Thursday Oct 14

Sit with your GROUP today!

Topic #8 The Global Energy Balance (cont.)

ANNOUNCEMENTS

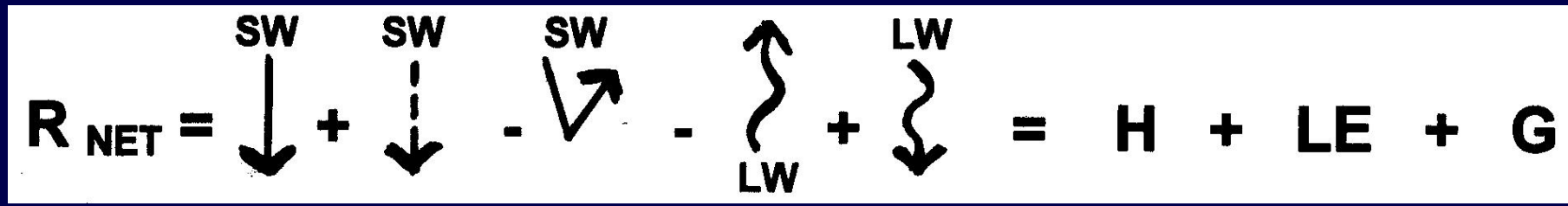
- The Midterm Exam is THIS Thursday, Oct 16th
- The Study Guide w/ Practice Questions is posted
- STUDY SESSIONS will be held in Bannister 110:

  Today: 4:30 – 5:30 pm

  Wednesday: 4 – 6:00 pm

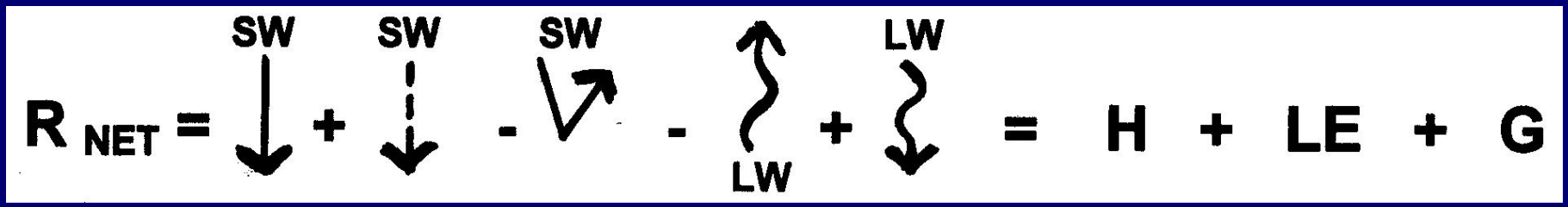
  IMPORTANT: Come prepared to the study session by reading through the STUDY GUIDE and working through the Practice Questions IN ADVANCE!
  Only THEN you will know what you still need to work on and ask questions about at the Session!

Topic # 8
THE EARTH'S GLOBAL ENERGY BALANCE (cont.)



Energy Balance Equation 3 ways:

$$R_{net} = (Q + q) - a - Lu + Ld = H + LE + G$$



Net Radiation =

Direct Shortwave

+ Diffuse Shortwave

- Albedo

- Longwave upward from Surface

+ Longwave down to Surface

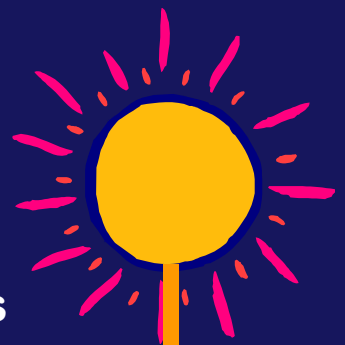
= Sensible Heat

+ Latent Energy

+ Ground or Ocean Storage

Balances at the TOP of the Atmosphere!

