How Will Global Change Affect Tropical Forests?

Recent Findings and Debates

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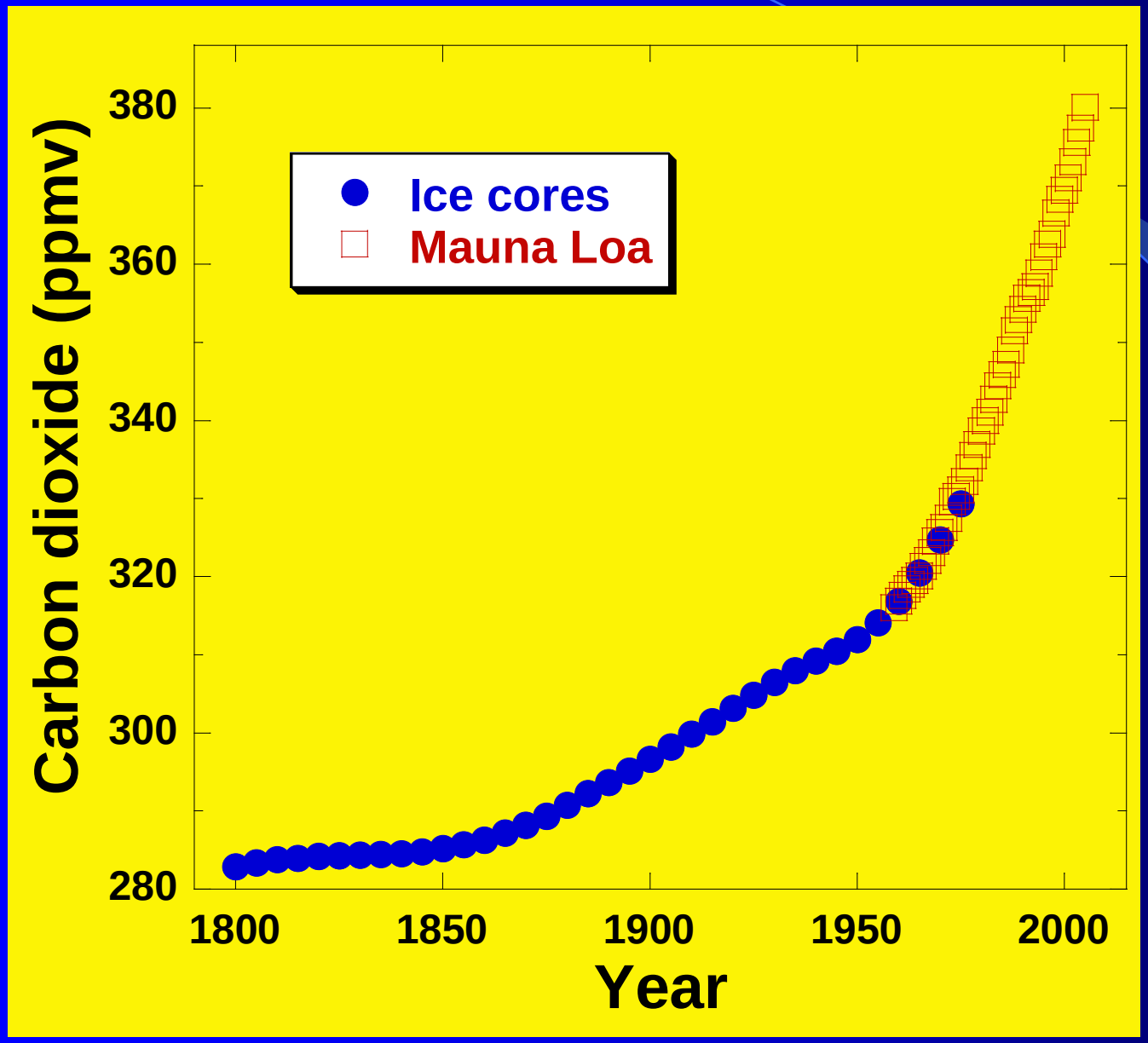
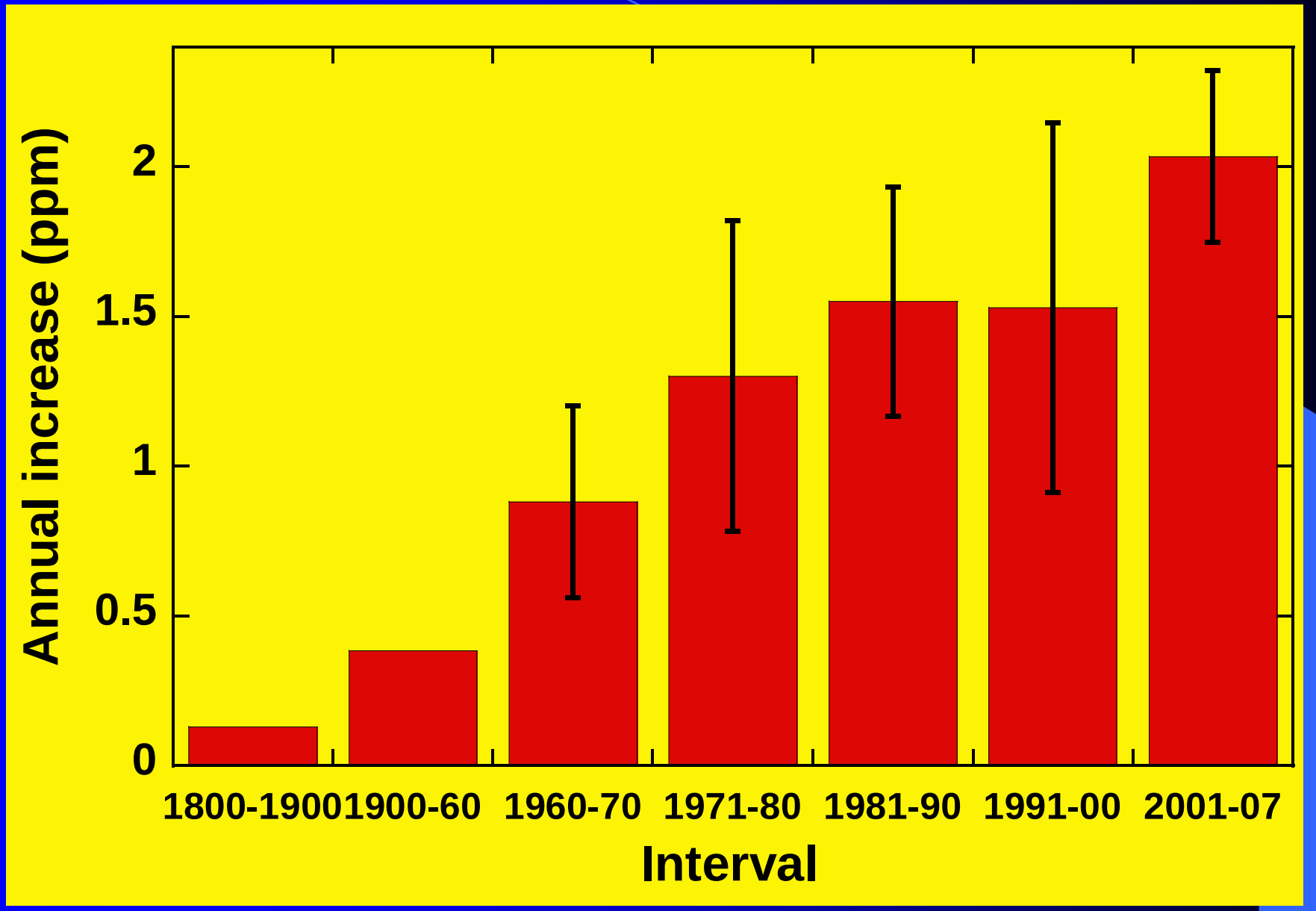
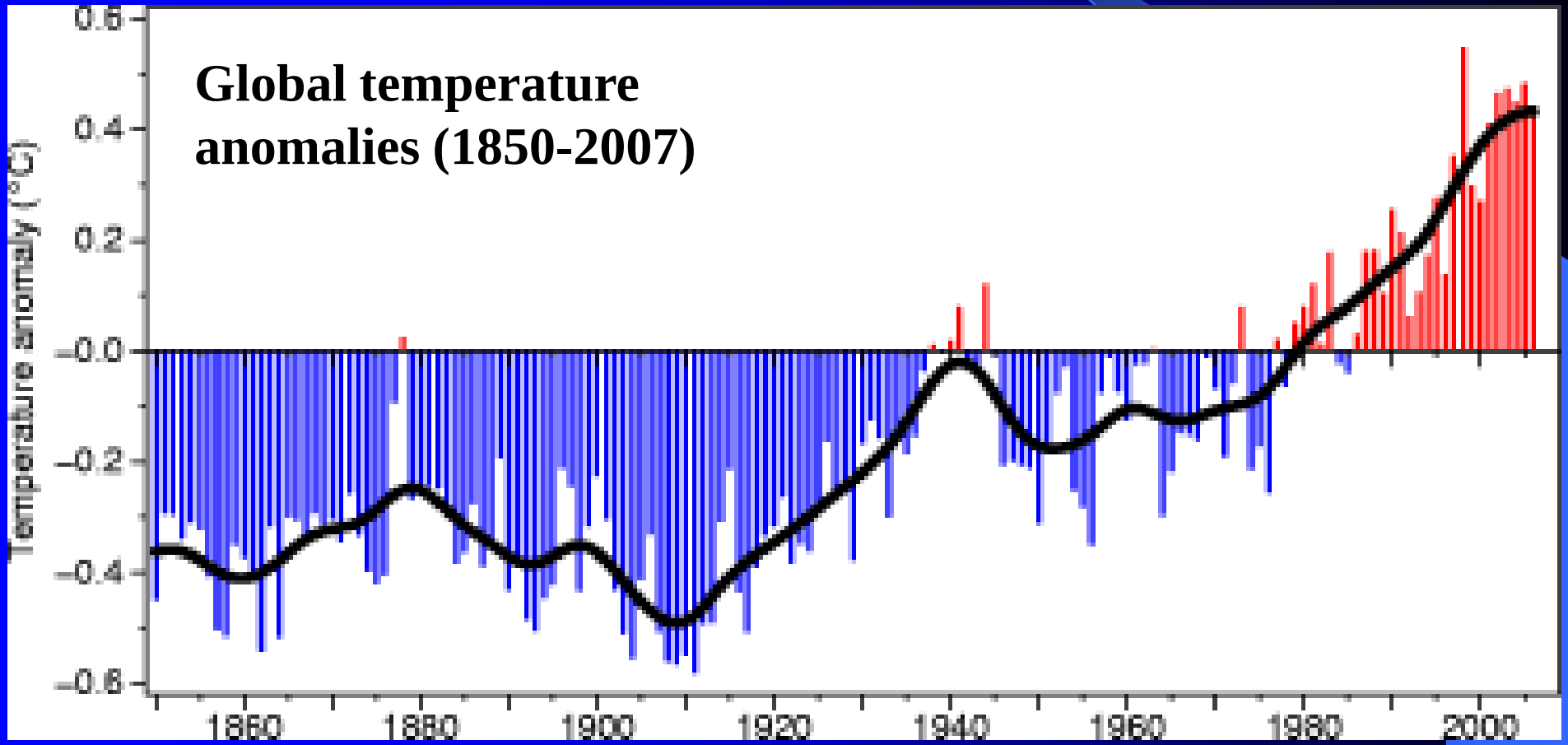
Rising CO_2 levels



