

Earth's Energy Budget

Reflection of Incoming Solar Radiation

MODULE 3.3

3.3 Reflection of Incoming Solar Radiation

Lesson Goals:

- » Predict how particular changes in the reflective properties of Earth's surface or atmosphere would likely affect Earth's temperature.
- » Construct feedback loops involving reflectivity.

Changing reflectivity

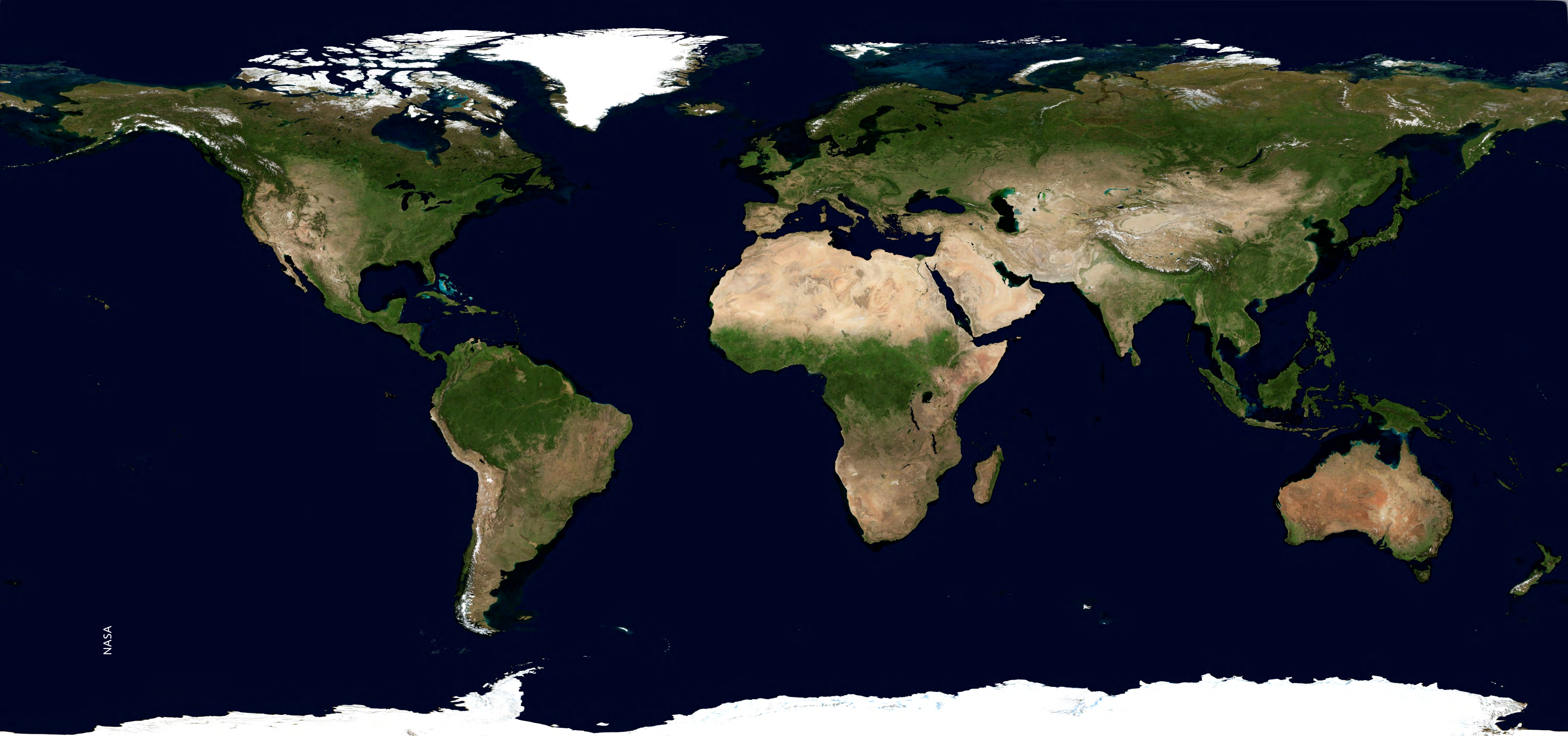
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The diagram illustrates the Earth's energy balance with the following components and values:

