TOPIC # 10

UNDERSTANDING SYSTEMS & FEEDBACKS – PART II

Class notes pp 57-58

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

~ John Muir

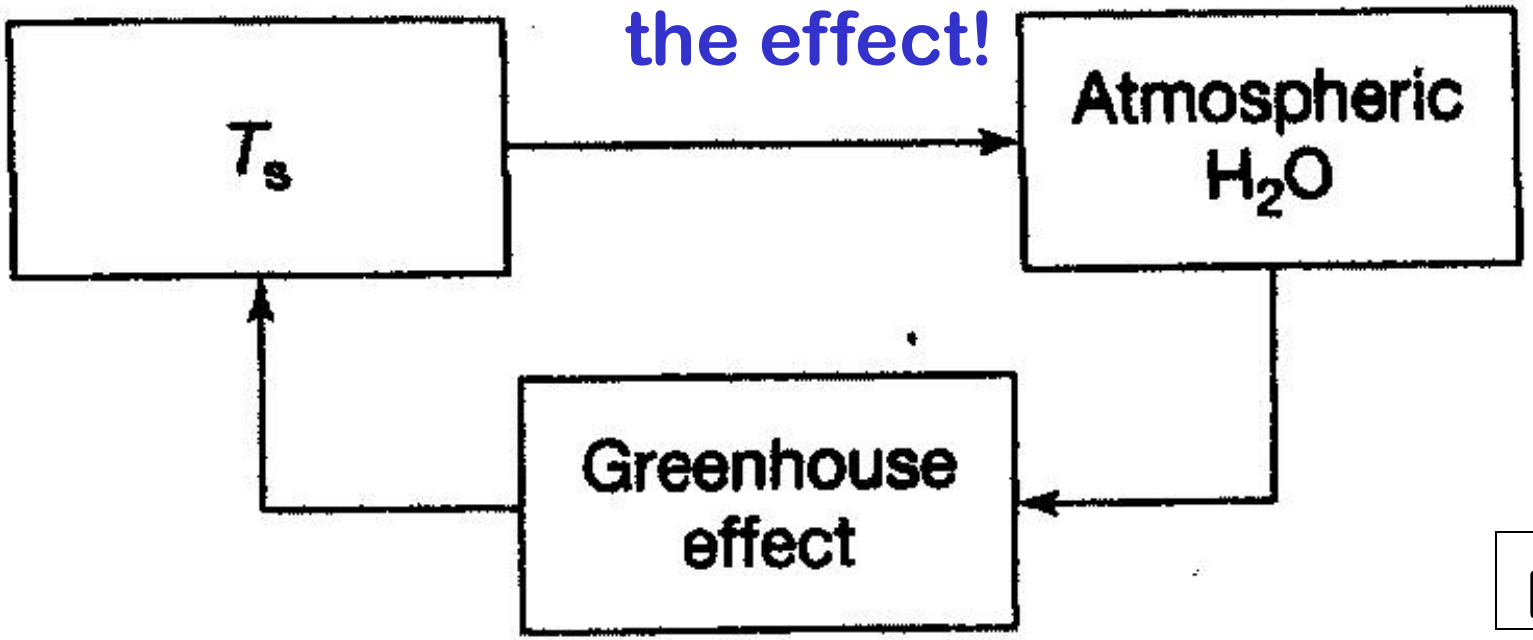
Review:

WATER VAPOR Feedback in the Earth-Atmosphere

What kind of FEEDBACK LOOP IS THIS?

Positive + OR Negative -

POSITIVE FEEDBACK LOOP that amplifies the effect!

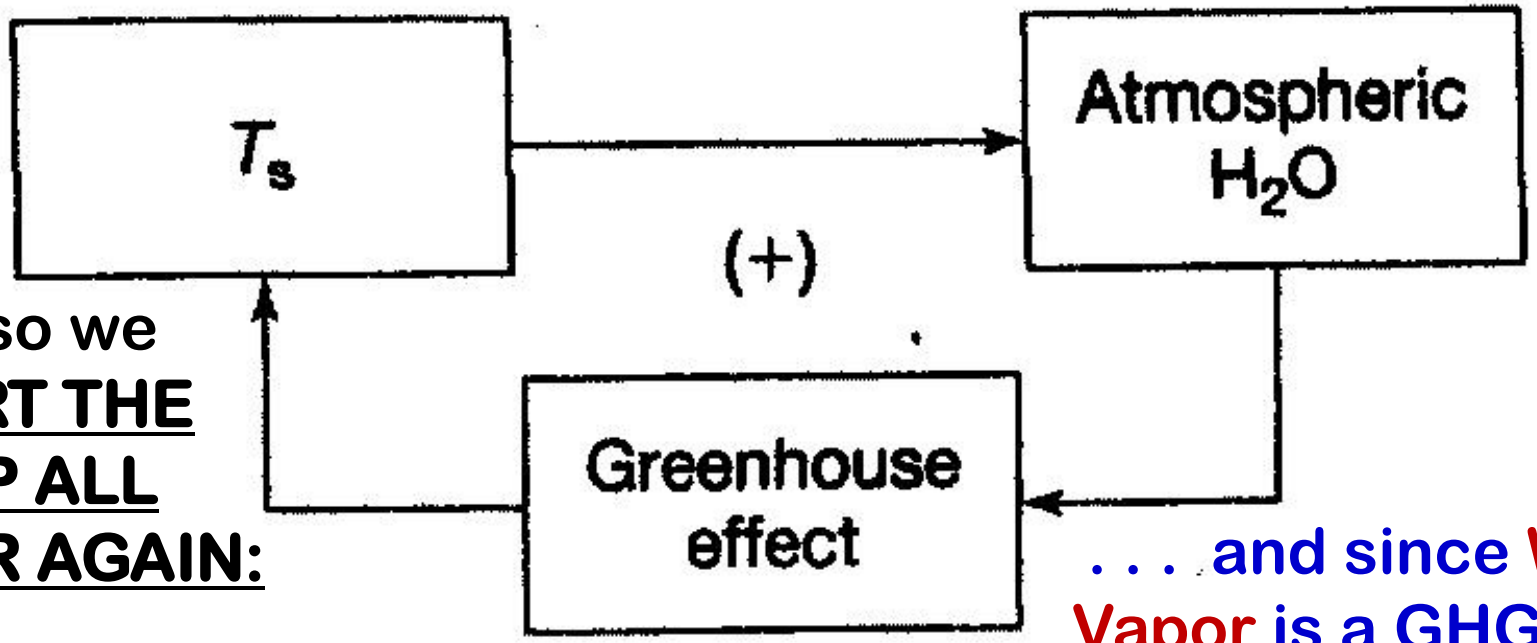


p 57

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 . . . . .



