

Climate Impacts Mid-1800's Deforestation in New England using the Weather, Research, and Forecasting (WRF) Model



Photos: UNH Special Collections



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Motivation

21 December 1979, Volume 206, Number 4425

SCIENCE

Anthropogenic Albedo Changes and the Earth's Climate



Carl Sagan, Owen B. Toon, James B. Pollack

Following the end of the last ice age, 10,000 years ago.

Although the human population of the earth has increased dramatically recently, humans have been widely distributed for hundreds of thousands to millions of years. Powerful motivations exist for

$$Q = (1 - \alpha) * I * K \quad (\text{Robinson \& Kukla, 1985})$$

Where Q = absorbed solar radiation at the surface

α = surface albedo

I = solar radiation at the top of the atmosphere

K = atmospheric screening factor

Global Land Cover Change

Crop and Pasture Fraction Difference: 1992-1870

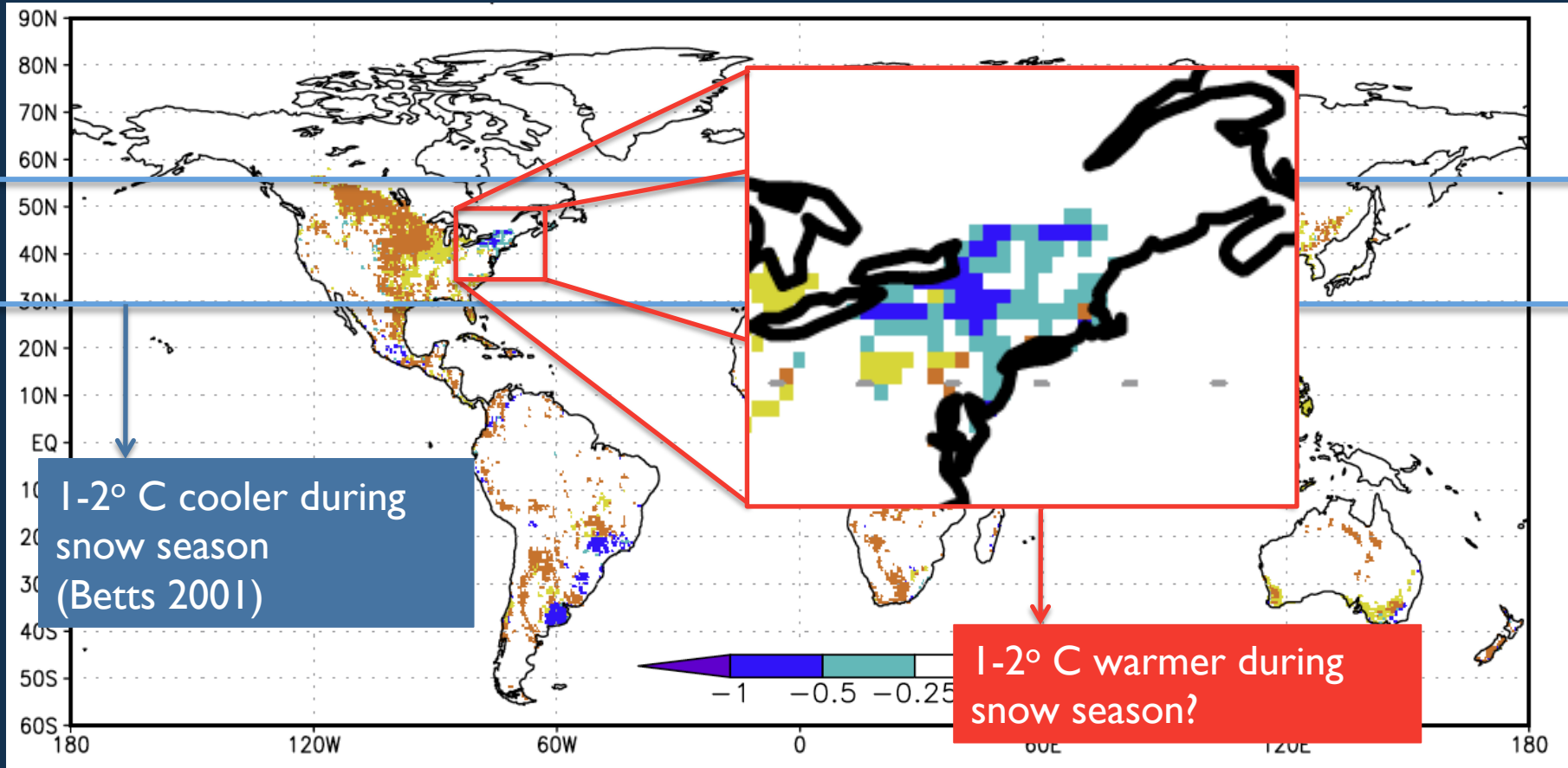
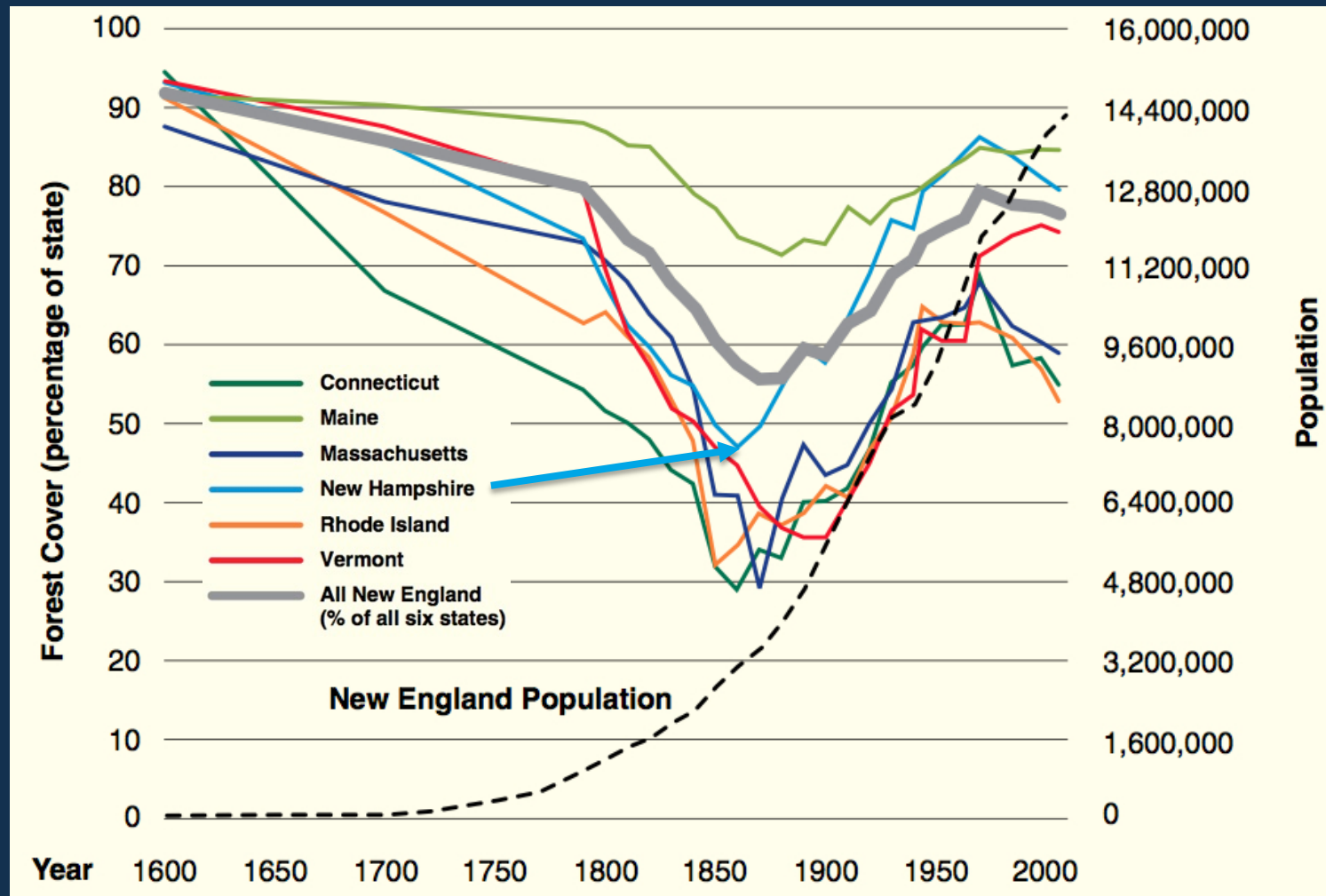


