Disturbance Effects on Carbon Dynamics in Amazon Forest: A Synthesis from Individual Trees to Landscapes

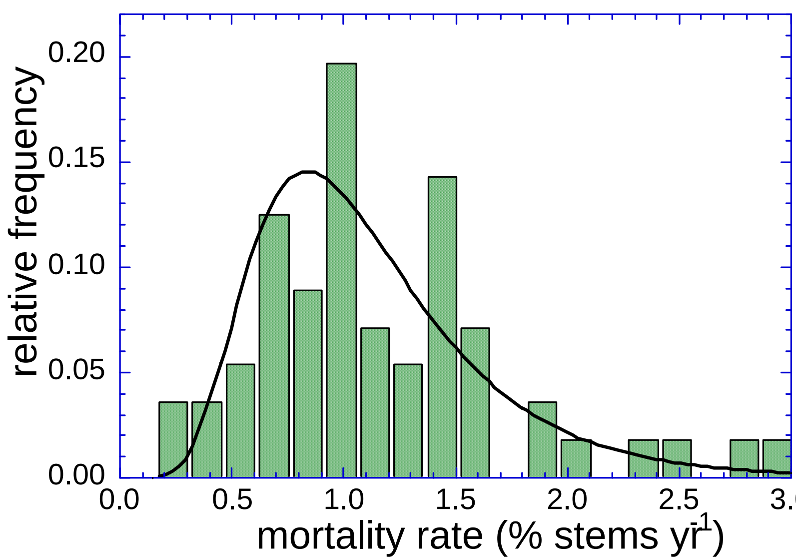
- **Workshop 1 – Tulane University, New Orleans, Late June 2004**
  - (i) developing a consistent basin wide dataset of tree mortality dynamics from inventory plot data
  - (ii) exploring different remote sensing methods for detecting intermediate-scale (~0.1 to 5 ha) canopy gaps – e.g. blowdowns, selective logging.
  - (iii) comparing modeling approaches of forest response to gap disturbance

- **Workshop 2 – Tulane University, New Orleans, Late May 2005**
  - (i) exploring a general forest response framework across the natural to anthropogenic disturbance gradient
  - (ii) comparing various remote sensing methods for detecting a range of disturbance types and processes
  - (iii) evaluating modeling approaches for simulating this disturbance gradient

Tree Mortality Probability Distribution Function

The temporal and spatial distribution of mortality events at the landscape scale can have important control over regional carbon balance.

