TOPIC # 9

UNDERSTANDING SYSTEMS & FEEDBACKS (cont.)

Class notes pp 53-58

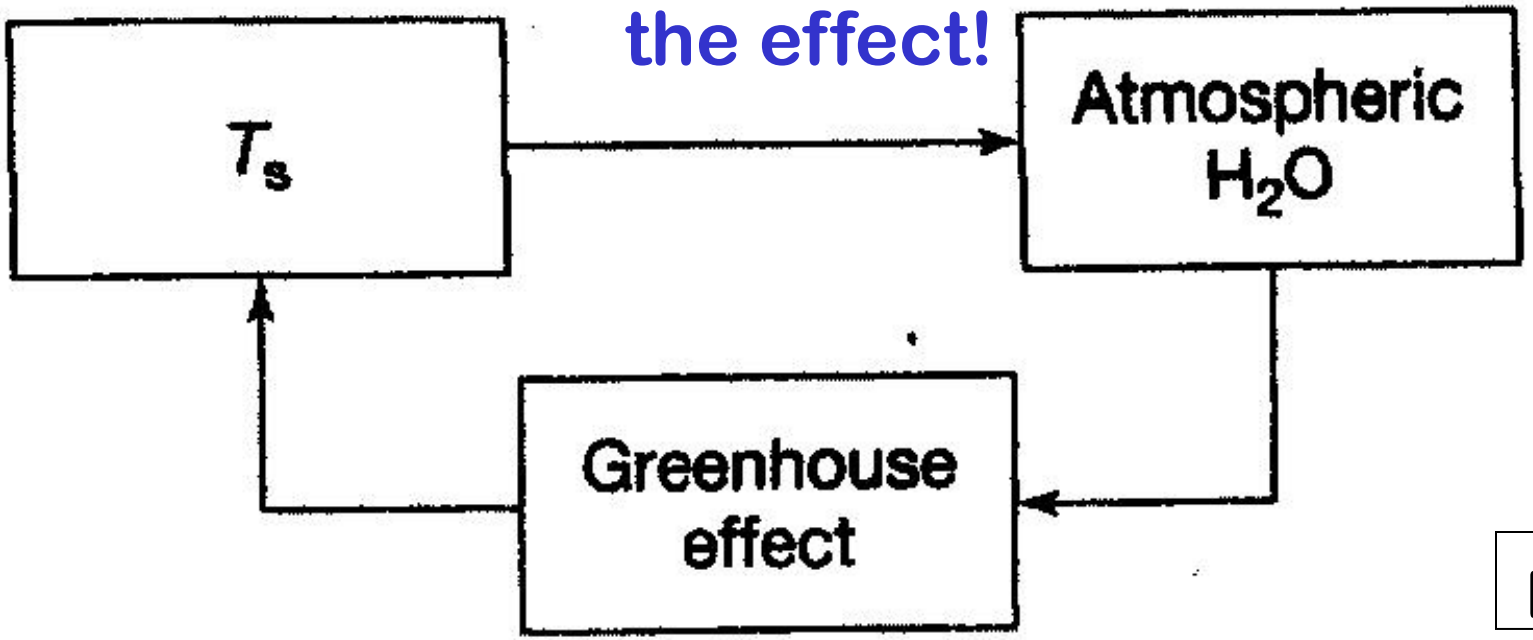
Review:

WATER VAPOR Feedback in the Earth-Atmosphere

What kind of FEEDBACK LOOP IS THIS?

Positive + OR Negative -

POSITIVE FEEDBACK LOOP that amplifies the effect!



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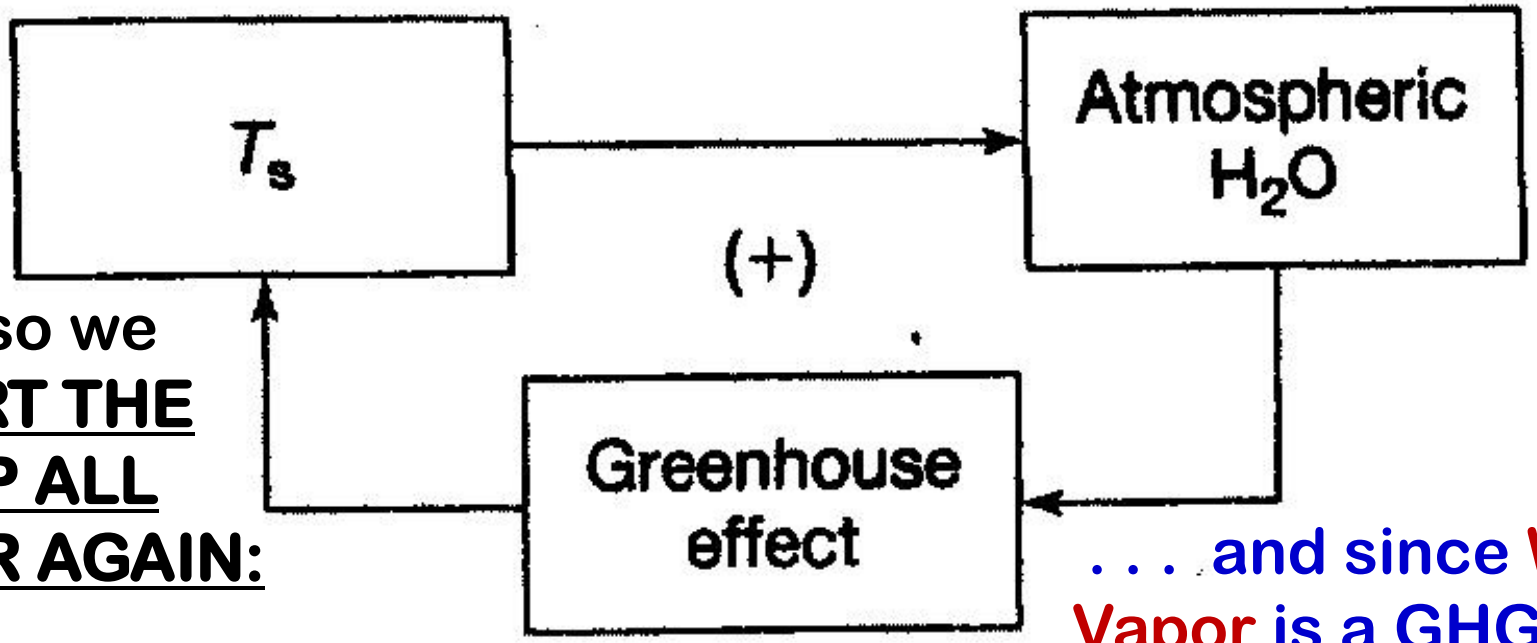
START HERE:

If the temperature of the Earth's surface (Ts) DECREASES ↓. . . .

. . . the colder temperatures will reduce evaporation, which will result in a DECREASE ↓ in the amount of Water Vapor in the atmosphere . . . . .



And so we **START THE LOOP ALL OVER AGAIN:**

. . . and since Water Vapor is a GHG, the Greenhouse Effect will then DECREASE ↓ . . . .