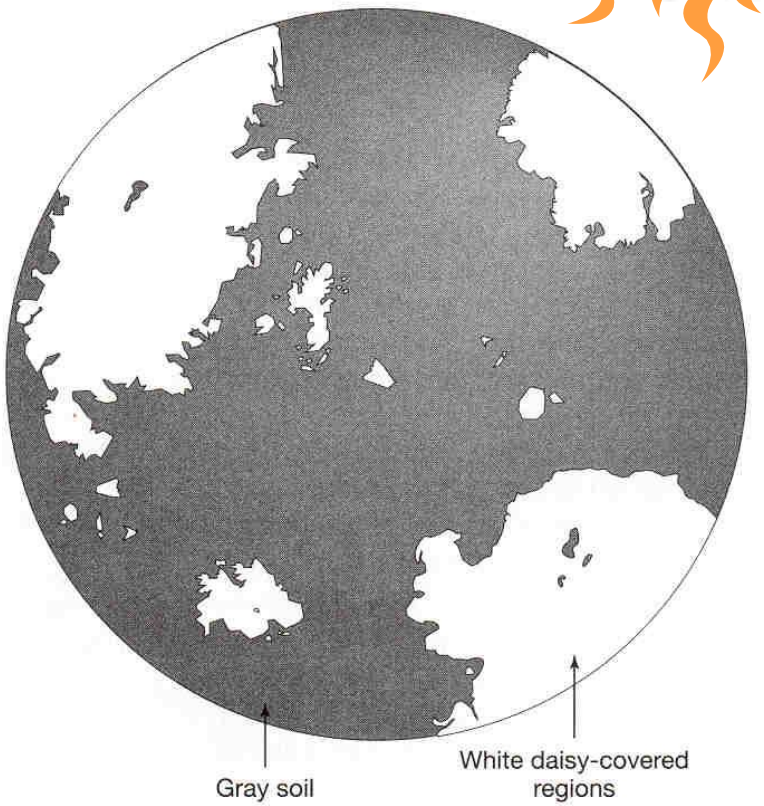
And so we **START THE LOOP ALL OVER AGAIN:**

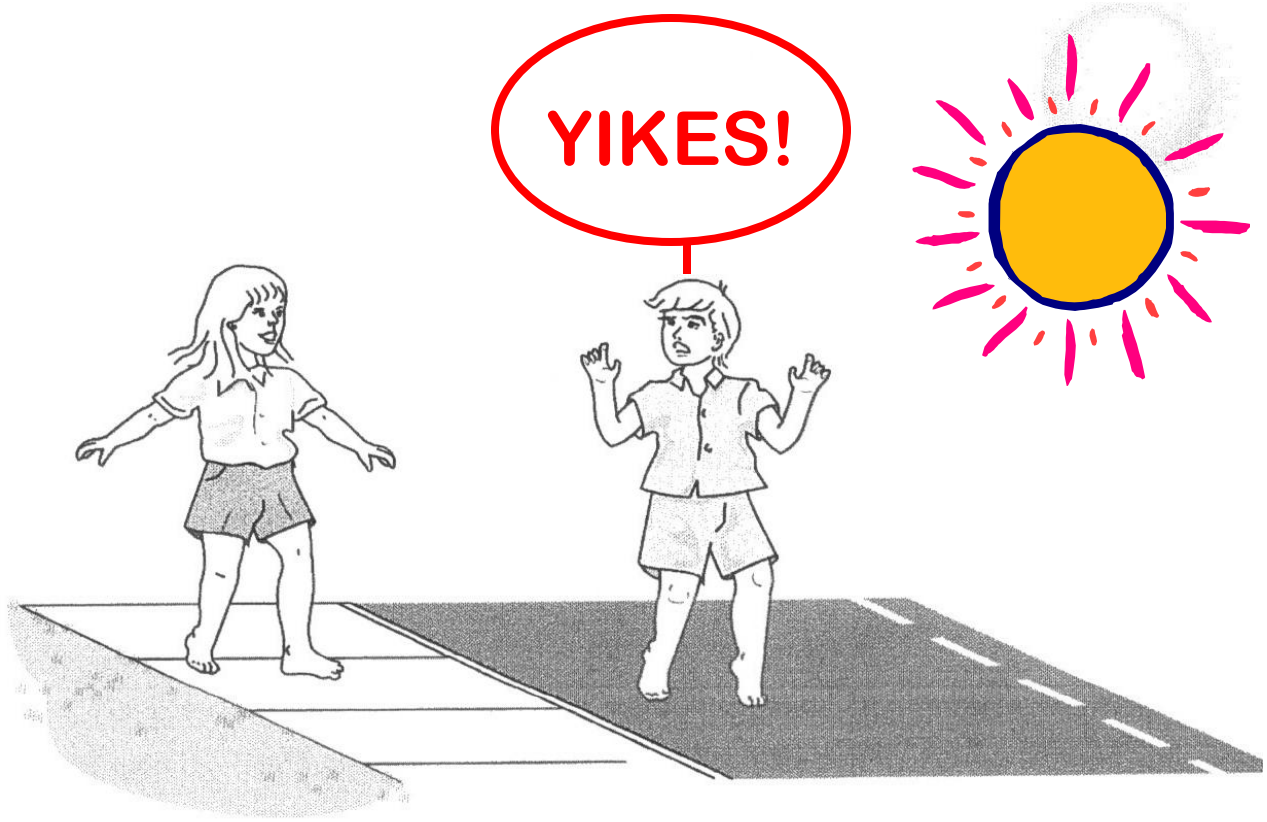
. . . and since Water Vapor is a GHG, the Greenhouse Effect will then DECREASE ↓ . . . .

