Episodic tree mortality disturbance and the steady-state mosaic of an old-growth Central Amazon forest landscape

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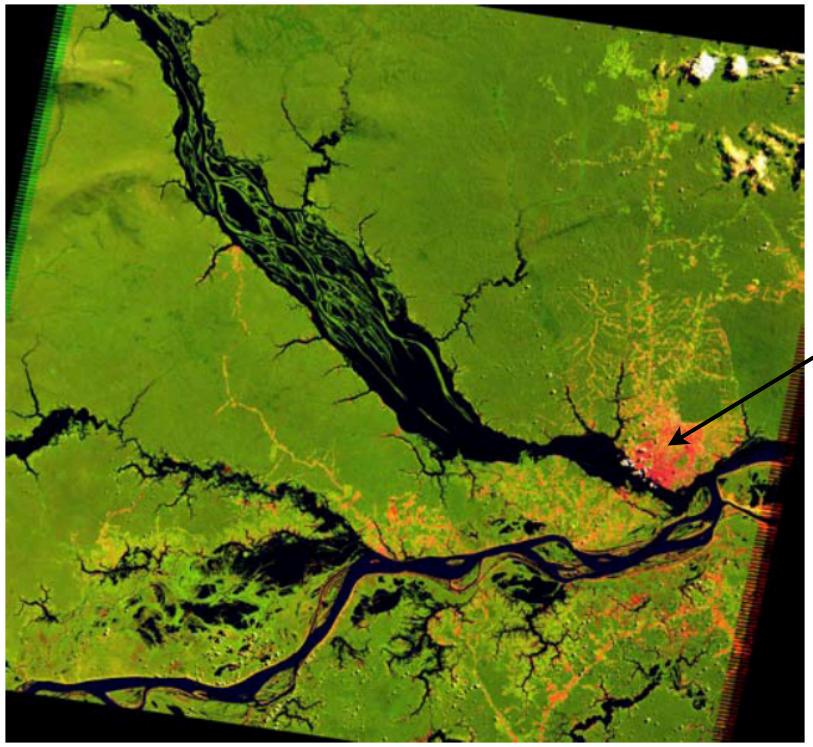
What is the current state of old-growth Amazon forest?

How do large disturbances affect landscape-level biomass dynamics?

- Increase of 1.22 Mg Biomass ha^{-1} yr^{-1} (Baker et al. 2004)
- Plot-based estimates likely overestimate biomass sink
  - Do not capture large, low-frequency mortality events

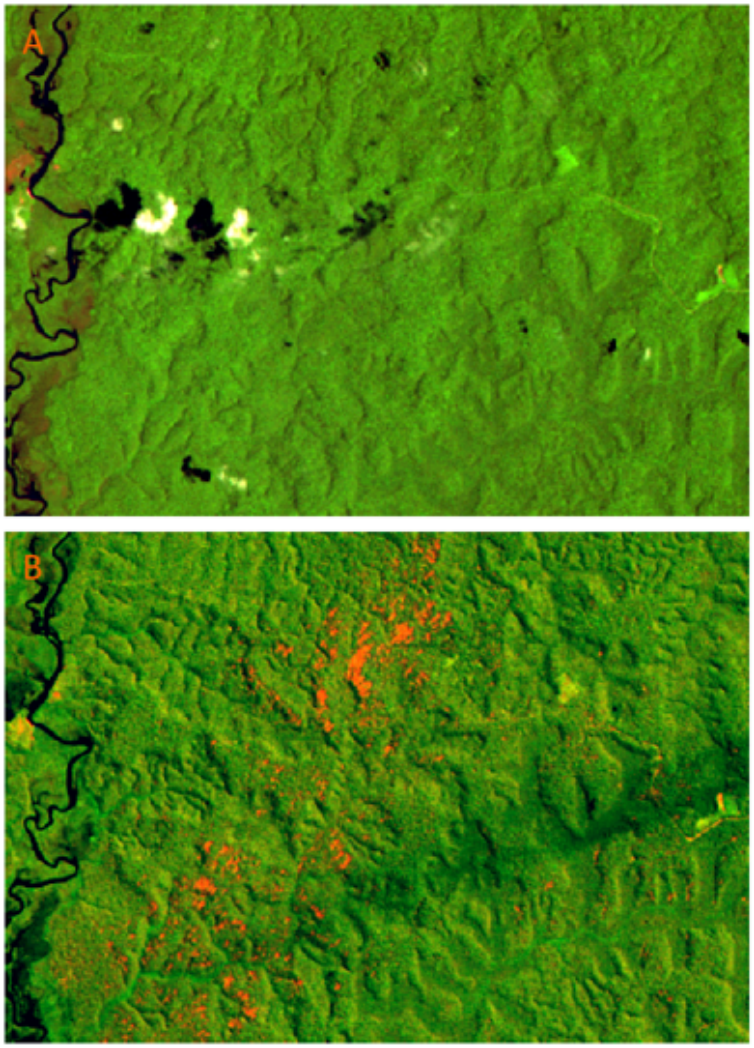
Test old-growth equilibrium hypothesis



RS: Negrón-Juárez et al. 2010
TREES: Chambers et al. 2004

- More complete wind mortality frequency distribution
  - Permanent field plot data
  - Remote Sensing (RS) analysis (Landsat path 231, row 062)
- Tropical tRee Ecology and Ecosystem Simulator (TREES)
  - Multiple 100 ha (2500, 400 m^2 stands), 2000 yr runs
  - No directional forcing (e.g. CO_2 fertilization, logging)

