Estimating solar insolation in riparian areas using high density point clouds

Michael Bartczyszyn, Demetrios Gatziolis, Cameron Naficy, Bogdan Strimbu

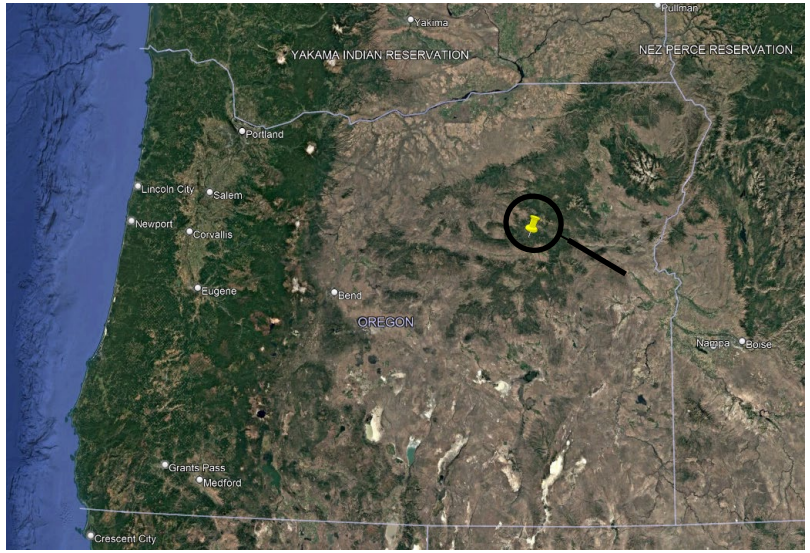
OSU, College of Forestry and USDA Forest Service

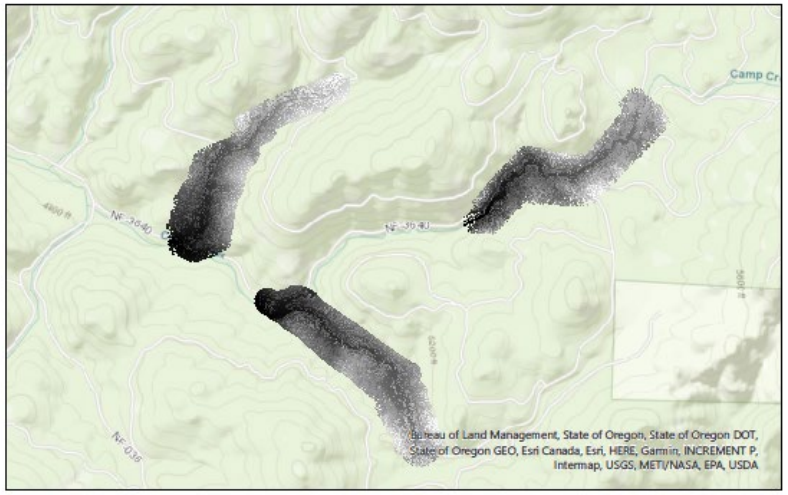
Introduction

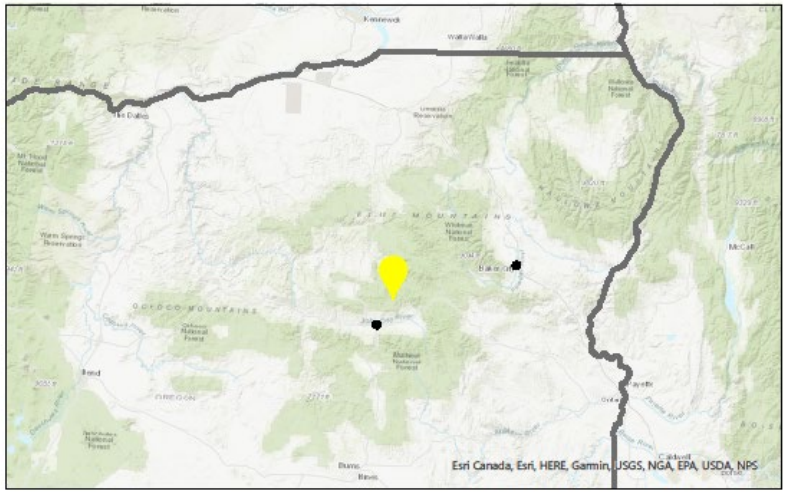
- Riparian systems cover a small land area but support huge levels of biodiversity (Naiman et al., 1993; Gregory et al., 1991)
  - Up to one-third of plant species, 60% of vertebrates, and 70–80% of wildlife depend on them
- Increased light from canopy loss raises stream-water temperature, negatively impacting cold-water species(Anderson et al., 2007)
- Both the Oregon Forest Practices Act and Clean Water Act require the retention of riparian vegetation to preserve shade (ODF, 2023; ODEQ, 2019)
  - reduce solar heat input and maintain stream temperatures critical for aquatic species

Data

- Area of interest







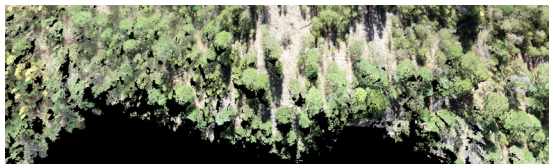
Data

- Data collection:
- November 2024
- DJI Matrice 300 RTK
- DJI Zenmuse L1
  - 70% forward overlap
  - 50% side overlap

Data

- Buffer each stand by 50m

  - Reduce fringe effect



Methods

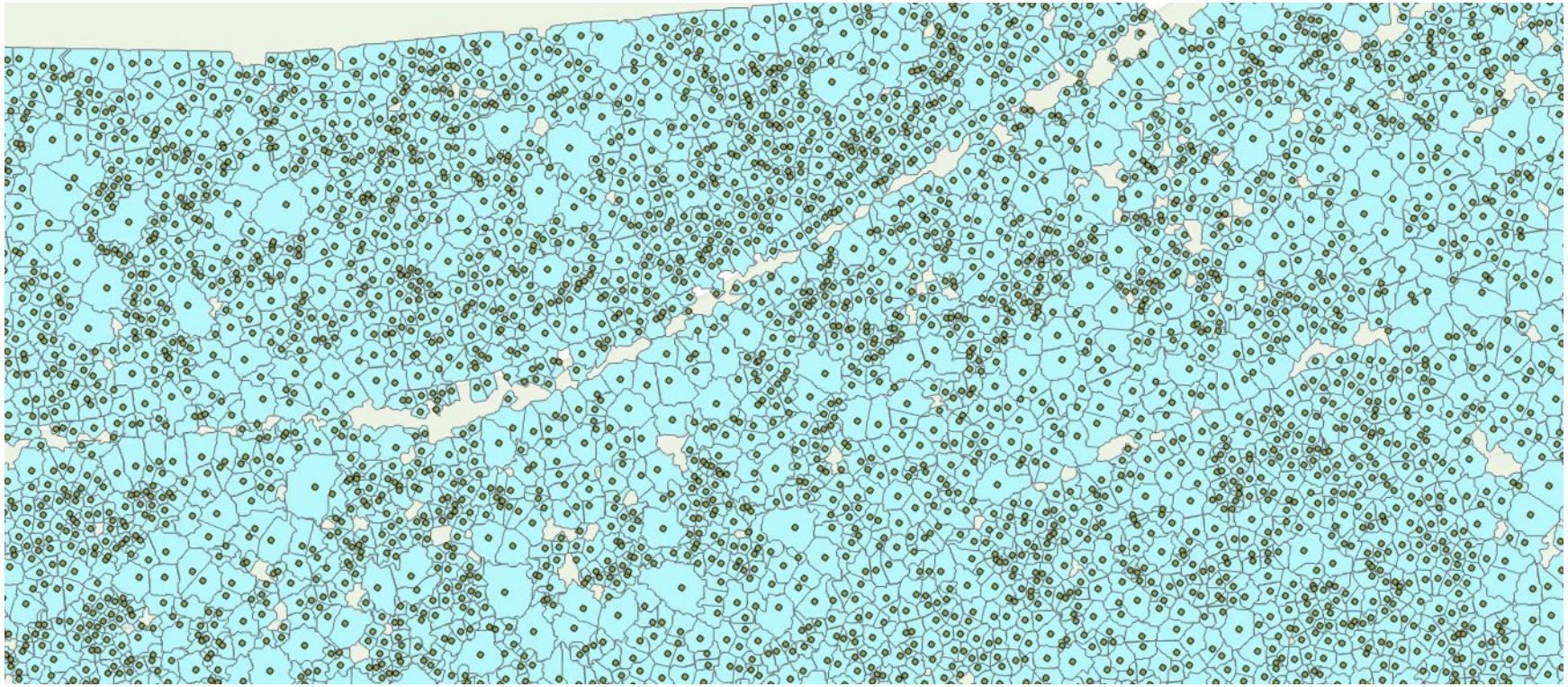
1. Normalize the densities of the points
2. Identify tree crown
3. Thin
4. Compute ground illumination

Methods: Normalize densities

- Random:
  - 15 ppsm
    - Non-ground points
- Voxel:
  - Separate plot into voxels
  - Original Size: .4m per side
  - Keep one point in each voxel
    - Non-ground points
  - Runs 10 times
  - Increase the side size of the voxel by .13 each iteration (.400, .413, .426, … .520)
- 10 iterations of Rnd and Vox

Methods: ITC segmentation

- Tree and crown identification: based on DSM
- Modified series of algorithms for optimal refined smoothing
  - Accuracy proven to be >95% for dominant and codominant trees
    - *Hengl 2012*
    - *Pouliot et al. 2005*
    - *Fasola et al. 2018*

