

Earth Systems Overview

The Earth is a system consisting of four major interacting components:

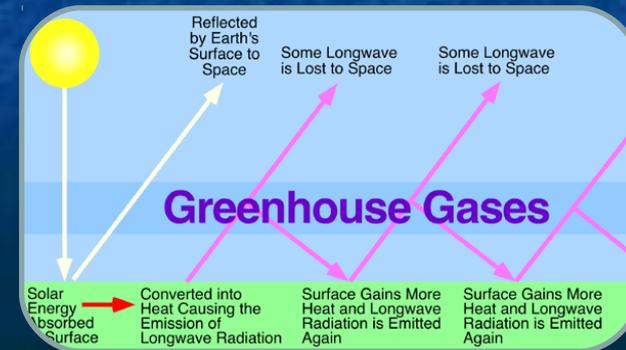
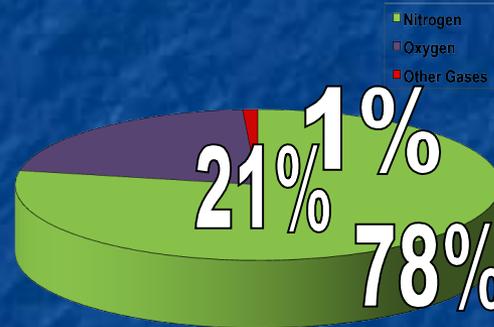
- **the atmosphere,**
- **the biosphere,**
- **the hydrosphere, and**
- **the lithosphere**

Let's examine each of these four spheres in detail.....



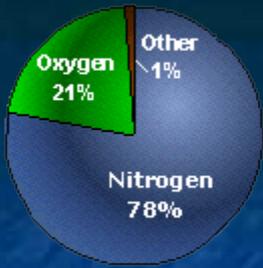
What is the Earth's Atmosphere?

- Mostly made of invisible gases that surround the Earth.
- Contains the air we breathe.
- **Composition**
 - 71% Nitrogen
 - 23% Oxygen
 - 1% Trace Gases.
- Traps Heat Energy from the sun.
 - Greenhouse effect, keeps the planet warm.



Some important roles of the atmosphere:

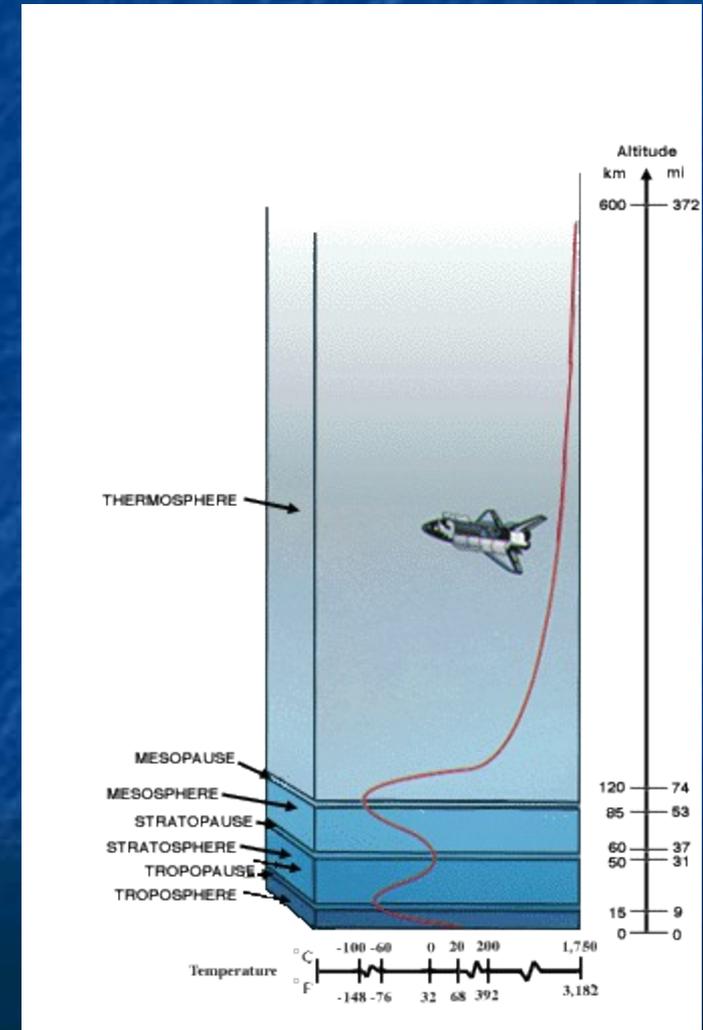
1. Contains the gases that living things need for survival (e.g., carbon dioxide for photosynthesis, and oxygen for aerobic respiration).
2. Transfers heat.
3. Ozone in stratosphere protects living things from excess ultraviolet radiation.