. . . and with a weaker GHE, the temperature (Ts) will DECREASE further ↓

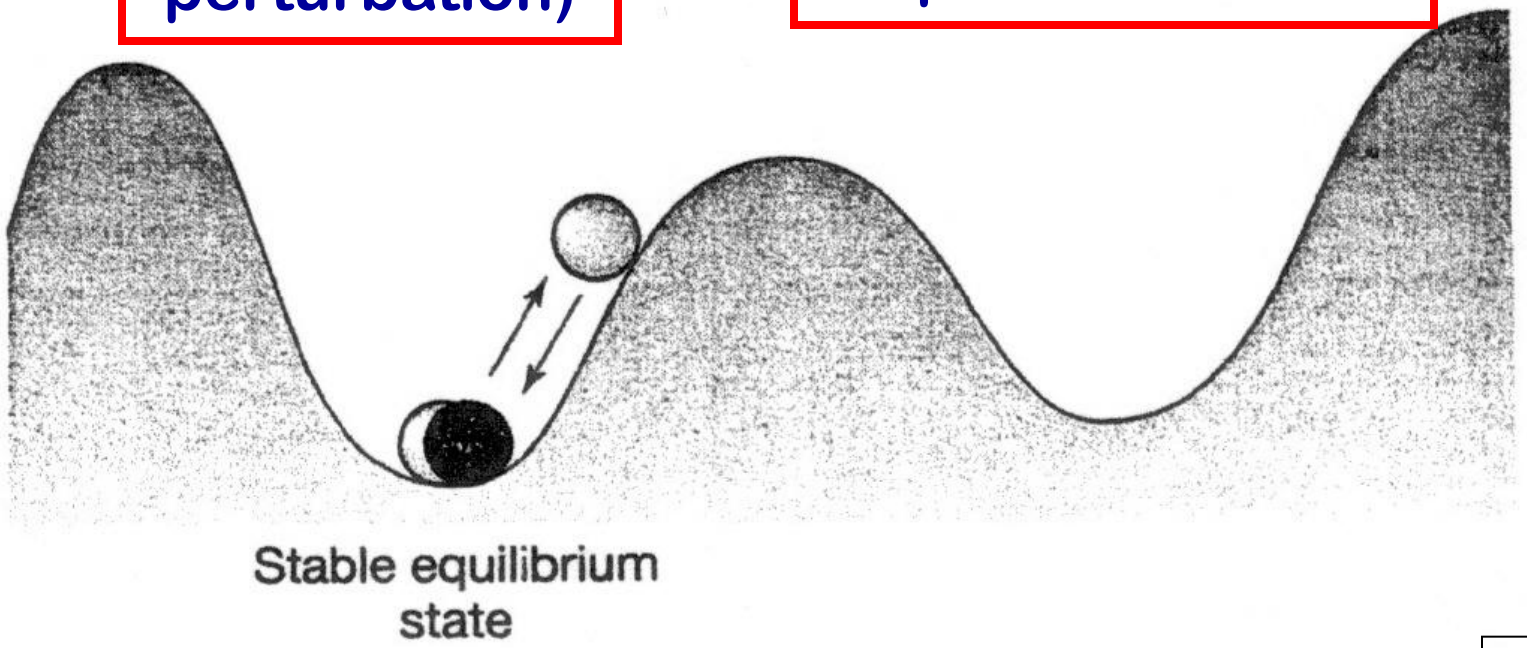
AMPLYFYING the initial perturbation!!

A negative feedback loop
(can also be described as)
a STABLE EQUILIBRIUM STATE :

A modest disturbance (short-term perturbation)