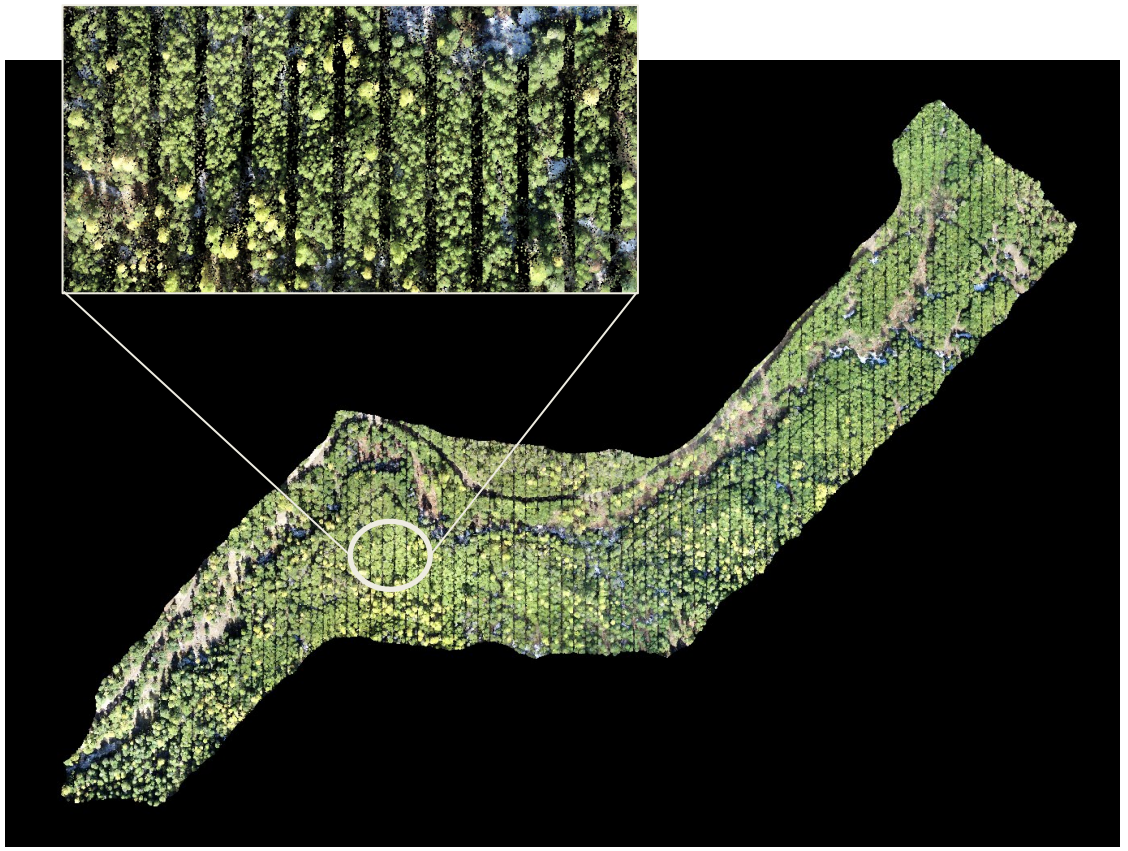


Methods: Thinning

- Mechanical & Thinning from Below
  - Thin from below
    - 30% thin by basal area
  - Mechanical
    - NS & EW

