Fire Ecology & Global Change
Ecología del Fuego & Cambio Global
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Fire severity and tree/forest structures derived from pre- and post-fire LiDAR data in a large forest fire in SE Spain

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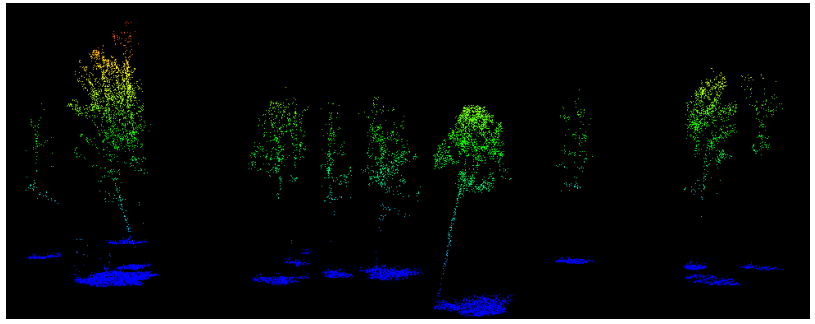
Introduction

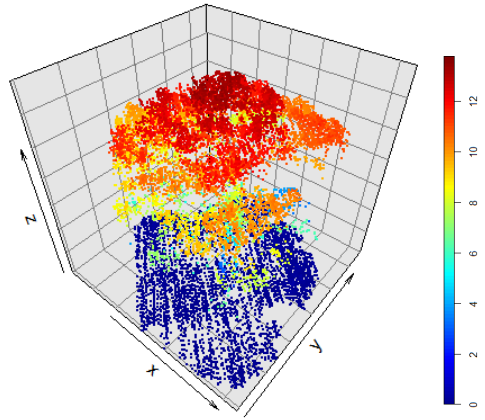
For an ecological understanding of disturbed systems severity data at a very fine spatial resolution is required.

Satellite data is not enough to assess ecological processes at soil-plant level.

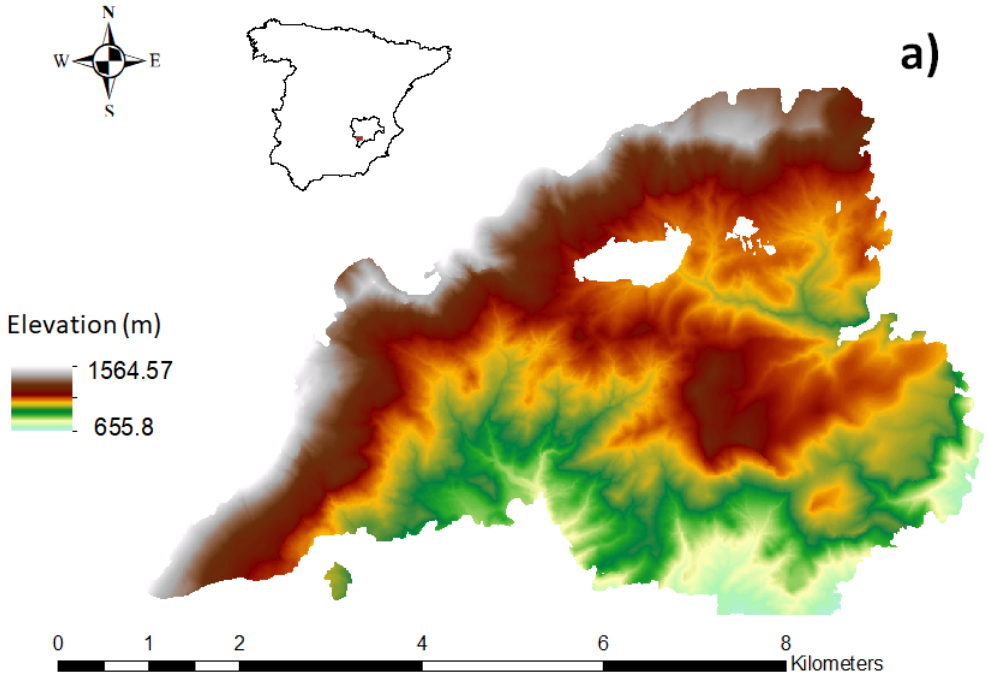
Objective

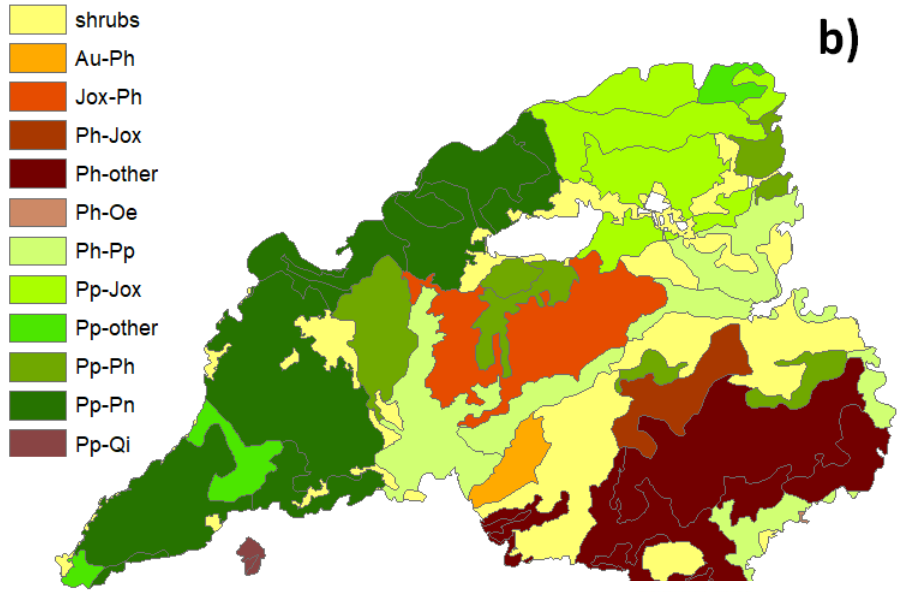
Determine with high spatial resolution the internal variability of satellite fire severity data in terms of tree morphologies and forest stands using pre- and post- fire LiDAR data.

