Biogeochemical processes of forest ecosystem in northern Hokkaido

Implication to climate change

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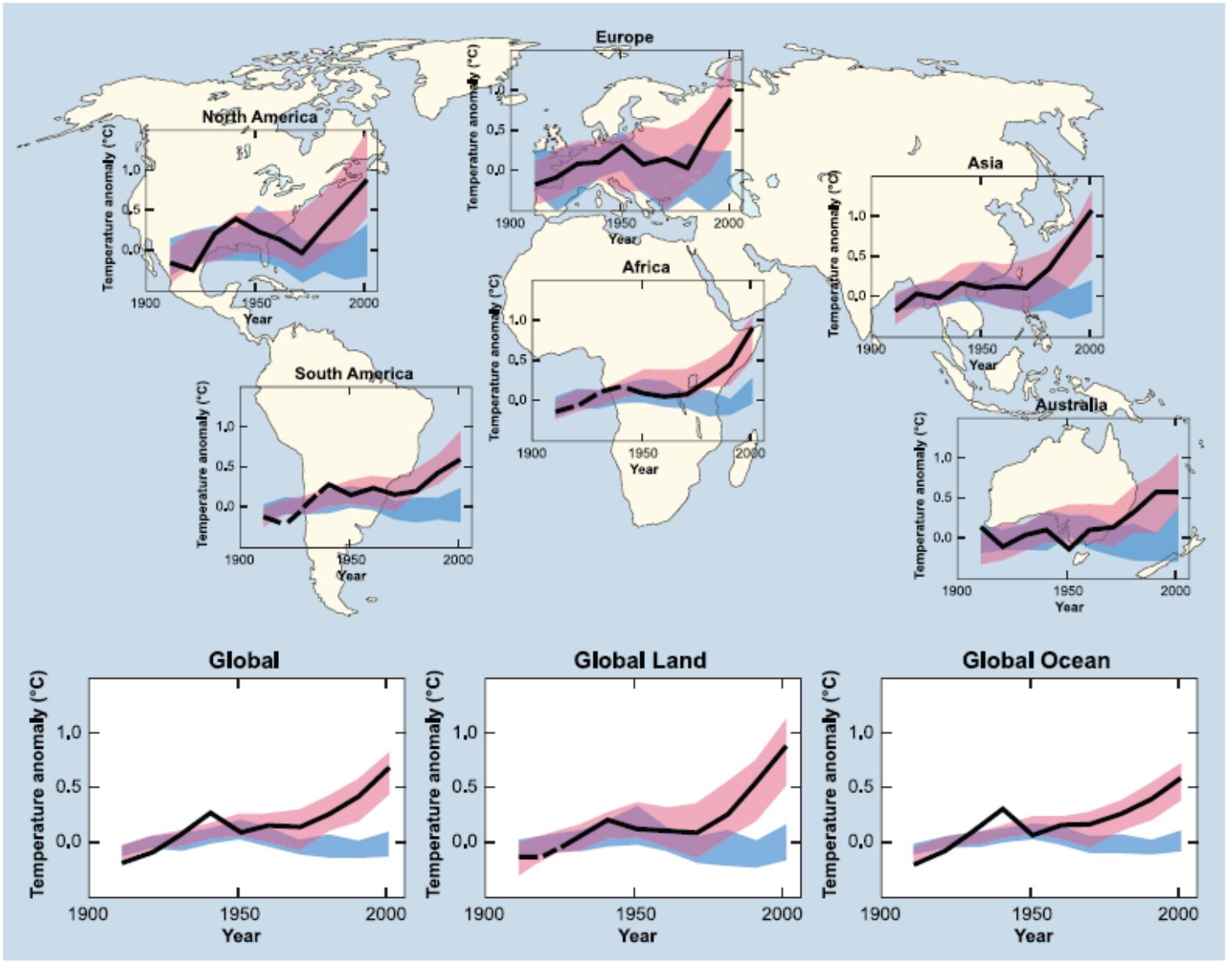
Global and continental temperature change (IPCC AR4)



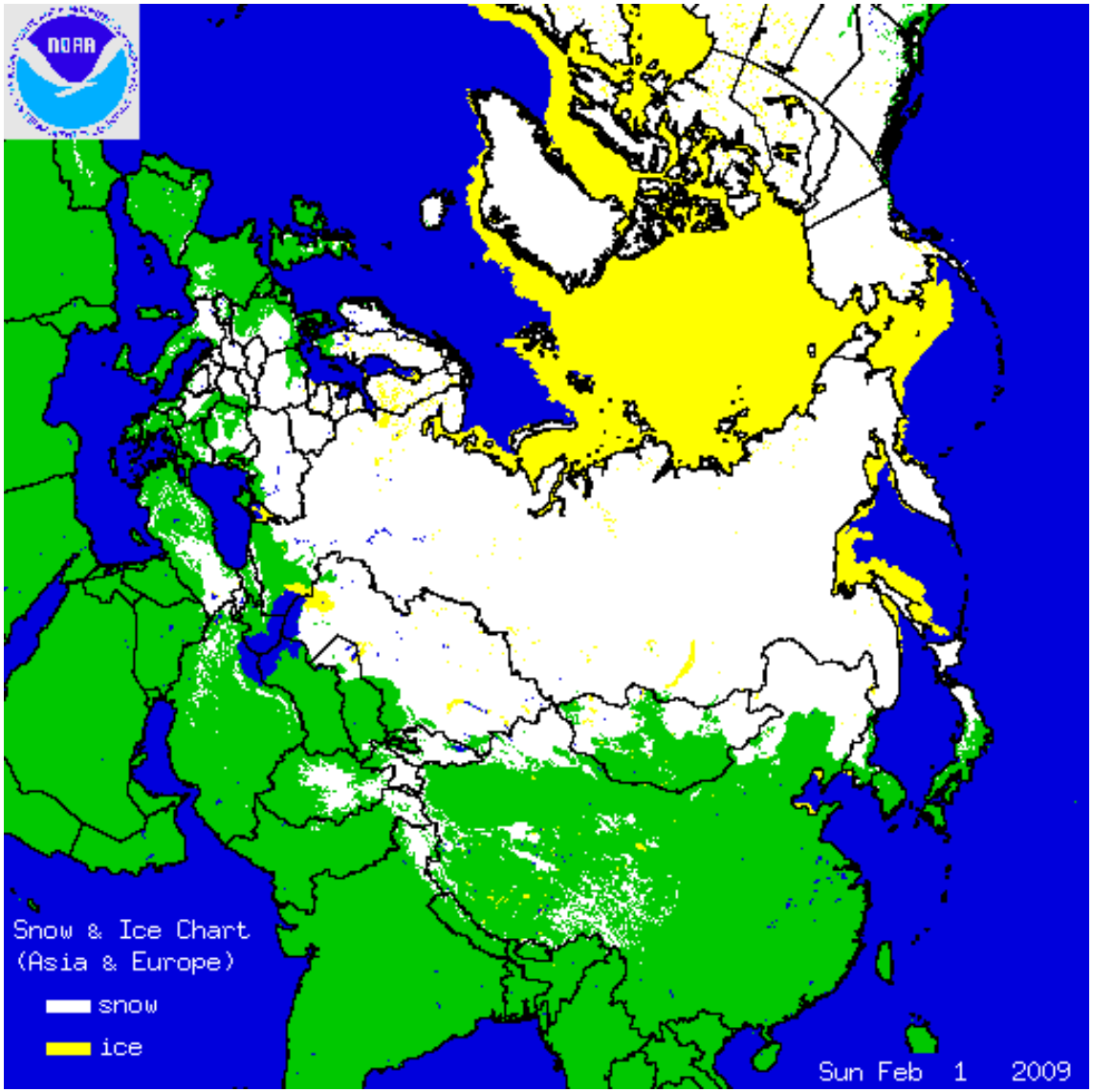
Response of forest ecosystem to climate change

