

Agricultural Land Management

Danica Lombardozzi

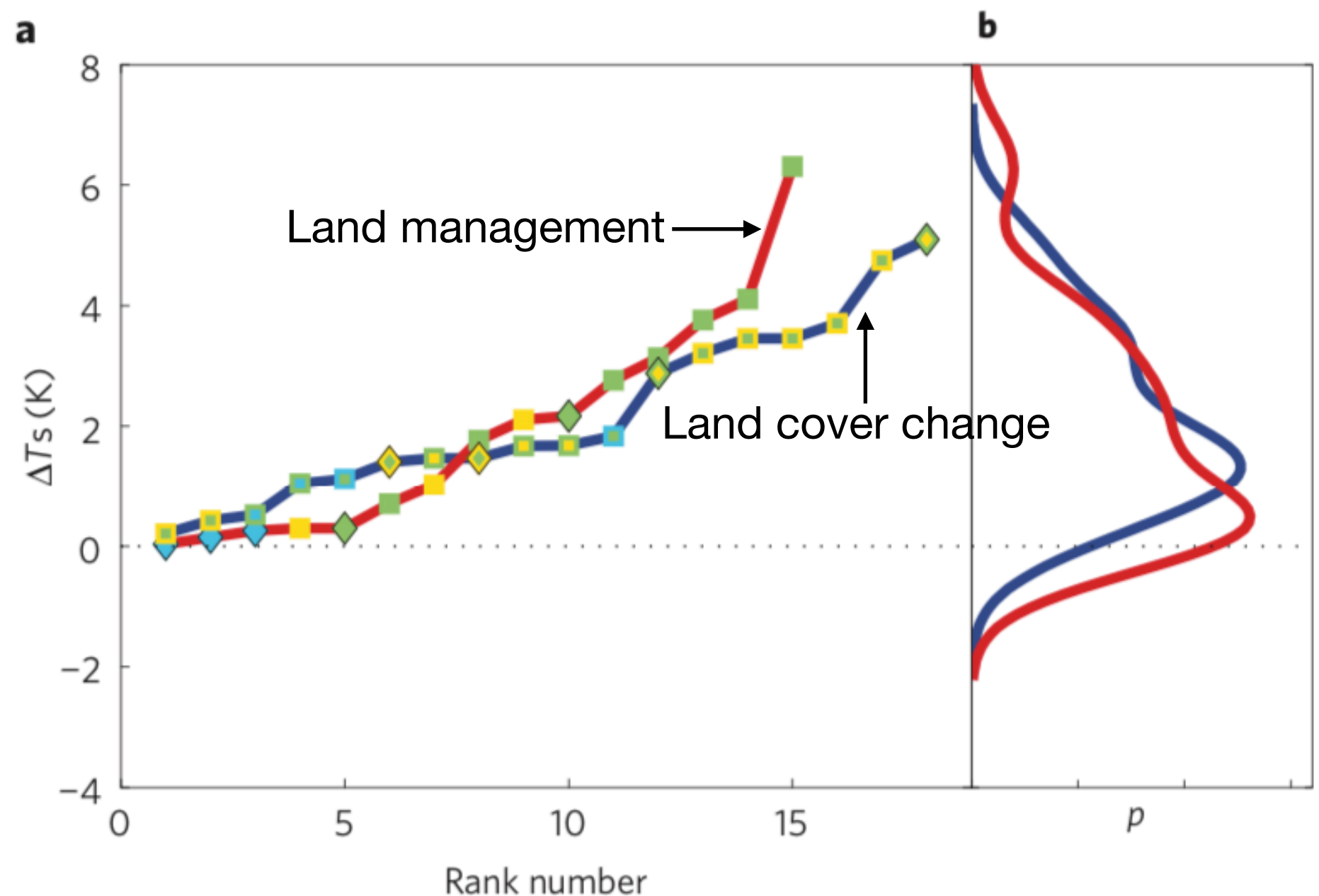
National Center for Atmospheric Research

Yaqiong Lu, Peter Lawrence, Dave Lawrence, Sean Swenson, Keith Oleson, Michael Graham, Lisa Ainsworth



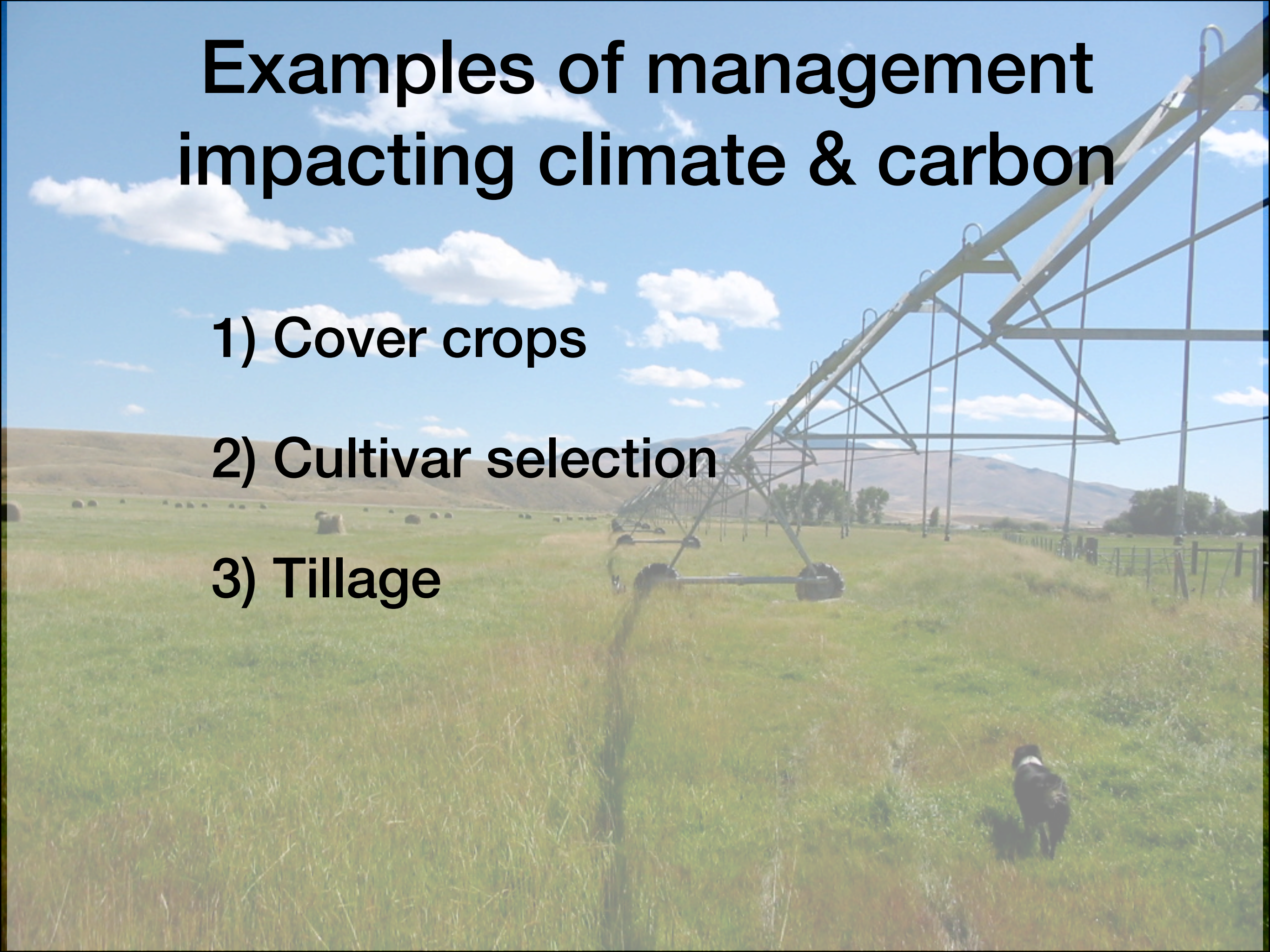
Land management and land-cover change have impacts of similar magnitude on surface temperature

Sebastiaan Luyssaert *et al.*[†]



Examples of management impacting climate & carbon

- 1) Cover crops
- 2) Cultivar selection
- 3) Tillage



Cover Crops

Cover Crops

Bare Ground

www.npr.org; Courtesy of Paul Jasa/University of Nebraska-Lincoln

Cover crops provide localized benefits:

Weed & pathogen suppression

Reduced erosion, runoff, & N-leaching

Increased soil infiltration & aeration

Improved nutrient cycling, pH, soil biota

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How do cover crops impact climate?

