

# Daily Pollen Levels and Emergency Room Visits/Hospitalizations in California



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UNIVERSITY OF CALIFORNIA

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# Disclosure:

## **No financial conflicts of interest**

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## **I don't have all the answers yet!**

- I will focus on the pollen estimation procedures
- Will discuss the next step – the health data

# Outline

## Background

- Broad view of pollen significance
- My personal context for pollen estimation

## Methodology

- Interpolation versus prediction
- The model

## Limitations & Next Step

# Background



When pollen triggers an allergic reaction, the condition is called hay fever, or seasonal allergic rhinitis

**You're not alone:**

- 26.1 million Americans experience hay fever symptoms each year
- 14.6 million have asthma



Itchy ears,  
buzzing sound

Red, itchy,  
watery eyes

Sneezing,  
congestion,  
runny nose

Itchy or sore  
throat, post-  
nasal drip,  
cough

# Pollens and Health

## **More than a nuisance**

Increased ambient exposure correlates with increased emergency room visits and increased hospital discharges for asthma exacerbation in children

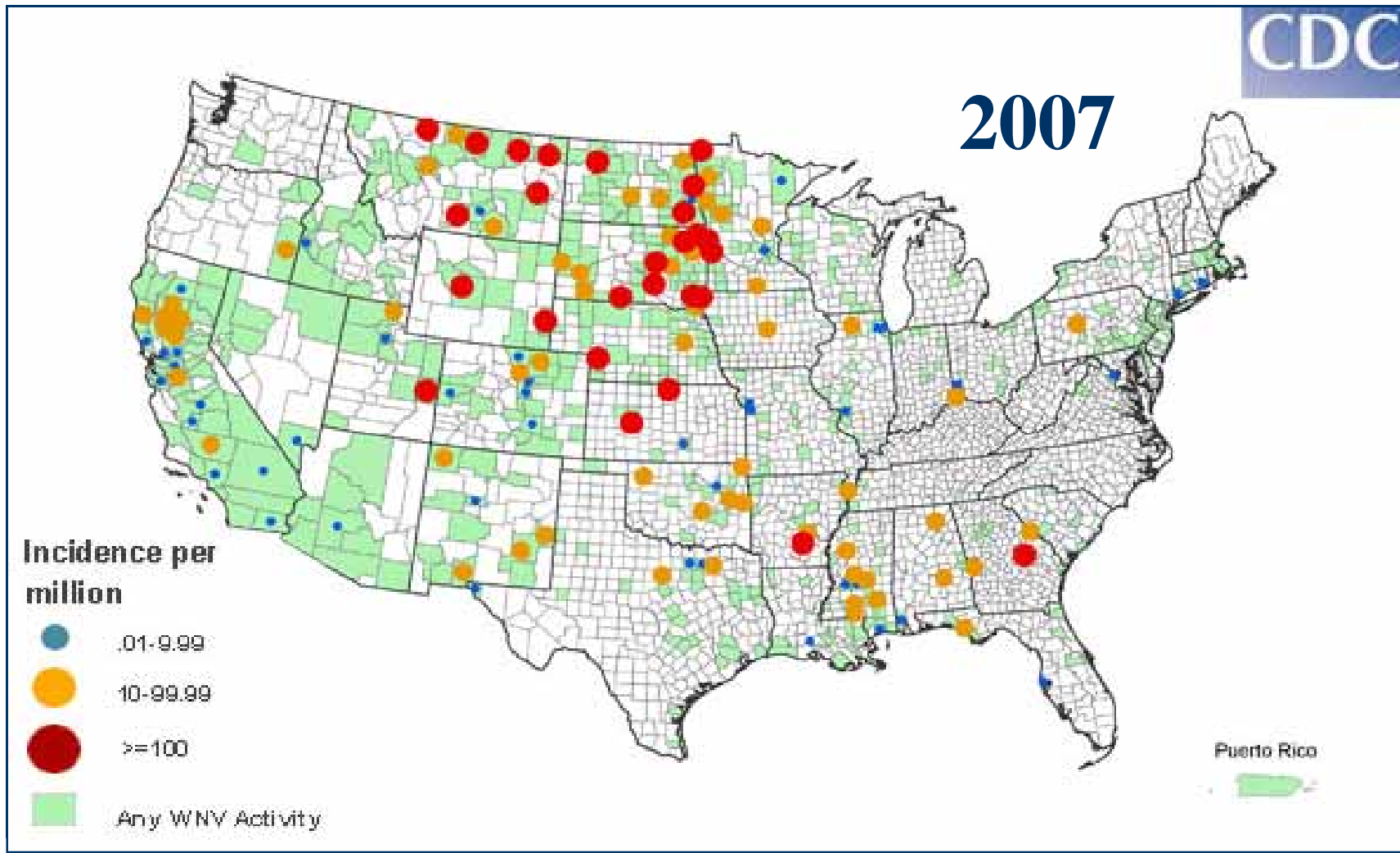
**Rarely studied as an effect modifier and/or confounder in respiratory health studies** (and I now know why)

# WNV in the United States

## WNV Epidemiology

- came to U.S. 1999
- CA had epidemic in 2005
- Sacramento an epicenter
  - ♦ More human cases than any other county in the U.S.
- WNV health effects
- now endemic
- spraying works

# Epidemiology of WNV



Source: CDC ArboNET Surveillance System



# Pesticides

WNV Epidemiology

## Pesticide Sprayed Aerially

- pyrethrin pesticides
  - ♦ skin
  - ♦ eye
  - ♦ neurologic
  - ♦ respiratory

### Evergreen Crop Protection EC60-6



# Prior Work

WNV Epidemiology  
Pesticide Sprayed  
Aerially

## Prior Studies Limited

- ground spraying
- small study size
- asthma only
- inadequate control for environmental variables



# Pollutants

WNV Epidemiology

Pesticide Sprayed

Aerially

Prior Studies Limited

## **Pollutants**

- criteria pollutants cause respiratory problems
  - ♦ asthma
  - ♦ COPD exacerbation



