3D biodiversity and ecosystem function: Using lidar (and hyperspectral) remote sensing to understand ecosystem patterns and processes in a temperate forest

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Ecological Remote Sensing & Modeling Lab

bristleweed.bsky.social

BIOSPACE25

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photo: Aaron Kamoske

Where is the University of Michigan Biological Station (UMBS)?


J Adler


neonscience.org

Why study at the University of Michigan Biological Station?

Specifically, though…

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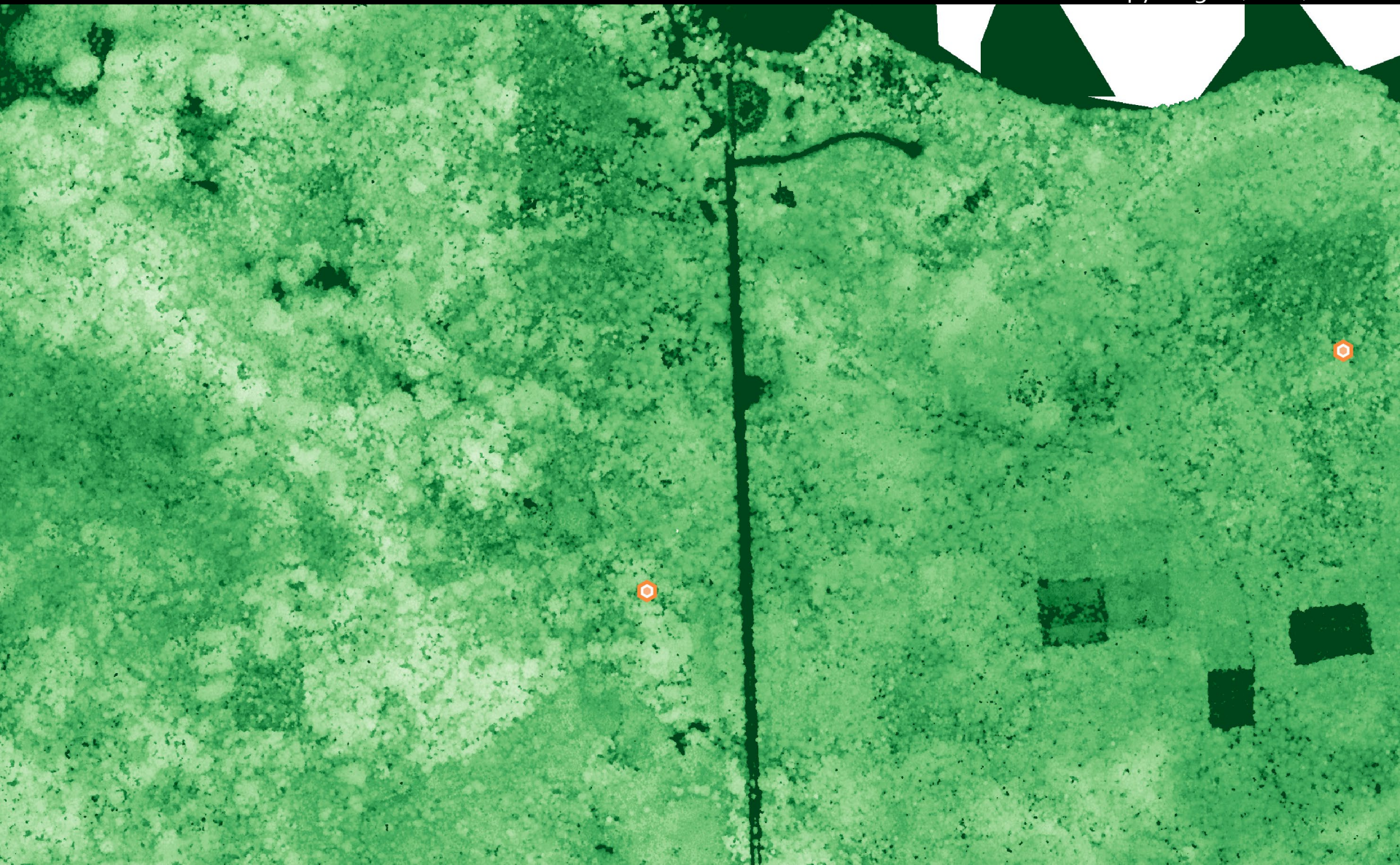
- New FoRTE project in 2019 girdled both small and large trees at varying intensities in 16 40-m radius plots while monitoring lots of physiological impacts (see Atkins et al 2021, and more!).

Preliminary Questions:

- What do disturbed forest stands look like from above?
- How disturbed does a forest stand need to be before it can be detected with remote sensing (relative to background variation)?
- Can we detect really old (85 yrs) disturbances?

Let's look!