Cover Crops

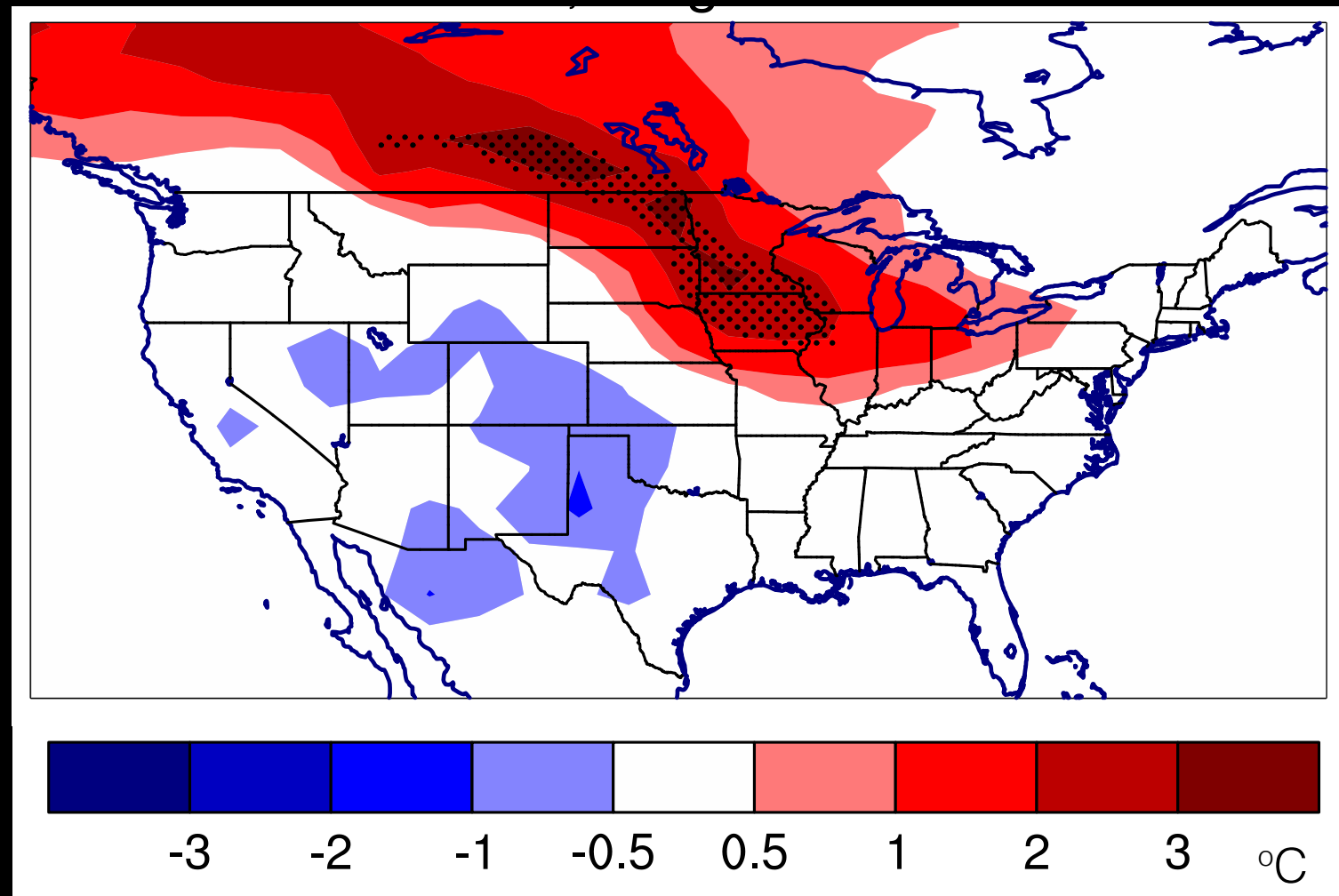
Bare Ground

A map of North America, including the United States and Canada, is shown with a green grass texture. The map is outlined in black, and the grass texture is applied to the landmasses. A semi-transparent dark grey box is overlaid on the map, containing the text.

Idealized Scenario: Plant cover crops in all crop regions throughout North America

Goal: Determine impact on winter temperatures compared to bare ground

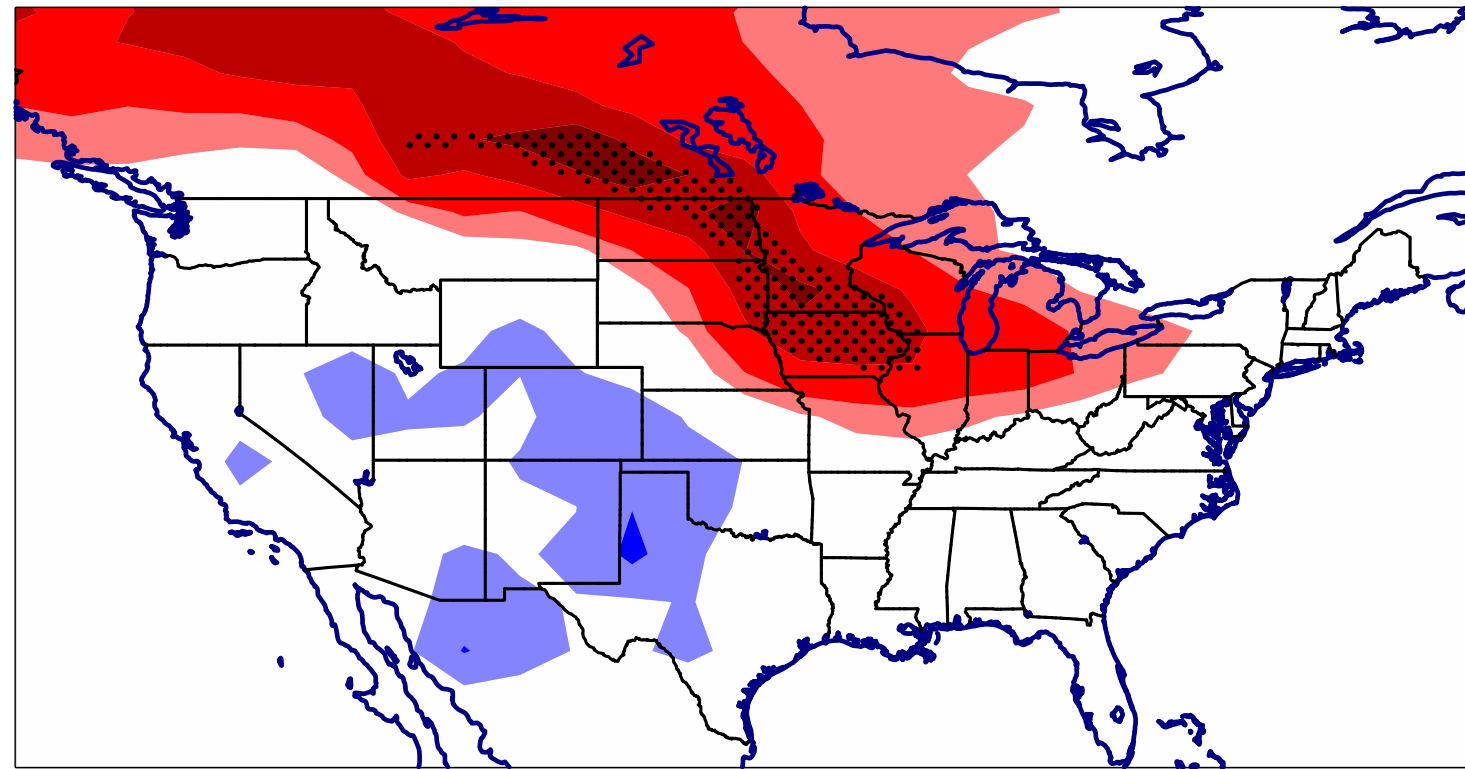
Change in Winter* Temperature (°C)



