https://ntrs.nasa.gov/search.jsp?R=20130010248 2019-08-31T00:13:13+00:00Z

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

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Moscow Birch Pollen

Pollen Release

Pollen per cone

Sonora	472,000 pollen grains/cone
Dallas	402,000 pollen grains/cone
San Marcos	374,000 pollen grains/cone
Junction	363,000 pollen grains/cone

Cone and pollen production for representative trees

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

Summary Statistics for 2010 and 2011 *Juniperus pinchotii* pollen seasons at source

Location	Average daily concentration Pollen grains/m3	Peak daily concentration Pollen grains/m3	Date of peak	Peak hourly concentration Pollen grains/m3	Time of peak hour	Date of peak hour
2010						
Erick, OK	337	5,563	25-Oct	15,898	10:00 AM	25-Oct
Sonora, TX	286	3,019	25-Oct	12,152	10:00 AM	25-Oct
San Angelo, TX	653	5,542	1-Nov	10,195	Noon	1-Nov
2011						
Erick, OK	12	214	16-Oct	800	10:00 AM	16-Oct
Sonora, TX	64	428	26-Oct	2,422	10:00 AM	31-Oct
San Angelo, TX	60	493	26-Oct	2,747	4:00 AM	26-Oct
Quanah, TX	22	190	19-Oct	703	8:00 PM	19-Oct

Influence of preseason meteorological variables for *Juniperus ashei*

- Start date
  - Significantly correlated with mean monthly temperature in December (r = 0.467, p = 0.038) and November rainfall (r = 0.468, p = 0.038)
- Cumulative Season Total (CST)
  - Significantly correlated with mean maximum temperature in December (r = 0.4740, p = 0.035)

Correlation of average daily *Juniperus* pollen concentration with meteorological variables from 1987 to 2006

Meteorological Variable	Main season r
Max daily temperature	0.607***
Min daily temperature	0.371***
Mean daily temperature	0.546***
Rainfall	-0.143***
Rainfall (1 day lag)	-0.164***
Rainfall (2 day lag)	-0.069
RH	-0.282***
Mean wind speed	0.117**
Sunshine	0.257***

* p <0.05   ** p<0.01   *** p<0.001

Multiple regression model for main season pollen concentration and meteorological variables

R^2	Meteorological variable	Beta value	p
0.379			<0.001
	Max daily temperature	0.583	<0.001
	Rainfall	-0.071	0.014
	Rainfall (1 day lag)	-0.064	0.027
	Mean wind speed	0.033	0.253

Multiple Regression Model for Start Date and Preseason Meteorological Variables

R^2	Meteorological variable	Beta value	p
0.736			<0.003
	November rain	0.795	0.001
	December mean T	0.566	0.004
	January rain	0.559	0.009
	October rain	-0.500	0.016
	November mean T	0.502	0.032
	August rain	0.316	0.104

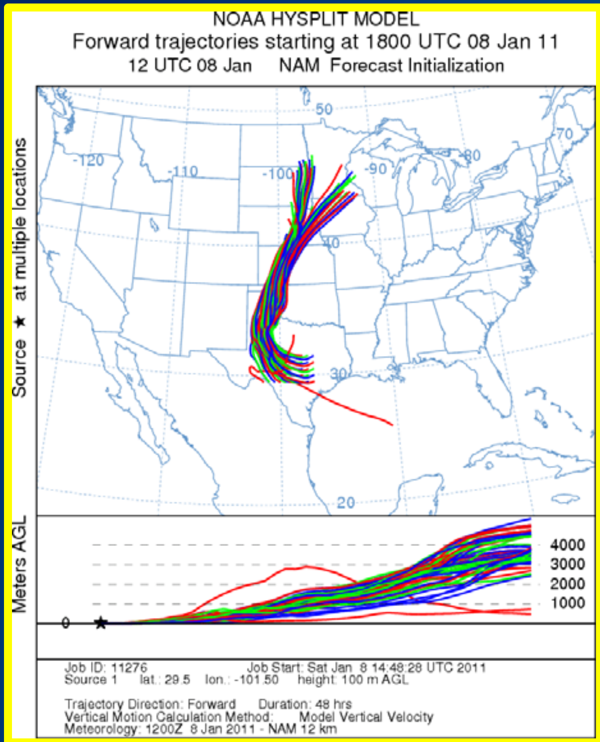
Multiple Regression Model for CST and Preseason Meteorological Variables

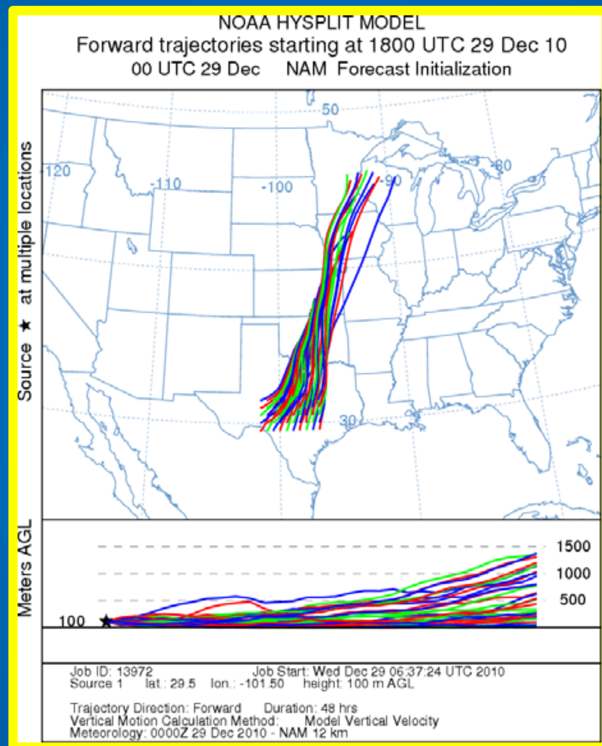
R^2	Meteorological variable	Beta value	p
0.639			<0.019
	December maximum T	0.754	0.002
	June rain	0.469	0.021
	December rain	-0.384	0.045
	January mean T	-0.237	0.211
	September rain	-0.285	0.148
	January rain	-0.208	0.262

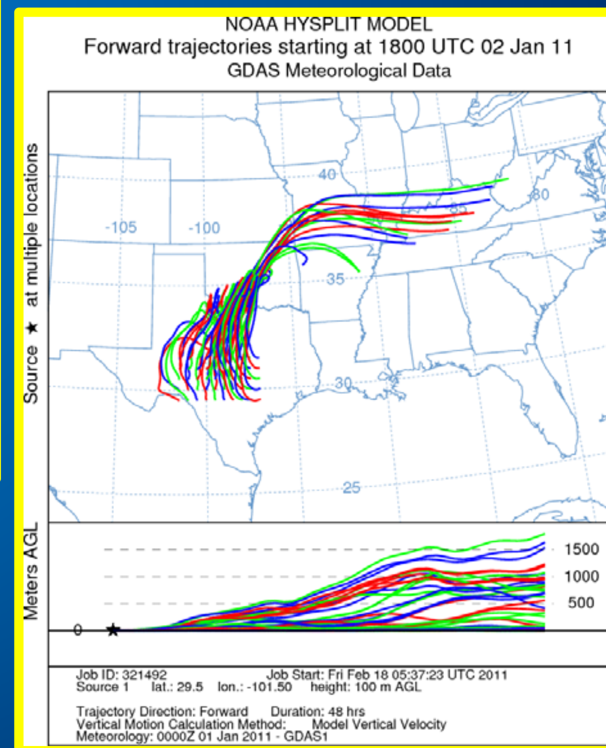
Red Cedar Encroachment

- Oklahoma has 17 million acres of prairie, shrub land, cross timbers forests and other forests
- 1950: 1.5 million acres with cedar problems
- 1985: 3.5 million acres with cedar problems
- 1994: 6.3 million acres with 50 trees/acre and 2.5 million acres with 250 trees/acre - 37% loss of native ecosystems
- 2001: 8.0 million acres with 50 trees/acre and 5.0 million acres with 250 trees/acre - this represented a 47% loss of native ecosystems
- 2013 projection: 12.6 million acres with 50 trees/acre and 8.00 million with 250 trees/acre

