CLIMES SYMPOSIUM

Remote sensing in the mapping of biodiversity, habitats and ecosystem services

LiDAR based mapping of forest biodiversity

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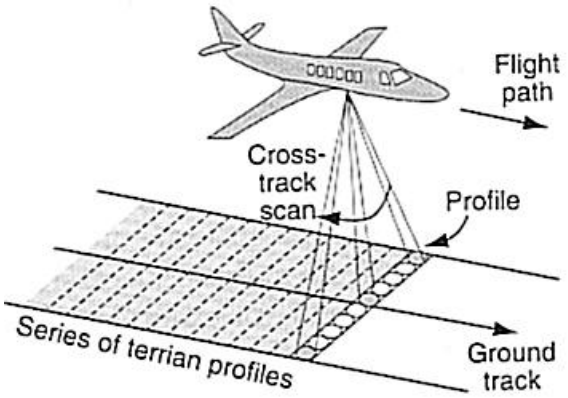
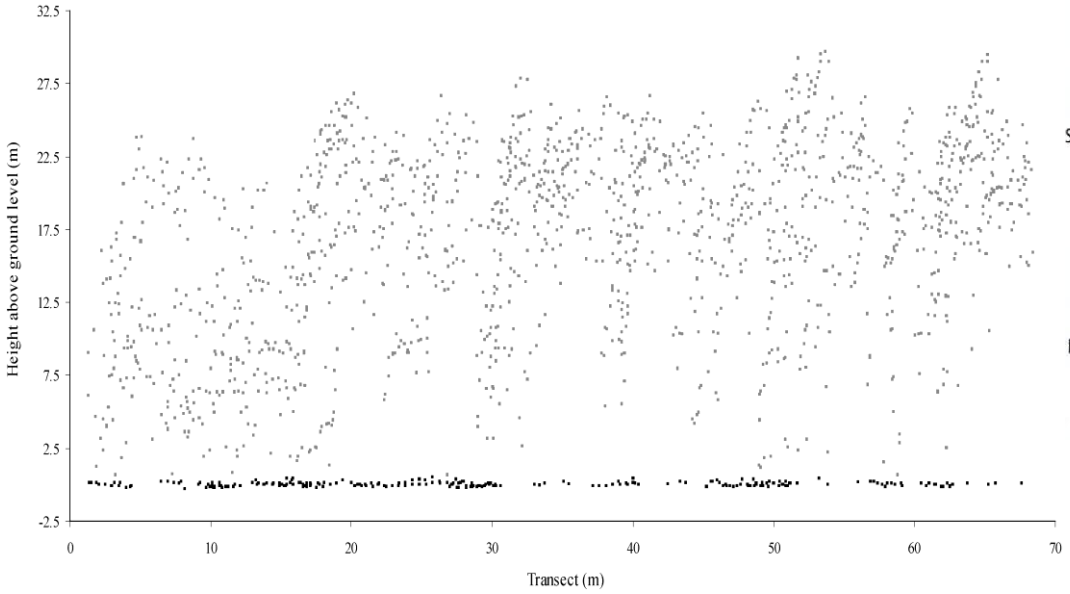
Background

