Geography shapes climate

Solar energy powers the climate system, but mountains, elevation and the ocean modify local temperature and precipitation. Places at similar latitudes need not have similar climates.

1. WEATHER IS SHORT-TERM; CLIMATE IS THE PATTERN

Weather describes atmospheric conditions at a particular time and place: today's rain, wind or temperature. Climate describes long-term averages, variability and seasonal patterns, commonly assessed over 30-year periods. One cold day does not establish a cold climate.

2. CONNECT EACH FEATURE TO A MECHANISM

LATITUDE	Changes solar angle and energy input; this is the background pattern developed in Topic 4.7.
ELEVATION	Higher locations are generally cooler in the troposphere. Local inversions can temporarily reverse this pattern.
MOUNTAINS + WIND	Terrain forces moist air upward. The direction of incoming wind determines which slope is windward.
OCEANS	Water stores and transports heat. Distance from the coast, water temperature and wind affect nearby land.

3. FOLLOW THE AIR, NOT JUST THE LOCATION

To compare two places, trace where their air comes from, whether it passes over warm or cold water, and whether it rises or sinks over terrain. Latitude alone cannot explain a wet mountain slope next to a dry basin. The key links are heat transfer, cooling, condensation and precipitation.

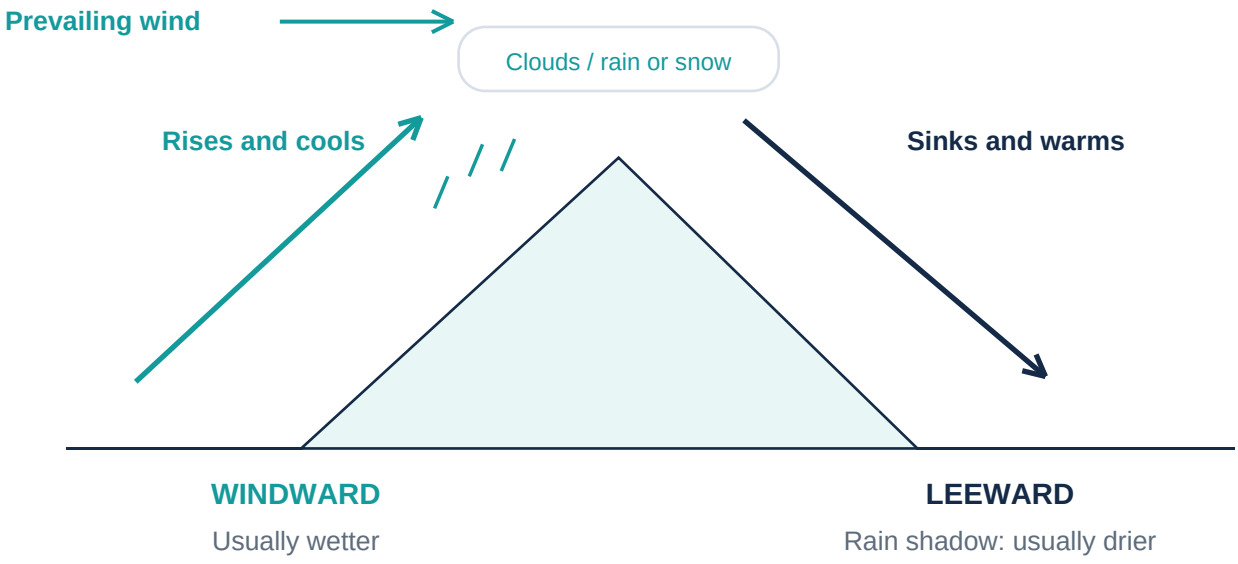
Weather/climate distinction: Met Office, What is climate?
Latitude, altitude and coastal influence: Met Office, Understanding weather.

Scope: College Board AP Environmental Science CED, Topic 4.8, p. 87.

