

Land Surface Modeling of A Flux Tower Cluster in the Northeastern US with CLM4.5

Elizabeth Burakowski, Scott Ollinger, Andrew Ouimette, Lucie Lepine, Sean Fogarty, UNH-Durham
Gordon Bonan, NCAR/CGD/TSS





Harvard Forest Museum;

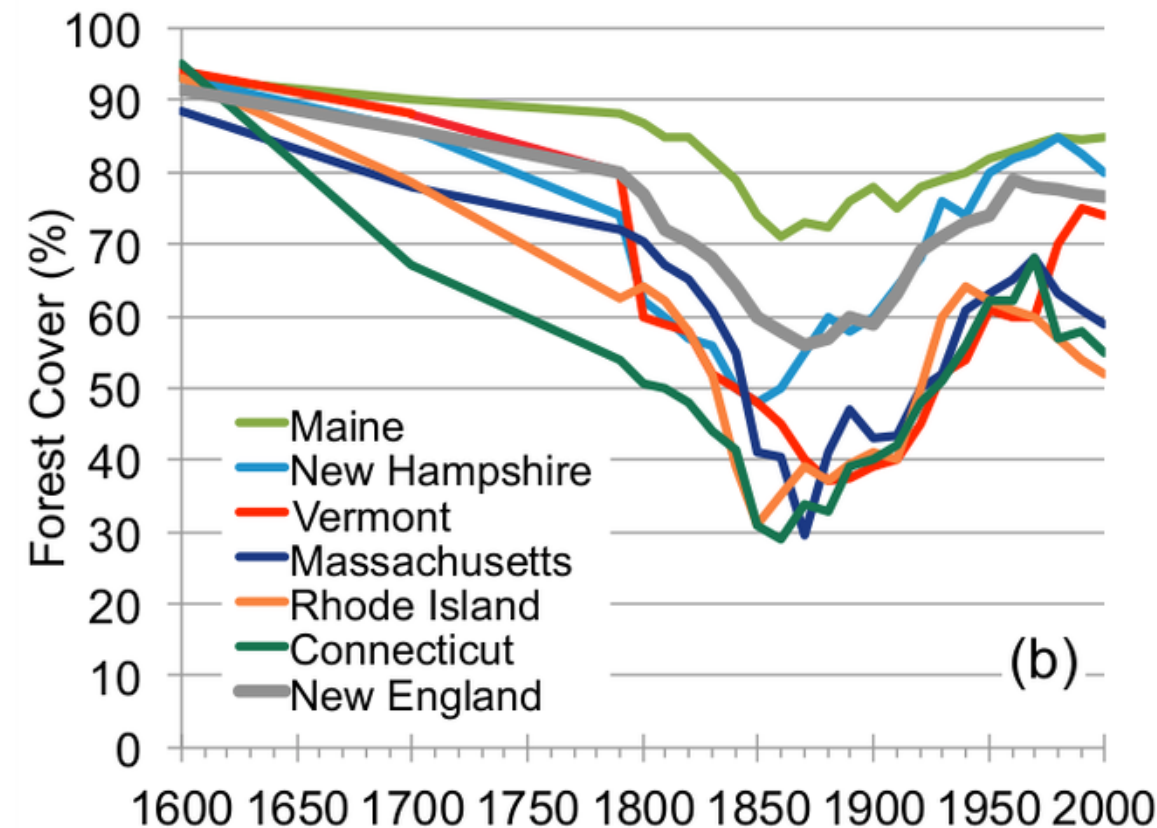


Harvard Forest Museum;



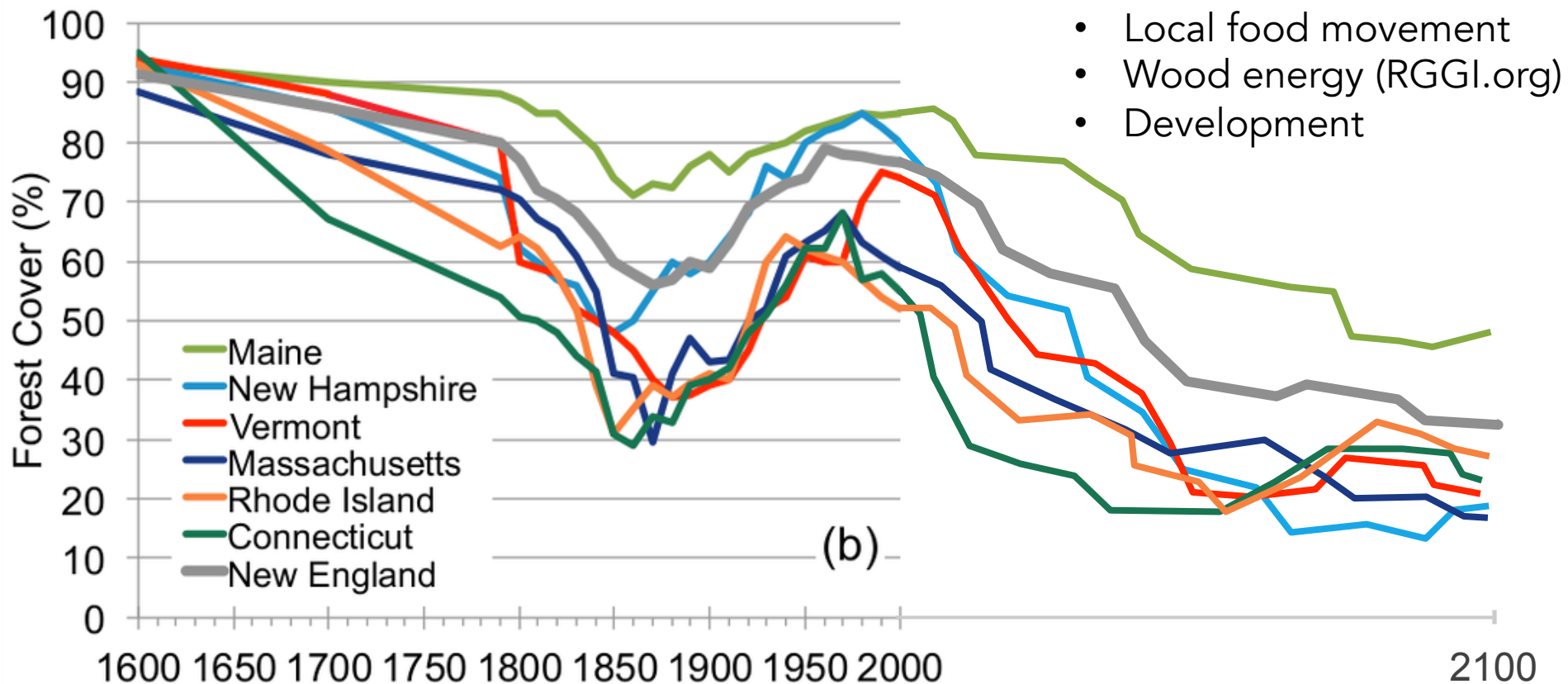
Reynoldston NY Historical Society

Deforestation is part of New England history...



