Public Health Applications in Remote Sensing

PHAIRS Project Overview

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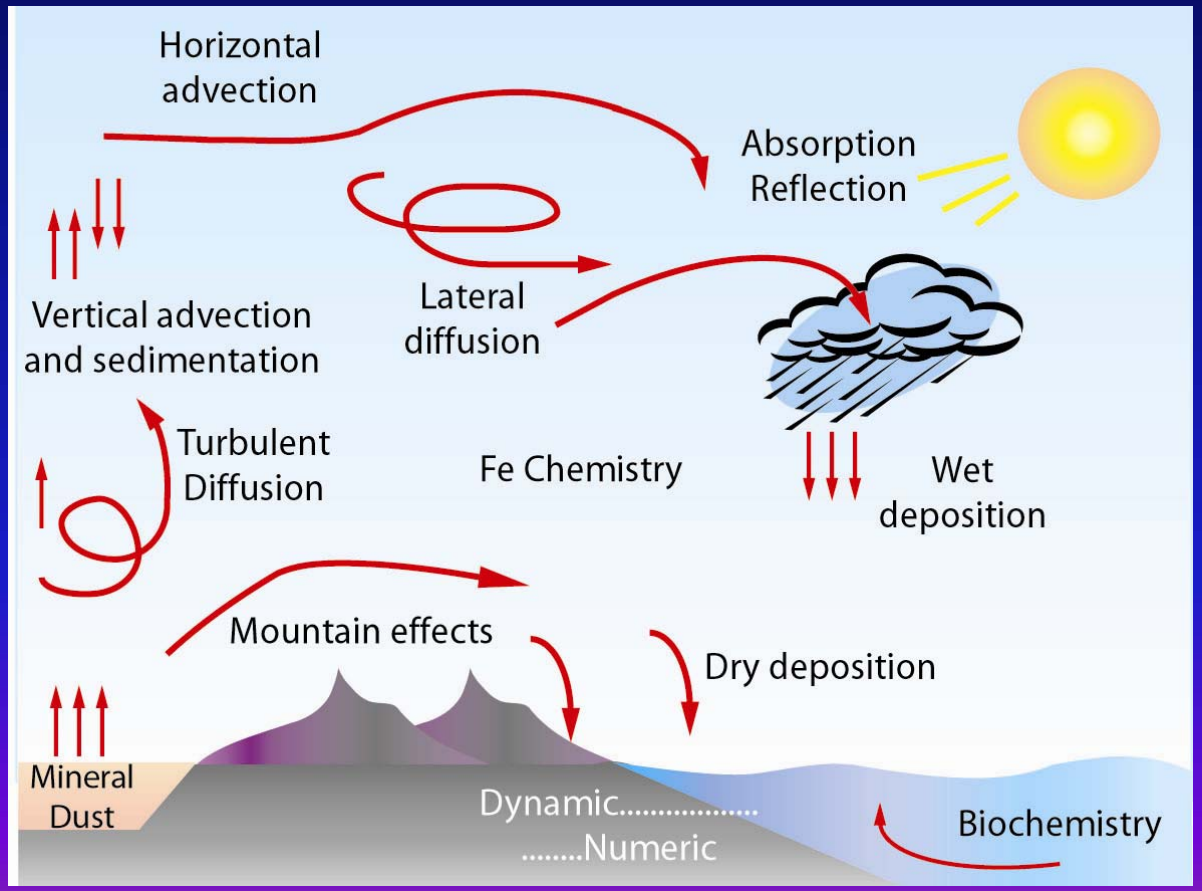
Public Health Applications in Remote Sensing (PHAiRS)