CO_2 Increases are Accelerating

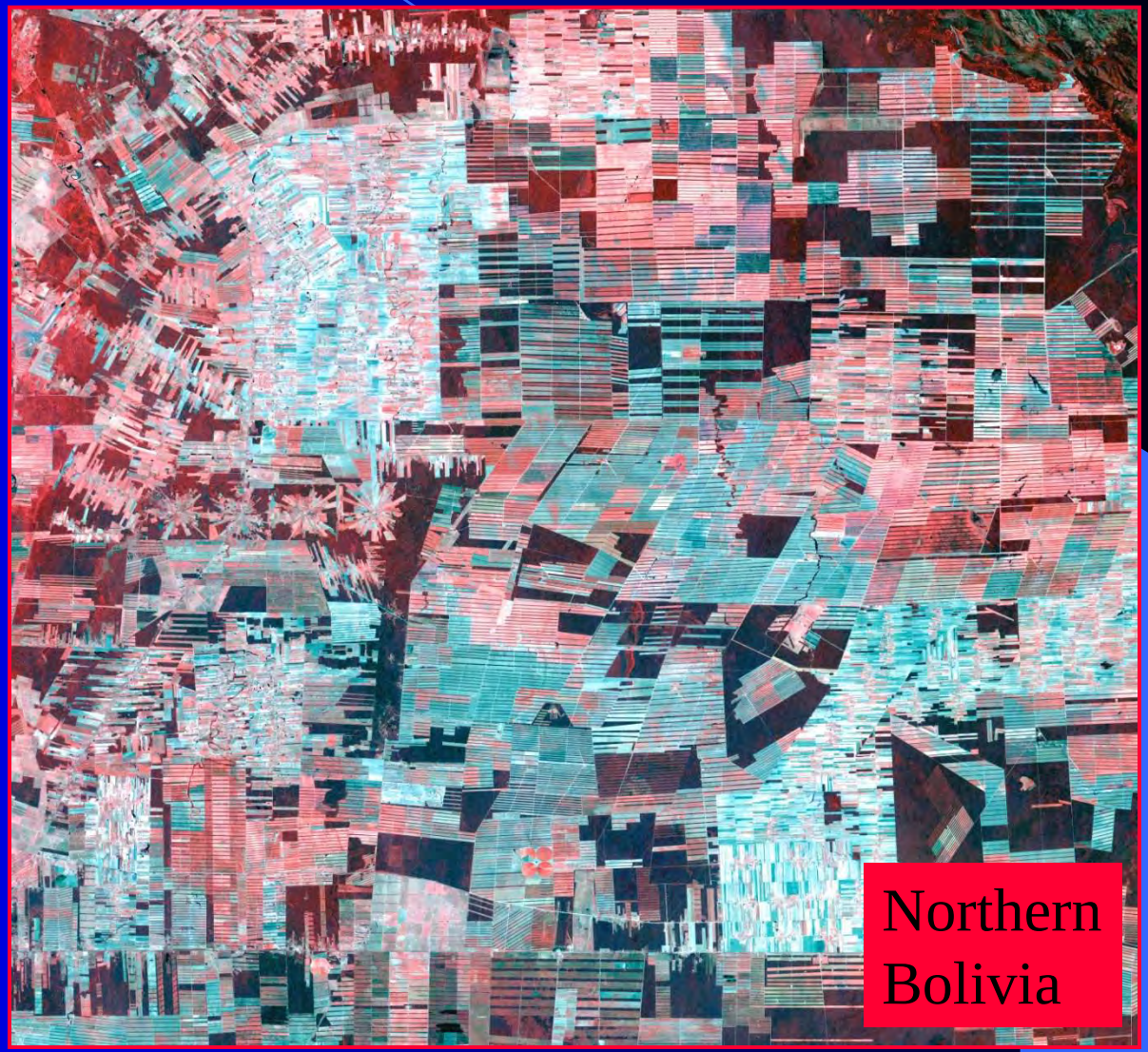


Rising Temperatures



Many Other Global- and Regional-scale Changes

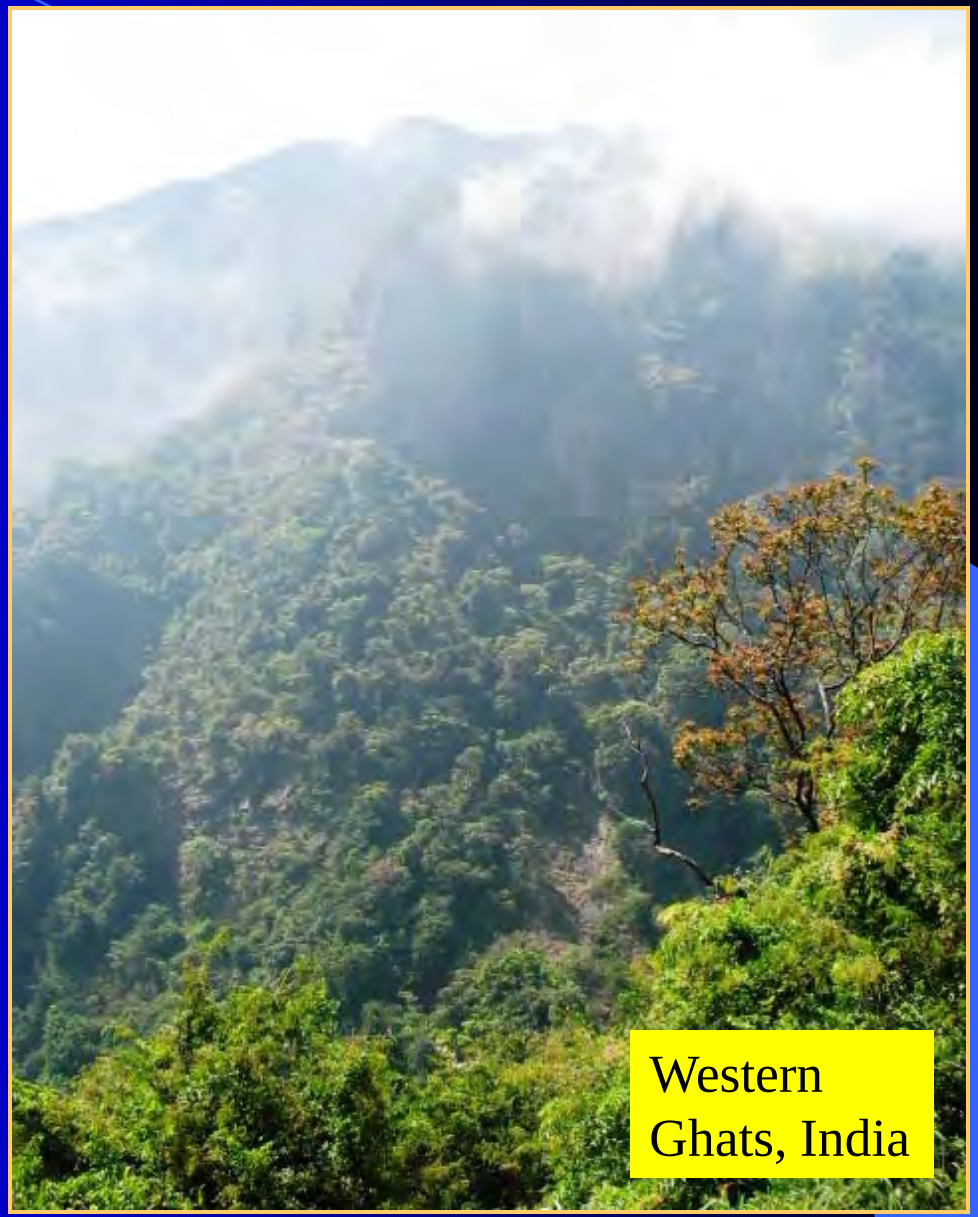
- Massive land-use changes
- Shifts in precipitation
- Changes in cloudiness and insolation
- Increased nutrient deposition
- Air and water pollution
- Legacy of past disturbances