- Incoming Solar Radiation:** 341.3 W/m^2
- Reflected Solar Radiation:** 101.9 W/m^2 (Total)
- Reflected by Clouds & Atmosphere:** 79 W/m^2
- Reflected by Surface:** 23 W/m^2
- Absorbed by Surface:** 161 W/m^2
- Absorbed by Atmosphere:** 78 W/m^2
- Thermals:** 17 W/m^2
- Evapo-transpiration (Latent Heat):** 80 W/m^2
- Surface Radiation:** 396 W/m^2
- Emitted by Atmosphere:** 169 W/m^2
- Emitted by Clouds:** 30 W/m^2
- Atmospheric Window:** 40 W/m^2
- Greenhouse Gases (Back Radiation):** 333 W/m^2
- Outgoing Longwave Radiation:** 238.5 W/m^2

Cloud-free Earth



**What if the forest expanded into the desert area?
Reflectivity would ____.**

- A. Increase
- B. Decrease
- C. Stay the same



**Warming at northern
high latitudes**

Perturbation

**More area covered
with taller
vegetation**

**Darker vegetation
sticks up above
snow**

AMPLIFYING

**Less incoming solar
energy reflects
back to space.
More solar
energy absorbed**

**Warmer
temperatures**



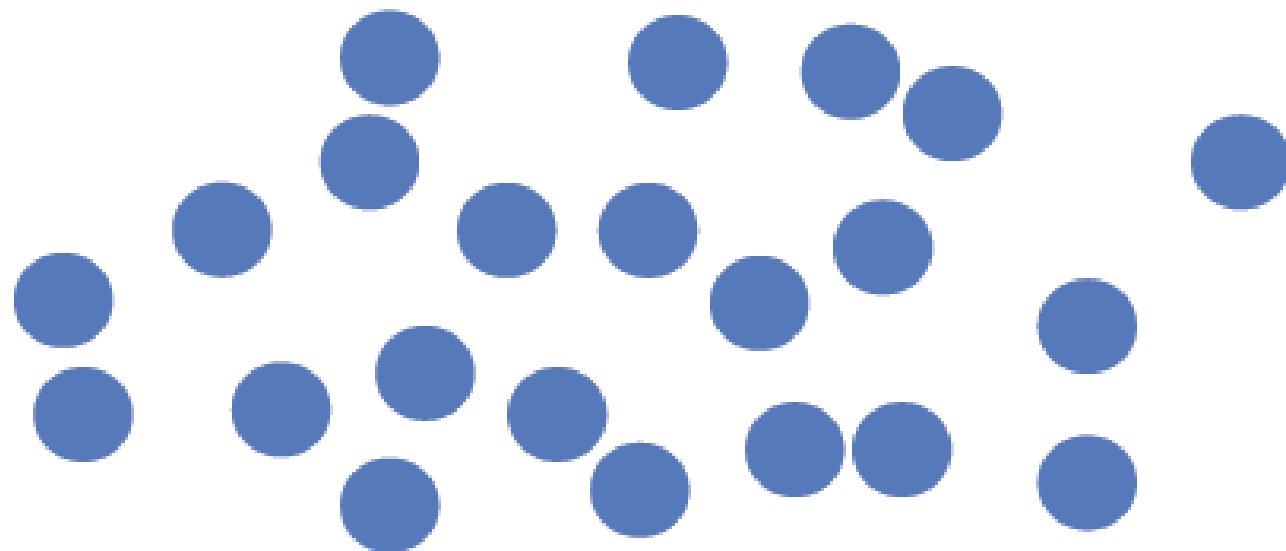
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MORE reflective