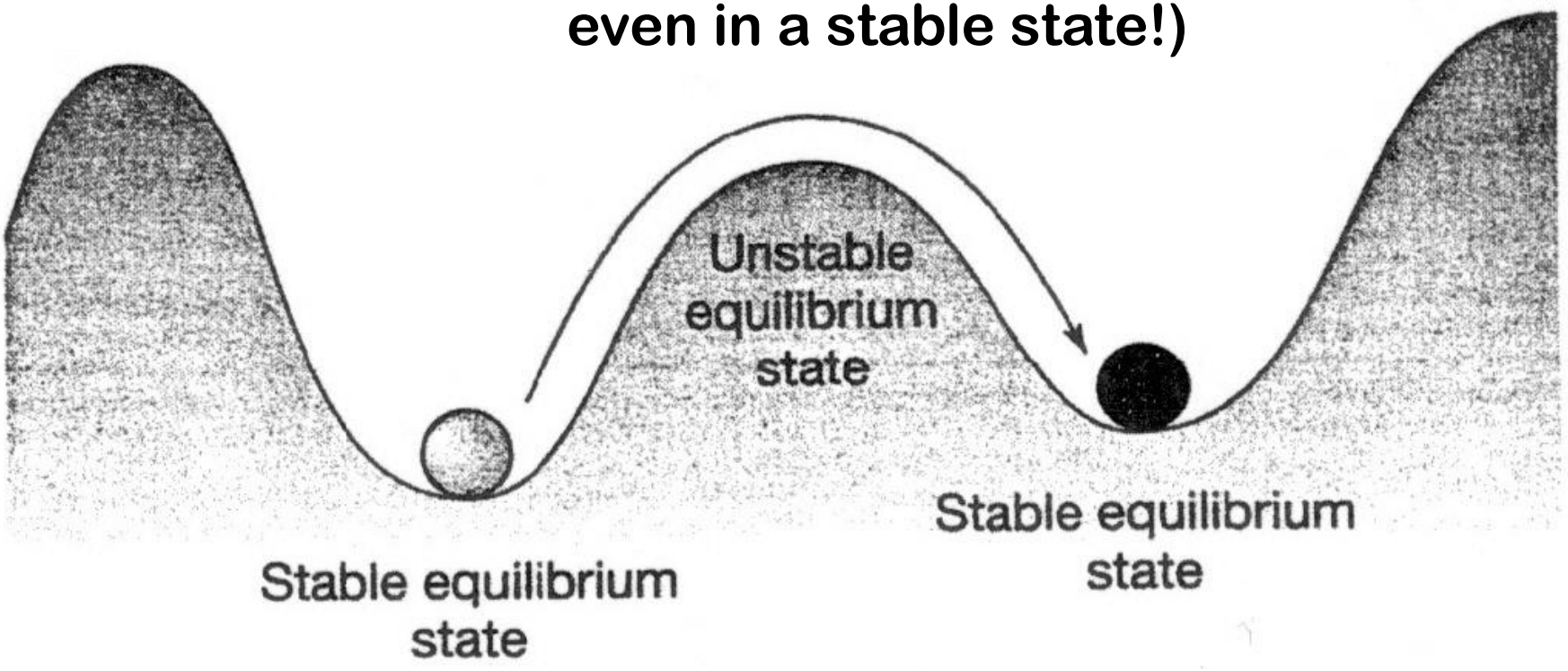
→

response that tends to return the system to its equilibrium state

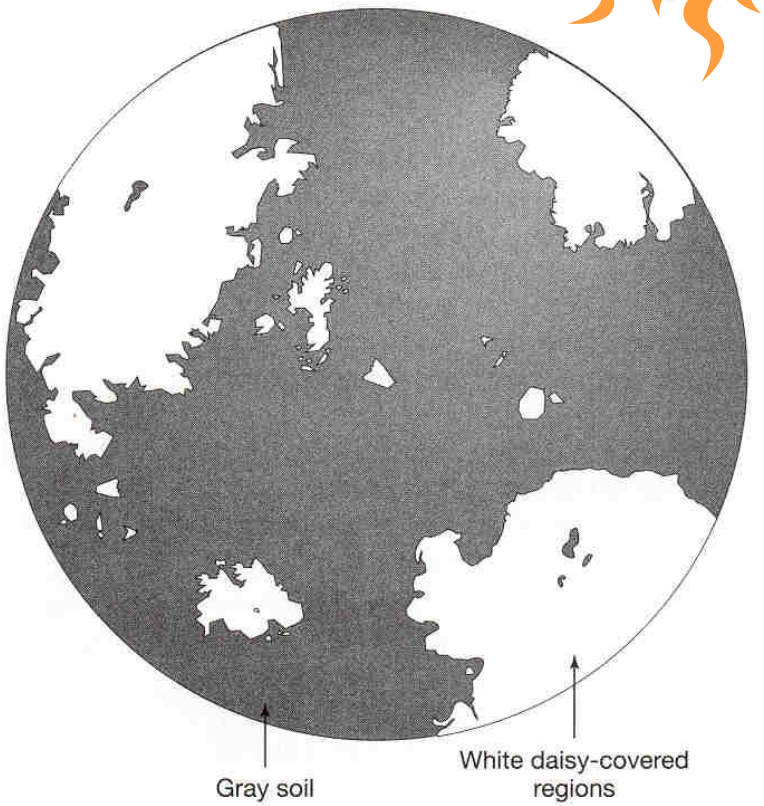


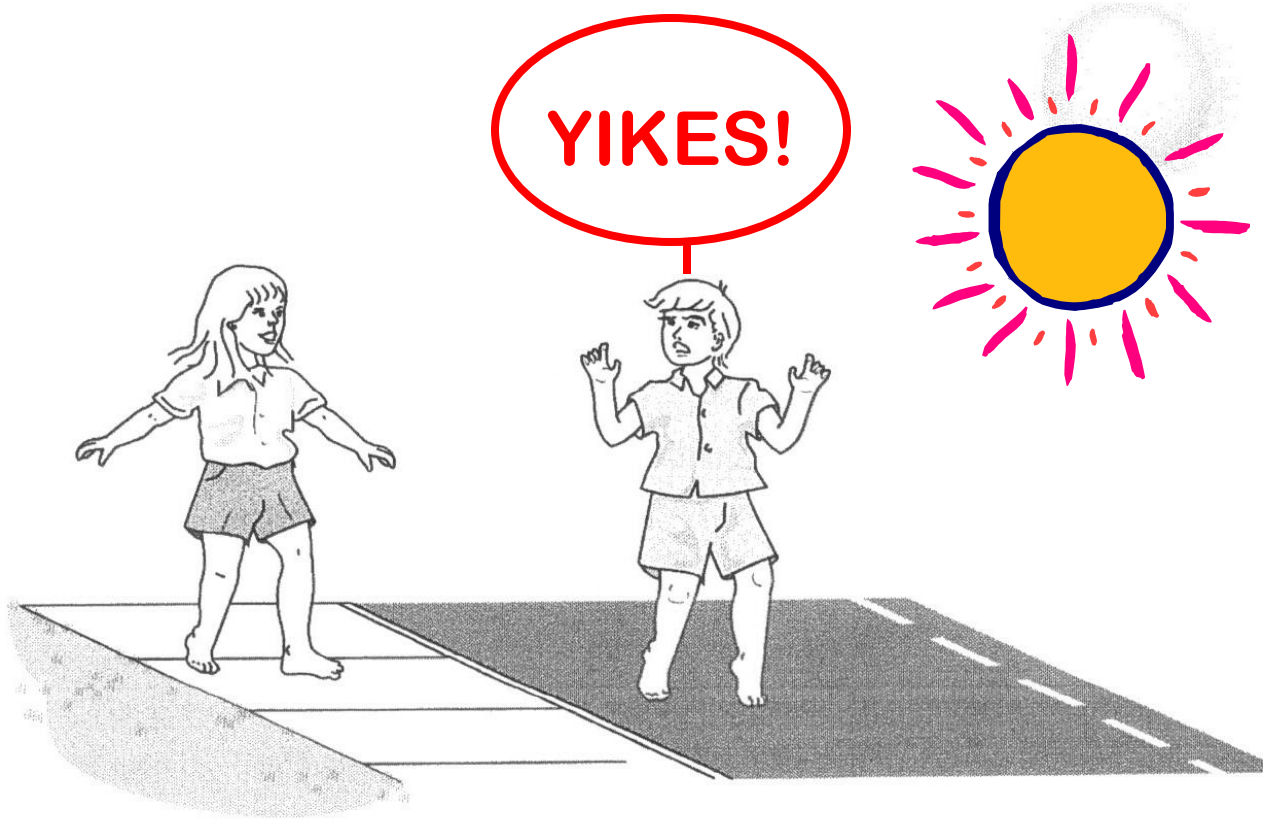
A LARGE or more persistent disturbance (a forcing) can carry the system to a different equilibrium state

(so there area some limits to stability, even in a stable state!)



Ok, so what's this Daisyworld Climate System all about and why should I care??????





