Irrigation improves needle size and leaf area index of pine trees (*Pinus sylvestris*) in a dry alpine valley (Valais, Switzerland)

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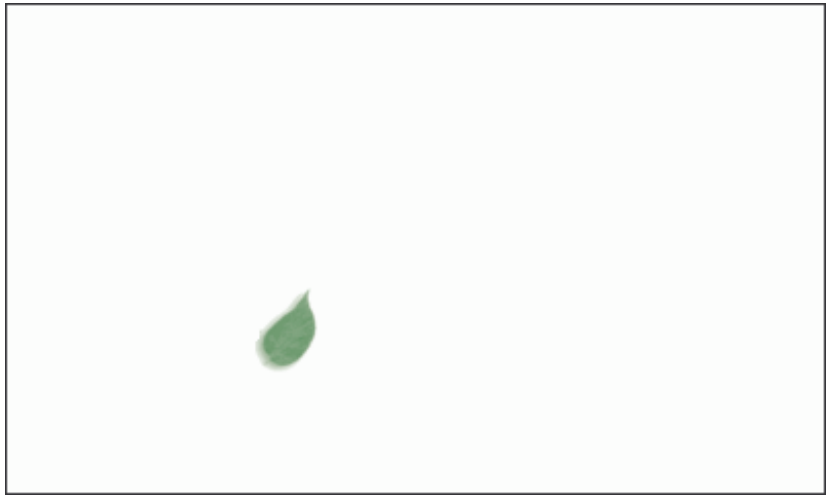
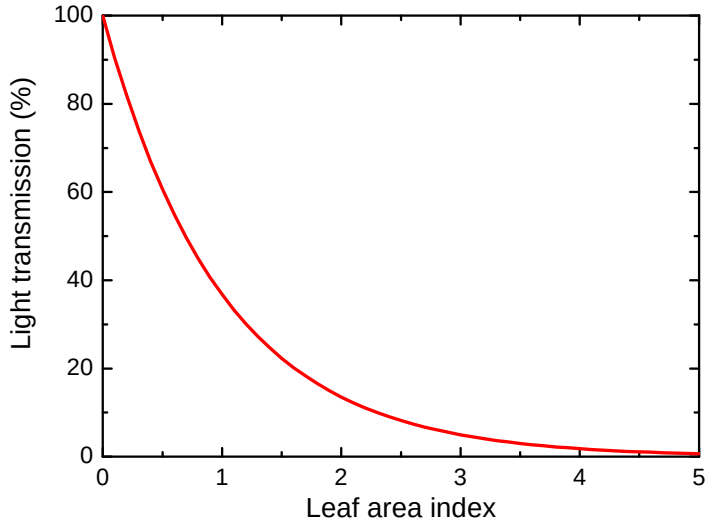
Leaf area index and light transmission



First approach, 2-dimensional:

$- dI / I = L$

$I = I_0 e^{-L}$

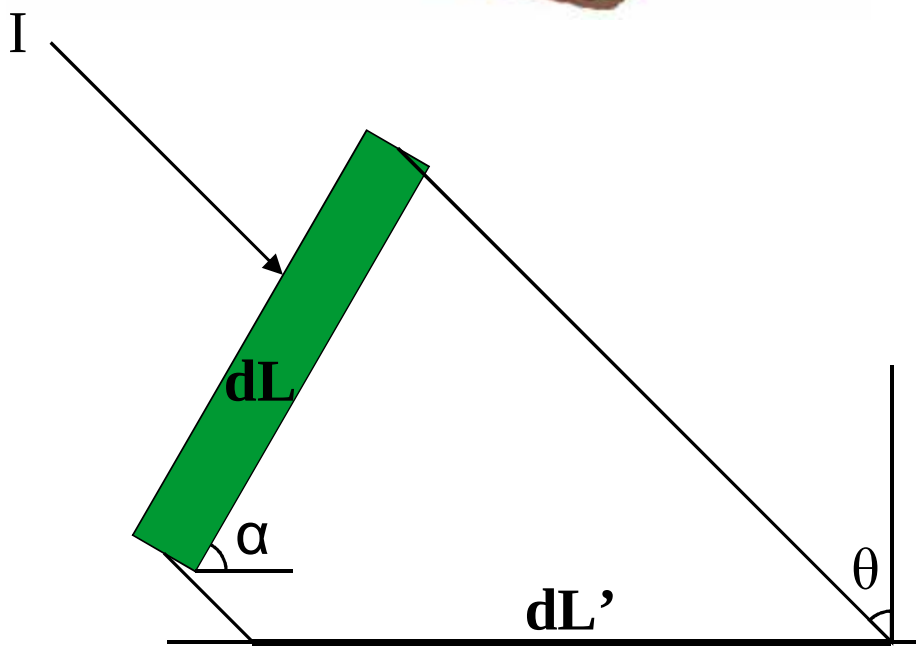


Leaf area index and light transmission

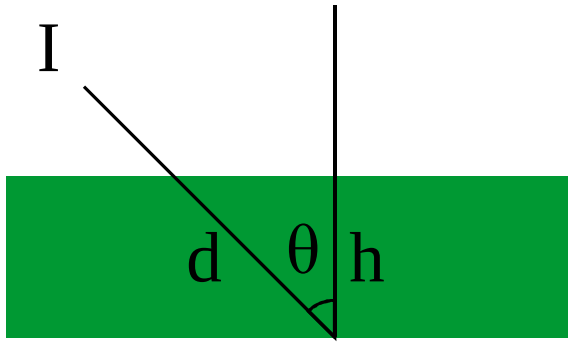
Ideal 3-dimensional canopy:

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

θ: zenith angle of light
α: leaf inclination angle

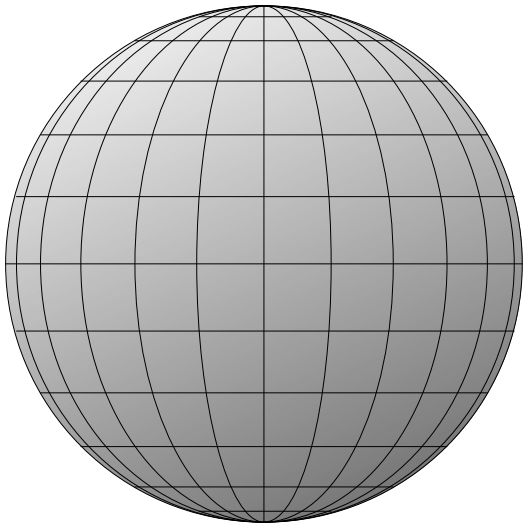


$d = h / \cos\theta$

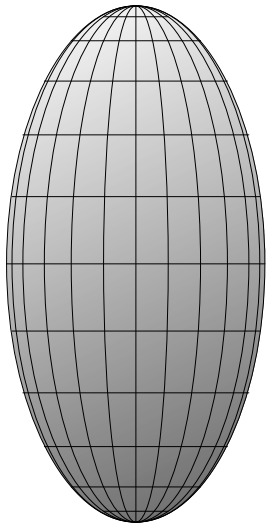


Leaf area index and light transmission

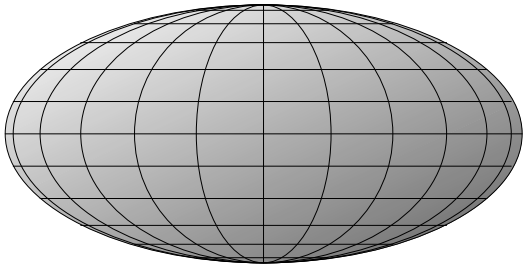
Leaf orientation: the ellipsoidal model



all probabilities equal
spherical distribution
x = 1
average α = 57.3°



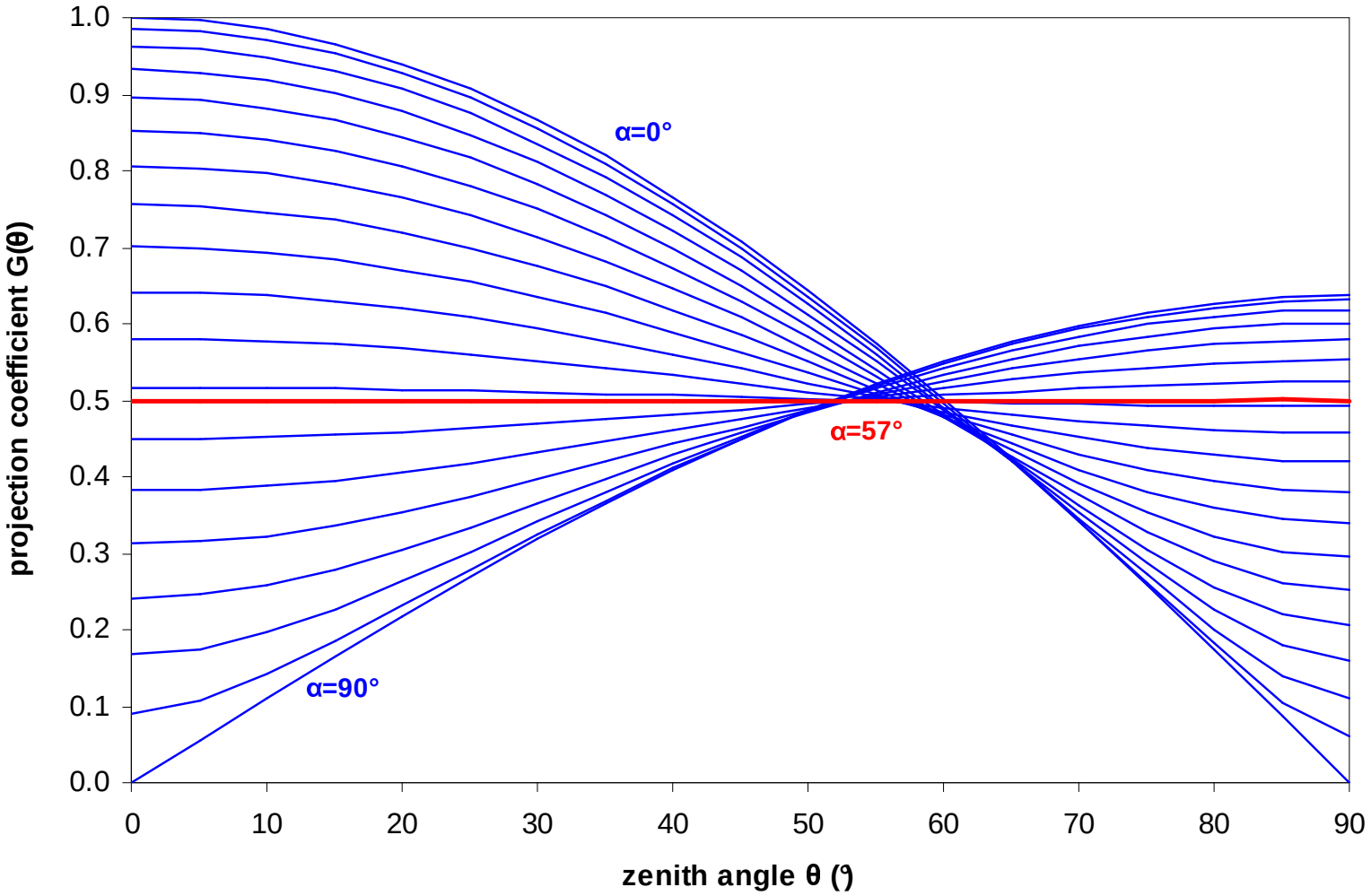
erectophile foliage
x = 0.5
average α = 71°



