Cal/Val Activities at the Harvard Forest in Support of the DESDynI Mission

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Goals

Create a resource for analyzing SAR, InSAR and Lidar data, relevant to the DESDynI mission, for the purpose of algorithm development and error analysis

Inputs:

- ALOS/PALSAR data (FBS, FBD and PLR)
- UAVSAR overflights (Aug. 2009)
- LVIS overflights (July 2009 & July 2006)
- High-resolution imagery (30 cm) and single-shot high-resolution lidar (1m footprint)
- Terrestrial scanning lidar for selected sites (Echidna)
- 15 1-hectare plots, covering a range of vegetation types and degrees of maturity.

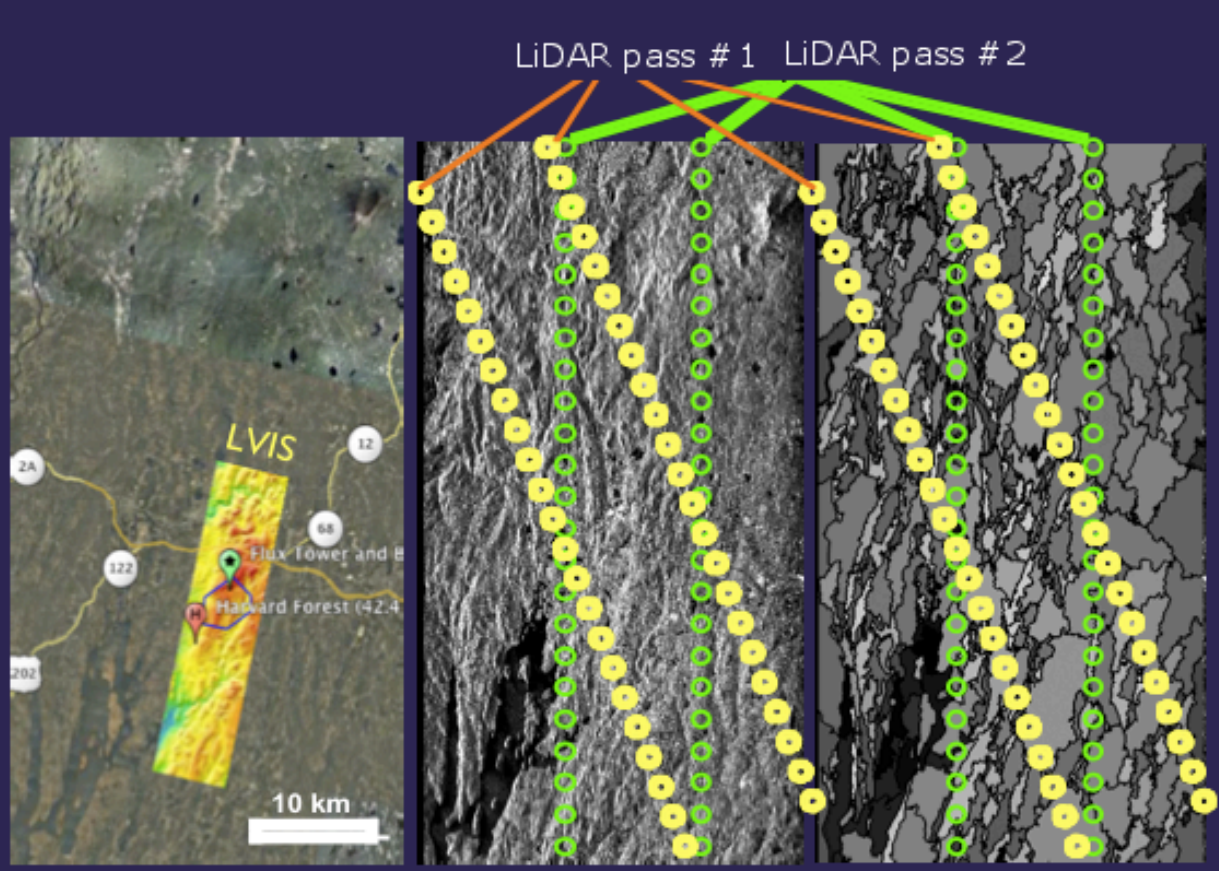
Motivation: Segmentation Approach

- Due to difficulties in measuring structure from backscatter and repeat-pass interferometry, an alternate approach to structure estimatation is being investigated.

- Relies on the fundamental sensitivity of SAR backscatter power, texture and polarimetry to varying ground cover.

- Aggregate regions of a like response via an image segmentation

- Utilize coicident LiDAR observations on a scene by scene basis to assign values of interest to the segmented RaDAR image.

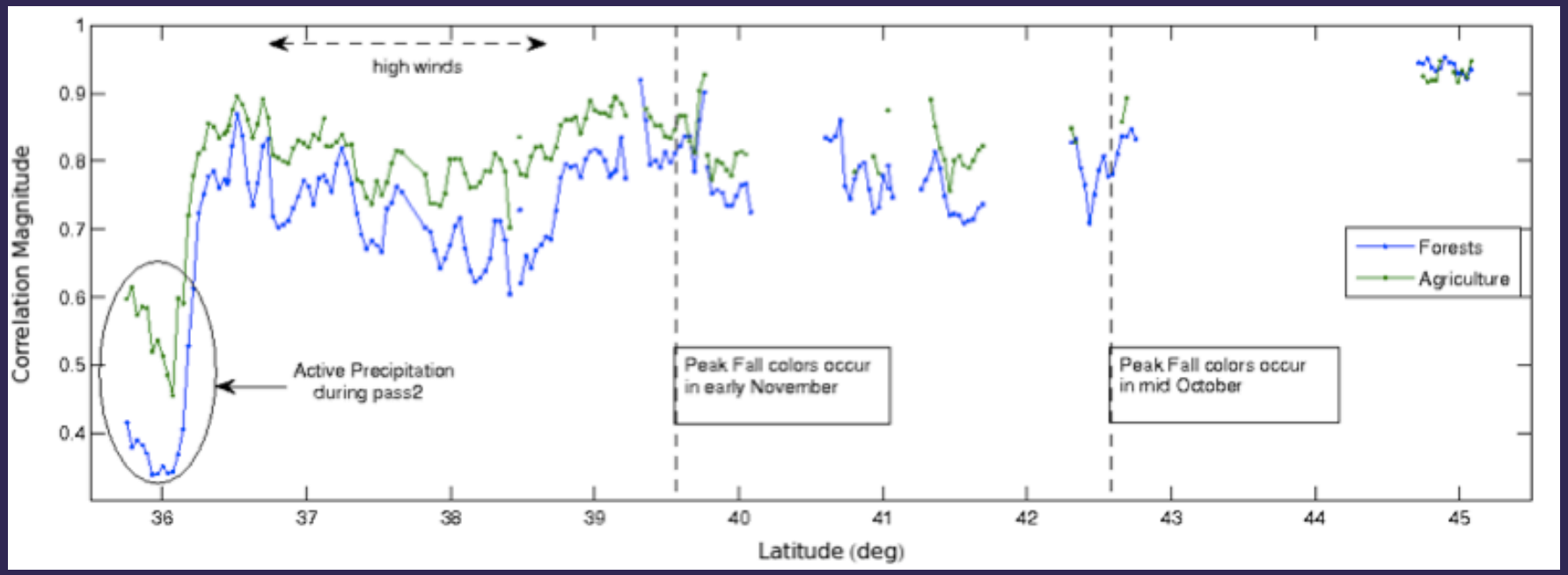


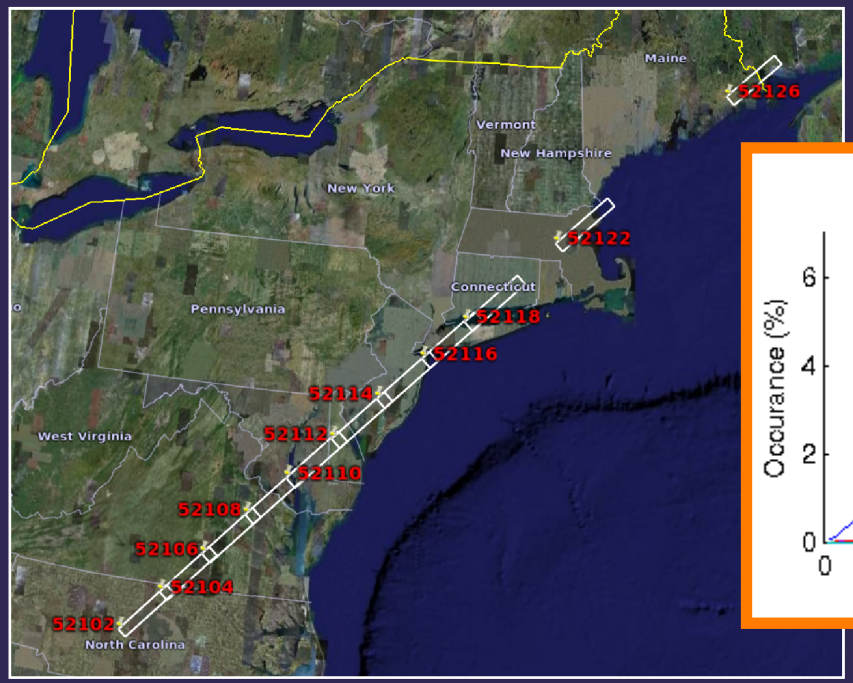
Optical plus full-waveform lidar (LVIS) coverage

