HEALTH EFFECTS FROM EXPOSURE TO SMOKE

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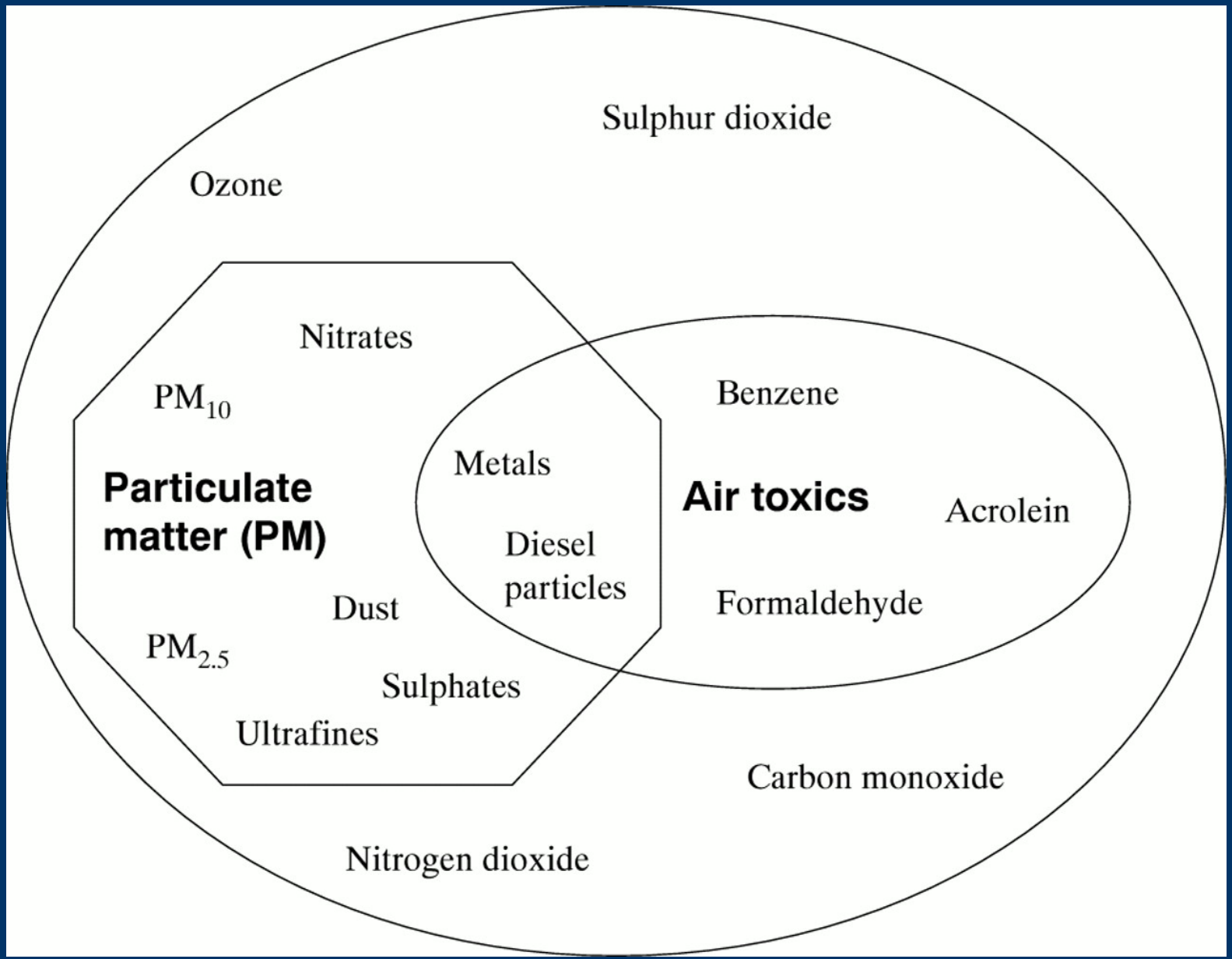
What's in smoke?