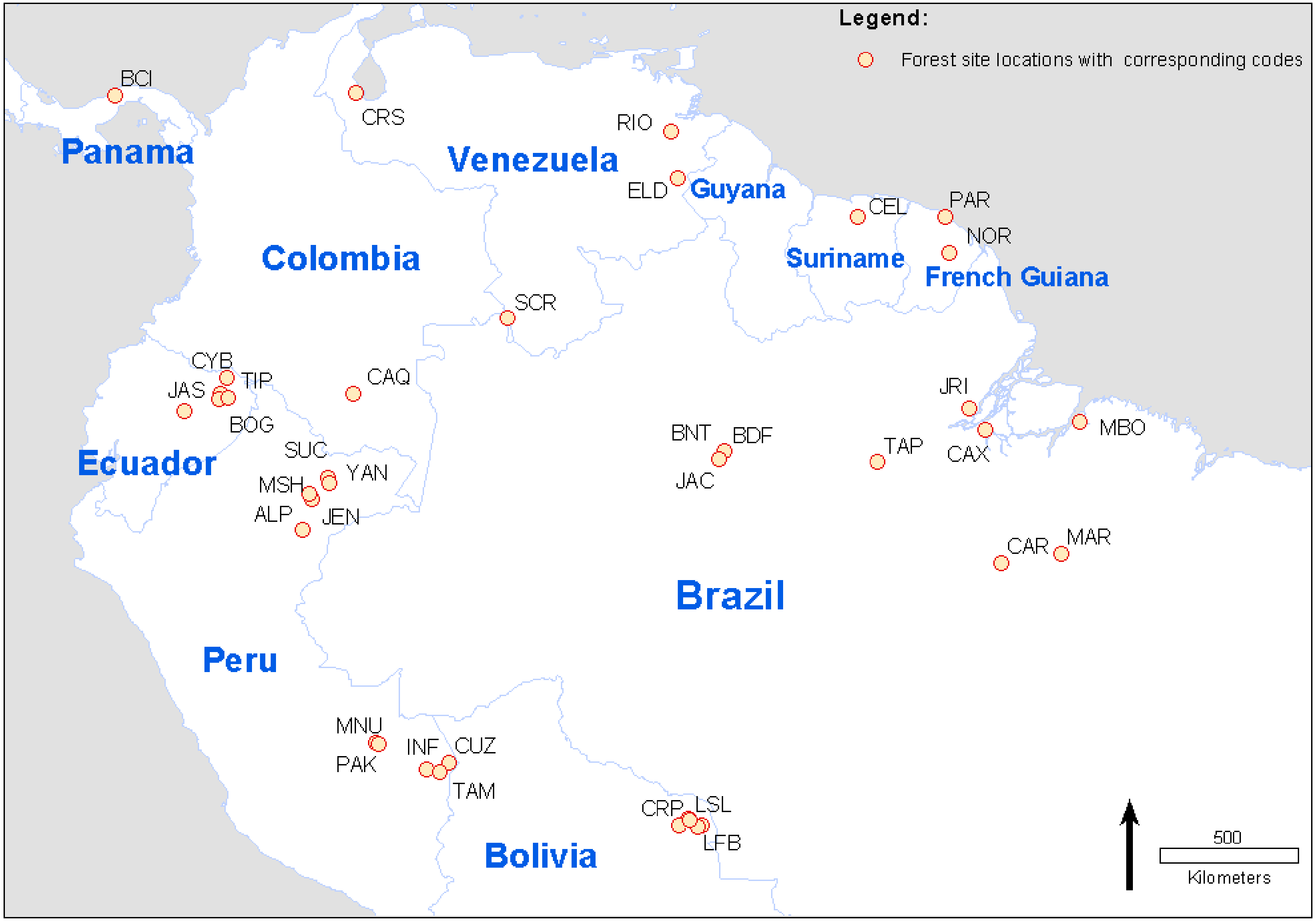
How frequently does a catastrophic mortality event initiating secondary succession strike a given patch of forest?



