Ultrafine Particles
A New Challenge to Community Health Studies

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Introduction

- UF particles of recent health concern
  - May contribute to early mortality, asthma, respiratory illness
- A new pollutant to air pollution researchers
- Sources
  - Diesel and gas powered vehicles
  - Wood/biomass combustion
  - Secondary aerosols
  - Transport from upper atmosphere
- Definition--Ultrafine PM ~7nm to 100nm (.1micron)

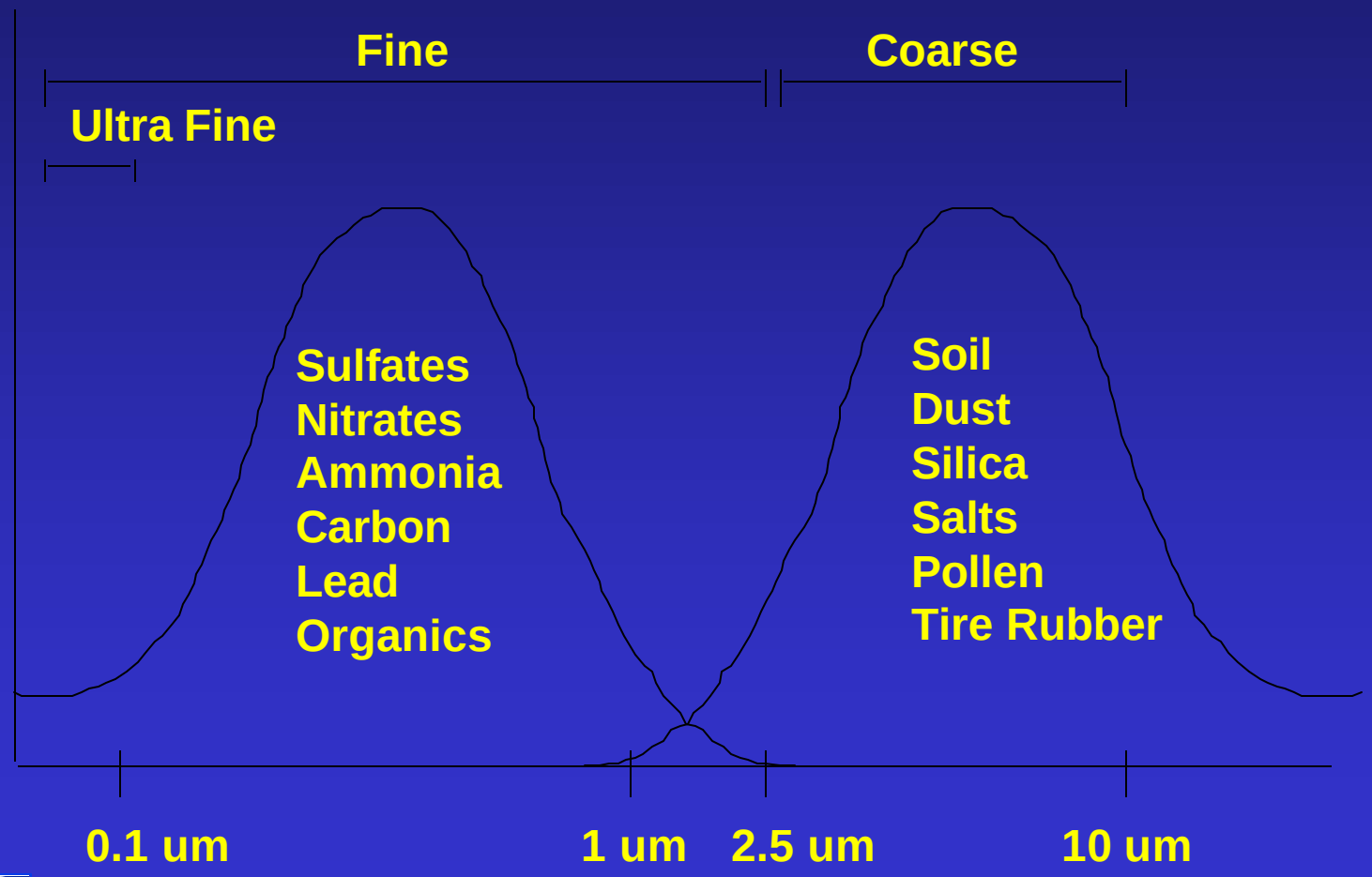
Objectives

- Inform health researchers
  - UF particles are different than other pollutants
  - complexity of UF particles in community air
- Inform atmospheric scientists
  - What health researchers need
  - How monitoring data can best be used
- Present illustrative data from studies

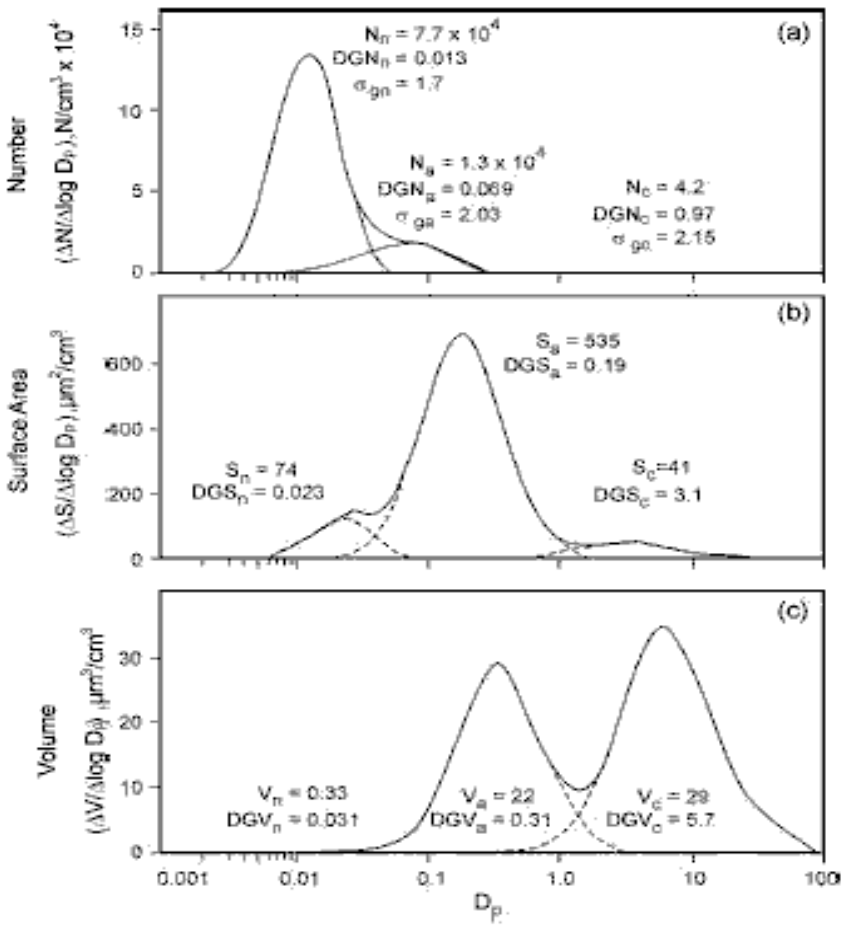
Sources of Ultrafine PM in Community Air

- Combustion
  - especially diesel and gas powered vehicles
  - wood/biomass combustion
- Secondary aerosols
- Transport from upper atmosphere

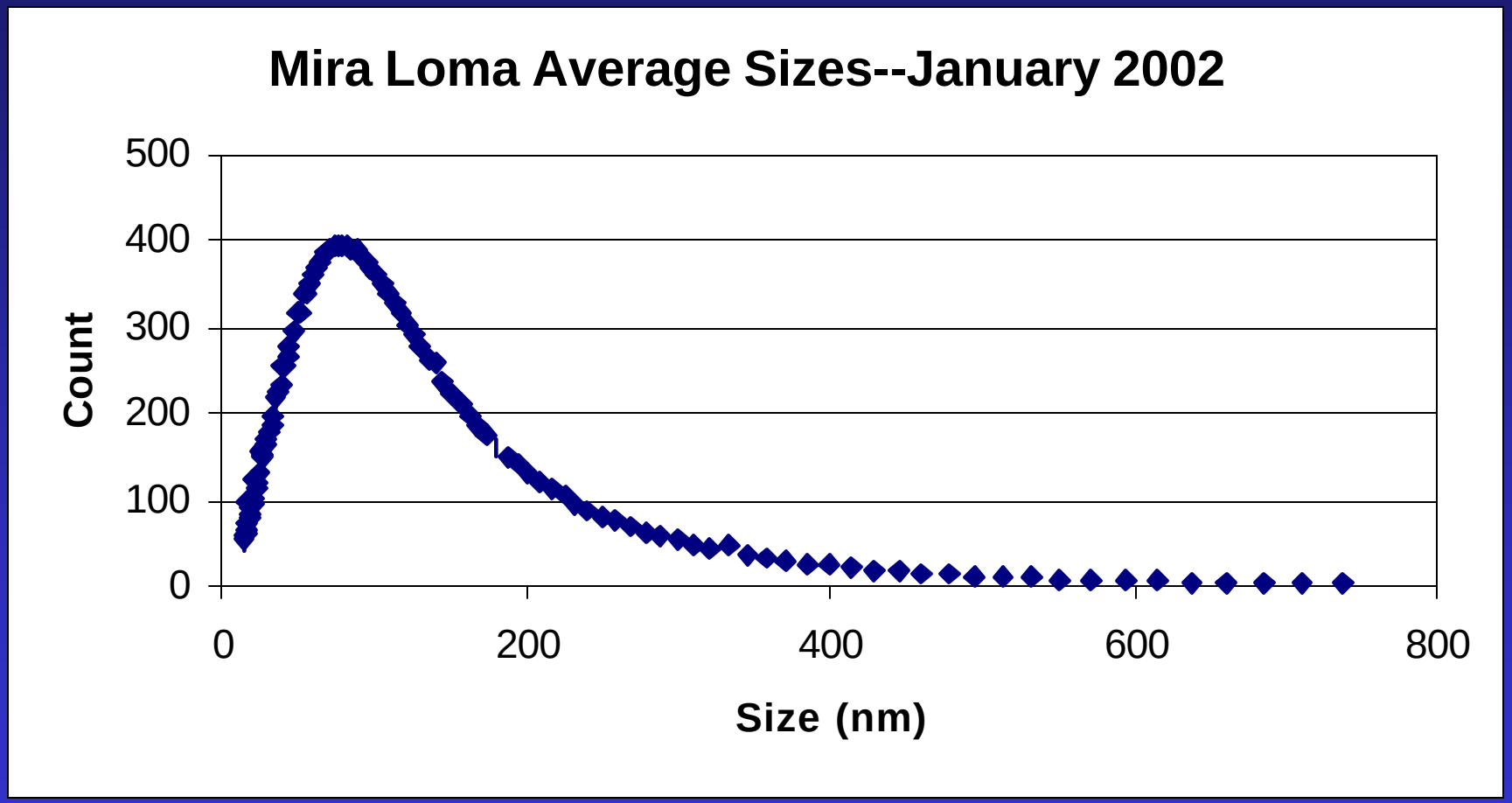
PM_{10} Air Pollution Size and Composition



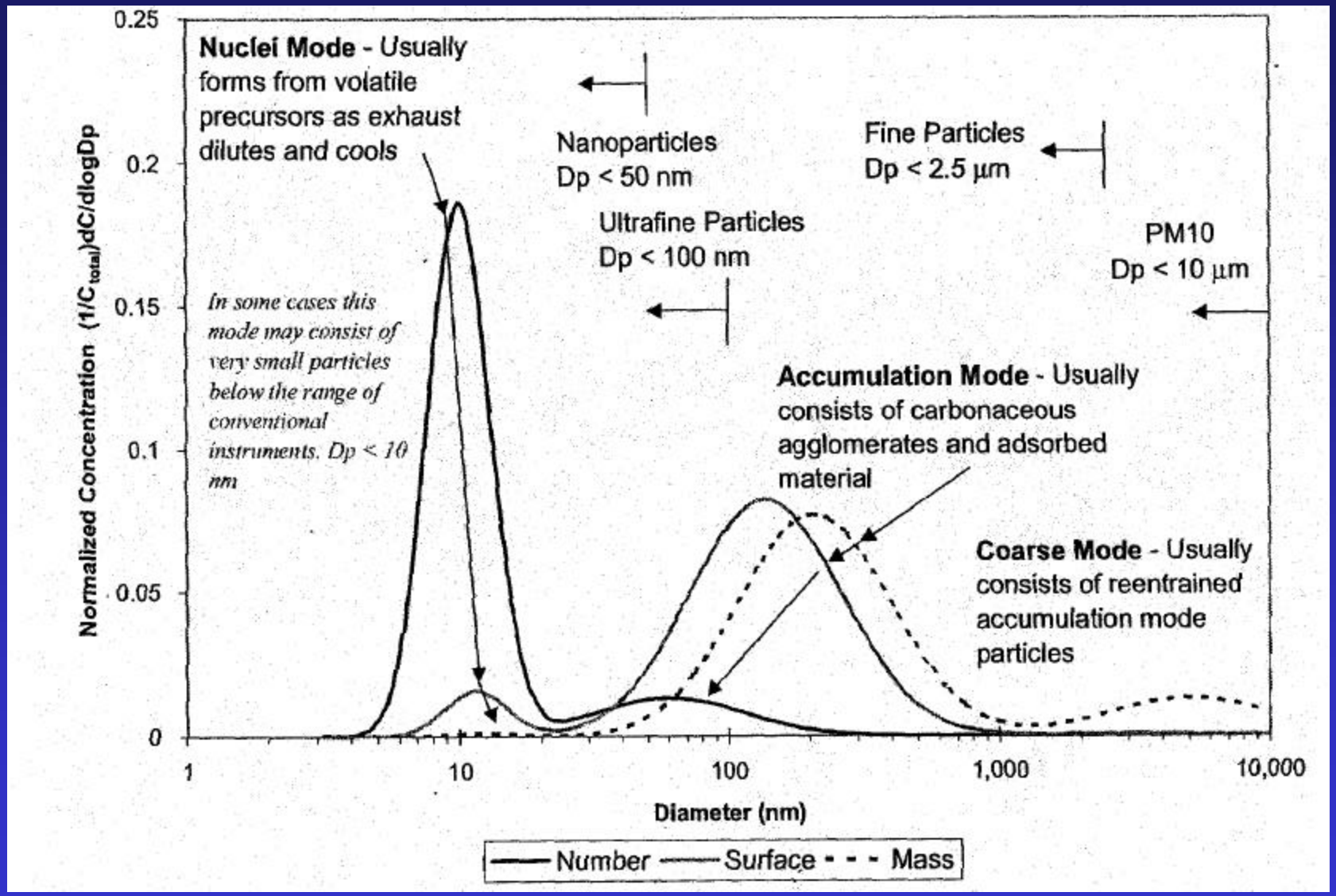
Particle Number, Surface Area and Volumes Relate to Size



Particle Sizes

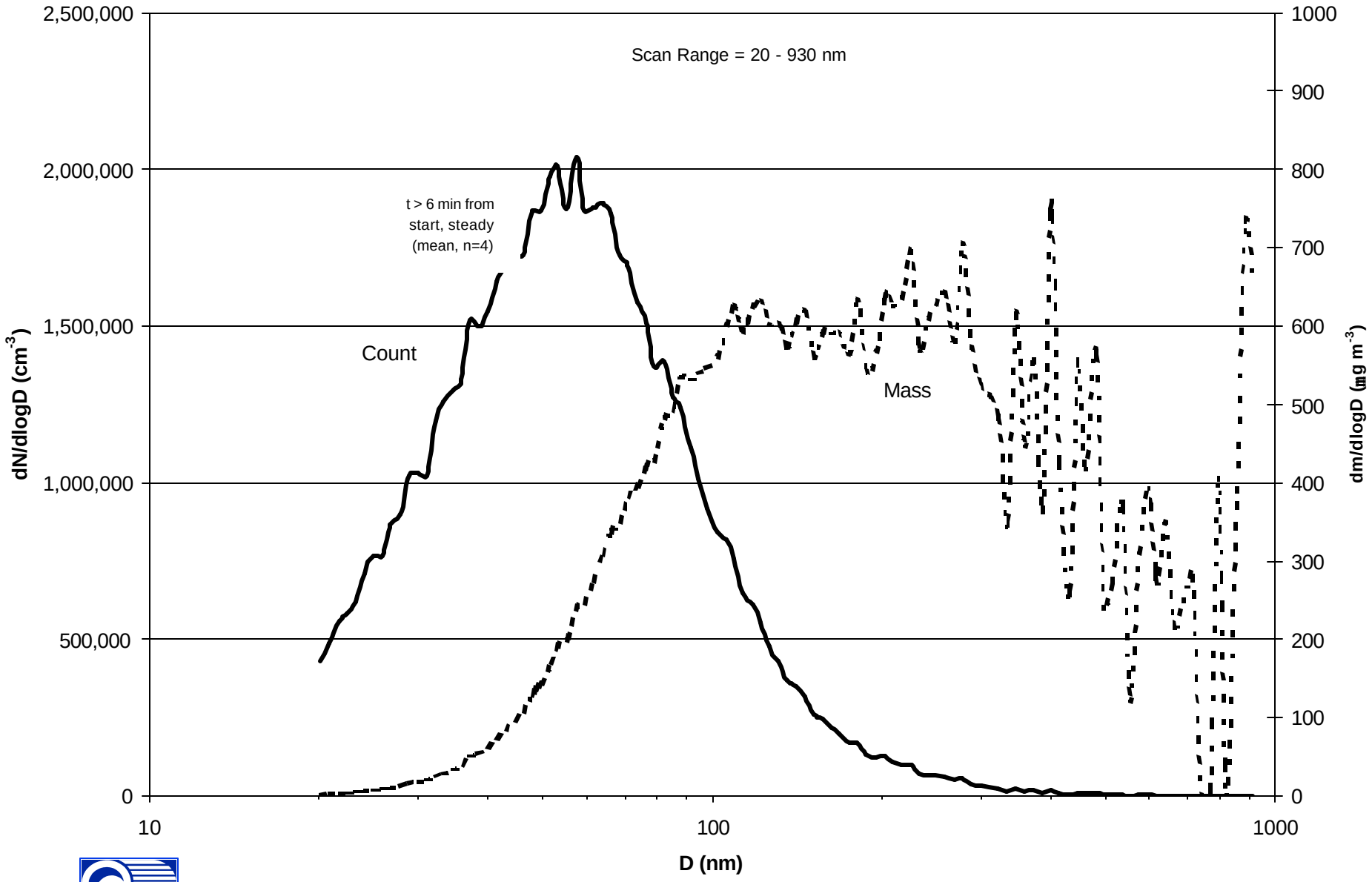


Idealized Size Profiles--Diesel Exhaust



Source:Kittelson, Course Materials,University of Leeds, Oct 2001

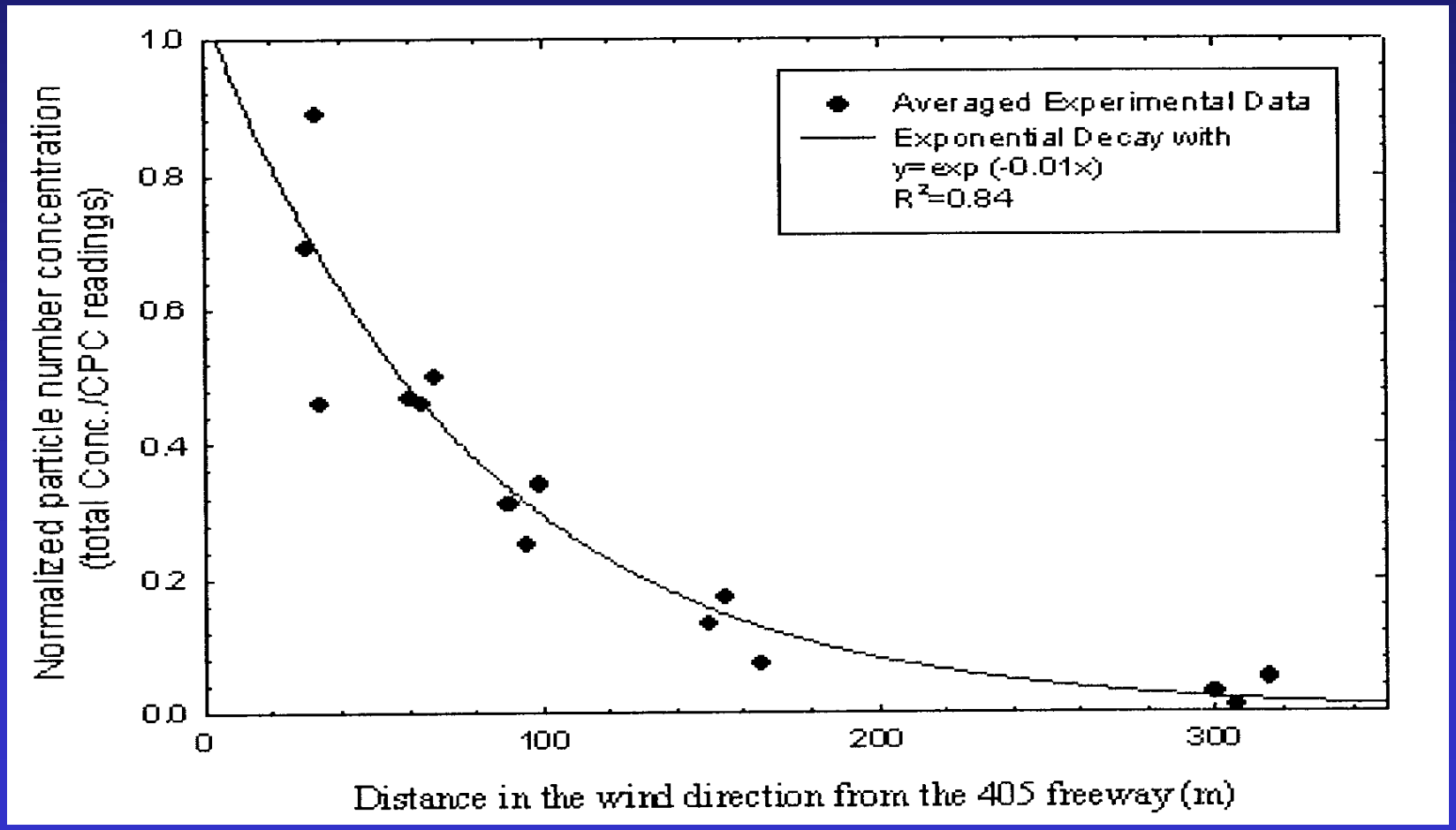
Smoke in Chamber/45 s Firing Interval/With Surge Mixing Fan