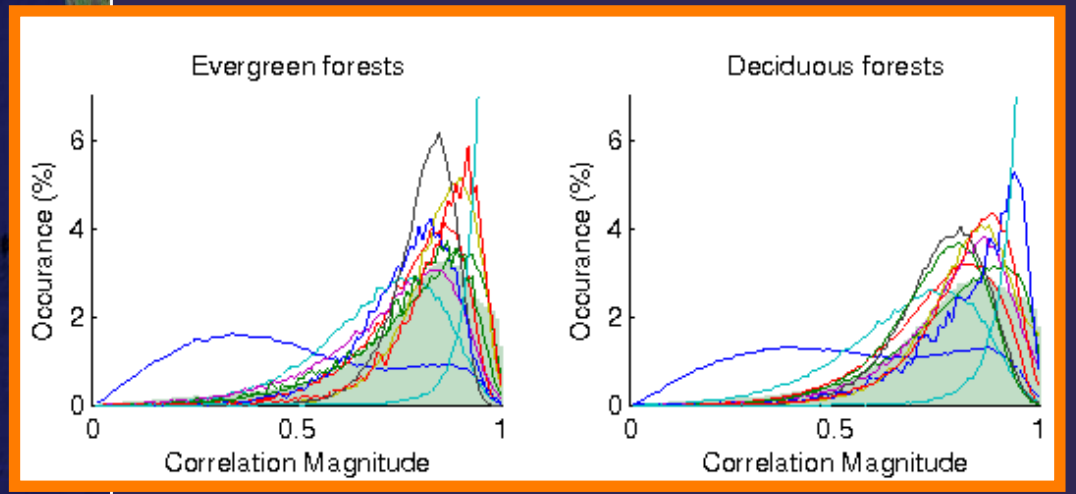
SAR backscatter image

Segmented SAR

Temporal Decorrelation from SIR-C

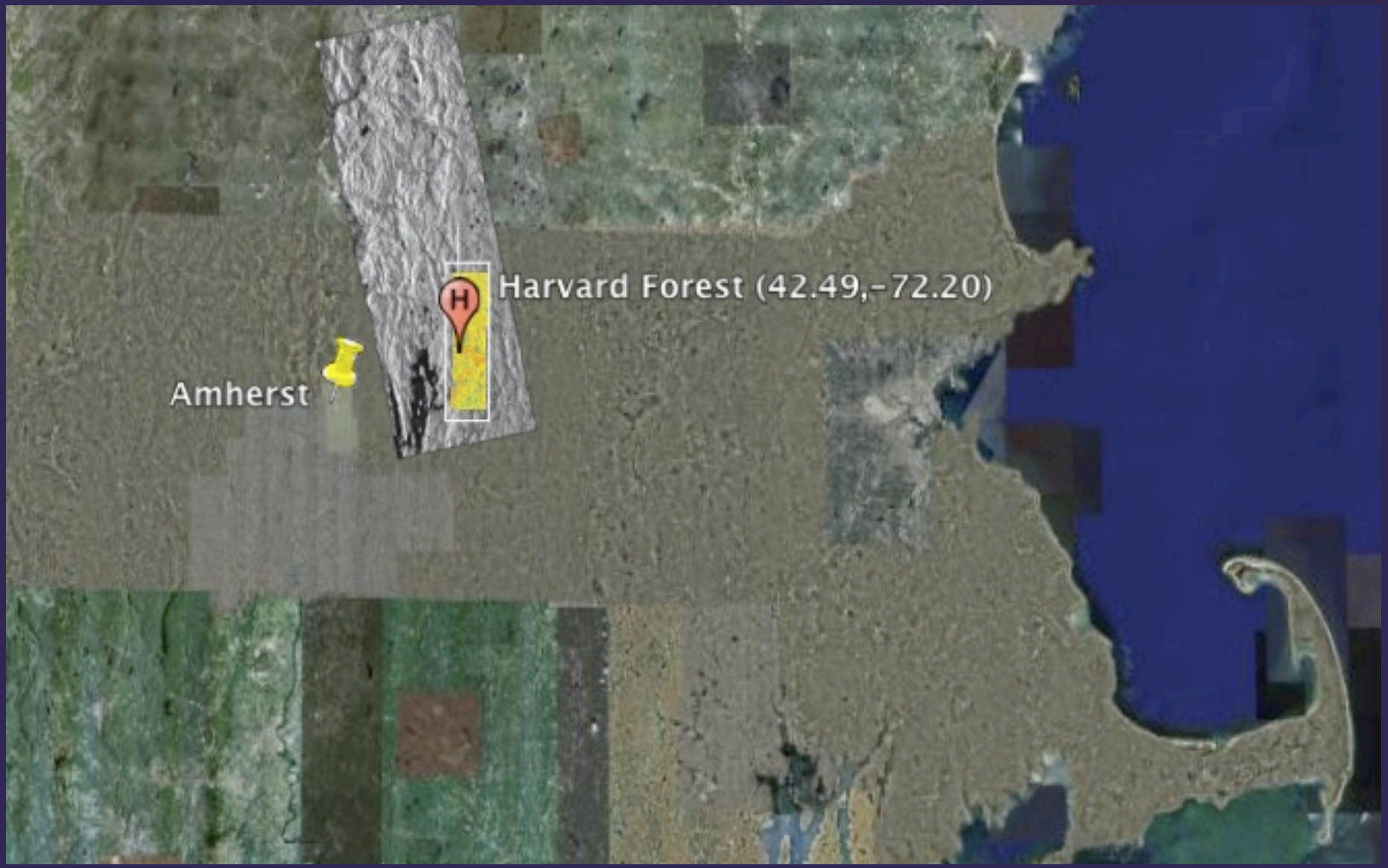






The Harvard Forest as a Test Site

The need for a quantiative method for estimating carbon stocks and biomass continues



General Information

1200 ha in Western Massachusetts, New England Upland Region (200 - 400 m elevation), mean precipitation of 110 cm/ year. Transition Hardwoods, White Pine and Hemlocks.

Dominant Species

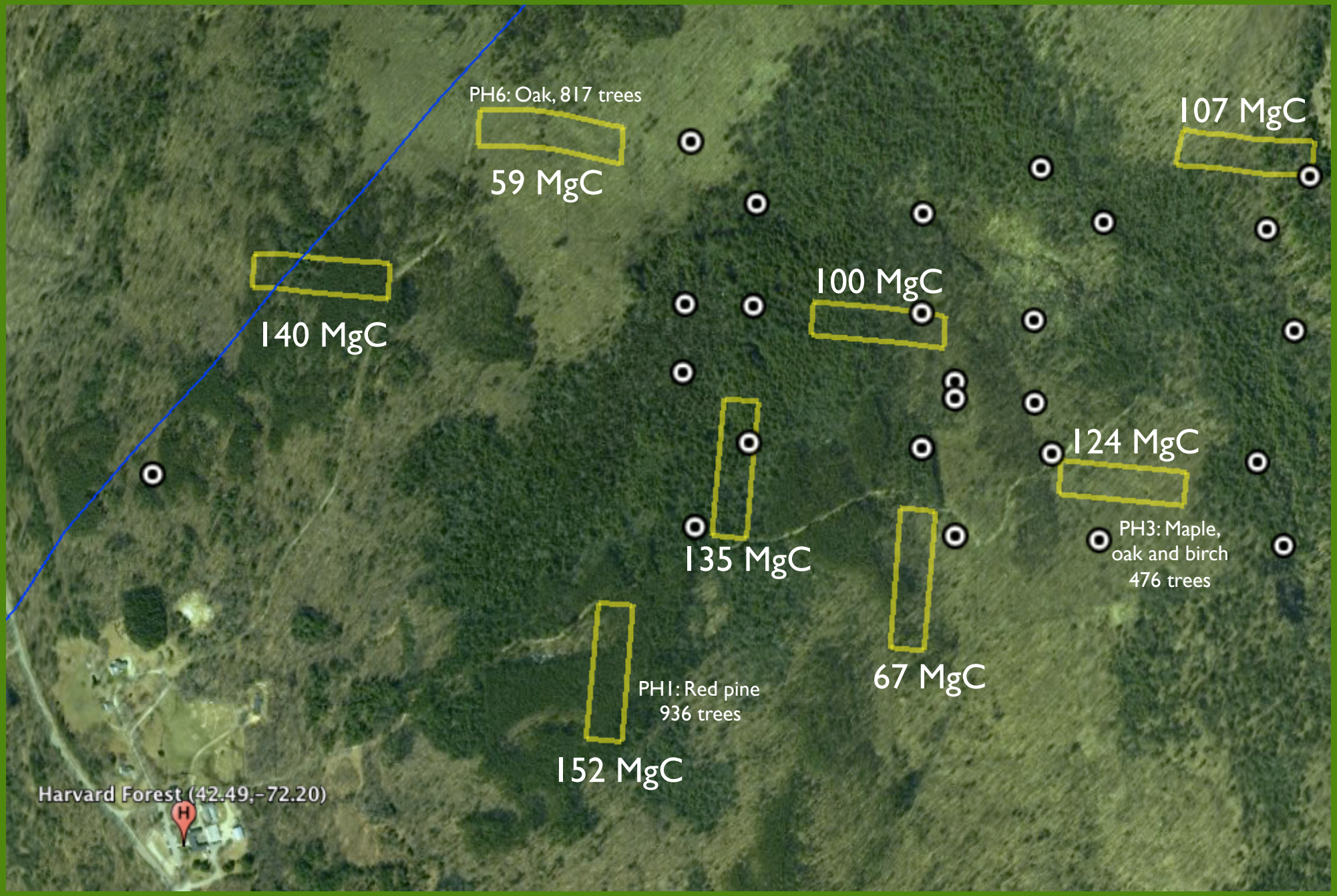
Red Oak, Red Maple, White Pine, Eastern Hemlock

Secondary Species

White and Black Oak, Sugar Maple

- Region was heavily forested in early 20th century.
- Donated in 1907 to Harvard University to study sustainable forestry.

Ground Validation Effort



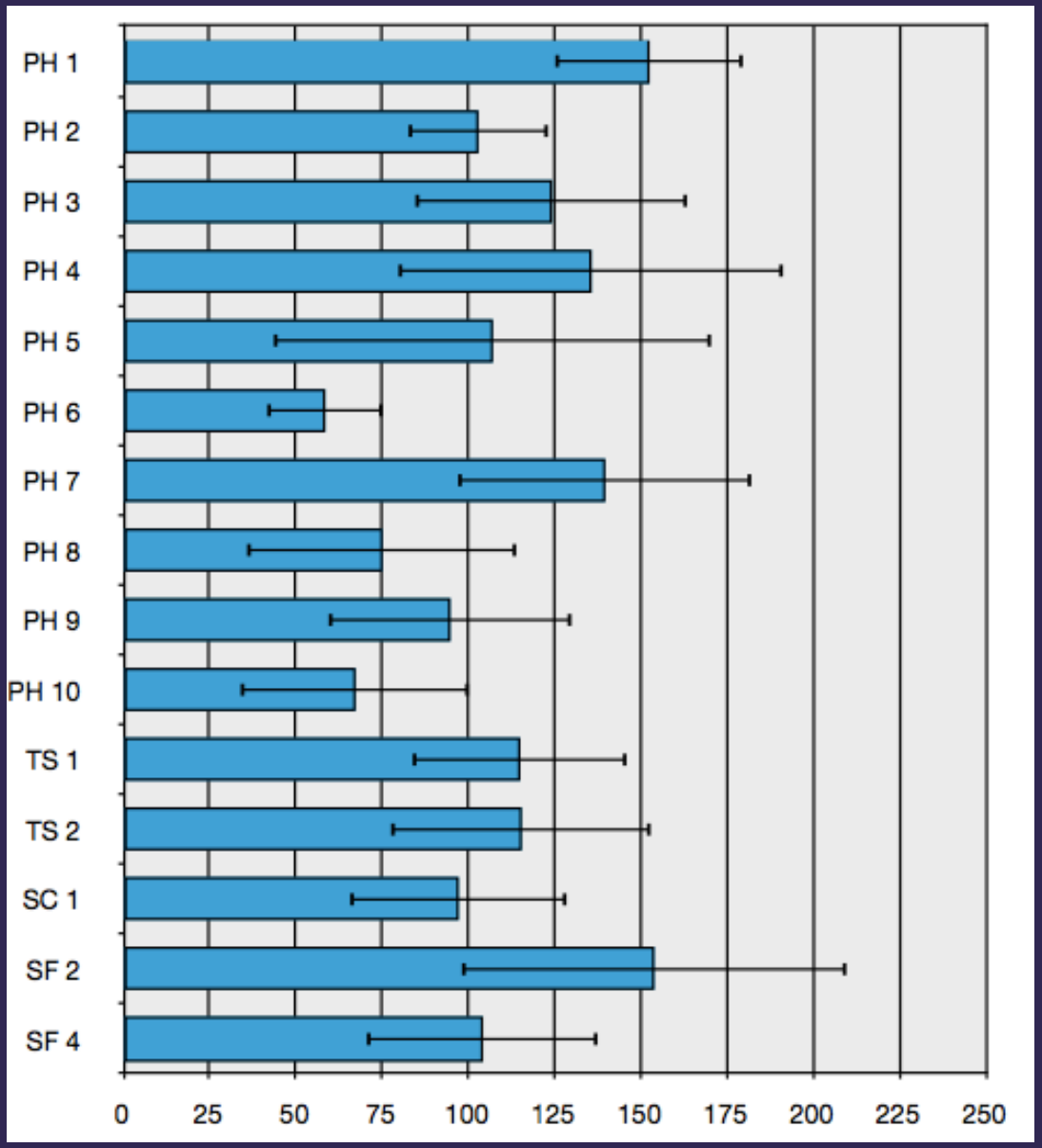
Some Participants

A red pine stand at the Harvard Forest
The tree density : ~1000 trees/ha
Average height : 30 m.

Total trees counted at Harvard: 10166

Yes, fieldwork can be fun!

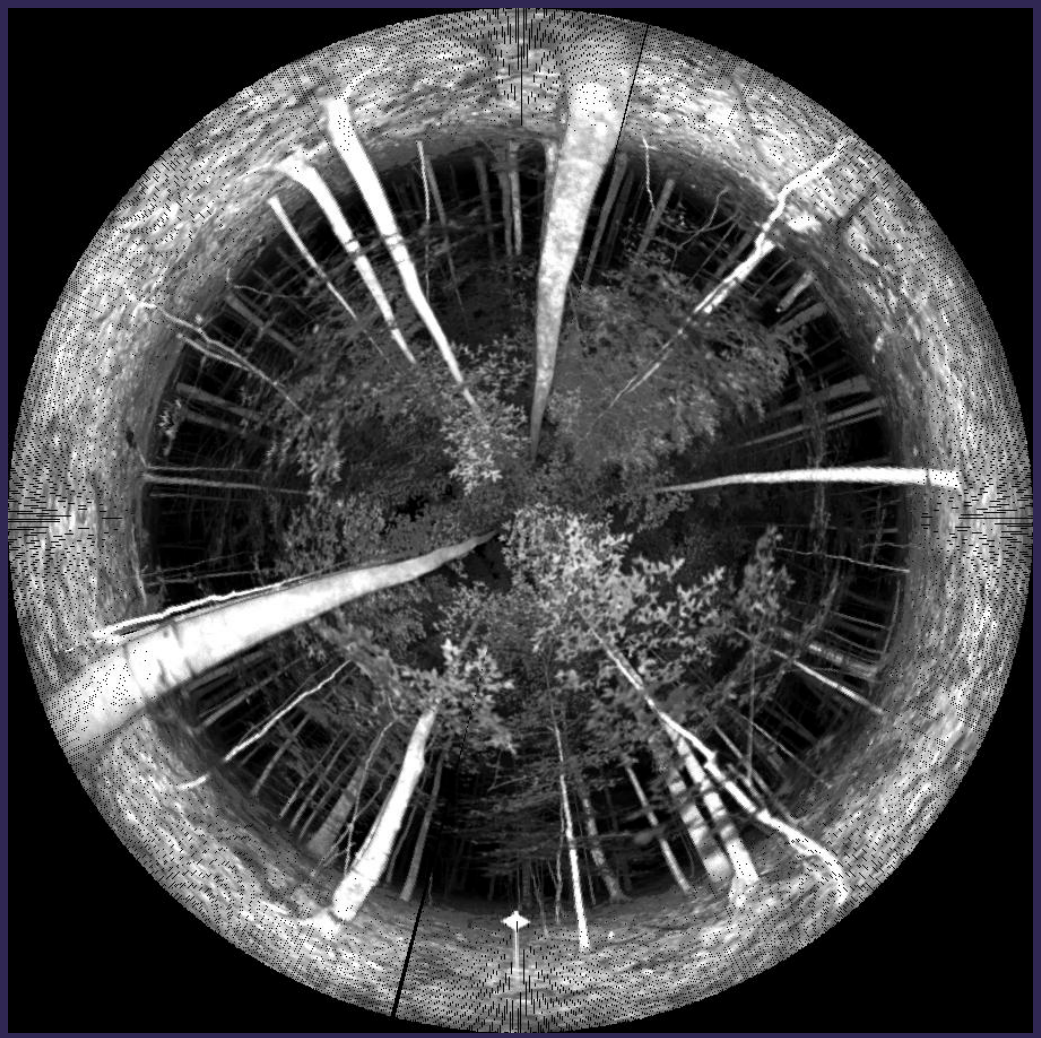
Ground Validation Summary



carbon content MgC/ha

Within the 15 one hectare validation sites, DBH, species and number density were recorded. These are converted into Biomass and carbon content via allometric equations. The reange of biomasses are from 120 to 310 tons per hectare.