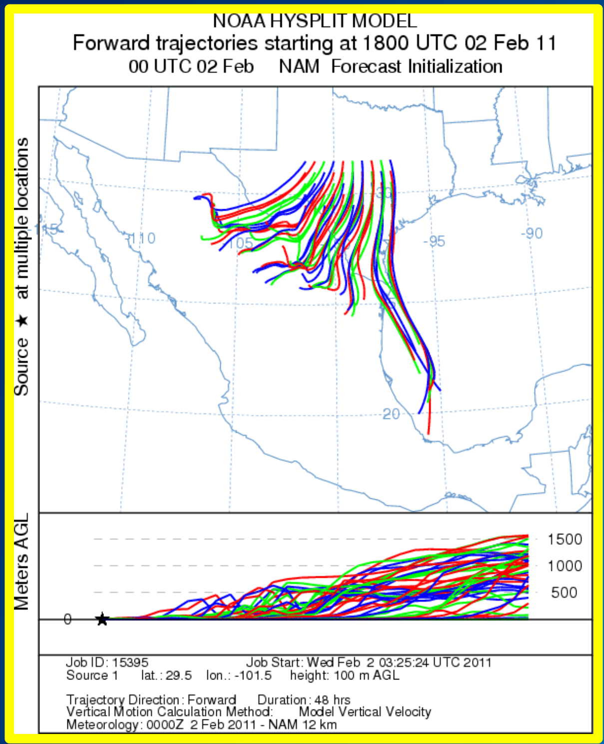
Northerly Flow

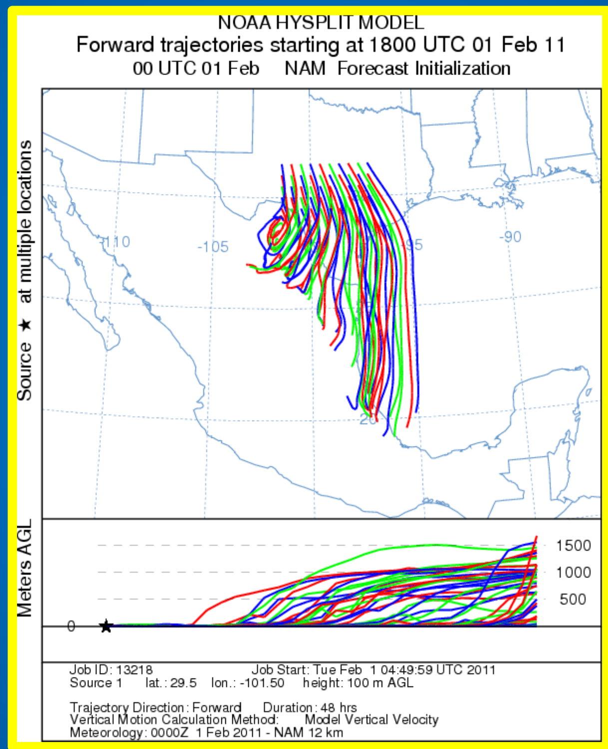


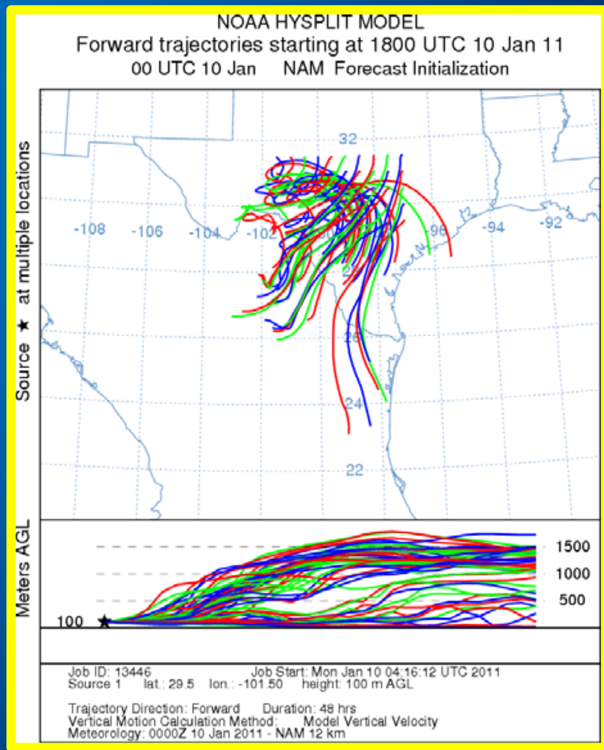




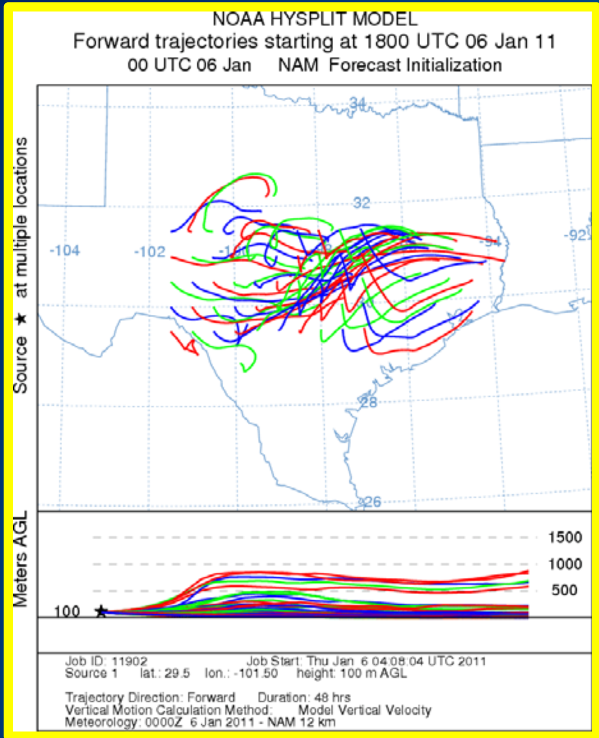
Southerly Flow

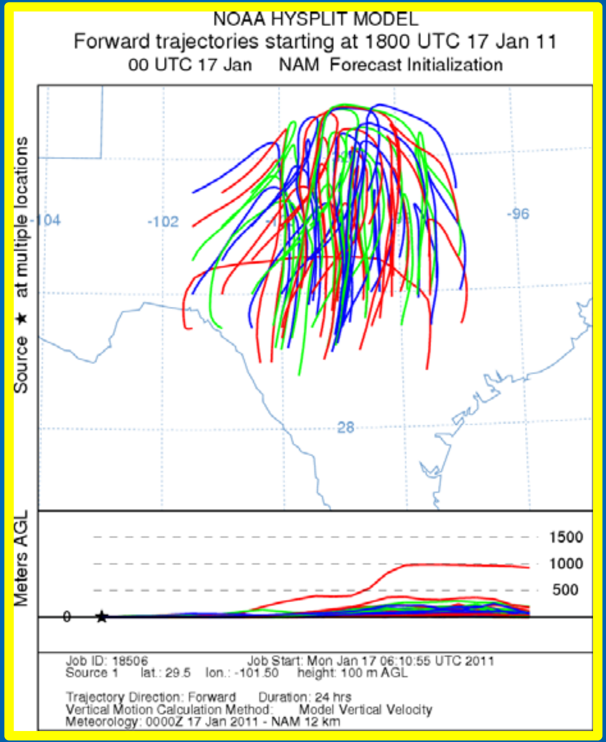


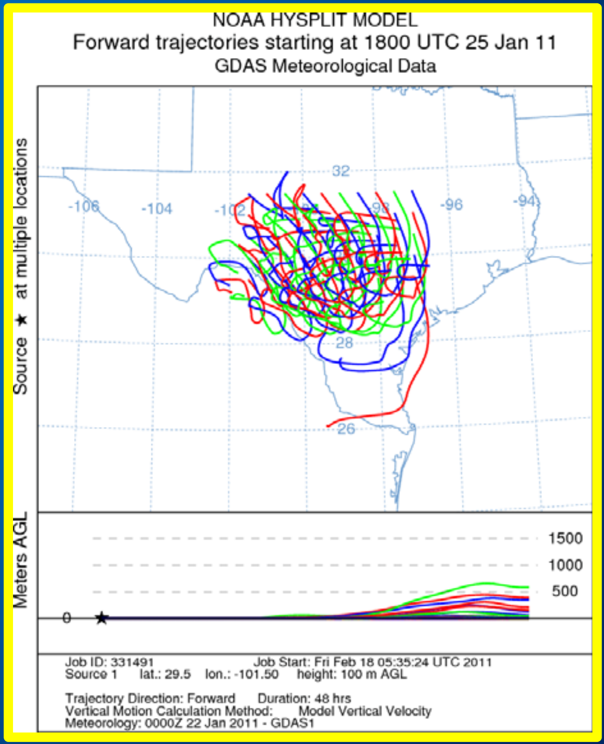




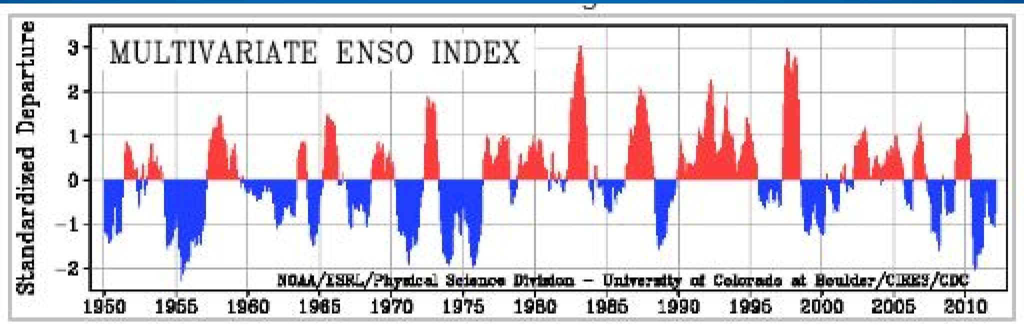
Within Texas







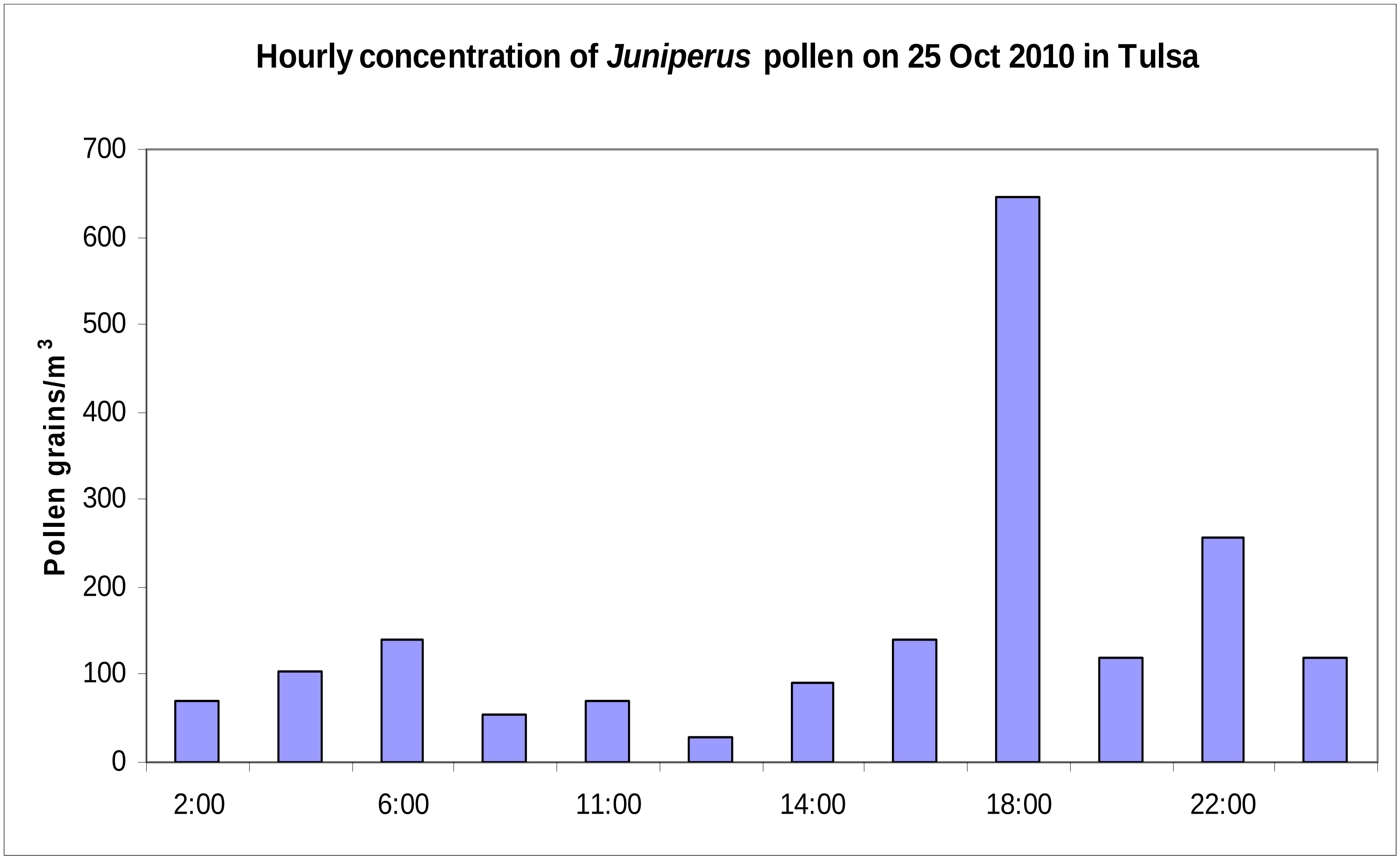
Trajectory Wind Directions				
	Southerly	Northerly	Within TX	Other
2007 to 2008 Pollen Year				
	17%	54%	24%	5%
2008 to 2009 Pollen Year				
	12%	68%	7%	12%
2009 to 2010 Pollen Year				
	31%	50%	7%	11%
2010 to 2011 Pollen Year				
	26%	41%	30%	4%
2011 to 2012 Pollen Year				
	18%	54%	16%	13%



