Waldwachstum
Systemanalyse

Comparison of T-Laser Scanning and Hemispherical Photography on Estimating Leaf Inclination Angle Distributions

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Objectives

- Comparison of gap fraction measurement
  H-Photo Cal-Photo Laser
- Feasibility of the algorithm
- Profile of Leaf Inclination Angle

Topics

1 Method: How to meausre

2 Results: Camparision

3 Conclusions: Problems

Leaf Orientation

- Difficult to be directly measured
- Statistically described
- Idealized leaf angle distribution functions

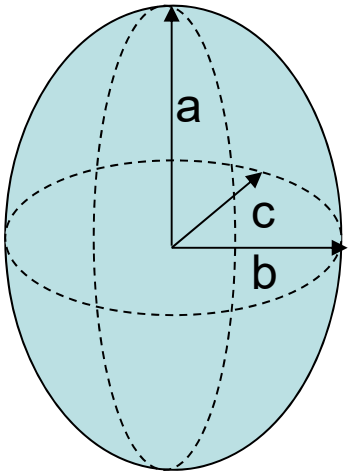
Idealized leaf angle distribution functions

- Azimuth: **Random** distribution

  b=c

- Zenith: **Ellipsoidal** distribution

  x=b/a **(Campbell, G. S., 1990)**



***ALIA*=** $90(0.1+0.9e^{-0.5x})$

(x bigger, more horizontal)

Coventional optical LIAD determination

Measurement:

Light penetration

Instrument:

Fisheye camera

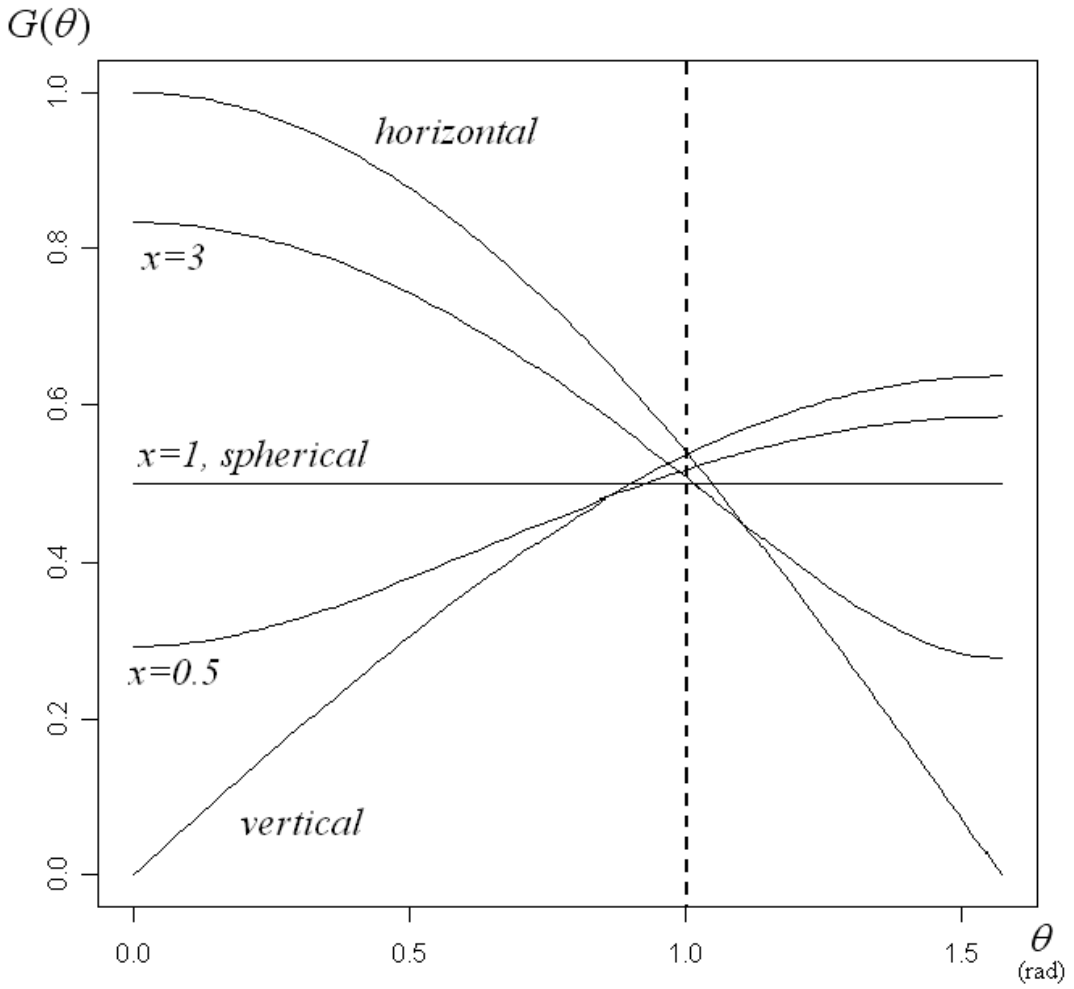
LAI2000 Plant Canopy Analyser

Principle:

G-function values → x → ***ALIA***

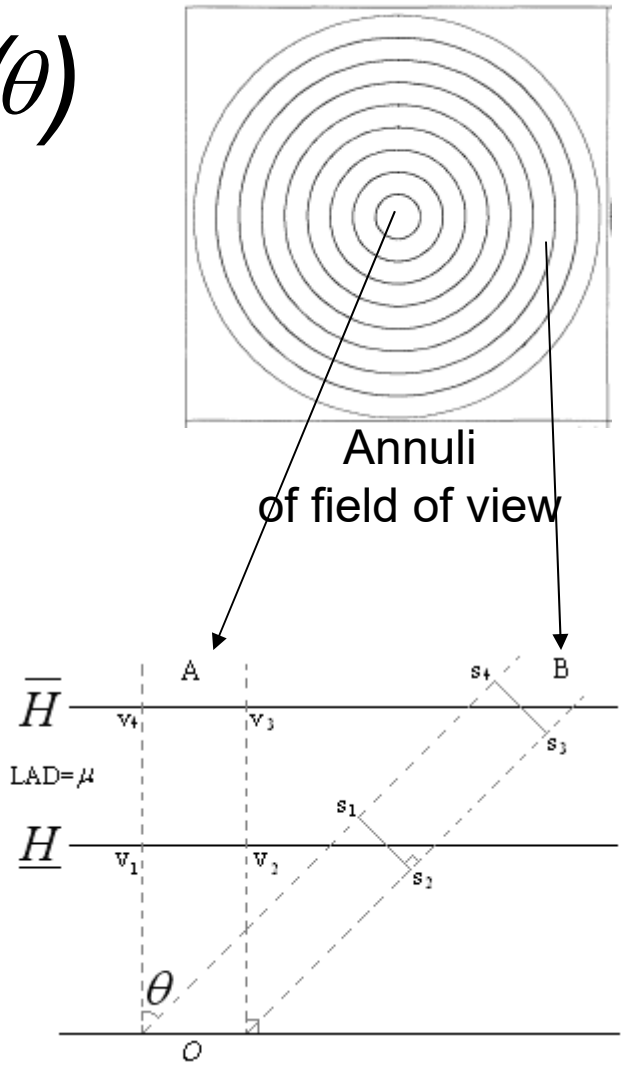
G-function

The average projected area of a unit leaf area onto a surface normal to the sun beam



$$L_e = -\ln P_0(\theta) \cdot \cos\theta / G(\theta)$$

- L_e - *effective leaf area index*
- P_0 - *gap fraction*
- G - *extinction coefficient*
- θ - beam zenith angle