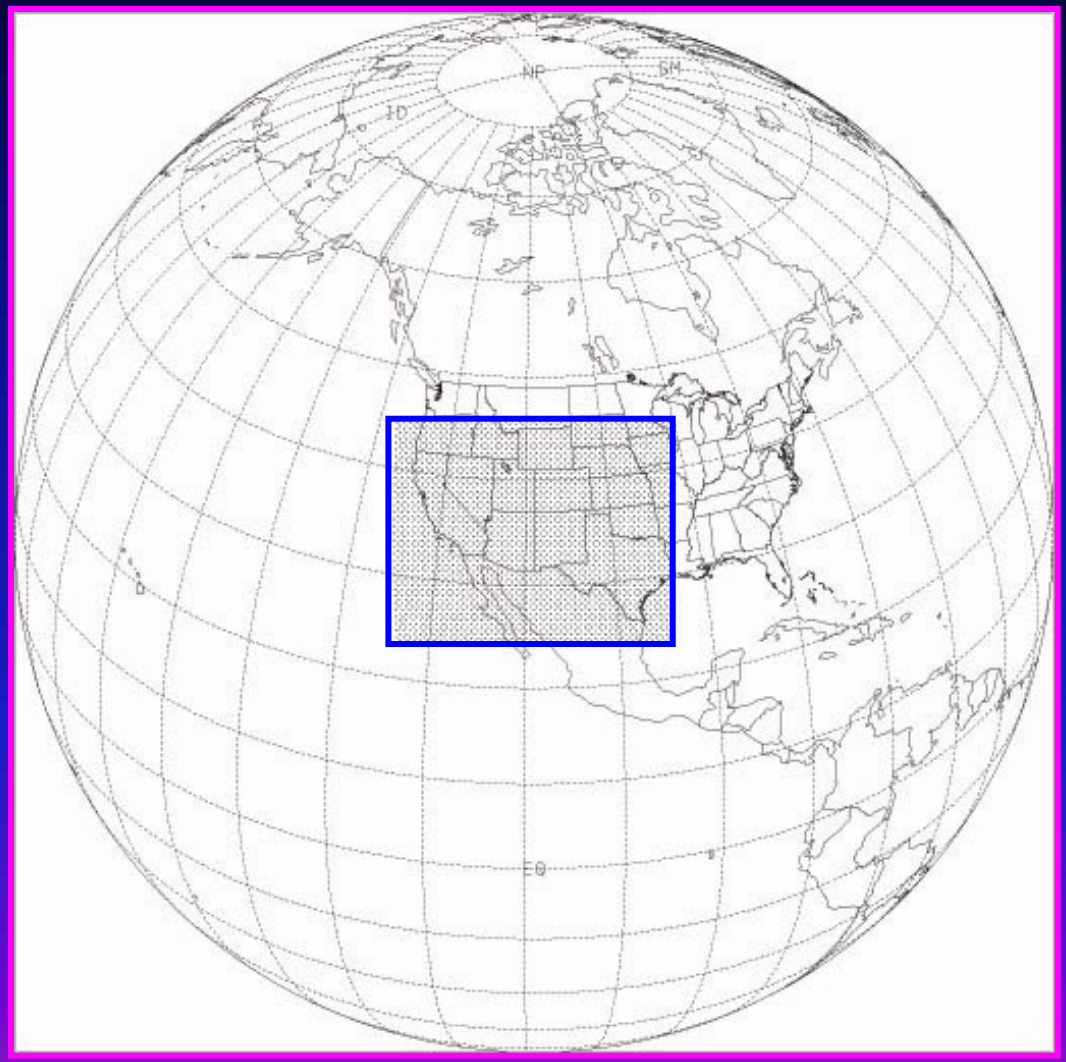
- Focus on SW, dust storms, respiratory diseases, and syndromic surveillance
- 3 thrusts
  - Assimilate EO data into DREAM as part of NCEP/Eta forecasting system
  - Measure incremental improvements to DREAM outputs as inputs to surveillance & decision support systems
  - Create collaborations with public health authorities to validate relationships between dust episodes and respiratory complaints

