Climate Modeling Using Earth Observation Data to Improve Public Health Decisions

PHAIRS Team
CCSP Workshop
Climate Science in Support of
Decision Making

14-16 November, 2005 Arlington, VA

The PHAiRS Team

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Public Health Partners

- City of Lubbock Dept of Health
- Pima County Dept of Environmental Quality
- Arizona Dept of Health Services
- NM Dept of Health
- ARES Corporation

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 RSVP/SYRIS
 - Create collaborations with public health authorities to validate relationships between dust episodes and respiratory complaints

EARTH SYSTEM MODELS

Modeling Framework
NCEP/Eta* + "DREAM"

Candidate Adjunct Models
Plume dispersion
Ecological Models (e.g. HPS)

Statistical models
(e.g., NARA, NARISA)



MONITORING & MEASUREMENTS

MODIS Data Products
MOD04,08,09,11-17
ASTER Data Products
AST14, AST05,08
MISR Data Products
MIS05,08,09
AMSR-E
SRTM

Project Framework

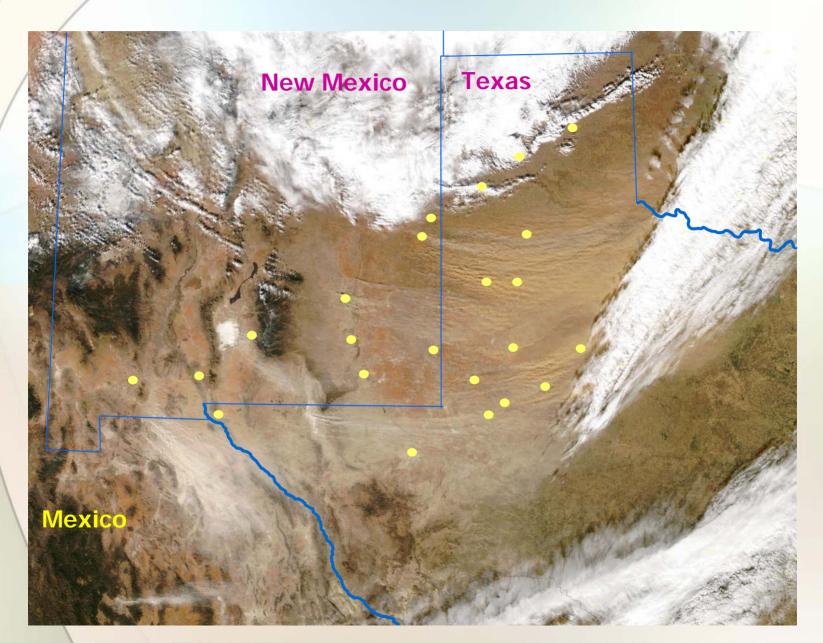
DECISION SUPPORT TOOLS

Enhance RSVP capabilities w/
visualizations and animations of
key environmental triggers
Improve DREAM inputs w/
NASA products
Improve NCEP/Eta weather
forecasting model w/
DREAM inputs
Improve aerosol and smoke
dispersion models w/ NASA
products

VALUE & BENEFITS

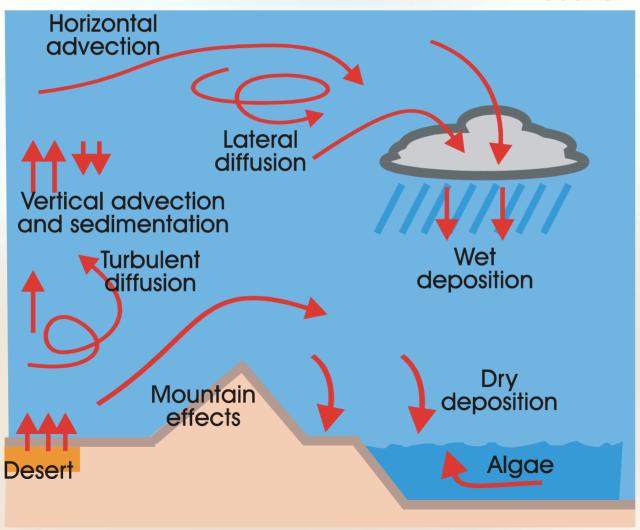
Expand user base for RSVP
Refine quality of public health response NASA assets feed DSS
Provide quicker public health response
Benchmark value of solutions
Integrate NASA/CDC solution
Stimulate Workforce Dev

New Mexico/Texas Dust Storm - Dec 2003

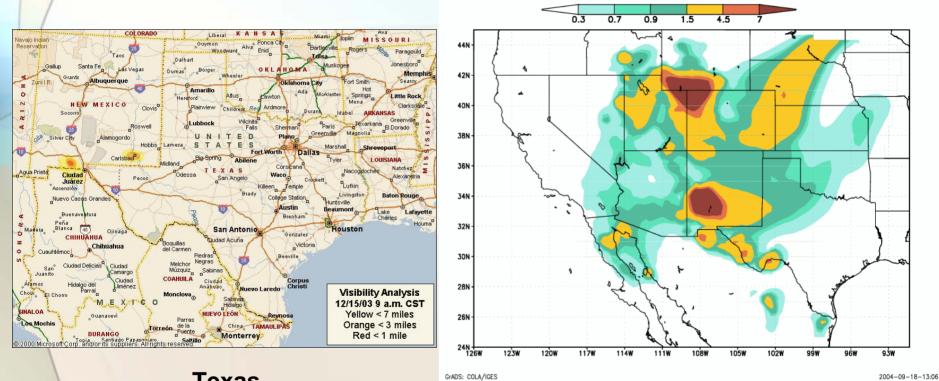


DREAM's Governing Equation

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



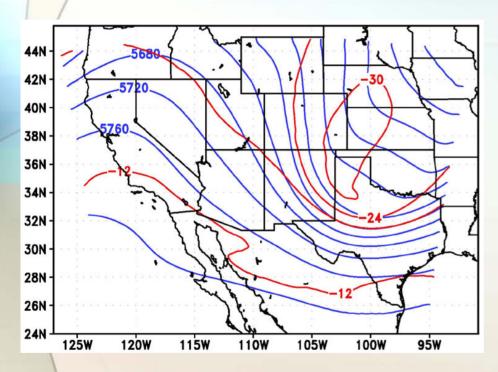
Observed Visibility vs Modeled Dust Concentrations Dec. 15-16, 2003



