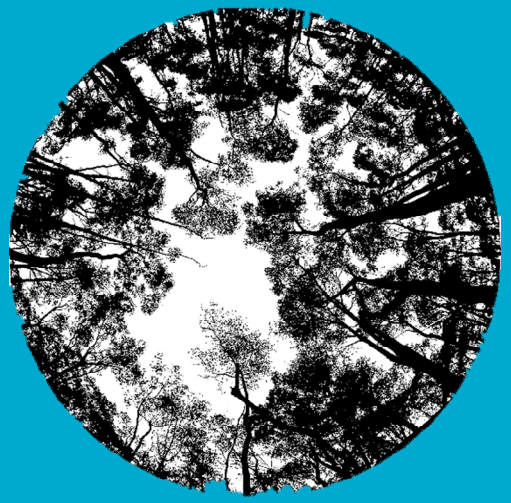

From classified photo to LAI..

...the easy part, right..?

Will Woodgate

November 2015

OCEANS & ATMOSPHERE
www.csiro.au

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RMIT UNIVERSITY

From classified photo to LAI..

The three key components affecting canopy gaps

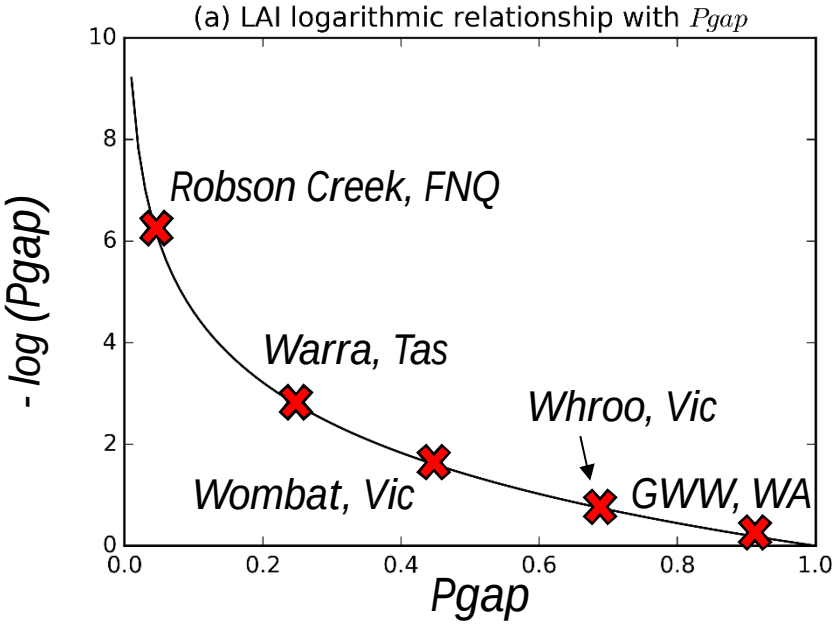
1. Leaf and Wood Angle Distribution
2. Clumping
3. Woody material proportion (α)

} *extinction coefficient 'k'*

The extinction coefficient '*k*'

The only thing between us and accurate LAI

$$LAI = -\log(Pgap\ \Theta_{image}) / \mathbf{k}$$



Methods to estimate *k*:

Wood and leaf angle +
Clumping +
Woody proportion
or
Destructive with *Pgap*

Challenge: how accurate can we derive *k* and LAI? Can we get ± 5% accuracy?

