Time-lapse hemispherical photography to better assess the effect of the light environment on the optimisation of exposure and thresholding

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Vignetting

Definition:
Light received by the sensor decreasing towards the borders of the picture.

Question:
Do we have to consider this effect in the analysis of hemispherical photographs?
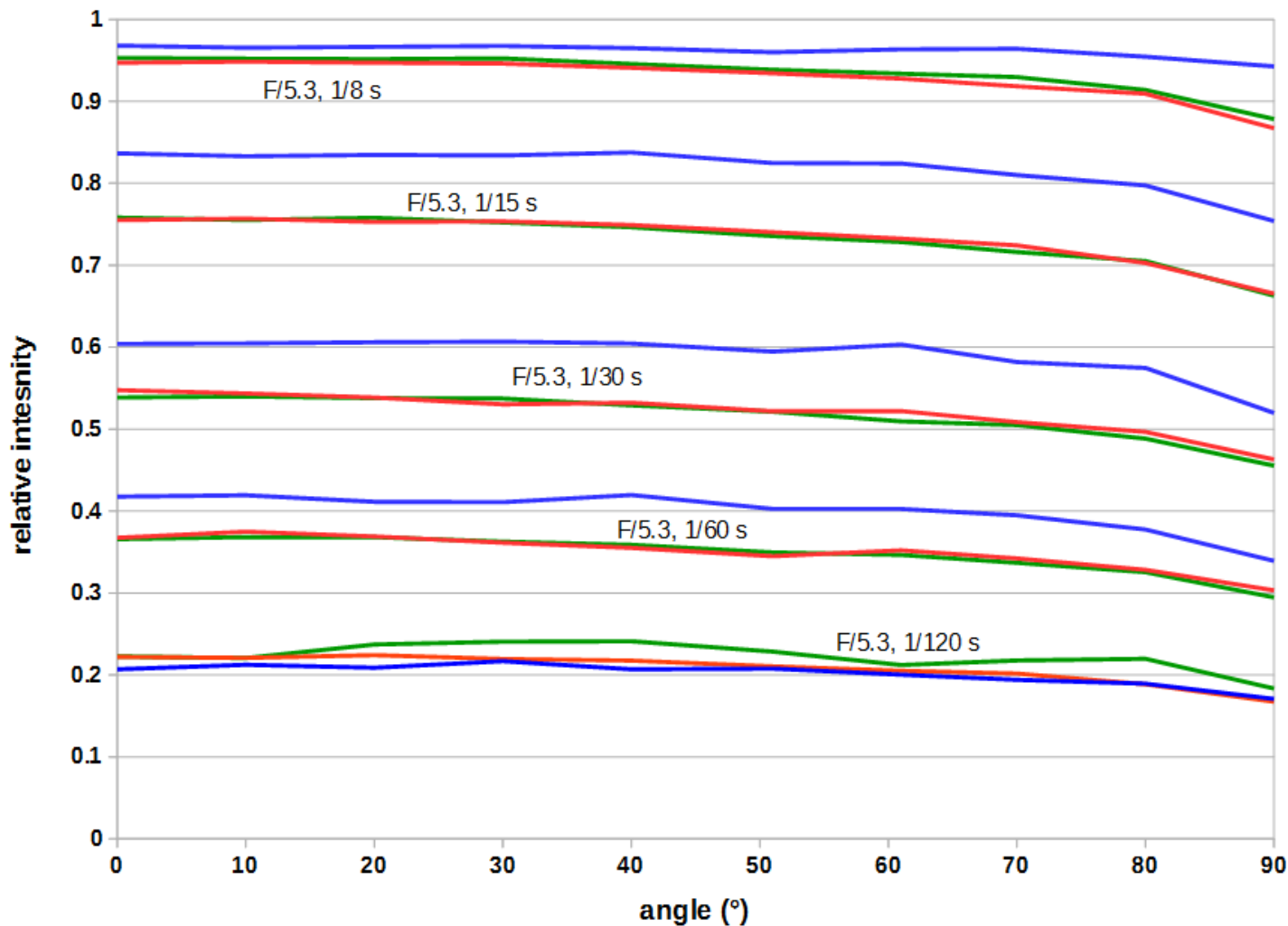
Vignetting

