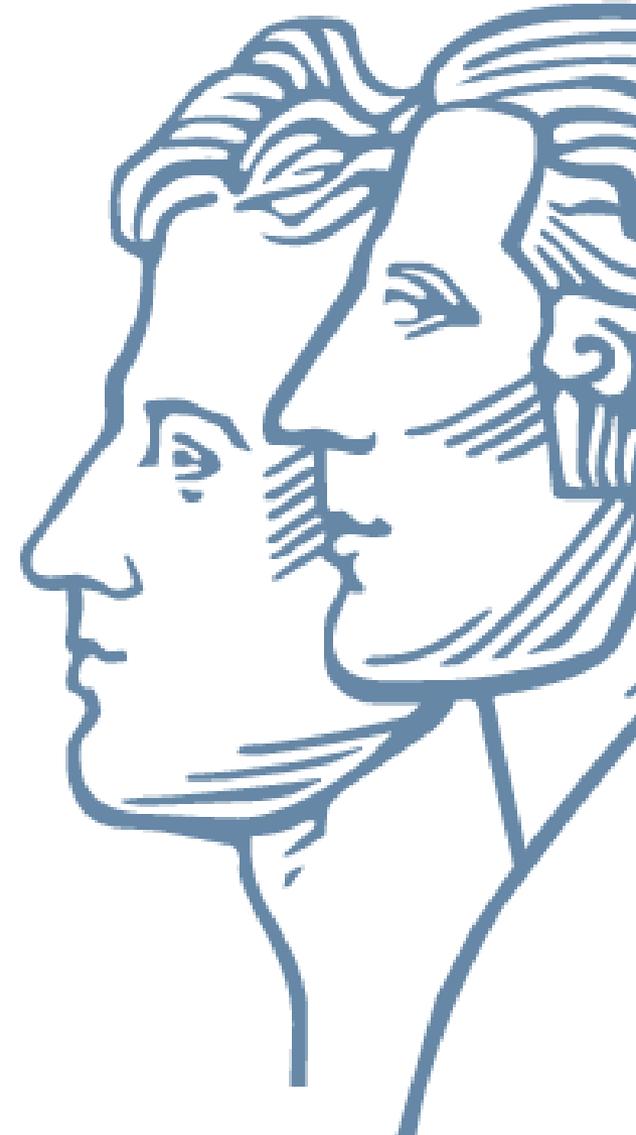


Mapping deforestation and post-deforestation dynamics in the tropics with Landsat time series

**Patrick Hostert
Patrick Griffiths
Hannes Müller
Philippe Rufin
Tobias Kuemmerle
Dirk Pflugmacher**

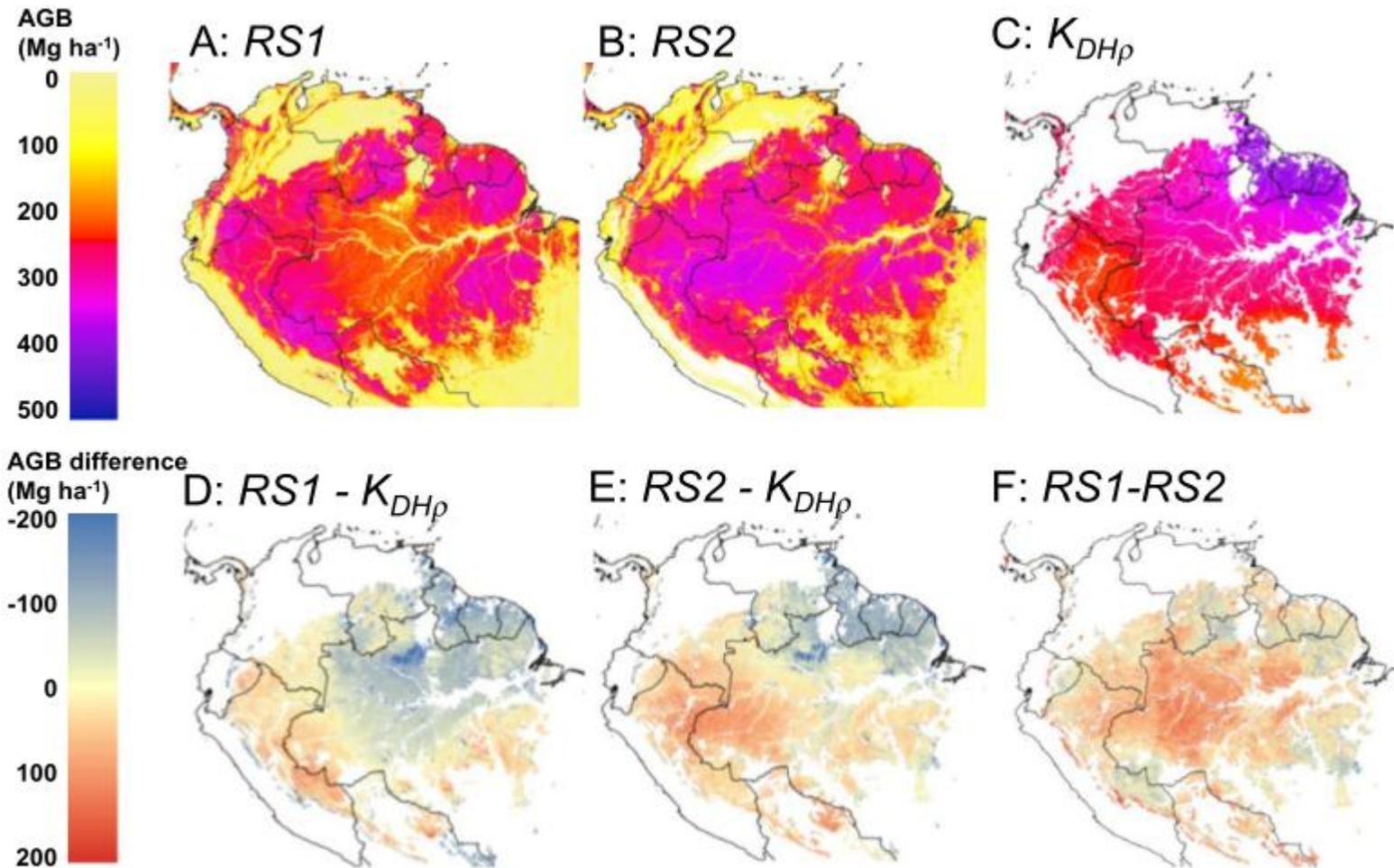




- One of today's most active deforestation frontiers runs along the BR-163 from Mato Grosso to the Amazon
- PRODES digital: yearly deforestation maps since 2002, 6.25 ha MMU, visual interpretation of spectrally unmixed Landsat mosaics



Uncertain carbon stock estimates for the Amazon...



Mitchard et al., 2014 (referring to Saatchi et al. 2011 and Baccini et al. 2012)

Southern Pará

Land use system dominated by extensive pastoralism

Fast regrowth of invasive species



Mato Grosso

Land use system dominated by intensive crop cultivation

Large-scale soy monocultures

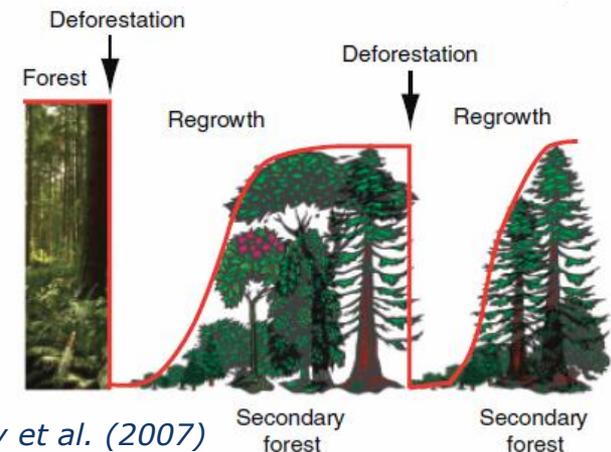
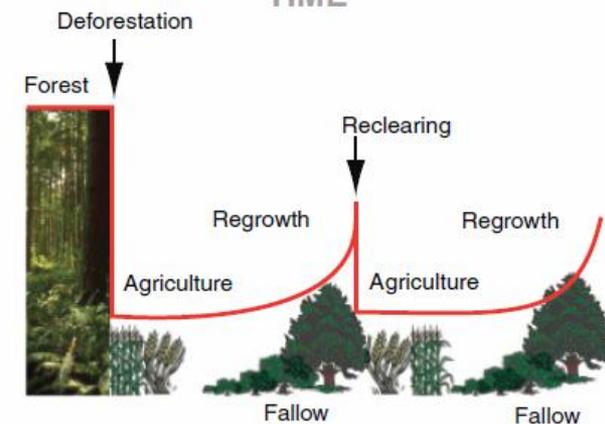
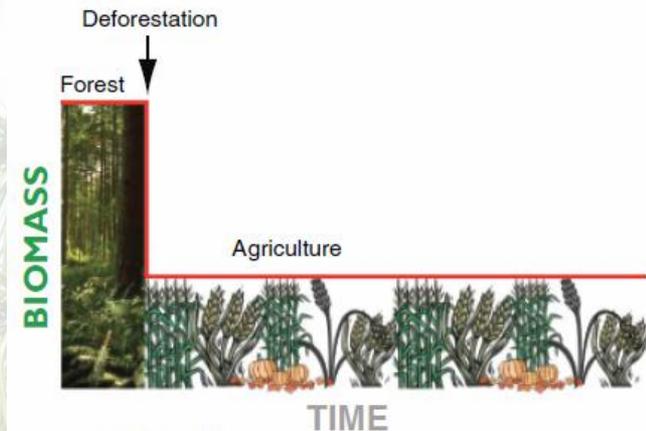


Post-deforestation analysis

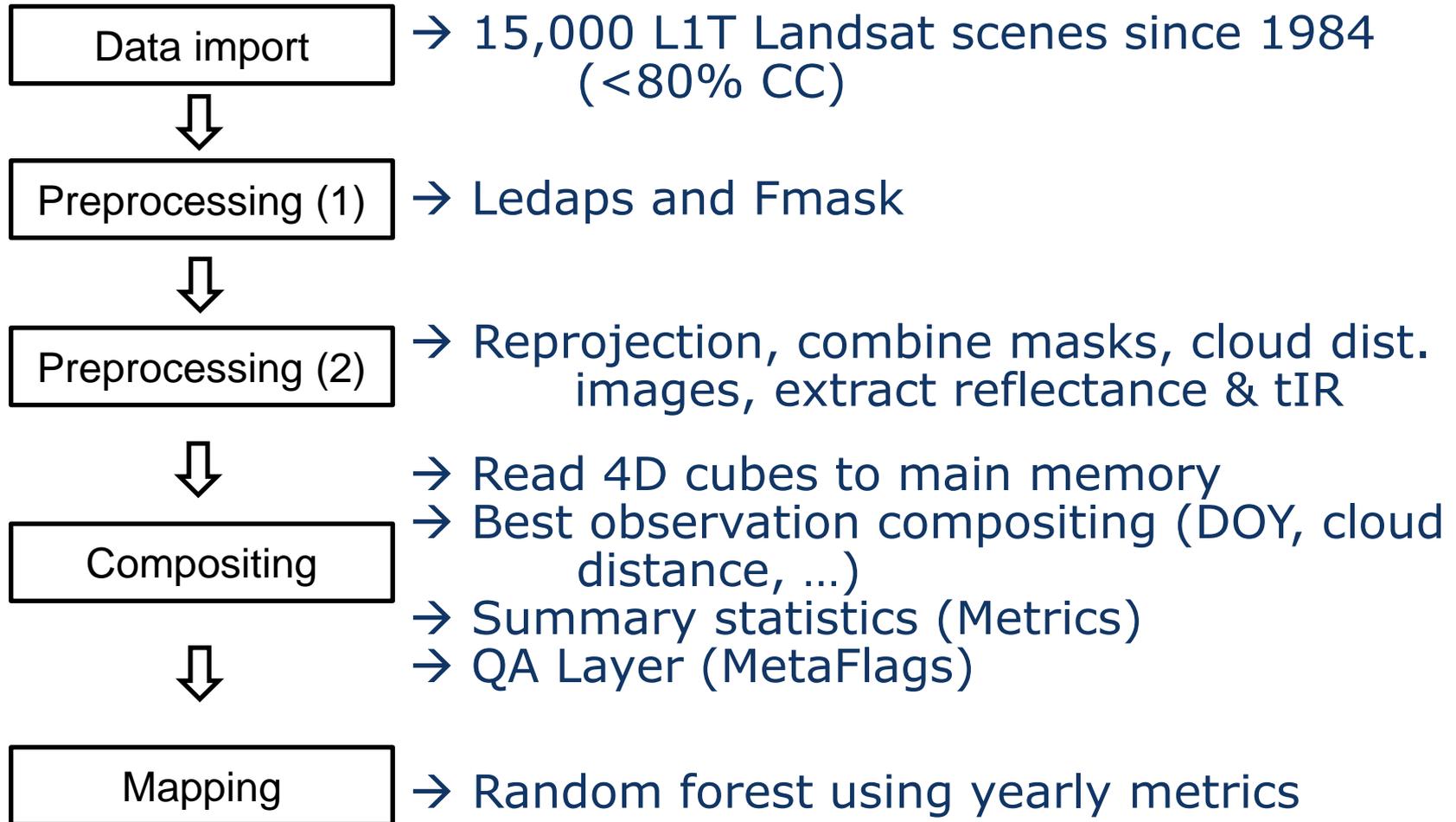
- Post-deforestation vegetation dynamics are complex and depend on growth rates and land management.



