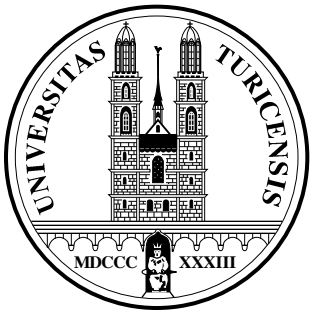


ASSESSMENT ON THE INFLUENCE OF FLYING HEIGHT AND SCAN ANGLE ON BIOPHYSICAL VEGETATION PRODUCTS DERIVED FROM AIRBORNE LASER SCANNING

Felix Morsdorf, Othmar Frey, Erich Meier, Klaus I. Itten and Britta Allgöwer

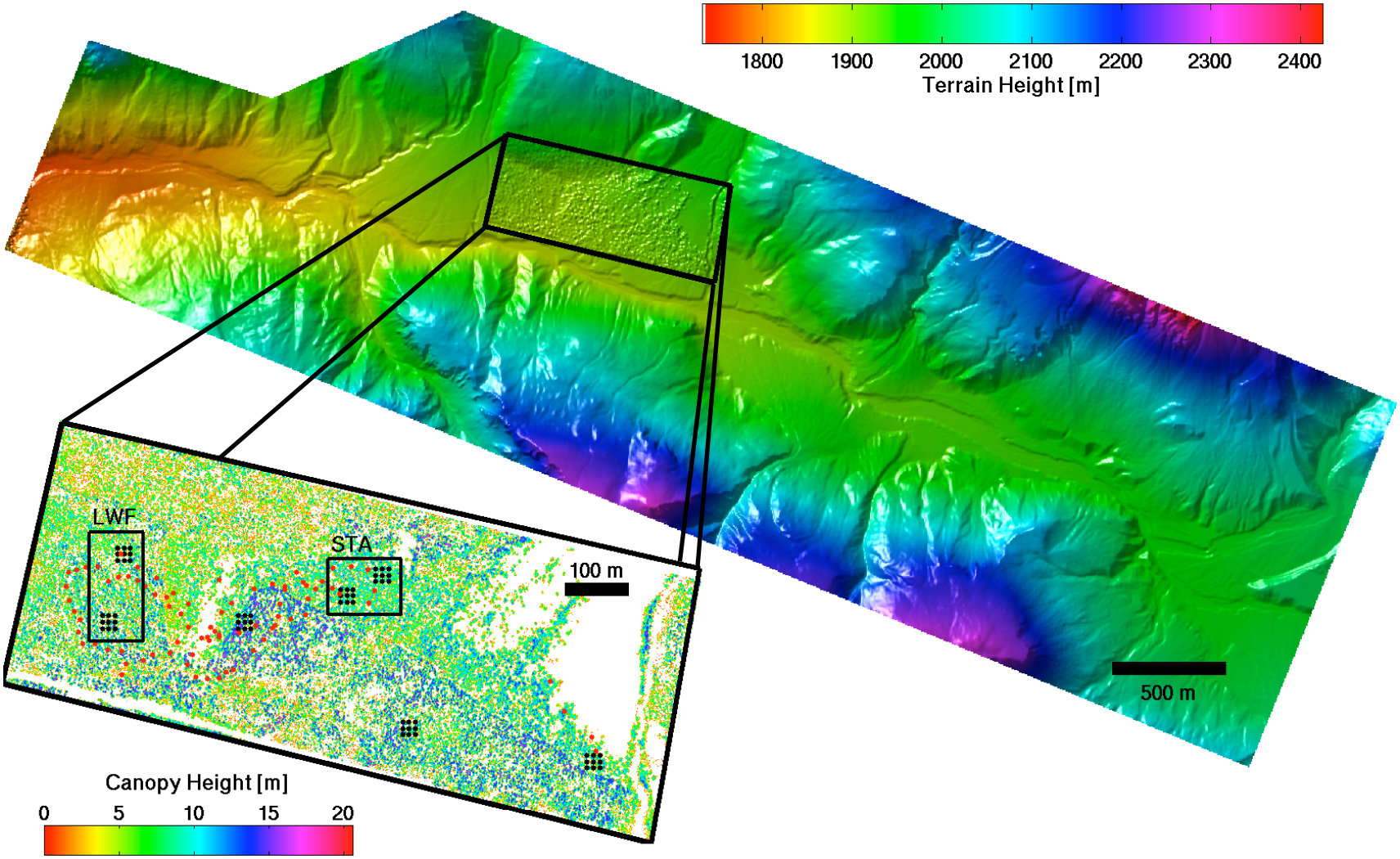
REMOTE SENSING LABORATORIES RSL

Lidar data and testsite

- Test Site is located in the Swiss National Park
  - boreal vegetation dominated by mountain pine trees and some larch
  - height range of 1800 - 2400 MSL
  - contains long-term monitoring site of WSL with about 1200 trees with BHD > 0.15 m
- LIDAR flight took place October 2002
- processing of raw data into terrain models done by TopoSys
- two nominal flight altitudes, two datasets :

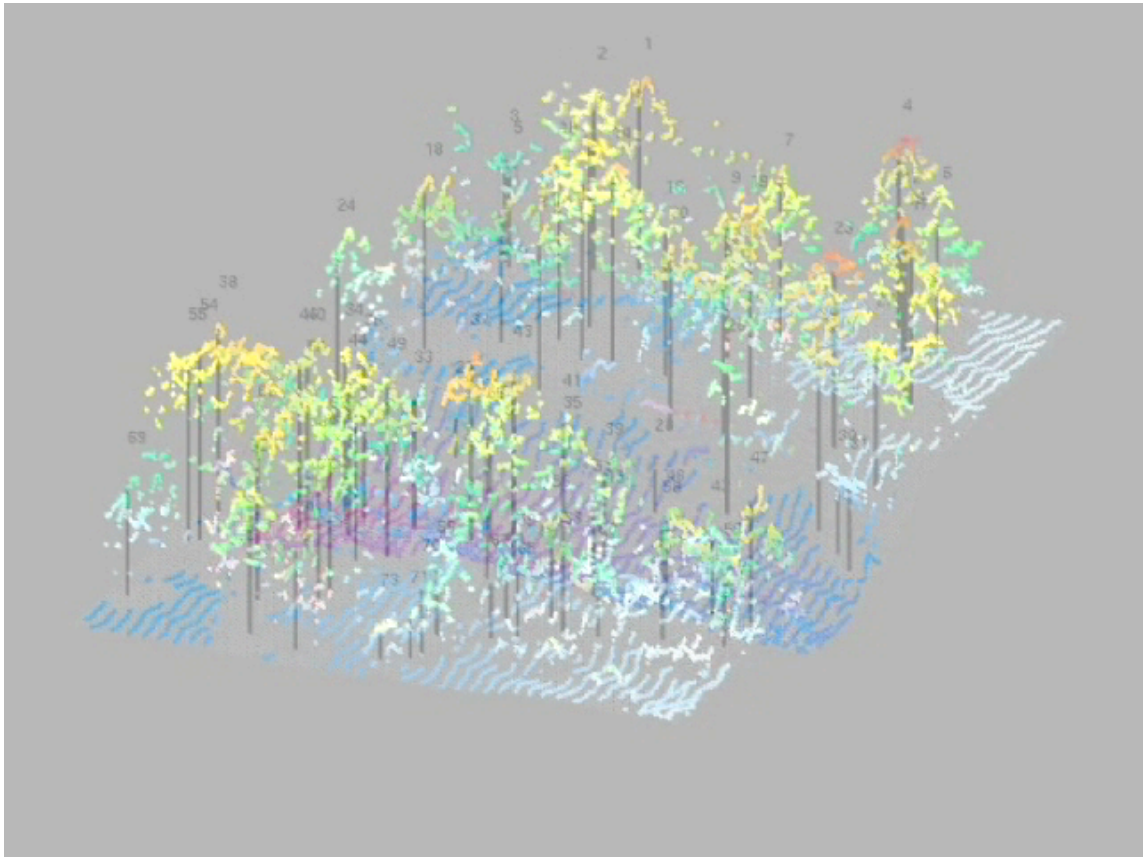
Area	Height AGL [m]	Point Density	Grid Spacing	Height Res.
14 km2	850 m	~ 10	1 m	0.1 m
0.6 km2	500 m	~ 20	0.5 m	0.1m

Testsite in the Swiss National Park (SNP)



Biophysical properties : Tree height

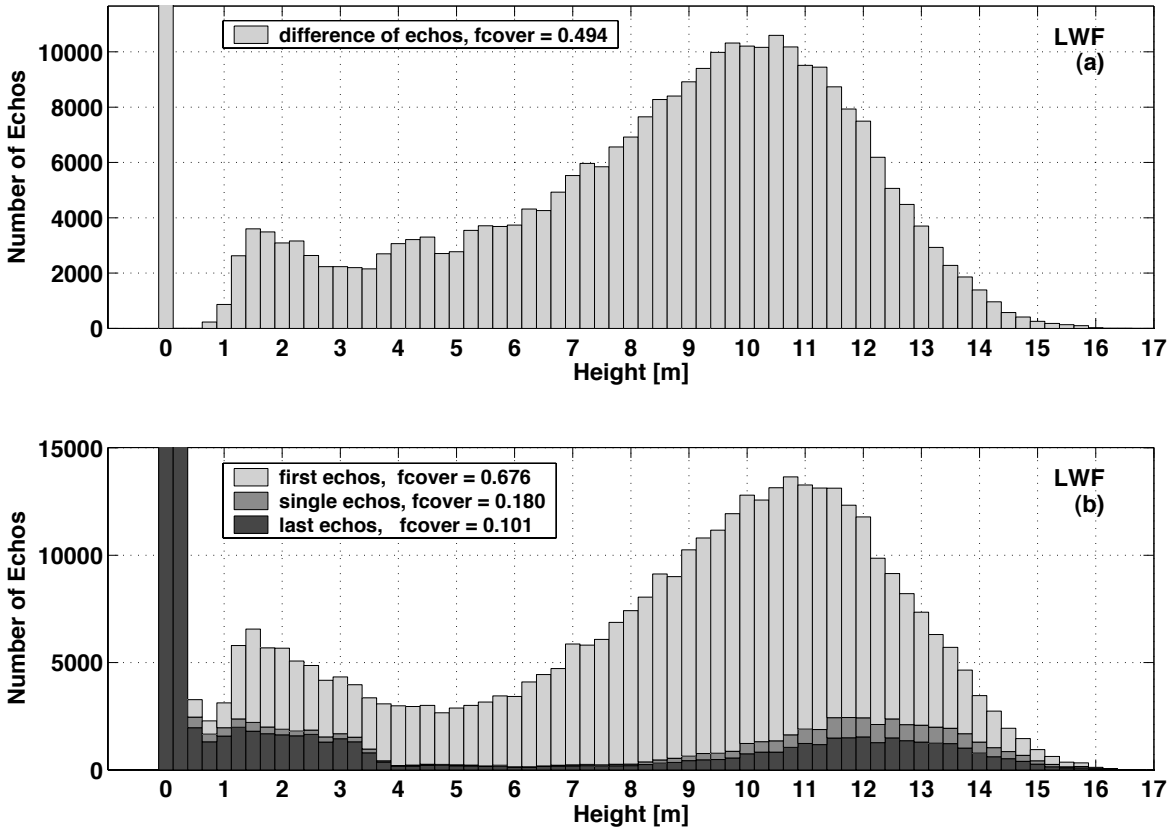
- Single tree segmentation based on clustering of raw laser echos, seedpoints are derived from DSM



