GLOBAL CHANGE in the News!

Green

A Blog About Energy and the Environment

October 18, 2010, 2:05 PM

Lake Mead Hits Record Low Level

By FELICITY BARRINGER

Jim Wilson/The New York Times

Bleached rock indicating a former high-water mark on outcroppings surrounding Lake Mead.

Living

Sometime between 11 and noon on Sunday, the water level in Lake Mead, the massive reservoir whose water fills the taps of millions of people across the Southwest, fell lower than it ever has since it was filled 75 years ago.

http://green.blogs.nytimes.com/2010/10/18/lake-mead-hits-record-low-level/?hp

GLOBAL CHANGE in the News!

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

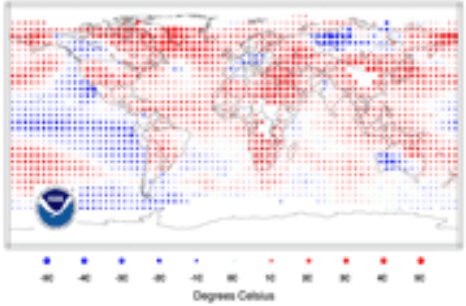
NOAA: Year-to-Date Global Temperature Ties for Warmest on Record

Arctic sea ice reaches its third lowest minimum extent on record

October 15, 2010

The first nine months of 2010 tied with the same period in 1998 for the warmest combined land and ocean surface temperature on record. The global average land surface temperature for January-September was the second warmest on record, behind 2007. The global ocean surface temperature for January–September was also the second warmest on record, behind 1998.

The monthly analysis from NOAA's National Climatic Data Center, which is based on records going back to 1880, is part of the suite of climate services NOAA provides government, business and community leaders, so they can make informed decisions.



Temperature Anomolies, September 20

High Resolution (Credit: NOAA)

Global Temperature Highlights

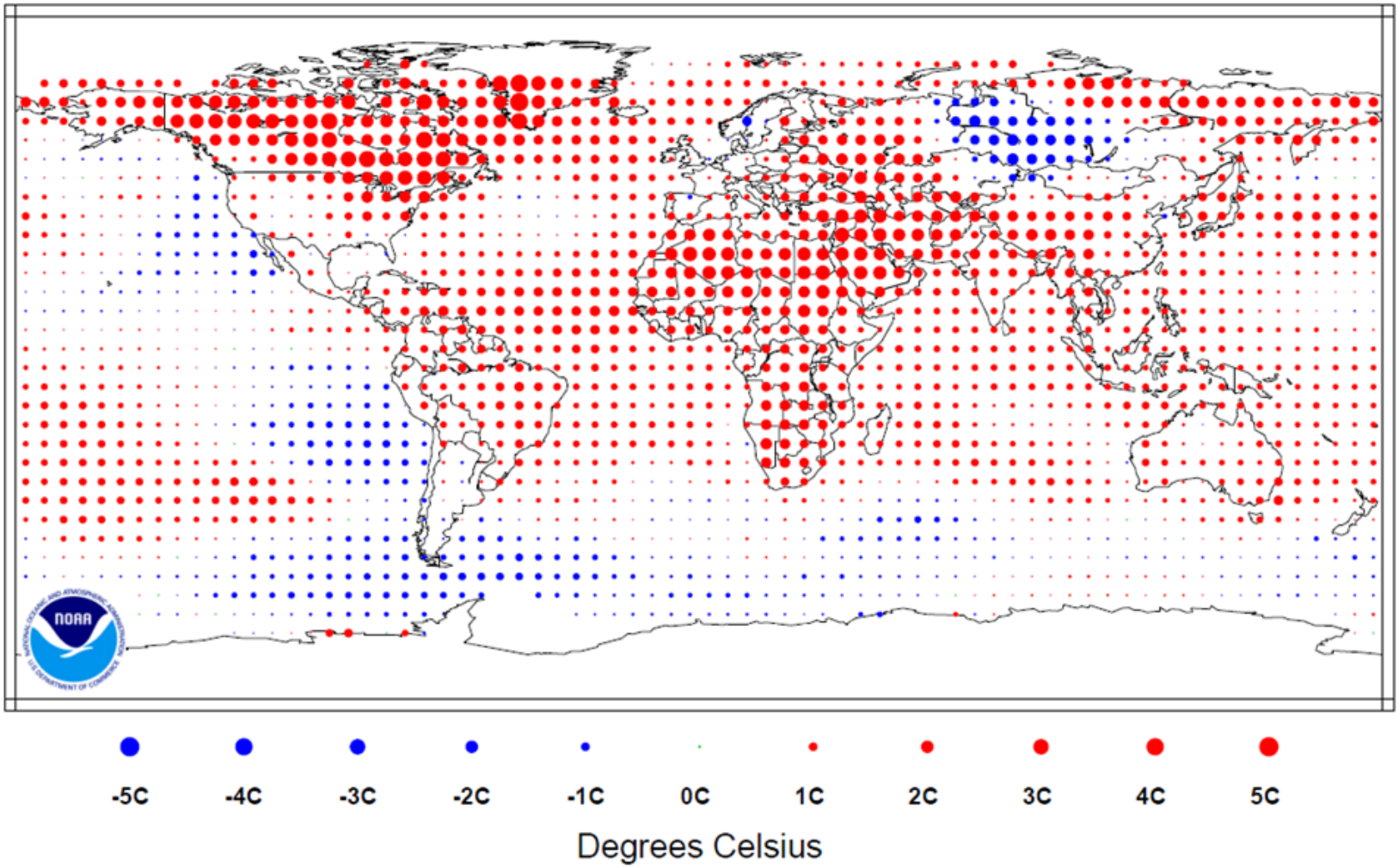
» For the year-to-date, the global combined land and ocean surface temperature of 58.67 F (14.75 C) tied with 1998 as the warmest January-September period or record. This value is 1.17 F (0.65 C) above the 20th century average.

http://www.noaanews.noaa.gov/stories2010/20101015_globalstats.html

Temperature Anomalies Jan-Sep 2010

(with respect to a 1971-2000 base period)

National Climatic Data Center/NESDIS/NOAA



But some positive news about possible solutions too!

http://azstarnet.com/business/local/article_429f06a4-f33b-54b5-b541-6cd45e170c57.html

Arizona Daily Star SN www.azstarnet.com
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Home News Sports Opinion Entertainment Lifestyles Cla

SOLAR-POWER PLANT ACTIVATED

1-megawatt facility expected to create jobs, curb pollution

Alex Dalenberg Arizona Daily Star | Posted: Tuesday, October 19, 2010 12:00 am | Comments

RON MEDVESCEK / ARIZONA DAILY STAR
Here are some of the 3,700 panels at the solar plant, dedicated Monday at 3035 W. El Camino del Cerro. The plant will provide electricity to the Roger Road Wastewater Reclamation Facility.

Government officials and solar-power leaders hailed the activation Monday of a 1-mega-watt solar plant on Tucson's north side as a job-creating, money-saving, pollution-reducing boon to Pima County.

The plant's 3,700 solar panels were built locally by Solon Corp., a solar technology manufacturer, at its factory in Tucson. SunEdison, a solar energy services provider, funded the plant.

The roughly 2-acre photovoltaic plant will help power the Roger Road Wastewater Reclamation Facility, 3035 W. El Camino del Cerro, and is the largest of its kind to be deployed within Pima County, according to a fact sheet provided by county supervisors.

Because the solar plant was financed by SunEdison, Pima County taxpayers paid no up-front capital costs for the system. The county will buy energy generated by the plant from SunEdison for the duration of a 20-year contract. Solon Corp. will operate and maintain the plant under contract with SunEdison.

Arizona Daily Star www.azstarnet.com

CONFERENCE HERE FOCUSES ON ALTERNATIVE PATHWAYS TO EFFICIENT SOLAR POWER

Scientists look to tap sun in new ways

Tom Beal Arizona Daily Star | Posted: Sunday, October 17, 2010 12:00 am | Comments

The next generation of solar collectors might be thinner and still collect nearly every wavelength of the energy contained in sunshine. They might be painted on our roofs and their orientation toward the sun might not even matter.

We might use the sun to generate electricity from the proteins in spinach or the iron in bacteria.

We might each have a handy little reactor that heats and cools our homes with sunlight and water and may drive cars that run on fuel made in a similar process.

One thing is clear, say researchers at the experimental edge of alternatives to fossil fuels, the sun is the only source that can supply all of our future needs.

We just need to think beyond the conventional solar panel.

Many of the young scientists who gathered at the University of Arizona's Biosphere 2 in the past week, under the auspices of the Research Corporation for Science Advancement, are investigating aspects of artificial photosynthesis.

Others are looking for ways to overcome the physical barrier that keeps standard solar cells from being more than 33 percent efficient. Still others want to generate electricity from biological processes.

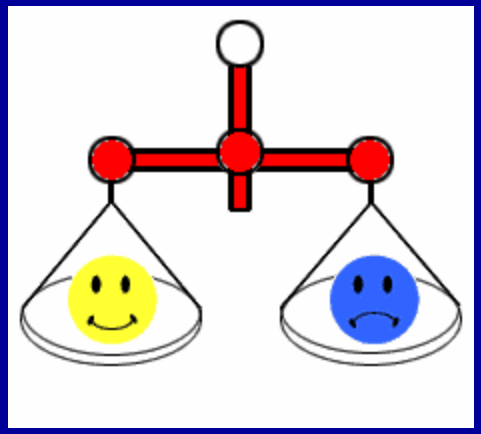
http://azstarnet.com/news/science/environment/article_79fe7daf-d135-578f-af64-6e03b1728bb4.html?mode=story

Topic # 10
THE EARTH'S GLOBAL ENERGY BALANCE

Applying the laws, etc. to understand how processes all work together to create global weather & climate!!

➔ BOOKMARK pp 49 & 122
in Class Notes now for lecture today

Today's Quote:
A Different Sort of "ENERGY BALANCE":



Look at life as an energy economy game. Each day, ask yourself,

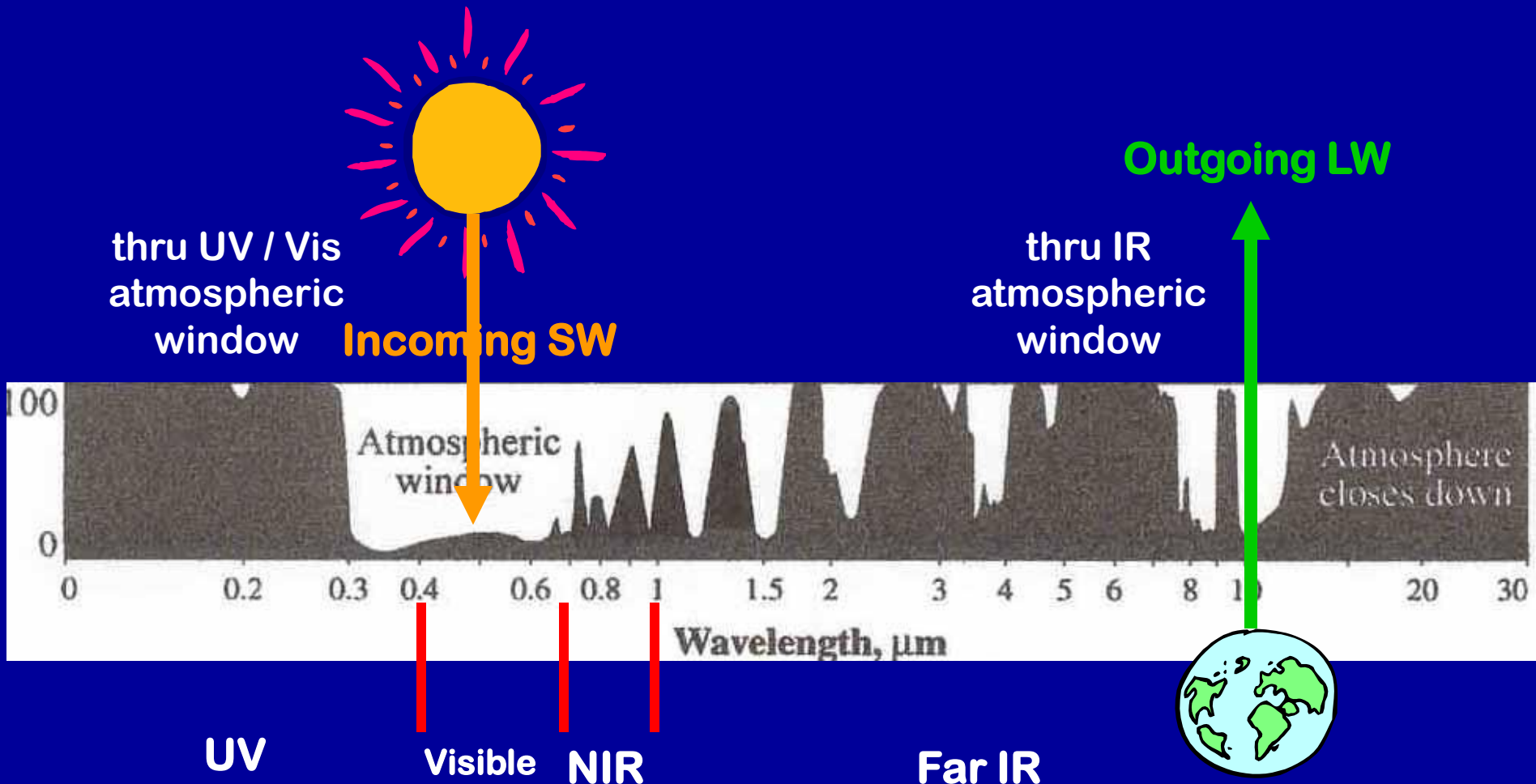
Are my energy expenditures (actions, reactions, thoughts, and feelings) productive or nonproductive?

During the course of my day, have I accumulated more stress or more peace?

~ Doc Childre and Howard Martin

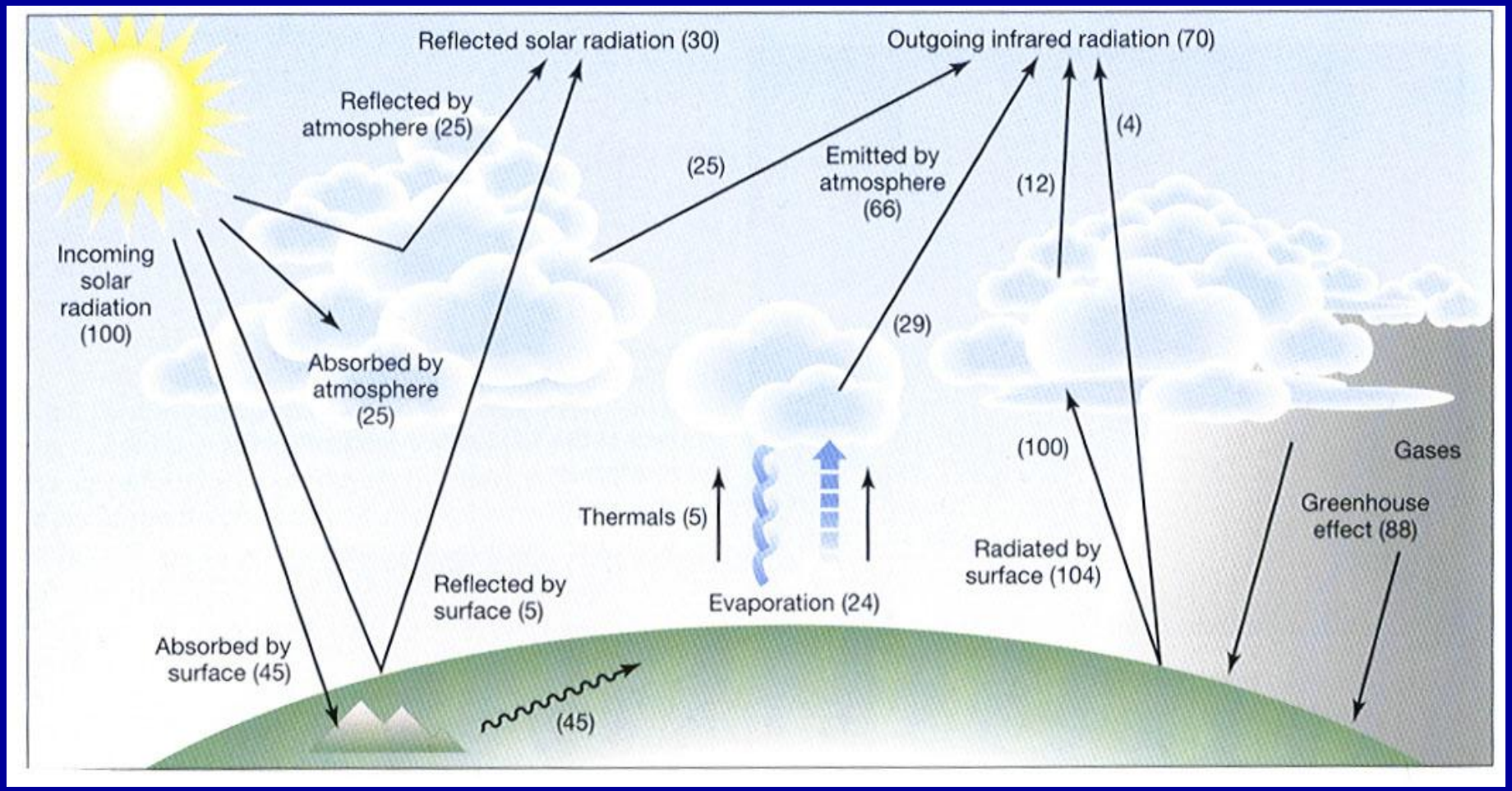
Review: Absorption curve for the "Whole Atmosphere"

OVERALL BALANCE: **Incoming = Outgoing**



Review

Typical Energy Balance Diagram



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

From SGC-I Chapter 3, p 50, Fig 3-19

Similar to p 49 in Class Notes

Energy Balance Equation:

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

(one of several ways this equation can be written)

Let's try to find an easy way to understand and remember all the components of the Earth's Energy Balance

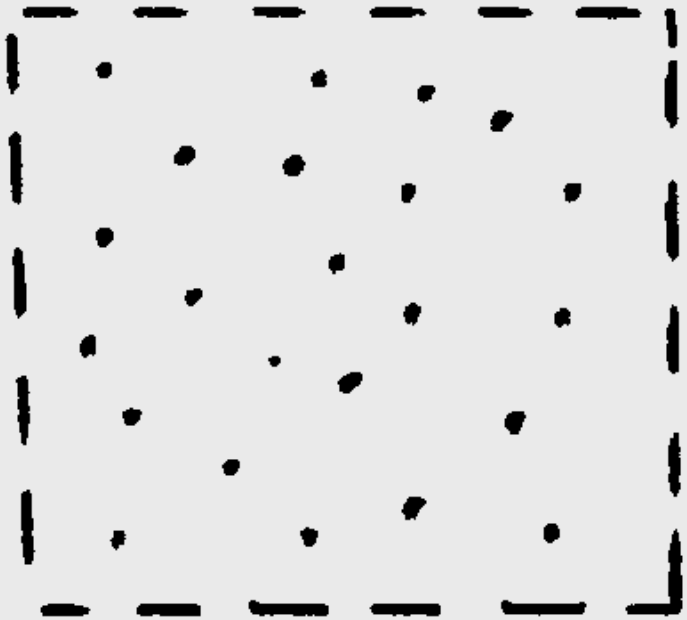
We'll use "cartoon symbols" . . .