# Pollens

WNV Epidemiology

Pesticide Sprayed  
Aerially

Prior Studies Limited  
Pollutants

## **Pollens/Molds**

- respiratory problems
- increased ED visits



# Research Questions

**Overarching Question: Is the aerial application of pyrethrin pesticides safe for humans?**

- Respiratory
- Neurologic
- Skin
- Eye

**How can we build a better model for pollution and pollen estimation?**

# What to estimate?...

## 5-digit Zip as Enumeration Unit

### HIPAA Considerations

- Protected Personal Health Information
  - ♦ Anything more specific than a 3-digit zip code
- Large California databases have human health data coded to 5-digit zip code of residence (1,687 in the state)
  - ♦ Possible to obtain with IRB approval, plans for small cell analysis and patience

# Why not interpolate pollen?

**Interpolation** is about estimating unknown points from nearby knowns

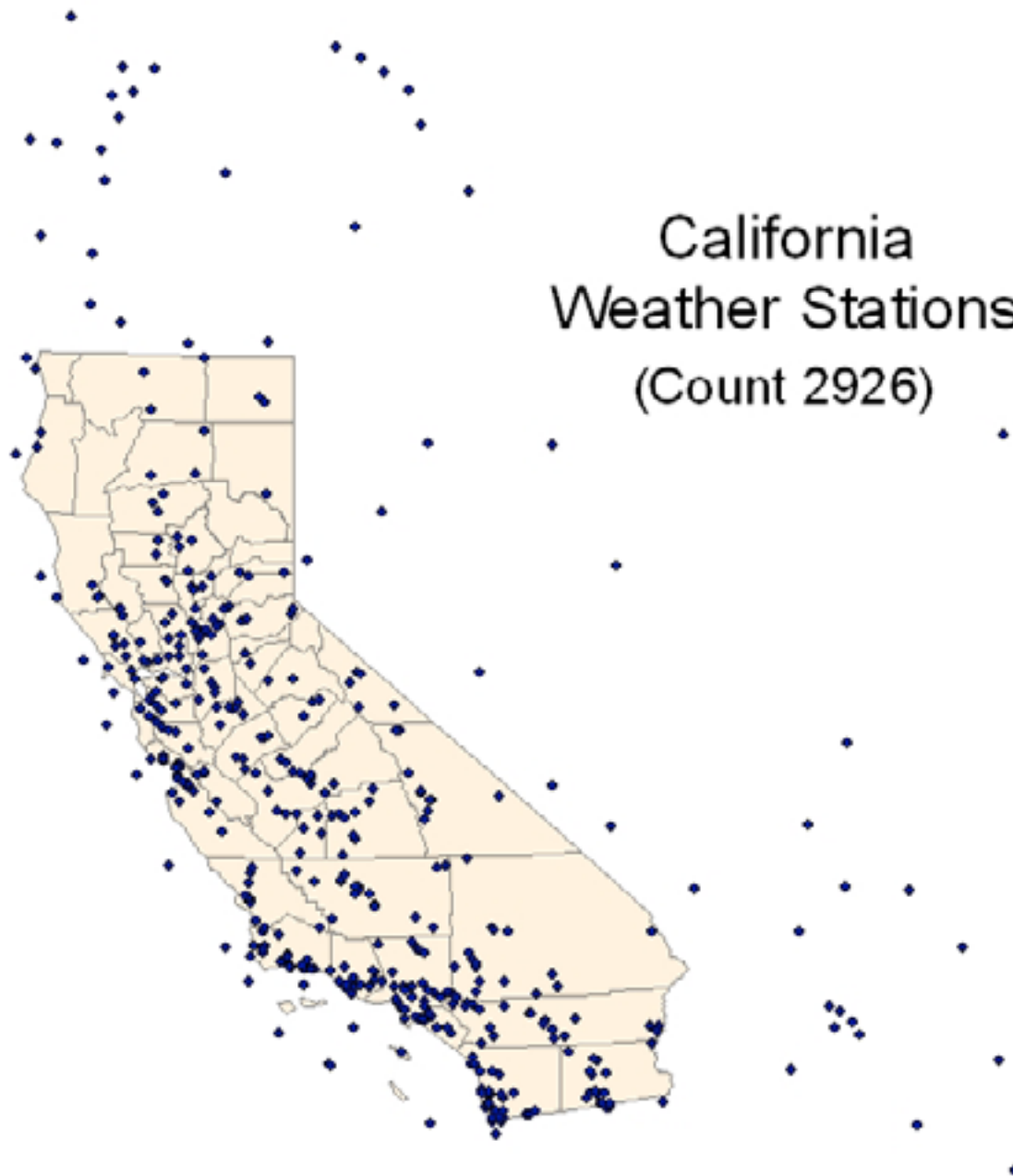
Commonly used in pollution estimation

- Ozone
- Particulate matter pollution

Also used in meteorologic models

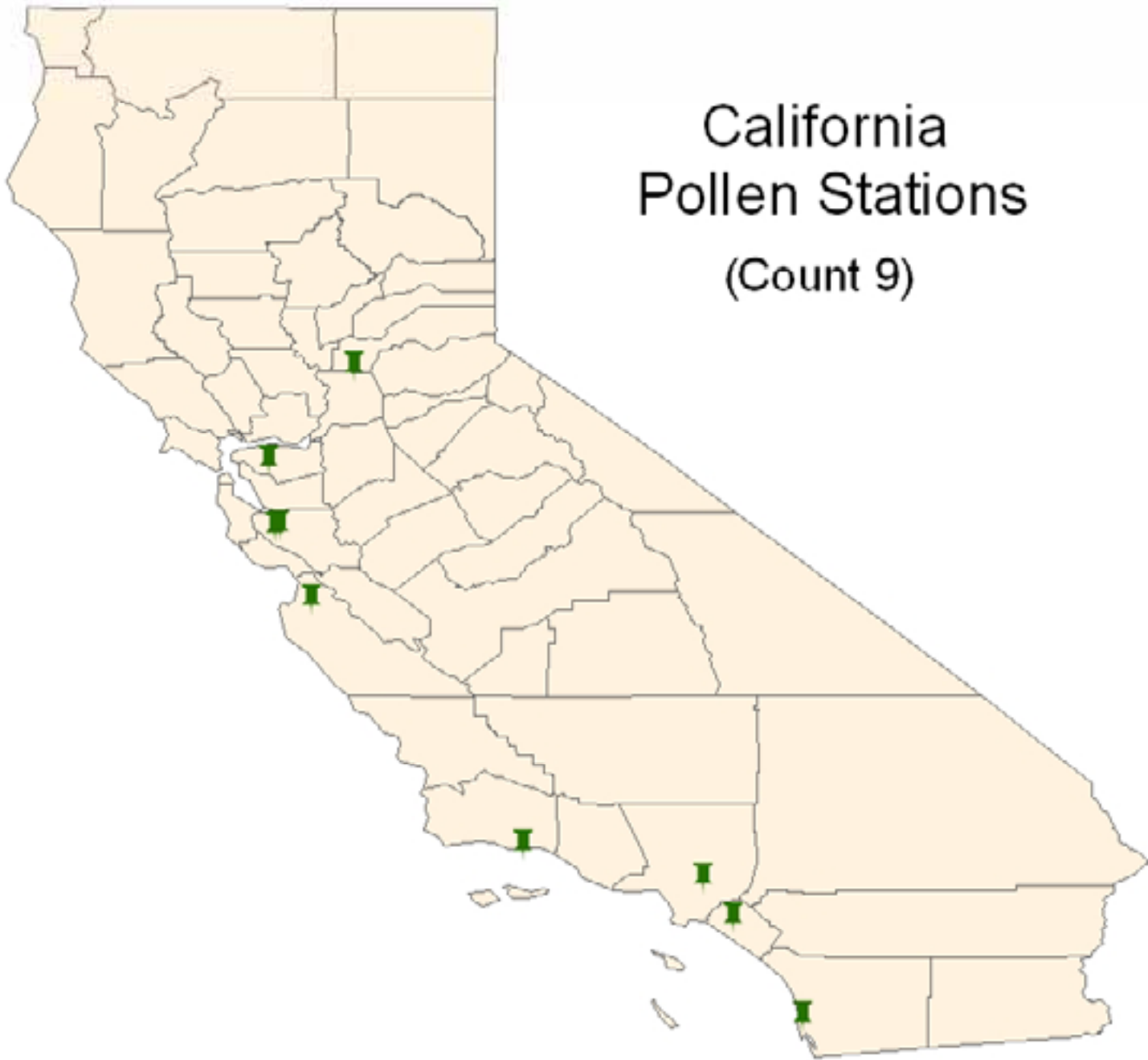
- Temperature
- Precipitation
- Humidity
- Etc.

California  
Weather Stations  
(Count 2926)





# California Pollen Stations (Count 9)



# Methodological Approach

## Pollen estimation to the 5-digit zip code

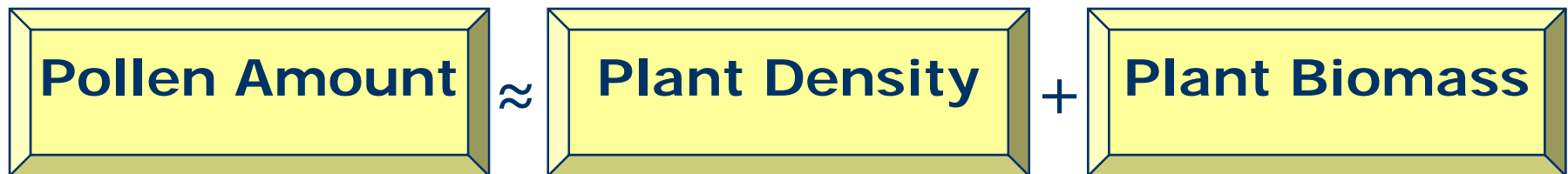
Because there are so few pollen monitors in CA, interpolation is not an option

- We need a **prediction** model, which uses other variables to assist in the estimation of the unknown

# Methodological Approach

**'Reverse engineer' the problem...**

Boris Fumanal, *et al.* studied pollen estimation from ragweed in France and found...



