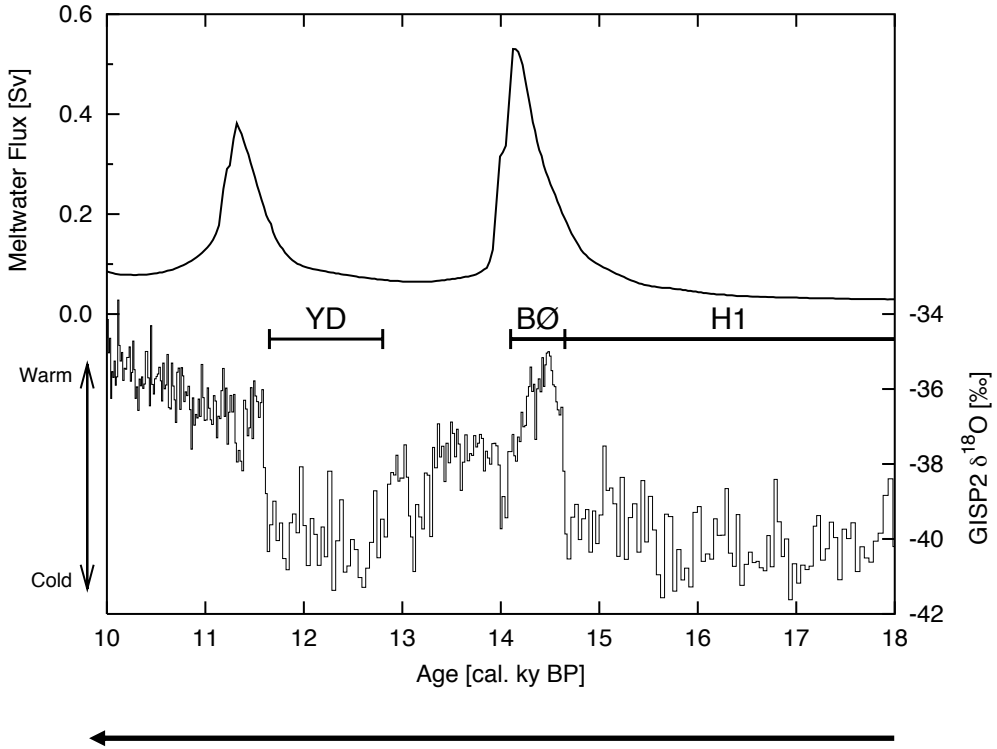
Kinetic energy spectrum (Irminger Sea)

Olbers et al. 2012

Lohmann et al., in prep

Deglacial meltwater & climate



Lohmann and Schulz, 2000; based on Fairbanks et al., 1992, Grootes and

Proglacial lakes due to melting ice sheet model

Glacial

Holocene

Hinck et al., 2020, The Cryosphere Discuss

Deglacial Hosing: Ocean response

Calving of ice bergs:
Heinrich Events (“solid“)

Result of Zweck and Huybrecht‘s ice sheet model

Lohmann et al., Paleoceanography. 2020; based on Zweck and Huybrechts (2005)

