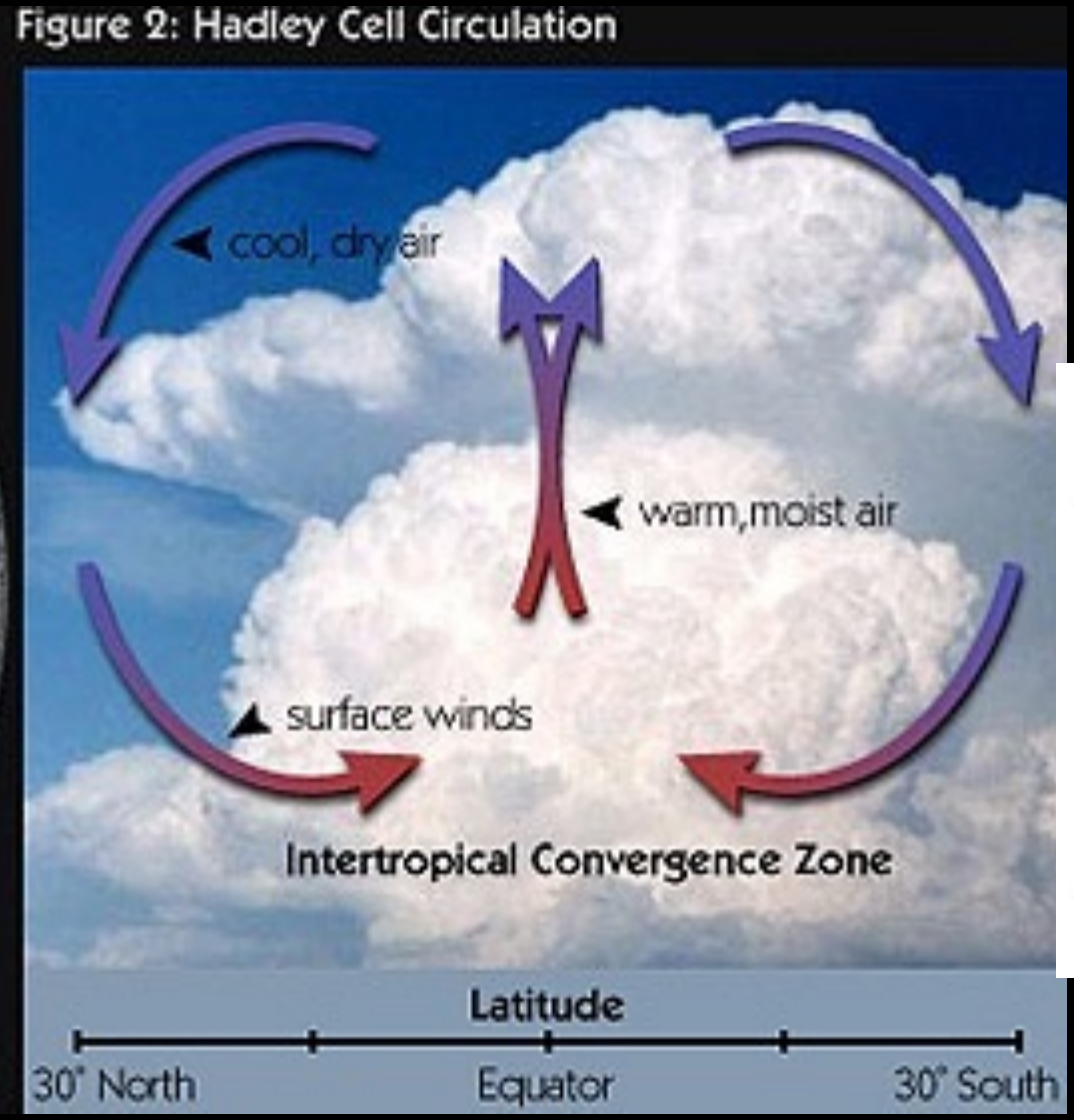
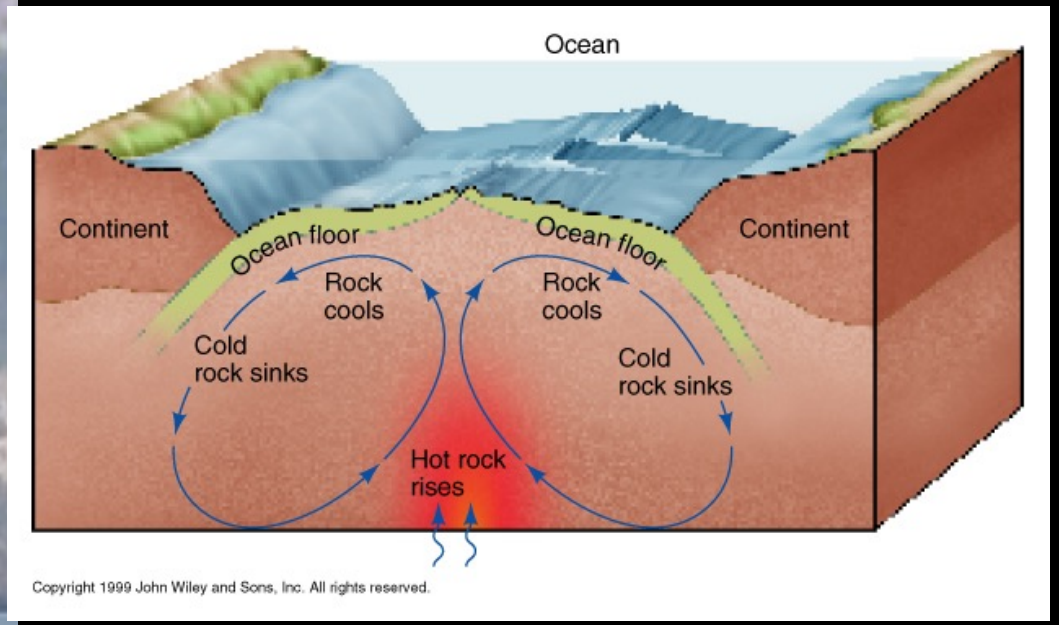
Atmospheric Convection



These are called Hadley Cells



Hadley cells are similar to convection in Earth's mantle.

