Ultrafine Particles
Coming to a network near you?

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Presented at the National Air Monitoring Conference, Las Vegas
November 8, 2006

Introduction

- Why should you be concerned?
- What is ultrafine PM?
- What is the current monitoring method?
- Lessons from monitoring data
- Operational and siting issues
- Are new technologies needed?
- Conclusions

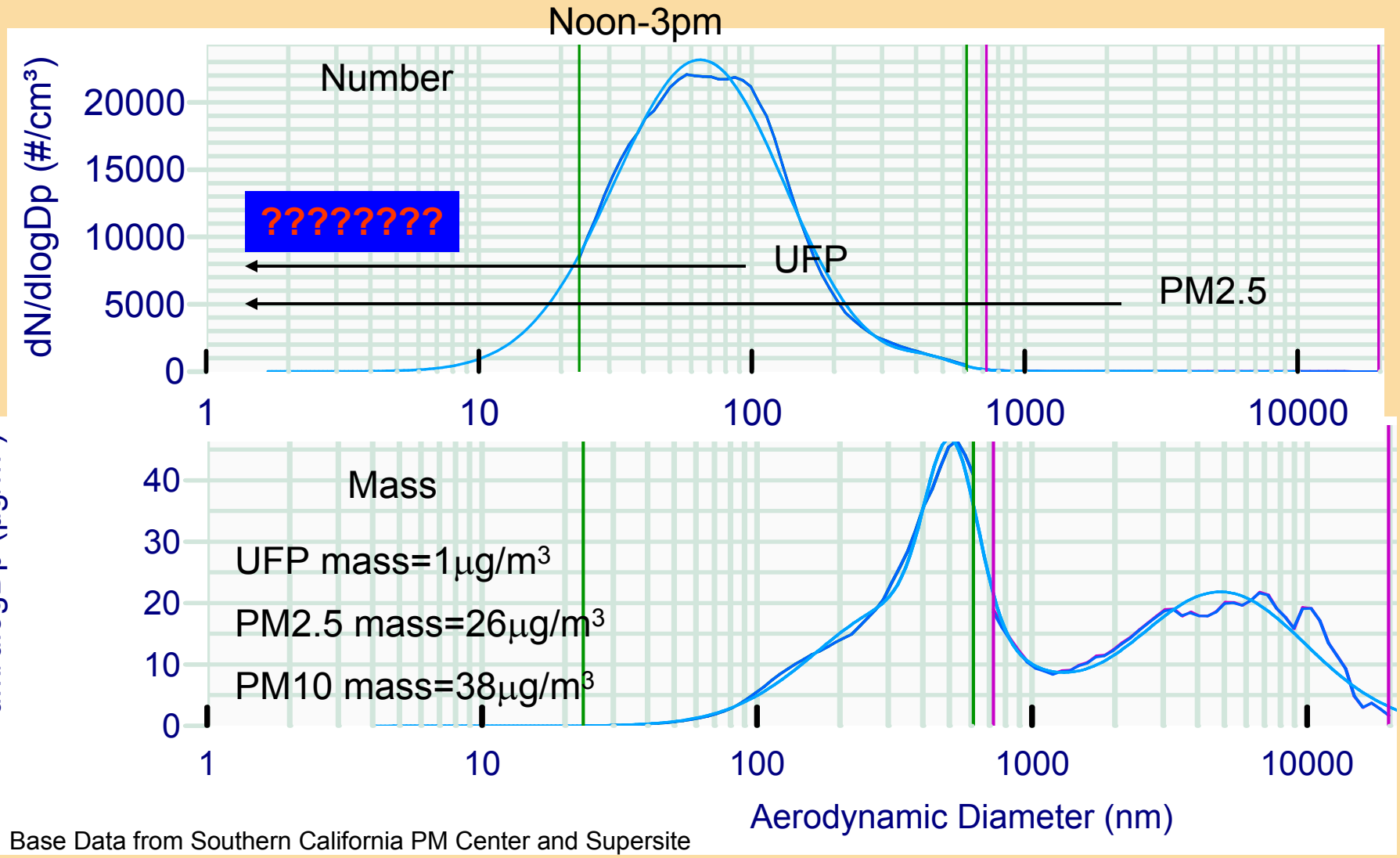
Why the Concern?

