

CSIRO Canopy Lidar Initiative

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Canopy Lidar Initiative, EOC/ASM 2002

Task Objectives

- Develop LIDAR methods for forest inventory
- Acquire Airborne Laser Scanning data over Tumberumba
- Integrate components for ground-based laser ranging system (RPE)
- Integrate hemispherical camera with mast
- Undertake field trials including inventory
- Test algorithms and methods



FWPRDC Grant

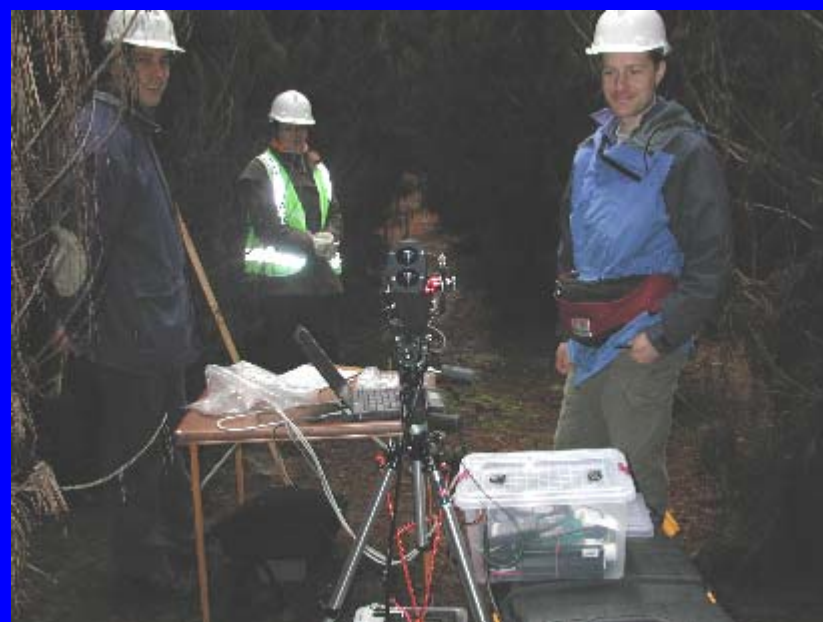
- 3 years from March 2002
- Develop ECHIDNA™ hardware
- Validate algorithms for deriving forest parameters from ECHIDNA™ data
- Use current-technology airborne Lidar data
- Use multi-angular ECHIDNA™ results to overcome limitations of airborne view
- Industry support - ForestrySA & SFNSW



ECHIDNA™ features

- Multi-angle scanning (hemisphere)
- Broad-beam laser
- Variable beam size and shape
- Digitized return
- Calibrated intensity





Canopy Lidar Initiative, EOC/ASM 2002



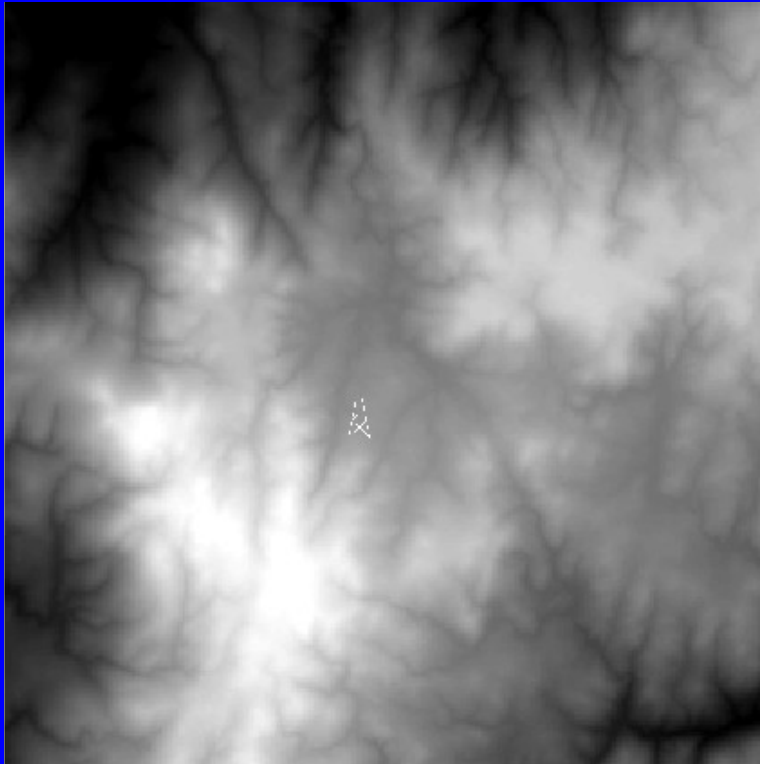
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Tumbarumba field experiment

- ALS 5km² area, average spacing 0.8m
- Four 200m² areas, average spacing 0.5m
- Ponderosa Pine, Snow Gum, Alpine Ash, Blue Gum
- RPE and hemispherical photography
- 0.1 ha plot inventory
 - Height, DBH, crown diameter, crown density, branching height, BA sweep, stem locations, slope and aspect

