Thursday Oct 21

Sit with your Group TODAY!!

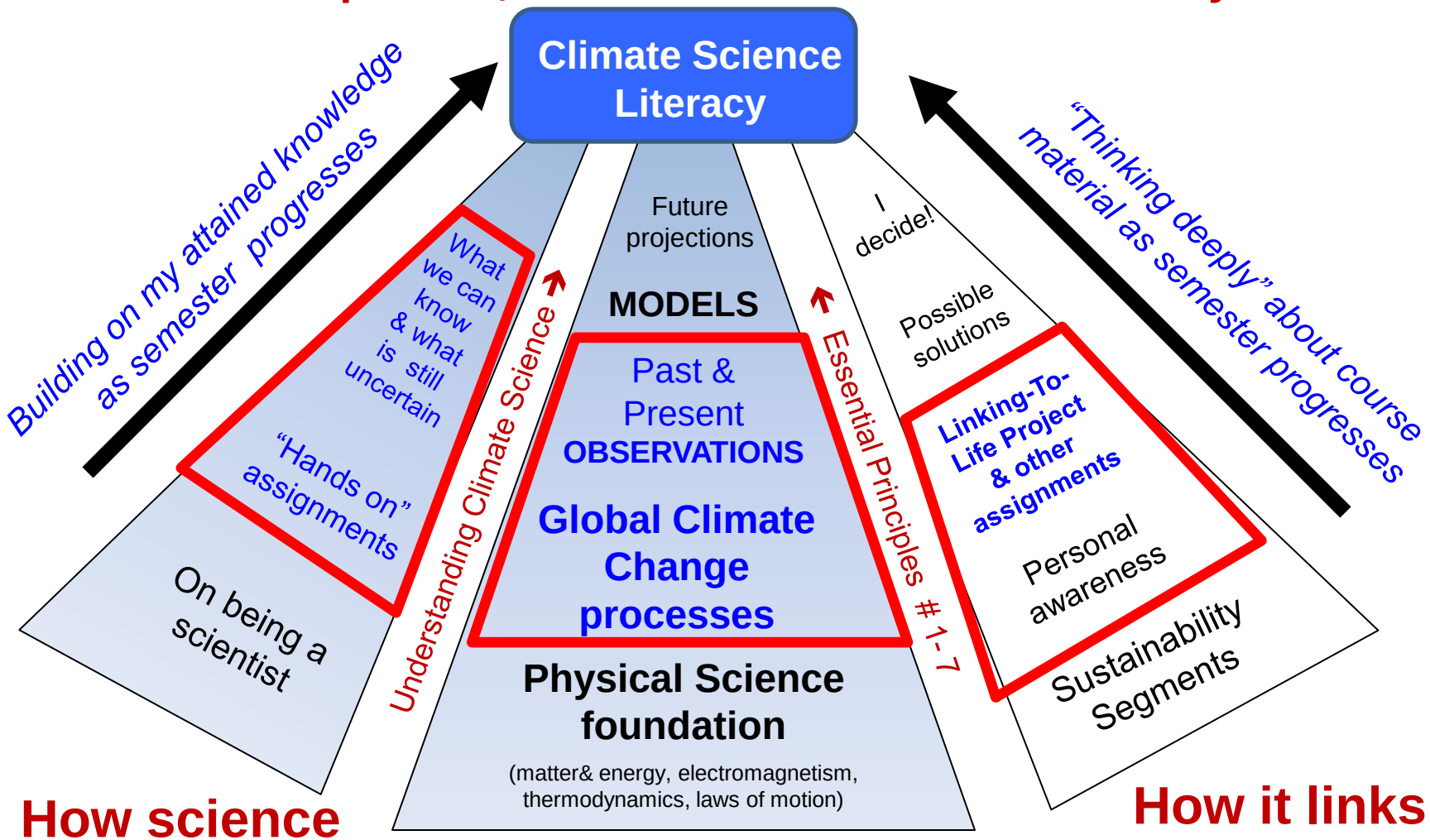
TODAY'S NEW TOPIC:

Topic # 9 Systems & Feedbacks

ANNOUNCEMENTS

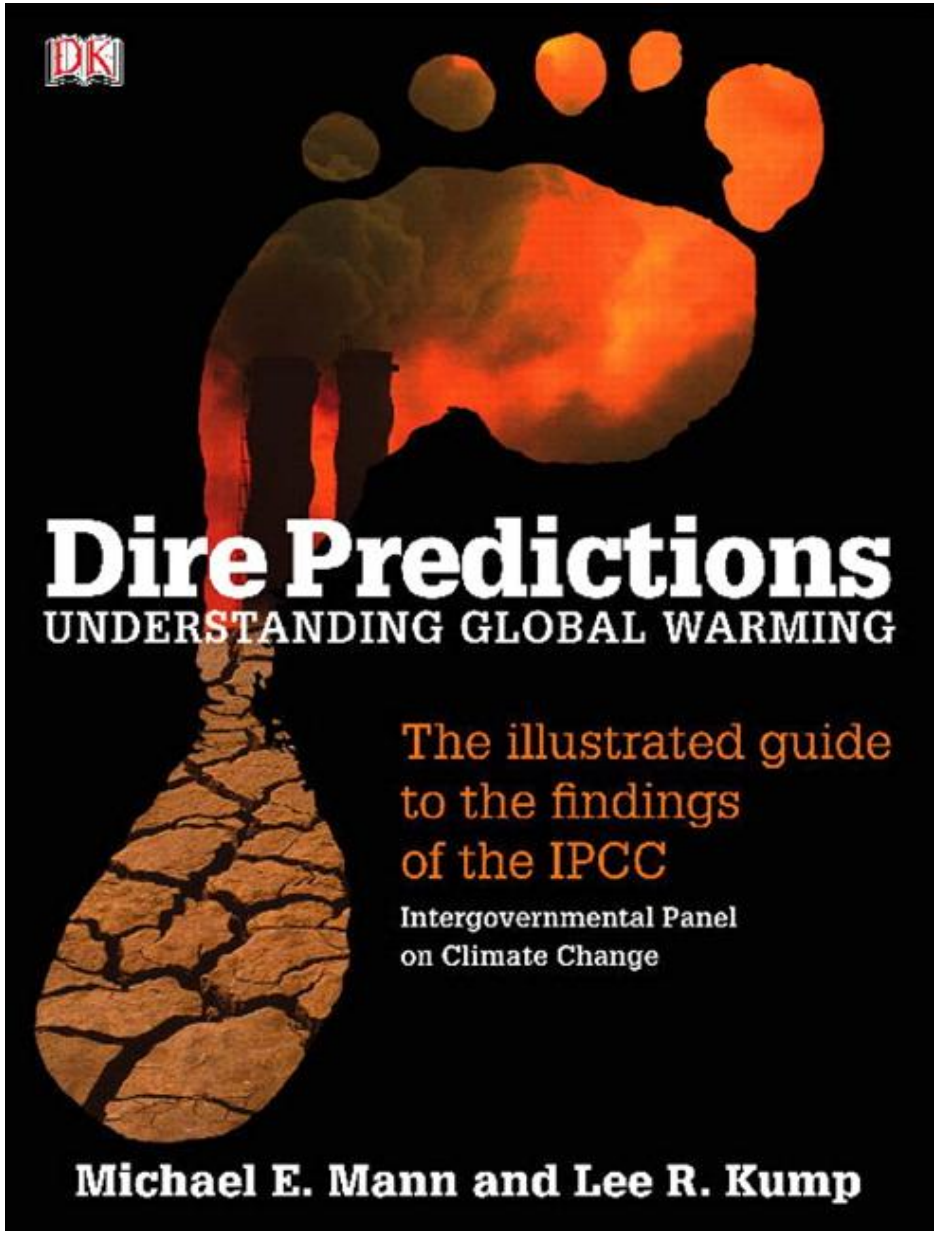
- Due to the D2L outage last night, the RQ-5 cutoff has been extended until TONIGHT at 11:30 pm
- New I-2, 1-3, and I-4 Assignments have been posted. (The answer sheets will be linked tonight)
- RQ6 on Natural Climate Processes & Forcing is coming up NEXT Tuesday -- Get started on the reading NOW!
- Exam grading is in process – will be returned next week

GOAL: Enhanced Understanding Of Global Change Science, How It Operates, & What It Means To Me Personally



Remember to always review the WEEKLY D2L CHECKLIST for what you should be doing . . . . (Next week's Checklist is already posted!)

NOTE: We'll be reading more in the Dire Predictions text in upcoming weeks – see Checklist for the specific pages.



