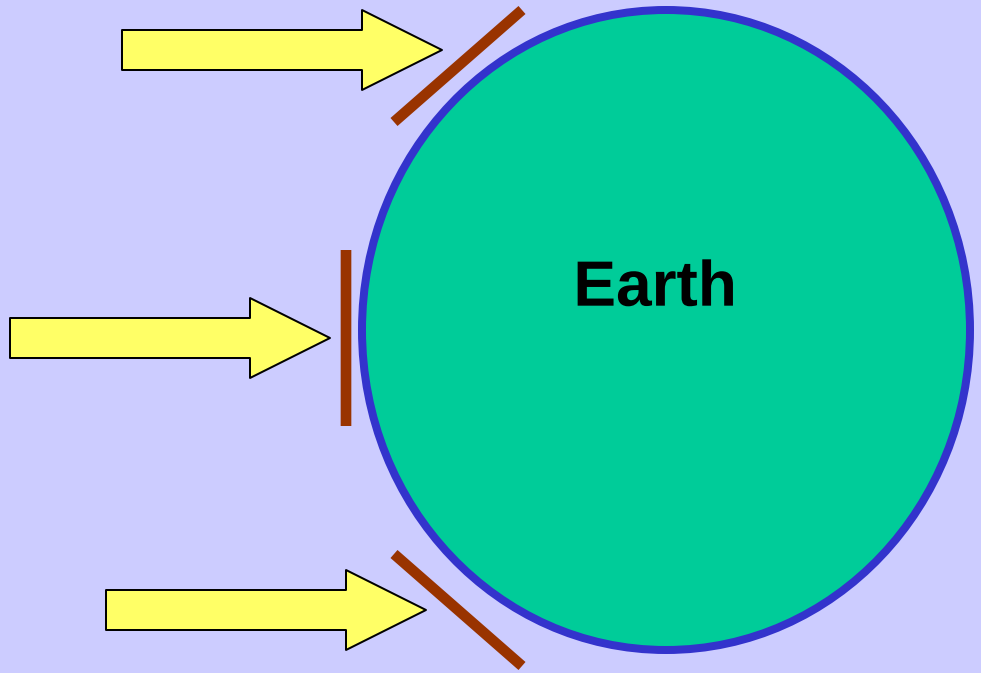
Chapter 4

Atmospheric Circulation

Regions near the equator receive light at 90^{o}

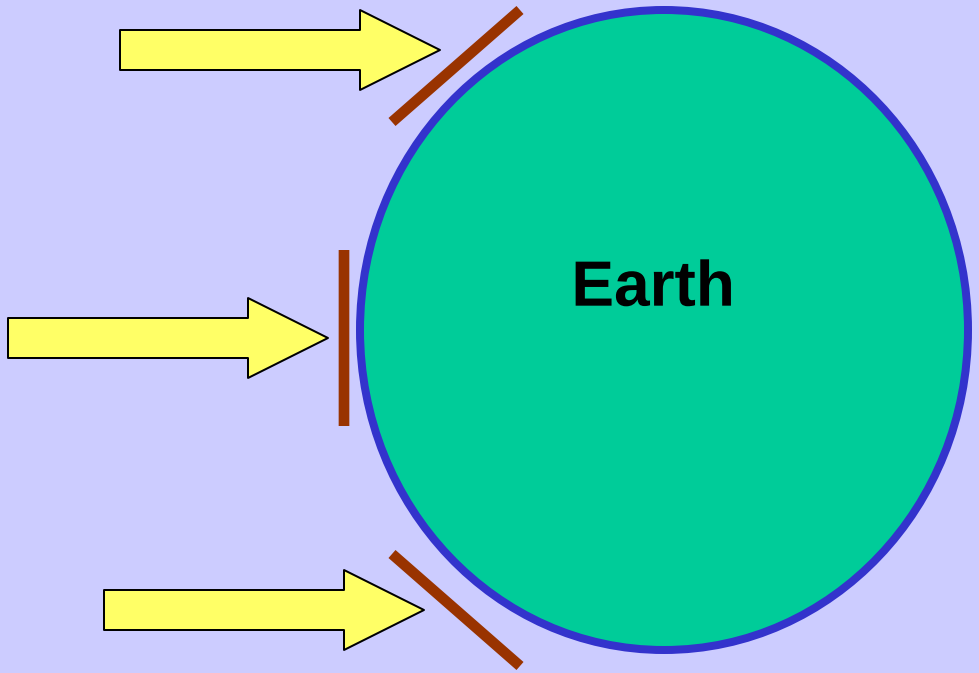
High latitudes receive light at low angles



Regions near the equator receive light at 90^{o}

High latitudes receive light at low angles

Light energy is more concentrated near the equator. In other words, there is a greater flux per unit area (W/m^{2})