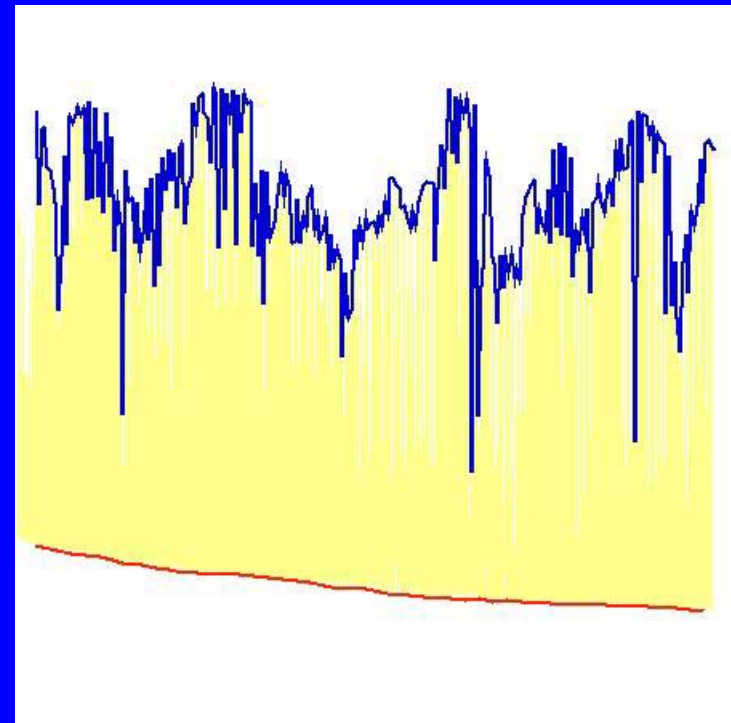


Characterisation of Flux Tower footprint with hyper-spatial data (Hymap & Lidar)



Canopy Height

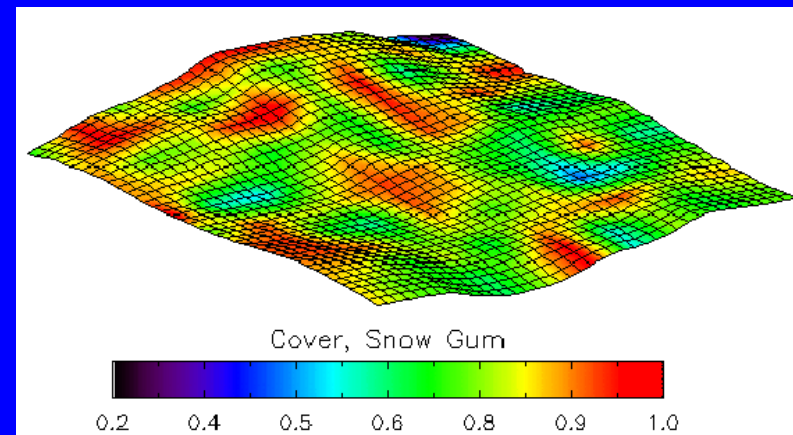
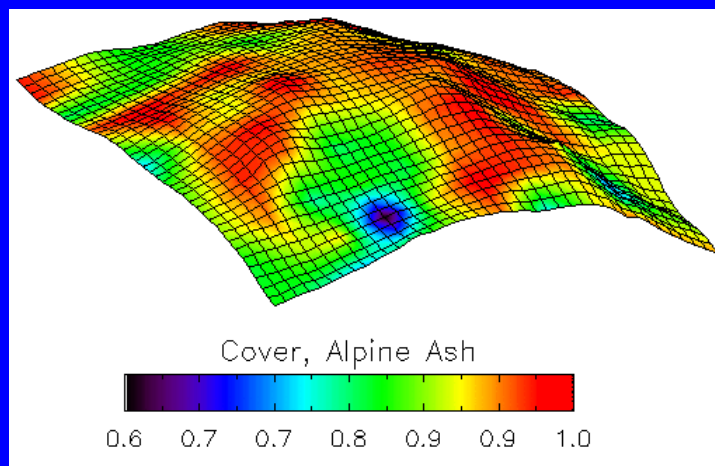
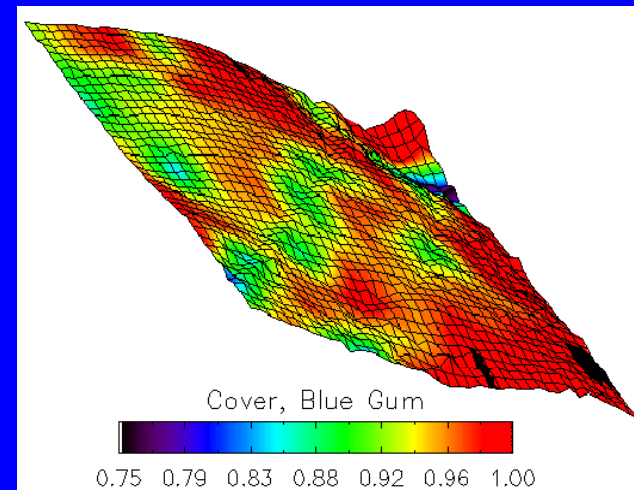
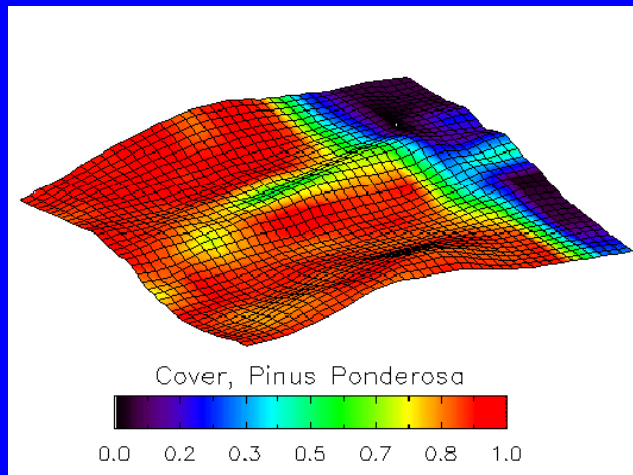
- Ground elevation
- Canopy elevation model
- Highest hit in region
- Percentile hit in region
- Predominant Height