Relate change imagery to number of dead trees per disturbance patch



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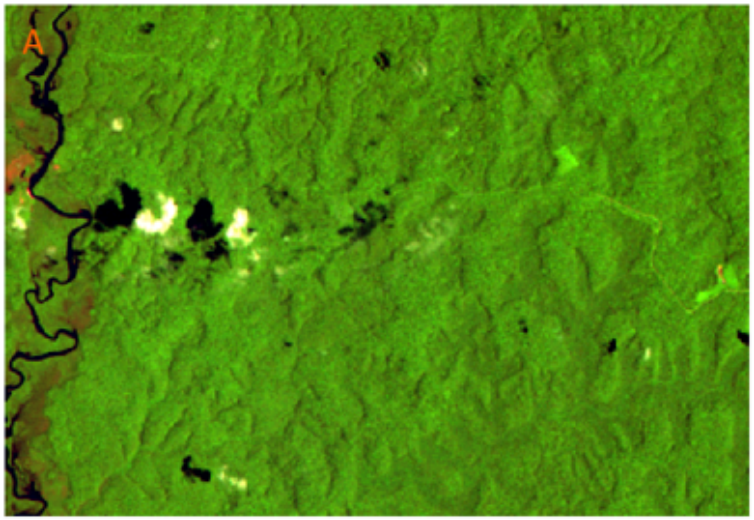