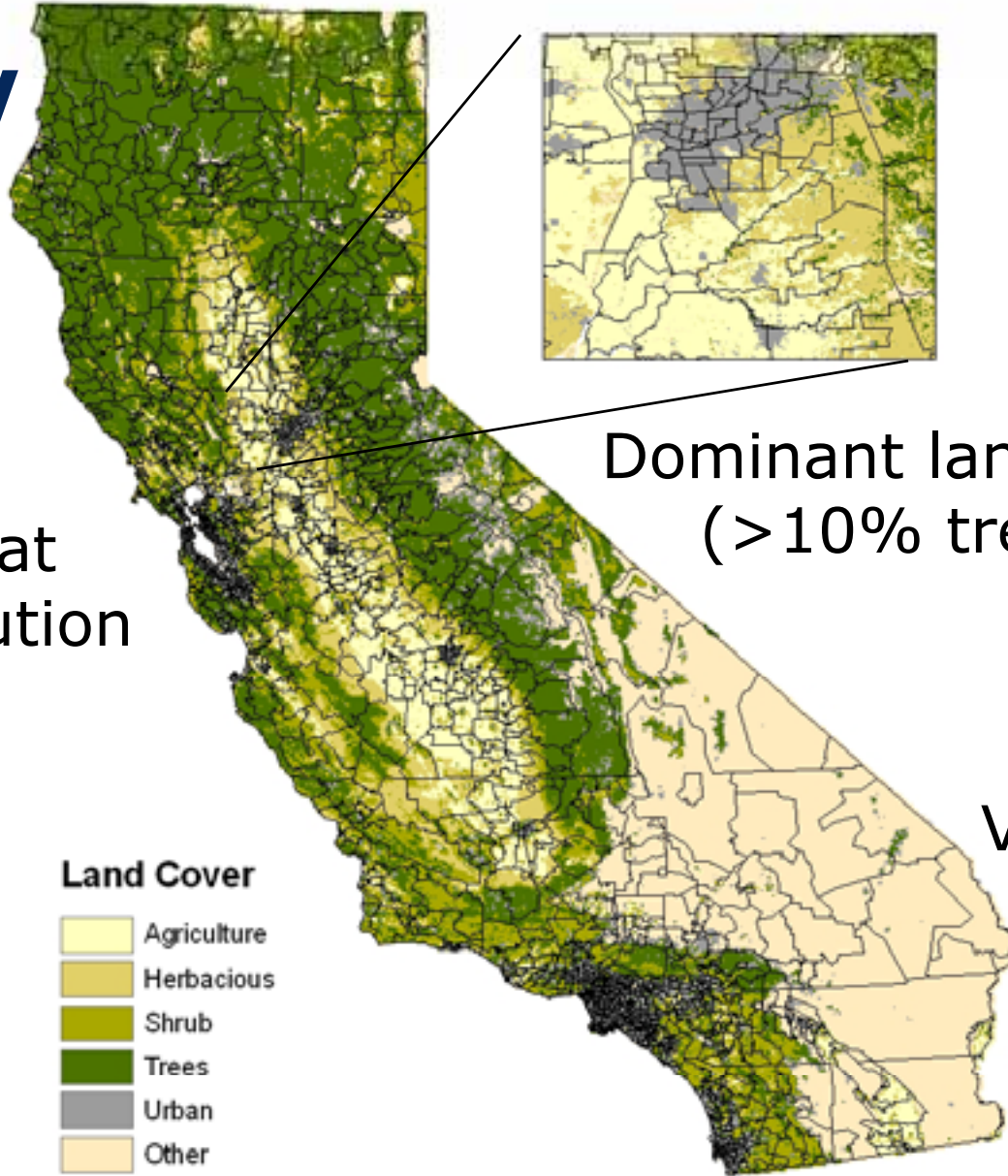
# Plant Density

## Possible Data Sources:

- Ecoregions/CalVeg data from US Forestry Service
  - ♦ Large areas of the state were left out because they were not 'forest service' land (vector)
- CALJEP data ~ 1800 regions
  - ♦ Only notes 'presence' of specific species in a region (vector)
- FRAP – Fire and Resource Assessment Program data – CA Dept of Forestry
  - ♦ Combines data (raster and vector) from USDA/USFS, CA DFG, USGS, and others.

# Plant Density

## California Vegetation Types



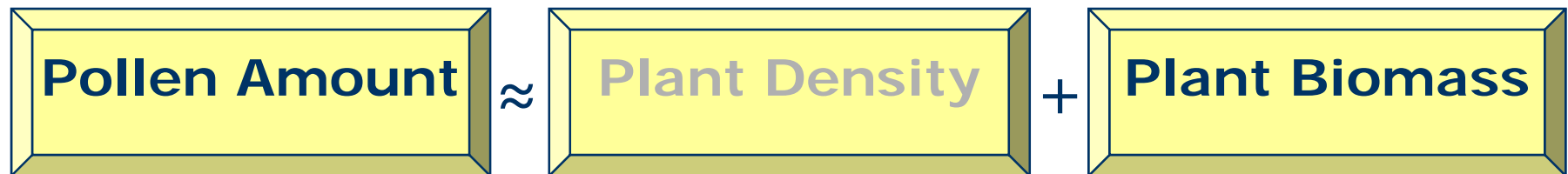
Data exists at 100m resolution

Reclassified land cover

Dominant landcover/ cell (>10% tree = tree)

Vectorized the raster data: 821,420 polygons

# Methodology



Chen *et al.* predict ragweed distribution in China

Surrogate measure ... habitat suitability

- Temperature (min) & Sunshine (max)
- Precipitation (mean annual)
- Elevation
- Land cover
- Soil Quality

# Soil Quality

STATSGO – potential variables:

- vegetative productivity index
- available water supply
- preferred by USDA soil experts
- yields of non-irrigated crops
- Spatial scale 1:24,000m
- yields of irrigated crops
- Spatial scale 1:250,000m

SSURGO – may be a better choice?