Foliage Cover

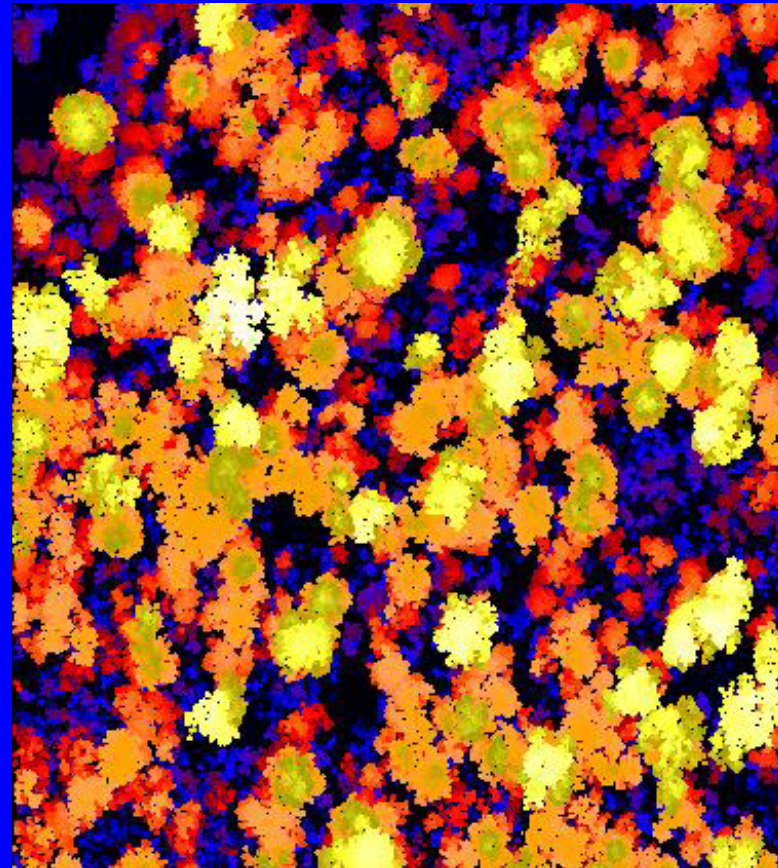
- Projected Foliage Cover
 - Number of veg hits / total shots
 - Over-estimates cover
- Use both first and last hit data and classify
 - Veg-veg
 - Veg-ground
 - Ground-ground
- Use Intensity





Tree density – Crown size

- Individual tree crowns can be seen in the raw ALS data
- Trees can be counted
- Crowns can be measured



Predominant Height

- Average of 75 tallest trees per hectare
- Top height = average of the 100 tallest trees per hectare
- Lidar definition is analogous
 - Average of 100 x (plot size in ha) highest hits
 - Make sure hits are from separate trees