“CARTOON” SYMBOLS:

To represent the Earth’s surface:

Go to p 122

“CARTOON” SYMBOLS:



To represent the atmosphere – composed of both invisible gases, aerosols, dust and other particulate matter:

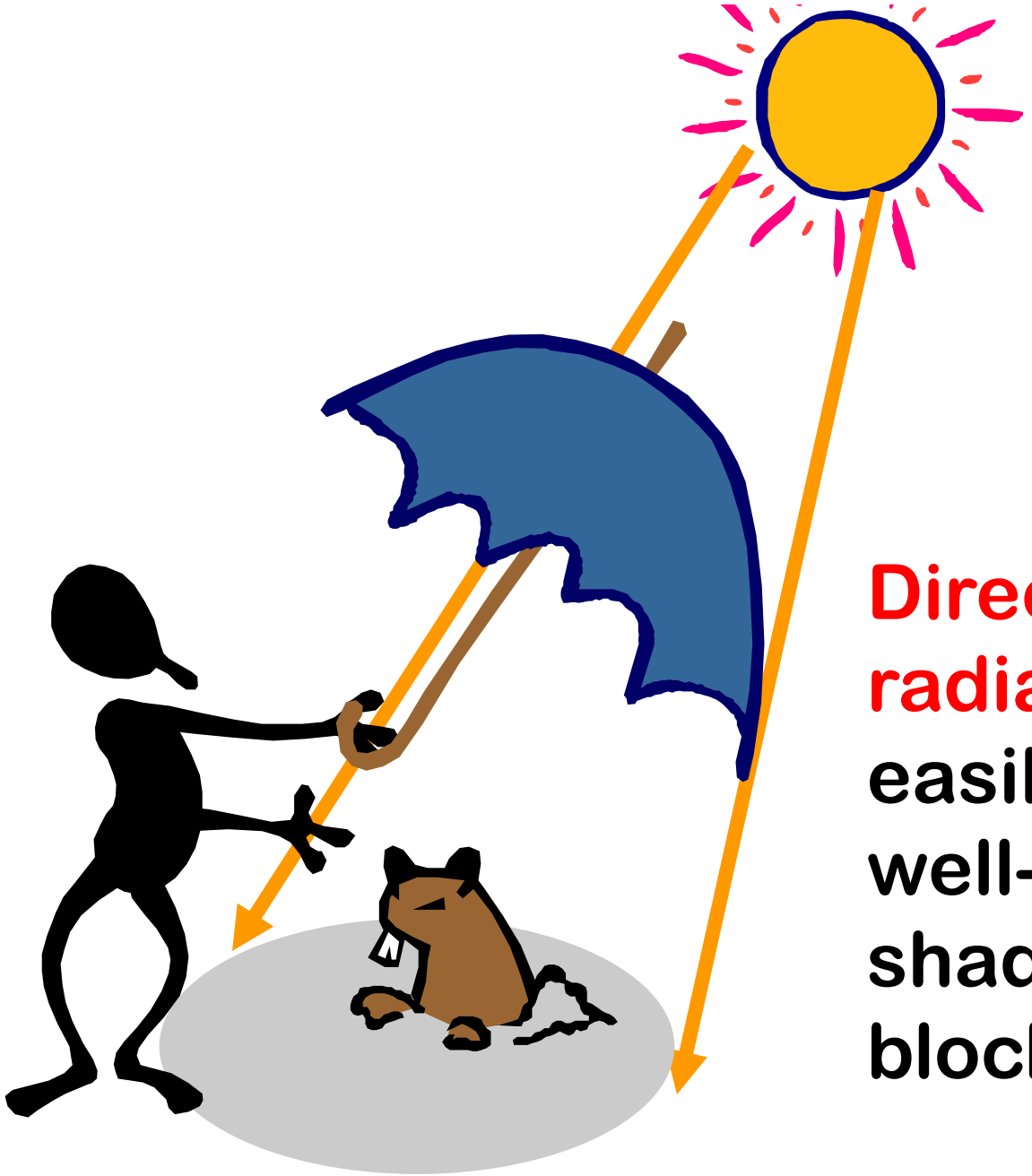
p 122

“CARTOON” SYMBOLS:

To represent CLOUDS

"CARTOON" SYMBOLS:

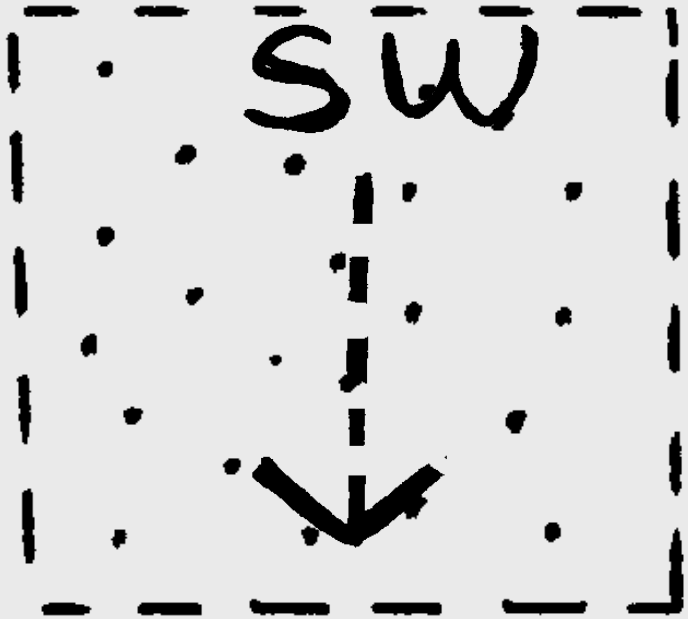
To represent SOLAR (shortwave) radiation coming in DIRECTLY.
(aka Direct shortwave radiation)



Direct SW radiation easily casts well-defined shadows when blocked

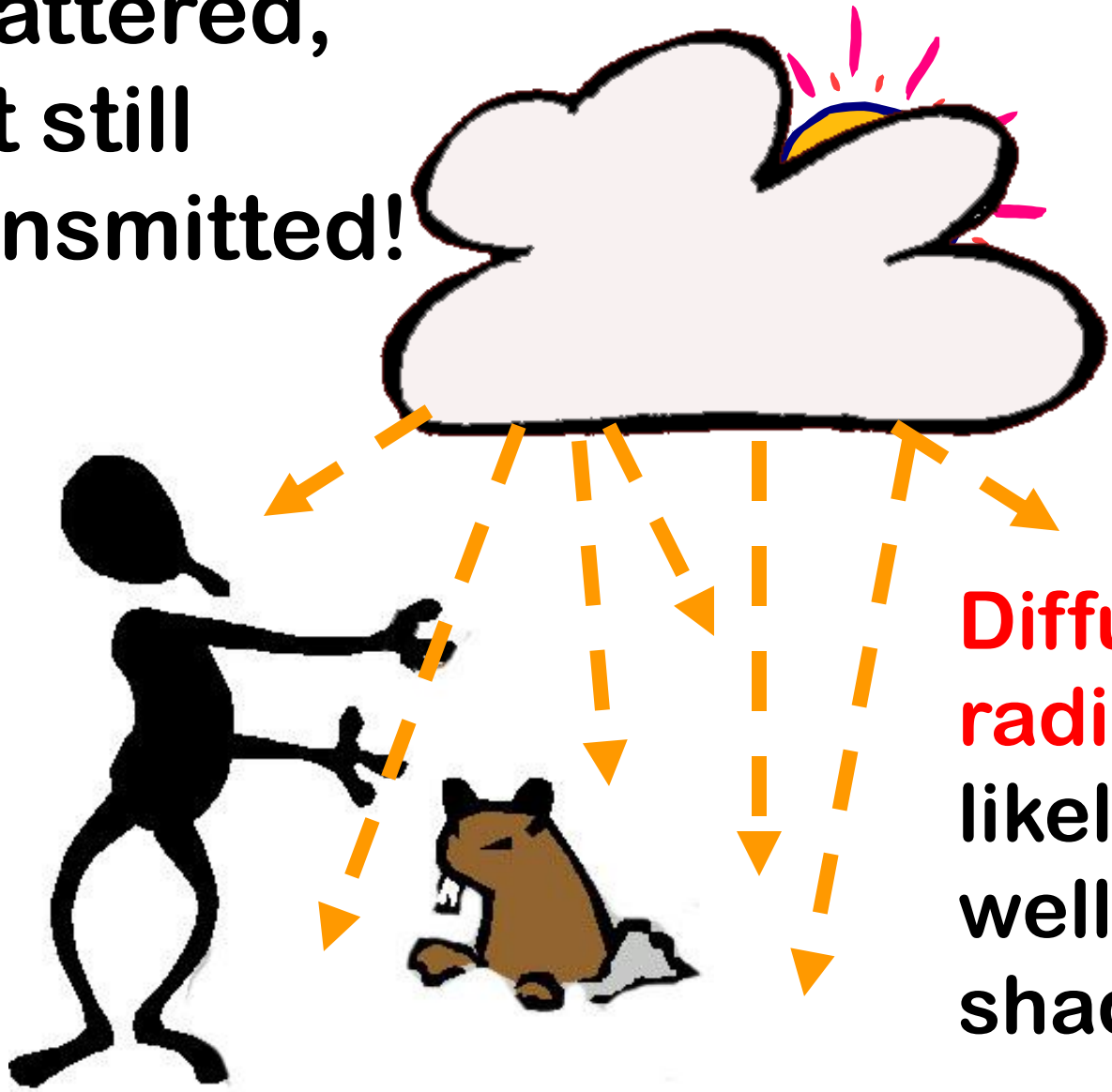
Take notes

"CARTOON" SYMBOLS:



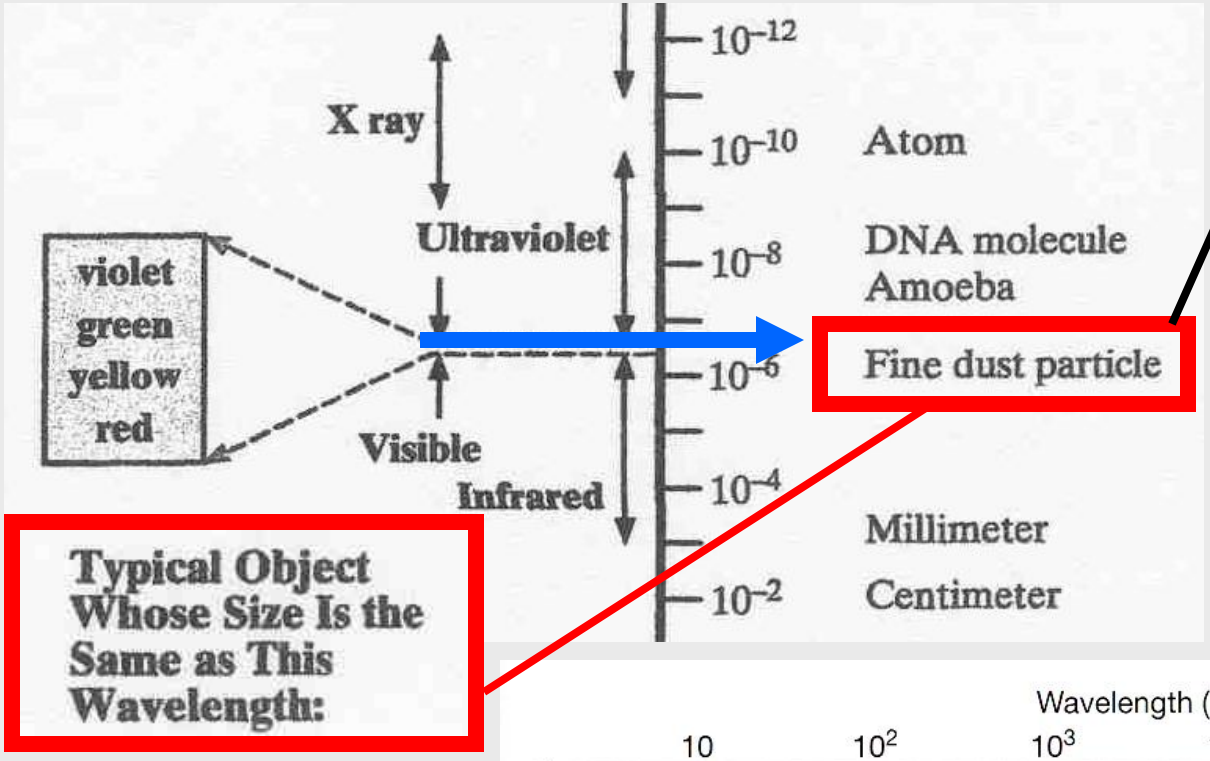
To represent SOLAR (shortwave) radiation coming in as **DIFFUSE shortwave radiation**, i.e. scattered by gases, clouds, and particles in the atmosphere.

Scattered, but still transmitted!



Diffuse SW radiation is less likely to cast a well-defined shadow!

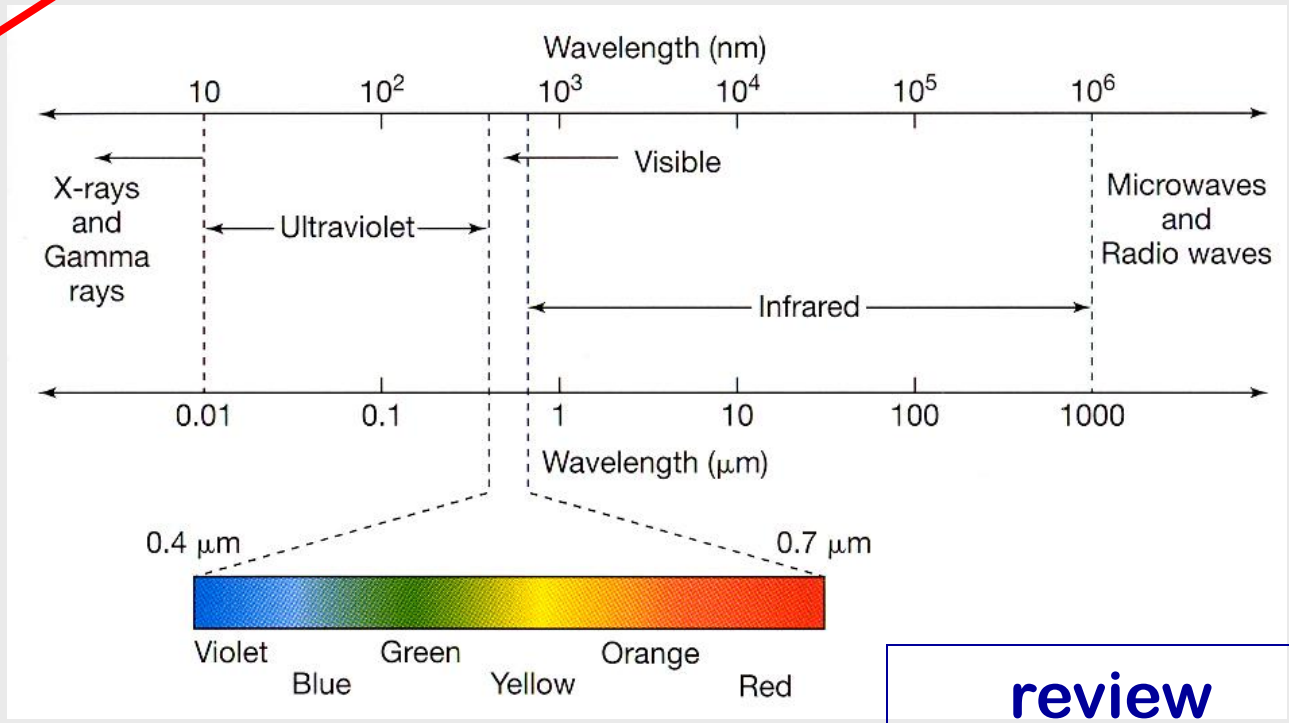
Take notes



Different sized dust particles, water droplets, aerosols,

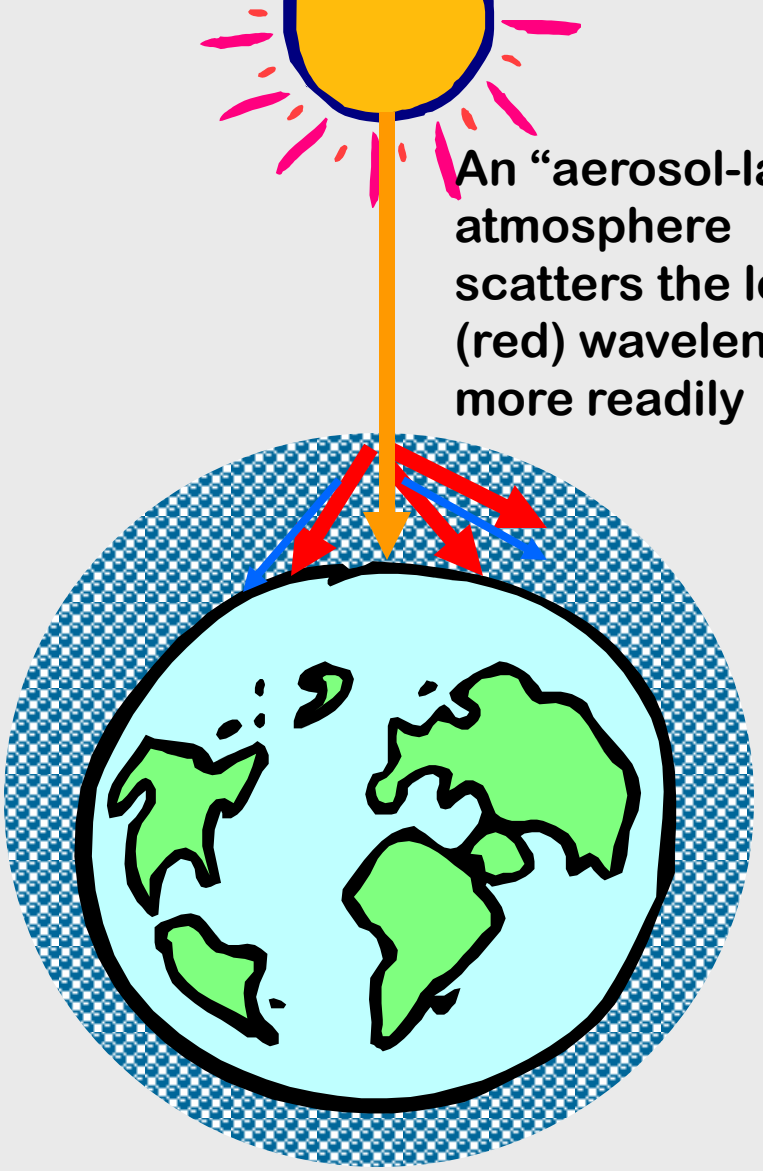
(even gas molecules themselves)

Scattering of visible light



review

"Clear" atmosphere composed primarily of fine particles, water droplets, gas molecules