# Soil Quality – Storie Index

Soil rating system based on characteristics that go to the land's potential utilization and productive capacity. It is independent of other physical or economic factors that might determine the desirability of growing certain plants in a given location.

**Excellent**

**Grade 1**

**Wide range crops**

**Good**

**Grade 2**

**Most crops**

**Fair**

**Grade 3**

**Certain crops**  
*-R. Earl Storie*

Includes four soil characteristics:

**Poor**

**Grade 4**

**Narrow range**

1. Soil profile

2. Texture of surface soil

**Very Poor**

**Grade 5**

**Limited growth**

3. Slope

4. Other conditions (nutrient level, alkali content, erosion, drainage, etc)

**Non-Ag**

**Grade 6**

**Non-Ag**



# Soil Quality

- Soil map units generally contain several components in differing percentages
- Must separate components and then sort by dominant component
- Then use the Storie Index for the dominant component

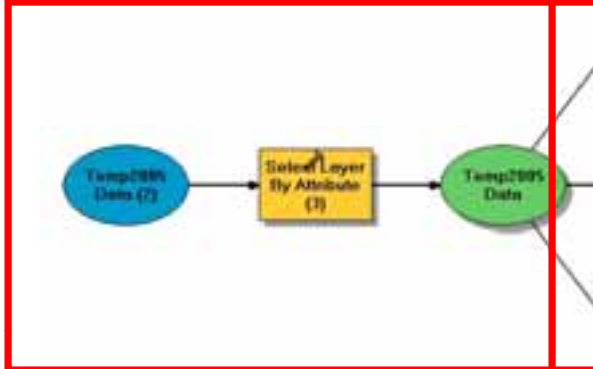


# Climate Data

## California Air Resources Board

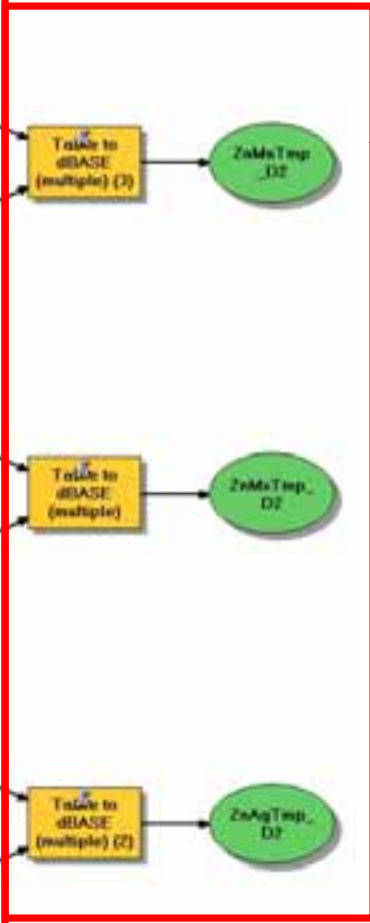
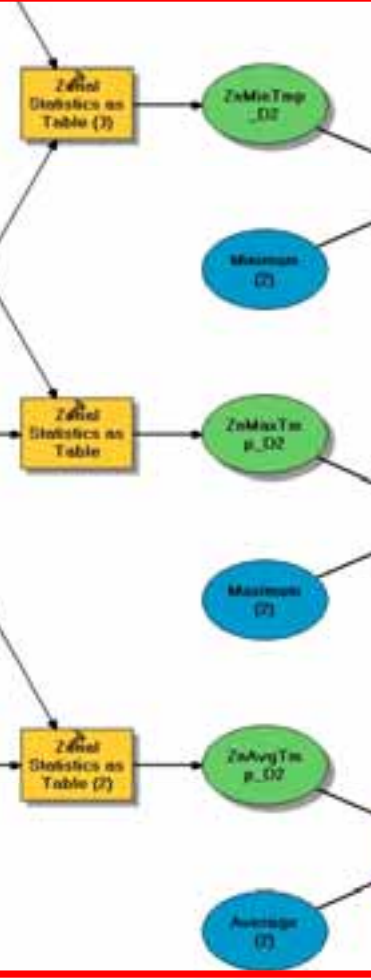
- Collected 2003-2006 hourly data from 2,926 monitors in state (~16 million data points per variable)
- Applied a kriging model to create a continuous surface (for every day)
- Performed zonal analysis to the zip code level