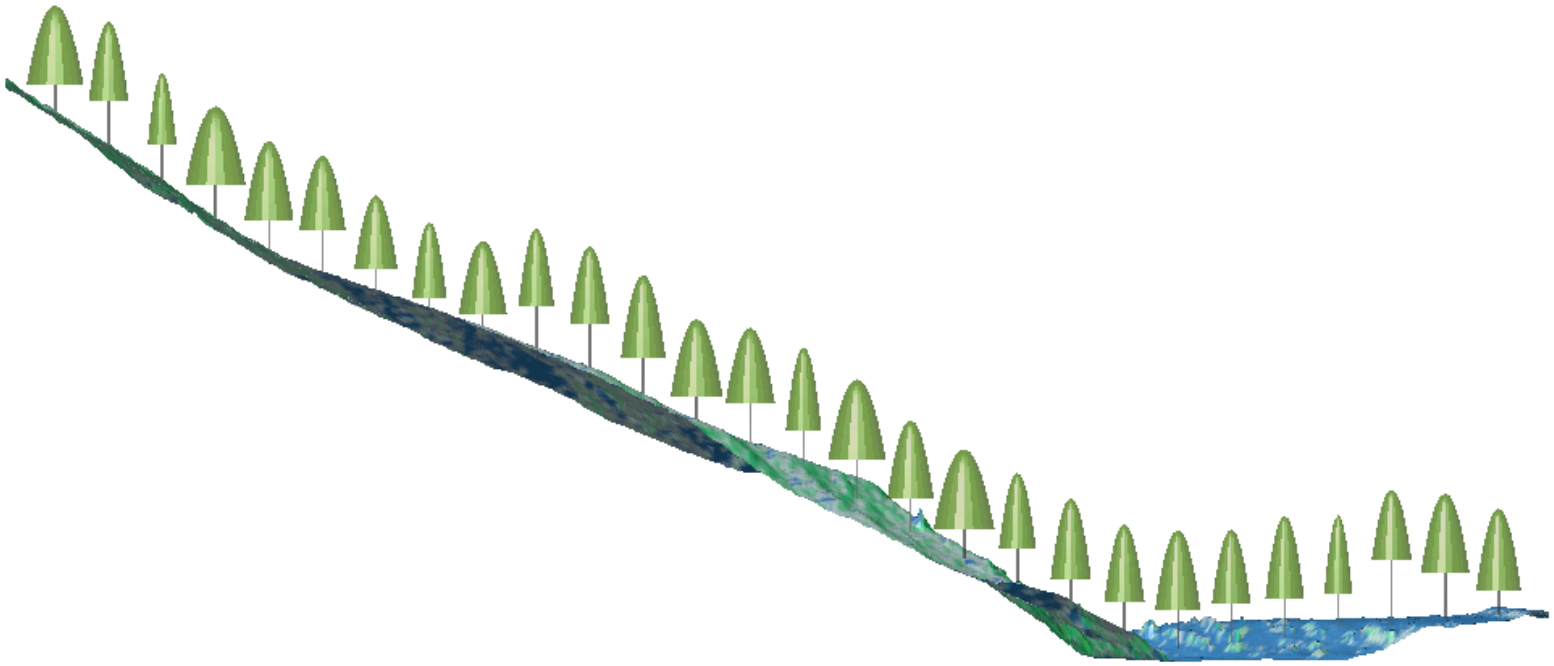
- Geometric information was used by B. Koetz with FLIGHT for simulations of canopy reflectance

Biophysical properties - fCover and LAI

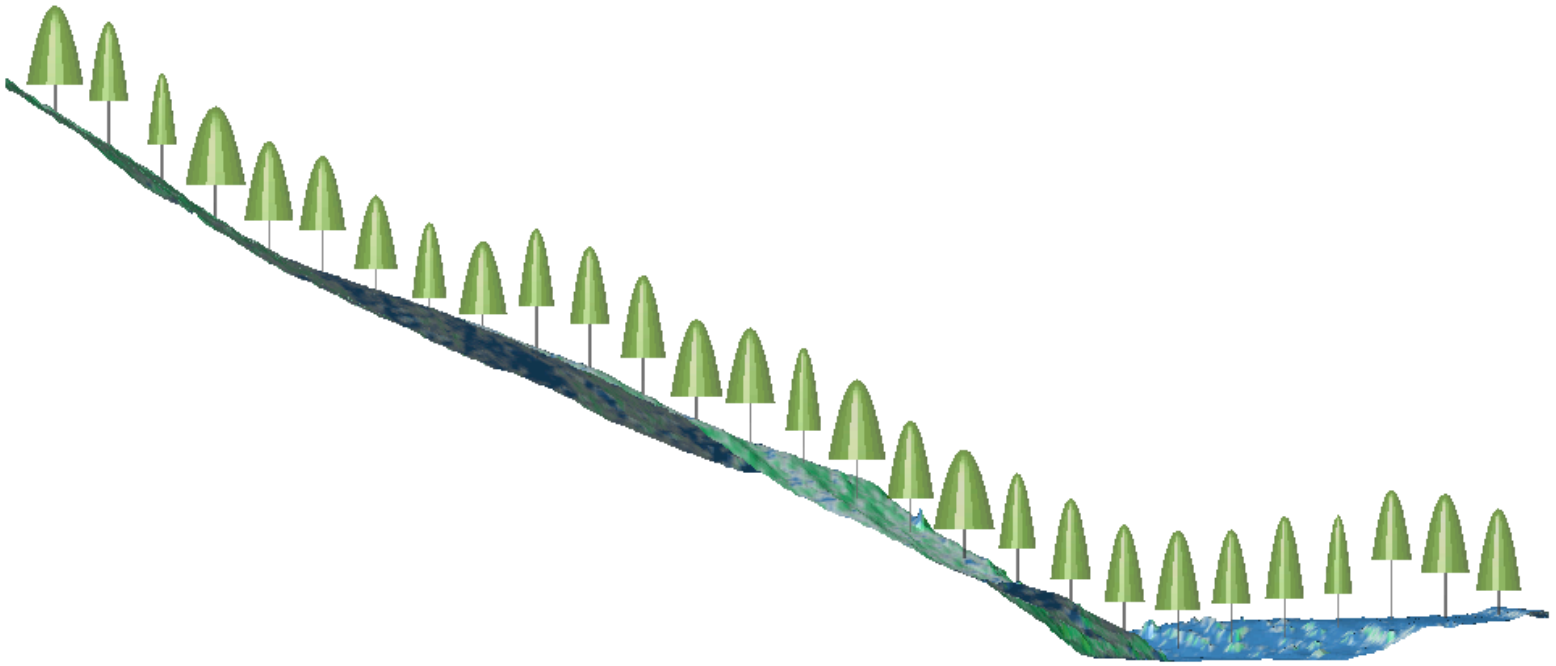
- Fractional cover (fCover) and leaf area index (LAI) are computed from raw laser hits
  - fraction of different echo types
- Method tested and validated with LAI and fCover values from 83 hemispherical photographs



