Ecosystem Data Products:

Canopy Nitrogen and Albedo

Mary Martin, Scott Ollinger, Lucie Lepine

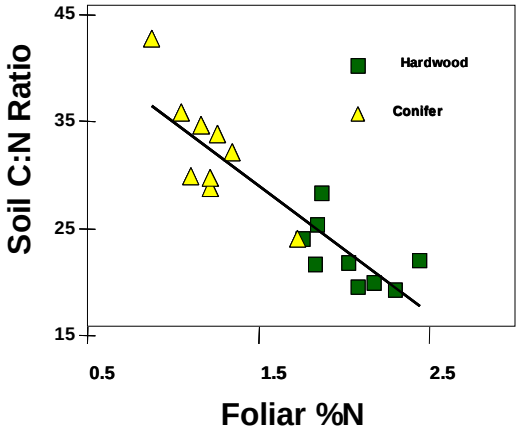
University of New Hampshire

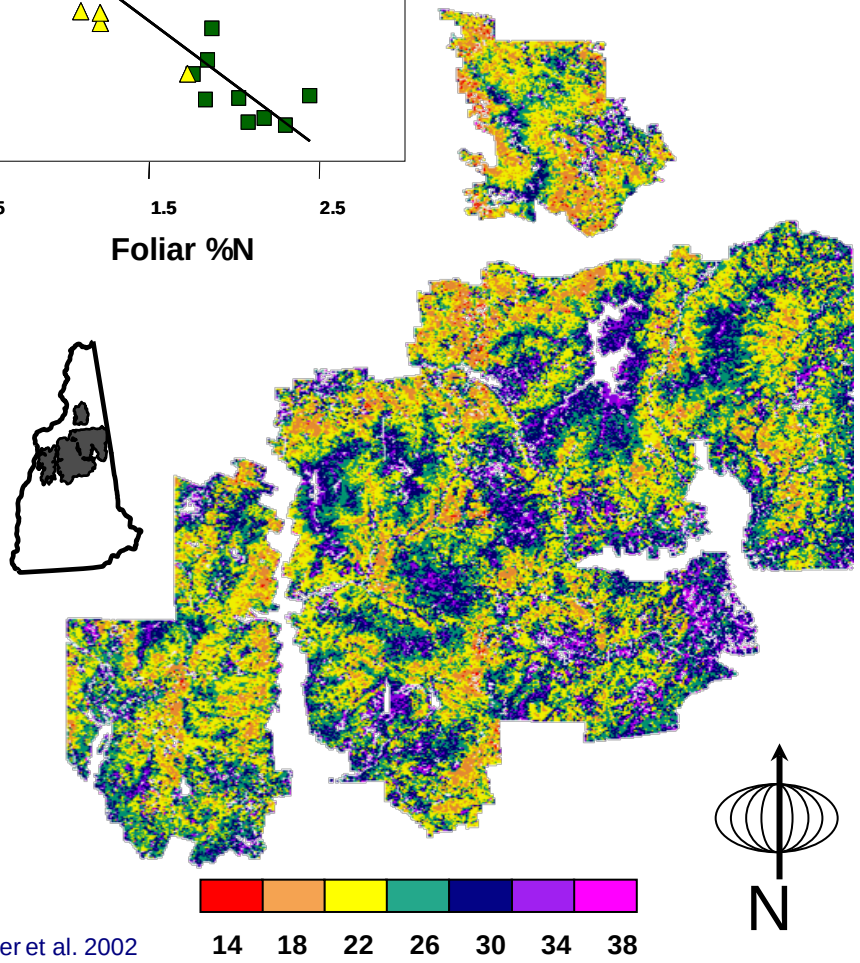
HyspIRI Science Symposium on Ecosystem Data Products

5/4/2010

UNIVERSITY of NEW HAMPSHIRE

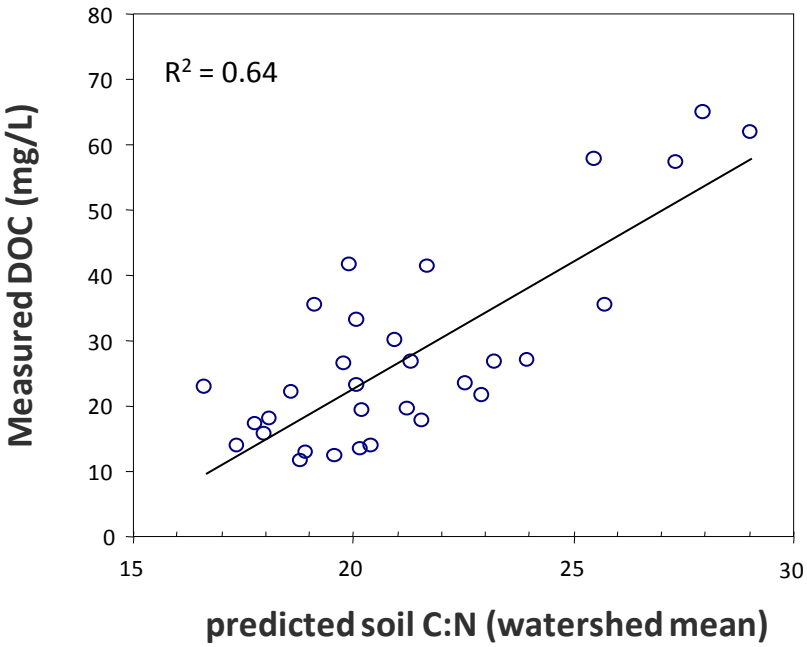
AVIRIS-Predicted Foliar Chemistry Used to Estimate Soil Nitrogen Cycling