Mountains create a rain shadow

A rain shadow is a comparatively dry area downwind of a mountain barrier. The mountain changes the air's path and moisture, rather than simply acting as an umbrella.

1. TRACE MOIST AIR ACROSS THE RANGE



2. RISING AIR: EXPANSION, COOLING, CONDENSATION

On the windward side, air is forced to higher elevations where pressure is lower. It expands and cools. If it cools to saturation, water vapor condenses into cloud droplets or ice crystals. Sufficient growth produces rain or snow, removing some water from the moving air.

3. DESCENDING AIR: COMPRESSION AND WARMING

On the leeward side, air moves into higher pressure, compresses and warms. Its relative humidity falls, making cloud formation less likely. Combined with moisture already lost upwind, this produces a drier climate. Windward and leeward refer to wind direction, not fixed east and west sides.

Expansion, compression and relative humidity: NOAA/NWS, Down Slope Winds.
Rain-shadow formation: National Park Service, Great Basin Deserts.

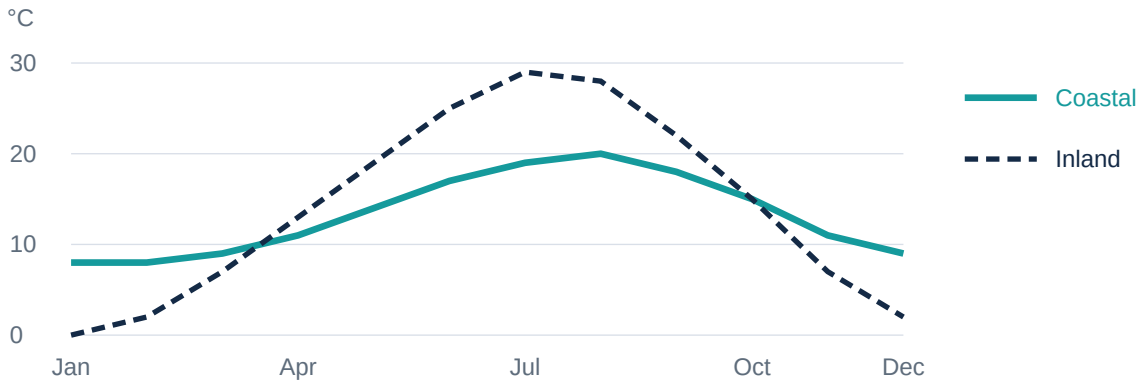
Scope: College Board AP Environmental Science CED, Topic 4.8, p. 87.

Oceans soften temperature extremes

Water changes temperature more slowly than land. Ocean currents also redistribute heat, while winds connect ocean conditions to nearby land. These effects vary with location and season.

1. COASTAL AND INLAND: A CONTROLLED COMPARISON

Illustrative monthly means, not measured city data; imagine sites at similar latitude and elevation in the Northern Hemisphere.



Annual range = warmest minus coldest monthly mean: coastal 12°C; inland 29°C. The ocean often reduces this range, especially with onshore winds.

2. OCEAN TEMPERATURE AND CURRENTS MATTER

Warm currents can warm nearby air; evaporation supplies water vapor that winds may carry inland. Cold currents can cool adjacent air. These effects depend on wind direction and circulation: a warm current does not guarantee rain, because precipitation also requires suitable cooling and cloud development.

3. REAL-WORLD LINK: THE GREAT BASIN

Moist Pacific air rises over the Sierra Nevada and loses water as precipitation. The Great Basin lies downwind in the rain shadow. It is a cold desert: dryness, not constant heat, defines a desert. A rain shadow means reduced precipitation, not no precipitation; winter snow can still occur.

Coastal moderation: Met Office, Understanding weather; ocean heat transport: NOAA.
Sierra Nevada rain shadow and cold desert: National Park Service, Great Basin Deserts.

Scope: College Board AP Environmental Science CED, Topic 4.8, p. 87.