Sunlight Drives Hadley Cells

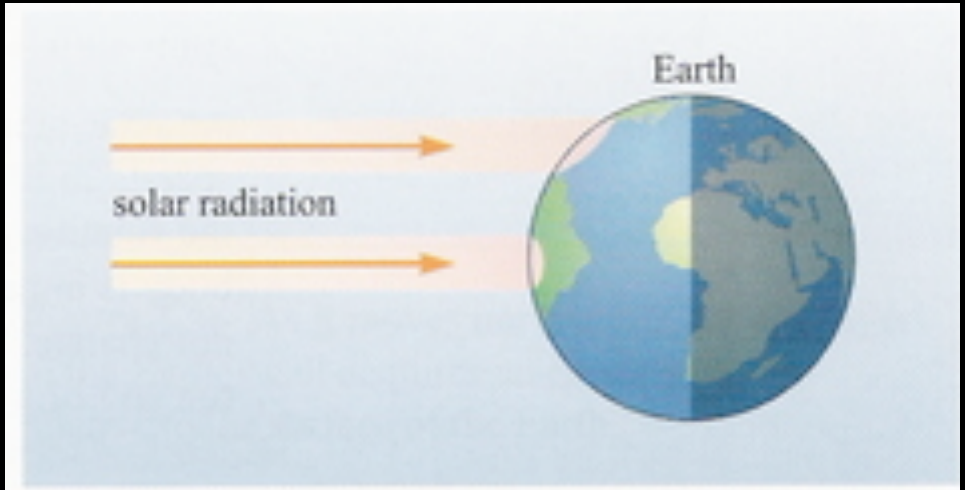
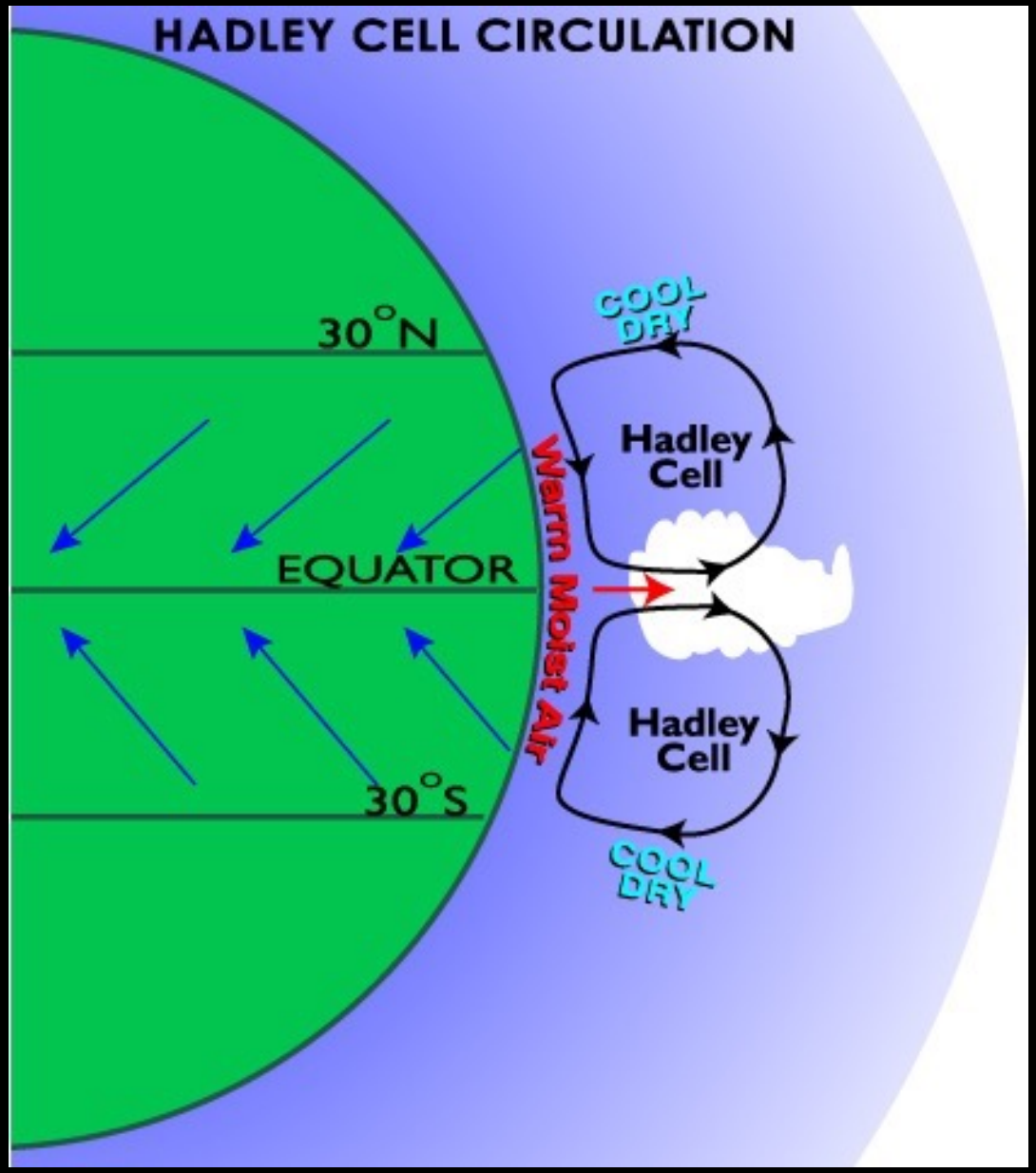
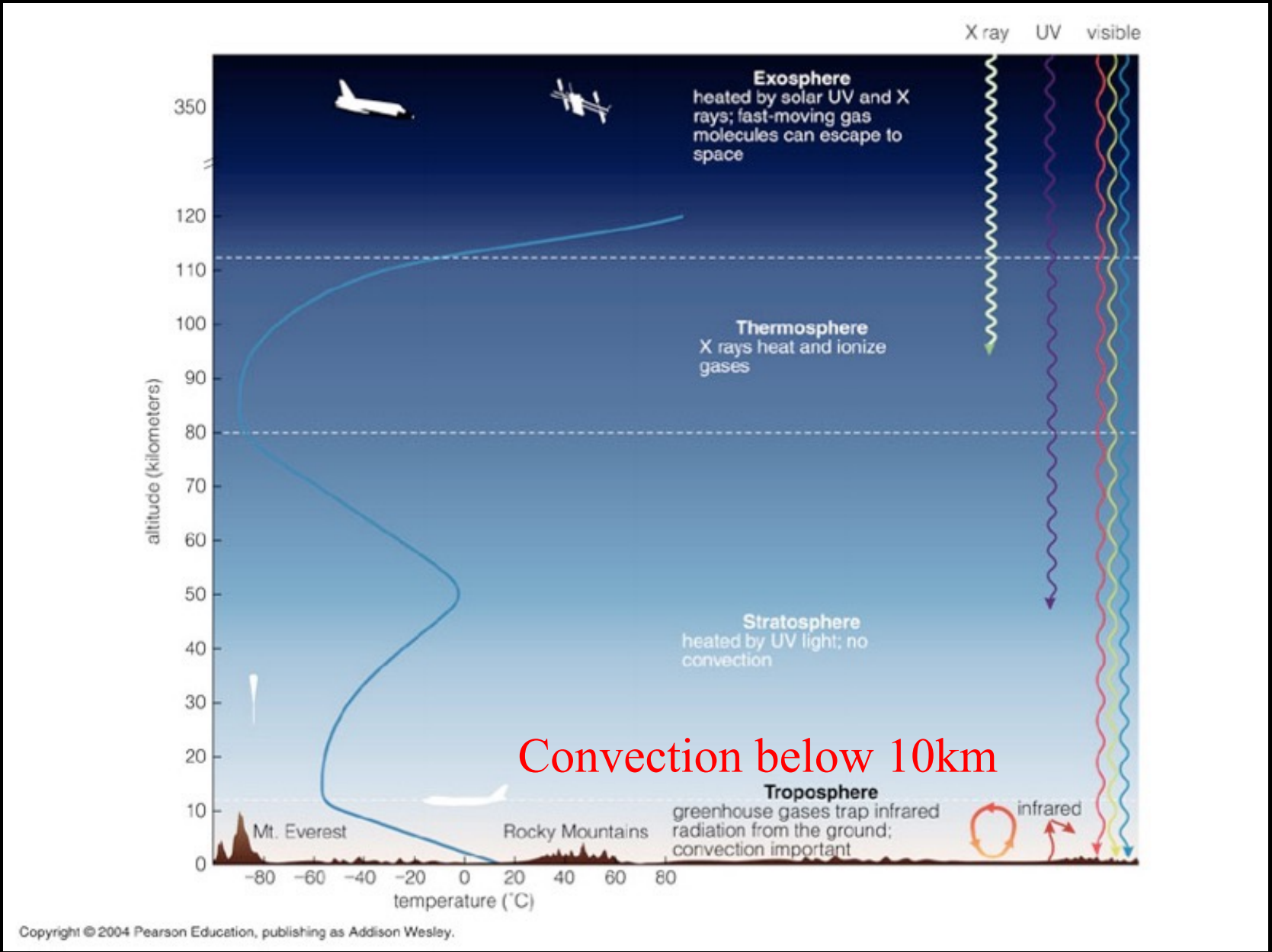


Figure 5.33 The Earth's surface receives more solar energy per unit area of the surface, near the Equator than it receives near the poles.

This is how clouds form! (hot moist air rises, cools, and water droplets precipitate out).