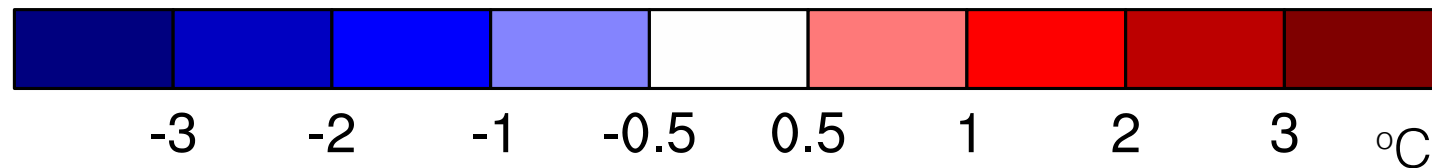
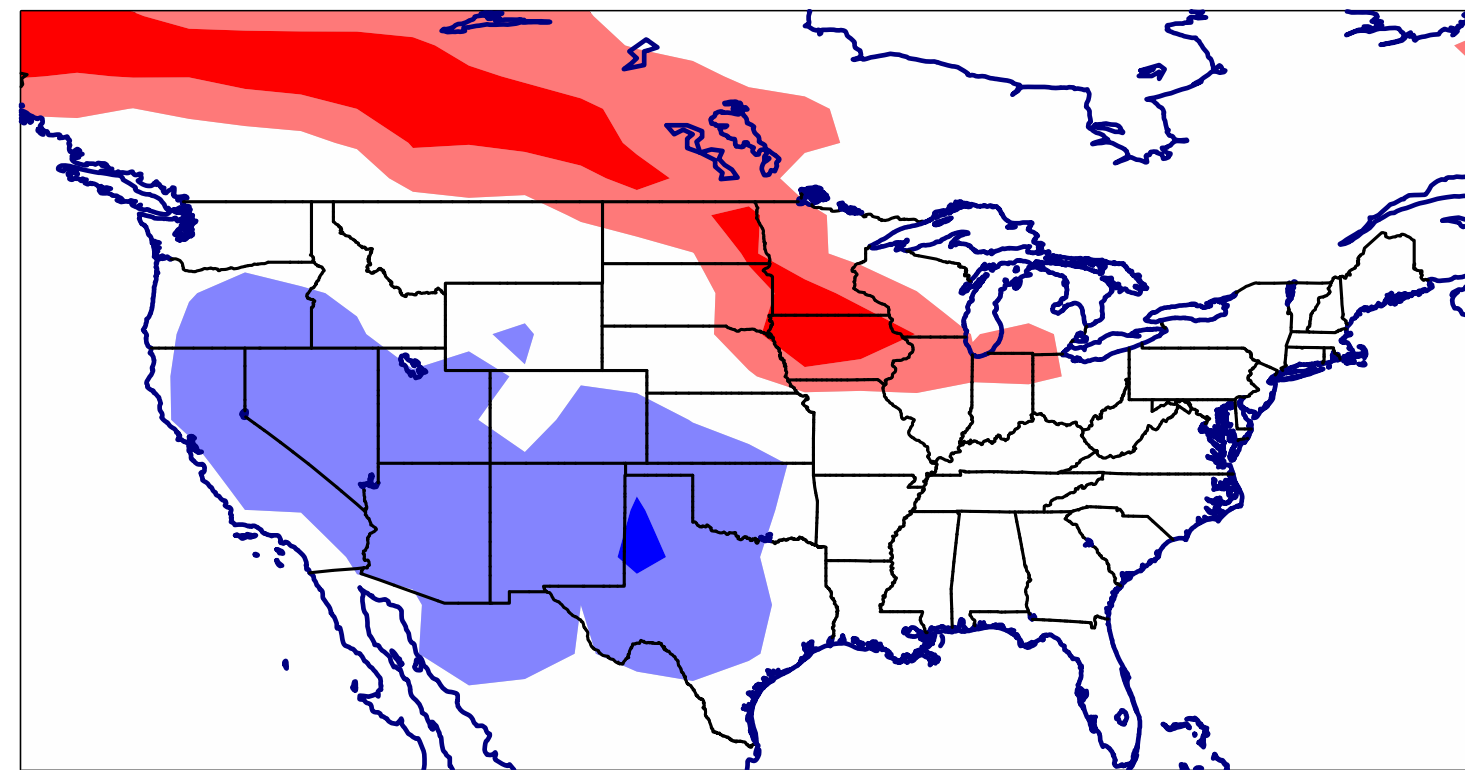
Cover crops may increase winter temperature in snowy regions

Shorter cover crops may minimize winter warming

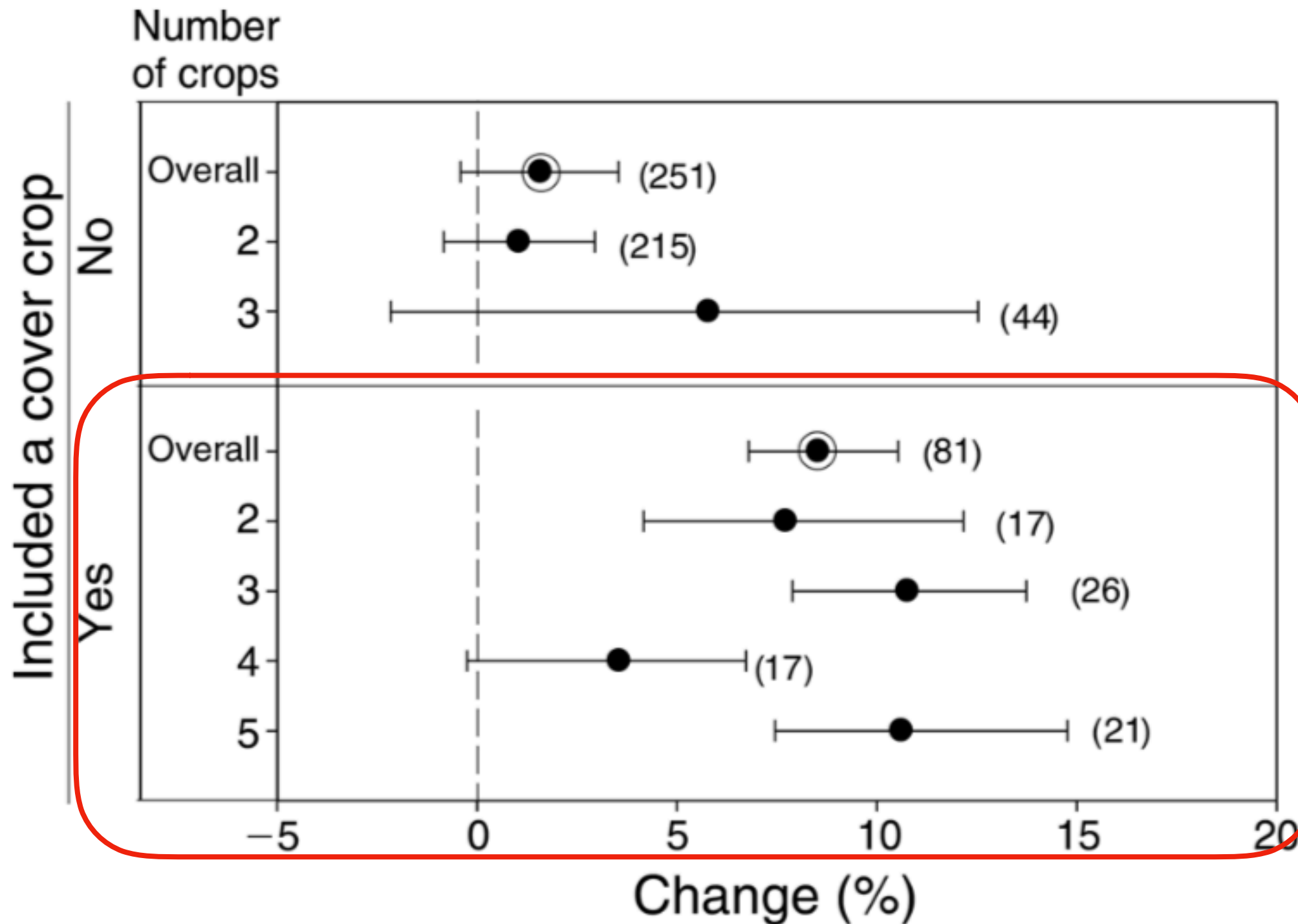
Height = 50 cm



Height = 10 cm



Cover crops increase soil C



Cultivar Selection

Corn

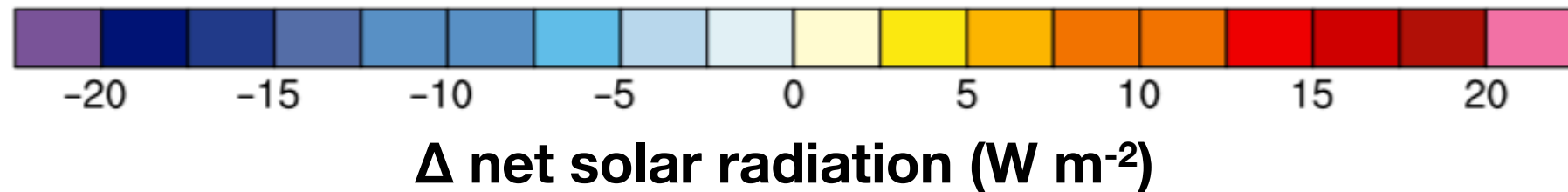
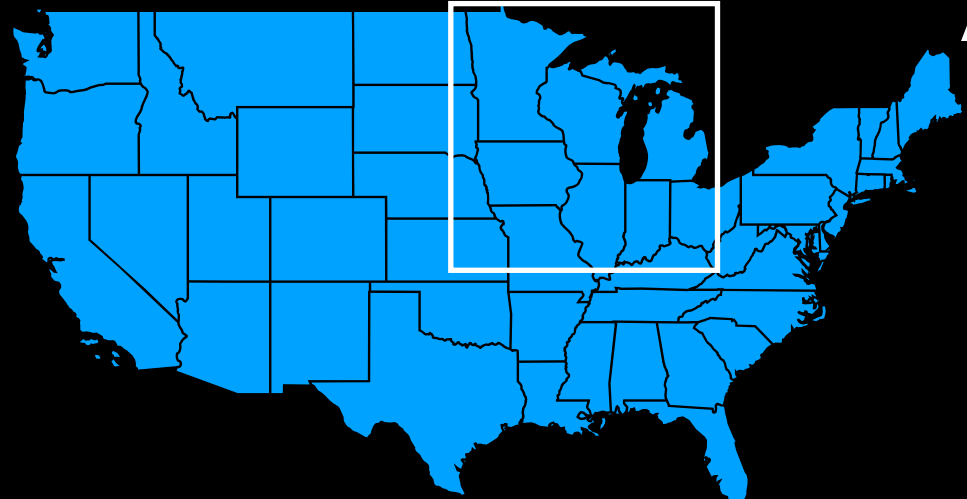