There is an important spatial dimension to mortality events

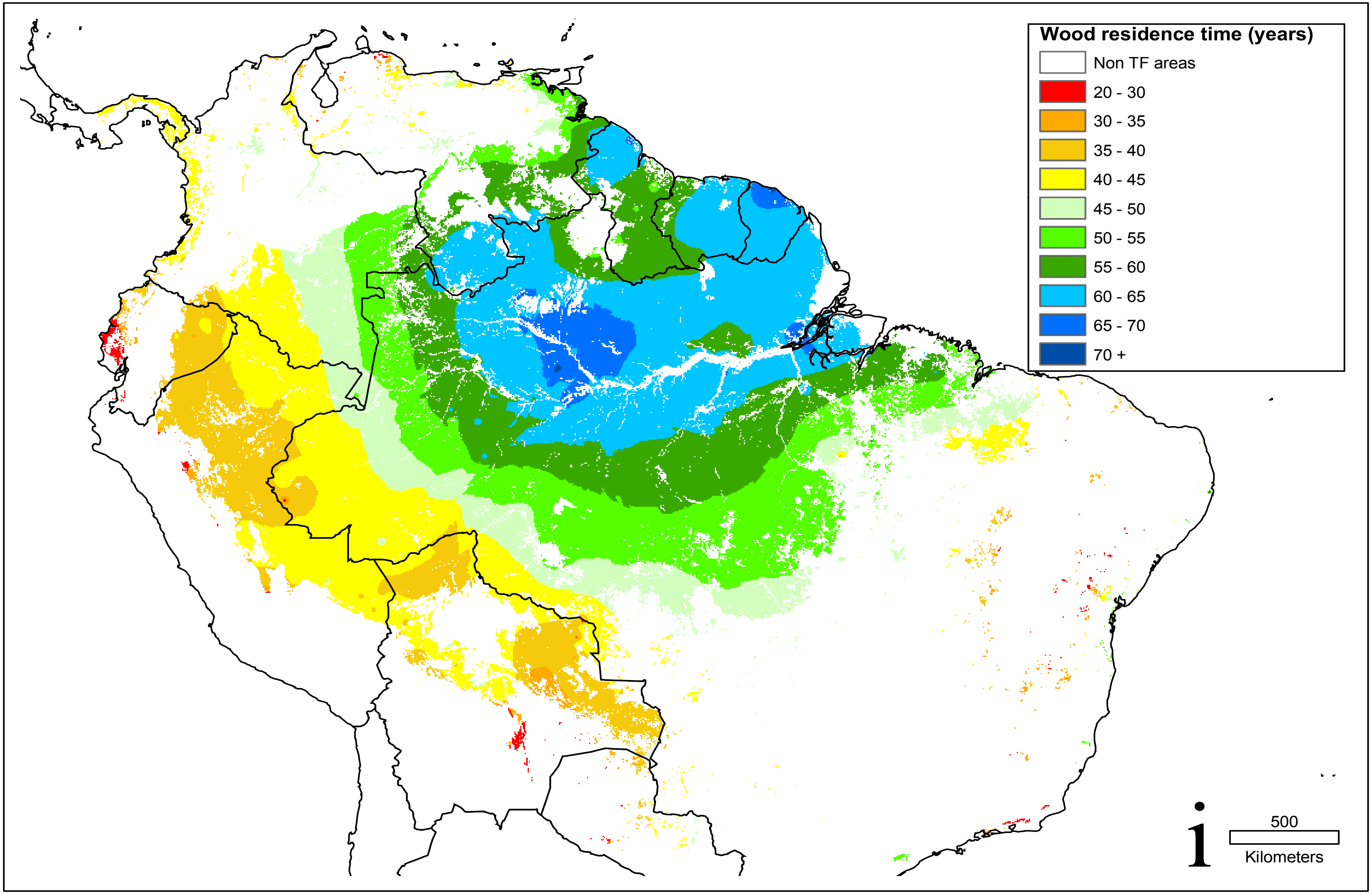
The RAINFOR Project

www.leeds.geog.ac.uk/rainfor
Malhi *et al*, **An international network to understand the biomass and dynamics of Amazonian forests (RAINFOR)**
Journal of Vegetation Science, 2002