- Fine-particle pollutants
  - PM_{10}
  - $PM_{10-2.5}$
  - $PM_{2.5}$
  - $PM_{0.1}$
- Polycyclic aromatic hydrocarbons (PAHs)
- Carbon monoxide
- Aldehydes
- Nitrates / Sulfates
- Organic acids (e.g., formic acid)
- Semi-VOCs & VOCs
- Free radicals
- Ozone (O_3)
- Trace gases (PCDDs, methyl bromide, etc.)
- Radionuclides
- Herbicides

The air pollution mixture

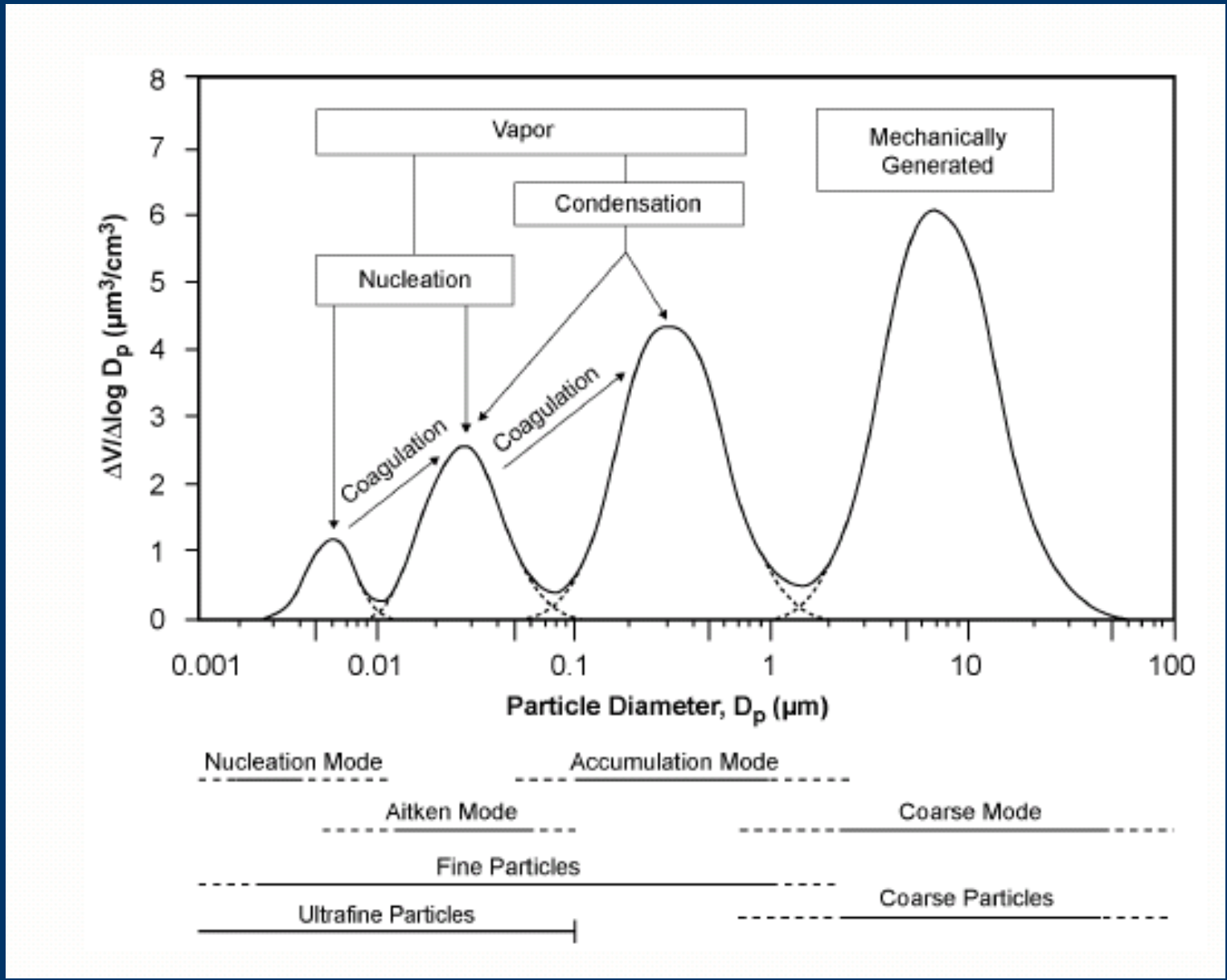


Grigg, J Arch. Dis. Child. 86:79-83, 2002

Fine-particle pollutants