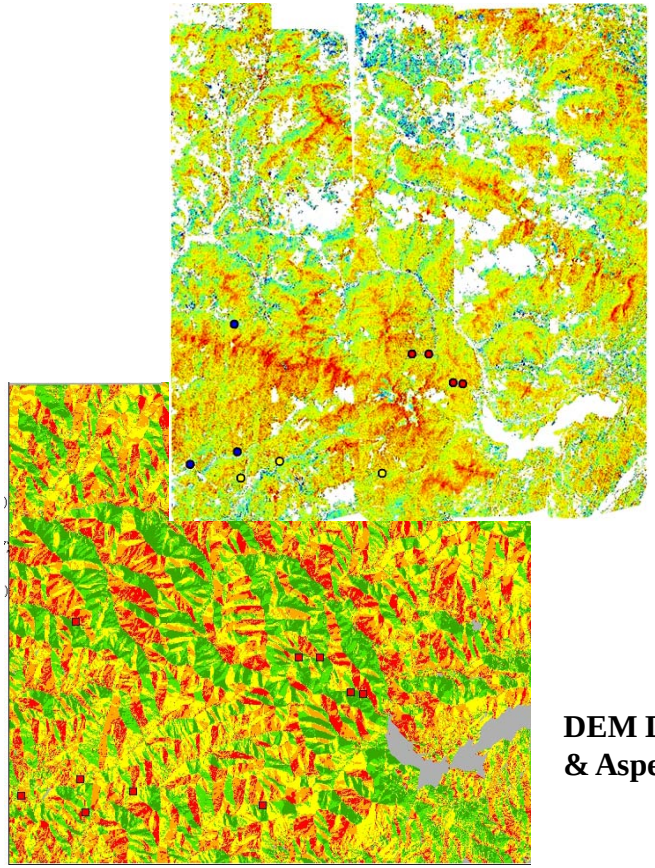
Ollinger et al. 2002

Predicted C:N versus Stream DOC



Forest N status and Susceptibility to the Hemlock Wooly Adelgid

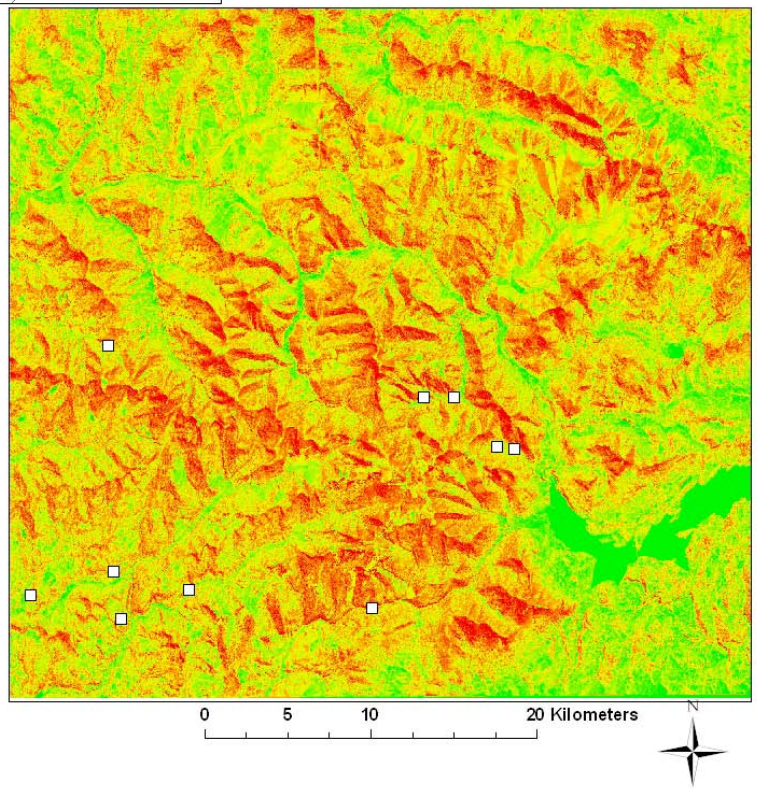
Input Data Layers



AVIRIS-Derived Foliar %N

DEM Derived Slope & Aspect

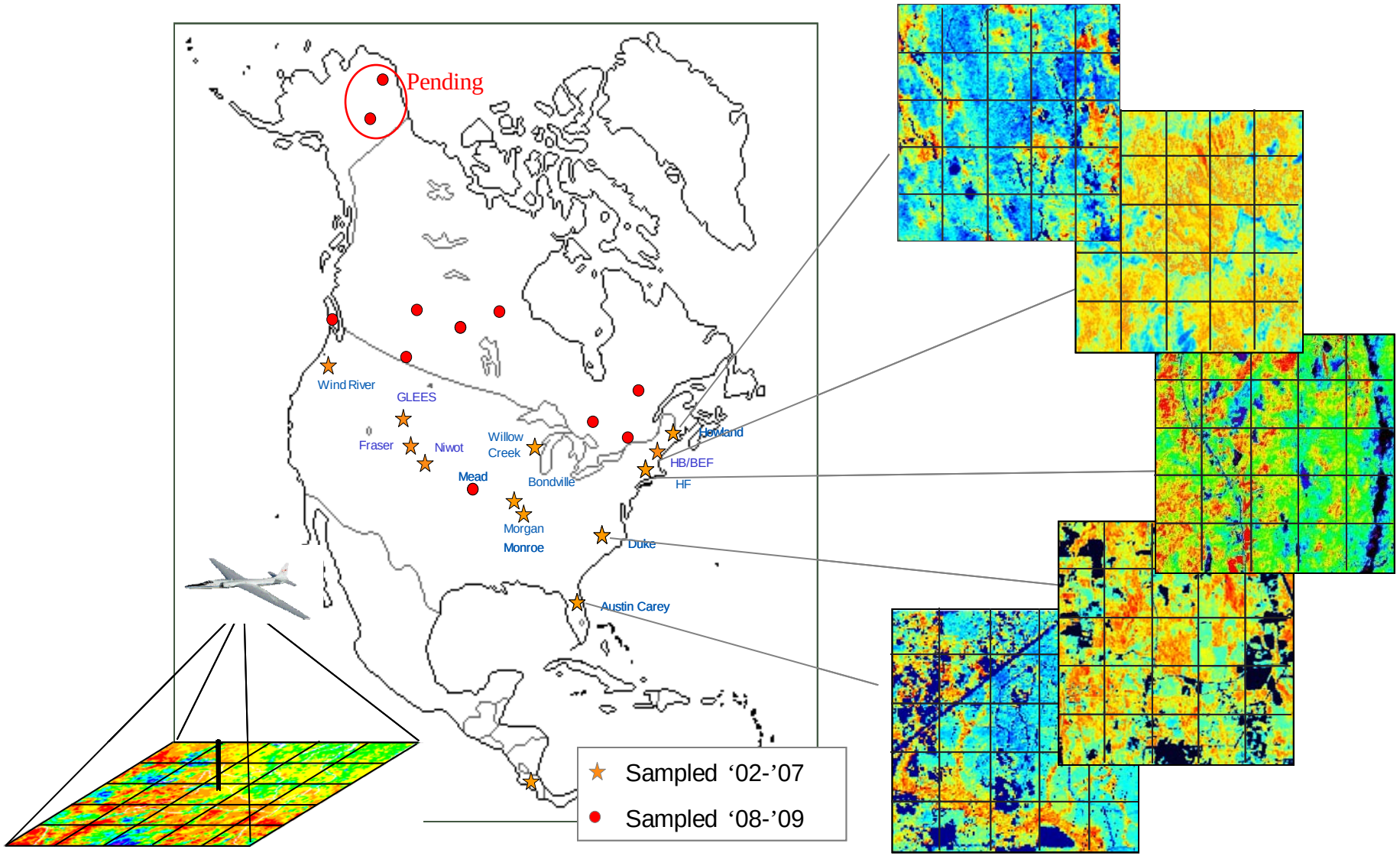
Susceptibility Risk: Slope/Aspect/Foliar N



