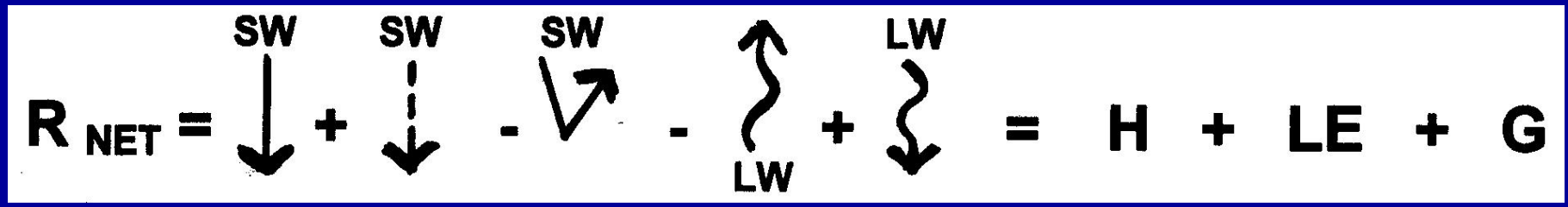
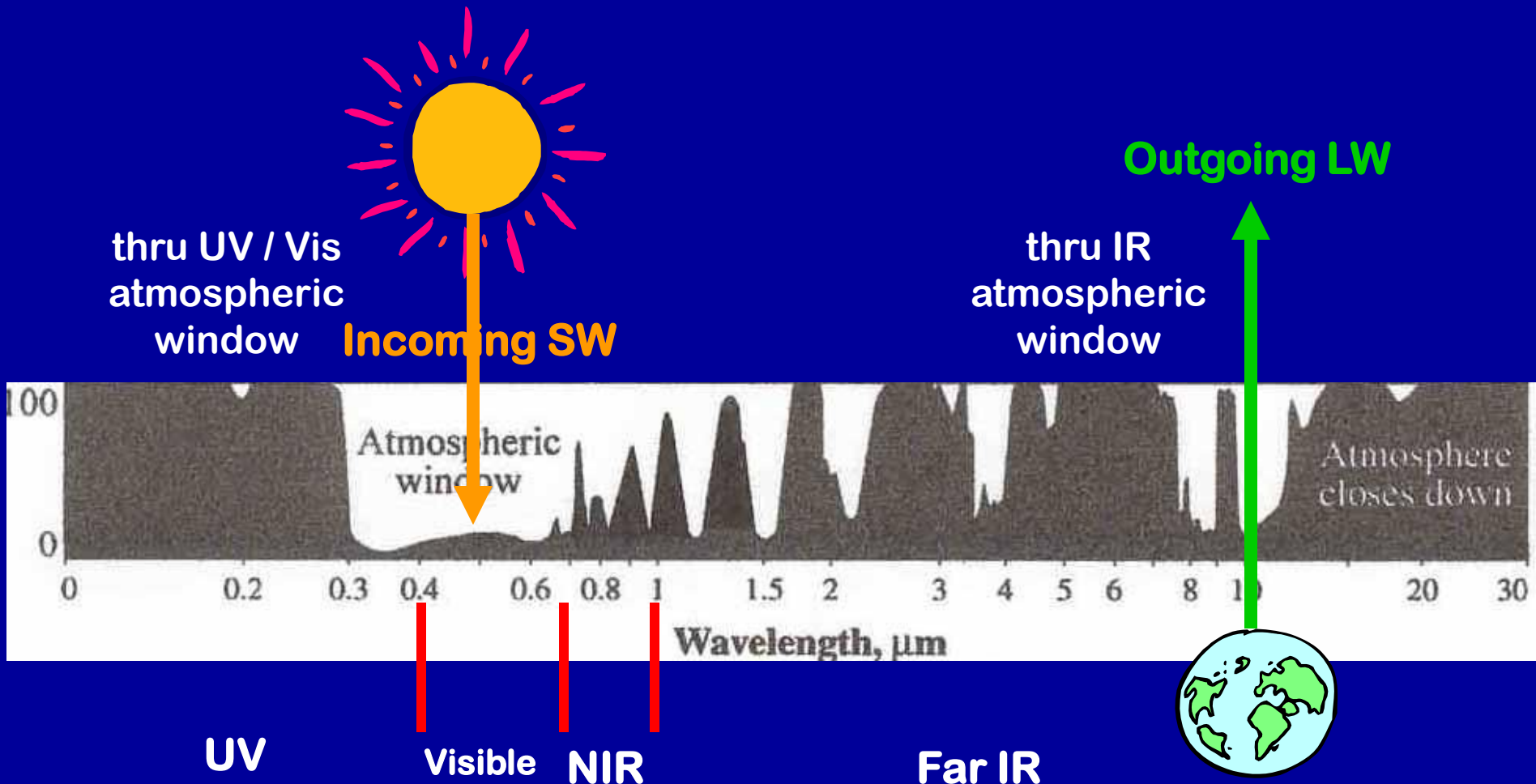
Topic # 9
THE EARTH'S GLOBAL ENERGY BALANCE (cont.)

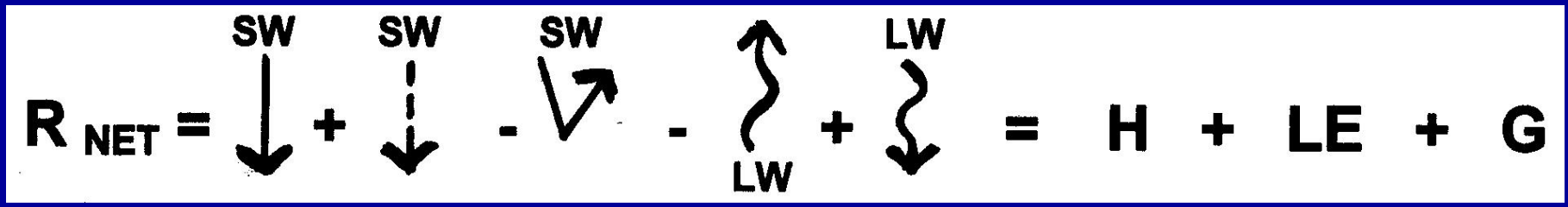


OVERALL BALANCE:

Incoming = Outgoing



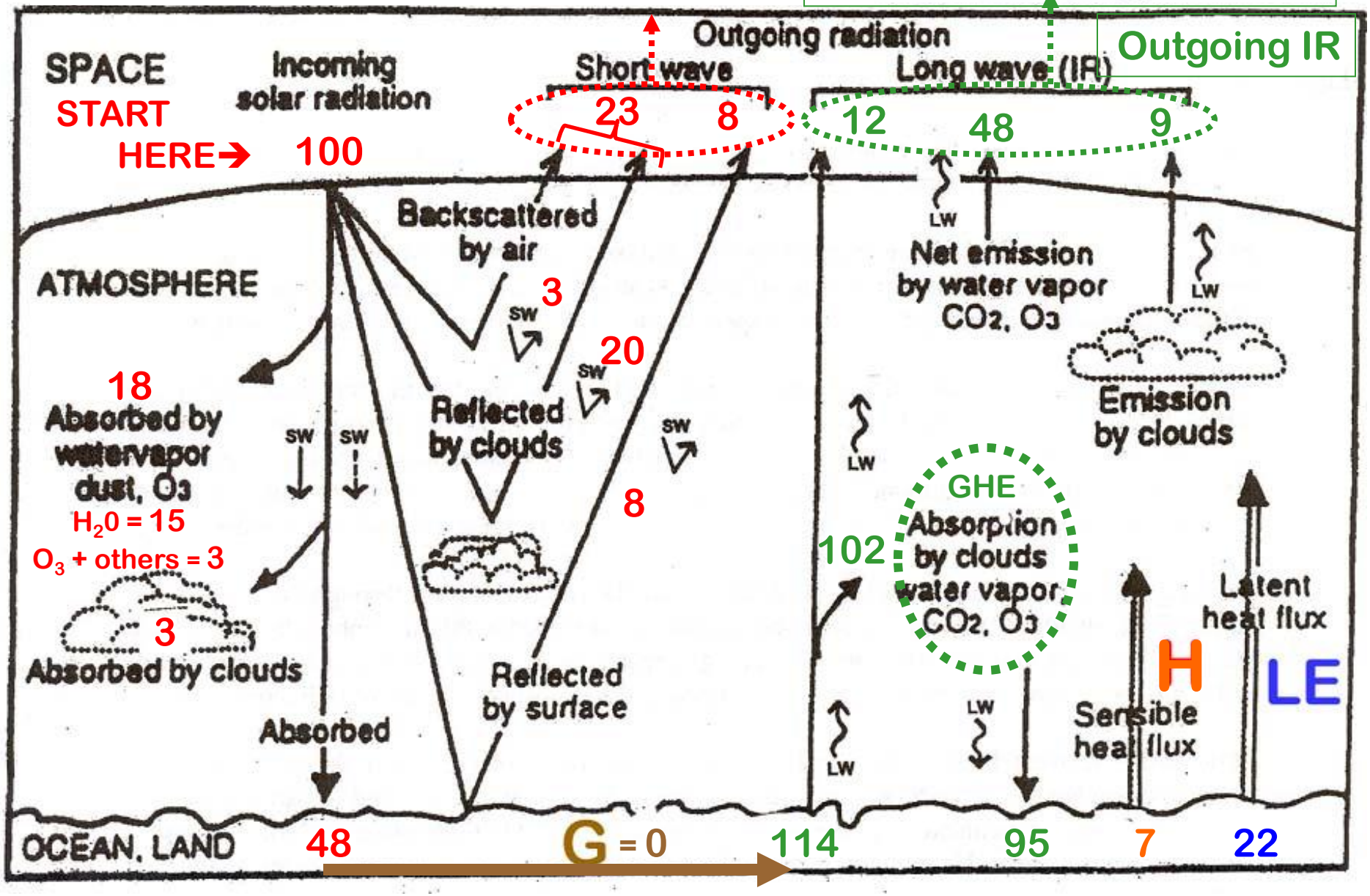
Review



R_{NET} : NET RADIATION

In – Out = R_{NET}

Earth's new average albedo: 23 + 8 = 31 12 + 48 + 9 = 69



G + H + LE

48 ↓ - 114 ↑ + 95 ↓ = 29 → 0 + 7 + 22 = 29 = R_{net}

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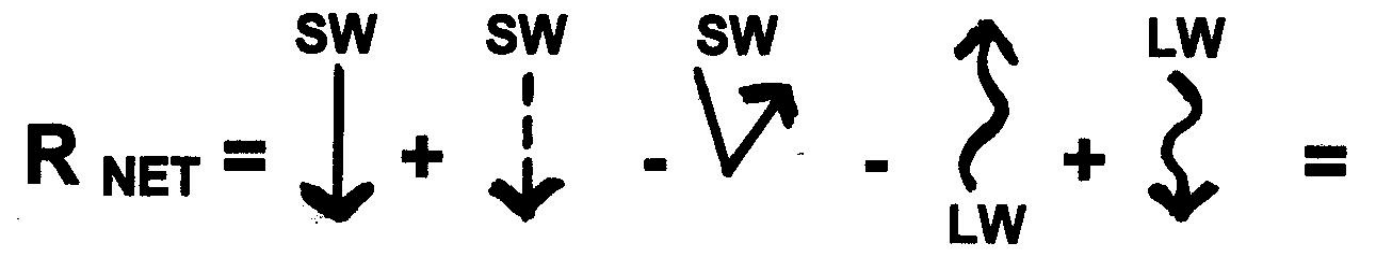
NET RADIATION = In – Out = Whatever is left over



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

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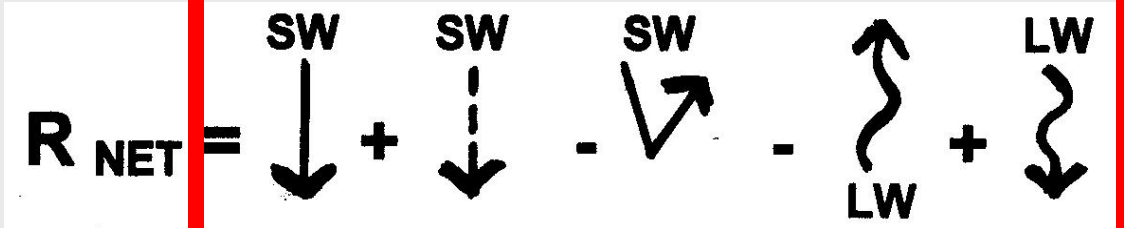
FINAL PART OF TOPIC # 9:

The RIGHT side of the ENERGY BALANCE EQUATION . . .

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).

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

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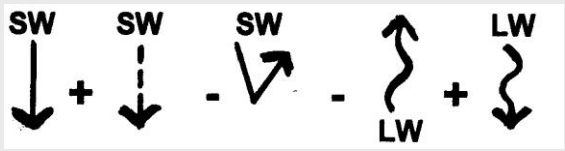
Review of: THERMODYNAMICS & HEAT TRANSFER

Radiation: 

Also:

Conduction

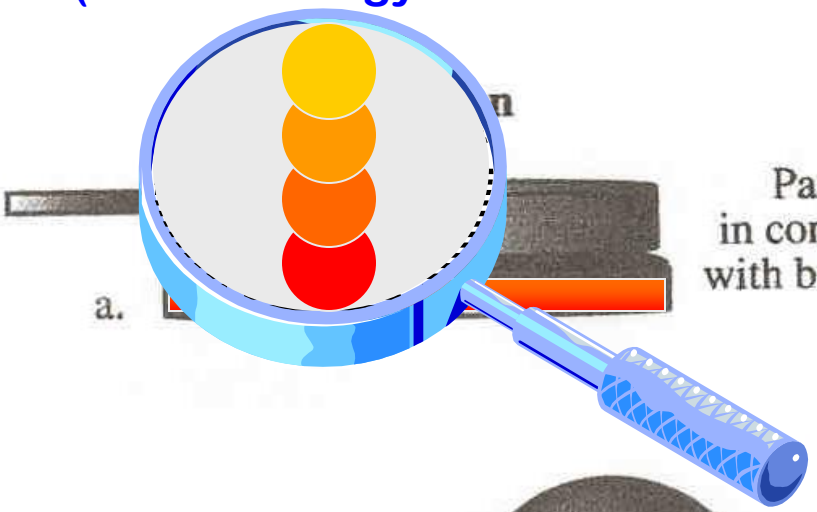
Convection

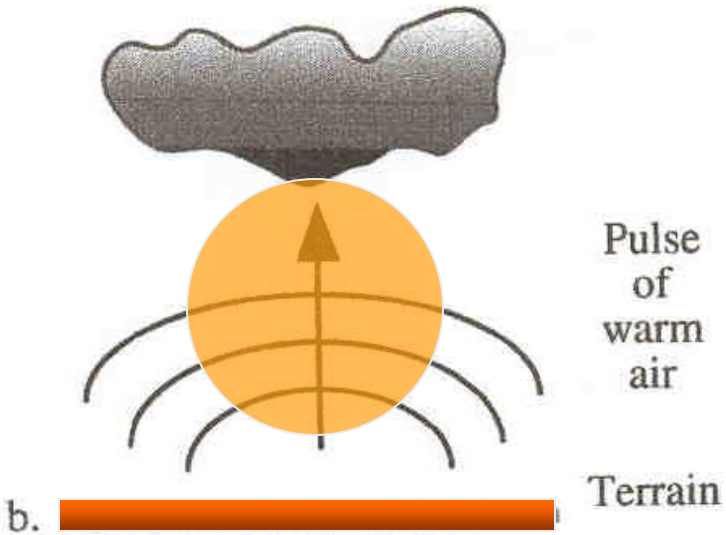
CONVECTION

Mass of warm air or liquid heats, expands, rises

CONDUCTION

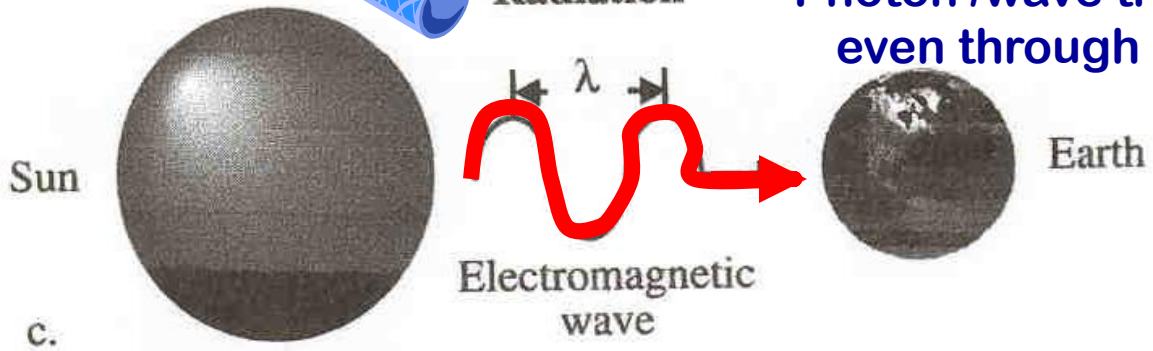
Jiggling molecule ➔ jiggling molecule
transfer of heat
(kinetic energy at molecular scale)





RADIATION

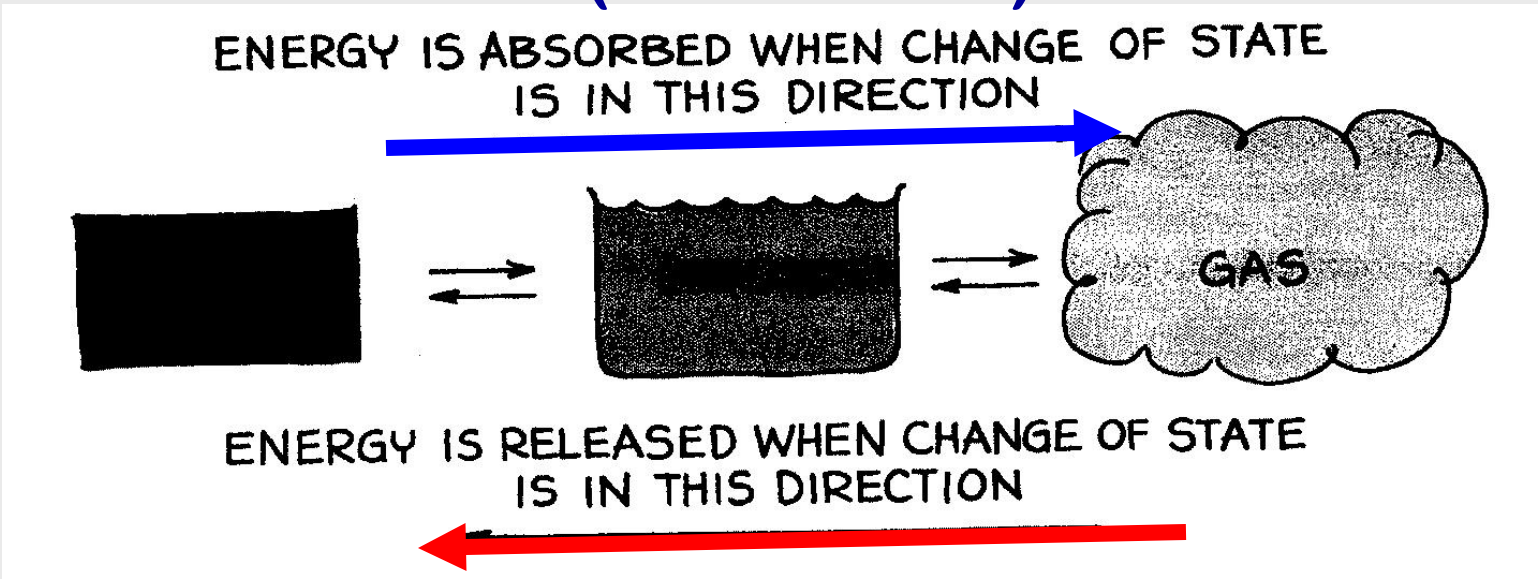
Photon /wave transport:
even through a void!



review

HEAT TRANSFER & STORAGE DURING PHASE CHANGES: LE & H

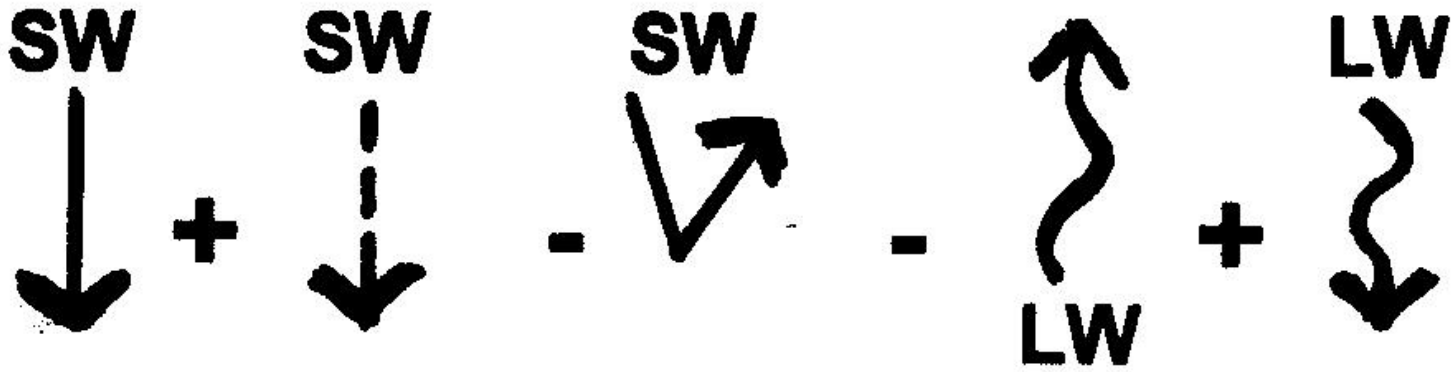
LE = LATENT (hidden) ENERGY (LE stored)



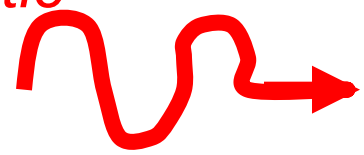
(LE released, hence it can be sensed as H)

H = SENSED (via thermometer) ENERGY

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.)