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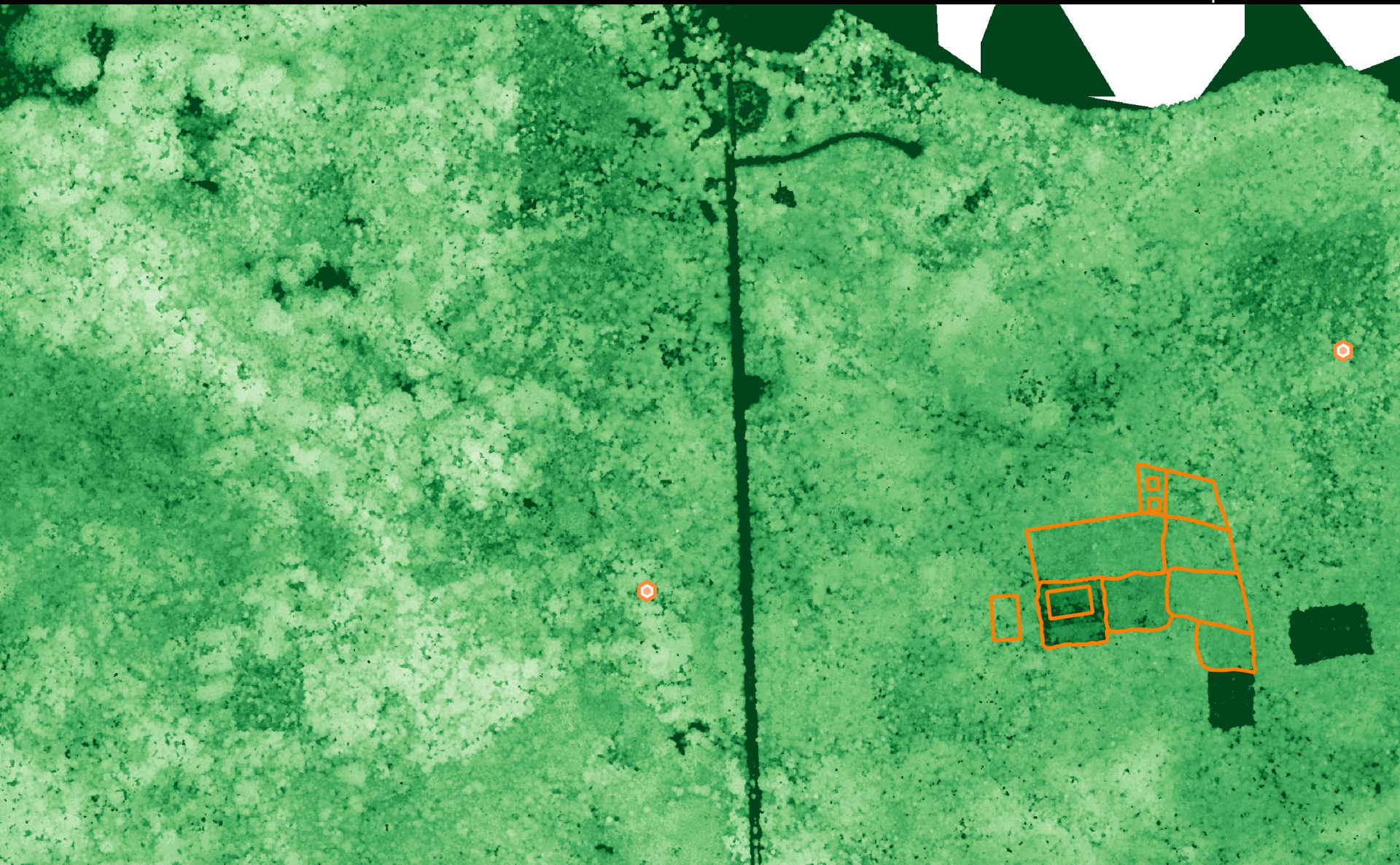
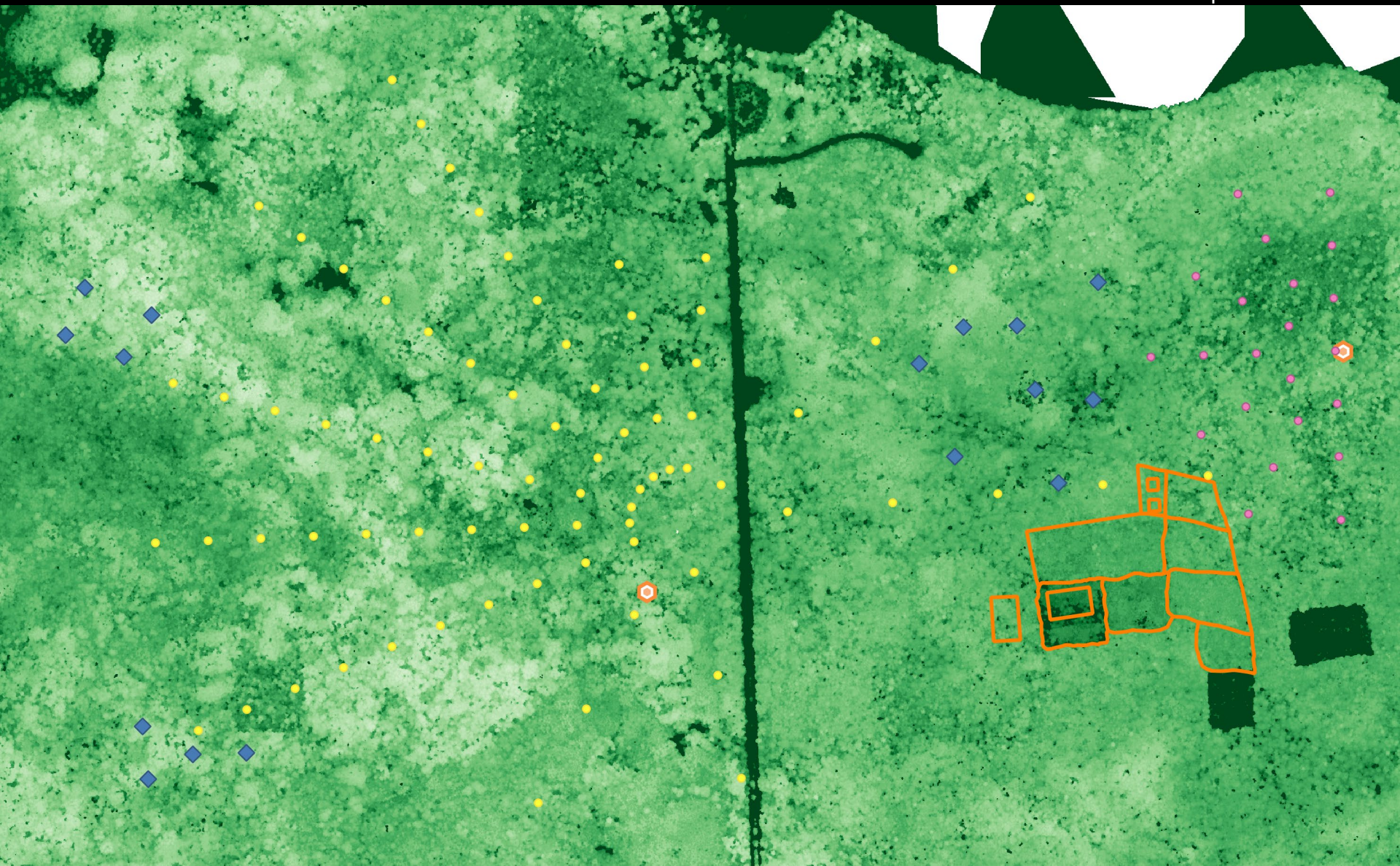