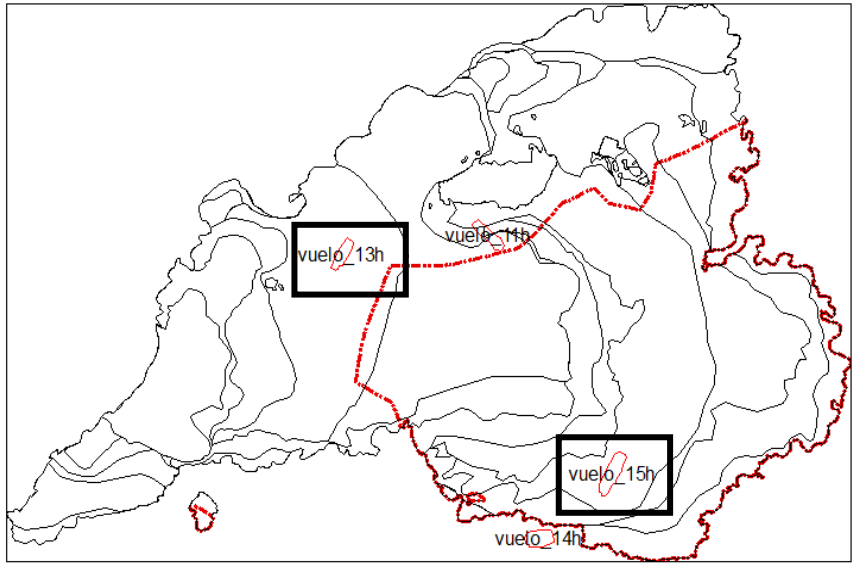


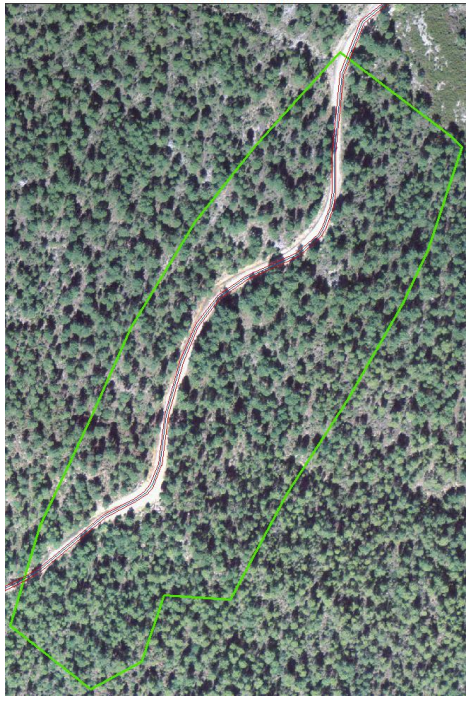


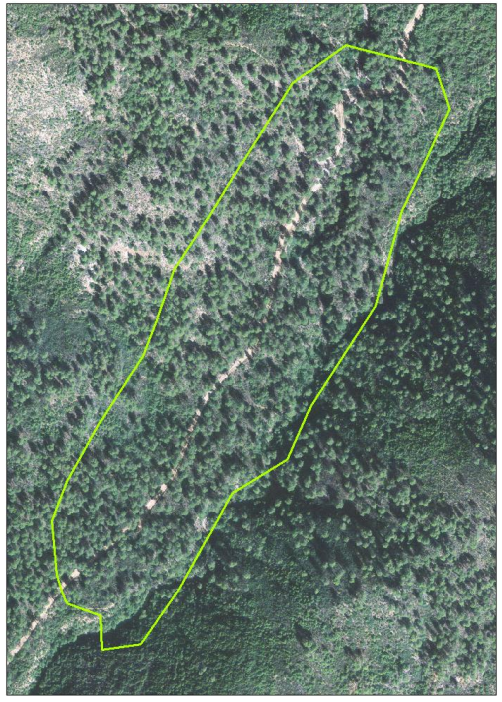
Study Area: The Yeste Fire (SE Spain) > 3,300 ha (Summer 2017)