Why $\cos(\theta)$ *?*

$$L_e G(\theta) = -\ln P_0(\theta) \cdot \cos\theta$$

$$\downarrow \int_0^{\pi/2} G(\theta)\sin\theta d\theta = 1/2$$

$$L_e = 2\int_0^{\pi/2} -\ln P_0(\theta)\cos\theta\sin\theta d\theta$$

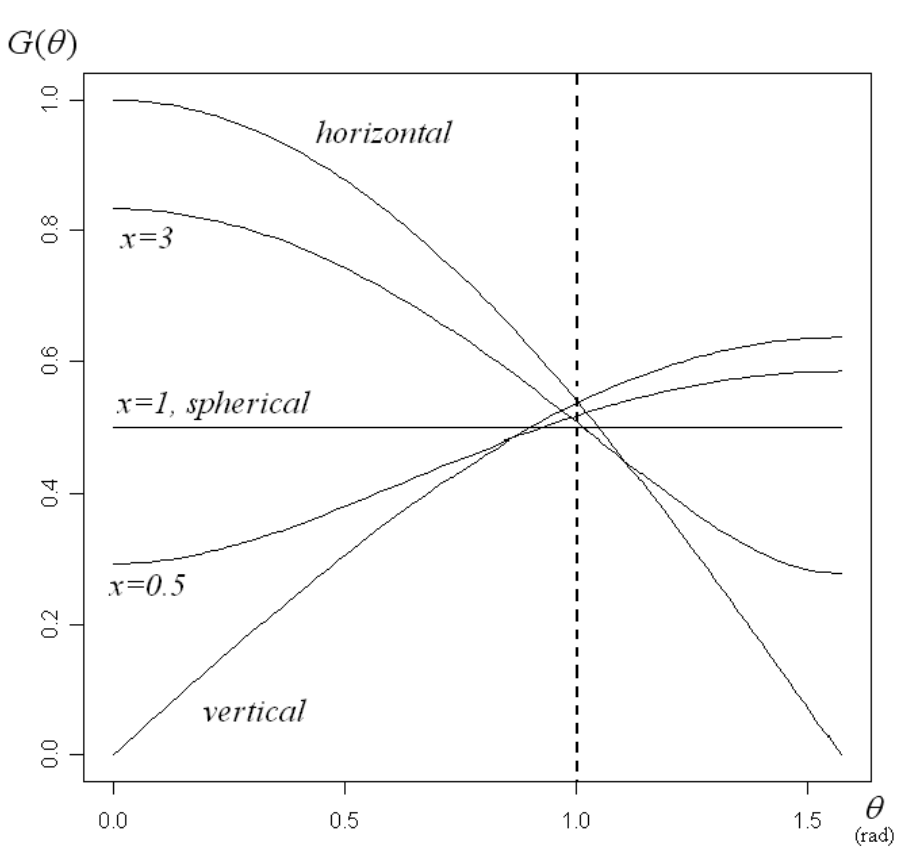
$$L_e = 2\sum_{i=1}^{5} \frac{-\ln(P_{0i})}{S_i} \mathrm{W_i}$$

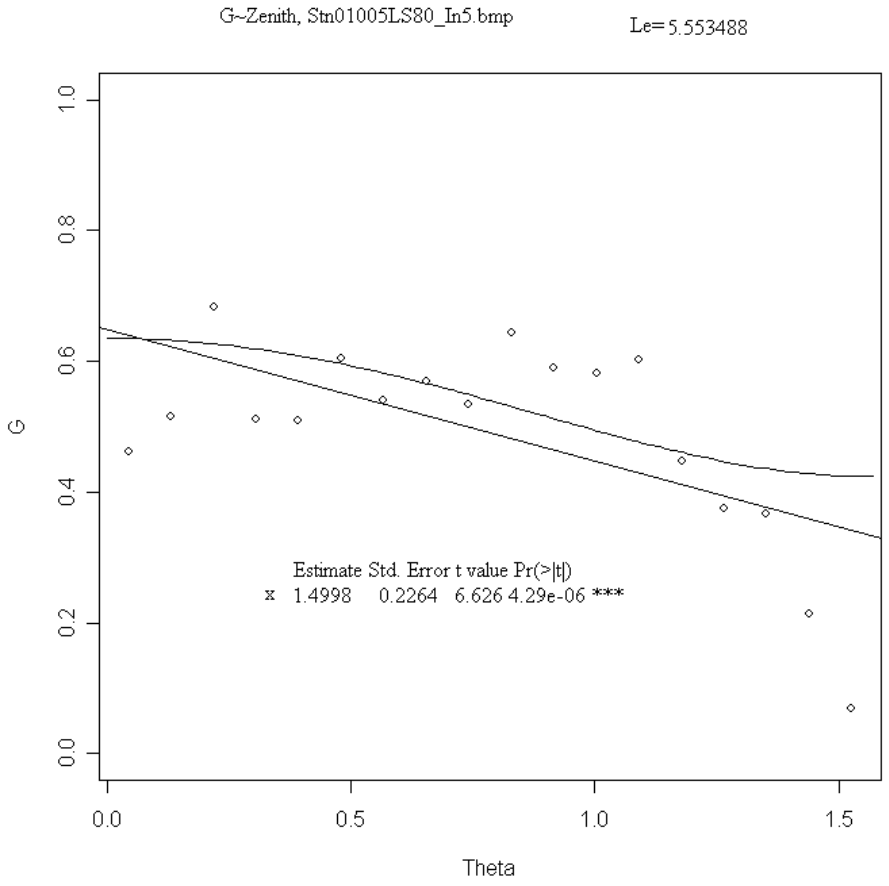
$$G_n = -\ln P_{0n}\cos\theta_n / L_e$$

Non-linear Regression

G(n)→G(θ), adjust X

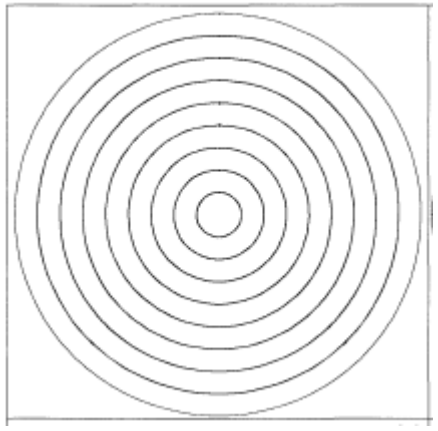
- $G(\theta) \approx (x^2 \cos^2\theta + \sin^2\theta)^{1/2} / (x + 1.774(x + 1.182)^{-0.733})$





Gap Fraction Measurements

$$P_{0n} = \frac{N_s}{N}$$



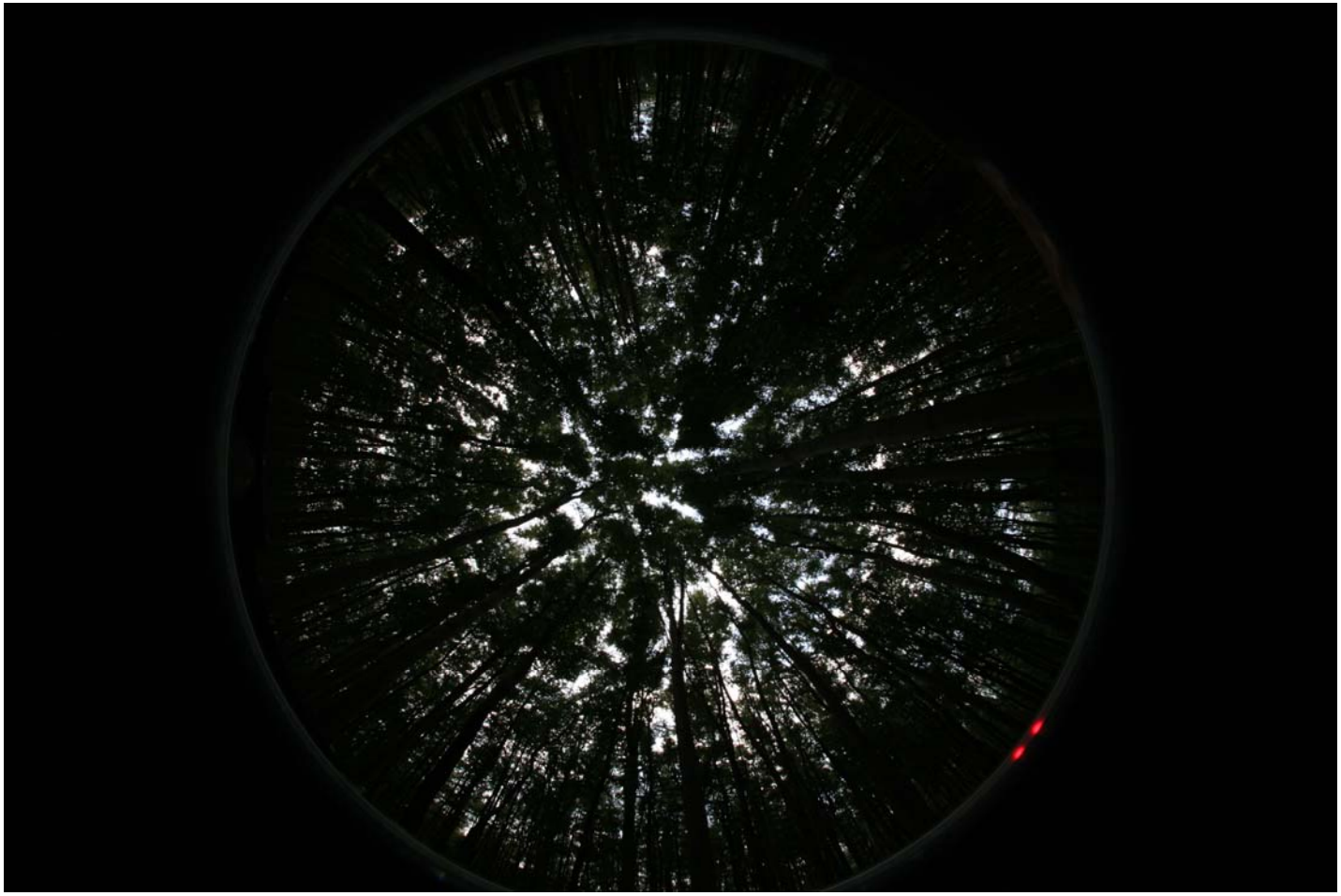
18 rings span from 0 to 90 degree and each scope occupies an interval of 5 degrees

