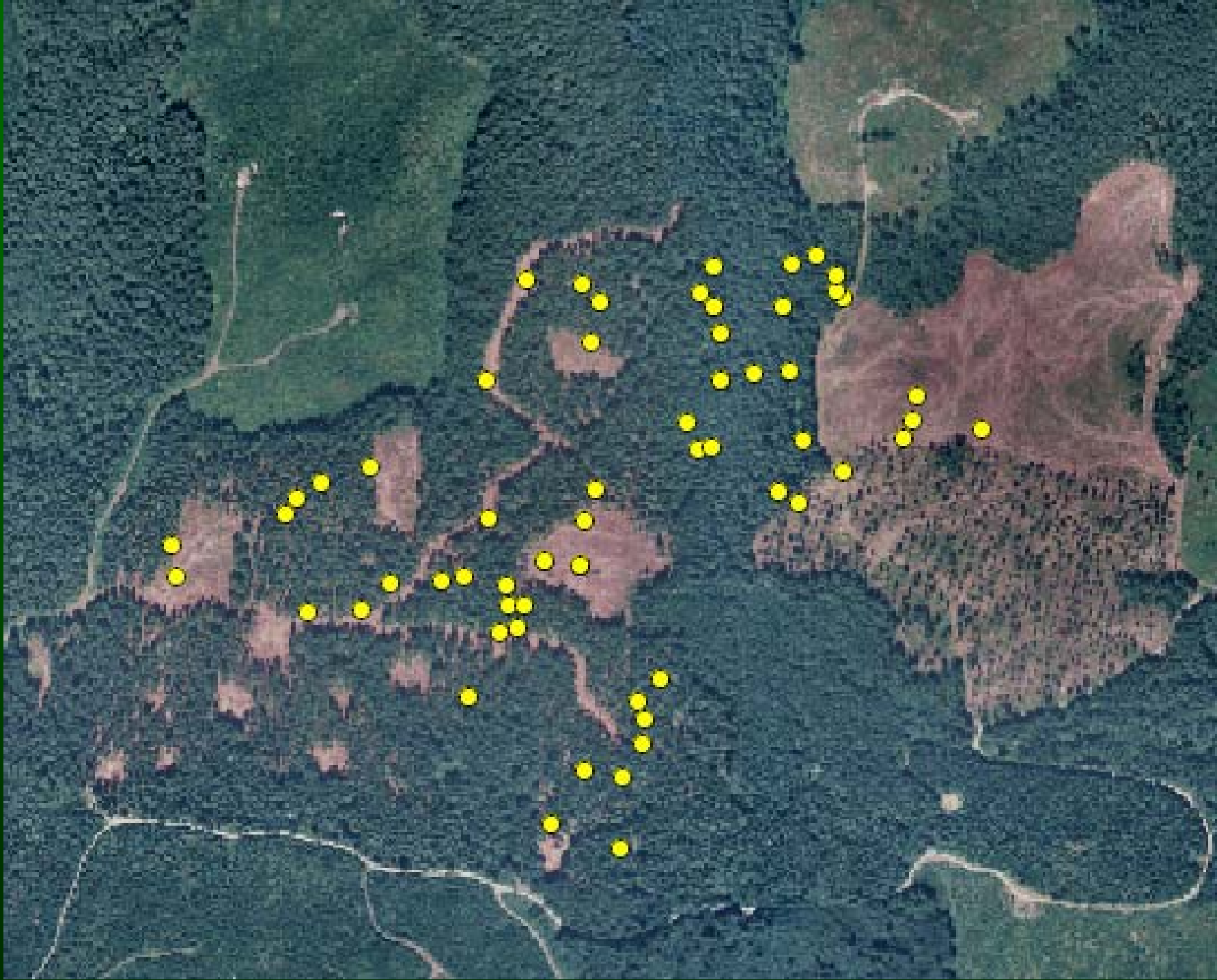


# “Modeling GPS Error with LIDAR-derived Tree Canopy”

