Welcome Back to NATS 101, Lec 34 Intro to Global Change

Thursday Sep 29

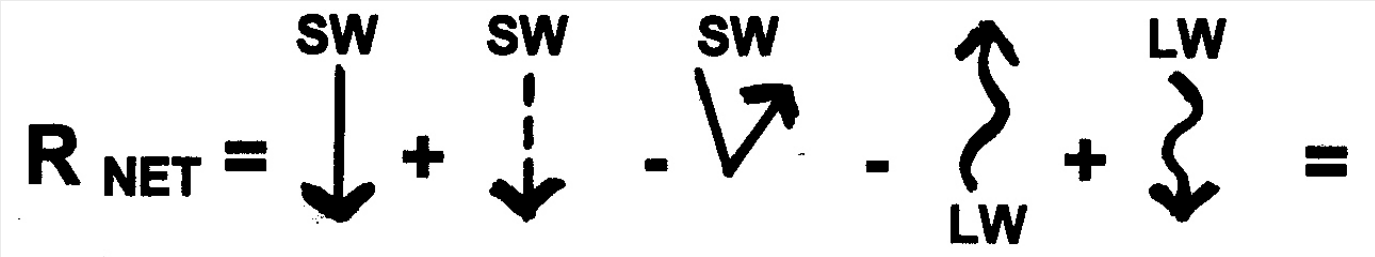
SIT WITH YOUR GROUP, GET YOUR GROUP FOLDER, & FINISH WORKING ON ASSIGNMENT G-3

IMPORTANT ANNOUNCEMENT ABOUT TEST #2:

It will be POSTPONED a week until Thursday Oct 6th

(See the revised CHECKLIST!!)

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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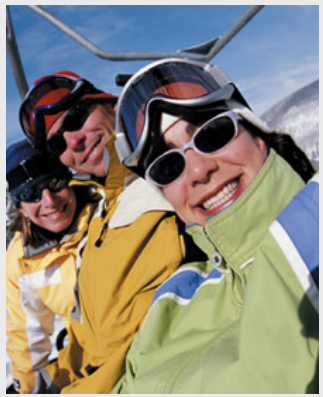
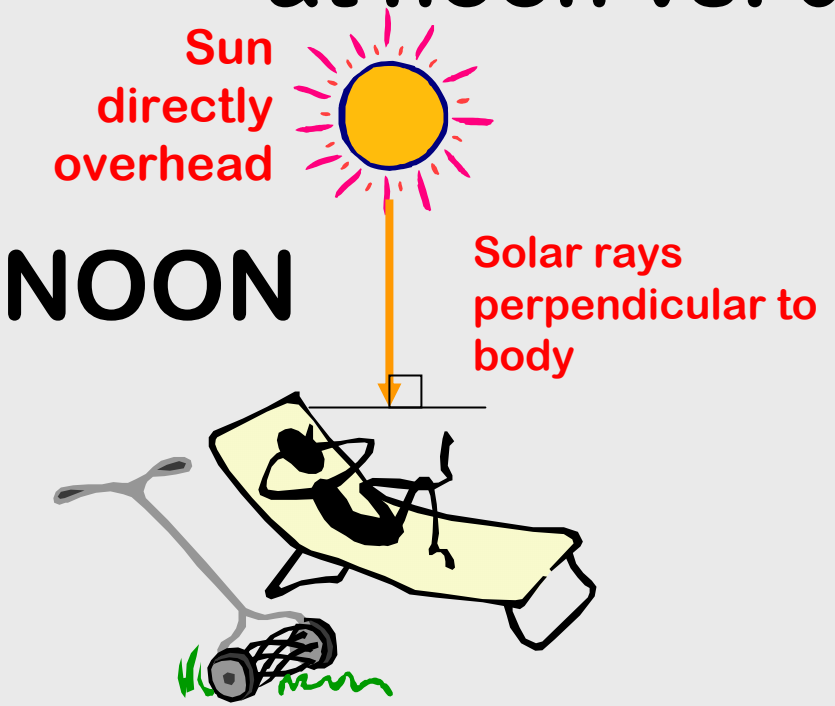
1. blue skies

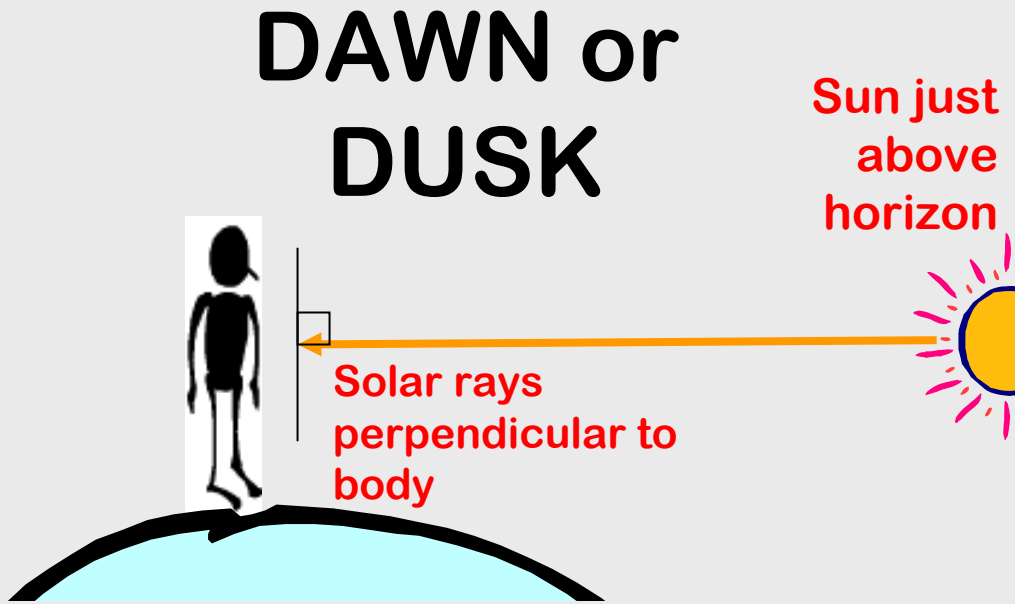
2. Sunglasses while skiing



3. Bright even though cloudy

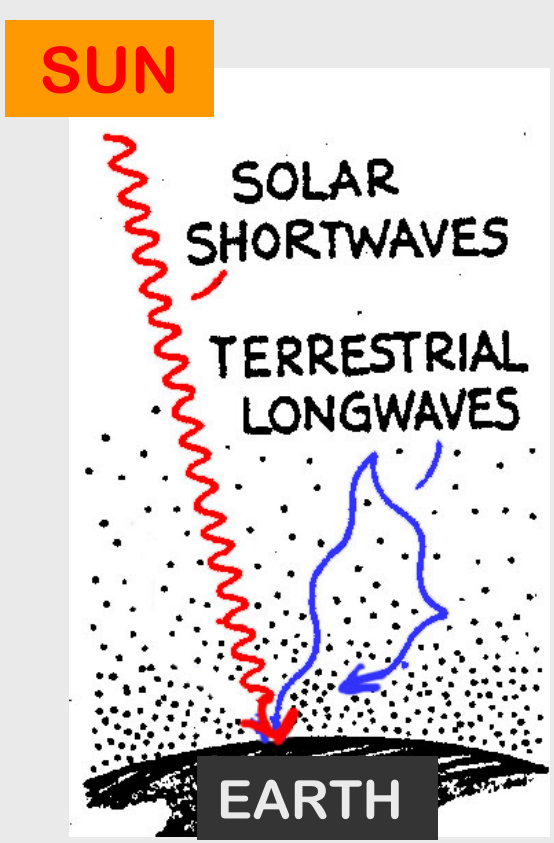
4. More intense solar radiation (tan /skin damage, etc.) at noon vs. dawn or dusk

