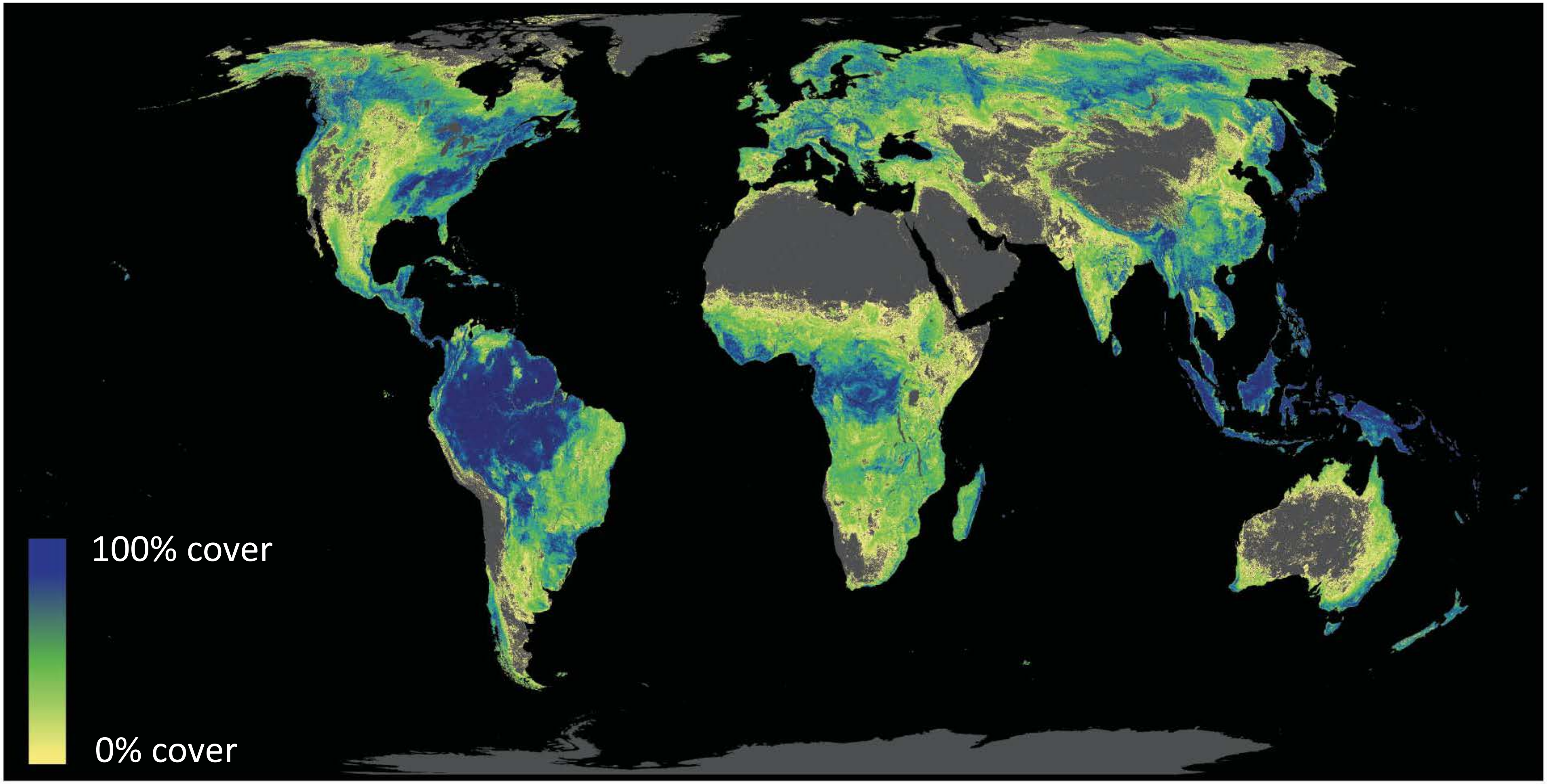
# Role of Forests/Land Use Change in Deep Decarbonization