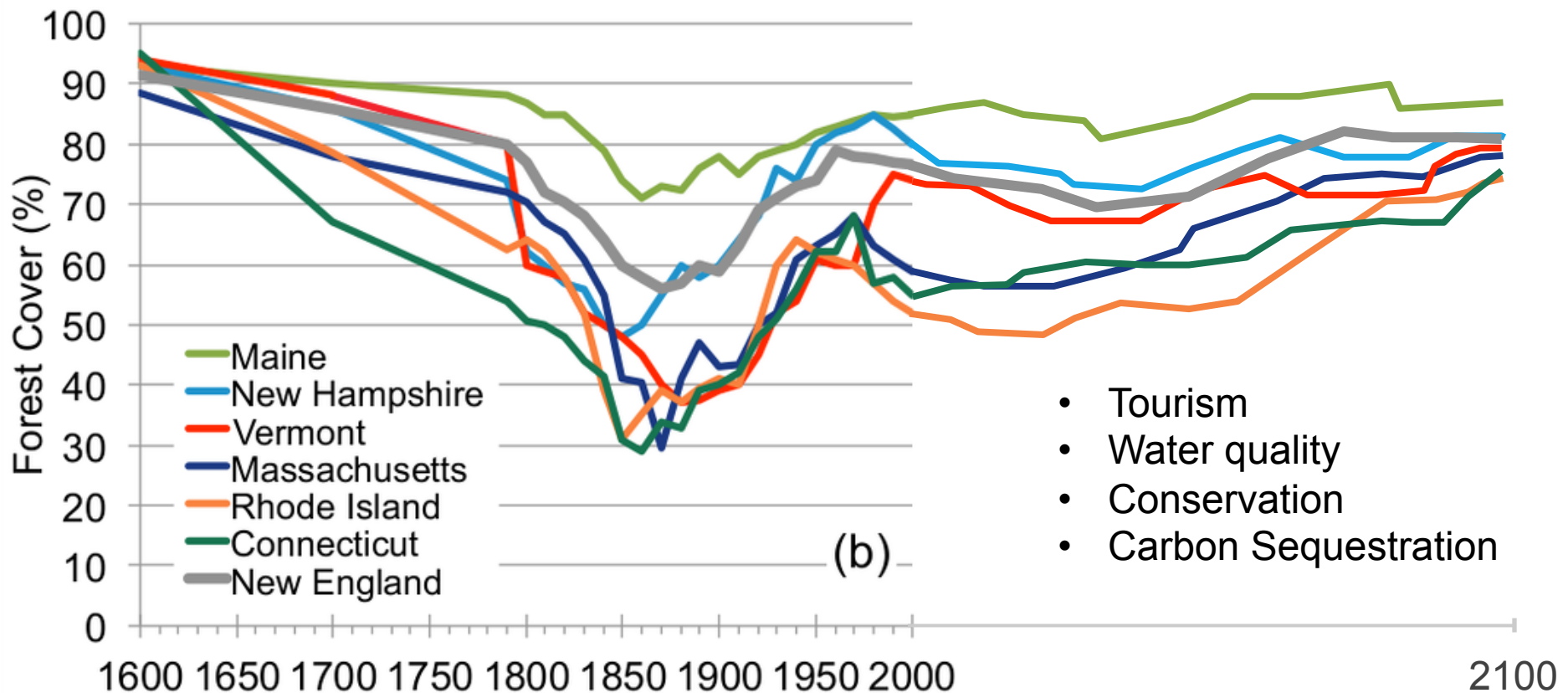
Deforestation is part of New England history...

... but what about the future?



Deforestation is part of New England history...

... or what about this future?



Climate Regulation as an Ecosystem Service: Biogeophysical Processes

$$\Delta T_s \approx \frac{\lambda_0}{1+f} \Delta S + \frac{-\lambda_0}{(1+f)^2} R_n \Delta f_1 + \frac{-\lambda_0}{(1+f)^2} R_n \Delta f_2$$

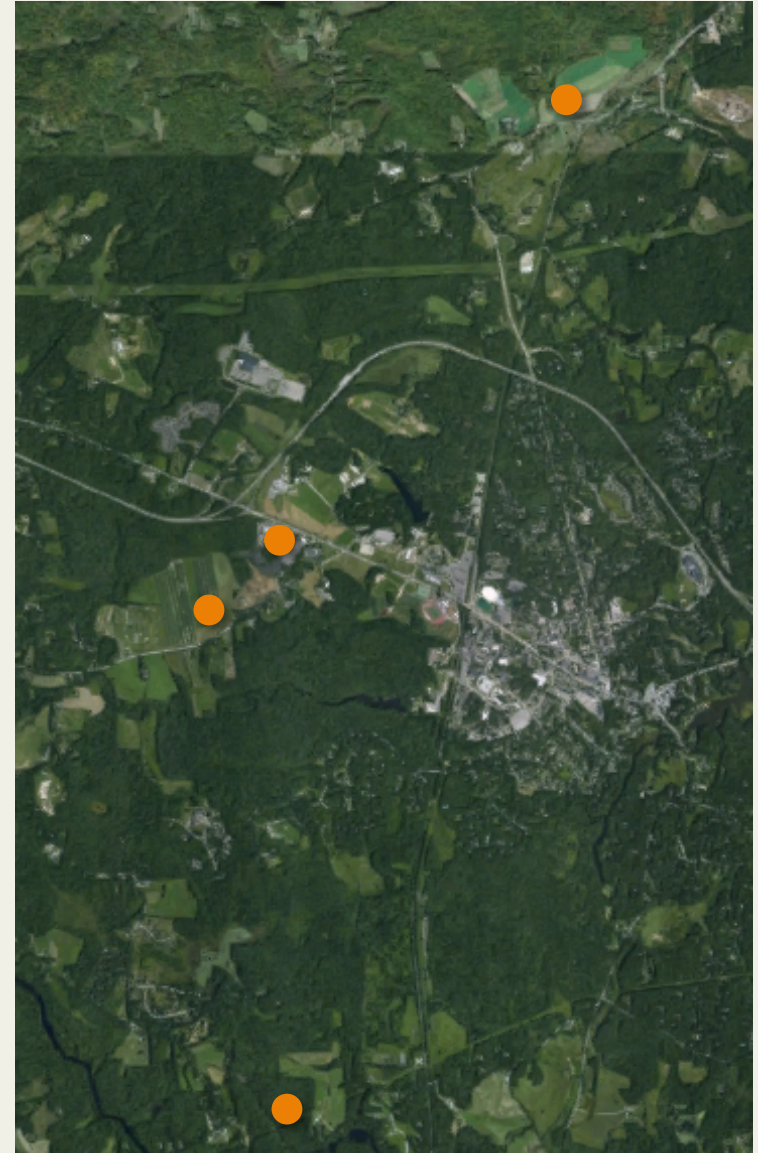
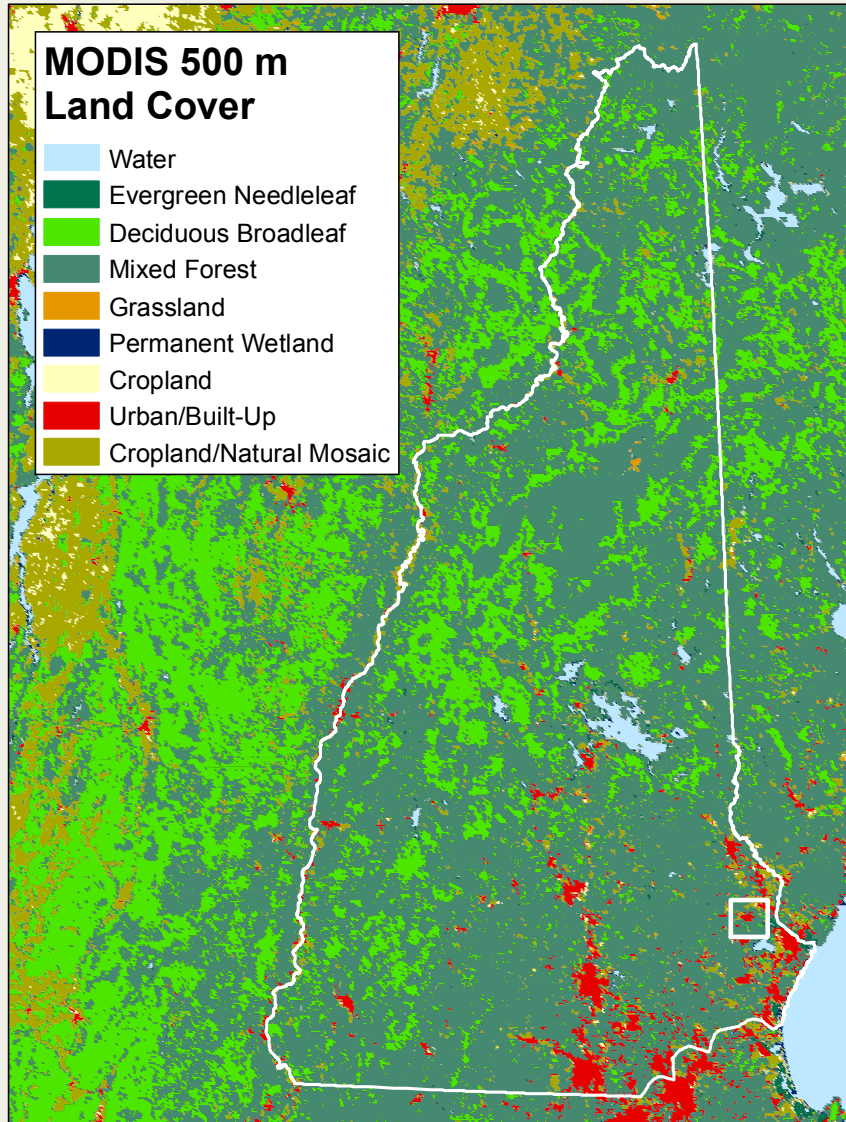
Radiative forcing
due to changes in
albedo

