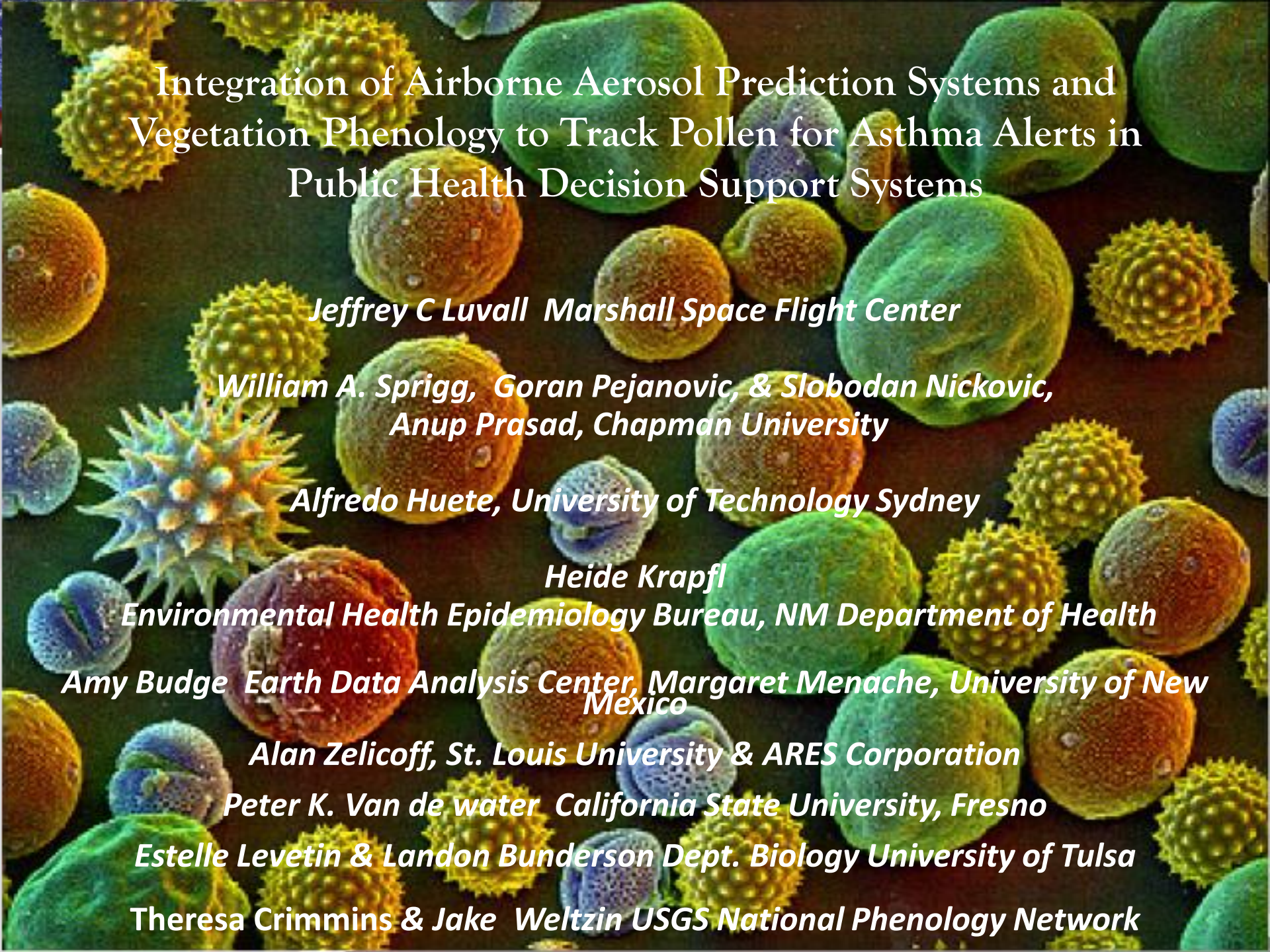


# Integration of Airborne Aerosol Prediction Systems and Vegetation Phenology to Track Pollen for Asthma Alerts in Public Health Decision Support Systems


*Jeffrey C Luvall Marshall Space Flight Center*

*William A. Sprigg, Goran Pejanovic, & Slobodan Nickovic, Anup Prasad, Chapman University*

*Alfredo Huete, University of Technology Sydney*

*Heide Krapfl*
*Environmental Health Epidemiology Bureau, NM Department of Health*

*Amy Budge Earth Data Analysis Center, Margaret Menache, University of New Mexico*

*Alan Zelicoff, St. Louis University & ARES Corporation*

*Peter K. Van de water California State University, Fresno*

*Estelle Levetin & Landon Bunderson Dept. Biology University of Tulsa*

Theresa Crimmins & *Jake Weltzin USGS National Phenology Network*

# NASA Public Health Review September 2011

Transitions

Science Update

1. Pollen Sampling
2. Remote Sensing
3. DREAM
4. NM EPHT

Outreach Activities

1. National Phenology Network
2. School
3. Medical Community
4. AccuWeather – Jonathan Porter

Presentations

Students

Housekeeping- Schedule, Budget, Problems

FY11 Plans

# Transitions

Bill Sprigg to Chapman University

Anup Prasad Chapman University

Alfredo Huente permantly at University of Technology Sydney

Al Zelicoff to St. Louis University

Orrin Myers replaced by Margaret Menache

Guillermo Ponce finished PhD

Viviana Balzaretti - volunteer 2 pollen count stations Los Alamos

# Pollen Collection

*Sampled J. ashei field sites in Texas in early January 2011*
Collected initial field data from Cedar Ridge Preserve in Dallas
Increased the number of transects at the other Texas field sites

Year 2 air sampling for *J. ashei* pollen was completed in February

Expanded the geographic range of air samplers. Three new sites were selected including Santa Rosa Lake State Park (approximately 120 miles east of Albuquerque), Mountainair (approximately 70 south, southeast of Alb.), and Taos (approximately 70 miles north of Santa Fe). The other locations were Los Alamos, Santa Fe, and Jimez Springs.

The influence of meteorological conditions on concentrations of airborne *J ashei* pollen were analyzed. Analysis showed that temperature and dew point were the factors with the highest correlation coefficients at most locations.

# Pollen Collection

Field data for *J. ashei* populations were updated with new data from Jan 2011 and a new method of analyses for cone production was developed with the assistance of a biostatistician.

Experiments to determine pollen size and weight change under different RH and temperature conditions are still on-going.

Year 2 pollen sampling in New Mexico was completed in mid-May 2011. The analysis of these slides has started and we are making good progress, with about 30% done. It is anticipated that these slides will be completed this fall.

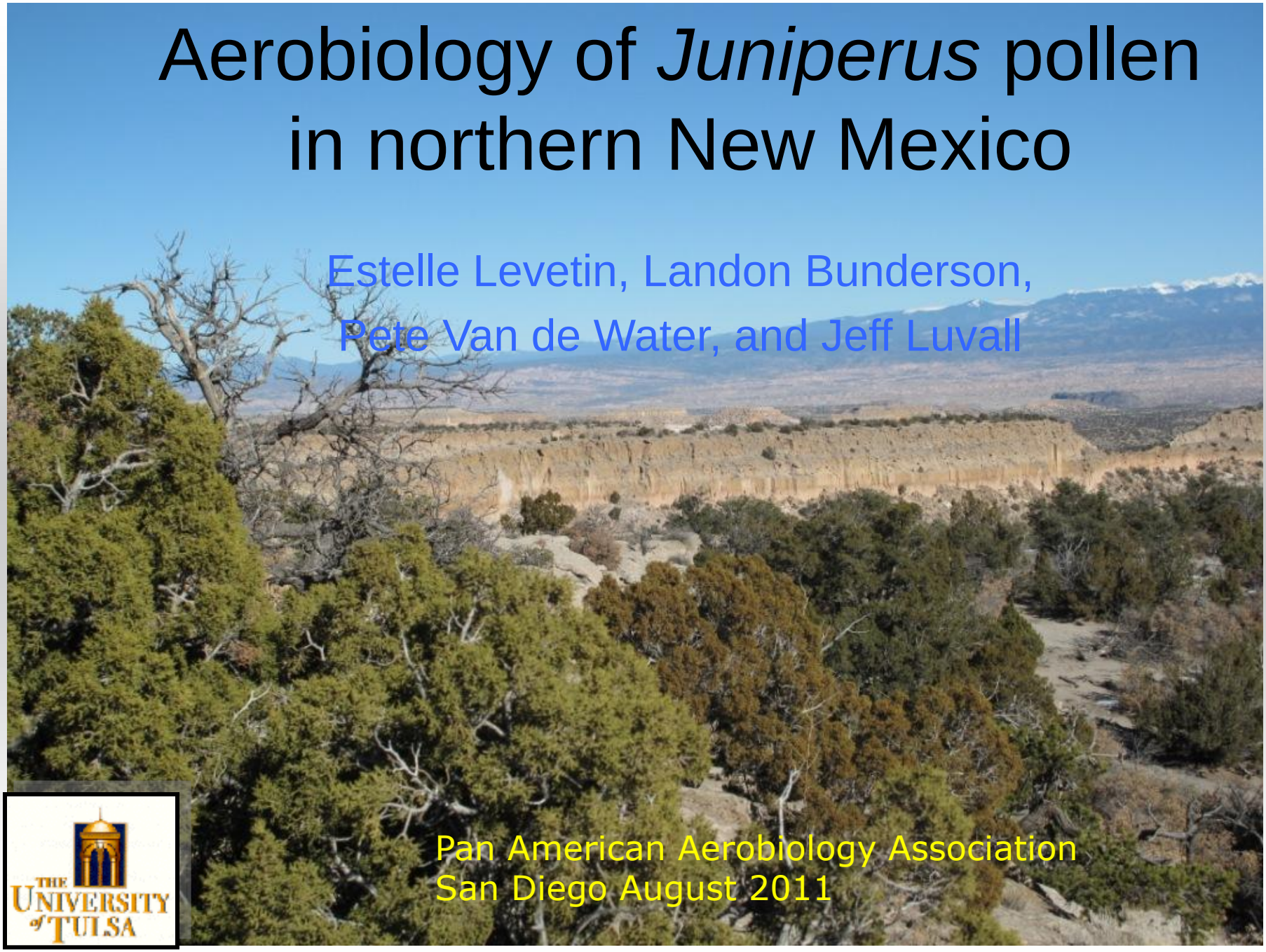
Moved the Burkard samplers from New Mexico to sampling locations in west Texas in early August. These will be used to monitor the *J. pinchotii* populations, and we will begin sampling in mid-September.