Solar energy is concentrated near the equator

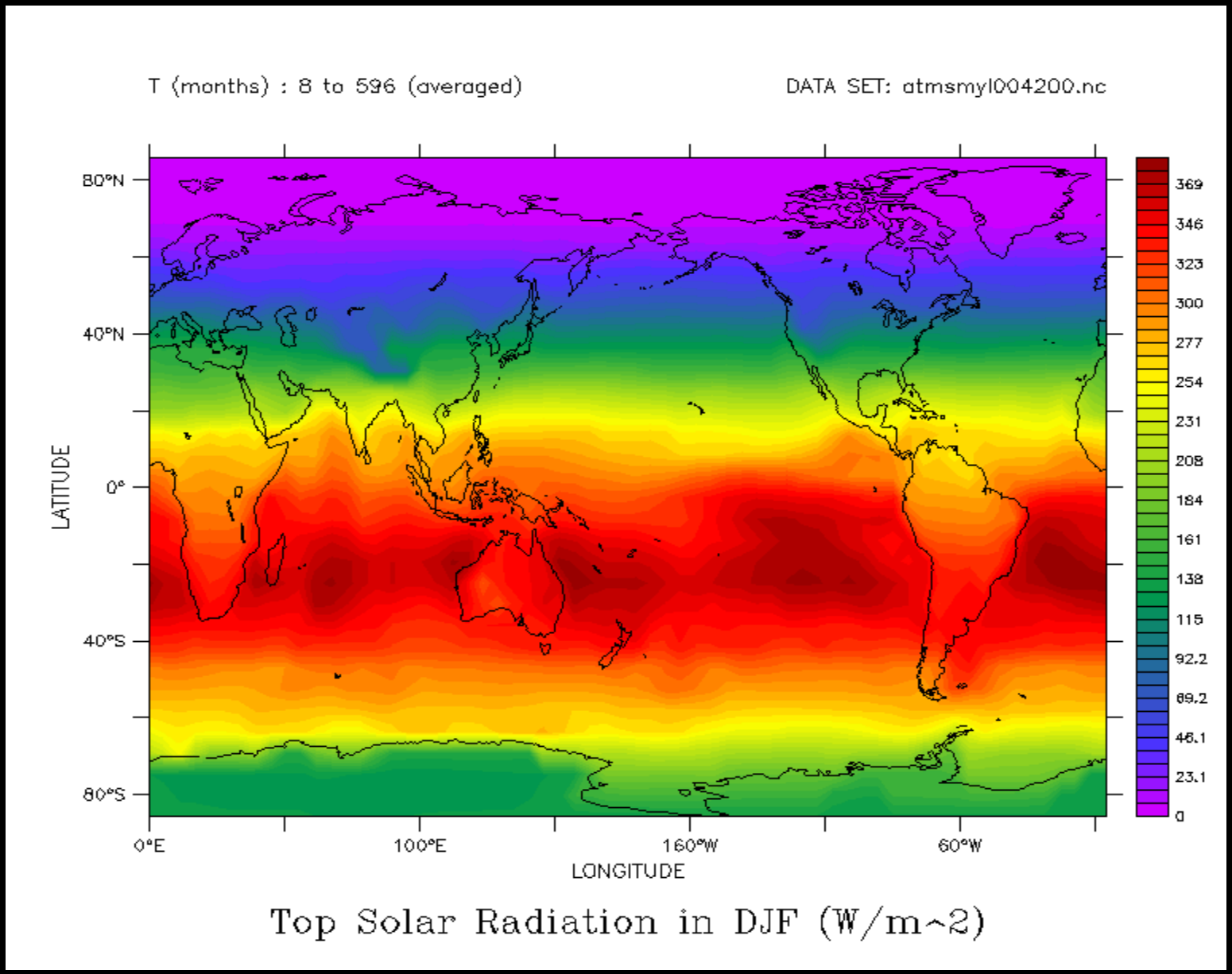
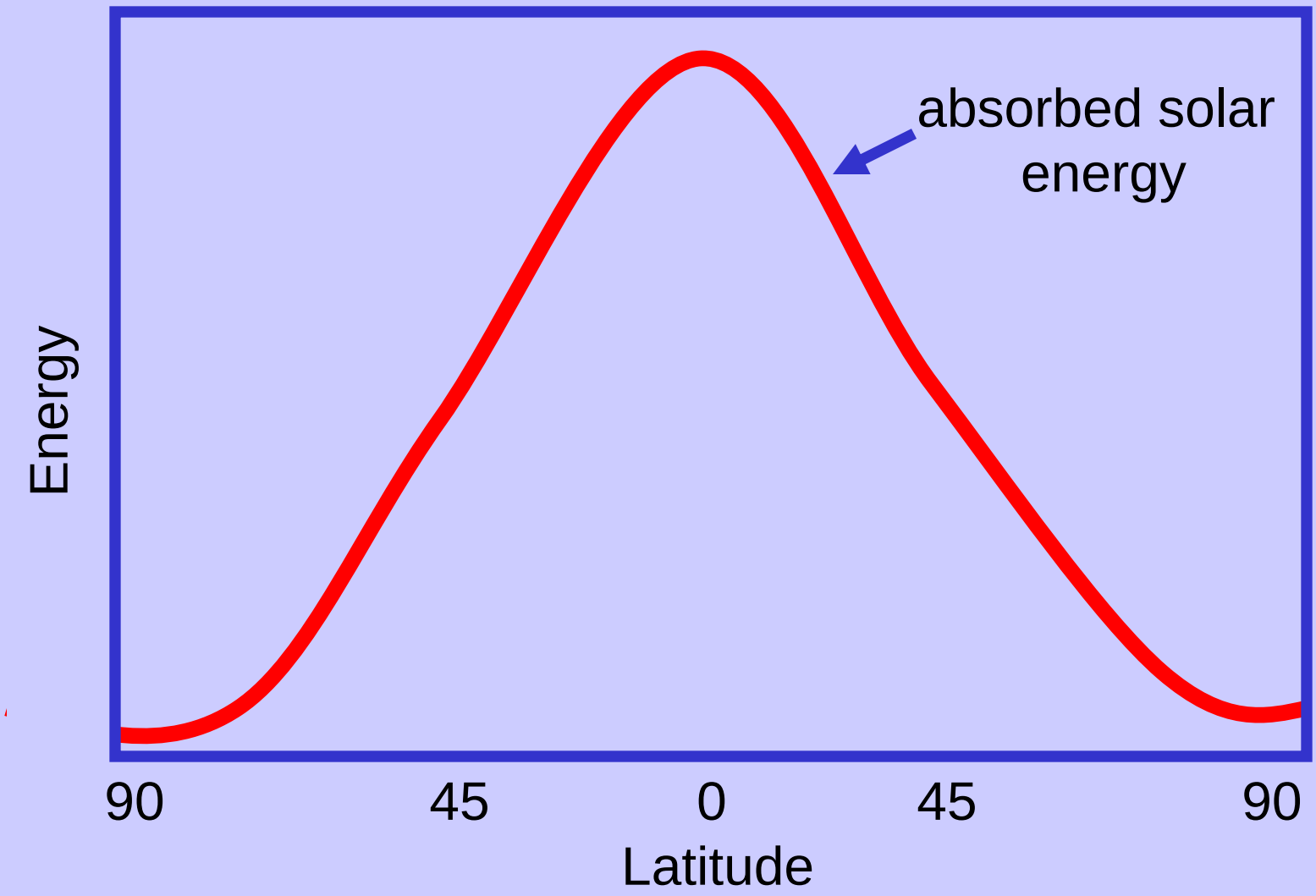
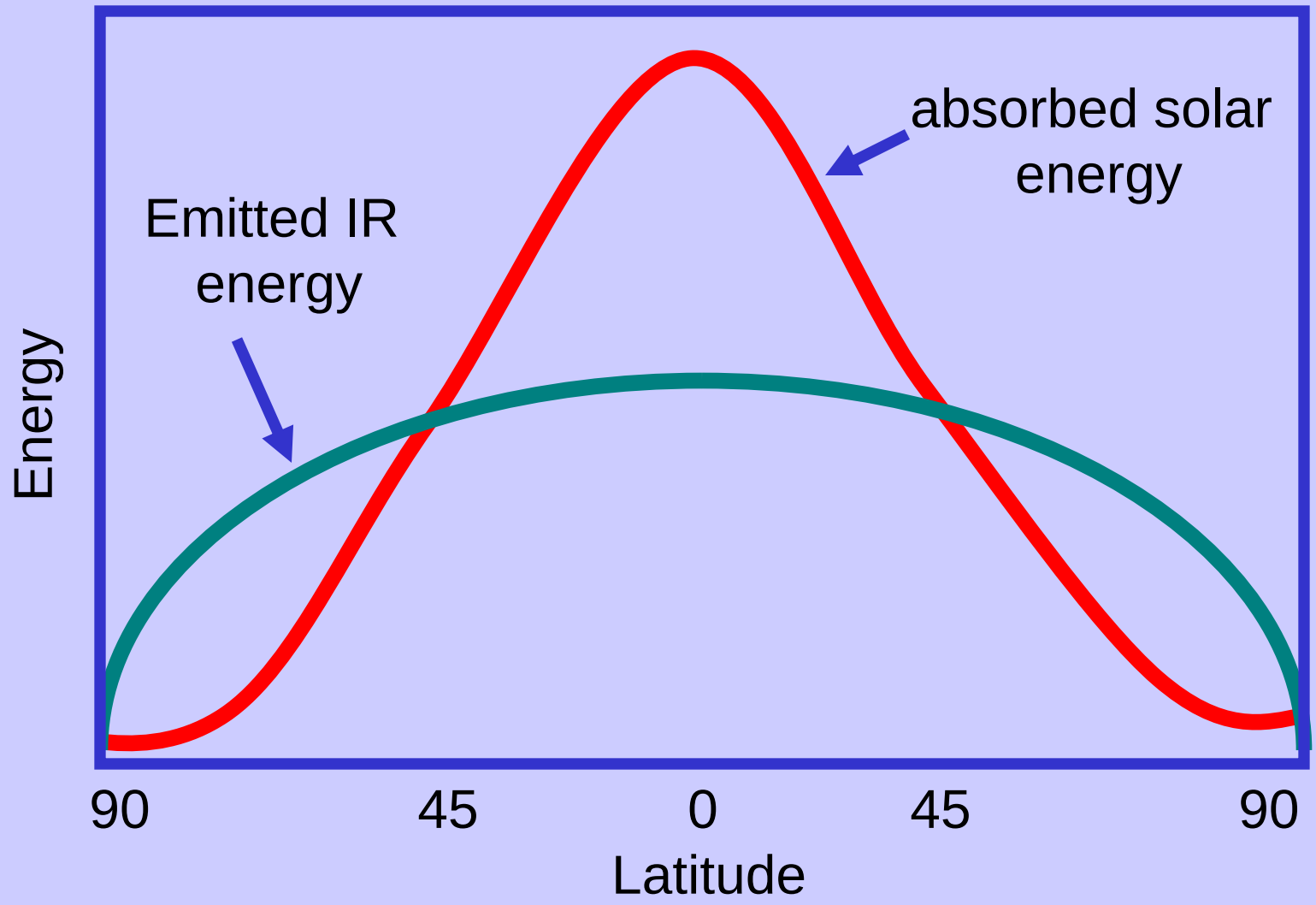
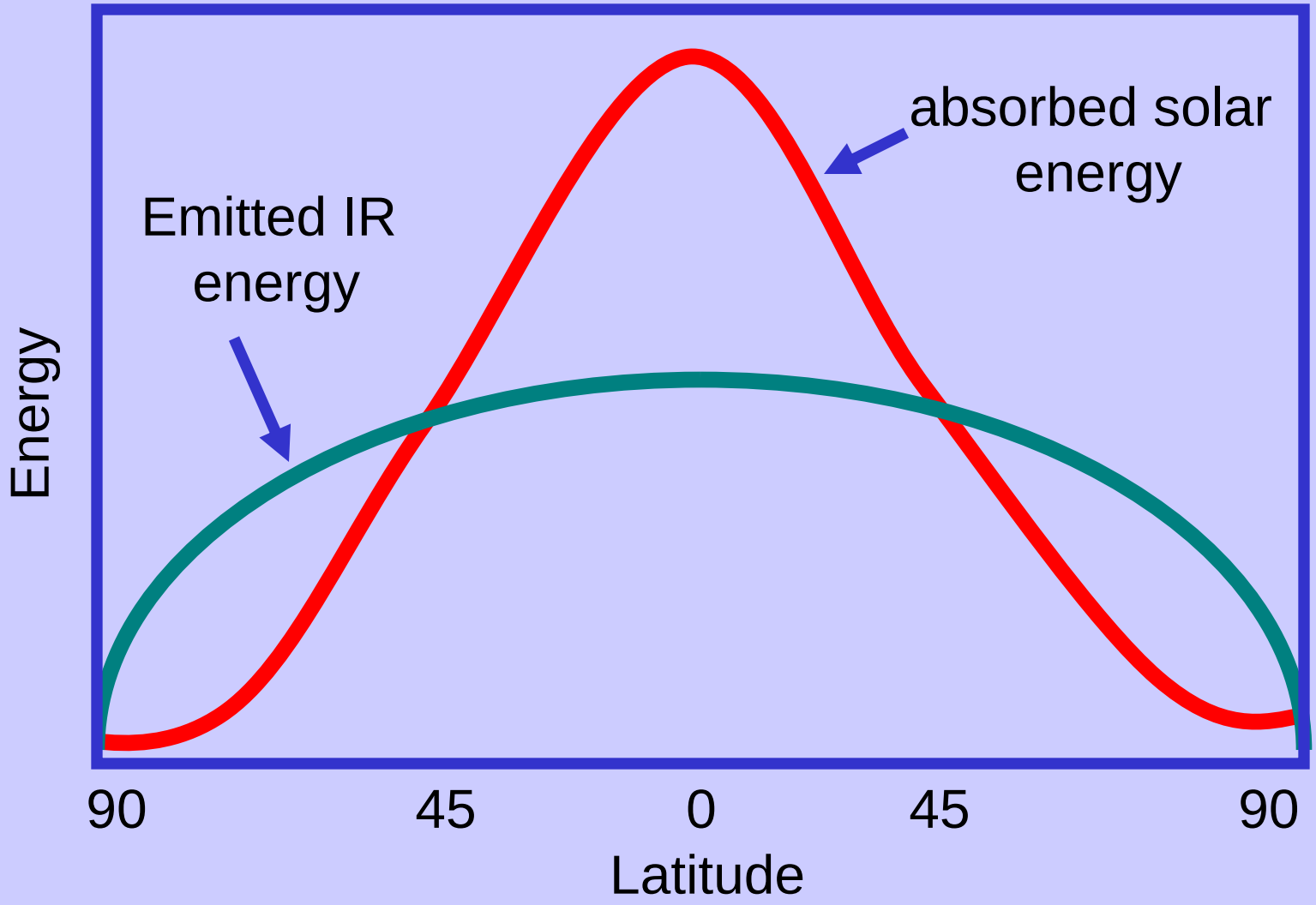


