The U.S. National Biomass and Carbon Dataset for the Year 2000 (NBCD 2000)

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GEOSS Asia-Pacific Symposium, April 15th 2008

Outline

- Vegetation Height Signal in Shuttle Radar Topography Mission Data
- The National Biomass and Carbon Data Set in the U.S.
- Follow-on Projects:
  - The RGGI Region Biomass and Carbon Data Set
  - Fusing Lidar and Radar in Support of DESDynI
- Summary and Outlook

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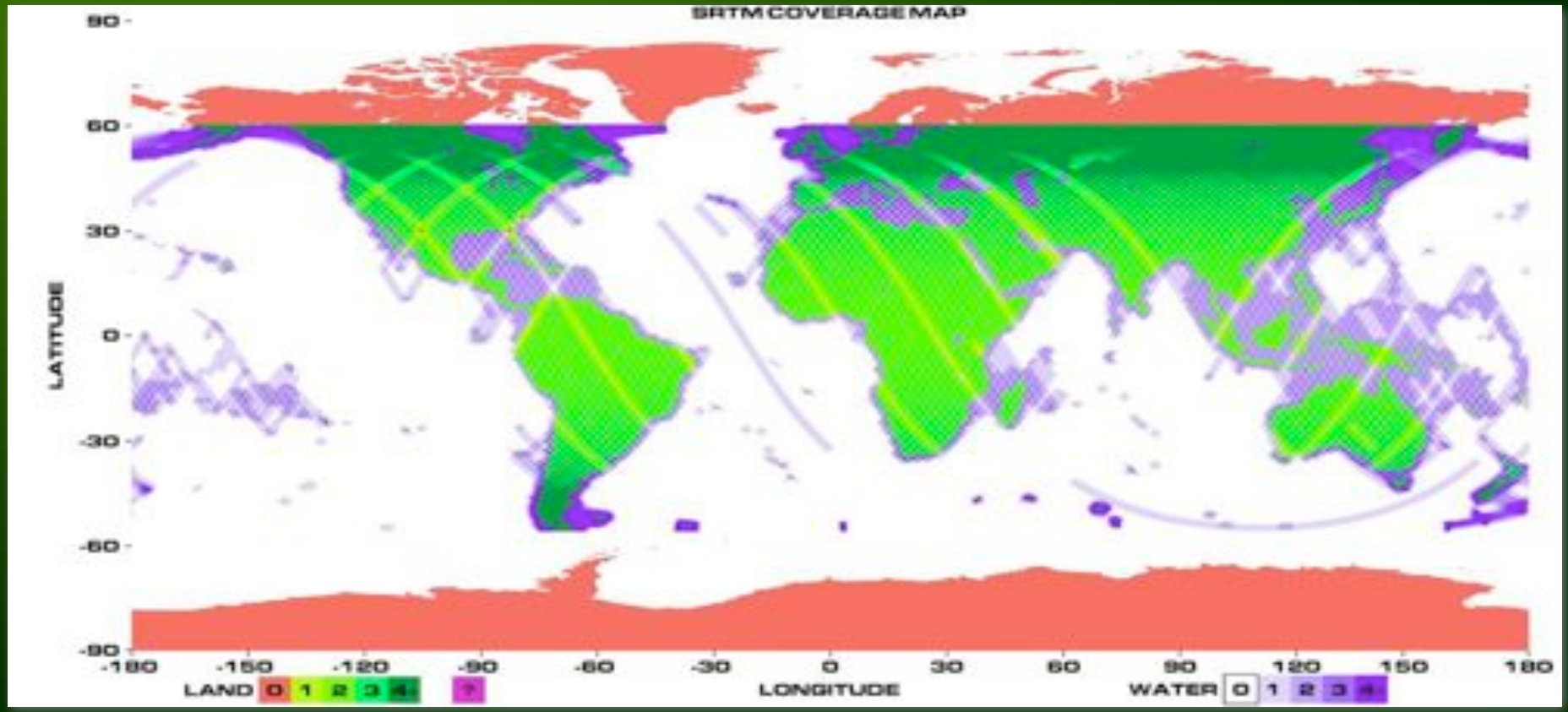
A Global Mission: The Shuttle Radar Topography Mission

- Flown in February 2000 during mission STS-99 on Space Shuttle *Endeavor*
- First mission of its kind using ***radar interferometry***
- Covered 119 million square kilometers in 11 days
- Goal: Best global 3-D data set of Earth

Kellndorfer et al., 2008

Shuttle Radar Topography Mission: Global Coverage in 11 Days

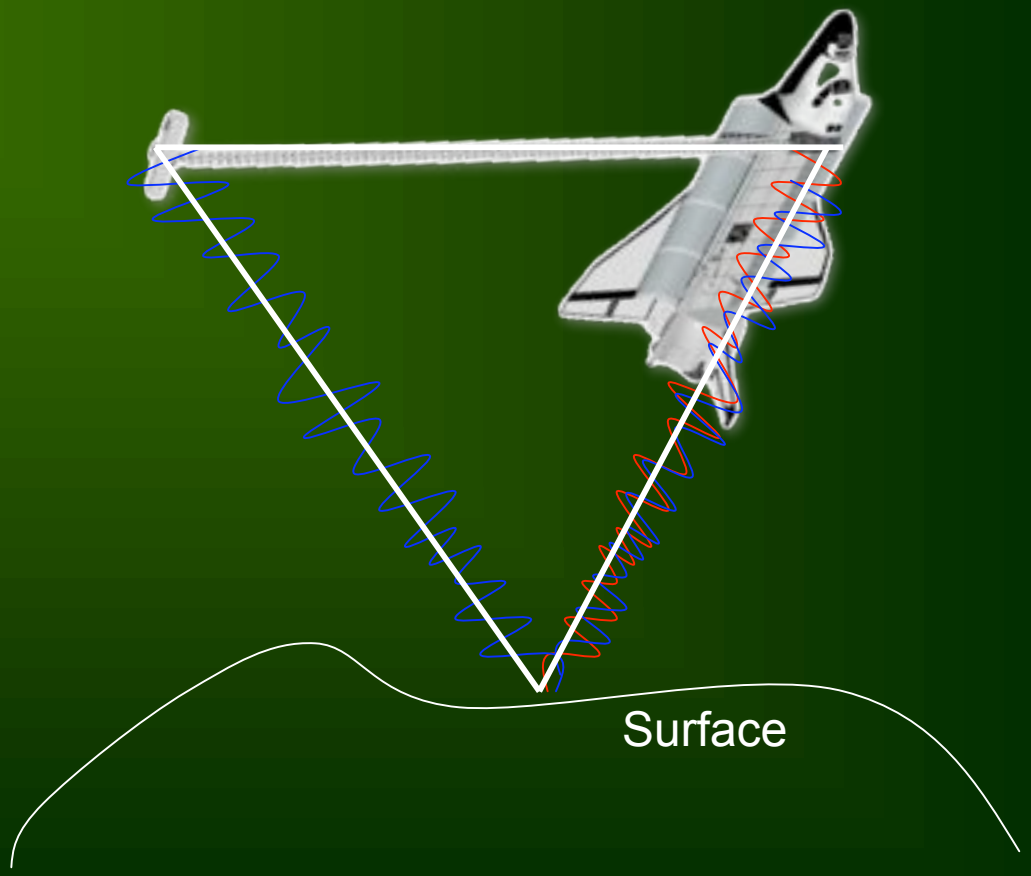


Source: USGS

Kellndorfer et al., 2008

What is Radar Interferometry anyway?

- It's simple trigonometry



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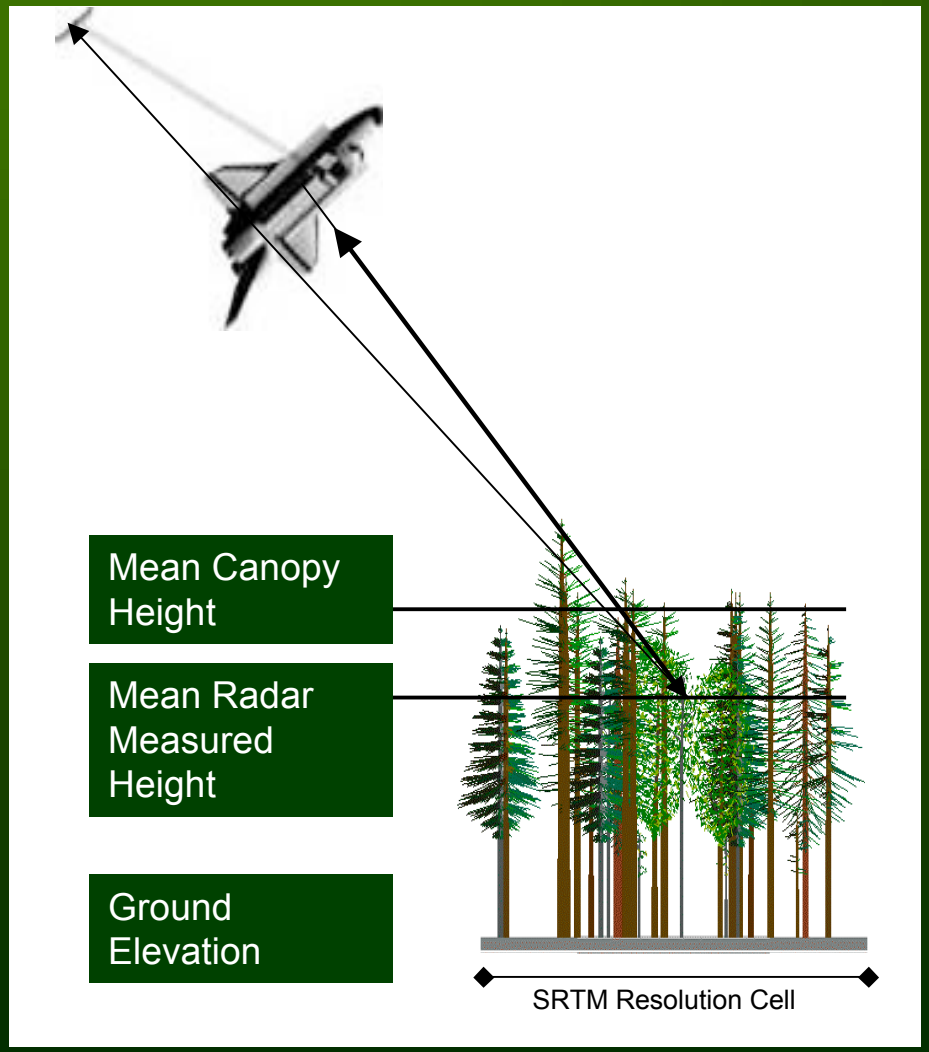
SRTM Vegetation Response



- A fundamental law of science applies to the SRTM data:

  "One scientist's noise is another scientist's signal!"

