc.



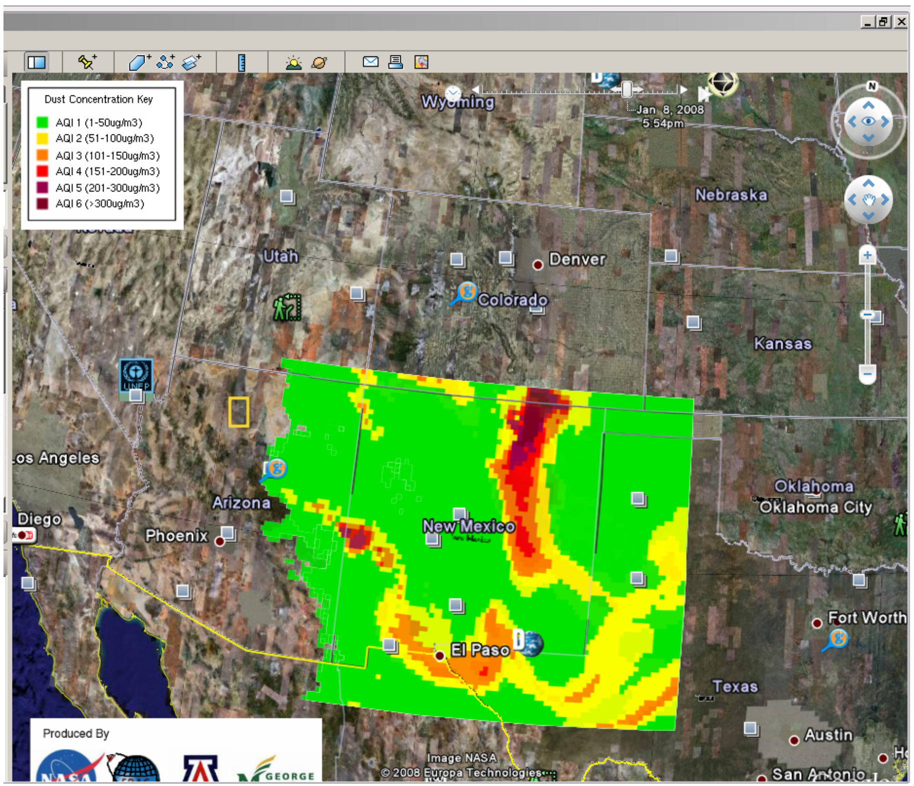
Sample PHAiRS 8-bin dust output. Download from: https://edac.grouphub.com/P16139153

The following URL provides an image of DREAM 8-bin output:

http://129.24.63.59/cgi-bin/mapserv?map=mapmodule_dream8bin_wms.map&SERVICE=WMS&VERSION=1.1.1&REQUEST=GetMap&TRANSPARENT=TRUE&STYLES=&FORMAT=image/gif&BBox=-112.000,30.000,-100.000,38.000&SRS=EPSG:4326&Width=600&Height=388&Layers=dream8_nmm7_rec,us_counties&TIME=2008-01-06T03:00:00Z

Below is the URL to a simple web site that allows the dynamic assembly of a KML file for the DREAM 8-bin NMM model results provided by the GMU team. Once the DREAM model is in production, users can select the date, particle size bin, and model type (e.g. ETA vs. NMM), and have the service build a KML file to observe the output. http://129.24.63.59/cgi-bin/dream8_kml_access.py. There is one file for this post at

https://edac.grouphub.com/P16913913



1.2.3 Product Coding

Bill Hudspeth finished scripting a service that allows registered Interoperability Testbed team members to download an arc-ascii formatted representation of MODIS dust masks. Each mask is coded such that values of 1 represent barren ground (potential dust sources), and values of 0 represent everything else. In order that the latest version will be available for input into the DREAM model, a new MODIS image is downloaded weekly. While it is not expected that a new MODIS layer will be available so frequently, the automation of this task will ensure that when a new version is available, it will be available quickly. At present, MODIS dust masks have a filename that describes the beginning date of data acquisition (e.g. b20040101), and ending date for data acquisition (e20041231), and the date that the image was downloaded and processed on the systems at EDAC (p20081002). Filenames take the form:

MODIS_bYYYYMMDD_eYYYYMMDD_pYYYYMMDD_mask.asc

The web-based services that allow registered Interoperability Testbed users to both query the existing archive of MODIS dust mask images, and to download selected versions, can be accessed via the following URL:

http://phairs-devel.unm.edu:8080/cgi-bin/request_modis.py

At present, there are three different dust mask products from which to select. The first is MODQ1 data downloaded with WCS. It is a simple mask that codes the barren ground category as 1, and all other pixels as 0. To view available dates, go to:

http://phairs-devel.unm.edu:8080/cgi-bin/request_modis.py?request=get_dates

The second category is the 'No Snow NDVI' mask, where barren agricultural lands are added to the barren ground category (coded as 1). To view available dates, go to:

http://phairs-devel.unm.edu:8080/cgi-bin/request_modis_nosnow.py?request=get_dates

The third category is the 'Snow NDVI' mask. It is the same as the 'No Snow NDVI' mask, but areas under snow have been removed from the barren ground category. For available dates go to:

http://phairs-devel.unm.edu:8080/cgi-bin/request_modis_snow.py?request=get_dates

To complete the service, additional arguments are assigned to the 'request' parameter in the URL to actually download the data. In URL numbers 2 and 3 below, one would simply replace "..request_modis.py? " with " request_modis_nosnow.py?.." or " request_modis_snow.py? ".

Any combination of requests can be passed as arguments to the URL:

1) "get_most_recent" will download the most recent version of the dust mask:

http://phairs-devel.unm.edu:8080/cgi-bin/request_modis.py?request=get_most_recent

2) "get_dates" will download an XML file that describes all of the available dust masks:

http://phairs-devel.unm.edu:8080/cgi-bin/request_modis.py?request=get_dates

The XML document returned is a hierarchical description of each available MODIS layer. As seen in the example below, it includes the filename, data acquisition start date, data acquisition end date, the date of data processing, the lat/lon coordinates of the SW corner, the grid cell size, and the coordinate system. Users should record the beginning and end dates of data acquisition when they select a specific MODIS dust mask in the third type of service request (see below).