Selects a date



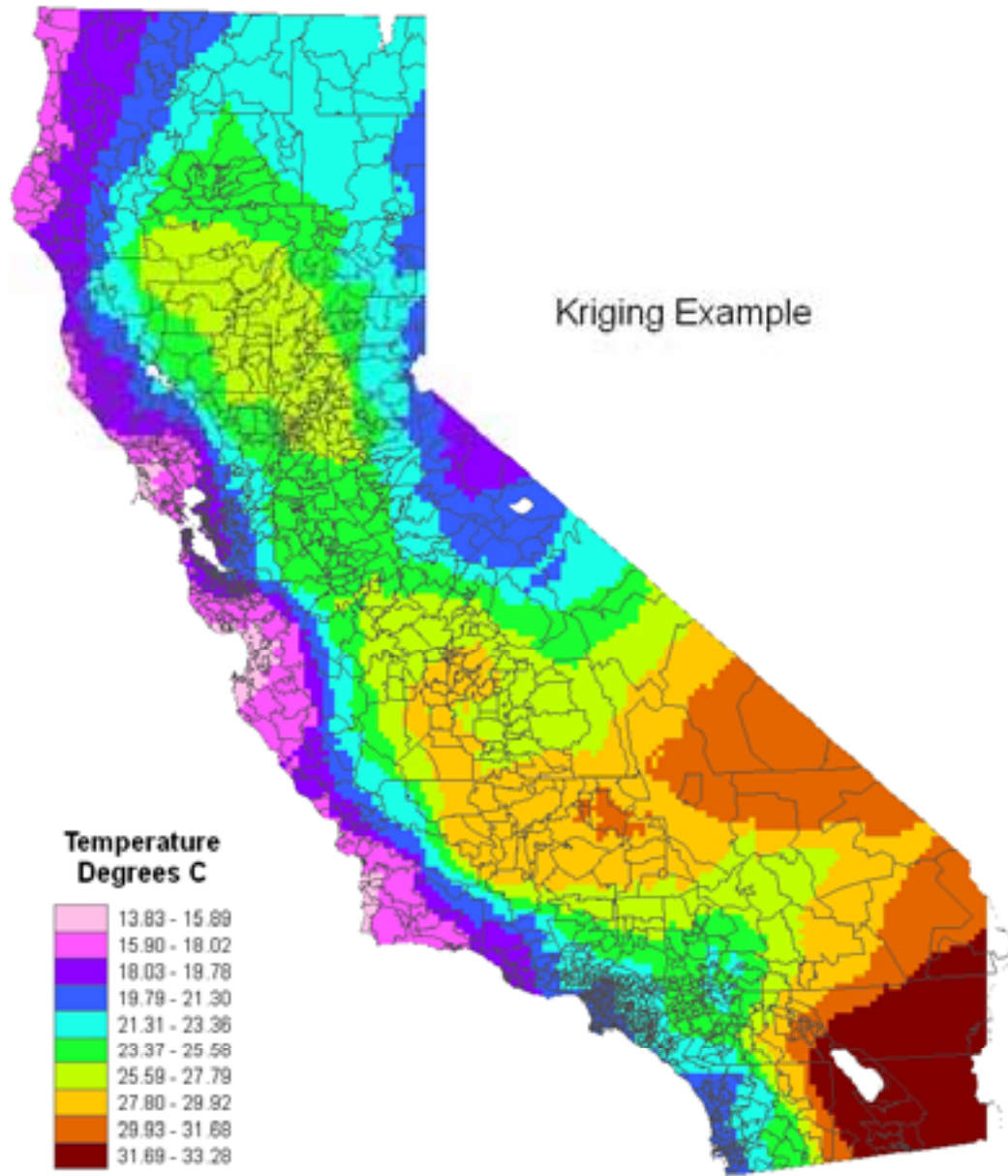
Performs simple kriging

Performs zonal analysis by zip code  
Creates a \*.dbf for conversion to STATA



# Mean Temperature

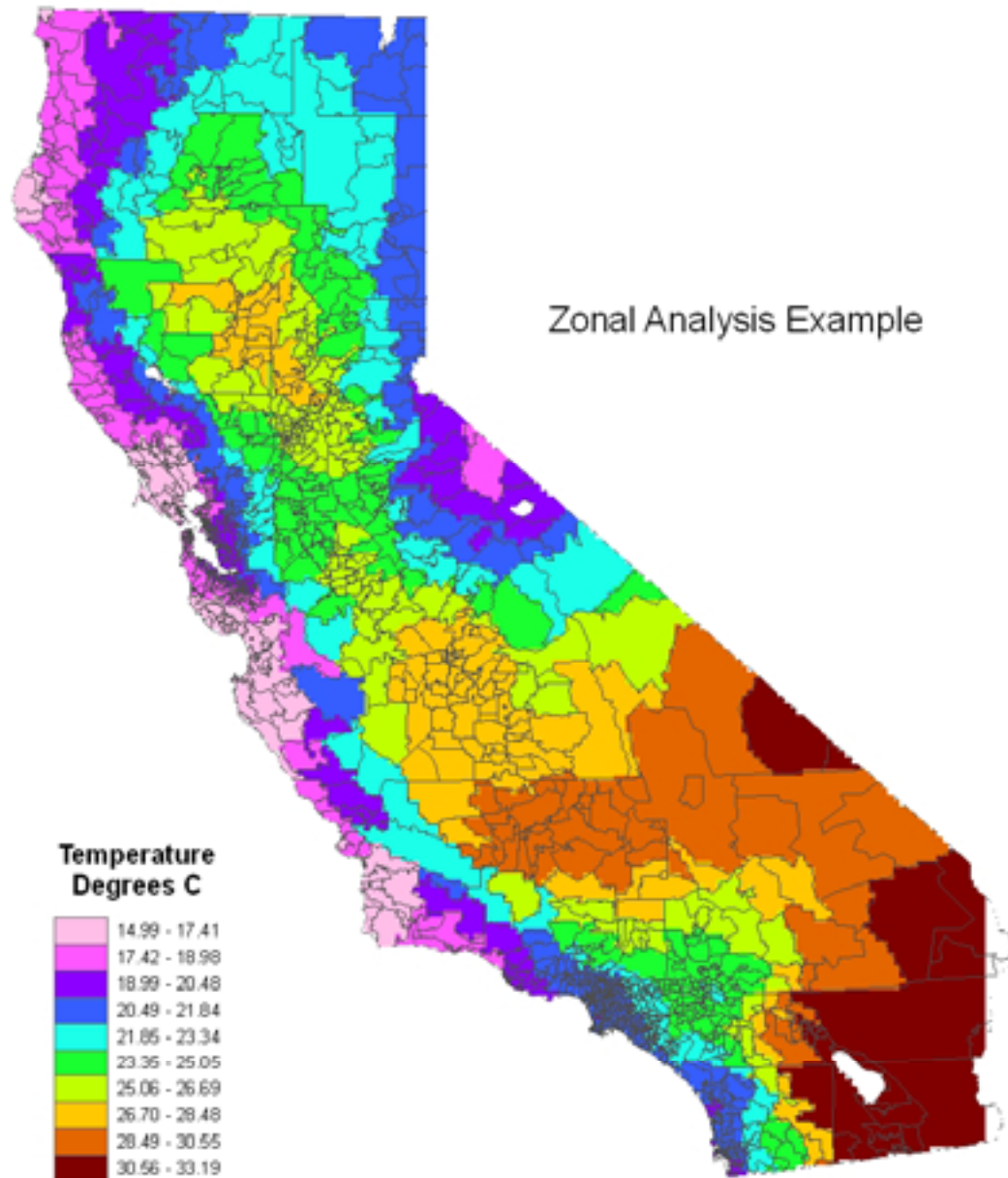
California, August 3, 2005



Data Source: California Air Resources Board

# Mean Temperature

California, August 3, 2005