Let's look!



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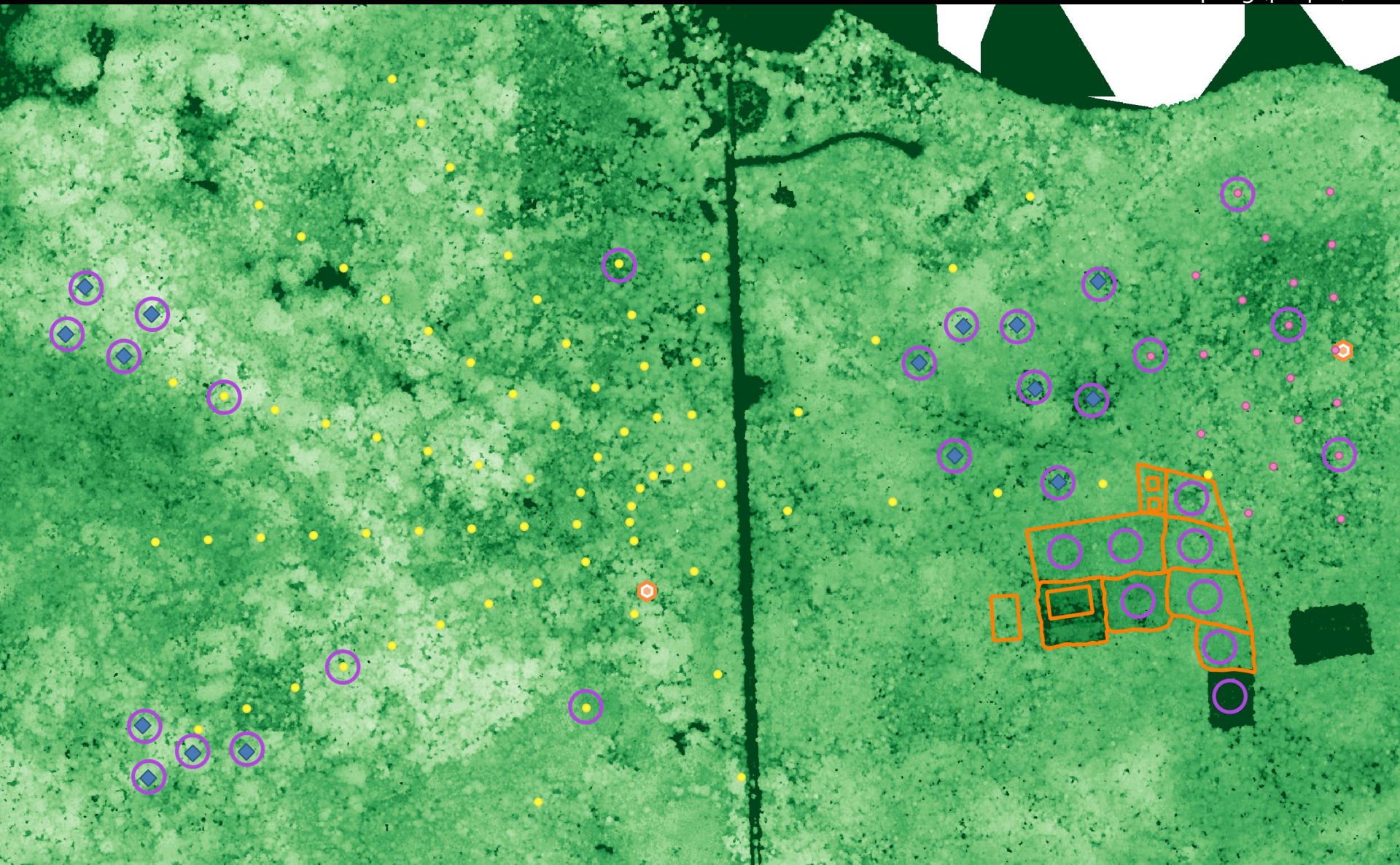