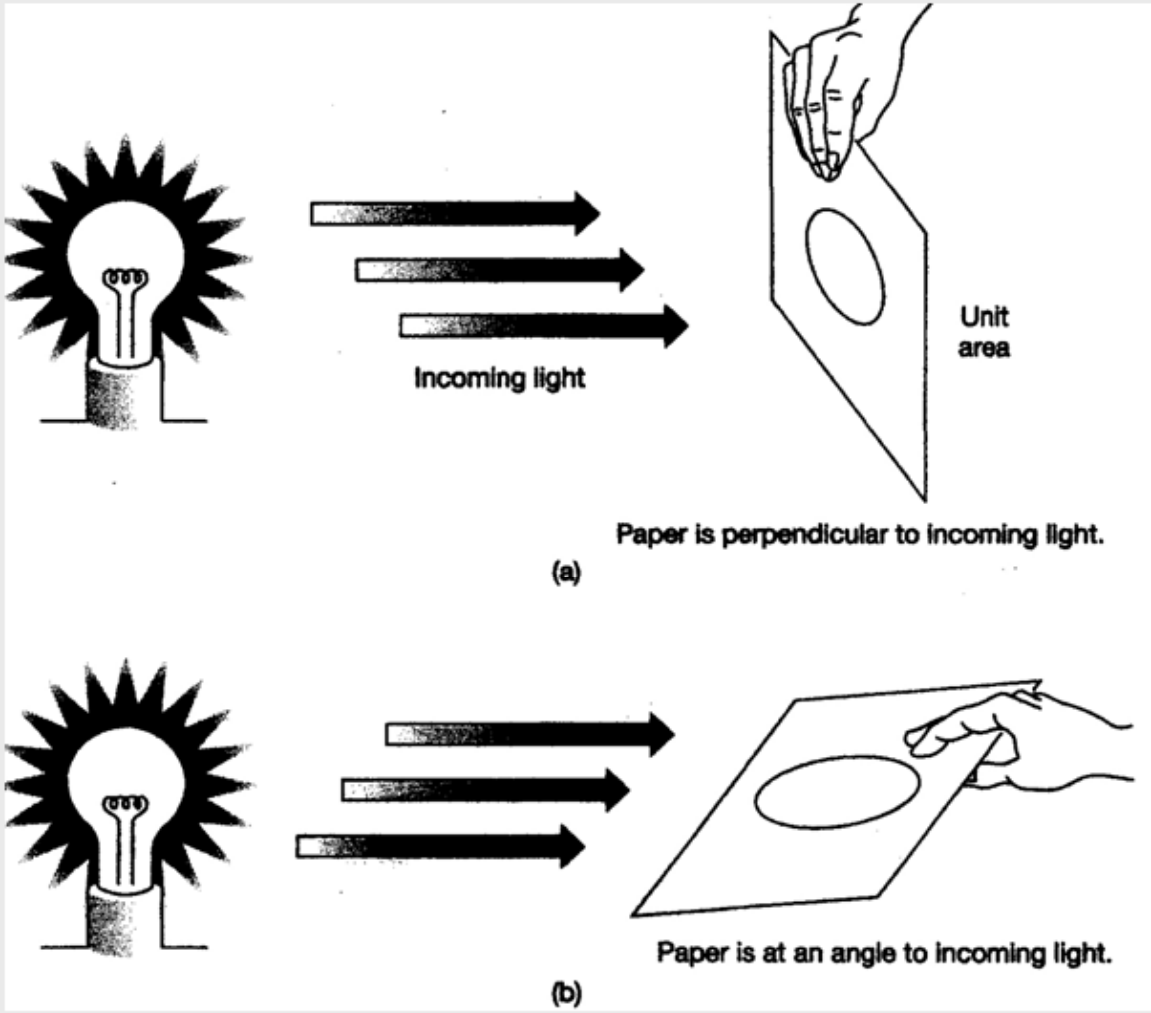
An "aerosol-laden" atmosphere scatters the longer (red) wavelengths more readily

"Dirty" (aerosol-laden) atmosphere composed of fine particles, gases, & H_2O -- PLUS larger dust particles, aerosols, pollution, etc.

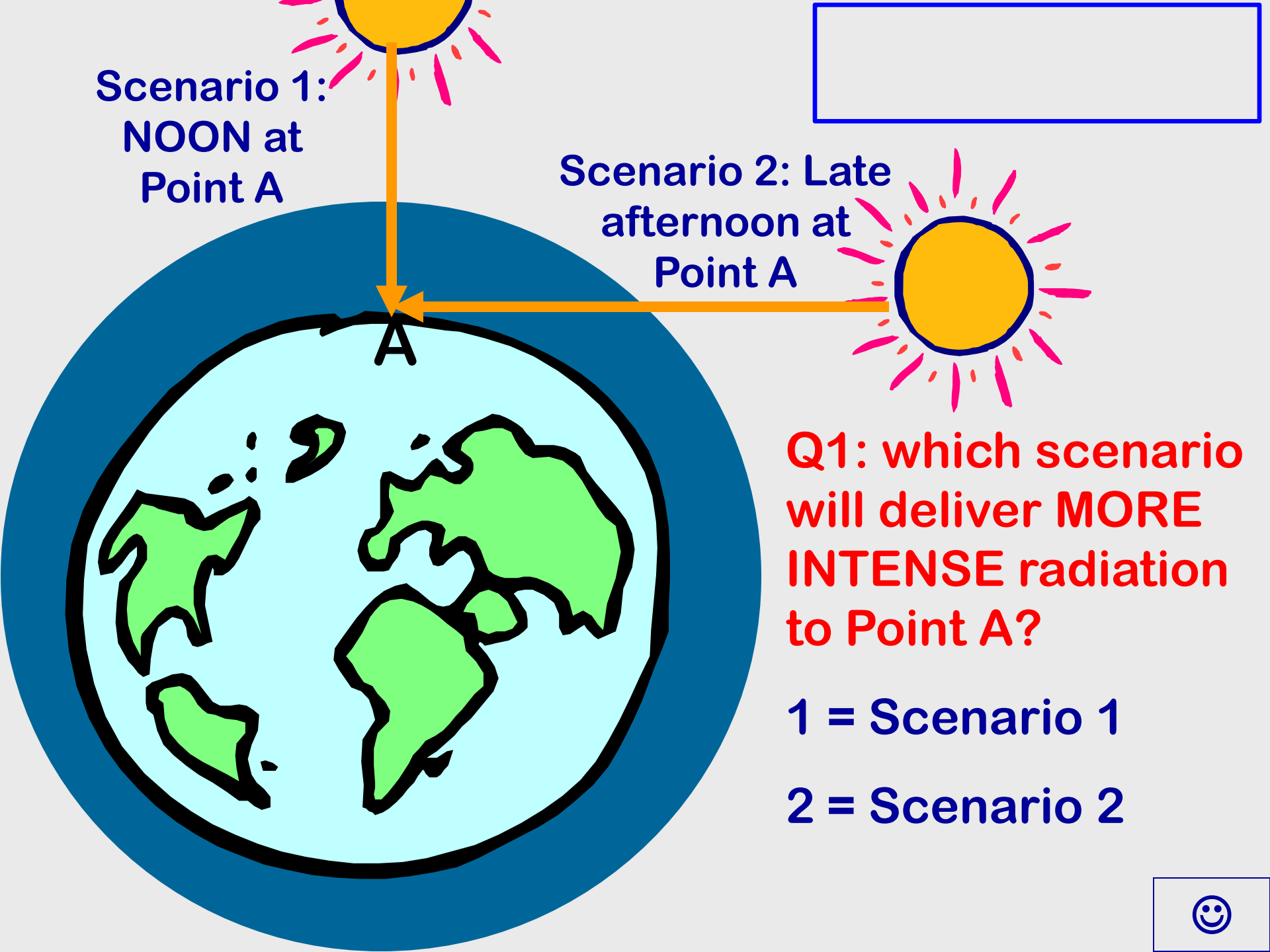
ALSO: The angle at which direct SW radiation is intercepted by a surface makes a difference!!

Radiation is concentrated over a small area & hence is more intense when it comes in perpendicular to the surface

Radiation is spread out over a larger area & hence is less intense per unit area when it comes in at an angle.



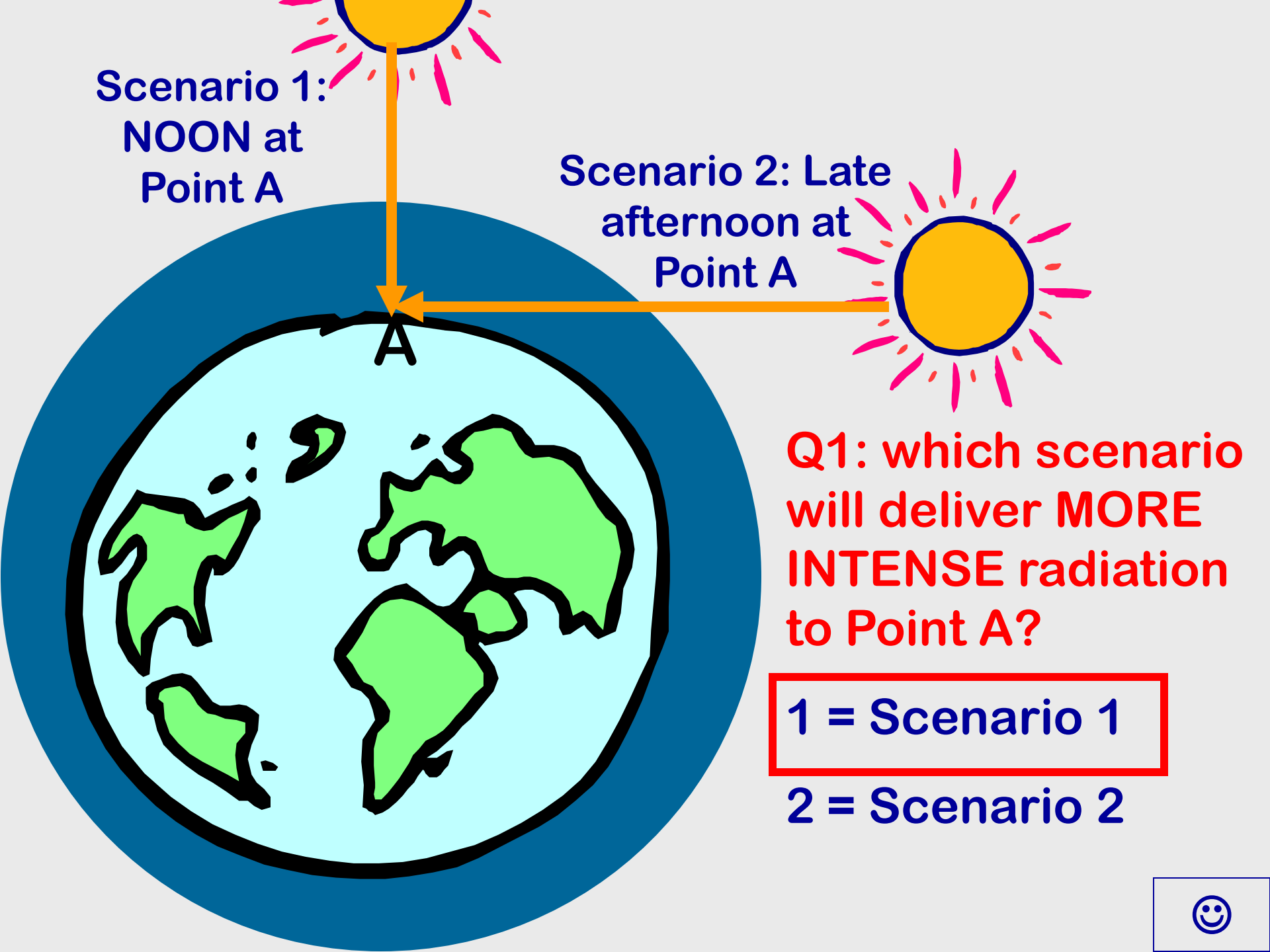
From Figure on p 37 in SGC-I, Ch 3



Q1: which scenario will deliver MORE INTENSE radiation to Point A?

1 = Scenario 1

2 = Scenario 2



Q1: which scenario will deliver MORE INTENSE radiation to Point A?

1 = Scenario 1

2 = Scenario 2

(Not a clicker question)

WHY is the intensity of the SW radiation at Point A not as strong in the late afternoon as it is at noon?

1 = because as the Sun goes down close to sunset time, it gives off less radiation

2 = because the SW radiation is coming in at an angle in the late afternoon, and is not directly overhead (perpendicular) like it is at noon.

3 = because the SW radiation is being transmitted through a thicker atmosphere & hence scattered more

BOTH #2 & #3 are applicable!

"CARTOON" SYMBOLS:

To represent SOLAR (shortwave) radiation that is REFLECTED (or scattered) BACK TO SPACE by: atmosphere, clouds, Earth's surface, etc.

Key term:

ALBEDO = reflectivity of a surface

"*symbol*" = a

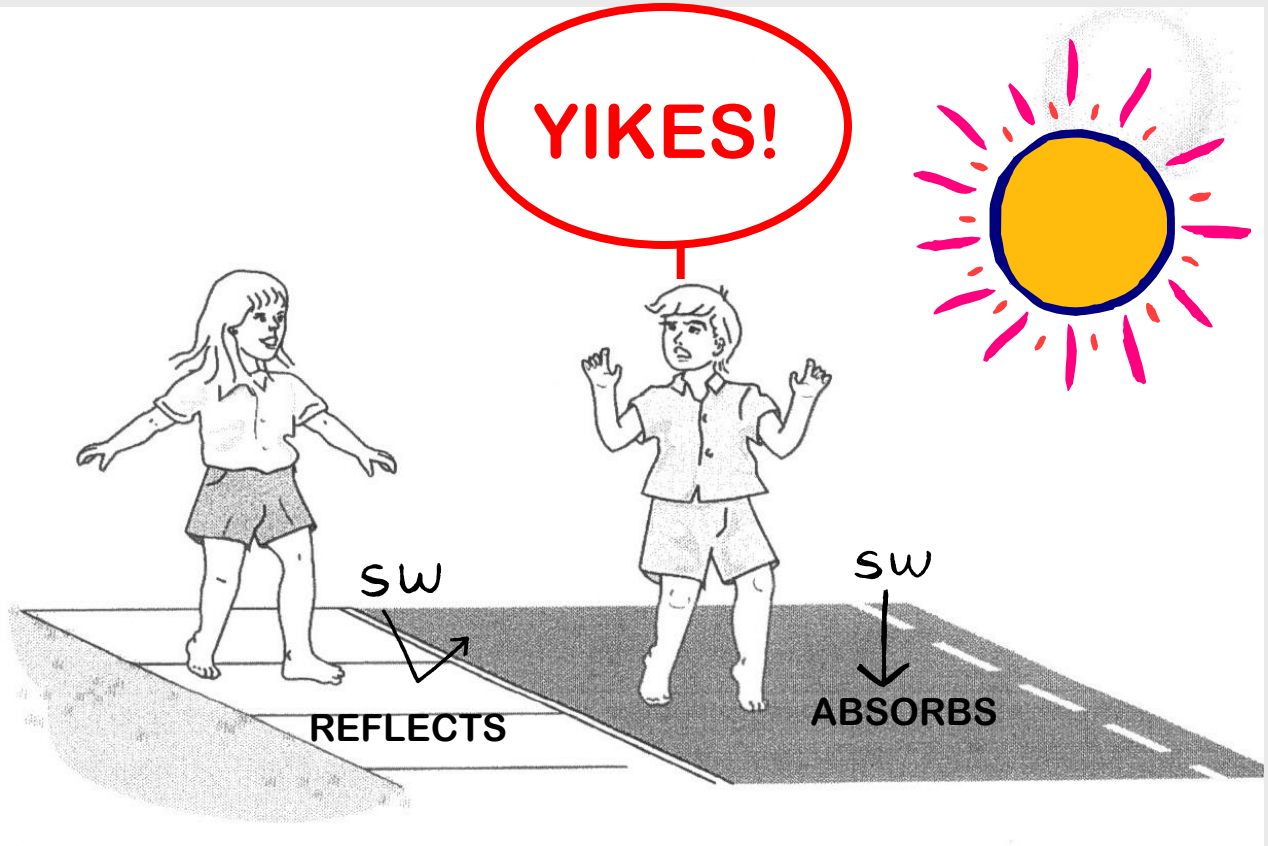
Represented as:

a decimal from 0 to 1.0 *or*

% from 0 – 100 % (perfect reflectivity)

Hence, amount ABSORBED = (1 – albedo)

← Flip back to p 49



If a surface's albedo is HIGH, absorption by the surface is LOW ➔ COOLER surface

If a surface's albedo is LOW absorption by the surface is HIGH => HOTTER surface!

Albedos of Some Common Surfaces

Type of Surface	*Albedo*
Sand	0.20–0.30
Grass	0.20–0.25
Forest	0.05–0.10
Water (overhead Sun)	0.03–0.05
Water (Sun near horizon)	0.50–0.80
Fresh snow	0.80–0.85
Thick cloud	0.70–0.80

Low albedo

High albedo

➔ CLOUDS: 0.44 (high, thin clouds) - 0.90 (low, thick clouds)

AVERAGE PLANET EARTH = ~ 0.30

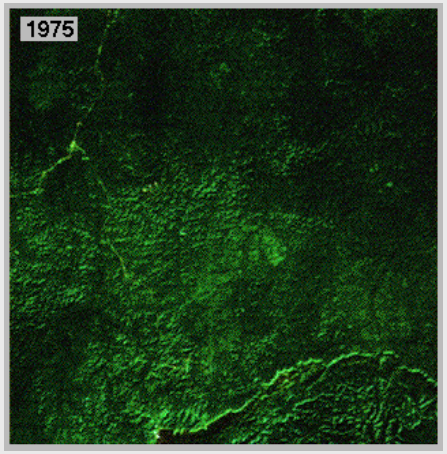
CLICKERS!

Q2: What will happen to incoming SW over the Amazon Rain Forest if parts of it are deforested?

1 = more SW will be absorbed

2 = less SW will be absorbed

Before



After

Q2: What will happen to incoming SW over the Amazon Rain Forest if parts of it are deforested?