The Atmosphere

The Earth is surrounded by a blanket of air, which we call the **atmosphere**.

- The atmosphere consists of four unique layers (the troposphere, the stratosphere, the mesosphere, and the thermosphere).
- The atmosphere reaches over 560 kilometers (348 miles) up from the surface of the Earth.



How do human actions affect the atmosphere?

Negative

- aerosols- deplete the ozone layer
- driving cars- adds excess greenhouse gases to the atmosphere
- factories- (same as cars)
- burning tires/garbage- adds harmful gases to the atmosphere

Positive

- hybrid vehicles- decreases the amount of greenhouse gas emissions
- alternative power (wind/solar)- (same as hybrid vehicles)
- planting trees- absorbs CO₂ from the atmosphere and adds O₂

What is the Earth's Biosphere?

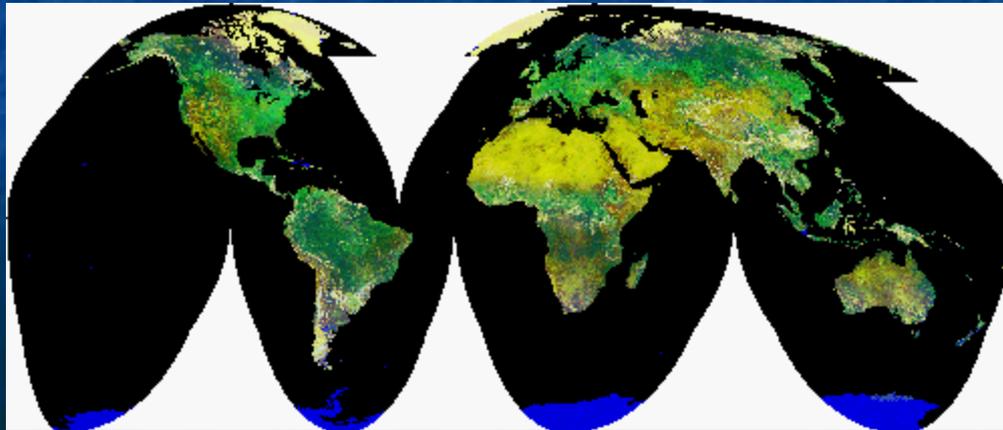
- Made up of living things and their habitats.
- Must Have:
 - Oxygen
 - Carbon Dioxide
 - Liquid Water
 - Moderate Temperatures
 - Source of Energy
 - Sun
 - Plants and Algae (photosynthesis)



The Biosphere

The ***biosphere*** is the “**life zone**” of the Earth, and includes all living organisms (including humans), and all organic matter that has not yet decomposed.

- The biosphere is structured into a hierarchy known as the food chain (all life is dependant on the first tier – mainly the primary producers that are capable of photosynthesis).
- Energy and mass is transferred from one level of the food chain to the next.



What is the Earth's Hydrosphere?

- Part of the Earth that is liquid water.
- Always moving, through all spheres.
- 71% of Earth's surface is the ocean.
 - Lakes
 - Rivers
 - Marshes
 - Rain
 - Underground water
 - Droplets in clouds.