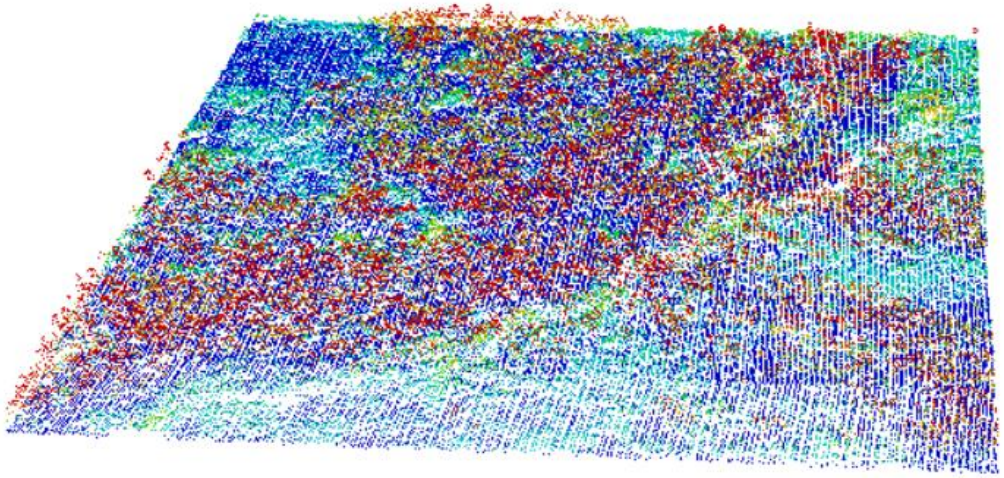




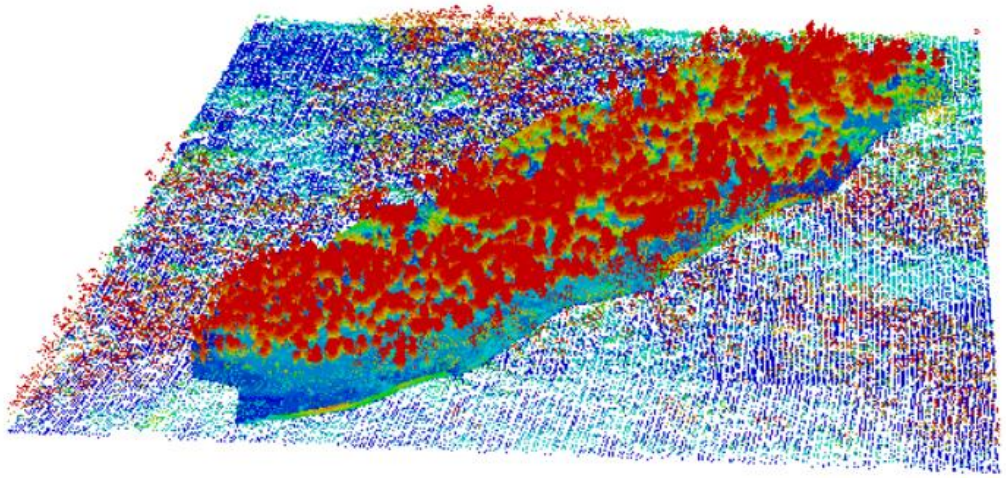


LiDAR Flights

PREFIRE 2016: LIDAR PNOA (1 POINT/M²)
sensor ALS 50 – II

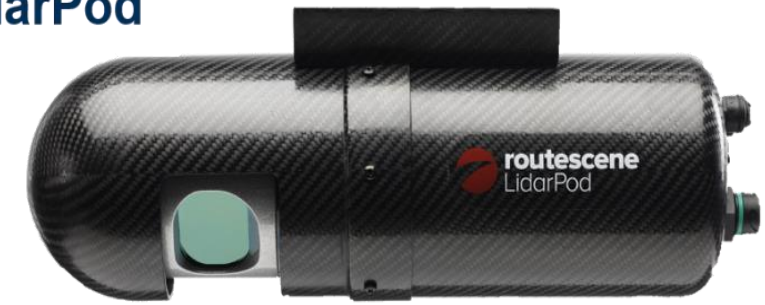


POSTIFRE 2018: LIDARPOD (300 PUNTO/M²)
Velodyne HDL-32e



Sistema TerraSystem-LidarPod

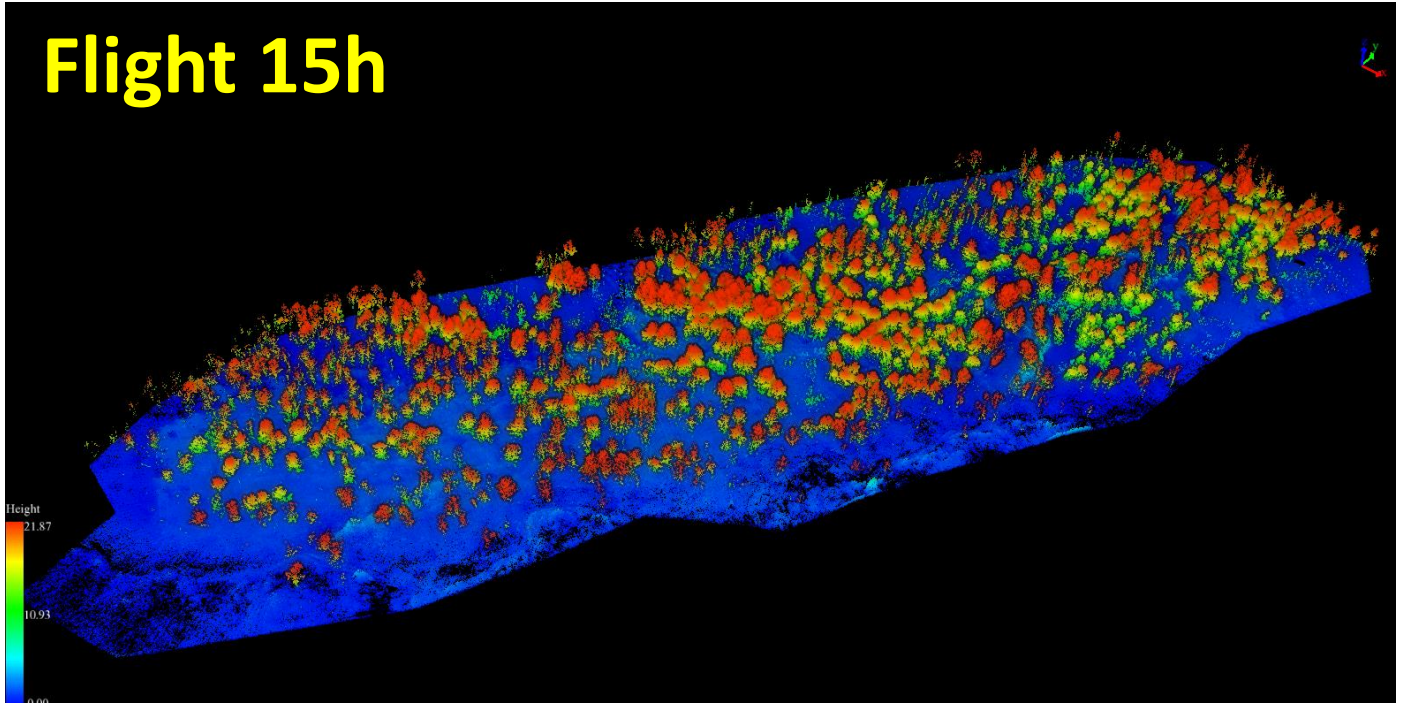
Sistema integrado compacto
LIDAR + INS + GNSS
Peso: 2.0 kg
Kit montaje en Dron: 0.8 kg
Dimensiones 320 x 100 mm

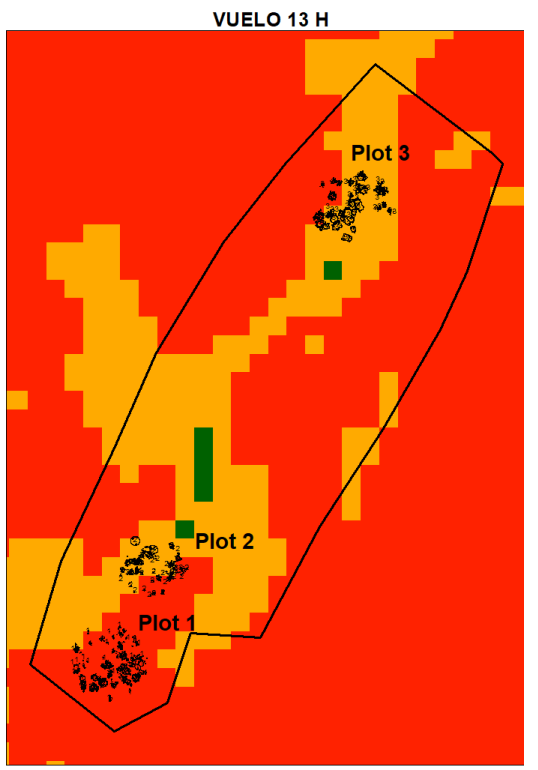


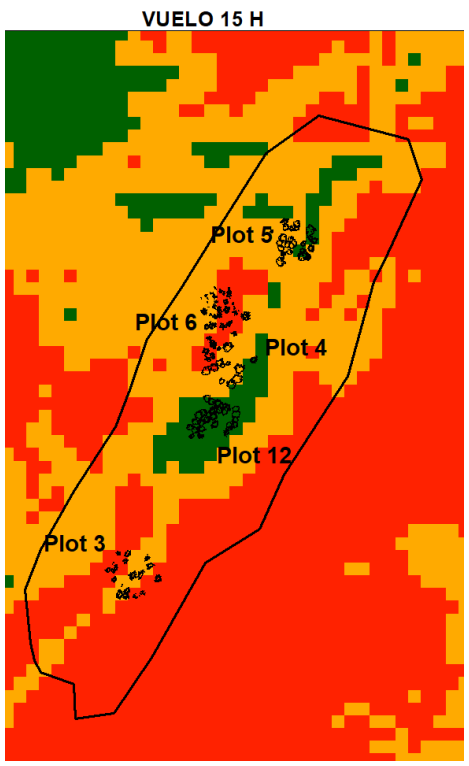
Sistema de Posicionamiento
RTK GNSS/INS
220 canales L1, L2 & L5
GPS \ Glonass \ Beidou \ Galileo
Doble antena GNSS
Precisión: Horizontal: 8mm (RMS)
Heading: 0.07 grados
Pitch & Roll: 0.15 grados

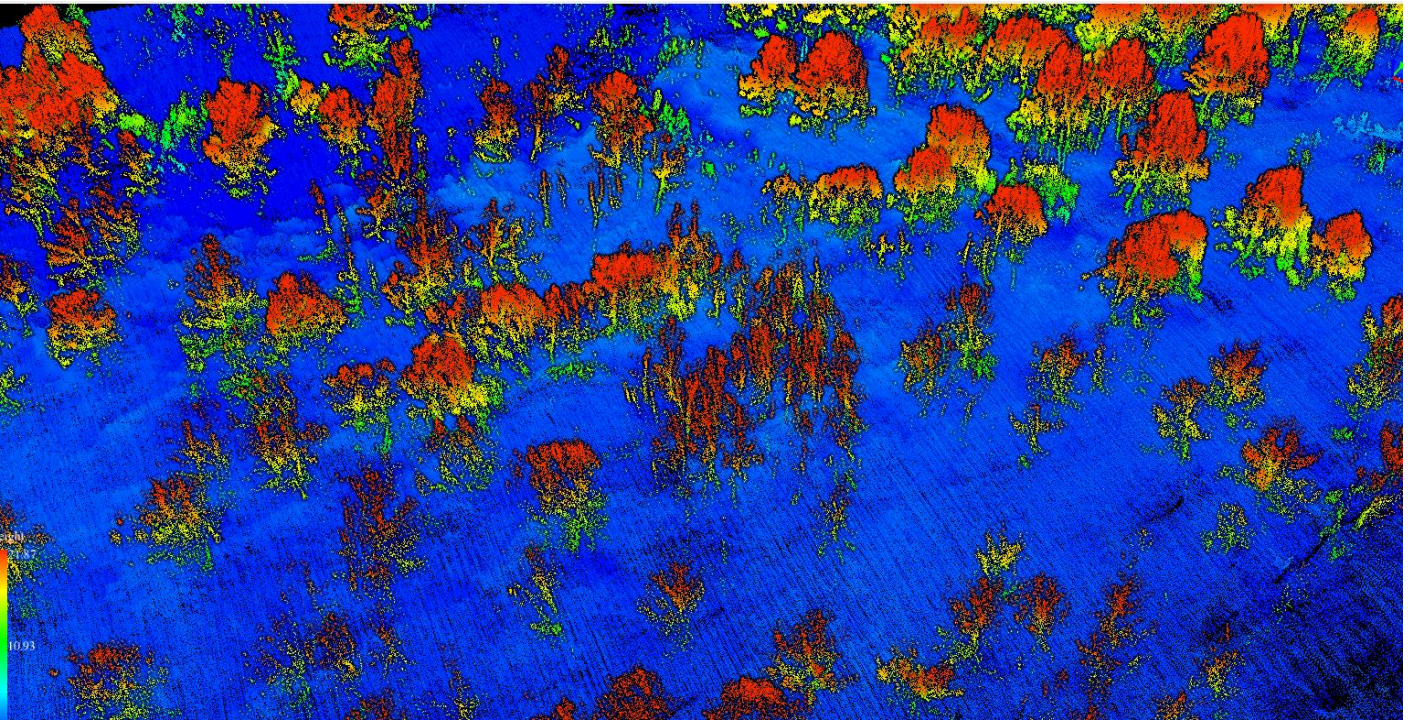
LIDAR Velodyne HDL32
32 sensores láser
Láser Clase I eyesafe (905 nm)
Rango (max) 110 m
FOV: 360 x 40 grados
700,000 puntos por segundo