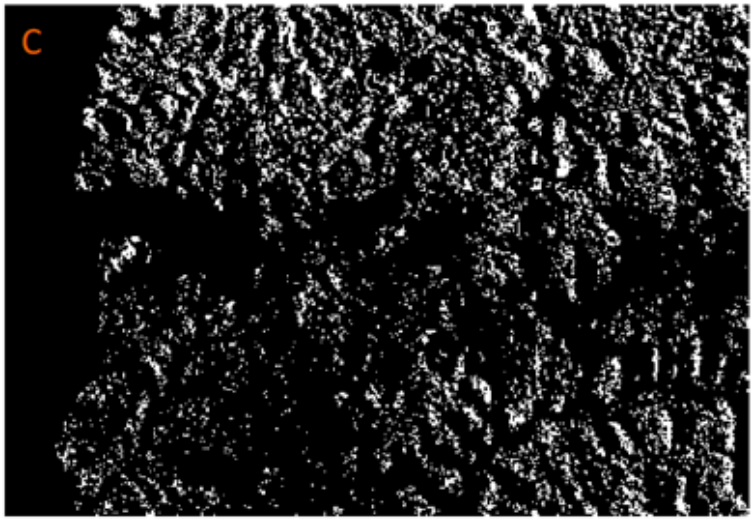

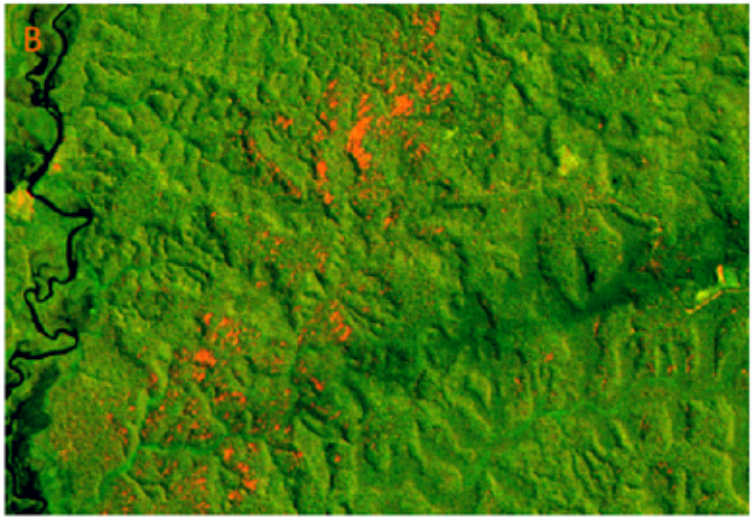

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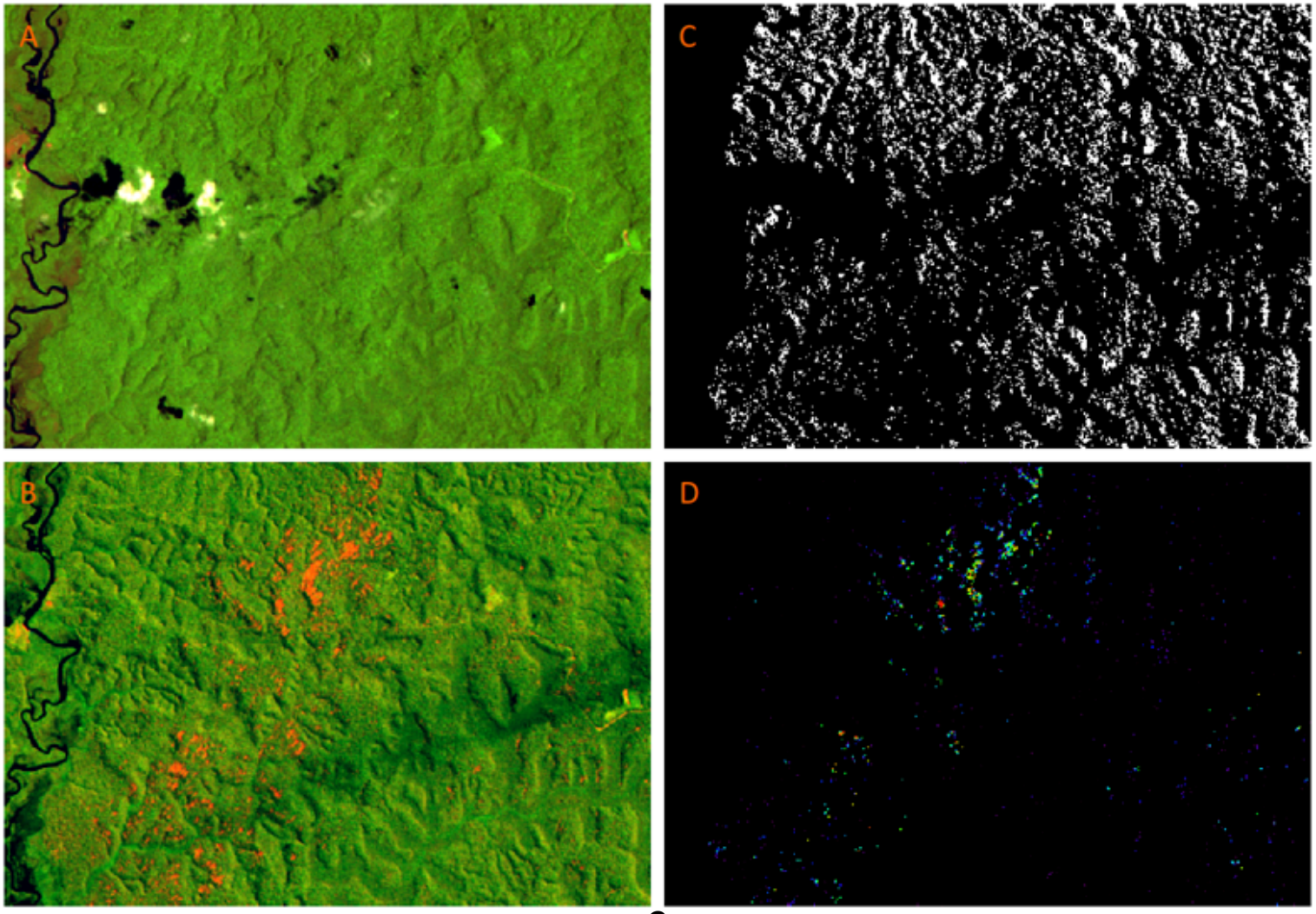
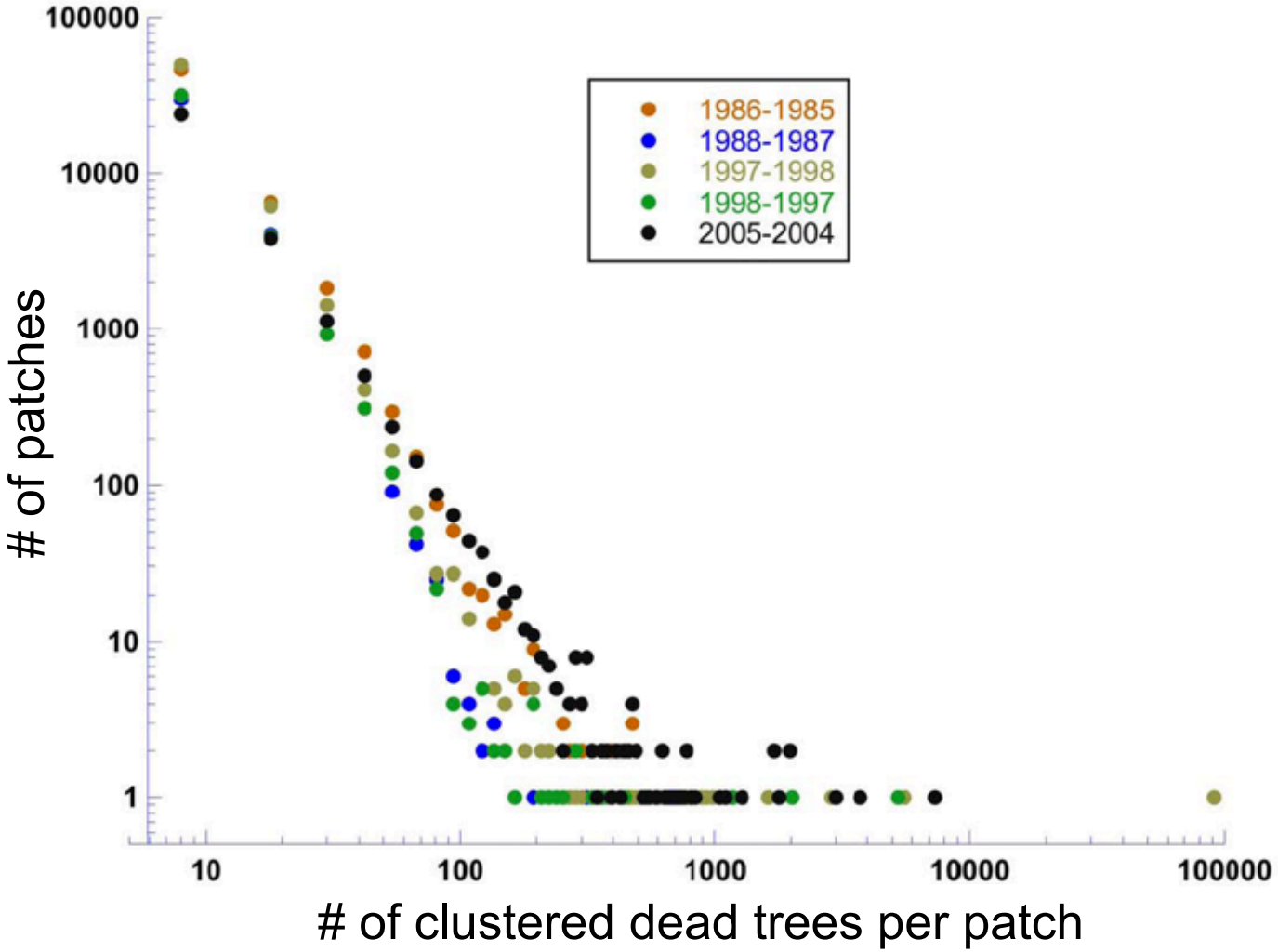


