Remote Sensing and Public Health

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Mississippi Gulf Coast Geospatial Conference
Biloxi, MS
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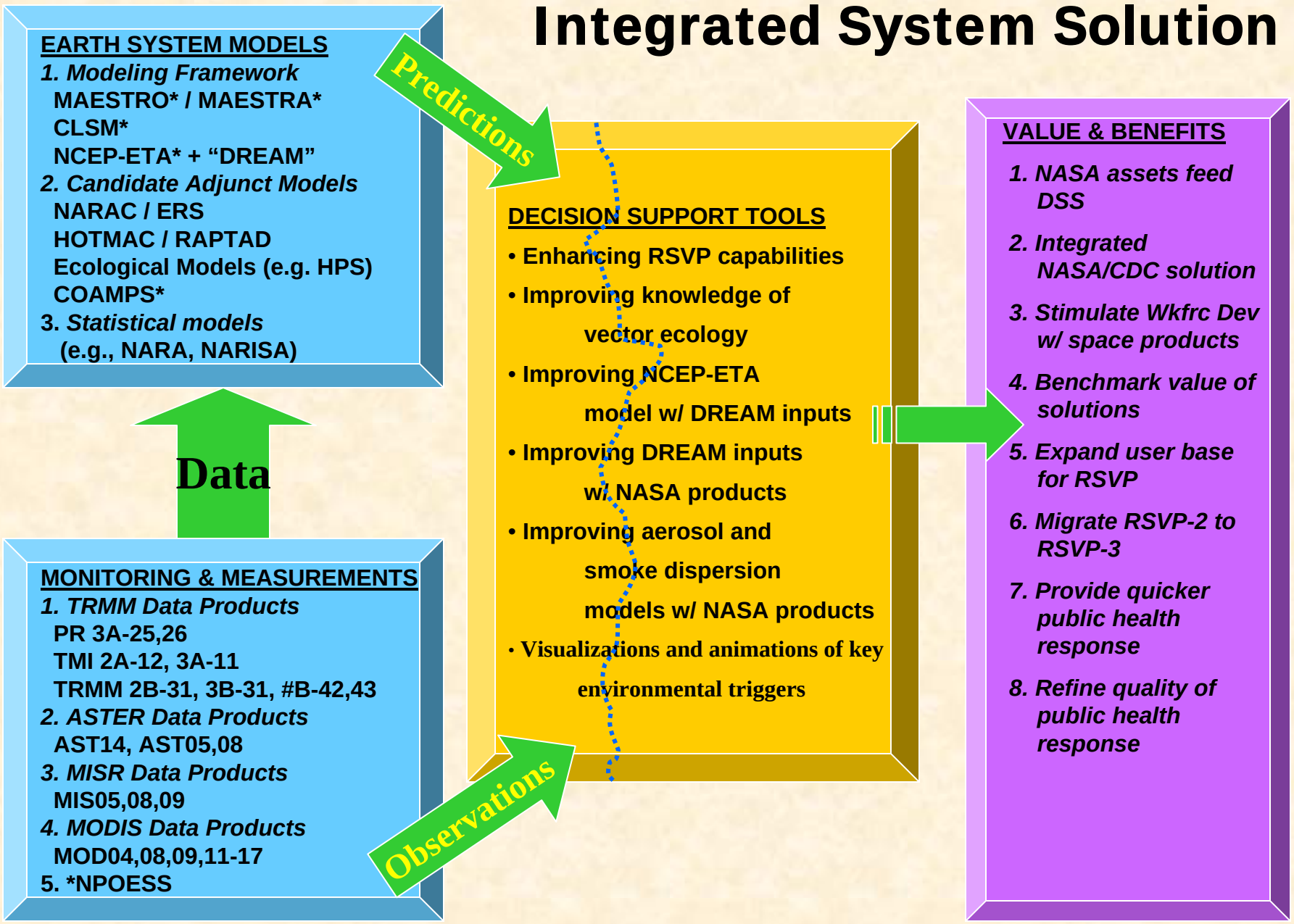
Project Participants

UNM	U of A		SNL	Stake-holders
	Atmos. Sci.	Opt. Sci. Ctr.		
Stan Morain	Bill Sprigg	Kurt Thome	Susan Caskey	NM / AZ-DOH
Amy Budge	Brian Barbaris	Chris Cattrall		NM / AZ-DEQ
Karl Benedict	Dazhong Yin			Hospitals
Bill Hudspeth	Beena Chandy			Private Firms
Tom Budge	Slobodan Nickovic			
Chandra Bales				
Gary Sanchez				

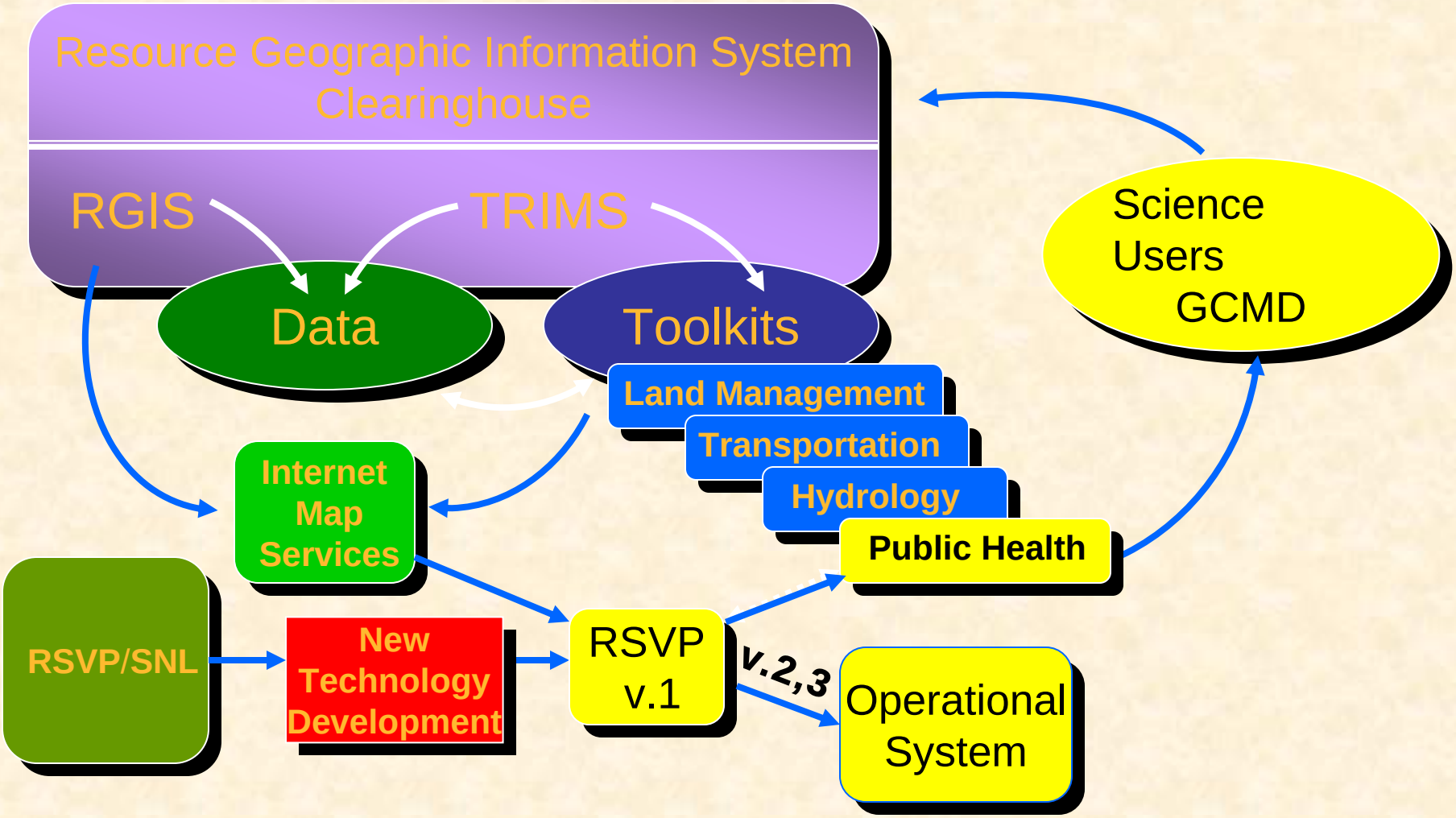
Discussion Topics

- Project Aims and Goals
- Dust model-Inputs and Outputs
- Data Assimilation
- Decision Support System
- Test events-NM/TX Dust Storm
- Health data
- Benchmarking

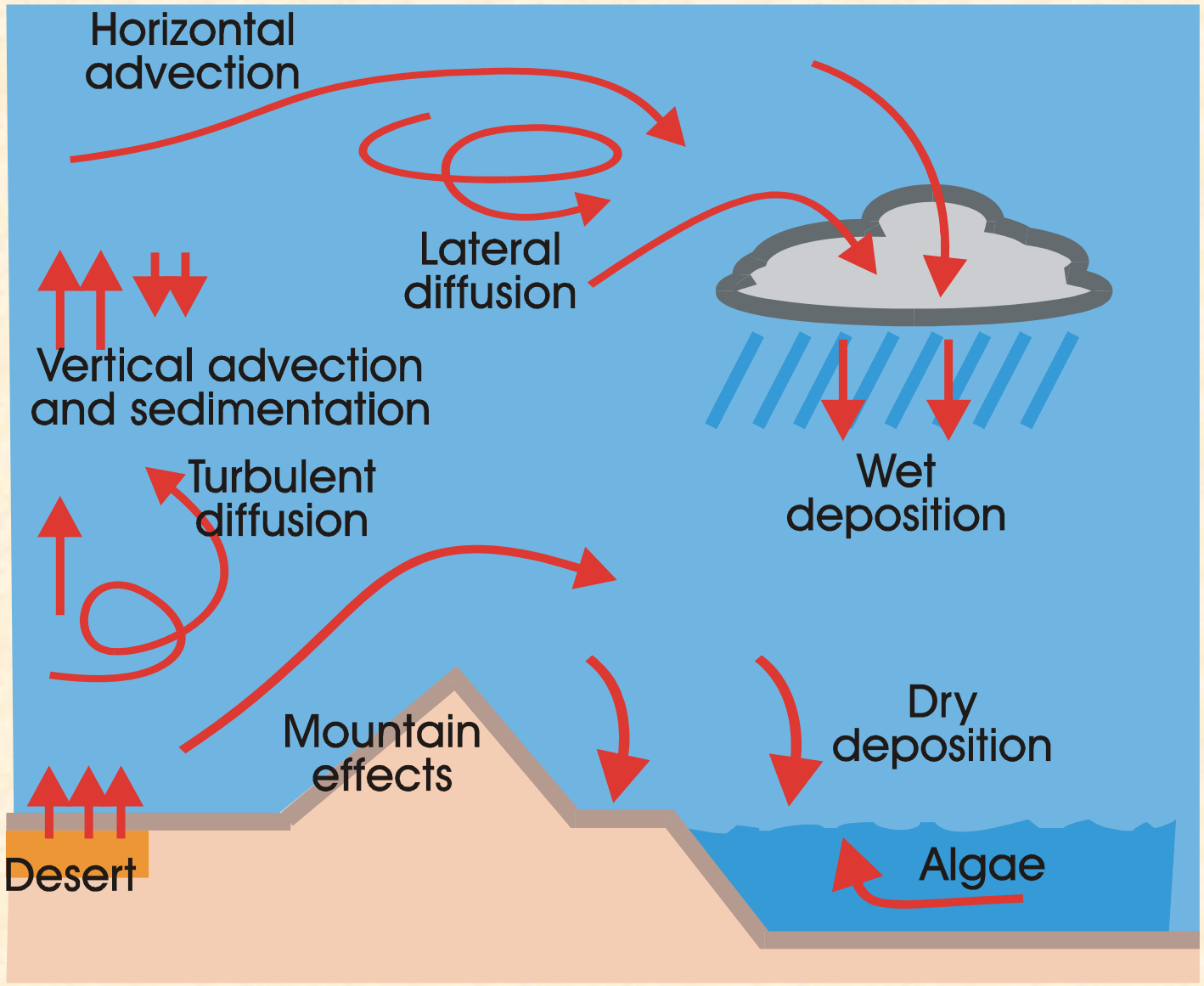
Integrated System Solution



Data Flow and Delivery System



Governing Concept for DREAM

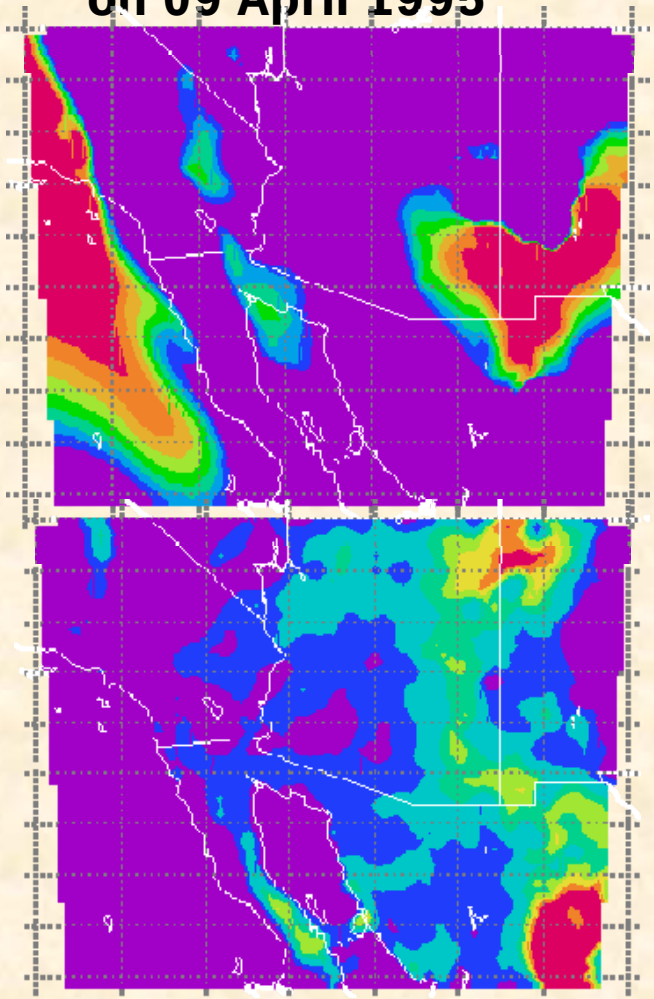


DREAM Has Two Main Parts

- **An atmospheric modeling system**
  - 32 model layers extending from the Earth's surface to 100 hPa in the vertical
  - In the x,y dimensions resolutions range from 0.1 degree to 1.0 degree lat. / lon.
- **A dust concentration module**
  - parameterizes both wet and dry deposition
  - Soil textures are specified by the NCEP/Eta model using
    - ZOBLER seven textural classes @ 1° resolution
    - The UNCEP/GRIDDED FAO/UNESCO soil units @ 2´res.
  - vegetation cover
  - Soil moisture
  - Surface atmospheric turbulence
  - Topography

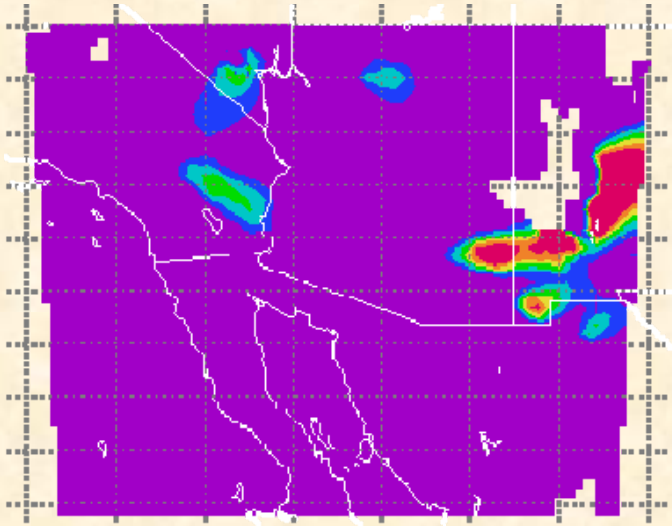
Current DREAM Output

Near ground wind (m/s) on 09 April 1995



Friction velocity (m/s) on 09 April 1995

Near ground dust concentration ($\mu g/m^3$) on 09 April 1995

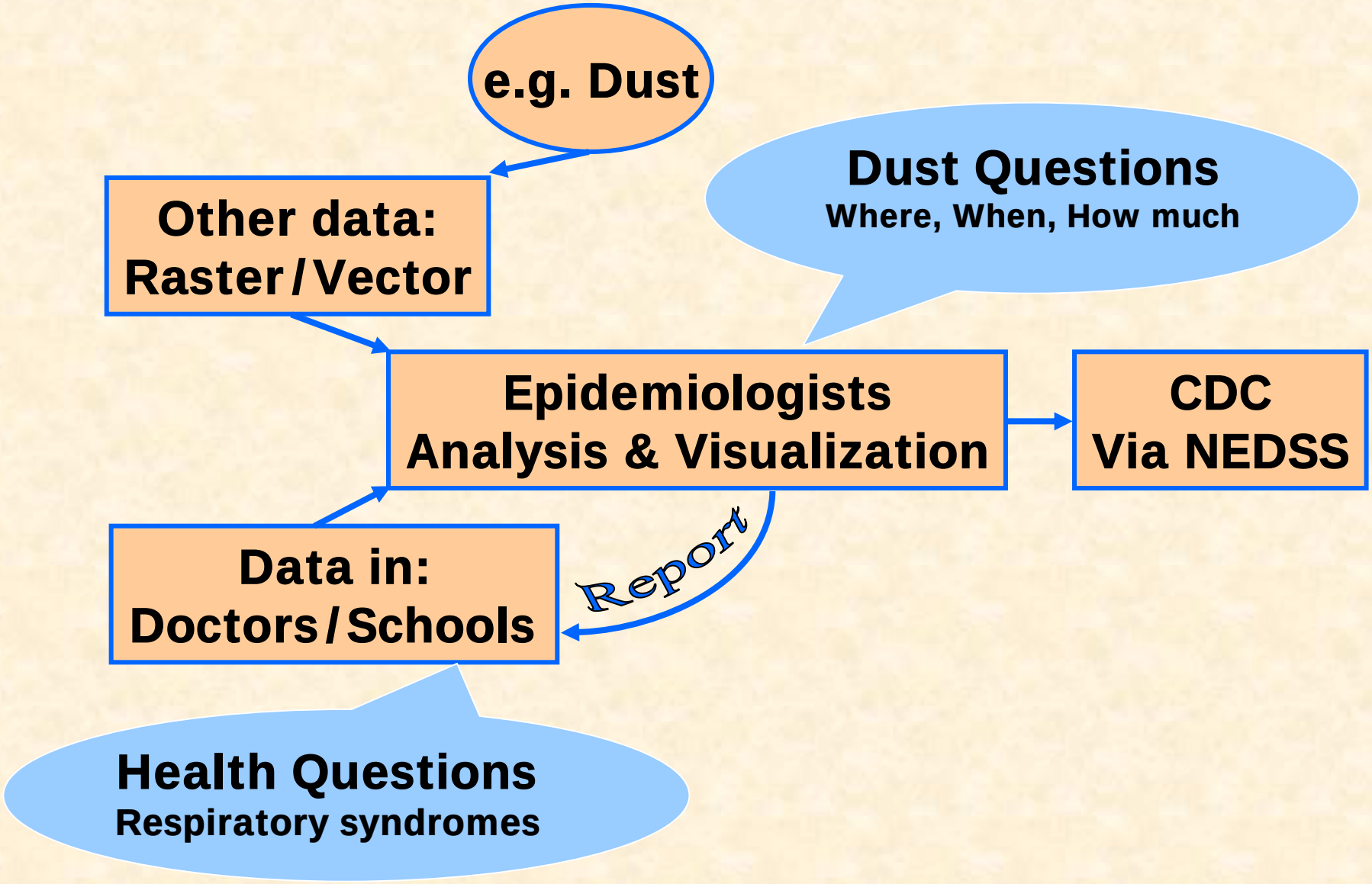


This dust episode caused several auto accidents and resulting deaths

Static Inputs	Dynamic/Variable Inputs	Assimilation Potential
Global topography (1x1 km)	Latitude/longitude, thinned grid standard	ASTER-AST 14/SRTM Digital elevation
Global soil types FAO 2x2 minute (converted into texture classes)	10 pressure levels	NRCS: SSURGO and STATSGO
Global vegetation types USGS (1x1 km)	Geo-potential height	MOD 15 vegetation LAI, FPAR (1km)
	Wind components	Not addressed
	Specific humidity	AIRS/AMSU-A atmospheric humidity
	Surface fields (soil temp, moisture, and albedo)	MOD 11 soil temp TRMM 3A-53 5-day rain map (2 x 2 km)