Hydrosphere

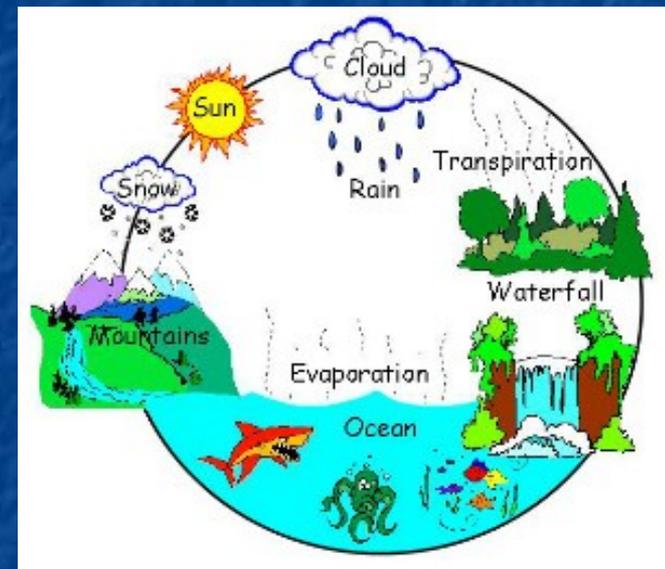
Some important roles of the hydrosphere:

1. Moderates climate
2. Transfers heat
3. Organisms need water to transport nutrients and waste

Hydrosphere

The ***hydrosphere*** contains all the water found on our planet.

- Water found on the surface of our planet includes the ocean as well as water from lakes and rivers, streams, and creeks.
- Water found under the surface of our planet includes water trapped in the soil and groundwater.
- Water found in our atmosphere includes water vapor.
- Frozen water on our planet includes ice caps and glaciers.
- Only about 3% of the water on Earth is “fresh” water, and about 70% of the fresh water is frozen in the form of glacial ice.



What is the Earth's Lithosphere?

- Mostly solid, rocky part of the Earth.

