BAY AREA AIR QUALITY MANAGEMENT DISTRICT

# Ultrafine Particles (UFPs): A Cause for Concern, Part II, 2012

Presentation to the Board of Directors

By the BAAQMD Advisory Council

December 5, 2012

# UFP: Two-Year Investigation

**2011**

- Health Effects Values, and Use in Air District Actions
- Health Effects, Measurements, and Analyses
- Characteristics, Sample Analyses, and Study Results
- Mobile Source Emissions and Health Effects

**2012**

- Ambient Monitoring and Field Studies
- Exposure Assessment
- Exposure Reduction

# UFP: 2012 Topics and Speakers

## UFP Ambient Monitoring and Field Studies

- Philip Fine, PhD - SCAQMD (ambient monitoring)
- Eric Fujita, PhD – DRI (roadway field studies)

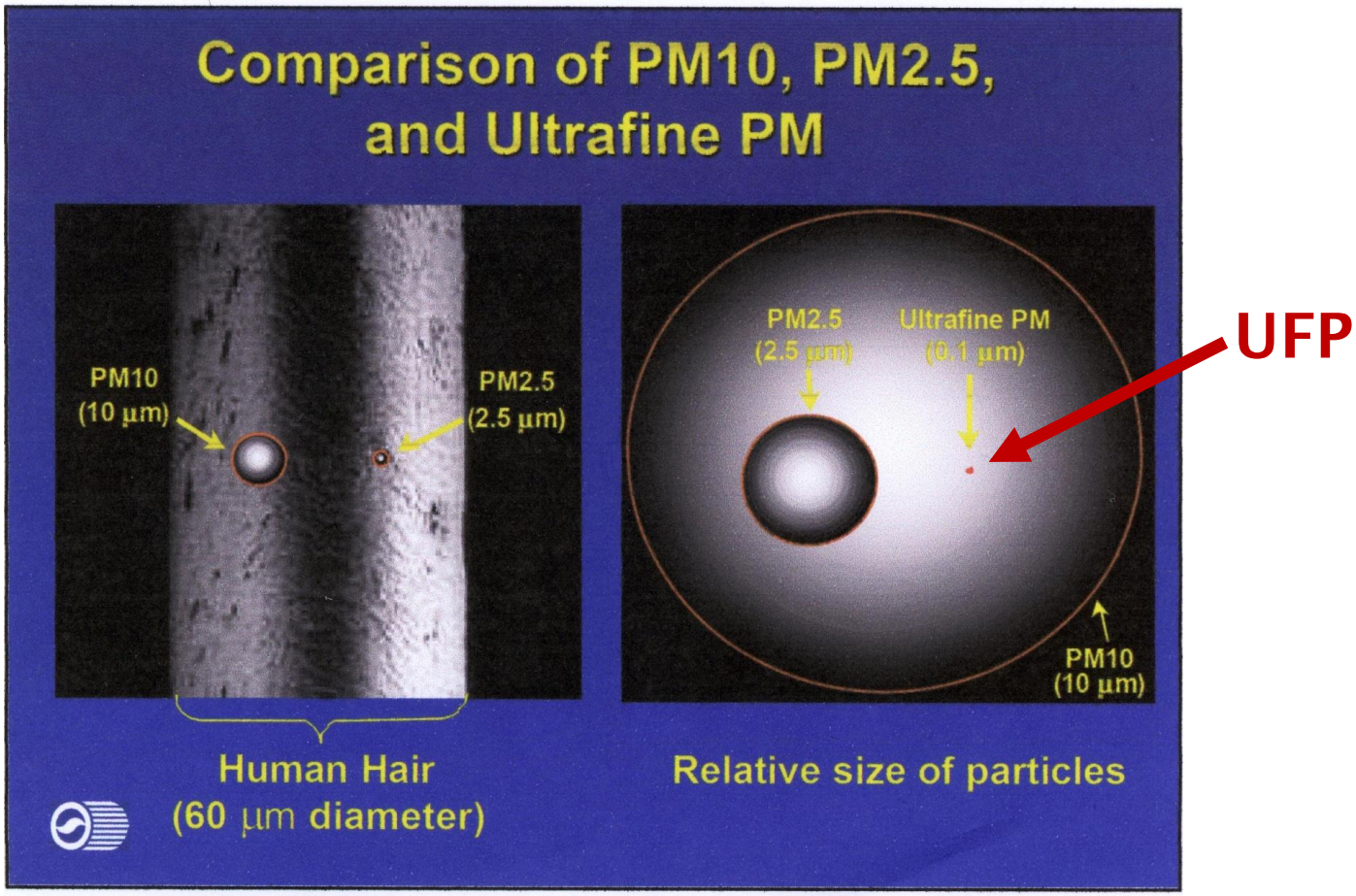
## UFP Exposure Assessment

- Lynn Hildemann, PhD - Stanford (indoor exposure)
- William Nazaroff, PhD – UC Berkeley (indoor exposure)

## UFP Exposure Reduction

- Yifang Zhu, PhD – UCLA (roadway exposure reduction)
- Rajiv Bhatia, MD, MPH – SF Dept. Public Health (policy strategies)