Items in blue are NASA-generated products. Idea is to migrate from static to dynamic inputs

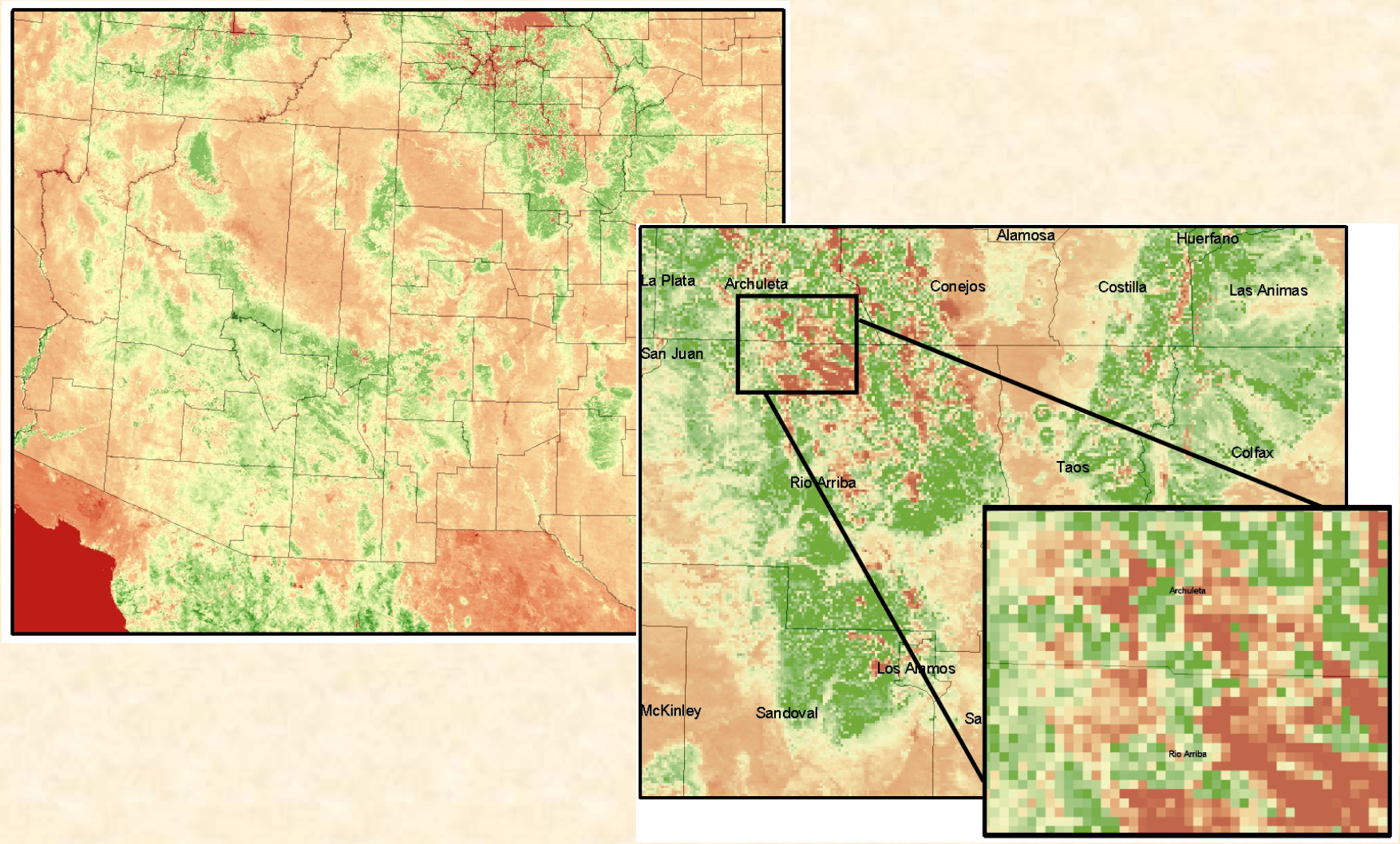
Data Assimilation Concept



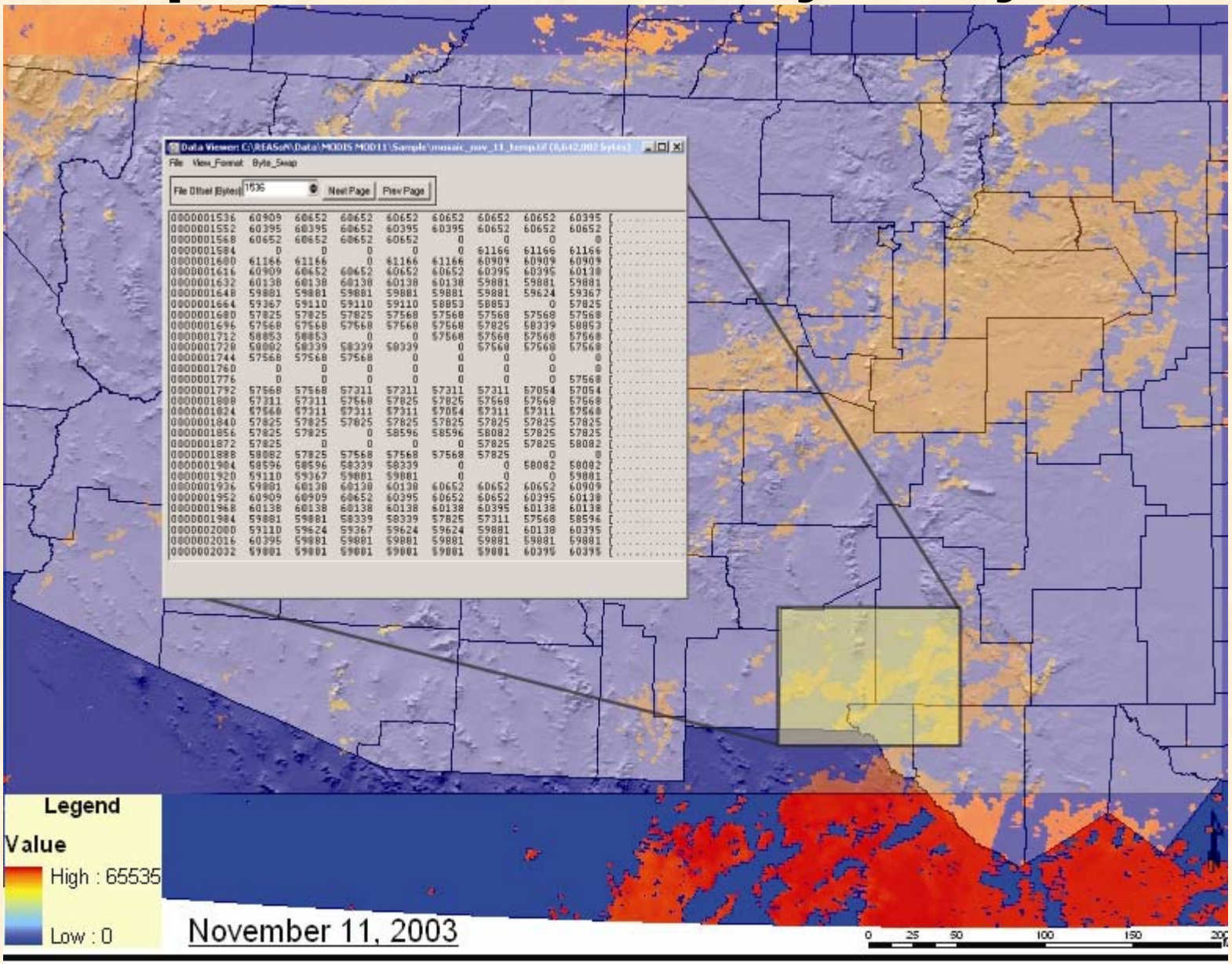
Steps in Assimilation

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

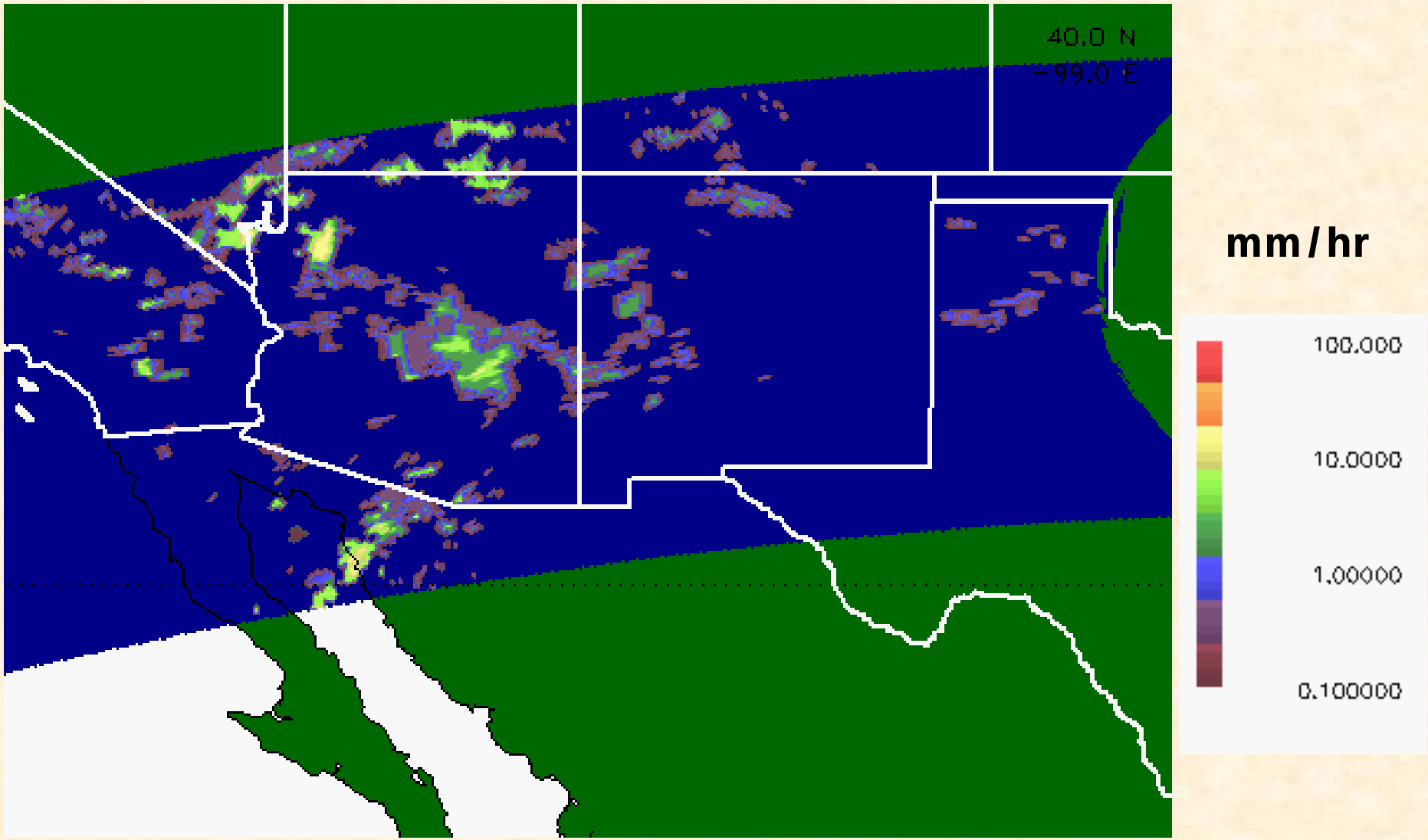
AZ/NM (MOD13A4) 16-Day Vegetation Index 1-km



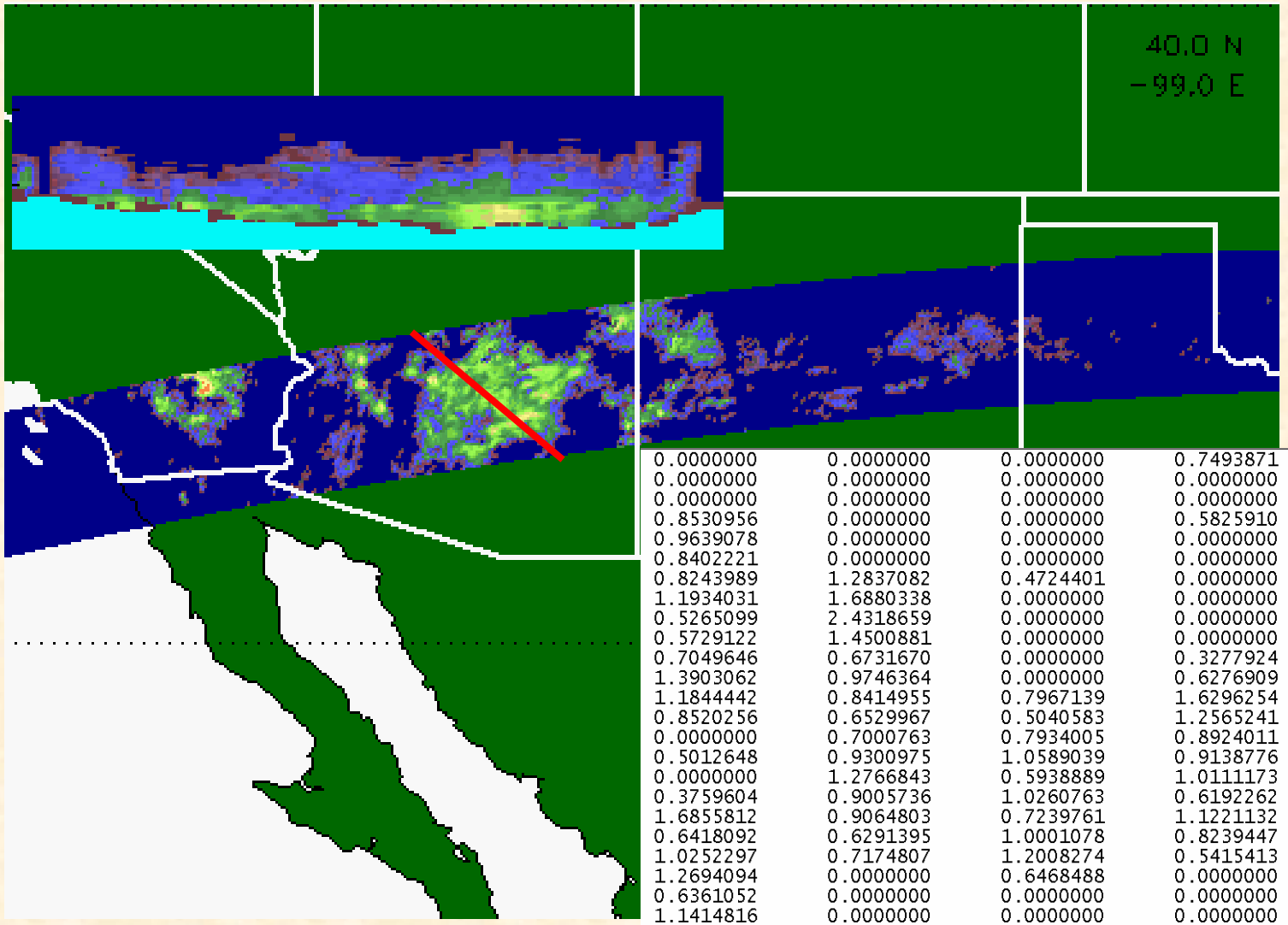
TERRA/MODIS MOD11A1 Land Surface Temperature/Emissivity-Daily 1-km