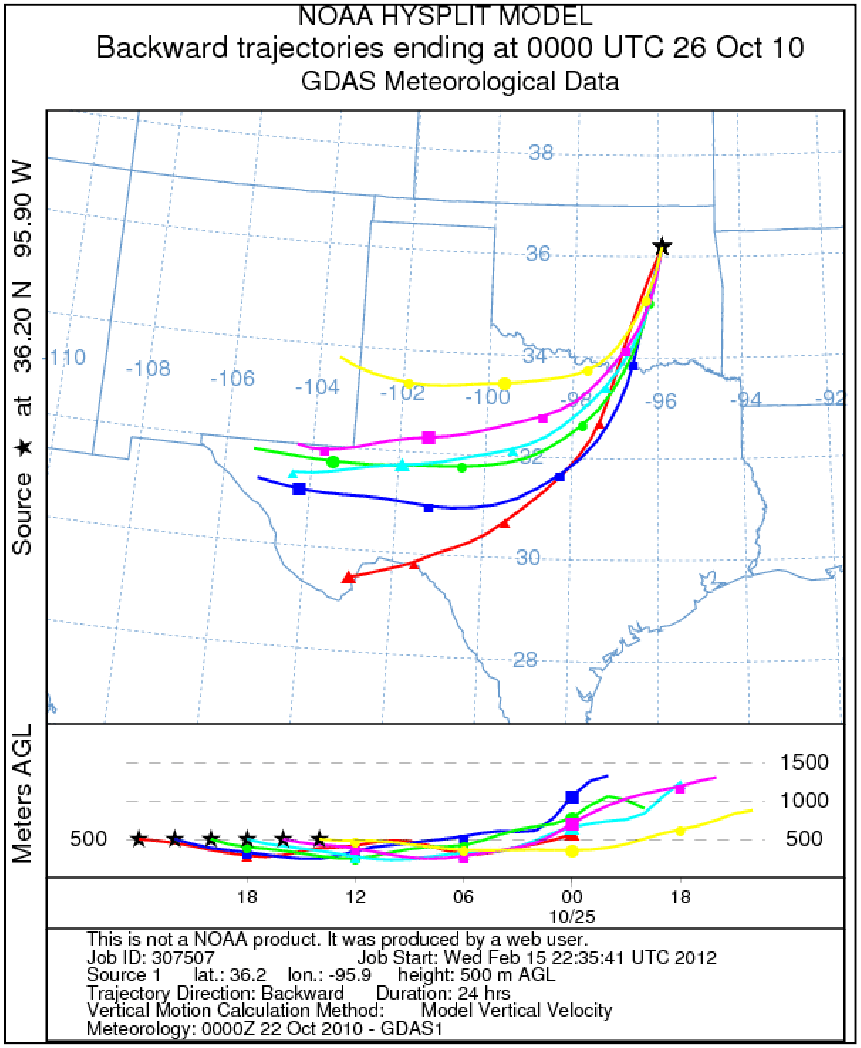
Incursion of *J. ashei* Pollen into Tulsa

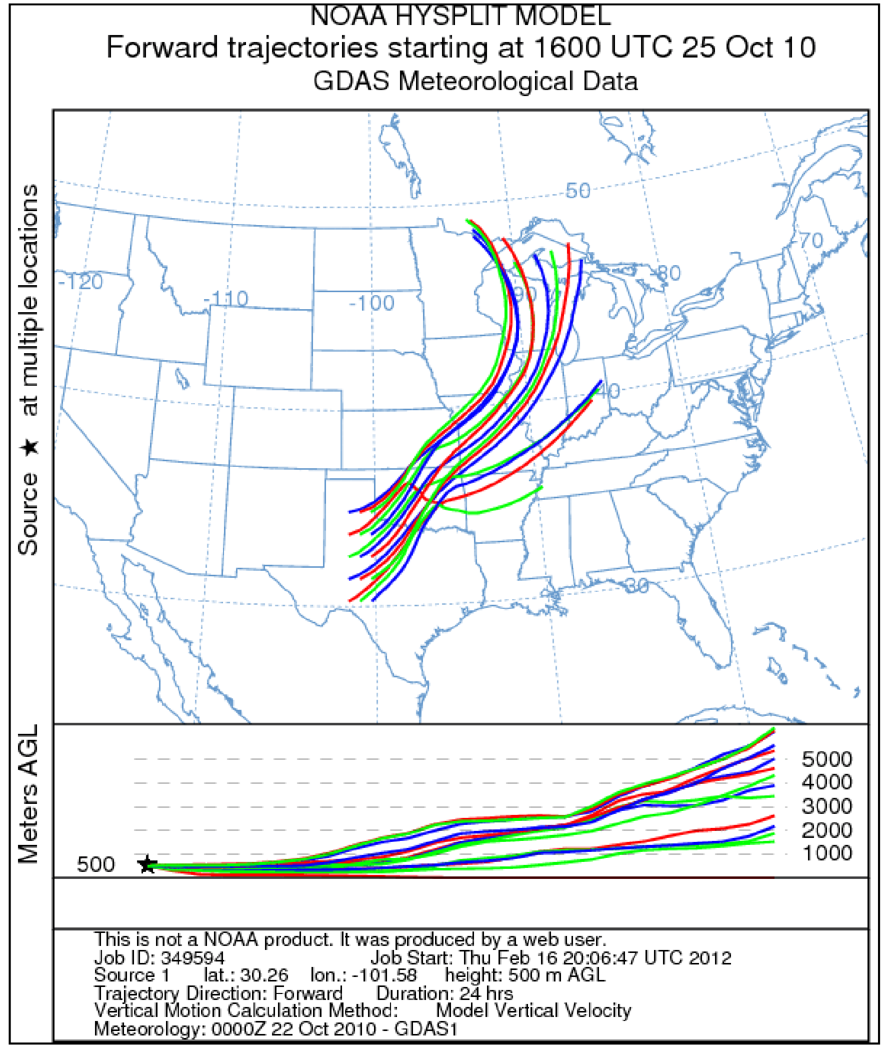
- Each winter since 1980 *J. ashei* pollen has been registered by our Tulsa air samplers
  - Levetin and Buck, Annals of Allergy, 1986.
  - Levetin, Aerobiologia, 1998
  - Rogers and Levetin, Int J Biometeorol, 1998
  - Van de Water and Levetin, Grana, 2001
  - Van de Water et al, Int J Biometeorol, 2003
- Pollen recorded on 48% of the days in Dec and Jan (range 11% to 79%)
- Concentrations typically low; however, *"Very High"* concentrations have been registered on several occasions (based on National Allergy Bureau level of very high >1500 pollen grains/m^3)