OVERALL BALANCE: Incoming = Outgoing

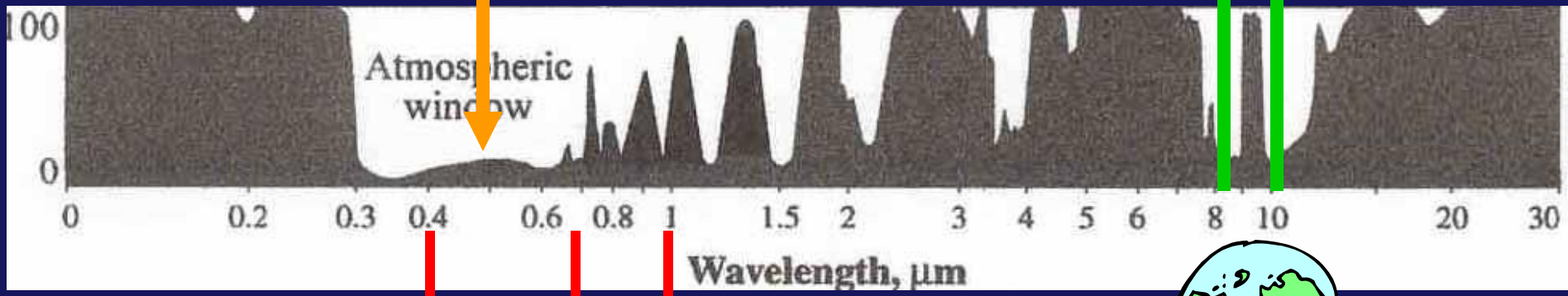


Outgoing LW

thru UV / Vis atmospheric window

Incoming SW

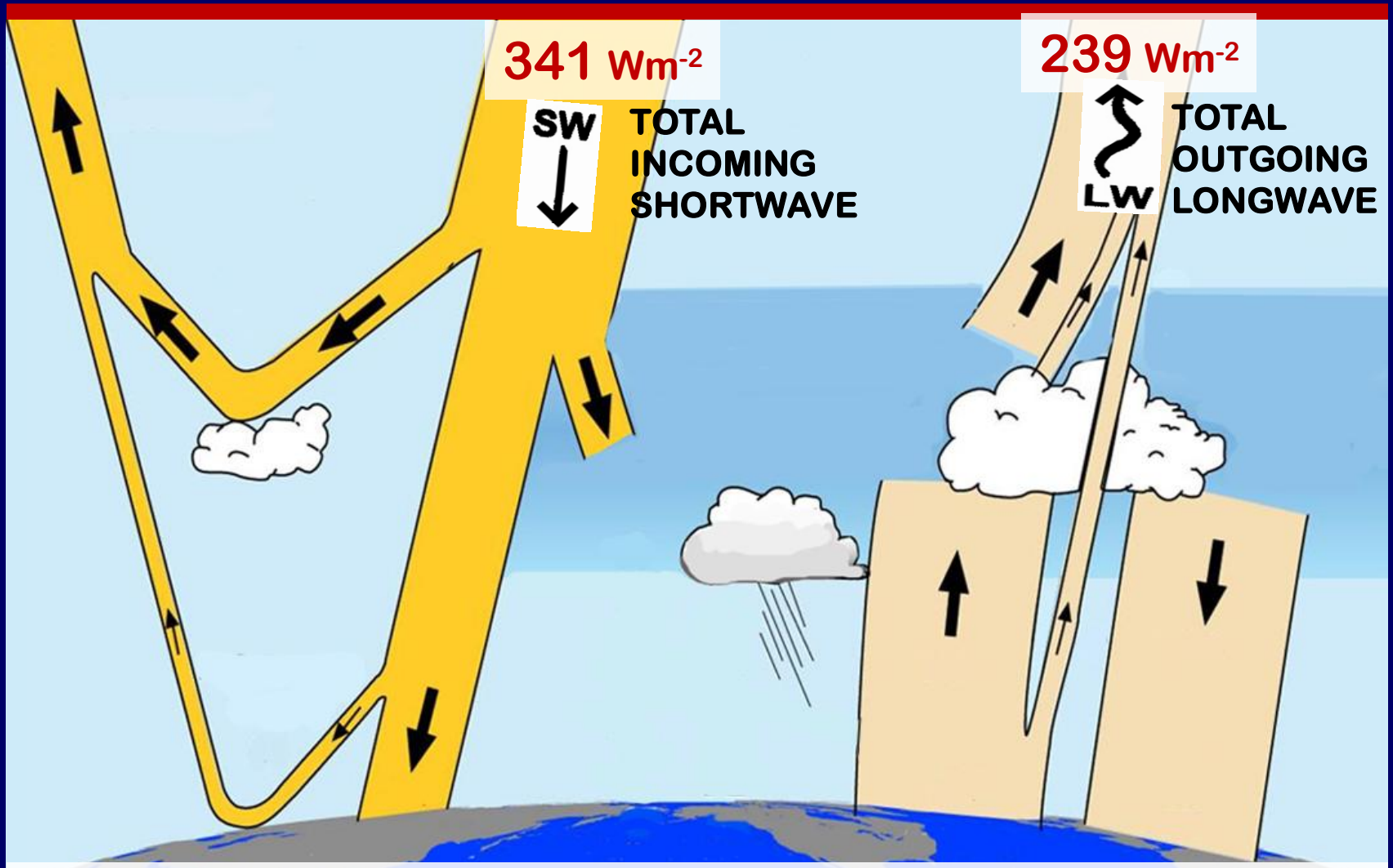
thru IR atmospheric window



UV | Visible | NIR | Far IR

Review

Watts / meter ^{2} measured at the "TOP" of the Atmosphere:

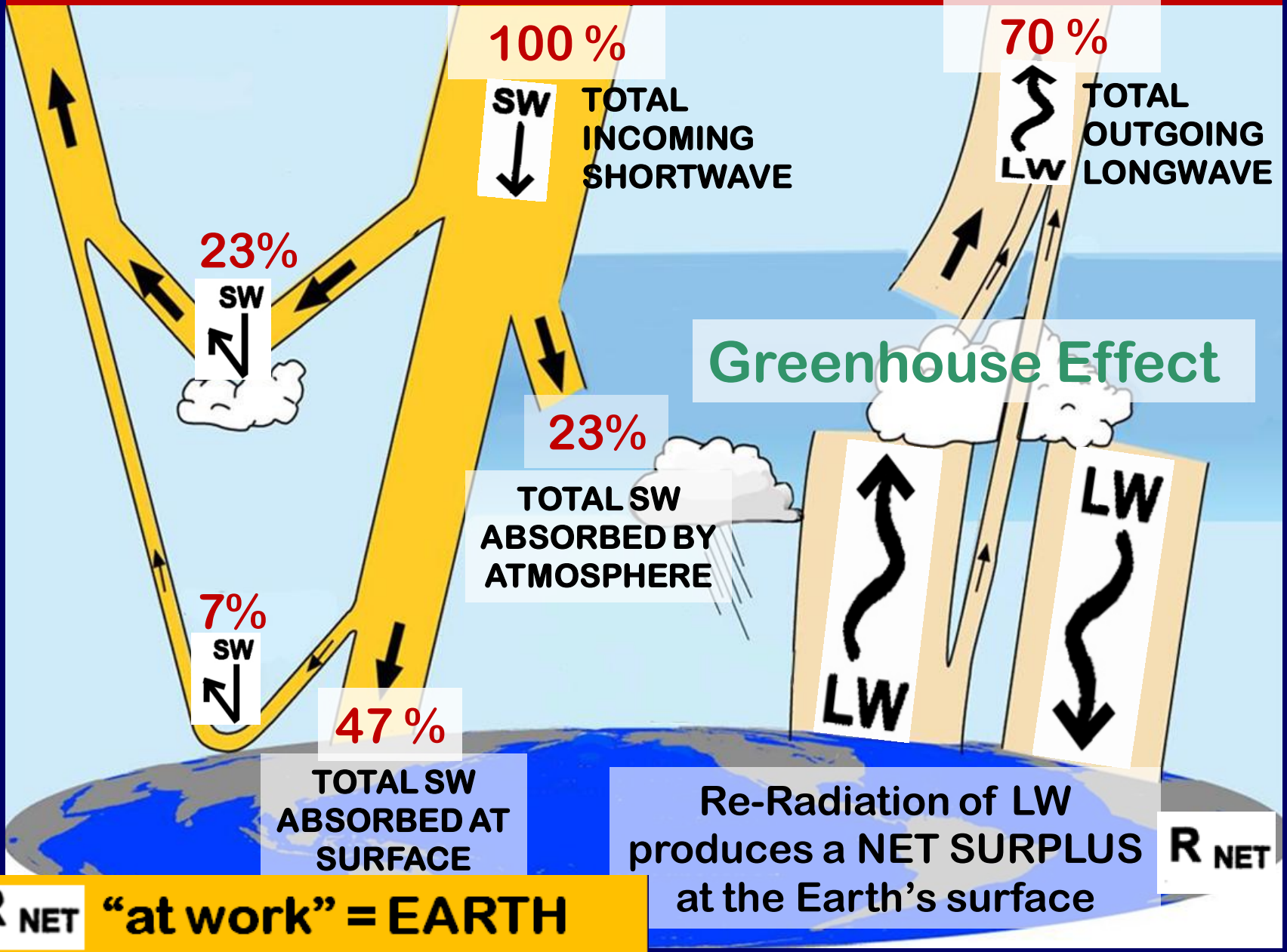


The WIDTH of the arrows represents how much energy is in each pathway

(averaged globally per year)

Review p 49

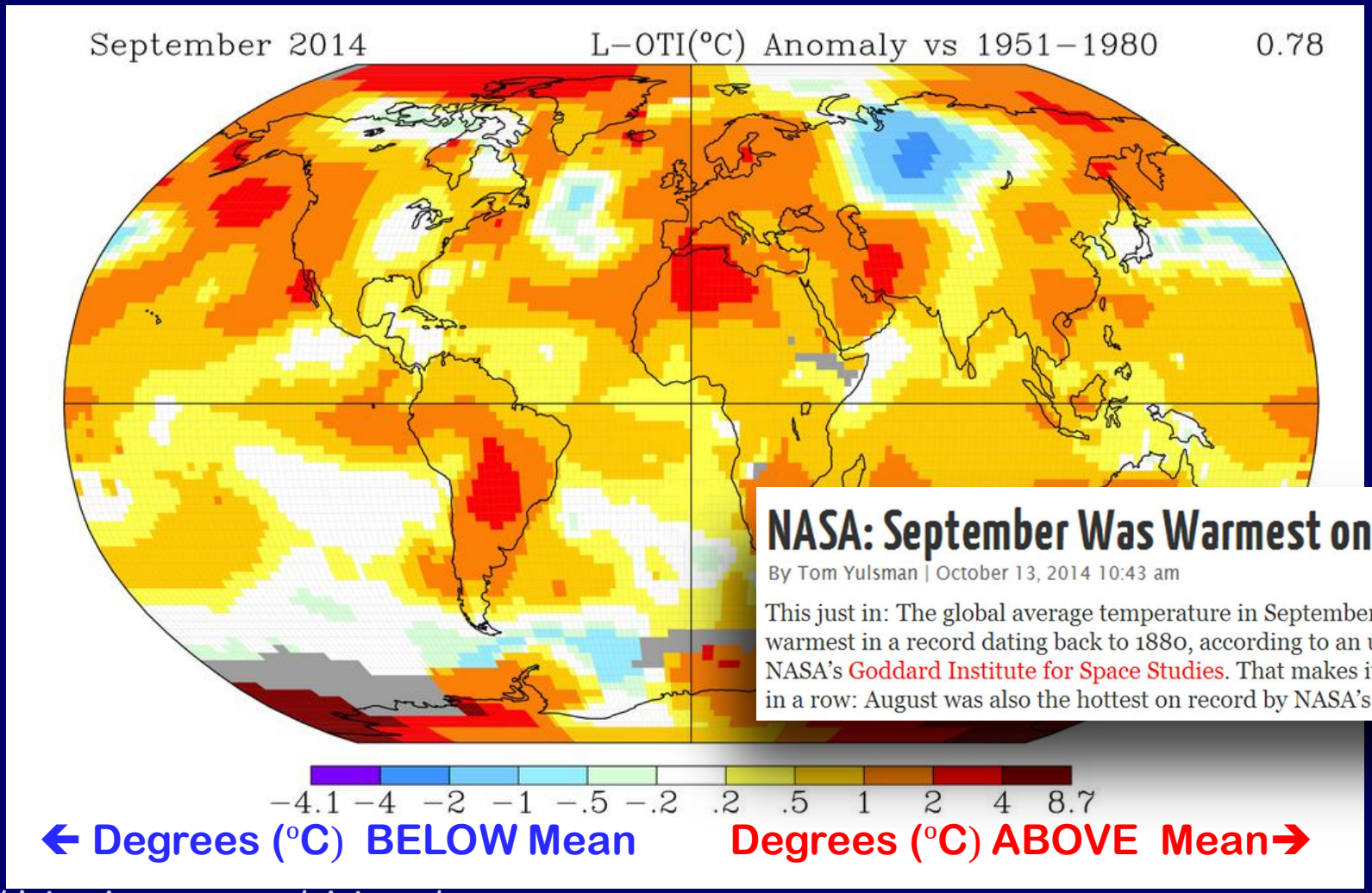
Percent % measured at the "TOP" of the Atmosphere:



R NET "at work" = EARTH SURFACE TEMPERATURES!

How did September 2014 compare?

"Anomaly Map" = a map of the difference (in °C) of September 2014 Temperatures compared to the 1951-1980 Mean Temperature



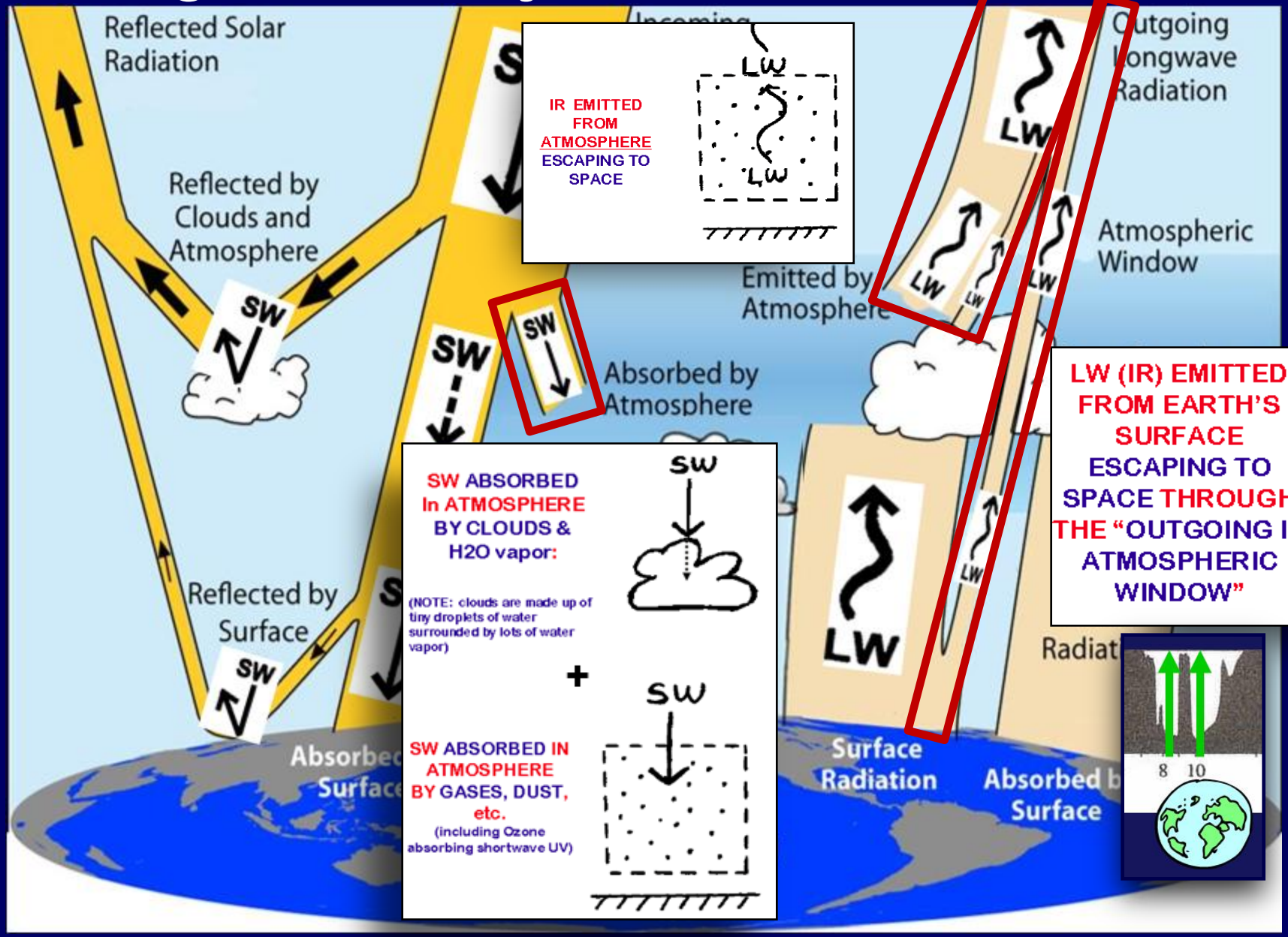
NASA: September Was Warmest on Record

By Tom Yulsman | October 13, 2014 10:43 am

This just in: The global average temperature in September was the warmest in a record dating back to 1880, according to an update from NASA's Goddard Institute for Space Studies. That makes it two months in a row: August was also the hottest on record by NASA's reckoning.