n From 1 to 18

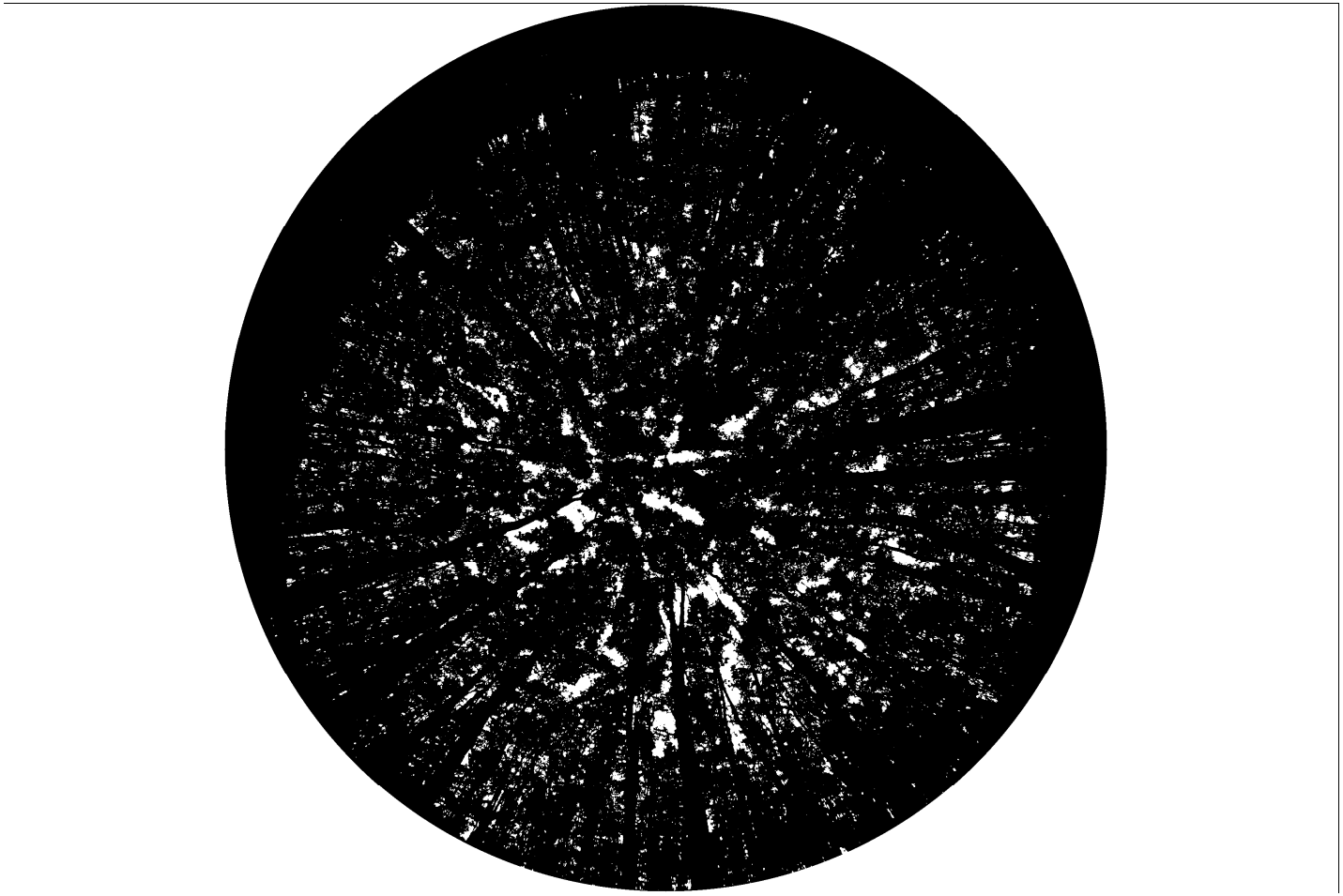
N_s The number of non-intercept probes in the zenith scope