Motivation



Motivation



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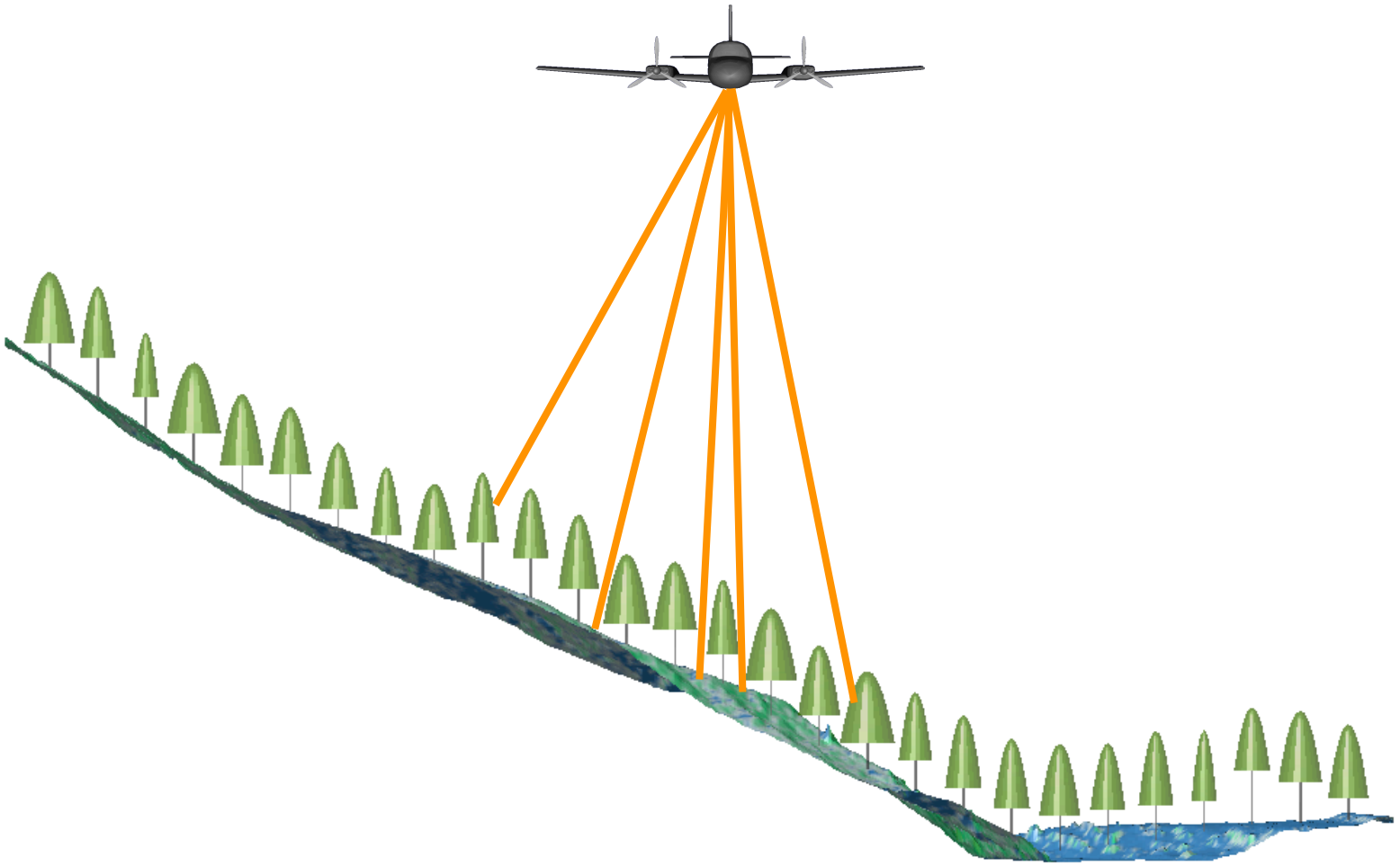

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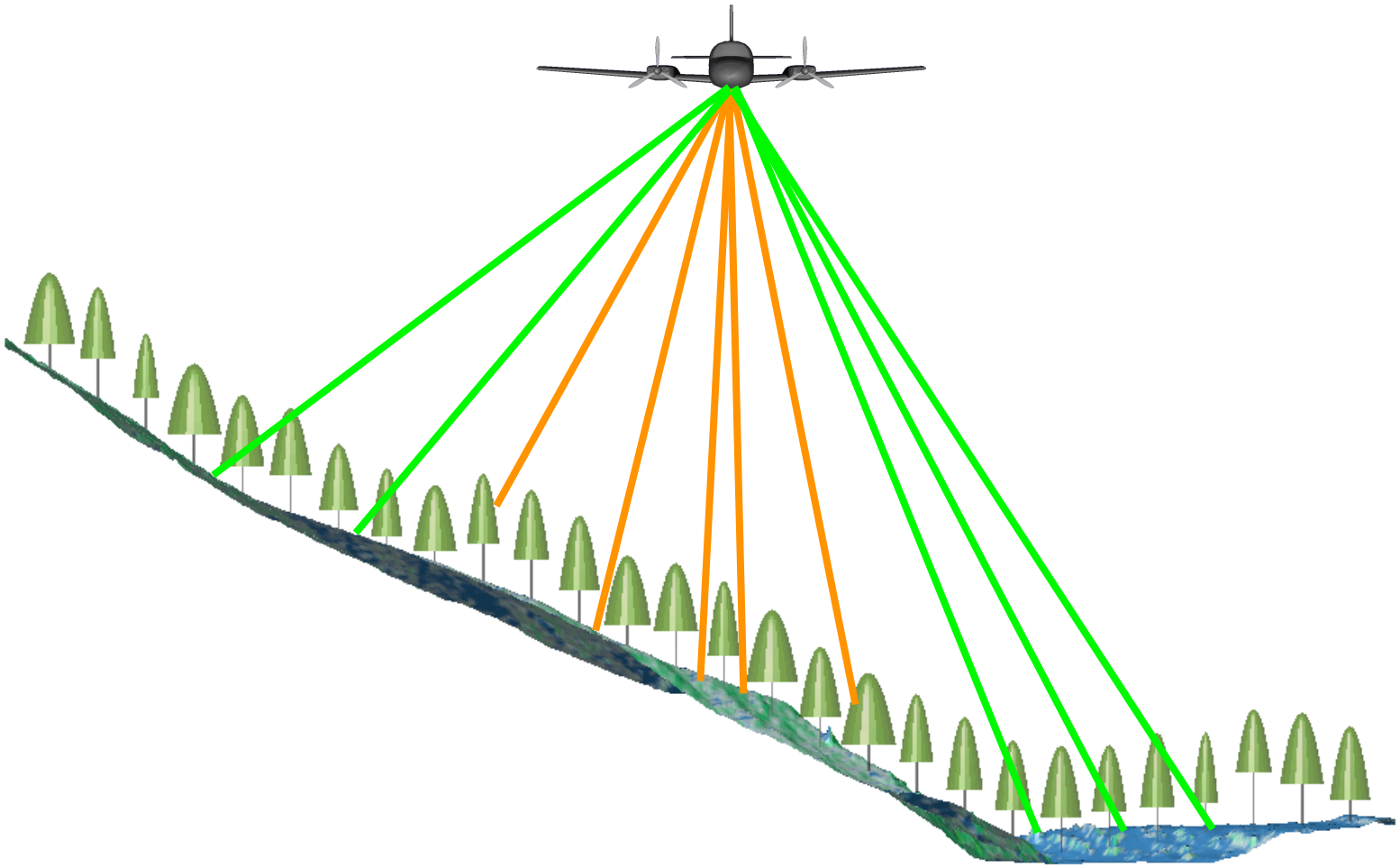

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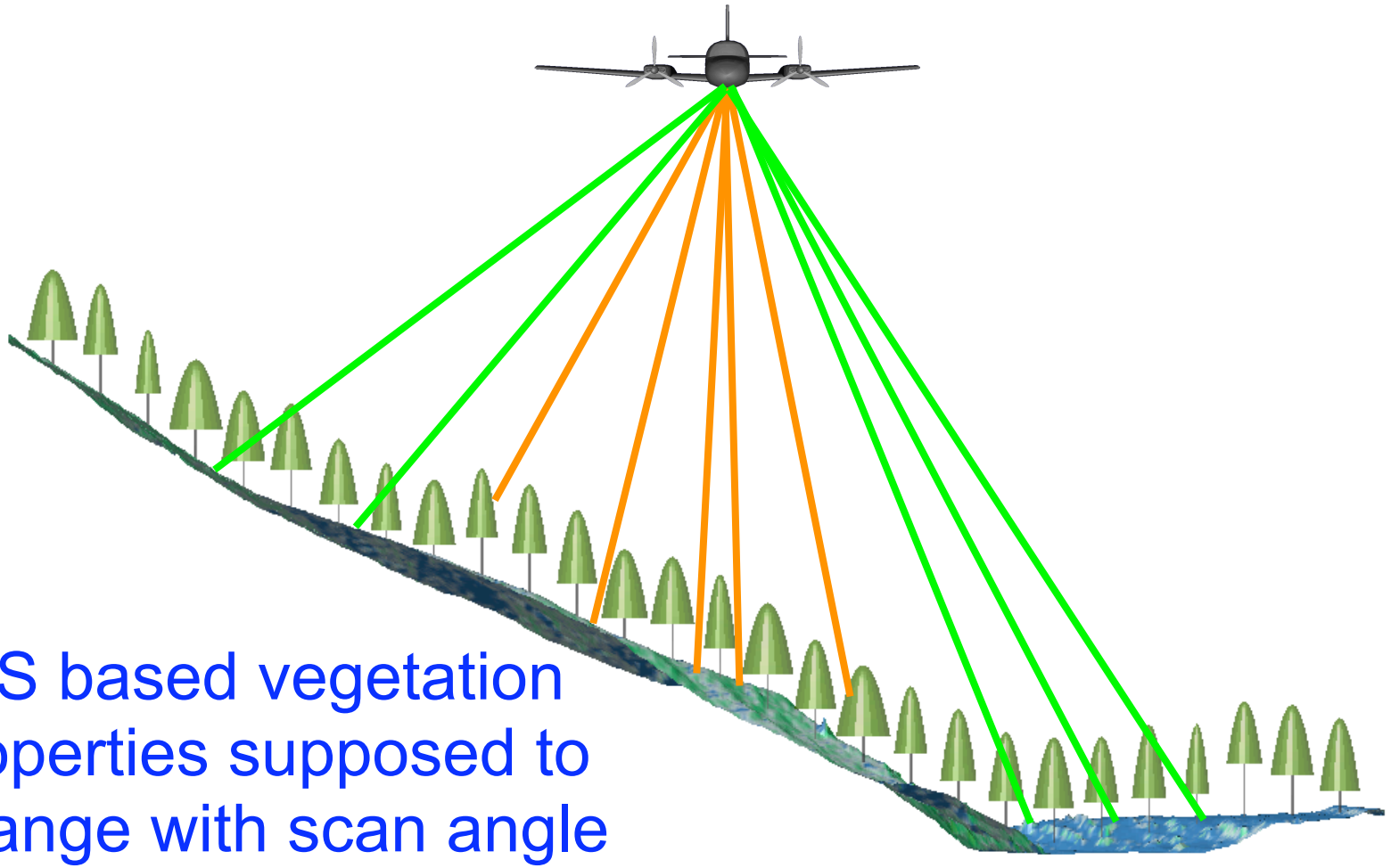
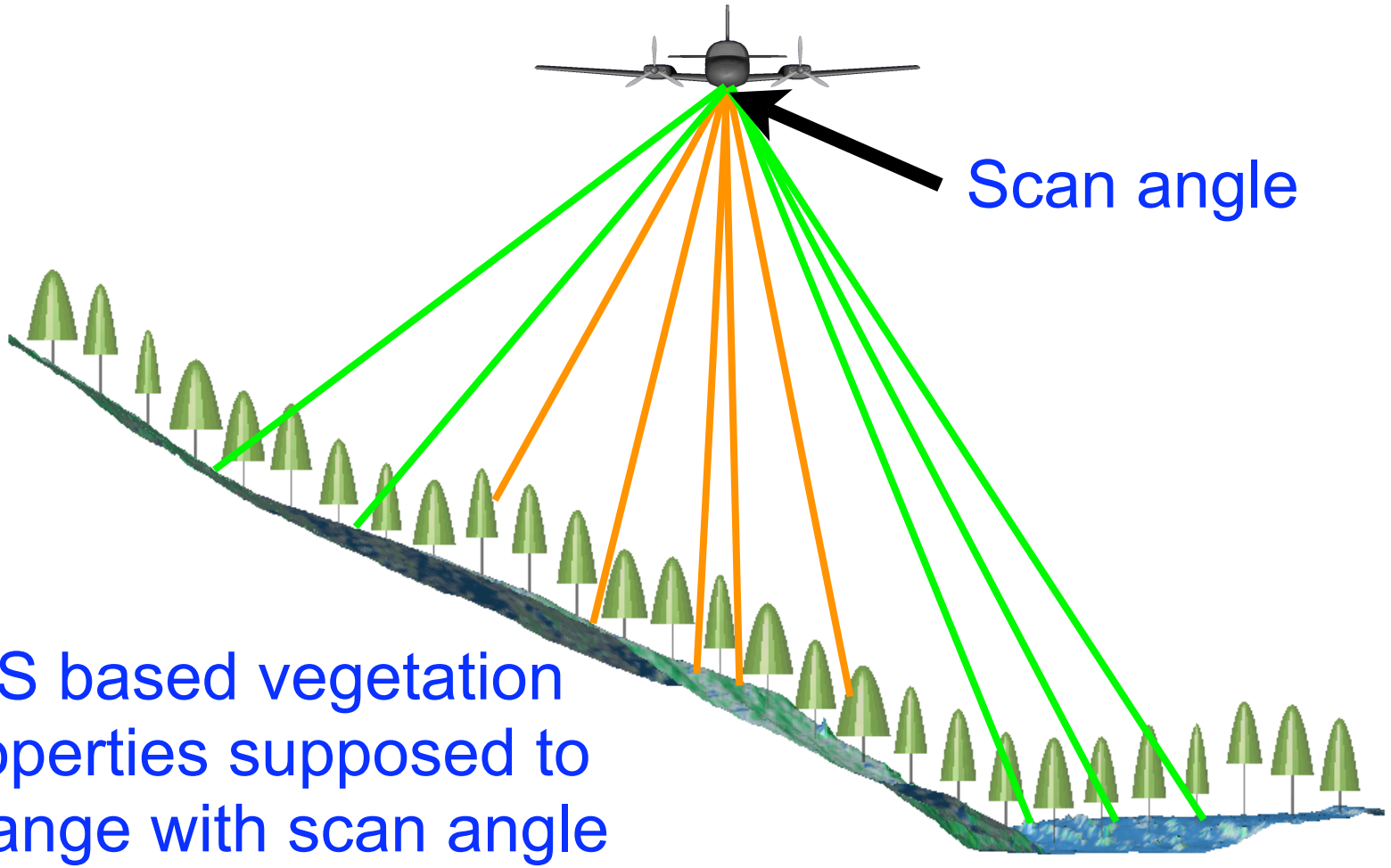


