Chapter 14. Atmospheric Aerosols

Read:

- Chapter 14

Natural vs. Anthropogenic

- Natural source strength (mass/year) dominated by coarse mode (dust, sea salt) at ≈3000 Tg/y (Table 14.1).
- Anthropogenic source strength dominated by fine mode (primary and secondary) at ≈350 Tg/y.
- Natural fine source strength ≈ anthropogenic (a cause for concern).

Size Distribution (overview)

- Trimodal size distribution is classic but not all modes visible in all samples (Figure 14.1). Figure 14.2a shows nuclei (i.e., Aitken or ultrafine), accumulation and coarse modes in a number distribution. Volume or surface area distributions tend to emphasize the trimodal pattern (Fig. 14.2d).
- Ultrafine mode sources – condensation of hot gases, gas-to-particle conversion, a few primary sources.
- Ultrafine mode sinks – diffuse rapidly due to small size, then collide and coagulate with each other or preexisting larger particles. Hence, fairly short lifetime (hours to days),
- Accumulation mode sources – condensation of hot gases, gas-to-particle conversion, primary sources, and growth of ultrafine into this mode.
- Accumulation mode sinks – too large to diffuse, but too small to sediment therefore accumulate. Eventually lost by rainout/washout so lifetime is same as for atmospheric water (rain), i.e., ≈10 days.
- Coarse mode sources – mechanical action (tires on roadways, wind blown dust, volcanic eruptions, sea spray, foam/bubbles).
- Coarse mode sinks – too large to diffuse/coagulate therefore only sedimentation important (few hours to days).

Typical Chemical Composition

See Table 14.4

- Ammonium sulfate dominates, ammonium nitrate also found (especially in urban atmospheres).
- “Elemental” (black) carbon and “organic” carbon next most prevalent.
- Mineral dust, sea salt: much lower concentrations, dependent on location.

Mt. Lemmon Aerosols

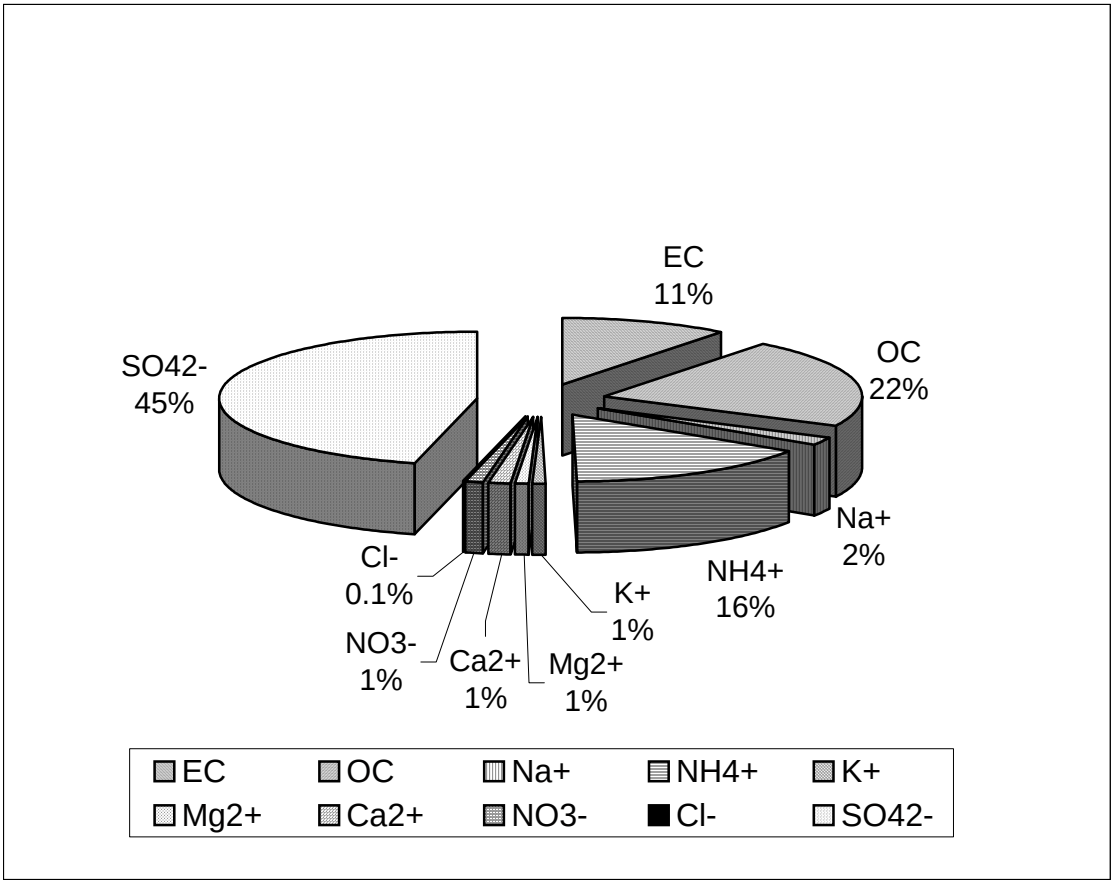

Figure 1. Decade-long mean composition of $PM_{2.0}$ from September 1992 to December 2002 in percent by mass ($\mu g\ m^{-3}$). Mean total mass is 1.48 $\mu g\ m^{-3}$.