Small droplets ●

Higher concentration

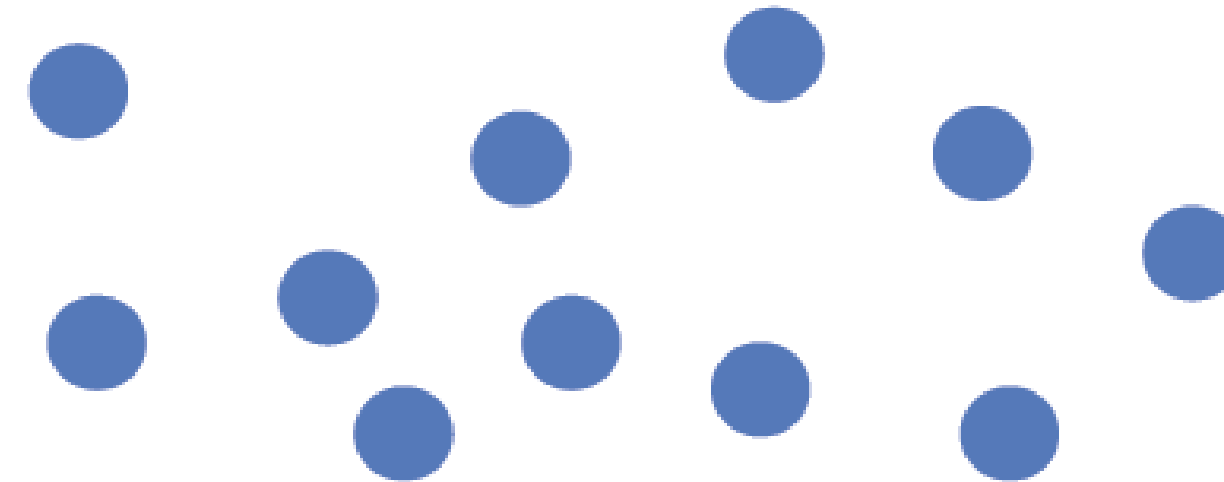


LESS reflective

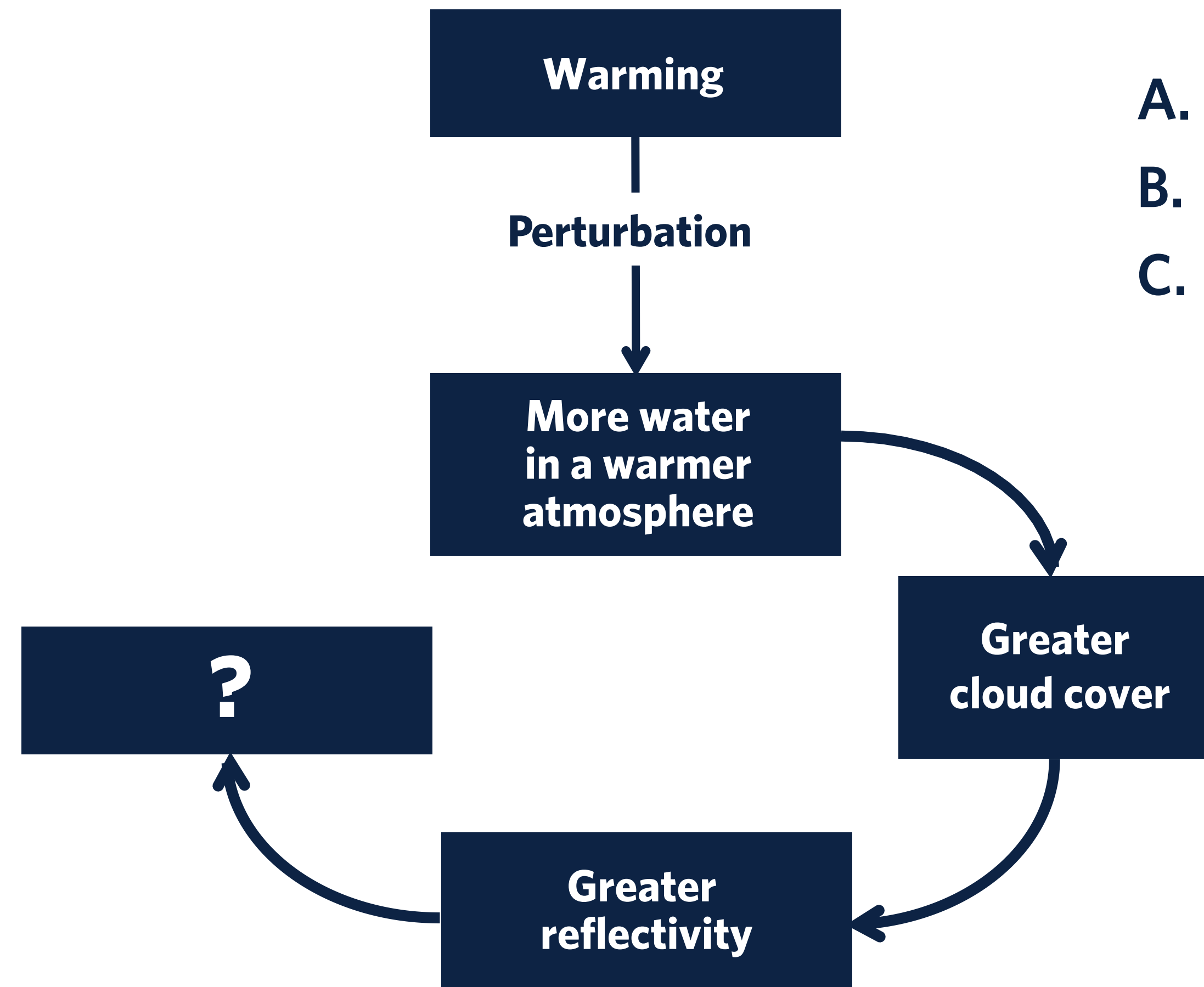