DREAM's Governing Equation

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



Model Domain

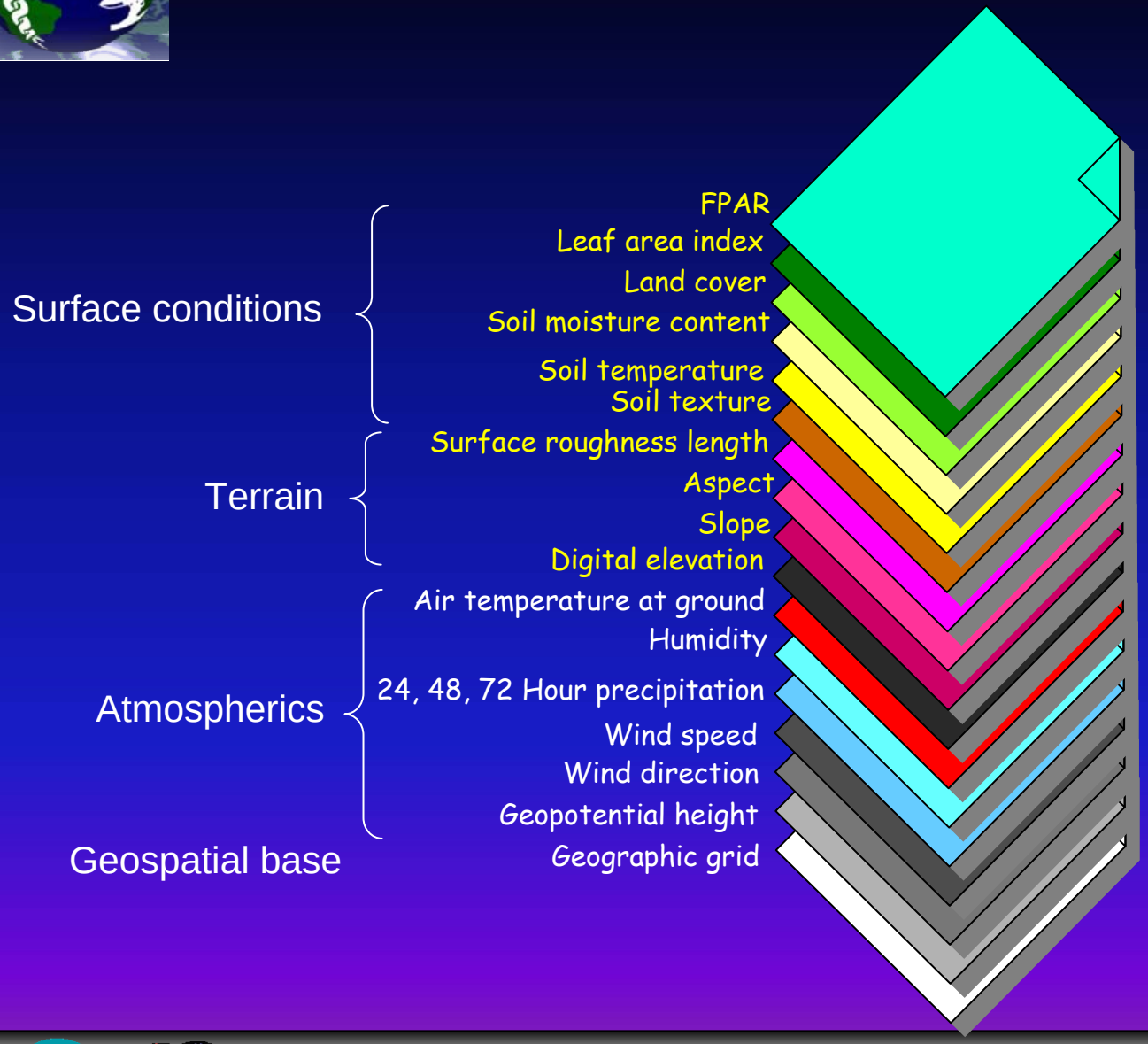


- Domain center at (109°W, 35°N)
- Horizontal semi-staggered Arakawa E grid
- Horizontal grid spacing 1/3 degree

