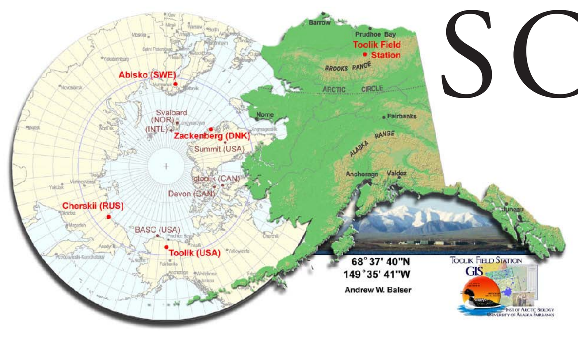

Our study site is near Imnavait Creek, east of Toolik Field Station, on the north slope of the Brooks Range in Alaska.

SOIL NITROGEN DYNAMICS DURING SNOW MELT IN MOIST ACIDIC TUSSOCK TUNDRA SOILS

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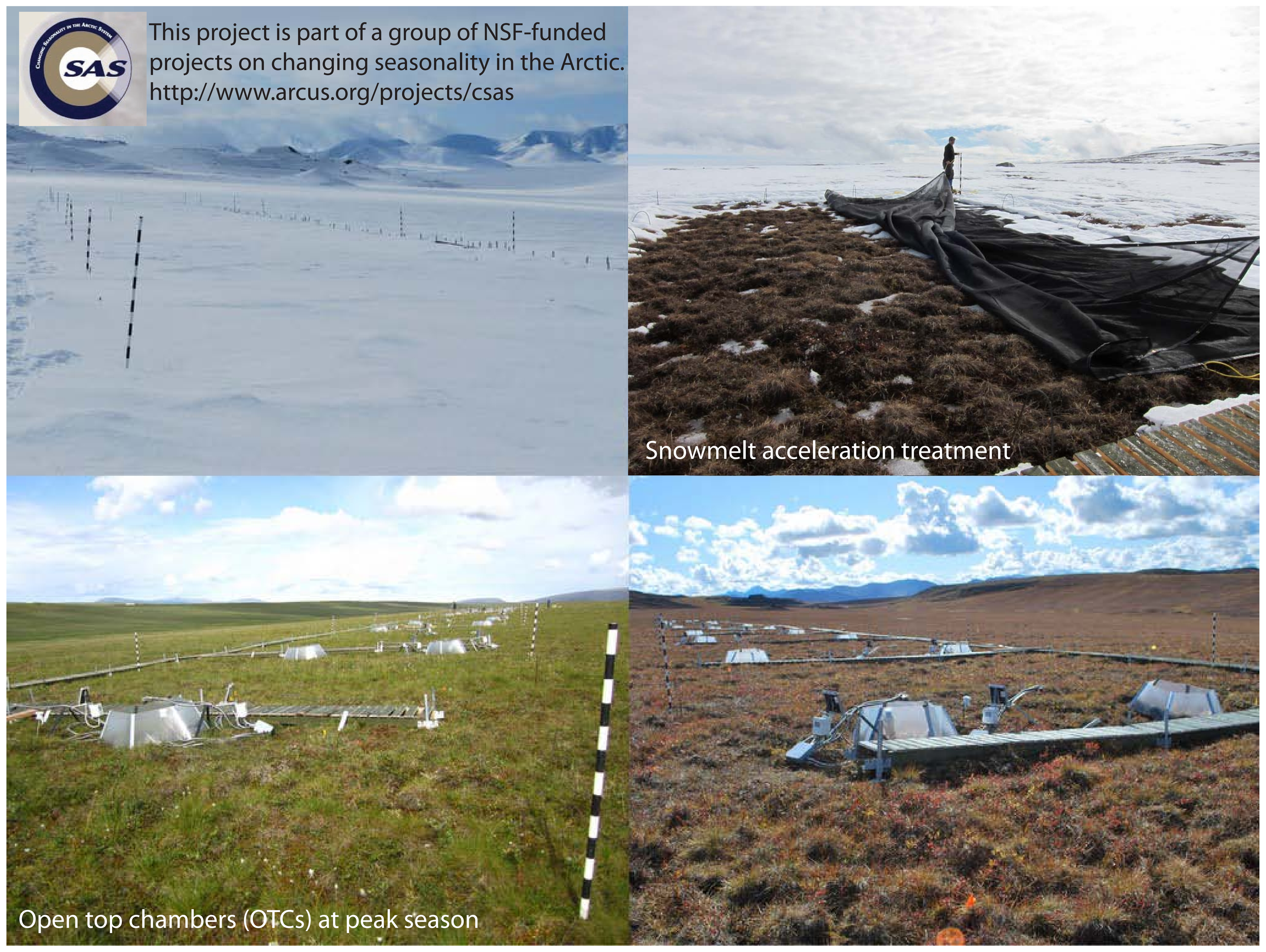
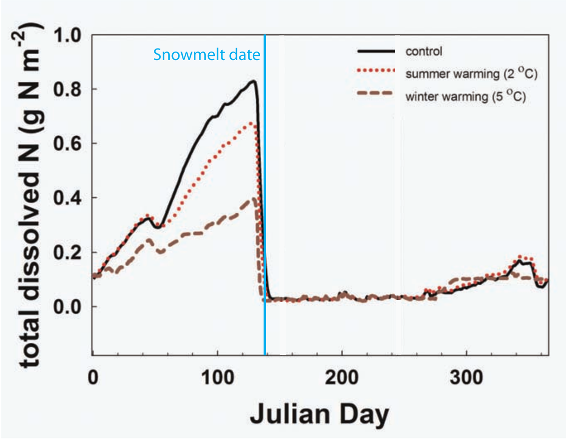