Ocean Model configuration FESOM

Atmosphere: ECHAM6 T63
JSBACH
CMIP/PMIP version
Fixed ice sheet

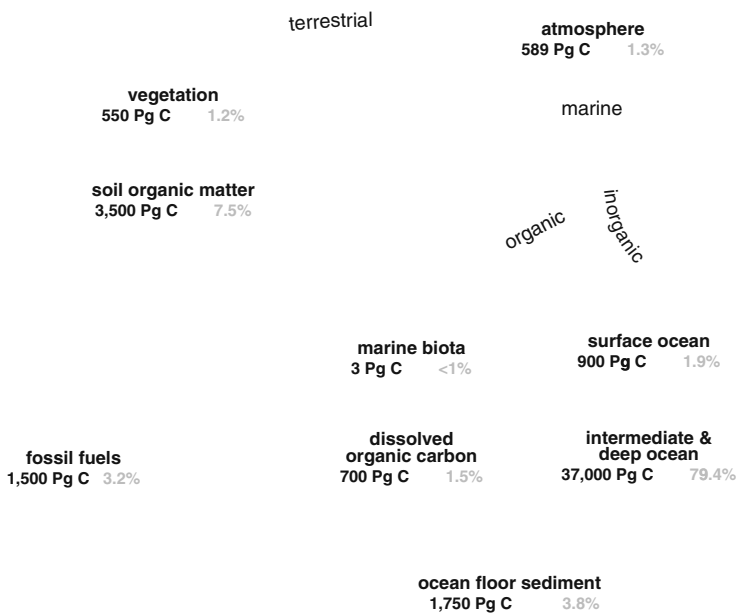
Sidorenko et al., 2015, 2019

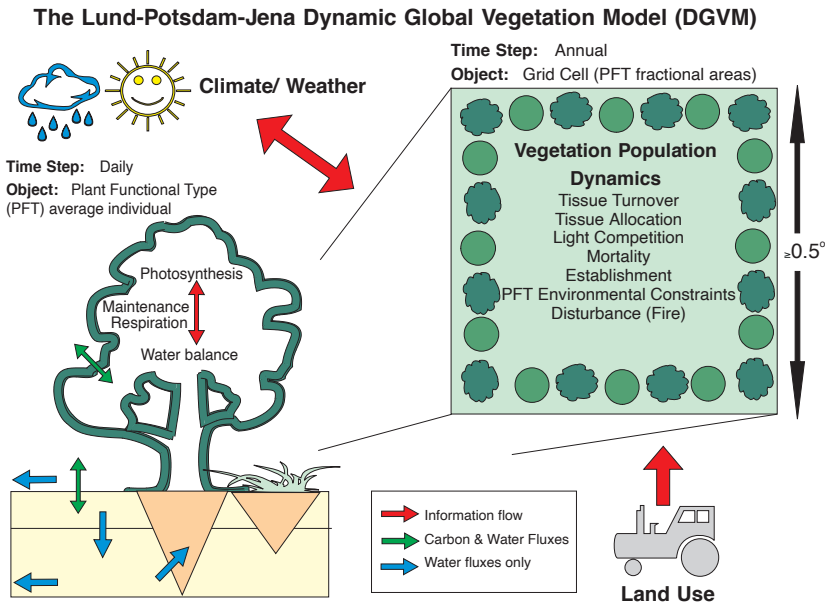
Lohmann et al., in prep

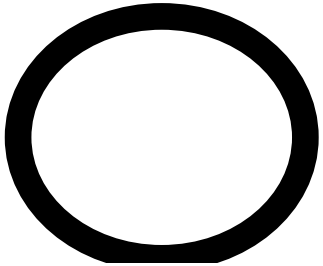
Deglacial Hosing: Ocean response

Lohmann et al., Paleoceanography. 2020

Earth system models
tracers and dynamical vegetation







The Carbon Cycle

- Carbon is the key element for **living** things.
- Carbon in the atmosphere and dissolved in the oceans as part of the inorganic CO_2
- CO_2 is recycled into more complex organic substances through **photosynthesis**.

- **<u>Photosynthesis</u>** – process by which green plants make their own food from **water**, carbon dioxide, and light energy, producing sugar (stored energy) and oxygen (a by-product).

- The general equation for photosynthesis is:

$$6CO_2 + 6H_20 \rightarrow C_6H_{12}O_6 + 6O_2$$

Carbon dioxide

Water

Carbohydrates

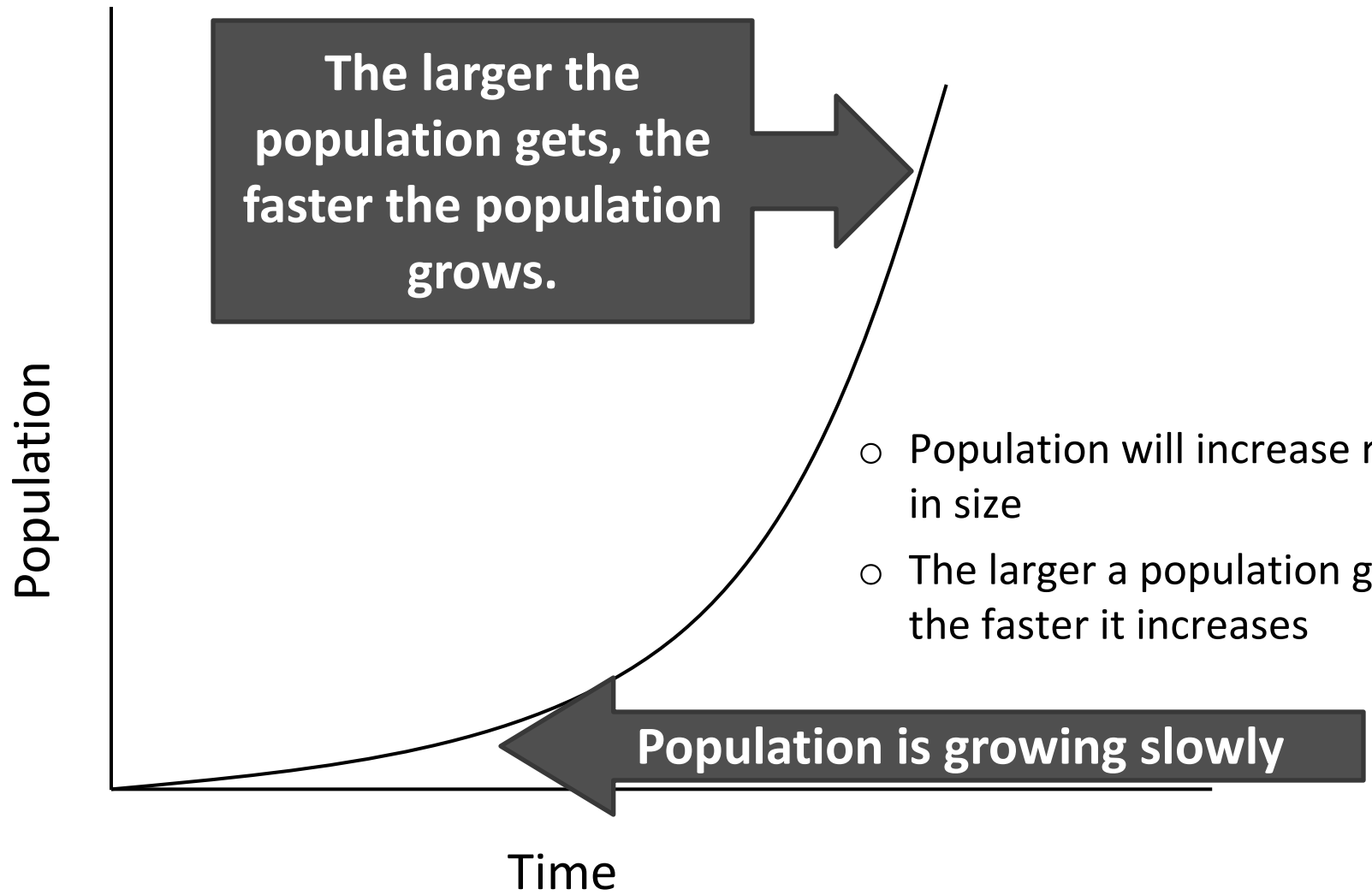
Oxygen

Vegetation & Ecosystem

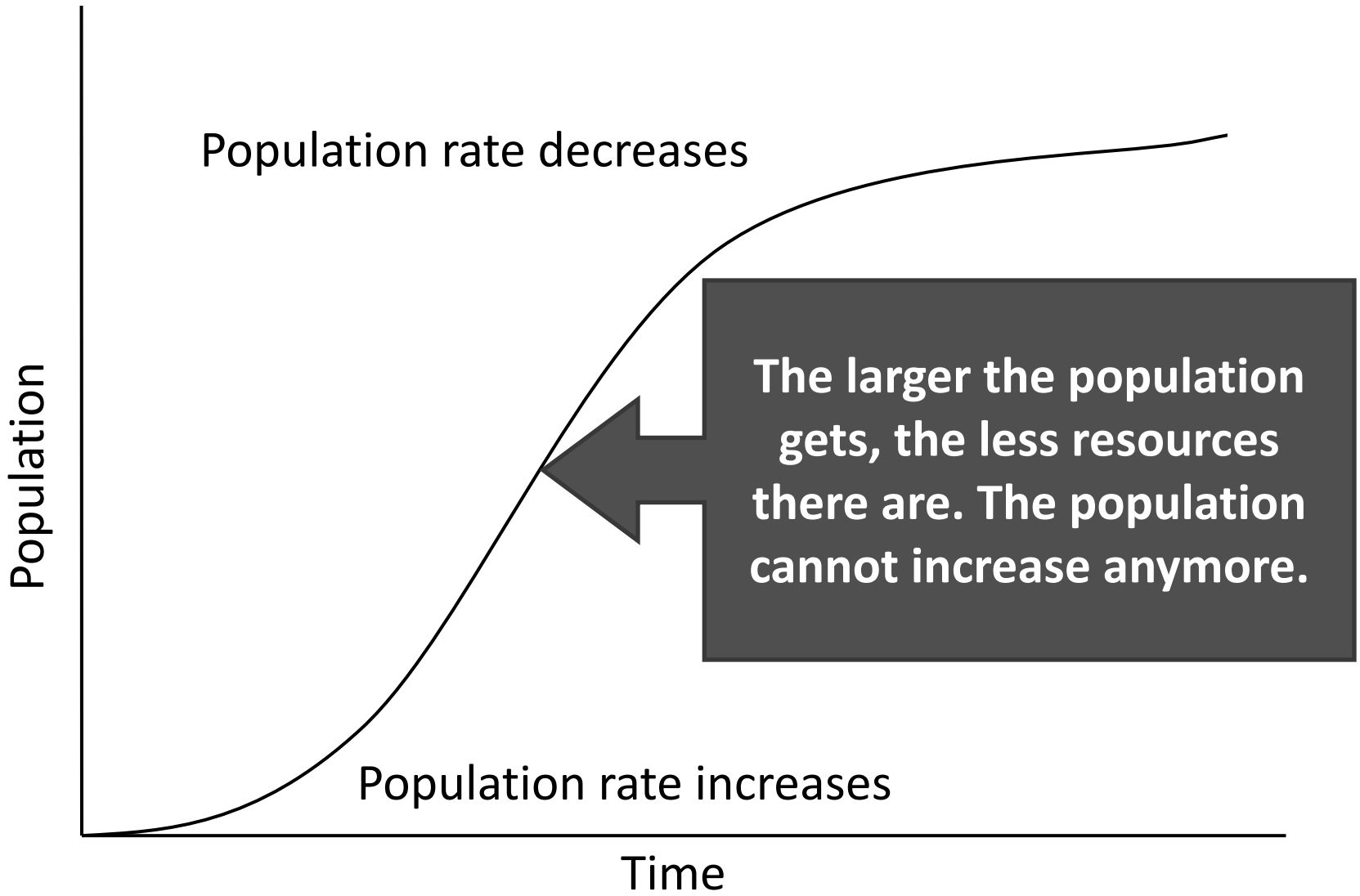
Human Impact

1. **Deforestation** – cutting down forests has reduced the amount of plants available for photosynthesis, which means that less CO_2 can be removed from the atmosphere.
2. **Burning (combustion) of fossil fuels** – gasoline, coal, and natural gas contain carbon and when burned, they release CO_2 into the Earth's lower atmosphere. There is concern that the increase in CO_2 will lead to global warming.