- Most tropical countries have larger areas of secondary forests than primary forests
- We need to better understand regrowth dynamics: carbon stocks, habitat analyses, land management optimization, ...

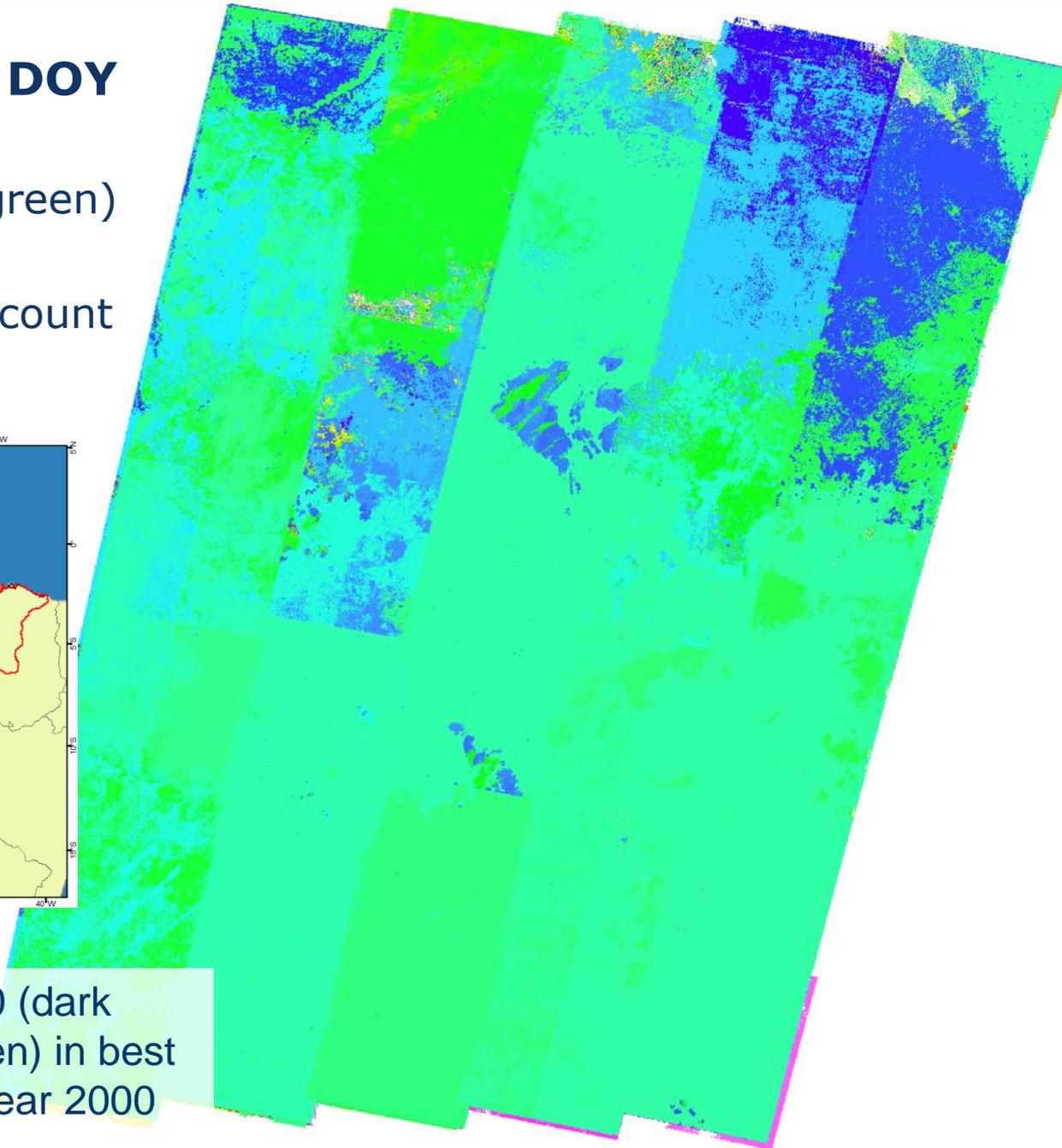
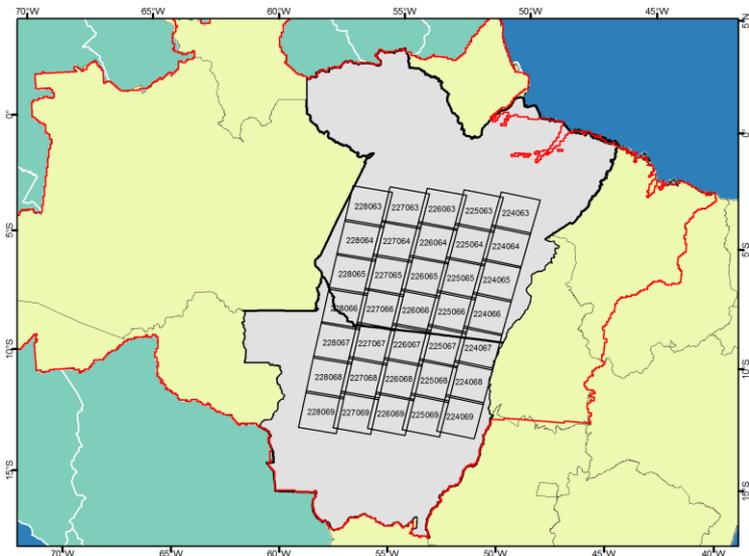


Processing workflow



Yearly compositing - DOY

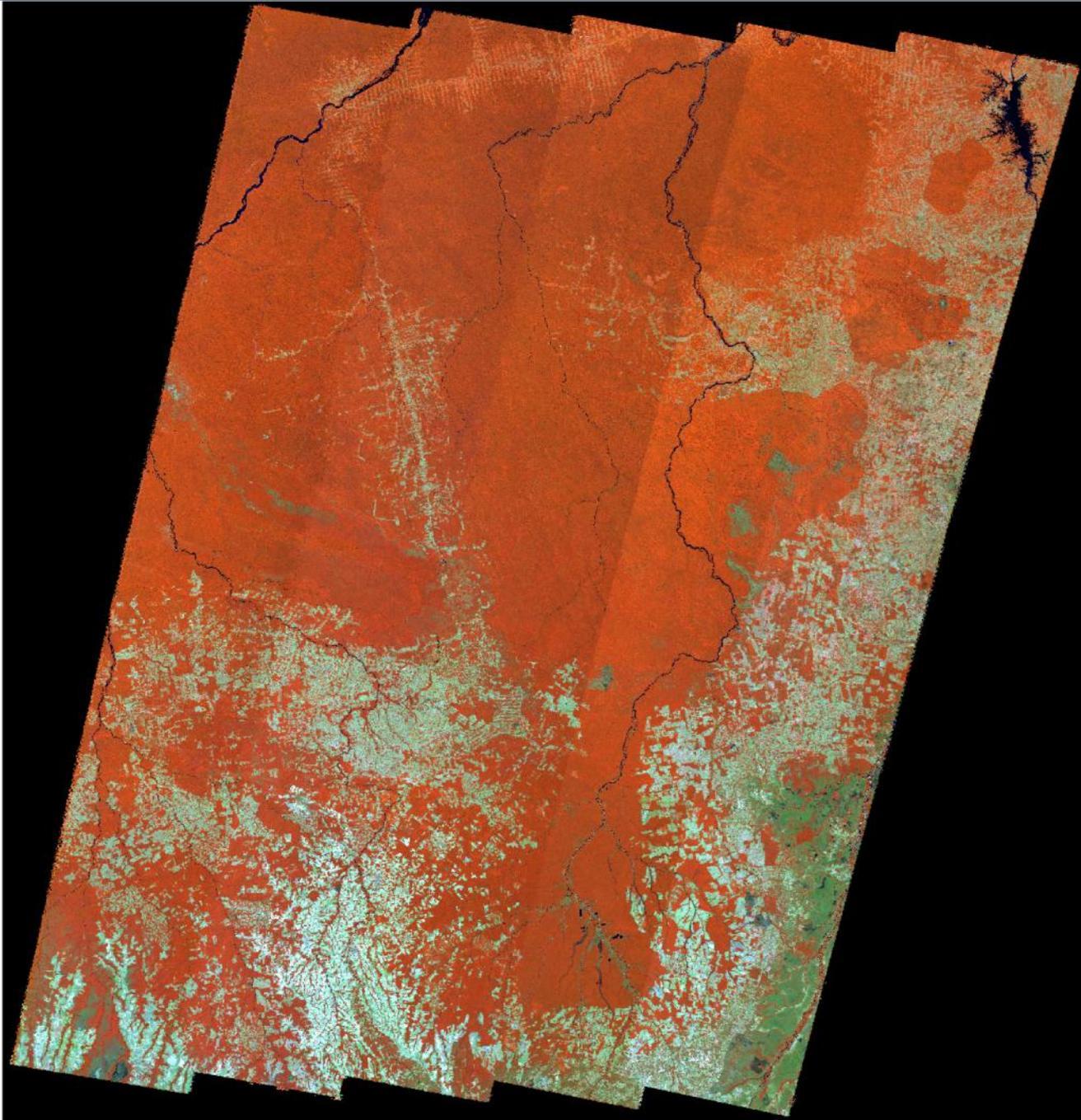
- Target DOY 213 (light green)
- Few no-data values
- Max. clear observation count for 2000: 31



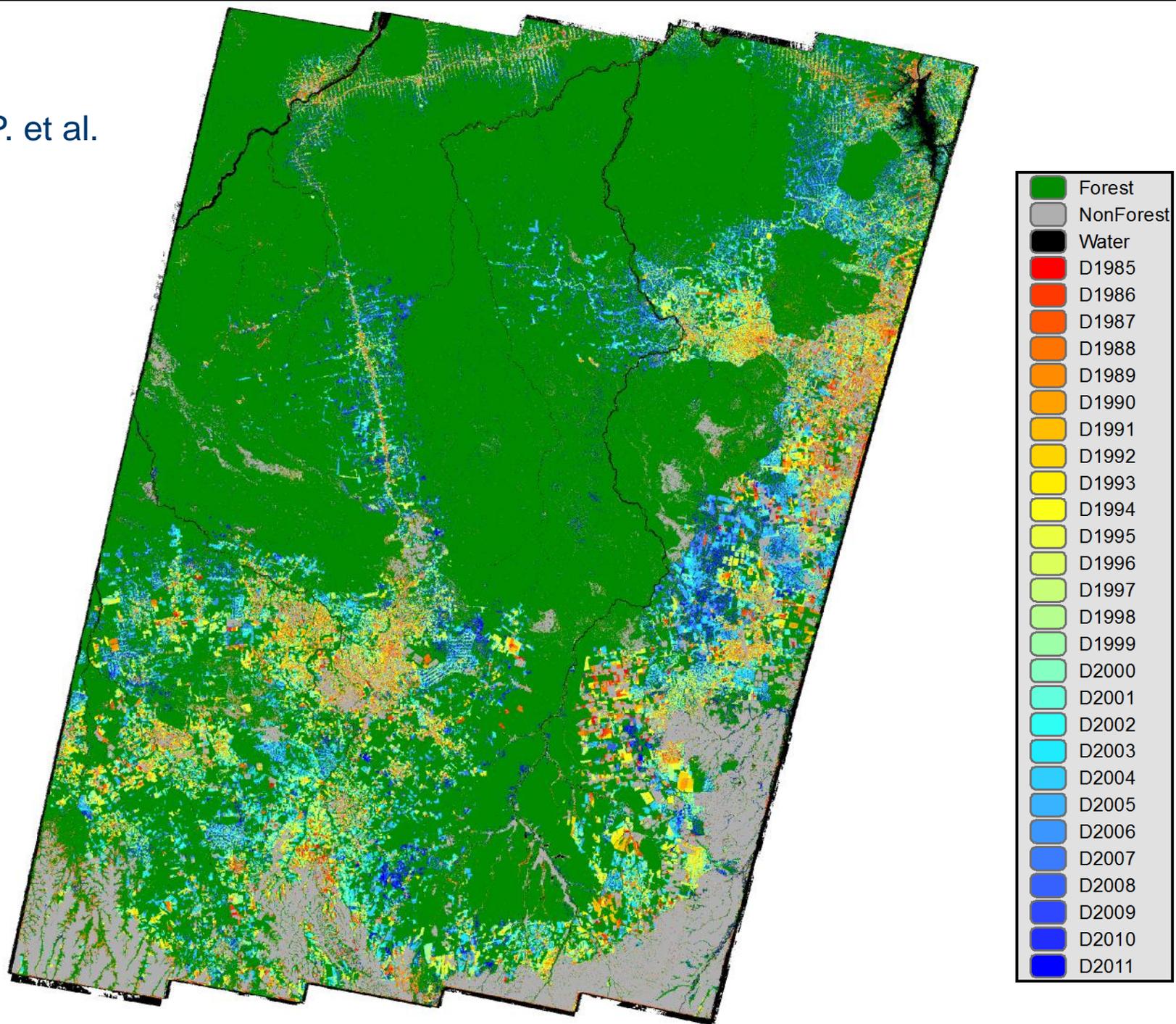
Observations from DOY 150 (dark blue) to DOY 240 (dark green) in best observation composite for year 2000

