

## Chapter 1. Introduction

### Read:

- Chapter 1
- Handouts, especially IPCC Report summaries and figures
- Visit IPCC, IMPROVE, EPA PM and PDEQ Air Info Now web sites

### Definitions

Aerosol = solid or liquid particles suspended in a gas, e.g., dust in air, fog in air.

### Characteristics

See Figure 1.6, 1.3, 1.4 of handouts

- Size range: diameter  $\approx 0.001$  to  $1000 \mu\text{m}$  (6-orders of magnitude). Compare to visible light ( $\lambda = 0.5 \mu\text{m}$ ), human hair ( $\approx 20 \mu\text{m}$  D), gas molecule ( $\approx 0.001 \mu\text{m}$ ), etc.
- Smaller particles often formed by gas-to-particle processes, larger by mechanical action, e.g.,  $(\text{NH}_4)_2\text{SO}_4$  vs. NaCl.
- A dimer (cluster of two molecules) is regarded as smallest aerosol particle.
- Terminology: ultrafine, fine, coarse modes; fog, smog, smoke, spray, etc.
- Shapes: spherical (liquid), irregular crystals, agglomerates, fibers. All can be represented by “aerodynamic diameter” – how they would behave aerodynamically if perfectly spherical.
- Composition: pure, internal or external mixture, porous, solid, liquid. Ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$ , a common component of natural aerosols.
- Concentration: mass concentration ( $\mu\text{g}/\text{m}^3$ ) and number concentration ( $\#/\text{m}^3$ ) are the most common units. Values range over 16-orders of magnitude ( $10^{-13}$  to  $10^3 \text{g}/\text{m}^3$  (Fig. 1.7).

### Importance

See handouts.

- Global radiation budget
  - Sulfate trends (Fig 2b, IPCC)
  - Radiative forcing (Fig 3, IPCC)
    - Certain aerosols might have net cooling effect (white sulfate particles)
    - Certain aerosols might have net warming effect (black soot particles)
    - Indirect aerosol effect (Twomey, Fig 5.5) might be comparable to greenhouse gas effect, but in opposite direction.
    - Very large uncertainty associated with most aerosol effects requires further study.
- National level
  - $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  are “criteria” pollutants regulated by EPA under NAAQS to protect human health and welfare.  $\text{PM}_{10} = 150 \mu\text{g}/\text{m}^3$ , 24-h average;  $\text{PM}_{2.5} = 65 \mu\text{g}/\text{m}^3$ , 24-h average.



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- Health – e.g., see chronic obstructive pulmonary disease (COPD, Dept. H.H.S.) the 4<sup>th</sup> leading cause of death – mainly due to tobacco smoke (an aerosol).
- Welfare – e.g., see visibility monitoring at IMPROVE website.
- Local level
  - See Pima Count DEQ Air Info Now web site for criteria pollutant air quality index (AQI) observations.
  - Only exceedance ever recorded was PM<sub>10</sub> in 1999, due to wind blown dust, a natural event, which led to a Federally mandated natural event action plan (NEAP).