Natural Resources Canada | Ressources naturelles Canada

Optical Leaf Area Index (LAI) In-situ Measurements

S.G. Leblanc
Canada Centre for Remote Sensing

Introduction

To perform accurate canopy leaf density mapping, accurate field measurements of the leaf density are required. Many techniques exist to assess the state of vegetation density in-situ, and these techniques' limitations are not always well known. NRCan scientists have developed methods to measure the leaf density in vegetation canopies with minimum destructive sampling. The measured quantity is Leaf Area Index (LAI) that is used in estimates of carbon absorption by plants.

Tracing Radiation and Architecture of Canopies (TRAC)

TRAC is an optical instrument for measuring LAI. TRAC measures canopy 'gap size' distribution in addition to canopy 'gap fraction'. Gap fraction is the percentage of gaps in the canopy at a given zenith angle. It is usually obtained from radiation transmittance. Gap size is the physical dimension (e.g. cm) of a gap in the canopy. For the same gap fraction, gap size distributions can be quite different.Plant canopies, especially forests, have distinct architectural elements such as tree crowns, whorls, branches, shoots, etc. Since these structures dictate the spatial distribution of leaves, this distribution cannot be assumed to be random. Because of foliage clumping in structured canopies, gap fraction-based LAI is often considerably underestimated. A canopy gap size distribution contains information of canopy architecture and can be used to quantify the effect of foliage clumping on indirect (i.e., non-destructive) measurements of LAI.

Digital Hemispherical Photography

The TRAC gap size theory has been applied to digital hemispherical photographs. By using pixels at a given view zenith angle, a gap size distribution can be estimated from hemispherical photographs. This gap size distribution is angular and not a physical length such as the one from the TRAC. LAI estimates can be performed using only hemispherical photographs or TRAC, or in combination with other instruments.

Further information

For information about TRAC and Digital Hemispherical Photography, please contact Sylvain G. Leblanc.

The TRAC instrument is commercially available. For more information, please contact:

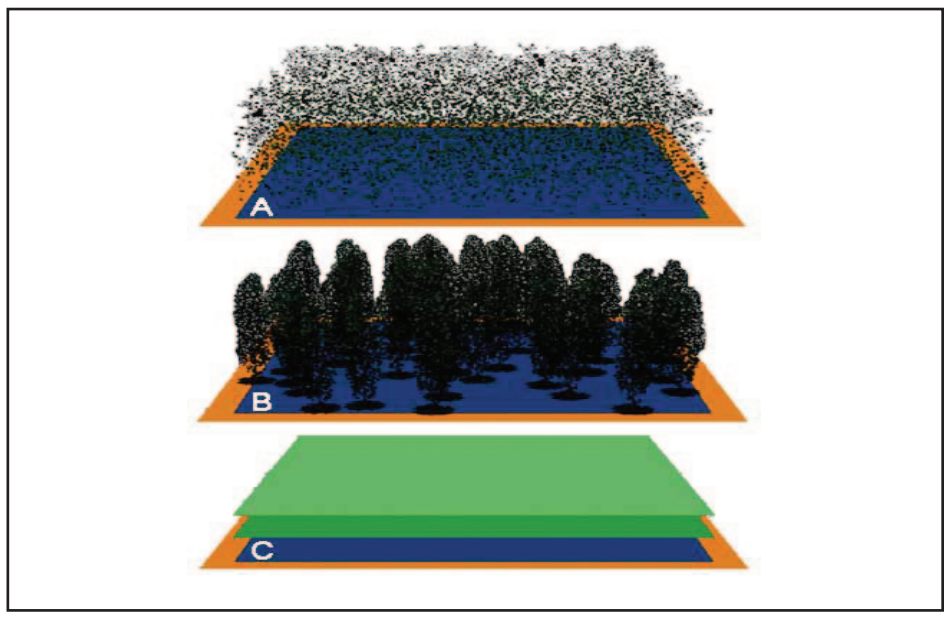
3rd Wave Engineering
14 Aleutian Road, Nepean, Ontario, Canada, K2H 7C8.
Attention: Mr. Mike Kwong, Tel: (613) 828-2195/ Fax: (613) 828-9498
Email: mikek@3wce.com