25 Oct 2010 incursion of *Juniperus* pollen into the Tulsa atmosphere with a average daily concentration of 106 pollen/m^3

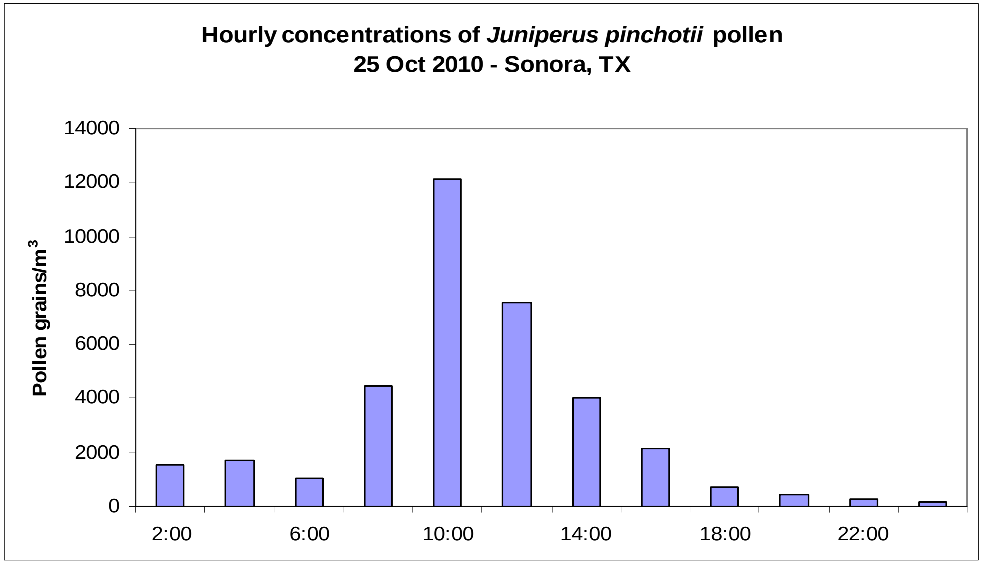


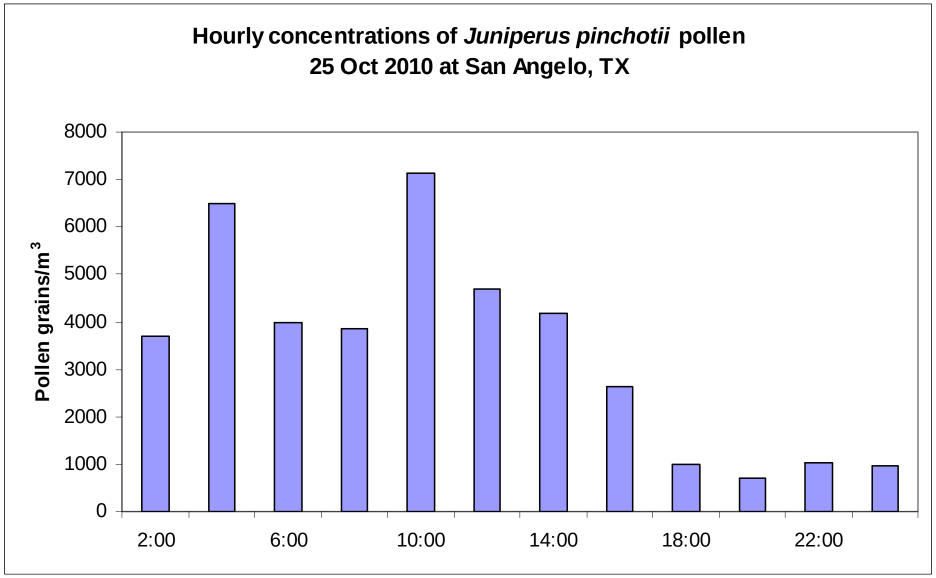
Trajectory analysis indicates the pollen originated in southwest Texas approximately 8 hours earlier

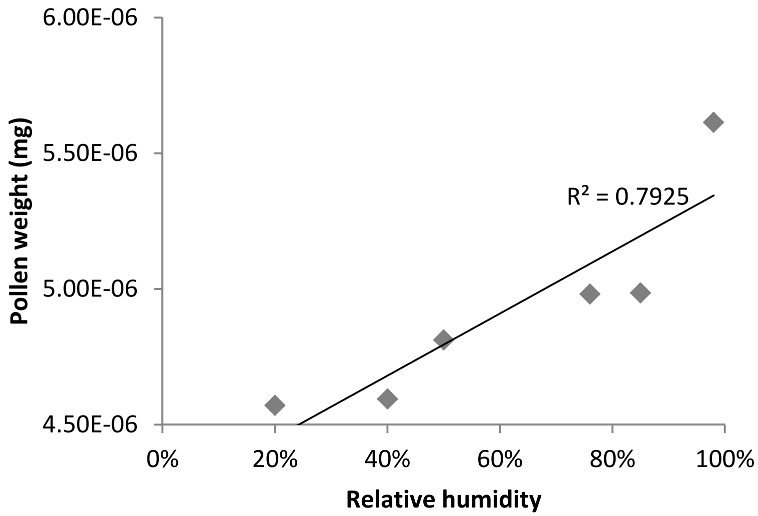




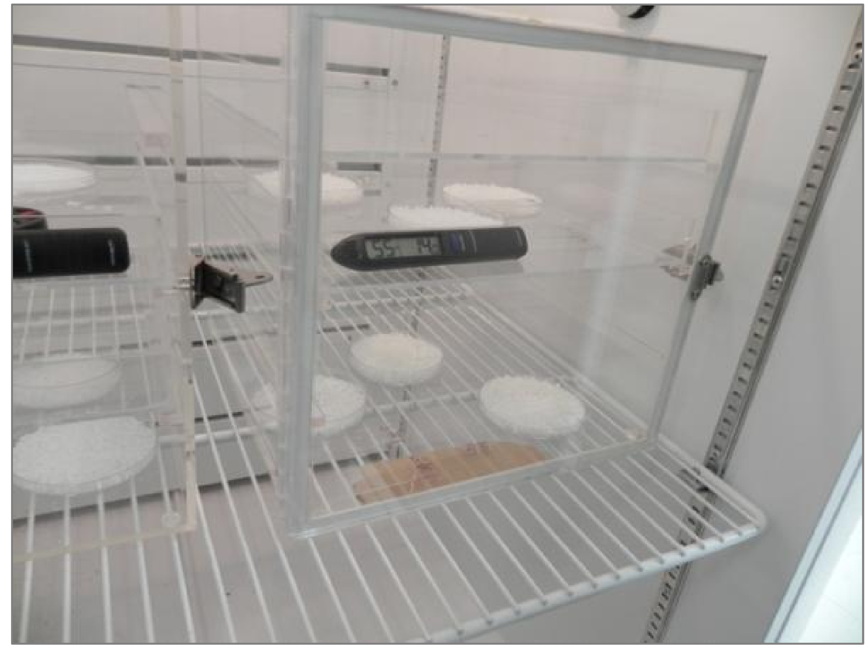
Juniperus pinchotii concentrations at Sonora and San Angelo confirm the trajectory model

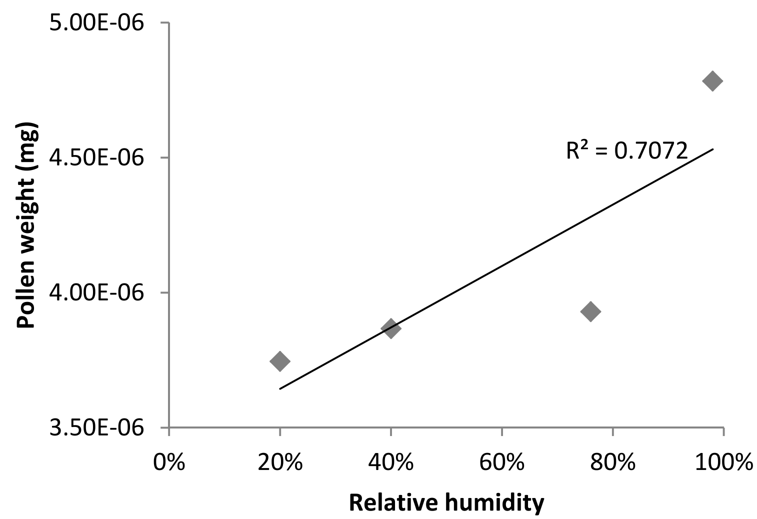






Estimated weight per pollen grain (*J. monosperma*) after 2 hrs across the range of relative humidity levels at 20° C





Estimated weight per pollen grain (*J. pinchotii*) after 2 hrs across the range of relative humidity levels at 20° C

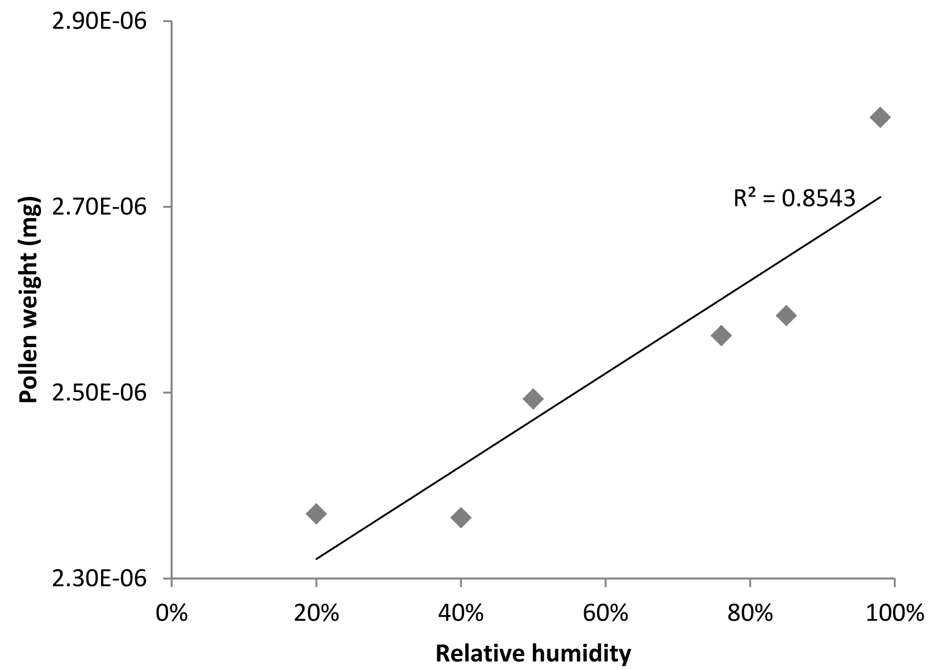
While *J. monosperma* and *J. pinchotii* were larger in size, their percent weight gain was similar to that of *J. ashei*.