TOPIC # 9

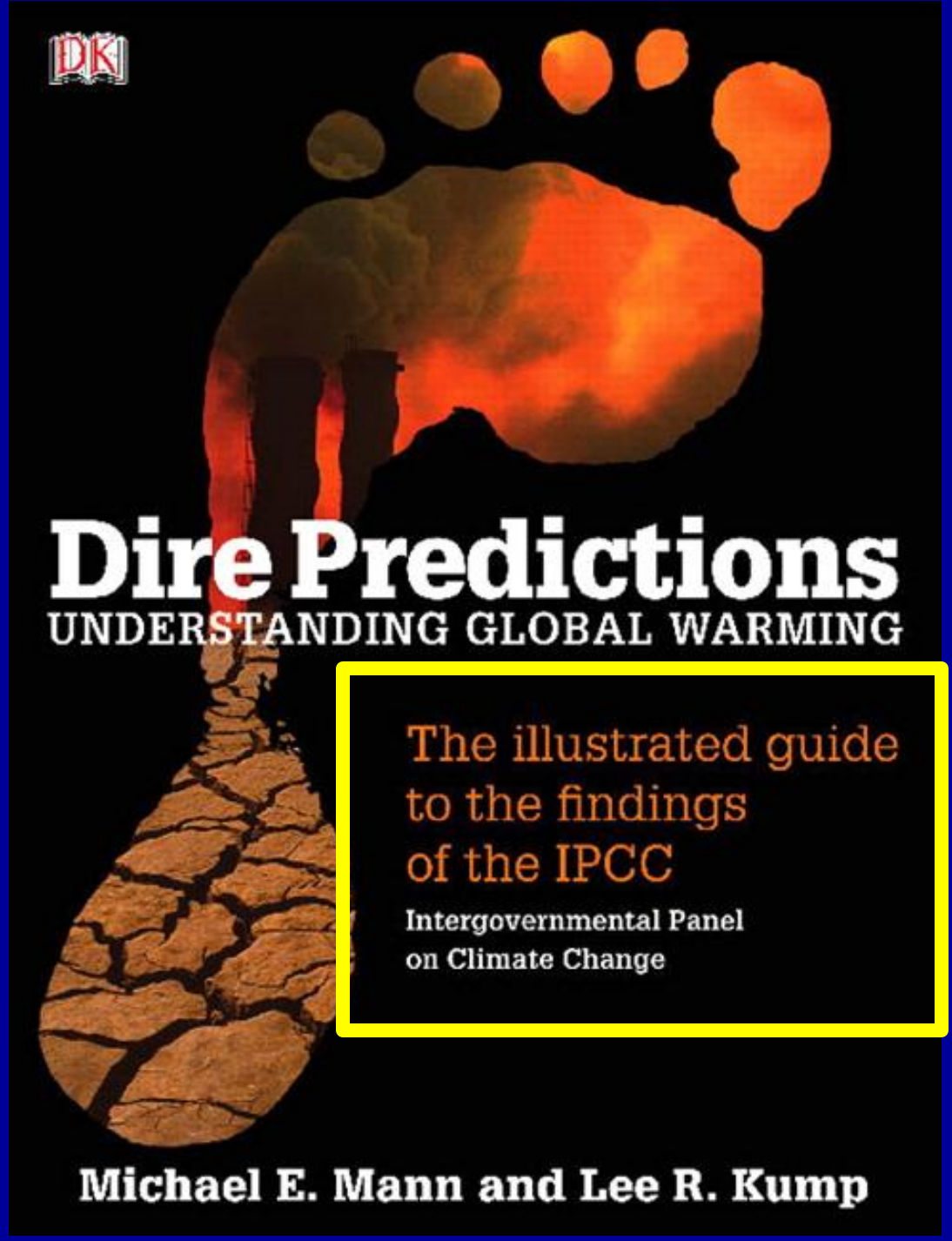
Introduction to Models:

UNDERSTANDING SYSTEMS & FEEDBACKS

Class notes pp 57 -61

“When one tugs at a single thing in nature, one finds it attached to the rest of the world.”

~ John Muir



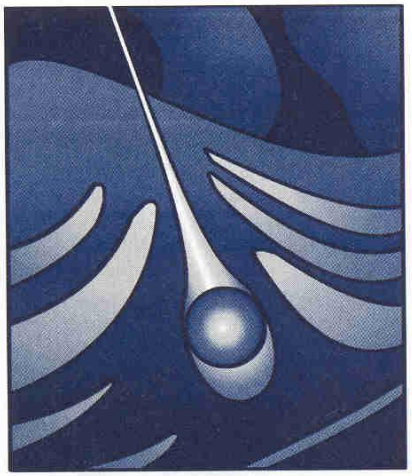
Projections of what the FUTURE CLIMATE will be like are based on GIANT COMPUTER MODELS – results are given in the **IPCC Report** and summarized in your DIRE PREDICTIONS text .

(More on these projections later under Topic # 13)

THIS CHAPTER INTRODUCES YOU TO

"THNKING LIKE"
The IPCC COMPUTER MODELS WORK

CHAPTER 2



Daisyworld: An Introduction to Systems

WHAT IS A SYSTEM?

SYSTEM = a set of interacting components

COMPONENT *(def)* = An individual part of a system.

A component may be a reservoir of matter or energy, or some other aspect of the system, a "system attribute" or a subsystem:

e.g. the atmosphere, the energy in the atmosphere as measured by temperature, or the amount of CO_2 in the atmosphere, etc.

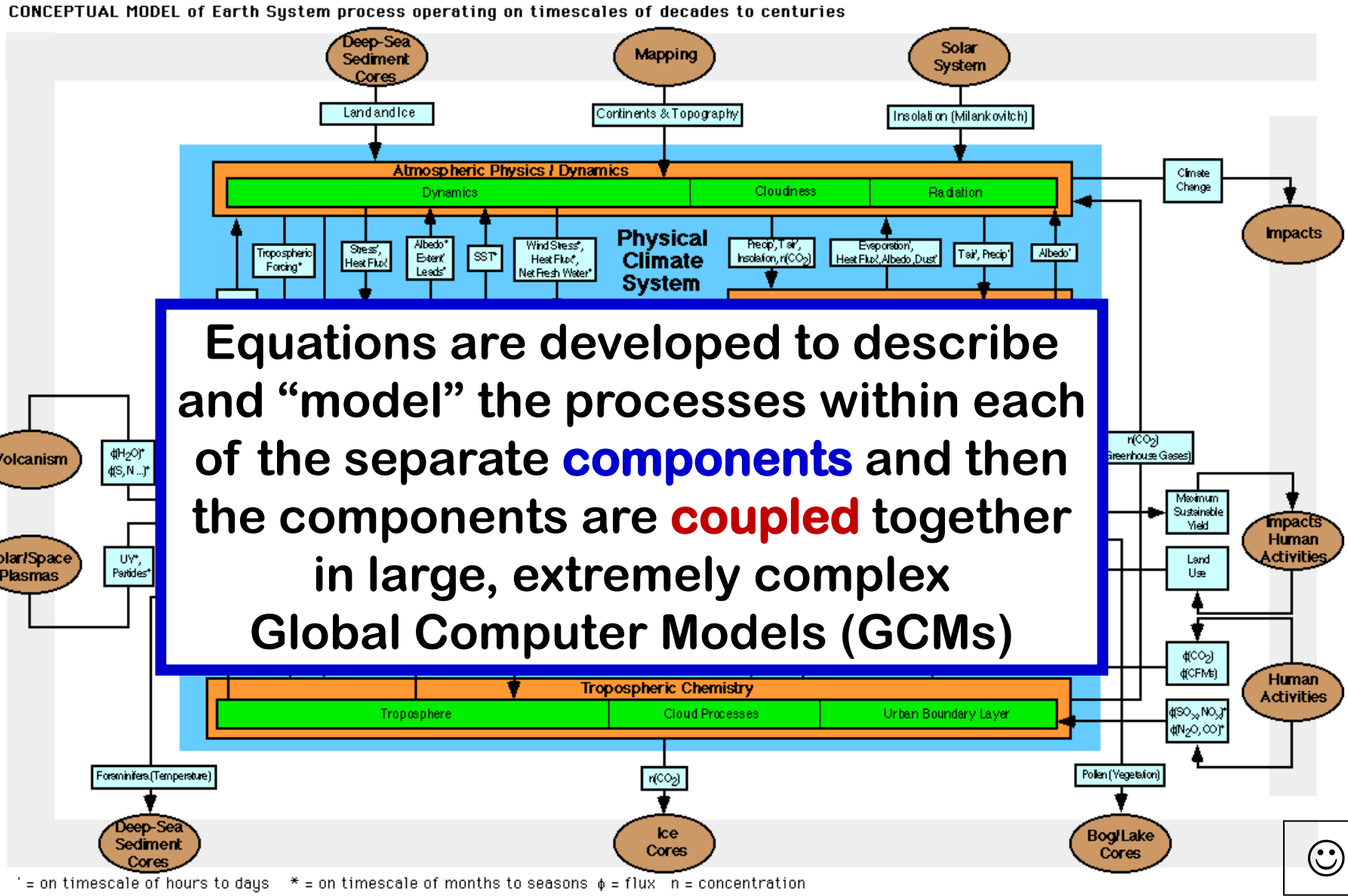
SYSTEM MODEL =

a set of assumptions, rules, data and inferences that define the interactions AMONG the components of a system and the significant interactions between the system and the "universe" outside the system

SYSTEM DIAGRAM =

A diagram of a system that uses graphic symbols or icons to represent components in a depiction of how the system works

A complicated "system diagram" of the Earth-Atmosphere System:



Coupling *(def):*

The links between any two components of a system.