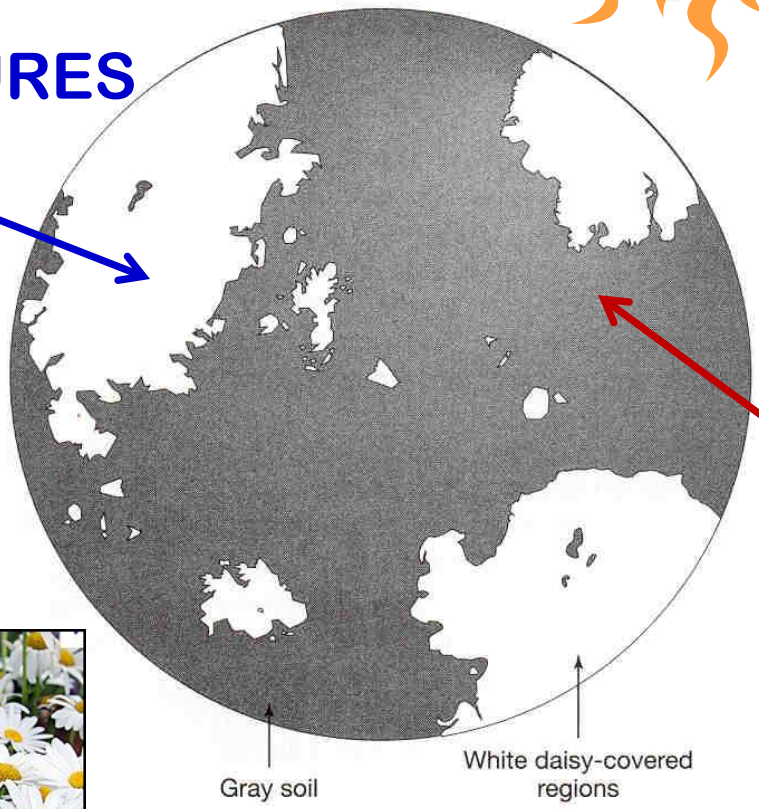
HIGH ALBEDO **LOW ALBEDO**

Review

HIGH albedo,
HIGH reflectivity,
& LOW absorption
➔ COOL TEMPERATURES

FEW or NO DAISIES

Lots of WHITE DAISIES

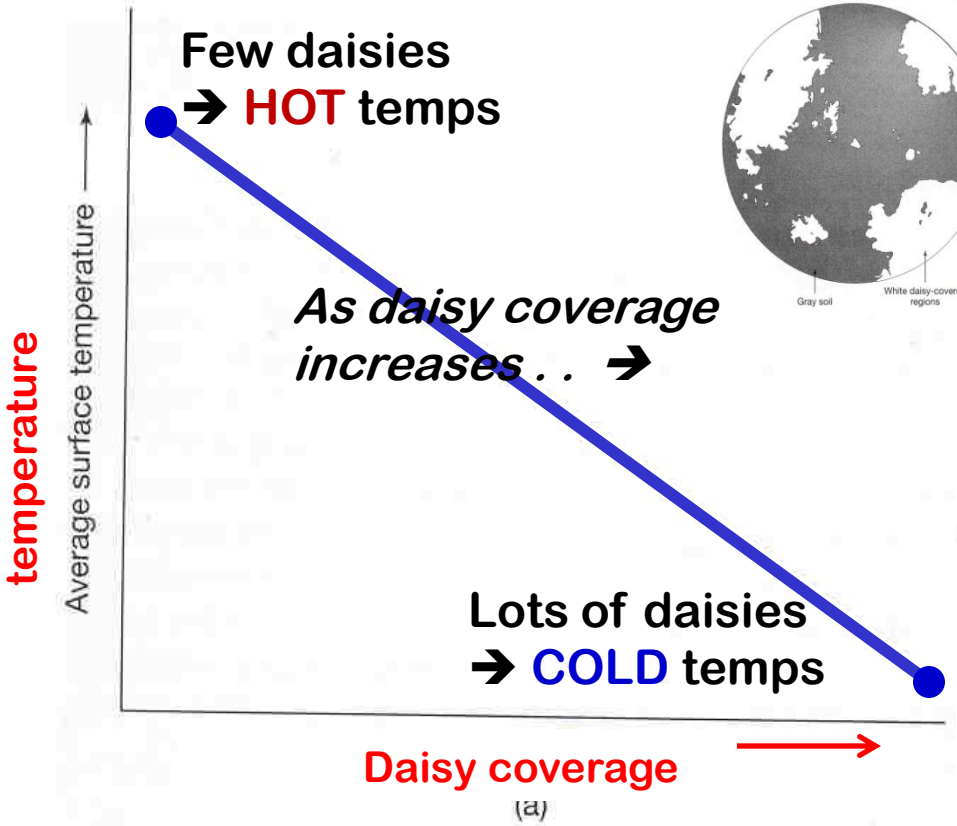


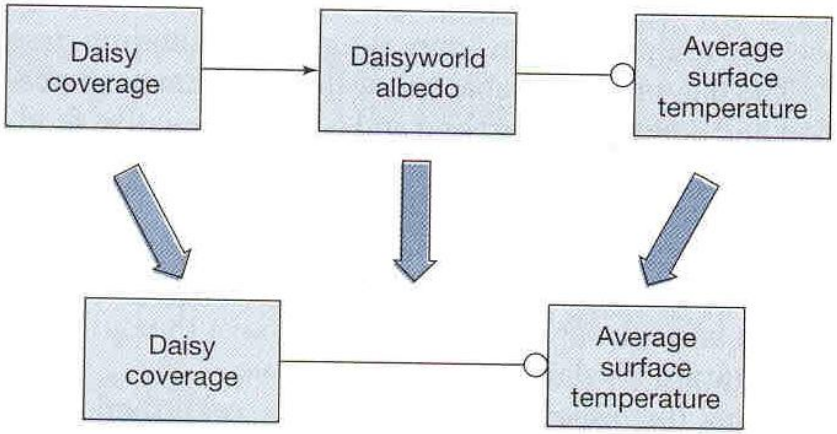
LOW albedo,
LOW reflectivity,
& HIGH absorption
➔ HOT TEMPERATURES

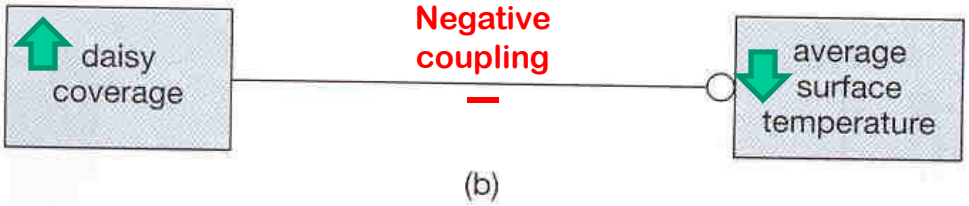
HOW DAISY COVERAGE AFFECTS TEMPERATURE:

An increase in daisy coverage ➔ a decrease in surface temperature

WHY? because more sunlight is reflected back (albedo increases) ➔ less sunlight is absorbed ➔ cooler temps







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Now, let's think about the relationship between temperature & daisies in the <u>OTHER direction!</u>

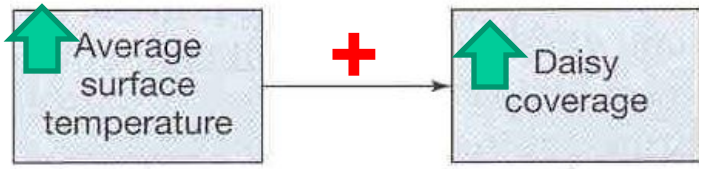
Instead of :

Daisy coverage ➔ Temperature

How does:

Temperature ➔ Daisy coverage

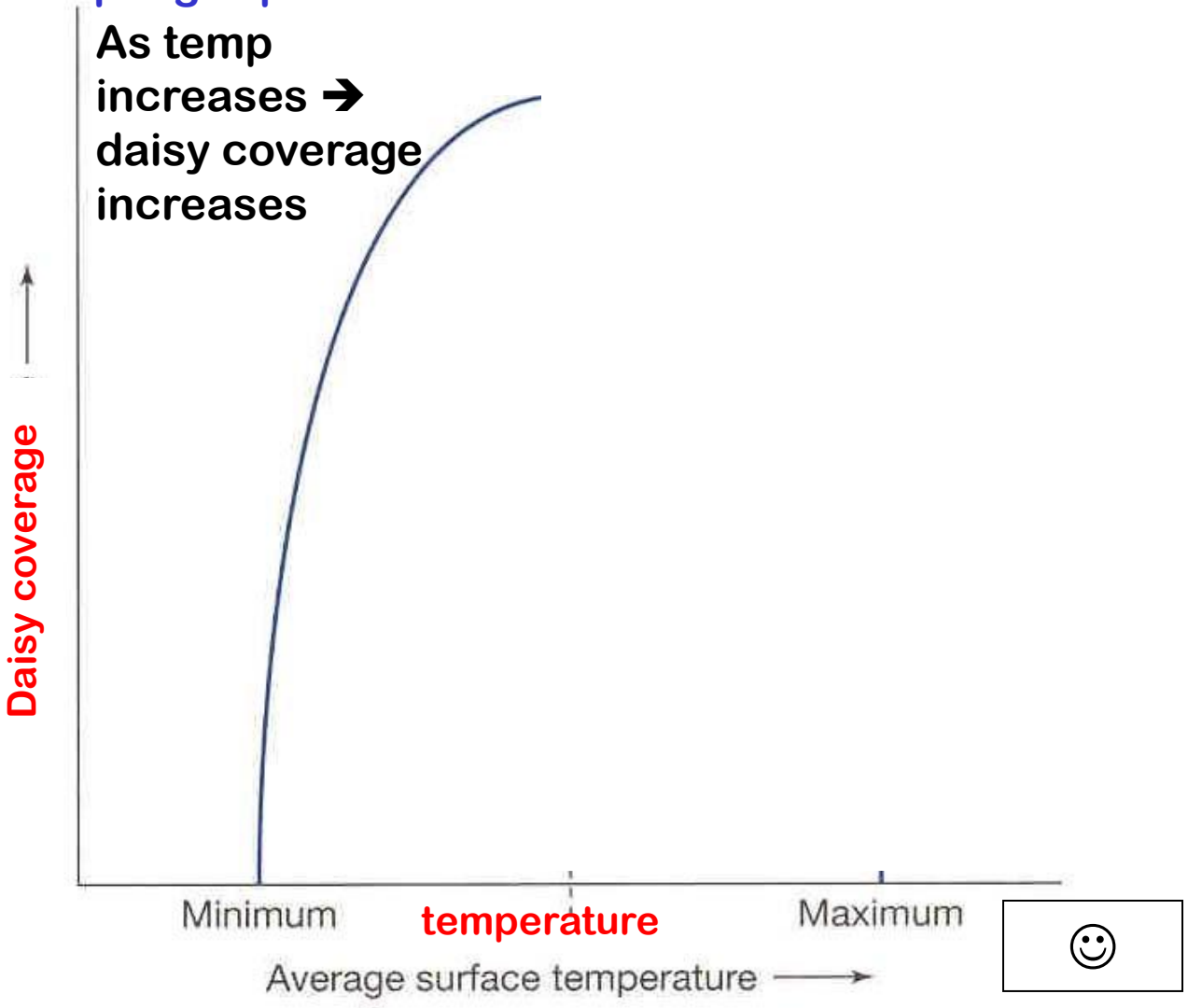
????