Figure from Pitman et al. (2009). Land cover map constructed using data from Ramankutty and Foley (1999) and Goldewijk et al (2001).

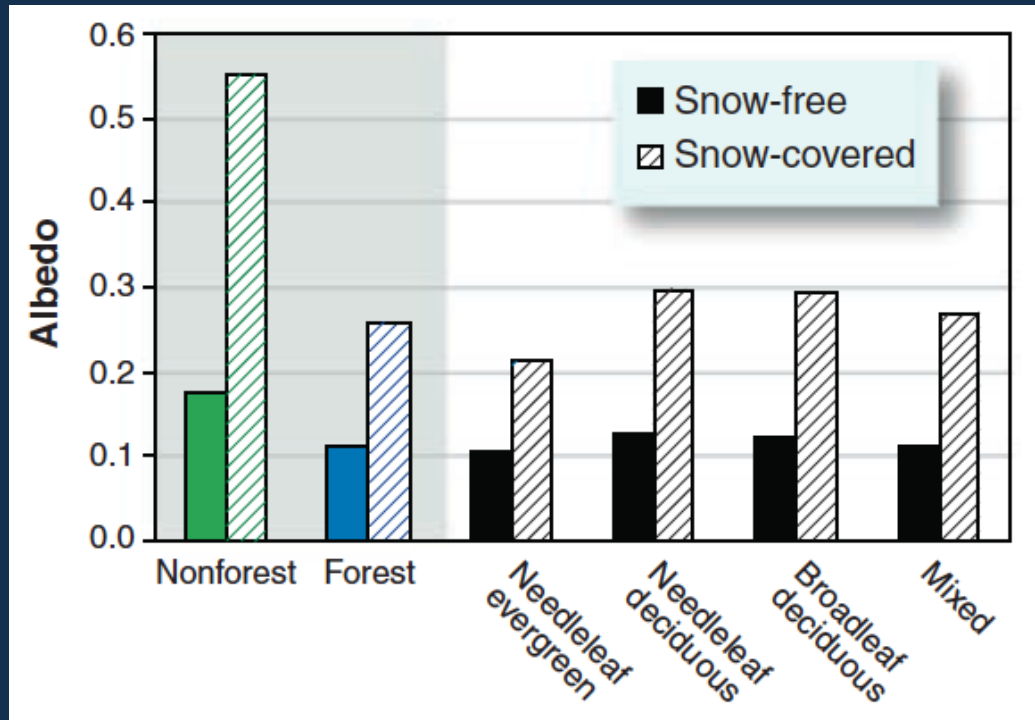
New England Forest Cover



Foster et al., 2010. *Wildlands and Woodlands*

Biogeophysical Changes

Albedo



Satellite-derived direct-beam albedo

Figure from Bonan et al (2008)