N The number of total probes in the same zenith scope

1 Hemispherical Photo



Segmentation by Winscanopy



Colored-2D view-Laser Data

Cylinder projection

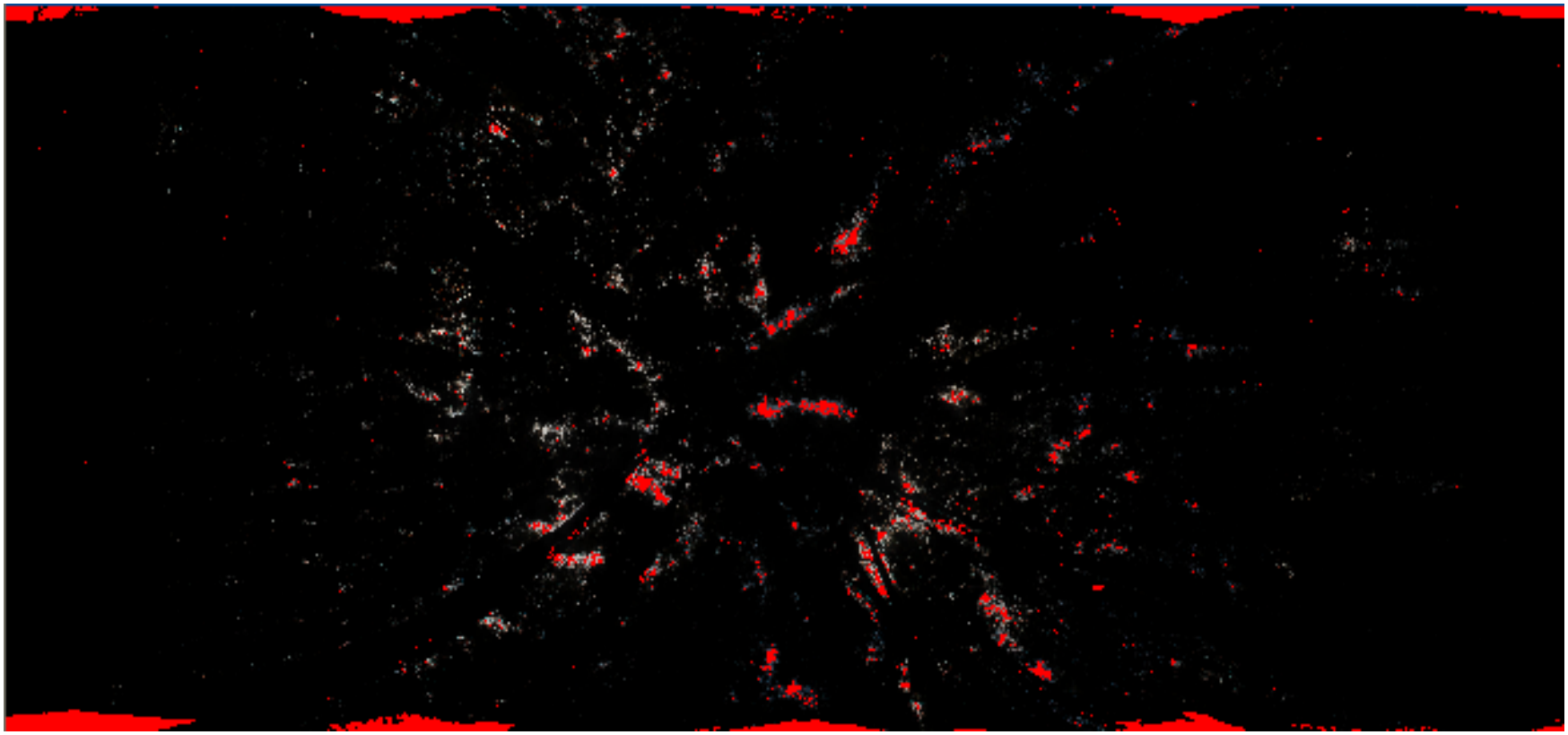
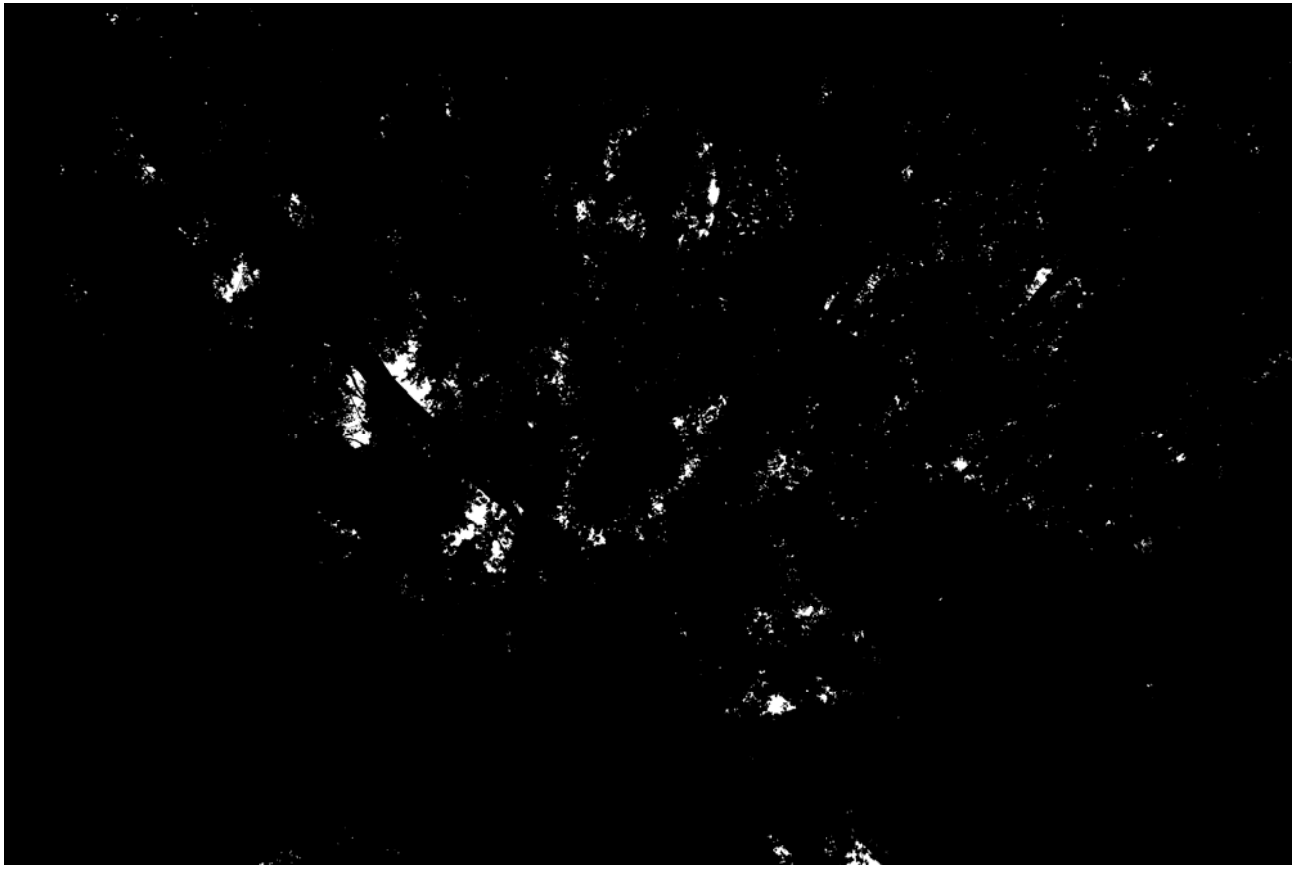
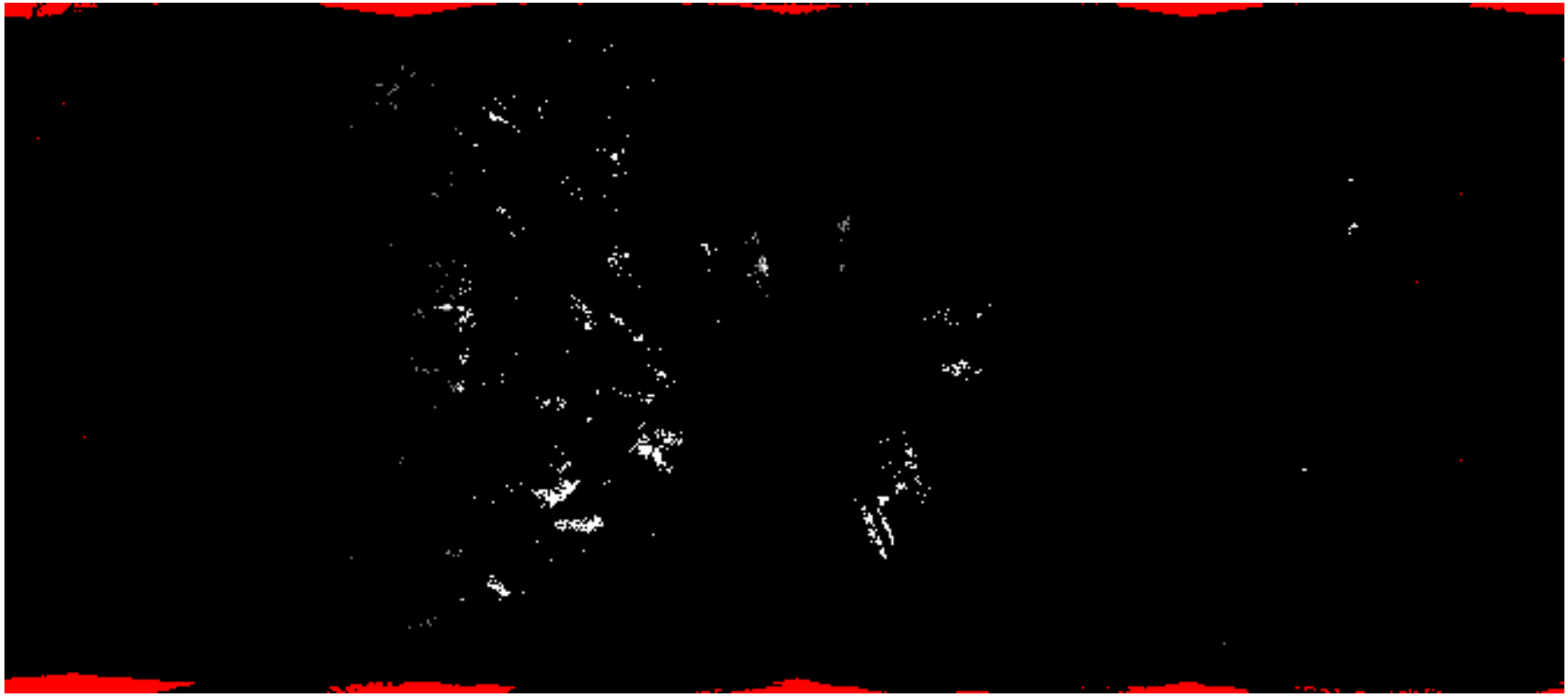