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

AMPLYFYING the initial perturbation!!

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

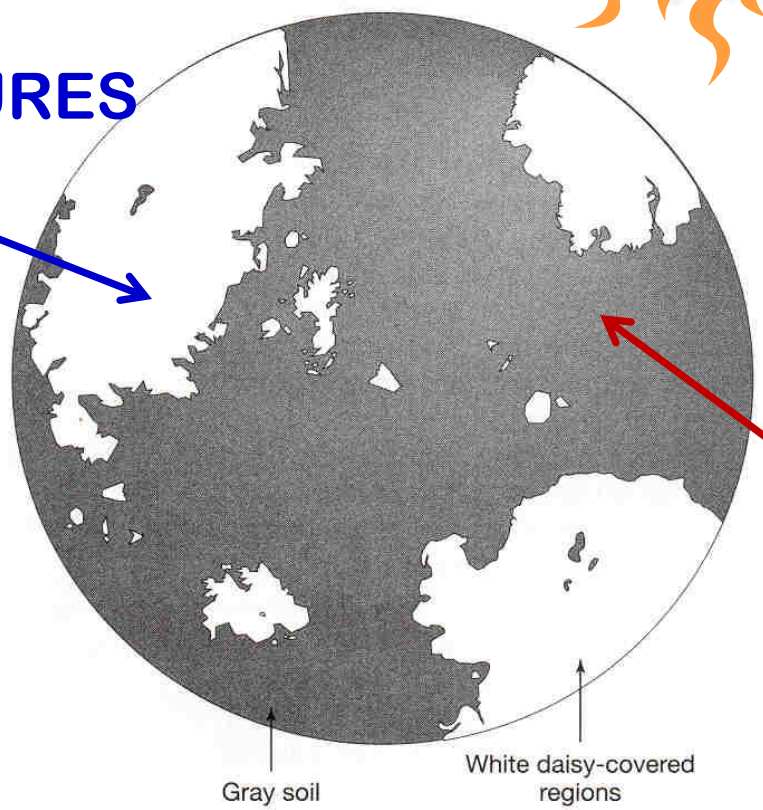




HIGH ALBEDO **LOW ALBEDO**

Review

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

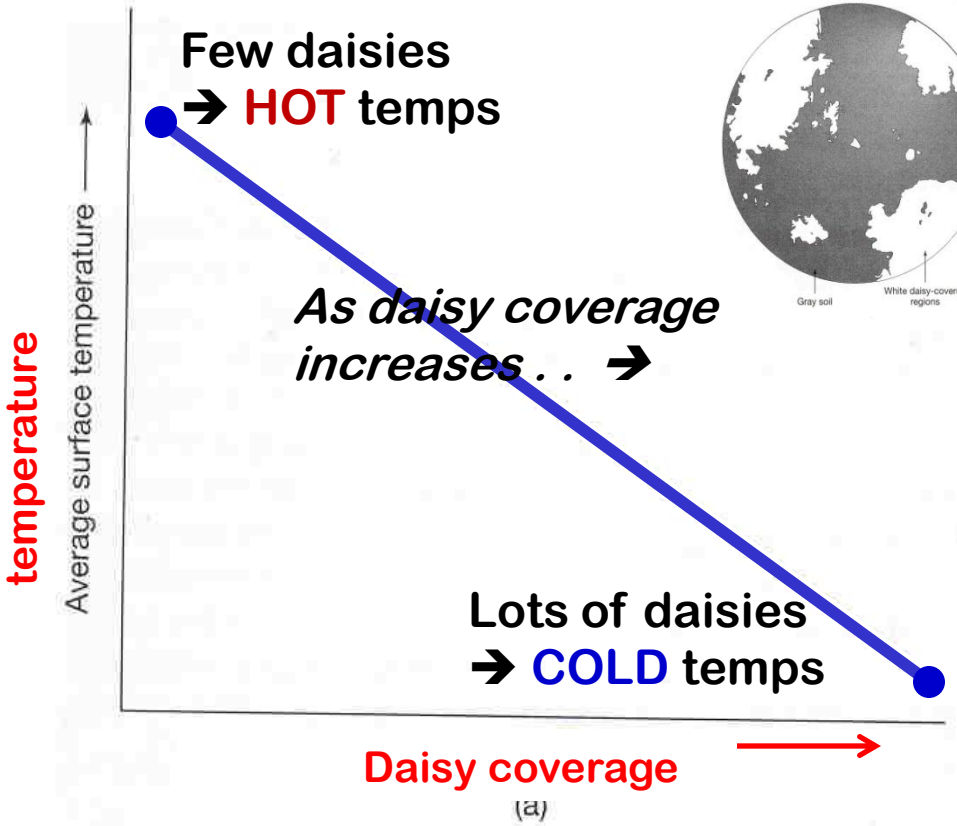


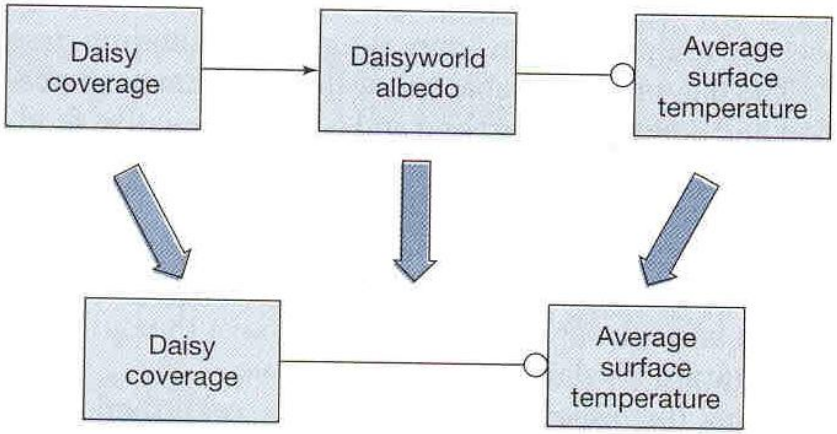
LOW albedo,
LOW reflectivity,
& HIGH absorption
➔ HOT TEMPERATURES