Echidna, Ground Based Lidar



A spatial record of the forest structure

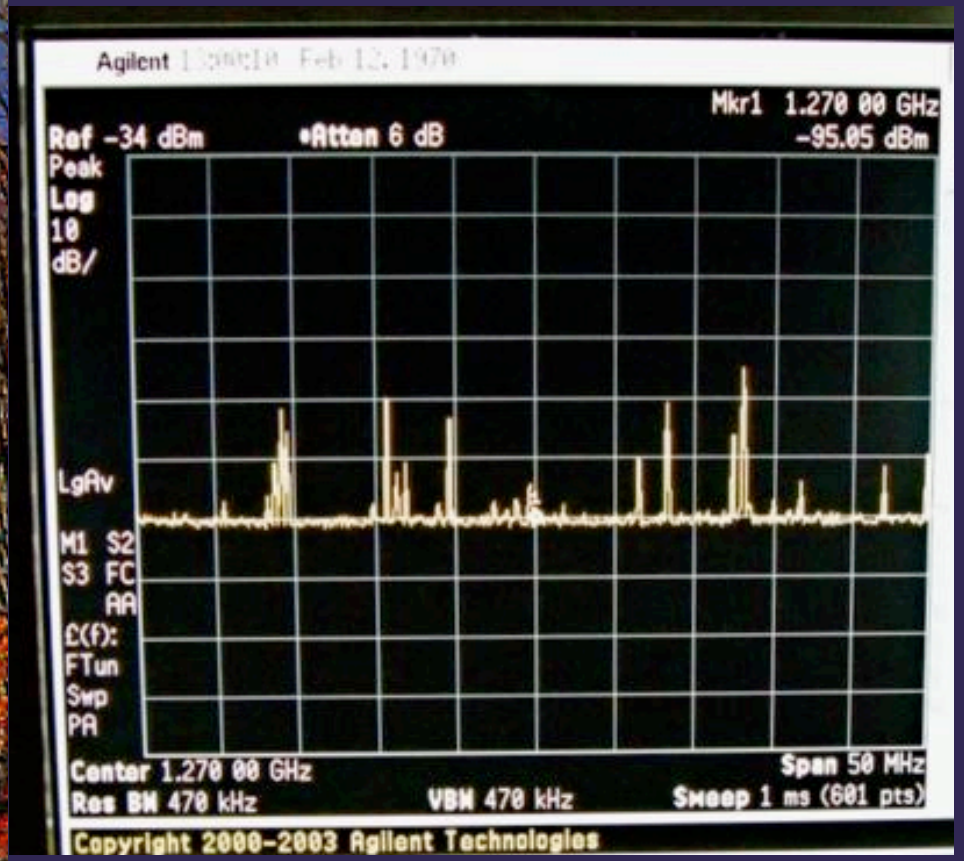
- Echidna works over a region approximately 50m in diameter
- A full scan over one region takes approximately 10 minutes, but can take several hours to set up.
- Nine scans are necessary to fully cover a 50m x 50m area

Ground Calibration of SAR Imagery

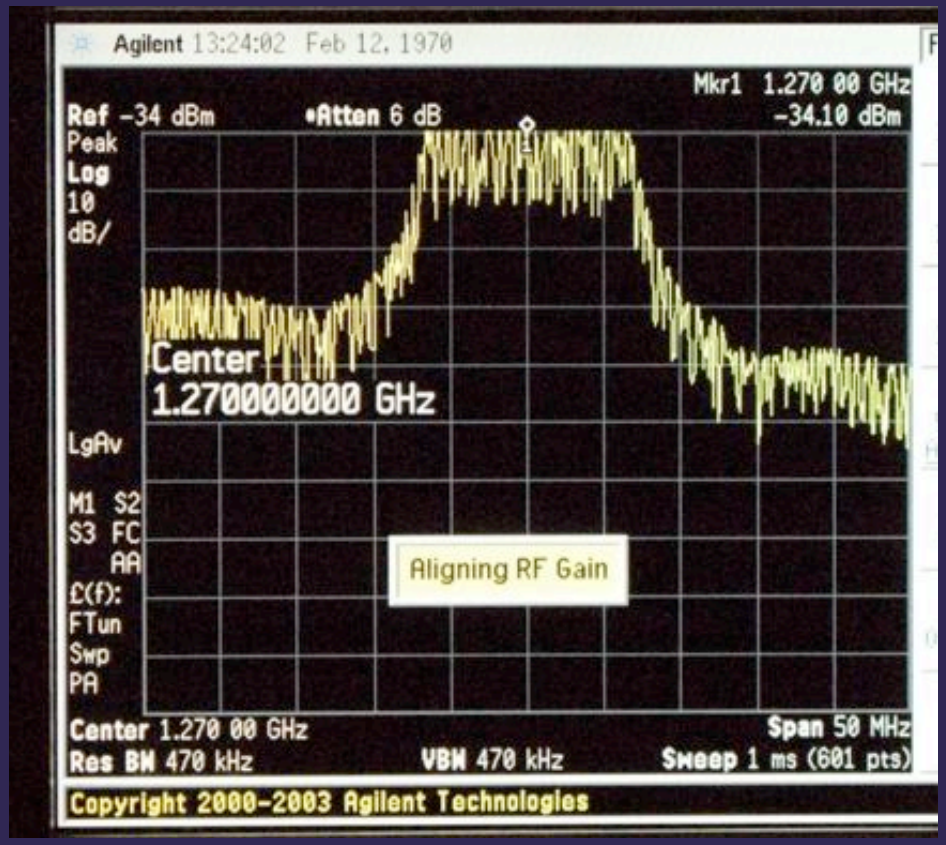
Dual-use, field deployable calibration targets

An active polarimetric calibrator (ProSensing)

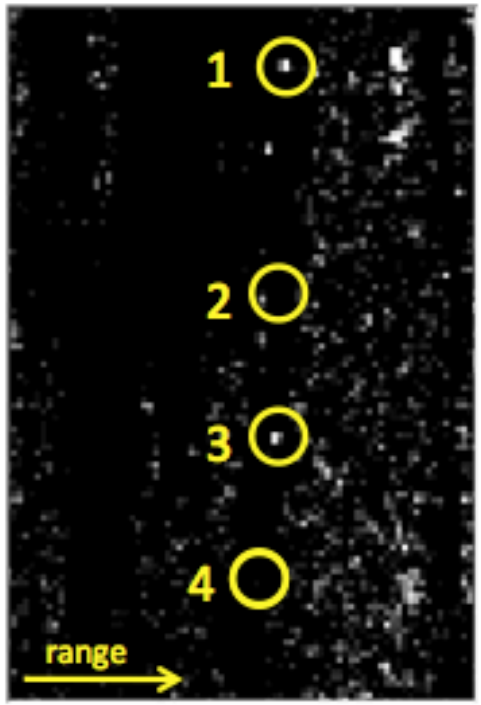
ALOS Spectrum (PLR-14 MHz BW)