Energy Redistribution
due to changes
in surface roughness

Energy Redistribution
due to changes
in Bowen ratio

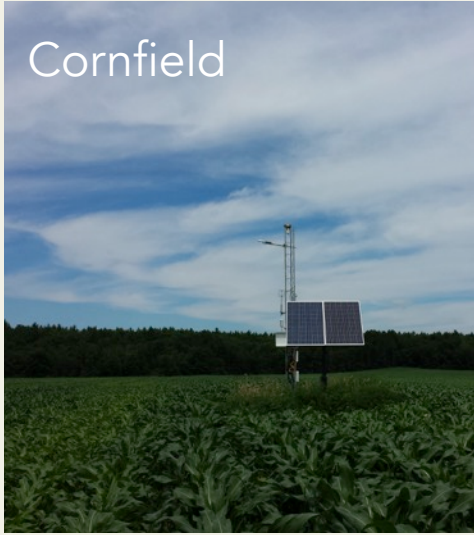


Flux Tower Cluster



Flux Tower Cluster

Cornfield



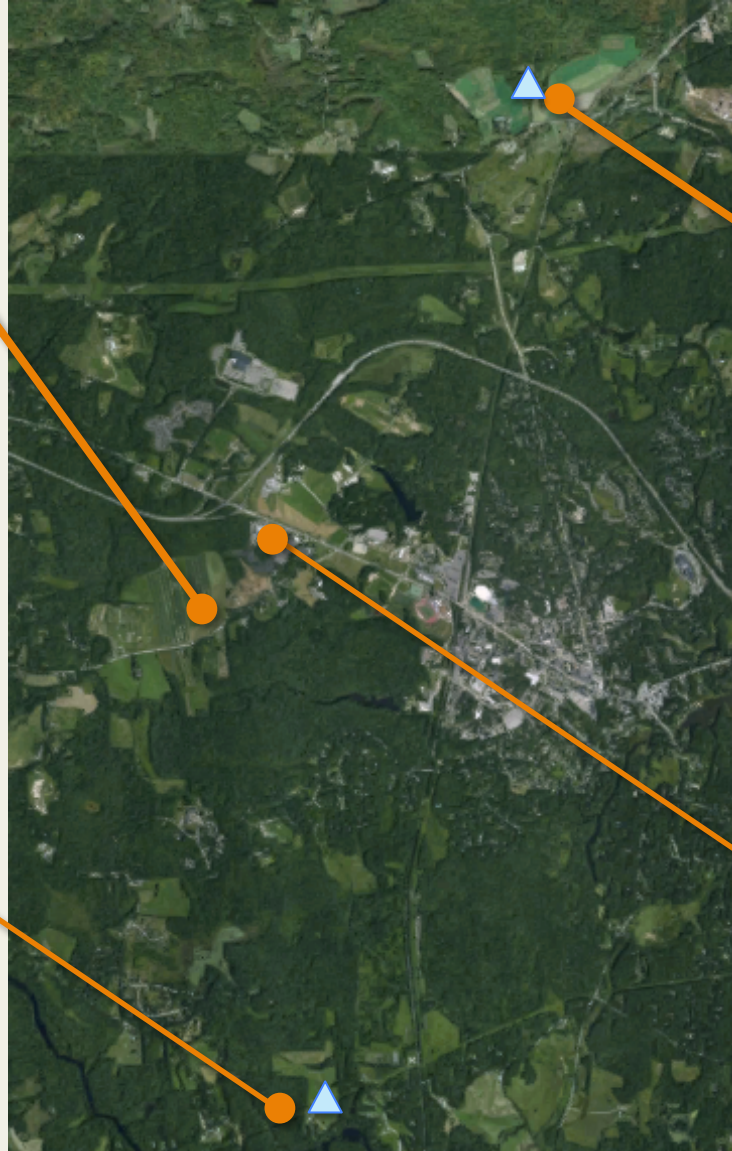
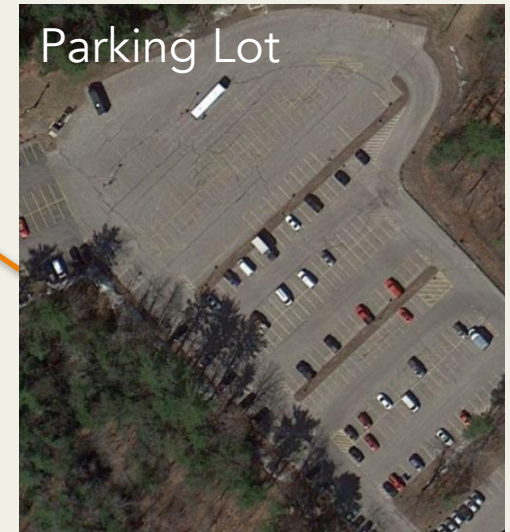
Hayfield