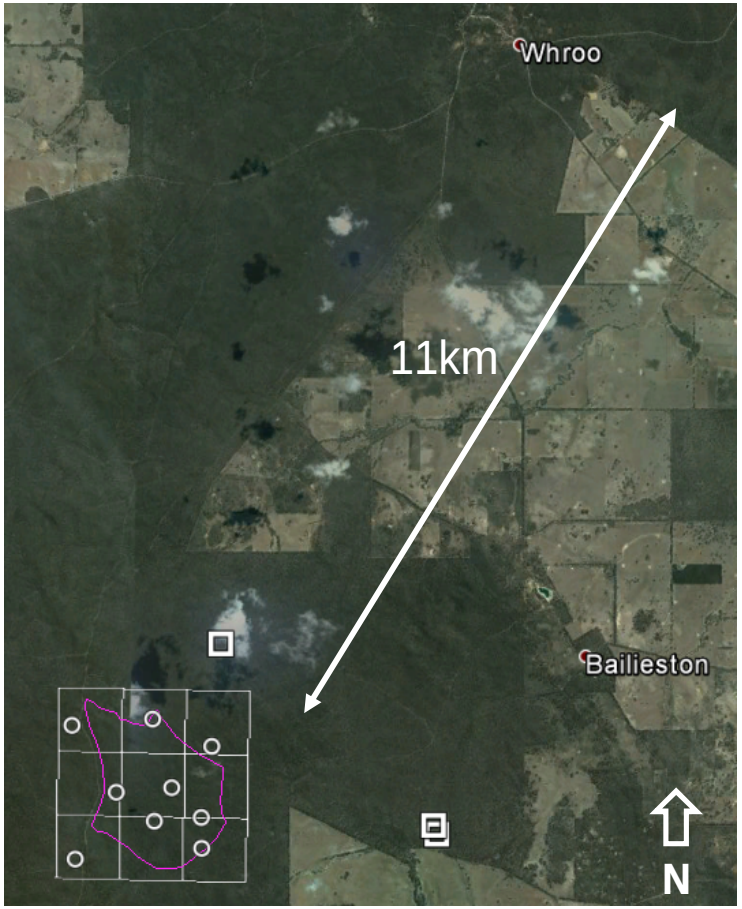
The virtual forest

Enabling precise benchmarking of indirect methods

(a) *E. tricarpa*
Height = 18.6 m, DBH = 28.3 cm

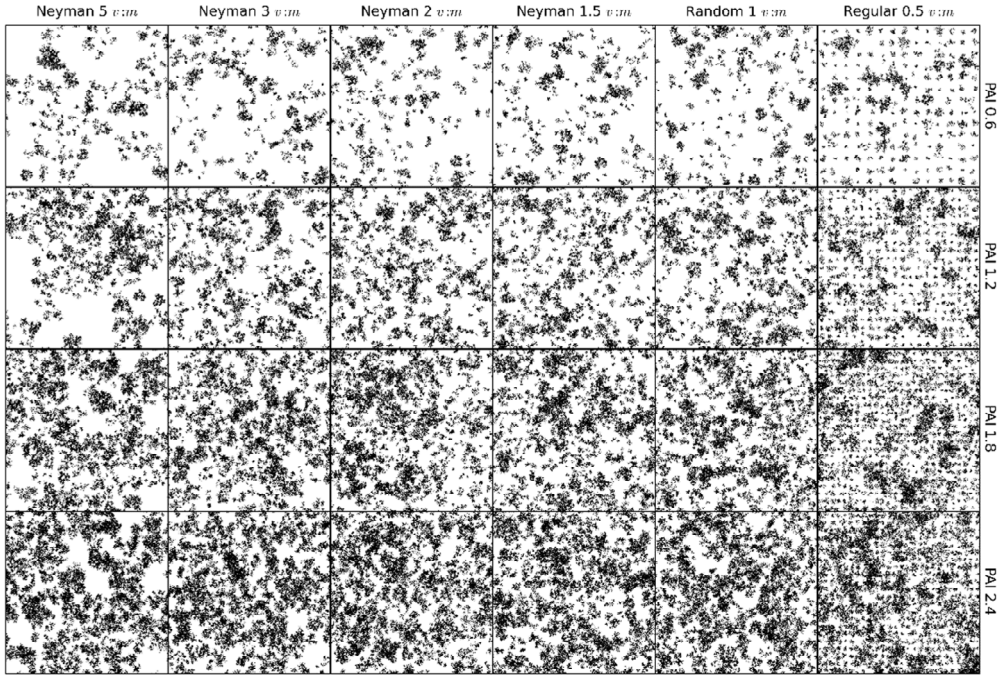
(b) *E. macrorhyncha*
Height = 9.6m, DBH = 12.8 cm