Atmospheric Convection

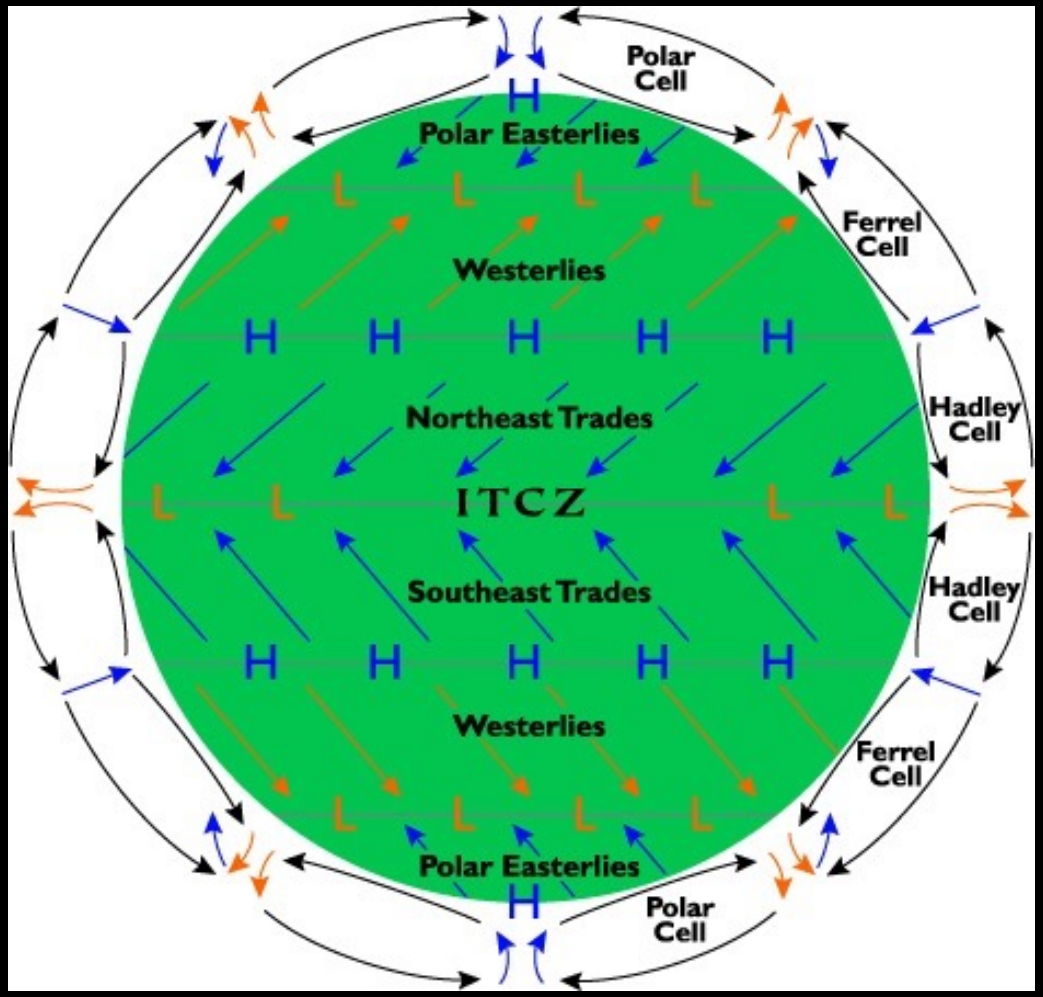


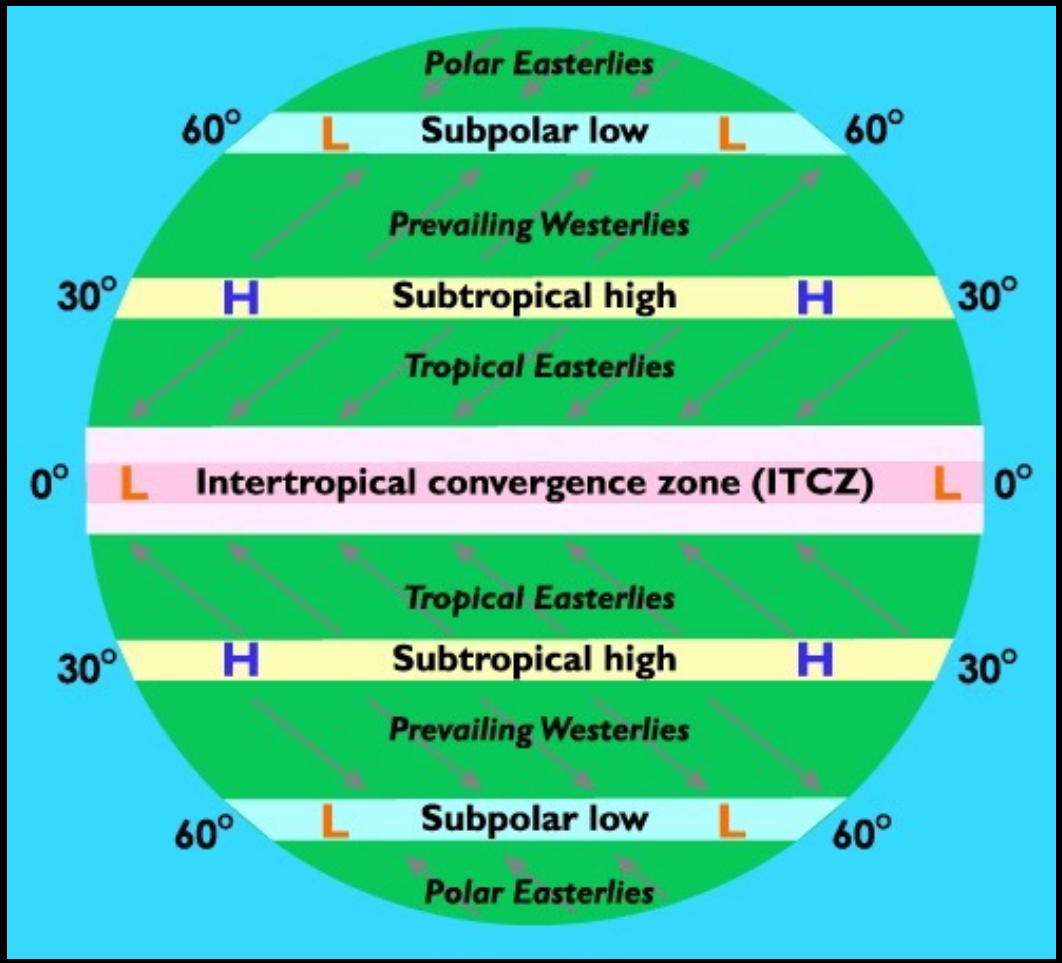
Prevailing Winds

Hadley cells do not flow solely North-South - they get deflected to the East and West by the Coriolis Force.
Planets with faster rotation have more deflection, and the single Hadley cells breaks into several independent ones.

Figure 5.36 As it moves northwards, the top layer of the Hadley cell acquires an easterly motion relative to the surface of the Earth.

Hadley Cells and Surface Winds

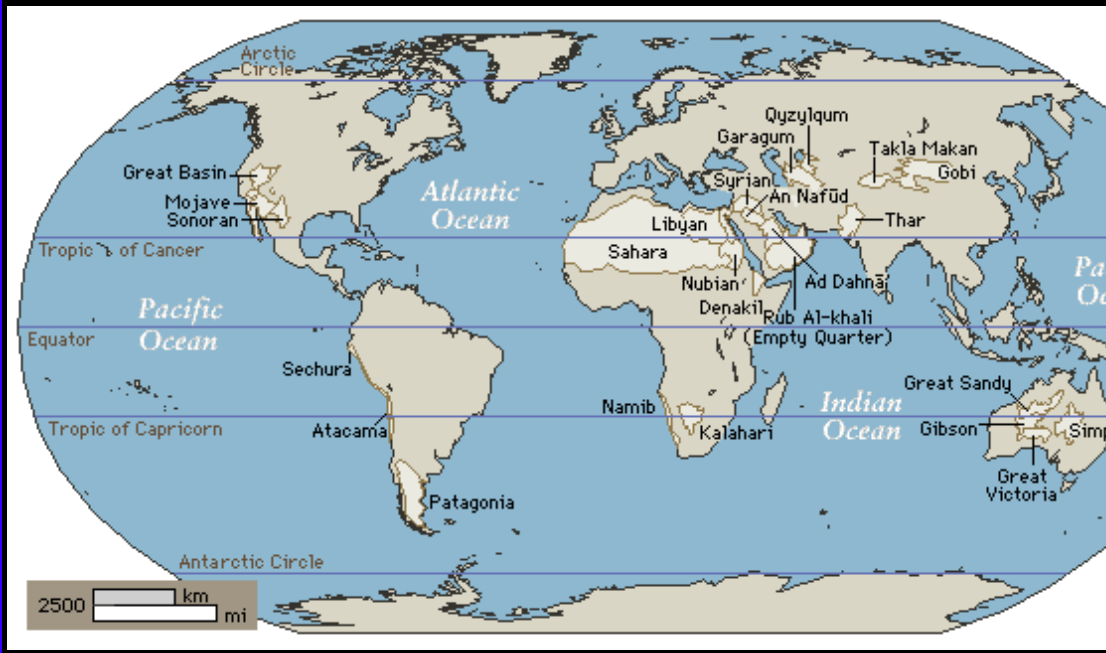




World Climate

Rainforests occur where air is forced upward - it cools, clouds form, and rain falls.
Deserts occur when cool dry air descends - no clouds form.

Tropical Rainforests



Deserts

Earth has 24 Hour Rotation

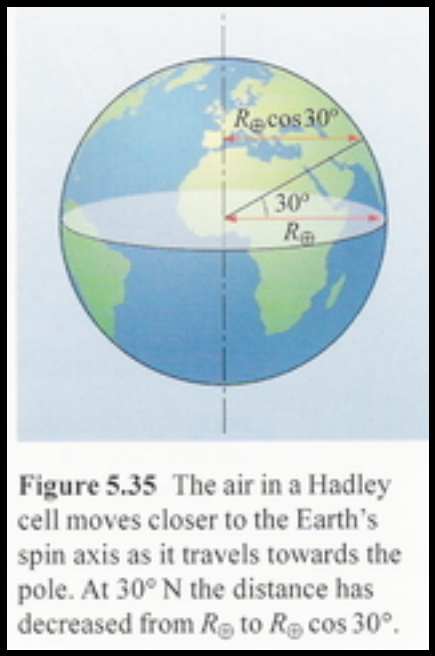


Figure 5.35 The air in a Hadley cell moves closer to the Earth's spin axis as it travels towards the pole. At 30° N the distance has decreased from $R_\oplus$ to $R_\oplus \cos 30°$.

Earth's Radius

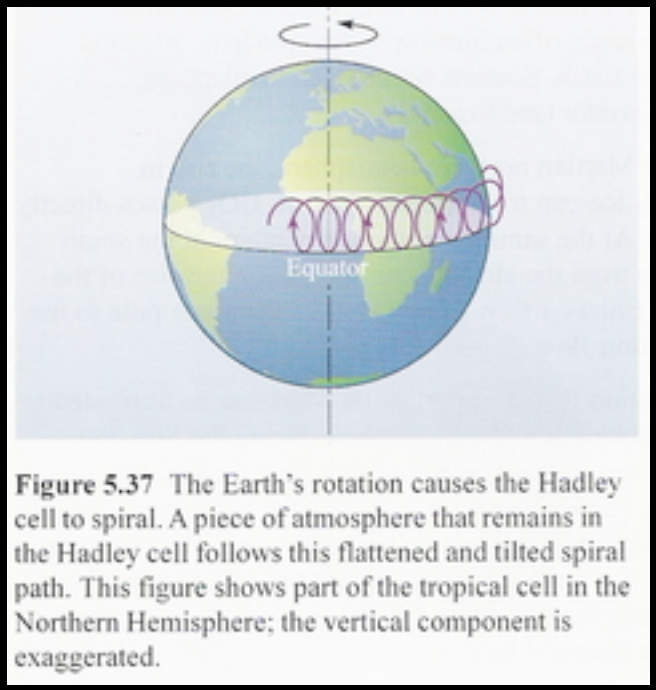
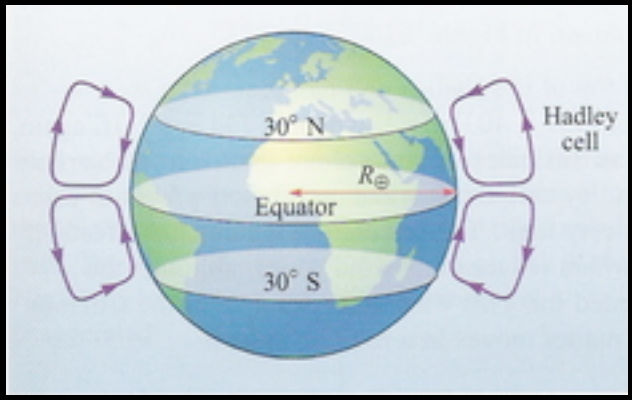


Figure 5.37 The Earth's rotation causes the Hadley cell to spiral. A piece of atmosphere that remains in the Hadley cell follows this flattened and tilted spiral path. This figure shows part of the tropical cell in the Northern Hemisphere; the vertical component is exaggerated.