Mixed Forest

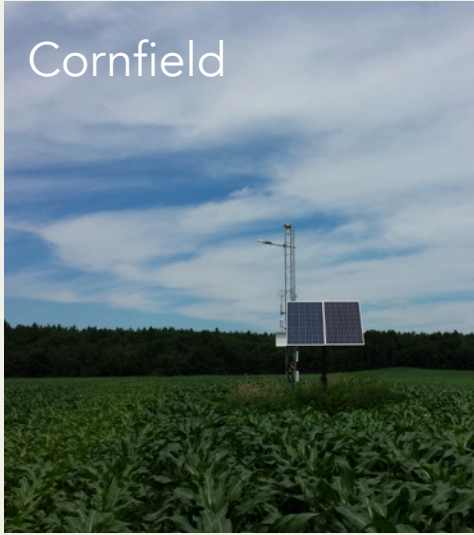


Parking Lot



Flux Tower Cluster

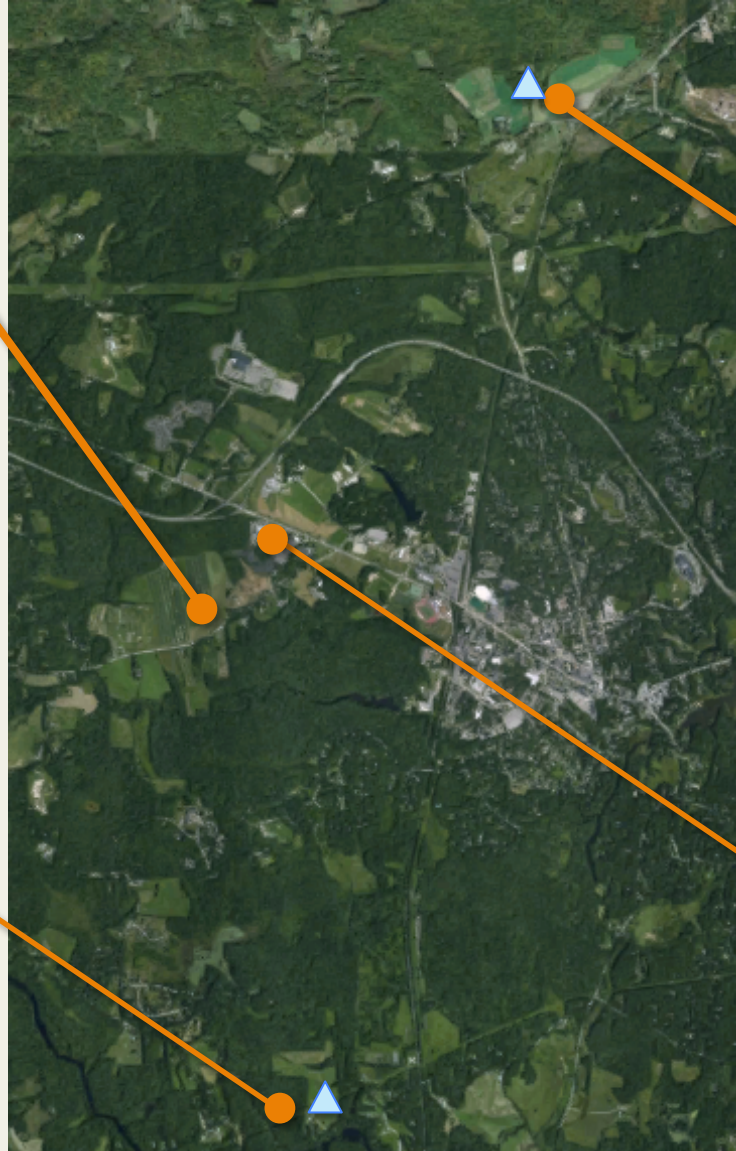
Cornfield



Hayfield



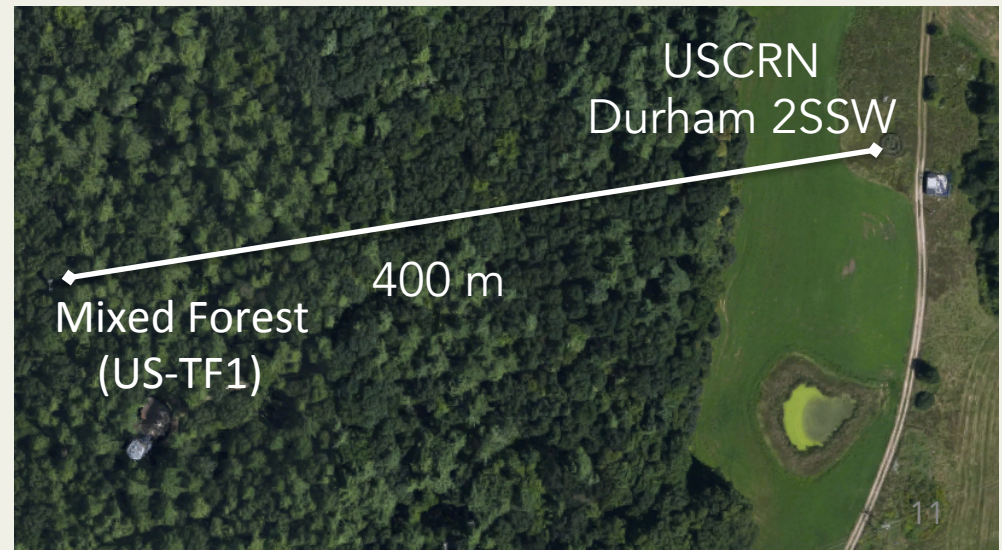
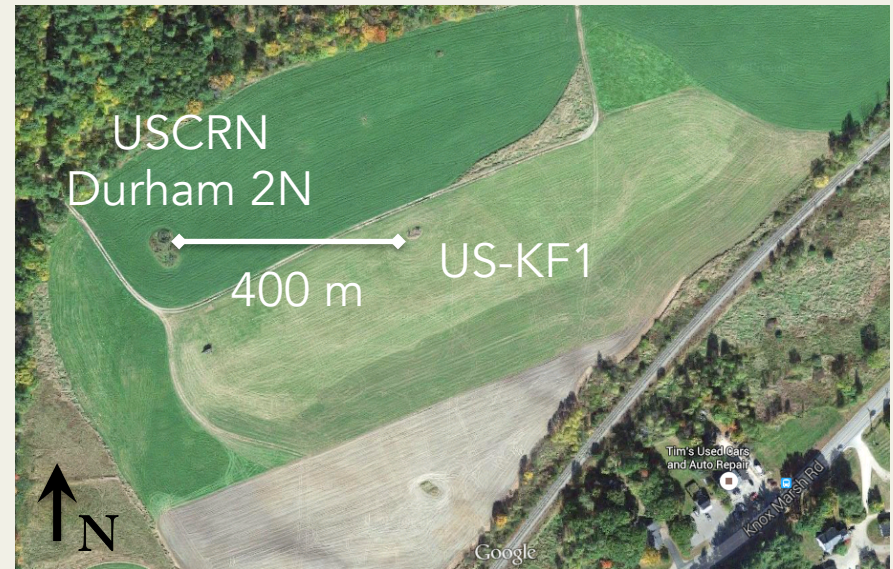
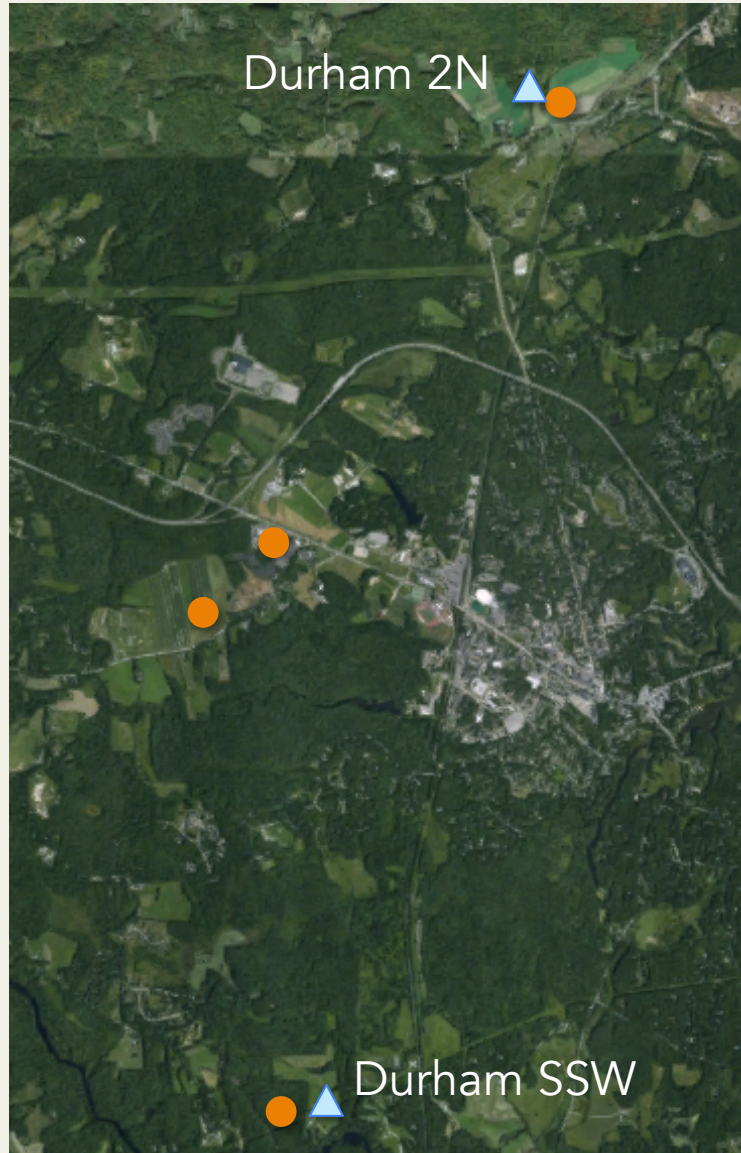
Mixed Forest



