

Ecosystems on Land

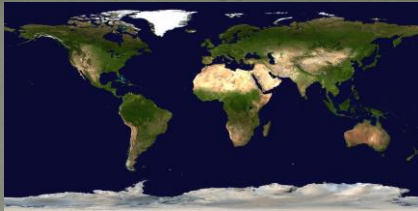


To me every hour of the light and dark is a miracle, every cubic inch of space is a miracle, every square yard of the surface of the Earth is spread with the same.
- Walt Whitman



- This is the **biosphere** -- the part of the Earth that supports life.
- Scattered throughout the biosphere is a wide range of geographic areas called **biomes**, each with its own unique climate, landforms, and biodiversity.

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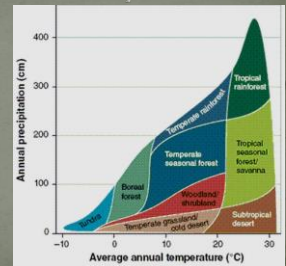


- Each biome is defined by two sets of characteristics:
 - **Abiotic factors**, which are nonliving.
Example: Soil type, average rainfall.
 - **Biotic factors**, which are living.
Examples: Species of decomposers, producers, and consumers present.

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Abiotic Influences of an Ecosystem

- The two most significant abiotic factors that influence life in a biome are average temperature and precipitation.



- Temperature and precipitation are very heavily influenced by **latitude**, distance from the equator measured in degrees.

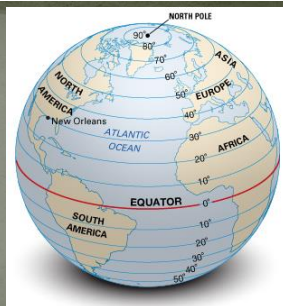
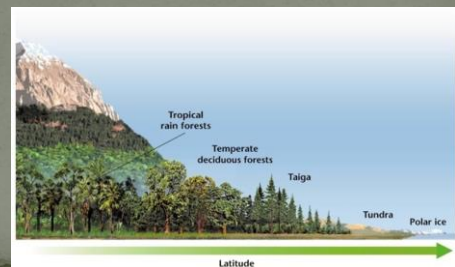


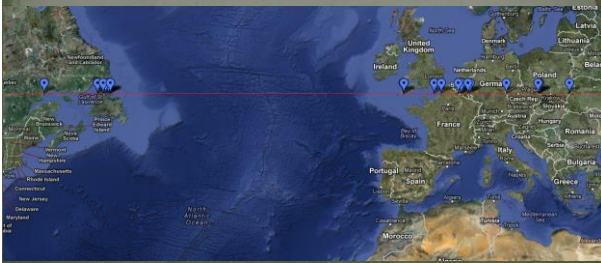
Image from Encyclopedia Britannica, 2012

- As the latitude of an ecosystem increases, average temperature tends to decrease.



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- Latitude is not the only factor influencing climate. Newfoundland, Canada and Northern France both fall along the 50°N latitude line, yet have very different climates.



- The same latitude in Newfoundland, Canada will have an average January temperature of 12°F in Newfoundland, Canada and 37°F in Rouen, France.



Rouen, France. (49.4°N)

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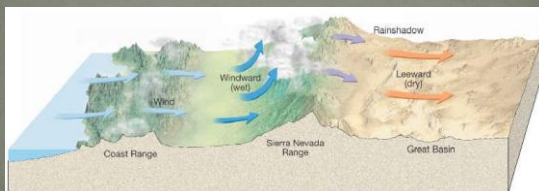
Mount Kilimanjaro, Tanzania (3°S)

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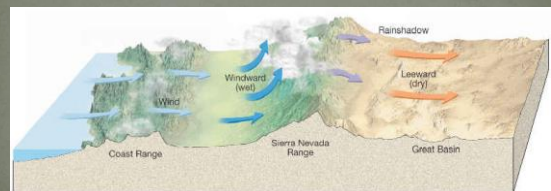
- Biomes located near a large body of water often have greater precipitation levels and milder, more stable temperatures.



