



Challenges of a landscape level individual tree inventory from UAS lidar

Bogdan Strimbu



Overview

- Forest inventory
- UAS
- Issues
 - Device
 - Reality
 - Data processing
- Solutions



Background

- Forestry world -> Decision
- Economic and social context -> Speed
- Forest inventory context (2000 and beyond)
 - Material sciences -> sensors
 - Informatics -> algorithms
 - Hardware -> computing power
- Workforce
- Solutions: remote sensing
 - Large areas: fixed wing
 - Small areas: rotary wings





Forest Inventory

- Describe the forest a particular moment in time
 - Ground inventory (golden standard?)
 - Remote sensing inventory (the future is now?)
- Laser scanner (3D) and multispectral imagery
- Point density:
 - Area inventory: <20 ppsm
 - Tree level inventory: >100 ppsm
 - From 20-100 ppsm ?



UAS lidar

- Rotary wing: payload constrain
- Relatively Affordable: ~ \$30,000
- Suitable for small areas (1 - 200 ac)
- Most popular:
 - DJI Matrice 300 RTK
 - Zenmuse Lx
- Flight
 - “Solid” time
 - “Adventurer” proof





Forest wide inventory with UAS

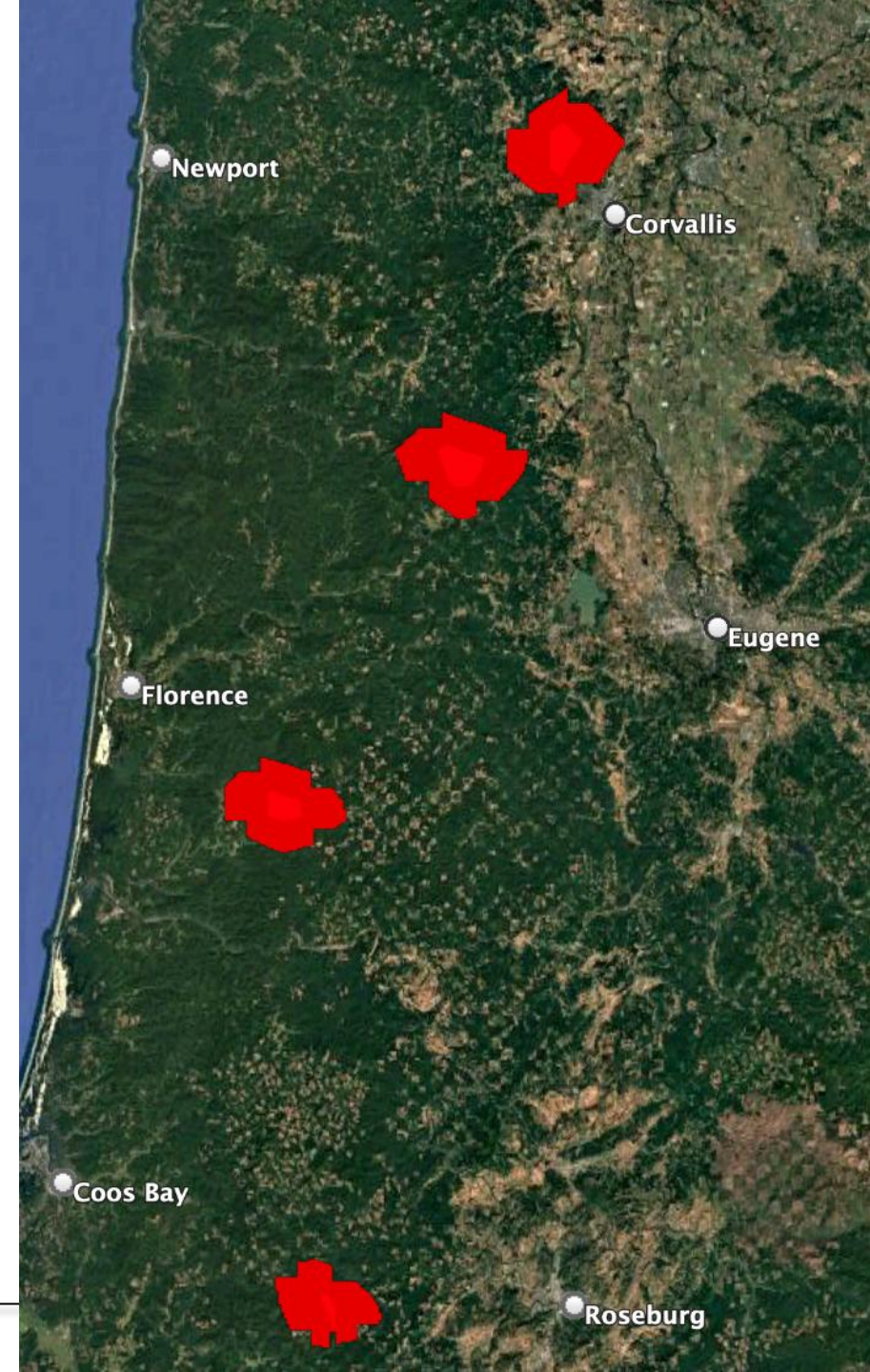
- One flight: aprox. 50 ac
 - Includes time to scanned area
- Forest: >5000 ac
 - Many, many, many flights
- High point cloud density: >250 ppsm
 - Colored point clouds
- Individual tree level inventory