Warmer temperatures and earlier onset of spring in Arctic ecosystems have the potential to alter the cycling of soil nitrogen (N), a key limiting nutrient. To simulate warming and an earlier spring, we experimentally accelerated snowmelt by 4-15 days in a moist acidic tundra ecosystem using 8×12 m sheets of shadecloth fabric and warmed the tundra by 1-3°C using ITEX-style open top chambers (OTCs). We examined early season soil N dynamics in response to these treatments.

STUDY QUESTION

How will early season soil nutrient dynamics respond to earlier snowmelt and warming?



Plant-microbe-enzyme model (Seeta Sistla, *in prep*)

PLANT-SOIL-MICROBE MODEL

To complement our field study, we developed a simulation model for Arctic soils that includes plants, microbes, and soil enzymes. Model runs indicate that labile N builds up over the winter and is then taken up by plants and microbes at the time of soil thaw. The model also suggests that global change-type manipulations can have substantial effects on nutrient dynamics.

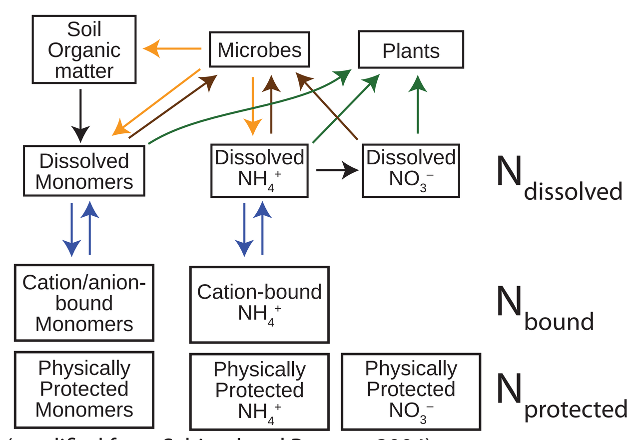
Soil core collection

Soil core processing

Moist acidic tundra

The vegetation at our study site is moist acidic tundra, dominated by *Eriophorum vaginatum*, a tussock forming sedge. The organic layer underneath *Eriophorum* plants consists primarily of decaying *Eriophorum* roots. All of our samples come from this organic tussock soil.