ALS based vegetation properties supposed to change with scan angle

Motivation



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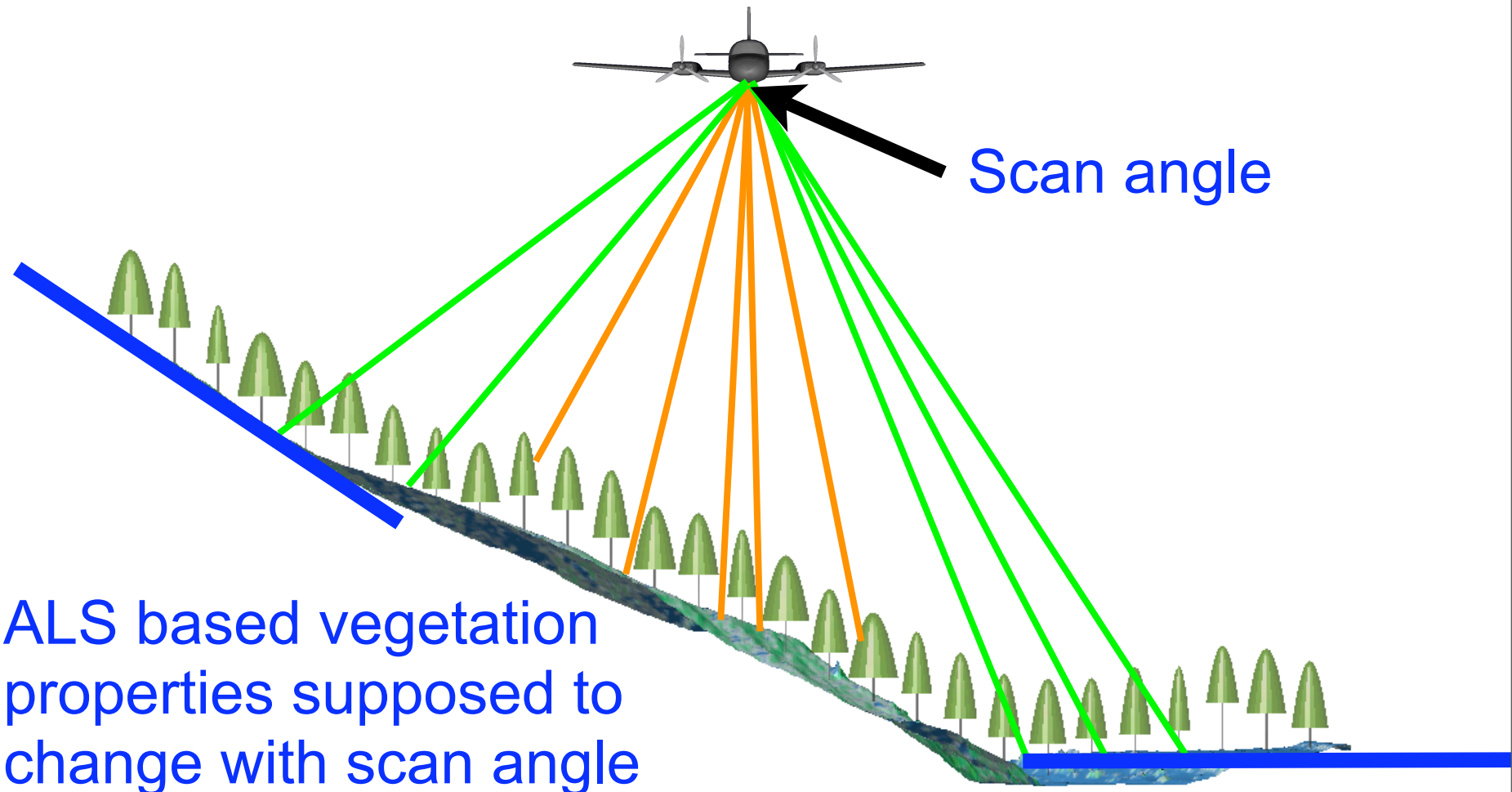

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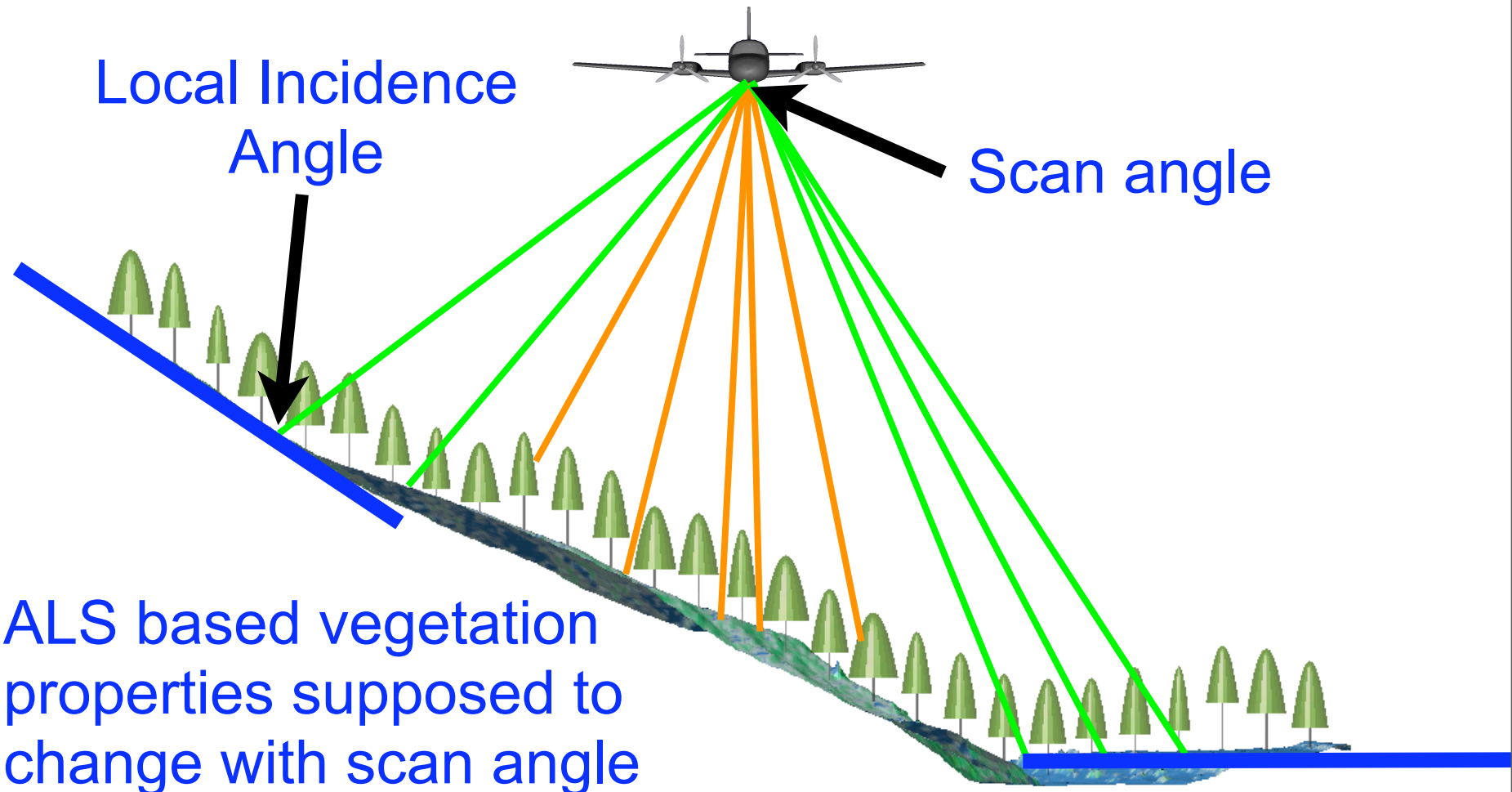