Known or Hypothesized Effects of Rising Temperatures

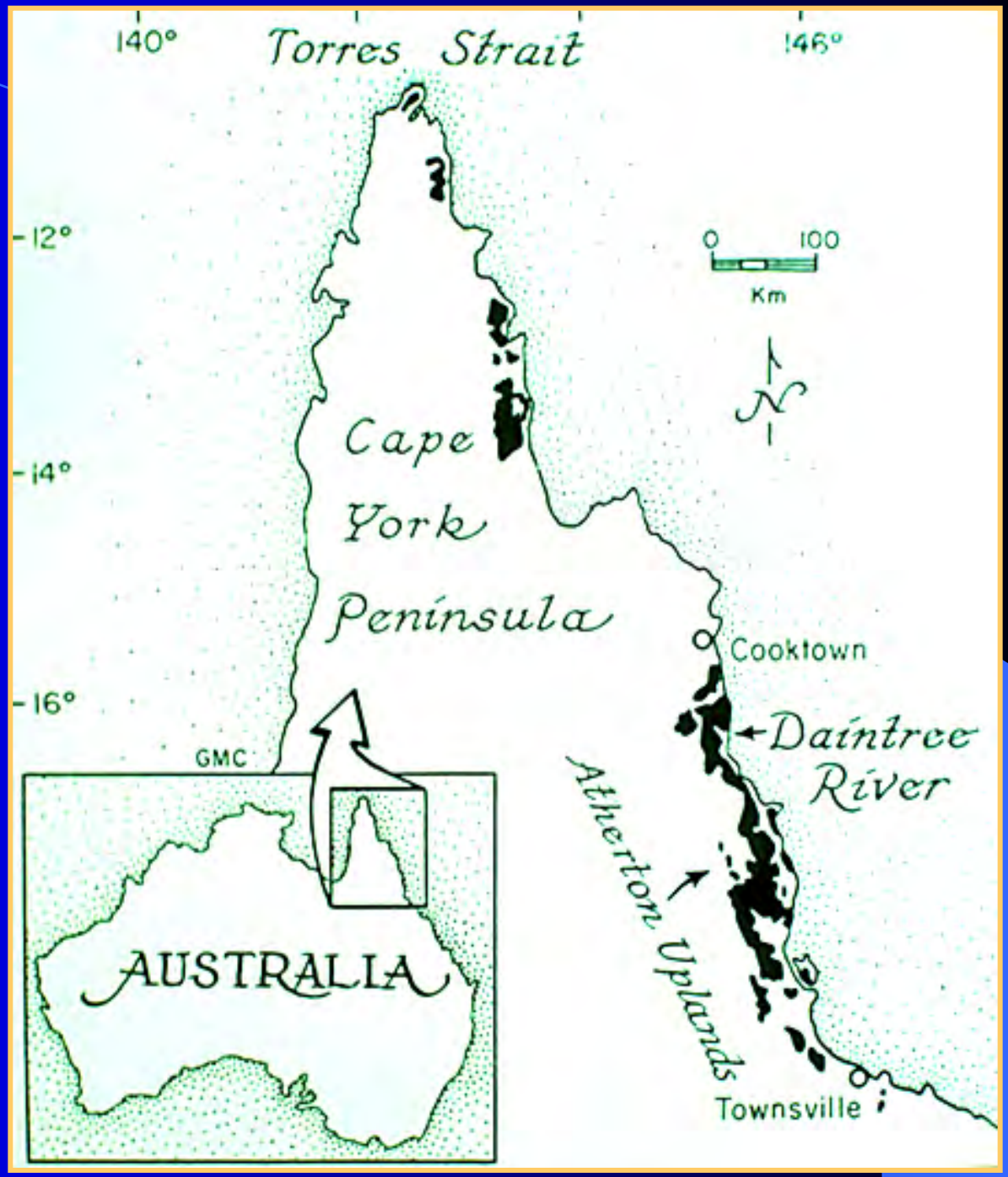
1) Declines of high-elevation biota

- Many elevational specialists in tropics
- High endemism



Australia's tropical rainforests

- Tiny, relictual distribution
- 0.3% of the continent's land area

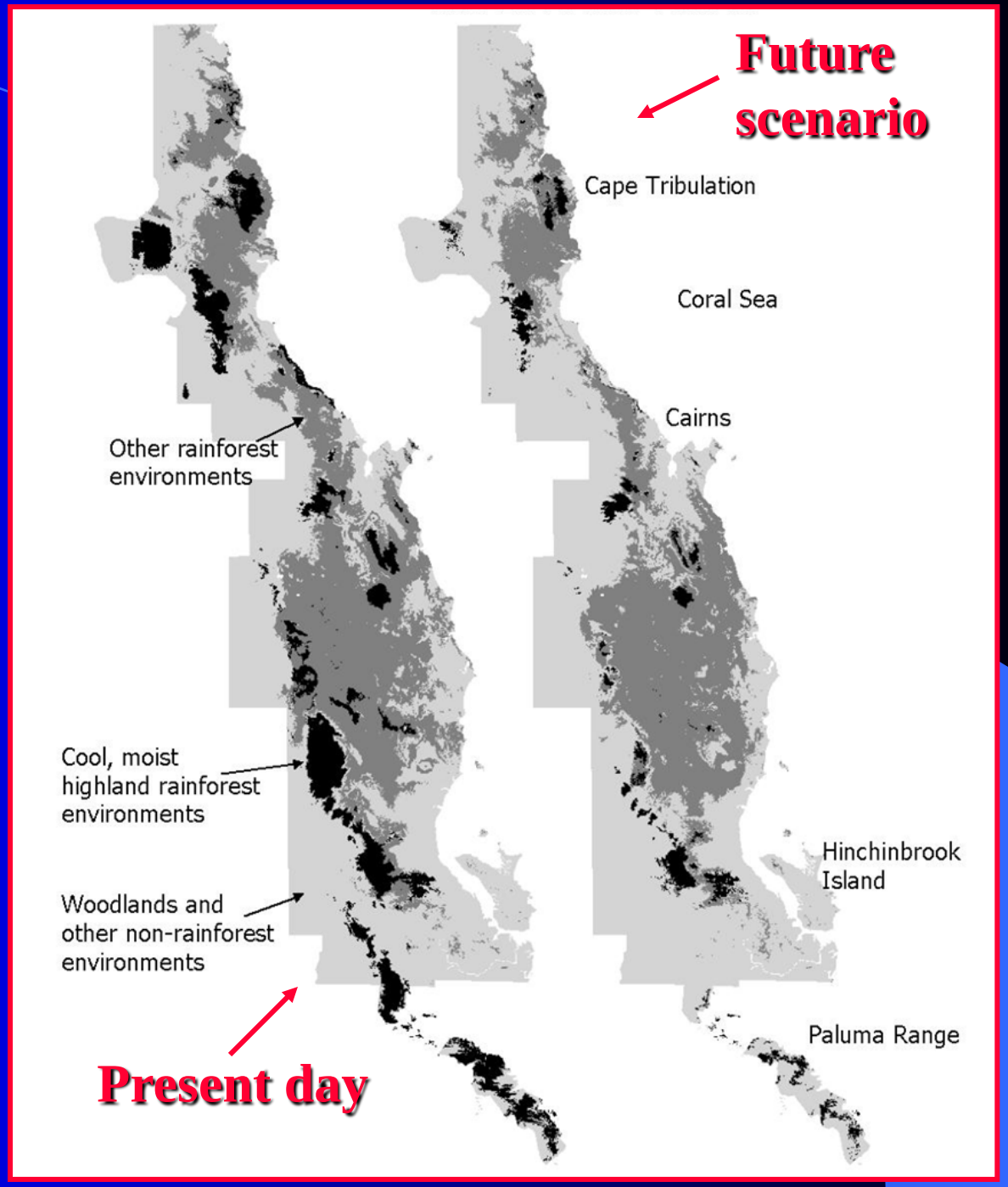


Many Upland Endemics

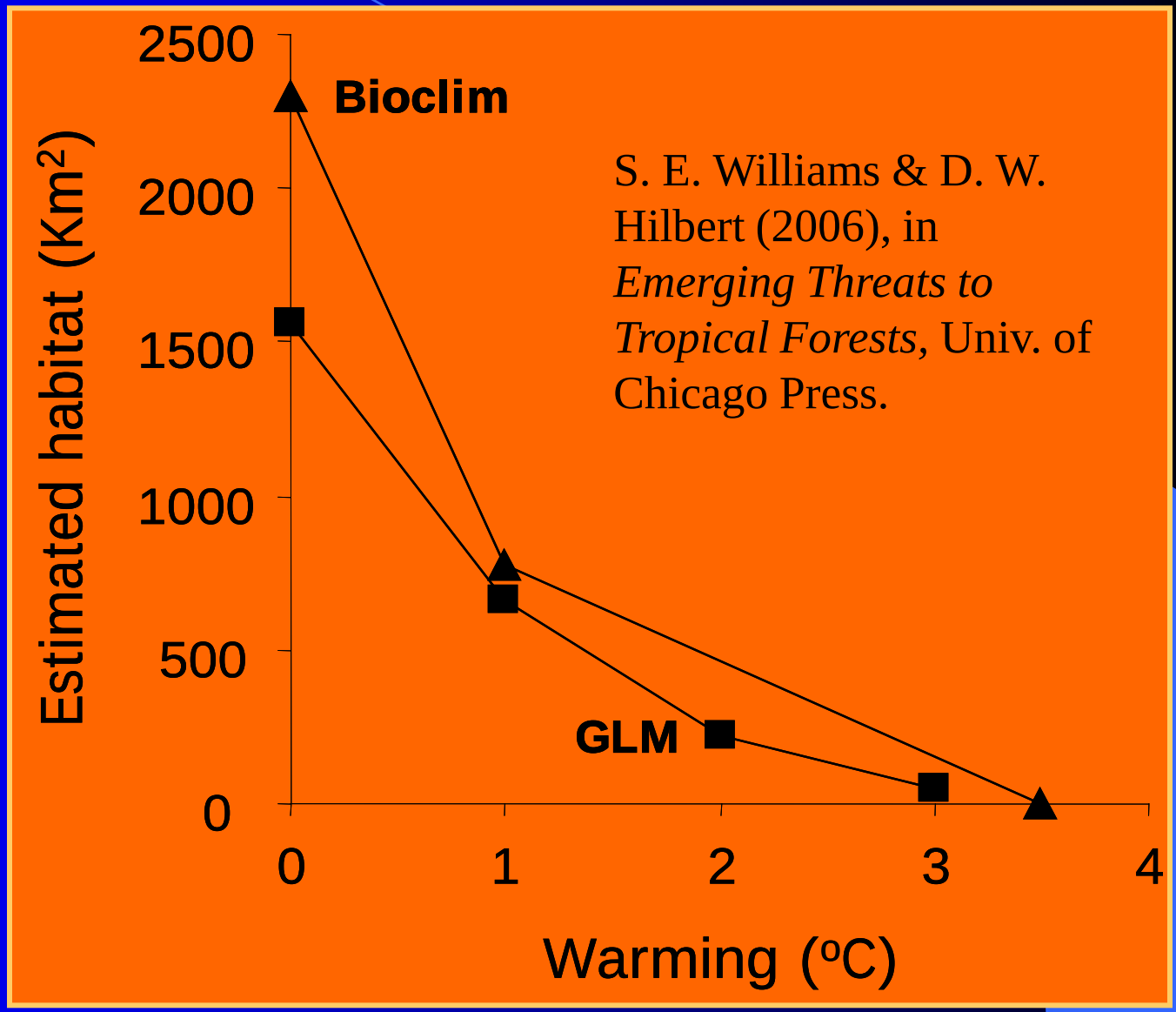
Bioclimatic Models of Future Warming

Even modest warming (1º C) and drying (10%) could dramatically reduce & fragment cool upland forests