Landsat-derived disturbance increases plot-derived tree mortality rate by 18%



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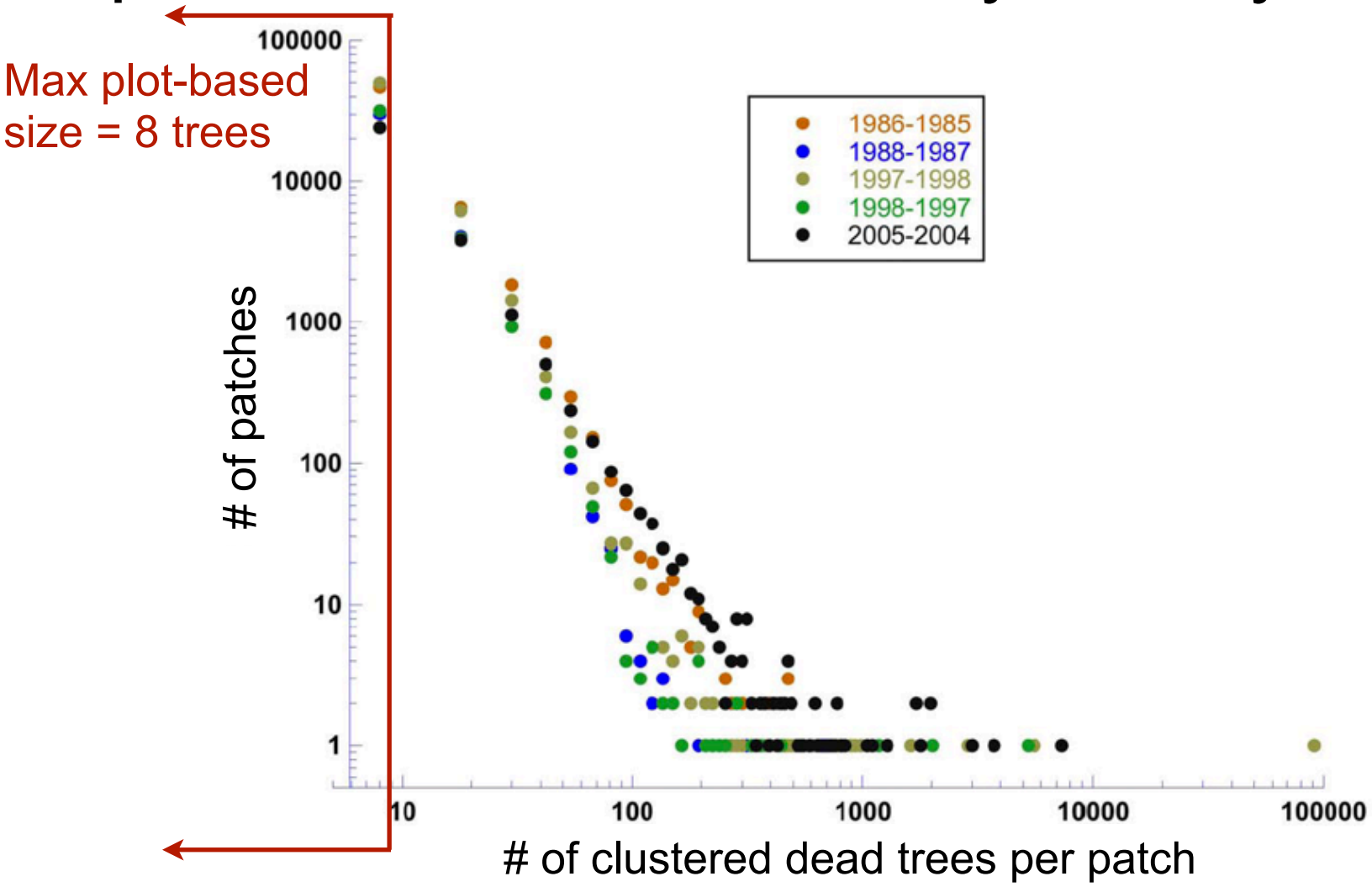
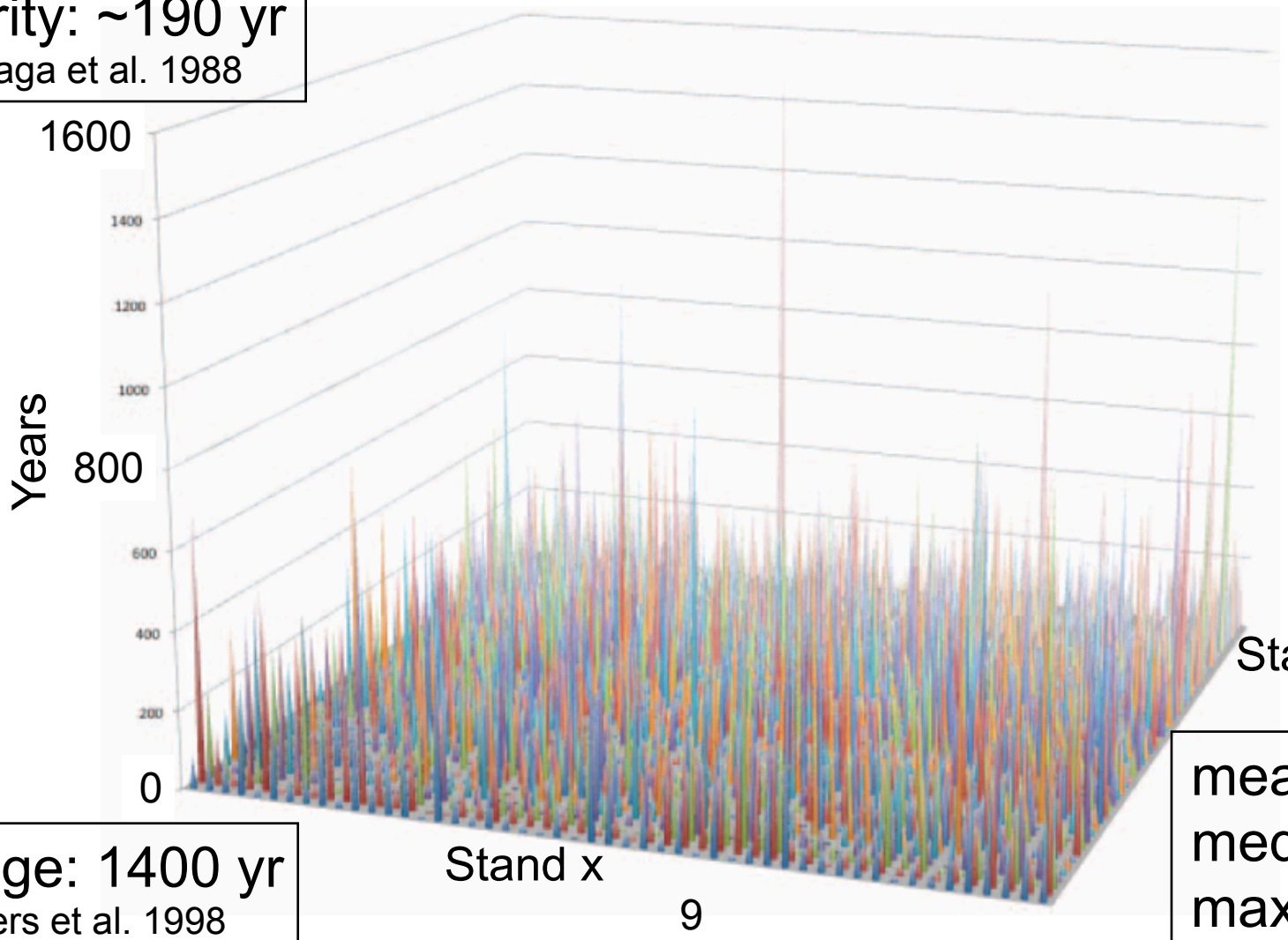