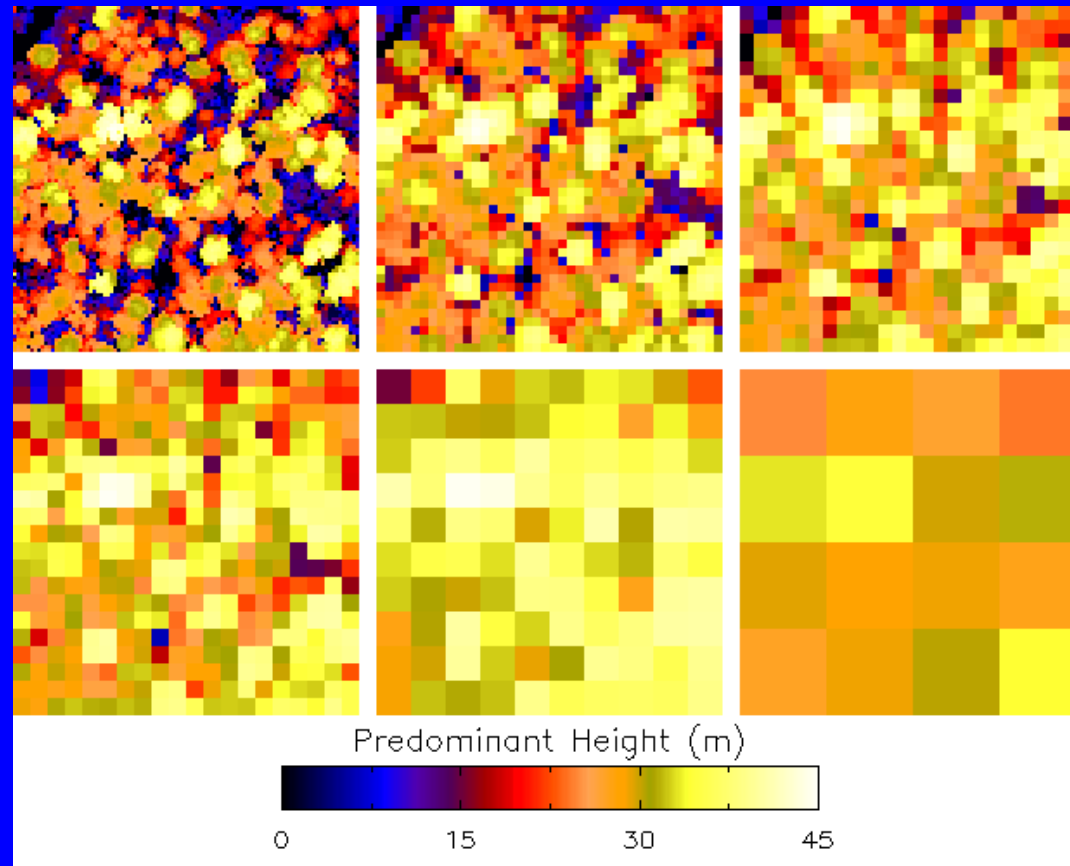


Height comparison

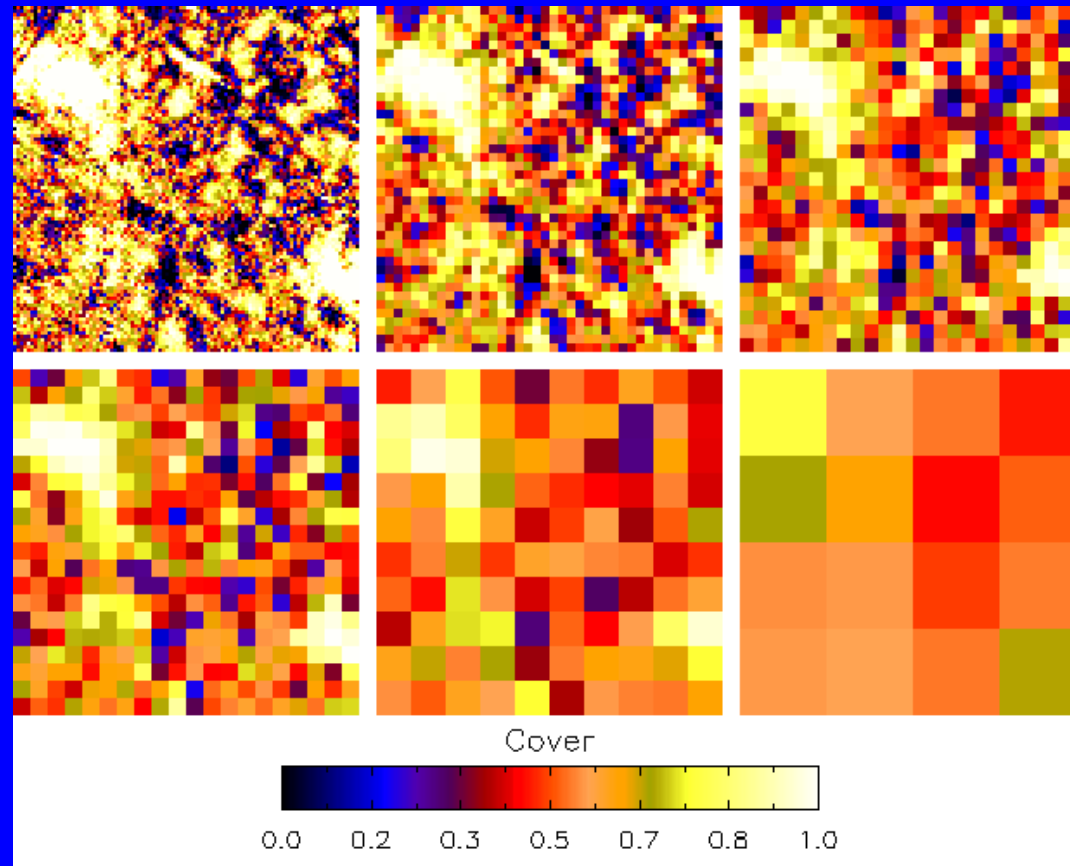
Site	0.1 ha inventory	ALS 30m plots
Ponderosa Pine	30.0 ± 1.1	27.0 ± 7.7
Snow Gum	30.5 ± 2.2	29.1 ± 3.0
Blue Gum	29.3 ± 7.4	31.6 ± 8.5
Alpine Ash	44.3 ± 5.9	35.9 ± 2.7