Steven Hamburg
Environmental Defense Fund

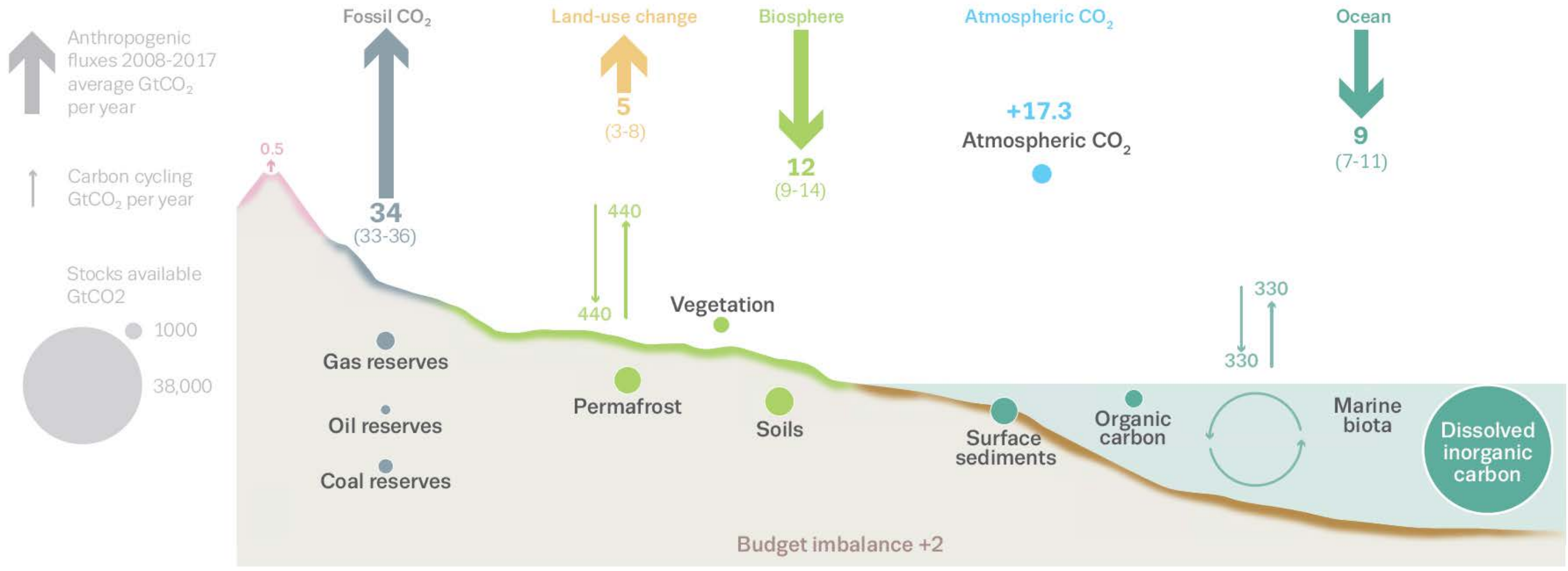
# Potential Forest Canopy Cover




**Bastin et al. 2019 Science**

# Anthropogenic perturbation of the global carbon cycle

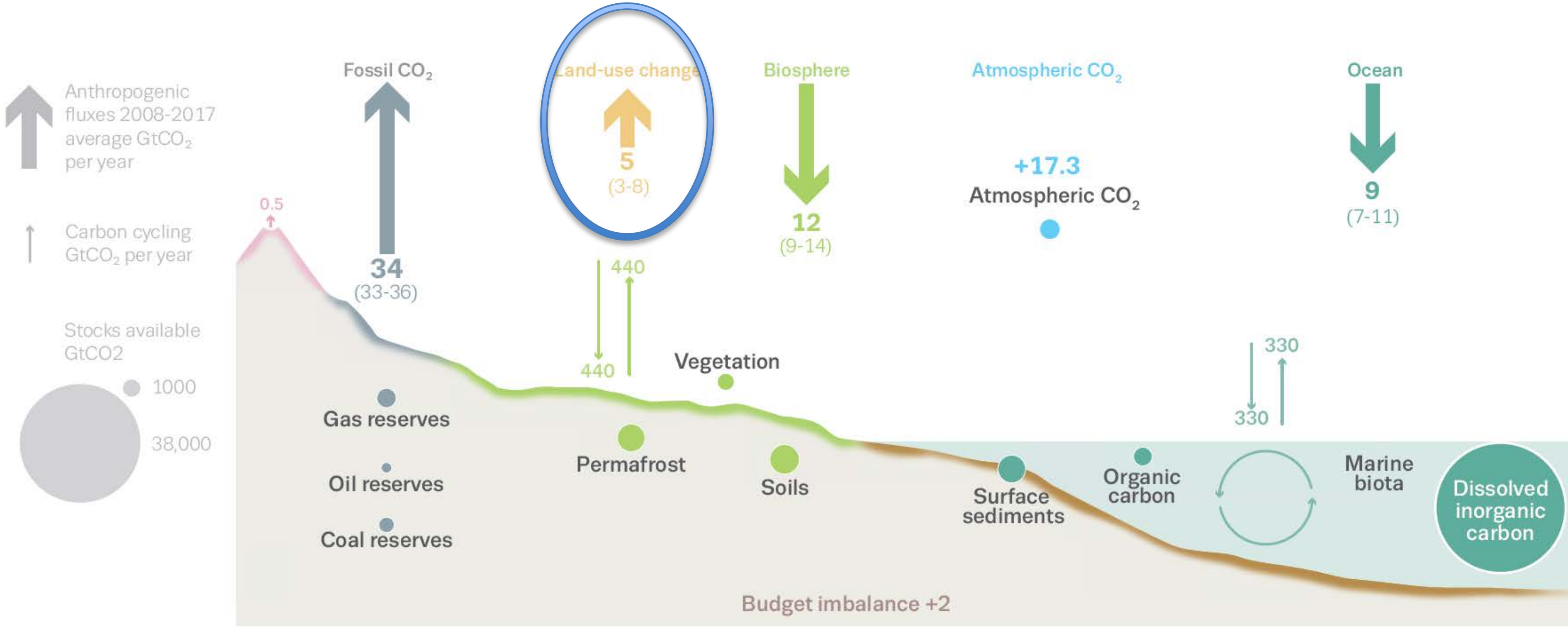
Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2008–2017 ($GtCO_2$/yr)