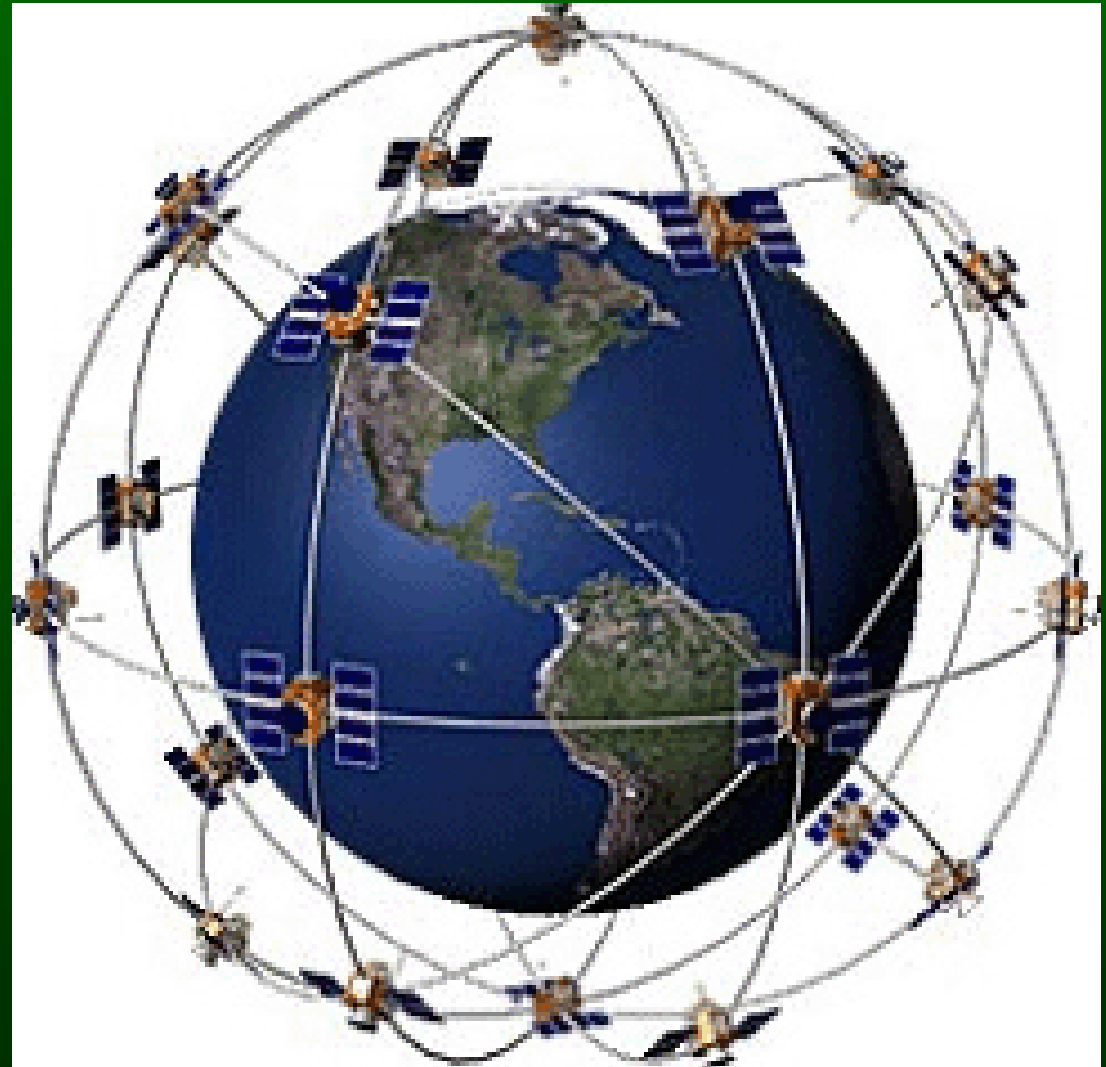
Tobey Clarkin



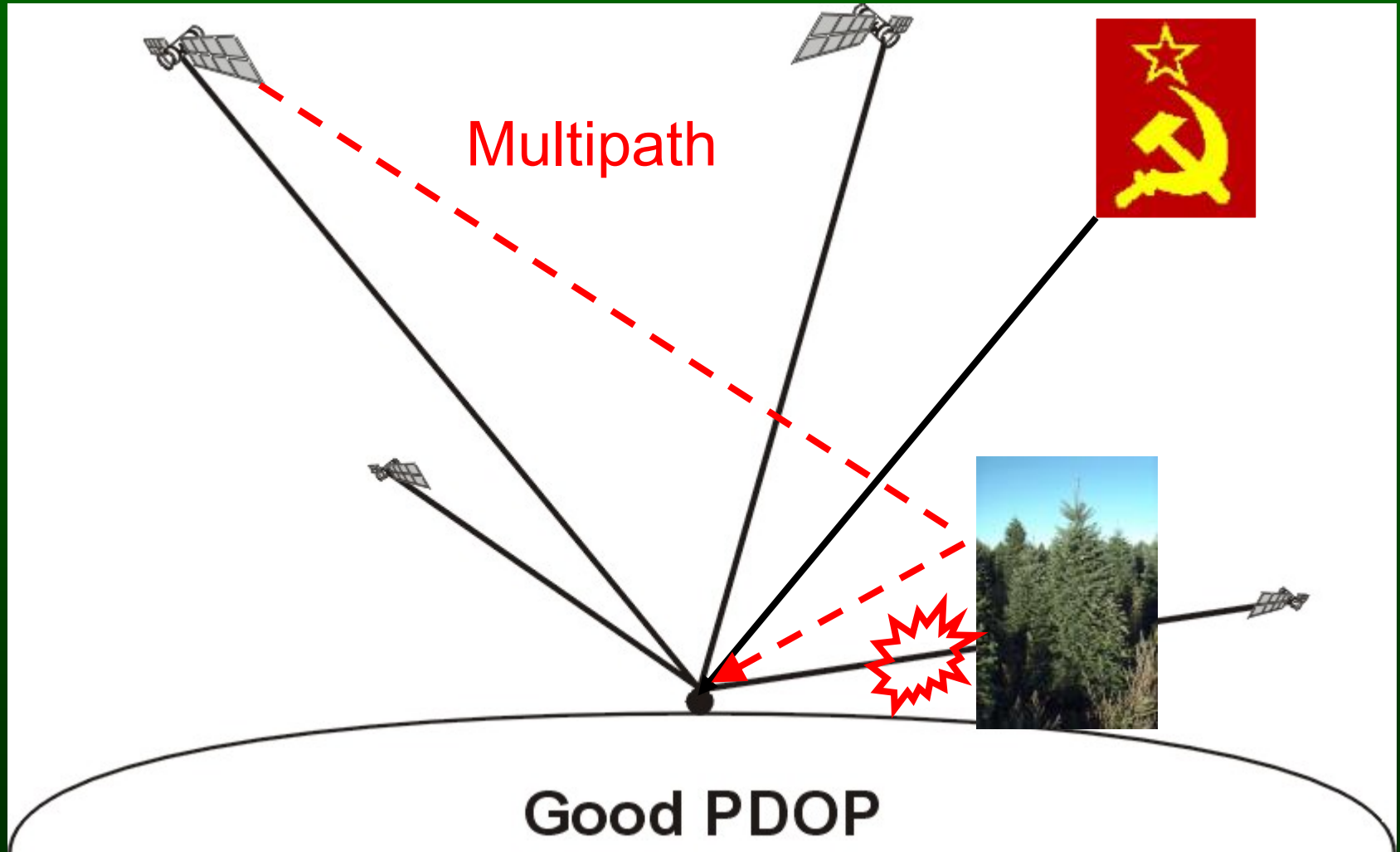


# Global Positioning System (GPS)

- Satellite constellations
  - GPS: 24
  - GLONASS: 14
  - Galileo (2008)

