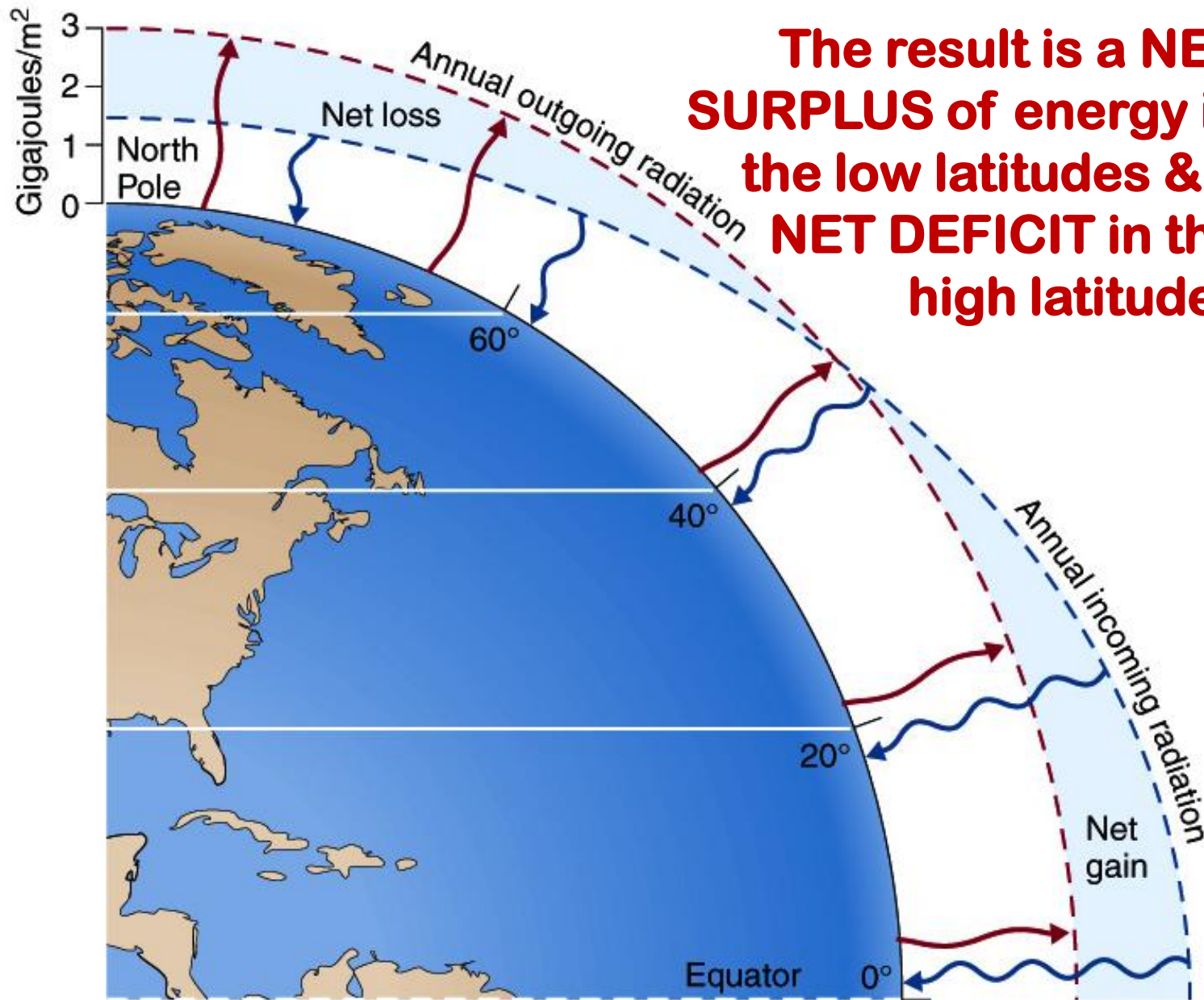


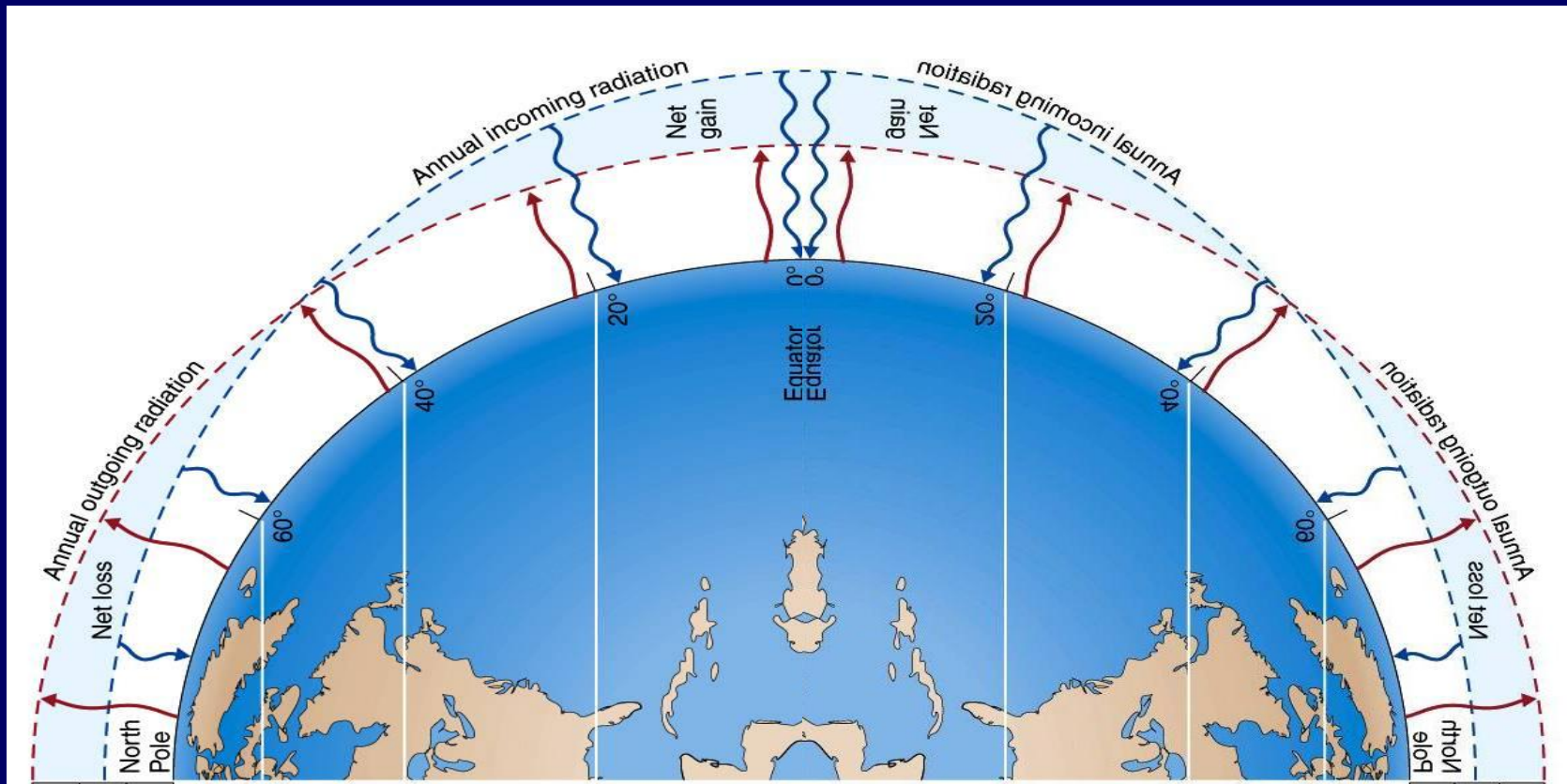
Topic # 12
HOW CLIMATE WORKS –
PART III

**Connecting everything to global
climate patterns**

Turn to pp 64 -67 in Class Notes

The result is a **NET SURPLUS** of energy in the low latitudes & a **NET DEFICIT** in the high latitudes



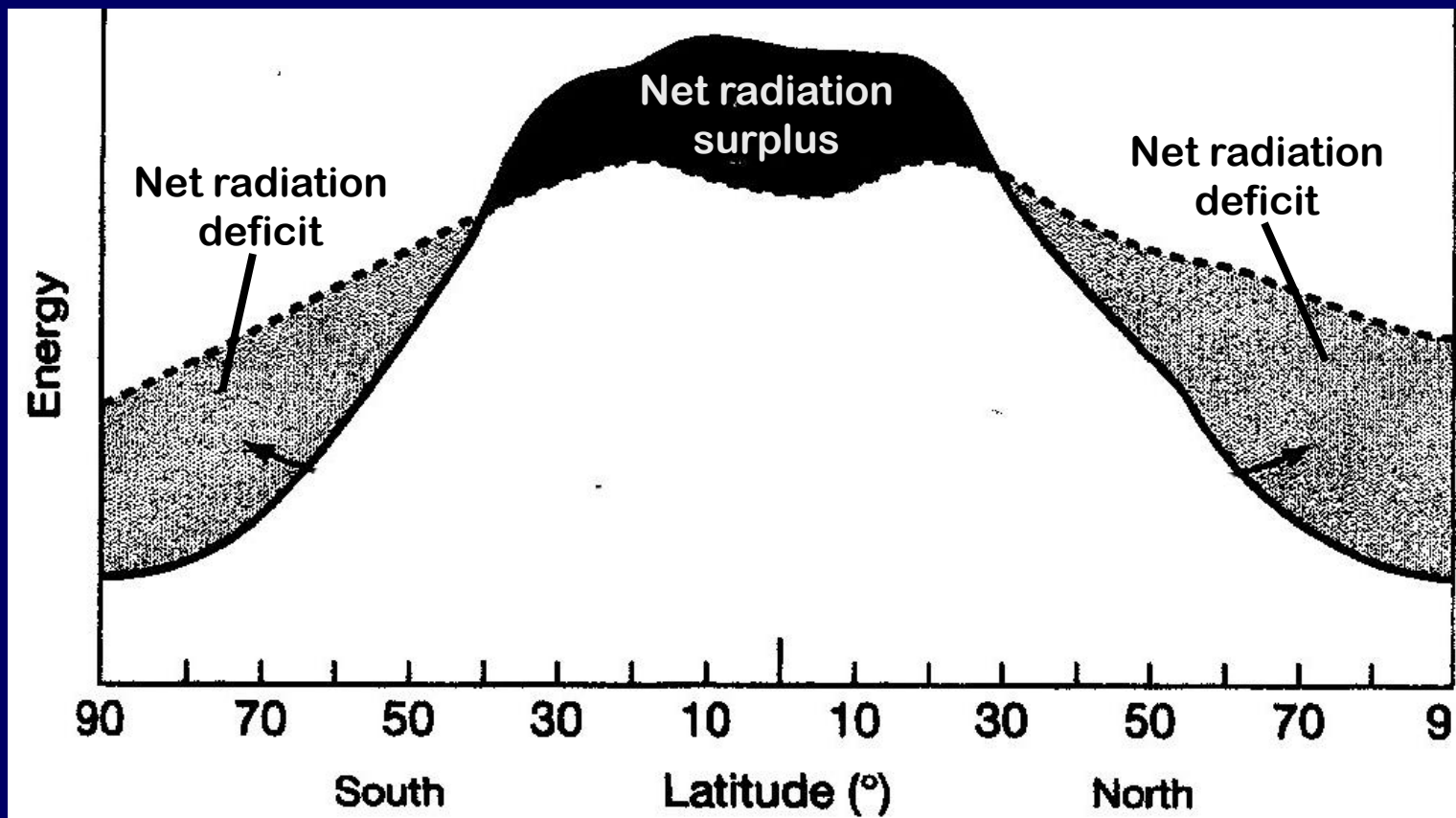


POLE

EQUATOR

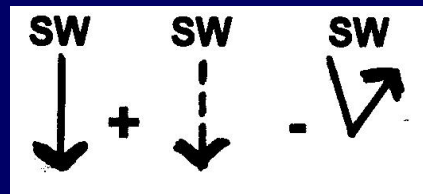
POLE

Now lets look at a Pole to Pole Transect

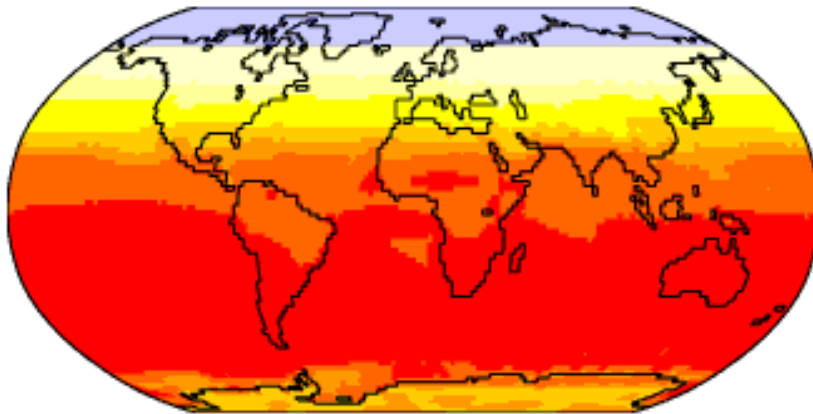


————— Absorbed solar energy

----- Emitted infrared energy
(at top of atmosphere)

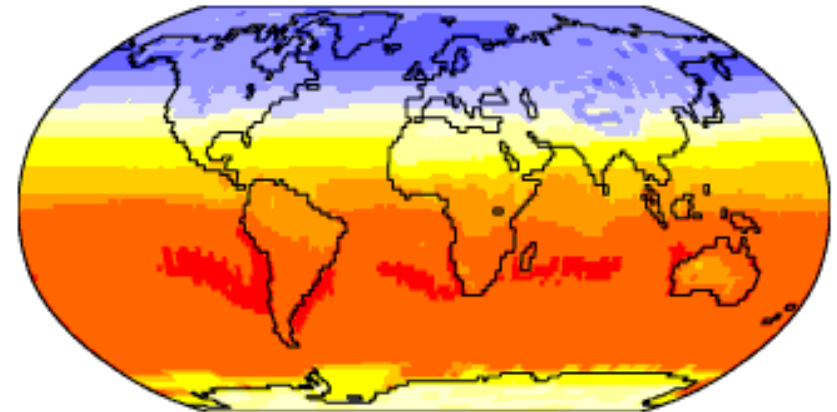


Short-Wave Radiation

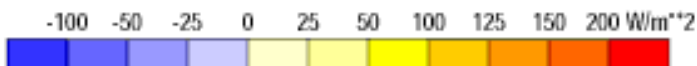
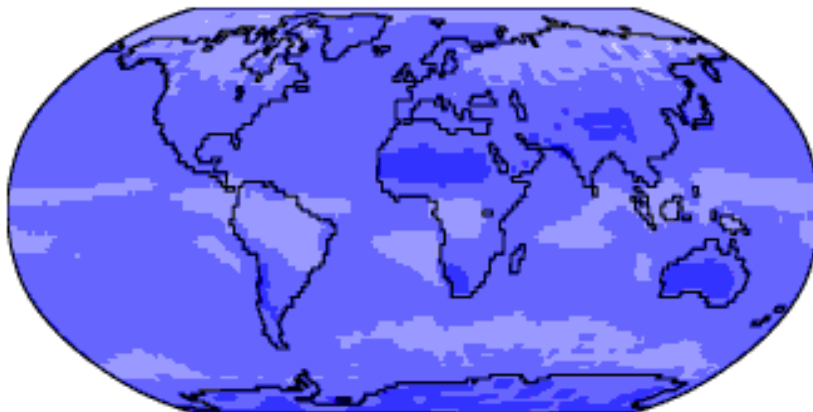