Yearly compositing (year 2000)

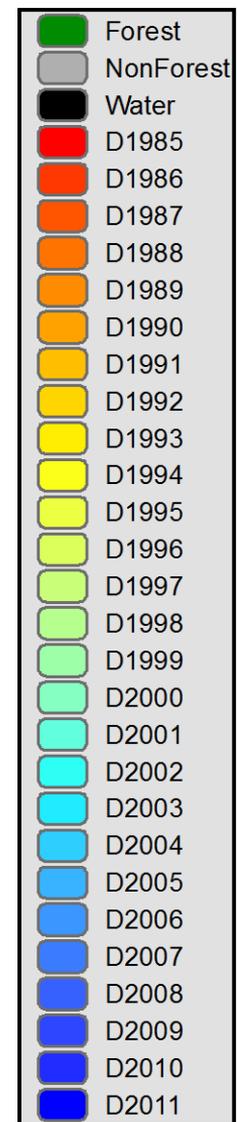
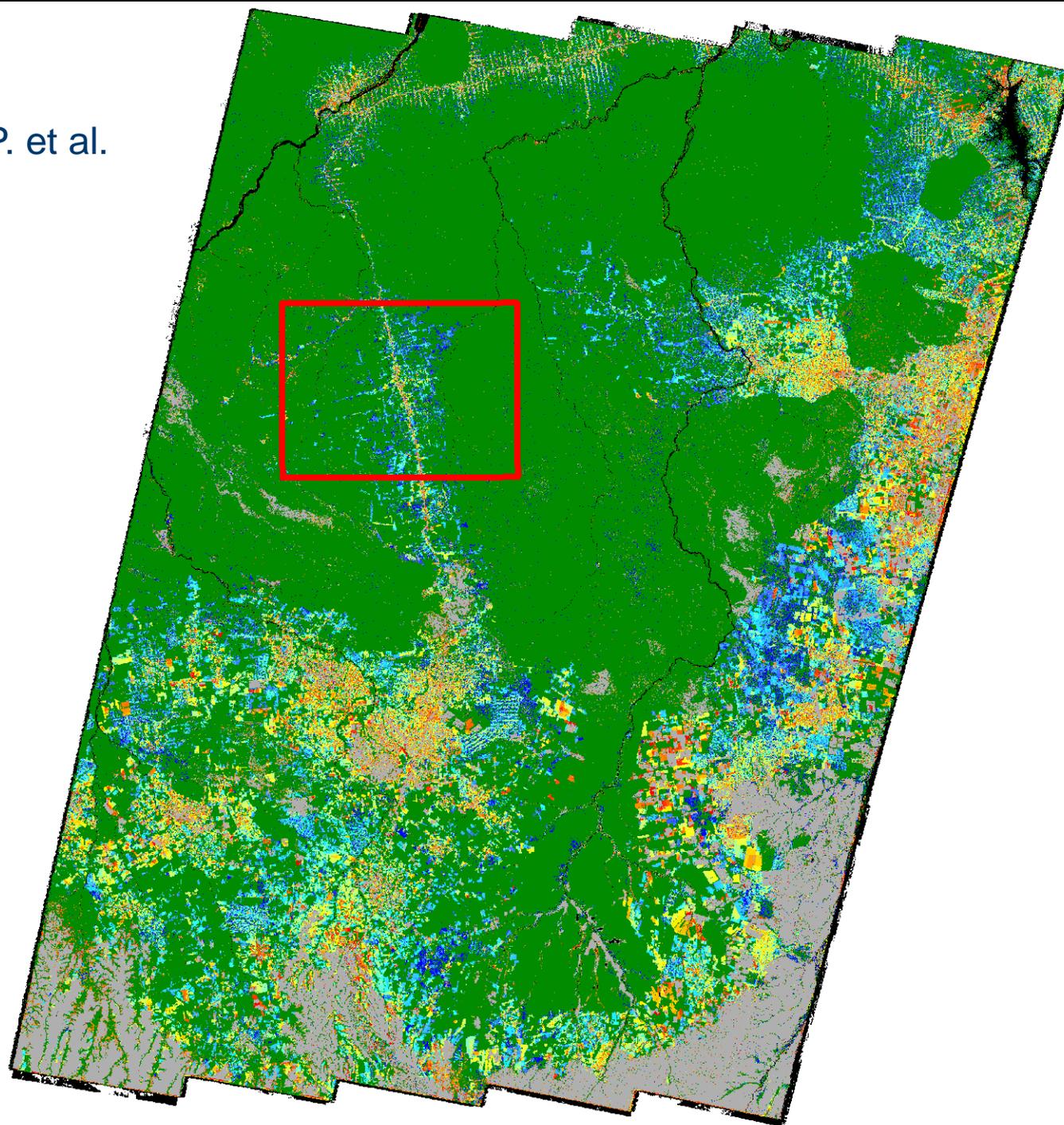
- Number of cloud free observations per year strongly decreases from S to N
- Data scarcity in the 1980s and 1990s (specifically close to the Amazon)



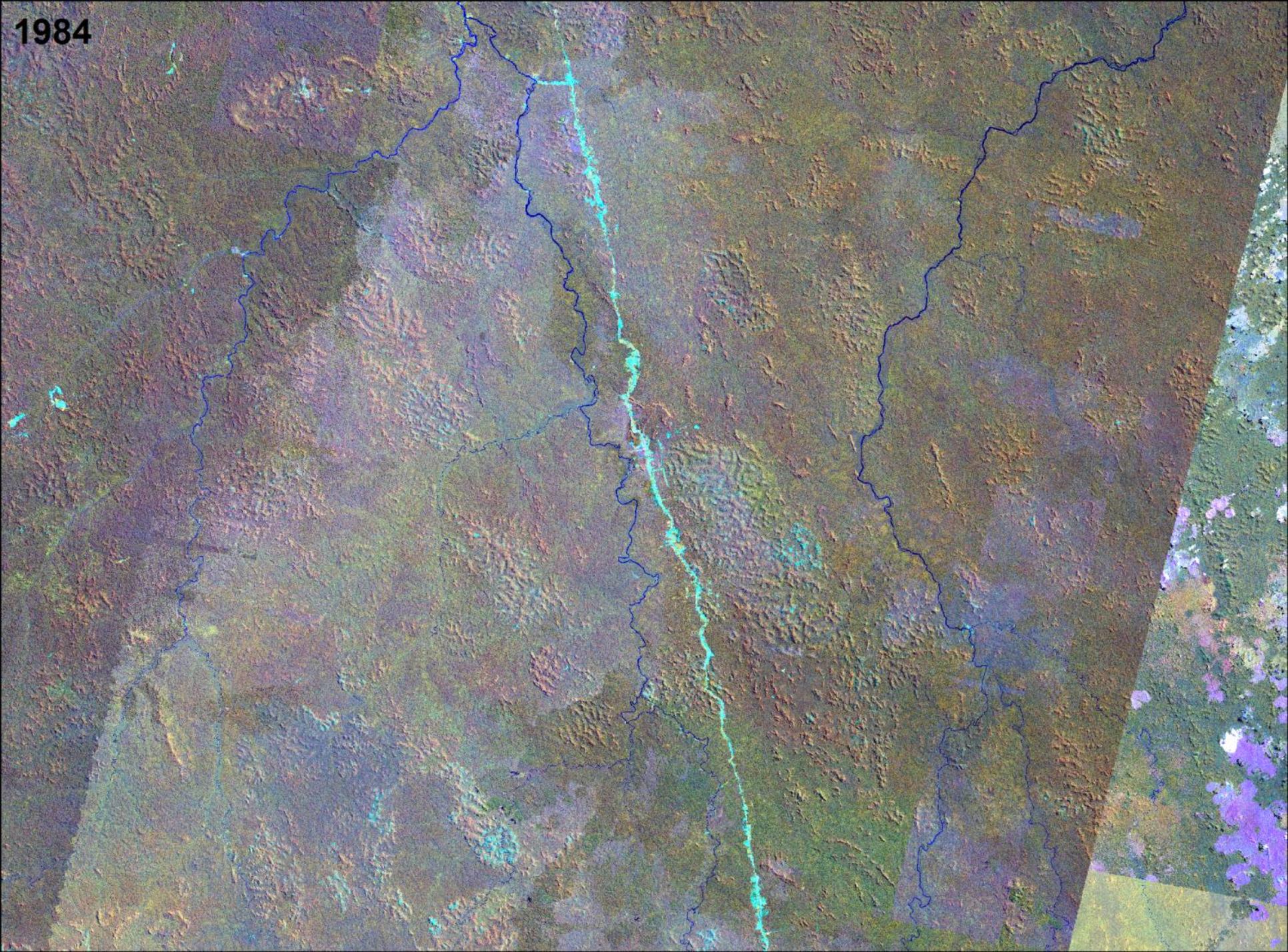
Griffiths, P. et al.
(in prep.)

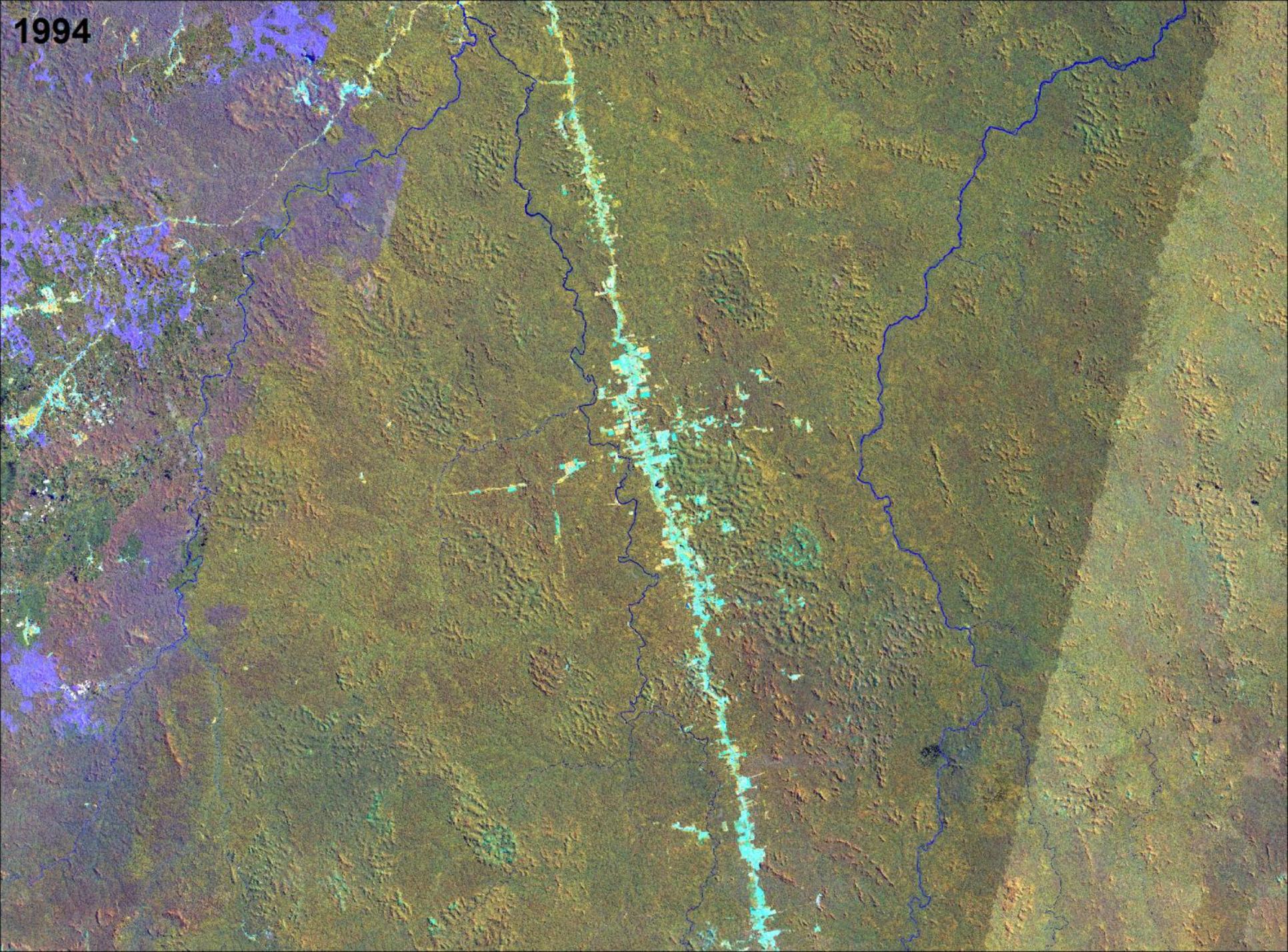


Griffiths, P. et al.
(in prep.)