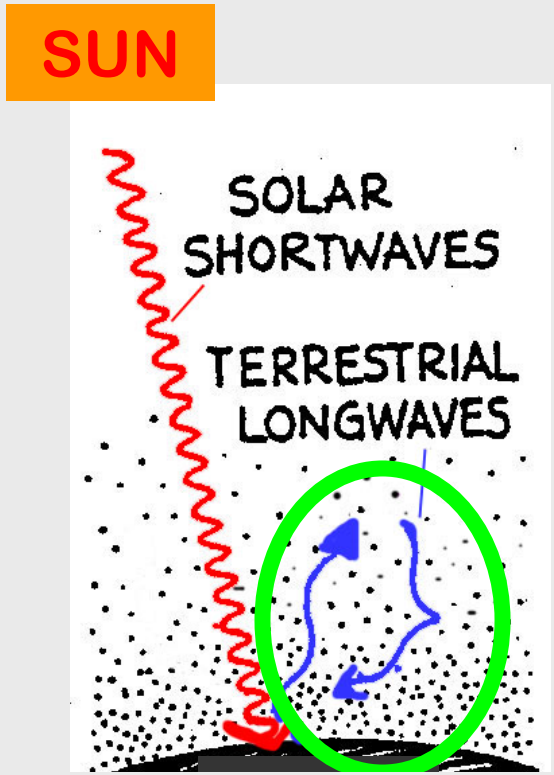




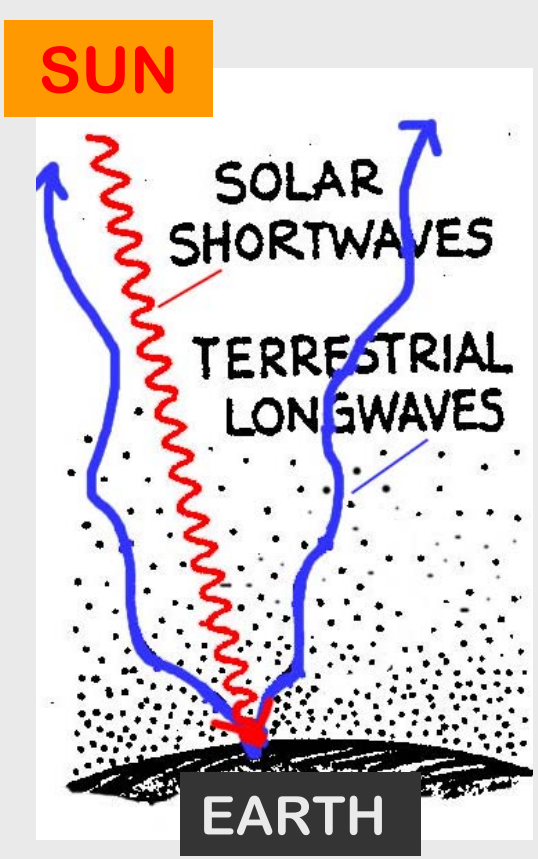
5. The Greenhouse Effect ➔

To illustrate the GREENHOUSE EFFECT:





Greenhouse effect

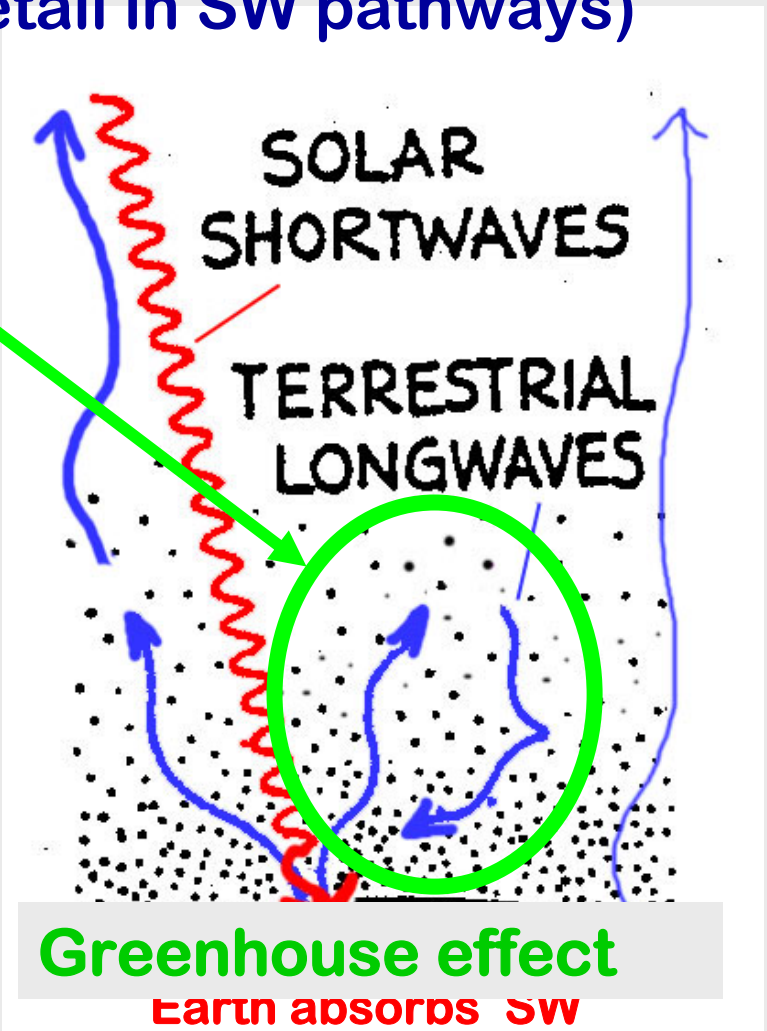


B is better than the others . . . But only the circled part represents the GH Effect!! . . . (also the energy pathways in the rest of the diagram are incomplete) ➔

Here's a more complete diagram of LW energy pathways . . .

(but not enough detail in SW pathways)

But only the circled part represents the GH Effect:



DEFINITION OF A GREENHOUSE GAS:

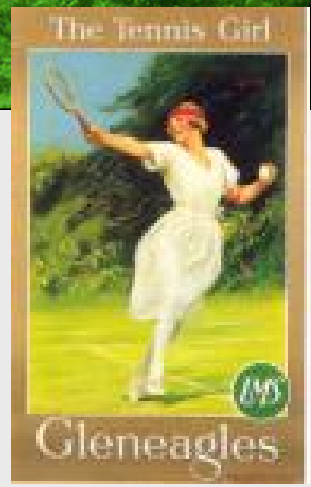
A gas that warm's the planet's surface by absorbing infrared radiation and reradiating some of it back toward the surface.

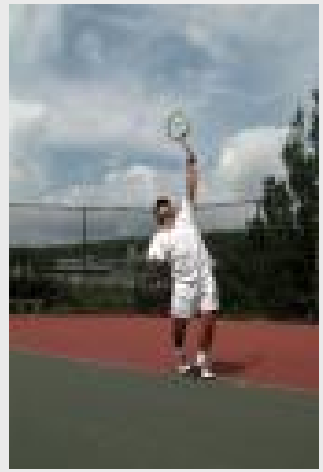
(see IGC Glossary p 409)

6. Red sunsets

7. Infrared cameras / "night vision"

8. "Tennis whites" tradition





9. Shadow on sunny day

10. Rainbow

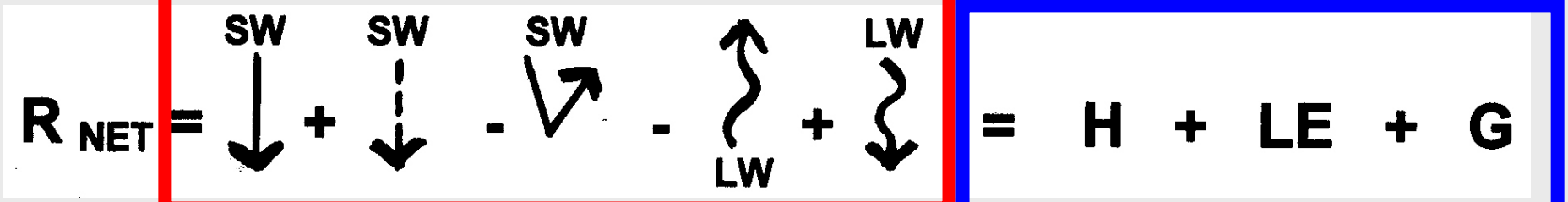
11. Black streaks

12. Parking on blacktop

FINAL PART OF TOPIC #10:

The RIGHT side of the ENERGY BALANCE EQUATION . . .

Left side of equation



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).