Data from Yin et al. (2002)

Biogeophysical Changes

Roughness Length

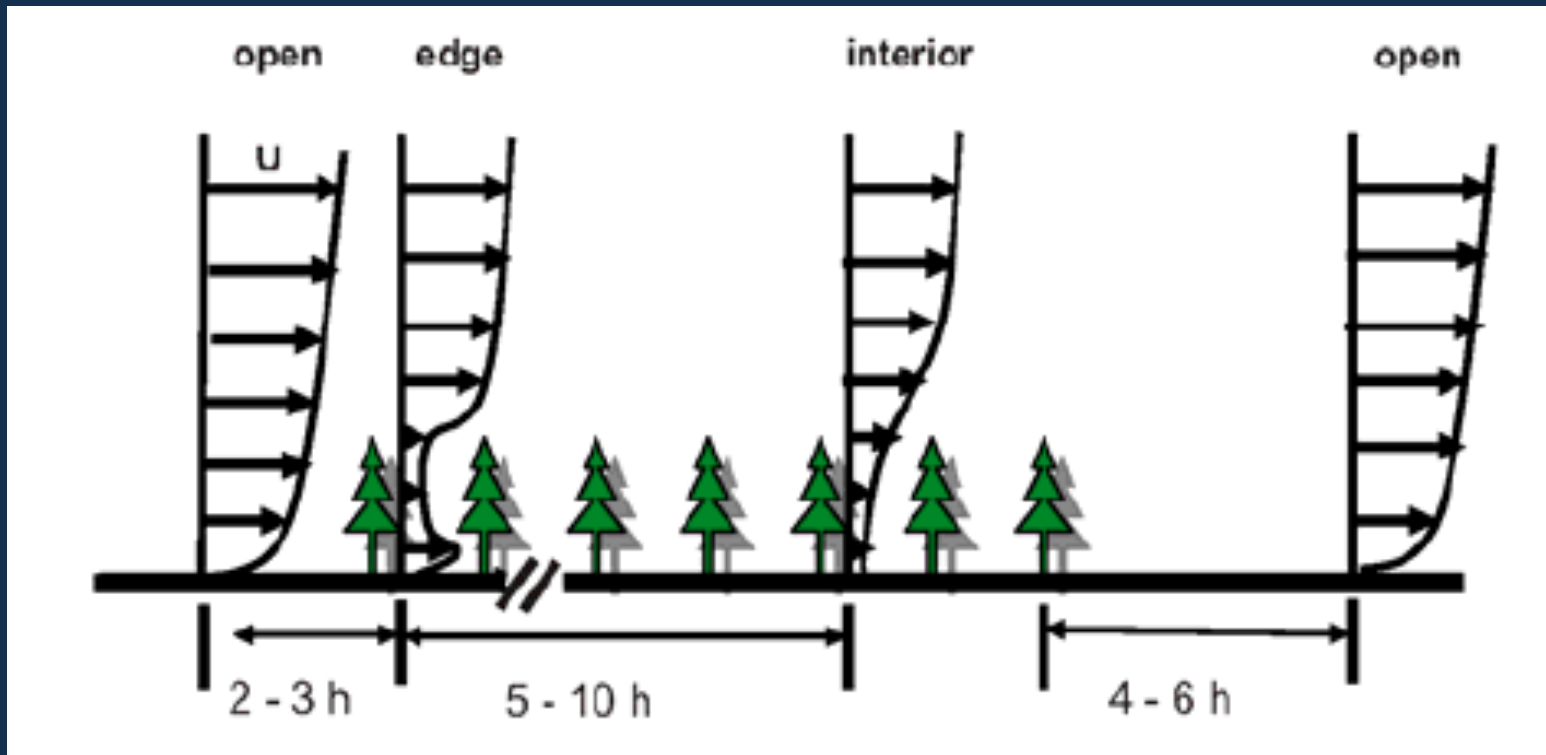
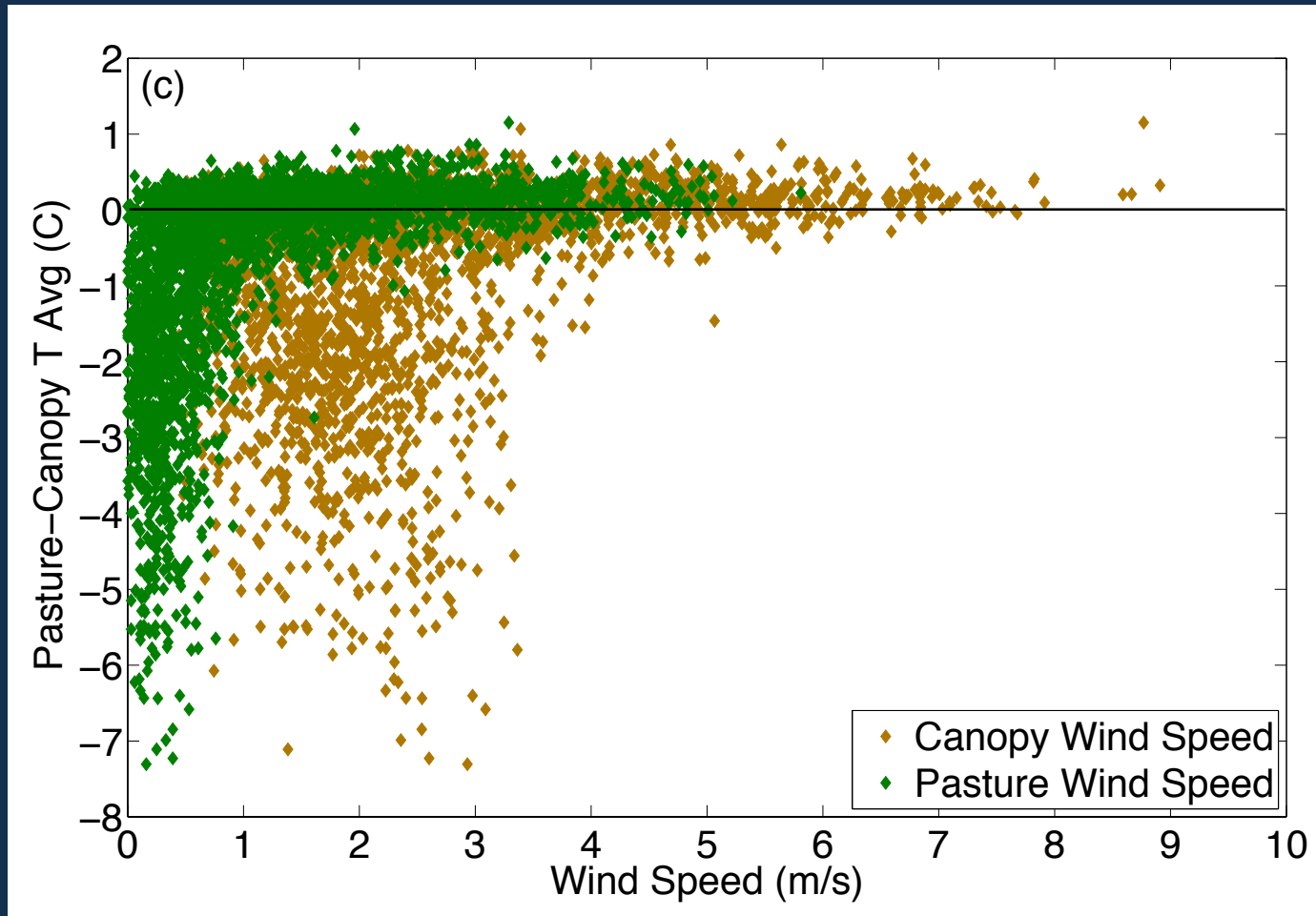