Perennial Bioenergy
(Miscanthus)



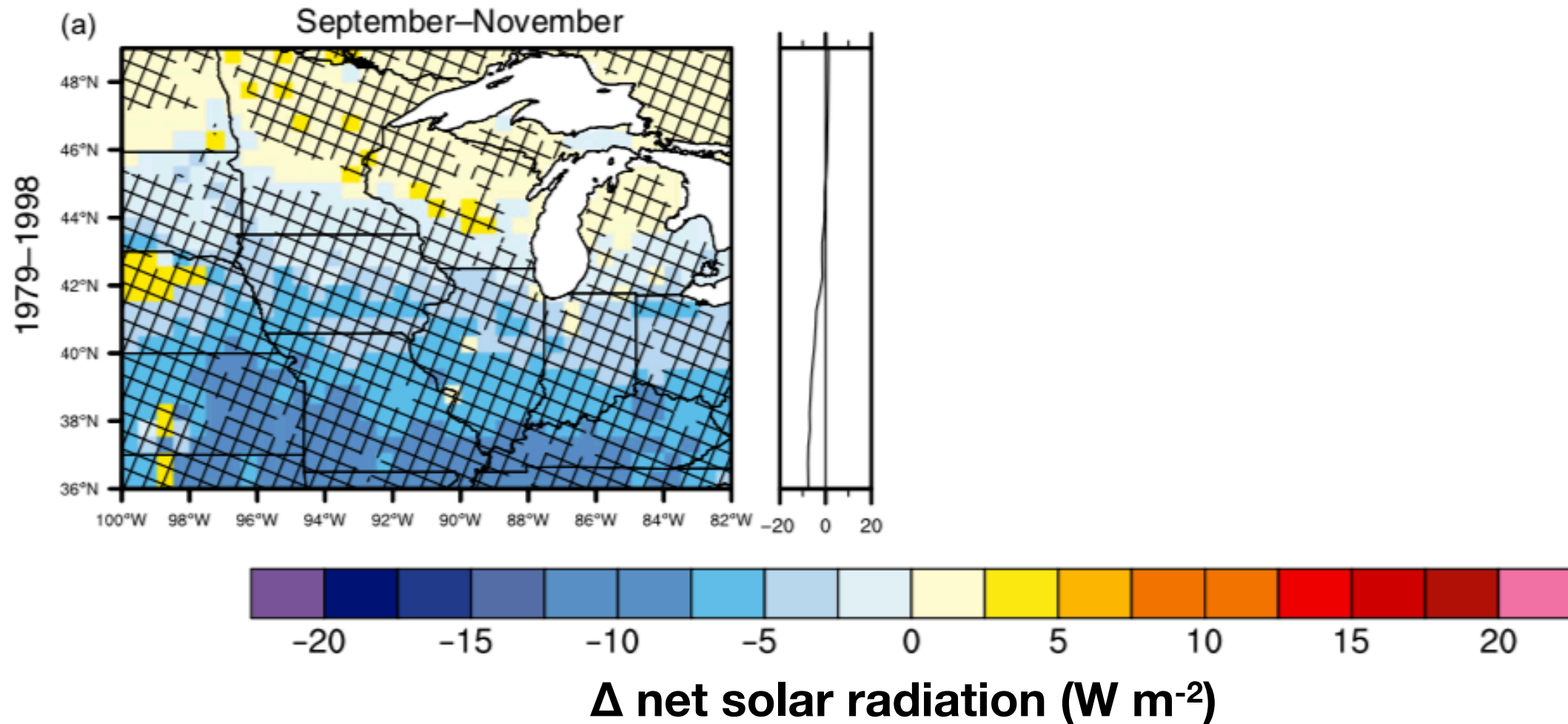
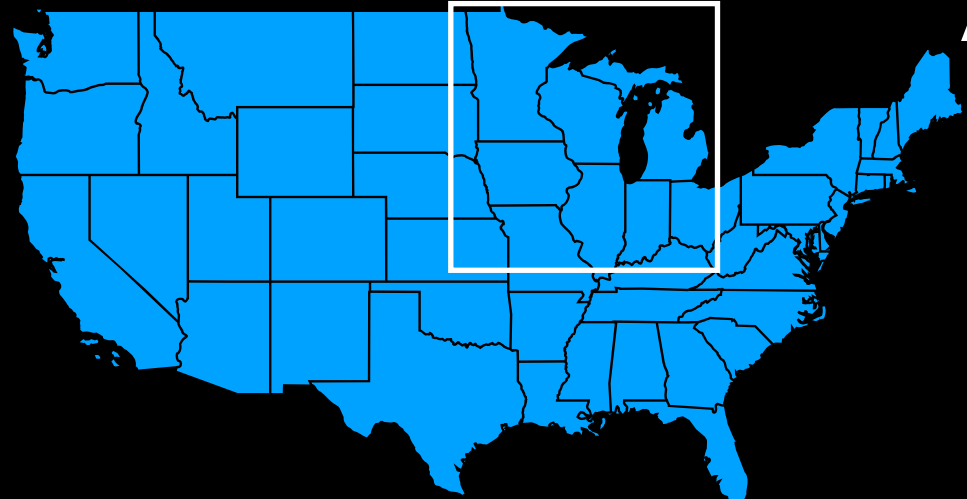
Change in solar radiation

Δ = Perennial - Corn



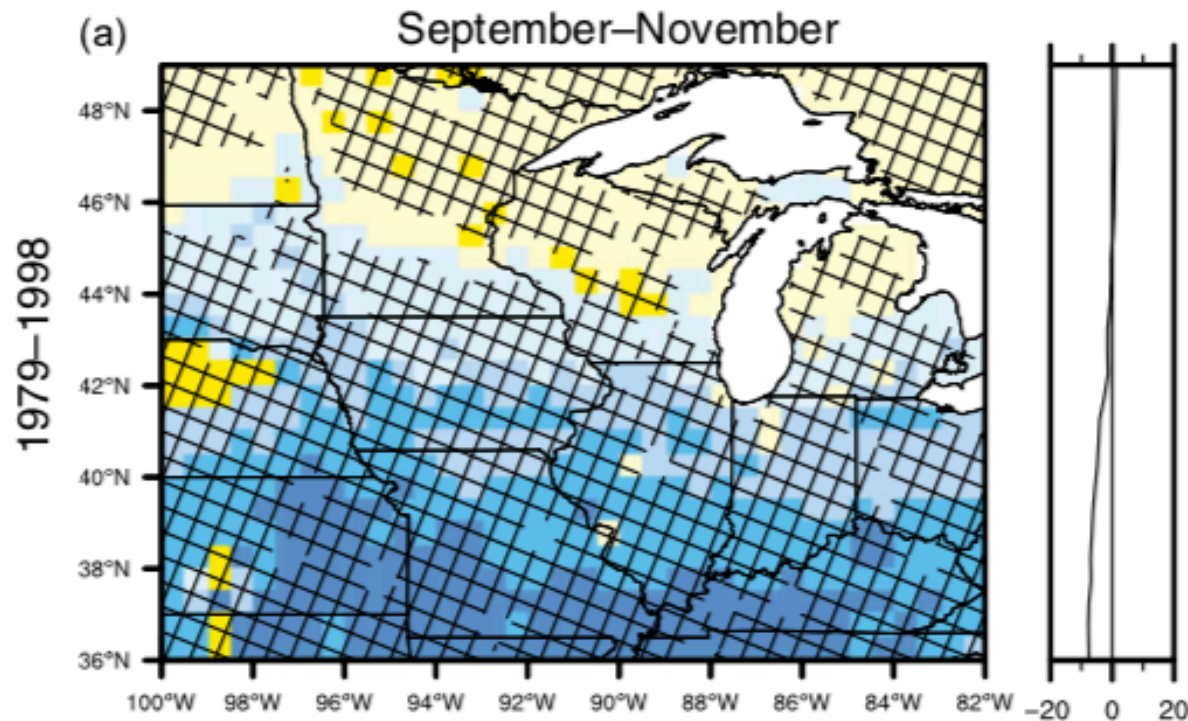
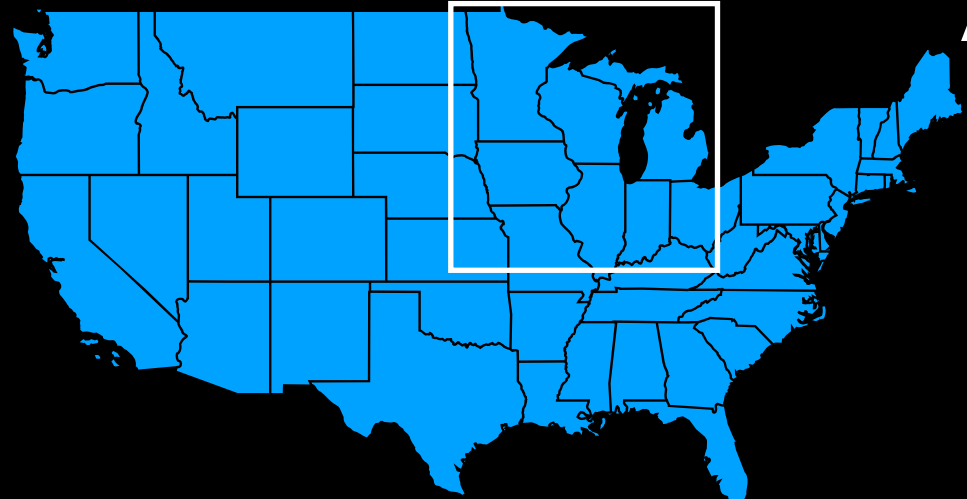
Change in solar radiation

