GLOBAL MAPS OF 21ST CENTURY FOREST CARBON FLUXES

Nancy Harris, February 24, 2021

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Anthropogenic CO_2 sources and sinks (2009–2018)

Sources

34.7 $GtCO_2$/yr

86%

14%

5.5 $GtCO_2$/yr

= Sinks

17.9 $GtCO_2$/yr

44%

29%

11.5 $GtCO_2$/yr

23%

9.2 $GtCO_2$/yr

Budget Imbalance:
(the difference between estimated sources & sinks)

4%

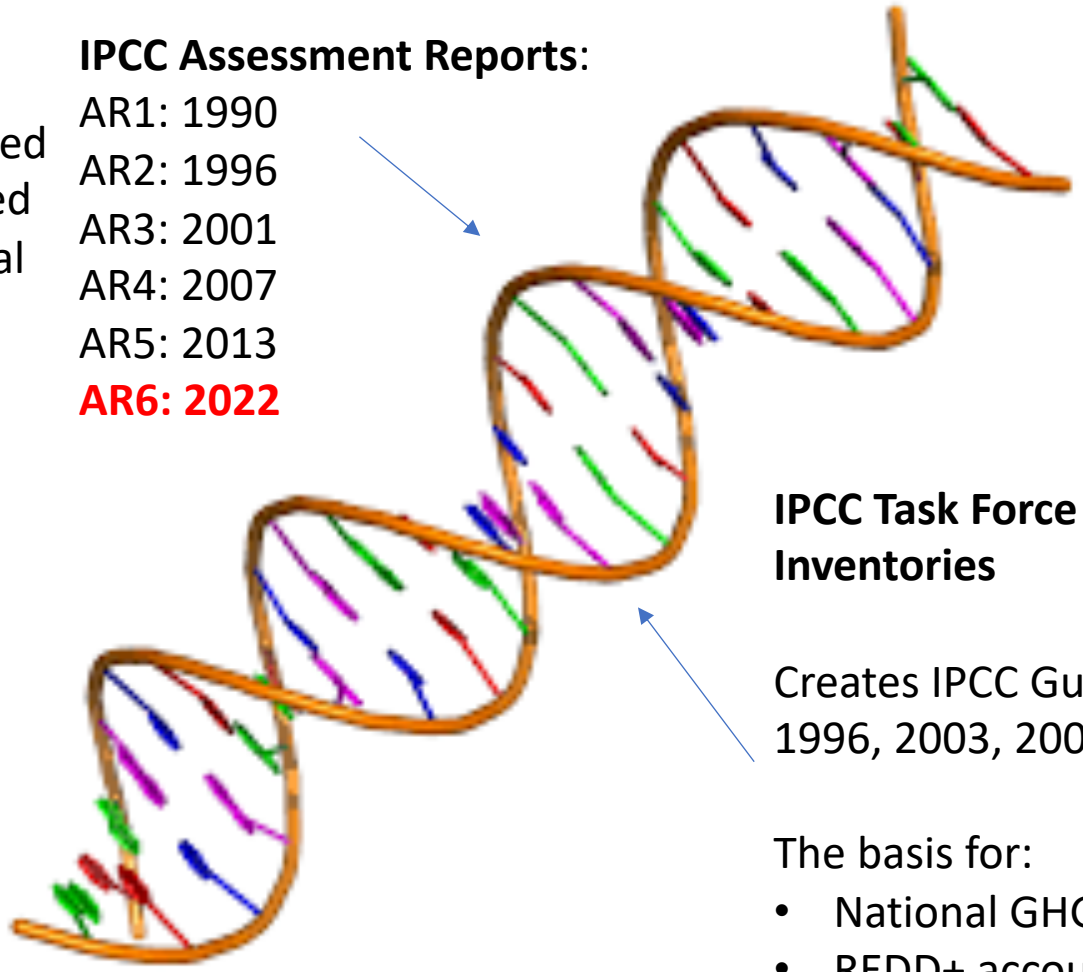
1.6 $GtCO_2$/yr

Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Friedlingstein et al 2019; Global Carbon Budget 2019

The Tale of Two IPCCs..

Based on published and peer reviewed scientific technical literature.

IPCC Assessment Reports:
AR1: 1990
AR2: 1996
AR3: 2001
AR4: 2007
AR5: 2013
AR6: 2022



IPCC Task Force on National Greenhouse Gas Inventories

Creates IPCC Guidelines for National Inventories 1996, 2003, 2006, 2019

The basis for:

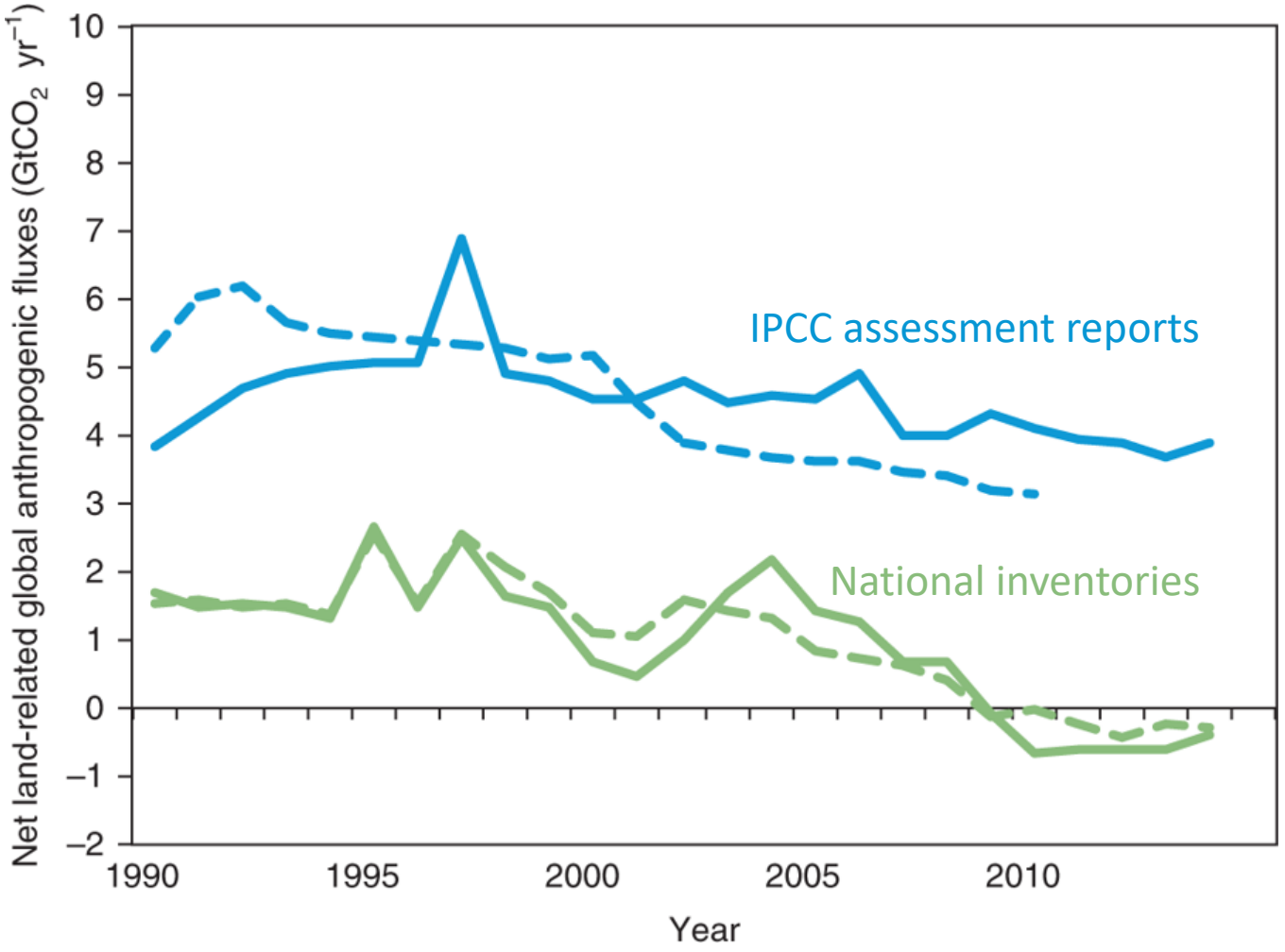
- National GHG Inventory reporting
- REDD+ accounting
- NDC target-setting
- Corporate GHG Inventory reporting
- Community GHG inventory reporting