Parking Lot



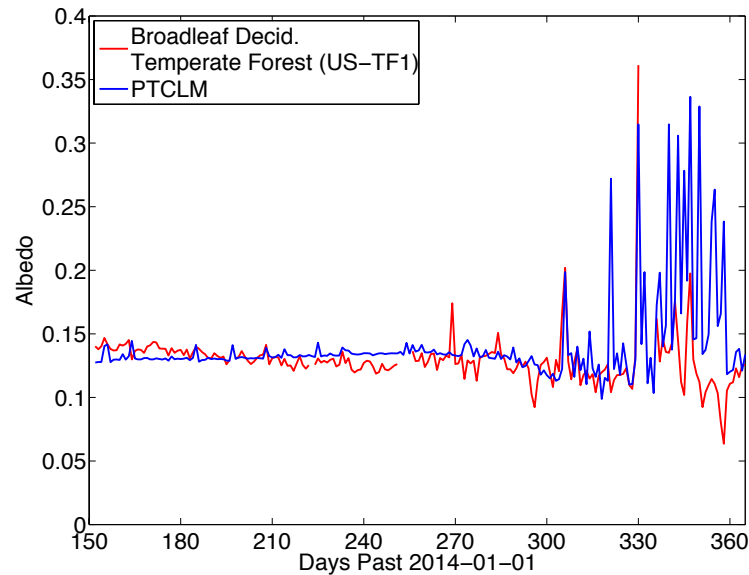
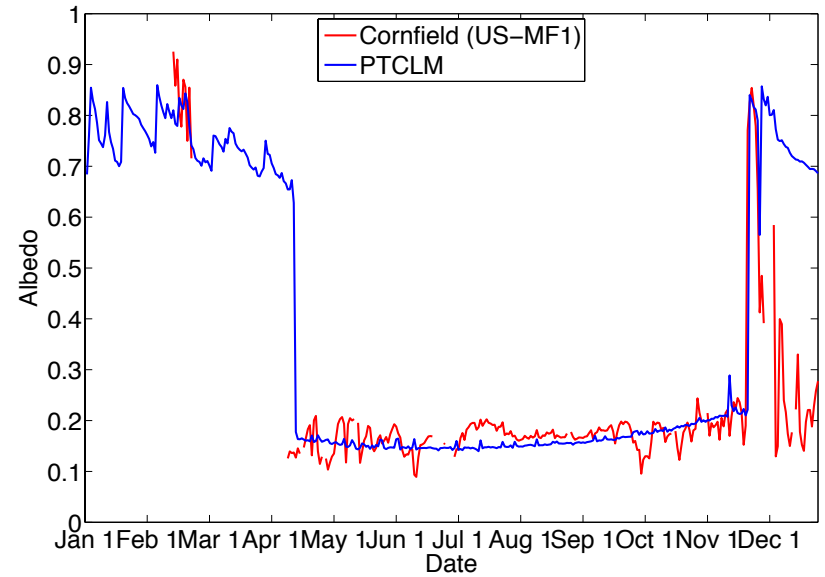
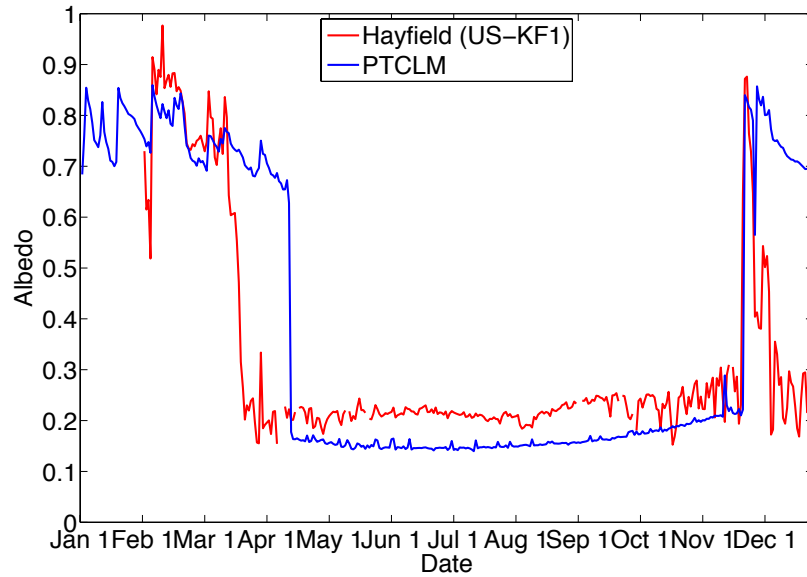
US Climate Reference Network



PTCLM45-SP

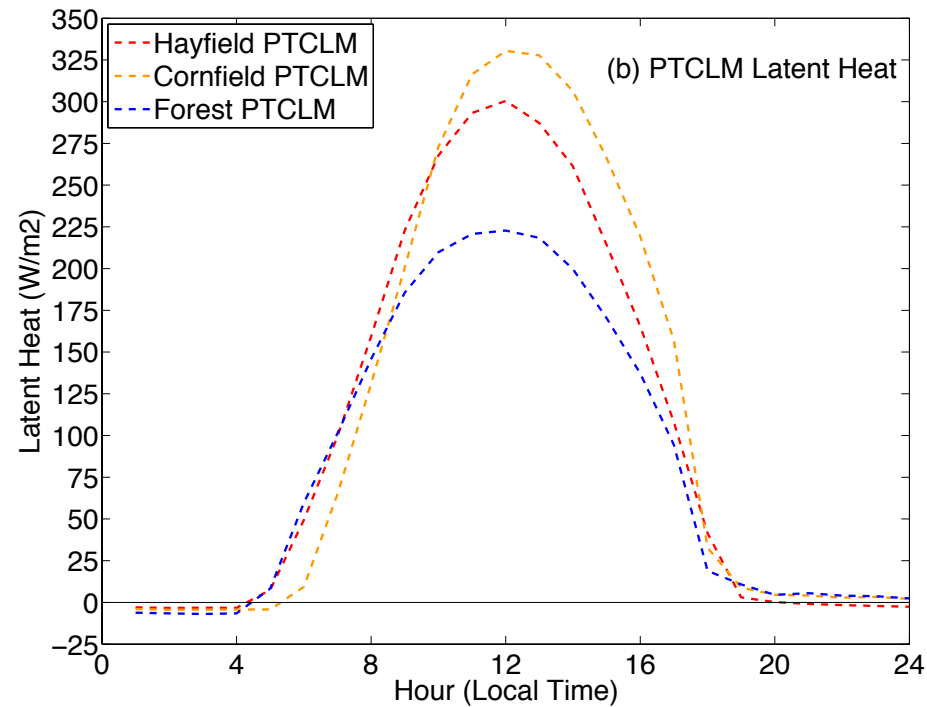
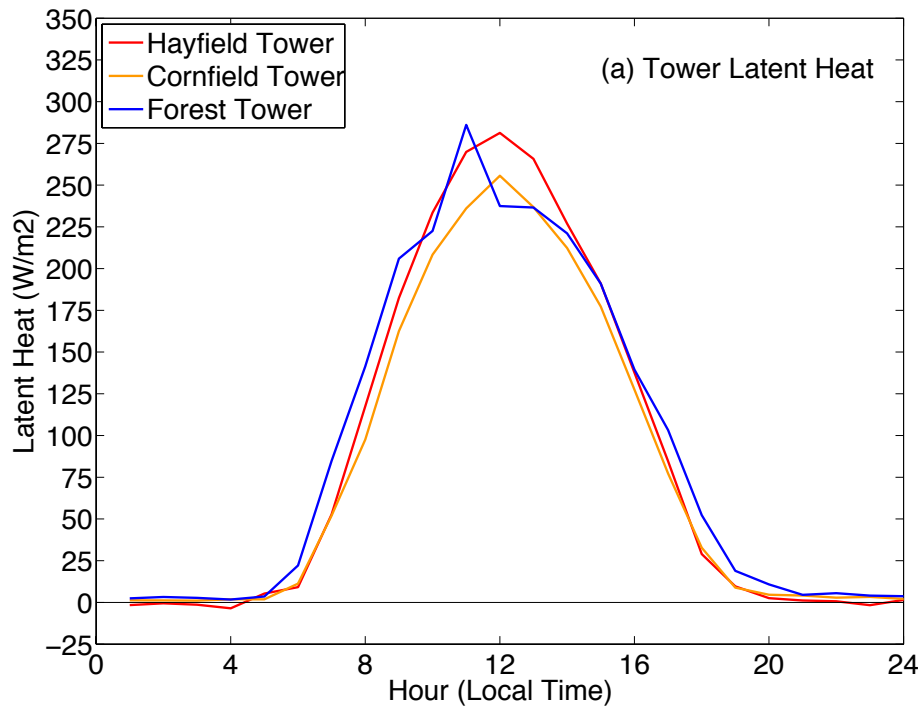
- Single point simulation using CLM45-SP
- Meteorology from three flux towers:
 - Hayfield: C3 non-arctic grass [13]
 - Cornfield: Crop 1 [15]
 - Mixed Forest: Broadleaf deciduous temperate [7]
- One year simulation (2014-01 through 2014-12)
- Satellite Phenology
- 35 year spin-up (except Mixed Forest)