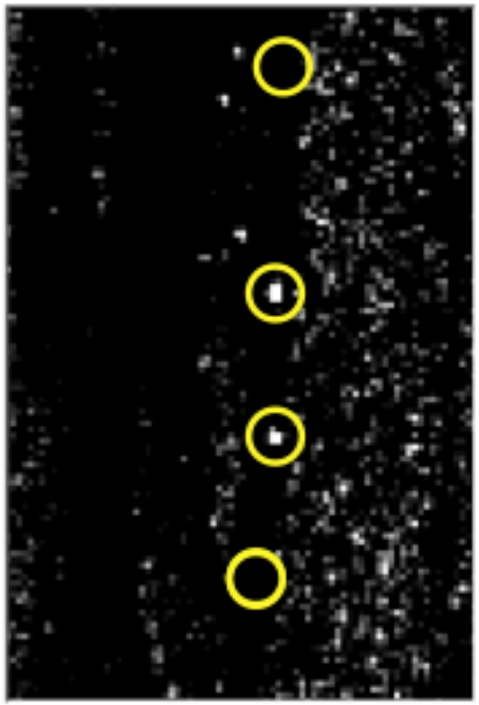
before



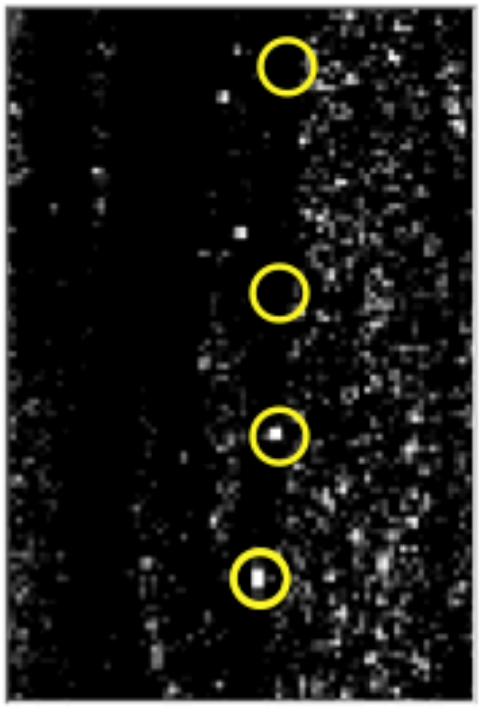
during



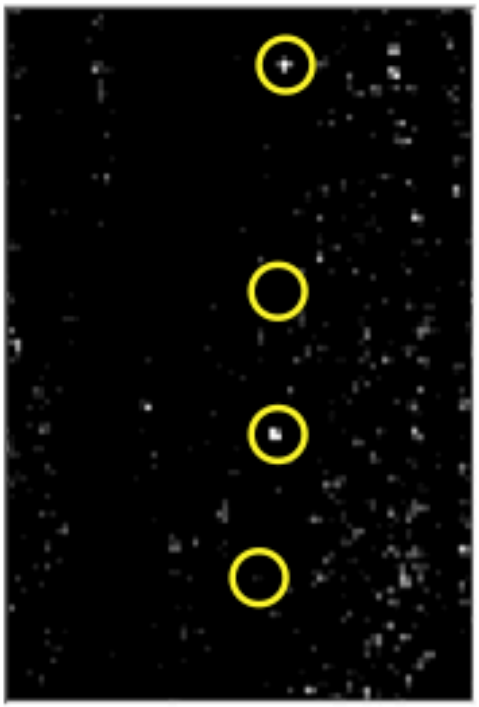
HH



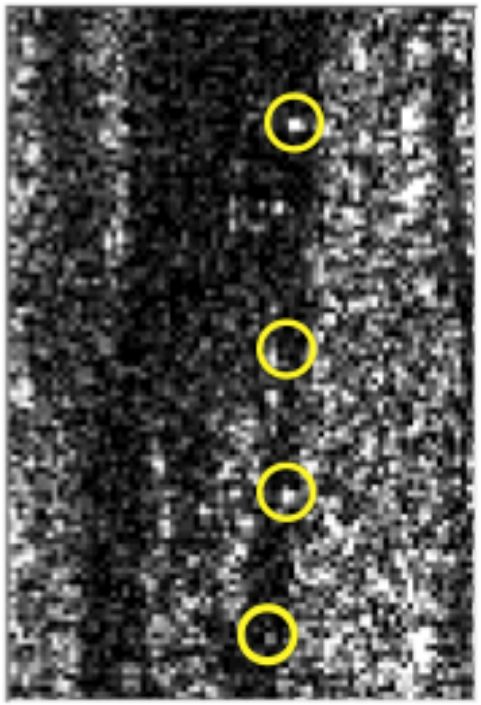
HV



VH



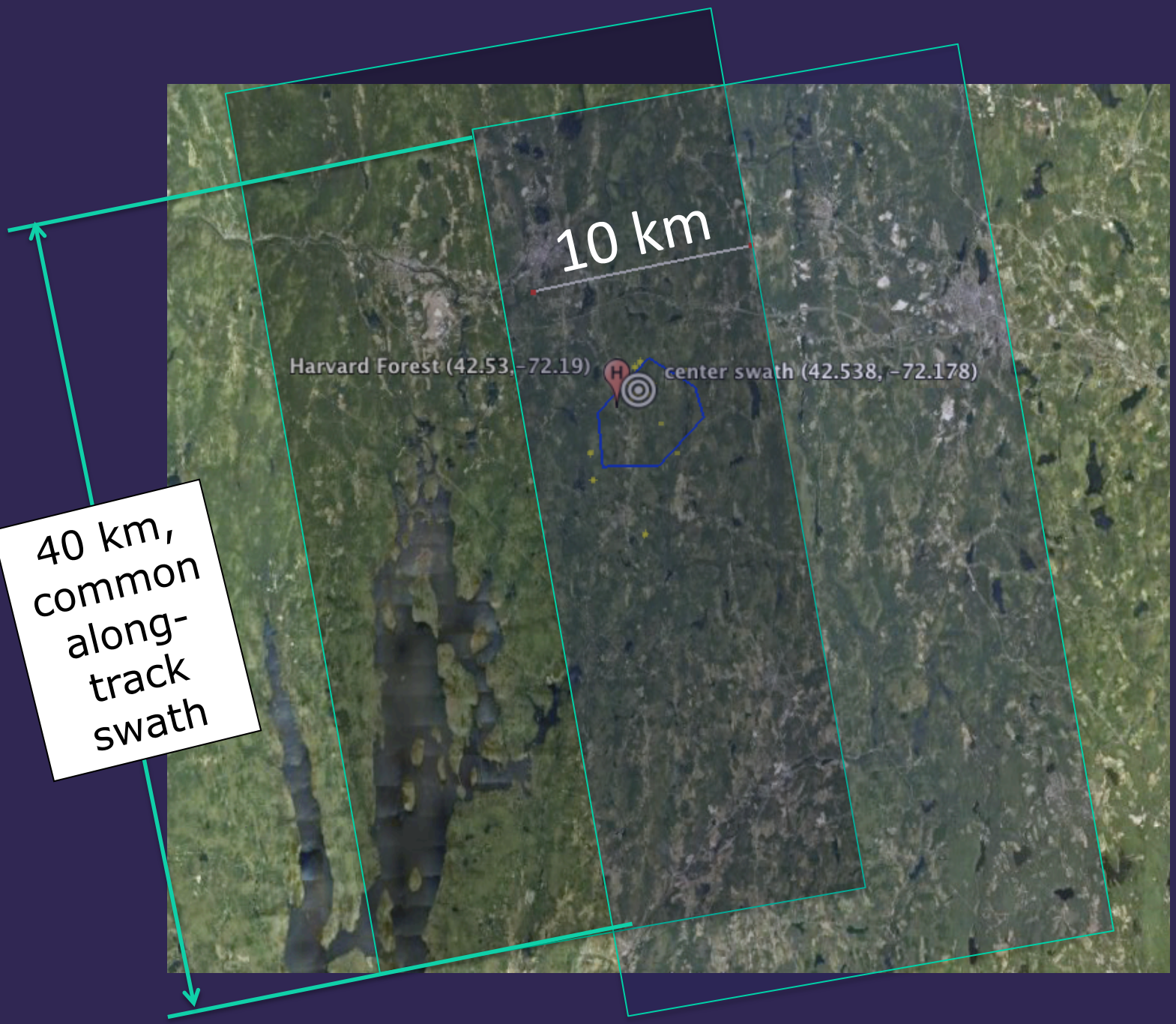
VV



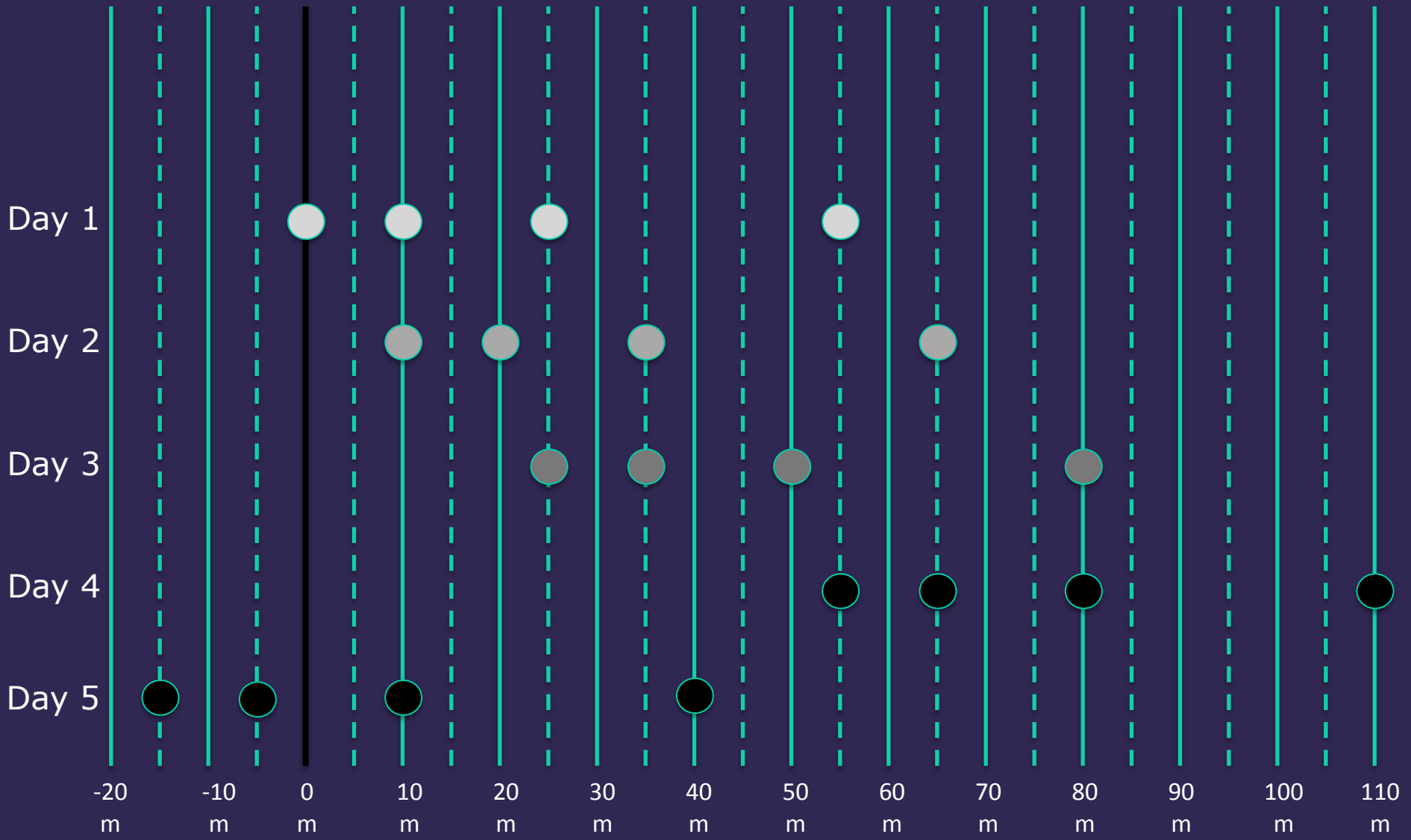
	HH	HV	VH	VV
1	1.57	0.16	0.22	1.79
2	0.14	2.45	0.21	0.09
3	1.79	4.36	3.92	1.33
4	0.07	0.07	3.02	0.23

Shown are the corner reflector (#1) and PARCs (#'s 2,3,4) near the Orange airport in Massachusetts on October 19th, 2009. The maximum scattered field, relative to the default ALOS calibration, is shown for each calibration target, as a function of polarization. For reference purposes, two scenes are shown each for HH and HV polarizations, the only difference being the scaling factor for the gray-scale mapping to observed power. The radar imagery is in the slant range, with pixel spacing of (9.4,3.5) meters in (range,azimuth). The local incidence angle was 24 degrees.

UAVSAR swath geometry

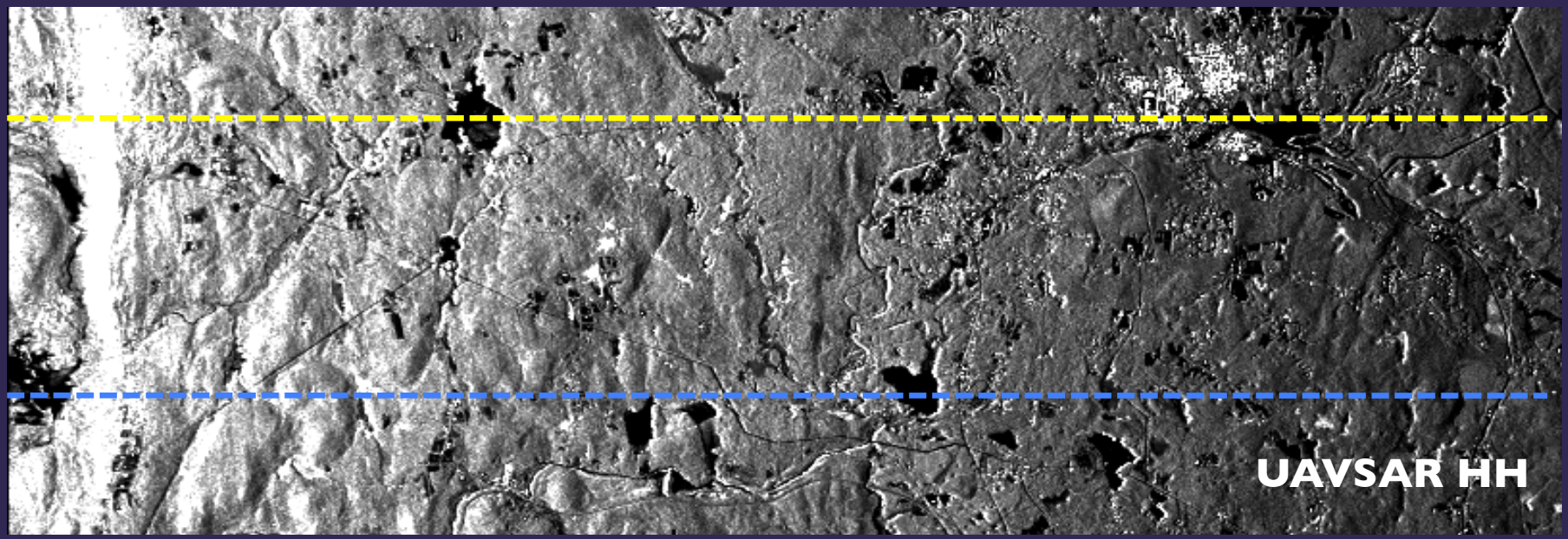


UAVSAR observing strategy

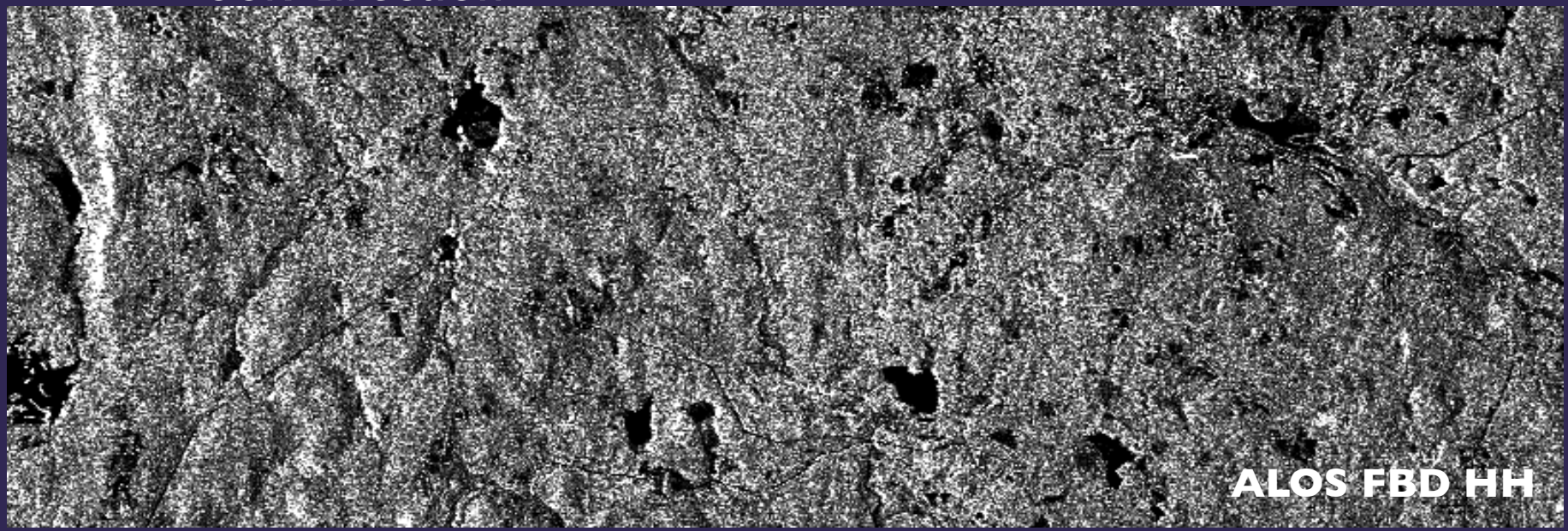


All passes occur at same altitude (12.5 km), with a 40 degree look angle to center swath