- Divided into 3 Layers

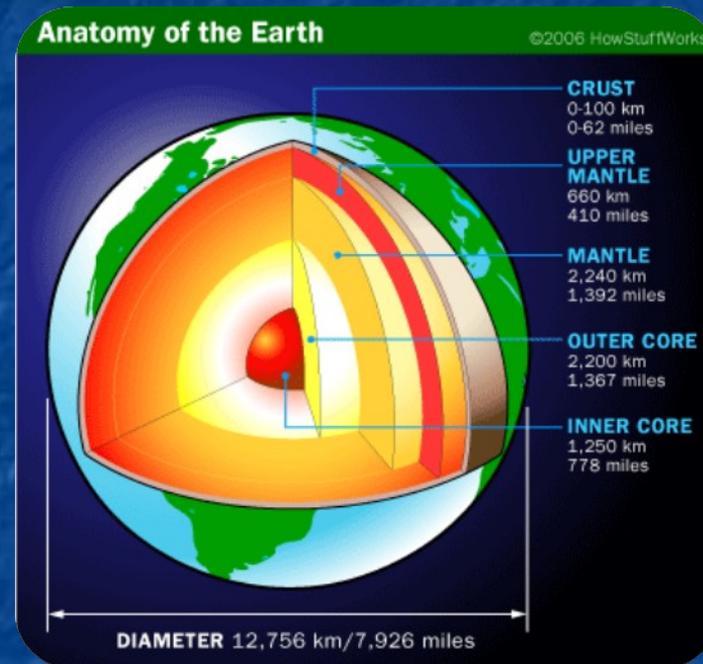
1. Crust

2. Mantle

3. Core

- a. Inner Core

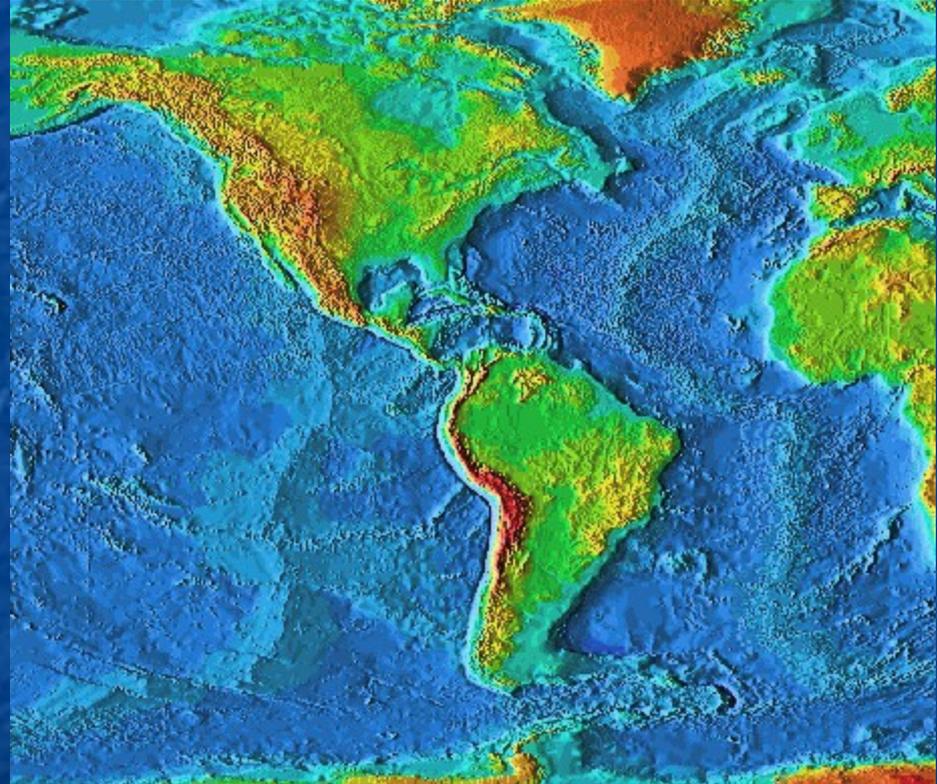
- b. Outer Core



Lithosphere

The ***lithosphere*** is the solid Earth that includes the continental and ocean crust as well the various layers of Earth's interior.

- 94% of the Earth is composed of the elements oxygen, silicon, and magnesium.
- The lithosphere is not static (unchanging), but its surface (crust) is in a constant state of motion.
- Mineral resources are mined from the lithosphere.



How do human actions affect the lithosphere?

Negative

- mining- strips the earth of nutrients
- littering/using non-recyclables- ends up in landfills and contaminates the earth
- construction- destroys natural environments, decreases drainage
- pesticides- add unnatural chemicals to soils
- deforestation- increases soil erosion because tree roots no longer help hold soil in place

Positive

- composting- can decrease the amount of garbage in landfills
- aeration- allows for air to enter soils
- conservation areas and provincial parks- preserve/protect the land
- planting trees- prevent soil erosion
- gardening/green rooftops- regreens the landscape in urban areas

How Do Earth's Spheres Interact?

■ Matter and Energy

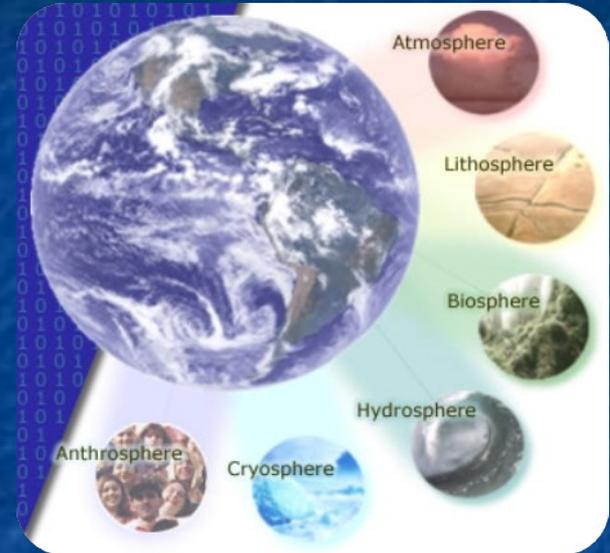
■ 1. By exchange of matter.

■ **Water Cycle**

- water evaporates into the atmosphere.
- Water condenses forming clouds.