PHAiRS Approach

- Assimilate NASA Earth observations data into a regional dust model (DREAM) nested in the NCEP/Eta weather forecasting model to
  - simulate dust entrainment and dispersion patterns
  - replace traditional model parameters with actual measurements
  - improve dust forecasts by combining atmospheric and land surface measurements that influence health outcomes.
- Use air quality data to
  - verify & validate model outputs of dust episodes
  - transition modeled dust concentrations with air quality standards
- Develop forecast products for users
  - model output animations 24-36 hour regional forecasts
  - provide web interfaces for health care communities and authorities

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 Earth observation 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

DREAM Assimilations as of 9/30/07

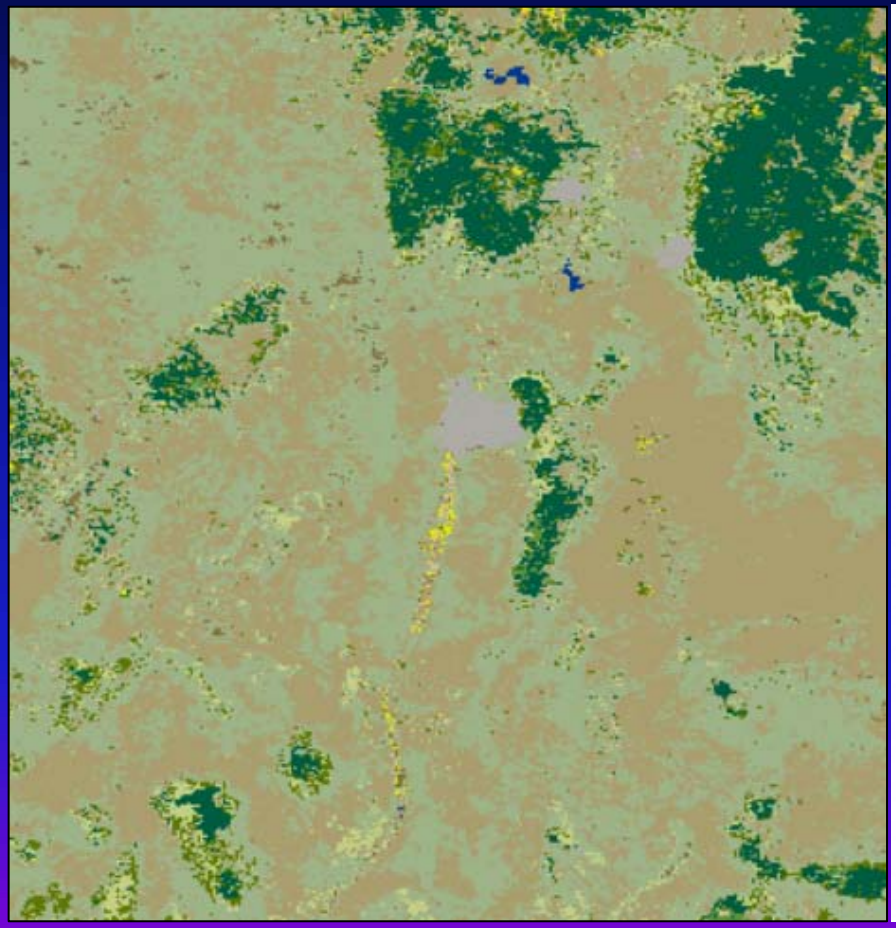
Previously used data

- Soil Moisture: simulated using a land surface model
- Topography: USGS 1 km terrain data
- Vegetation: Olson World Ecosystems 10-minute (± 19 km resolution)
- Aerodynamic Roughness Length predicted using 12 land cover types

