Canopy structural complexity as a continental predictor of primary production: Using NEON to transform understanding of forest structure-function

Jeff Atkins, Robert Fahey, Chris Gough, and Brady Hardiman
Physical structure and carbon cycling at the continental scale
Physical structure and carbon cycling at the continental scale

- Canopy structural complexity (CSC) varies at the continental scale
- Beyond LAI
- Scaling and model integration
- Cross-platform comparison

Physical Structure → Resource Acquisition + Efficiency → Production
We are using NEON, LTER, Ameriflux, and other field station sites to examine how and why ecosystem structure relates to forest net primary production.
We are using NEON, LTER, Ameriflux, and other field station sites to examine how and why ecosystem structure relates to forest net primary production.
Let's talk about CSC, baby

Porosity
Let's talk about CSC, baby

Porosity

Deep gaps

Credit: ian.umces.edu/imagelibrary
Let's talk about CSC, baby

Porosity

Rugosity

Deep gaps

Credit: ian.umces.edu/imagelibrary
Metric of canopy complexity
Arrangement of leaves, rather than amount (LAI)
LAI saturates, while Rugosity continues to increase with stand age

From Hardiman et al. 2013 (FEM)
Portable Canopy LiDAR (PCL)

Reigl 3100VHS-FLP - A near-infrared pulsed laser firing at 2000 Hz
A Portable Airborne Laser System for Forest Inventory

Ross Nelson, Geoffrey Parker, and Milton Hom

Canopy-structure effects on surface roughness parameters: Observations in a Great Lakes mixed-deciduous forest

Kyle D. Maurer, Brady S. Hardiman, Christopher S. Vogel, Gil Bohrer

The role of canopy structural complexity in wood production of a maturing northern deciduous forest

Brady S. Hardiman, Gil Bohrer, Christopher M. Gough, Christoph S. Vogel

The canopy surface and stand development: assessing forest canopy structure and complexity with near-surface altimetry

Geoffrey G. Parker, Mary E. Russ
<table>
<thead>
<tr>
<th>Frequency Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARNO</td>
</tr>
<tr>
<td>FERN</td>
</tr>
<tr>
<td>GRSM</td>
</tr>
<tr>
<td>HARV</td>
</tr>
<tr>
<td>MLBS</td>
</tr>
<tr>
<td>OSBS</td>
</tr>
<tr>
<td>SCBI</td>
</tr>
<tr>
<td>SERC</td>
</tr>
<tr>
<td>TALL</td>
</tr>
<tr>
<td>TREE</td>
</tr>
<tr>
<td>UNDE</td>
</tr>
<tr>
<td>UVAX</td>
</tr>
<tr>
<td>Rugosity</td>
</tr>
</tbody>
</table>

The table above shows the frequency distribution of various categories labeled ARNO, FERN, GRSM, HARV, MLBS, OSBS, SCBI, SERC, TALL, TREE, UNDE, and UVAX. Each category is represented by a histogram on the right side of the table, with the x-axis showing Rugosity and the y-axis showing the frequency distribution.
Ordway-Swisher Biological Station

Canopy Rugosity – 0.9
Great Smoky Mountains
Great Smoky Mountains

Canopy Rugosity – 75.0
Arnot Forest
Arnot Forest

Canopy Rugosity – 14.4
Beyond LAI . . .

Resource efficiency and acquisition

fPAR
Beyond LAI . . .
Resource efficiency and acquisition

fPAR
Residual Analysis
Beyond LAI . . .

Resource efficiency and acquisition
Beyond LAI . . .

Resource efficiency and acquisition

Greater than 94% of variance in fPAR from LAI, Deep Gaps, and Porosity
Scaling and model integration

Scaling (e.g. Landsat, etc.)

Model Integration (e.g. ED2)
Scaling and model integration

B53J-07: Comparison of Aerial and Terrestrial Remote Sensing Techniques for Quantifying Forest Canopy Structural Complexity and Estimating Net Primary Productivity

Friday, 16 December 2016 14:55 - 15:10
Moscone West - 2006

B53I-0624: Canopy structural complexity influences forest canopy reflectance: linking terrestrial lidar with Landsat observations

Friday, 16 December 2016 13:40 - 18:00
Moscone South - Poster Hall
TLS-PCL Comparisons

UVA A4-01 West (TLS)
Rugosity = 13.31

UVAX_A4_01W.CSV
Rugosity = 13.77
CSC and NPP relationships?
Special thanks . . .
Cynthia Scheuermann, the Gough lab (Ellen, Ben, Jeff-Ben), Courtney Meier, Tim Morin, Atticus Stovall, Jason Tallant, Jan van Aardt, Kyla Dhalin, Shawn and Tony, Tim Fahey, Brenden McNeil, Cynthia Ragland, Michael Cramer, Gary Belovsky, Eric Nagy and all at MLBS, UMBS, Krista Teixeira, Ty Lindberg, SCBI, Hank Shugart, Stephen Costes and OSBS, Josh Mantooth, Mike Dietze, Kevin Burns and Treehaven, Alan Strahler and the TLS RCN, the VCU Rice Rivers Center and many, many others.
$r^2 = 0.72$
$p = 0.001$
We are using NEON, LTER, Ameriflux, and field station sites to examine how and why ecosystem structure relates to forest net primary production.
From Hardiman et al. 2011 (Ecology)