Dec

Net Radiation



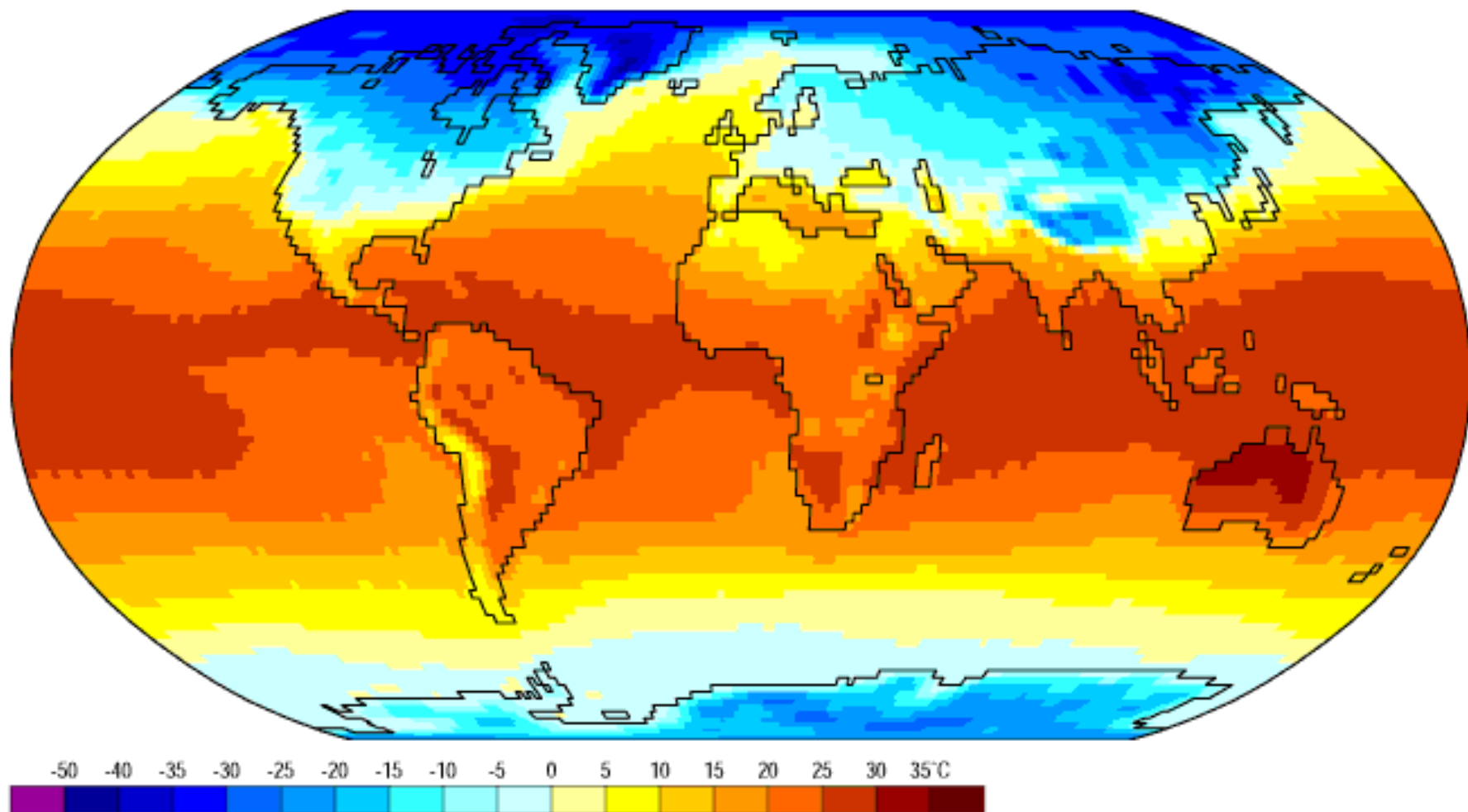
Long-Wave Radiation



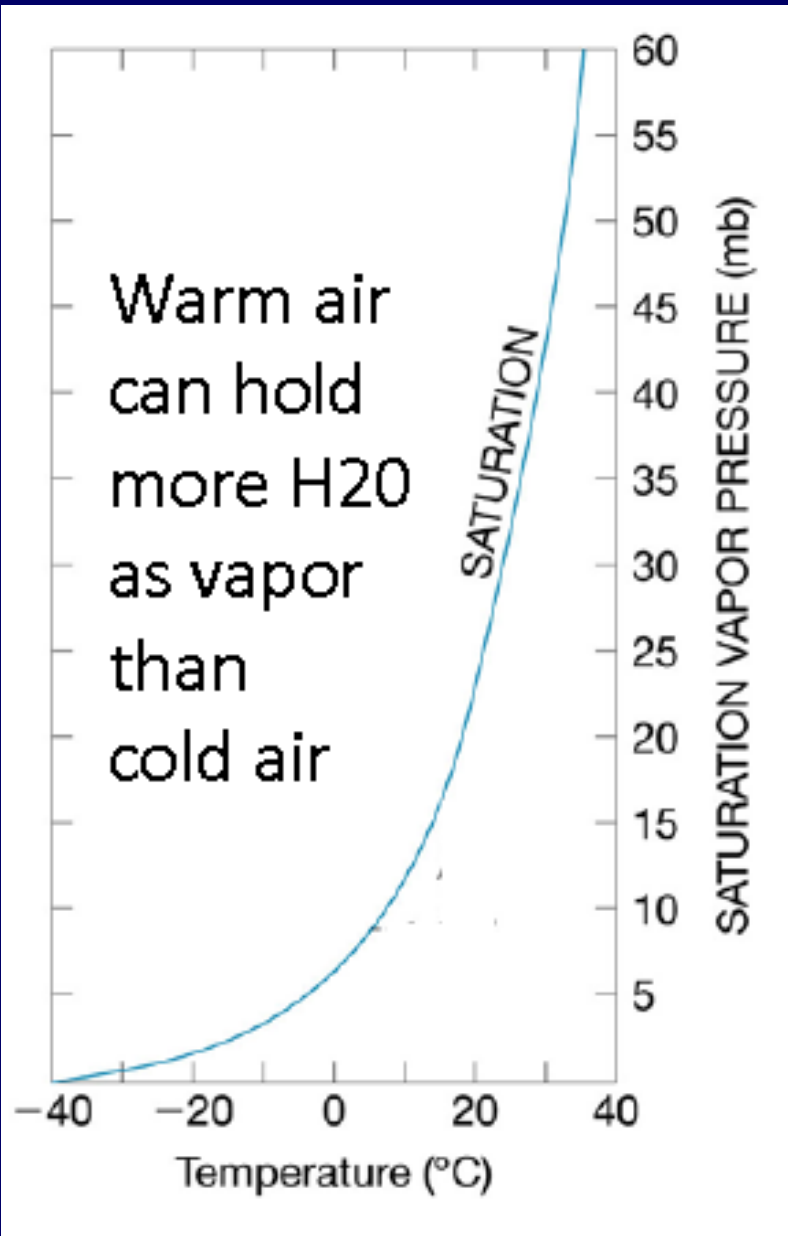
Data: NCEP/NCAR Reanalysis Project, 1959-1997 Climatologies
Animation: Department of Geography, University of Oregon, March 2000

Air Temperature

Dec



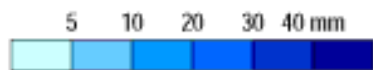
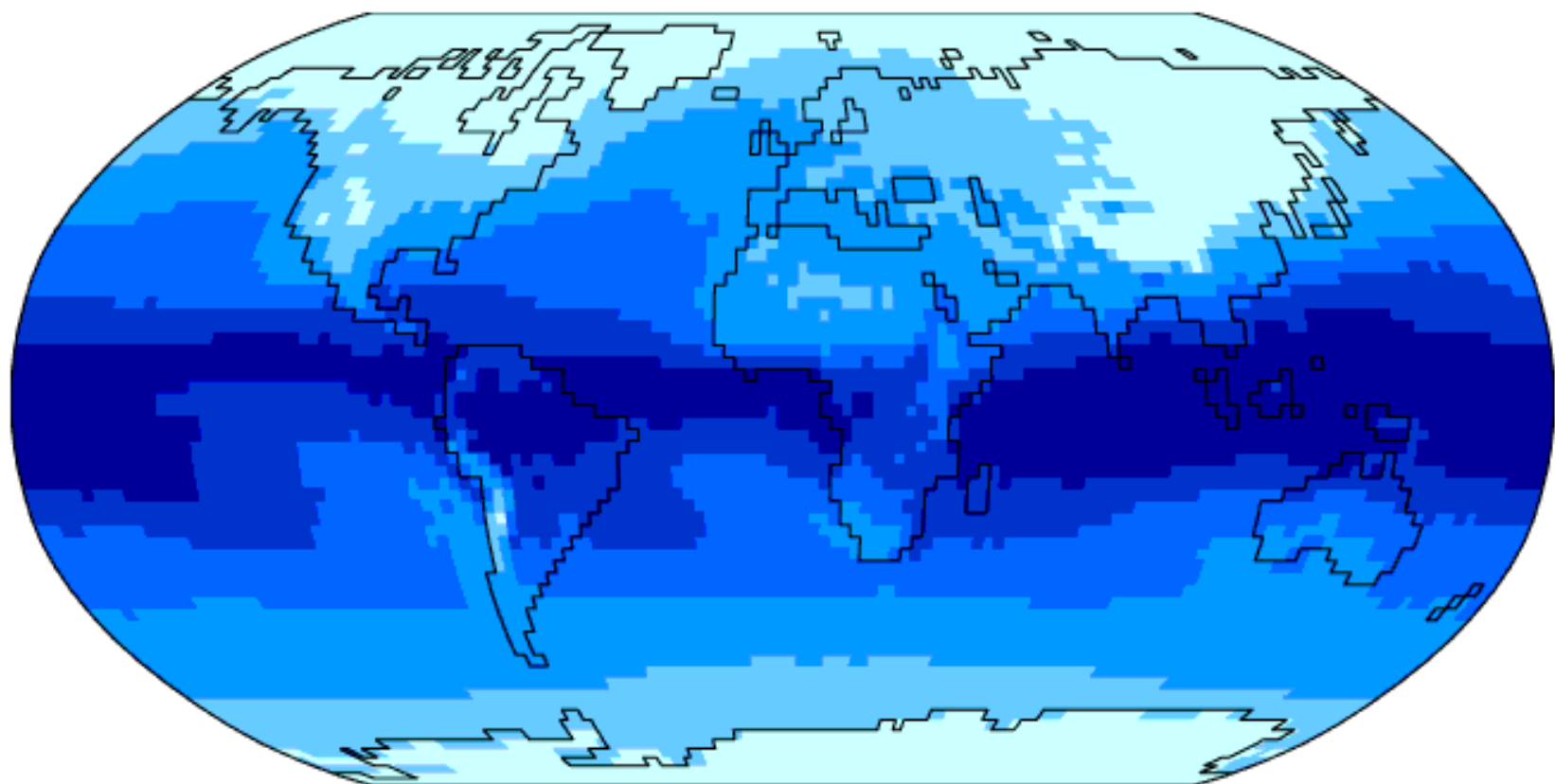
Data: NCEP/NCAR Reanalysis Project, 1959-1997 Climatologies
Animation: Department of Geography, University of Oregon, March 2000



**WARM REGIONS
(Tropics)
vs
COLD REGIONS
(Arctic/Antarctic
& Poles)**

Precipitable Water

Dec



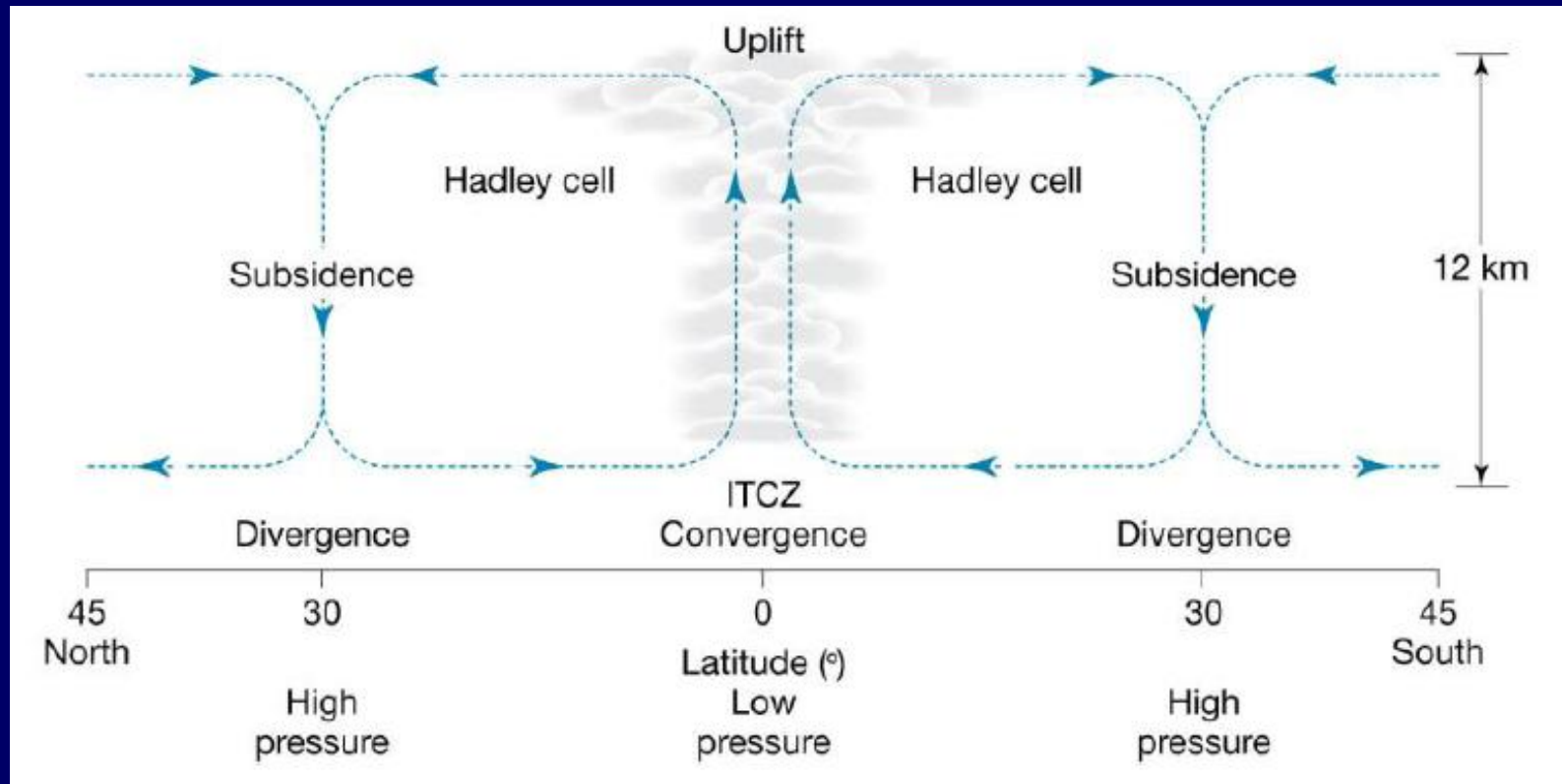
Data: NCEP/NCAR Reanalysis Project, 1959-1997 Climatologies
Animation: Department of Geography, University of Oregon, March 2000

UPLIFT vs SUBSIDENCE

DRY

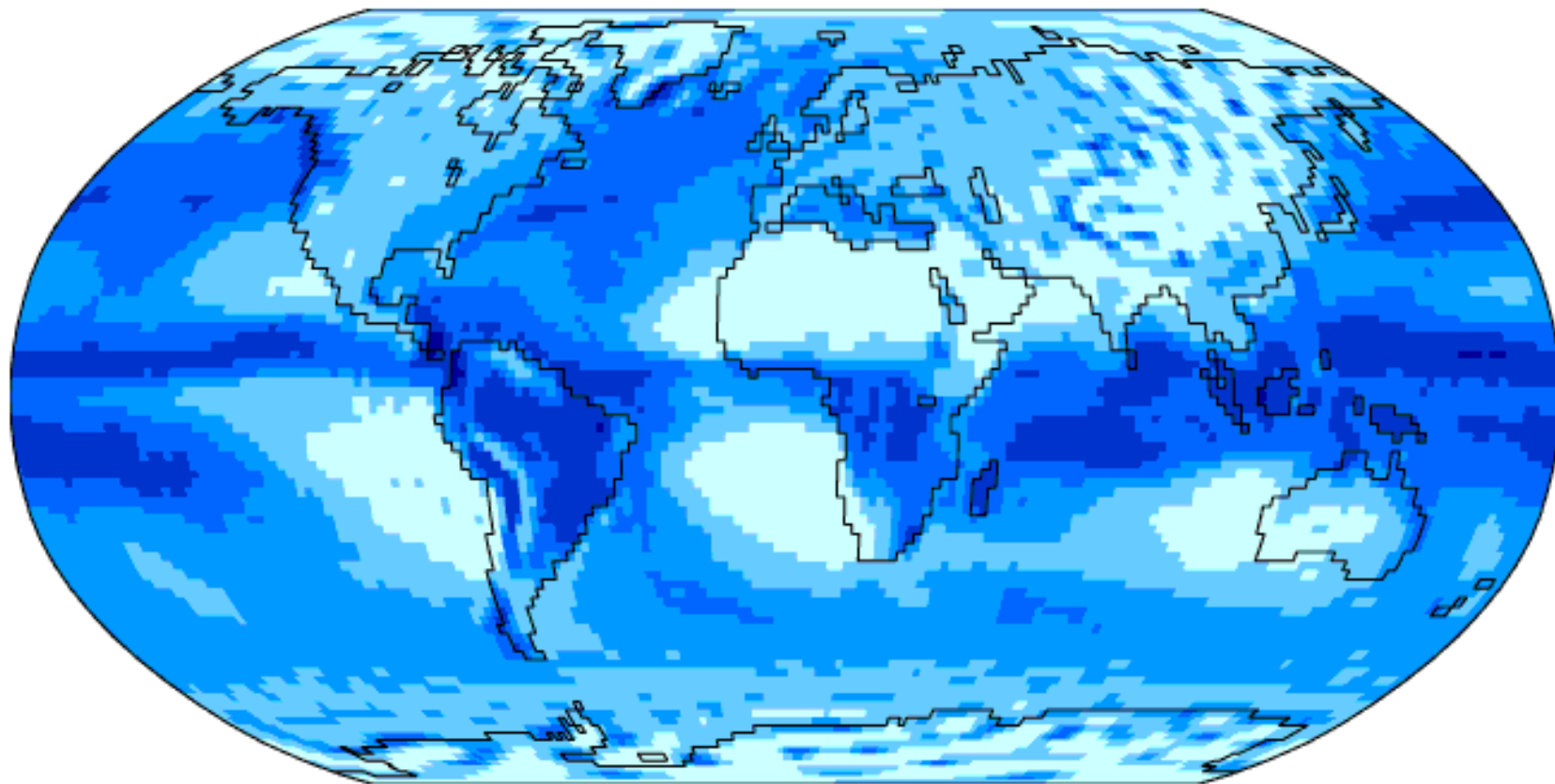
WET

DRY



Precipitation

Dec



Data: NCEP/NCAR Reanalysis Project, 1959-1997 Climatologies
Animation: Department of Geography, University of Oregon, March 2000

5 minute GROUP CHALLENGE! (Closed Book No Peeking!!)

★ GROUP BONUS POINT CHALLENGE! GROUP # _____

GLOBAL CLIMATE PATTERN QUIZ
Rough Sketch of Basic Global Climate / Vegetation Regions

On the blank map below, sketch in as best you can:

- 1) The major mountain ranges of the world
- 2) The major desert areas of the world
- 3) The major areas of boreal forests
- 4) The major areas of tropical rainforest
- 5) The major areas of tundra
- 6) The major warm and cold ocean currents

USE THESE SYMBOLS:



MAJOR MOUNTAIN RANGES



AREAS OF TROPICAL RAIN FOREST



MAJOR DESERT AREAS



AREAS OF BOREAL FOREST

★ GROUP BONUS POINT CHALLENGE! GROUP # _____

GLOBAL CLIMATE PATTERN QUIZ

Rough Sketch of Basic Global Climate / Vegetation Regions

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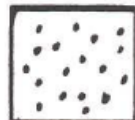
USE THESE SYMBOLS:



MAJOR MOUNTAIN RANGES



AREAS OF TROPICAL RAIN FOREST



MAJOR DESERT AREAS



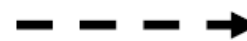
TUNDRA AREAS



AREAS OF BOREAL FOREST



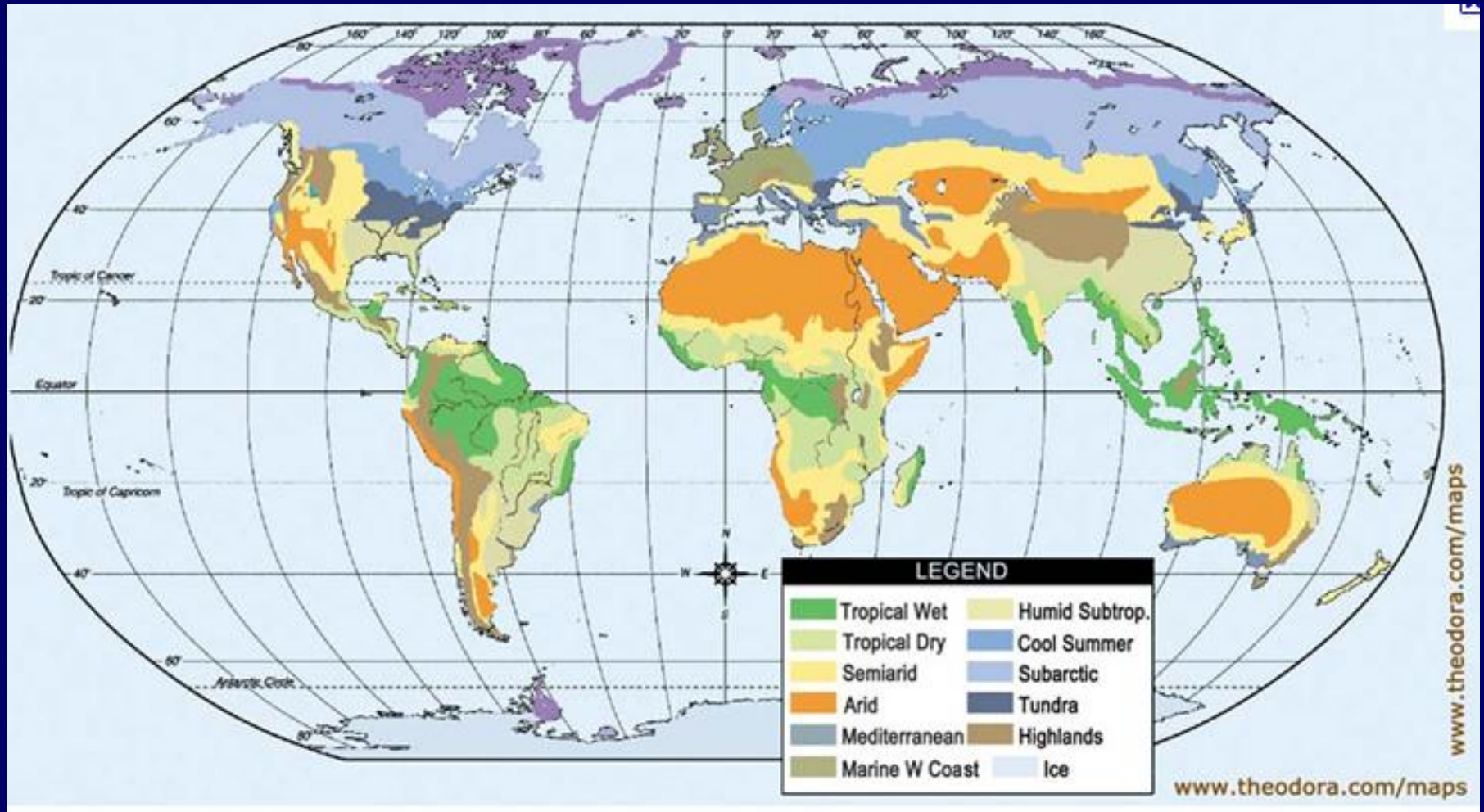
WARM OCEAN CURRENTS



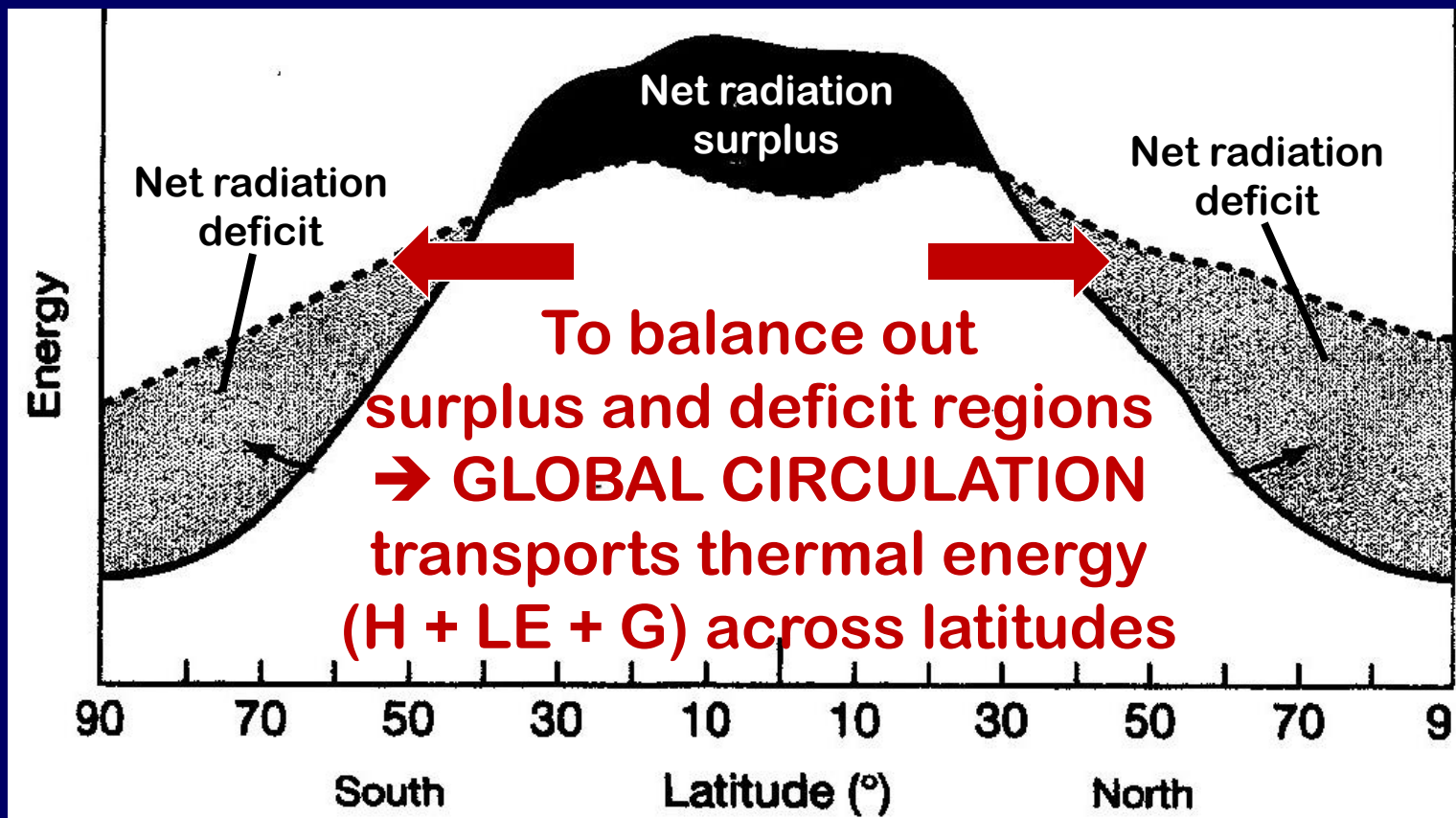
COLD OCEAN CURRENTS



...which leads to **Global Climatic Regions:**

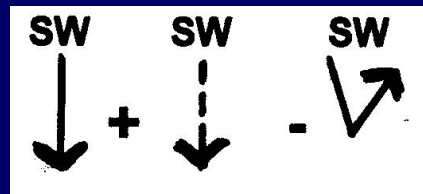


...and **CHANGES** in these regions!

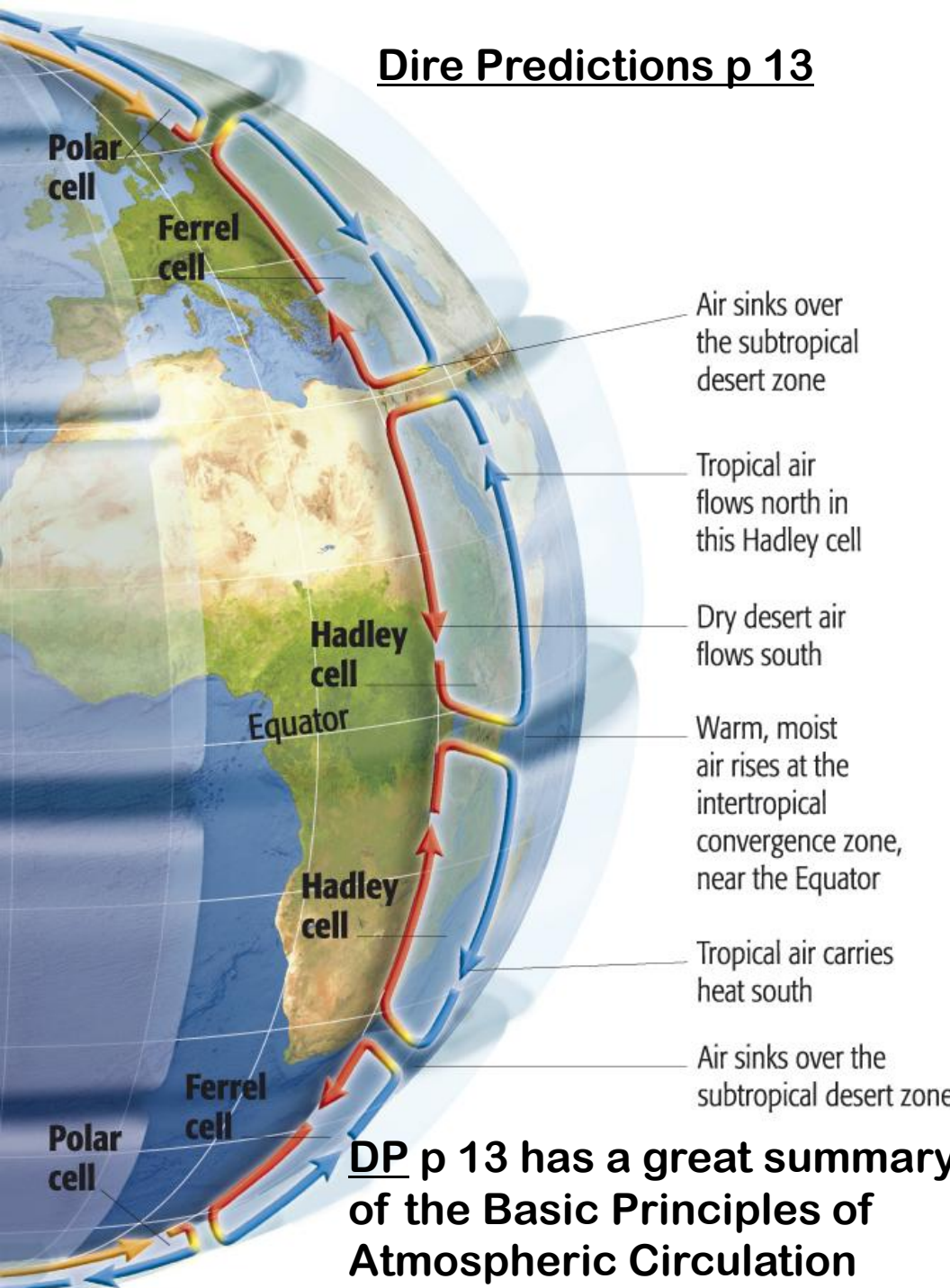


————— Absorbed solar energy

..... Emitted infrared energy
(at top of atmosphere)

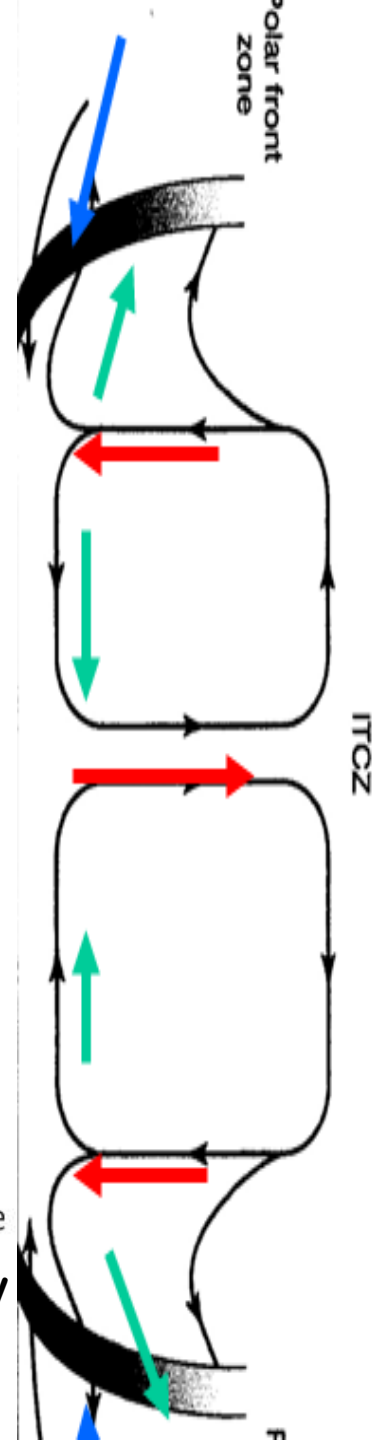


Dire Predictions p 13



DP p 13 has a great summary of the Basic Principles of Atmospheric Circulation

- Air sinks over the subtropical desert zone
- Tropical air flows north in this Hadley cell
- Dry desert air flows south
- Warm, moist air rises at the intertropical convergence zone, near the Equator
- Tropical air carries heat south
- Air sinks over the subtropical desert zone



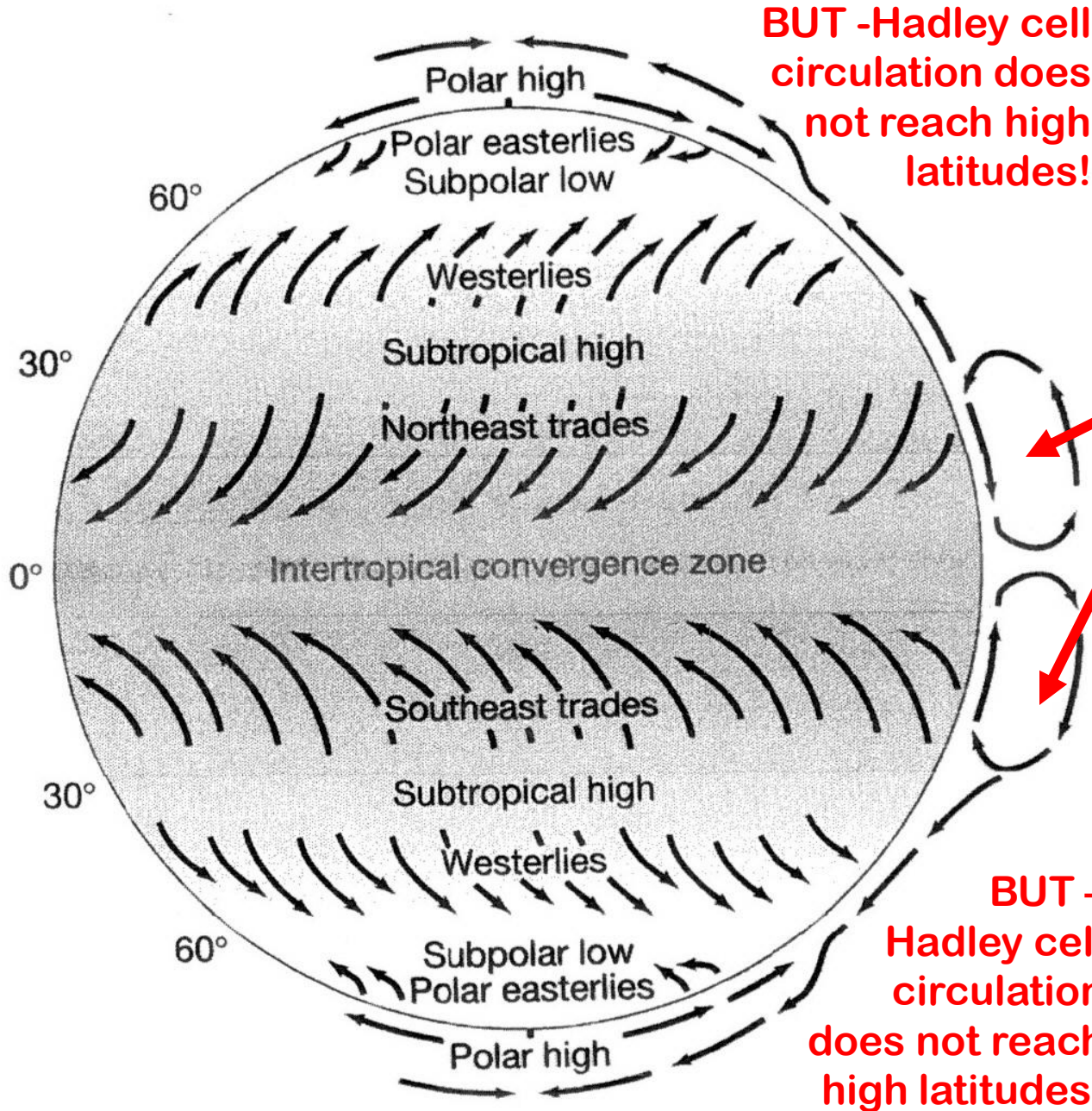
cold polar air vs. warm low lat air

sinking dry subtropical air

rising tropical warm, moist air

sinking dry subtropical air

warm low lat air vs. cold polar air



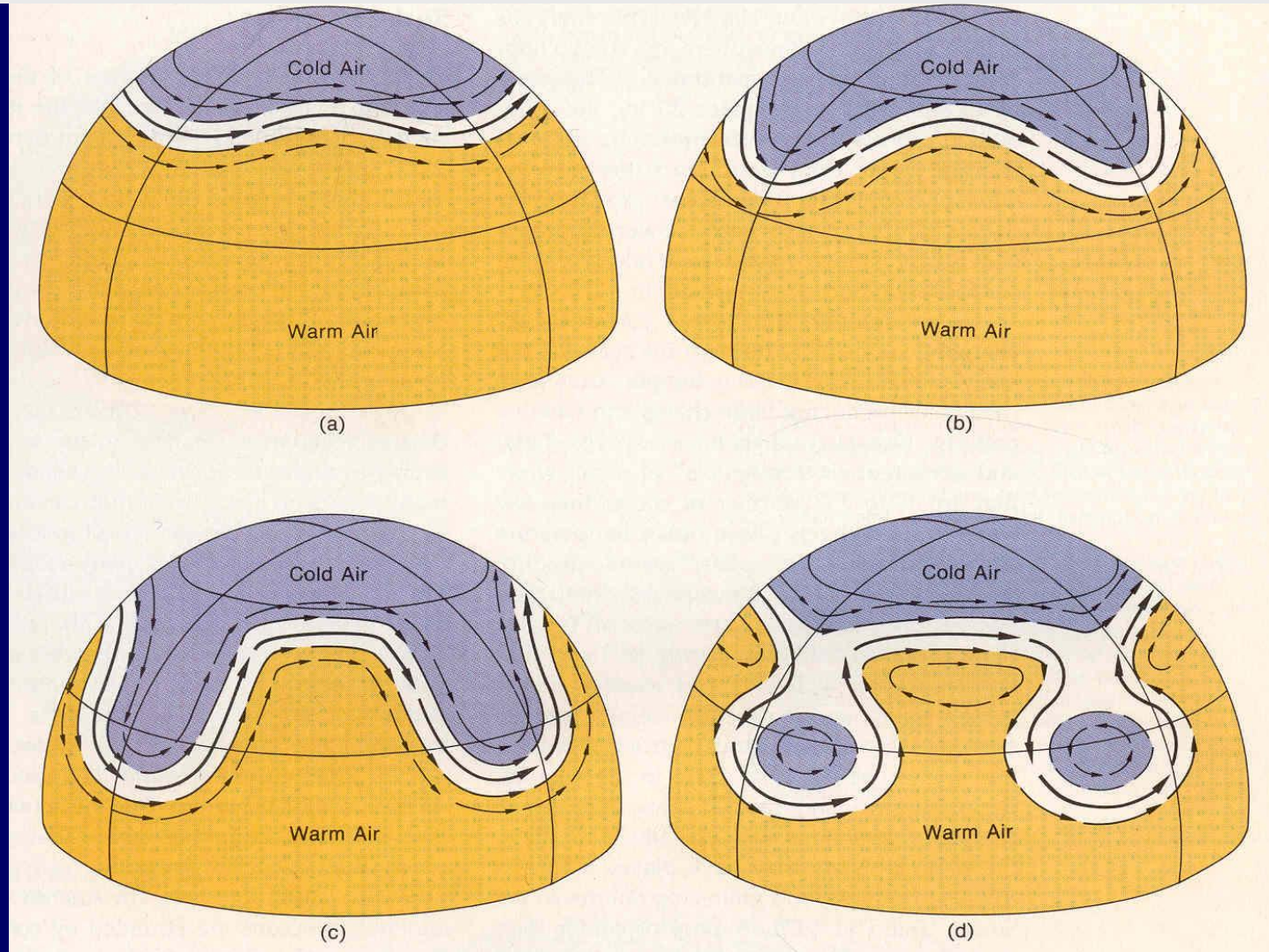
BUT - Hadley cell circulation does not reach high latitudes!