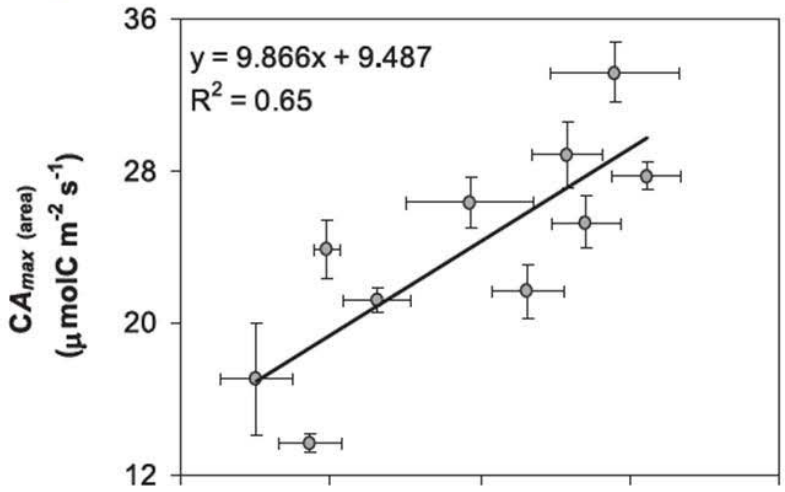
Pontius et al. 2008

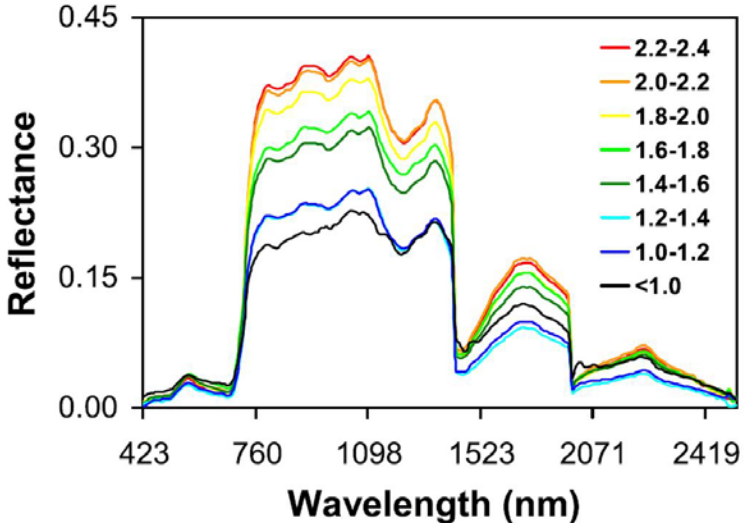
The resulting model explained 51% of the variability in observed hemlock decline

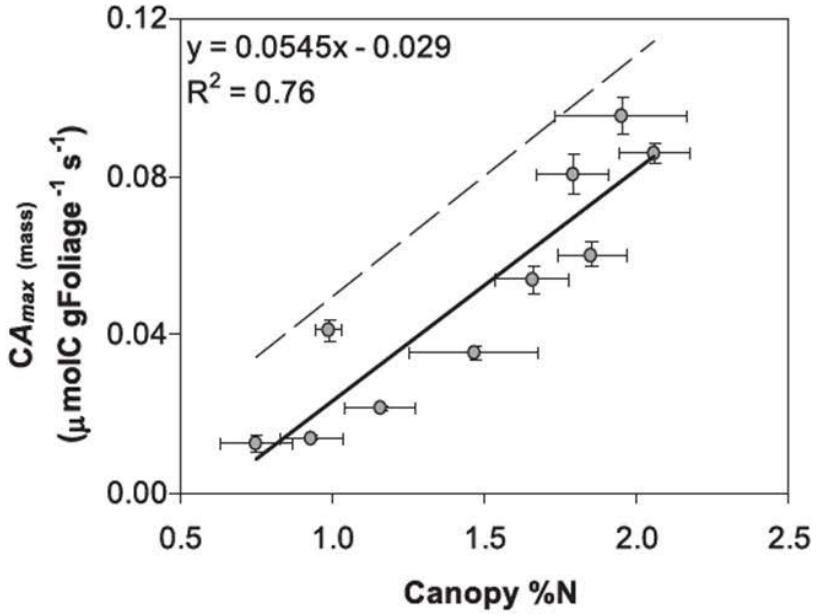
Continental synthesis of CO_2 Flux data, field measurements, imaging spectroscopy and global satellite sensors

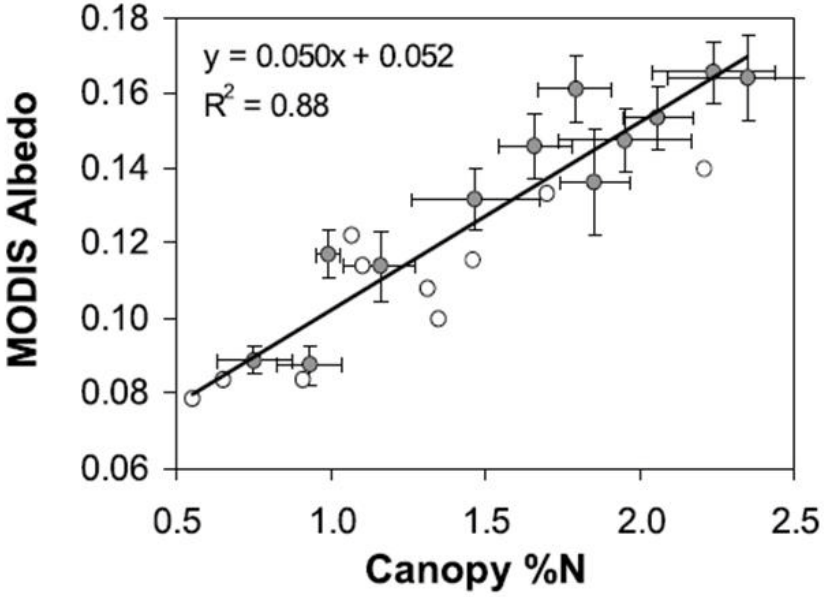


Canopy nitrogen, photosynthetic capacity (Amax) and shortwave albedo are inter-related in N. American forests