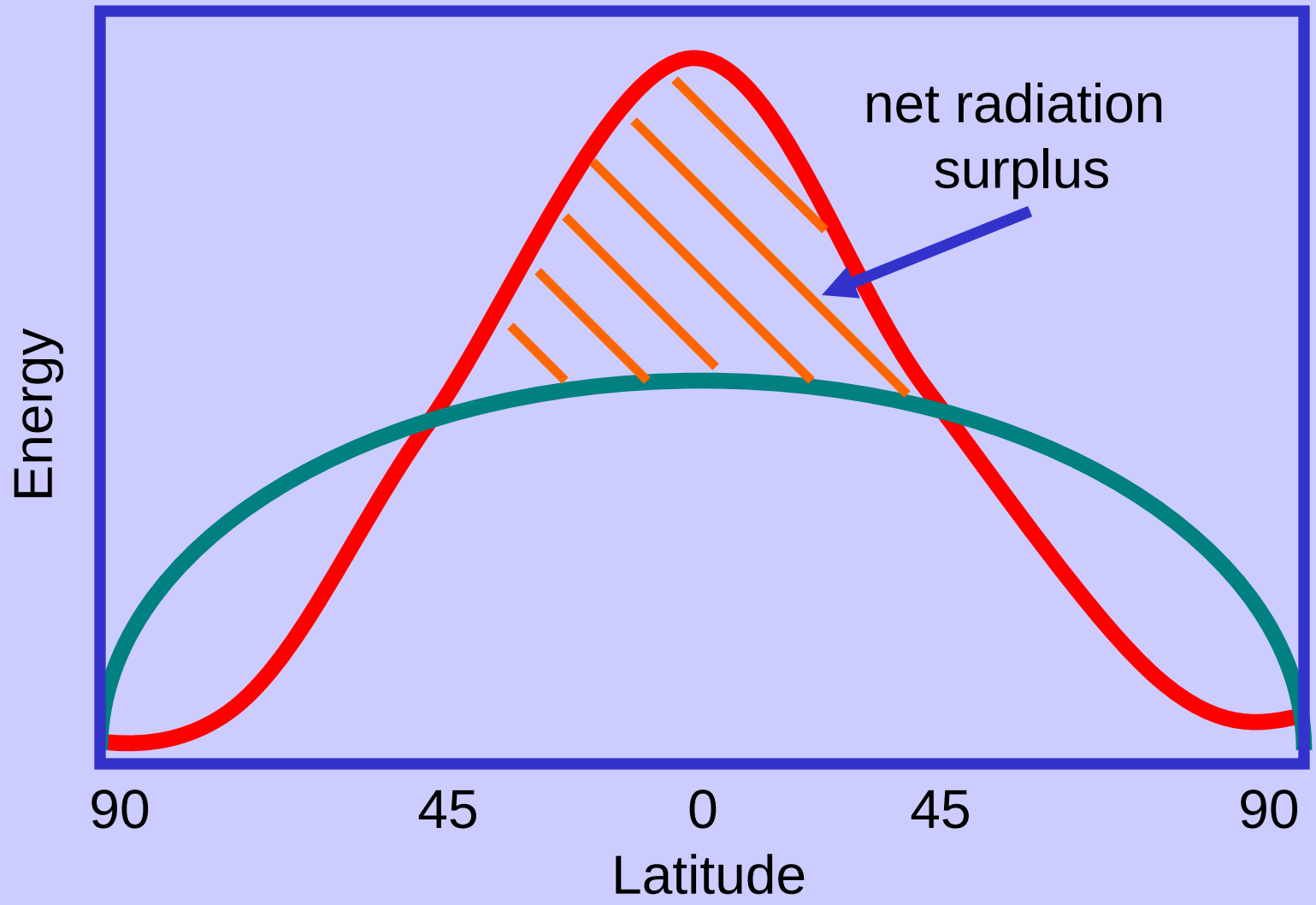
Image: Netherlands Center for Climate Research


absorbed solar energy
Energy
90
45
0
45
90
Latitude

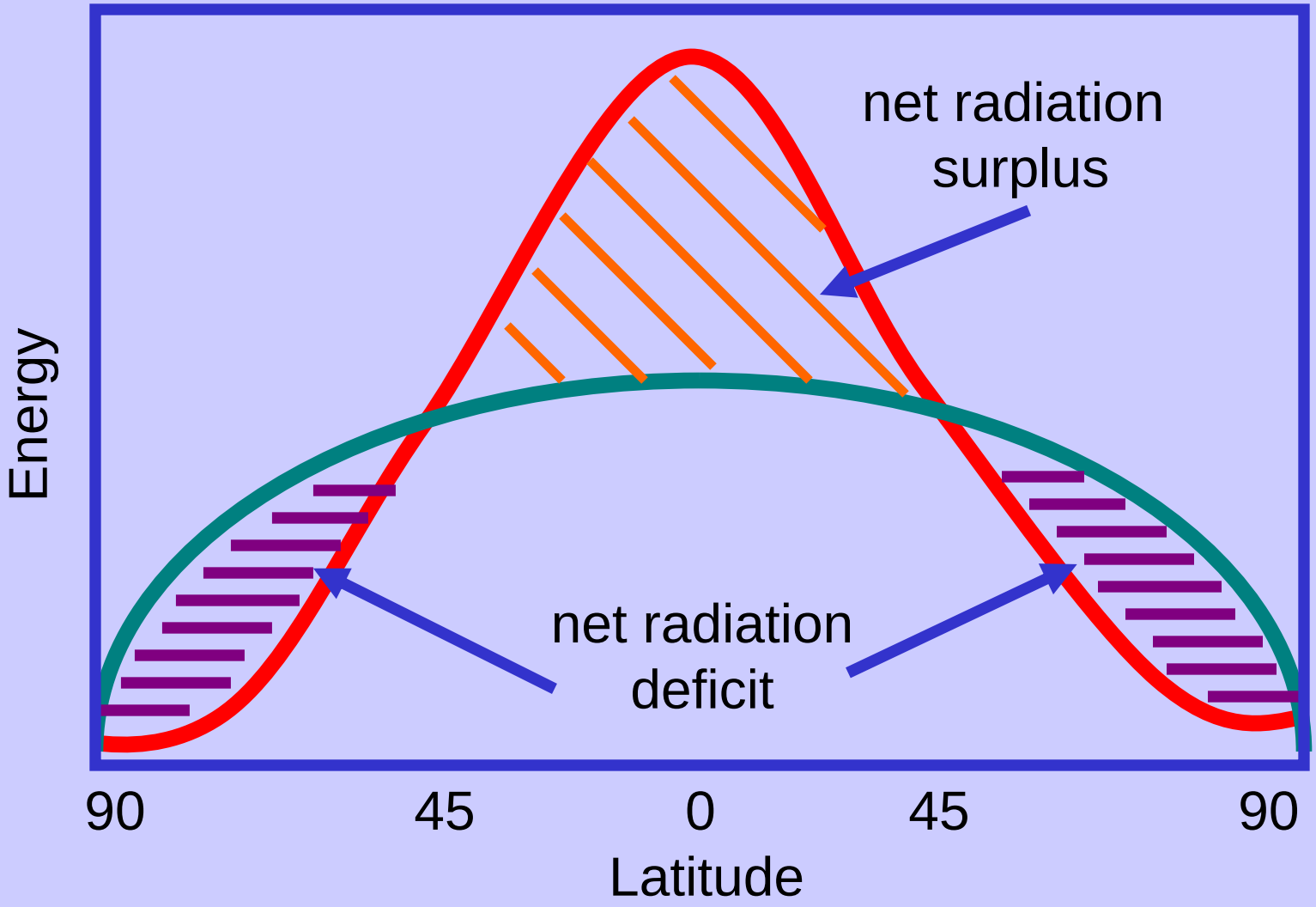

absorbed solar energy
Emitted IR energy
Energy
90
45
0
45
90
Latitude

More energy is absorbed near the equator than emitted
And more energy is emitted near the poles than is absorbed.




net radiation
surplus
Energy
90
45
0
45
90
Latitude

Excess energy at the equator is transferred towards the poles by convection cells



Solar energy received is greatest near the equator.

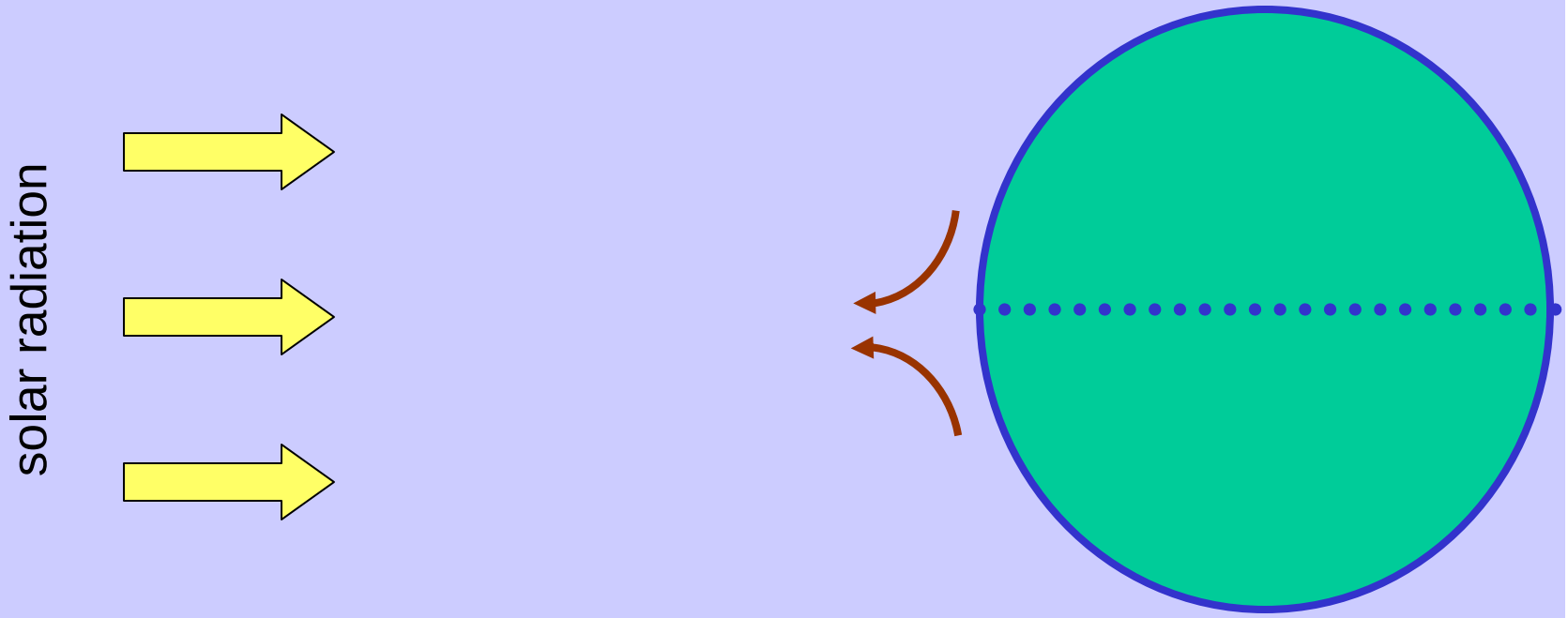
Energy is moved from the equator to the poles.