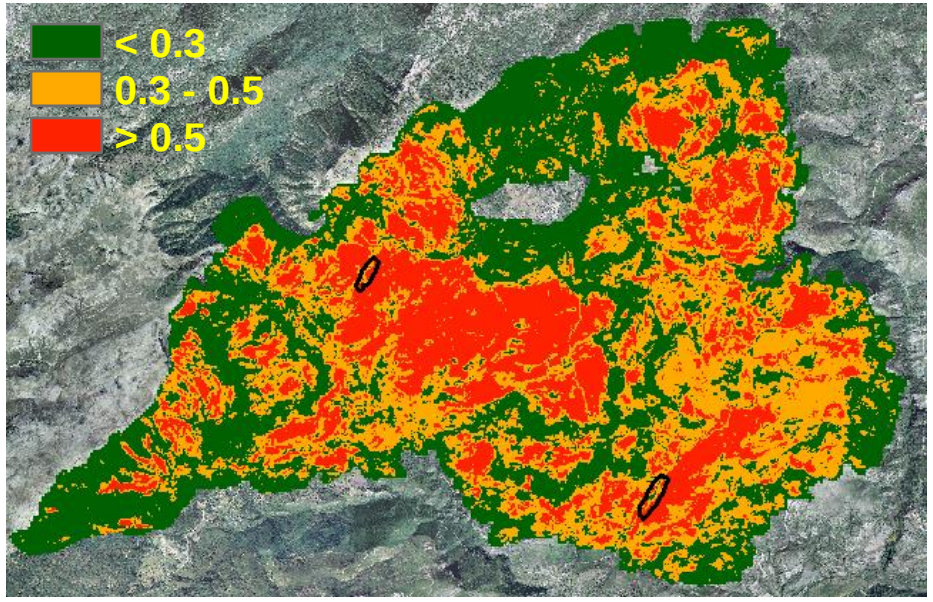
Almacenamiento Interno
Disco duro de 130 Gb =
Más de 13 horas de grabación


Flight 15h
Height
21.87
10.93


VUELO 13 H
Plot 3
Plot 2
Plot 1


VUELO 15 H
Plot 5
Plot 6
Plot 4
Plot 12
Plot 3

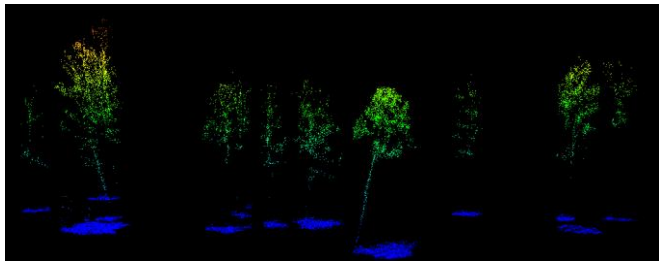



< 0.3
0.3 - 0.5
> 0.5

Characterizing *Post-fire Trees*

1. ***Pitfree Canopy Height Models***

2. Tree segmentation
(Silva method)



3. Tree tops
Crown contours

Crown metrics
Tree height,
Crown area
Crown perimeter

***4. Majority Filter* on Crowns contours**: remove holes before extracting metrics

Gridmetrics
All height values
< 4 m height
> 4 m height

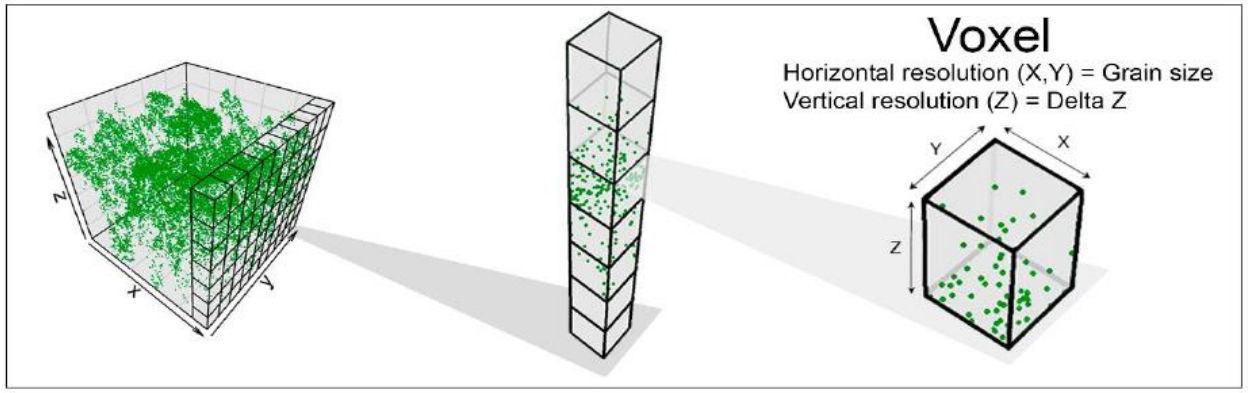
5. Clip individual tree clouds
Z profiles
(continuous values)

LAD profiles
Canopy Base Height
Crown volumen
LAI

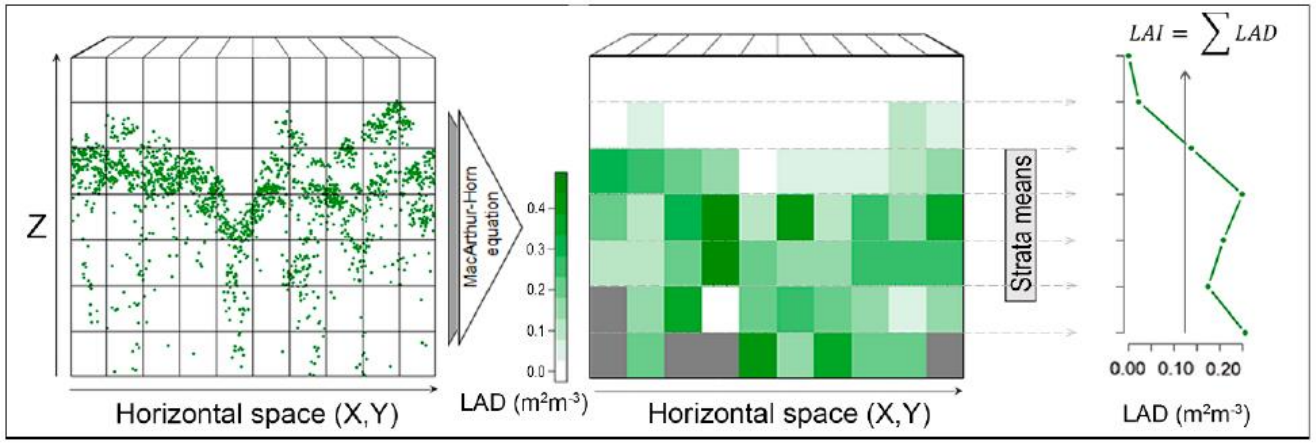
Density (% all returns)
Height bins (0.5 m)