Test:
Pictures of a light source (a computer screen) at different angles and with different apertures.
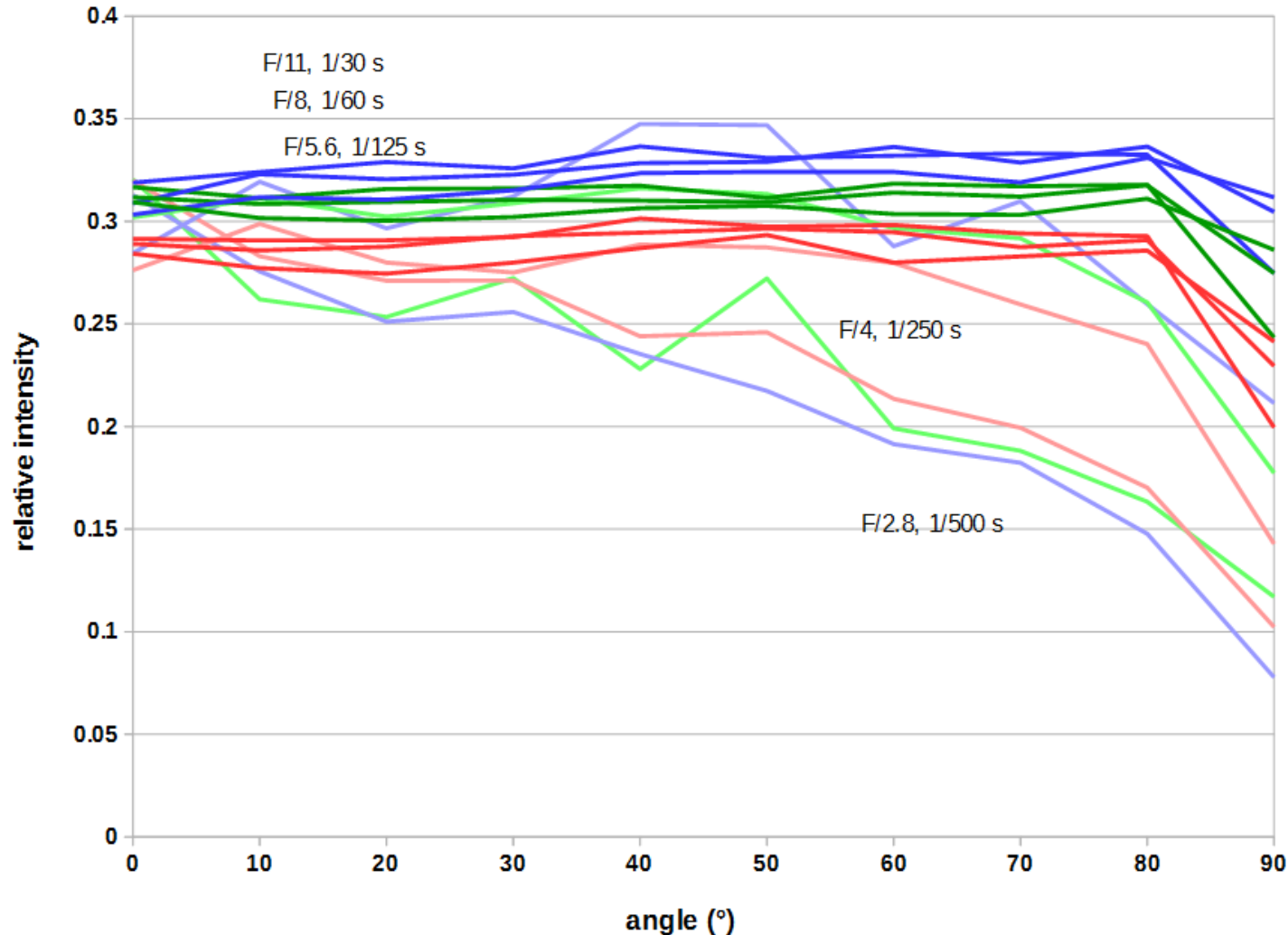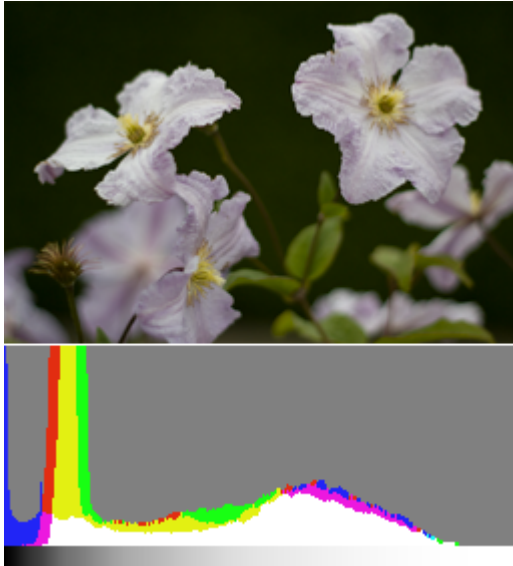
Vignetting

Coolpix 4500 + FC-E8: Slight vignetting at angles > 70° (fixed aperture: f/5.3)