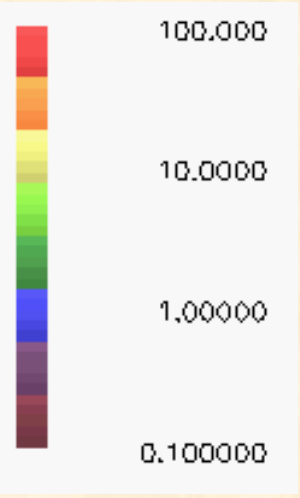


TRMM TMI 2A12-Rain Rate 11/12/03



TRMM PR 2A25 Surface Rain Rate 11/12/03





Data values

0.0000000	0.0000000	0.0000000	0.7493871	2.6275146
0.0000000	0.0000000	0.0000000	0.0000000	1.2568434
0.0000000	0.0000000	0.0000000	0.0000000	0.8377122
0.8530956	0.0000000	0.0000000	0.5825910	0.0000000
0.9639078	0.0000000	0.0000000	0.0000000	0.4286181
0.8402221	0.0000000	0.0000000	0.0000000	0.0000000
0.8243989	1.2837082	0.4724401	0.0000000	0.0000000
1.1934031	1.6880338	0.0000000	0.0000000	0.0000000
0.5265099	2.4318659	0.0000000	0.0000000	0.0000000
0.5729122	1.4500881	0.0000000	0.0000000	0.0000000
0.7049646	0.6731670	0.0000000	0.3277924	0.0000000
1.3903062	0.9746364	0.0000000	0.6276909	0.9028456
1.1844442	0.8414955	0.7967139	1.6296254	1.1281947
0.8520256	0.6529967	0.5040583	1.2565241	0.4813882
0.0000000	0.7000763	0.7934005	0.8924011	0.4720266
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0.0000000	1.2766843	0.5938889	1.0111173	1.4852282
0.3759604	0.9005736	1.0260763	0.6192262	1.4995747
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1.2694094	0.0000000	0.6468488	0.0000000	0.0000000
0.6361052	0.0000000	0.0000000	0.0000000	0.0000000
1.1414816	0.0000000	0.0000000	0.0000000	0.0000000
1.0768880	0.7671593	0.0000000	0.0000000	0.0000000
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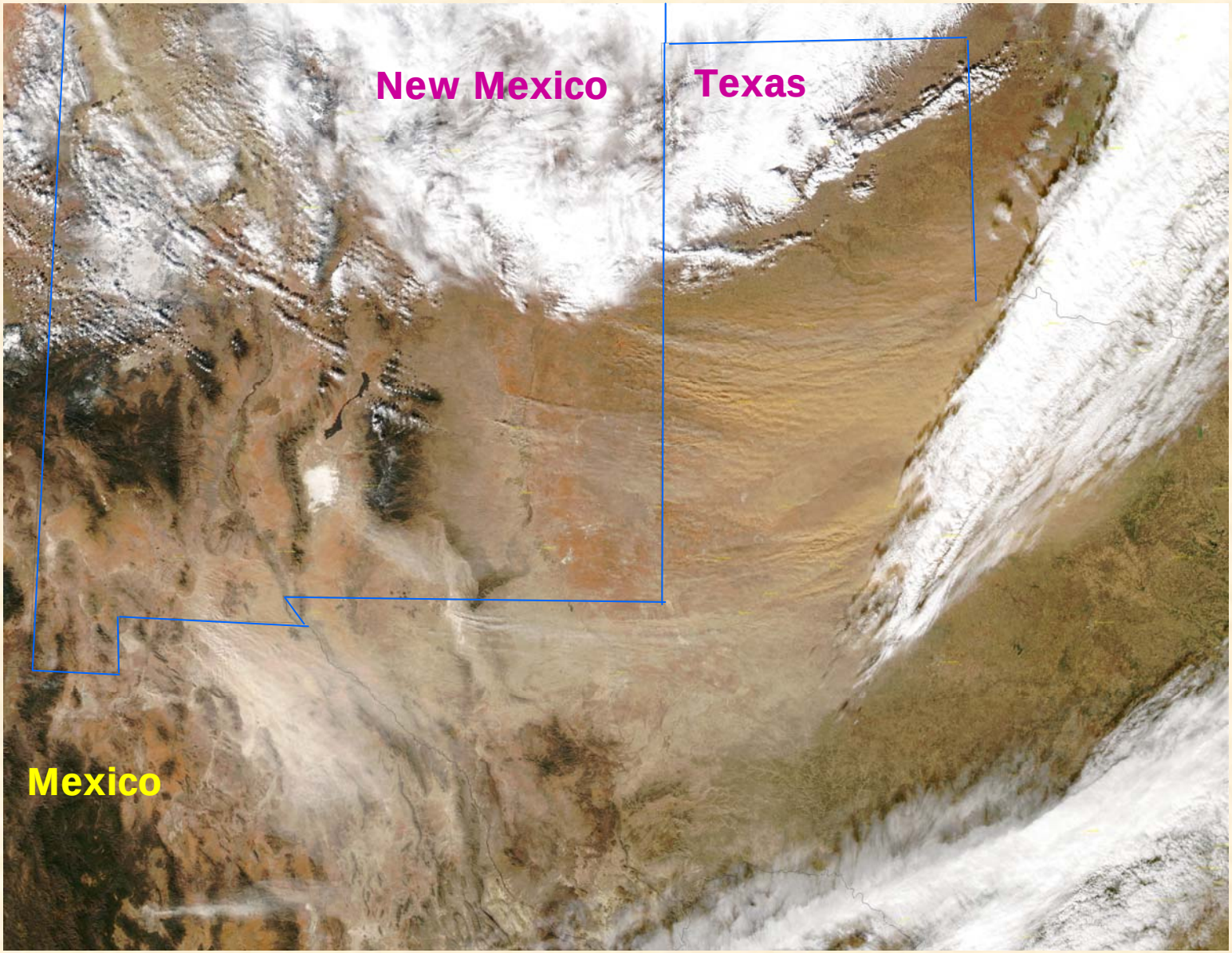
New Mexico/Texas Test Case



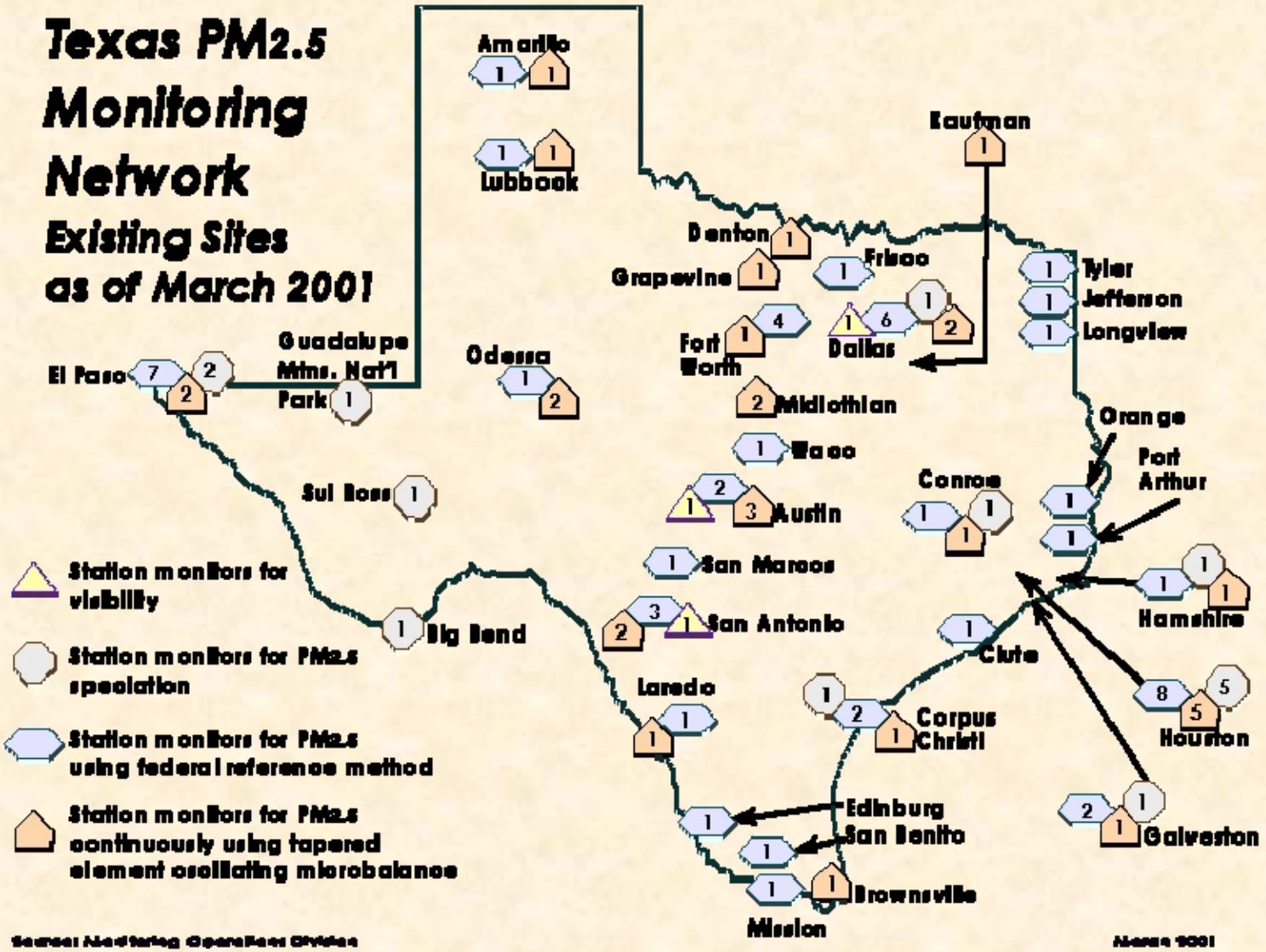
Ground-Based Aerosol Data Sources (PM2.5)

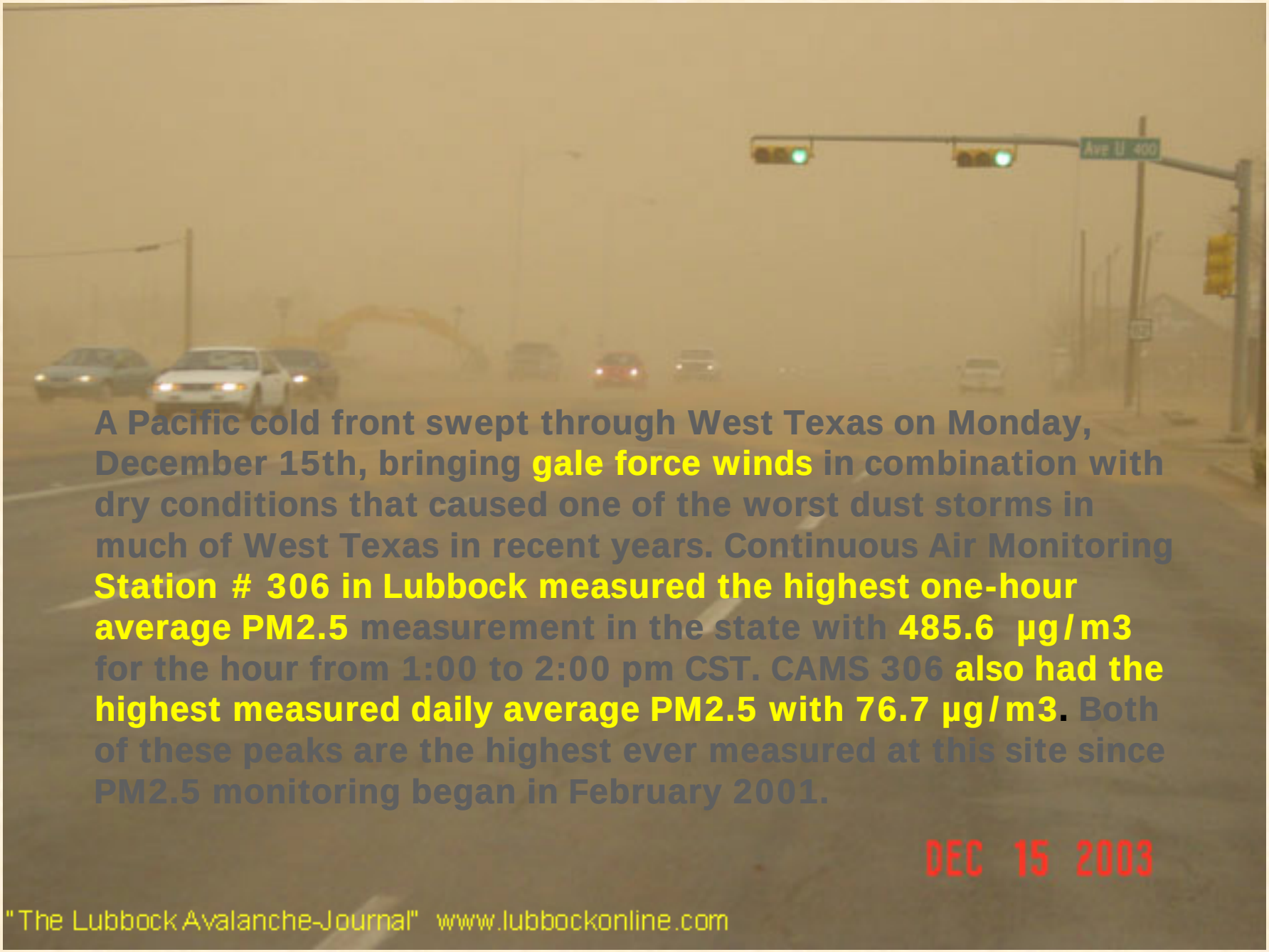
Texas Natural Resource Conservation Commission (www.tnrcc.state.tx.us)

Texas Tech Atmospheric Science Group (www.atmo.ttu.edu)

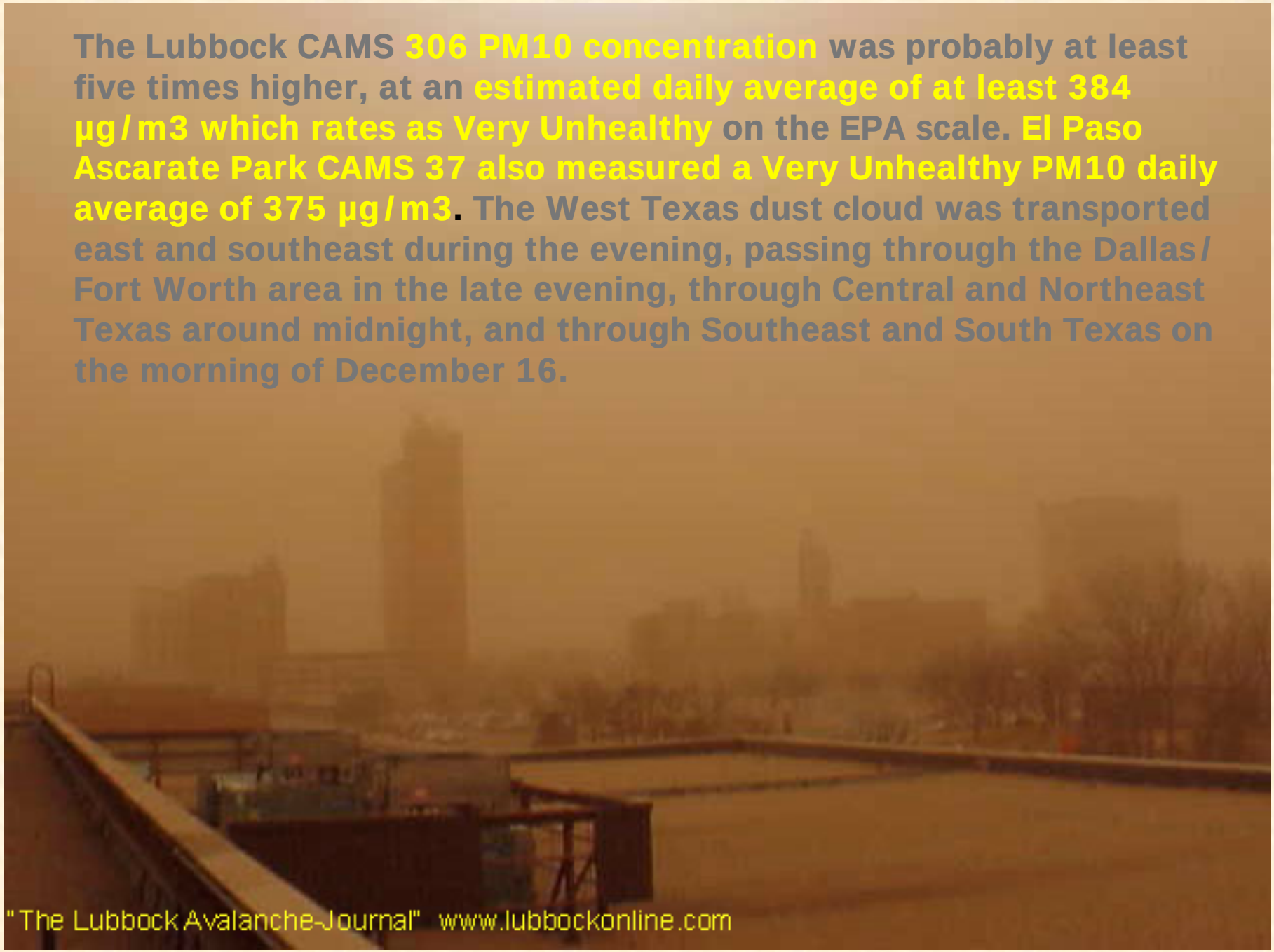
EPA Airnet Data - New Mexico (www.epa.gov)