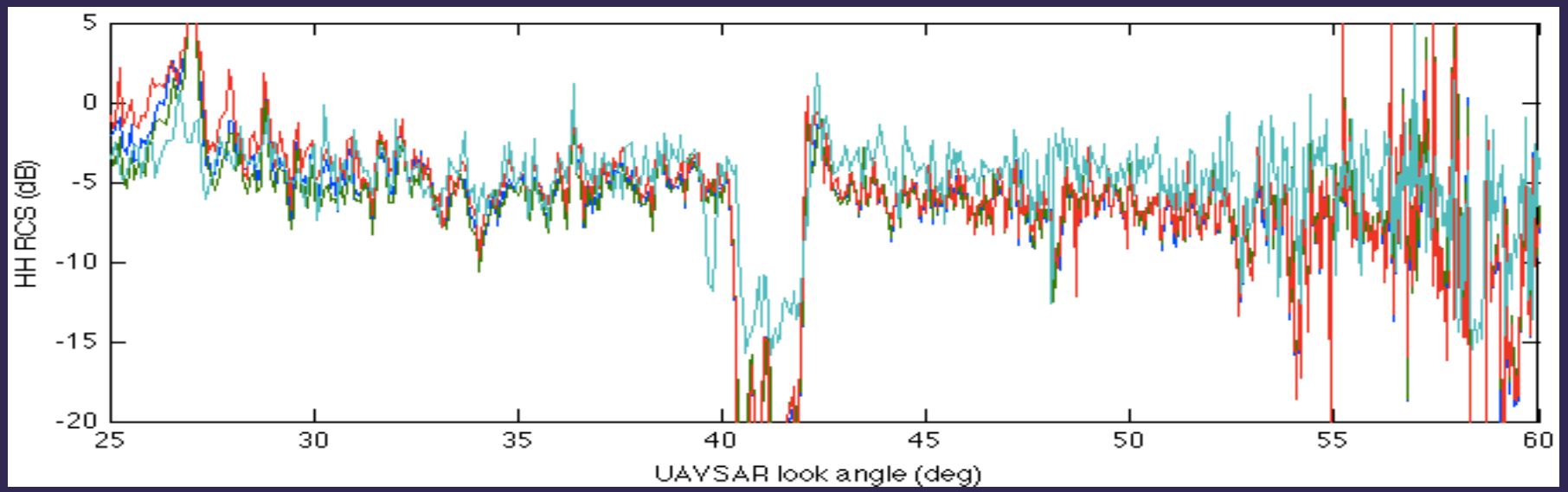
UAVSAR & ALOS Comparison

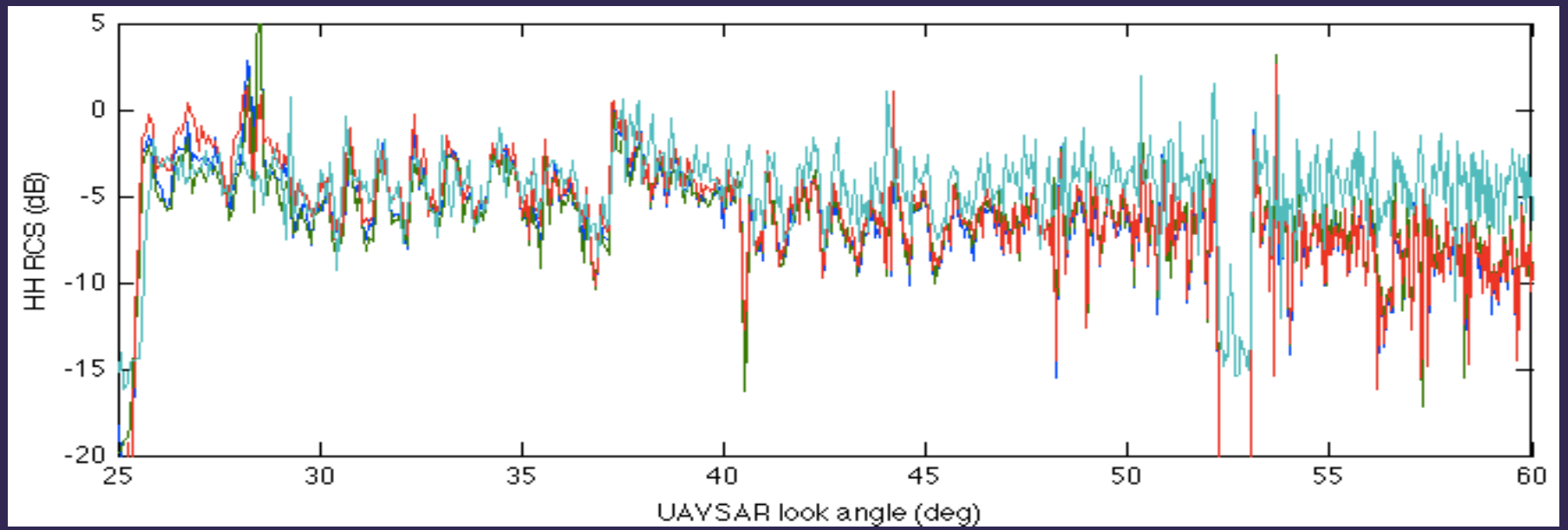


look direction

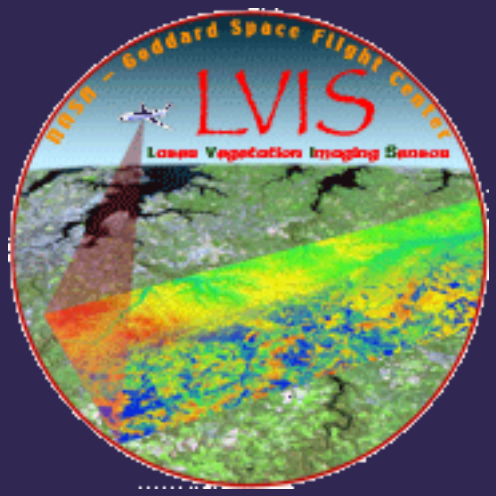


UAVSAR and ALOS

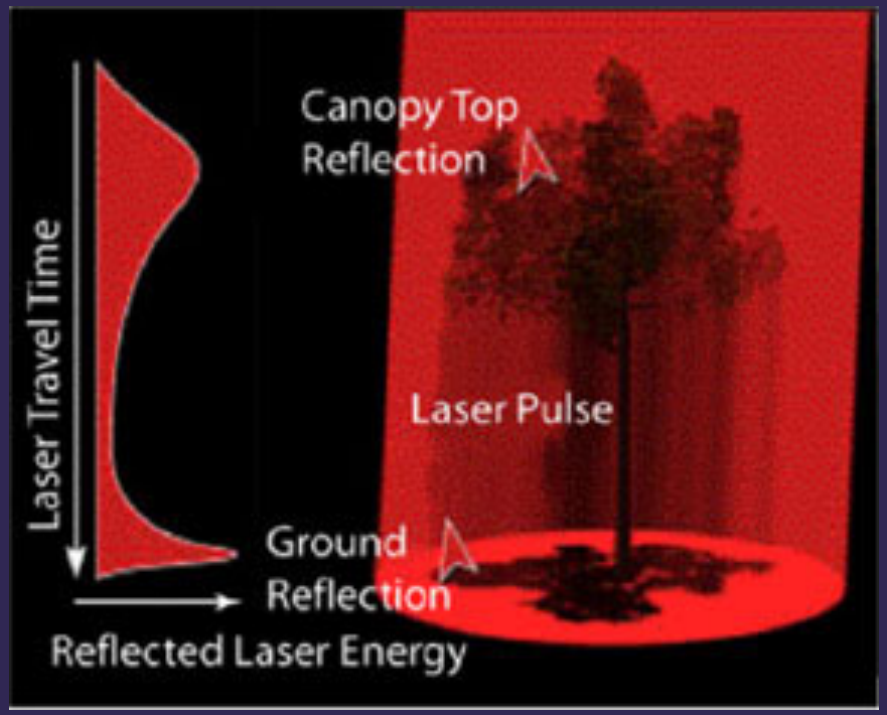


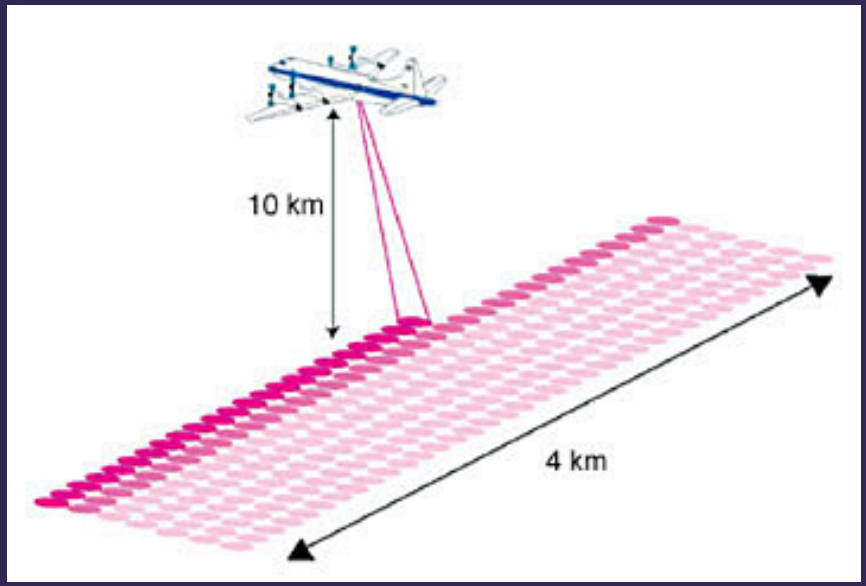


Airborne Lidar (LVIS)

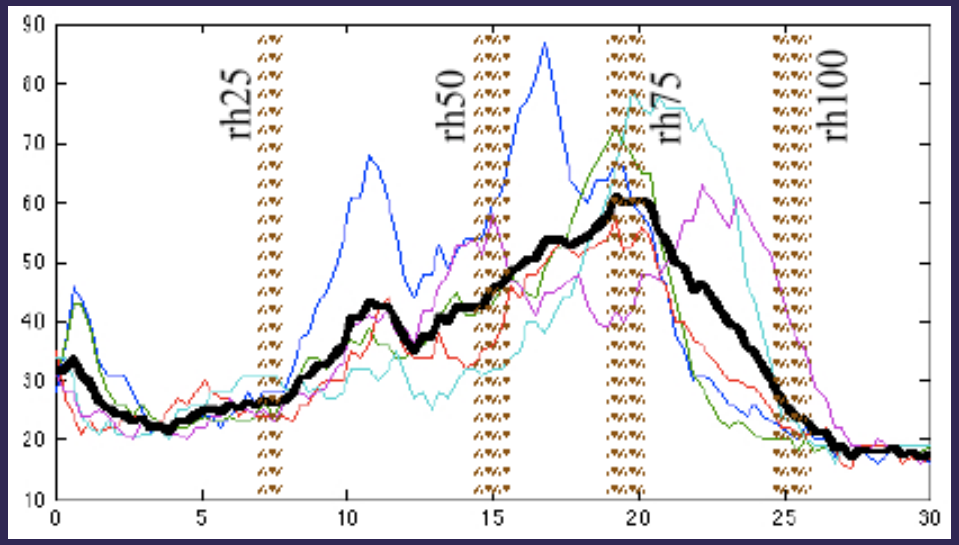


- Airborne Lidar can perform a similar task at a much greater speed.
- Airborne system flies at 10 km over the ground, and covers a swath 4 km wide, performing imaging by systematically flying over an extended track of land. Much like a lawn mower would do to cover the grass.
- Waveforms can be 'multiple-return' or 'full-waveform'
- Footprints can be narrow beam (~50cm) or wide beam (25m)
- Topography and clouds can be confounding factors