Vignetting

F/11, 1/30 s
F/8, 1/60 s
F/5.6, 1/125 s

F/4, 1/250 s

F/2.8, 1/500 s

Canon 70D:
Vignetting at angles > 80° and at apertures > F/4

Exposure to the right

Pictures: Joe Haythornthwaite, public domain
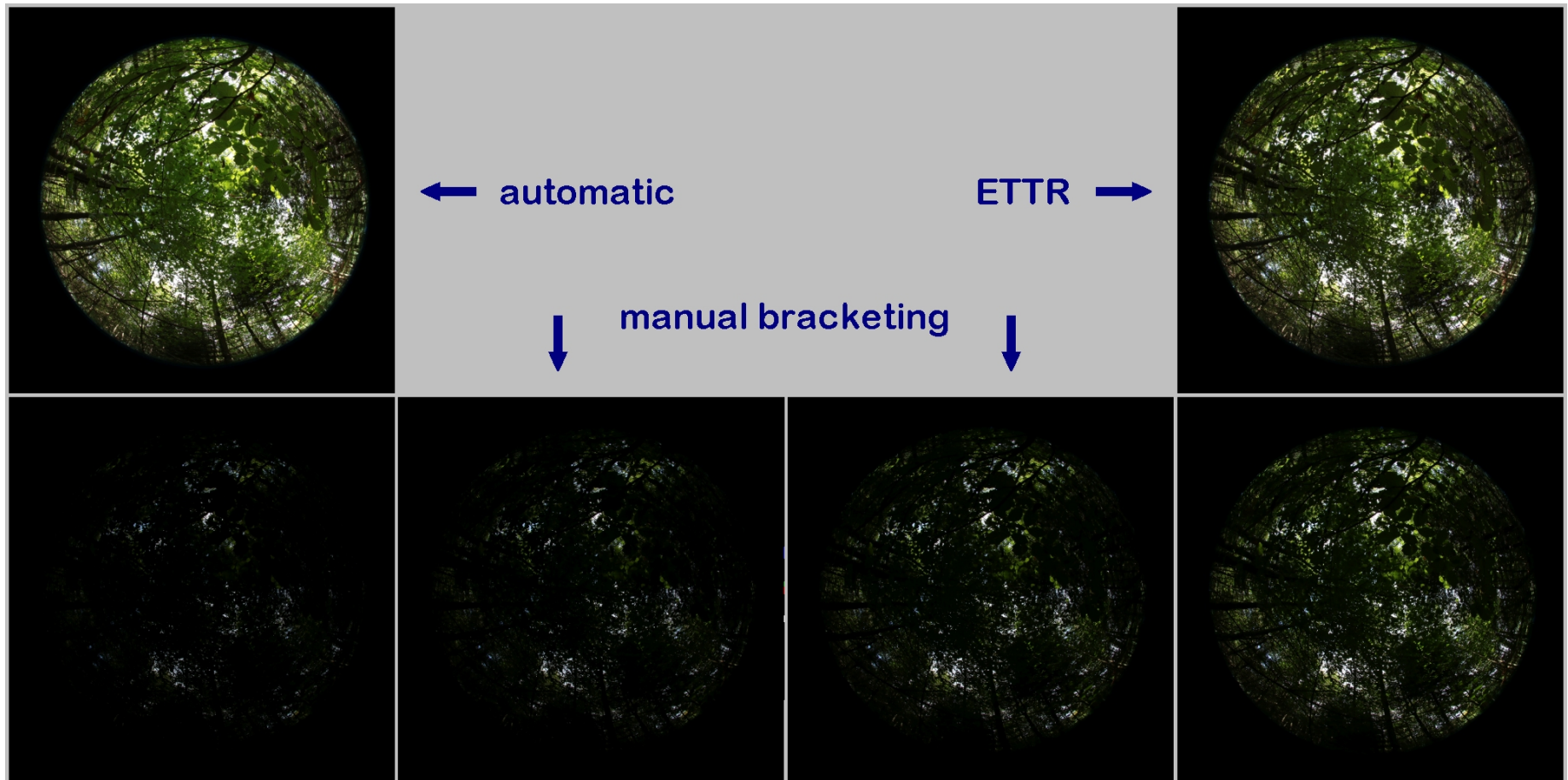
Basic idea:
Take full advantage of the scale 0 - 255 to retain the maximum of information on the picture.
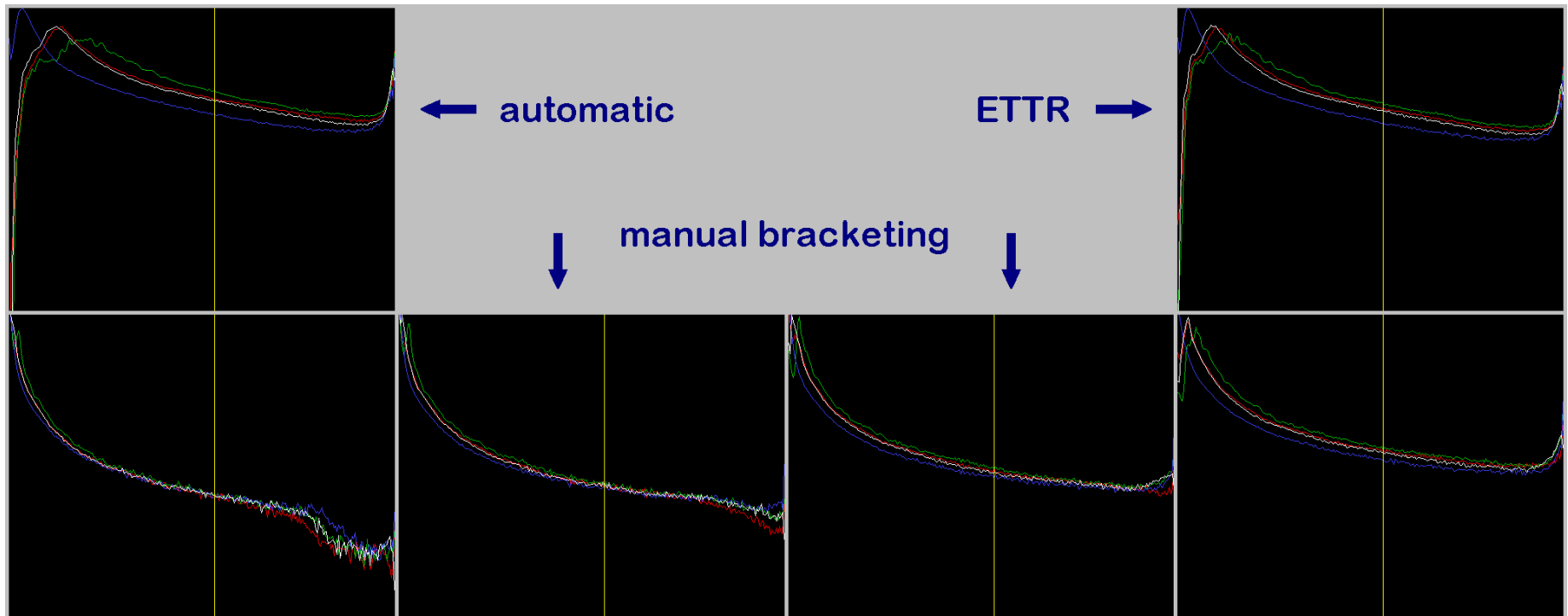
Question:
Applicable in hemispherical photography for an automatic exposure independent of the canopy density?
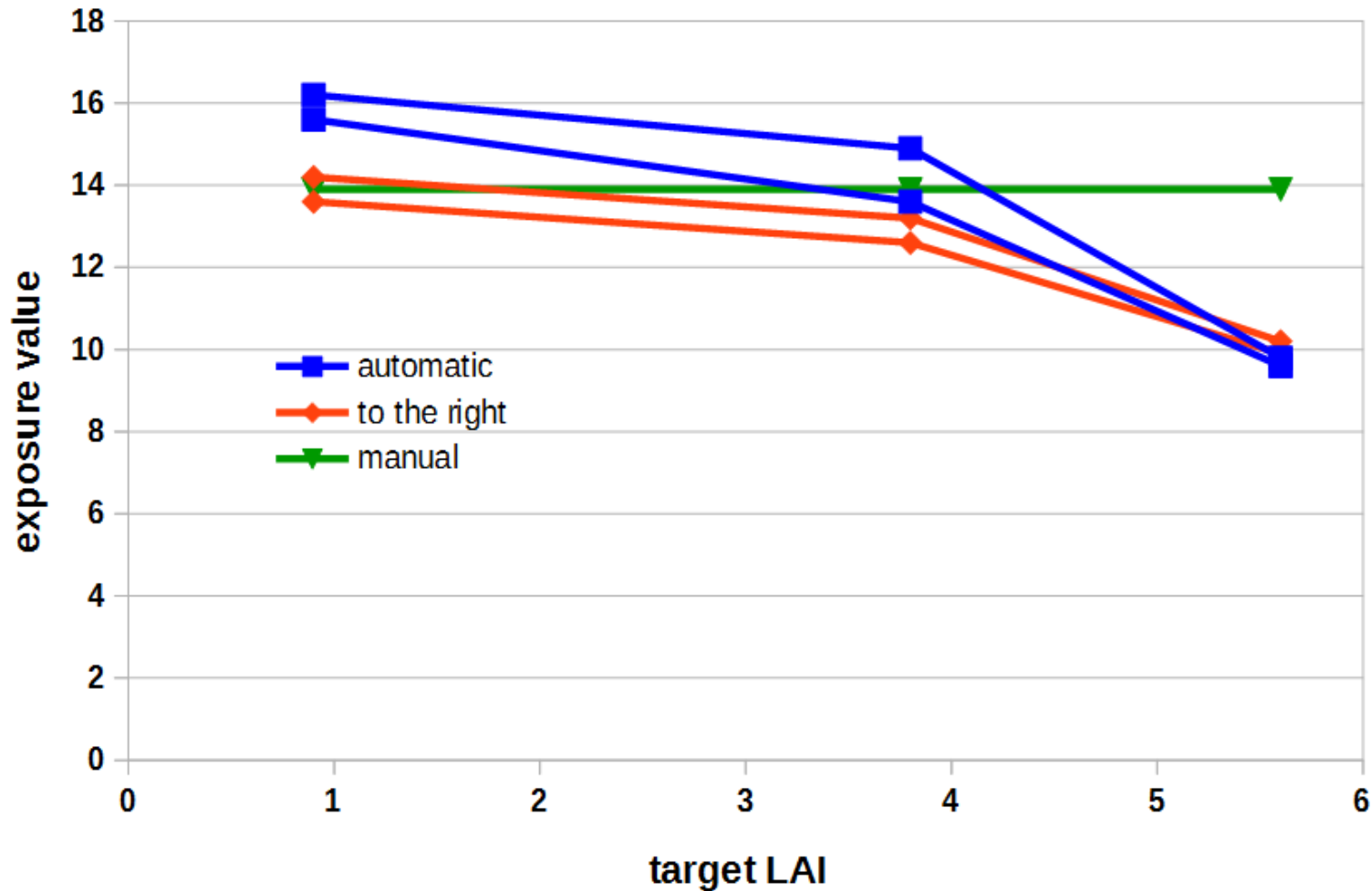
Exposure to the right