References

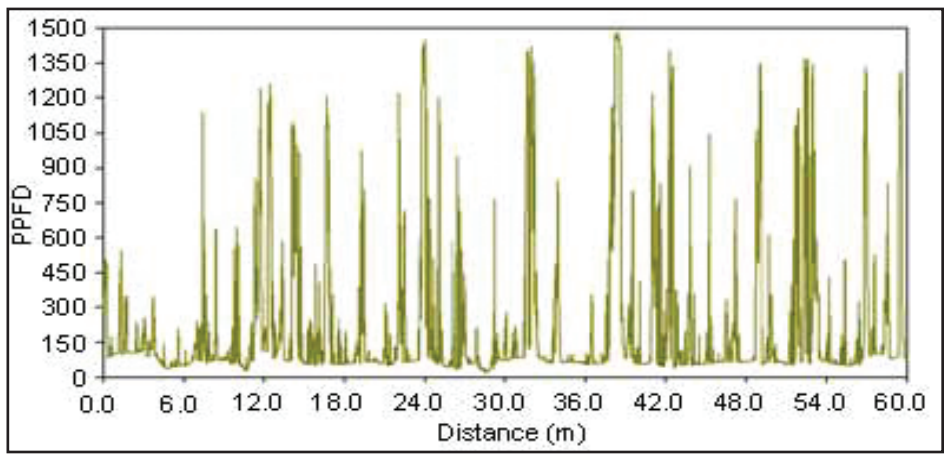
Leblanc, S. G., Chen, J. M., Fernandes, R., Deering, D. W., and Conley, A. Methodology comparison for canopy structure parameters extraction from digital hemispherical photography in boreal forests. Agric. For. Meteorol. Vol. 129, pp. 187-207. 2005.

Leblanc, S. G., Correction to the plant canopy gap size analysis theory used by the Tracing Radiation and Architecture of Canopies (TRAC) instrument. Applied Optics Vol. 41, No. 36, pp. 7667-7670, 2002.

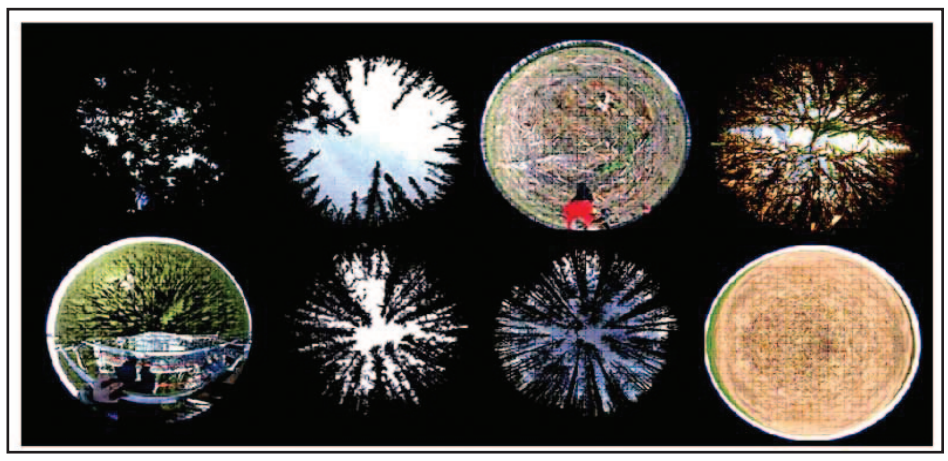
Chen, J. M., 1996. Optically based methods for measuring seasonal variation in leaf area index of boreal conifer forests. Agric. For. Meteorol., vol. 80, pp.135-163.



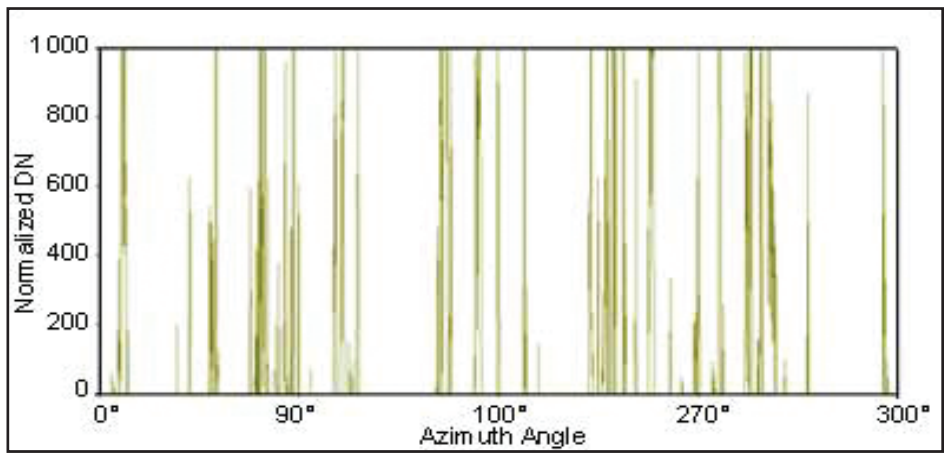
These three simulations have the same LAI of 2.0 but a) random distribution; b) clumped distribution and c) all leaves removed and placed side by side to form 2 layers covering the domain.



TRAC instrument and an example of a 60m transect in a black spruce stand. Spikes represent sun fleck intensity (PPFD) through gaps in the canopy.



Digital hemispherical photographs (DHP). The up-looking DHP can be used to estimate a gap size distribution that is used in estimating the foliage clumping.



360 degree gap fraction for each pixel of one DHP in a black spruce stand, similar to a TRAC transect.

Cat. No.: M77-4/20-2010E-PDF (On-line)
ISBN: 978-1-100-15033-8

Canada