Assimilated Data

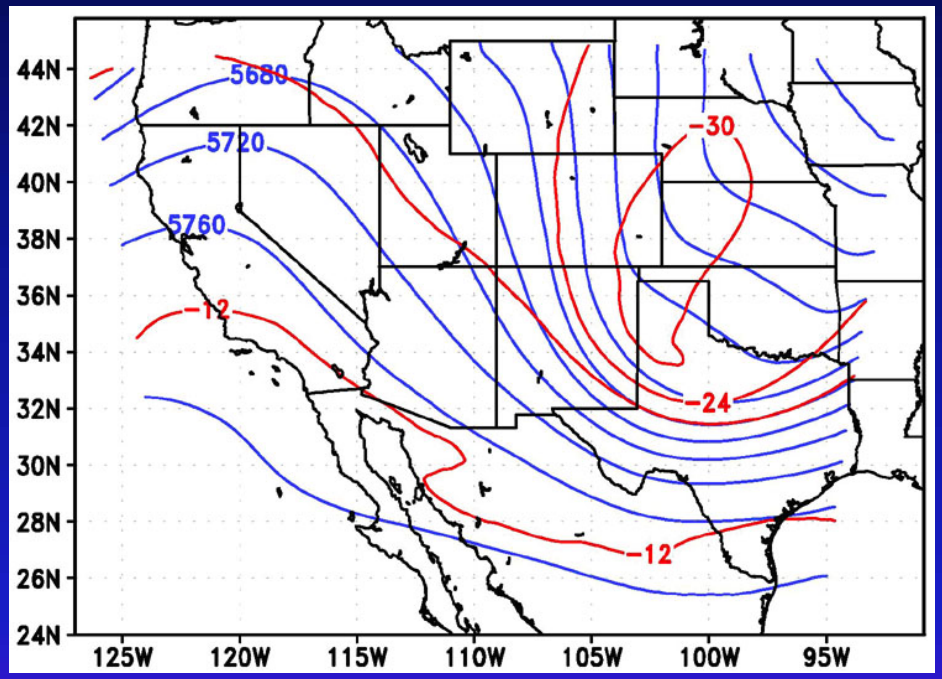
- AMSR-E soil moisture data
- SRTM 90 meter terrain data
- MOD12 Land Cover 1km resolution
- Look-up table based on MOD12 land cover, 1km resolution

Sample MOD-12 Image and Pixel Cover Type Designations for Categories 1-16

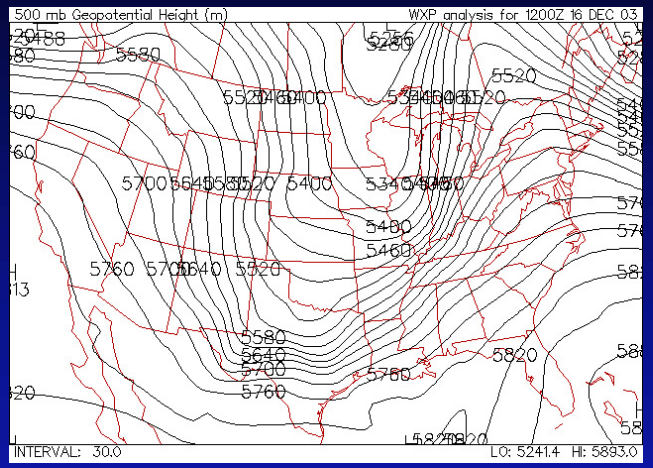


X	Y	F1 B1
-115.5098527410	33.2672987437	7
-115.5015067424	33.2672987437	16
-115.4931607437	33.2672987437	16
-115.4848147451	33.2672987437	16
-115.4764687465	33.2672987437	16
-115.4681227479	33.2672987437	16
-115.4597767493	33.2672987437	16
-115.4514307506	33.2672987437	16
-115.4430847520	33.2672987437	16
-115.4347387534	33.2672987437	16
-115.4263927548	33.2672987437	16
-115.4180467561	33.2672987437	16
-115.4097007575	33.2672987437	16
-115.5098527410	33.2589527450	7
-115.5015067424	33.2589527450	16
-115.4931607437	33.2589527450	16
-115.4848147451	33.2589527450	16
-115.4764687465	33.2589527450	16
-115.4681227479	33.2589527450	16
-115.4597767493	33.2589527450	7
-115.4514307506	33.2589527450	16
-115.4430847520	33.2589527450	16
-115.4347387534	33.2589527450	16