Ultrafine PM in Community Air

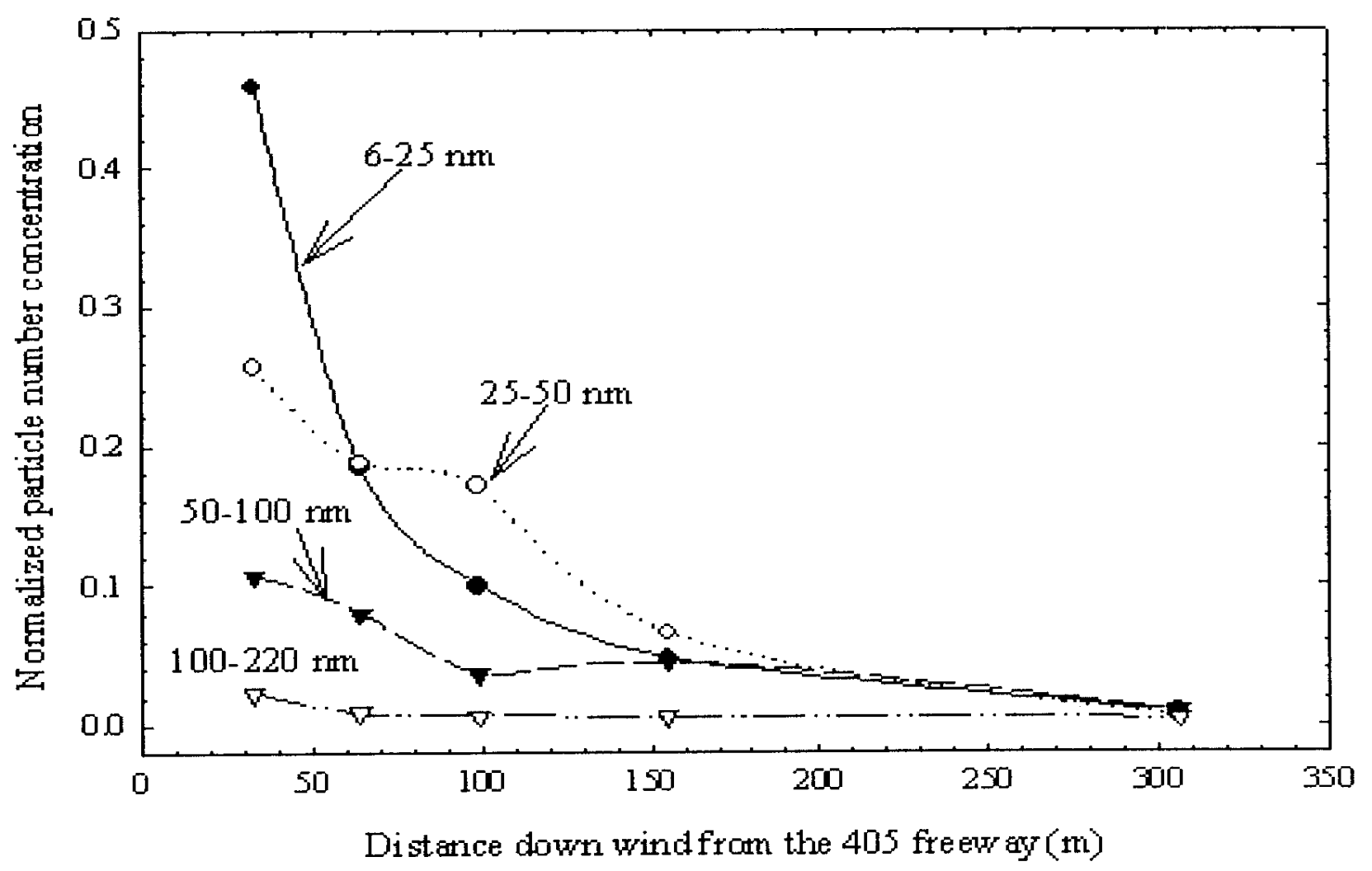
- Sioutas in Los Angeles
  - UF up- and downwind of a busy freeway
- Scalf in San Diego, CA
  - Models of fresh emissions from highways
- Wichmann in Erfurt, Germany
  - Health study including UF and fine particles
- EPA studies in Fresno and El Paso

Ultrafine PM Counts Drop With Distance from Highway



Source:Sioutas with permission, unpublished data

UF Particles Grow Quickly

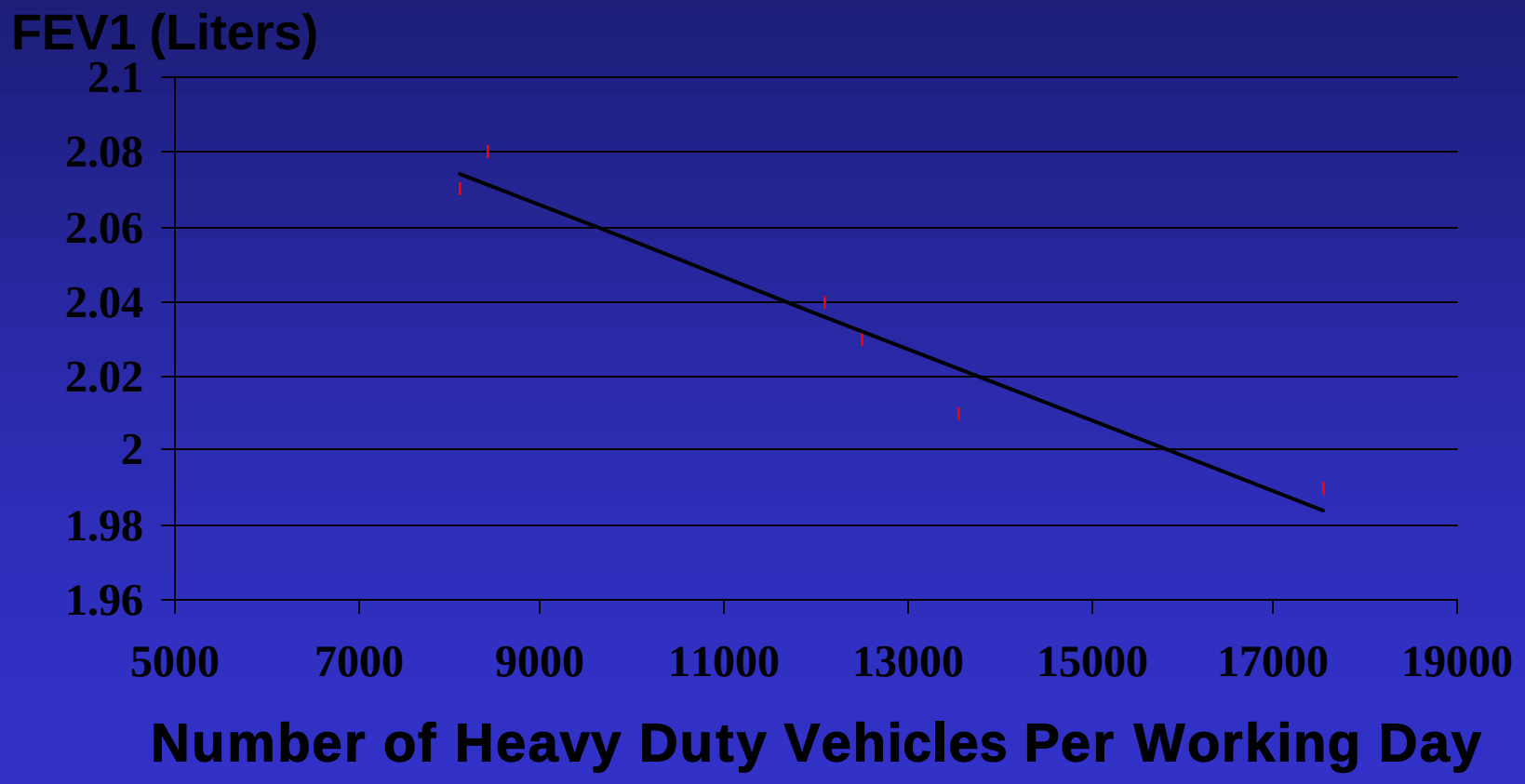


Source:Sioutas with permission, unpublished data

Traffic and community HC levels

Source: Scalf with permission, presented at 2001 ISEA meeting,

Association Between Lung Function of Children Living <300 Meters From Motorway and Intensity of Cargo Traffic



Source: Brunekreef B, et al, Air Pollution from truck traffic and lung function in children living near motorways

Air monitoring in Erfurt Germany

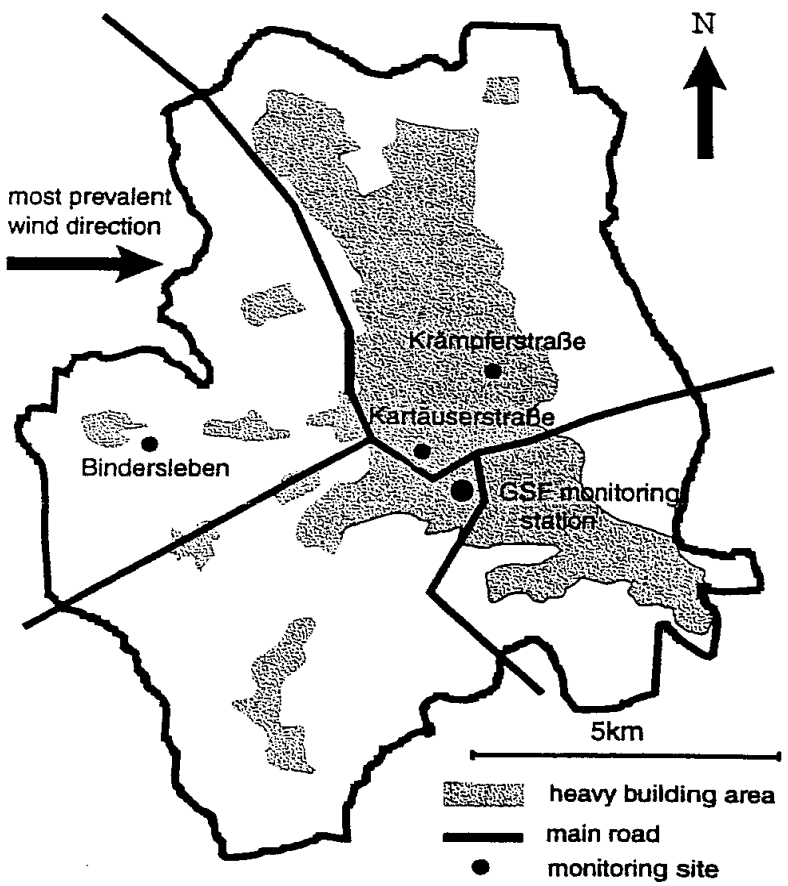


Figure 1. Map of Erfurt showing measuring stations.

Source:Wichmann/HEI,Daily Mortality and Fine and Ultrafine Particles in Erfurt, Germany, HEI Report 98, 2000

UF Particle counts vary with season

Erfurt Germany

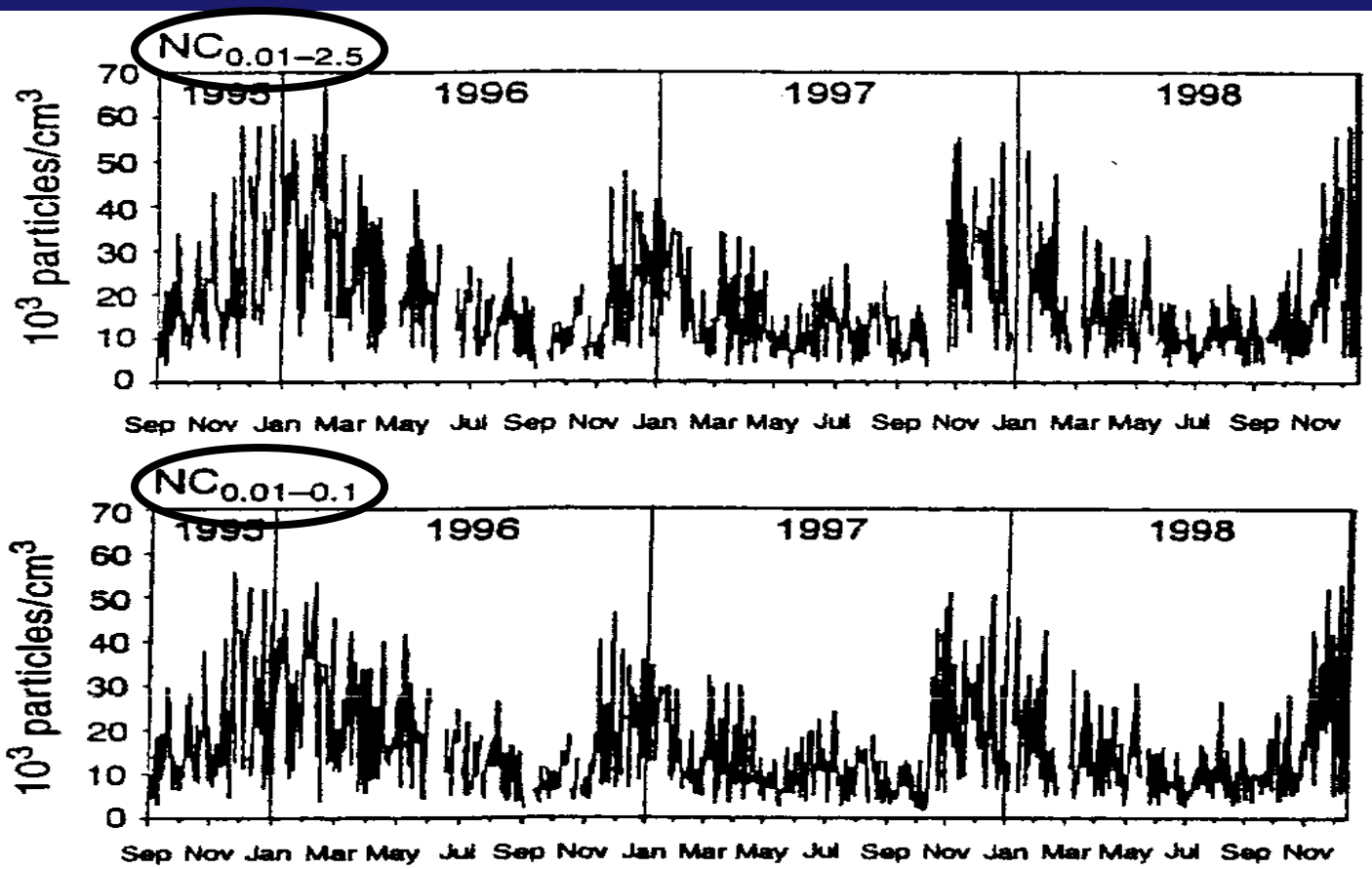


Figure 5. Time series of daily average total particle number ($NC_{0.01-2.5}$) and ultrafine number ($NC_{0.01-0.1}$).