Data Source: California Air Resources Board

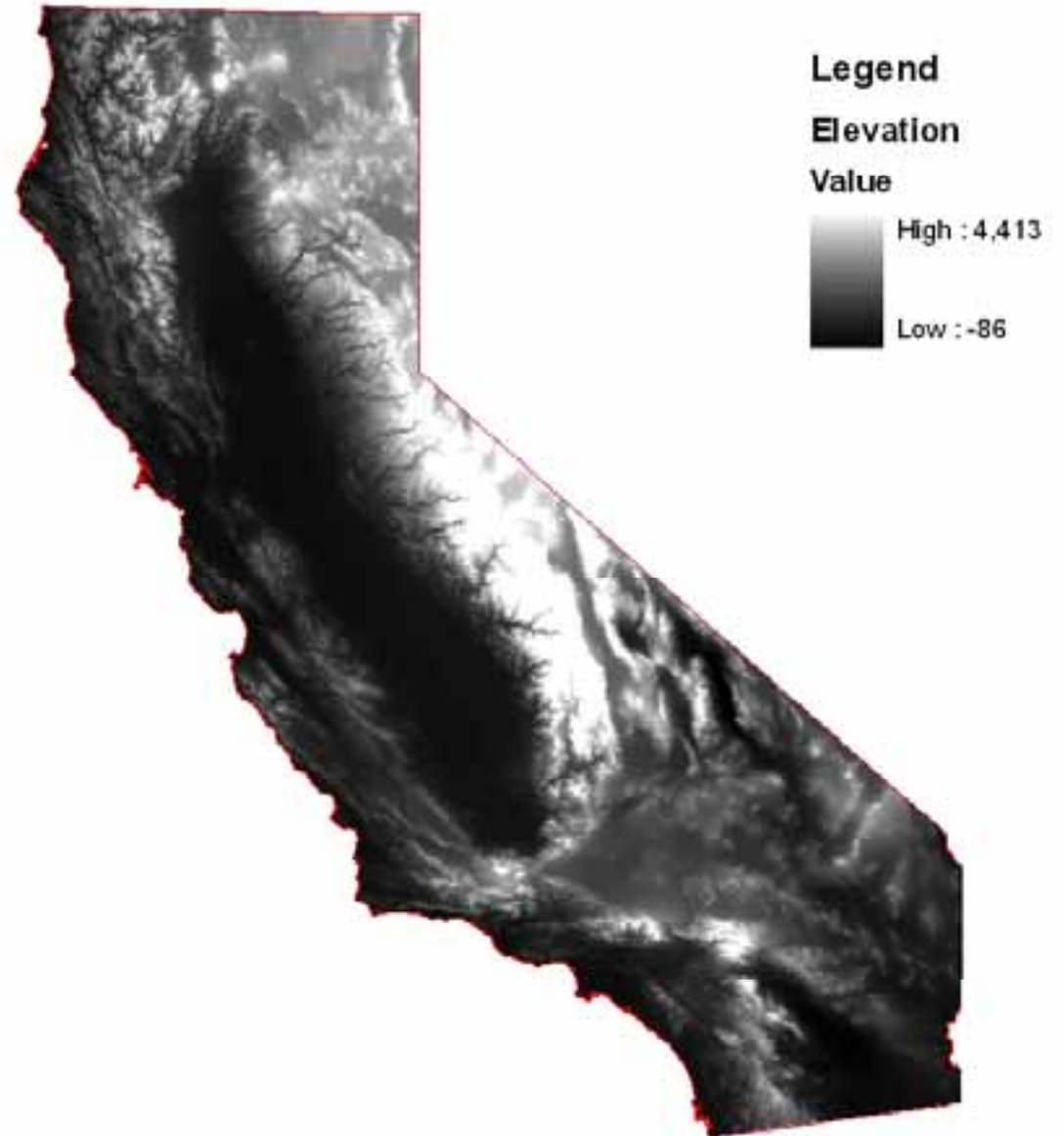
# Elevation Data

Mosaic process

55 parts

6 GBs

California Elevation Grid



# A *'little'* problem...

$$\text{Pollen Amount} \approx \text{Plant Density} + \text{Plant Biomass}$$

We've estimated pollen amount,  
but is that our answer?