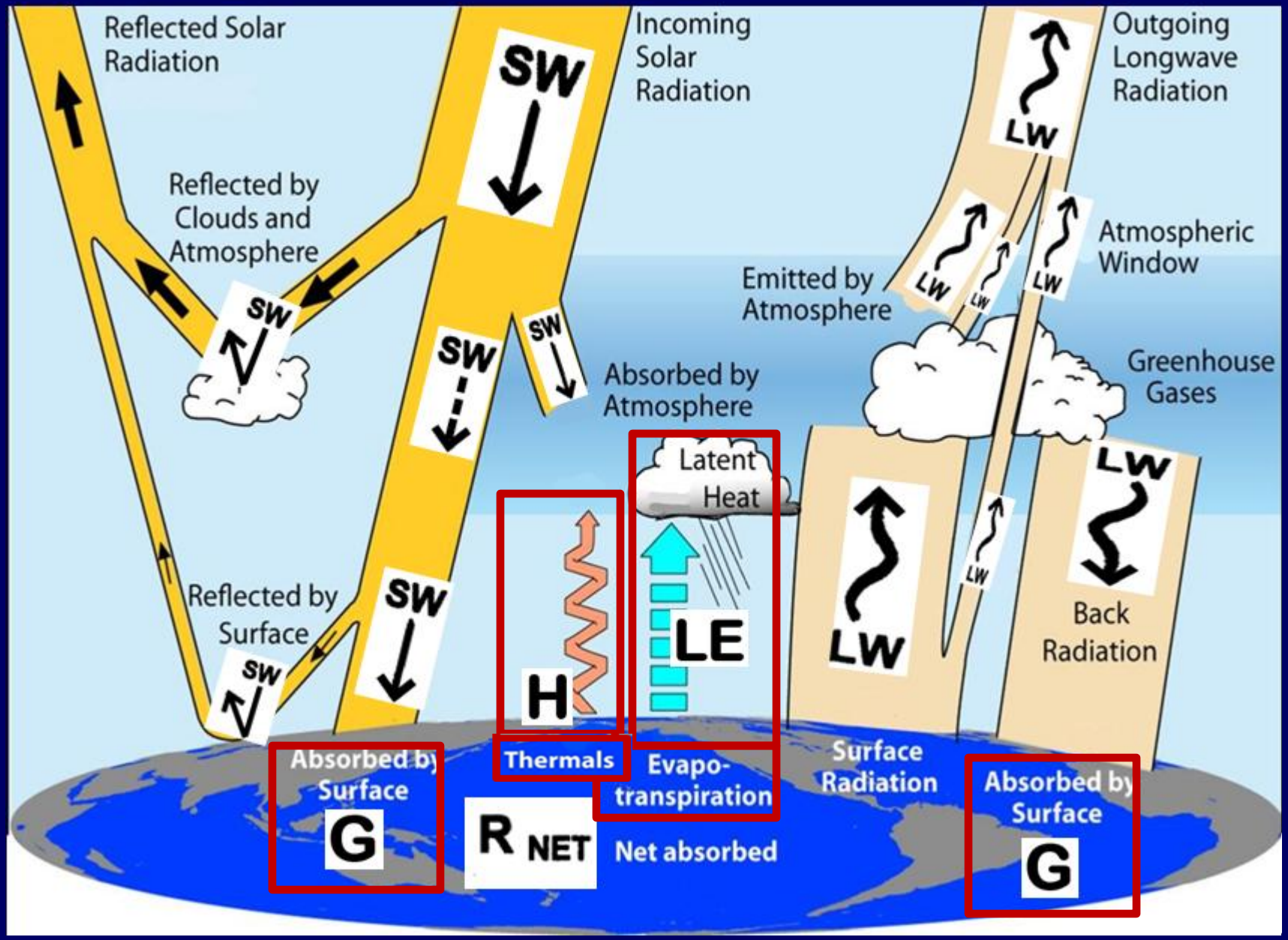
http://data.giss.nasa.gov/gistemp/

Naming the Pathways . . . .



Link back to Appendix pp 121-122

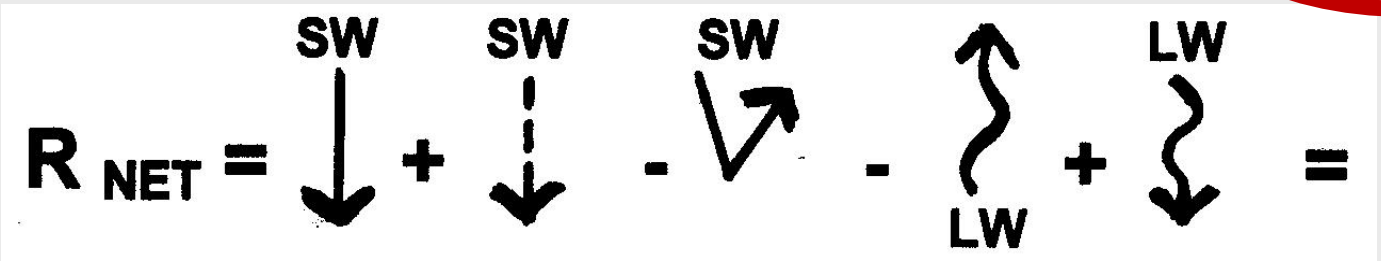
One more set of PATHWAYS to add:



THE FINAL PART OF TOPIC # 8:

The RIGHT side of the ENERGY BALANCE EQUATION . . .

NET RADIATION = In – Out = Whatever is left over



If at the Earth's Surface, there is a NET SURPLUS of energy "left over" . . . .

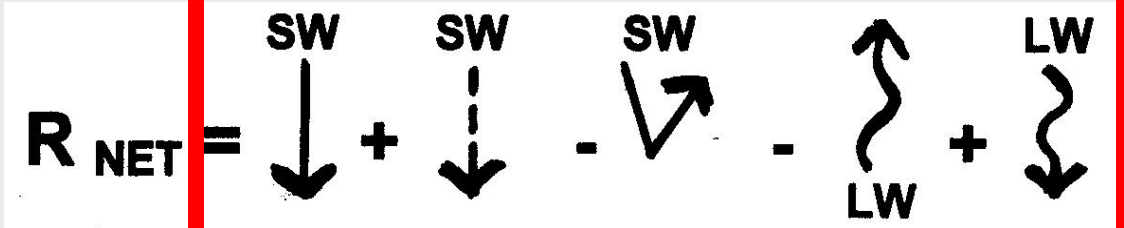
➔it can be used to DRIVE WEATHER & CLIMATE

➔through HEAT TRANSFER processes into the ATMOSPHERE

➔ OR it can be STORED for awhile at the SURFACE (in the ground or ocean).

p 51 bottom

Left side of equation



= H + LE + G

Right side of equation

R net = "net" left over energy can be used to DRIVE WEATHER & CLIMATE through HEAT TRANSFER processes or it can STORED by the Earth (in the ground or ocean).

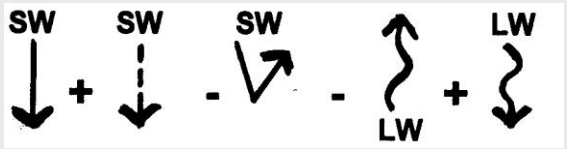
$$R_{NET} = H + LE + G$$

Review of: HEAT TRANSFER PROCESSES

"There are 3 ways that Heat can travel"

- **Radiation**
- **Conduction**
- **Convection**

MATTER may or may not be involved:



involve MATTER:

H + LE + G

plus . . .
PHASE CHANGES
in matter

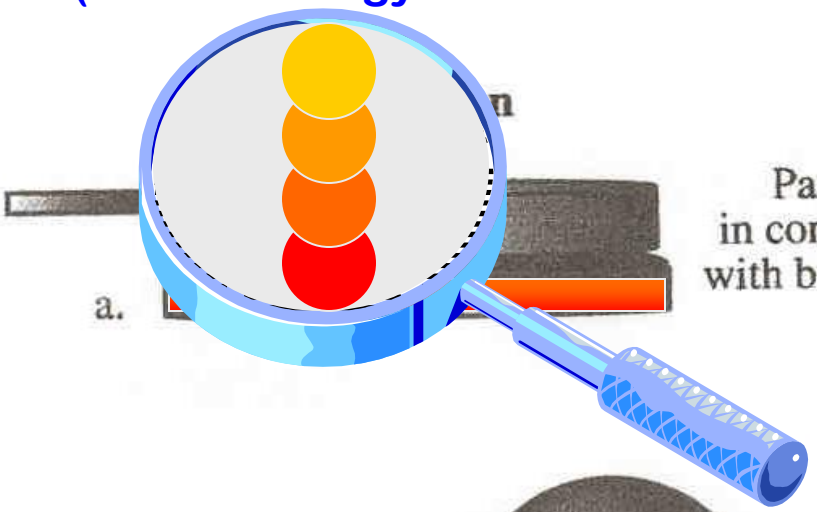
review

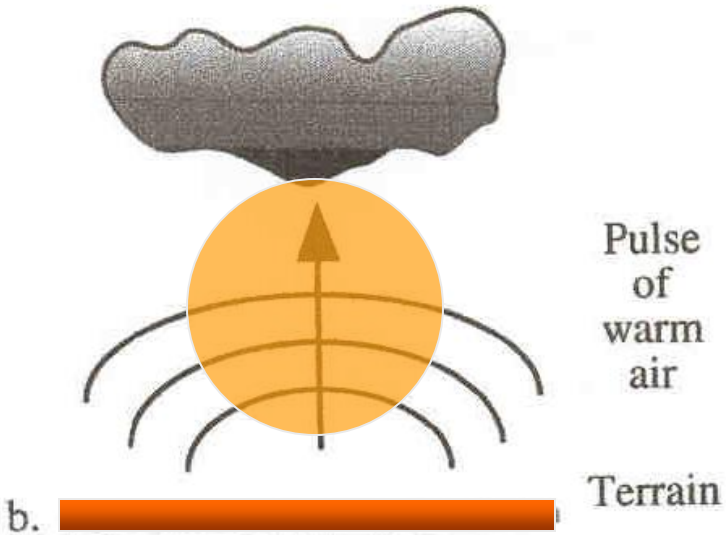
CONVECTION

Mass of warm air or liquid heats, expands, rises

CONDUCTION

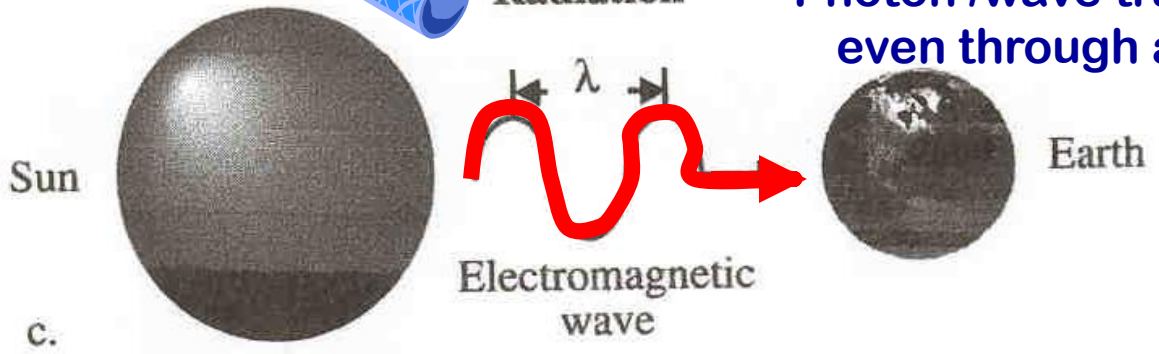
Jiggling molecule ➔ jiggling molecule
transfer of heat
(kinetic energy at molecular scale)





RADIATION

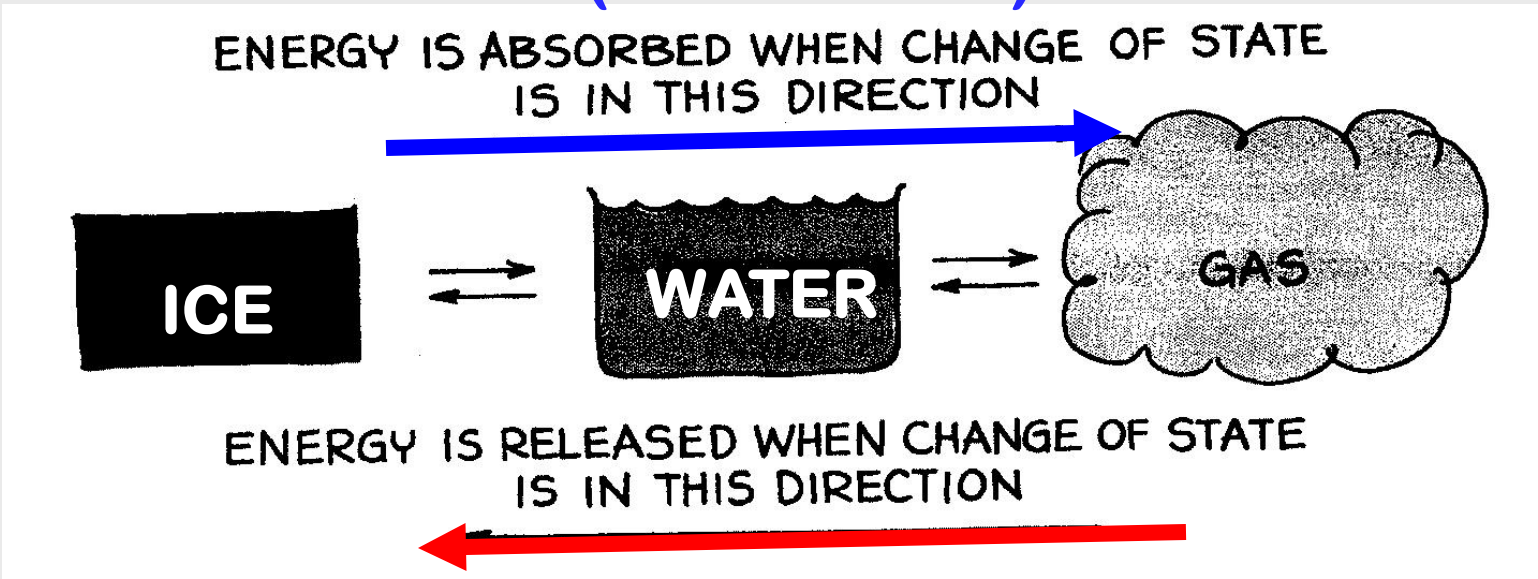
Photon /wave transport:
even through a void!



review

HEAT TRANSFER & STORAGE DURING PHASE CHANGES: LE & H

LE = LATENT (hidden) ENERGY (LE stored)



(LE released, hence it can be sensed as H)

H = SENSED (via thermometer) ENERGY

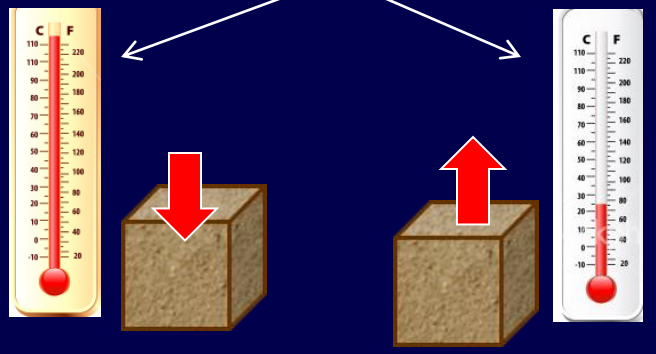
DEFINITIONS:

LATENT ENERGY (LE) & SENSIBLE HEAT (H)

LATENT ENERGY (LE) = the amount of energy released or absorbed by a substance during a **change of phase**, such as when water evaporates.

G
Temporary "Ground" Storage
↓
Temperature of Soil

SENSIBLE HEAT (H) = the amount of energy released or absorbed by a substance during a change of temperature (which is not accompanied by a change of state)

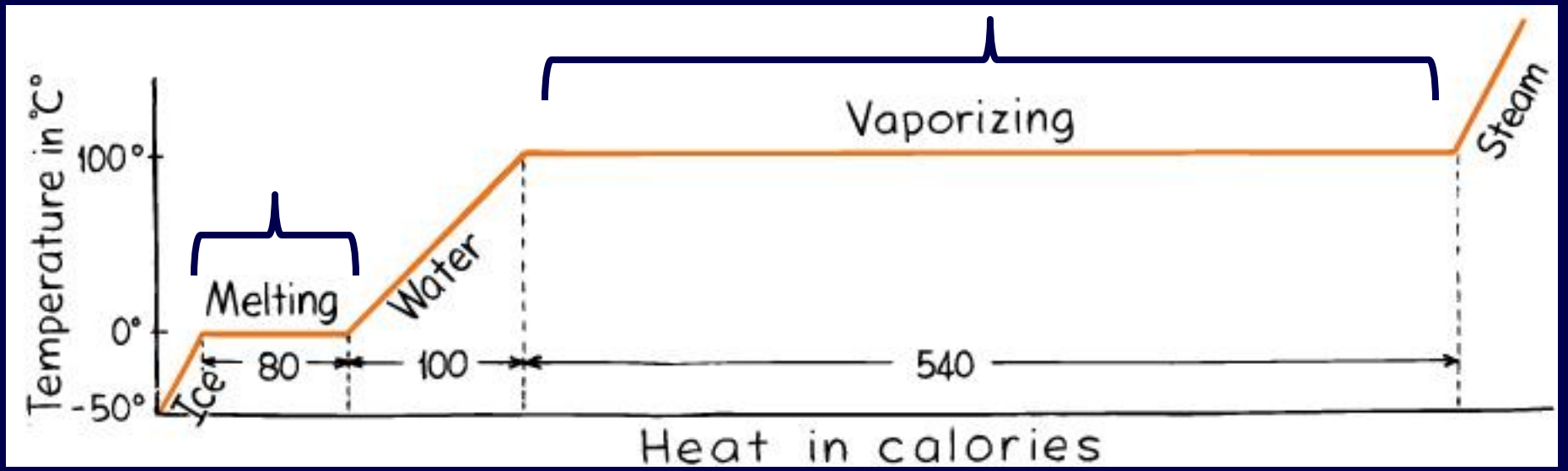


Soil absorbs heat during day

Soil releases heat at night

THOUGHT QUESTION:

In this graph, what's happening to the energy in the portions where the graph is horizontal?