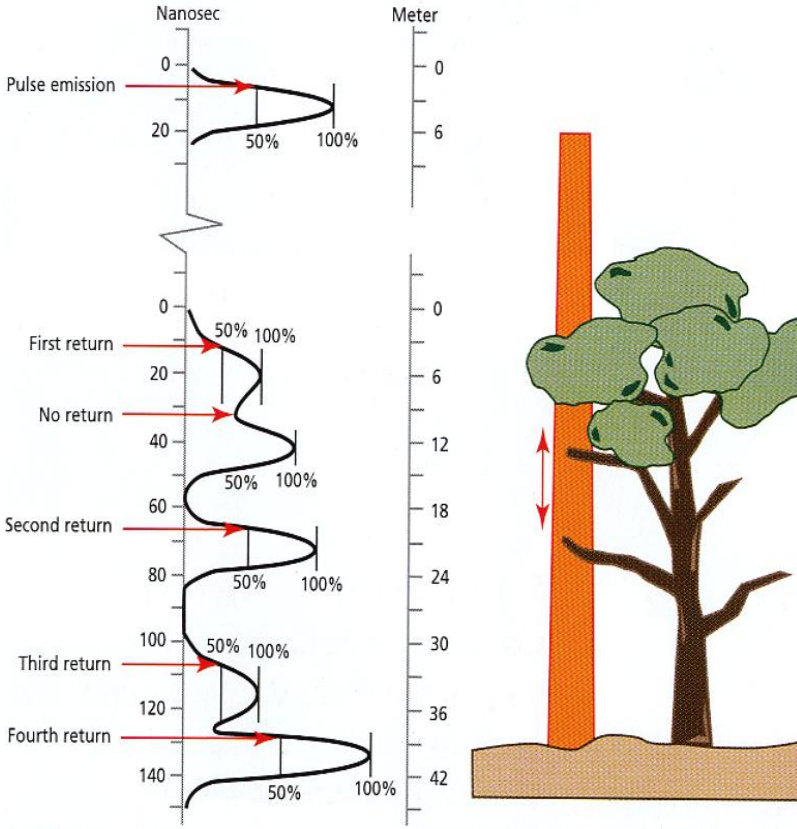
- LIDAR: Light Detection and Ranging
- LASER : Light Amplification by Stimulated Emission of Radiation
- Active remote sensing instrument
- Different platforms, here discrete return airborne laser scanning



Background

- Accurate XYZ-positioning for each pulse
  - Height information
- Also intensity values available





Height at above ground level / Specs

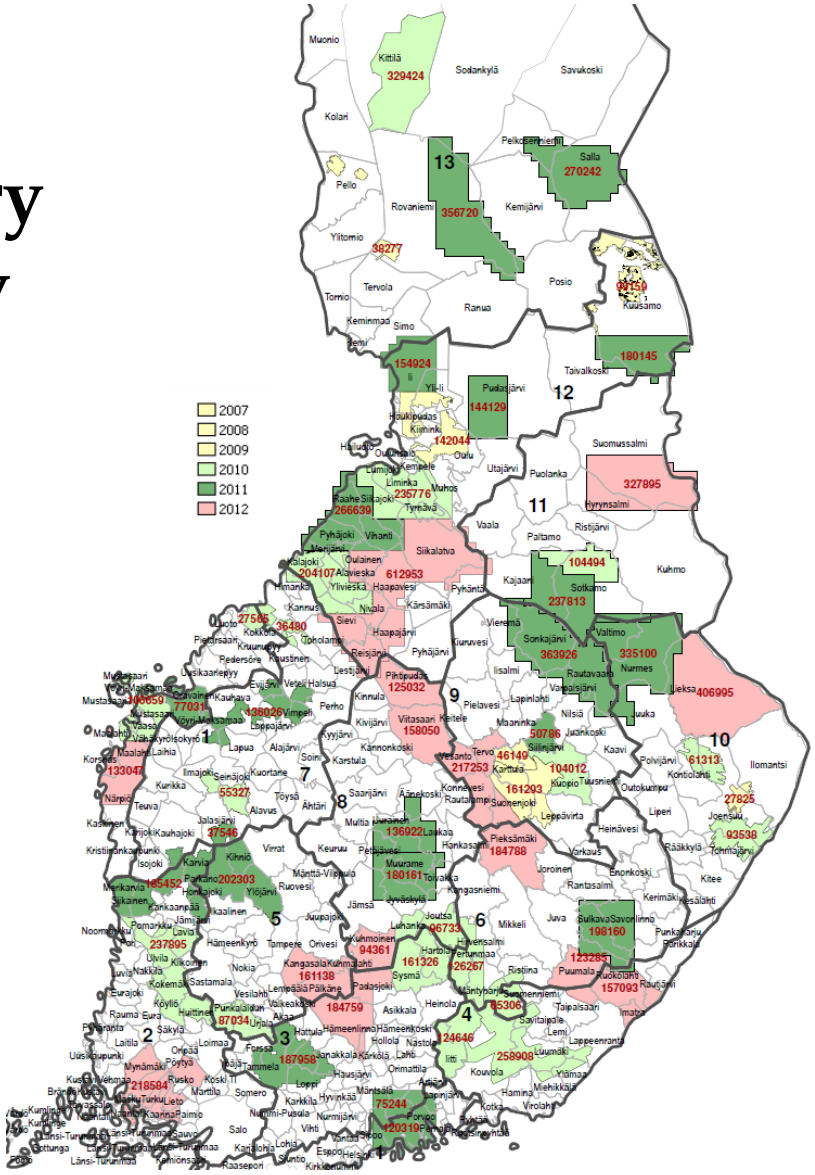
- ALS data suits very well for the generation of digital terrain model (DTM)
- In many applications, such as in forest inventory, the primary interest is in vegetation at a.g.l. which can be calculated by vegetation surface – DTM
- The typical flight altitude is 300-3000 metres a.g.l.
- The footprint diameter is usually 0.1-1 m
- Vertical accuracy of about ± 5-50 cm
- The pulse density on the ground is usually something like 0.1-10 measurements per m^2