Couplings can be positive (+) or negative (-)

A coupling between an electric blanket temperature component and a body temperature component:

If the electric blanket's temperature INCREASES . . .

The person's body temperature will also INCREASE

What type of COUPLING IS THIS?

Positive + OR Negative - ???

A coupling between a person's body temperature and an electric blanket's temperature

If the person's body temperature INCREASES and she gets too hot . . .

The electric blanket's temperature control will be turned down and the blanket temperature will DECREASE

What type of COUPLING IS THIS?

Positive + OR Negative - ????

THE "RULE" – how to tell if the diagram is showing a positive or negative coupling:

Positive couplings have a **solid "arrow"** with a normal arrowhead pointing in the direction of the coupling:

Negative couplings have an **"open circle"** arrowhead pointing in the direction of the coupling:

FEEDBACKS

Feedback mechanism *(def):*

a sequence of interactions in which the final interaction influences the original one.

Feedbacks occur in loops ➔

Feedback Loop *(def)* =

A linkage of two or more system components that forms a ROUND-TRIP flow of information.

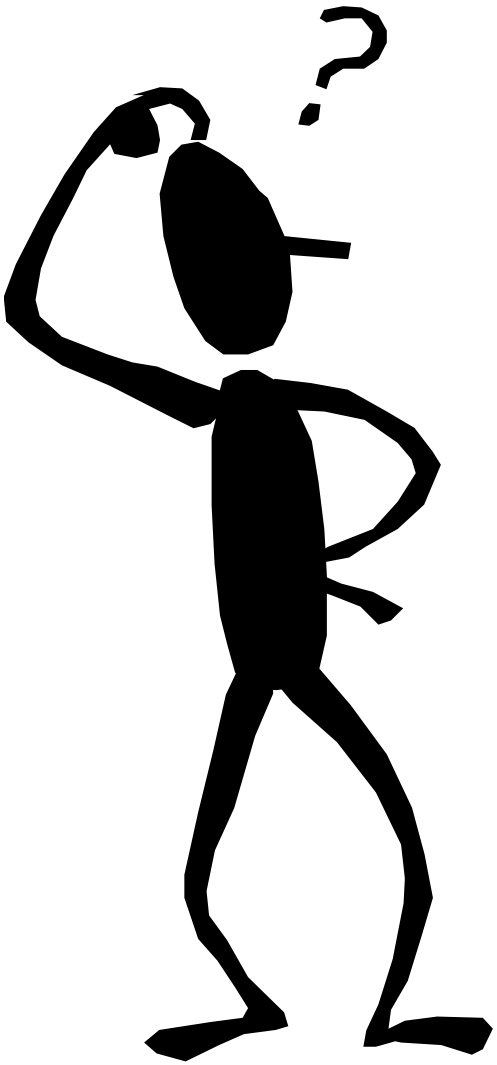
Feedback loops can be positive (+) or negative (-).

A ***positive feedback*** is an interaction that amplifies the response of the system in which it is incorporated

(self-enhancing; amplifying).

A ***negative feedback*** is an interaction that **reduces** or **dampens** the response of the system in which it is incorporated

(**self-regulating**; diminishes the effect of perturbations)



One way to remember the effect that a NEGATIVE feedback loop has is to think of the word "negligible"

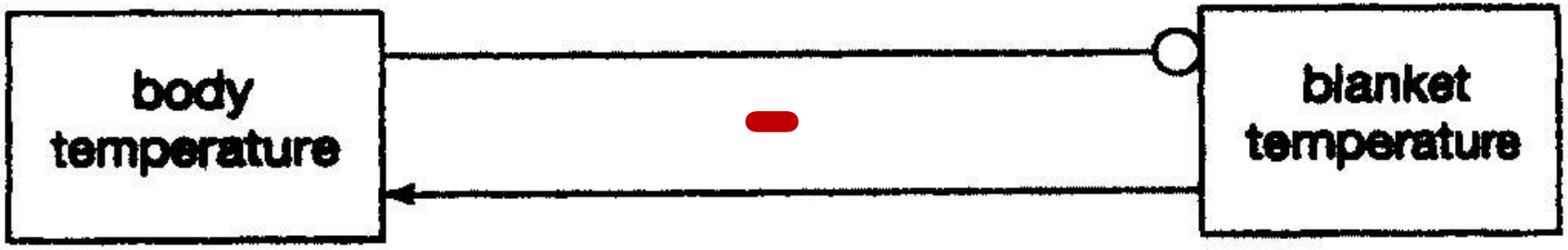
i.e., a perturbation or disturbance in a system characterized by a negative feedback loop will be able to adjust to the perturbation and ultimately the effect on the system will be negligible

FEEDBACK LOOP

Clicker Q1

What kind of FEEDBACK LOOP is it?

1) Positive (+) 2) Negative (-) ???

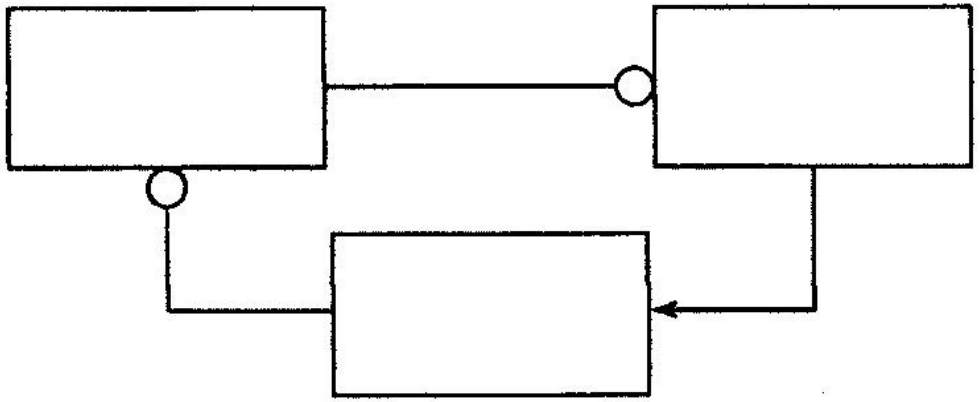


THE "RULE" – how to tell if the diagram is a positive or negative feedback LOOP:

Count the # of number of NEGATIVE COUPLINGS:

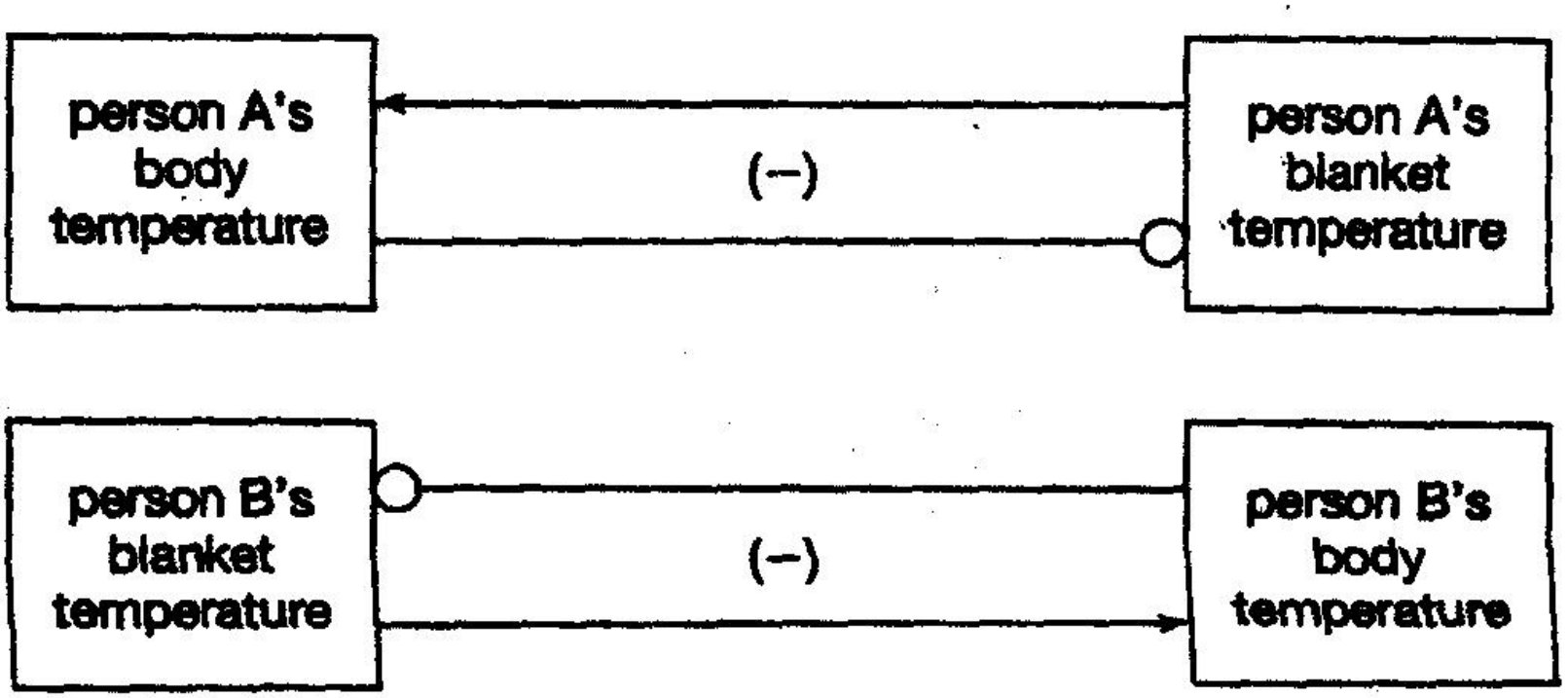
If there is an ODD # of negative Couplings, the loop is NEGATIVE:

If there is an EVEN # of negative couplings, the loop is POSITIVE



Everyday life example:

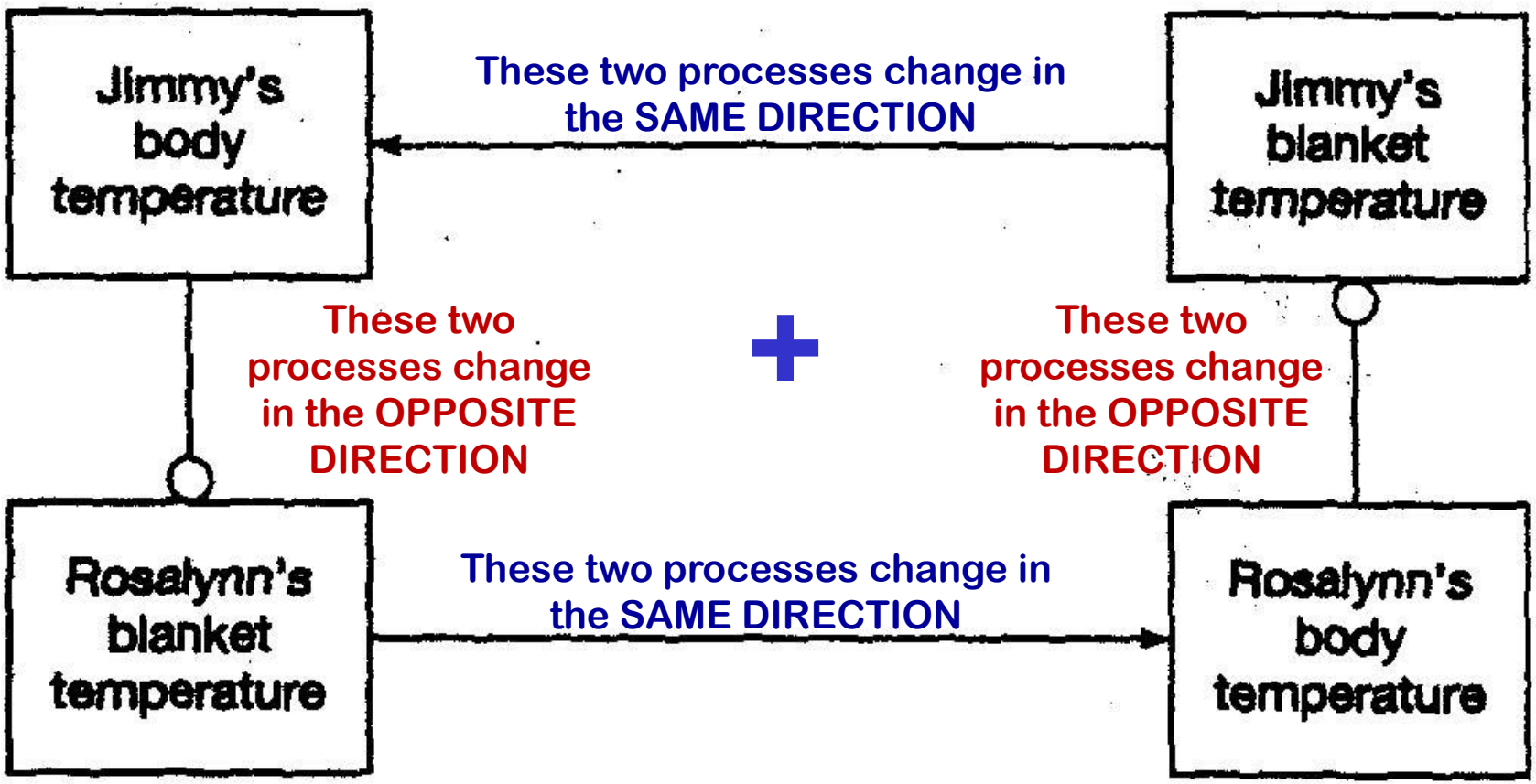
Proper alignment of dual control electric blanket:



Improper alignment:

Clicker Q2 What kind of FEEDBACK LOOP is it?

1) Positive + 2) Negative -



A POSITIVE FEEDBACK LOOP that amplifies the effect!

QUICK SUMMARY:

- **NEGATIVE** feedback loops:
  - are **resistant to a range** of disturbances
    (small changes have a "negligible" effect)
  - system can return to it's beginning state
  -- STABLE equilibrium state

+ **POSITIVE** feedback loops:

  - **amplify the effects of disturbances**
    (small changes can "amplify" the response)
  - system can become UNSTABLE and
    be taken to a new, amplified state

LINKING TO GLOBAL CHANGE:

In Global Change science we are concerned about disturbances that both humans and natural factors can produce in the Earth system:

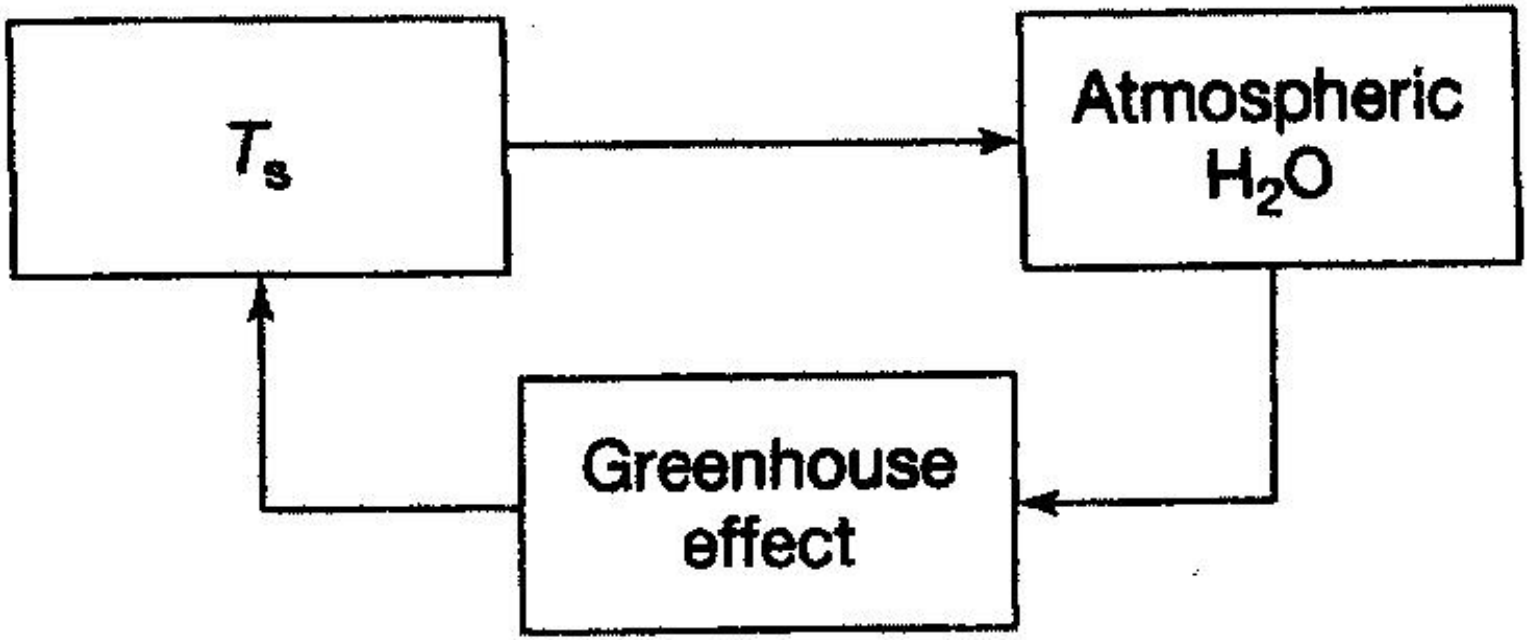
(e.g. increasing carbon dioxide)

. . . and whether or not the Earth can adjust to these and have a stable equilibrium state, or be thrown into an unstable state due to positive feedback loops

WATER VAPOR Feedback in the Earth-Atmosphere

Clicker Q3 What kind of FEEDBACK LOOP IS THIS?