Daily albedo



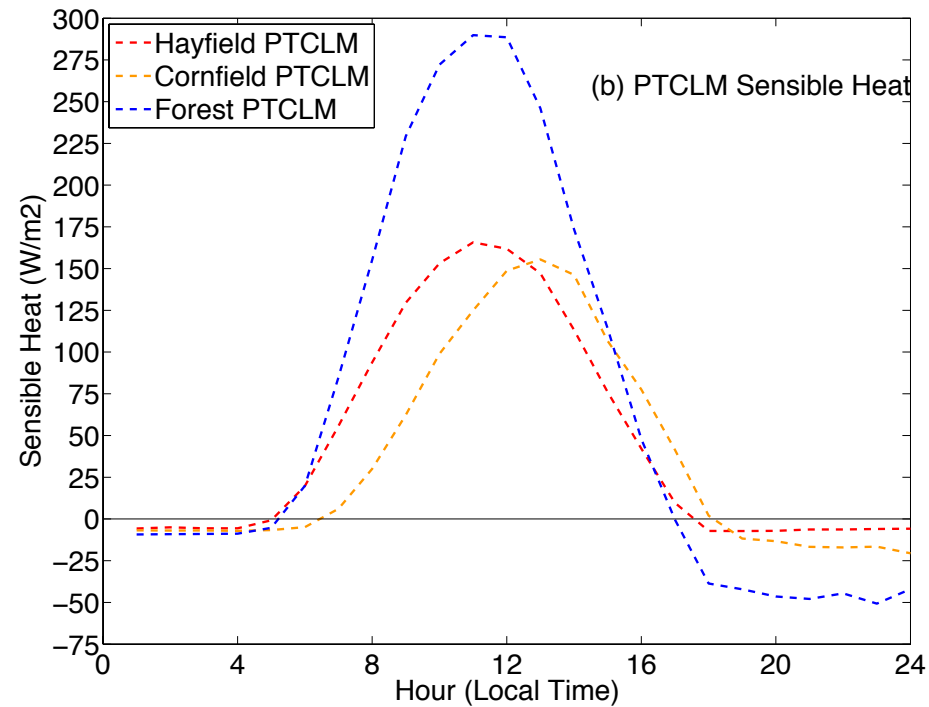
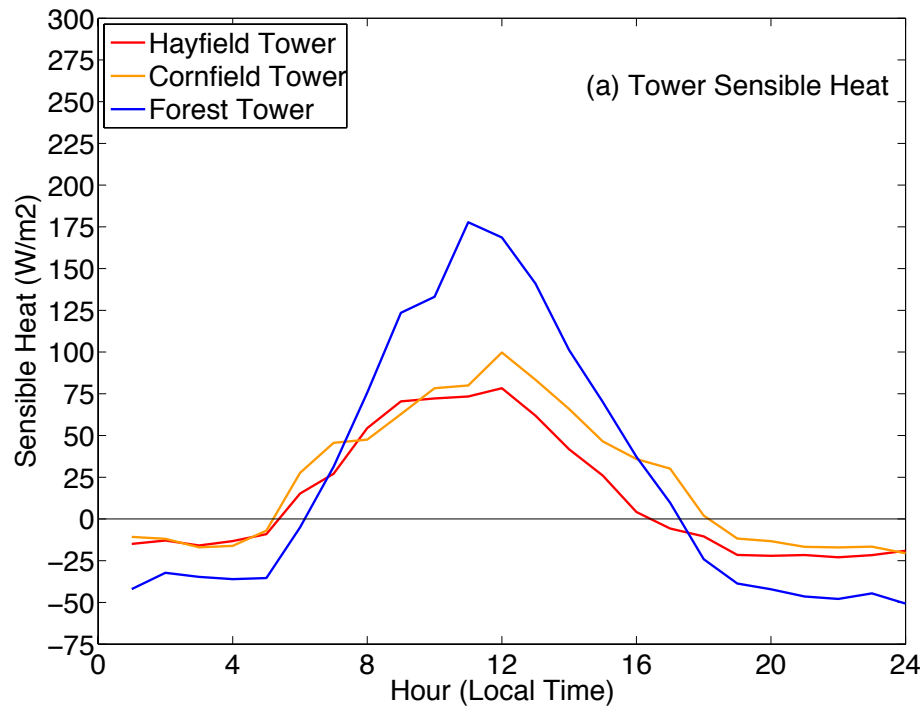
Summer diurnal latent heat fluxes

Much larger differences between forest and crops sites in PTCLM than in flux towers



