Unit 7: Dynamic Planet: Earthquakes & Volcanoes

Lecture 4

Objectives:

E2.1B - Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.

E2.1C - Explain, using specific examples, how a change in one system affects other Earth systems.

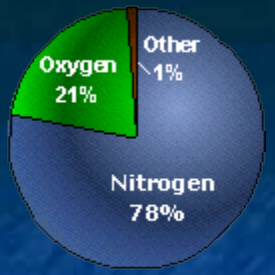
E3.4e - Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.

Earth Systems Overview

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

- the atmosphere,
- the biosphere,
- the hydrosphere, and
- the geosphere

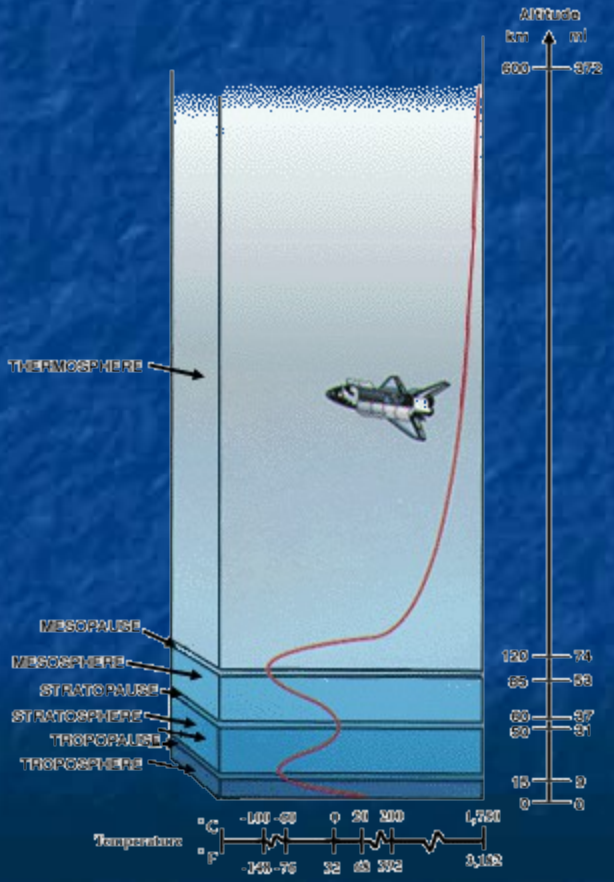
Let’s examine each of these four spheres in detail……



The Atmosphere

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

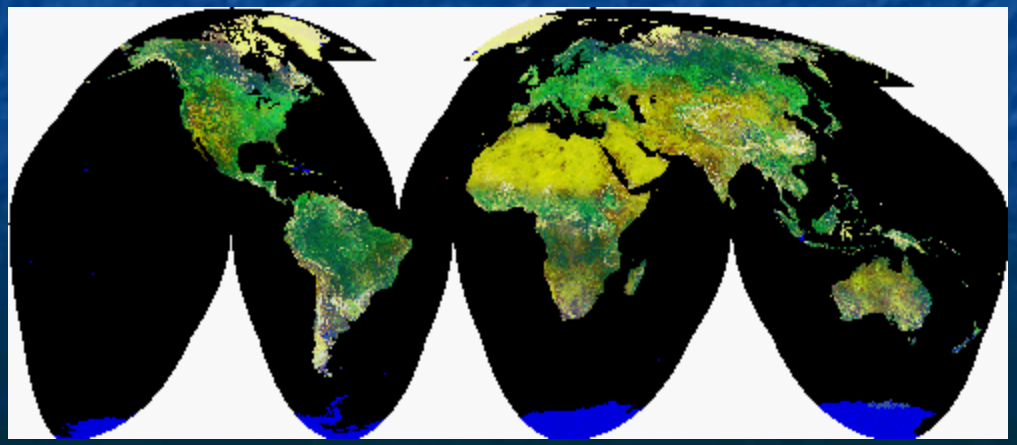
- The atmosphere consists of four unique layers (the troposphere, the stratosphere, the mesosphere, and the thermosphere).
- The atmosphere reaches over 560 kilometers (348 miles) up from the surface of the Earth.
- The atmosphere is primarily composed of nitrogen (about 78%) and oxygen (about 21%). Other components exist in small quantities.