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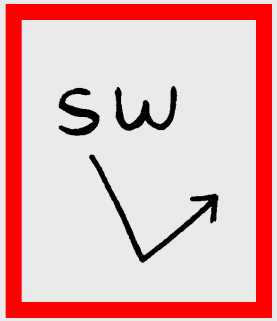
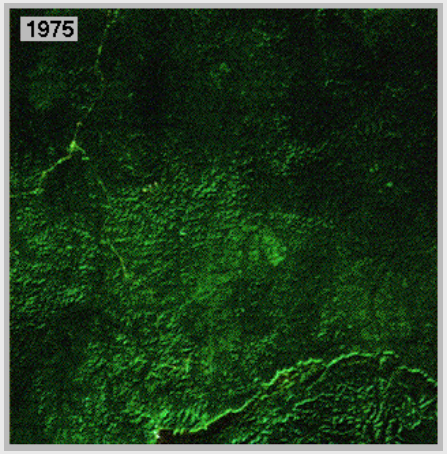


Before



After

"CARTOON" SYMBOLS:

To represent TERRESTRIAL (longwave IR) radiation emitted upward by the Earth's surface or the atmosphere

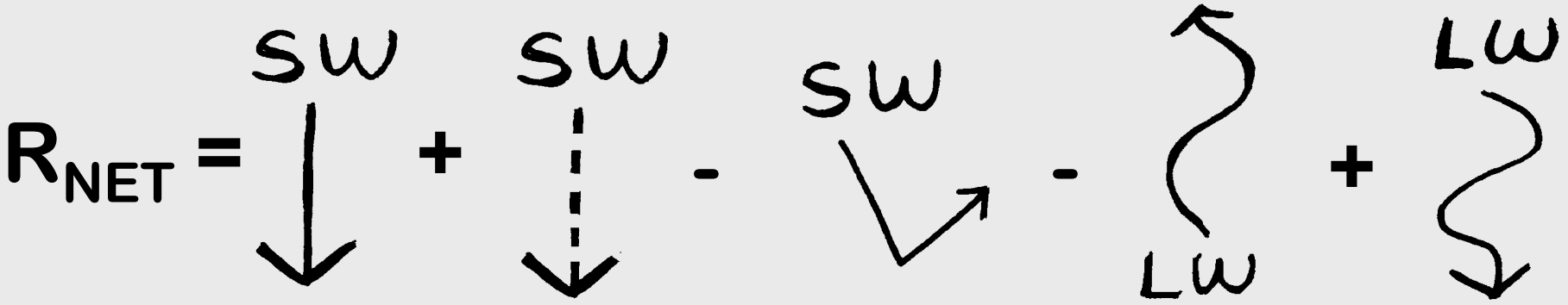
Return to p 122

"CARTOON" SYMBOLS:

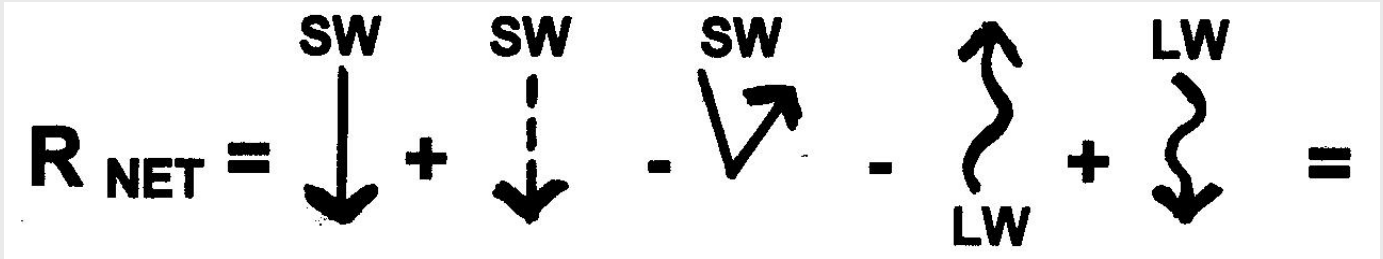
To represent TERRESTRIAL (longwave IR) re-radiation emitted downward by the Earth's ATMOSPHERE

PUTTING IT TOGETHER:

Can you place + and – signs where they ought to go in the equation?



$$R_{NET} = (Q + q) - a - Lu + Ld$$



Now we'll look at the energy pathways in a bit more detail by combining the cartoon symbols in various ways . . .

See top p 49

First, what if . . .

. . . The Earth didn't have an atmosphere, and therefore didn't have a greenhouse effect??

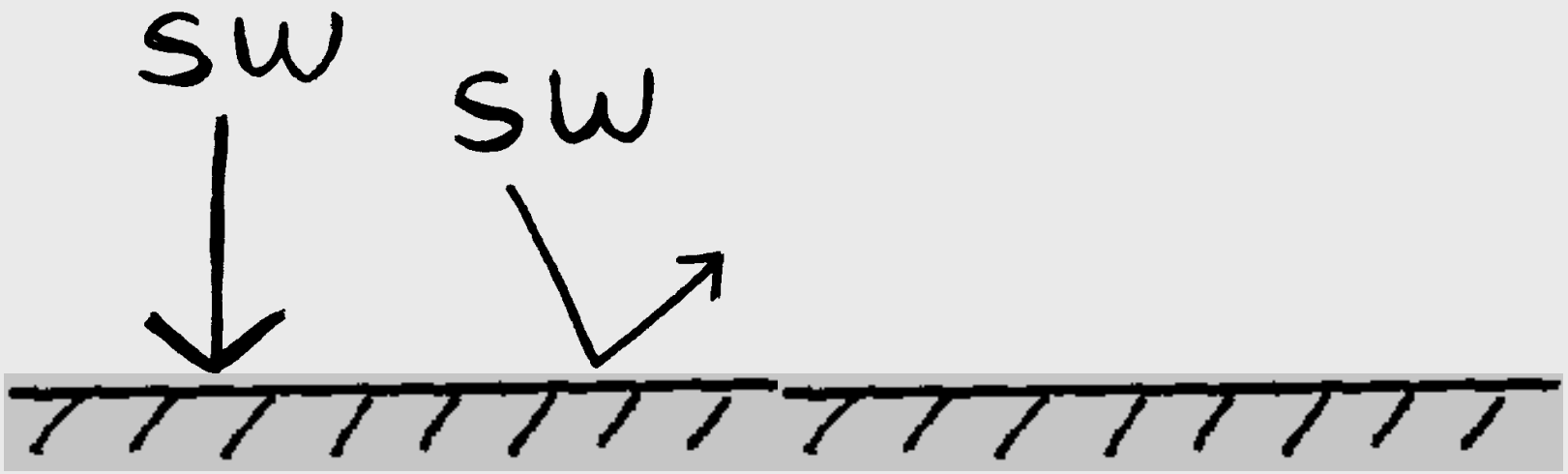
What would the energy pathways in the Earth-Sun system look like?

LW

Which terms are not involved?

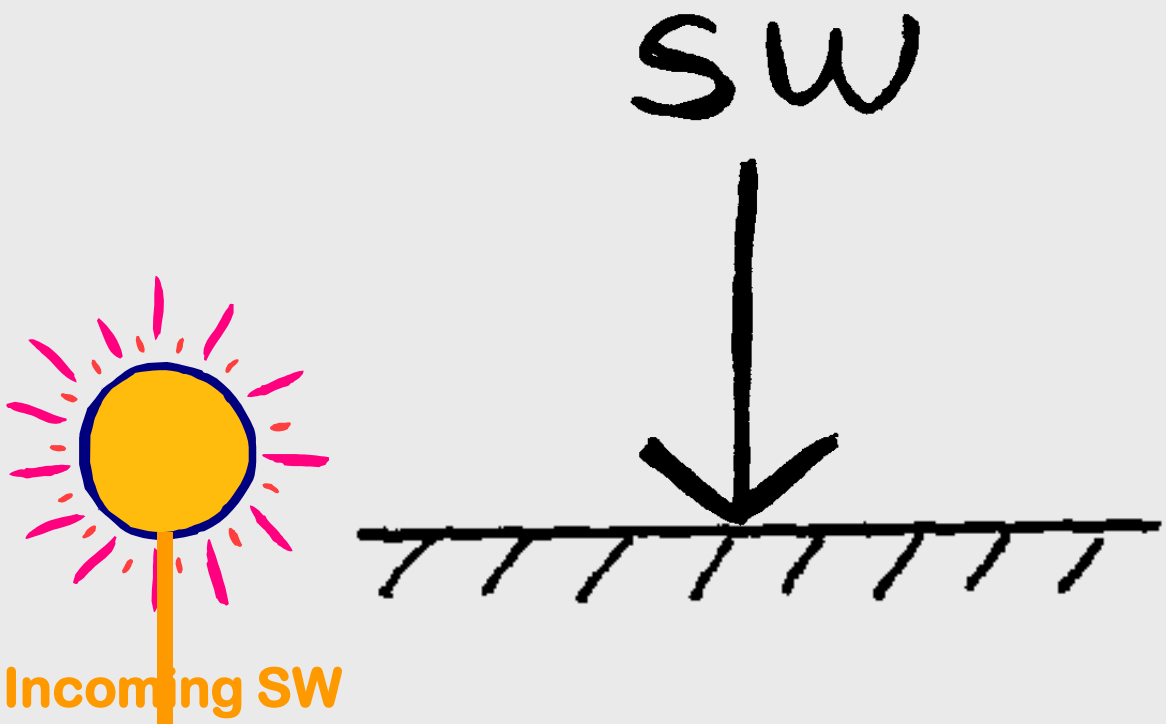
No scattering by atmosphere

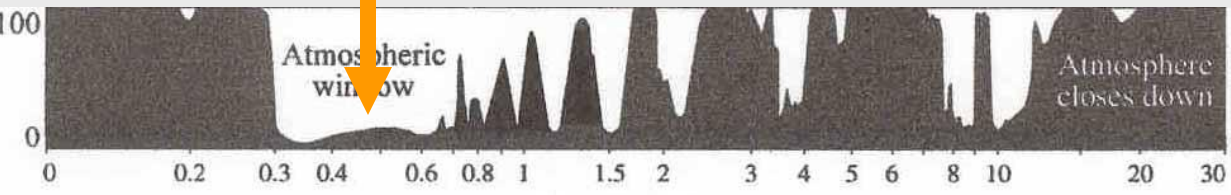
No re-radiation of infrared by GHG's



To describe the real Earth-Atmosphere system, more detail is needed in our simple representation . . . . .
We'll use our symbols to build an energy balance "model"

SW BEAMED DIRECTLY TO EARTH'S SURFACE WHERE IT IS ABSORBED:



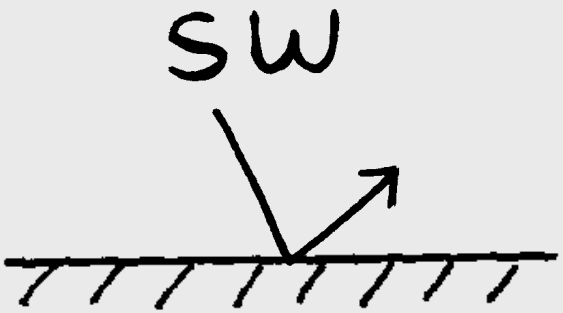


p 123

SW REFLECTED BACK TO SPACE:

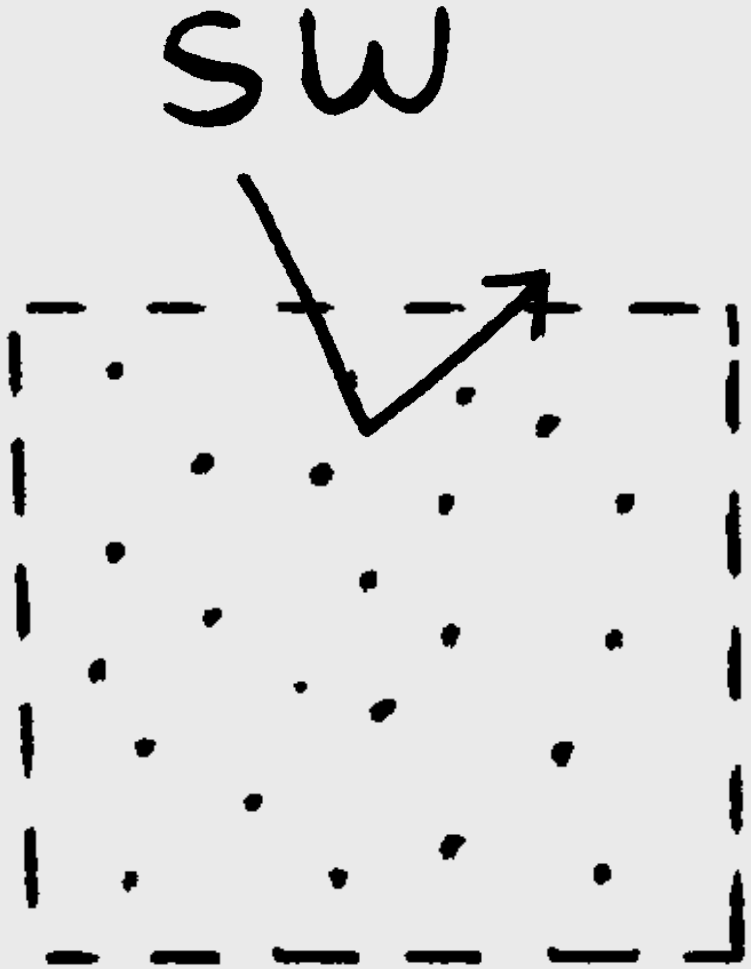
By
clouds

By
Earth's
surface

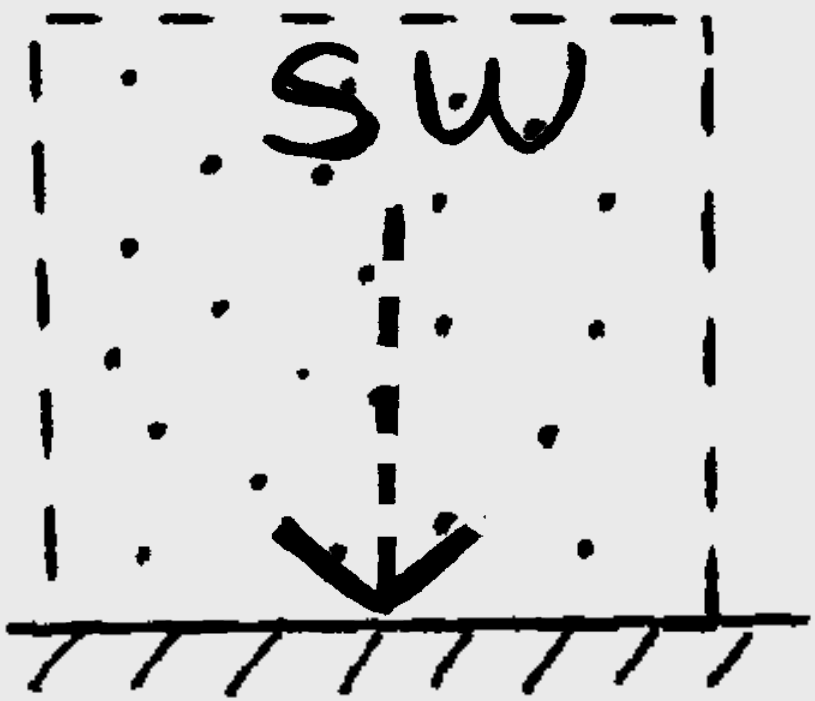


This is determined by the ALBEDO of the clouds or surface

SW SCATTERED BACK TO SPACE BY ATMOSPHERE:

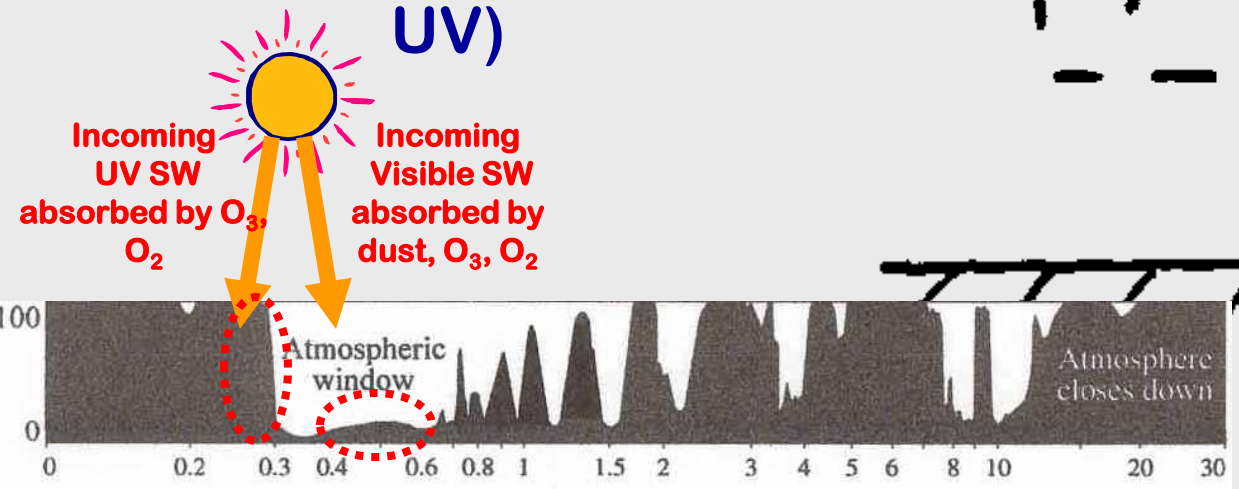


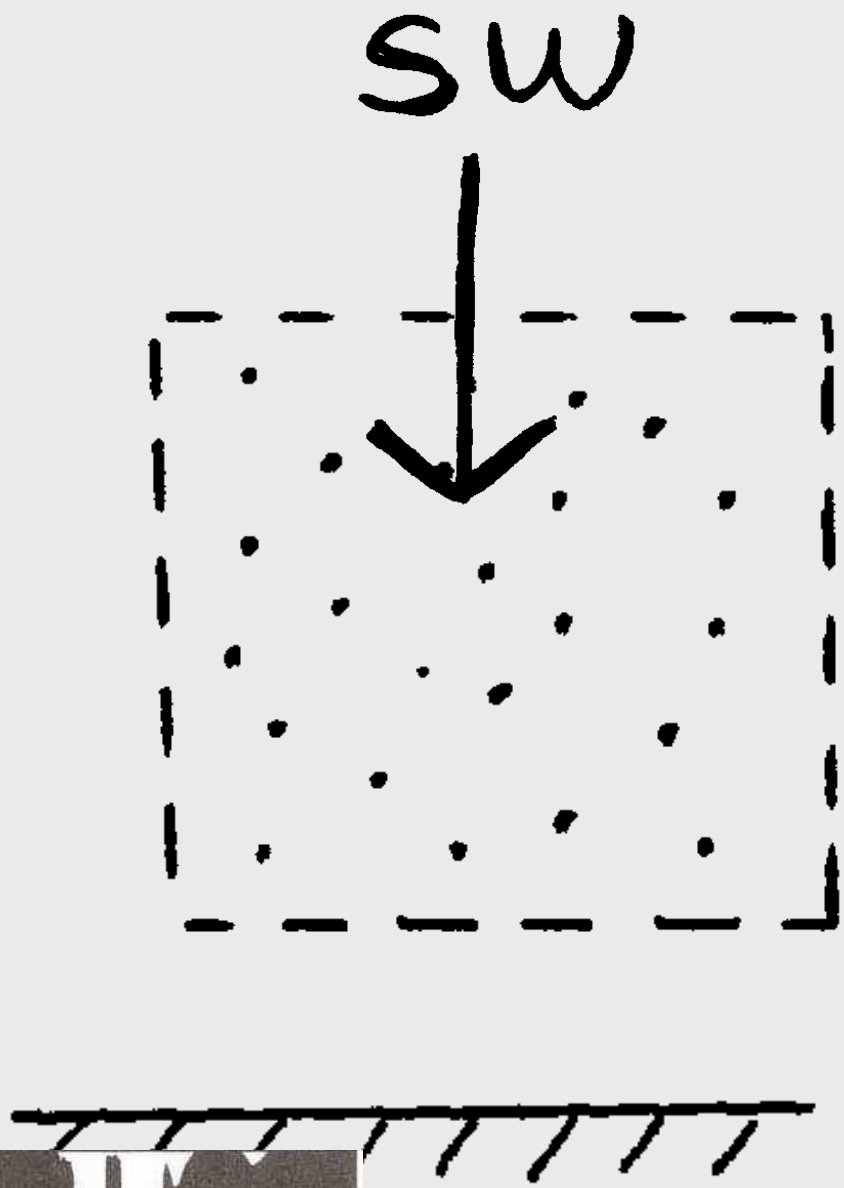
SW SCATTERED DOWN TO EARTH's SURFACE where it is absorbed



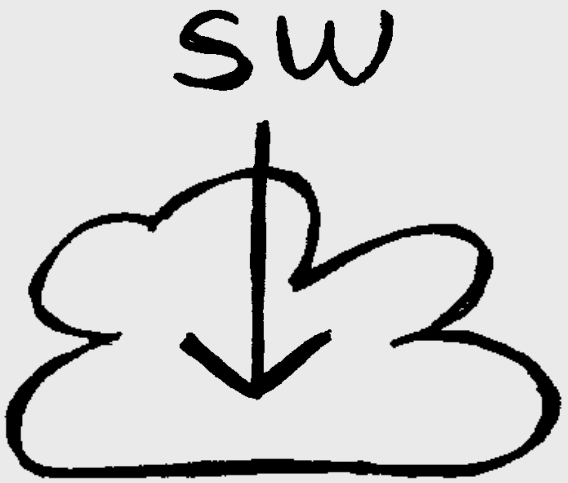
SW ABSORBED IN ATMOSPHERE BY GASES, DUST, etc.