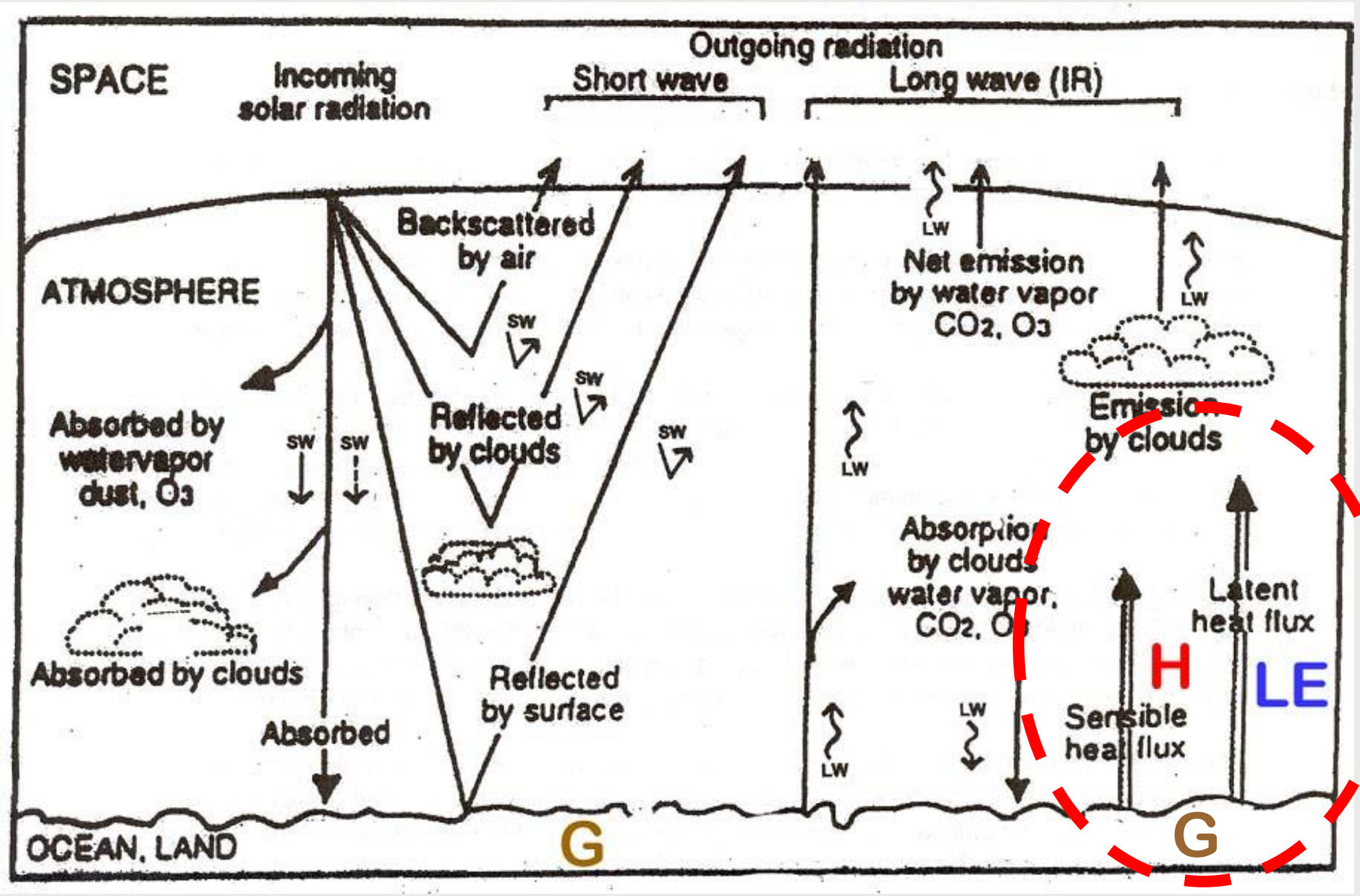
Link to the Right Side of Equation:

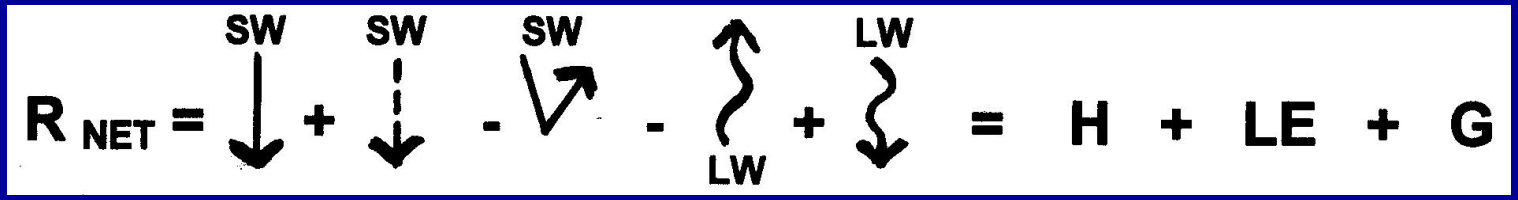
WHAT IS G???

G = GROUND STORAGE

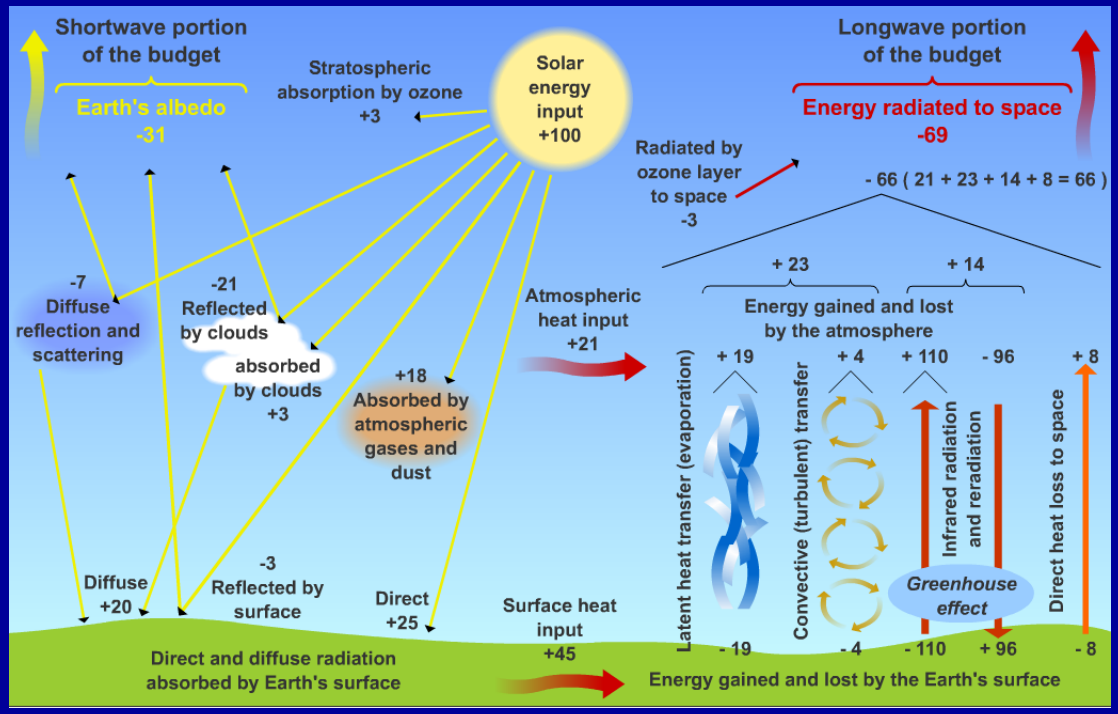
ENERGY CONDUCTED into soil or CONVECTED & CONDUCTED into water (e.g. ocean) and temporarily STORED THERE

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


SPACE
Incoming solar radiation
Outgoing radiation
Short wave
Long wave (IR)
ATMOSPHERE
Backscattered by air
Net emission by water vapor CO2, O3
LW
SW
Absorbed by watervapor dust, O3
Reflected by clouds
Emission by clouds
Absorbed by clouds
Absorption by clouds water vapor, CO2, O3
Latent heat flux
H
LE
Sensible heat flux
Reflected by surface
Absorbed
G
OCEAN, LAND



ENCORE:

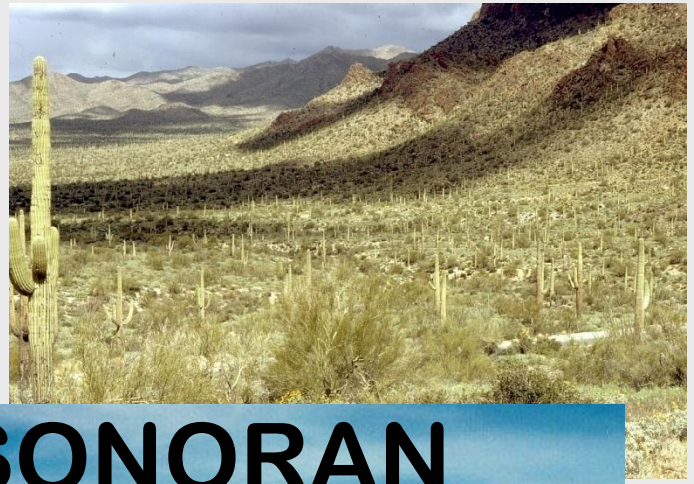


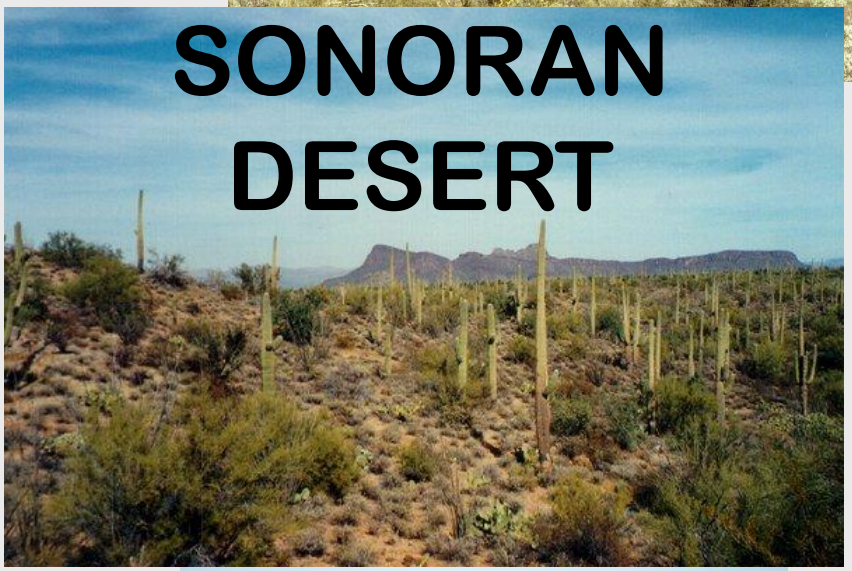
ENERGY BALANCE ANIMATION:

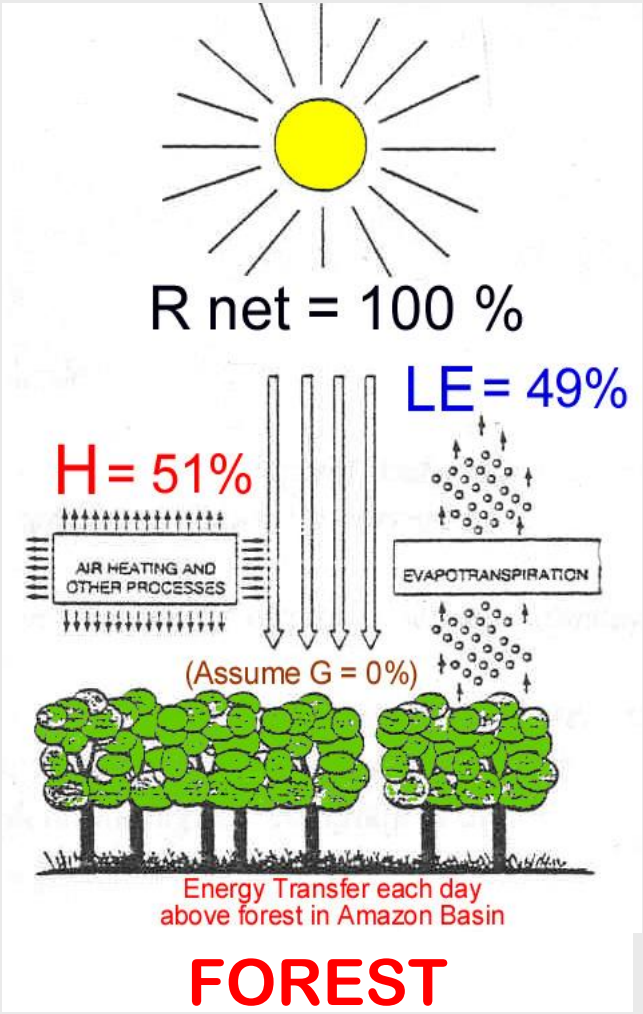
http://mesoscale.agron.iastate.edu/agron206/animations/10_AtmoEbal.html

Because climate is changing, the “units” in the above animation have changed slightly and differ from p 52

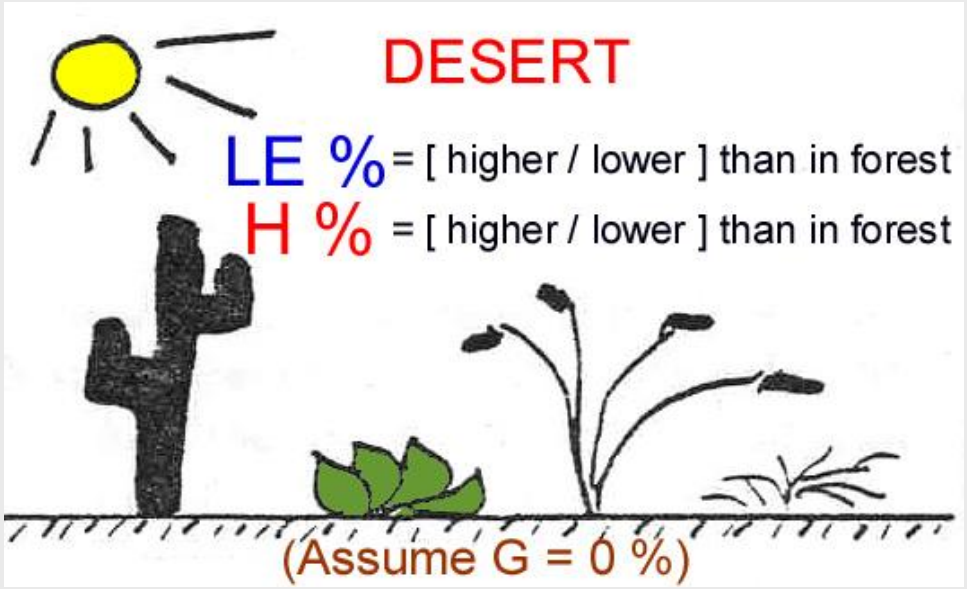

AMAZON RAIN
FOREST




SONORAN
DESERT



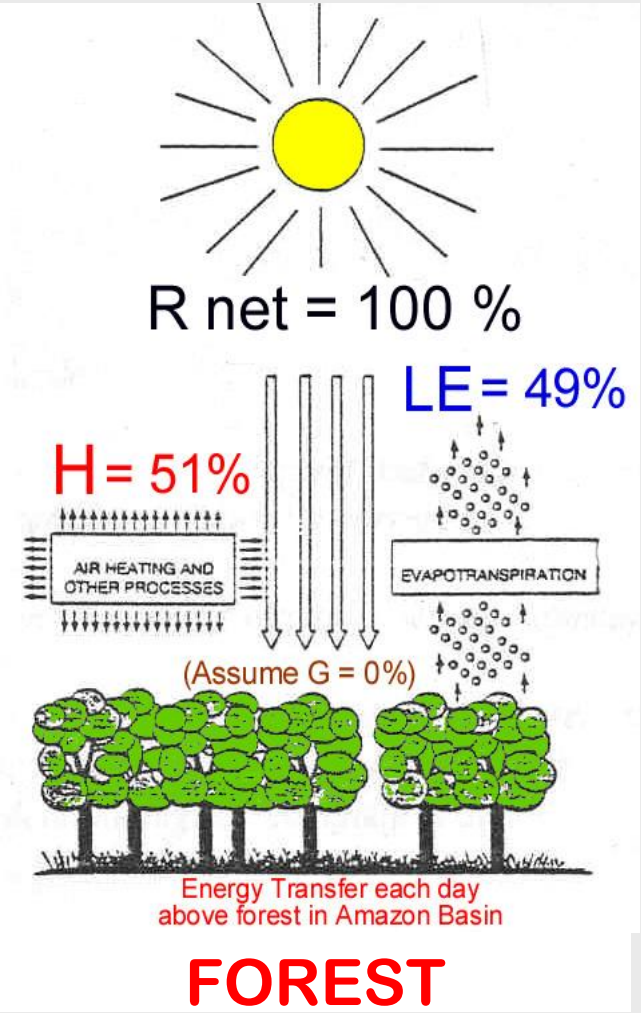
Q-1 Will the % of net radiation in LE form be HIGHER or LOWER in the Desert, when compared to a Rainforest?