Hygroscopic Weight Gain of *Juniperus* Pollen

•*Juniperus ashei, J. monosperma*, and *J. pinchotii* were dusted on greased slides and exposed to a range of temperatures and humidity levels and weighed at 2 hrs and 6 hrs.

•*J. ashei* was weighed at temperatures 4° C, 15° C, and 20° C at relative humidity levels; 20%, 40%, 50%, 75%, 86%, 97%.

•Weight was not significantly affected by temperature or time.



Estimated weight per pollen grain (*J. ashei*) after 2 hrs across the range of relative humidity levels at 20° C


NE Alamos
SE Alamos
Santa Fe
Tijeras A
Tijeras B
Palo Duro
SSWMA
Crossbar
Classen
Copper
San Angelo
Junction
Sonora
San Marcos
Sonora
Chihuahuan Desert
Gulf of California

Pollen release potential Source Map/Mask

($PRPSM\_of\_J_i$) of a Juniper species "*i*" is calculated as:

$$\mathbf{PRPSM\_of\_J_i = T_i \times M_i \times H_i \times C_i \times P_i}$$

Where
T_i = Number of J_i trees
M_i = Male/Female ratio of J_i
H_i = HCP_LCP/All ratio for J_i
C_i = Cones per J_i tree
P_i = Pollens per cone for J_i

The number of trees of a Juniper species "i" per grid cell is calculated as

$$\mathbf{T_i = GAP_i \times MODIS \times TC}$$

Where
GAP_i = Fraction of J_i at 1 km grid (range 0-1)
MODIS = MODIS derived percent tree cover per 1 km^2 grid cell (in fraction, range 0-1)
TC = Tree count or number of trees.

Ground truth (transect data)

(a) Male to Female ratio

(b) HCP_LCP to All ratio

- 0 – Only enough cones to determine gender
- 1 – Low Cone Production (LCP) tree
- 2 – High Cone Production (HCP) tree

(c) Cones per tree

(d) Pollens per cone

(d) Age

(Height & edge effect)

Juniper Species and Pollination Season

- **Juniper Ashei (J_a)** is mostly found to be distributed over Texas and Oklahoma and pollinates during **December to January**. Thus, the dispersion of juniper pollens during December-January is mostly restricted to J_a type..

- **Juiper Pinchotti (J_p)** is mostly distributed over Texas and pollinated during **late September-November**. Thus, the dispersion of juniper pollens during this period is mostly restricted to J_p type.

- **Juniper monosperma (J_m) and Juniper scopulurum (J_s)** are prevalent in New Mexico and pollinates during **March-May** period. Thus, the dispersion of juniper pollens during this period is mostly restricted to J_m and J_s type.

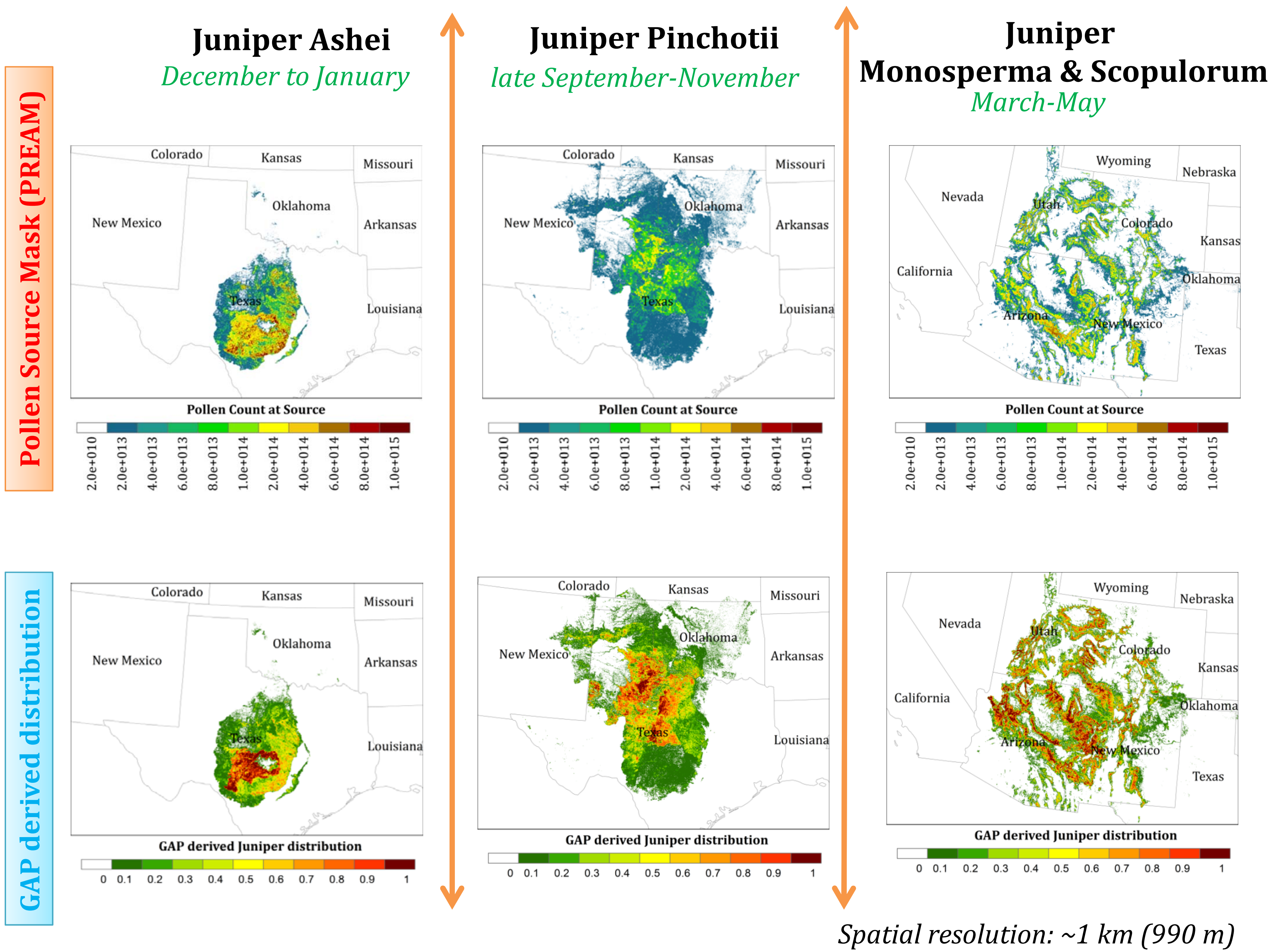
Field data

- Juniper Ashei
- Juniper Pinchotii
- Juniper monosperma and scopulorum

Information Needed (to update mask):

For all sampling sites:

- HCP/LCP/0
- Male/Female ratio
- Number of trees (tree density)
- Number of cones
- Pollens/cone


Pollen Source Mask (PREAM)
GAP derived distribution
Juniper Ashei
December to January
Juniper Pinchotii
late September-November
Juniper Monosperma & Scopulorum
March-May
Colorado
Kansas
Missouri
Oklahoma
New Mexico
Arkansas
Texas
Louisiana
Nevada
Utah
Wyoming
Nebraska
California
Arizona
Pollen Count at Source
2.0e+010 2.0e+013 4.0e+013 6.0e+013 8.0e+013 1.0e+014 2.0e+014 4.0e+014 6.0e+014 8.0e+014 1.0e+015
GAP derived Juniper distribution
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Spatial resolution: ~1 km (990 m)

PREAM

Pollen Plume Simulation for Juniper Emissions
For the period 15 December 2009 – 1 January 2010

Run by Slobodan Nickovic, September 2012

Atmosphere Model Setup

Model horizontal domain: Southwest US

Model resolution: ~40 km

Simulation period:
15 December 2009 – 1 January 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 December 2009 – 1 January 2010