- PM_{10} (thoracic particles)
  - $PM_{10-2.5}$ (coarse fraction)
  - Can lodge deep in lungs; less harmful
- $PM_{2.}$ (fine particles)
  - 70-95% of smoke particles
  - Can more easily penetrate lungs; not harmless
- $PM_{0.1}$ (ultrafines)
  - Can enter bloodstream and brain; not harmless
  - Better correlation with adverse health effects

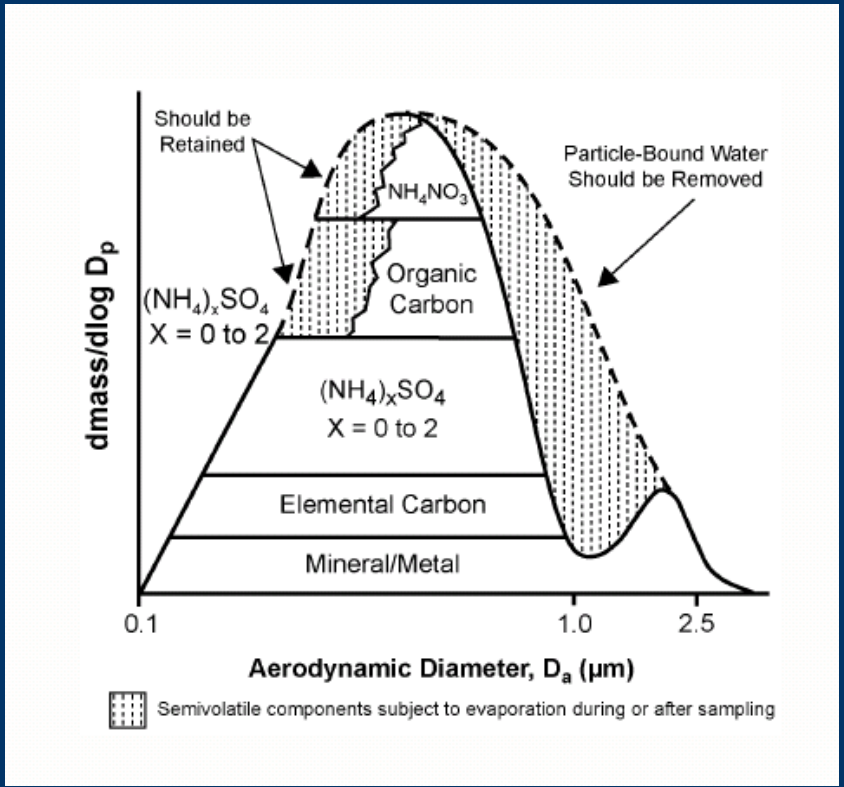
Idealized size distribution of smoke



from U.S. EPA Air Quality Criteria for Particulate Matter (October 2004)