# Wind Speed and Direction

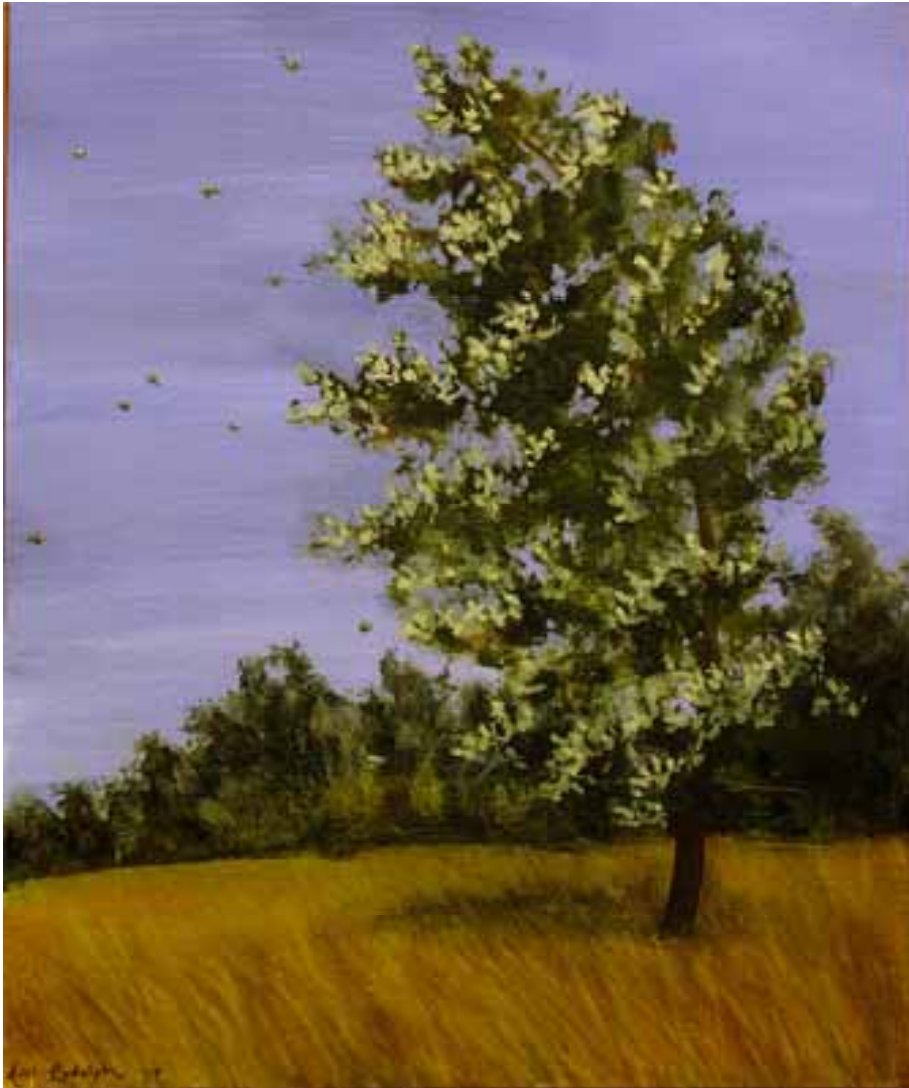
Pollens don't stay put  
- Dispersed by wind

Other options:

-Wind Wizard

-Tracking Analyst? As  
seen in a previous  
Healthy GIS Newsletter

Note: elevation may  
act as a barrier





# Pollen Counts & Validation

## Pollen Counts

- National Allergy Bureau, 2002-2006
- Seasonality vs 'month of the year'
- Bootstrapping or Jack-Knife validation
- May have access to 'ground-truthing' data collected in Fresno (central CA)

# The Regression

I have  
categorical  
variables and not  
enough 'y' values



## Options:

- Geographically weighted regression
- Ordinary least squares regression
- Land-use regression

# Limitations

## Land Cover

- Static data
- Consider remotely sensed data
  - NVDI (Normalized Difference Vegetation Index)