planophile foliage
x = 2
average α = 38°

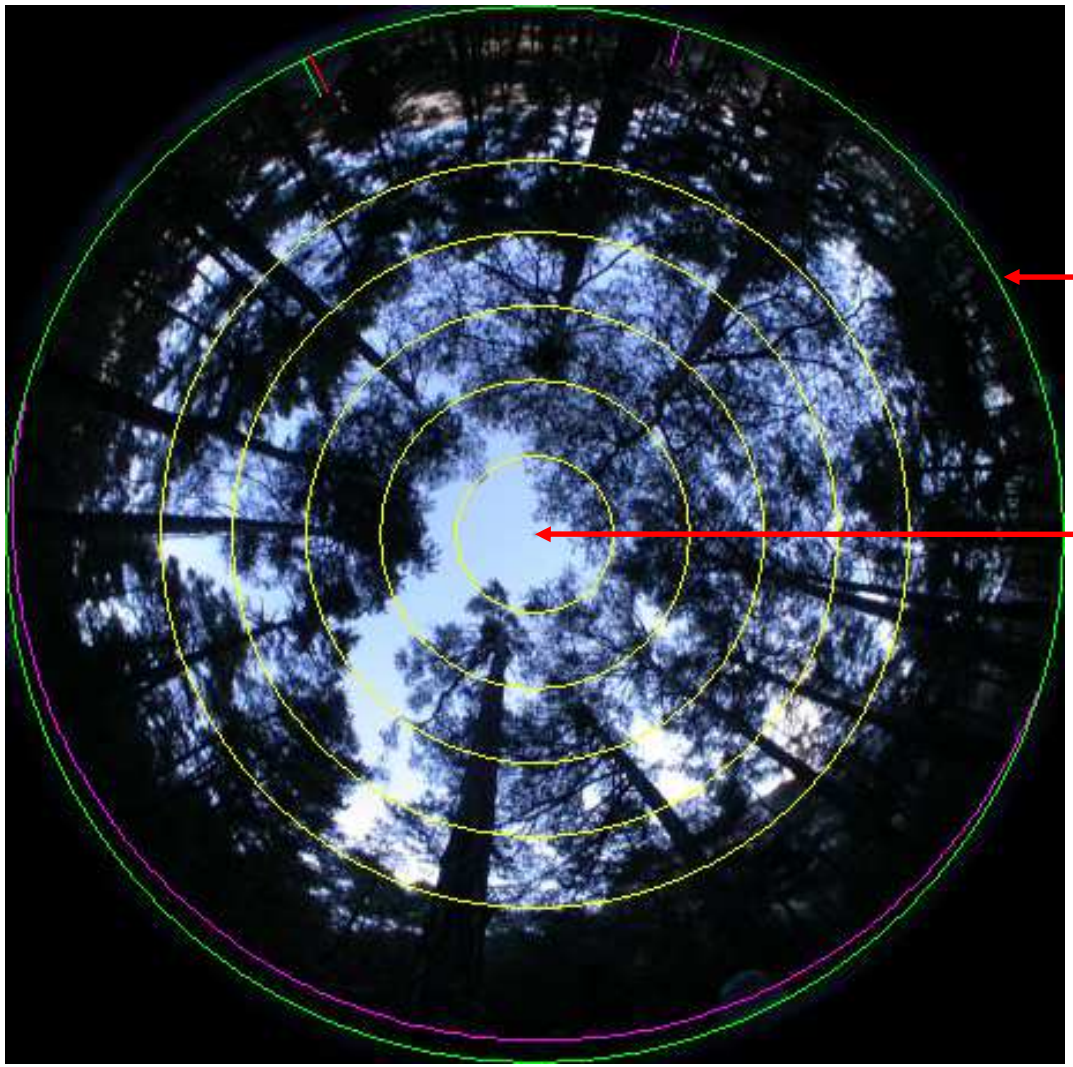
Leaf area index and light transmission

Leaf orientation: the ellipsoidal model



Hemispherical photography

Hemispherical photography

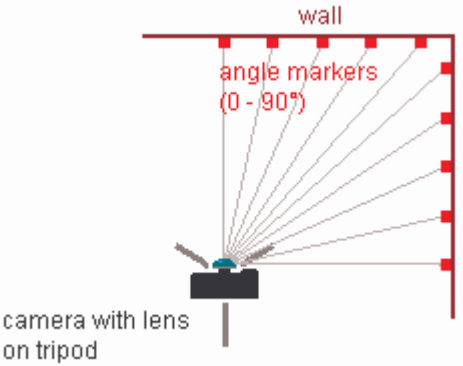


fisheye lens
view angle 180°

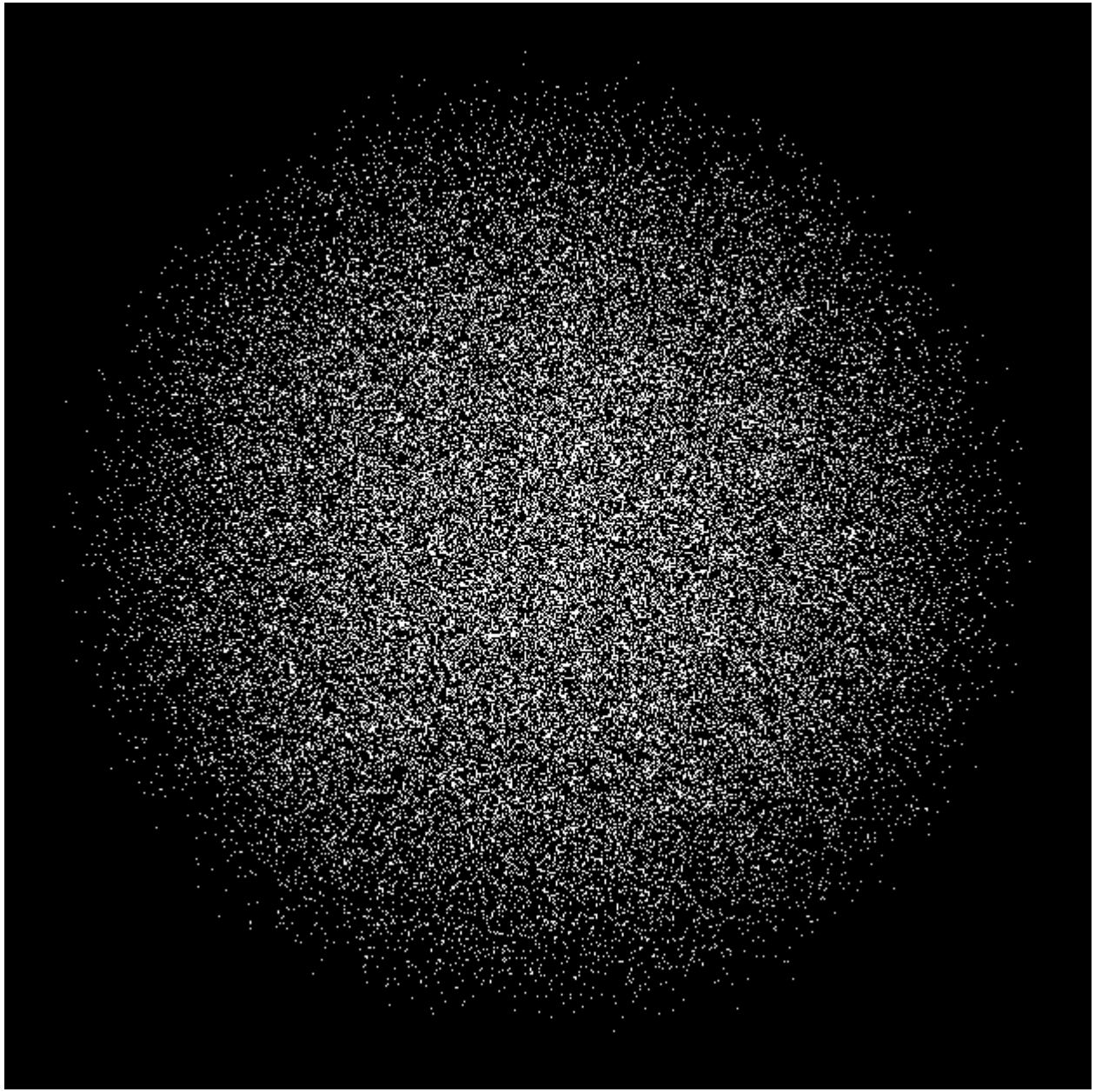
horizon

zenith

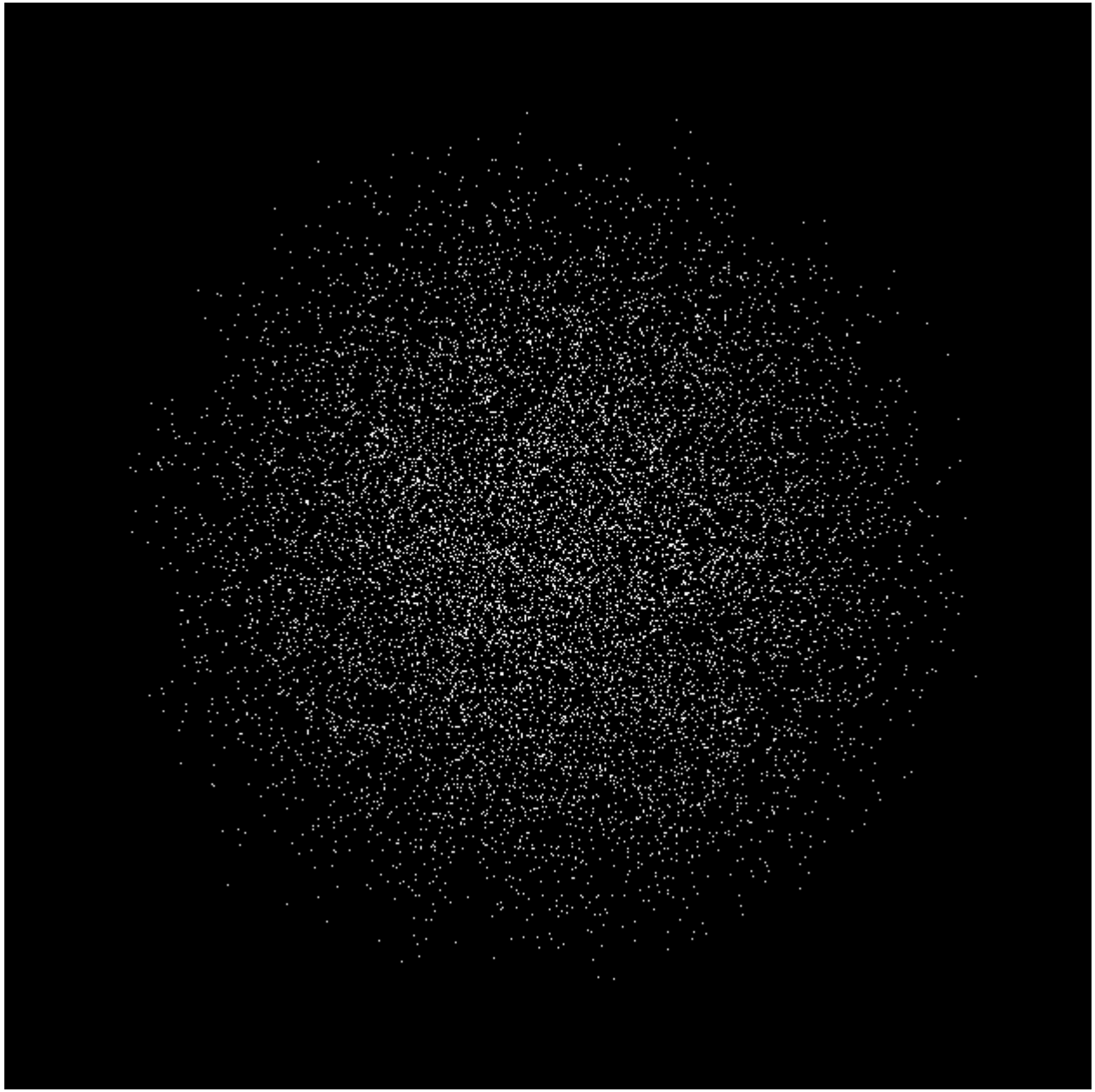
calibration:



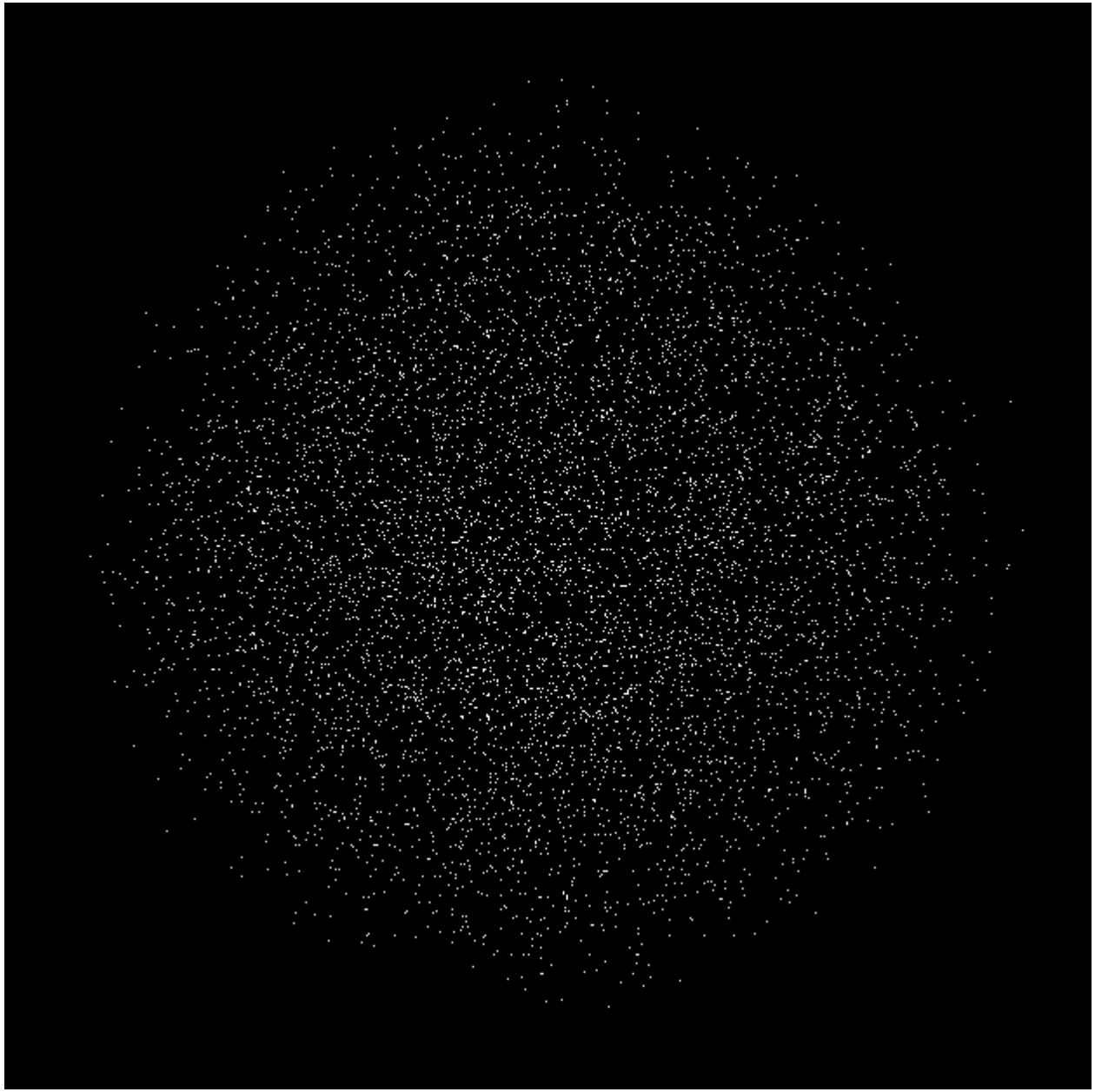
LAI = 2
α = 56°



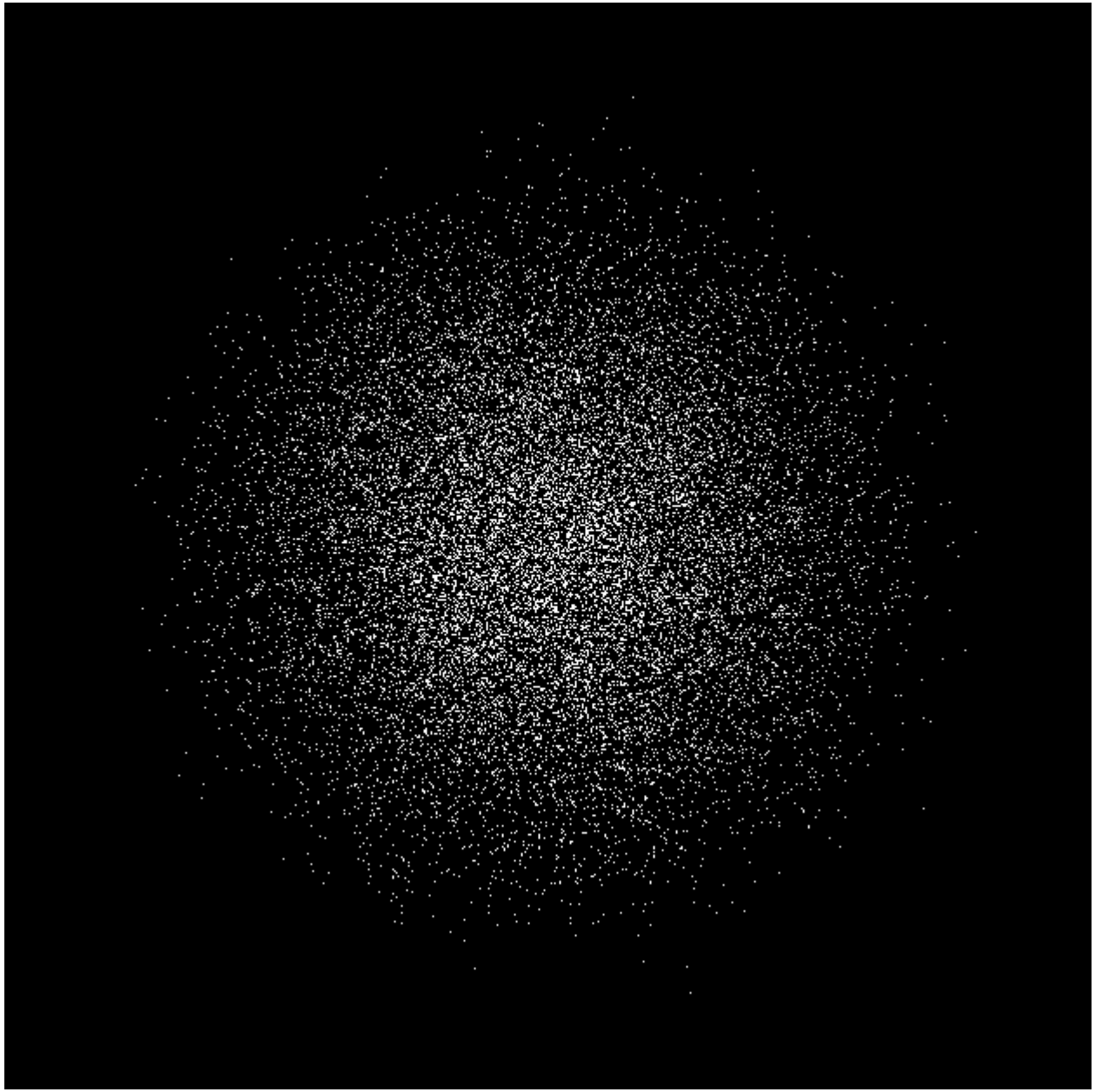
LAI = 4
α = 56°



LAI = 4
α = 38°



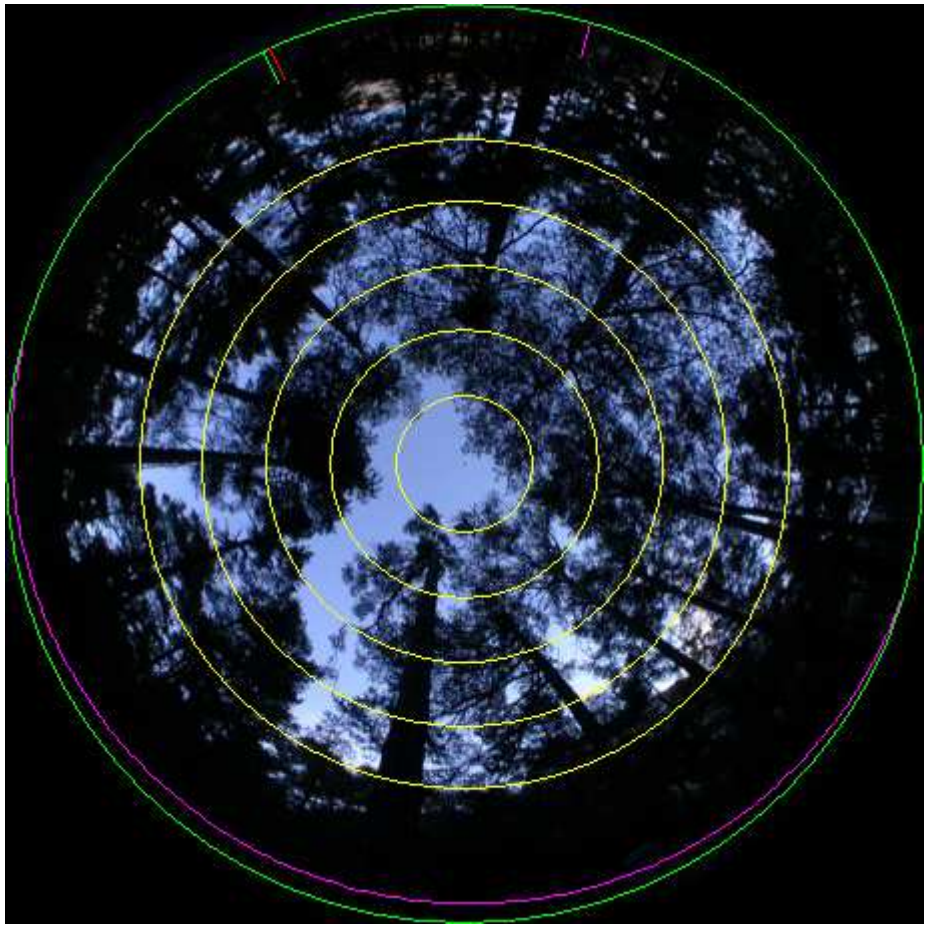
LAI = 4
α = 71°

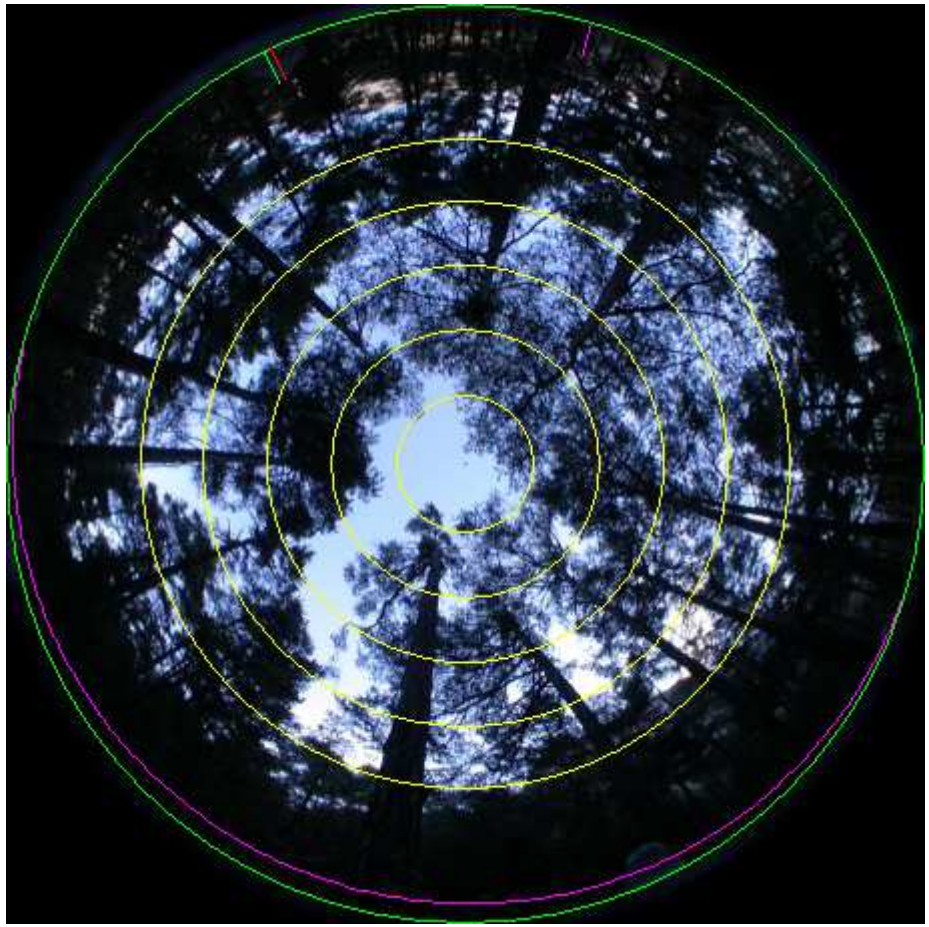