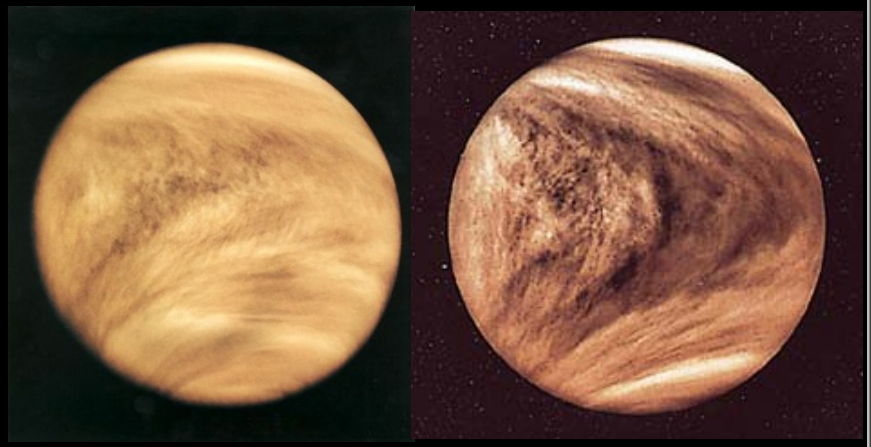
How Hurricanes get to the US



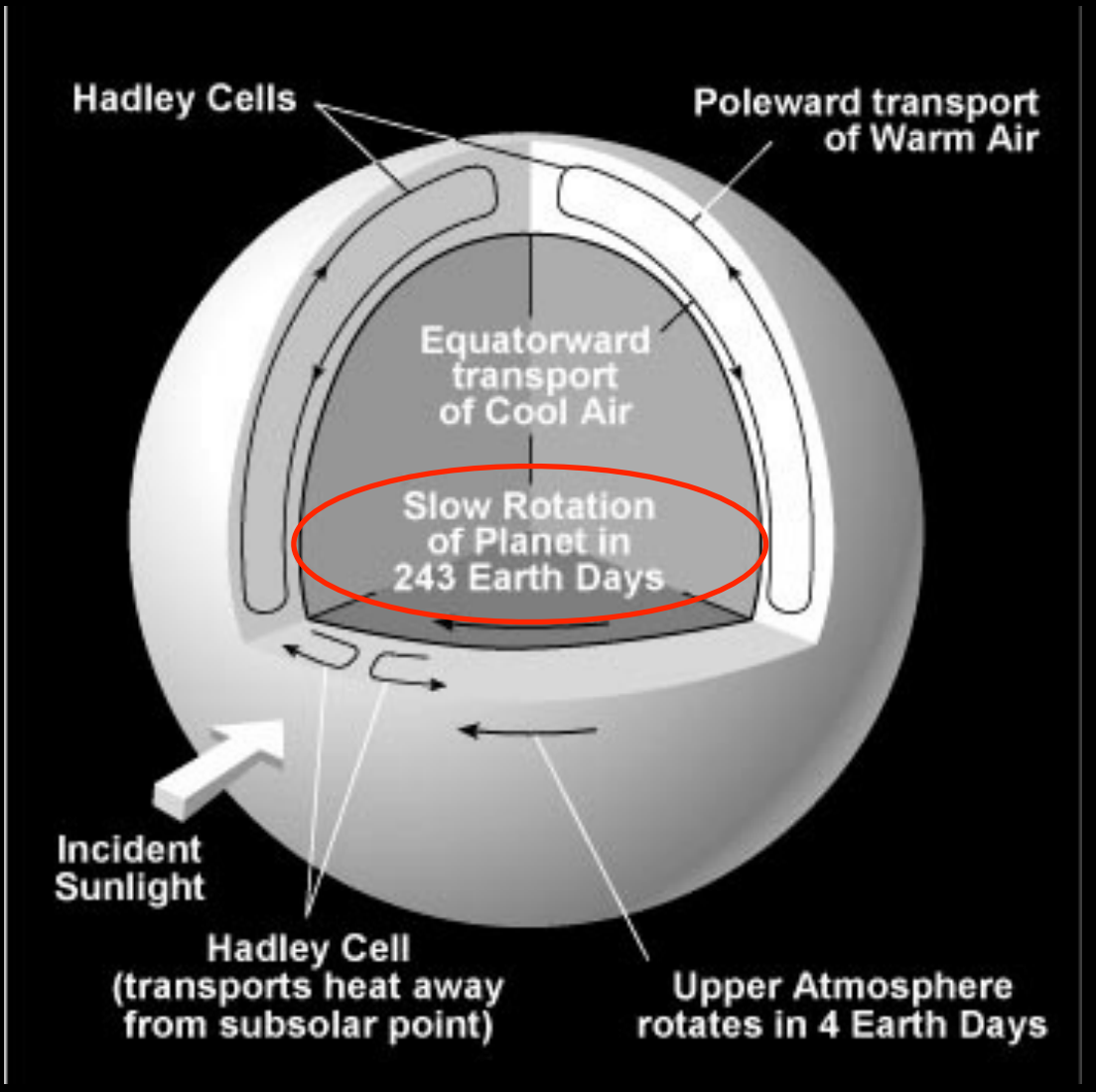
3 Hadley Cells North of Equator

Hadley Cells on Venus

What are Hadley Cells?
Convection!

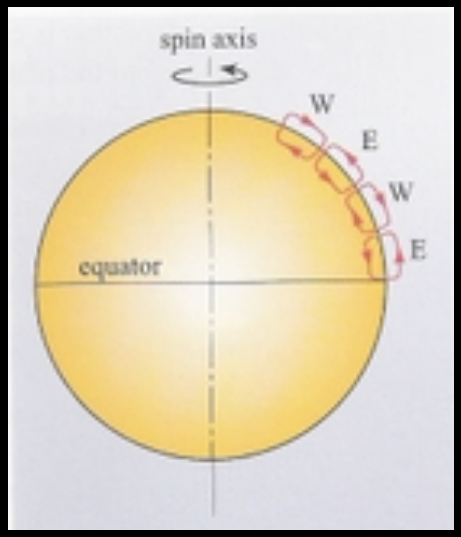


On a slowly-rotating planet like Venus, there is one Hadley cell in the N. hemisphere and one in the South.