D. W. Hilbert *et al.* (2001)
Austral Ecology

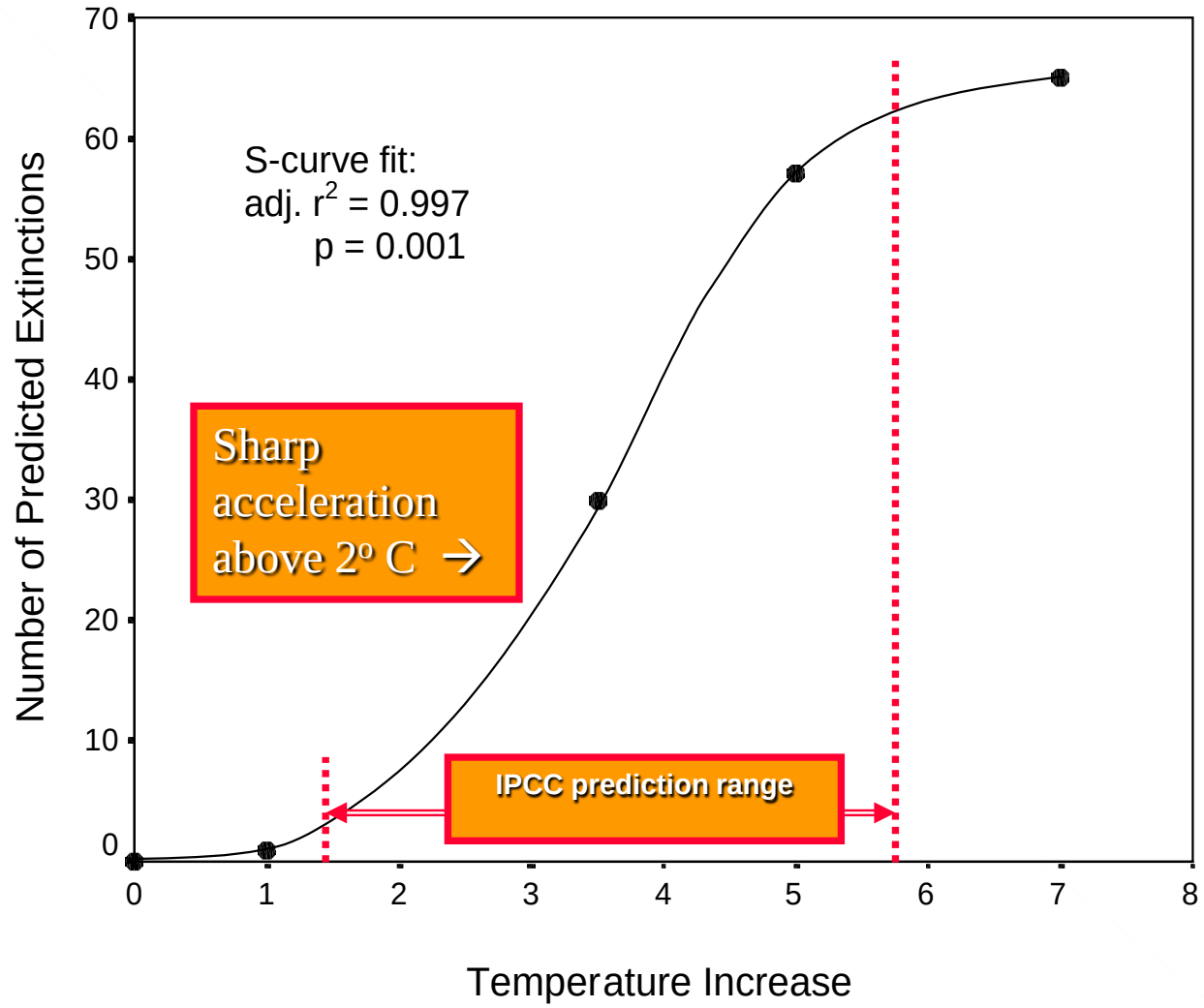


Projected Habitat Declines for the Golden Bowerbird, an Upland Endemic



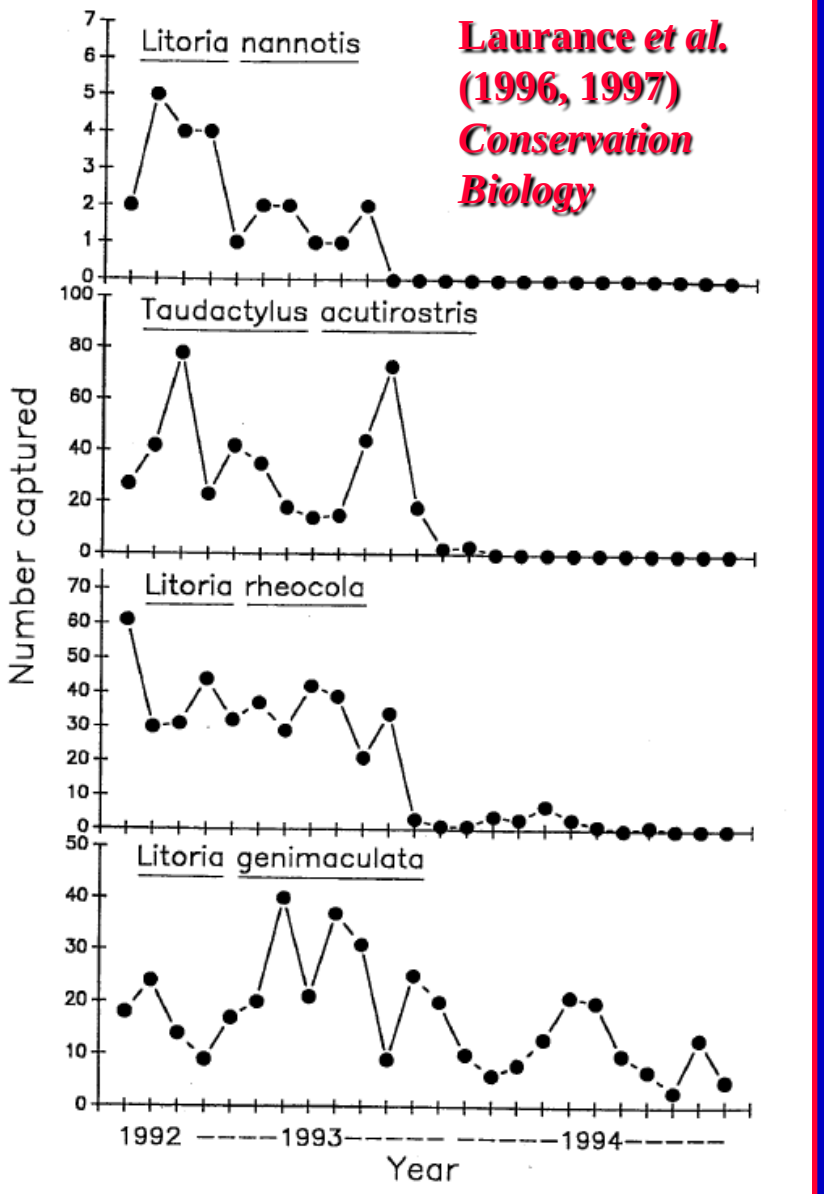
S. E. Williams & D. W. Hilbert (2006), in *Emerging Threats to Tropical Forests*, Univ. of Chicago Press.