Global Stocktake

(2023)

carried out once every five years to assess the collective progress made towards achieving the long-term goals of the Paris Agreement

Discrepancy in global estimates

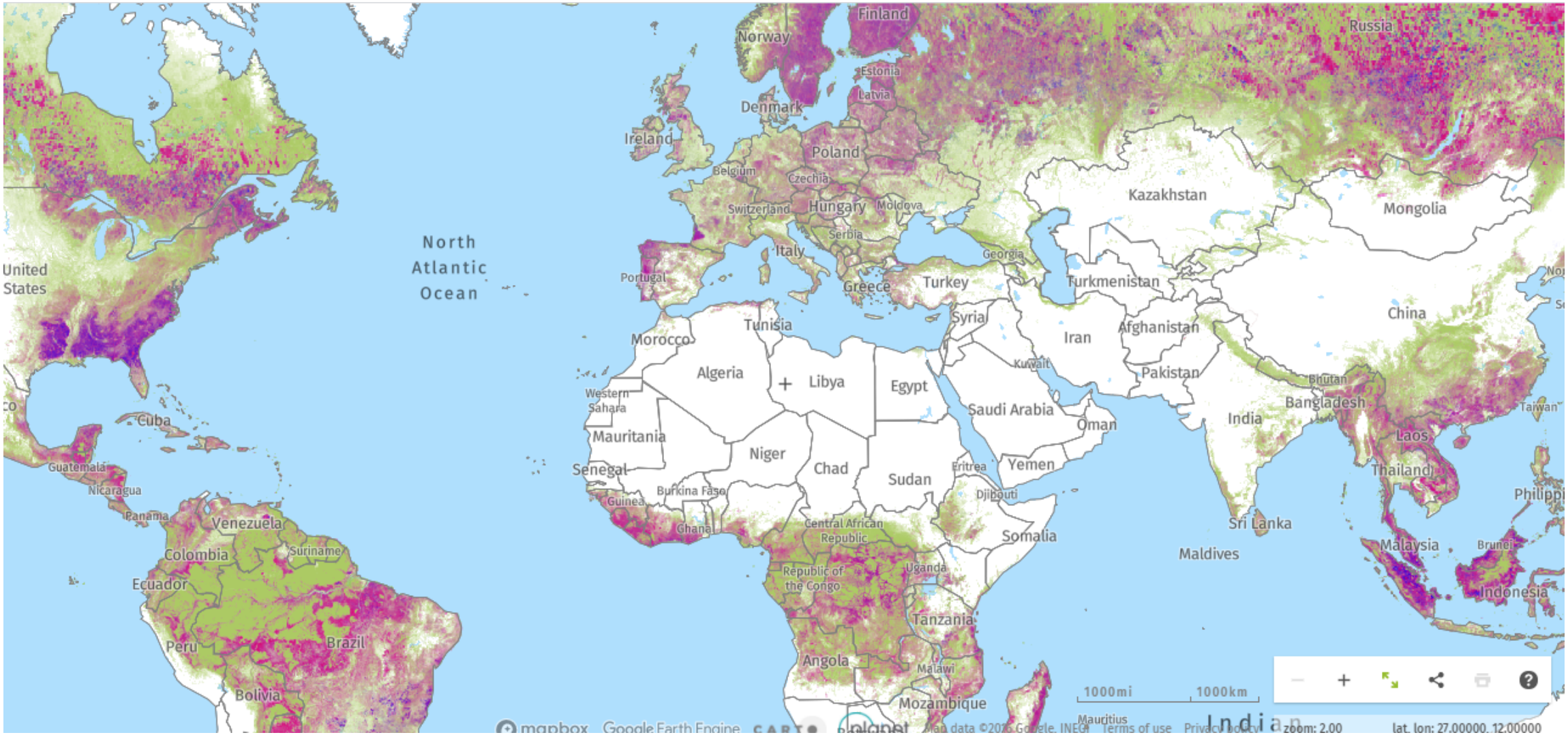


Grassi et al. 2018

How well do we know GHG fluxes from forests?

NOT WELL AT ALL.

We need a better empirical basis for measuring and tracking GHG fluxes from forests and more detailed information to inform climate policy.