(including Ozone absorbing shortwave UV)

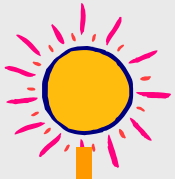




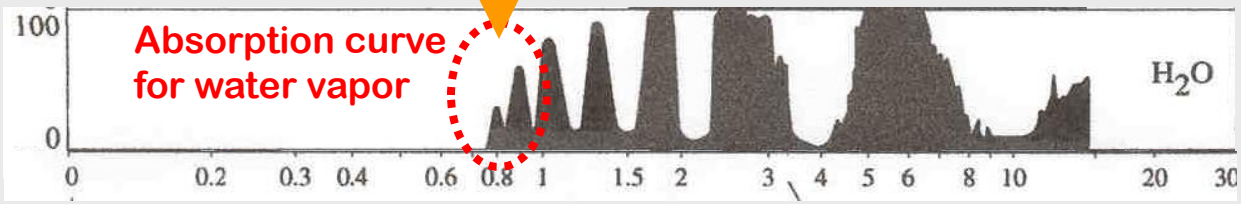
SW ABSORBED In ATMOSPHERE BY CLOUDS & H2O vapor:



(NOTE: clouds are made up of tiny droplets of water surrounded by lots of water vapor)



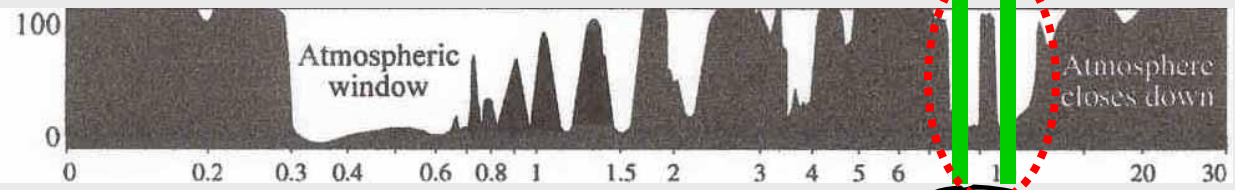
Incoming Visible & Near IR SW absorbed by water vapor & clouds



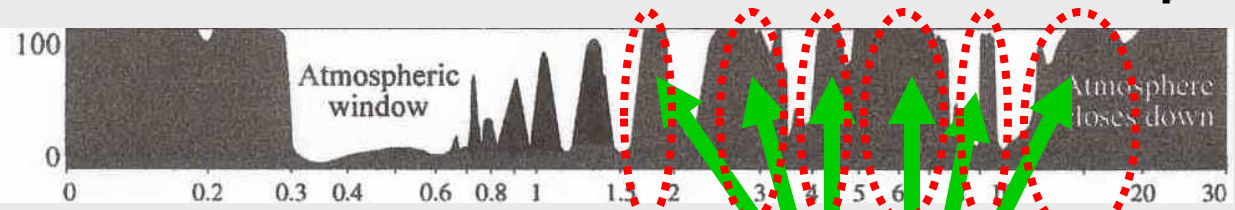
LW (IR) EMITTED FROM EARTH'S SURFACE ESCAPING TO SPACE THROUGH THE "OUTGOING IR ATMOSPHERIC WINDOW"

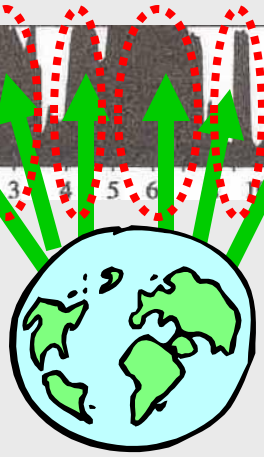
LW

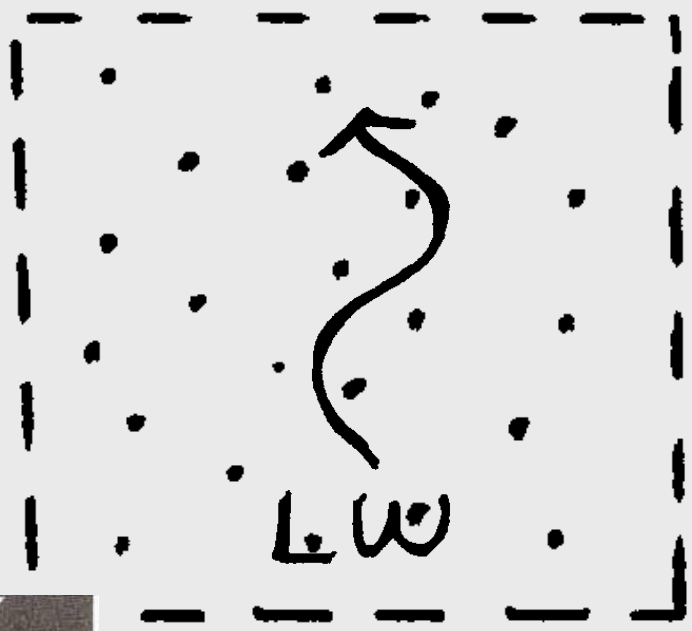
Outgoing LW

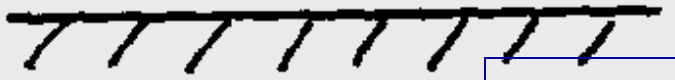


IR EMITTED FROM EARTH'S SURFACE BUT ABSORBED IN THE ATMOSPHERE BY GREENHOUSE GASES (H_2O,CO_2, CH_4, ETC.)

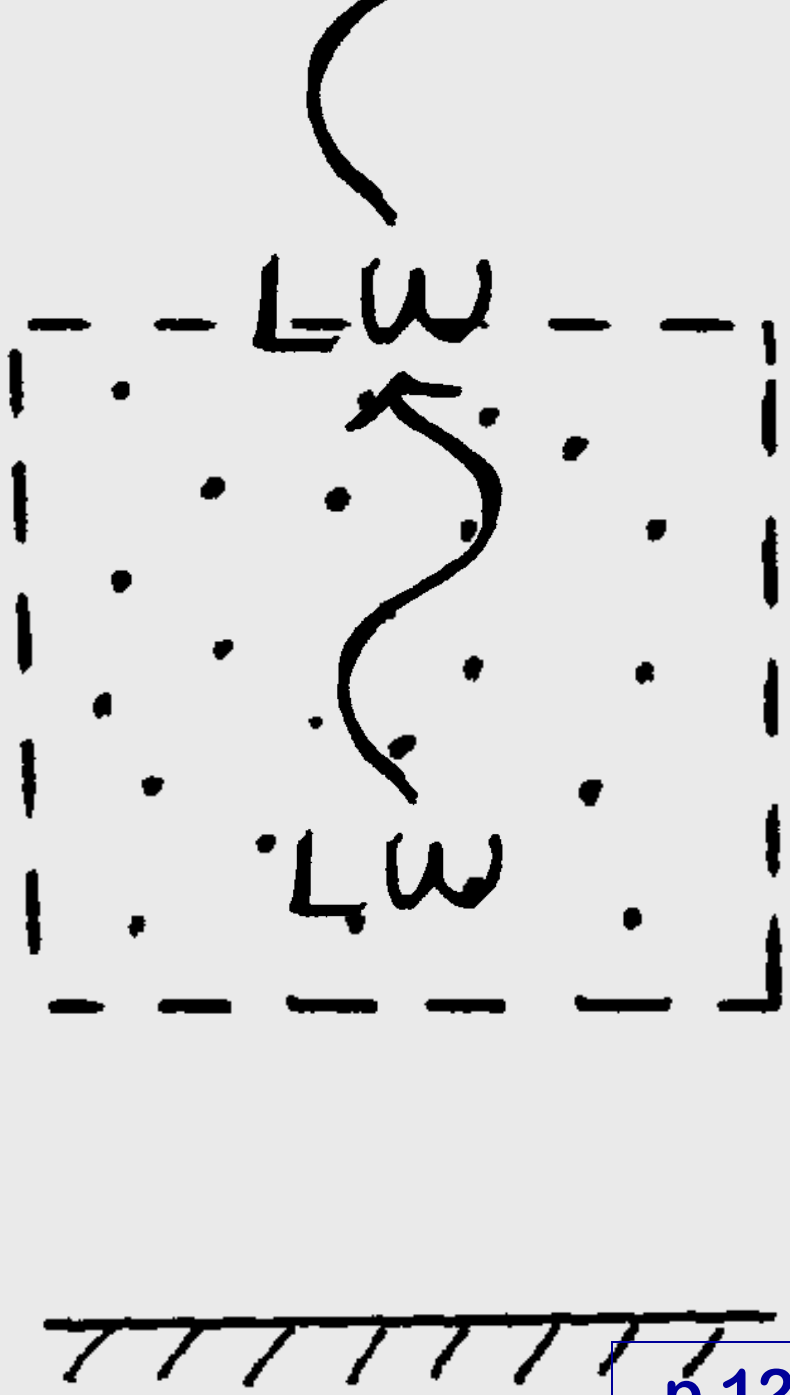




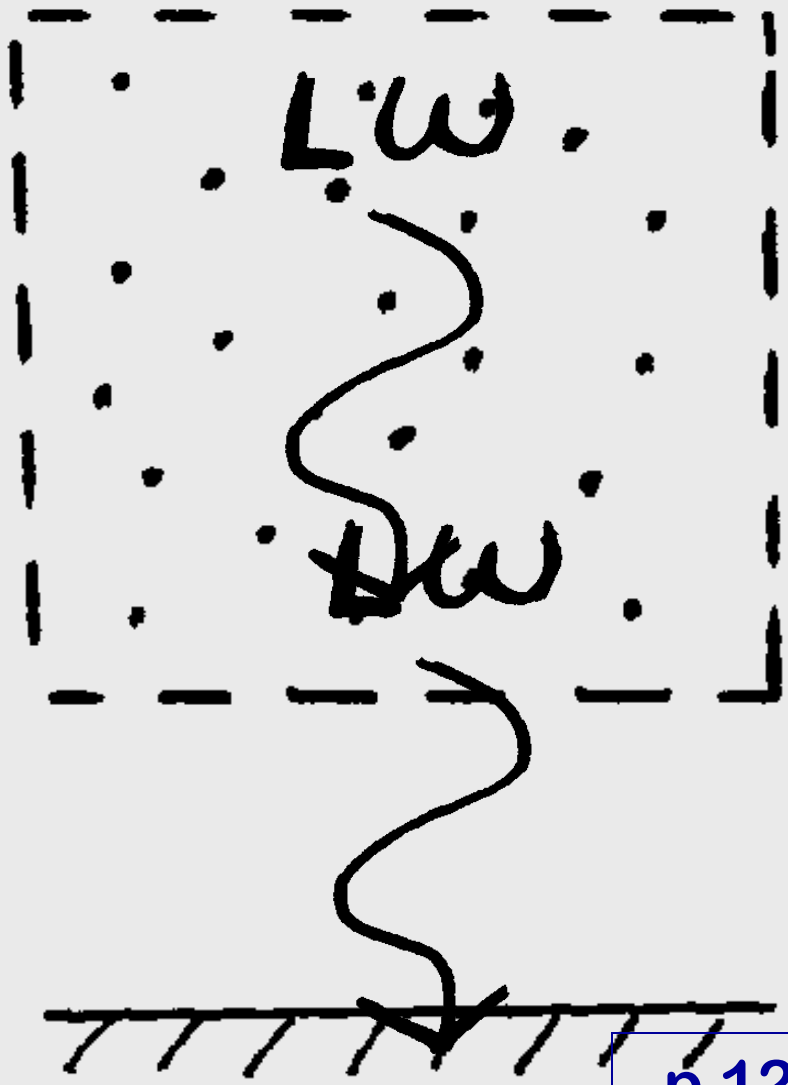




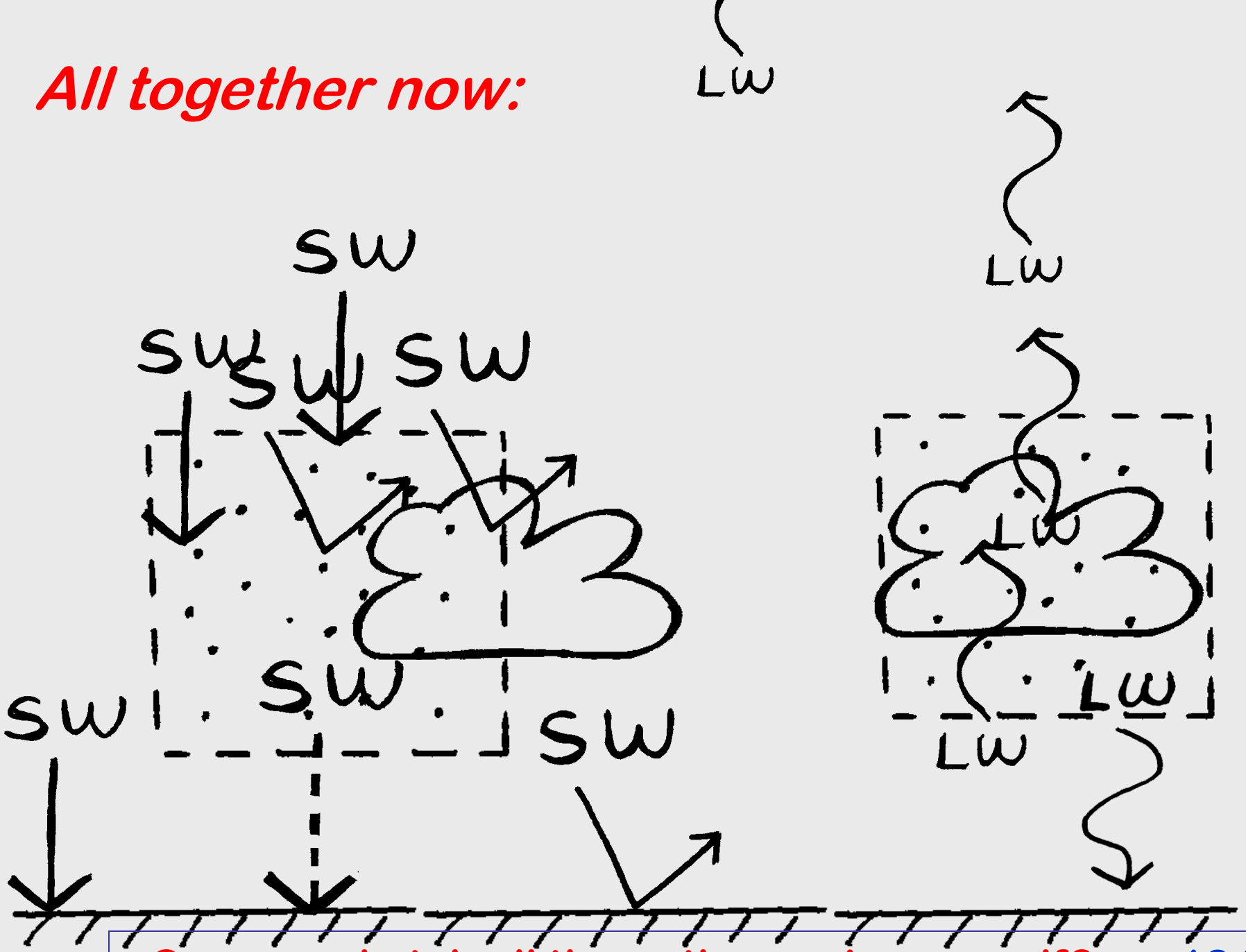
IR EMITTED FROM ATMOSPHERE ESCAPING TO SPACE



IR EMITTED FROM ATMOSPHERE AND RADIATED BACK TO SURFACE WHERE IT IS ABSORBED



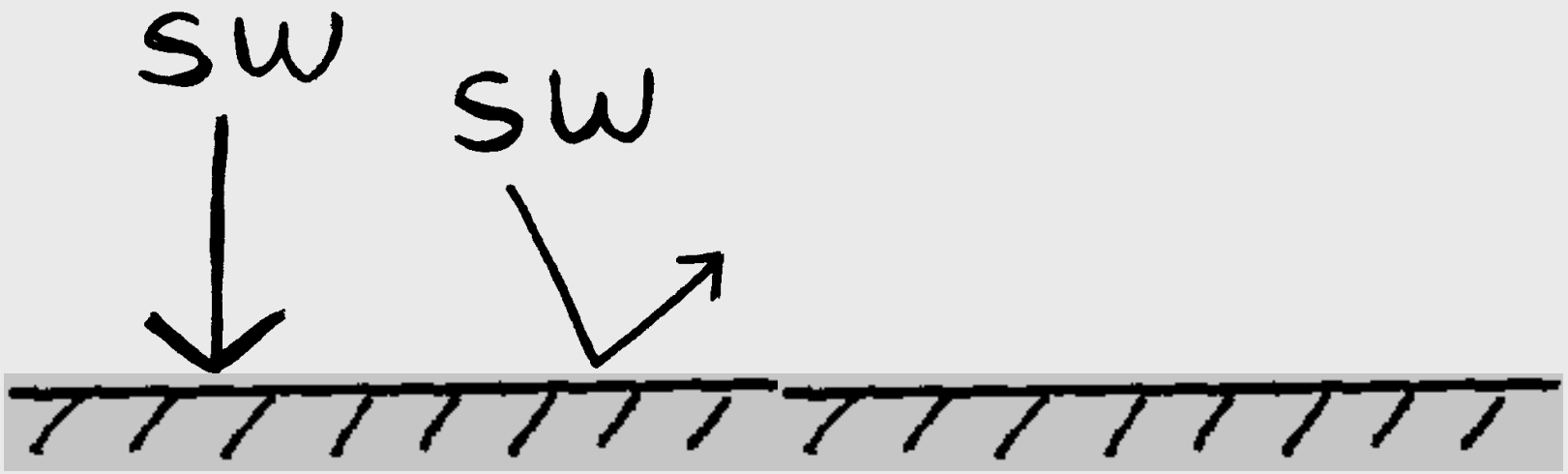
All together now:



Can you sketch all the pathways in yourself? p 124

LW

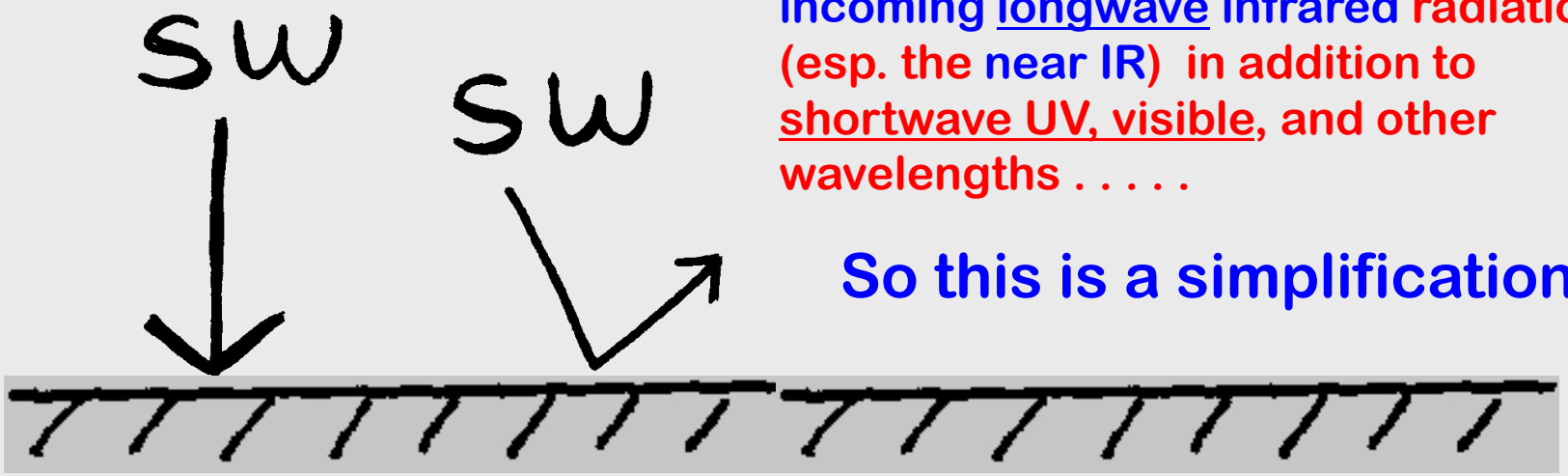
Compare with simpler model of energy balance with NO atmosphere:



Which terms are not involved?