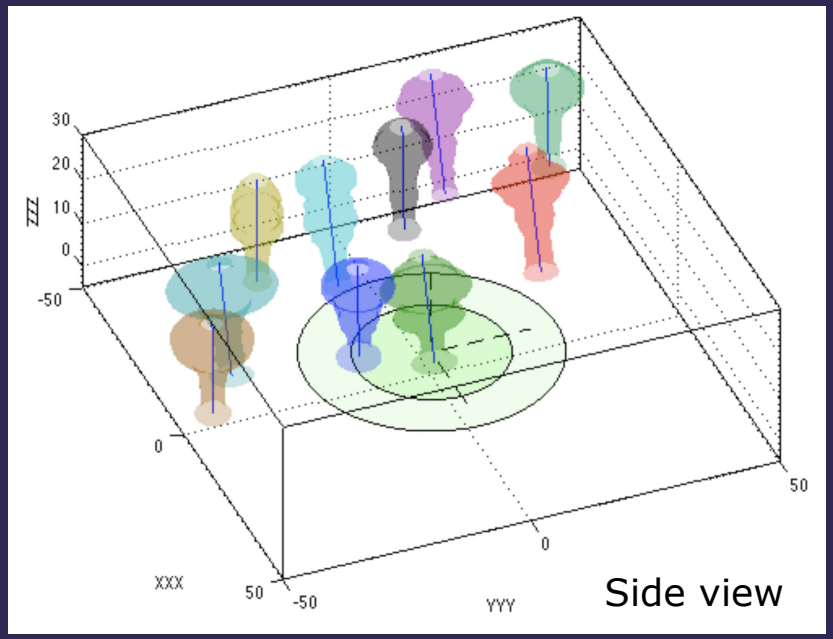


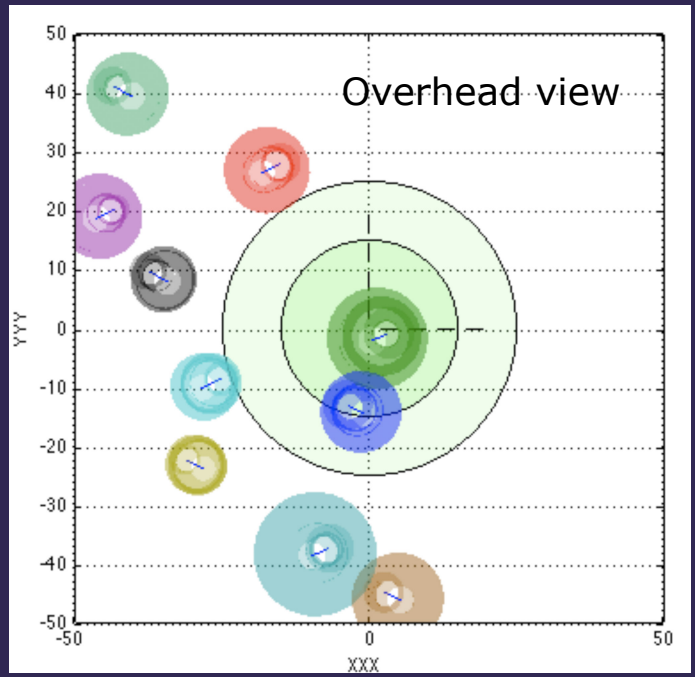


Working With LiDAR Data

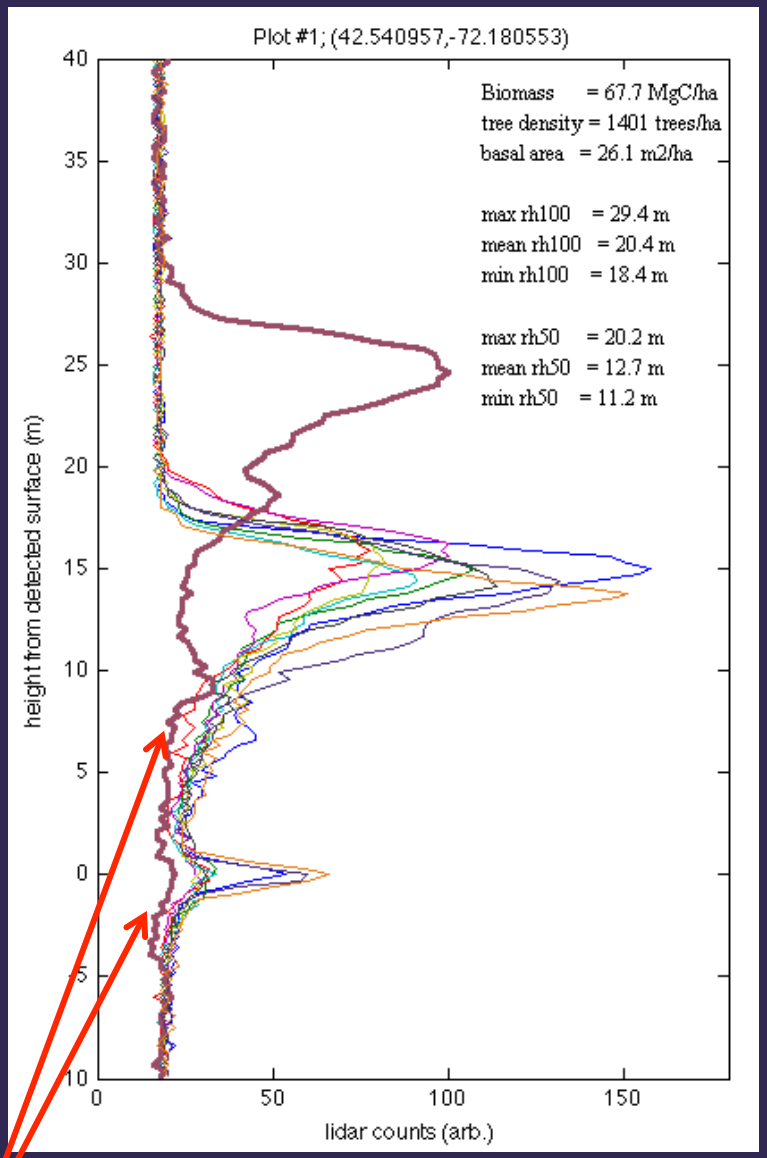


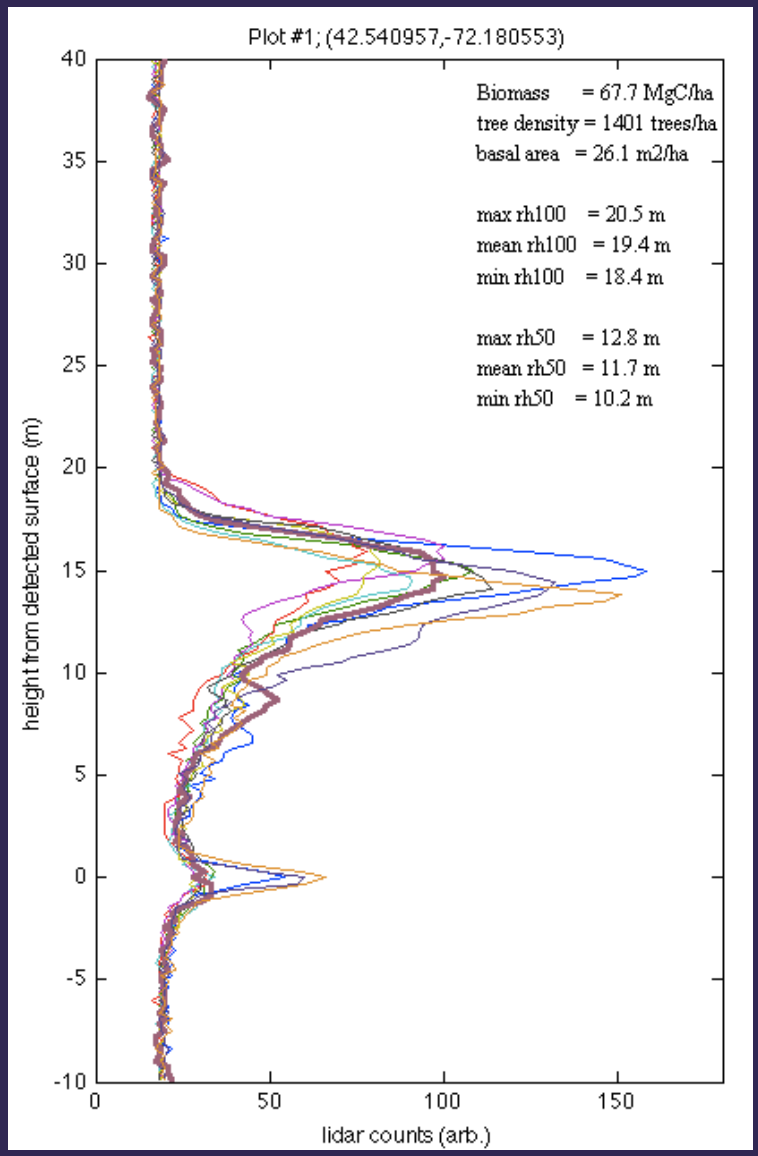
Google Earth





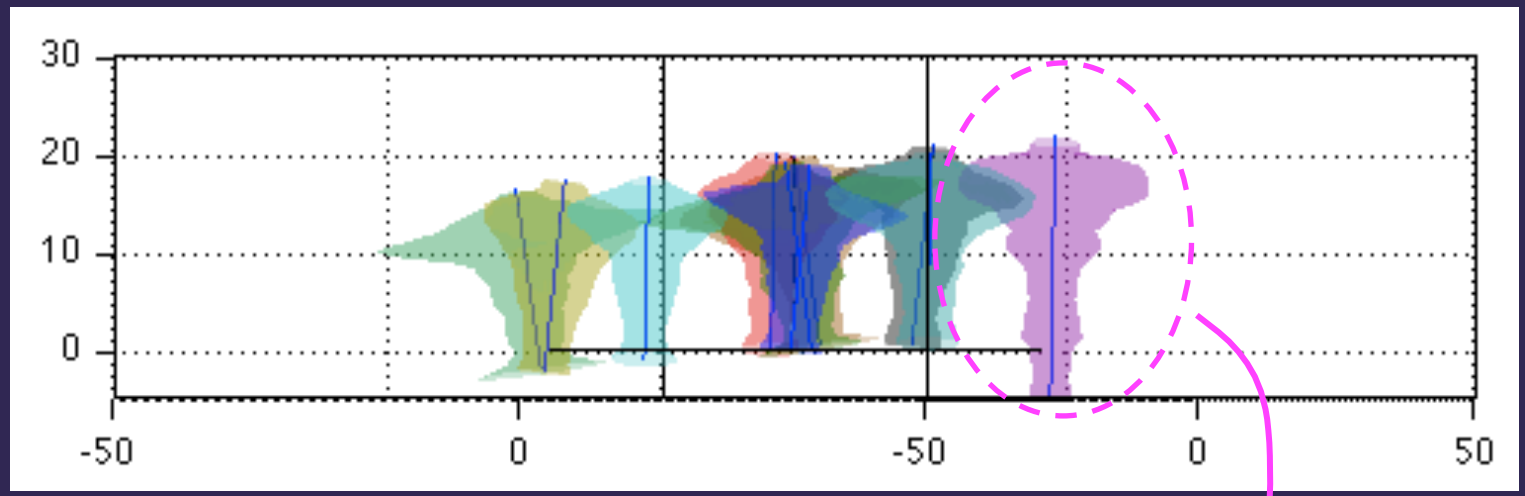
Working with LiDAR data



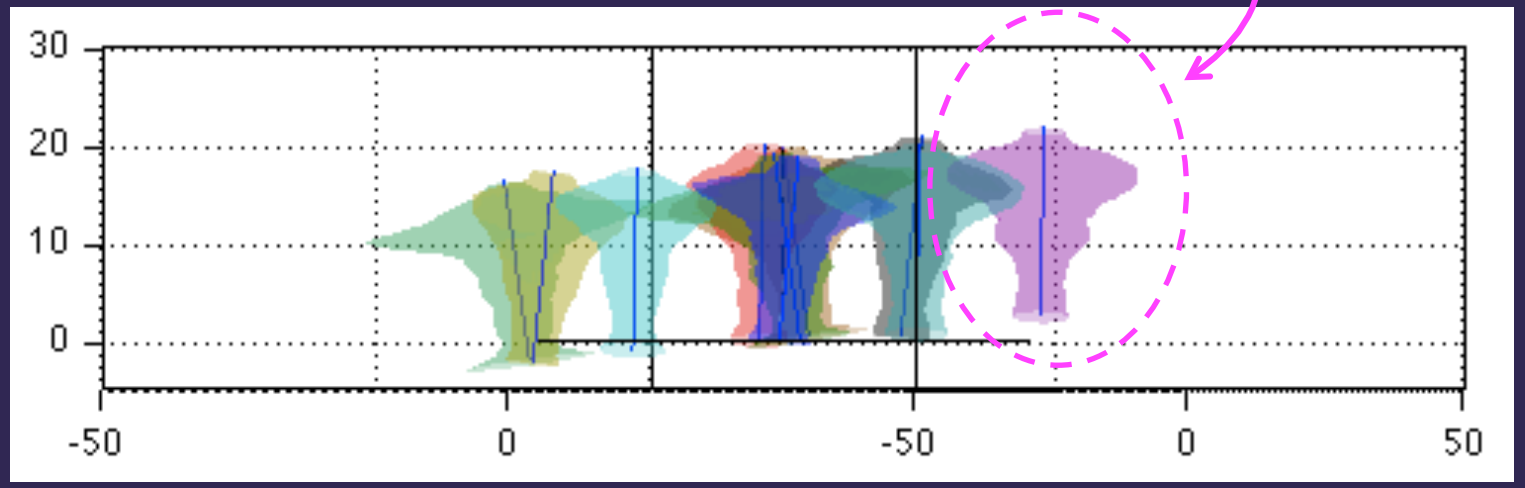


- A false detection of the ground return leads to errors in estimating lidar metrics.