1) Positive + 2) Negative -



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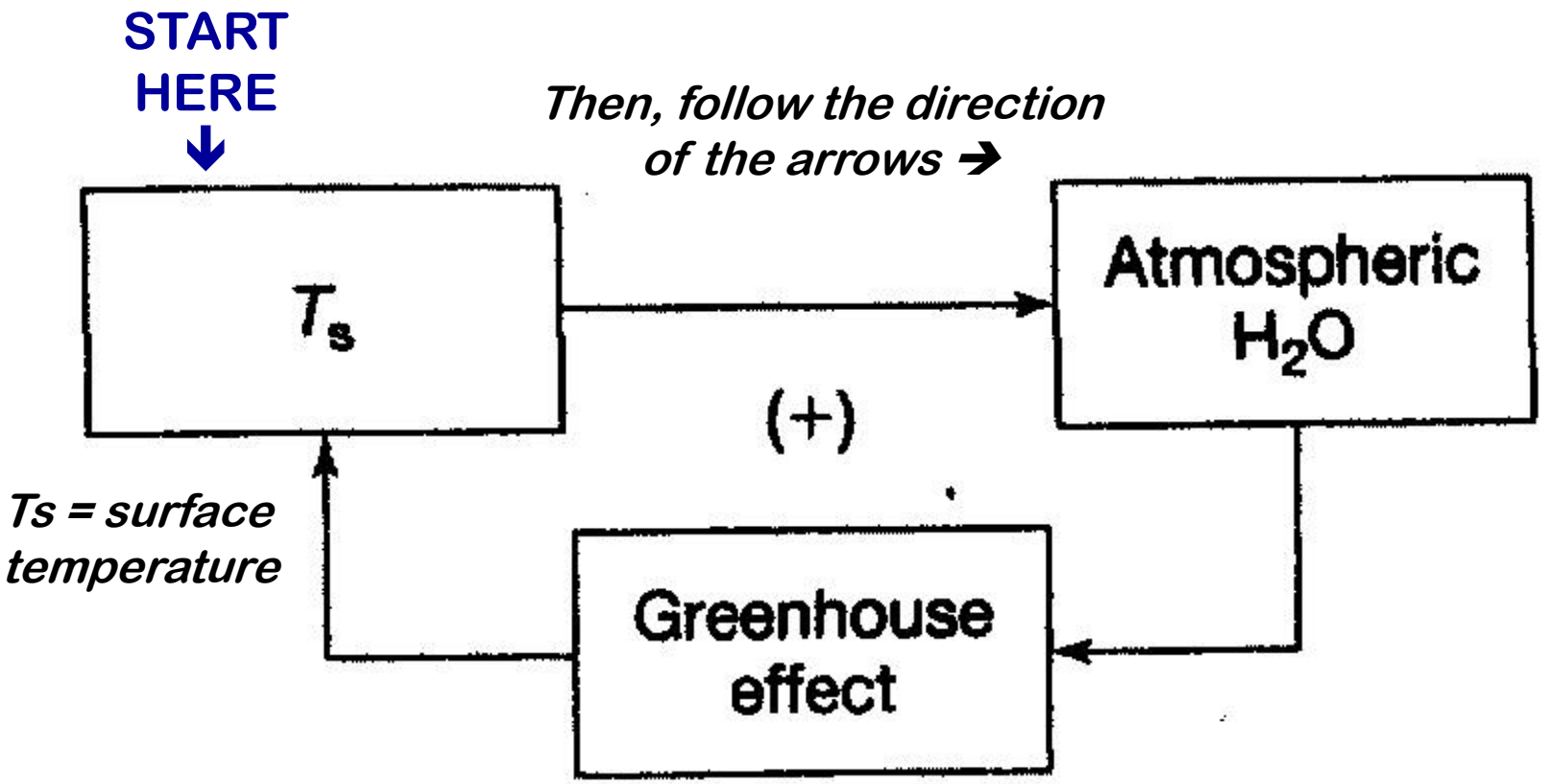
POSITIVE FEEDBACK LOOP
that amplifies the effect!

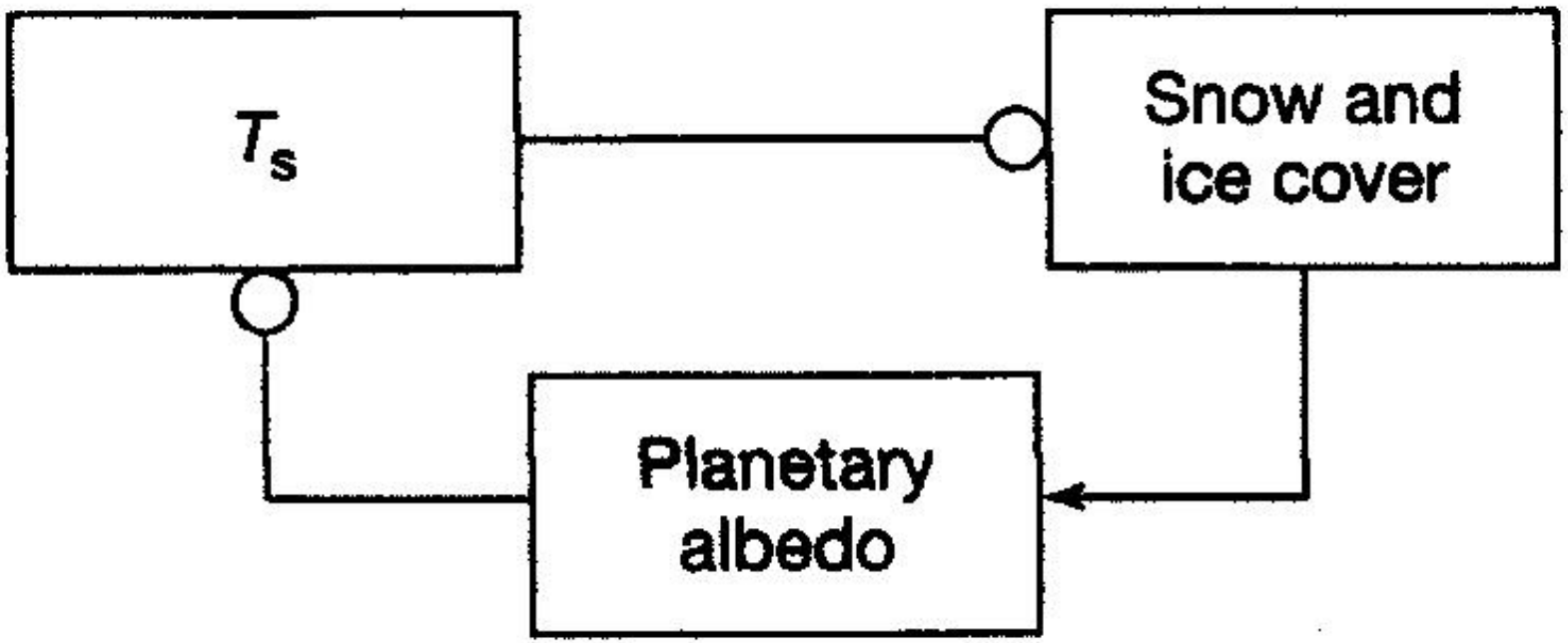


Let's reason it through . . .

SNOW AND ICE ALBEDO Feedback

Clicker Q4 What kind of FEEDBACK LOOP IS THIS?