Figure from Wang and Cionco 2007

Forested and Deforested Field Observations in New Hampshire

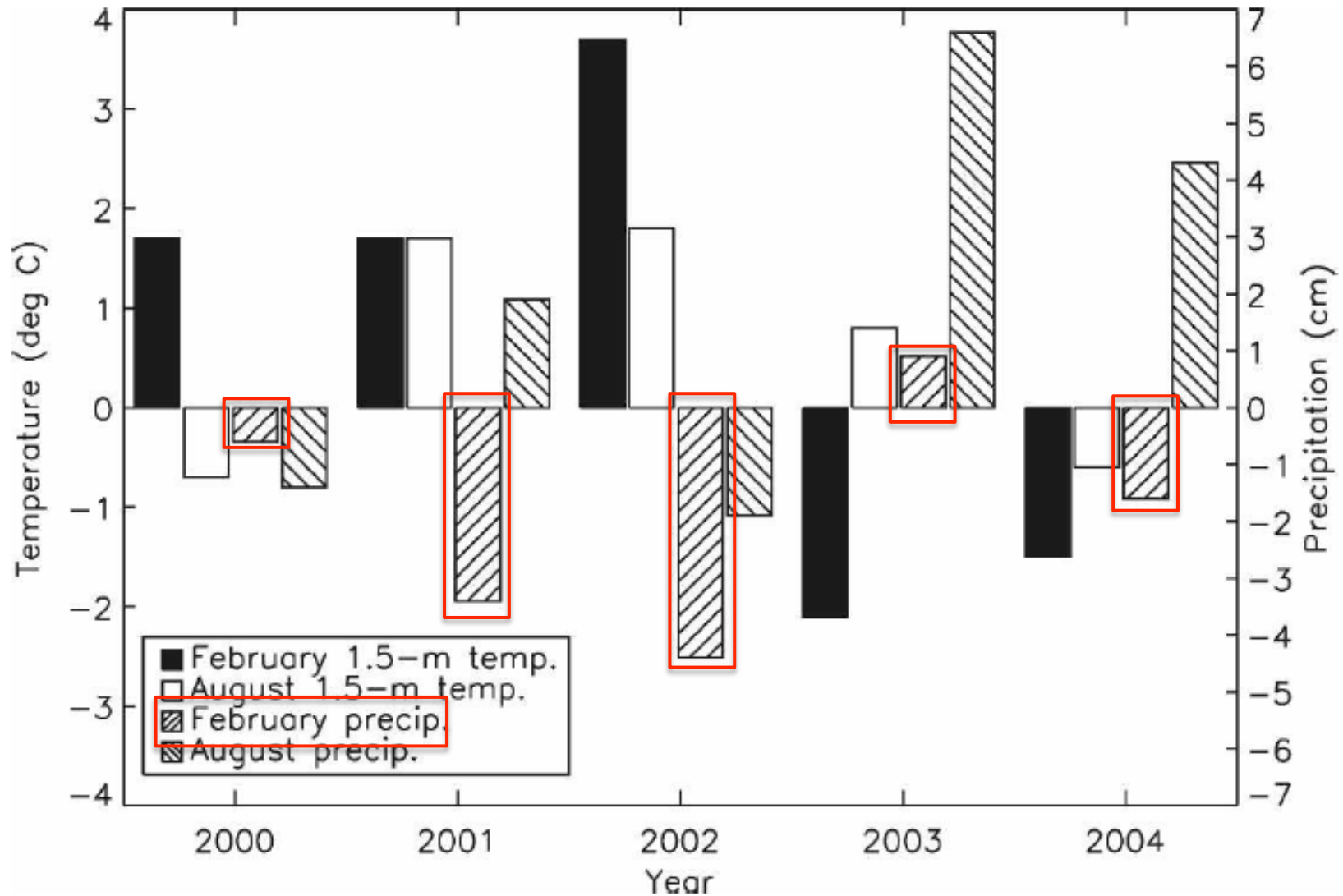


Research Question

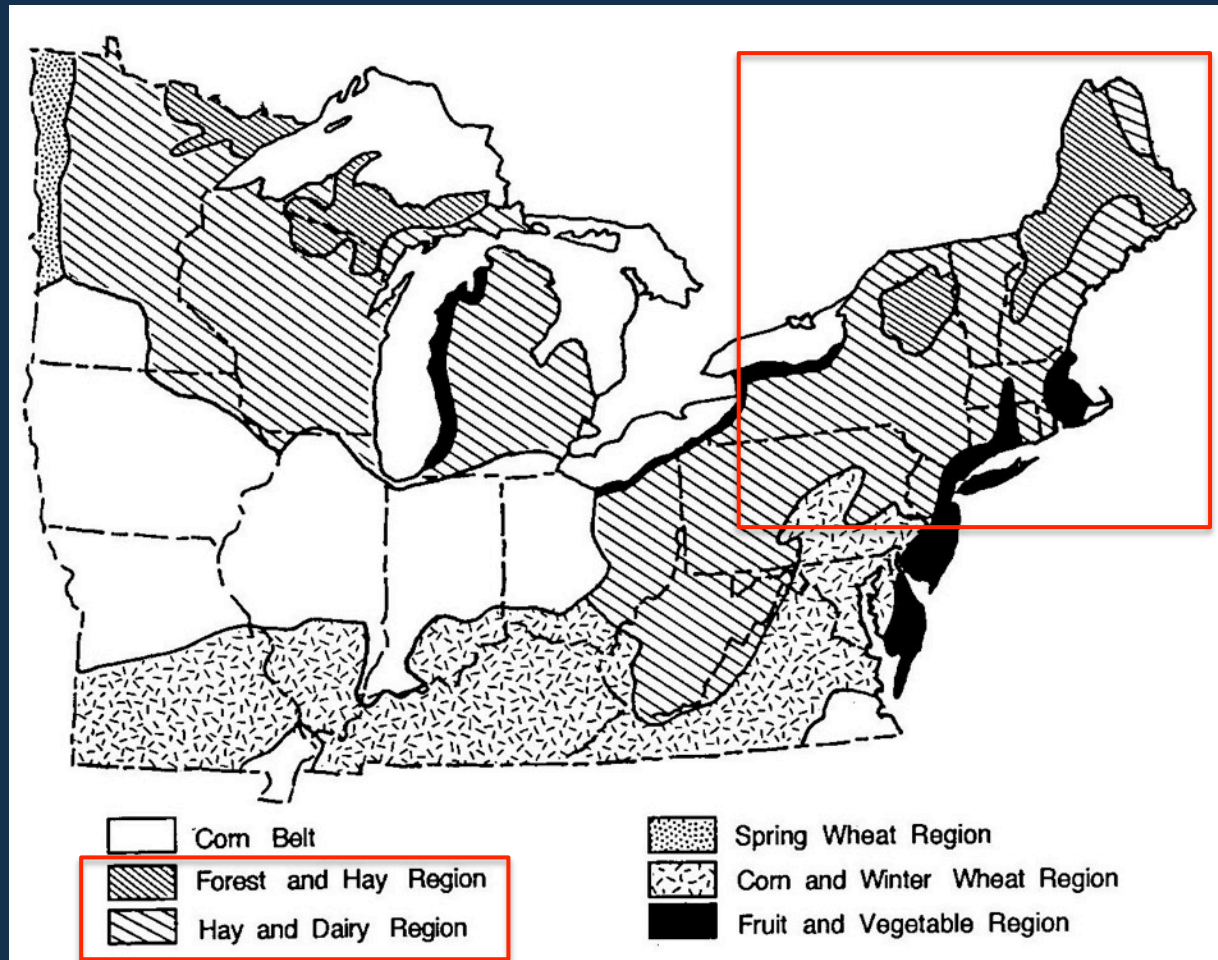
Did early New Englanders make winters harsher by deforesting the landscape?