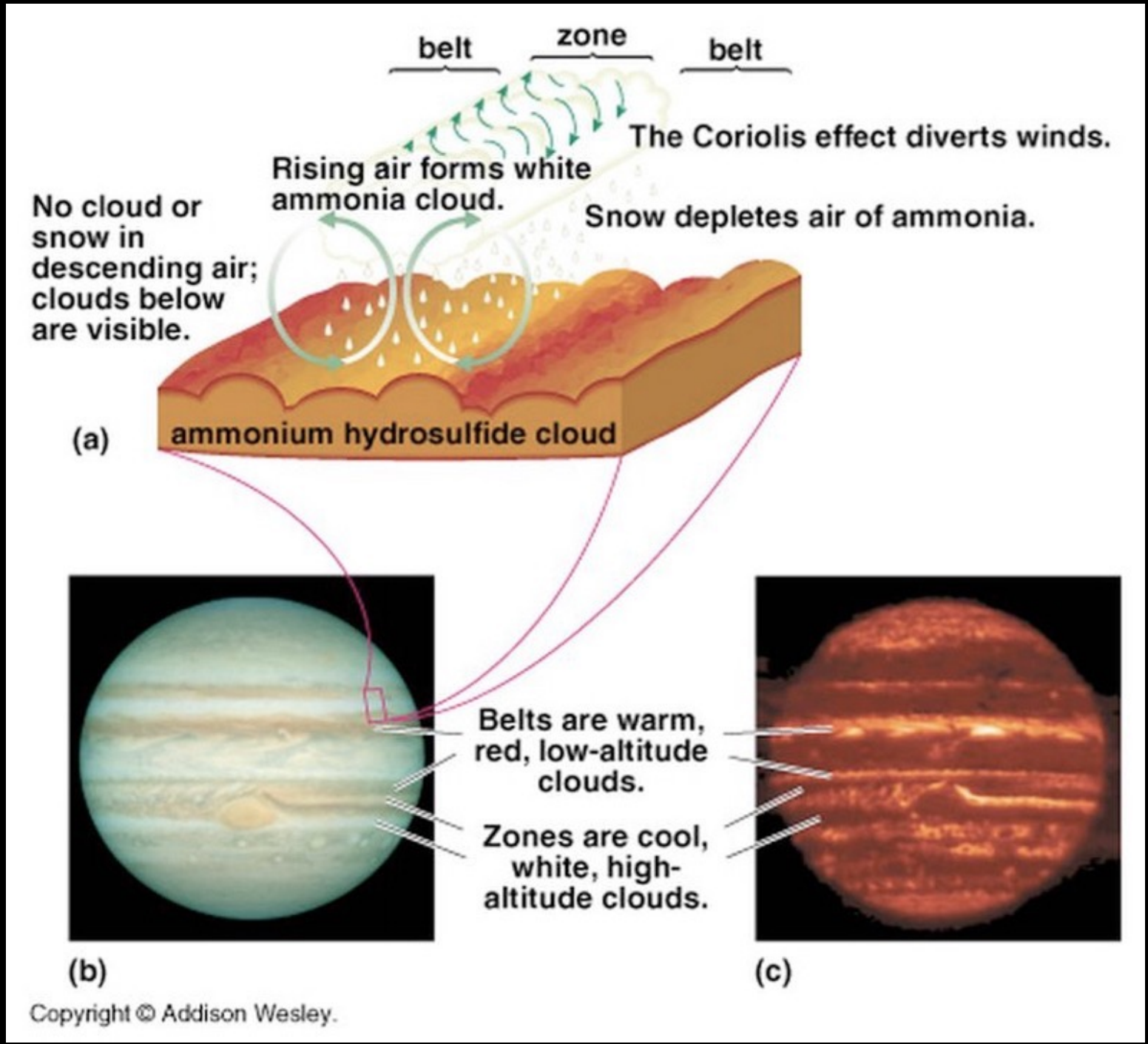


Hadley Cells on Jupiter

On a rapidly rotating planet like Jupiter, there are about six Hadley cells per hemisphere

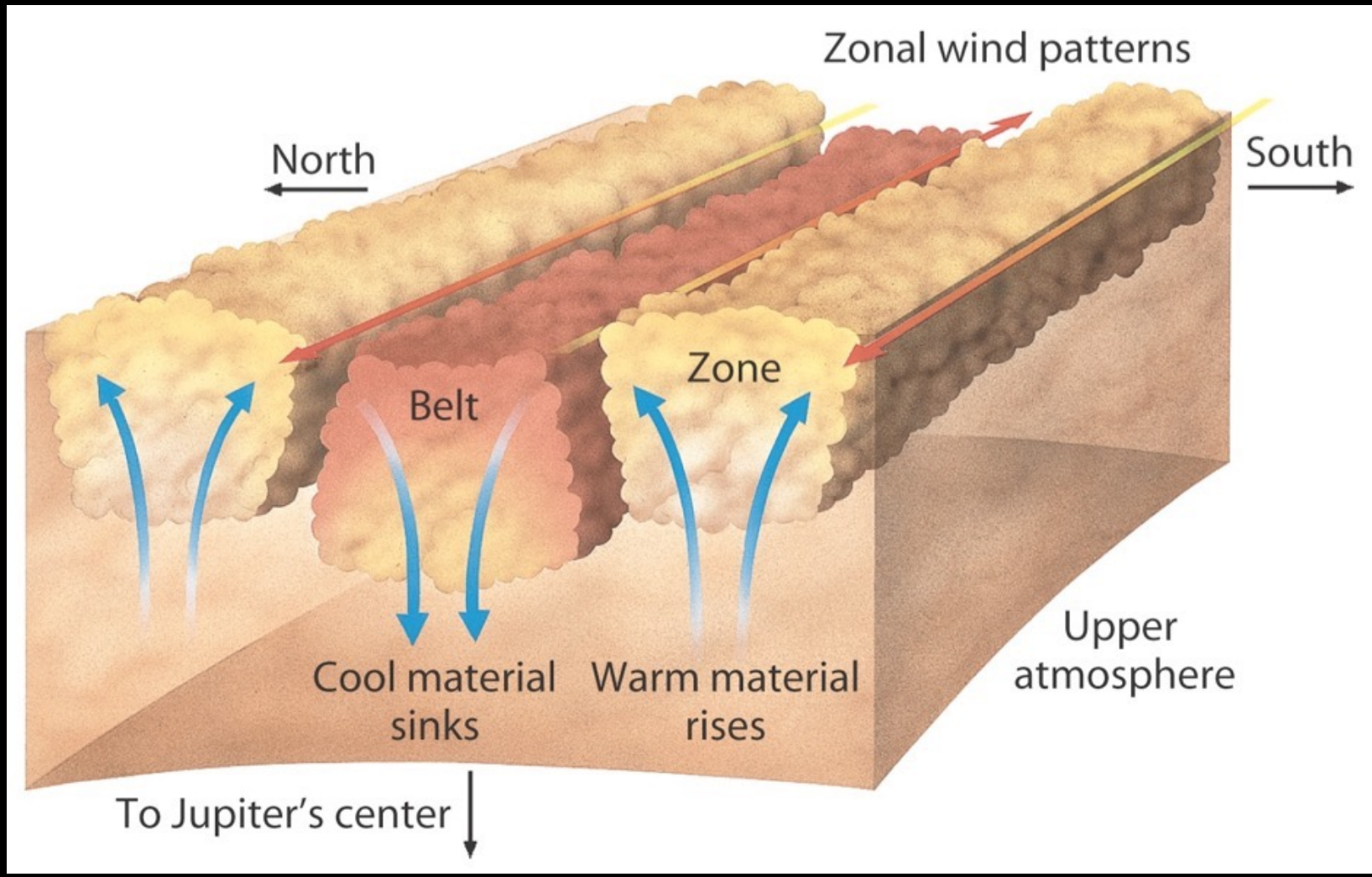


Belts and Zones



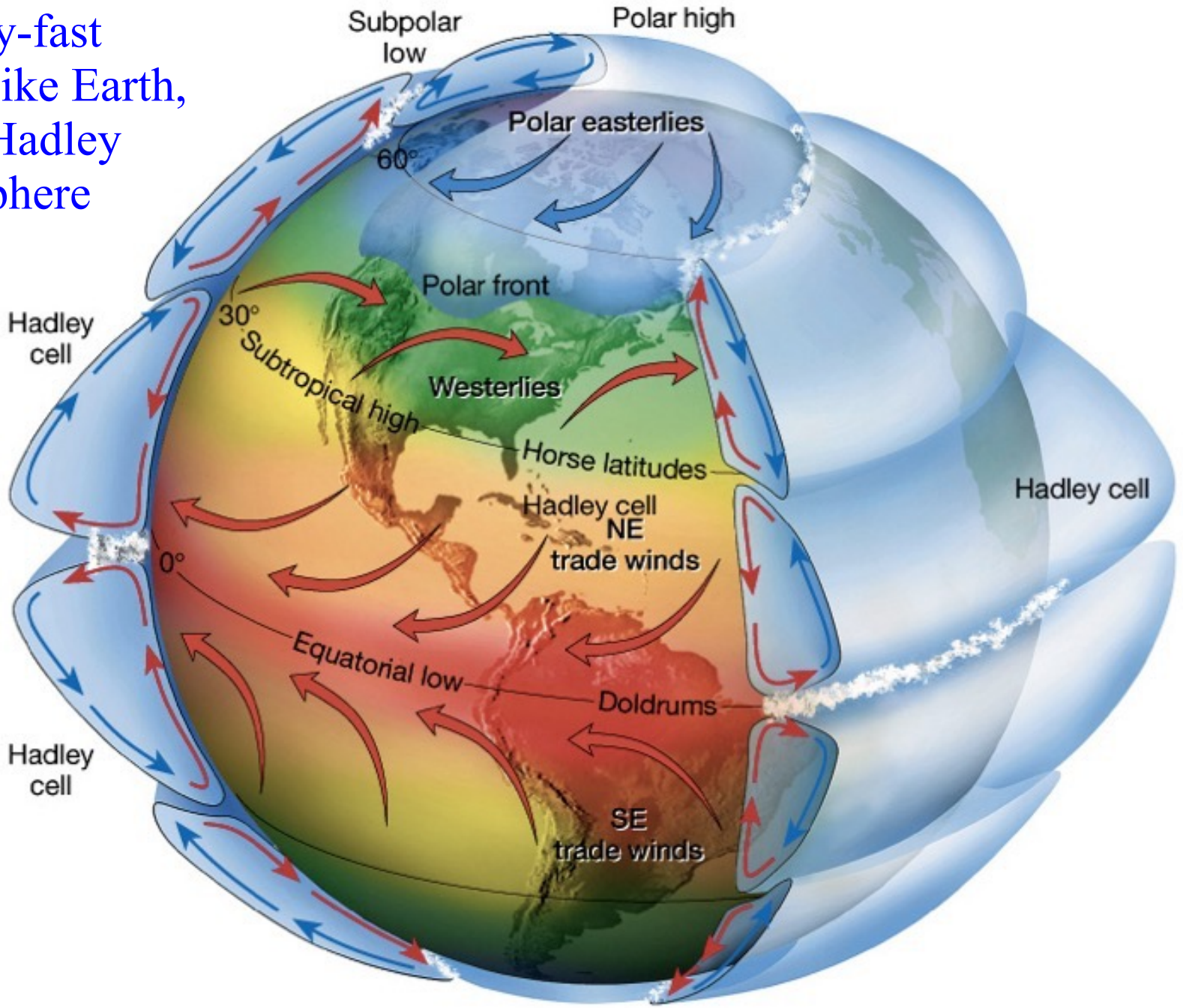
Belts (downflow) and Zones (upwelling air)