automatic

ETTR

manual bracketing

Exposure to the right

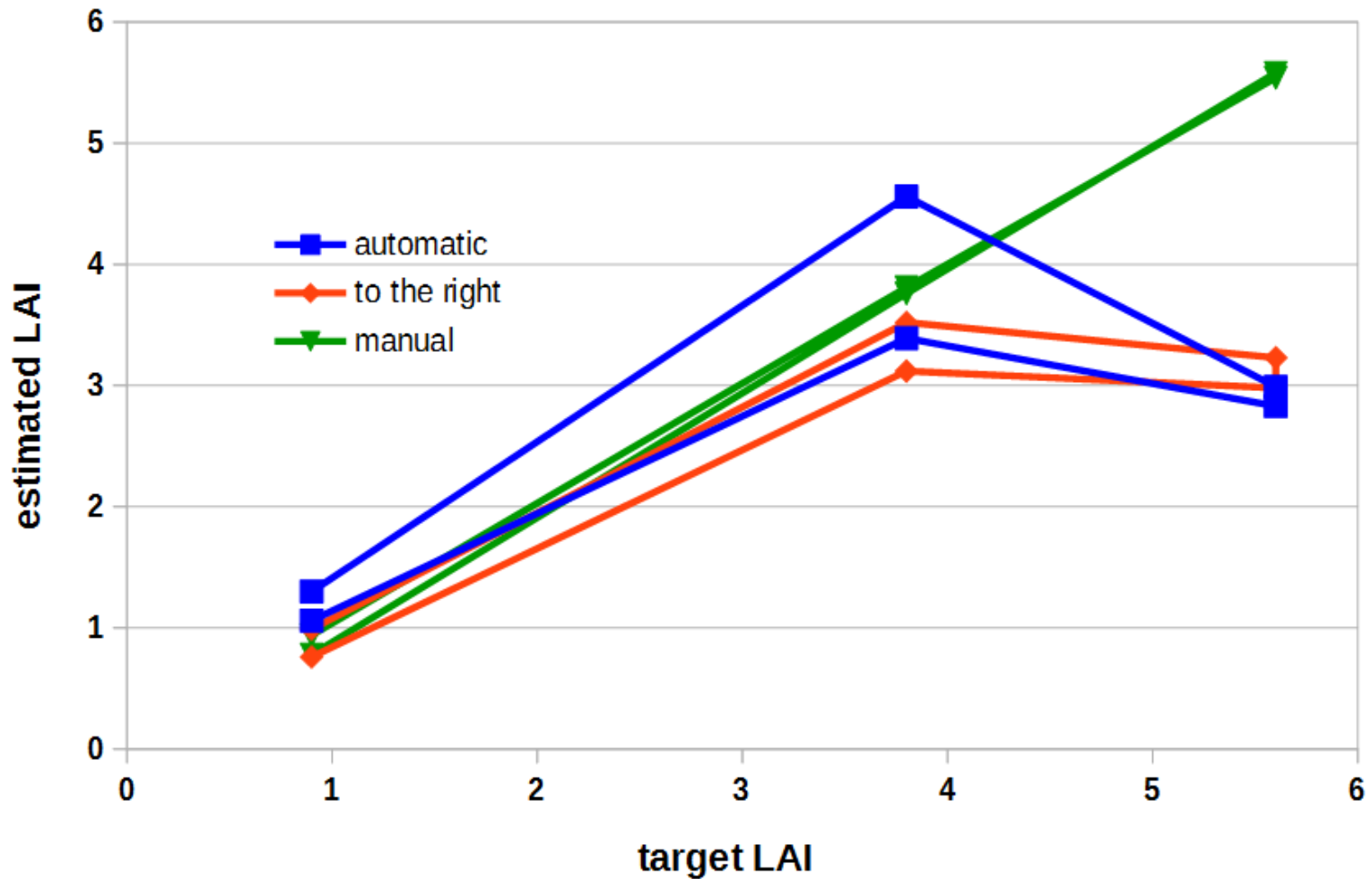← automatic   ETTR →

↓ manual bracketing ↓

Exposure to the right

Achieved exposure:
only slightly less depending on canopy density than auto-exposure

Exposure to the right

Estimated LAI:
exposure to the right fails to render high LAI values

Time-lapse photography

Basic idea:
Check how changing light conditions affect exposure, thresholding and results of image analysis.

First question:
Which material?

Time-lapse photography

Fish-eye adapter on cell phone:
- if you have an old cell phone with camera...
- just need a cheap fisheye adapter

But:
- insufficient optical quality (blurred)