Source:Wichmann/HEI,Daily Mortality and Fine and Ultrafine Particles in Erfurt, Germany, HEI Report 98, 2000

UF Particles day-of-week pattern

Erfurt Germany

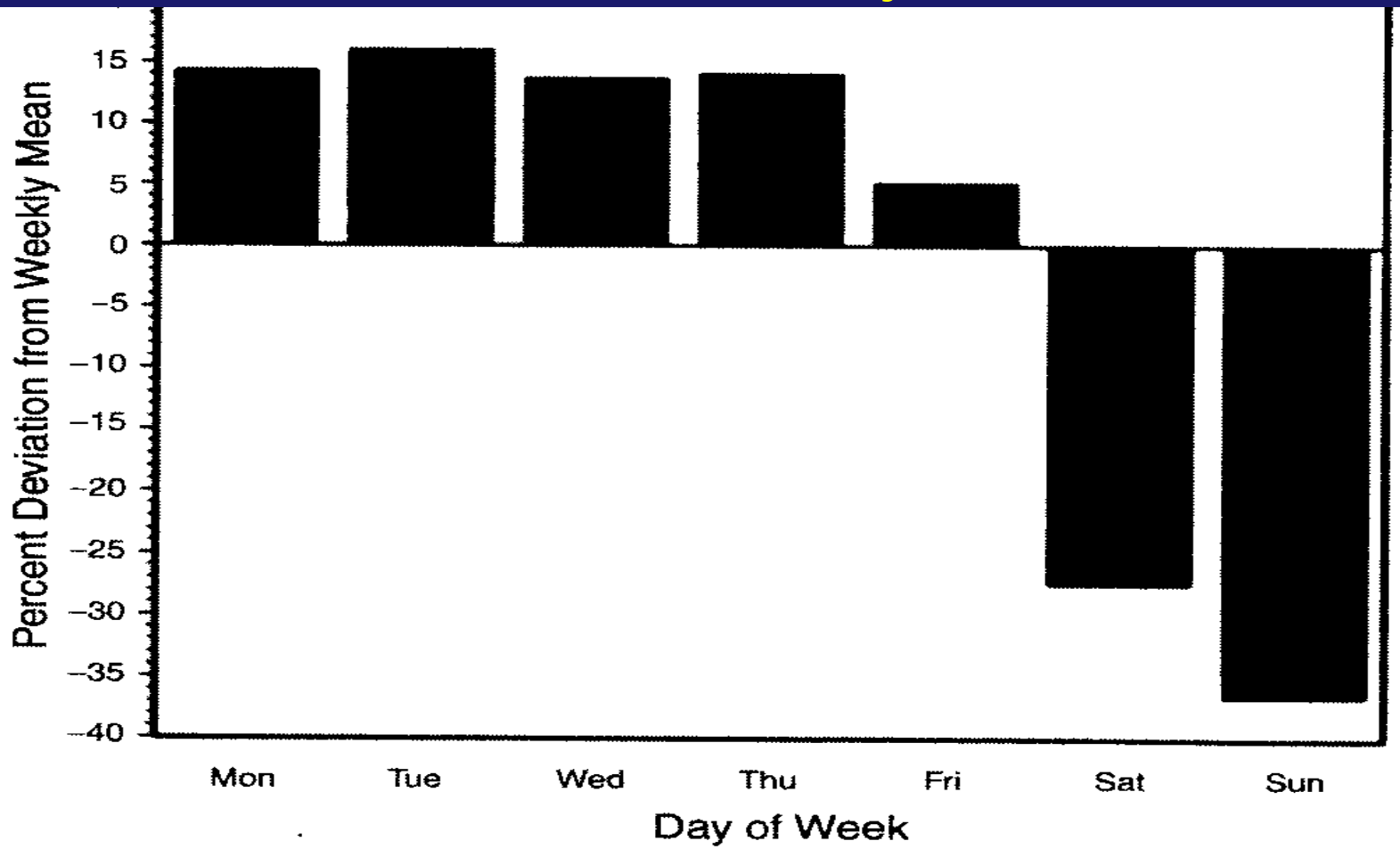


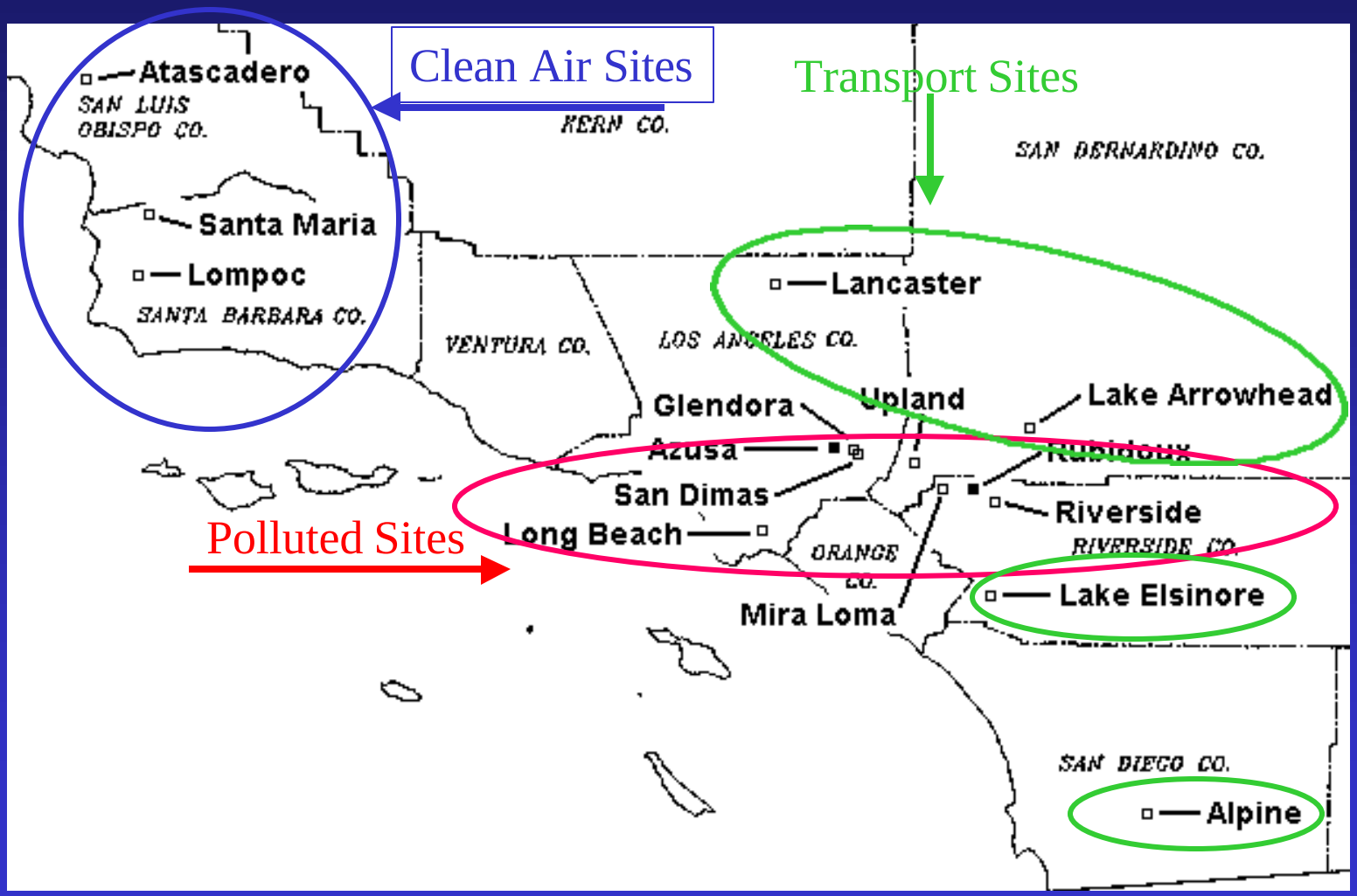
Figure 7. Day-of-week pattern of $NC_{0.01-0.1}$ with percentage deviation from mean per weekday compared with the grand mean.

Source:Wichmann/HEI,Daily Mortality and Fine and Ultrafine Particles in Erfurt, Germany, HEI Report 98, 2000

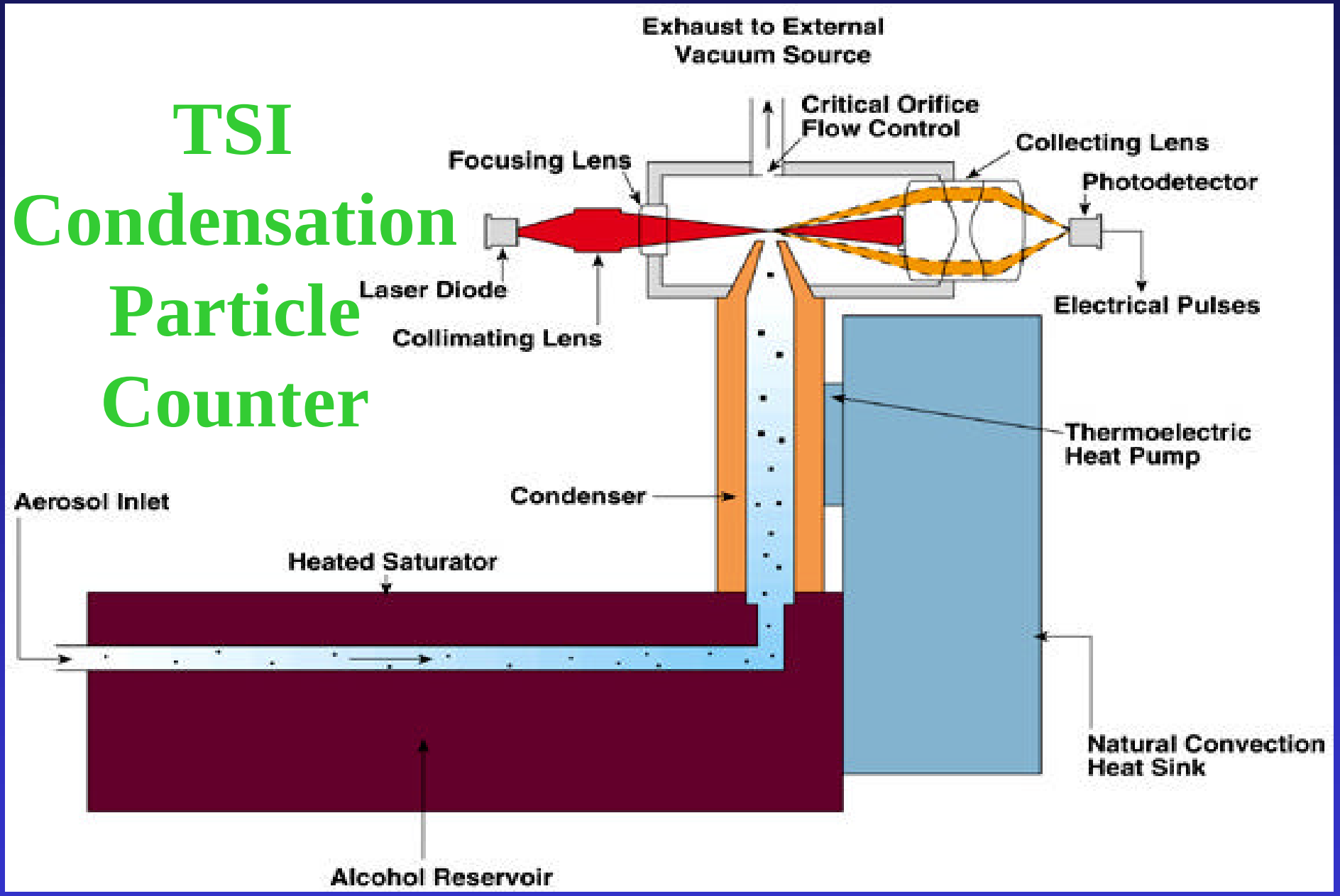
Children's Health Study

- 12 communities begun in 1993
- Communities widely spread--span~250km
- Extensive PM and gaseous pollutants
- Lung growth and respiratory health effects
- ARB funded w/contributions--EPA,SCAQMD
- Ultrafine PM added to 12 stations in 2001
- Ultrafine PM size info collected at selected sites

Children's Health Study Locations



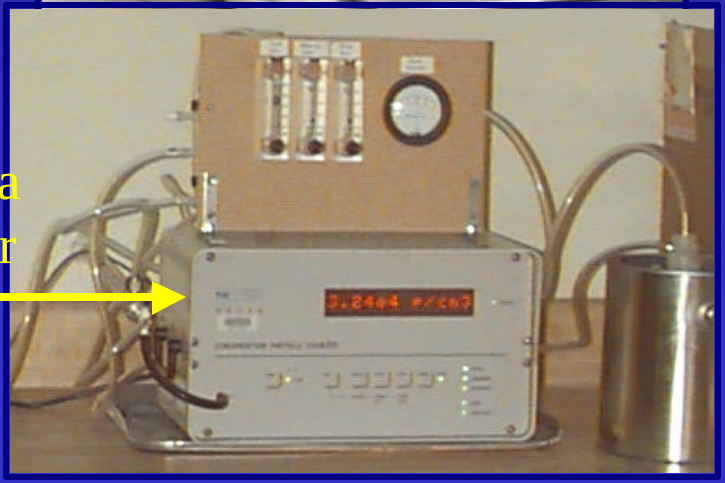
TSI Condensation Particle Counter



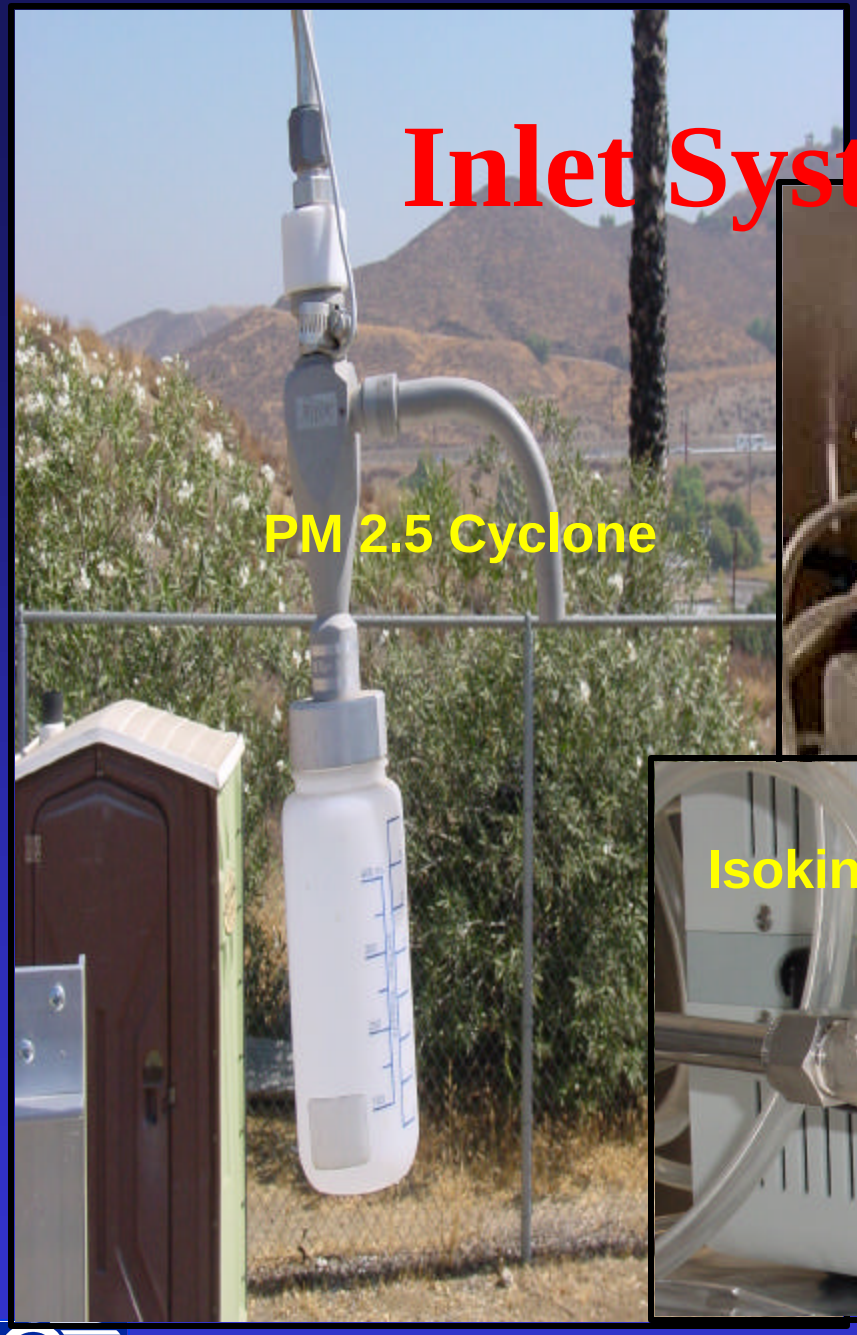
Ultrafine Air Monitoring Equipment

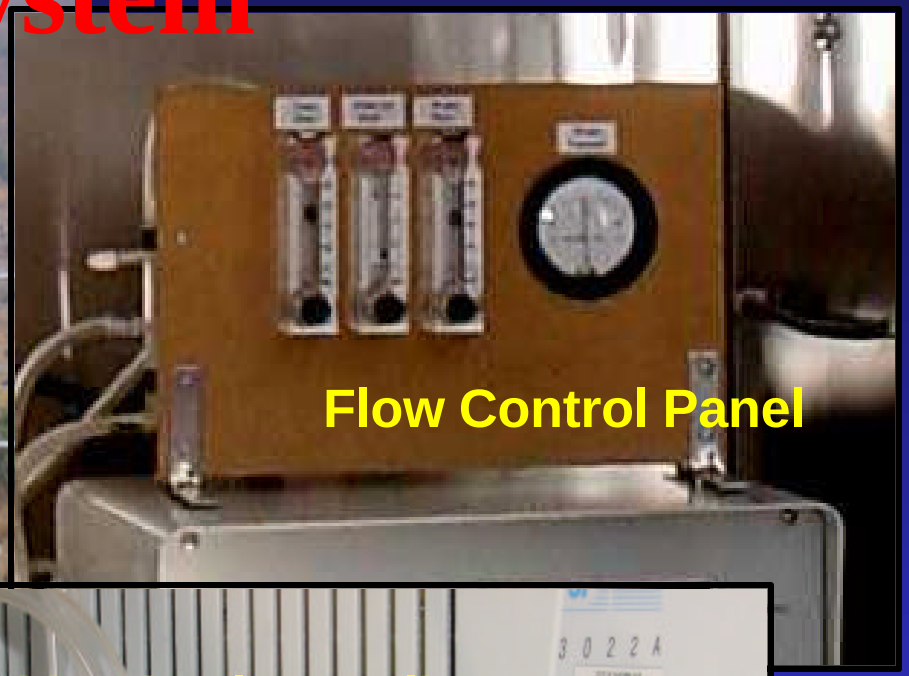
Instrument Enclosure

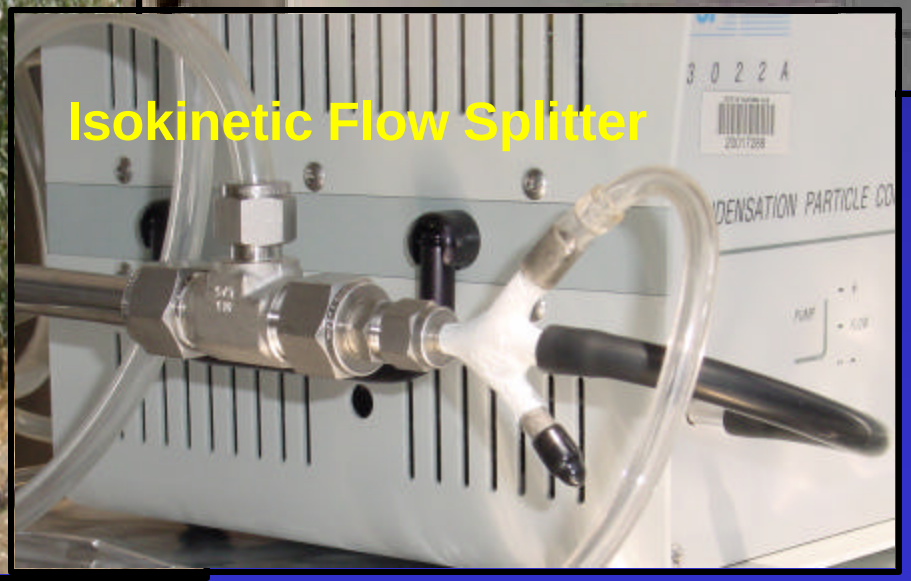
TSI Model 3022a
Particle Counter



Inlet System



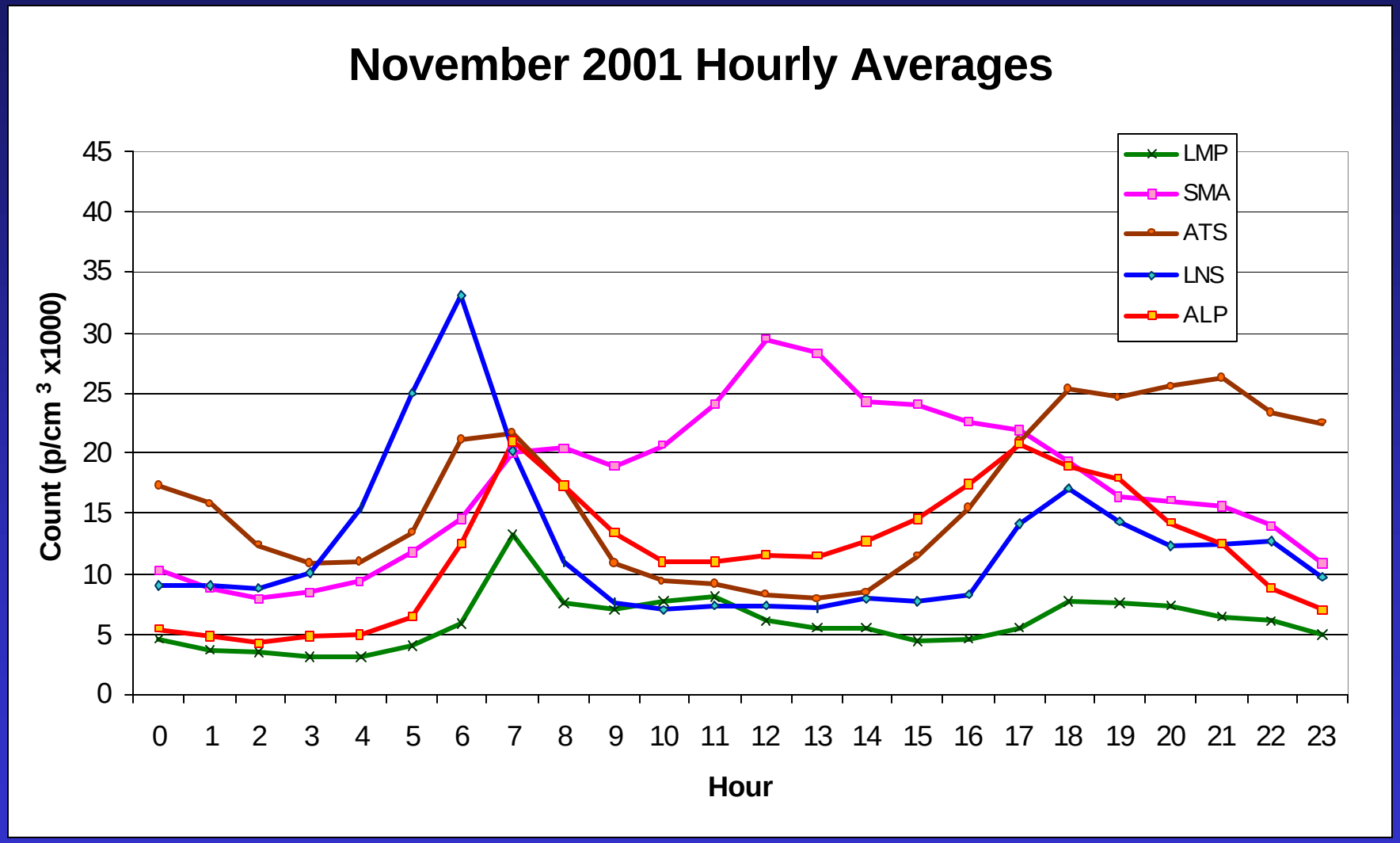




Observations from ARB UF Monitoring

- Seasonal differences between sites
- Distance from freeways influences UF counts
- Traffic impacts reflected in data
- Local sources are important
- UF counts are correlated with other pollutants
- UF size + number observations are complex

