

# Tropical Forest Biomass Accumulation Rates from GLAS and Landsat

Landsat Science Team Meeting

July 15-17, Reston, Virginia

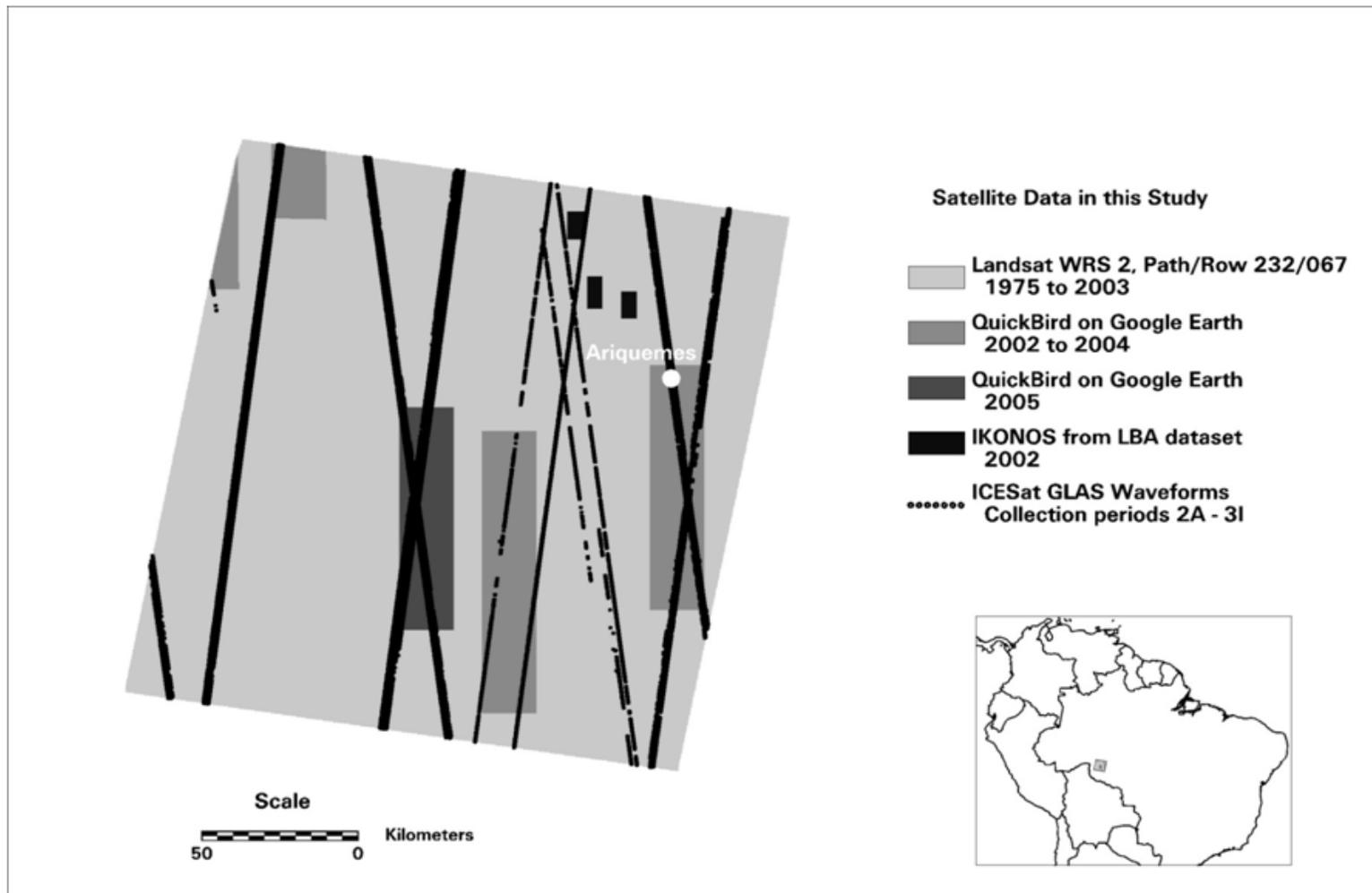
E. H. Helmer, Michael A. Lefsky and Dar A. Roberts