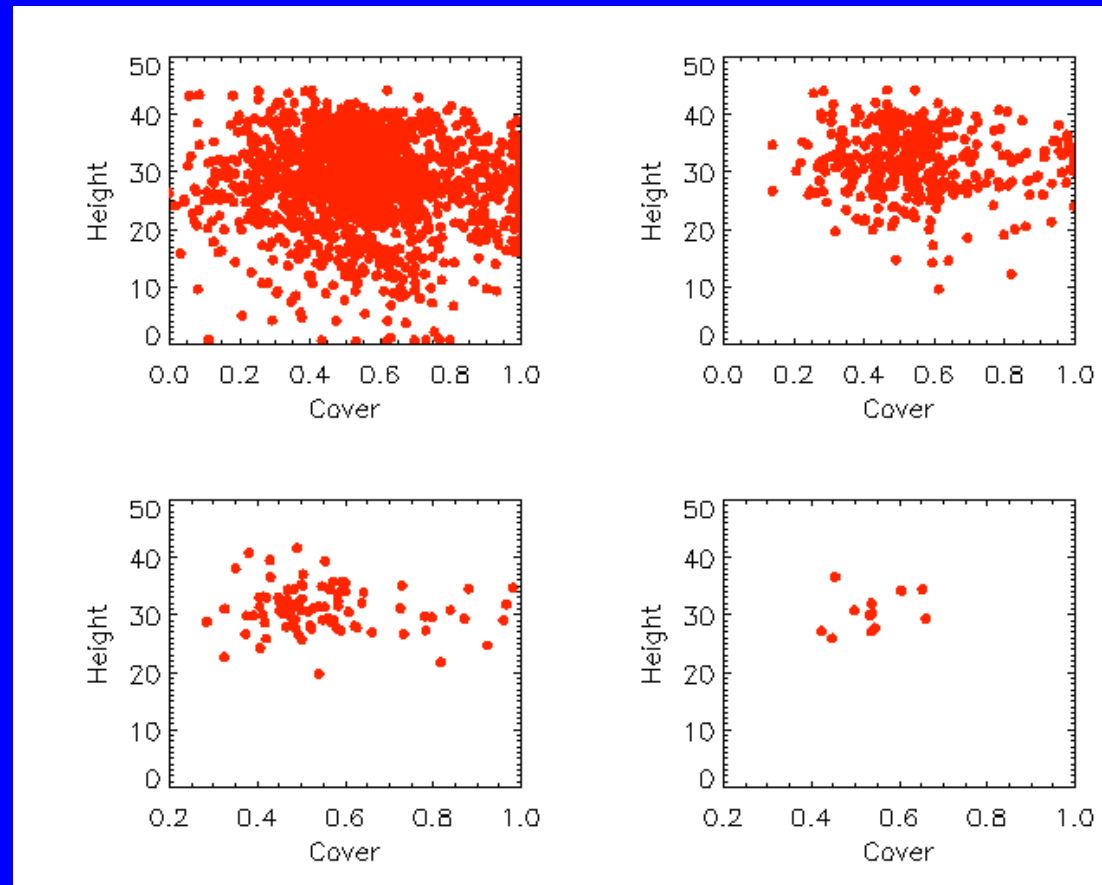
Predom H vs Plot Size

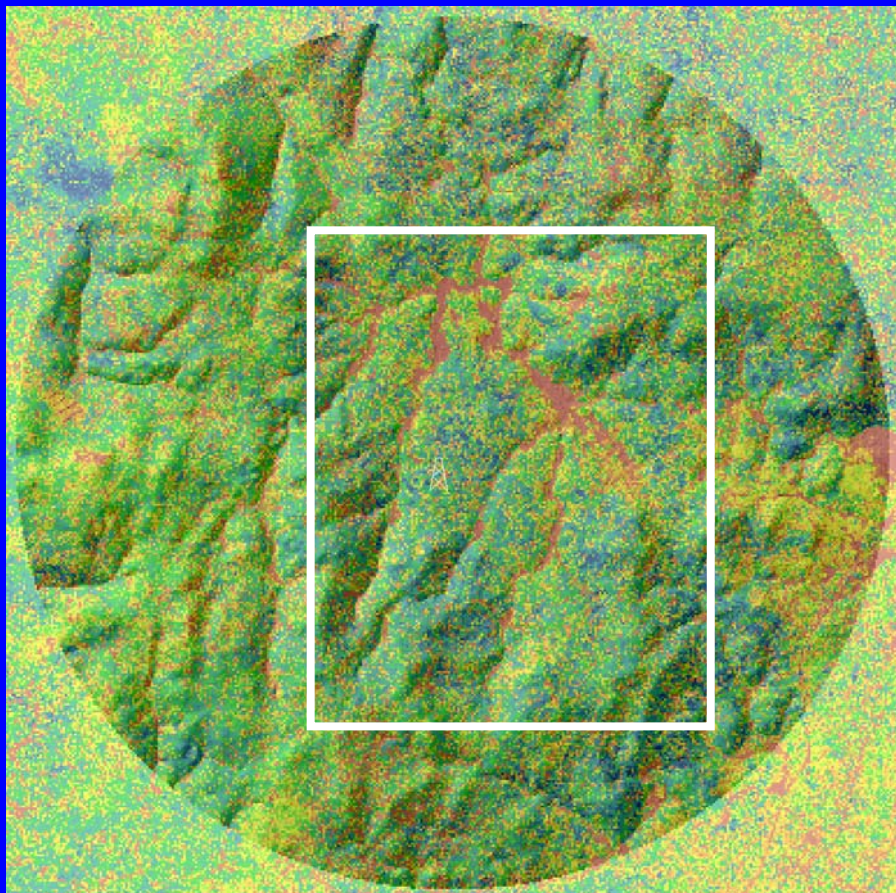


Cover vs Plot Size

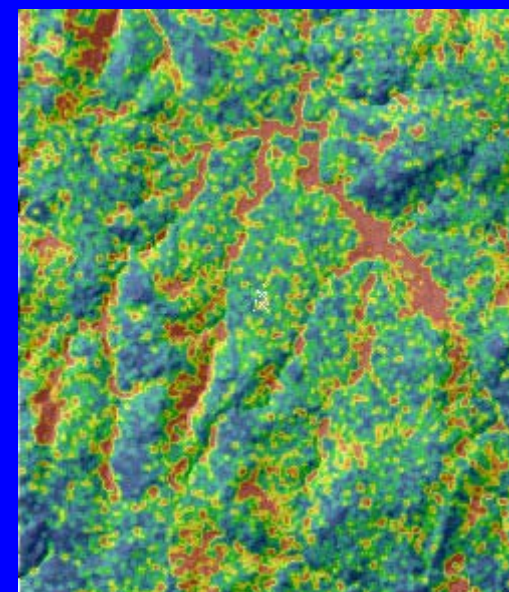


Cover vs Height

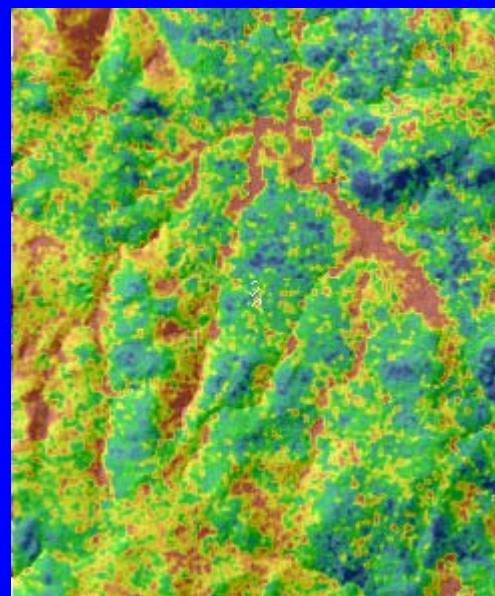




Airborne Lidar-derived canopy height



Cover (%)



Predominant Height
(75 trees/ha)

