Remote Detection and Modeling of Tropical Forest Disturbance and Recovery: Synthesis Workshop New Orleans June 2006

Remote Detection and Modeling of Tropical Forest Disturbance and Recovery

Time	Mon 5 June	Tue 6 June	Wed 7 June	Thu 8 June	Fri 9 June
9:00 - 9:20	Introduction -- Chambers	Research Talk -- Kramer	Research Talk -- Smith	Research Talk -- Hurtt	Research Talk -- Aragao
9:20 - 9:40	Research talk -- DeFries	Research Talk -- Palace	Research Talk -- Fisher	Research Talk -- Costa	Research Talk -- TBA
9:40 - 10:00	Research talk -- Souza	Research Talk -- Anderson	Research Talk -- Higuchi	Research Talk -- Klooster	Research Talk -- TBA
10:00 - 10:20	Research talk -- Asner	Research Talk -- Saatchi	Research Talk -- Chambers	Research Talk -- Malhi	Research Talk -- Keller
10:20 - 10:45	Break				
10:45 - 12:15	Remote sensing review manuscript combined working session	Review Manuscript working groups	Review Manuscript final working document preparation and discussion	Modeling review manuscript combined working session	Modeling review manuscript working session
12:15 - 1:30	Lunch				
1:30 - 3:30	Review Manuscript working groups	Review Manuscript working groups	Remote Sensing to Simulation Modeling Transition Session	Modeling review manuscript working session	Modeling review manuscript final document prestation and discussion
3:30 - 4:00	Break				
4:00 - 5:00	Group presentations	Group presentations	Modeling manuscript review discussion session	Group presentations	Final wrap-up discussion and presentation

Synthesis Workshop Products

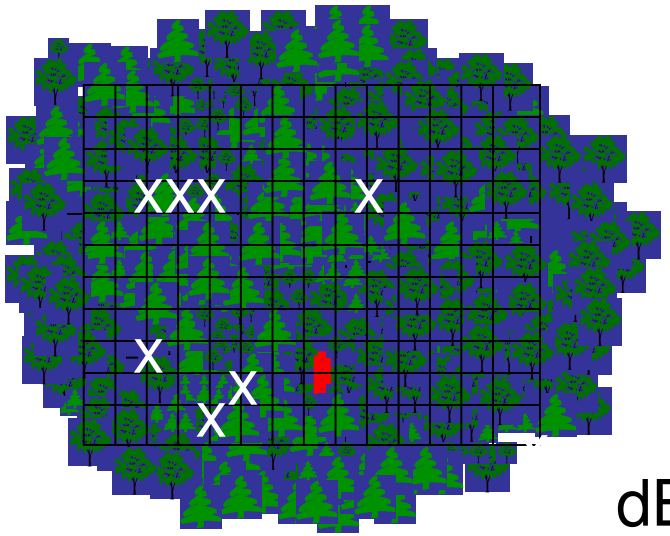
- *Trends in Ecology and Evolution* (*TREE*) – proposed review manuscript accepted: **Regional Ecosystem Structure and Function: New Ecological Insights from Remote Sensing of Tropical Forests**

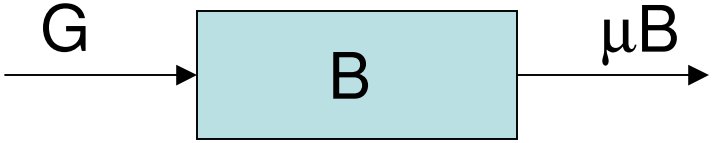
- Overall question addressed in *TREE* review: **How has our understanding of regional ecosystem processes and forest structure improved with recent advances in remote sensing methods? –** Review manuscript deadline 11 Nov 2006.

Synthesis Workshop Products

- **Review manuscript**: ***Modeling disturbance and recovery processes in tropical forests*** – led by Jeremy Fisher working with George Hurtt at UNH.
- E-mail from Fisher soliciting input to disturbance/recovery review paper – **draft manuscript will soon be circulating**.
- One overall them of **disturbance/recovery manuscript** is that efforts at modeling the photosynthetic input side of the carbon balance question generally receives much more attention than the output side via mortality.

Lessons from a Simple Model





$$dB(t)/dt = G-\mu B(t)$$

$$B(t)=G/\mu*(1-\exp(-\mu t))$$

$$B^*=G/\mu$$

$$t^* = -\ln(\varepsilon)/\mu$$

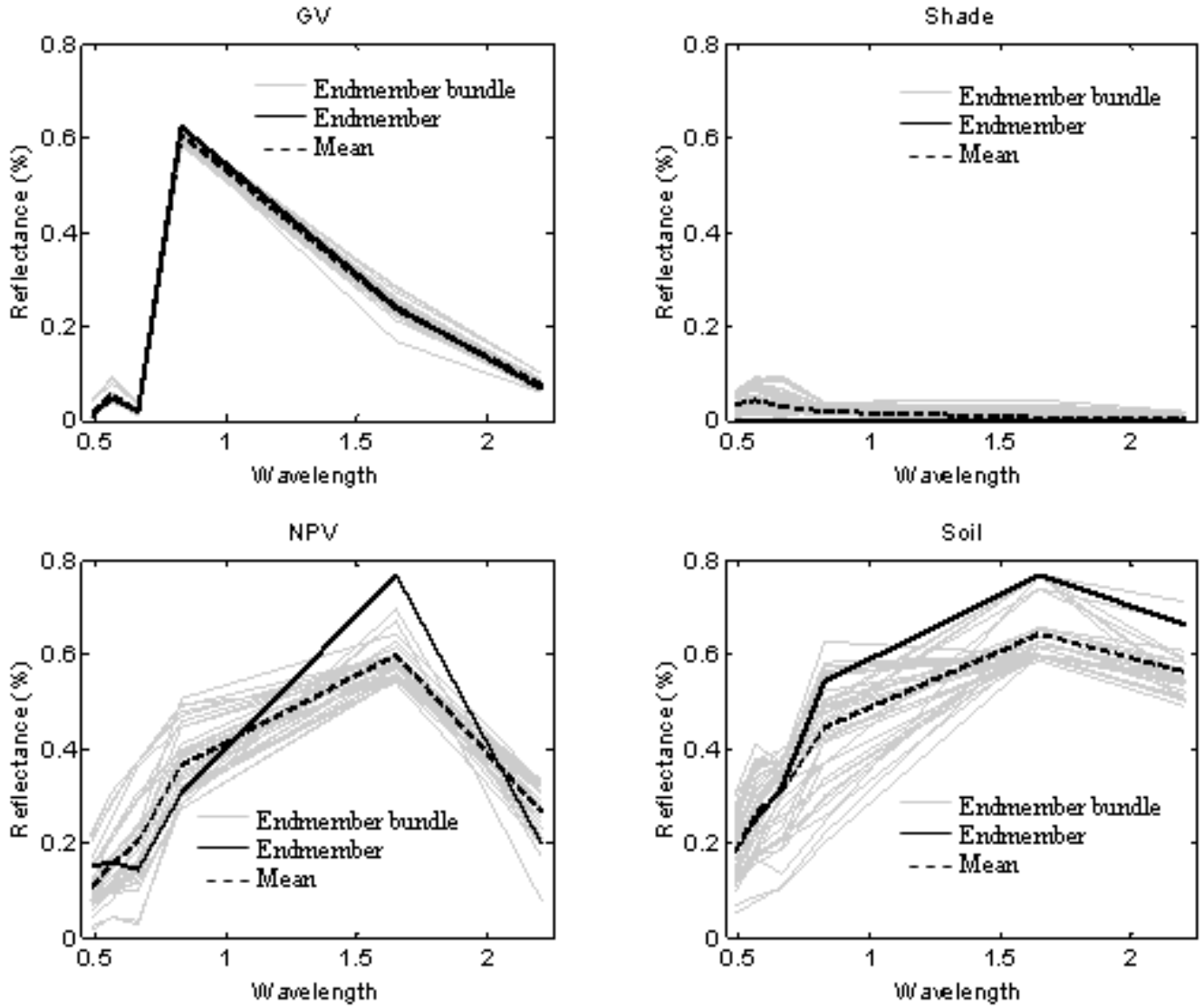
Lessons from a Simple Model

- Equilibrium determined by both G and μ
- Timescale of succession governed by μ
- Changes to conditions that change G and/or μ potentially alter stocks, fluxes, timescales, etc…
- Local fluxes not generally good indicator of larger scale carbon balance

New Ecological Insights from Remote Sensing of Tropical Forests

- Detecting subtle logging/disturbance signals, mapping spatial and temporal distribution of these events, and understanding how rapidly leaf canopy recovers.