Geologist

Ecologist

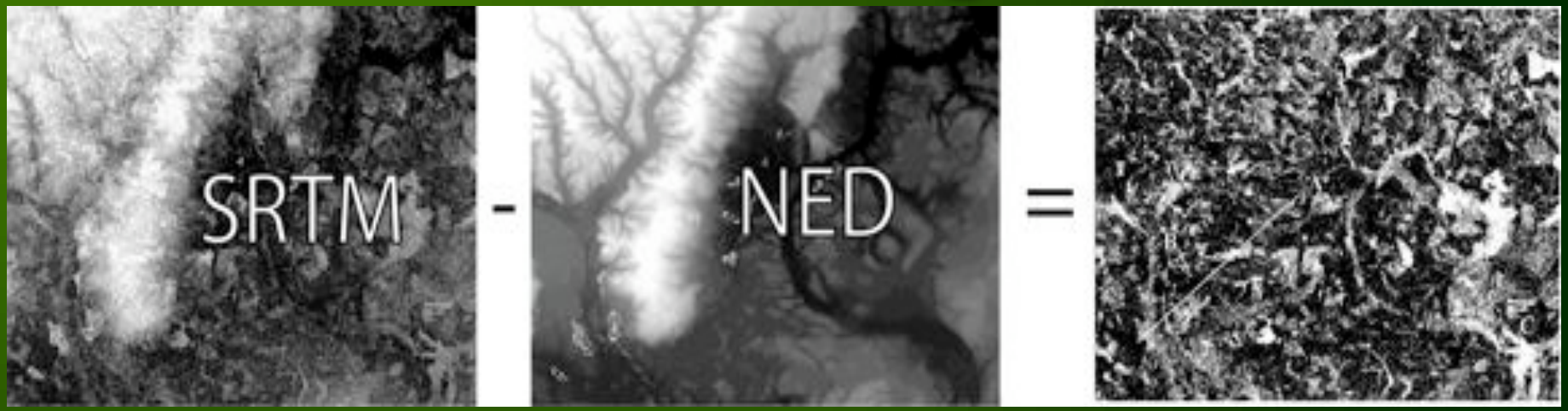
Kellndorfer et al., 2008

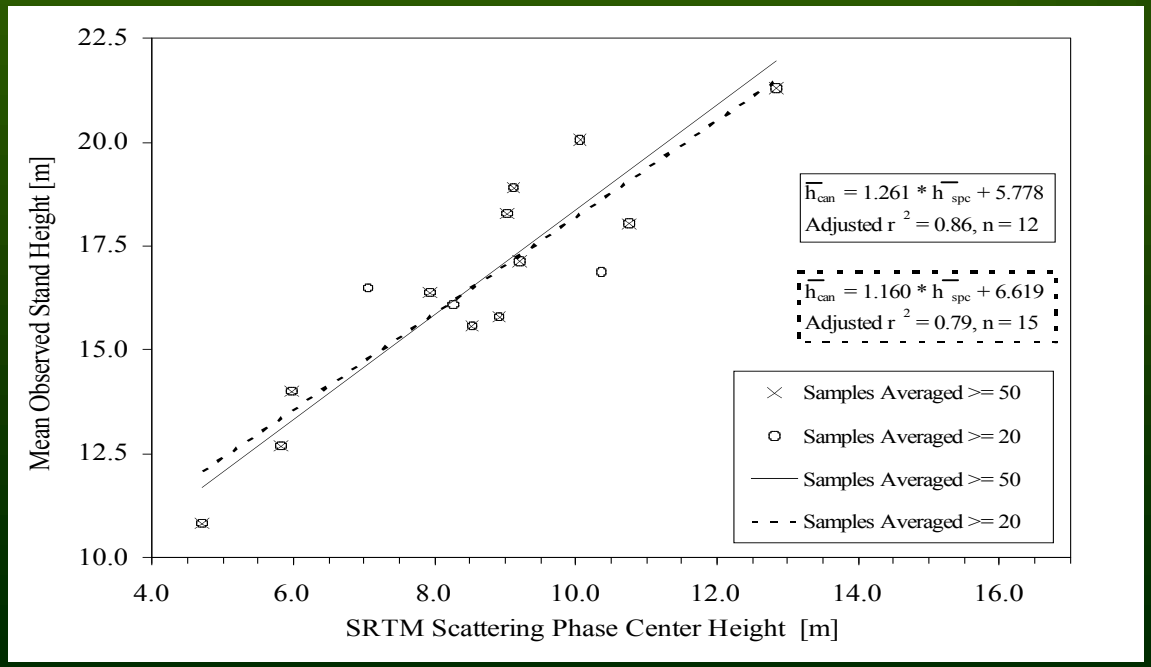
What do we see in the SRTM data?

Port Huron

Hillshade of the
90 m C-band DEM

Pilot Studies for SRTM Height Retrieval: Georgia



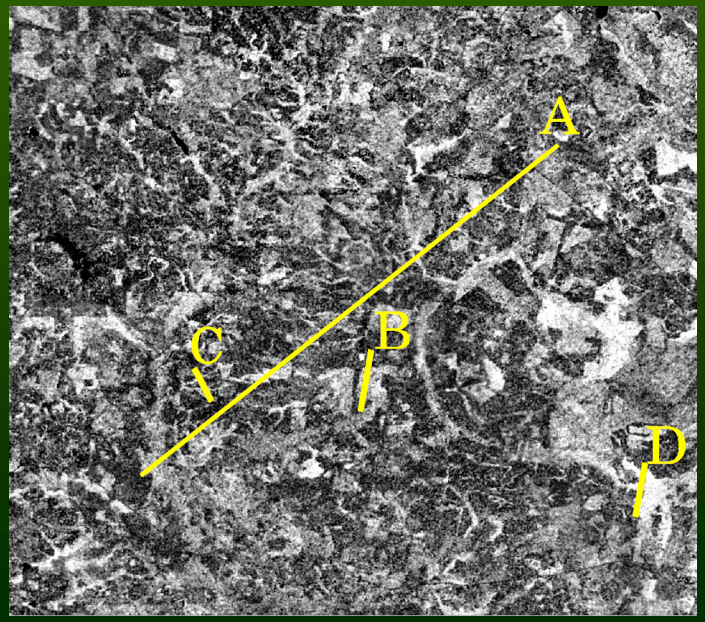


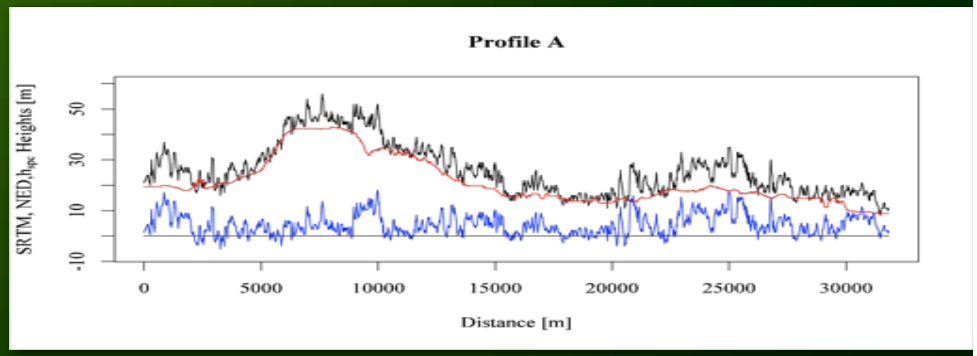
- Kellndorfer, J.M., W.S. Walker and L.E. Pierce, M.C Dobson, J. Fites, C. Hunsaker, J. Vona, M. Clutter, "***Vegetation height derivation from Shuttle Radar Topography Mission and National Elevation data sets.***" Remote Sensing of Environment, Vol. 93, No. 3, 339-358, 2004.

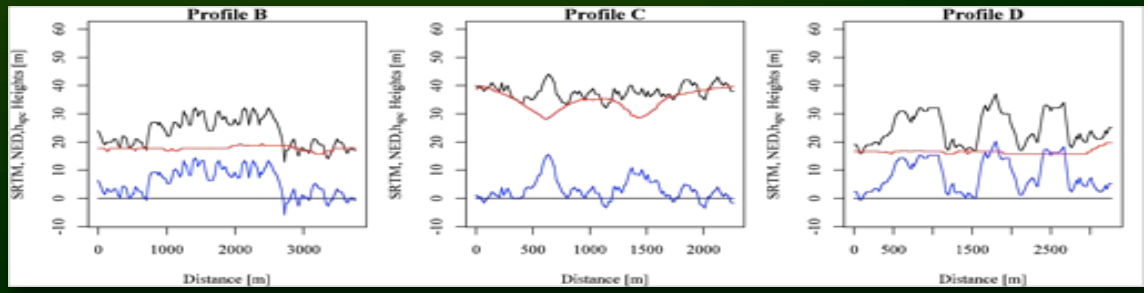
Kellndorfer et al., 2008

SRTM Vegetation Signal Extraction

- Per pixel measurements have typical SAR noise characteristics -> Need to develop noise reduction approach which optimizes the retrieval of vegetation height







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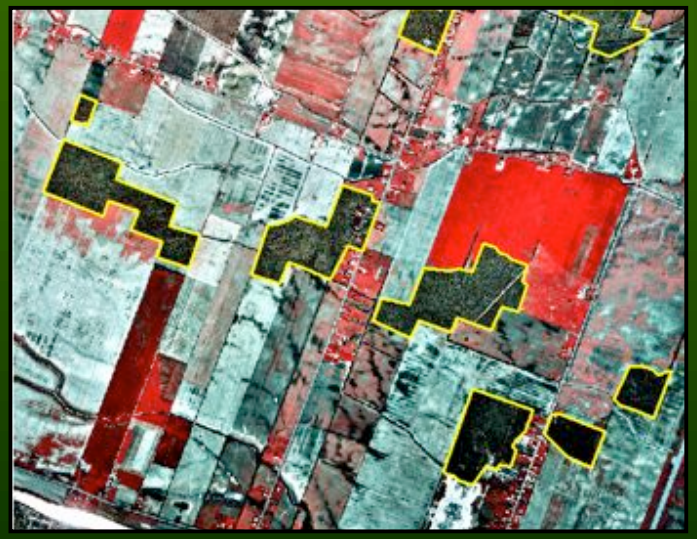
Noise Mitigation