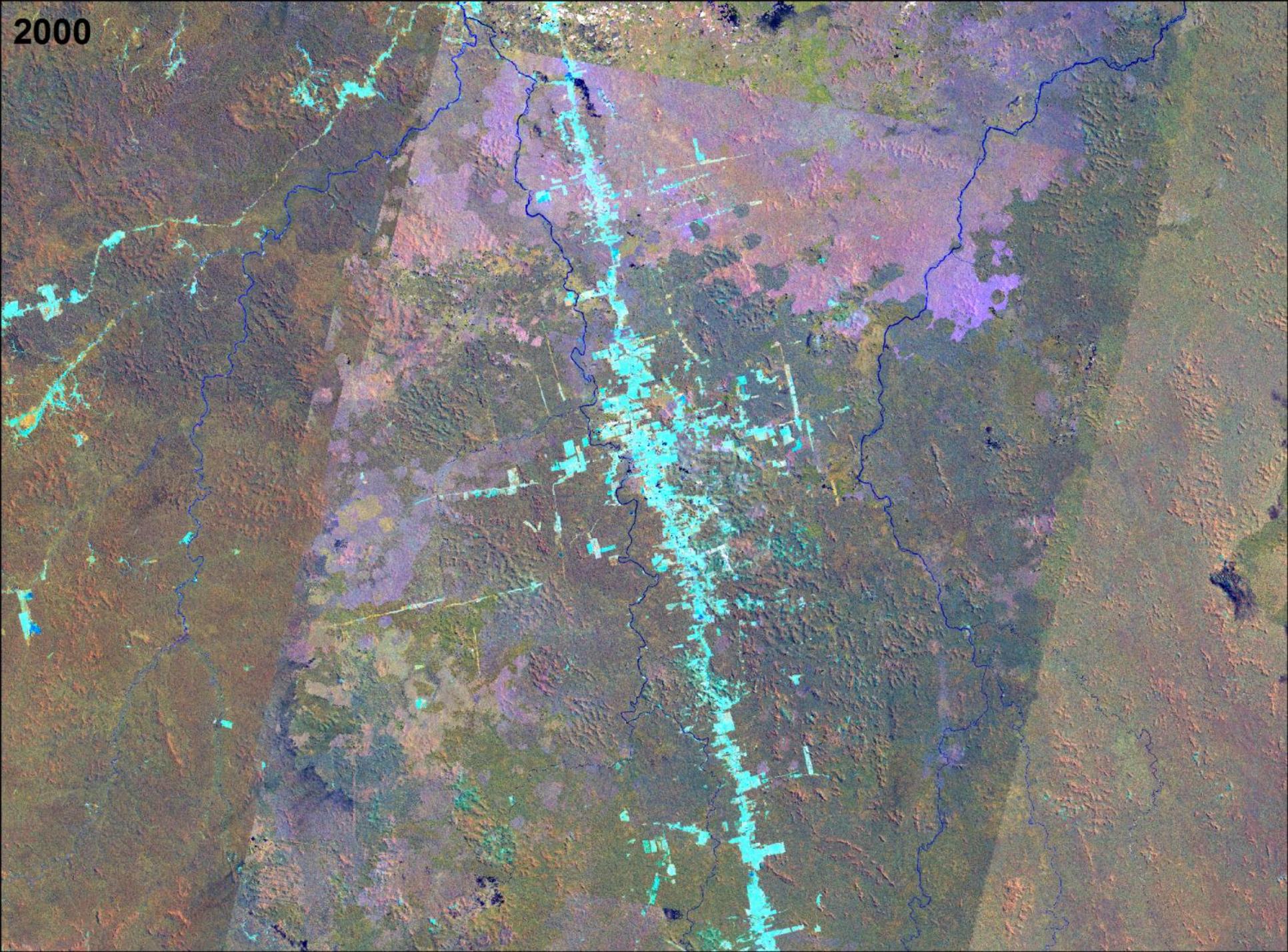


1984

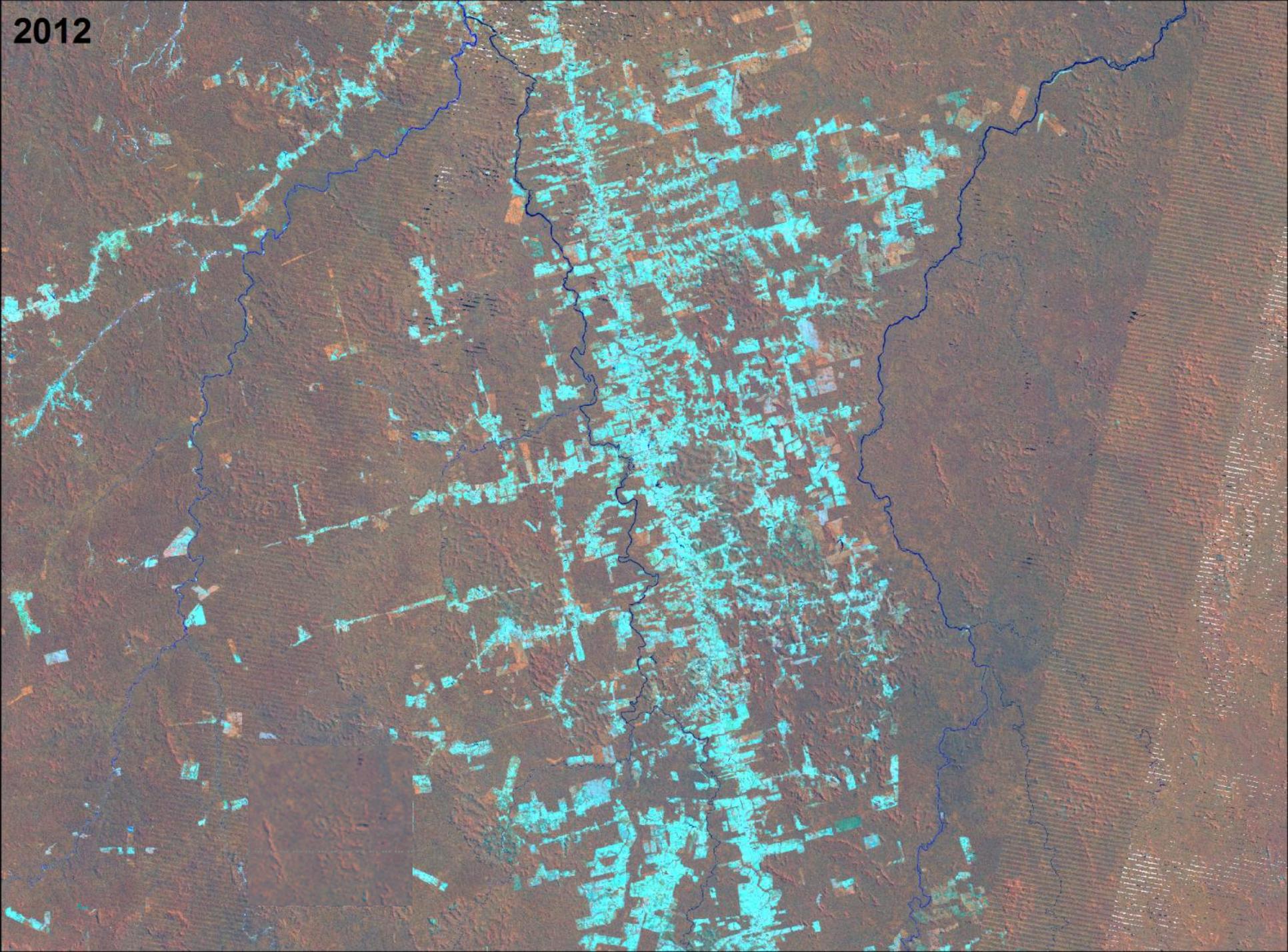




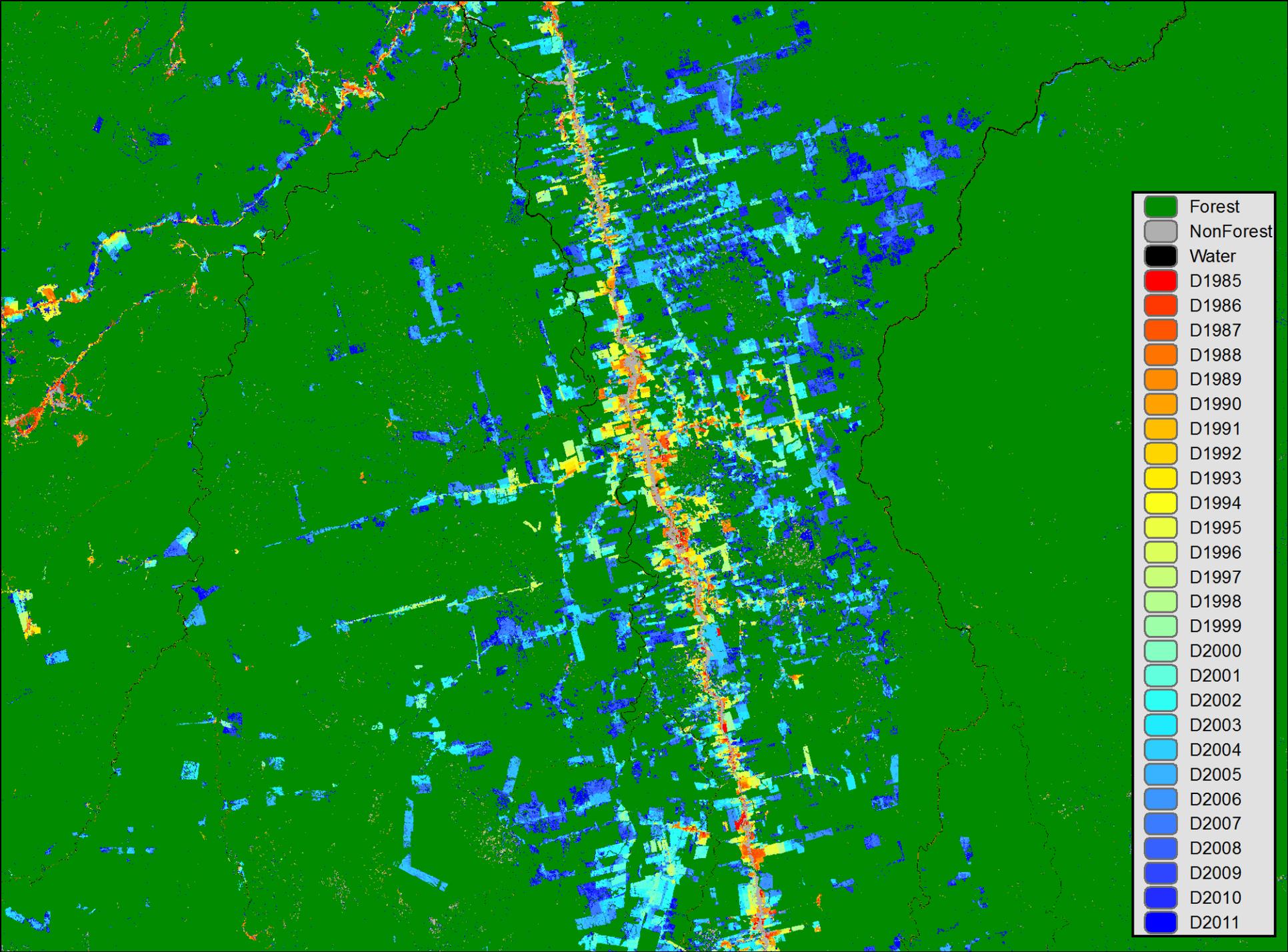
1994



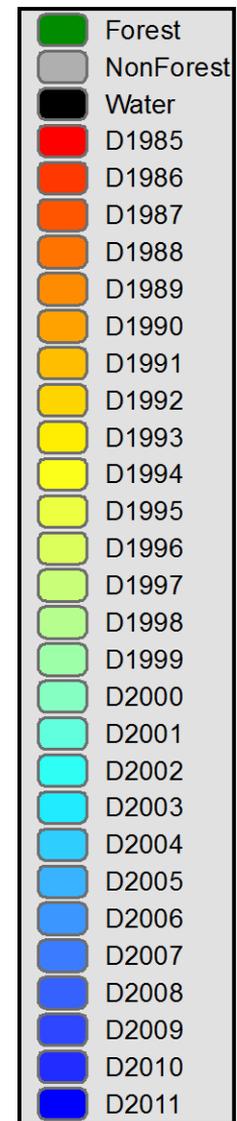