Hadley Cells transport warm air poleward as SENSIBLE HEAT

HADLEY CELLS = key drivers!

Convection cell transfer of thermal energy from low latitude area of energy SURPLUS to higher latitude area of energy DEFICIT

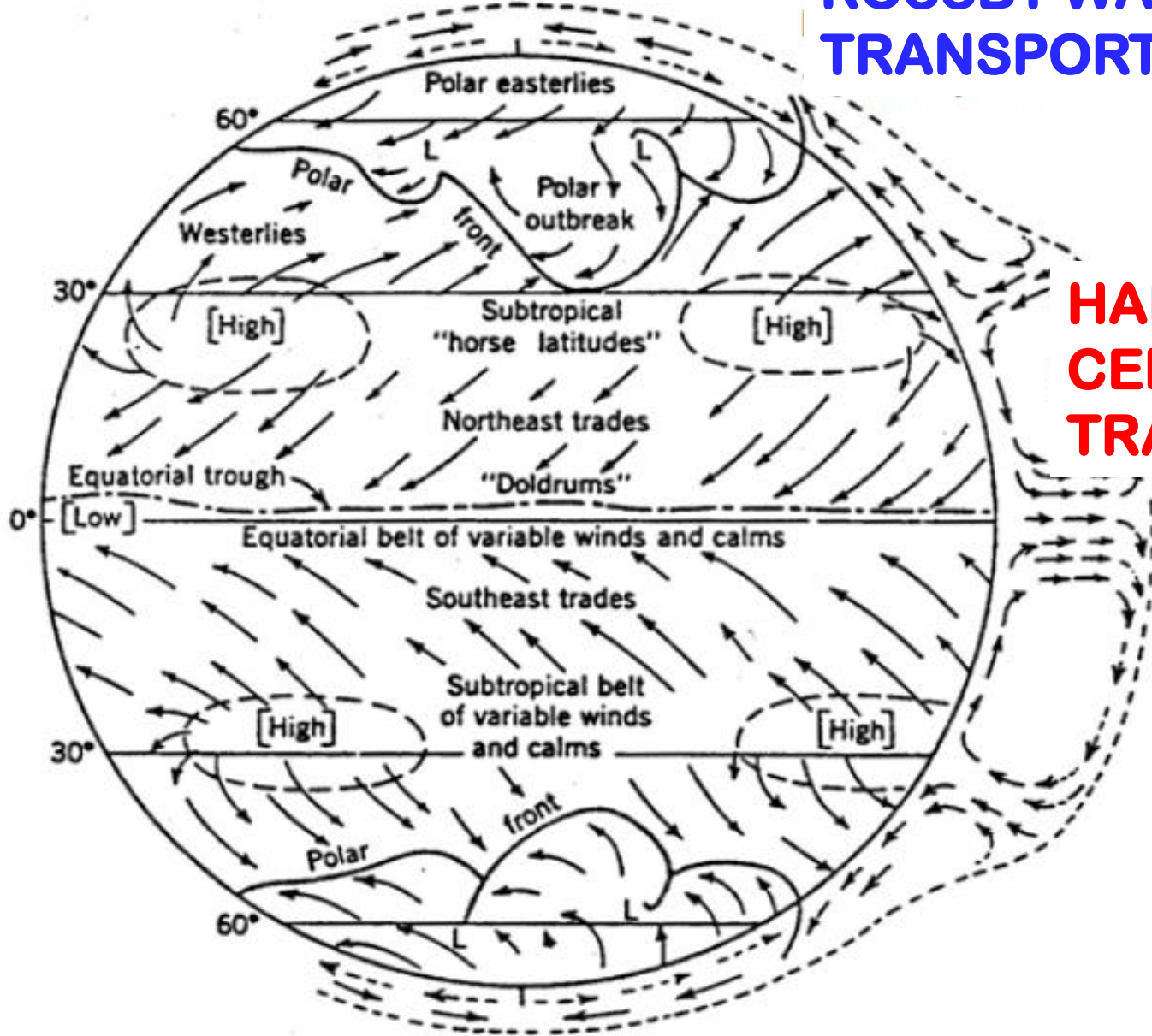
UPPER LEVEL “ROSSBY WAVE” CIRCUMPOLAR WINDS !



Review
p 65

“Wave” transport of SENSIBLE HEAT (in lobes of warm air) instead of Hadley cell transport!

ROSSBY WAVE TRANSPORT



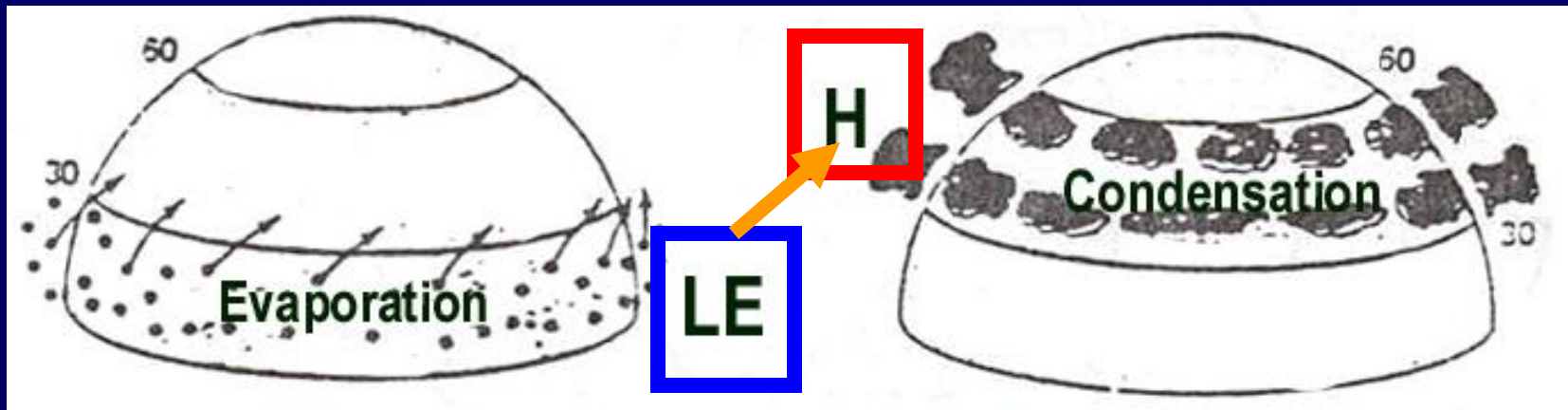
HADLEY CELL TRANSPORT

Energy is transported from areas of surplus to deficit via:

H (sensible heat)

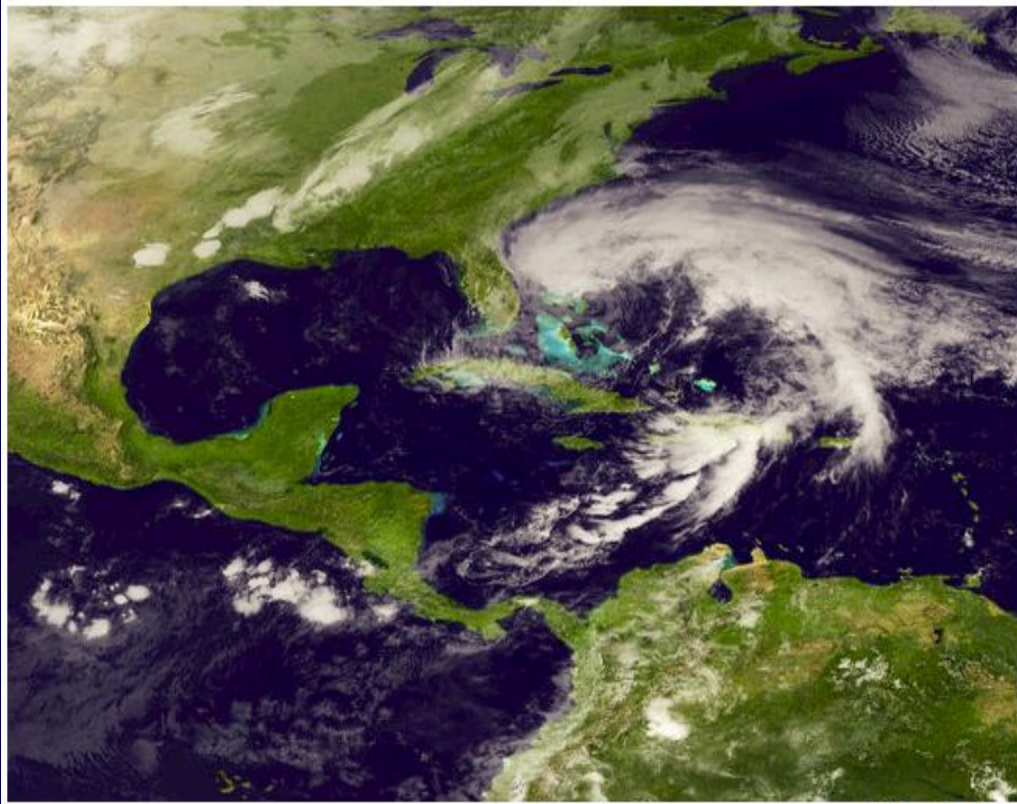


& LE (Latent Energy)



H + LE

East Coast Keeps Watchful Eye on Hurricane Sandy



NOAA via Getty Images



Steve Nesius/Reuters

ing the jetty at Lighthouse Point Park as Hurricane Sandy passes offshore in Ponce Inlet, Fla.,

Pre-Halloween 'Frankenstorm' takes aim at East Coast

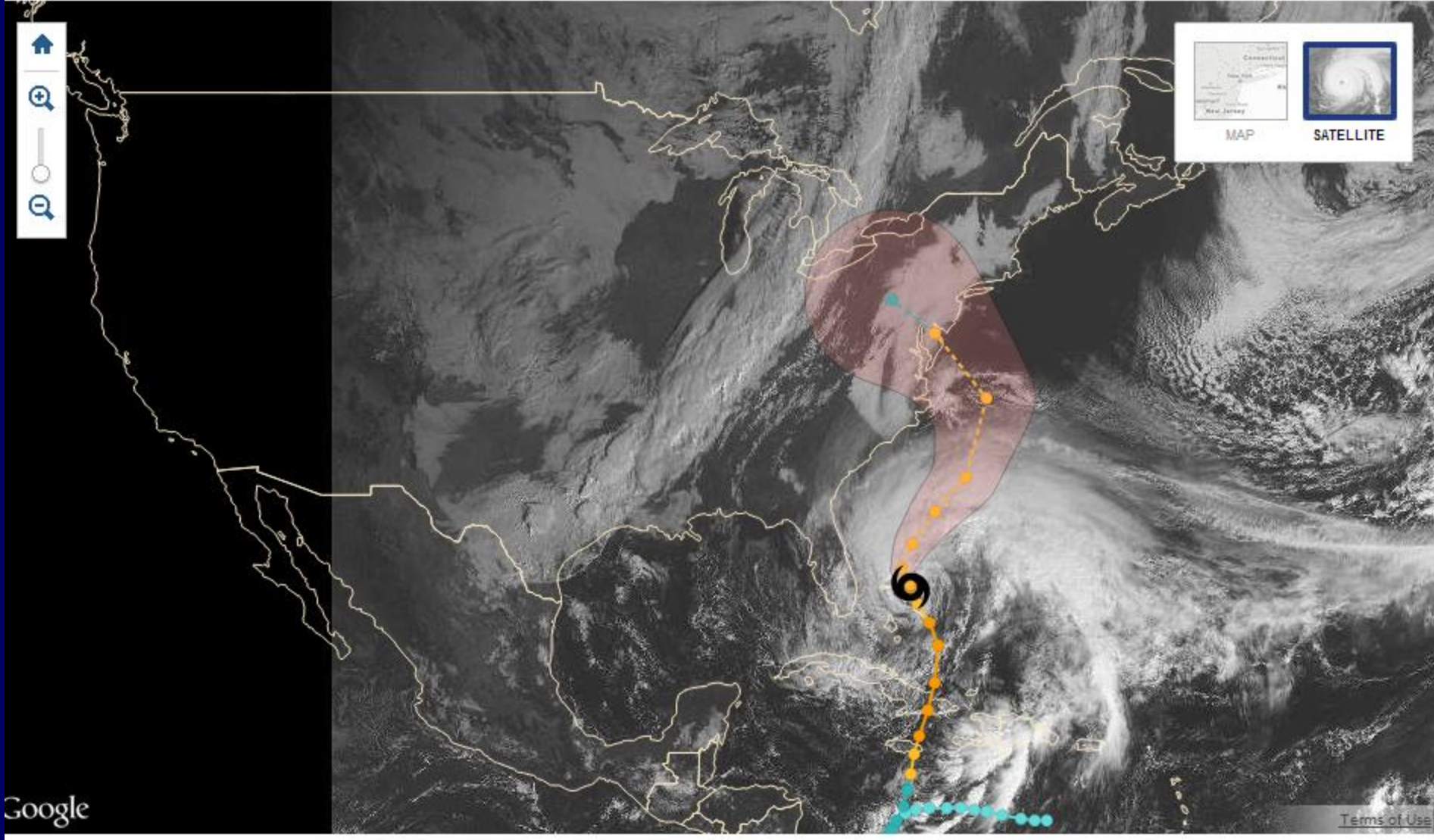
<http://www.foxnews.com/weather/2012/10/26/east-coast-prepares-for-pre-halloween-frankenstorm/>

Hurricane Sandy

Max. winds **81** m.p.h.

Category **1**

Updated 11 A.M. ET Oct. 26

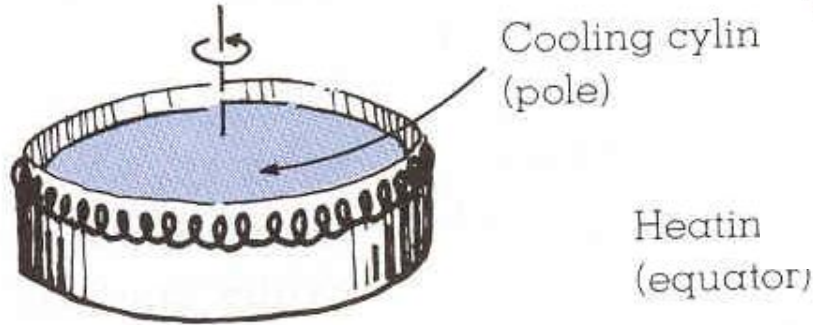
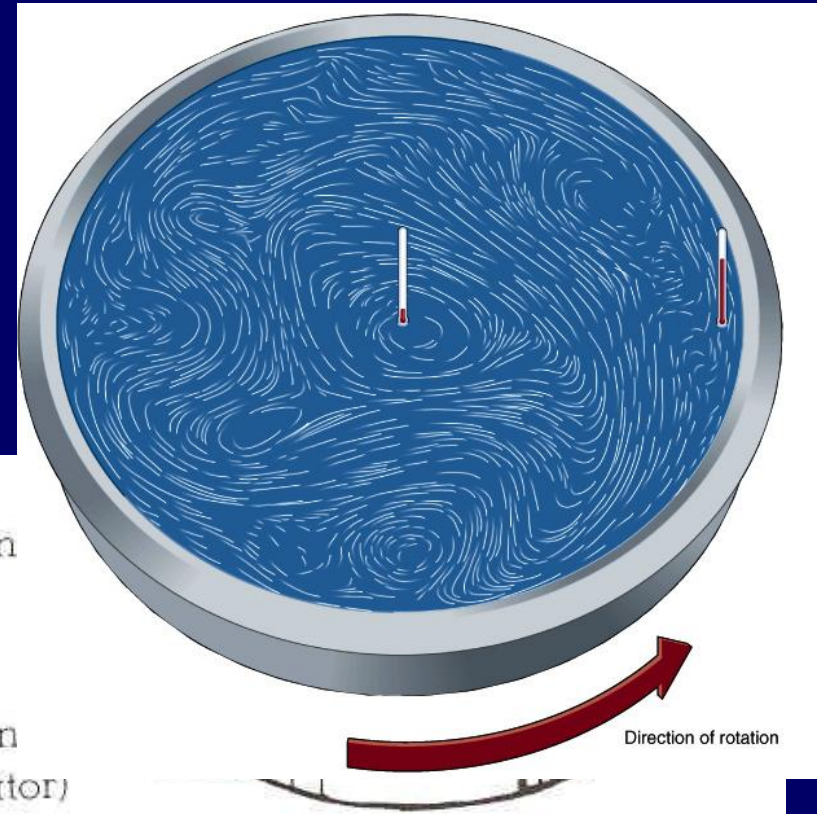


Google

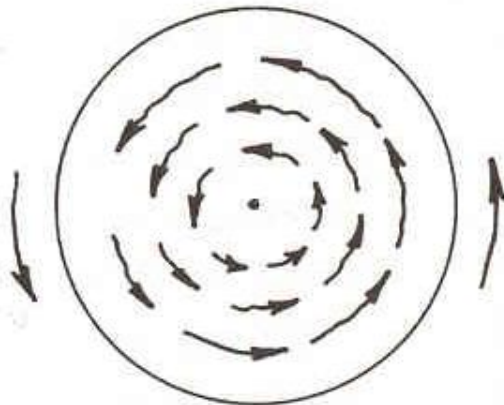
[Terms of Use](#)

Why Hadley convective cell transport breaks down at higher latitudes:

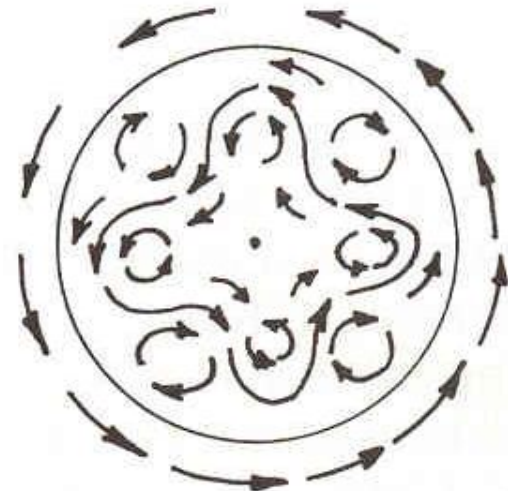
Review p 65



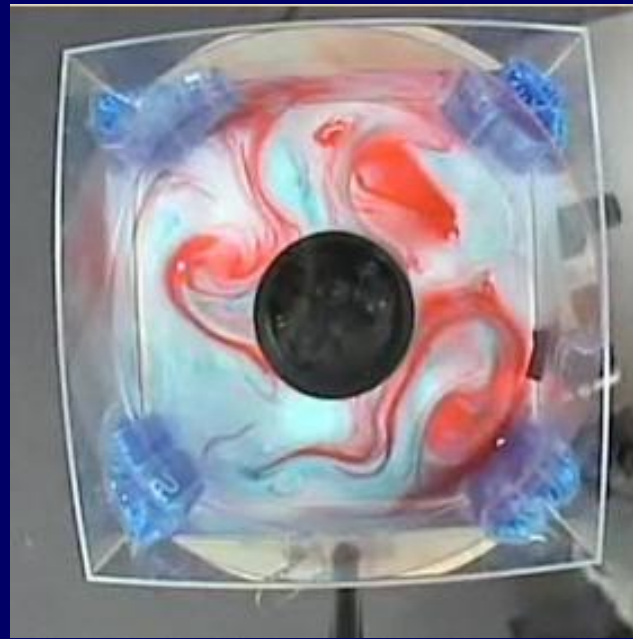
(a) Slow rotation



(b) Faster rotation

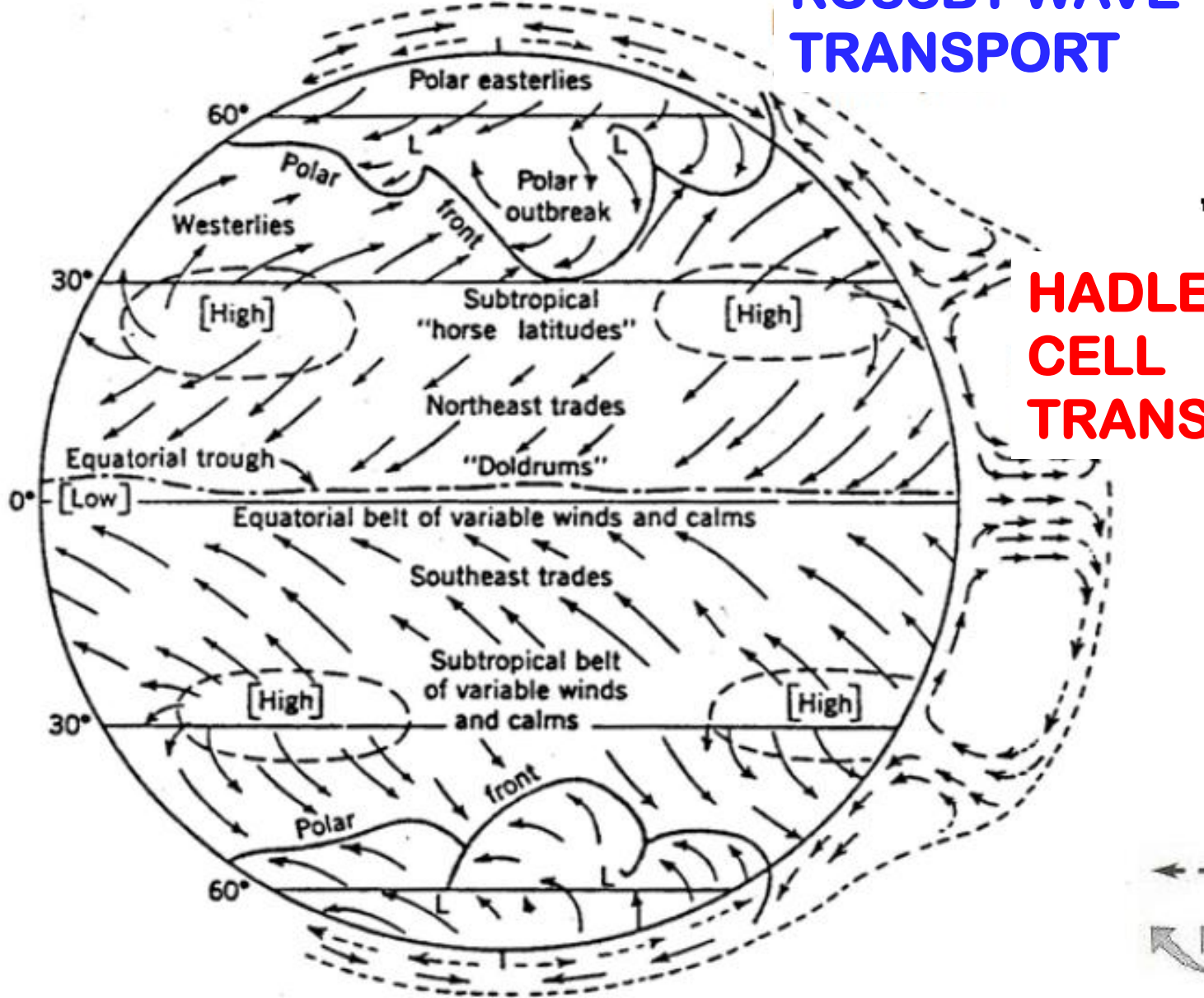


**A DEMONSTRATION
OF THE DISHPAN:
ROSSBY WAVES RULE
in HIGH LATITUDES!!**



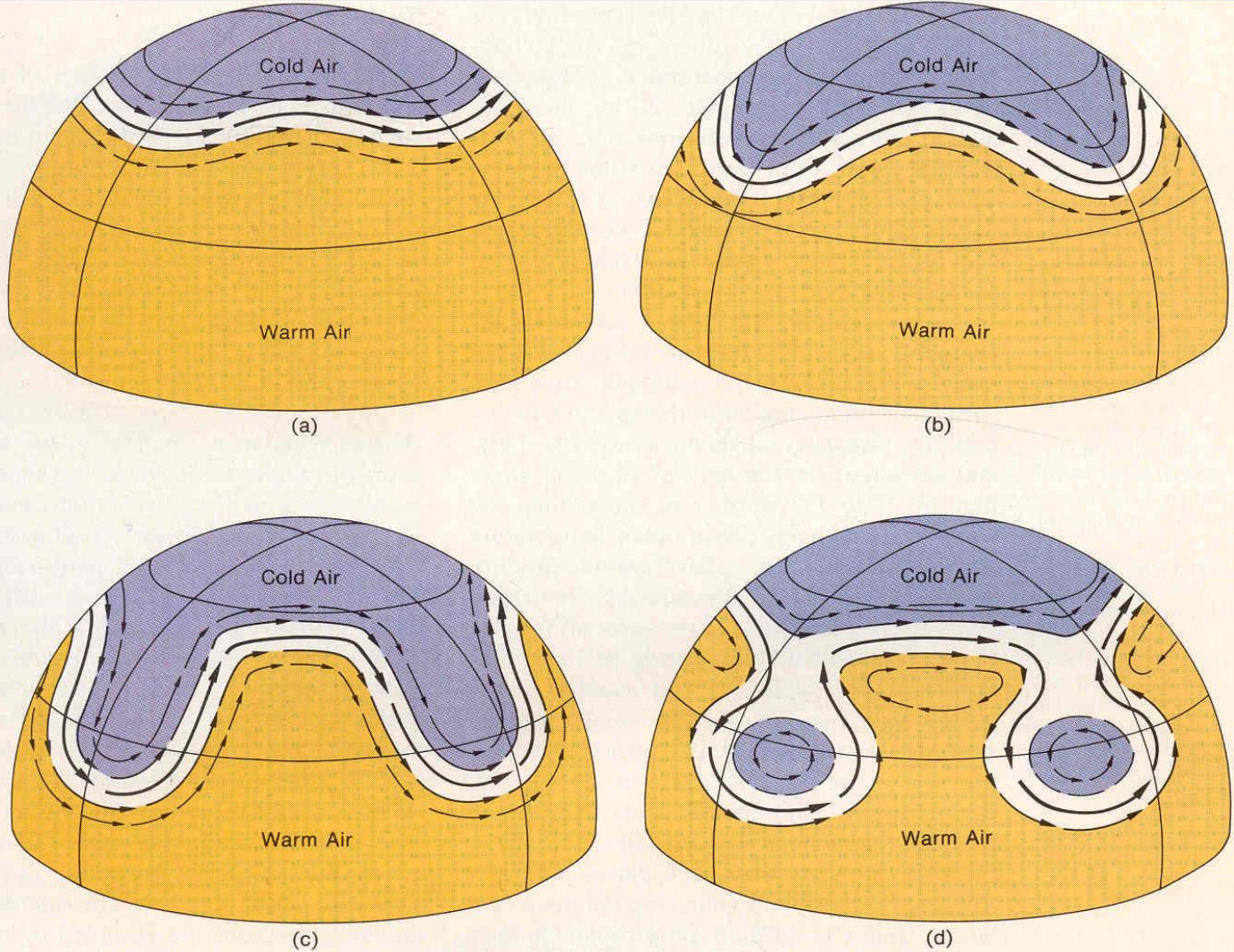
http://www.windows2universe.org/earth/Atmosphere/global_circulation_isop_video.html

ROSSBY WAVE TRANSPORT



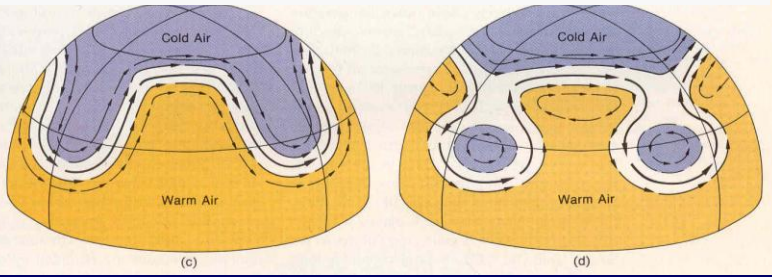
HADLEY CELL TRANSPORT

UPPER LEVEL “ROSSBY WAVE” CIRCUMPOLAR WINDS !



“Wave” transport of SENSIBLE HEAT (in lobes of warm air) instead of Hadley cell transport!

Rossby wave patterns

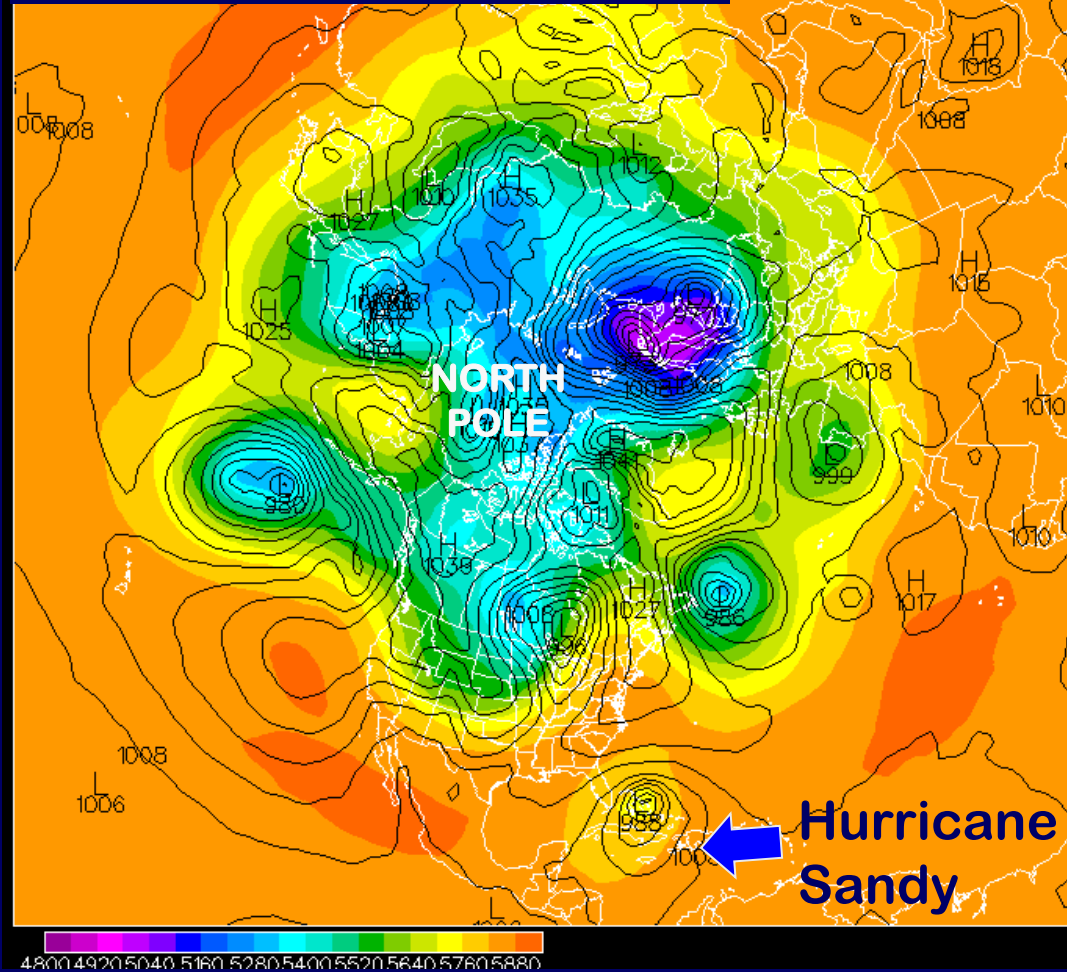


Blue areas =
upper-level / mid-
troposphere
“Rossby” waves
of colder polar air

Orange & Yellow
areas =
Lower latitude
warmer air

500mb hght/SL Pres GFS analysis for 00Z 26 OCT 12

**BLACK LINES = Surface
HIGH & LOW pressure areas**



**Current Weather Chart of
Northern Hemisphere**

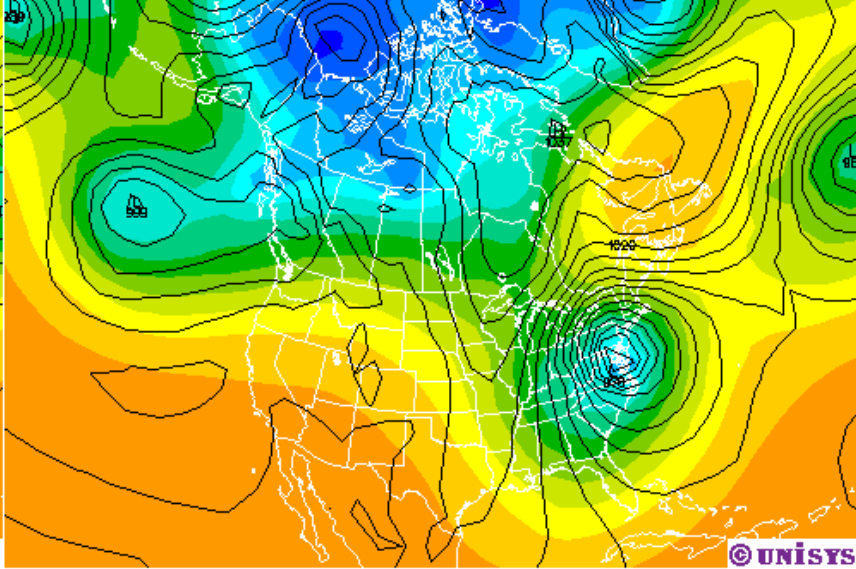
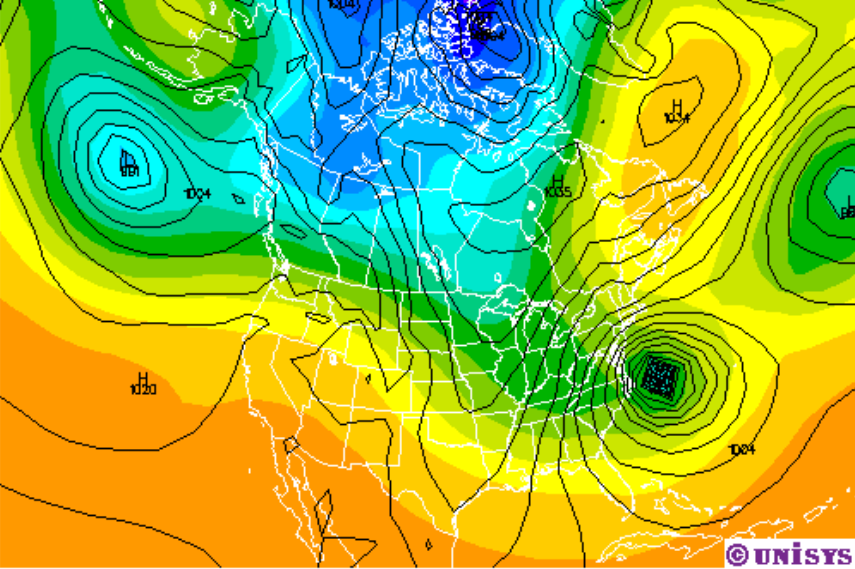
<http://weather.unisys.com/nam/nam.php?plot=500&inv=0&t=1>

FORECAST: MONDAY

TUESDAY

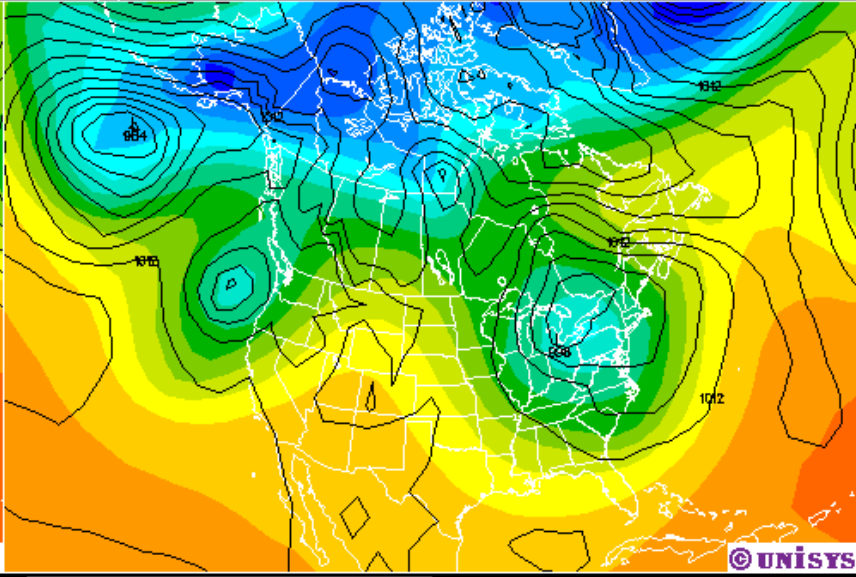
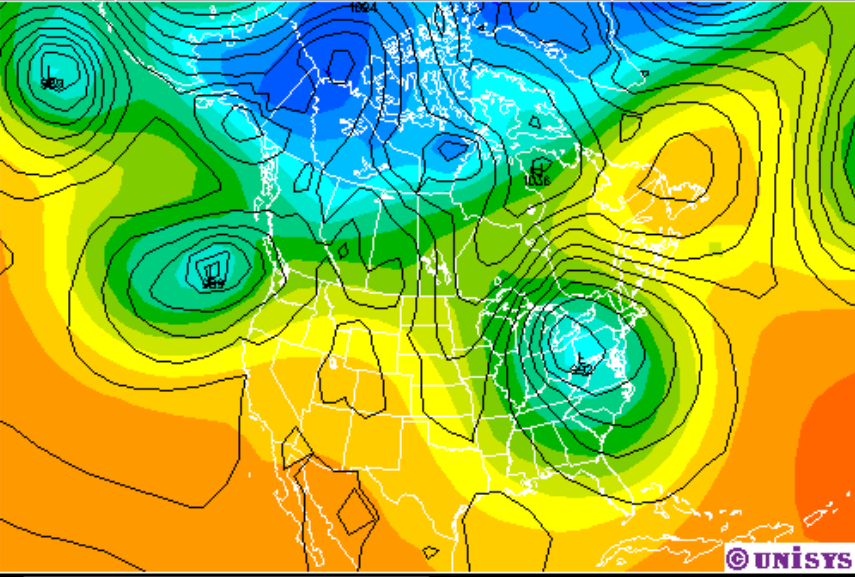
500mb hght/SL Pres 3 day valid 00Z MON 29 OCT 12

500mb hght/SL Pres 4 day valid 00Z TUE 30 OCT 12



500mb hght/SL Pres 5 day valid 00Z WED 31 OCT 12

500mb hght/SL Pres 6 day valid 00Z THU 1 NOV 12



WEDNESDAY

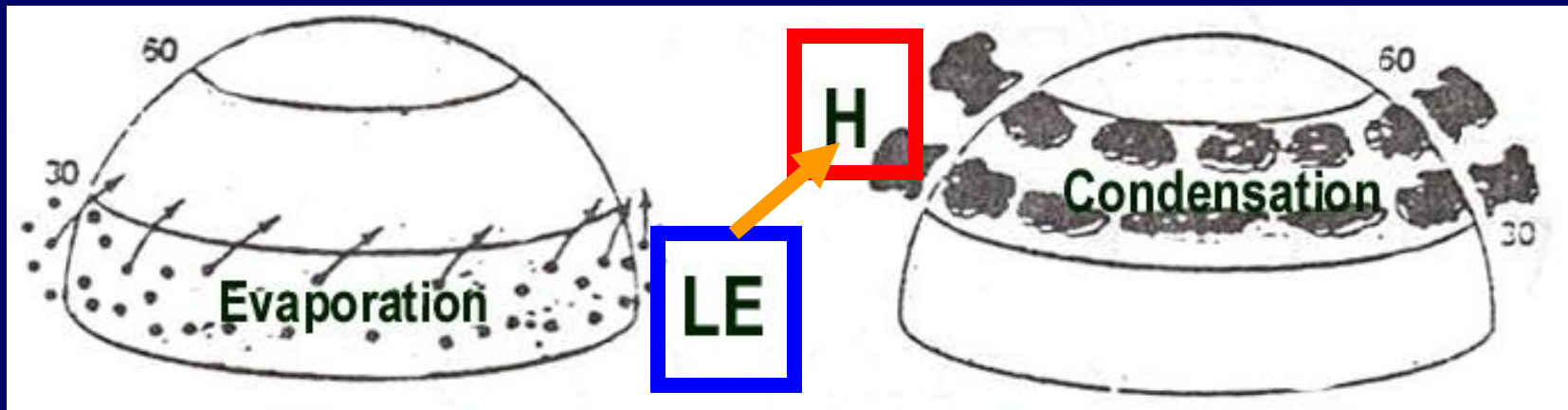
THURSDAY

Energy is transported from areas of surplus to deficit via:

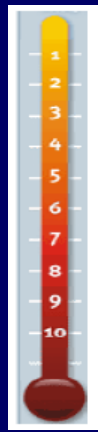
H (sensible heat)



& LE (Latent Energy)



H + LE



INDICATOR INTERLUDE ...

