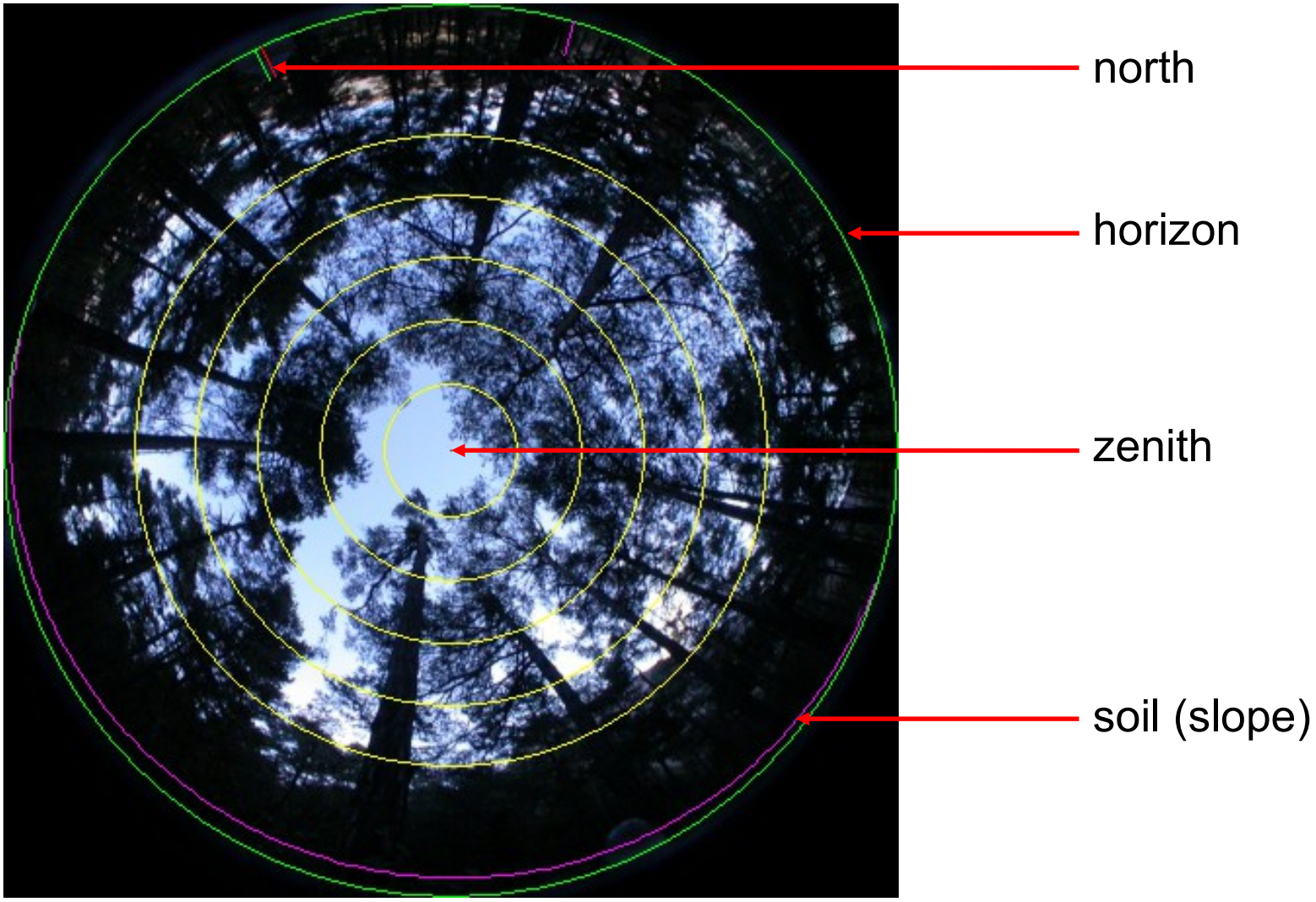
Calculating the below-canopy light regime of forests from hemispherical photographs