File name:	MODIS_b20040101_e20041231_p20081021_mask.asc
Data acquisition start date:	2004-01-01
Data acquisition end date:	2004-12-31
Data processing date:	2008-10-21
Lat/Lon coordinates of SW corner :	-171.166666666667, 20.000000000000
Grid cell size:	0.008333333333
Coordinate system:	

GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["wgs84",6378137,298.257223563]],PRIMEM["Greenwich",0],UNIT["Degree",0.017453292519943295]]

3) “get_user_defined” will download a specific dust mask file, as selected from a list of available masks listed with the get_dates request. Note that when selecting this request type, the user must add a data acquisition begin and end date, formatted as YYYYMMDD. See the example below: http://phairs-devel.unm.edu:8080/cgi-bin/request_modis.py?request=get_user_defined&begin_date=20040101&end_date=20041231 The acquisition begin and end dates MUST match a corresponding pair as listed in the XML provided by the “get_dates” request.

1.3 High Performance Computing

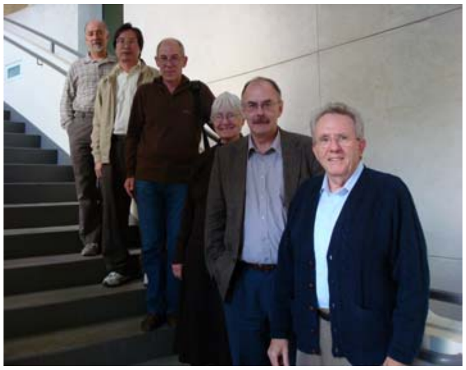
1.3.1 Project Overview

GIO sponsored and managed an Interoperability & High-Performance Computing Testbed (IHPTC) as an extension to the fifth and final year of the PHAiRS project. This Testbed, a collaborative effort between GIO, George Mason University, and the Universities of New Mexico and Arizona, has resulted in the following accomplishments:

- Enhanced end-user access, via Web-based standards, to two different atmospheric dust models: the Dust Regional Atmospheric Model (DREAM/Eta) and the Non-hydrostatic Mesoscale dust model (NMM/dust), both based on meteorological models developed by NOAA's National Center for Environmental Prediction (NCEP). Operational Web services running at the University of New Mexico are “powered by” George Mason University's high-performance computing resource via a high-speed (Lambda Rail) Internet link.
- Enhanced model access to NASA MODIS-based land-cover data on demand (again, via Web-based standards) from NASA’s Land Processes Data Archive (LP-DAAC) in Sioux Falls, SD. A suite of scripts retrieve the land-cover data, infer surface dust sources from it, and feed them as input to the two models. This will, in the near future, allow modelers to experiment easily with alternative representations of dust sources – e.g. weekly greenness maps in place of a yearly composite product – from LP-DAAC or anywhere that uses WCS. This may lead to more accurate forecasts.
- Enhanced the performance of the NMM-dust model using parallel computing: e.g., using 60 or more CPU cores speeds up model runs tenfold. Significantly faster run-times open up new possibilities for wholesale model validation (e.g., comparing daily forecasts and observations for a whole year) and for experimental and exploratory usage (e.g., trying out various representations of land cover and surface dust sources).
- Enabled cooperation between the two dust models: forecasts from coarse-grain, regional runs of DREAM/Eta are being used as initial conditions for fine-grain runs of NMM/Dust. This was accomplished by homogenizing the format and content of their dust inputs and outputs, based on the GRIB1 standard from the World Meteorological Organization.
- Developed a new fine-grain dust model, known as NMM/Dust. This was not called for in the project plan, but became necessary upon a staff change on the U. Arizona modeling team.

1.3.2 Transition to UA Super Computer

The UofA team met with the UofA High Performance Computing staff (Lucy Carruthers, Jimmey Ferng, Marvin Landis) to develop a strategy for establishing quasi-operational DREAM model runs on the UA supercomputer (See Figure 1). This required developing a procedure to incorporate the DREAM dust component into NMM, and rewriting the DREAM code transition into NMM. The DREAM/NMM modeling system is now being tested prior to "operational" runs for access by UNM. The DREAM/NMM code for one dust-storm situation has been tested by Peja on two different UA HPC systems to see which system may be most efficient for dust simulations, forecasts and operations.



Marvin Landis
Jimmy Ferng
Goran Pejanovic
Lucy Carruthers
Slobodan Nickovic
Bill Sprigg

Meeting at the University of Arizona, December 2008

2.0 Other Technical Achievements (September 15, '08 – February 28, '09)

2.1 Linking to SYRIS

As of 10-Feb-2009, the DREAM model outputs (both PM_{10} and $PM_{2.5}$ for the current hour and for the last hour of the current forecast) had been integrated into the SYRIS developmental version. Public health officials from the Lubbock Department of Health were briefed in January 2009 on the new capabilities that have been added to the developmental version of SYRIS, and the Texas Region 1 public health officials received their briefing on the SYRIS upgrades on 10-Feb-2009. Feedback from the Lubbock public health officials indicates that they are ready for the developmental SYRIS version (which includes DREAM dust forecast data) to transition to the production system. The team is awaiting final comments from the Region 1 officials on any further changes to the system that would need to be made prior to deployment. Once approval is received, the developmental version will be pushed onto the production version, and the dust forecast data will be available to SYRIS users in the Lubbock PH Department and Texas Region 1.

2.2 V&V (Questions from Main Street)

Q. Newspapers call attention to two different violations of air quality standards, PM_{10} violations from construction and $PM_{2.5}$ violations from the city of Phoenix. Why make the distinction?

A. Airborne particulate matter consists of aerosol particles ranging from nanometers to millimeters in diameter. Two size classifications are routinely used in the air quality field due to their relevance to human health. PM_{10}, the mass of particles 10 micrometers in diameter, and smaller; and $PM_{2.5}$, the mass of particles 2.5 micrometers, and smaller. The larger particles get trapped in the upper airways when inhaled, while the small particles penetrate deep into the lungs. Thus $PM_{2.5}$ is thought to be more dangerous and is the primary focus of health professionals. In fact, the EPA once regulated national standards for both size ranges, but is phasing out both the PM_{10} standard and the stations that monitor it.

Q. How does a mathematical model calculate dust being picked up off the desert floor? How does the dust model tell them apart? And, are actual measurements of PM_{10} and $PM_{2.5}$ used to see if the model is accurate?