Typical average time since last disturbance is on the order of 100 years

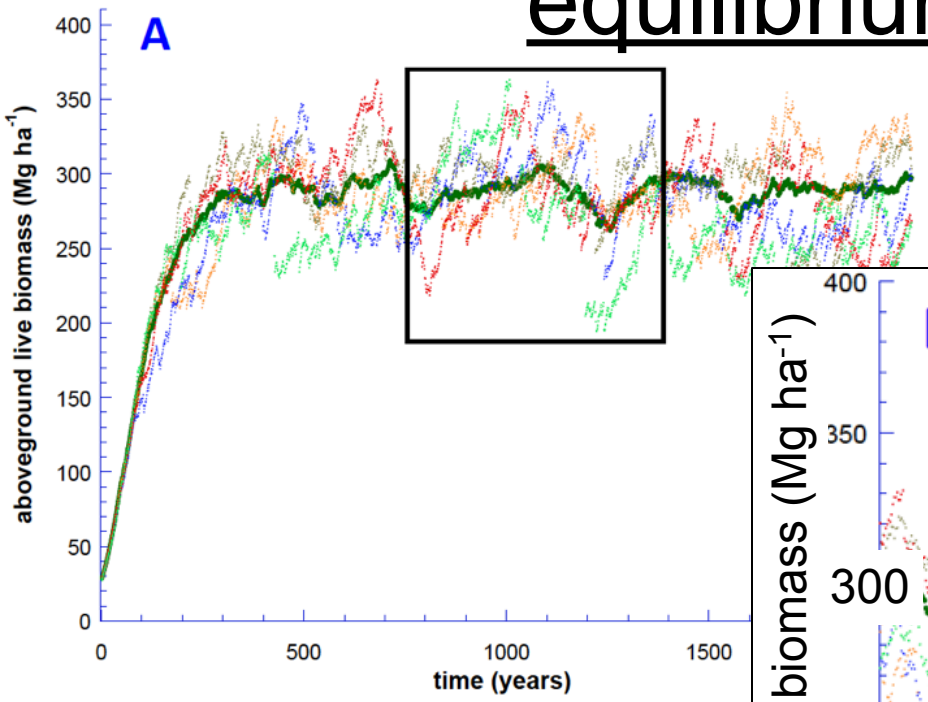
Maturity: ~190 yr
Saldarriaga et al. 1988