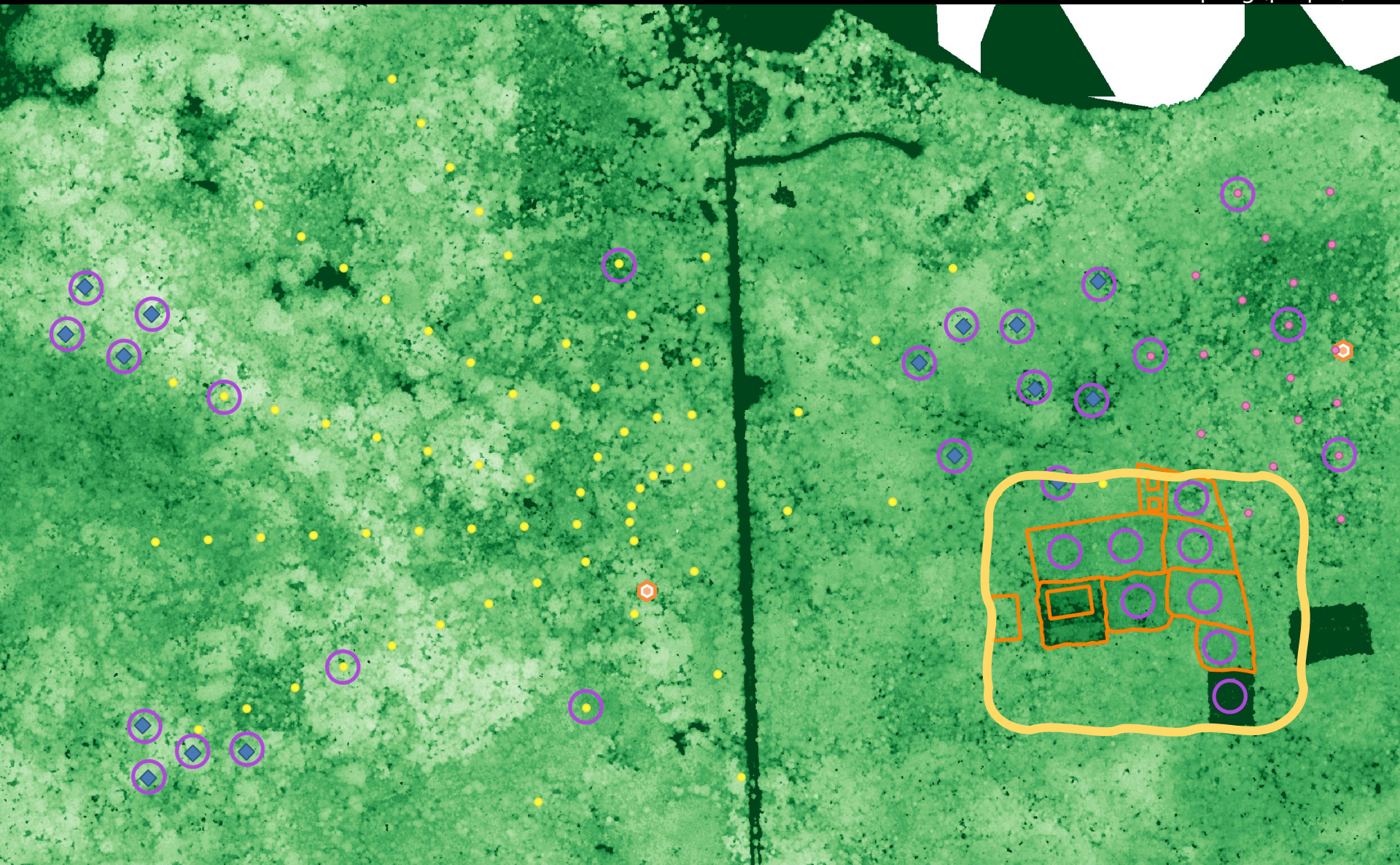
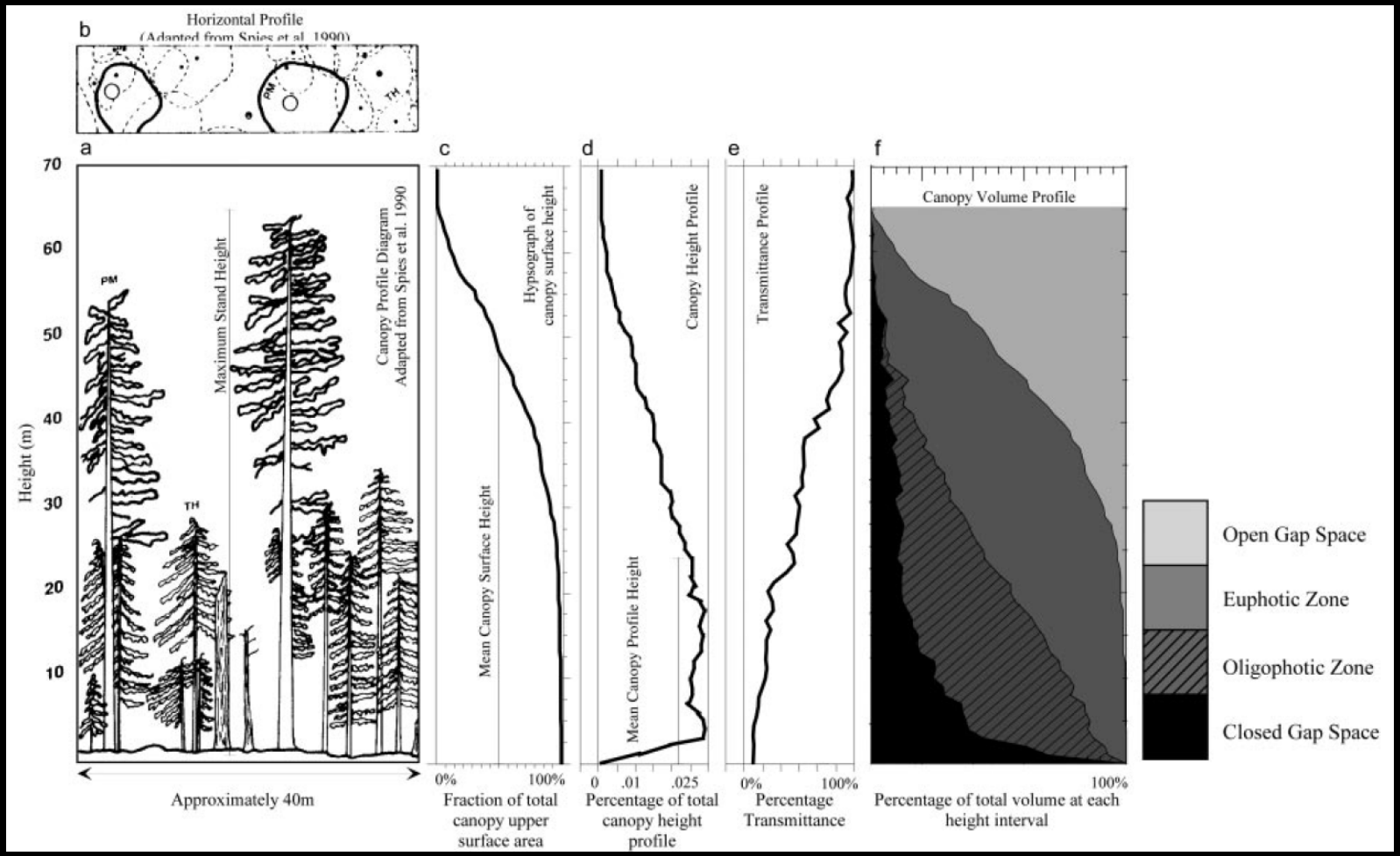