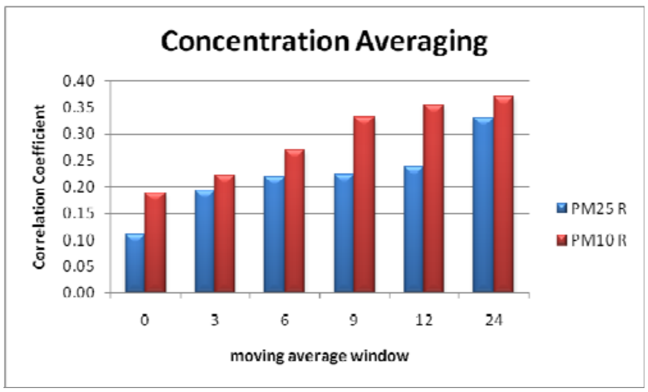
A. Most dirt that gets kicked into the air by cars, trucks and strong winds, and moves along on air currents is classed as PM_{10}. Laboratory experiments in wind tunnels and observations in the natural environment show that when wind speeds approach 20 mph, and dirt is disturbed, small particles bounce into other particles and these particles bump into other particles in a chain reaction. Some particles are tossed into the free air stream above. A dust storm can result. The Dust Regional Atmospheric Model (DREAM) used in this study captures this process in mathematical terms. All particles are considered to be round to simplify the calculations; and, size matters. Naturally, larger particles will fall to the ground faster than smaller ones. The modeler determines which sizes are of interest and programs the model for particular size ranges to calculate ejection rates, fall velocities, whether they become part of cloud droplets, fall as rain or as dry particles some distance downwind; and, a host of other atmospheric processes.

PM_{10} is useful in testing the accuracy of the DREAM. This is the size of most mechanically generated dust. The term "mechanically" refers to the physical suspension of particles generated by wind, kicked up by vehicles or via industrial grinding. This is compared to the chemically active $PM_{2.5}$ size range, where many smaller particles are converted from gases or created in combustion processes and auto exhaust. DREAM can and does predict in both size ranges, but validates better for PM_{10}. The larger particles are usually mineral dust particles, so PM_{10} is a more consistently composed size fraction to compare with model output. $PM_{2.5}$ is usually a big mix of particles made of different elements, a small fraction of which is mineral dust. Thus, repeated validation shows DREAM performs better at matching PM_{10} concentrations than with $PM_{2.5}$. As more PM_{10} measuring sites are decommissioned, there will be fewer opportunities to validate the model. The hypothesis that DREAM actually works is founded on repeated validation of PM_{10}. Scientists try to find more ways to compare the model with the real world by other means, such as measurements of dust profiles from satellites. Because of the mix of particle composition, $PM_{2.5}$ validation requires more thought and finesse, but it is being done.

Q. I would like to use DREAM to forecast local, timely health risks to people with severe asthma or suffering from cardiovascular stress. Can DREAM forecast these conditions an hour in advance? If it does not do well by the hour, can we give 3-hour or 6-hour forecasts, and how well would those do?

A. The normal reporting of both DREAM and EPA AIRNow data is by the hour; however, a pure hour by hour validation generally yields poor comparative statistics. Based on these statistical tests, it is sometimes difficult to assign confidence to single hour peaks in particulate matter concentration. If a school nurse, for example, wanted to give the precise hour of an approaching dust cloud (for location and concentration), the likelihood of matching the modeled peak with the observed peak would be poor. There are several reasons for this timing discrepancy: outdated source regions, coarse grid spacing in the model, micrometrological conditions that defy prediction using these models over such large areas, among others. But, DREAM has shown better capability for predicting in a larger time window, such as a 3 hour or 6 hour forecast. A school nurse could give a warning 3 or 6 hours in advance and have a better chance at mitigating the health impacts. In other words, the nurse could recommend that children stay inside for that 3 or 6 hour warning period. Statistics improve even more when using a 24 hour window. One would have more confidence in "day-in-advance" forecasts. A school nurse could warn about tomorrow's air quality and urge students to stay inside for the whole day rather than erring on a specific hour.

STATISTICAL BACKGROUND: To compare averaging forecast windows, hourly model and hourly observed data were both converted to averages of different time lengths (3 hour, 6 hour, 9 hour, 12 hour and 24 hour). Then the averages were compared directly. For example, the running 9 hour averages of model data were compared to the corresponding running 9 hour averages of in-situ data at each site. For a particular case study, over 1000 hourly data points were compared in this fashion. As the length of the windows increased, so does the correlation coefficient (R) between modeled and observed. The hourly $PM_{2.5}$ correlation was 0.11 and increased to 0.33 for daily averages. For PM_{10}, the hourly correlation was 0.19 and increased to 0.37 for daily averages. While these R values seem relatively low even for the daily averages, we consider this improvement promising and within range for a model with such sensitivity to inputs and in-situ data that is highly problematical. (See next sections)



Q. Local air quality departments are mandated to use EPA 24 hour PM standards to enforce air quality regulations. How well does DREAM simulate or predict 24 hour regulatory standards?

A. EPA regulates particulate levels for air quality with 24 hour average standards. The current standards are violated if the 24 hour average of PM_{10} exceeds 150 ug/m^3, and/or $PM_{2.5}$ exceeds 35 ug/m^3. So to align with federal air quality regulation and make the model appealing to air quality officials, it makes more sense to validate according to the standards in place. DREAM has been shown to perform better at predicting violations of these standards. It is possible to develop a "threat of violation" that could be used by forecasters during windy conditions.

STATISTICAL BACKGROUND: So-called threat scores and skill scores are needed when predicting with respect to a threshold value. The EPA violation limit is set as the threshold, so any hourly data point that exceeds the limit counts as a "hit", whereas data below the limit counts as a "miss". Threat scores and skill scores are calculated by counting the number of hits and misses by the model with the number of hits and misses in the observed data.

