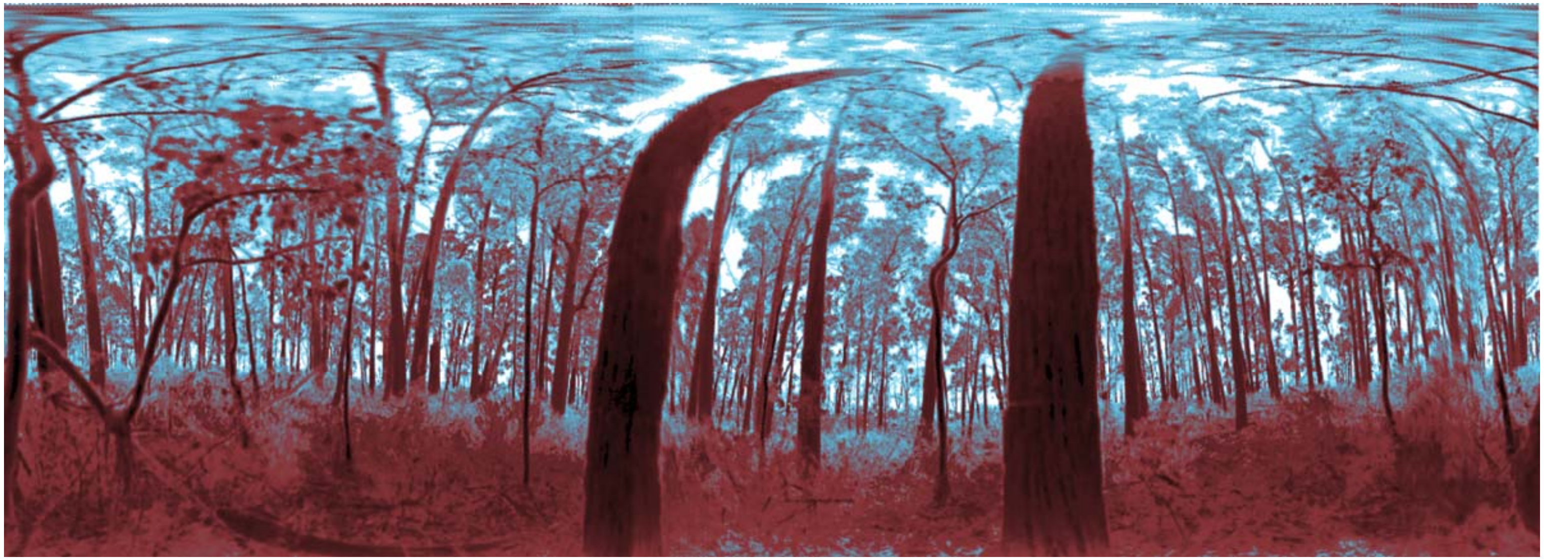


within-canopy remote sensing
hemispherical photographs, lidar, spectrometers

Bill Sea, Eva van Gorsel
02/02/2010
CSIRO Marine and Atmospheric Research

complex structure in forests – who is interested in what information?

complex structure in forests – who is interested in what information?

- Environmental, Habitat and Conservation Focus
- Forestry (native Forests and Plantations)
- Carbon accounting

→ different focus may lead to different assessment method and sampling strategies

complex structure in forests – what's the relevance?

BOOSTED CARBON EMISSIONS FROM AMAZON DEFORESTATION

• Standing biomass is a major, often poorly quantified determinate of carbon losses from land clearing.

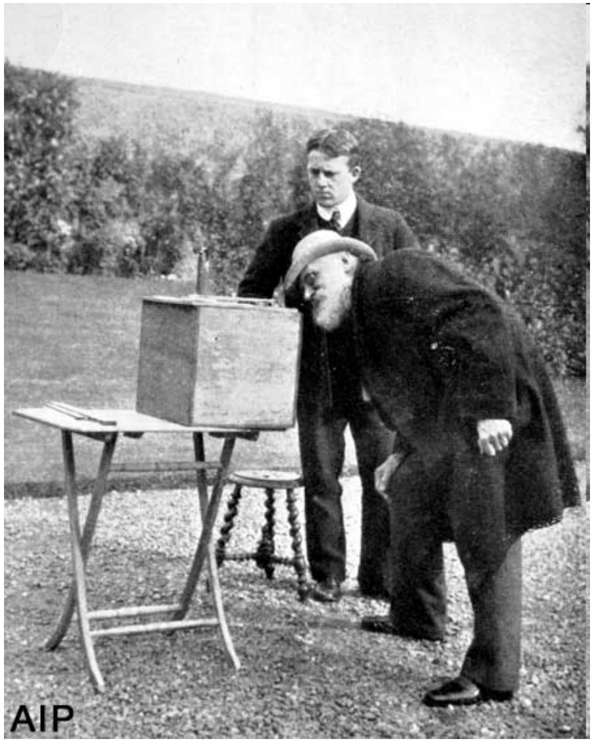
• Annual rate of deforestation has not changed significantly BUT biomass lost per unit of forest cleared increased .

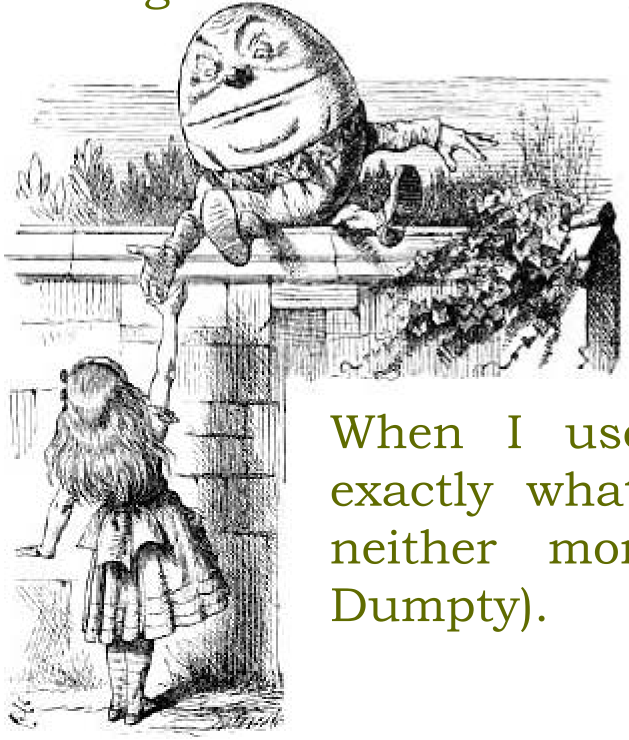
• if the annual area deforested remains unchanged, future clearing will increase regional emissions by 0.04 Pg C yr1 – a 25% increase over 2001–2007 annual carbon emissions.