- ✓ Carbon sequestration (CO_2 flux)
- ✓ Vegetation response (phenology)
- ✓ Microbial response (soil nitrogen dynamics)
- ✓ .....



Phenological changes of tree leaf in autumn (Uryu Exp. Forest)

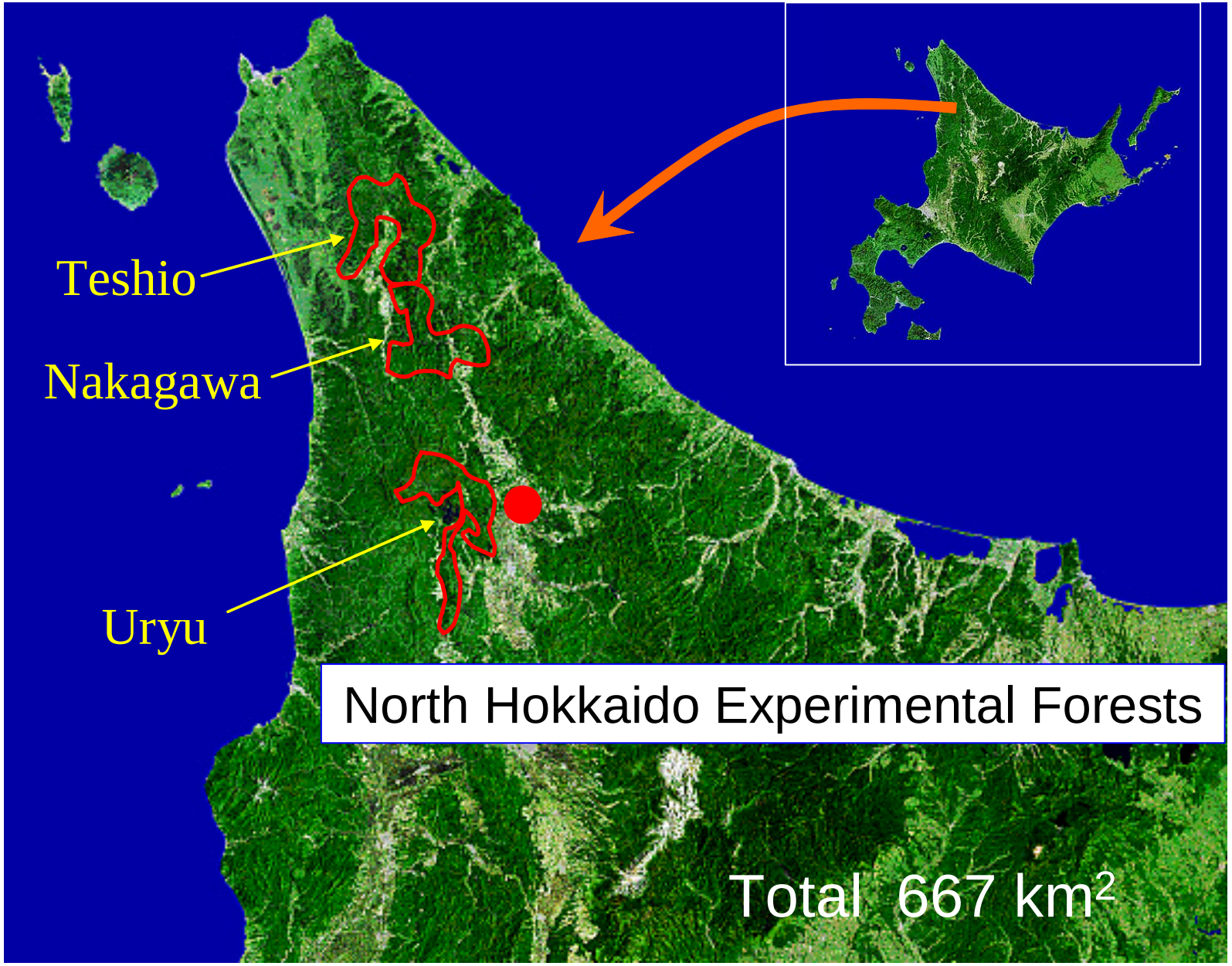
Importance of winter climate in northern ecosystems