Q. Does DREAM account for the wide variety of dust compositions? (answer: No). If no, how are models validated? (answer: speciation)

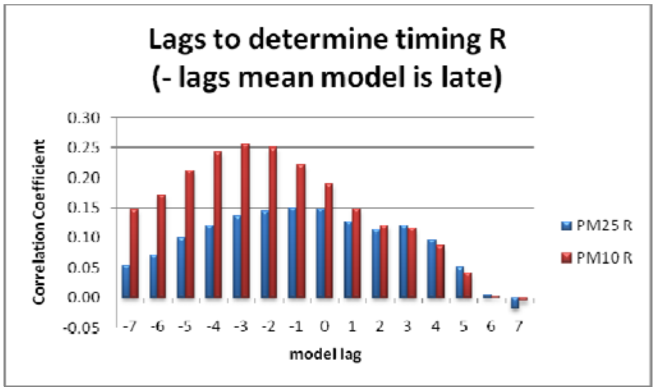
A. Most PM measurements are generic mass concentrations of all the particles that are collected for a given size cutoff. For example, hourly $PM_{2.5}$ is recorded in micrograms (as directly measured with a microbalance) of aerosol mass on a filter, per meter cubed (the volume of dust-laden air that passed through the filter) at a diameter of 2.5 microns. No information is given about what fraction of that mass belongs to which geological, chemical, or biological species. A “species” is a type of aerosol, for example soot or salt particles. We also know that these dusts contain bacteria, mold, pollen and spores. There are several types of species acknowledged in the air quality community: mineral dust, organic carbon, black carbon (soot), ions (sulfates, nitrates, ammonium, etc.) and trace heavy metals. Most of the time man-made particles will dominate the recorded levels of $PM_{2.5}$ in urban locations, but mineral dust will be high during windy conditions. Thus it appears that the generic EPA hourly measurements are good for air quality warning, but not for validation of a dust transport model. DREAM does not presently account for anthropogenic particles and, in order to make valid statistics, must be compared with mineral dust only. The EPA does offer another data set from the Speciation Trends Network (STN). The term “speciation” refers to the chemical analysis of a bulk aerosol sample into the individual components or species. The STN data give the mass concentrations of the aforementioned species at many locations in the southwest, but only as 24 hour composites every 3rd or 6th day. Time is needed to analyze the samples for speciation; it is not as quick or routine as hourly $PM_{2.5}$, and the days in between are skipped. This yields only a glimpse of what happens to the aerosol species’ concentrations during the change from an anthropogenic pollution event to a natural windblown dust event. But, the data are promising: when DREAM is compared to the mineral dust (soil) component from the STN data at daily averaged time scales, the model validation shows improvement. Granted, this is not on an hourly basis nor is it every day, but the general hypothesis that DREAM does in fact model mineral dust well is demonstrated with speciation.

STATISTICAL BACKGROUND: The study by Shaw (2008) compared speciation data from the EPA Speciation Trends Network (STN). Almost one full year of model and in-situ data were compared at five cities (Phoenix, AZ, El Paso, TX, Salt Lake City, UT, Bakersfield, CA and Austin, TX). In-situ data included hourly $PM_{2.5}$ data, and 24 hour averaged mineral/soil component collected every 3rd day by the STN. Comparing every model and AIRNow hourly data point ($N > 24000$) there was virtually no correlation ($R < 0.00$). When the properly averaged model was compared to STN data, correlation improved across the board ($R = 0.16$, $N > 300$). Furthermore, the industrial particle bias in $PM_{2.5}$ between modeled and observed was reduced when the daily STN soil/mineral dust data replaced the hourly AIRNow total $PM_{2.5}$ in the comparison (root mean square error reduced from 18.6 $\mu g/m^3$ to 12.0 $\mu g/m^3$). While speciation reduces the degrees of freedom needed to compute statistics, it supports the hypothesis that DREAM predicts $PM_{2.5}$ nearly as well as PM_{10}. Nonetheless, the lack of frequent speciation begs hourly data for validation, but now it can be assumed that the poor hourly statistics are a bottom bound. The comparison must always be assumed to be better than calculated due to anthropogenic offsets accounted for in the speciation study.

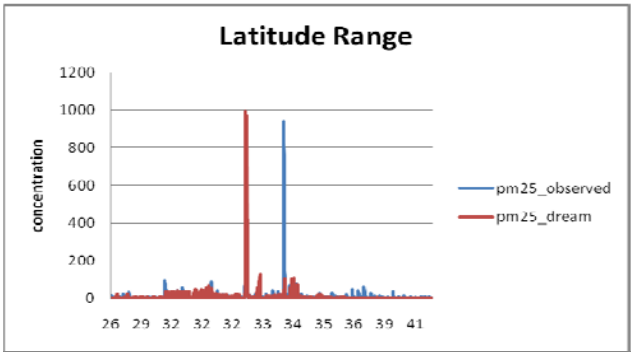
Q. How accurate is DREAM in predicting the time and place of geographically large dust storms?

A. GENERAL: Complex fine scale meteorology, coarse land cover and computation time limit the resolution of DREAM in time and space. But validation and verification has shown that the forecast can be accurate for a given range in time and space. A case study showed that DREAM has a spatial accuracy of roughly 1 degree in both latitude and longitude, and a temporal range of 6 hours. This means that the model was able to reproduce the geographically large event at multiple locations separated by many miles; and, that the difference in location between the modeled and observed cloud was less than 2 degrees in latitude and less than 1 degree in longitude. For a long forecast over a wide area, this is considered to be a good representation of large scale PM clouds generated by modeled winds.

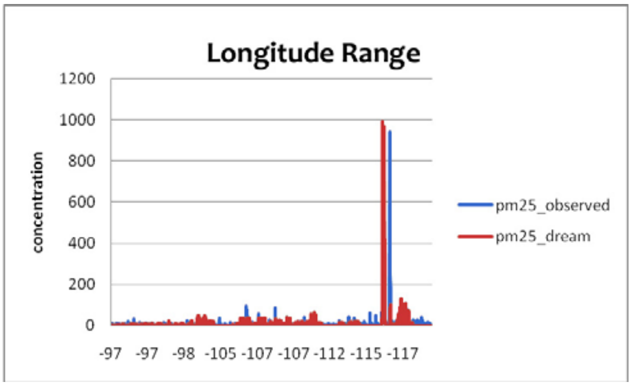
STATISTICAL BACKGROUND: Hourly model data were lagged behind or ahead by varying intervals (-7 to + 7 hours) and compared to in-situ hourly data. For PM_{10}, the best correlation exists between -4 to 0 hour lags, meaning that PM_{10} clouds arrive on time to 4 hours late. The best lags for $PM_{2.5}$ show that the $PM_{2.5}$ clouds arrive between 3 hours early and 3 hours late. These are considered to be acceptable ranges on timing.



Latitude and longitude ranges were calculated by plotting concentration of $PM_{2.5}$ for all stations in the entire domain separately by latitude and separately by longitude. The peak in latitude appeared around 32 degrees in the model, but appeared around 34 degrees in the observed. We determined this to be roughly a 1 to 2 degree difference.



The same was performed for longitude, and the range was found to be less than 1 degree.