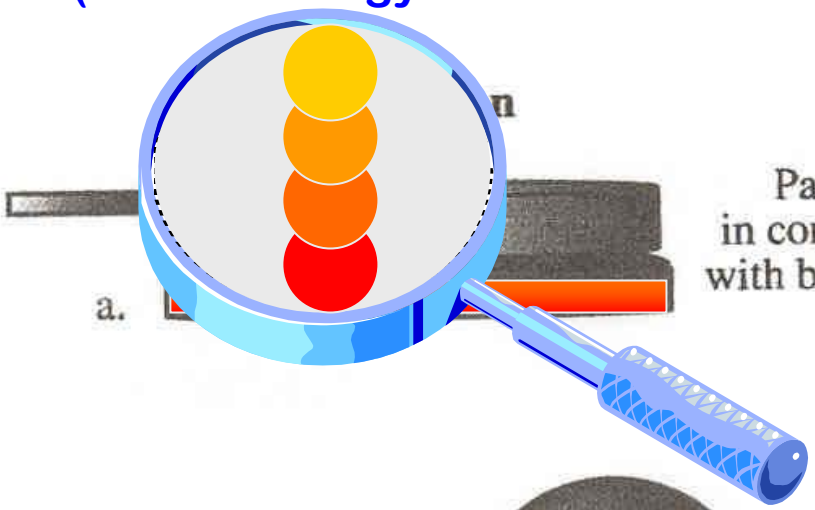
$$R_{NET} = H + LE + G$$

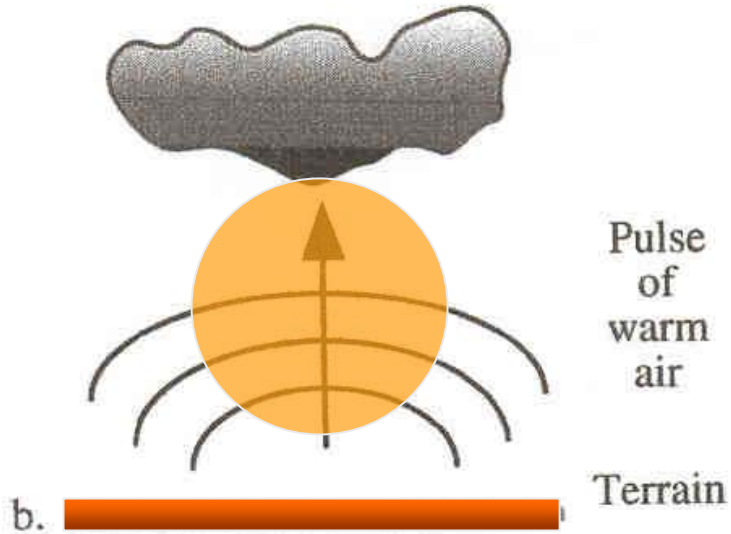
CONVECTION

Mass of warm air or liquid heats, expands, rises

CONDUCTION

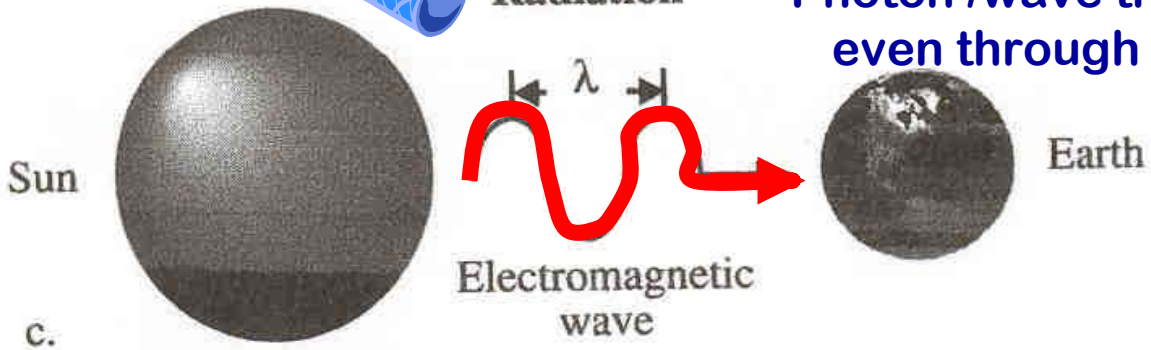
Jiggling molecule ➔ jiggling molecule
transfer of heat
(kinetic energy at molecular scale)





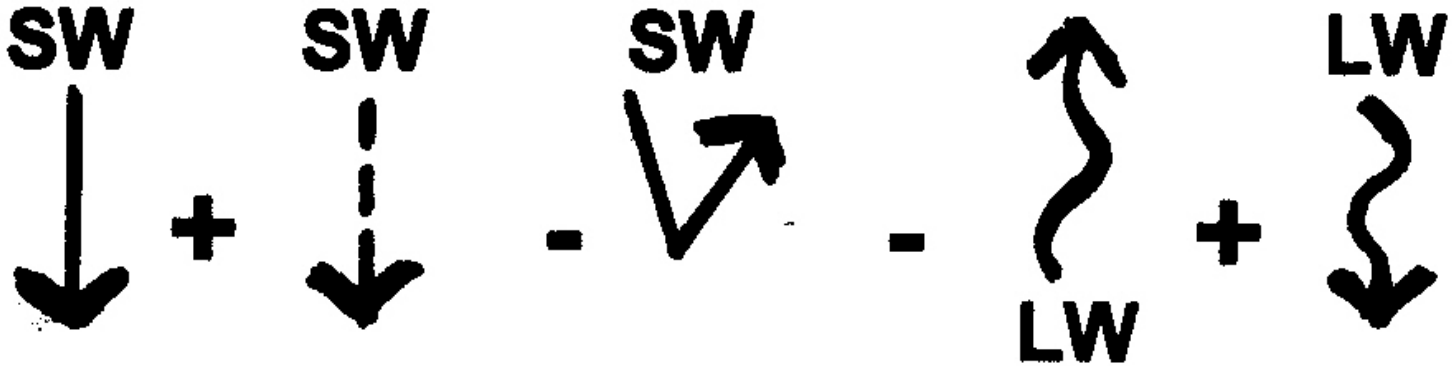
RADIATION

Photon /wave transport:
even through a void!

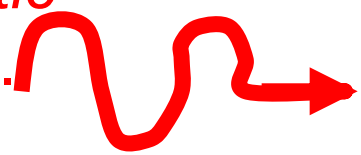


Review

Link to the Left Side of Equation:



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



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

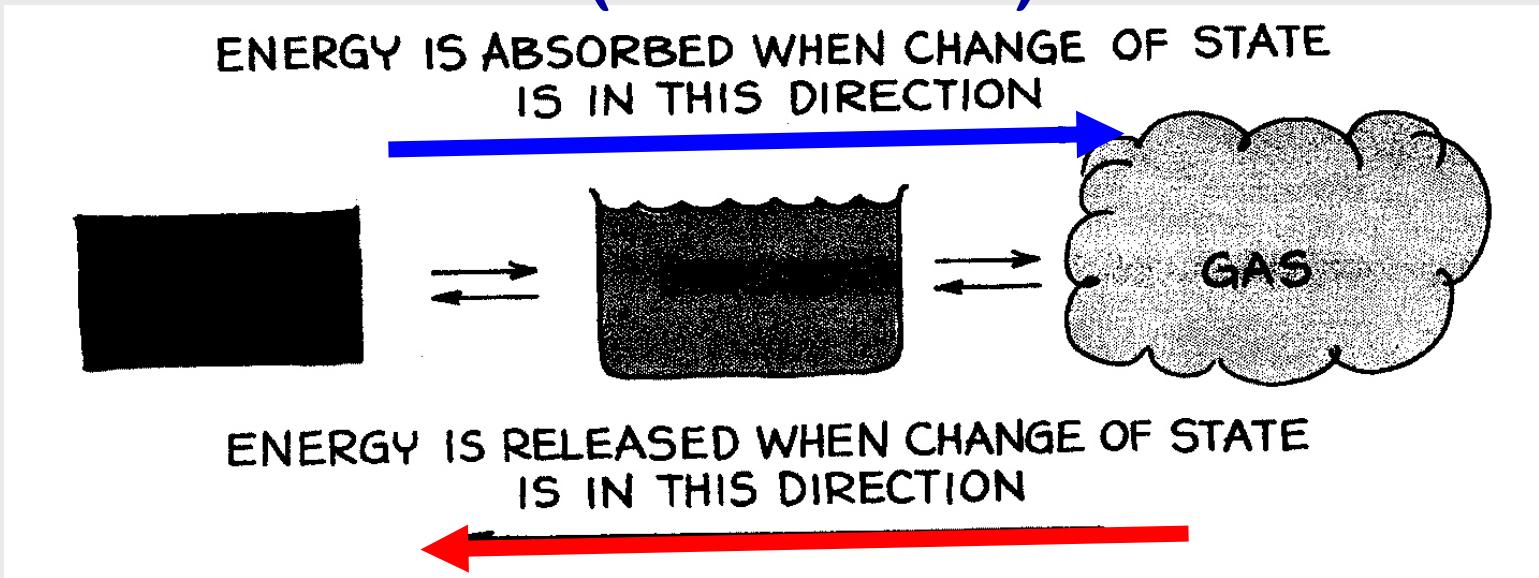
Link to the Right Side of Equation:

$$H + LE + G$$

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

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

review

H = sensible heat transfer

Sensible heat is the energy or heat of molecular motion. It can be "sensed" with a thermometer, and we "feel" it as heat, unlike LE.

- It is transferred by ***conduction*** from warmer to cooler objects (most common in solids);
- and by ***convection*** (large scale, mostly vertical, motion of gases or liquids)

Bottom p 73

LE = latent energy (latent heat) transfer

Latent energy is energy needed for ***phase changes*** in H_2O:

- LE is removed from the environment and "hidden" in H_2O during the evaporation of water and melting of ice => environment cools.
- LE is released to the environment from H_2O during condensation of water vapor and freezing of ice => environment warms.