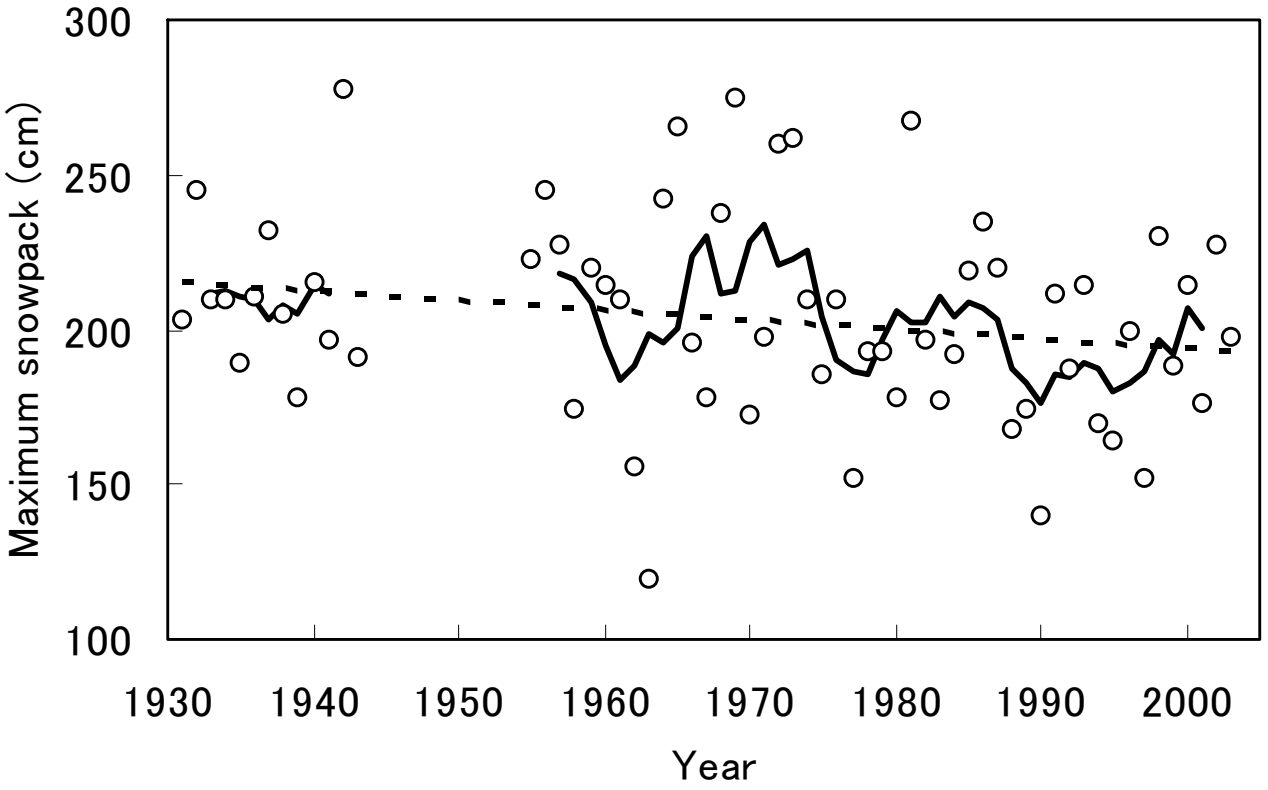
Snow-covered area in Asia and Europe (Feb. 2009)

(NASA satellite image; www.natice.noaa.gov/ims/)

Location of Hokkaido University's experimental forests in northern Hokkaido



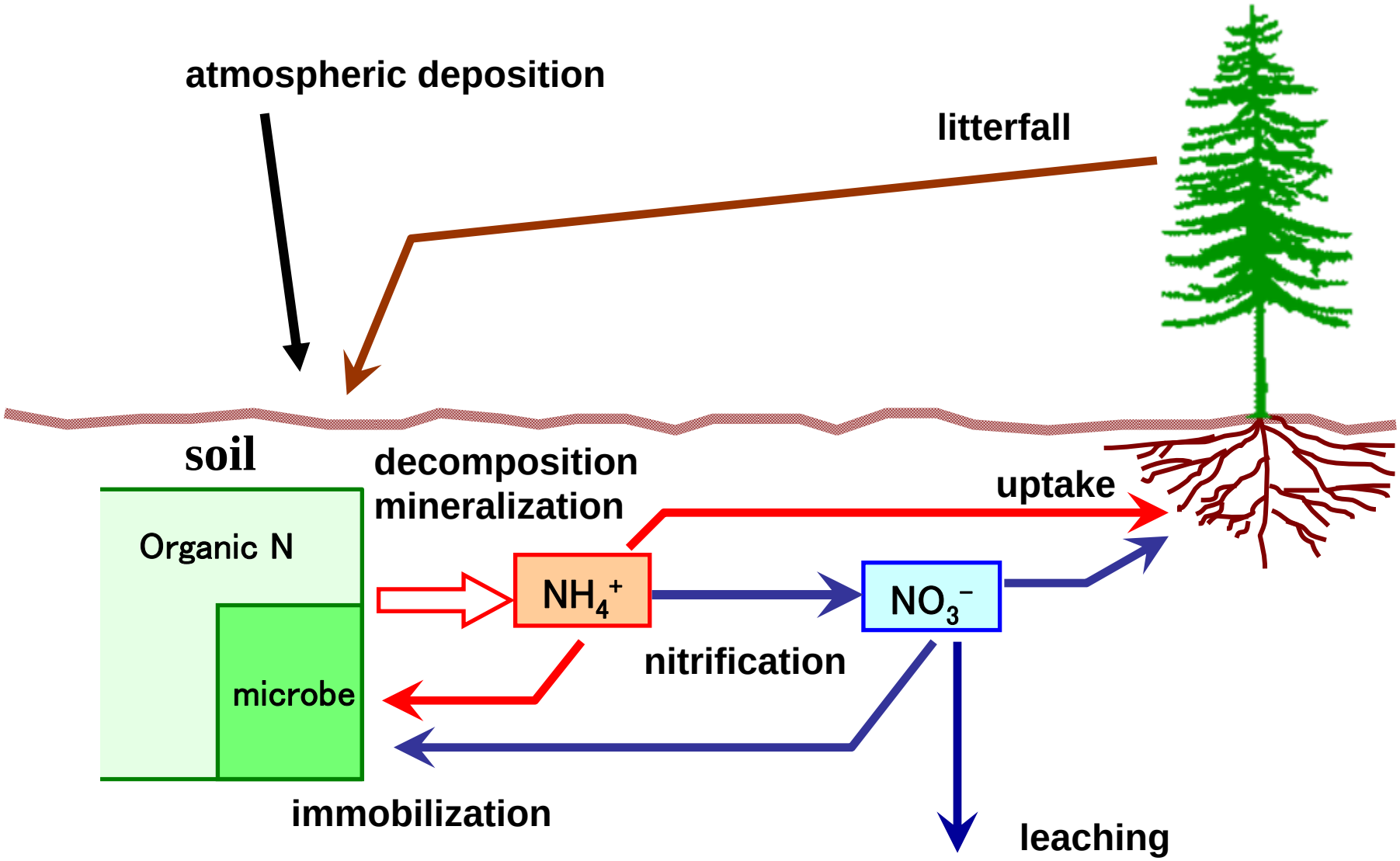
Long-term decreases of snowpack in northern Hokkaido