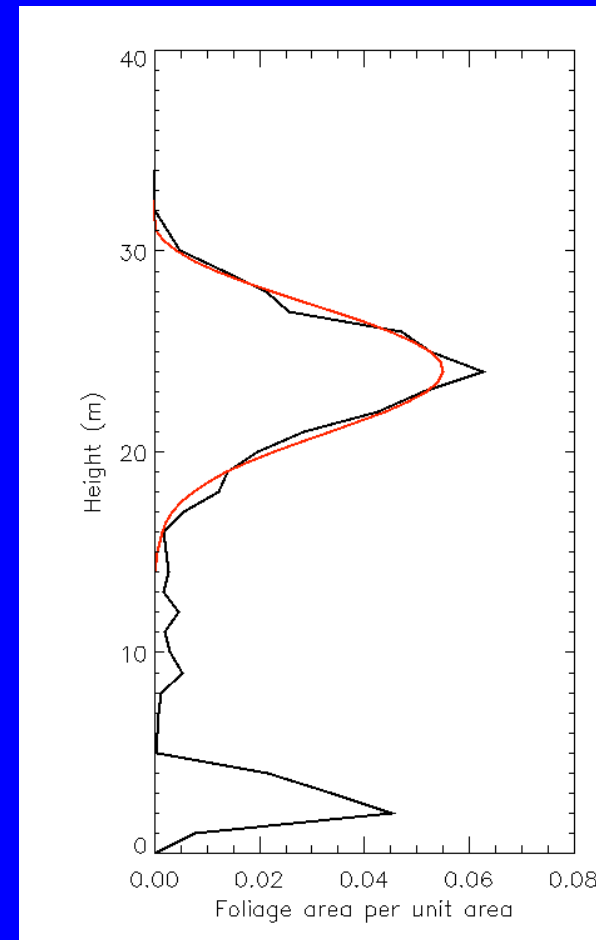
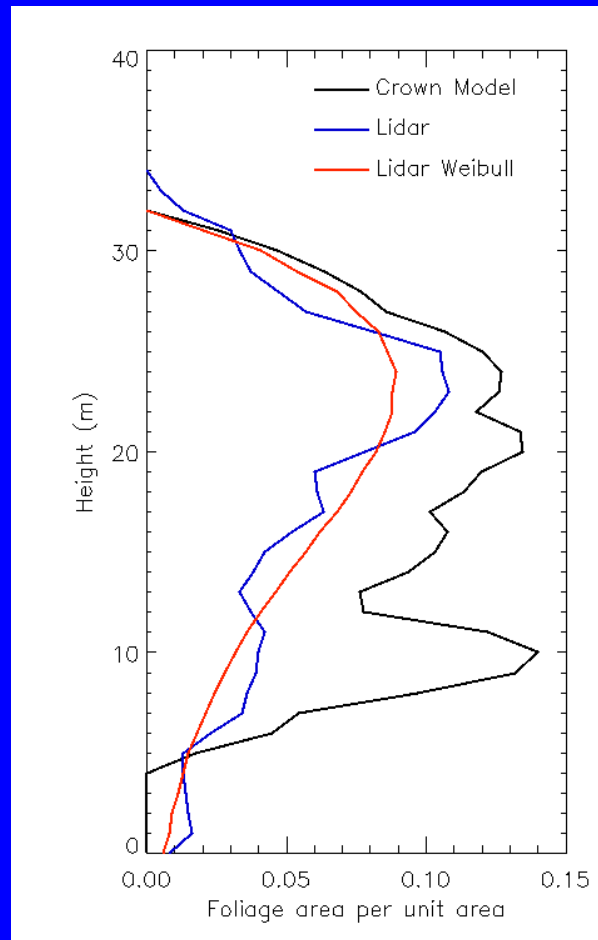


Foliage Profile

- Foliage area per unit area vs height
 - Derived from gap probability as a function of height
 - Canopy layers, understorey, crown depth
- Model fit → stabilizes results
- Model fit provides another height estimate



Snow Gum Foliage Profiles



Basal Area

- Horizontal scans with ECHIDNA™
 - Gap probability as a function of range is directly related to tree density and average diameter
 - A variable beam shape will allow operation in a Relaskop-like mode



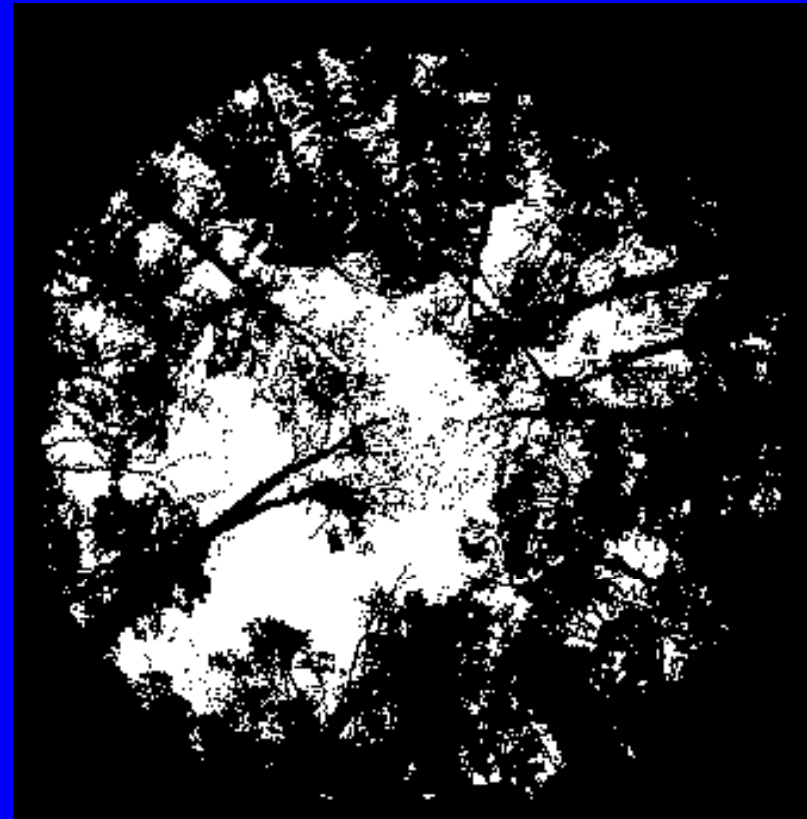
Foliage Angle Distribution

- ECHIDNA™ multi-angular scans allow the foliage angle distribution to be sampled
 - Foliage angle will vary with height
 - Foliage angle information can be used to overcome the limitations of vertical viewing airborne instruments
 - A discontinuity (or at least a distinct change) should be detectable where branching begins

