Spatially Explicit Sources and Sinks of Carbon from Deforestation, Growth and Degradation in the Tropics

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Outline

- Aboveground carbon loss
  - Remote sensing based stratification and deforestation combined with GLAS biomass
  - IPCC good practices
  - Results

- Aboveground carbon density loss and gain
  - “Direct” carbon density change
    - Change point analysis of biomass time series
    - Based on GLAS and MODIS biomass
  - Results
**Stratification Based Biomass Loss**

\[ Emissions = AD \times EF \]

\[ AGC_{loss} = \sum AD_i \times EF_i \]

- Forest cover loss map (AD) by Hansen et al. 2013
- Forest cover stratification for year 2000 (prior to disturbance)
  - Canopy cover
  - Tree height
  - IFL (intact forest)
- Mean carbon density estimate for each forest stratum (EF) by Baccini et al. 2012

Tree based strata AGC density values (MgC/ha)

1 – low cover
2 – medium cover short
3 – medium cover tall
4 – dense cover short
5 – dense cover short intact
6 – dense cover tall
7 – dense cover tall intact

IFL 2000

no

yes

Canopy cover (%)
GLAS Co-located Field Measurements

Biomass = 205 (t/ha)

Biomass = 78 (t/ha)

Biomass = 30 (t/ha)

Attributes of Budongo Forest Plots

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Field observation network & calibration

>300 locations > 30,000 trees measured

- Columbia
- Ecuador
- Bolivia
- Brazil
- Gabon
- DRC
- Uganda
- Tanzania
- Vietnam
- Cambodia
- Indonesia
Aboveground Biomass from LiDAR (GLAS)

- Biomass estimates at each GLAS location
- Height and metrics from GLAS waveform

Biomass = HOME + H10 + H60 + CANOPY_ENE + H25

Standard error 22.6 MgC/ha
Adjusted R-squared: 83.2

GLAS year 2007
Results – Stratification Based

Biomass strata map

Biomass loss map

Forest area change (AD)
Hansen et al 2013

\[ AGC_{loss} = \sum AD_i \times EF_i \]

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“Direct” Biomass loss and gain

Baccini et al. 2012

Error 25 Mg C ha\(^{-1}\)  Error 19 Mg C ha\(^{-1}\)  Error 24 Mg C ha\(^{-1}\)

Amazon Basin detail from the map

DRC detail from the map

PNG detail from the map
Carbon density trajectories over time and space

- Time series approach based on “change point” analysis
- For each 500 m x 500 m pixel we identify the trajectory of carbon density
Continuous spatially explicit carbon density change

**Gain**
- High: 128
- Low: 1

Gain = 59.2
- StdE = 24.2
- P-V = 0.041

**Loss**
- High: -1
- Low: -252

Loss = -201.2
- StdE = 8.4
- P-V = 0.003

**Stable**
- High: 293
- Low: 0

StdE = 46.1
- P-V = 0.99

190 km x 215 km
Consistent with deforestation and sensitive to “degradation”? 

Deforestation Landsat based (30 m resolution) 
Hansen et al. 2014
Summary

• Stratification approach, simple, scalable, endorsed by IPCC

• “Direct” approach globally consistent, continuous, no need for strata and land cover change products

• Sensitive to losses (deforestation, degradation, natural disturbance) and gain (growth, reforestation, and afforestation)

• Fewer inputs resulting in smaller uncertainty

• Difficult to provide attribution (Deforestation or Degradation?). Do we need to?
Thank you!