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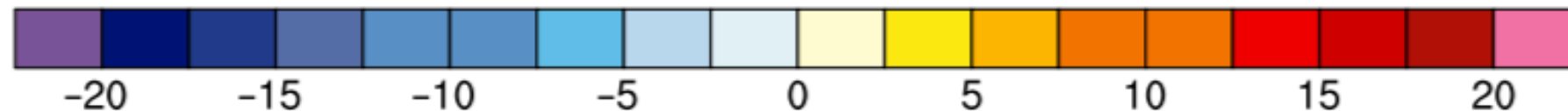


Change in solar radiation

$$\Delta = \text{Perennial} - \text{Corn}$$



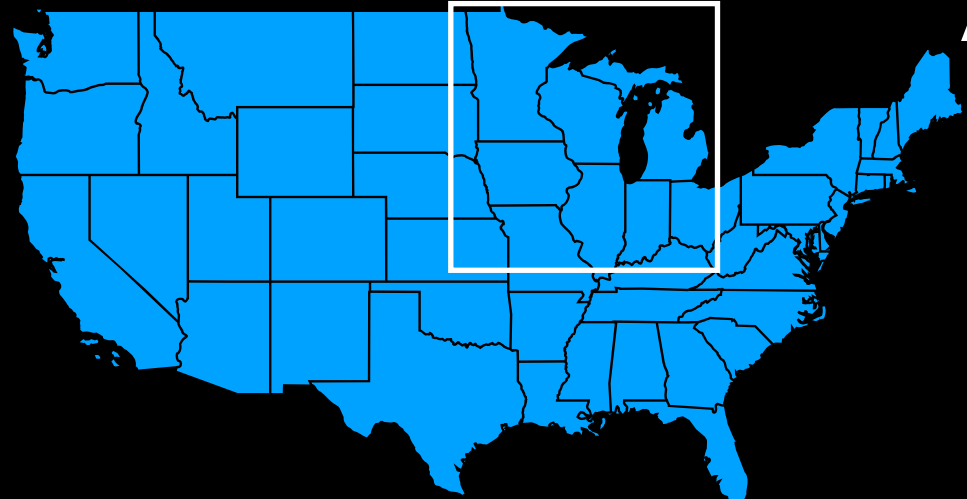
Perennial has higher albedo than corn



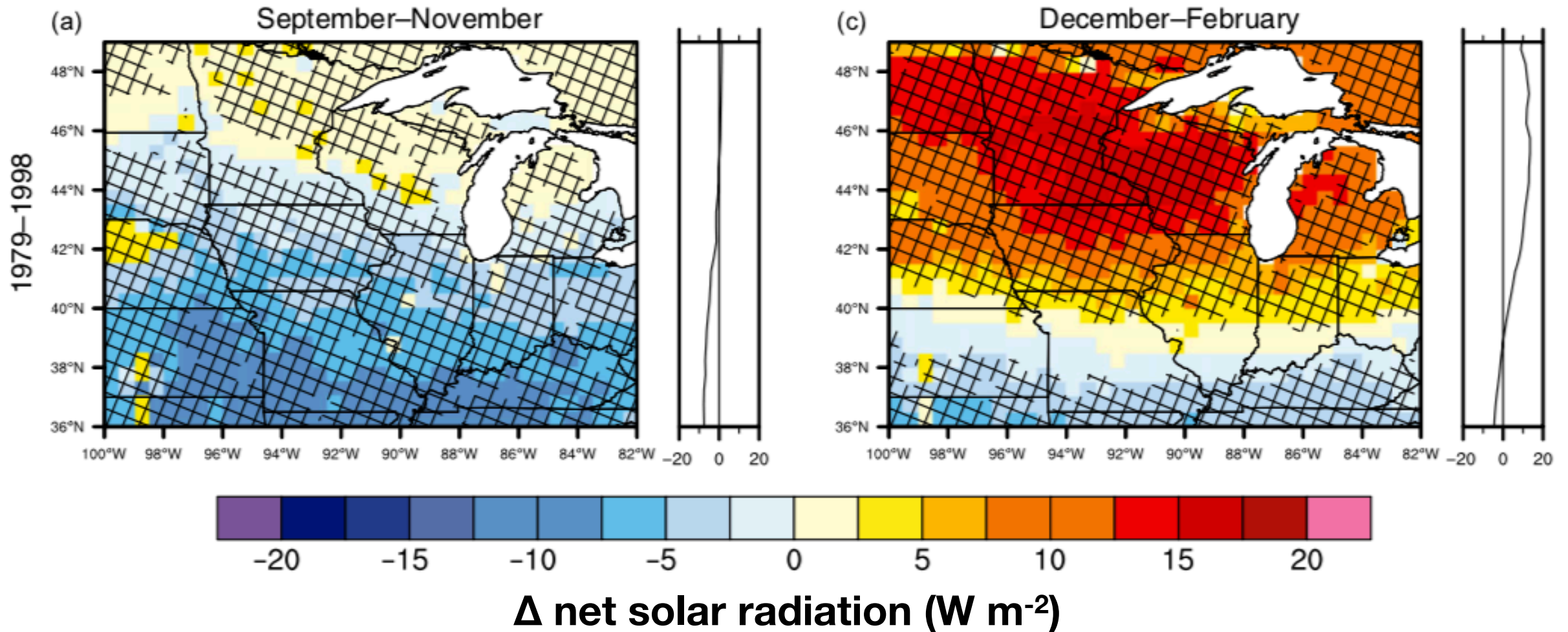
Δ net solar radiation (W m^{-2})

Change in solar radiation

$$\Delta = \text{Perennial} - \text{Corn}$$



Perennial extrudes above snowpack

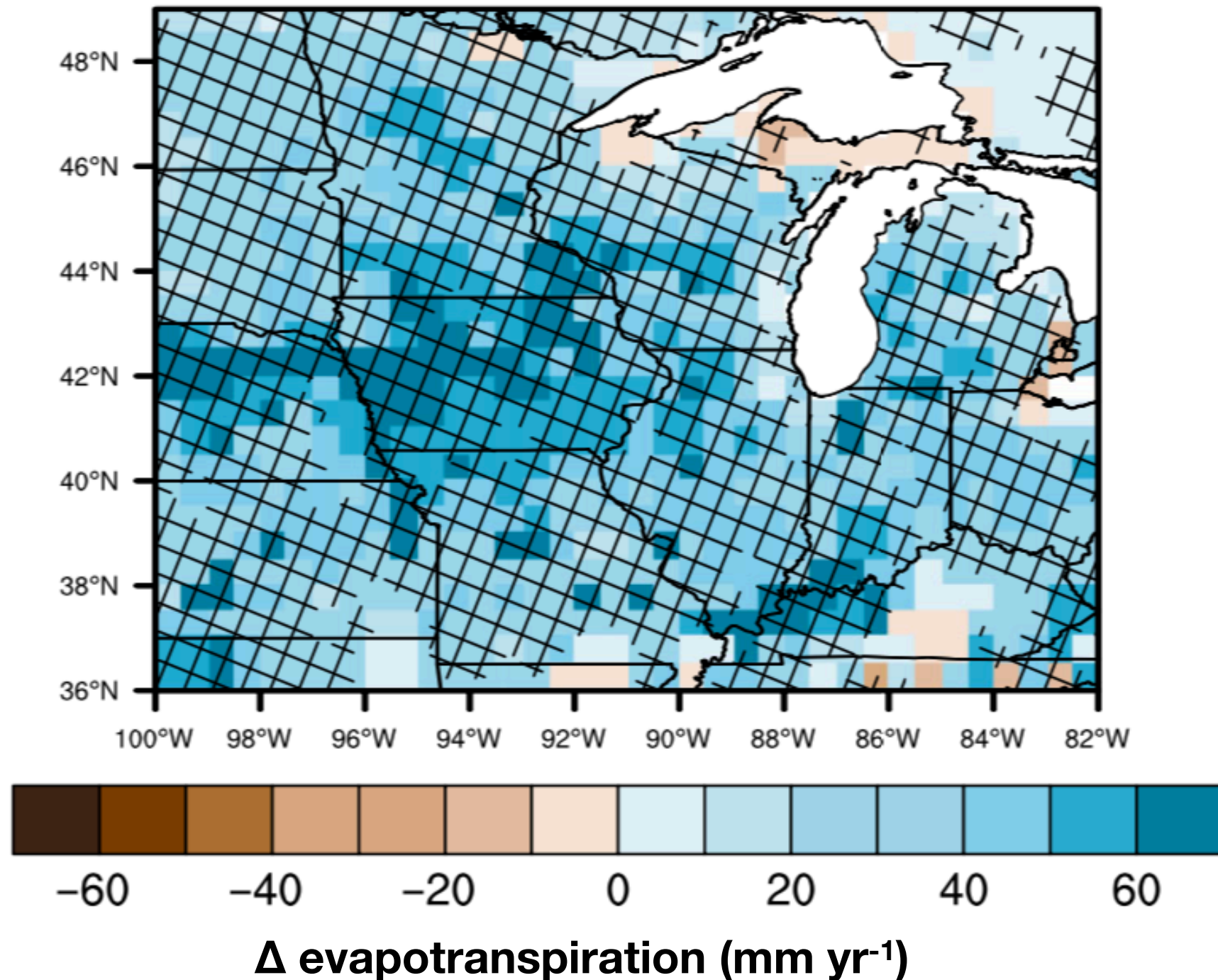


Change in evapotranspiration

$$\Delta = \text{Perennial} - \text{Corn}$$

(a)