■ **Nitrogen Cycle**

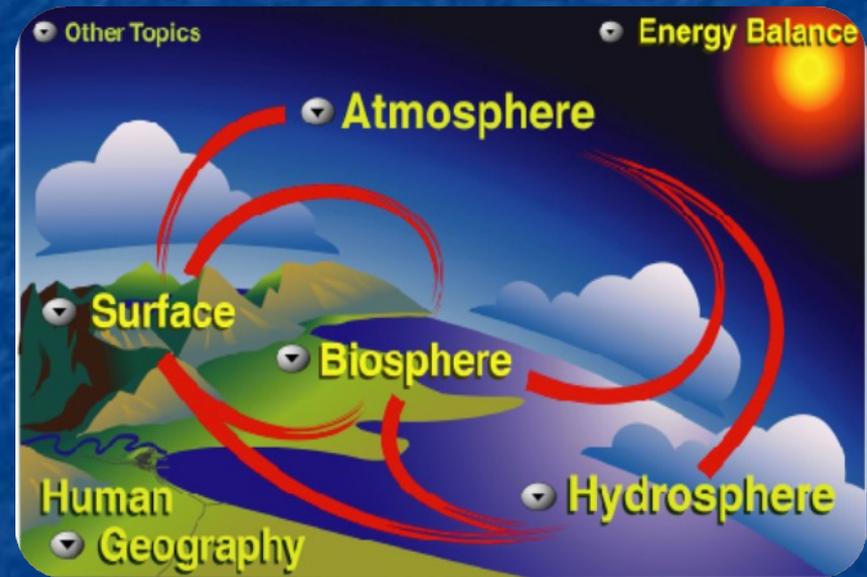
- Bacteria release nitrogen into the soil from the atmosphere.
- Plants use nitrogen to grow.



How Do Earth's Spheres Interact?

2. By exchange of energy

- Moves back and forth between spheres.
- Plants use solar energy to make food.
- Animals eat plants for energy.
- Solar Energy
 - Drives winds and Weather