PREAM – Pollen Regional Atmospheric Model

Derived from DREAM (dust), modified to simulate pollen

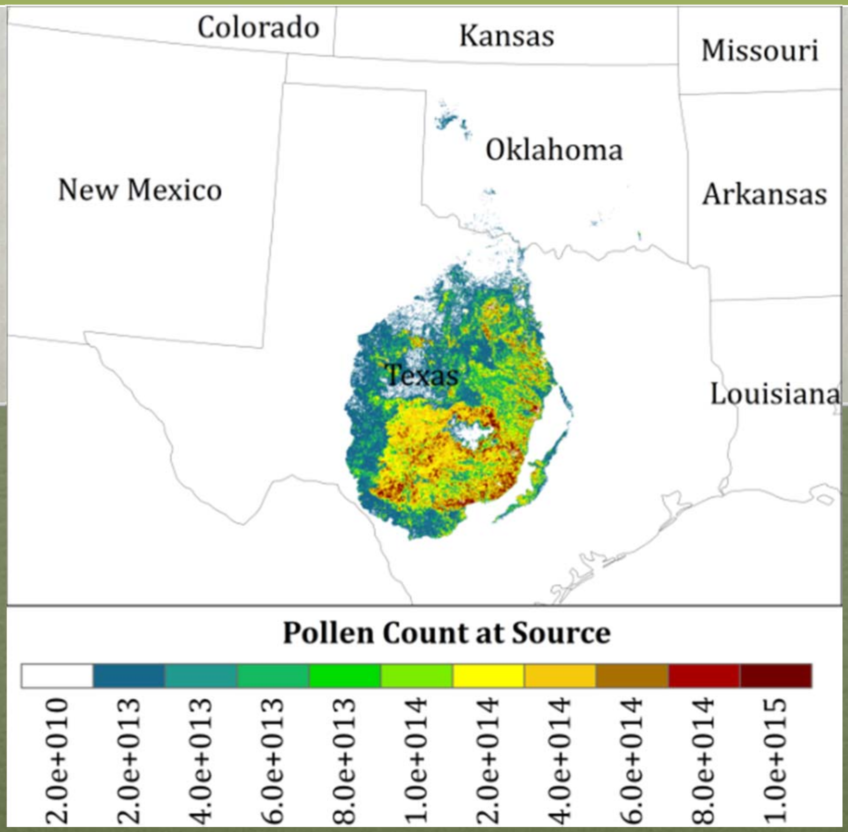
- 4 particles bins

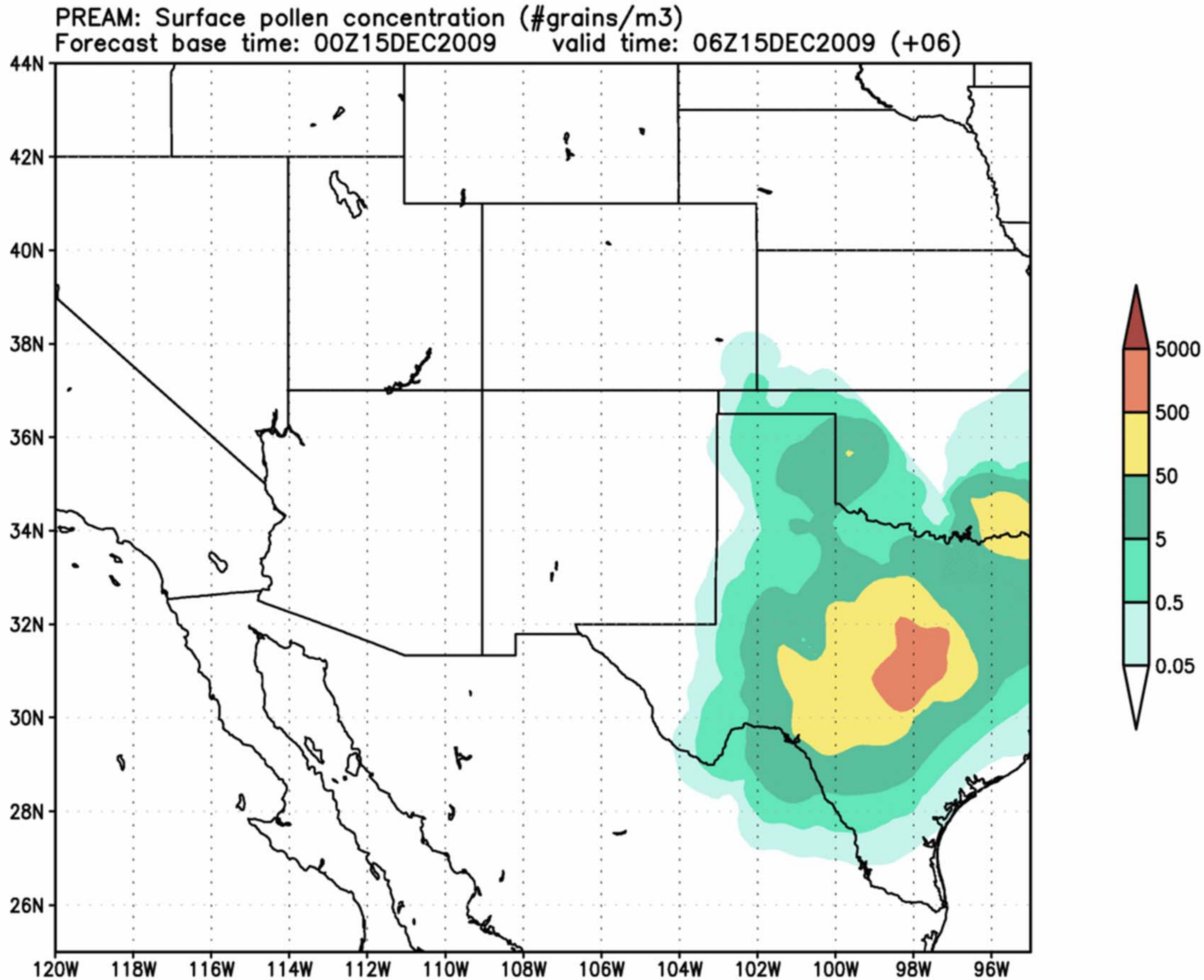
- PREAM is online driven by the NCEP/ETA

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

The PREAM 15 December 2009– 1 January 2010 Run

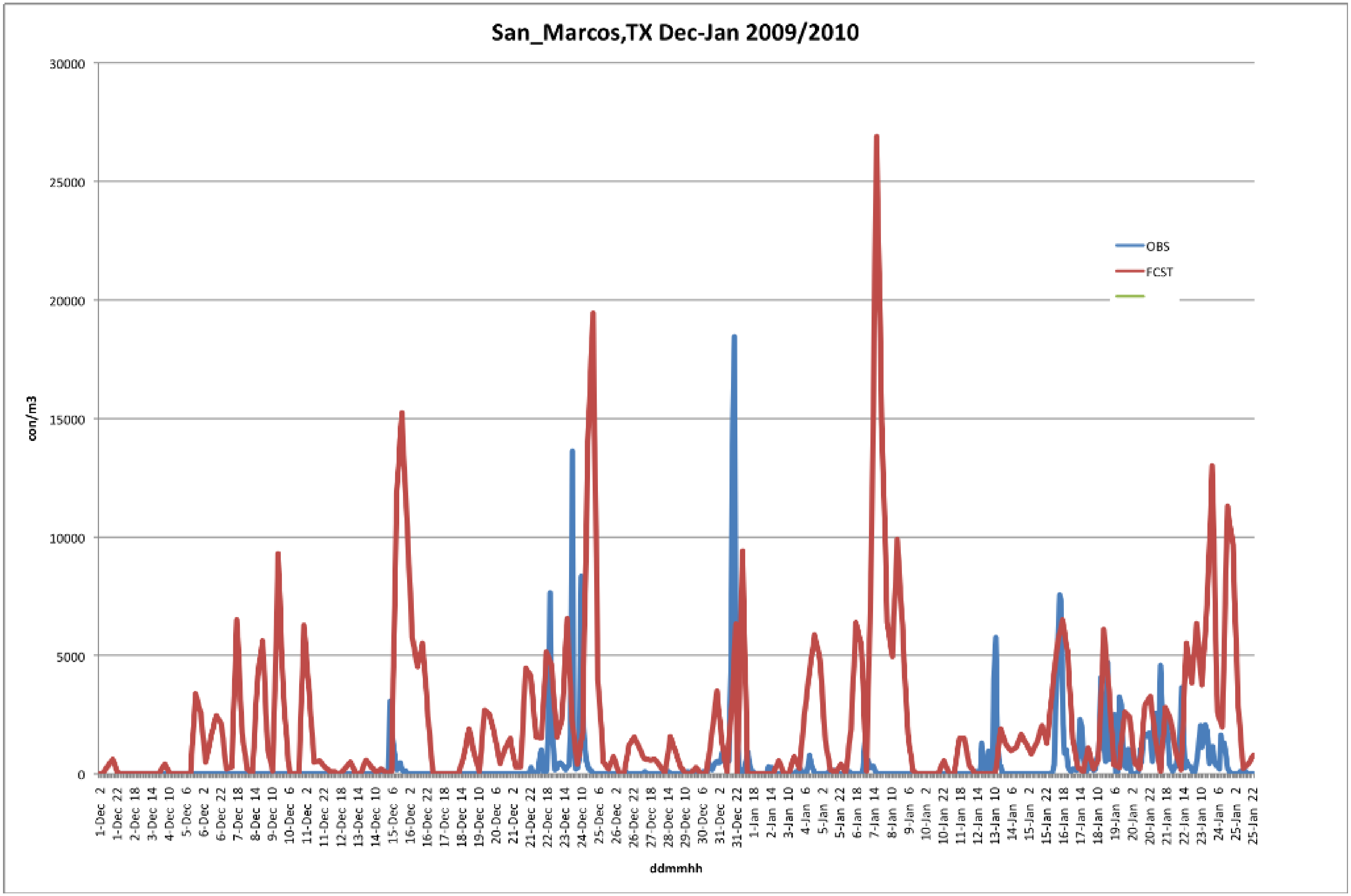
• “cold start” used for the very first day
• simulated 3D concentration from the previous day is the initial condition for the next day simulation