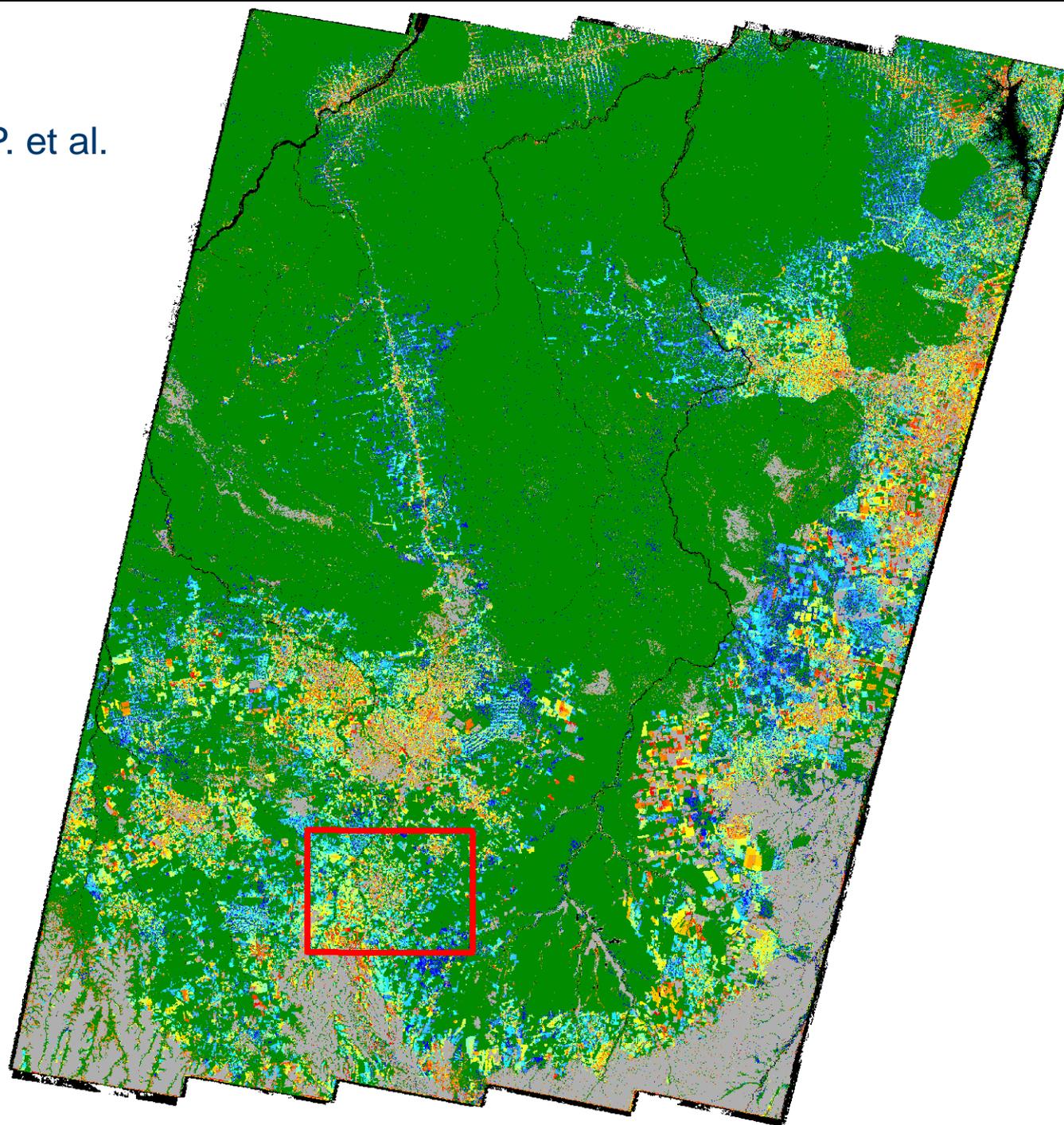
2000

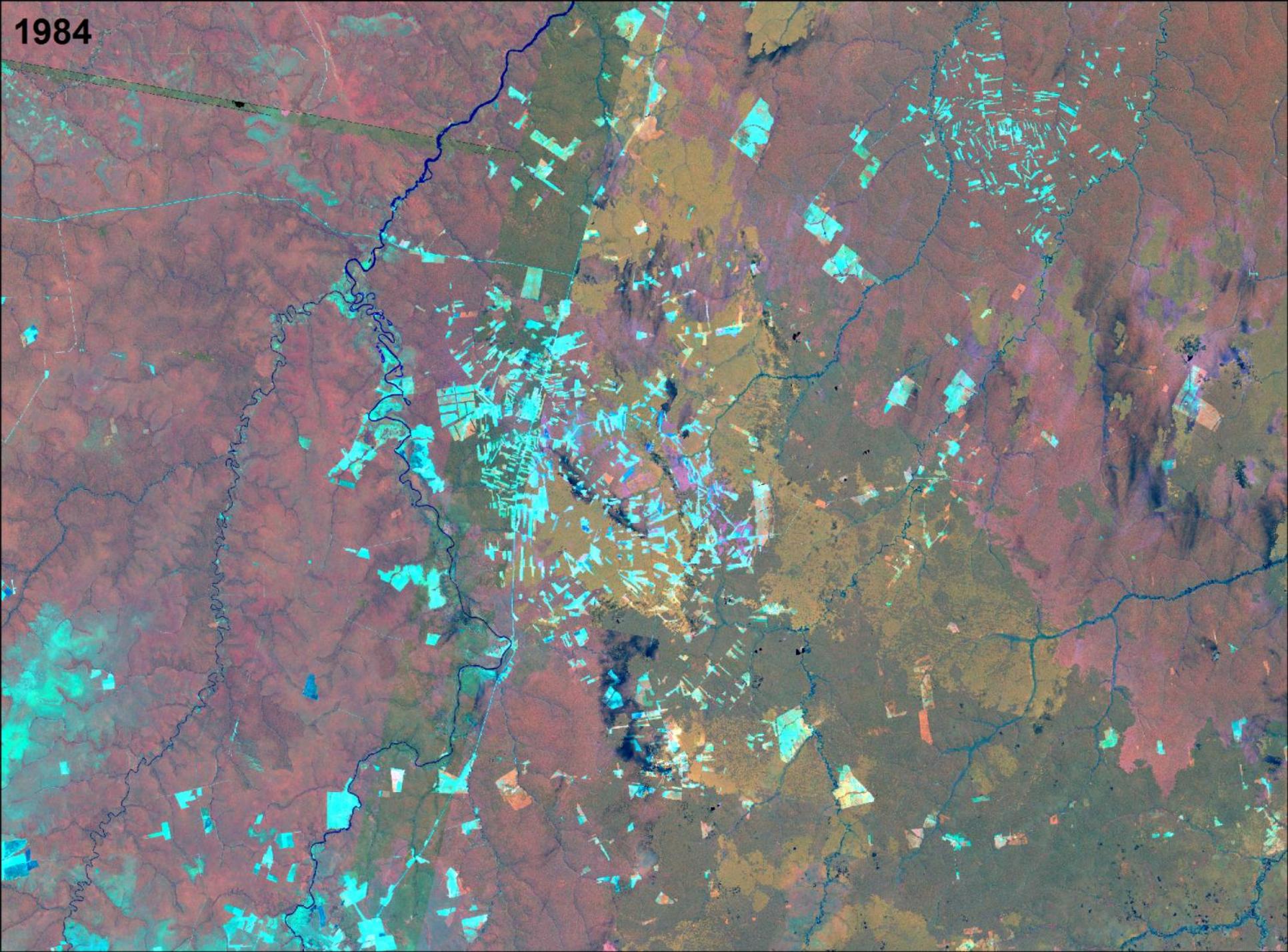


2012

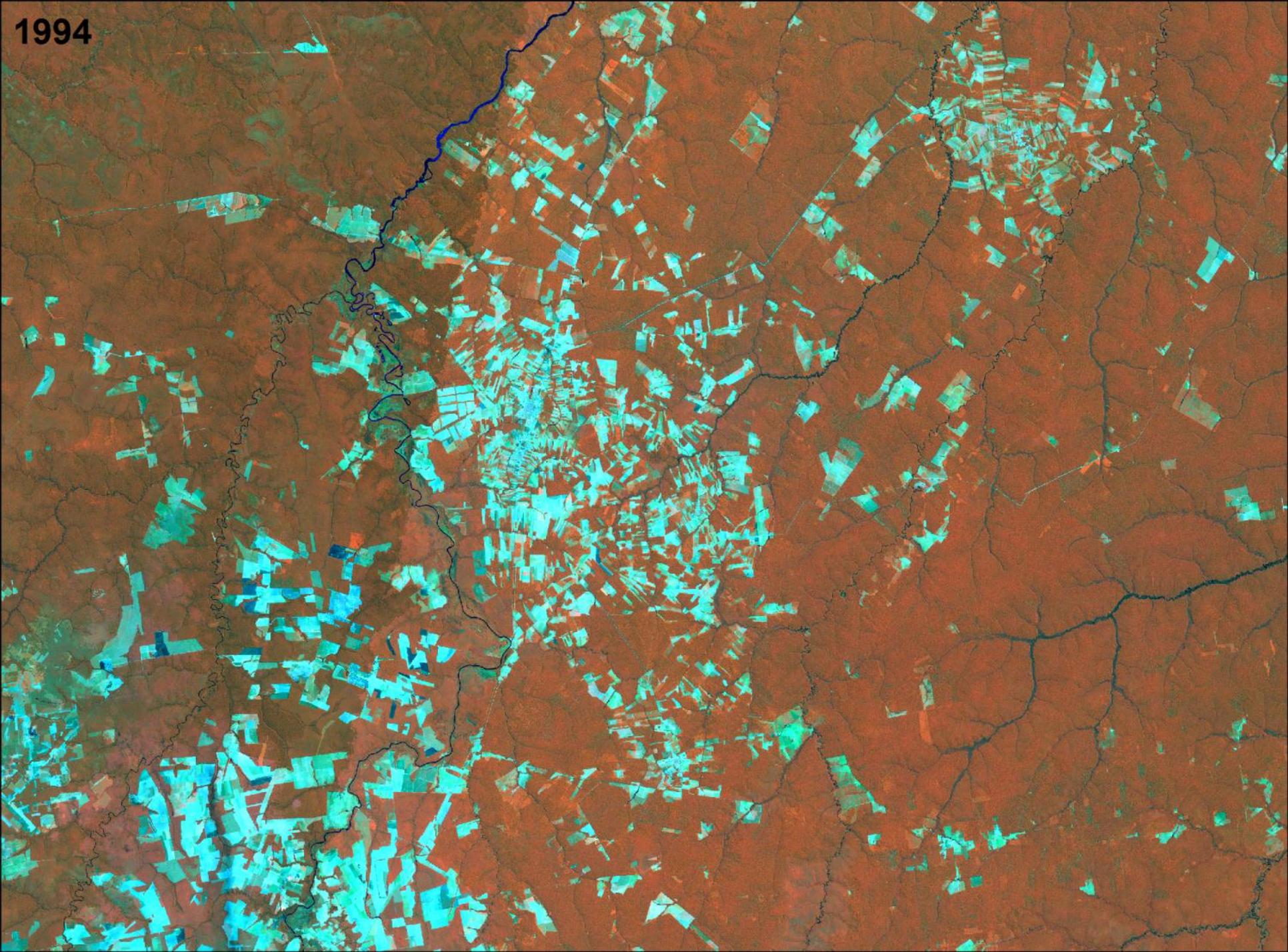


Griffiths, P. et al.
(in prep.)



