Will Tropical Forests Slow or Accelerate Climate Change

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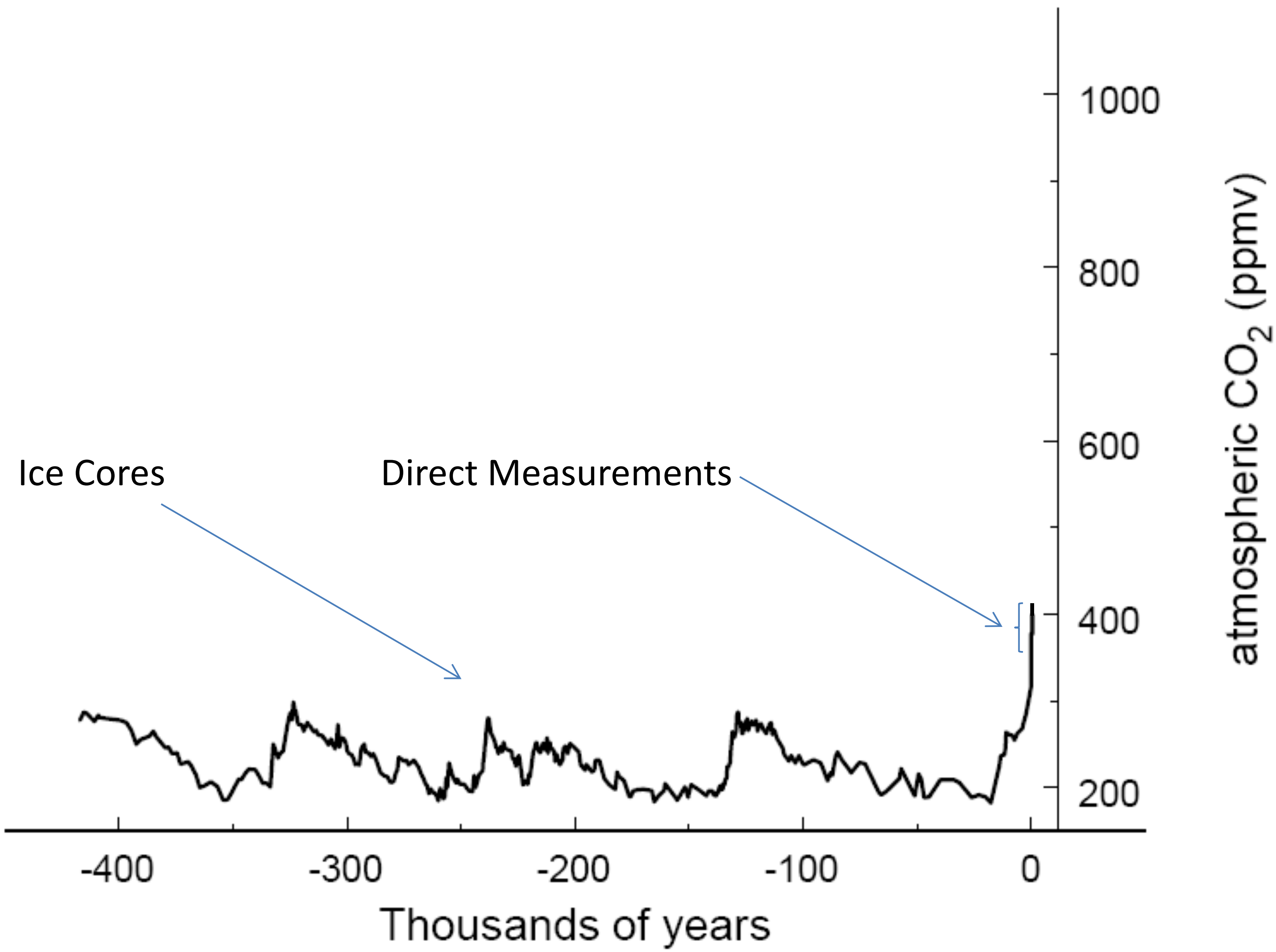
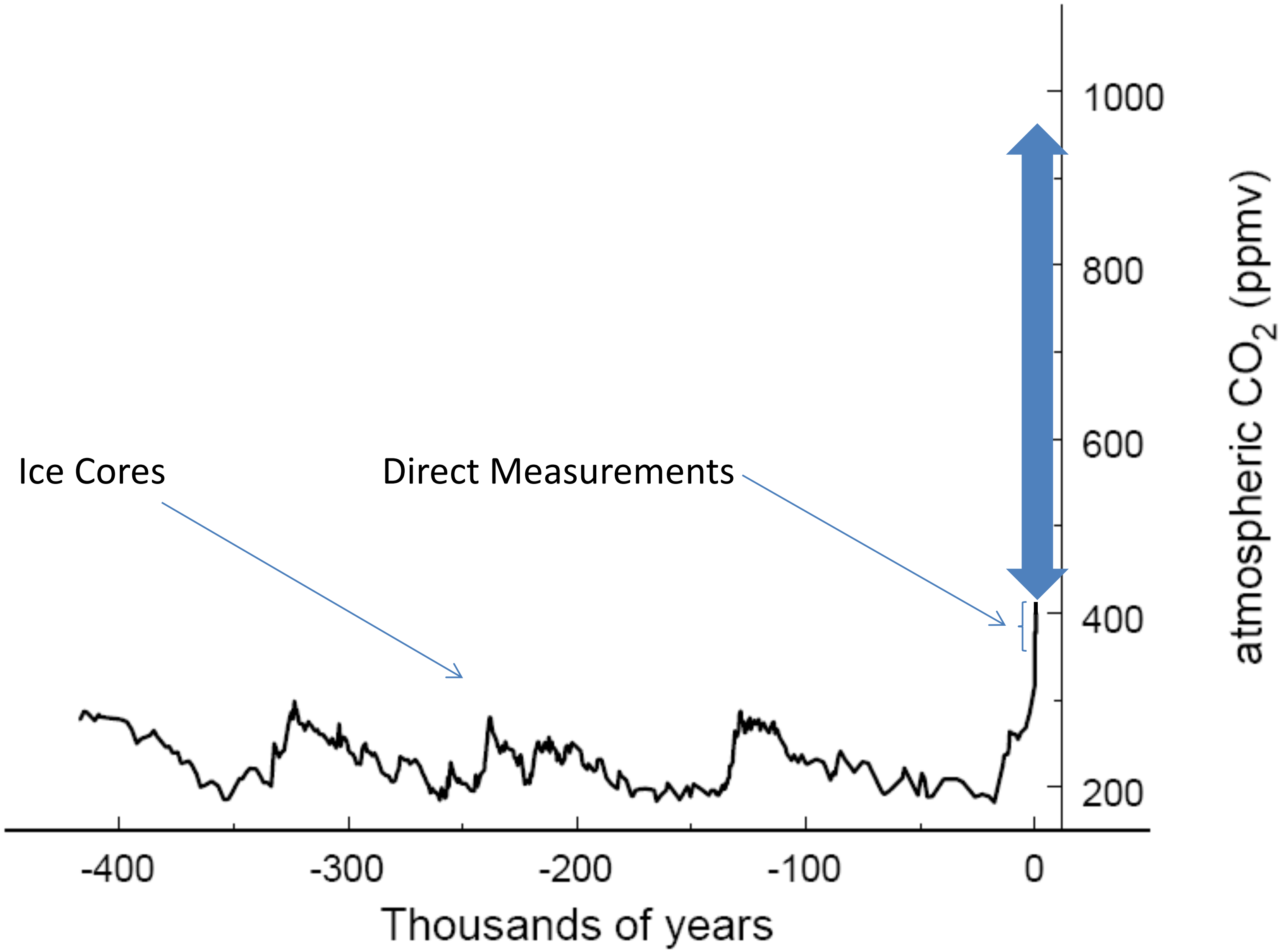


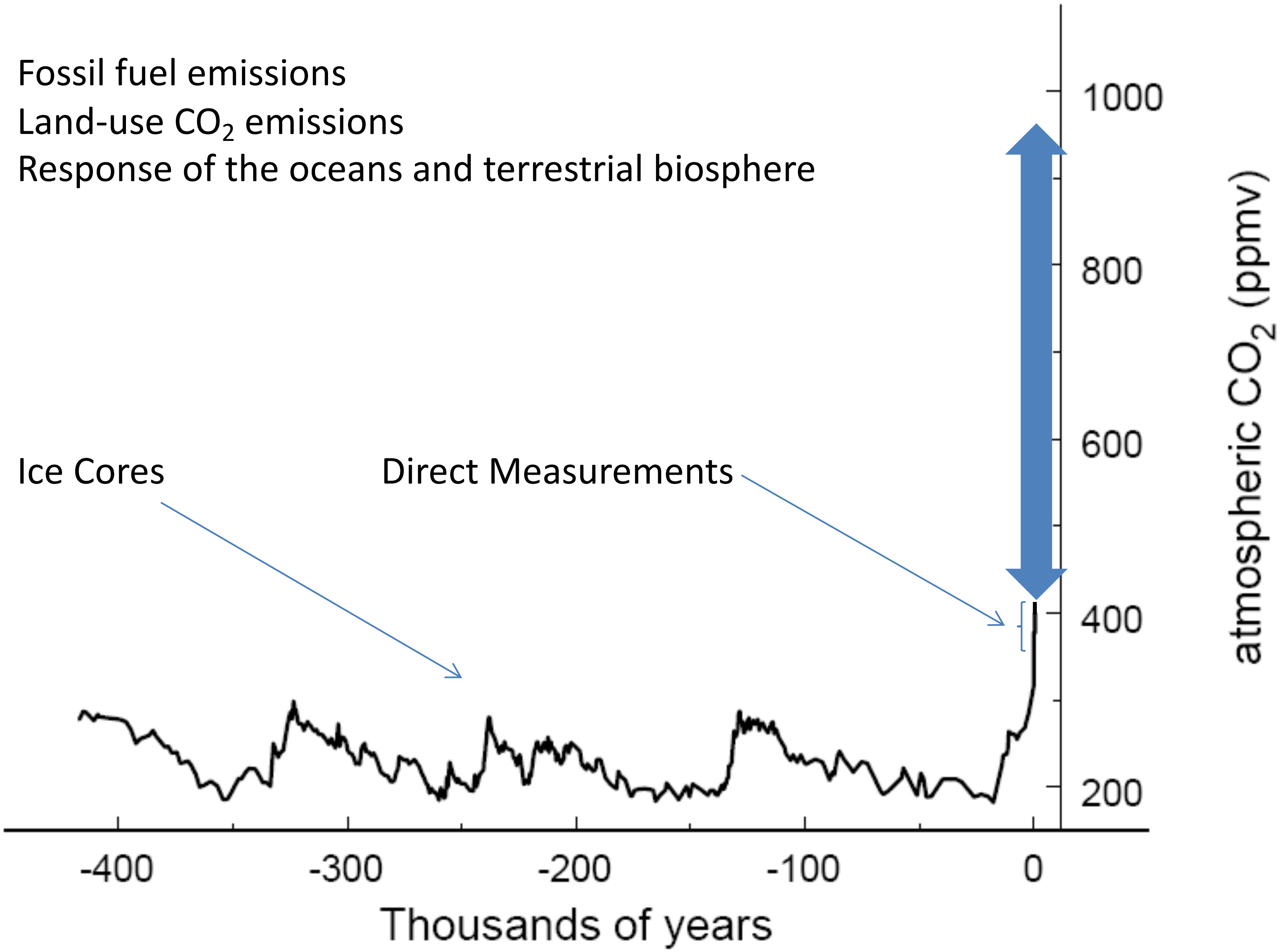
Lewis & Maslin 2018, The Human Planet (Yale Uni Press)



Lewis & Maslin 2018, The Human Planet (Yale Uni Press)