1) Positive + 2) Negative -



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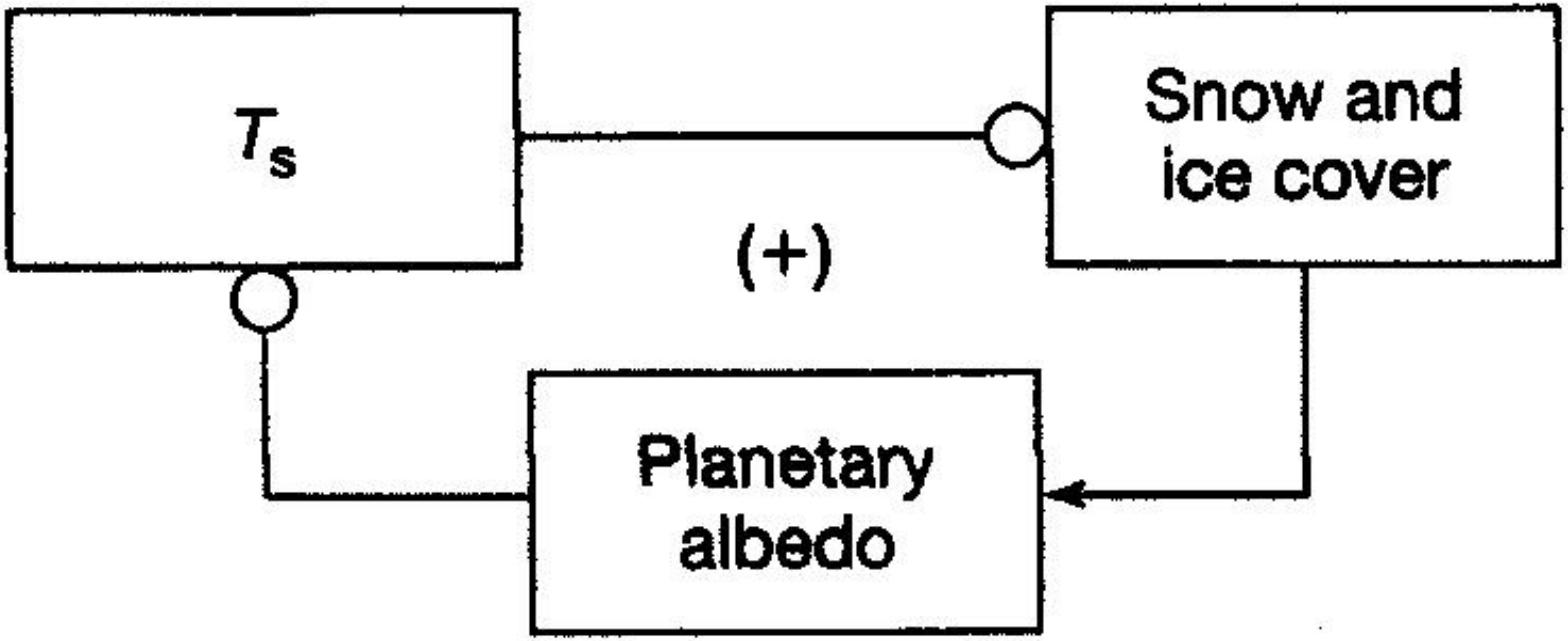
ALSO a POSITIVE FEEDBACK LOOP that amplifies the effect!

but

HOW DOES IT WORK?



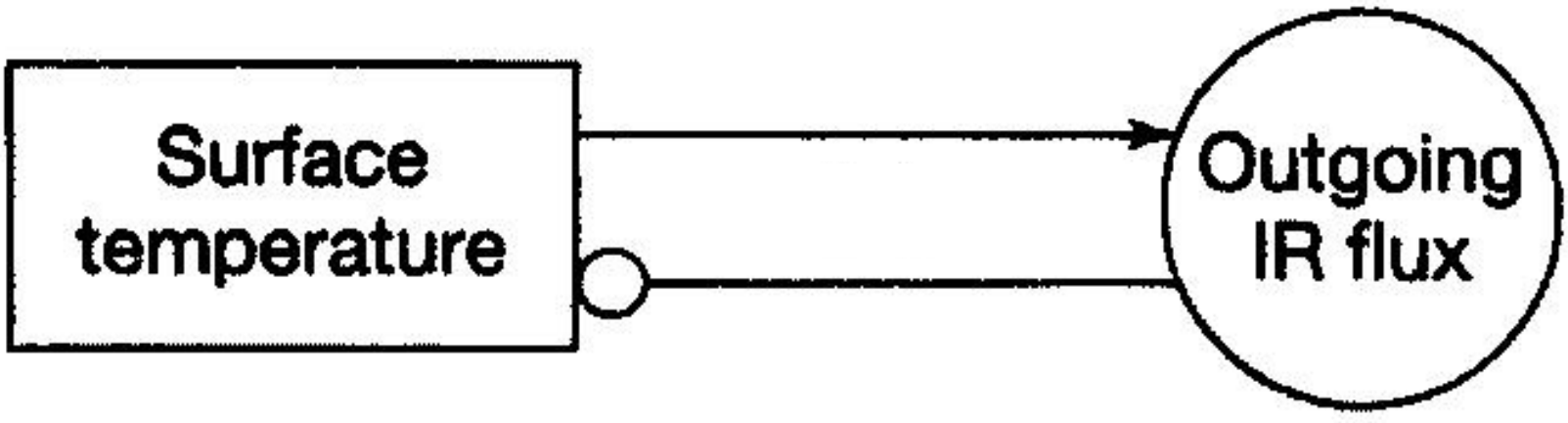
ALBEDO REVIEW:

Fresh Snow & Ice = very high albedo (0.80 - 0.85)

OUTGOING INFRARED ENERGY FLUX / TEMPERATURE Feedback

Clicker Q5 What kind of FEEDBACK LOOP IS THIS?

1) Positive + 2) Negative -



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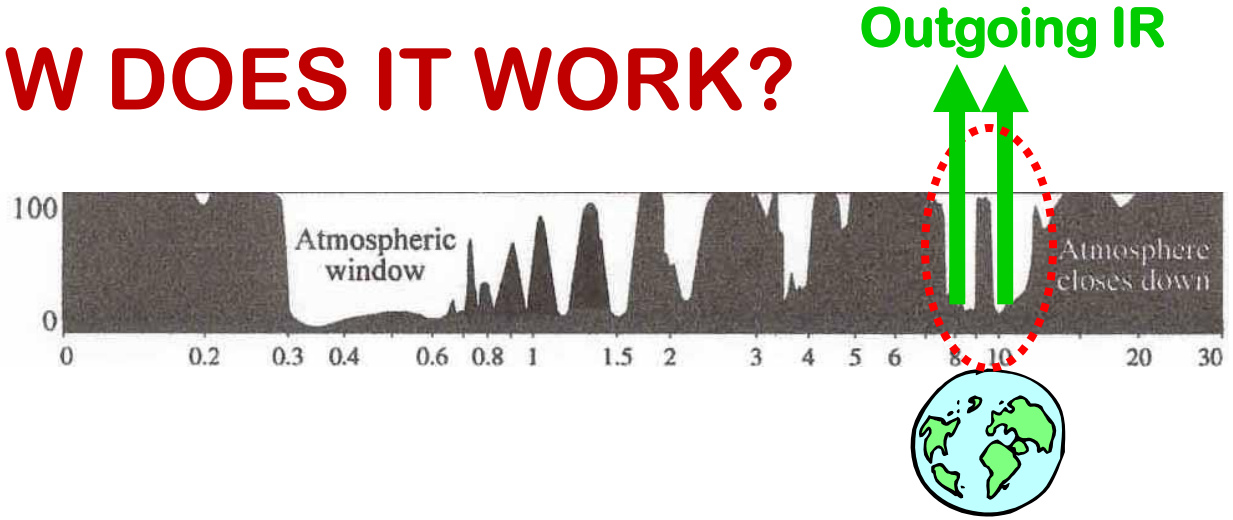
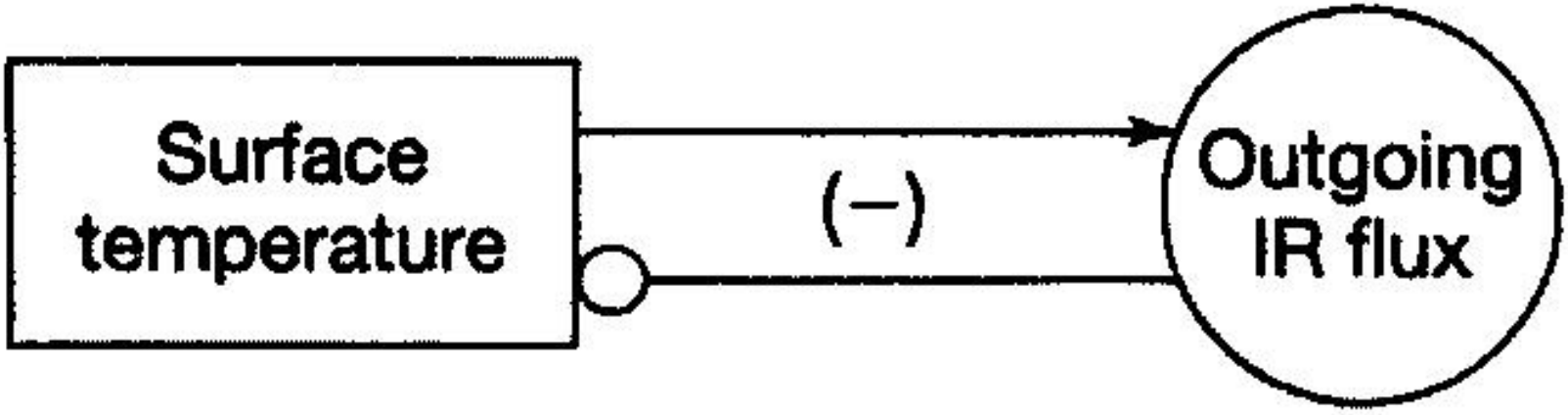
NEGATIVE FEEDBACK LOOP

that is self-regulating!