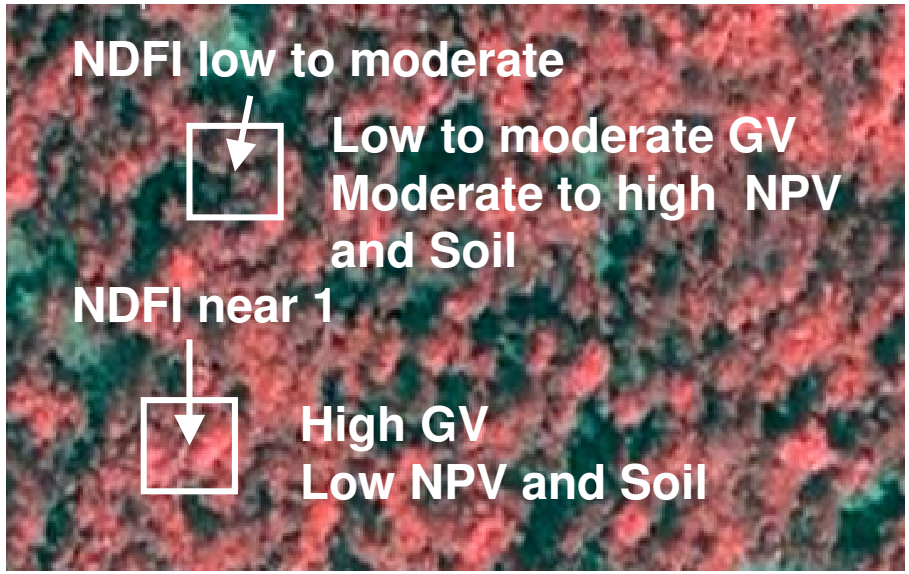
Generic Image Endmembers

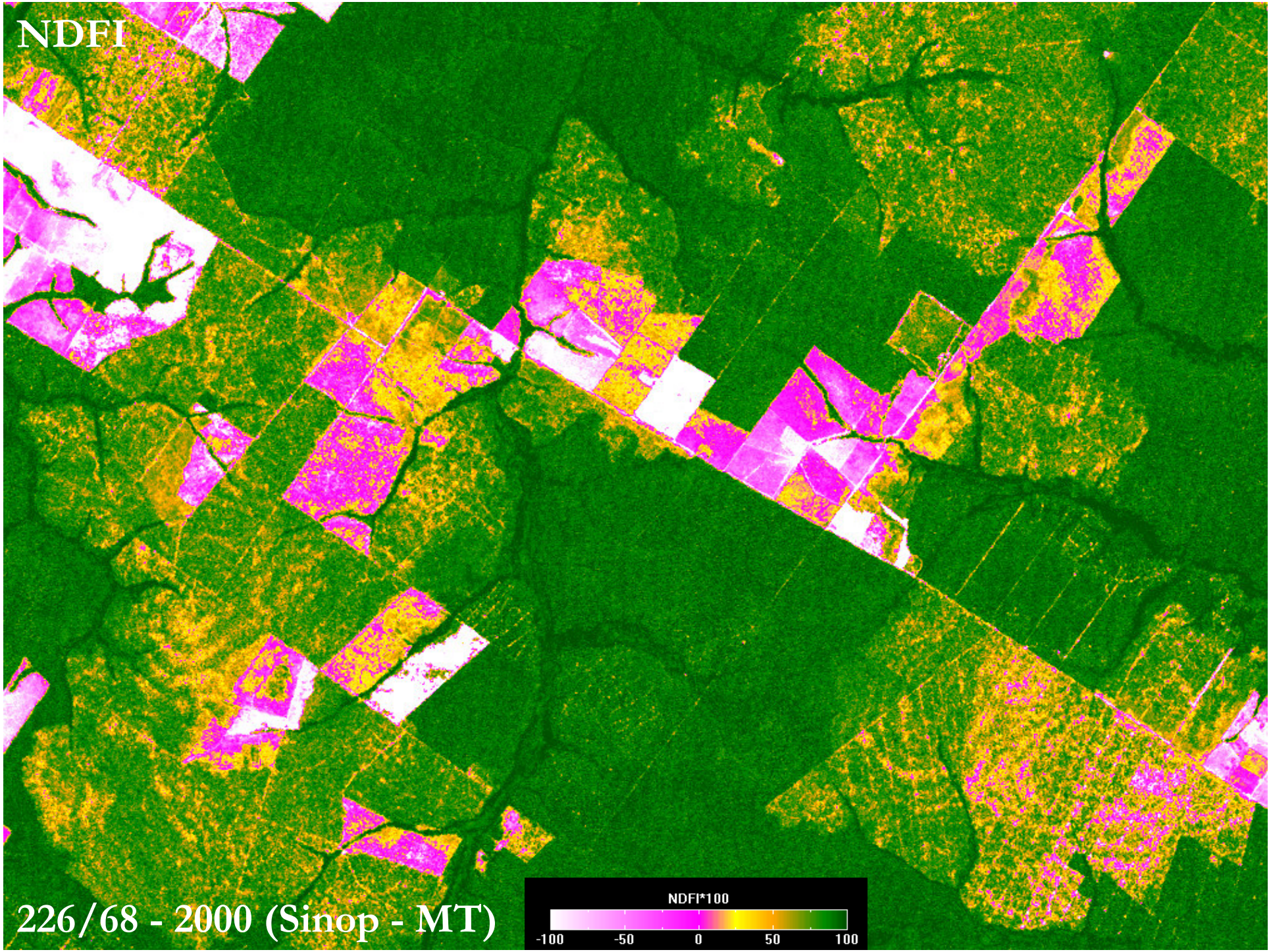


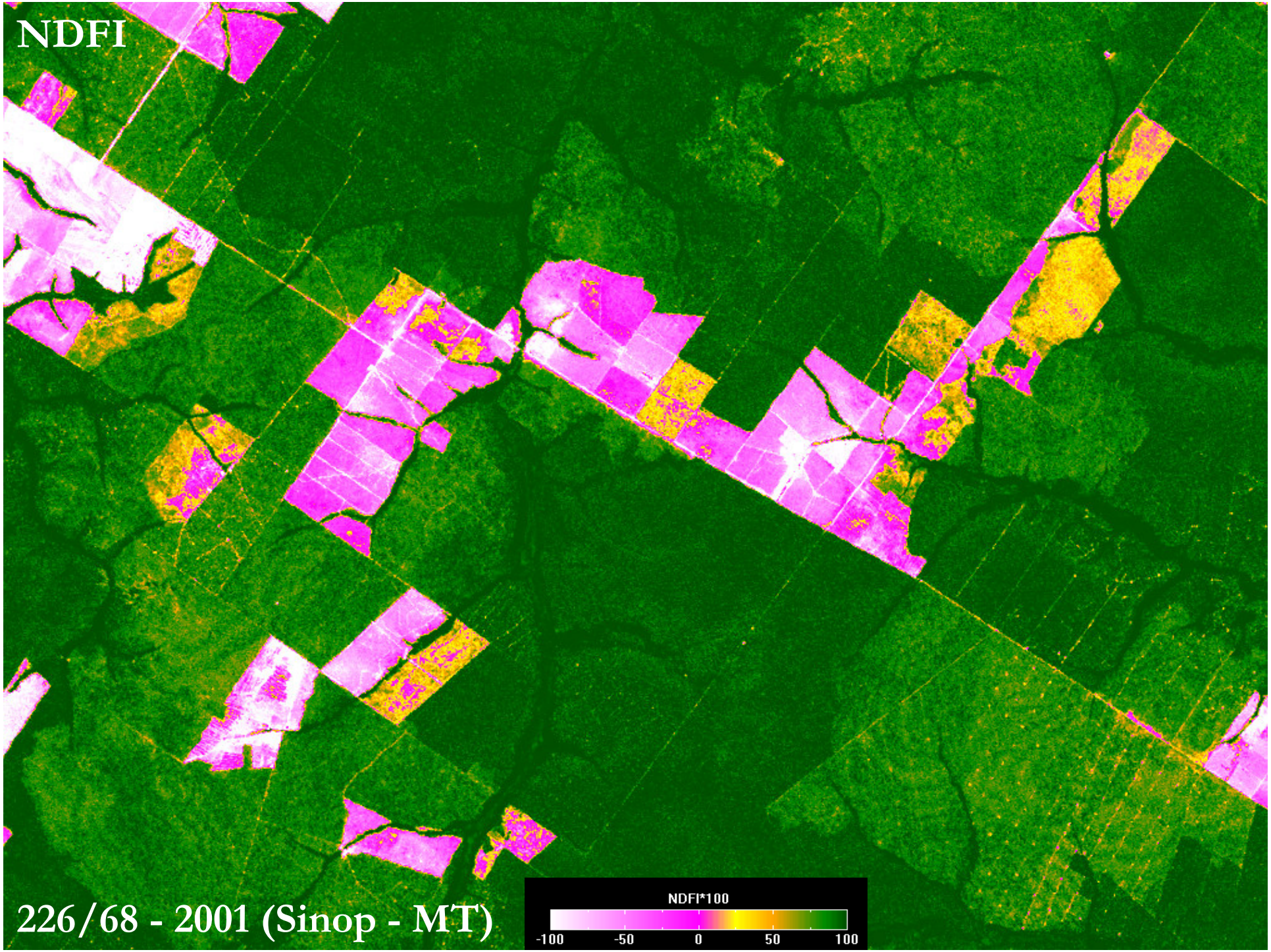
Normalized Difference Fraction Index

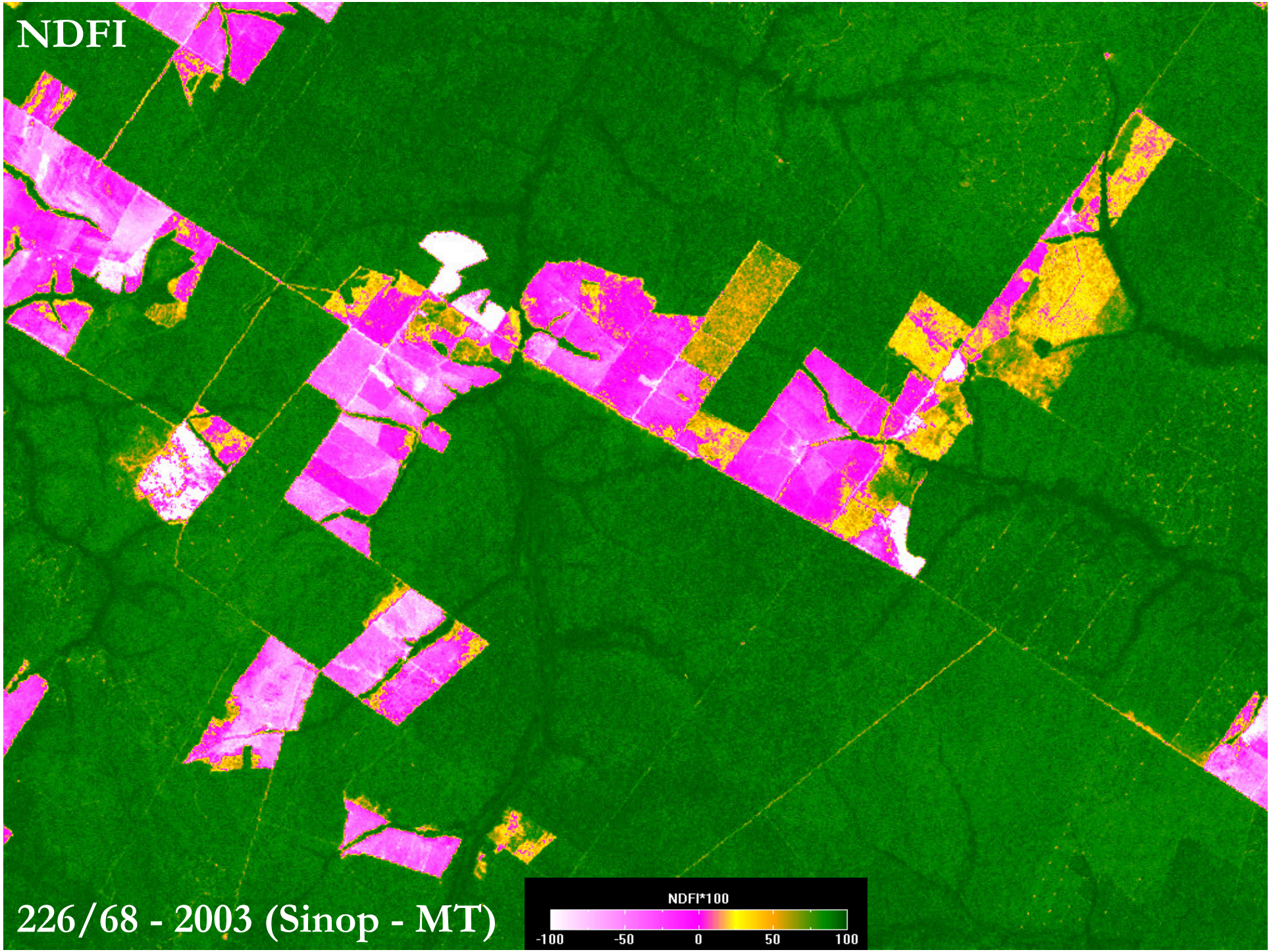
$$NDFI = \frac{GV_{Shade} - (NPV + Soil)}{GV_{Shade} + NPV + Soil}$$