- Health impacts
  - Harmful constituents in UFP (toxic organics, metal, carbon)
  - Studies very suggestive of health impacts
  - Co-pollutants commonly present
  - Specific UFP metric of concern is not known
    - Counts, surface area, bulk chemistry, surface chemistry, size, solubility, ???
- Exposures to UFP common in community air
  - Outdoor, indoor, in-vehicle, special micro-environments
- An ambient air quality standard may be coming
  - If so, you need to get ready to monitor

What is Ultrafine PM?

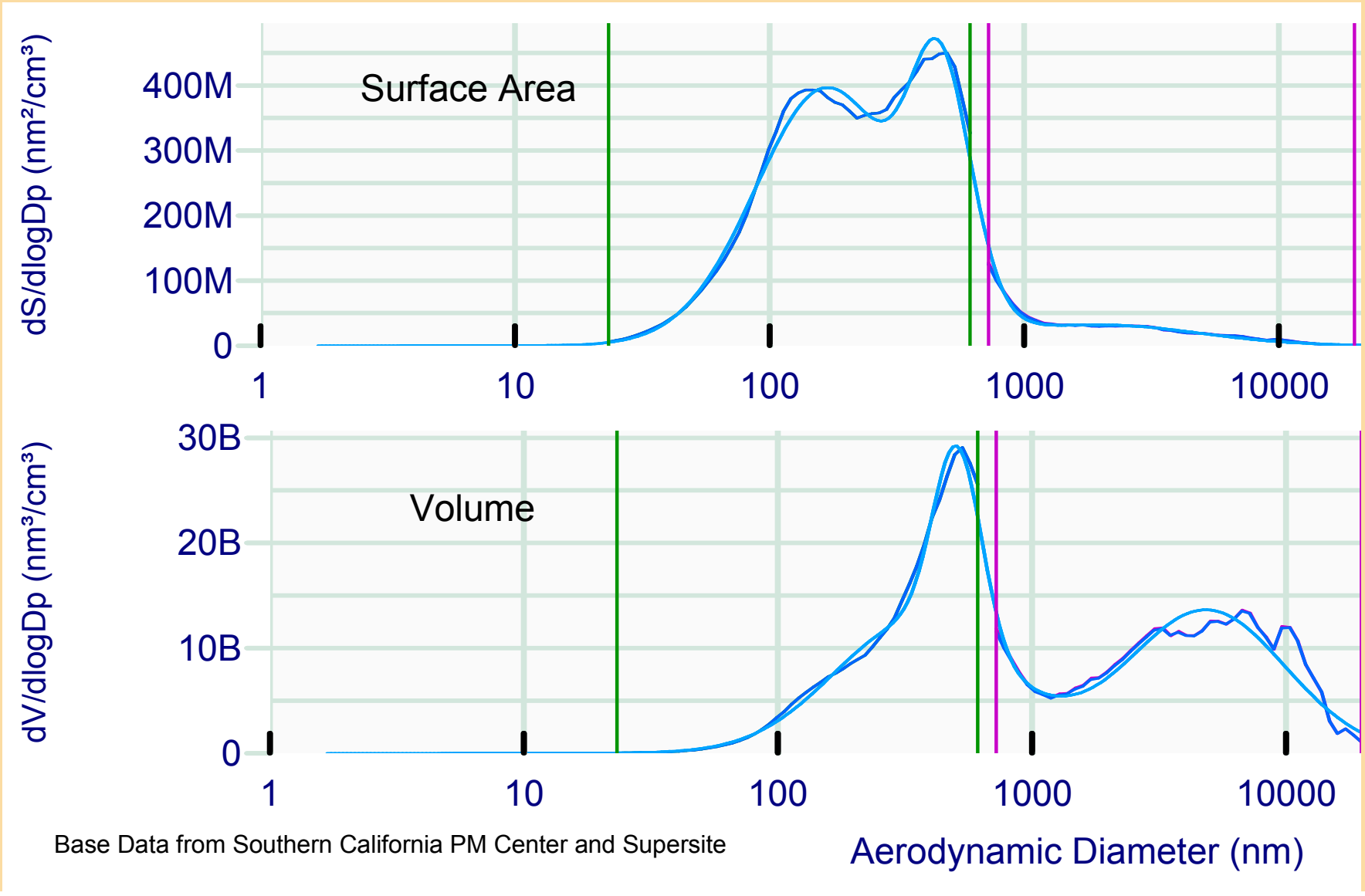
- Ultrafine Particles (UFP)
  - Liquid droplets, dry particles, or combinations <0.1 μm diameter
  - Large particle numbers in urban air (10-40K/cm^3)
  - Low mass in urban air (less than 1 or 2 μg/m^3)
  - Invisible to optical methods
  - Combustion and atmospheric chemistry are common sources of ambient UFP
  - Very complex spatial distributions exist
    - Strong concentration gradients in community air
    - Very high concentrations near freeways, airports