# UFP: Characteristics

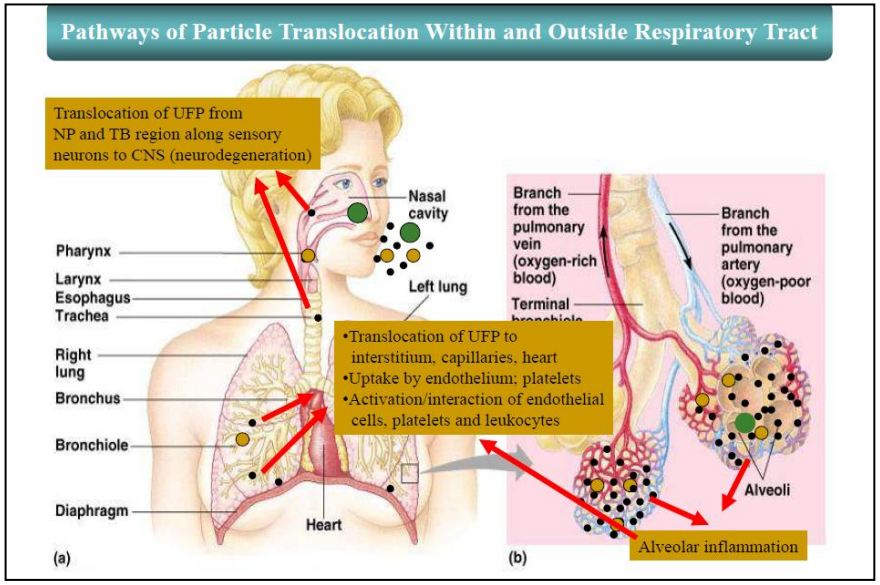



More than 600 times smaller than human hair

# UFP: Health Effects

- Likely more potent health effects than larger PM
  - UFPs travel deeper into lungs, enters cells more easily due to their small size
  - UFPs carry many (possibly toxic) compounds into lungs due to their large surface area

- UFPs thus reach:
  - Respiratory tract
  - Liver and heart
  - Brain



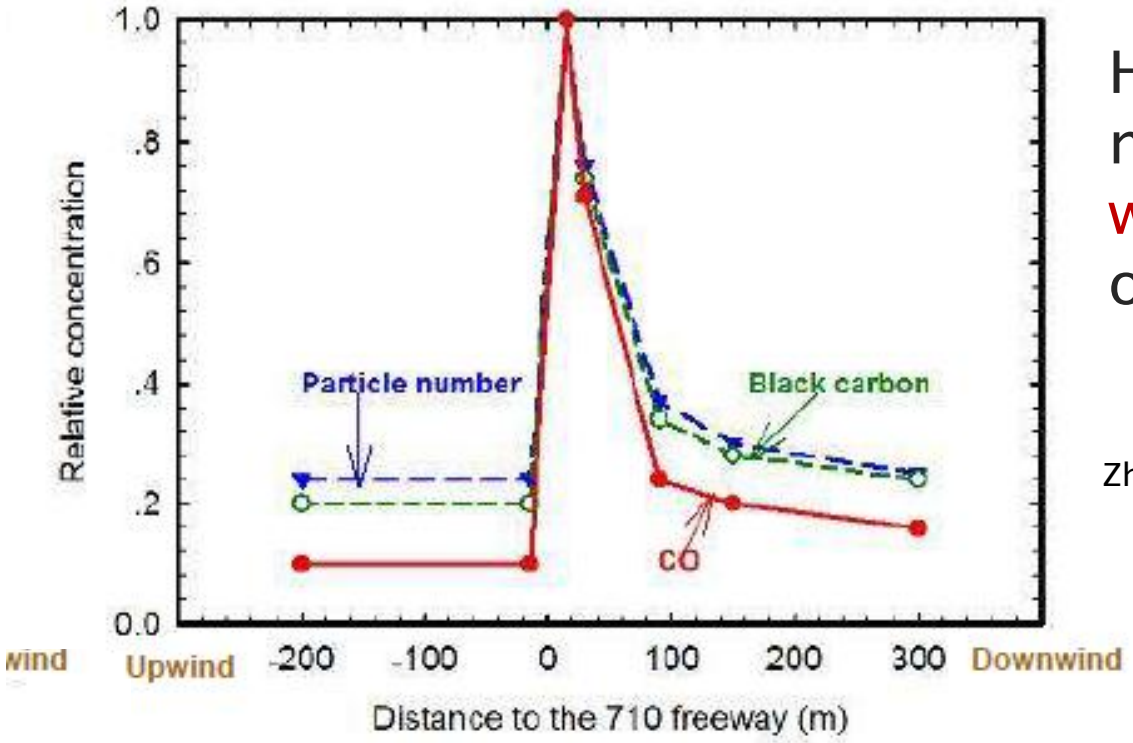
# UFP: Health Effects

- Acute and chronic health effects vary with UFP:
  - Number
  - Exposure duration
  - ***Composition*** *(size, chemistry, and shape)*
- Specific health effects may include:
  - Premature death
  - Respiratory disease, including asthma
  - Lung and other cancers
  - Cardiovascular diseases
  - Adverse birth outcomes
  - Immune system effects
  - Neurotoxicity
  - Autism