Q. Television news has shown pictures of giant 'haboobs' that sweep through the desert during Arizona monsoon season. What are they? How do they form? Can your model predict them?

A. Haboobs are towering walls of suspended dust, usually found in the Middle East and Saharan Desert, but they sometimes occur in summer in Arizona. A combination of dry desert surfaces and high winds created from thunderstorm downdrafts send dust high in the air. When downdrafts hit the desert floor, they have nowhere to go except horizontally. Typical winds needed to create a haboob, depending on wind direction, surface roughness, soil moisture, soil type and dust grain size, are between 10 and 20 mph. This wind speed is required to initiate the process of 'saltation', where large particles of sand and soil are dislodged and start a chain reaction of ejecting smaller particles as they bounce along the ground. Smaller particles stay aloft easier, and the high winds entrain them into the thunderstorm edge, where the source of wind can last an hour or more.

The Dust Regional Atmospheric Model (DREAM) has shown it can forecast these spectacular events. As the research team increases the time and space resolution of the model and of satellite surveys of dust source areas, such forecasts will become more reliable and even more important, warning people to stay off the highways and to take shelter indoors.

3.0. Publications, Meetings/Presentations

3.1 Publications

W. Sprigg, B. Barbaris, S. Morain, A. Budge, W Hudspeth, and G. Pejanovic. 2009. Public Health Applications in Remote Sensing. SPIE Newsroom DOI 10.1117/2.1200902.1488
http://spie.org/x33688.xml?pf=true&ArticleID=x33688

3.2 Meetings/Presentations

Karl Benedict

2009. Scientific Applications. Poster presented to the New Mexico State Legislature, Science Day, Santa Fe, NM, January 22, 2009

2009. Service Adoption Experience of the PHAiRS Project. Paper presented at the ESIP Federation Winter Meeting, Washington, DC. January 6-8, 2009.

2009. General-Purpose KML Generation via XSLT for Presentation of OGC WMS Layers. Poster presented at the ESIP Federation Winter Meeting, Washington, DC. January 6-8, 2009.

2008. The Infusion of Dust Model Outputs into Public Health Decision Making - an Examination of Differential Adoption of SOAP and Open Geospatial Consortium Service Products into Public Health Decision Support Systems. Poster presented at the American Geophysical Union Fall Meeting. San Francisco, CA. December 15-19, 2008.

2008. Interoperable Earth Observation Services and Their Use in a Variety of Decision Support Contexts. Workshop presented at the EPA OEI Environmental Information Symposium. Phoenix, AZ. December 10-12, 2008.

2008. Delivery of Time-Enabled WMS via KML. Paper presented at the NASA Earth Science Data Systems Working Group (ESDSWG) Annual Meeting. Philadelphia, PA. October 21, 2008.

Bill Hudspeth and Karl Benedict

2008. Integration of Multiple OGC Standards for Delivery of Earth Science Information - Presentation of Time-Enabled WMS through KML as Implemented by the PHAiRS Project. Poster presented at the American Geophysical Union Fall Meeting. San Francisco, CA. December 15-19.

Stan Morain

2008. Air Quality Forecasts for Asthma Mitigation, Intervention, and Surveillance in the Southwest. Presentation at the UNM Project ECHO Telemedicine Pulmonary Clinic Video Conference, December 12, 2008.

2008. Assessing Environmental Impacts on Human Health: Sample Programs and Initiatives. Presentation at the 17th Pecora Symposium, Denver, CO. November 17-20, 2008.

Stan Morain, Bill Sprigg, and Amy Budge

2008. *Project PHAiRS: Evolution and Implementation*. NASA Public Health Applications Group Meeting, Biloxi, MS. September 17-19, 2008

Slobodan Nickovic

2008. Simulation of Iron/Dust in the Atmosphere by a Regional Model. In: Session A41K American Geophysical Union Fall Meeting. San Francisco, CA. December 15-19.

Bill Sprigg

2008. The World Meteorological Organization's Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Poster in Session A43A, American Geophysical Union, Fall Meeting. San Francisco, CA. December 15-19.

2008. International Sand and Dust Storm Warning and Advisory System. Presentation at 17th Pecora Symposium, Denver, CO, November 18, 2008.

2008. Science, Policy, and Pinter – Lessons from Climate Change. Presentation at the Ecosystems Engineering Seminar, Center for Environmental Fluid Dynamics, Global Institute of Sustainability, ASU, Tempe, November 12, 2008.

Bill Sprigg and Slobodan Nickovic (Session Organizers and Presenters)

2008. Airborne Mineral Dust: Sources, Emissions, Destinations I (Session A41K). American Geophysical Union, Fall Meeting. San Francisco, CA. December 15-19.

2008. Airborne Mineral Dust: Sources, Emissions, Destinations II with Atmospheric Aerosols and Electron Microscopy I (Session A42A). American Geophysical Union, Fall Meeting. San Francisco, CA. December 15-19.

2008. Airborne Mineral Dust: Sources, Emissions, Destinations III (Session A43A). American Geophysical Union, Fall Meeting. San Francisco, CA. December 15-19.

4.0. Outreach & Transition

4.1 NASA Press Release

RELEASE: 08-274

NASA-Enhanced Dust Storm Predictions to Aid Health Community

WASHINGTON -- NASA satellite data can improve forecasts of dust storms in the American Southwest in ways that can benefit public health managers. Scientists announced the finding as a five-year NASA-funded project nears its conclusion.

Led by investigators Stanley Morain of the University of New Mexico in Albuquerque, and William Sprigg of the University of Arizona in Tucson, scientists evaluated the influence of space-based observations on predictions of dust storms. Using NASA satellite data, forecasters could more accurately predict the timing of two out of three dust events.

NASA's Public Health Applications in Remote Sensing project, or PHAiRS, released a report on the study this month. Such forecasting capability is the first step toward a reporting system that health officials could use to warn at-risk populations of health threats and respond quickly to dust-related epidemics.

"The program has been successful in its work to improve dust storms predictions, which has important implications for air quality and respiratory distress warnings," said John Haynes, Public Health Applications program manager at NASA Headquarters in Washington.

Dust and the pathogens it carries have been blamed for exacerbating some cardiovascular and respiratory diseases, including asthma. Dust also obscures visibility on roads, which can contribute to closures and traffic accidents.