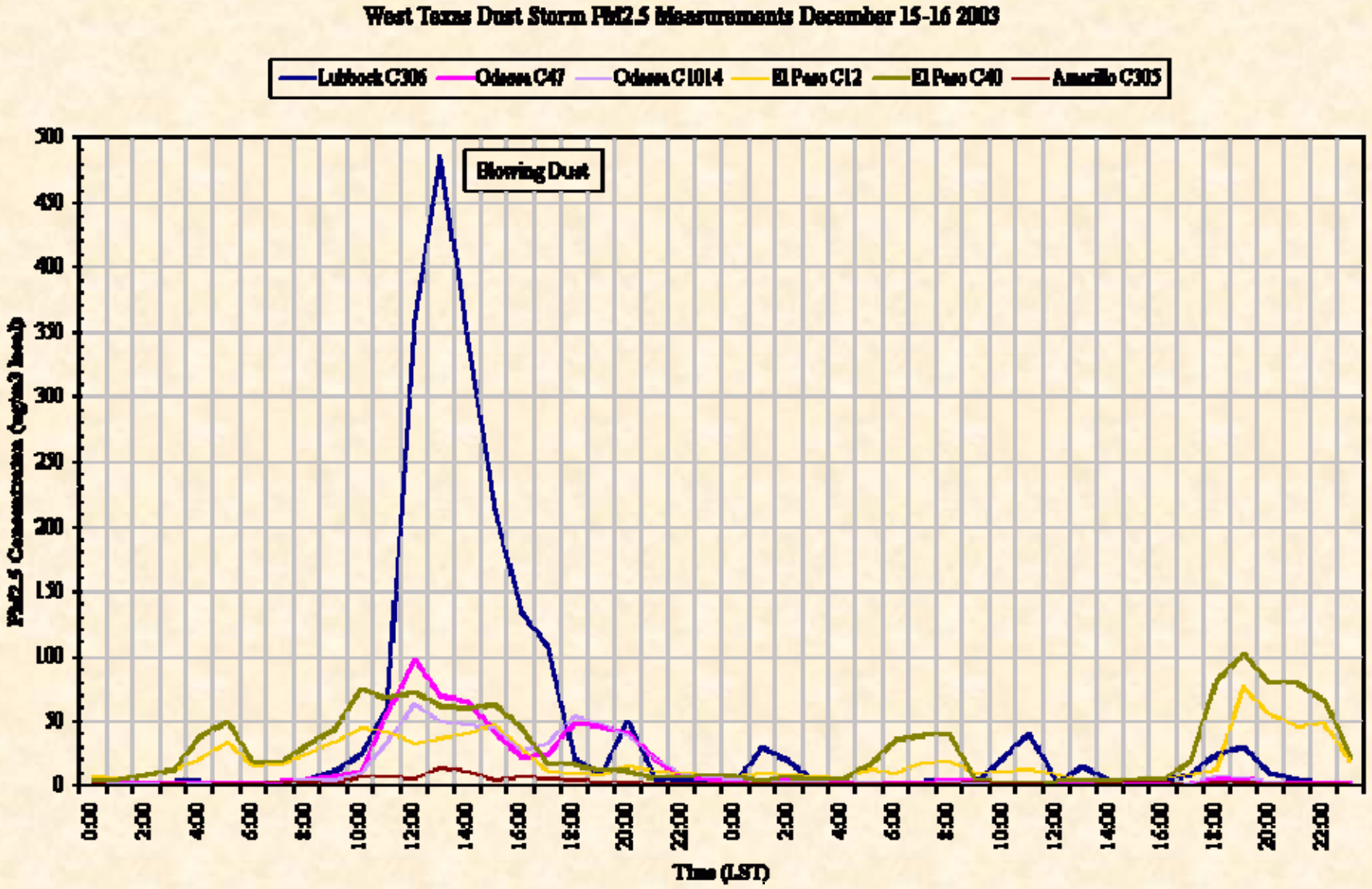
Los Alamos National Laboratory (www.lanl.gov/orgs/rres/maq/index.htm)


Texas PM2.5 Monitoring Network
Existing Sites as of March 2001
Amarillo
Lubbock
Kaufman
Denton
Grapevine
Frisco
Tyler
Jefferson
Longview
Fort Worth
Dallas
Guadalupe Mtns. Nat'l Park
El Paso
Odessa
Midlothian
Orange
Port Arthur
Waco
Conroe
Sul Ross
Austin
San Marcos
Hamshire
Big Bend
San Antonio
Clute
Laredo
Corpus Christi
Houston
Edinburg
San Benito
Galveston
Brownsville
Mission
Station monitors for visibility
Station monitors for PM2.5 speciation
Station monitors for PM2.5 using federal reference method
Station monitors for PM2.5 continuously using tapered element oscillating microbalance

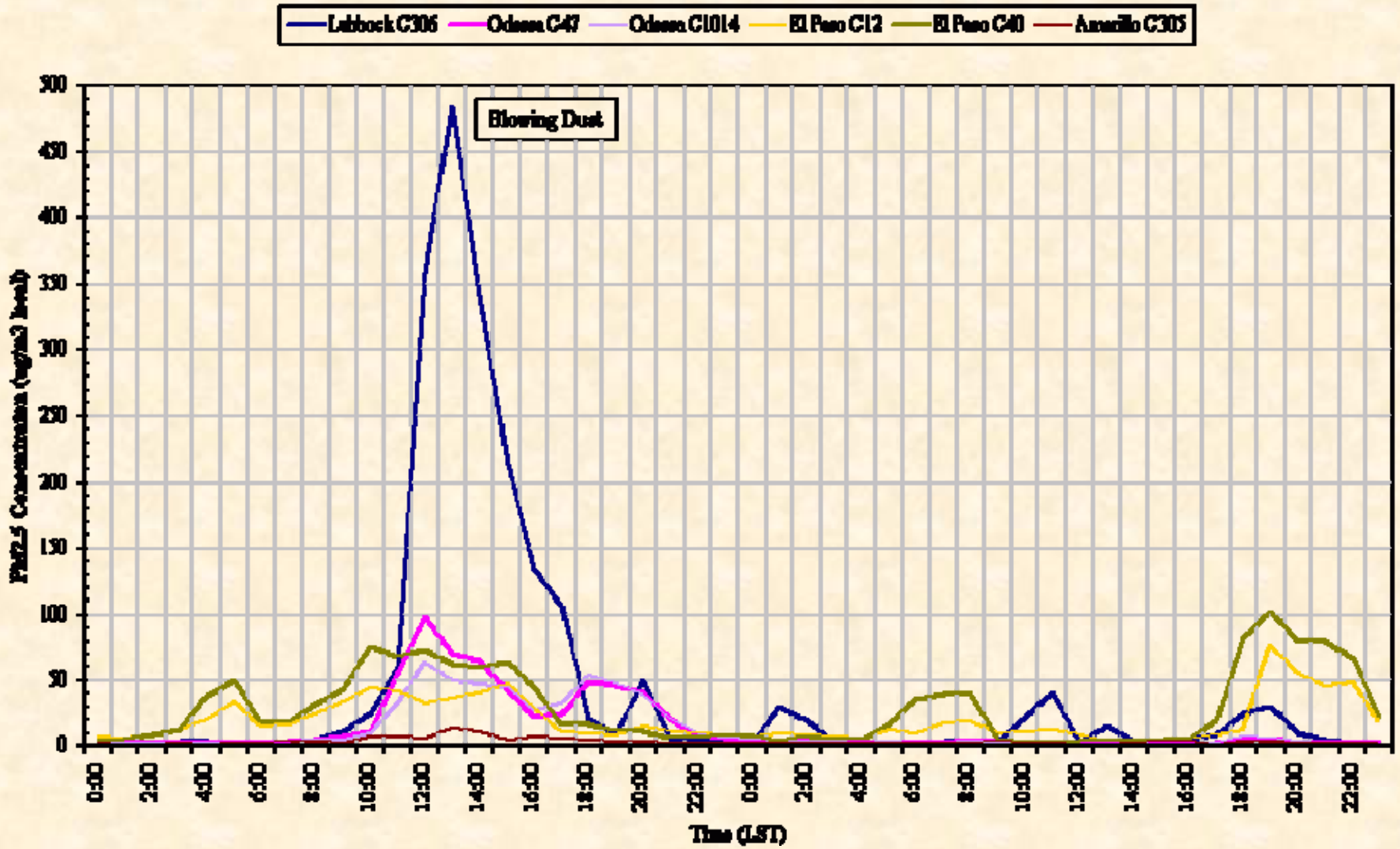


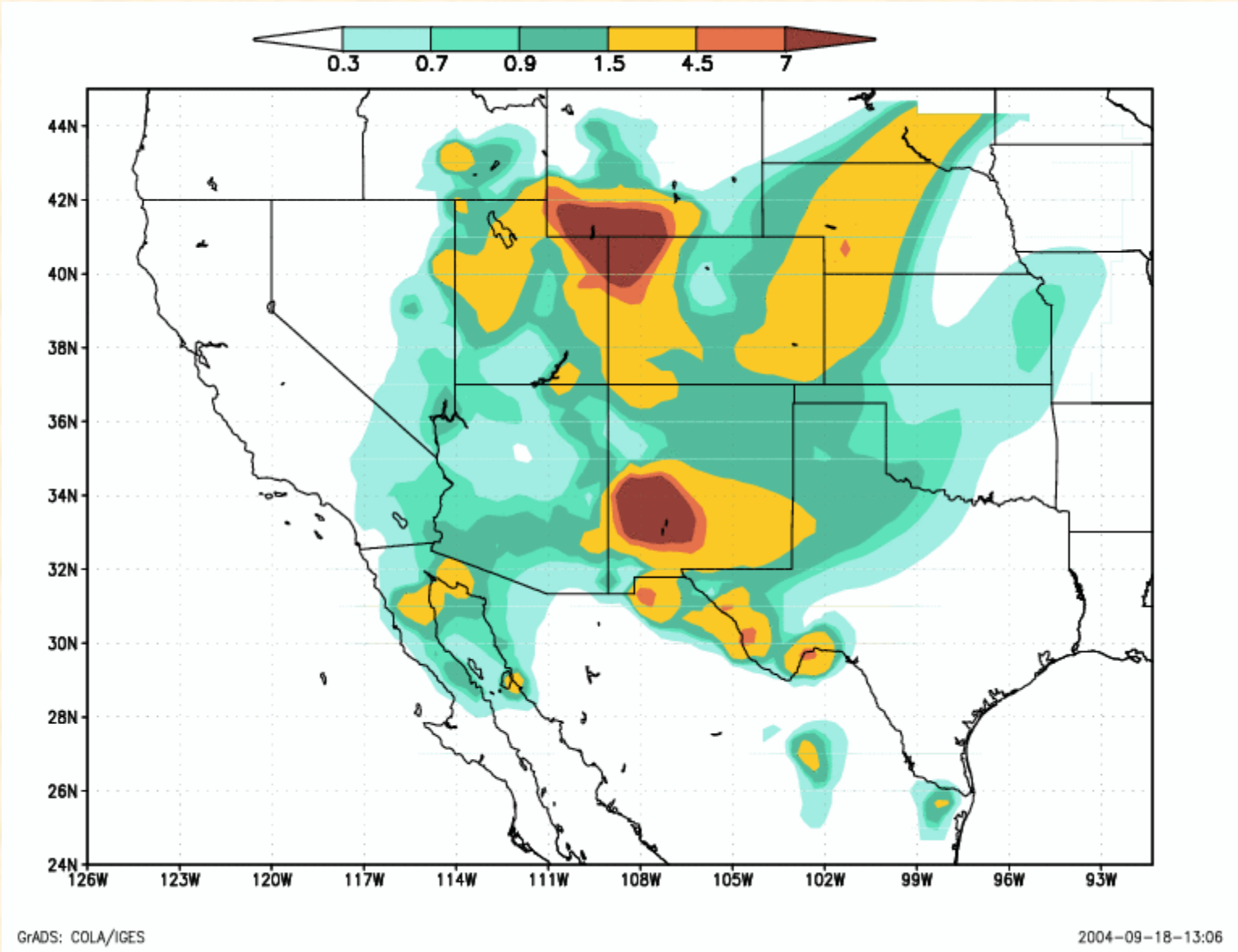
A Pacific cold front swept through West Texas on Monday, December 15th, bringing **gale force winds** in combination with dry conditions that caused one of the worst dust storms in much of West Texas in recent years. Continuous Air Monitoring **Station # 306 in Lubbock measured the highest one-hour average PM2.5** measurement in the state with **485.6 µg/m3** for the hour from 1:00 to 2:00 pm CST. CAMS 306 **also had the highest measured daily average PM2.5 with 76.7 µg/m3**. Both of these peaks are the highest ever measured at this site since PM2.5 monitoring began in February 2001.


The Lubbock CAMS 306 PM10 concentration was probably at least five times higher, at an estimated daily average of at least 384 µg/m3 which rates as Very Unhealthy on the EPA scale. El Paso Ascarate Park CAMS 37 also measured a Very Unhealthy PM10 daily average of 375 µg/m3. The West Texas dust cloud was transported east and southeast during the evening, passing through the Dallas/Fort Worth area in the late evening, through Central and Northeast Texas around midnight, and through Southeast and South Texas on the morning of December 16.
"The Lubbock Avalanche-Journal" www.lubbockonline.com

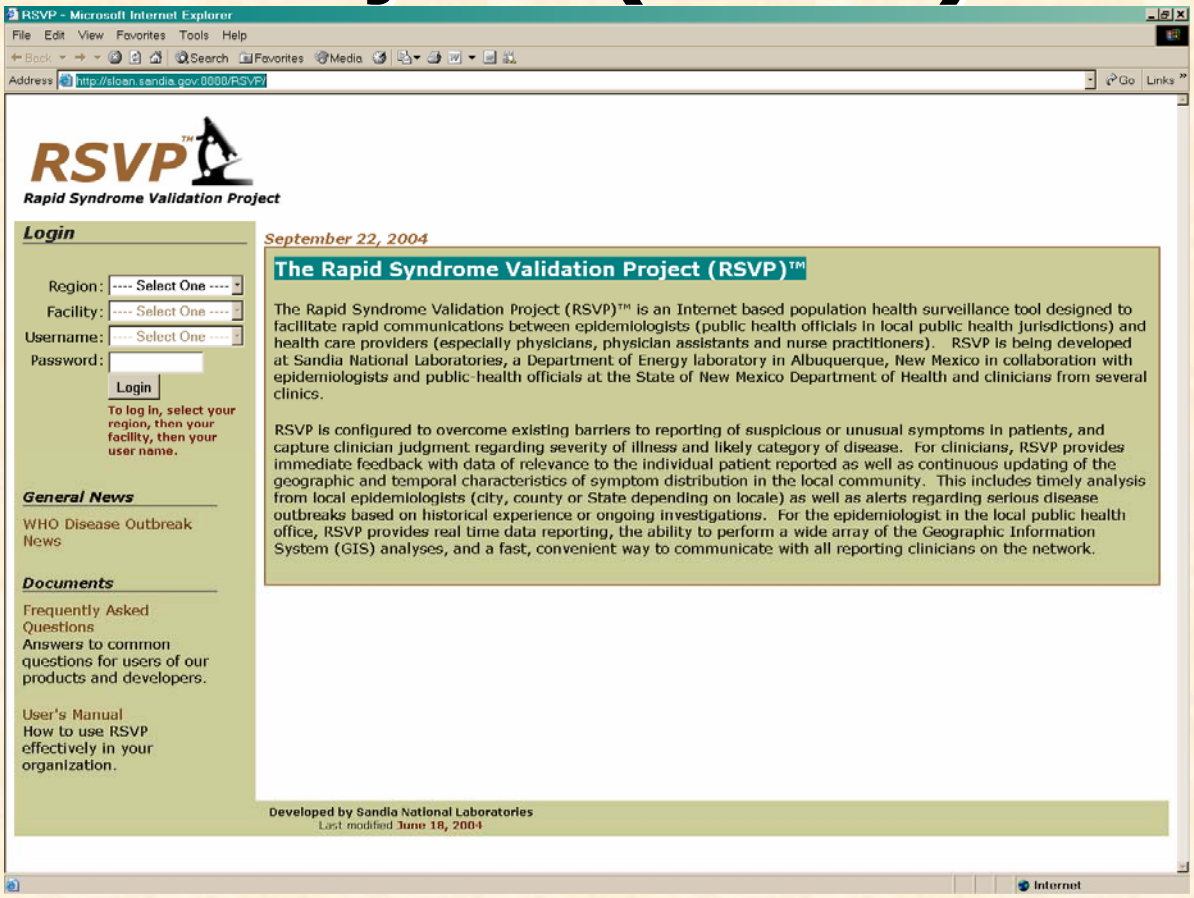

West Texas Dust Storm PM2.5 Measurements December 15-16 2003
Lubbock C306
Odessa C47
Odessa C1014
El Paso C12
El Paso C40
Amarillo C305
Blowing Dust
PM2.5 Concentrations (ug/m3 hourly)
0
50
100
150
200
250
300
350
400
450
500
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Time (LST)

West Texas Dust Storm PM2.5
December 15-16, 2003



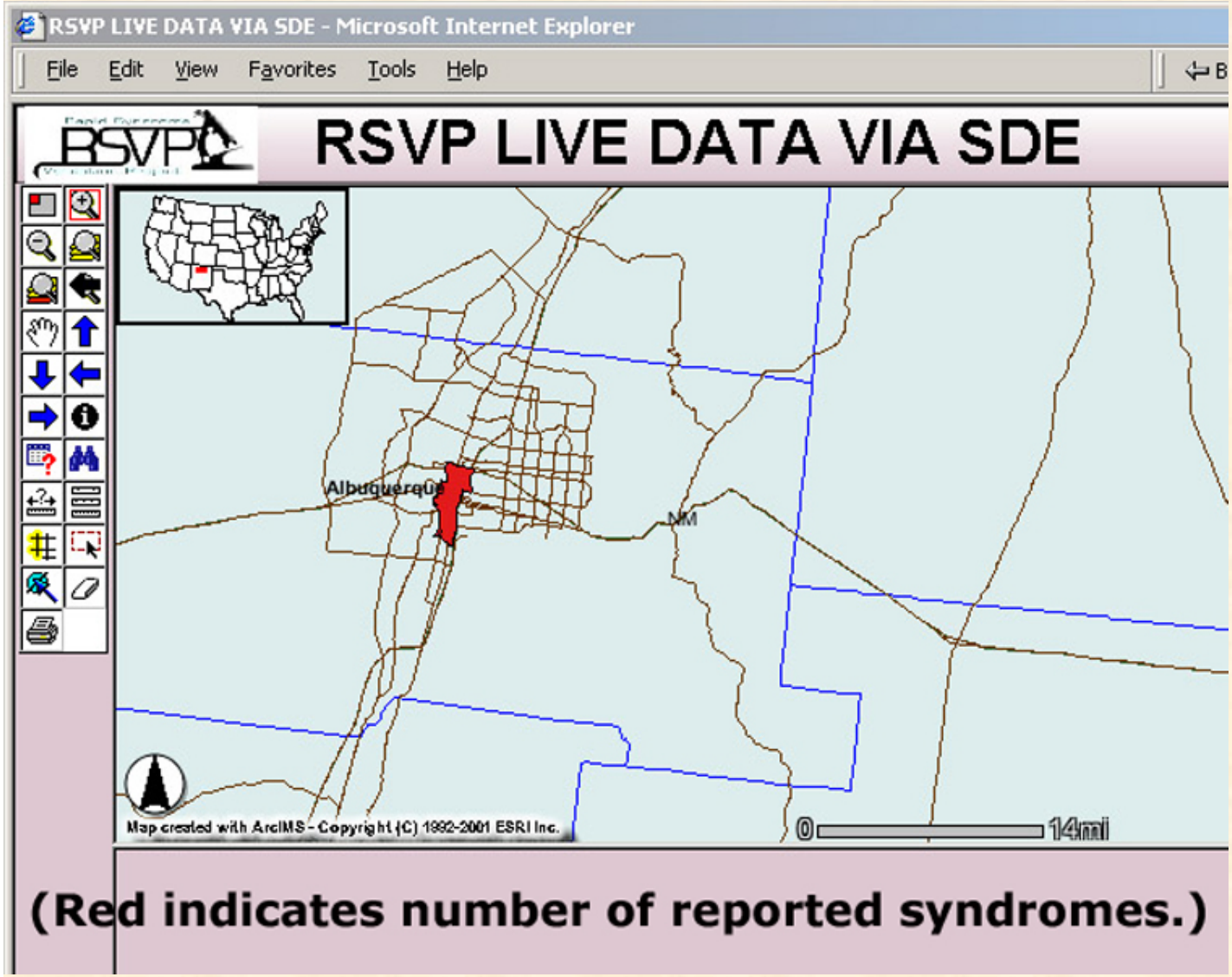

0.3
0.7
0.9
1.5
4.5
7
44N
42N
40N
38N
36N
34N
32N
30N
28N
26N
24N
126W
123W
120W
117W
114W
111W
108W
105W
102W
99W
96W
93W
GrADS: COLA/IGES
2004-09-18-13:06