Diversity metrics

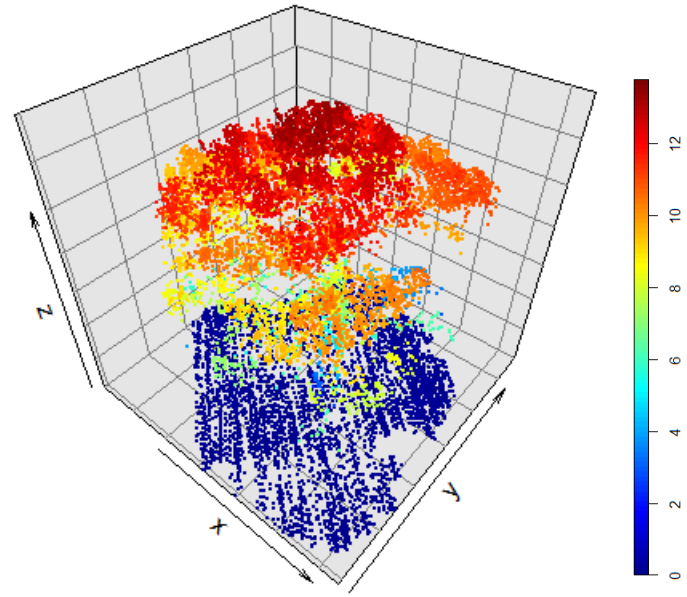
Characterizing *Post-fire Trees:* **LAI and LAD profiles**

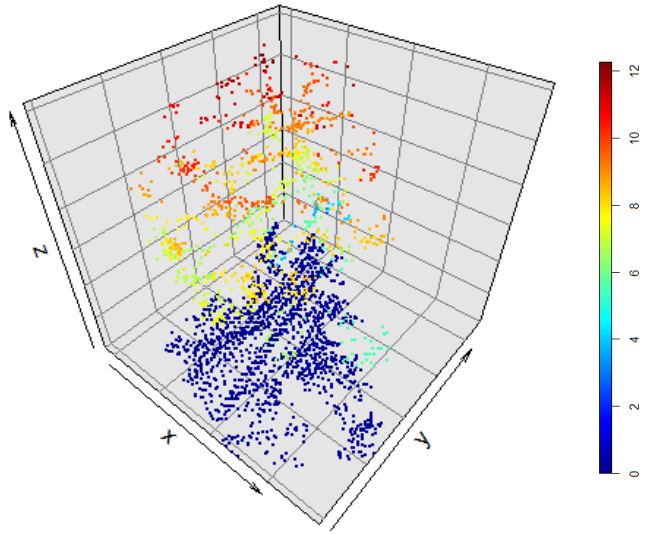


$$\text{Effective LAD} = -\ln(\text{pulses.out}/\text{pulses.in}) \times \frac{1}{D} \times \frac{1}{K},$$



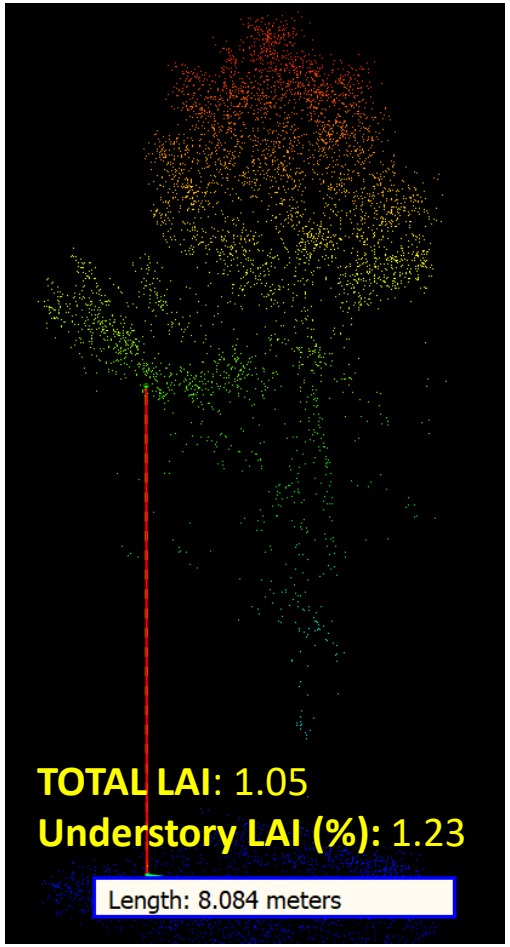
Source: Almeida et al. 2016 (Remote Sensing of Environment, 184 pp.153–160.

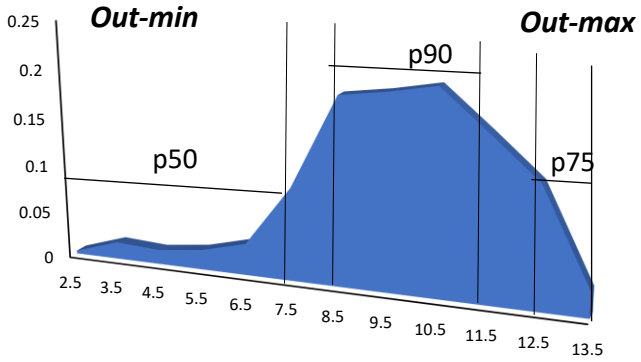




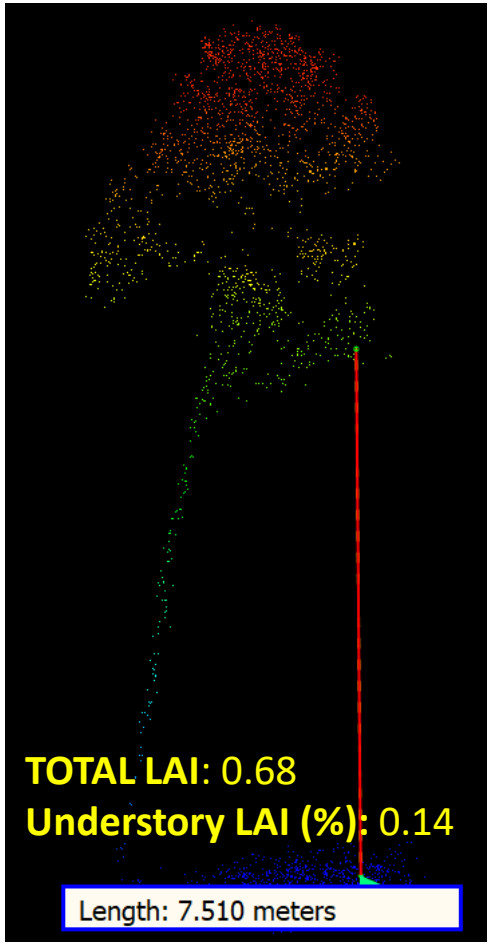
Point clouds were homogenized by thinning them to 250 points/m^2 (We are testing other point densities: 150 / 50 / 5 points…)