Patrick Schleppi

Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), CH-8903 Birmensdorf

Hemispherical photography

Hemispherical photography



Exposure and thresholding

automatic exposure

exposure spotmeter on sky + 1-2 stops

Exposure and thresholding

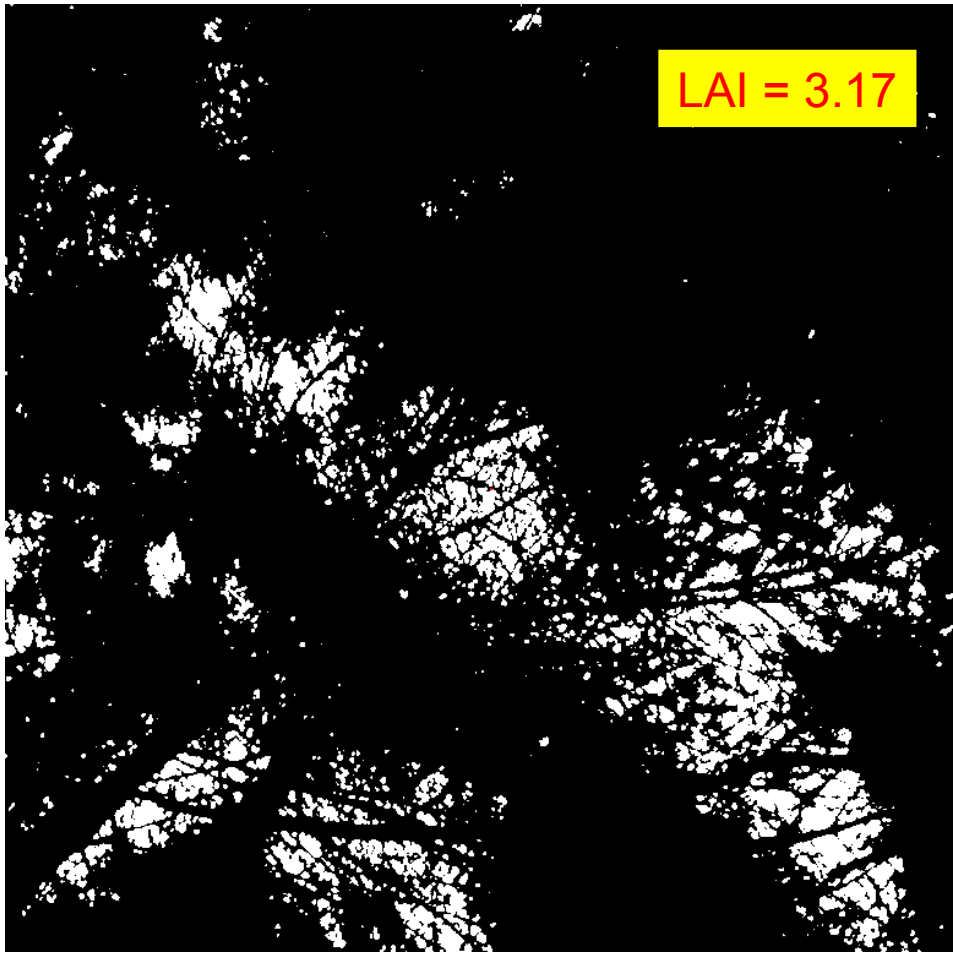
automatic exposure

exposure spotmeter on sky + 1-2 stops

Exposure and thresholding

automatic exposure

exposure spotmeter on sky + 1-2 stops



sky radiance neither uniform nor constant => exposure never perfectly reproducible!

Picture analysis

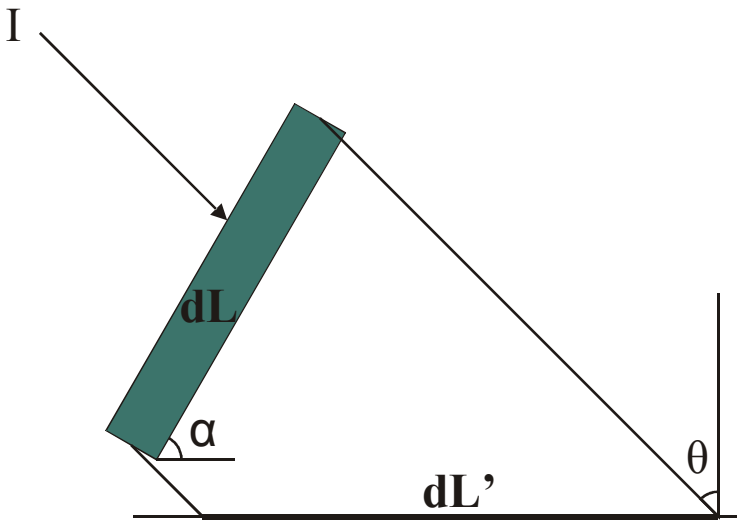
1. Canopy analysis

principle:
- Beer-Lambert-Bouger absorption

model:
- statistical distribution of leaf angles
- projection = f (leaf angle, view angle)