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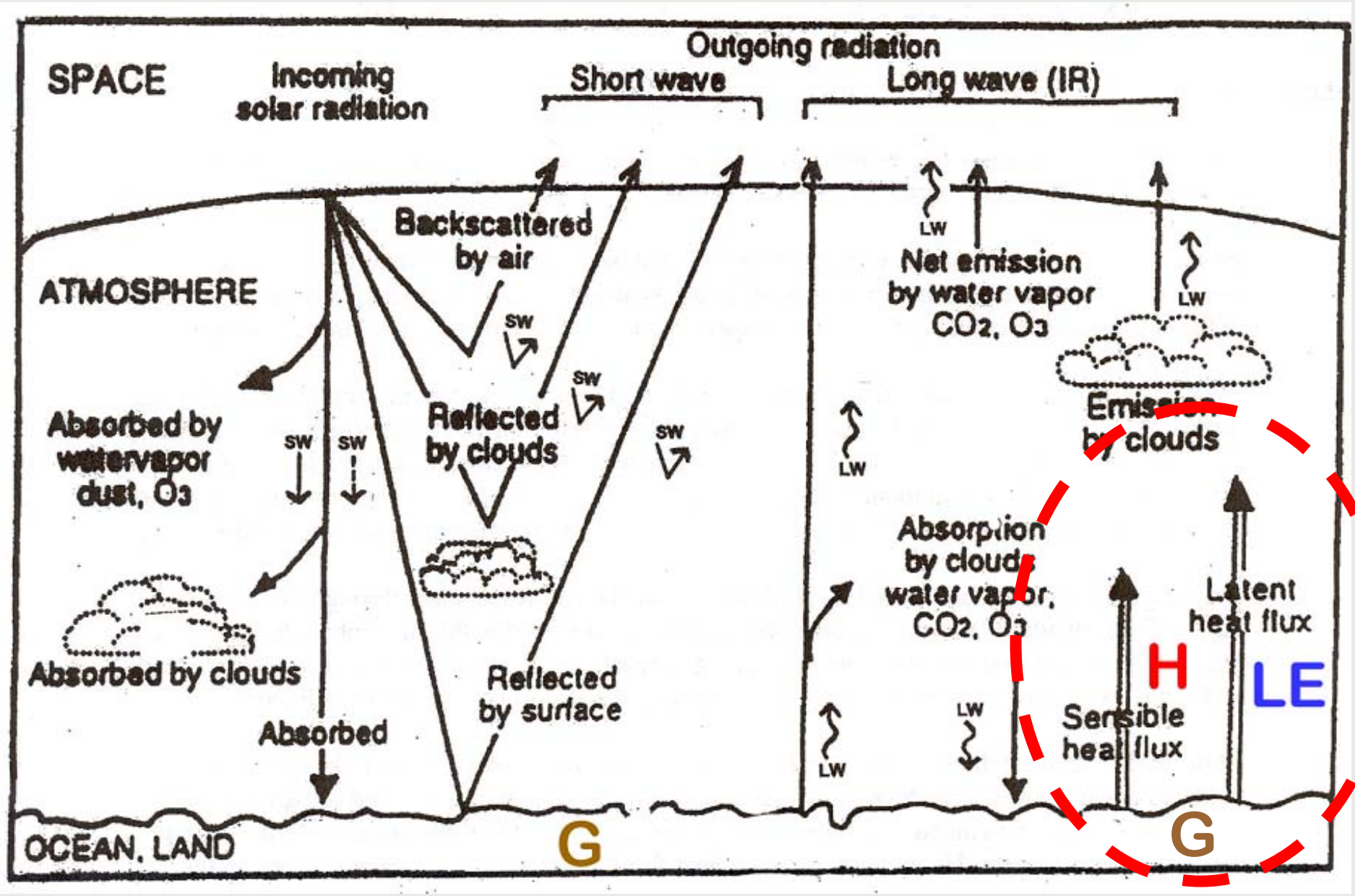
G = "ground storage," i.e. transfer of heat into the ground or soil; ground / soil heat flux

Heat *conducted* into soil (or water) and temporarily STORED there to be released later.

- **On a daily time scale, G is usually stored during the day and released at night.**
- **On an annual basis, G tends to be stored during the warm season and released during the cold season.**
- **Averaged over several years, G stored and G released balances out to be zero.**

Bottom p 73


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

Back to p 71

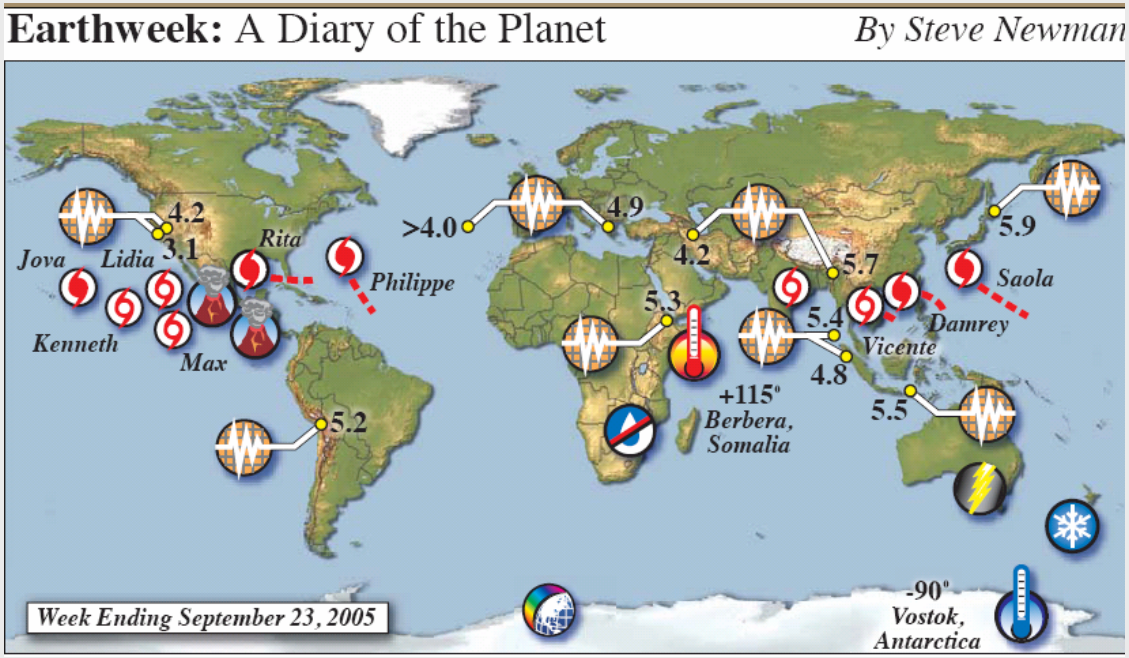
Encore: Energy Balance Animation

showing energy flow pathways
& "units" of energy that
eventually balance out:

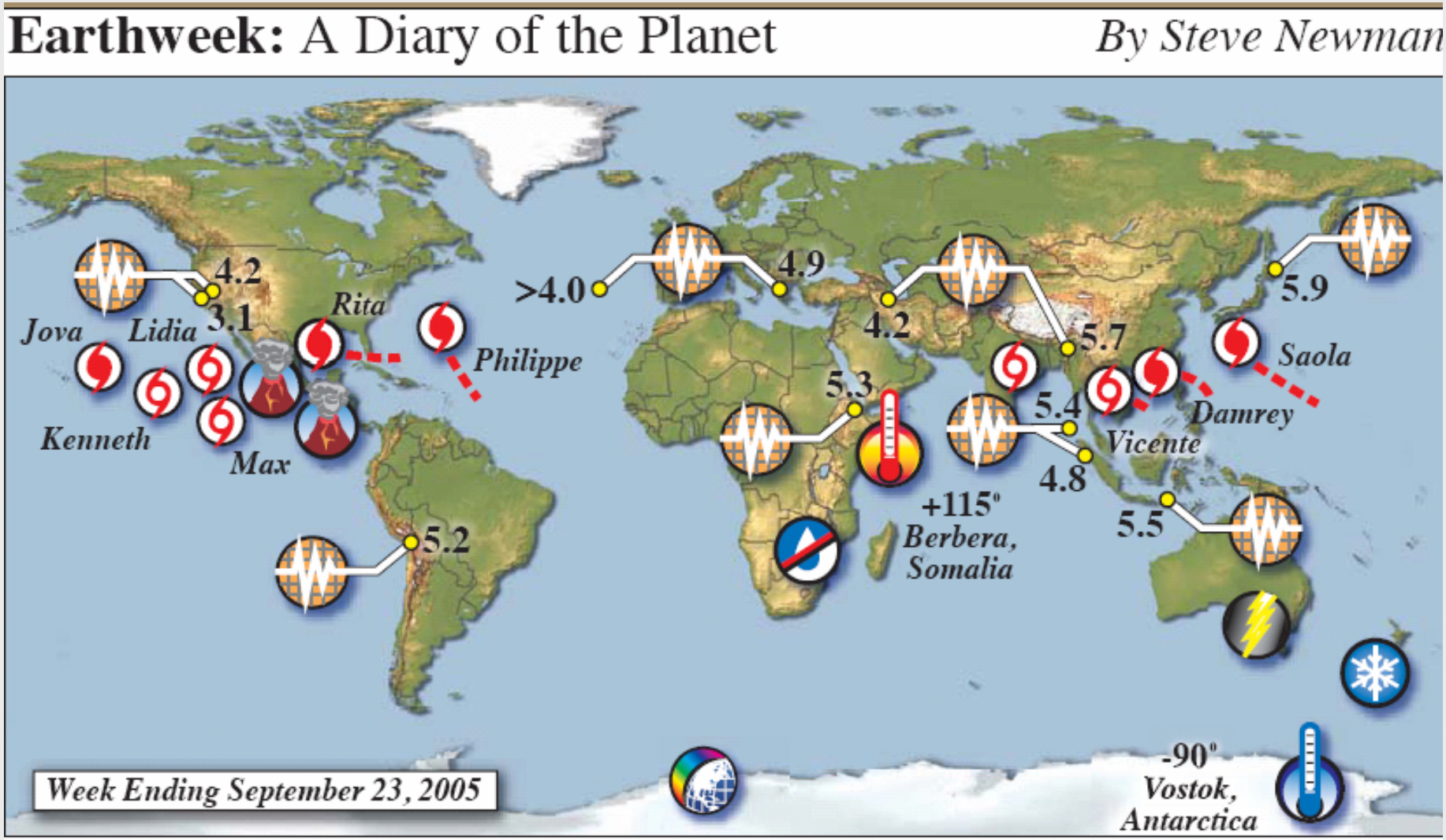
SHORTWAVE & LONGWAVE ENERGY FLOW & BUDGET:

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

SOME APPLICATIONS OF THE ENERGY BALANCE IN DIFFERENT PARTS OF THE GLOBE:



http://www.earthweek.com/



H + LE + G

More UV SW ↓ **reaches surface**

y of the Planet

Tropical Cyclones

Tidal surges and flash flooding from an unnamed tropical storm killed at least 55 people in Bangladesh and India.