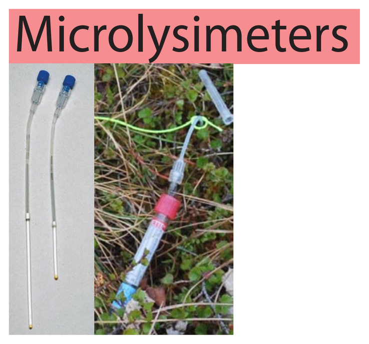
NUTRIENT AND ENZYME ANALYSIS



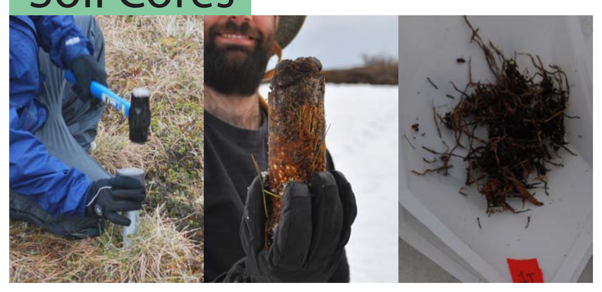
(modified from Schimel and Bennett 2004)

We used two methods for measuring N dynamics: microlysimeters and soil core extractions. Microlysimeters were used to collect soil pore water, giving an estimate of the most readily available N. Soil core extractions in K_2SO_4 gave larger values (~5x larger) that included some cation-bound N as well as some additional N likely released during the homogenization and extraction process. This additional N may be part of a physically protected pool. Finally, we measured microbial biomass N and oxidative and hydrolytic enzyme activity, including leucine amino peptidase activity on the same soil cores.