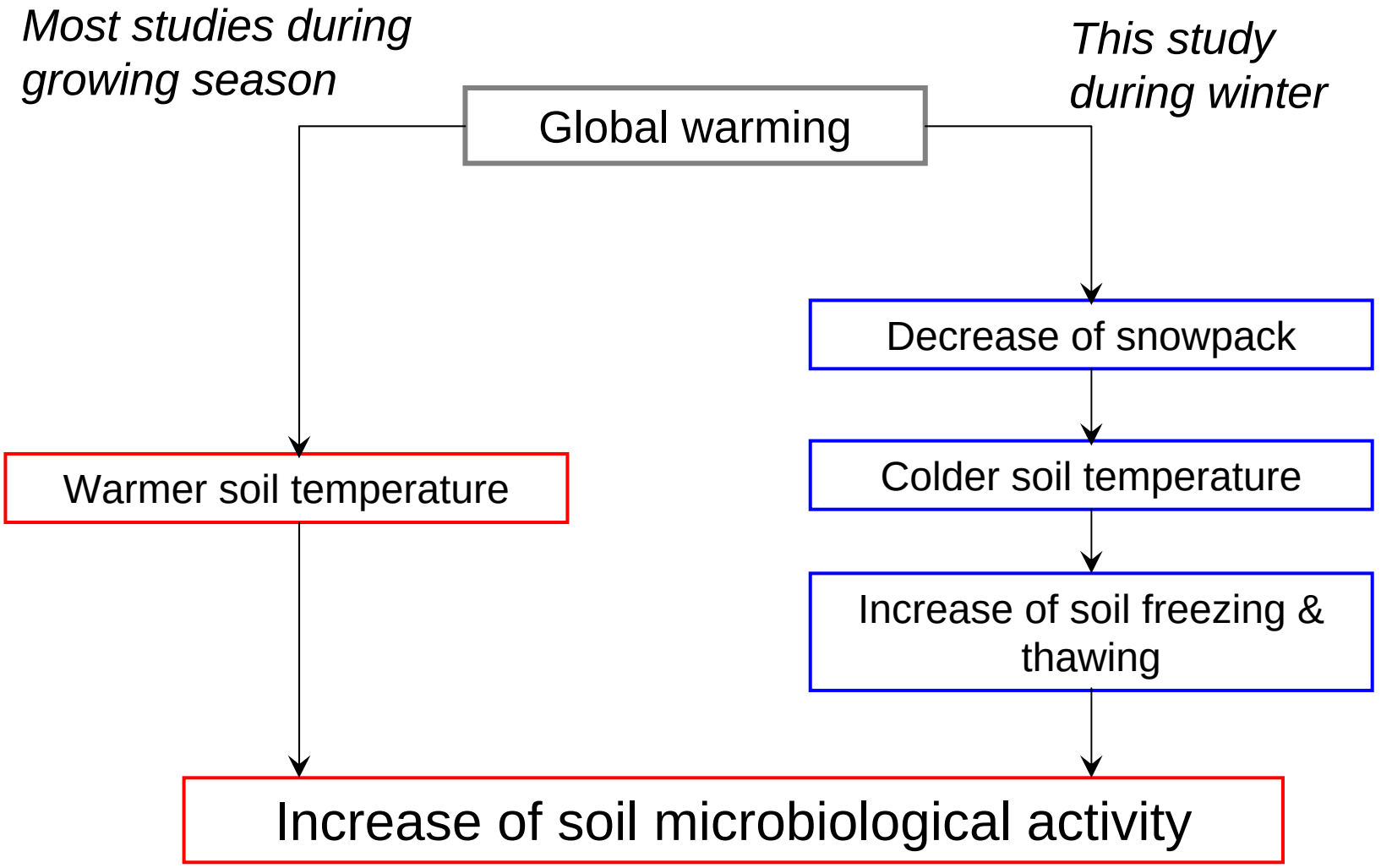
Long-term changes in maximum snowpack depth in Hokkaido University's Uryu Experimental forest located in northern Japan

(Park & Shibata et al. Accepted)