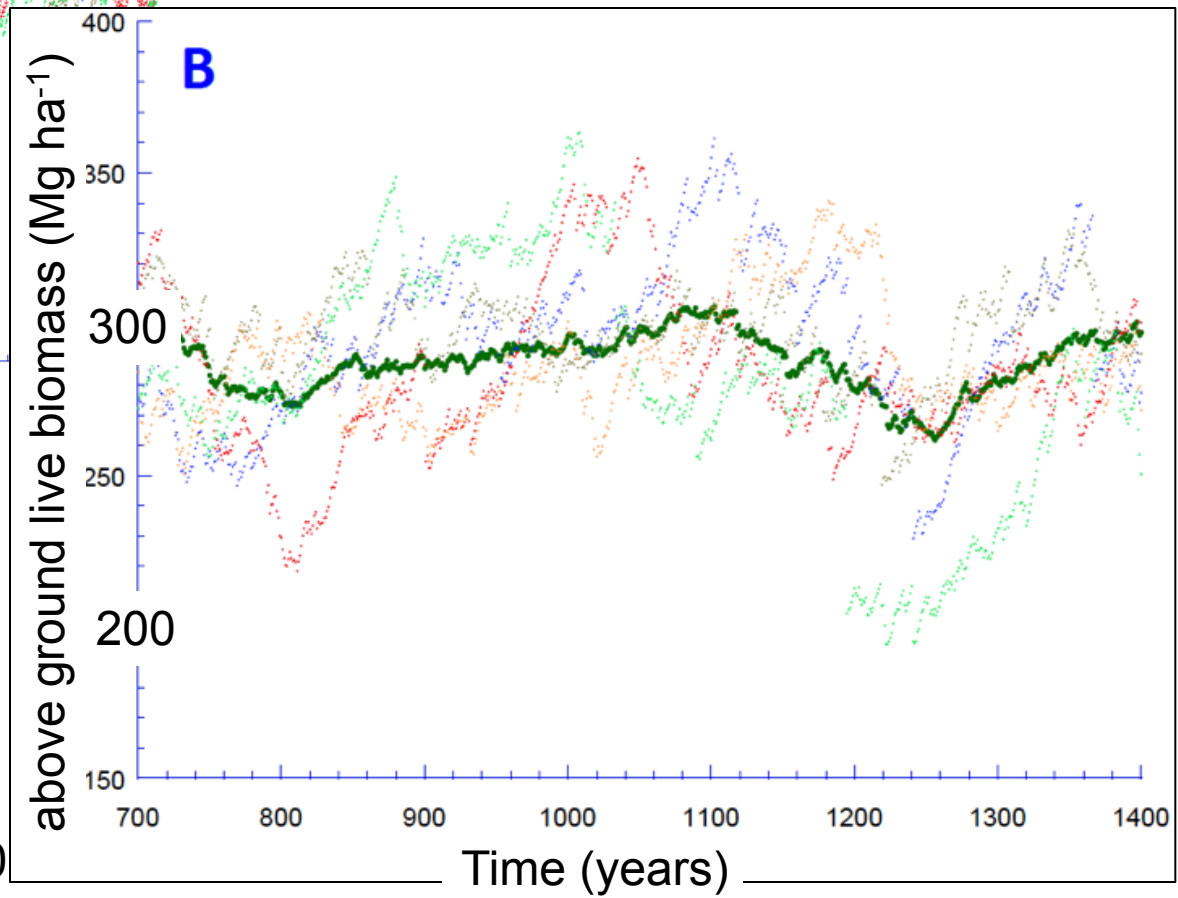
Old age: 1400 yr
Chambers et al. 1998

mean = 133
median = 104
max = 1521

1 ha 'plots' do not exhibit landscape equilibrium behavior



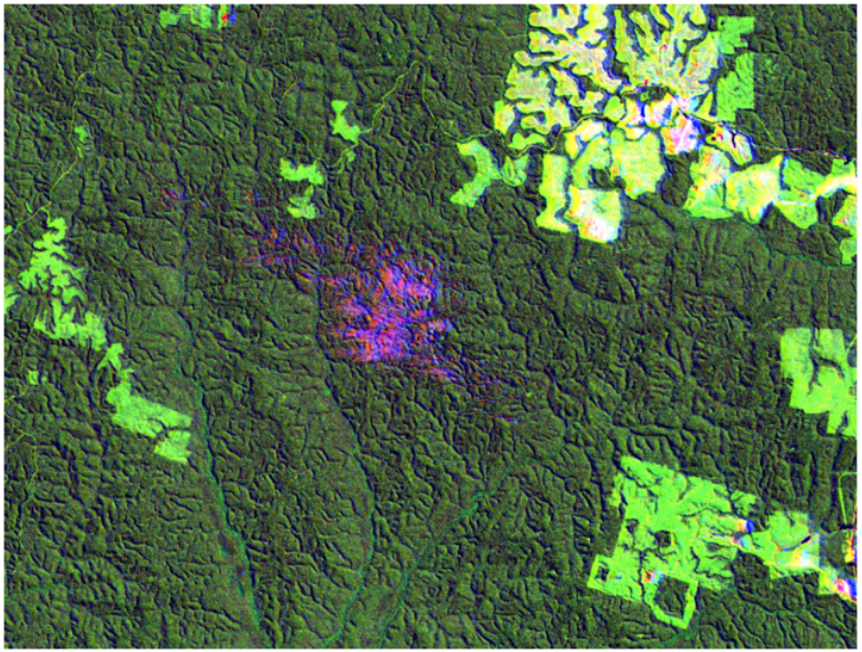
Dark green symbols = 100 ha mean
Other colors = 5 random 1 ha 'plots'



Random plot: +1.13 Mg ha^{-1} yr^{-1} over average 21-year interval

Conclusions

- Old-growth sink is highly uncertain
- Large, low-frequency events are not well captured by plots



- Remote sensing improves mortality estimate
- Improved frequency distribution is necessary to:
  - adequately estimate carbon balance
  - adequately estimate ecological dynamics

Implications and future directions

- Land conversion
  - Conversion fluxes and Integrated Assessment Modeling
  - Before/after land-atmosphere exchange and regional/global Earth System Models