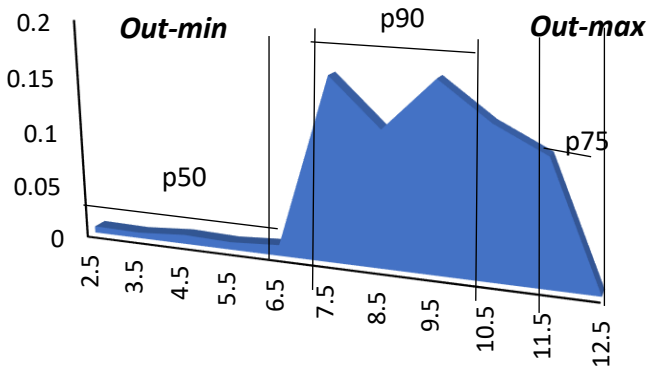
TREE Nº 356 FLIGHT 15 H



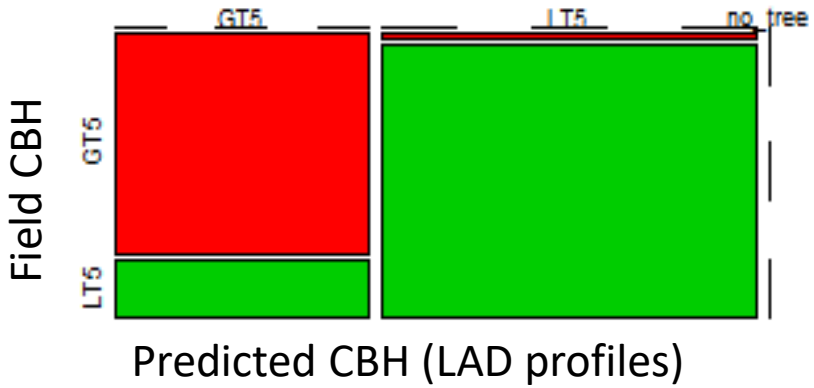


TREE Nº 83 FLIGHT 15 H



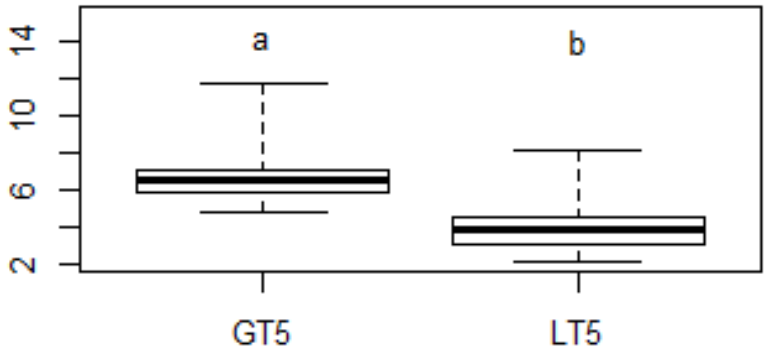


Crown Base Height (CBH)
< 5 m and > 5 m

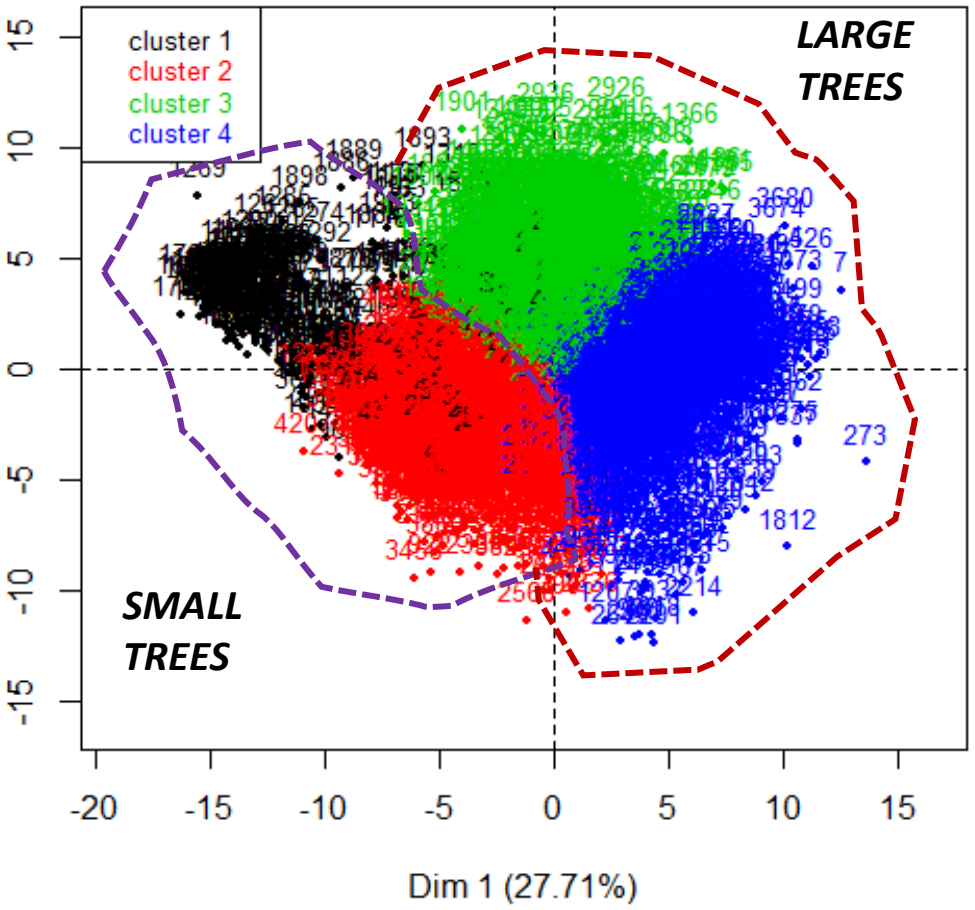


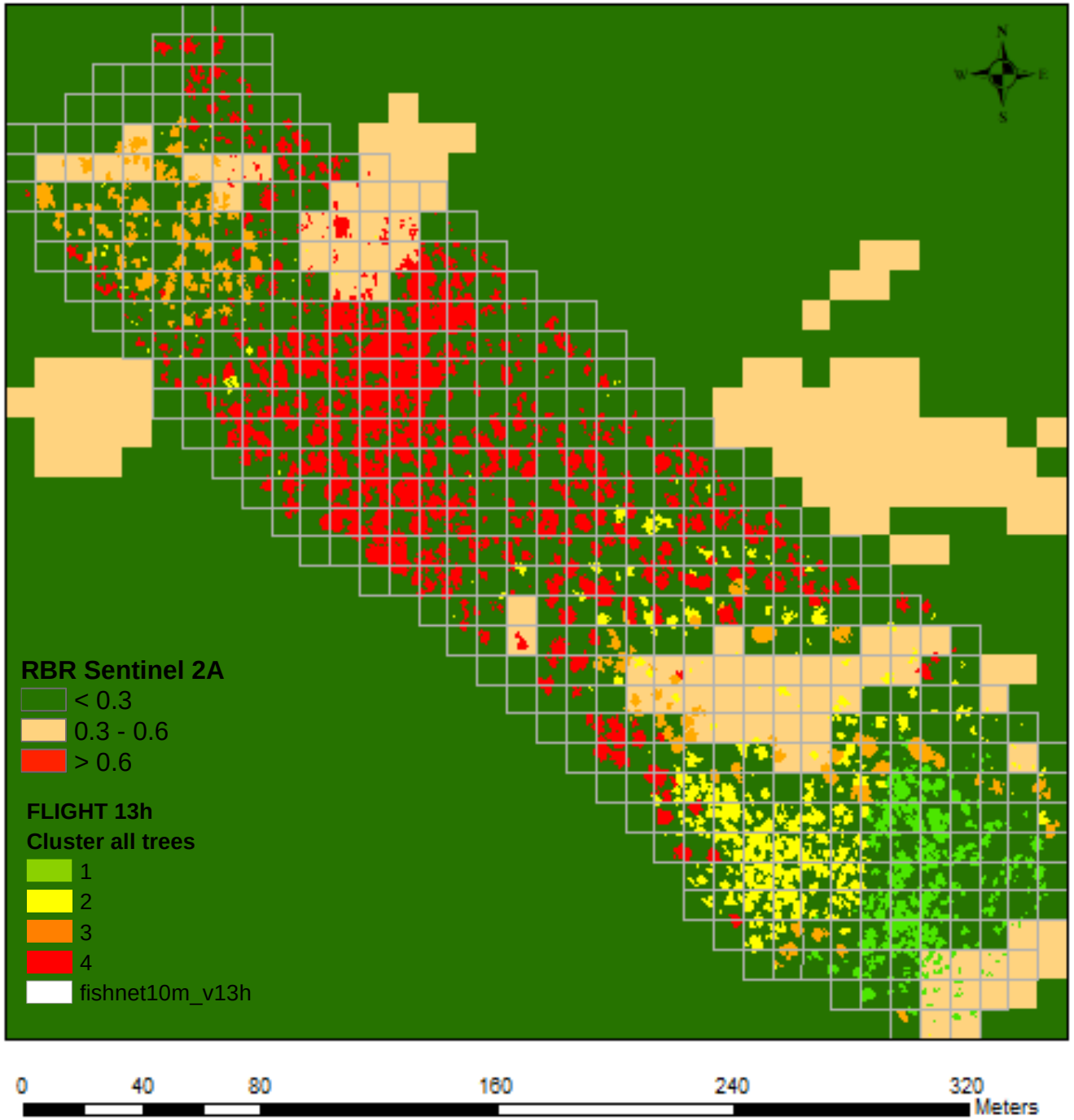
Predicted CBH (LAD profiles)