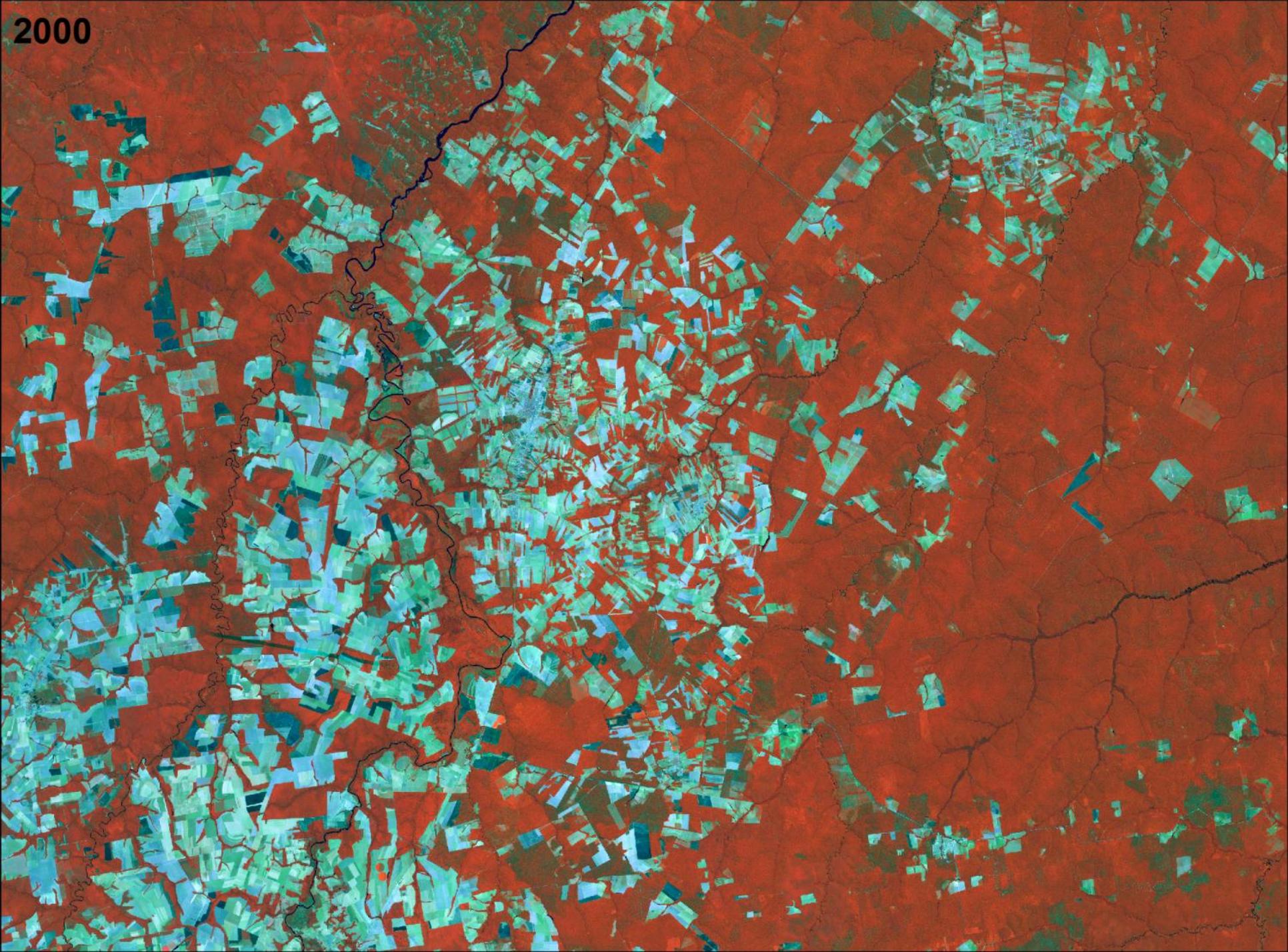


1984

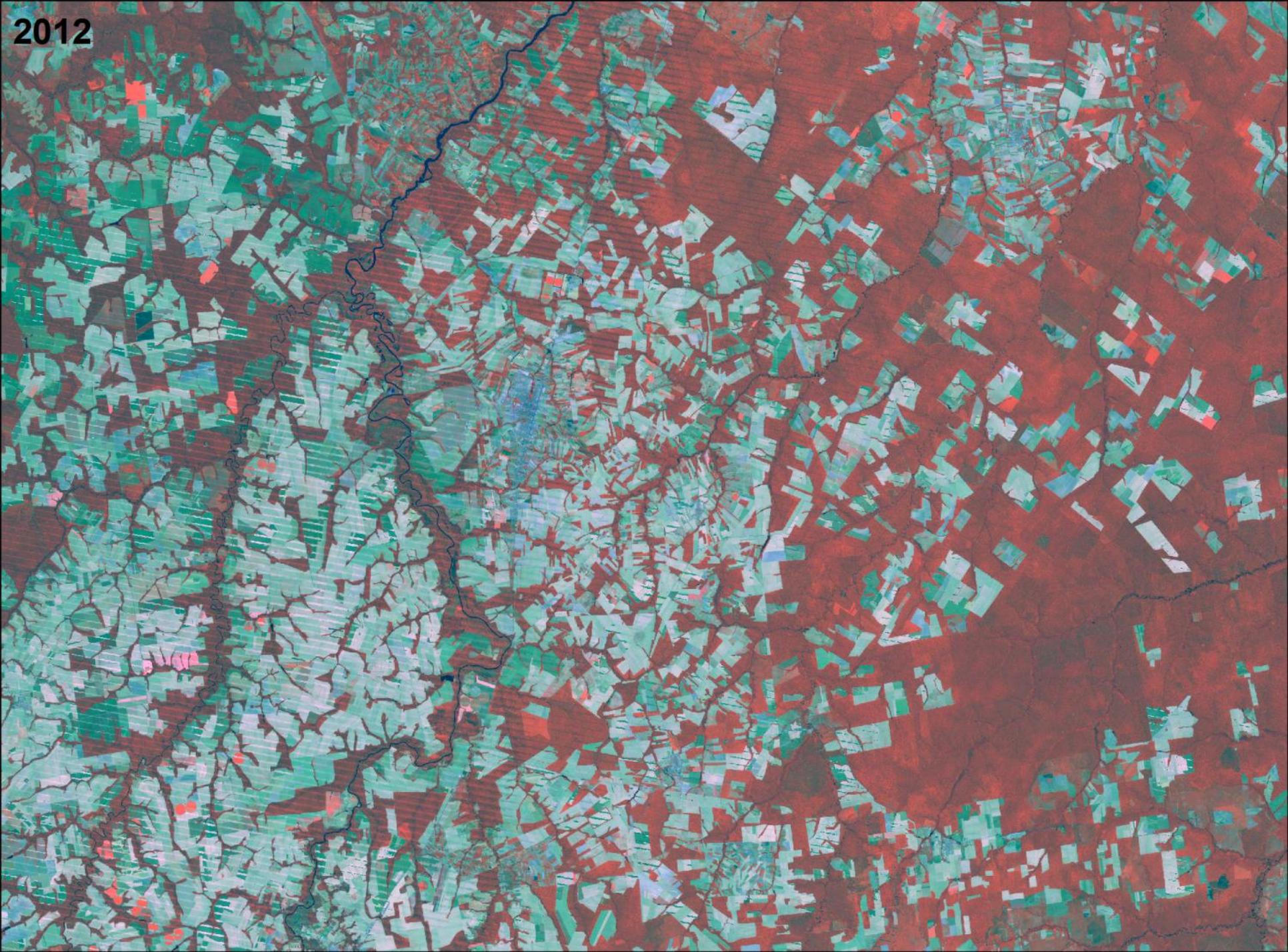


1994

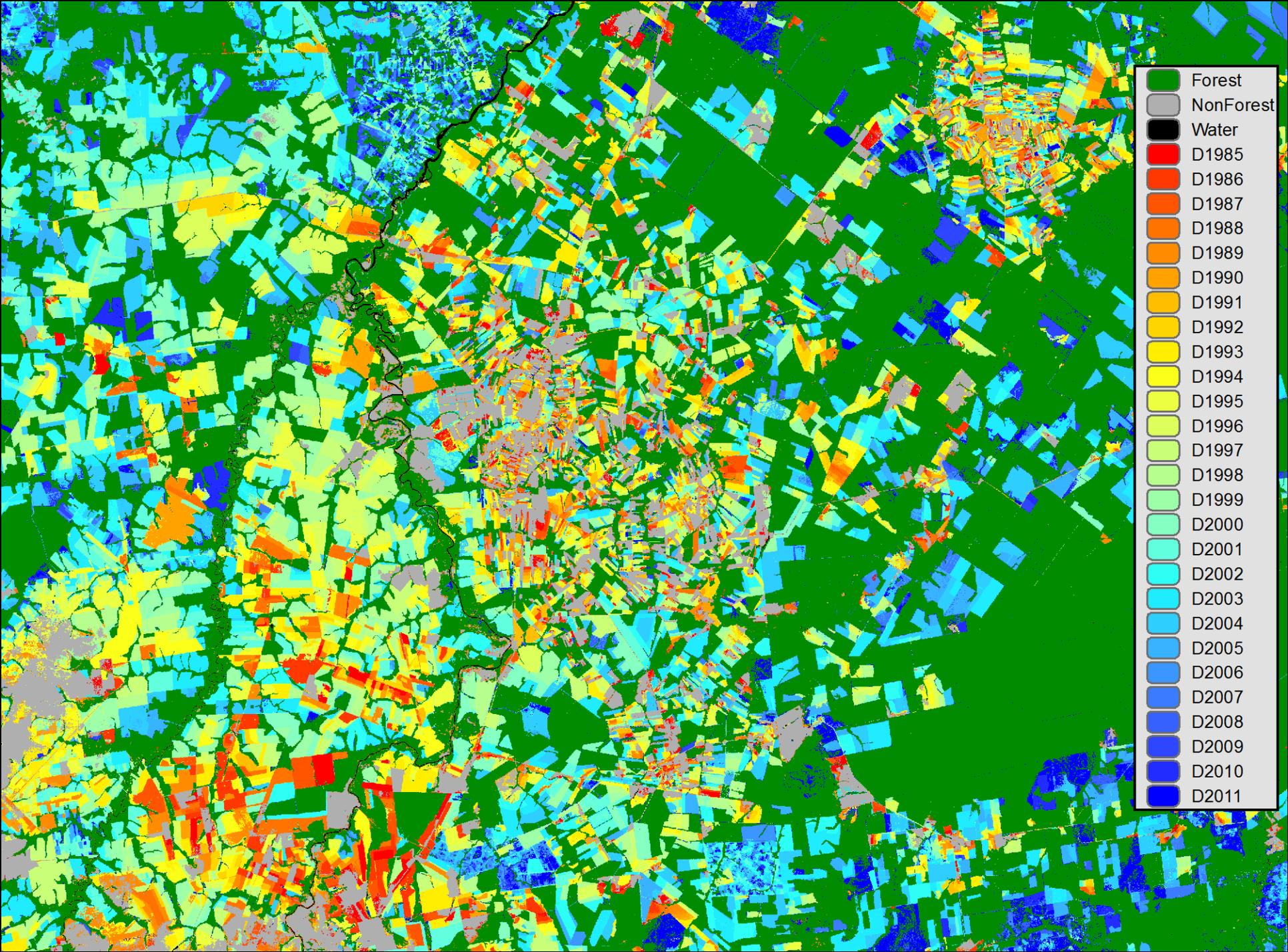
1500



2000



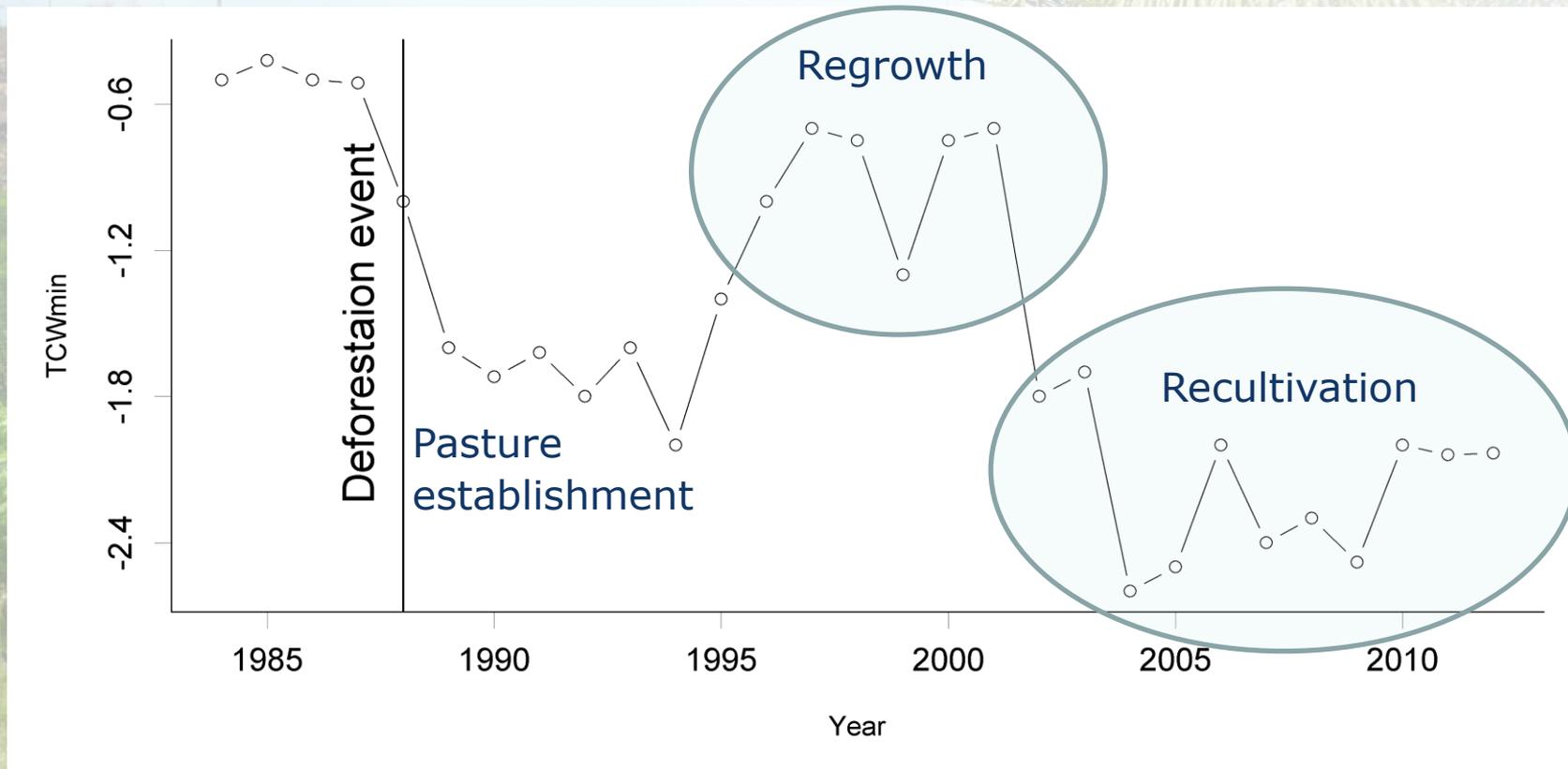
2012



- Forest
- NonForest
- Water
- D1985
- D1986
- D1987
- D1988
- D1989
- D1990
- D1991
- D1992
- D1993
- D1994
- D1995
- D1996
- D1997
- D1998
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- D2006
- D2007
- D2008
- D2009
- D2010
- D2011