# Rondônia, Brazil

## Landsat, GLAS, fine resolution imagery

*GLAS = Geoscience Laser Altimeter System*

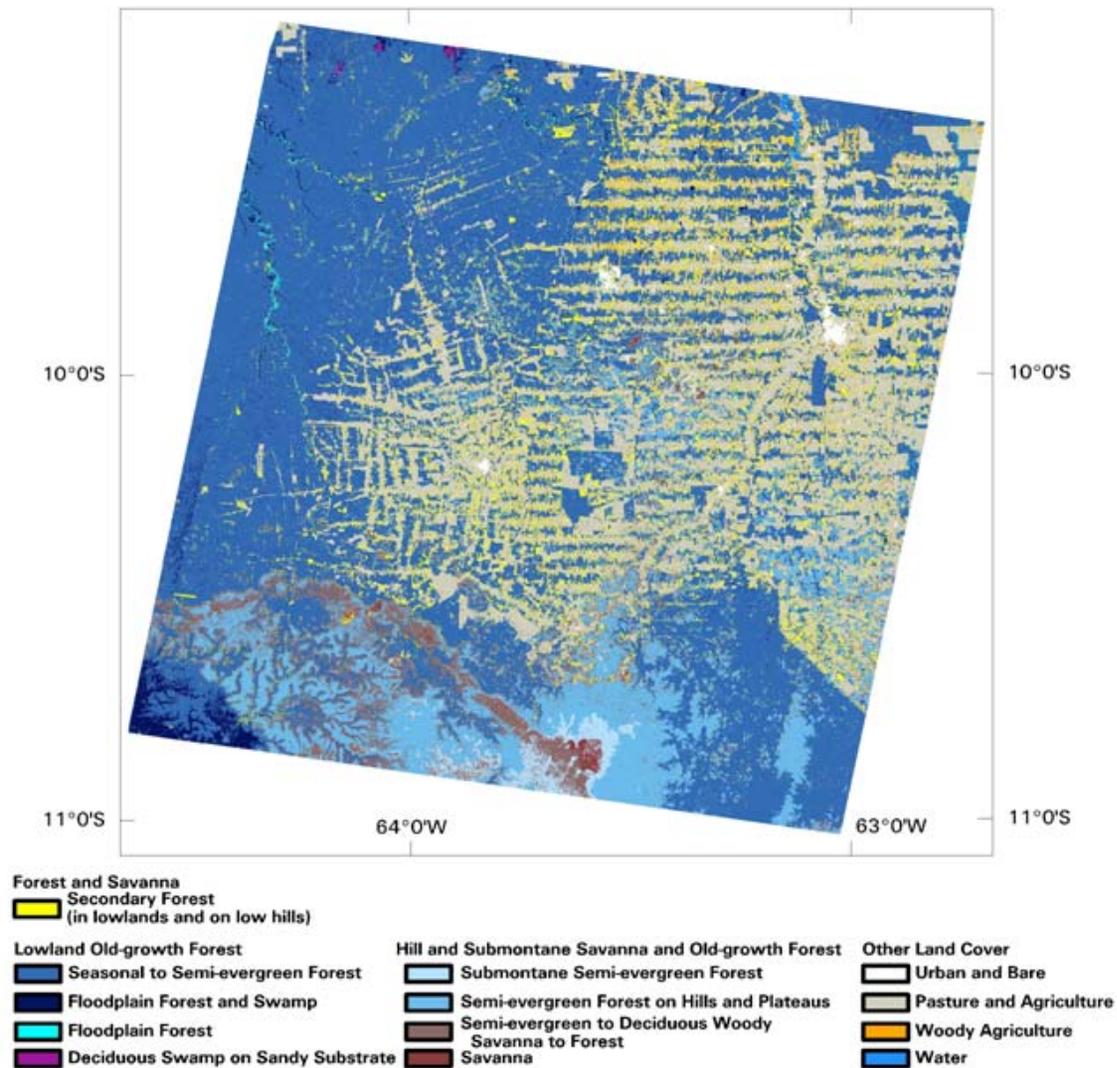


# Main parts of study

- Isolate lowland forests by mapping land cover and forest type
- Map lowland forest age with TAMA
- Estimate biomass from GLAS waveforms of different old-growth types and secondary forest ages