# *Juniperus* in New Mexico

- Pinyon-pine and juniper (P-J) woodlands widespread in New Mexico
- Juniper savannas also abundant
- Seven *Juniperus* species in state – 2 abundant
  - *J. monosperma** - dominant species on millions of hectares in NM
  - *J. scopulorum** - usually found at higher elevations
  - *J. deppeana*
  - *J. osteosperma*
  - *J. pinchotii*
  - *J. coahuilensis*
  - *J. communis*

# Aerobiology of *Juniperus* pollen in northern New Mexico

Estelle Levetin, Landon Bunderson,
Pete Van de Water, and Jeff Luvall

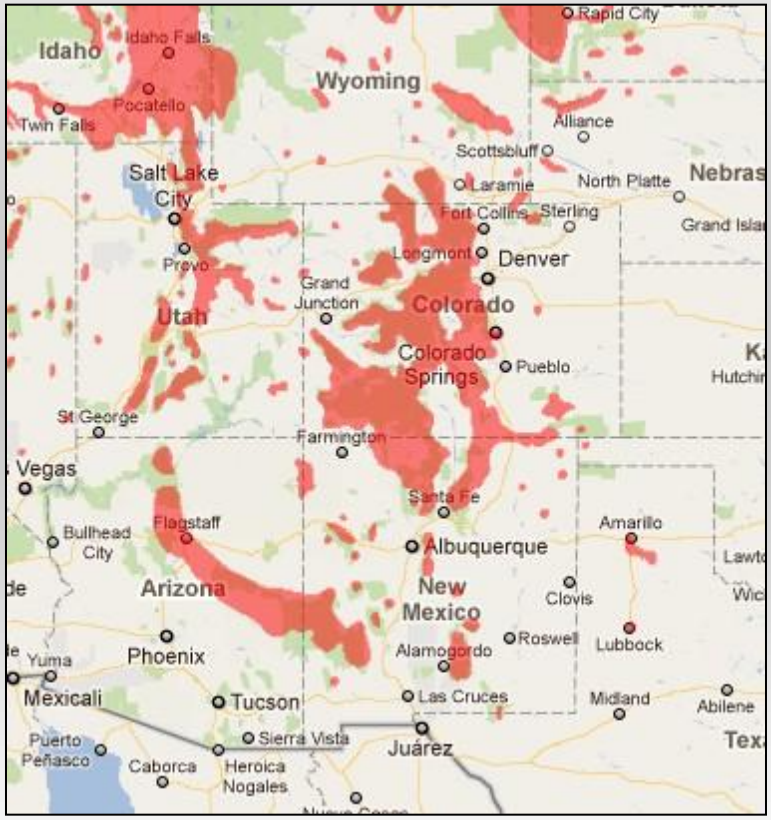


Pan American Aerobiology Association
San Diego August 2011

THE UNIVERSITY of TULSA

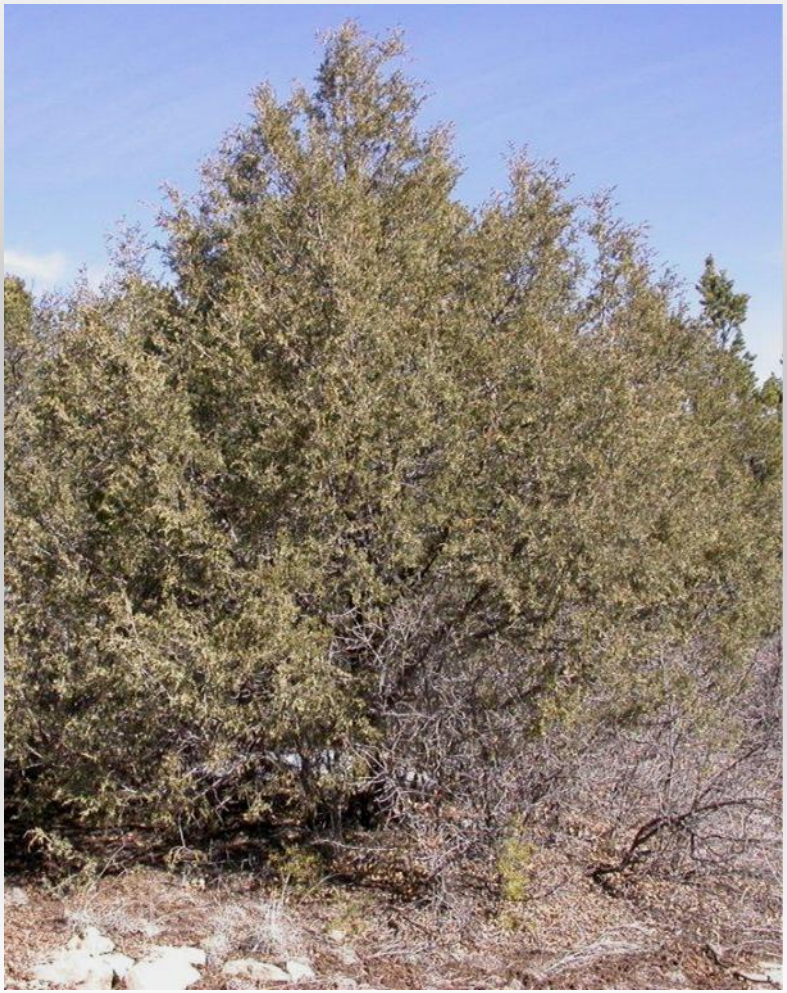
*Juniperus monosperma*


*Juniperus scopulorum*



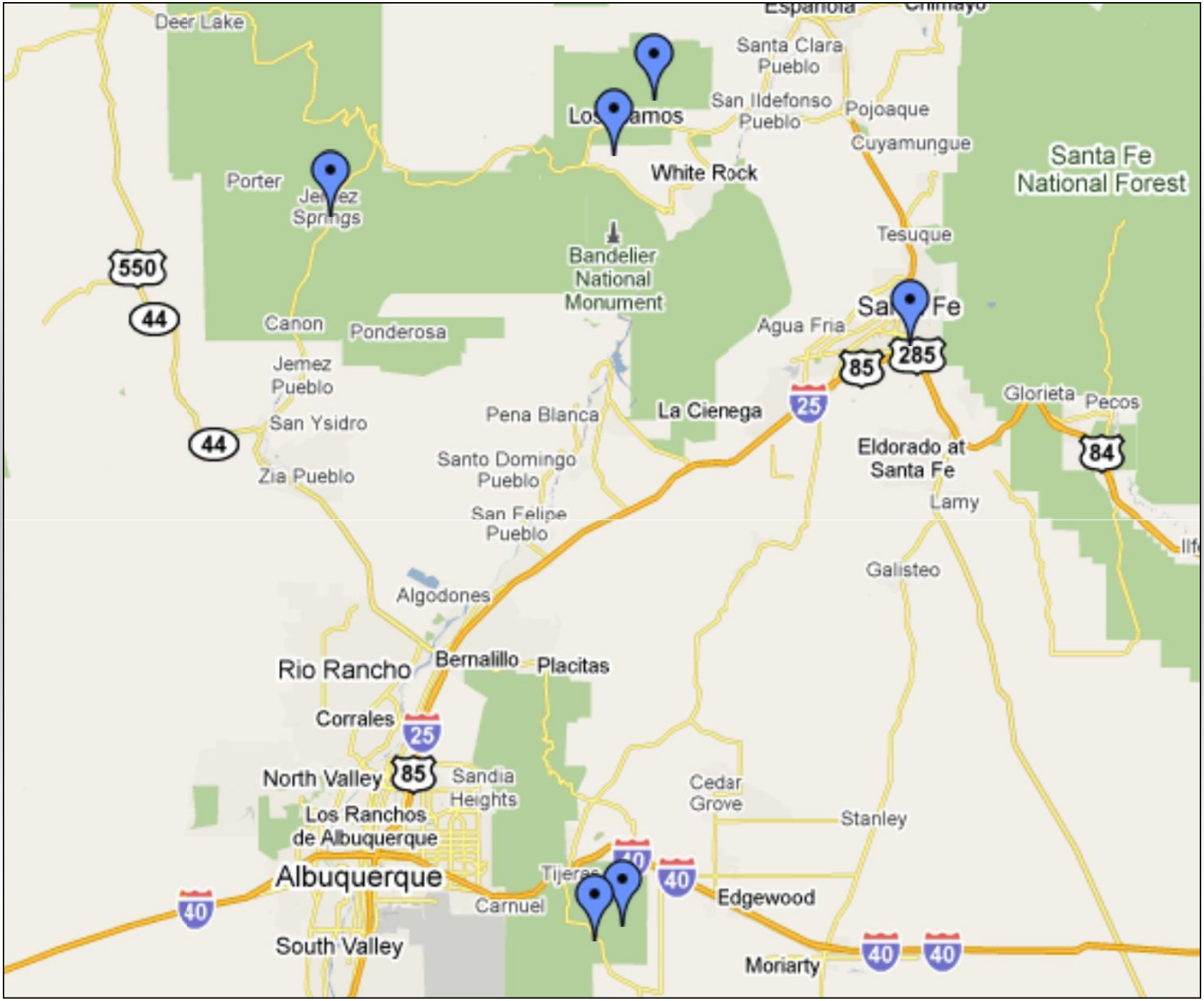
# *Juniperus monosperma*

# *Juniperus scopulorum*



# Sampling Locations for New Mexico Junipers

- NE Los Alamos, NM
- SE Los Alamos (LANL), NM
- Jemez Springs, NM
- Santa Fe, NM
- Tijeras, NM - A
- Tijeras, NM - B


Deer Lake
Santa Clara Pueblo
San Ildefonso Pueblo
Pojoaque
Cuyamungue
White Rock
Santa Fe National Forest
Porter
Jemez Springs
Bandelier National Monument
Tesuque
550
44
Canon
Ponderosa
Agua Fria
85
285
Jemez Pueblo
San Ysidro
Pena Blanca
La Cienega
25
Glorieta
Pecos
84
Zia Pueblo
Santo Domingo Pueblo
Eldorado at Santa Fe
Lamy
San Felipe Pueblo
Galisteo
Algodones
Rio Rancho
Bernalillo
Placitas
Corrales
North Valley
Sandia Heights
Cedar Grove
Stanley
Los Ranchos de Albuquerque
Albuquerque
Tijeras
40
Carnuel
Edgewood
South Valley
Moriarty

# Pollination Ecology

- Transects: 3 to 6 transects in a *Juniperus* woodland near each air sampling location
  - Canopy cover percent
  - Male : Female ratio
  - Tree size – height, diameter
  - Surface area and percent live vegetation
  - Estimates of cone production
- Cone harvesting for lab studies
  - Cone counts
  - Pollen grains/cone
  - Experiments of effects of humidity on weight

# Percent *Juniperus* canopy cover

| | |
|---|---|
| Jemez Springs | 20.03 |
| Los Alamos | 4.6 |
| Santa Fe | 17.37 |
| Tijeras | 22.57 |

# Percent male trees in transects

| | |
|---|---|
| Jemez Springs | 48.9 |
| Los Alamos | 48.0 |
| Santa Fe | 36.5 |
| Tijeras *J. monosperma* | 42.9 |
| Tijeras *J. scopulorum* | 48.2 |

# Mean height of *Juniperus* trees on transects at each site

| | |
|---|---|
| Jemez Springs | 2.5 m |
| Los Alamos | 2.75 m |
| Santa Fe | 2.5 m |
| Tijeras – *J. monosperma* | 3.33 m |
| Tijeras – *J. scopulorum* | 3.92 m |

* Mean height of all Juniperus trees on the transects at each location

# Cone production

- Trees categorized as 0, LCP, and HCP
  - 0 trees: only enough cones to determine sex
  - LCP: Low cone producing trees
  - HCP: High cone producing trees
- 1/8 sections of 3 representative trees were harvested and brought back to the lab. All the cones were counted.