- Typhoon Damrey unleashed flash flooding that killed two people in the northern Philippines. The storm was taking aim on far southern China late in the week.
- Eight people, including three children, were killed when Tropical Storm Vicente battered Vietnam's northern and central provinces.
- Typhoon Saola skirted Okinawa, and was predicted to brush southern Japan's Kyushu Island.
- After drenching the Florida Keys and Cuba's northern coast, Hurricane Rita was bearing down on Texas.
- Hurricane Philippe churned the North Atlantic. Hurricane Jova and tropical storms Kenneth, Lidia and Max passed over the open waters of the eastern Pacific.

SW ↓ SW ↗

Volcanoes

An explosive eruption of Mexico's Volcano of Fire was heard in villages up to 10 miles from the crater.

- **Red sunsets due to scattering of red wavelengths**
- **Possible cooling due to reflection of incoming SW**

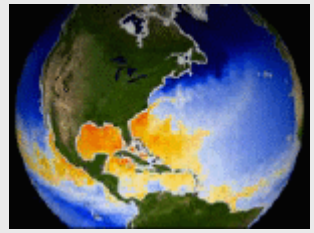
Ozone Hole Grows

The U.N. reported that the hole in the ozone layer above Antarctica has grown to near-record size this year, suggesting that 20 years of pollution controls have had little effect on the annual phenomenon. Geir Braathen, the World Meteorological Organization's top ozone expert, told a news briefing that the so-called ozone recovery has yet to be confirmed. Last month, U.S. scientists said that the Antarctic region's ozone layer had stopped shrinking, but recovery could take decades as previously released ozone-depleting chemicals filter out of the atmosphere. Chlorofluorocarbons containing chlorine and bromine have been blamed for thinning of stratospheric ozone because they interact with ozone molecules, causing them to break apart.

H + LE + G and Hurricanes:

http://www.nasa.gov/vision/earth/environment/HURRICANE_RECIPE.html

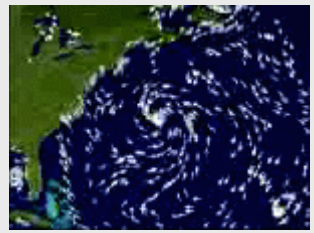
"Recipe for a Hurricane"



- Take warm water

(energy stored as "G" in ocean

Sea Surface Temperature (SST) > 82° F



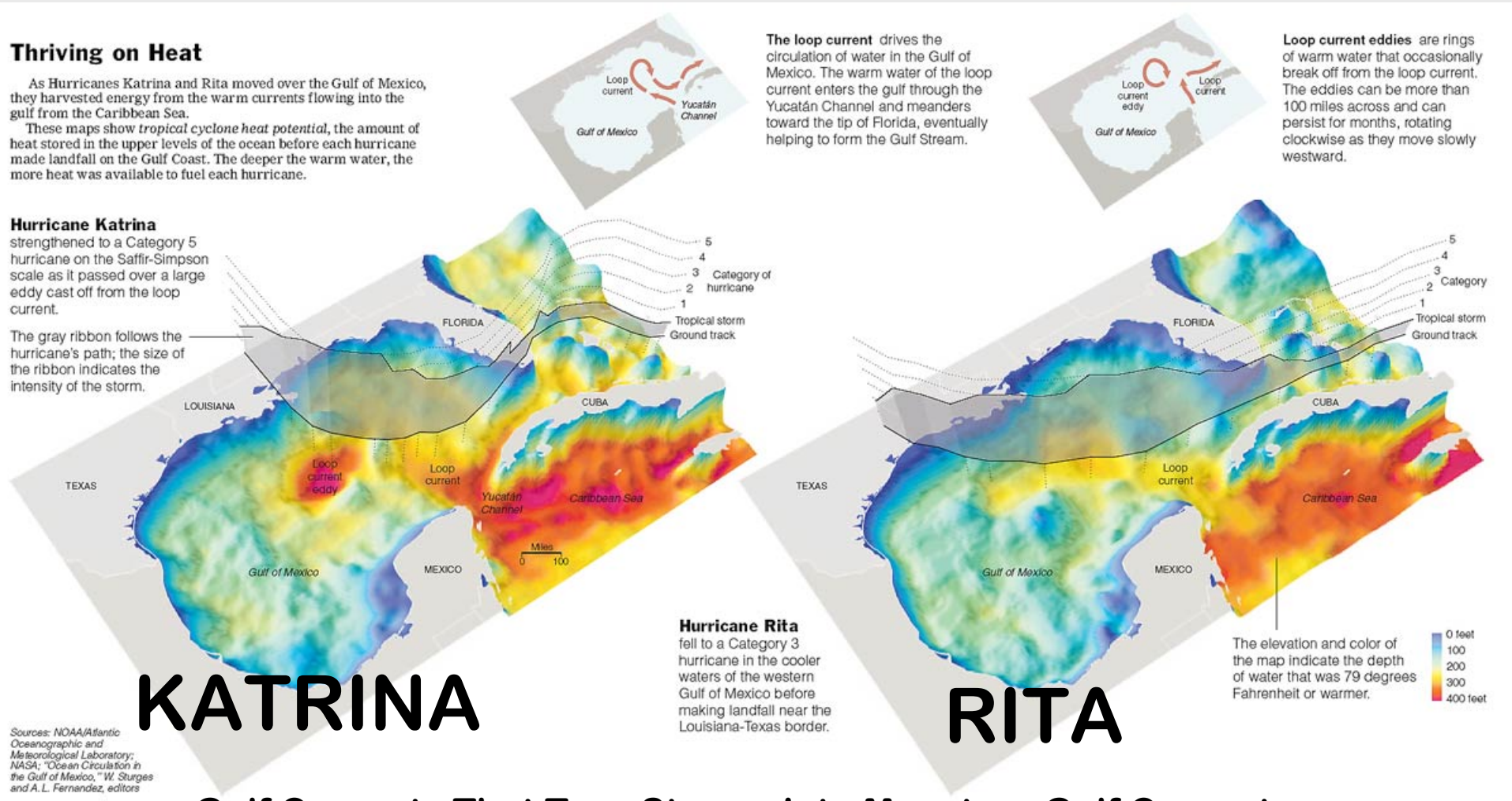
- Mix thoroughly (convection = H)

with right mix of SST's & winds,
Tropical Storm can develop

- Hurricane Heat Engine LE → H →LE

Evaporation process (LE) stores energy in water vapor,
this energy is released thru condensation when rain occurs (LE→H)
the sensible heat (H) released then drives MORE evaporation (LE)
etc. etc. etc.

THERMAL ENERGY & CONVECTION AT WORK
In Huricances Katrina & Rita



Gulf Currents That Turn Storms Into Monsters Gulf Currents

New York Times **9-26-05**

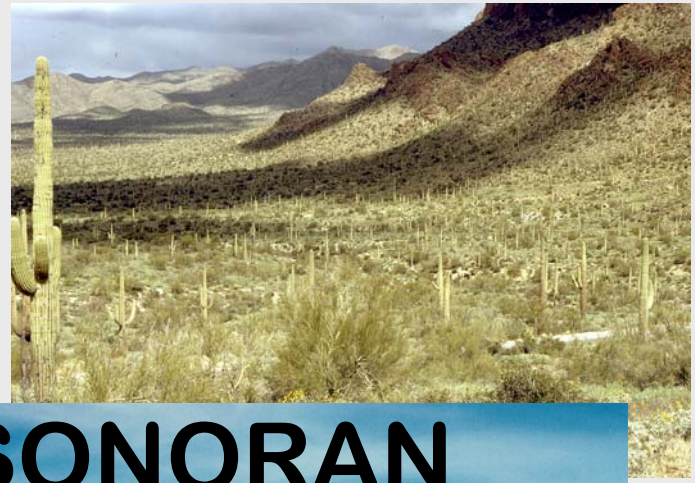
http://www.nytimes.com/2005/09/27/science/earth/27loop.html