# Isolate lowland forests

## Decision tree classification of Landsat and SRTM



*EH Helmer, MA Lefsky, DA Roberts, 2009, Journal of Applied Remote Sensing Vol 3:033505*

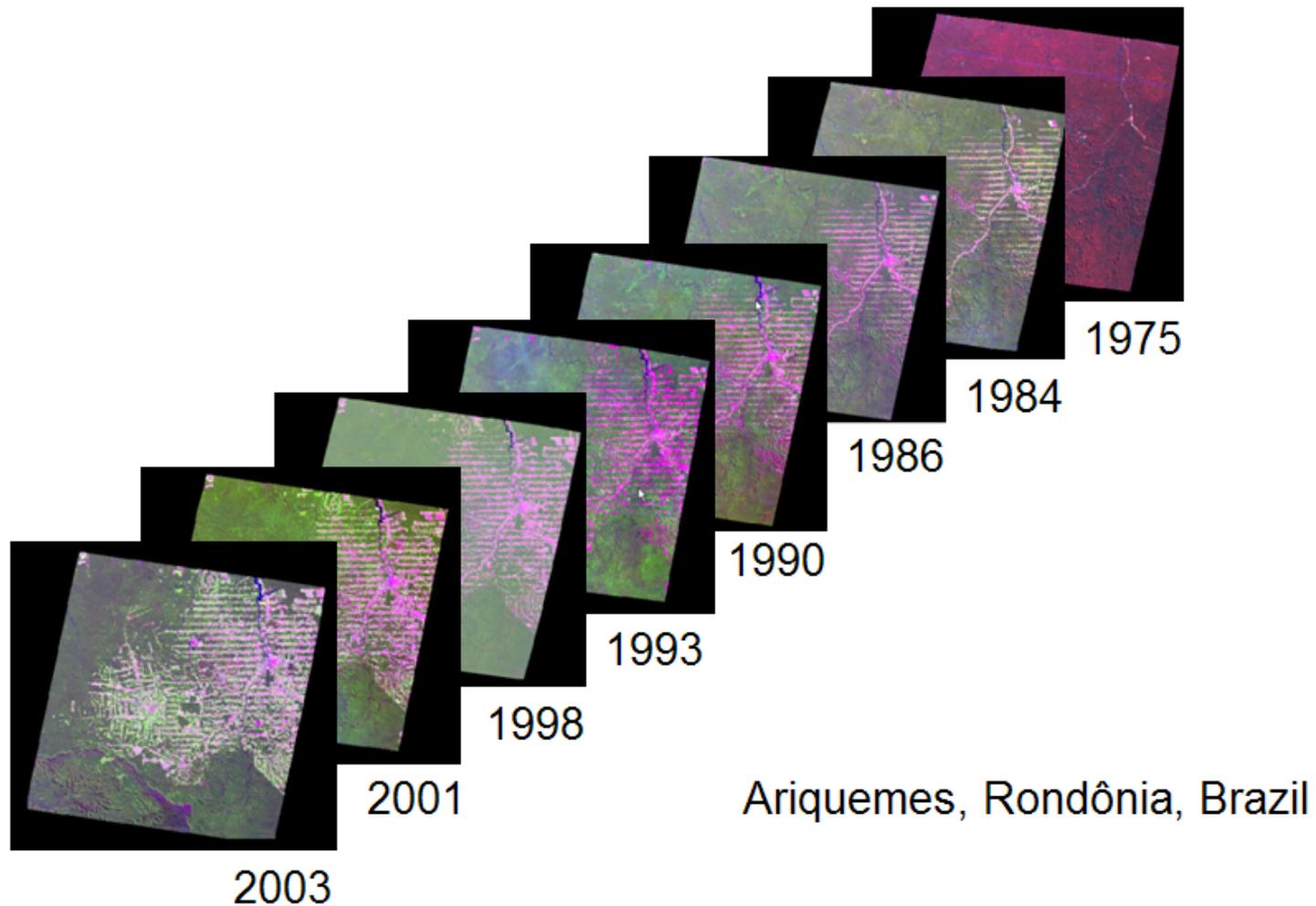
# Threshold Age Mapping Algorithm (TAMA)