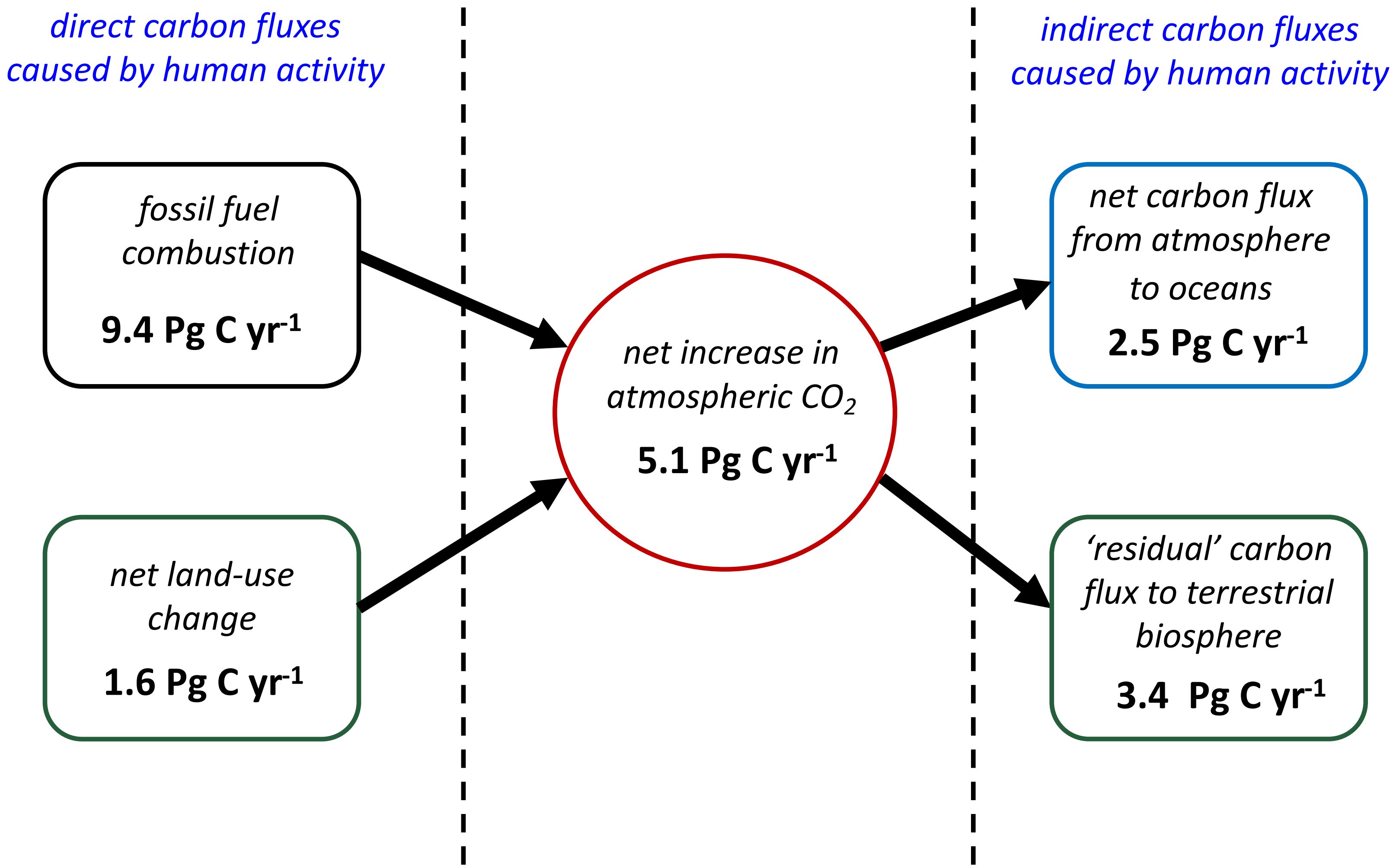
Projections depend upon:

- Fossil fuel emissions
- Land-use CO_2 emissions
- Response of the oceans and terrestrial biosphere



Lewis & Maslin 2018, The Human Planet (Yale Uni Press)

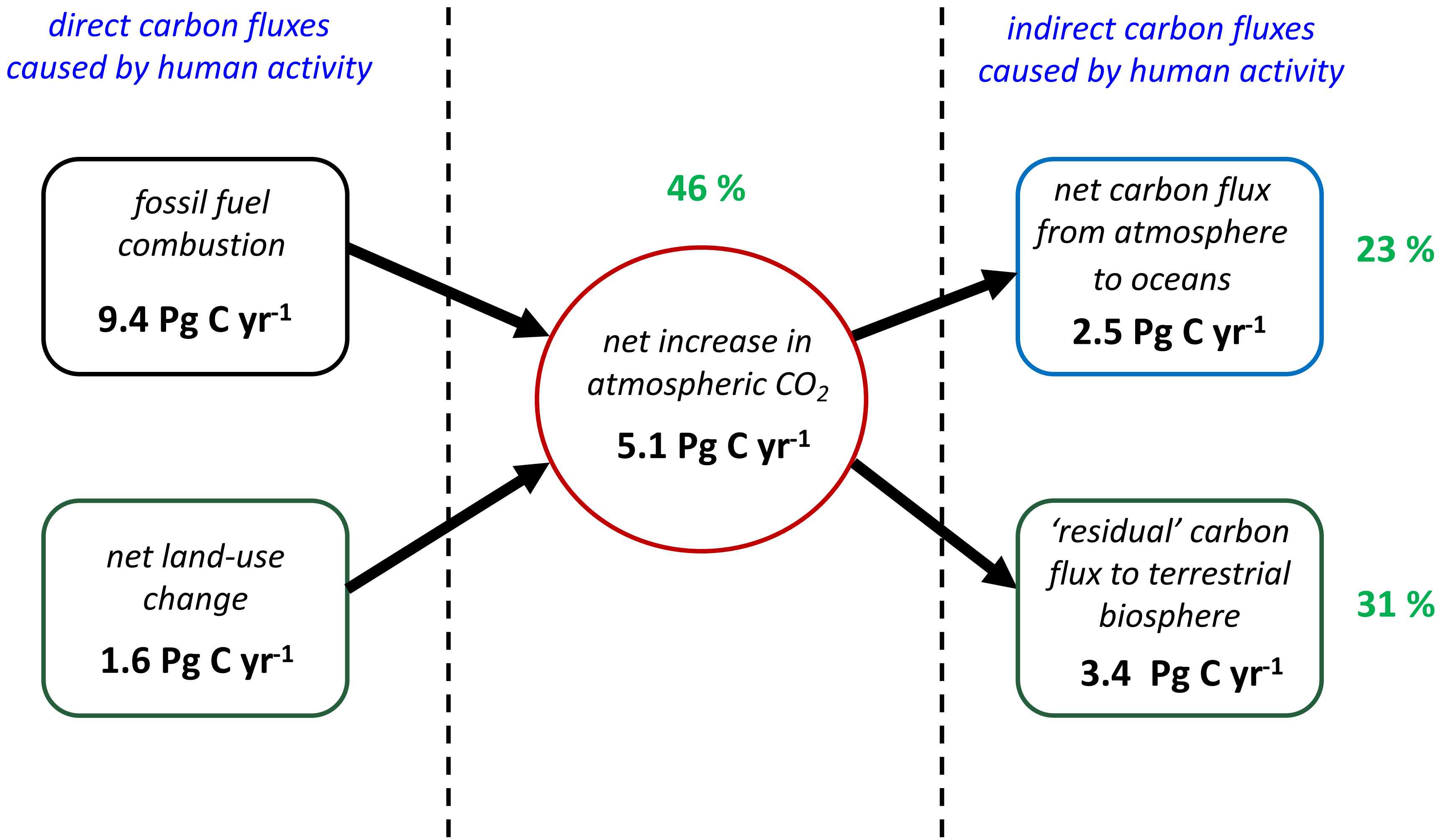
Overview: Annual carbon fluxes, 2010 to 2019



1 Pg = Peta gram = 1 billion tonnes = 1 $x10^{15}$g

Global Carbon Project data, after Lewis 2006

Overview: Annual carbon fluxes, 2010 to 2019



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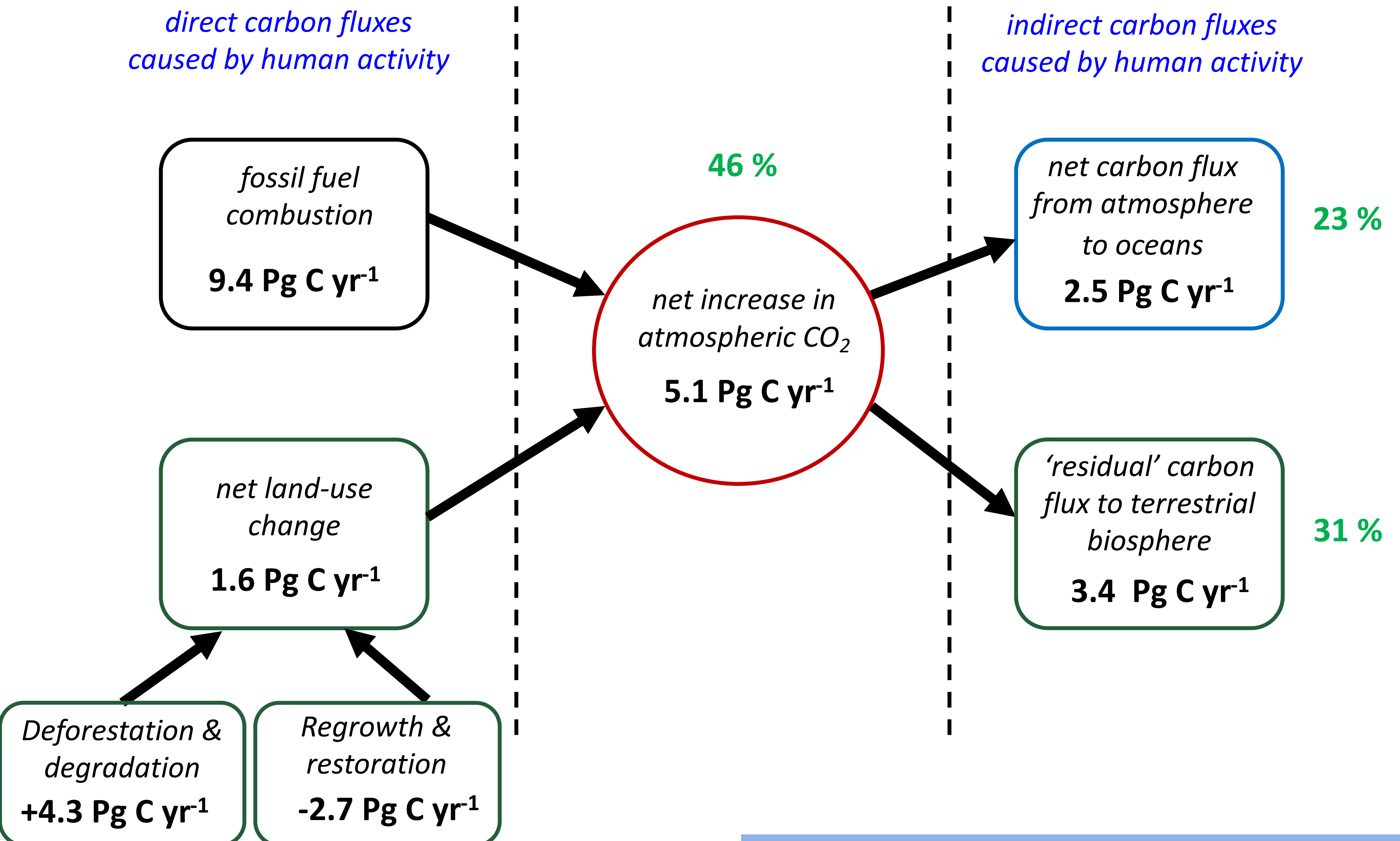

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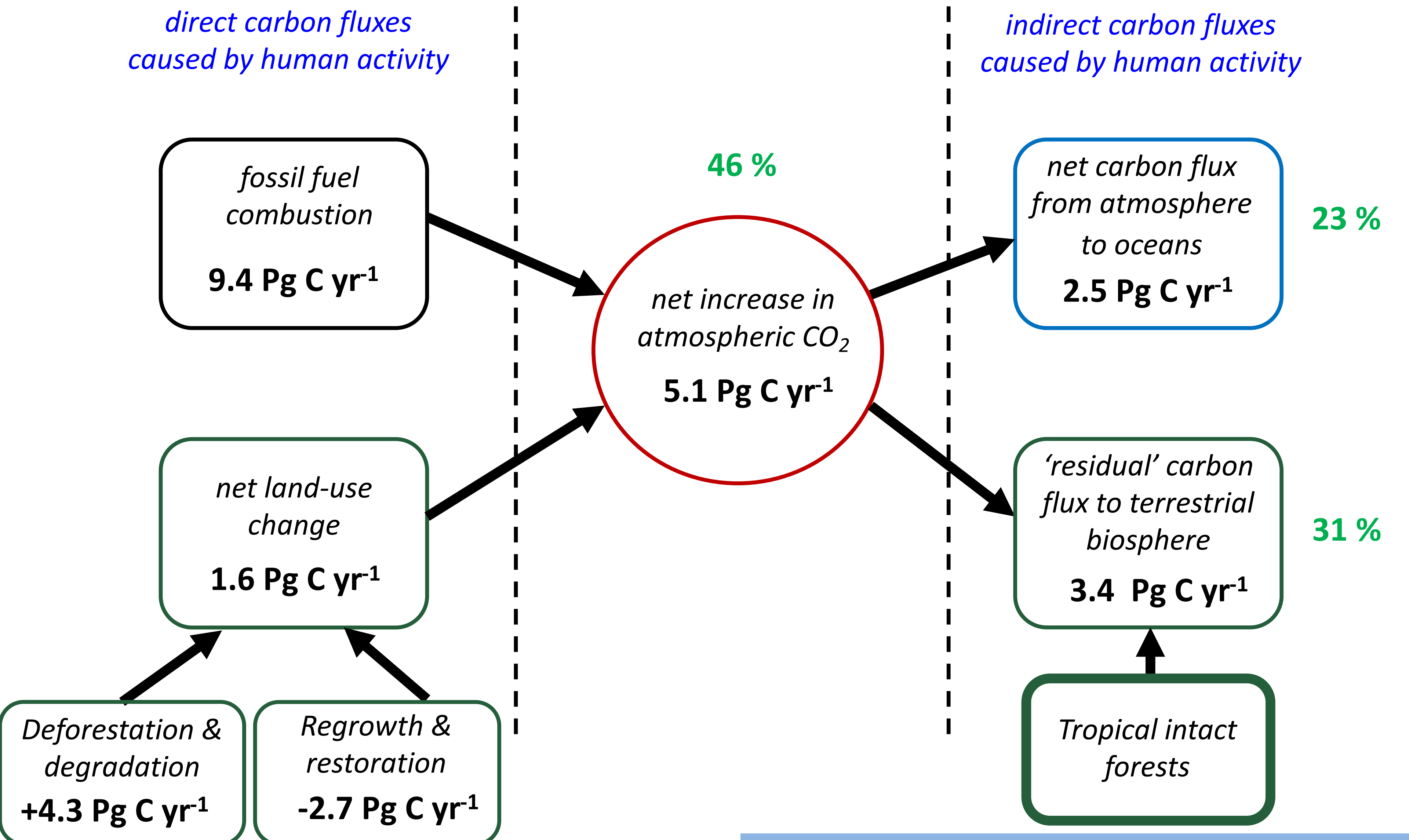