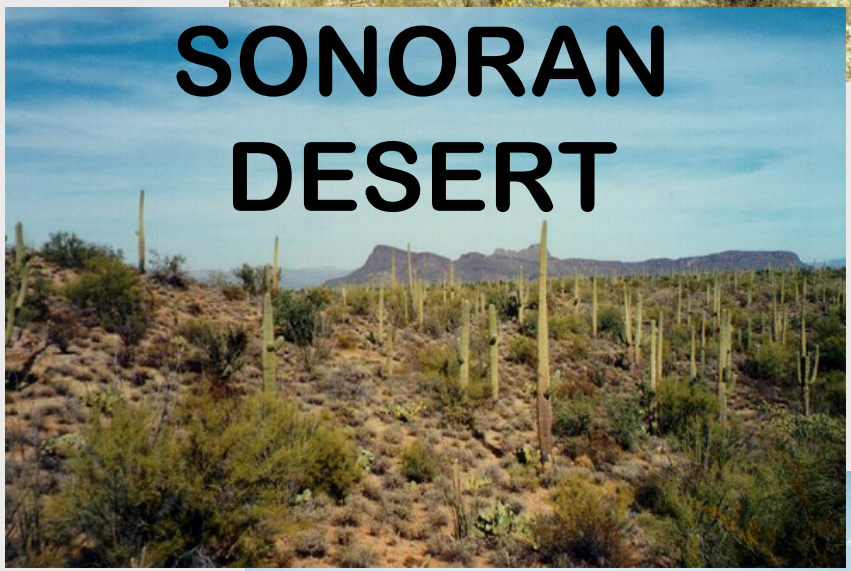
"Hurricanes feed on the energy from warm water.

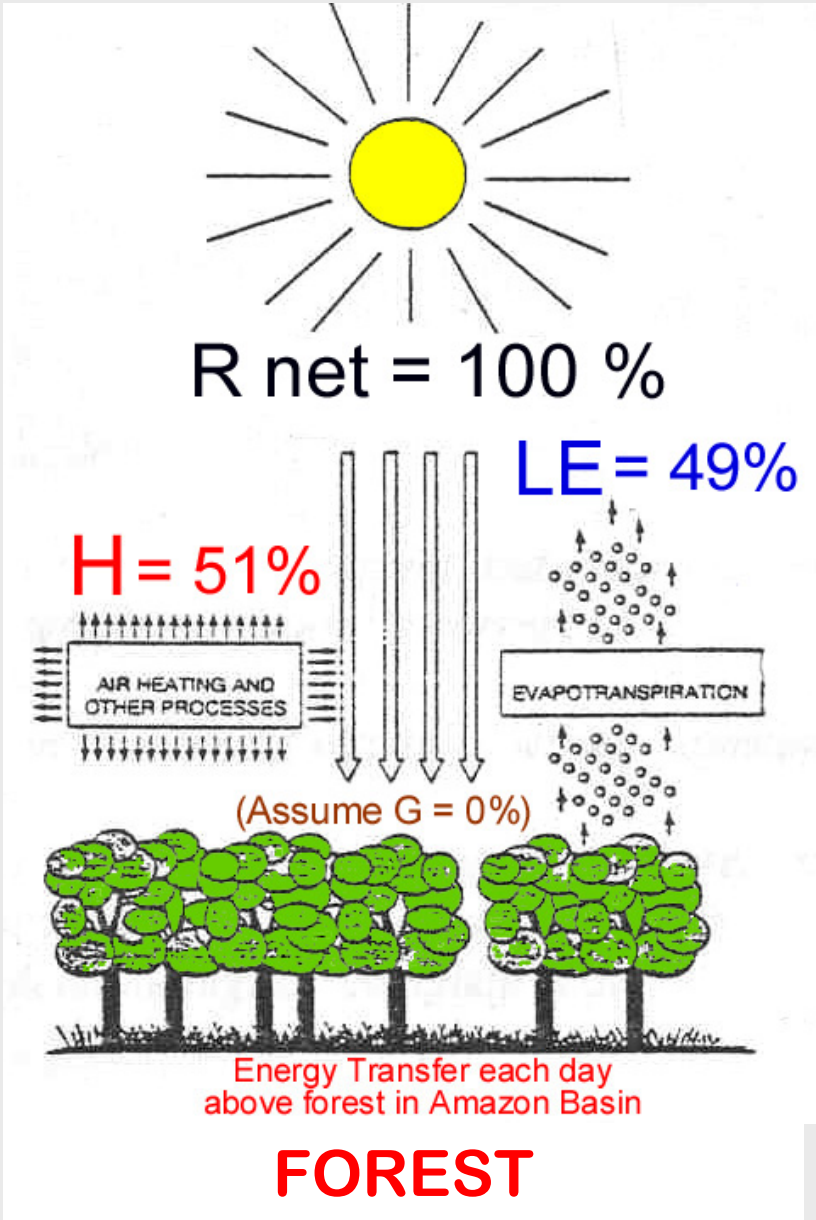
But while the gulf is often uniformly hot at the surface, that layer is so thin that it offers limited energy to hurricanes, which can stifle themselves as they churn along and draw up cooler waters from below.

But when such a storm passes over the loop current or one of its eddies, the water can be 79 degrees as much as 300 feet deep, meaning that no matter how much a passing hurricane stirs things up, it never exhausts its fuel supply." Andrew Revkin ,*New York Times,* 9-26-05