ALS in Forestry

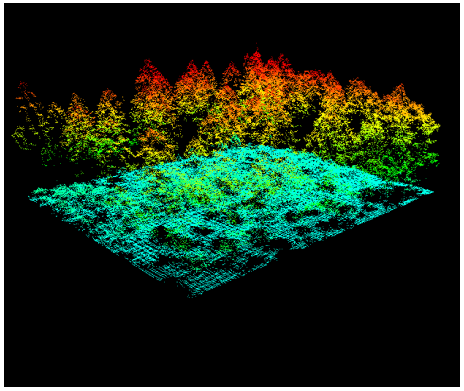
- ALS is mainly applied in forest inventory
  - Volume, biomass
  - REDD
- Even individual trees can be separated from ALS data or ALS information can be linked to vegetation at plot level
- ALS and aerial images have become main tool for operational stand level management inventory

Plan of inventory areas of Forestry Centres

2007–2012

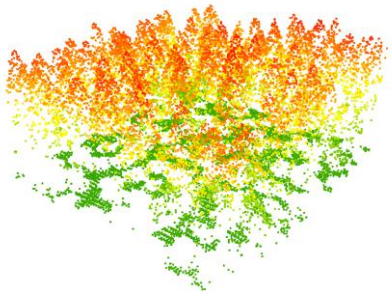


Forest ecological/ biodiversity applications of ALS



•ALS provide 3D information where each point has height (and intensity) value

• In general, almost all vegetation phenomenon which have height dimension can be at least by some level be observed

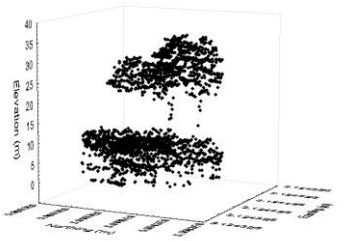


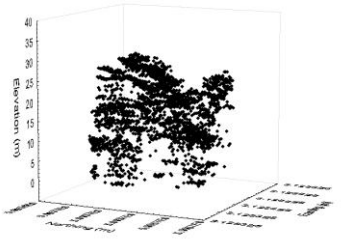
• ALS data give excellent possibilities to study different characteristics related to vertical forest structure

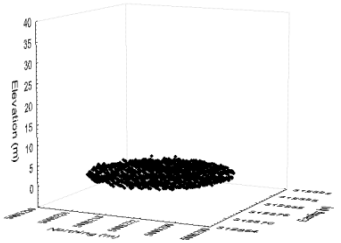
Forest structure

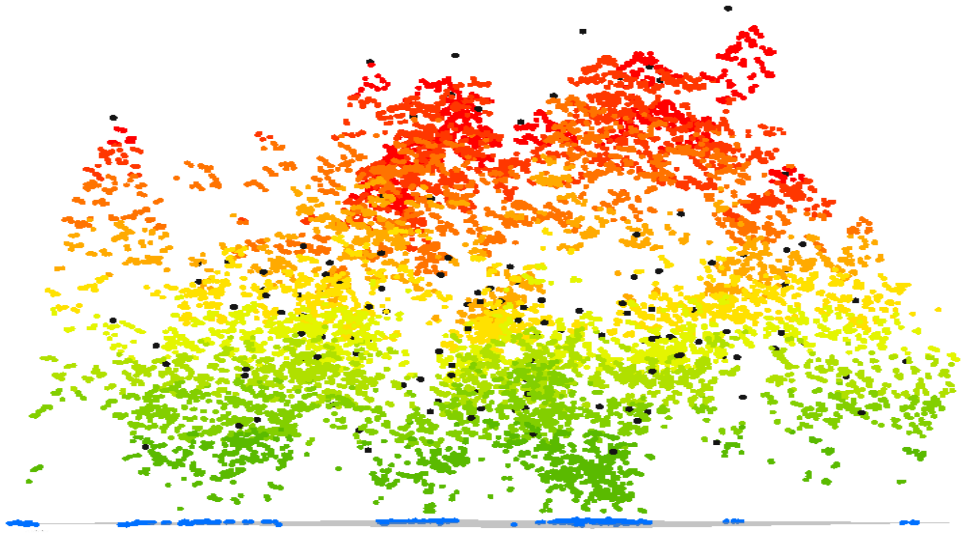
• ALS data have widely been used to examine vertical structures