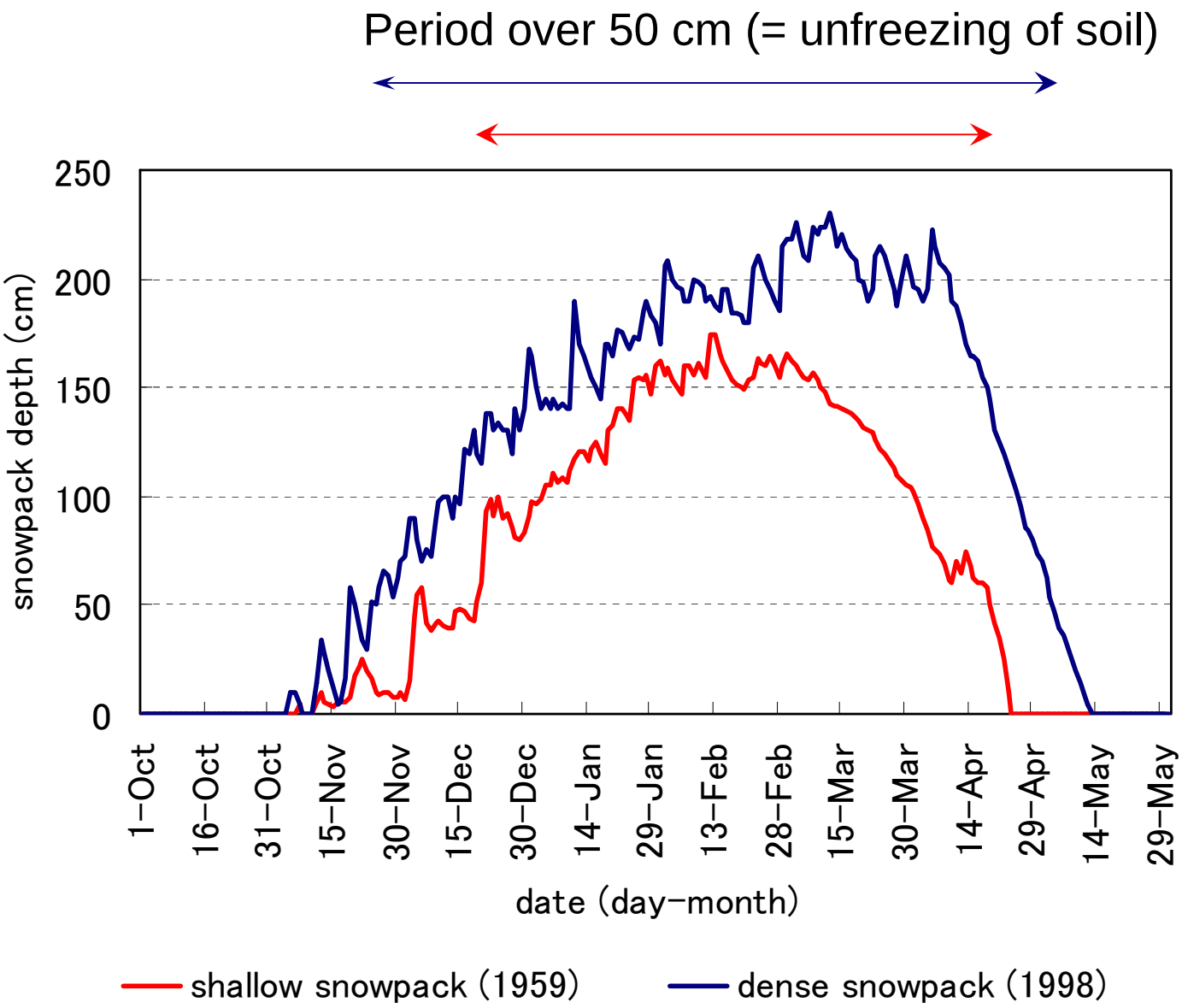
Open circles represent data of each year. The line represents five-year means, which indicates significant decreases with year (Dashed line, $p<0.001$).



Biogeochemical processes of nitrogen in forest ecosystem


Most studies during growing season
This study during winter
Global warming
Decrease of snowpack
Warmer soil temperature
Colder soil temperature
Increase of soil freezing & thawing
Increase of soil microbiological activity

Comparison of temporal pattern in snowpack at different winter climate



(Uryu Exp. Forest, Hokkaido Univ.)

Hypothesis of biogeochemical responses to winter climate change

Winter climate change

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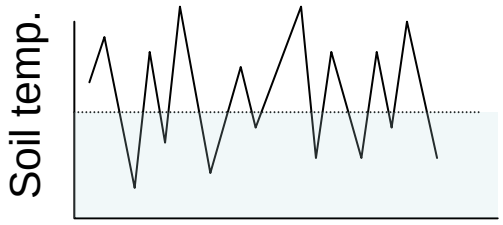
Decrease of snowpack

↓

Decrease of heat insulation by snowpack

↓

Increase of freezing & thawing cycle in soil



- Increase of physical damages to fine root and microbe

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- Increase in availability of organic matters as nutrient and energy source

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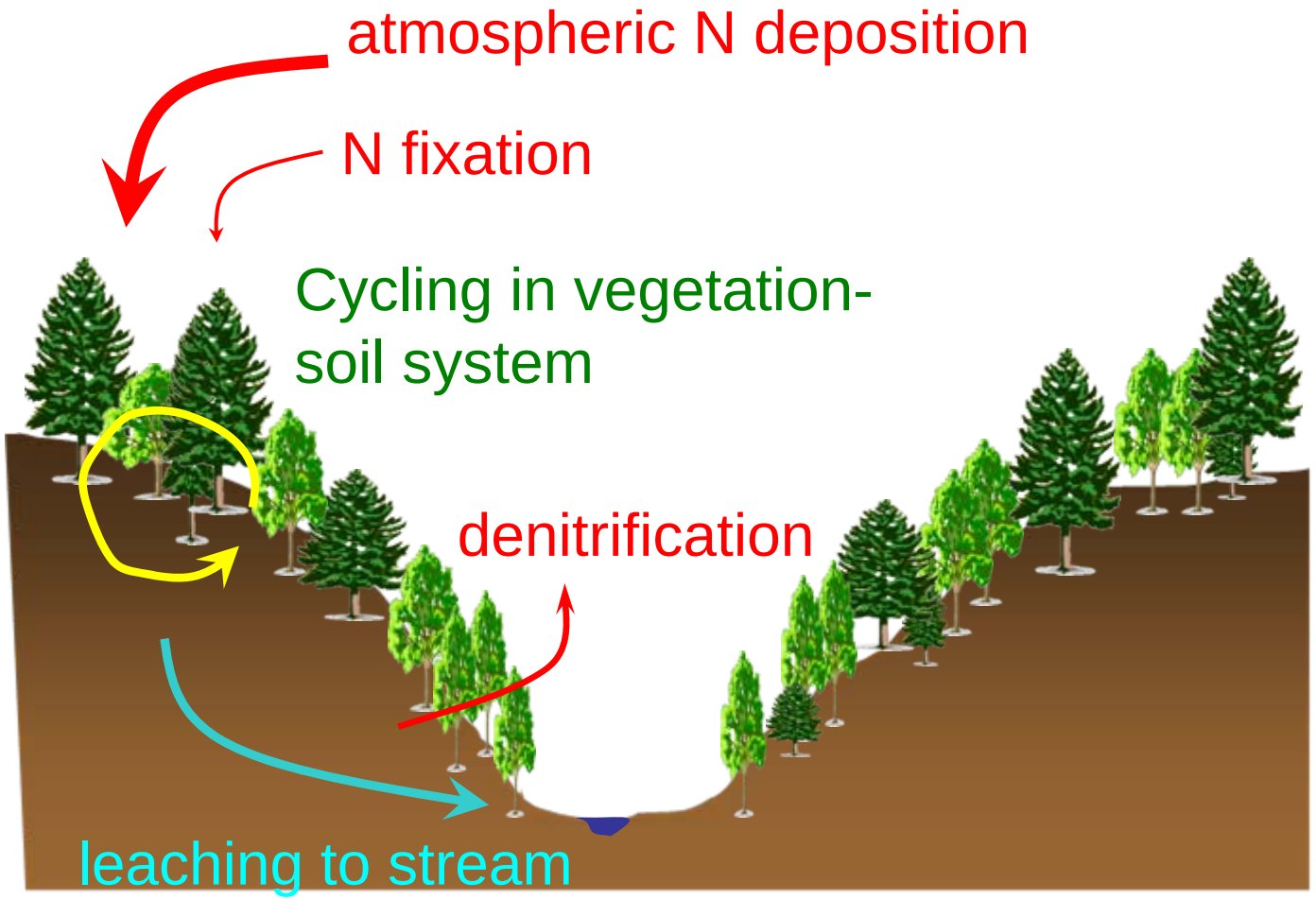
- Increase in microbial metabolisms of nitrogen (N) in soil