# Number of trees for each cone category for all transects

| | 0 | LCP | HCP |
|---|---|---|---|
| Jemez Springs | 0 | 4 | 38 |
| Los Alamos | 3 | 14 | 7 |
| Santa Fe | 2 | 16 | 6 |
| Tijeras – *J. monosperma* | 1 | 0 | 0 |
| Tijeras – *J. scopulorum* | 1 | 4 | 8 |

# Mean pollen production per cone

| | |
|---|---|
| *J. monosperma** | 290,000 grains/cone |
| *J. scopulorum*** | 242,000 grains/cone |

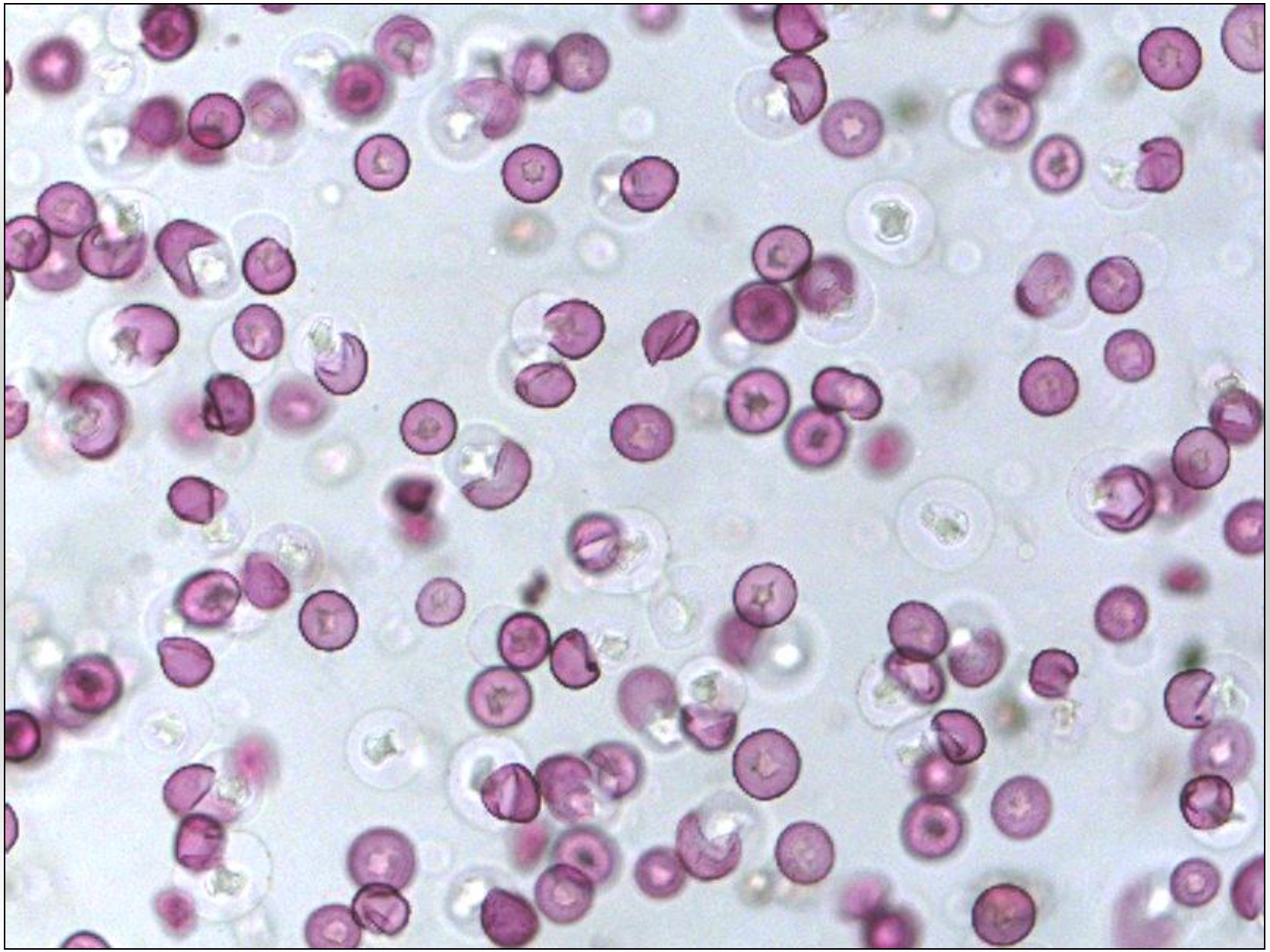
*Mean of 11 vials with 10 cones per vial
** Mean of 2 vials with 10 cones per vial

# Cone and pollen production for representative trees

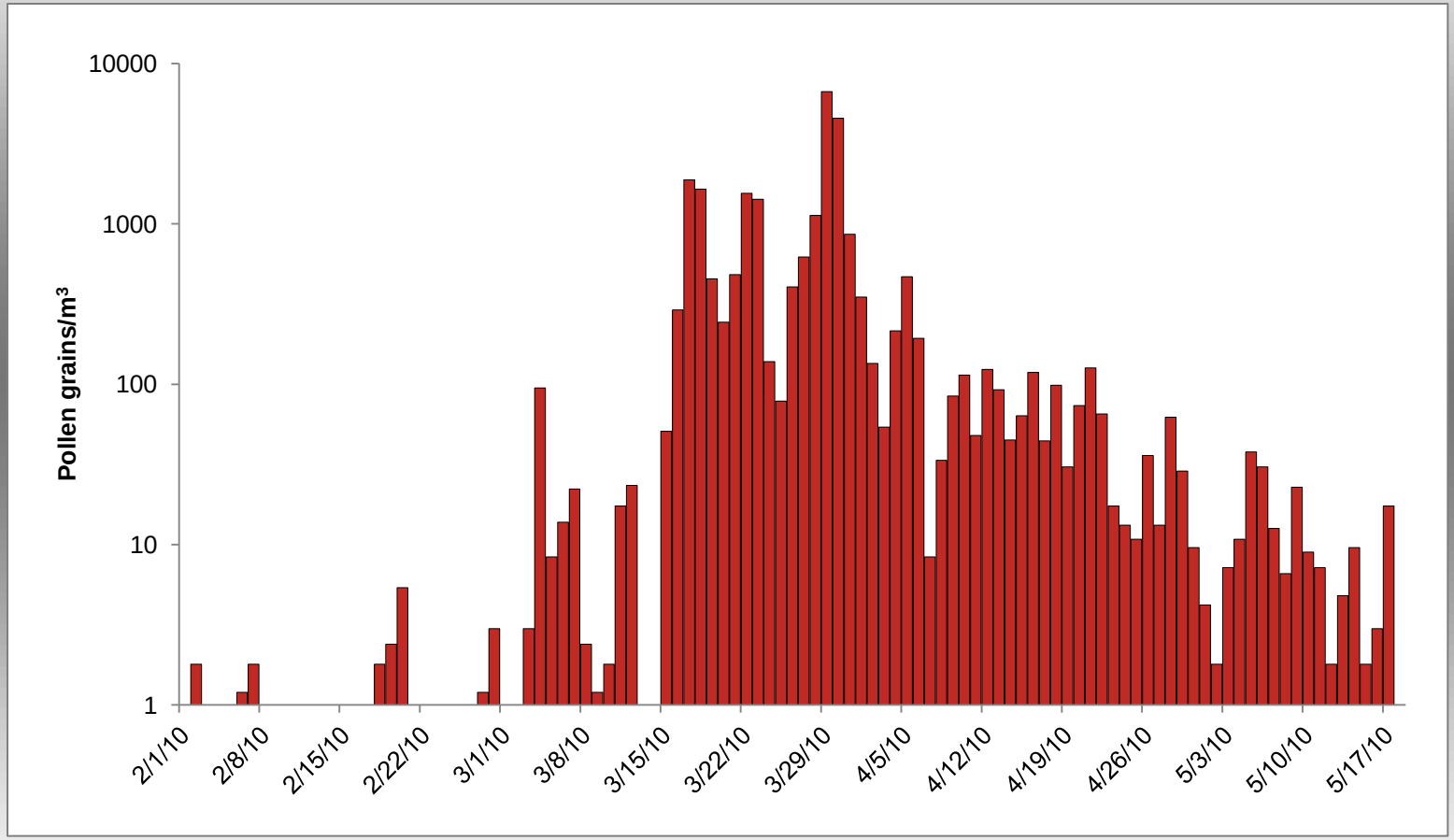
| | Cones/tree | Total pollen potential |
|---|---|---|
| Santa Fe - LCP | 52,808 | $1.53 \times 10^{10}$ |
| Santa Fe - HCP | 646,496 | $1.87 \times 10^{11}$ |
| Jemez Springs - HCP | 269,946 | $7.83 \times 10^{10}$ |

# Air Sampling

- 6 Burkard samplers
- Feb to May 2010
  - *Also 2011*
- Samples prepared using standard methods
- Analyzed bihourly using 12 transverse traverses

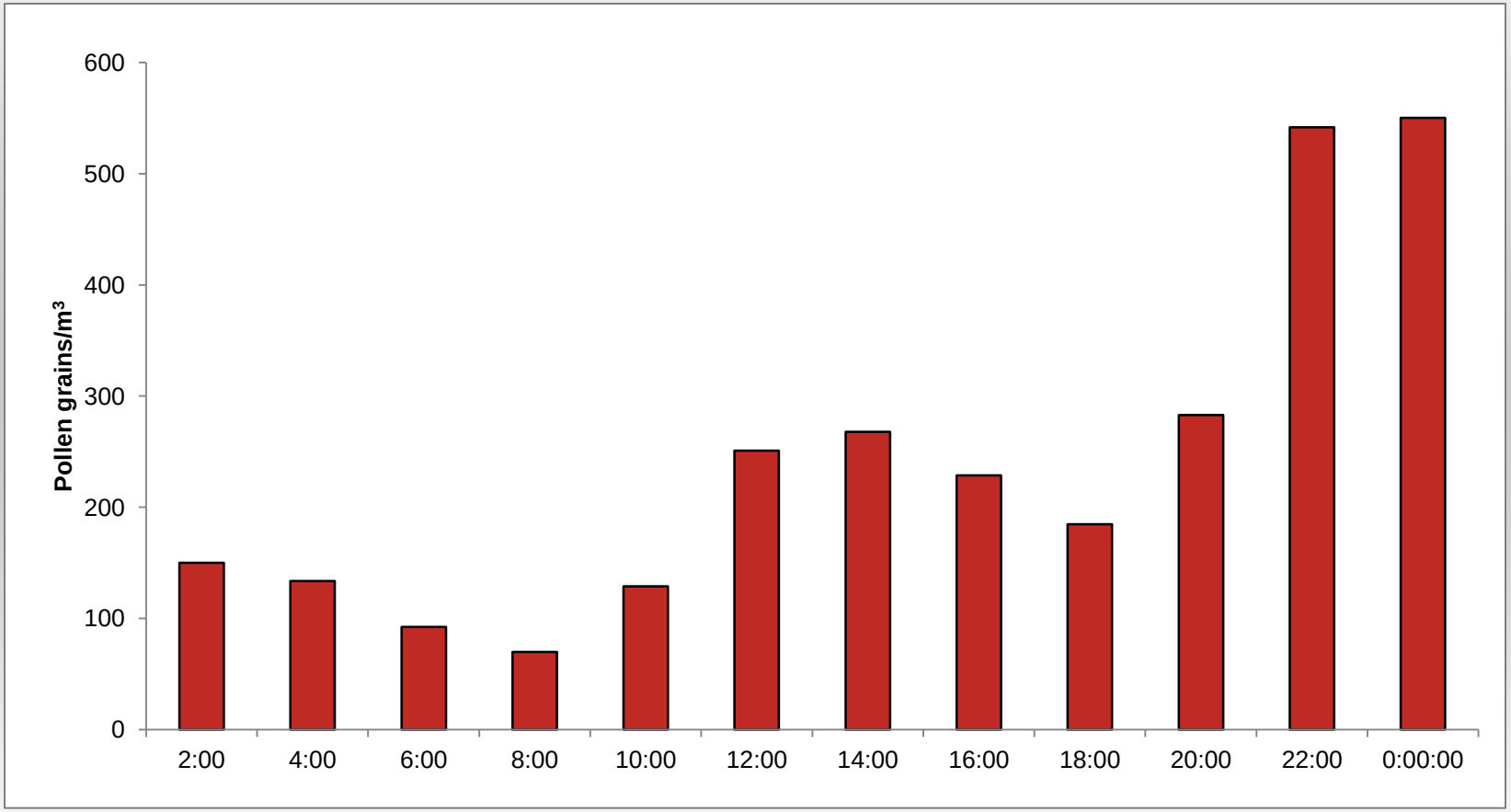


# Mean Daily Concentration* of Airborne *Juniperus* Pollen at Jemez Springs, NM




*Concentration for each day is the mean of 12 bihourly concentrations

# Mean Hourly Concentration* of Airborne *Juniperus* Pollen at Jemez Springs, NM




*Mean hourly concentrations for 107 days from 1 Feb to 18 May 2010

# Main Pollen Season

## 1% - 99% of Cumulative Season Total

| Location | Start Date | End Date | Length |
|---|---|---|---|
| Jemez Springs | 15 Mar | 28 Apr | 45 days |
| NE Los Alamos | 6 Mar | 29 Apr | 55 days |
| SE Los Alamos* | 18 Mar | 26 Apr | 40 days |
| Santa Fe | 14 Mar | 21 Apr | 39 days |
| Tijeras A | 4 Mar | 11 May | 69 days |
| Tijeras B* | 25 Feb | 29 Apr | 64 days |