- structural biodiversity
- to separate tree layers
- in fuel models
- habitat characterisation, e.g. birds
- lower limit of the canopy



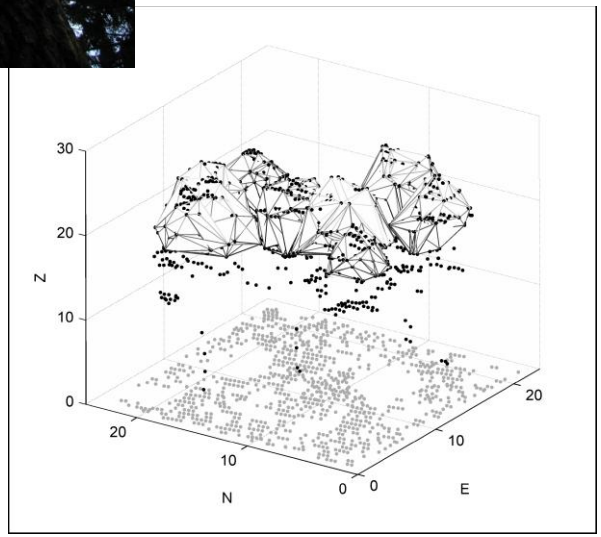






Recognition of rare and “valuable” tree species

- High pulse density ALS information needed to separate trees
- Tree species classification:
  - Intensity values
  - Height and density characteristics
  - Differences in leaf on/off data
  - Tree height by itself not good indicator
- We studied aspen recognition in Koli National park
  - Moderate succession
  - Difficult to apply in large areas

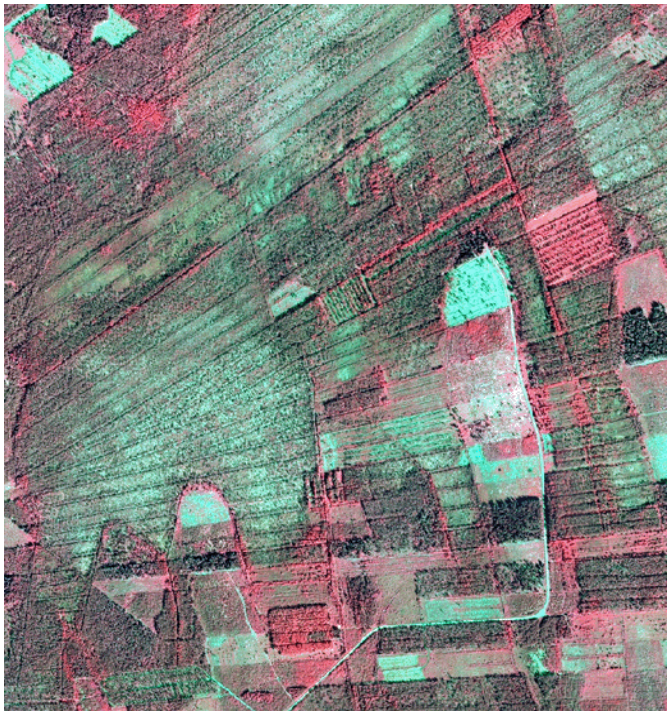


Prediction of dead wood

- In nature conservation areas dead wood can be mapped and predicted with meaningful precision by using ALS
- Approach based on ganopy gap dynamics: existence of dead wood can be seen on forest structure
- Prediction of dead wood not successful in managed stands
- ALS data can also be used to "guide" dead wood field inventory
    - Planning of plot locations before actual measurements
    - Based on correlations between ALS variable and ground truth CWD value
    - ALS as auxiliary information

Site classification etc.