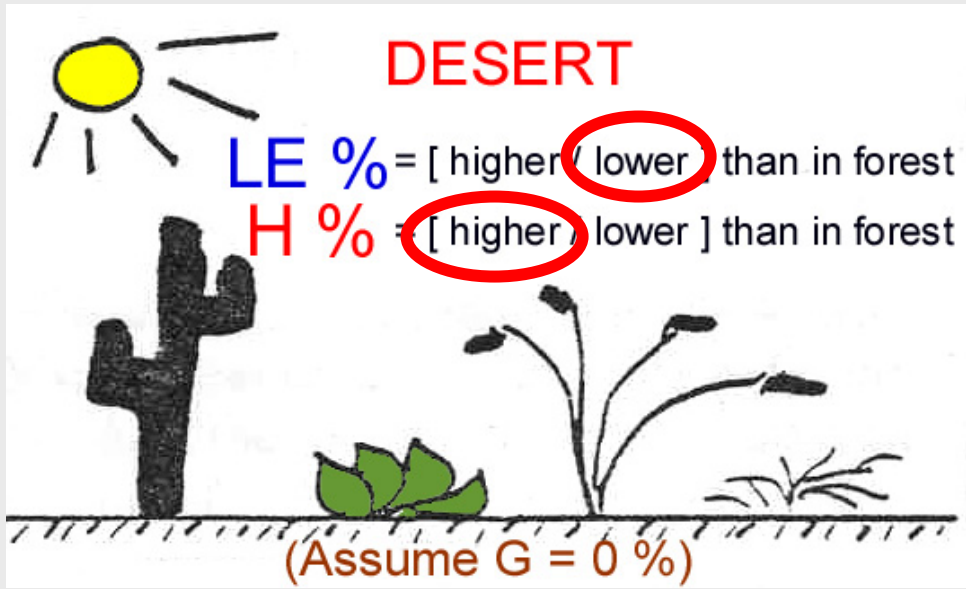

AMAZON RAIN
FOREST




SONORAN
DESERT

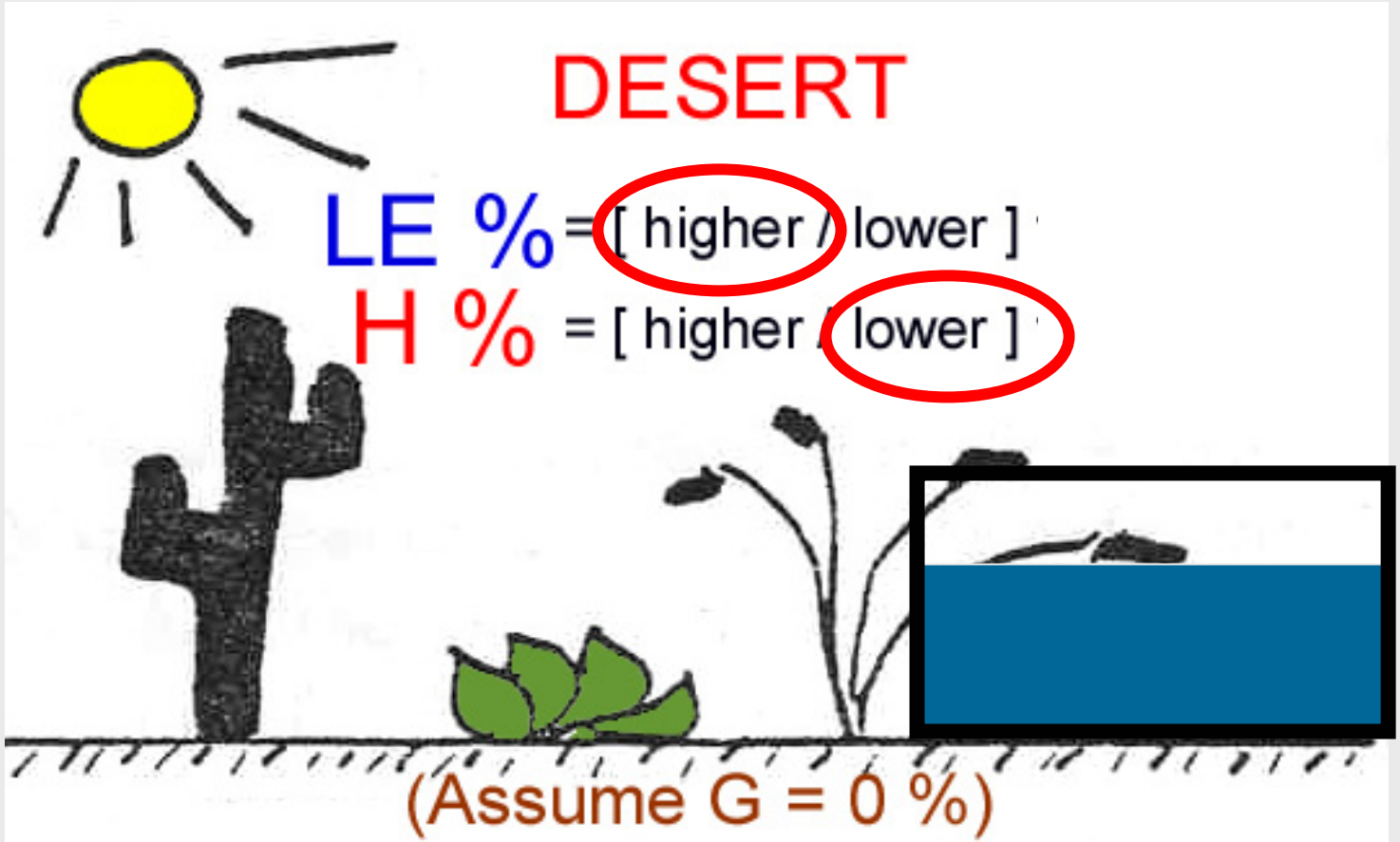


Will the % of net radiation in LE form be HIGHER or LOWER in the Desert, when compared to a Rainforest?



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

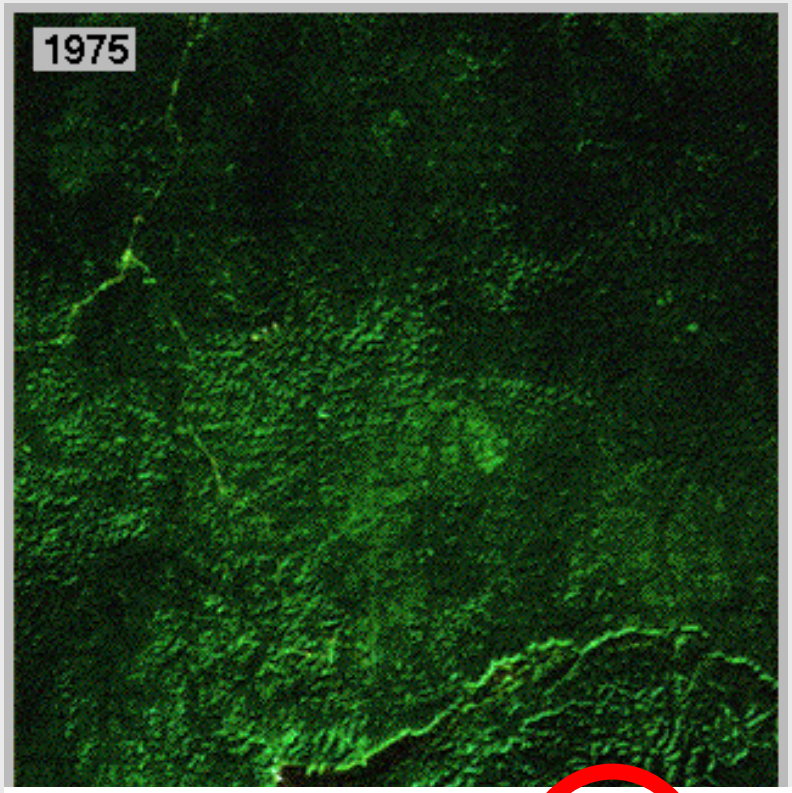
Central Arizona Project (CAP) Canal

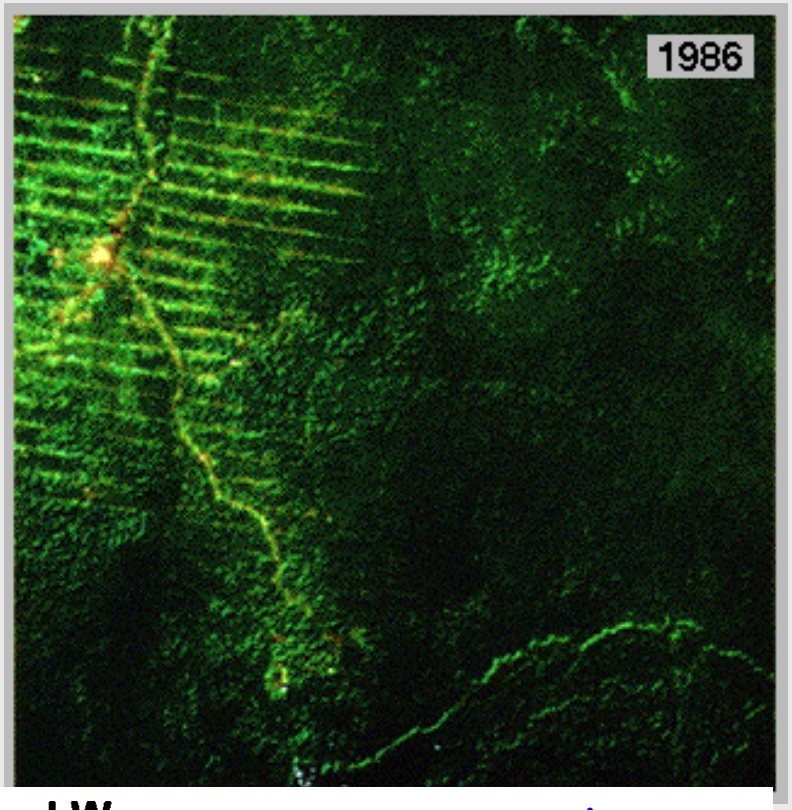


What if humans put in canals (CAP), lakes, & artificial water bodies in a desert?

How would the % of LE in the Desert change?

How does DEFORESTATION change the local energy balance???





$$R_{NET} = \downarrow_{SW} + \downarrow_{SW} - \uparrow_{SW} - \uparrow_{LW} + \downarrow_{LW} = H + LE + G$$

Less

More → cooler temperatures?

More → warmer temperatures?

FINISH G-3 ASSIGNMENT (10 pts)

Applying the Energy Balance Terms

Your task is to decide which component or components (working together) *are most directly related to* or *responsible for* the observed phenomenon.

 # 13 #14 #15

H + LE + G

13. Hot air balloon

14. Pigs cooling off in the mud

15. Evaporative coolers work best in the desert

TIME TO FINISH UP

G-3 ASSIGNMENT (10 pts) (cont.)