Solar energy received is greatest near the equator.

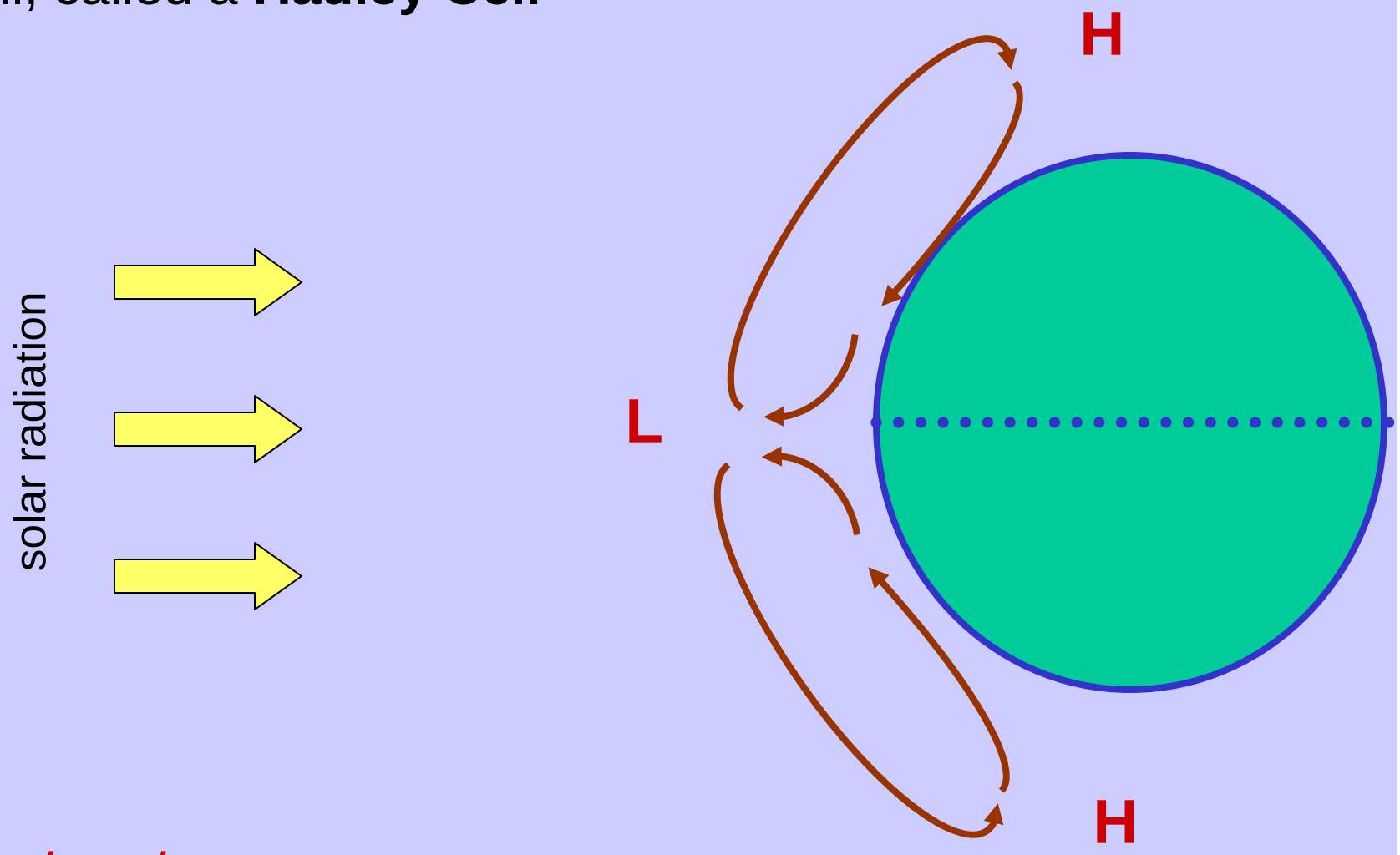
Energy is moved from the equator to the poles.