Photo by Cal-Camera

Segmentation by Winscanopy

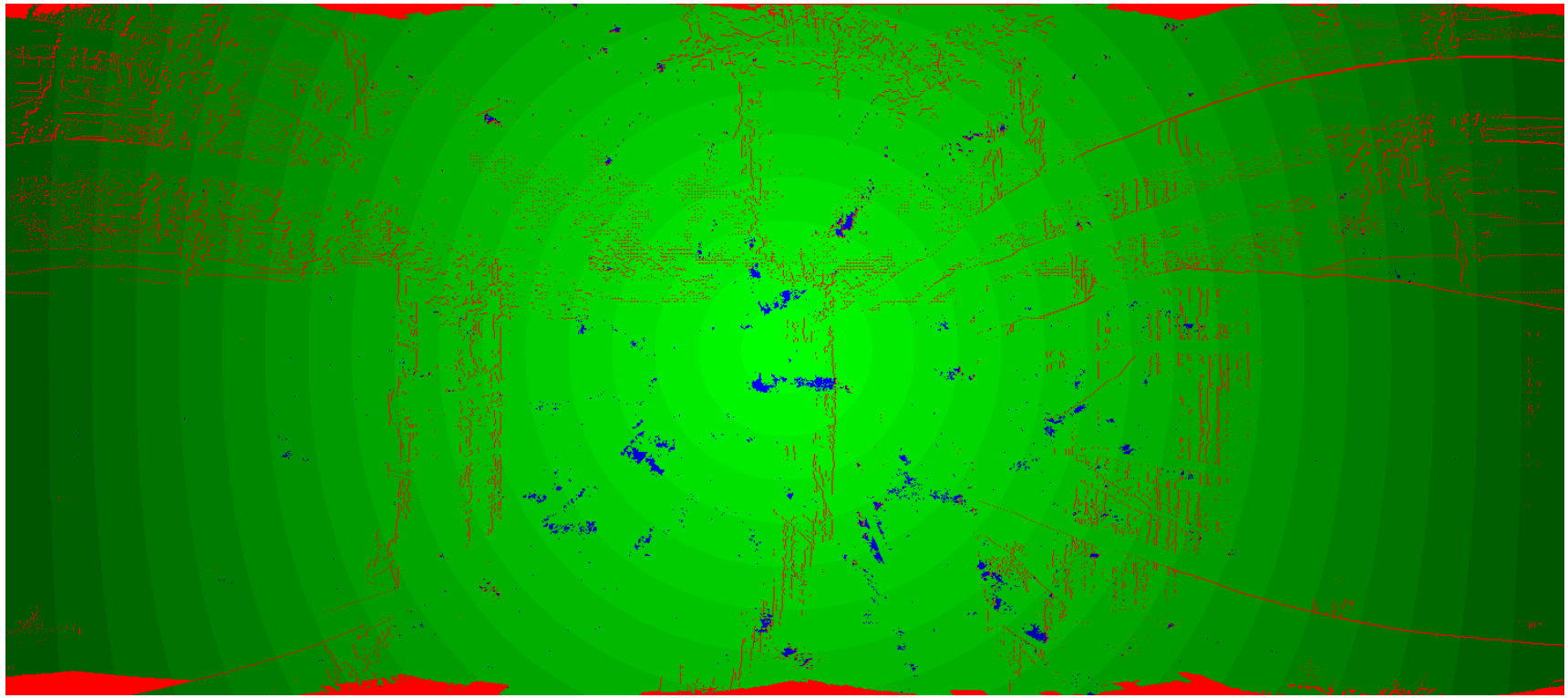


2 Photo Gap + Closed Laser



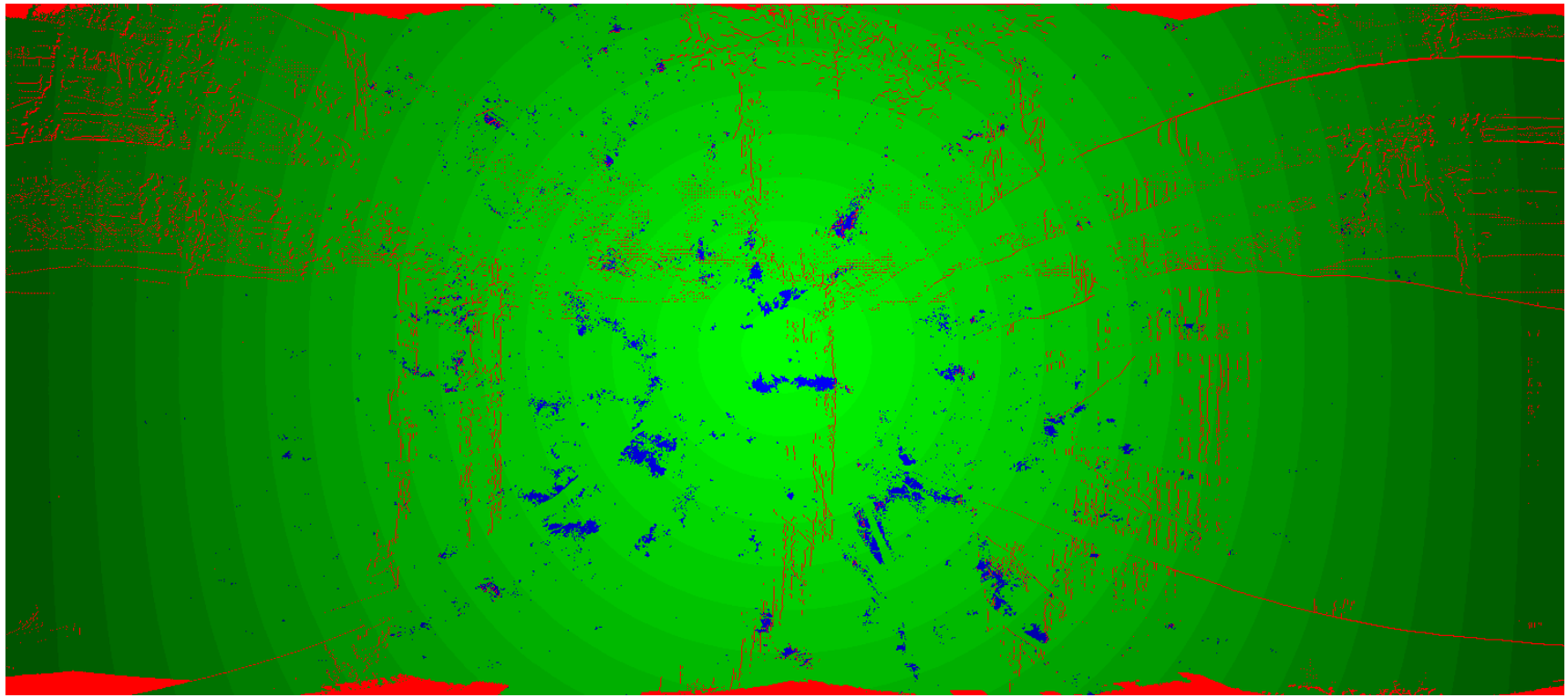
3 Laser Gap Image

Gap Foliage Invalid



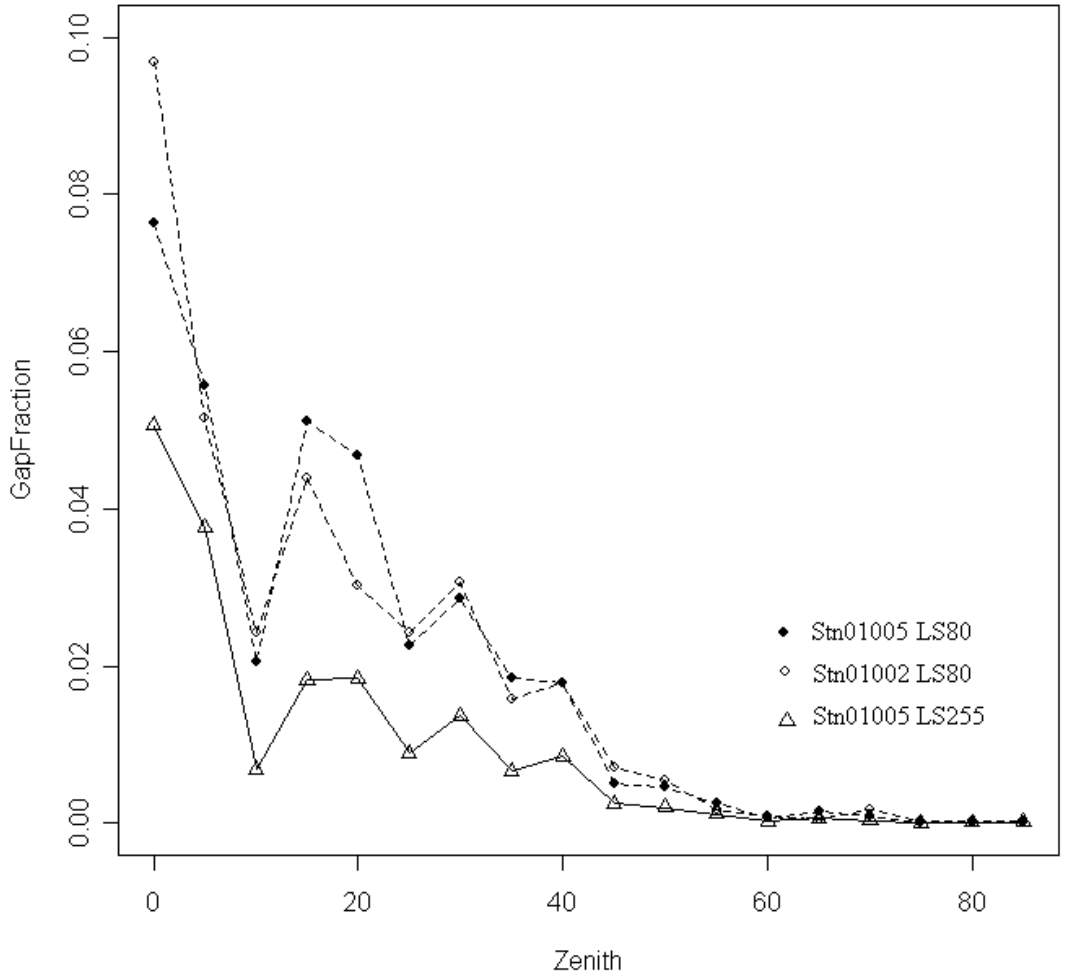
4 Photo Adjusted Laser Gap Image

Gap Foliage Invalid



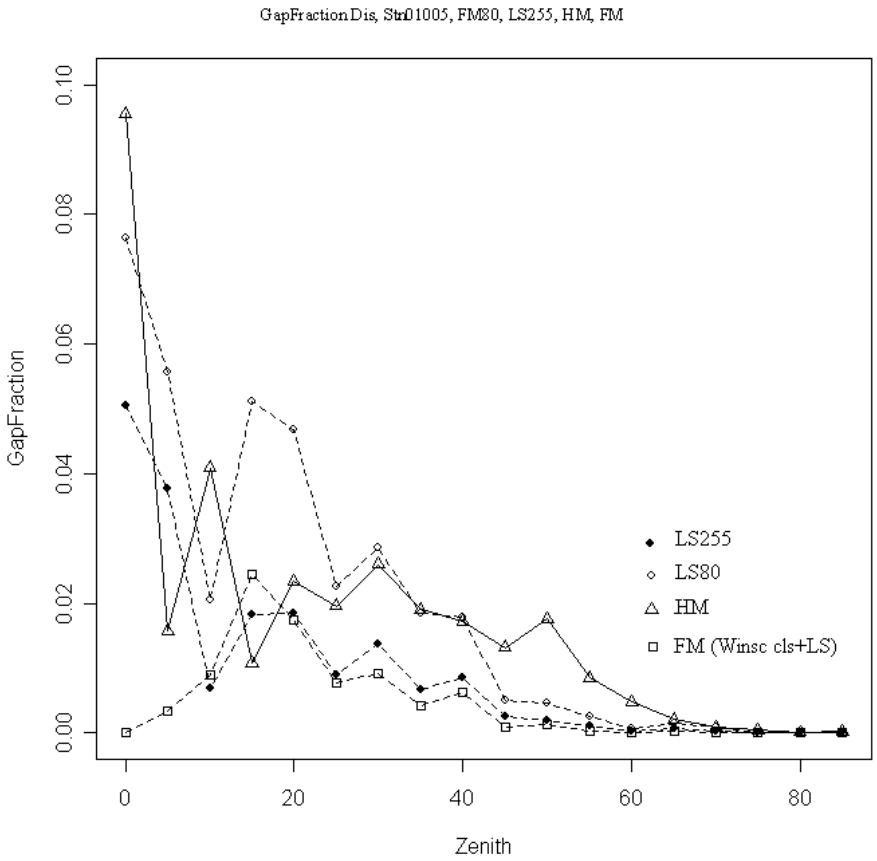
Results: Gap Fraction Distributions