The budget imbalance is the difference between the estimated emissions and sinks.
Source: CDIAC; NOAA-ESRL; Le Quéré et al 2018; Ciais et al. 2013; Global Carbon Budget 2018

# Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2008–2017 ($GtCO_2$/yr)

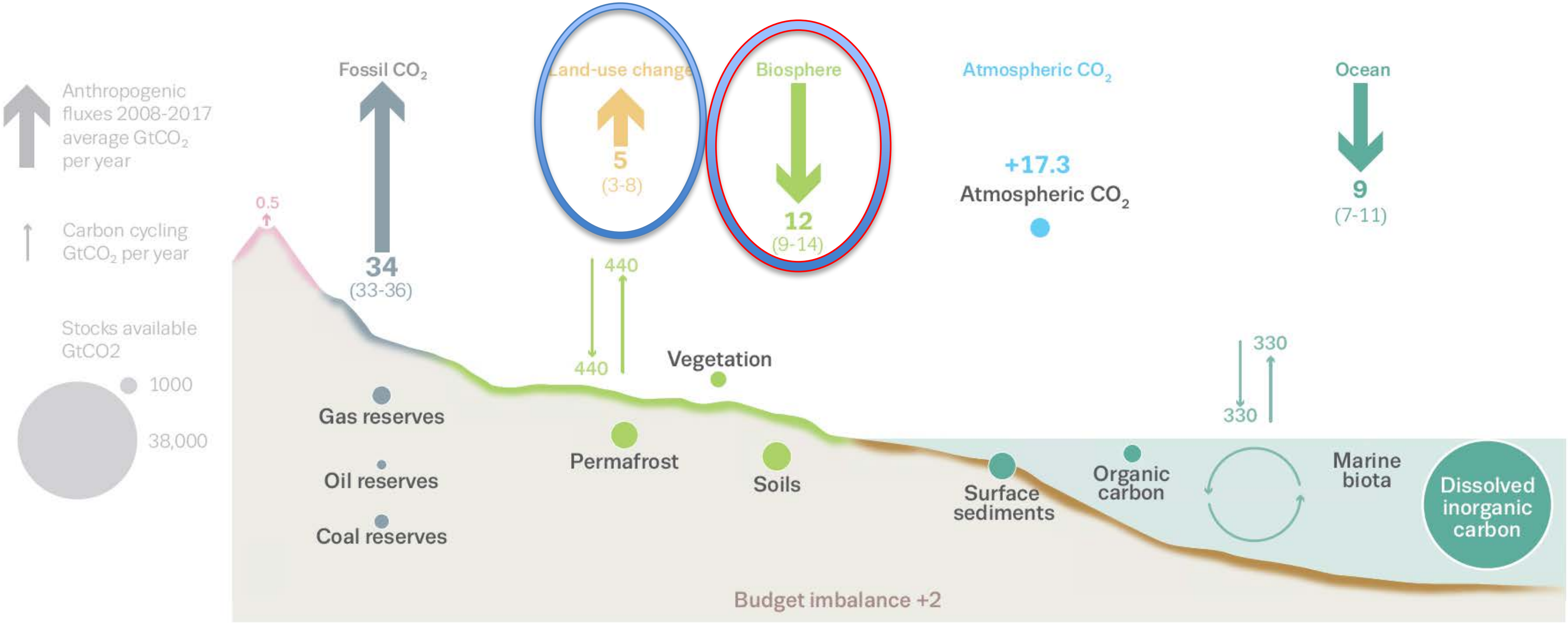



The budget imbalance is the difference between the estimated emissions and sinks.