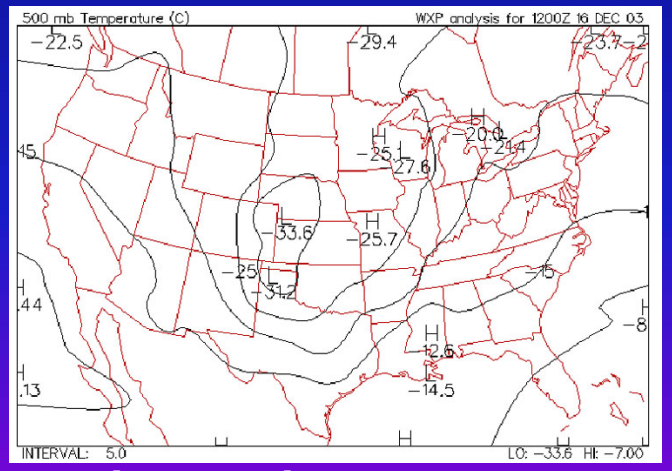
Modeled vs Observed Synoptic Patterns 12 Z on 16 Dec 03



DREAM Simulation



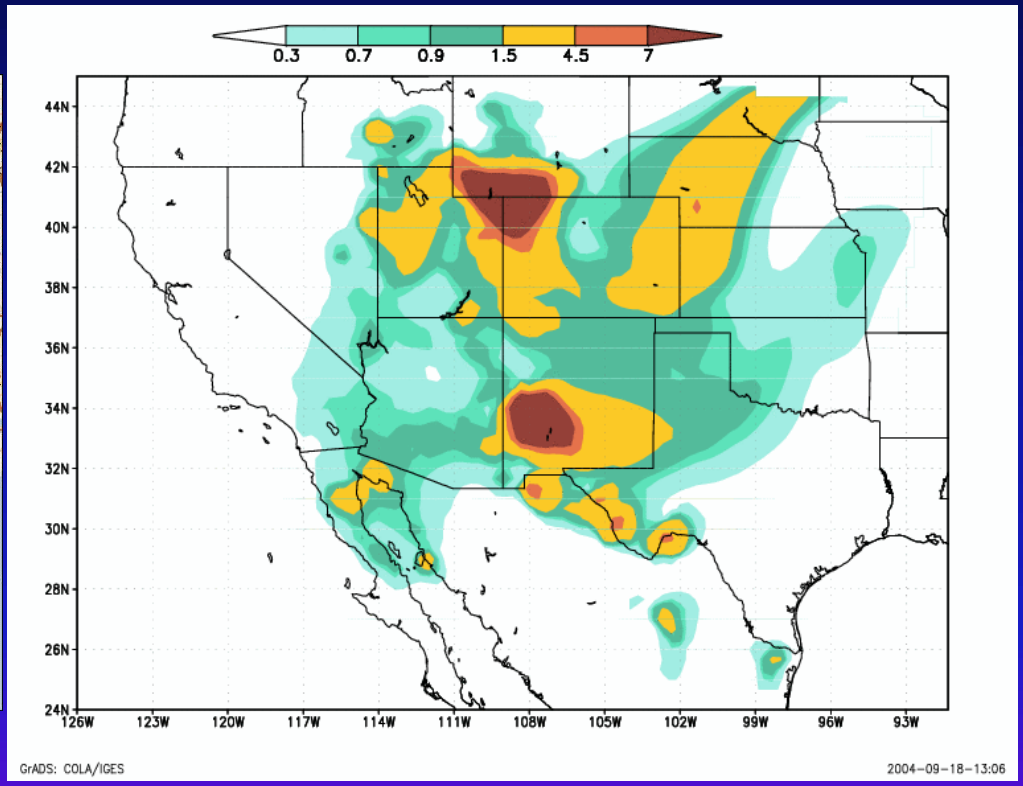