*Missing data

# Summary for 2010 New Mexico *Juniperus* Pollen Season

| Location | Peak Daily Concen | Date of Peak | Peak Hour | Time of Peak Hour | Date of Peak Hour | Aver Diurnal Peak | Aver Diurnal Low | Aver Daily Concen* |
|---|---|---|---|---|---|---|---|---|
| Jemez Springs | 6,680 | 29-Mar | 31,399 | 22:00 | 29-Mar | midnight | 8:00 am | 561 |
| NE Los Alamos | 6,912 | 30-Mar | 12,197 | noon | 30-Mar | noon | 6:00 am | 328 |
| SE Los Alamos | 9,272 | 30-Mar | 23,213 | noon | 30-Mar | noon | 6:00 am | 559 |
| Santa Fe** | 16,171 | 30-Mar | 52,198 | midnight | 30-Mar | 10:00 am | 6:00 am | 1686 |
| Tijeras A | 1,906 | 18-Apr | 13,880 | noon | 18-Apr | noon | 6:00 am | 231 |
| Tijeras B | 3,068 | 14-Apr | 16,560 | 4:00 | 14-Apr | 4:00 am | midnight | 277 |

*Mean for Main Pollen Season

** Possible location bias

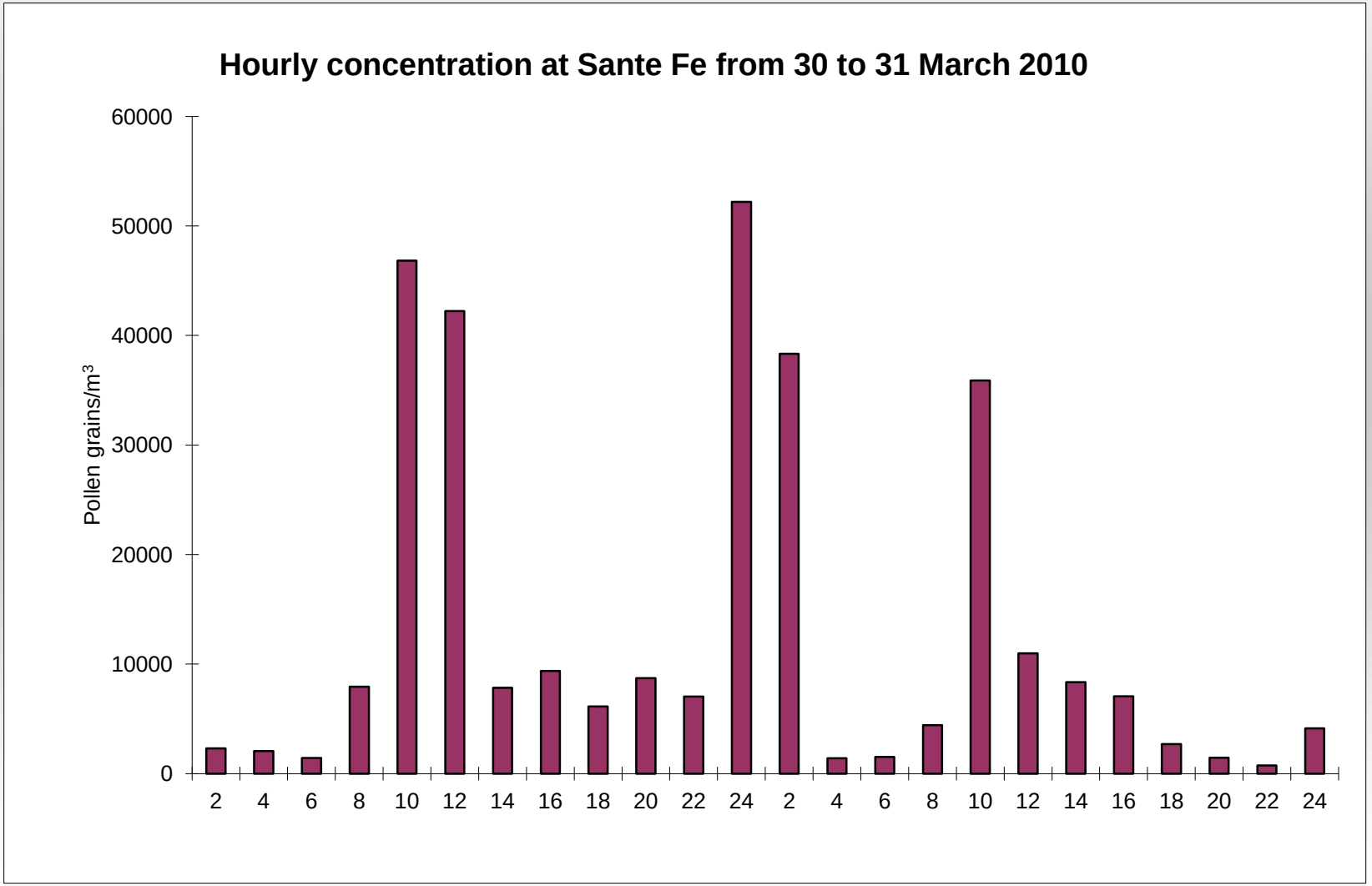
# Meteorological Effects

Spearman correlation coefficients* of bihourly concentrations and meteorological conditions

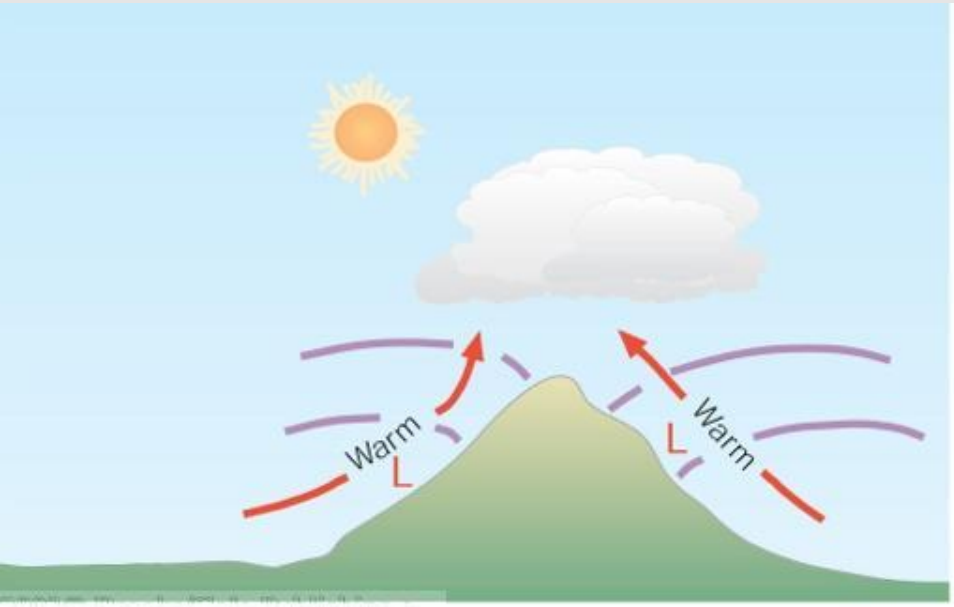
| Location | Temp | RH | Dew Point | Wind Speed | Rainfall |
|---|---|---|---|---|---|
| NE Los Alamos | **0.512** | **-0.488** | **-0.275** | **0.192** | **-0.131** |
| SE Los Alamos | **0.244** | **-0.386** | **-0.289** | **0.159** | -0.063 |
| Santa Fe | **0.493** | **-0.539** | **-0.217** | **0.310** | -0.054 |

*Significant correlation coefficients in boldface

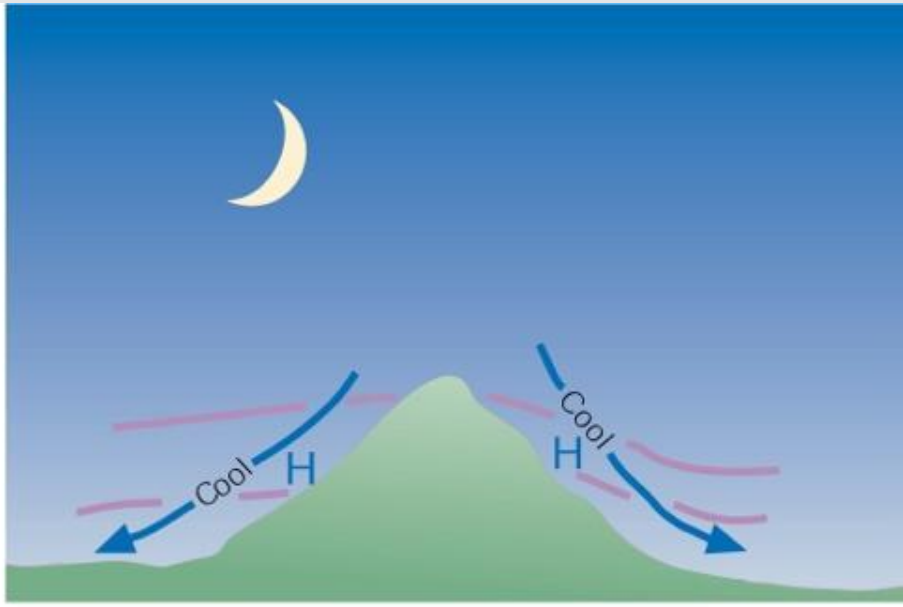
# Nighttime Peaks



# Mountain and valley winds




Valley Breeze




Mountain Breeze

Ahrens CD. 2000. Meteorology Today

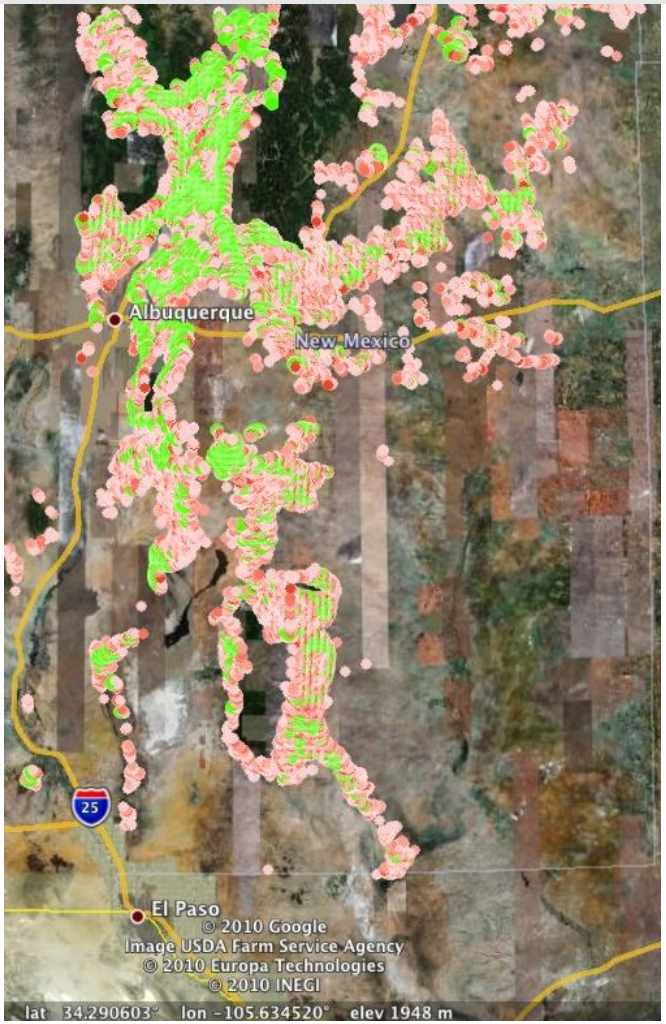
# Status of New Mexico project

- Meteorological analysis on-going for year one aerobiology data
- 2011 sampler locations:

| | |
|---|---|
| Los Alamos | Taos |
| Jemez Springs | Mountainair |
| Santa Fe | Santa Rosa Lake State Park |

- Year two sampling completed (Feb – May 2011)
- Slide analysis on-going
- Humidity experiments on-going