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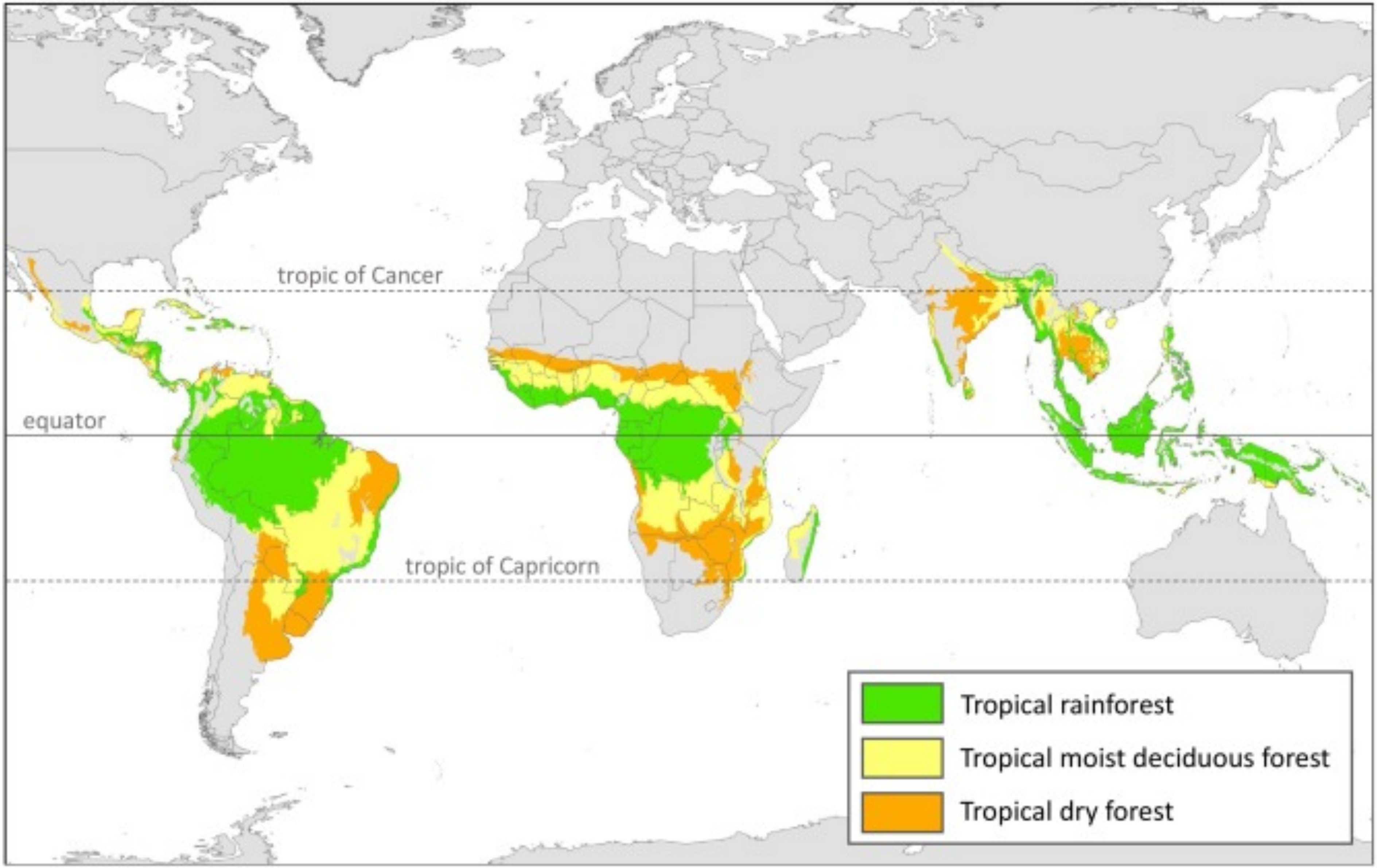
Global Carbon Project data, after Lewis 2006

Tropical Forests

- Cover less than 10 % Earth’s land surface
- Tropical forests house over half of Earth’s species
- Store almost half of Earth’s biomass carbon



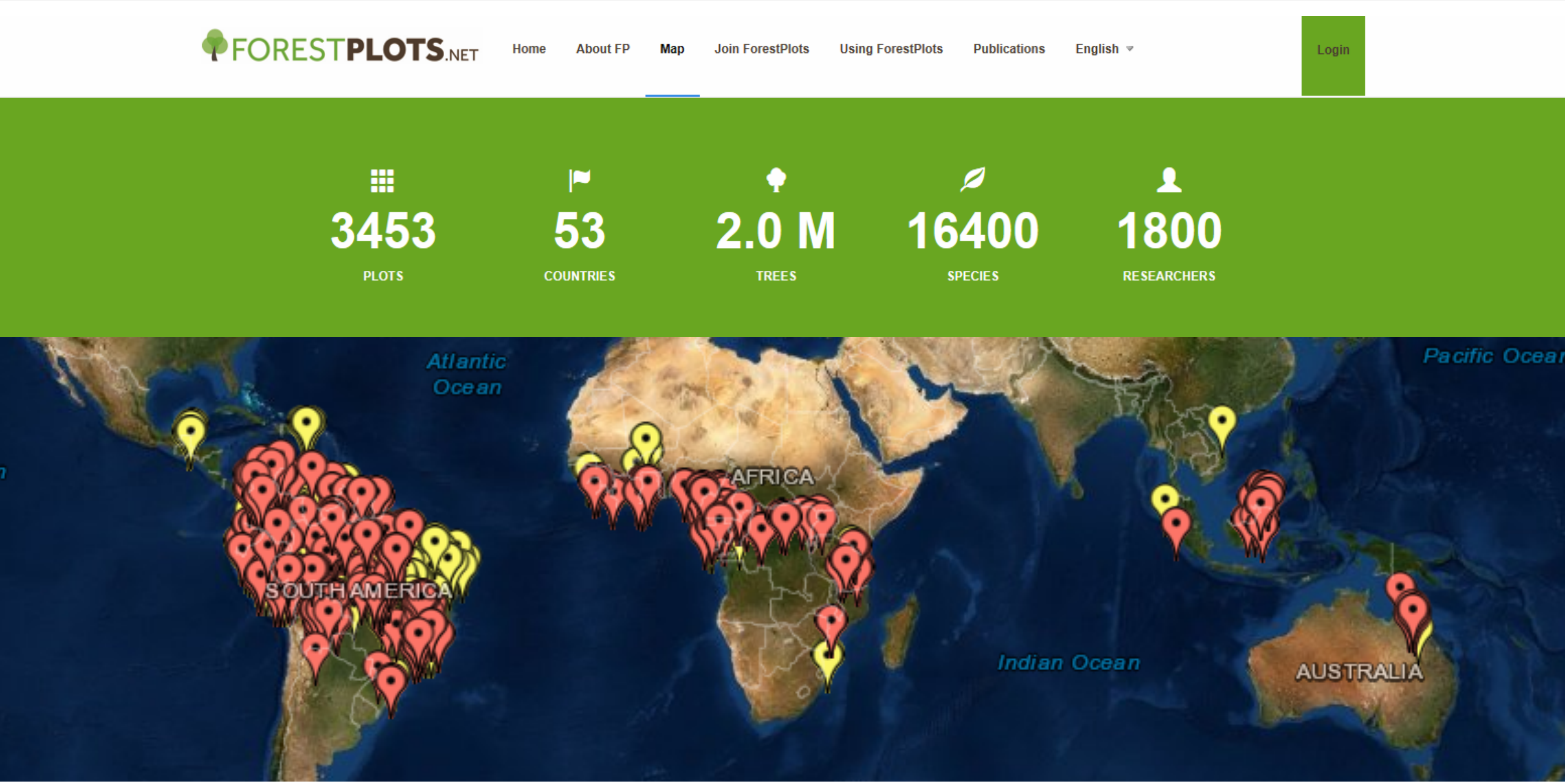
tropic of Cancer
equator
tropic of Capricorn
Tropical rainforest
Tropical moist deciduous forest
Tropical dry forest