REMEMBER THIS?

The **heat CONTENT** of the ocean is **MUCH** greater than the land

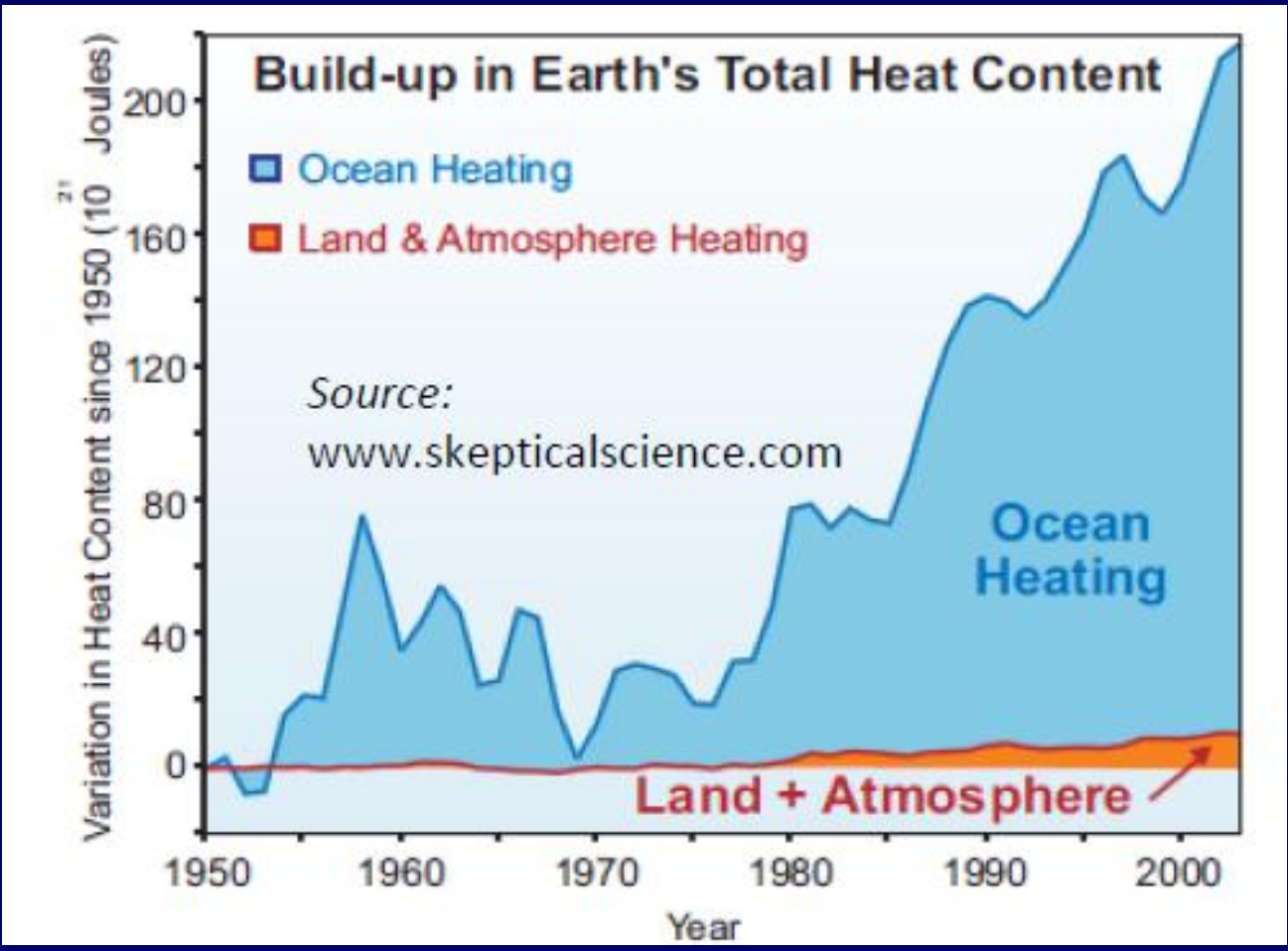


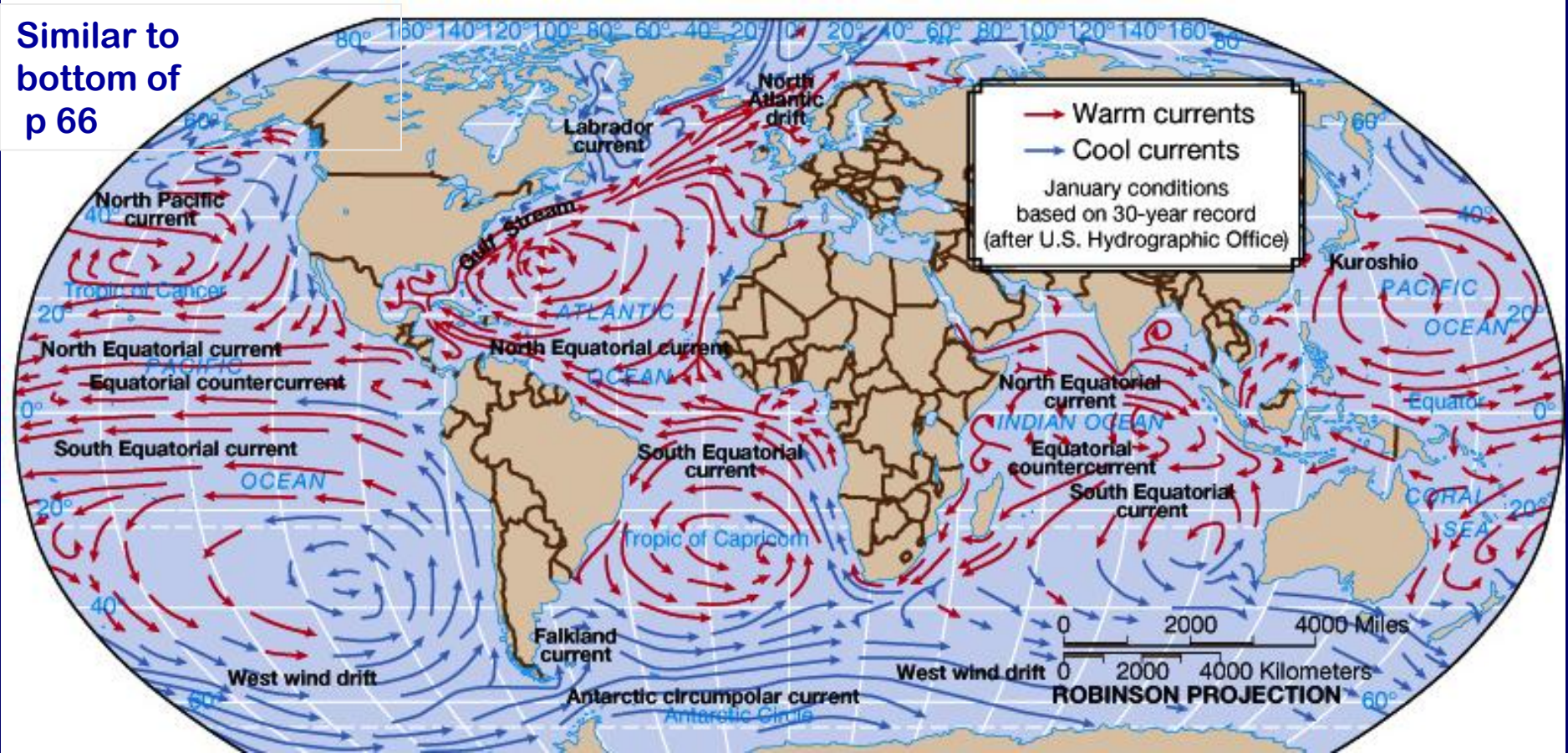
Figure: Total Earth Heat Content from 1950 (Murphy 2009). Ocean data from Domingues et al 2008. <http://www.skepticalscience.com/How-do-we-know-global-warming-is-still-happening.html>

H + LE + G

BUT WHAT ABOUT G?

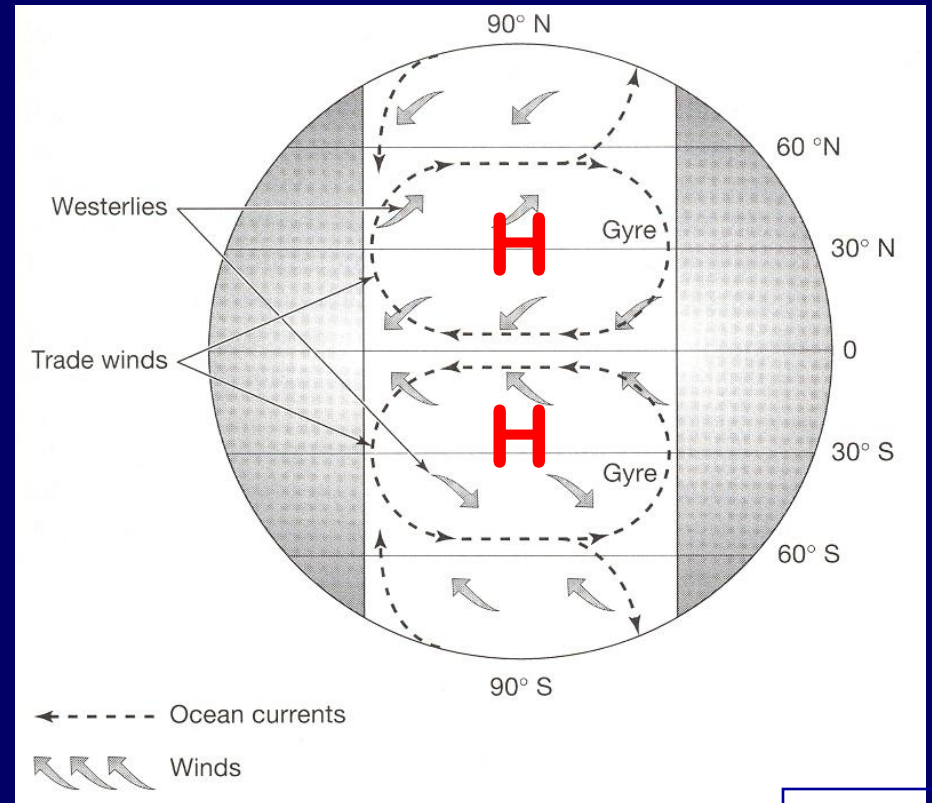
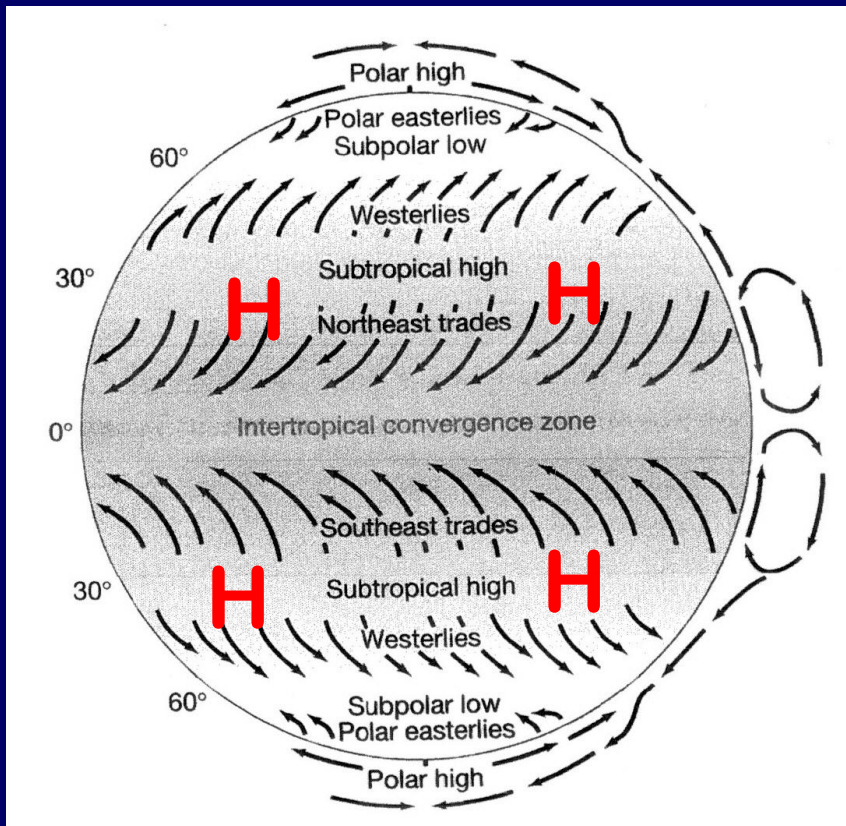
G is a **STORAGE** component, not a transfer component BUT energy stored in the OCEAN, can later be transported via ocean currents as **H** !

Similar to
bottom of
p 66

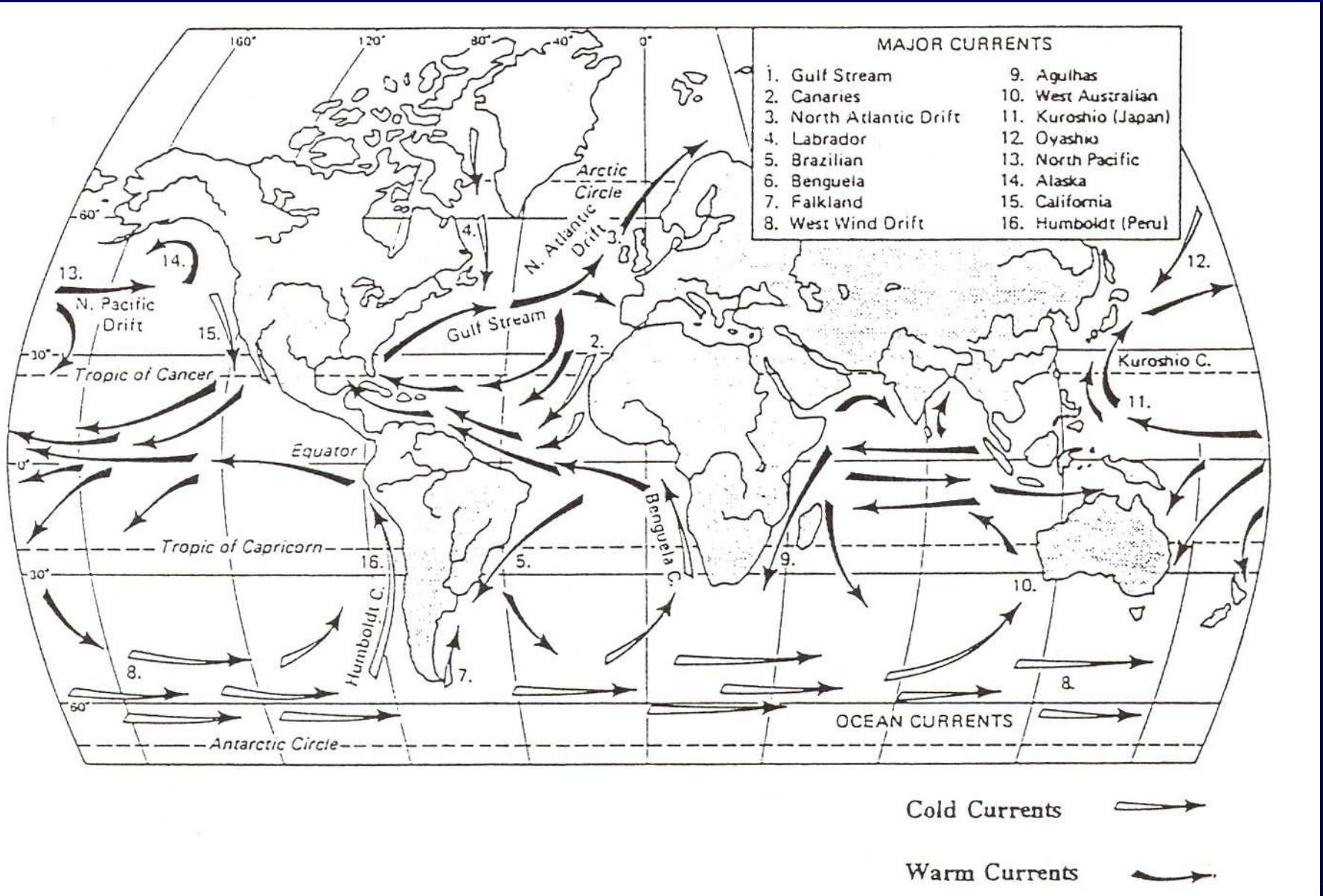


→ **Large OCEAN GYRES** -- driven by Trade Winds & Westerlies in Oceanic Subtropical HIGH PRESSURE CELLS (**STH**)