$$GV_{Shade} = \frac{GV}{100 - Shade} \qquad -1 \leq NDFI \leq 1$$



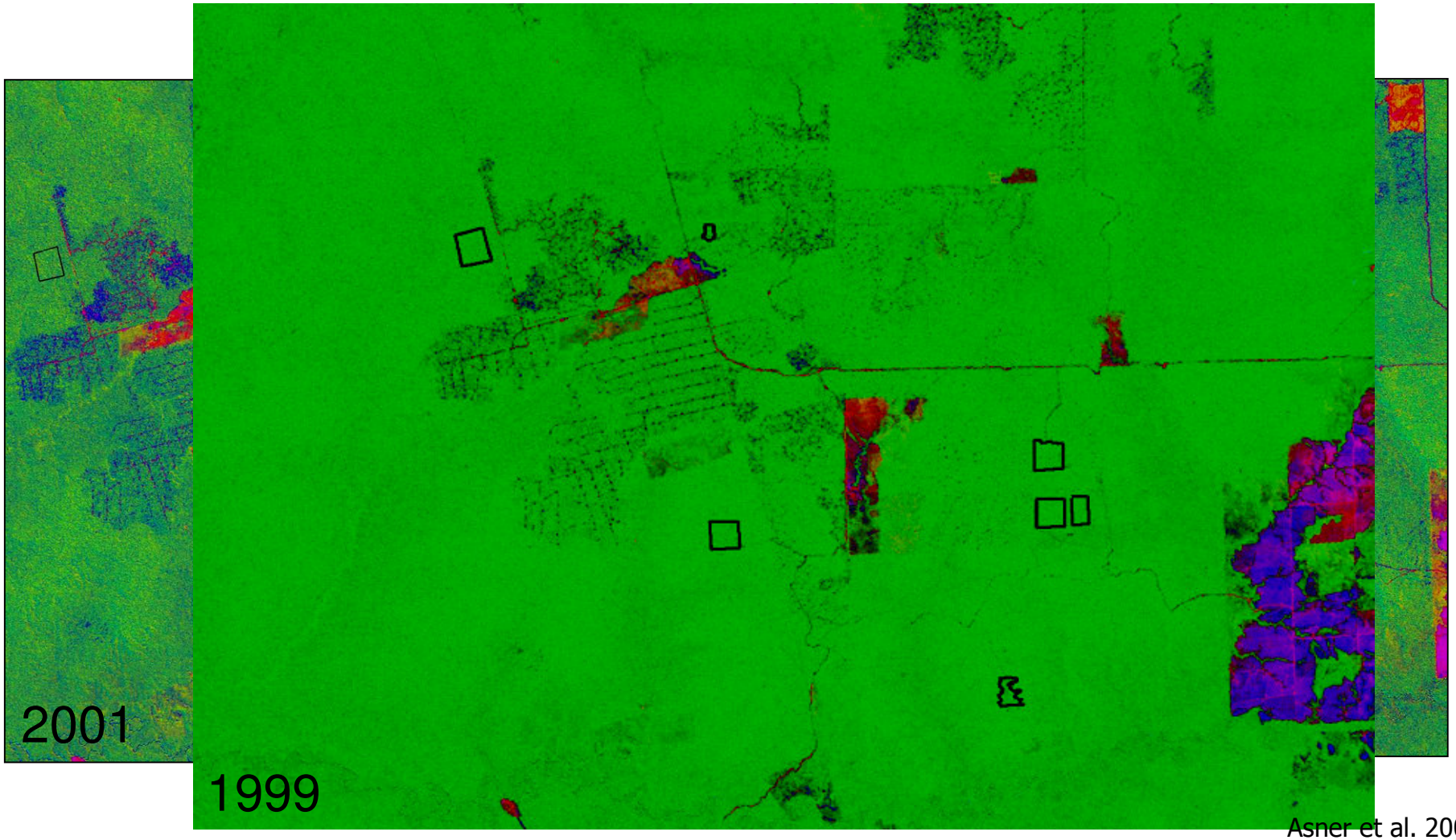

NDFI
NDFI*100
-100
-50
0
50
100
226/68 - 2000 (Sinop - MT)


NDFI
NDFI*100
-100
-50
0
50
100
226/68 - 2001 (Sinop - MT)


NDFI
NDFI*100
-100
-50
0
50
100
226/68 - 2003 (Sinop - MT)