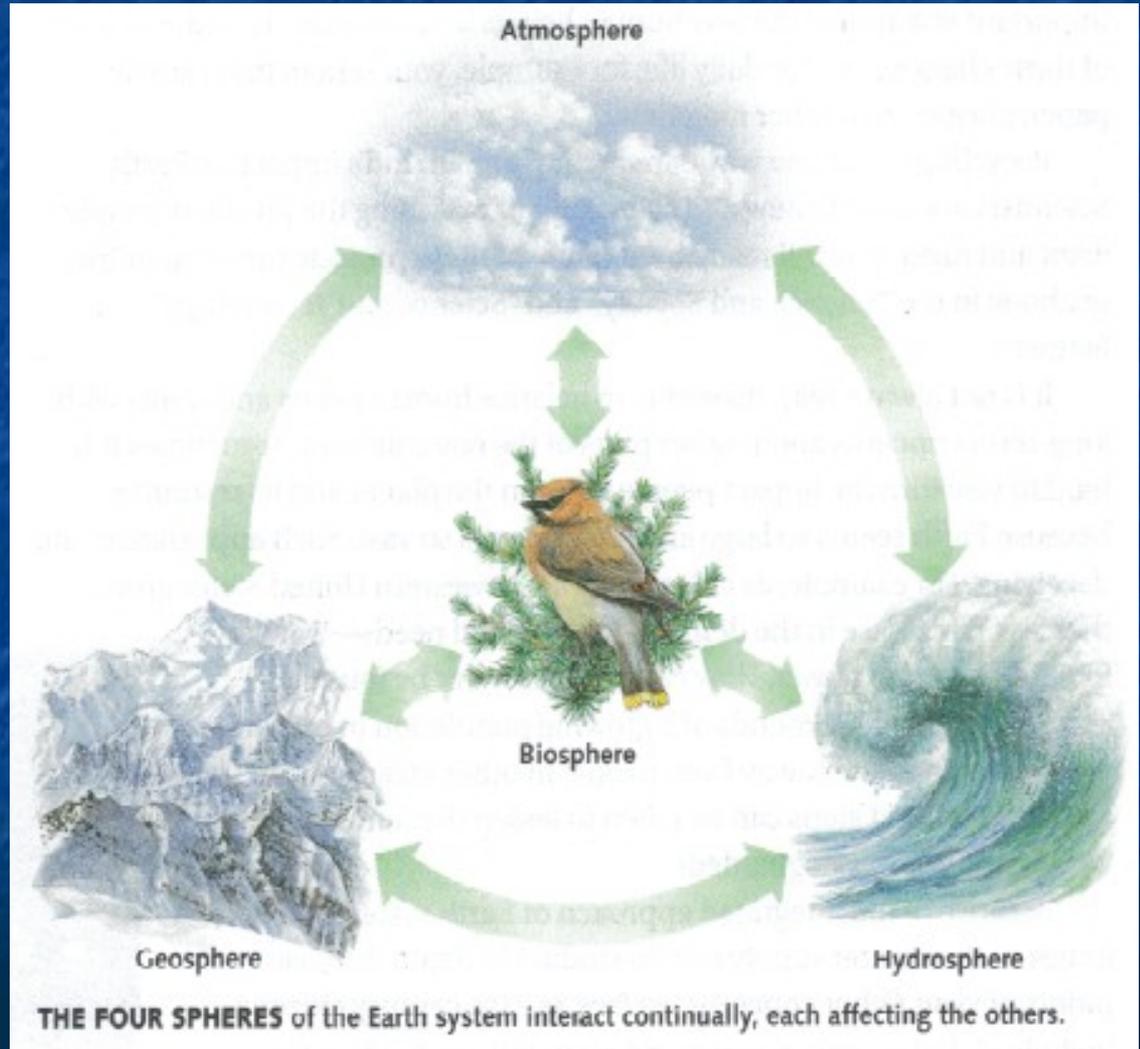


Earth System Science

Earth System Science

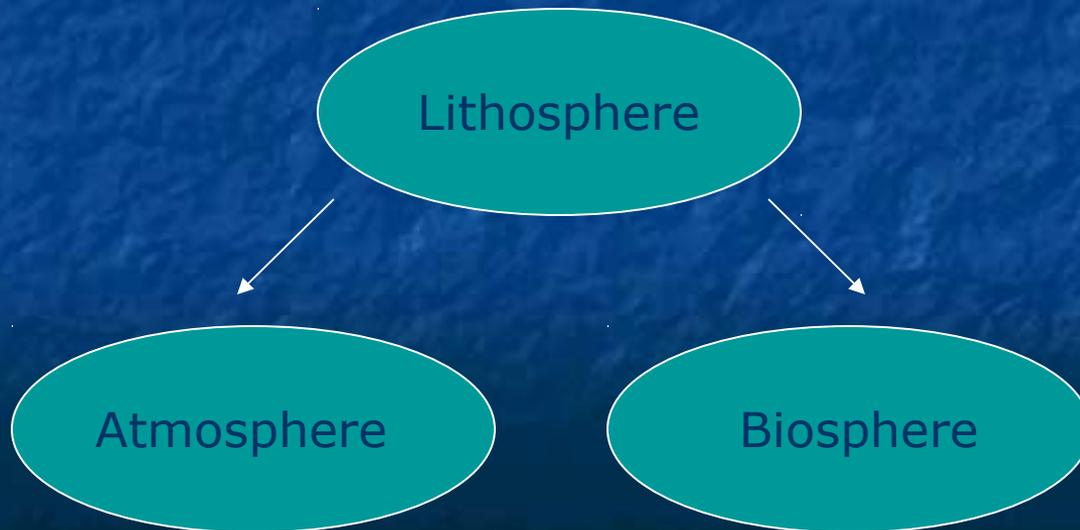
is the study of how the four spheres of the Earth system interact continually, each affecting the others.

Let's look at a couple of examples of how a change in one system (or sphere) affects other Earth systems.