Hemispherical photography

Finges 2005, exposure: spotmeter / sky

+ 1 stop

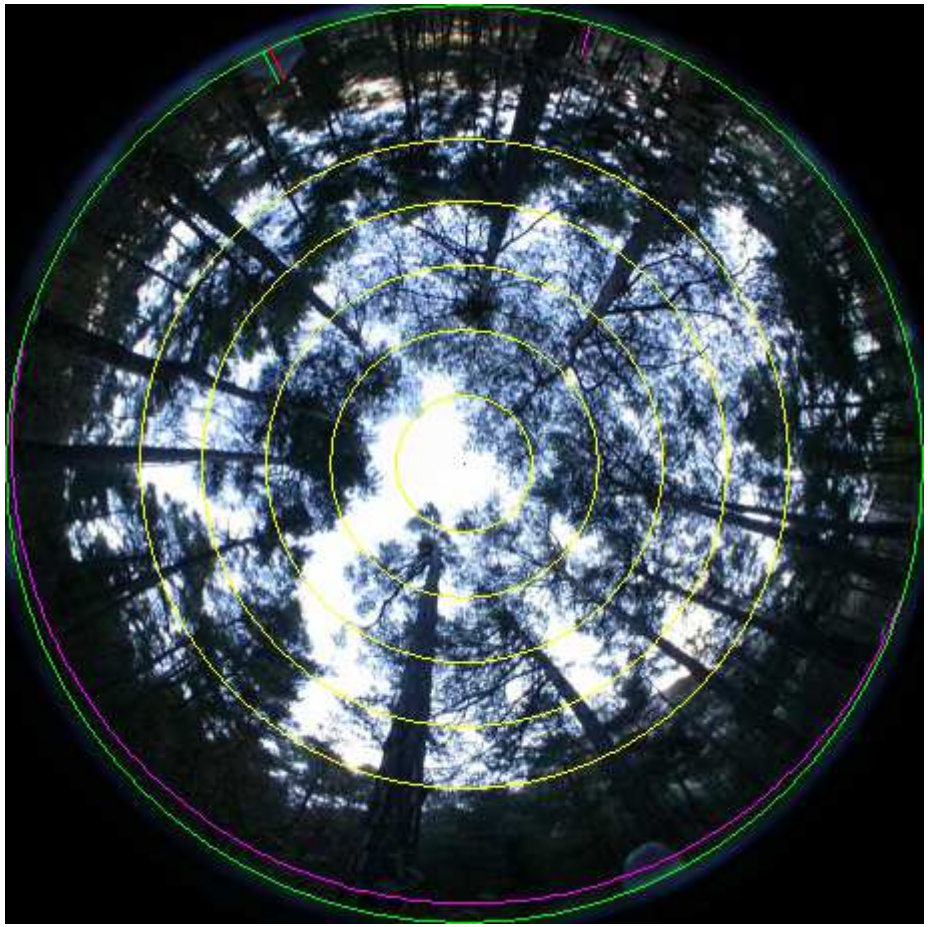




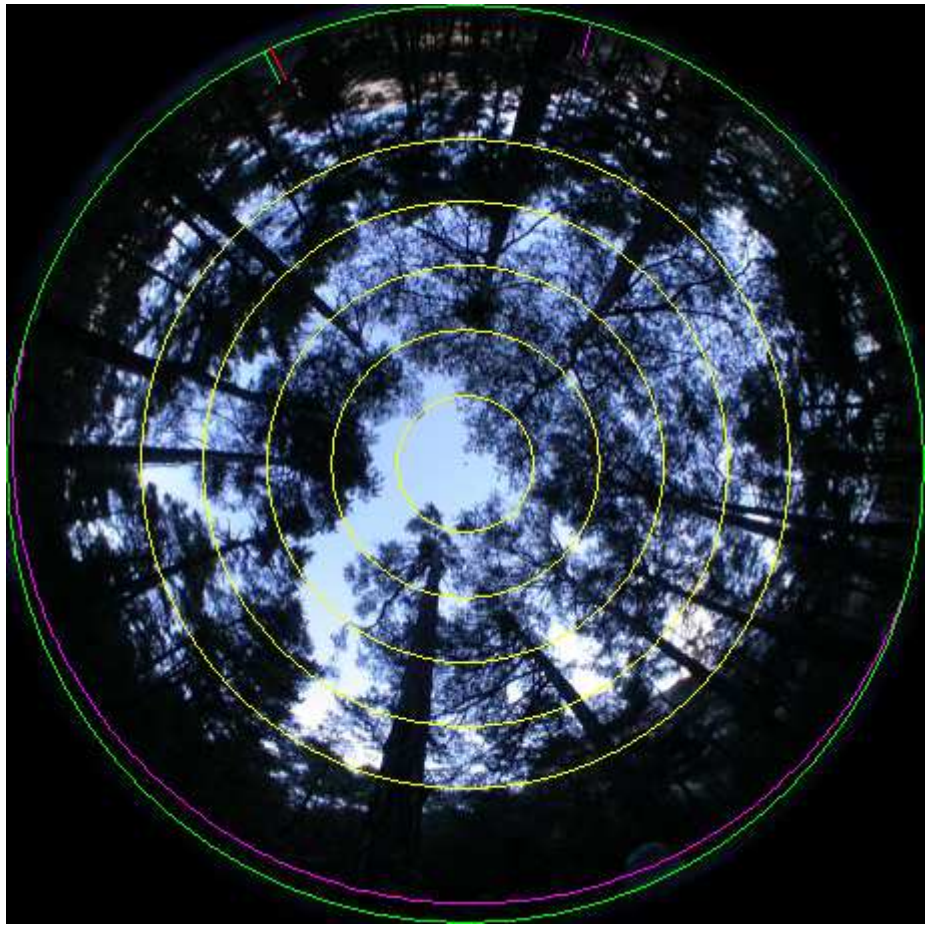
Hemispherical photography

Finges 2005, exposure: spotmeter / sky

+ 2 stops (some blooming)