Applying 21st Century Techniques to 20th Century Technology

Remote detection of tropical forest selective logging

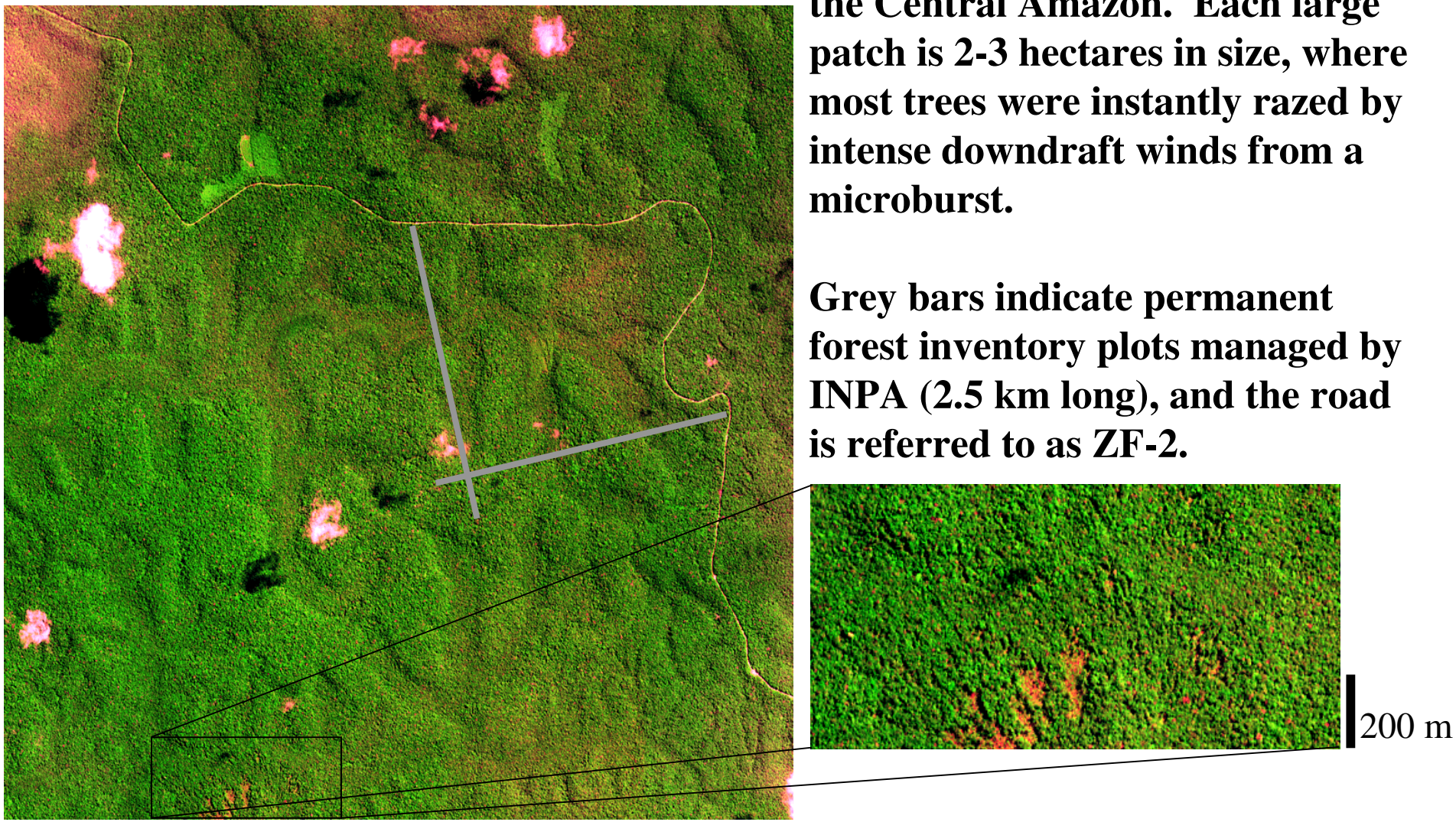


Asner et al. 2004

Catastrophic Tree Mortality and Microburst Winds

IKONOS image of a blowdown in the Central Amazon. Each large patch is 2-3 hectares in size, where most trees were instantly razed by intense downdraft winds from a microburst.

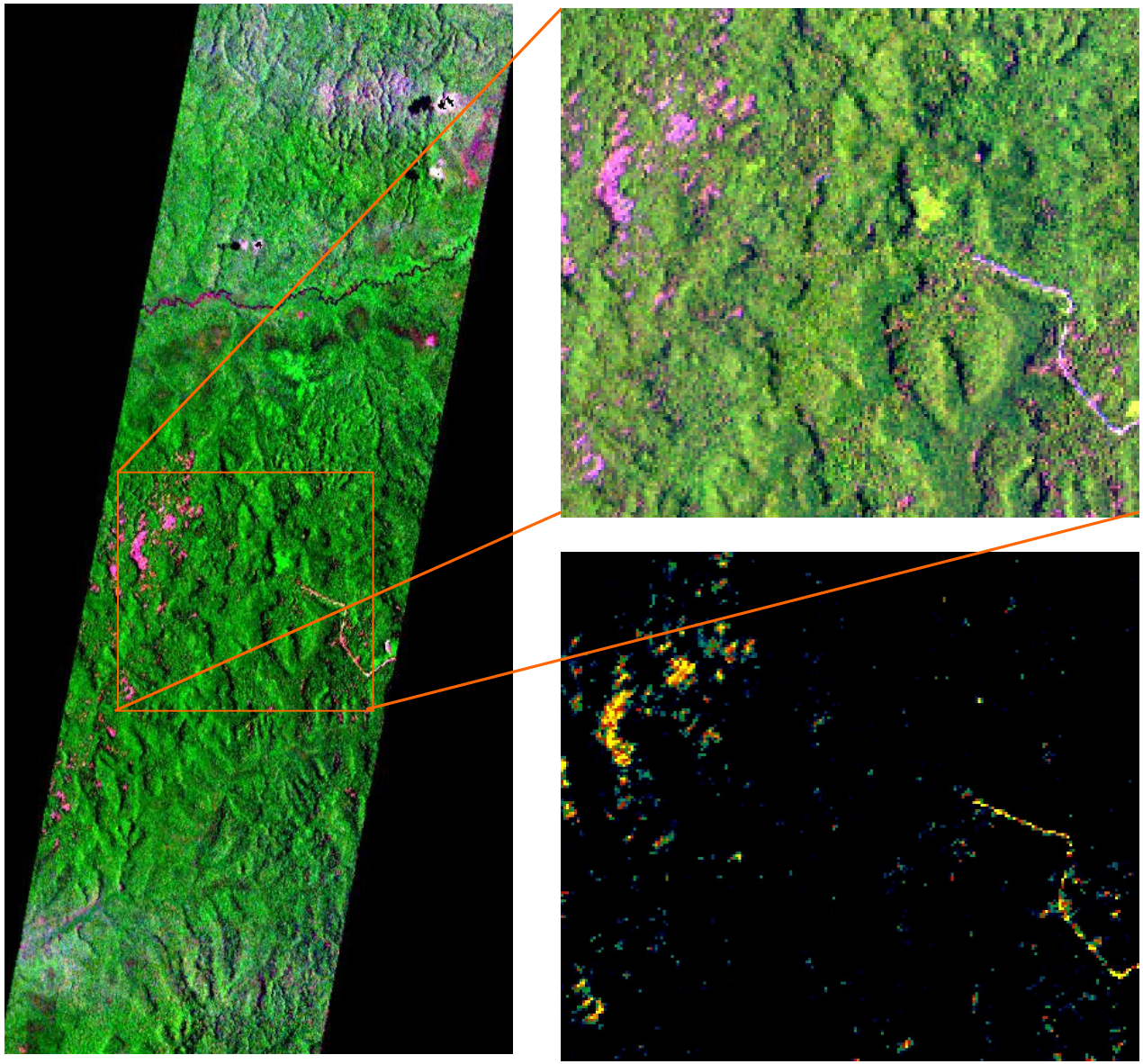
Grey bars indicate permanent forest inventory plots managed by INPA (2.5 km long), and the road is referred to as ZF-2.