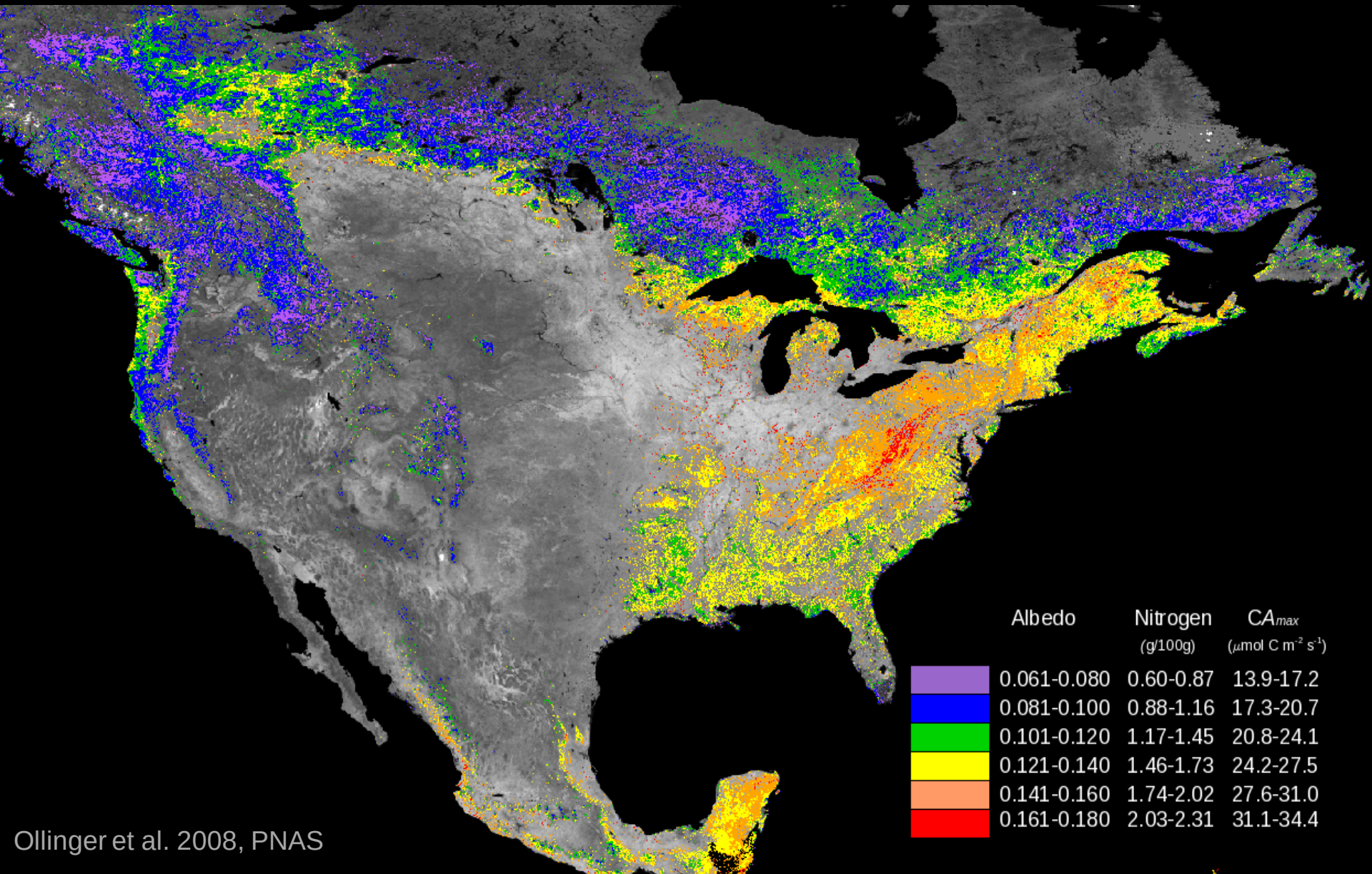






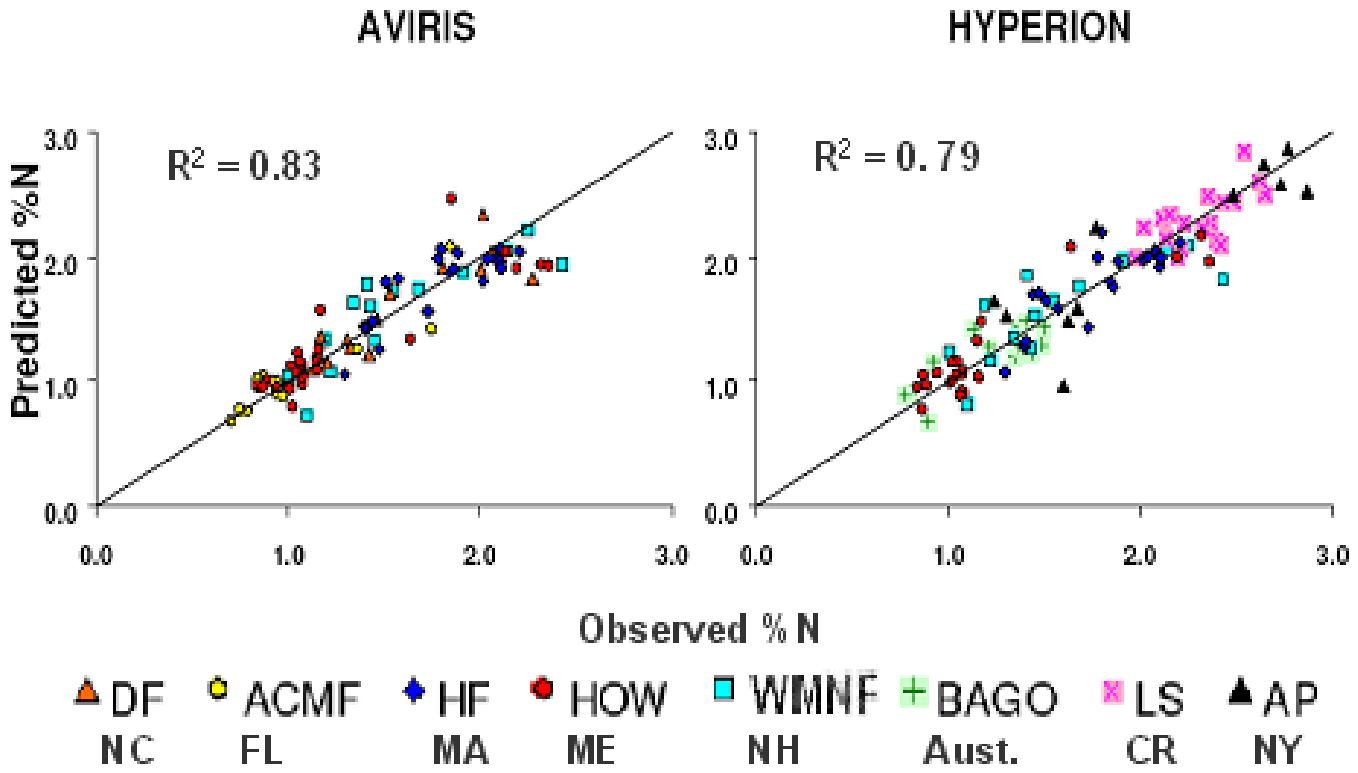


Predicted Canopy Nitrogen and Photosynthetic Capacity in N. American Forests



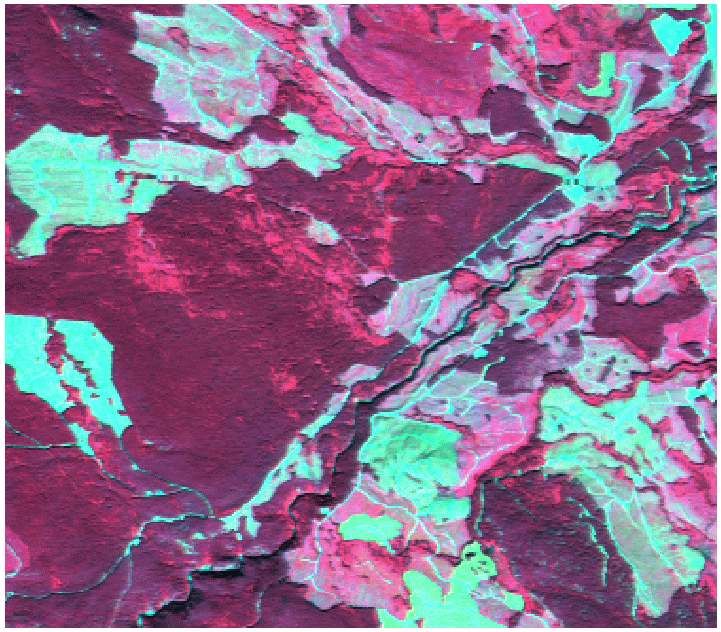
Ollinger et al. 2008, PNAS

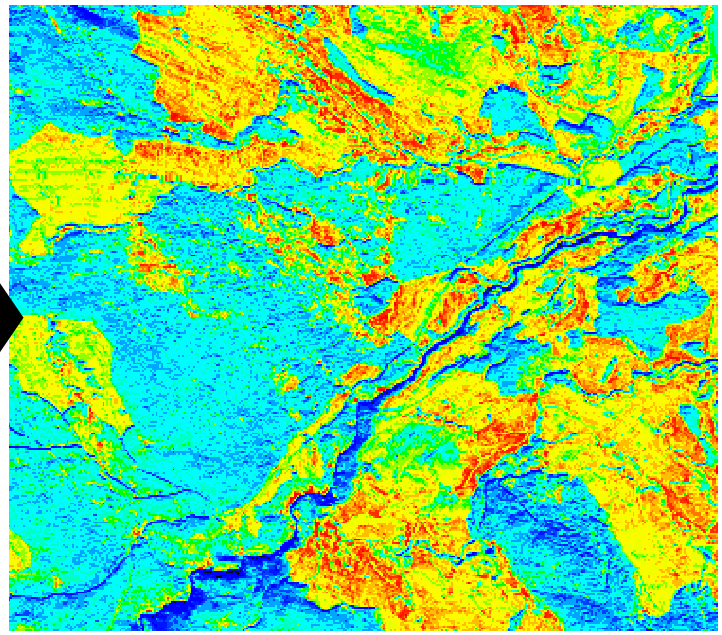
Developing a multi-site generalized equation to predict canopy nitrogen concentration

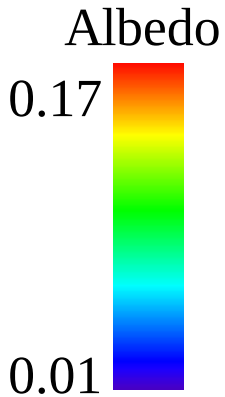


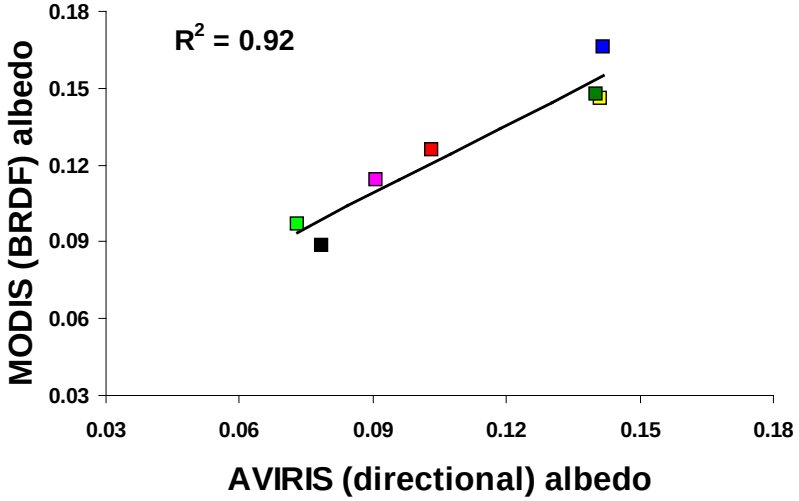
Martin et al. 2008 RSE

AVIRIS reflectance (left) used to calculate shortwave surface albedo (right).









- Bartlett, NH
- Hubbard Brook, NH
- Harvard Forest, MA
- Howland, ME
- Wind River, WA
- Campbell River (Harvested), BC
- Campbell River (Mature), BC

Ongoing Research Questions:

1. Do the trends observed in NA forests also apply across other biomes?

2. Do they also apply at local as well as continental scales?

3. Do regional patterns in N deposition and other disturbances have an influence on patterns of albedo?

4. What is the mechanism driving the N-albedo relationship?
   - Leaf angle distribution
   - Foliar spatial patterning (e.g. needle and leaf clumping)
   - Leaf or canopy level trait that we haven't yet examined.