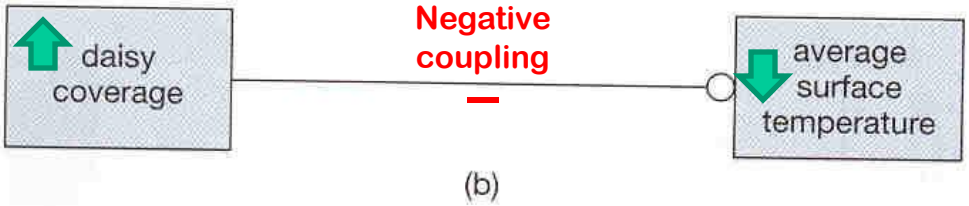
HOW DAISY COVERAGE AFFECTS TEMPERATURE:

An increase in daisy coverage ➔ a decrease in surface temperature

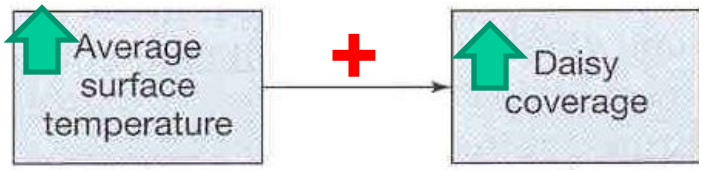
WHY? because more sunlight is reflected back (albedo increases) ➔ less sunlight is absorbed ➔ cooler temps







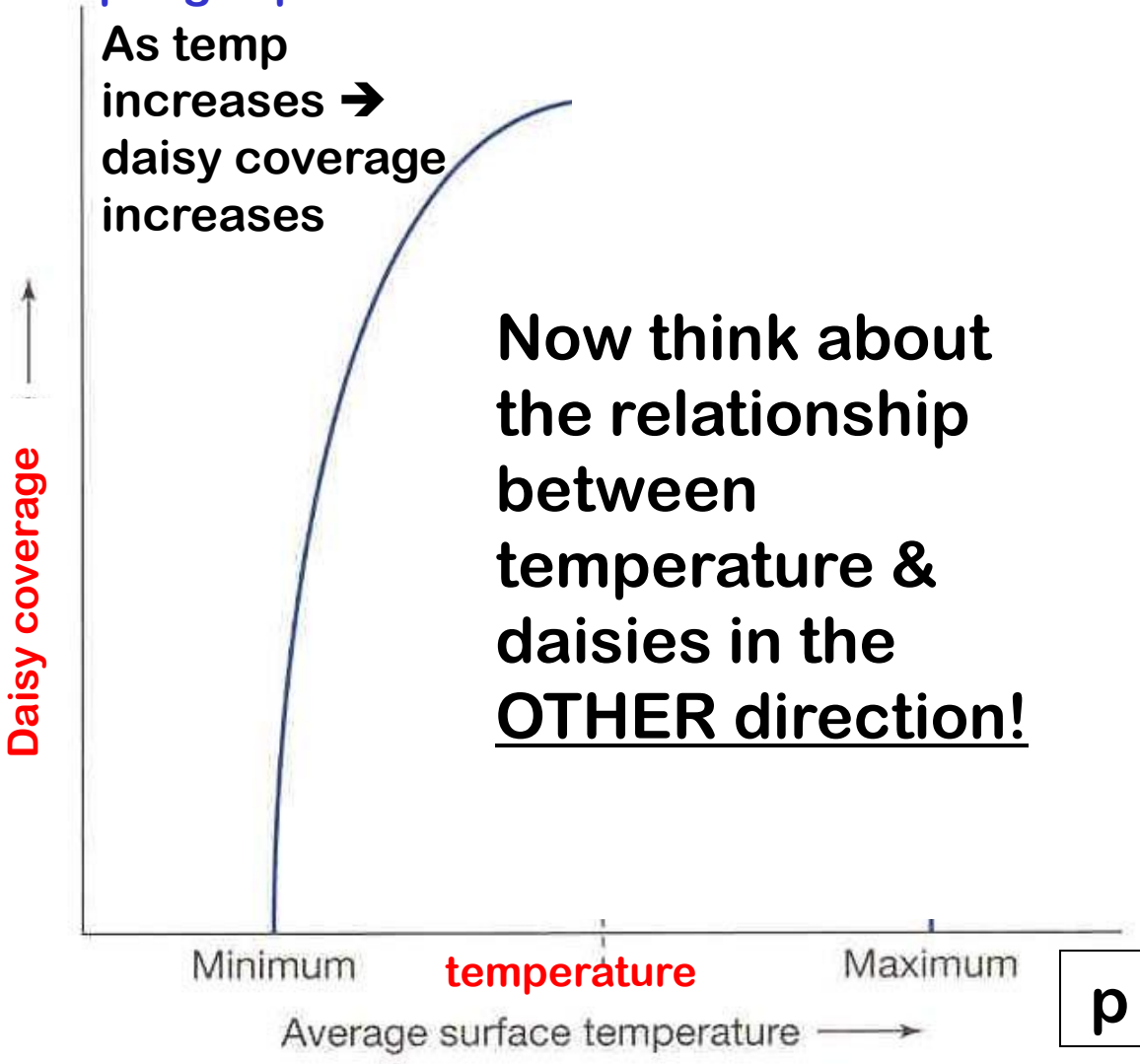
p 57



HOW DOES TEMPERATURE AFFECT DAISY COVERAGE?

Daisies thrive in warm temperatures . . .