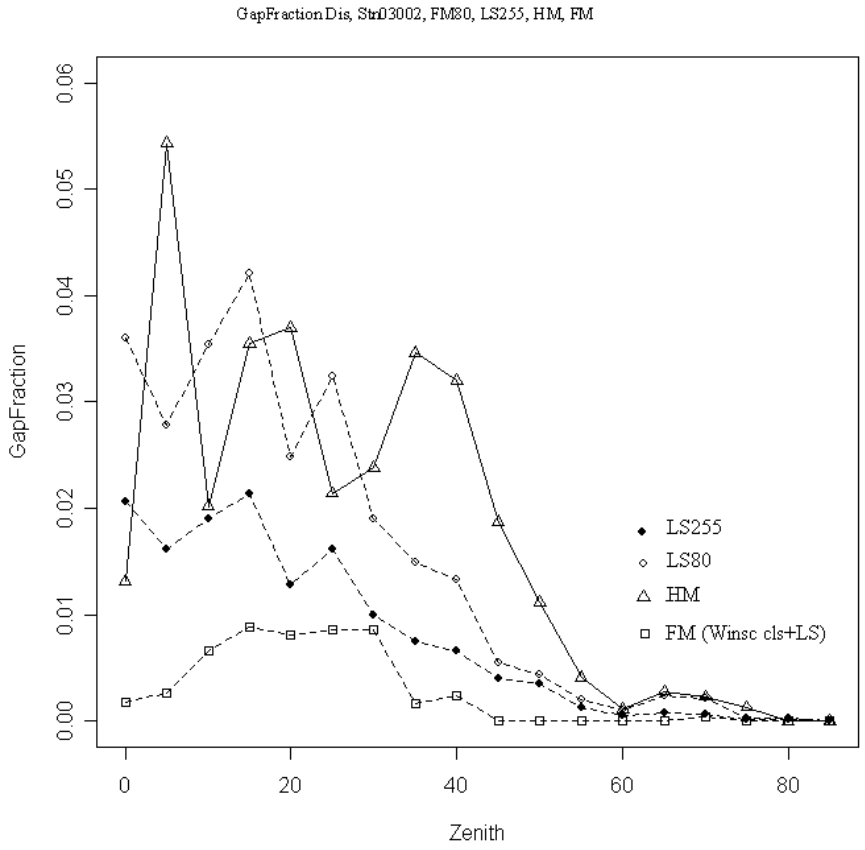
Adjusted (255vs.80), Orthogonal(05vs.02)



Results: Gap Fraction Distributions

4 methods





Results: x and Le comparison
(Starnberg, Beech, emperical x>3)

Position	HM		FM+closed LS		LS 0-35m		Adjusted LS 0-35m	
	L_e	x	L_e	x	L_e	x	L_e	x
Stn01005	5.29	2.02	7.18	1.49*	6.54	1.70	5.55	1.50
Stn03002	4.98	1.92**	9.07	1.31	6.42	1.87	5.62	1.76