Let's look!



How do we quantify & simplify a lidar point cloud?

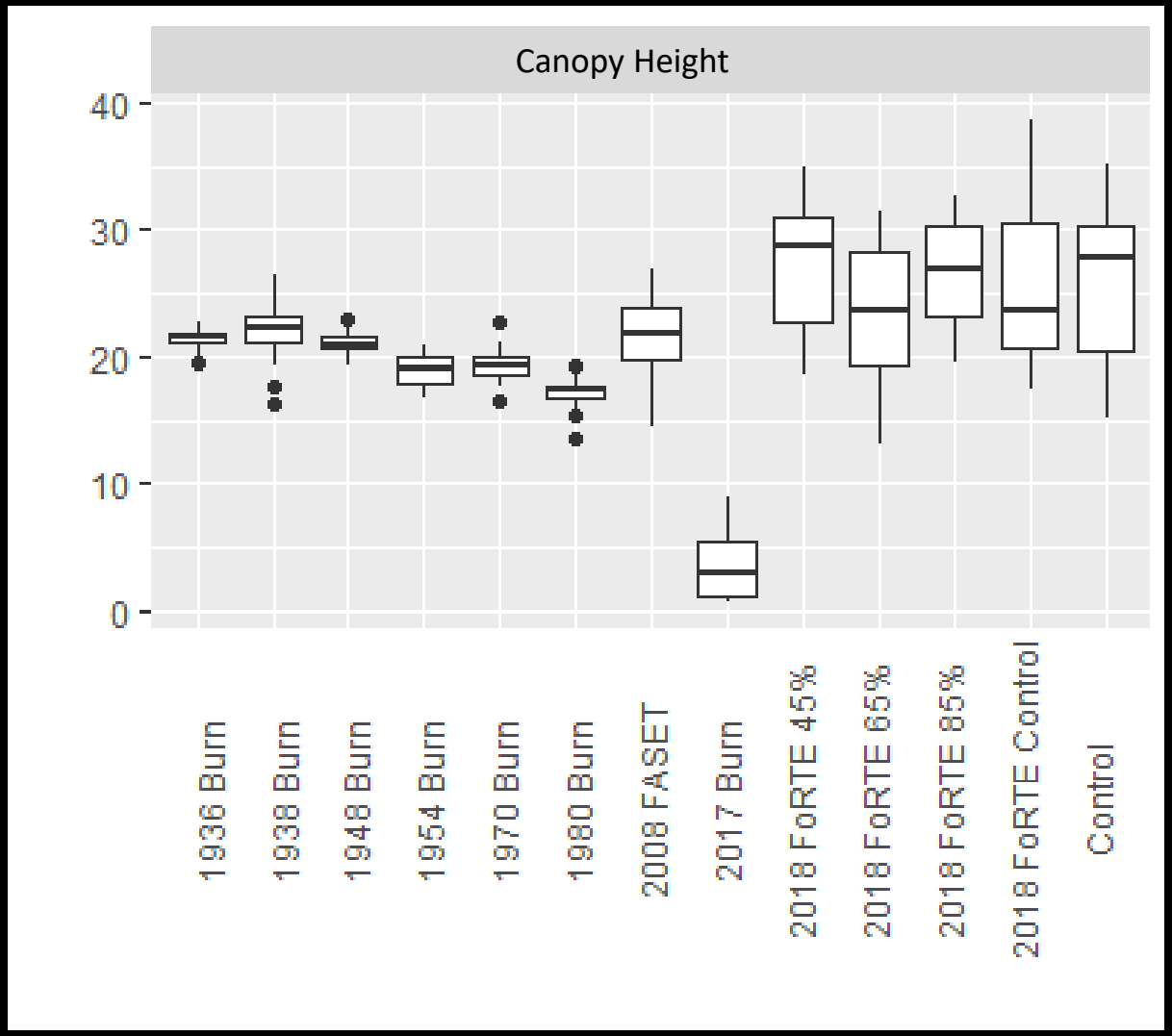
Lidar: It's not just vegetation height and topography