South Peruvian coast at Pisco (image from NASA)



- As a result, the **windward** side of the mountain facing the incoming air currents receives disproportionately more precipitation than the opposite, **leeward** side.
- This is called the **rain shadow effect**.



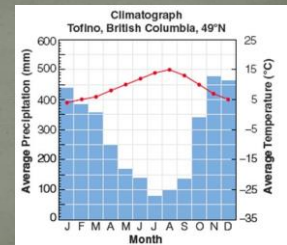
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- The rainshadow effect caused by the Cascade mountain range in Washington State creates the climate divide between the moist temperate rainforests and high deserts of Oregon.



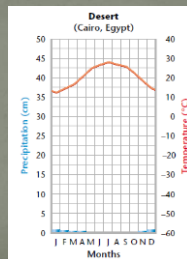
Climatographs

- Ecologists use a combination line/bar graph called a **climatograph** to compare and classify biomes.
- The average monthly precipitation for the area is displayed as a **bar graph**.
- The average monthly temperature is displayed as a **line graph**.



Deserts

- Lowest moisture levels of all ecosystems.
- Precipitation is infrequent and unpredictable.
- The lack of water is a major limiting factor for plant growth.
- The lack of plants, in turn, is a limiting factor for any other consumer or decomposer.



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- Subtropical deserts** are usually located in the interior of continents, far from sources of moisture.
- Wind patterns also prevent any moisture from collecting.



Kalahari Desert, Botswana, Africa

- Rain shadow deserts** are formed primarily due to their position on the leeward side of a large mountain range.
- The Gobi desert falls on the leeward side of the Himalayan mountains.



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- The Atacama Desert in Chile is the driest place on Earth, outside of Antarctica.
- Some weather stations have *never* recorded any rainfall!
- This is a **coastal desert**. The ocean water cools the air so much that it is unable to hold moisture well.
- The Andes Mountains form a rain shadow effect on the opposite side.



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- Midlatitude, or **temperate deserts** fall in higher latitudes, between 40 and 60 degrees.
 - This means much more temperature variability, including different seasons.
- Temperate deserts receive somewhat more precipitation than subtropical deserts, supporting plants adapted to the climate.
- Many temperate desert plants are succulents, meaning they have thickened, fleshy parts for storing water.
- Succulent plants also grow very slowly.
 - The Saguaro cactus grows 75 years before sprouting its first arm!



Saguaro cacti, *Carnegiea gigantea*
Sonoran Desert, Arizona, USA.

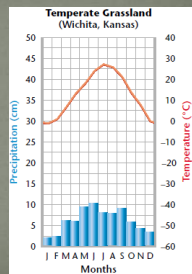
- Polar deserts** consistently experience temperatures below freezing.
 - The little precipitation that falls takes the form of ice or snow.
- Most of the interior of Antarctica is considered a polar desert.



250 year-old mummified seal carcass.
McMurdo Dry Valley, Antarctica.

Grasslands

- Grasslands receive more precipitation and cooler temperatures than deserts.
- With water being less of a limiting factor, more biomass is found here than in deserts.



- Tropical grasslands, also called **savannas**, are located near the equator, usually between desert and rainforest biomes.
- Savannas have consistent temperatures. The seasons are instead based on precipitation.



Serengeti National Park,
Tanzania, Africa.

- Temperate grasslands, called **prairies** in North America, are farther away from the equator and experience seasonal temperature shifts.



Badlands National Park, South Dakota, USA.

- Prairie plants have adapted to the cold winter and frequent absence of precipitation by developing root systems that can be several feet deep.
 - This enables prairie plants to recover quickly from drought or wildfire, while the slow growing trees cannot.



Missouri Goldenrod,
Solidago missouriensis



Compass Plant,
Silphium laciniatum
Photos from National Geographic

- Polar grasslands, also called **tundra**, are below freezing most of the year.
 - Limiting factor is temperature.
- Due to the short growing season, only the top layer of soil actually thaws and can support plant life.
 - The rest is permanently frozen soil, called **permafrost**.



Spitsbergen, Norway. Photo by John Shaw.