## Forest age in humid lowland Amazonian forests

*Simple, fast, accurate and self-calibrating*

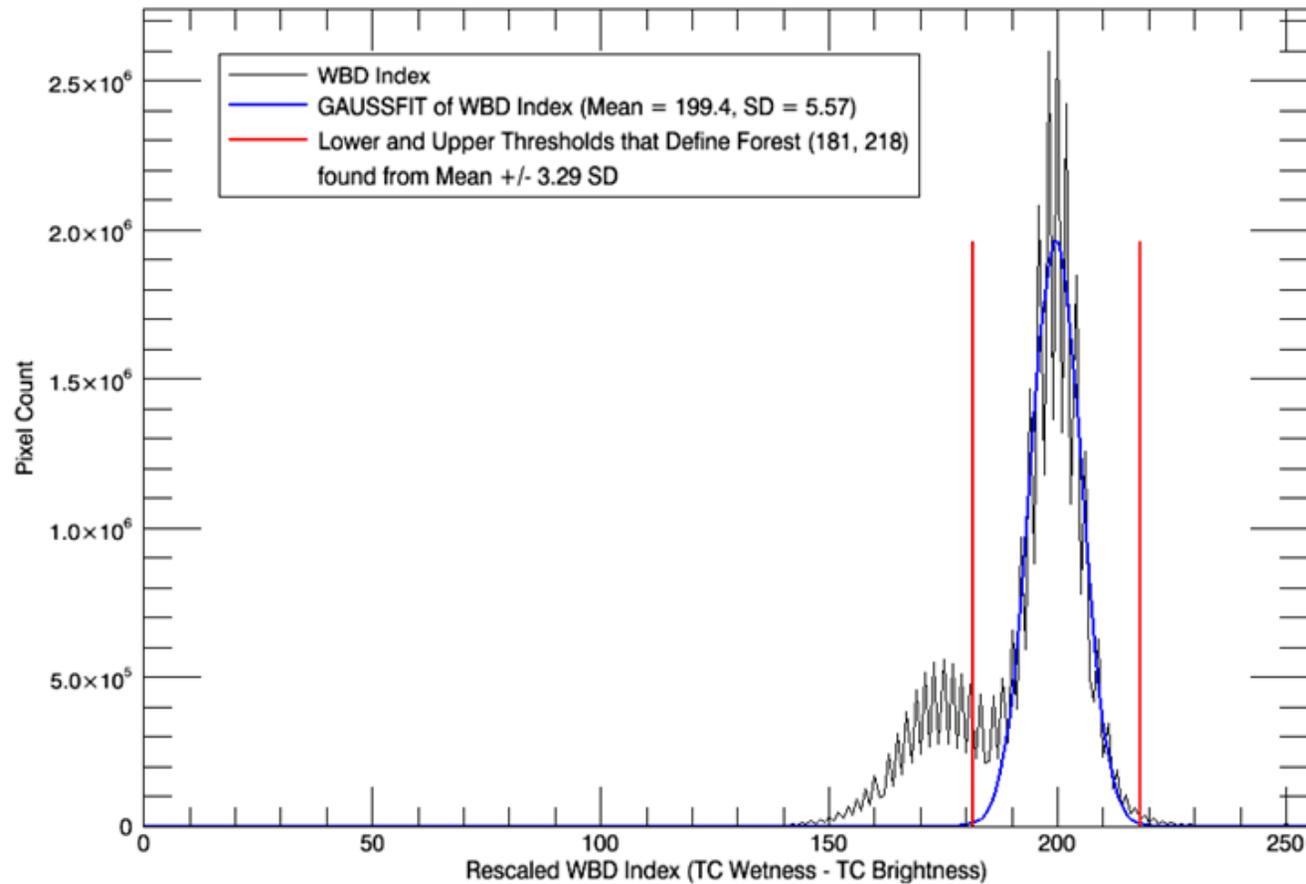
|   |  |
|---|--|
| 1 | Minimum forest mask  |
| 2 | Date-specific thresholds: forest, mature forest                                    |
| 3 | Last date the pixel was not forest or first date the pixel became secondary forest |
| 4 | Find forest age  |
| 5 | Smooth results   |