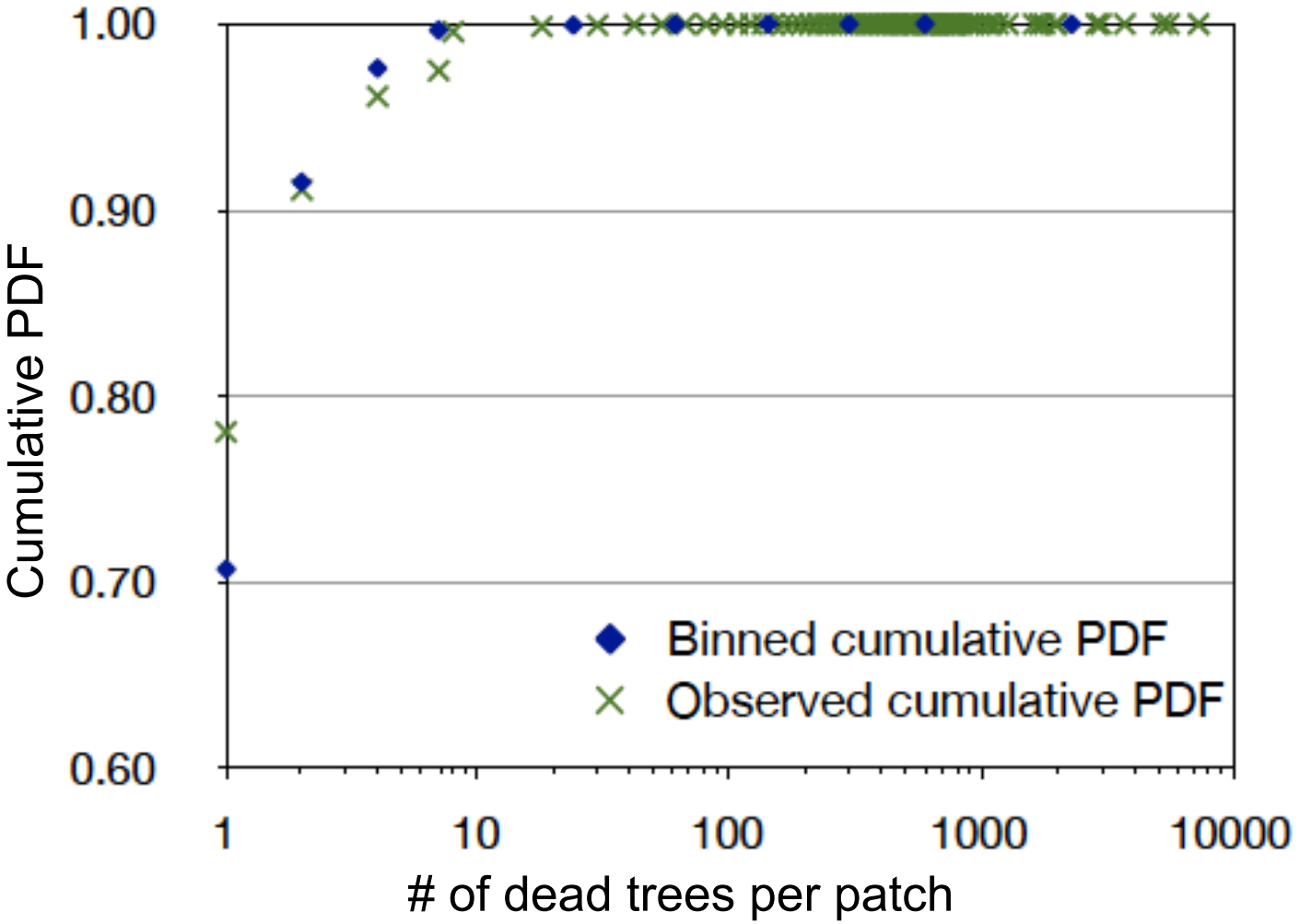
- Sugarcane in the Atlantic forest

- Oil palm in the Amazon forest?