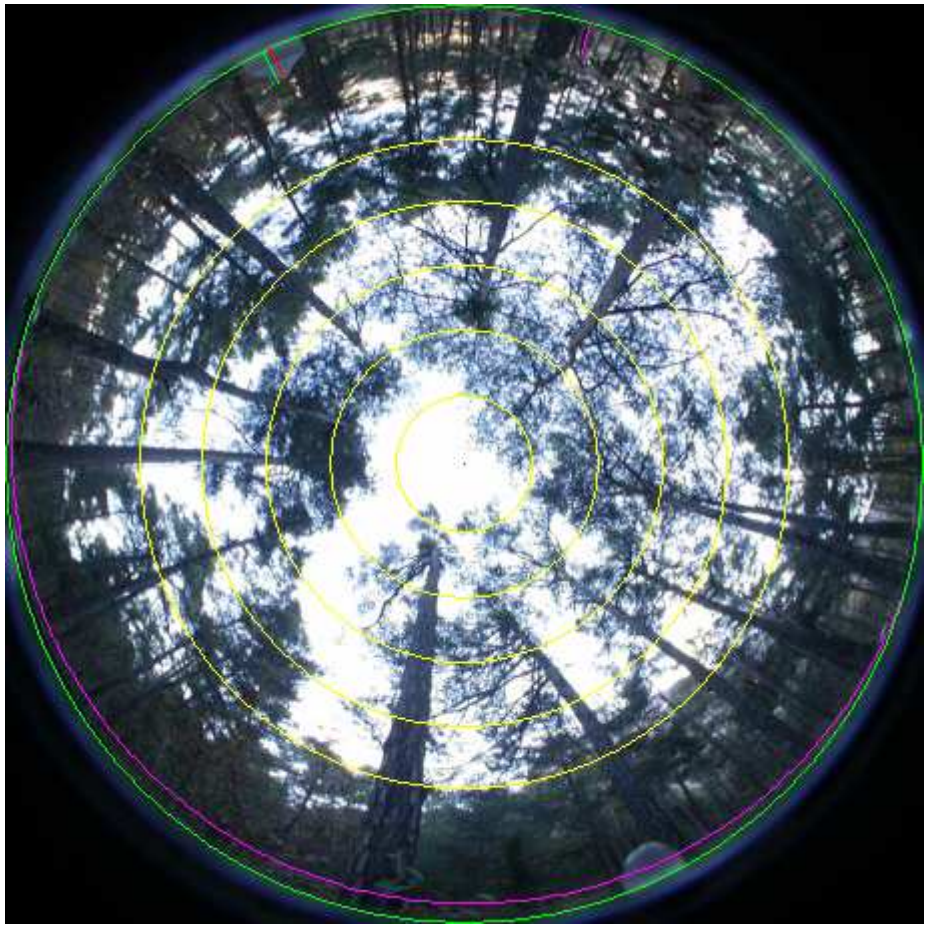
+ 1 stop



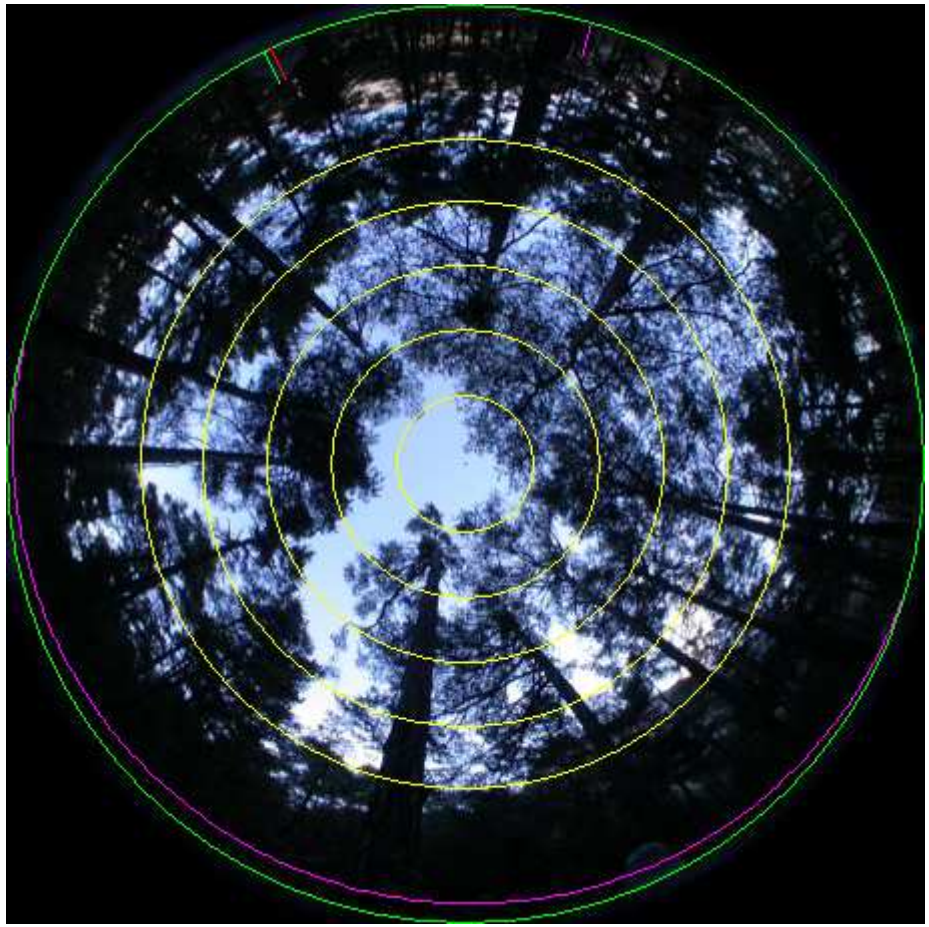
Hemispherical photography

Finges 2005, exposure: spotmeter / sky

+ 3 stops (much blooming!)