Study Areas

- Coast Range
- 20,000 ac
- 100 – 2500 ft
- Slopes: 10 – 100%
- Main species:
 - Douglas Fir
 - Big leaf maple / Alder
- Forest type
 - “Old growth”
 - Plantations





Issues

- Strength become weakness
 - Scan inexpensive: equipment and personnel
- 1. Reality issues
 - Access
- 2. Equipment issues
 - Connectivity
 - Scanning range
- 3. Software issues
 - Flight planning
 - Point clouds processing



1. Reality issues

- Access to site
 - Too far from the area to be scanned (tree interference)
 - 2 miles at the most
 - Lost connectivity between the UAS and RC
- Obstructions / Multipath
 - Road in a valley
 - GPS RTK lacks accuracy





Equipment issues

- Connectivity
 - Lack of accuracy: 2nd GPS
 - Obstacles RC - UAS
 - Change RC location
- Scanning range
 - ~150 m
 - Too short for deep valleys
 - No terrain follow



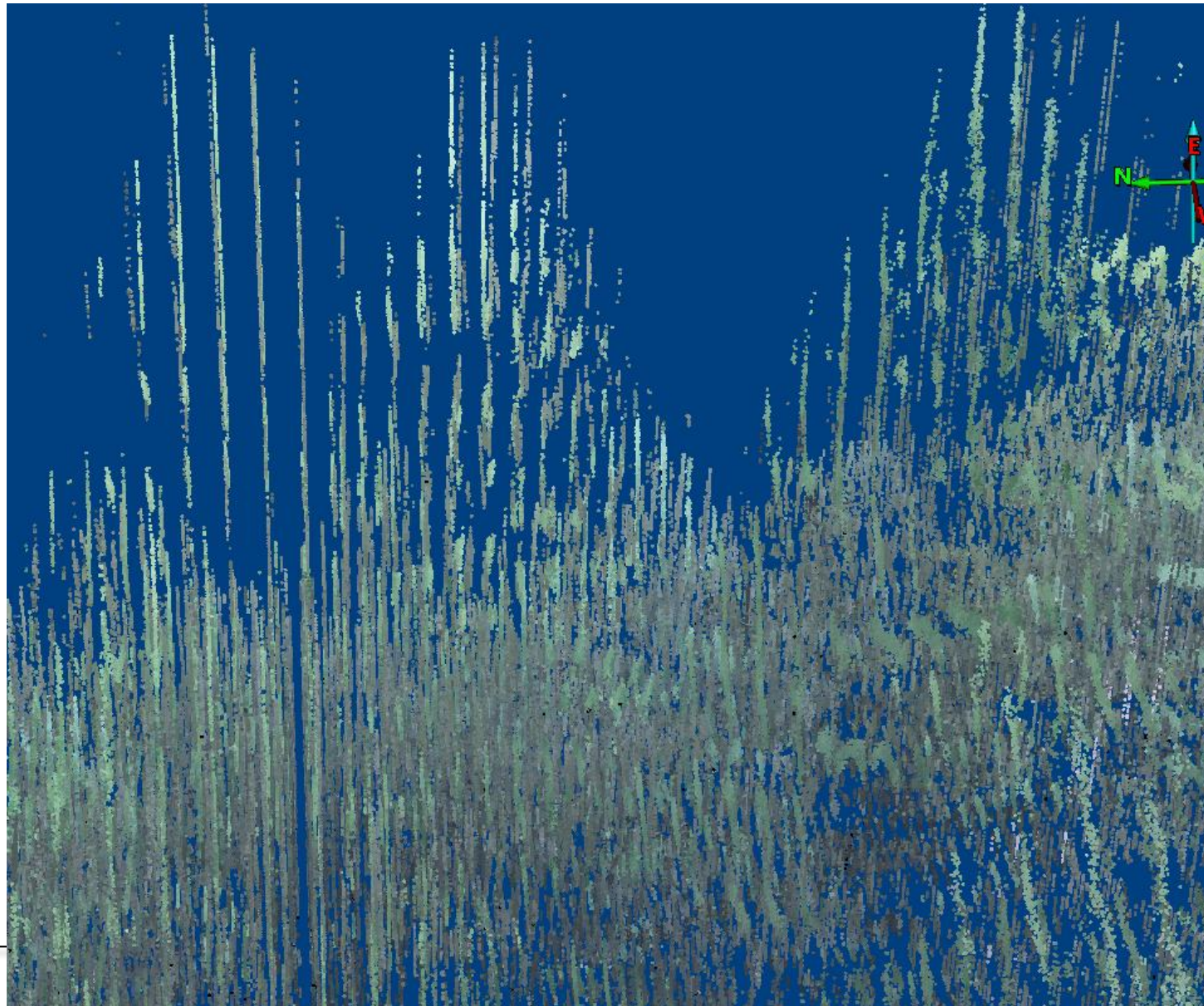


Software issues

1. Unrealistic returns
2. Flight plan
3. Few ground points
4. RTK does not operate as expected
5. Lack of automatic co-registration
6. **Objective: trees or ground?**