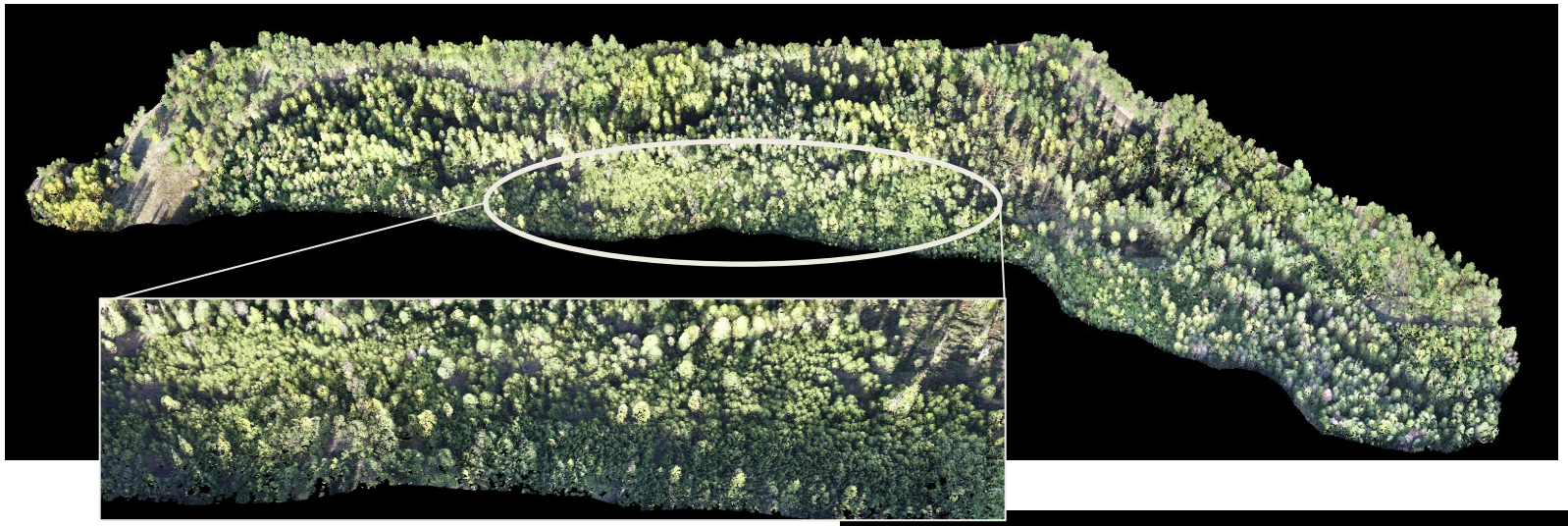
Methods

Stand 1 Unthinned

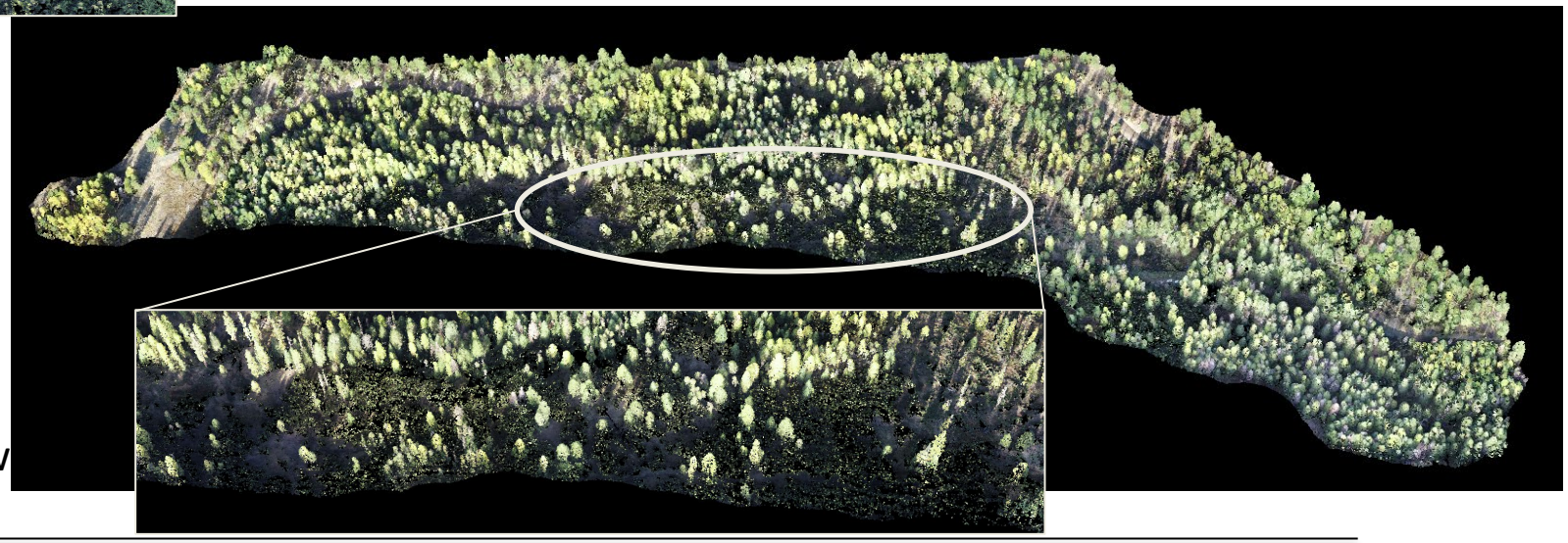


Stand 1 Thinned NS

Methods

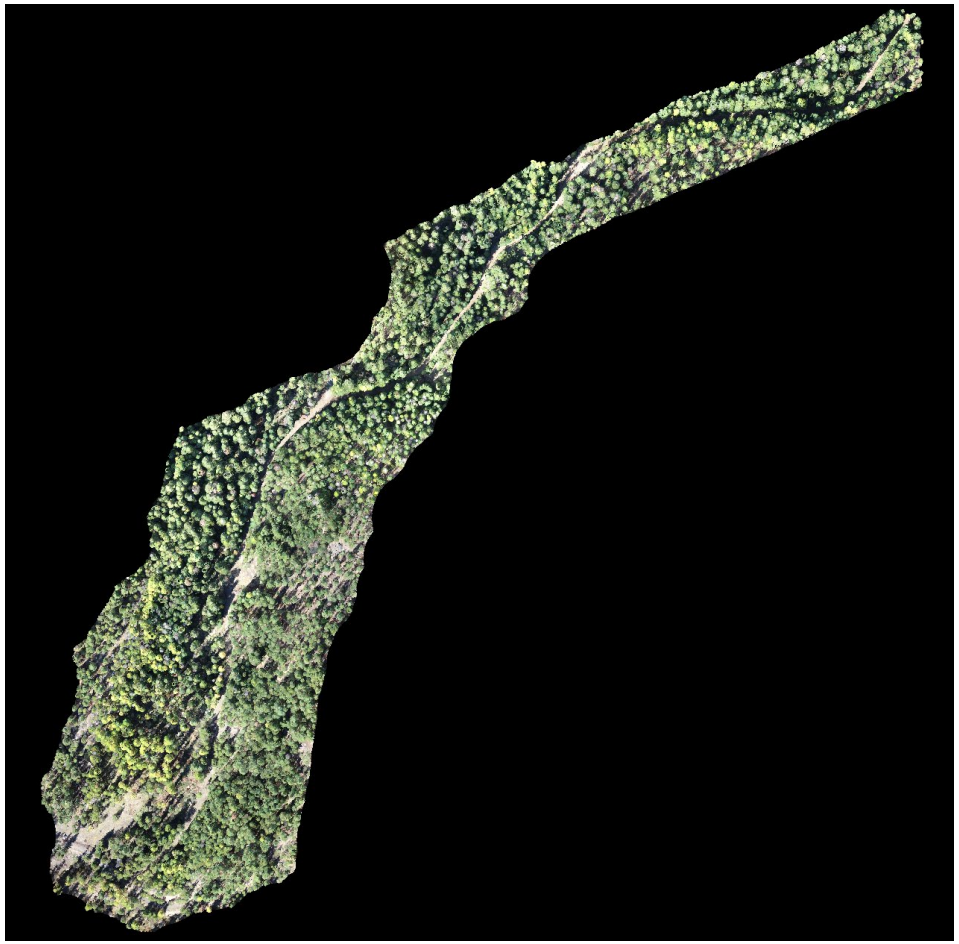


Stand 2 Unthinned

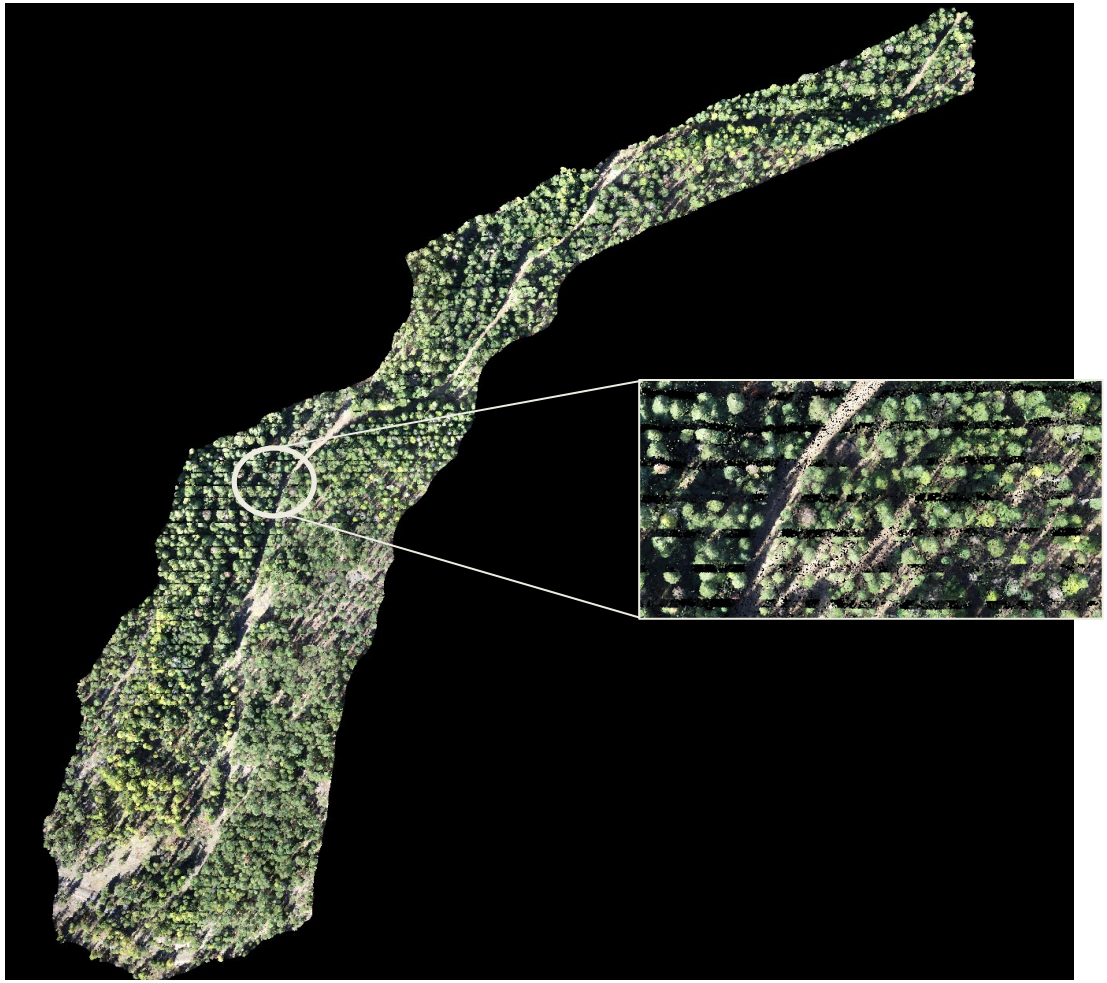


Stand 2 Thinned from below

Methods



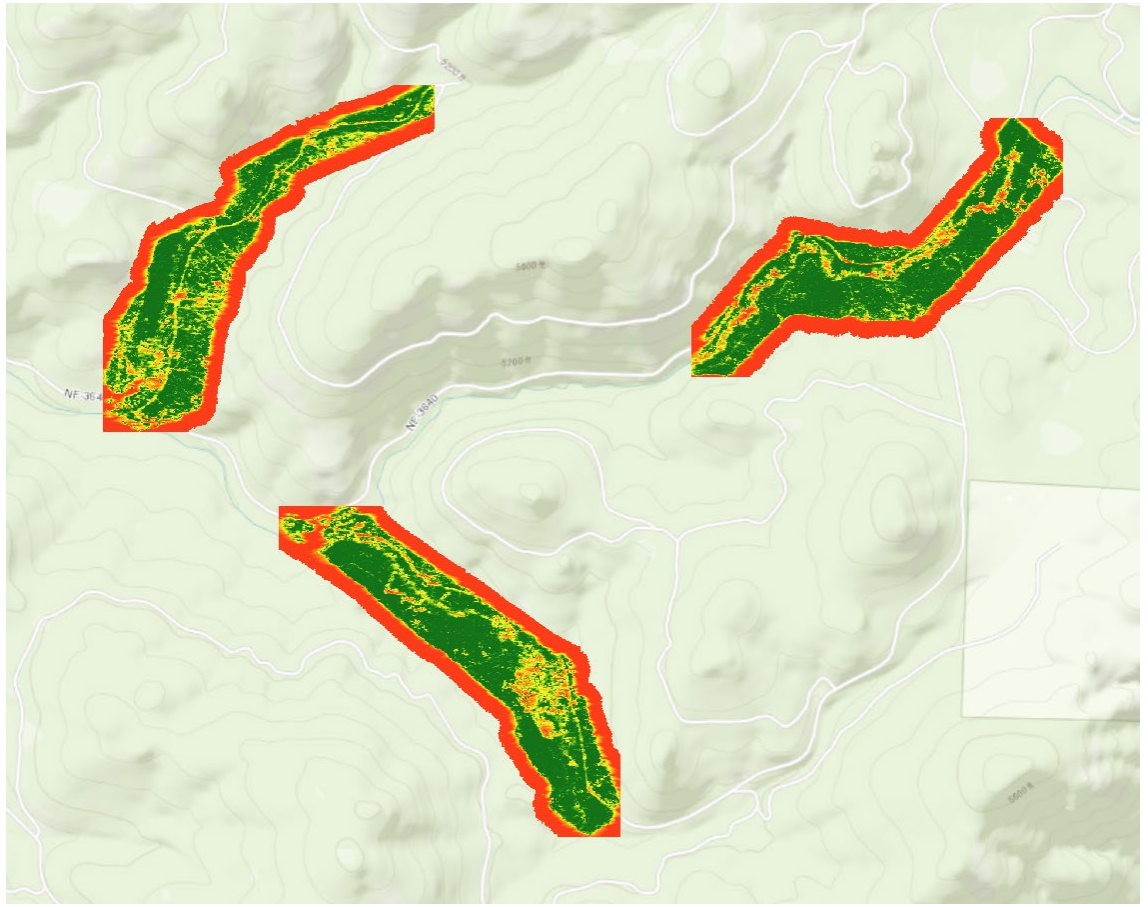
Stand 3 Unthinned



Stand 3 Thinned EW

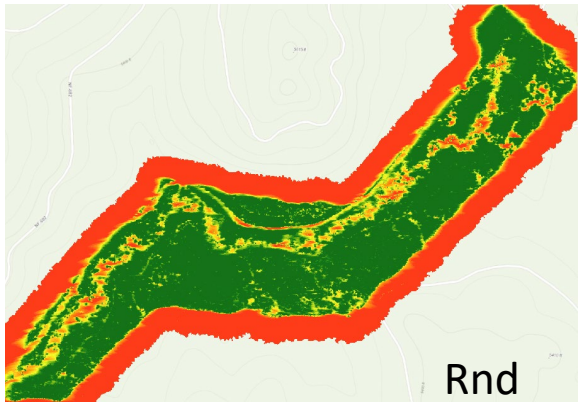
Analysis

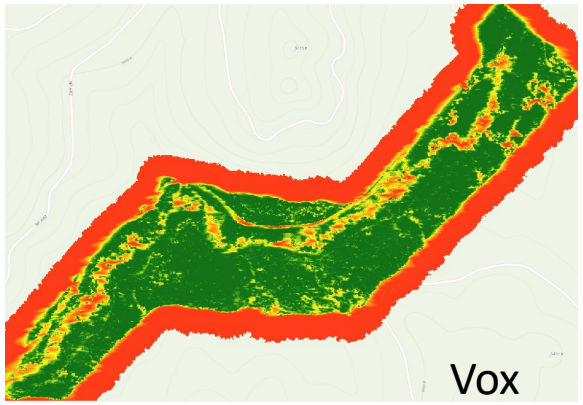
- 80 iterations per Stand (240 total)
  - 20 no treatment
    - 10 rnd & 10 vox
  - 20 Thin from Below
    - 10 rnd & 10 vox
    - Realism issues
  - 40 Mechanical Thinning
    - 20 NS
      - 10 rnd & 10 vox
      - Maximum illumination
    - 20 EW
      - 10 rnd & 10 vox
      - Minimum illumination
- Shade Algorithm