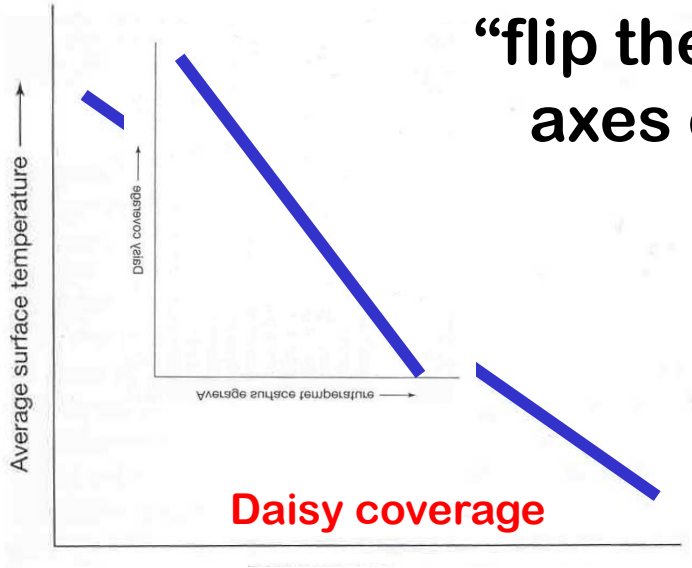
. . . until they reach some threshold temperature, then they start dying if it gets TOO HOT!



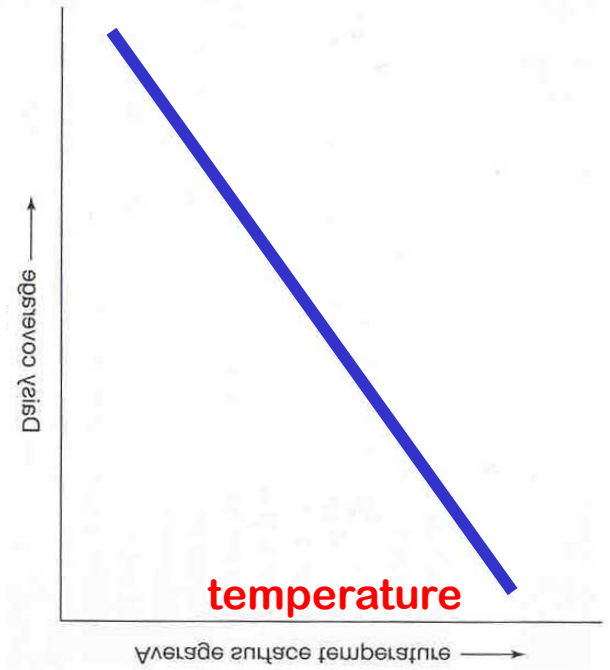
Now think about the relationship between temperature & daisies in the OTHER direction!

"flip the graph axes over"

temperature

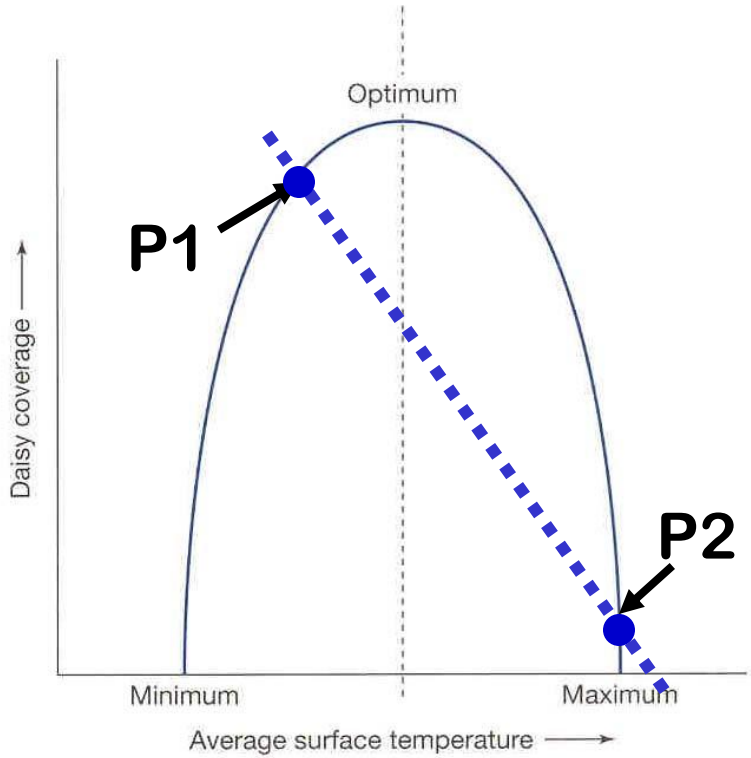


Daisy coverage



PUTTING THE TWO GRAPHS TOGETHER!