IKONOS image

Severe downdraft winds often associated with late dry season storms

Spatial Distribution of Tree Mortality Intensity



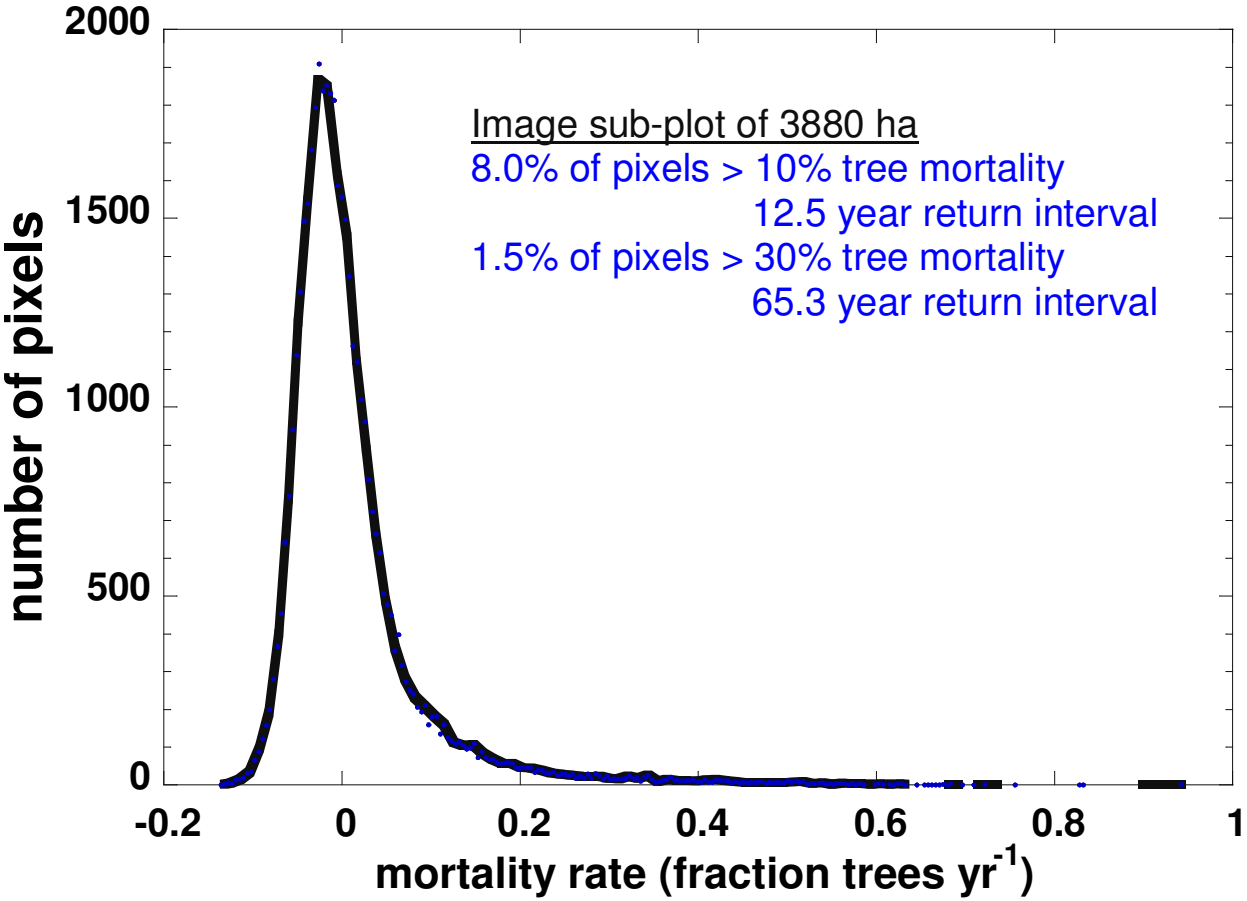
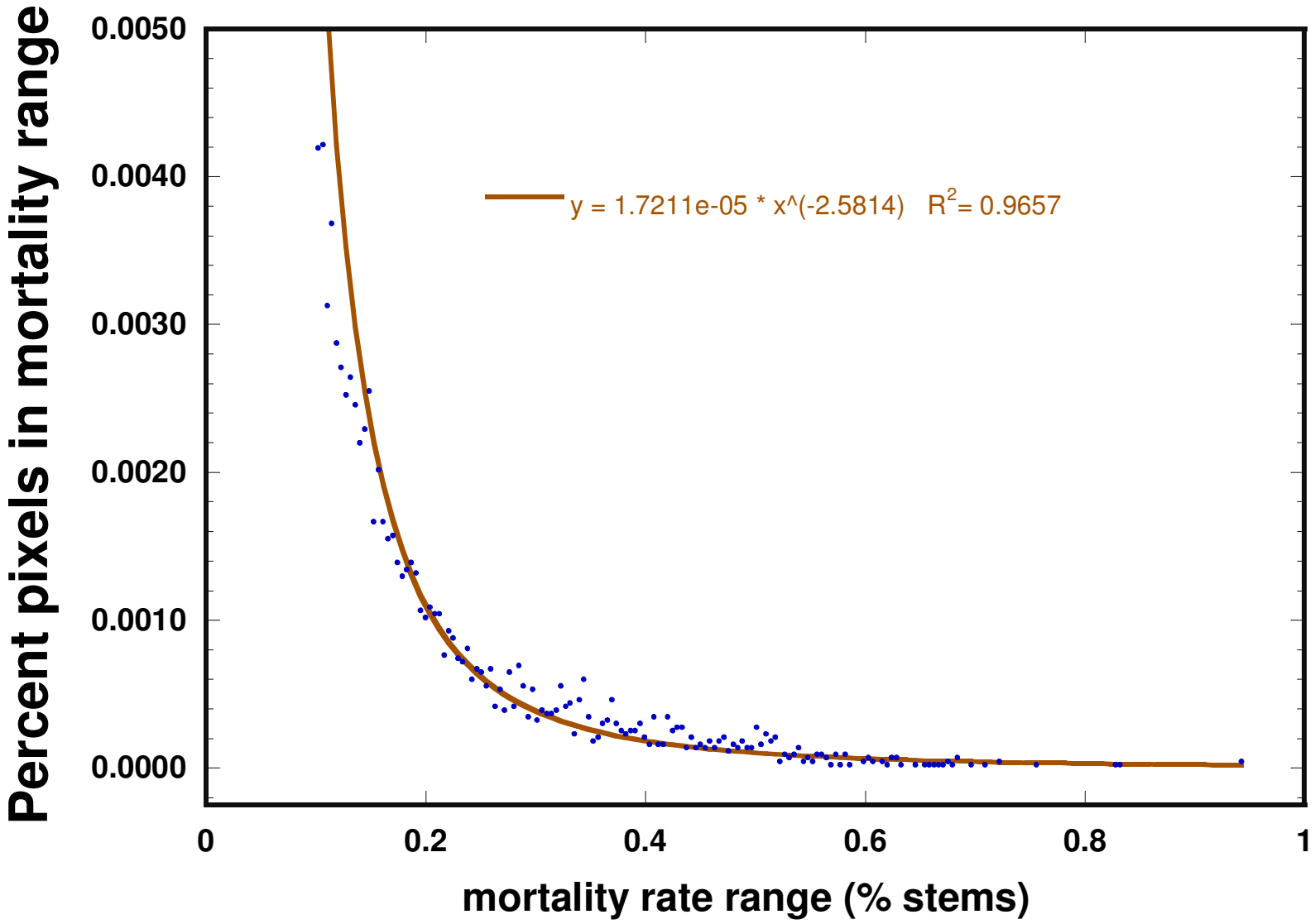


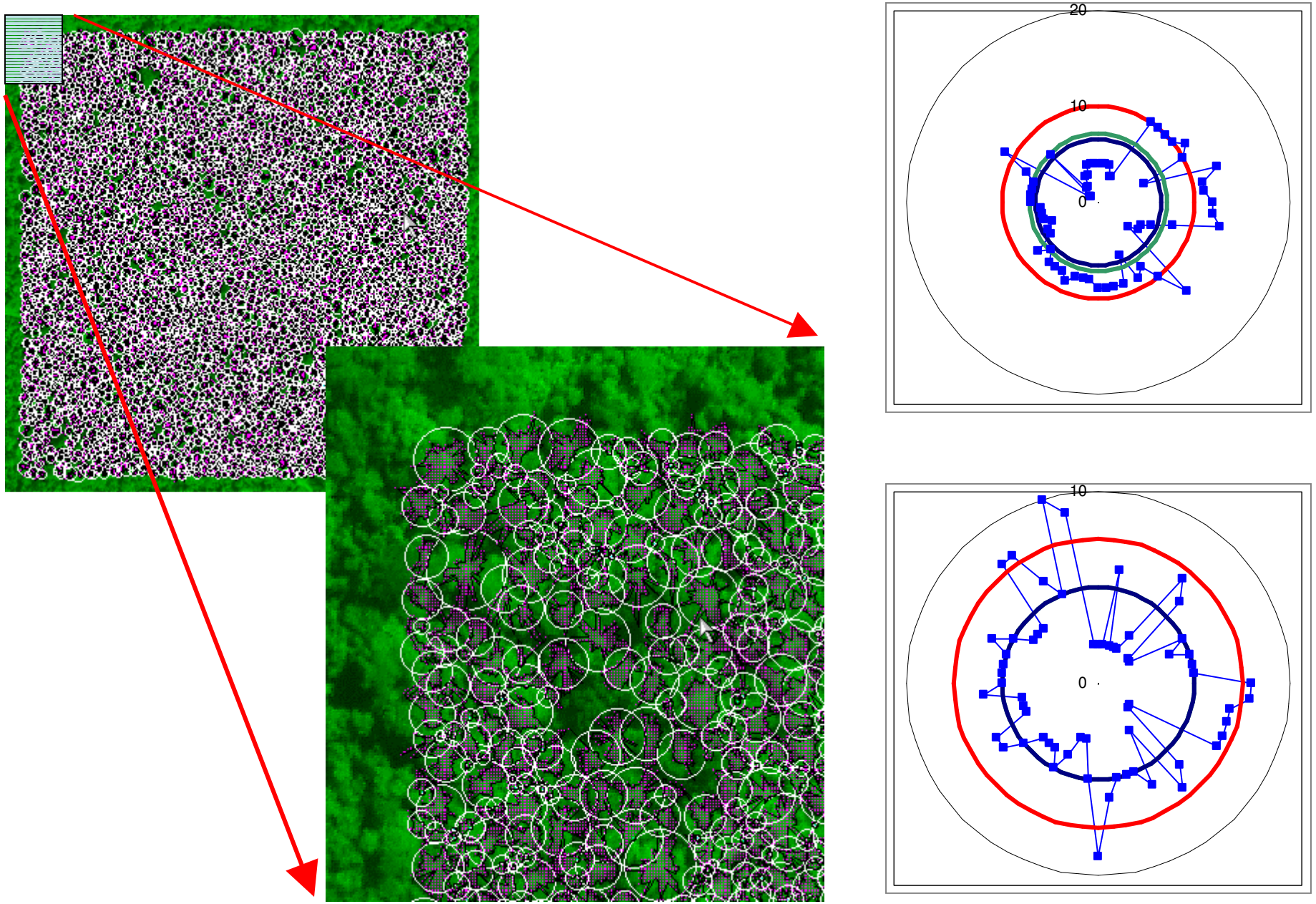
Image sub-plot of 3880 ha
8.0% of pixels > 10% tree mortality
12.5 year return interval
1.5% of pixels > 30% tree mortality
65.3 year return interval
number of pixels
2000
1500
1000
500
0
-0.2
0
0.2
0.4
0.6
0.8
1
mortality rate (fraction trees yr-1)