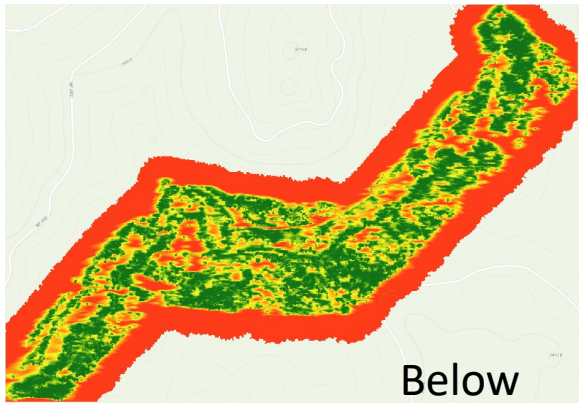


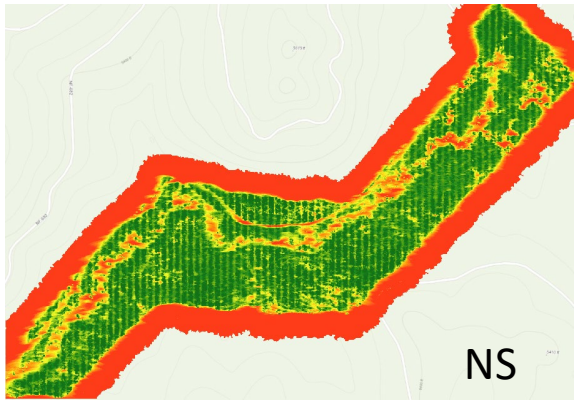
Analysis

– Stand 1



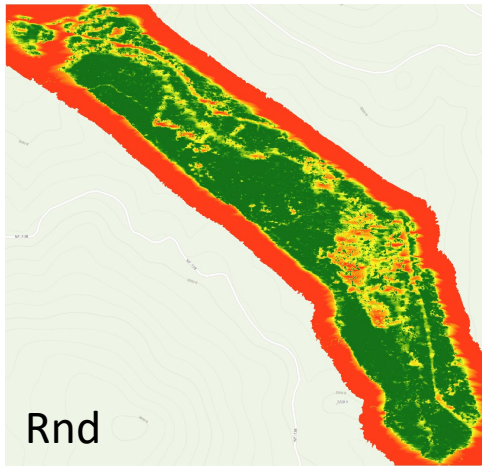


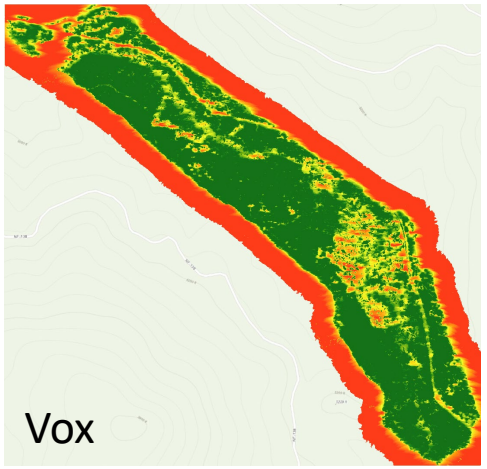


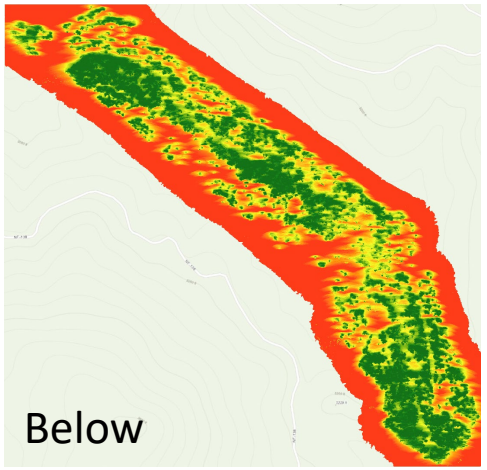


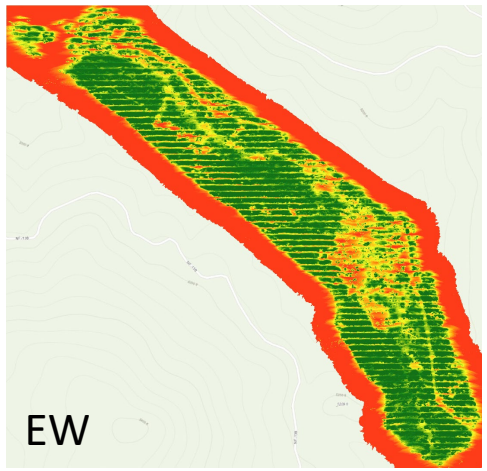
Analysis

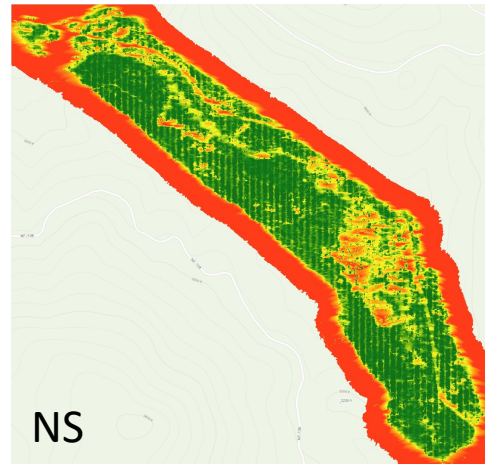
– Stand 2





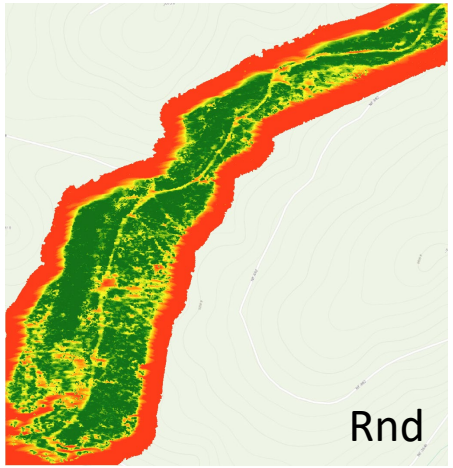


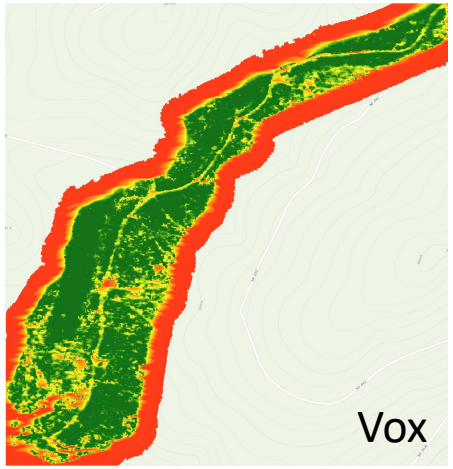