- ALS data have also been used to:
  - Mapping herb-rich mature forests
    - Differences in forest vertical structure
  - Site type classification
    - Height differences ->bonitet
  - Peatland classification
  - Mapping of lichens
    - Intensity values
  - Forest insect damage mapping
- From existing stand delineation information to site types or from ALS data segmentation to site types?



Canopy gaps

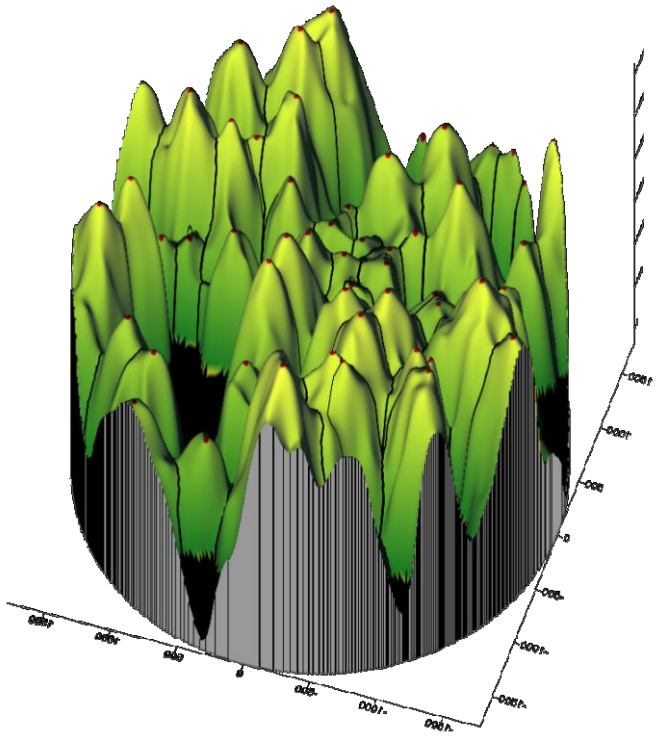
• Small disturbance regime including appearance, enlargement, reduction and disappearance of gaps

• Man made gaps

• Aerial photographs, problems with shadows, variation in images

• Very hard to characterise in the field, rather easy by using 3D ALS data

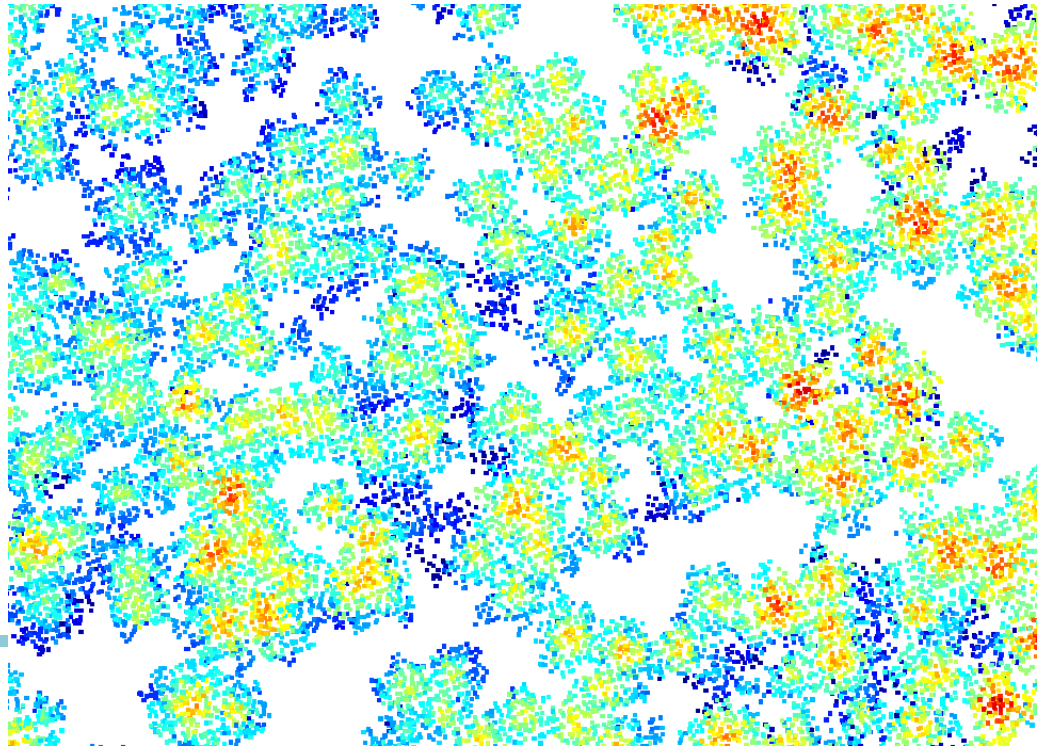
- Size, height limit
- Different studies on recognition of gap type, change detection according to time series of ALS data, etc.