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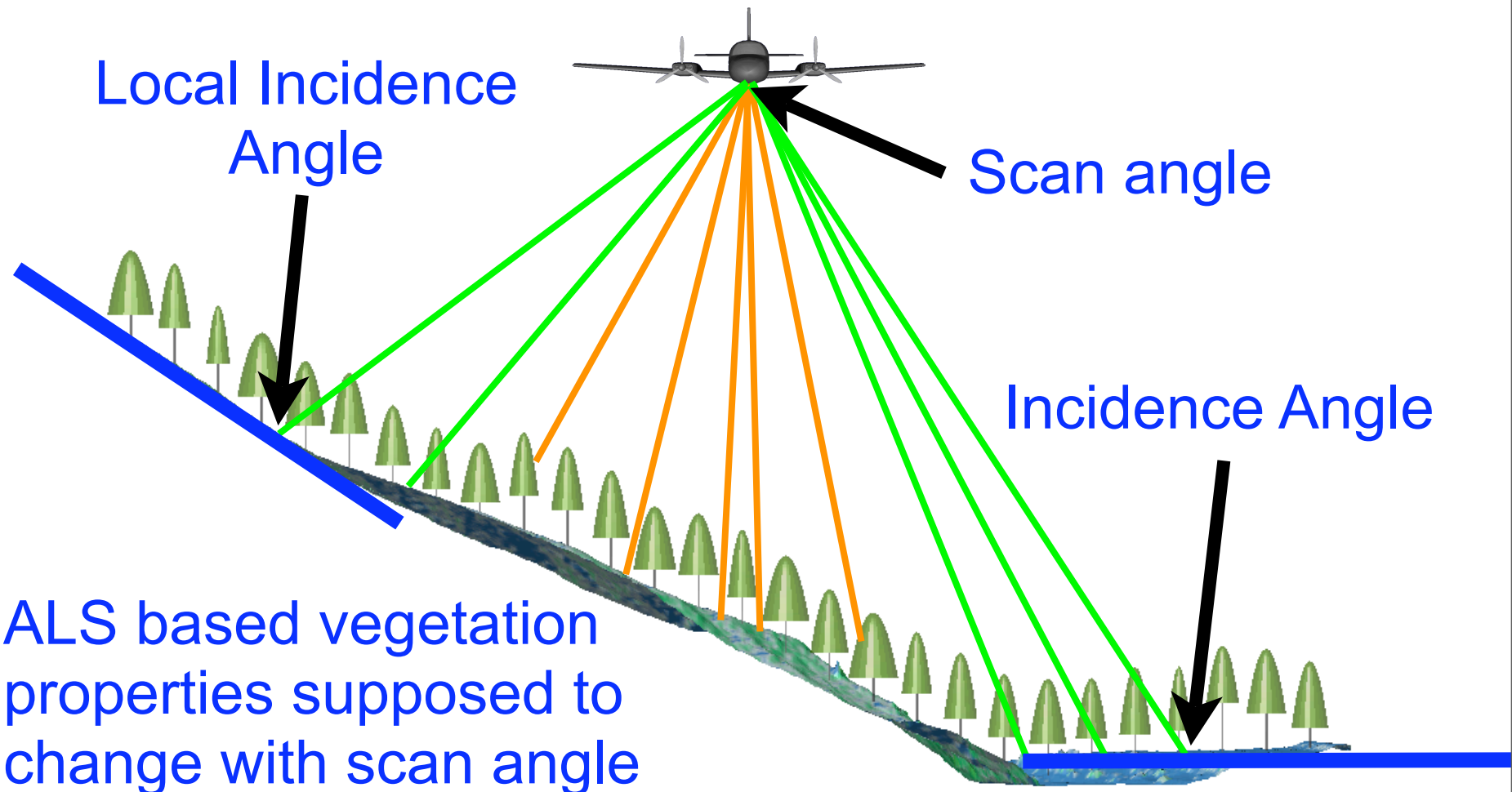
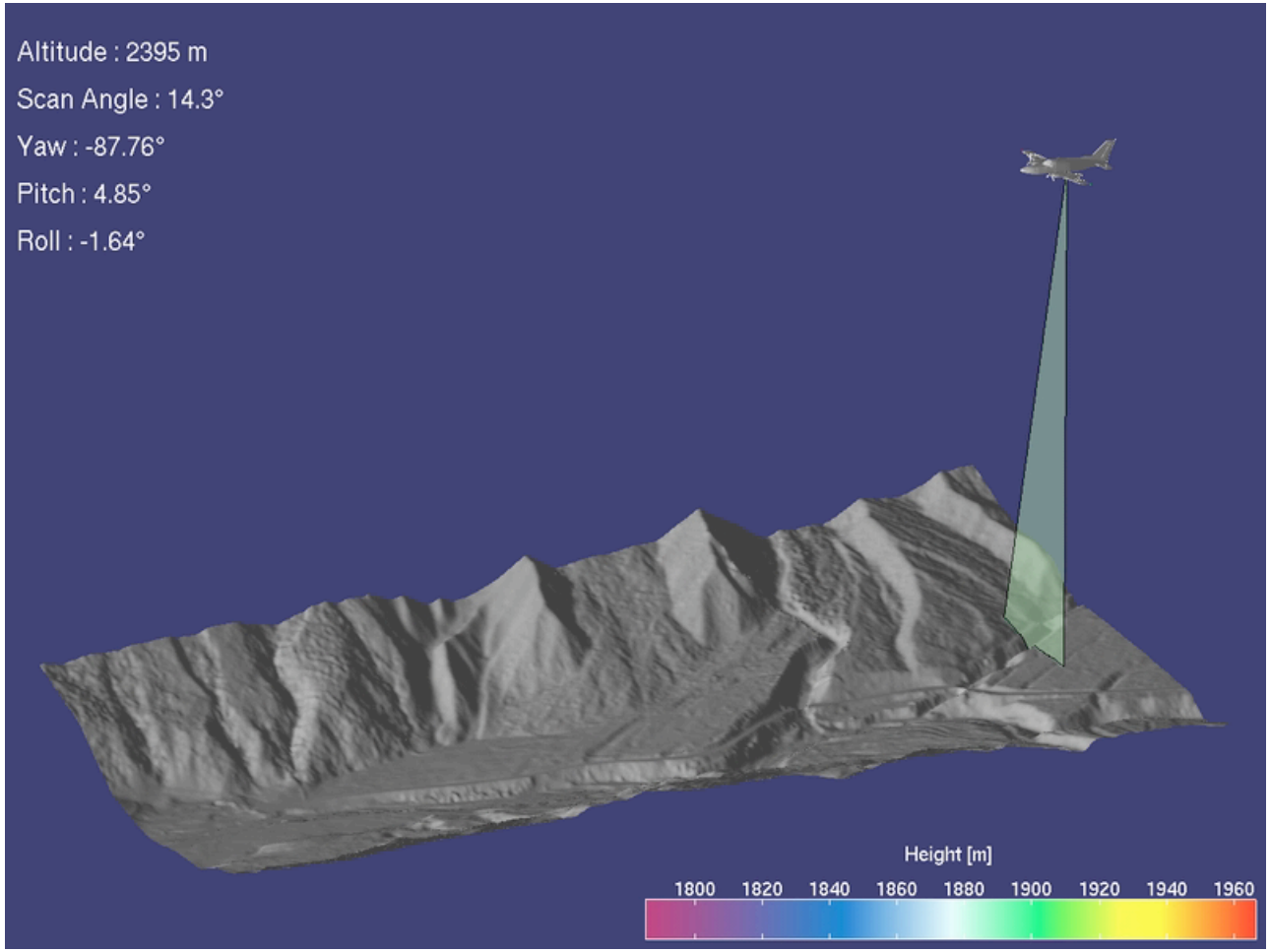


