

Potential distribution of plants (where specific plants/ecosystems/biomes are found) is highly dependent on climate. Vegetation is an excellent expression of climate. Two key climate factors:

Water is required to maintain metabolism and growth activities; lost during CO₂ uptake.

Temperature influences capacity to metabolize and maintain growth activities; partly controls evaporative gradient.

Seasons: dependent on Earth's rotation around sun and Earth's tilt on axis.

Solar radiation: non-uniformly distributed on Earth's surface (cosine relationship); yields latitudinal climate differences (temperature patterns).

Atmospheric circulation and **proximity to ocean:** heavily influence precipitation and temperature patterns.

Elevation: precipitation increases and temperature decreases with increasing elevation.

Topography: precipitation is highly influenced by mountain ranges (wetter and dryer sides of mountains).

Aspect: north-facing slopes receive less solar radiation than south facing slopes in the northern hemisphere; opposite is true in the southern hemisphere.

Evapotranspiration (ET): sum of evaporation from soil and transpiration from plants.

Potential evapotranspiration (PET): theoretical amount of water lost to atmosphere given current conditions and no regulation of water supply; dependent on energy input (largely solar radiation), temperature, humidity (atmospheric moisture content), and wind speed.

Actual evapotranspiration (AET): actual amount of water lost to atmosphere via evaporation and transpiration; dependent on same factors as PET, how much water is available, and regulation by plants and soil.

$P < PET$: arid climate; $P > PET$: humid climate

Growing season: length of year plants remain active; influenced by temperature (colder climates) and precipitation (drier climates).

Water balance = soil water availability – ET

Soil water availability = precipitation – (interception + runoff + percolation); accounts for water not available to plants

Water balance often controls lower elevation limits of plants; temperature often controls upper elevation limits. Water balance strongly influences leaf area index (LAI), where LAI is high when water balance is positive and low when water balance is negative.

Leaf area index (LAI) = leaf area [m²] / ground area [m²]

Examples of **tradeoffs**: CO₂ uptake versus water loss through stomata; resource input to produce leaves versus energy production by leaves in lower canopy (shaded leaves).

Raunkiaer life form classifications: based on location of perennating bud during unfavorable seasons, where perennating bud is the bud or growth point that survives from season to season.

Life forms:

Phanerophytes: > 0.5 meters above surface (perennial plants)

Chamaephytes: 0.0 - 0.5 meters above surface (perennial plants)

Hemicryptophytes: at soil surface (perennial plants)

Geophytes: below soil surface (perennial plants)

Therophytes: seeds (annual plants)

Temperature and precipitation patterns are described with **climate diagrams**; potential evapotranspiration is approximated from temperature line, providing an estimate of water balance.

Different combinations of temperature and precipitation produce different **biomes**. Similar biomes and ecosystems are found in similar climates around the world.

Biomes (major ecosystems of the world):

Deserts: $P < PET$; temperature changes are dependent on coastal versus interior location.

Grasslands and steppes: $P \approx PET$ during growing season; often occur in summer-wet regions.

Forests: $P > PET$ during warm temperature period, except for Mediterranean where $P < PET$.

Boreal forest: cold coniferous forest located between tundra and temperate regions.

Temperate coniferous forest: cold winter, cool summer.

Temperate deciduous forest: cold winter, warm summer.

Tropical rain forest: warm winter and summer, no dry season.

Savanna: warm winter and summer, distinct dry season.

Mediterranean (scrub woodland): mild and wet winter, dry and often hot summer.

Tundra: $P > PET$, but very cold winter temperatures and short, cool growing season; high altitudes and/or latitudes.