Compared to the Amazon Rain Forest the % of R_{NET} in LE will be . .

1 = HIGHER in the desert

2 = LOWER in the desert



FOREST

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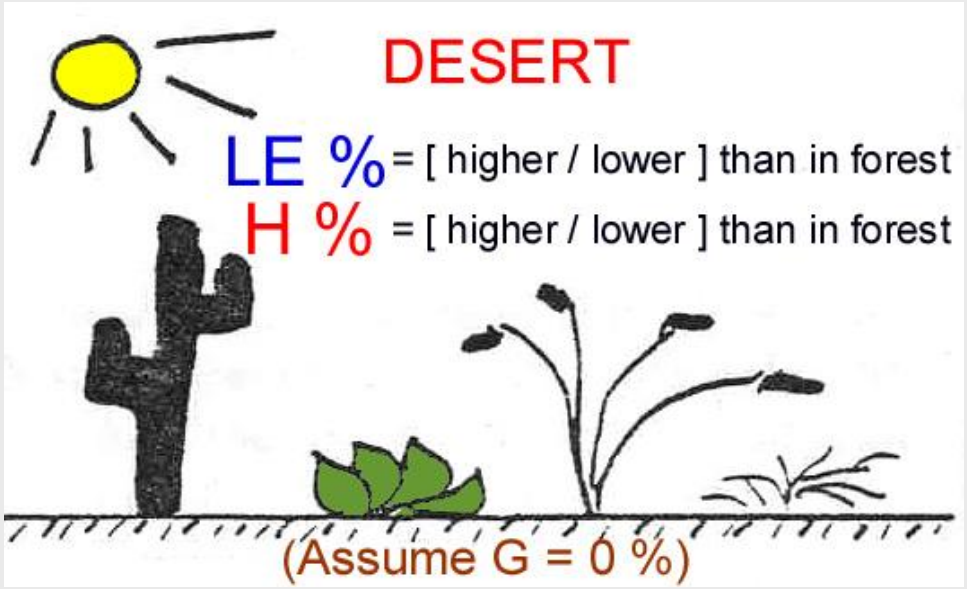

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What if humans put in canals (CAP), lakes, & artificial water bodies in a desert?

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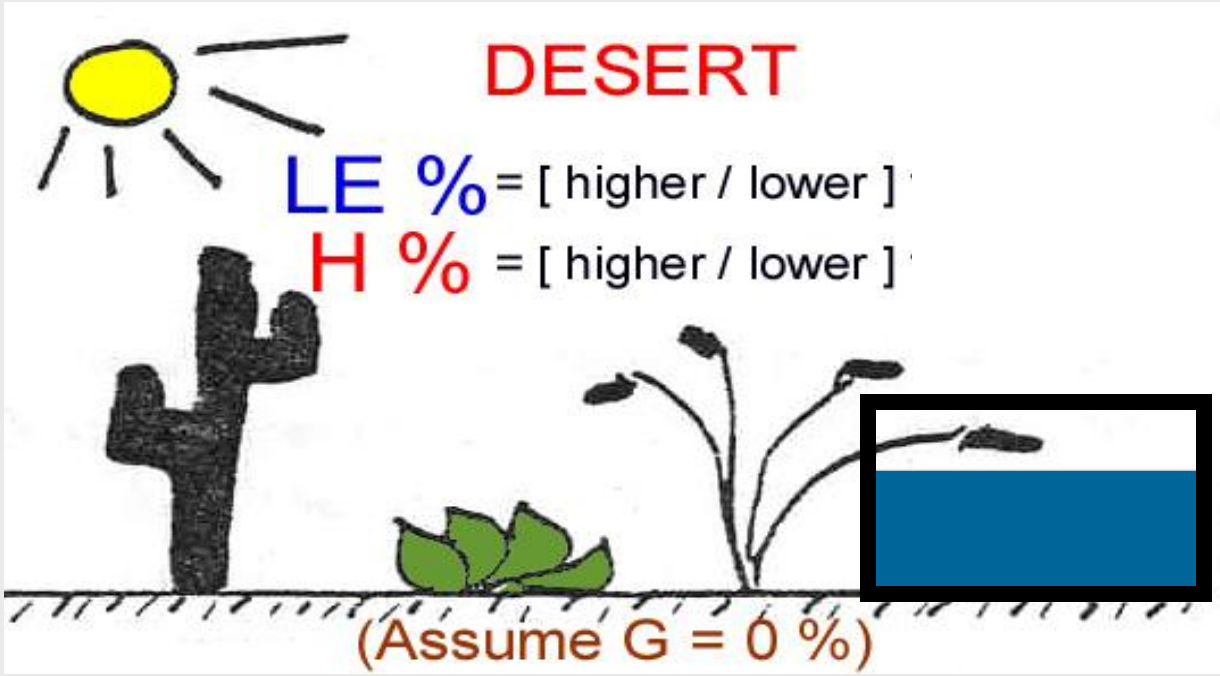
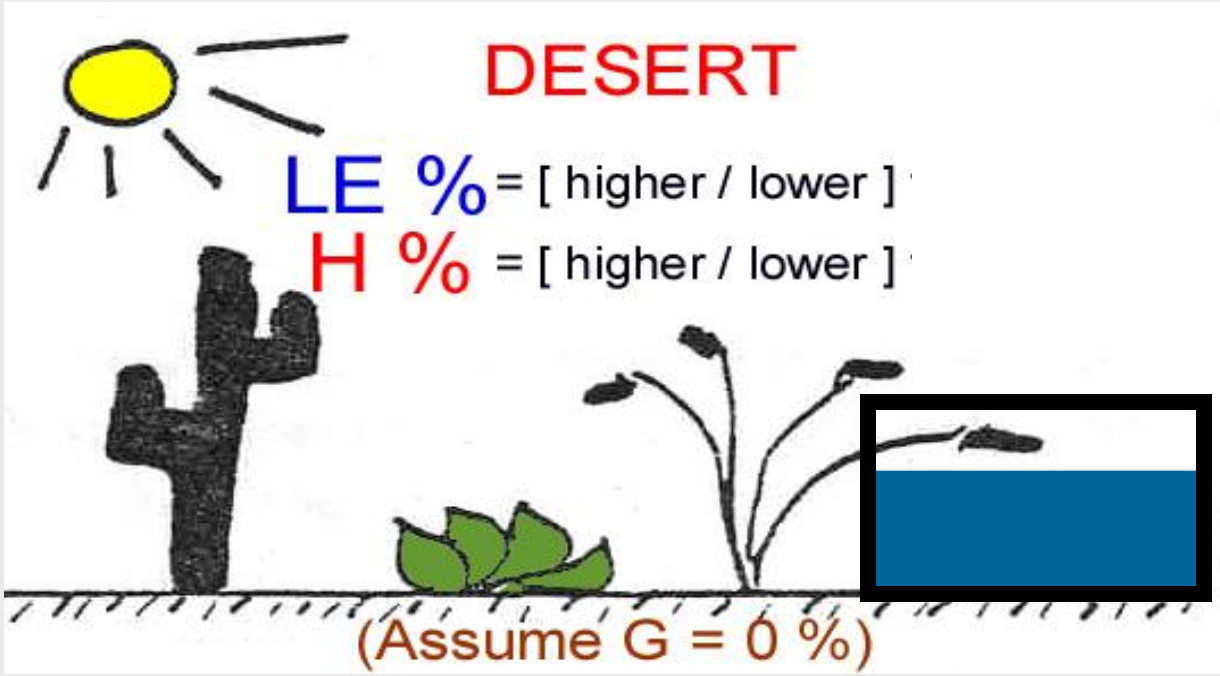


Q2 -How would the % of LE in the Desert change?

Compared to natural desert with no CAP canals, the % or R_{NET} in LE will be . . .

