Lecture 10. Grand chemical cycles of Earth. Global biogeochemical cycle of sulfur.

Objectives:
1. Reservoirs in the Earth system. Simple reservoir models.
2. Global biogeochemical cycle of sulfur.

Readings: Turco: p. 88-90; 293-301; Brimblecombe: p. 24-25, 38 (20-41)

1. Reservoirs in the Earth system. Simple reservoir models.

Global biogeochemical cycle of an element or a compound refers to the transport of that substance among the *principal global reservoirs* (**atmosphere, oceans, land and biosphere**), the amounts contained in the different reservoirs, and the rate of exchange among them.

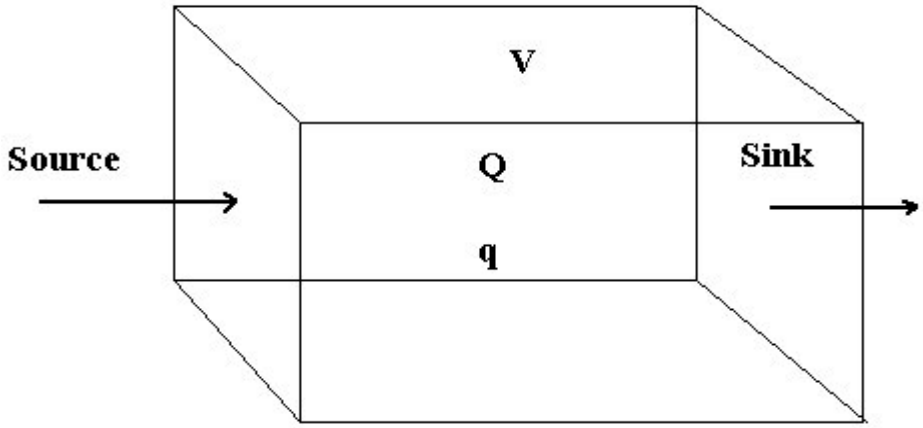
- Virtually every element in the periodic table is found in the atmosphere and undergoes the global cycle, however the most important and critical cycles are: sulfur (S) cycle (discussed in Lecture 10); nitrogen (N) cycle (discussed in Lecture 11), oxygen (O) cycle (discussed in Lecture 11), carbon (C) cycle (discussed in Lecture 12)

Table 10.1 Relative importance of various reservoirs.

Reservoir (contribution)				
Chemical	**Atmosphere**	**Oceans**	**Biosphere**	**Land (crust)**
S	**minor**	**large**	**small**	**large**
N	**large**	**minor**	**small**	**modest**
O	**small**	**small**	**minor**	**large**
C	**minor**	**small**	**minor**	**large**

Box model for Earth's reservoirs.

Box model is a model, in which we imagine that the reservoir is literally a "box" into which a material of interest can be added or removed in measurable amounts at controllable rates.



Key parameters for the box model:

Q = amount of the substance in the box volume, V;
expressed in mass units, such as grams (g);

V= volume of the box; expressed in volume units such as cm^3;

q = concentration of the substance in the box; expressed in concentration units such as g/cm^3;

S = source of the substance per unit time; expressed in units such as g/days;

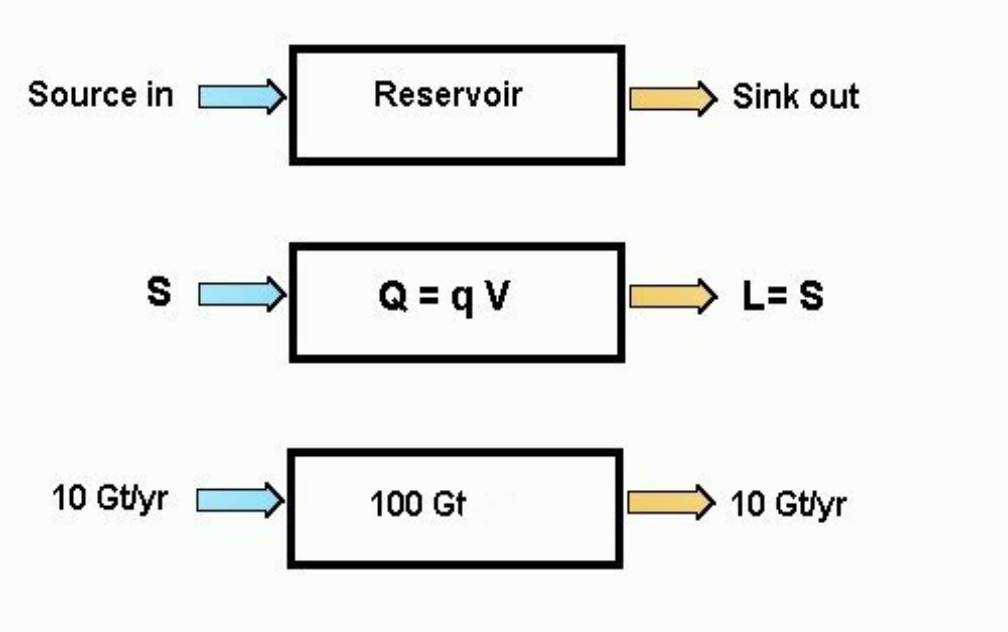
L = loss of the substance per unit time; expressed in units such g/days;

τ = residence time of the substance in the box; expressed in time units such as days.

Steady-state condition is a dynamic state of a system when rate of removal is equaled to rate of addition to the system that the amount of substance in the system remains constant: **S = L and Q=constant**

In steady-state condition: **$S = L = Q/\tau$**

Figure 10.1 Example of a steady-state reservoir box model.



Steady-state condition for a system with multiple sources and sinks:

$S_T = S_1 + S_2 + ...$

$L_T = L_1 + L_2 + ...$

$S_T = L_T = Q/\tau$

Closed system is a system in which the total amount of any element contained in all available reservoirs is fixed during the time of interest.

Coupled reservoirs are reservoirs that the sink of a material for one reservoir is a source for other reservoirs.

- Earth surrounded by space can be considered as a **closed system**. The reservoirs composing the Earth system are thus coupled together to form a conservative closed system.

Figure 10.2 A three-reservoir atmosphere-ocean-land system with specific mass transfer between reservoirs.