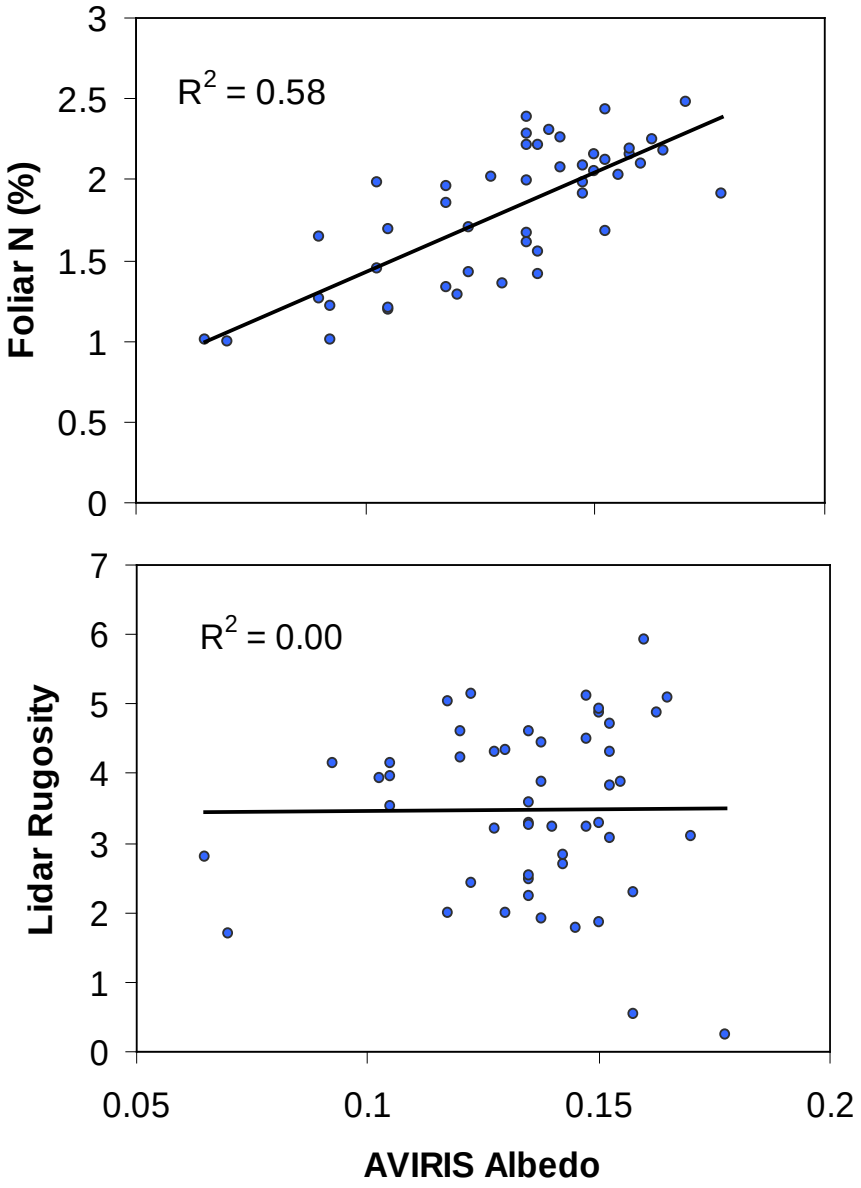
Role for HyspIRI data:

1. Ideal scale/coverage to bridge the gap between isolated AVIRIS datasets and continental scale MODIS data products

2. Nitrogen and Albedo data products can be generated as with AVIRIS.

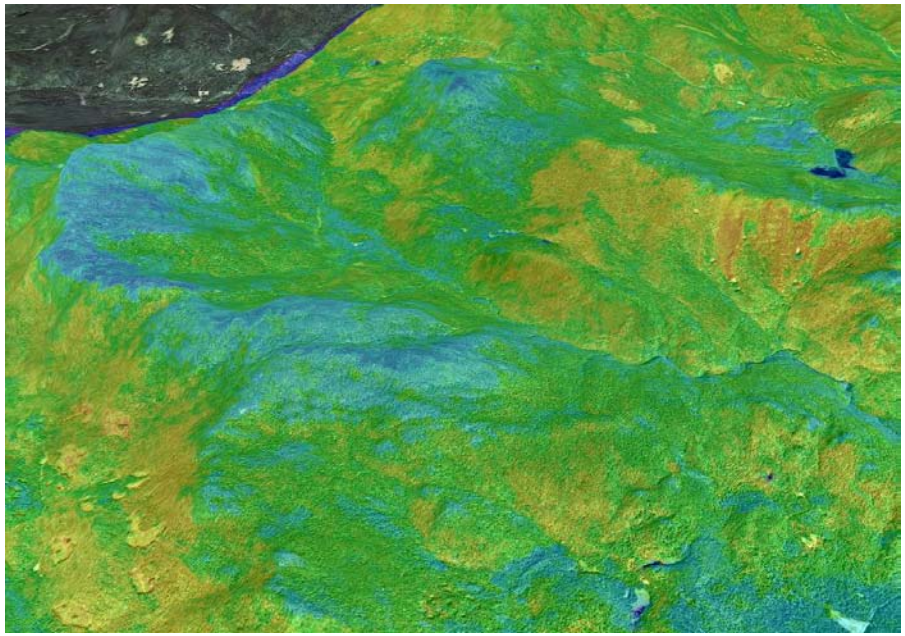
3. Provides an opportunity to better understand potential feedbacks in the climate system involving the N cycle as a regulator of both C cycling AND energy exchange.