Spatial Differences



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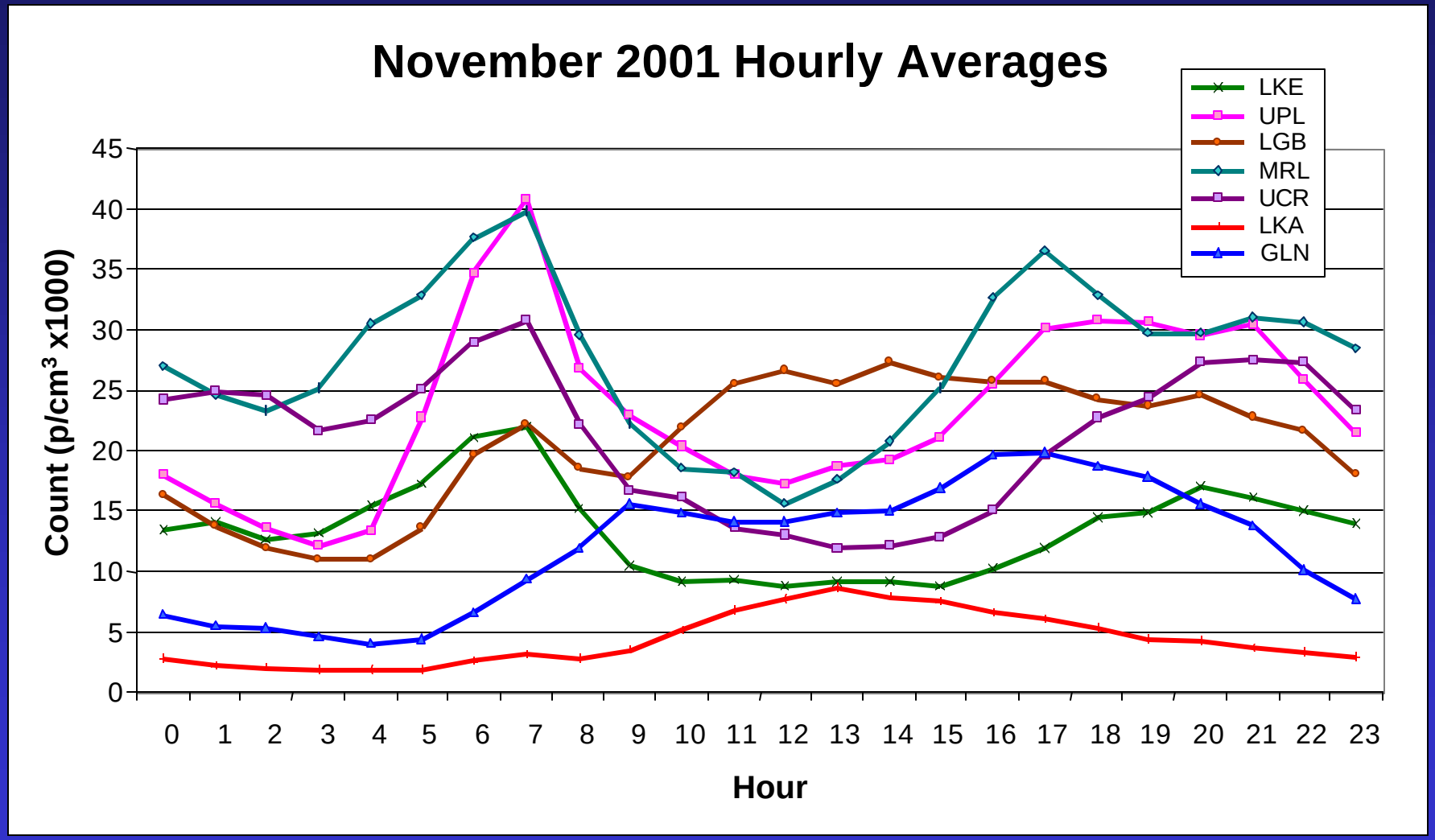
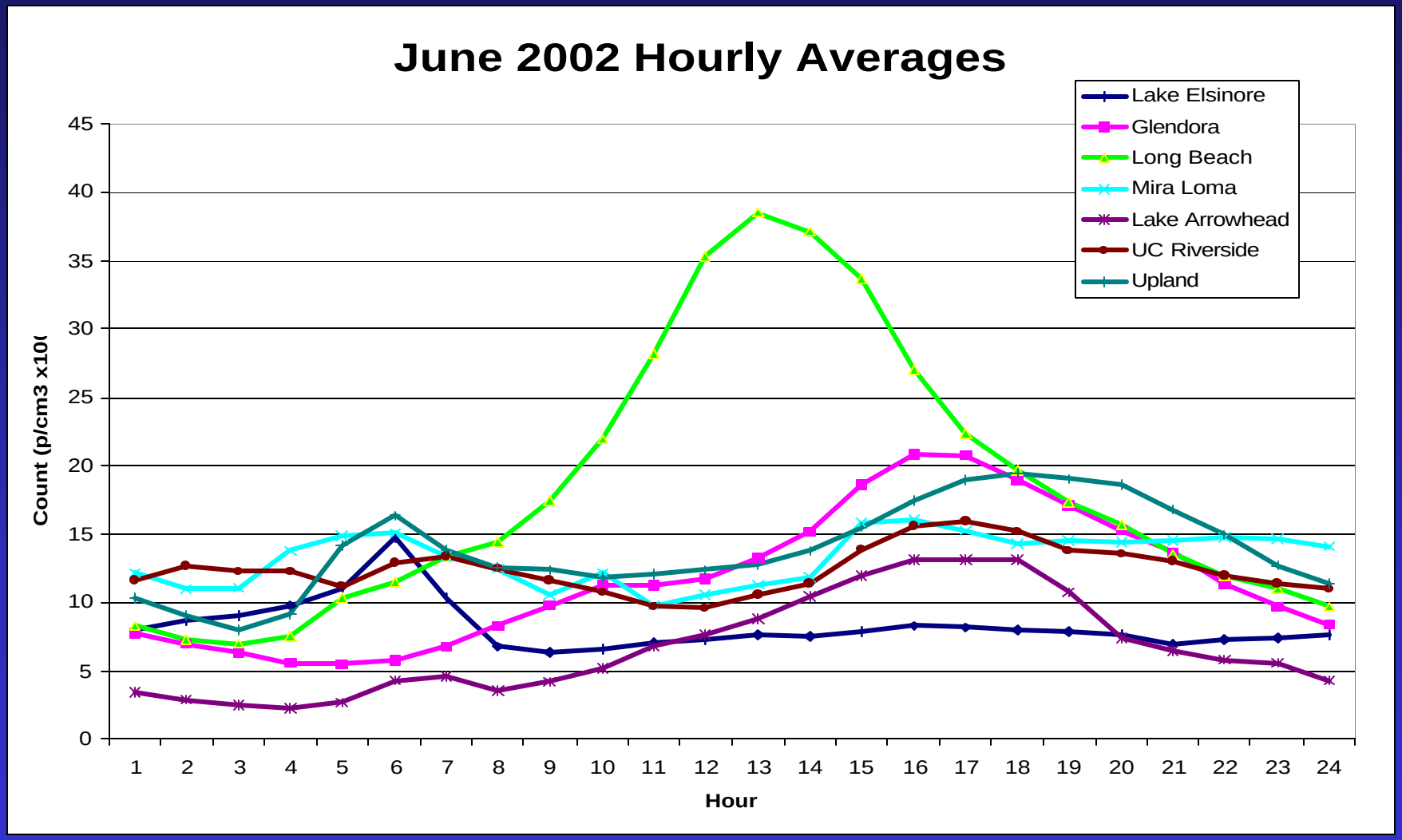
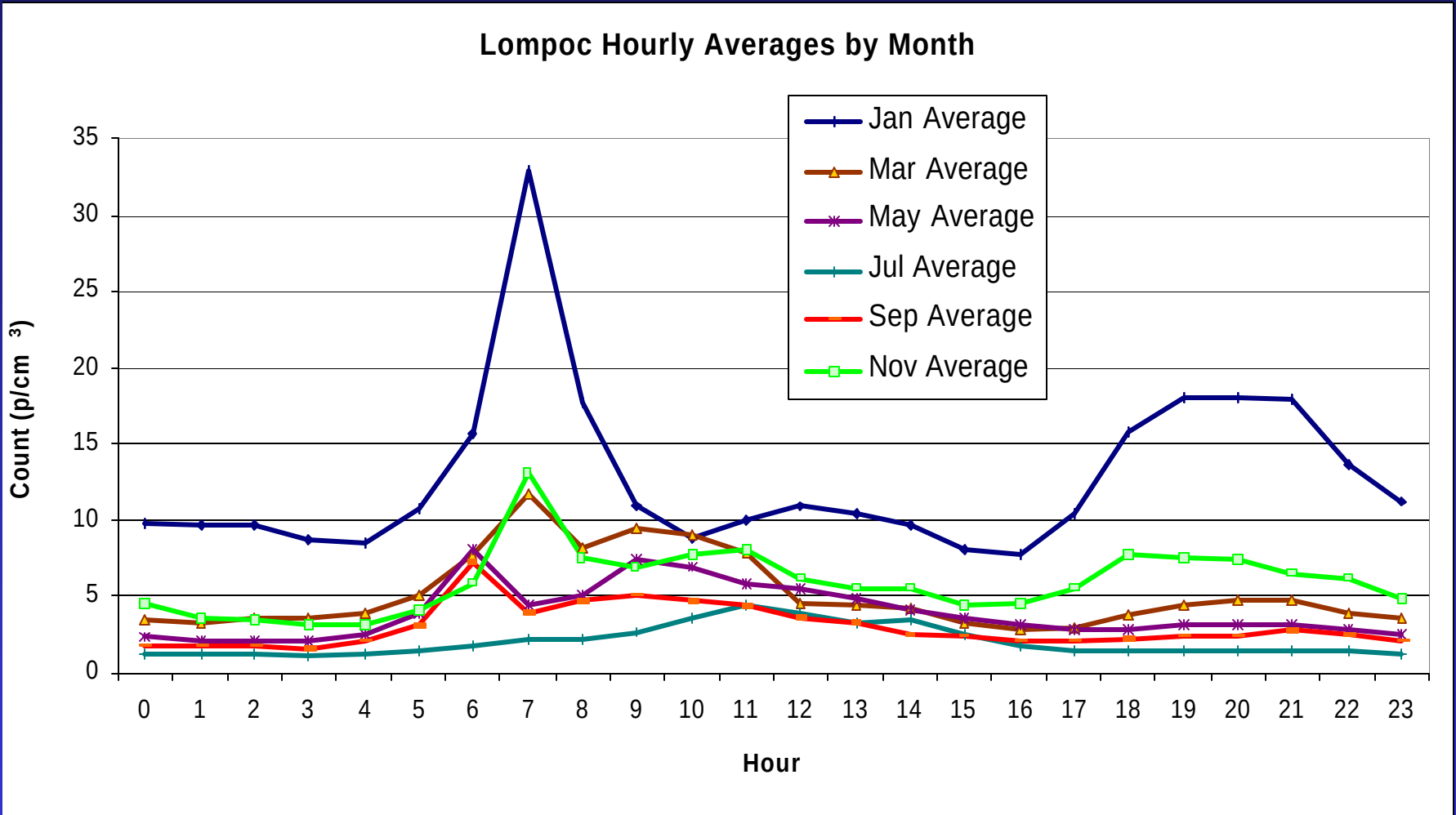