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.

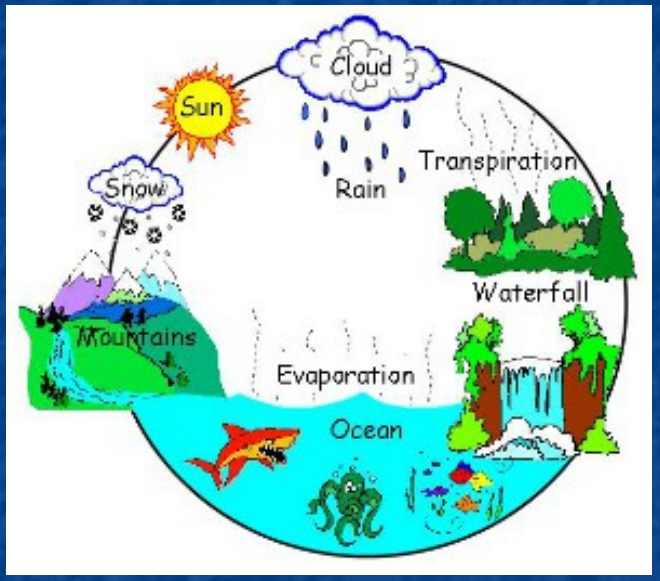
- The biosphere is structured into a hierarchy known as the food chain (all life is dependant on the first tier – mainly the primary producers that are capable of photosynthesis).
- Energy and mass is transferred from one level of the food chain to the next.



Hydrosphere

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

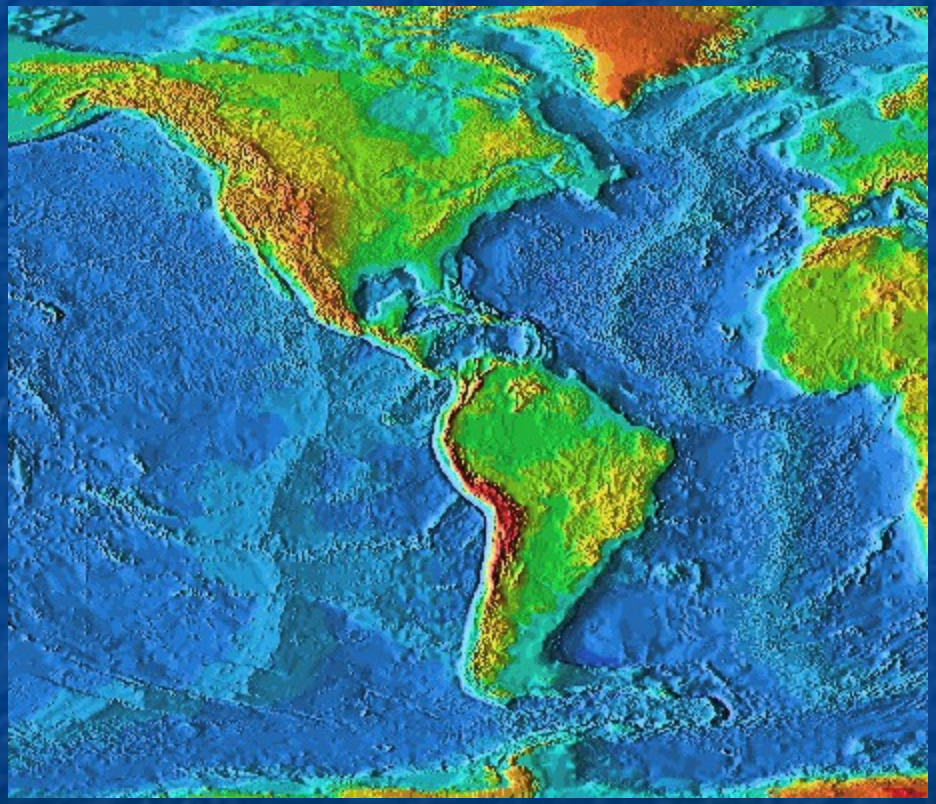
- Water found on the surface of our planet includes the ocean as well as water from lakes and rivers, streams, and creeks.
- Water found under the surface of our planet includes water trapped in the soil and groundwater.
- Water found in our atmosphere includes water vapor.
- Frozen water on our planet 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.