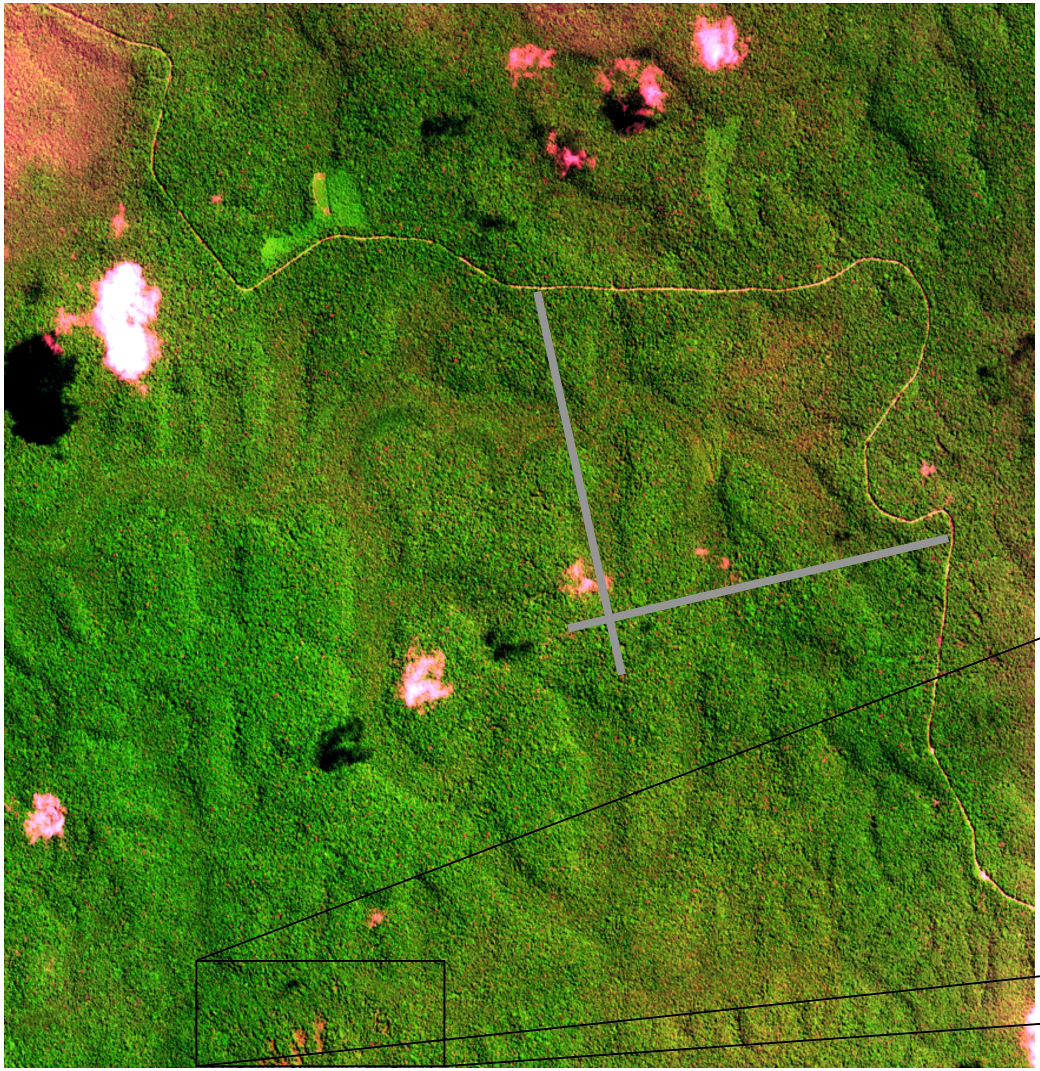


Legend:
Forest site locations with corresponding codes
Panama
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
BCI
CRS
RIO
ELD
CEL
PAR
NOR
SCR
CYB
TIP
JAS
CAQ
BOG
SUC
YAN
MSH
ALP
JEN
BNT
BDF
JAC
TAP
JRI
CAX
MBO
CAR
MAR
MNU
PAK
INF
CUZ
TAM
CRP
LSL
LFB
500
Kilometers

Mean Wood Residence Time



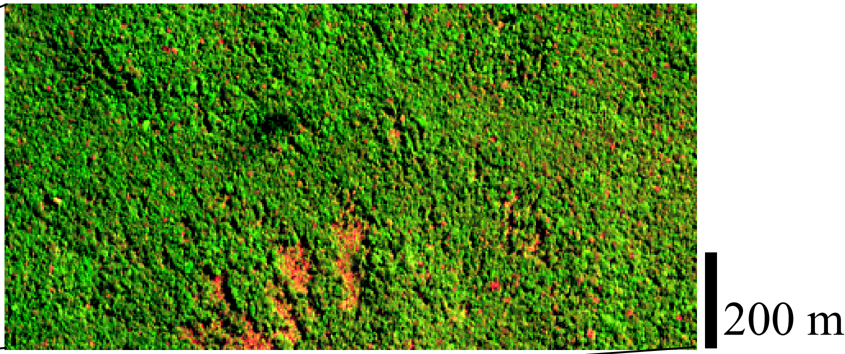
Catastrophic Tree Mortality and Microburst Winds



IKONOS image

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.