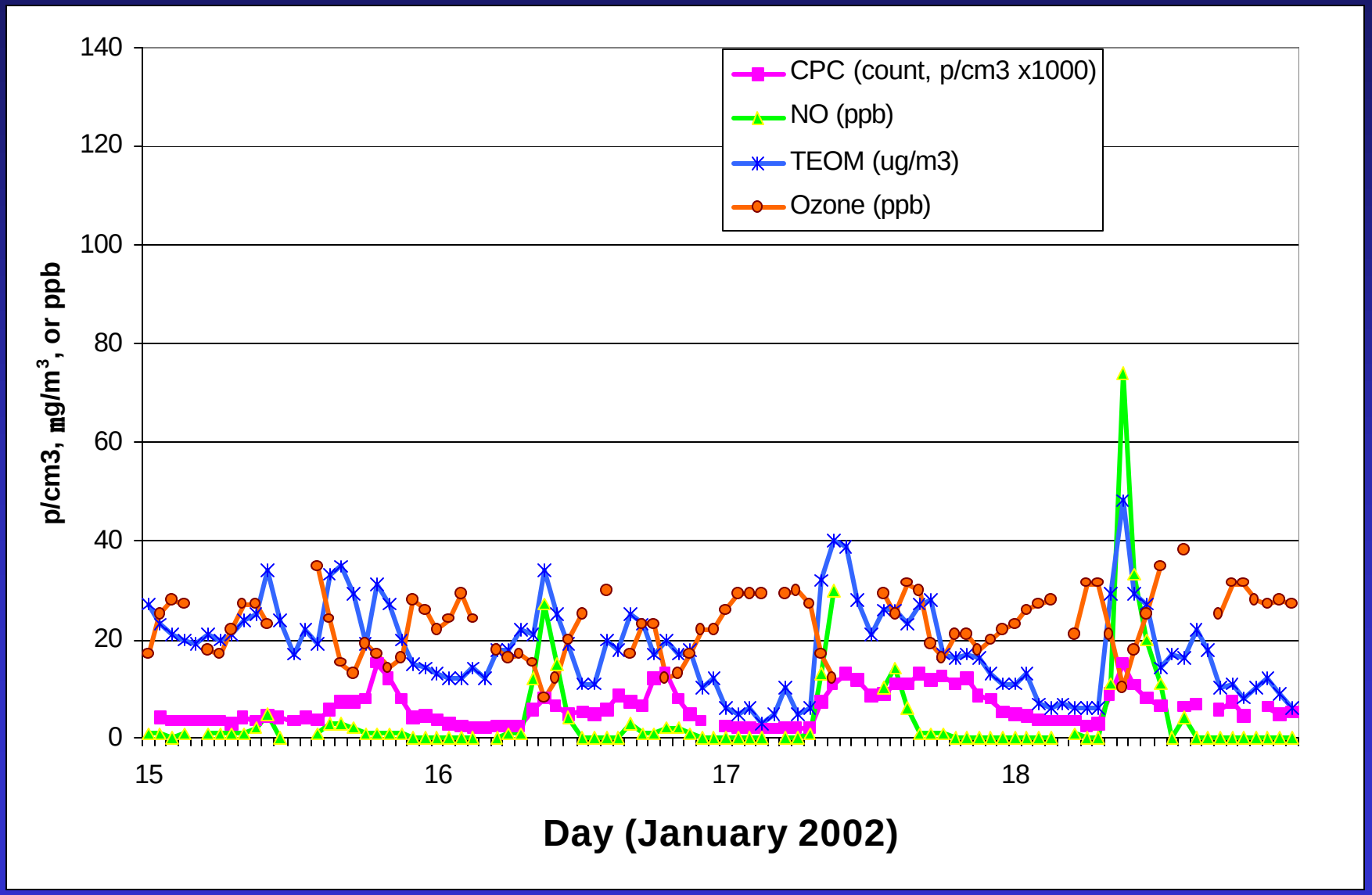
Seasonal Variation



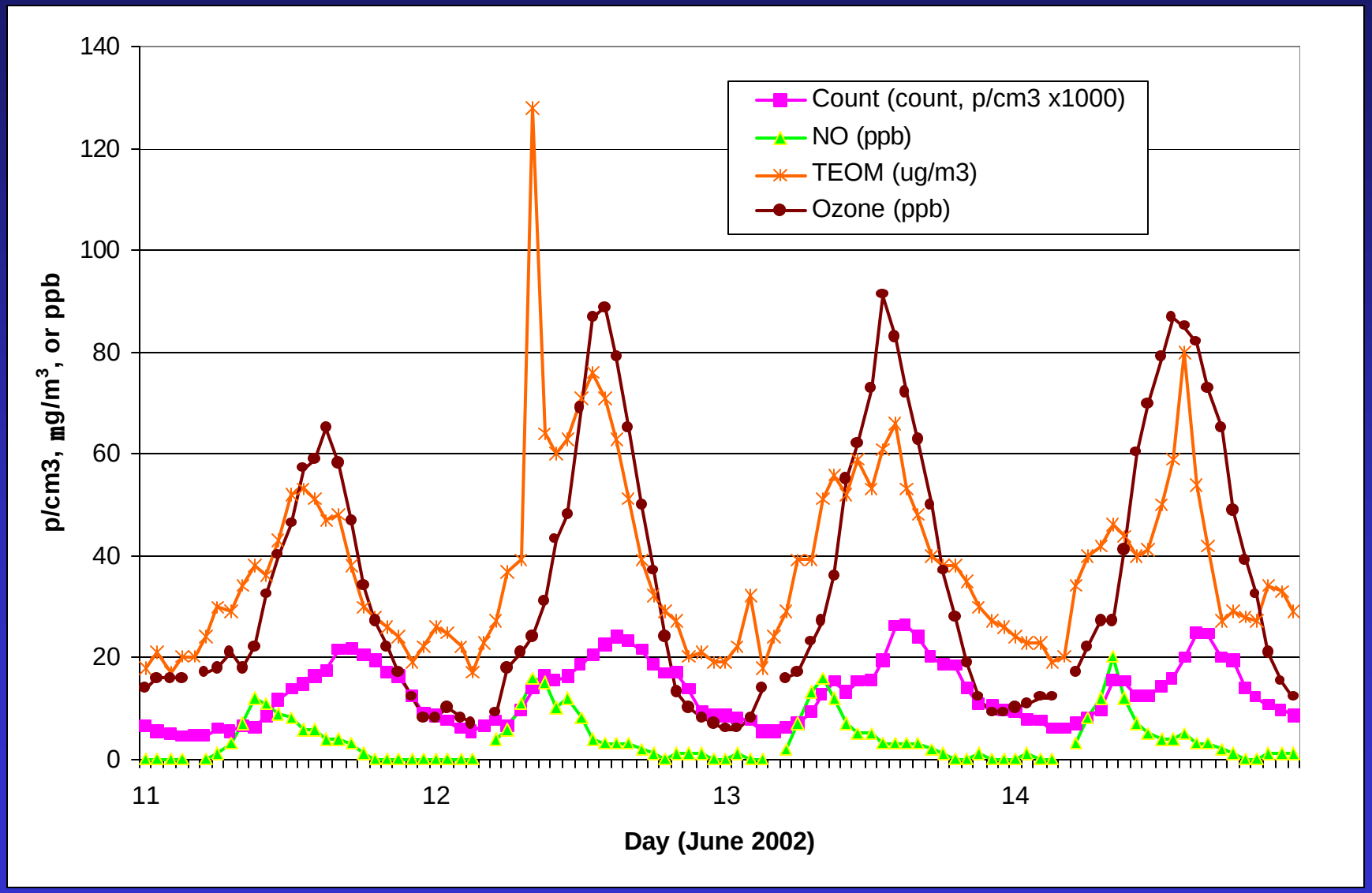
Seasonal Variation



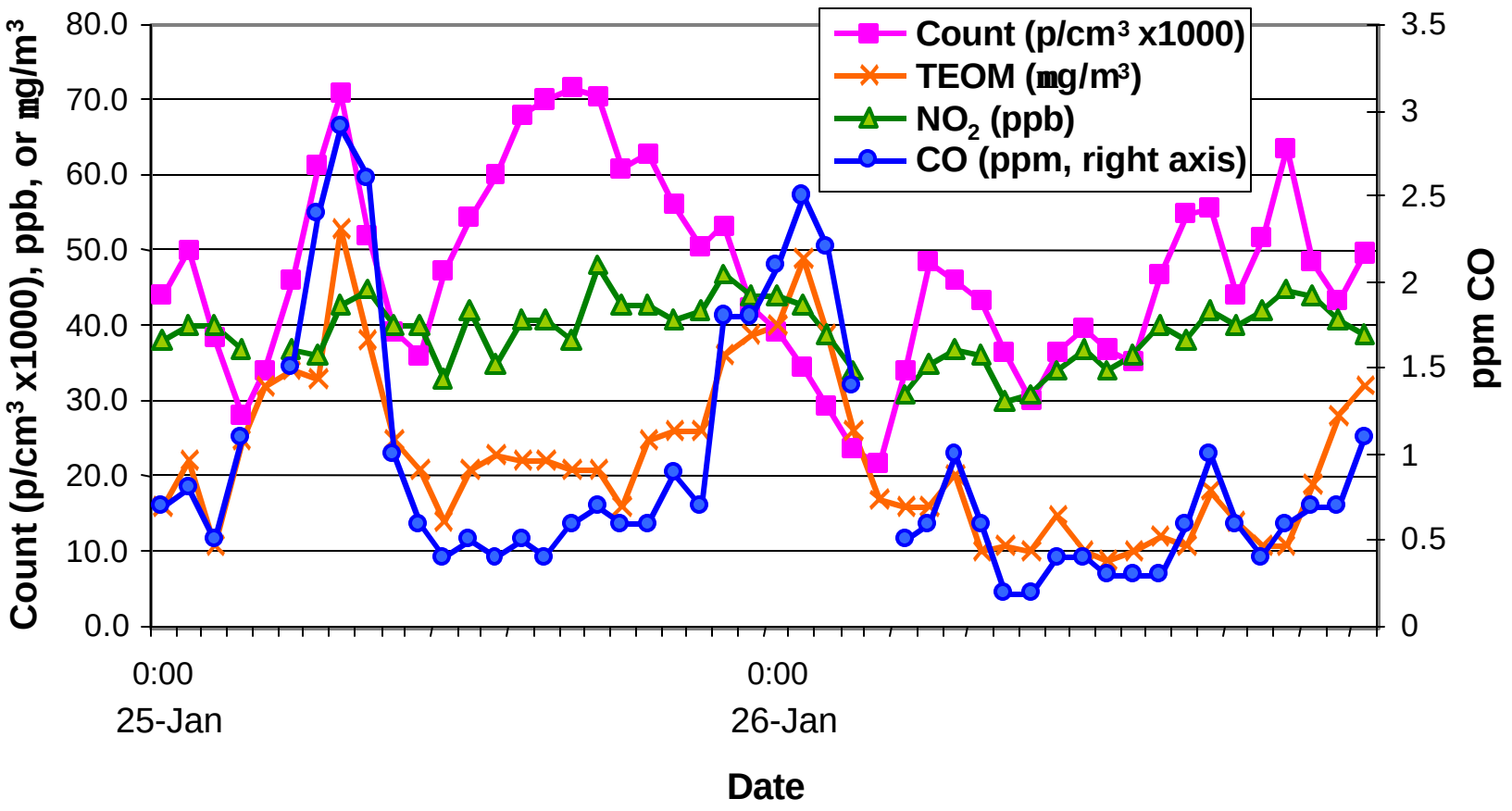
Glendora January 2002



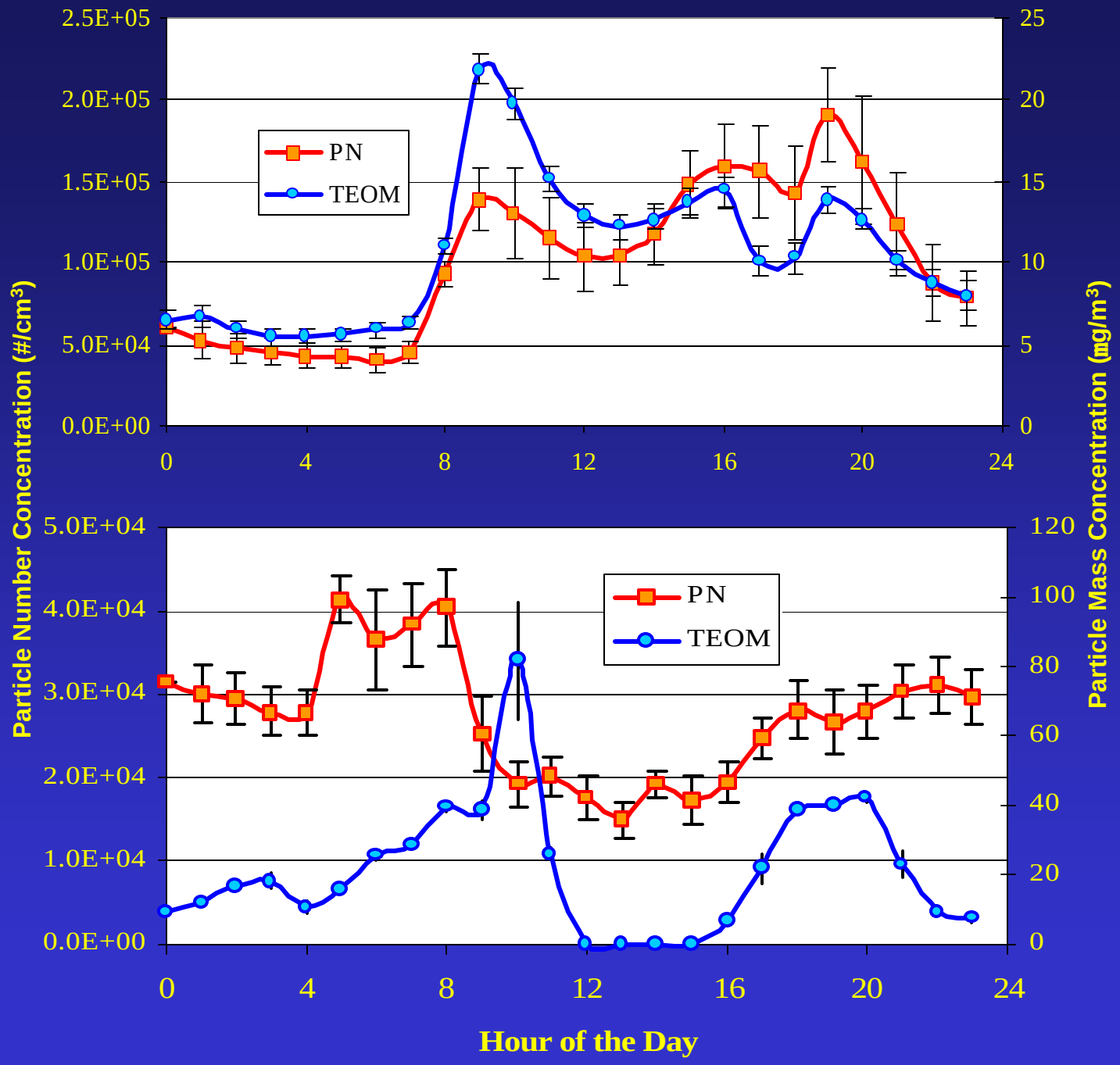
Glendora June 2002



Comparison of Monitored Parameters - Long Beach

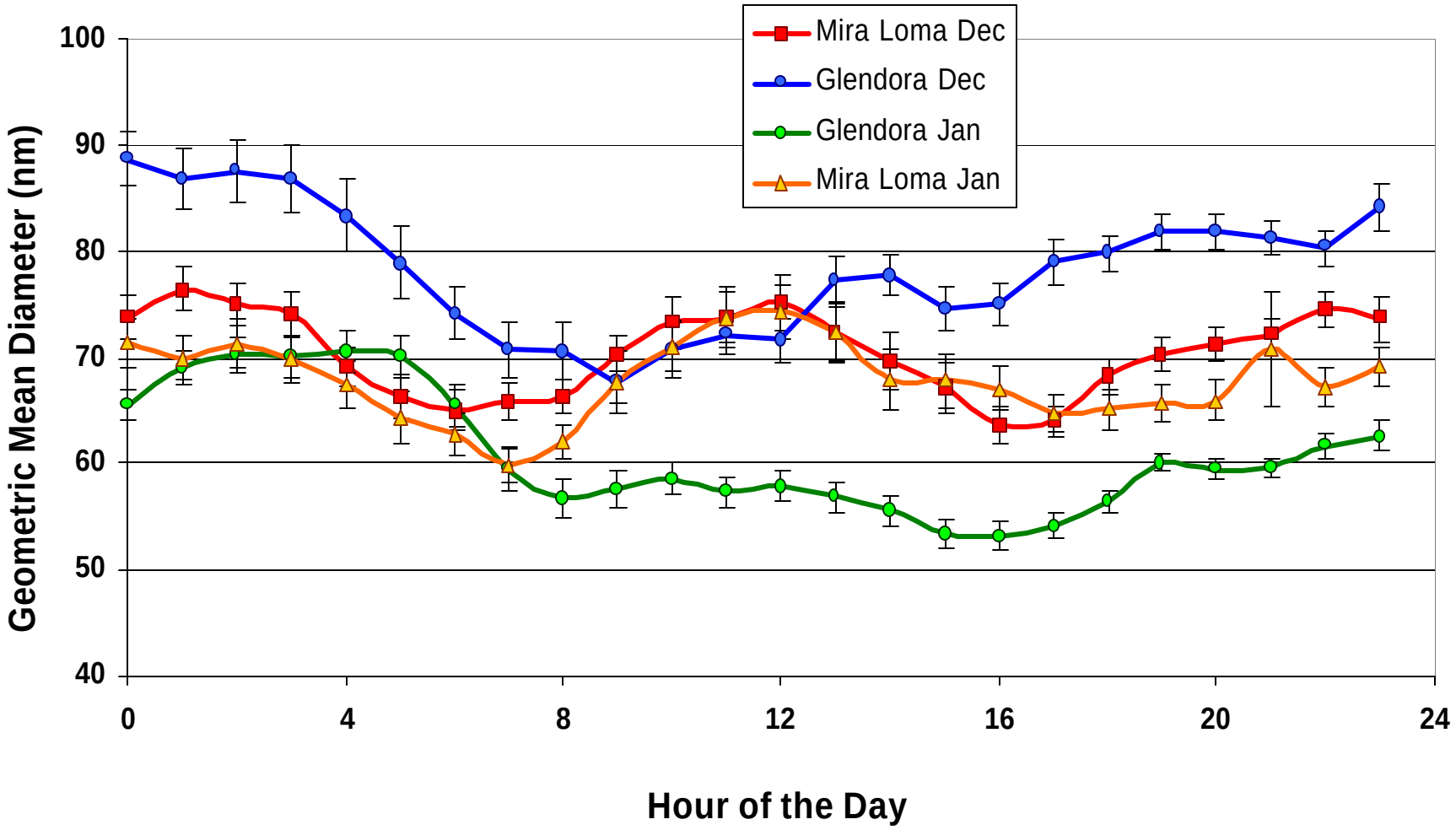


Particle Number *vs* PM10 Mass

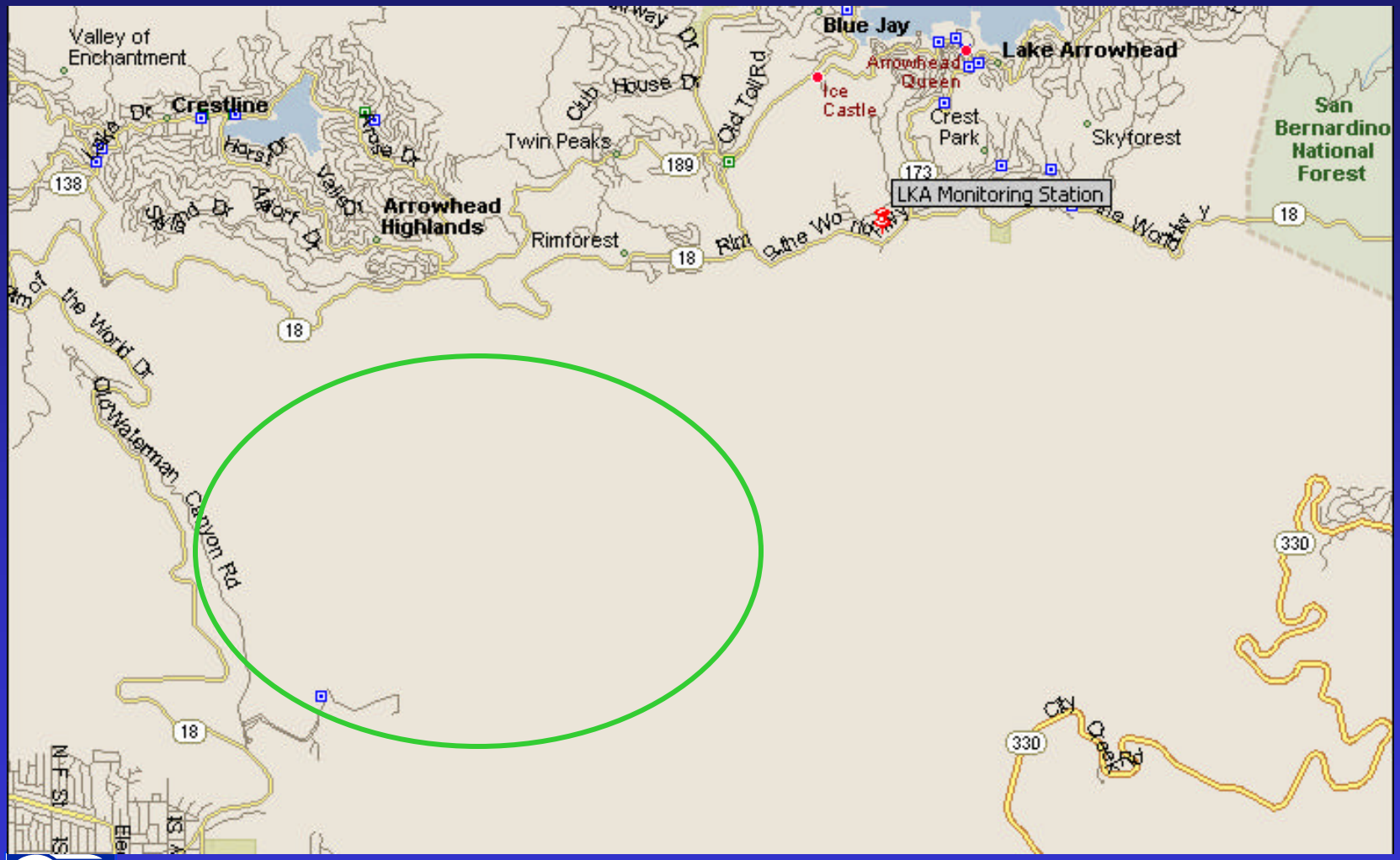


a) Glendora, January 2002
b) Mira Loma, January 2002

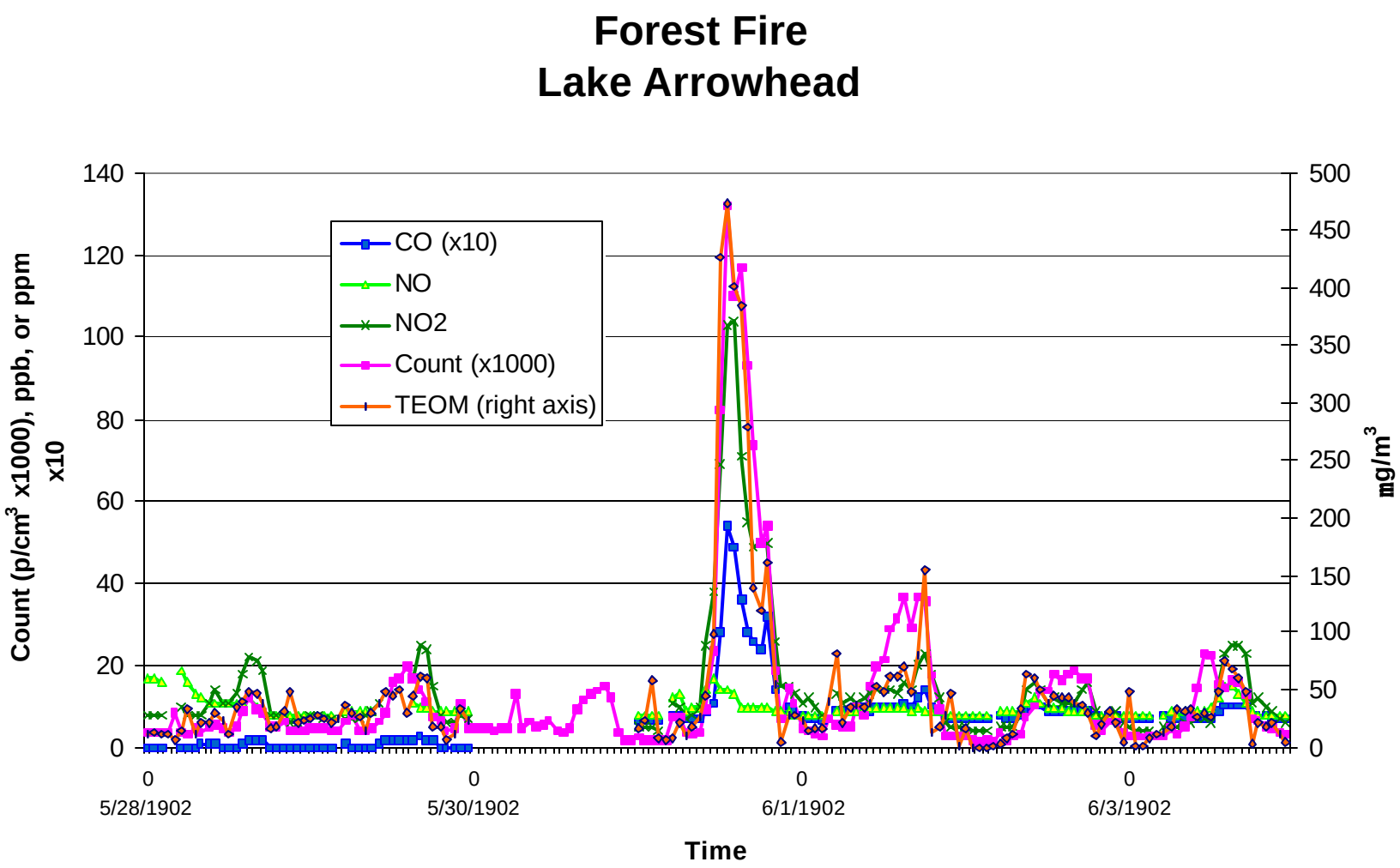