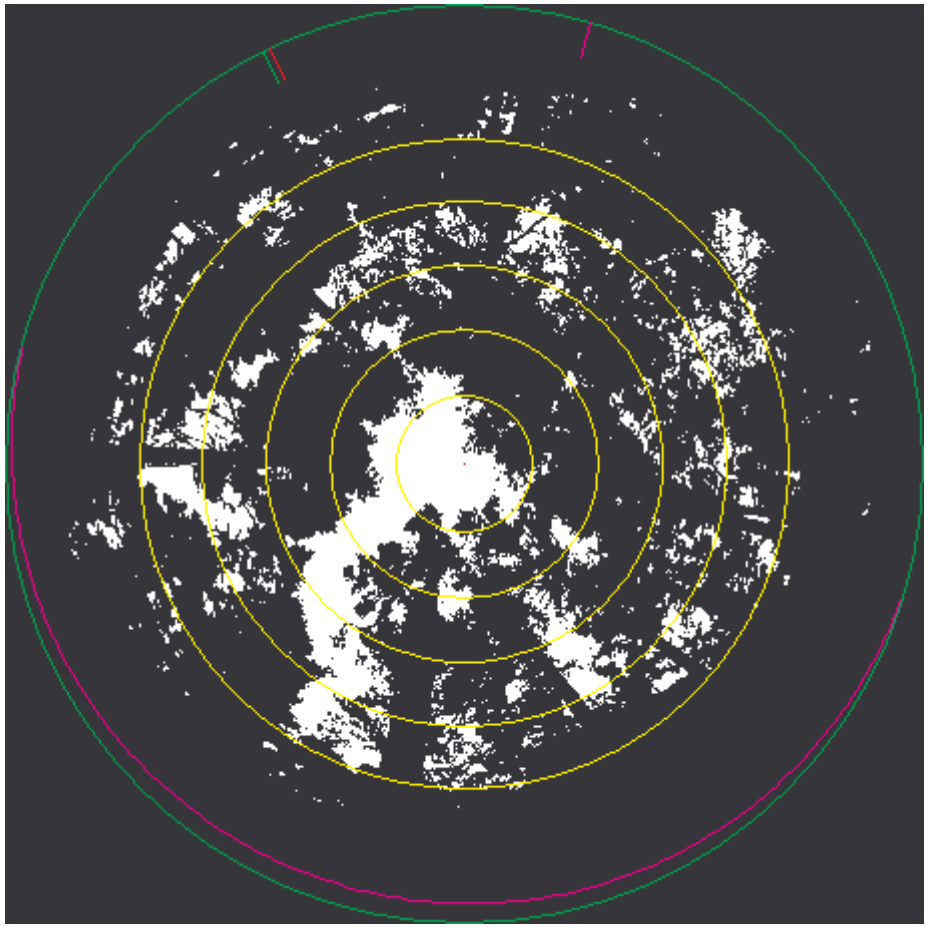
+ 1 stop



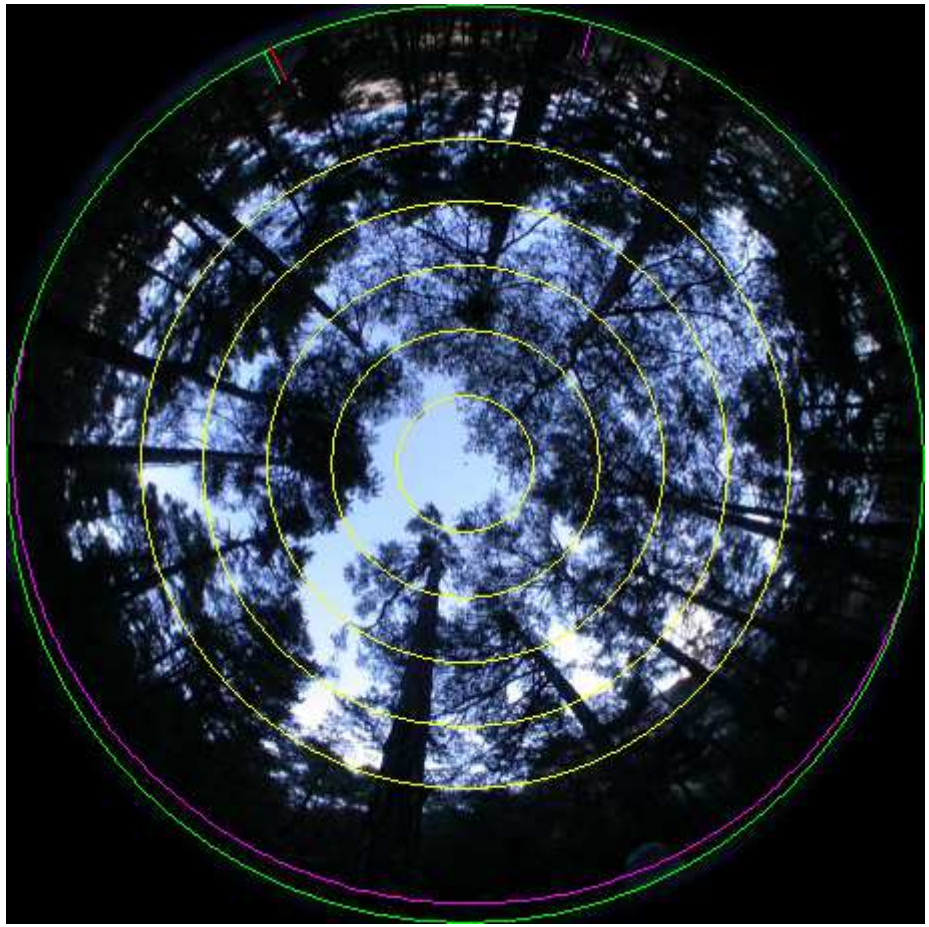
Hemispherical photography

Finges 2005, exposure: spotmeter / sky

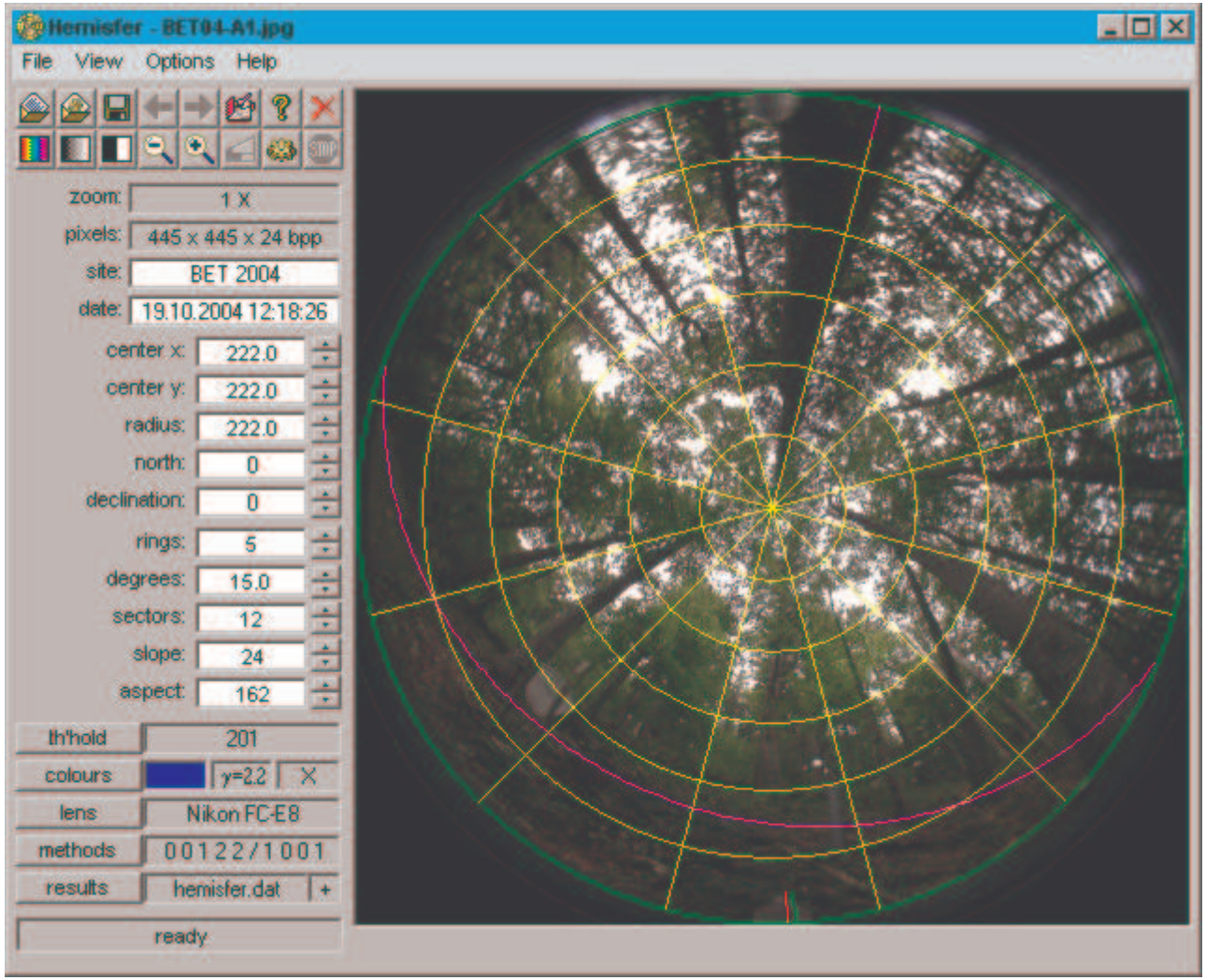
+ 1 stop, automatic threshold



+ 1 stop



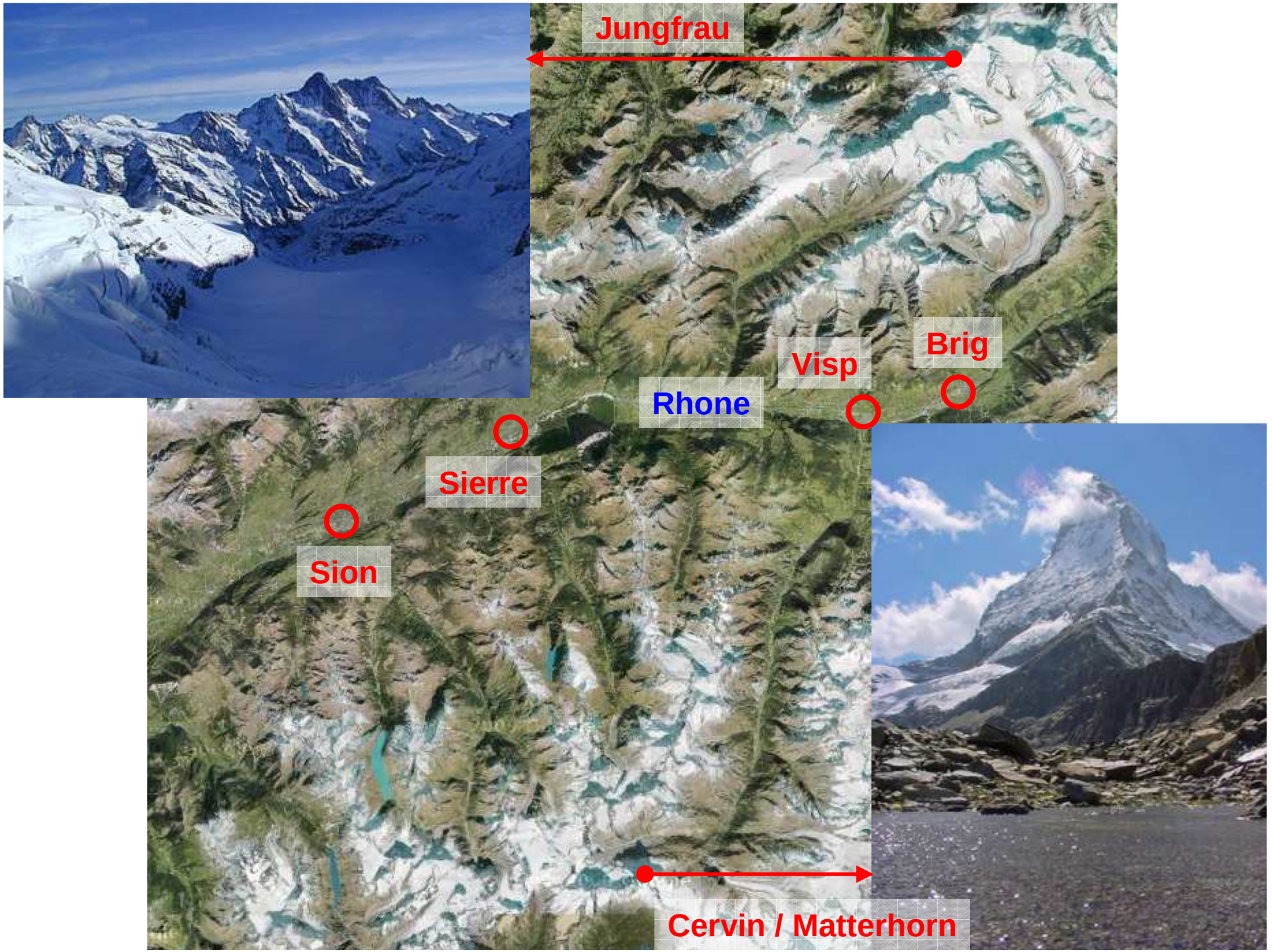
Hemisfer



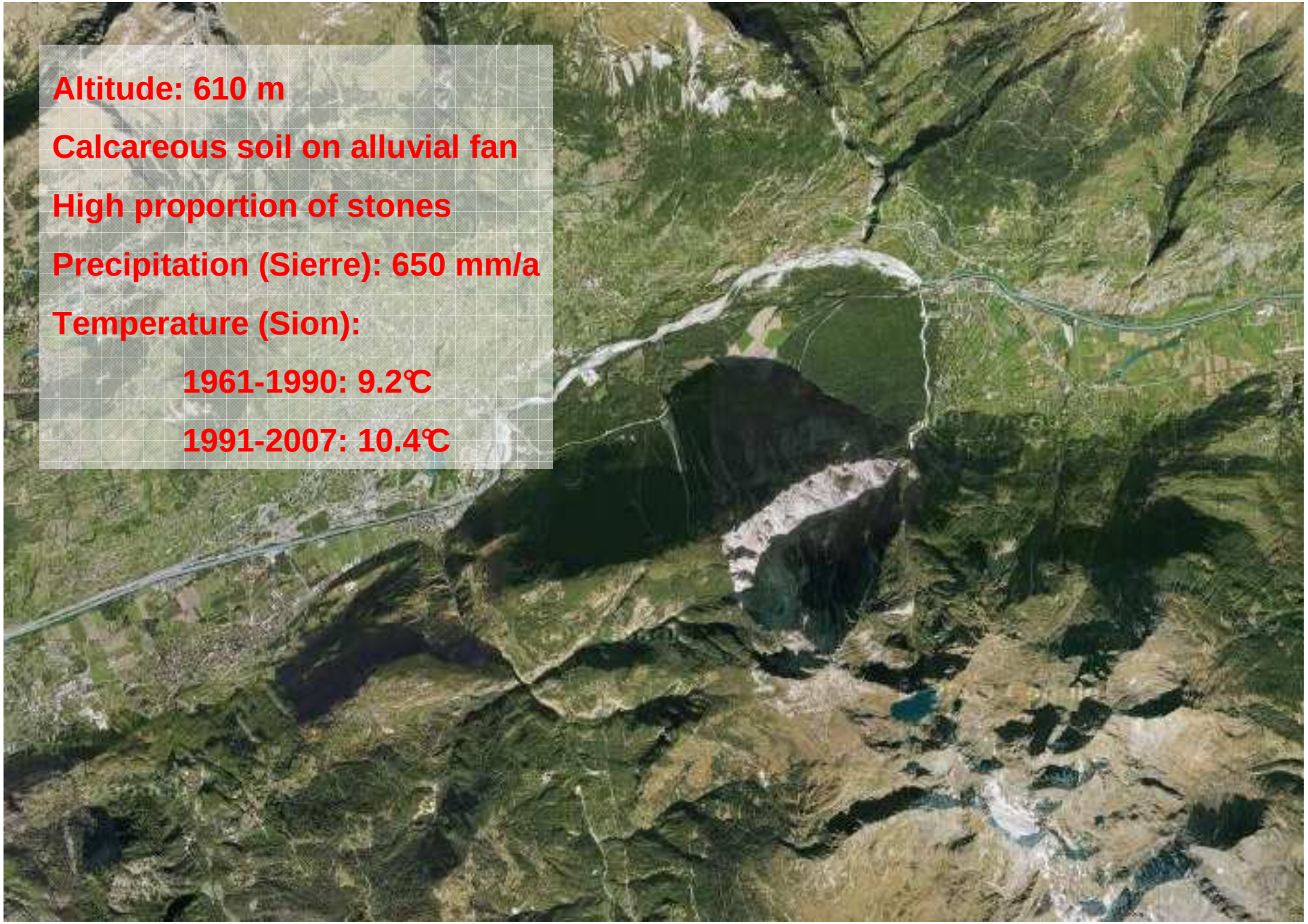
- shareware
- multilingual
- interactive or batch
- 5 LAI calculation methods
- slope effect
- automatic threshold
- canopy clumping

http://www.wsl.ch/dienstleistungen/hemisfer

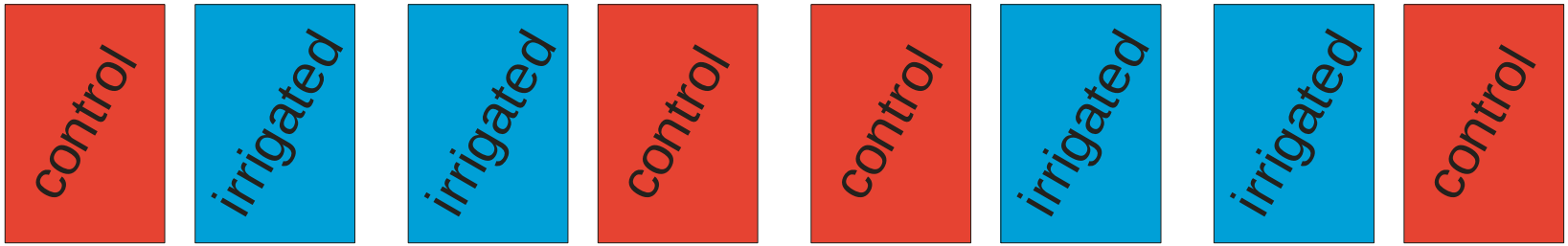
Finges / Pfynwald: *Pinus* irrigation project