Finland
Norway
Russia
Estonia
Latvia
Denmark
Ireland
Poland
Belgium
Czechia
Kazakhstan
Mongolia
Switzerland
Hungary
Moldova
Serbia
Italy
Georgia
North
Atlantic
Ocean
United
States
Portugal
Greece
Turkey
Turkmenistan
China
Syria
Tunisia
Afghanistan
Morocco
Iran
Algeria
Kuwait
Libya
Egypt
Pakistan
Bhutan
Western
Sahara
Saudi Arabia
Bangladesh
Taiwan
India
Cuba
Oman
Mauritania
Laos
Niger
Yemen
Guatemala
Chad
Sudan
Eritrea
Thailand
Nicaragua
Senegal
Djibouti
Burkina Faso
Philippi
Panama
Guinea
Venezuela
Central African
Republic
Somalia
Sri Lanka
Colombia
Ghana
Suriname
Malaysia
Maldives
Brunei
Ecuador
Republic of
the Congo
Uganda
Indonesia
Tanzania
Peru
Brazil
Angola
Malawi
Bolivia
Mozambique
1000mi
1000km
Mauritius
India
mapbox
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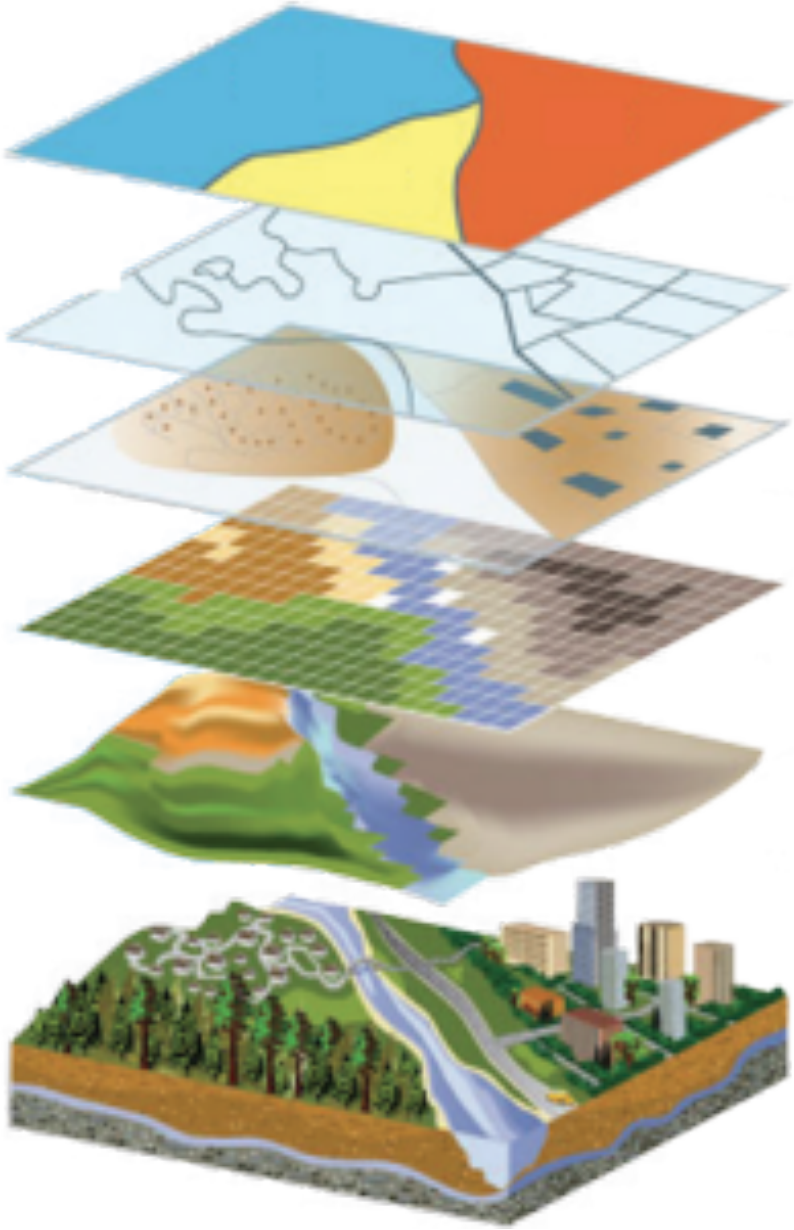
Map data ©2020 Google, INEGI
Terms of use
Privacy policy
zoom: 2.00
lat, lon: 27.00000, 12.00000

THE GOAL

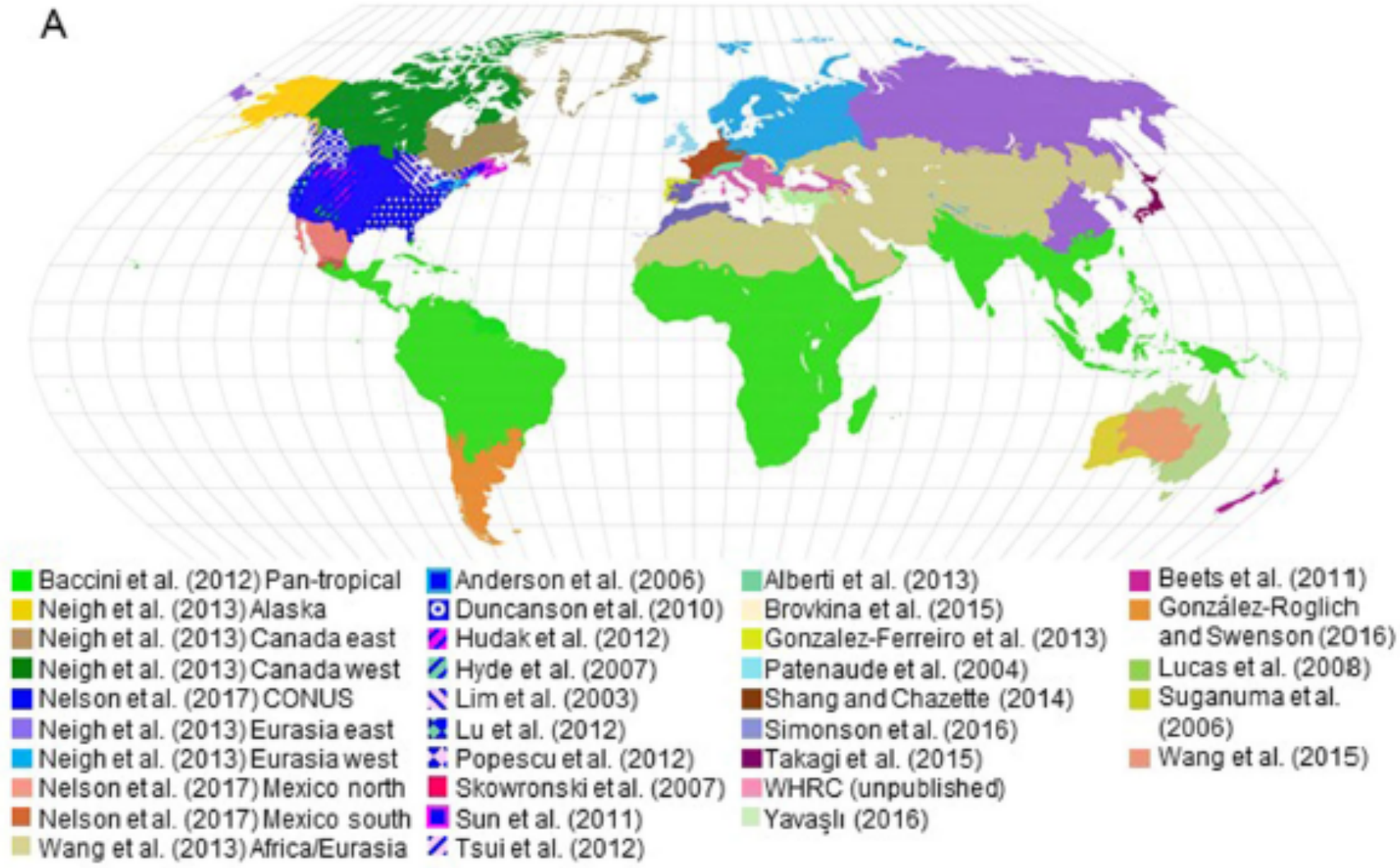
- Create 30-m global maps of forest-related greenhouse gas fluxes by combining IPCC methodologies with spatial data on forests