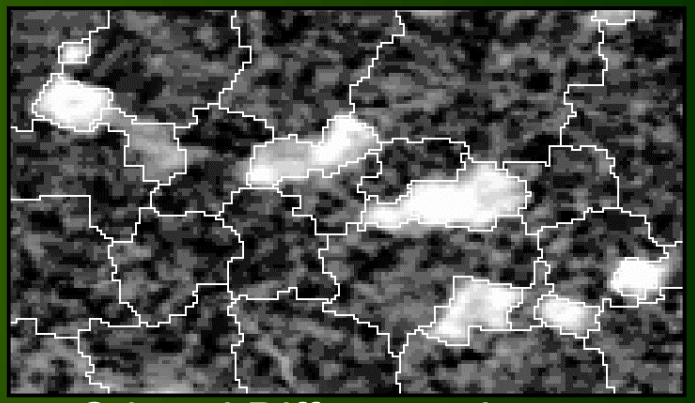
Example: Michigan Woodlots

Monroe County, MI

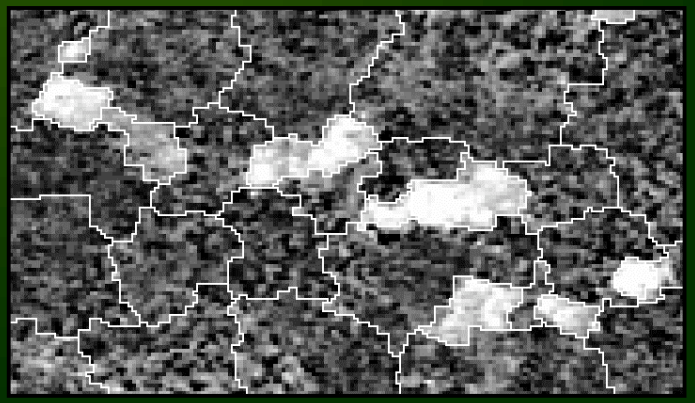


Aerial Photo (RGB=432)

Segmentations (eCognition)



C-band Difference Image



X-band Difference Image

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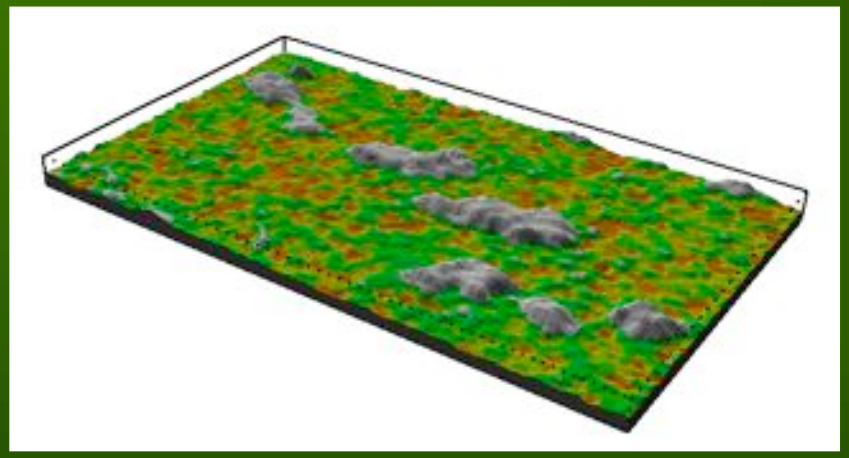
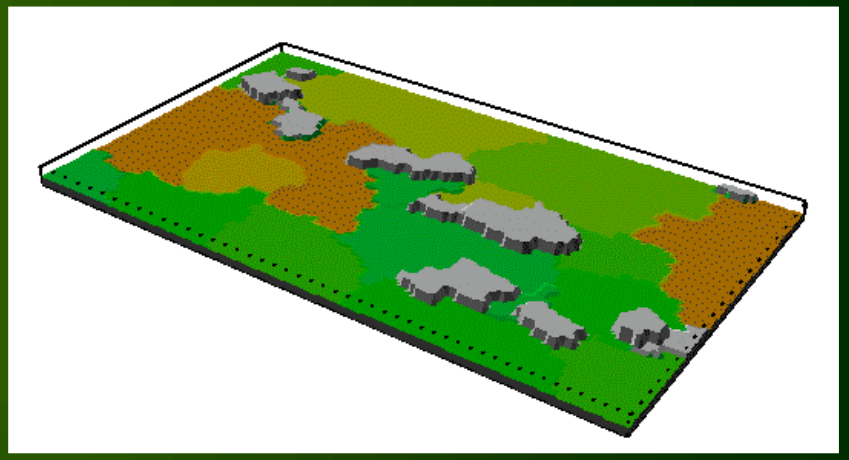
Noise Mitigation

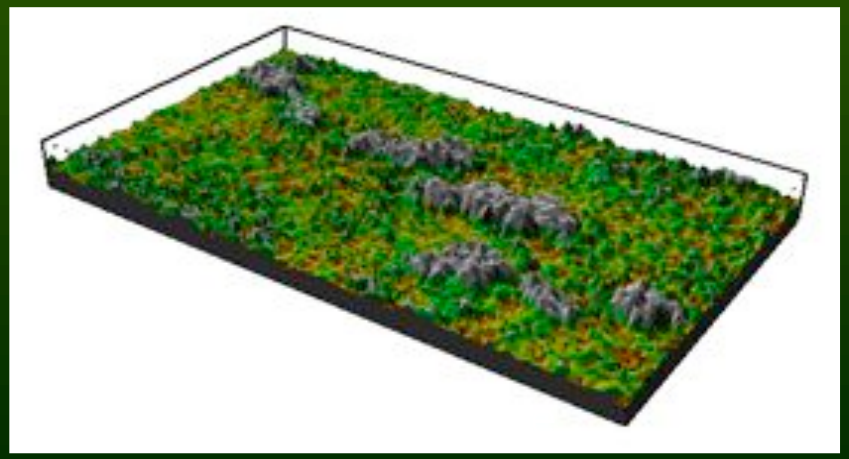
Example: Michigan Woodlots

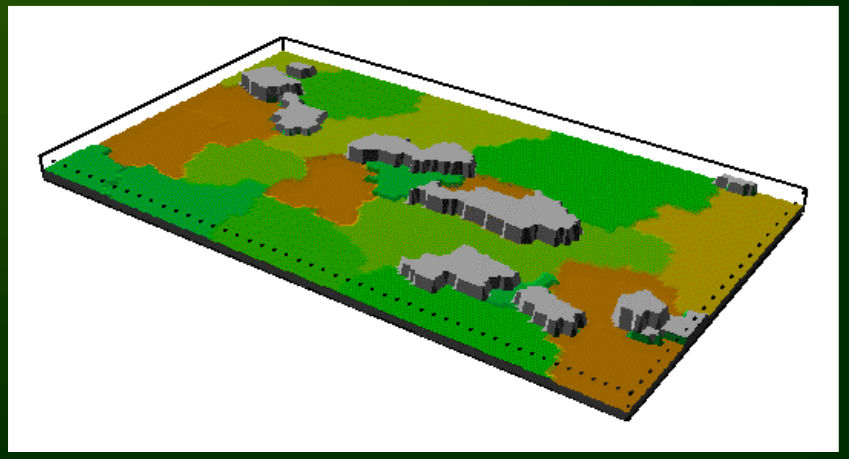


Before Object-based Averaging



After Object-based Averaging

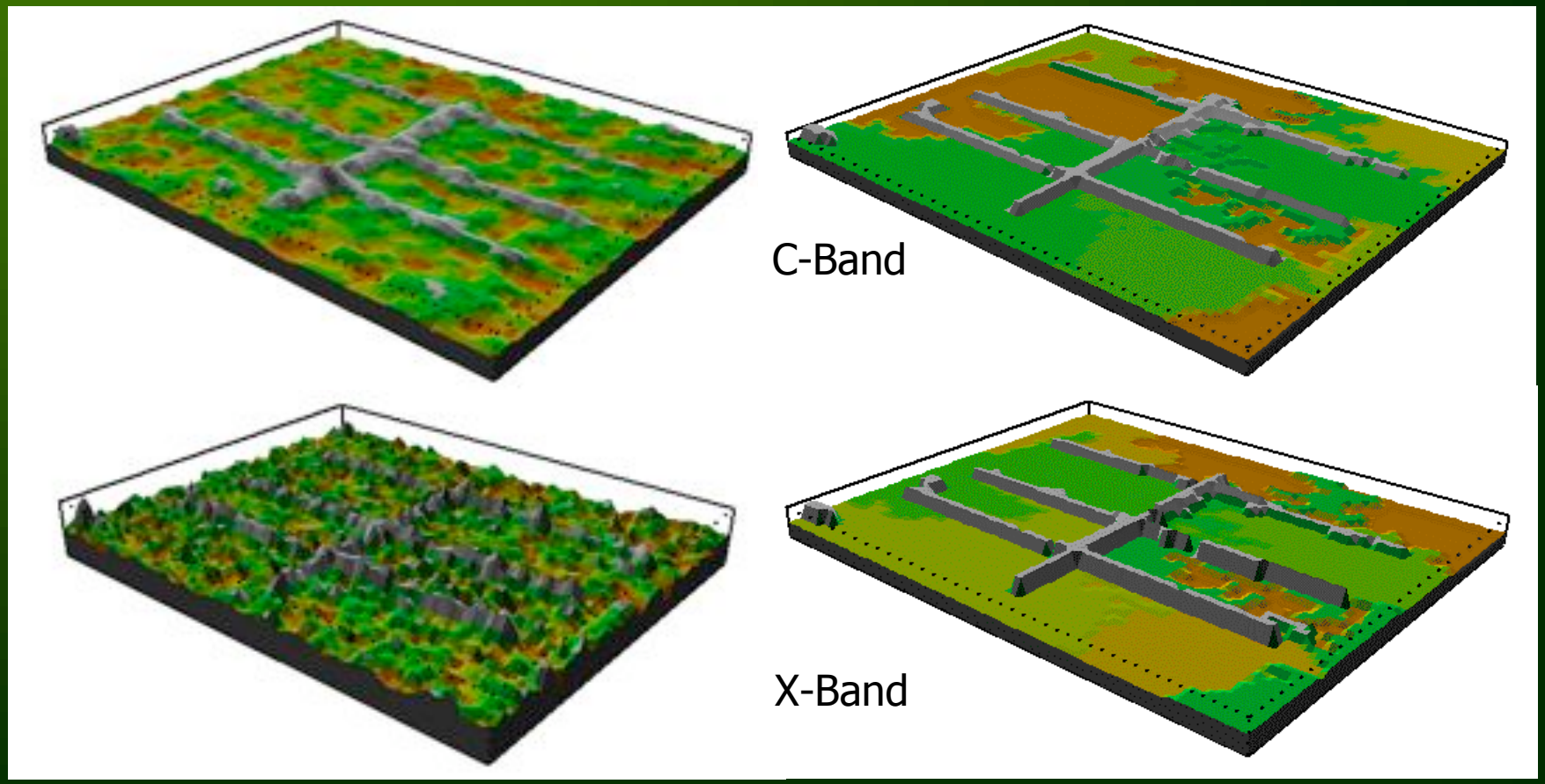




Kellndorfer et al., 2008

Noise Mitigation

Example: Iowa Hedgerows



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Modeling Approach

Hypotheses:

Height = f (SRTM-NED, canopy density, cover type, …)

Biomass = f (height, density, cover type, …)

Use statistical approach (ensemble learning algorithms based on regression trees) to generate the relationships and test how well height and biomass can be predicted compared to ground measured forest survey data

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The Opportunity …

- A "*millennium*" opportunity exists to combine SRTM and several national data sets:
  - National Land Cover Database 2001
    - Provides Landcover, Treecover, Imperviousness
  - MRLC Landsat ETM+ Datasets 1999-2002
  - National Elevation Dataset
    - Compiled from Topographic Survey data
    - Cohesive processing for the first time around 2000
  - USDA Forest Inventory and Analysis Data
    - Ca. 300,000 surveyed plots with forest attributes (including height, biomass)

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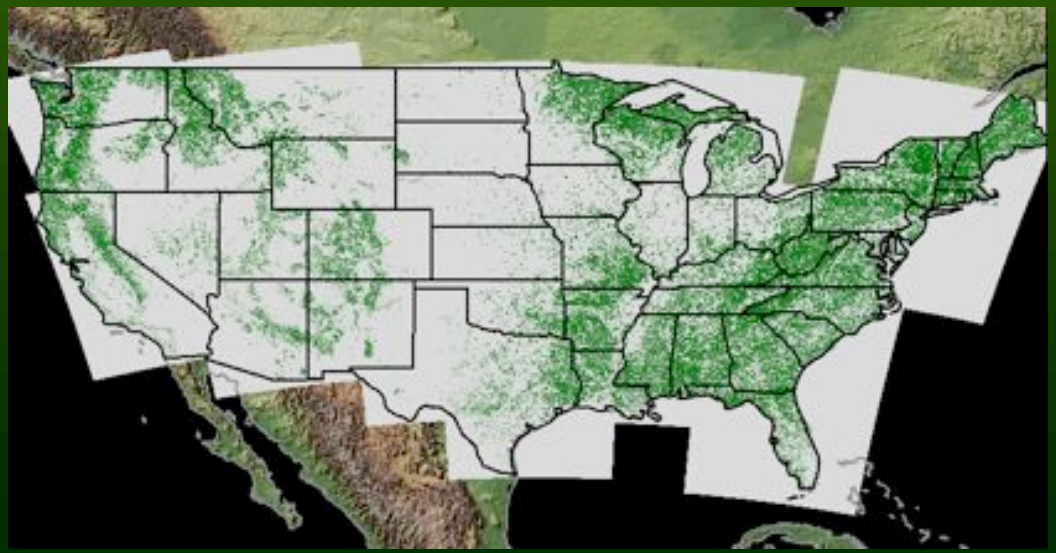
National Landcover Database 2001



- Based on Landsat ETM Data collected from1999-2002
- Completed in 2007
- 30 m resolution
- Provides
  - Land Cover
  - Canopy Density
  - Imperviousness

Source: seamless.usgs.gov

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National Elevation Dataset (NED)

- First nationally cohesive compilation of U.S. topographic data sets at 30 m resolution

http://erg.usgs.gov/isb/pubs/factsheets/fs10602.html

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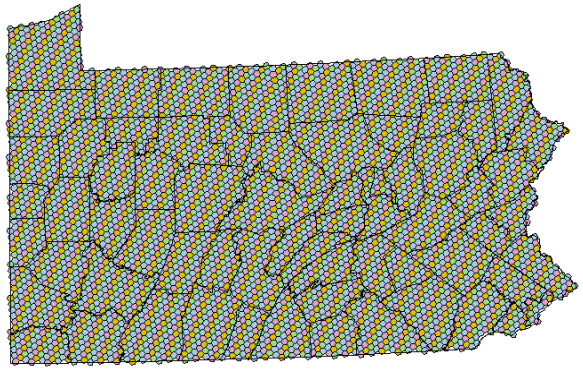
U.S. Forest Inventory and Analysis

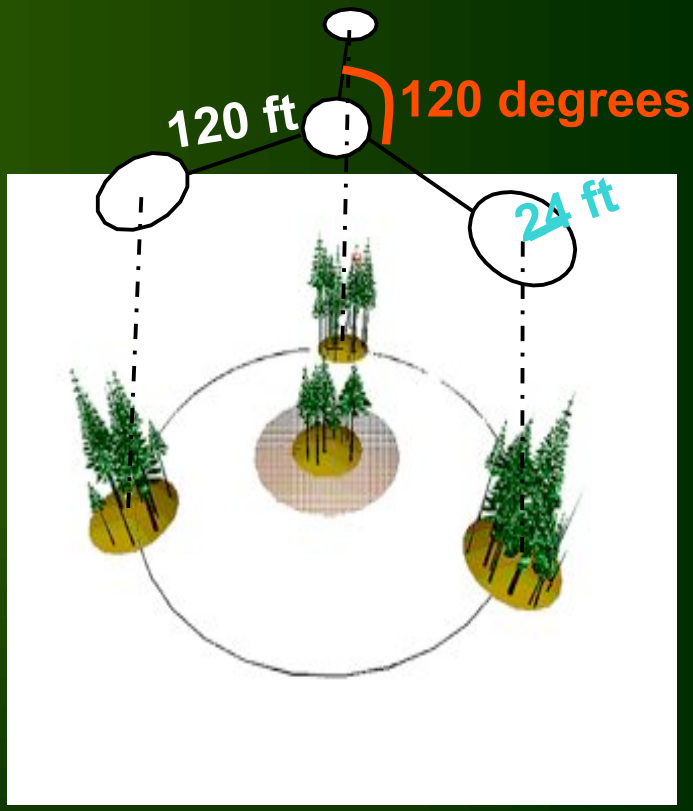


Sample Intensity = 1 sample location per hexagon (~ 6000 acres)

Inventory Cycle Length = Between 1/5 and 1/10 of the plots will be measured each year

> 300,000 Plots at Full Implementation

1/24 acre subplots



Plot locations are not revealed to the public to protect the privacy of land owners

Courtesy: M. Hoppus, A. Lister, USDA Forest Service

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How many trees are sampled in a plot depends ...

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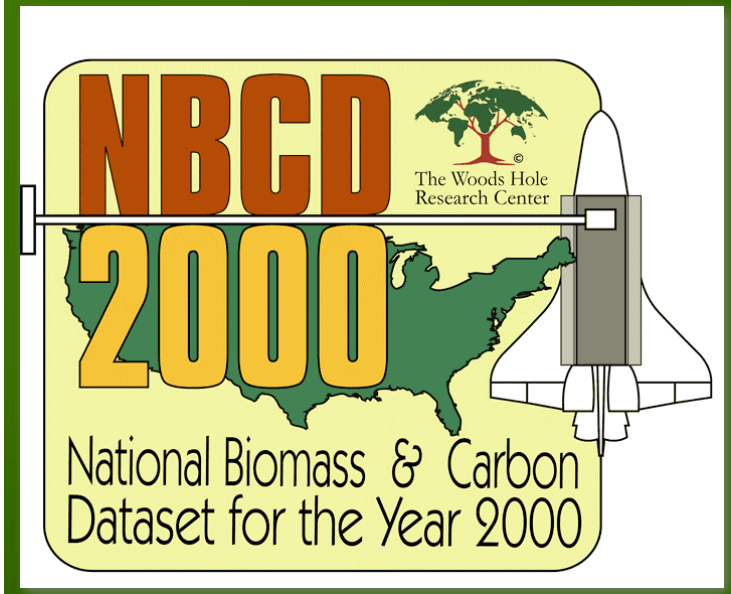


Principal Investigator:
Josef Kellndorfer
Woods Hole Research Center

Research Team:
Wayne Walker, Katie Kirsch, Greg Fiske
Woods Hole Research Center

Elizabeth LaPoint, Mike Hoppus, Jim Westfall
USDA Forest Service FIA Program:

Four year project to produce

-Forest vegetation height

-Biomass and

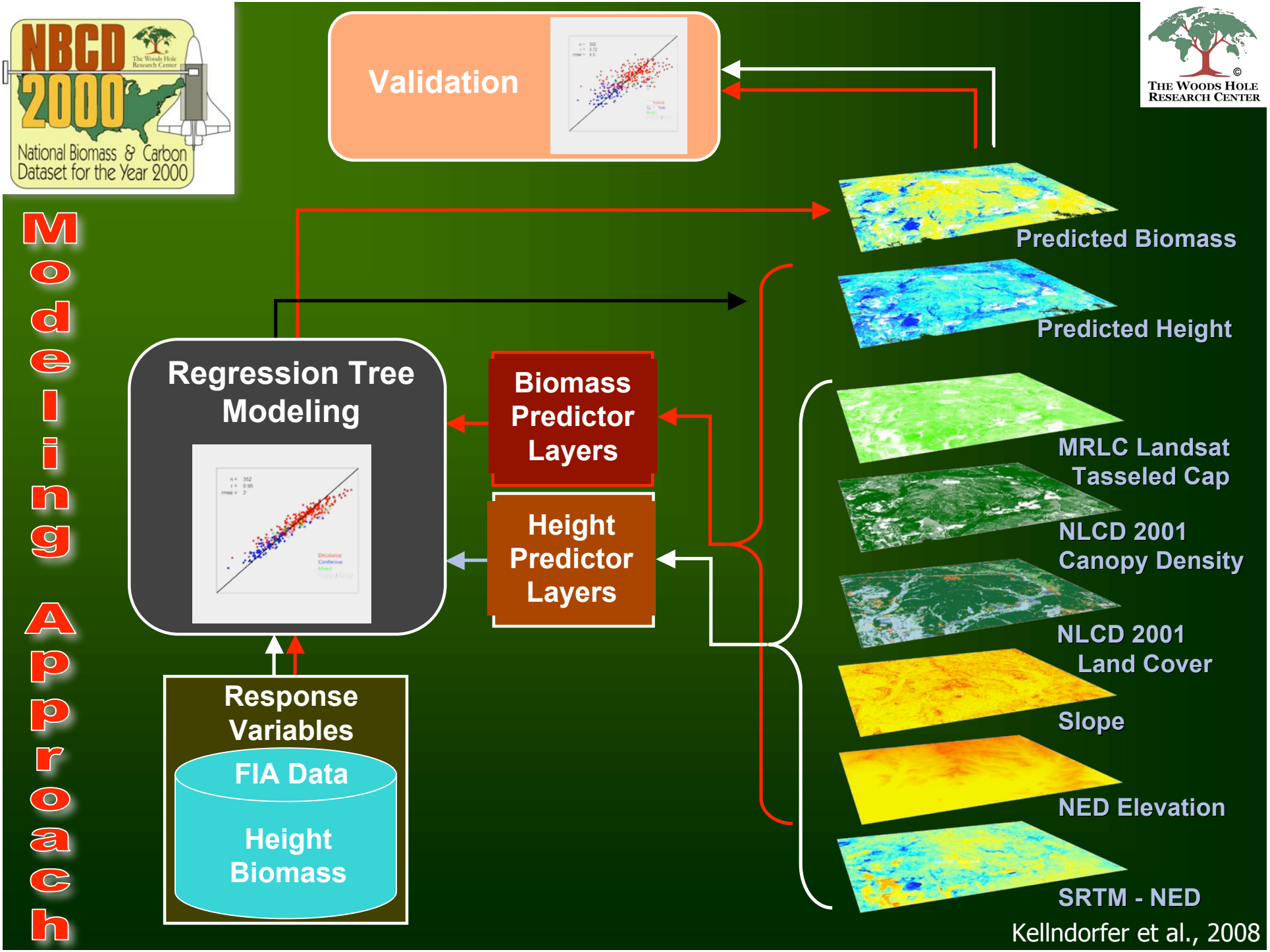
-Carbon Estimates

-Conterminous U.S.

-First attempt at 30 m resolution ever

Collaboration:
Dean Gesch, National Elevation Dataset, USGS
Collin Homer, National Land Cover Database 2001 / MRLC, USGS
Zhi-Liang Zhu, LANDFIRE, USGS

Funding and Support:
NASA Terrestrial Ecology Program
LANDFIRE
PCI Geomatics
Definiens Imaging/eCognition


NBCD 2000
National Biomass & Carbon Dataset for the Year 2000
The Woods Hole Research Center
Validation
Modeling Approach
Regression Tree Modeling
Biomass Predictor Layers
Height Predictor Layers
Response Variables
FIA Data
Height
Biomass
Predicted Biomass
Predicted Height
MRLC Landsat Tasseled Cap
NLCD 2001 Canopy Density
NLCD 2001 Land Cover
Slope
NED Elevation
SRTM - NED
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Results: Example Map Products

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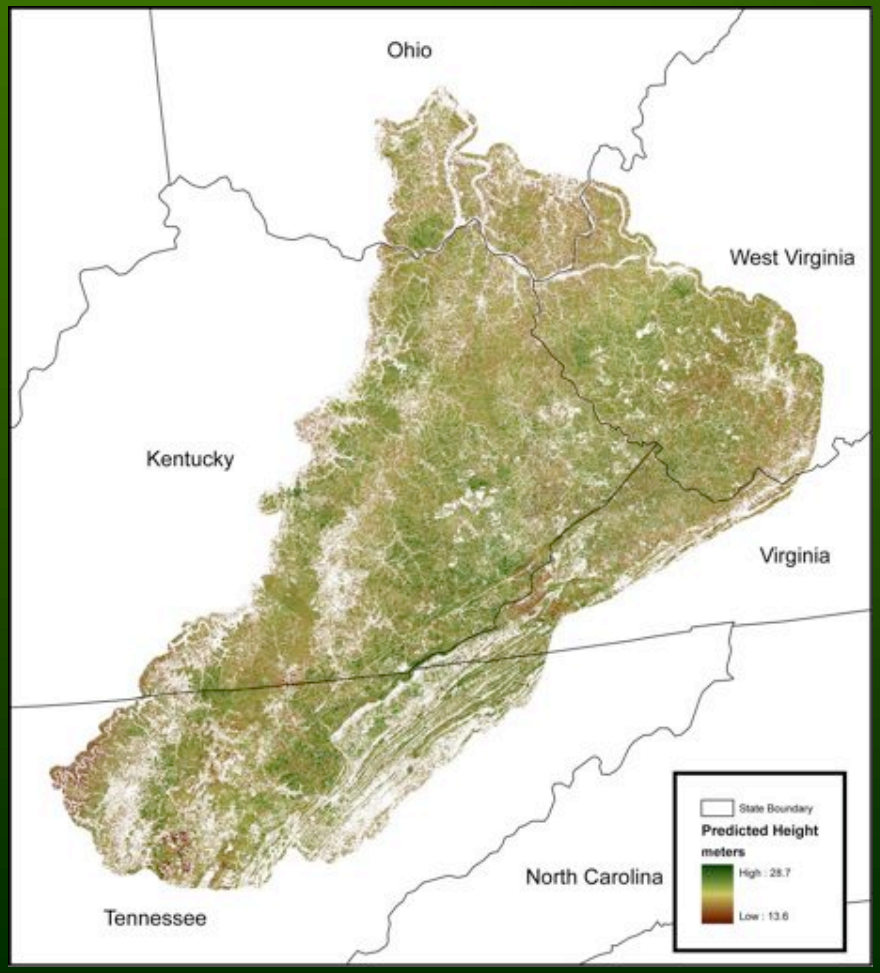
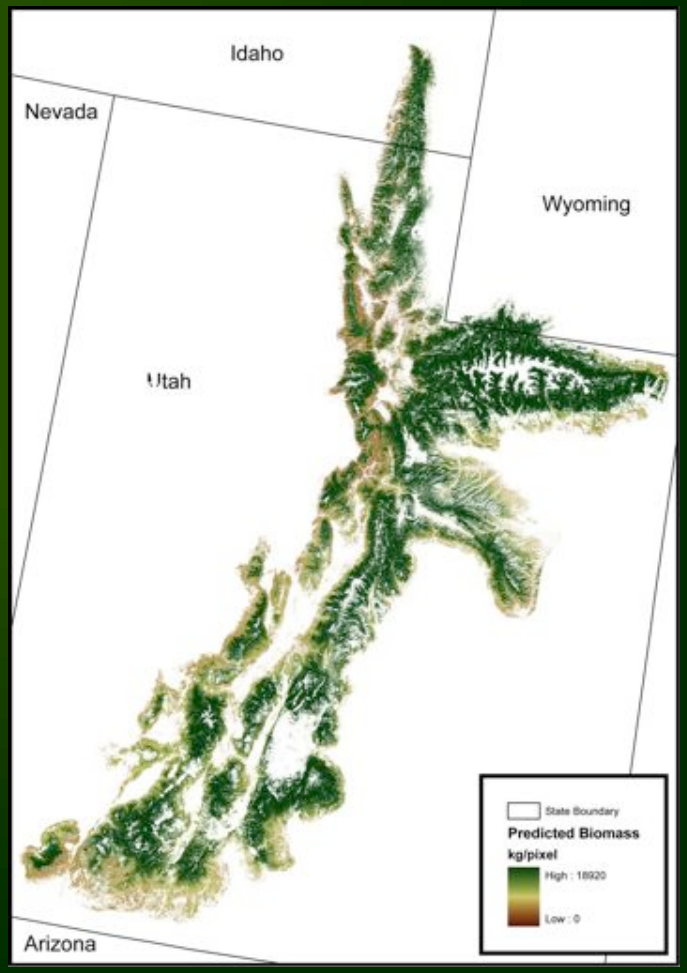
Mapping Zone 53:
Predicted Basal-Area Weighted Height



Mapping Zone 16:
Aboveground Live Dry Biomass



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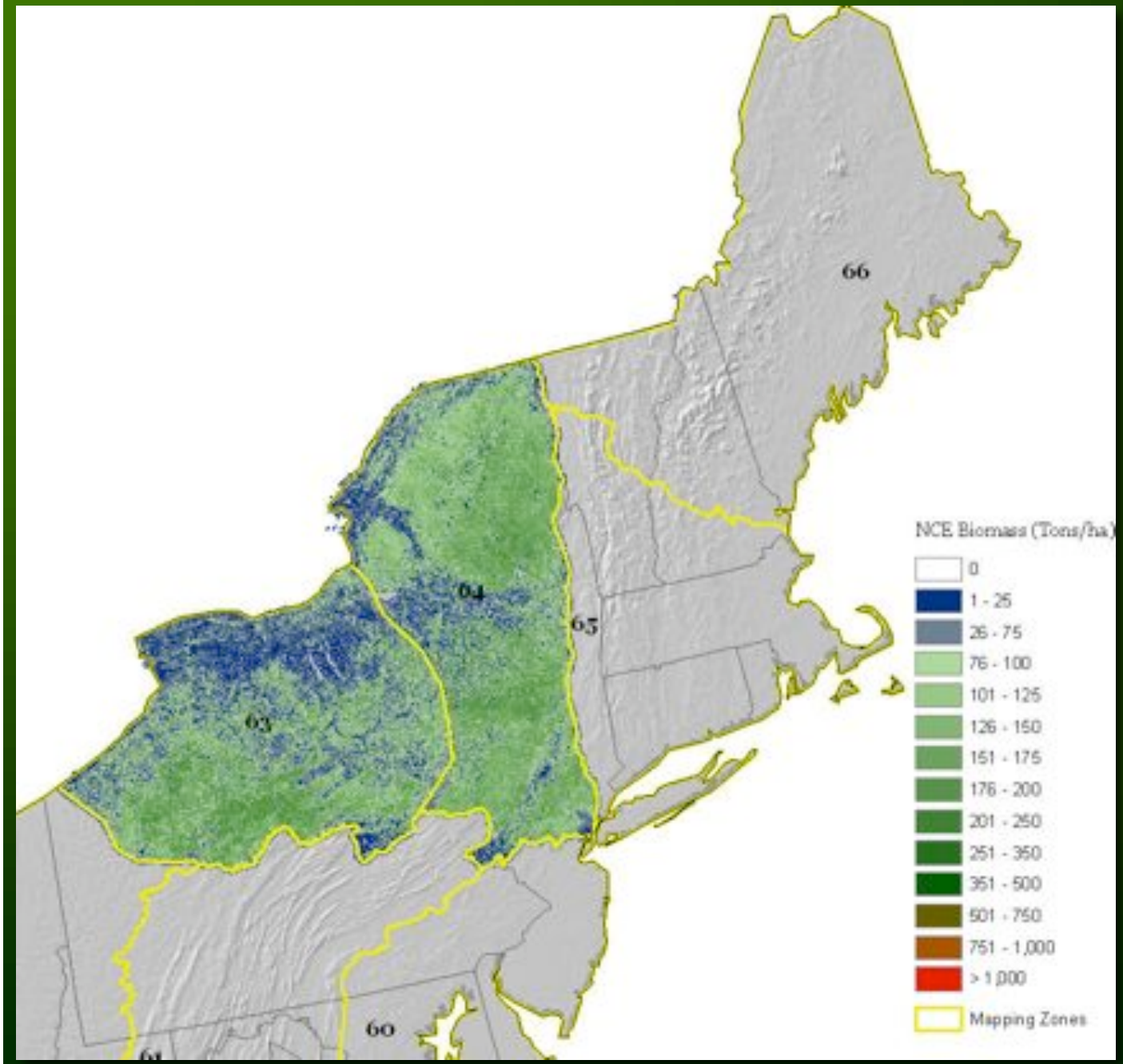