(c) *E. microcarpa*
Height=21.8 m, DBH=27.2cm



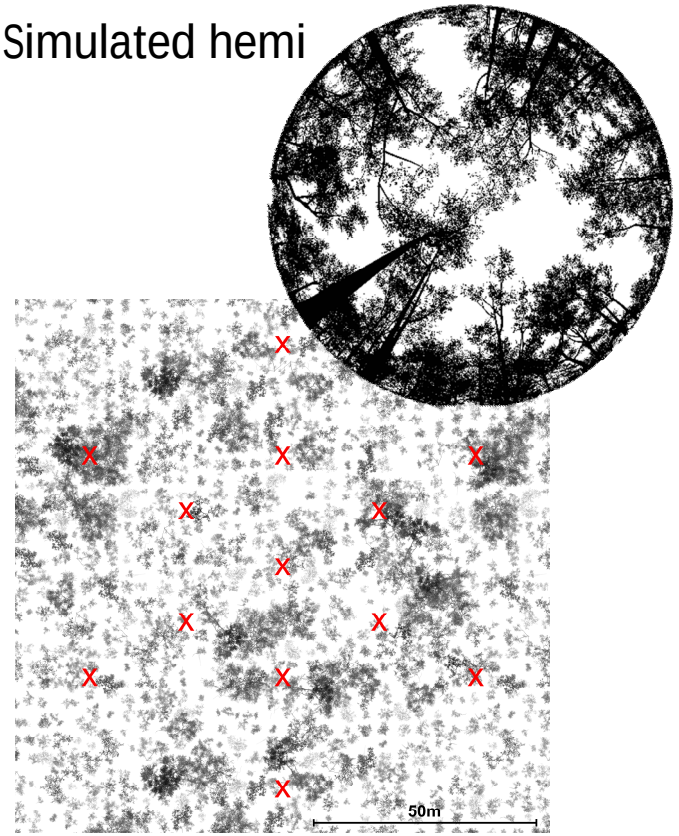
The virtual forest

Simulating the virtual scenes and measurements



Top down view (24 scenes, 90 m x 90 m +)

Simulated hemi

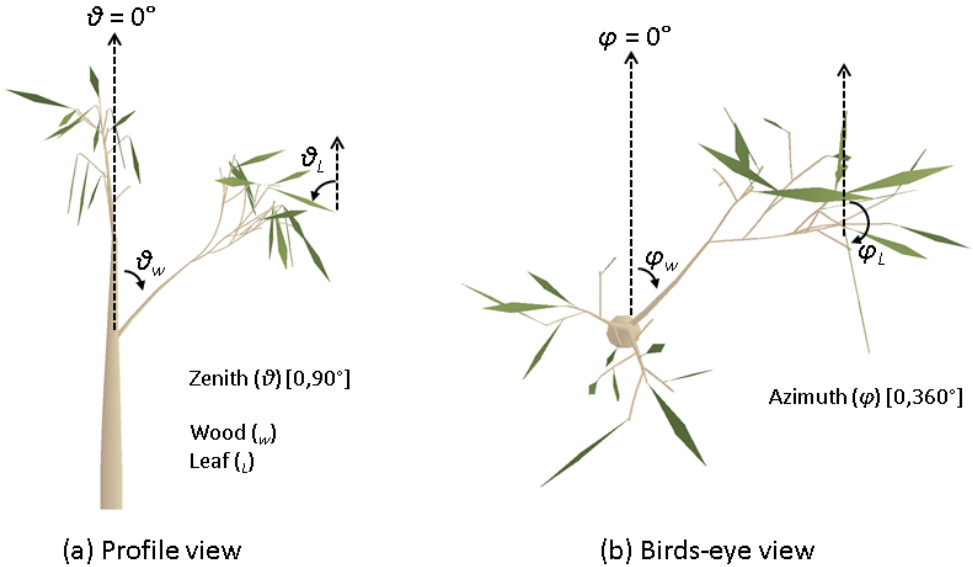


SLATS sampling design

From classified photo to LAI..

The three key components

1. Leaf and Wood Angle Distribution
2. Clumping
3. Woody material proportion



(a) Profile view (b) Birds-eye view

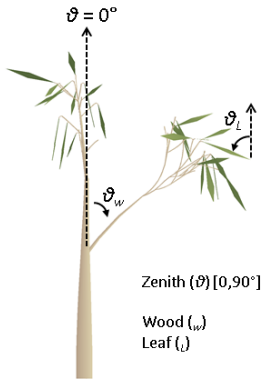
The leaf and wood angle distribution

From measurement to meaningful input value for '*k*'

What is the error if I don't know my wood angle distribution?

1. Step 1: measure the angles and compile a frequency distribution

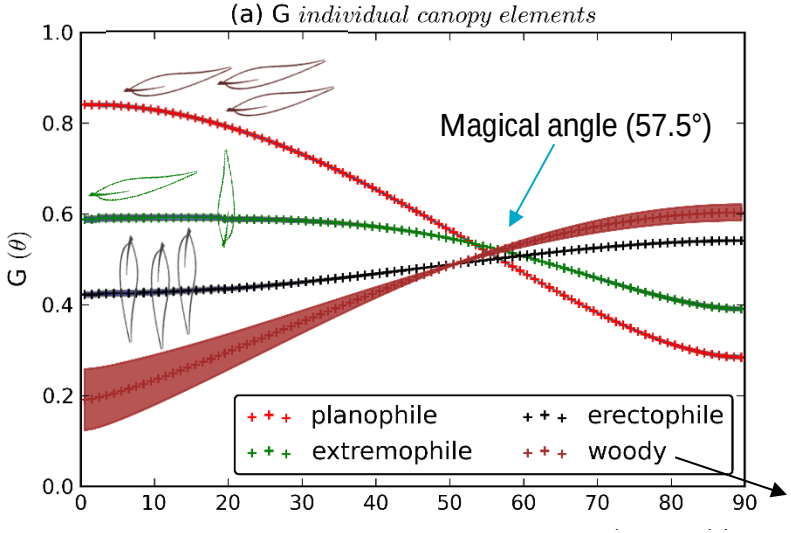
2. Step 2: characterise the projected area (G-function)