Energy is transferred by **wind** and **ocean currents**

Air near the equator is warmed, and rises

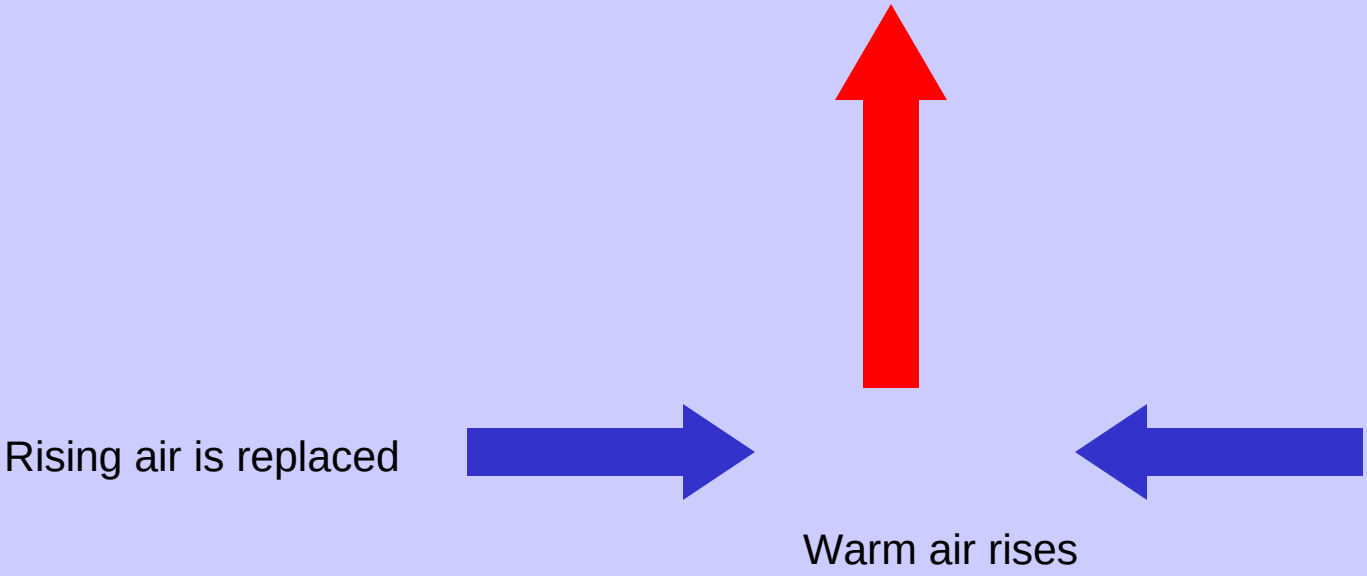


The rising air creates a circulation cell, called a **Hadley Cell**

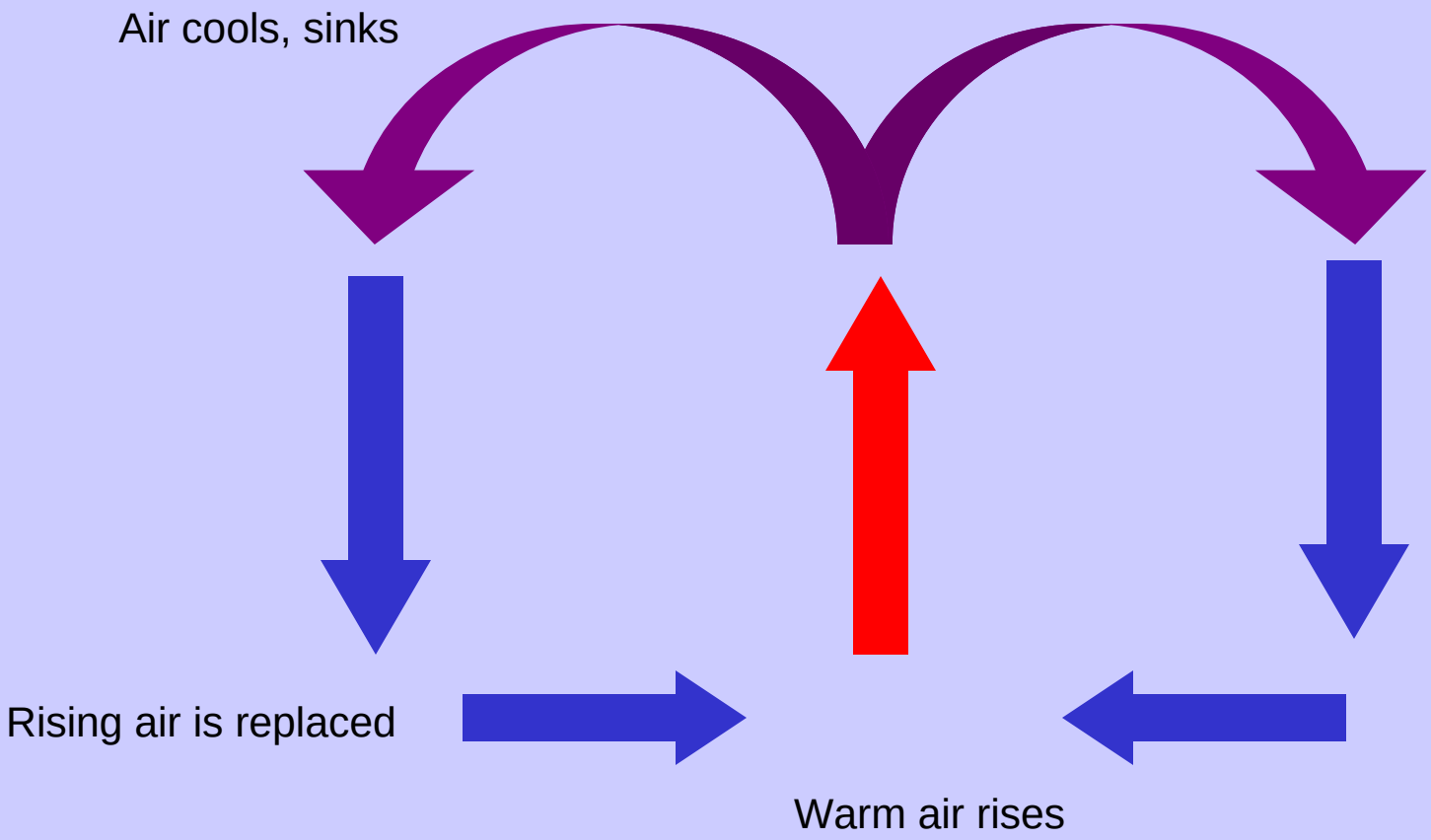


Rising air → low pressure
Sinking air → high pressure

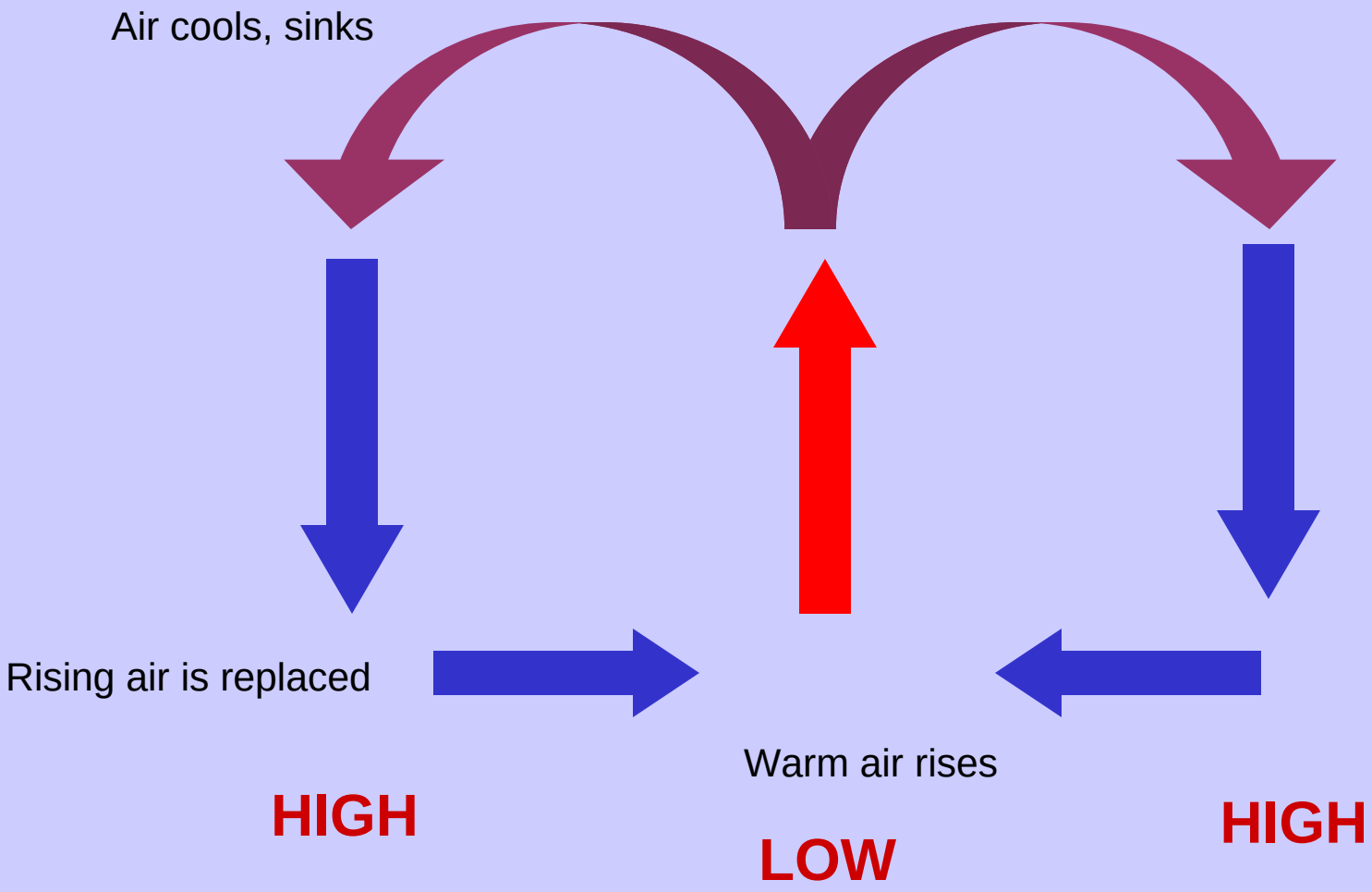
Hadley Circulation Cell



Hadley Circulation Cell



Hadley Circulation Cell



The Earth would have two large Hadley cells, if it did not rotate.

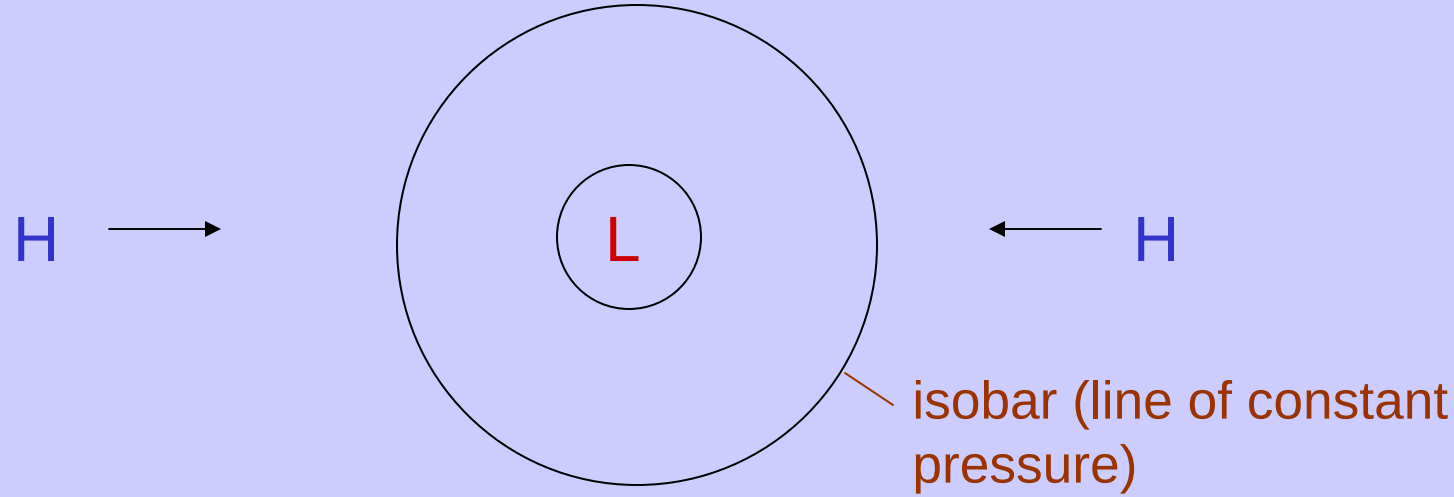
--This is exactly what we think occurs on Venus (which rotates very slowly)!

Rotation of the Earth leads to the **Coriolis Effect**

This causes winds (and all moving objects) to be deflected:

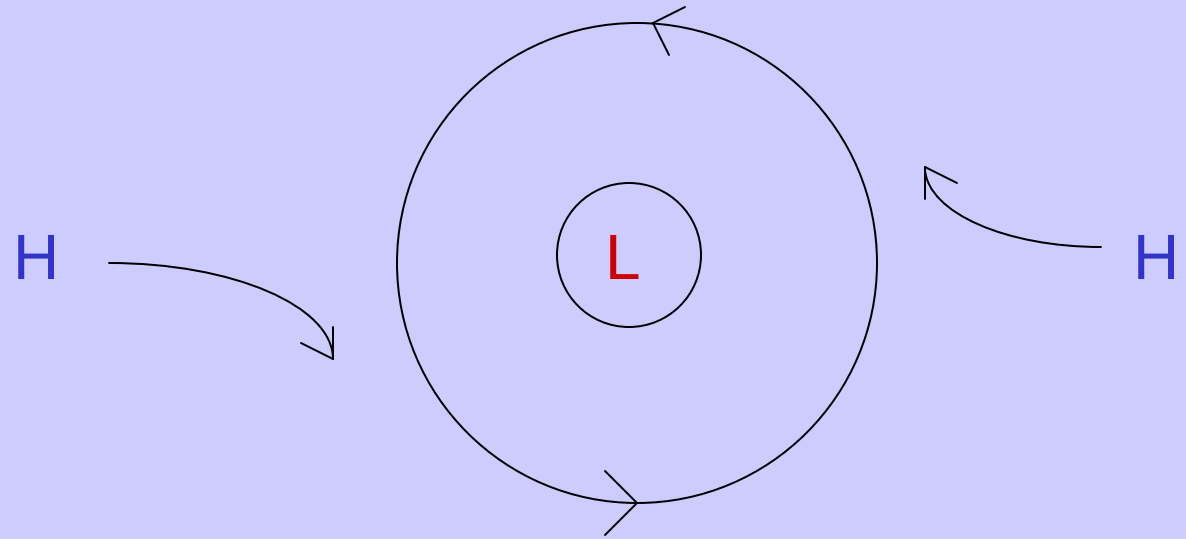
to the **right** in the **Northern Hemisphere**
to the **left** in the **Southern Hemisphere**

Example of Coriolis effect: hurricanes



- Hurricanes are low pressure centers
- Air moves from high pressure towards low pressure