Daily Geometric Mean Diameter



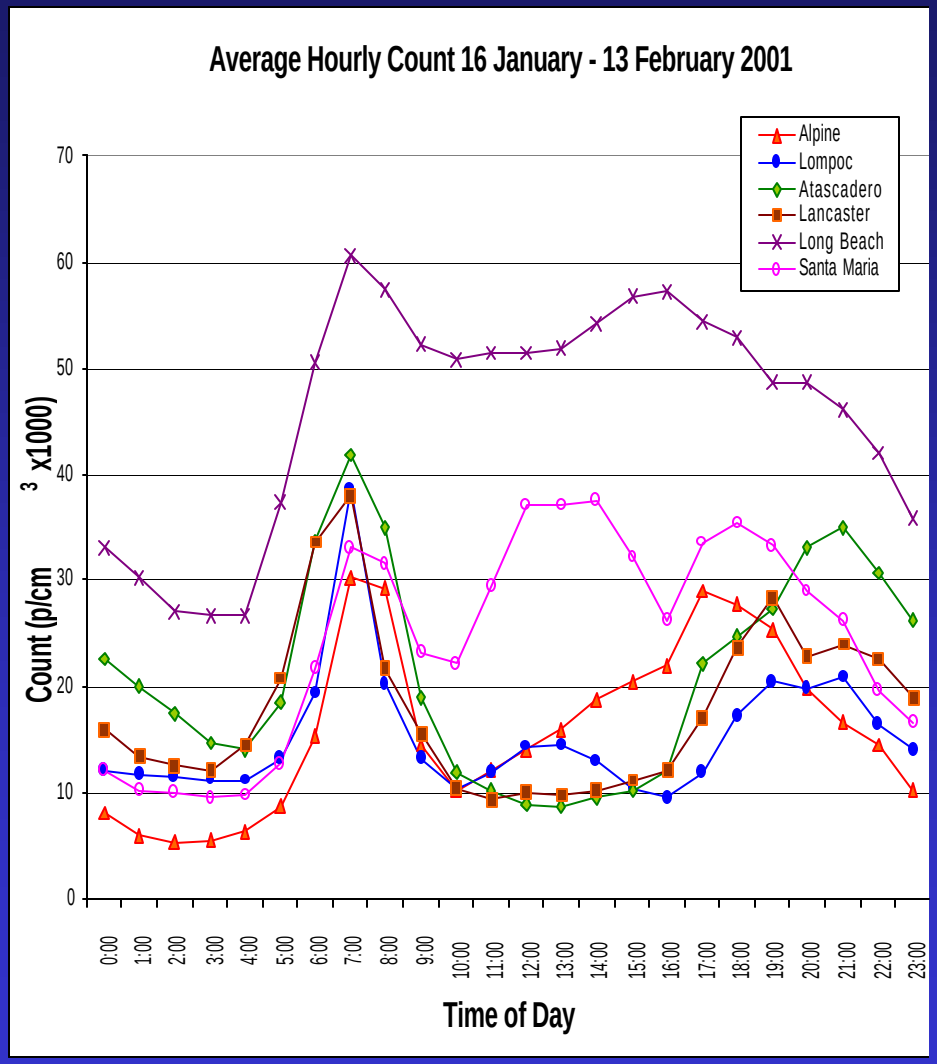
Lake Arrowhead Forest Fire

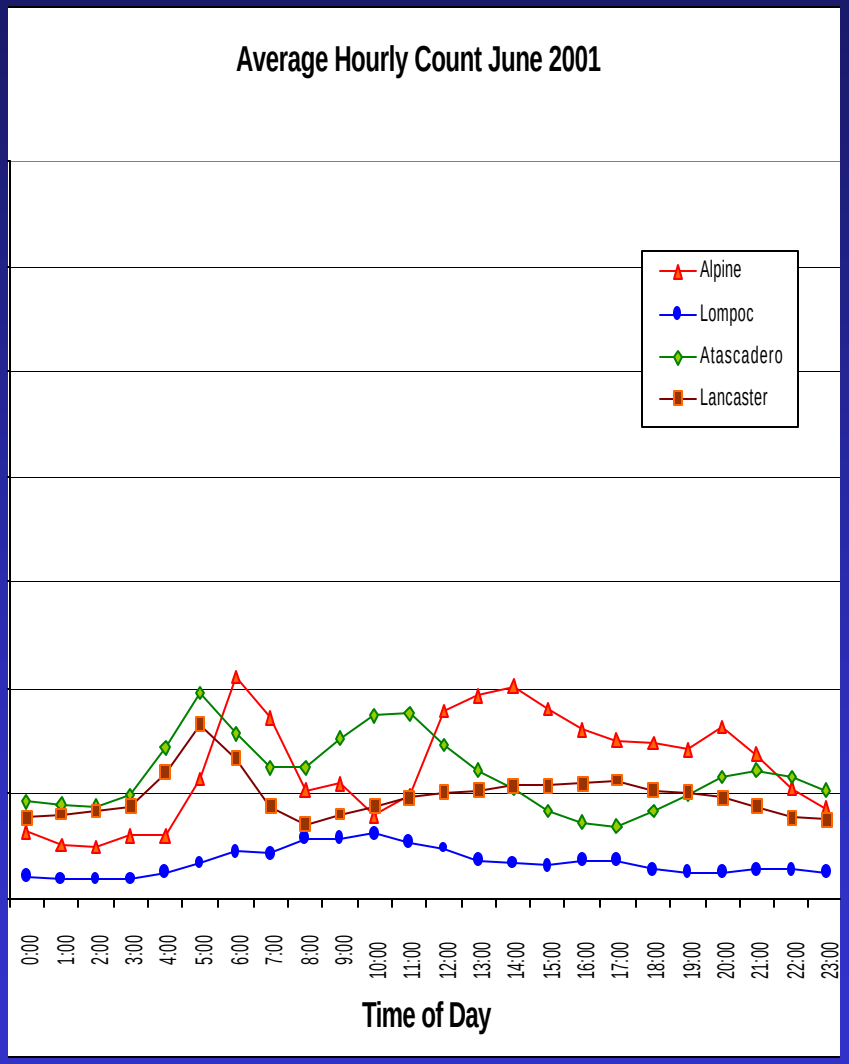


Forest Fire Effects

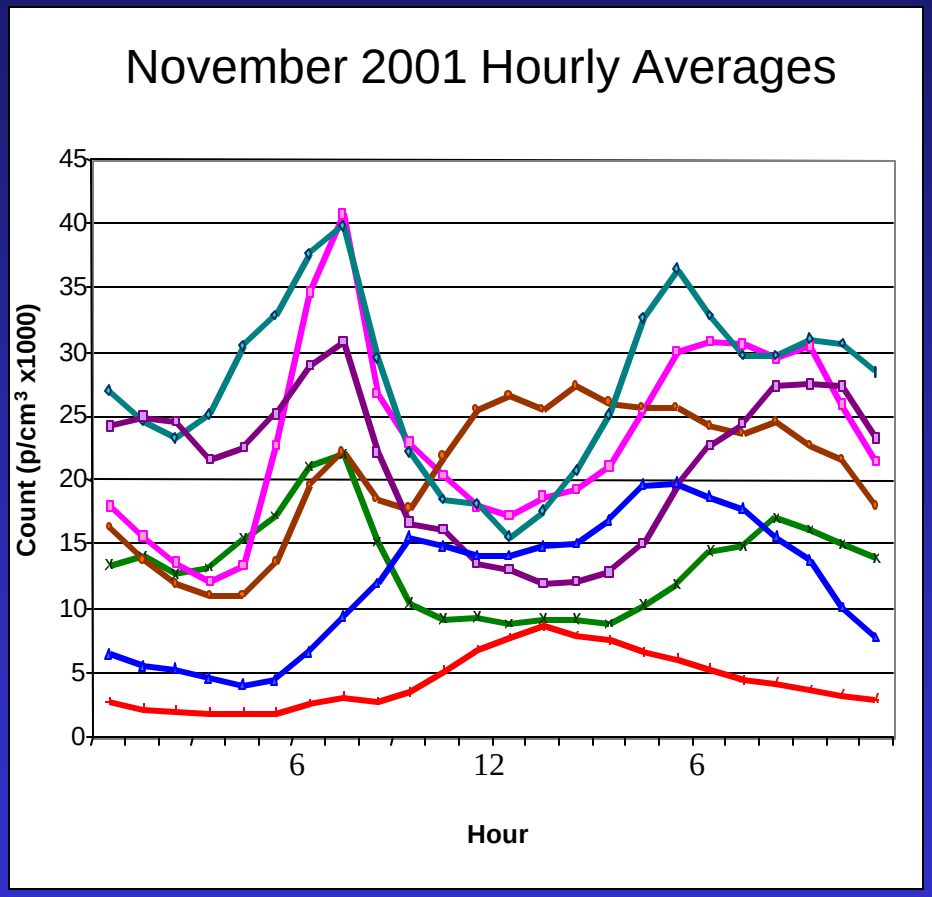


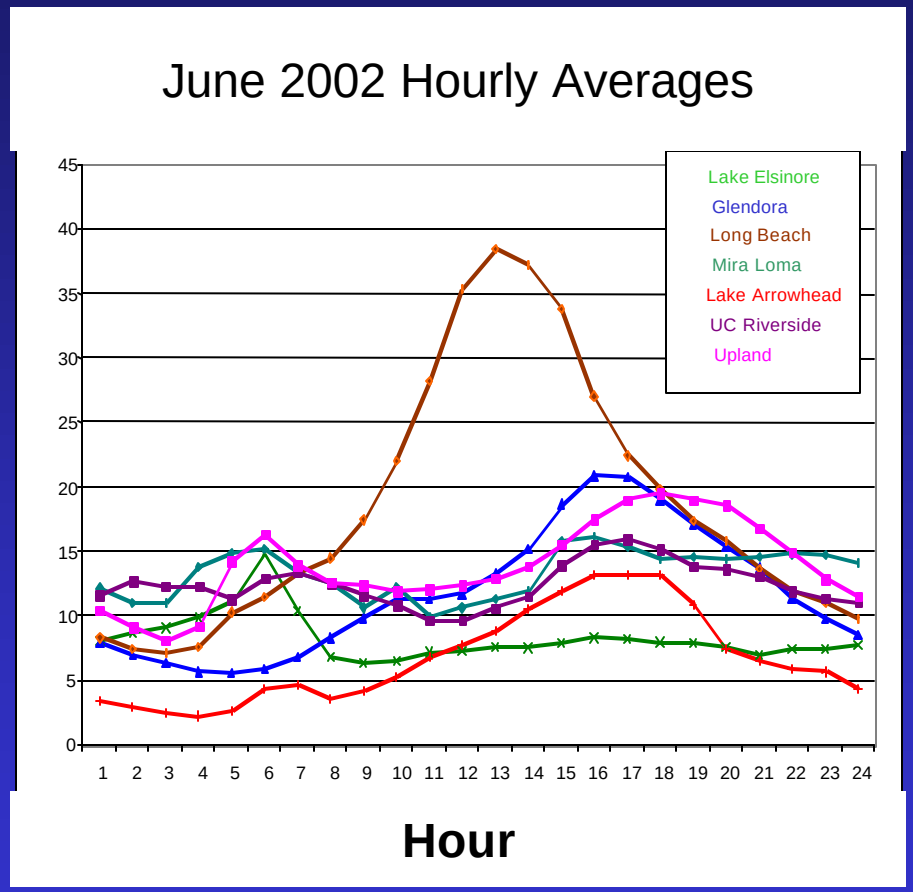
Seasonal differences



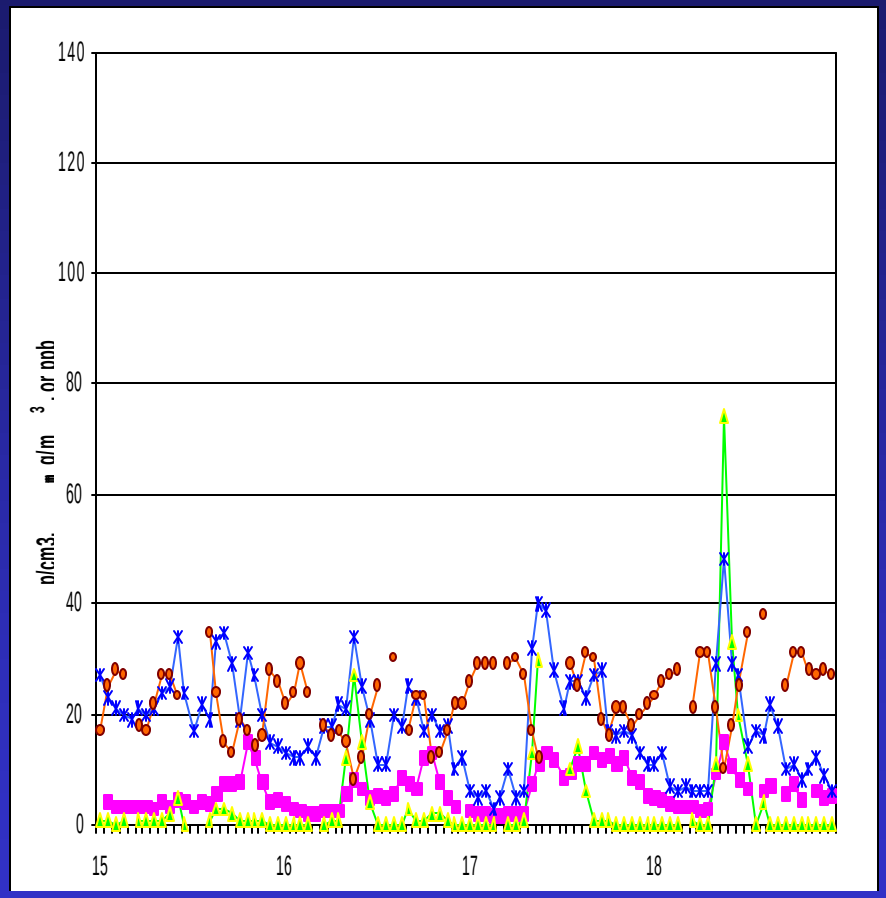


Seasonal Differences at Seven LA Basin Sites

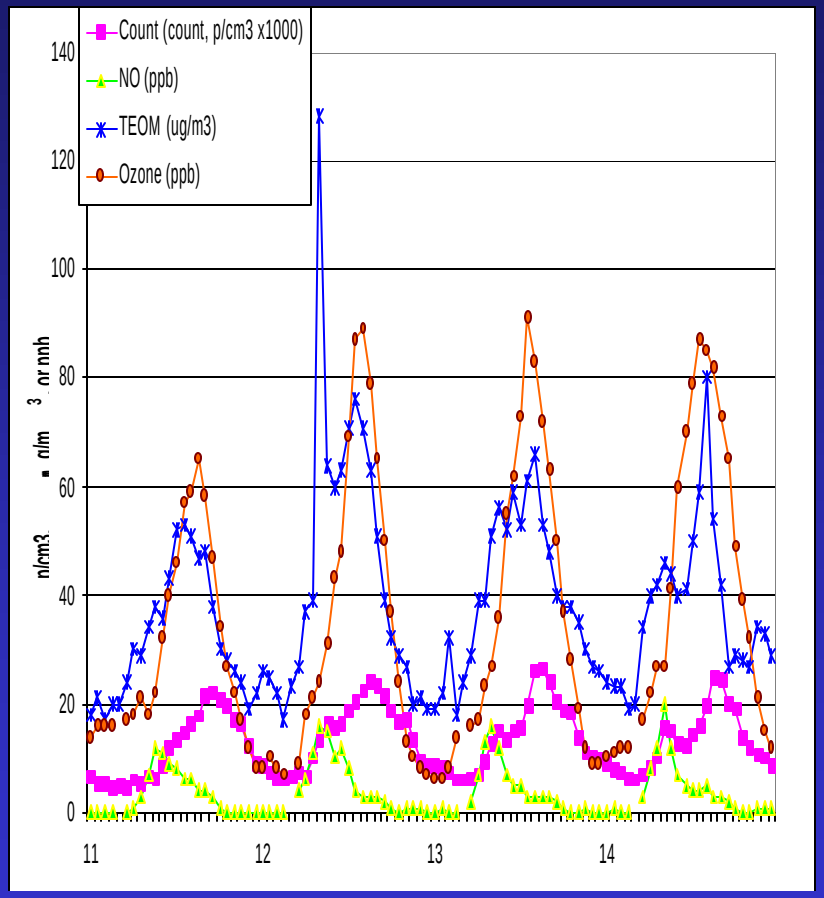




Seasonal Observations
Glendora

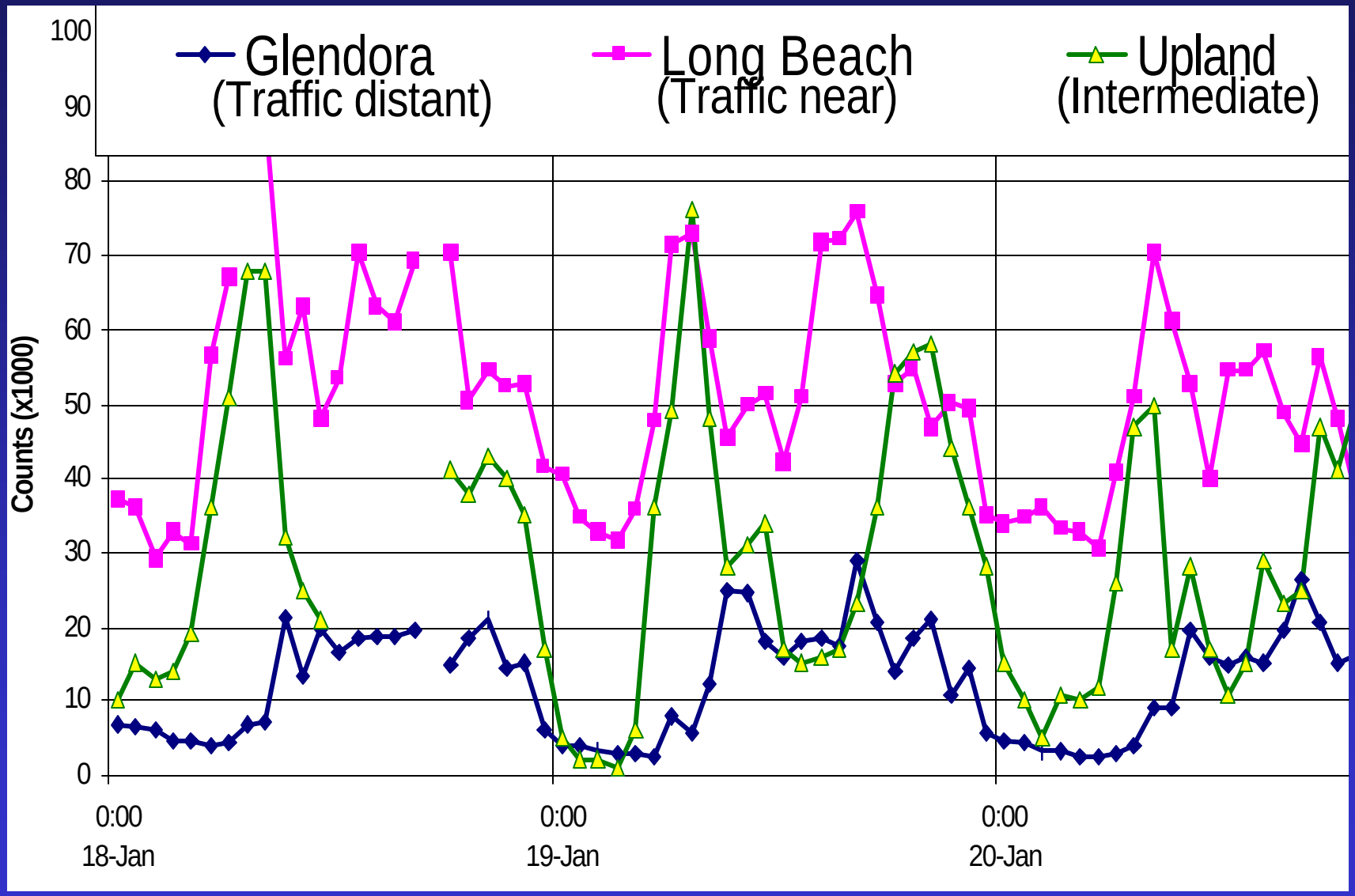


Day (January 2002)