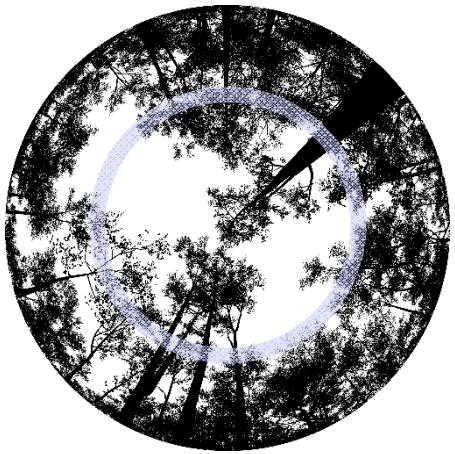
(a) Profile view

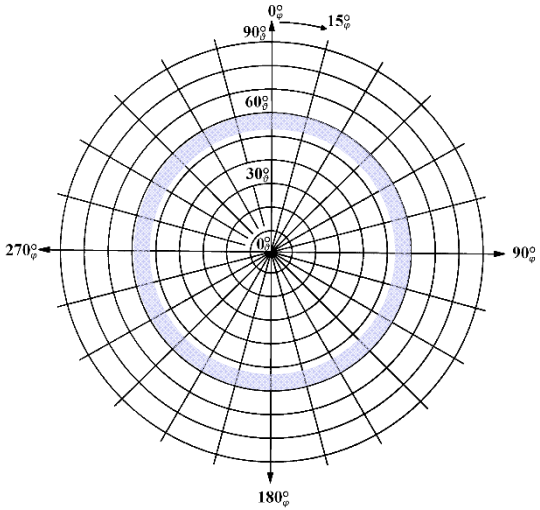
The magical angle

Accounting for the leaf and wood angle distribution



Rushworth





Take home message

Use the 57.5° viewing angle;

otherwise you must account for the leaf and wood angle distributions (see FEM article, 2015)

From classified photo to LAI..