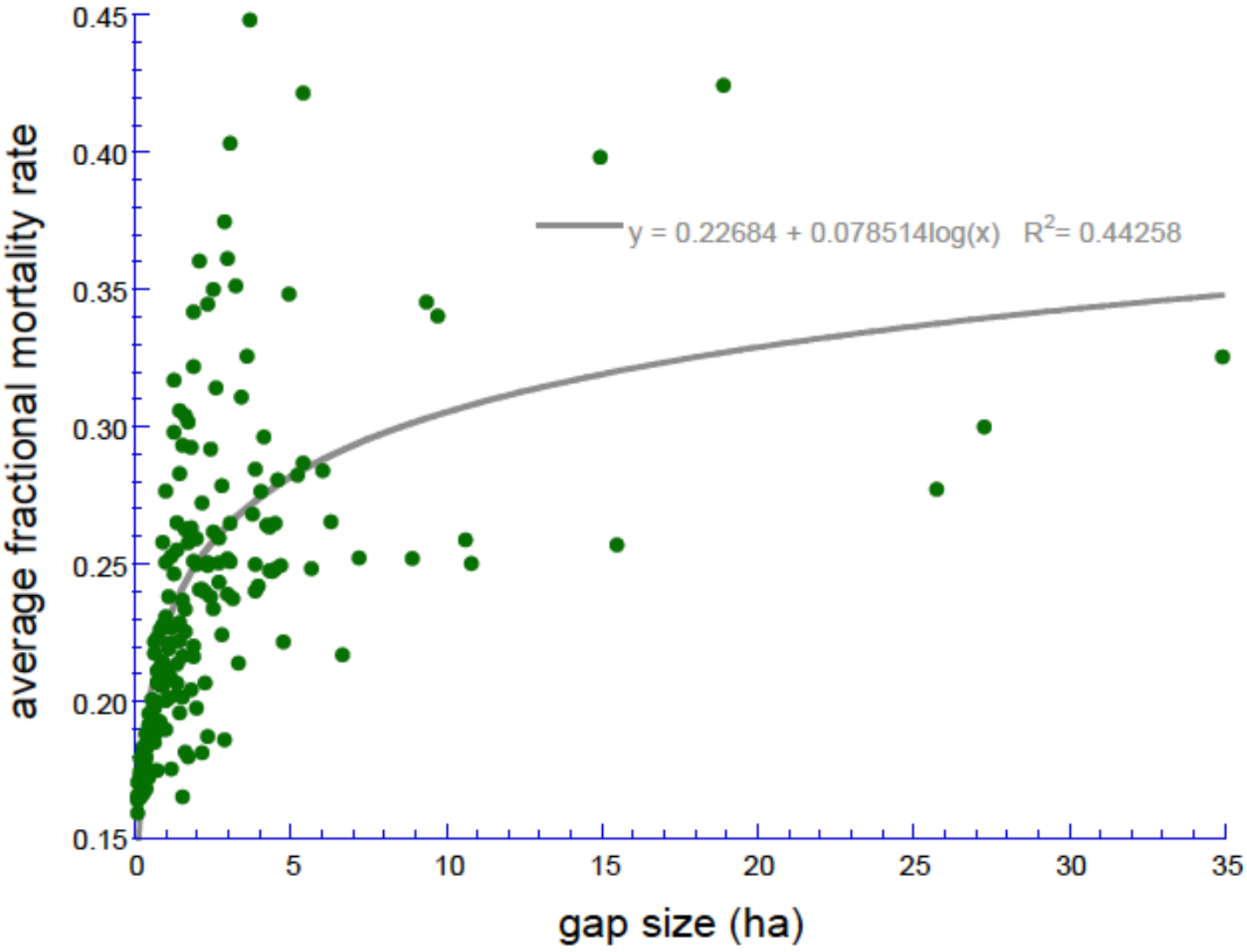
Acknowledgements

- NASA
- DOE contract No. DE-AC02-05CH11231
- Program on Integrated Assessment Modeling
- Project to Improve Human-Earth System Interactions in an Integrated Earth System Model.

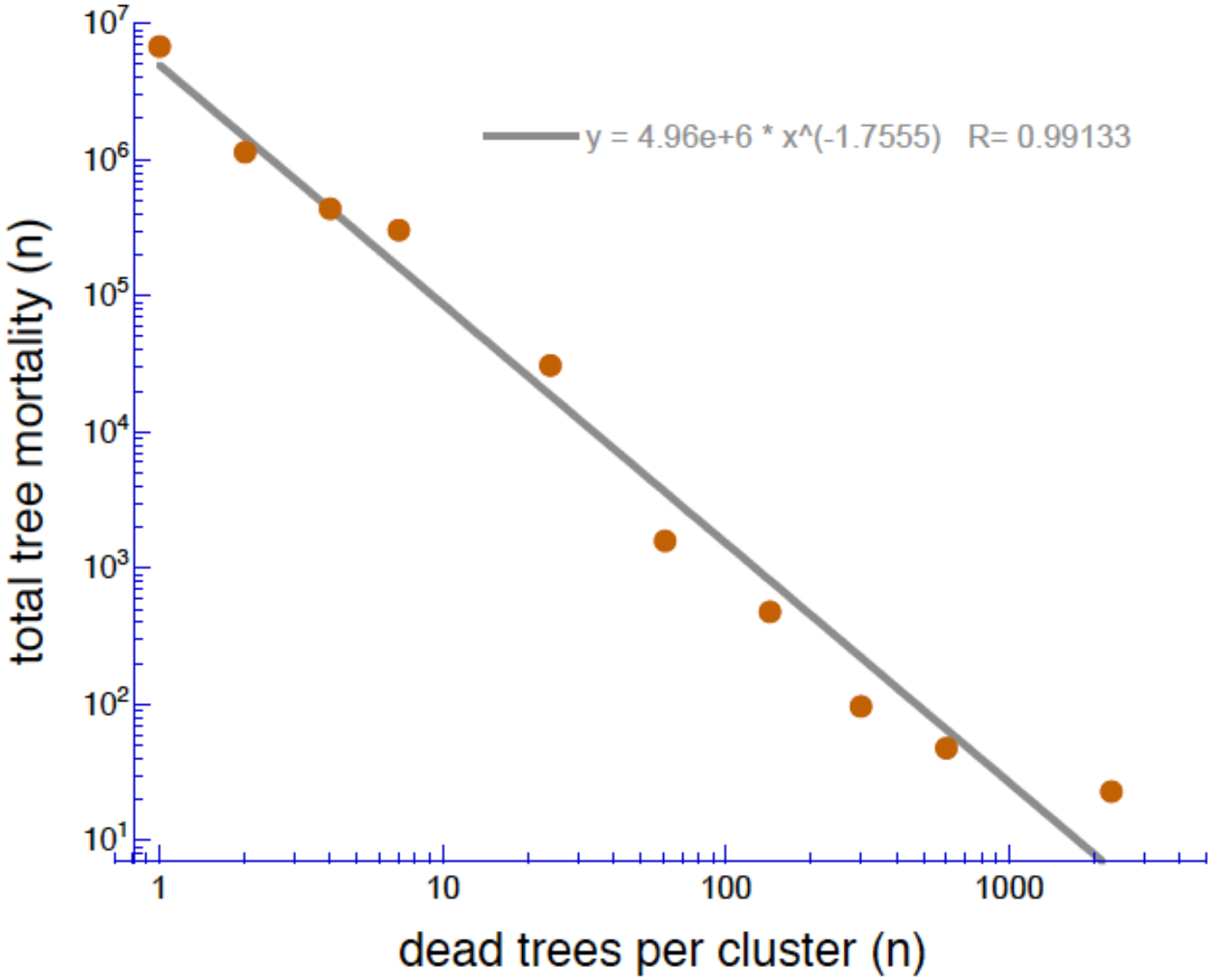
Binned Mortality Probability Distribution Function (PDF) for TREES



mortality rate vs. pixel patch size



binned freq. dist. regression



old-growth mask