Observed Geopotential Height



Observed Temperature

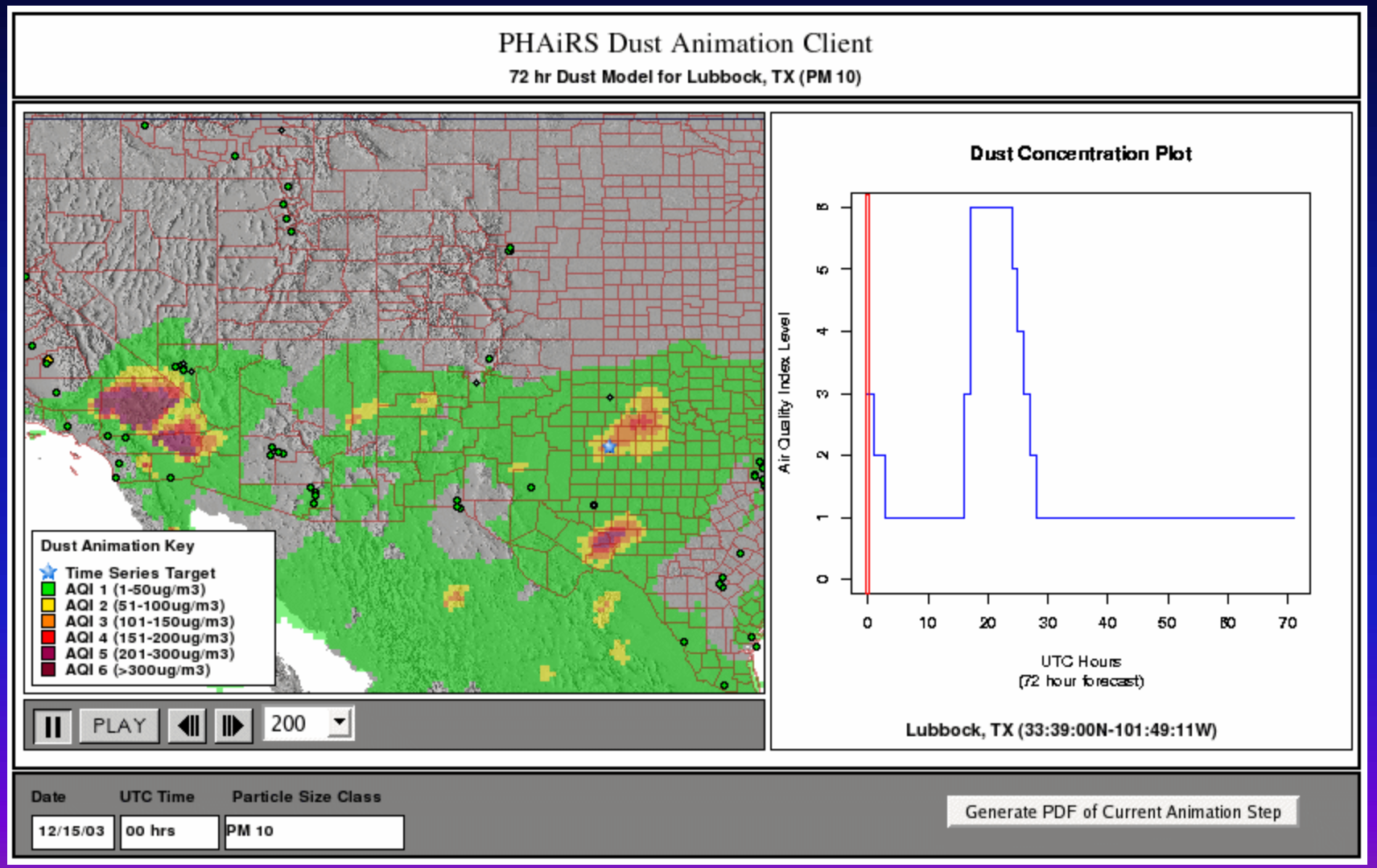
Observed Visibility vs Modeled Dust Concentrations Dec. 15-16, 2003

