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## Temperature Tutorial

One of the main large-scale influences on climate is latitude – polar regions receive less concentrated sunlight than tropical regions. Seasonality arises from the tilt of the earth's rotational axis with respect to its orbit around the sun, most noticeably at higher latitudes. Regional topography, large bodies of water, and the heat contributed by cities also affect temperature.

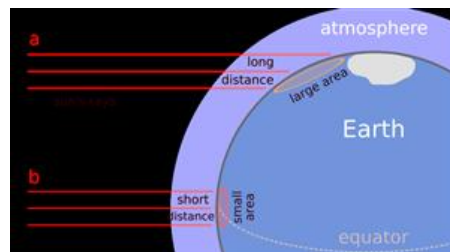
### Effect of Latitude

Temperature is highly dependent on the amount of solar energy reaching the earth's surface. Because of the curvature of the earth, solar energy reaching high latitude regions passes through more atmosphere, so more of it is scattered and reflected. Furthermore, the remaining solar radiation arrives at a lower angle, spreading its energy out over a larger area. As a result, regions at high latitudes receive much less solar energy per unit area, and have lower average temperatures than regions closer to the equator (see the solar radiation diagram on the right).

As the earth revolves around the sun, different regions of the earth are tilted towards and away from the sun because the earth's rotational axis is tilted at  $23.5^\circ$  with respect to the plane of its orbit. As the angle of sunlight varies over time, its warming effect varies also, just as with latitude, though the seasonal variation is exaggerated by the corresponding variation in the length of day. Winter occurs when a region is tilted away from the sun, while summer occurs when a region is tilted toward the sun.

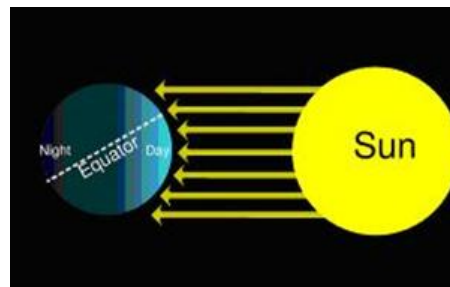
Equatorial regions experience only small seasonal changes in temperature due to the relatively constant angle between these regions and the sun.

The figure on the right shows how seasons are determined by the tilt of the earth's rotational axis and the orbit of the earth around the sun. In this snapshot the northern hemisphere is tilted away from the sun and experiencing winter, while the southern hemisphere is tilted towards the sun and experiencing summer.



Solar radiation at different latitudes.

Source: Peter Halasz  
([http://commons.wikimedia.org/wiki/Image:Oblique\\_rays\\_04\\_Pengo.svg](http://commons.wikimedia.org/wiki/Image:Oblique_rays_04_Pengo.svg))  
(click to enlarge)



Seasons determined by tilt.

Source: R.H. Castilhos (<http://en.wikipedia.org/wiki/Image:Seasons.svg>)  
(click to enlarge)

### Other Influences on Temperature

In coastal regions, temperature is also affected by the ocean – air masses can be warmed or cooled by contact with ocean currents before moving over the land. Also, because water warms and cools more slowly than land, nearness to the ocean or a large lake tends to moderate the daily temperature range – the difference between the daily maximum and minimum temperatures. The diurnal range in temperature increases with distance from the ocean or large lakes, and is highest in continental interiors.

Regional topography has its effect as well: temperatures decrease by about  $0.65^\circ$  with every 100 m gain in elevation, so mountainous regions will be cooler than low-lying regions, if all other factors are similar. Altitude can also affect temperature through exposure to solar radiation and influence on cloud cover.

Urbanization replaces natural components of the landscape with artificial surfaces and structures, differing in colour and material from the natural surface. These changes alter natural processes that affect temperature, including absorption and reflection of solar radiation, evaporation, and the movement of air and moisture. For example, dark surfaces (such as paved roads) absorb heat, while removal of vegetation can reduce both shade and cooling through evapotranspiration. The result is an **urban heat island** – an area several degrees warmer than surrounding rural areas.

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