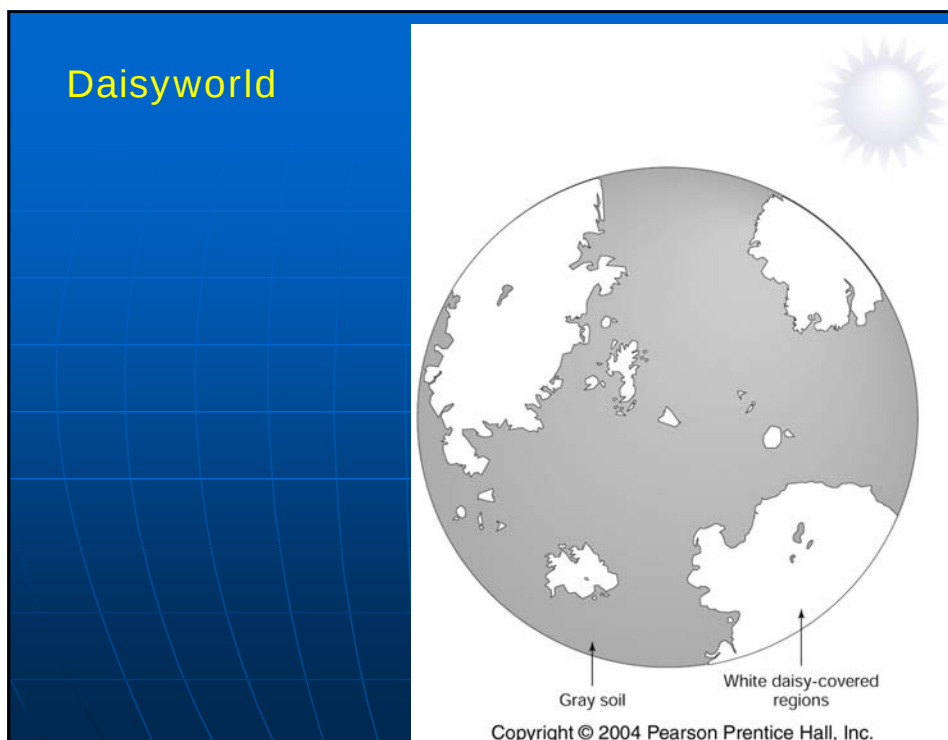
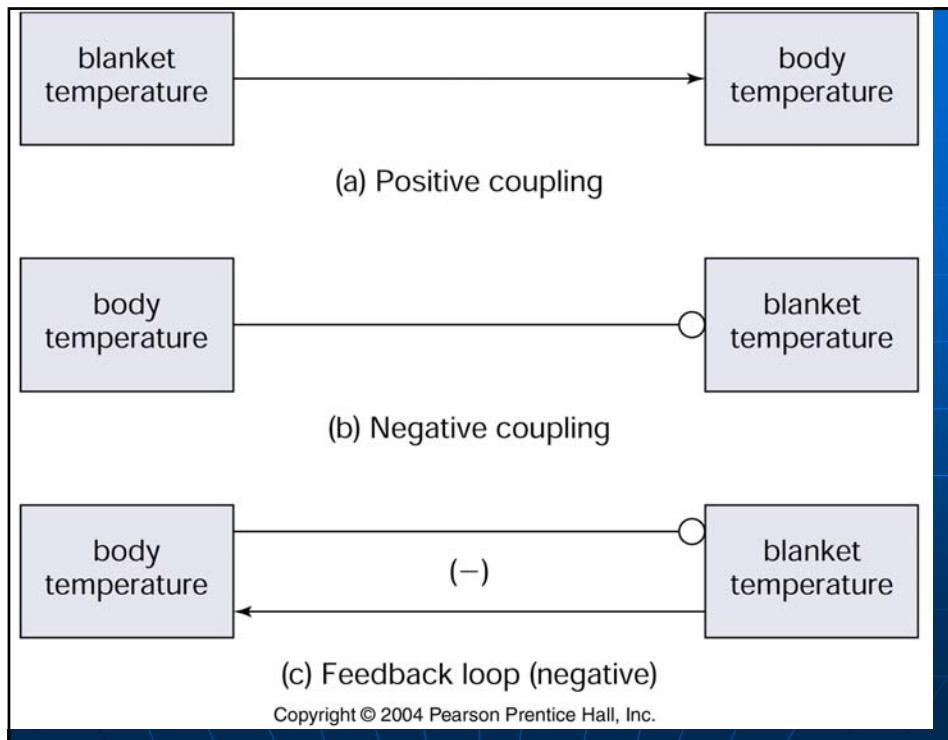
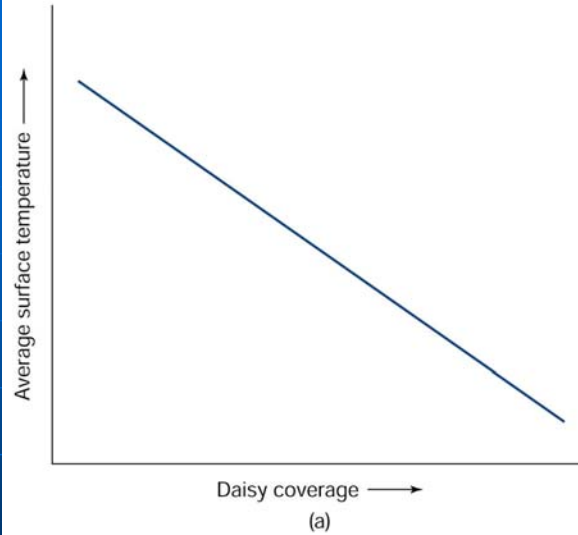