Projected Vertebrate Extinctions in Tropical Australia

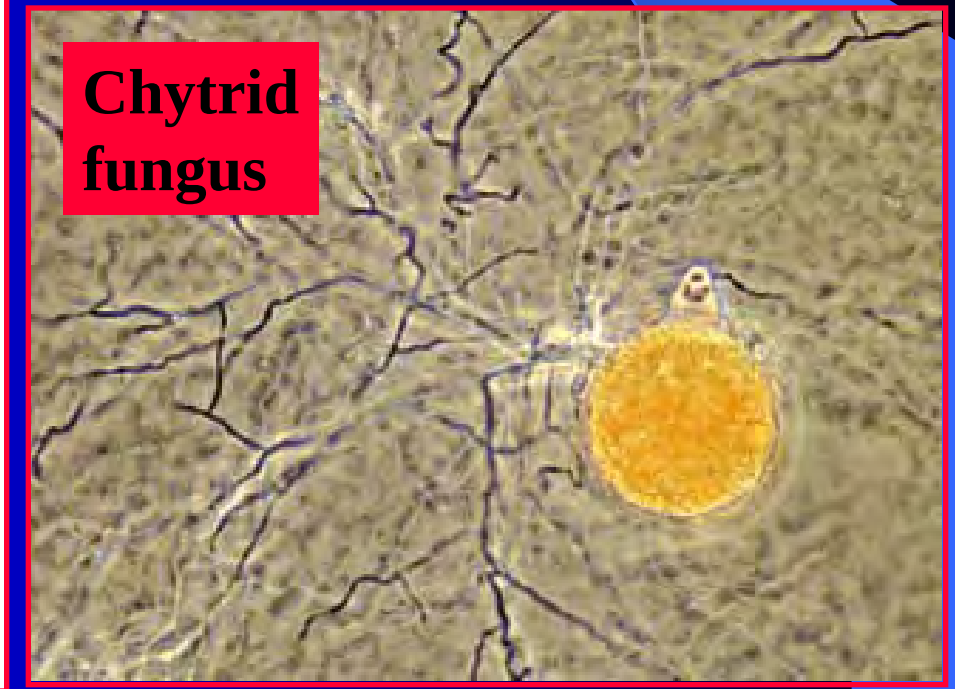


S. E. Williams *et al.* (2003) *Proc. Roy. Soc. B.*

2) Increasing pathogen impacts



Laurance *et al.* (1996, 1997) *Conservation Biology*

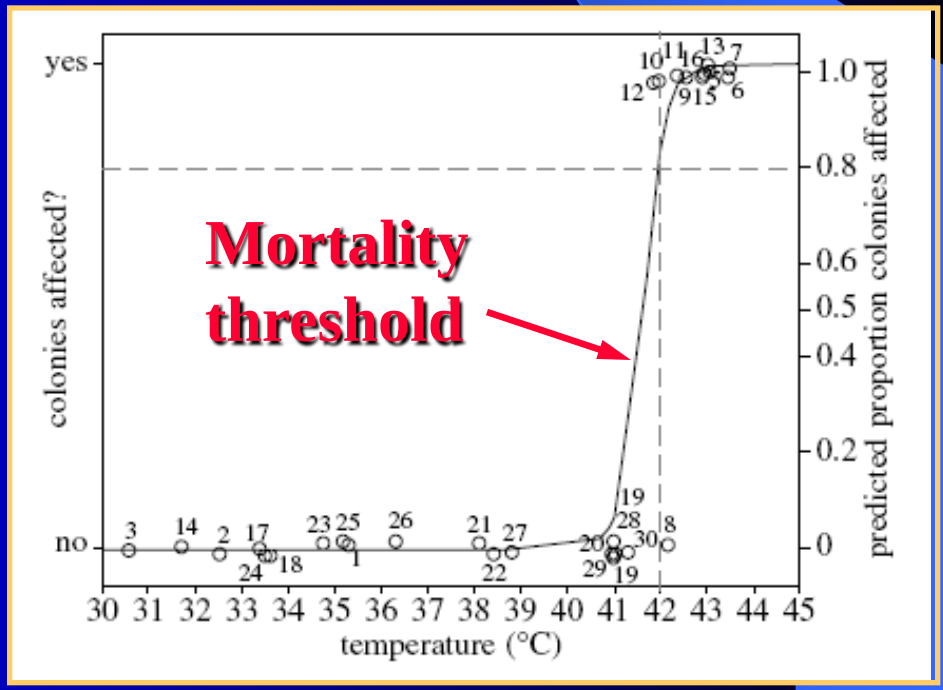


- **Pounds *et al.* (2006) *Nature***
  - Chytrid-driven extinctions of Andean harlequin frogs mainly occurred in warmer years (>100 species)
- **Laurance (2008) *Austral Ecology***
  - Similar patterns among Australian rainforest frogs (14 species)

3) Temperature-related stress and mortality

Welbergen *et al.* (2007)
Proc. Roy. Soc. B.

- 12 January 2002, heat-wave (>42º C) in E. Australia
- Animals exhibited extreme panting, wing flapping, stress
- Over 3500 died in 9 colonies
- Little black flying foxes most vulnerable, especially young and females
- At least 19 similar die-offs since 1994



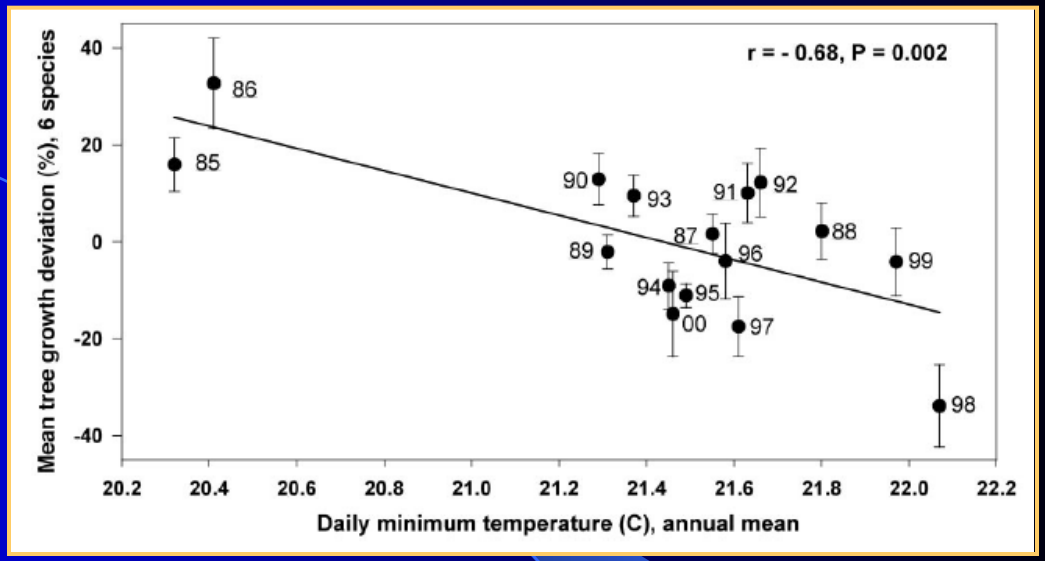
4) Declining forest growth

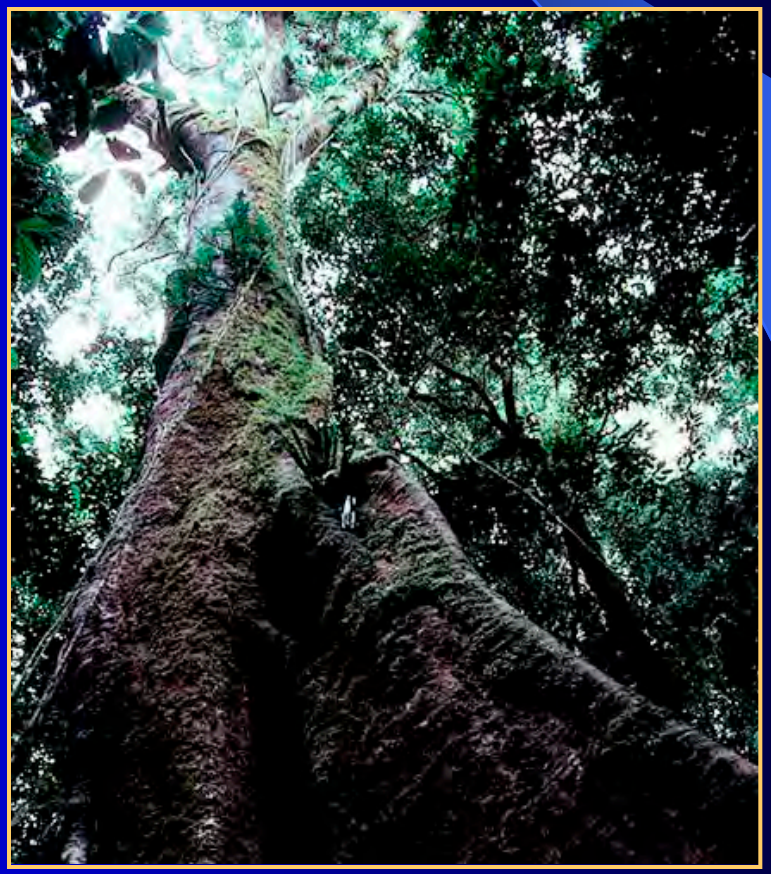
Clark *et al.* (2003) *Proc. Nat. Acad. Sci. USA*

- Night-time temperatures rising fastest in tropics
- Should increase plant respiration and possibly decrease growth
- May reduce carbon storage → *forests become carbon source*

Feeley *et al.* (2007) *Ecology Letters*

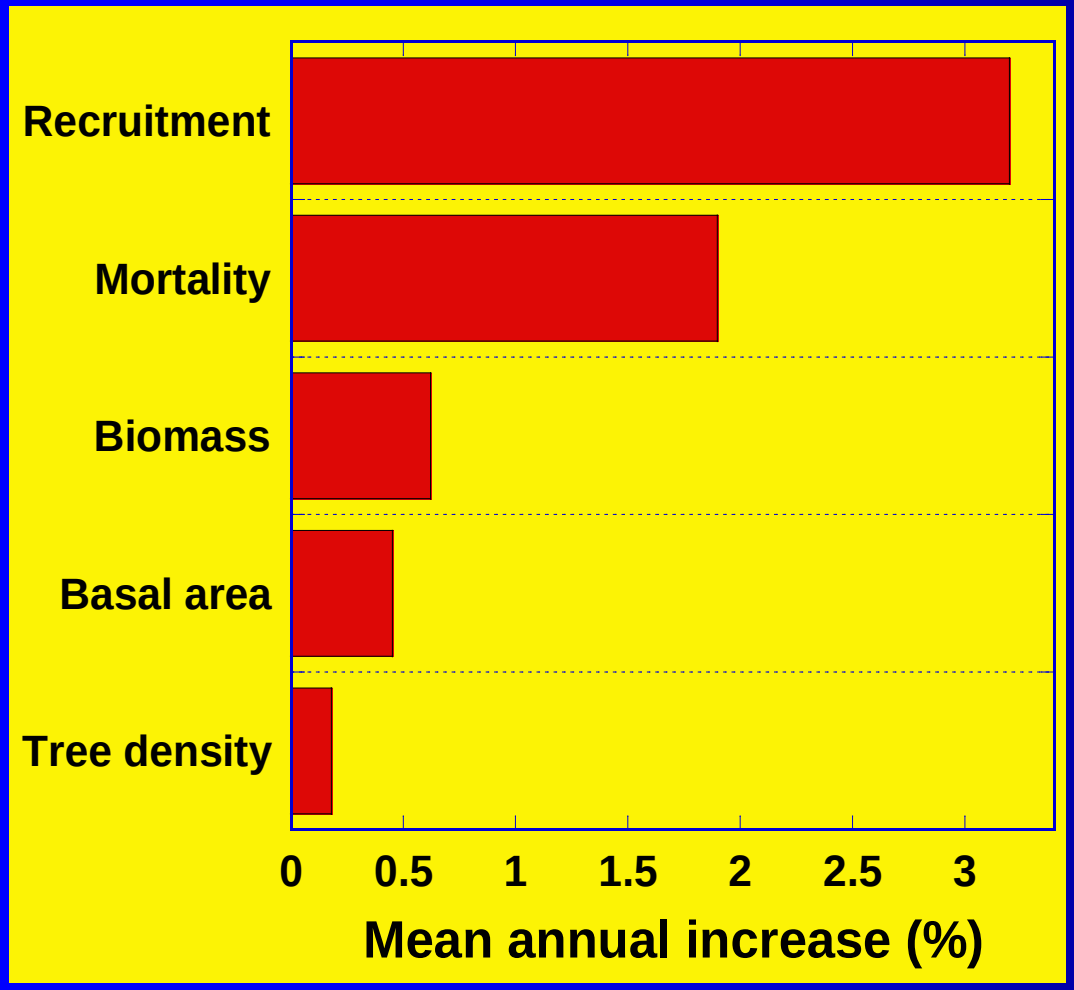
- Declining tree growth at BCI and Pasoh