The three key components

1. Leaf and Wood Angle Distribution
2. Clumping
3. Woody material proportion (α)

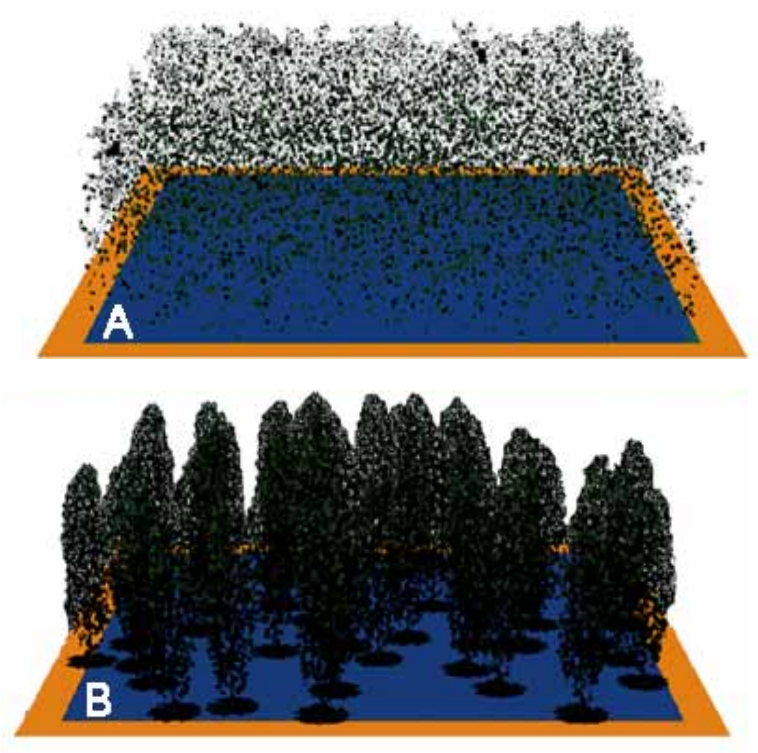


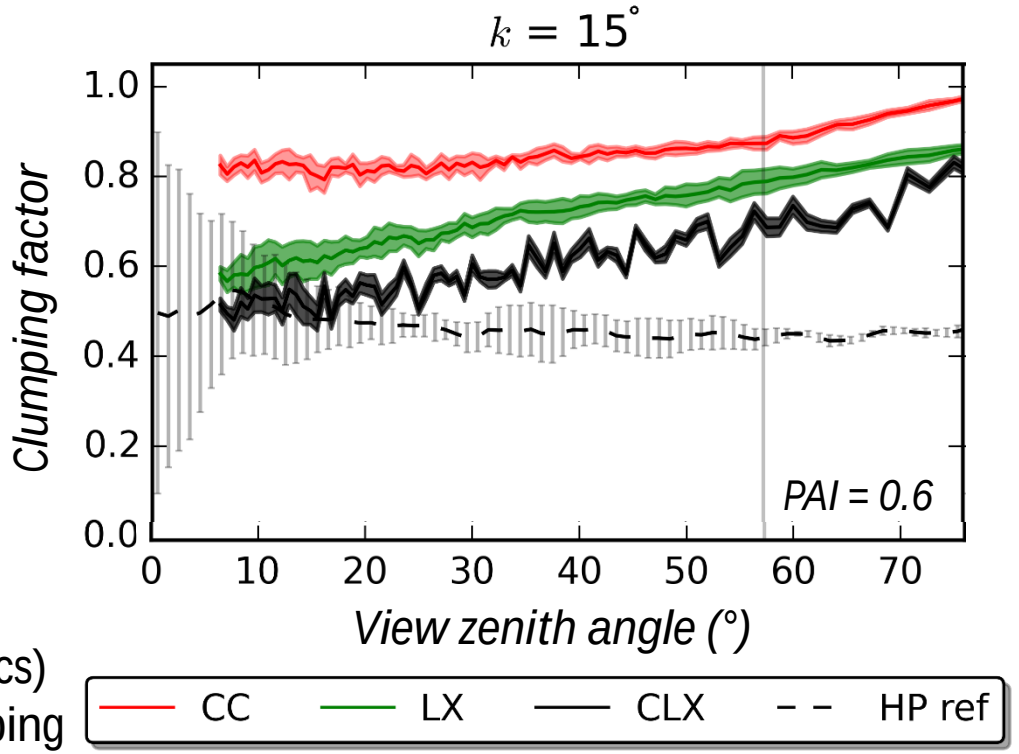
Figure from: Leblanc et al. (2012) Trac manual

Clumping method evaluation

Which performed the best?

- CC = TRAC instrument
- LX = LAI-2000/2200* (with view cap)
- CLX = combined CC and LX

HP ref = virtual reference

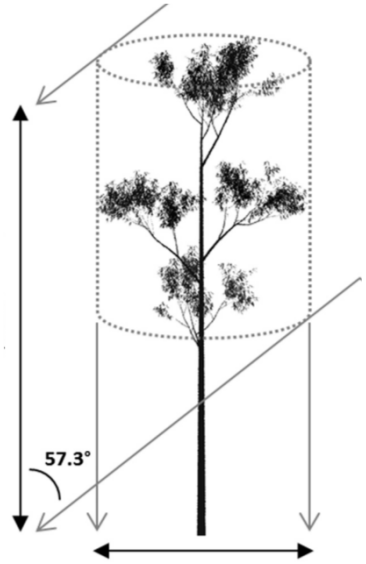


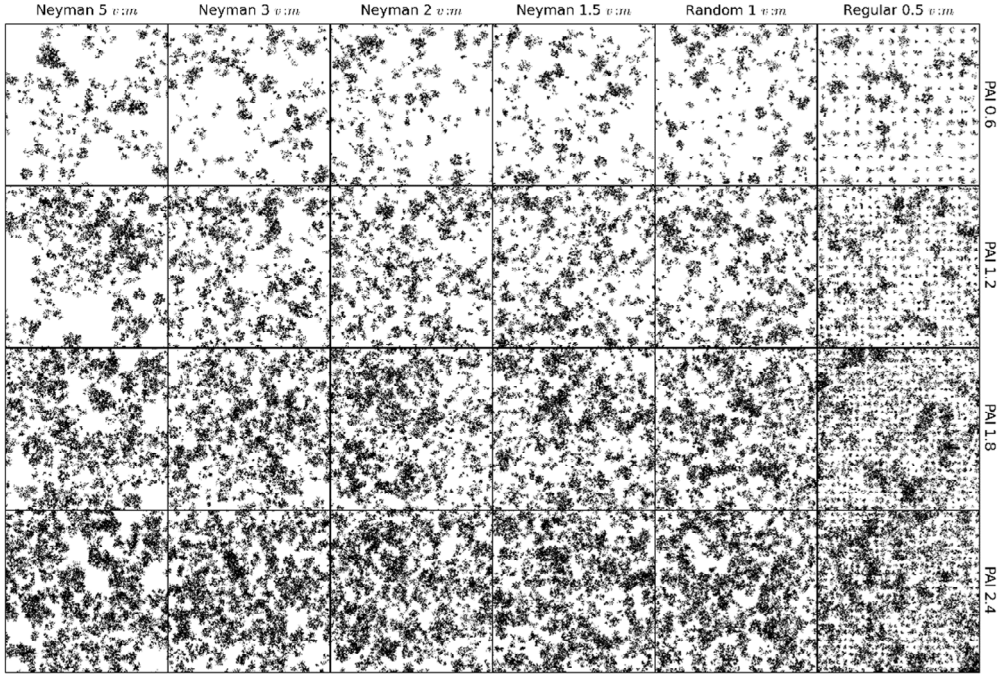
Take home messages

- Use the CLX method (at least for low Eucs)
- Do not use the LAI-2000/2200 for clumping

Clumping method evaluation

Where did most of the clumping occur?