Canopy cover

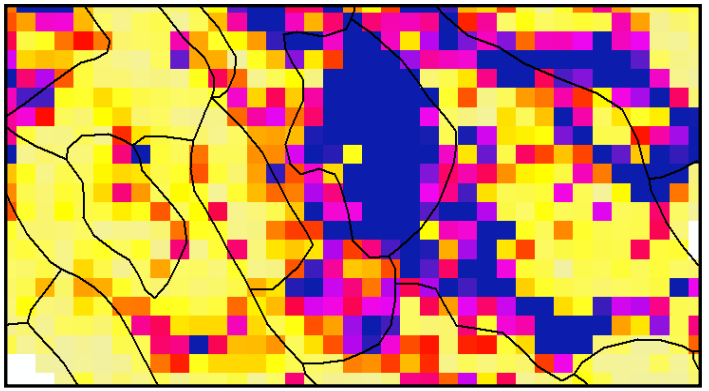
- Attribute dealing with stand density
- Globally, canopy cover (10%) defines what is forest (FAO)
- Also here, accurate field measurements are rather time consuming
- ALS provide excellent 3D data which can be directly utilized
- In simplest form proportion of vegetation hits
  - i.e. classification of ALS

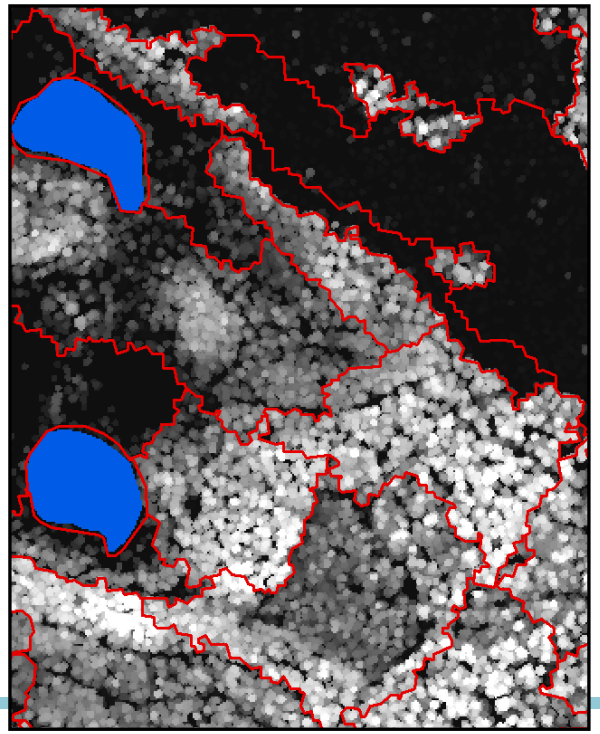
  hits using height border 0.5-2 m



Scale

- Scale is emphasized in ecological applications
  - Tree level
  - Grid (Artificial but still efficient)
  - Stand (Habitat) level
    - All attributes can be averaged or considered at stand level
  - Microsegment
    - Natural unit
    - Is there corresponding signal in ALS data than in ground measurements?
    - Size of the segment?, from tree (group)s to landscape level





Some international studies

• Muller & Brandl. 2009. Assessing biodiversity by remote sensing in mountainous terrain: the potential of LiDAR to predict forest beetle assemblages. Journal of Applied Ecolgy 46: 897-905

  • species level

  • mean body size and species composition predictable with LiDAR

•Vierling et al. 2008. Lidar: shedding new light on habitat characterization and modeling. Frontiers in Ecology and the Environment 6.

  • review on the possibilities of lidar

  • the role in replacing labor-intensive field measurements

Conclusions

- What can be done with ALS data?
  - Total amount of vegetation
  - Vertical structure of vegetation
  - Ecological applications like canopy gaps and canopy cover
  - Species recognition problematic
  - Not global monitoring