The Rapid Syndrome Validation Project (RSVP)™



http://sloan.sandia.gov:8888/RSVP/

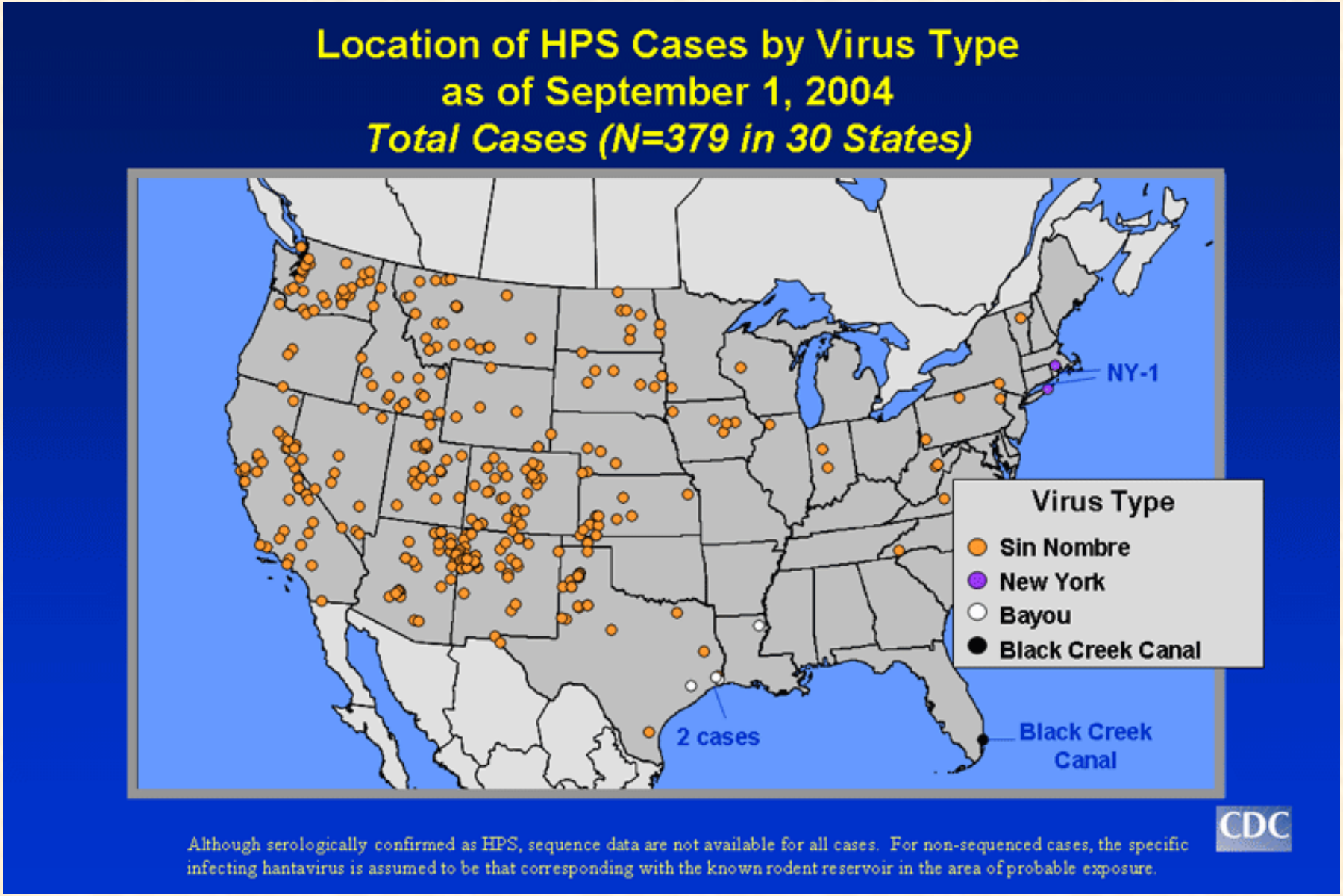
Rapid Syndrome Validation Project™



RSVP Objectives

1. Illustrate how Earth observing satellite data can assist RSVP design goals
2. Identify and validate scientifically sound relationships between environmental stimuli and resulting human health responses
3. Integrate scientific relationships into spatially explicit products for use in RSVP delivery systems for public health officials

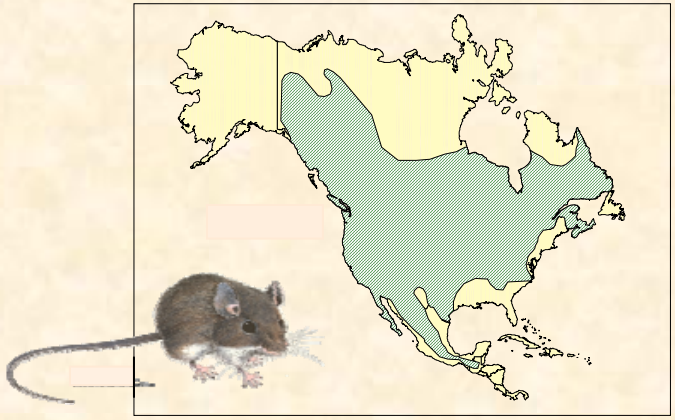
Hantavirus Pulmonary Syndrome



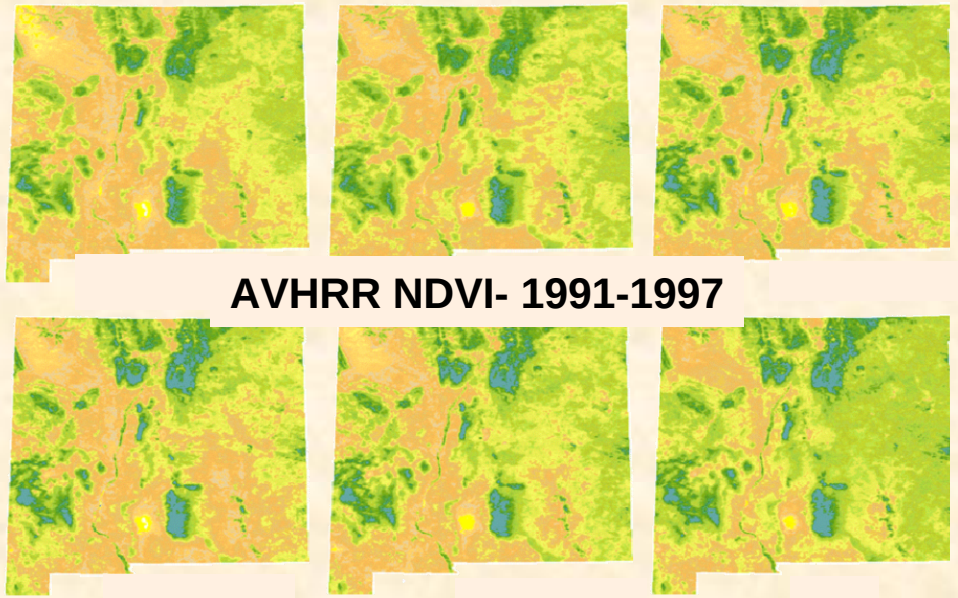
Epidemiology of HPS Slide set (CDC)

Hantavirus Pulmonary Syndrome

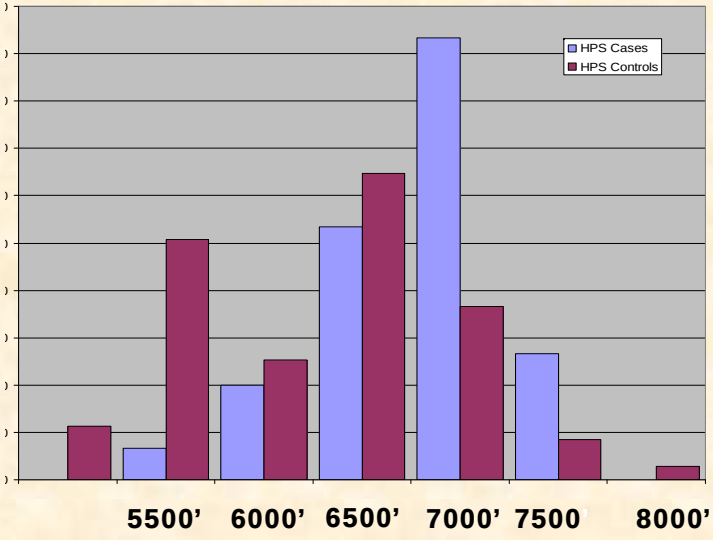
Peromyscus Maniculatus



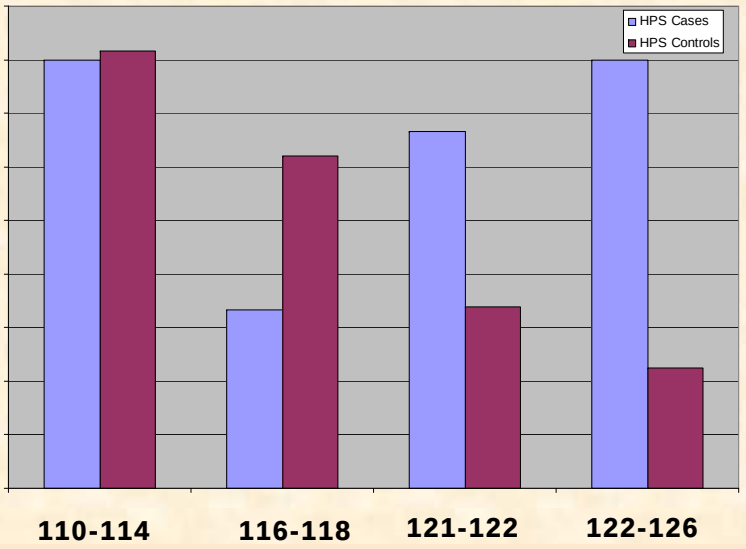
Reservoir for
Sin Nombre Virus



AVHRR NDVI- 1991-1997

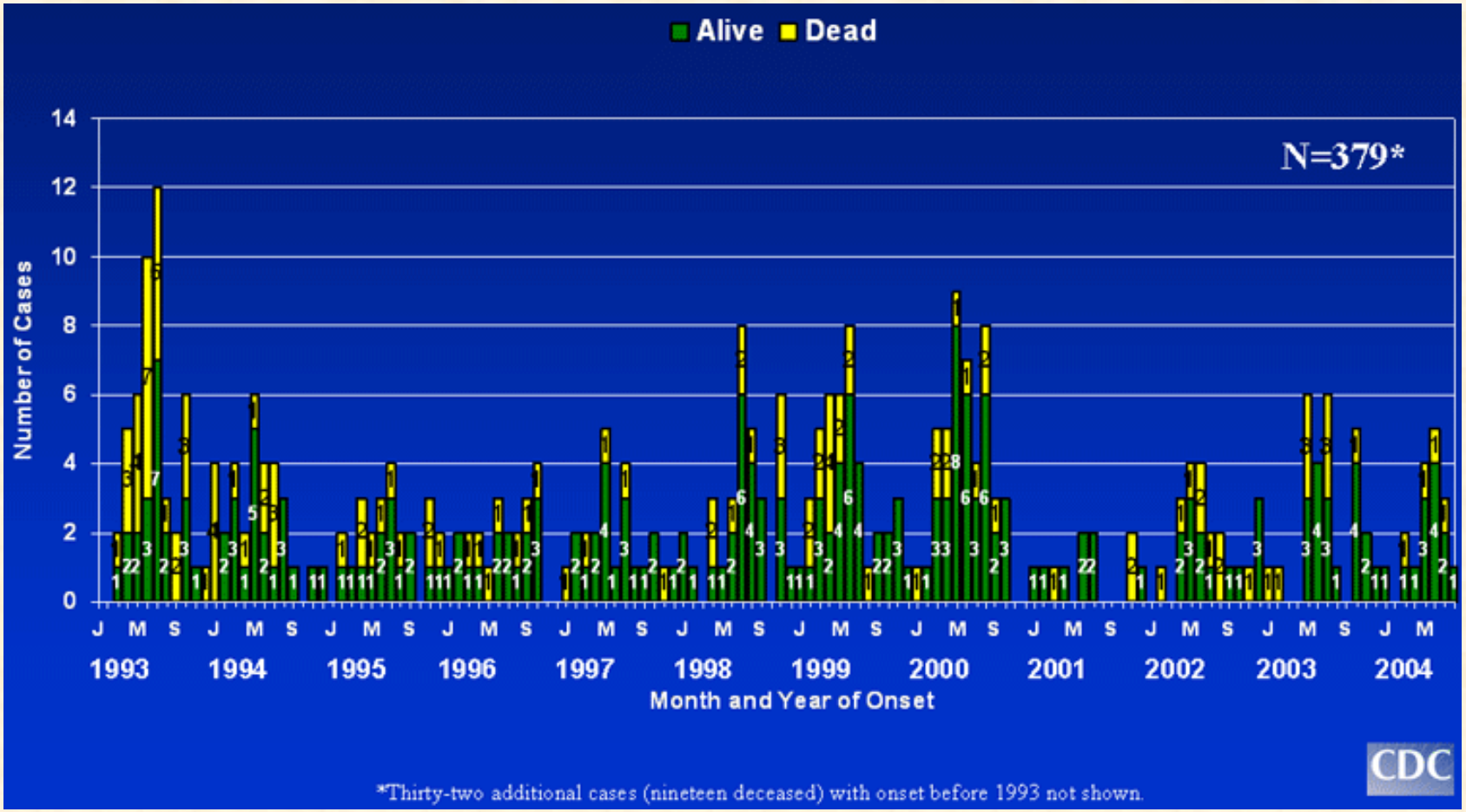


HPS Cases & Controls as a Function of Elevation

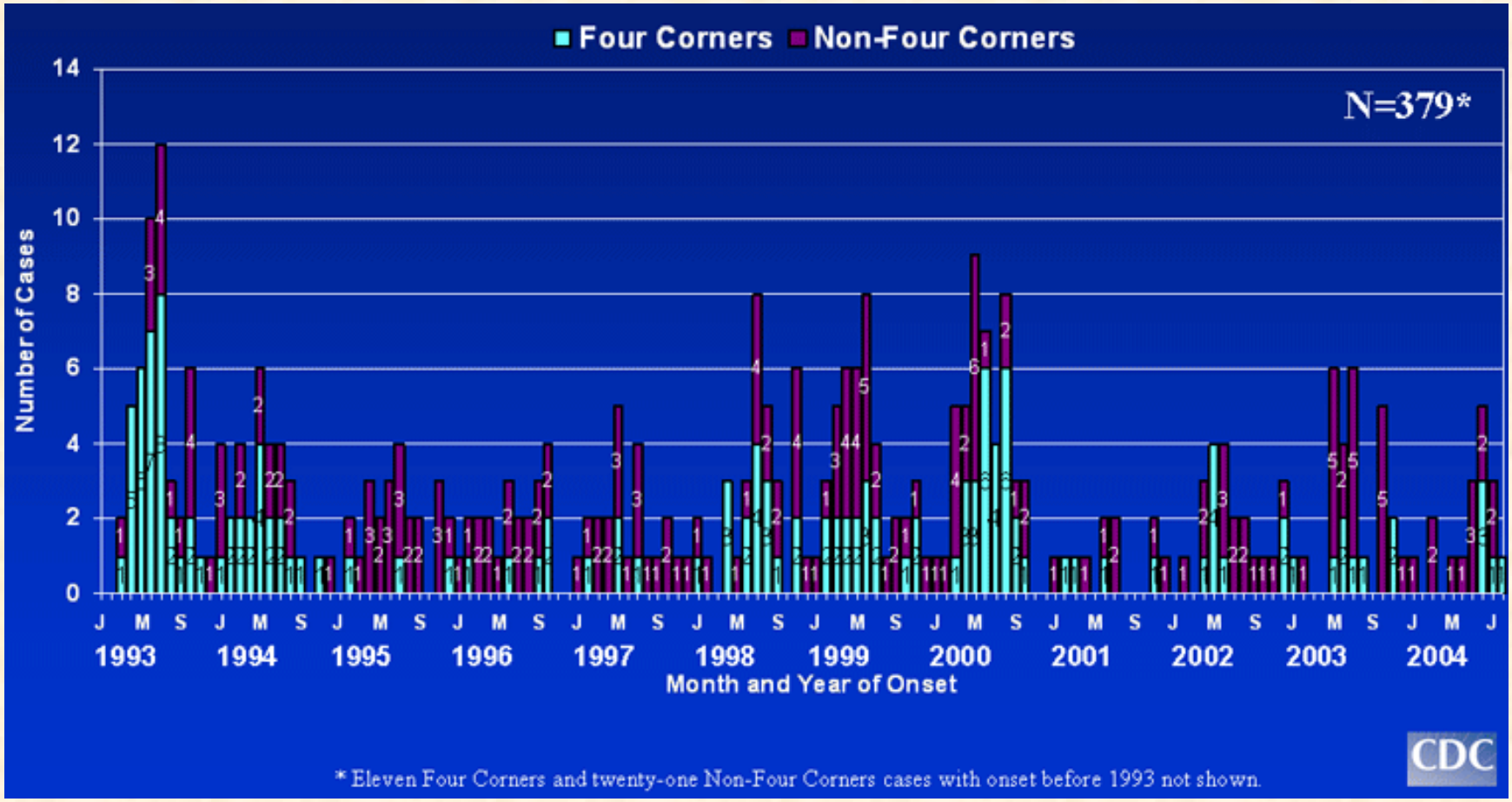


% Frequency of HPS and Control Sites w/i NDVI Intervals

HPS Cases by Outcome: U.S.
As of 9/01.04



HPS Cases by Region: U.S. as of 9/01/04



Asthma: Top ten cities for asthma

1) Tucson, AZ
2) Kansas City, MO
3) Phoenix-Mesa, AZ
4) Fresno, CA
5) New York, NY
6) El Paso, TX
7) Albuquerque, NM
8) Indianapolis, IN
9) Mobile, AL
10) Tulsa, OK

Reported Predictors &Triggers Of Asthma

Approach: Use multiple regression analysis on predictors and triggers to prioritize coefficients; then select NASA data and products that best supply measurements of these phenomena.