# Goal: Quantify Juniper Pollen Emission "**Sources**" for input to PREAM model.

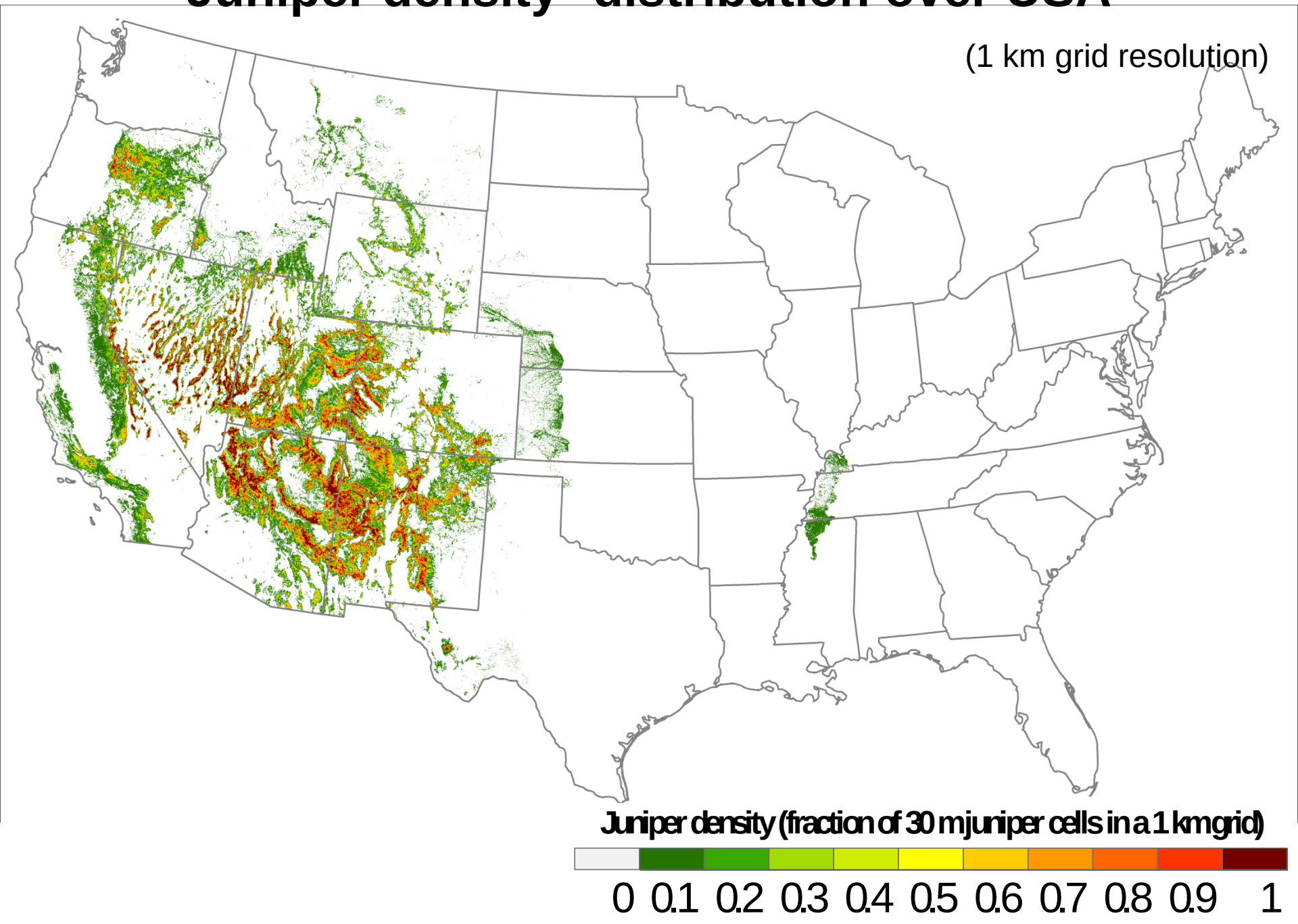

**Juniper density (relative)***

- 50%
- 60%
- 70%
- 80%
- 90%

*Juniper from Land Cover classes S038, S074, and S112 are mapped.

**Challenge**: *Juniper is commonly mapped as "Land Cover Classes" and actual Juniper tree cover is not known.*

# Juniper density* distribution over USA



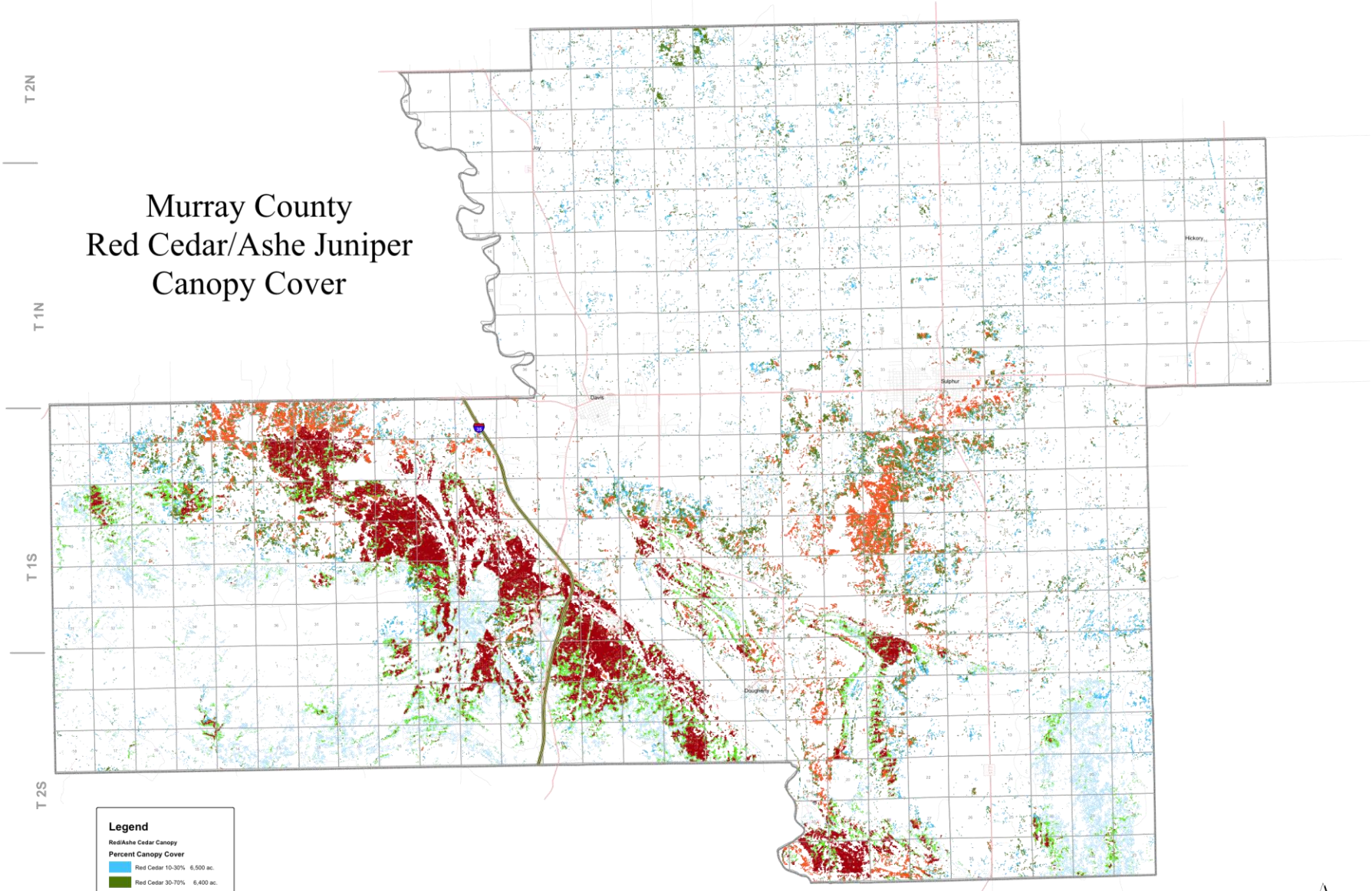
OKLAHOMA NRCS
Sept. 2008

NRCS Natural Resources Conservation Service

R 1W | R 1E | R 2E | R 3E | R 4E

T 2N
T 1N
T 1S
T 2S

# Murray County
# Red Cedar/Ashe Juniper
# Canopy Cover




**Legend**

**RediAshe Cedar Canopy**

**Percent Canopy Cover**

- Red Cedar 10-30% 6,500 ac.
- Red Cedar 30-70% 6,400 ac.
- Red Cedar >70% 5,000 ac.
- Ashe Juniper 10-30% 11,000 ac.
- Ashe Juniper 30 - 70% 5,000 ac.
- Ashe Juniper > 70% 8,000 ac.

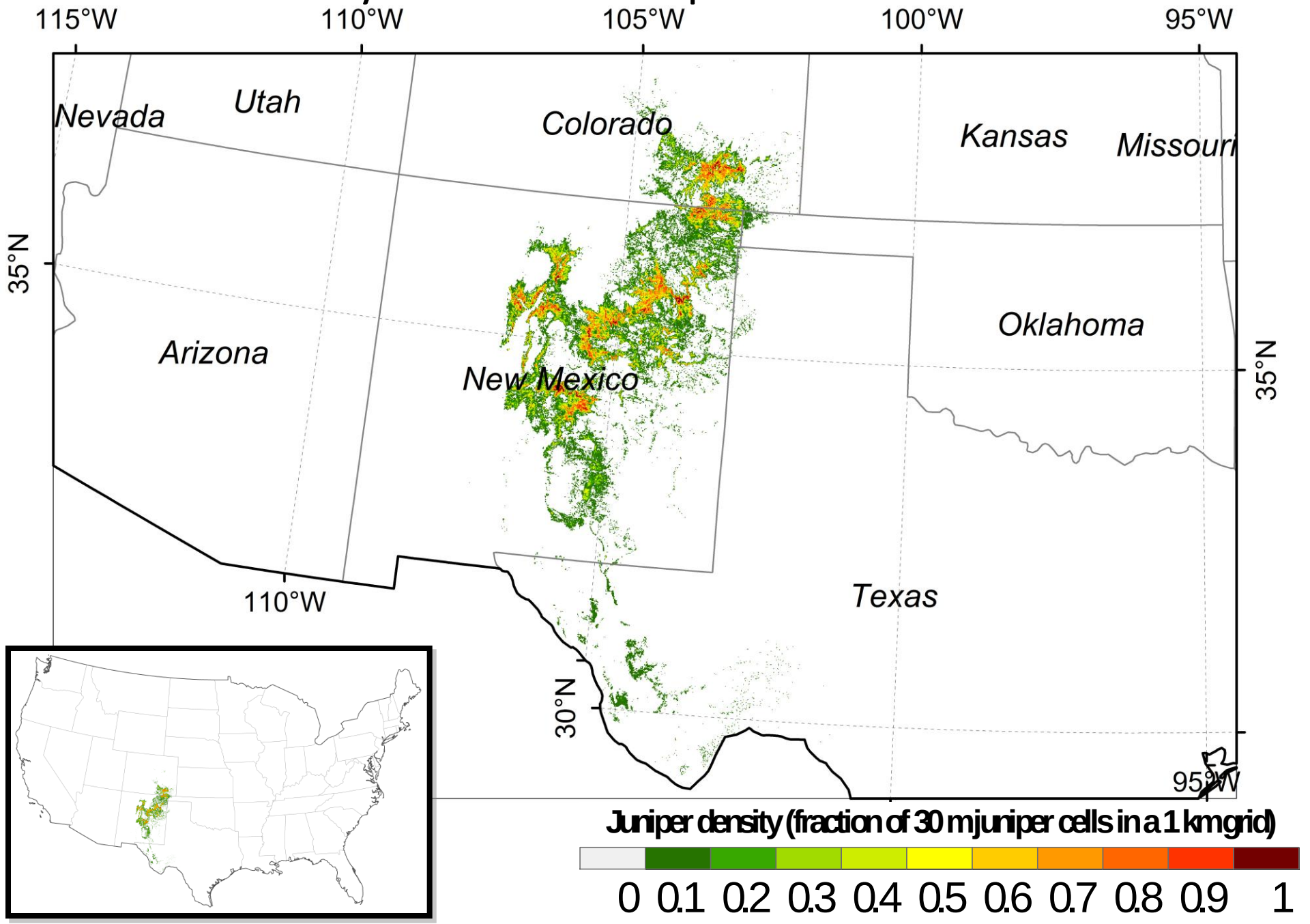
**Red Cedar canopy cover categories were developed from September 2005 Landsat -7 imagery**

This map was developed by NRCS to be used to access the concentration/spatial coverage of Eastern Red Cedar based on approximate canopy cover. It shows the spatial relationship of different canopy densities occuring in a county. It does not access the number or size of individual trees present.