No scattering by atmosphere

No re-radiation of infrared by GHG's

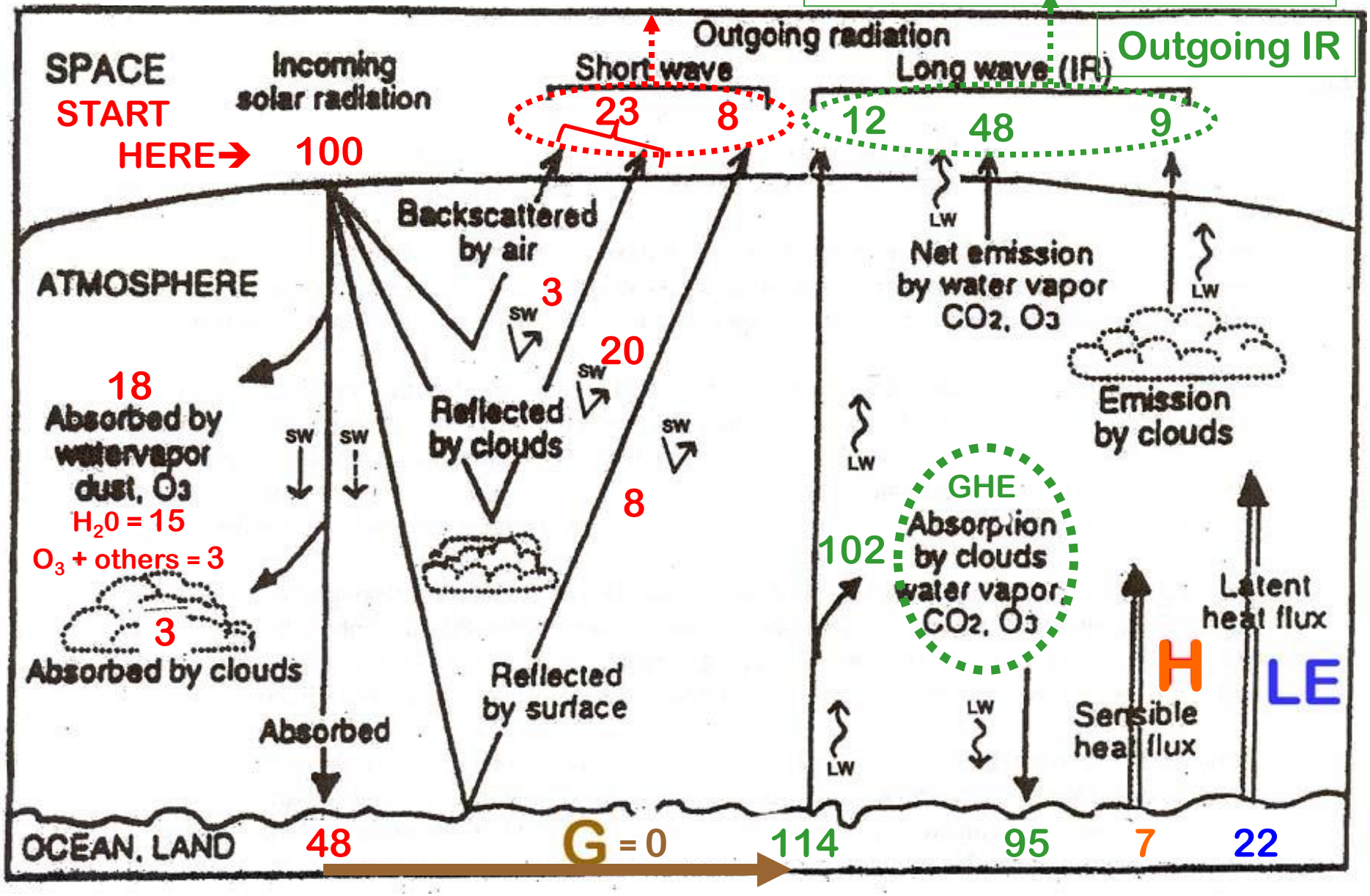


NOTE: Technically, the SUN does emit incoming longwave infrared radiation (esp. the near IR) in addition to shortwave UV, visible, and other wavelengths . . . . .

So this is a simplification!!!

Earth's average albedo: 23 + 8 = 31

12 + 48 + 9 = 69



G + H + LE

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

Back to p 49

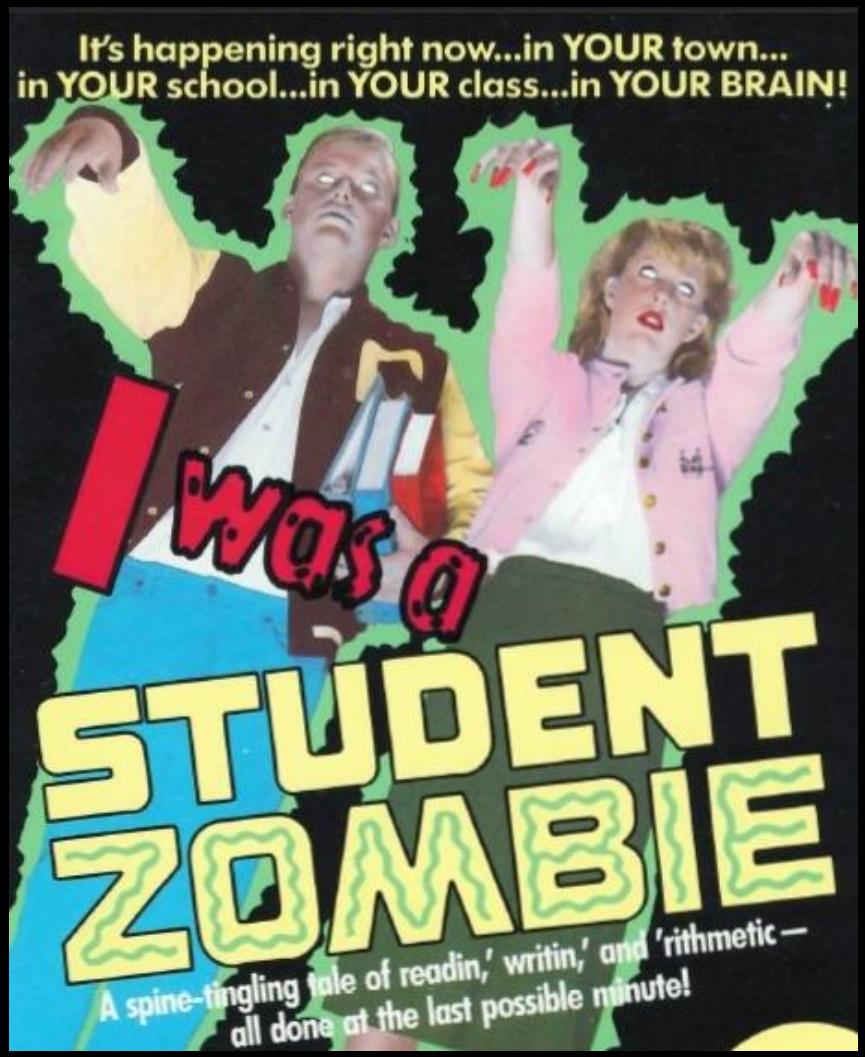
Two Energy Balance Animations

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

GLOBAL ENERGY BALANCE & PATHWAYS:

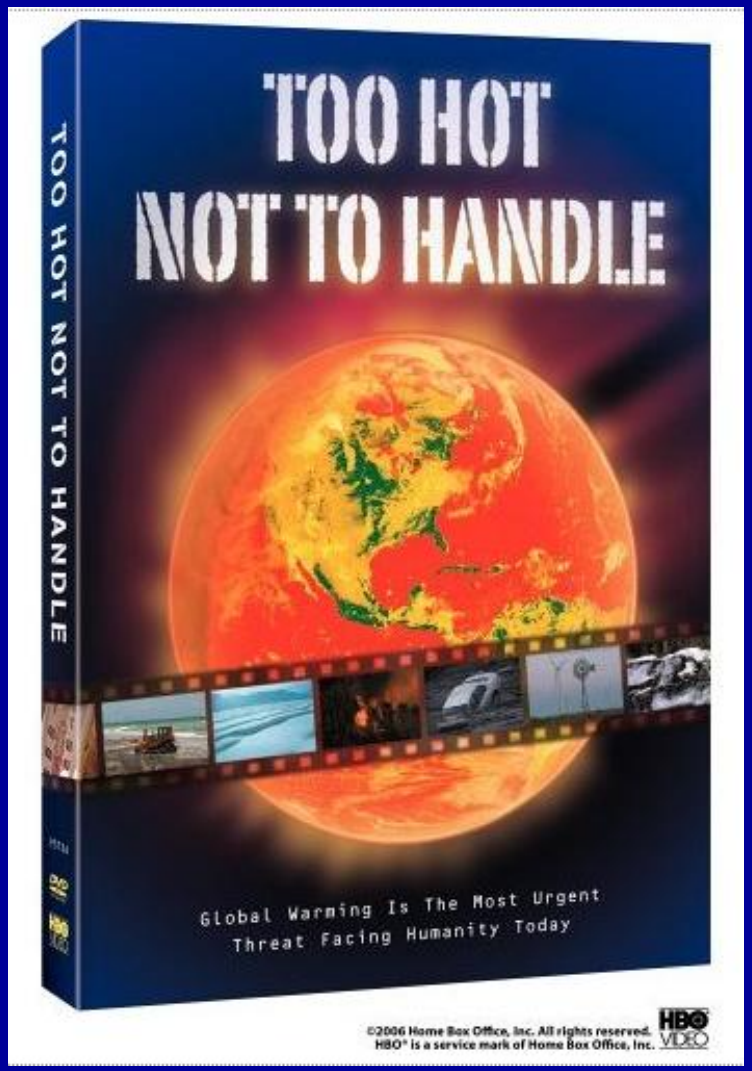
http://earthguide.ucsd.edu/earthguide/diagrams/energybalance/index.html

SHORTWAVE & LONGWAVE ENERGY FLOW & BUDGET:
http://mesoscale.agron.iastate.edu/agron206/animations/10_AtmoEbal.html



ZOMBIE BREAK !

A new film for our "SUSTAINABILITY SEGMENT"



HBO Documentary FIlm (2006)

As you watch the segments of this film . . . .

. . . note what is said about
observations of climate change &
record the direction of change on **p 30**
in CLASS NOTES :

Checklist of Direct Observations of Recent Climate Change:

Checklist of Direct Observations of Recent Climate Change

TEMPERATURE: [daytime _____ nighttime _____ heat waves ↑ _____ # cold days/ frosts ↓ _____]
etc., etc.

PRECIPITATION: [water vapor _____ drought _____ heavy rains _____]

HYDROLOGY: [streamflow _____ snowmelt ____ floods _____ reservoirs /dams____ water supply ____]

CRYOSPHERE: [snowpack ____ mt glaciers _____ sea ice____ ice caps ____ frozen ground ____]

OCEAN: [sea level ____ sea surface temps ____ salinity _____ corals ____ fisheries ____]

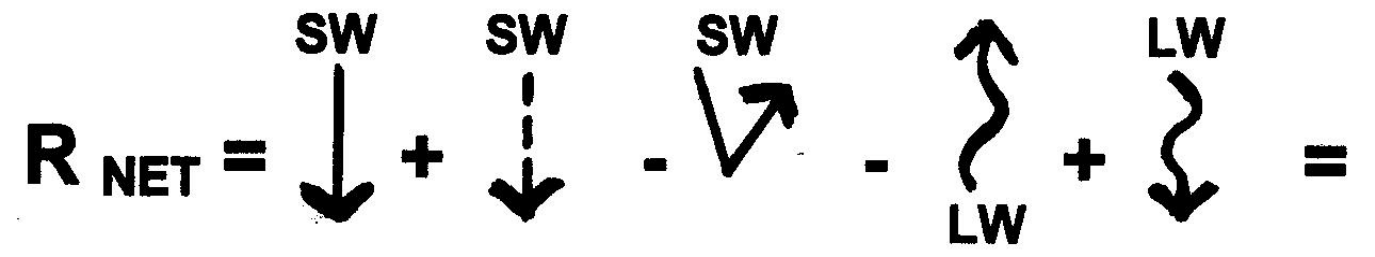
BIOSPHERE: [plant / animal ranges _____ phenology_____ crop dates _____ disease _____]

OTHER: [atmospheric circulation ____ wind belts / storm tracks _____ hurricanes _____]

p 30

BACK TO THE BALANCE!

NET RADIATION = In – Out = Whatever is left over



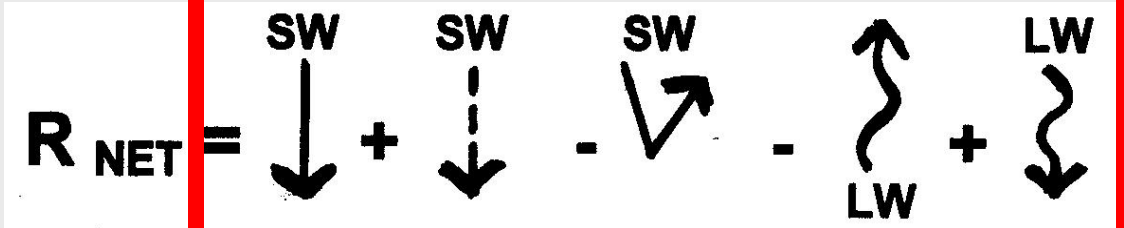
If some energy is "left over," it can be used to DRIVE WEATHER & CLIMATE through HEAT TRANSFER processes or it can STORED by the Earth (in the ground or ocean).

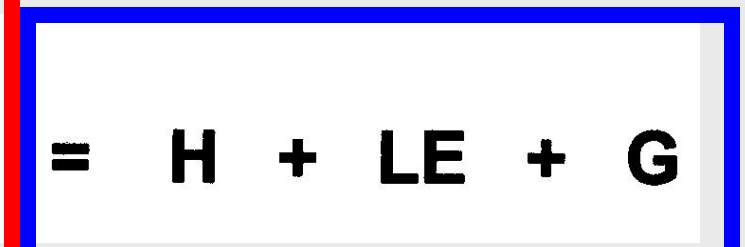
p 50 top

FINAL PART OF TOPIC #10:

The RIGHT side of the ENERGY BALANCE EQUATION . . .

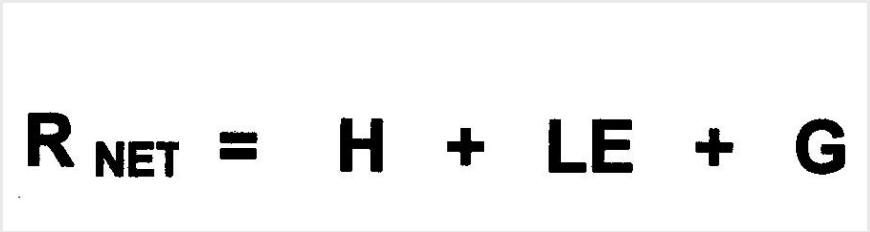
Left side of equation





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).



p 50 top

Review of: THERMODYNAMICS & HEAT TRANSFER

Conduction = passage of thermal energy through a body **without large-scale movement** of matter within the body. Most effective in SOLIDS.

Convection = passage of thermal energy through a fluid (liquid or gas) **by means of large-scale movements** of material within the fluid, as in a convection cell. Most effective in GASES & LIQUIDS.