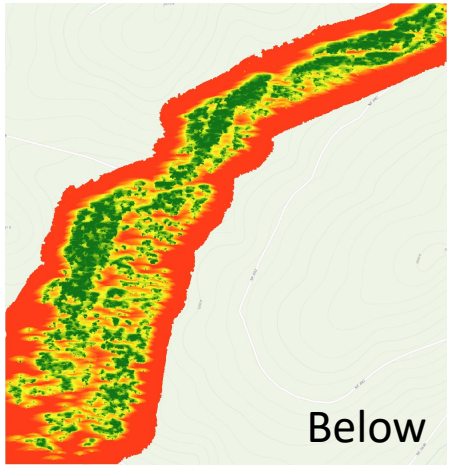


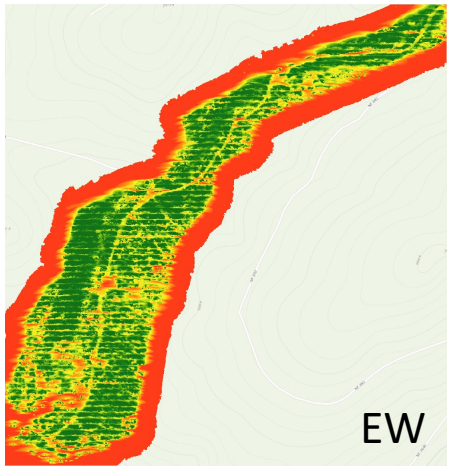
Analysis

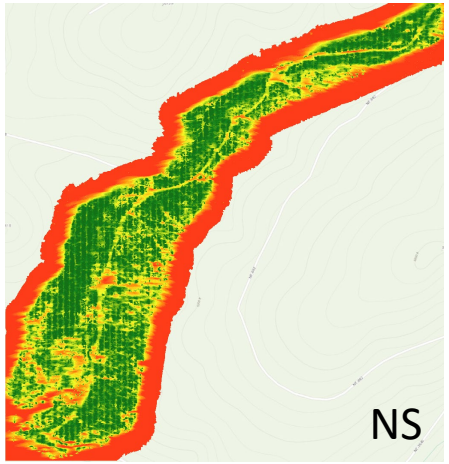
– Stand 3





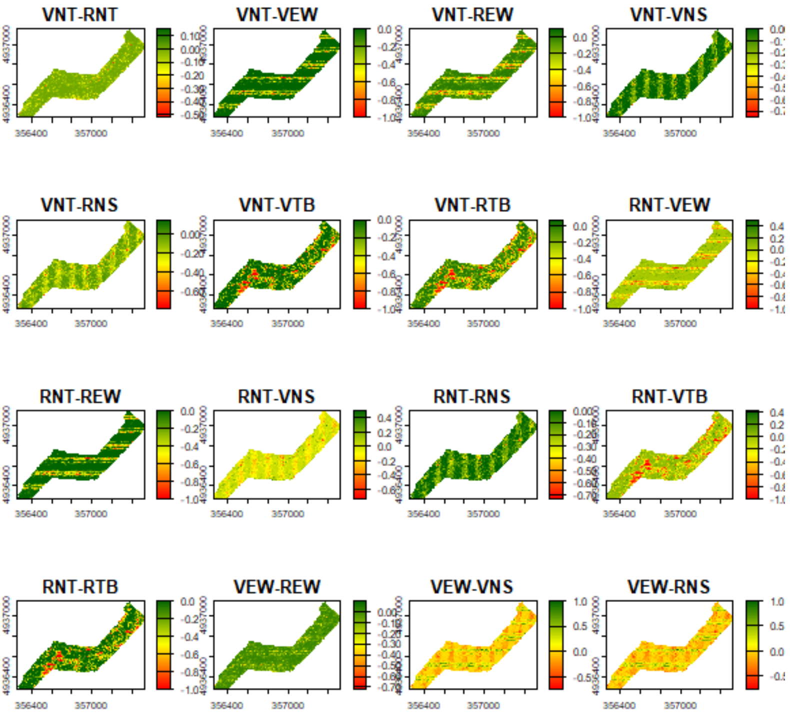


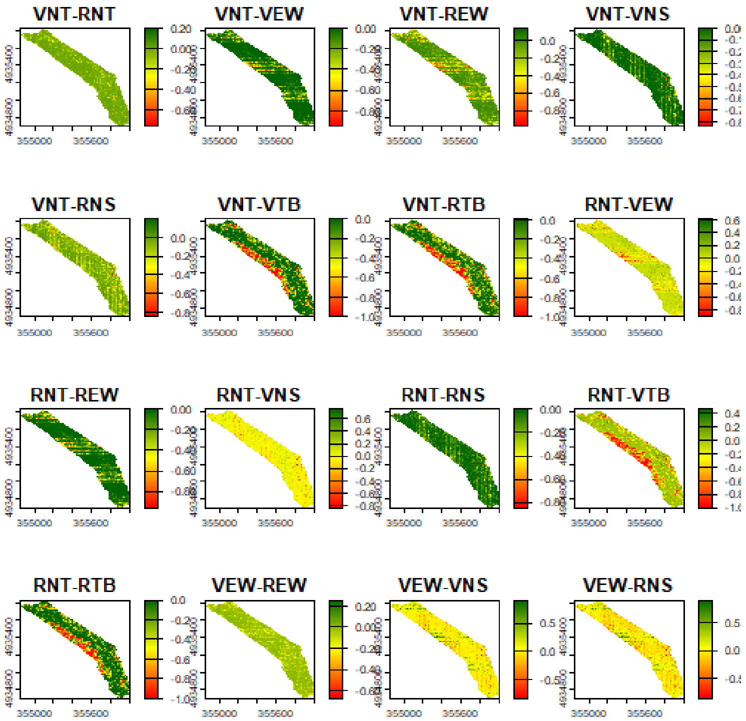


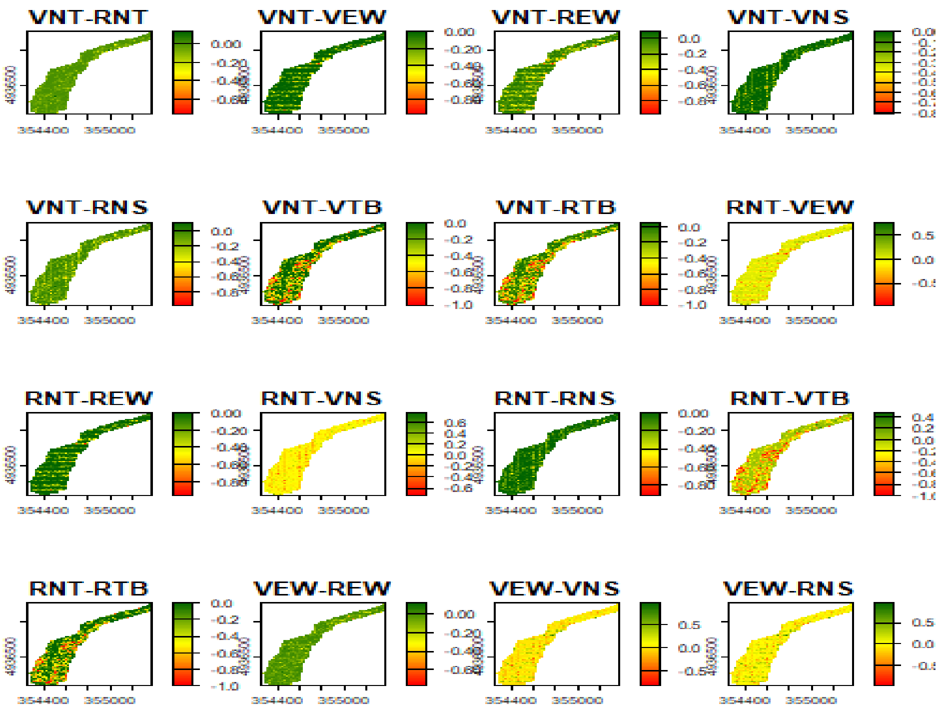


Analysis

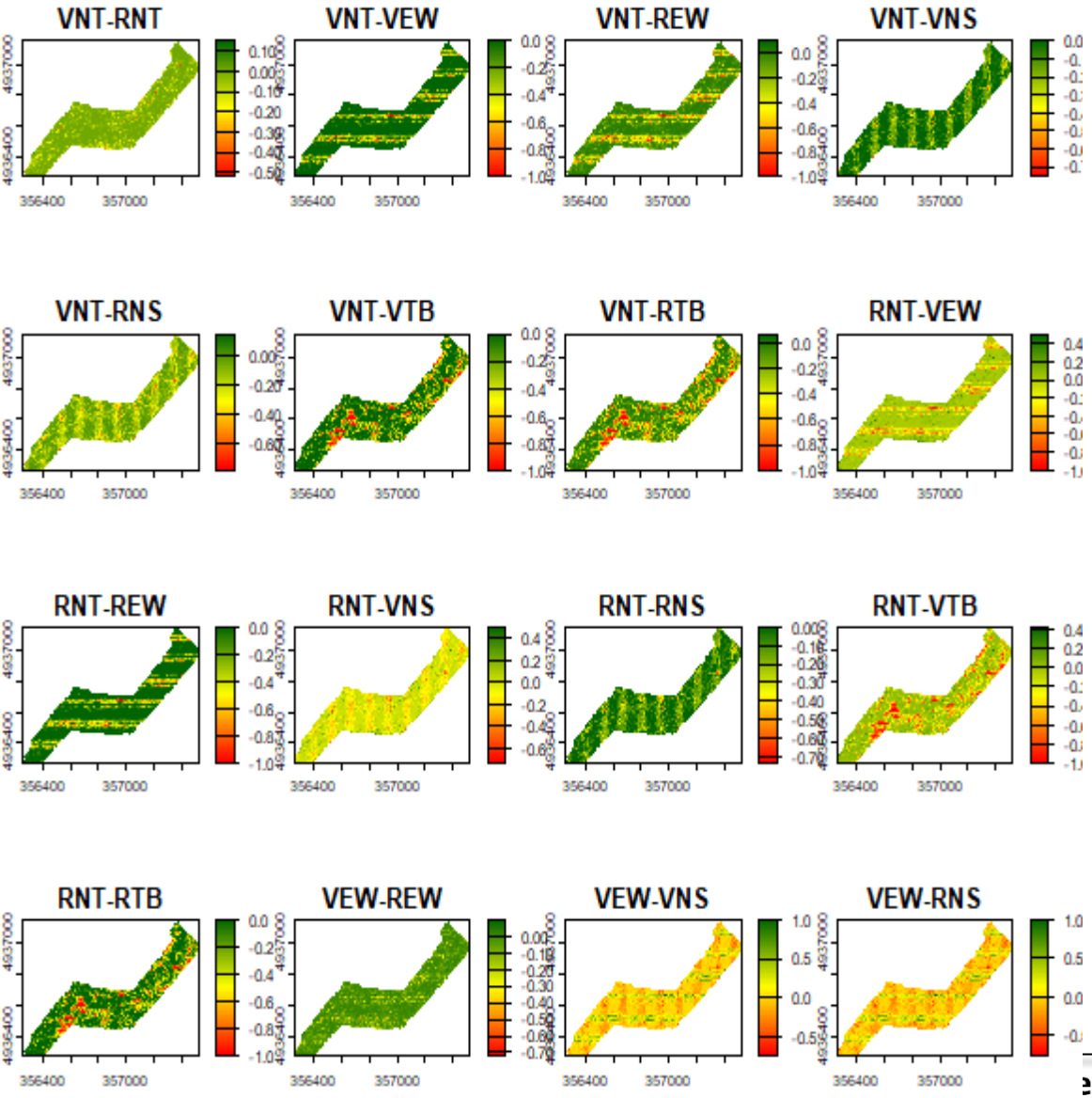
- Average all 10 of the same iterations
- Map the difference between the averages