ALS based vegetation properties supposed to change with scan angle

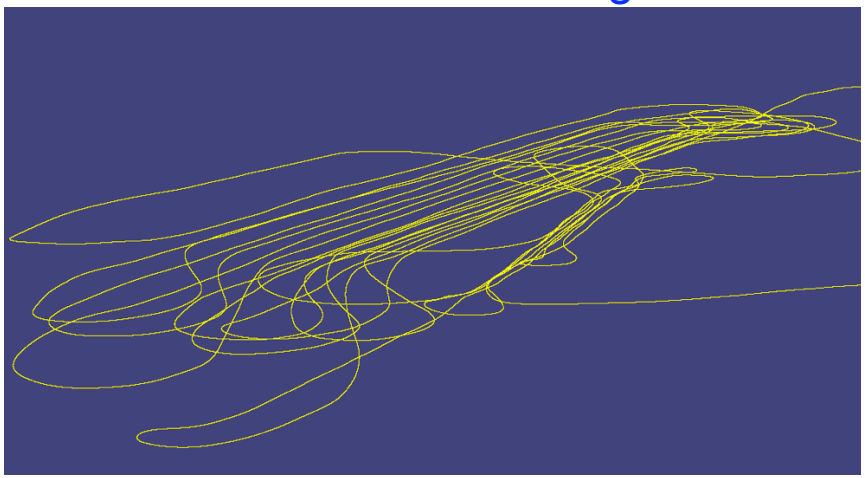
Platform Movements

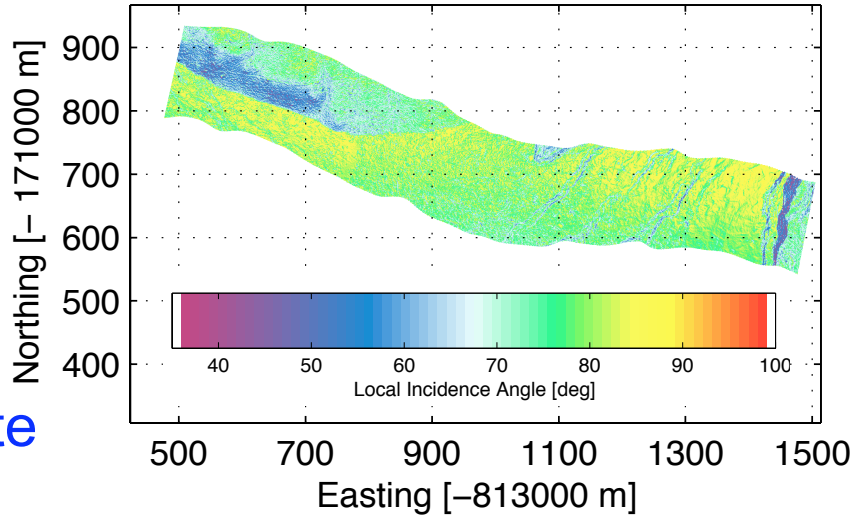
- Platform movement and terrain undulation alters viewing geometry
  - incidence angle
  - local incidence angle
  - point spacing
  - footprint size

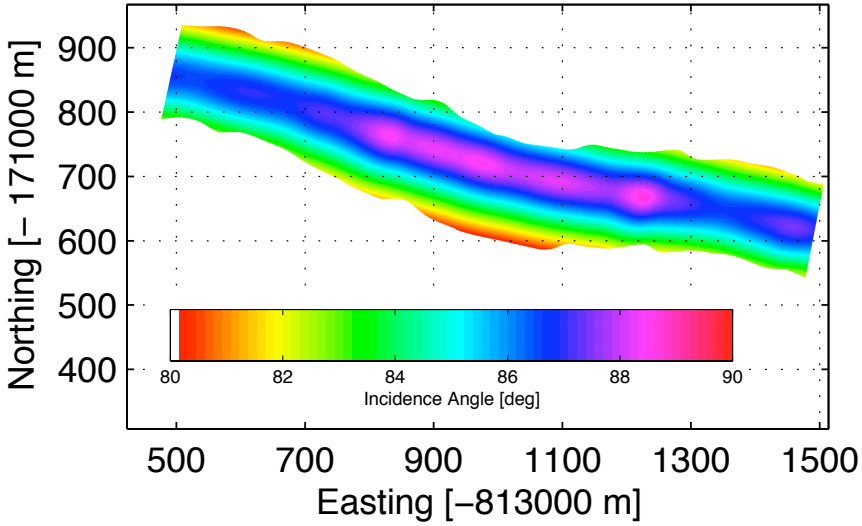


Computation of (local) incidence angle

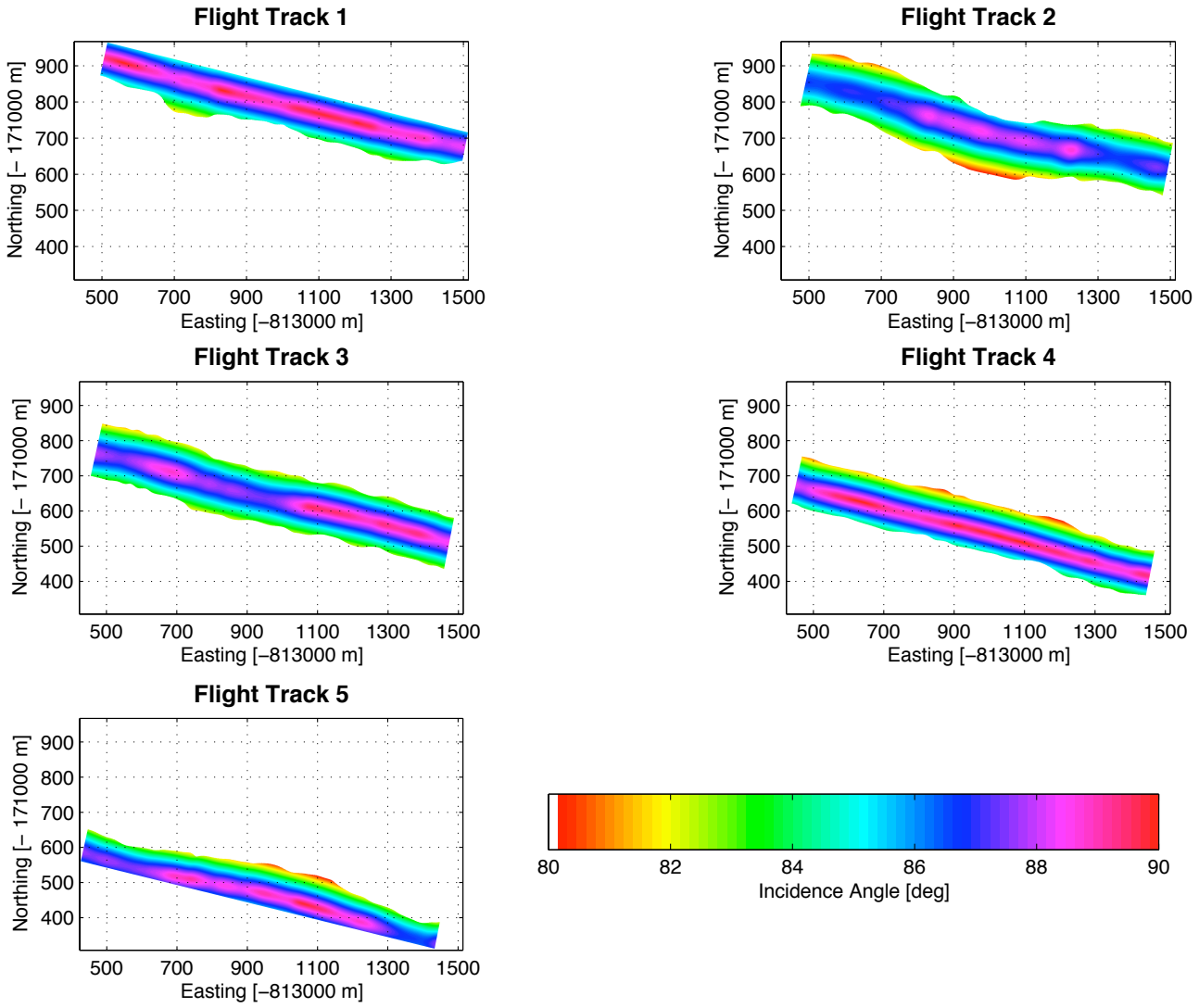
- Flight path data
  - Sensor location and attitude @ 200 Hz
- DTM of lower flight
  - 0.5 m pixel spacing
- For each pixel, backward geocoding is used to compute
  - Incidence angle
  - Local incidence angle