1 = HIGHER with CAP canals
2 = LOWER with CAP canals

What if humans put in canals (CAP), lakes, & artificial water bodies in a desert?



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1 = HIGHER with CAP canals

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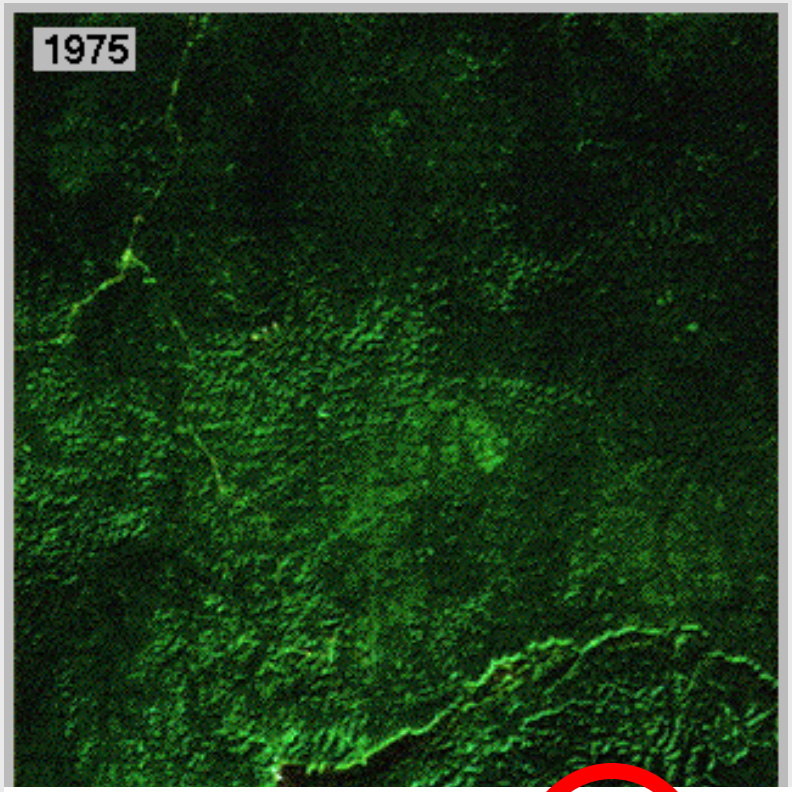
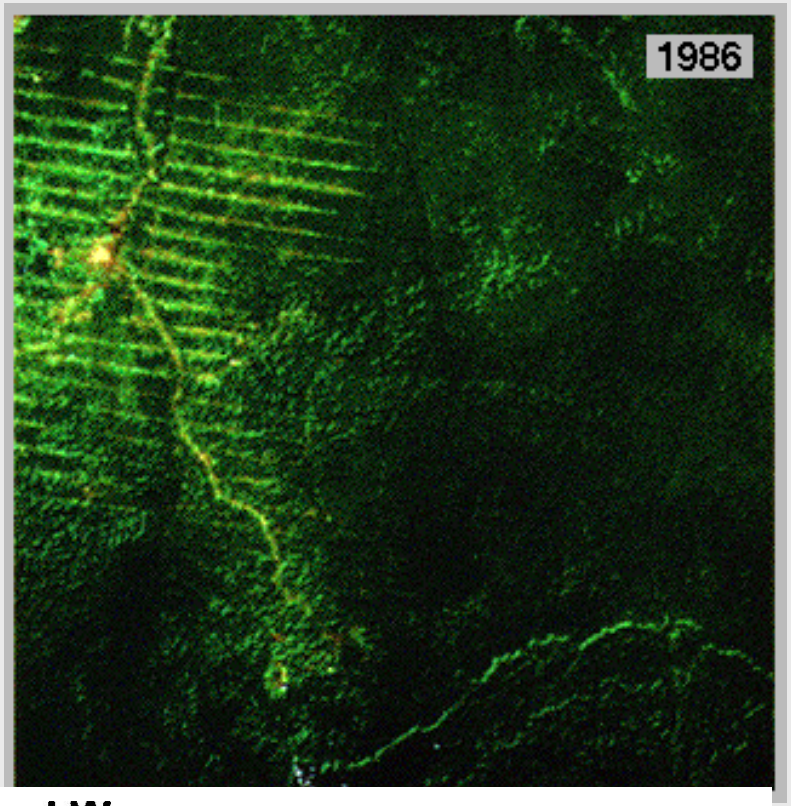
How does DEFORESTATION change the local energy balance???





R_{NET} = SW ↓ + SW ↓ − SW ↗ − LW ↕ + LW ↯ = H + LE + G

Less

More → cooler temperatures?

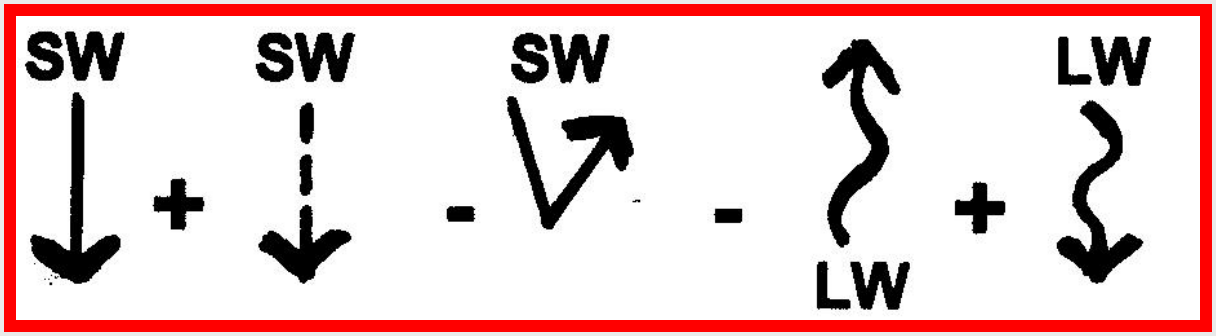
More → warmer temperatures?

THINK-PAIR-SHARE ACTIVITY
(IN YOUR GROUPS)

Applying the Energy Balance Terms

Your task is to decide which **component** or **components working together** ***<u>are most directly related to</u>*** or ***<u>responsible for</u>*** the observed phenomenon.