Unrealistic returns: Linear scans



Not an issue
An annoyance

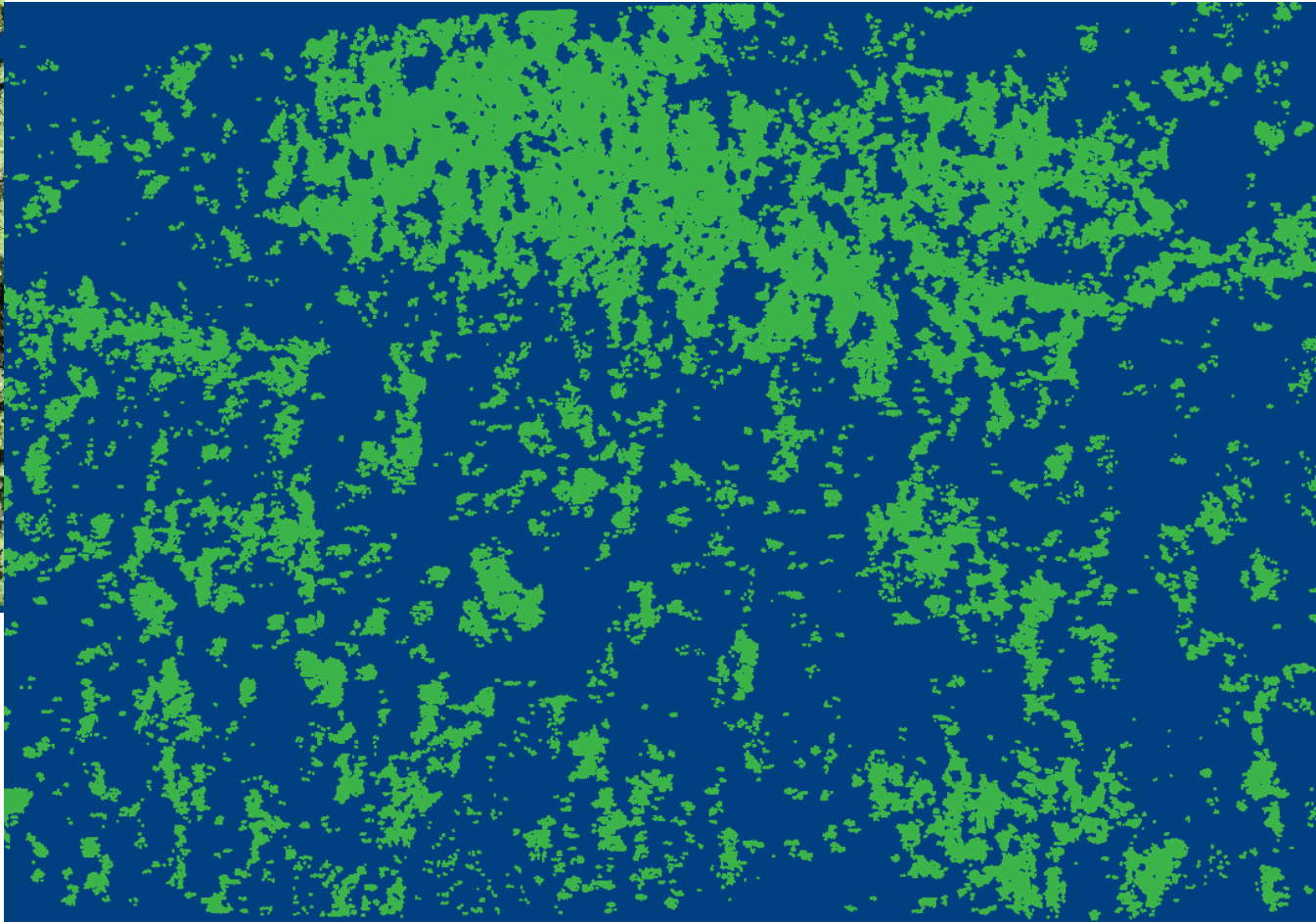
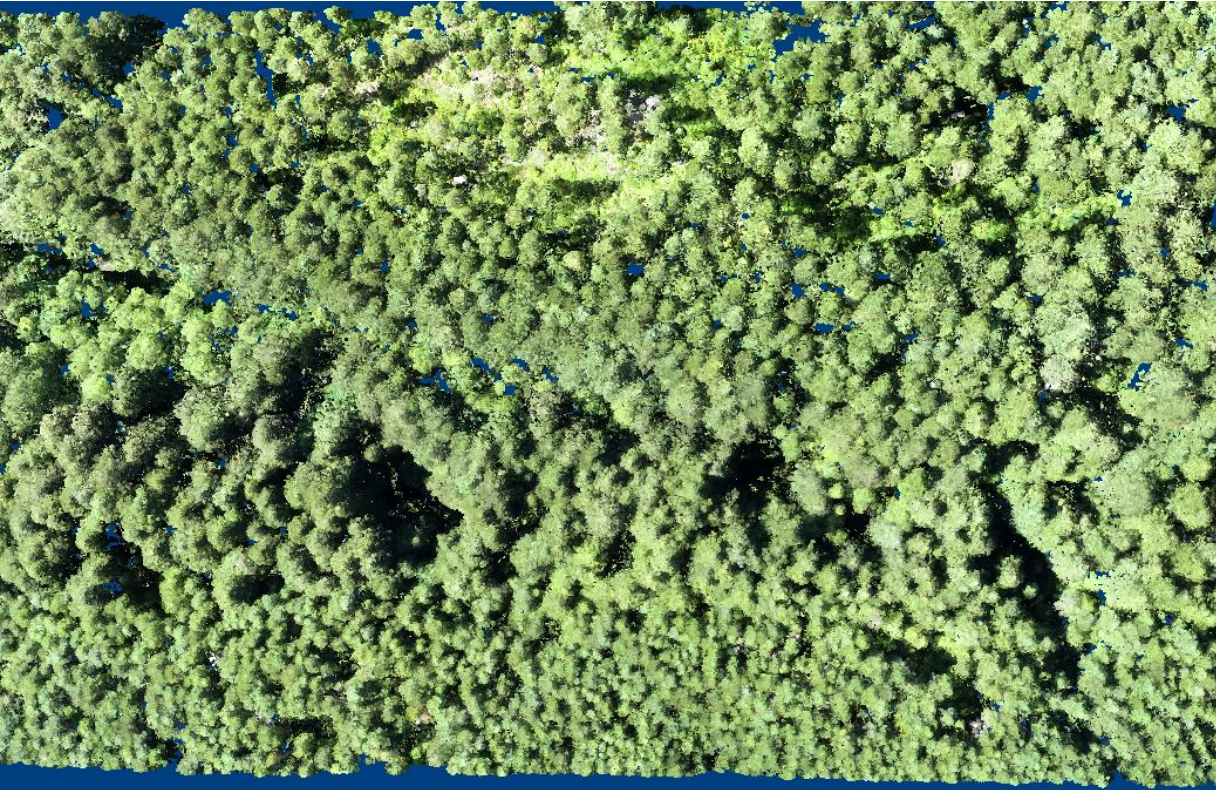