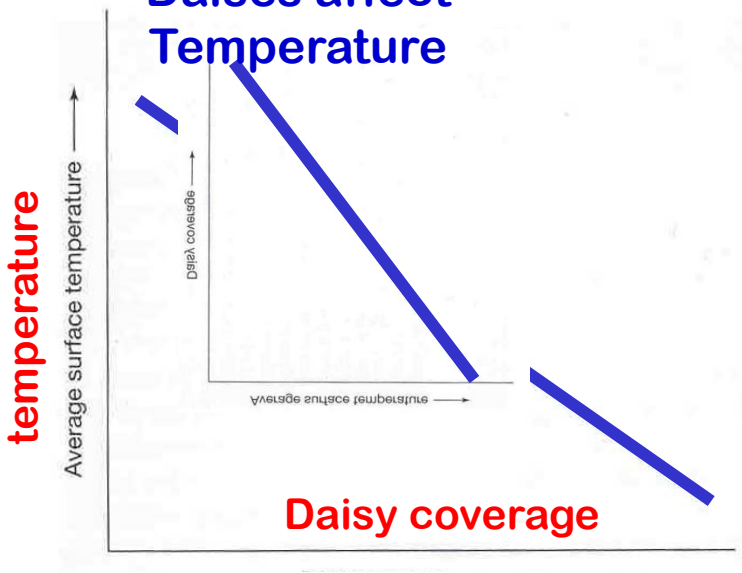
HOW DOES TEMPERATURE AFFECT DAISY COVERAGE?

Daisies thrive in warm temperatures . . .

. . . until they reach some threshold temperature, then they start dying if it gets TOO HOT!



Daises affect Temperature



To put temperature and Daisy coverage effects <u>TOGETHER</u> on the same graph with the axes in the same place – a 'flip" is done

Temperature affects Daisies

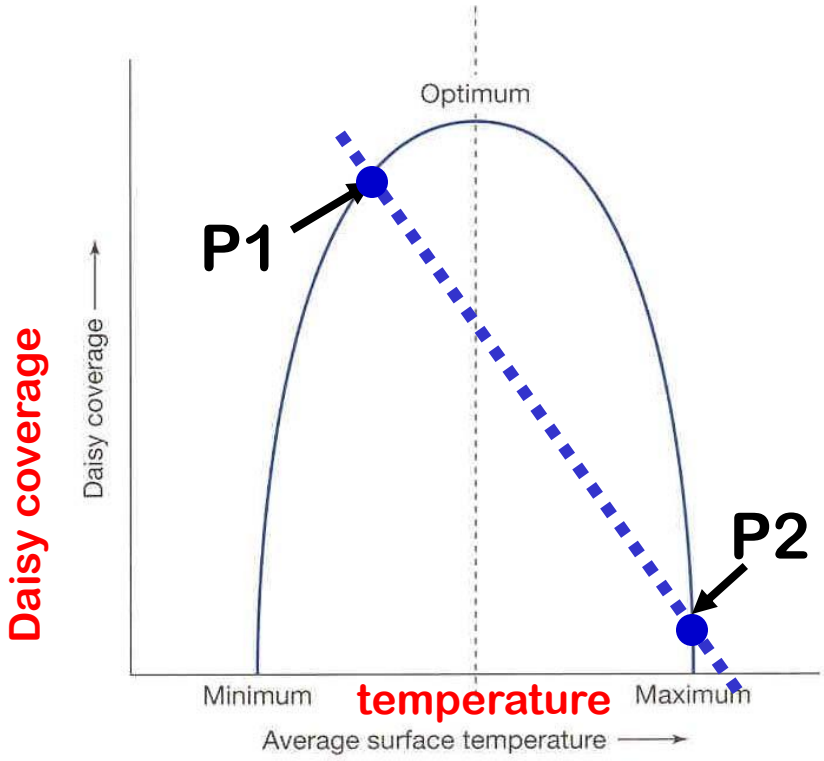
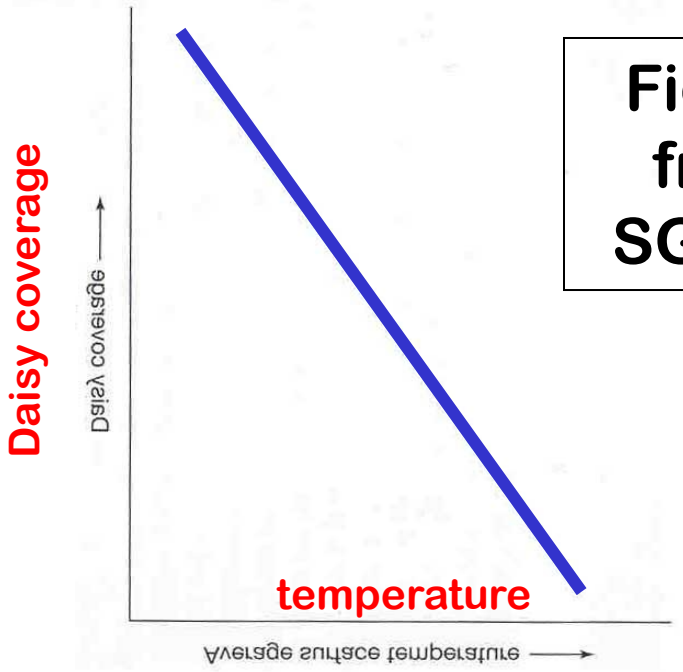