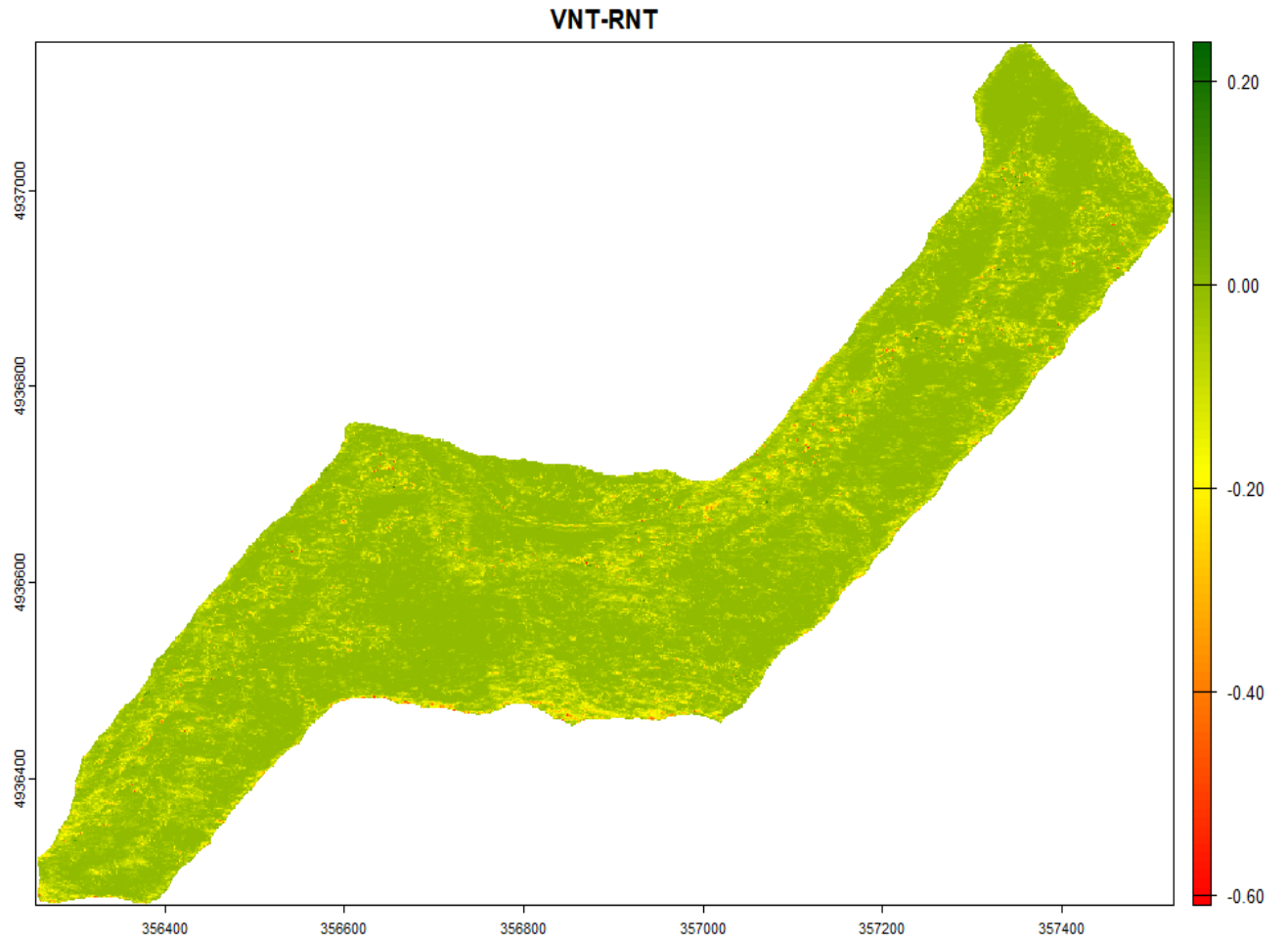




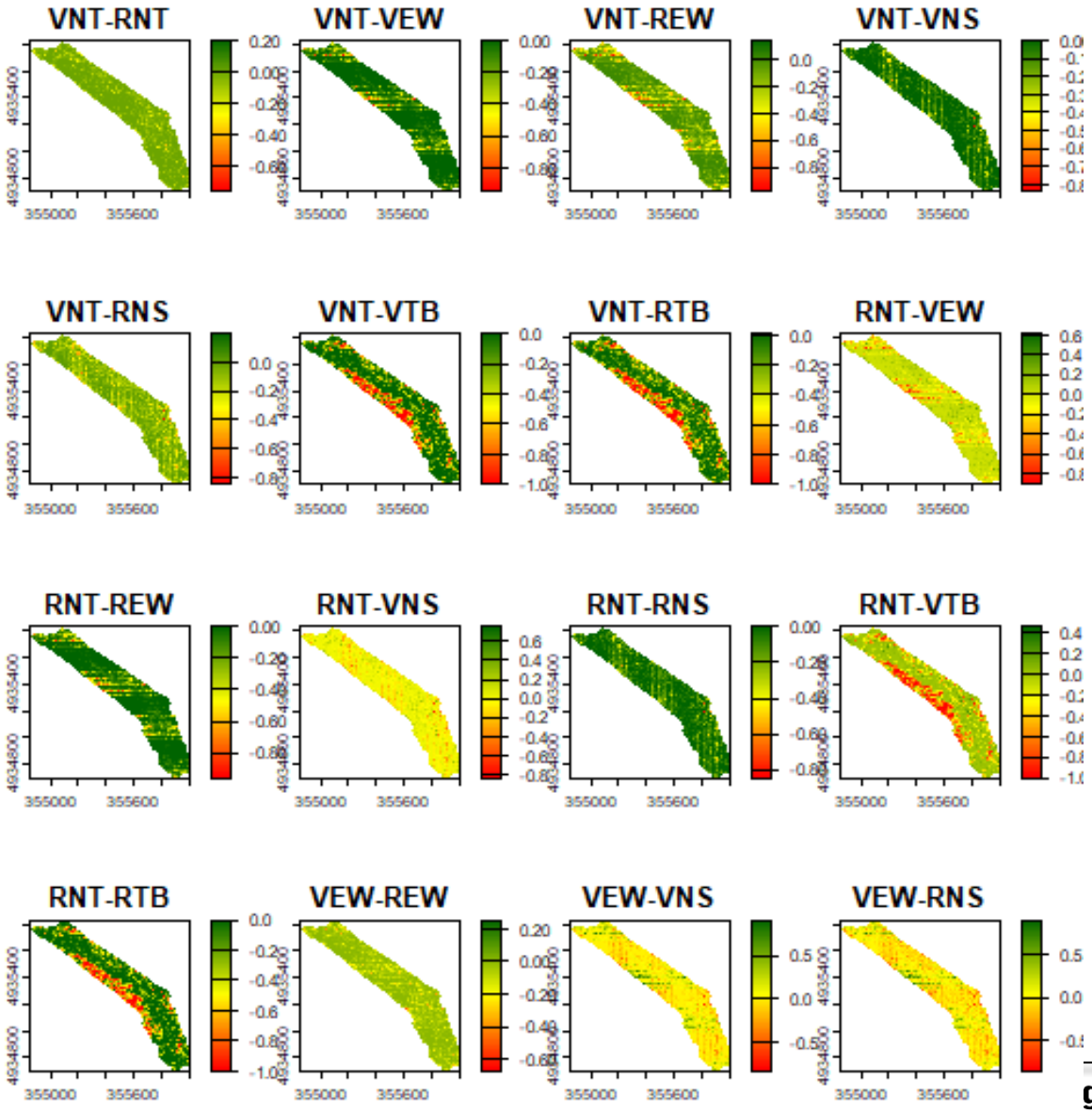


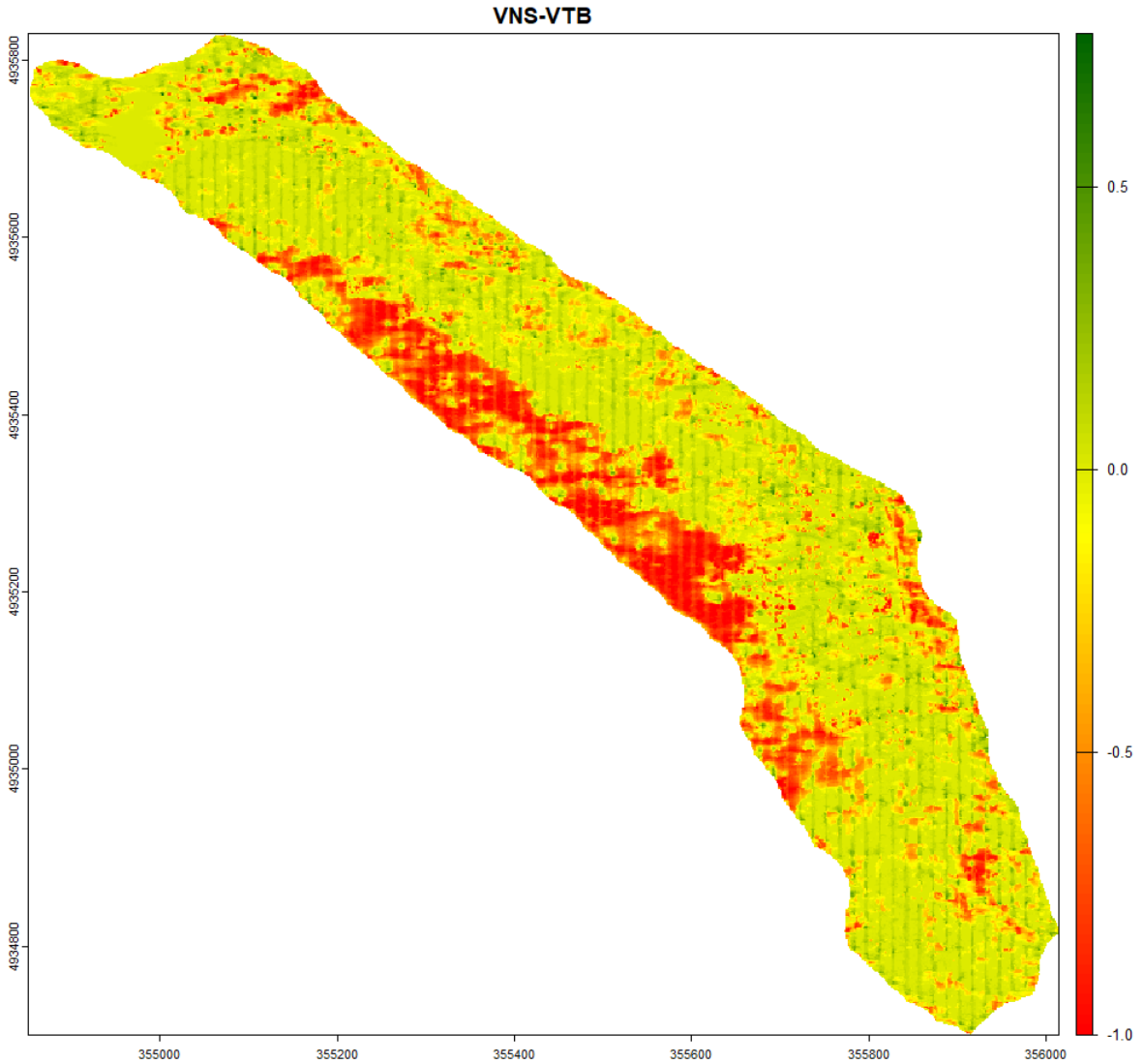
Analysis- Stand 1 Iteration difference



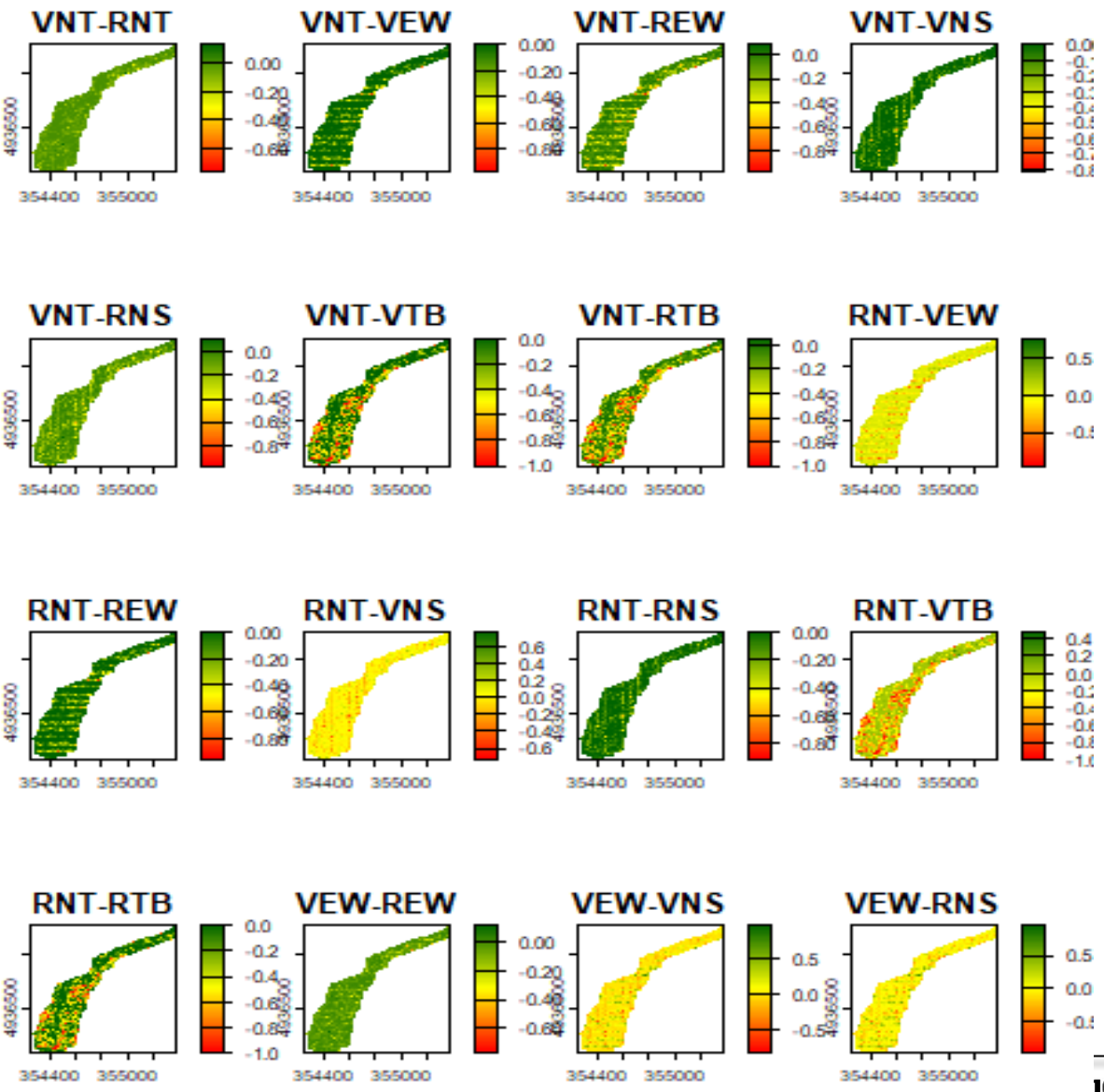


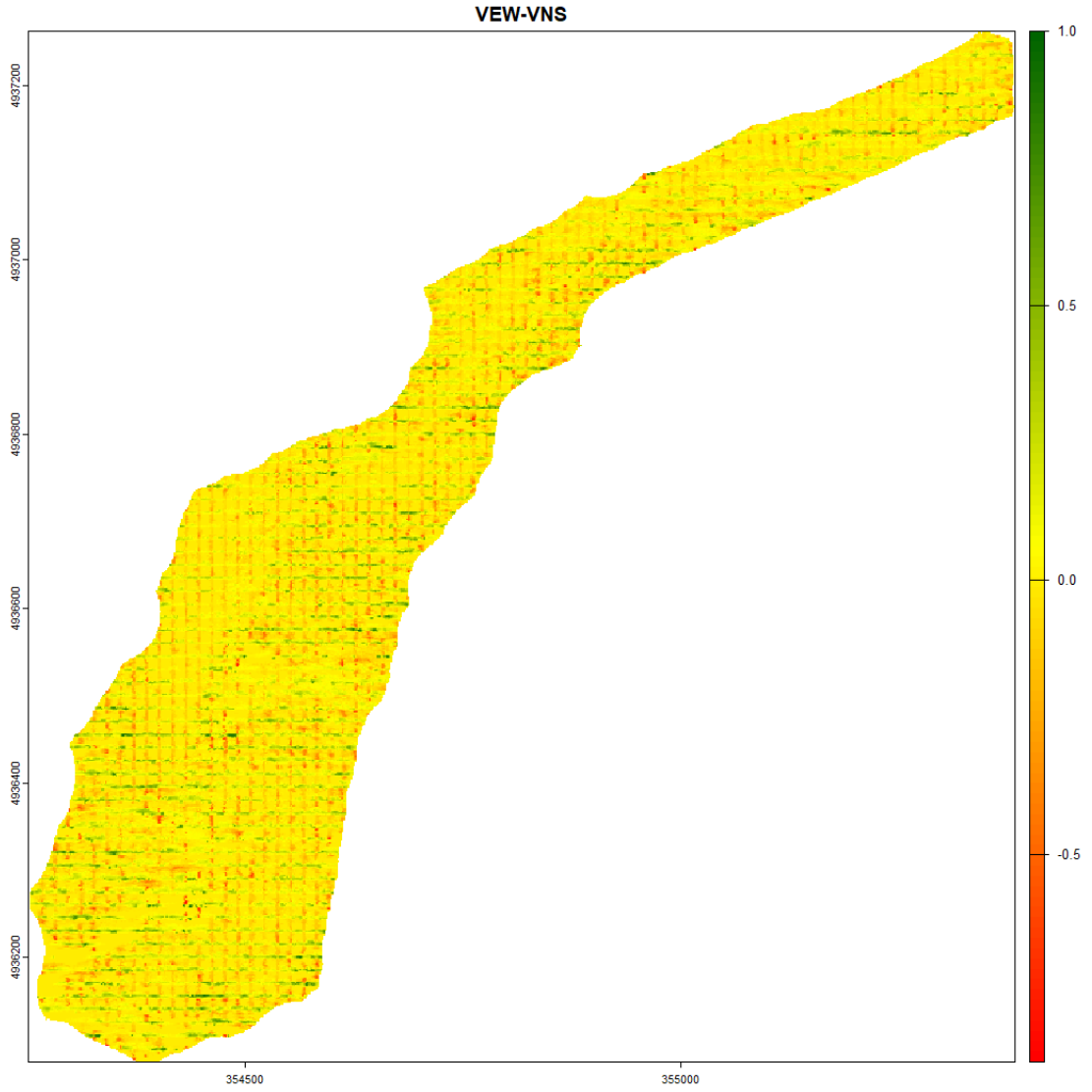
Analysis- Stand 2 Iteration difference





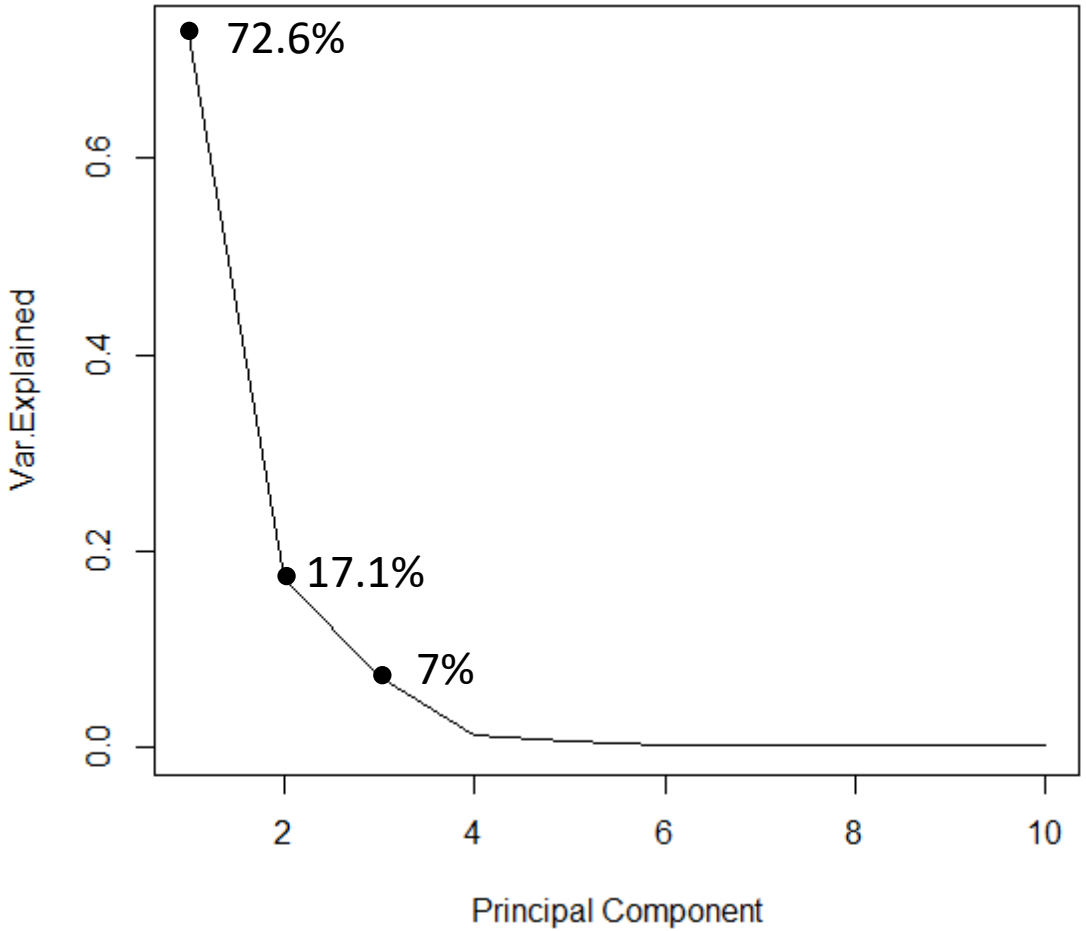