- Simulate forest greenhouse gas fluxes at 30 m from 2001-2019:
  - Gross emissions
  - Gross removals
  - Net GHG flux (difference between emissions and removals)

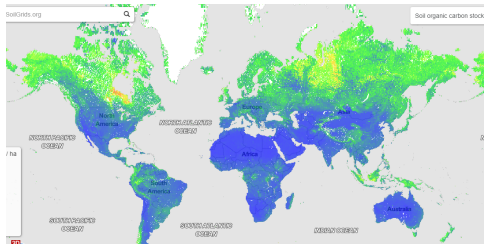


GLOBAL FOREST WATCH

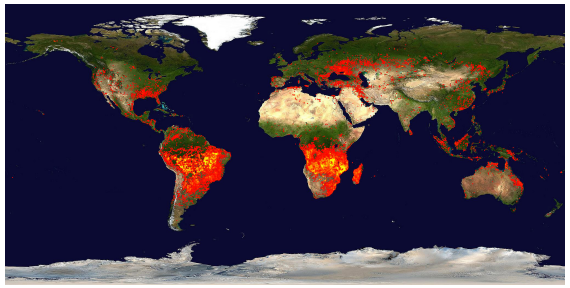
Map global biomass in 2000 @ 30m



Combine data sources in inventory framework

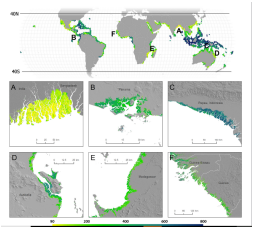


Soil Carbon
SoilGrids250, v2.0

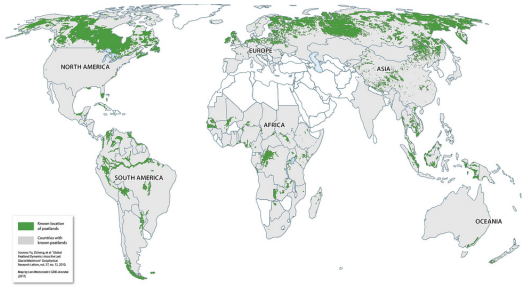


MODIS Burned Areas
Giglio et al. 2018

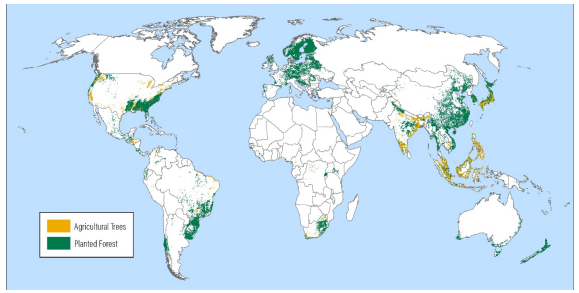
Mangrove Extent
Giri et al. 2000



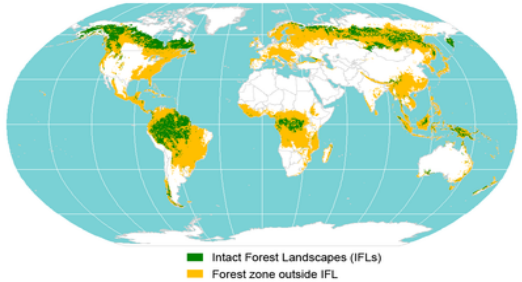
Mangrove Soil Carbon
Sanderman et al. 2018