Large droplets ●

Lower concentration

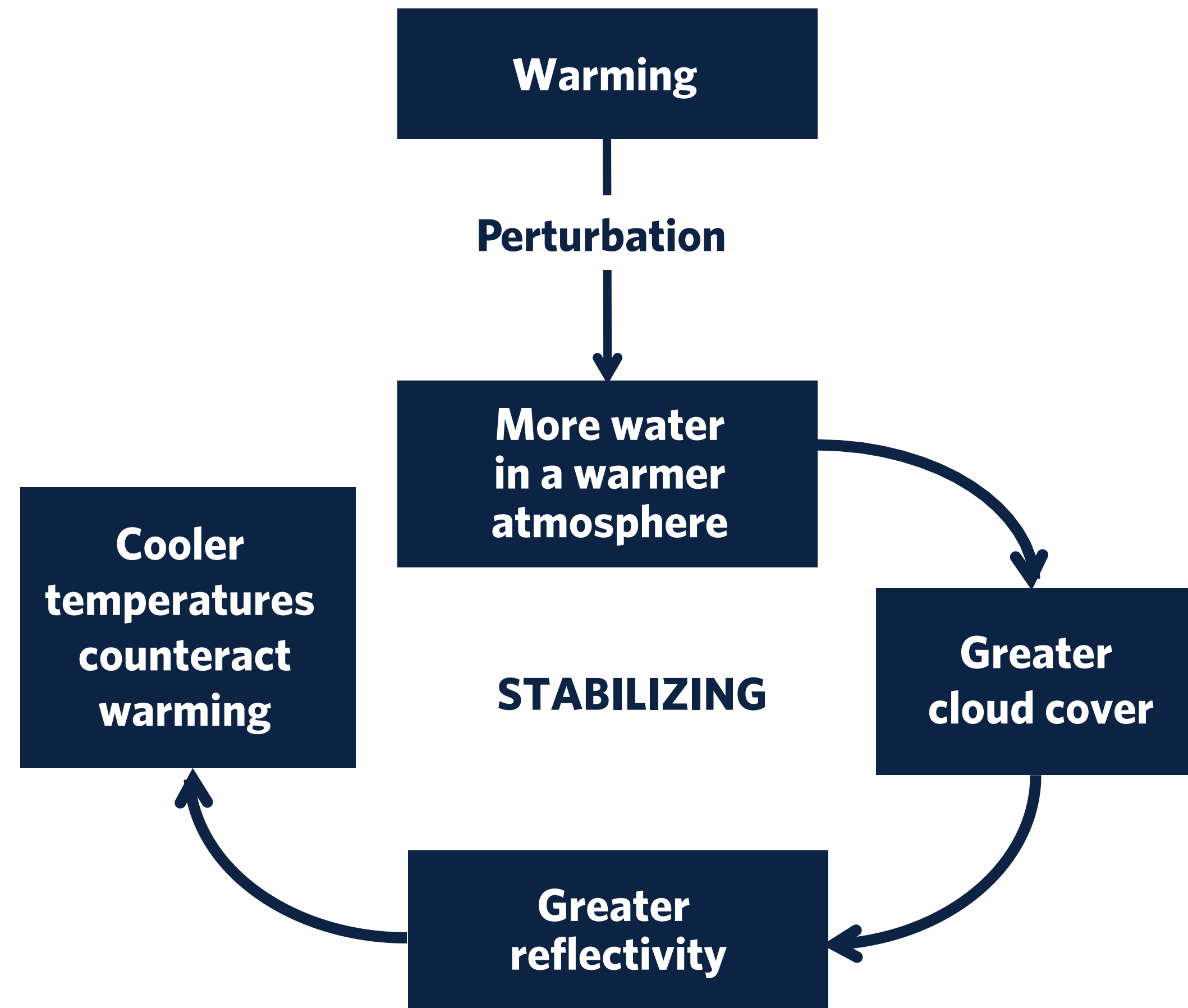


Cloud feedbacks: What if...