Particle Number and Mass Distribution 9/13/03 at USC



Base Data from Southern California PM Center and Supersite

Particle Surface Area and Volume Distribution 9/13/03 at USC



Base Data from Southern California PM Center and Supersite

Current Monitoring Method

Condensation Particle Counter (CPC)

- Old technology--based on cloud chamber effect
  - Grow nm particles in saturated alcohol or water atmosphere
  - Then use optical counter to determine number concentration
- First widespread application was in clean rooms
  - Needed to count very low levels
- CPCs are now common in air pollution research studies and to monitor industrial processes
- CPCs in routine air monitoring are novel
  - Children's Health Study included 12 sites in 2001
  - Currently no widespread use in routine monitoring
- Results are model specific!
  - No explicit upper size cut
  - Performance in smallest sizes is model specific

A Sample of CPCs

CPC as Deployed in Children's Health Study

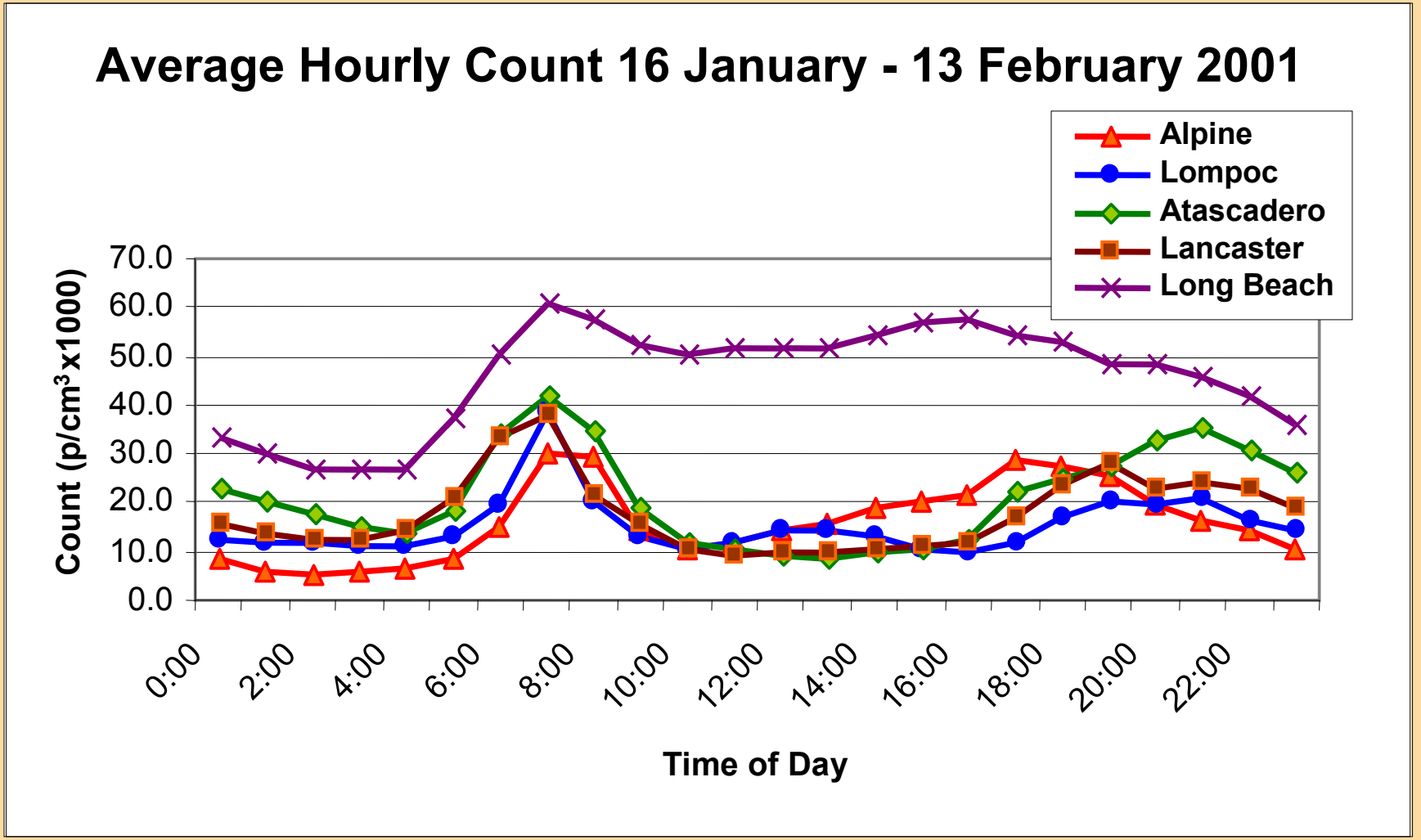
Model 3022a CPC

Conditioned enclosure

Data, Lessons and Issues

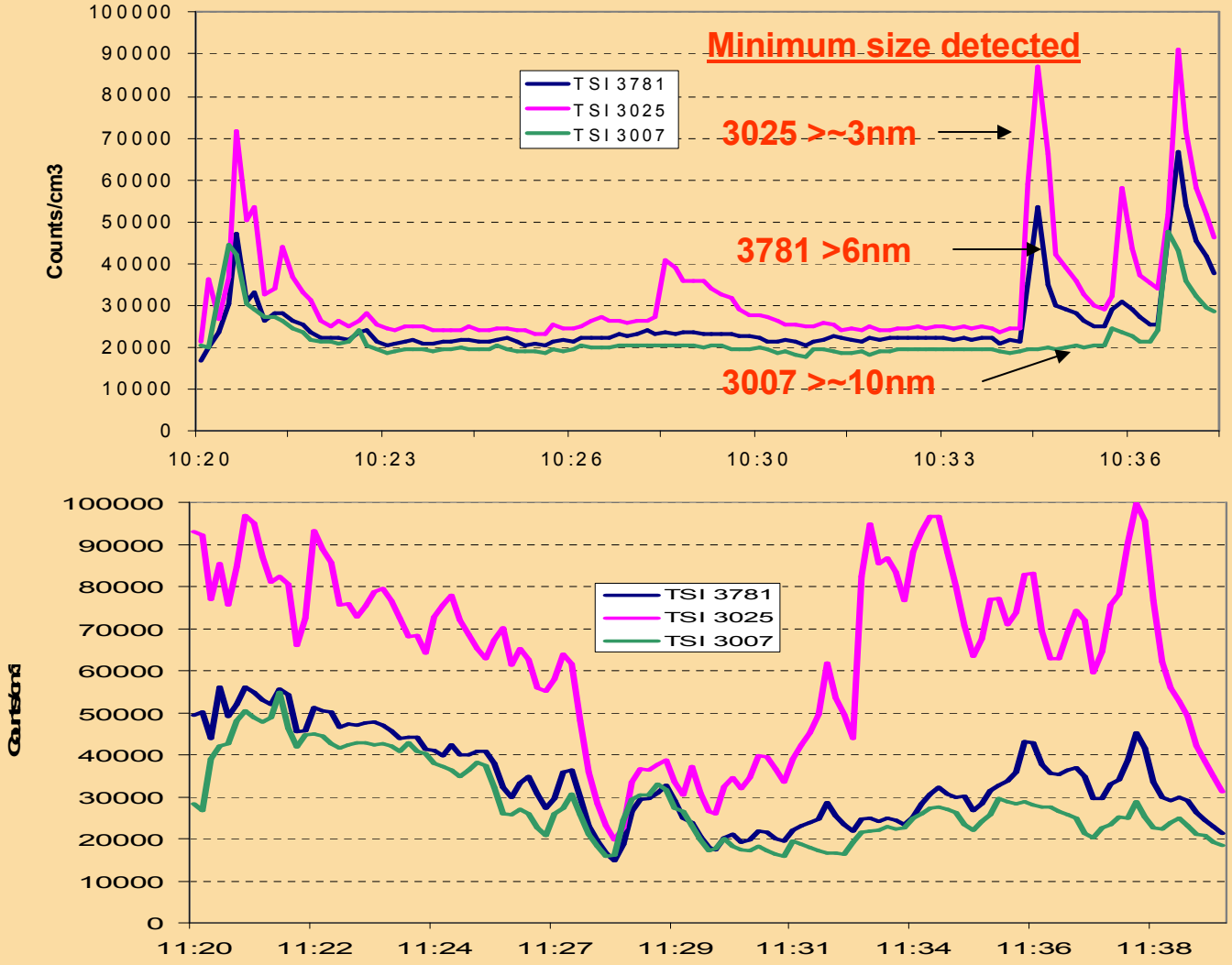
Example Urban CPC Data

Suggests impacts of sources + Met



Data from Three CPCs

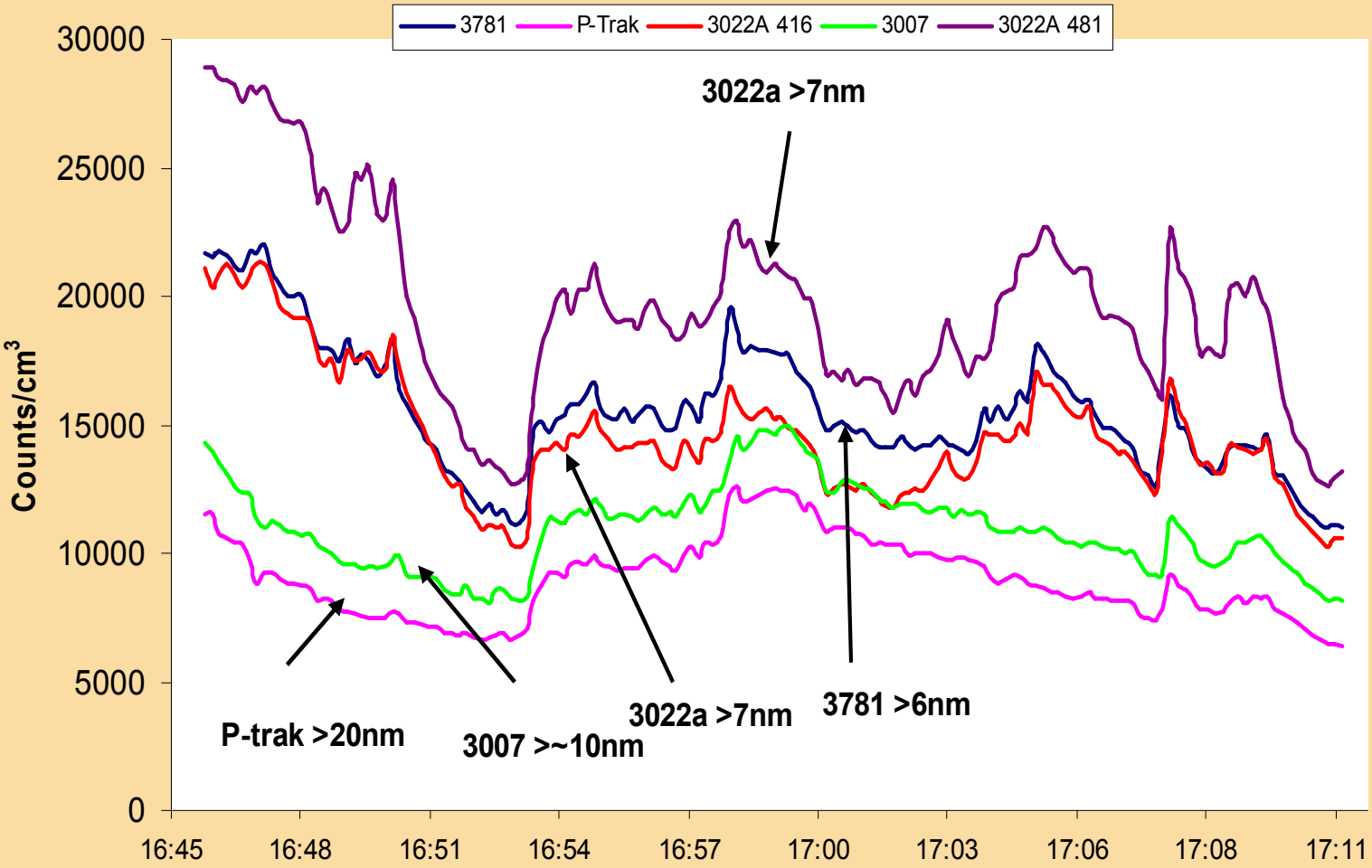
Effects of different lower size sensitivity