Deforestation in Pennsylvania



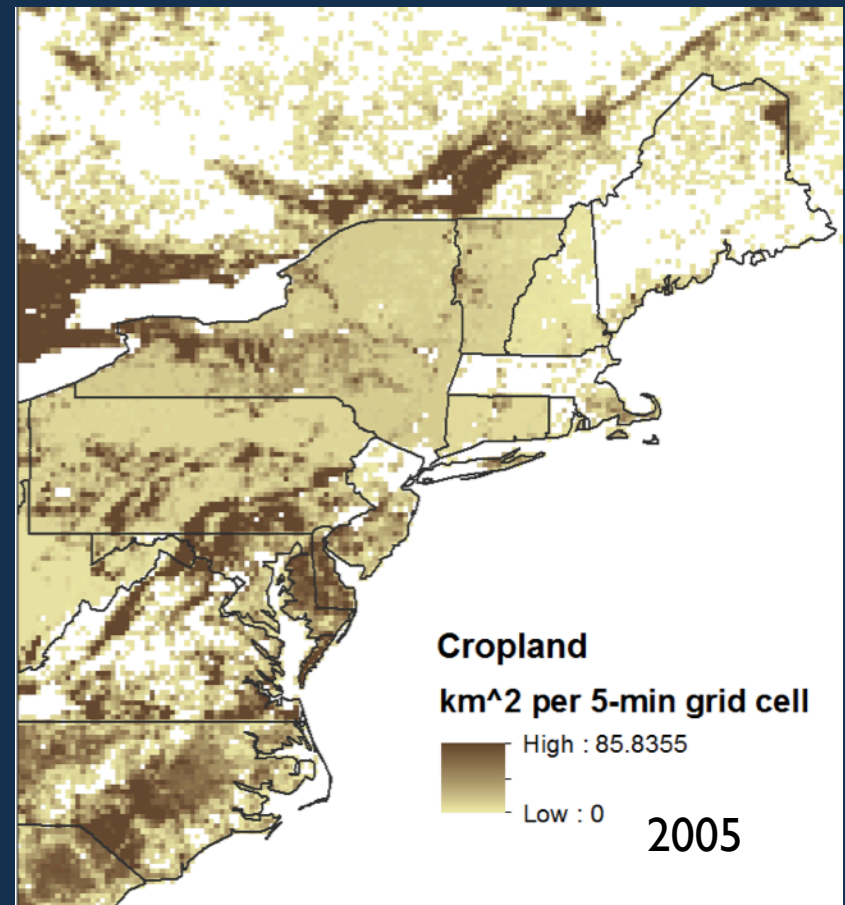
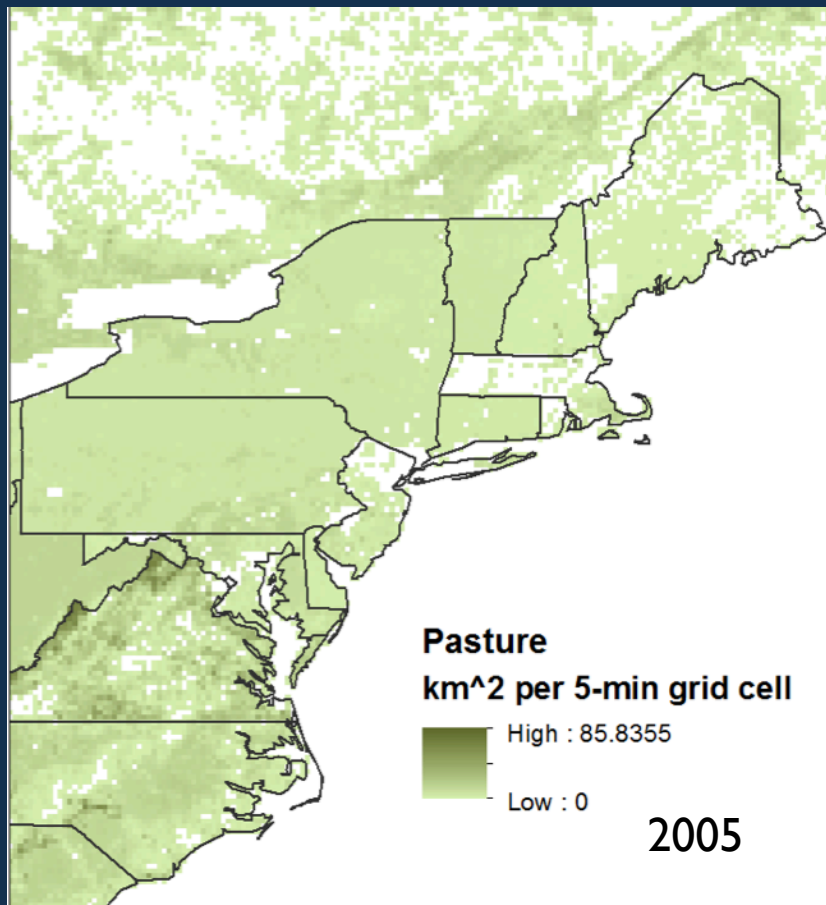
Eastern US Major Crops in 1900