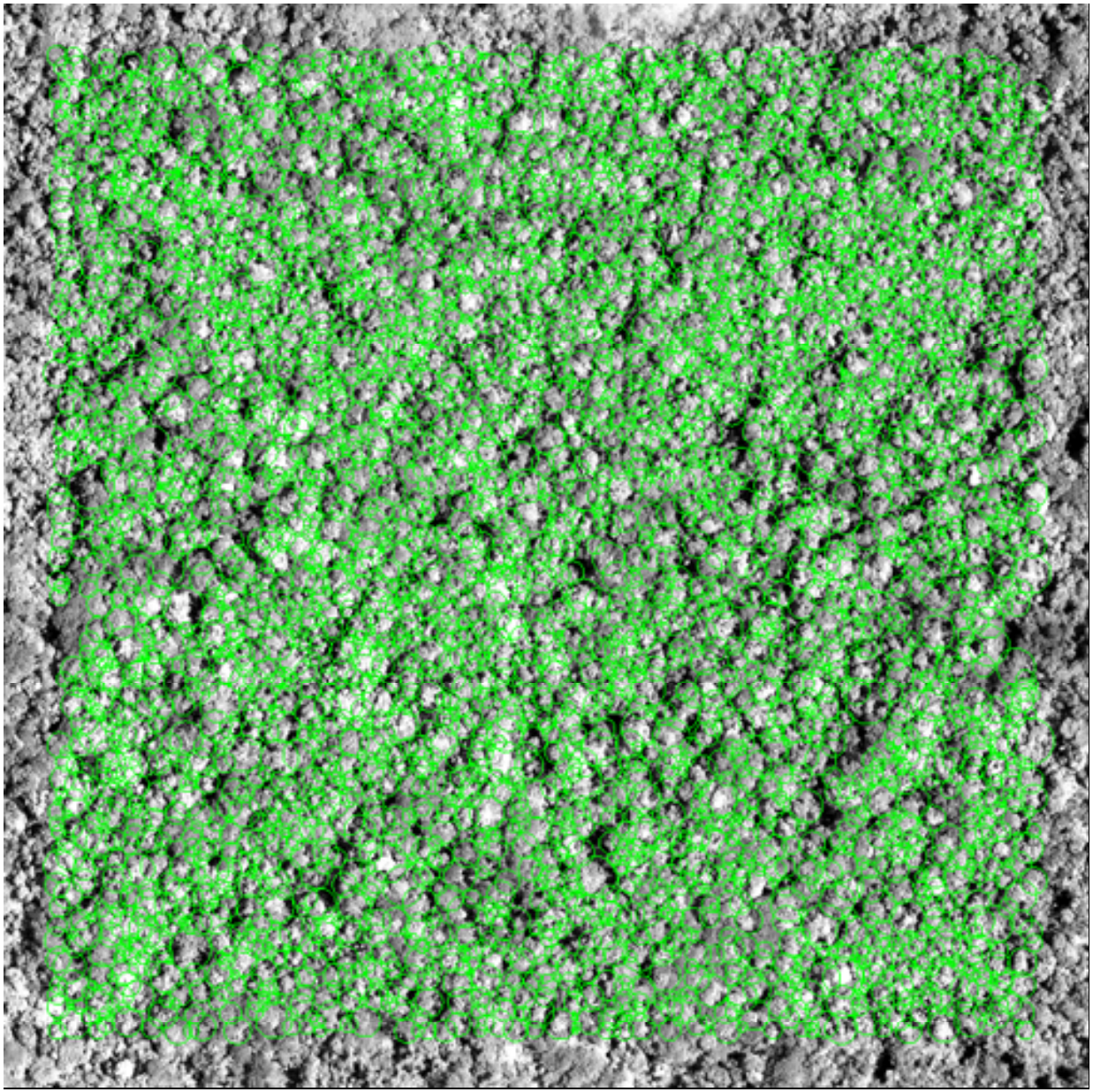

Percent pixels in mortality range
0.0050
0.0040
0.0030
0.0020
0.0010
0.0000
0
0.2
0.4
0.6
0.8
1
mortality rate range (% stems)
y = 1.7211e-05 * x^(-2.5814) R2= 0.9657

New Ecological Insights from Remote Sensing of Tropical Forests

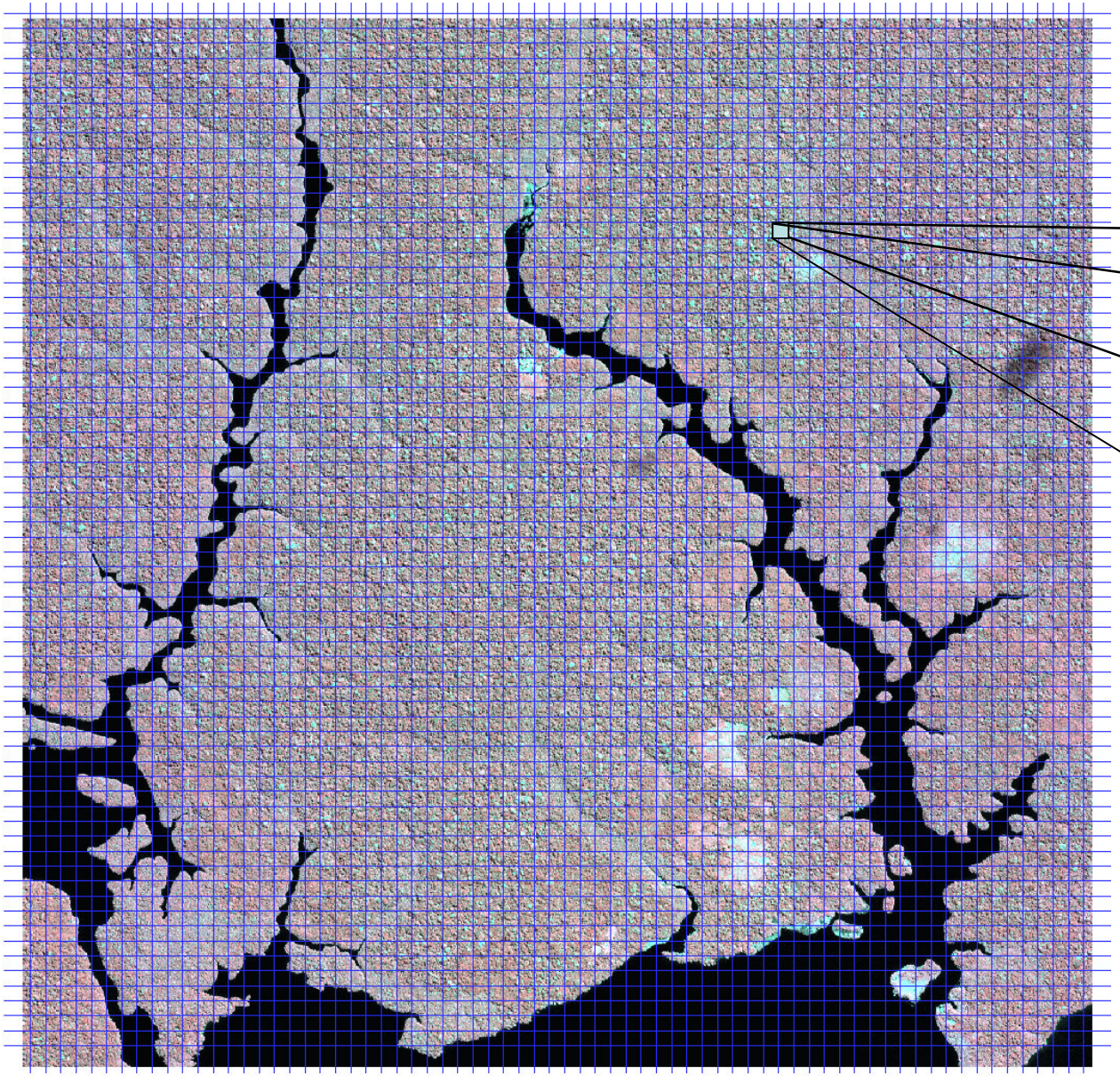
- Detecting subtle logging/disturbance signals, mapping spatial and temporal distribution of these events, and understanding how rapidly leaf canopy recovers.

- Spatial distribution attributes of individual trees over large spatial scales: crown size, mortality rates, phenological shifts in crown leaf state.