Dja, Cameroon

Dja, Cameroon


Salonga, Dem Rep. Congo

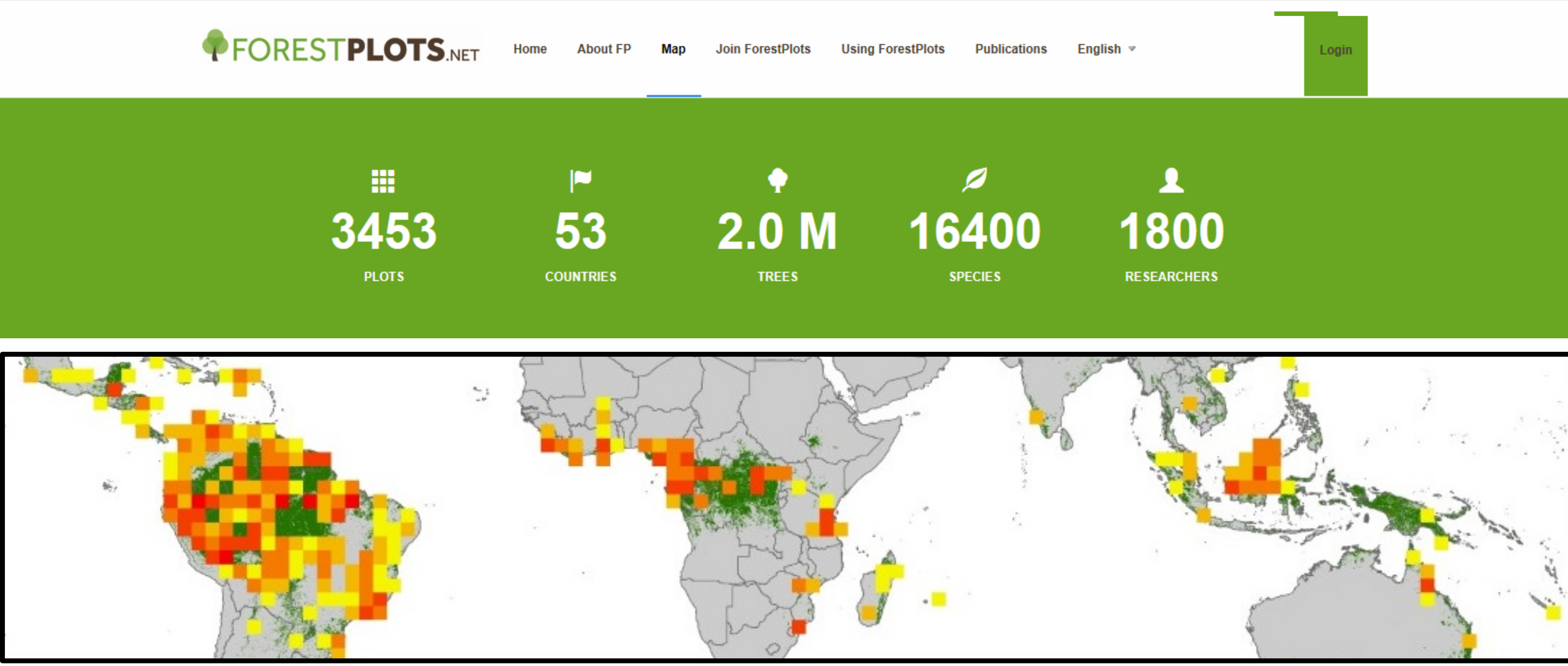
Ground observations



Red = multi-census

Yellow = single census

Ground observations



RAINFOR **AfriTRON** **T-FORCES**

Red = more than 20 plots

Ground observations

RAINFOR

>300 researchers
>100 partner insitutions

AfriTRON

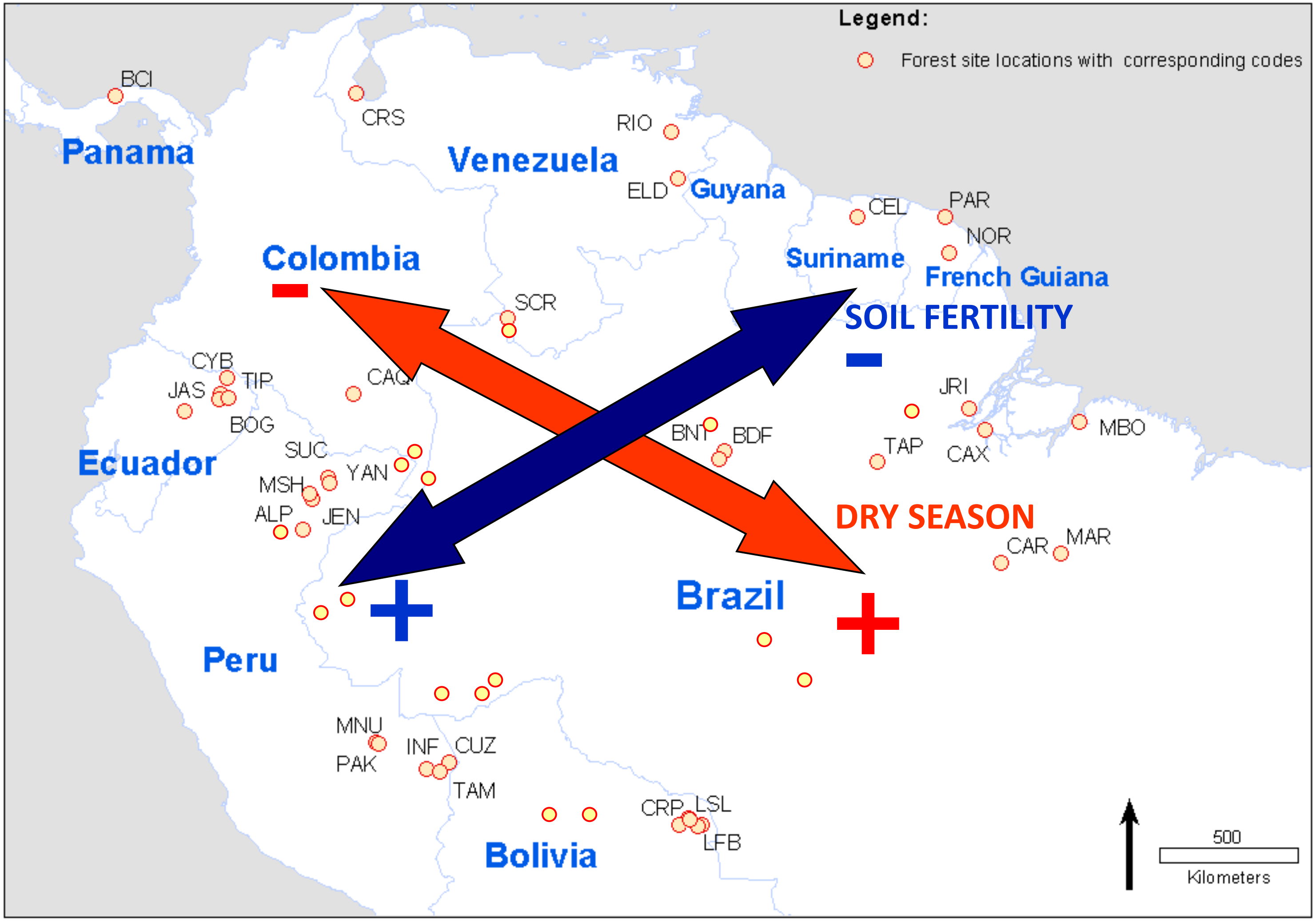
>70 researchers
>40 partner insitutions

T-FORCES

>40 researchers
>20 partner instiutions

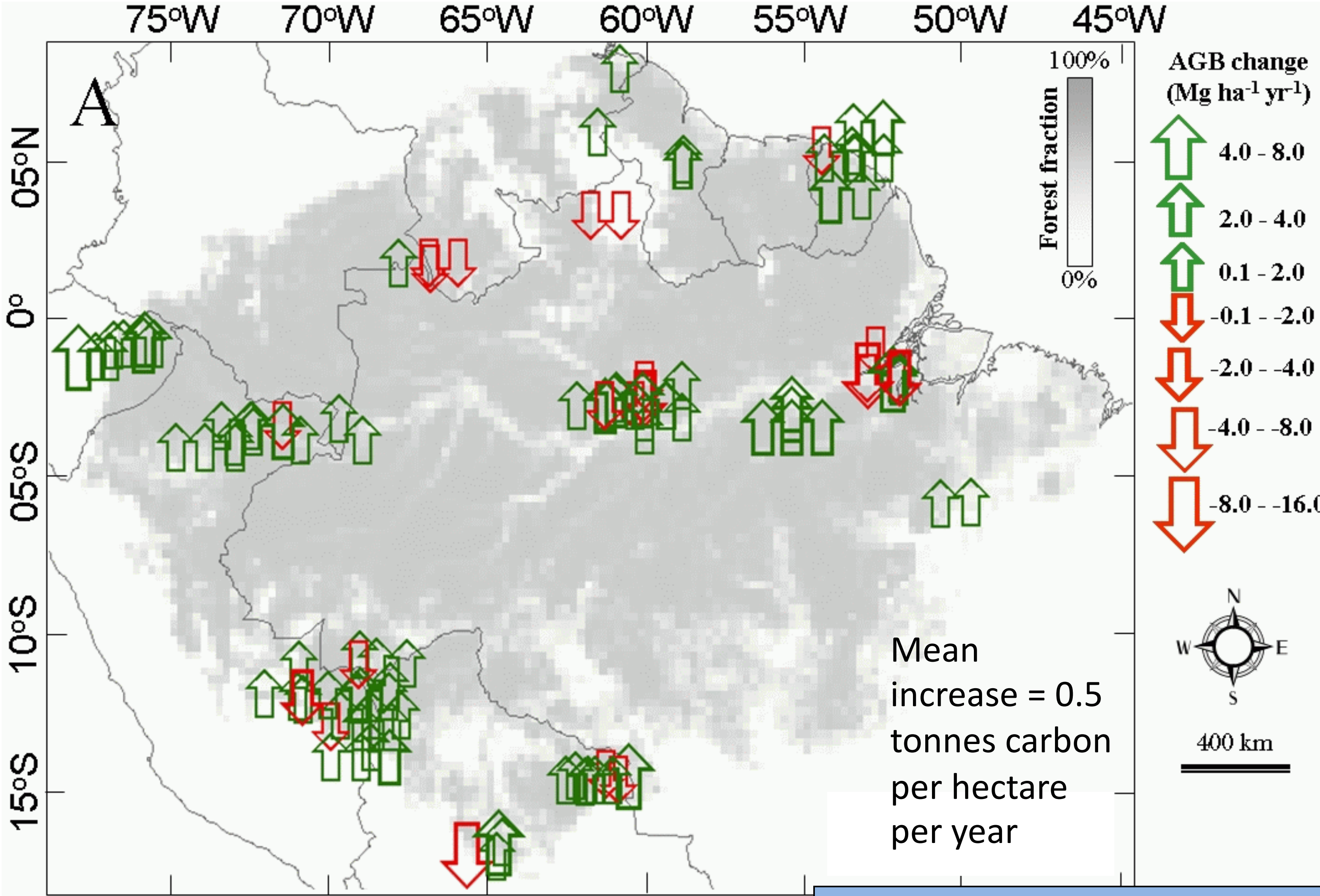
Global teamwork - people

Amazon, 123 RAINFOR plots 1980-2005



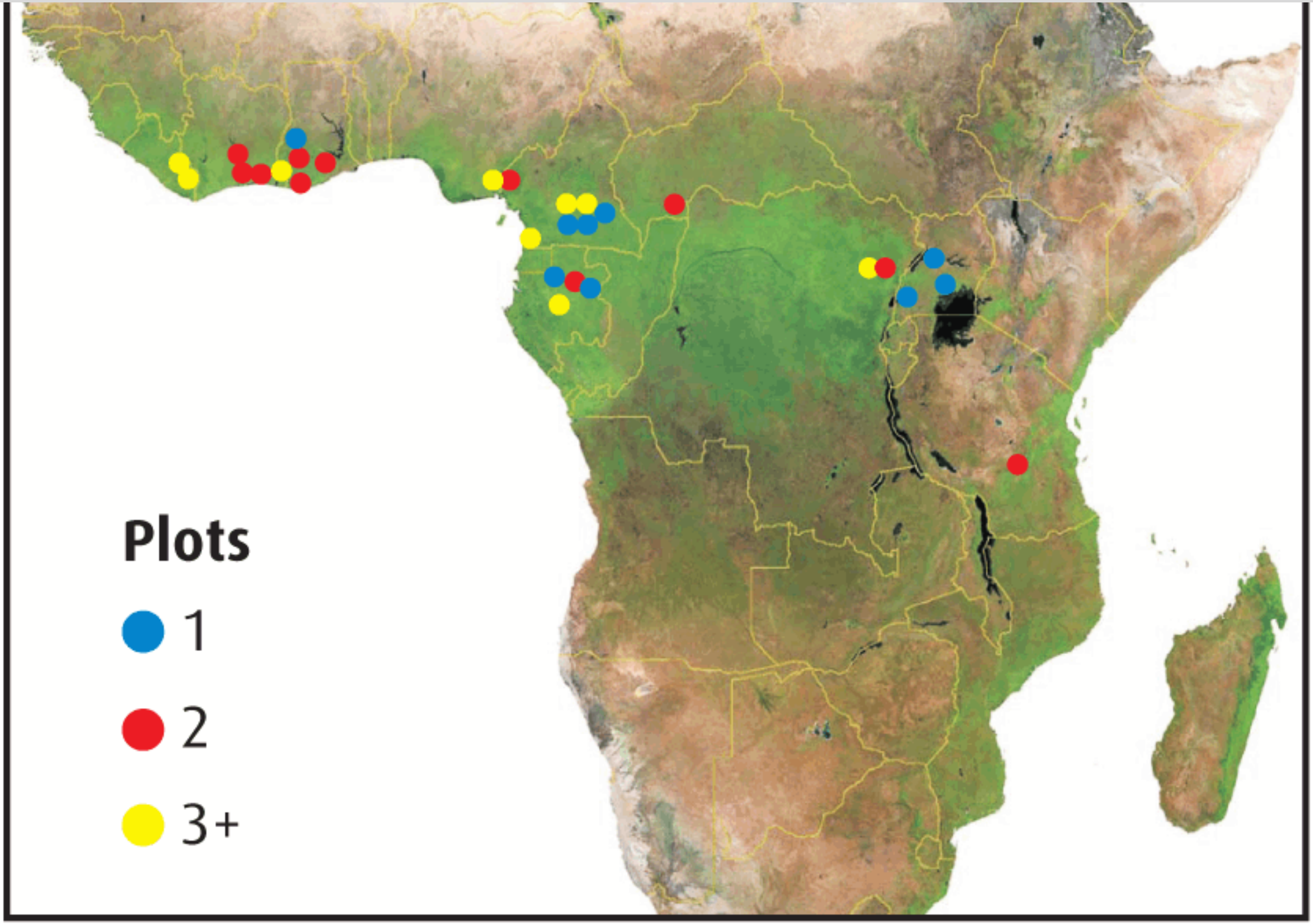
123 Plots, 44 different landscapes

Biomass trend, 123 RAINFOR plots 1980-2005



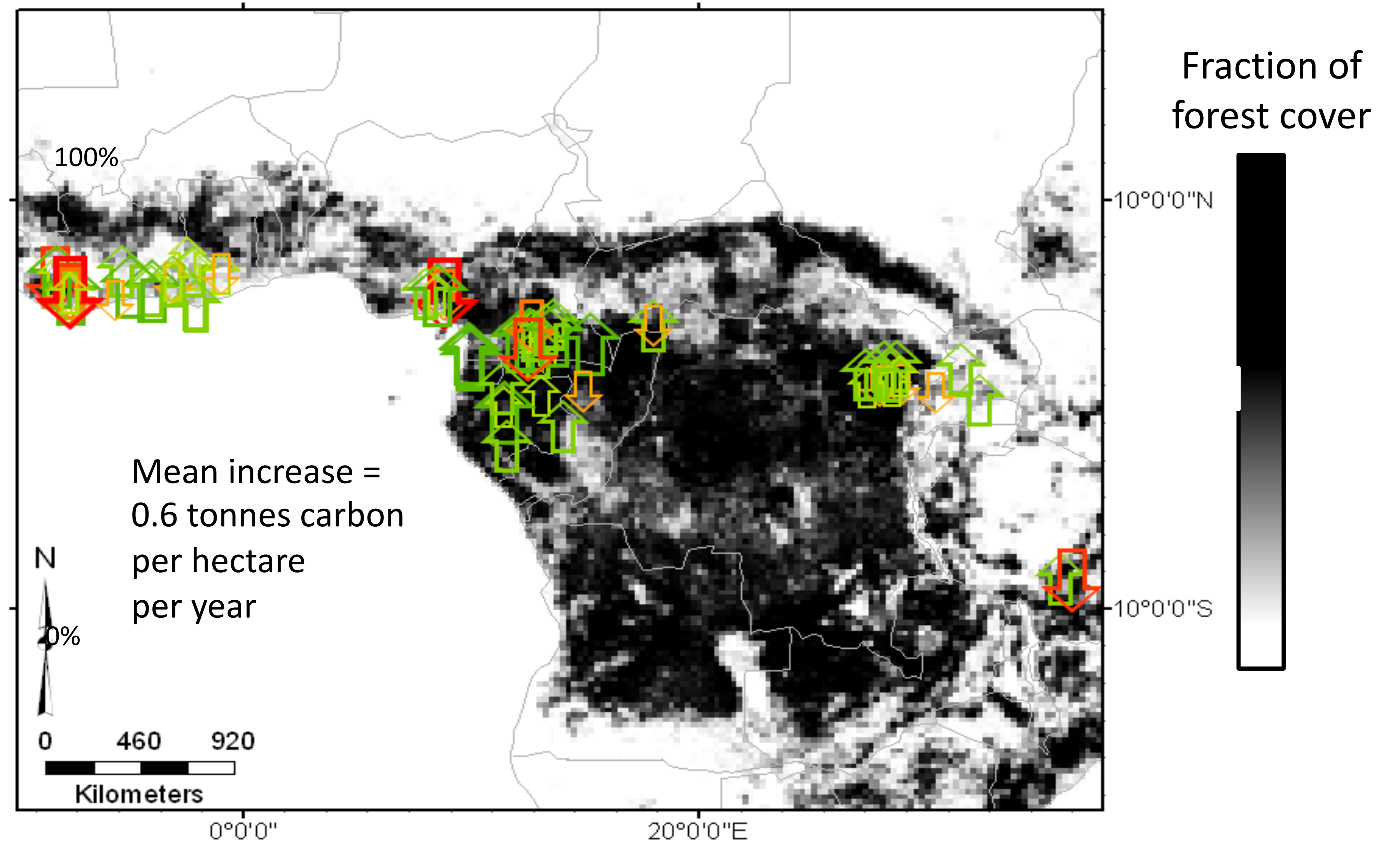
Phillips, Aragao, Lewis et al. 2009. *Science*