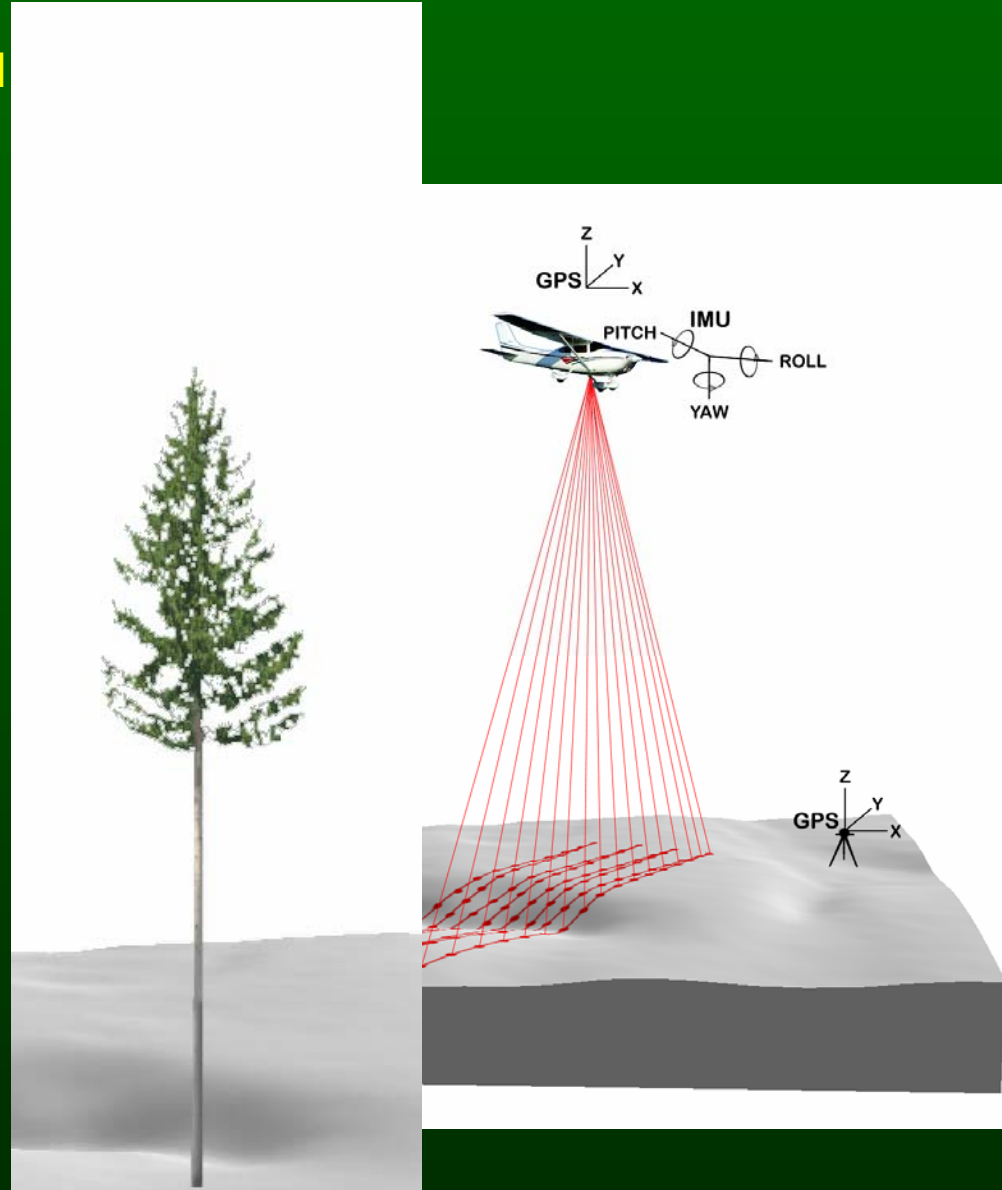


# Position Dilution of Precision (PDOP)

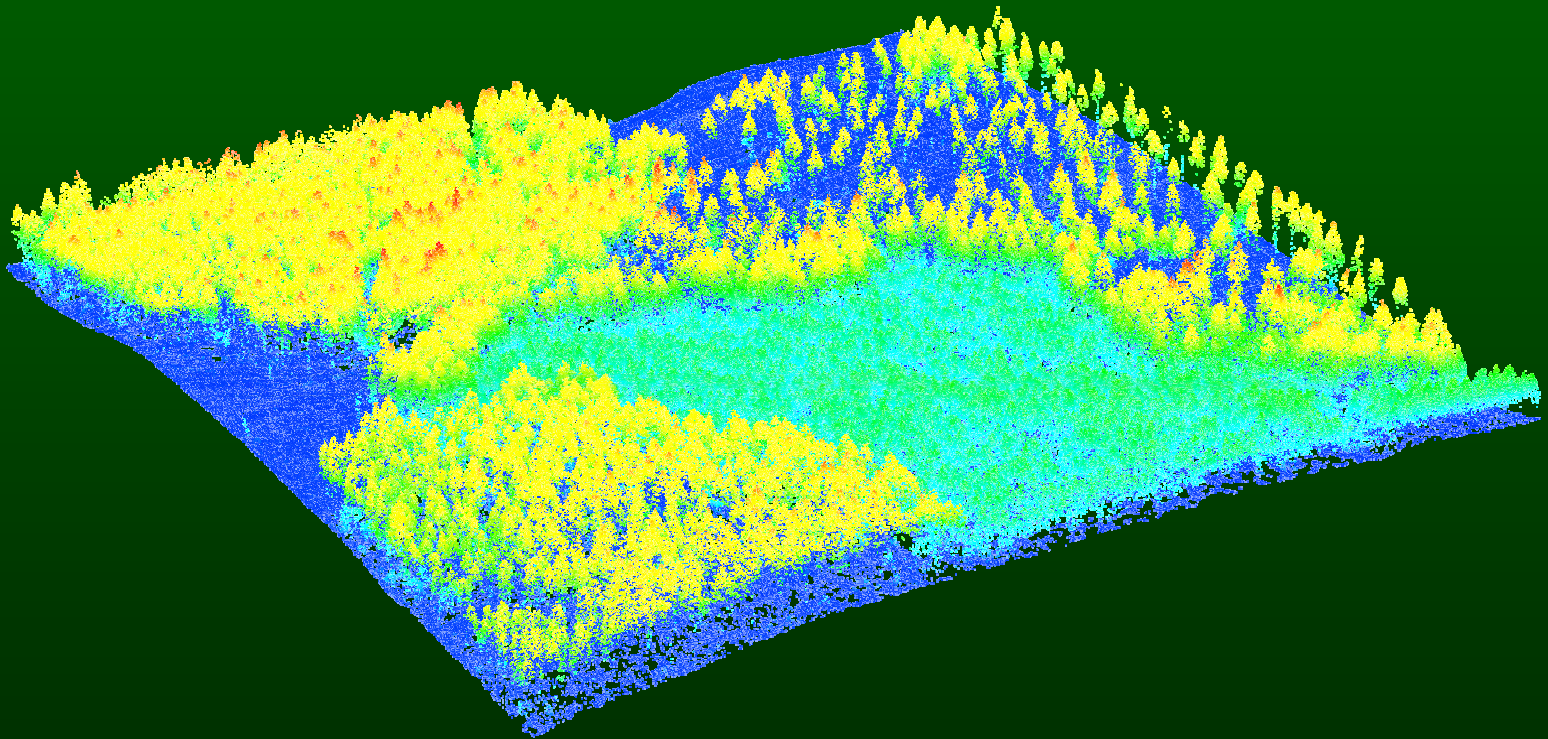


# Light Detecting and Ranging (LIDAR)(LIDAR)

- 10,00010,000''s of pulses/secs sec
- Georeferenced pointsGeoreferenced points—GPS & IMUGPS IMU
- Multiple returnsMultiple returns—XYZ CoordinatesXYZ Coordinates—Intensity ValuesIntensity Values