NASA launched PHAiRS in 2004 to identify how satellites could help modeling and forecasting of dust storms and to enhance a computer-based system that health managers can use to report and respond to dust-related health symptoms.
The key to better dust forecasts is to represent accurately the features that influence the behavior of dust: land topography, the proportion of land to water, and surface roughness.

"Dust modeling always has relied on surface characteristics that we knew were wrong," Sprigg said.

For instance, information in previous models about a region's features was patched together from old maps and topographic surveys, which do not accurately represent seasonal or cyclical changes in vegetation and related surface features.

Through PHAiRS, up-to-date measurements of Earth's surface features -- collected from instruments on NASA's Terra and Aqua satellites -- provided the critical details needed to enhance an existing dust model. Observations of Earth from space offer more complete information, filling in the gaps between the locations of surface measurements and providing up-to-date snapshots of changing surface features.

The team began with an existing model Slobodan Nickovic of the World Meteorological Organization in Geneva developed that describes how dust is lifted off the ground and carried in the atmosphere. Researchers coupled this model with an operational weather forecast model the U.S. National Weather Service created. The team adapted the model to accommodate dust storms in the U.S. Southwest and then introduced the new satellite-derived measurements.

After using the new model to make hourly dust forecasts for California, Arizona, New Mexico, and Texas during dust events, the team compared their results to real-world observations. They found that the NASA data improved the model estimates of wind speed, direction, near-surface temperature, and the location and amount of dust lifted off the ground. Statistics for the model's performance show that between January and April 2007, the timing of two out of three dust storms in Phoenix could be forecasted precisely.
Already, public health professionals have been enlisted to work with the PHAiRS team to assess the model's real-world utility. The team is collaborating with physicians, public health experts and community leaders in Lubbock, Texas, to integrate the NASA dust storm predictions into a computer-based decision-support system called the Syndrome Reporting Information System, which maps reported cases of respiratory distress. The satellite-enhanced system would allow health and environmental managers to "see" the next 48 hours of dust concentrations for their areas and track the number of respiratory distress situations that result.

Ultimately, the system could allow health officials to issue early warnings to populations at risk for dust-related health complications. Preliminary feedback from public health end-users about the enhanced system's performance is expected in January 2009.

For information about NASA and agency programs, visit: http://www.nasa.gov

4.2. NASA Draft 1-Page PHAiRS Project Synopsis

Forecasting Dust Events in the Southwest United States for Public Health Alerts

Applying NASA Earth Observations to Improve Model Performance

Project Goals

- Adapt Dust Regional Atmospheric Model (DREAM) to forecast dust events in the southwest United States
- Use NASA MODIS MOD12Q1 (barren land) and MOD15 (FPAR) products, and Shuttle Radar Topography Mission data as replacement parameters to improve the performance of DREAM
- Verify and validate improvements to DREAM using EPA AIRNow ground station data
- Enhance the operational Syndrome Reporting Information System (SYRIS) by integrating DREAM forecasts into this syndromic surveillance tool

Project Outcomes

- Timely and accurate regional dust forecasts in the southwest United States
- Provide information on impending dust events to public health officials, school nurses, and others who send alerts to persons with respiratory conditions such as asthma

List of partner organizations

- Earth Data Analysis Center, University of New Mexico
- Department of Atmospheric Sciences, University of Arizona
- ARES Corporation
- New Mexico Department of Health
- Pima County Department of Environmental Quality
- City of Lubbock Public Health Department
- Texas Public Health Region 1
- Albuquerque Public Schools Asthma Registry
- Asthma Allies

Summary

The Public Health Applications in Remote Sensing (PHAiRS) project improved performance of the Dust Regional Atmospheric Model (DREAM) by assimilating data from NASA's MODIS and SRTM sensors. DREAM forecasts dust patterns and concentrations by being nested within, and driven by, the U.S. National Weather Service's operational numerical weather forecast model, NCEP/eta. The project works closely with state public health, environment, and air quality offices which monitor air quality for public health conditions in the Southwest. The ultimate goal of this project is to contribute to an improved public health decision support system and to provide information on impending dust events to public health officials who issue early warnings on adverse environmental conditions.

Societal Benefits

Asthma is a primary concern for the American College of Allergy and Immunology. It is one of the most common chronic diseases in the United States and is the most prevalent chronic disease in children. The rate of asthma among children in the northern mid-latitudes has more than doubled in the last 20 years. Nationwide, more than 9 million children struggle to breathe. According to the National Center for Health Statistics, asthma causes more missed school days than any other chronic condition, and is the leading cause of hospitalization for children under 15. It is the most common reason that children younger than five go to the emergency room. Based on outpatient visits, the prevalence of asthma has increased by 50 percent over the last decade.

Economically, there is ample evidence that respirable particulates result in costly health effects. Direct health care costs currently exceed $11.5B annually. Indirect costs (lost productivity) add another $4.6B (Myers, 2006). Annual treatment costs in 2003 were over $4,900 per asthmatic. Forecasting dust events and issuing early warnings to the public may help reduce the number of emergency room visits, as well as missed school and work days. This translates into economic savings in health care and lost revenue due to lost productivity.