Africa, 79 AfriTRON plots, 1968-2007



Lewis et al. 2009, *Nature.*

Biomass change, 79 AfriTRON plots 1968-2007

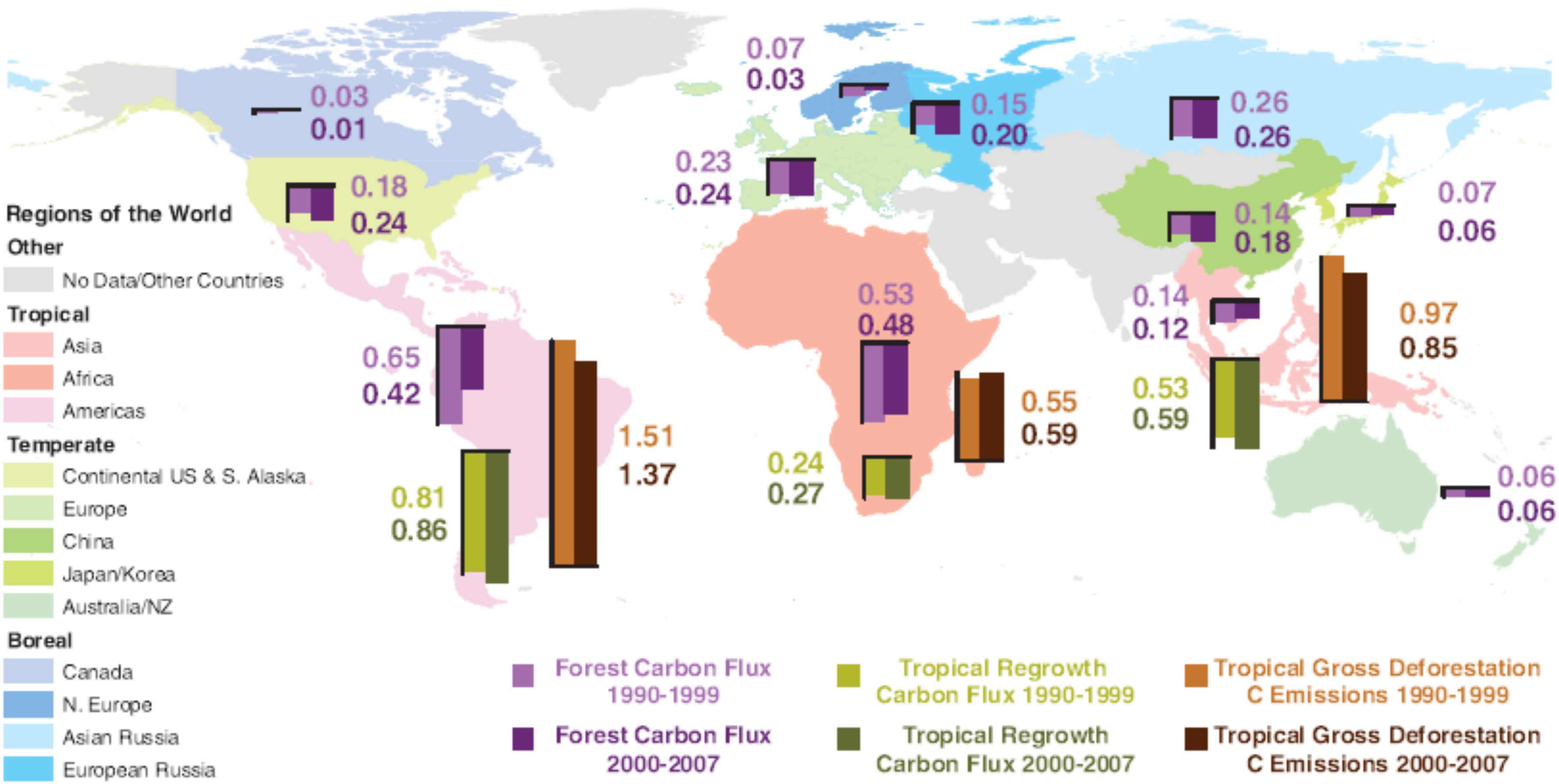


Lewis et al. 2009, *Nature.*

Science

A Large and Persistent Carbon Sink in the World's Forests

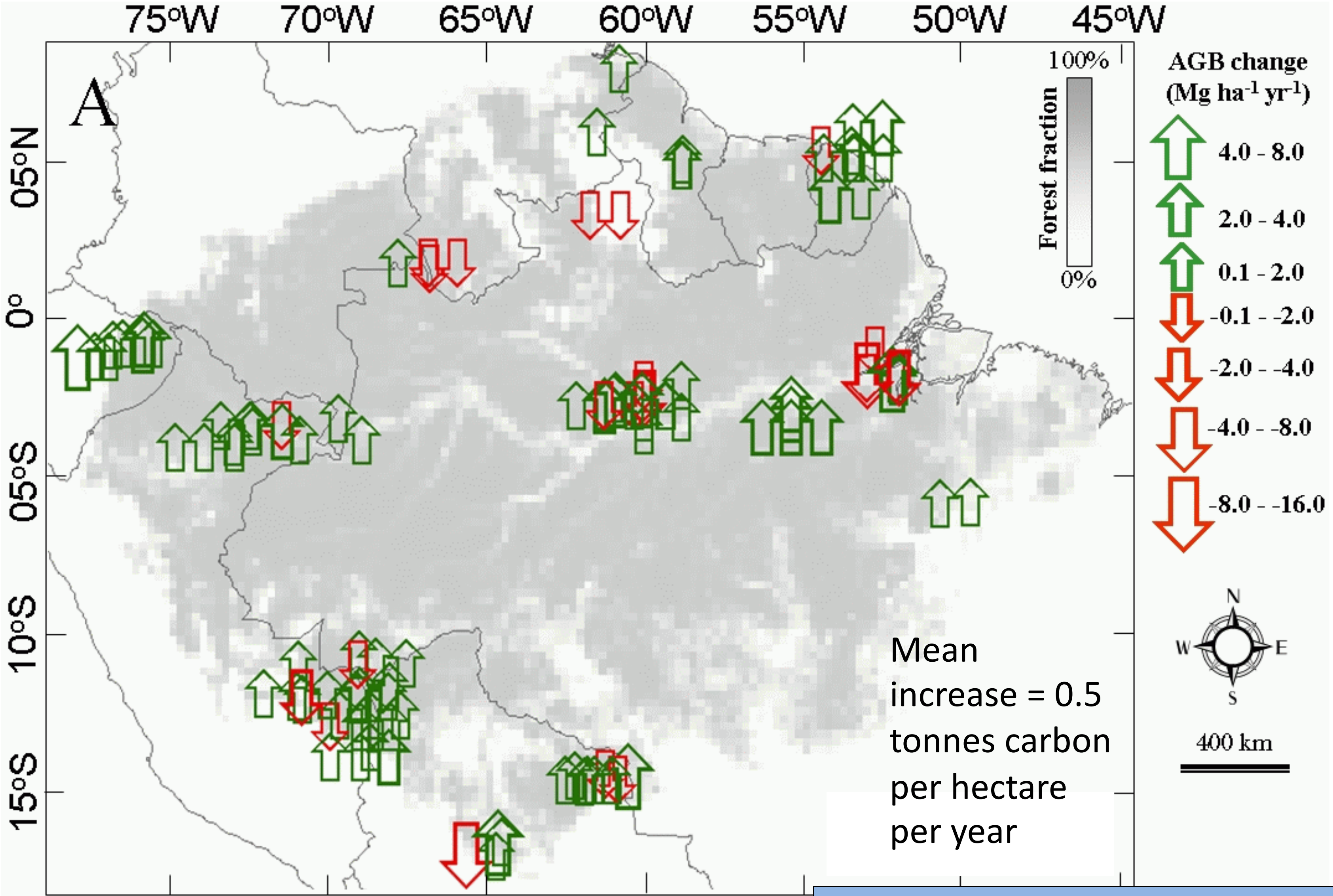
1990 to 2007



Pg C per year = billion tonnes C per year

Pan et al. incl. Lewis 2011. *Science*

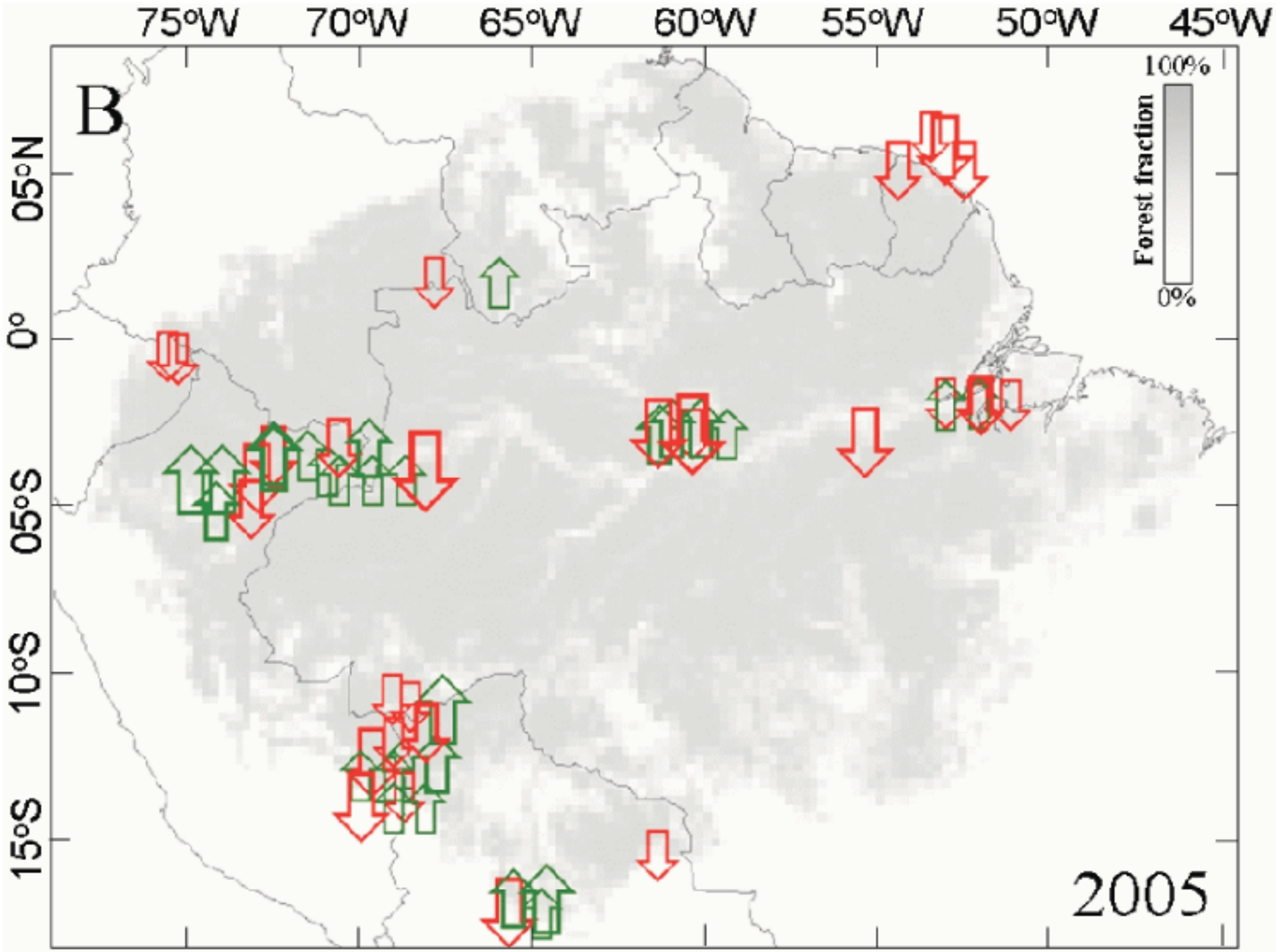
Biomass trend, 123 RAINFOR plots 1980-2005