Cloud formation on the Giant Planets



Hadley Cells on Earth

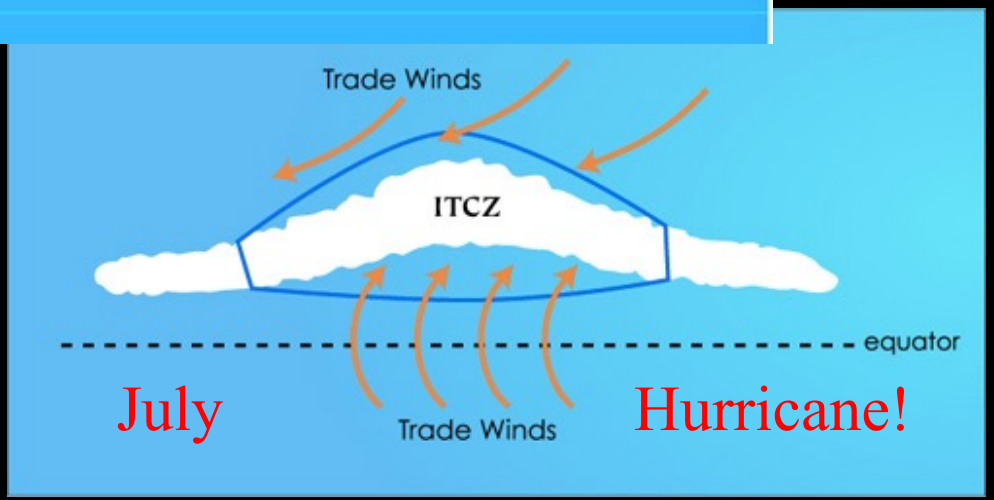
On a moderately-fast rotating planet like Earth, there are three Hadley cells per hemisphere



Hurricane Formation

ITCZ

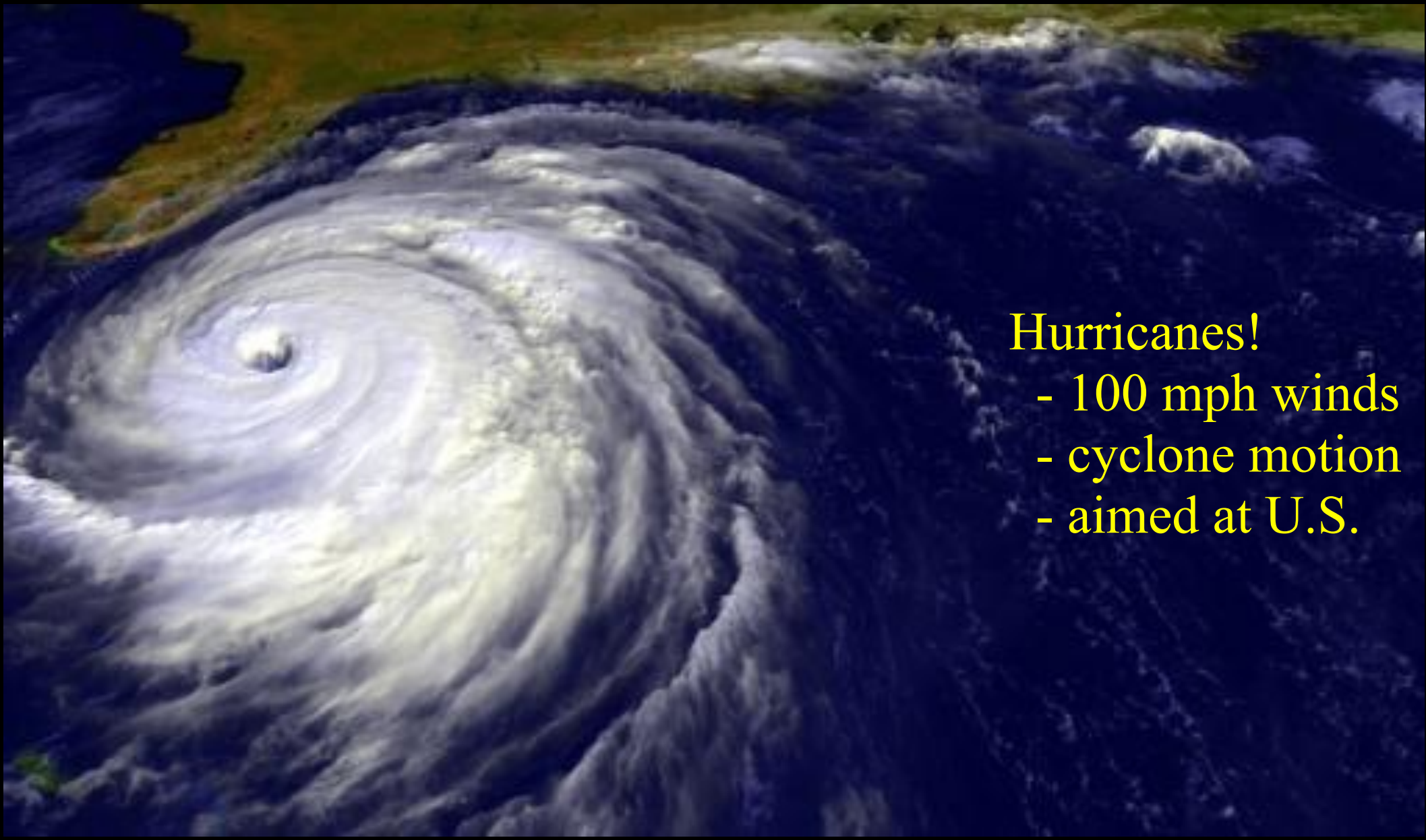
January: No Hurricane!



July

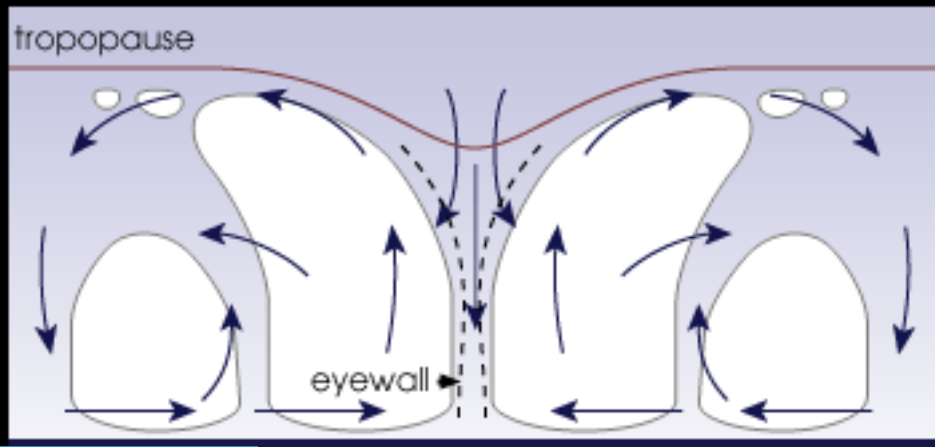
Hurricane!

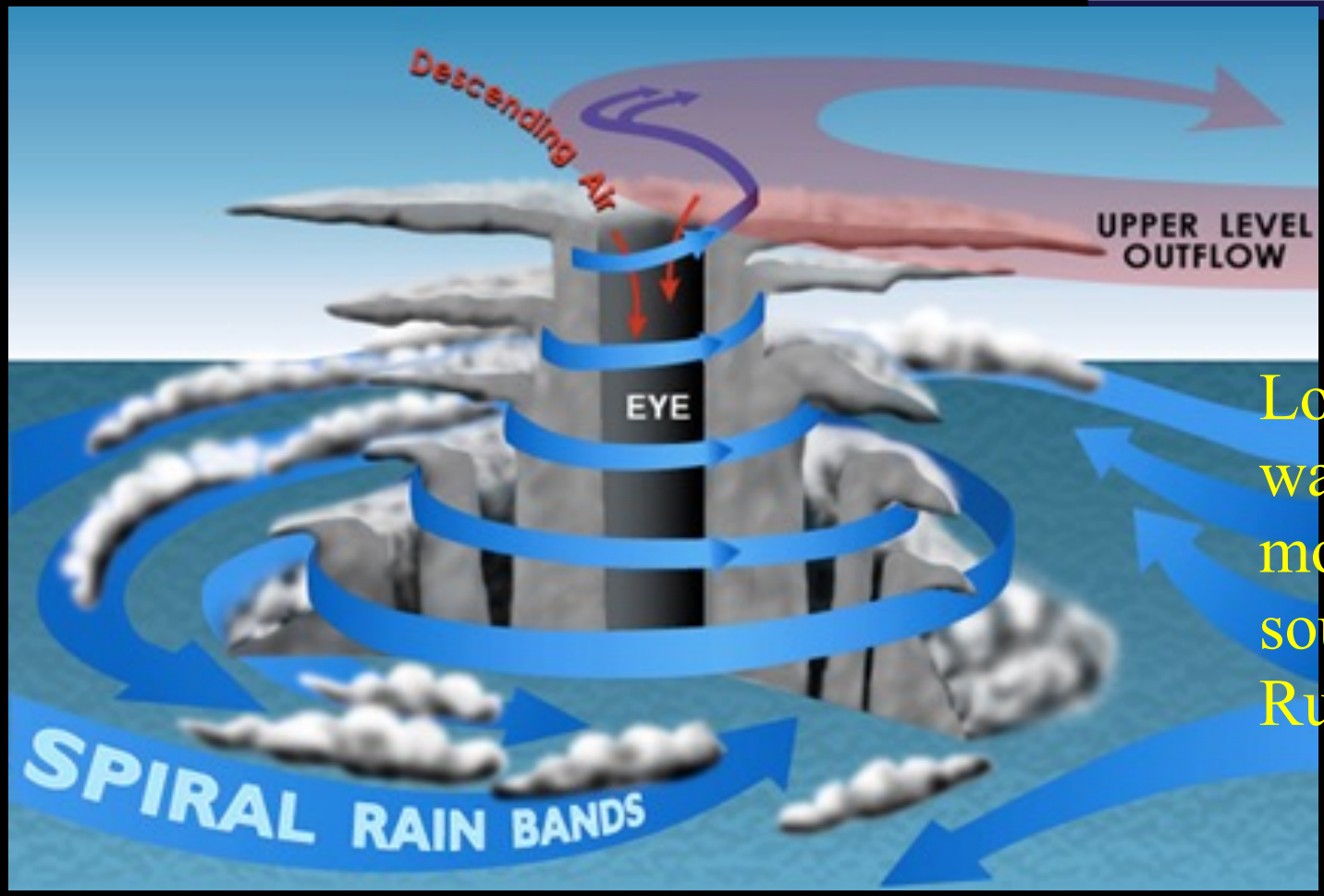
Hurricanes!