Time-lapse photography

Raspberry Pi with camera module:
- fully programmable
- cheap, fun
- same fisheye optics as for cell phone

But:
- camera module mechanically weak
- optics also insufficient precision

Time-lapse photography

Reflex camera:
- not so cheap, but high quality

Can be controlled by:
- tablet or cell phone (existing apps)
- Raspberry Pi (some programming)
- extension to firmware

Time-lapse photography

Classification of the pictures:

uniformly overcast (n=66)

clear sky, sun down (14)

irregularly cloudy (48)

very irregularly cloudy (4)

sunny (83)

partly cloudy, sun shining (32)
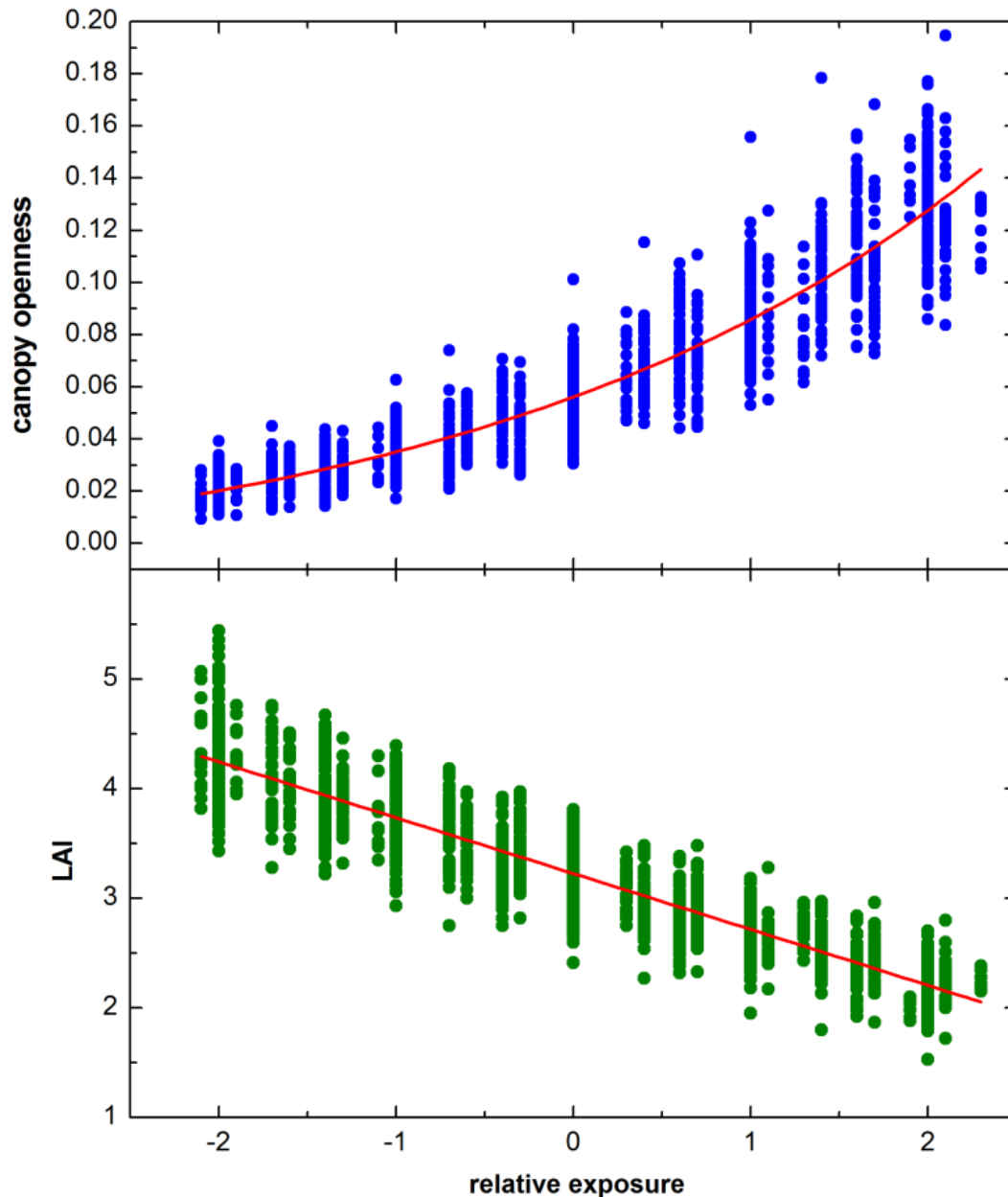
irregularly cloudy, sun (9)