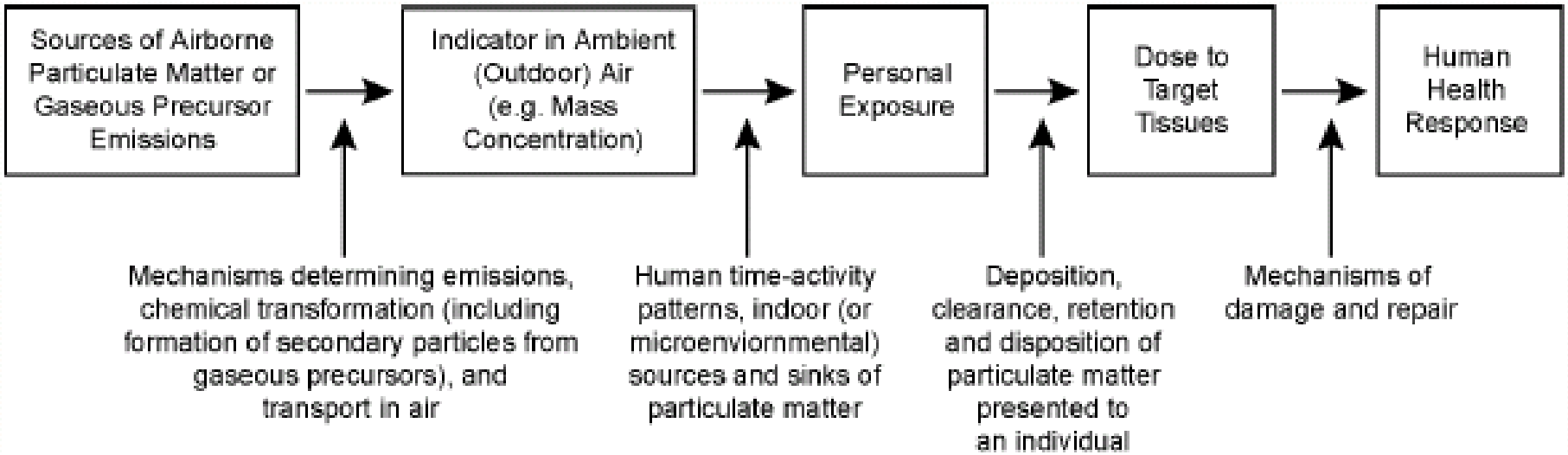
What makes $PM_{2.5}$ dangerous?

- **Size?**
  - Tiniest particles are most potent
- **Chemistry?**
  - What's on or in the particle?
  - Metal content?
- **Combination of both?**



Umatilla Smoke Management Workshop (May 2005)