Loarie et al. 2009

complex structure in forests – what's the relevance?

When you measure what you are speaking about and express it in numbers, you know something about it, but when you cannot (or do not) measure it, when you cannot (or do not) express it in numbers, your knowledge is of a meagre and unsatisfactory kind (Lord Kelvin).

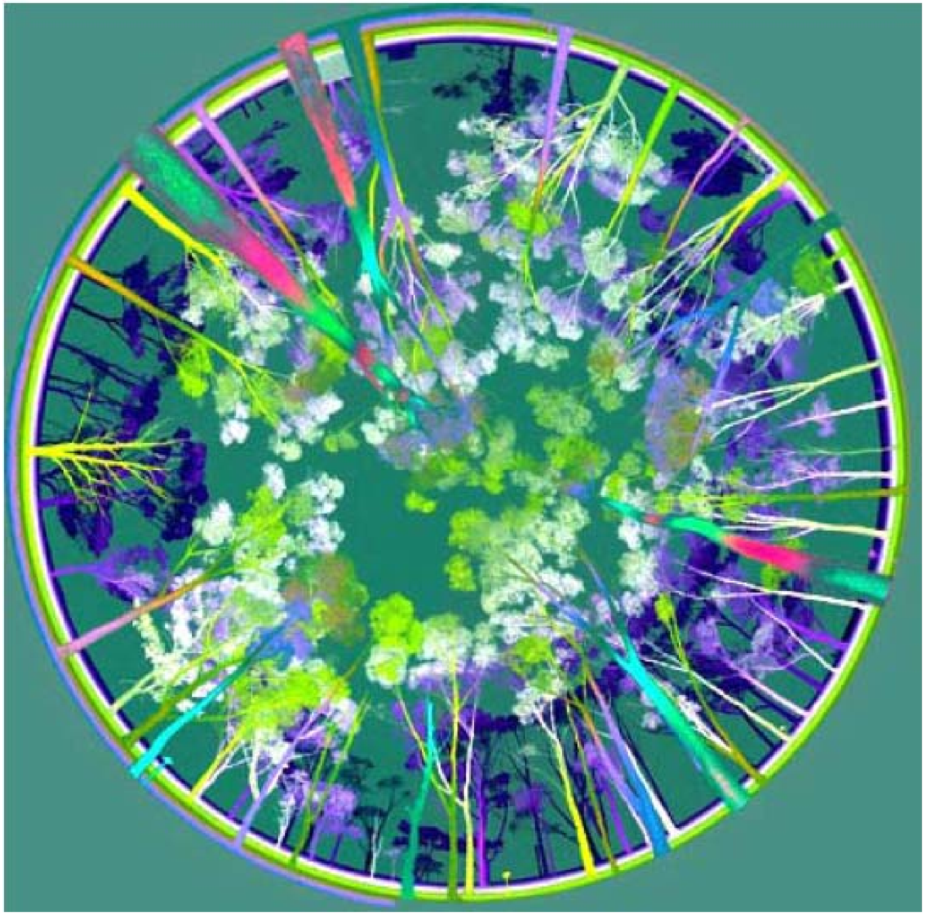




When I use a word, it means exactly what I want it to mean, neither more or less (Humpty Dumpty).

complex structure in forests – it must be measured, but how?

ground based Lidar



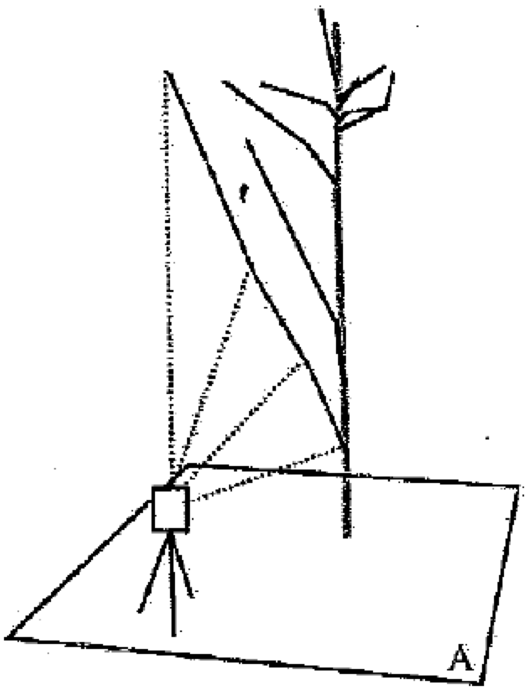
ground based Lidar

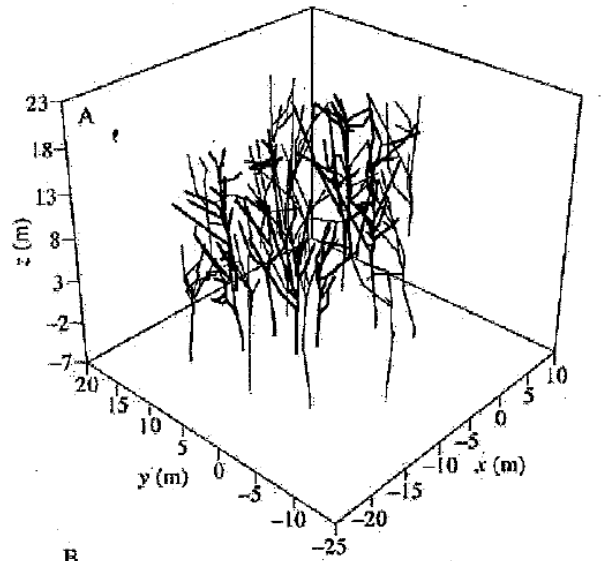
WHAT INFORMATION CAN WE GET FROM CANOPY LIDAR?