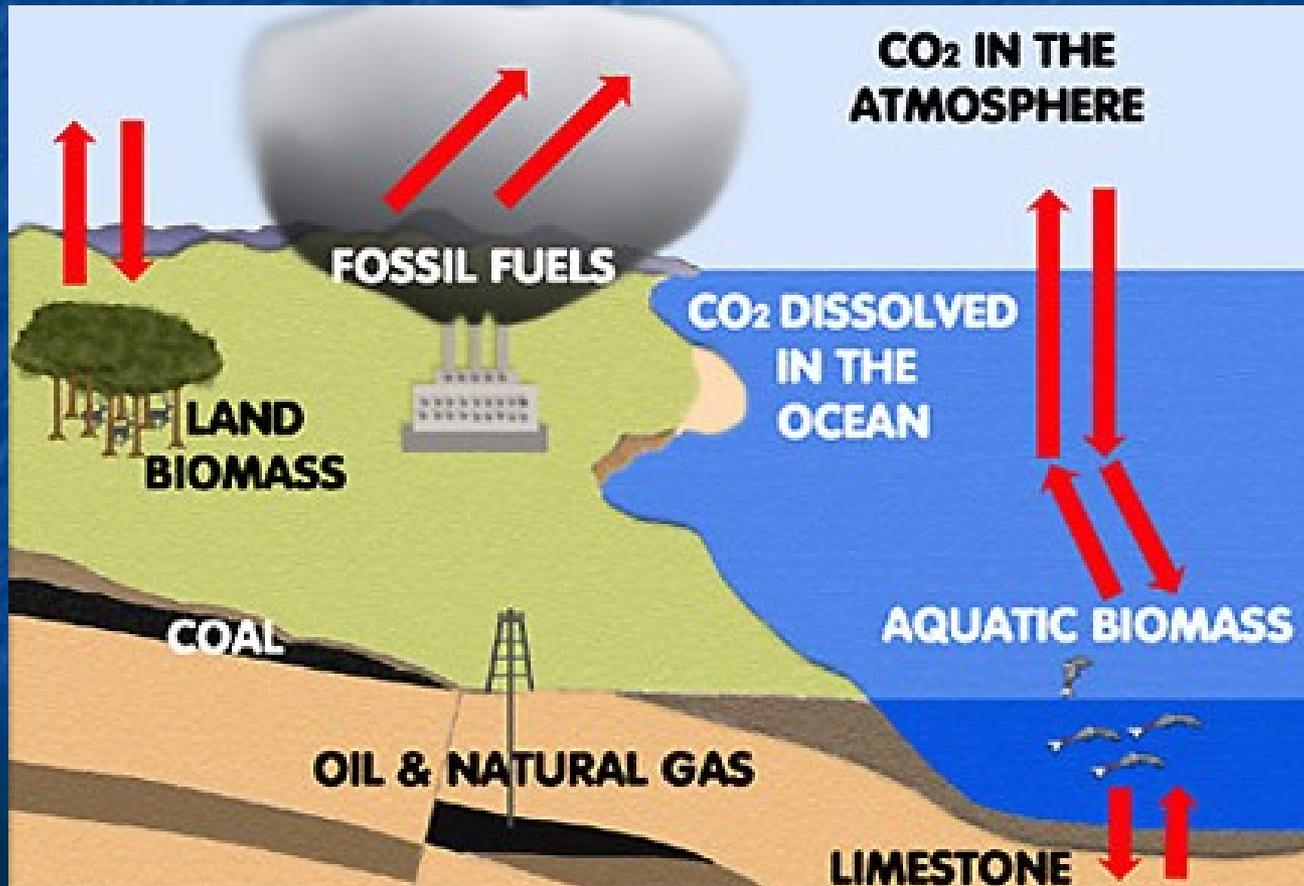
System Interactions

Volcanoes (lithosphere) erupt, sending ash and gases into the air (atmosphere) and sending lava and ash down onto surrounding forests (biosphere) and human habitations (biosphere).



System Interactions

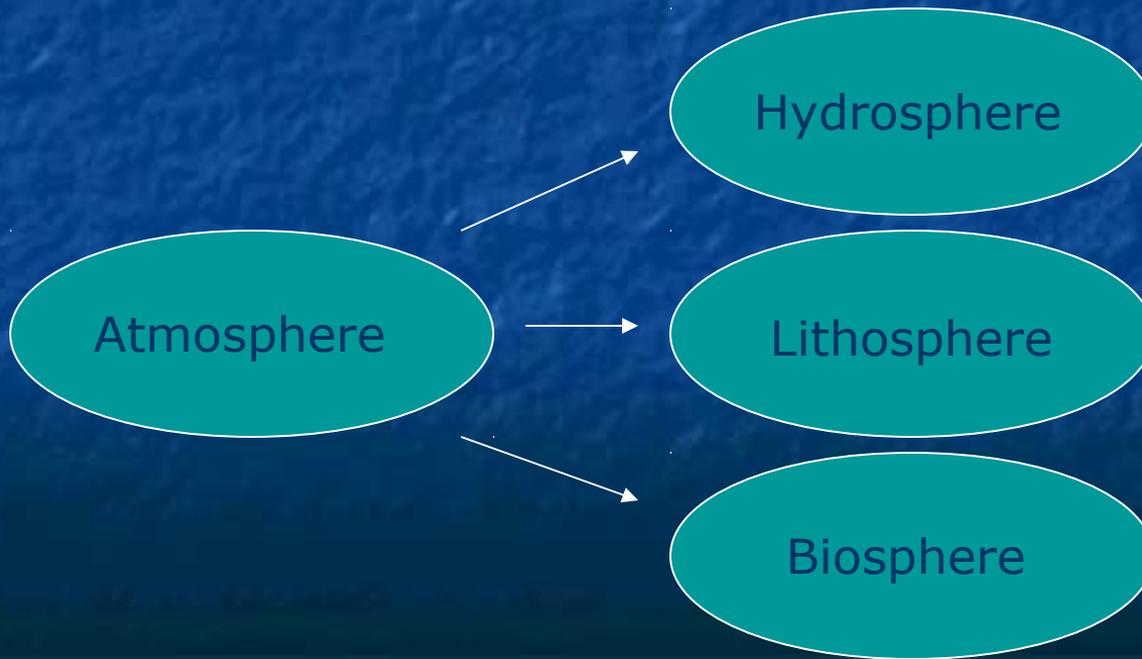
The carbon cycle.