$$I(\theta) = I_0(\theta)\, e^{-G(\theta,\alpha)L / \cos\theta}$$

results:
- canopy openness *vs*. closure
- leaf area index (LAI)
- mean leaf angle
- canopy clumping (Ω)
- canopy cover (vertical projection)
- average canopy transmission



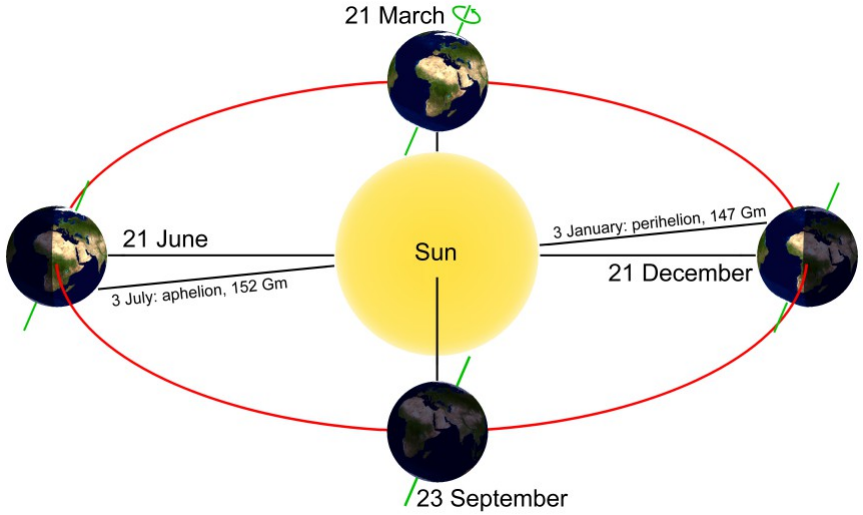
Picture analysis

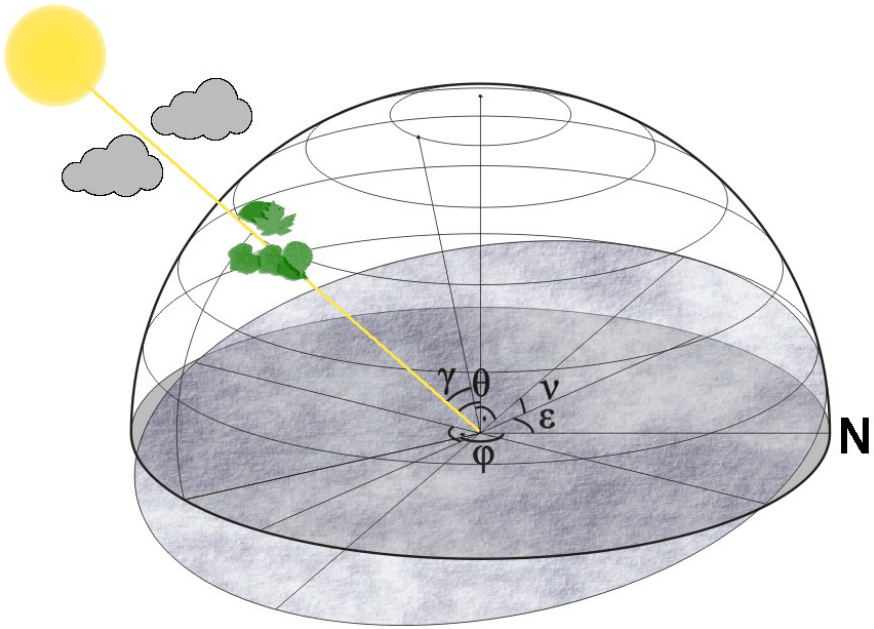
2. Local analysis

principle:
- hemispherical picture as a mask

models:
- astronomical model for Sun position
- atmospheric model of direct and diffuse radiation
- or: above-canopy measurements (separately for direct and diffuse)

results:
- local light climate
- ... on flat or inclined surface
- ... as long as canopy doesn't change
- light indexes