Leads to SURFACE ocean currents

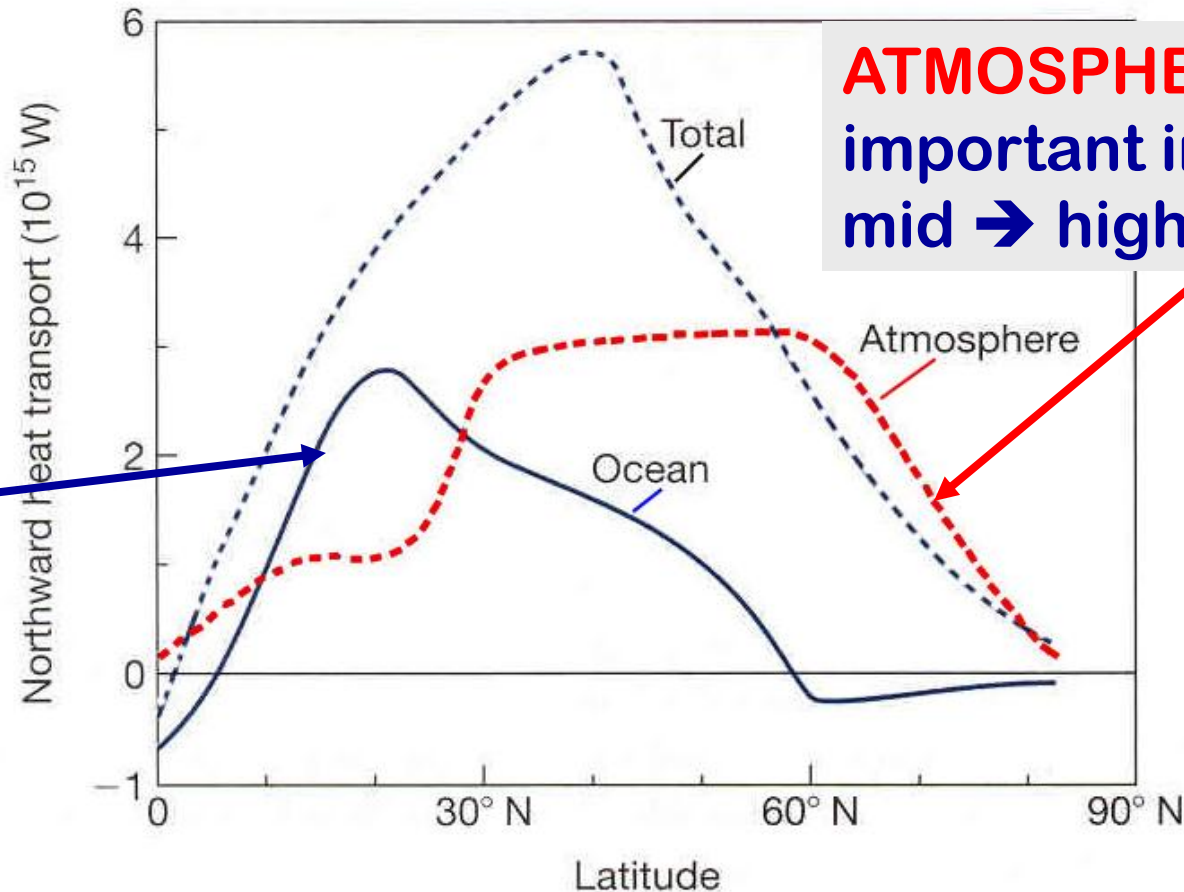


WARM & COLD SURFACE OCEAN CURRENTS:



Both **ATMOSPHERE** & **OCEAN** play important roles in **BALANCING OUT ENERGY SURPLUS & DEFICIT AREAS**:

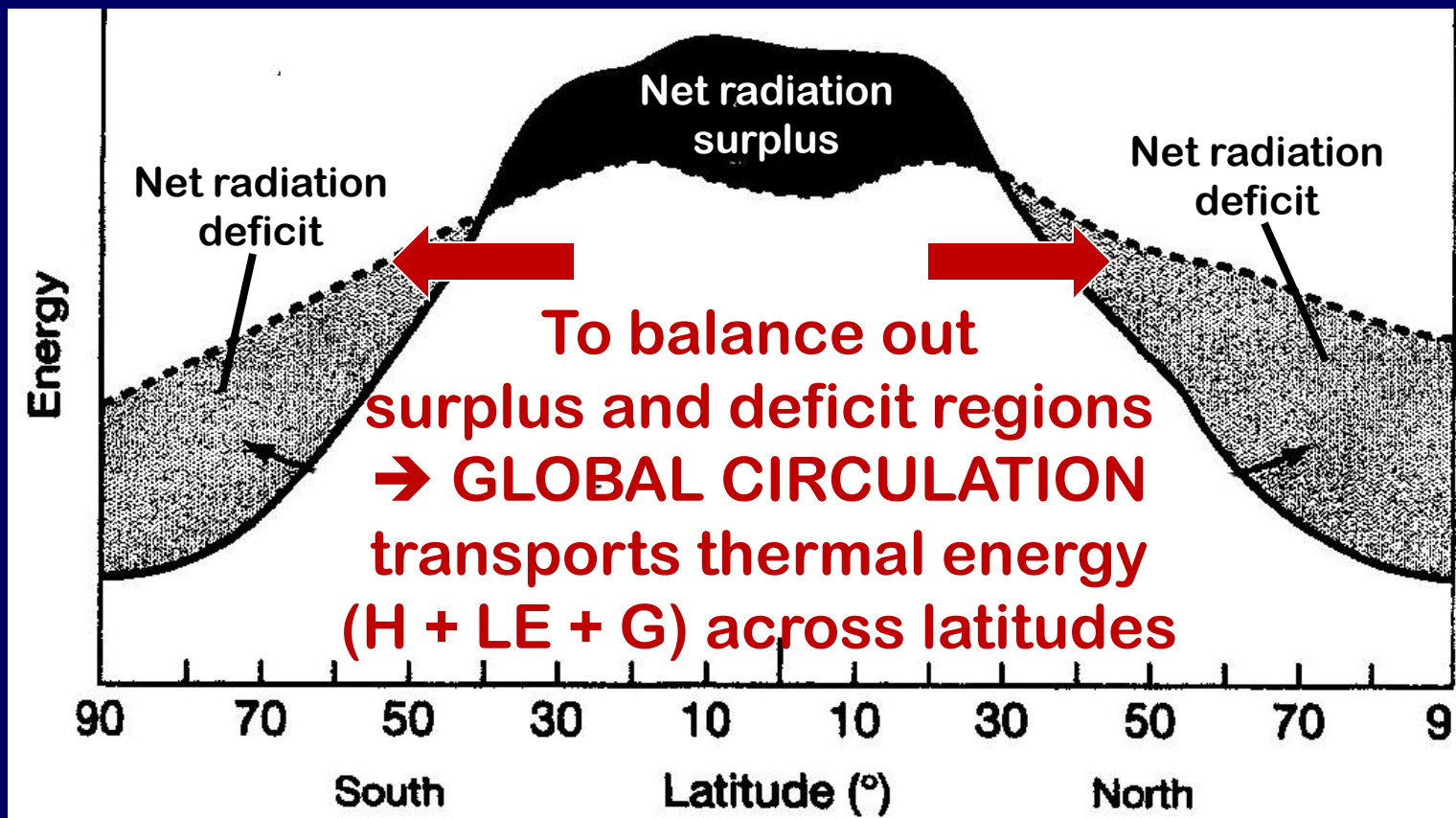
OCEAN transports **MOST** of the energy in **LOW** → subtropical latitudes



ATMOSPHERE more important in mid → high latitudes

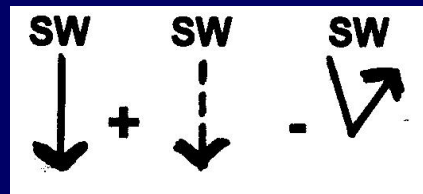
Poleward transport of energy in N.H.





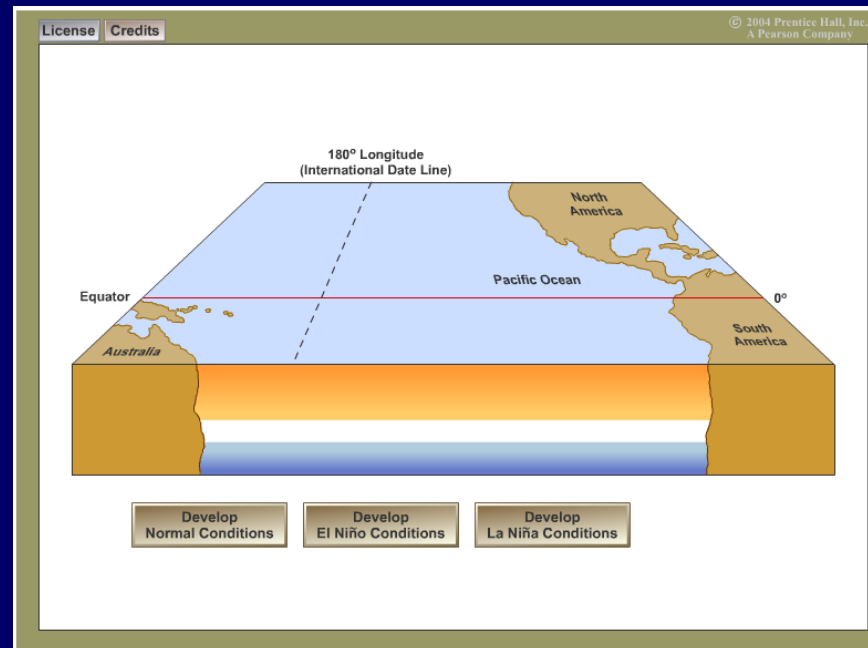
————— Absorbed solar energy

..... Emitted infrared energy
(at top of atmosphere)

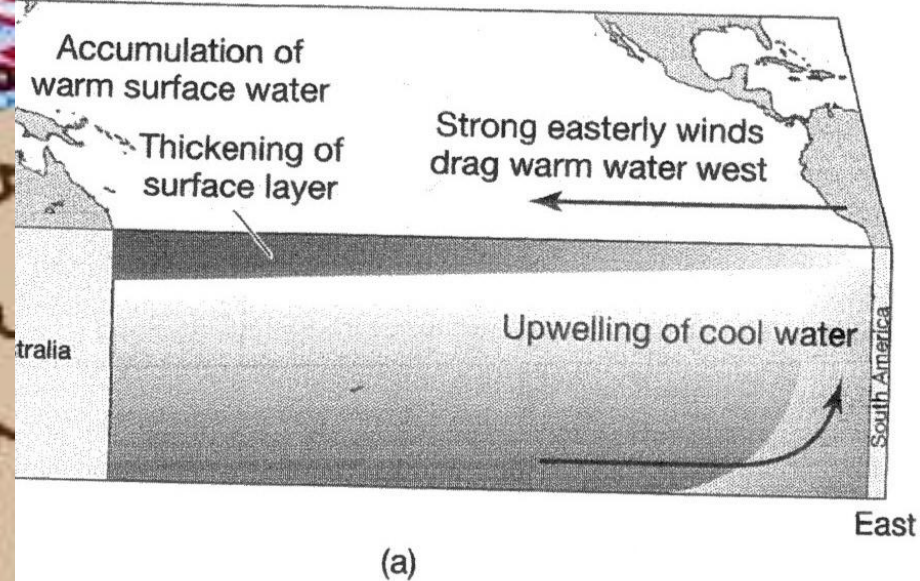
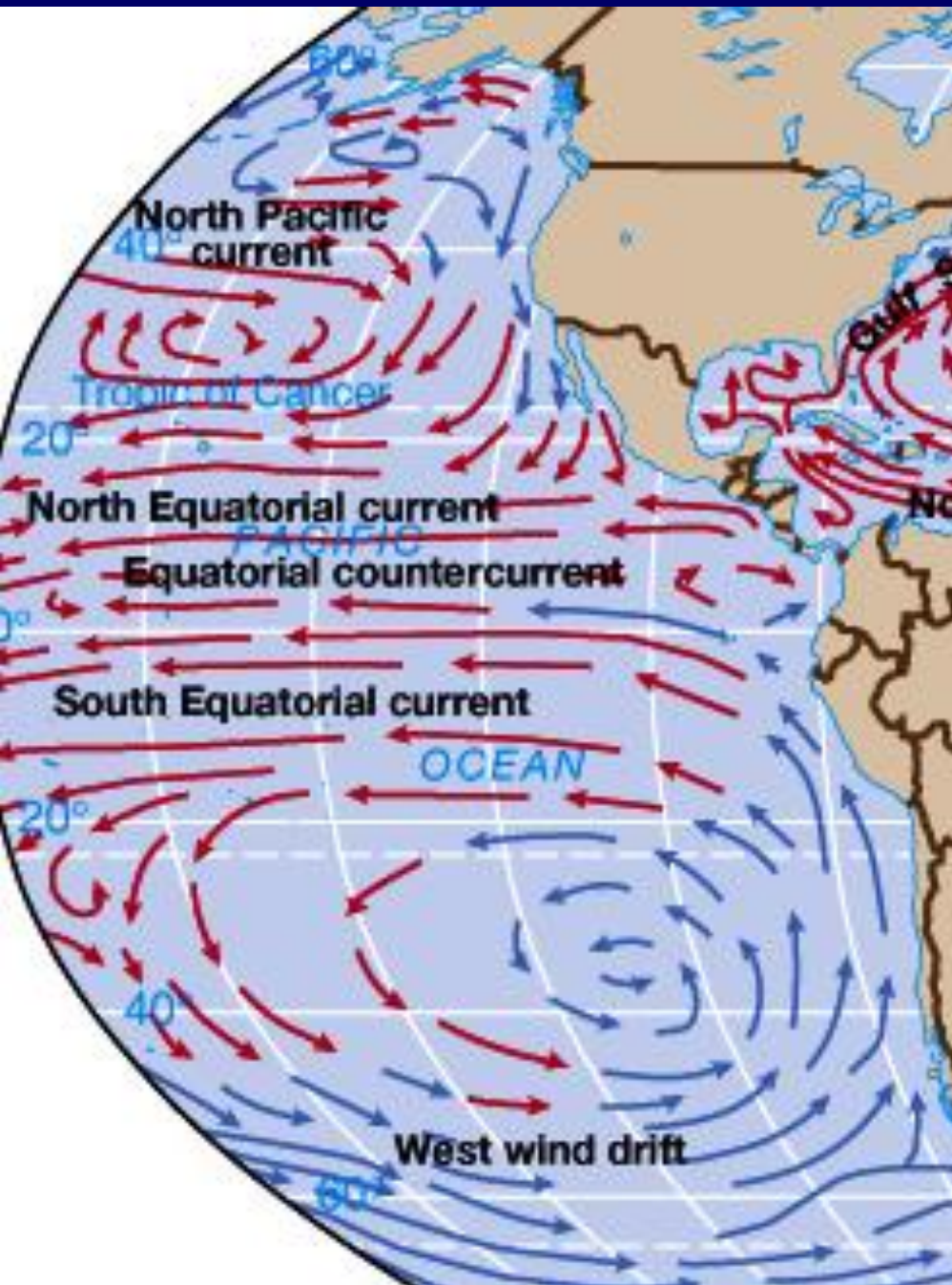


A KEY ATMOSPHERE-OCEAN INTERACTION : El Niño / La Niña ENSO (El Niño – Southern Oscillation)

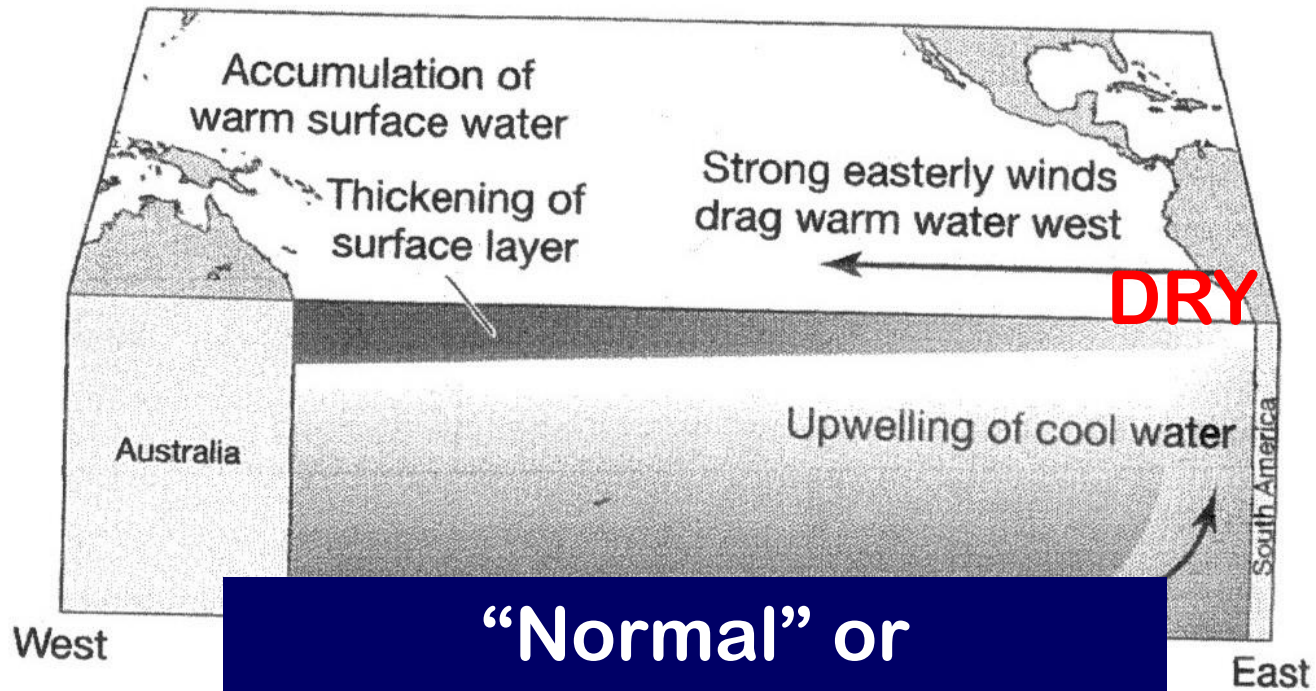
You'll learn more about it in **Climate
Science Basics Tutorial:
LESSON 2 “Mother Nature’s Influence”**