PREAM: Surface pollen concentration (#grains/m3)
Forecast base time: 00Z15DEC2009 valid time: 06Z15DEC2009 (+06)
44N
42N
40N
38N
36N
34N
32N
30N
28N
26N
120W
118W
116W
114W
112W
110W
108W
106W
104W
102W
100W
98W
96W
5000
500
50
5
0.5
0.05

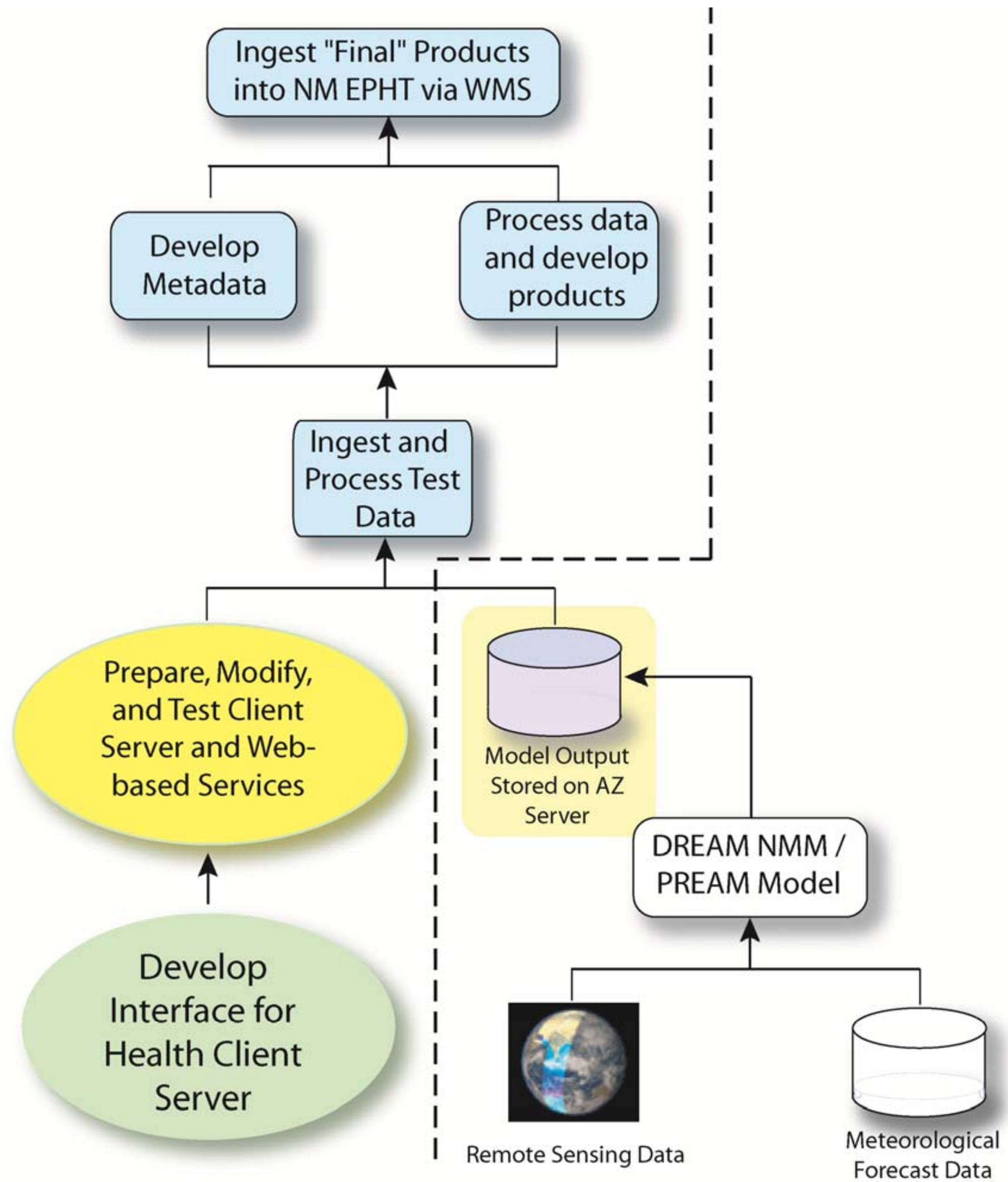
Model Validation (Juniper pollen count/ m^2)

Observed Forecast



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)



Post-processing Workflow

Acquire Pollen Forecast Output Files (.txt)

```
Dream-pollen  fct:06.03.2006.
conc*1.e+18 time       6        12        18        24
  45.00 -127.00 -9999.000 -9999.000 -9999.000 -9999.000
  45.00 -126.75 -9999.000 -9999.000 -9999.000 -9999.000
  45.00 -126.50 -9999.000 -9999.000 -9999.000 -9999.000
  45.00 -126.25 -9999.000 -9999.000 -9999.000 -9999.000
  45.00 -126.00 -9999.000 -9999.000 -9999.000 -9999.000
  45.00 -125.75 -9999.000 -9999.000 -9999.000 -9999.000

  44.25 -121.75   0.000    0.000    0.000    0.000
  44.25 -121.50   0.000    0.000    0.000    0.000
  44.25 -121.25   0.000    0.000    0.000    0.000
  44.25 -121.00   0.000    0.000    0.000    0.000
  44.25 -120.75   0.000    0.000    0.000    0.000
```

PREAM Post-Processing Script

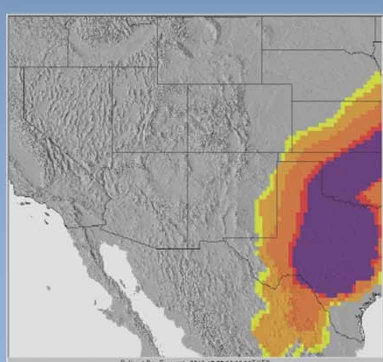
1. Read text file contents into Python lists while parsing hourly columns into separate data structures.
2. Convert Python lists into Python numPy Arrays.
3. Reconfigure numPy array into correct array dimensions.
4. Apply multiplication factor to each grid value. Export to GeoTiff using GDAL libraries.
6. Write records to GSToRE geospatial database and enable WMS, WCS services.

Store GeoTiffs on File System

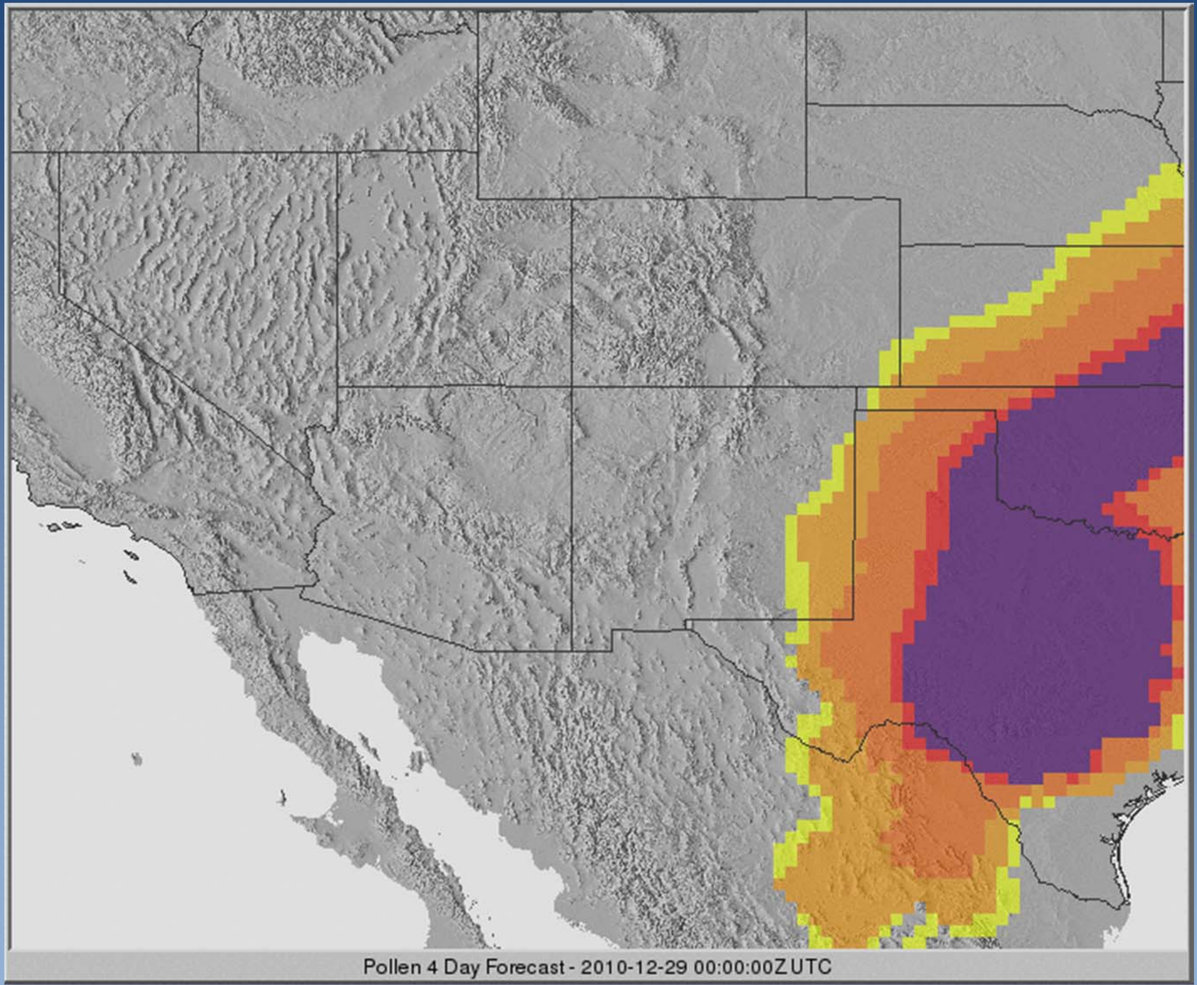
```
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060216_06.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060216_12.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060216_18.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060216_24.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060217_06.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060217_12.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060217_18.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060217_24.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060218_06.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060218_12.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060218_18.tif
-rw-r--r-- 1 bhudspeth bhudspeth 13643 2012-03-21 15:16 20060218_24.tif
```