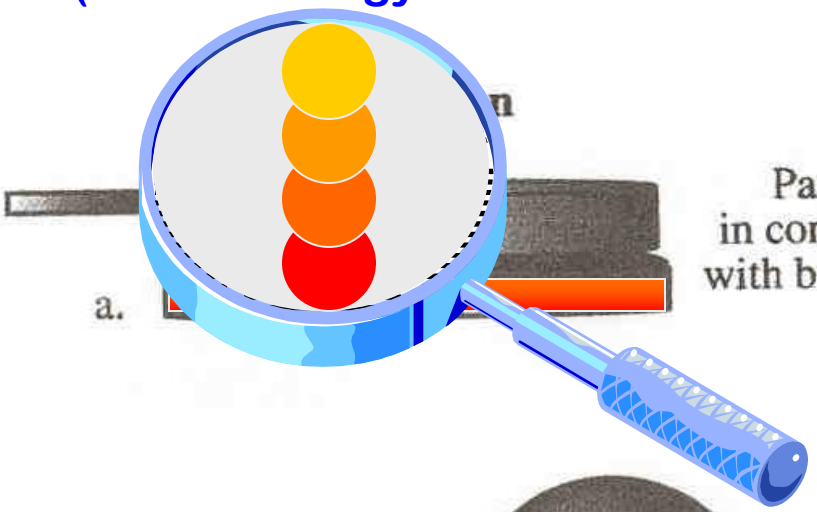
Radiation = the transfer of thermal energy by ***electromagnetic radiation.*** The only one of the three mechanisms of heat transfer that does not require atoms or molecules to facilitate the transfer process, i.e., **does not even need MATTER as a medium to transfer energy!**

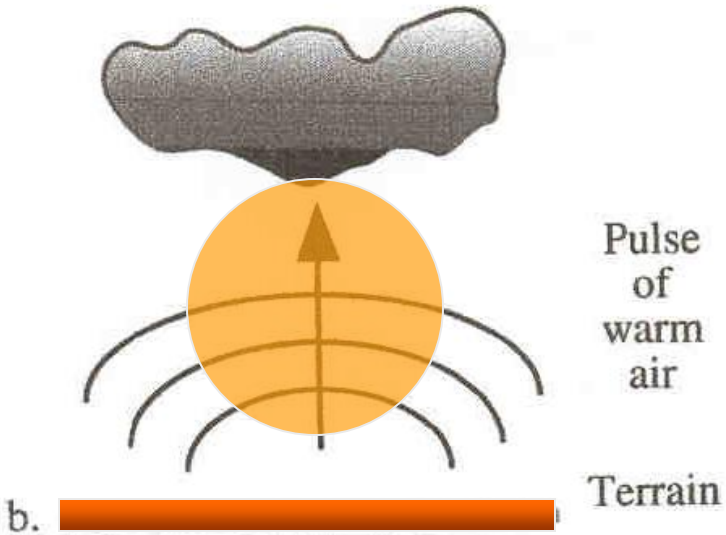
CONVECTION

Mass of warm air or liquid heats, expands, rises

CONDUCTION

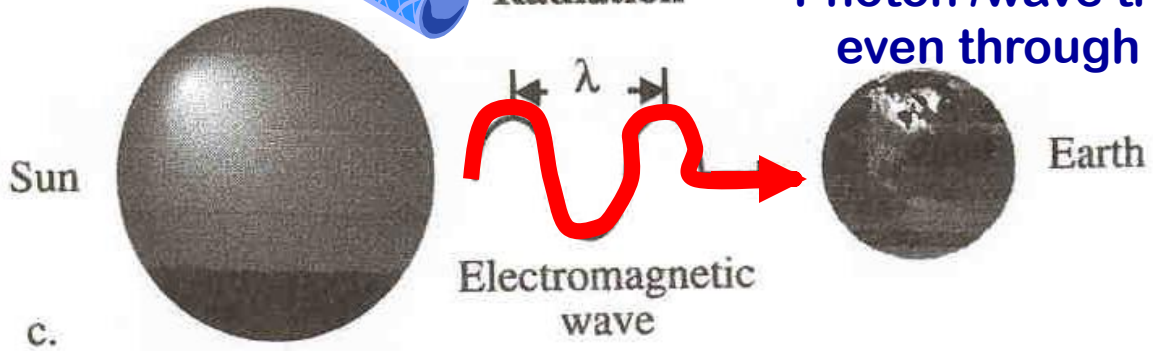
Jiggling molecule ➔ jiggling molecule
transfer of heat
(kinetic energy at molecular scale)





RADIATION

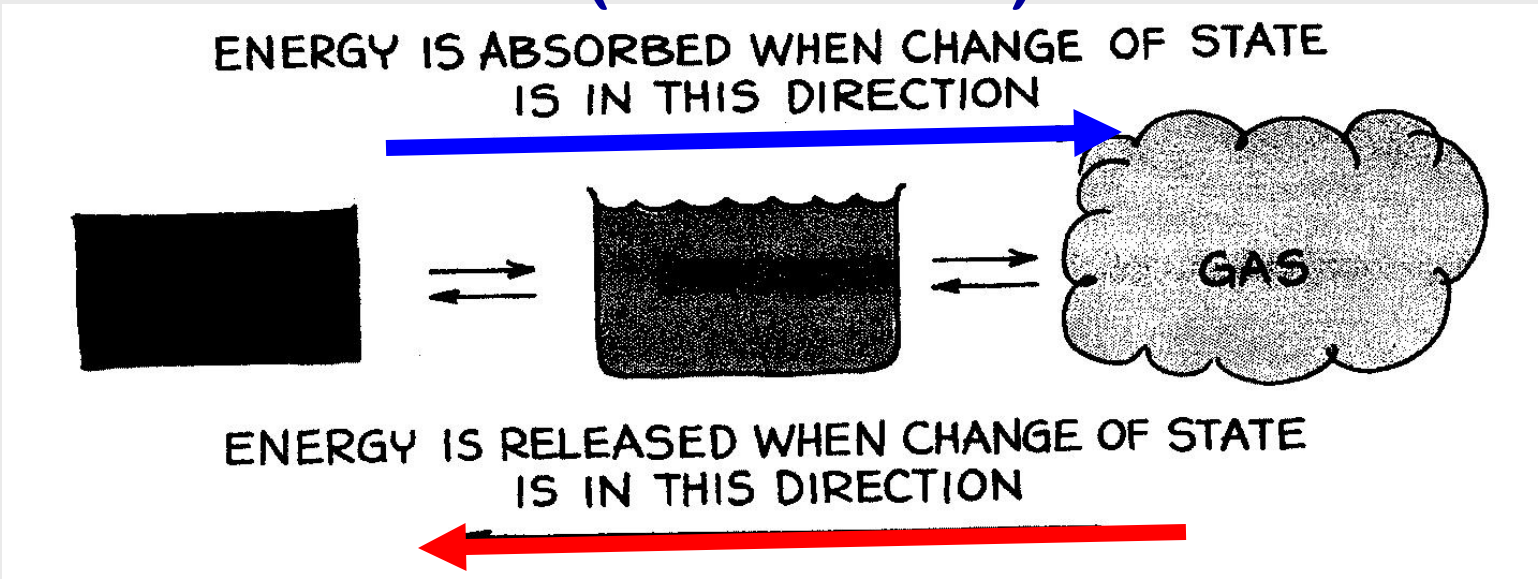
Photon /wave transport:
even through a void!



review

HEAT TRANSFER & STORAGE DURING PHASE CHANGES: LE & H

LE = LATENT (hidden) ENERGY (LE stored)

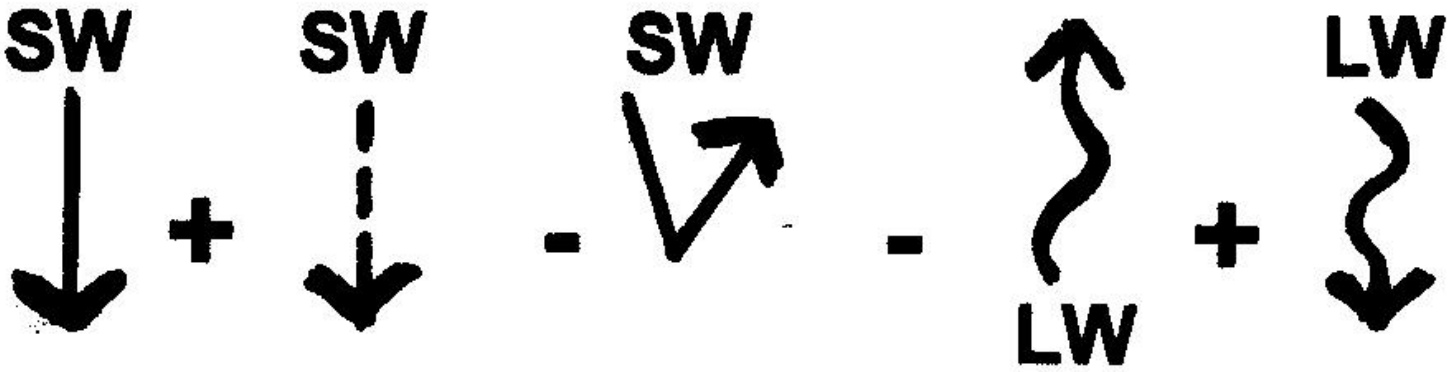


(LE released, hence it can be sensed as H)

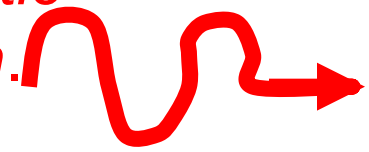
H = SENSED (via thermometer) ENERGY

Review p 51

Link to the Left Side of Equation:



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

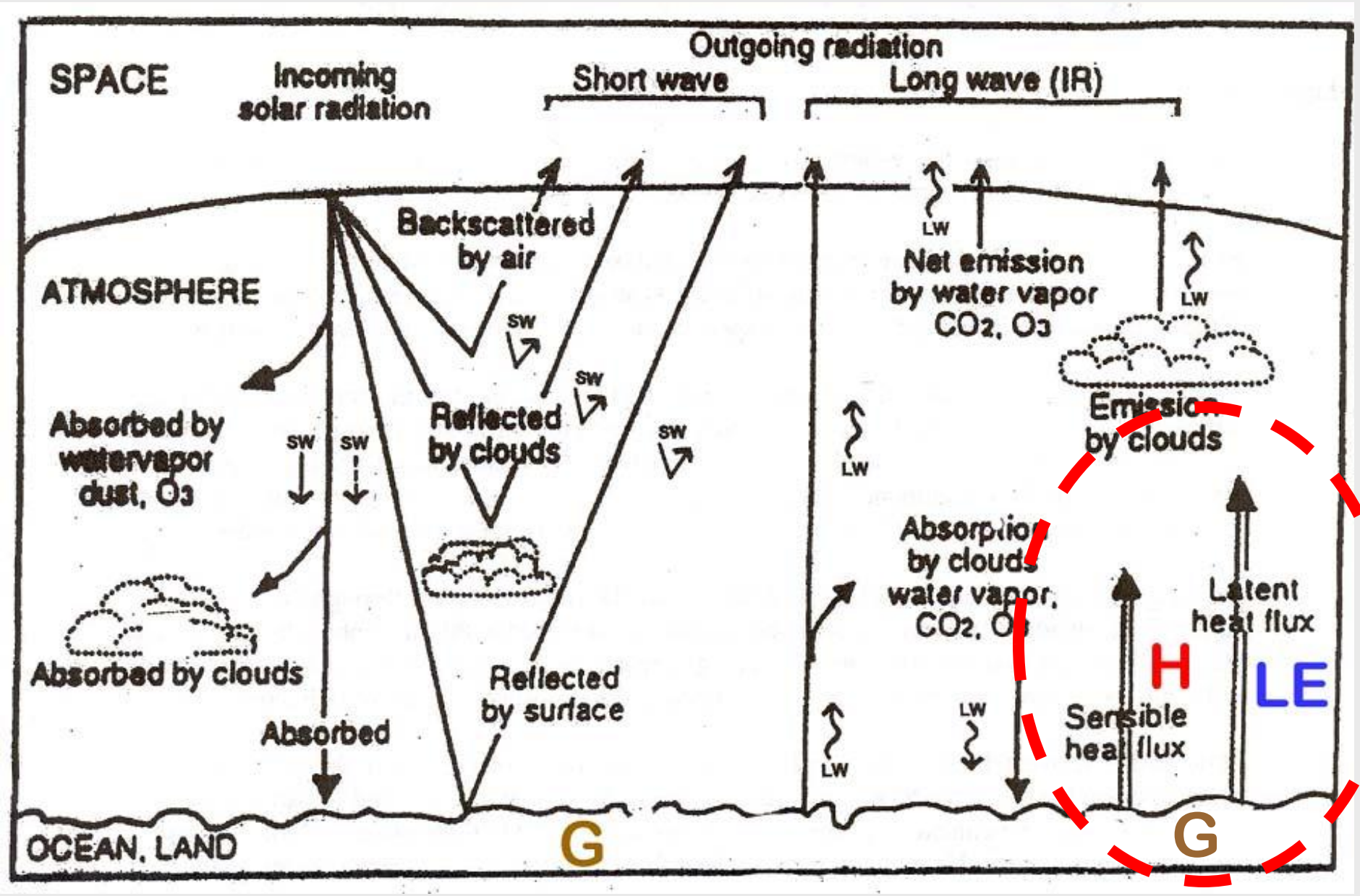


It doesn't need MATTER to transfer energy!
(sun ➔ earth, earth ➔ atmosphere, atmosphere ➔earth, earth ➔ space)

Link to the Right Side of Equation:

$$H + LE + G$$

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


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

Back to p 50

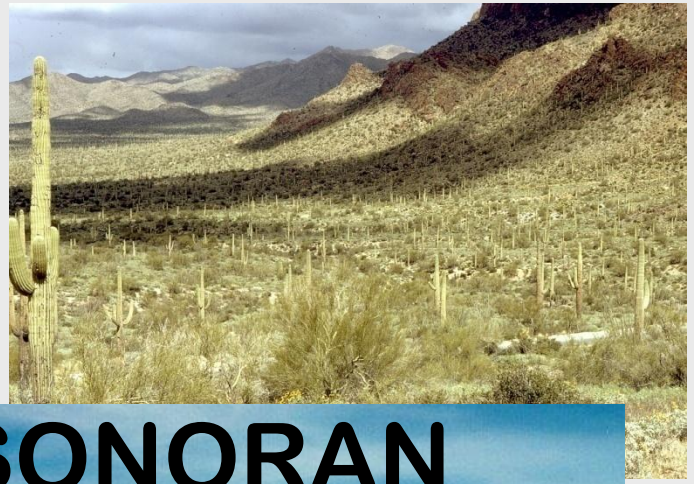
Encore: Energy Balance Animation

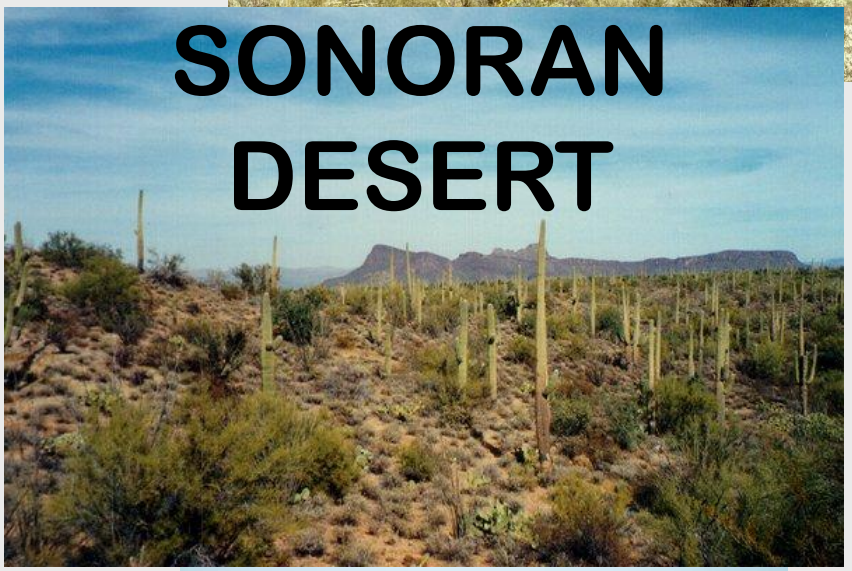
showing energy flow pathways
& "units" of energy that
eventually balance out:

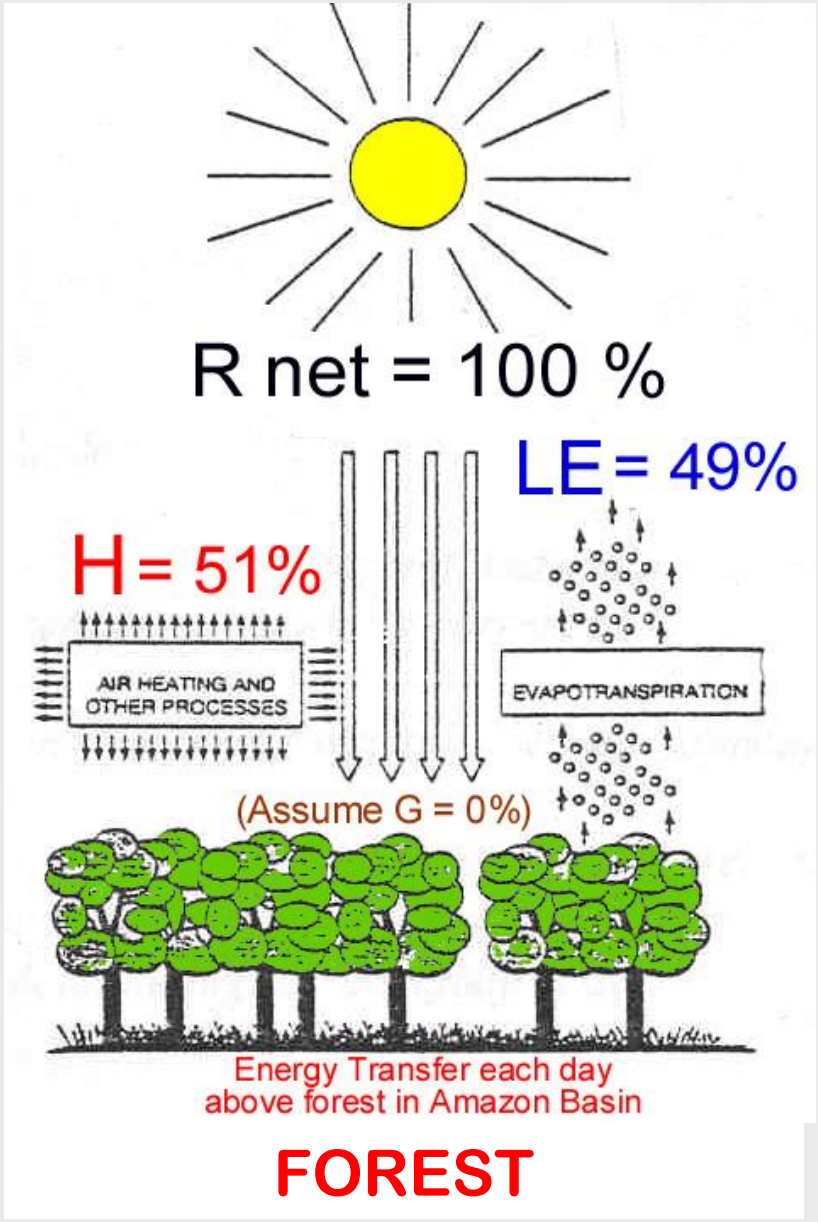
SHORTWAVE & LONGWAVE ENERGY FLOW & BUDGET:

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

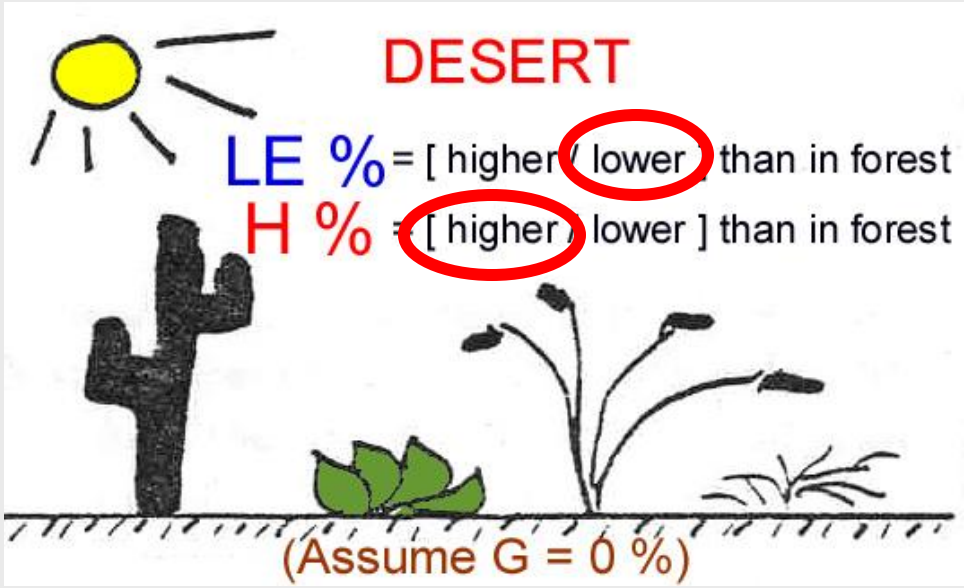

AMAZON RAIN
FOREST




SONORAN
DESERT

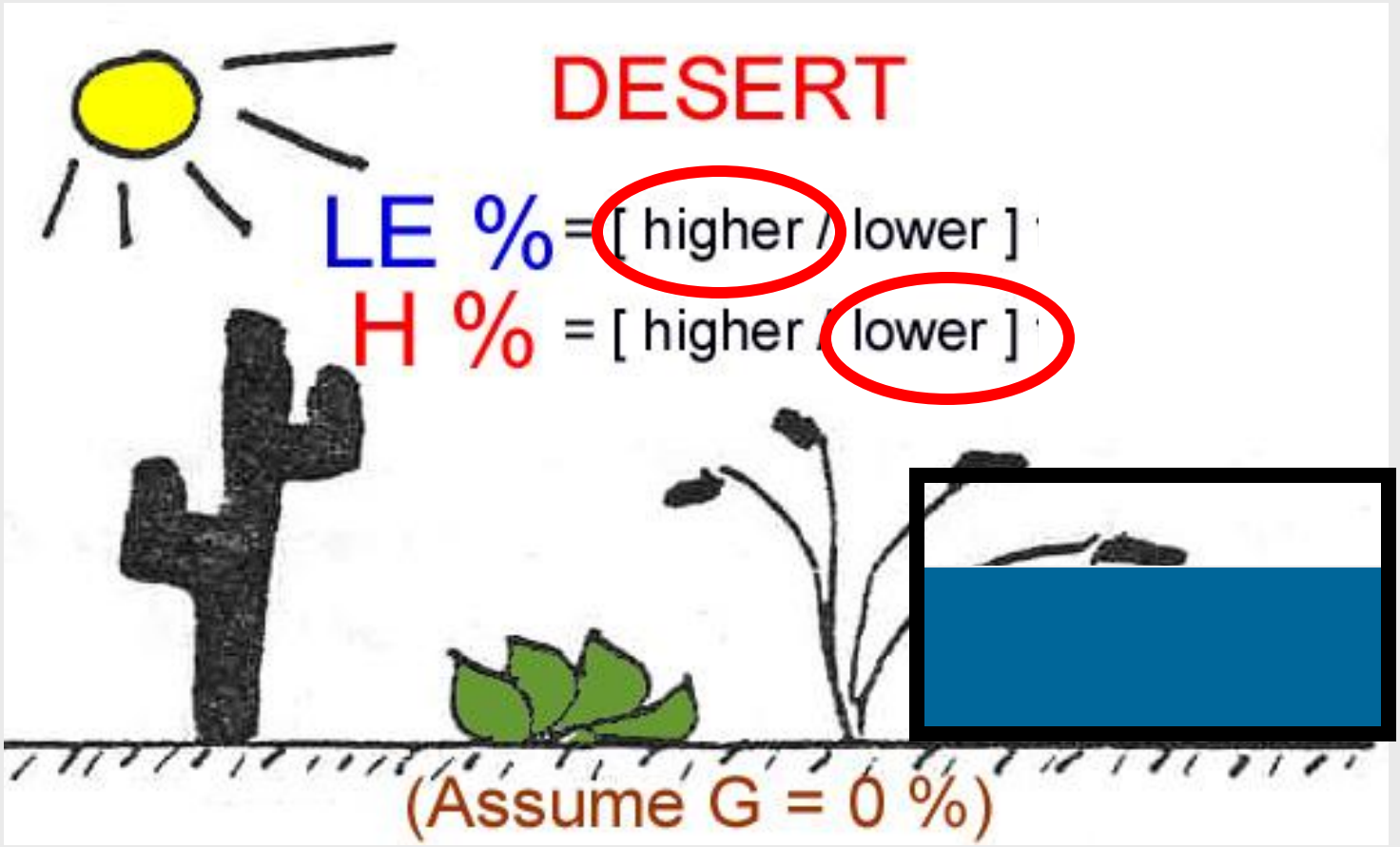


Will the % of net radiation in LE form be HIGHER or LOWER in the Desert, when compared to a Rainforest?



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

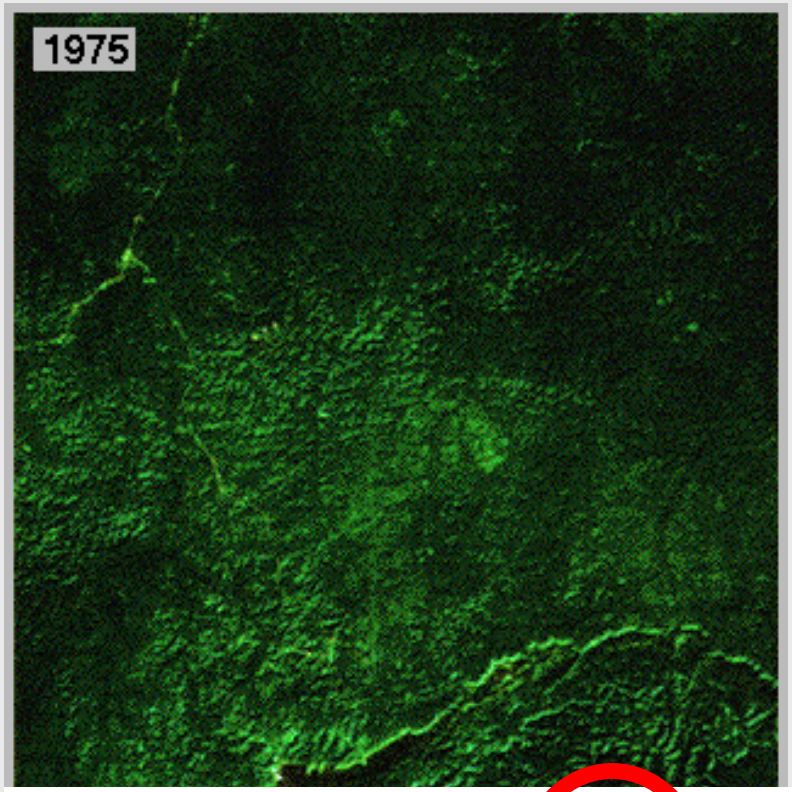
Central Arizona Project (CAP) Canal

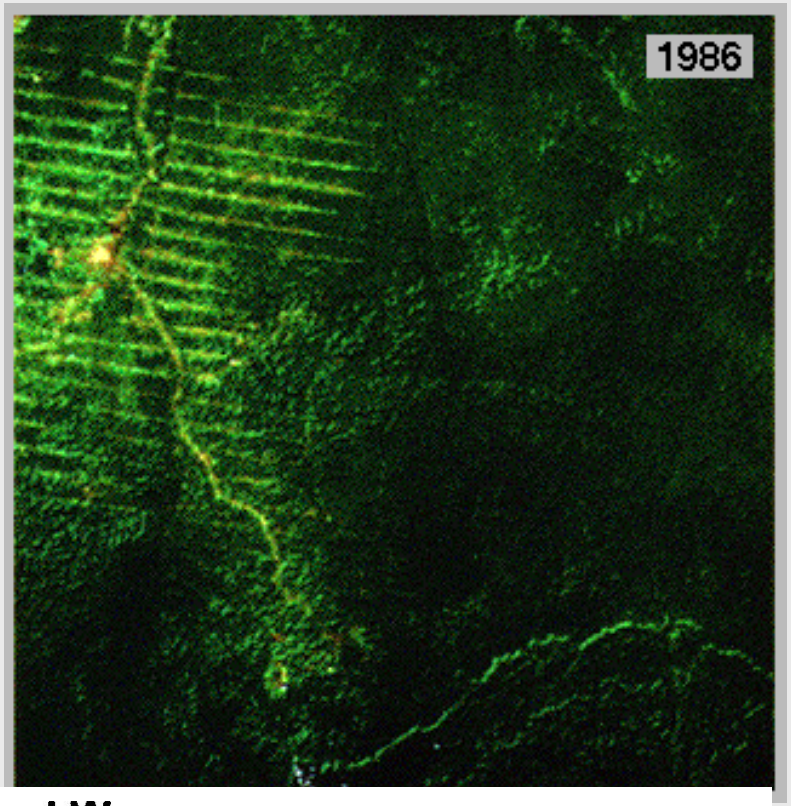


What if humans put in canals (CAP), lakes, & artificial water bodies in a desert?

How would the % of LE in the Desert change?

How does DEFORESTATION change the local energy balance???





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

Less

More → cooler temperatures?

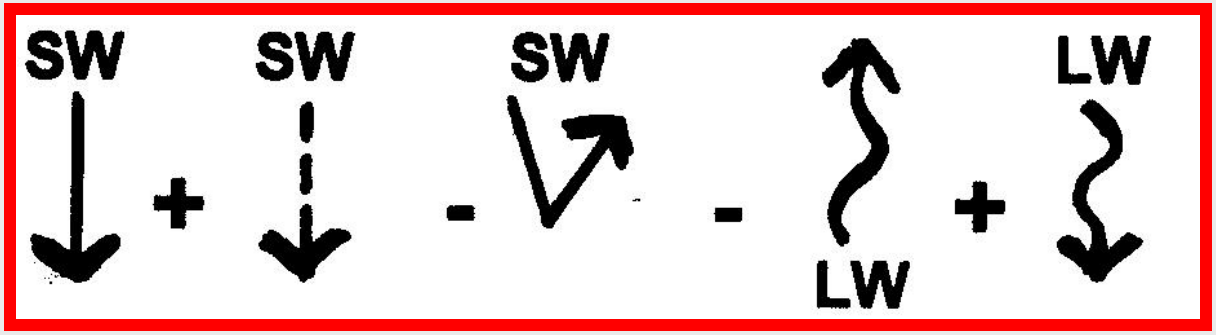
More → warmer temperatures?

Prep for G-3 ASSIGNMENT (5 pts)

Applying the Energy Balance Terms

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

1 – #12 : Left side of equation



13 - #15: Right side of equation

H + LE + G

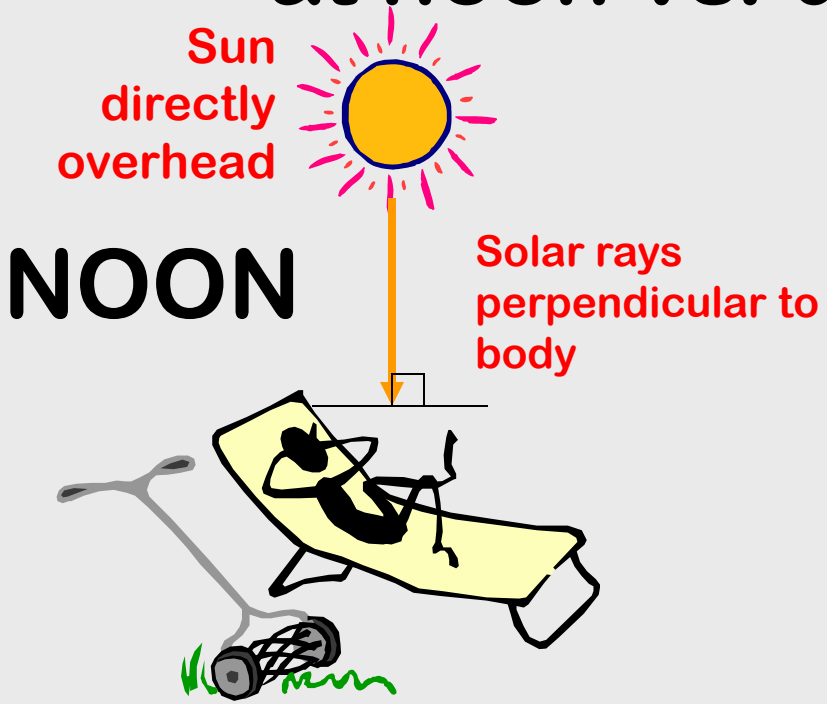
p 53

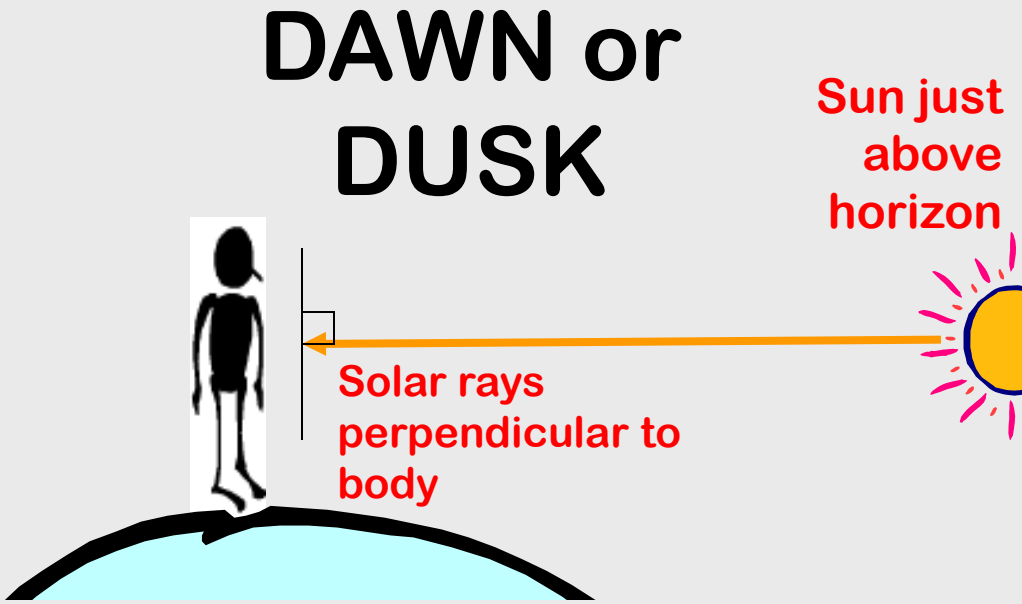
1. blue skies

2. Sunglasses while skiing

3. Bright even though cloudy

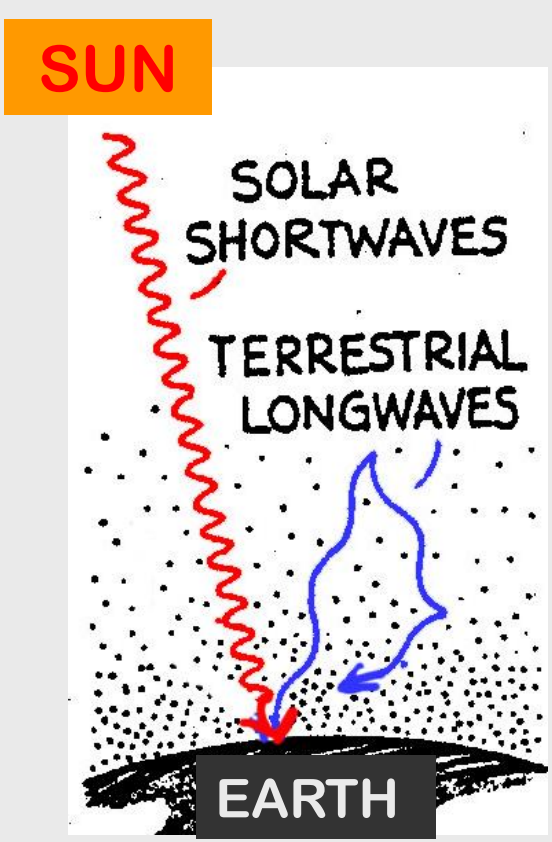
4. More intense solar radiation (tan /skin damage, etc.) at noon vs. dawn or dusk

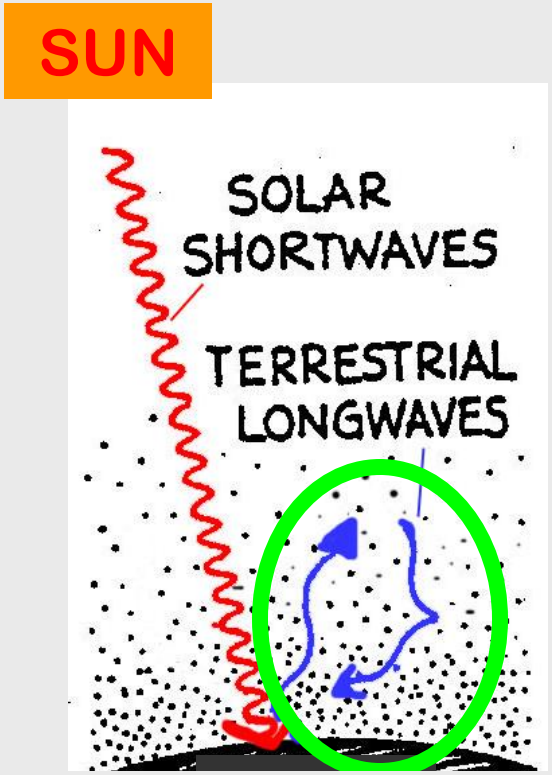




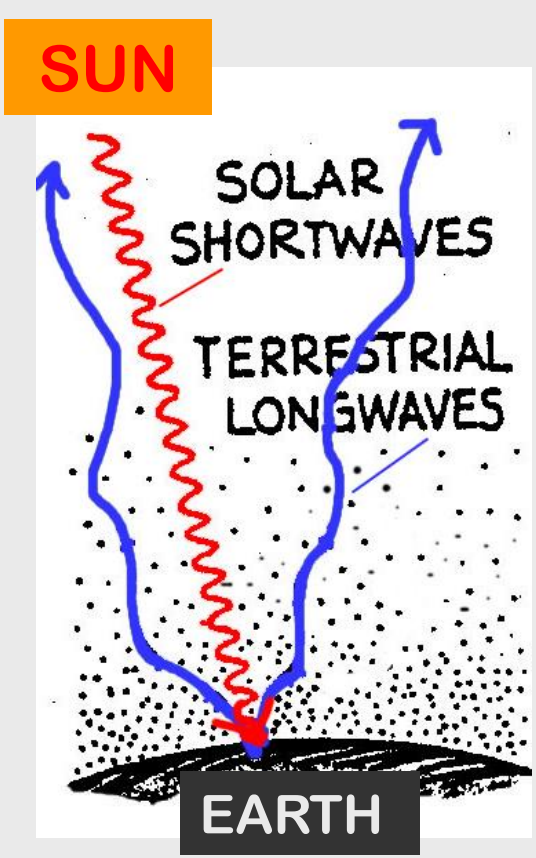
5. The Greenhouse Effect ➔

To illustrate the GREENHOUSE EFFECT:





Greenhouse effect



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

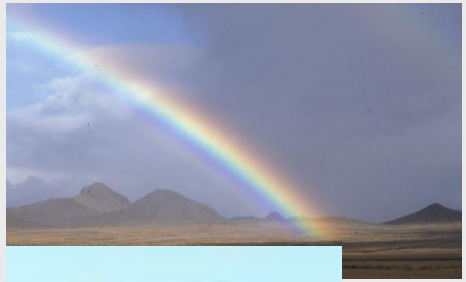
6. Red sunsets

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 Thursday

Don’t forget RQ-5!