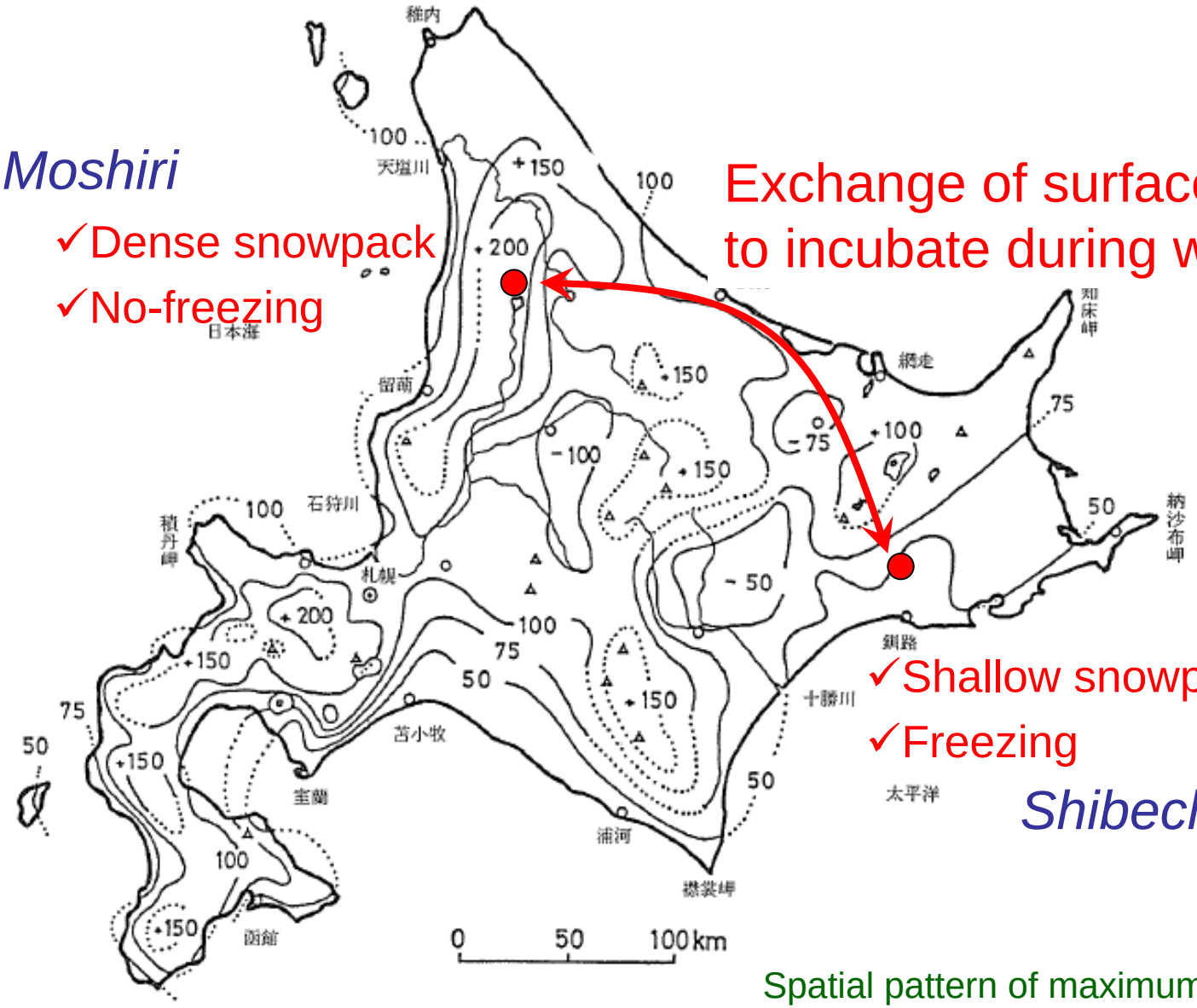
↓

- Change in N cycling and leaching in forest ecosystem



Nitrogen biogeochemistry in a forest watershed

Field incubation study on soil nitrogen dynamics of forest ecosystem in different winter climate (Christopher & Shibata et al. 2008)