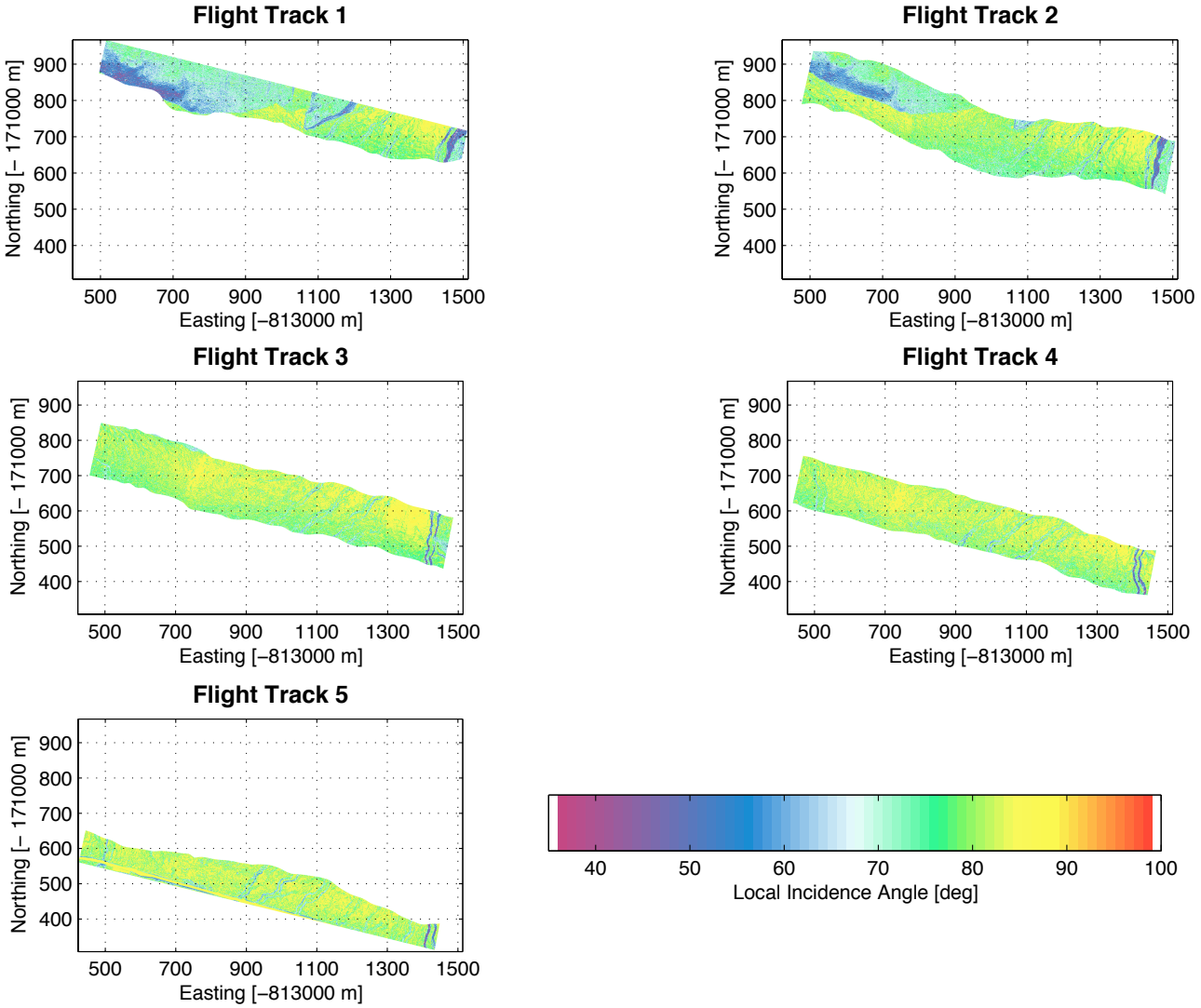




Incidence Angle - 500 m AGL

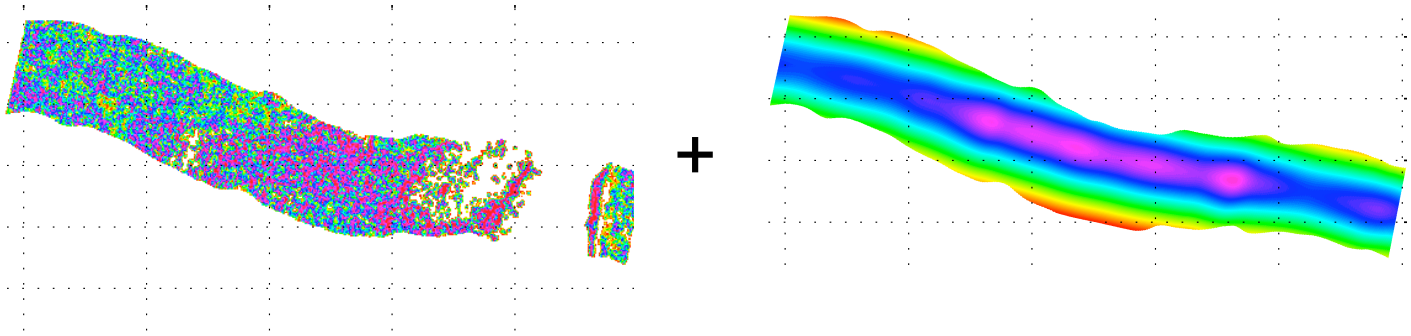


Local Incidence Angle - 500 m AGL

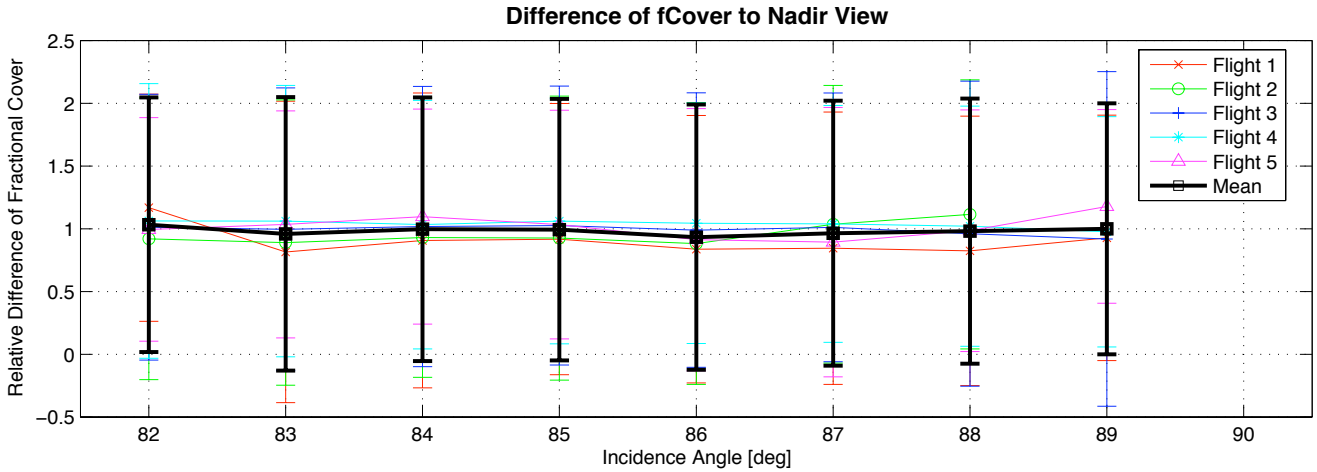


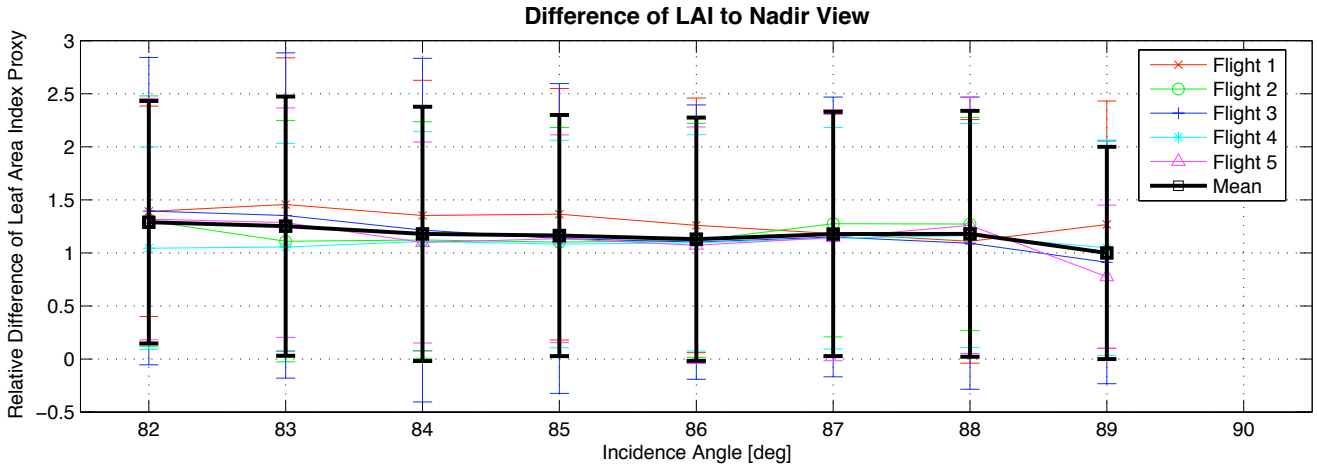
Methods

- For each property (fCover, LAI and tree height) the mean and standard deviation solely based on ALS data are computed for different angle classes
  - relative difference of properties to nadir angle class
- For each field measurement, a difference with ALS based estimates was computed
  - using the maps of local incidence and incidence angle these differences are assigned to an angle class
  - for each angle class, mean and standard deviation of the differences are computed



Results - Incidence Angle - fCover and LAI, 500 m AGL

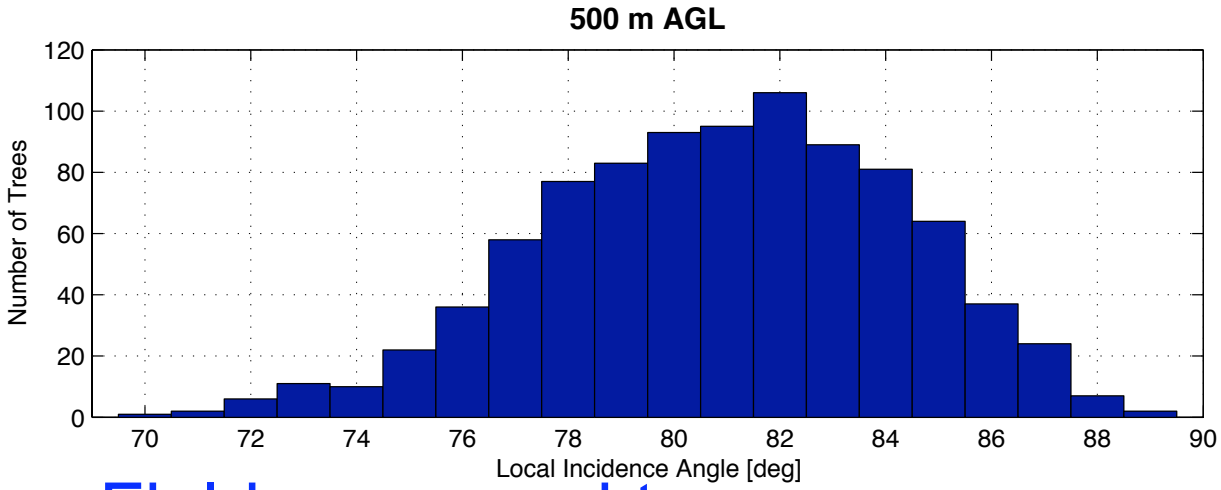




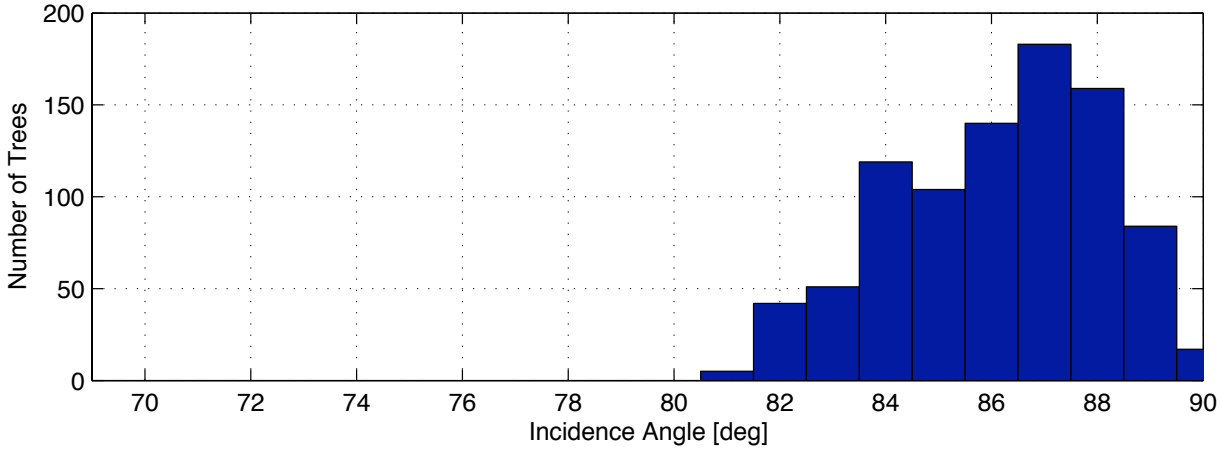
- Relative difference based solely on ALS estimation