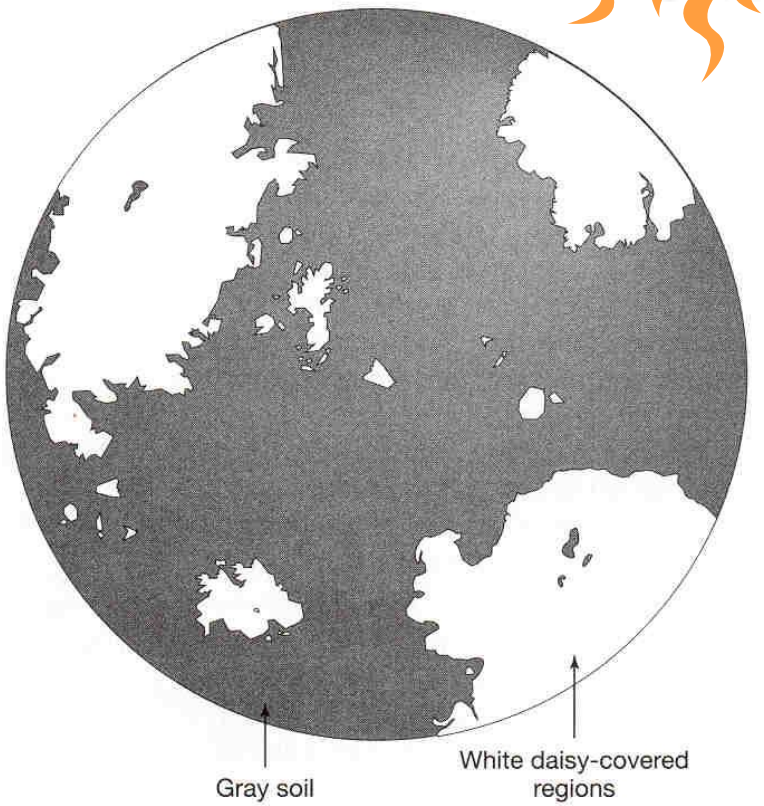
HOW DOES IT WORK?





This is how the **EARTH cools itself!**

We'll talk about the Daisyworld Climate System later . . .



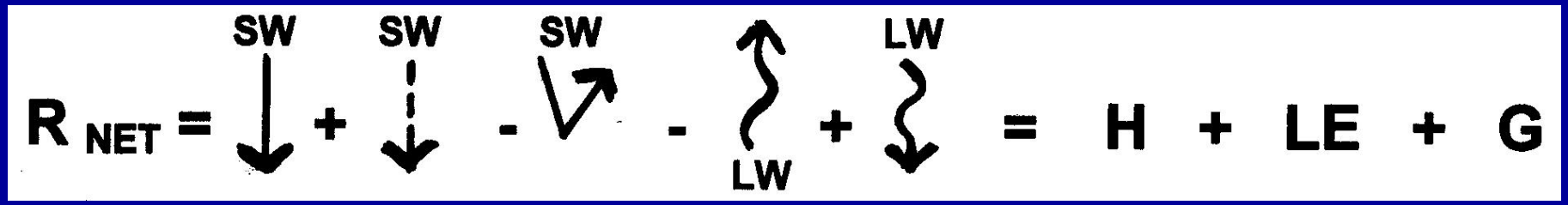
TO BE CONTINUED . . . . .

The next segment of:

http://www.pbs.org/wgbh/nova/solar/

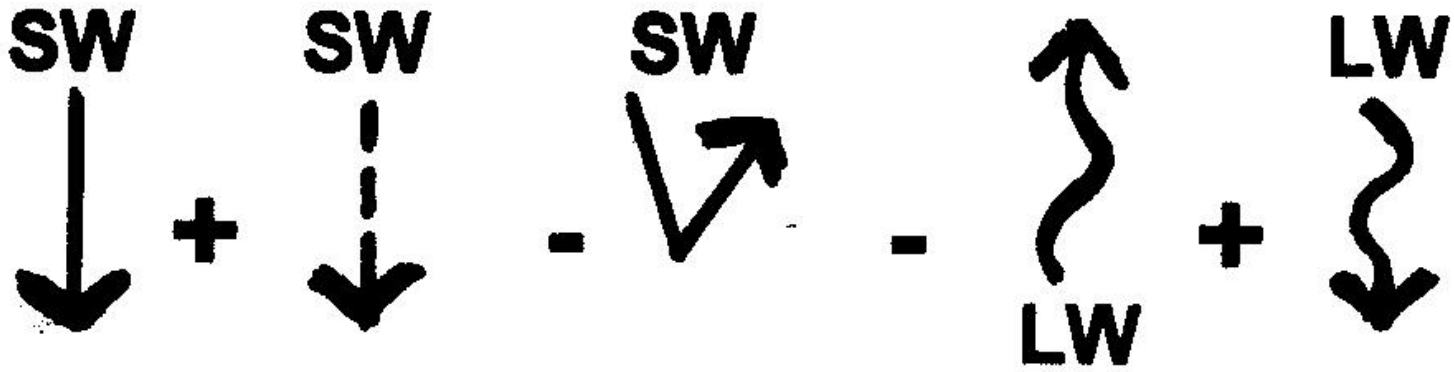
Applications of THE EARTH'S GLOBAL ENERGY BALANCE . . .

To Everyday Life



Flip to p 53

Left Side of Energy Balance Equation:



RADIATION = transfer of energy by *electromagnetic radiation*.

SHORTWAVE (VIS) and LONGWAVE (Infrared IR)

review

Right Side of Energy Balance Equation:

$$H + LE + G$$

Conduction

Convection

Phase changes:

(latent energy ←→ sensible heat)

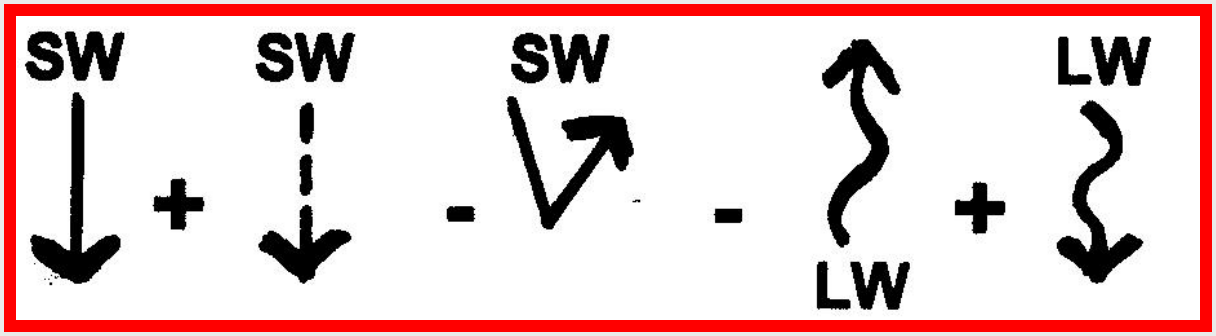
review

G-3 ASSIGNMENT
(IN YOUR GROUPS)

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.