Take home messages

- Clumping factors almost insensitive to stem distribution.
- The majority of clumping occurs within the crown envelope

From classified photo to LAI..

The three key components

1. Leaf and Wood Angle Distribution

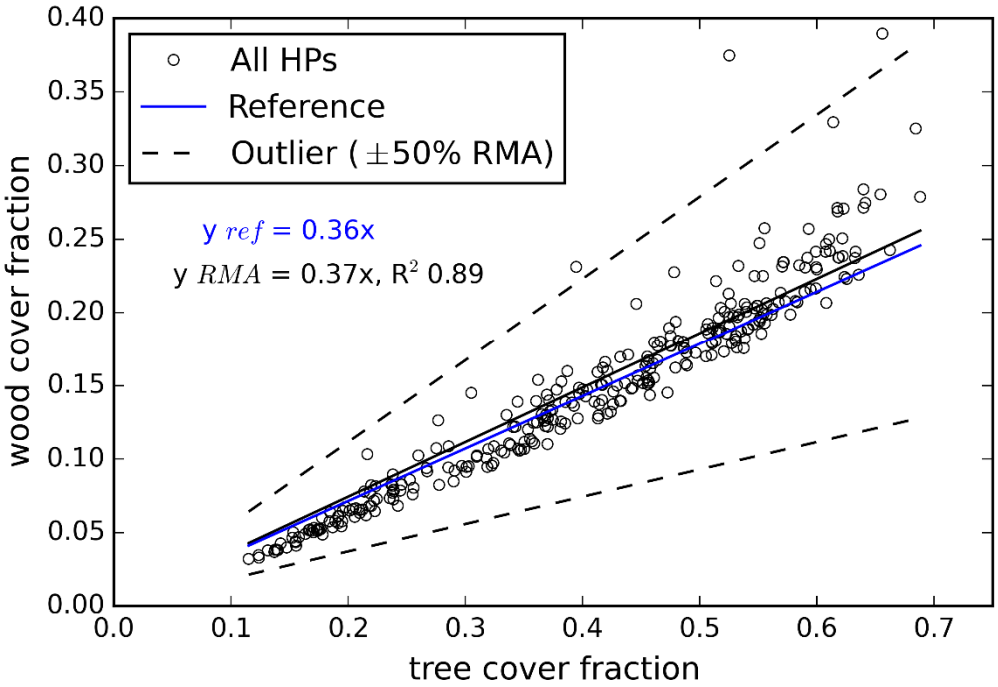
2. Clumping

3. Woody material proportion (α)

From PAI to LAI

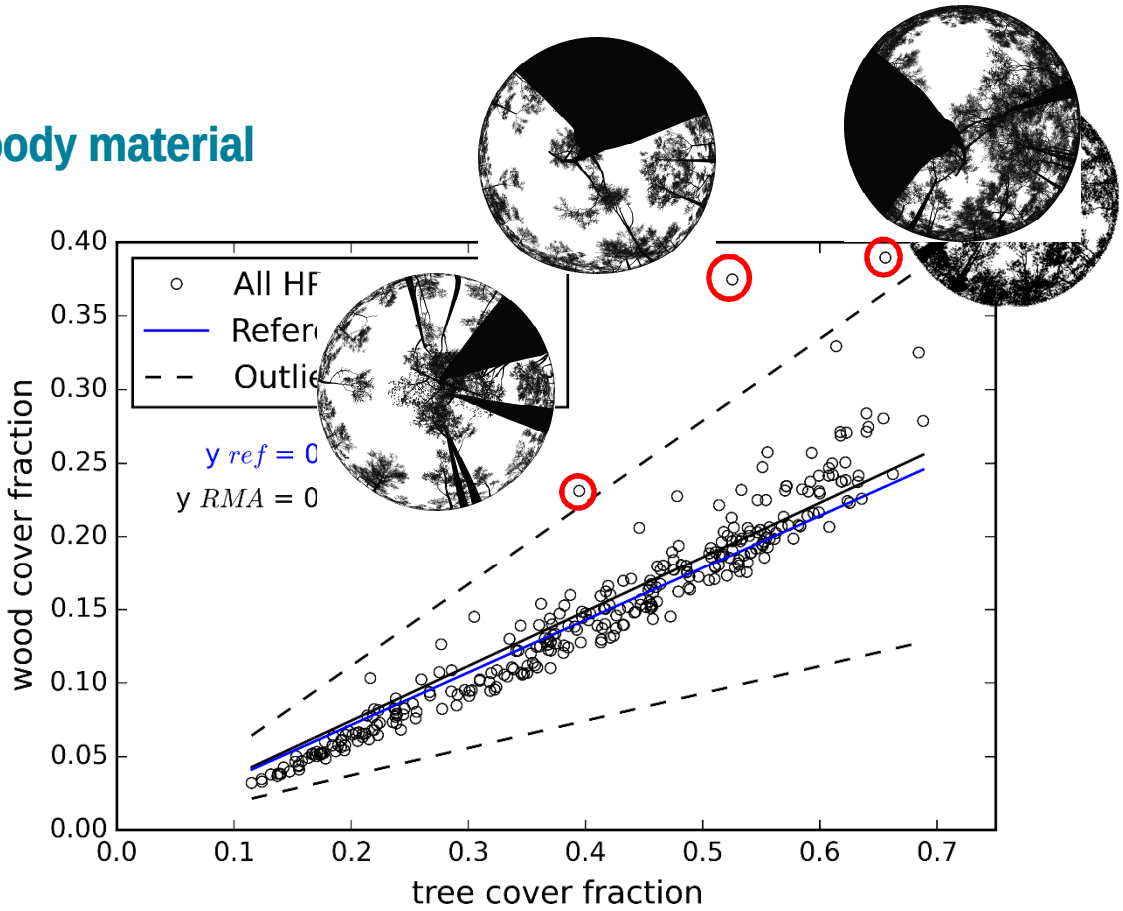
Accounting for proportion of woody material

Aim:
Test a simple method based on the proportion of woody pixels to wood and leaf pixels