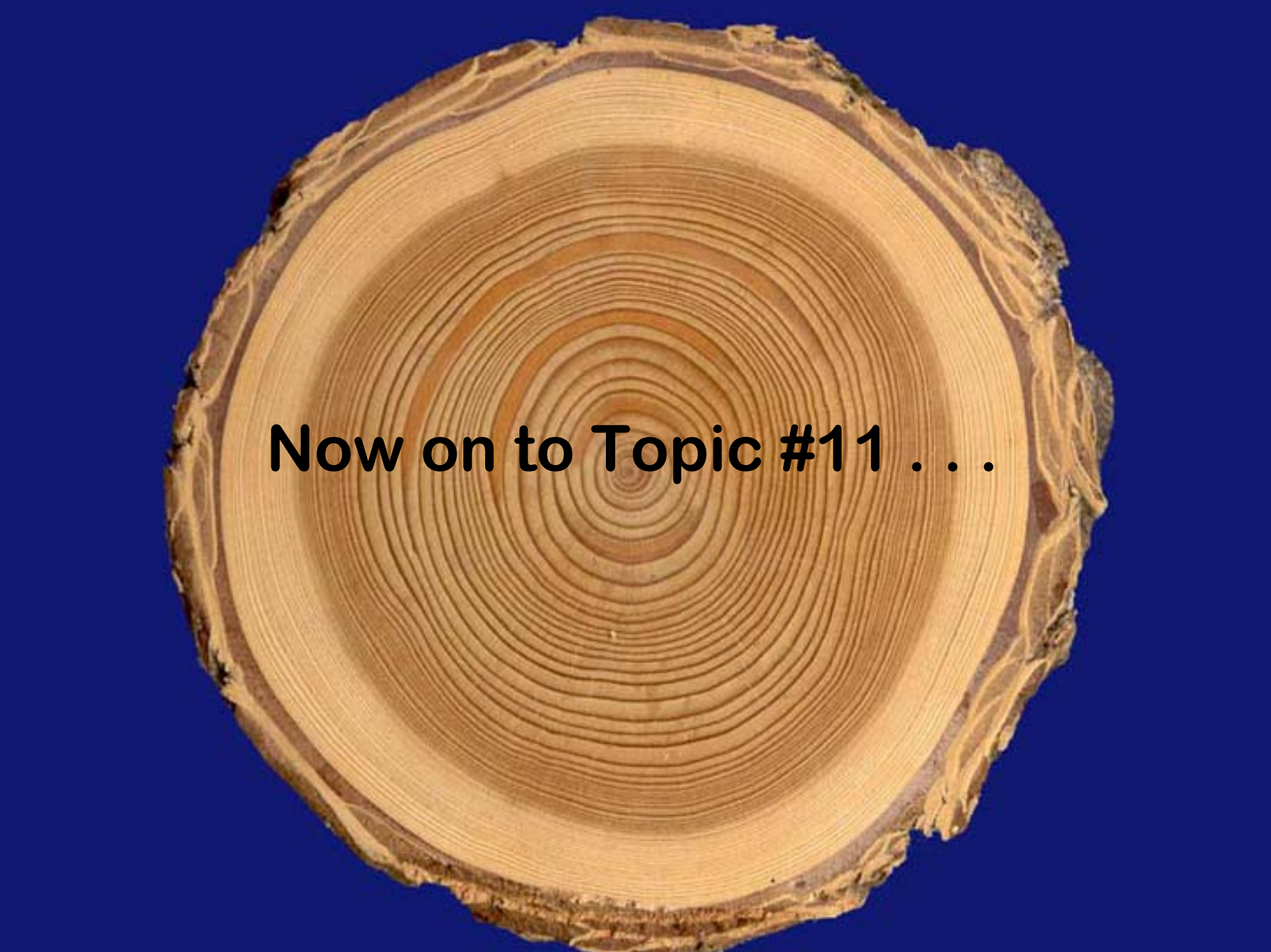
Applying the Energy Balance Terms

Your task is to decide which component or components (working together) *are most directly related to* or *responsible for* the observed phenomenon.

Each member of the group must take the lead in answering at least TWO of the items below *without* asterisks ** in his or her own handwriting. Members present should sign below and indicate which 2 or 3 items they filled in, e.g.: Katherine K. Hirschbeck (#2, #10, & #12)

_____ _____

Don't forget to SIGN IN with the #'s you wrote up!

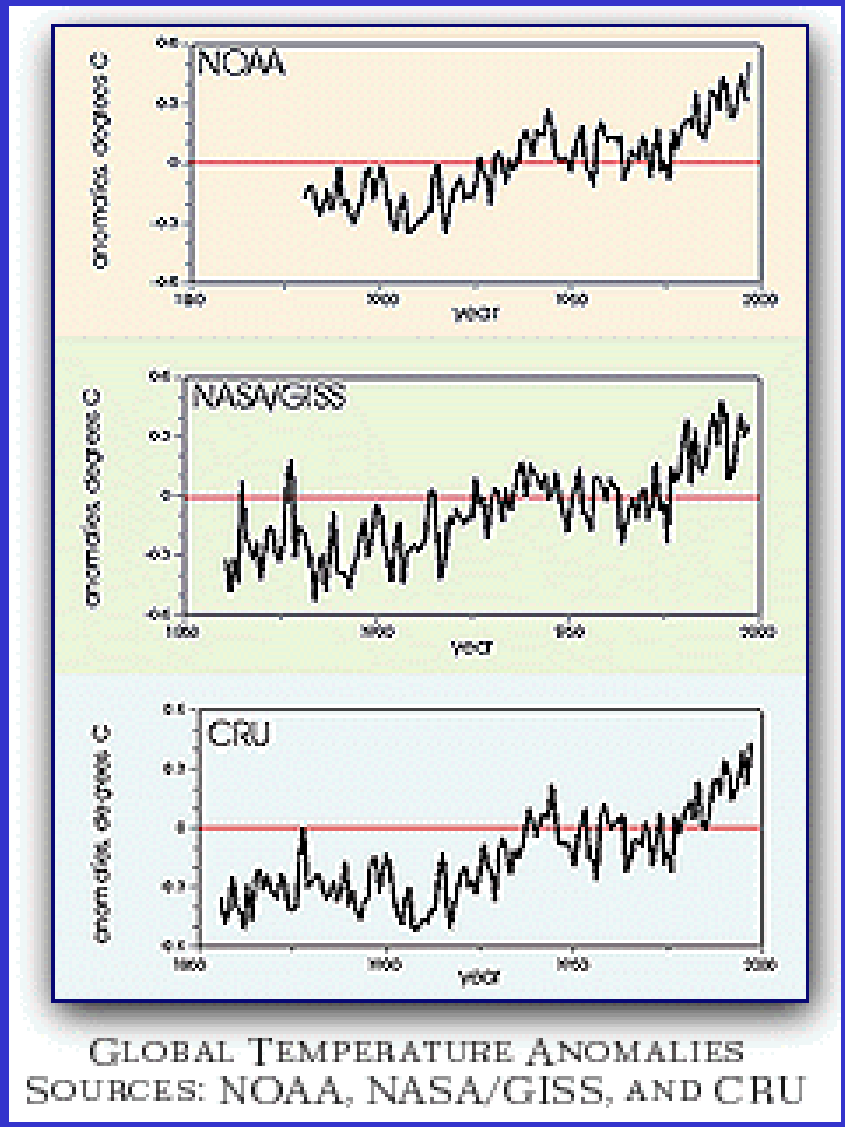

Now on to Topic #11 . . .

TOPIC #11 – Detecting Past Global Changes: INTRODUCTION TO TREE RINGS & DENDROCHRONOLOGY

DETECTING GLOBAL WARMING:

INSTRUMENTAL RECORD

Thermometer-based Temperature Trends



GLOBAL TEMPERATURE ANOMALIES
SOURCES: NOAA, NASA/GISS, AND CRU

To make an incontrovertible case about the role that humans play in global warming, what do scientists need?

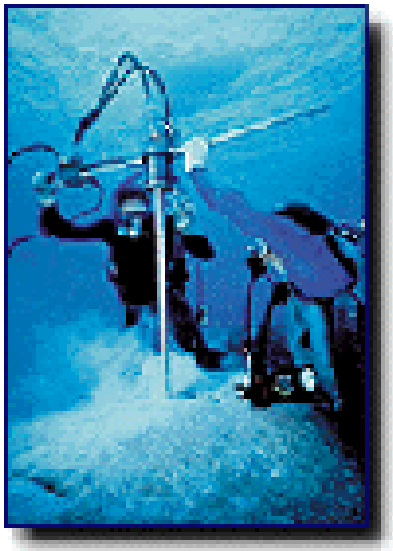
(a) a long-term temperature record (many centuries)

(b) that represents a large part of the globe

(c) . . . . so we can look over the long term record and say, “What's the average been for several hundred years, and is recent warming a significant departure from that average?”

So how do we get long-term temperature records?

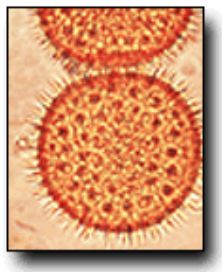
FROM TOOLS CALLED: "PROXY" DATA *or* "NATURAL ARCHIVES" of CLIMATE



Corals

Ice cores

Lake, bog & ocean sediments

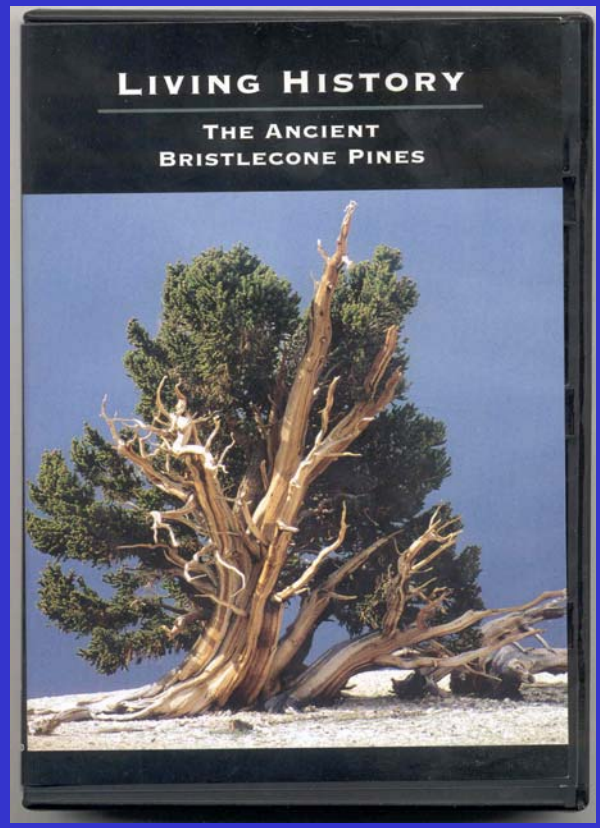


Pollen

Dendrochronology is the dating and study of annual rings in trees:

- ***chronos***: time, or more specifically events in past time
- ***dendros***: from trees, or more specifically the growth rings of trees
- ***ology***: the study of . . .

We then watched a 20-minute video/DVD →



ASSIGNMENT I-3 on Tree-Ring Crossdating was assigned at the end of class.