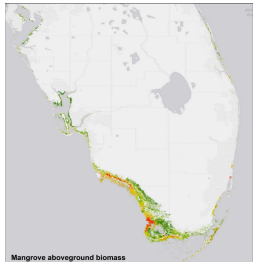
Peatlands
Gumbrect et al. 2017



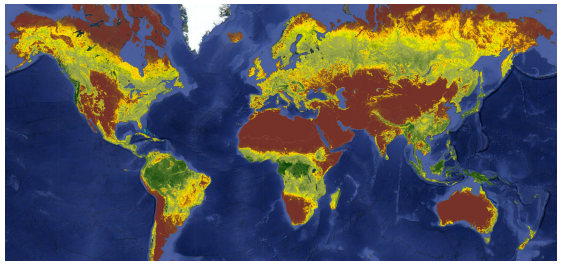
Plantations
Harris et al. 2019



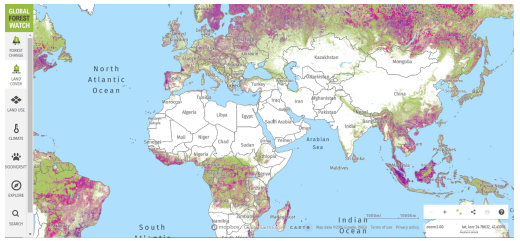
Intact Forests
Potapov et al. 2017



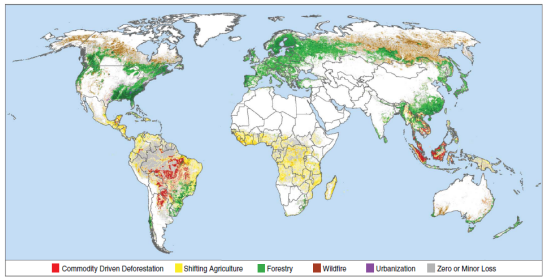
Mangrove Biomass
Simard et al. 2018



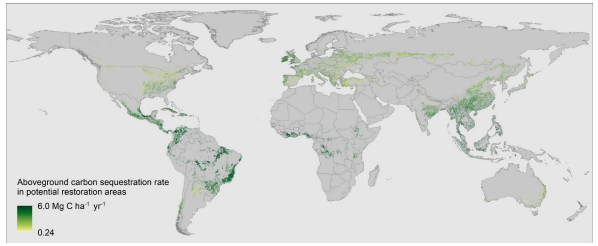
Biomass
Various



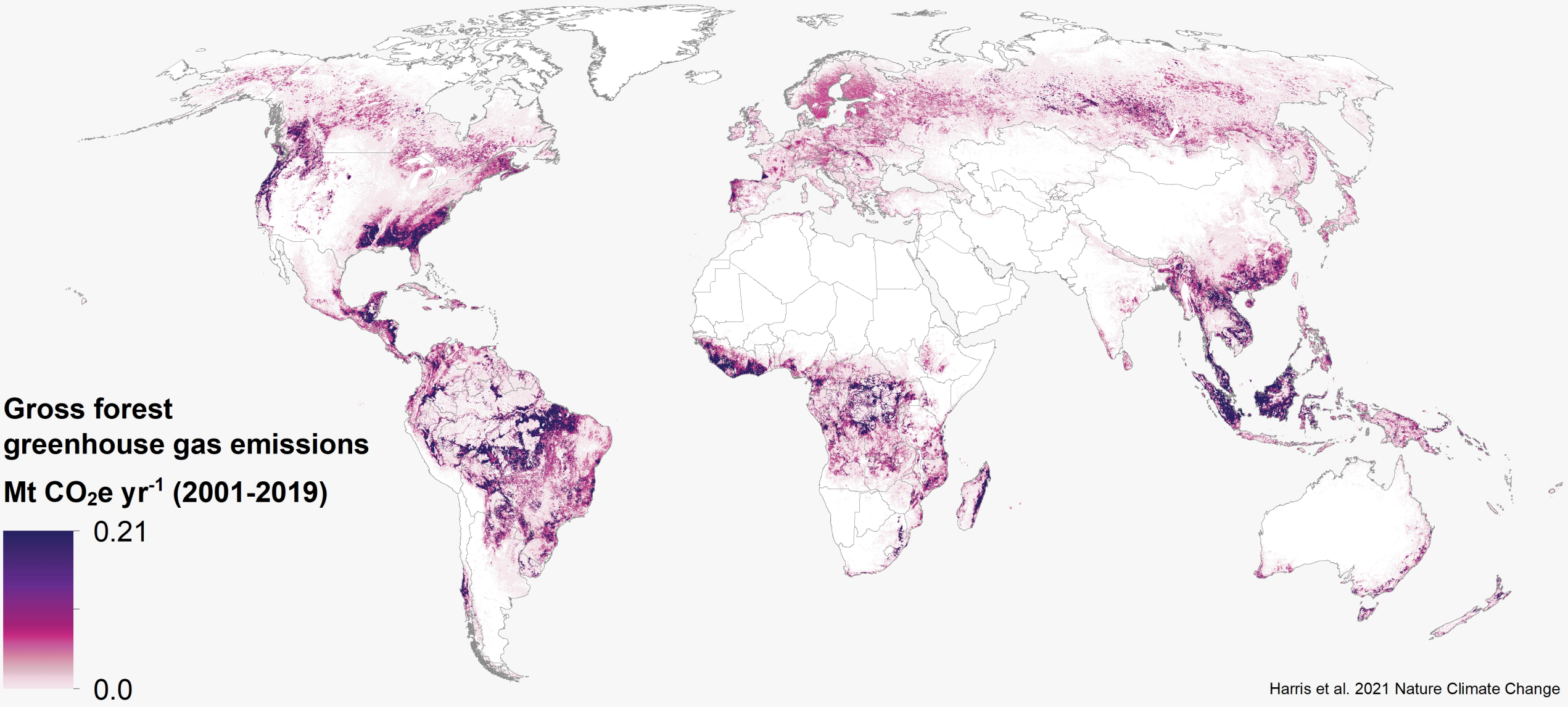
Tree Cover, Loss and Gain
Hansen et al. 2013



Drivers of Forest Loss
Curtis et al. 2018



Forest Regrowth C Rates
Cook-Patton et al. 2020



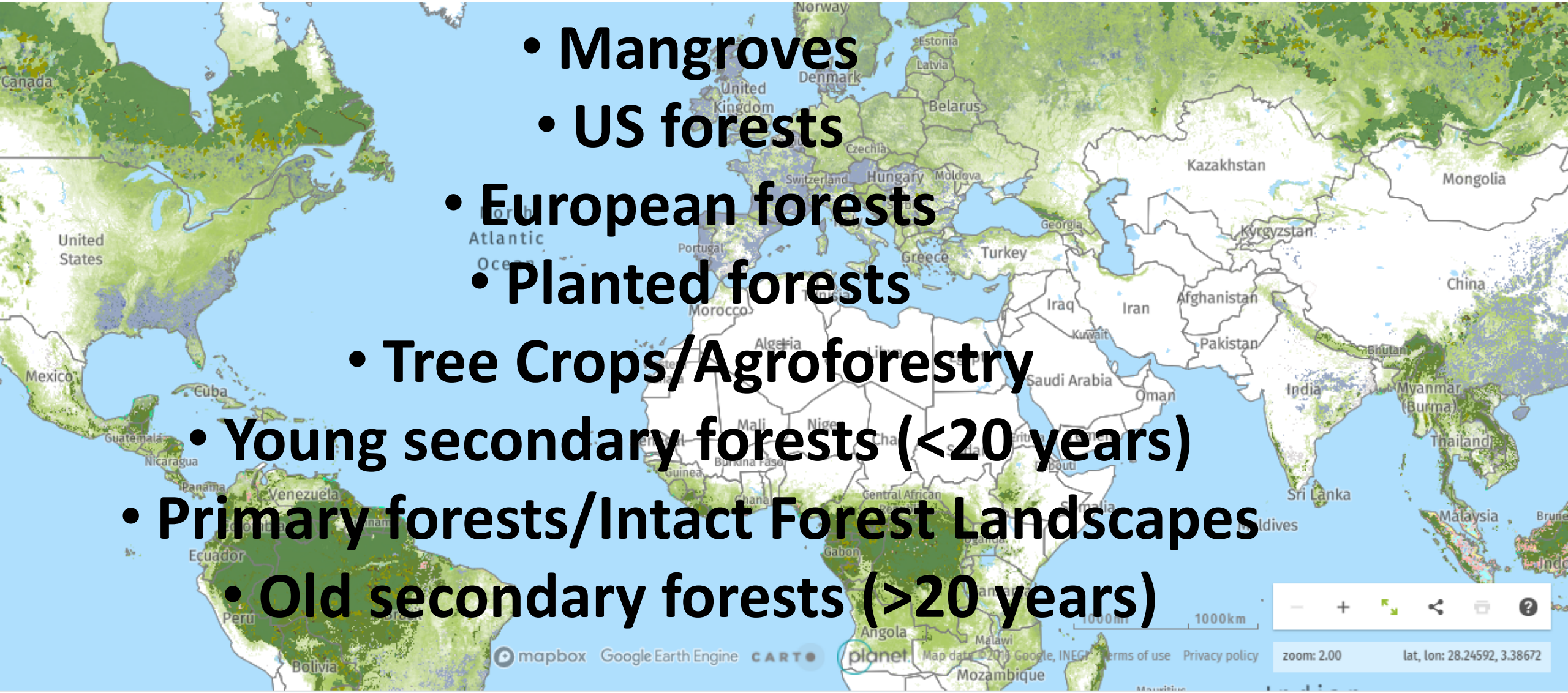
Harris et al. 2021 Nature Climate Change