Flight plan issues

- Field issue
- Plan not loading
 - Elevations issues
- Solution:
 - Change the direction of flight
 - Remove “Following terrain”
 - Fewer to no returns form valley bottoms



Ground returns fewer than expected



- Solution
 - Re-fly
 - Photogrammetry



Lack of accurate georeferencing without GCP

- Affine transformation
 - Simple
 - Very often
- Rotations
 - Complex
 - Not very rare





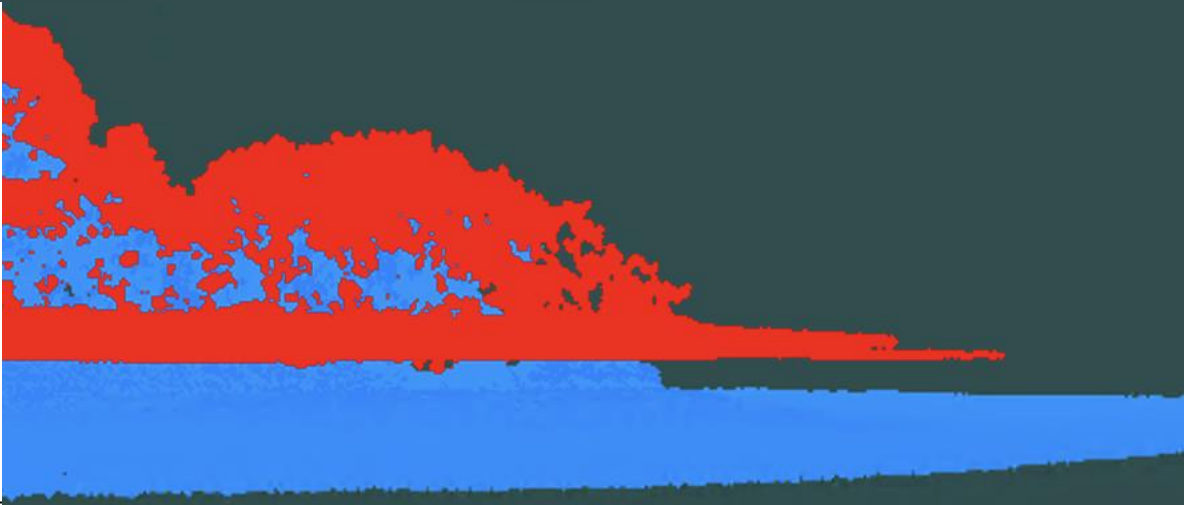
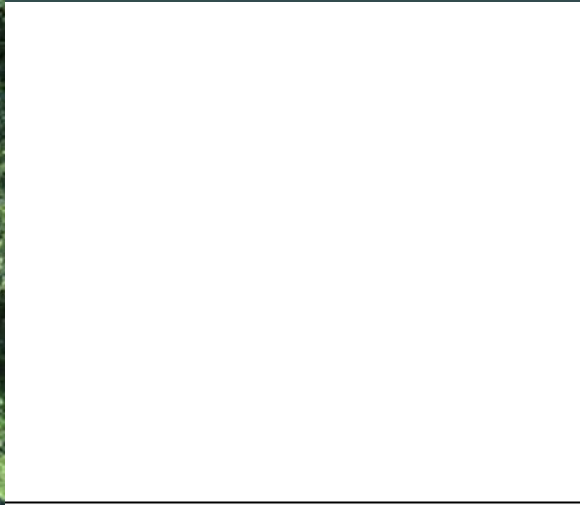
Lack of automatic co-registration

