ECV T11

LEAF AREA INDEX (LAI)

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SIGNIFICANCE FOR CLIMATE CHANGE ACTIVITIES

Monitoring the distribution and changes of Leaf Area Index (LAI) is important for assessing growth and vigour of vegetation on the planet. It is fundamentally important as a parameter in land-surface processes and parameterizations in climate models. This variable represents the amount of leaf material in ecosystems and controls the links between biosphere and atmosphere through various processes such as photosynthesis, respiration, transpiration and rain interception.

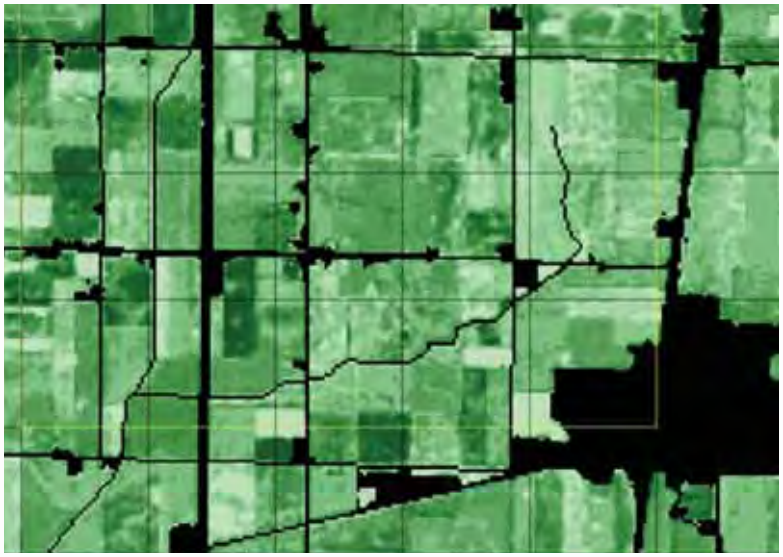
DEFINITION AND METHODOLOGIES

LAI [m^2/m^2] represents the amount of leaf material in an ecosystem and is geometrically defined as the total one-sided area of photosynthetic tissue per unit ground surface area. Ground-based measurements have no standards as several methods, like harvesting methods, hemispherical photography or light transmission through canopies, can be used. The conversion of effective values, as available from measurements using optical devices, to allometric values requires additional information about the structure and architecture of the canopy, e.g. gap size distributions, at the appropriate spatial resolutions.

CURRENT ACTIVITIES

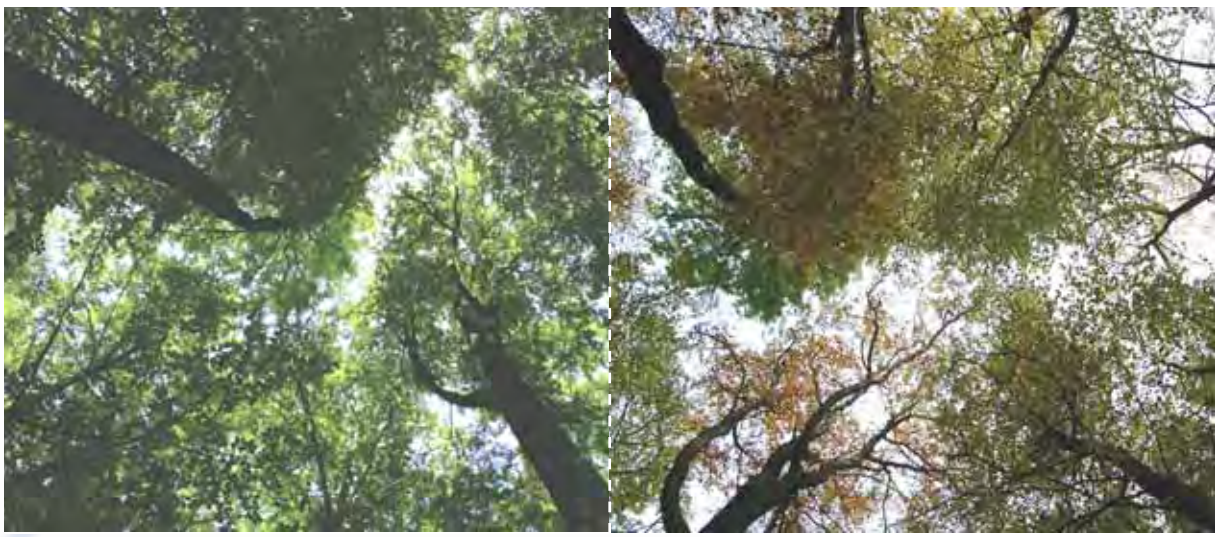
Space agencies and other institutional providers generate maps of LAI at various spatial resolutions from a daily to monthly period over the globe using optical space borne sensors. The actual delivered values correspond to an allometric or an effective value relating to the spatial resolution of observations. On the other hand, LAI values are occasionally estimated locally through ground-based measurements over several validation sites spanning a range of land cover types. These validation exercises are performed in the framework of ground-based networks, including both national research groups and international entities, such as the Land Product