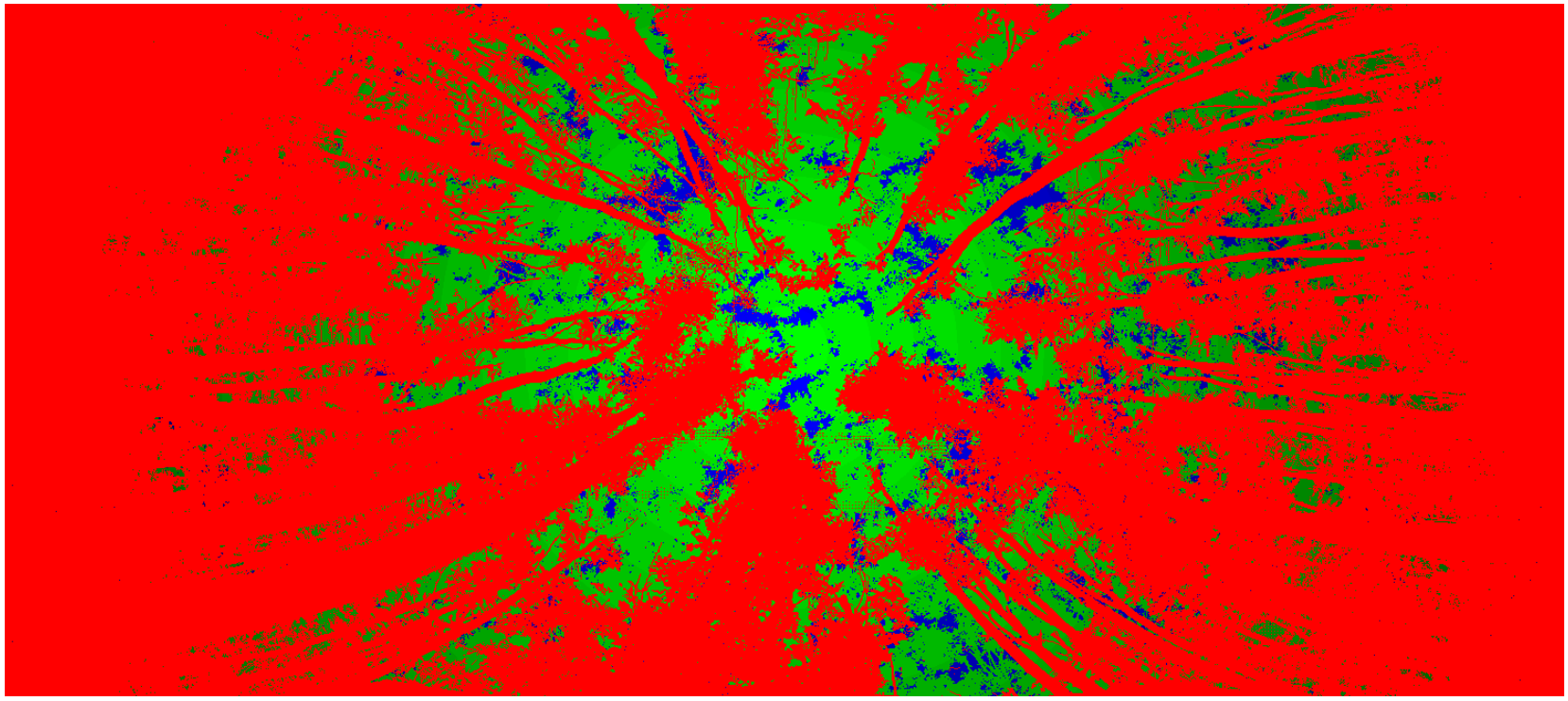
*(2-14)
**(1-16)

Results: x and Le comparison
(Fürstenfeldbruck, Spruce, emperical x=1)

FFB0116001			5.58	1.35	6.97	1.91	4.21	0.75
FFB0242001			6.41	1.05	7.62	1.80	5.74	0.90
FFB0341001			6.06	0.96	7.12	1.23	4.43	0.89
Mean of FFB	5.45***	2.75***	6.02	1.12	7.24	1.65	4.79	0.85

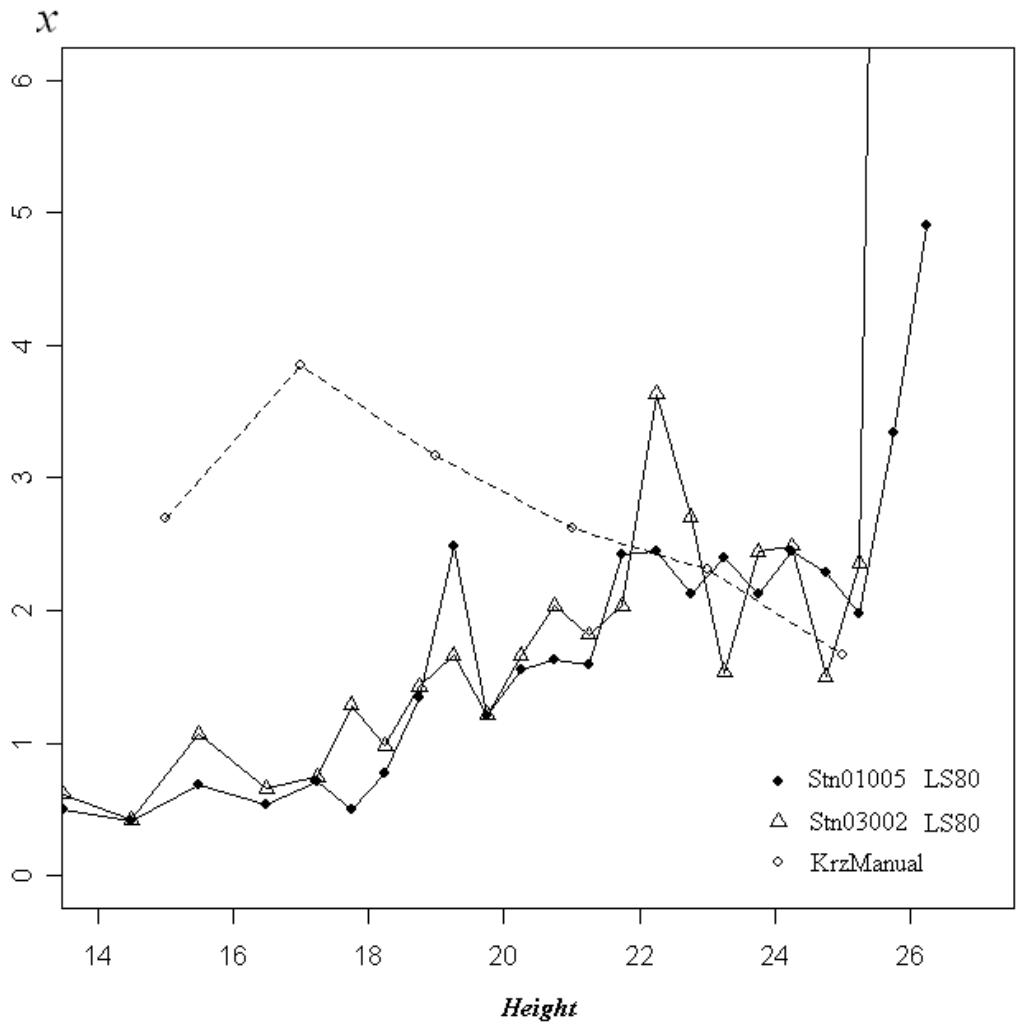
*** 10 positions

Laser Gap Image (19-25m)