Effect of daisy coverage on surface temperature

Albedo Effect



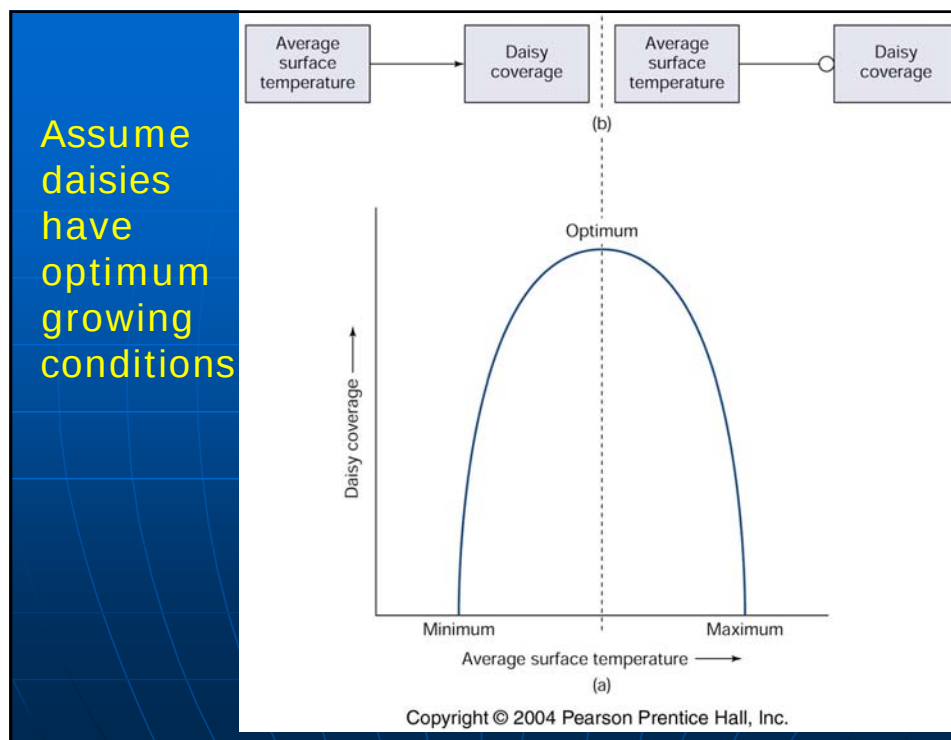
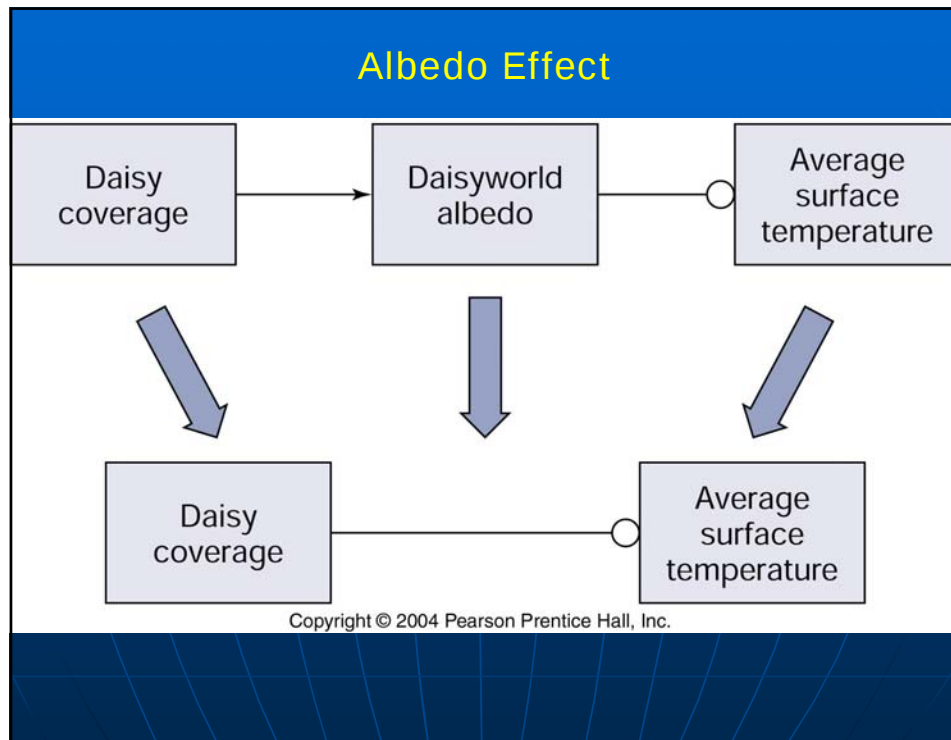
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TABLE 2-1