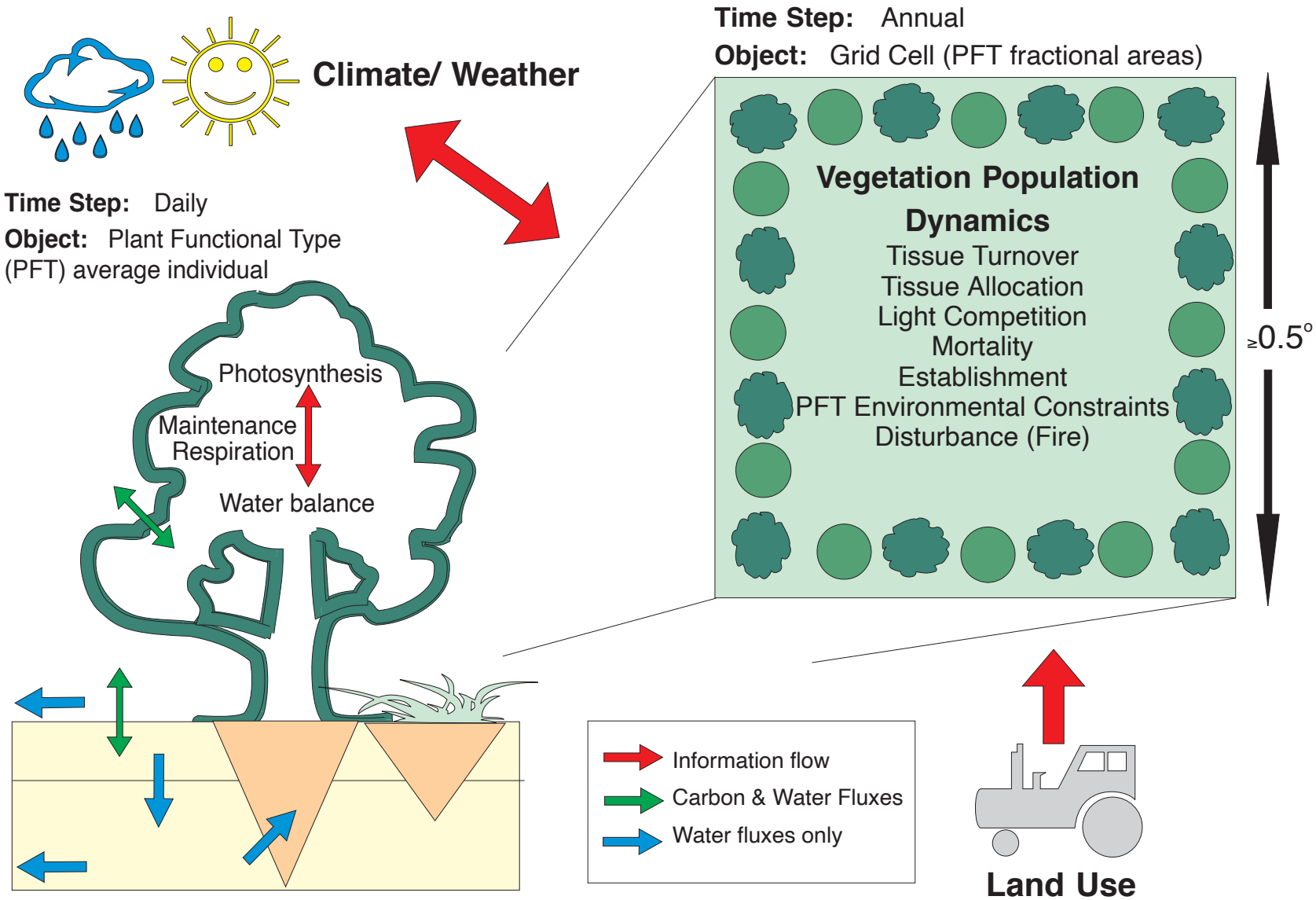
Population Growth (ideal conditions)



- Population will increase rapidly in size
- The larger a population gets, the faster it increases


Population rate decreases
The larger the population gets, the less resources there are. The population cannot increase anymore.
Population rate increases
Population
Time

The Lund-Potsdam-Jena Dynamic Global Vegetation Model (DGVM)



https://web.nateko.lu.se/lpj-guess/education/

Typical output of a vegetation model

Das Bild kann nicht angezeigt werden.

Daisy World & the Gaia Hypothesis

Sunlight reflects off different color daisies.
Black daisies absorb most light, turning it into heat.
White daisies reflect most light, and stay cooler.

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When the world is too cool for black daisies to warm it, or too hot for white daisies to cool it, the planet is barren.

Vegetation Model

Growth rate is temperature dependent

Vegetation Model

Growth rate is temperature dependent

Evolution of area fractions of white (a_w) and black (a_b) daisies

Vegetation Model

Growth rate is temperature dependent

Planetary albedo

Gobal temperature

L: luminosity

Climate Model

$q=2.06 \times 10^9$ K^4 is a heat transfert coefficient

https://paleodyn.uni-bremen.de/study/MES/daisy/

Exercise daisy

1) Run Daisy World with the the Daisies - black and white. Notice for what range of luminosity the daisies manage to control the planet temperature.

2) Do you think control would be better if you set the low and high albedos (for black and white) to a wider spread?

3) You will notice that the living area (“total daisies”) doesn’t exceed 70%. The deathrate is set to 0.3, which may explain the living percentage being no more than 0.7. Play with the deathrate parameter. What does the deathrate do to the daisies’ ability to control their environment’s temperature? To the species mix?