1 Atmosphere, 5 CPCs, Many Stories

(Model/minimum size detected)

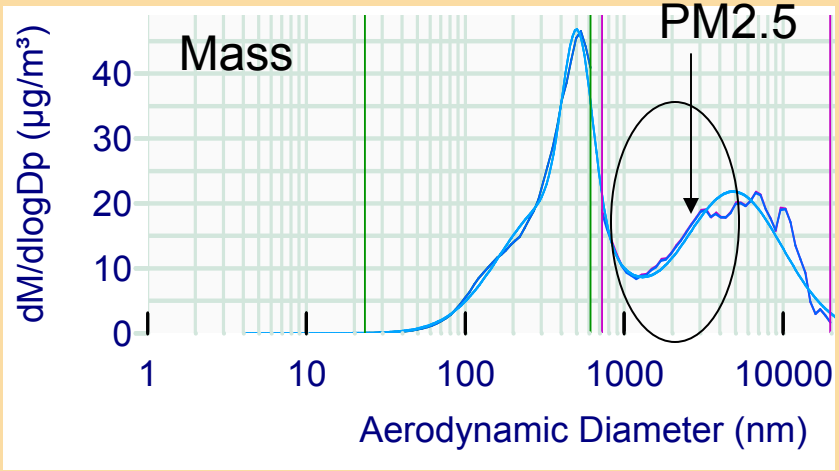
Know your CPC, Have a data objective, Calibrate your CPC!

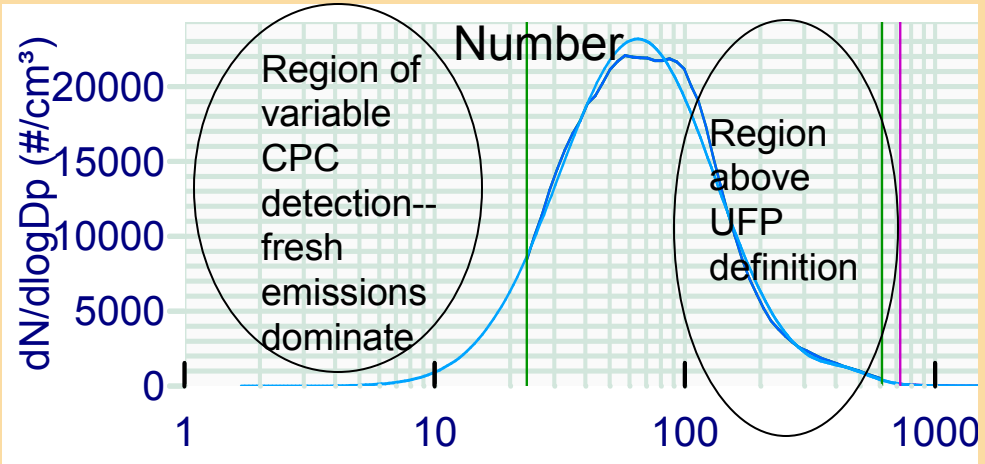


Upper and Lower Size Issues

Learn from PM2.5—what should size cut be?

- 2.5 μm is a problematic size cut for PM monitoring
- Is 100 nm a poor choice for UFP upper size “cut”?
- Should we select a lower size limit for counting?
- Again, performance of CPCs is model specific