0 2 4 8 Miles

N

# Southern Rocky Mountain Juniper Woodland and Savanna



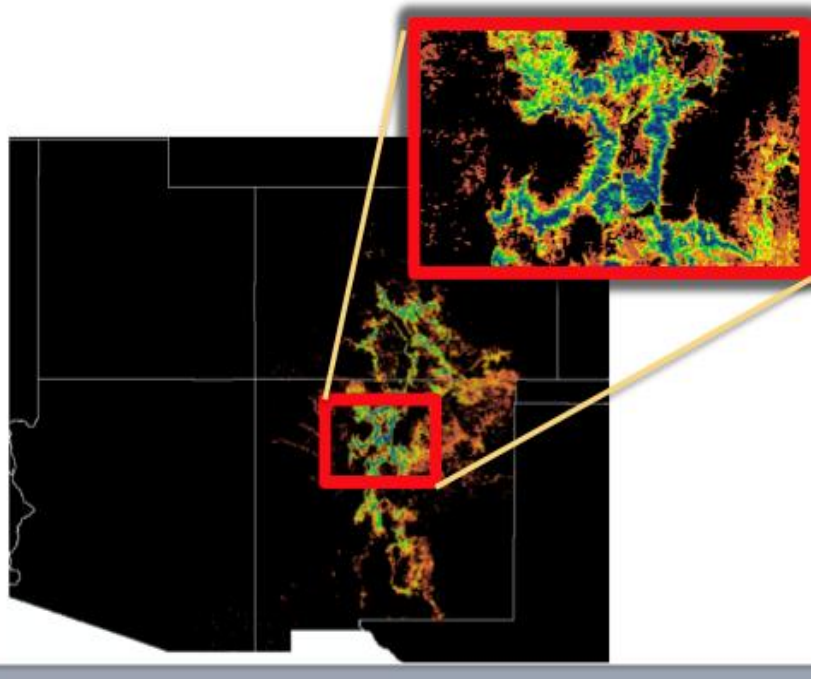

04/13/2009 14:11


04/13/2009 15:05

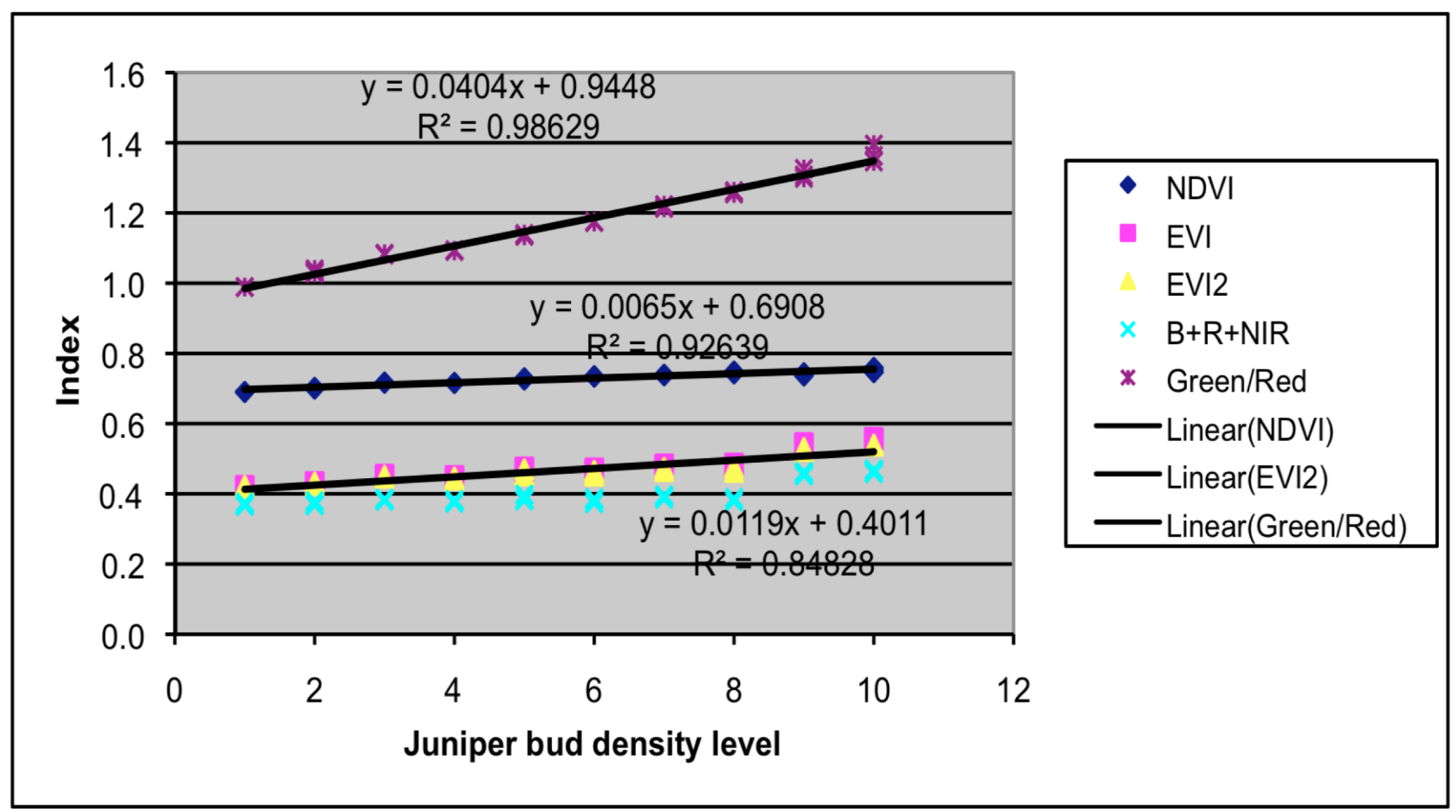
# Spectral characteristics of male juniper canopies at different bud density levels


| Density level | Bud density (g/m^2) |
|---|---|
| 1 | 204.2 |
| 2 | 190.0 |
| 3 | 176.9 |
| 4 | 164.9 |
| 5 | 151.1 |
| 6 | 136.2 |
| 7 | 115.8 |
| 8 | 92.9 |
| 9 | 45.9 |
| 10 | 0.0 |

**S038-SOUTHERN ROCKY MOUNTAIN PINYON-JUNIPER**
**During pollen eruption (Top) and seen from space (Bottom)**



# Relationships between spectral indices and juniper bud density levels



# Key Finding

*Reflectance values of the juniper canopy increase monotonously responding to the reducing juniper cones in the map quadrat, especially, in the green (545-565nm) and near infrared (841-1250nm), while in the red region (650-700nm) the reflectance showed a pattern of opposite change. Vegetation indices, such as NDVI, EVI, EVI2, and G/R, keep the monotonous decreasing with the increasing juniper cones in the quadrat, and showed significant negative correlations with juniper cone density, while a weaker significant positive correlation was observed between GNDVI and juniper cone density. According to the results of the binomial fitting equations between juniper cone density and vegetation indices, all of those vegetation indices except GNDVI can be used as an index for the detection of juniper cones, and G/R was the best among them.*

# PREAM

## Pollen Plume Simulation for Juniper Emissions

## For the period 15 February – 20 March 2010

*Run by Slobodan Nickovic, September 2011*

*Atmosphere Model Setup*

*Model horizontal domain*: Southwest US

*Model resolution*: ~40 km

*Simulation period*:

15 February - 20 March 2010

*Boundary conditions*: 1 degree global forecasts used to refresh

- initial conditions every 24 hours
- boundary conditions every 6 hours

# PREAM

## Pollen Plume Simulation for Juniper Emissions
## For the period 15 February – 20 March 2010

*PREAM – Pollen Regional Atmospheric Model*

*Derived from* DREAM (dust), modified to simulate pollen

- 4 particles bins

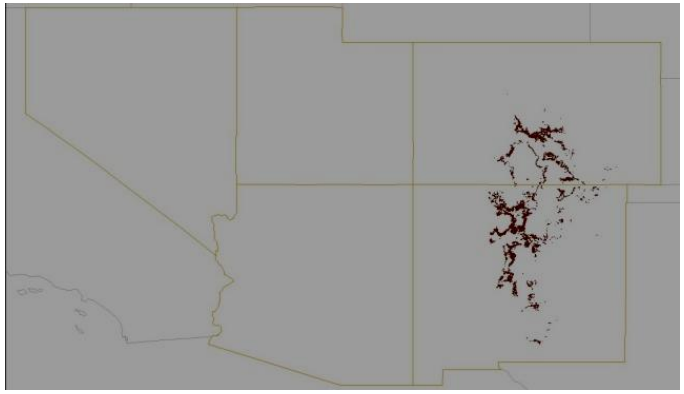
- PREAM is online driven by the NCEP/ETA

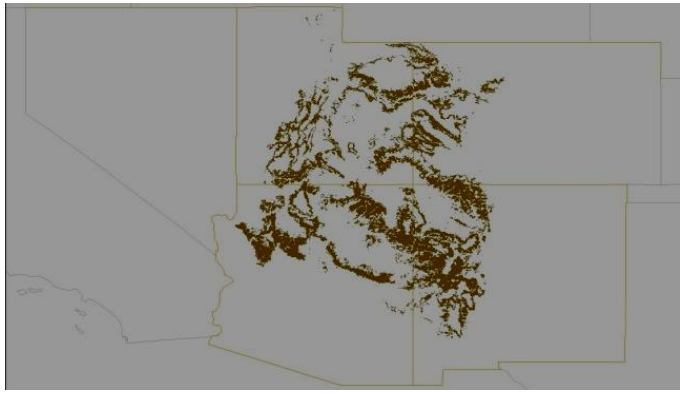
*Emission*:
- Viscous-sublayer parameterization
- Emission dependent on friction velocity

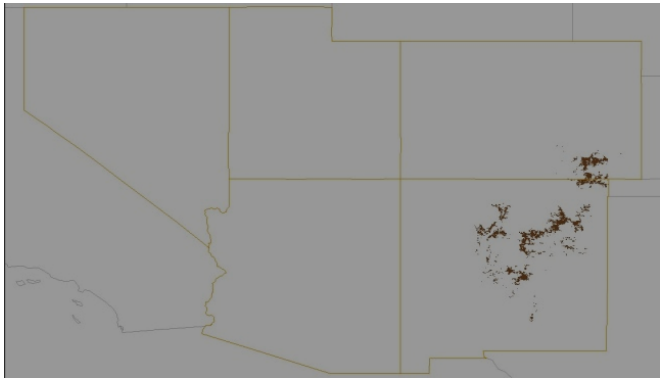
## The PREAM 15 February – 20 March 2010 Run

- "cold start" used for the very first day
- simulated 3D concentration from the previous day is the initial condition for the next day simulation