Known or Hypothesized Effects of Rising CO_2 levels

1) Increasing forest dynamics & carbon storage

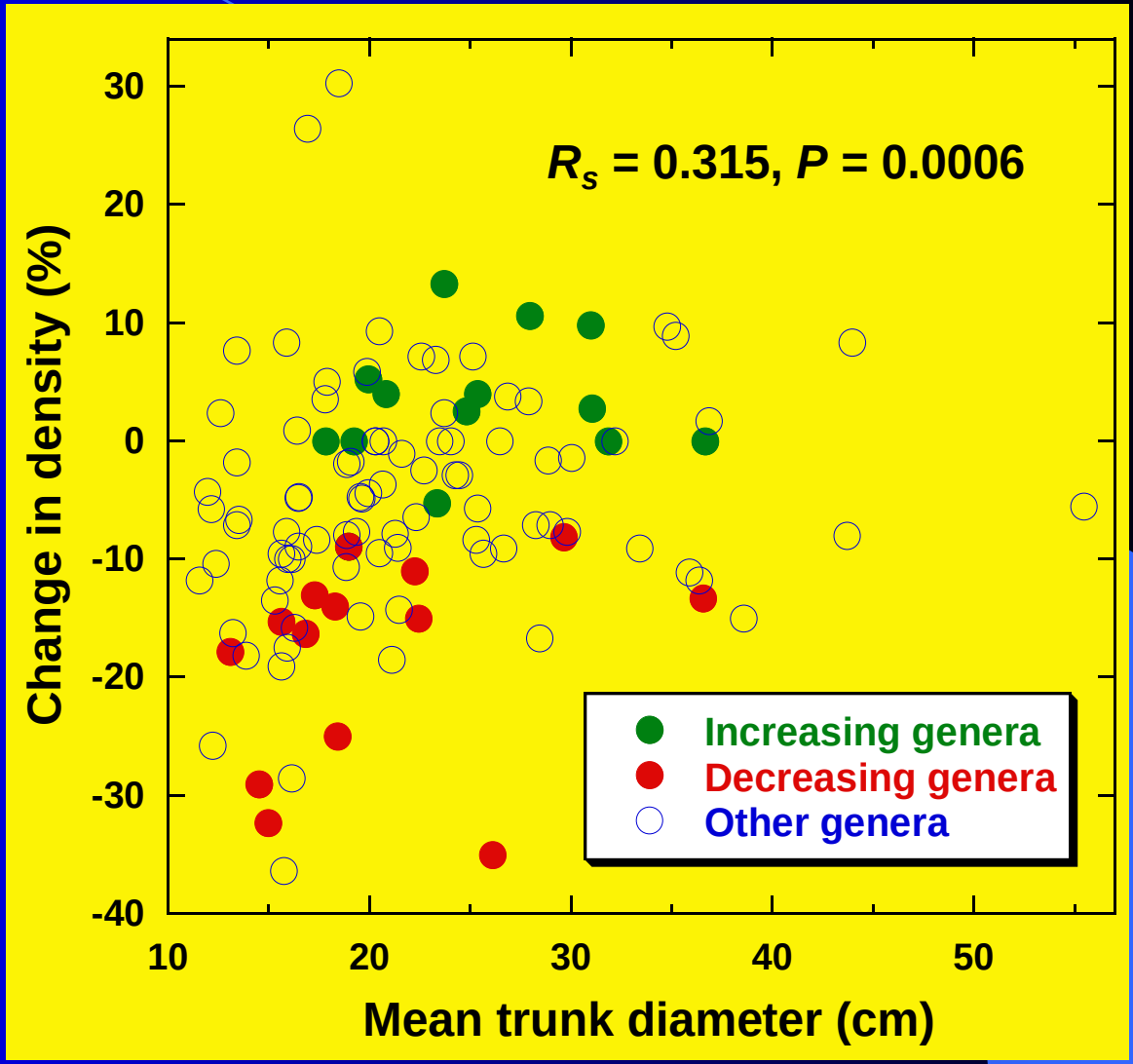


Wright (2005) *Trends Ecol. Evol.*

- Increasing forest turnover
  - Phillips & Gentry (1994) *Science*
- Increasing growth & productivity
  - Laurance *et al.* (2004) *Nature*
  - Lewis *et al.* (2004) *Phil. Trans. Roy. Soc. B*
- Increasing NDVI
  - Paruelo *et al.* (2004) *Int. J. Remote Sensing*
- Increasing biomass
  - Phillips *et al.* (1998) *Science*
- Whole-forest C sink
  - Grace *et al.* (1994) *Science*

2) Changes in forest composition

- Increasing liana densities
  - Phillips *et al.* (2002) *Nature*
  - Wright *et al.* (2004) *Ecology*
- Alterations in tree-community composition
  - Laurance *et al.* (2004) *Nature*



3) Declining evapotranspiration

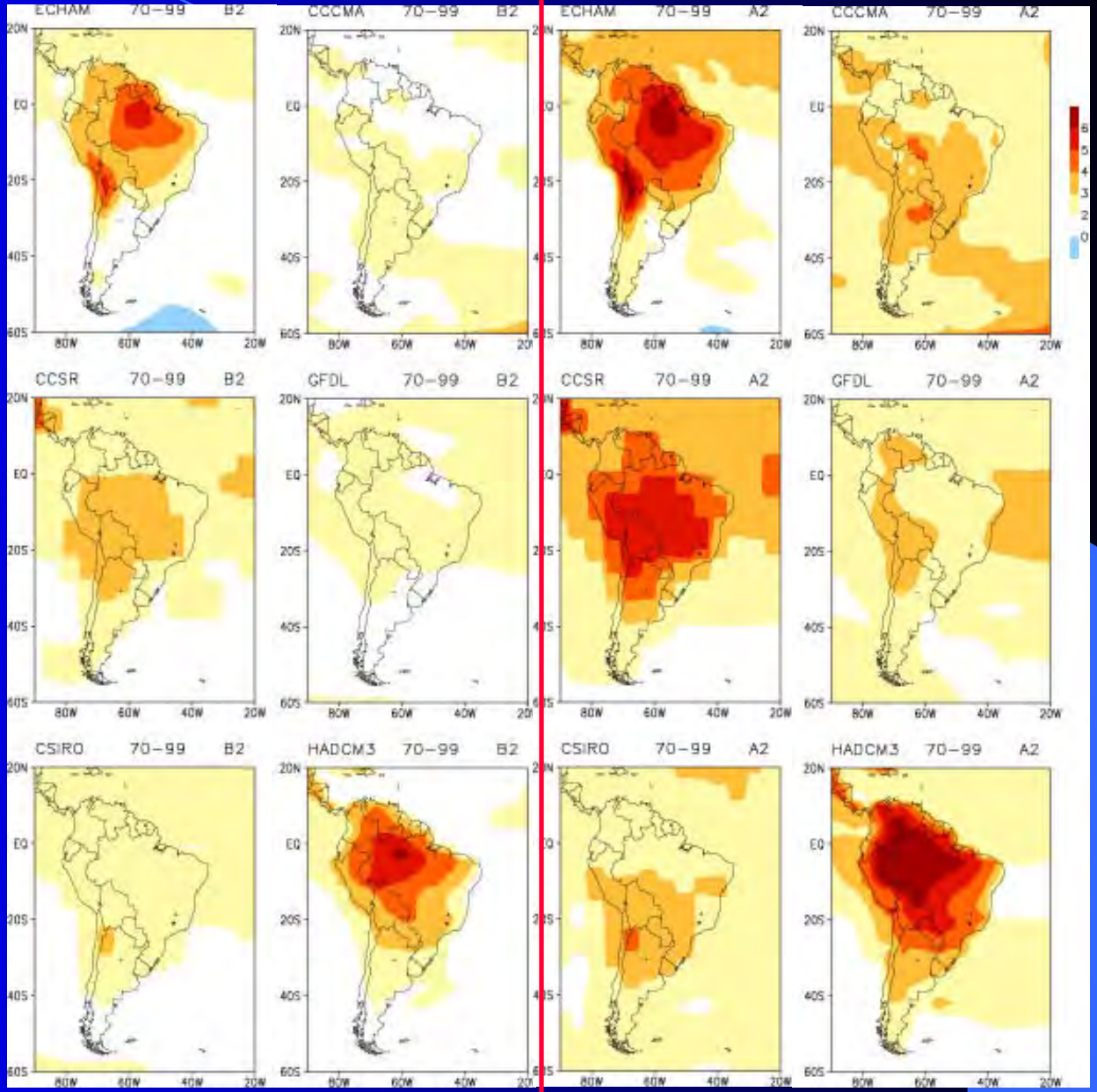
Known or Hypothesized Impacts on Tropical Climates