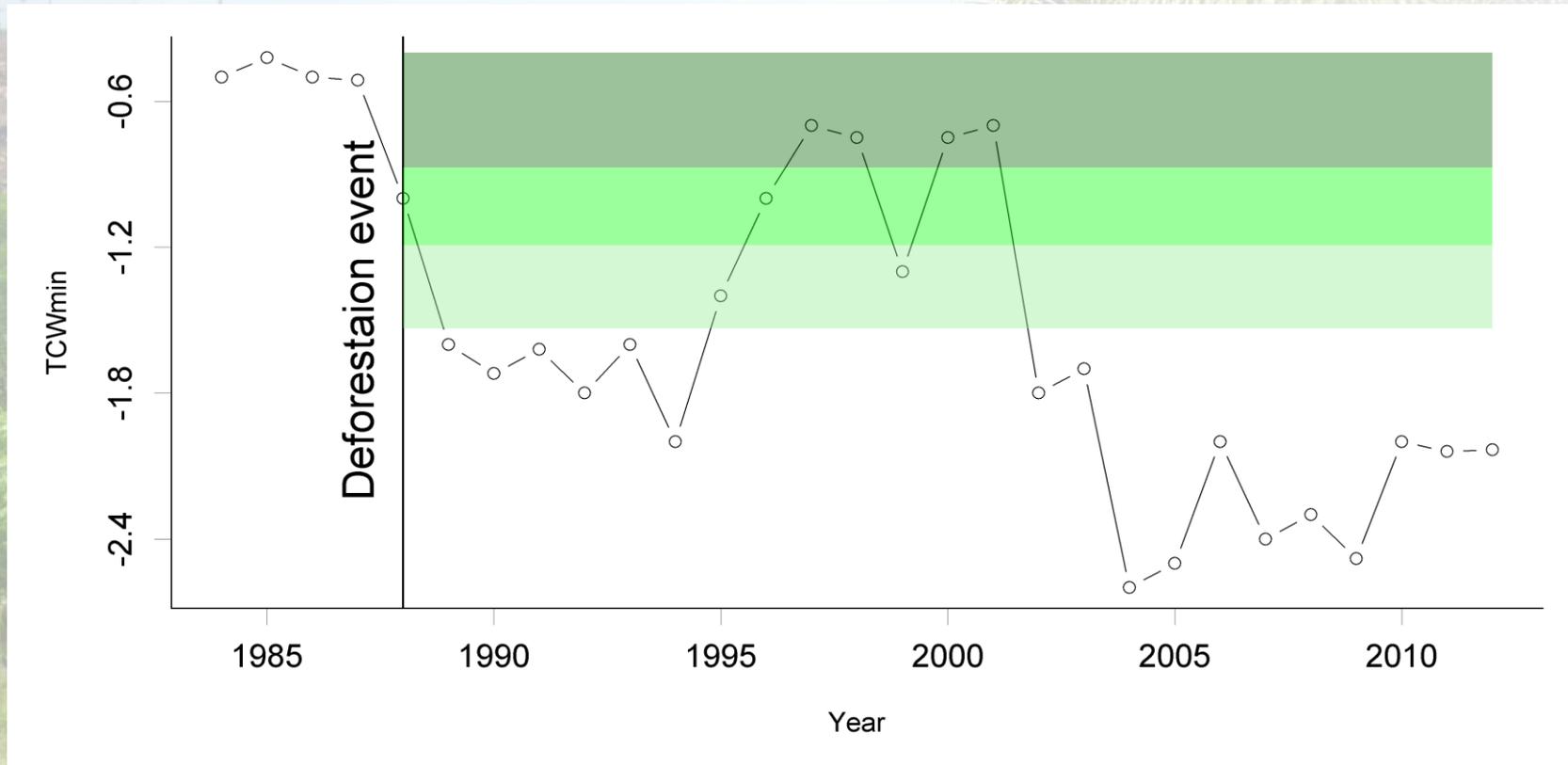
From multitemporal land cover to land use change

- Pixel based TCW_{min} as surrogate for vegetation density/coverage

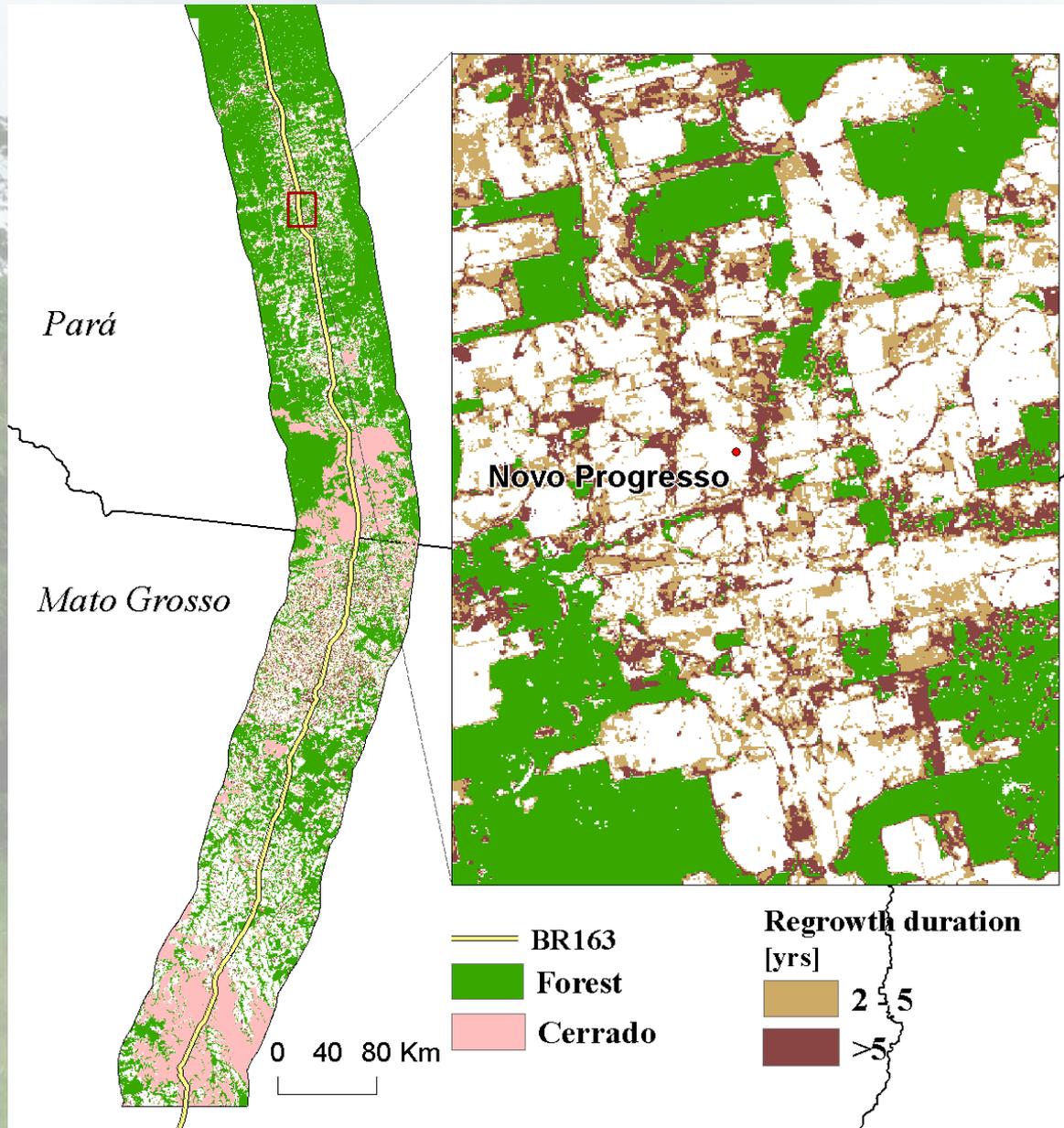


From multitemporal land cover to land use change

- TCW_{min} thresholding allows to include/exclude early stages of regrowth



- Needs to be fine-tuned based on field evidence



Secondary vegetation mapping

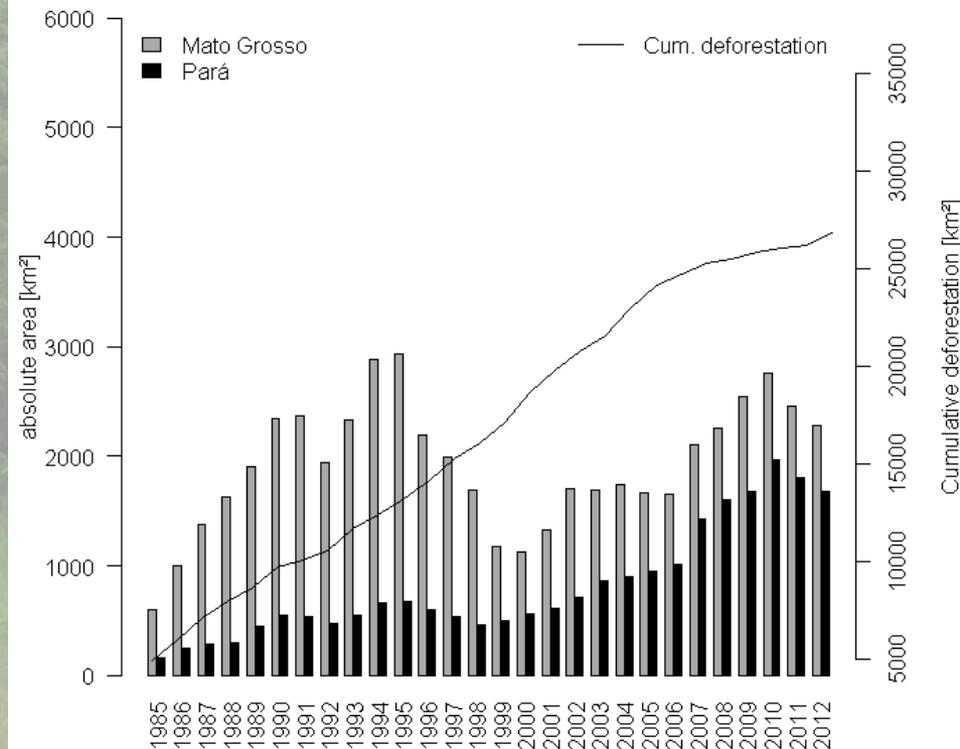
- Ca. 20% of the deforested area is covered by secondary vegetation after 2-3 years

Müller et al. (in prep)

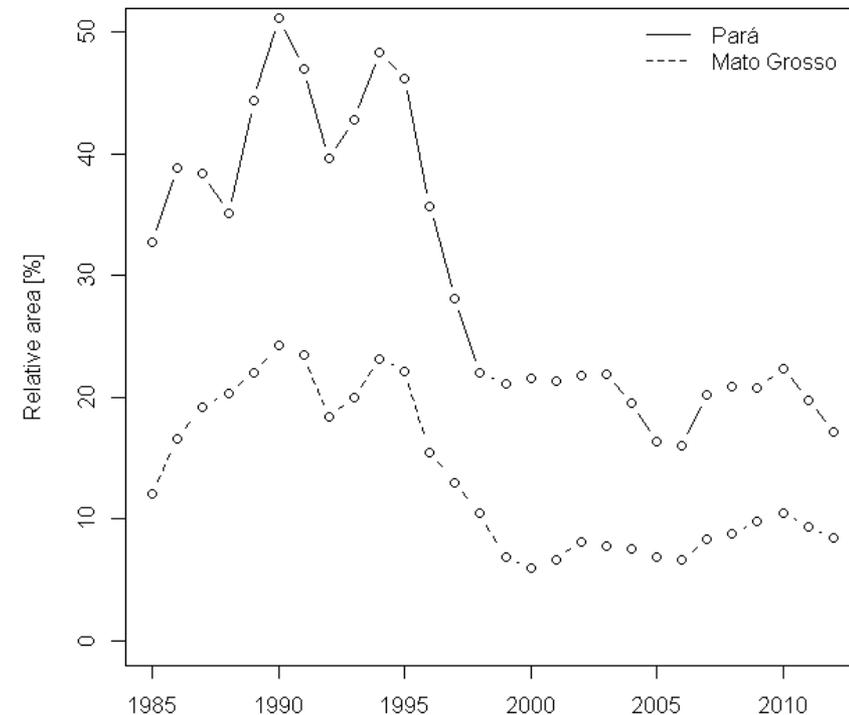
Secondary vegetation mapping

- Regrowth dynamics are an indicator of land use management intensity
- Relative regrowth rates e.g. decreased with soy boom in early 2000