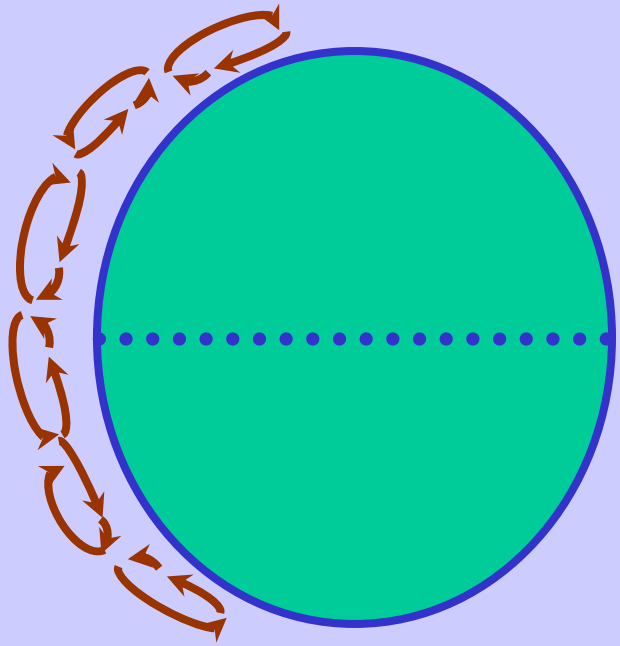
Hurricanes: Northern hemisphere



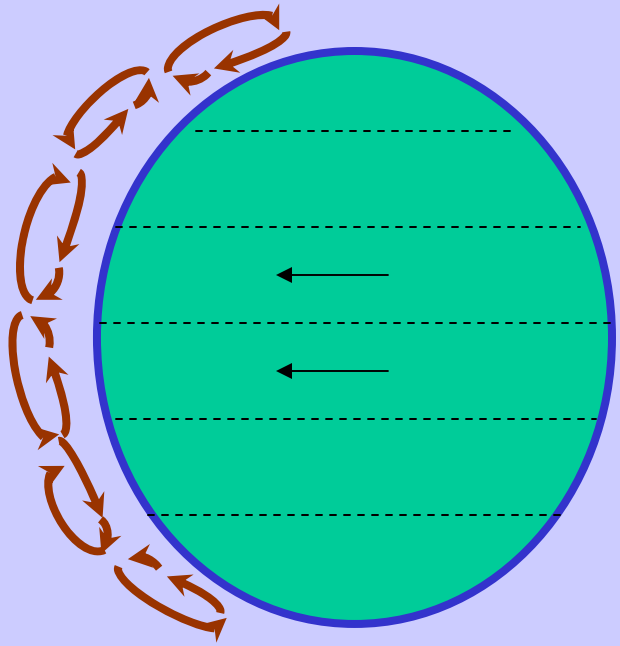
- As the air moves in, it is deflected towards the right in the NH
- Resulting circulation is counter-clockwise

The Coriolis effect causes winds to deflect as they travel within circulation cells

This breaks up the two large Hadley cells into six smaller cells.

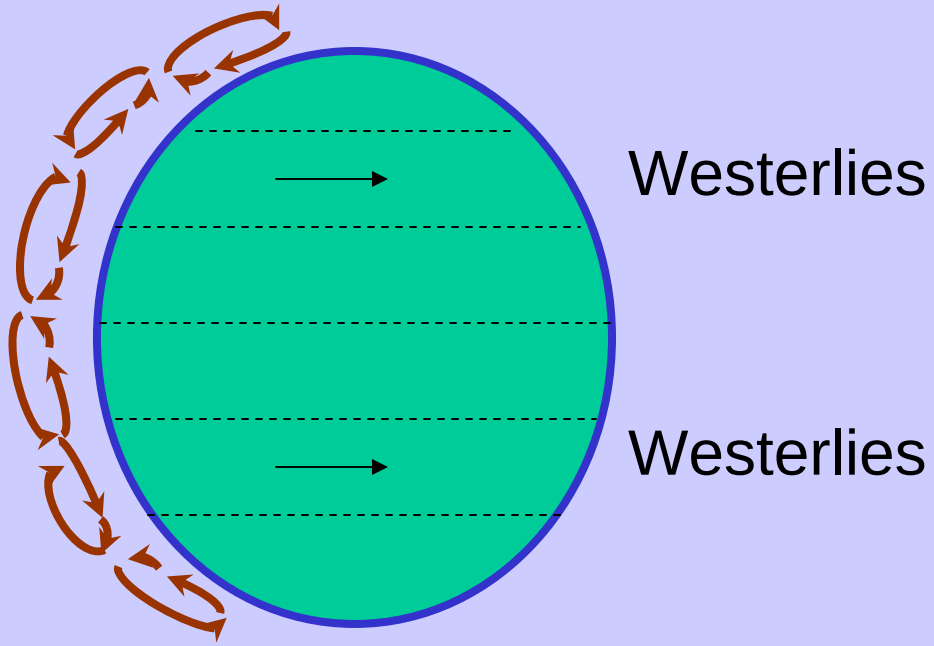


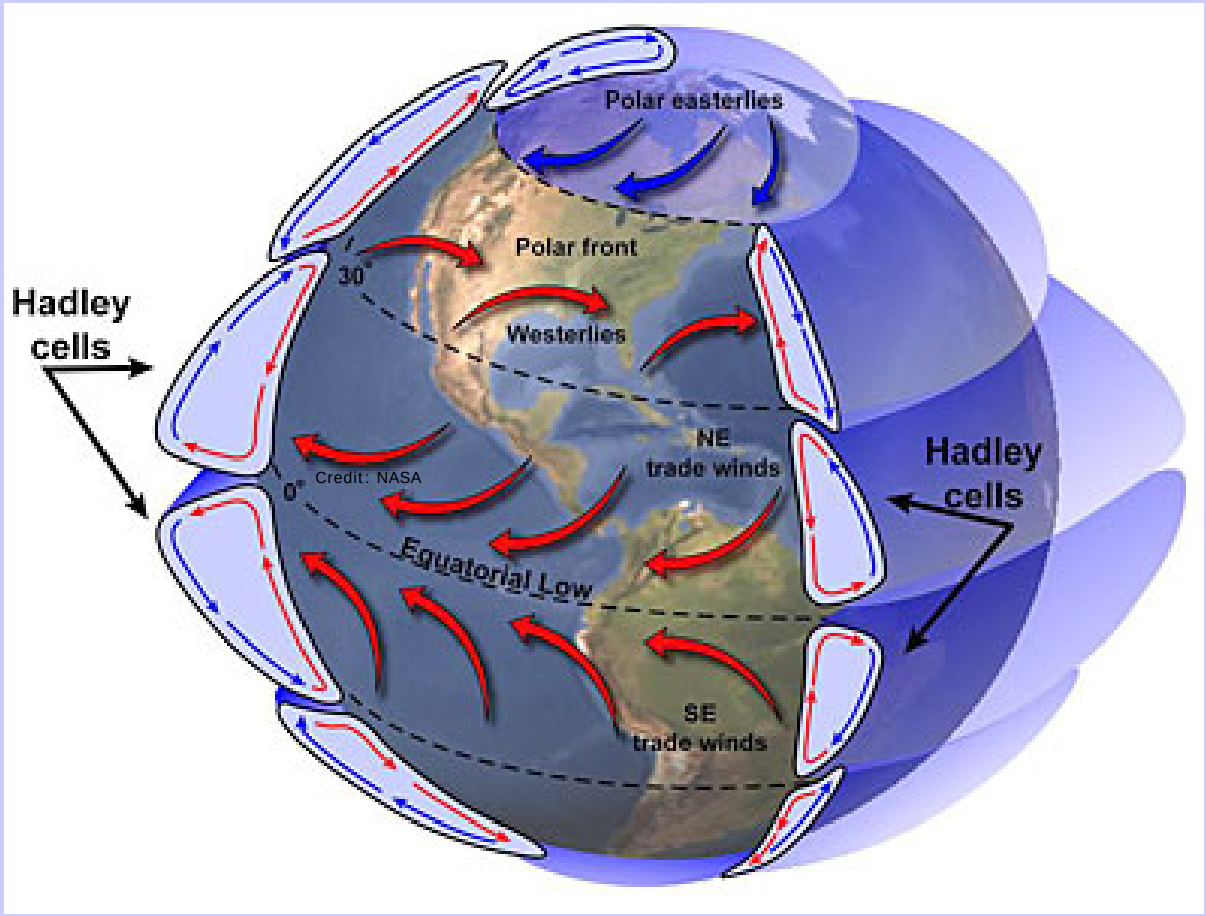
In the tropics, surface air is moving equatorward. It is deflected to the right in the NH (left in the SH), giving rise to easterly flow (the trade winds)