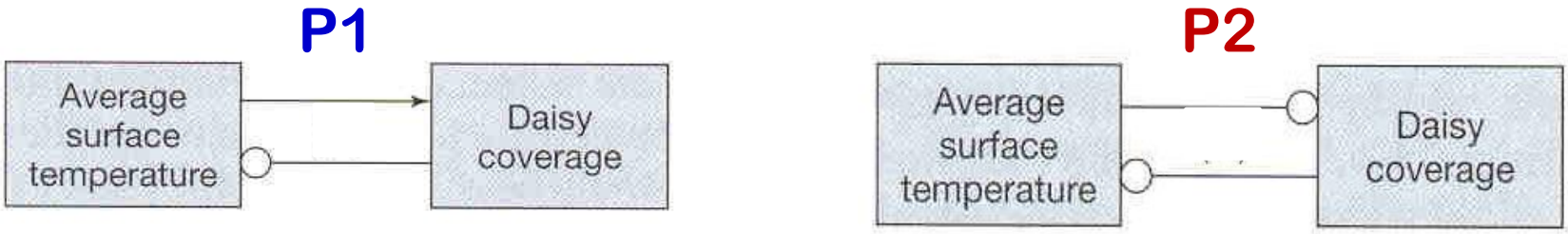
Figure from SGC →



As daisy coverage goes up, temperature goes down

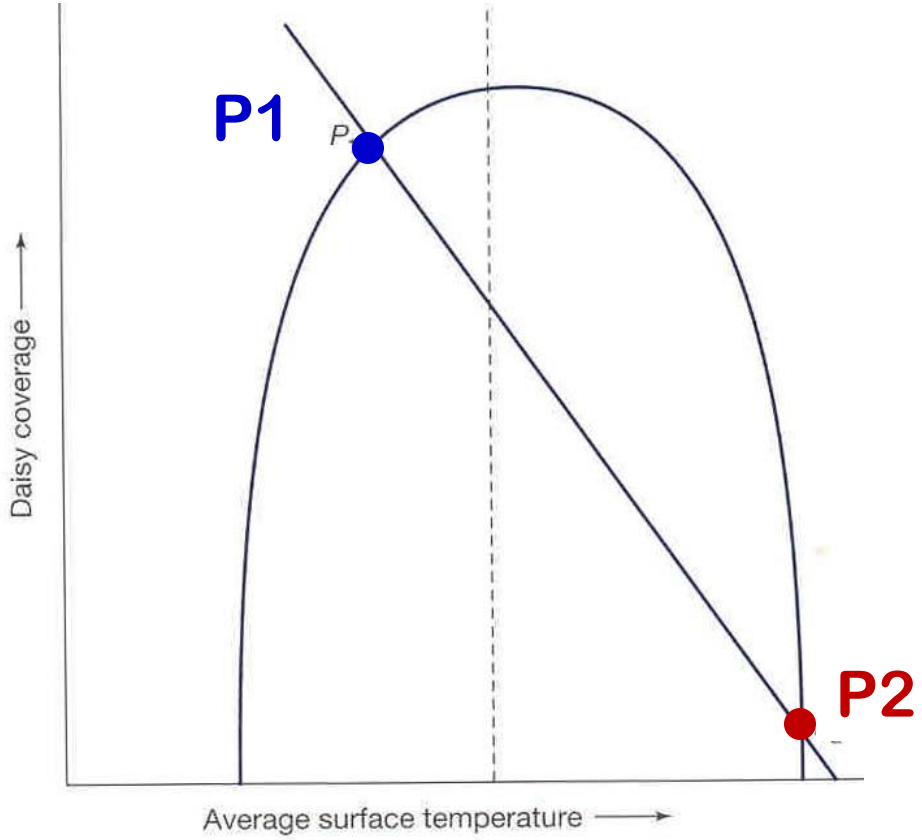
As temp goes up, daisies increase, but only to a point, then they begin decreasing

P1 and P2 each have their own FEEDBACK LOOP:



One feedback loop is positive + and one is negative –

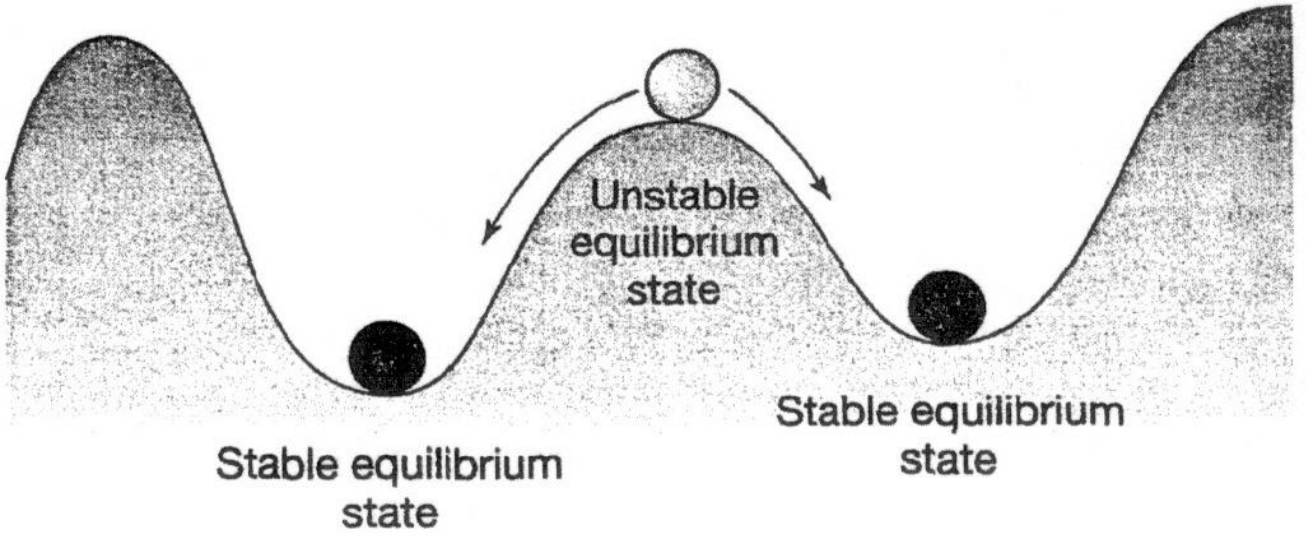
Which is which?



WORK ON BULLET Q's on p 56 TOGETHER

P1 and P2 are:

EQUILIBRIUM STATES



Defined:

EQUILIBRIUM STATE

= a state in which a system is in equilibrium

stated another way:

= the state in which the system will remain
UNLESS something disturbs it.

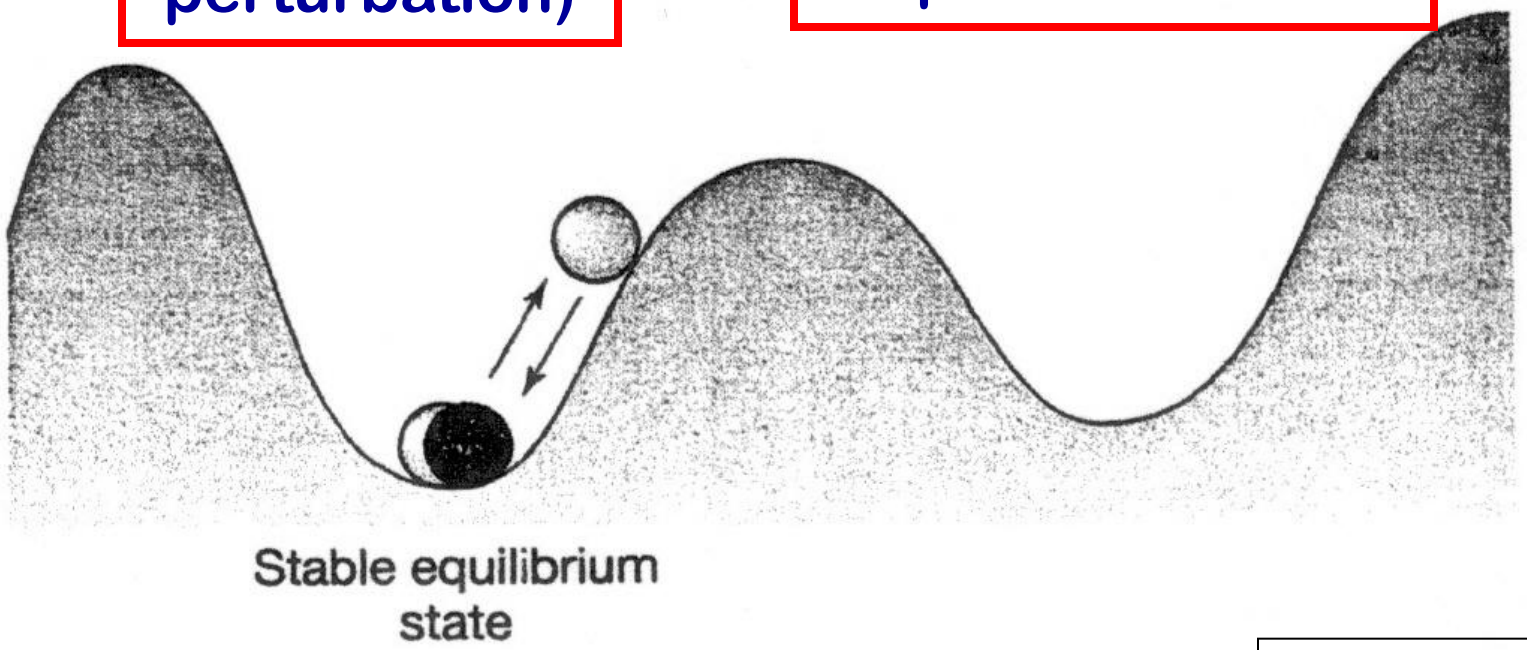
An equilibrium state can be:
stable or unstable.