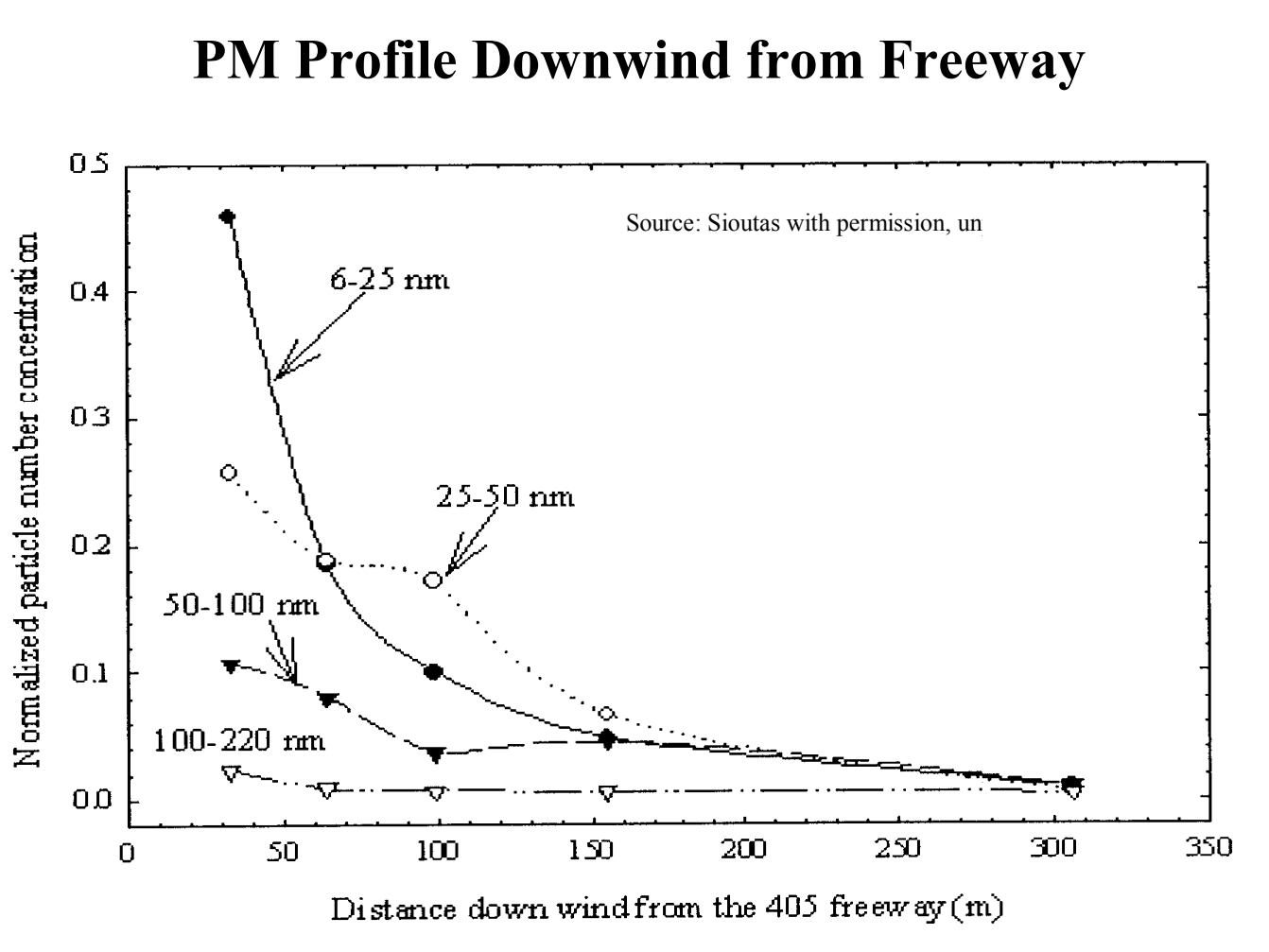


Operational and Siting Issues

Before monitoring UFP on a large scale

- Be careful about defining the index
  - Consider lower size detection + upper size limits
- Consider and limit inlet loses
- Develop + use calibration and reference standards
- Be careful about siting
  - Strong gradients near common sources
- Consider spatial relevance of results
  - Population exposure, source impacts assessment
- Have a clear purpose!

Strong Gradients May Impact Monitoring Data



Are New Technologies Needed?

Yes!