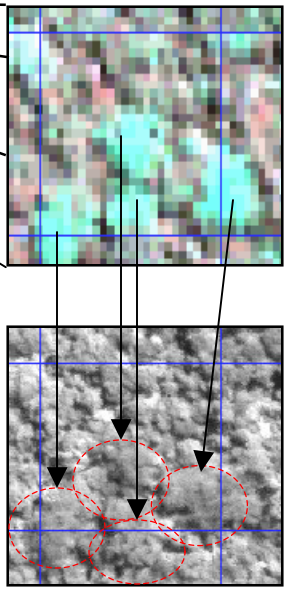

20
10
0
10
0



Spatial Analysis



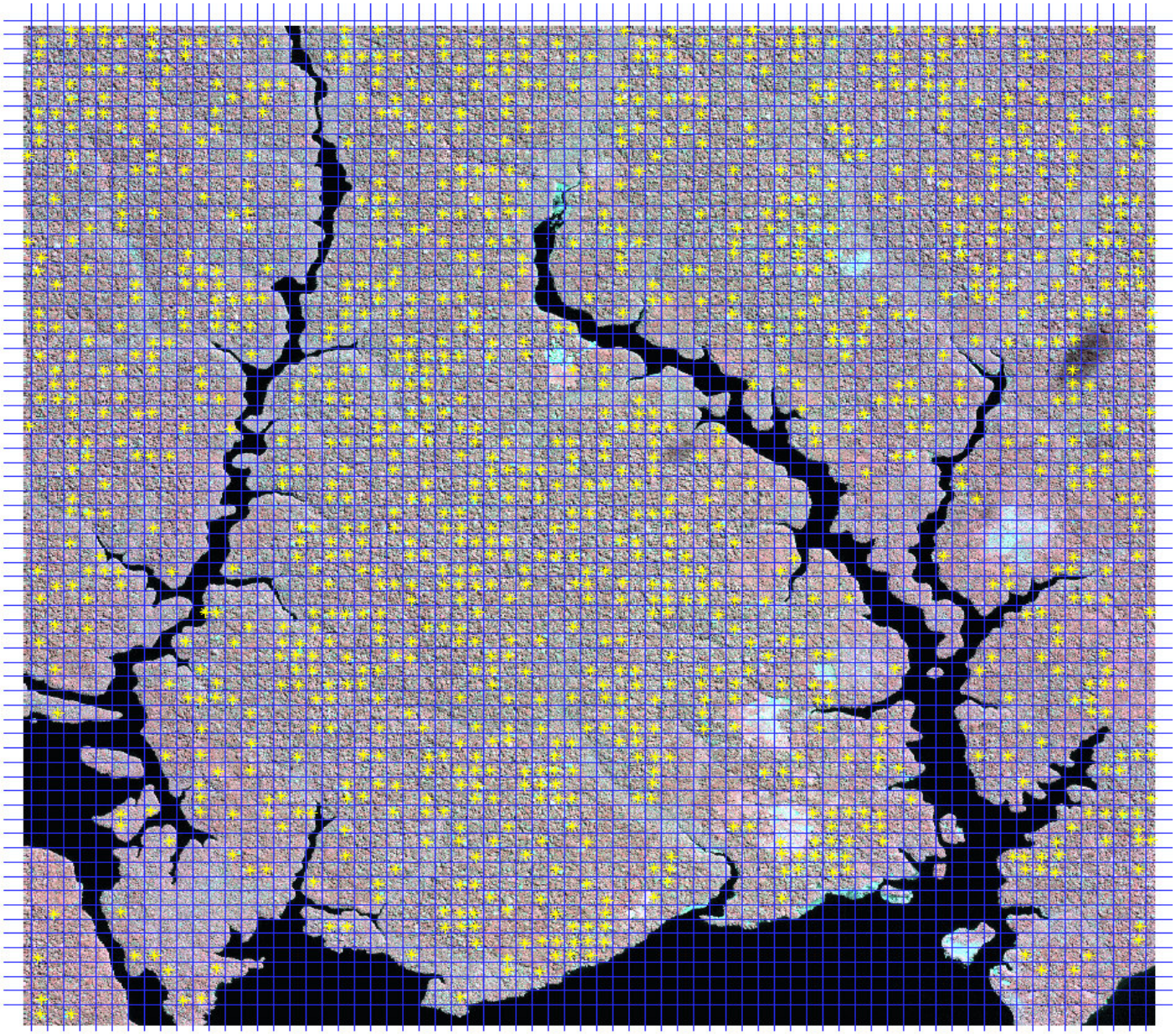
100 x 100 m



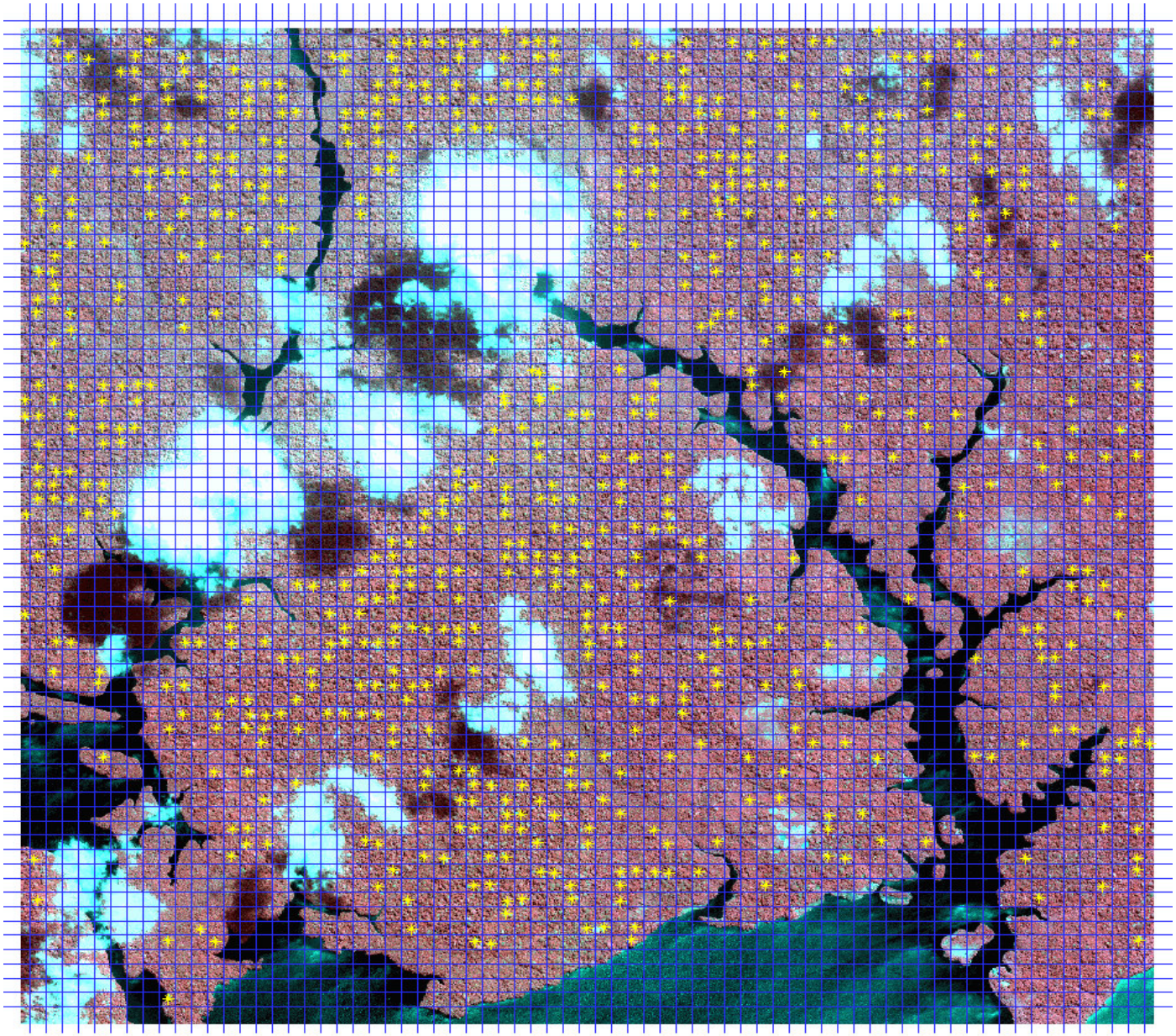
Arvores emergentes

N = 4

Emergent Trees without Leaves (Dry Ikonos Image)



Emergent Trees without Leaves (Wet Ikonos Image)



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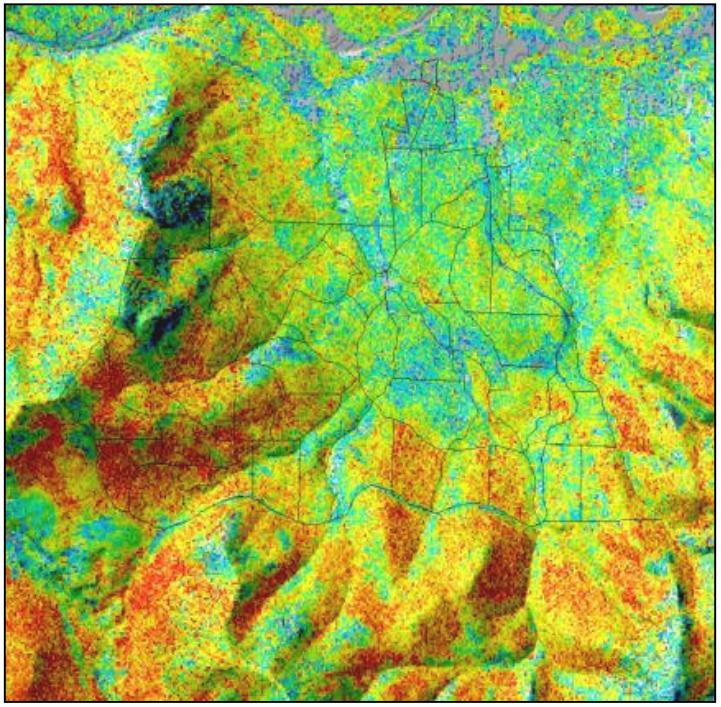
- Spatial variability in canopy leaf nitrogen content and ecosystem productivity.

Remotely-Sensed Canopy N Greatly Improves Model Predictions of Forest Productivity

Predicted NPP, Bartlett Experimental Forest, NH

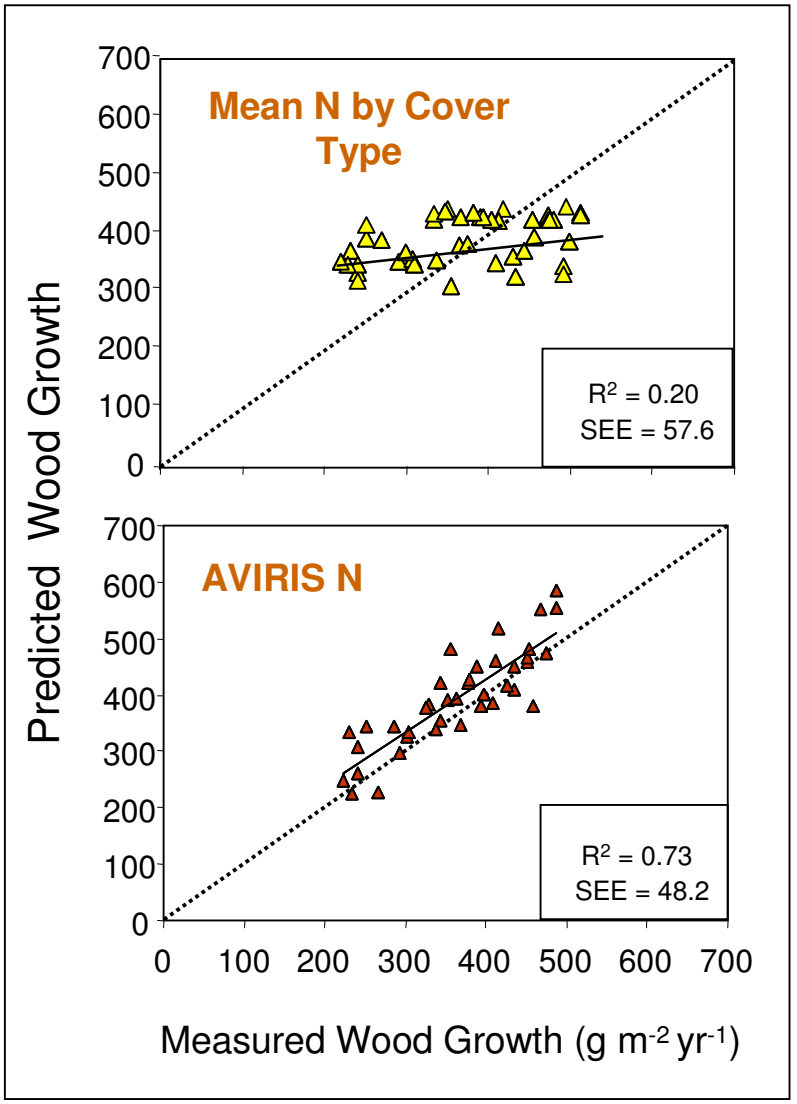


< 700
600
700
800
900
1000
>1300

NPP
(g m^{-2} yr^{-1})