A negative feedback loop
(can also be described as)
a STABLE EQUILIBRIUM STATE :

A modest disturbance (short-term perturbation)

→

response that tends to return the system to its equilibrium state

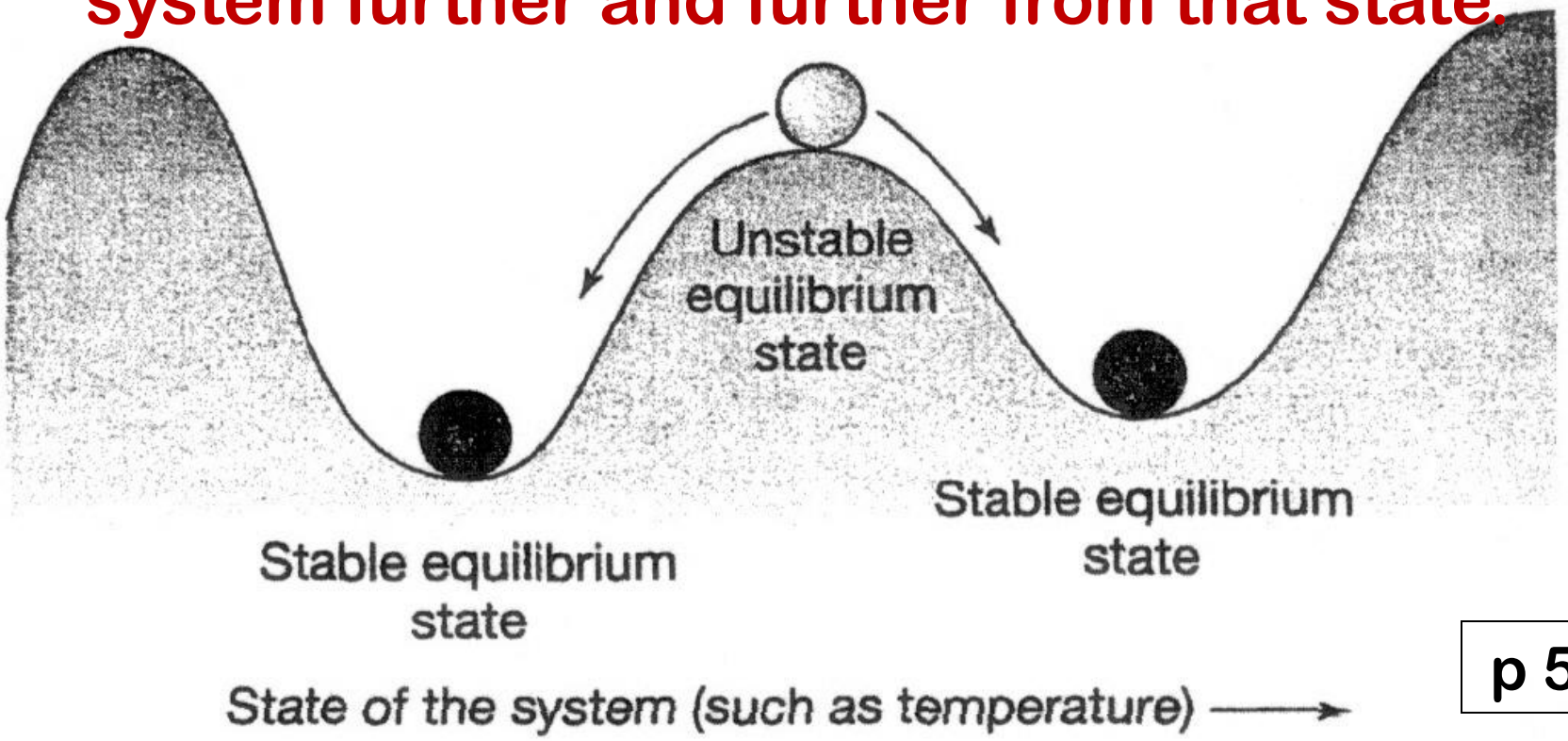


Stable equilibrium state

See this figure on p 55

A positive feedback loop can also be described as an UNSTABLE EQUILIBRIUM STATE :

the slightest disturbance from a comfortable state may lead to system adjustments that carry the system further and further from that state.



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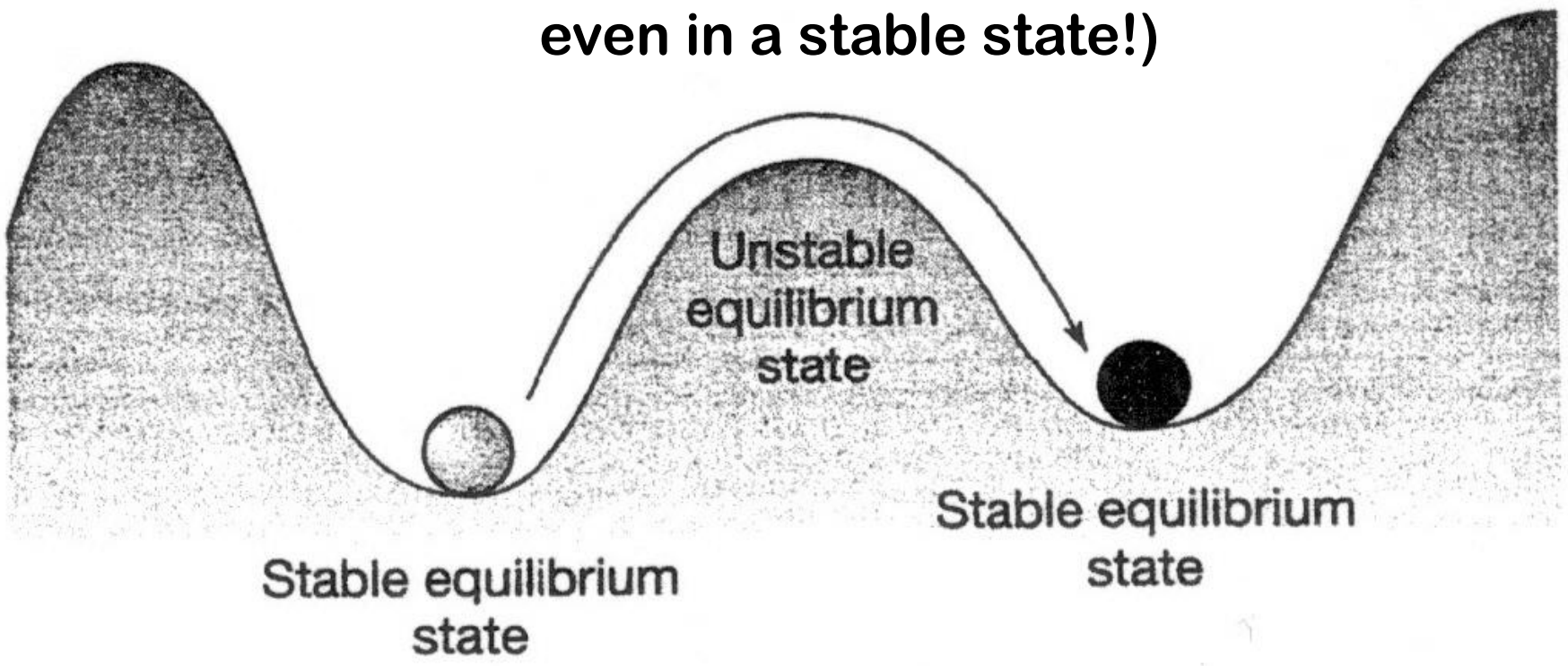