Picture analysis

Light indexes

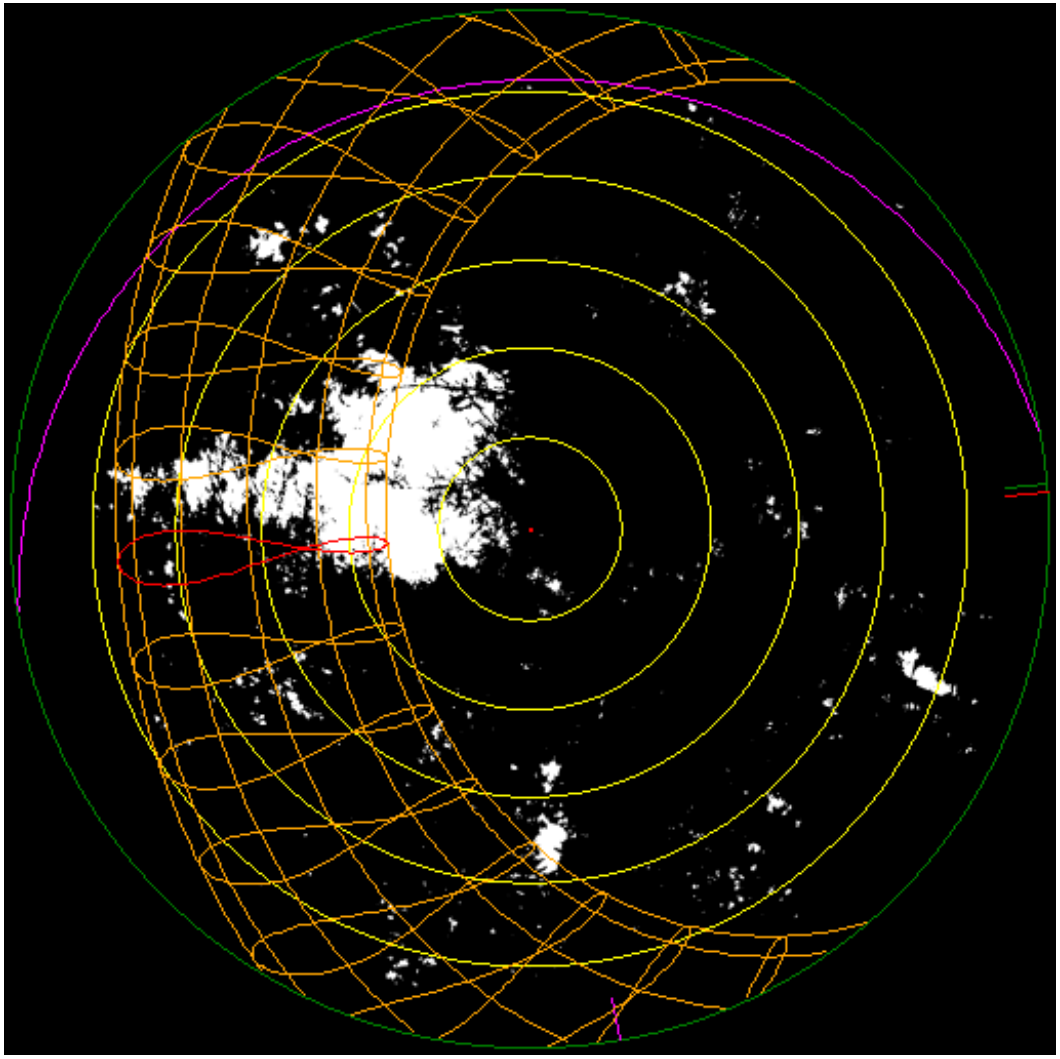
transmission through canopy, average over time:

- diffuse light index
  ≈ constant over time
- direct light index
  depends directly on sun tracks
- global light index (GLI)
  or "gap light index"
  or "global site factor"
  weighted average diffuse + direct