Respiratory Predictors

1. Urbanicity
2. Traffic density
3. Age
4. Gender
5. Temperature
6. Precipitation
7. Humidity

Respiratory Triggers

A. Outdoor Environment
   1. Dust
   2. Pollen

B. ~~Indoor Environment~~
   1. ~~Wall-to-wall carpet~~
   2. ~~Cockroaches~~
   3. ~~Stuffed toys~~

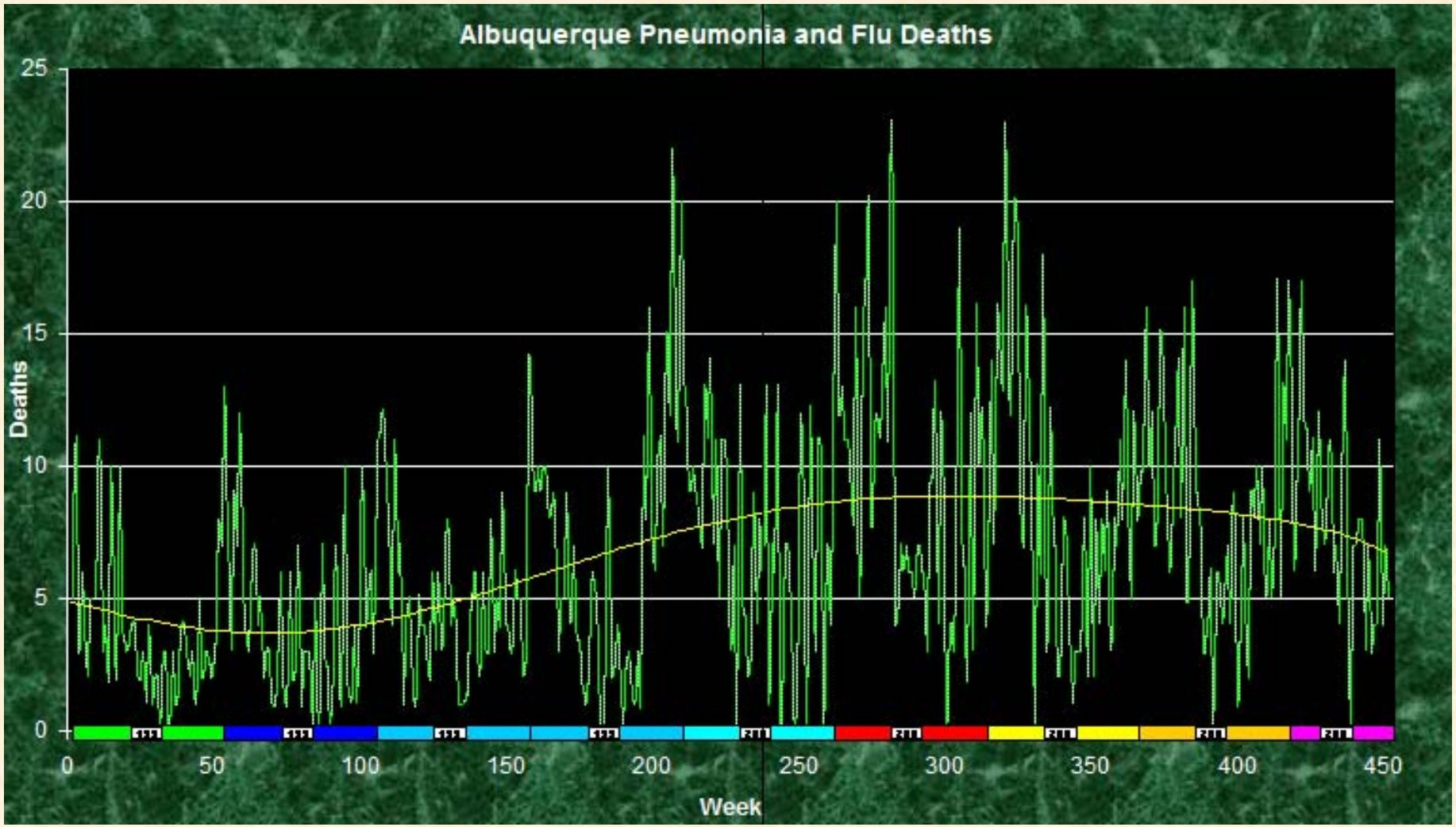
Influenza

1. Contagious disease caused by the influenza virus.
2. Attacks the respiratory tract in humans (nose, throat, and lungs). The main avenue of spreading is from person to person by inhaling droplets from coughs and sneezes.
3. Infection by dust ? (e.g.1918 Spanish Flu)

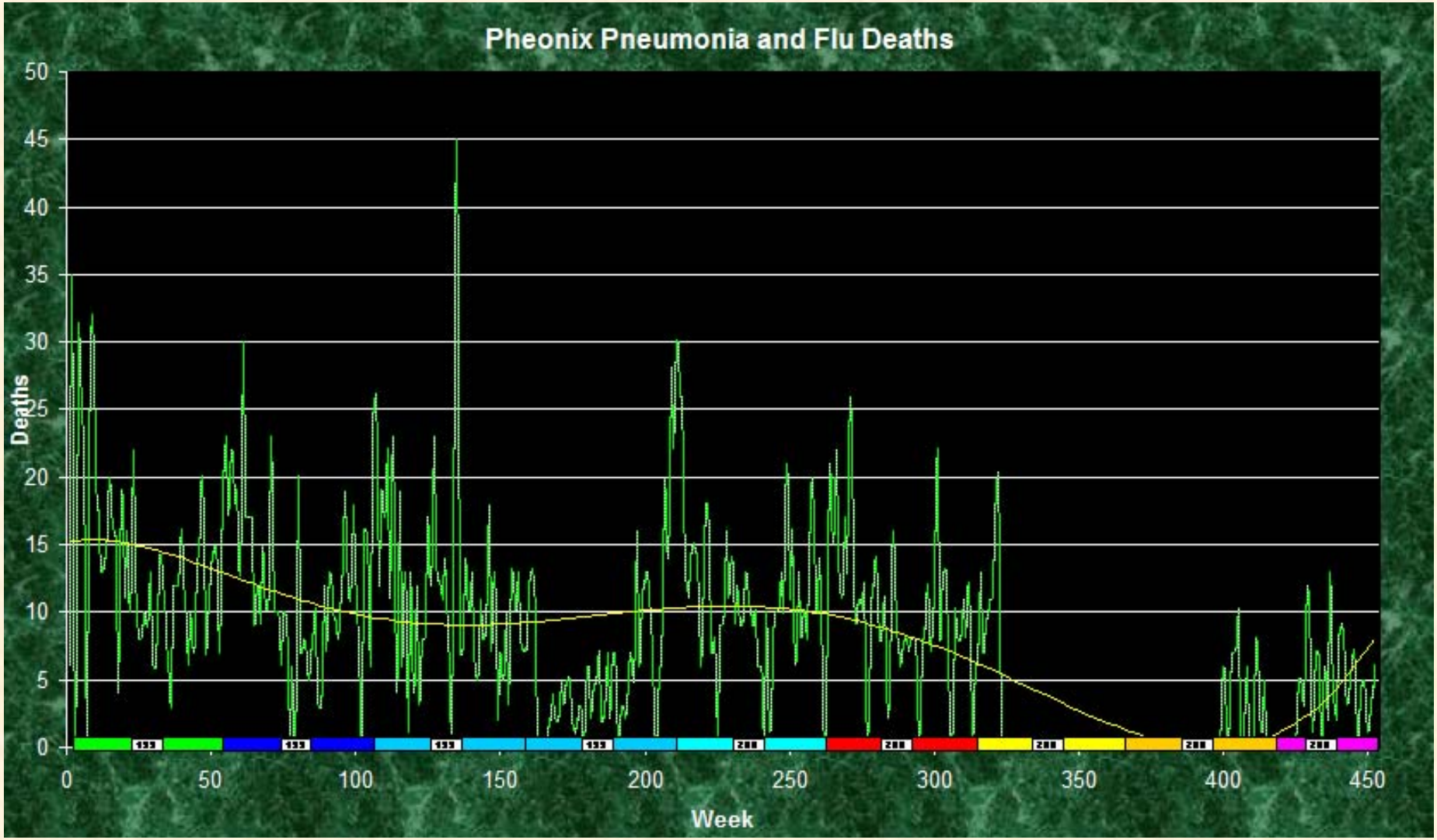
   -Infected 20-40% of the world's population; Killed 20 million in four months; The virus may have traveled through dust and changed into a respiratory illness

   -Early account in 1918 – Fort Riley Kansas burned tons of horse manure; It is believed the horses may have been infected with the equine virus; Dust storms kicked up and swept over the plains; Within a month over a thousand individuals infected in the area