Project Details

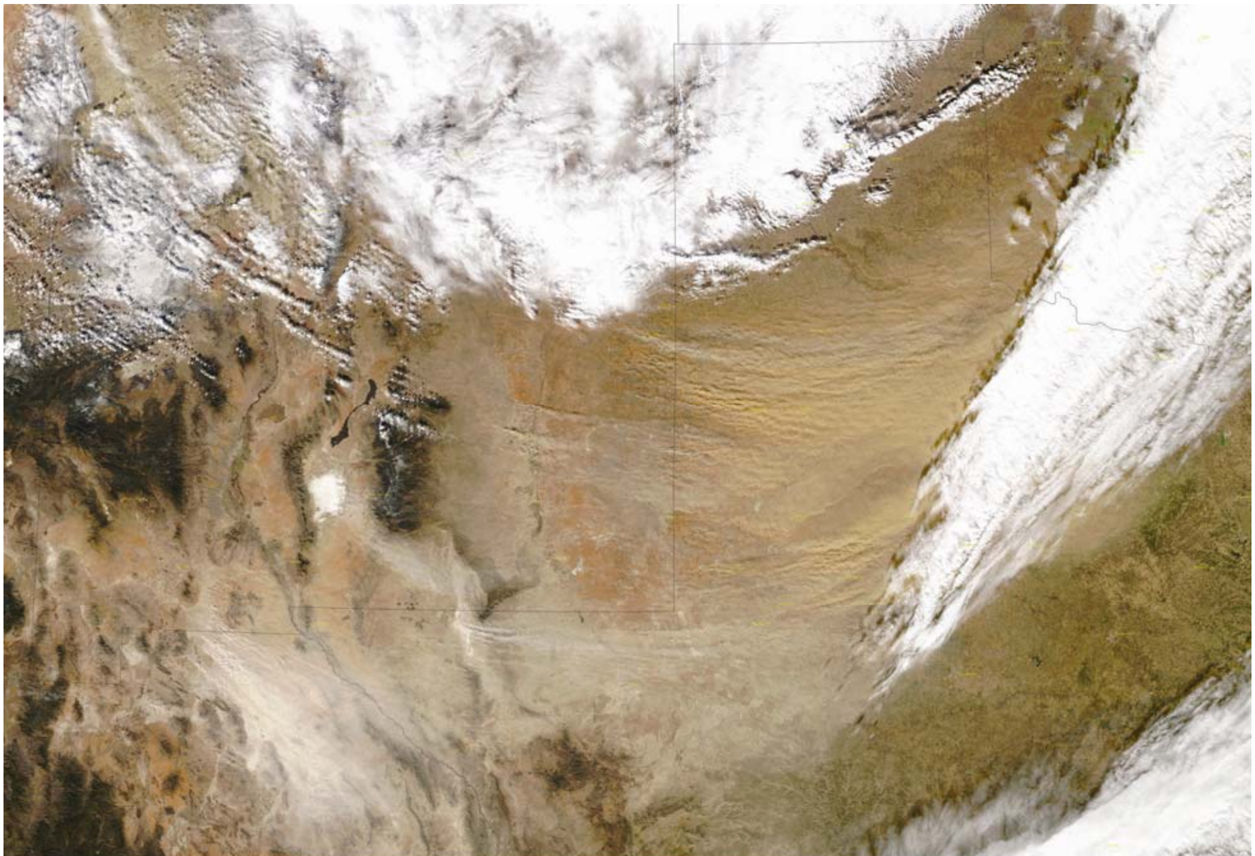
The project has three goals. The first focuses on assimilating satellite data from NASA's Terra and other platforms into a baseline version of DREAM developed originally for use in the Mediterranean region. This model was adapted for use in the Southwest United States. The aim is to: (a) verify that satellite image data can replace initial parameters to improve the model's performance; and (b), validate that parameter replacements can lead to more refined model forecasts of dust episodes. The second goal is to optimize model outputs by iterating inputs with a variety of satellite products and assessing incremental improvements to the Syndrome Reporting Information System (SYRIS). The third goal is to establish collaborative relations with public health communities to develop statistically valid relationships between dust episodes and increased respiratory complaints.

Meteorological fields modeled by the enhanced DREAM are generally in agreement with measured observations. Comparing model runs before and after assimilating NASA data showed that sea level pressure, 500 hPa geopotential height, and temperature patterns matched well with traditional weather observations. The upper-air fields were *not* affected by assimilating NASA data as replacement parameters into the model. Improvements to model performance are observed by assimilating MOD12Q1 data into DREAM. The model forecasts the timing of dust storm events very well at almost all locations in the model domain, but has variable success in forecasting dust concentrations.

Model performance is being verified and validated using simple correlations (peak hour and concentration) between hourly observed and modeled outputs to assess how well DREAM predicts dust events. Results show there are lags in model timing and concentration averaging, which help improve verification of model performance. Twenty-four-hour averages are compared to test the model's ability to predict exceedances of the EPA health standards for $PM_{2.5}$ and PM_{10}. The enhanced model performs better than the original version of DREAM in reporting fewer EPA exceedances, and it has fewer false alarms. Promising results from enhanced model runs indicate that data replacements improve dust episode forecasting in two out of three cases. These improvements should lead to more timely forecasts that enable public health officials to issue early warning alerts and implement health interventions for populations at risk.

Scholarly Reference

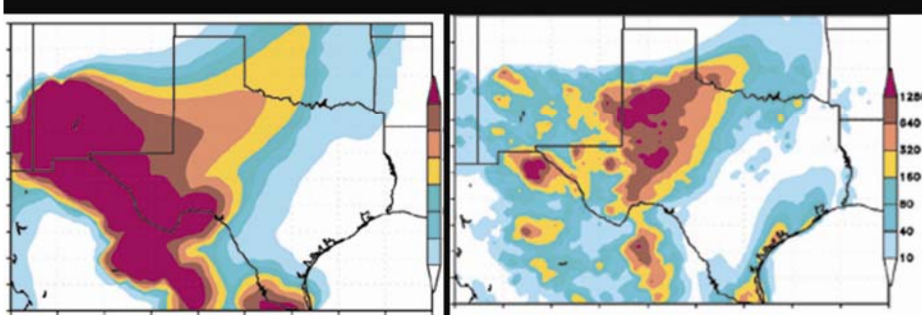
The PHAiRS project was inspired by application of an operational version of DREAM in the Mediterranean region where 72-hour forecasts were being run routinely. This work is described in a paper by Slobodan Nickovic, et al., "A model for prediction of desert dust cycle in the atmosphere" published in the *Journal of Geophysical Research*, Vol 106, No. D16, pages 18113-18129 in 2001.

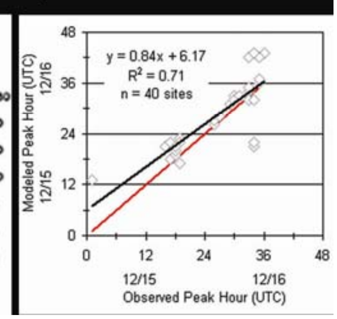


Dust storms in southeast New Mexico, west Texas, and northern Mexico are evident in this MODIS image acquired on December 15, 2003.

The image on the left illustrates distribution of dust concentration modeled by DREAM without using NASA data. By assimilating NASA MOD12 data into DREAM the resolution of modeled results are improved, seen in the image on the right.

Modeled peak hour for the dust event after adding NASA MOD12 data. Black line represents correlation between modeled and observed results. Red line is perfect correlation.





4.3. Radio Interviews

4.3.1 Austrian Public Radio 1/07/09

Madeleine Amberger of Austrian Public Radio interviewed Dr. Sprigg on January 7, 2009. Austrian interest had been raised by, among other things, concern about the effects of dust storms in developing countries, the NASA press release about PHAiRS, his presentation at AAAS a year ago, and the Washington Post article that followed.