Albedos of Some Common Surfaces

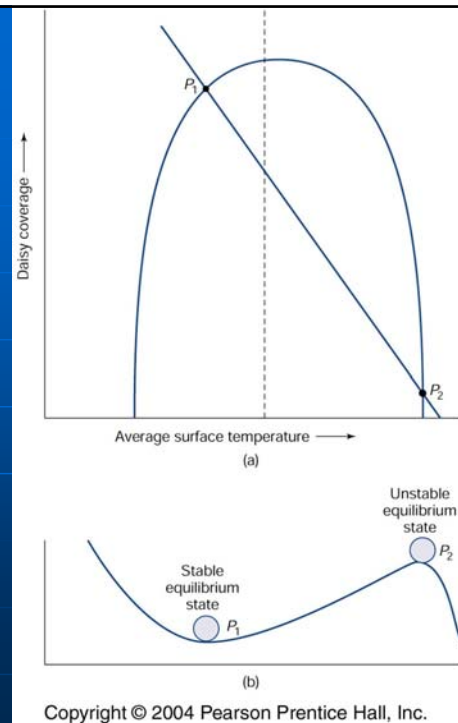
<i>Type of Surface</i>	<i>Albedo</i>
Sand	0.20–0.30
Grass	0.20–0.25
Forest	0.05–0.10
Water (overhead Sun)	0.03–0.05
Water (Sun near horizon)	0.50–0.80
Fresh snow	0.80–0.85
Thick cloud	0.70–0.80
Dark soil =	0.05 – 0.15

Albedo = fraction of incoming light which is reflected.

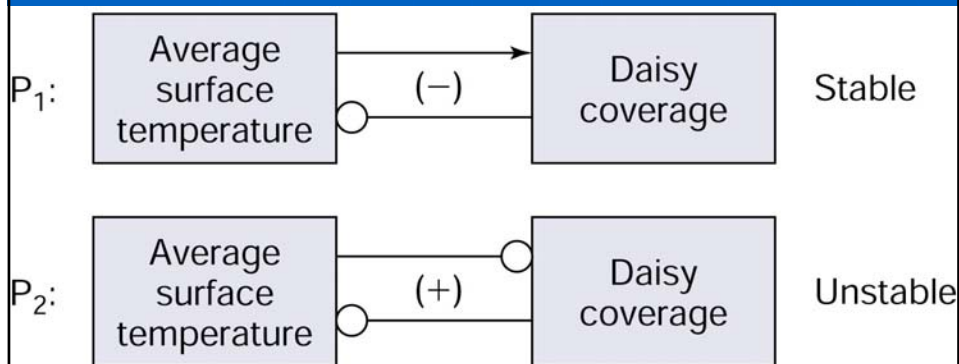


The two graphs intersect at two points, P_1 and P_2 . These are the only equilibrium points. The planet is either in state P_1 or in state P_2 .