Jungfrau
Brig
Visp
Rhone
Sierre
Sion
Cervin / Matterhorn

Bois de Finges / Pfynwald



Irrigation experiment Finges



block 1 block 2 block 3 block 4

control irrigated

Results: LAI

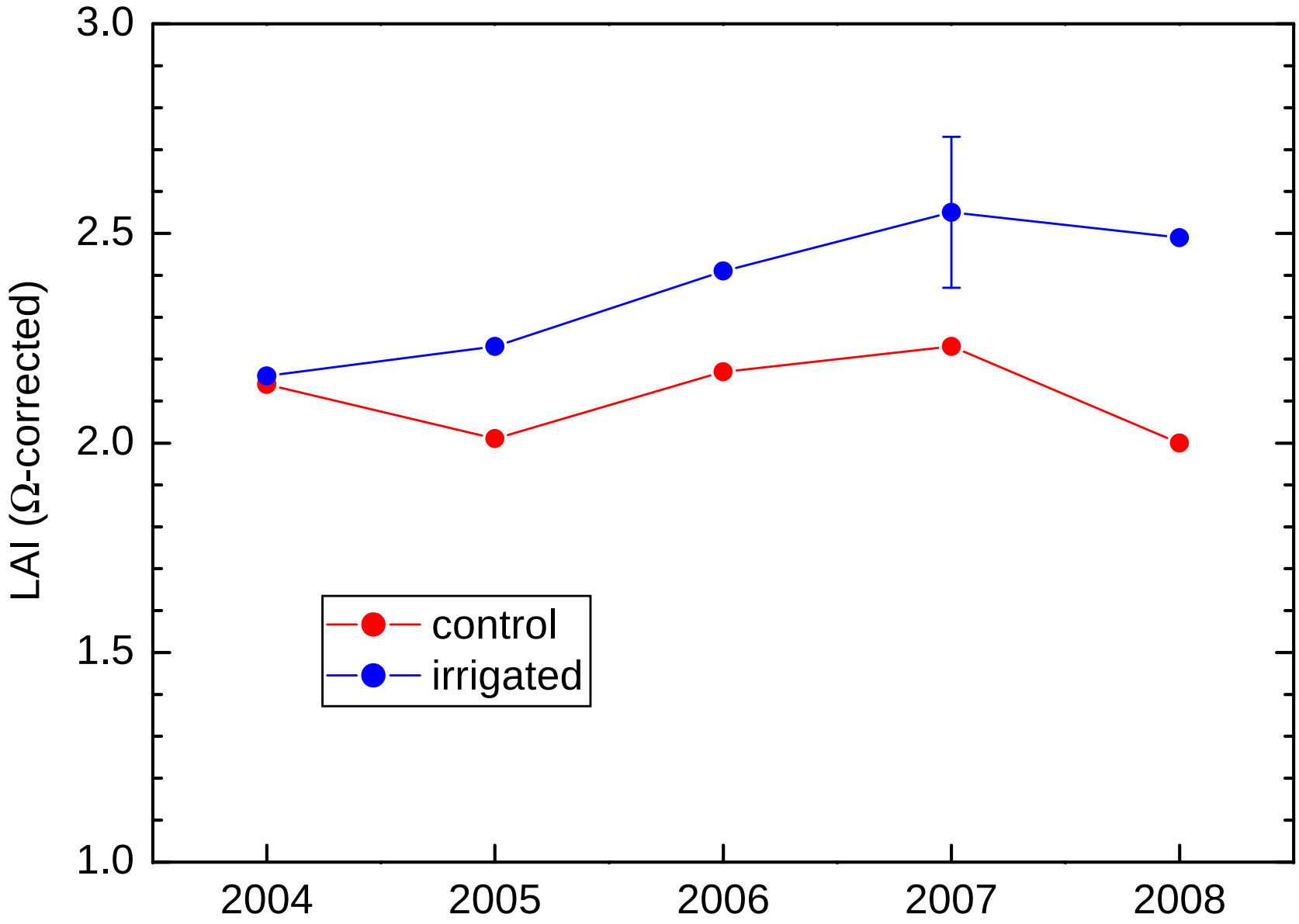
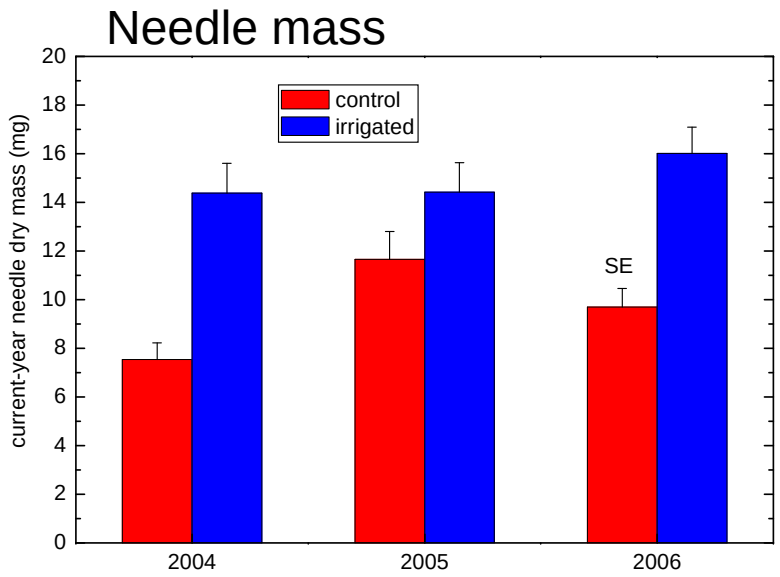
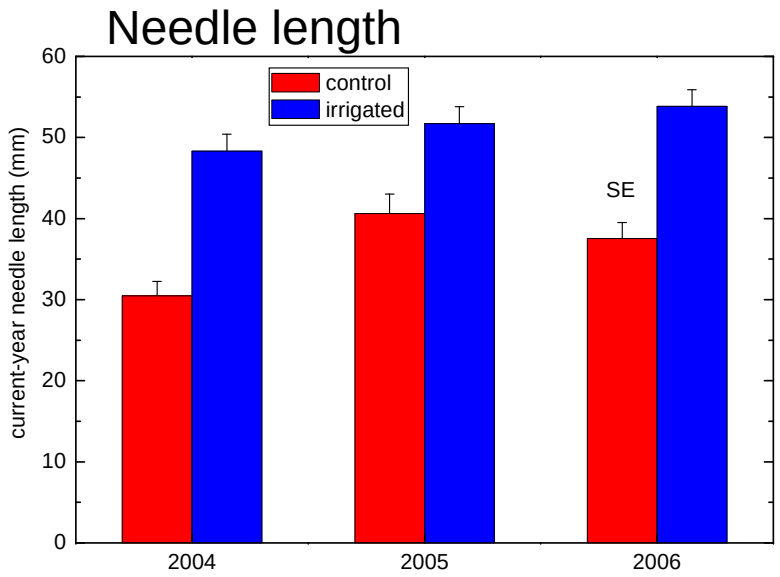
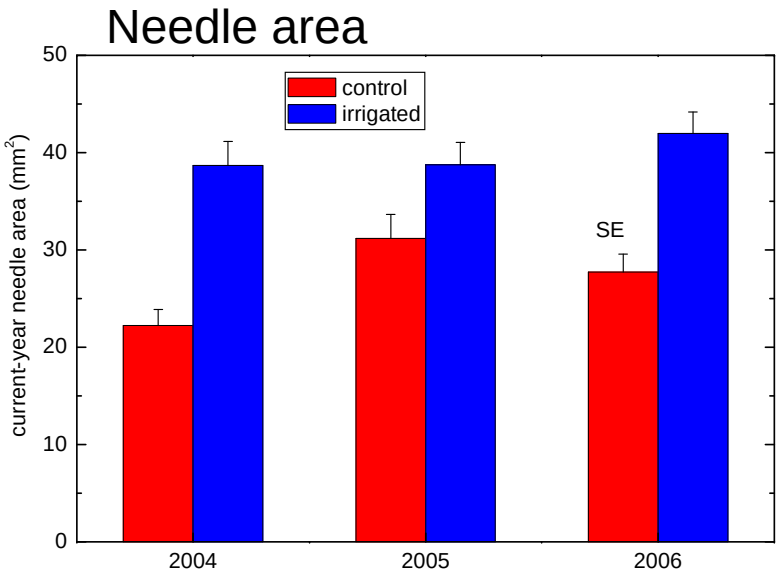

3.0
2.5
2.0
1.5
1.0
LAI (Ω-corrected)
2004
2005
2006
2007
2008
control
irrigated

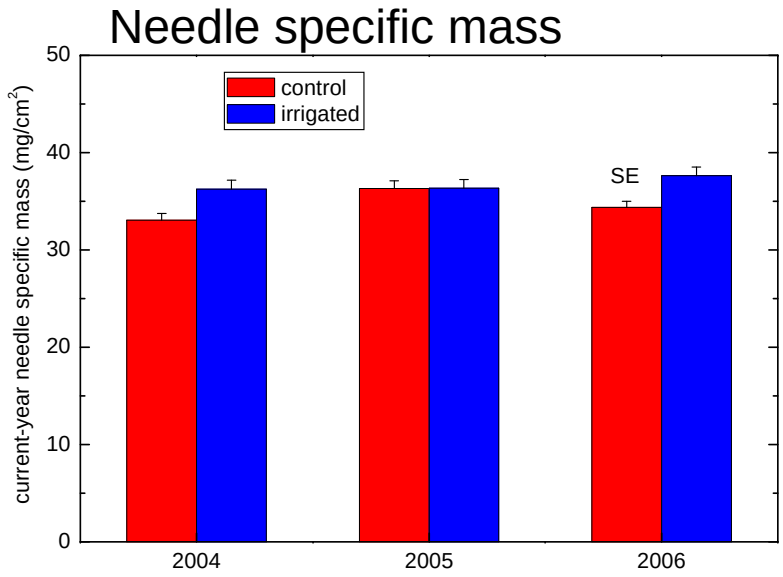
Image scanning: needles from (co-)dominant trees