NBCD 2000 in the Regional Greenhouse Gas Initiative (RGGI) Region

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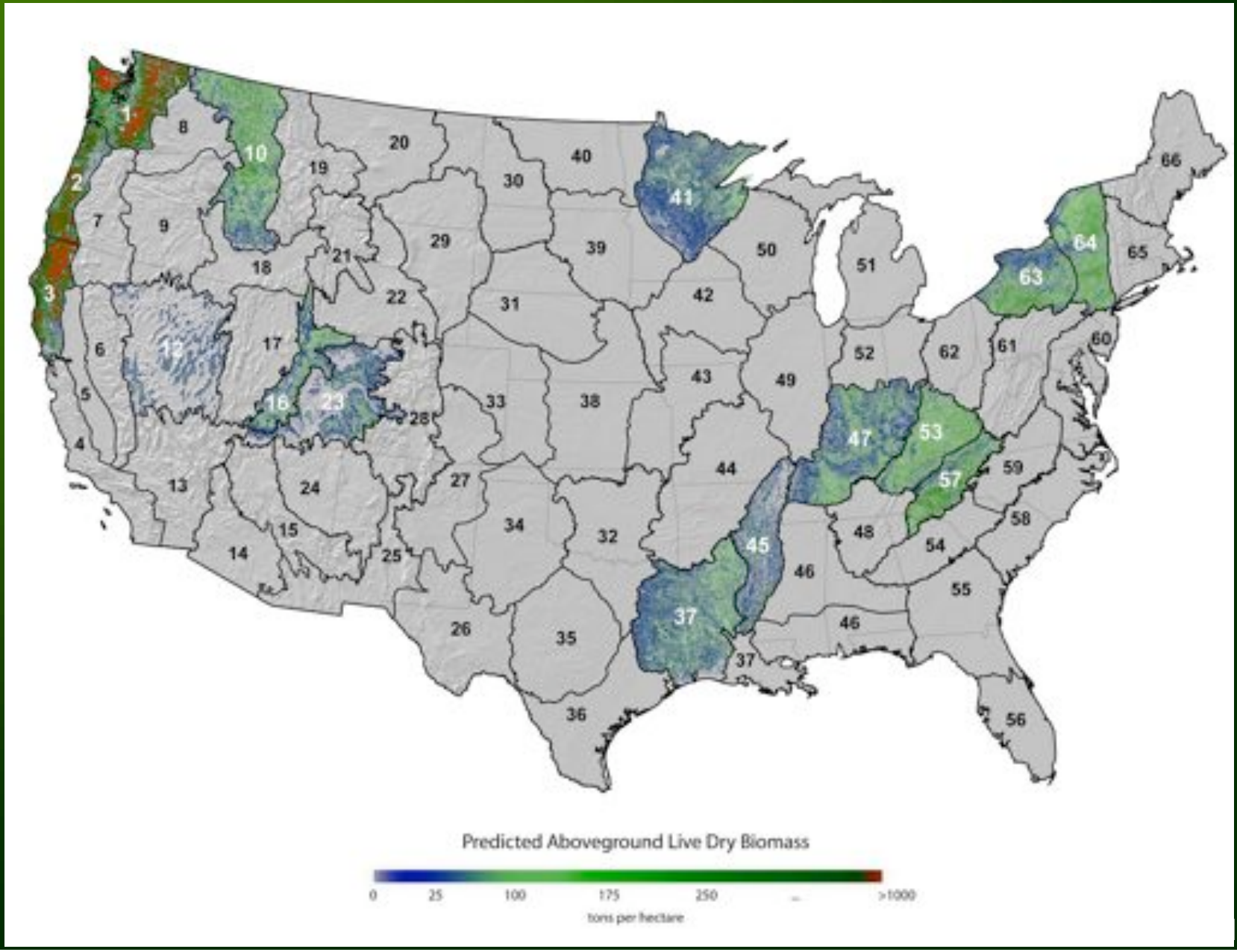
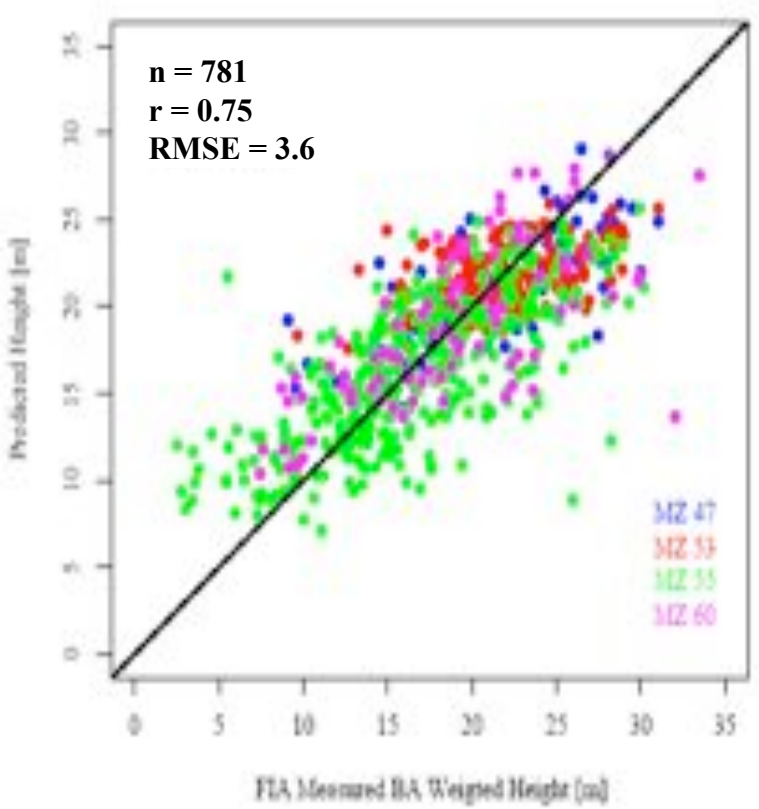
NBCD Status April 2008



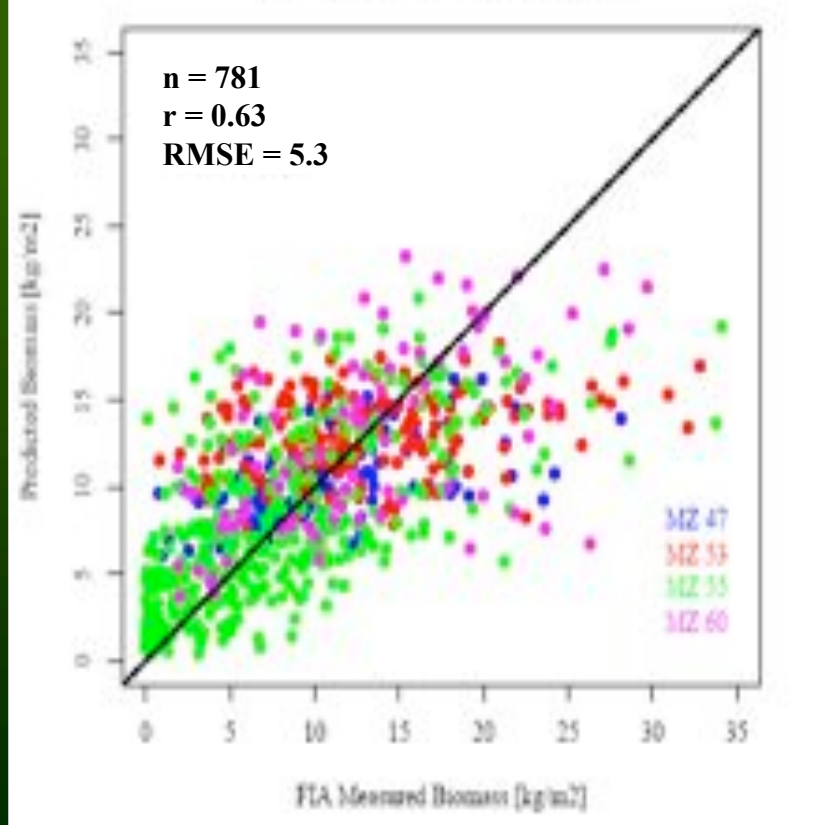
., 2008

Results: Eastern U.S. Validation

Eastern U.S. Combined Results: Height



Eastern U.S. Combined Results: Biomass



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NASA/USDA Funded Project under Carbon Cycle Science:

- Towards Spatially Explicit Quantification of Carbon Flux (2000-2007) in Northeastern U.S. Forests Linking Remote Sensing with Forest Inventory Data
- Project Time Frame: 5/2008 - 4/2011
- Team: WHRC, USDA Forest Service