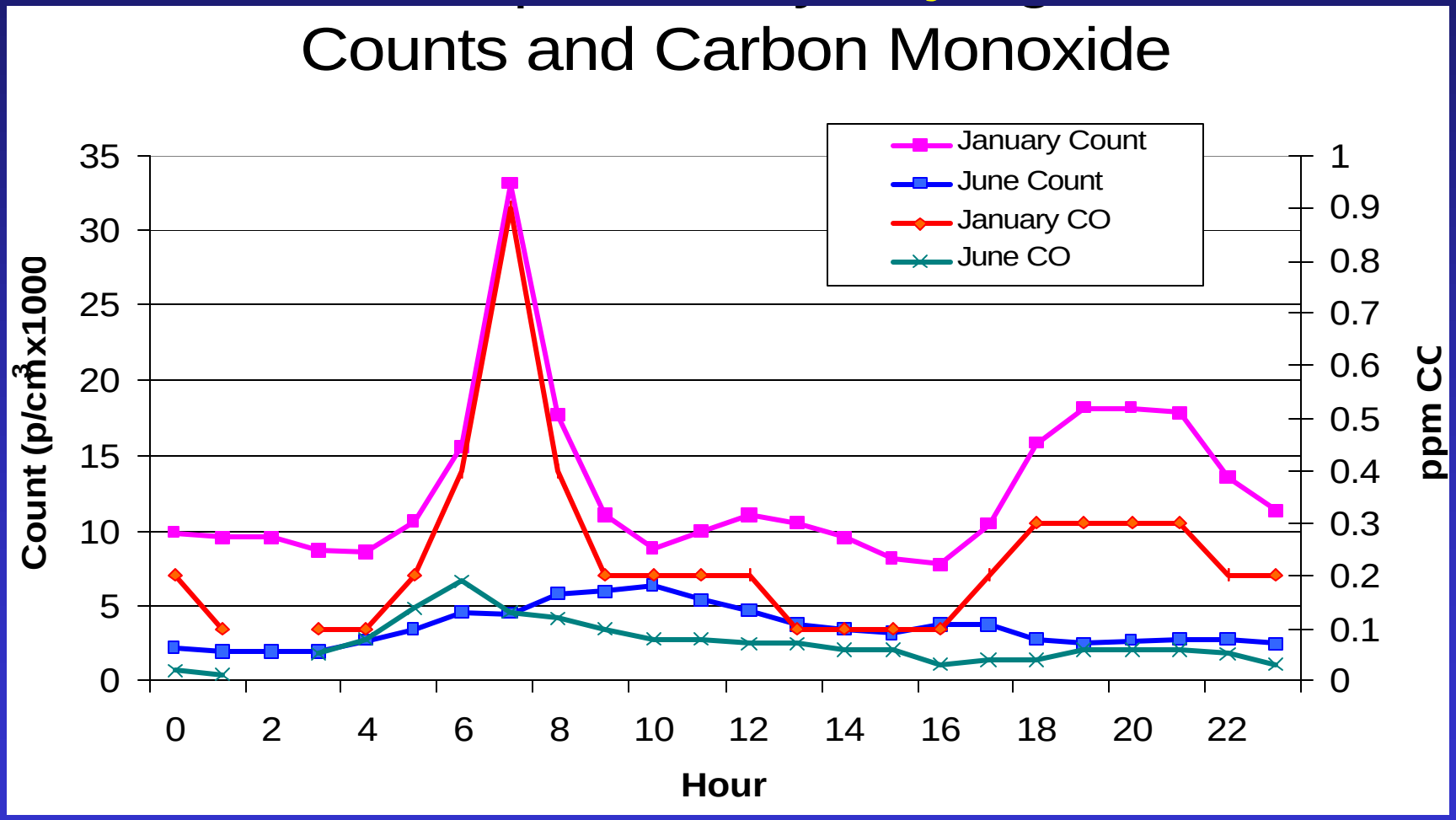
Day (June 2002)

Distance from Highways

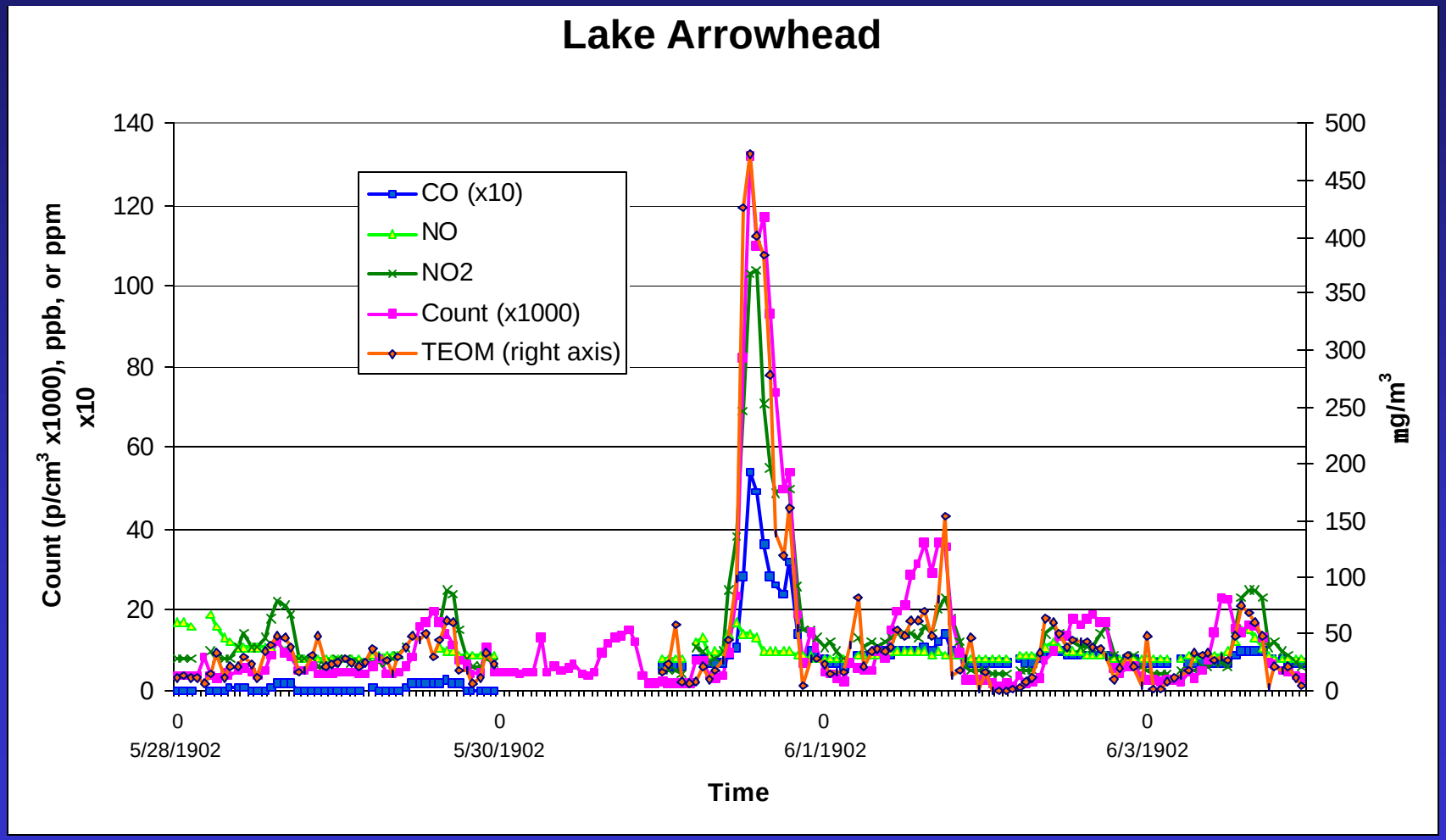


Impacts of Unique Local Sources

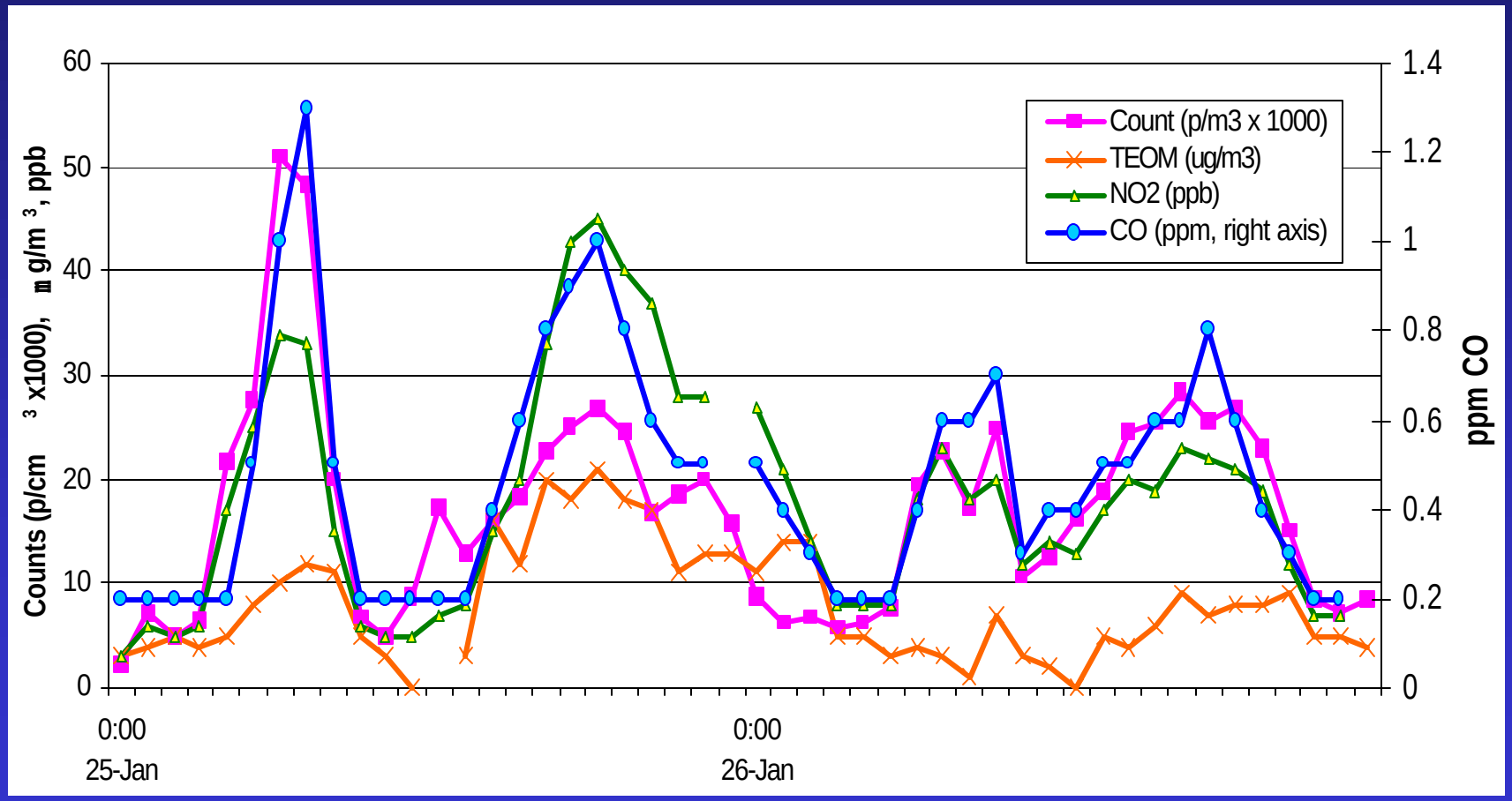
What's different January vs June?



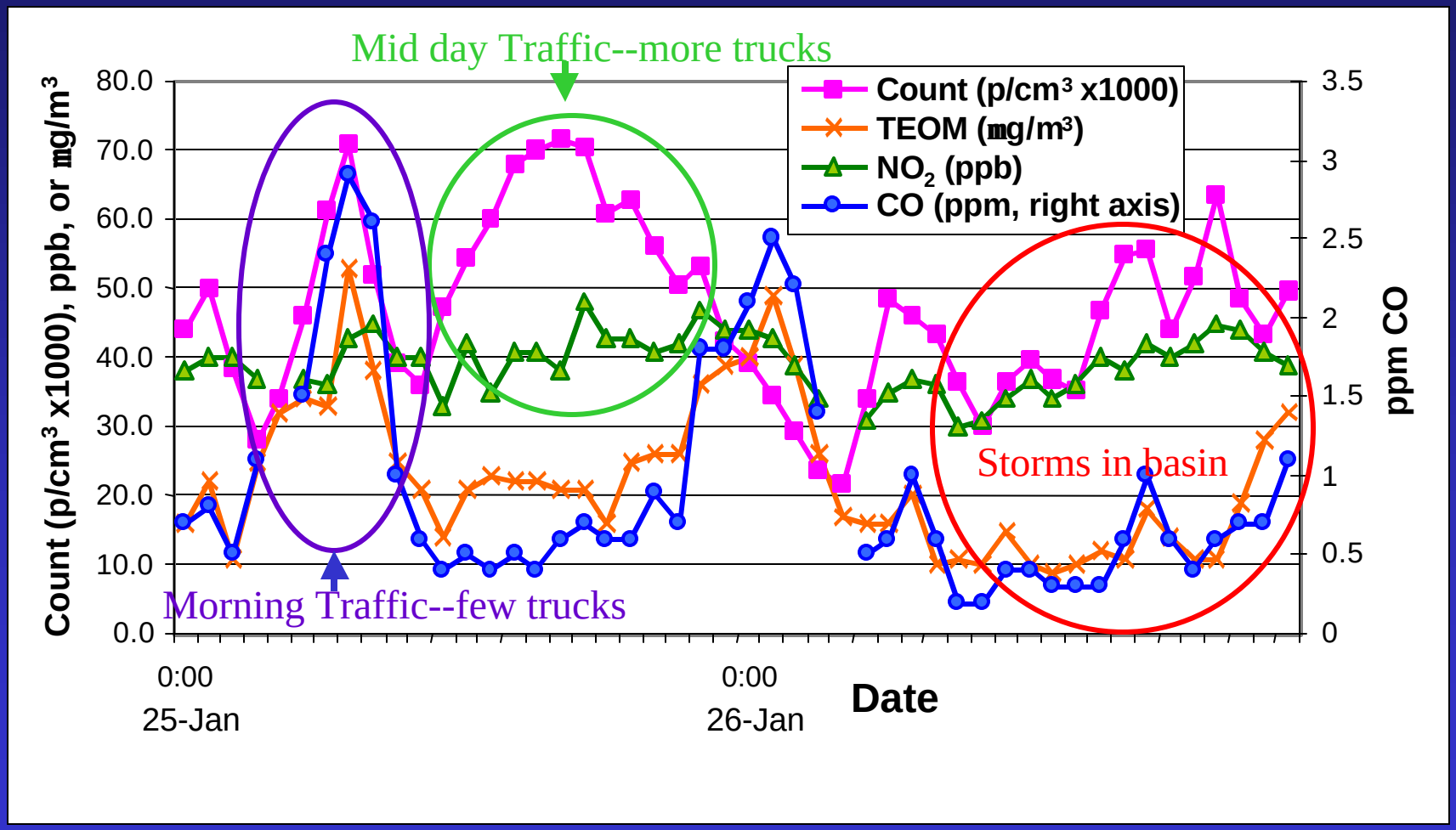
Impacts of Unique Local Sources
A Forest Fire