1) Hotter conditions

All models predict rising temperatures, but vary in magnitude

Temperature Anomalies (ºC) for 2070-2099

Low GHG Scenario | High GHG Scenario



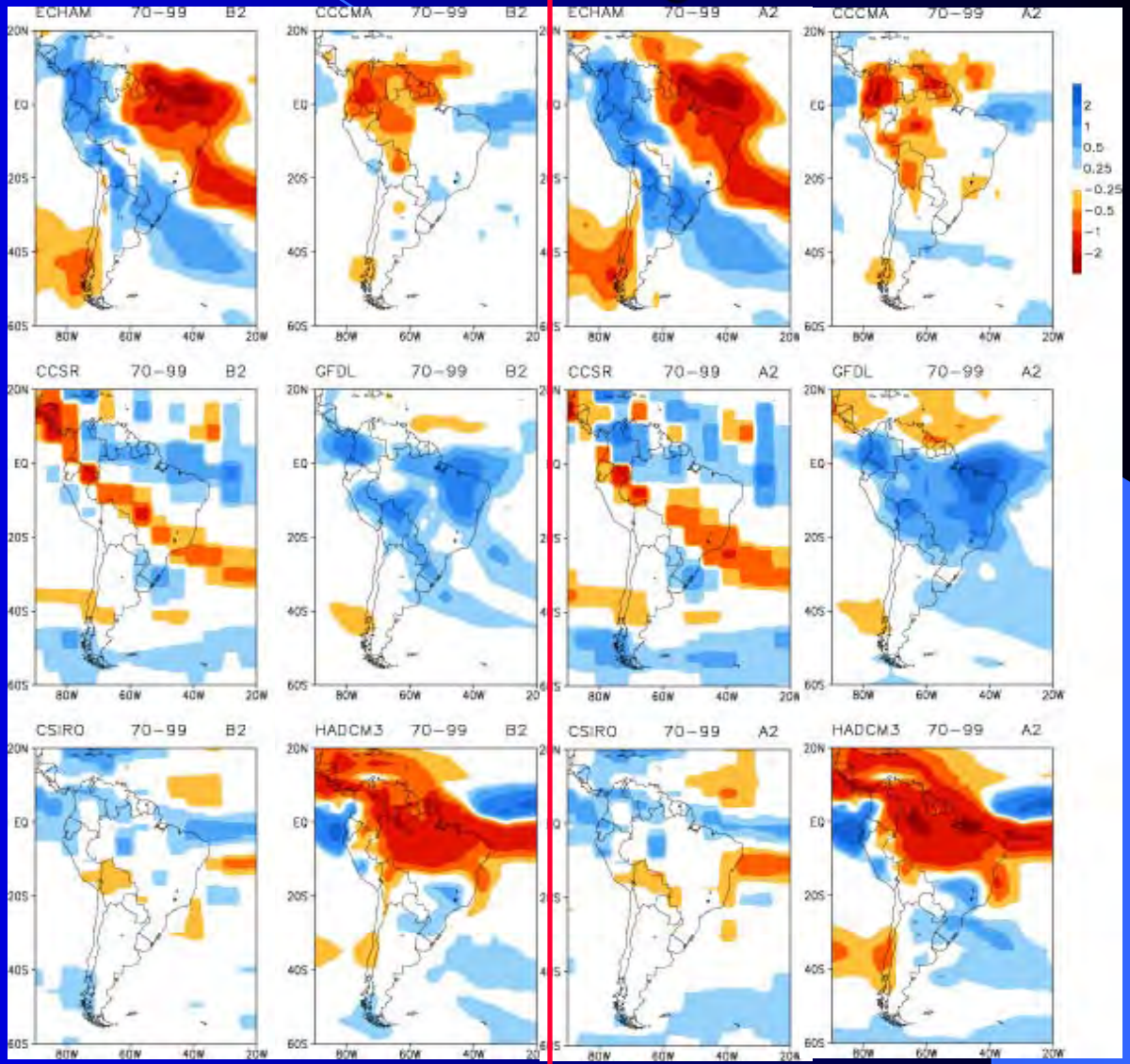
2) Altered precipitation patterns

Predictions vary greatly, especially at finer scales

- differing trends
- differing hotspots of vulnerability

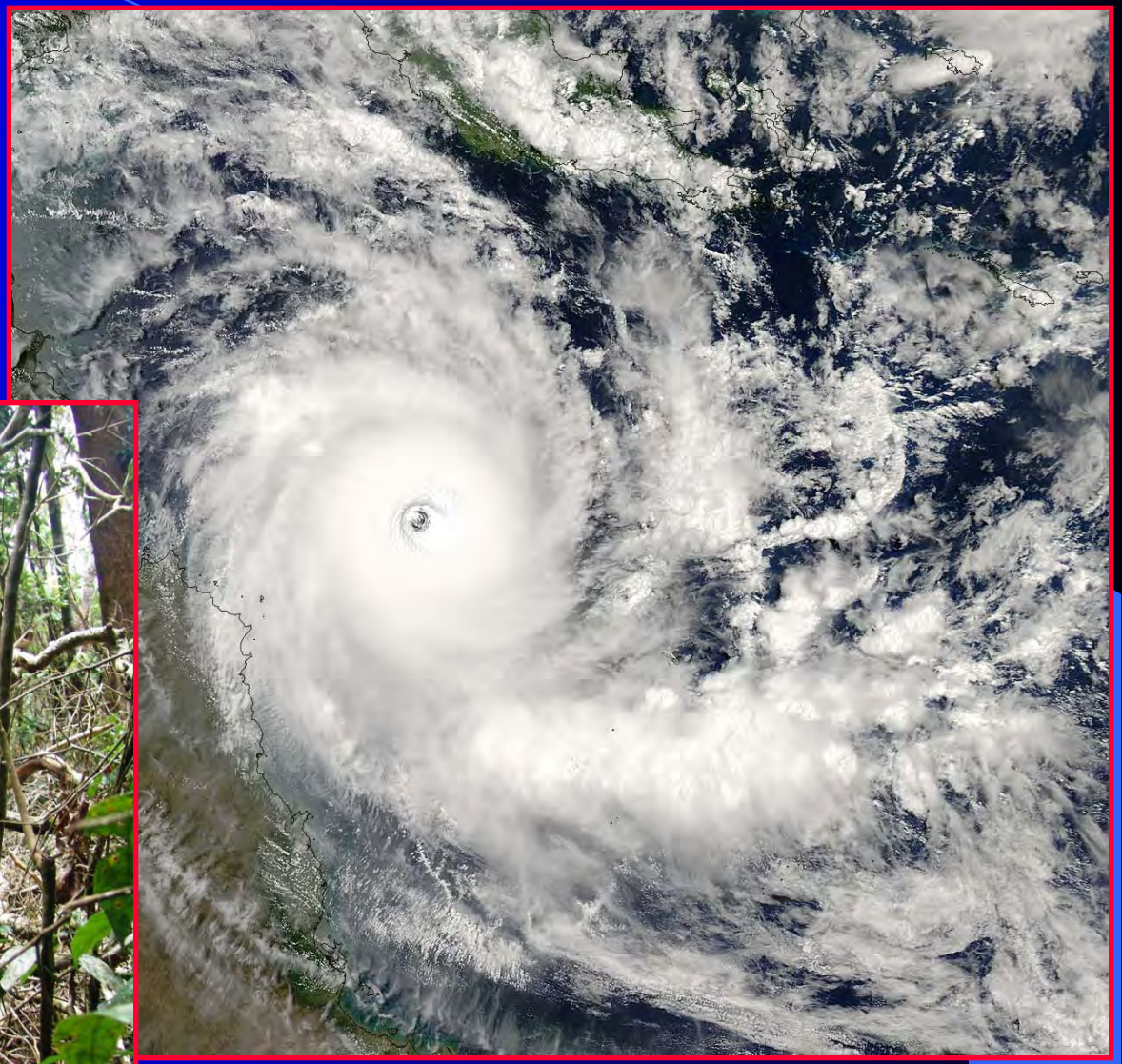
Precipitation Anomalies (mm/day) for 2070-2099

Low GHG Scenario | High GHG Scenario



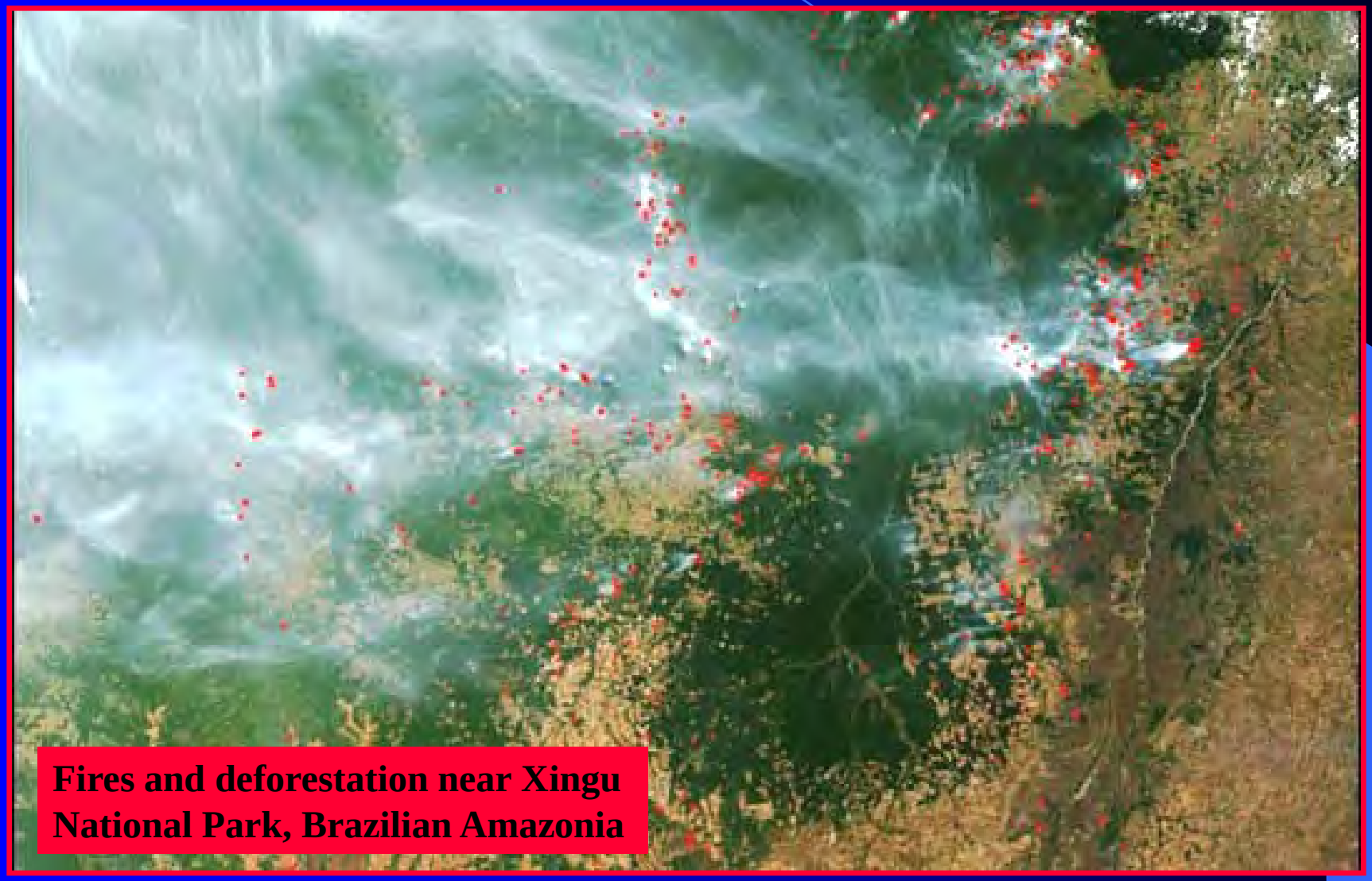
3) Increasing weather extremes

- Storms, floods
- ENSO droughts
- Great uncertainty



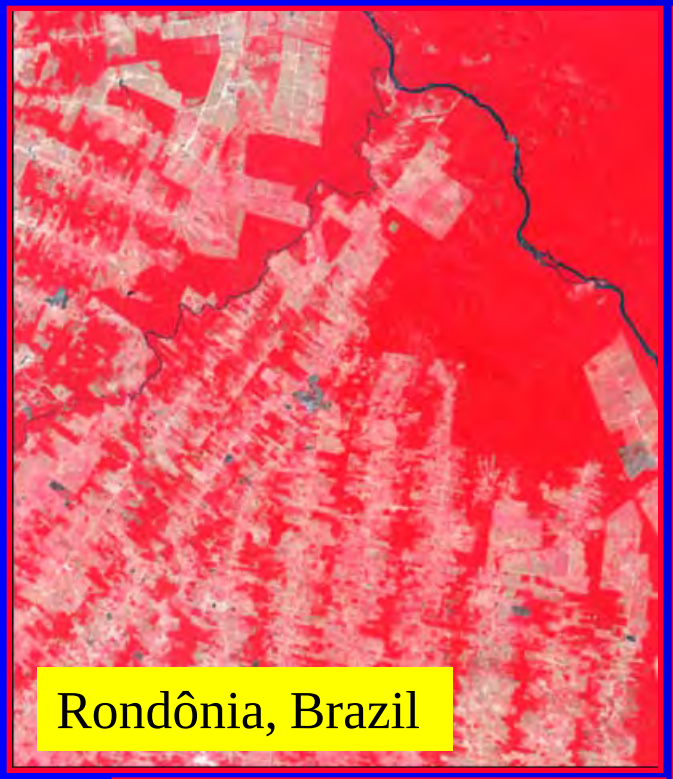
Aftermath of Cyclone Larry
north Queensland, 2006