Meyer 1987

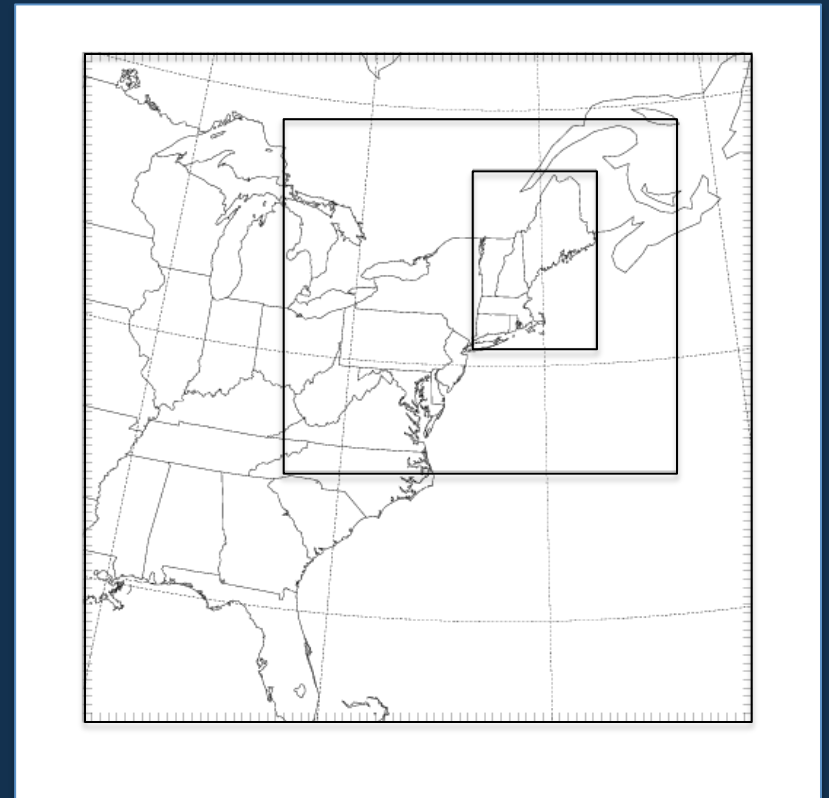
Land Cover Scenarios

- Modified HYDE 3.1 (Goldewijk et al. 2010) to allocate cropland as pasture



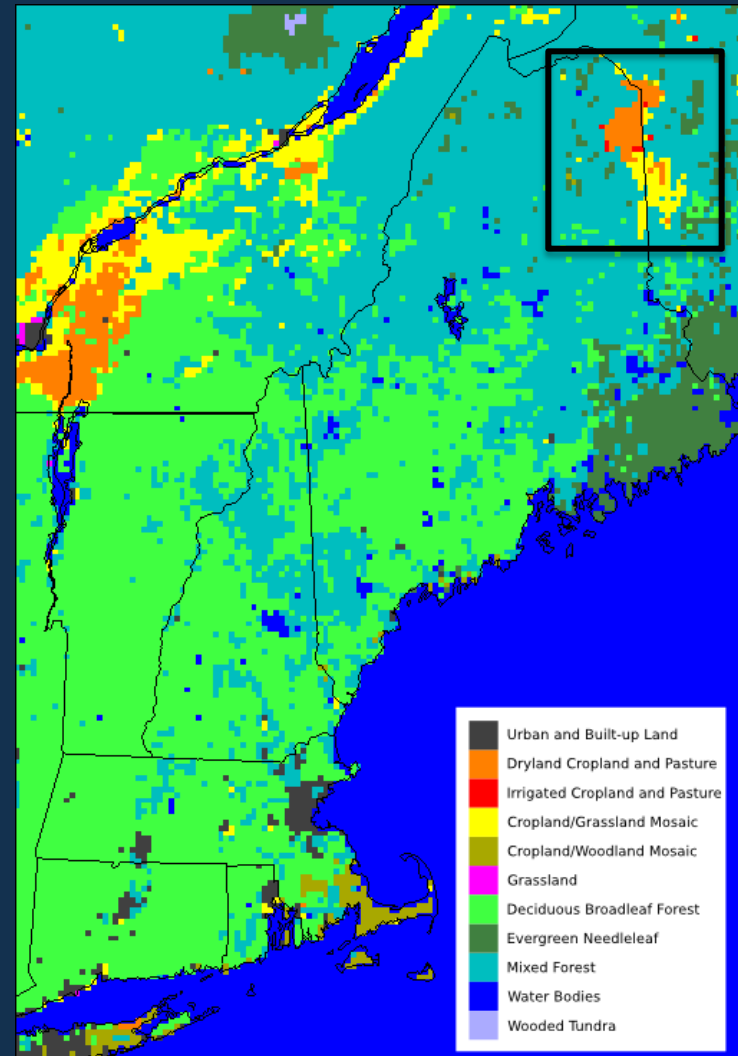
Modeling Approach

- WRF/NOAH LSM
- ERA-Interim Lateral Boundary Conditions
- WRF Single-Moment 5-class scheme
- Grell-D ensemble cumulus scheme
- Rapid Radiative Transfer Model Longwave
- Dudhia scheme Shortwave
- Triple one-way nested



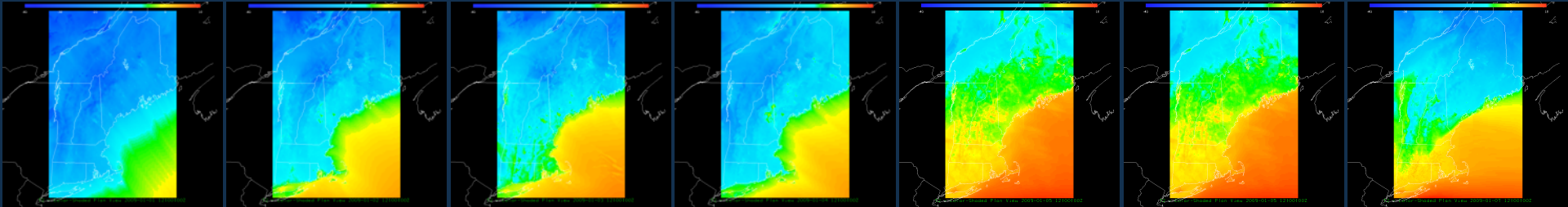
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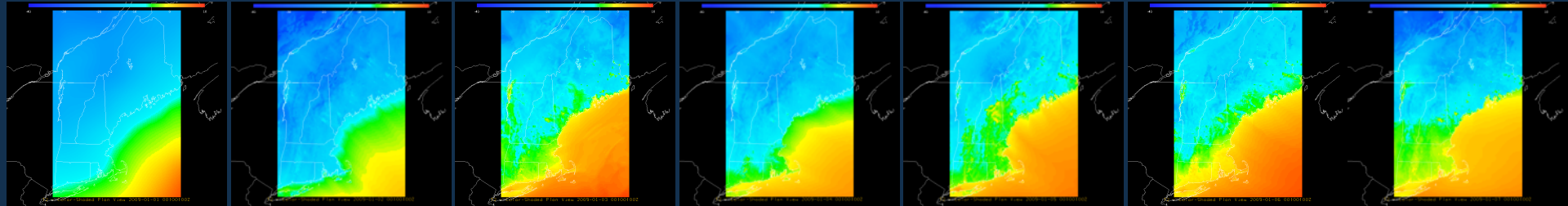