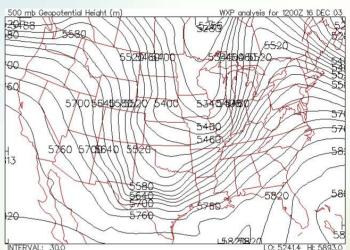
Texas
Continuous Air Monitoring Stations

DREAM Baseline (no EO data included)

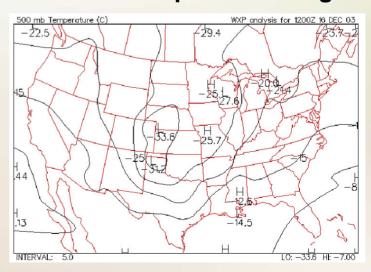
Modeled vs Observed Synoptic Patterns 12Z 16 Dec 03



DREAM Simulation

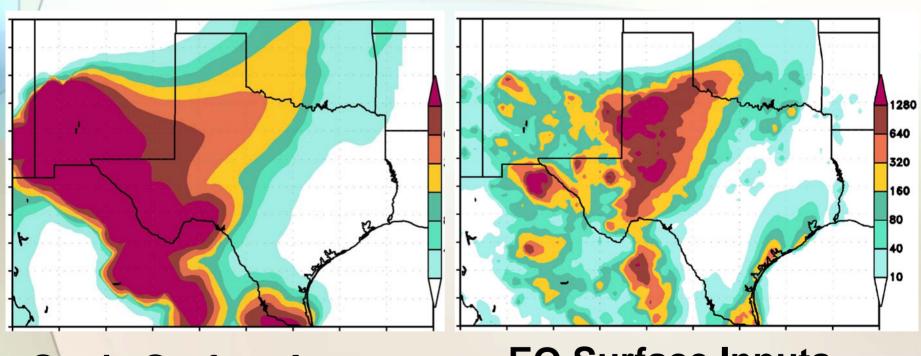


Observed Geopotential Height



Observed Temperature

Comparison of DREAM Dust Concentrations at 20Z 15 Dec 03



Static Surface Inputs

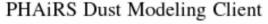
EO Surface Inputs

DREAM Performance Before & After EO Data Assimilation

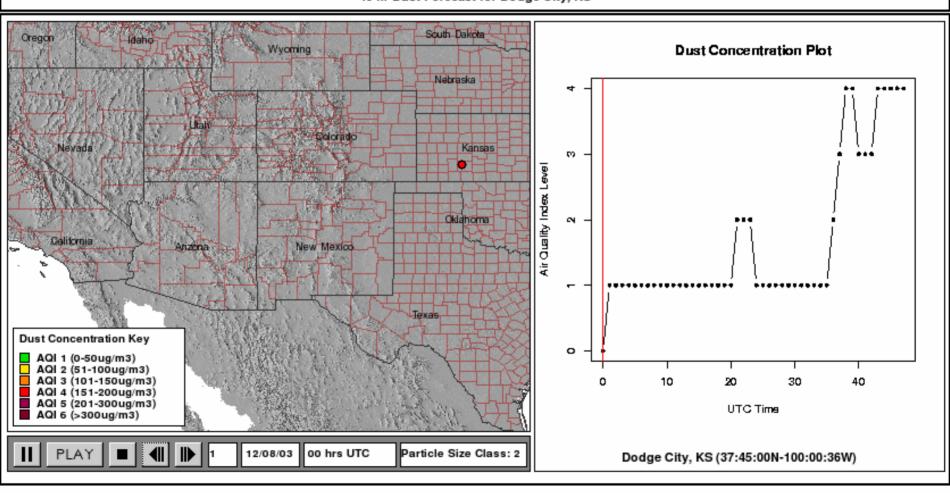
	Metrics	Wind Speed (m/s)	Wind Direction (°)	Temp. (K)	Definition (M: modeled; O: observed)
/	Mean observed	5.53	231.40	276.74	$\frac{1}{N}\sum_{i=1}^{N}O_{i}$
	Mean modeled	4.65 4.37	226.60 230.38	275.56 277.48	$\frac{1}{N}\sum_{i=1}^{N}M_{i}$
	Mean bias	-0.88 -1.16	-4.80 -1.02	-1.20 0.72	$\frac{1}{N}\sum_{i=1}^{N}\left(\boldsymbol{M}_{i}-\boldsymbol{O}_{i}\righ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

Blue values = before EO Data Assimilation Red values = after EO Data Assimilation

Enhancing Decision Support Tools



48 hr Dust Forecast for Dodge City, KS



Relevance to CCSP **Premature Mortality Risk** Attributable to **PM2.5** Locations of **Emerging** <25 26-50 Infectious 51-75 76-100 **Deaths per Diseases** 101-125 100,000 adults >125