Moshiri

✓Dense snowpack

✓No-freezing

Exchange of surface soil to incubate during winter

✓Shallow snowpack

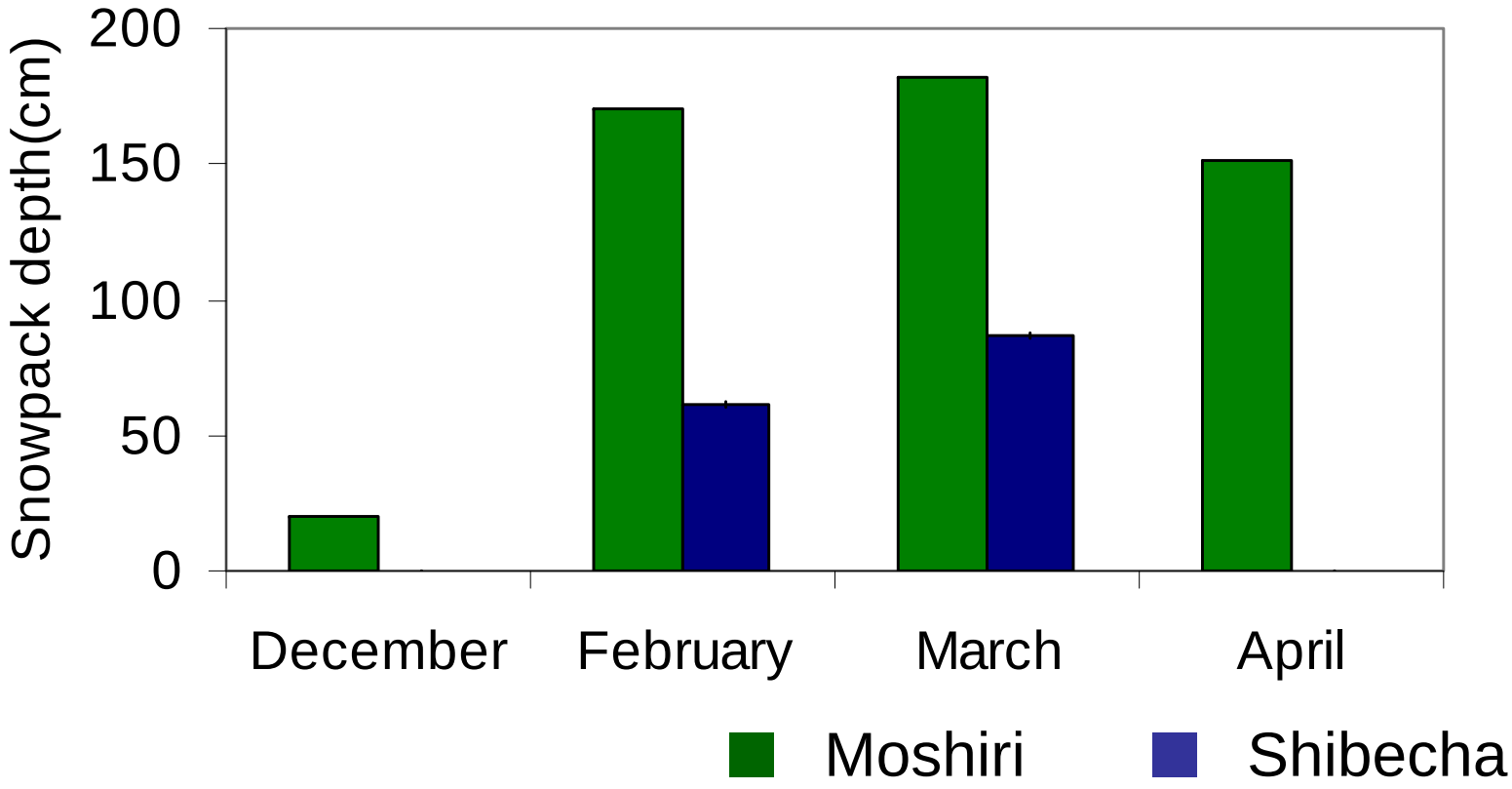
✓Freezing

Shibecha

図－２　平均最深積雪（cm）

Spatial pattern of maximum snowpack depth in Hokkaido island, northern Japan.

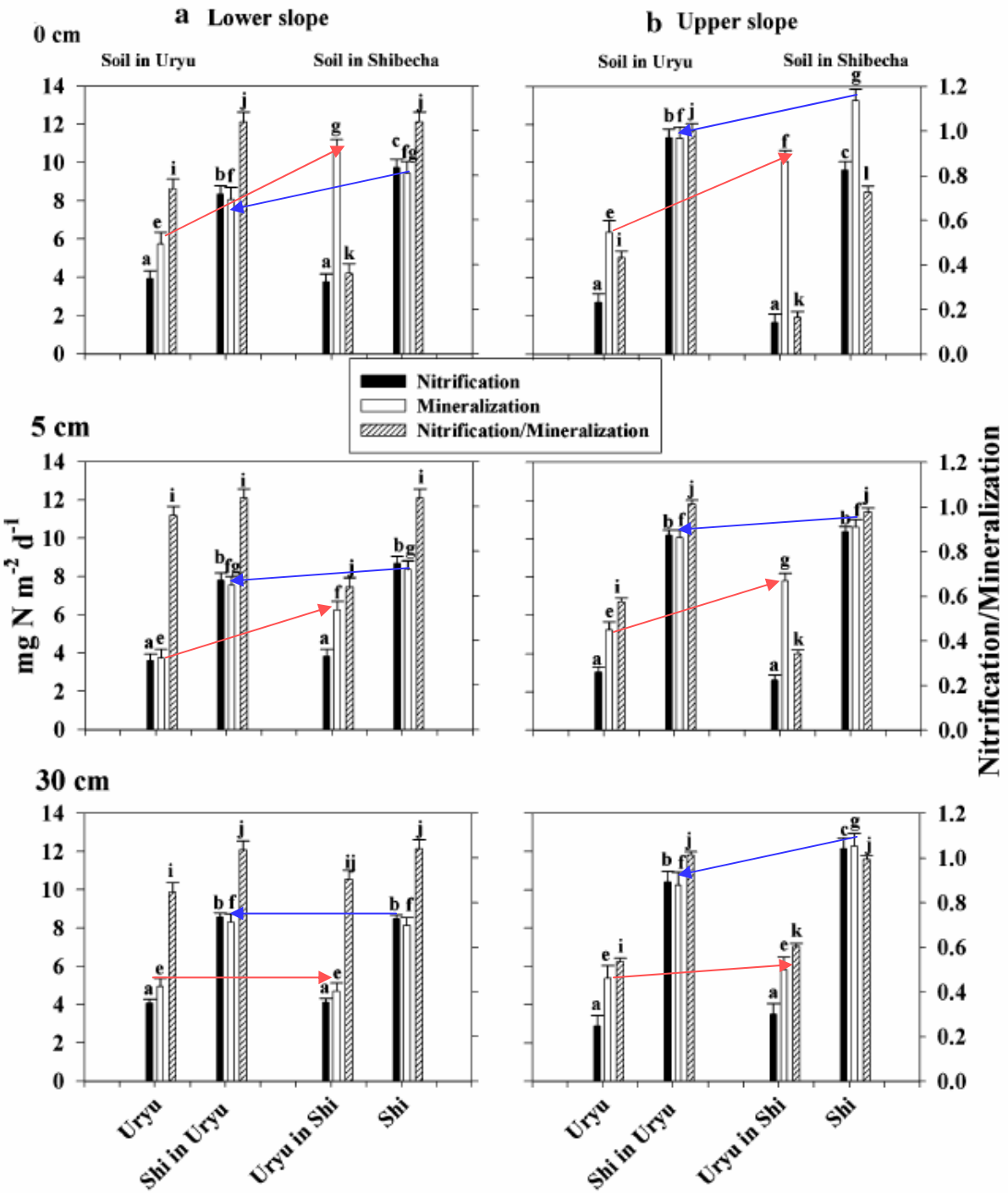
Comparison of winter climate in the studied sites