- DJI Software: Terra
- Professional software:
 - Terra Scan
 - LP360
- Solution:
 - Coarse: QTM
 - Fine: Connect



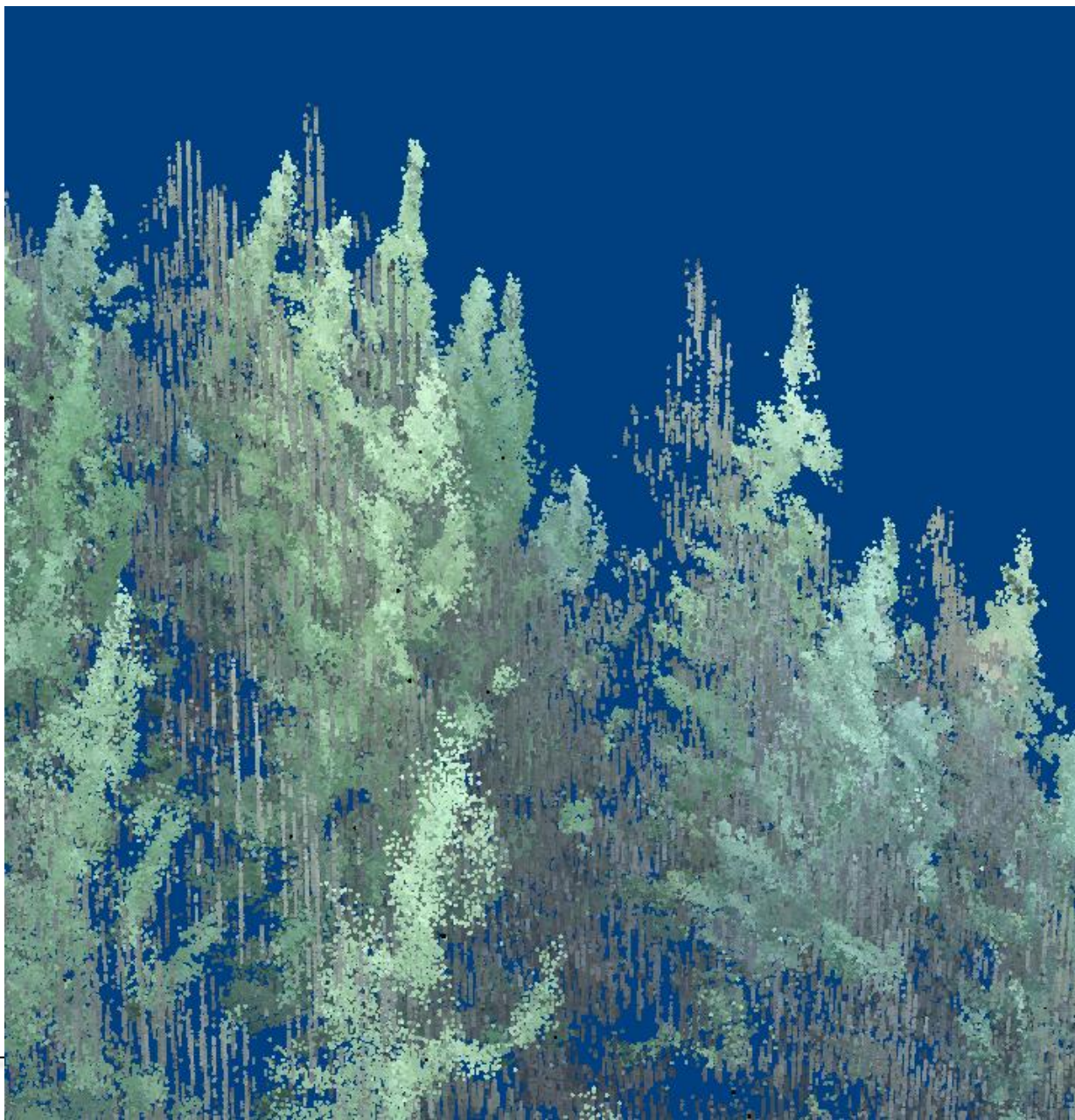


Lack of co-registration: Flat lands



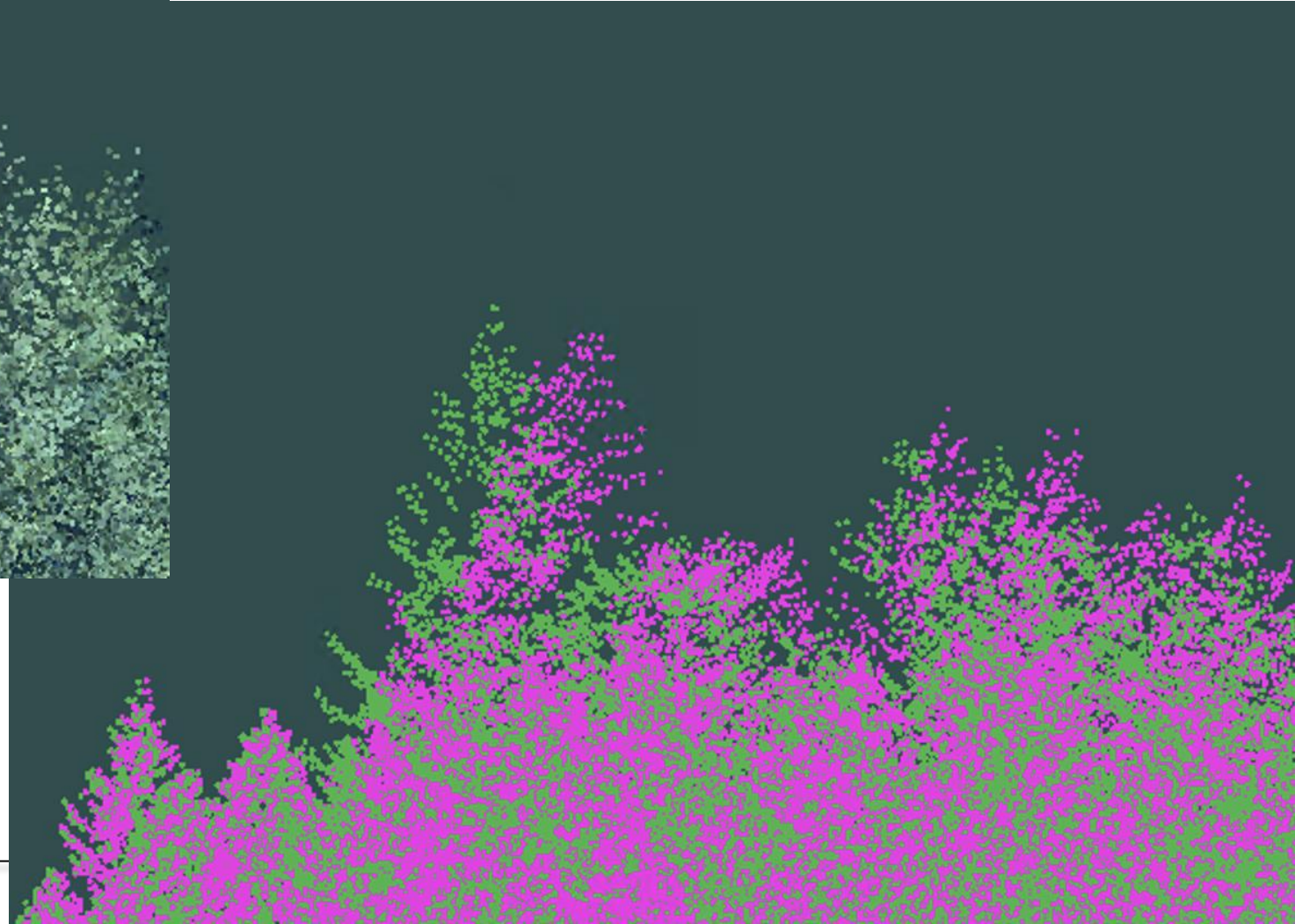