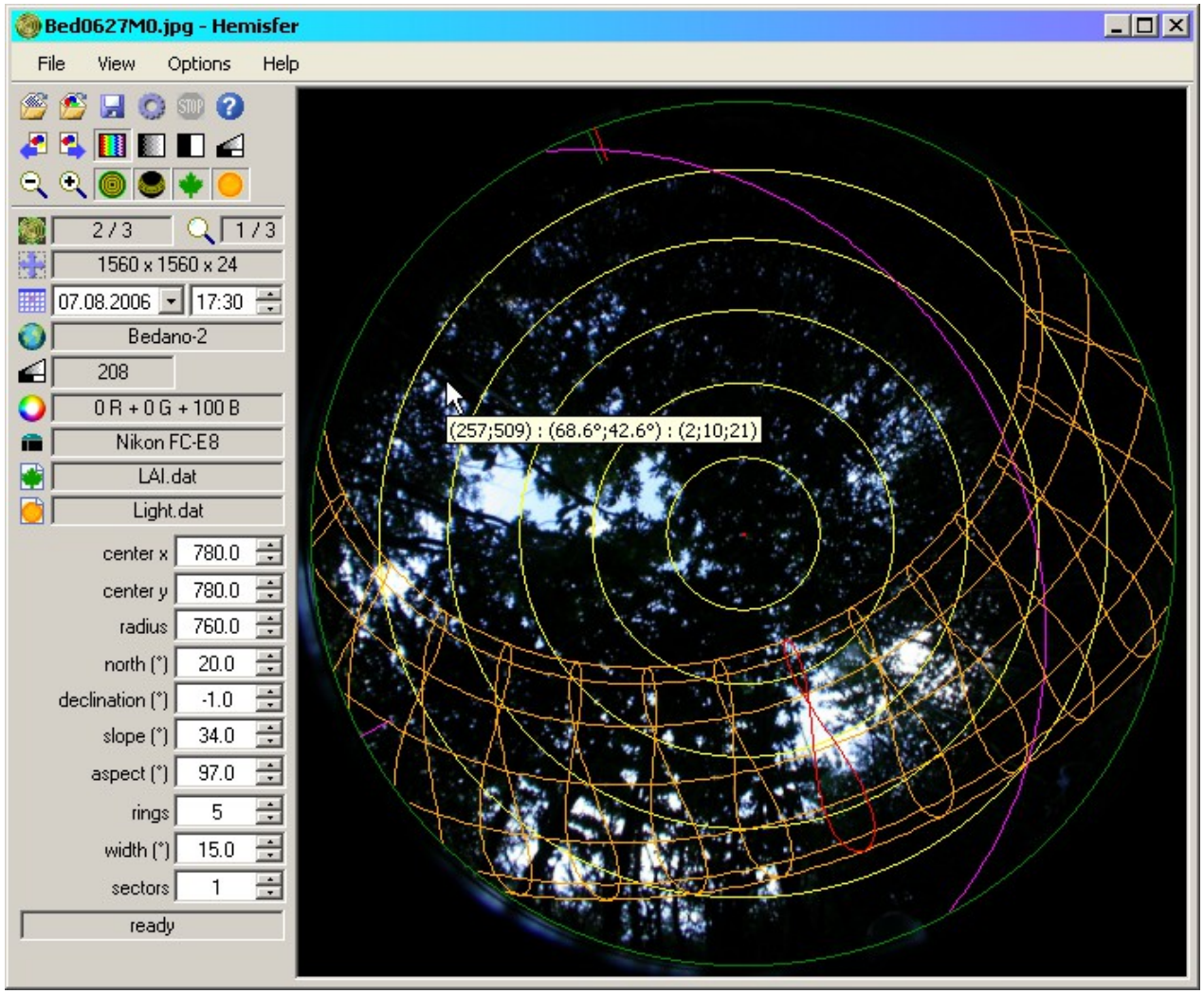
example (see picture):

- canopy openness ≈ 5 %
- diffuse light index ≈ 6 %
- direct light index ≈ 14 %
- GLI ≈ 10 %

... because of large gap to the south



Hemisfer



- shareware
- multilingual
- interactive or batch
- 5 LAI calculation methods
- slope effect
- automatic threshold
- canopy clumping

new in version 2

- light regime

http://www.schleppi.ch/hemisfer