Landscape-scale patterns of %N and canopy structure

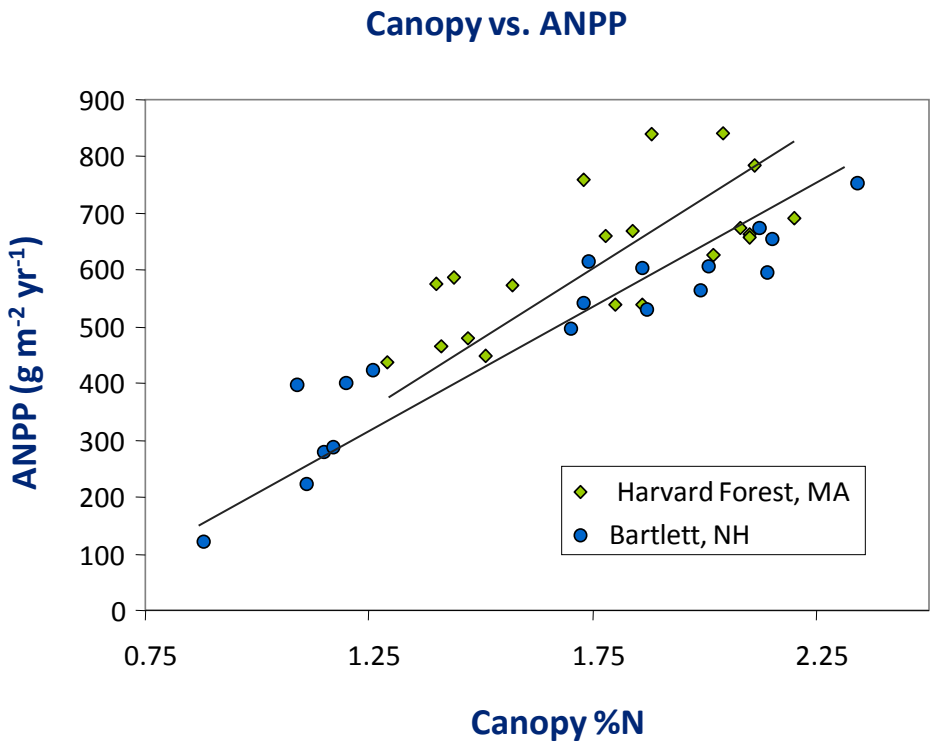


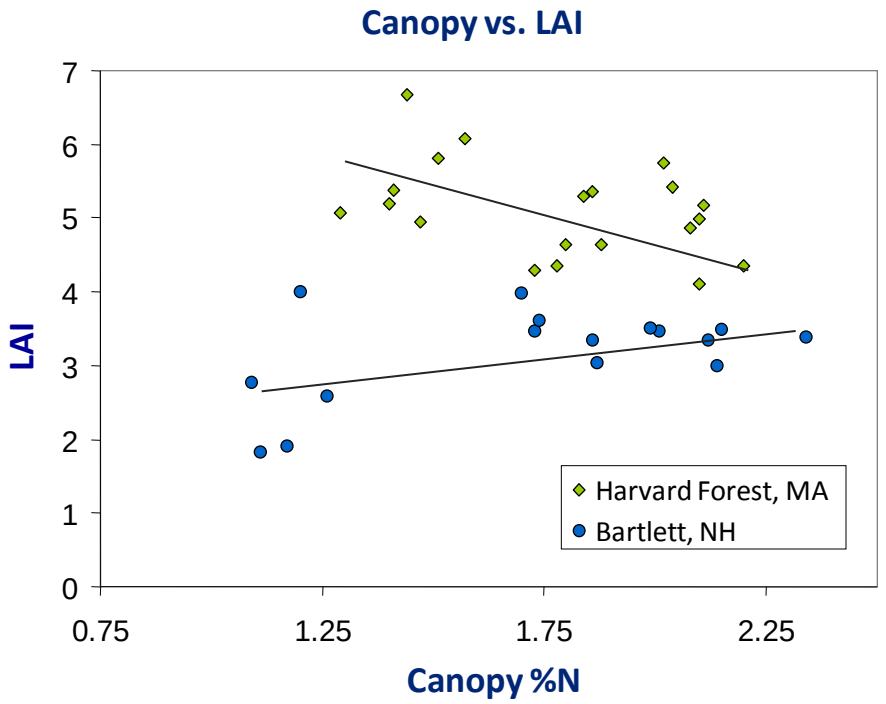
At 20 m spatial resolution, the N-based relationship holds.

No effect of canopy surface roughness (Rugosity)

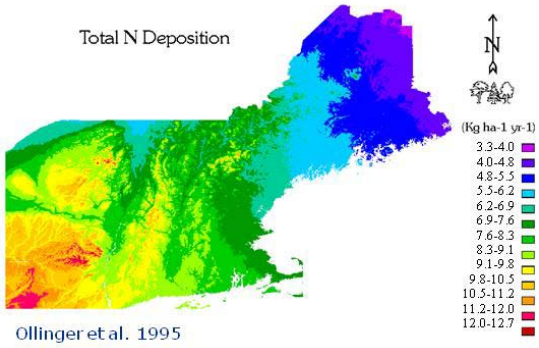


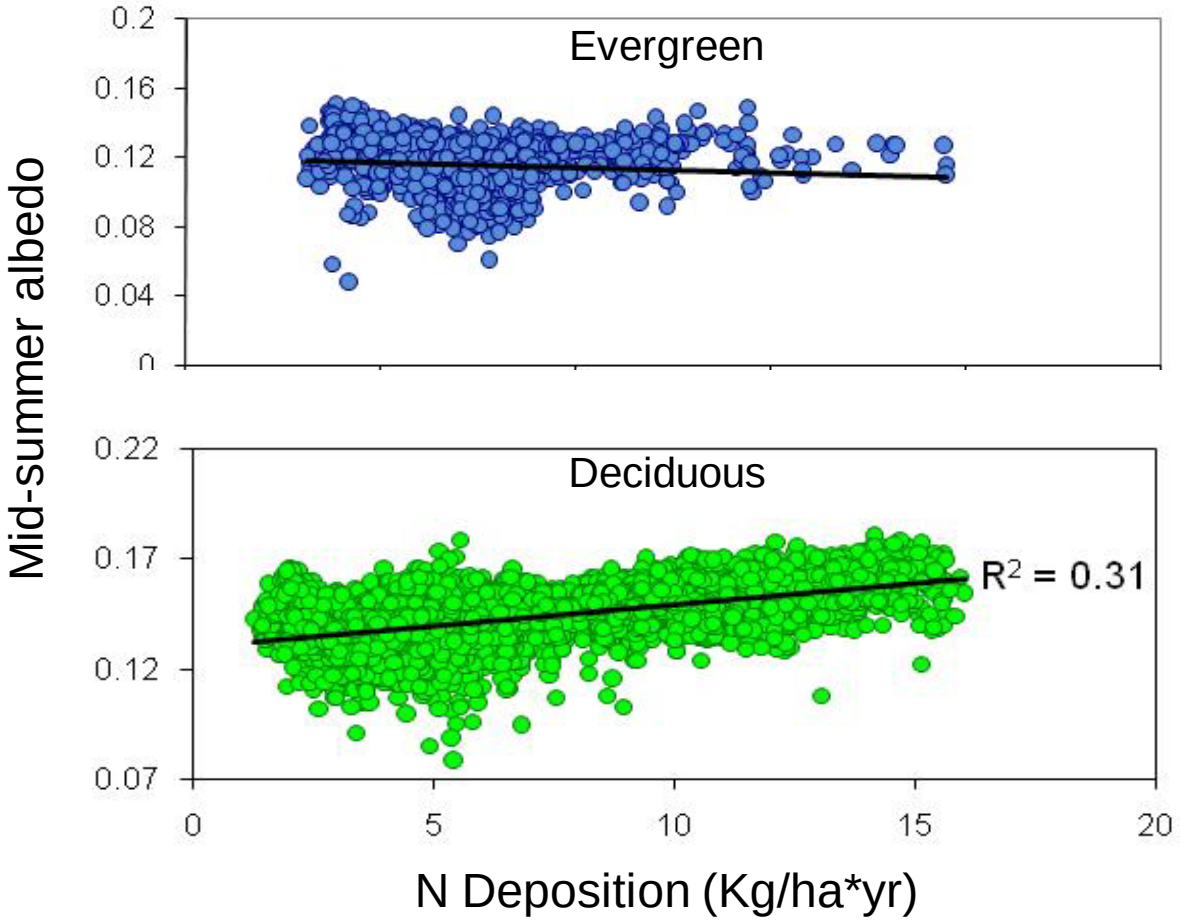
ANPP in Most Eastern U.S. Temperate Forests Scales with N Status, not LAI.