Geosphere

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

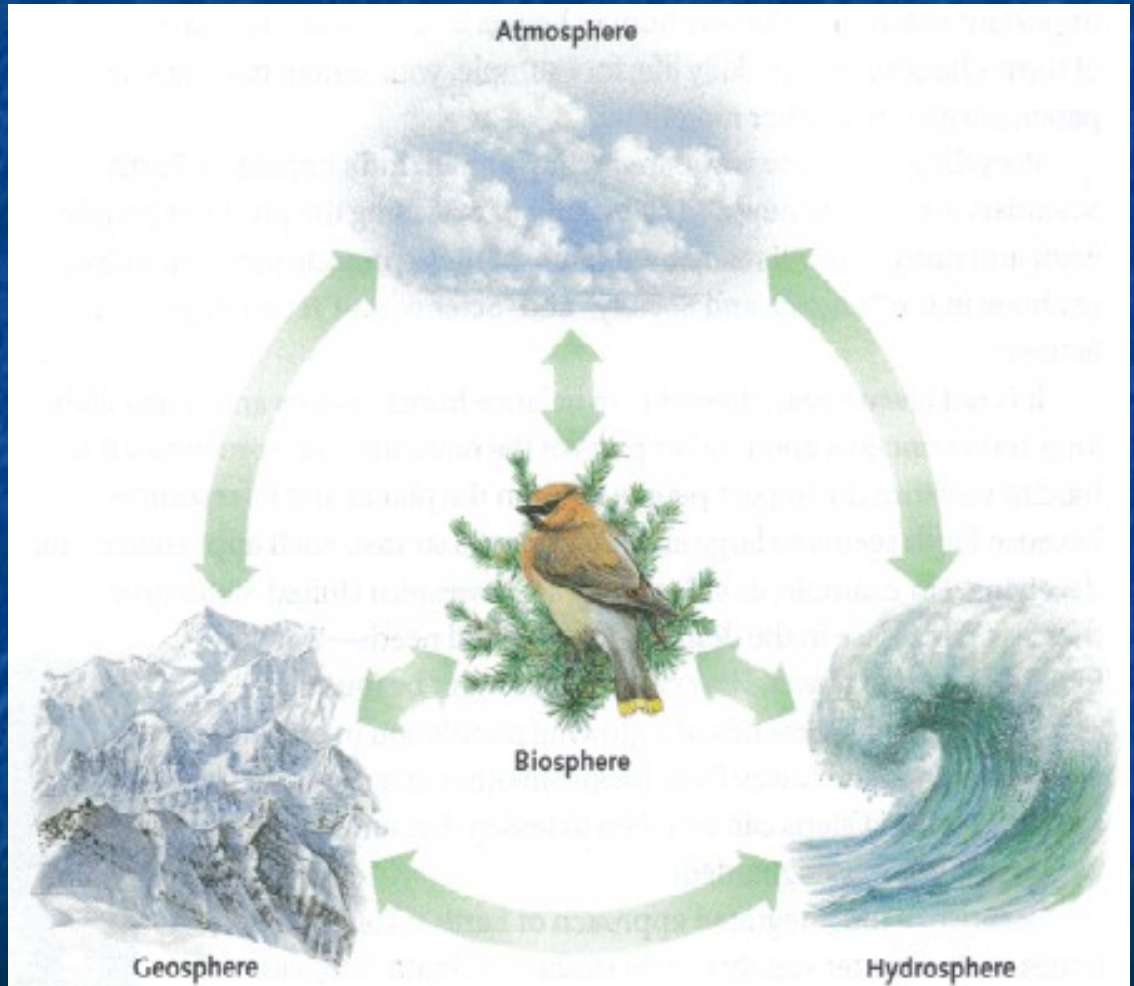
- 94% of the Earth is composed of the elements oxygen, silicon, and magnesium.
- The geopsphere is not static (unchanging), but its surface (crust) is in a constant state of motion.
- Mineral resources are mined from the geosphere.