# Landsat image sequence (“image cube”)



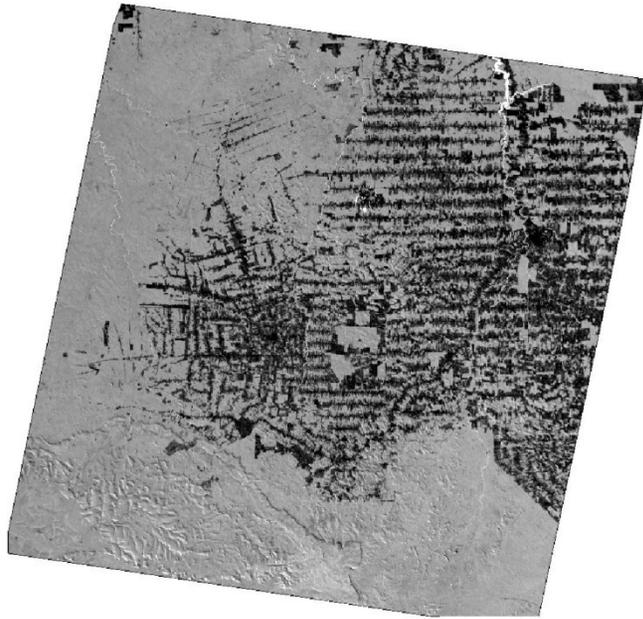
*EH Helmer, MA Lefsky, DA Roberts, 2009, Journal of Applied Remote Sensing Vol 3:033505*

# 1. Minimum Forest Mask with HFCM (Histogram Fitting for Cover Mapping)

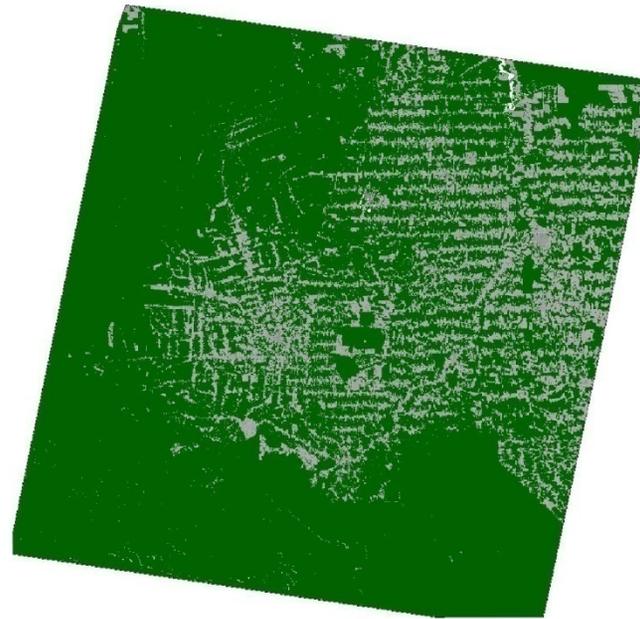


*EH Helmer, MA Lefsky, DA Roberts, 2009, Journal of Applied Remote Sensing Vol 3:033505*