Soil freezing days (<0 ºC)

Moshiri; 5 days

Shibecha; 108 days



Uryu; unfreezing soil

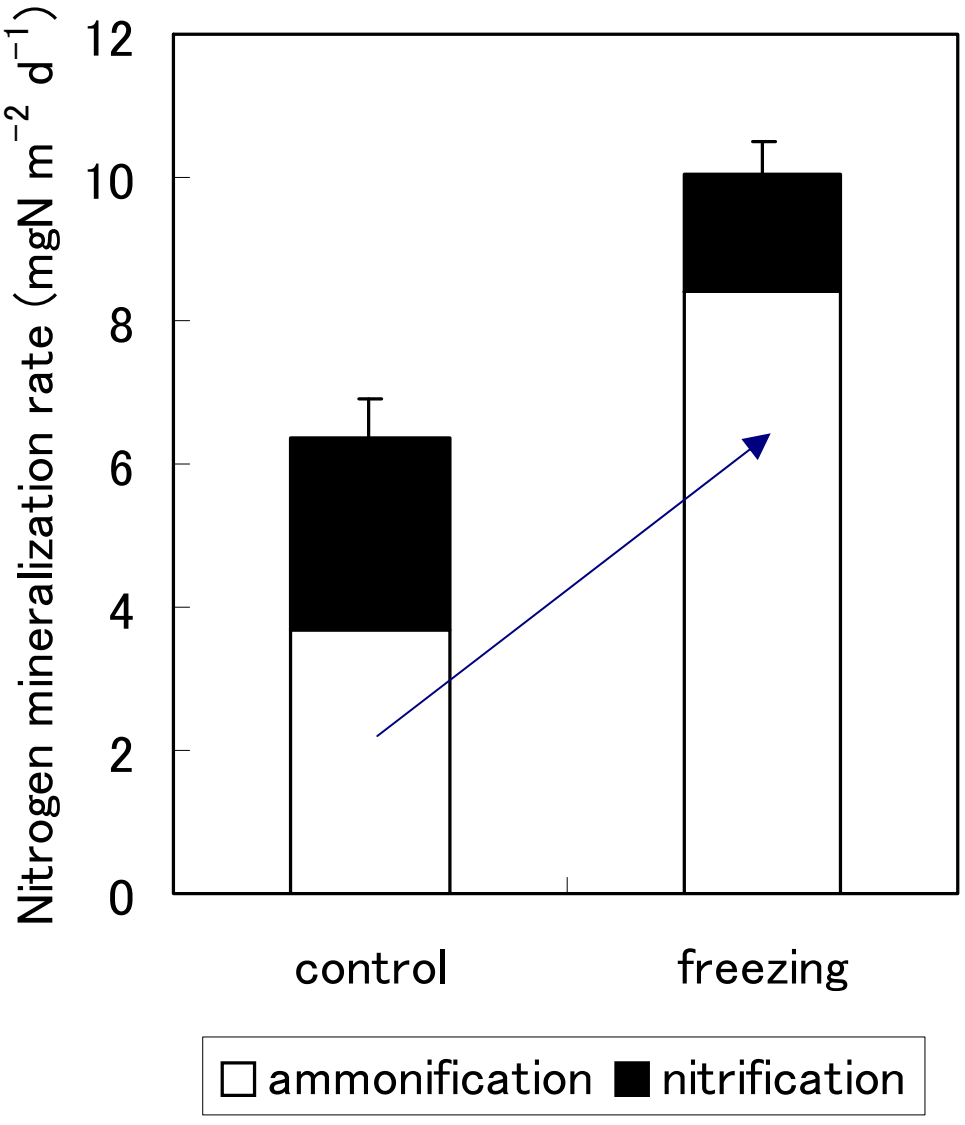
Shi; freezing soil

→ To freezing

← To unfreezing

Change of net nitrogen mineralization in two sites with soil exchange in winter

(Christopher & Shibata et al. 2008)



Increase of net ammonification in surface soil by freezing (Christopher & Shibata et al. 2008).

Conclusive remarks

✓Winter climate change would provide the unique response of forest biogeochemistry through the changes in nitrogen cycling due to the alteration of heat regimes associated with the decrease of snowpack.

✓These changes of nitrogen biogeochemistry due to the winter climate change would link with the other important ecosystem processes and services such as climate regulation, water purification and so on.

Acknowledgements

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