Texas
Continuous Air Monitoring Stations

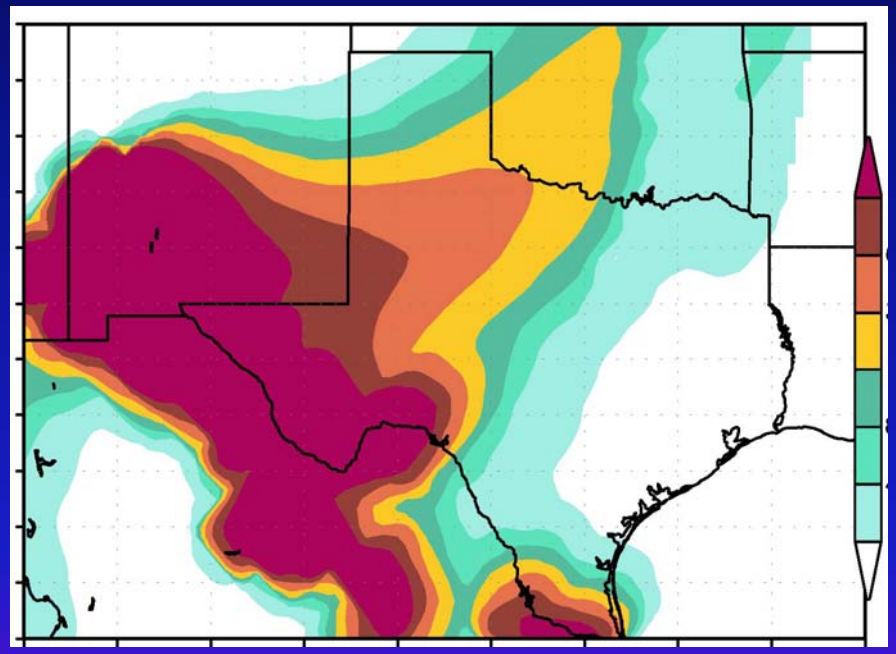


DREAM Baseline (no EO data included)

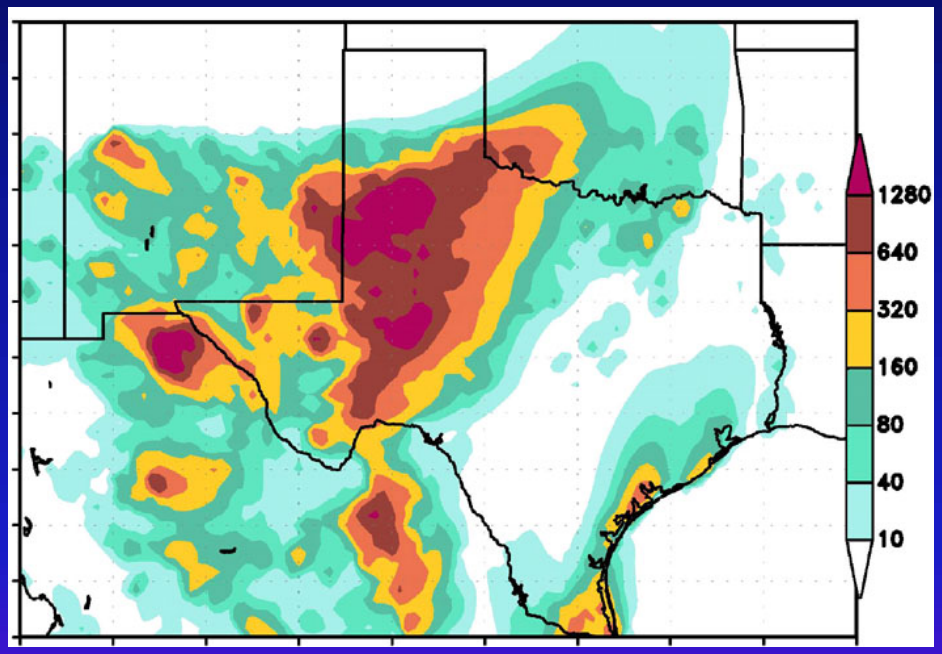
PHAiRS Dust Animation



Comparison of DREAM Dust Concentrations at 20Z 15 Dec 03



Static Surface Inputs



EO Surface Inputs

Sample V & V Results