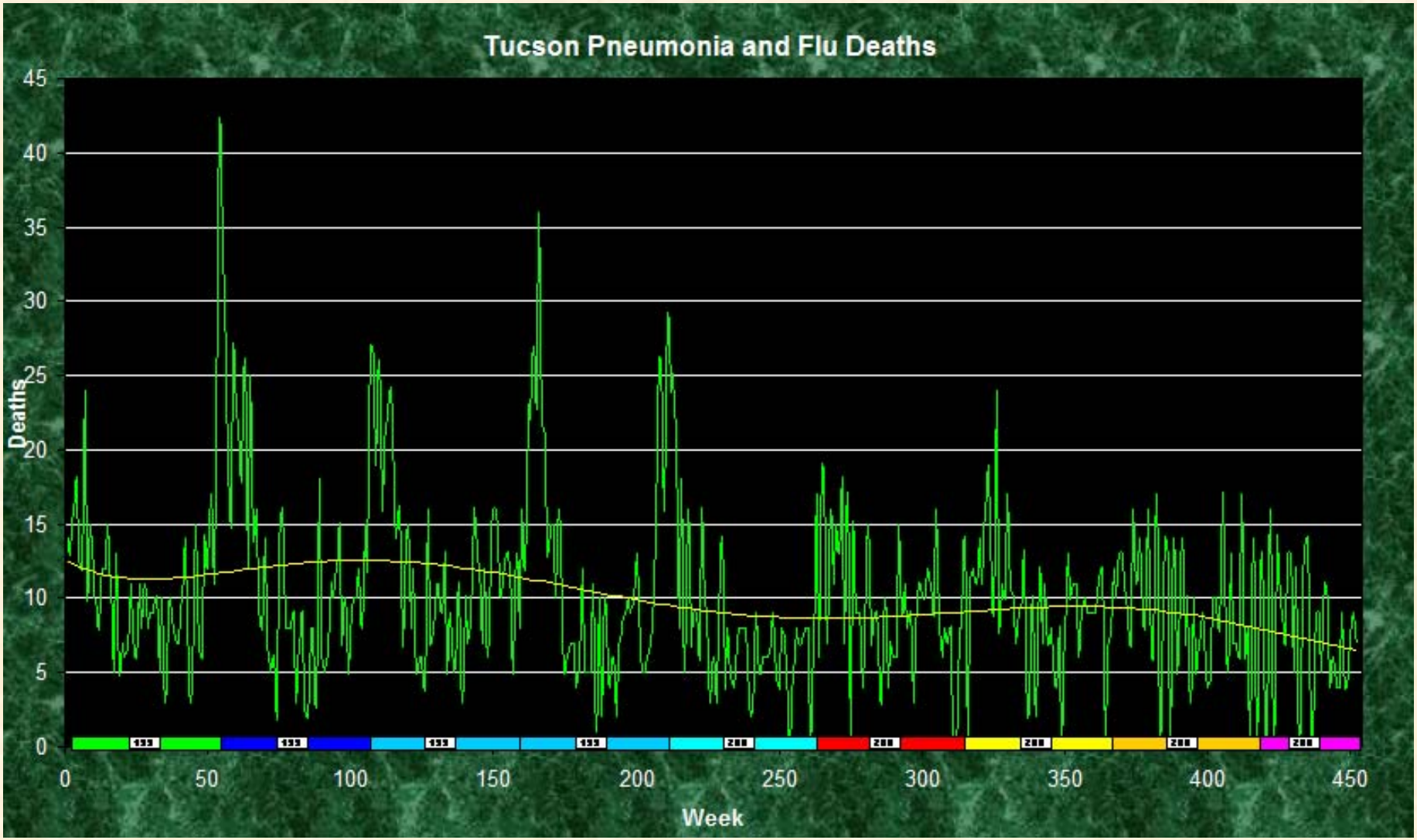
Pneumonia & Influenza: Albuquerque



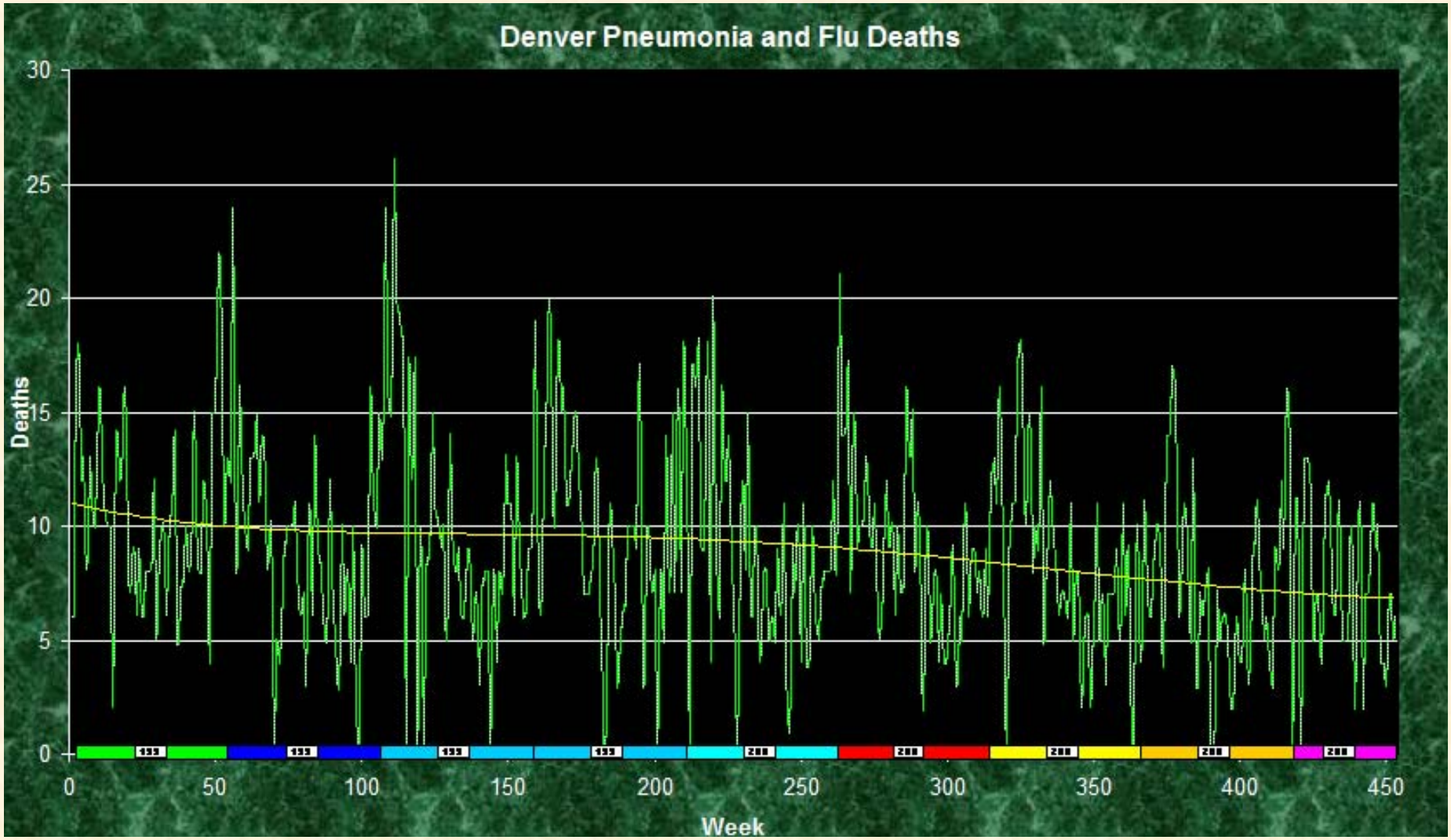
Pneumonia & Influenza: Phoenix



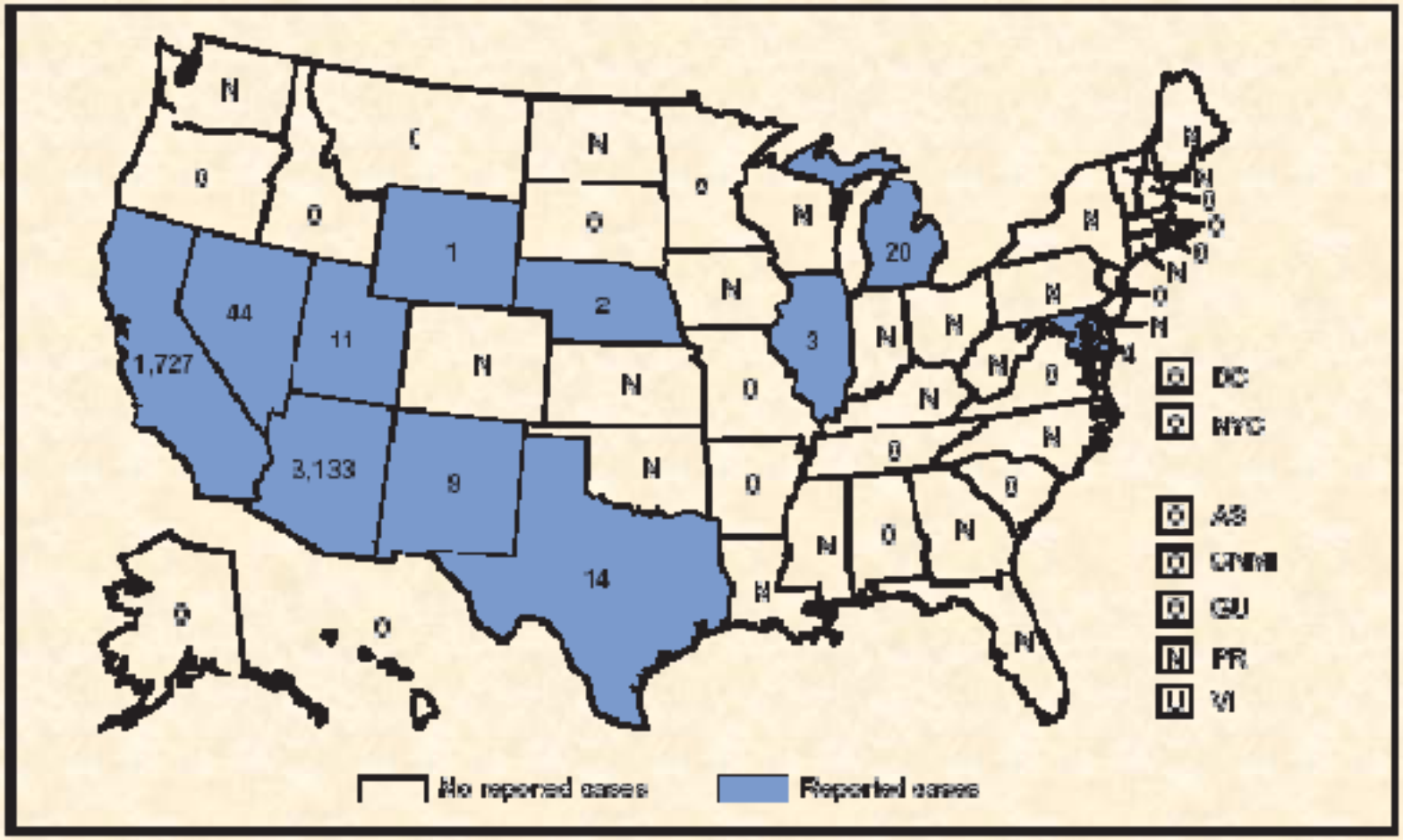
Pneumonia & Influenza: Tucson



Pneumonia & Influenza: Denver



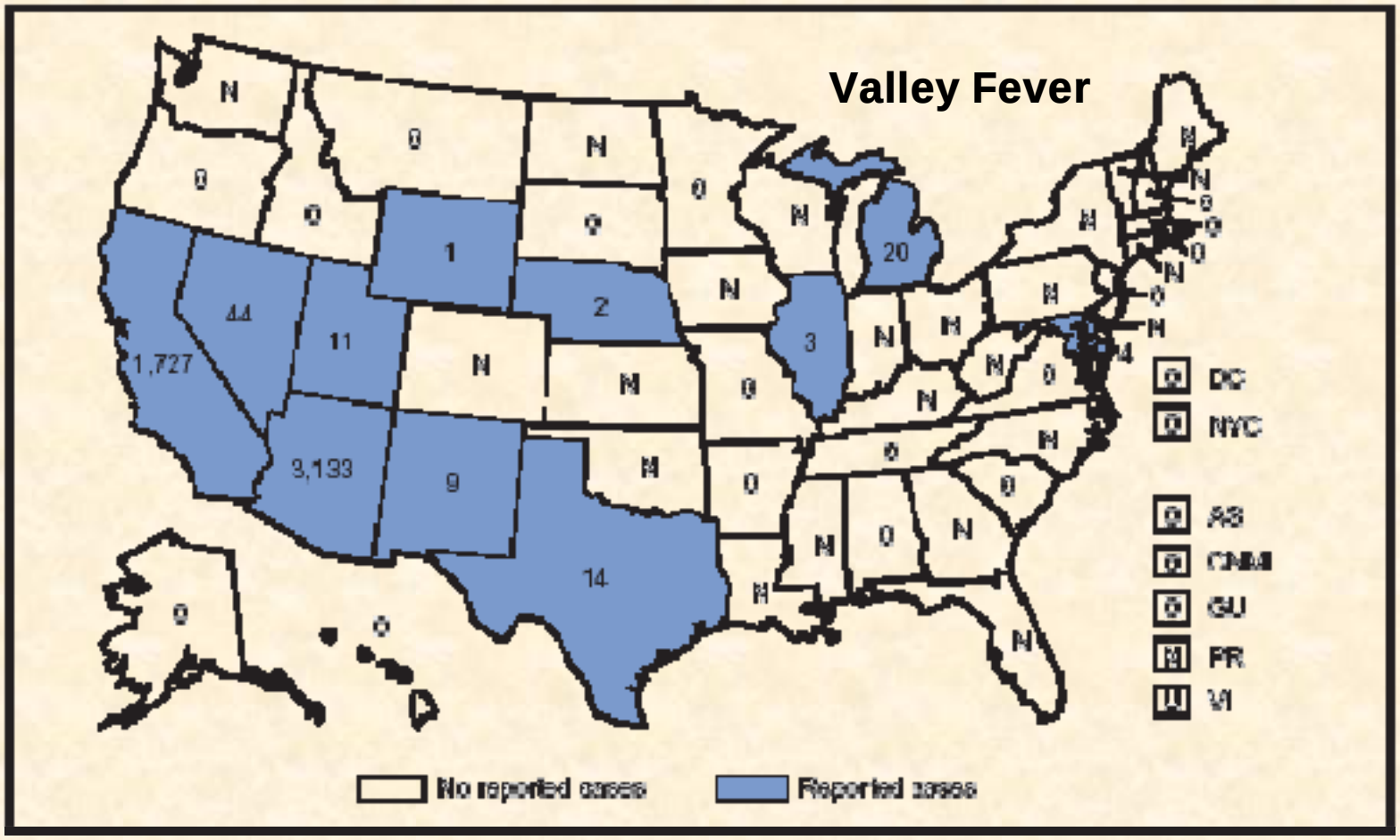
COCCIDIOIDOMYCOSIS. Reported cases — United States* and U.S. territories, 2002



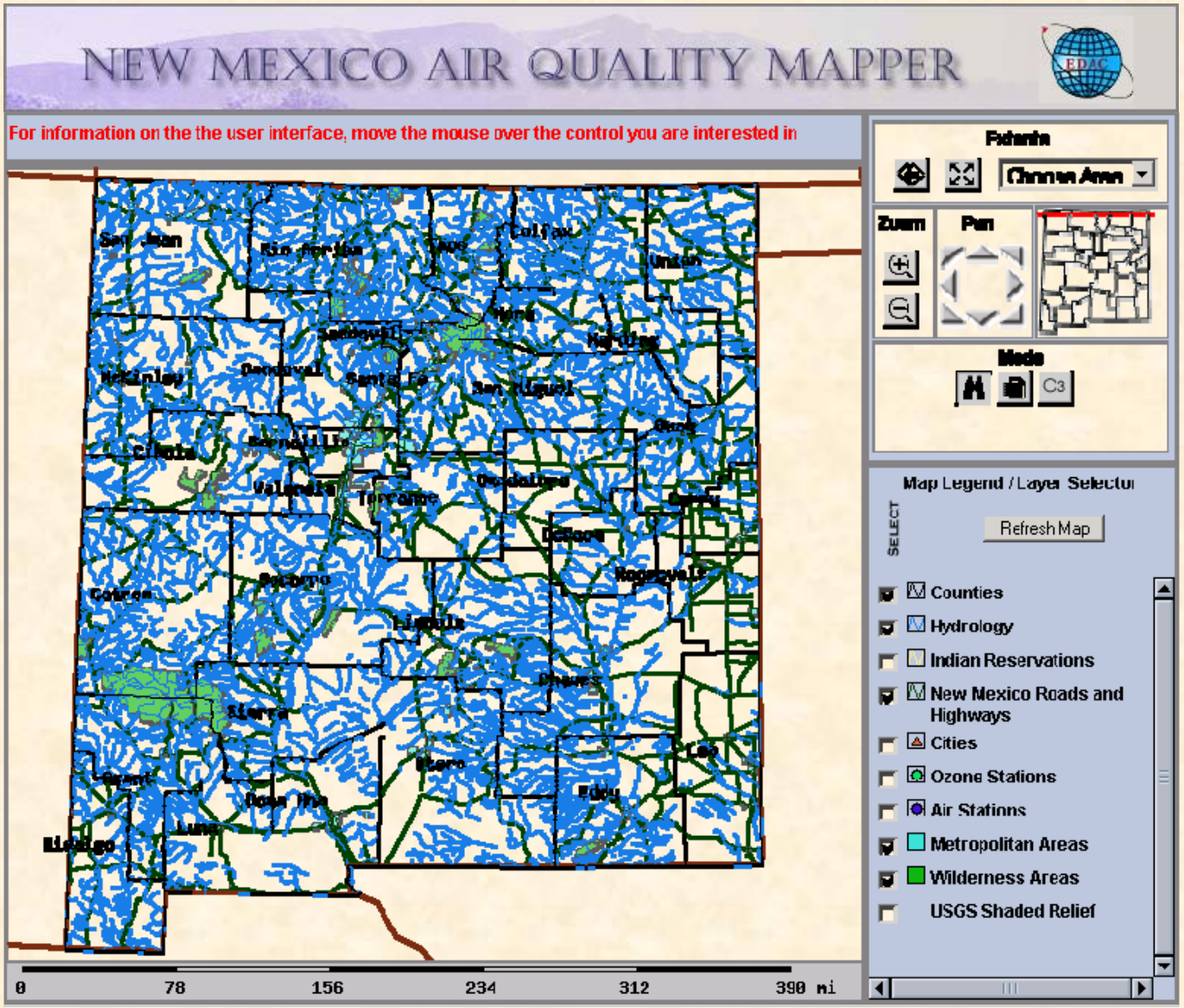
* In the United States, coccidioidomycosis is endemic in the southwestern region. However, cases have been reported in other states, usually among travelers returning from areas of endemic disease.

During the last few years, Arizona has experienced a significant increase in the incidence rates of coccidioidomycosis, from 16/100,000 in 1997 to 42/100,300 in 2001. This increase s likely related to demographic and climatic changes. Physicians should maintain a high suspicion for acute coccidioidomycosis, especial y for patients with a flu-like illness who live or have visited areas with endemic disease.

Reported Coccidioidomycosis Cases U.S. & Territories 2002



New Mexico Air Quality Mapper

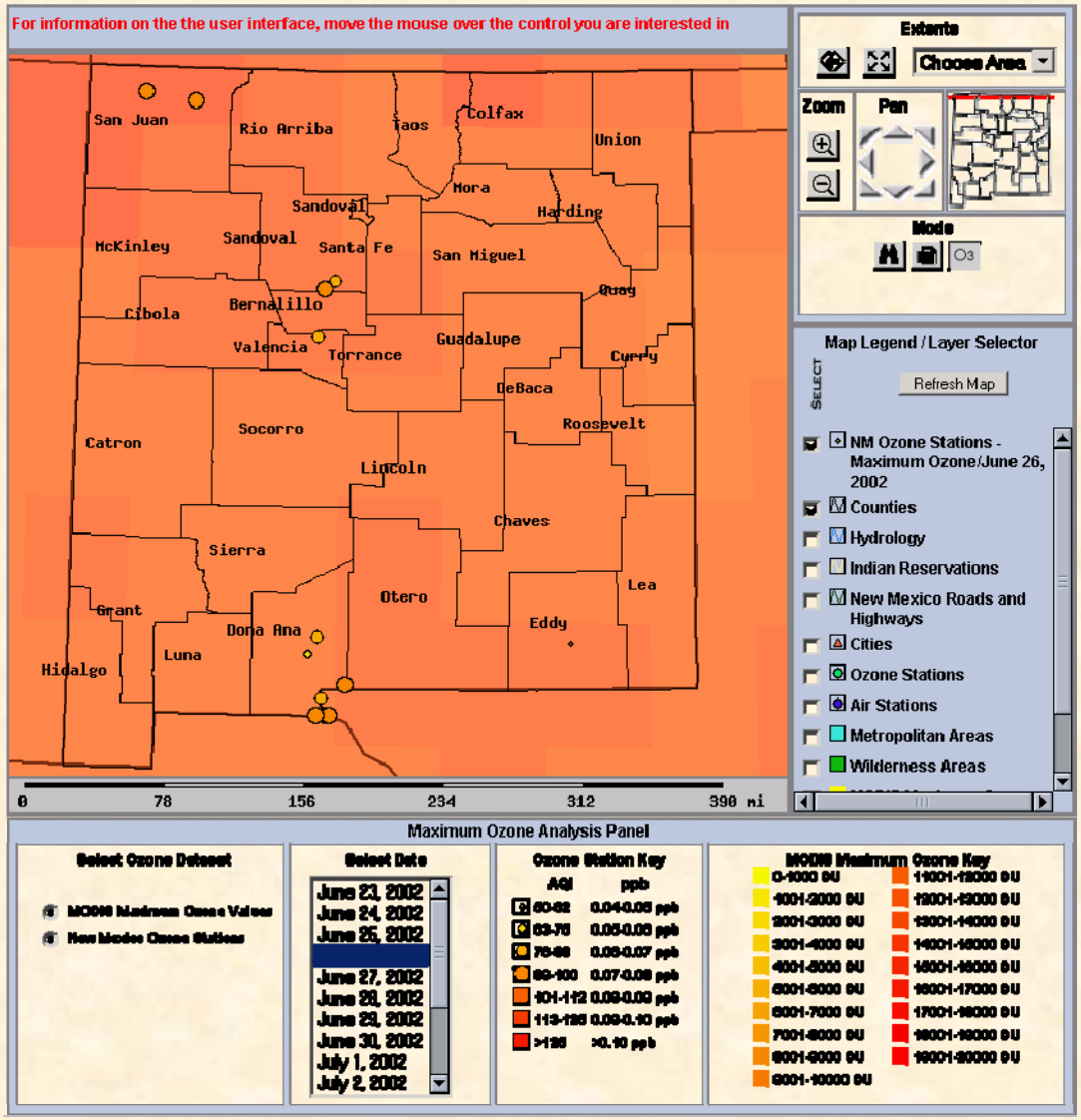


Standard GIS Functionality

-basic background vector data for orientation

-pan/zoom functions

MOD08_473 – Maximum Daily Ozone and New Mexico State Ground Stations



MODIS MOD08 Atmospheric Product

-subdataset 473, Maximum Daily Ozone

-derived from EOS-HDF4 formatted file

-1 by 1 degree resolution

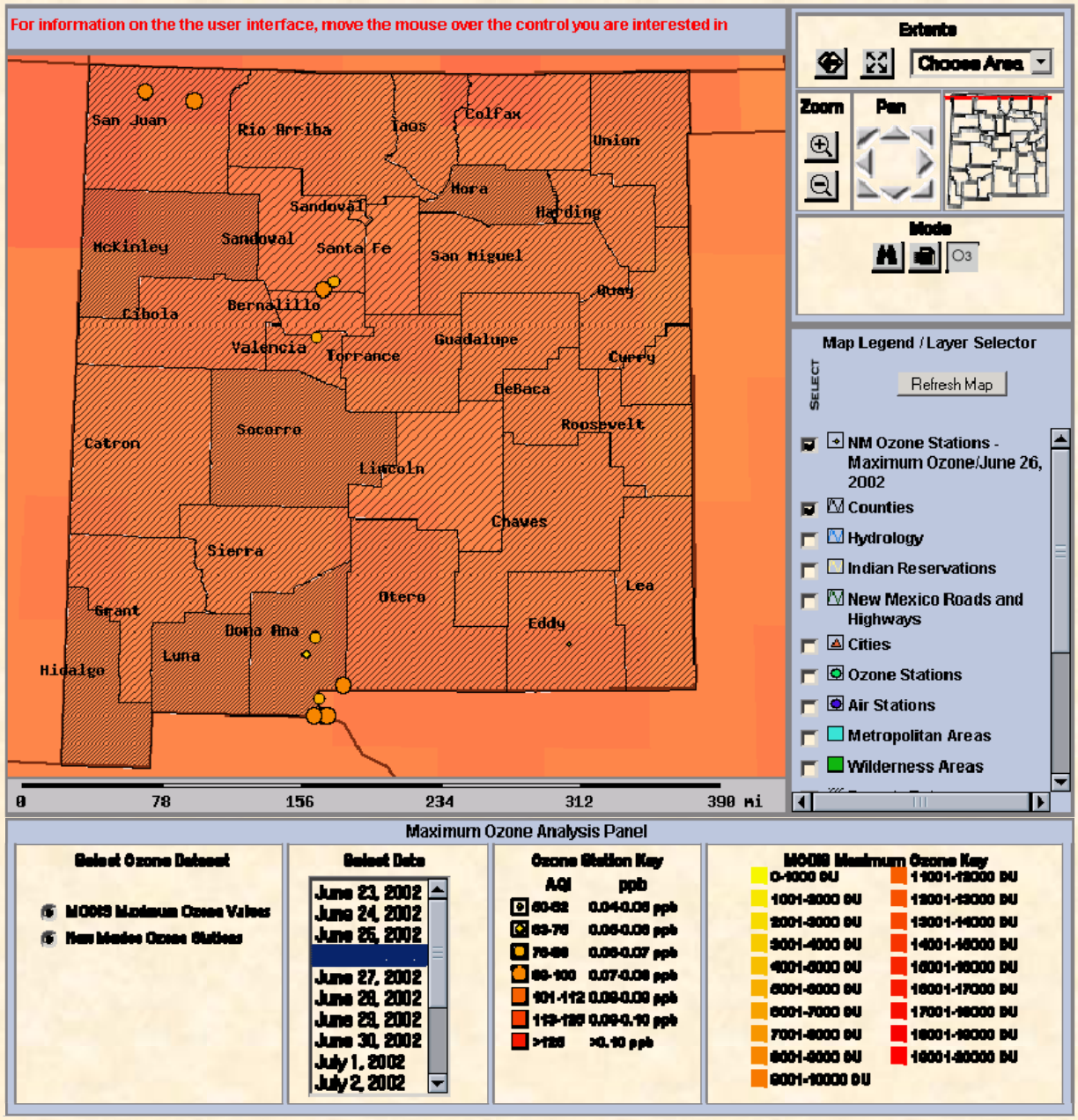
-classified in Dobson units that measure total atmospheric profile