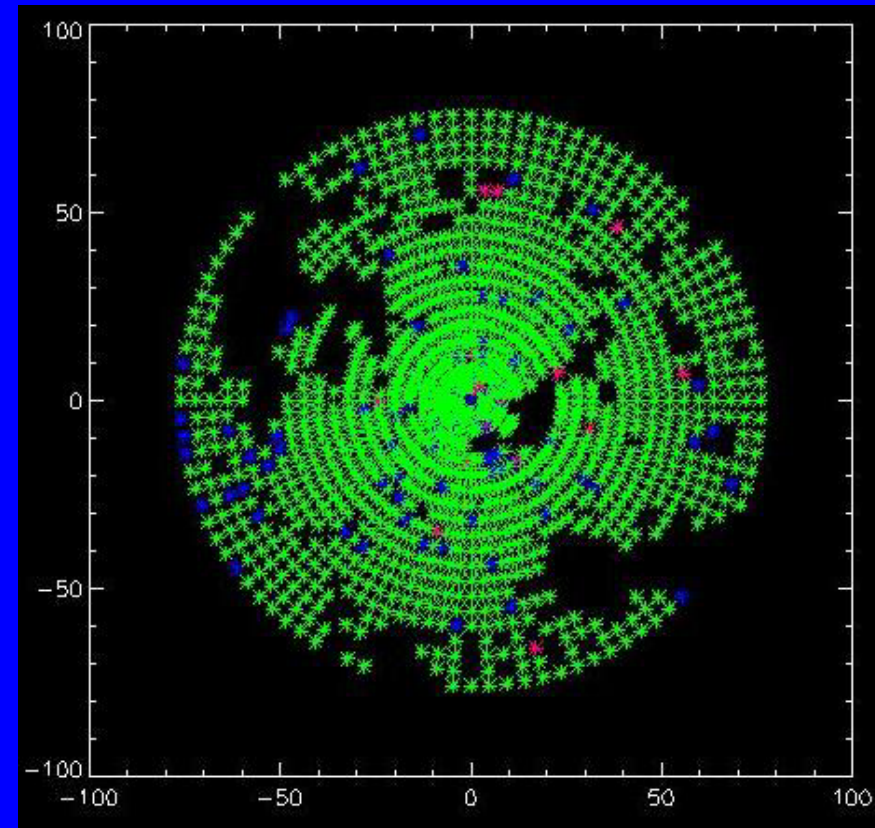


Hemispherical Photography

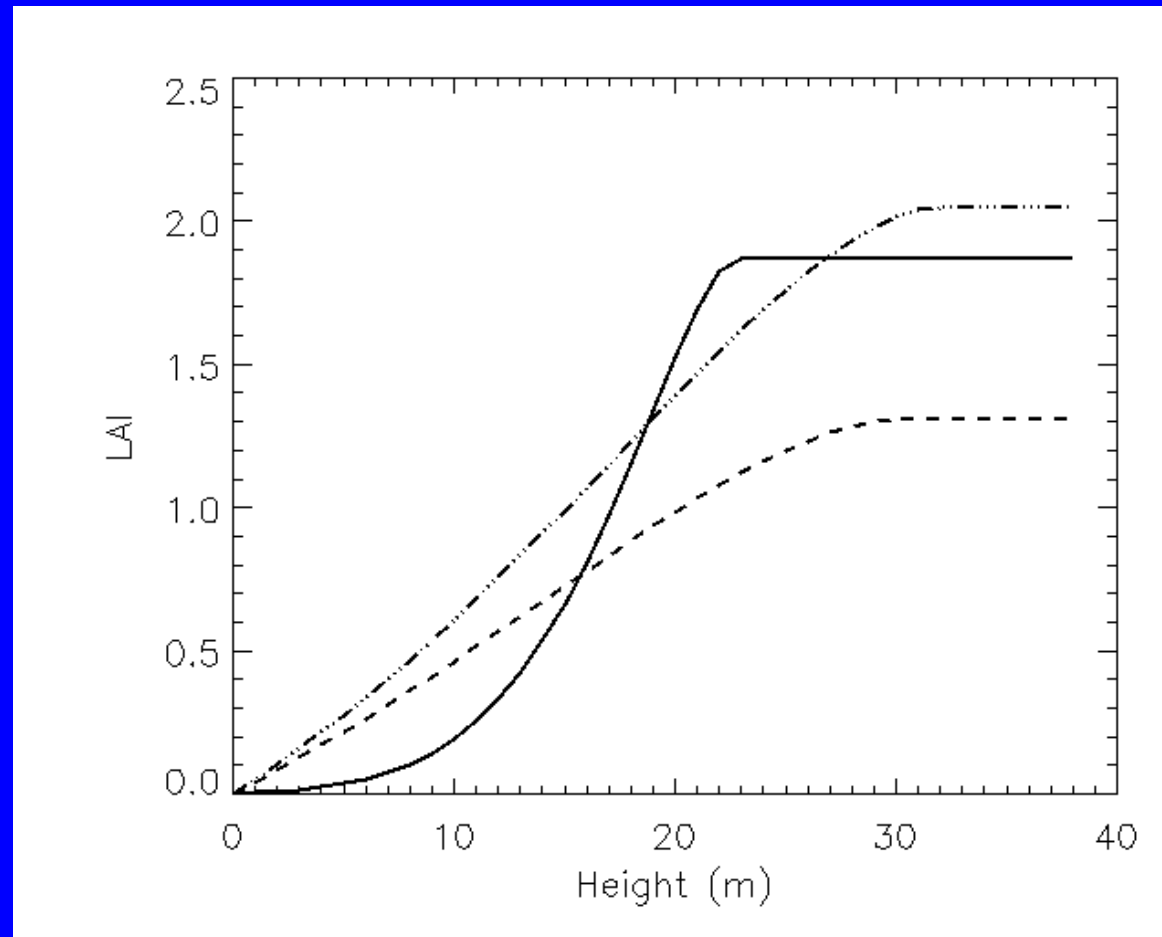
- Threshold image to separate sky, foliage
- Calculate LAI
 - Total
 - Zenith angle rings
- Raise camera through canopy to find LAI vs height