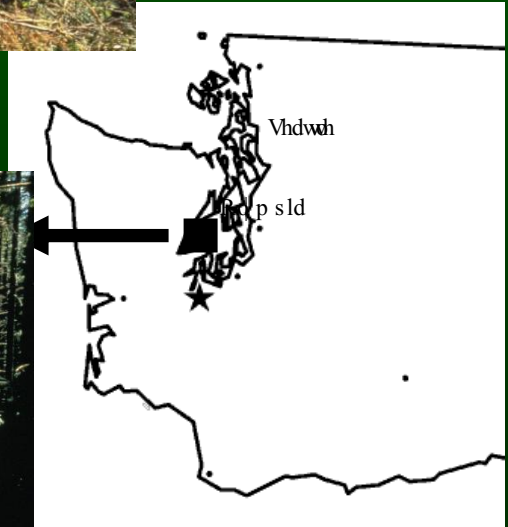
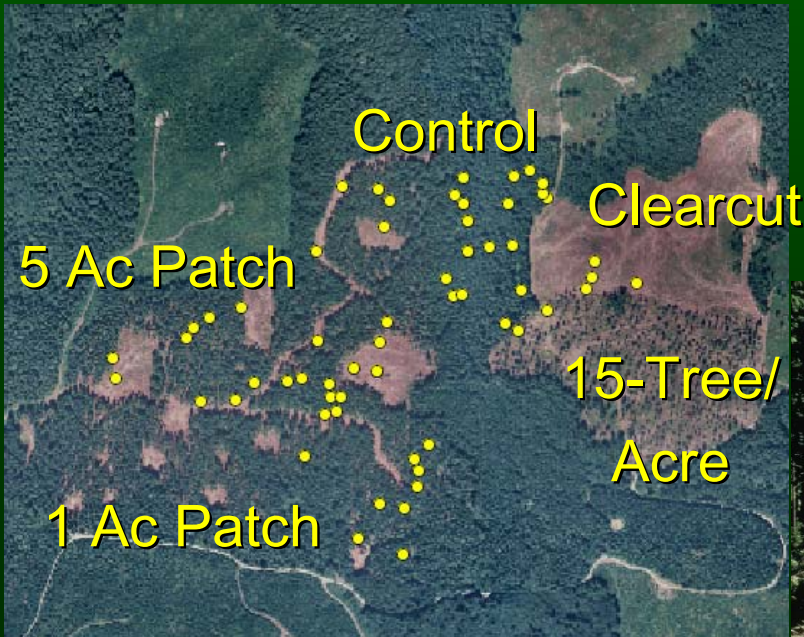