Daisy coverage



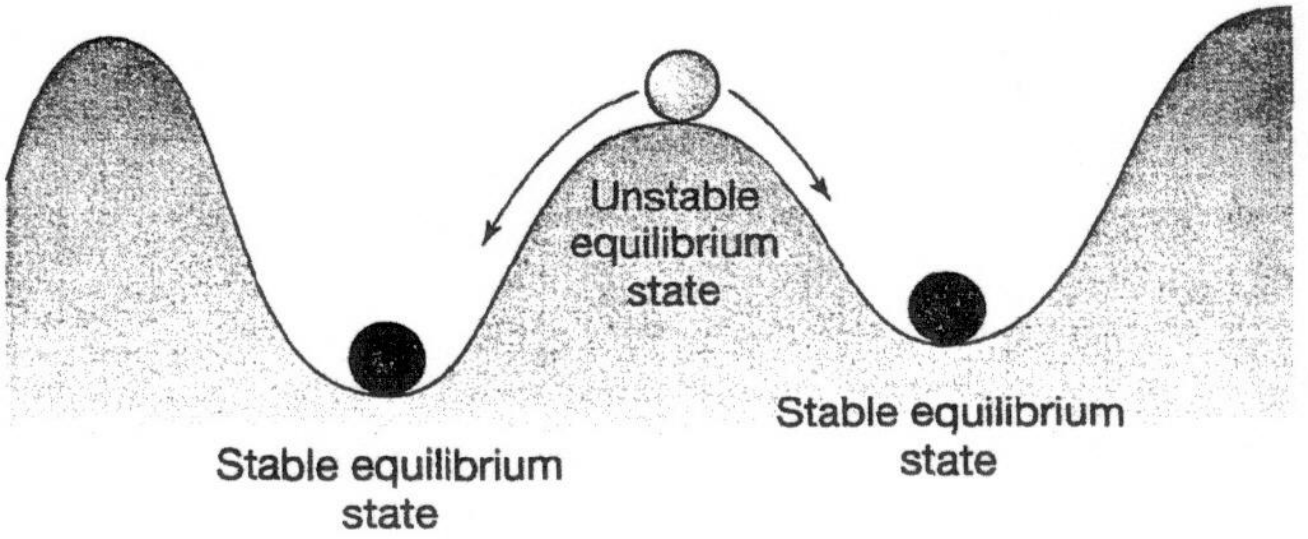
temperature

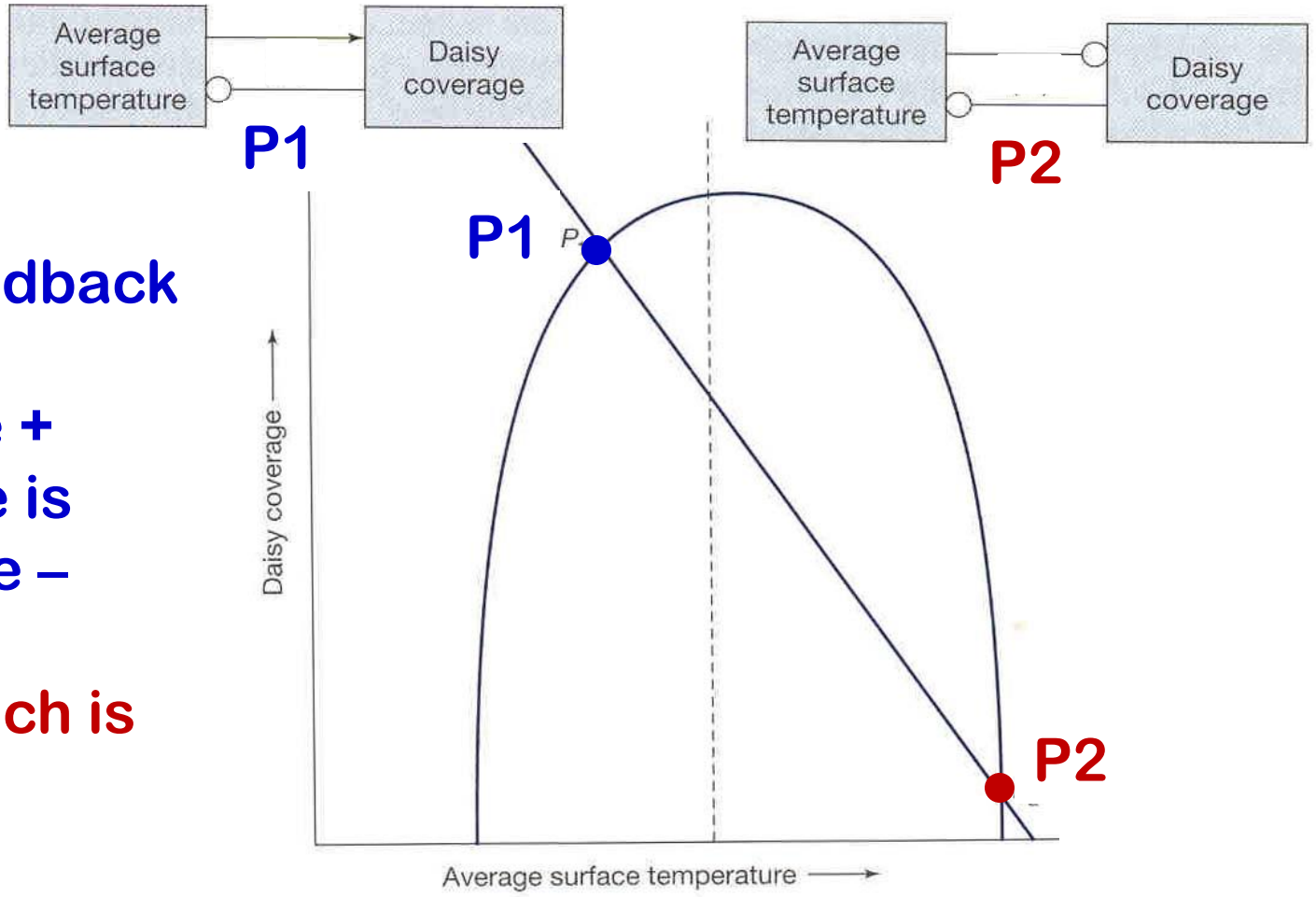
P1 and P2 are:

EQUILIBRIUM STATES

= a state in which a system is in equilibrium, that is, the state in which the system will remain UNLESS something disturbs it.

An equilibrium state can be stable or unstable.