Easterlies

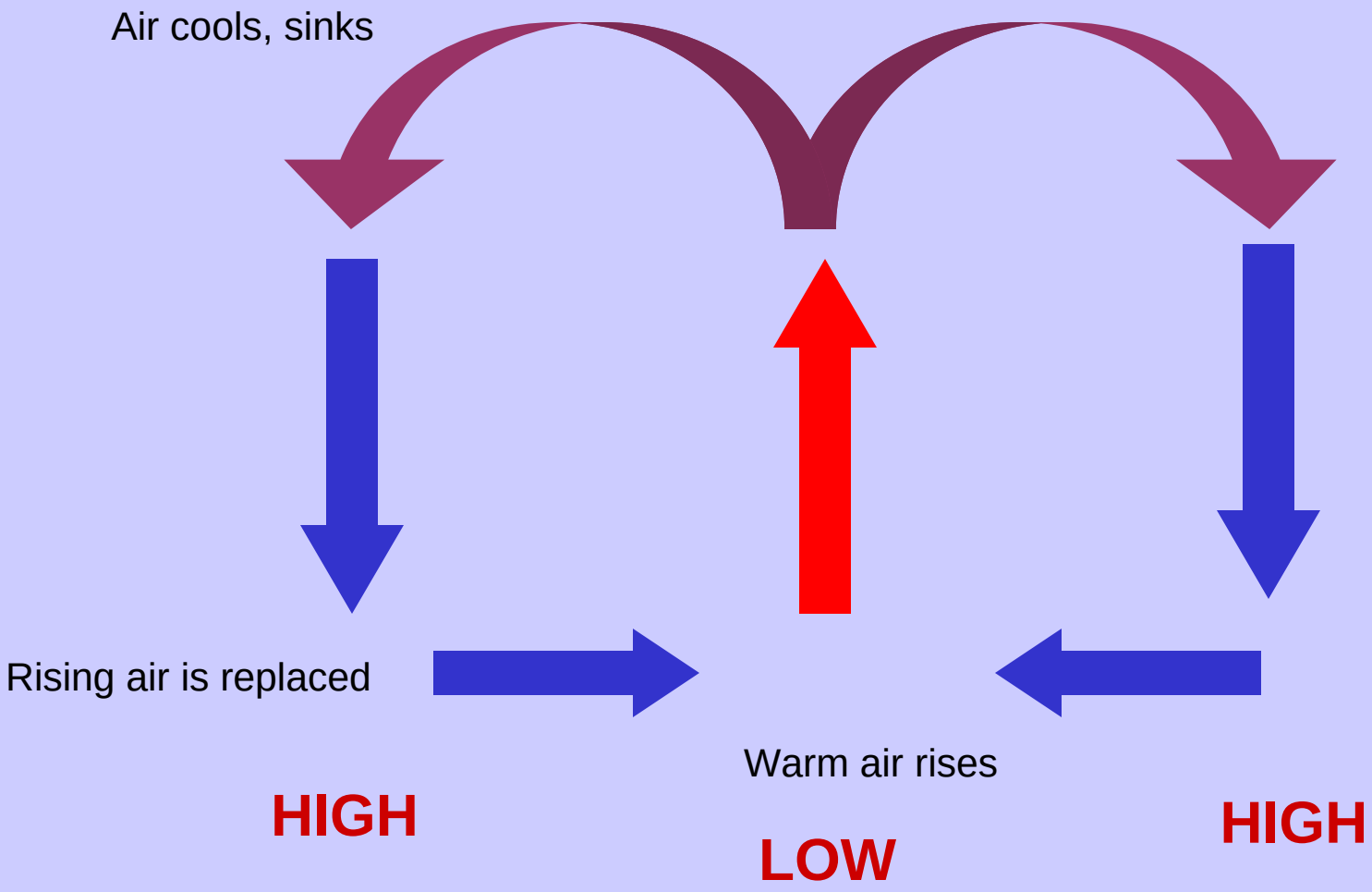
At midlatitudes, surface air is moving poleward. It is deflected to the right in the NH (left in the SH), giving rise to westerly flow (the prevailing westerlies)

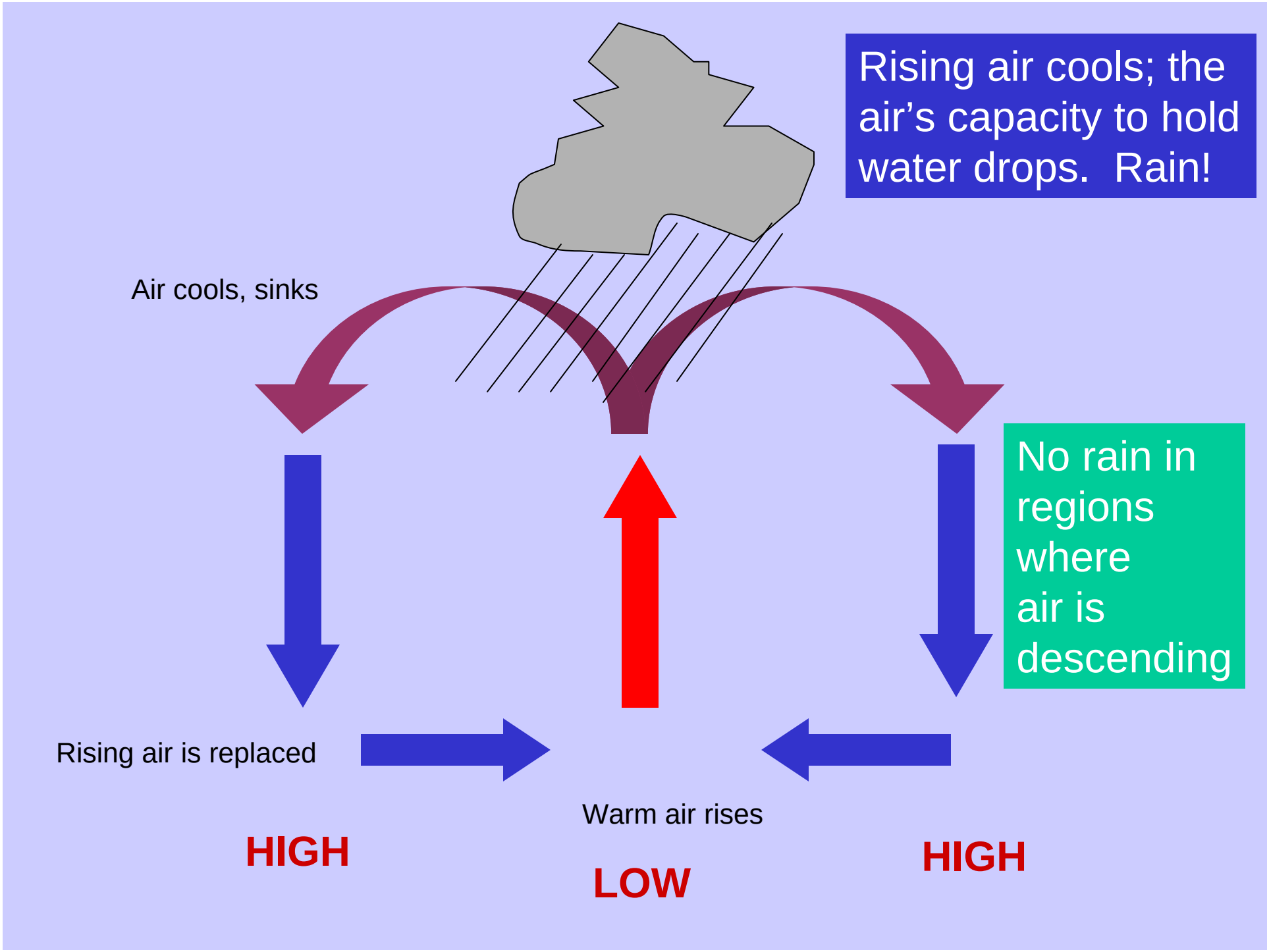


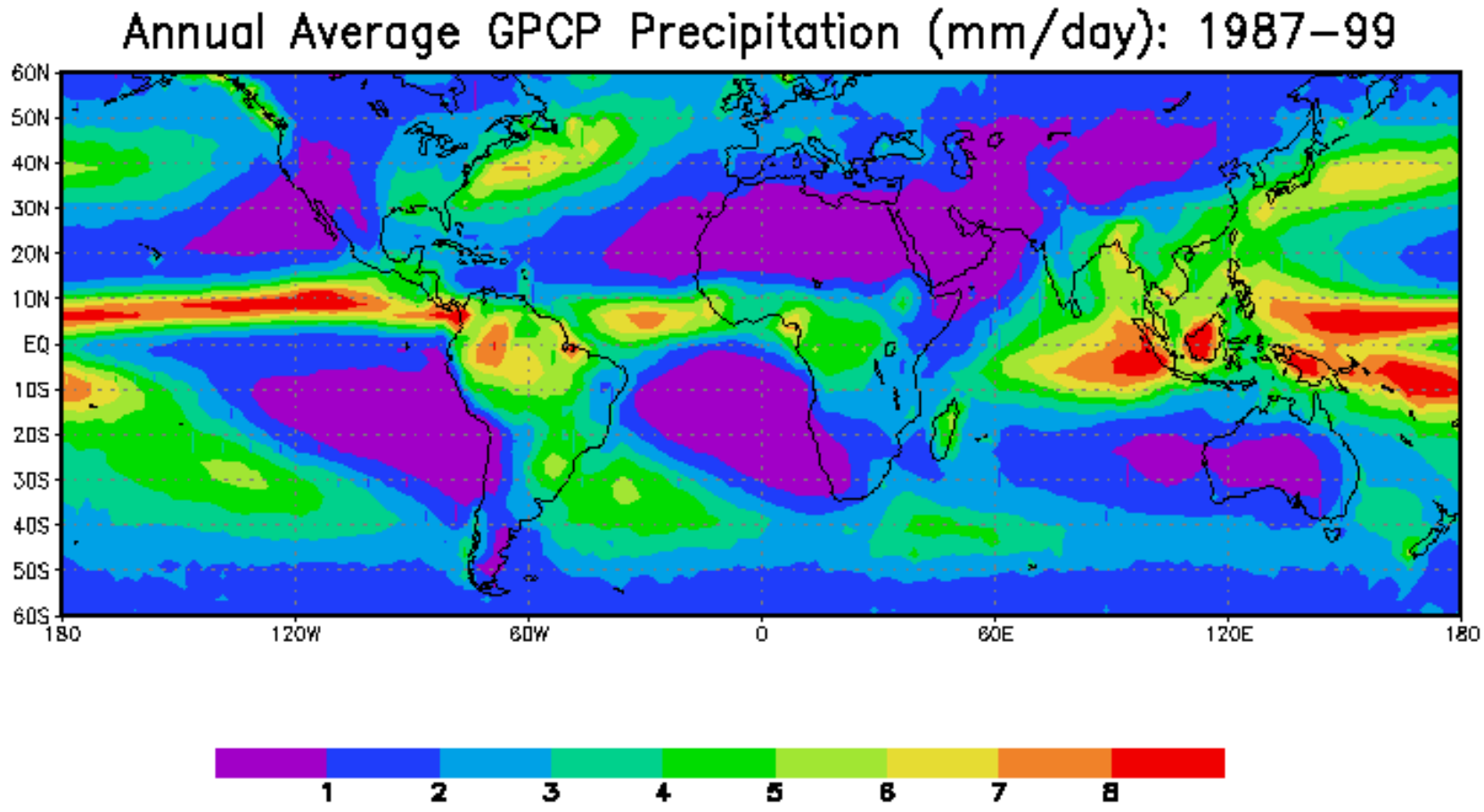

Polar easterlies
Polar front
30°
Westerlies
Hadley cells
NE trade winds
Credit: NASA
0°
Equatorial Low
Hadley cells
SE trade winds