Separability of Predicted CBH classes using Observed CBH classes

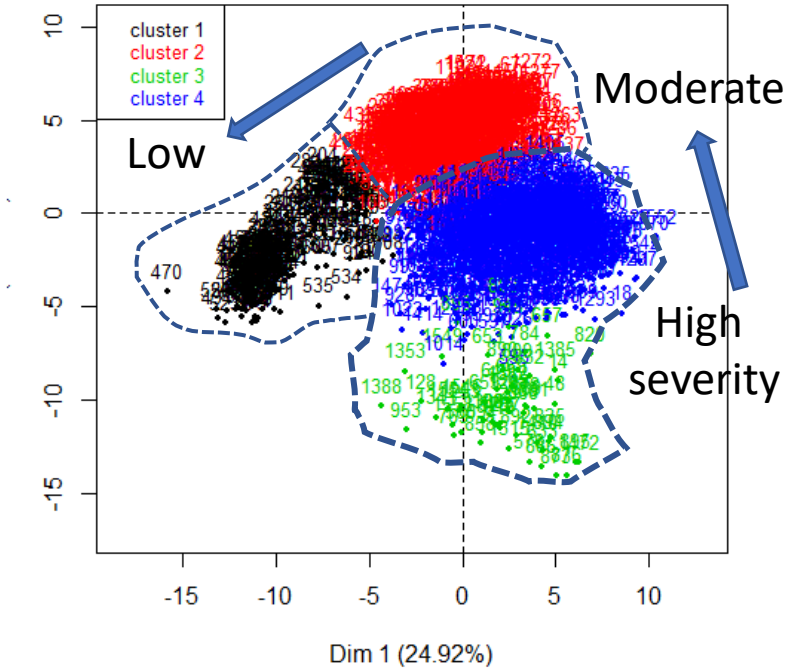


PCA CLASSIFICATION (TREE LEVEL)