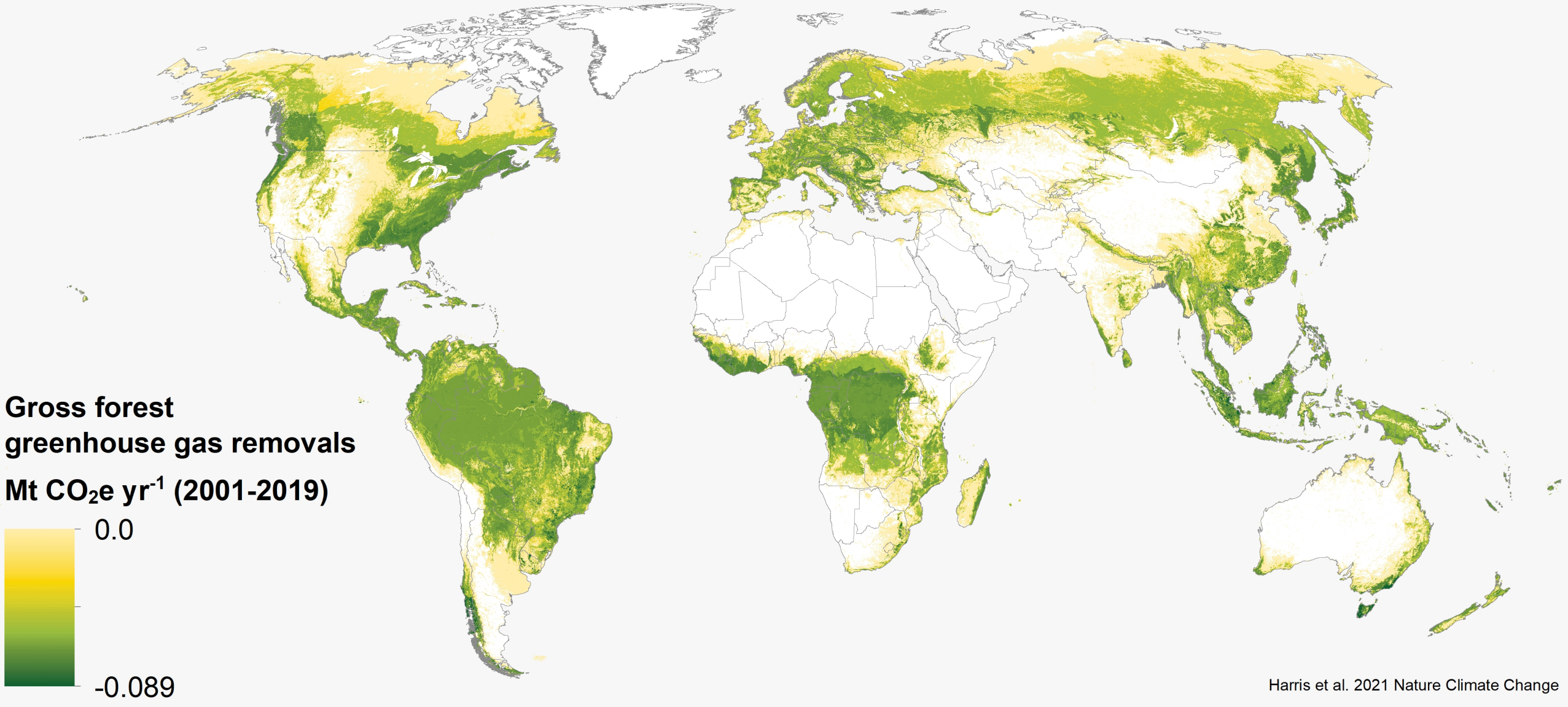
“Fast Out, Slow In”

Forest or tree canopy loss contributes to a large pulse of emissions

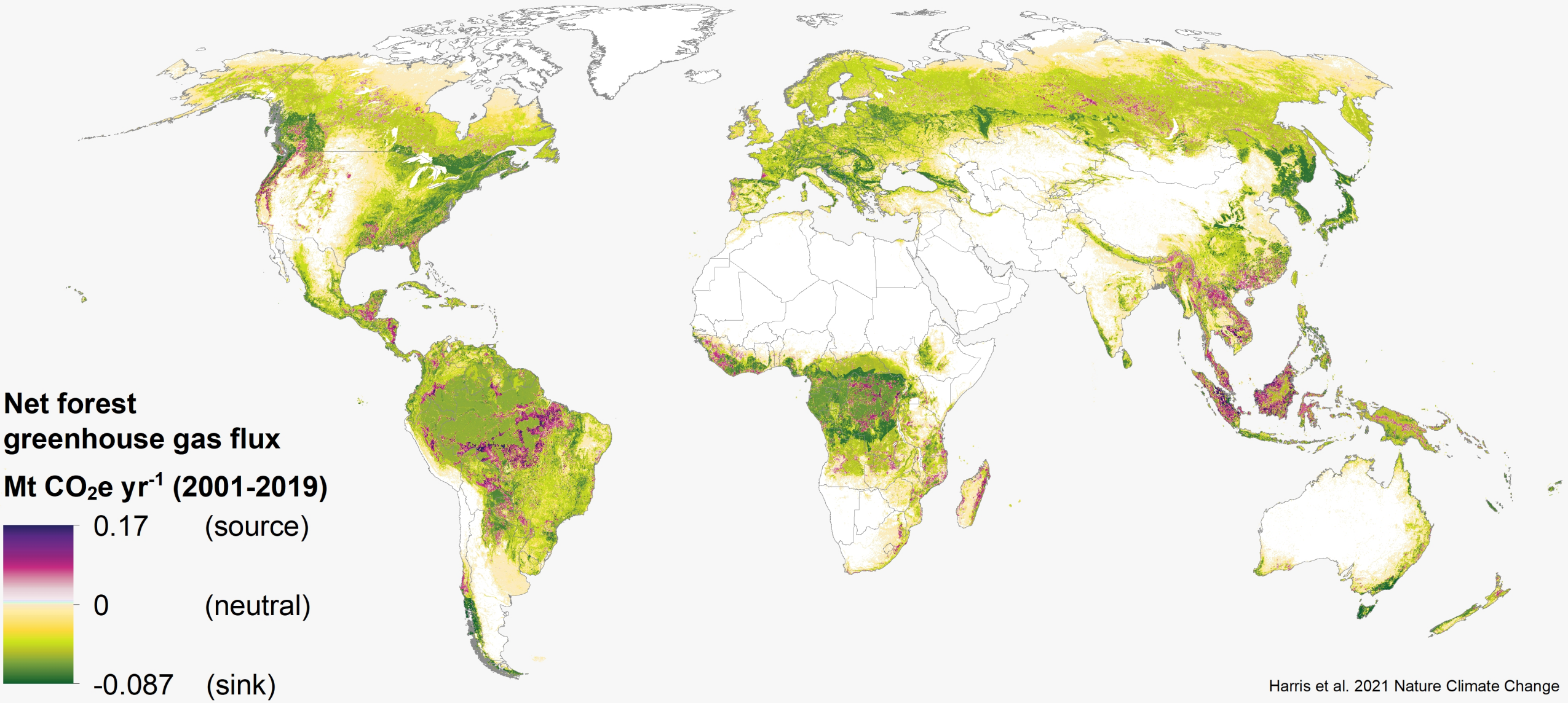
New forests or trees accumulate carbon slowly over decades