# LIDAR Data Landscape



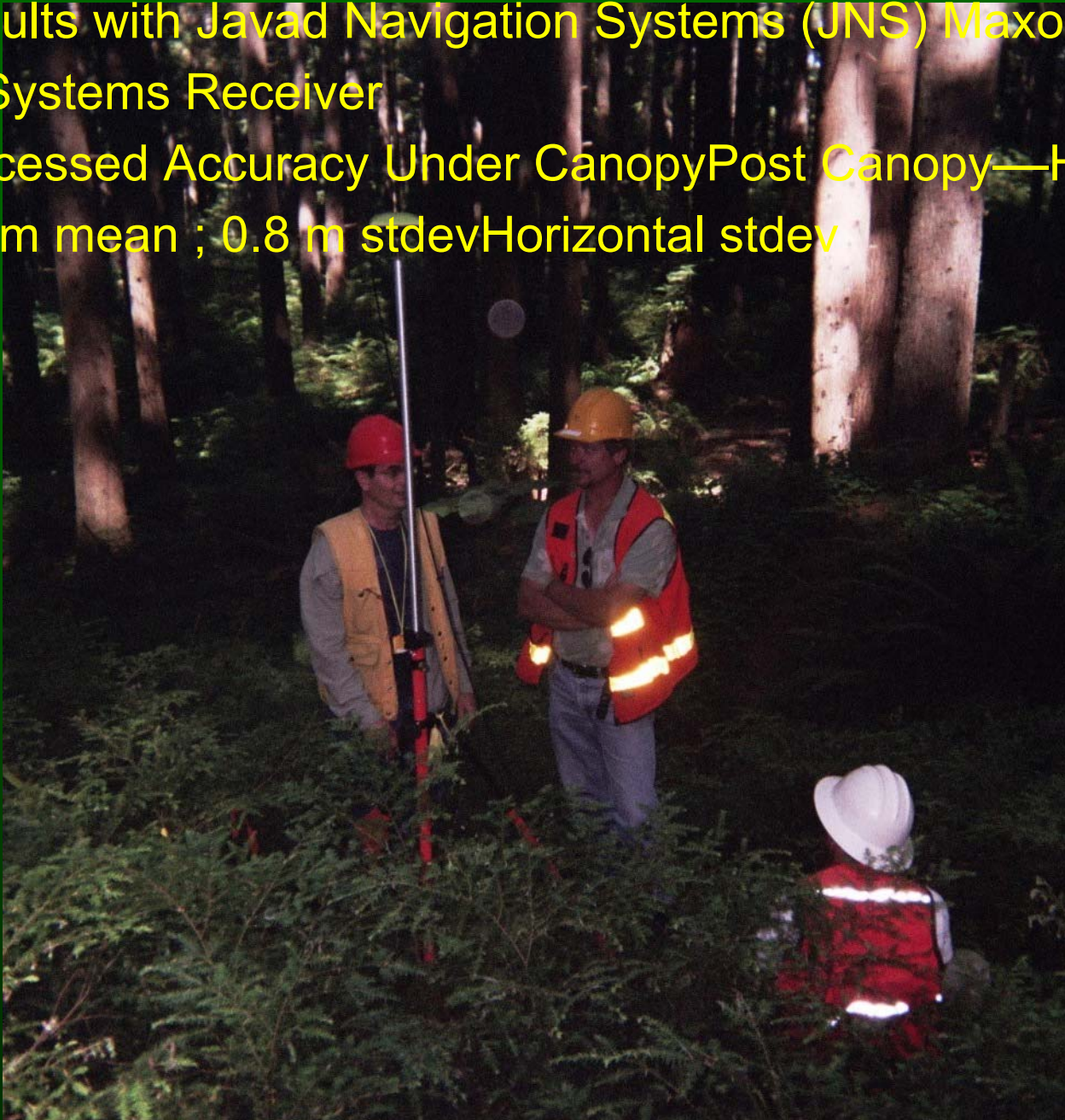
Capitol State Forest Test Site Capitol Site

- Five treatment areas; multiple LIDAR setsFive sets
- Traverses set with total stationTraverses station



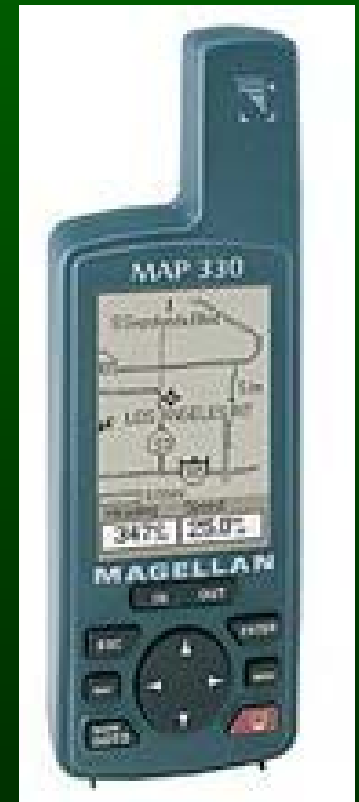
# Initial Results with Javad Navigation Systems (JNS) Maxor Receiver Systems Receiver

- Post Processed Accuracy Under Canopy Post Canopy—Horizontal error: 1.3 m mean ; 0.8 m stdev Horizontal stdev