Discarded:

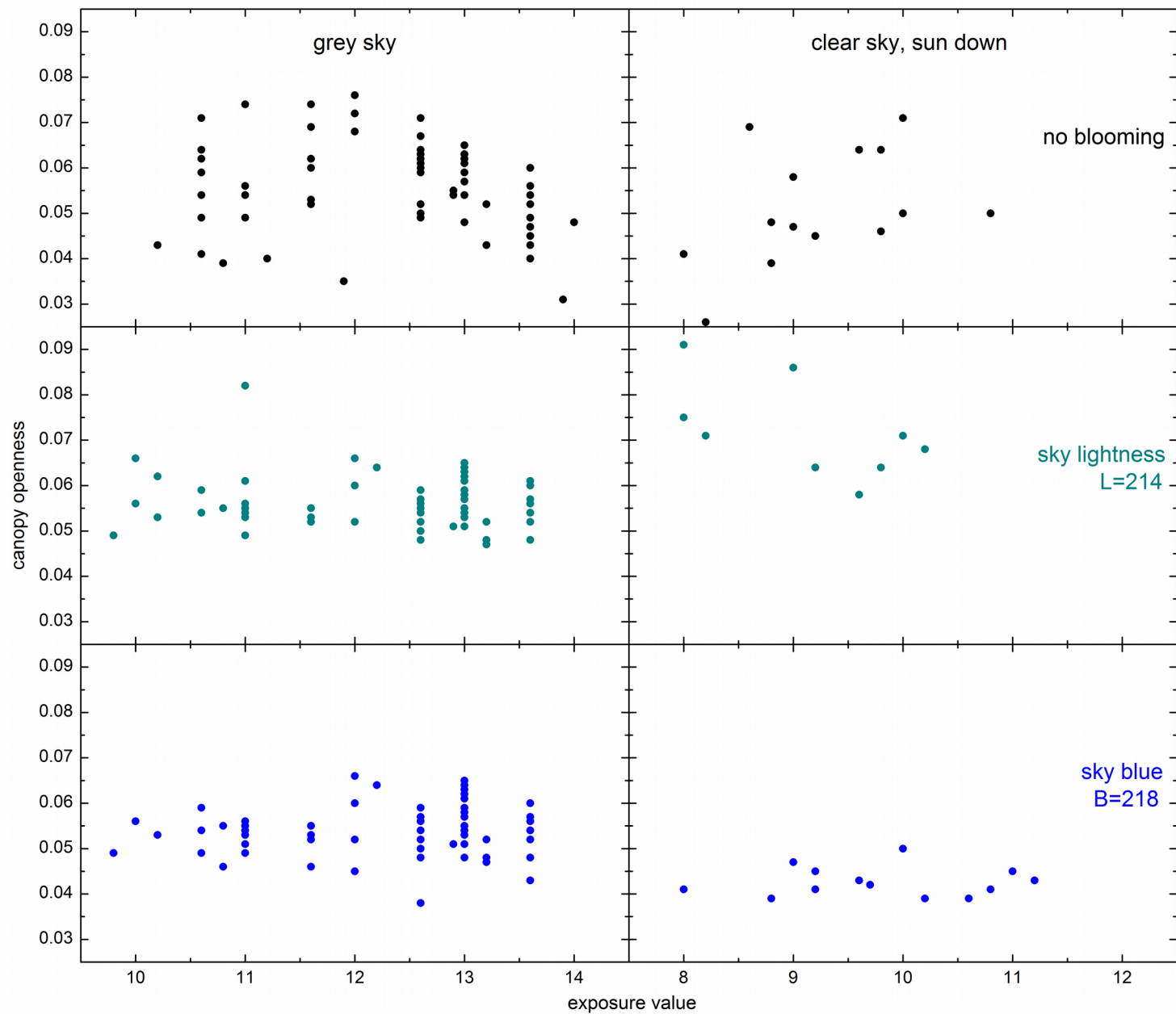sun on lenses

rain drops

insects
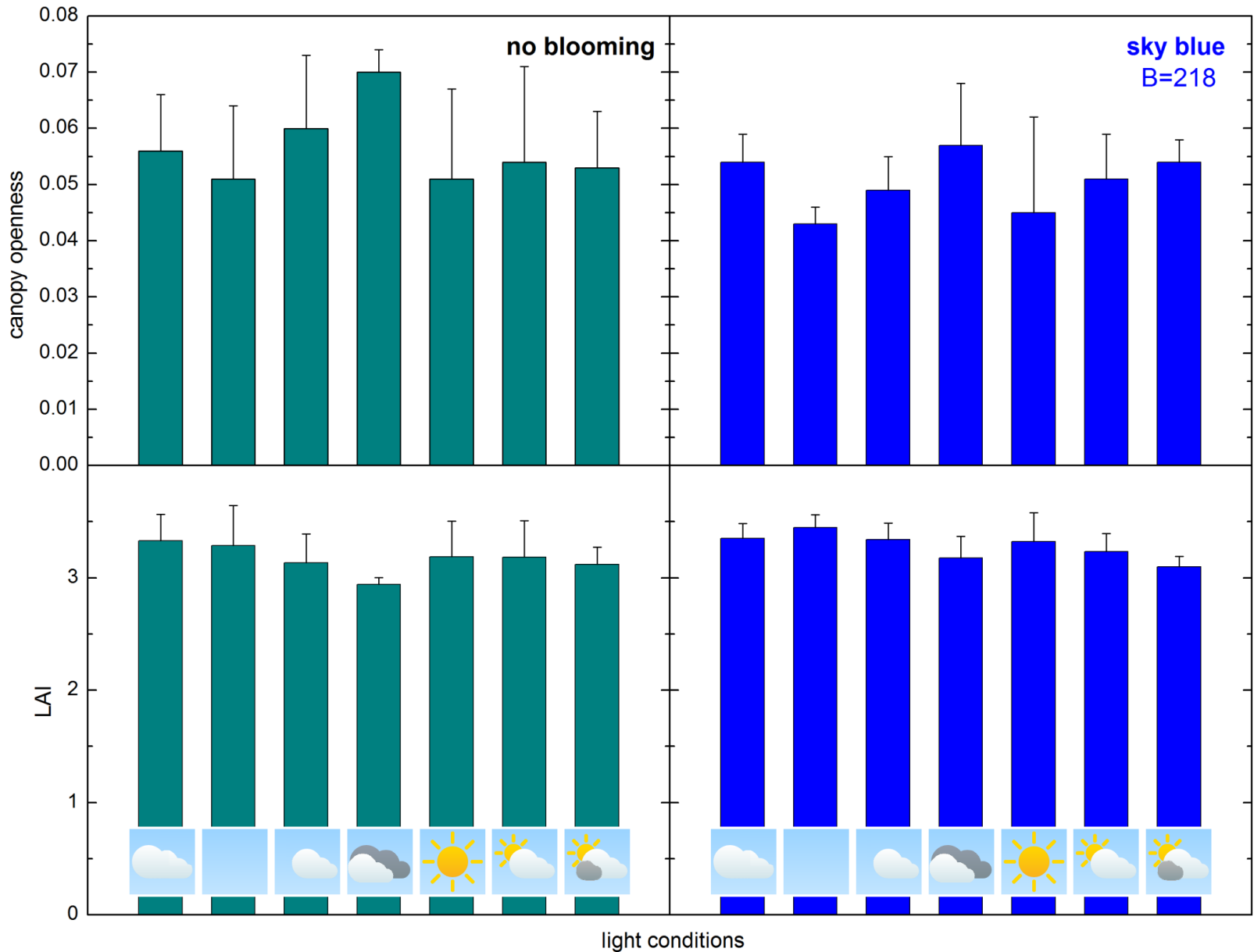
...

Time-lapse photography

Result as expected:
- EV affects canopy openness
- in spite of auto-threshold
- LAI decreases with exposure

Time-lapse photography

Time-lapse photography

Time-lapse photography

Conclusions:
- irregular clouds are bad (but really irregular skies are rare)
- sun shining on the trees is not as bad as thought
- choice of exposure after bracketing can probably be automated

Remaining question:
- effect of canopy density (of true LAI)

Ideas for future research:
- similar study in coniferous forest
- parallel time-lapse photography under different canopy densities
- camera moving along rail ?
- full automation of exposure by computer-connected camera?