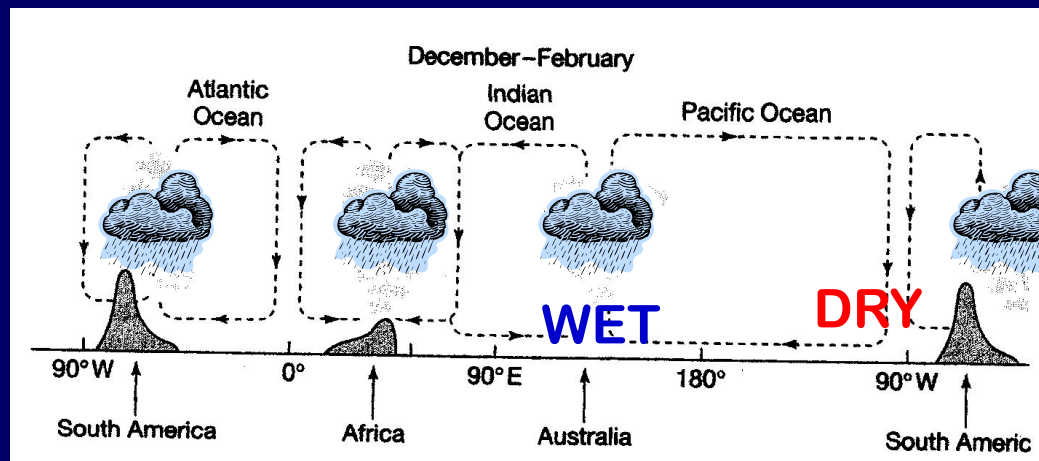
EL Nino & La Nina Ocean circulation shifts



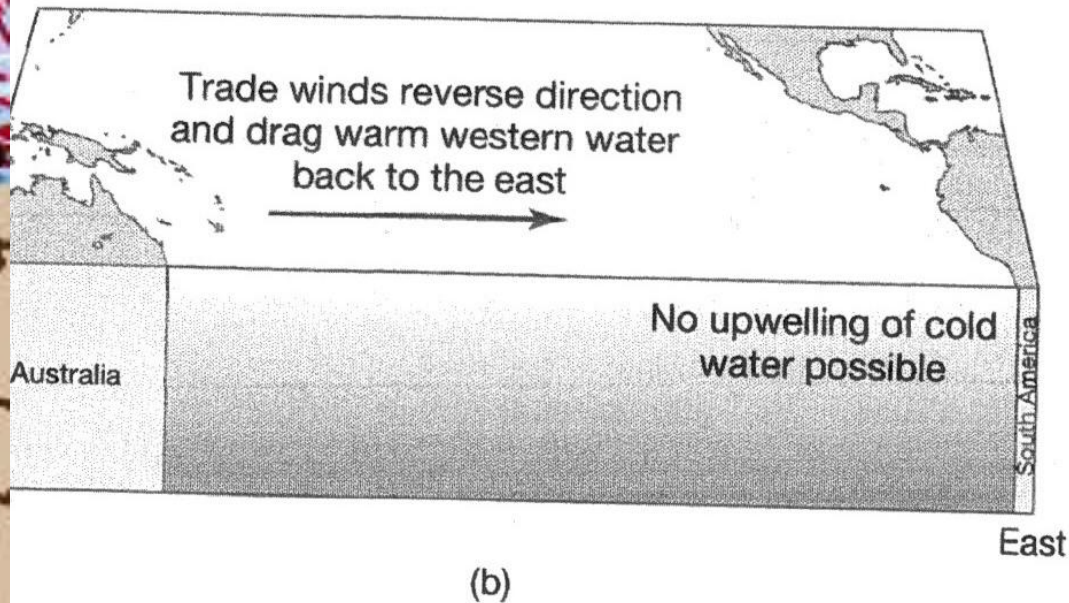
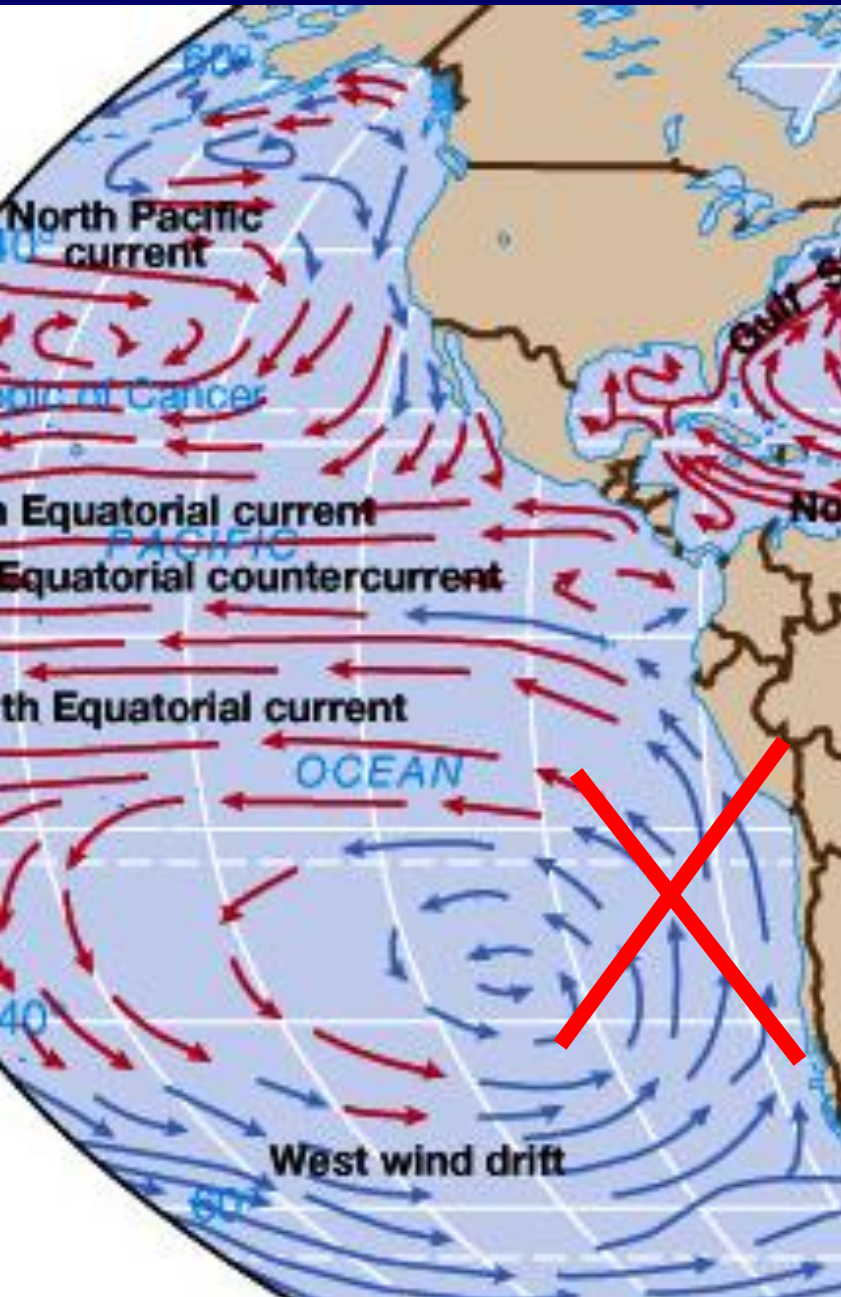
“Normal” situation
(La Nina –like)



**“Normal” or
(La Nina –like mode)**

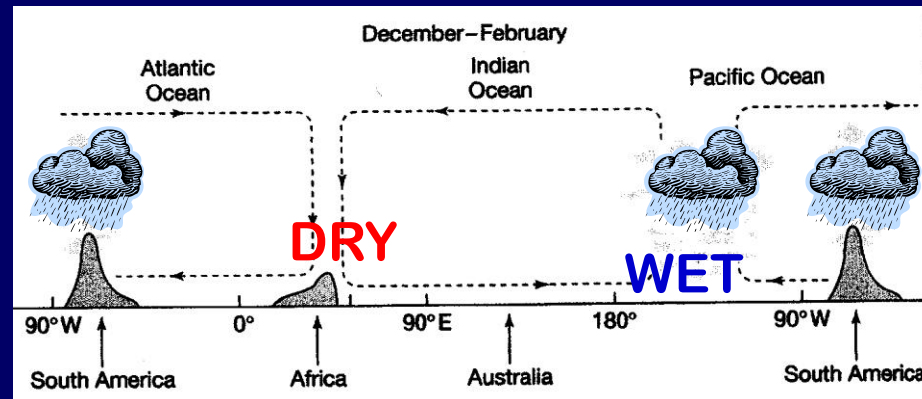
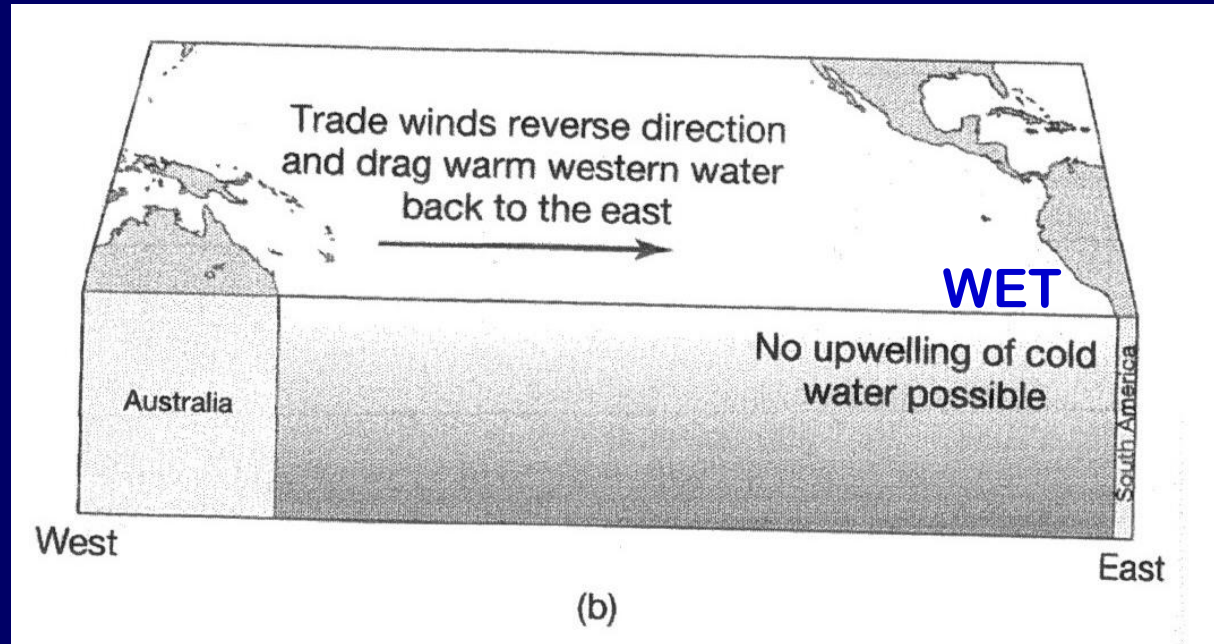


EL Nino & La Nina short-term ocean circulation shifts

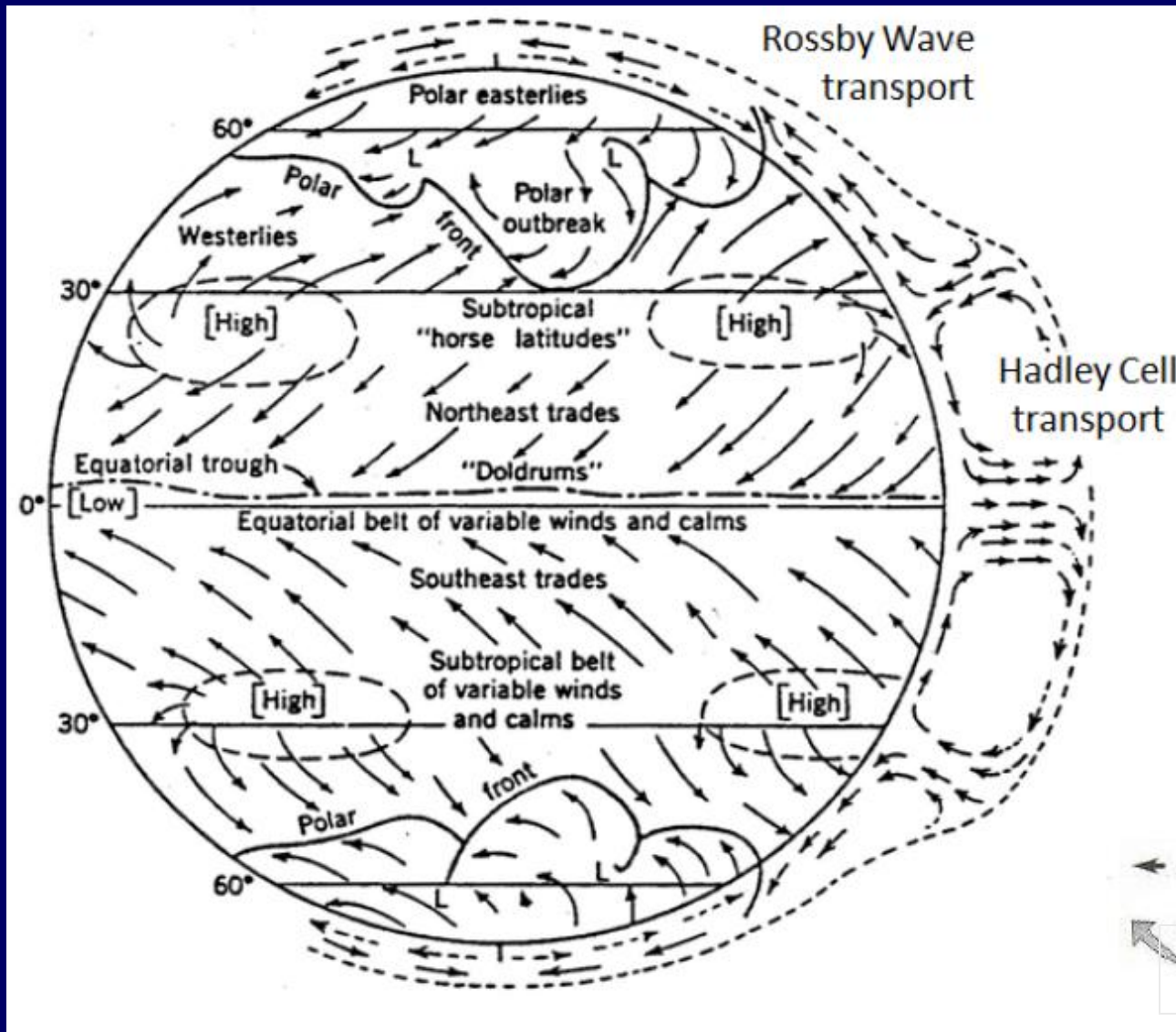


“El Nino” situation:
Upwelling fails

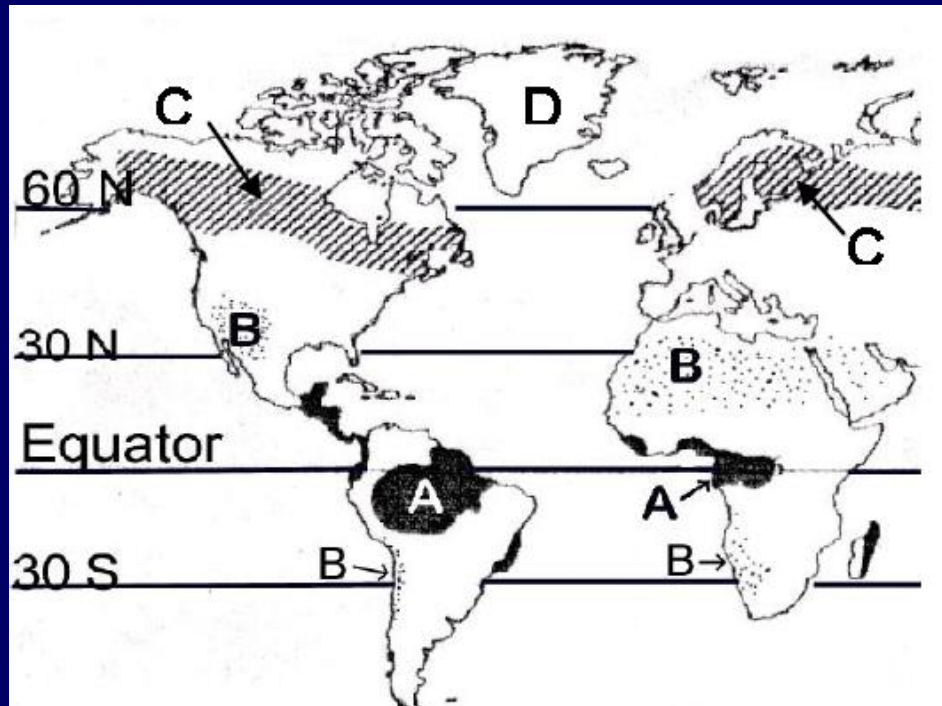
EL Nino mode



GLOBAL CLIMATE PATTERNS – BRIEF OVERVIEW



Q's. What kind of climate and vegetation will you find in the areas marked A, B , C, & D ?



Q-1 AREA A?

Q-2 Area B?

Q-3 Area C?

Q-4 Area D?

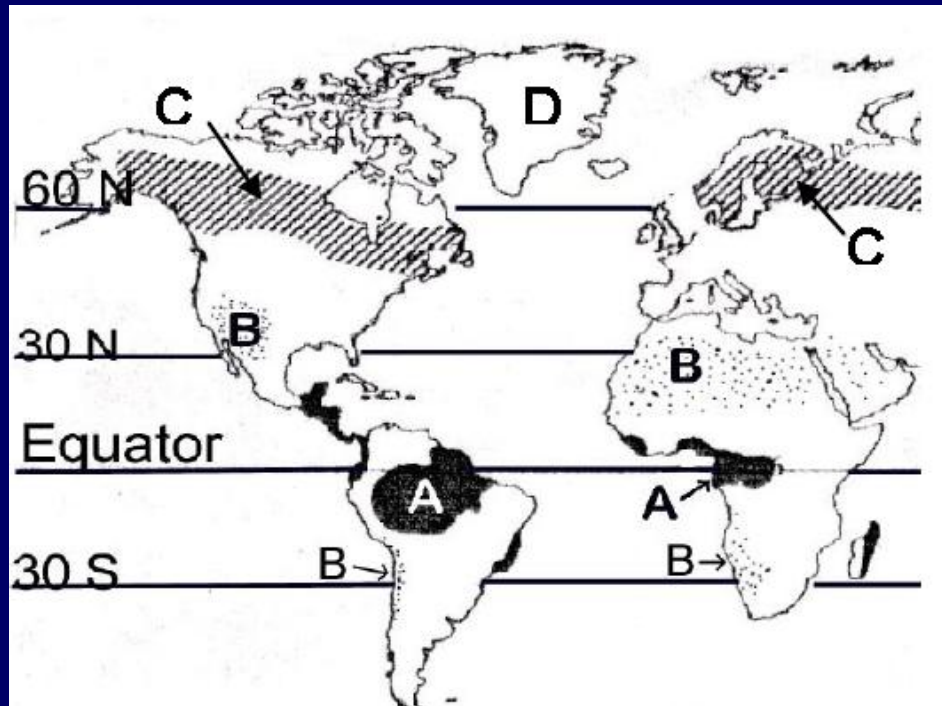
1-Tropical Forest

2 -Conifer Forest

3- Warm Desert vegetation

4 -No vegetation: snow and ice

Q's. What kind of climate and vegetation will you find in the areas marked A, B , C, & D ?



ANSWERS:

Q-1 AREA A = 1

Q-2 Area B = 3

Q-3 Area C = 2

Q-4 Area D = 4

1-Tropical Forest

2 -Conifer Forest

3- Warm Desert vegetation

4 -No vegetation: snow and ice

**Have a great
weekend!
See you on Monday!**



**GO CATS!!
Win another one!**