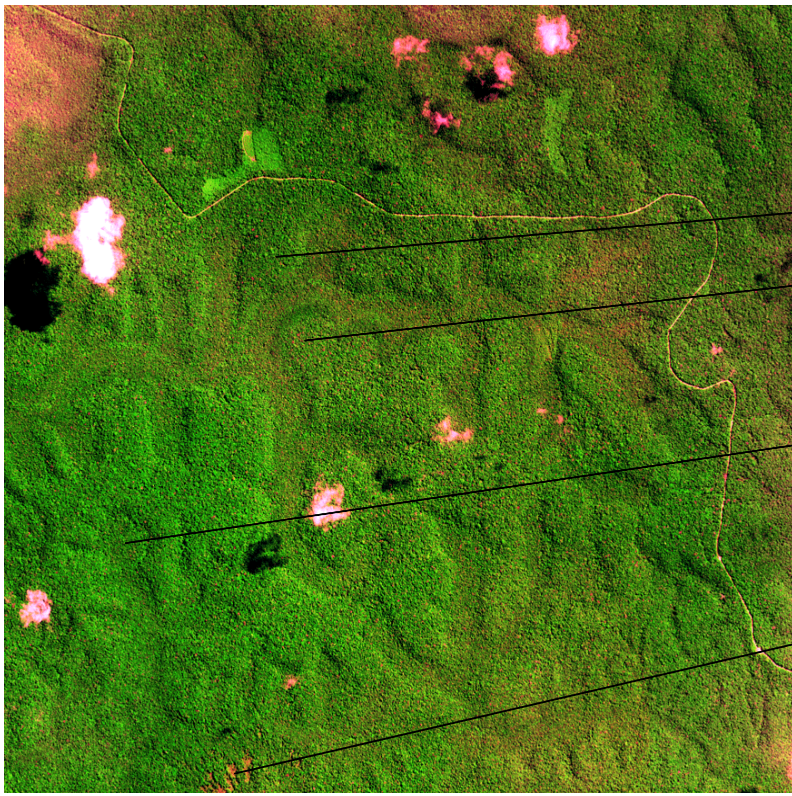
Grey bars indicate permanent forest inventory plots managed by INPA (2.5 km long), and the road is referred to as ZF-2.



Severe downdraft winds often associated with late dry season storms

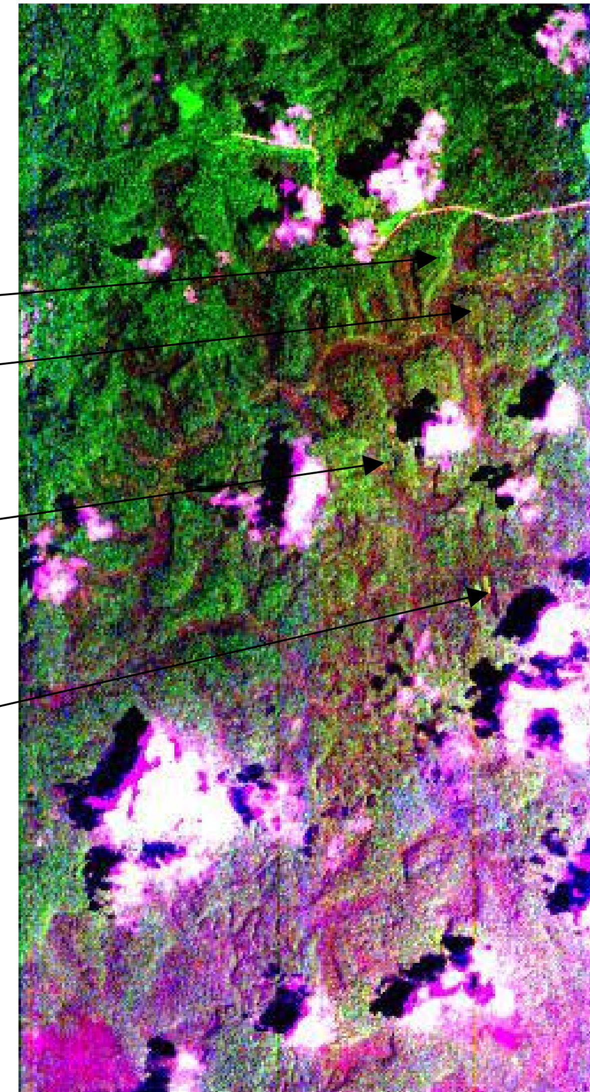
Mapping out relative abundance of blowdown-like vegetation using hyperspectral remote sensing data