Earth System Science*

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

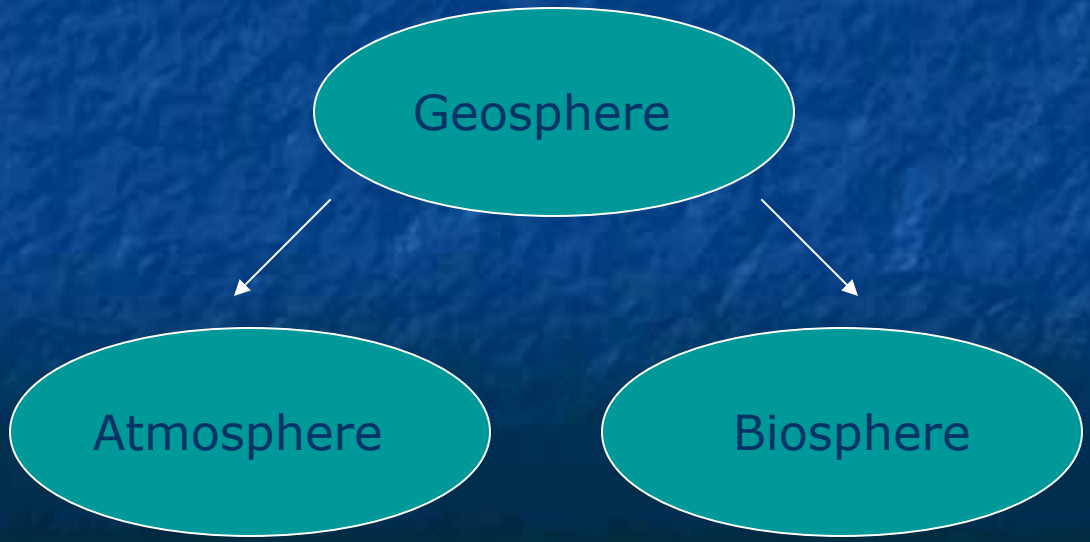
Let's look at a couple of examples of how a change in one system (or sphere) affects other Earth systems.



THE FOUR SPHERES of the Earth system interact continually, each affecting the others.