Assessing health impacts



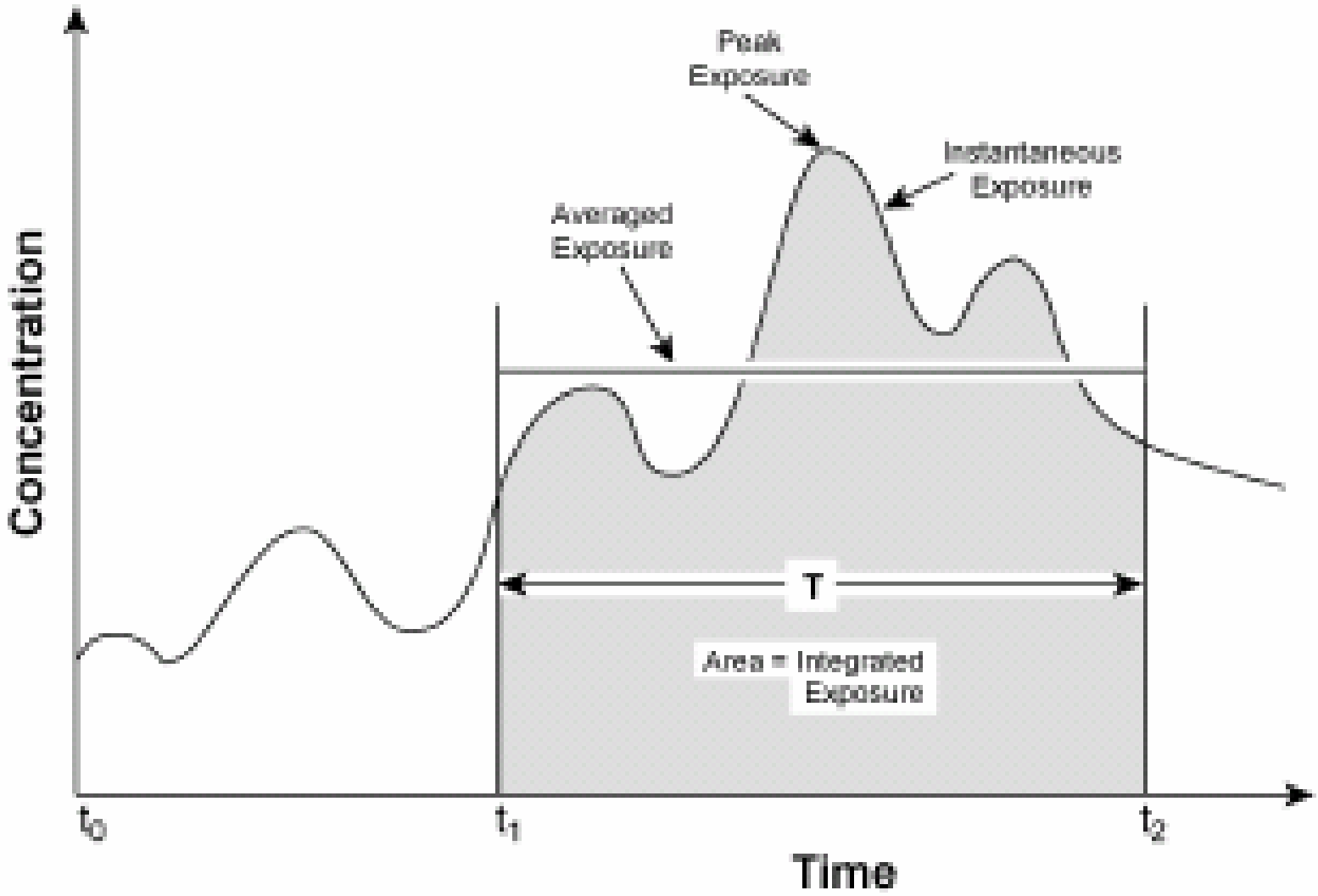
from U.S. EPA Air Quality Criteria for Particulate Matter (October 2004)