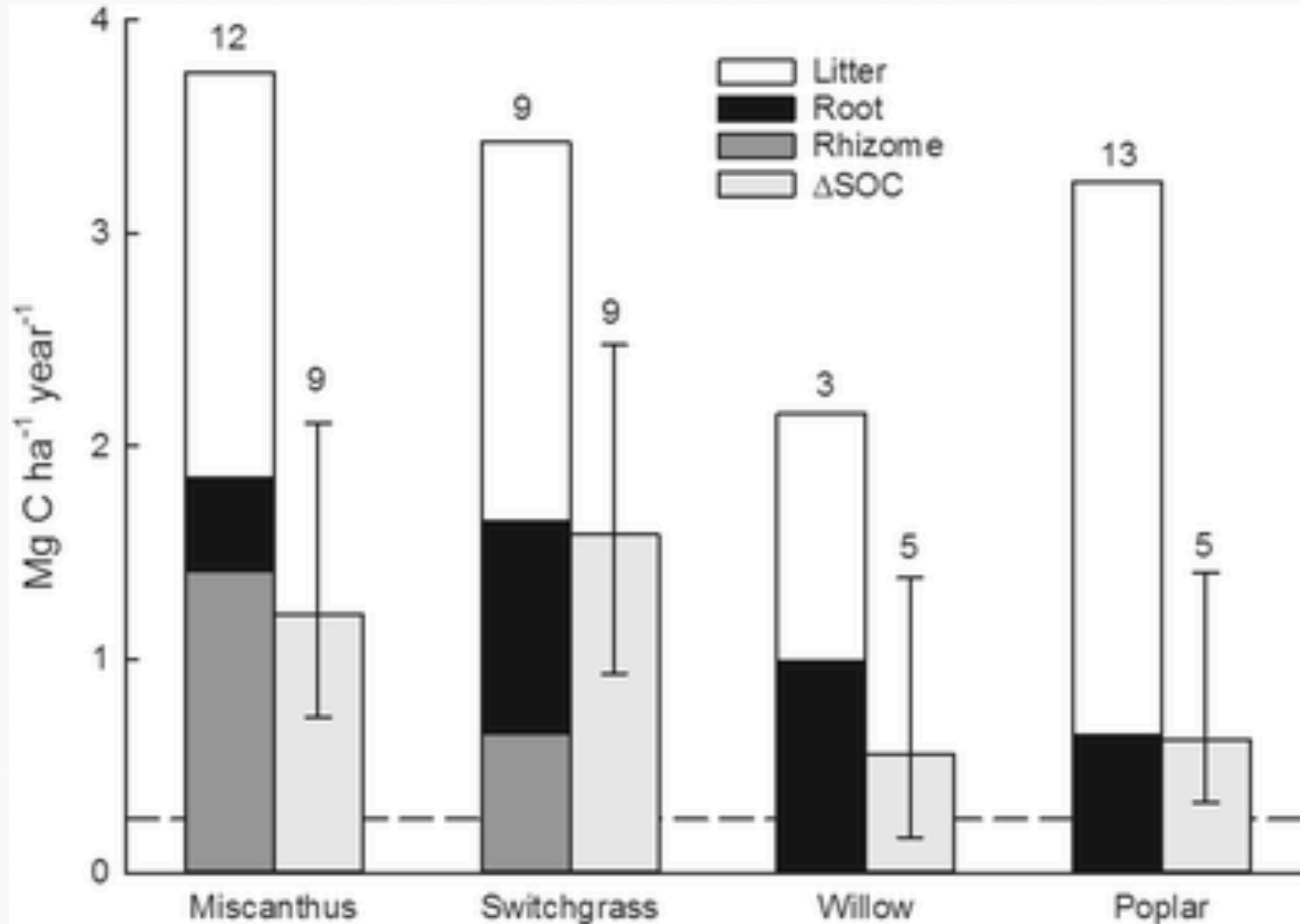
Annual



Longer perennial growing season

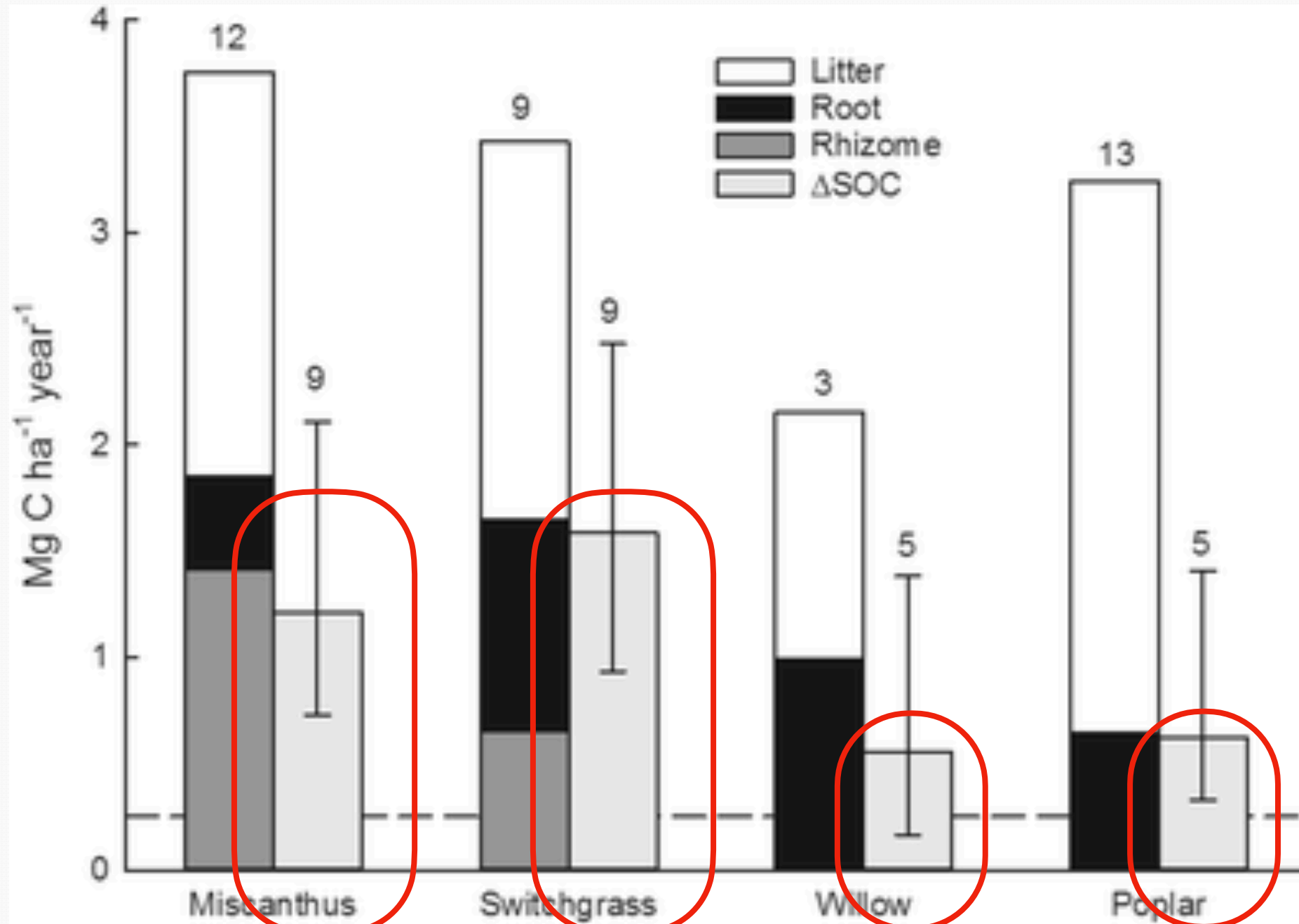
Change in soil carbon

After transitioning to perennial bioenergy crops



Change in soil carbon

After transitioning to perennial bioenergy crops

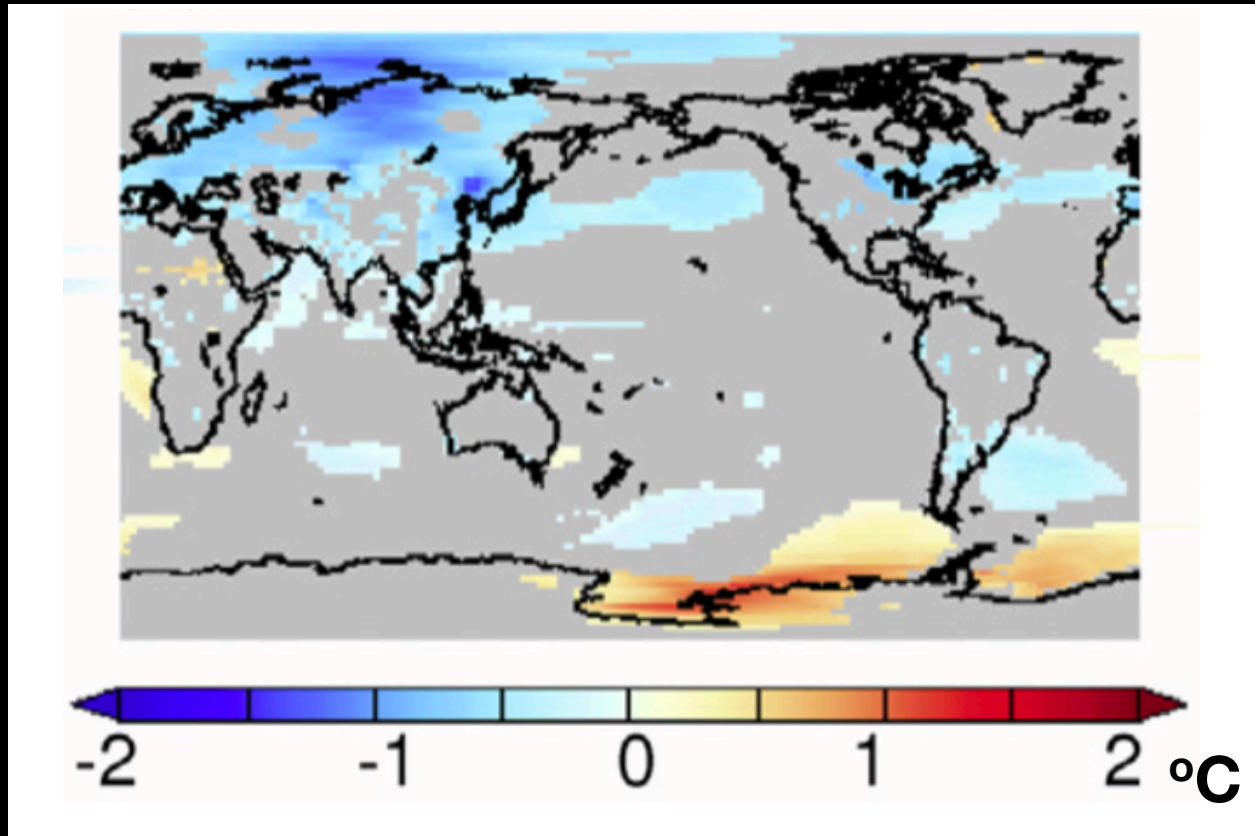


Soil Tillage

(Conservation practices do not till soil, referred to as no-till)