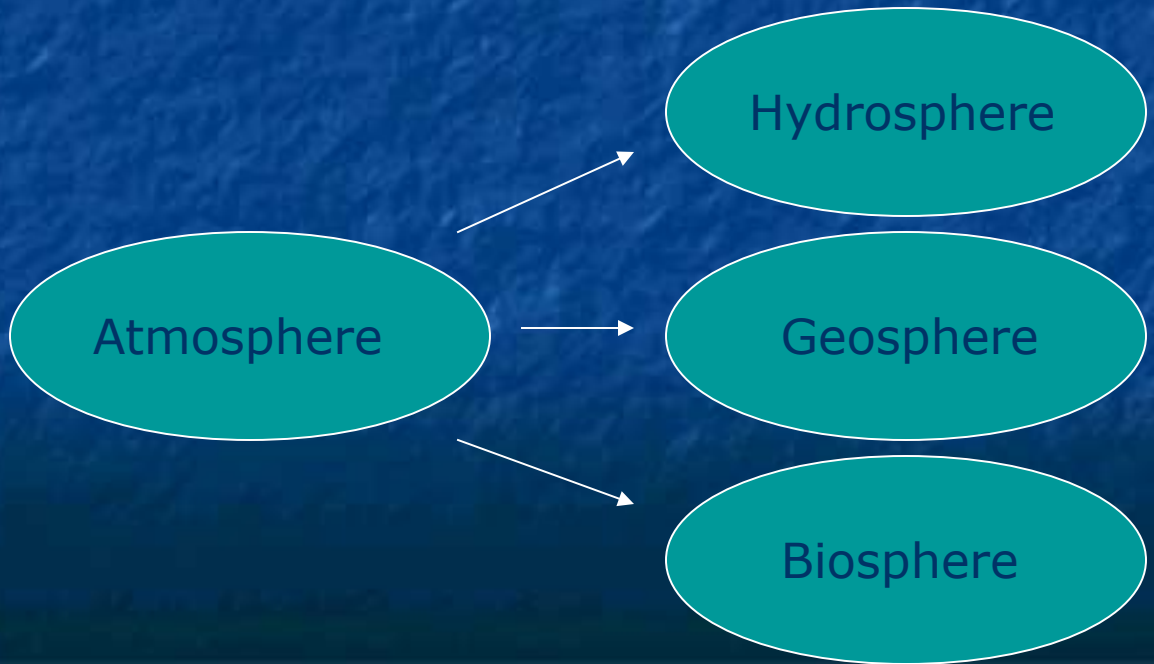
System Interactions*

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



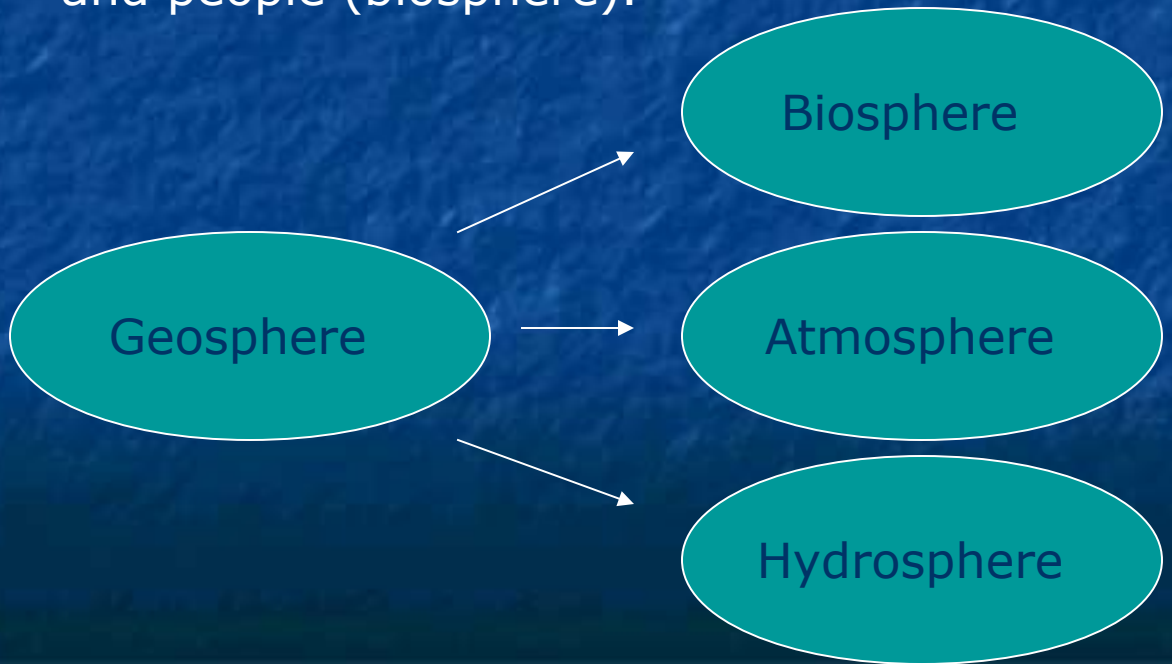
System Interactions

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



System Interactions

Earthquakes (geosphere) 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).