Analysis- Stand 3 Iteration difference



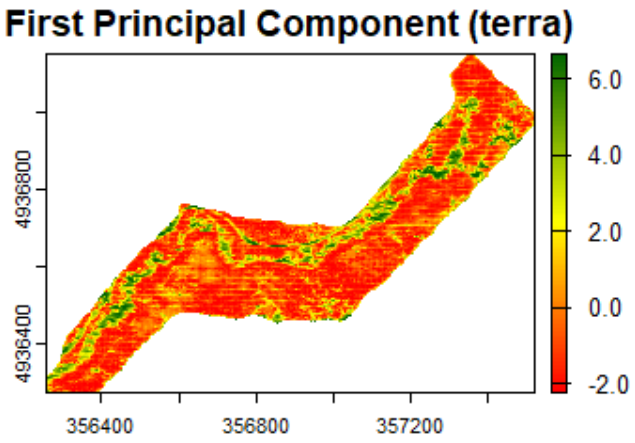


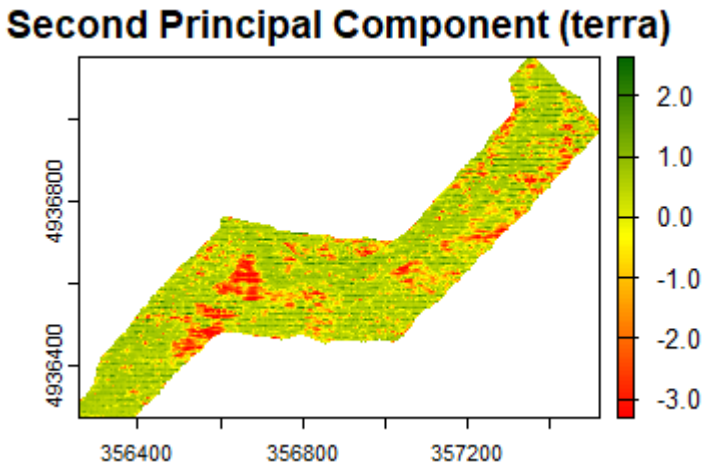
Results: Principal Component Analysis

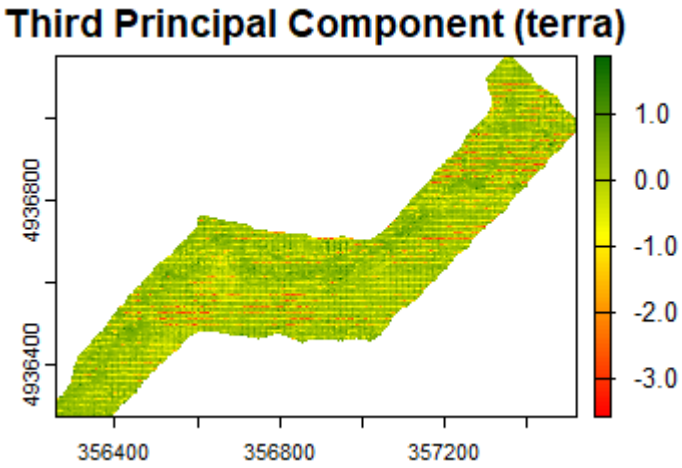
- PC1 >70% variation
- Similar values other 2 stands
- Loadings
  - Magnitude Range PC1: 0.10 - 0.12
  - Magnitude Range PC2: 0.19 - 0.1
  - Magnitude Range PC3: 0.17 - 0.12