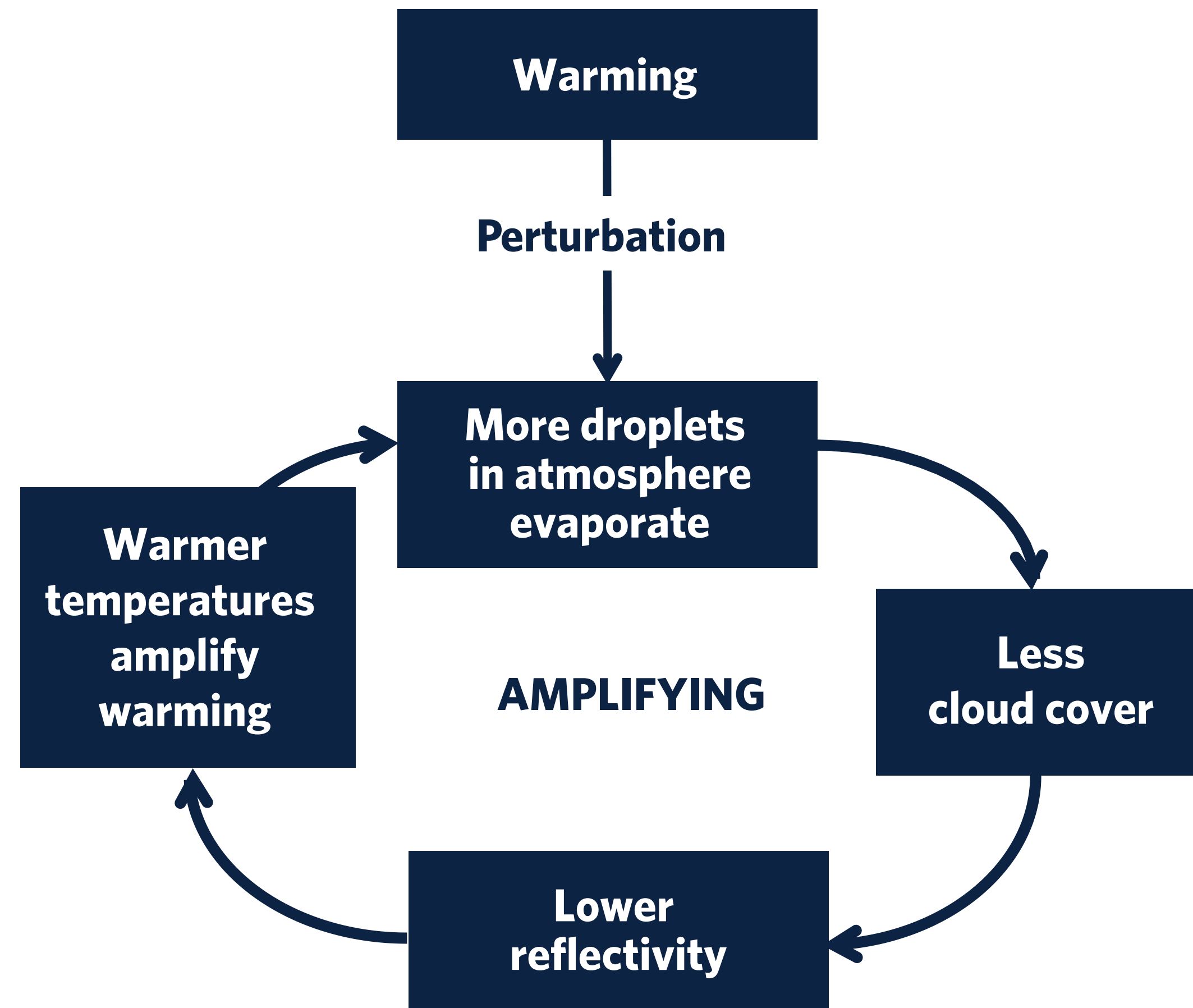


- A. Amplifying
- B. Stabilizing
- C. Could be either

Cloud feedbacks: What if...



Cloud feedbacks: What if...



Key Points

- » Changes in Earth's surface toward more reflective materials promote cooling; changes toward less reflective materials promote warming.
- » On Earth's surface, changes in vegetation cover and land use can alter reflectivity.
- » In the atmosphere, changes in cloud cover and the stock of reflective aerosols can change Earth's overall reflectivity.
- » Reflection is involved in important feedback loops in the climate system.
- » Feedbacks involving clouds are not well-constrained, but recent research suggests that cloud feedbacks in a warming world are likely to be net amplifying.