Sometimes Pollutants Track Together--Lancaster



Sometimes Pollutants Don't Track Together—Long Beach



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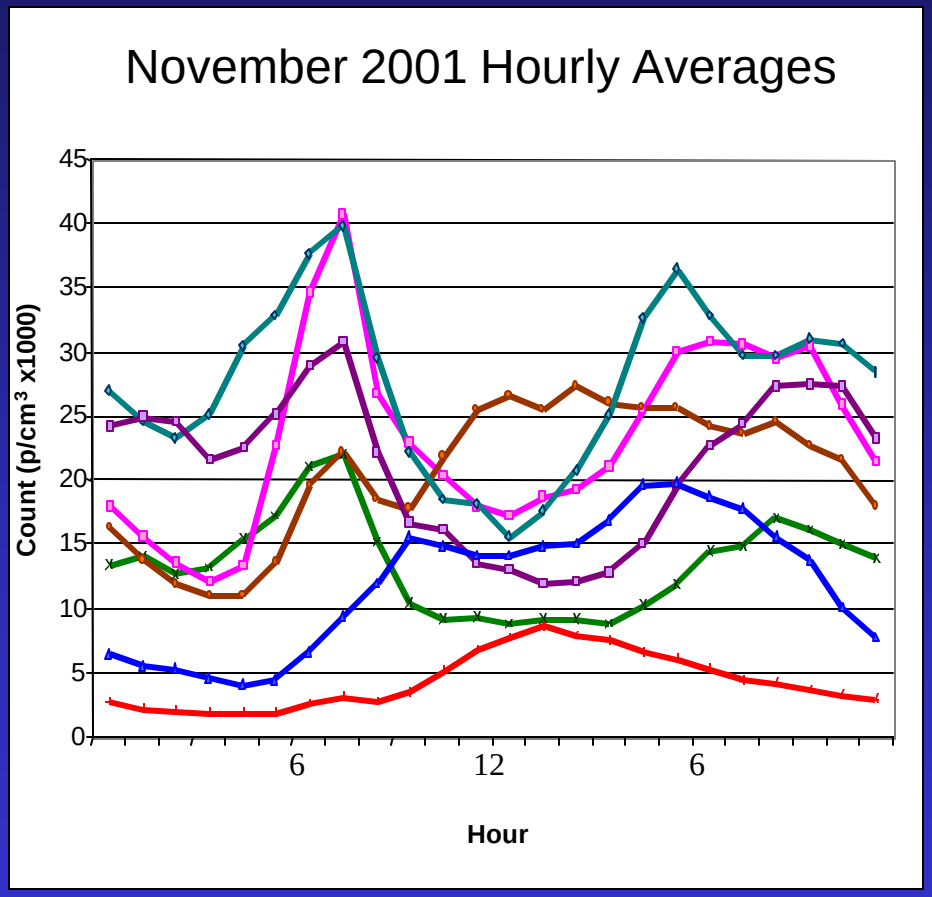
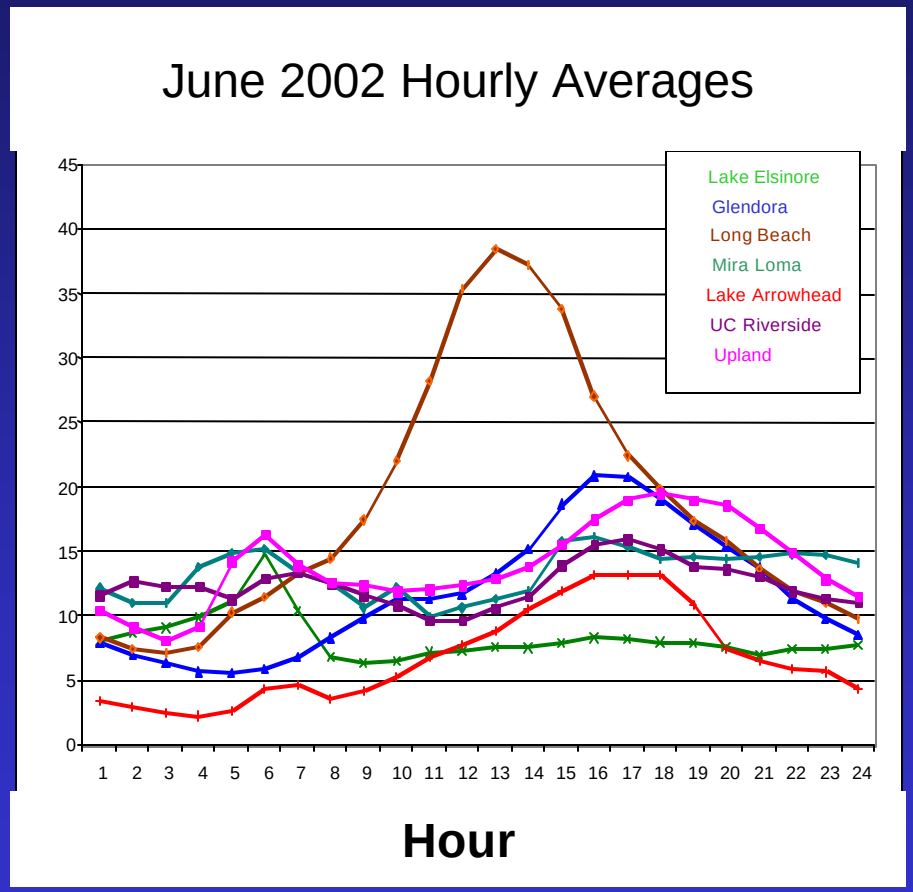
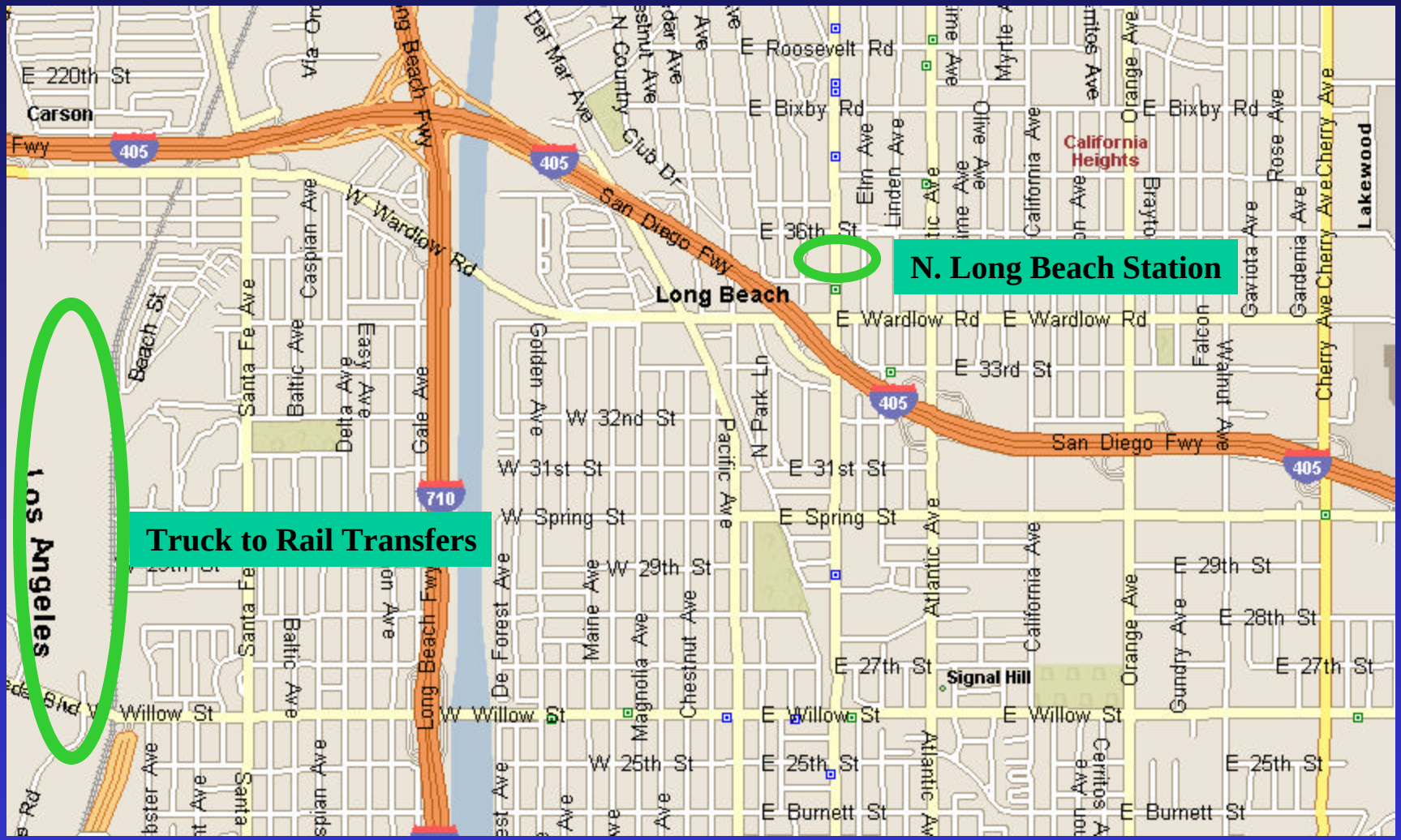
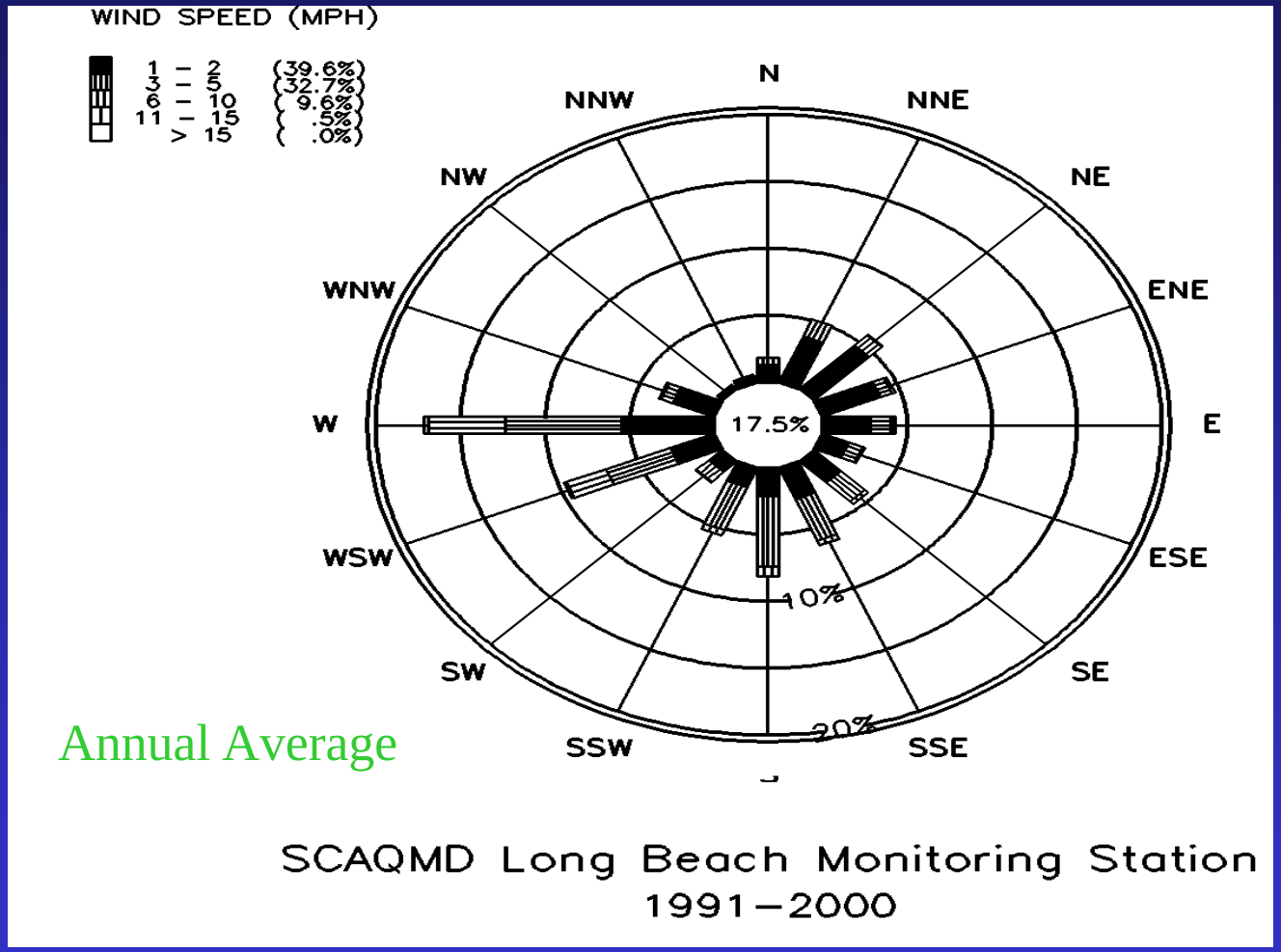




North Long Beach and Local Sources

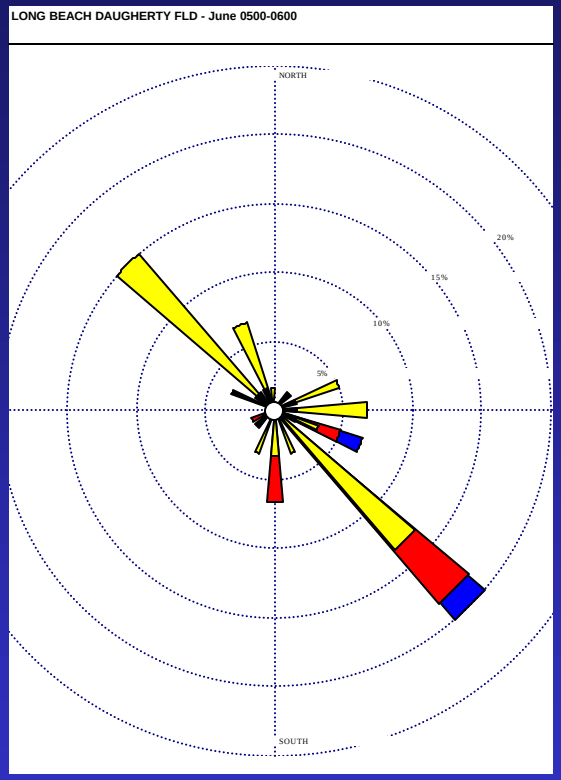


Winds at North Long Beach Site

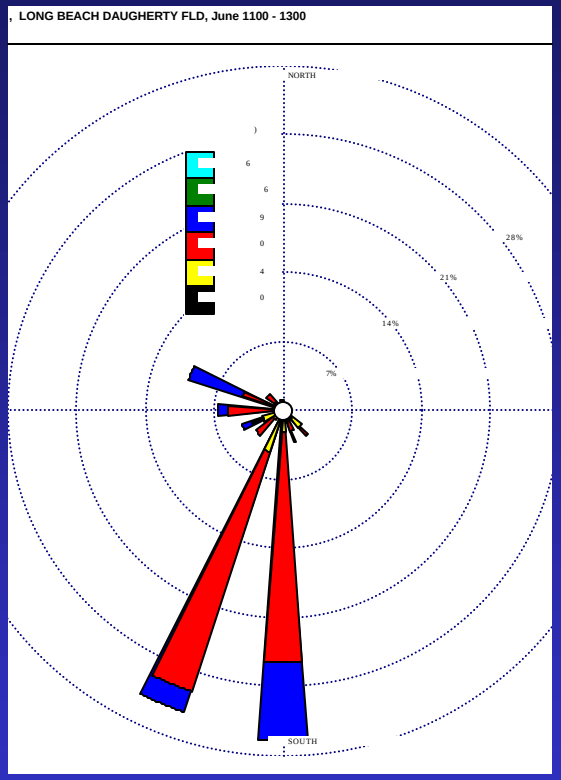


Annual Average

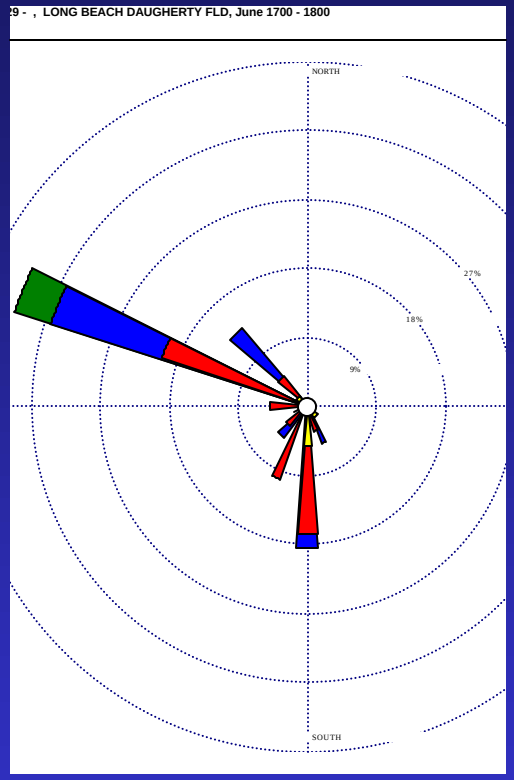
Winds at Long Beach Airport
Hourly Average Samples



5-6 AM



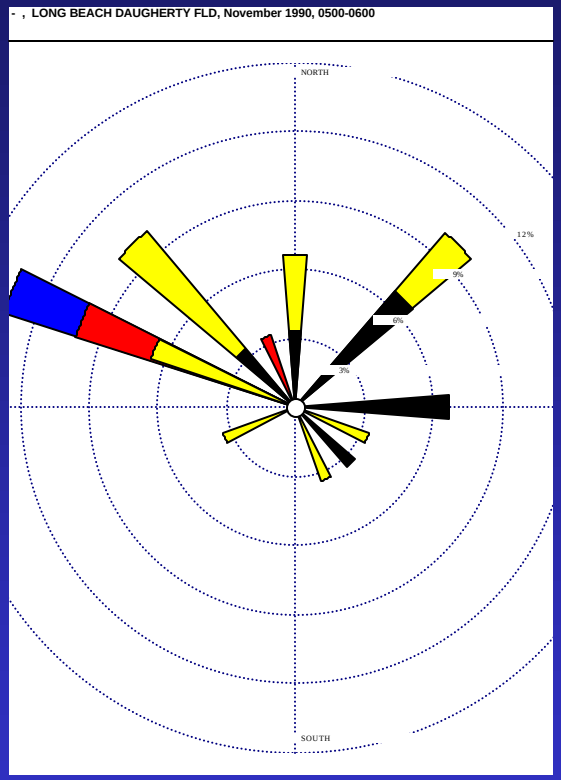
11AM-1PM

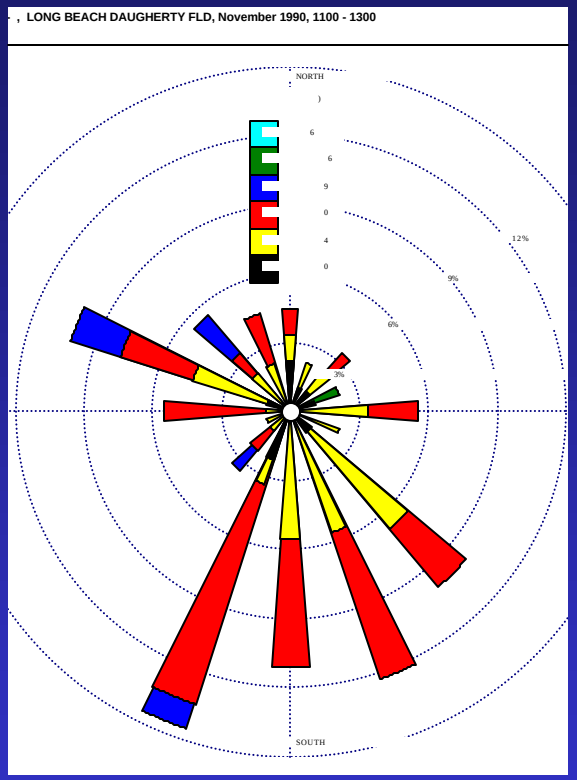


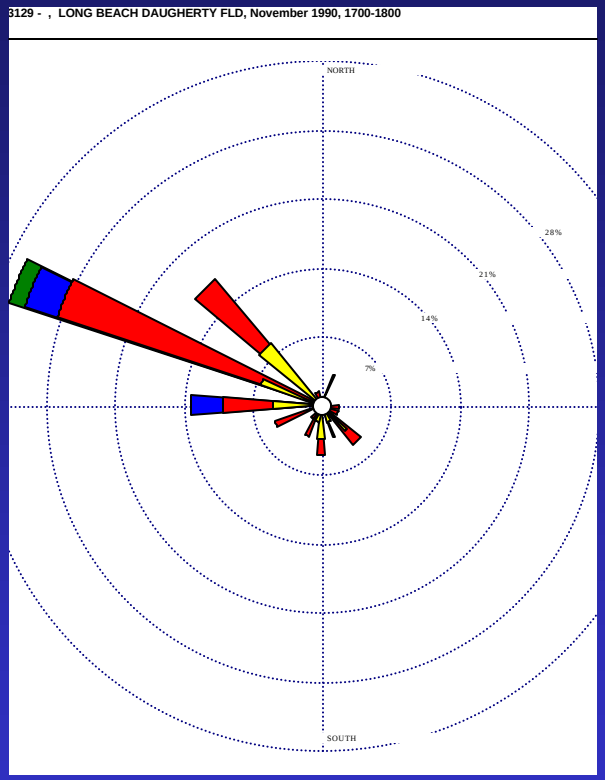
5-6PM

June Winds

Winds at Long Beach Airport
Hourly Average Samples





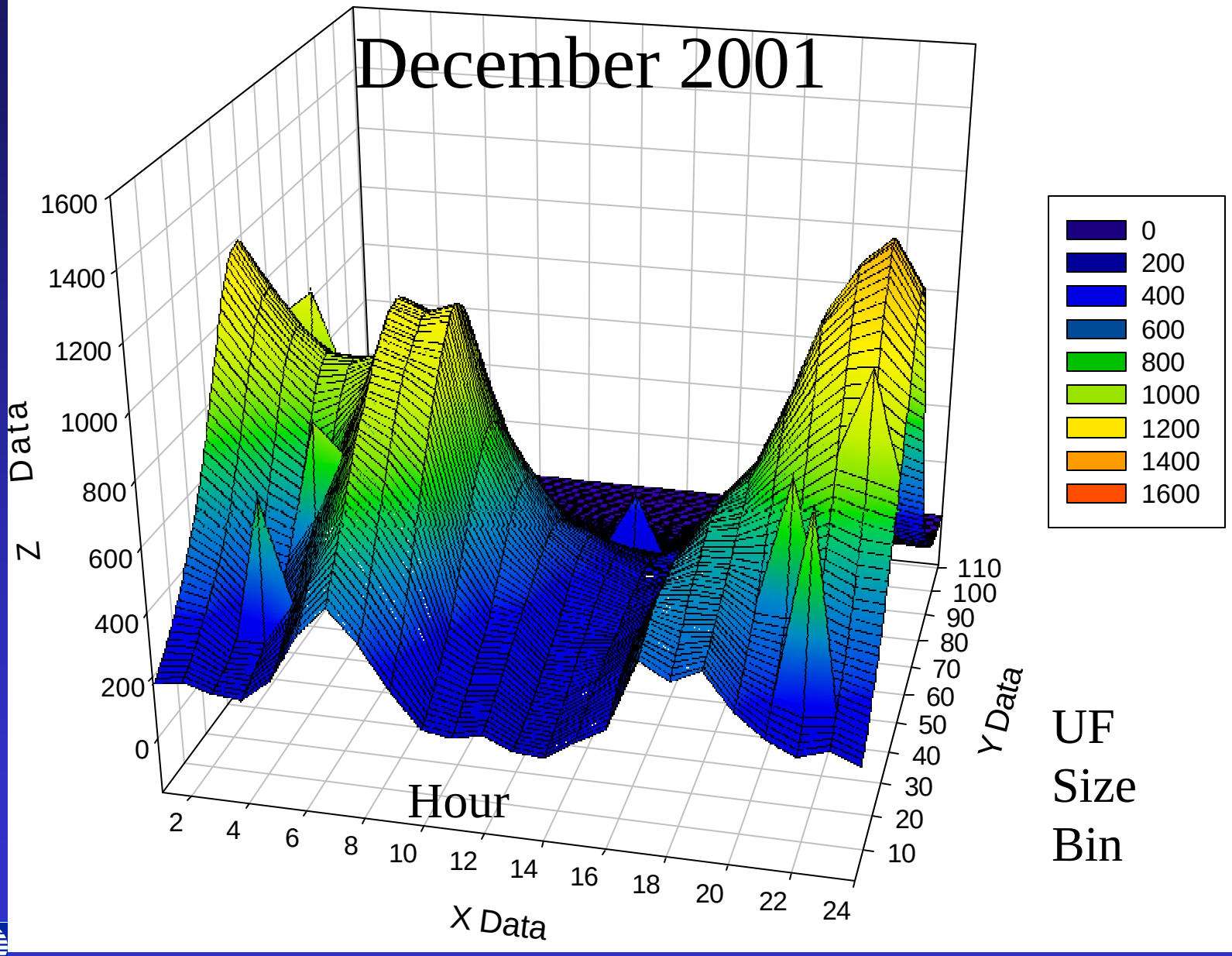


5-6 AM 11AM-1PM 5-6PM

November Winds

Mira Loma Particle Size Distribution

December 2001



Thoughts for Health, Exposure, and Atmospheric Scientists

- Don’t oversimplify interpretation of UF data
- Question whether data represents population
- Consider correlative effects of other pollutants
- Pick sites carefully
- Use consistent terminology for UF particles
- Describe monitoring system performance
- Communicate uncertainties to data users
- Consider community variation
- Emissions don’t equal ambient air
- Size matters