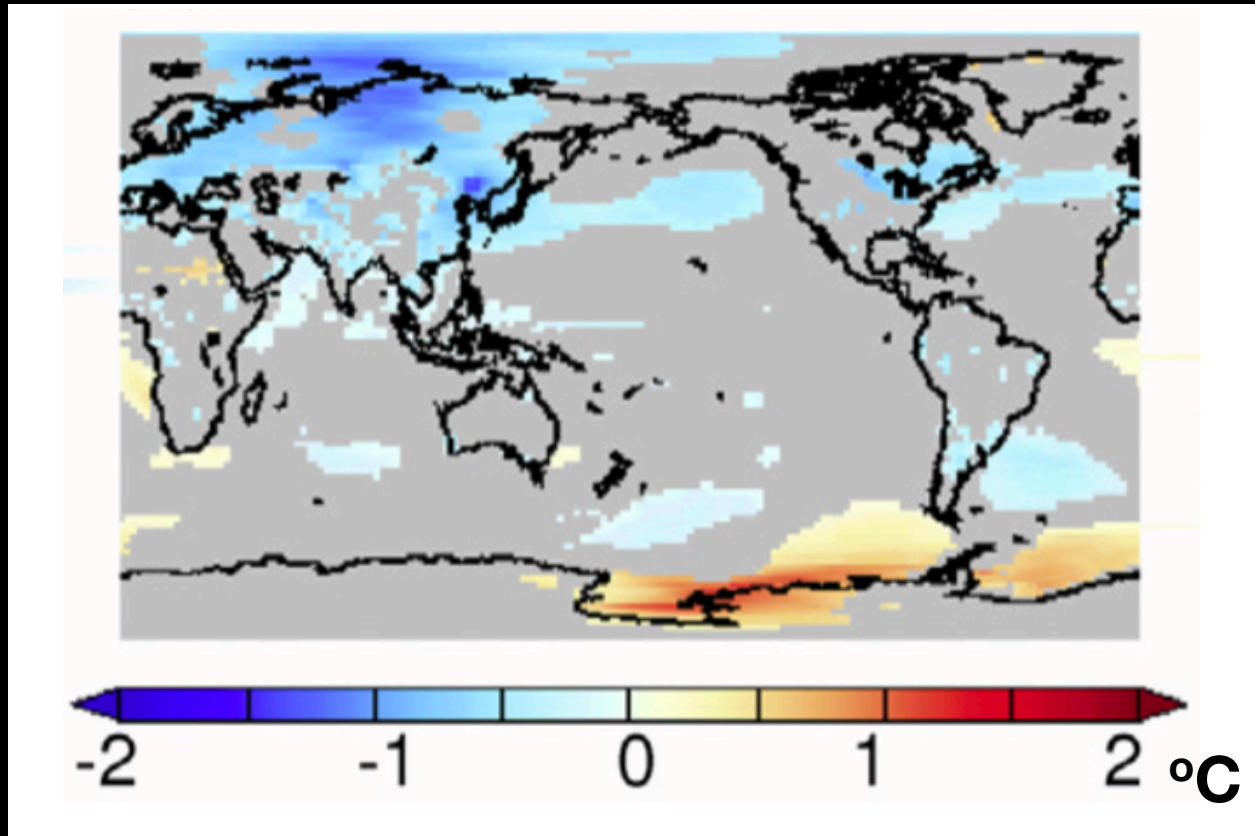


No-till leads to cooler air temperatures

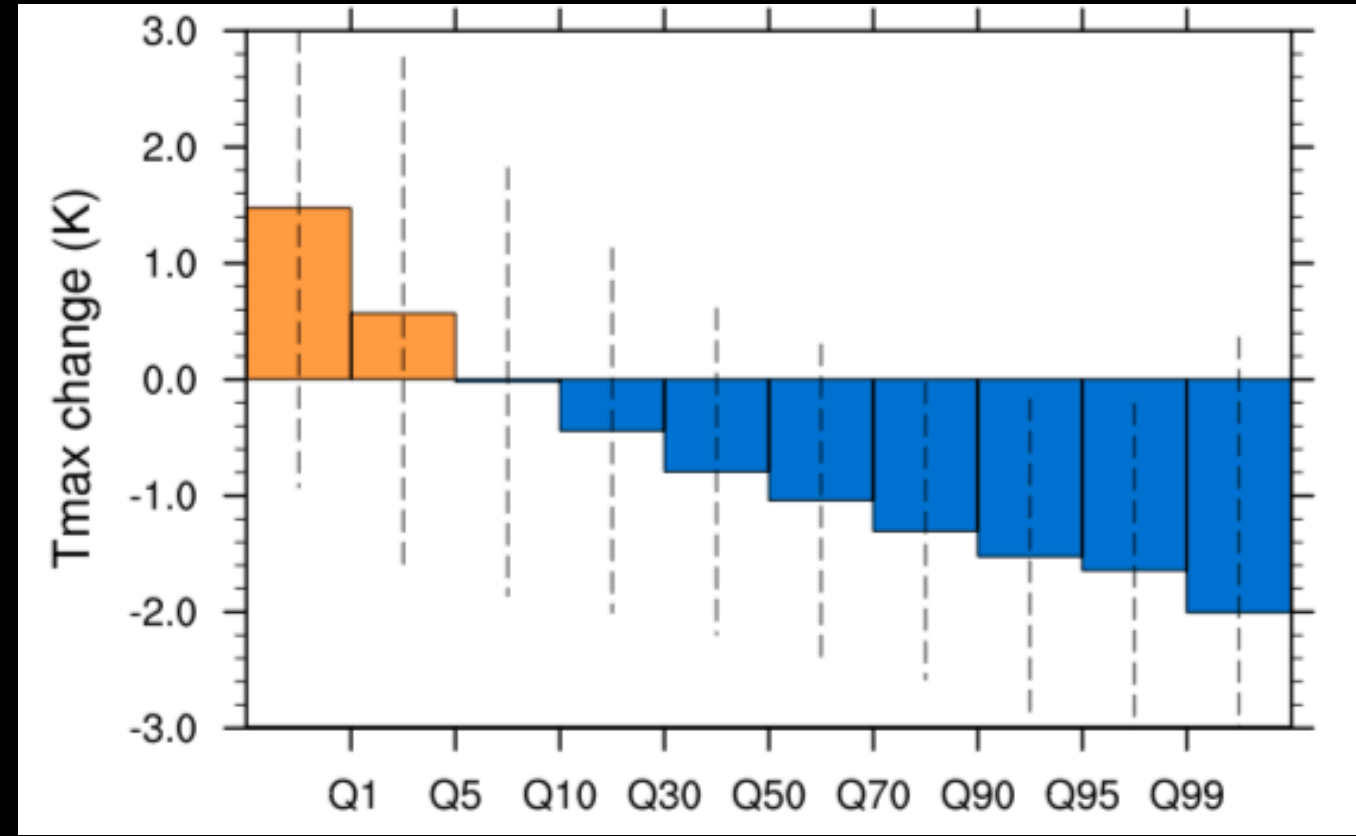


Lobell et al. 2006 GRL

No-till leads to cooler air temperatures

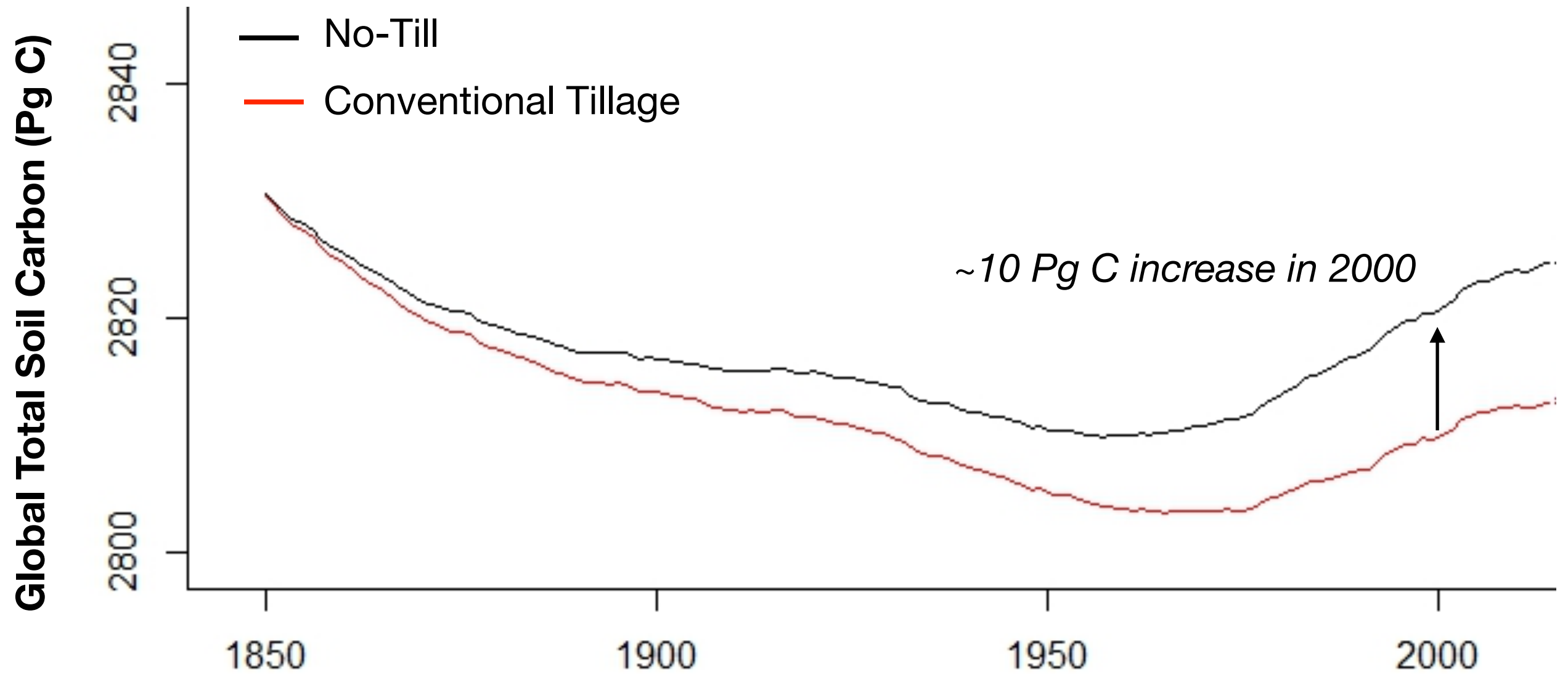


Lobell et al. 2006 GRL

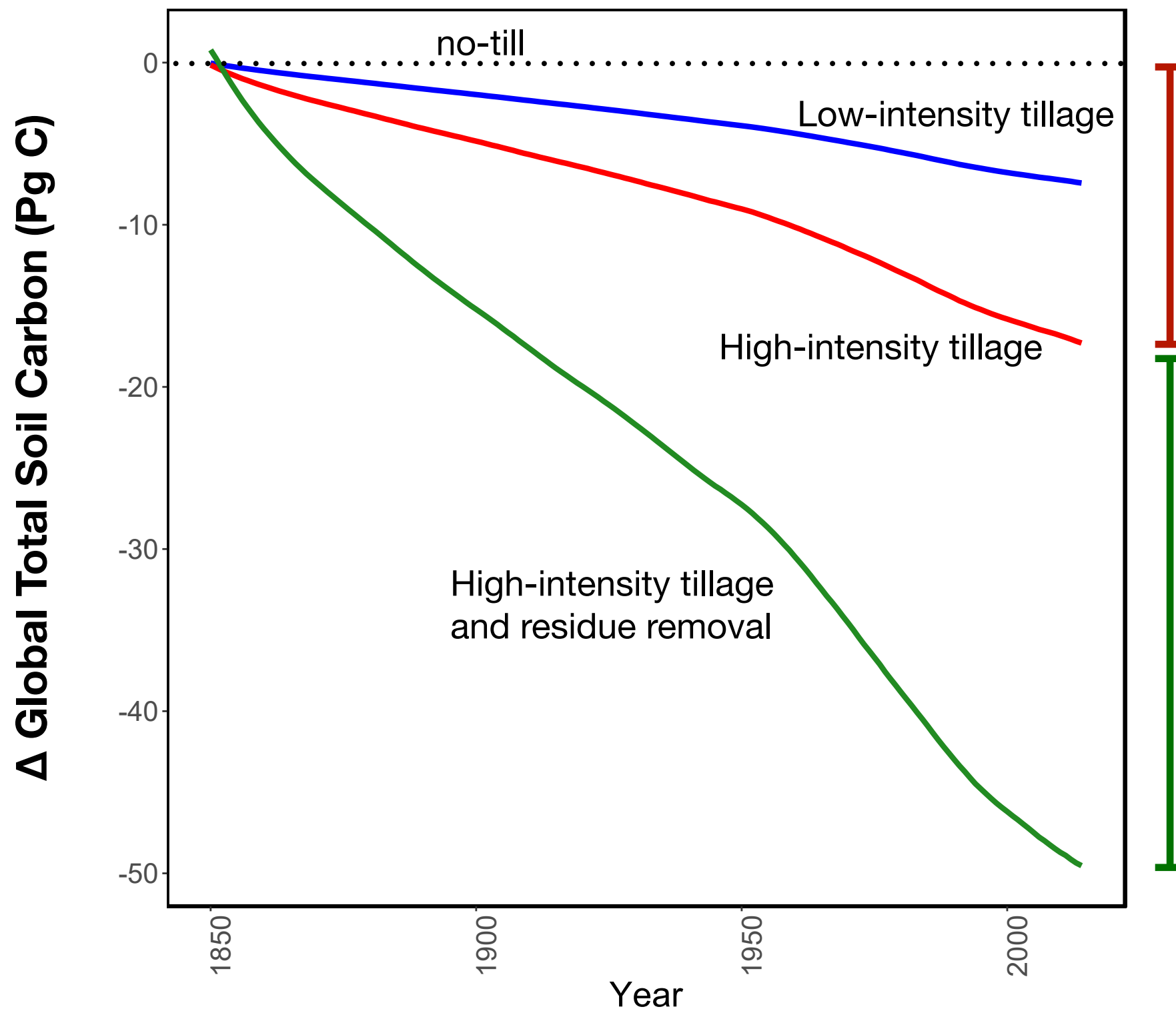


Davin et al. 2014 PNAS

No-till increases soil carbon



Residue removal may have a larger impact on soil C than tillage



Climate impacts of Agricultural Land Management

Cover crops, cultivar selection, tillage, and other management practices change water and energy fluxes and carbon storage

What wins? Few land management studies incorporate both biogeochemical and biogeophysical impacts

(data & process representation aren't always available)

Easier to determine biogeophysical climate impacts.

Studies assessing possible biogeochemical climate impacts tend to focus on soil C storage and don't/can't quantify impacts.