IKONOS: 5 bands



July 2000: blowdown + 9 months

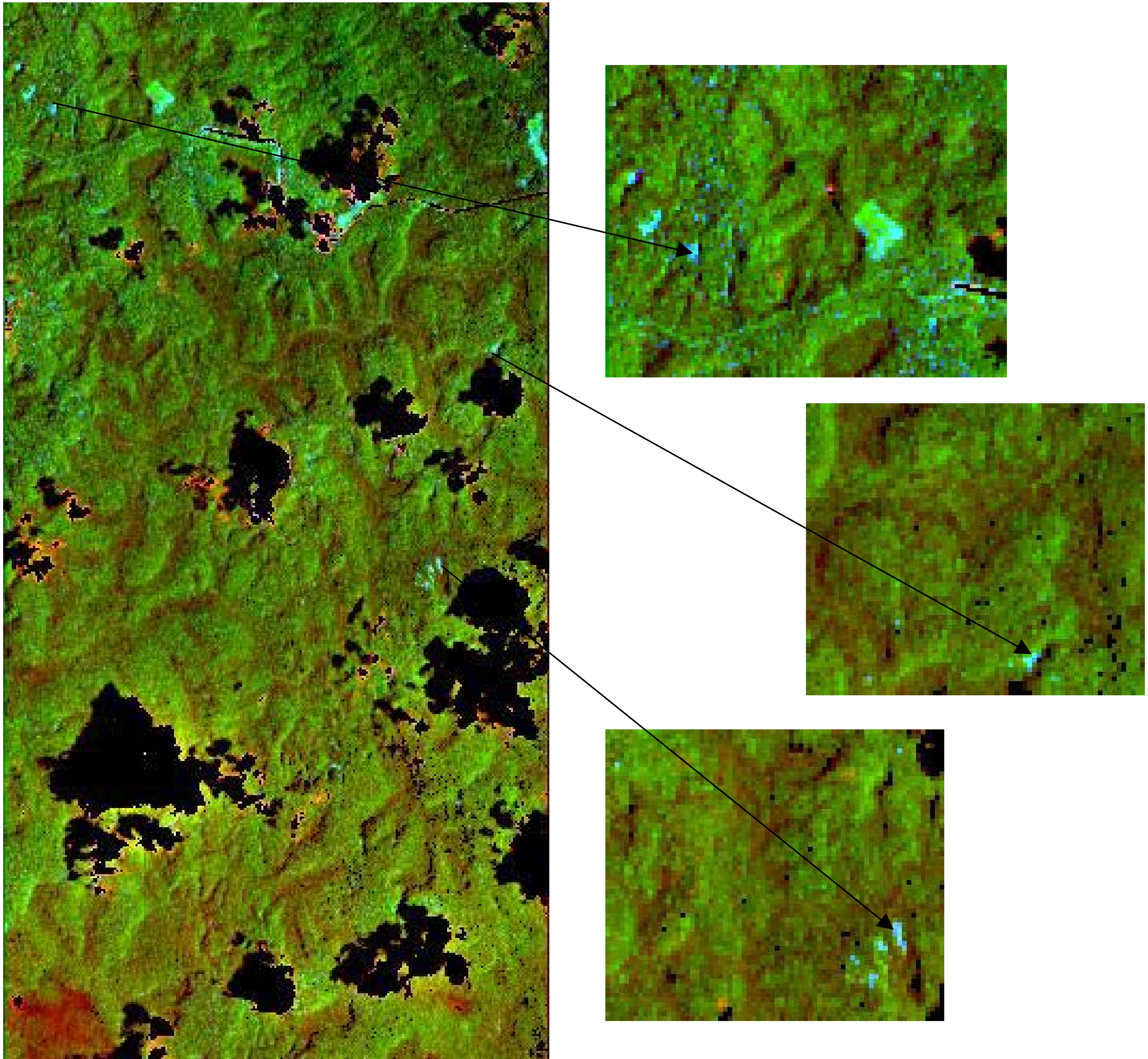
HYPERION: ~160 bands



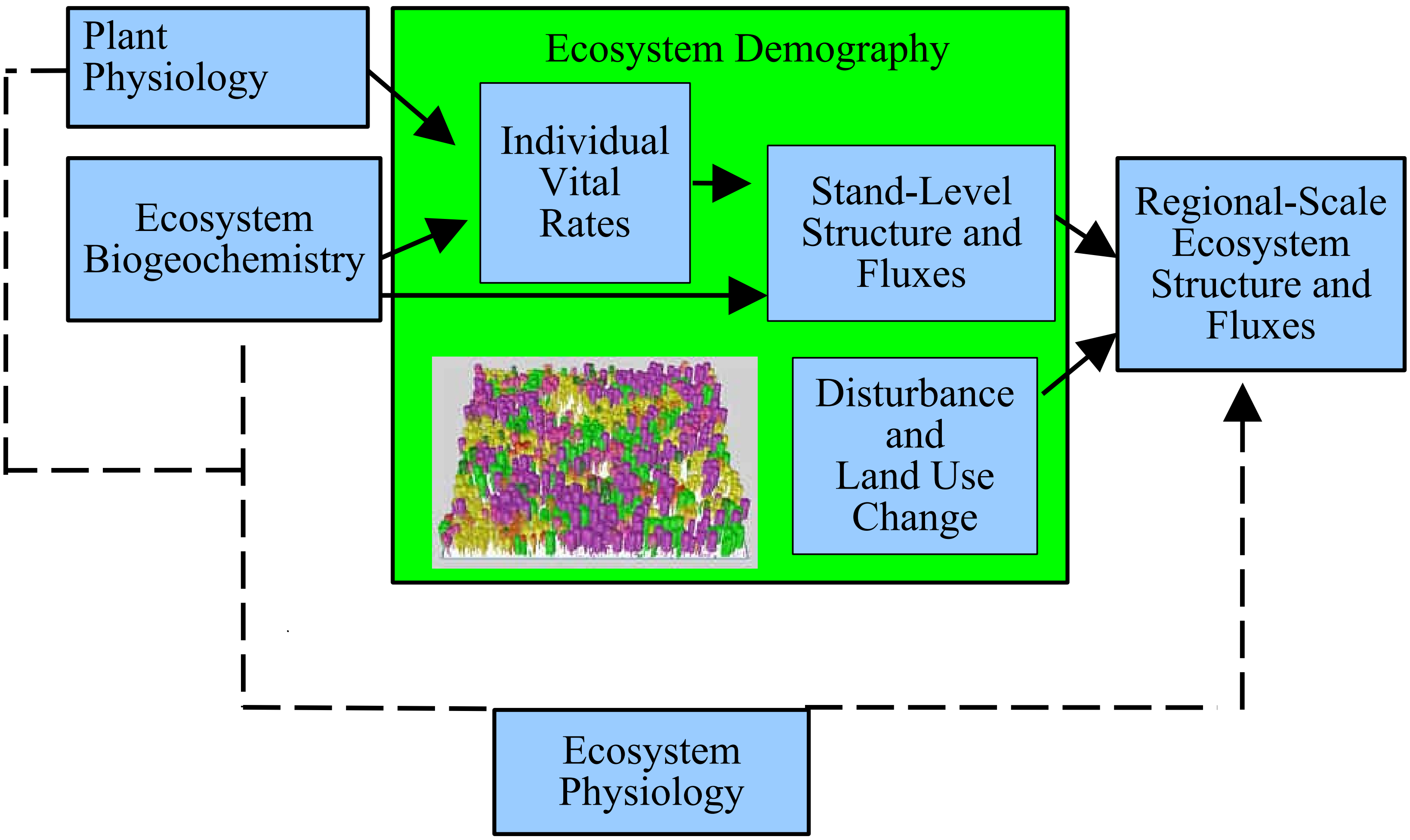
Nov 2002: blowdown + 3 years

Overall Image Analysis Approach

1. Subset Hyperion data for ZF2 blowdown scene – "Destreak" and run ACORN for radiance → apparent reflectance.
2. Minimum noise fraction (MNF) transformation and pixel purity index (PPI) to identify blowdown endmembers.
3. Create ROI from most spectrally pure blowdown pixels and use mixture tuned matched filter (MTMF) to map out fractional abundance of blowdown the entire scene.
4. Run "Destreak", ACORN, and MNF for entire Hyperion scene (7 x 45 km) – use MTMF to map out fraction of landscape in large-gap (blowdown) recovery phase.
5. Establish inventory plots in pixels identified as recent blowdowns to determine stand structure and species composition.
6. Carry out this analysis across the Amazon basin at sites with widely differing dynamics.



Ecosystem Demography (ED) Model



ED

Core: The core of ED is a new scaling method for stochastic point processes.