# WBD Index and Resulting Minimum Forest Mask



**(a) WBD Index for image dated in 2003  
(date with minimum forest cover)**



**(b) Minimum forest mask (dark green)  
based on WBD index**

## 2. Find Thresholds

For each image date  $i$ , calculate for the minimum forest mask:

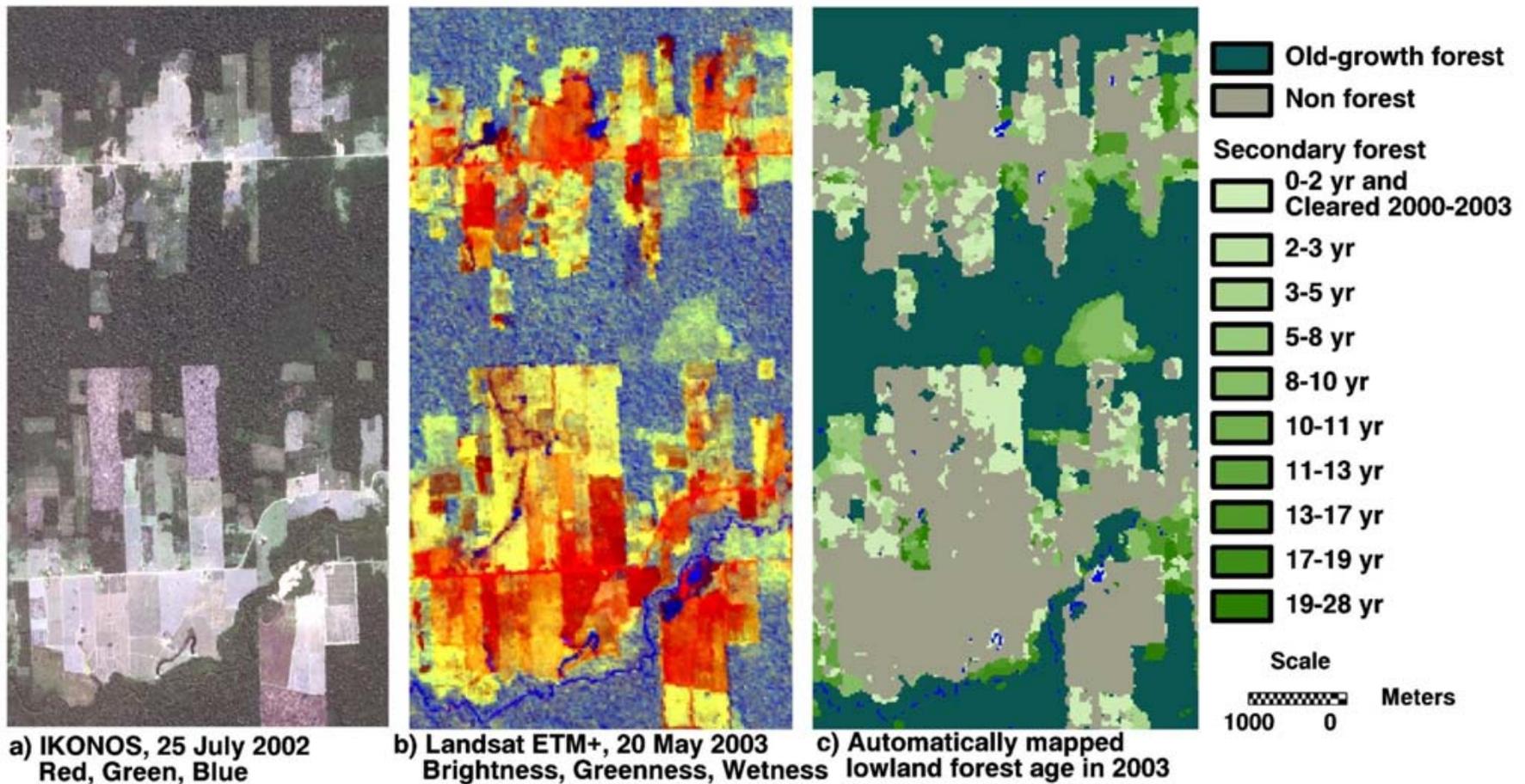
- Minimum wetness threshold for forest