HINT: it has to do with

SENSIBLE HEAT (H)

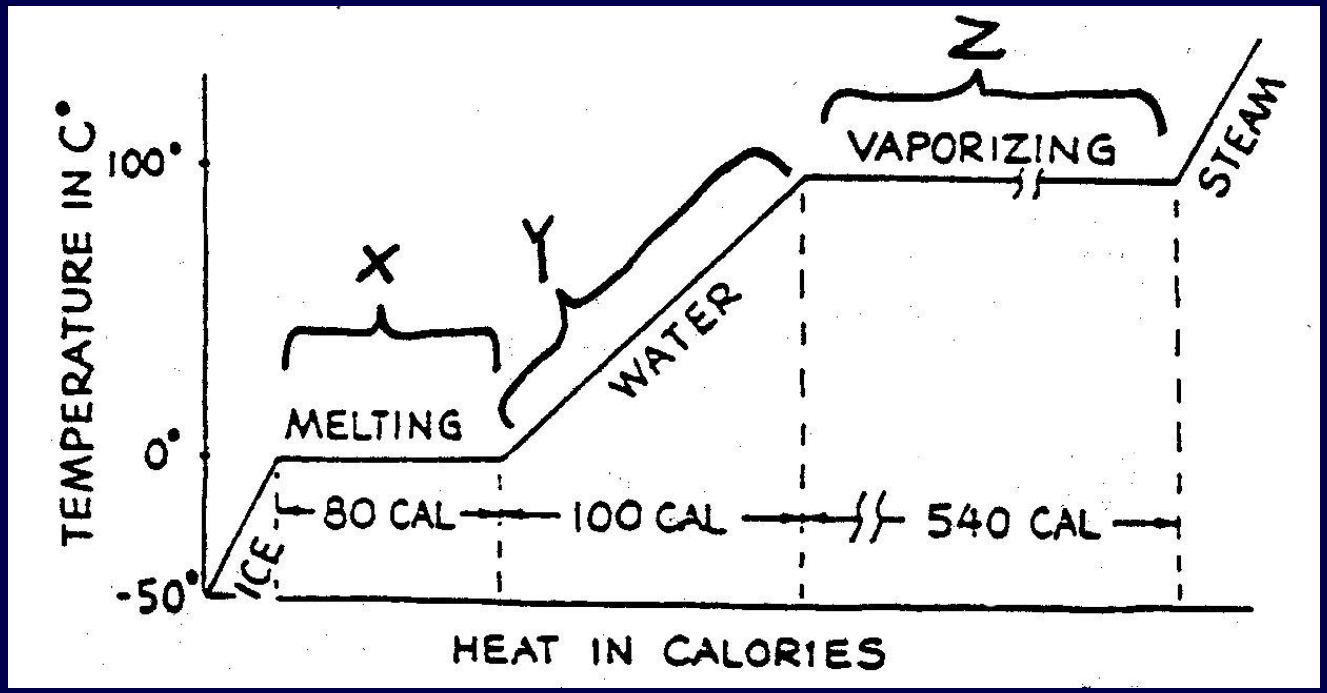
&

LATENT HEAT (LATENT ENERGY) LE

REVIEW / BACKGROUND:

SENSIBLE = the energy can be SENSED (e.g., with a thermometer, by the environment, etc.)

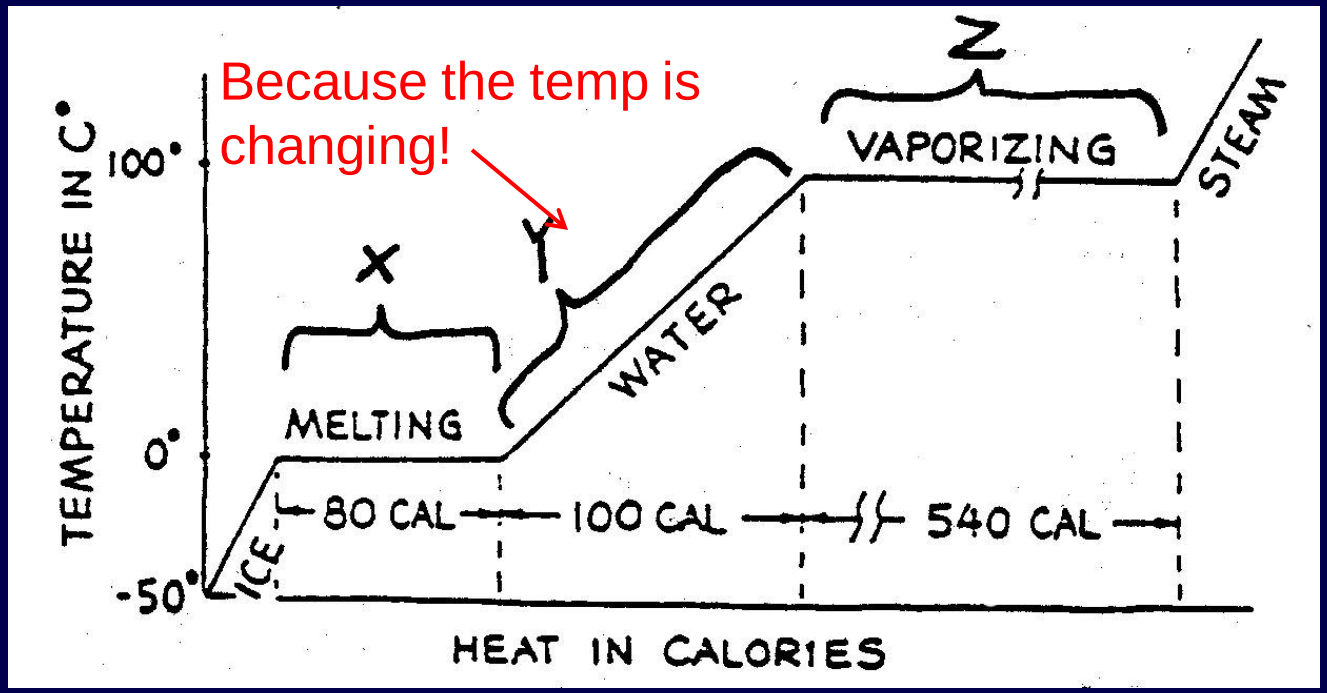
LATENT (means “HIDDEN”) = the energy is there, but it is NOT SENSED by the environment, a thermometer . . . or YOU!



Clicker Q1 -- Which segment or segments of the graph represent(s) **SENSIBLE HEAT (H)** ?