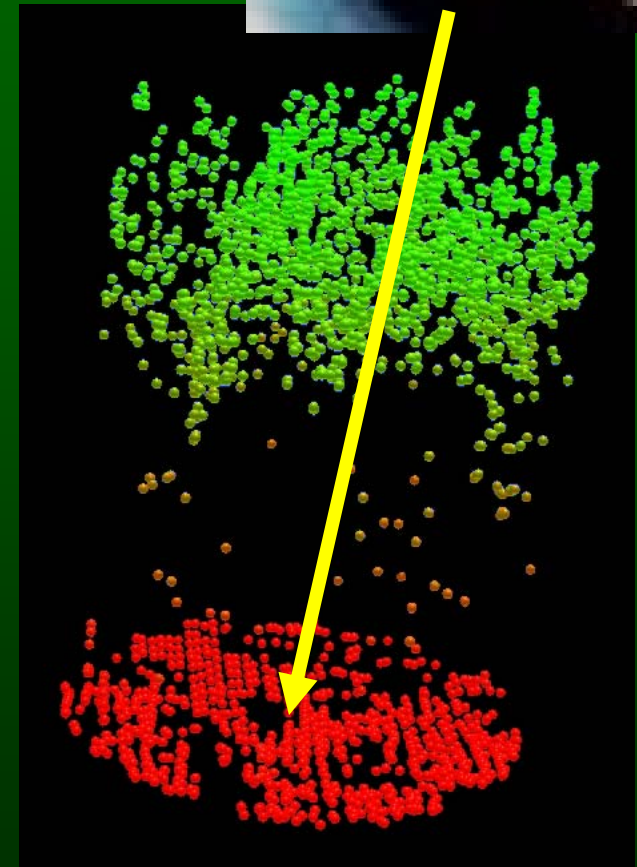
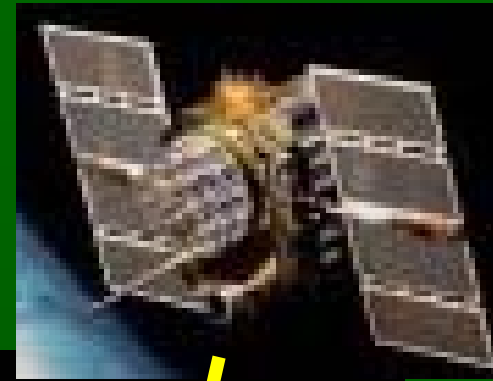
# GPS Receiver Comparison (Accuracies Under Canopy)

- JNS Maxor
  - Dual frequency
  - GPS & GLONASS
  - 1-3 m accuracy
- Magellan Map 330
  - Single frequency
  - GPS
  - 5-20 m accuracy



# Analysis

- Canopy density
  - LIDAR point-cloud
- Buffer vector to satellite
- Average across satellites
- Position Error =  
 $f(\text{PDOP}, \text{Canopy density})$

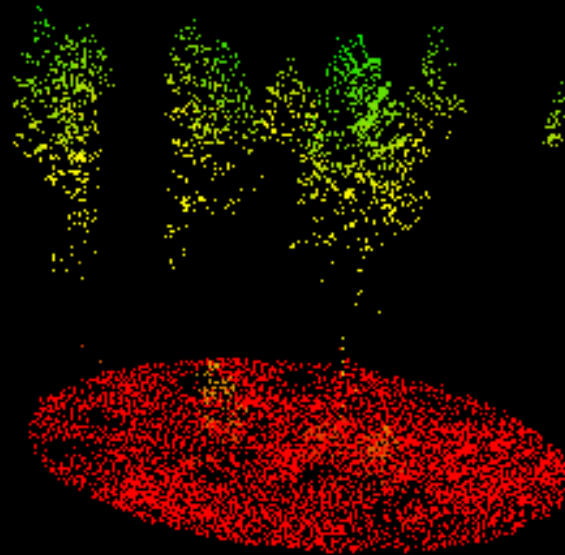


# Research Expectations

- Find accuracy of JNS Maxor under canopy
- Model GPS accuracy with canopy density to determine accuracy of past/future GPS locations

# Management Application: Forest Inventory & Analysis

LDV -- V1.30 -- USDA Forest Service -- Pacific Northwest Research Station



# Future Directions

- Use model to correct position error
- Determine effect of time on position error
- Correlate position error to LIDAR pulses reaching forest floor
  - General confidence interval