- Info on crown diameter, leaf area, …, **vertical profile of leaf area**!
- Info on dbh, basal area, tree density …
- Carbon stocks

- Environmental, Habitat and Conservation Focus
- Forestry (native Forests and Plantations)
- Carbon accounting

ground based Lidar





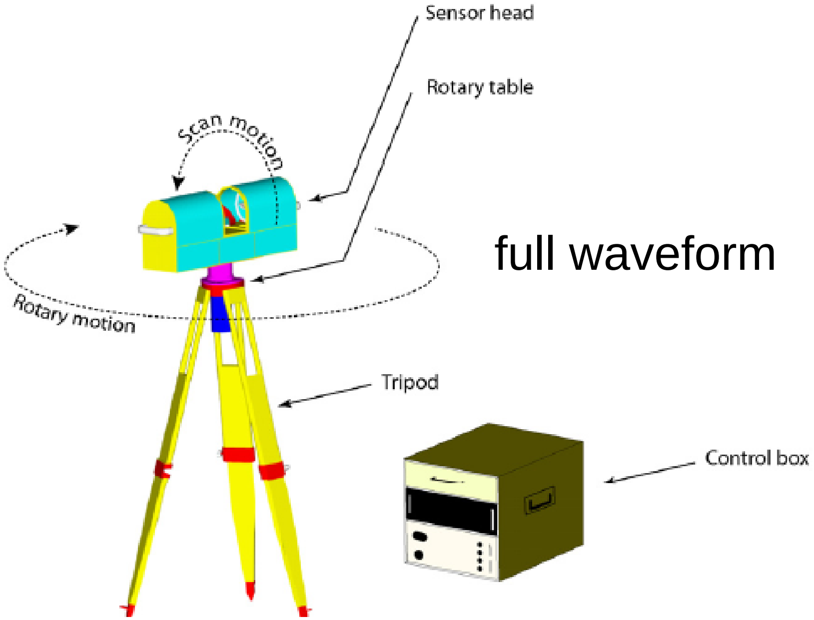
Sumida et al. 2002

time of flight principle

laser emits pulse; measured is the time taken by the pulse to be reflected off the target and returned to the sender: D = ct/2

