3

Simple Models

The concentrations of chemical species in the atmosphere are con trolled by four types of processes:

- *Emissions*. Chemical species are emitted to the atmosphere by a variety of sources. Some of these sources, such as fossil fuel combustion, originate from human activity and are called *anthropogenic*. Others, such as photosynthesis of oxygen, originate from natural functions of biological organisms and are called *biogenic*. Still others, such as volcanoes, originate from nonbiogenic natural processes.
- *Chemistry*. Reactions in the atmosphere can lead to the formation and removal of species.
- *Transport*. Winds transport atmospheric species away from their point of origin.
- *Deposition*. All material in the atmosphere is eventually deposited back to the Earth's surface. Escape from the atmosphere to outer space is negligible because of the Earth's gravitational pull. Deposition takes two forms: "dry deposition" involving direct reaction or absorption at the Earth's surface, such as the uptake of CO_2 by photosynthesis; and "wet deposition" involving scavenging by precipitation.

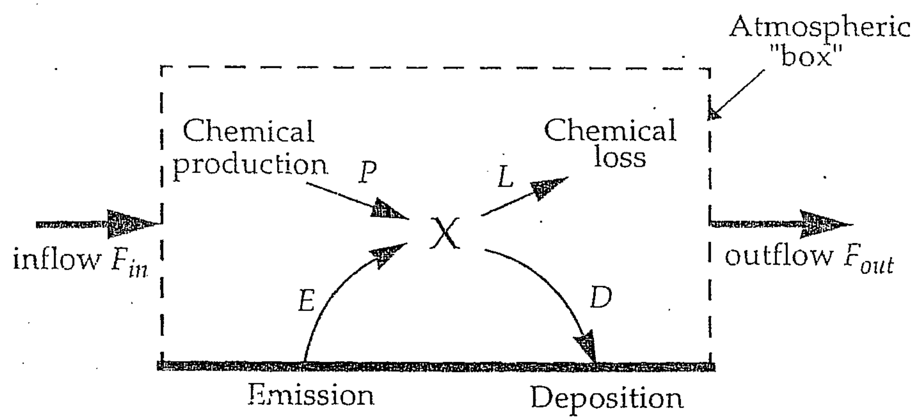

Fig. 3-1 One-box model for an atmospheric species X.

continuity equation. We will also use box models in chapter 6 tc investigate the geochemical cycling of elements.

3.1 One-Box Model

A one-box model for an atmospheric species X is shown in figure 3-1. It describes the abundance of X inside a box representing a selected atmospheric domain (which could be, for example, an urban area, the United States, or the global atmosphere). Transport is treated as a flow of X into the box (F_{in}) and out of the box (F_{out}). If the box is the global atmosphere then $F_{in} = F_{out} = 0$. The production and loss rates of X inside the box may include contributions from emissions (E), chemical production (P), chemical loss (L), and deposition (D). The terms F_{in}, E, and P are *sources* of X in the box; the terms F_{out}, L; and D are *sinks* of X in the box. The mass of X in the box is often called an *inventory* and the box itself is often called a *reservoir*. The one-box model does not resolve the spatial distribution of the concentration of X inside the box. It is frequently assumed that the box is well mixed in order to facilitate computation of sources and sinks.