 # 1 – #12 : Left side of equation



 # 13 - #15: Right side of equation

H + LE + G

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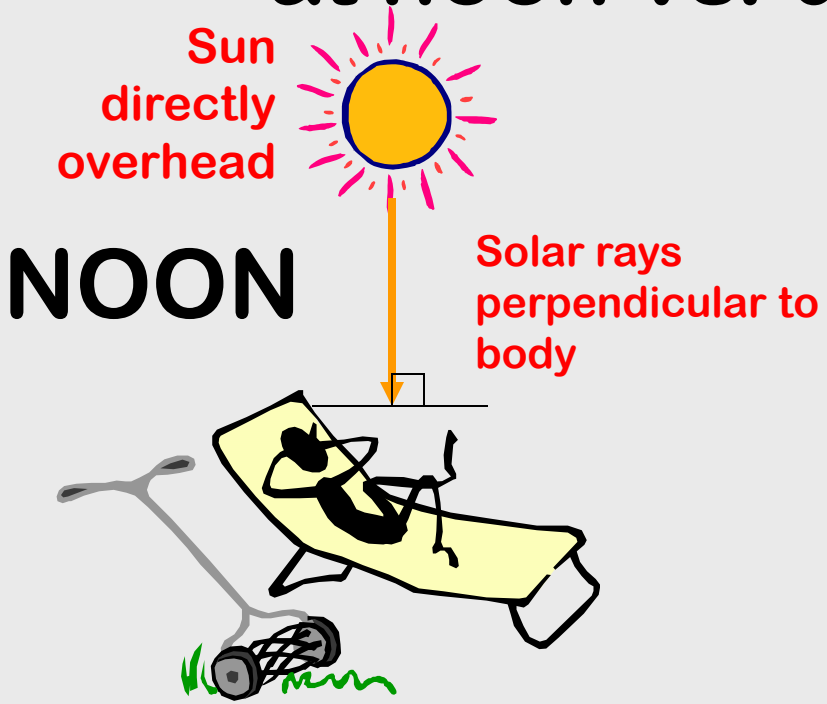
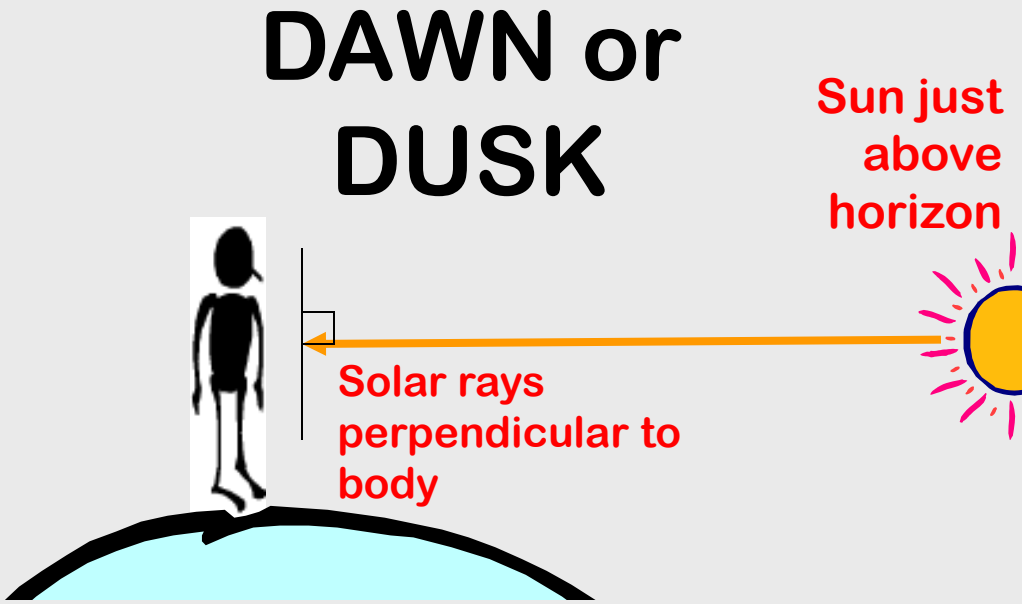
1. blue skies

2. Sunglasses while skiing

3. Bright even though cloudy

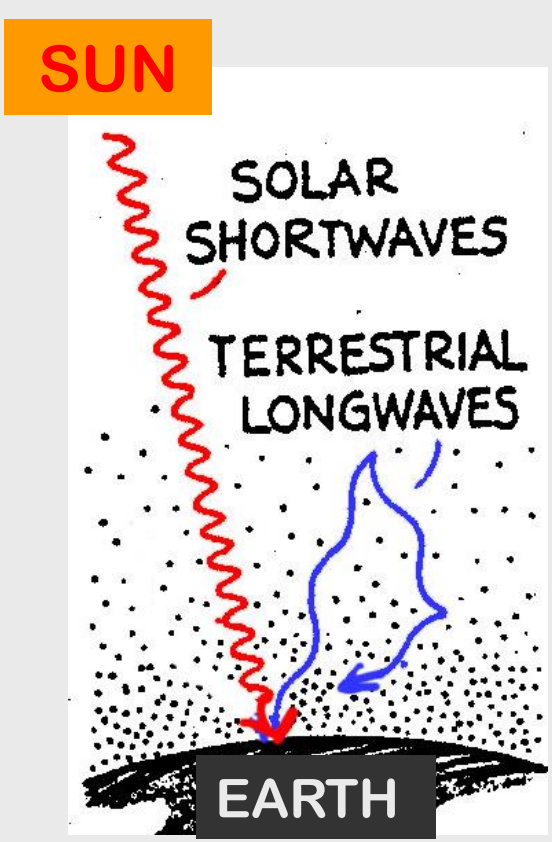
4. More intense solar radiation (tan /skin damage, etc.) at noon vs. dawn or dusk

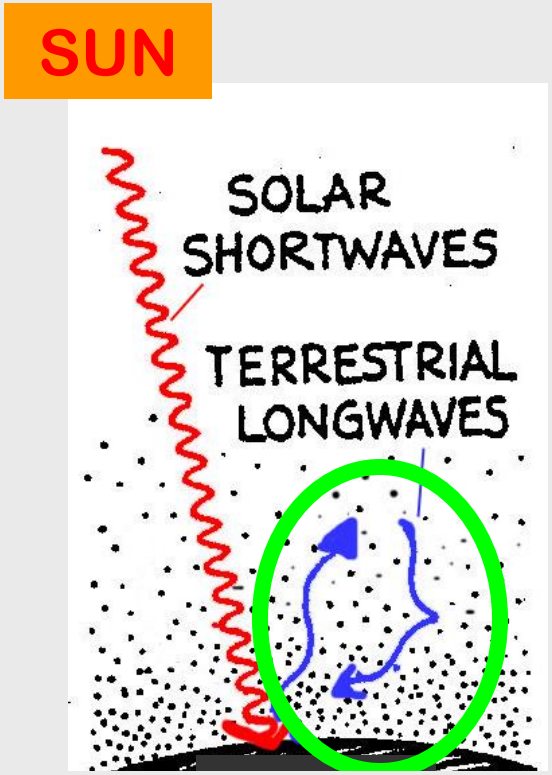




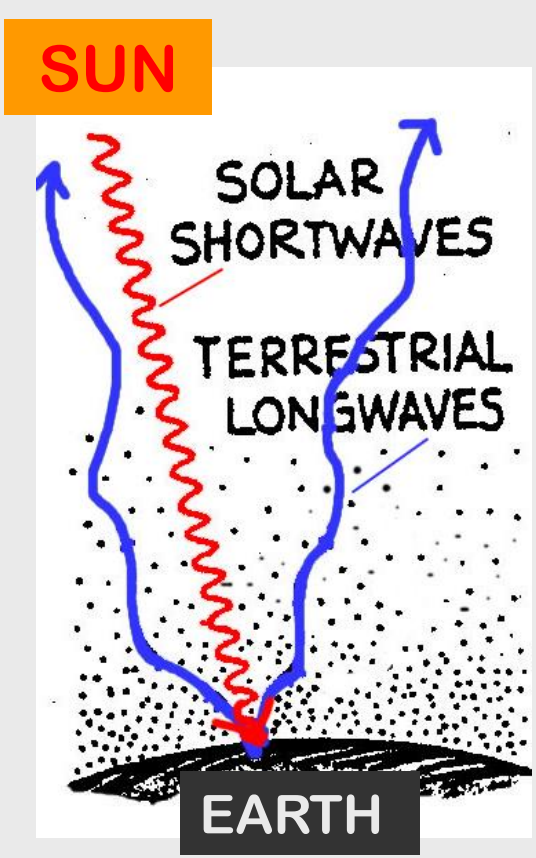
5. The Greenhouse Effect ➔

To illustrate the GREENHOUSE EFFECT:





Greenhouse effect



B is better than the others . . . But only the circled part represents the GH Effect!! . . .

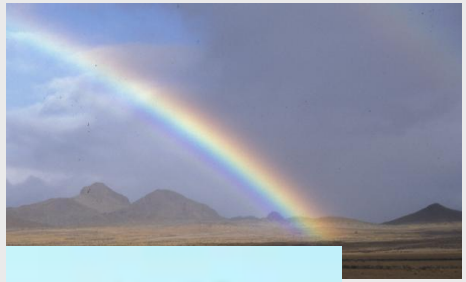
6. Red sunsets

7. Infrared cameras / “night vision”

8. “Tennis whites” tradition

9. Shadow on sunny day

10. Rainbow



11. Black streaks

12. Parking on blacktop

13. Hot air balloon

14. Pigs cooling off in the mud

15. Evaporative coolers work best in the desert

See you on MONDAY

Don’t forget RQ-5!
Due 30 Minutes before class!