$$W(t_i) = W_{AVG}(t_i) - 2SDW(t_i)$$

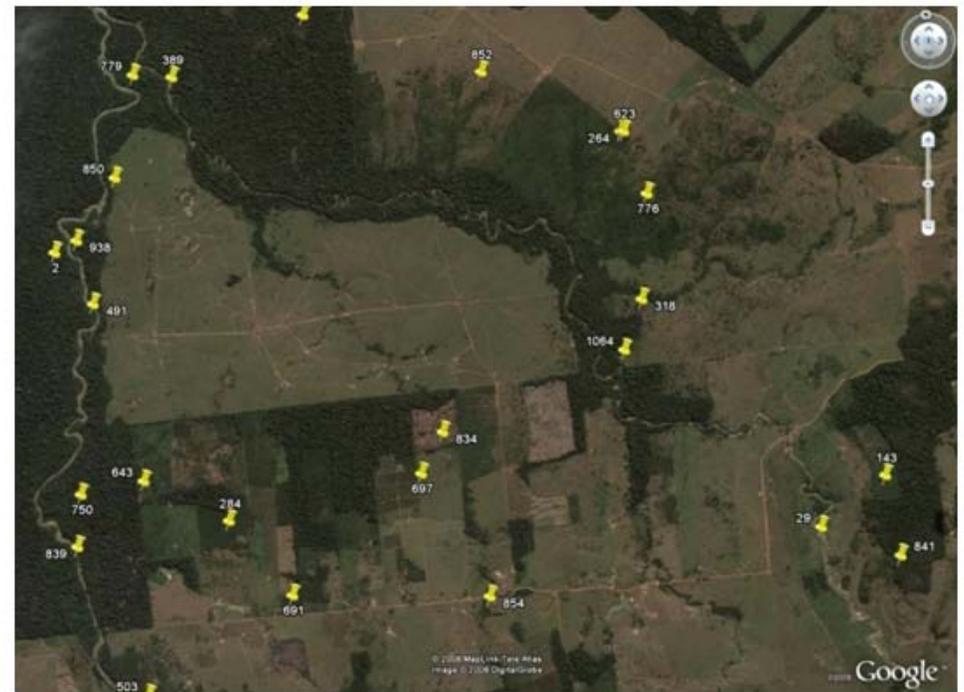
- Maximum greenness for mature forest

$$G(t_i) = G_{AVG}(t_i) + 2SDG(t_i)$$

3. Last non-forest or first secondary forest date
4. Find forest age
5. Smooth results



# The Rondônia study uses Google Earth for reference data



*EH Helmer, MA Lefsky, DA Roberts, 2009, Journal of Applied Remote Sensing Vol 3:033505*