State P_1 is stable and P_2 is unstable.



P_1 is stable because there is a negative feedback there.



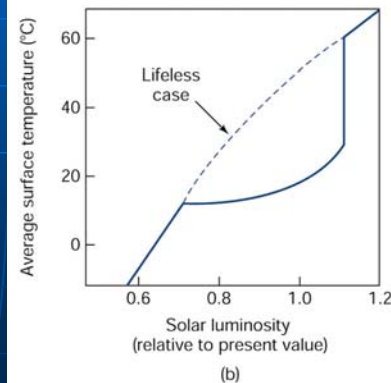
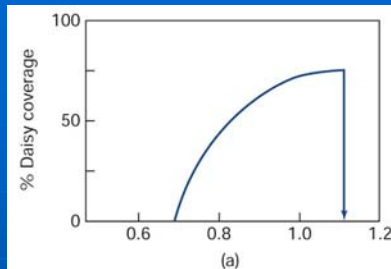
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P_2 is unstable because there is a positive feedback there.

Thus the response of the planet (Daisyworld) to a change in temperature depends on the temperature of the planet.

Assign reasonable values for the growth curve for real daisies, their albedo, the albedo of soil, and the solar luminosity of the earth.

Daisies regulate the climate and keep it within narrow bounds. But once the solar luminosity increases beyond some limit, the daisies die and there is no stabilizing negative feedback.



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Lessons of Daisyworld

- Negative feedback loops counter external forcings – the Earth's climate system has negative feedback loops that keep its climate relatively stable.
- Nonhuman systems that self-regulate are not “intelligent”. The GAIA hypothesis does not require intelligence.
- Self-regulation is not perfect.
- The real Earth has maintained its surface temperature within the tolerance of living organisms for more than 3 billion years despite substantial changes in solar luminosity.

Climate Feedbacks

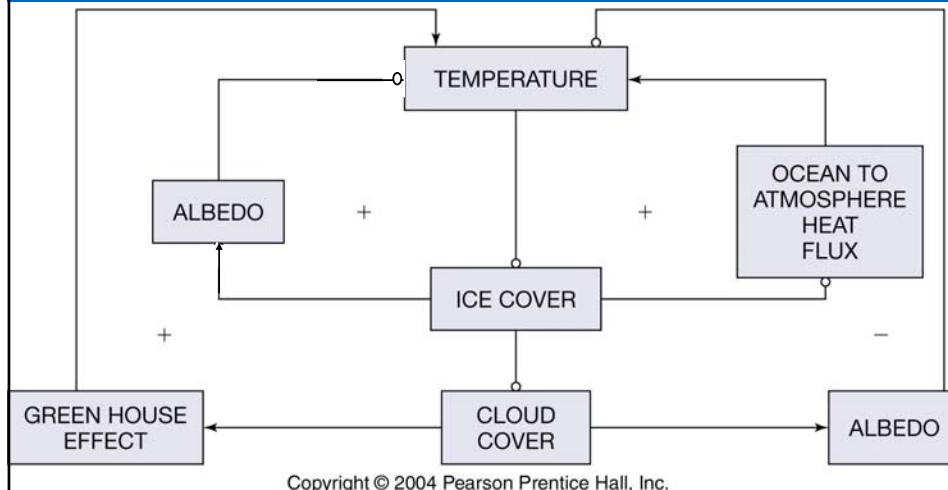
Positive feedbacks:

- water vapor
- albedo/ice cover
- high clouds

Negative feedbacks:

- ocean uptake (CO_2 and heat)
- low clouds (albedo)

Climate Feedbacks



The feedbacks can get complicated quickly.

Climate Modeling