From PAI to LAI

Accounting for proportion of woody material

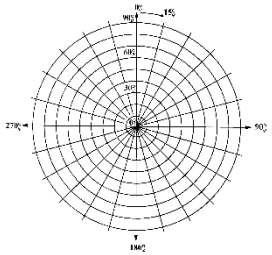


Take home messages

- A simple method classifying the entire image worked very well to get the proportion of woody material
- Photos taken close to very large stems were outliers – these images also adversely affected clumping estimates

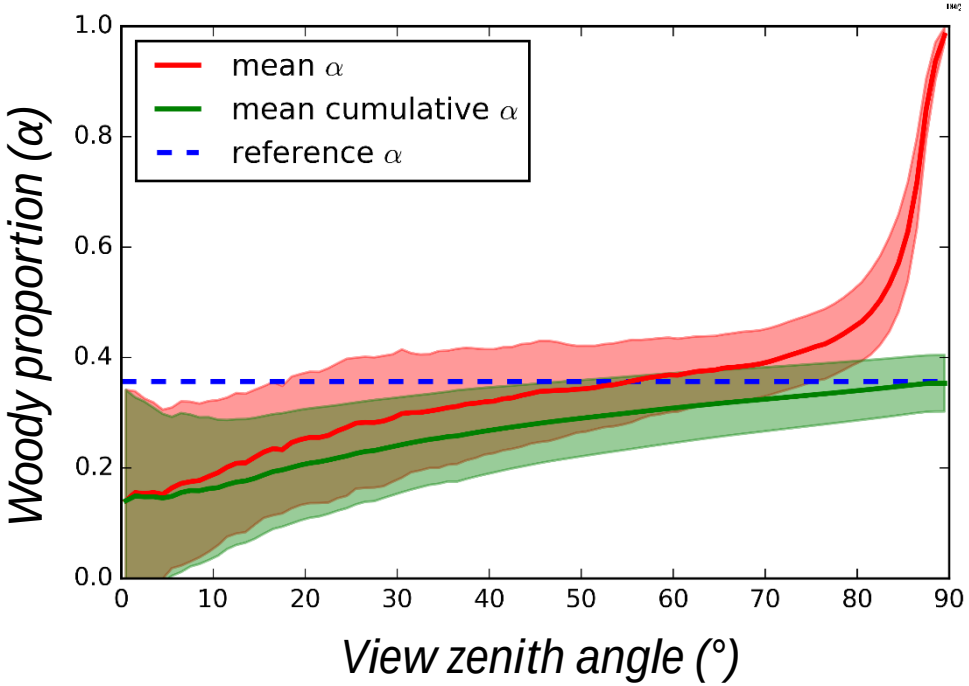
From PAI to LAI

Does my field of view make a difference?