Absolute area of Secondary Vegetation

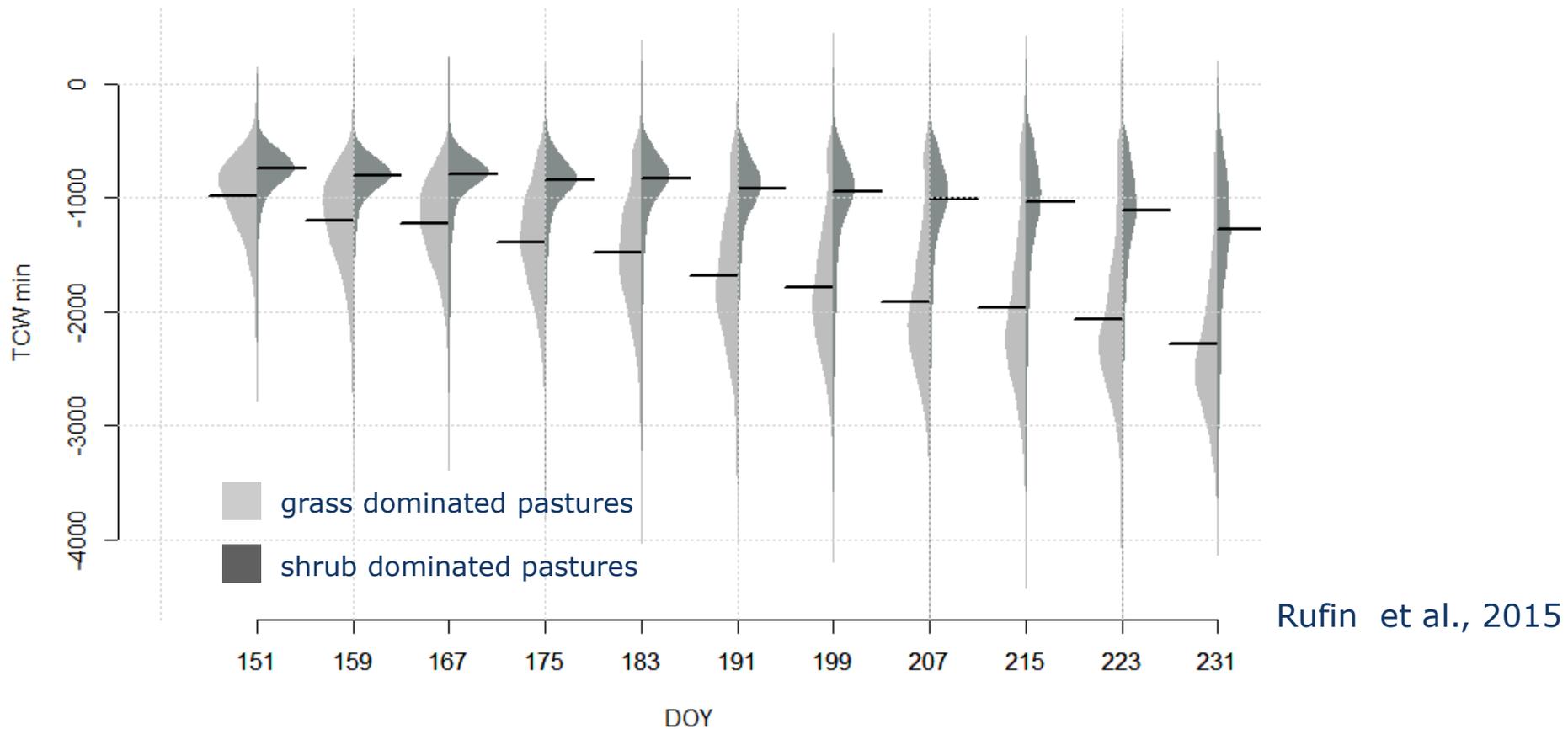


Sec. Veg. normalized to deforestation area



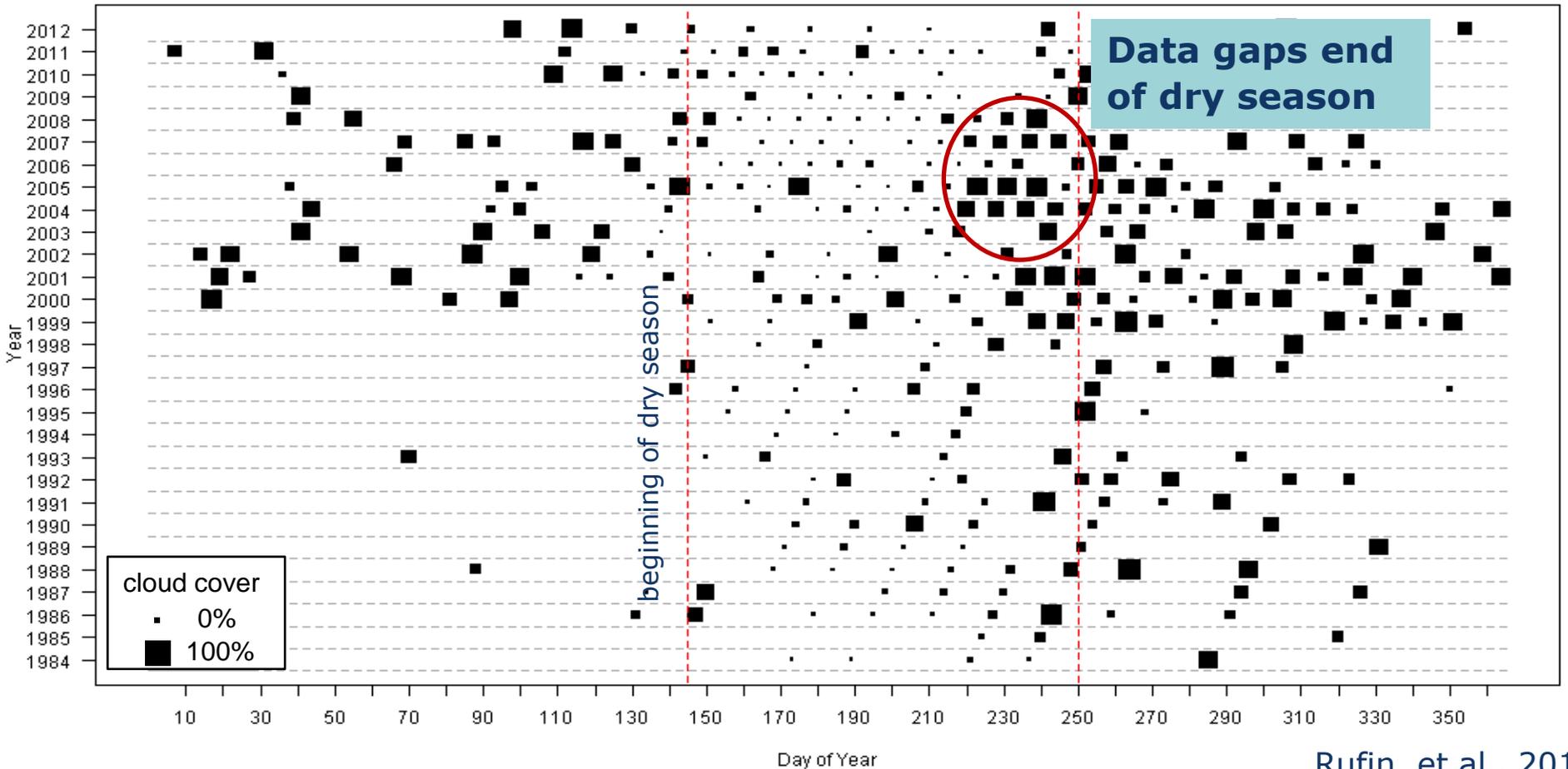
Sensitivity analysis

- Identification of deforestation and regrowth increases towards the end of the dry season (Day Of Year 231)



- End of dry season is critical for detecting deforestation and regrowth.

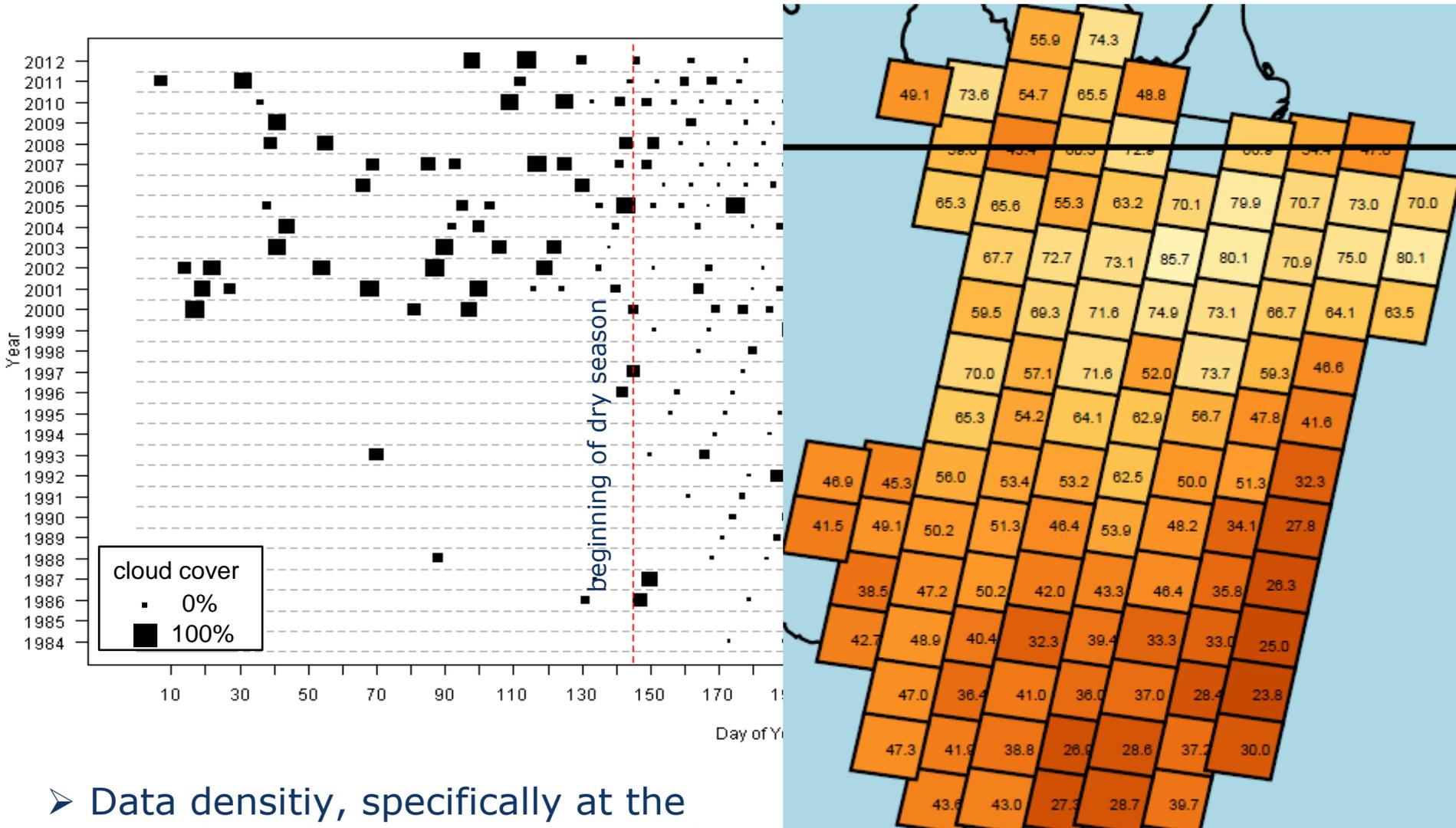
Sensitivity analysis



Rufin et al., 2015

Distribution of annual Landsat TM/ETM+ observations (227/65). Size of dots represents cloud cover. Red lines mark beginning and end of the dry season.

Sensitivity analysis



➤ Data density, specifically at the end of the dry season is critical for detecting deforestation and analyzing regrowth

Avg. cloud cover 2000
MT and PA states

Summary and outlook

- Compositing approach suited for annual deforestation analysis in Brazil since the 1980s
- Long time series allow inferring regrowth and secondary vegetation dynamics
- Regionalized biomass data needed (Mitchard et al. 2014)
- Higher acquisition frequency will further improve results -> Sentinel-2

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- German Federal Ministry for Economic Affairs and Energy (SenseCarbon; project no. 50EE1254)

A photograph showing three individuals in a field setting. One person is standing and leaning over a large satellite map spread out on a table. Two other people are seated at the table, looking at the map. The map displays a green and white pattern, likely representing vegetation and deforestation. The background shows a dirt path and some vegetation.

**Thanks -
questions?**

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