0 1 Kilometers

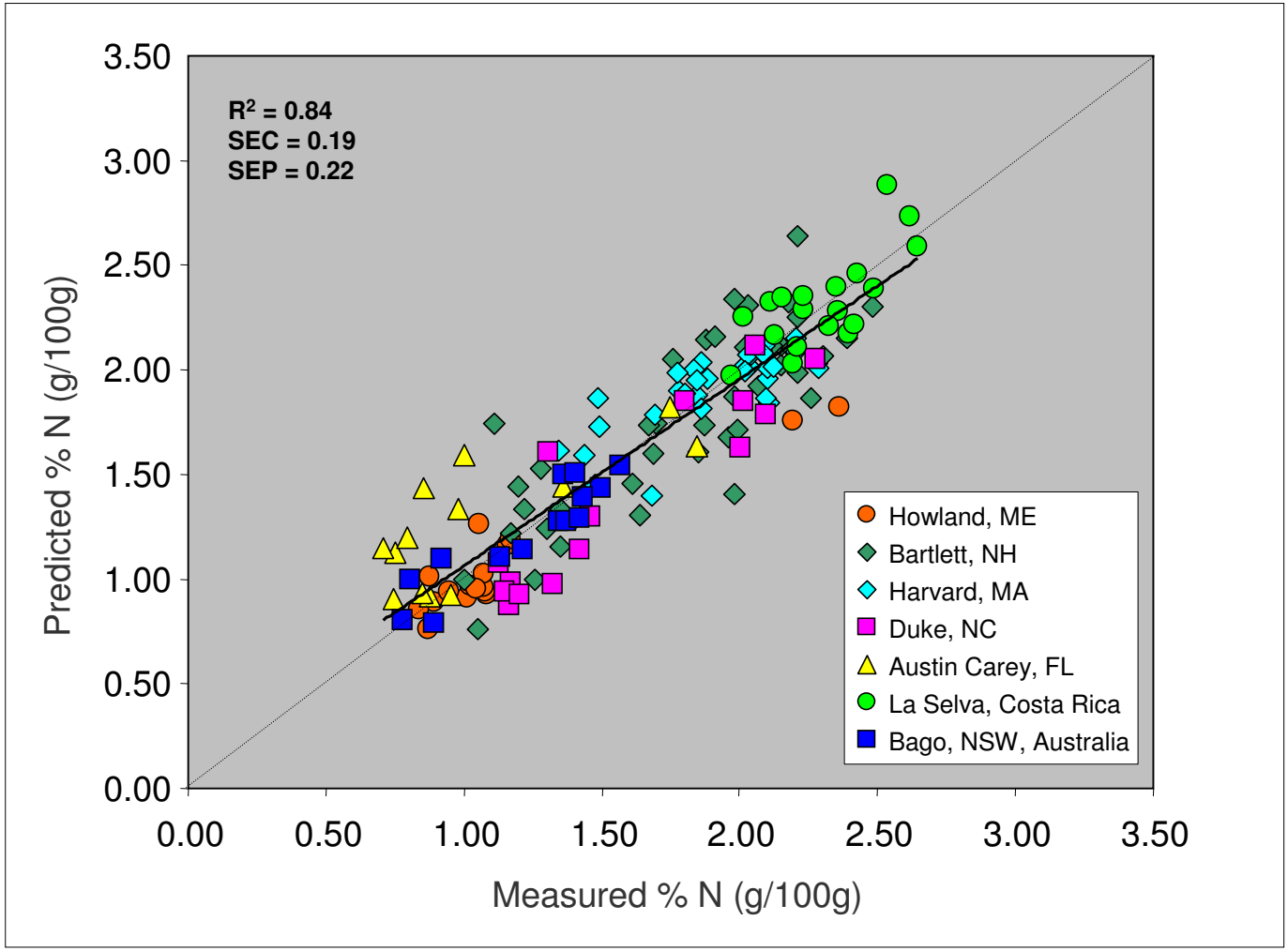
PnET



Ollinger and Smith, *Ecosystems*, 2005

2. Is a Global Canopy N Calibration Feasible?

Multi-site, canopy-level N calibration based on Hyperion spectral reflectance



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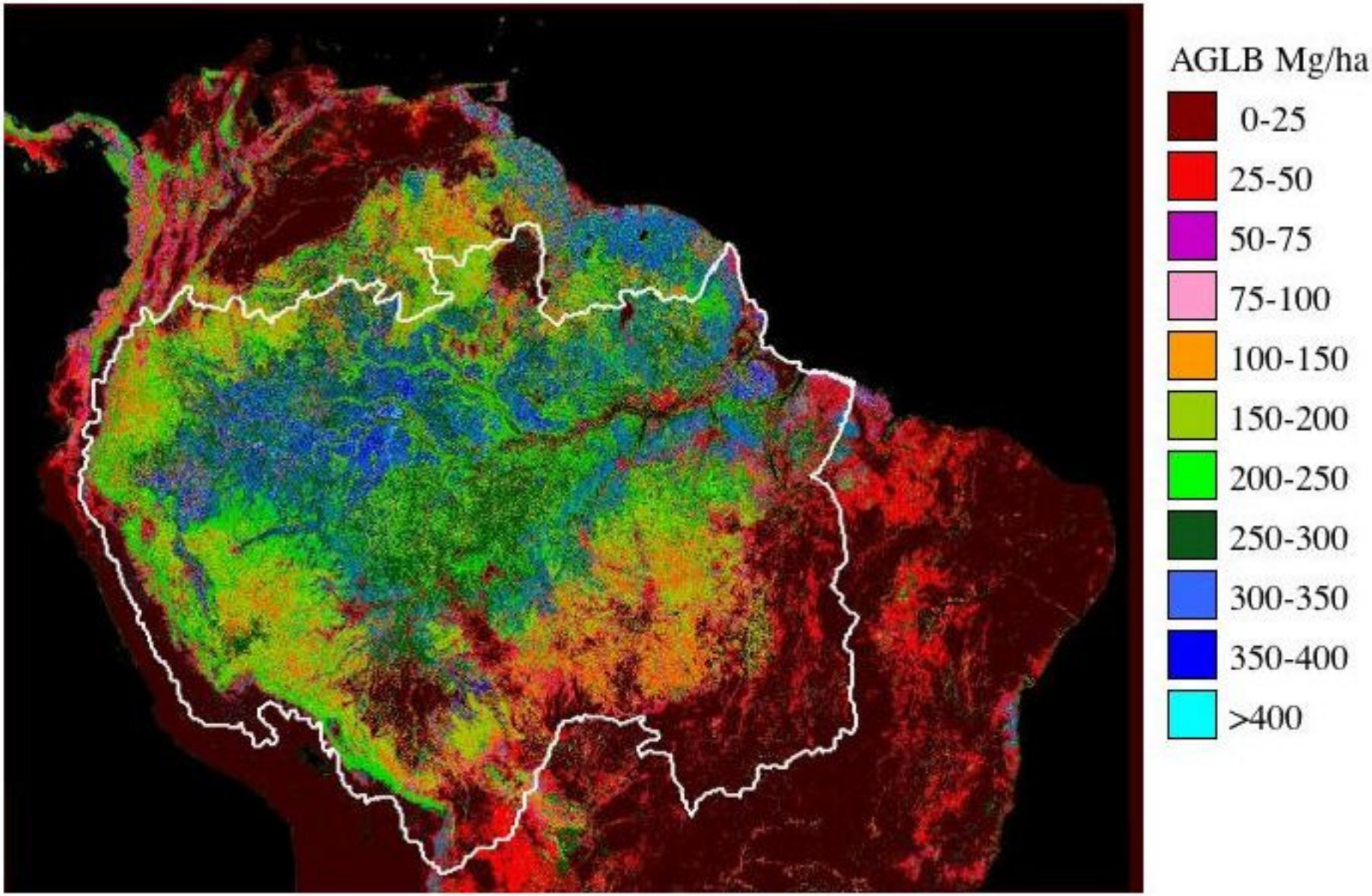
- Basin-wide biomass map leading to testable hypothesis: biomass lower on East Bank than West Bank of Rio Negro.

Aboveground Live Biomass Distribution in the Amazon Basin



Predominant Modes of Disturbance?