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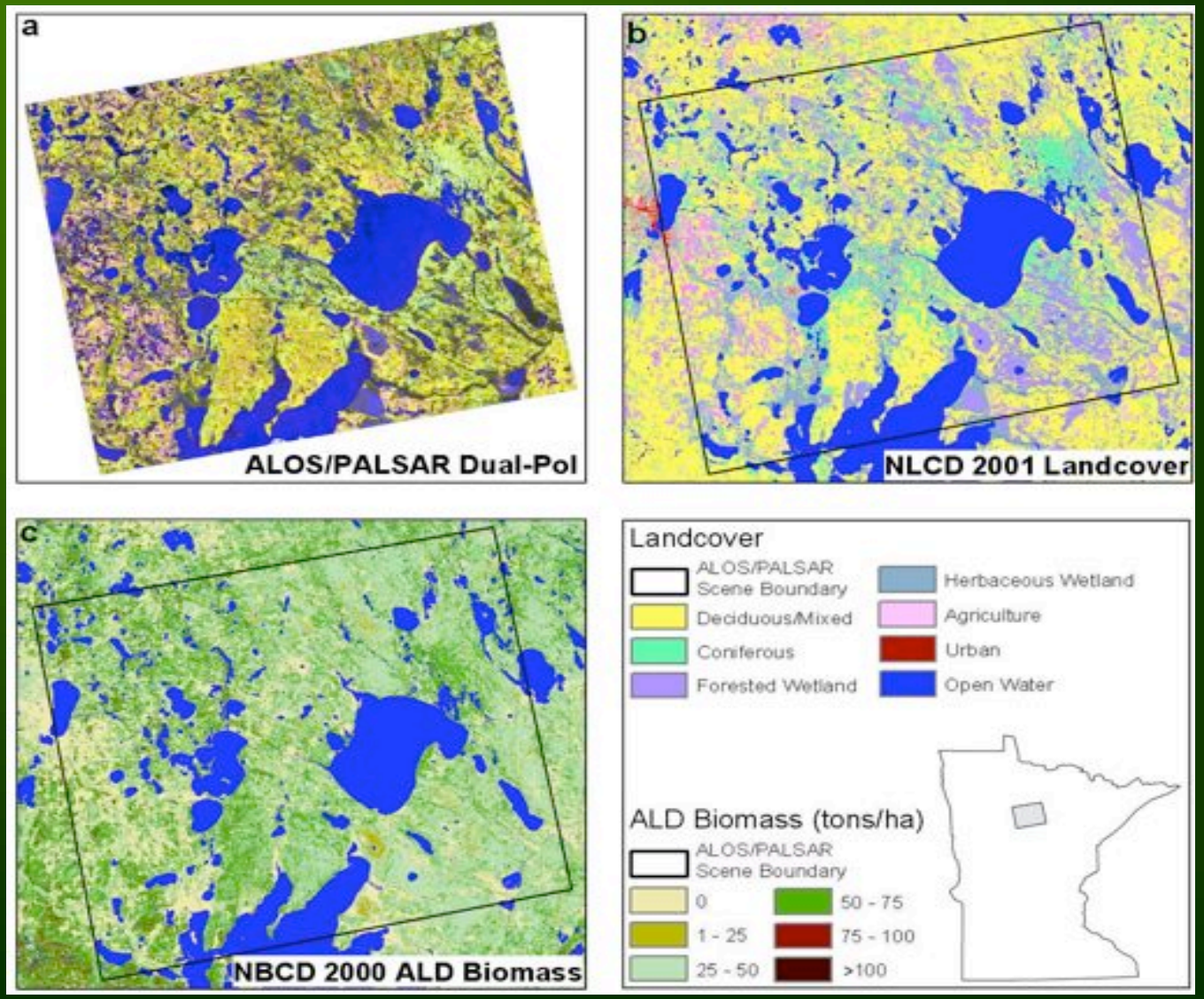
Biomass Change in NE U.S.



Example of input data for change detection (Proposal objective 2) and carbon flux calculation (Proposal objectives 3 and 4) from ALOS/PALSAR (a), NLCD 2001 landcover (b), and NBCD2000 biomass prediction (c).

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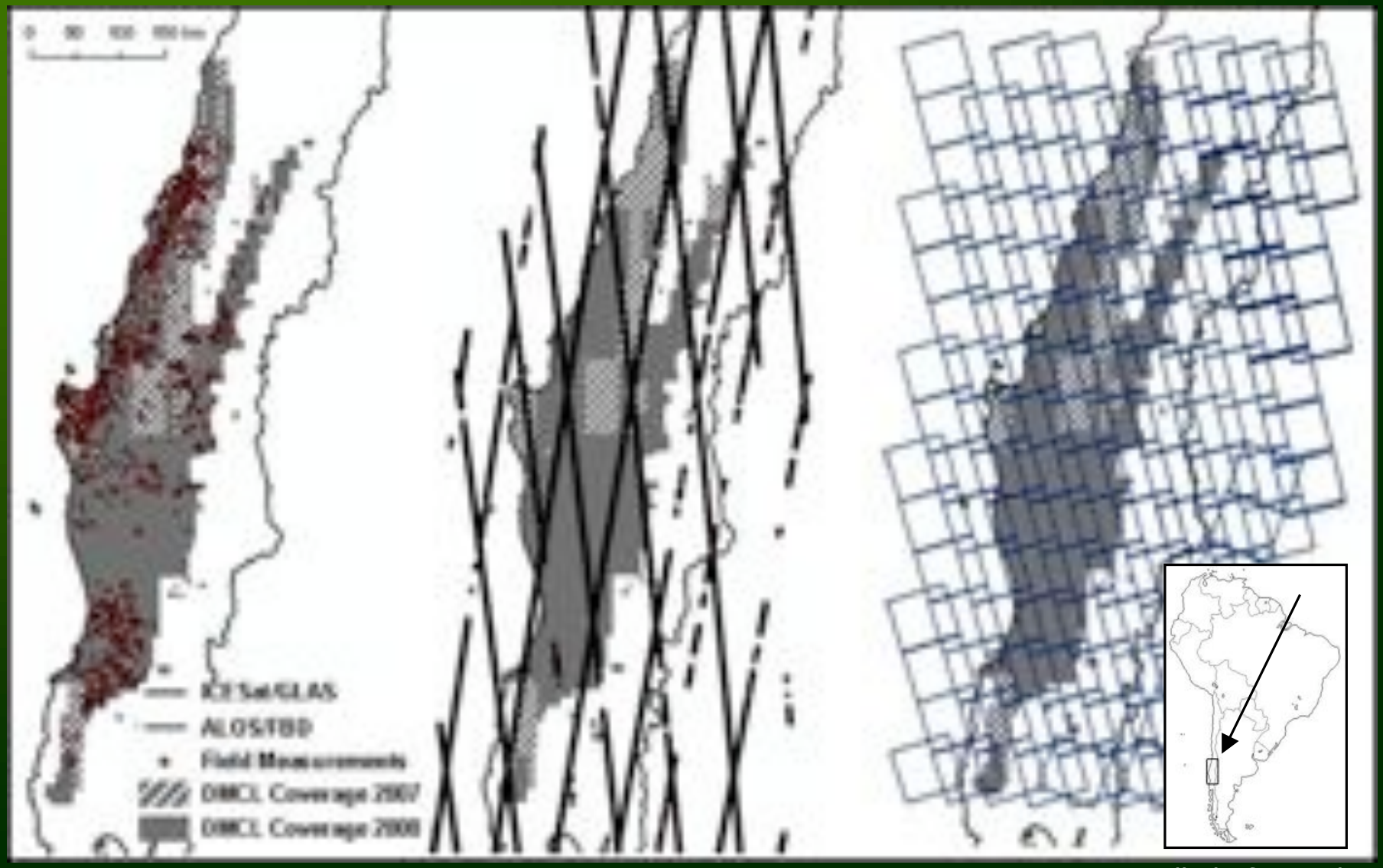
NASA Funded Project under Terrestrial Ecology Program:

- Ecosystem Structure Measurements from DESDynI: Studies of technological options and data fusion using IceSAT/GLAS, Airborne Lidar and ALOS/PALSAR data sets over Central Chile
- Project Time Frame: 5/2008 - 4/2010
- Team:
  - WHRC
  - Digimapas, Chile
  - Arauco Chile

Studies on Lidar/Radar Fusion in Chile



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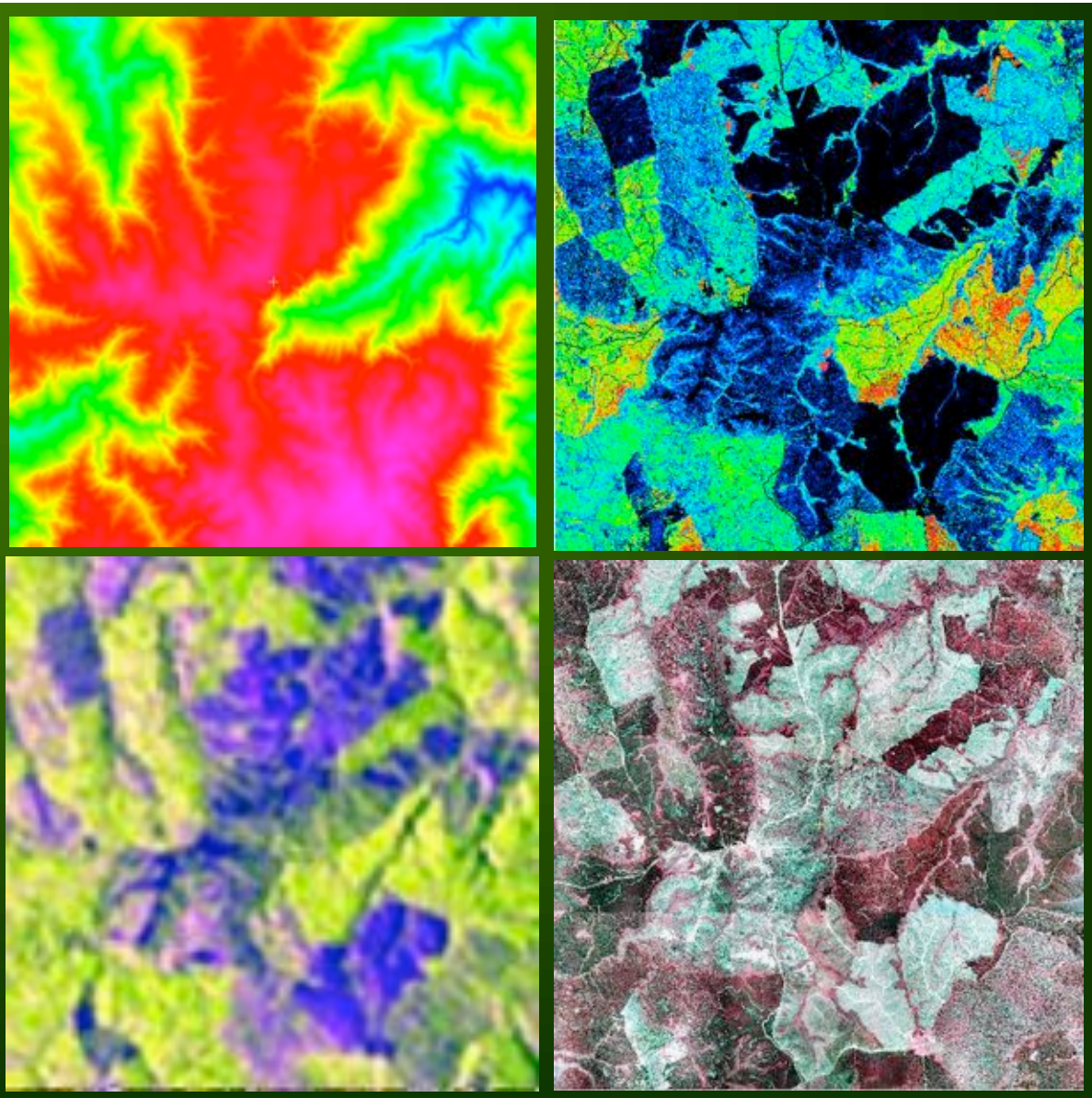