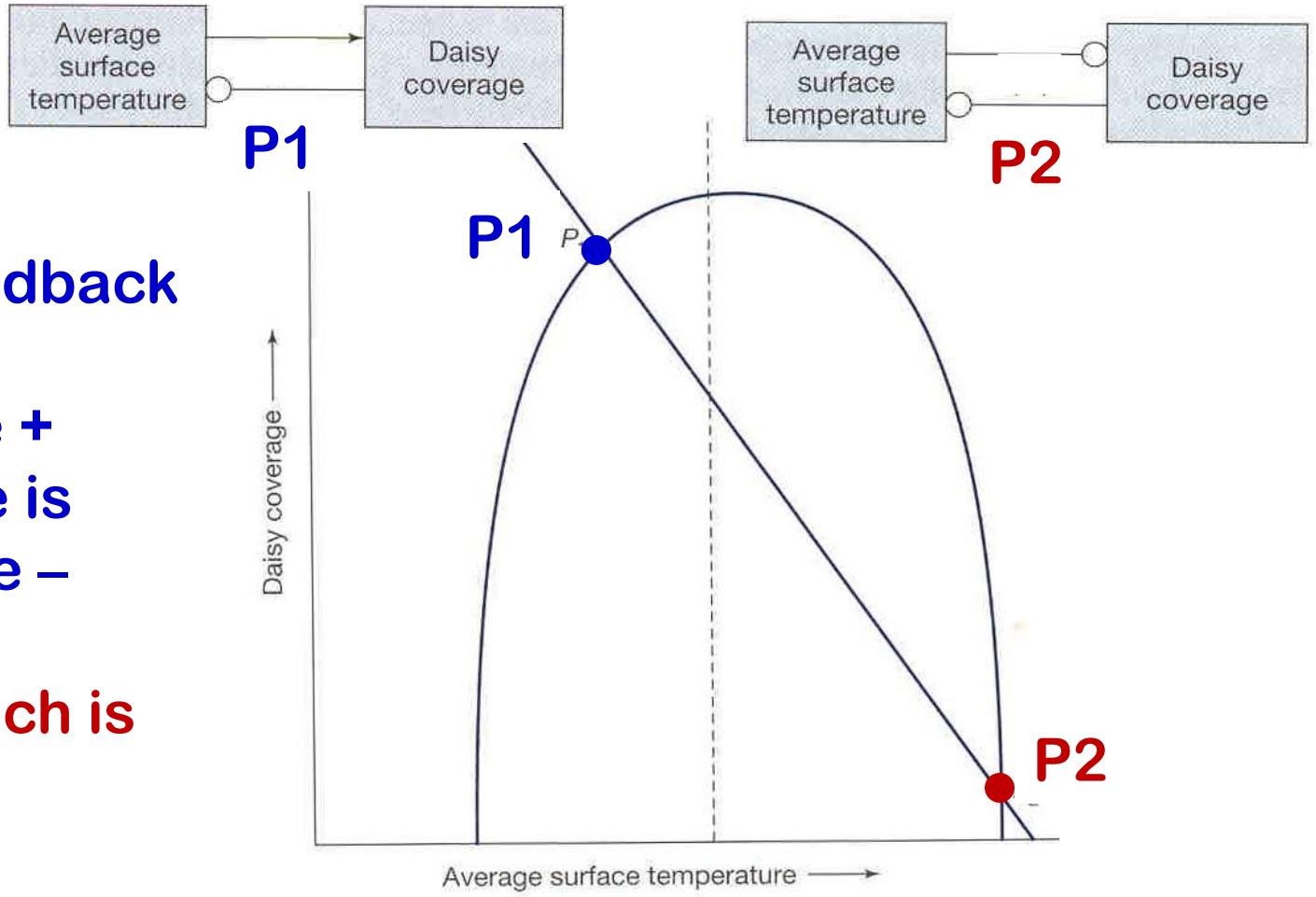


One feedback loop is positive + and one is negative –

Q1: Which is which?