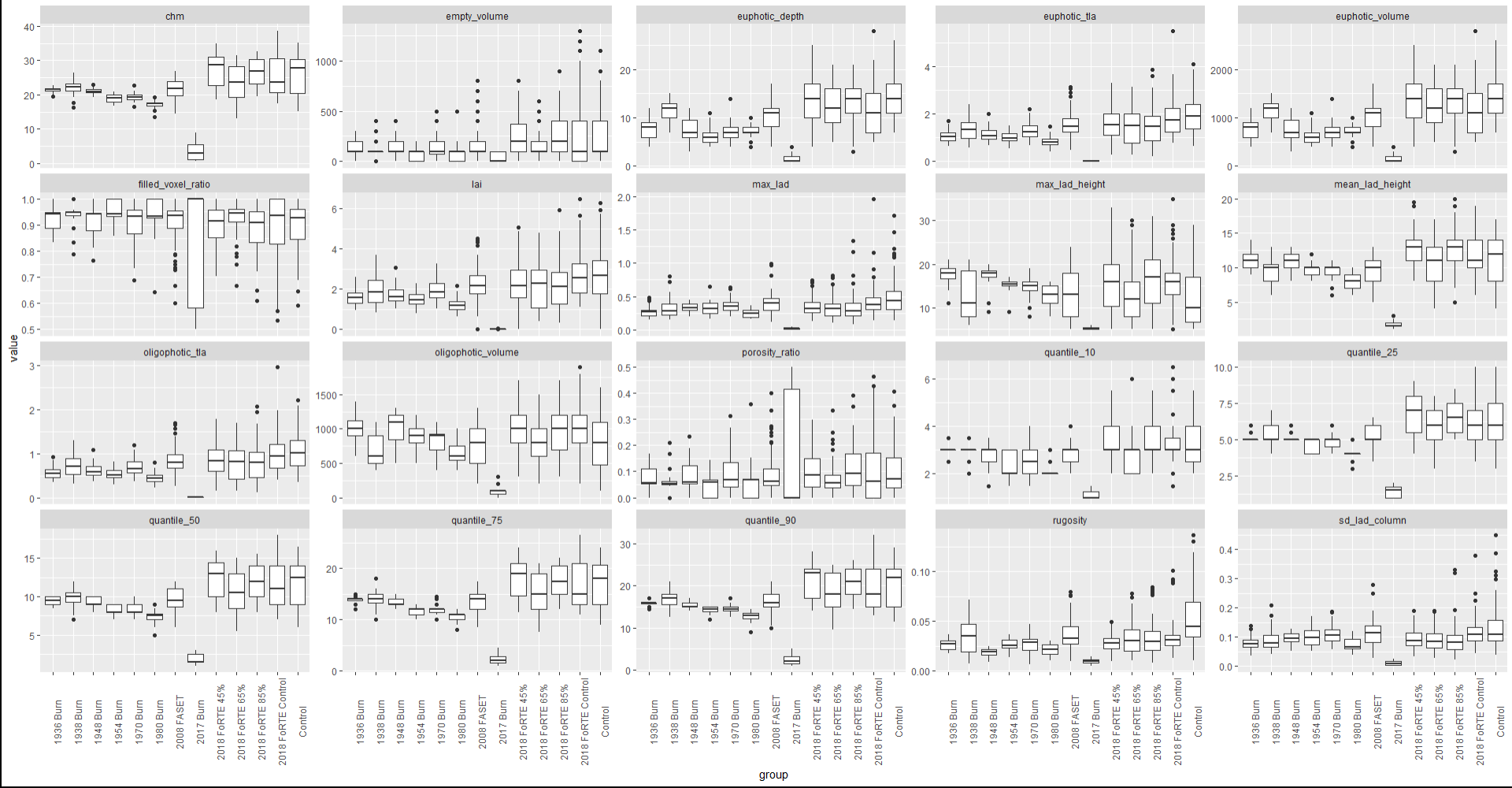
Lefsky et al. 2002

How do we analyze plot-scale data (with only 1 plot per treatment in most cases)?

Boxplots!


Canopy Height
40
30
20
10
0
1936 Burn
1938 Burn
1948 Burn
1954 Burn
1970 Burn
1980 Burn
2008 FASET
2017 Burn
2018 FoRTE 45%
2018 FoRTE 65%
2018 FoRTE 85%
2018 FoRTE Control
Control

Boxplots!


chm
empty_volume
euphotic_depth
euphotic_tla
euphotic_volume
filled_voxel_ratio
lai
max_lad
max_lad_height
mean_lad_height
oligophotic_tla
oligophotic_volume
porosity_ratio
quantile_10
quantile_25
quantile_50
quantile_75
quantile_90
rugosity
sd_lad_column
value
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Control
group

Modeling Time Since Disturbance with the burn plots

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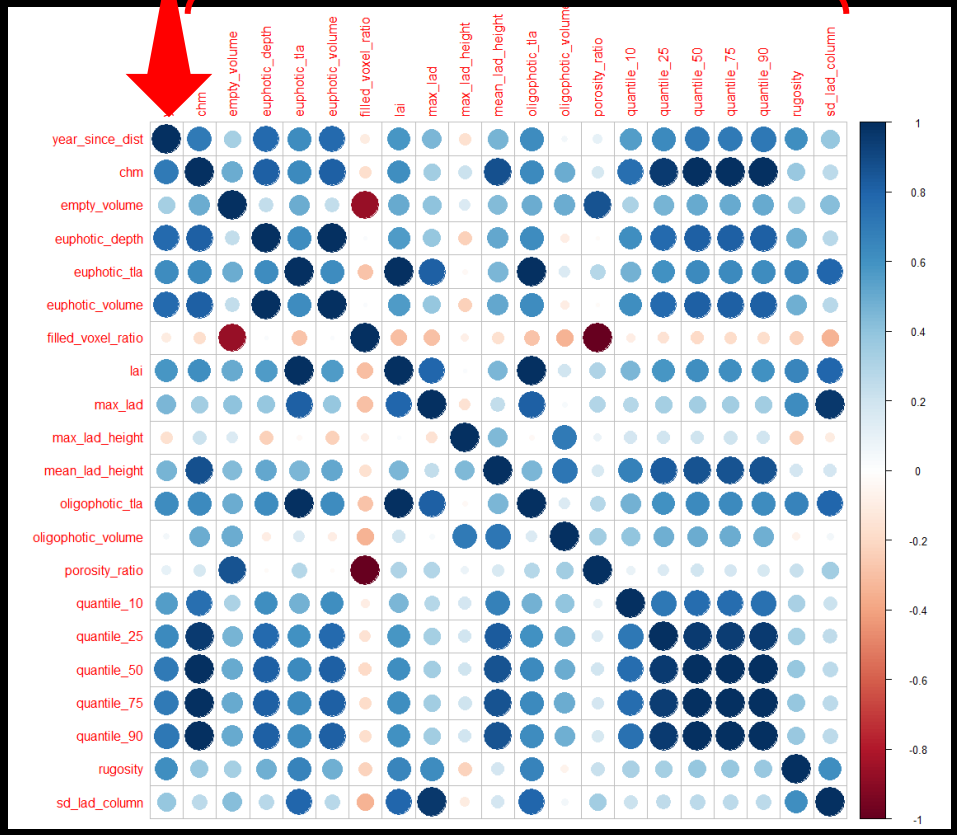
Years Since Disturbance

