Introduction

Chloroplasts to canopies: Analysis of leaf spectral trait variability across spatial scales

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Objectives

1. To develop a more mechanistic method for determining leaf structure and biochemistry from spectral data that characterizes and partitions sources of variability and uncertainty
2. To investigate the spatial scales and processes driving leaf trait variability.

Data

Figure 1 (above) Data were collected for 1349 leaves from 52 species across 12 sites. Both reflectance spectra and direct biochemical measurements were collected.

Figure 2 (right) Example leaf-level reflectance of leaves of Acer rubrum and Quercus rubrum.

The PROSPECT4 model

Figure 3 Sensitivity of PROSPECT4 model to its four leaf biophysical parameters (Feret et al. 2008 Remote Sens. of Environ. 112(6):3030)

Bayesian inversion

Figure 4 Sample output of PROSPECT4 inversion for a leaf of Acer rubrum.

Water content

Figure 5 Comparison of measured and estimated leaf water content (g cm⁻²) for three broad plant types. Dashed line is a 1:1 fit. Colors distinguish between plant type (left) or ecological succession (center, right).

LMA

Figure 6 Comparison of measured and estimated leaf mass per unit area (g cm⁻²) for three broad plant types. Dashed line is a 1:1 fit. Colors distinguish between plant type (left) or ecological succession (center, right).

Canopy position

Figure 7 The effect of relative leaf location in canopy on inverted spectral traits. Except for chlorophyll in conifers, all spectral traits increase significantly with higher position in the canopy.

Variability

Figure 8 Fraction of variance explained by different sources in entire data set (left) and by major plant category (below). Variability across individuals and species is consistently high. Hardwood traits are very sensitive to canopy position. Conifer traits are more sensitive to succession.

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The PECAn RTM package developed for performing these analyses can be downloaded at:

www.github.com/PecanProject/pecan/modules/rtm