Mean increase = 0.5 tonnes carbon per hectare per year

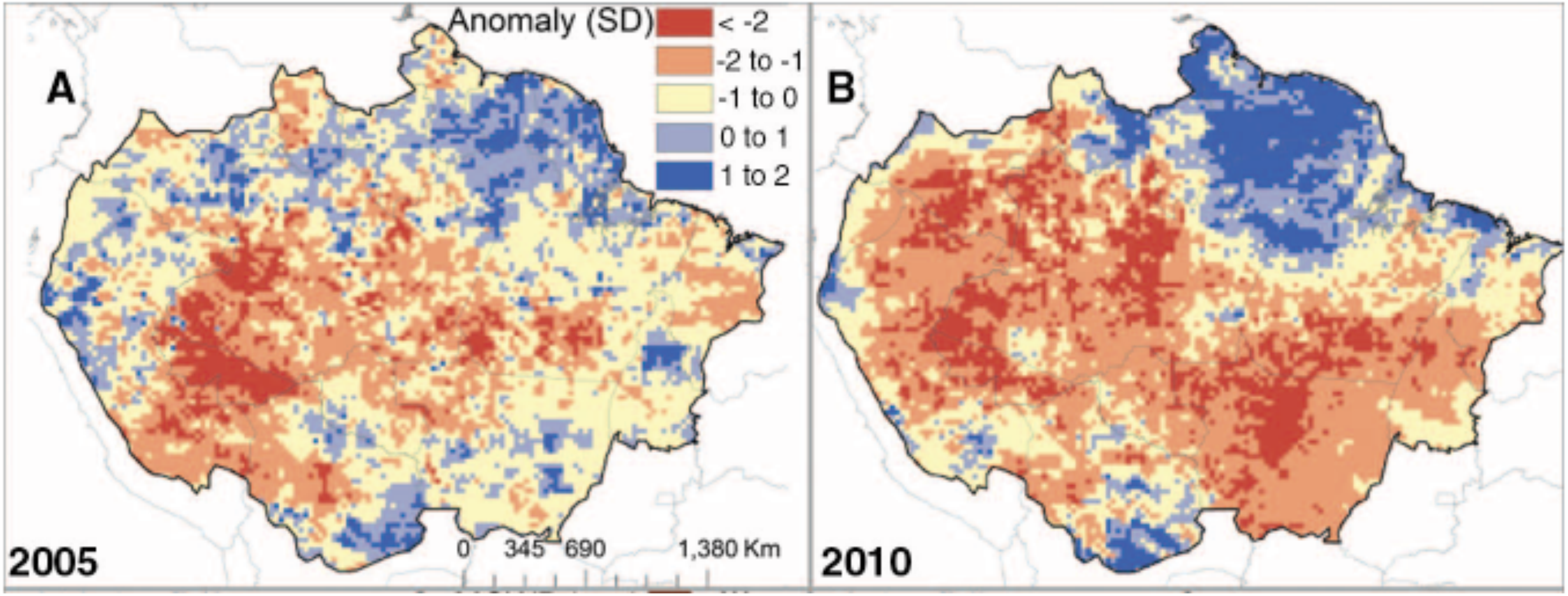
Phillips, Aragao, Lewis et al. 2009. *Science*

2005 Amazon led to committed *loss* of 0.9 [0.2,1.6] Pg C



Future carbon sink is uncertain: Amazon droughts

Jul/Aug/Sep (dry season) rainfall anomaly

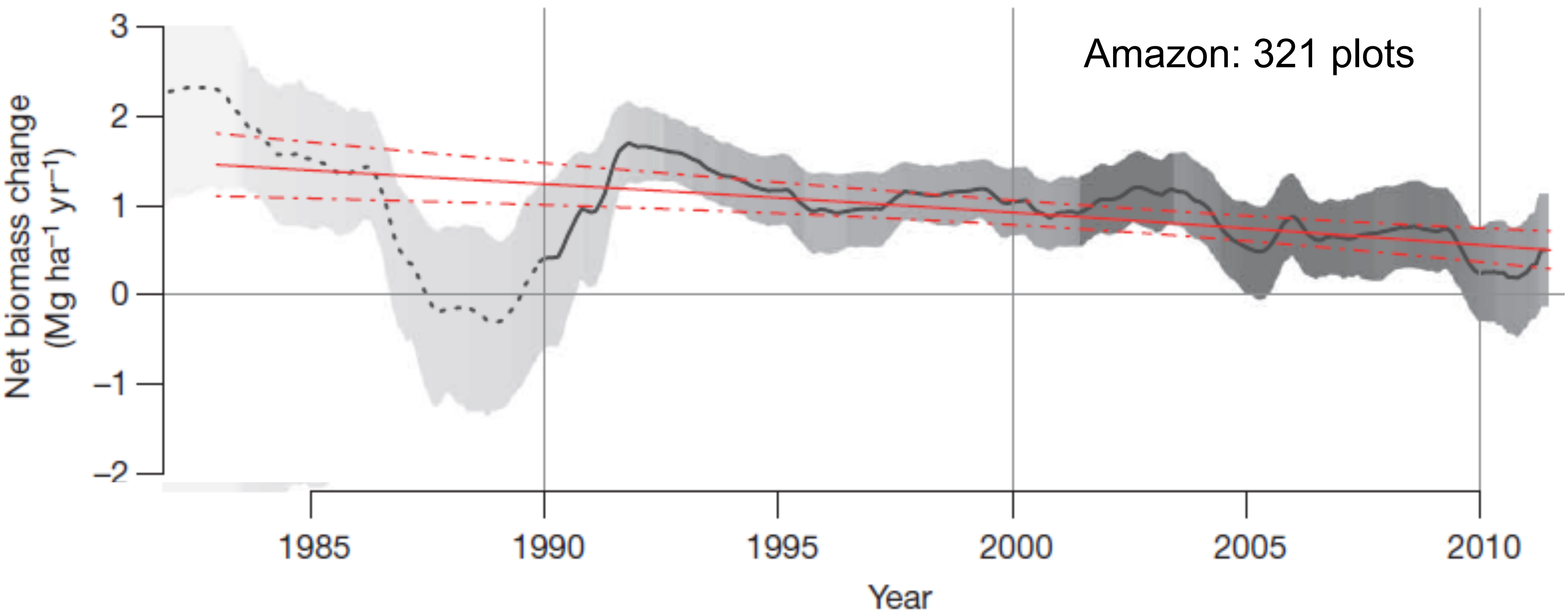


RED = drier than usual

Lewis et al. 2011, *Science*.

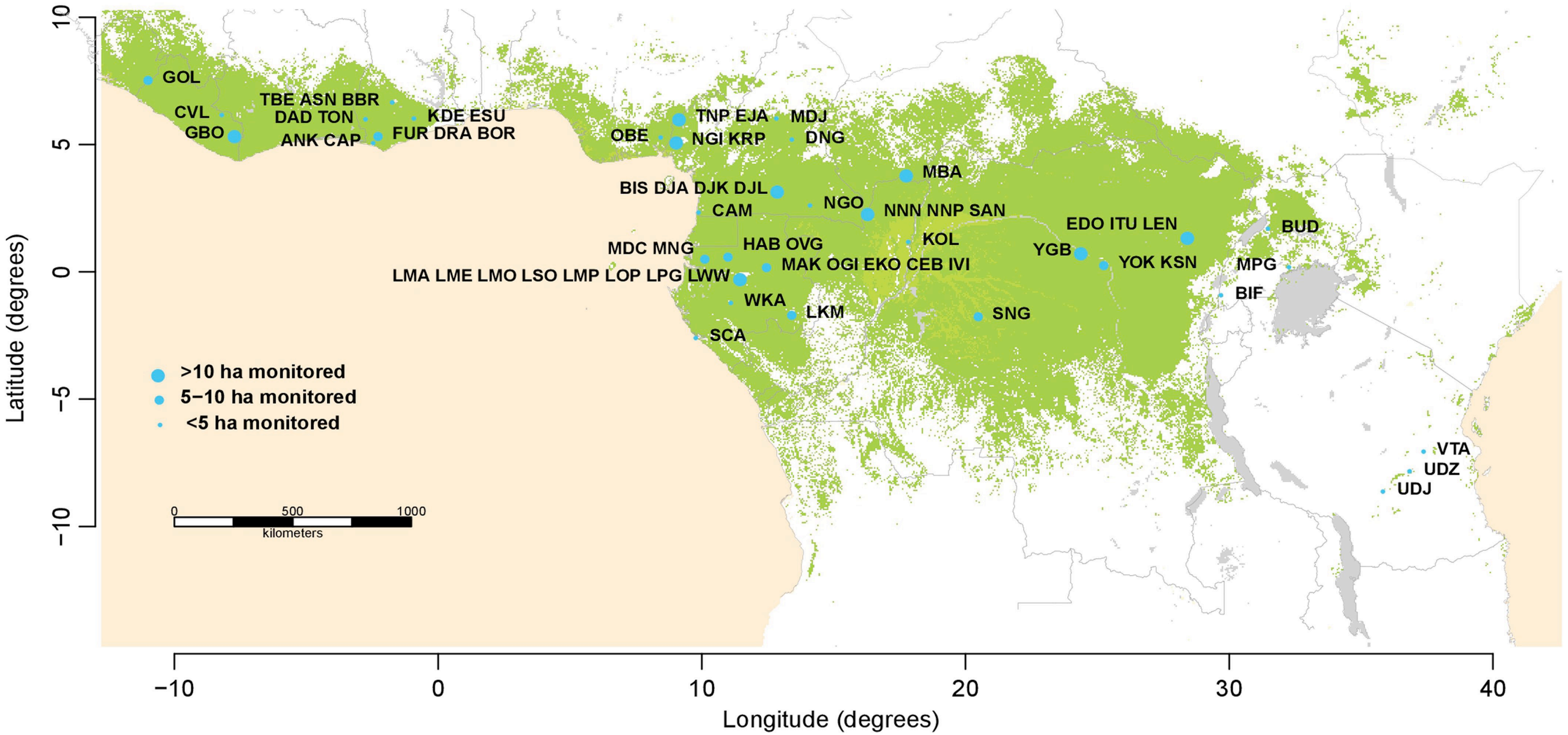
Tropical forests: 2020 results

Amazonian tropical forest sink declining since 1990s



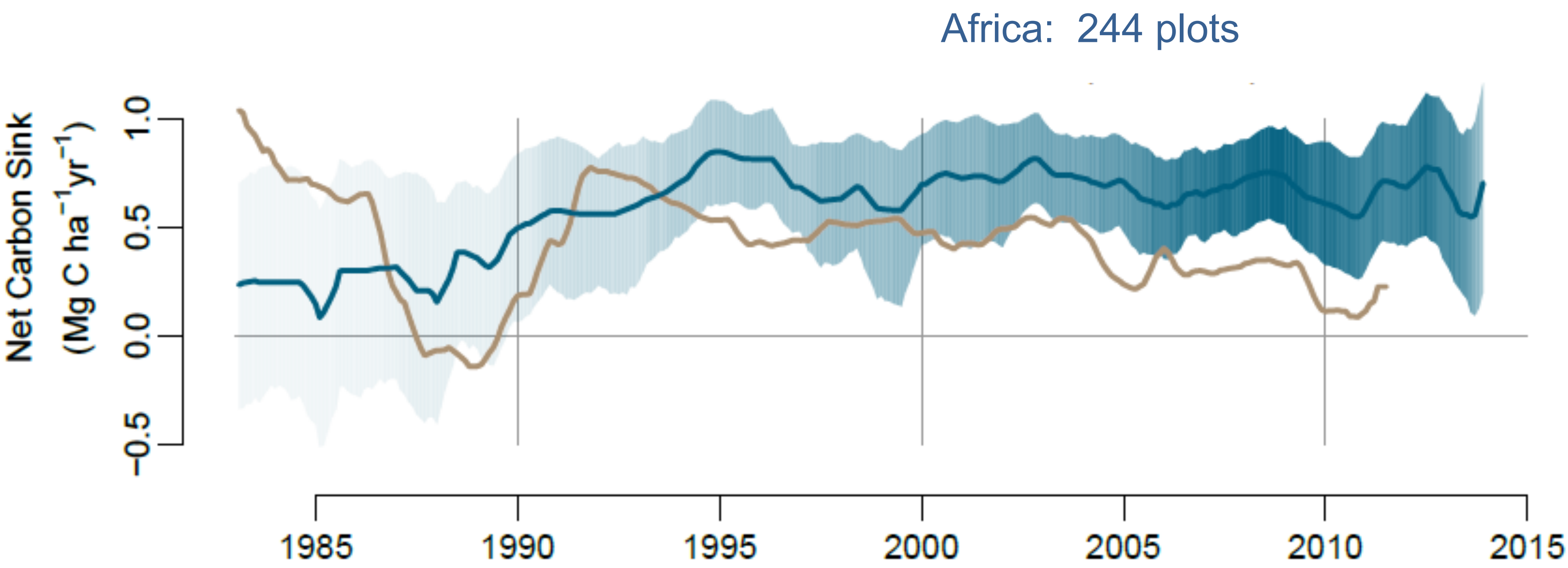
Brienen et al. incl. Lewis 2015. *Nature*

African tropical forest sink sampling



Hubau, Lewis, et al. 2020. *Nature*

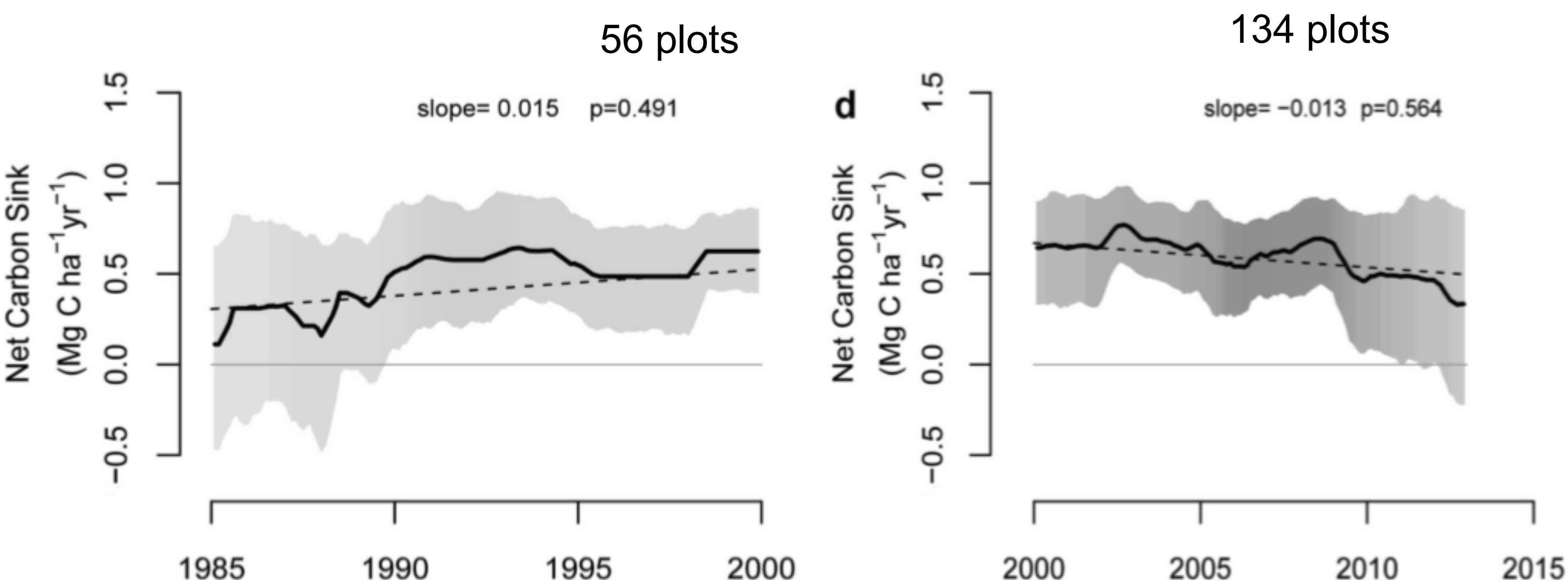
African tropical forest sink has been stable since 1990s