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- There is a growing season in the tundra, but it is only a few months long.
 - Only small plants and lichens grow there.

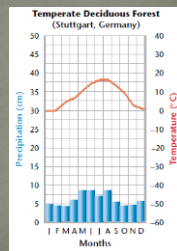


Ilulissat, Greenland. Photo from mvfram.blogspot.pt

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Forests

- Forest biomes receive much more consistent precipitation than deserts and grasslands, allowing them to support hardwood trees.



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- The **canopy** is the outermost layer of leaves within a group of trees.
 - Most of the animal life is found here.
- The **emergent layer** consists of the tallest trees that reach above the canopy.



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- The **understory** consists of vegetation immediately below the canopy.
- The **shrub layer** consists of shorter plants that utilize the 5% of sunlight that passes through the canopy.
 - Mostly small shrubs and seedlings.
- The **forest floor** is mostly home to decomposers due to the lack of sunlight.



Phallus indusiatus, Veiled Lady Fungus

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- **Tropical rainforests** receive the greatest amount of rainfall of any other biome and are consistently warm.
 - Few abiotic limiting factors for plant growth.
- Nutrient cycles occur very rapidly in rainforests due to the rapid growth of both producers and decomposers.



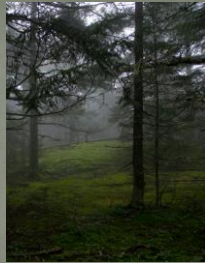
Iguazu Falls, border of Brazil, Argentina, and Bolivia.

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- **Temperate rainforests** receive a comparable amount of precipitation to tropical ones, but are in higher latitudes.

- One example is the Northern Pacific coast of the United States and Canada, which has two geographic advantages:

- Located on the windward side of the Olympic mountain range.
- Receives constant moisture from the wind currents off the Pacific ocean.



Issaquah, Washington,
United States

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- **Deciduous forests**, located at higher latitudes, experience a winter that reaches below freezing.

- Like rainforests, these mostly contain broadleaf trees which have more surface area for absorbing sunlight.
- Deciduous forests have the same layers as rainforests.



White oak, *Quercus alba*.
An example of a broadleaf tree.



Norway spruce, *Picea abies*.
An example of a needle leaf tree.

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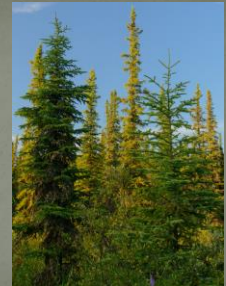
- Broadleaf trees lose moisture rapidly through transpiration, so they will shed their leaves during winter or dry seasons.



Dandenong Ranges, Australia.

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- **Boreal forests**, also called taiga, are found throughout the far northern latitudes.
- These forests are characterized by coniferous trees, which are much more well-adapted to the long, cold, dry winters.
- Needle-shaped leaves have a waxy coating that retains moisture in the winter.
- The cone shape of the trees allows accumulated snow to slide to the ground.



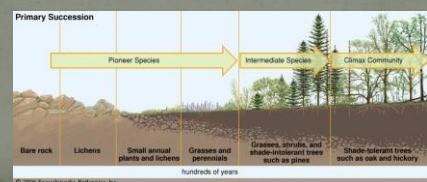
Fairbanks, Alaska, United States.

Ecosystems in Transition

- Biomes are dynamic – they change as the Earth changes. This process is called **succession**.
- Organisms that thrive during the early stages of succession are called **pioneer species**. Those only found in later stages are called **climax species**.
- Ecosystem succession takes two forms, depending on the starting point.

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- **Primary succession** occurs when a new ecosystem develops where there was none before.
- A combination of wind, water, and pioneer species such as lichens break down rock into soil.
- Once the soil has enough organic matter, small plants and shrubs can be supported. Over time, trees spout and become dominant.



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- **Secondary succession** occurs following the disruption of an existing ecosystem.
 - Fire, flood, volcanic eruption, clear-cutting, etc.
- This form of ecological succession does not take as long. Soil is already in place, and pioneer species appear within days or weeks.