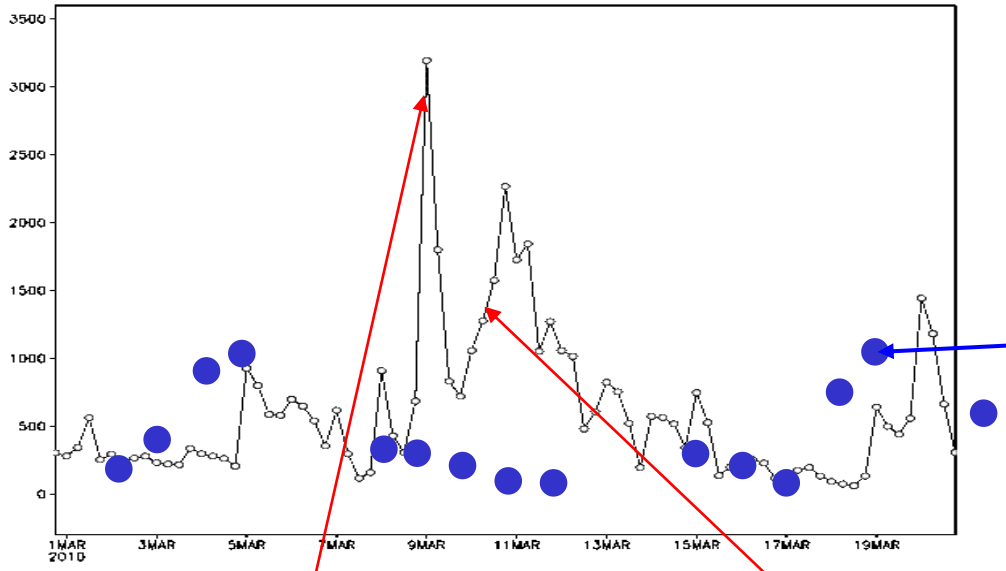
A composite of 3 Juniper pollen sources (provided by Huete group)





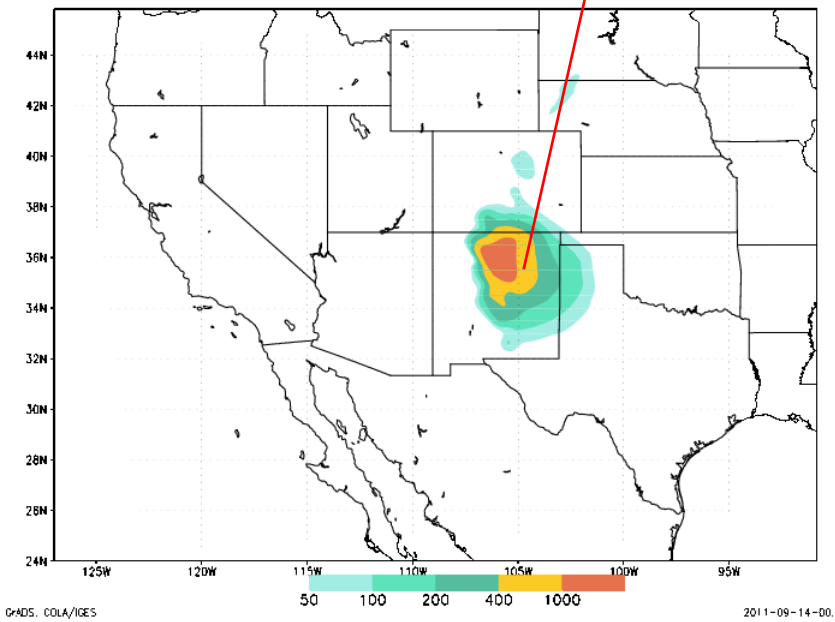


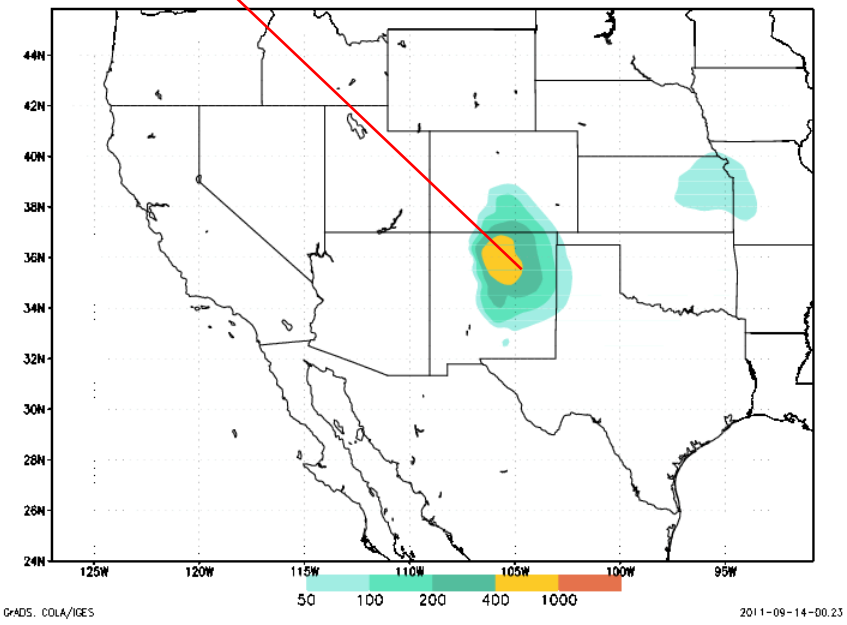
# Pollen grains




Albuquerque

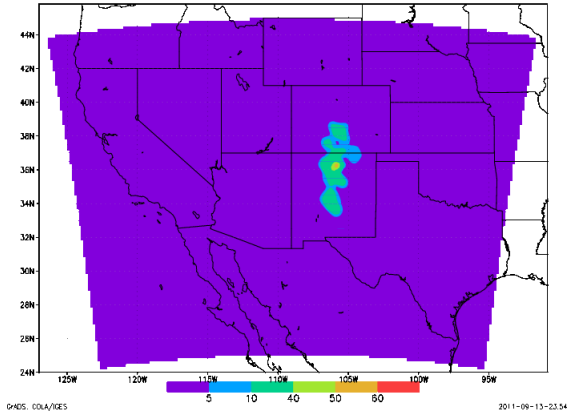
observations



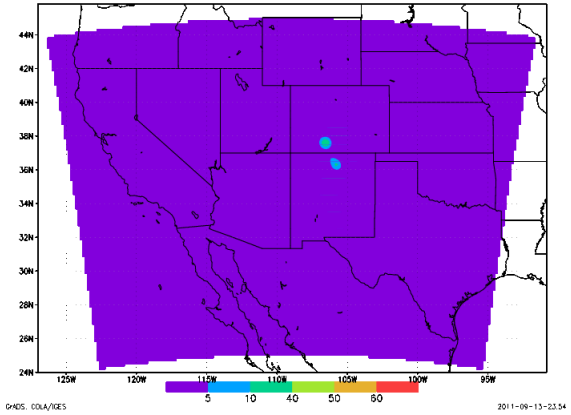




9 March 2010 00UTC

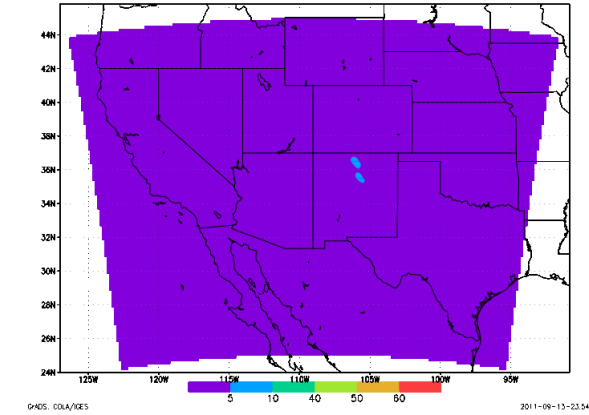
10 March 2010 00UTC



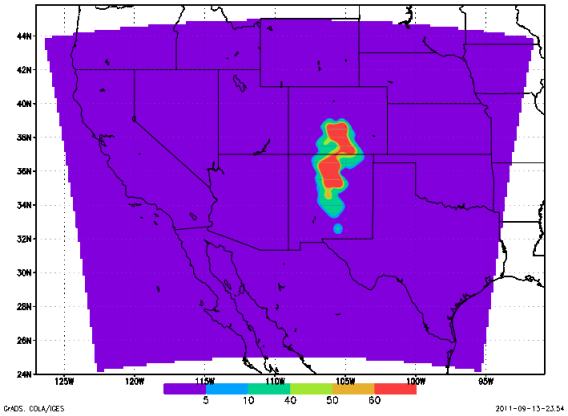
sfx.05.03.10.00h.gif



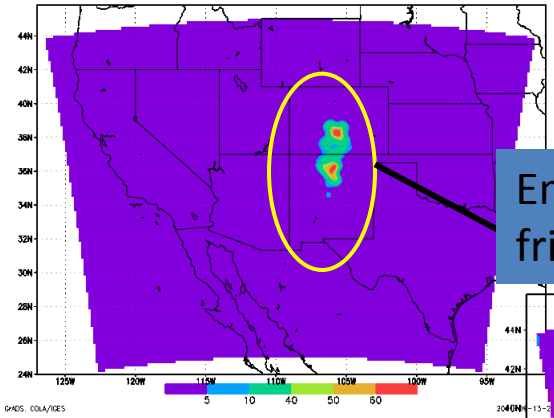
sfx.05.03.10.06h.gif



sfx.05.03.10.12h.gif

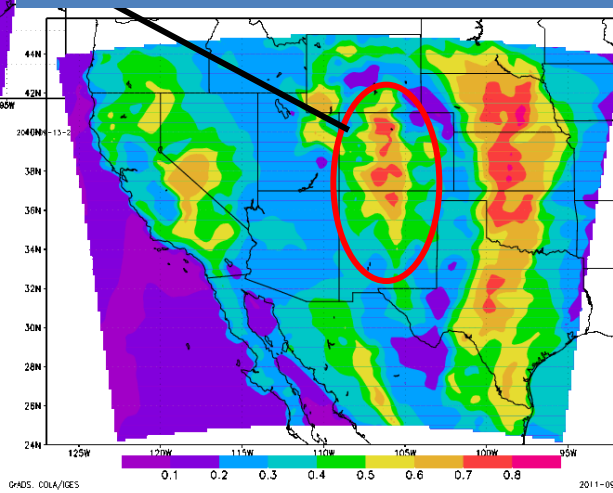


sfx.05.03.10.18h.gif



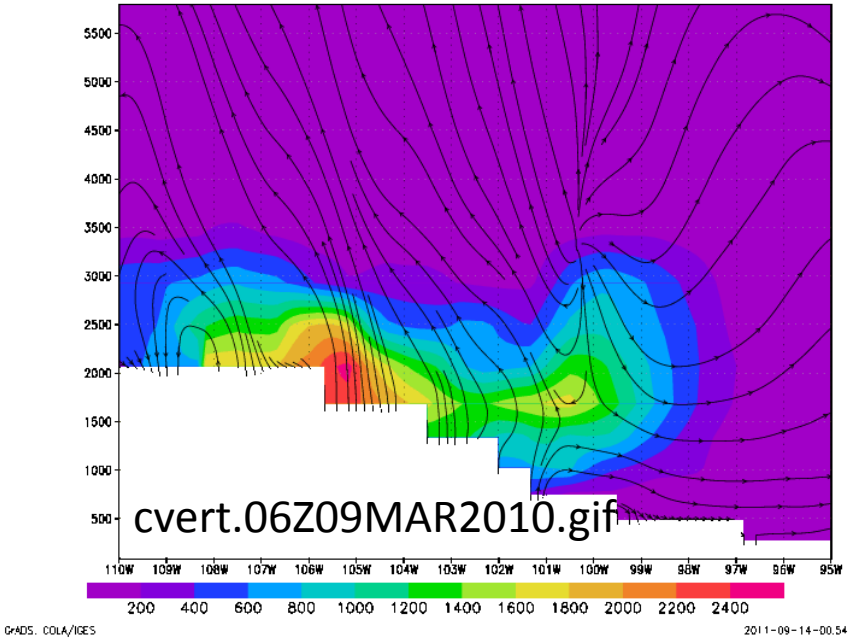
sfx.06.03.10.18h.gif

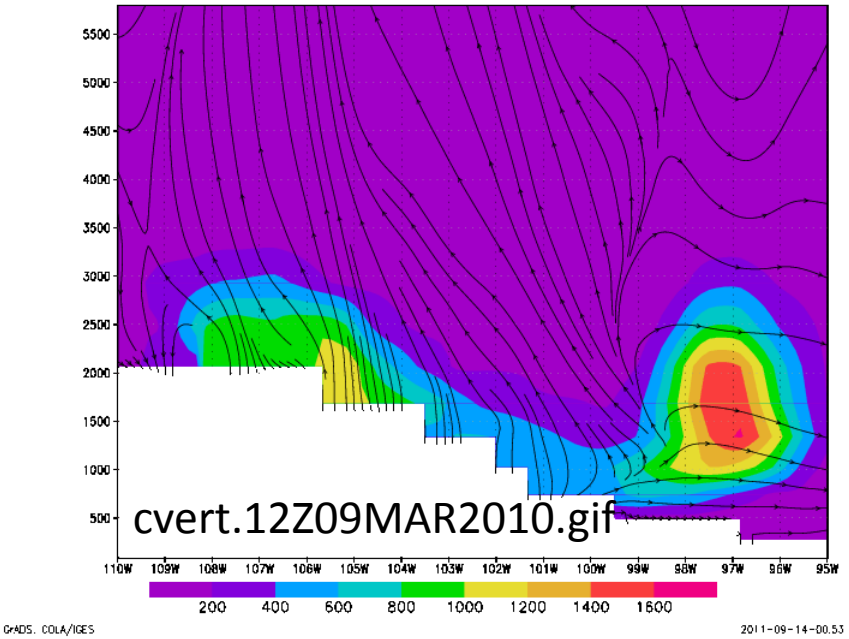
Emission and
friction velocity U* dependen