On 1/10/09 "Madeleine.Amberger@orf.at" wrote:

Bill,
The version for Austrian Radio aired already yesterday (January 9, 2009). I did say that you are using NASA satellites.

Best regards,
Madeleine.

Ms. Amberger e-mailed again after the interview:

Bill,
I forgot to ask you about your (future) cooperation with the Italians. What is this about?
Thanks!
Madeleine.

And, I responded:

Madeleine,
Dr. Franco M. Buonaguro, M.D. and I are in a strategic planning stage for a project that would (a) examine windblown dust from the Sahara for harmful bacteria, virus, etc, especially the meningitis bacteria and (b) attempt to relate this in epidemiological studies in Africa. I would let him know when dust storms will occur, he will alert his colleagues in African hospitals to set out dust collectors, they would mail the samples to him at his lab in Naples to analyze. Epidemiologists would relate this to incoming patients in Africa who may have been exposed to the dust. That's it in a nutshell. We are just at the beginning stages of planning. We will have to seek funds to do the job correctly. Thanks again for the opportunity to spread the word about our progress.

4.3.2 Puerto Rican 'Live' Radio 11/28/08

Susan Soltero of Puerto Rican radio contacted us after reading the NASA press release concerning PHAiRS. The e-mails below yield insight as to why our work is needed and how we can make our product as useful as possible in everyday life. Her show runs live every day at 2pm ET.

October 29, 2008

Susan Soltero SSoltero@UNIVISION.NET
Hi there:
I'm a reporter in Puerto Rico and was wondering if this study (see NASA Press Release Below) also helps us with Saharan Dust events? Any Spanish speakers in your working group available for an interview?

Susan
There followed several e-mails, including:

October 29, 2008
Subject: Re: Dust study

Dear Susan,

Re. Spanish speakers: One of our colleagues, Prof. Alfredo Huete, works with us in modifying the dust model to predict pollen plume dispersal. A graduate student who has not been on the project, but has been following our work, might be interested in answering a few questions.

Now, to answer your question about Saharan dust events: At present we are not funded to work on the African dust events, but our study certainly helps us understand the problem of African dust events. (As you may know, the problem may not just be mineral dust, but include bacteria, viruses, and plant pathogens that remain viable over long distances on strong winds.) The World Meteorological Organization has asked if we could establish a Pan-American Centre to provide studies and forecasts for our part of the world. Unfortunately, we need funds to do this.

Today, we collaborate with medical researchers and health scientists who are concerned about Saharan dust events for both people in Africa and regions beyond, including the Western Atlantic and Caribbean. Together, we hope to apply our model and methods for monitoring dust sources in Africa to alert health services on both sides of the Atlantic. The same principals we use in the US Southwest can be applied for Africa and all over the globe.

Both Prof. Morain and I would be happy to talk with you. Unfortunately I cannot do this is Spanish. But, I could find someone to translate for us.

Best Regards, and thank you for your interest.
Bill Sprigg

November 04, 2008

From: William Sprigg [mailto:wsprigg@email.arizona.edu]
To: Susan Soltero
Cc: Alfredo Huete
Subject: Re: Dust study

Dear Susan,
I hope you received the contact points for Professor Huete I sent
several days ago. To see another news article about our work, please see the front
Page of yesterday's Tucson Citizen:
http://www.tucsoncitizen.com/altss/printstory/frontpage/101432

I believe Professor Huete may not be aware of the WMO Pan American Dust Warning Centre that we hope to establish. This Centre would address many of the questions you raise. The international team has not yet been formed to do this, and we would like to include appropriate government officials from Puerto Rico in these deliberations. Your help in making this happen would be appreciated.
Best Regards, Bill Sprigg
November 11, 2008

"Susan Soltero" <SSoltero@UNIVISION.NET>

Hi William:
I'd be happy to put you in touch with the right people. In fact, I'll forward your message and ask them to contact you. In the meantime, let’s do an interview next week about all this. I'll translate.

How are you next week at 2pm ET? Can you do a live interview with me for Eastern Puerto Rico? We lead the nation in asthma incidence per capita. I, too, am asthmatic. Big issue down here and people thought it was the Saharan dust, but it turns out to be the pollen.

Susan

The radio interview took place on November 28, 2008.
Questions centered on how PHAiRS may be able to help in regions other than the US Southwest. Ms. Soltero thought her listeners would like to access the PHAiRS webpage and I gave her the URL. Later she informed me the page was too complicated. She hoped to find just the forecast. I replied:

Dear Susan,

This week, tests were made on the University of Arizona supercomputer. This will make 3-day forecasts in 1.5 hours. The simple forecast, every day, will be put on the PHAiRS website for people to see. This will be much easier for the public. The priority to do this occurred to me after my interview on your radio program; you said your audience wanted to see the forecasts. You have made a very nice improvement to our public "outreach."

I will keep you informed of our progress and you can let your audience know how they helped us.
Best Regards,
Bill

December 12, 2008

Susan Soltero wrote:

Hi Bill:

Thanks for keeping me posted. As soon as you are ready to launch a more user friendly model...let me know and we'll do another interview. What's great is that it sounds like it might be right before the next season for us.

Susan

4.4. Expanding User Communities

The UNM team has met twice with the New Mexico Chapter of Asthma Allies. This group has served the project well in further representing PHAiRS at their venues, and in introducing the team to new user groups. Their role is primarily education and outreach so they are good emissaries for groups not yet known to the team. Two such organizations are the Albuquerque Public School (APS) nurses and the Project Echo: Telemedicine Pulmonary Clinic.

The APS has developed an asthma registry of over 2000 grade school children (mainly K-6) who have been diagnosed with chronic or severe asthma. Meetings with school nurses have confirmed their high interest in adopting the daily dust forecasts as a means of early warning for dust events that might trigger health responses. They are beginning to use the information to telephone, fax, or text-message parents about children taking their asthma medications, staying in-doors for the duration of the event, or at least during the peak hour of dust concentration. Other interventions could include school nurses keeping members in the

Registry indoors during recesses. The objective is to avoid severe attacks and to reduce emergency room admissions.

Project Echo is a similar, but state-wide, group of doctors and nurses who hold regular video and teleconferencing sessions to share information about severe cases, treatment options, and diagnoses. They, too, have been briefed by the PHAiRS team. As a result of these gradually expanding user communities, the team now displays its 2-day rolling forecast on the opening page of http://phairs.unm.edu.