Take home messages

- Field-of-view does matter
- Either use it all of it or a narrow range around 57.5°
- Robustness of findings need to be tested in forests with different structure (extends to clumping as well)



From classified photo to LAI..

The road ahead

1. Best practise procedure: Unknowns remain

2. Room for improvement → scope for ‘disruptive’ monitoring technologies

3. Ongoing curation of LAI estimates: helping to differentiate actual canopy change from a method artefact

Thank you

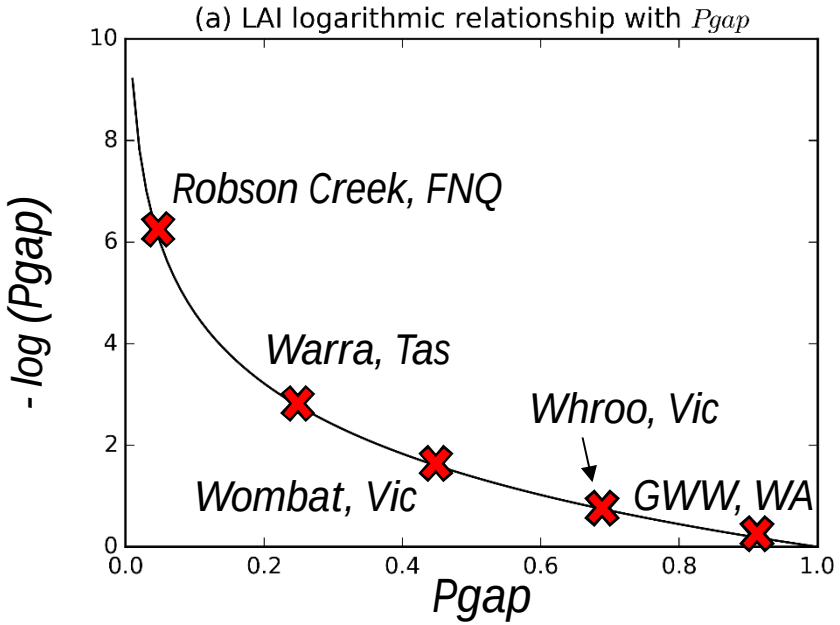
Oceans & Atmosphere
Will Woodgate

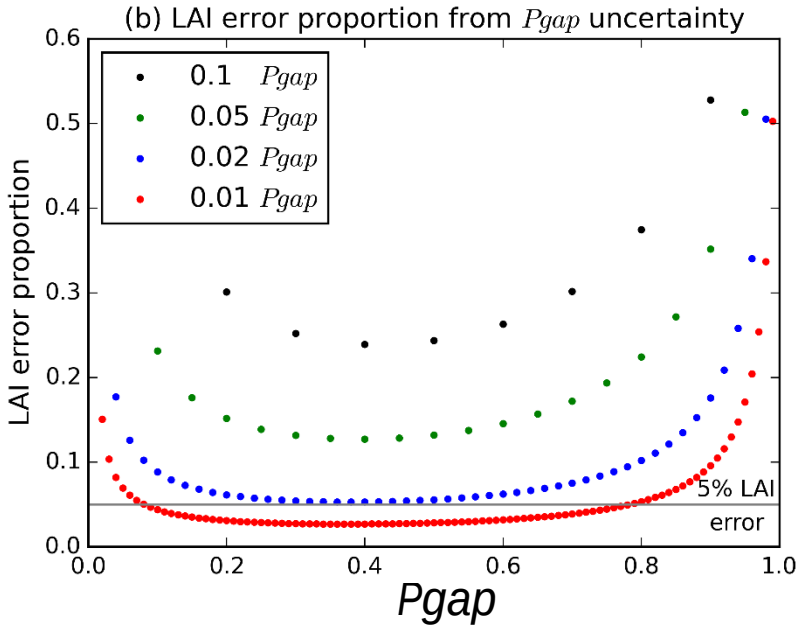
e will.woodgate@csiro.au

The extinction coefficient '*k*'

The only thing between us and accurate LAI

$$LAI = -\log\left(Pgap\,\Theta_{image}\right) / \boldsymbol{k}$$





From classified photo to LAI..

The three key components and the road ahead

Option 1

1. Leaf and Wood Angle Distribution
   - Use 57.5°, otherwise a big assumption is made or a lot of effort is required
   - TLS can be used to accurately reconstruct the tree structure → wood angle
2. Clumping
   - 2D gap size methods are challenged by highly clumped environments (Eucs)
   - Trade-off with view zenith angle and accuracy
   - 3D methods (using LiDAR) countering occlusion are probably the way forward
3. Woody material (α)
   - Promising simple method based on classification
   - The mutual shading effect and an even distribution assumption is must be noted
   - Further work required in other forest types with different structure (clumping too)