# UFP Exposure: Sources

- Fuel combustion is primary source of exposure
- Highest UFP exposures occur in two places:
  - On or near heavily travelled roadways, including inside vehicle cabin
    - Sources are other vehicles
    - Particularly diesels, gross-emitters, and lubricating oil burners
  - Indoors
    - ~70% of exposure: indoor sources
    - ~30% of exposure: outdoor sources infiltrating indoors
- High UFP spatial- and temporal-variability

# UFP Exposure: In Traffic




Highest UFP numbers within 100 m of roadway

Zhu et al., 2002

In-vehicle exposure to traffic-generated UFP is affected by:

- Penetration, filtration, and recirculation
- Coagulation and deposition

# UFP Exposure: Indoors

- Californians spend 80-90% of time indoors
- Indoor UFPs can sometimes exceed outdoor levels
- Indoor sources include:

  Cooking, cleaning products, gas appliances, smoking, air fresheners, candles, and fireplaces

- Proportion of indoor UFPs that originate outdoors can be highly variable

# UFP Exposure: Reduction Strategies

- Standard hierarchy of controls
  - Reduce (e.g., reduce VMT, gross polluters)
  - Replace or substitute (e.g., more electric/alternative fuel vehicles; increased bicycle/pedestrian travel)
  - Engineering (e.g., lower-emitting vehicles; more effective in-cabin filters; better building-ventilation to protect from indoor and out-door sources; safer cleaning products)
  - Administrative (e.g., land use zoning, especially near major road-ways; lowered/variable speed limits; congestion pricing; incentives for biking/walking/public transit; indoor smoking bans)
  - Personal behavior (e.g., in-cabin ventilation practices; driving speed, route and timing; use of public transit; ventilation during cooking; in-home smoking/candle use/fireplace use)

# 2012 Recommendations

## Categories

| | |
|---|---|
| Integration of UFPs and PM2.5 Planning | Cooperation with Other Agencies |
| Public Education and Outreach | Further Research |

# Recommendations:
## Integration of UFPs into Air District Planning

- Continue to:
  - Integrate UFP control efforts with PM2.5 planning
  - Develop and refine UFP emission inventories
  - Model UFP at a regional level
- Consider local UFP monitoring to better understand UFP exposures in varying traffic and neighborhood environments
- Evaluate and prioritize relative health impacts of various UFP sources and composition
- Incorporate emerging analysis methods for UFP exposures, health risks, and mitigation into Air District's multi-pollutant air quality planning

# Recommendations:
## Cooperation with Other Agencies

- With regional and local agencies:
  - Provide guidance and administrative guidelines for evaluating and reducing UFP exposures (outdoors and indoors); focus on agencies with land use authority
  - Assist development of neighborhood-level air pollution models to supply community health information
  - Encourage integrated strategies for improving indoor air quality (including ventilation and filtration); also consider issues of energy efficiency & cost effectiveness
- With state agencies:
  - Encourage development of standards to reduce UFP exposure in vehicles (e.g., in-cabin vehicle filtration and recirculation systems).
  - Encourage CARB and BAR to screen for vehicles that burn lubricating oil

# Recommendations:
## Public Education and Outreach

- Integrate latest information on UFP health effects and behavior-oriented recommendations into Air District's public education and outreach efforts
- Concepts could include:
  - Use in-vehicle air recirculation, change cabin filters regularly, and avoid following smoking vehicles
  - When indoors, keep windows and doors closed when possible, if living or working near heavily traveled roadways
  - Open windows or use kitchen exhaust fan when broiling, avoid smoke from grills, and ventilate well if using self-cleaning ovens
  - Avoid using scented cleaning products, air fresheners, and candles
  - Minimize time in confined garages, tunnels, and near wood fires
  - Targeted messages for bicyclists and joggers

# Recommendations:
## Further Research

- Encourage further research on UFPs, including:
  - UFP health effects
  - UFP number concentrations and composition in ambient and indoor air
  - Impacts of atmospheric conditions
  - UFP indoor, in-vehicle, and outdoor exposures
  - Interaction of indoor and outdoor UFP sources
  - UFP exposure mitigation measures
  - Interaction of mitigation methods for PM2.5 and UFPs
- Encourage efforts to determine most effective UFP mitigation measures
  - Focus on schools, sensitive receptors, commuters, and people living or working on or near heavily traveled roadways
  - Consider measures across the hierarchy of controls

# Recommendations:
## Additional Ideas

- Further investigate state of science of cumulative impacts analyses including UFP in combination with other pollutants
- Further investigate role of Air District with respect to indoor air quality
- Consider development, or offer prize for development, of District smart-phone and/or iPad app to provide public with air pollution-related information

# Looking Forward to 2013

- We appreciate your time and interest
- We're looking forward to next year and our next topic
- Thanks very much!