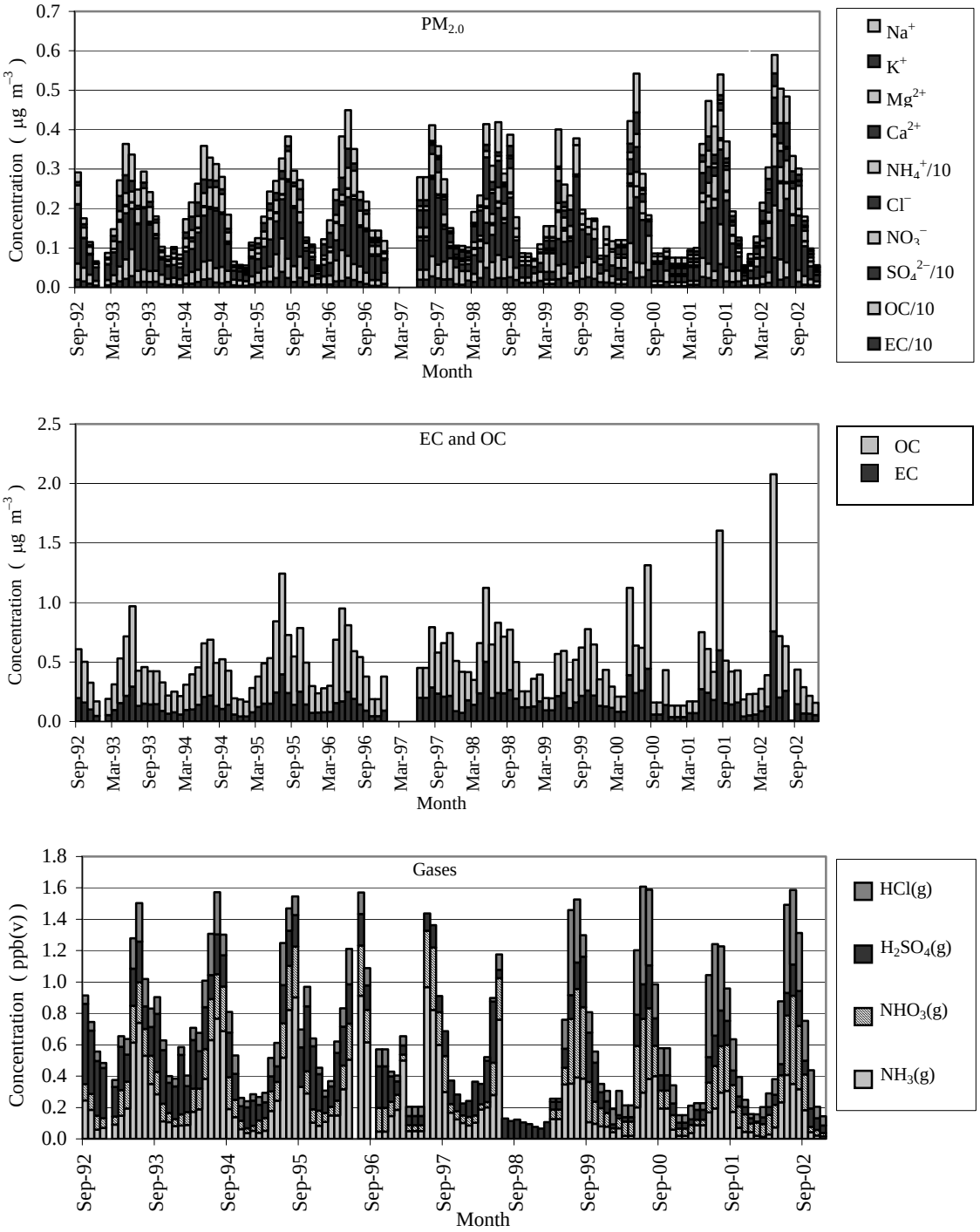

Figure 2. Monthly mean mass concentrations of $PM_{2.0}$, EC and OC and precursor gases. Gaps in data represent months for which data are not available.

Source: Rebecca Matichuk, Brian Barbaris, Eric A. Betterton*, Masahiro Hori, Naoto Murao, Sachio Ohta, Dale Ward, "A Decade of Mid-Tropospheric Aerosol and Gas Precursor Chemical Characterization at Mt. Lemmon, Arizona (1992 to 2002), submitted.