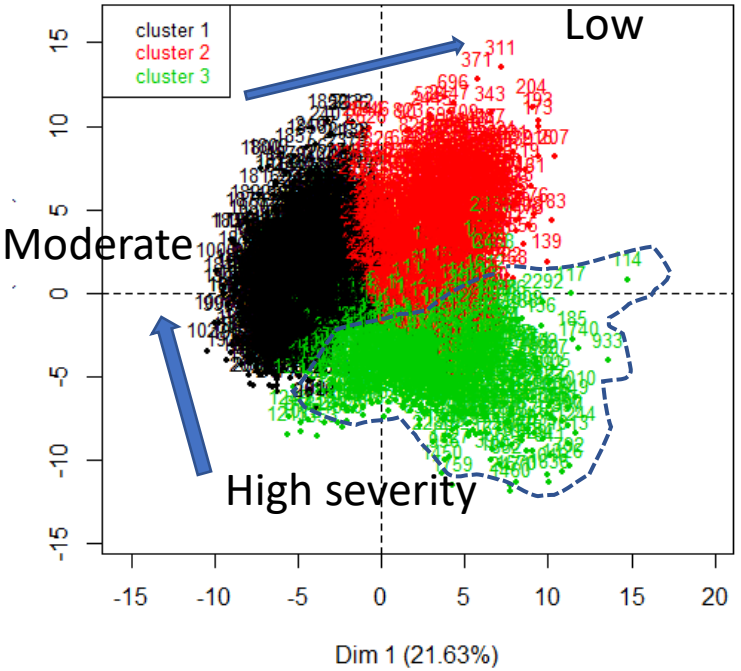




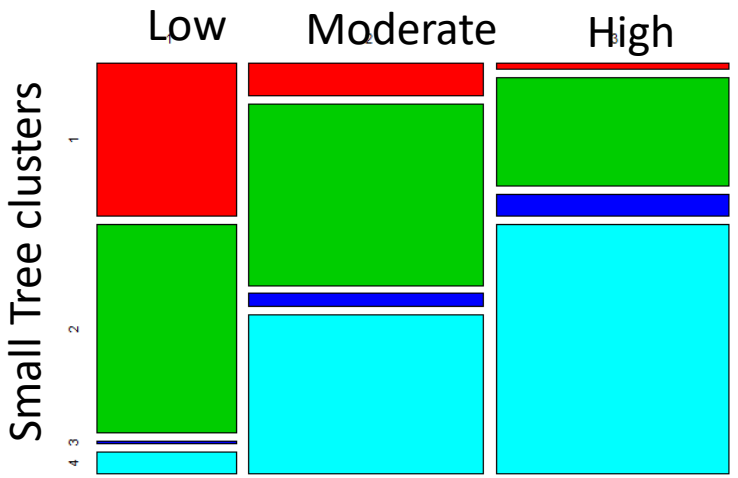
SMALL TREES

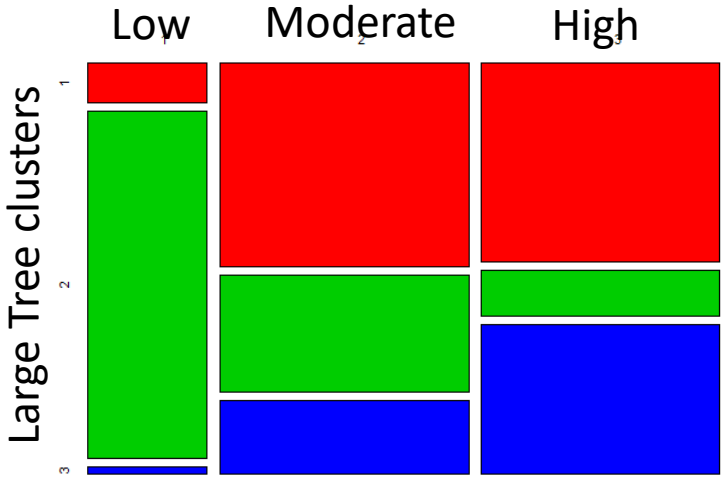


LARGE TREES

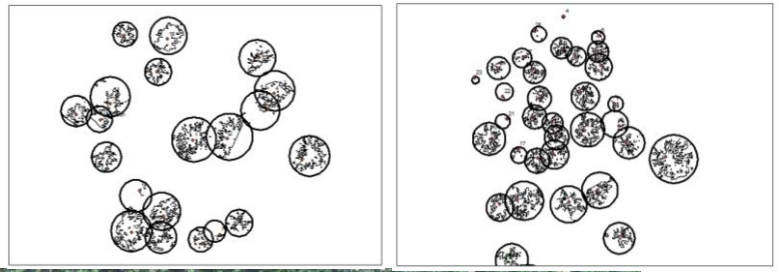


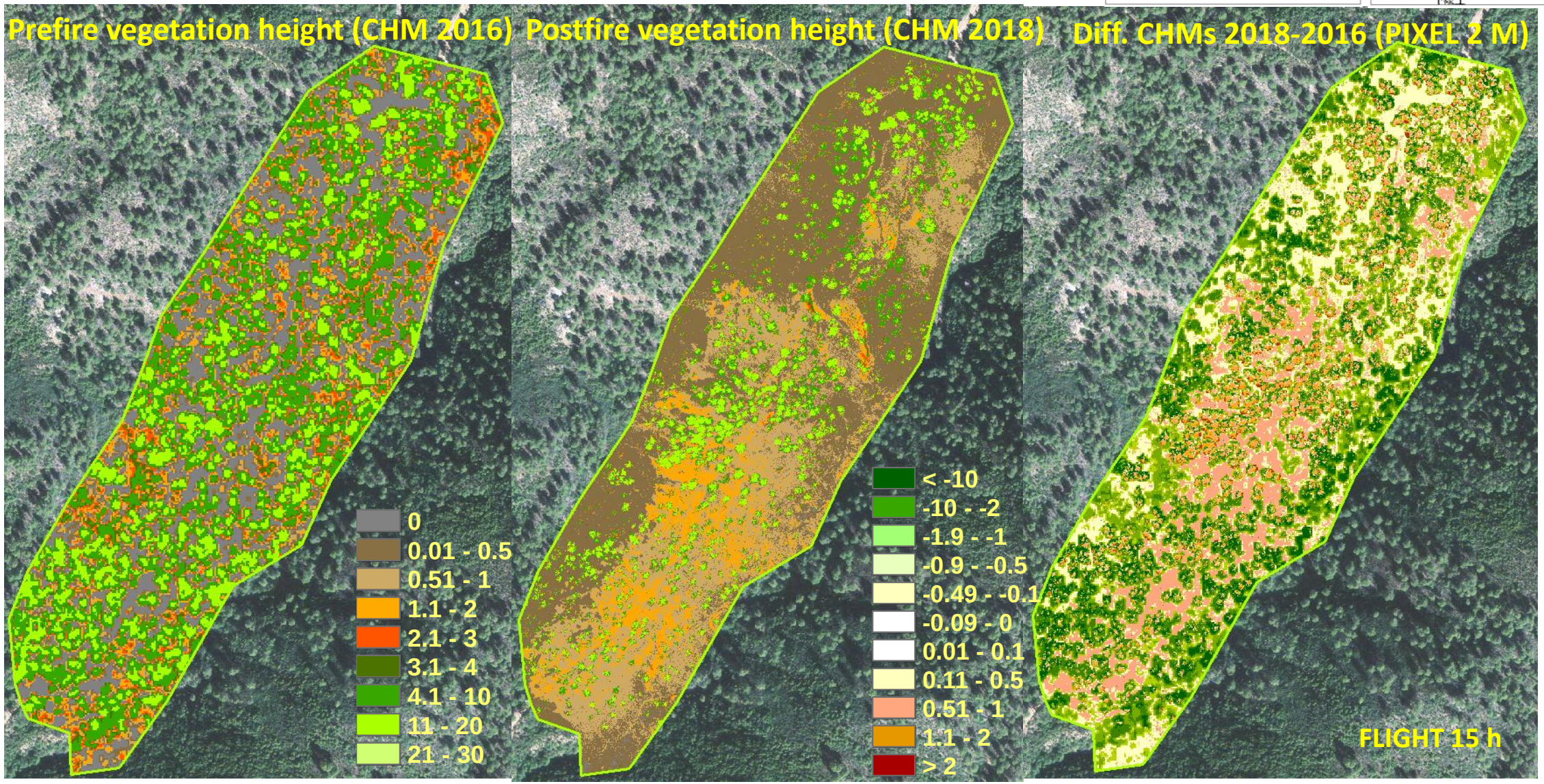
Sentinel 2A Fire Severity (RBR classes)





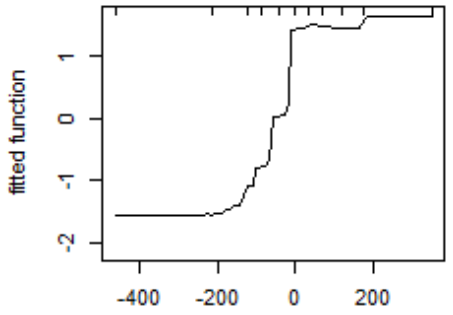
Relative Severity metrics derived from LiDAR



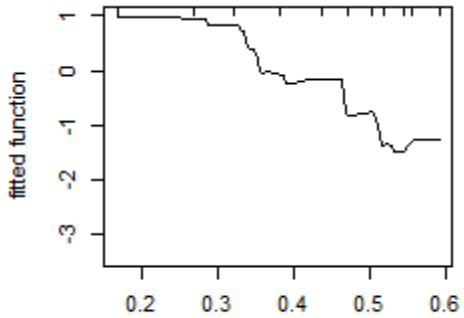


Relative Severity metrics derived from LiDAR

Mean Height Difference

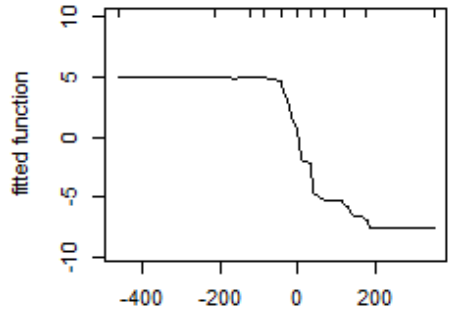


Crown volumen loss (27 %)

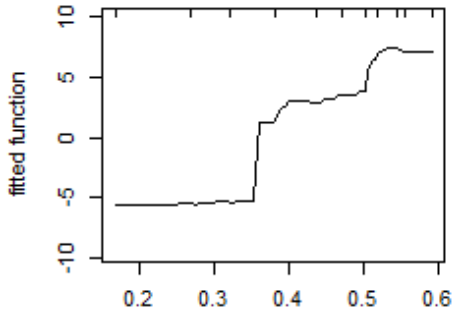


RBR Sentinel 2A (16 %)

Percentage of Height Loss

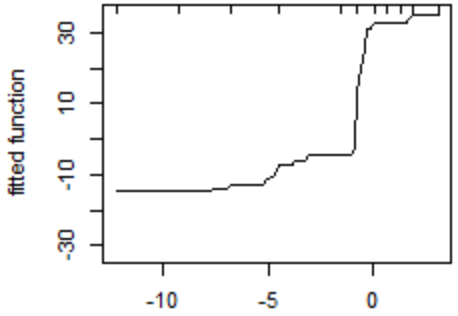


Crown volumen loss (13 %)

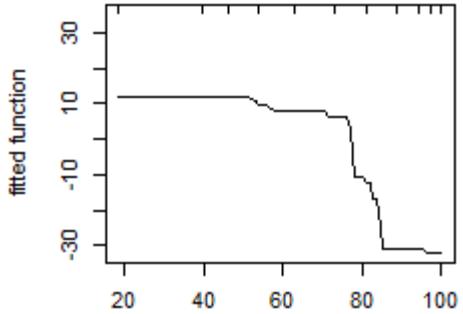


RBR Sentinel 2A (16 %)

Crown Volume Difference



Height difference (37 %)



% Height loss (30 %)

Conclusions

- ✓ For coarse analyses, spectral fire severity indices derived from Sentinel 2A are good proxies of biomass comsuption. However, ***there is a high variability in trees morphologies*** within their classes that is not captured by satellites.

- ✓ ***Absolute LiDAR metrics*** indicated that tree size, among other tree properites, were important for estimating the impact of fire, features that were not captured by the satellite.

- ✓ ***Relative Severity metrics*** derived from LiDAR (changes in height and crown) correlated rather well with severity indices derived from Sentinel providing finer spatial resolution with the precision level needed for ecological impact studies.

- ✓ **Lidar provided detailed and robust metrics of biomass loss** allowing more precise quantification of fire-carbon balance and ecosystem impacts.

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Thank you for your attention!

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