Preliminary Results

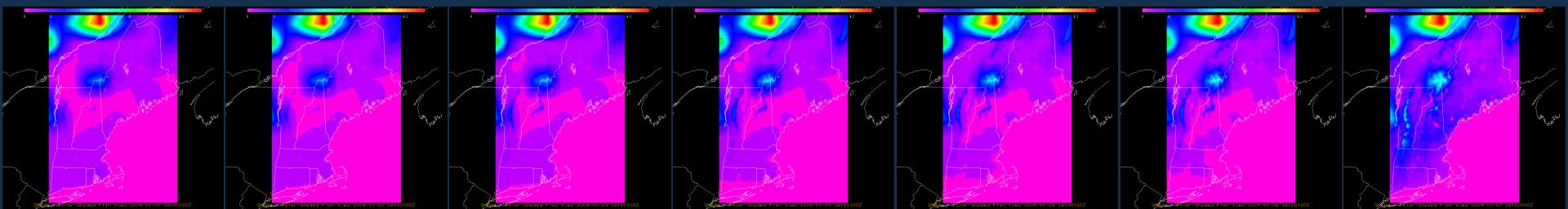
[Delays due to opening of Yellowstone]



Daytime 2-m temperature (°C)



Nighttime 2-m temperature (°C)

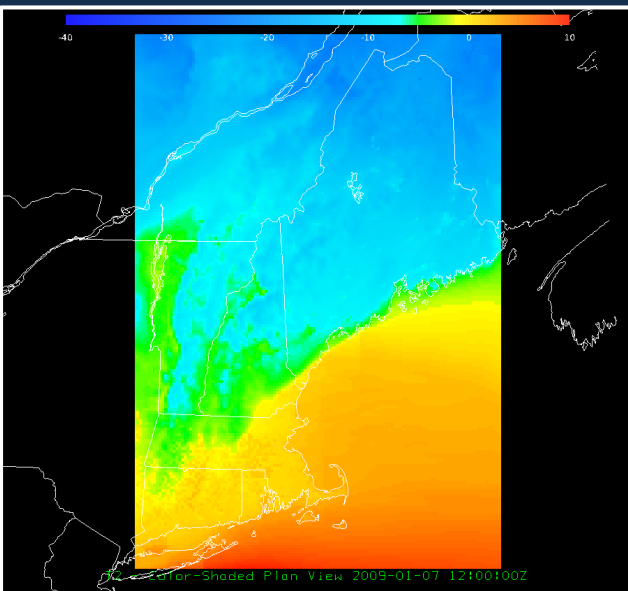


Snow depth (m)

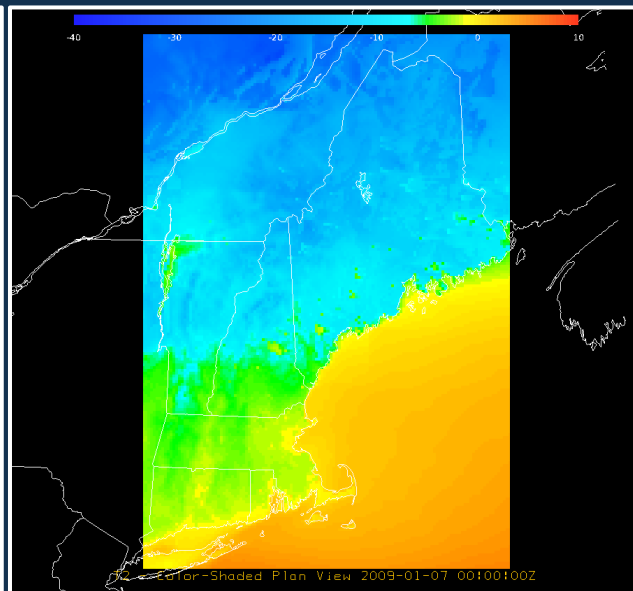
Preliminary Results

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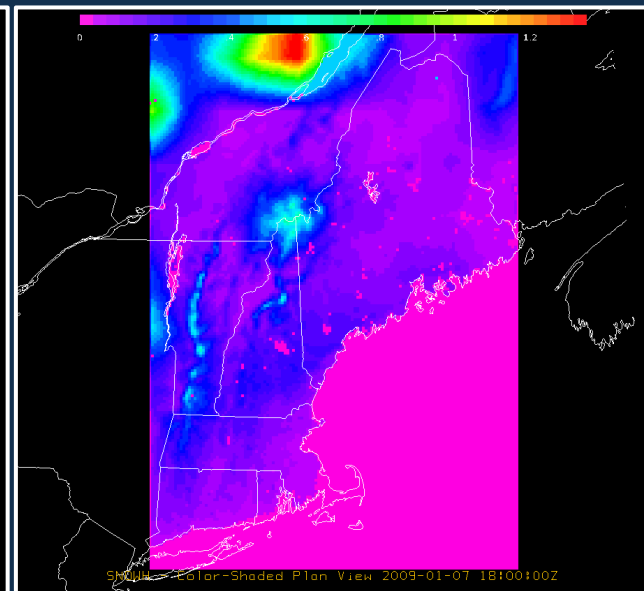
Deforested signature in nighttime temperature



Daytime
2-m temperature (°C)



Nighttime
2-m temperature (°C)



Snow depth (m)

Conclusions and Future Work

- Continue with multi-month winter (Oct-Apr) simulations that include both historically lower and higher than average snowfall winters
- Compare multiple land surface models (e.g., CLM4)
- Additional field work in forested and deforested field site at UNH tower to obtain temperature profiles during inversions

Acknowledgements

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