## Free / Accessible Data

- Self-imposed restriction

**Unlikely to achieve 'exact' pollen amounts**

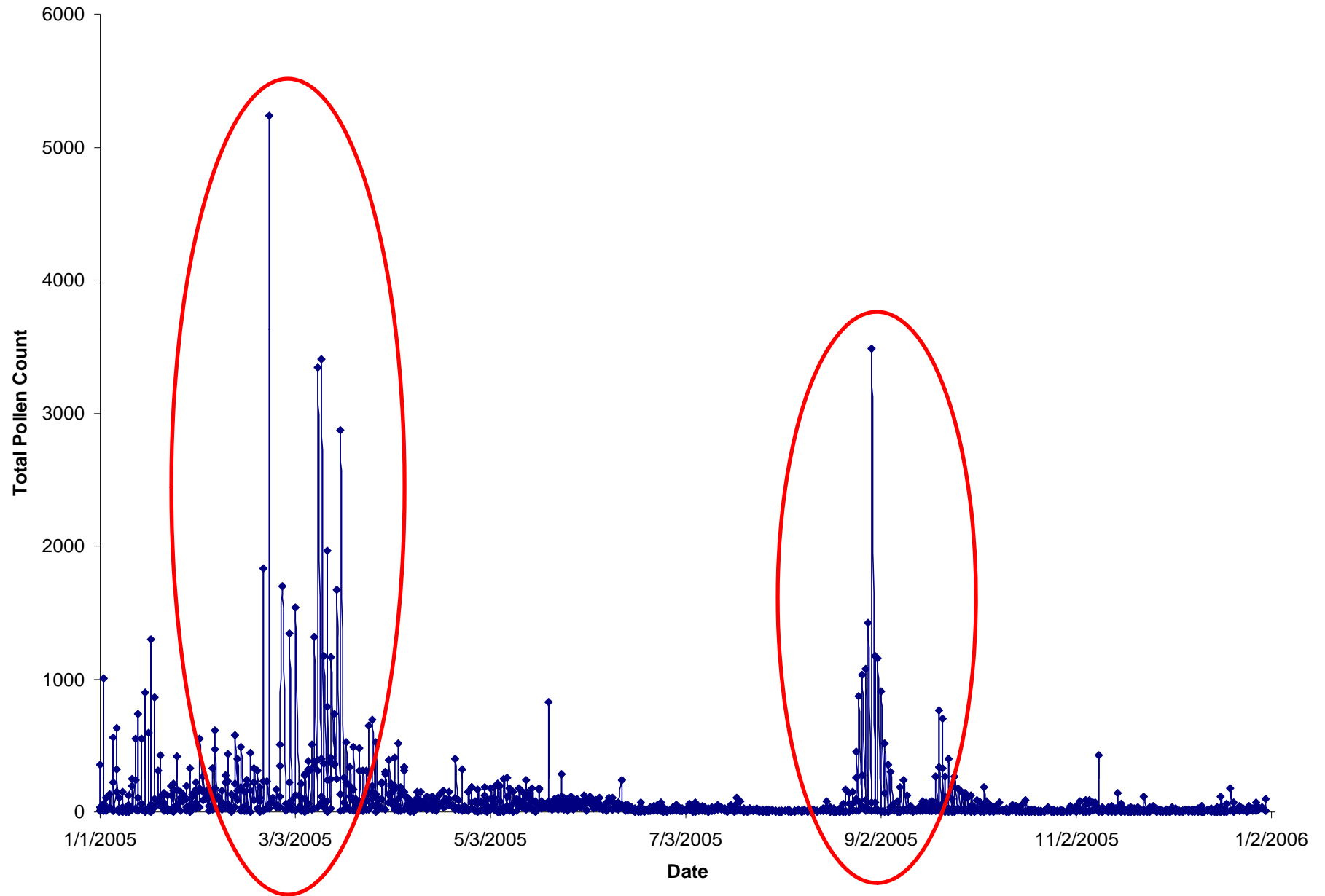
# Next Step

## Grass Pollens

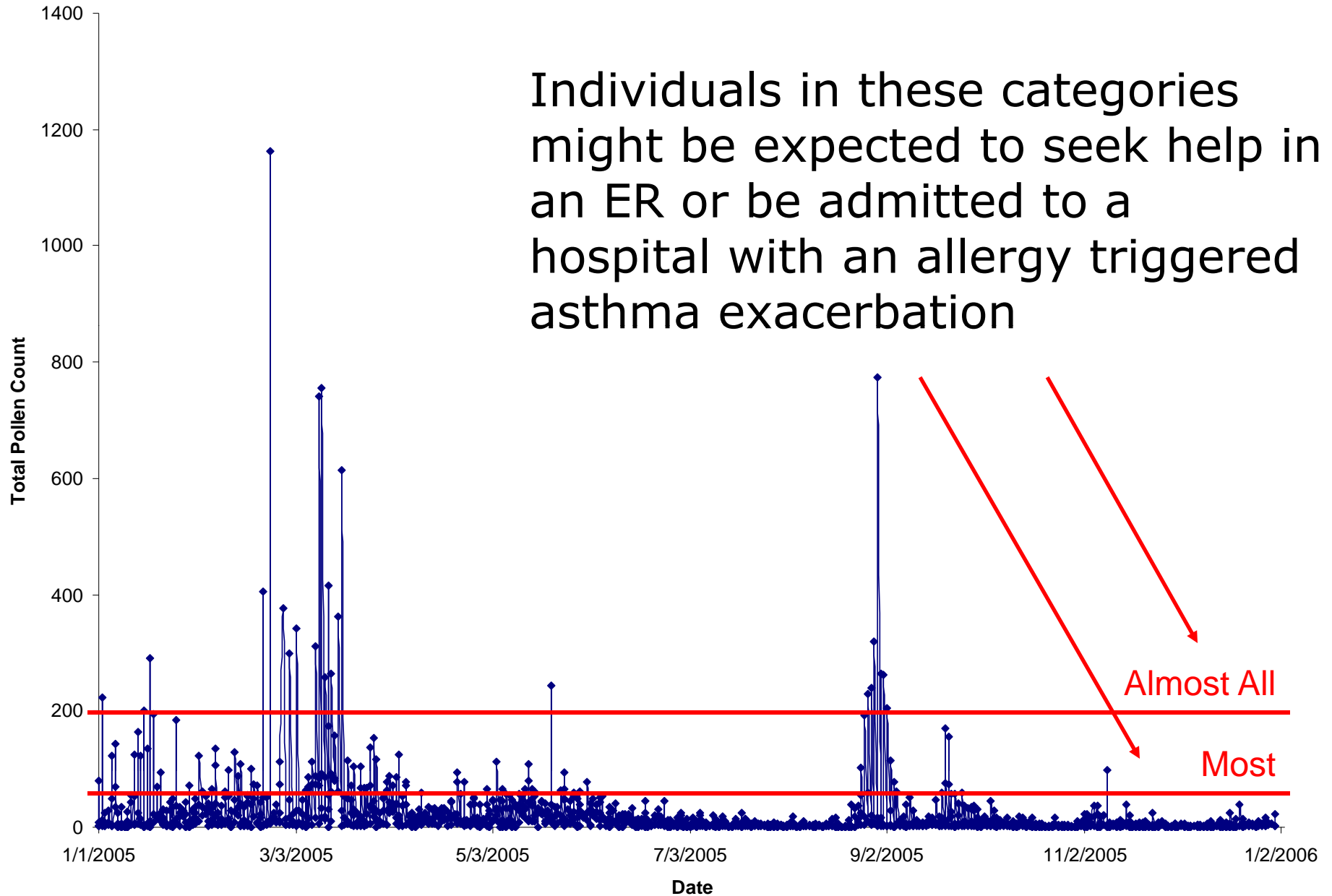
Grains per Cubic Meter	Level
0-5	Low
5-20	Moderate
20-200	High
200 or more	Very High

Level	Those who will likely suffer symptoms
Absent	No symptoms
Low	Only individuals extremely sensitive to grass pollens
Moderate	Many individuals sensitive to grass pollens
High	Most individuals with any sensitivity to grass pollens
Very High	Almost all individuals with any sensitivity to grass pollens. Extremely sensitive people could have severe symptoms.

# California 2005 Pollens



## California Effective Pollens, 2005



# The End

**Thank you for your attention!**

**Questions?... Answers?**