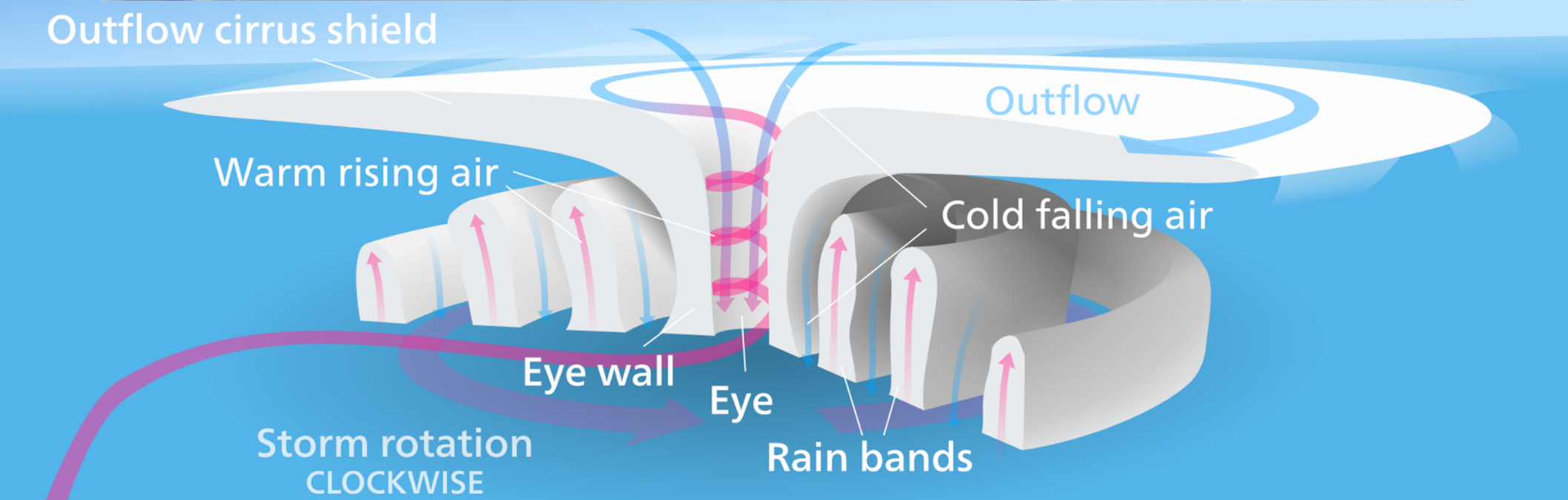
Are Hurricanes Damaging?

How Does a Hurricane Work?





Local convection system. warm sea water leads to moist air and a power source for the hurricane. Runaway condensation!

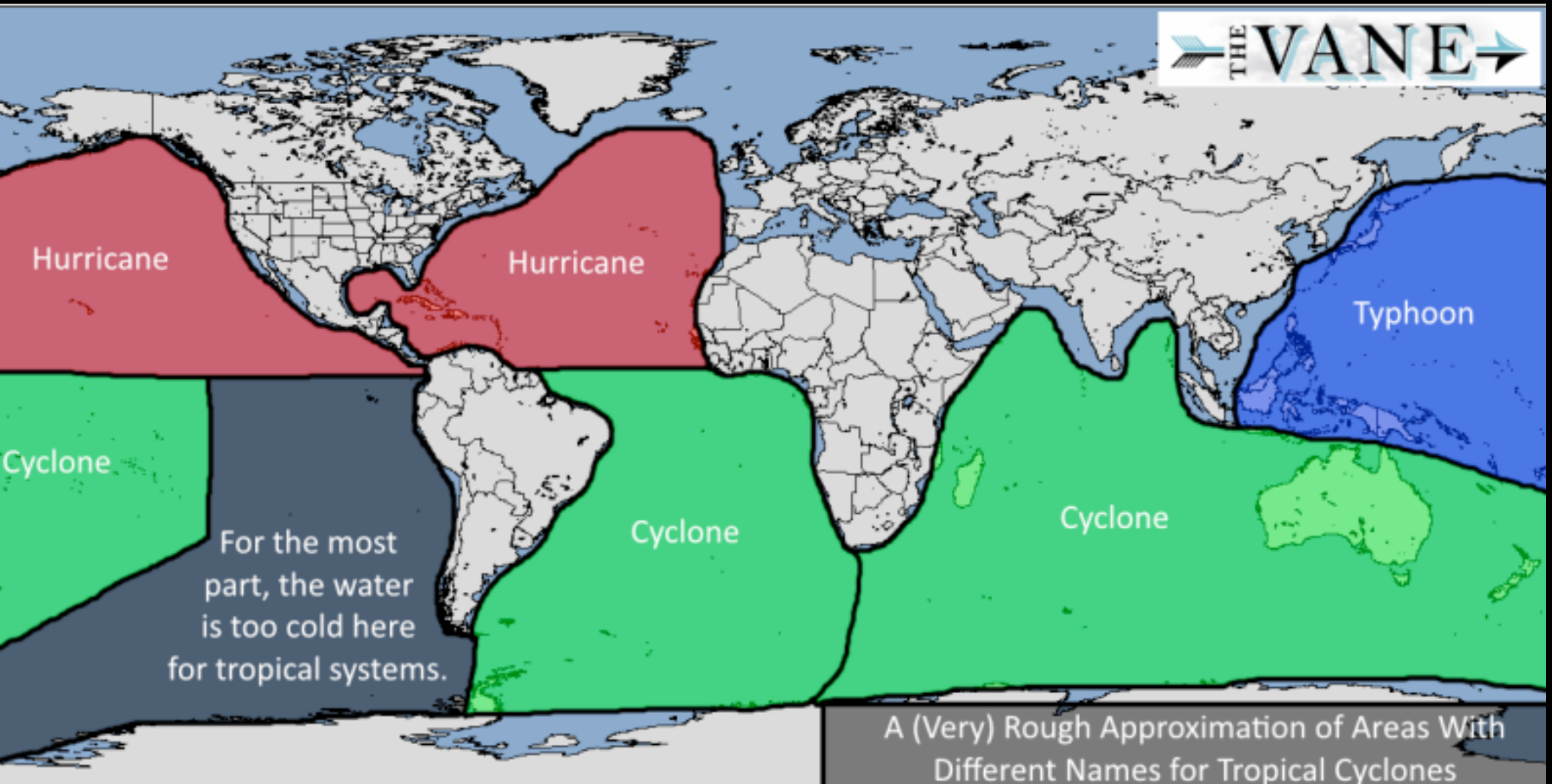

Outflow cirrus shield
Outflow
Warm rising air
Cold falling air
Eye wall
Eye
Storm rotation
CLOCKWISE
Rain bands

Hurricane interference

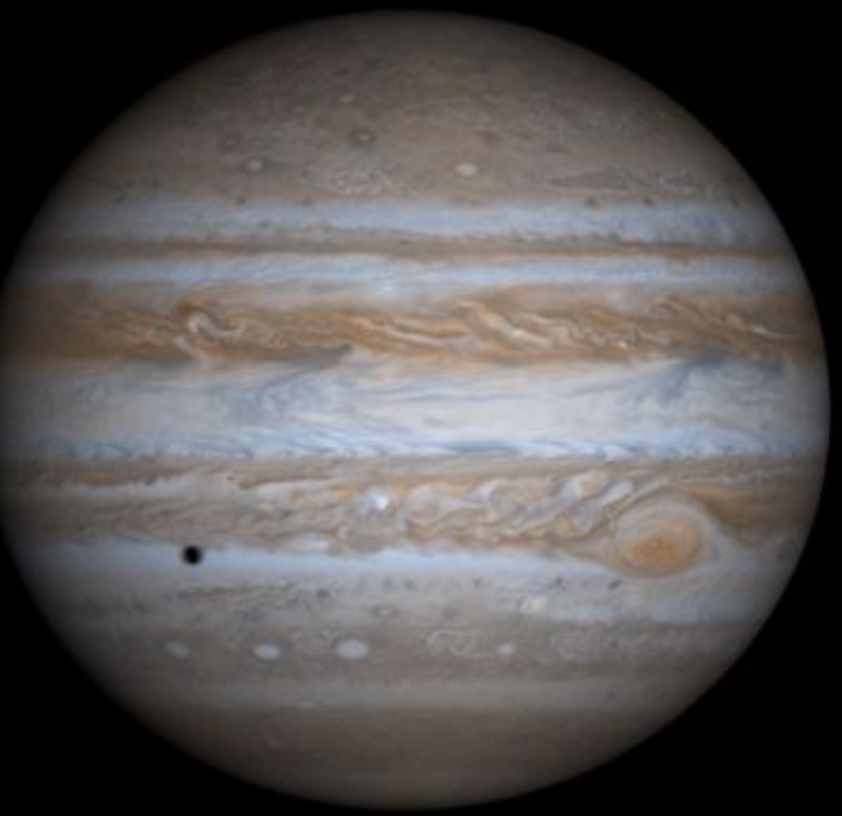
Cooler ocean temperatures in blue. The second hurricane weakened significantly when it crossed the path of the first.