Note that at any given point in time, carbon occurs in all of the great spheres.

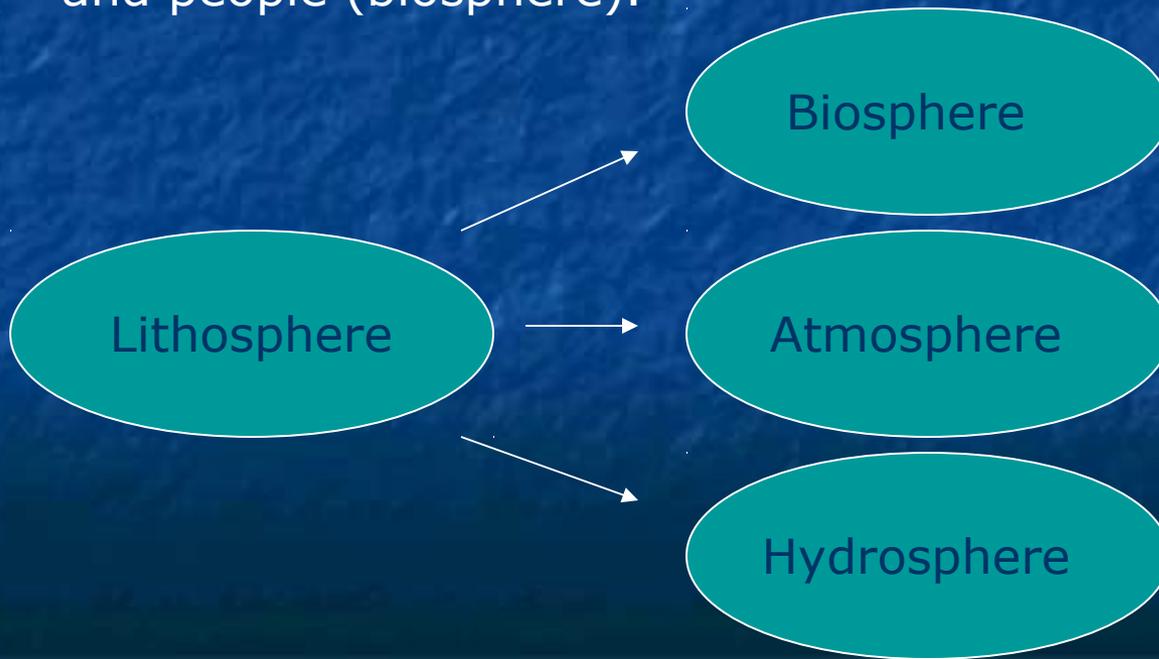
System Interactions

Hurricanes (atmosphere) sweep across the ocean (hydrosphere) and onto the land (lithosphere), damaging the dwellings of people (biosphere) who live along the coast.



System Interactions

Earthquakes (Lithosphere) can damage buildings which may kill people (biosphere), as well as cause fires which release gases into the air (atmosphere). Earthquakes in the ocean may cause a tsunami (hydrosphere) which can eventually hit land and kill both animals and people (biosphere).



Small-scale example: A forest fire



Interactions Between Spheres: Cause and Effect

Initial Conditions

Lithosphere: The ground could have been very permeable, preventing moisture from being retained in the upper part of the soil profile.

Hydrosphere: The area could have been prone to fire due to lack of precipitation.

Atmosphere: The fire could have started due to a lightning strike.

Biosphere: Dead wood, leaves and needles may have enhanced the ability of the fire to start and spread.