1) **P1** is <u>positive</u> & **P2** is negative

2) **P1** is negative & **P2** is <u>positive</u>

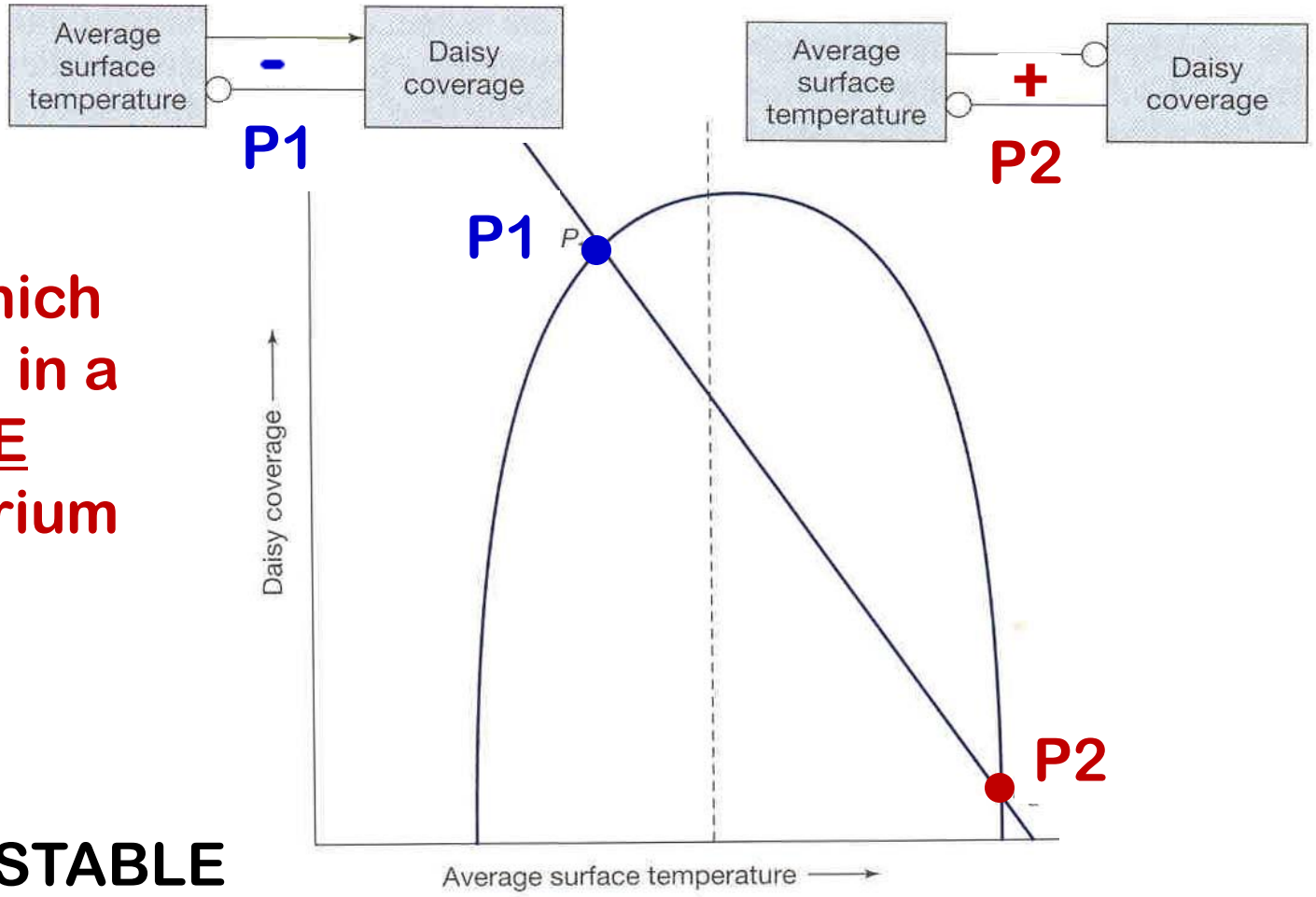


One feedback loop is positive + and one is negative –

Q1: Which is which?

1) **P1** is <u>positive</u> & **P2** is negative

2) **P1** is negative & **P2** is <u>positive</u>

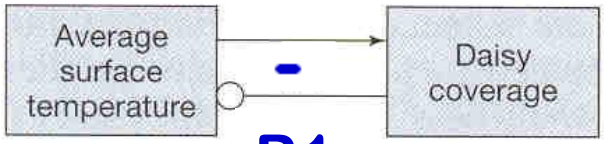


Q2: Which Loop is in a <u>STABLE</u> equilibrium state?

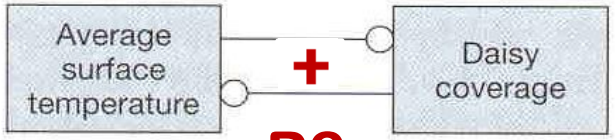
1) **P1 is STABLE**

2) **P2 is STABLE**

Self regulating feedback: STABLE **Amplifying feedback: UNSTABLE**

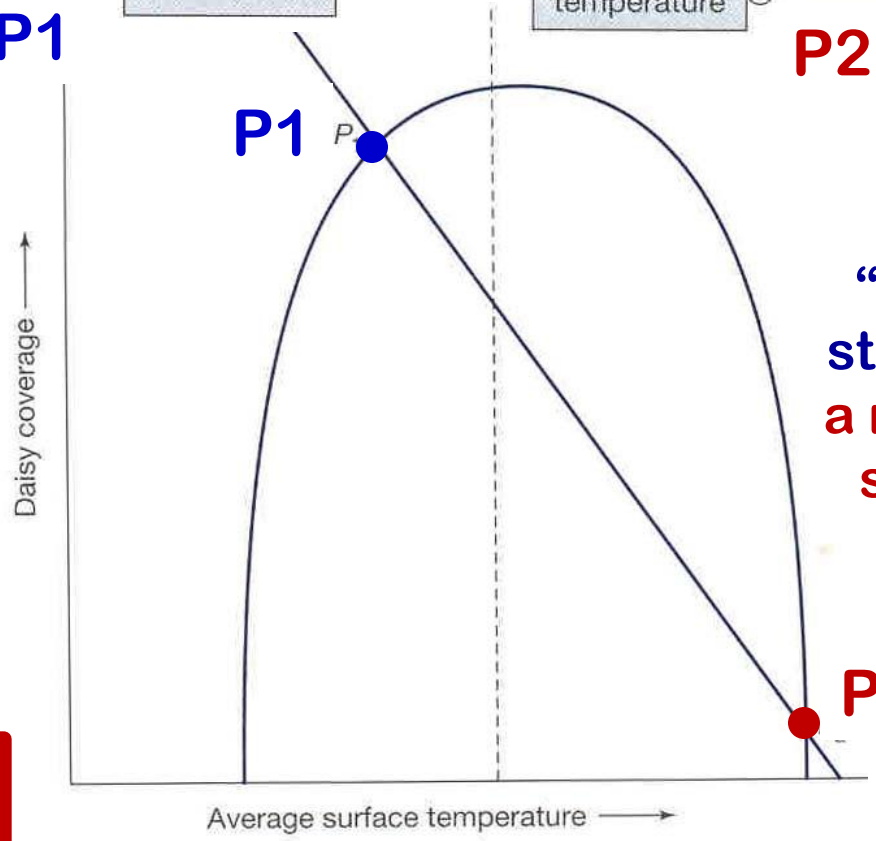


P1



P2

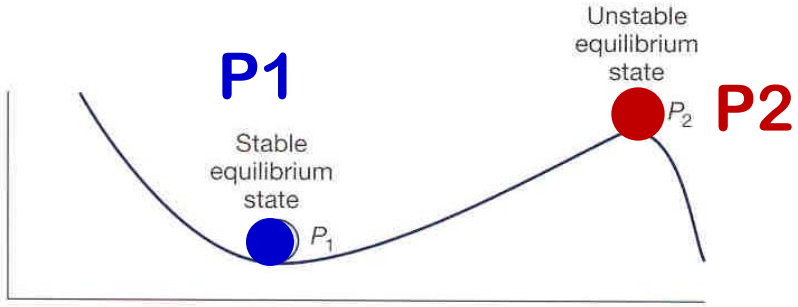
Q-2 Which Loop is in a <u>STABLE</u> equilibrium state?



P1 & P2 are <u>each</u> "EQUILIBRIUM" states, but P2 is in a more <u>precarious</u> state (unstable) than the P1!!

1) P1 is STABLE

2) P2 is STABLE



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.

The last part of Chapter 2 illustrates that:

FEEDBACK FACTORS that are negative provide a "buffer" from FORCINGS – they allow the daisies to survive LONGER after a climate change (e.g., an increase in solar luminosity) than they could have survived if NO feedback processes were in operation.

We will learn that this is EXACTLY what is happening on EARTH under many circumstances.

What we are worried about are the circumstances when feedback factors that are POSITIVE under a climatic FORCING.