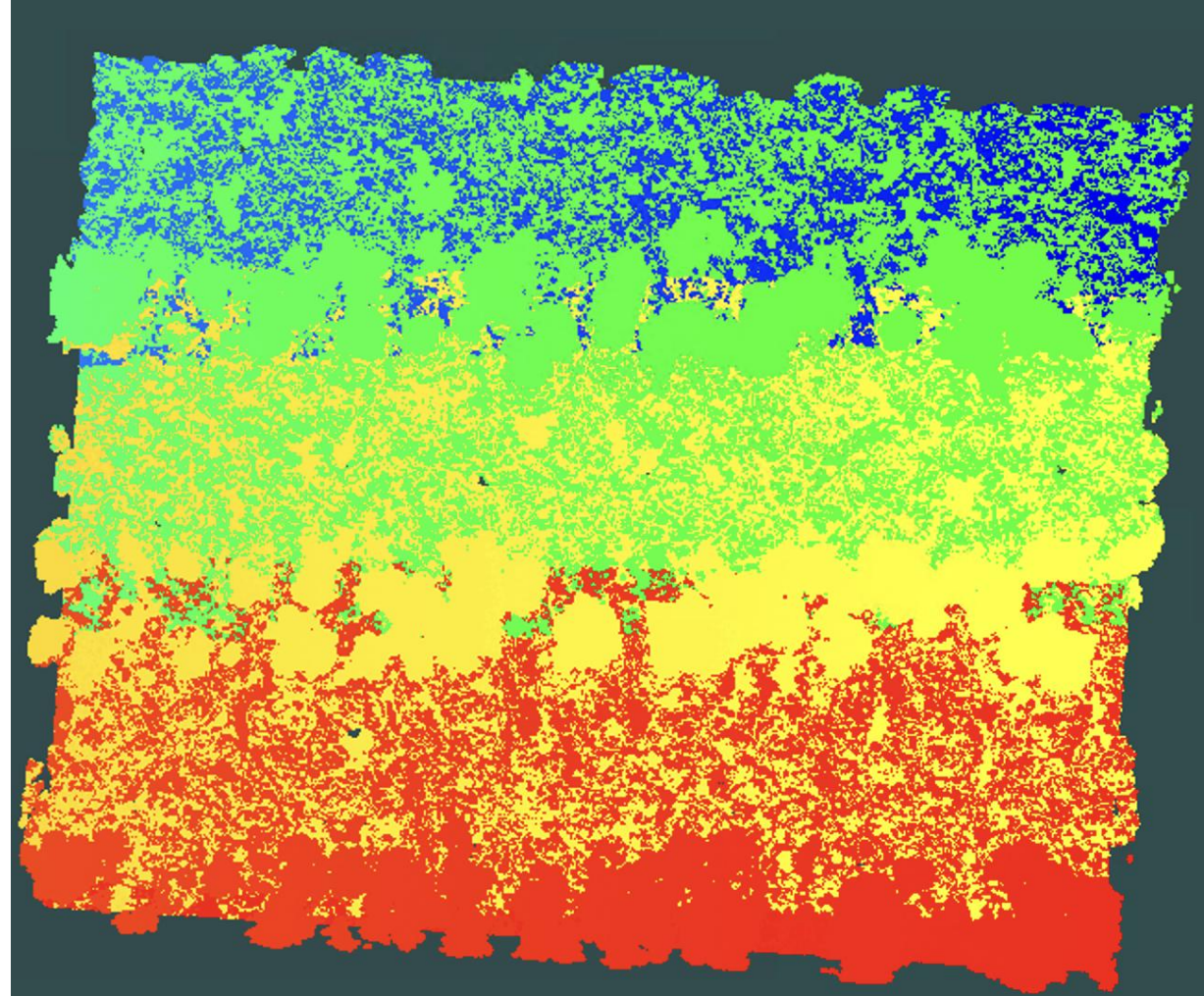
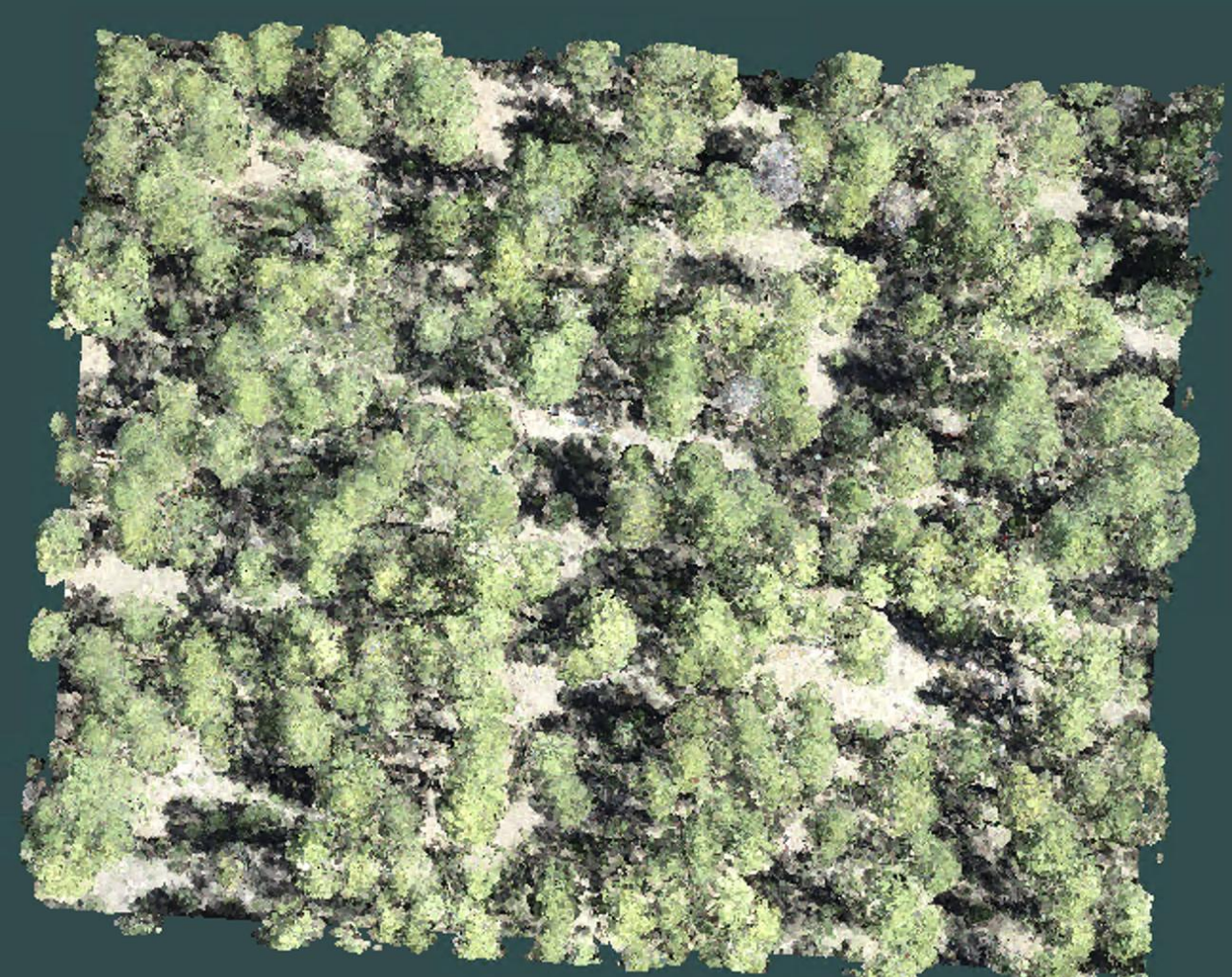
Objective: Trees Top or Ground