Sinks of Earth's two largest tropical forests have diverged

Hubau, Lewis, et al. 2020. *Nature*

African tropical forest sink has also saturated



Hubau, Lewis, et al. 2020. *Nature*

Pan-tropical total forest sink is declining

Declining per unit area forest sink capacity

Declining area of intact tropical forest area

Hubau, Lewis, et al. 2020. *Nature*

Pan-tropical biomass forest sink is declining

Declining per unit area forest sink capacity

Declining area of intact tropical forest area

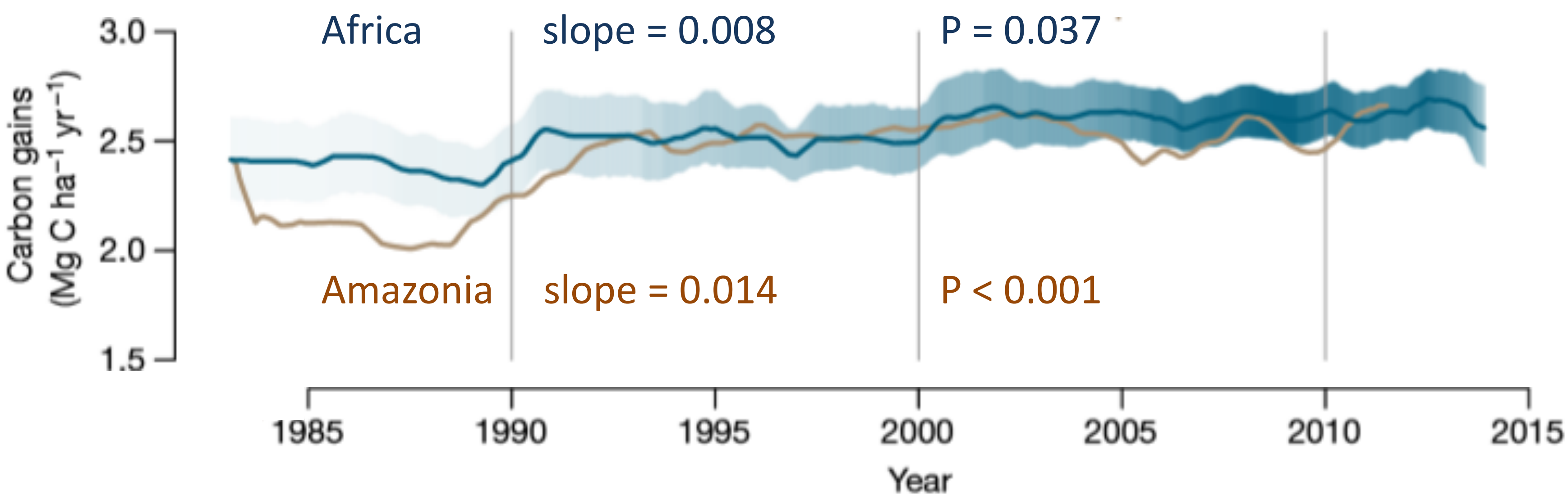
Period	Total C sink[a] (Pg C yr^{-1})		
	Africa	Amazon	Pan-tropics[b]
1980-1990	**0.28** (0.05–0.53)	**0.49** (0.08–0.82)	**0.87** (0.16–1.52)
1990–2000	**0.50** (0.32–0.66)	**0.68** (0.54–0.83)	**1.26** (0.88–1.63)
2000–2010	**0.46** (0.37–0.56)	**0.45** (0.31–0.57)	**0.99** (0.70–1.25)
2010–2020[d]	**0.37** *(0.21–0.53)*	**0.25** *(–0.05–0.54)*	**0.68** *(0.17–1.16)*

46% loss of total forest sink capacity

Hubau, Lewis, et al. 2020. *Nature*

Mechanism of saturation: tree growth

Increases on both continents, but now saturating in Amazonia

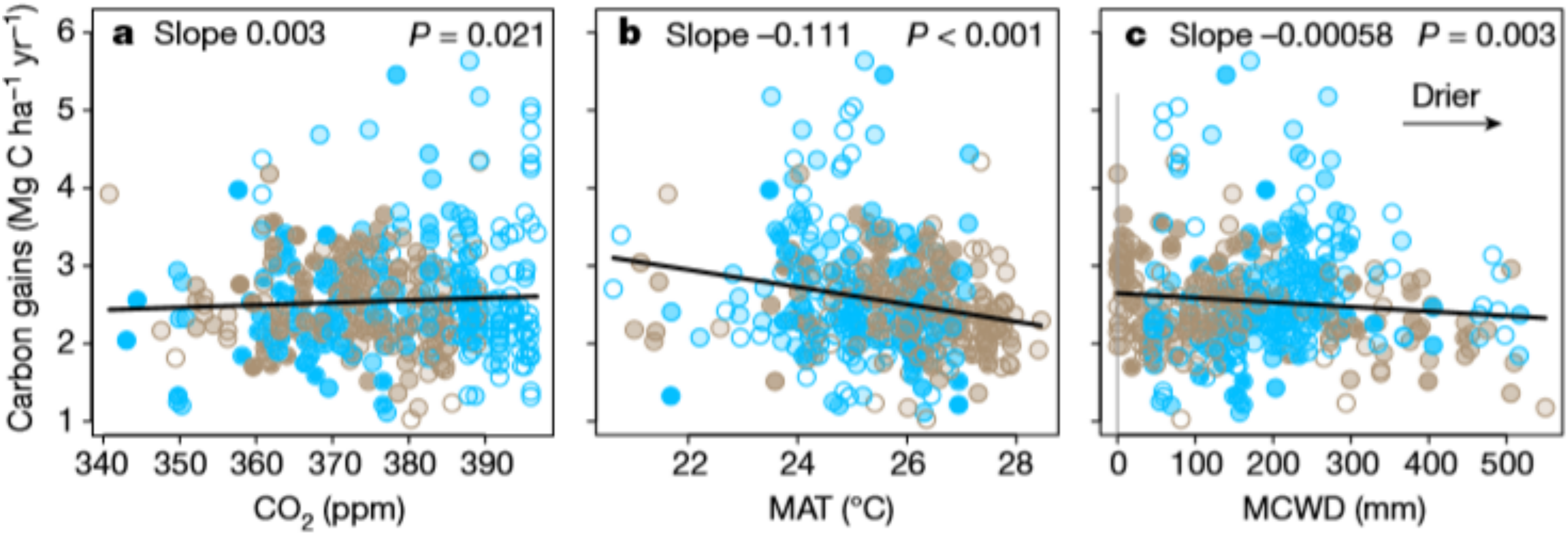


1 Mg = 1 metric tonne

Hubau, Lewis, et al. 2020. *Nature*

Mechanism of saturation: tree growth

More carbon dioxide increases tree growth
Higher temperature increases tree growth
Drought decreases tree growth