- **Level and duration of exposure**
- **Susceptibility of exposed populations**

Sensitive populations

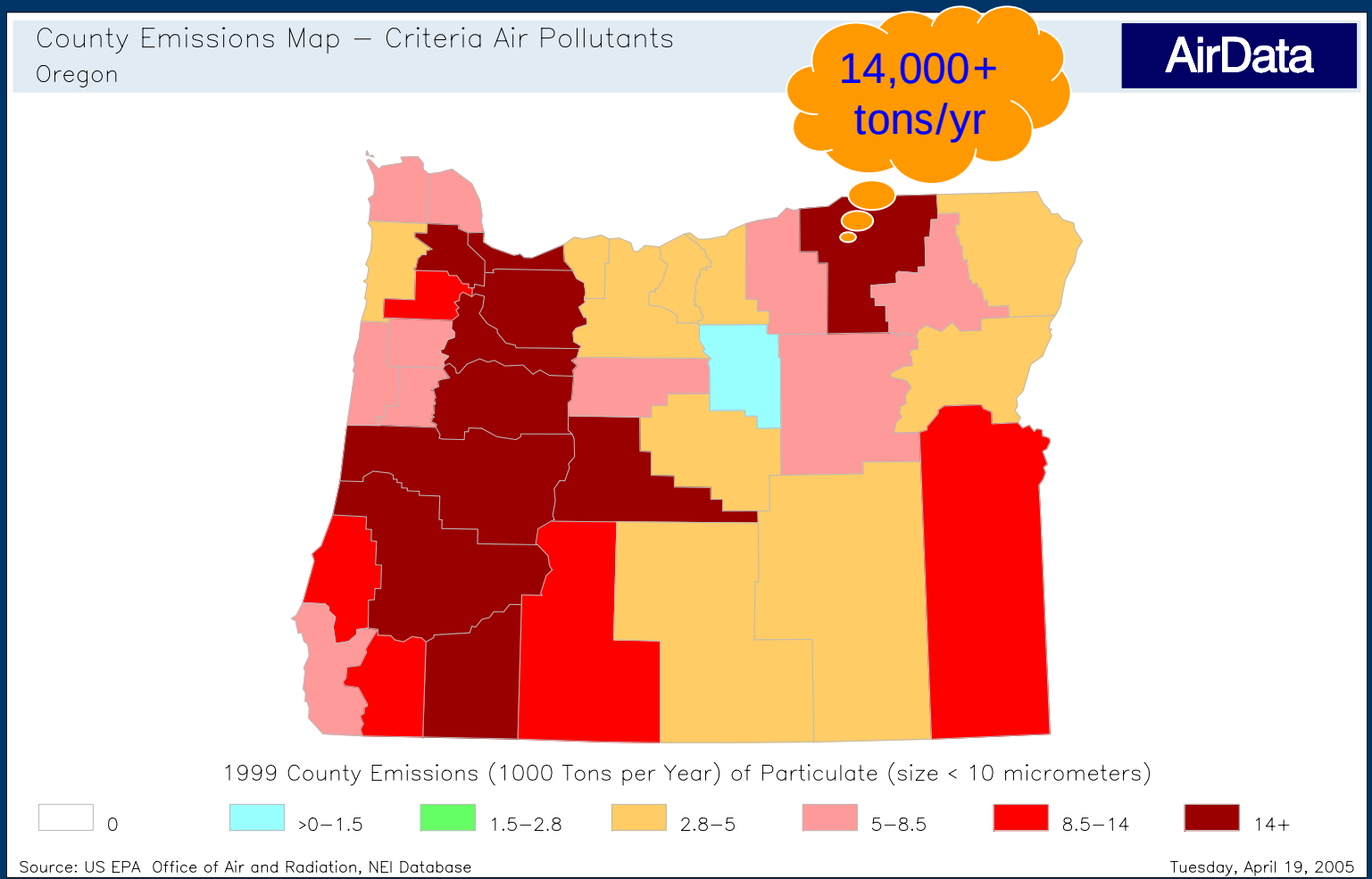
- Asthmatics
- Children (pre- & post-natal)
- Pregnant women
- Elderly (age > 65 years)
- Smokers
- Individuals with pre-existing conditions
  - Cardiopulmonary diseases
  - Chronic obstructive pulmonary disease
  - Cardiovascular disease