Removal factors: Stratify global forests





Harris et al. 2021 Nature Climate Change



Harris et al. 2021 Nature Climate Change

Carbon Fluxes from World's 3 Major Rainforests

AMAZON RIVER BASIN

SINK

Net flux (Gt CO2e/yr): **-0.10**

Emissions (Gt CO2e/yr): **1.1**

Removals (Gt CO2e/yr): **-1.2**

CONGO RIVER BASIN

SINK

Net flux (Gt CO2e/yr): **-0.61**

Emissions (Gt CO2e/yr): **0.53**

Removals (Gt CO2e/yr): **-1.1**

SOUTHEAST ASIA

SOURCE

Net flux (Gt CO2e/yr): **0.49**

Emissions (Gt CO2e/yr): **1.6**

Removals (Gt CO2e/yr): **-1.1**

Source: Harris et al. 2021.

Notes: all values in units of billion metric tonns CO2e per year

20.01.21

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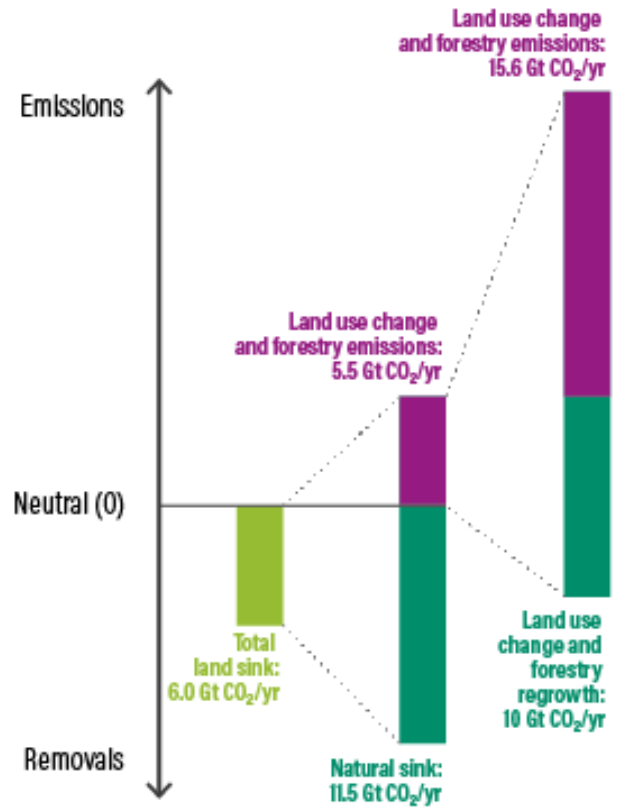
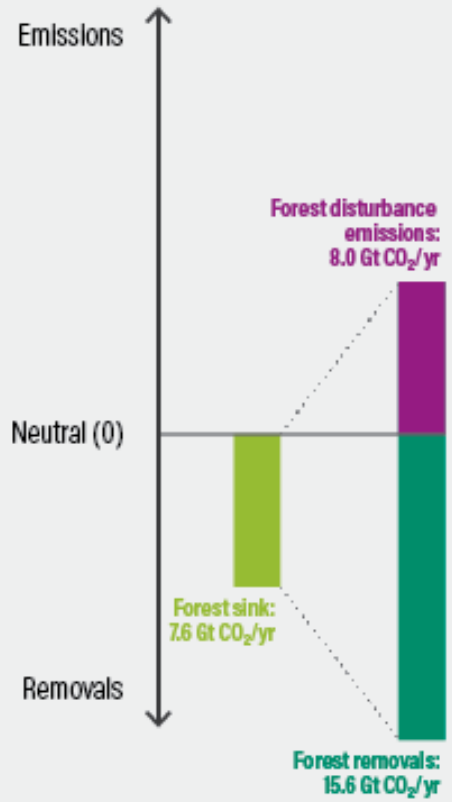
Breakdown of Carbon Flux Estimates



All land
(Global Carbon Project)



Forest land
(GFW)

Source: Harris et al. (2021), Global Carbon Project.

21.01.27

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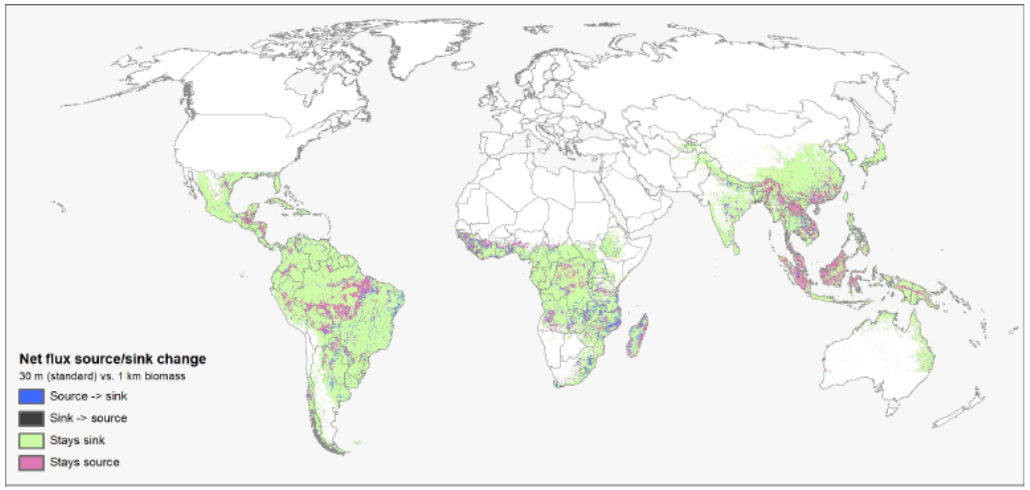
What's with the high uncertainty?