1 = X & Z **3 = Y only**

2 = X only **4 = Z only**



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3 = Y only

2 = X only

4 = Z only

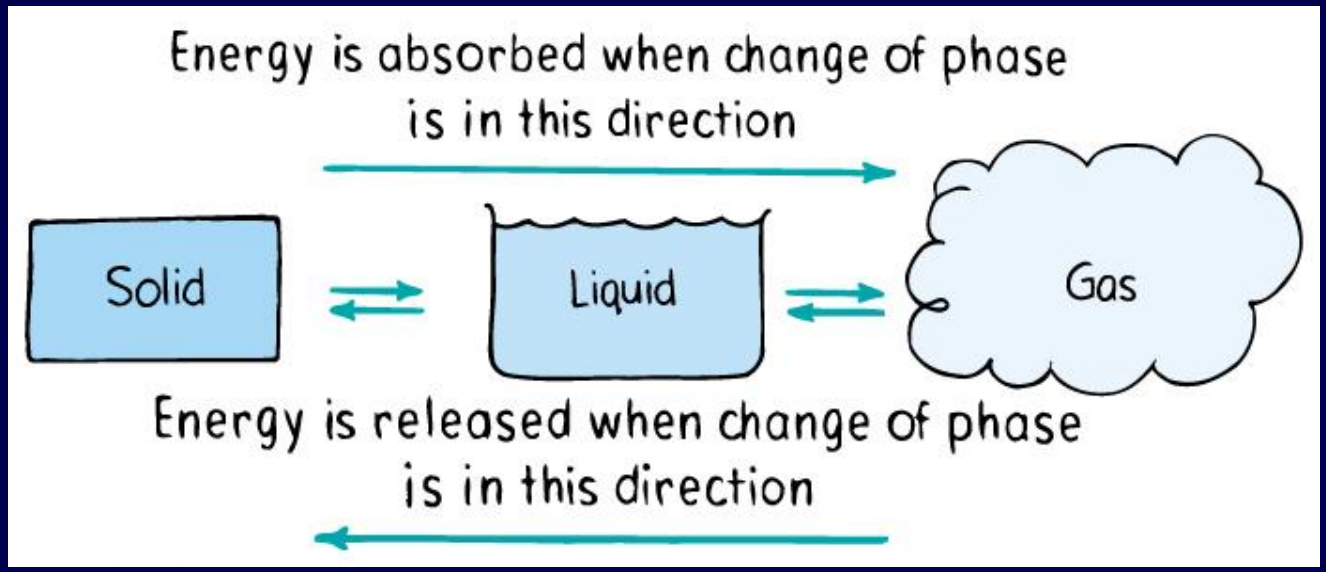
☺

Clicker Q2 - In a phase change from ice to water or water to water vapor, <u>WHAT</u> is absorbing the energy?

1 = the surrounding environment

2 = the H_2O molecules

3 = both the environment & the H_2O



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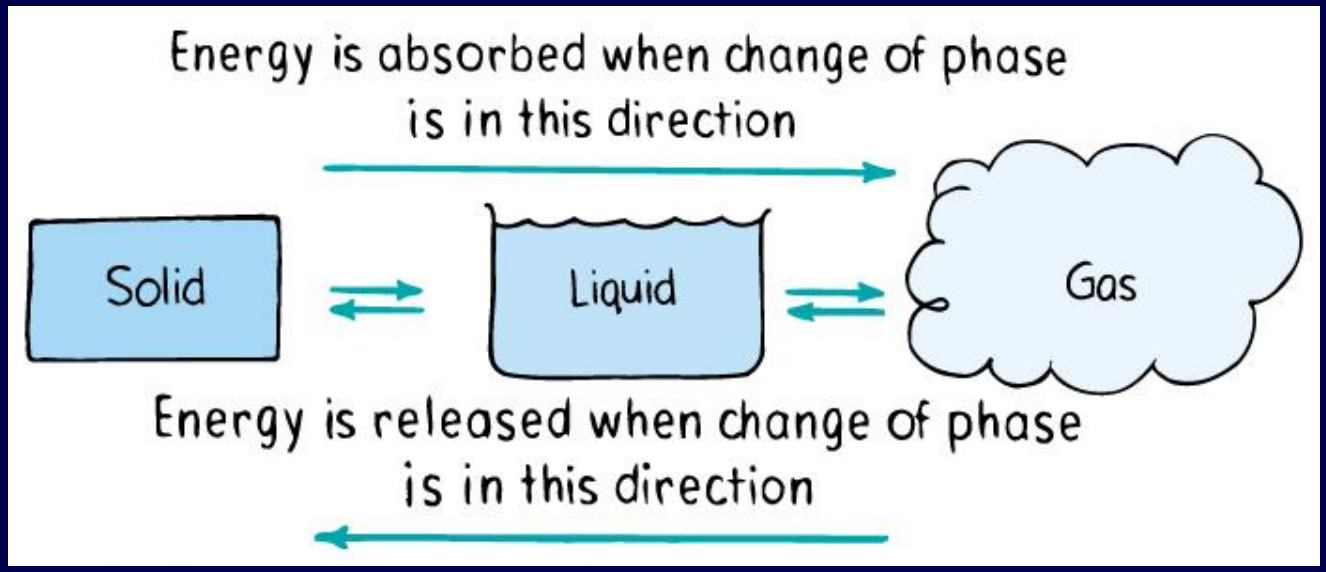
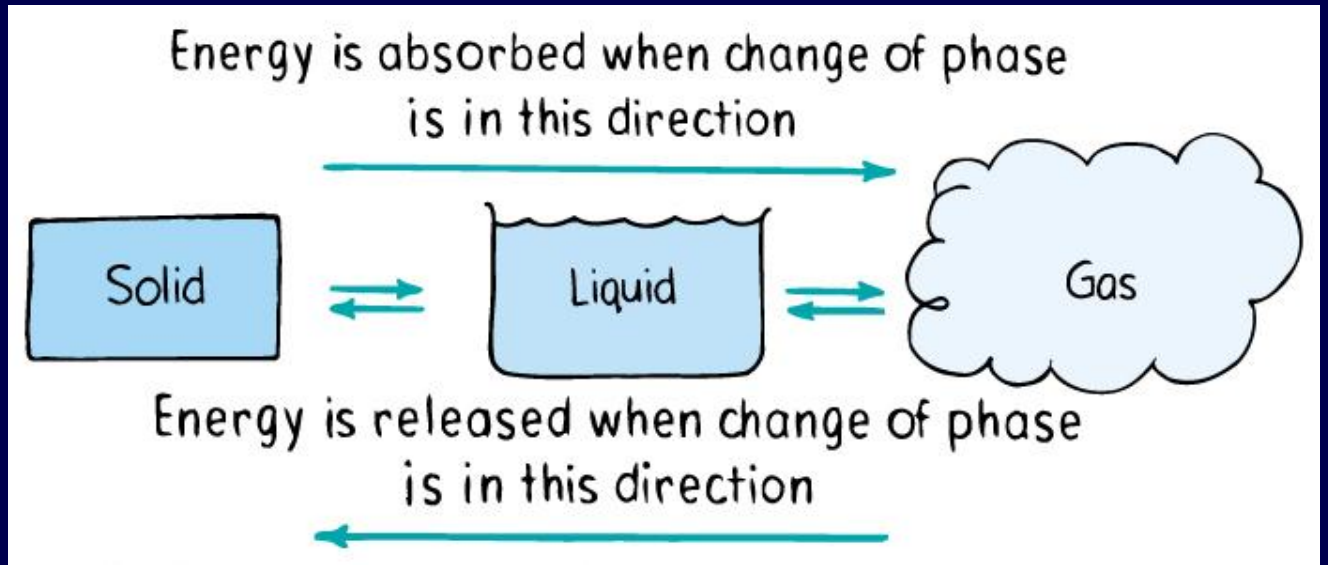


Clicker Q3 - In a phase change from water vapor to liquid water or liquid water to ice, TO WHERE is the energy being released?

