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Impact of Bison reintroduction in Siberia

What is the optimal density of American bison to reintroduce in Siberia to slow down the thawing of the permafrost by trampling the snow ?

CONTEXT :

Scientists reintroduced large herbivores in Pleistocene park in Siberia.

Increasing mammalian population density leads to a temperature decrease of about -1,9 °C in Pleistocene park.

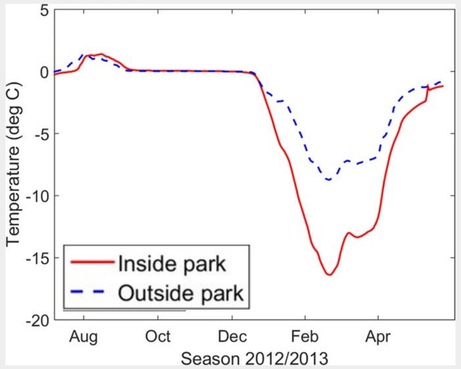


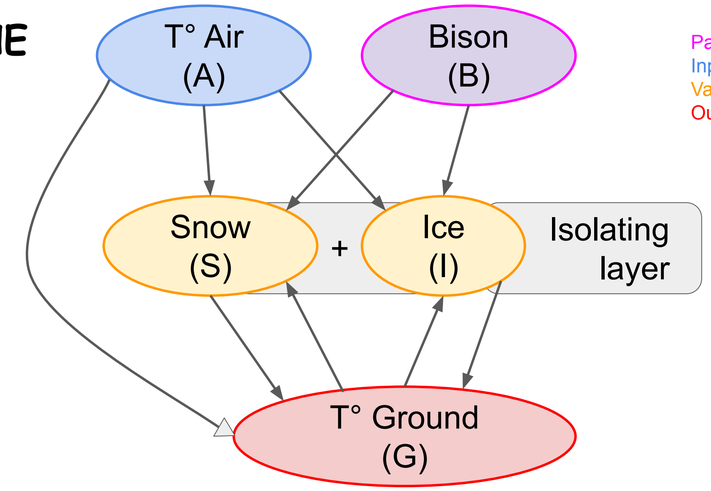
Figure 1: Evolution of soil temperature from August 2012 to April 2013.[2]

How could reintroducing animals to an ecosystem slow down global warming ?
Bisons and other large herbivores used to live in Siberia at the Pleistocene era. With their extinction, and with the climate turning warmer, the permafrost layer started to thaw. The goal of reintroducing Bisons and other large herbivores is to conserve the permafrost.[1]

BUILDING THE MODEL :

Bisons trample snow → Snow more dense → Snow becomes ice

Hypothesis



Parameters
Input variable
Variables
Output variable

Figure 2: Diagram of our system interconnections

Differential equations

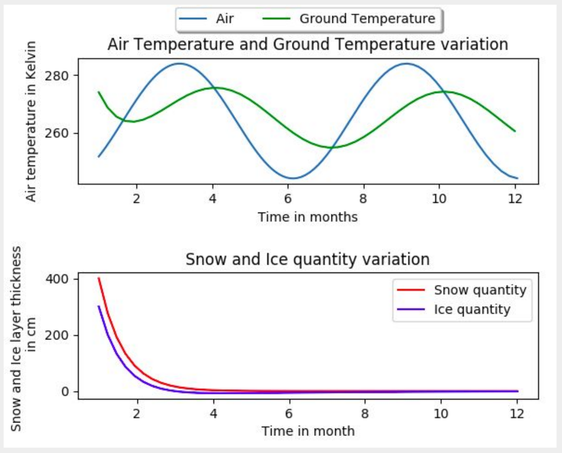
$$dSdt = - kAS * A * S - kGS * G * S - kB * B * S$$

$$dIdt = - kAI * A * I - kGI * G * S + kB * B * S$$

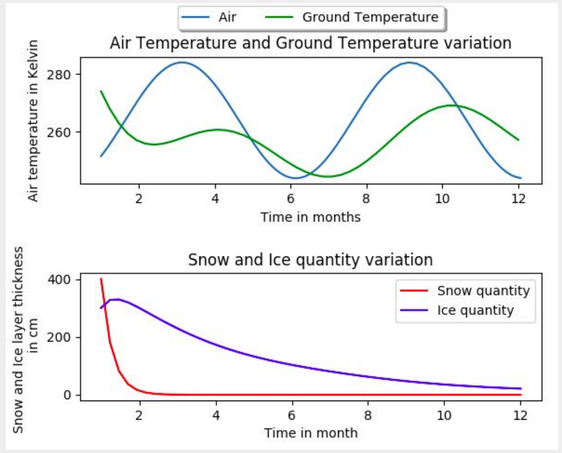
$$dGdt = kAG * (A - G) - kIG * I$$

THE RESULTS :

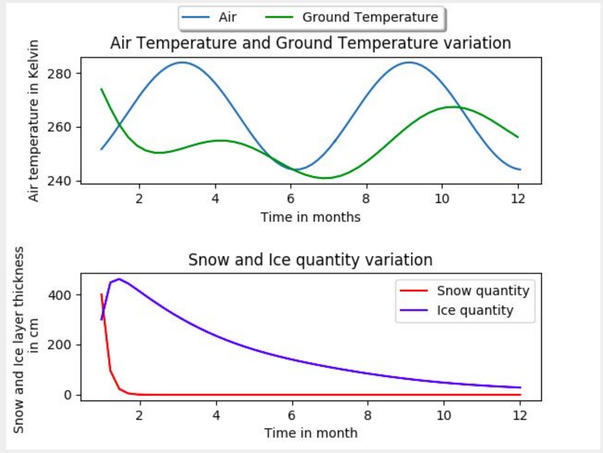
With 0 bison



With 20 bisons



With 50 bisons



LIMITATIONS & PERSPECTIVES :

- Greenhouse gases (positive feedback loop)
- Snow falling (input in snow)
- Bisons as a variable

[1] Peters, Adele, et al. “Baby Bison Are Being Flown To Siberia To Try To Save The Permafrost.” *Fast Company*, 23 Apr. 2018, https://www.fastcompany.com/40561843/baby-bison-are-being-flow-to-siberia-to-try-to-save-the-permafrost.
[2] Beer, Christian, et al. “Protection of Permafrost Soils from Thawing by Increasing Herbivore Density.” *Scientific Reports*, vol. 10, no. 1, Mar. 2020, pp. 1–10, doi:10.1038/s41598-020-60938-y.