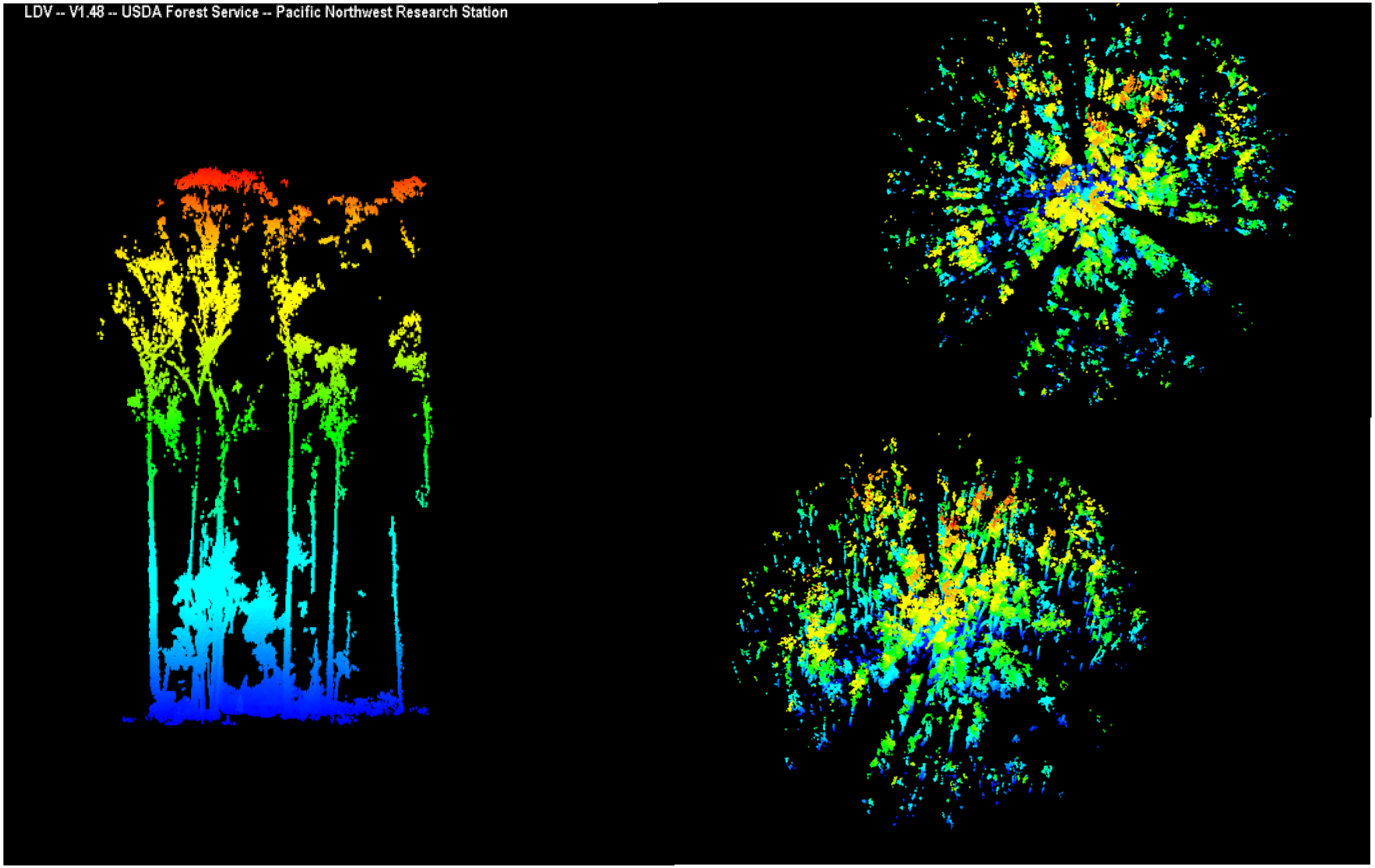
ground based Lidar

first or last return

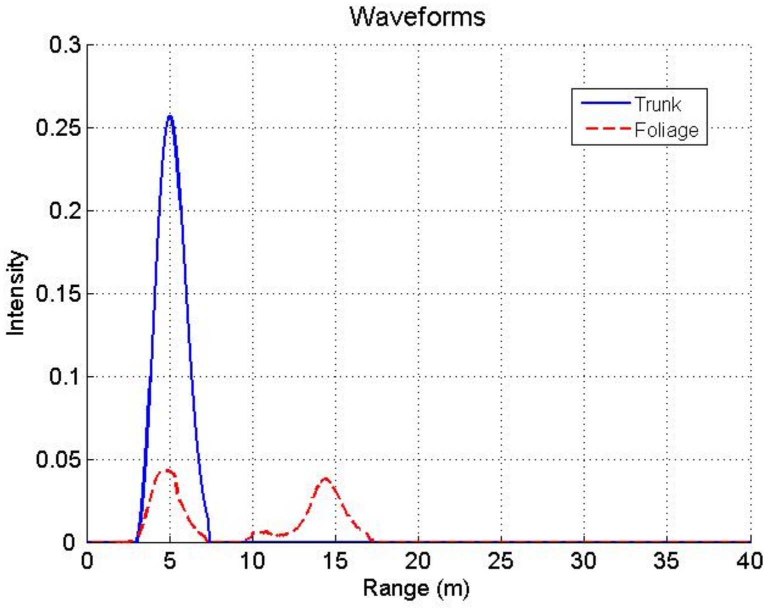


full waveform

ground based Lidar



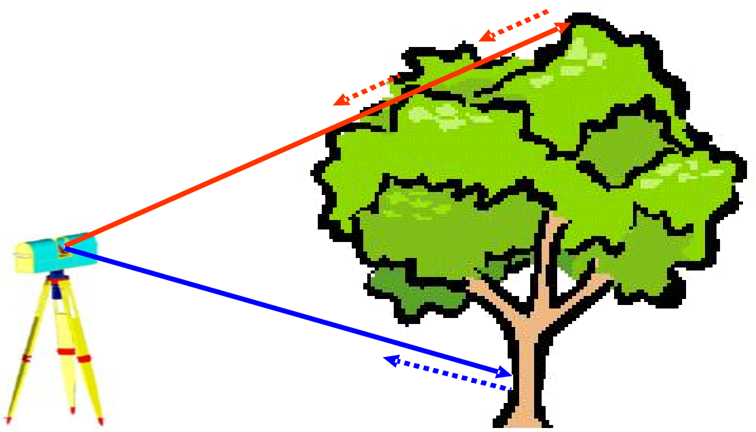
ground based Lidar



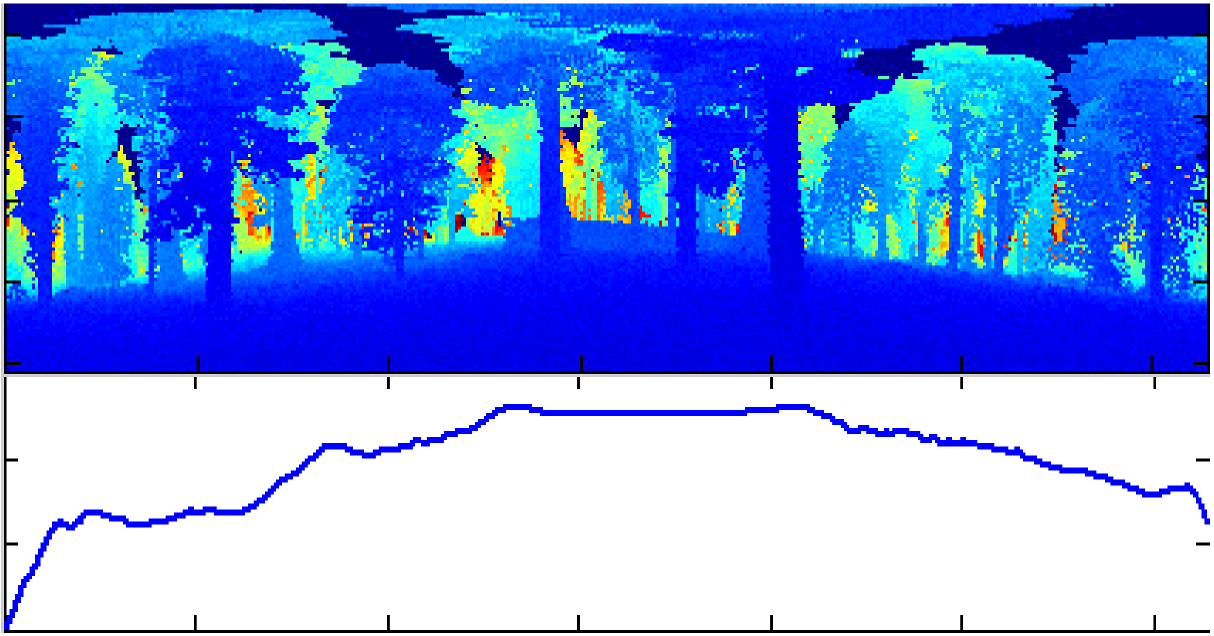
Tian YAO, Boston University

Soft Targets form distributed Returns over a range