Example of a 6 x 6 km^2 region mapped by the DMCL small footprint lidar sensor and color infrared digital camera processed to 1 m resolution. Top left: Digital Terrain model (DTM); top right: Canopy height model (DSM-DTM); bottom left ALOS/PALSAR L-band hh/hv color composite; bottom right: False color infrared digital orthophoto.

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Summary and Outlook

- SRTM Vegetation Signal provides an unprecedented global data set with sensitivity for forest vertical structure
  - Extraction of Signal depends on good terrain models
- To model vegetation height and biomass, synergy of radar with optical, terrain, land cover and canopy density data is exploited
- Network of well calibrated ground reference data (forest inventory plots) is absolutely crucial for the development and validation of prediction models
- ALOS/PALSAR's systematic observations of global ecosystems with sensitivity to forest vertical structure is invaluable for forest carbon mapping.
- GEOSS has a critical role to facilitate linkage of spaceborne, airborne, and ground reference data sets for global forest carbon mapping and monitoring

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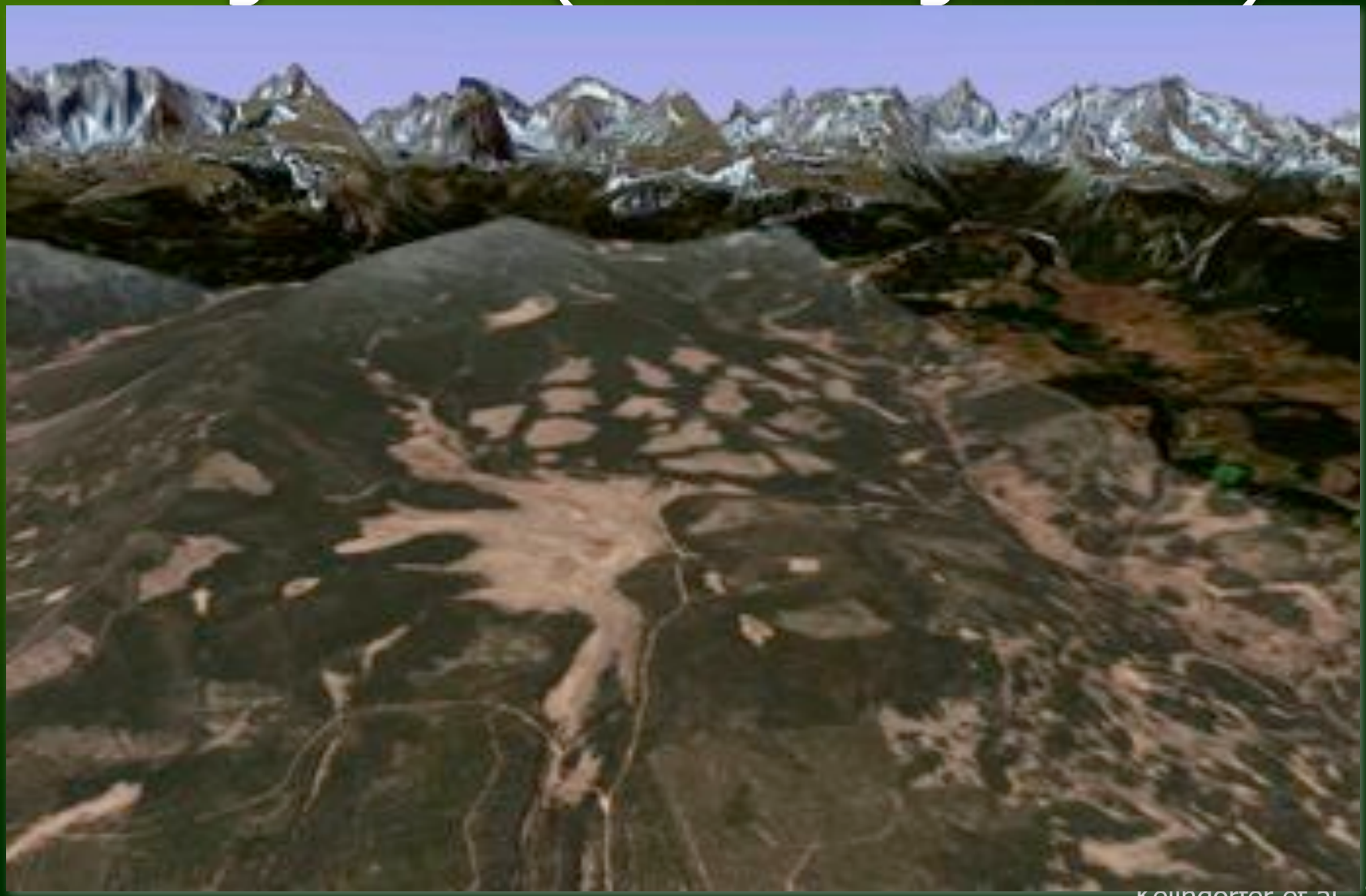
Terrain Visualization: Flat Vegetation (from Google Earth)



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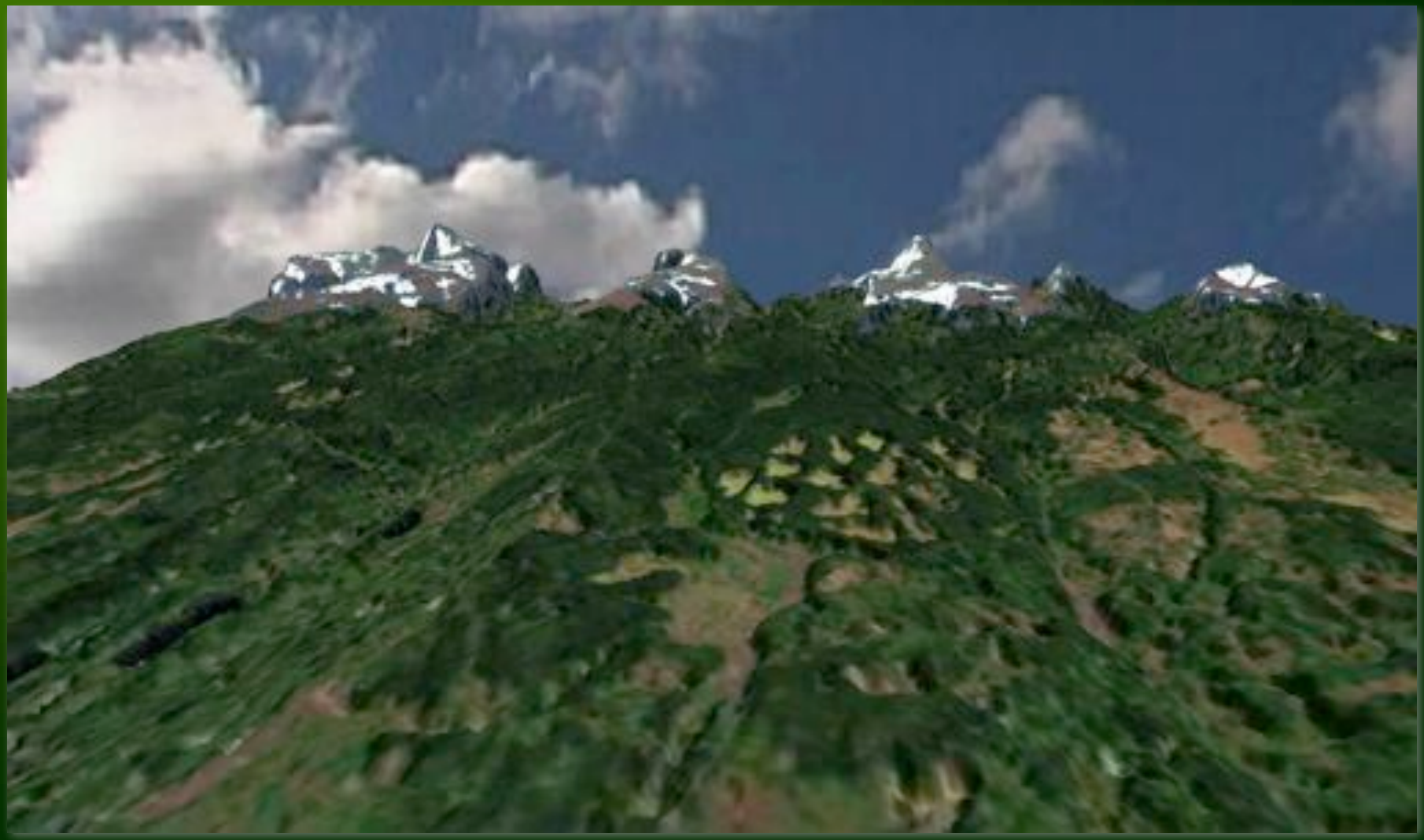
Terrain Visualization: Next Generation With Vegetation Height



GEOSS Asia-Pacific Symposium, April 15th 2008 THANK YOU!

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