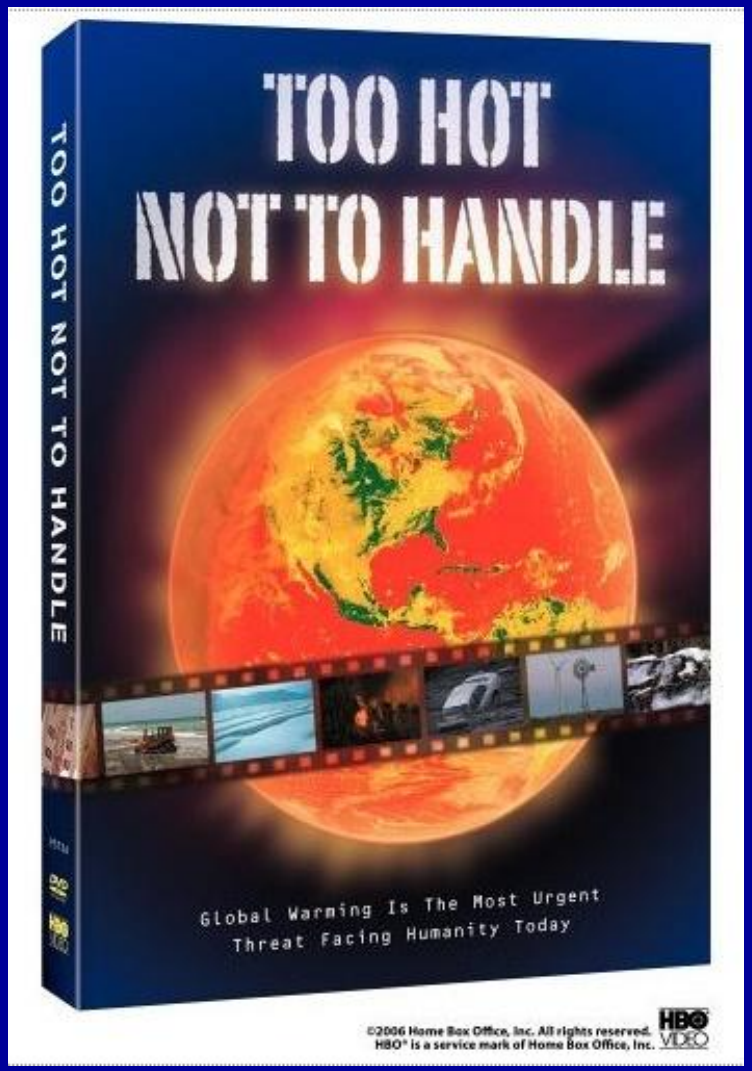
RECAP/ SUMMARY

The presence of FEEDBACK LOOPS leads to the establishment of EQUILIBRIUM STATES

- **Negative feedback loops establish STABLE equilibrium states that are resistant to a range of perturbations; the system responds to modest perturbations by returning to the stable equilibrium state**

- **Positive feedback loops establish UNSTABLE equilibrium states. A system that is poised in such a state will remain there indefinitely. However, the slightest disturbance carries the system to a new state.**

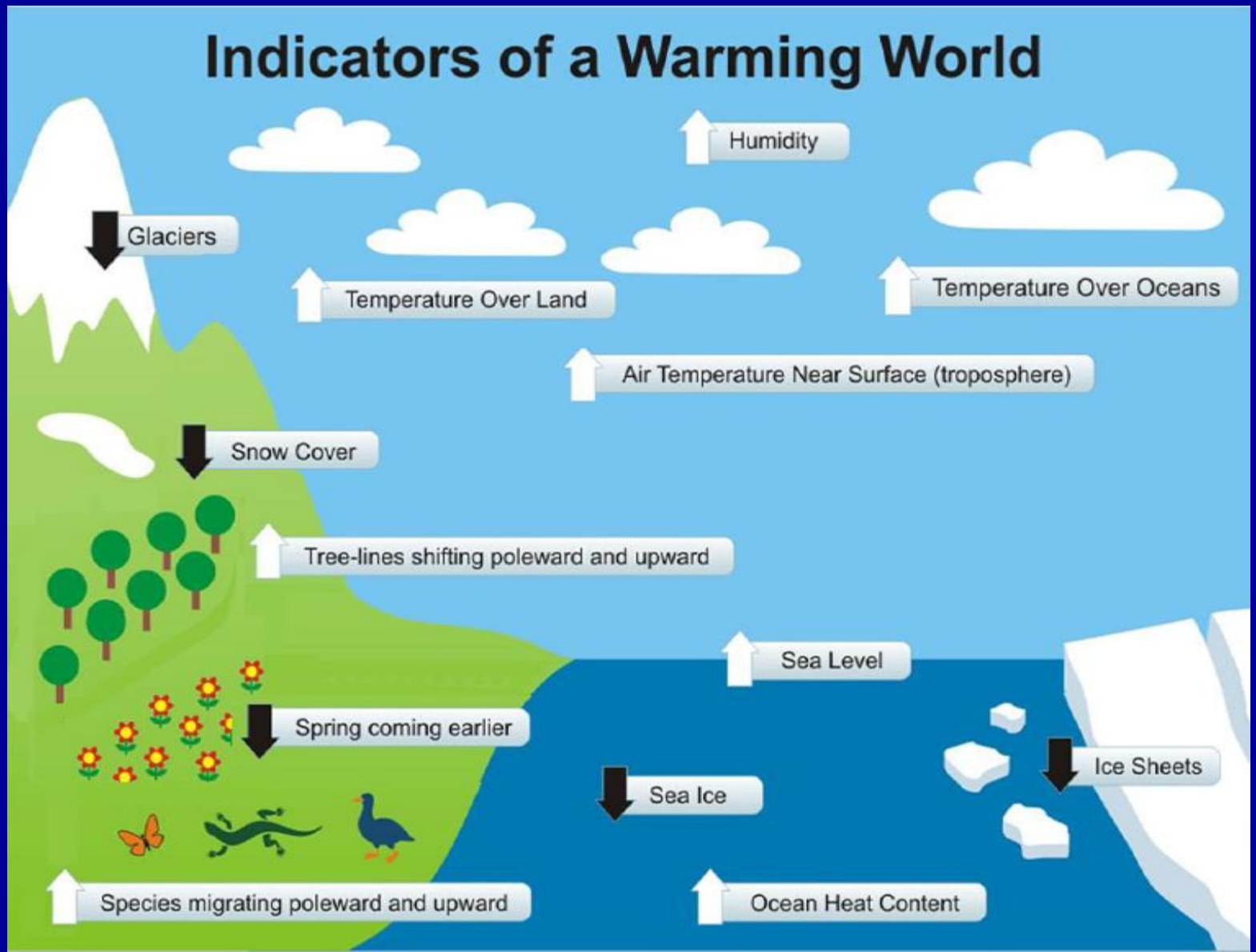
A new film for our "SUSTAINABILITY SEGMENT"



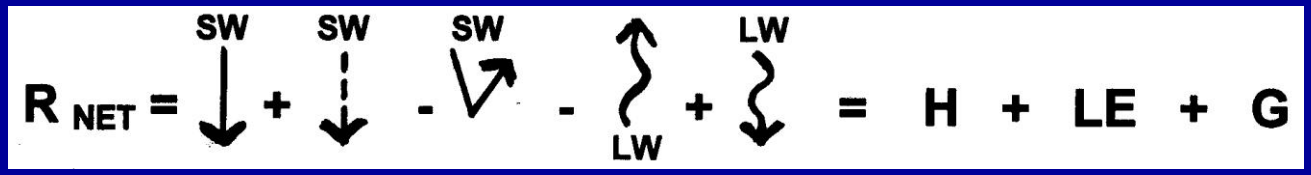
HBO Documentary FIlm (2006)

On the purple card,
TAKE NOTES
on what the processes, causes, and impacts of global warming are as they are discussed in the film

Also turn to Page 119 and indicate WHICH OF THESE ARE MENTIONED in the FILM:



TIME TO FINISH G-3



Then go to p 50 & answer Q's

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

Flip to p 50

See you on
Wednesday!