Hard Targets form a Single return that is a Copy of the outgoing pulse

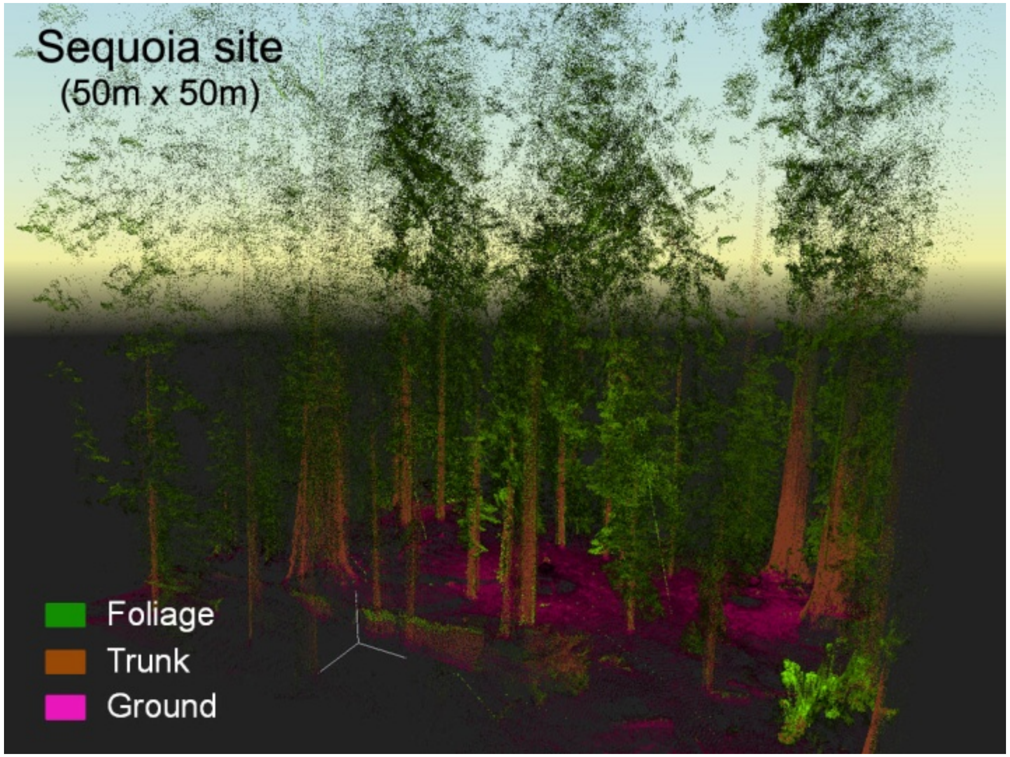


ground based Lidar



Tian YAO, Boston University

ground based Lidar

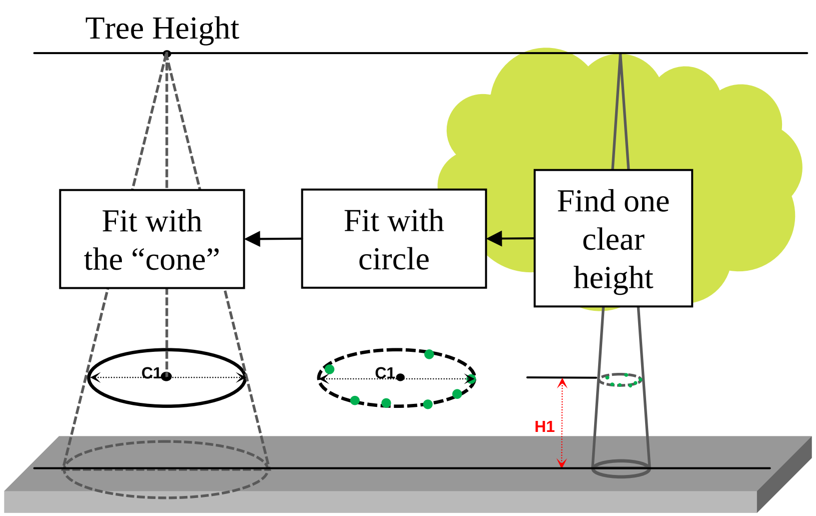


Xiaoyuan Yang, Boston University

Intensity & range based classification

ground based Lidar

"Cone" model simplified



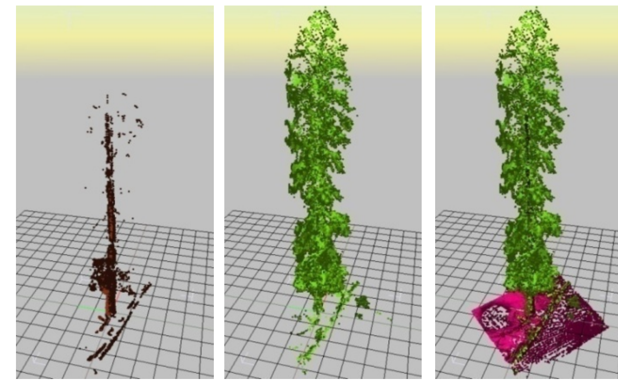
Assumptions:

1."Cone" shaped trunk

2.Straightly growing trunk

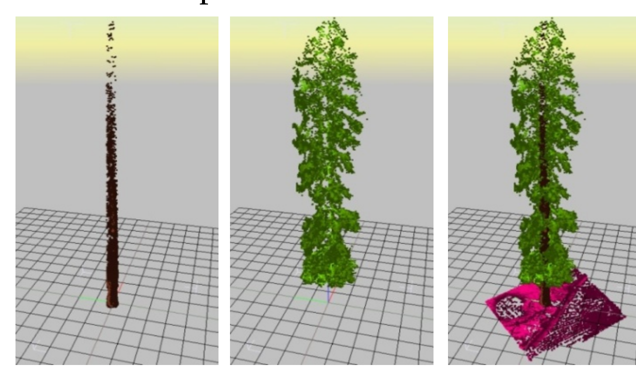
3."Clear height" can be easily defined

Original classification



Trunk Foliage Single Tree

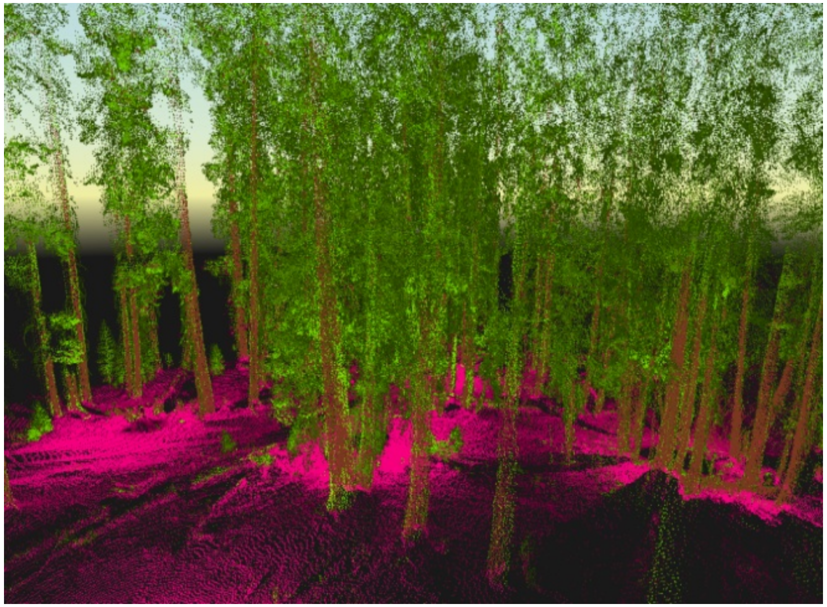
Improved classification



Trunk Foliage Single Tree

ground based Lidar

"Cone" model simplified

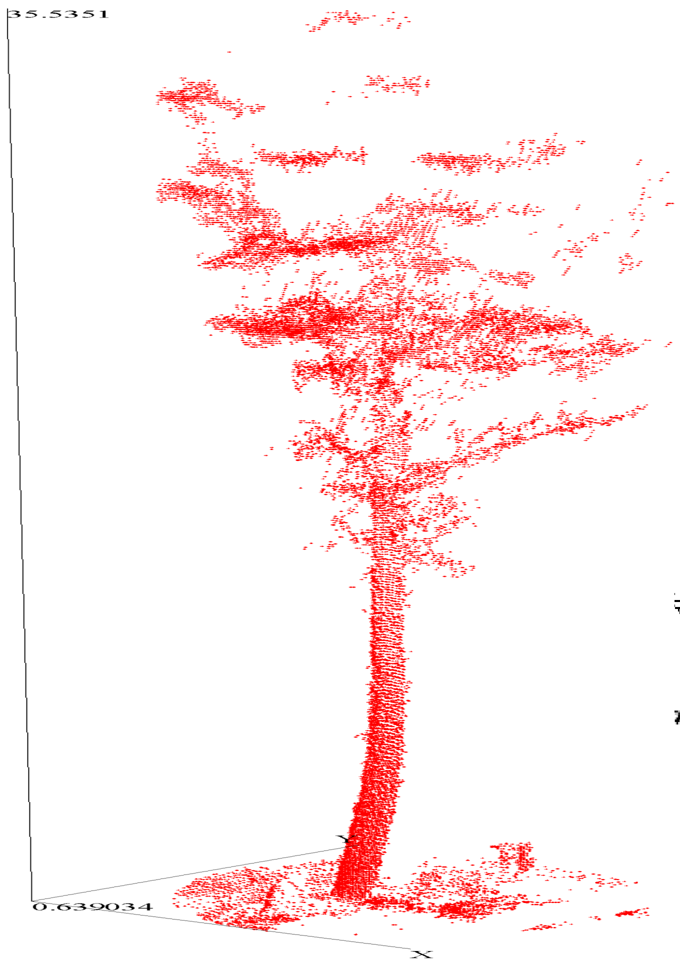


before

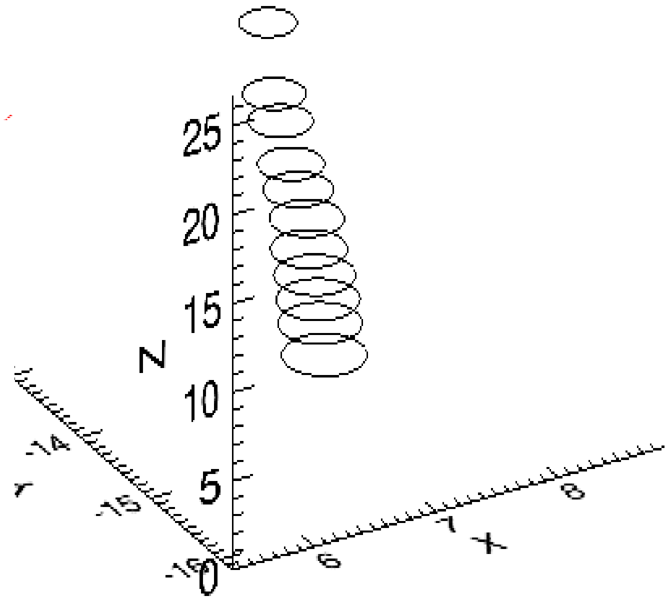
after

Courtesy D.Jupp, CSIRO

ground based Lidar

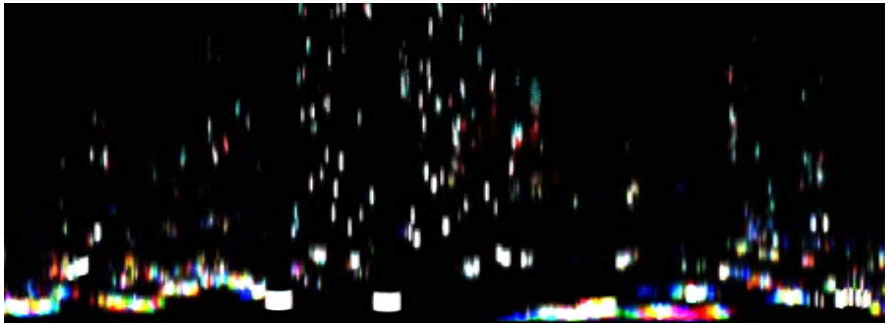


Estimating taper



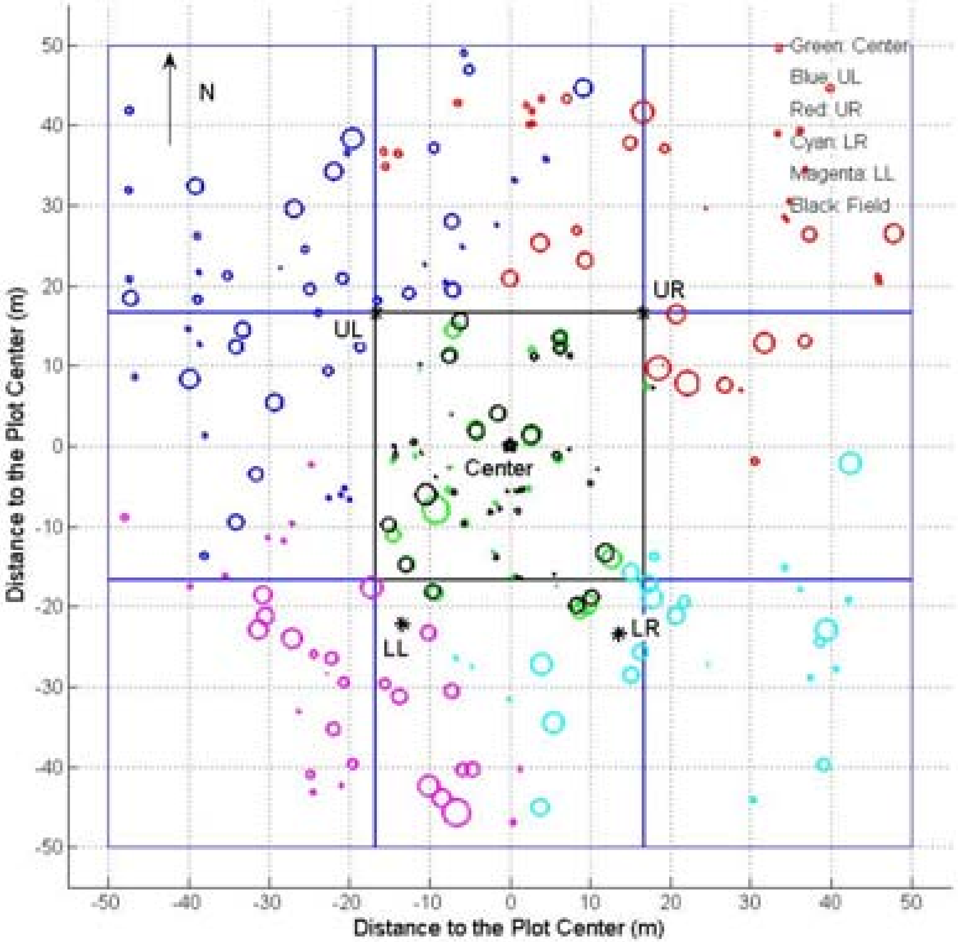
ground based Lidar

Waveform using Andrieu projection