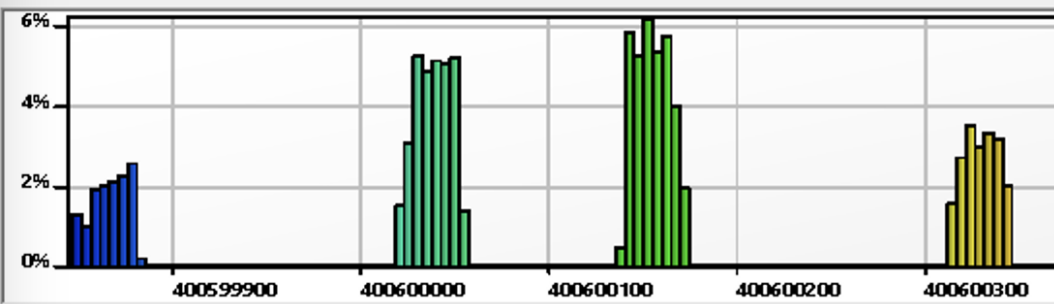


Aerial ALS (fixed wing)

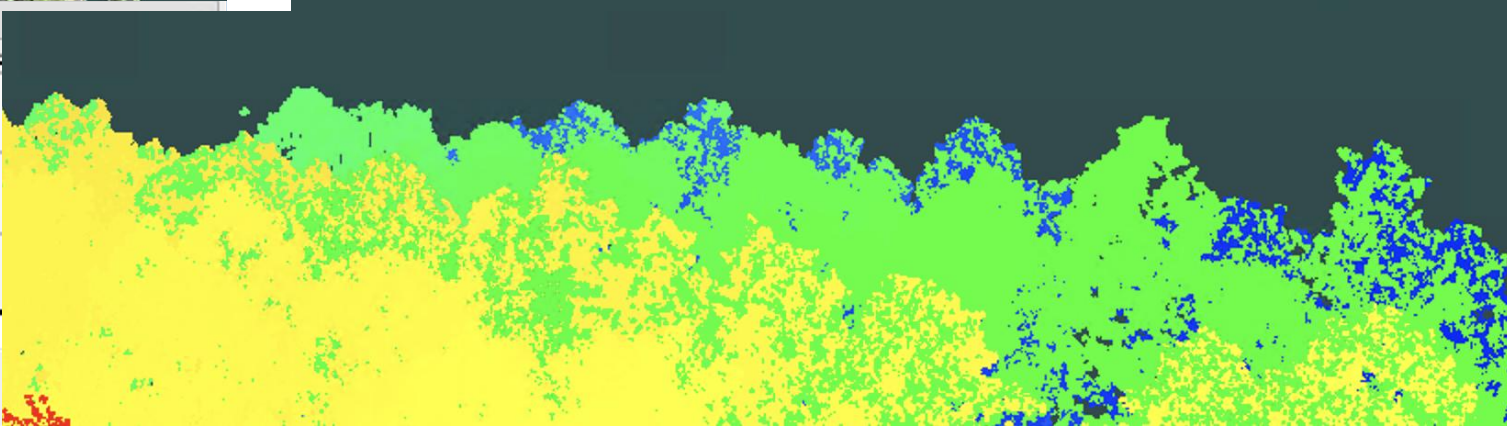




QTA: Time



Min 400,599,846.5895326 s Max 400,600,473.4639647 s Mean 400,600,114.9192932 s StdDev





Summary

- Small areas scanned: multiple co-registrations
 - Solution: longer flights
 - No GCP on multiple flights (most actually)
- Reduced penetrability
 - Solution: better devices -> L2 vs L1
- Loos connectivity
 - Solution: Fix reality?
- Unfeasible economically (inventory alone)
- Excellent for dedicated survey (thin, regeneration cuts)