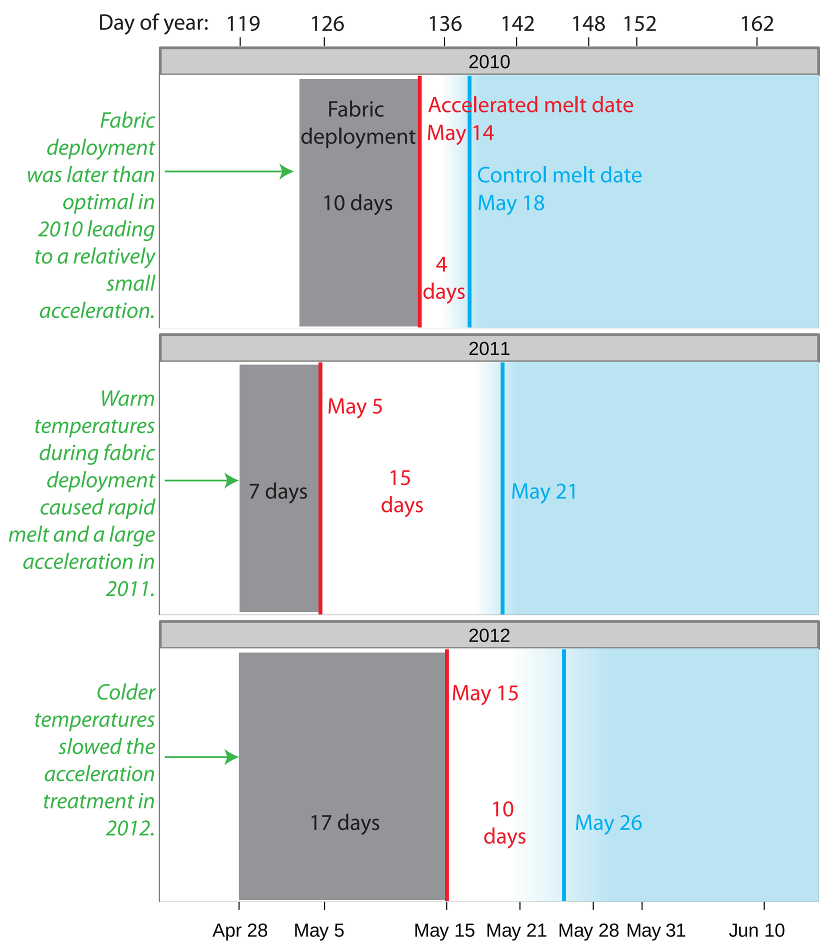
Microlysimeters



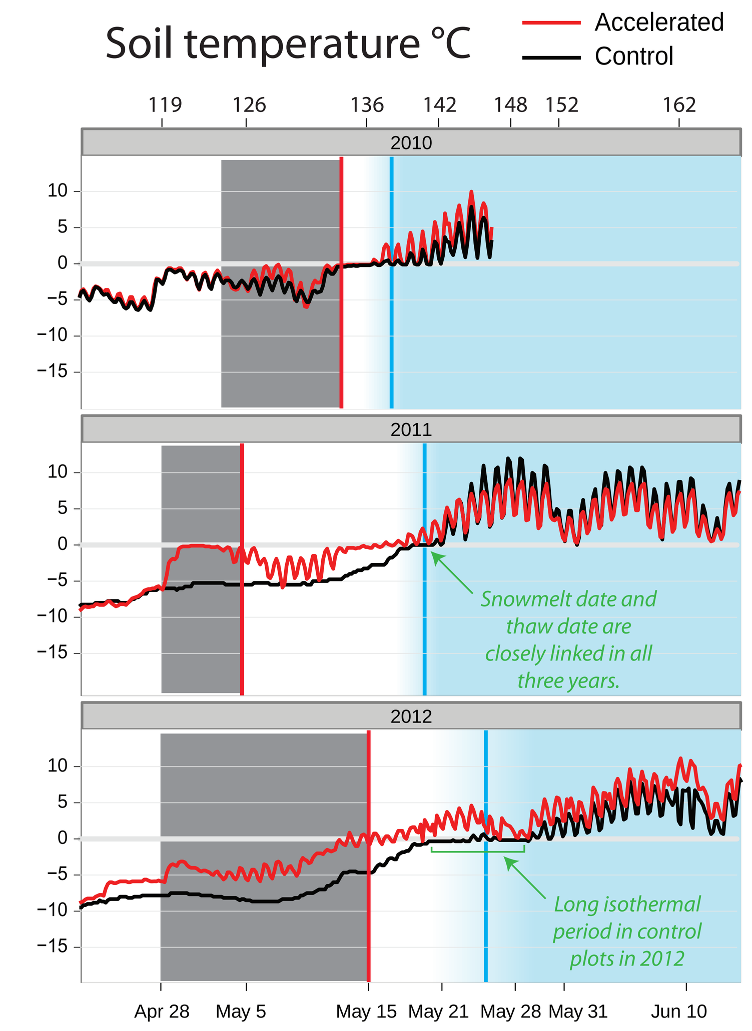
Soil Cores



Timing of melt fabric deployment and melt date 2010-2012

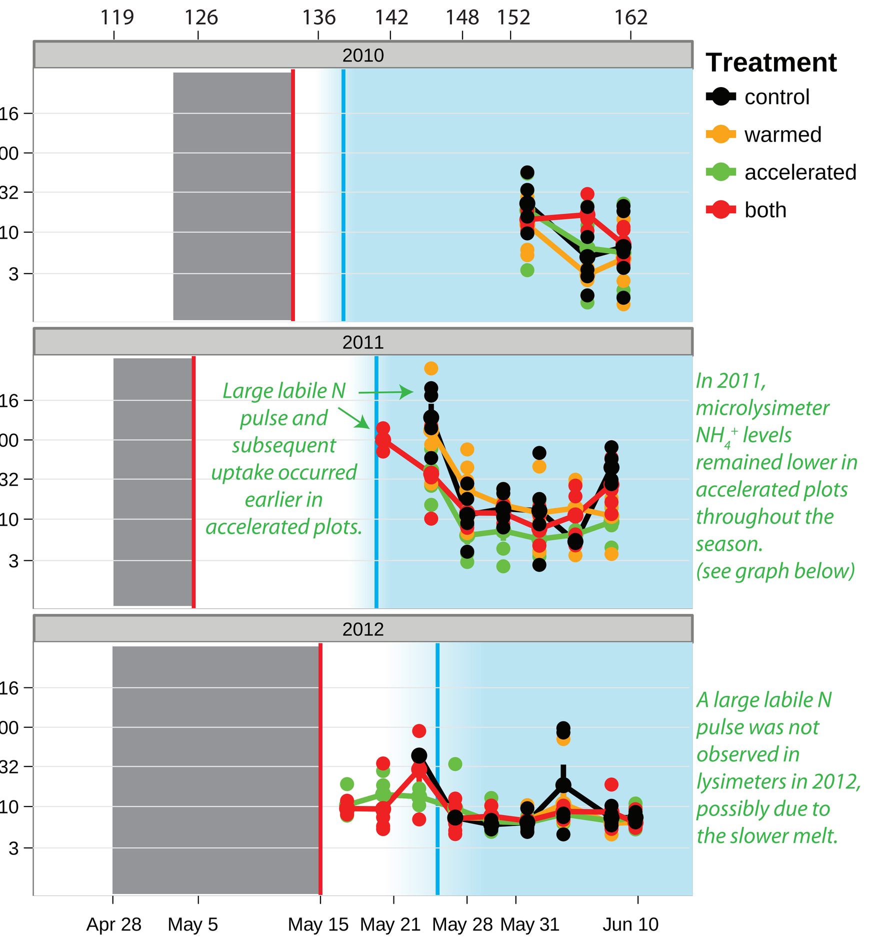


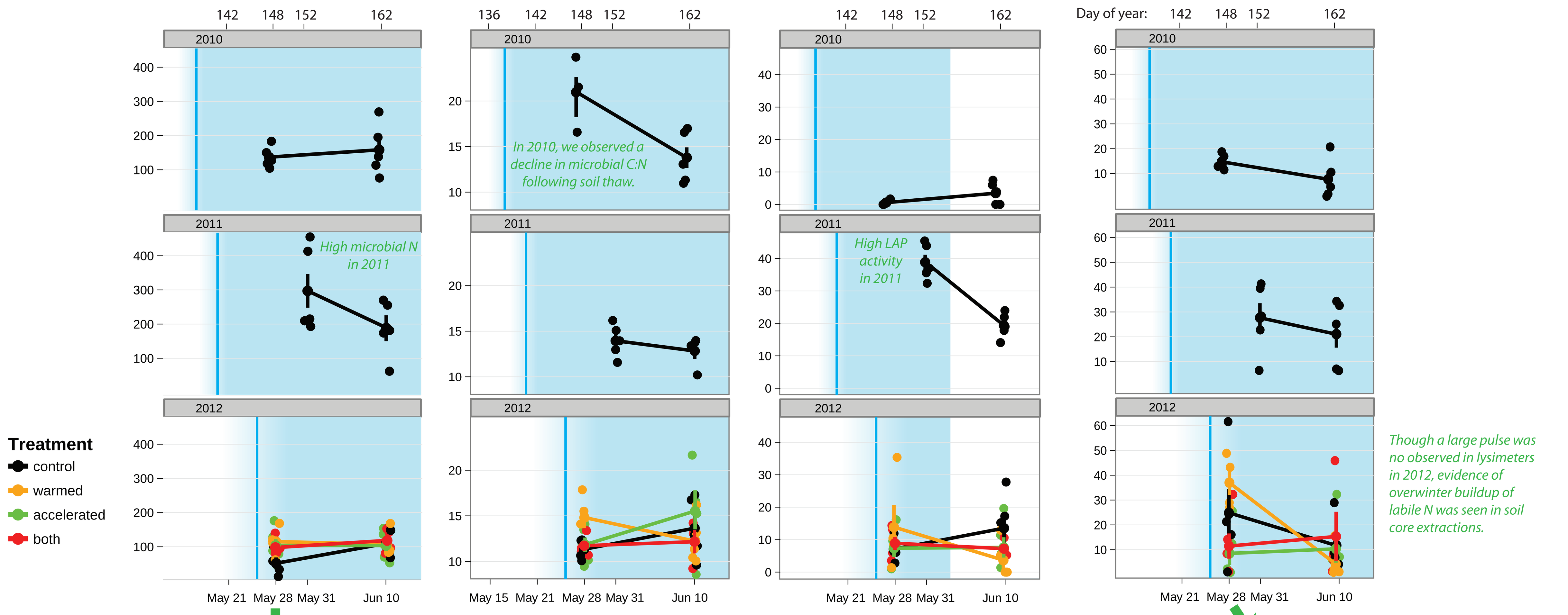
Soil temperature °C



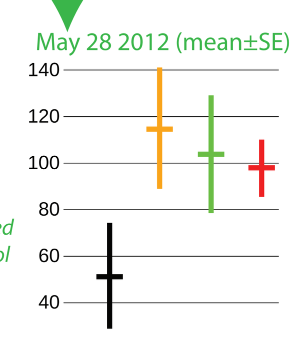
Microlysimeters — Labile N

(NH_4^+ + NO_3^- + free primary amines) µmol L^{-1}

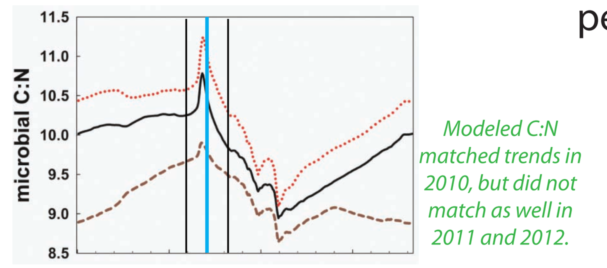




Soil Cores
Microbial N
µg N g^{-1} soil



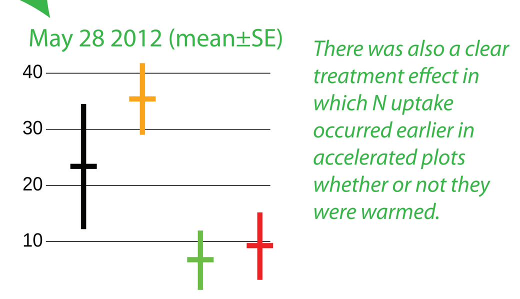
Soil Cores
Microbial C:N

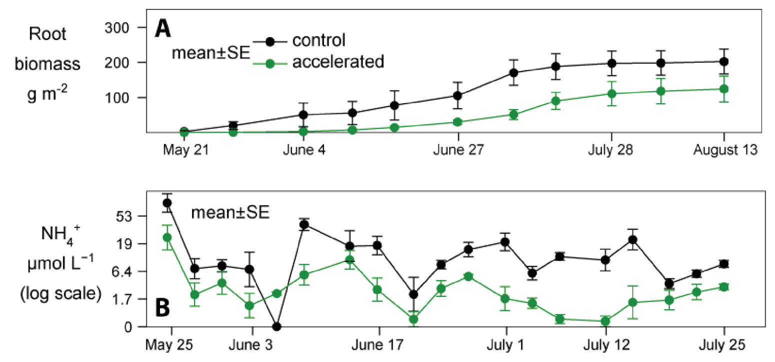


Modeled microbial C:N

Soil Cores
Leucine amino peptidase activity
nmol g^{-1} soil hr^{-1}

Soil Cores
Labile N
(NH_4^+ + NO_3^- + free primary amines)
µg N g^{-1} soil





Microlysimeters

In 2011, microlysimeter NH_4^+ levels remained lower in accelerated plots throughout the season. Root biomass was also delayed and lower in accelerated plots.

RESULTS SUMMARY

– We observed a pulse of labile nitrogen at the time of soil thaw that was rapidly assimilated by plants and soil microbes.

– The timing of this labile N pulse and assimilation was altered by our acceleration treatment, occurring earlier in accelerated plots whether or not they were warmed.

– The size of the labile N pulse and the amount of microbial biomass N also varied interannually, possibly due to differences in the speed of soil thaw or pre-snowmelt enzyme activity.

CONCLUSIONS

– Our data are consistent with model predictions that labile N builds up over the winter, is released at snowmelt, and is rapidly taken up by plants and microbes.

– The timing of this N transfer process appears tightly linked to climatic conditions and thus may be shifted in time with future changes in climate seasonality.

– Because microbial N uptake is accelerated by rapid snowmelt while plant root growth is delayed, changes in seasonality may lead to altered plant/microbe N balance throughout the growing season. ■

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