RPE validation



RPE LAI vs Height



LAI comparison

Site	Hemi LAI	RPE LAI
Ponderosa Pine	2.5	1.9
Snow Gum	1.2	1.3
Blue Gum	2.0	2.0

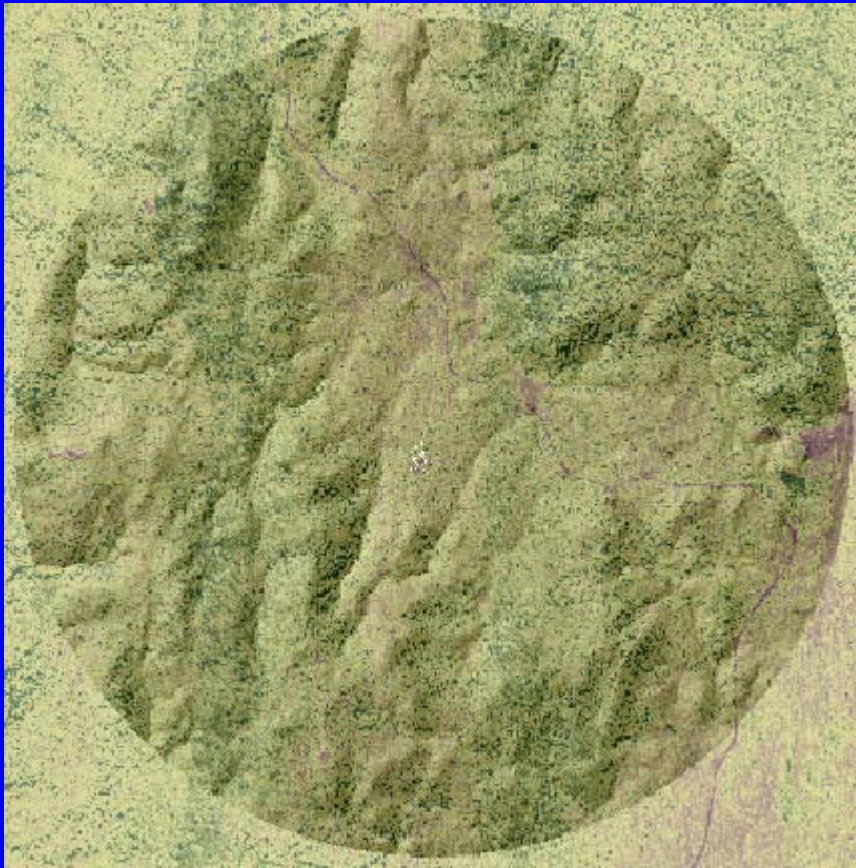


Future work, Tumberumba

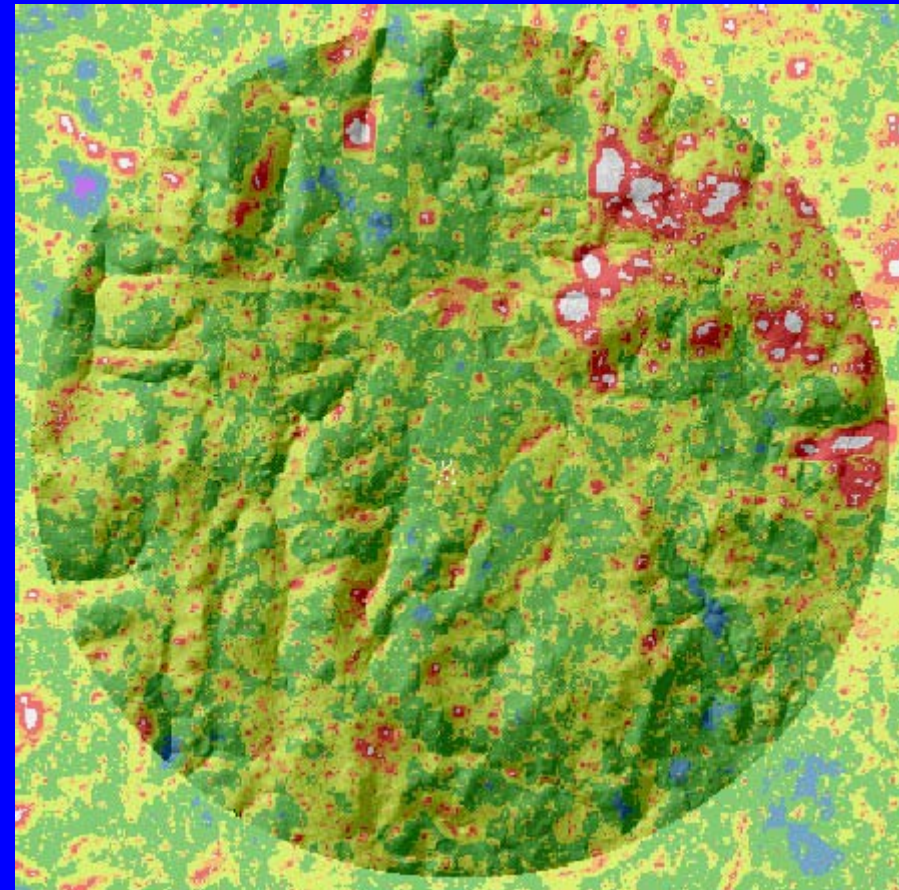
- Analysis of LAI vs height from photos
- Analysis of 5km low-resolution ALS data
 - Spatial variation of foliage profiles
- Comparison with other data
 - Hymap



Hymap-derived Indices



Predicted leaf chlorophyll content



Habitat complexity score



Mount Gambier visit

- ForestrySA recently acquired ALS on three transects
- Plantation – Radiata Pine
- Extensive GIS database
 - site quality assessment
 - inventory
- RPE and Hemispherical photography
- Test methods to provide key allometric and structural parameters