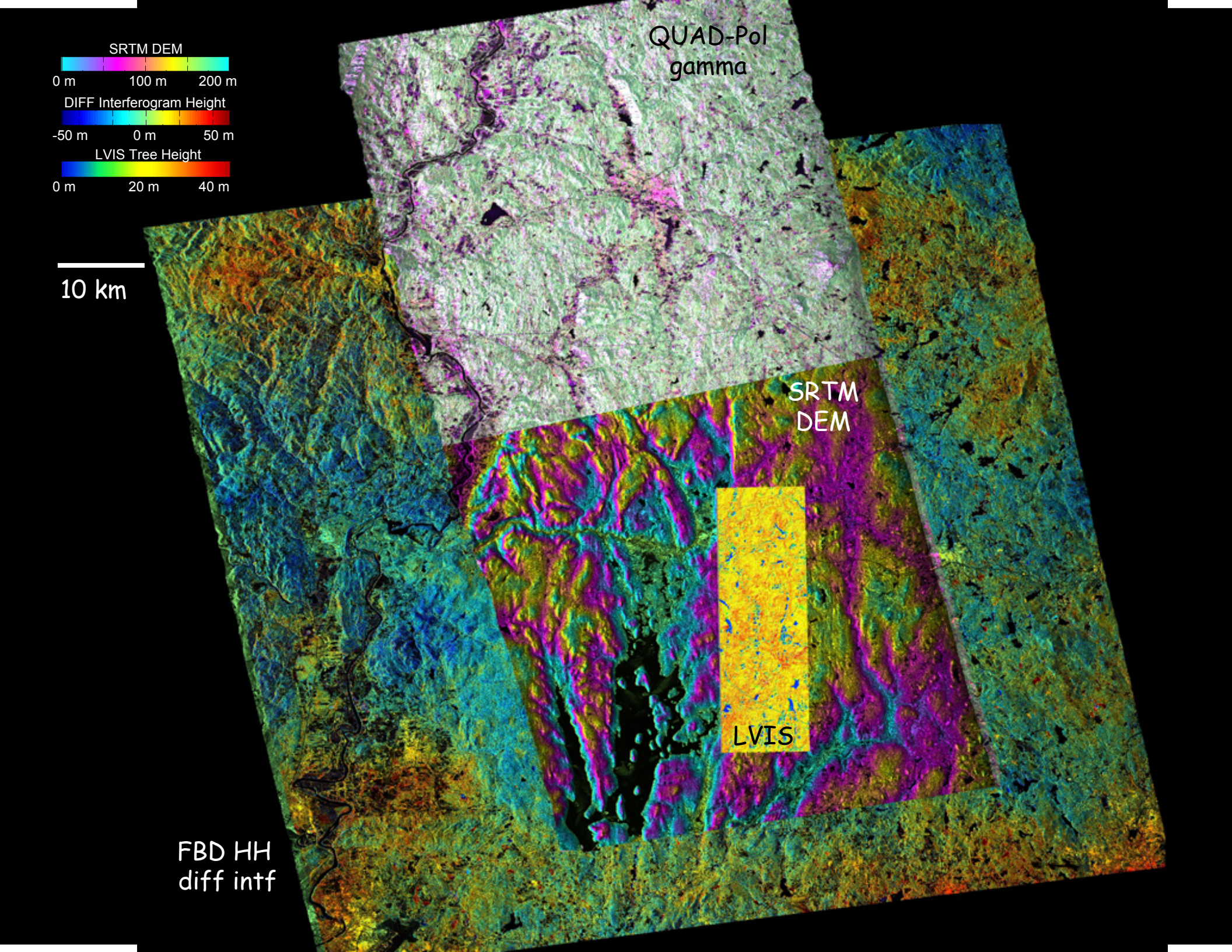
uncorrected



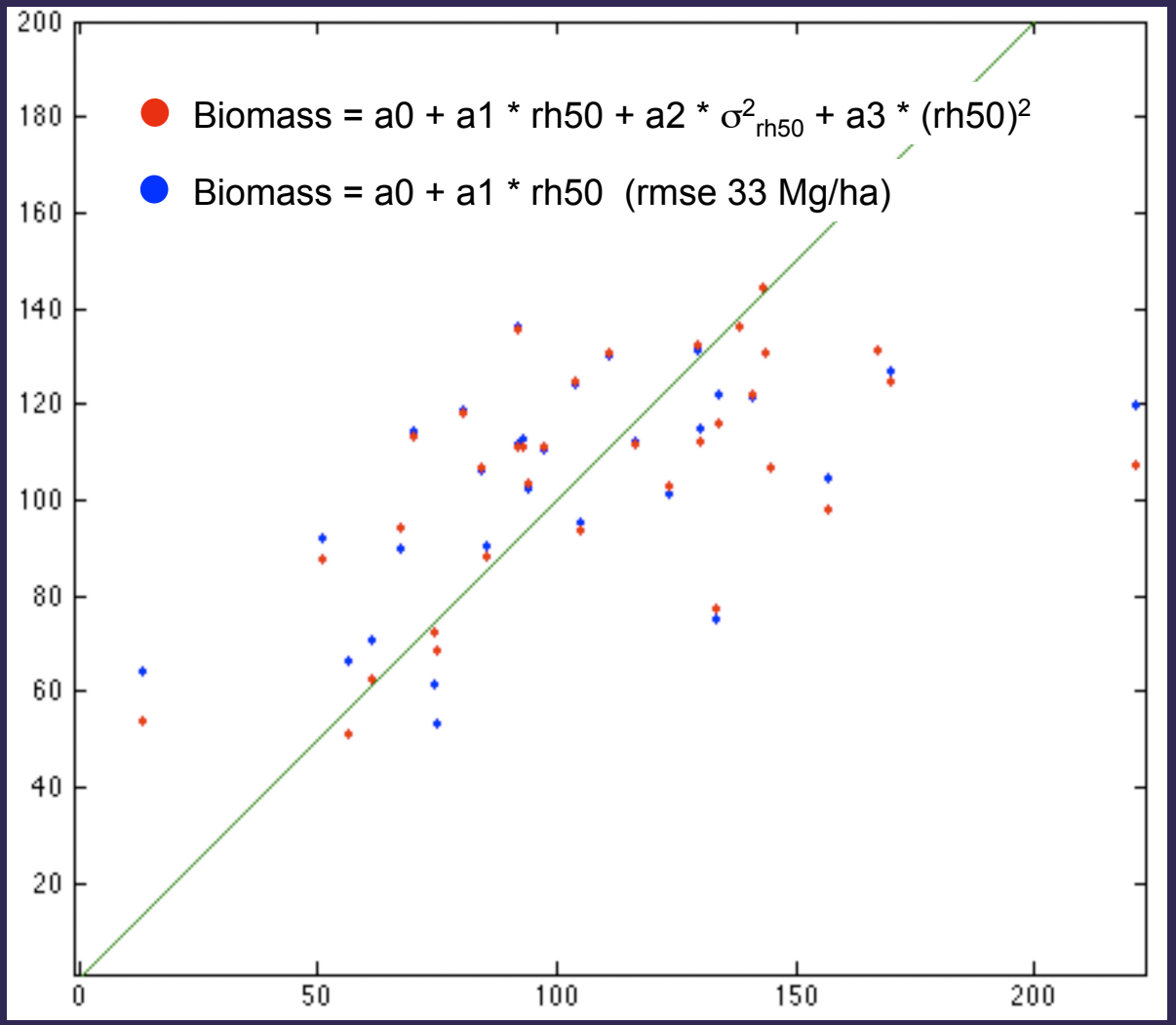
corrected



- The only reliable way for correcting the problem is to make a three dimensional plot of the lidar waveforms, and inspect them for possible anomolies


SRTM DEM
0 m
100 m
200 m
DIFF Interferogram Height
-50 m
0 m
50 m
LVIS Tree Height
0 m
20 m
40 m
10 km
QUAD-Pol
gamma
SRTM
DEM
LVIS
FBD HH
diff intf