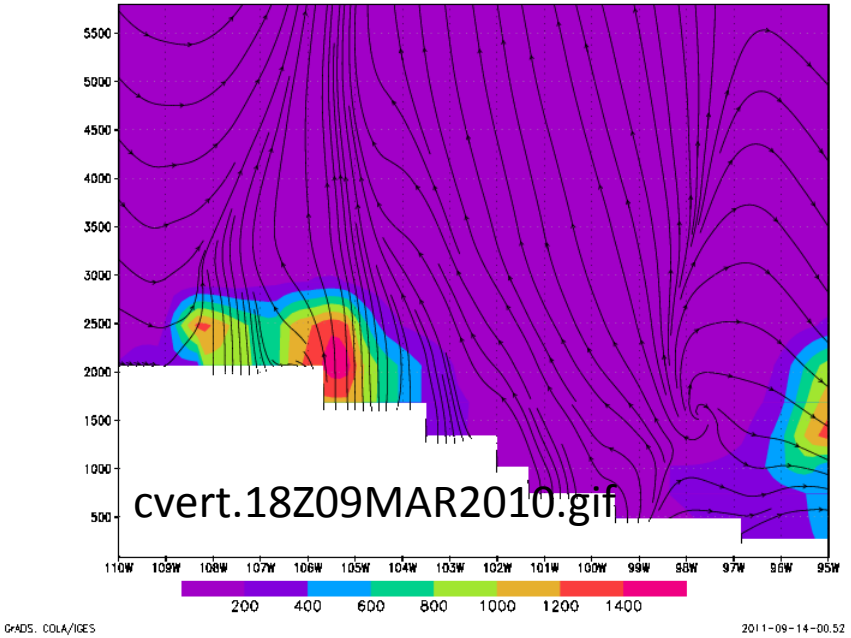


U*.06.03.10.18h.gif

**Time evaluation of emission**



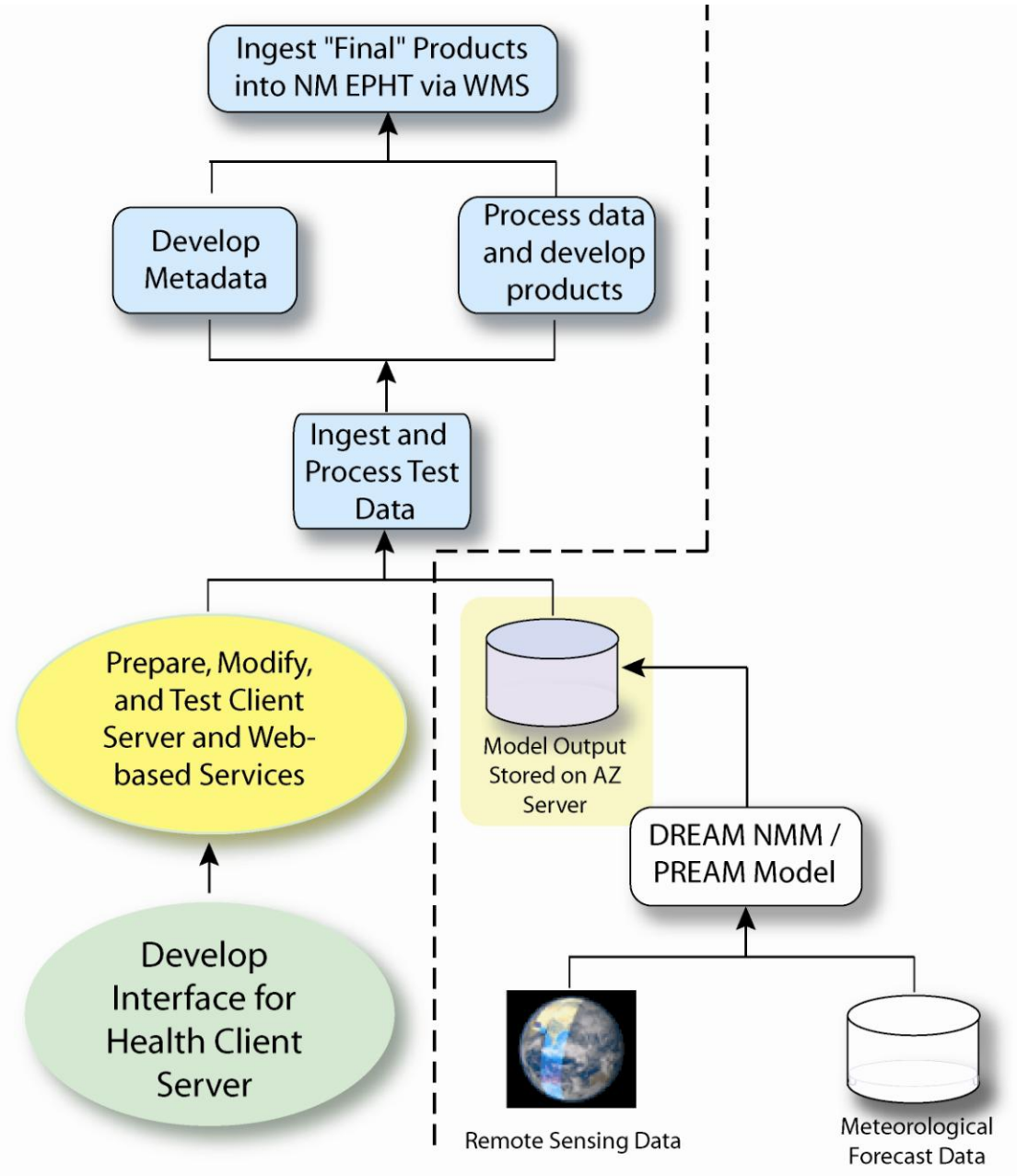




Vertical cross section of pollen C
along the Albuquerque latitude
In the day of simulated maximum

## Status of Transitioning Pollen Data Into NM EPHT

- Progress in year 1 (green oval):
  - Prepare interface for health client server
  - Prepare server for pollen data output
- Test server functions: (yellow oval):
  - Dependent upon receiving sample data from modeling team
- Activities for out years: (blue boxes)



USA npn National Phenology Network

A new data resource—*a national network of integrated phenological observations across space and time*

*<u>Key Goal</u>*

*Understand how plants, animals and landscapes respond to environmental variation and climate change*

USA National Phenology Network

*Taking the Pulse of Our Planet*

Log In

ABOUT | PARTICIPATE | RESOURCES | EDUCATION | RESULTS | ARCHIVE

Search Site | search

western columbine

View All Species

## Join Us!

We are looking for volunteers to help us monitor plant and animal species found across the United States. Click "Observe" to join us!

Observe

### Featured Projects

Juniper Pollen Project

1 of 2 ››

### Sponsors

# USA National Phenology Network

The USA National Phenology Network brings together citizen scientists, government agencies, non-profit groups, educators and students of all ages to monitor the impacts of climate change on plants and animals in the United States. The network harnesses the power of people and the Internet to collect and share information, providing researchers with far more data than they could collect alone.

Learn more about us

## What is phenology?

Phenology refers to recurring plant and animal life cycle stages, or phenophases, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. Many of these events are sensitive to climatic variation and change, and are simple to observe and record. As an USA-NPN observer, you can help scientists identify and understand environmental trends so we can better adapt to climate change.

Why is phenology important?

**USA-NPN News** | **Phenology Feed** | **Join the Conversation**

- Phenoclimatology Position at UA
- Introducing the USA-NPN Video
- ***Nature's Notebook:*** "How to Observe" Handbook and Training Videos
- Phenology Special Issue in the Philosophical Transactions of the Royal Society
- USA-NPN Reports (including Strategic Plan and 2009 Annual Report)
- Call for Papers: 4th Annual PROSE in Tucson, AZ, October 2010

- Recent Media Reports
- Newsletter Archive

***Are you...?***

New to phenology?

Ready to start observing?

One of our partners?

Interested in creating a partnership?

An educator?

Interested in finding data to use?

A media outlet?



USA National Phenology Network, National Coordinating Office
1955 E. Sixth St., Tucson, AZ 85721
Admin Login

# Presentations 2010-2011

AAAI –American Academy of Allergy Asthma & Immunology, San Francisco Jan 2011. 4 posters

PAAA - Pan American Aerobiology Association San Diego August 2011- 2 presentations

Graduate School Research Colloquium spring 2011 Landon

International Symposium of Remote Sensing of the Environment (ISRSE): 3 papers

CDC - Center for Disease Control  Heat Watch project program review/EHTN.

American Meteorological Society Annual Meeting Seattle January 2011

ISPRS International Society for Photogrammetry and Remote Sensing Santa Fe Sept 2011.

NSSTC seminar series February 2011

University of Tulsa – invited seminar Nov 2010

November 2010 American Public Health Association (APHS) annual conference

# Students

Graduate student, Landon Bunderson, University of Tulsa (Estelle)

Guillermo Ponce – University of Arizona

# Year 2

***Pollen Sampling Activities***

Pollen timing concentrations/size distributions - Tauber Traps & Burkard samplers
Humidity effects on pollen weight/extine separation
ID & Obtain pollen count data from creditable sources
Recruitment of observers for NPN.

***Remotely Sensed Data***

Track phenology to ID pollen (male cones) formation & density (MODIS)

***DREAM Modeling***

Use measured surface pollen concentrations from sample sites
Humidity effects on weight
Spatial /time resolution
Parameterization & Optimization

***Public Health Supp****ort*

Modification of SYRIS to accept pollen tracking data
Preliminary data products for EPHTN
Recruitment of allergists for SYRIS
Hospital records for asthma and COPD

# Year 3

***Pollen Sampling Activities***

Finish yr 2 pollen sampling & counting
Pollen release timing concentrations & microclimate
Humidity effects on pollen weight/extine separation
ID & Obtain pollen count data from creditable sources
Recruitment of observers for NPN.

***Remotely Sensed Data***

Track phenology to ID pollen (male cones) formation & density (MODIS)
Pollen source masks for all Juniper communities

***DREAM Modeling***

Use measured surface pollen concentrations from sample sites
Humidity effects on weight
Spatial /time resolution
Parameterization & Optimization
Output products into EPHTN
Eta to NMM (drivers for pollen generation plume calculations)

***Public Health Supp****ort*

Modification of SYRIS to accept pollen tracking data
Abstentee data correlations Lubbock, TX – 58 schools 15k students 2007-10
Preliminary data products for EPHTN
Recruitment of allergists for SYRIS
Hospital records for asthma and COPD
AccuWeather – Jonathan Porter

# Schedule, Budget, Problems

Many personel changes

Moving models to Chapman

Opimization, the NCEP/Eta to the NCEP/NMM

Anup Prasad taking over from Gullierimo RS

New Mexico & Texas fires & drought

Source Maps for TX- no GAP data

Funding for Landon Bunderson