Needle morphology



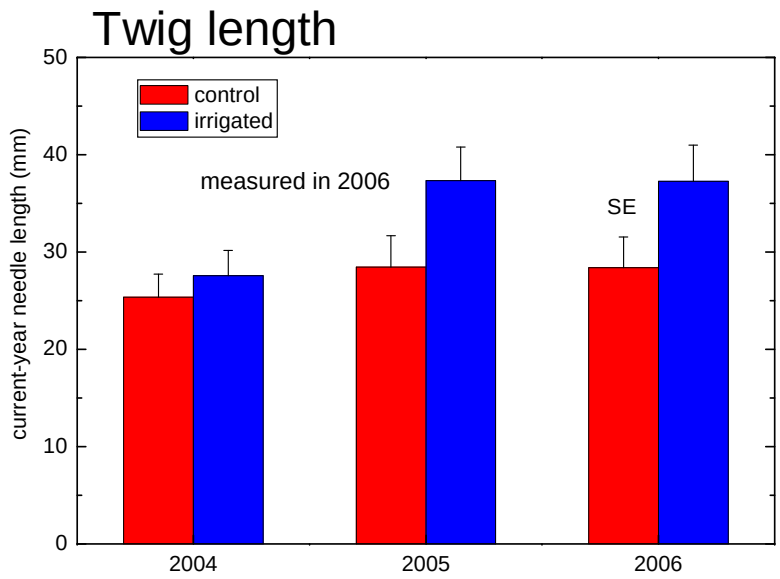






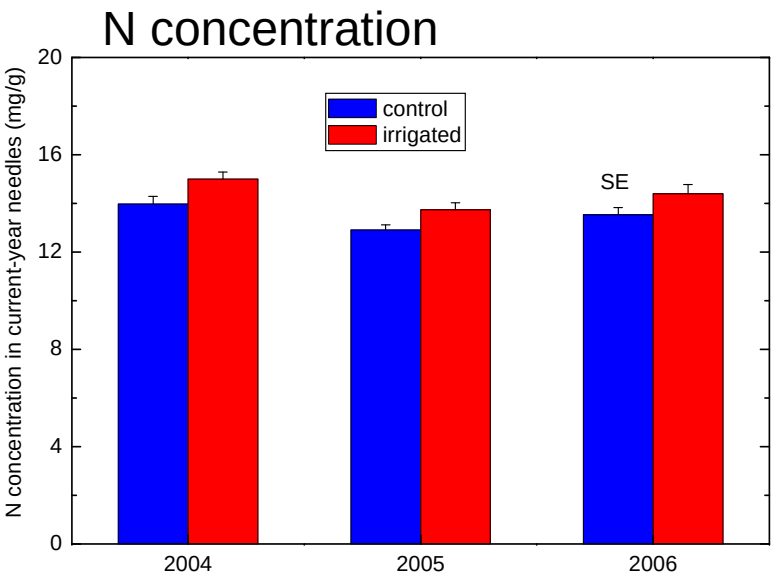
Larger, longer and heavier needles on irrigated trees

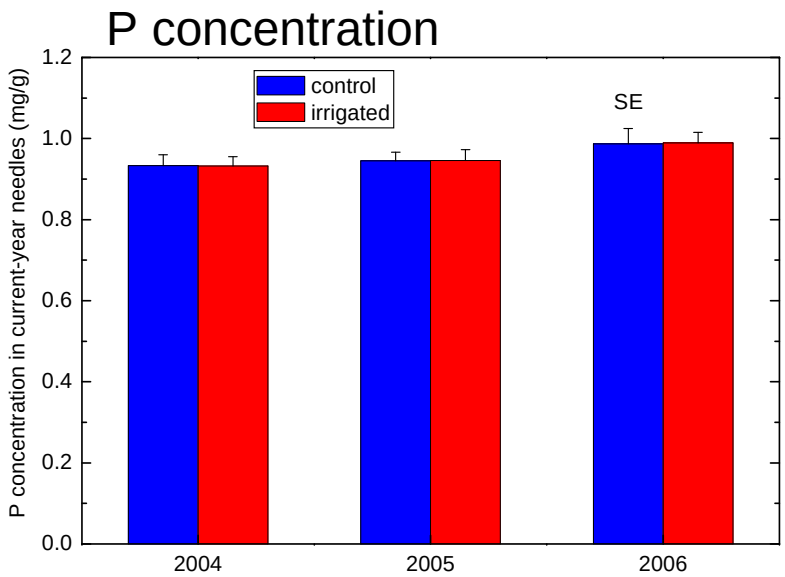
Twigs

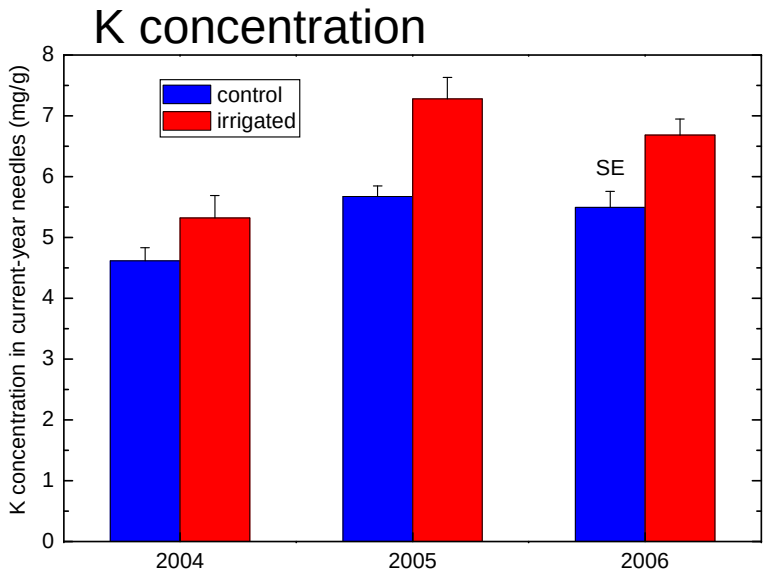


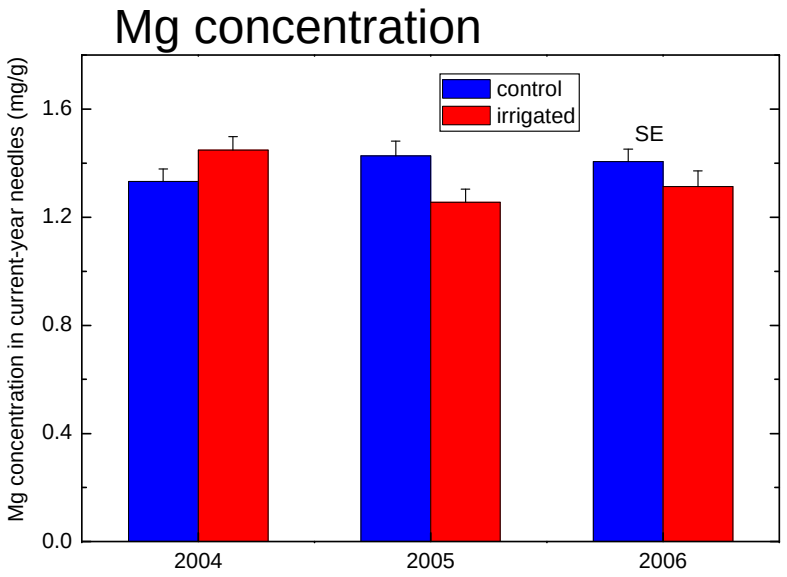
Longer twigs on irrigated trees

Needle chemistry

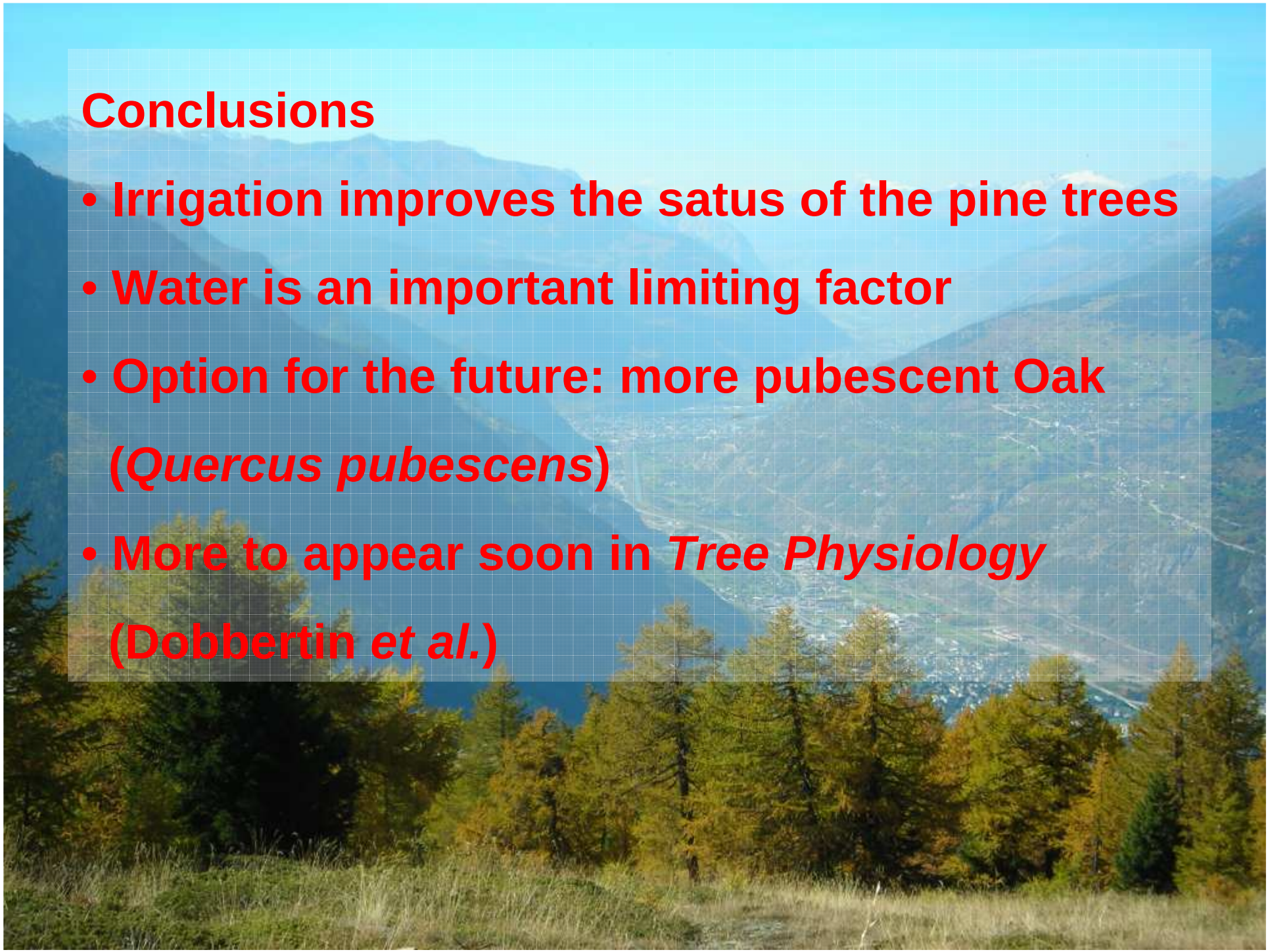








Nutrients either unaffected (N, P, Mg) or remaining in optimum range (K)



Conclusions

- Irrigation improves the satus of the pine trees
- Water is an important limiting factor
- Option for the future: more pubescent Oak (*Quercus pubescens*)
- More to appear soon in *Tree Physiology* (Dobbertin *et al.*)