- At least reduce limitations of current CPCs
  - Resolve particle size limits (upper and lower) issues
  - Employ less toxic working fluids
  - Develop calibration/standardization protocols
  - Reduce instrument cost
  - Make machines more suitable for routine use
- Are there alternatives to CPCs?
  - Electrometer-based systems (EAD, NSAM, ELPI)

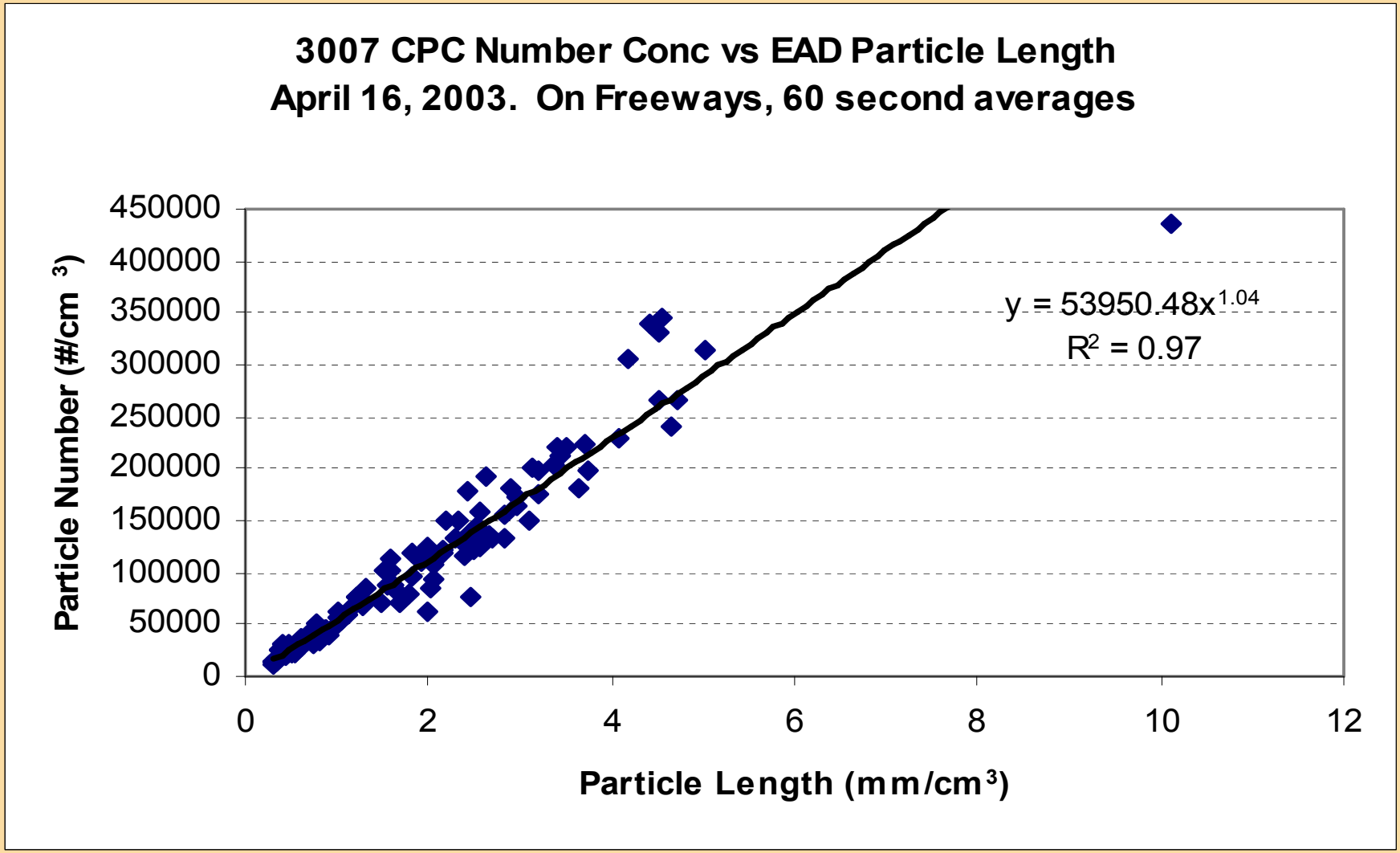
Alternatives to CPCs for UFP Monitoring

Electrical Aerosol Detector/ Surface Area Monitor

Electrical Low Pressure Impactor

Fast Mobility Particle Scanning Spectrometer

Electrical Aerosol Detector vs. CPC



Conclusion

- Regulators, industry + researchers need to assure useful monitors are available
- Learn from PM2.5—what should size cut be?
  - 100nm may be a poor choice for upper size
  - Lower limit for detection should be determined