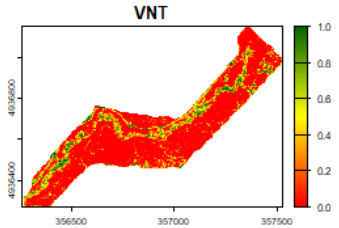


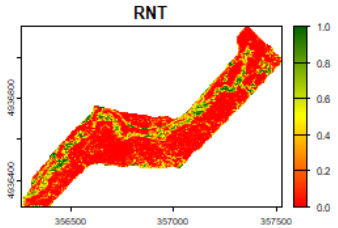
Results- Stand 1 PCA

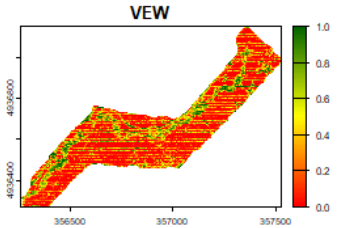


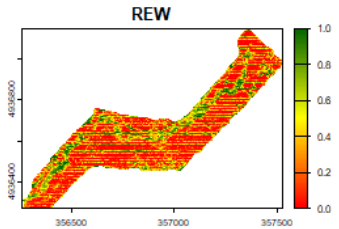


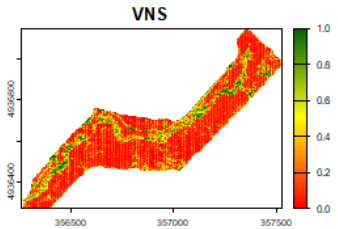


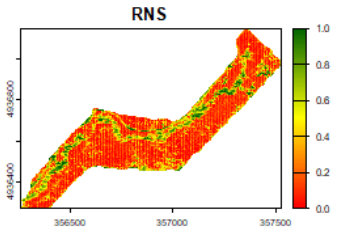


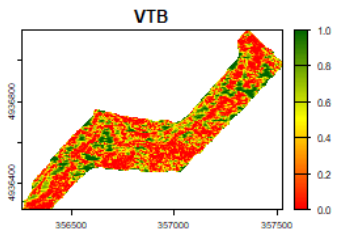


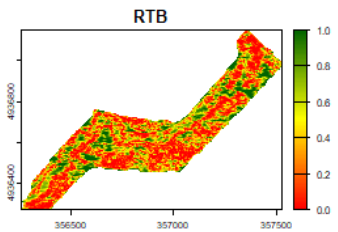




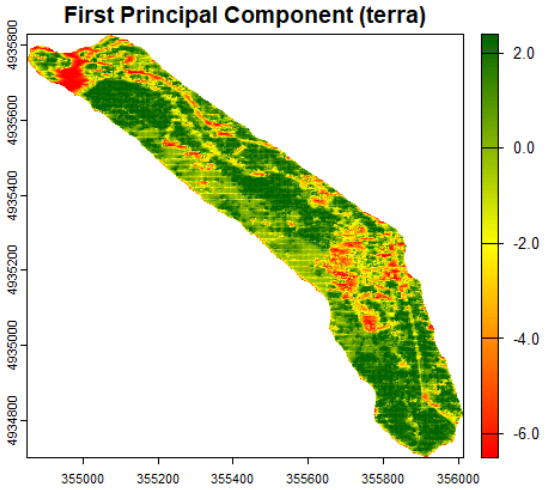


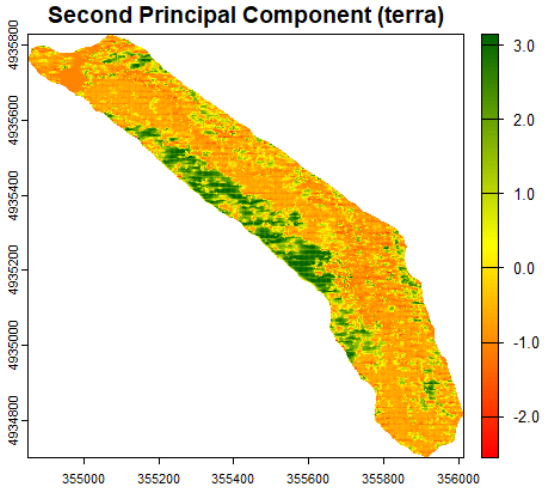


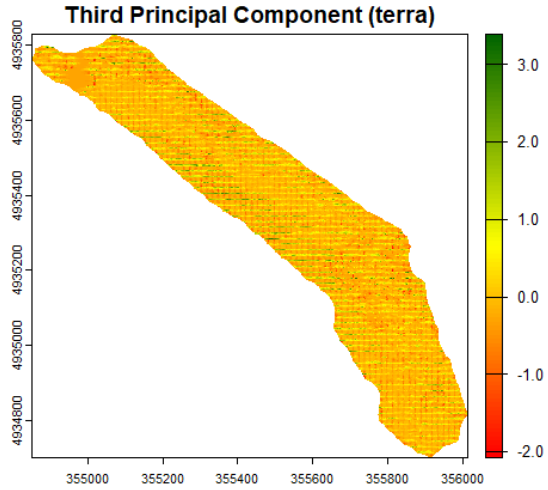


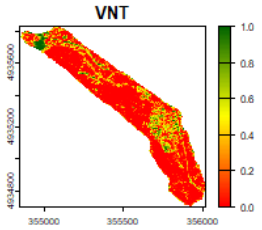


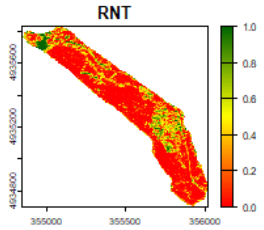
Results- Stand 2 PCA

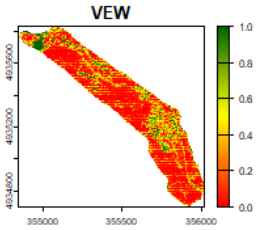


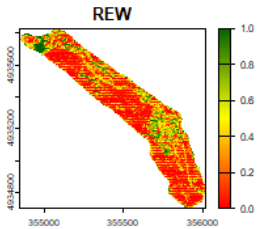


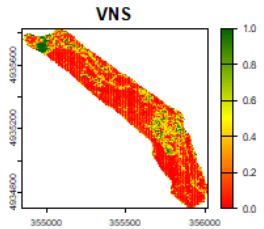


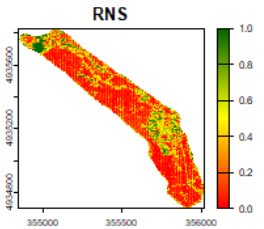


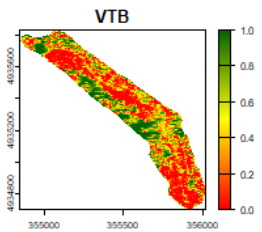


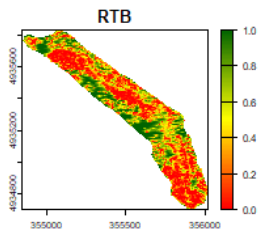




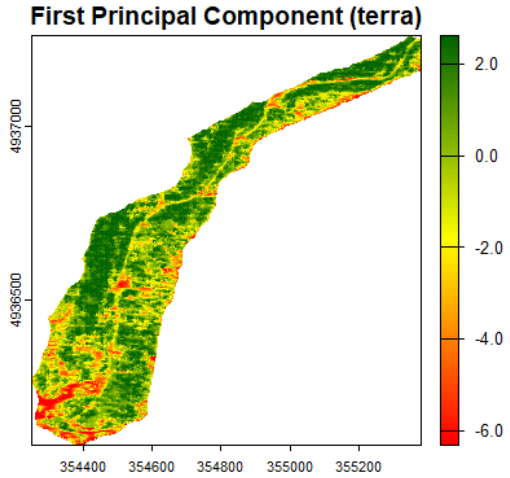


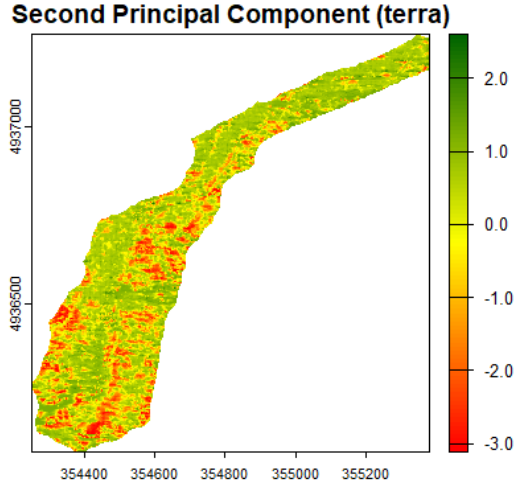


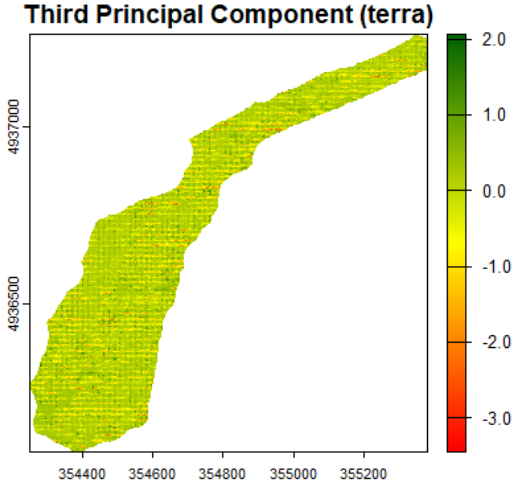


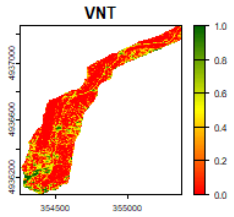


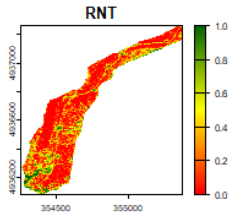
Results- Stand 3 PCA

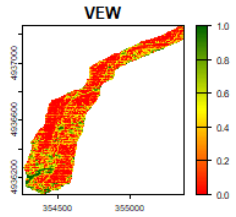


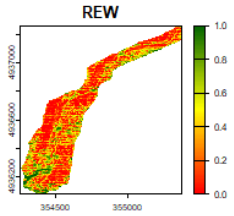


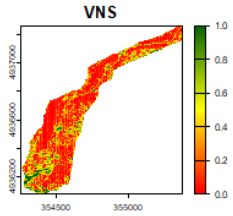


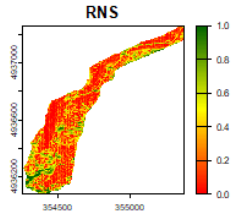


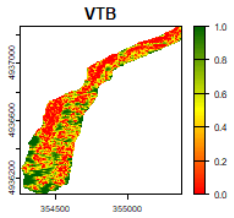


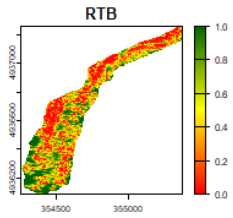












Conclusions

- Thinning and decimation type impacts the ground illumination
  - Thinning have more of an effect
- The current PCA projection shows limited need to recompute
  - captures the dominant variation caused by thinning treatments in PC1
  - Detects smaller, consistent effects from decimation method in PC2
- Direction of the thin matters
- Thin from below allowed for the most light hit the surface

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  - USDA Forest Inventory and Analysis
  - Oregon Department of Forestry

Thank you for your time

Sources

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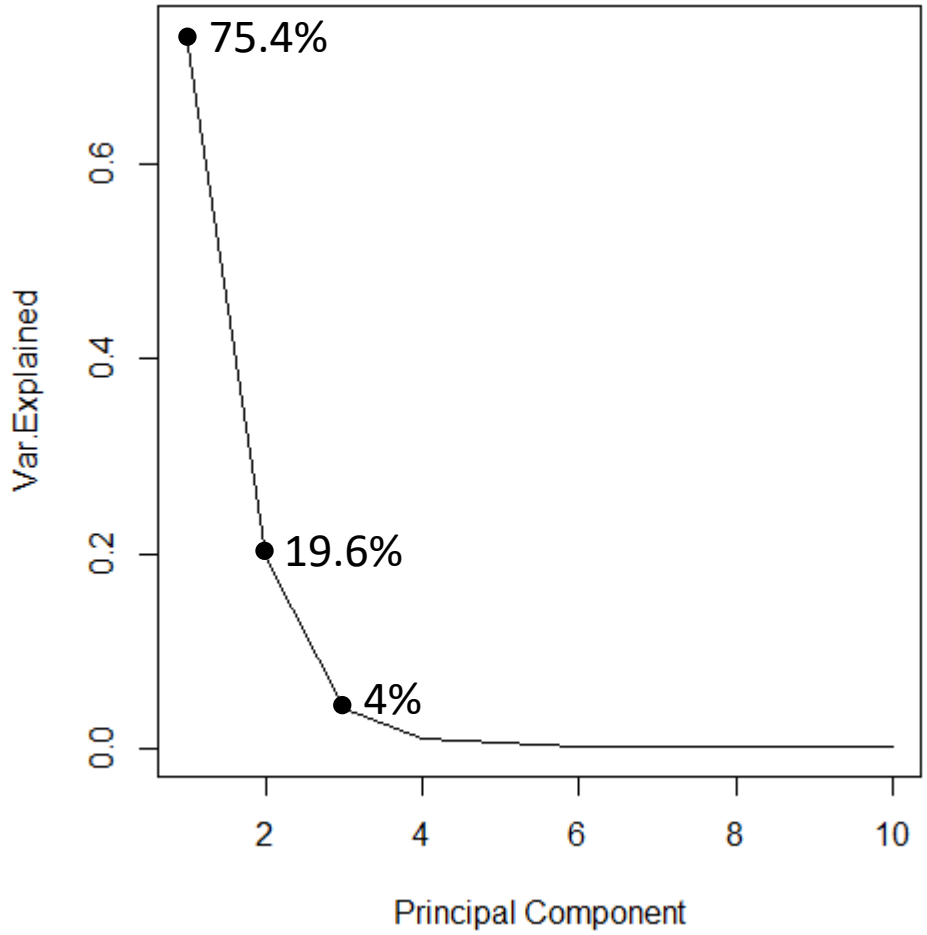
Analysis

- Principal Component Analysis: Stand 2
  - Range PC1: -.10 - -.12
  - Range PC2: -.07 - .19



Analysis

- Principal Component Analysis: Stand 3
  - Range PC1: -.10 - -.12
  - Range PC2: -.08 - -.19