Hurricane, Typhoon, Cyclone?

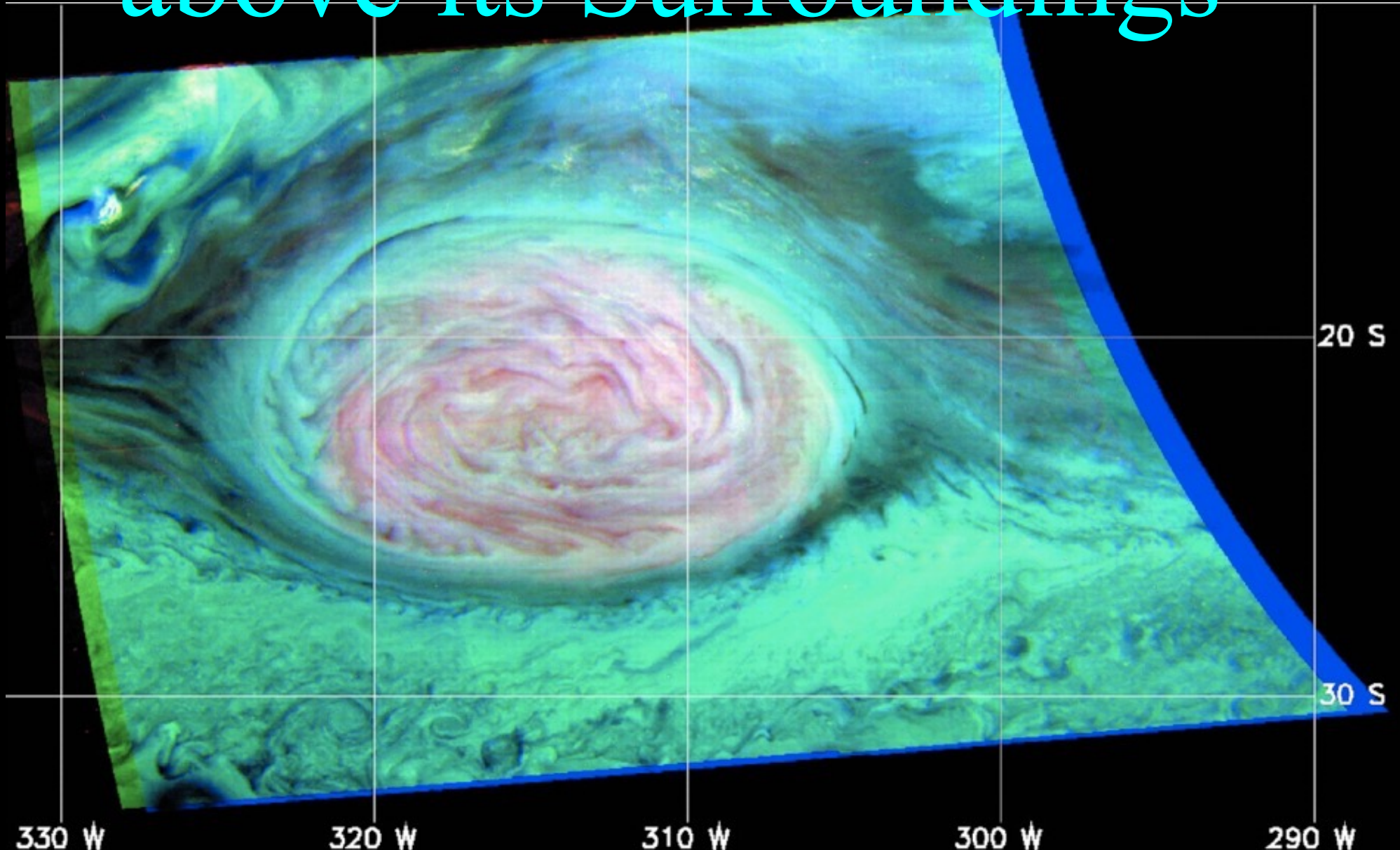
Hurricanes - Atlantic, Eastern Pacific
Typhoon - Western Pacific
All are called Tropical Cyclones



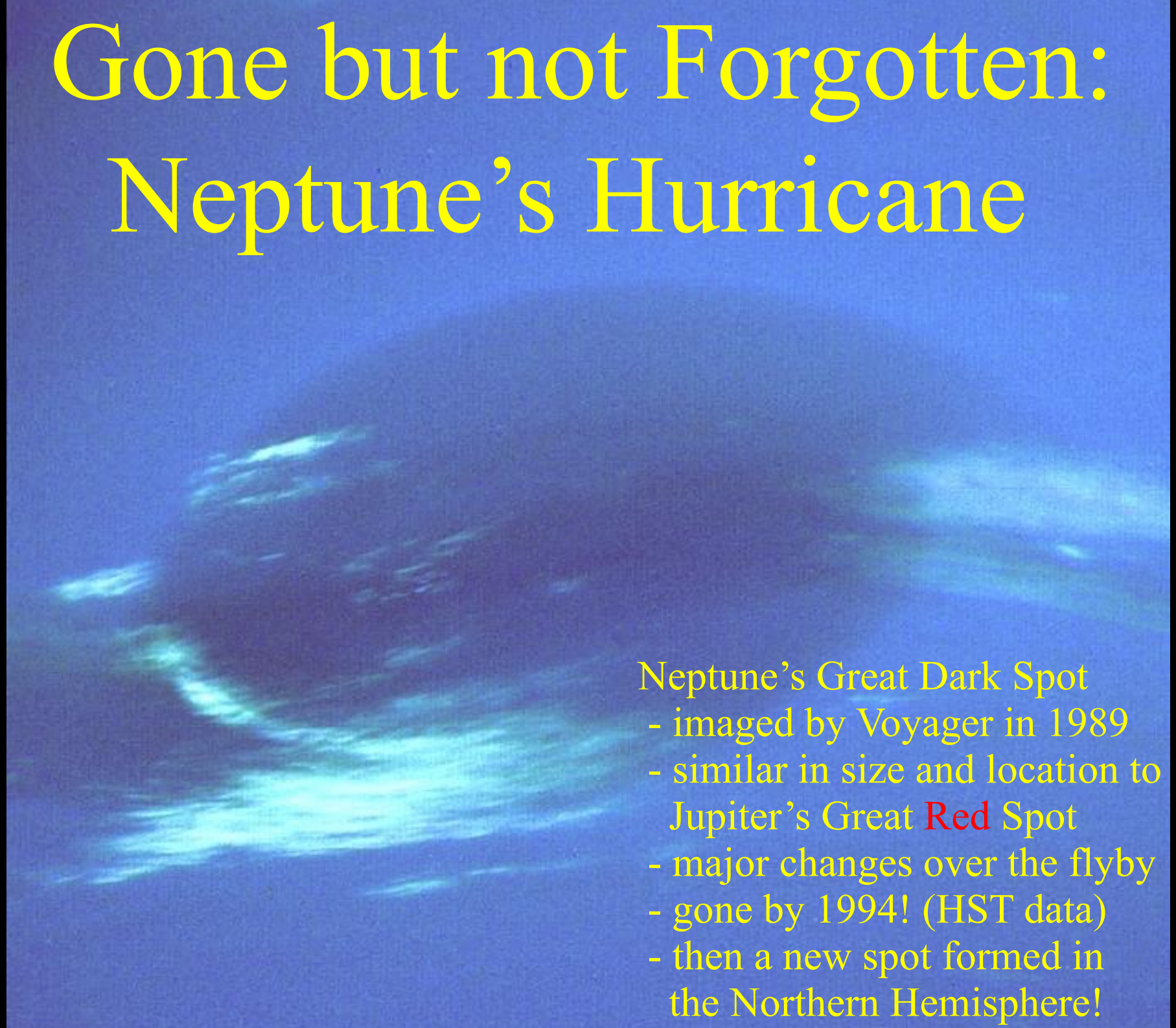
Jupiter Red Spot is a giant spinning Hurricane!



The Red Spot is ~ 8km above its Surroundings



Gone but not Forgotten: Neptune's Hurricane



Neptune's Great Dark Spot
- imaged by Voyager in 1989
- similar in size and location to Jupiter's Great Red Spot
- major changes over the flyby
- gone by 1994! (HST data)
- then a new spot formed in the Northern Hemisphere!