1 = into the surrounding environment

2 = into the H_2O molecules

3 = into both the environment & the H_2O



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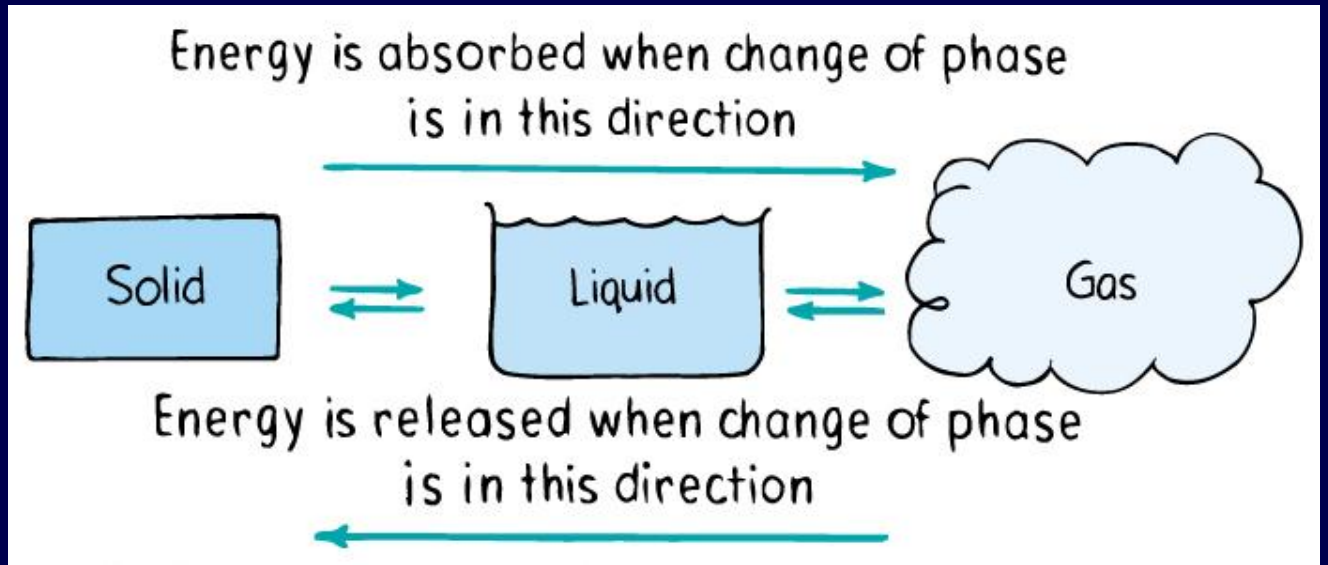
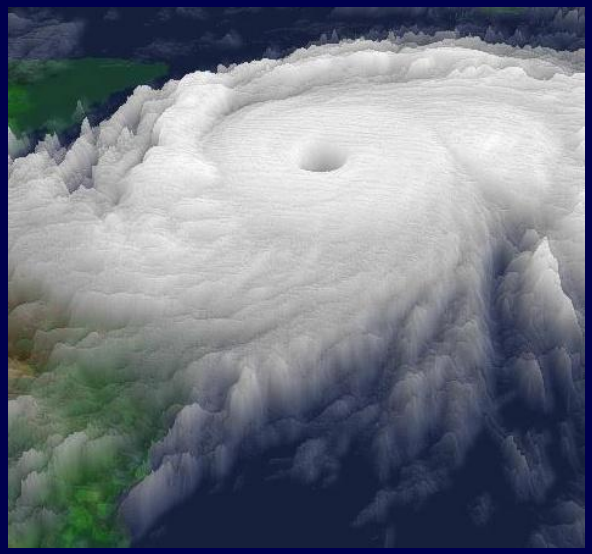
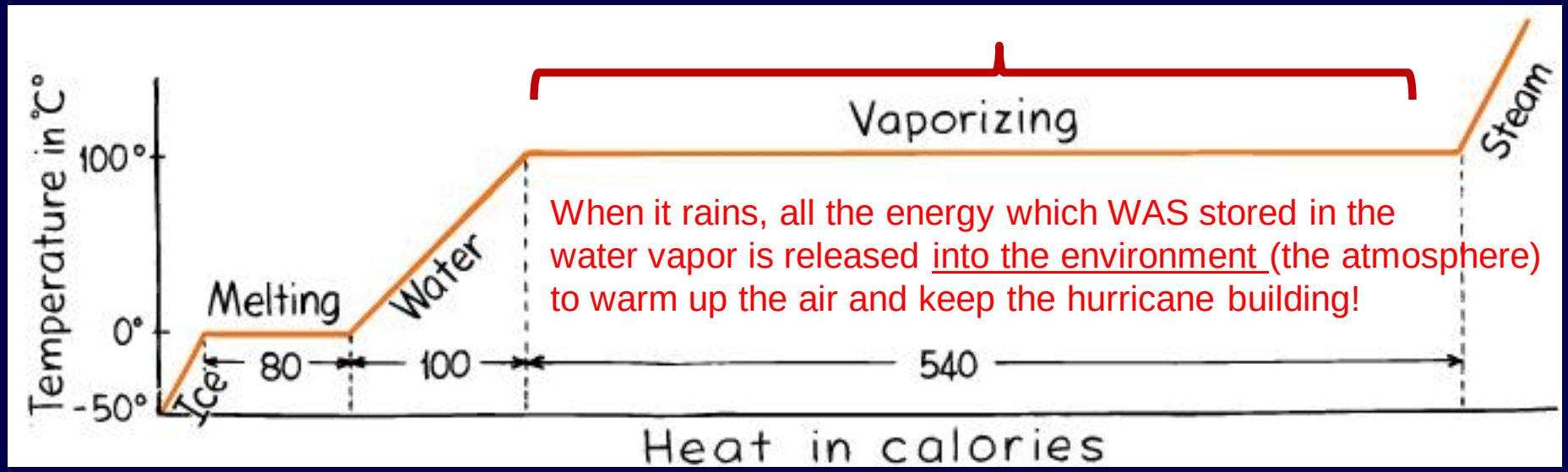
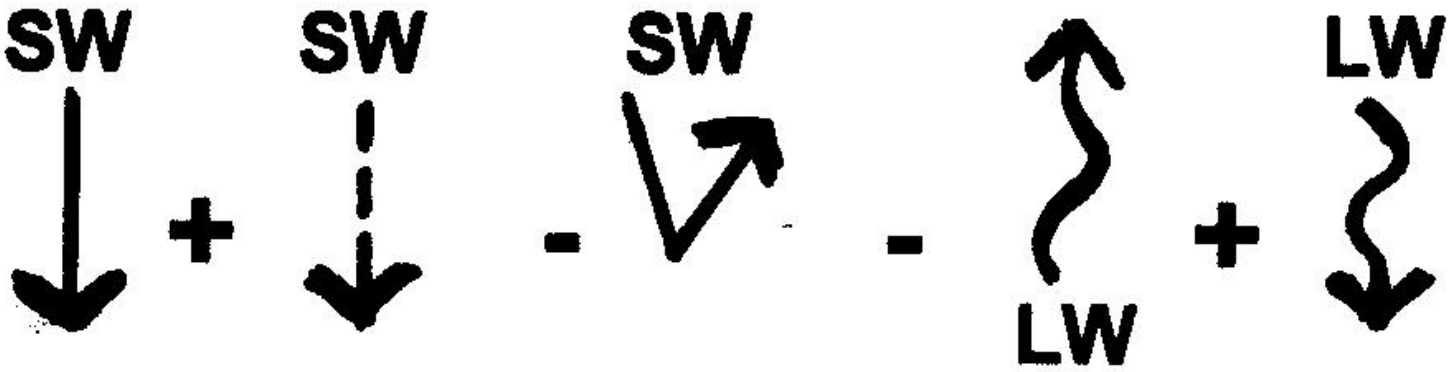


This is what drives tropical storms & HURRICANES!!





Link to the Left Side of Equation:



Radiation = the transfer of energy by ***electromagnetic radiation***.

It **doesn't need MATTER** to transfer energy!
(sun ➔ earth, earth ➔ atmosphere, atmosphere ➔earth, earth ➔ space)

Link to the Right Side of Equation:

$$H + LE + G$$

Conduction & convection plus energy stored & released during phase changes (latent energy => sensible heat, etc.)

Link to the Right Side of Equation:

WHAT IS G???

G = GROUND STORAGE

ENERGY CONDUCTED into soil or CONVECTED & CONDUCTED into water (e.g. ocean) and temporarily STORED THERE

Tends to "zero out" over an annual cycle or several years

Mini Exam Review!!!