Level and duration of exposure

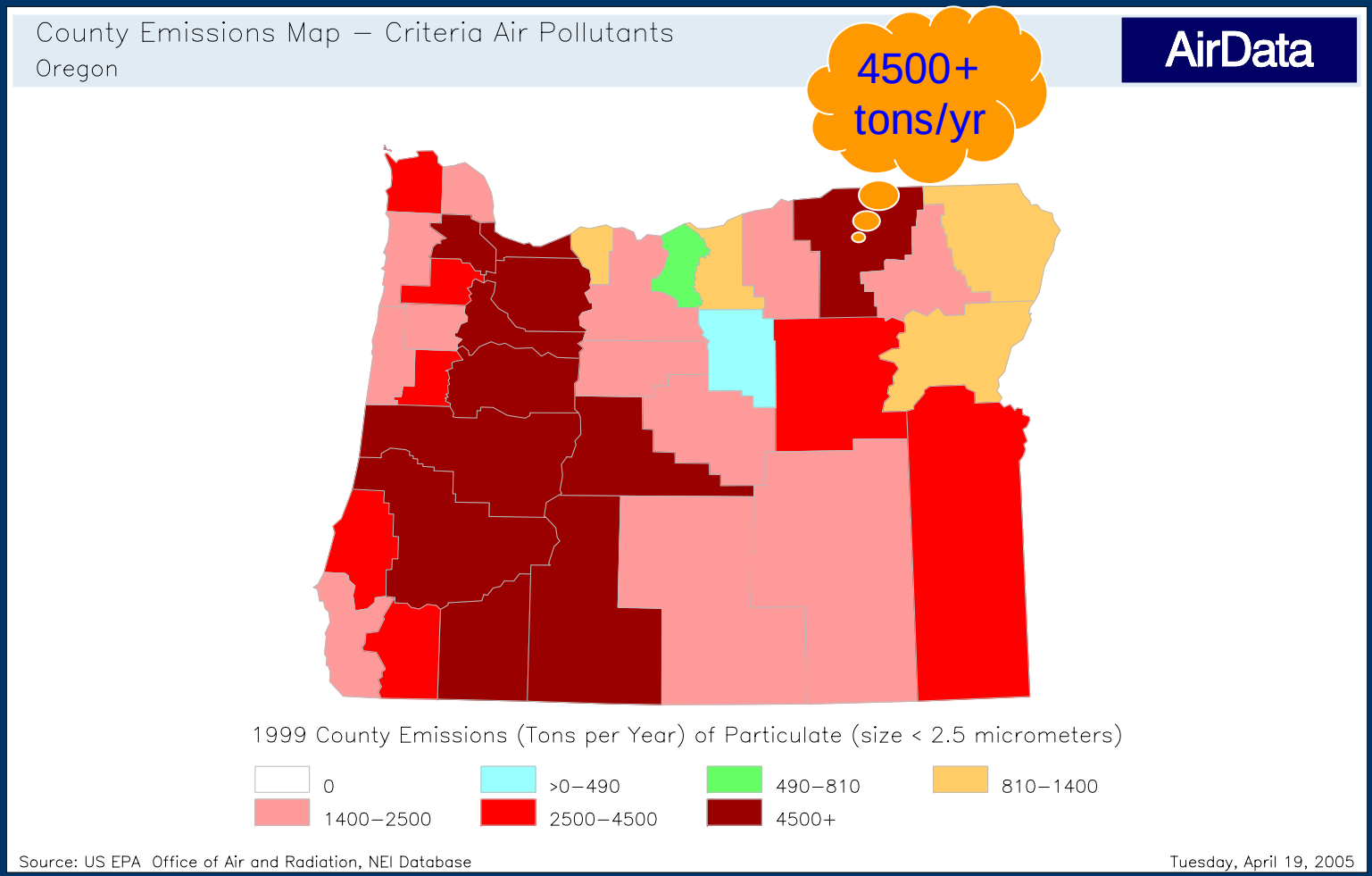


from U.S. EPA Air Quality Criteria for Particulate Matter (October 2004)

Emissions (PM_{10} - 1999)



Emissions ($PM_{2.5}$ - 1999)



Short-term exposures

- Coughing and difficulty breathing
- Decreased lung function
- Aggravated asthma and bronchitis
- Increased ER and hospital visits

Long-term exposures

- **Deaths per day**
  - 0.21% ⇧ per 10 μg m^{-3} ⇧ in PM_{10}
- **Long-term risk of dying**
  - 4% ⇧ per 10 μg m^{-3} ⇧ in annual $PM_{2.5}$
- **Other**
  - Similar to 2° smoke in causing cancer
  - Tentatively linked to systemic and genetic effects in newborns
  - Adversely affects heart (Δ rhythm, block flow)

Some unresolved issues

- Lack of demonstrated biological mechanisms for PM-related effects
- Confounding by co-pollutants (e.g., air toxics)
- Characterization of daily & annual background concentrations
- Exposure estimates performed outdoors
  - 50-60% of indoor $PM_{2.5}$ from domestic sources

Summary

- $PM_{2.5}$ & ultrafines appear to be the issue
- Short-term exposures
  - General population – transient health impacts
  - Sensitive populations – potentially more serious health impacts
- Long-term exposures
  - May lead to serious health impacts, in both general & sensitive populations