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How the Atmosphere Influences Aridity

We live at the bottom of a gaseous envelope--the atmosphere--that is bound gravitationally to the planet Earth. The circulation of our atmosphere is a complex process because of the Earth's rotation and the tilt of its axis. The Earth's axis is inclined 23.5° from the ecliptic, the plane of the Earth's orbit around the Sun. Due to this inclination, vertical rays of the Sun strike 23.5° N. latitude, the Tropic of Cancer, at summer solstice in late June. At winter solstice, the vertical rays strike 23.5° S. Latitude, the Tropic of Capricorn. In the Northern Hemisphere, the summer solstice day has the most daylight hours, and the winter solstice has the fewest daylight hours each year. The tilt of the axis allows differential heating of the Earth's surface, which causes seasonal changes in the global circulation.

On a planetary scale, the circulation of air between the hot Equator and the cold North and South Poles creates pressure belts that influence weather. Air warmed by the Sun rises at the Equator, cools as it moves toward the poles, descends as cold air over the poles, and warms again as it moves over the surface of the Earth toward the Equator. This simple pattern of atmospheric convection, however, is complicated by the rotation of the Earth, which introduces the Coriolis Effect.

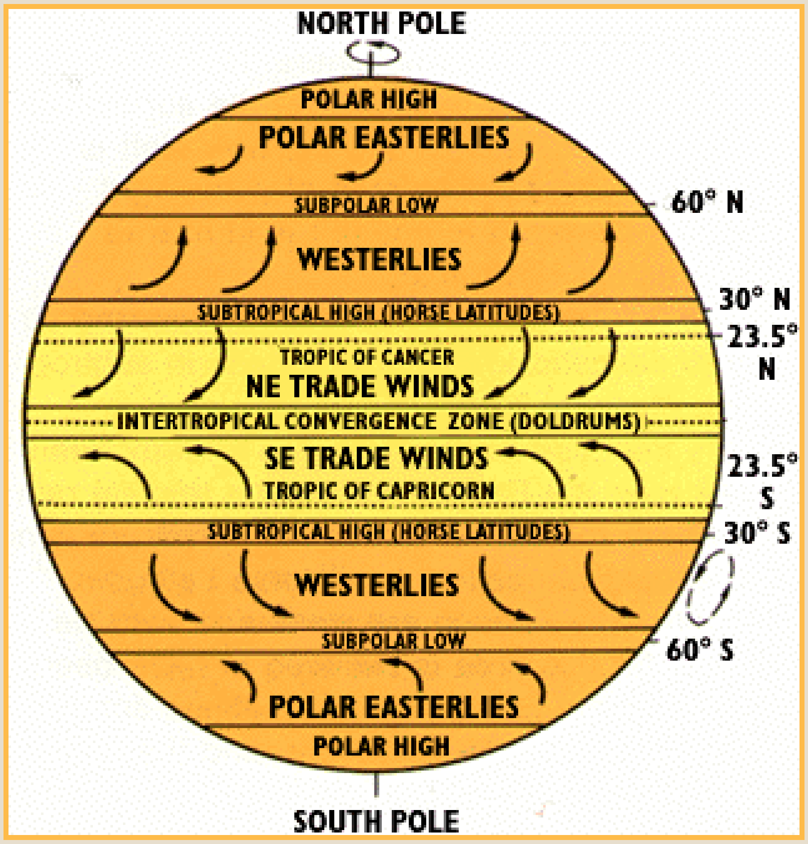
To appreciate the origin of this effect, consider the following. A stick placed vertically in the ground at the North Pole would simply turn around as the Earth rotates. A stick at the Equator would move in a large circle of almost 40,000 kilometers with the Earth as it rotates.

The Coriolis Effect illustrates Newton's first law of motion--a body in motion will maintain its speed and direction of motion unless acted on by some outside force. Thus, a wind travelling north from the equator will maintain the velocity acquired at the equator while the Earth under it is moving slower. This effect accounts for the generally east-west direction of winds, or streams of air, on the Earth's surface. Winds blow between areas of different atmospheric pressures.
The Coriolis Effect influences the circulation pattern of the Earth's atmosphere. In the zone between about 30° N. and 30° S., the surface air flows toward the Equator and the flow aloft is poleward. A low-pressure area of calm, light variable winds near the equator is known to mariners as the doldrums.

Around 30° N. and S., the poleward flowing air begins to descend toward the surface in subtropical high-pressure belts. The sinking air is relatively dry because its moisture has already been released near the Equator above the tropical rain forests. Near the center of this high-pressure zone of descending air, called the "Horse Latitudes," the winds at the surface are weak and variable. The name for this area is believed to have been given by colonial sailors, who, becalmed sometimes at these latitudes while crossing the oceans with horses as cargo, were forced to throw a few horses overboard to conserve water.

The surface air that flows from these subtropical high-pressure belts toward the Equator is deflected toward the west in both hemispheres by the Coriolis Effect. Because winds are named for the direction from which the wind is blowing, these winds are called the northeast trade winds in the Northern Hemisphere and the southeast trade winds in the Southern Hemisphere. The trade winds meet at the doldrums. Surface winds known as "westerlies" flow from the Horse Latitudes toward the poles. The "westerlies" meet "easterlies" from the polar highs at about 50-60° N. and S.

Near the ground, wind direction is affected by friction and by changes in topography. Winds may be seasonal, sporadic, or daily. They range from gentle breezes to violent gusts at speeds greater than 300 kilometers/hour.



The circulation pattern of the Earth's atmosphere. Most of the nonpolar deserts lie within the two trade winds belts.

These dunes in the Algodones Sand Sea of southeastern California move as much as 5 meters per year. The dunes in this photograph, looking south, move toward the east (left). (Photograph by Peter Kresan)

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