 # 1 – #10 : Left side of equation



 # 11 - #13: Right side of equation

$$H + LE + G$$

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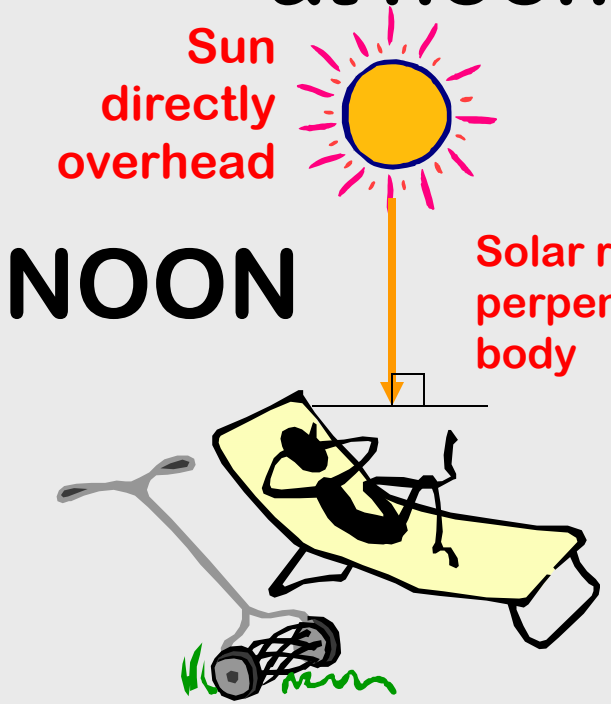
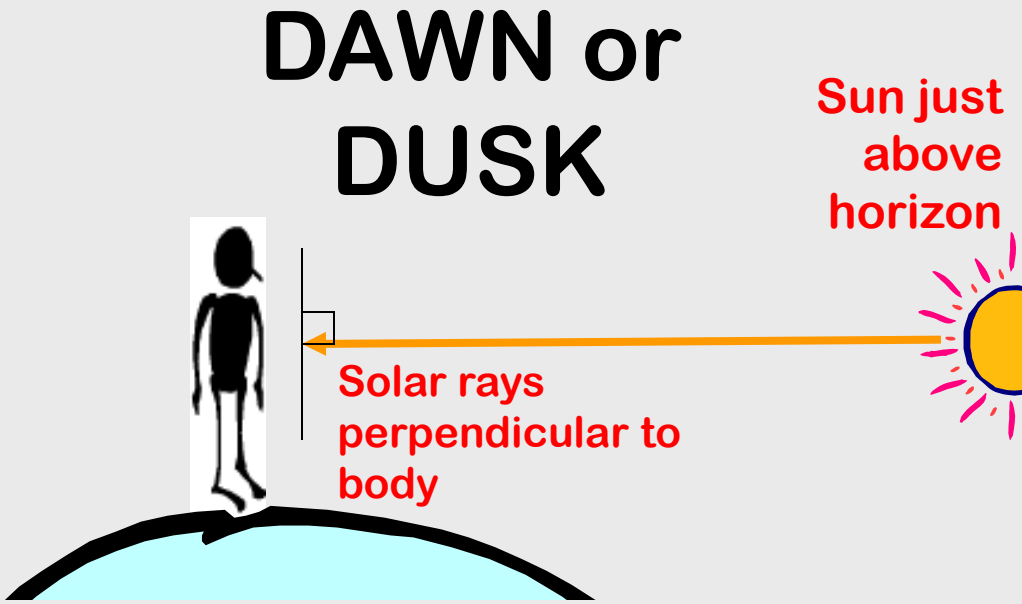
Practice:
blue skies

1. Sunglasses while skiing

2. Bright even though cloudy

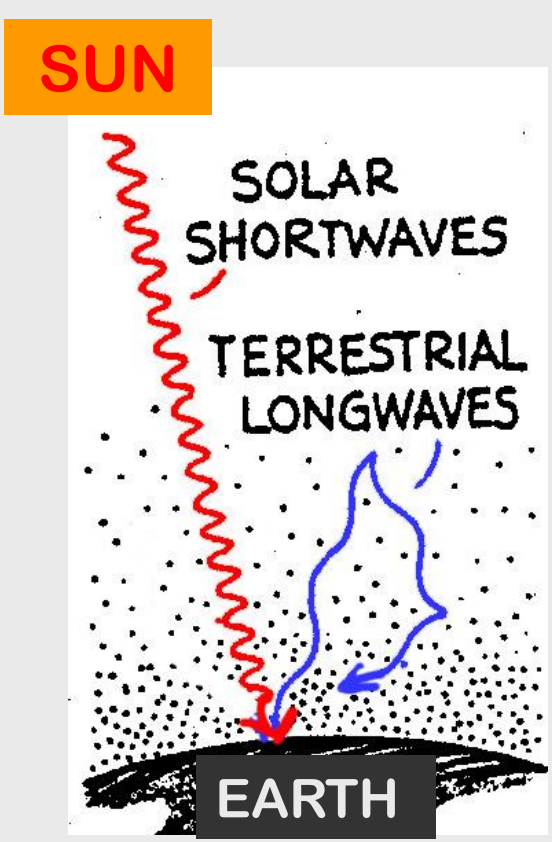
3. More intense solar radiation (tan /skin damage, etc.) at noon vs. dawn or dusk

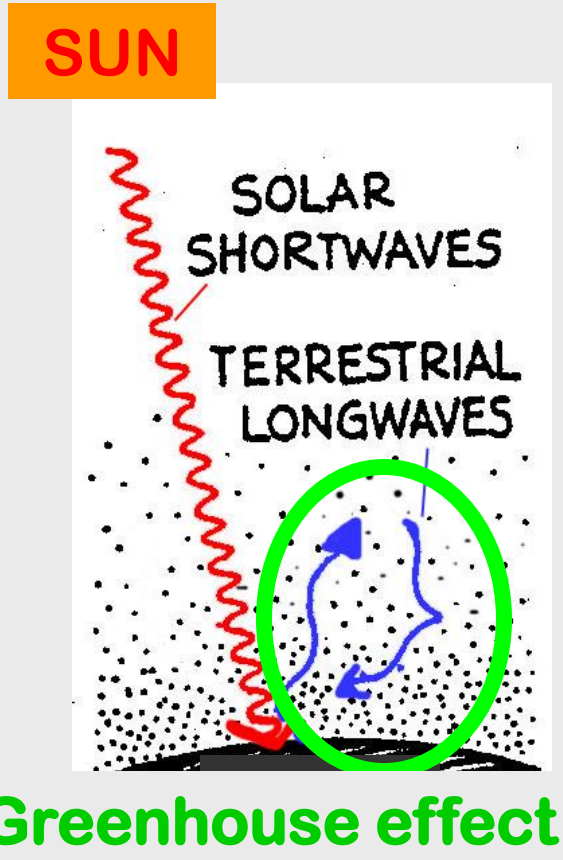




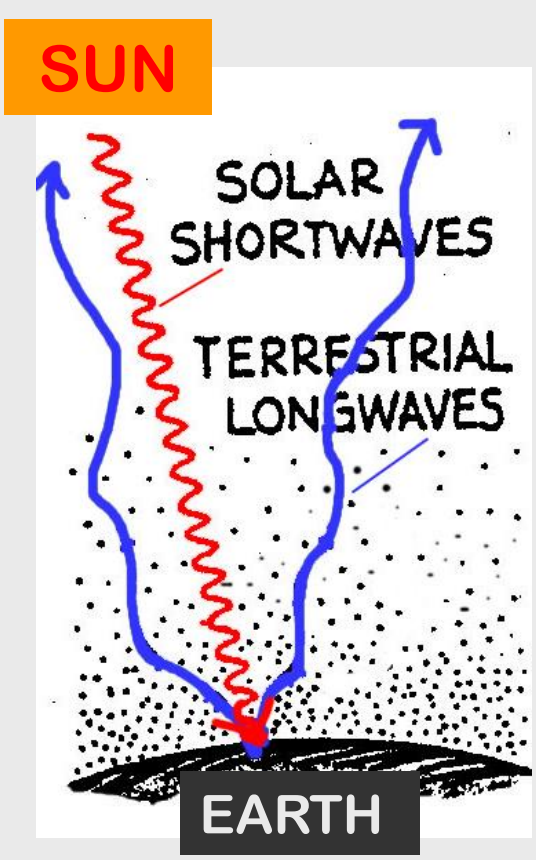
4. The Greenhouse Effect ➔

To illustrate the GREENHOUSE EFFECT:





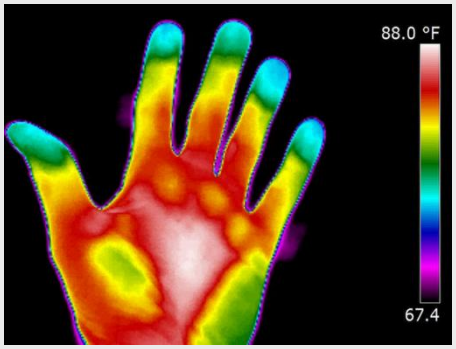
Greenhouse effect

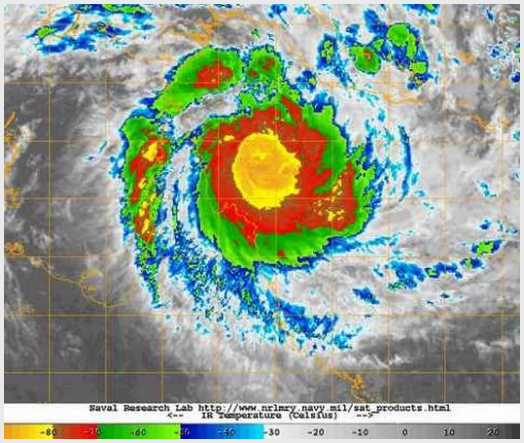


. . . May need two symbols together to answer some of these!

5. Red sunsets

6. Infrared Imagery





7. Shadow on sunny day

8. Rainbow

9. Black streaks

10. Parking on blacktop on a sunny day

11. Hot air balloon

12. Pigs cooling off in the mud

13. Evaporative coolers work best in the desert

G-3 ASSIGNMENT (10 pts)

Applying the Energy Balance Terms

G-3 WHAT TO DO: . . . Discuss the answers together, but EACH GROUP MEMBER must take the lead in answering 1 or 2 questions (in your own handwriting)

Pass the form around & when you sign in, list the # or #'s you did:

Stella Student (#2, #10, & #12) _____

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

See you on Thursday!