Measurements using a TRAC instrument. The TRAC is used to measure gap size distribution (clumping) to later convert LAI-2000 measurements to *effective* LAI (*Source*: Dirk, Pflugmacher)



Example of Landsat based map of LAI retrieval for validation purposes over a cropland site (*Source*: Warren B. Cohen)

The Leaf Area Index (LAI) of plant canopies plays an important role in controlling the interactions between terrestrial environments and atmospheric variables



Hemispherical photos of the Hainich forest (CarboEurope-IP site) on June 21, 2005 (left panel) and October 25, 2005 (right panel) (Source: Werner Kutsch)

Validation (LPV) Subgroup of the CEOS Working Group on Calibration and Validation (CEOS-WGCV). The main validation efforts concentrate on the improvement of the reliability and accuracy of the ground-based estimates by defining state of the art protocols suitable to address the very different spatial dimensions of *in situ* and remote sensing measurements. The Terrestrial Ecosystem Monitoring Sites (TEMS) database contains details on research sites and the observations they are undertaking including *in situ* information on LAI values. For example, LAI is a standard parameter observed in all sites of FLUXNET.

A community effort takes place to find a compromise on providing LAI maps suitable for land-surface parameterizations for ensuring the equivalence between the current deliverable values which are observed and computed. This consistency requires also the production of associated spectral properties of the underlying soil.

FUTURE ACTIVITIES

Long-time series of accurate and precise Leaf Area Index products derived from space are essential for climate change studies, especially at regional and local scale for improving the parameterization of the process in various classes of models. Systematic data acquisition from space sensors is thus crucial in the development of such well-documented information about the changes occurring in the biosphere.

Networks of ground-based measurements for the routine acquisition of relevant observations, in particular over subsampled geographical regions, as well as harmonization of existing data are to be promoted. These networks must ensure the standardization of measurements, the distribution of these measurements as well as the benchmarking of the measurement protocols.

The consistency between this LAI, a state variable, and the FAPAR (ECV T10), a radiation flux, is important and must be ensured. This promotes the use of modern retrieval algorithms delivering a series of by-products such as the spectral properties of the underlying soil and the vegetation canopies as well.

FUNDS

The total expense for acquisition, processing and storage of both data and geophysical products at medium resolution amounts to about €300 000 per year. The reprocessing of archives can be estimated at €10 000 per year per sensor.

Cost for ground-based measurements, including analysis of data to up-scale *in situ* estimates, depends on the site infrastructure already installed and the financial support already being received. When new advanced algorithms have to be developed, substantial research costs may be required.

RELATED LINKS:

CEOS WGCV: http://wgcv.ceos.org | **GTOS standards activity**: www.fao.org/gtos/ECV-T11.html | **TEMS**: www.fao.org/gtos/tems
Bigfoot activity: www.fsl.orst.edu/larse/bigfoot/index.html