Known or Hypothesized Synergisms with Land-use

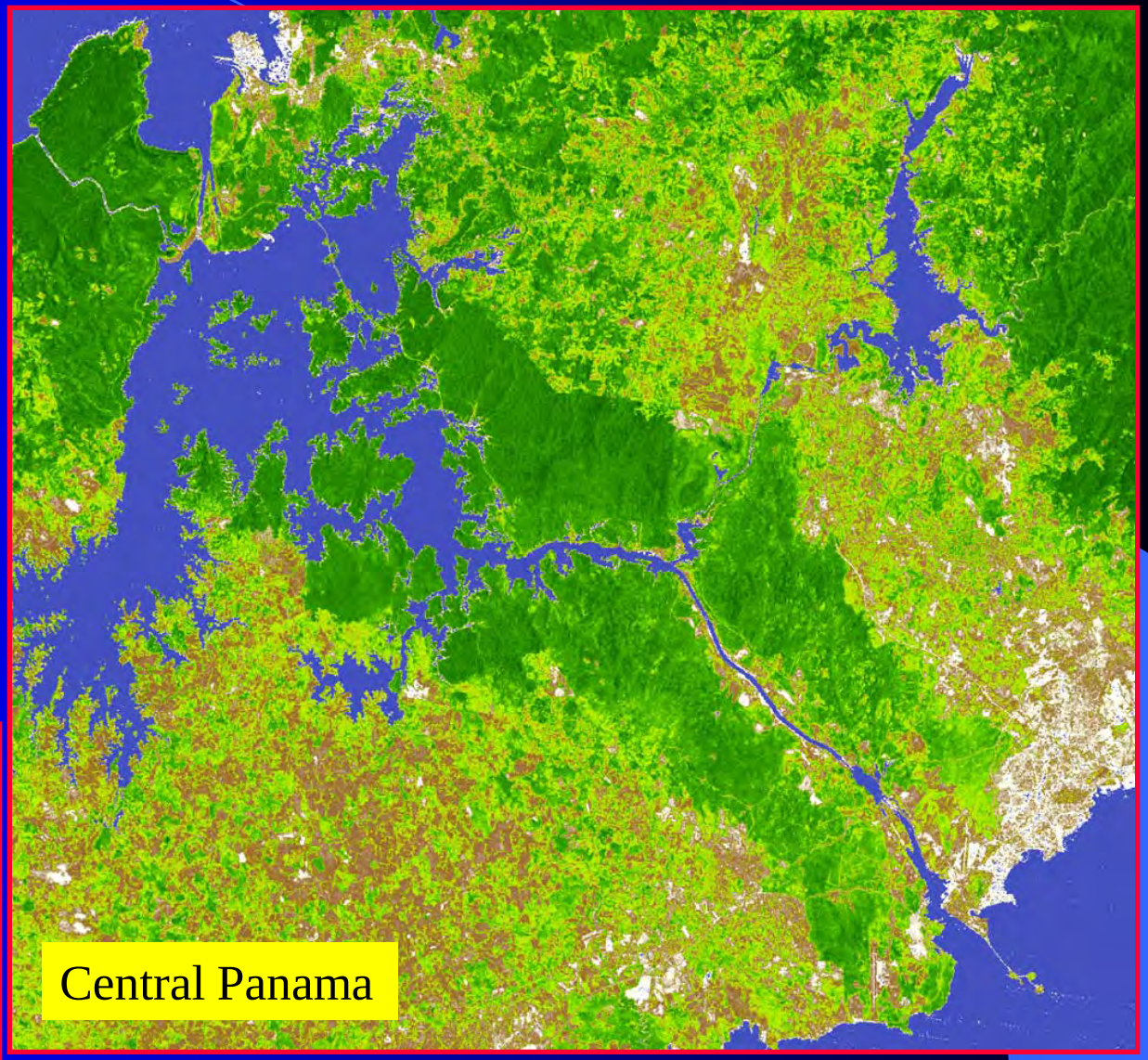


Fires and deforestation near Xingu National Park, Brazilian Amazonia

1) The island effect



Rondônia, Brazil

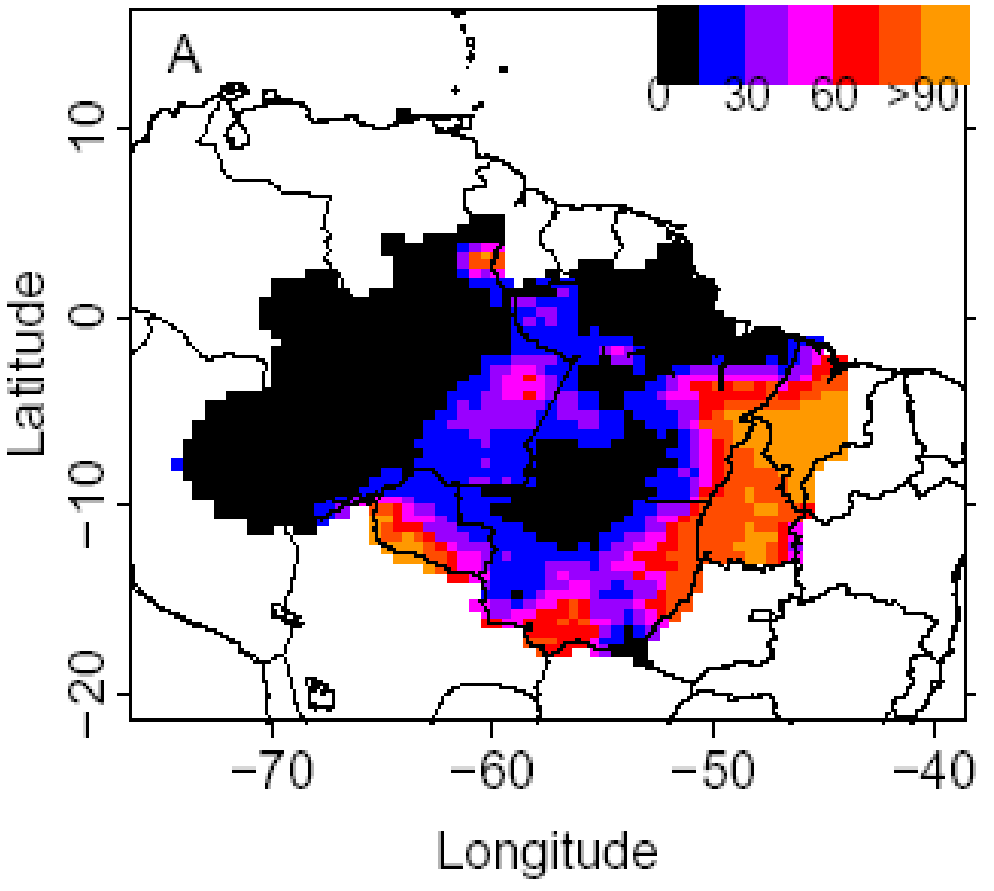


Central Panama

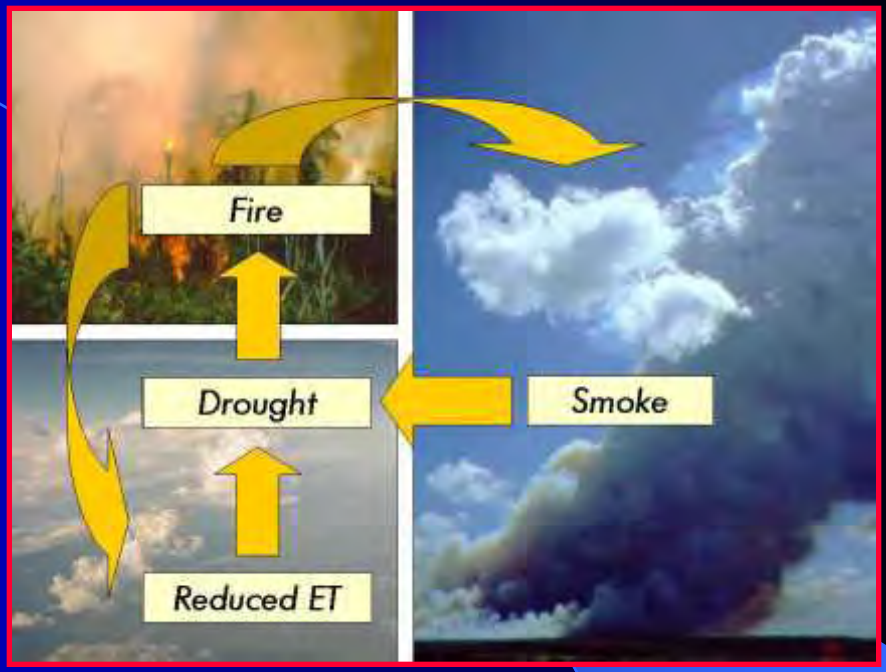
2) Escalating fires

Vast areas of the tropics are already near the physiological limits of rainforest…

Percentage of years with drought



…and forest disruption increases desiccation



…and ignition sources have multiplied dramatically