# Atmospheric Aerosols

Liquid droplets or solid particles suspended in the atmosphere
(mist, fog, clouds, smog) (dust, smoke, pollen)

Associated with 'haze'
Cause incoherent scattering of visible light, therefore interfer with transmission.

Scattering occurs when aerosols have size comparable to wavelength of light.
eg 400 nm (blue light) scattered by particles in the 0.04 μm to 4 μm range

Large particles (> 10 μm) settle out
Very small particles (< 0.01 μm) coagulate to form larger particles
Aerosols in the 0.01 – 1 μm range remain suspended for months

Can be classified in terms of size, source and type (pre-formed vs condensation).

**Natural Sources:**

- Wind blown dust, silt, fine sand etc.
- Sea Spray
- Volcanoes: dust, ash, $\mathbf{H_2SO_4}$(aq)
- Forest Fires: smoke particles, soot
- Terpenes/isoprenes: naturally occurring VOC's and their breakdown products such as aldehydes
- Pollens

**Anthropogenic Sources:**

- Industrial dusts: eg cement, soot, fly ash (may be removed or reduced using scrubbers or precipitators)
- Agriculture: land clearing, tilling etc
- Transportation: roadway dust, diesel exhaust, PAH's, smog

**Effects:**

- Health:
  Large particles (> 10 μm) trapped in nose or upper respiratory tract.
  Small particles (< 2.5 μm) transported into lower lung cavity where they become immobilized and cause serious ailments and disease.

- Visibility, climate (affects radiation budget), soiling of materials.

- Major participants in heterogeneous atmospheric reactions (eg. ozone hole formation, acid rain production)

**Processes:**

May be involved in many processes (diffusion, coagulation, condensation, chemical reactions, sedimentation).

$$\text{Sedimentation rate} \propto \frac{(\text{size})\,(\text{density})}{(\text{air viscosity})}$$

eg 1 μm diameter droplet of $H_2O(l)$ settles about $10^{-4}$ m $s^{-1}$ whereas a 1 mm diameter droplet of $H_2O(l)$ settles at 6.5 m $s^{-1}$

# Aerosol Measured Quantities

**Coefficient of Haze (COH)**
300 linear meters of air drawn through porous filter (collecting mostly 5 – 10 μm)
Absorbance measured and compared to reference standards
COH = 100 x absorbance
COH > 6 may cause adverse symptoms

**Total Suspended Particulate (TSP)**
Known quantity of air is filtered and trapped particle mass is recorded ($\mu g/m^3$)
TSP > 60 $\mu g/m^3$ considered harmful

Similar to $PM_{10}$ (<10 μm only)
$PM_{10}$ ~ 0.45 TSP

**Total Dustfall (TDF)**
Measured by recording mass of accumulated particles per $m^2$ per month

TDF > 7 g $m^{-2}$ $month^{-1}$ considered excessive

**Particulate Standards:**

Clean Air 0 – 20 $\mu g/m^3$

**Canadian Standard**
24 hr exposure limit 120 $\mu g/m^3$ 1 yr exposure limit 70 $\mu g/m^3$

**BC Standards** (same as Canadian plus the following)
24 hr exposure limit $PM_{10}$ 70 $\mu g/m^3$ 1 yr exposure limit $PM_{10}$ 50 $\mu g/m^3$

**US EPA**
24 hr exposure limit $PM_{10}$ 150 $\mu g/m^3$ 1 yr exposure limit $PM_{10}$ 50 $\mu g/m^3$

(recently added)
24 hr exposure limit $PM_{2.5}$ 50 $\mu g/m^3$ 1 yr exposure limit $PM_{2.5}$ 15 $\mu g/m^3$