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

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

Where

Q = absorbed solar radiation at the surface
\alpha = 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).

1-2° C cooler during snow season (Betts 2001)

1-2° C warmer during snow season?
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
Forest and Deforested Field Observations in New Hampshire
Research Question

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

Deforestation in Pennsylvania

Klingaman et al. (2008)
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

Birkel et al (unpublished)
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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

[Delays due to opening of Yellowstone]

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
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