# Optional with TAMA

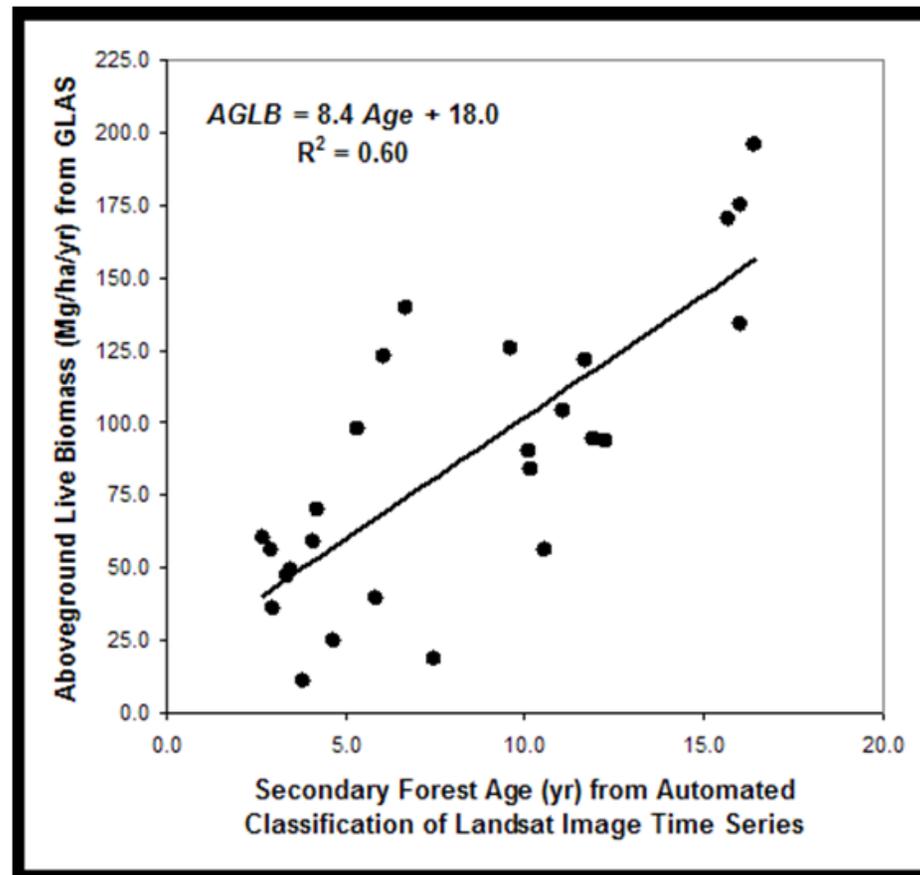
- Atmospheric correction
- Time series normalization
- Same season imagery

# Other Assumptions

- Secondary forest
  - Post agricultural, heavily logged, denser woody agriculture
- Topography
  - Scope of inference limited to lowland forests
- Recently burned areas
  - When missed by wetness threshold, will be detected as non-forest or secondary forest in later scenes

| Lowland forest age | Users' Accuracy (%) | Producers' Accuracy (%) |
|--------------------|---------------------|-------------------------|
| 0-2 yr             | 41                  | 63                      |
| 2-3 yr             | 29                  | 19                      |
| 3-5 yr             | 75                  | 82                      |
| 5-8 yr             | 74                  | 72                      |
| 8-10 yr            | 87                  | 76                      |
| 10-11 yr           | 76                  | 79                      |
| 11-13 yr           | 71                  | 74                      |
| 13-17 yr           | 80                  | 91                      |
| 17-19 yr           | 77                  | 83                      |
| 19-28 yr           | 69                  | 92                      |
| Old growth         | 93                  | 84                      |

# Landscape-level young forest biomass accumulation rate



*EH Helmer, MA Lefsky, DA Roberts, 2009, Journal of Applied Remote Sensing Vol 3:033505*

# AGLB\* of old-growth forest types from GLAS and Landsat classification

| Old-growth forest type                                  | Mean<br>AGLB<br>Mg ha <sup>-1</sup> | SD<br>AGLB<br>Mg ha <sup>-1</sup> | N    |
|---|-------------------------------------|-----------------------------------|------|
| <i>Lowland formations</i>                               |                                     |                                   |      |
| Seasonal to Semi-evergreen Forest                       | 185                                 | 52                                | 1898 |
| Floodplain Forest and Swamp                             | 146                                 | 48                                | 25   |
| Deciduous Swamp on Sandy Substrate                      | 68                                  | 49                                | 6    |
| <i>Hill and submontane formations</i>                   |                                     |                                   |      |
| Semi-evergreen Forest                                   | 166                                 | 60                                | 71   |
| Semi-evergreen to Deciduous, Woody<br>Savanna to Forest | 63                                  | 43                                | 22   |
| Submontane Semi-Evergreen Forest<br>(≥500 m elevation)  | 166                                 | 34                                | 18   |

\*AGLB = Aboveground Live forest Biomass, dry weight (Mg/ha)