Results - Distribution of field data

- Number of field measured trees per angle bin
- Number of hemispherical photographs per angle bin
- low values for small (local) incidence angles



Field measured trees



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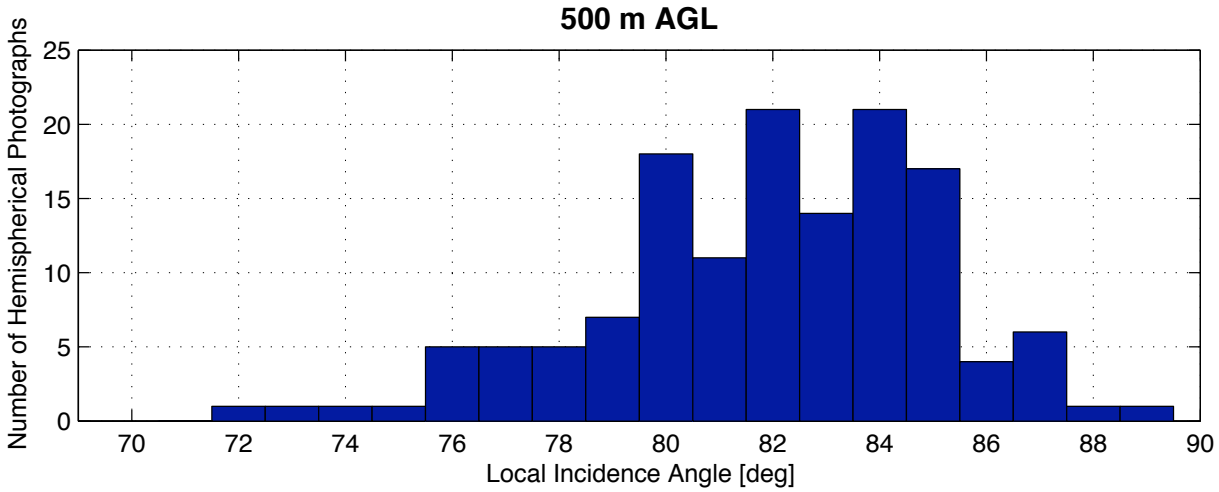
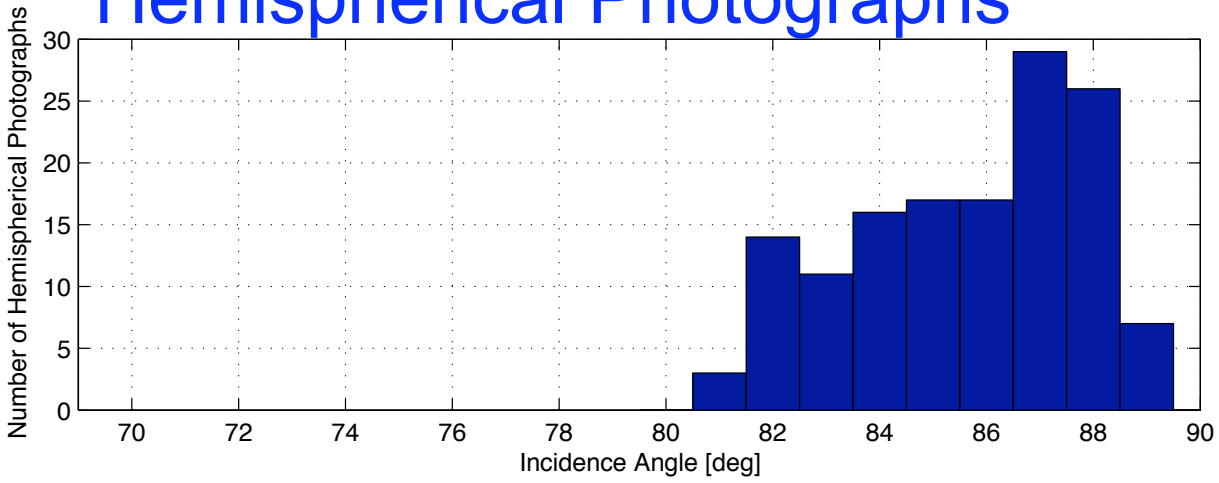
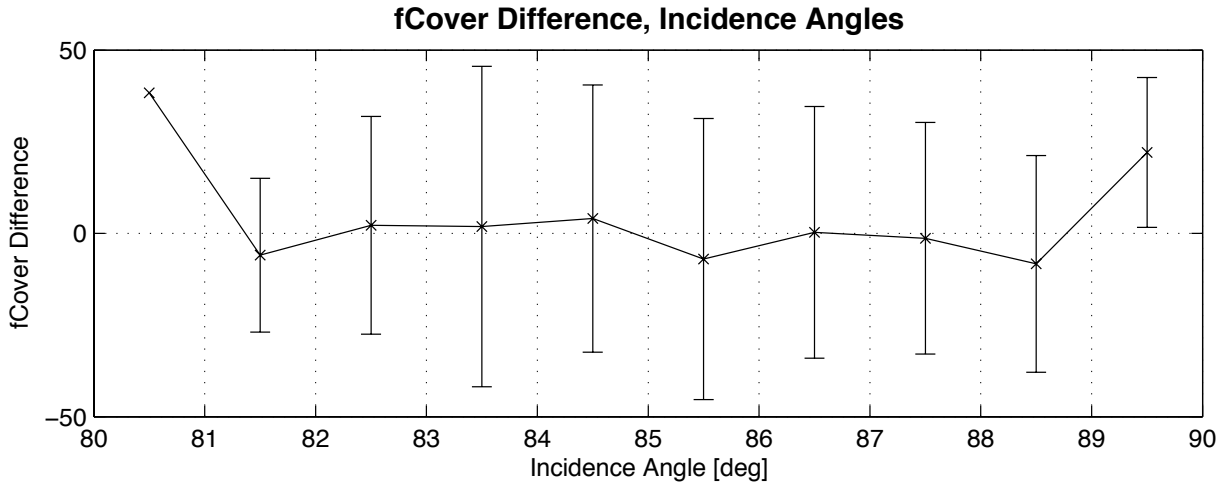
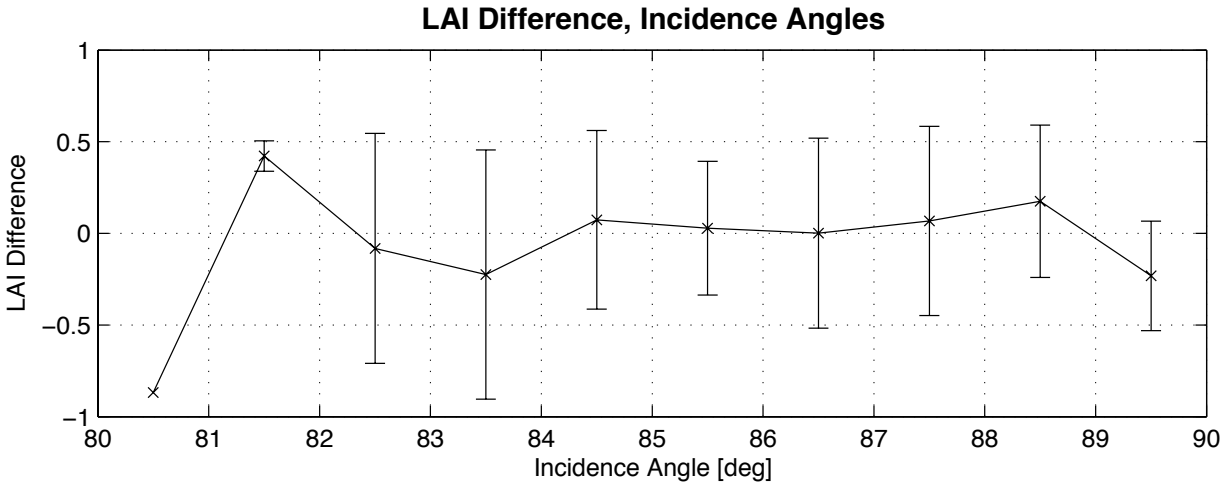


Hemispherical Photographs



Results - Incidence Angle - fCover and LAI, 500 m AGL





- Absolute difference based on field measurements

Results - Flight Altitude

Absolute difference: ALS estimates - field measurements	Mean	Median	Std. Deviation	Samples
fCover 500 m AGL [%]	1.21	10.7	33.7	139
fCover 900 m AGL [%]	-10.2	-8.3	30.7	166
LAI 500 m AGL	-0.06	-0.18	0.56	156
LAI 900 m AGL	0.29	0.18	0.63	177
Tree Height 500 m AGL [m]	-0.38	-0.05	1.39	658
Tree Height 900 m AGL [m]	-0.69	-0.29	1.49	485

- ALS based fCover decreases with flying altitude
  - about 10 % from 500 m AGL to 900 m AGL
- ALS based LAI increases with flying altitude
  - about 0.3 from 500 m AGL to 900 m AGL
- Tree height underestimation increases with flying altitude
  - from 0.38 m at 500 m AGL to 0.69 m at 900 m AGL
- Standard deviations for vegetation density estimates are large

Summary and Discussion

Summary and Discussion

- Tree height and vegetation density estimations not significantly affected by incidence angle variation **IF** scanning angle is small (less equal 7.15 degrees...)
  - LAI shows a slight increase towards smaller incidence angles, further studies needed here ...
- Height dependencies more evident
  - fCover estimations decrease with flying altitude
  - LAI estimations increase with flying altitude
  - Tree height underestimation increases with flying altitude
- Study should be carried out using data from larger scan angles
- Numerical simulations might prove more useful for quantification of acquisition geometry effects on ALS data products !

Last slide ...

Last slide ...