Nitrogen Deposition and Mid-Summer Shortwave Albedo

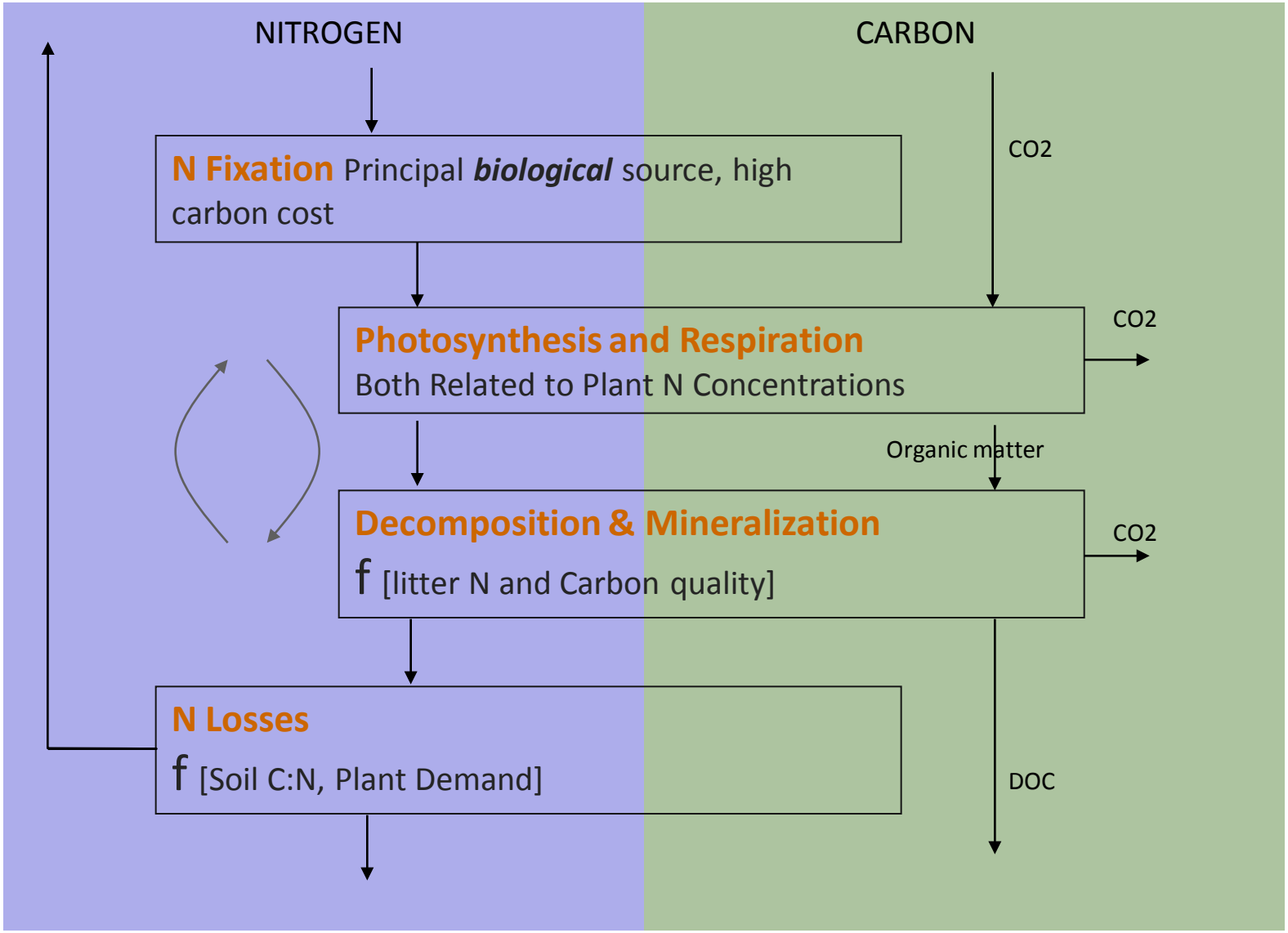




DOES NITROGEN PLAY A PREVIOUSLY UNRECOGNIZED ROLE IN THE CLIMATE SYSTEM?

- C cycle effects and albedo effects typically viewed as separate mechanisms.
- Our results indicate that they are more intimately related and are linked via plant nitrogen status.
- This suggests a potential feedback in the climate system involving the N cycle as a regulator of both C cycling *AND* energy exchange.

C & N: Joined by a Shared Set of Biological Reactions



Nitrogen availability is a key constraint on carbon cycling in terrestrial ecosystems and it is largely in this capacity that the role of nitrogen in the climate system has been considered.

Nevertheless, broad-scale analyses rarely include spatial variation in plant N status as a driving variable. ***WHY?***

1. *Uncertainty about how leaf-level photosynthesis-nitrogen relationships aggregate to whole canopies and ecosystems.*

2. *There are no methods to remotely sense canopy nitrogen concentrations at broad spatial scales.*