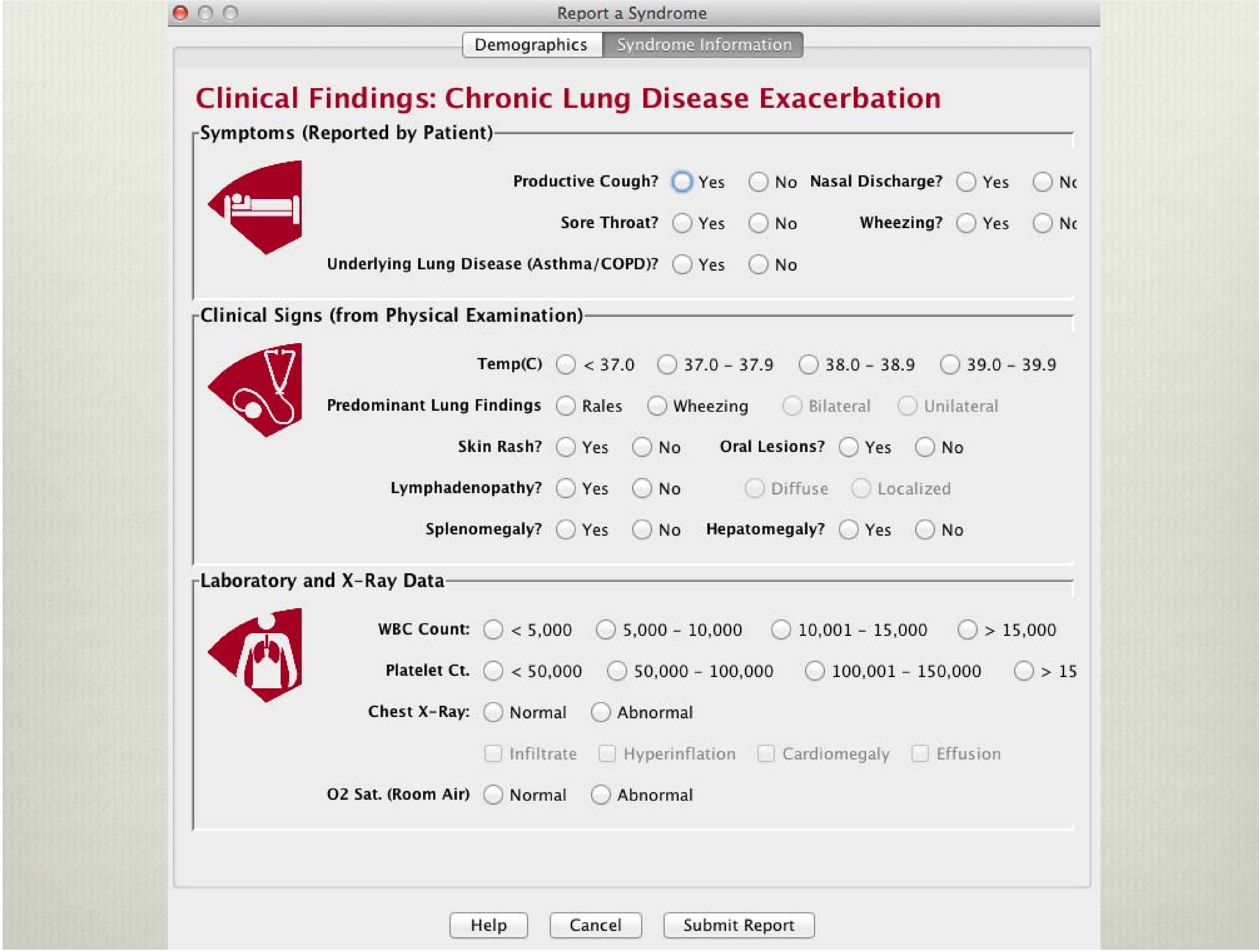
GSToRE Spatial Database

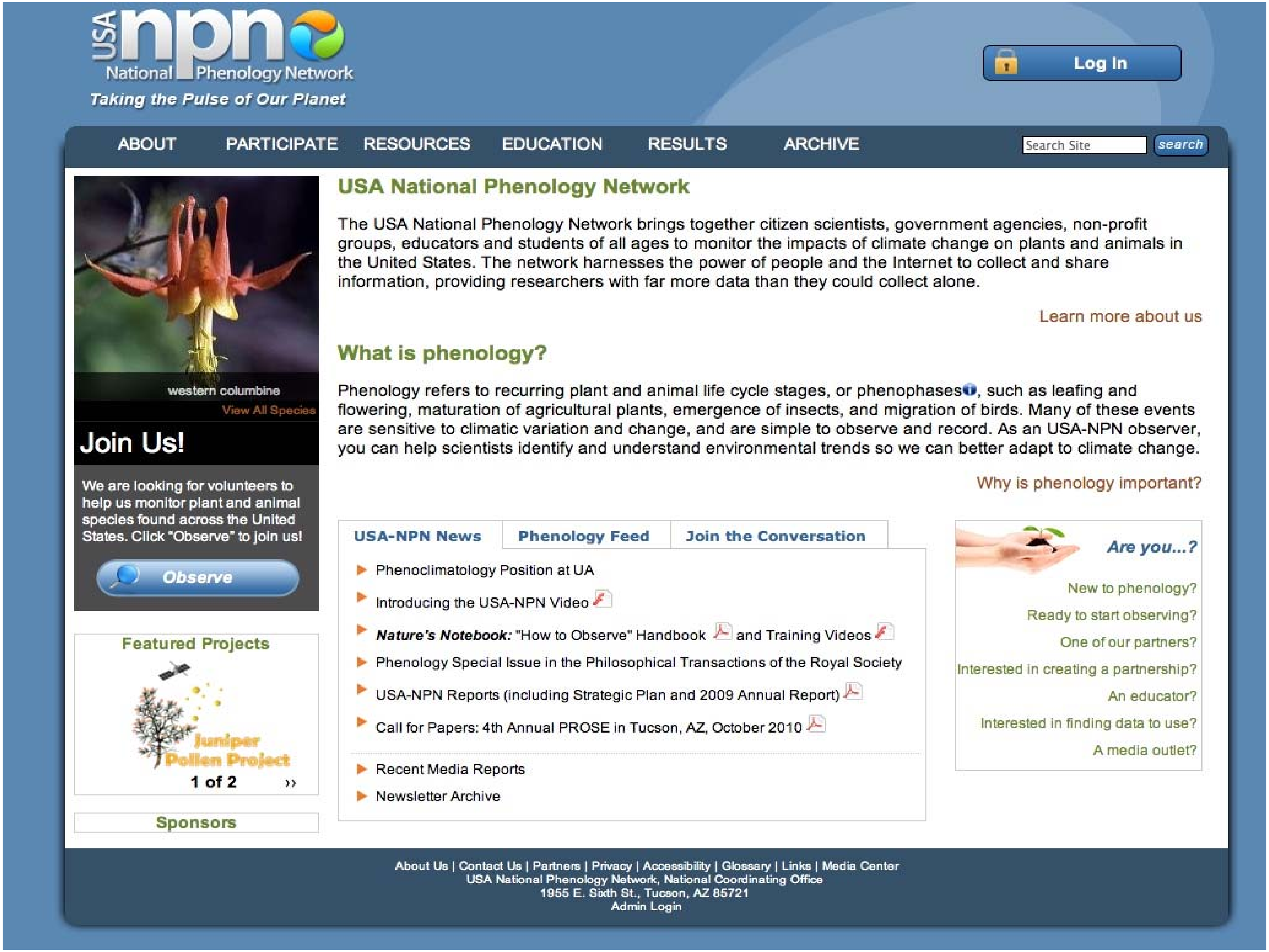
WMS / WCS Services



Sample Animation for *Juniperus ashei* (Dec 29, 2010 to Jan 1, 2011)




Report a Syndrome
Demographics
Syndrome Information
Clinical Findings: Chronic Lung Disease Exacerbation
Symptoms (Reported by Patient)
Productive Cough? Yes No
Nasal Discharge? Yes Nc
Sore Throat? Yes No
Wheezing? Yes Nc
Underlying Lung Disease (Asthma/COPD)? Yes No
Clinical Signs (from Physical Examination)
Temp(C) < 37.0 37.0 - 37.9 38.0 - 38.9 39.0 - 39.9
Predominant Lung Findings Rales Wheezing Bilateral Unilateral
Skin Rash? Yes No
Oral Lesions? Yes No
Lymphadenopathy? Yes No Diffuse Localized
Splenomegaly? Yes No
Hepatomegaly? Yes No
Laboratory and X-Ray Data
WBC Count: < 5,000 5,000 - 10,000 10,001 - 15,000 > 15,000
Platelet Ct. < 50,000 50,000 - 100,000 100,001 - 150,000 > 15
Chest X-Ray: Normal Abnormal
Infiltrate Hyperinflation Cardiomegaly Effusion
O2 Sat. (Room Air) Normal Abnormal
Help
Cancel
Submit Report


USA npn 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)
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