New Mexico ground station network

-primarily in urban contexts

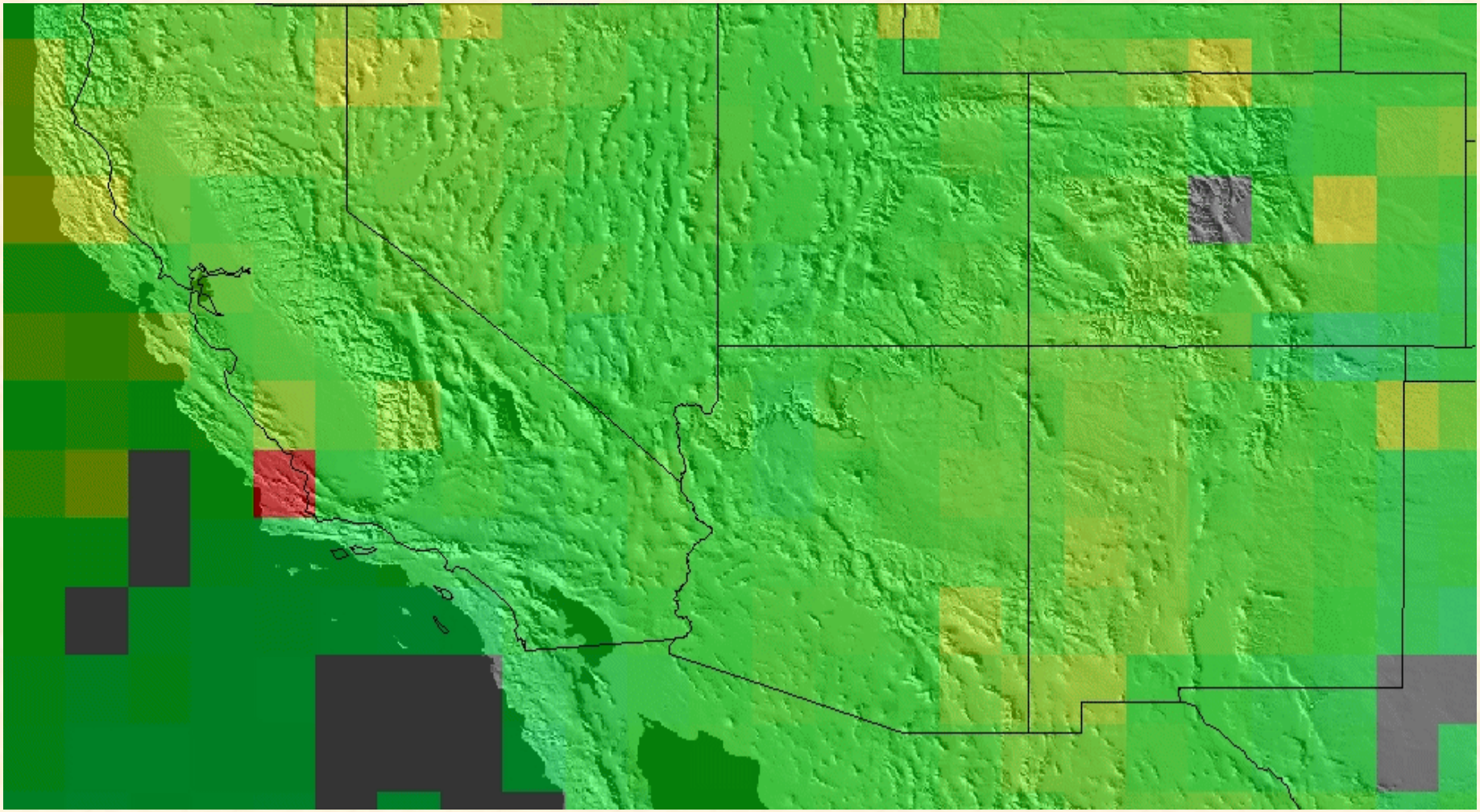
-classified in ppb ozone

MODIS-08 Maximum Daily Ozone and Total Percent of Households in Poverty

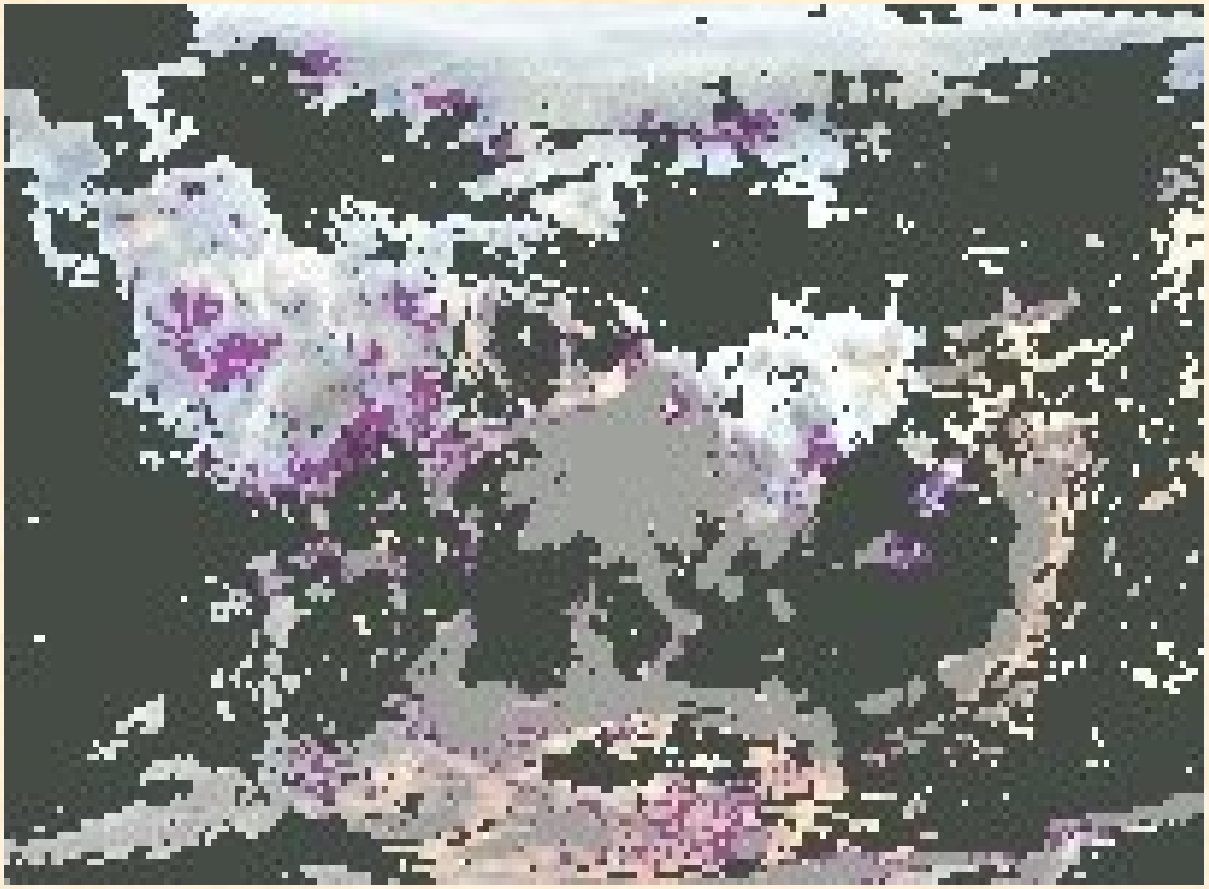


U.S. Census Data

-Total percent of households in poverty by county



MOD04 – Chediski-Rodeo Fires, Arizona (June 23,2002)



MODIS MOD04 Atmospheric Product

-MOD04-L2, Level 2 Aerosol product #23

-three bands at 0.47, 0.55, and 0.66 µm

-measure corrected optical thickness

Development Goals of DDP

- The Defect Detection and Prevention (DDP) Tool implements the DDP Process, as developed by Dr. S. Cornford at JPL
- The purpose of the DDP process is to perform:
  - Risk Assessment
  - Risk Mitigation
- Provide a framework for identifying the mitigations that provide the greatest risk reduction for the lowest cost.
- The DDP Tool manages data for the process and provides visualizations for interpretation.

REASoN Benchmarking Requirements

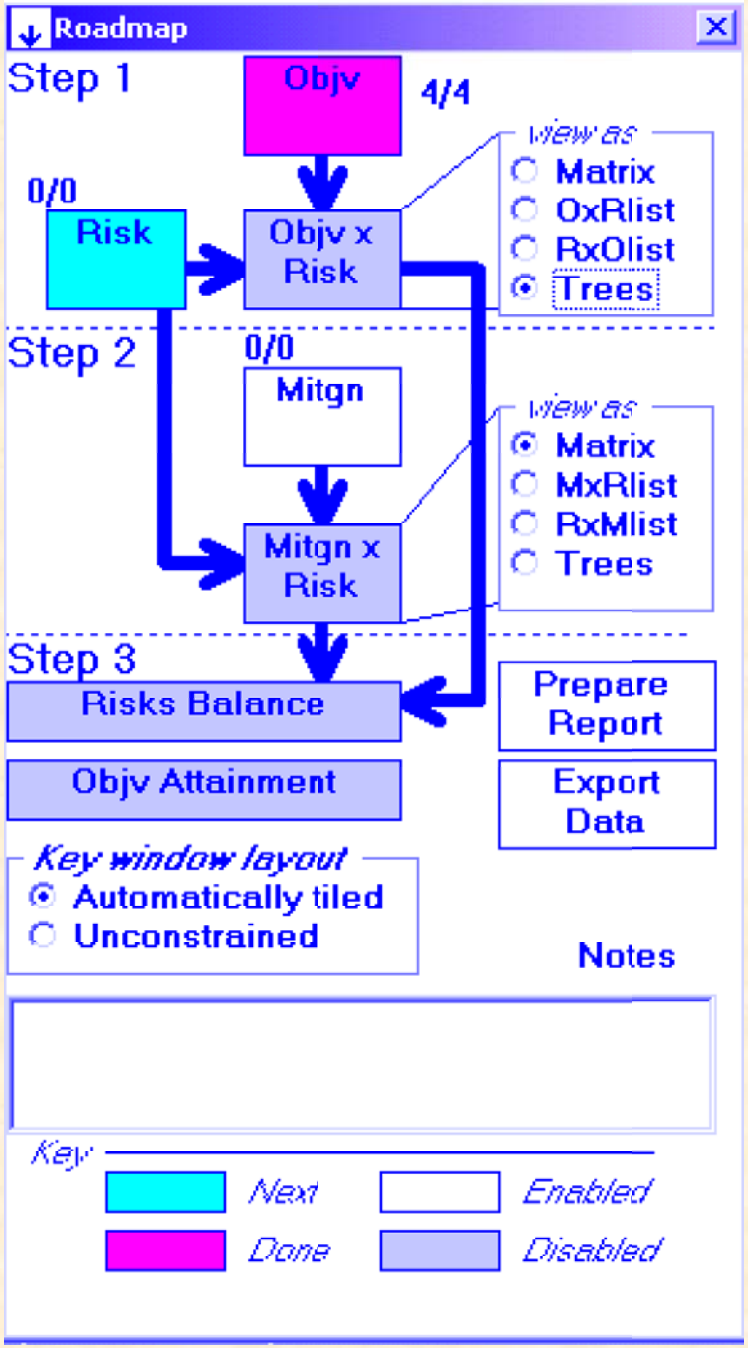
- Benchmark and validate how raster and vector data from NASA measurements contribute to migrating RSVP (v.2) into RSVP (v.3)
- These benchmarking goals require measuring the current baseline conditions of the system components so that improvements in those components can be measured.
- The Defect Detection and Prevention (DDP) tool provides a means for measuring views of system improvements.

DDP as a Benchmarking Tool

- While oriented toward risk mitigation, the DDP process may also be generally applied to scenarios where a set of objectives may be defined, barriers to those objectives identified, and activities for overcoming those barriers undertaken.
- The ‘risk reduction’ analyses performed by the DDP tool may be conceptualized as progress towards achieving the defined project objectives.

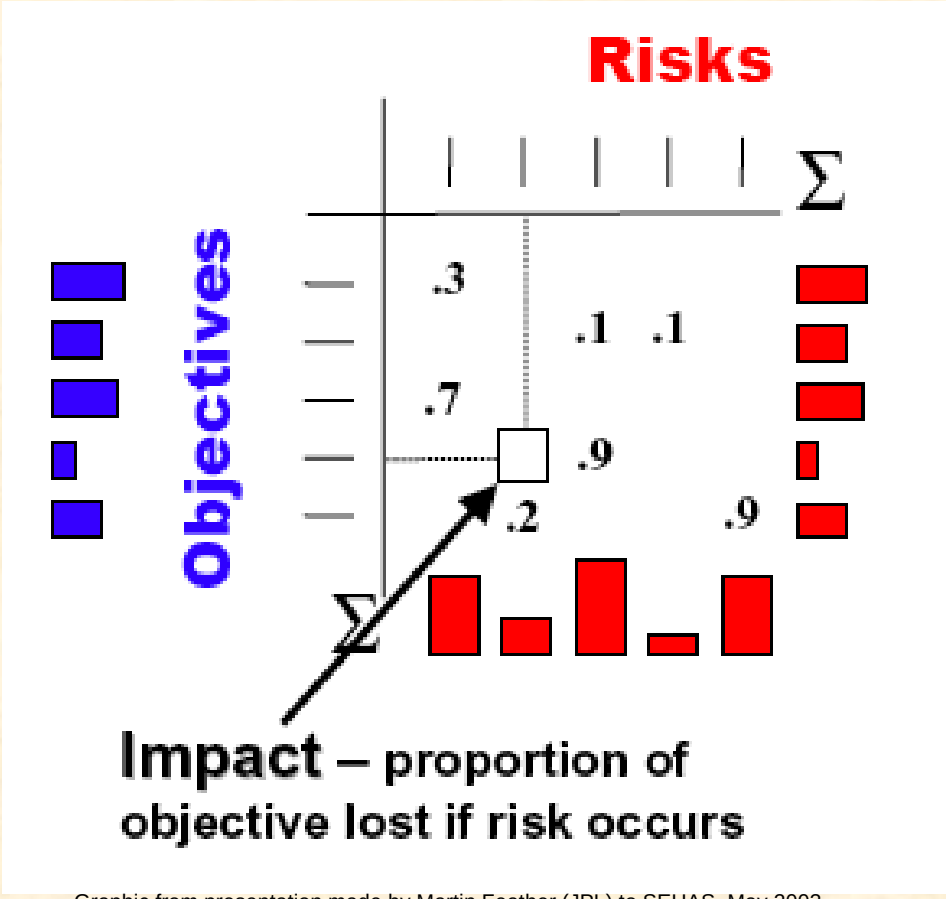
General DDP Tool Process

- Define Objectives & Risks
- Determine Impacts:
  - –Objective x Risk
  - –Proportion of Objective lost if Risk occurs
- Develop Mitigations
- Determine Effects:
  - –Mitigation x Risk
  - –Proportion by which Mitigation reduces Risk



Identification of Risks, Impact Determination

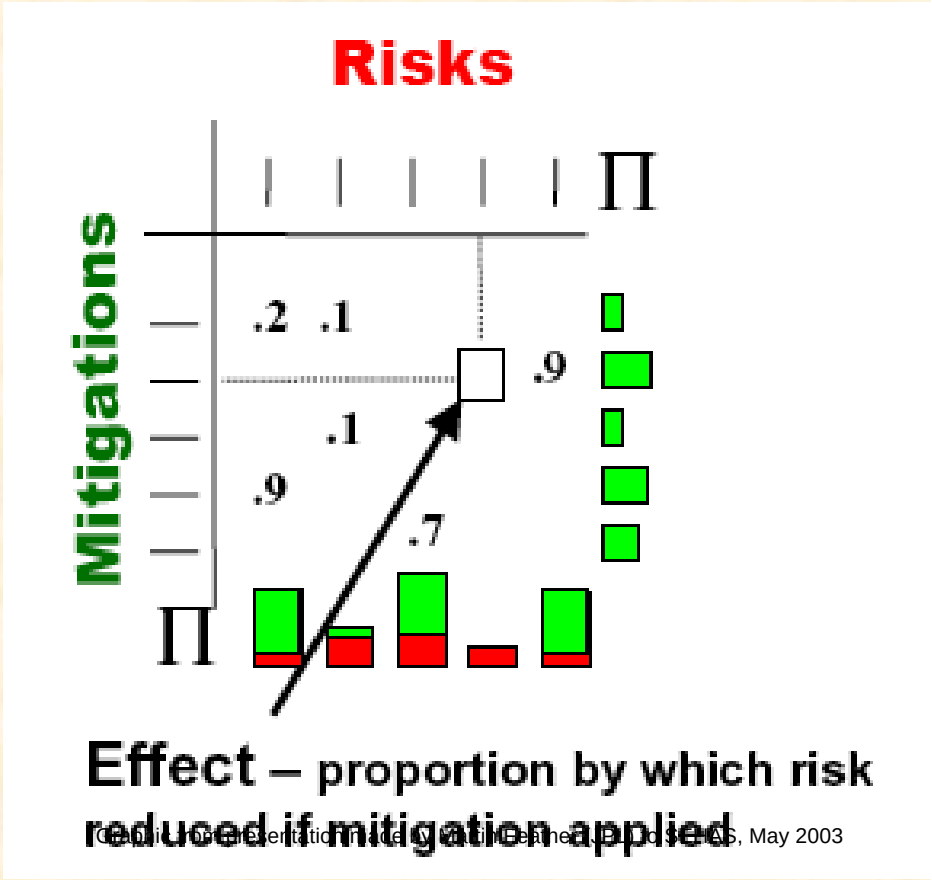
- Any factors that might adversely effect the attainability of any of the identified objectives should be identified.
- Like the process of identifying objectives, the level of detail for risks should be appropriate for mapping them to one or more objectives in a *quantifiable* manner.
- Impacts are assigned to the intersection of risks and the objectives that they effect.



Graphic from presentation made by Martin Feather (JPL) to SEHAS, May 2003

Mitigations and Effects

- Mitigations should correspond with one or more previously identified risks.
- Mitigations have costs, types, and status.
- These characteristics, in conjunction with the *effects* of mitigations on risks contribute to decision-making about which mitigations should be applied.



Exercise in Identifying Objectives and Risks

- Develop hierarchical listing of REASoN project objectives, including weights for those objectives.
- Develop list of risks associated with objectives, with impact matrix values.

Next Steps

- Concentrate effort on Dec. 15-16 Dust Storm
- Retrieve air quality data for New Mexico
- Perform statistical analysis on medical data from Texas Panhandle
- Assimilate land cover and soil texture data into DREAM
- Perform “before” and “after” model runs and assess improvements
- Correlate air quality and medical data
- Receive training on DDP for benchmarking
- Present interim results at ICORSE-31 6/05