Three planar slices as color composite using cylindrical projection of the data cube.

ground based Lidar

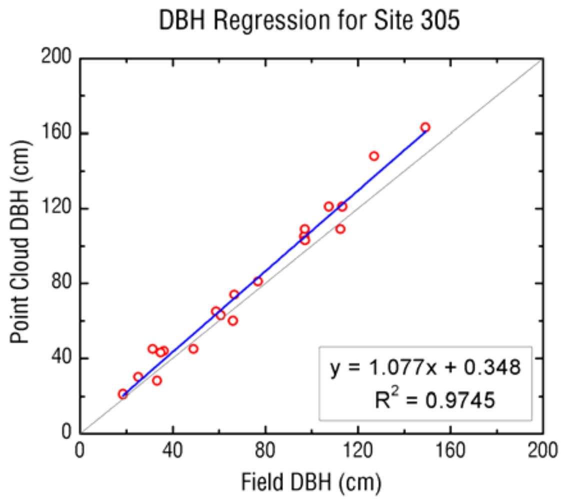


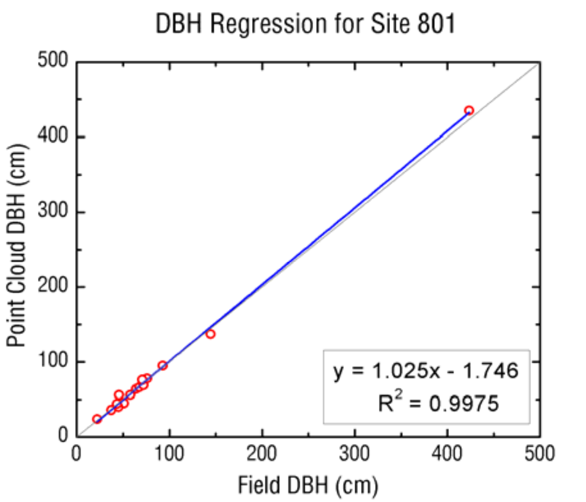
Xiaoyuan Yang, Boston University

ground based Lidar

DBH

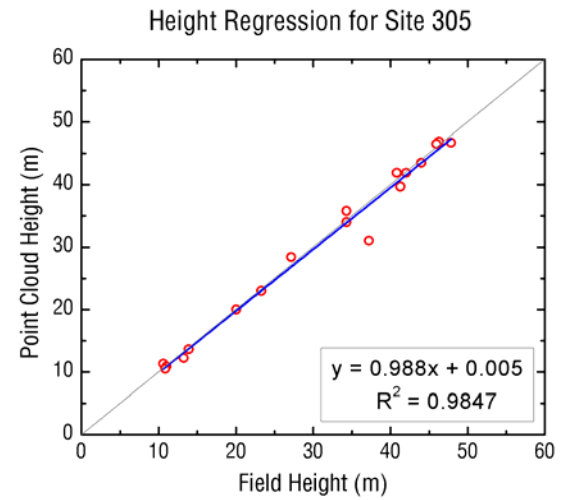
Tree#	n) cloud
1	64
2	45
3	78
4	36
5	40
6	95
7	66
8	69
9	76
10	435
11	56
12	24
13	44
14	137
15	56
16	
17	
18	
19	
20	
Mean	8.07
STD	5.77

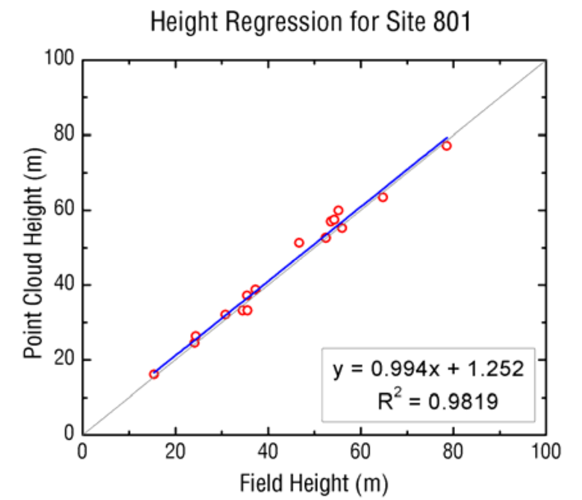




Tree height

Tre	) cloud
1	8.8
2	3.2
3	2.6
4	4.5
5	6.3
6	57
7	3.4
8	7.5
9	5.2
1(	1.3
1	7.2
1	3.2
1	6.1
1	2.1
1	9.9
1(	7.2
1	
18	
Me	4.72
ST	.21