→ Physiologically-based “gap model”

→ Other ecosystem processes (e.g. decomposition, nutrients)

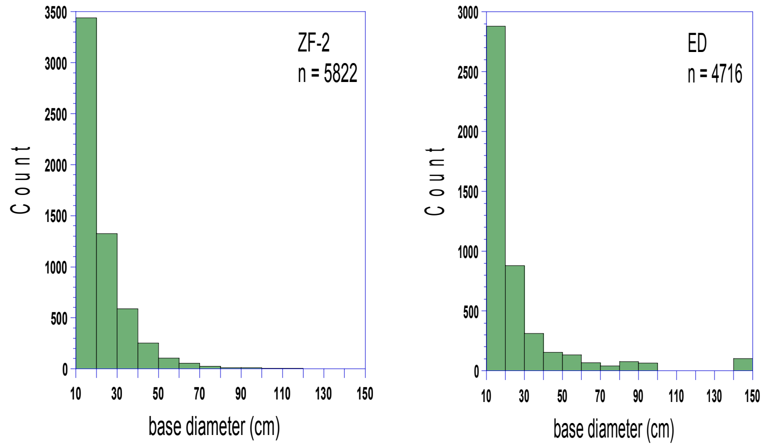
→ Disturbance processes (e,g, treefalls, fires, abandonment)

→ From climate, soil, and land use drivers

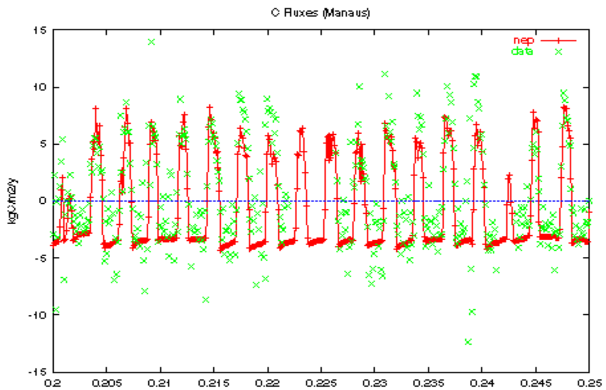
Resulting form: A system of partial differential equations for each grid cell

•Connections to Data

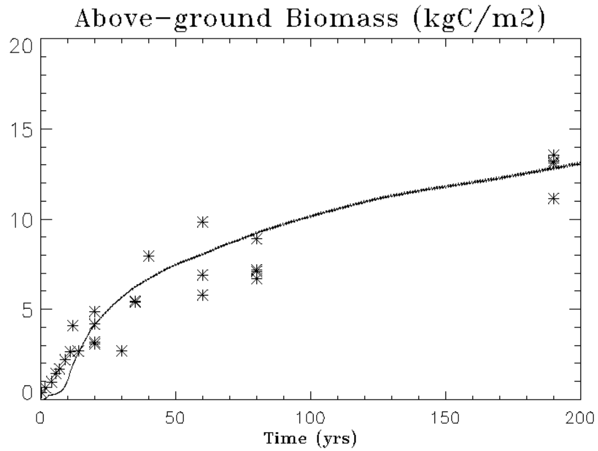
Stand Composition



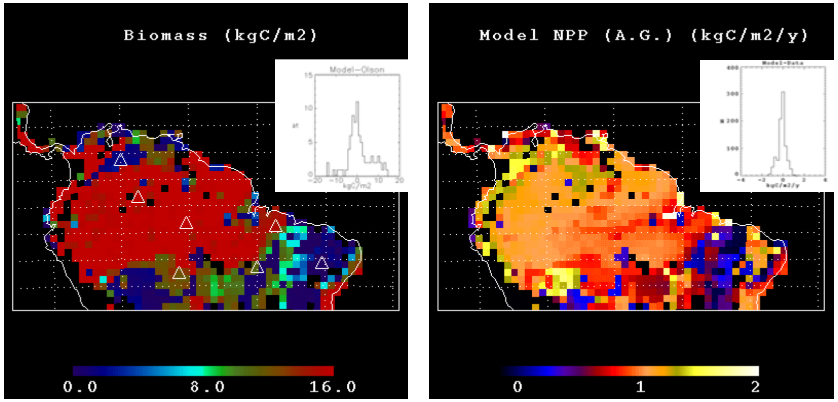
Flux-Tower Data



Stand Development



Regional Data



Disturbance Effects on Carbon Dynamics in Amazon Forest: A Synthesis from Individual Trees to Landscapes

- **Workshop 1 – Planning Meeting Agenda**
  - **Chambers: Overview – Hyperion gap detection, mapping and modeling disturbance**
  - **Asner: Gap detection and selective logging**
  - **Souza: NDFI and canopy damage**
  - **Nascimento: Matrix effects on tree species recruitment in disturbed areas**
  - **Discussion**