Biomass to LiDAR Relationships



Other Variables

rh100

rh75

rh50

rh25

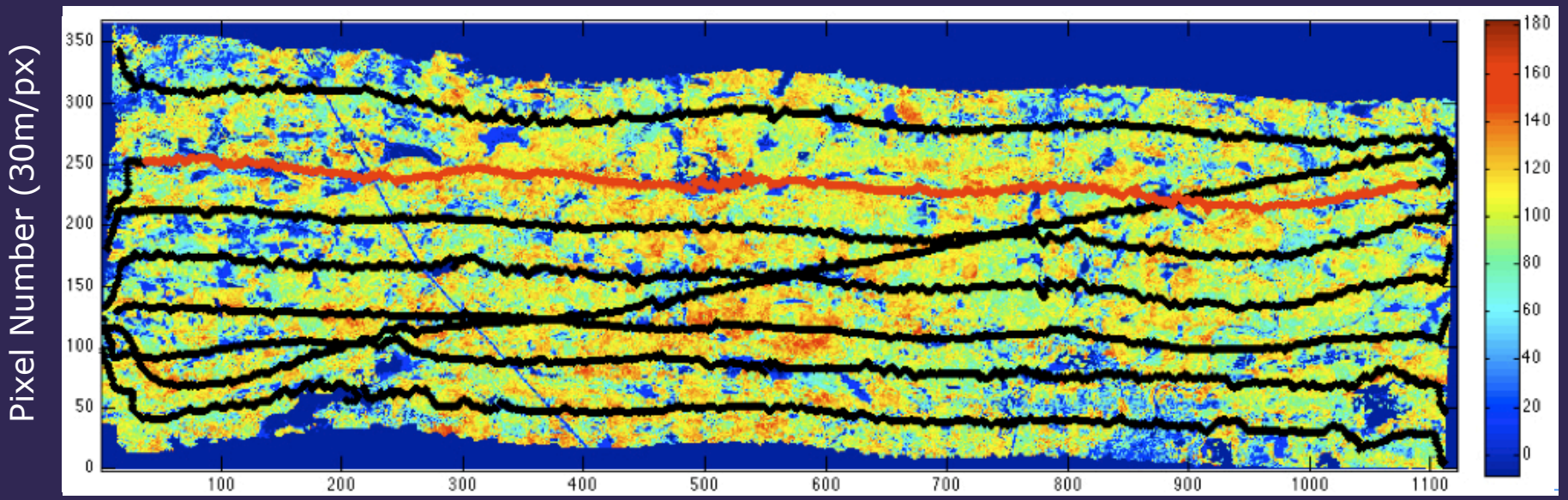
$(rh50)^2$

$(rh100)^2$

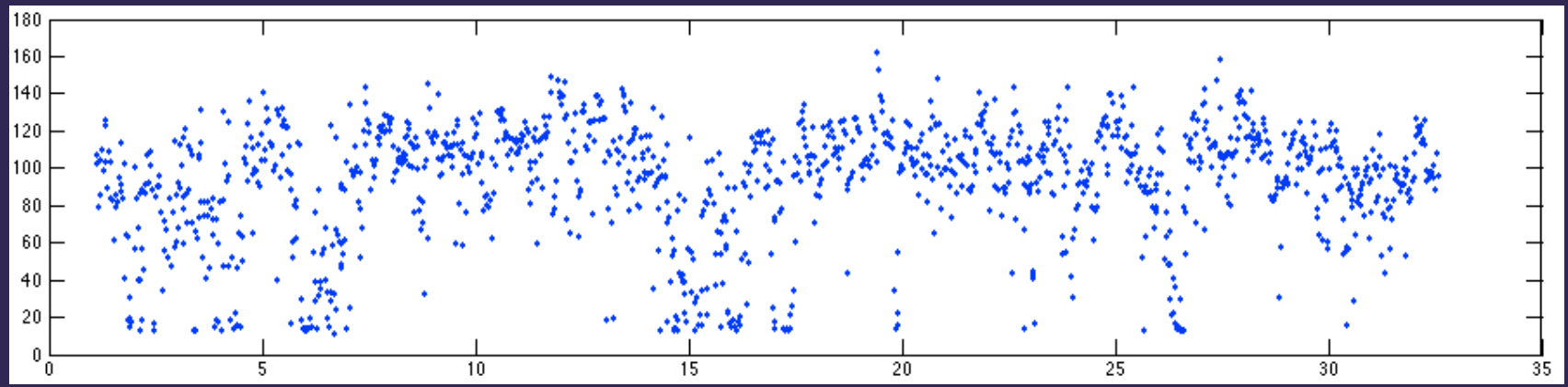
σ^2_{rh50}

σ^2_{rh100}

A Biomass Map of the Harvard Forest

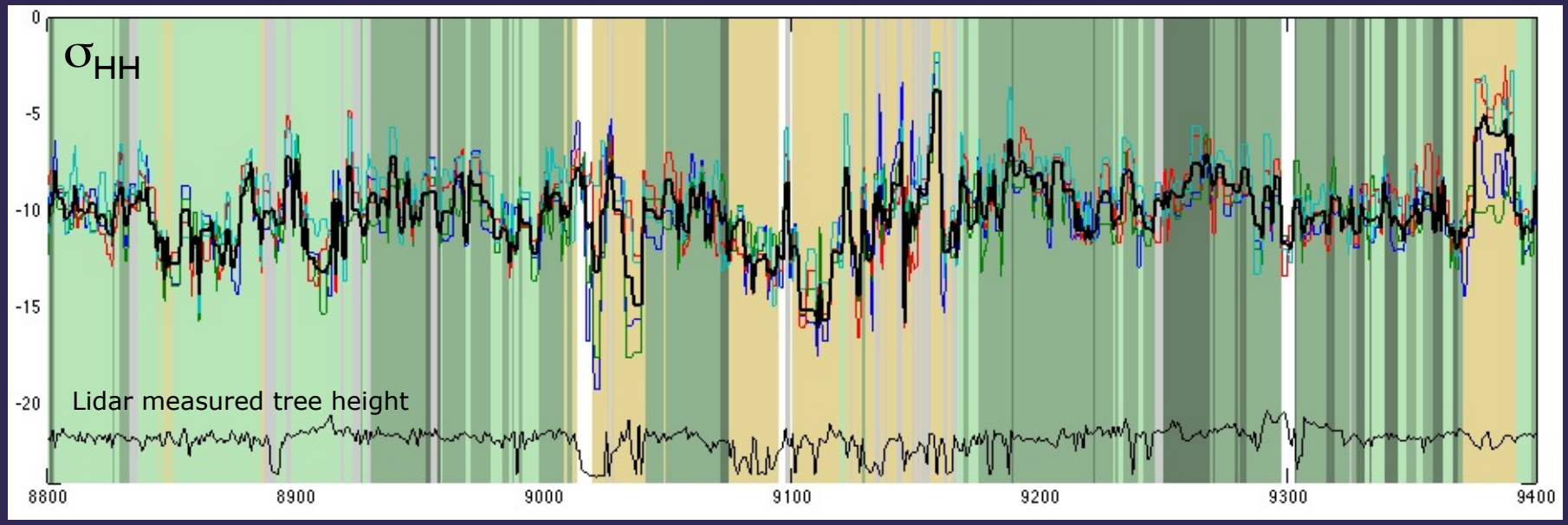


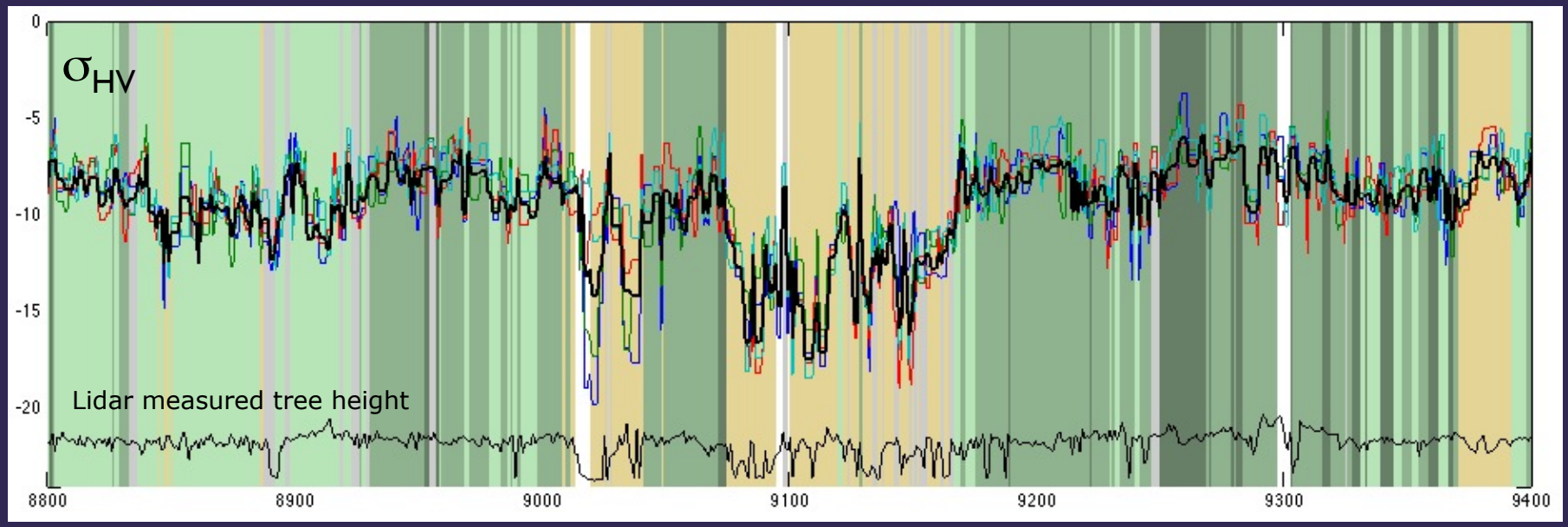
Pixel Number (30m/px)



Along Track Distance (km)

Other Backscatter Relationships

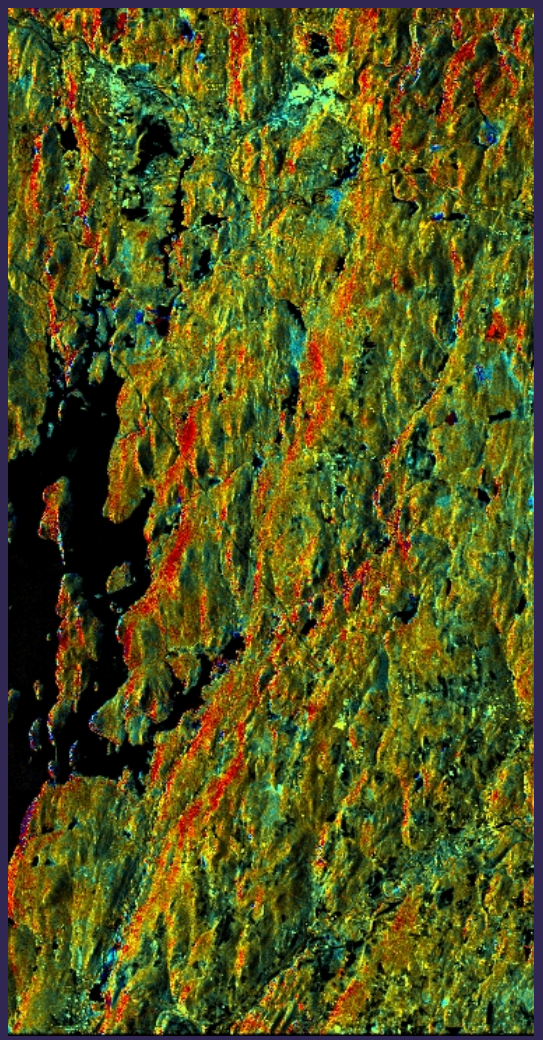




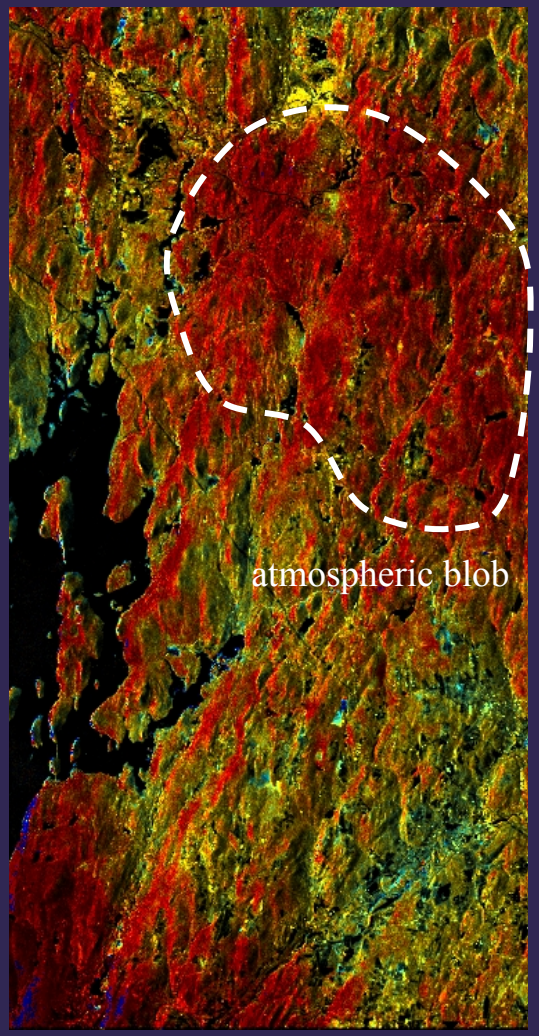
Differential Interferometry?

A C-band DEM and PALSAR interferometric pairs could, in principal, be used to measure differential penetration

Initial results show that the signature is dominated by atmospheric effects



PALSAR, PLR HH
11/06 - 12/06 Diff. Hgt.



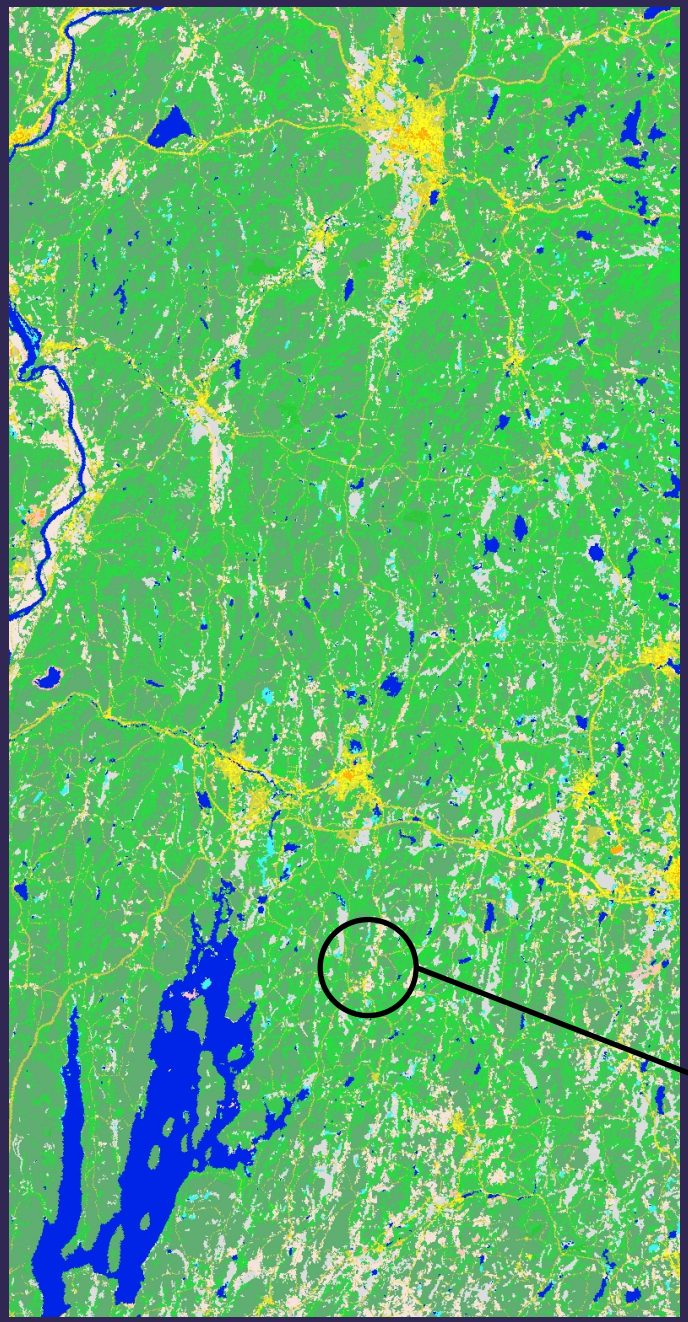
PALSAR, PLR HH
12/06 - 4/07 Diff. Hgt.

differential height

Charismatic Megafauna


this is the
End
… of the
presentation

Classification



A landcover classification (NLCD 2001) is used to perform post-analysis, and to understand the impact of landcover type.

NLCD Classes

- Open Water
- Low Intensity Residential
- High Intensity Residential
- Commercial & Transport.
- Bare Rock/Sand
- Quarry/Strip Mine
- Transitional Barren
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Grass/Herbaceous
- Pasture/Hay
- Row Crops
- Small Grains
- Other Grasses
- Woody Wetlands
- Herbacious Wetlands

Harvard forest region