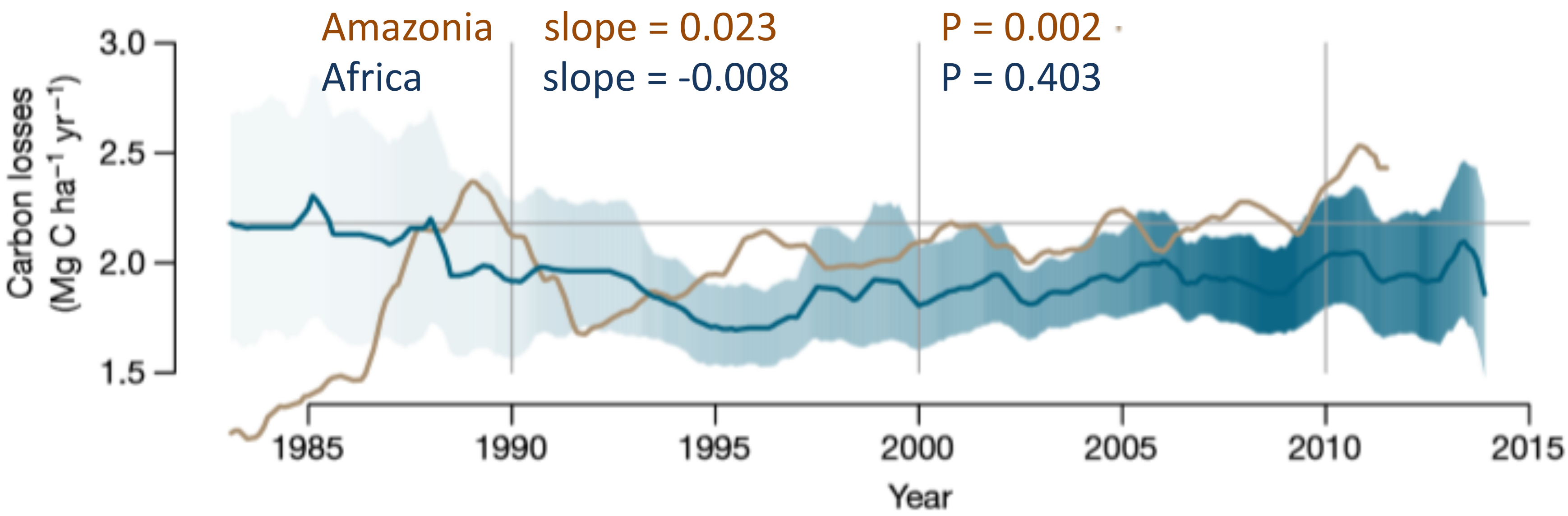


Blue Africa; Brown Amazonia

Hubau, Lewis, et al. 2020. *Nature*

Mechanism of saturation: tree mortality

Increasing carbon losses from mortality in Amazonia



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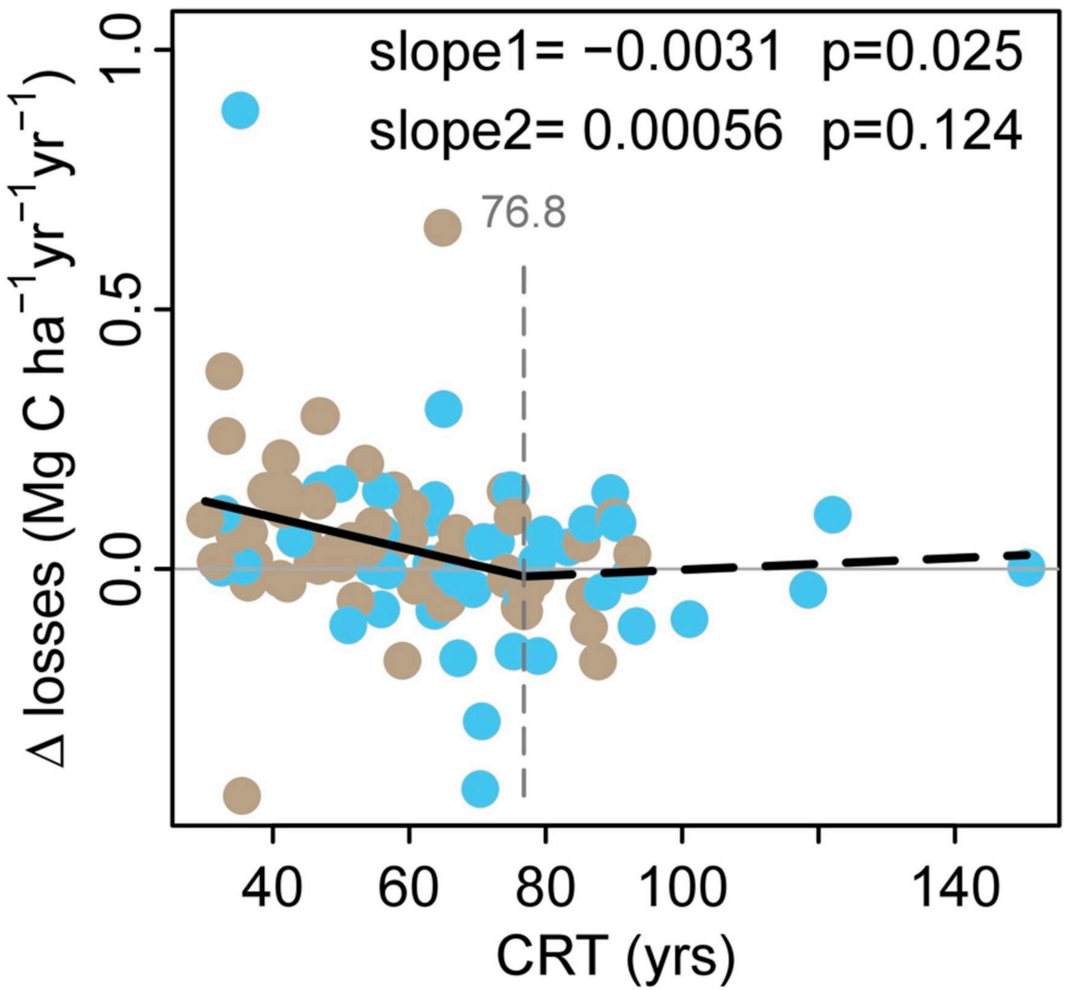
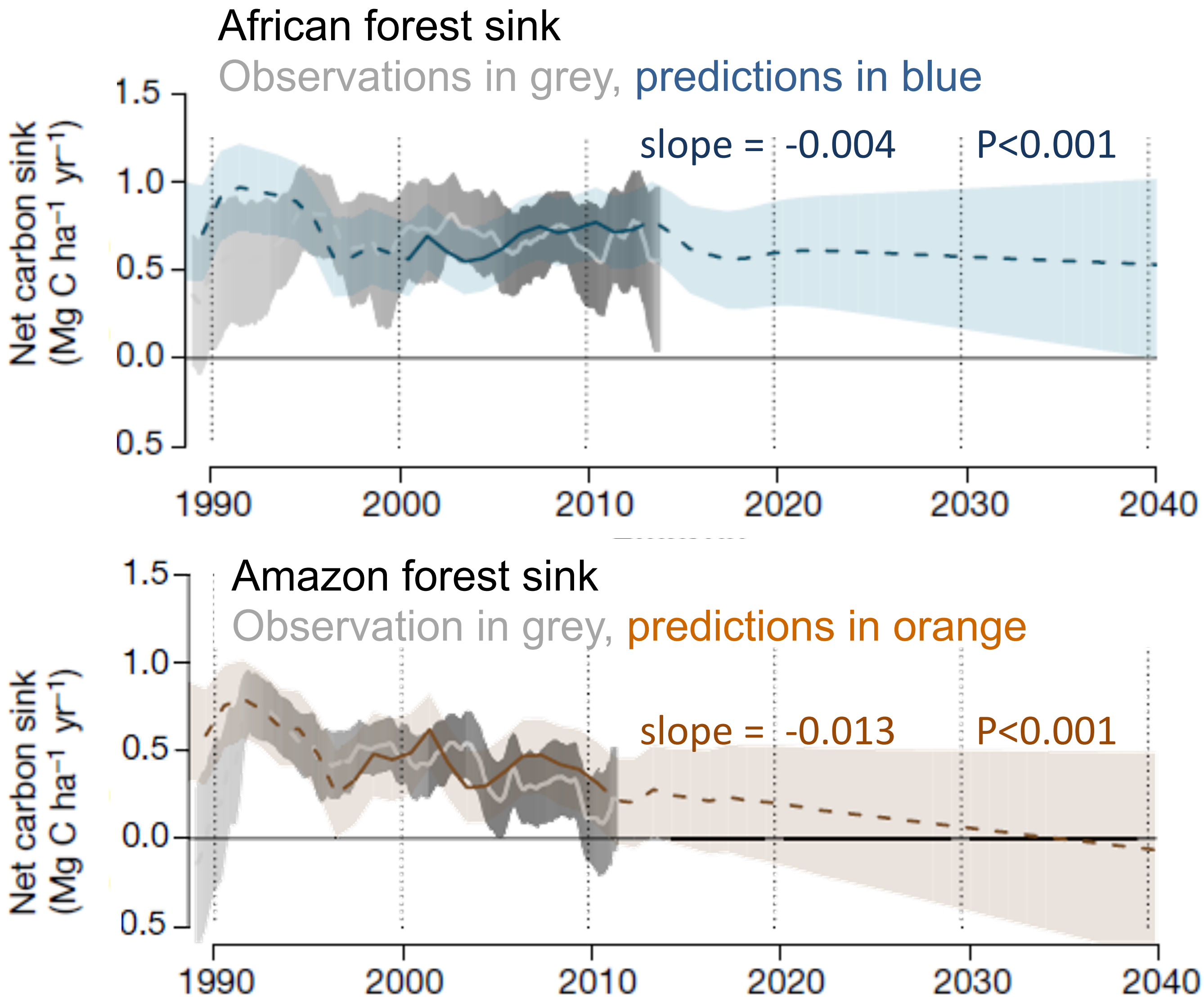
Mechanism of saturation: tree mortality



CRT = Carbon residence time

Hubau, Lewis, et al. 2020. *Nature*

Future of the tropical forest sink



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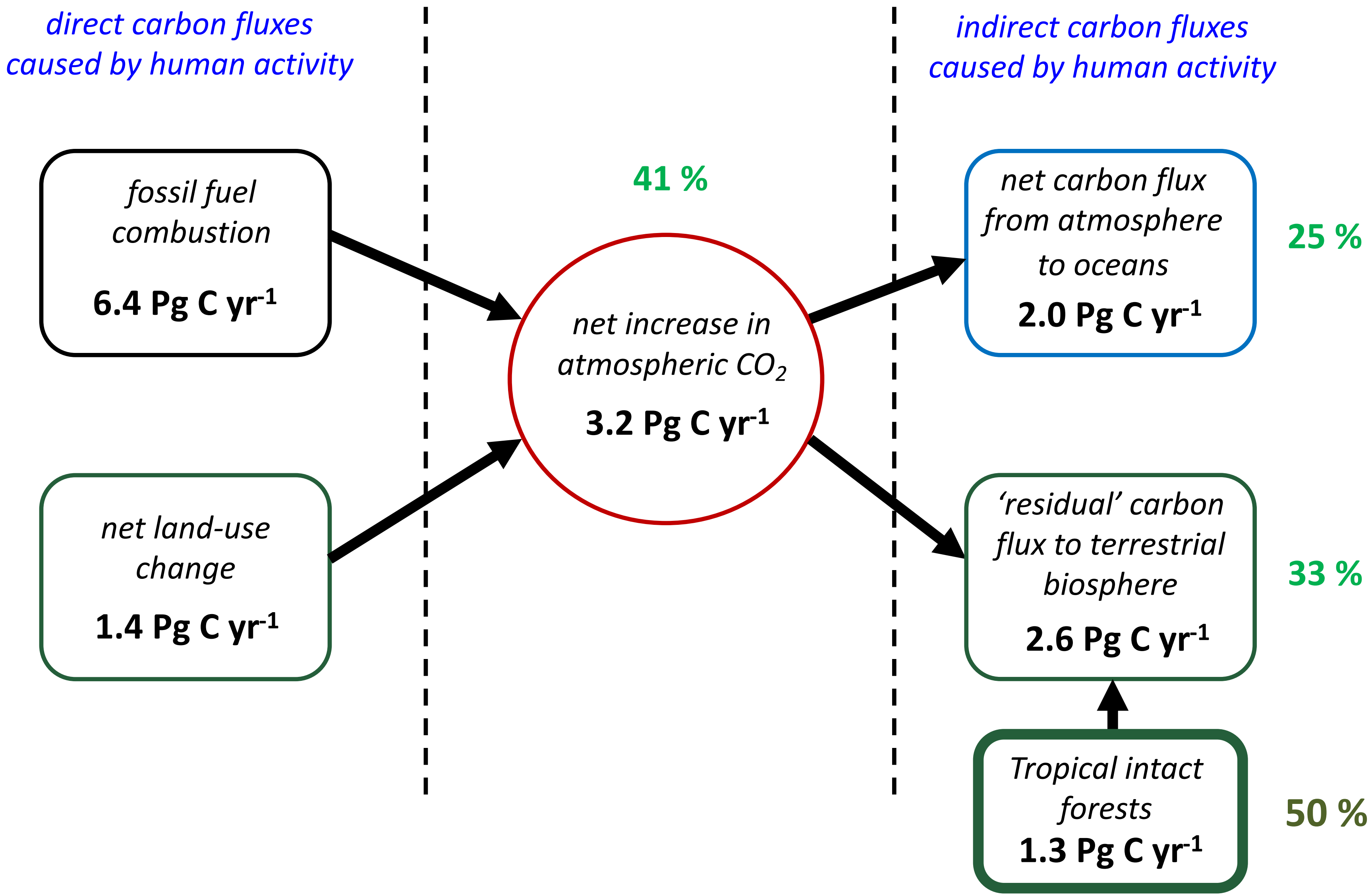
Overview: Annual carbon fluxes, 1990 to 1999



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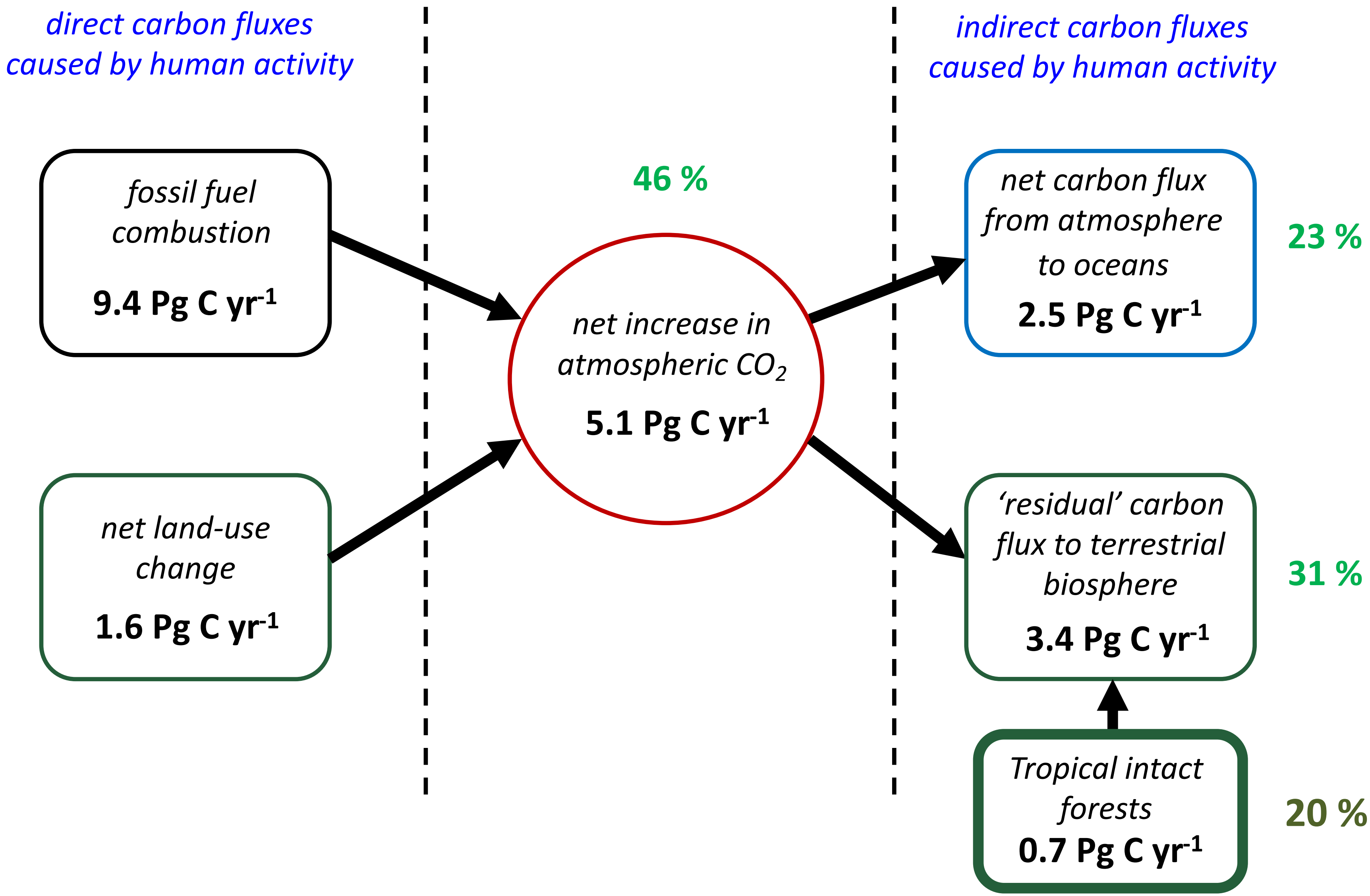

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Global Carbon Project data, after Lewis 2006

Take Home Messages

- Intact tropical forests are still a globally important carbon sink removing about **2.5 billion tonnes CO_2** from the atmosphere each year.
- Intact tropical forests were absorbing 17% of global anthropogenic CO_2 emissions in the 1990s, down to **just 6% in the 2000s**.
- The sink has saturated and is beginning to decline in the 2000s; the beginning of a carbon cycle feedback appears to be kicking in, decades ahead of even the most pessimistic climate models.

To protect tropical forests of the future

- Protection:
  - Development without destruction pathways, with local people at the heart of decision-making
  - Minimise climate impacts via limiting GHG emissions
- Connection:
  - corridors North-South and to high altitude areas, so species can move as the climate changes
- Restoration:
  - Bring the hydrological, climatic, and other benefits of forests back to areas with little forest remaining


Thanks for listening
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