**Lifetime of air pollutants**

As we pervious studied, air pollutants might be removed close to their point of emission or might get carried high into the atmosphere and then transport a great distance before they ultimately are removed. Averaging the life histories of all molecules of a substance yields an average lifetime for that substance. The atmosphere presents two exits: precipitation and the surface of Earth itself. Species released into the air must sooner or later leave by one of these two routes.

Once particles are in the atmosphere, their size, number, and chemical composition are changed by several mechanisms until ultimately they are removed by natural processes. Some of the physical and chemical processes that affect the “aging” of atmospheric particles are more effective in one regime of particle size than another. In spite of the specific processes that affect particulate aging, the usual residence time of particles in the lower atmosphere does not exceed a few weeks. Very close to the ground, the main mechanisms for particle removal a resettling and dry deposition on surfaces; whereas at altitudes above ∼100 m, precipitation scavenging is the predominant removal mechanism.

If we let *Q* denote the total mass of the substance in the volume of air; Fin and Fout the mass flow rates of the substance in and out of the air volume, respectively; Pthe rate of introduction of the species from sources; and Rthe rate of removal of the species, then conservation of mass can be expressed:



If the volume we are referring to is the entire atmosphere, then Fin = 0 and Fout = 0, and for a substance at steady-state conditions, its rate of injection from sources must equal its rate of removal, P = R. The average residence time or life time τ, is

**Example:** Consider all sulfur-containing compounds in the troposphere, if the average mixing ratio of these compounds is 1 part per billion by mass (ppbm) and a steady state is assumed to exist, then with the mass of the troposphere about 4×1021g, the total mass of sulfur-containing compounds in the troposphere is *Q*=4×1012g. If natural and anthropogenic sources of sulfur contribute to give a total *P* of about 200×1012 g yr\_1, the mean life time of sulfur compounds in the troposphere is estimated to be



Calculations of lifetimes can be useful in estimating how far from its source a species is likely to remain airborne before it is removed from the atmosphere.

lifetime is against loss only and is independent of a gas’s emission rate or rates of production from other sources. It is possible to estimate the lifetimes of a gas against loss by an individual reaction or against all reactions.