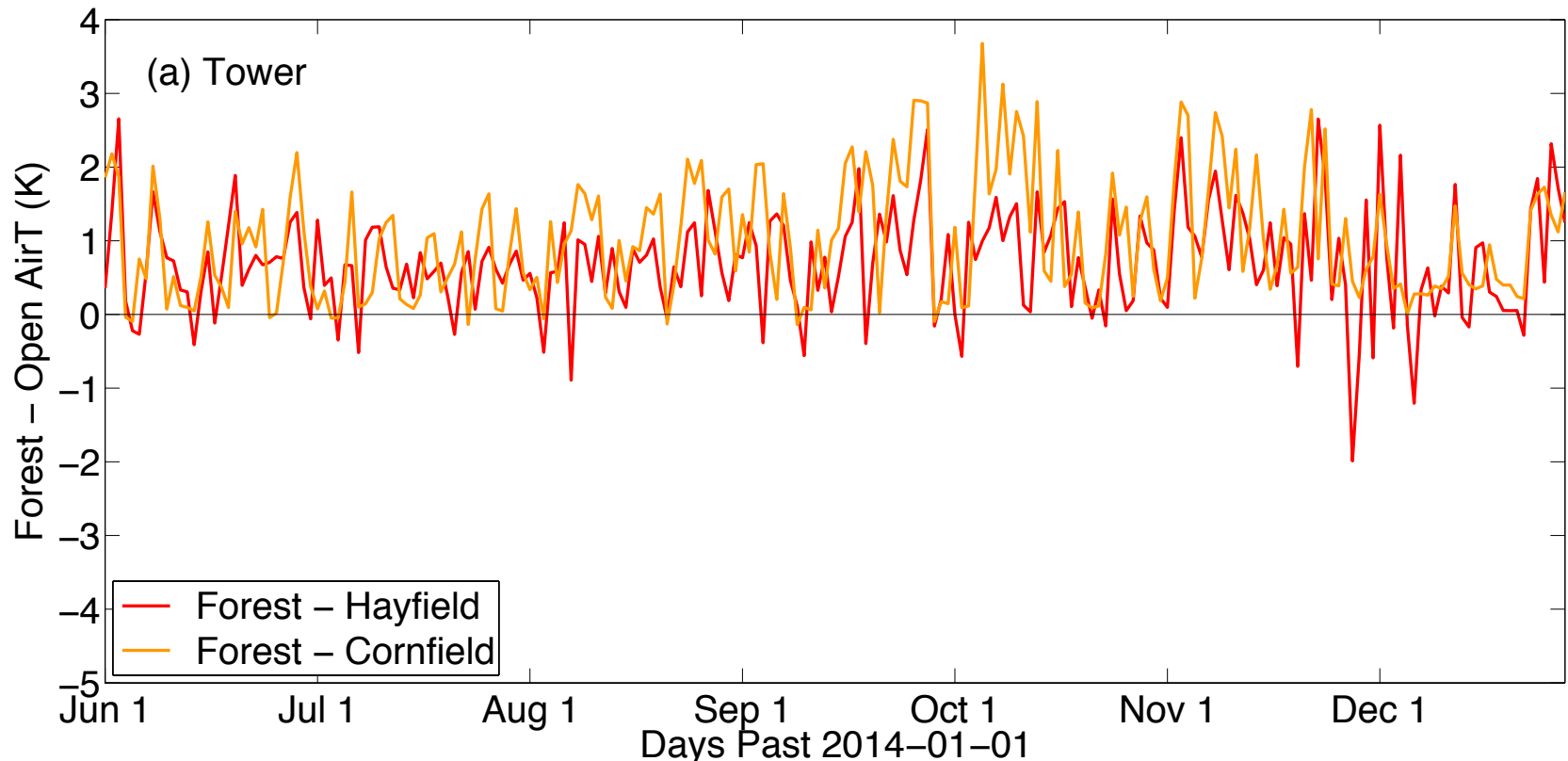
Summer diurnal sensible heat fluxes

Peak sensible heat flux much greater in PTCLM than in the flux towers



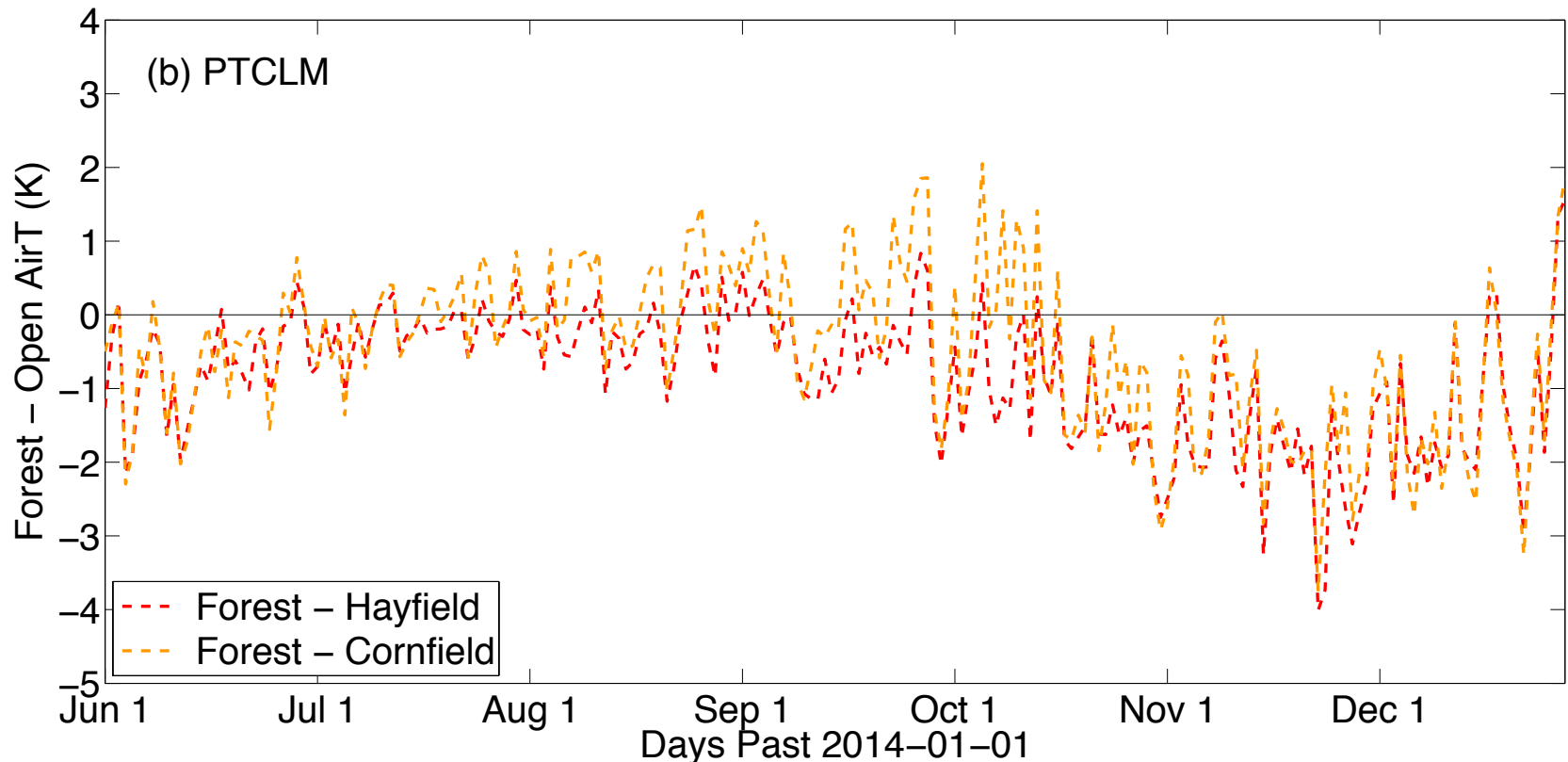
Daily mean air temperature differences

Forest generally warmer than hayfield and cornfield June through December.



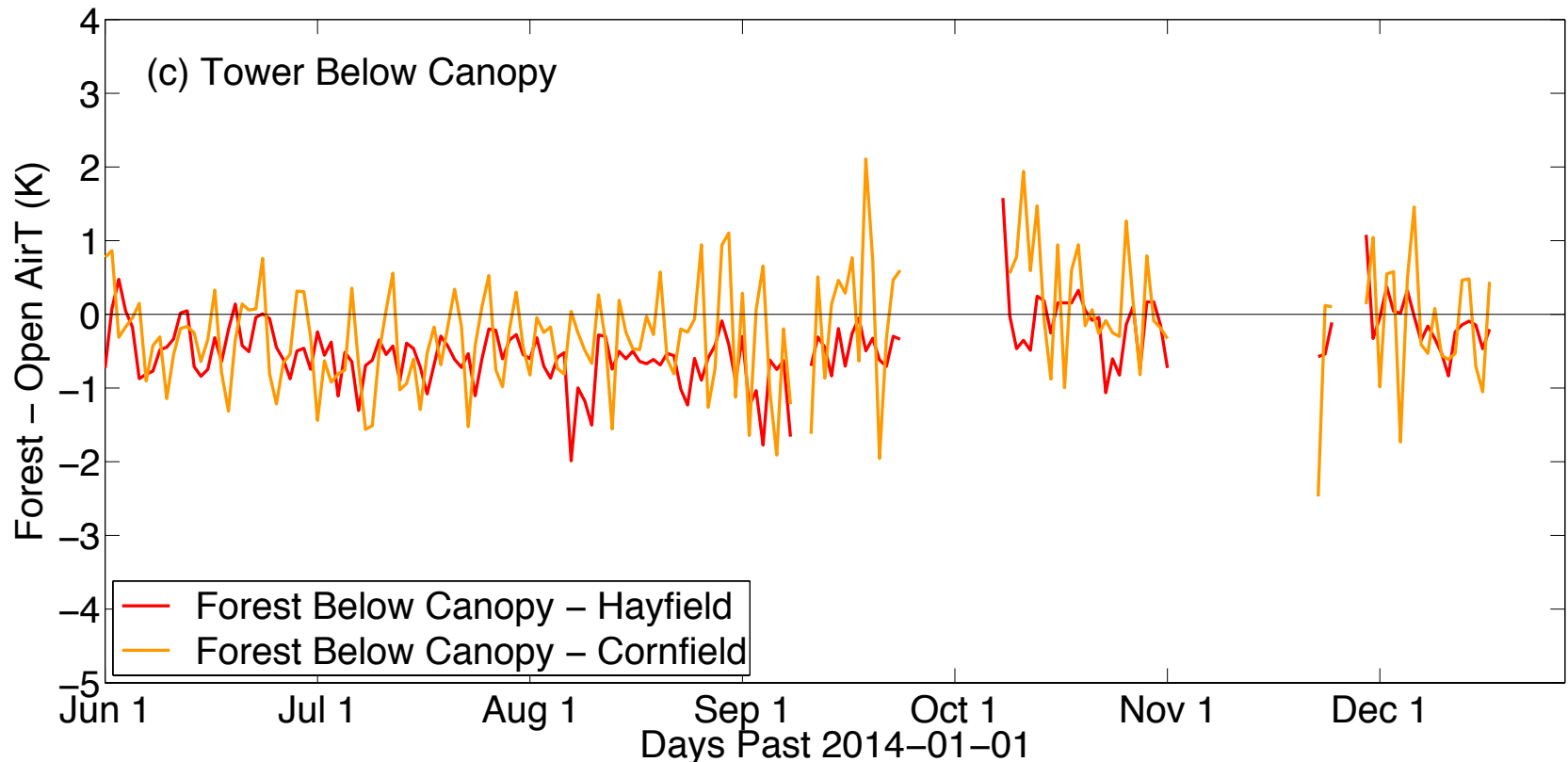
Daily mean air temperature differences

Forest generally cooler than hayfield in early summer and late fall.



Daily mean air temperature differences

Forest generally cooler than hayfield in early summer and late fall.