Credit: NASA

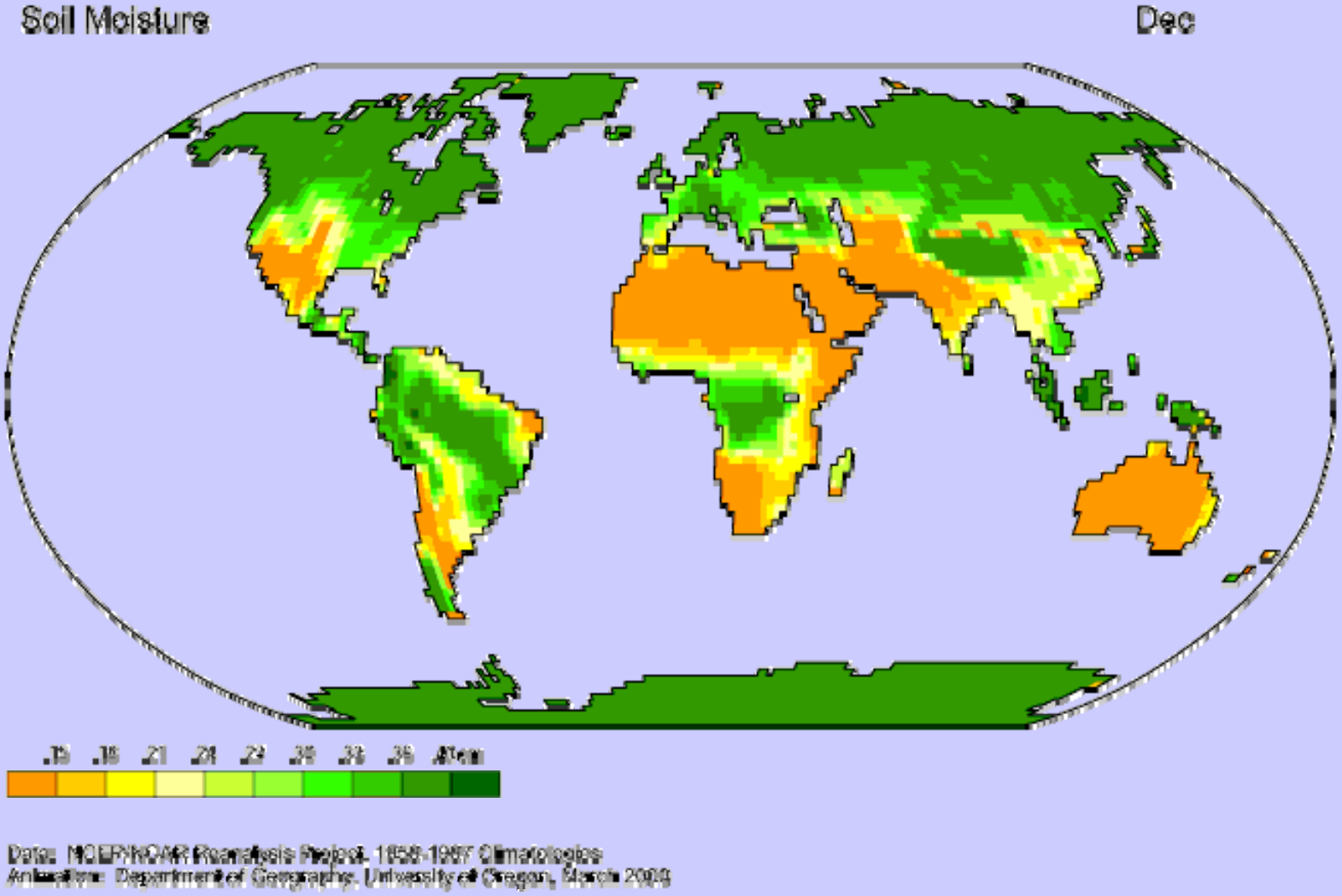
Hadley Circulation Cell




Rising air cools; the air's capacity to hold water drops. Rain!
Air cools, sinks
No rain in regions where air is descending
Rising air is replaced
Warm air rises
HIGH
LOW
HIGH



: **orbit-net.nesdis.noaa.gov/arad/ gpcp/maps/frontmap.gif**


Soil Moisture
Dec
Data: NCEP/NCAR Reanalysis Project, 1958-1997 Climatologies
Animation: Department of Geography, University of Oregon, March 2003

Caution:

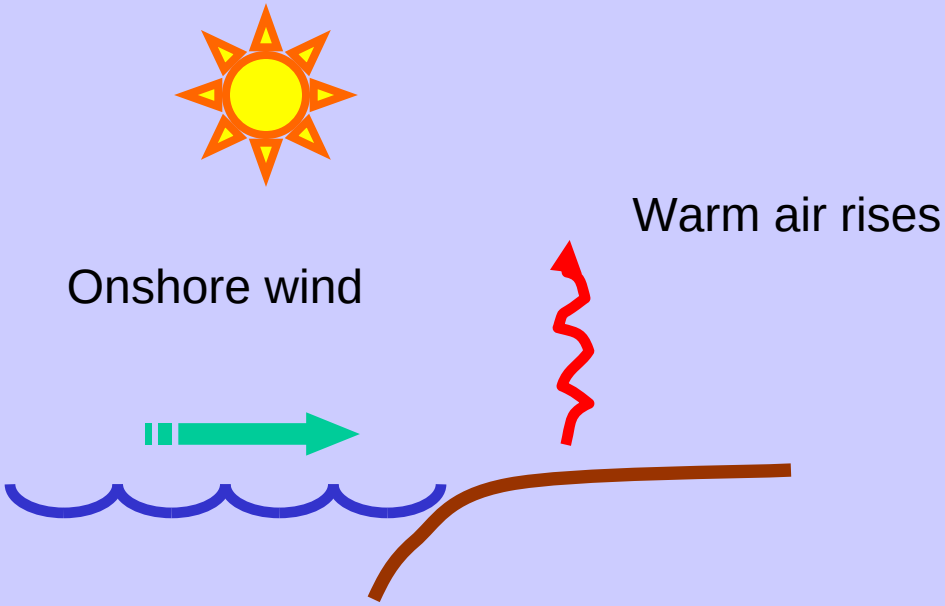
Zonal weather pattern is not completely true

The pattern is disrupted by land-sea contrasts

Land heats and cools rapidly

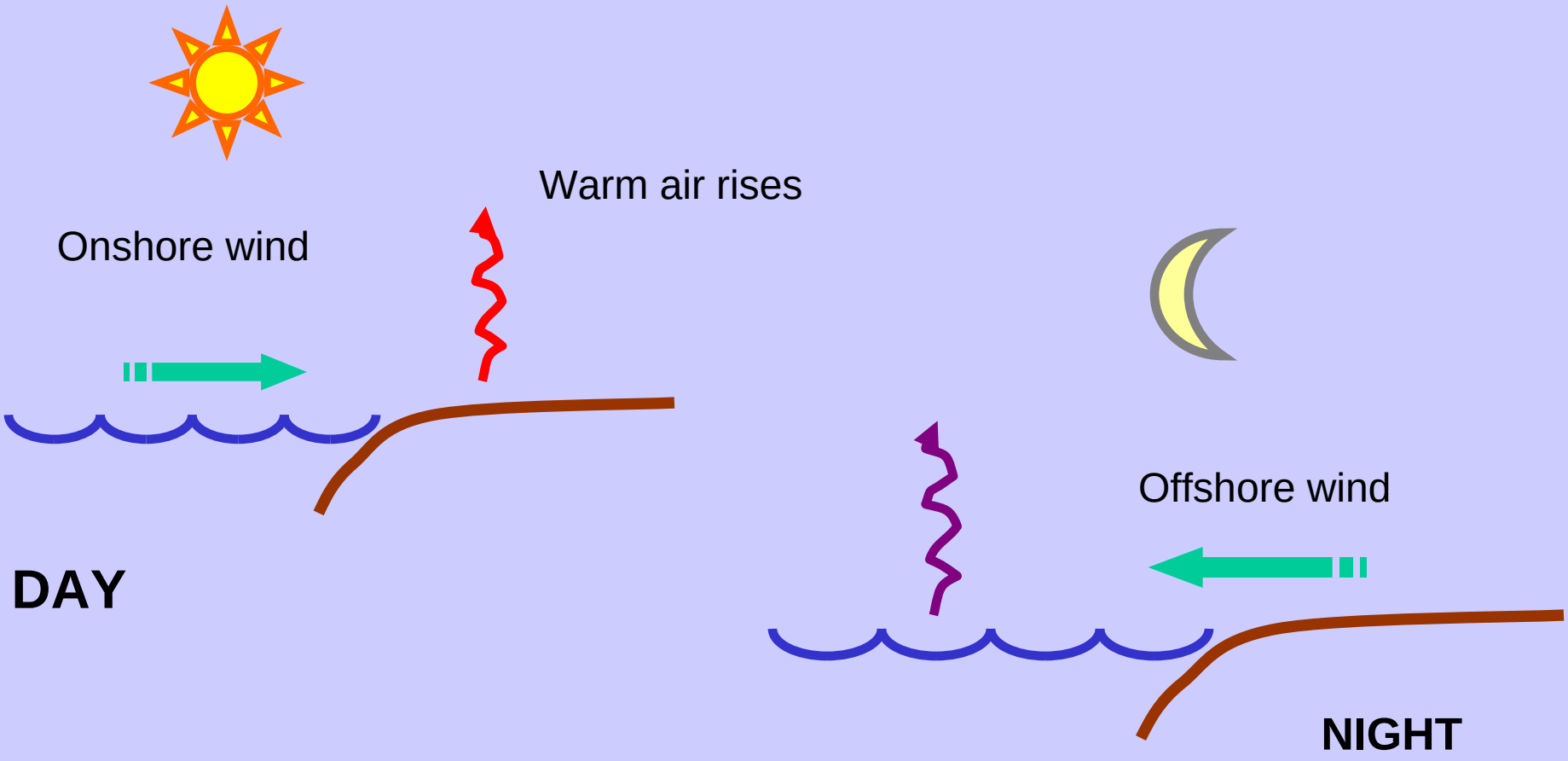
Water heats and cools slowly

Sea Breezes



DAY

Sea Breezes



Tibetian Plateau--Monsoon Circulation