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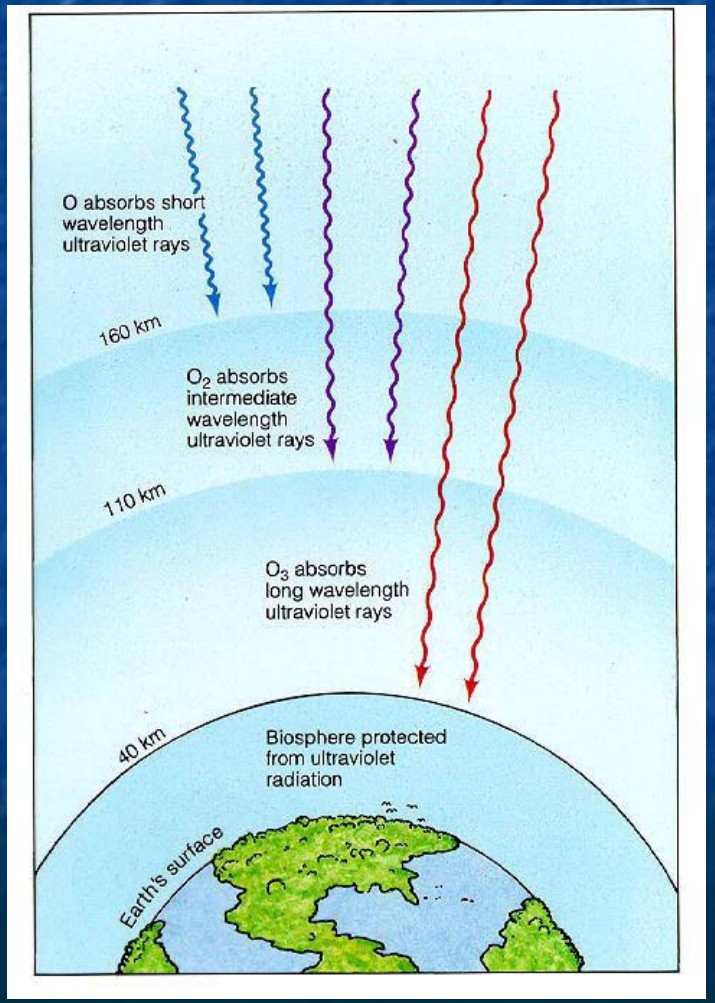
Volcanoes and the Atmosphere

*Volcanic eruptions are thought to be responsible for **global cooling**.* As volcanoes erupt, they blast huge clouds into the atmosphere. These clouds are made up of particles and gases, including sulfur dioxide. Millions of tons of sulfur dioxide gas can reach the stratosphere from a major volcano. There, the sulfur dioxide converts to tiny persistent sulfuric acid (sulfate) particles, referred to as aerosols. These sulfate particles reflect energy coming from the sun, thereby preventing the sun's rays from heating the Earth.

Mt. Pinatubo

Volcanoes and the Atmosphere

*Another possible effect of a volcanic eruption is the destruction of stratospheric ozone. *Researchers now are suggesting that ice particles containing sulfuric acid from volcanic emissions may contribute to ozone loss. When chlorine compounds resulting from the breakup of chlorofluorocarbons (CFCs) in the stratosphere are present, the sulfate particles may serve to convert them into more active forms that may cause more rapid **ozone depletion**.



Volcanoes and the Atmosphere

*Volcanoes also release large amounts of **water and carbon dioxide**. When these two compounds are in the form of gases in the atmosphere, they absorb heat radiation (infrared) emitted by the ground and hold it in the atmosphere.* This causes the air below to get warmer. Therefore, you might think that a major eruption would cause a temporary warming of the atmosphere rather than a cooling. However, there are very large amounts of water and carbon dioxide in the atmosphere already, and even a large eruption doesn't change the global amounts very much. In addition, the water generally condenses out of the atmosphere as rain in a few hours to a few days, and the carbon dioxide quickly dissolves in the ocean or is absorbed by plants.

Volcanoes and the Hydrosphere

Volcanoes change the hydrosphere in many ways. The flow from an eruption could block the movement of a river. This could cause the river to change its path. It could also make the river to expand and cover an area that was dry. In the ocean, some volcanoes become islands. Volcanoes form on the ocean floor and change the structures there.

After Mt. St. Helens eruption