Crown X Profiles

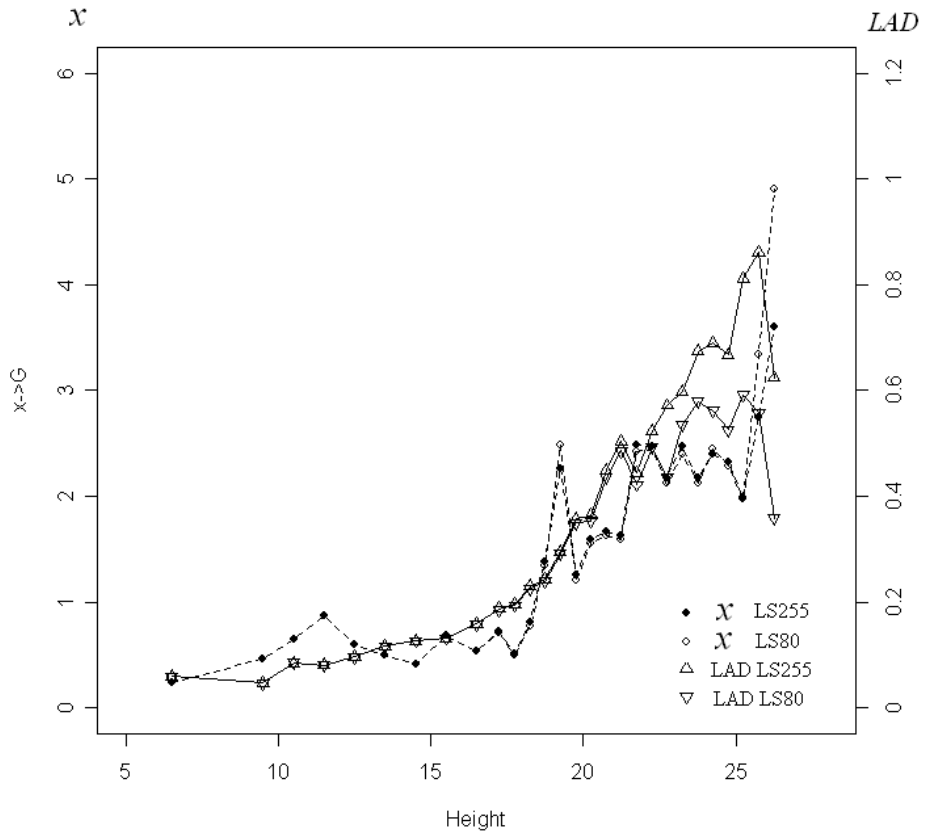
Stn, Beech



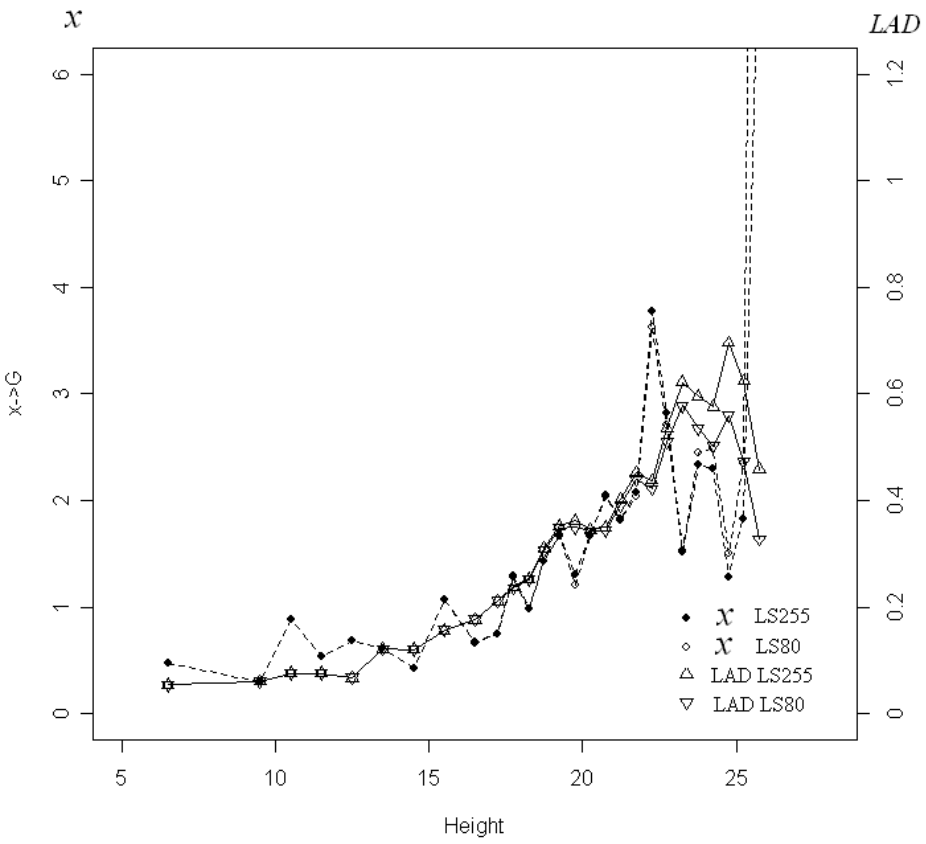
X Profile Vs. LAD Profile

Stn, Beech

Stn01005



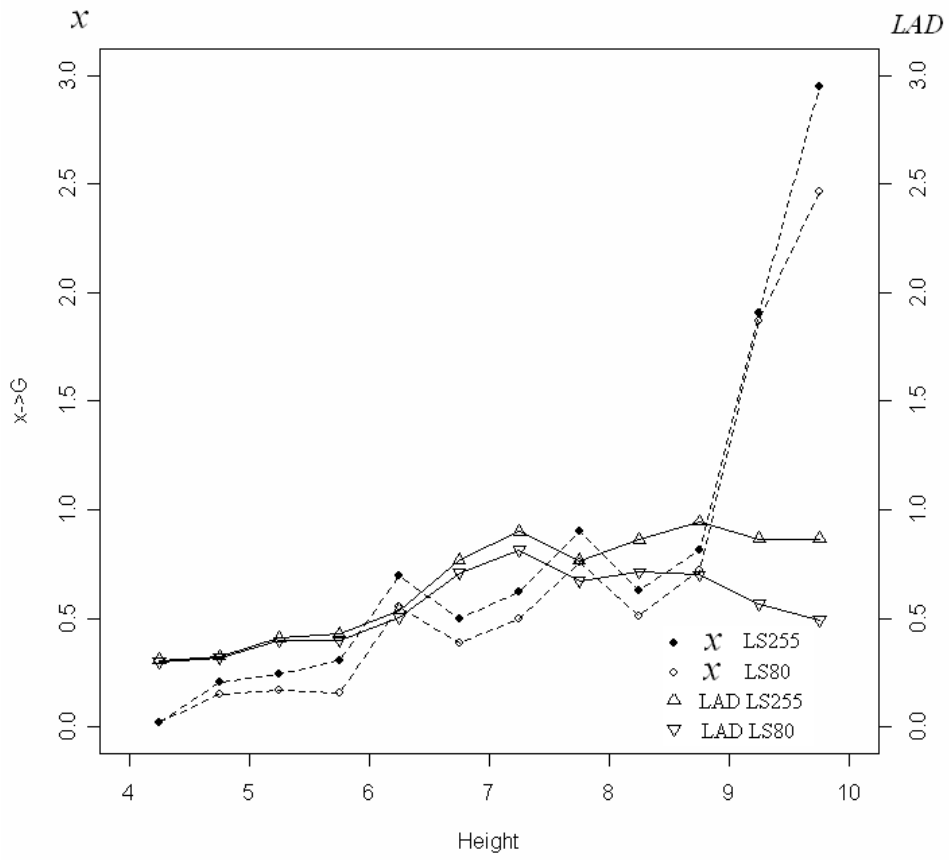
Stn03002



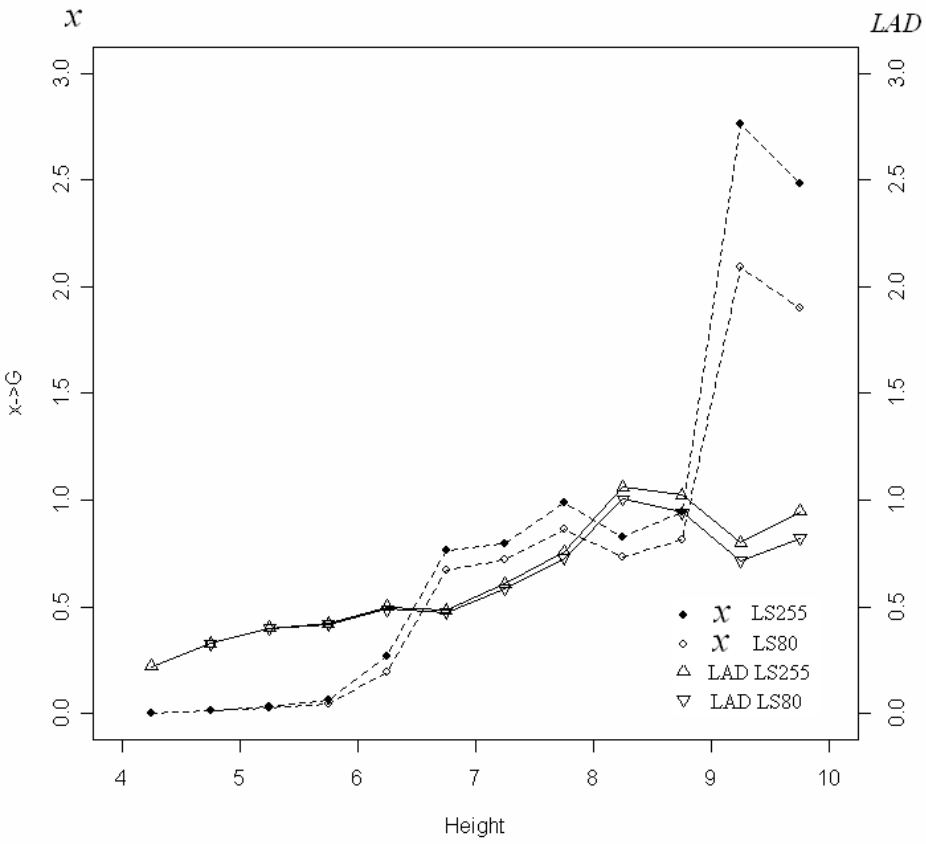
X Profile Vs. LAD Profile

FFB, Spruce

FFB01001



FFB02001



X values in different height interval

Position	0-19		19-25		25-35	
	L_e	x	L_e	x	L_e	x
Stn01005 LS80	1.778	0.495	2.783	2.029	0.992	6.091
Stn01005 LS255	1.791	0.506	3.072	2.086	1.674	5.629
Stn03002 LS80	1.818	0.665	2.667	1.976	1.131	48.4
Stn03002 LS255	1.825	0.668	2.862	1.930	1.734	8.628

Conclusions

- Photo Gap Measurements can be heavily influnced by such factors: Light Ambient, Segementation threshold and methods; but work better for conifers
- Optical Leaf angle are plant angle, like LAI

Thanks!