lidar metrics



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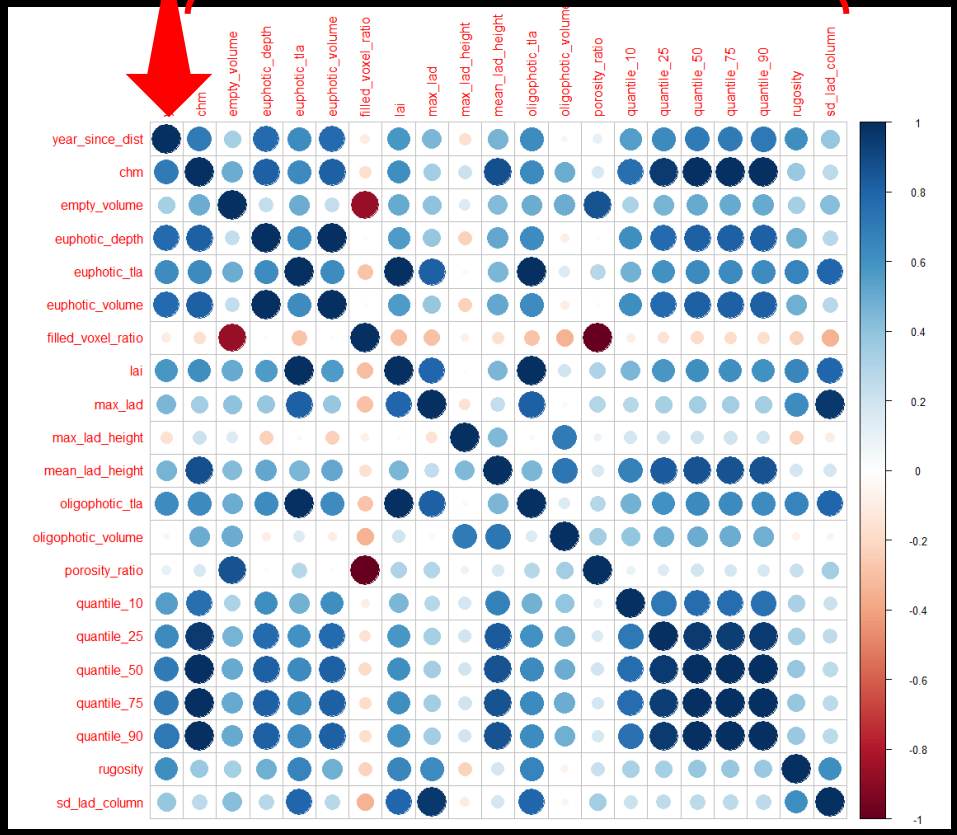
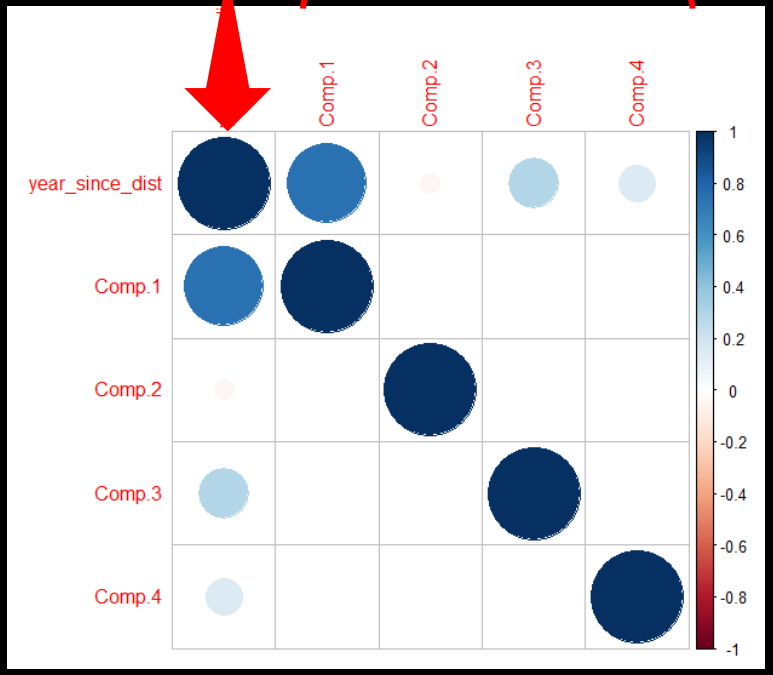


Years Since Disturbance

lidar principal components



Modeling Time Since Disturbance with the burn plots

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  - **Adjusted $R^2 = 0.87$ ($p < 0.001$)**
  - Pretty good given this is ONLY using the lidar data!
  - Caveats caveats caveats

In Conclusion…

- Vegetation structure is VERY important for understanding forest function & diversity.
- Disturbance & other field experiments **should be** designed to be used for RS model training and prediction.
- More collaboration between field ecologists & RS experts is needed at the project planning phase.
- **If you are interested in field data and uncertainty, come to the Integration Workshop on Thursday!**

Thanks to the US NSF for supporting this work!

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