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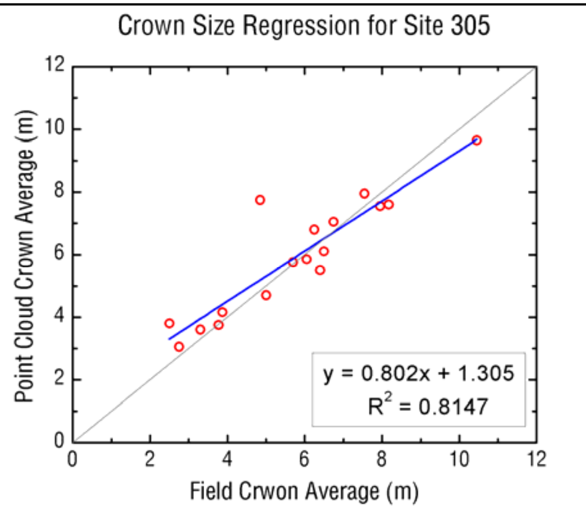
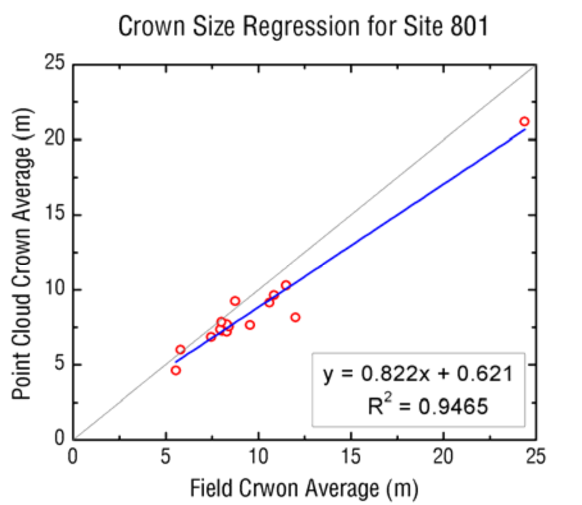
ground based Lidar

Crown size

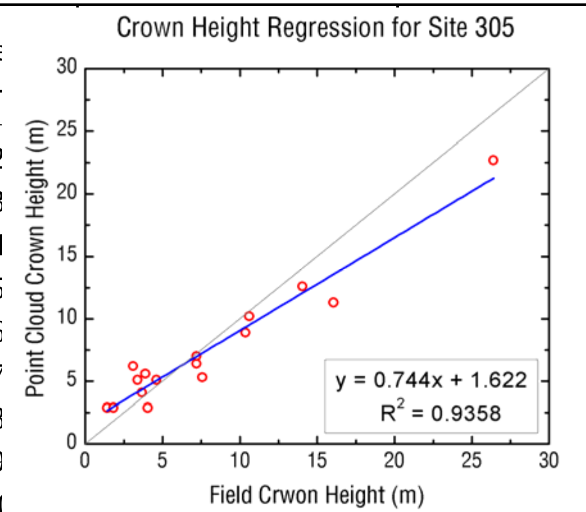
Tre	(m) P-cloud
1	7.65
2	7.25
3	9.25
4	7.2
5	7.35
6	10.3
7	8.15
8	7.55
9	7.7
1(	6.85
11	21.2
12	6
13	4.6
14	7.85
15	9.65
16	9.15
17	
Mea	8.61
STI	0.91

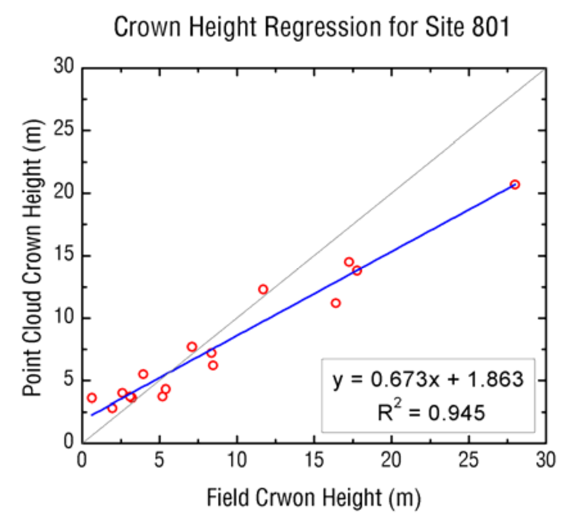




Height to Crown

Tre	m) -cloud
1	4
2	12.3
3	3.6
4	2.8
5	6.2
6	14.5
7	20.7
8	5.5
9	7.2
1(	3.7
1:	13.8
1:	7.7
1:	3.7
1	3.6
1:	11.2
1(	4.3
Me	7.80
ST	1.30





within canop

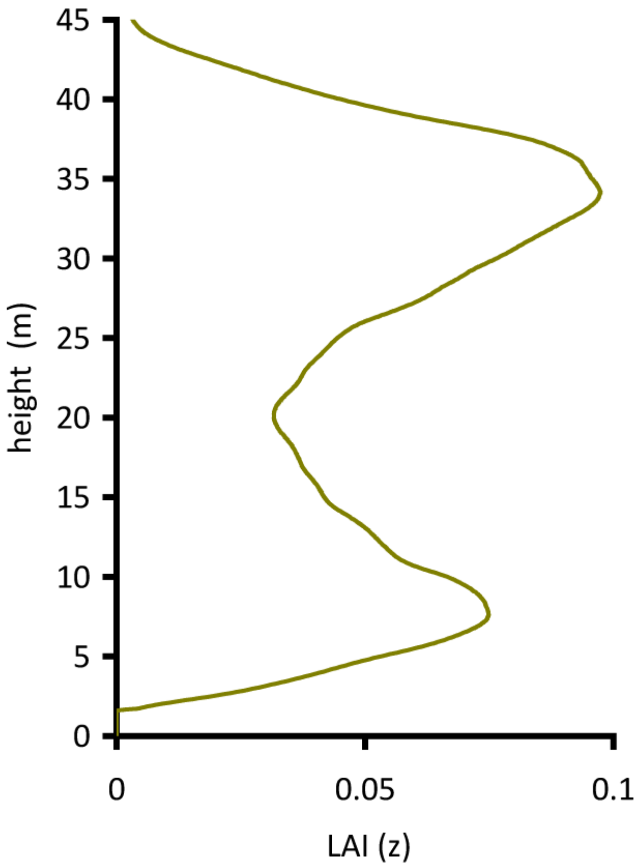
ground based Lidar

Pgap can be directly modelled

Statistical Lidar model:

$$E(r) = -E_0 \frac{C(r)}{r^2} \rho_v \frac{dP_{gap}}{dr}(r)$$

E(r) = measured power
P_{gap} = gap probability



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THANK YOU