Climate Regulation as an Ecosystem Service: Biogeophysical Processes

$$\Delta T_s \approx \frac{\lambda_0}{1+f} \Delta S + \frac{-\lambda_0}{(1+f)^2} R_n \Delta f_1 + \frac{-\lambda_0}{(1+f)^2} R_n \Delta f_2$$

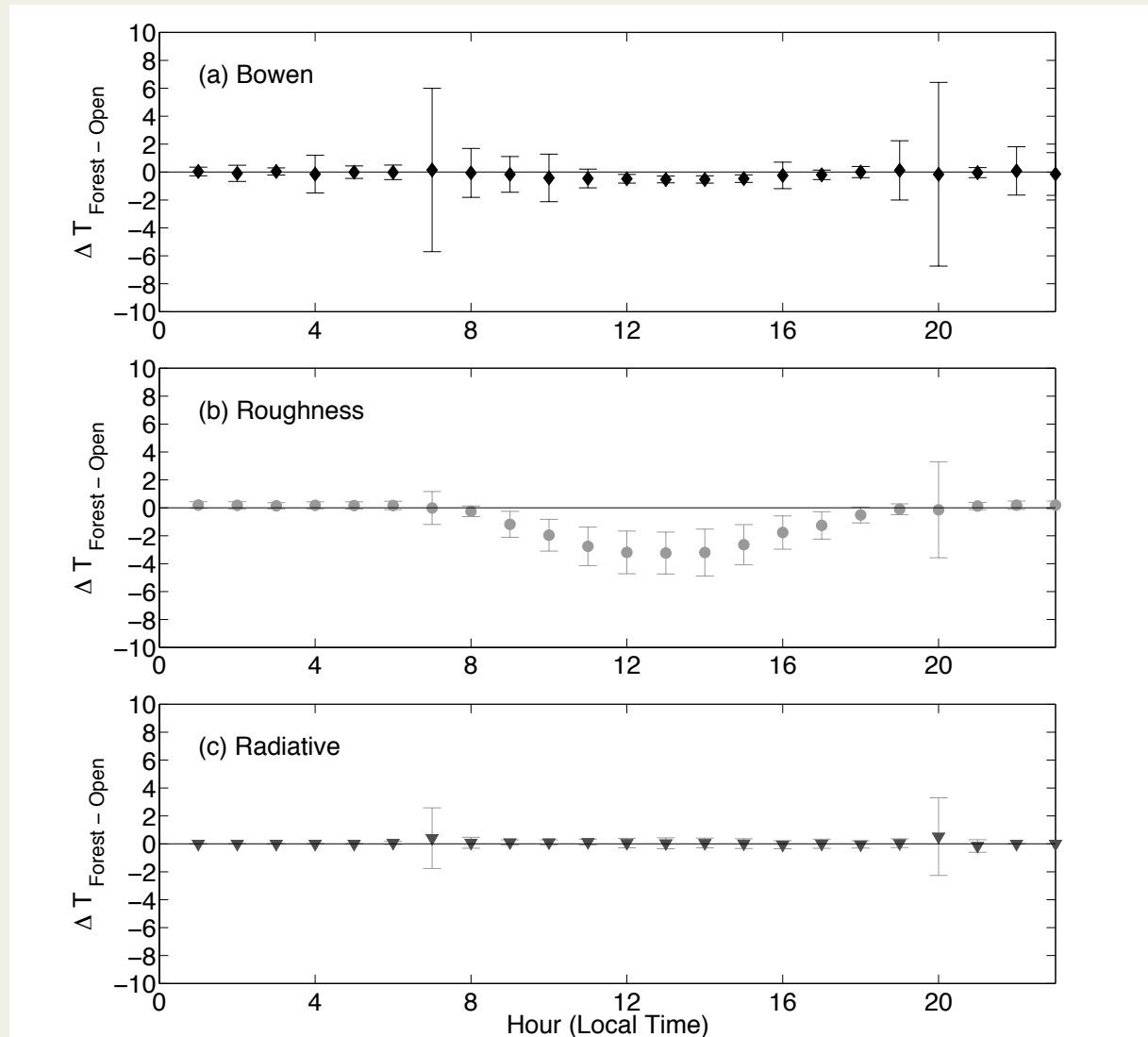
Radiative forcing
due to changes in
albedo

Energy Redistribution
due to changes
in surface roughness

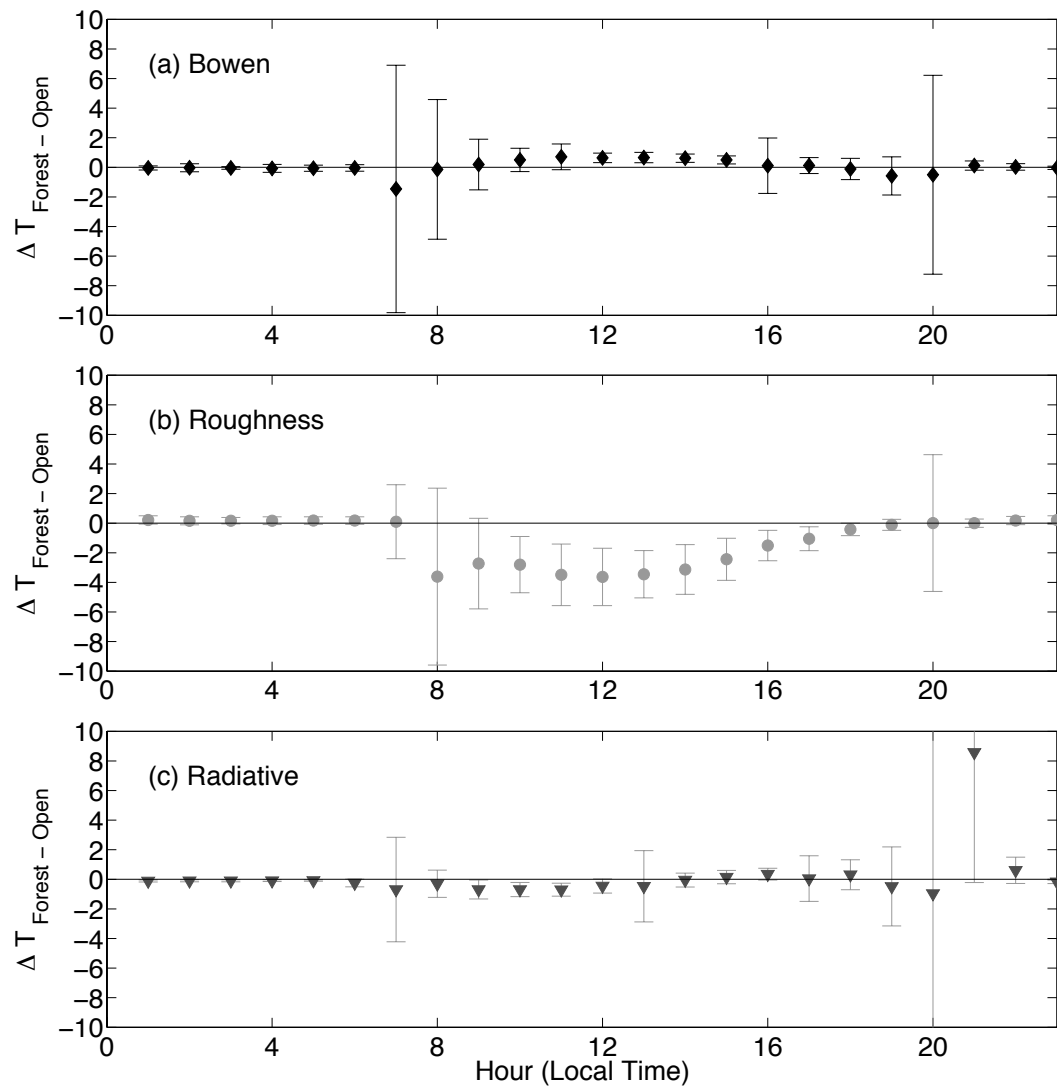
Energy Redistribution
due to changes
in Bowen ratio



Forest vs. Hayfield



Forest vs. Cornfield



Summary

- Snow cover persists longer at the hayfield site compared to PTCLM
- Summer albedo relatively well simulated at all sites
- Summer latent heat simulated by PTCLM higher in forest compared to towers; sensible heat lower
- Forest temperatures consistently warmer above canopy compared to open sites from June through December
- Below canopy forest temperatures more representative of CLM 2-m temperature
- Surface roughness dominates temperature differences between forest and open during the day
- Flux tower clusters contribute to better understanding of land cover influences at the local scale

Next Steps

- Identify flux tower clusters in boreal and tropical regions for PTCLM simulations
- Sensitivity analyses to identify what drives differences in sensible and latent heat fluxes between forested and open sites
- Apply Intrinsic Biophysical mechanism framework to global CLM simulations

Acknowledgements



National Science Foundation Experimental Program to Stimulate Competitive Research (EPSCoR) Award #1101245



Computing, processing, and data storage provided by the NCAR Computational and Information Systems Laboratory (CISL)