Temperate	Oceanic	New Zealand	Primary	0.37	±0.85	95%CI	33
			Secondary >20 years	2.12	±0.82	95%CI	33
			Secondary ≤20 years	3.12	0.83	SE	34
		Europe	All	2.3	-	-	35
		North and South America	Secondary >20 years	9.1	20.2	SD	36
			Secondary ≤20 years	6.3	7.4	SD	36
	Continental	North and South America	Secondary >20 years	3.6	15.0	SD	36
			Secondary ≤20 years	3.3	5.2	SD	36
	Mountain	North and South America	Secondary >20 years	4.4	100.7	SD	36
			Secondary ≤20 years	3.1	3.6	SD	36

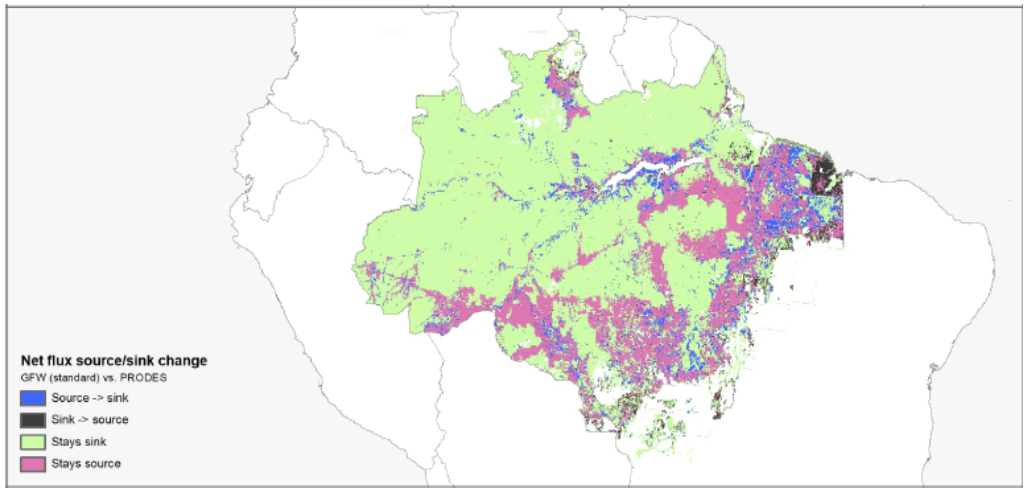
Table 4.9, IPCC 2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories

Sensitivity analyses provide transparency

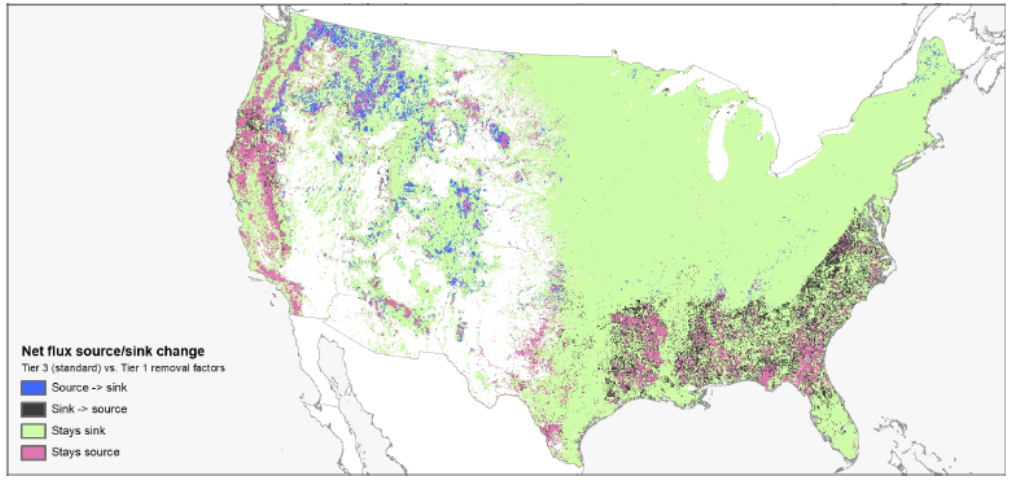
Benchmark biomass density map



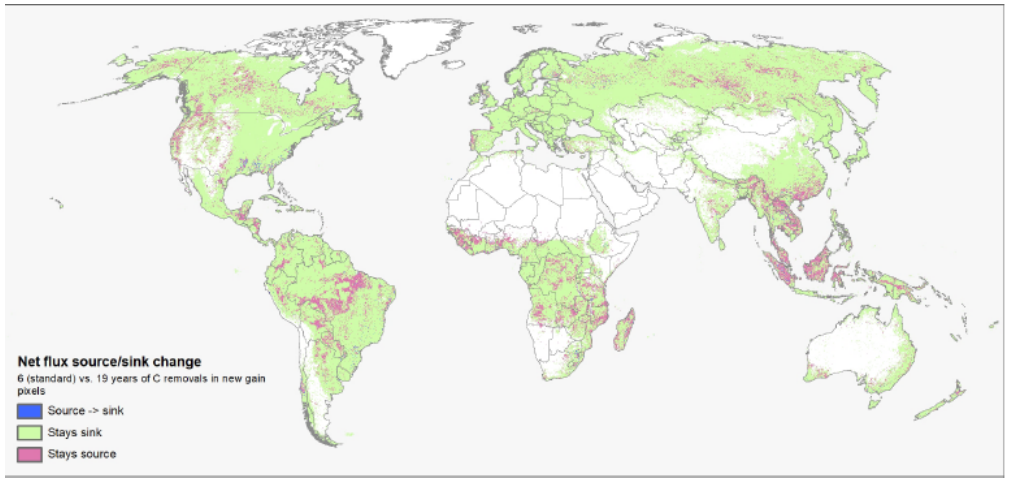
Source of deforestation data



Generic vs. detailed removal factors



Lack of updated tree cover gain data



Conclusions

- To make progress on forest-based mitigation, we must reduce emissions AND increase removals.
- We have created a framework for measuring and tracking GHG fluxes from forests at scales more relevant for informing climate policy
- Estimates of emissions are relatively constrained; removals much less so.
- Improvements are needed! New and improved data sources can populate the framework to reduce uncertainties

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Next Steps

- Update model to 2020
- Refine removal factors:
  - Old secondary and primary forests (a la Cook Patton et al. 2020)
  - Incorporate more data from national inventories (e.g., Canada)
- Comparisons between top-down vs. bottom-up estimates to inform GST
  - National GHG inventories (UNFCCC)
  - FAO/FRA
  - Other satellite-based maps (Saatchi, Ciais)
  - Top-down atmospheric inversion/transport models

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