Source: [CDIAC](); [NOAA-ESRL](); [Le Quéré et al 2018](); [Ciais et al. 2013](); [Global Carbon Budget 2018]()

# Anthropogenic perturbation of the global carbon cycle

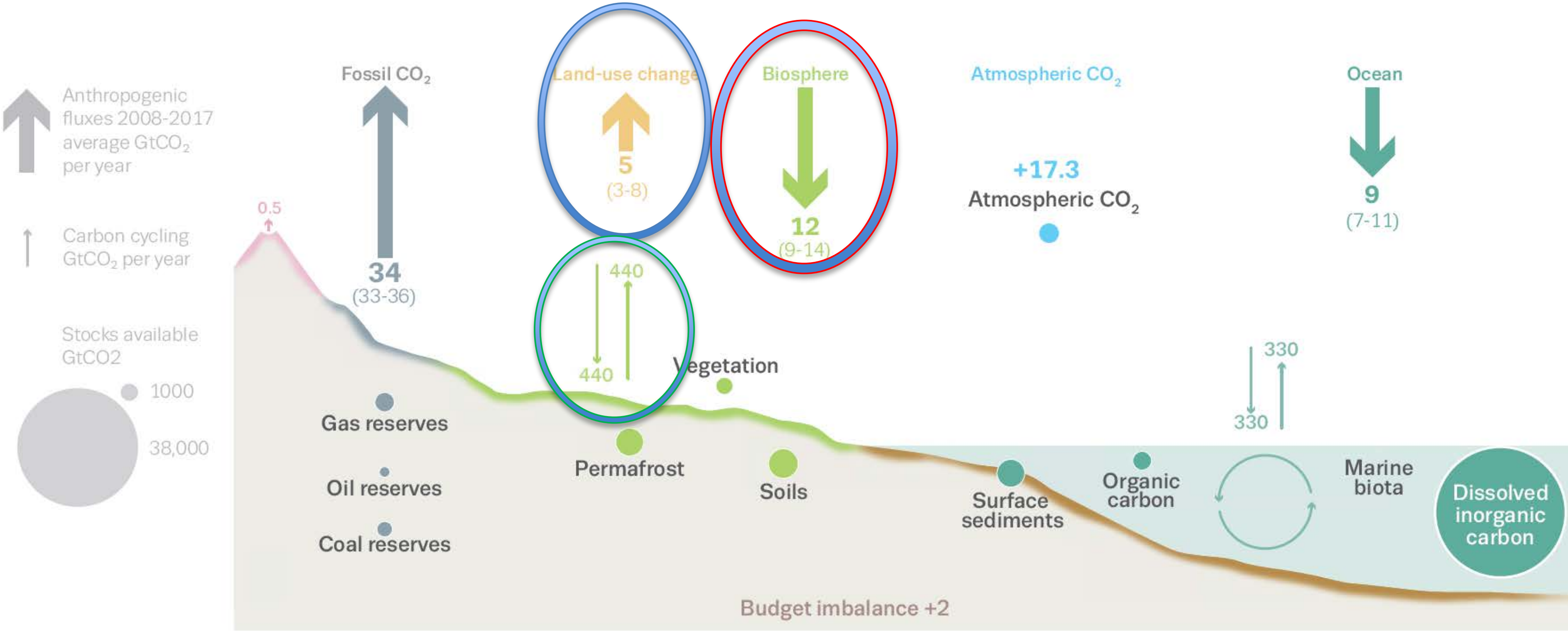
Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2008–2017 ($GtCO_2$/yr)




The budget imbalance is the difference between the estimated emissions and sinks.
Source: CDIAC; NOAA-ESRL; Le Quéré et al 2018; Ciais et al. 2013; Global Carbon Budget 2018

# Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2008–2017 ($GtCO_2$/yr)




The budget imbalance is the difference between the estimated emissions and sinks.

Source: CDIAC; NOAA-ESRL; Le Quéré et al 2018; Ciais et al. 2013; Global Carbon Budget 2018

# Fate of anthropogenic $CO_2$ emissions (2008–2017)

## Sources = Sinks

34.4 $GtCO_2$/yr

87%

13%

5.3 $GtCO_2$/yr

17.3 $GtCO_2$/yr

44%

29%

11.6 $GtCO_2$/yr

22%

8.9 $GtCO_2$/yr

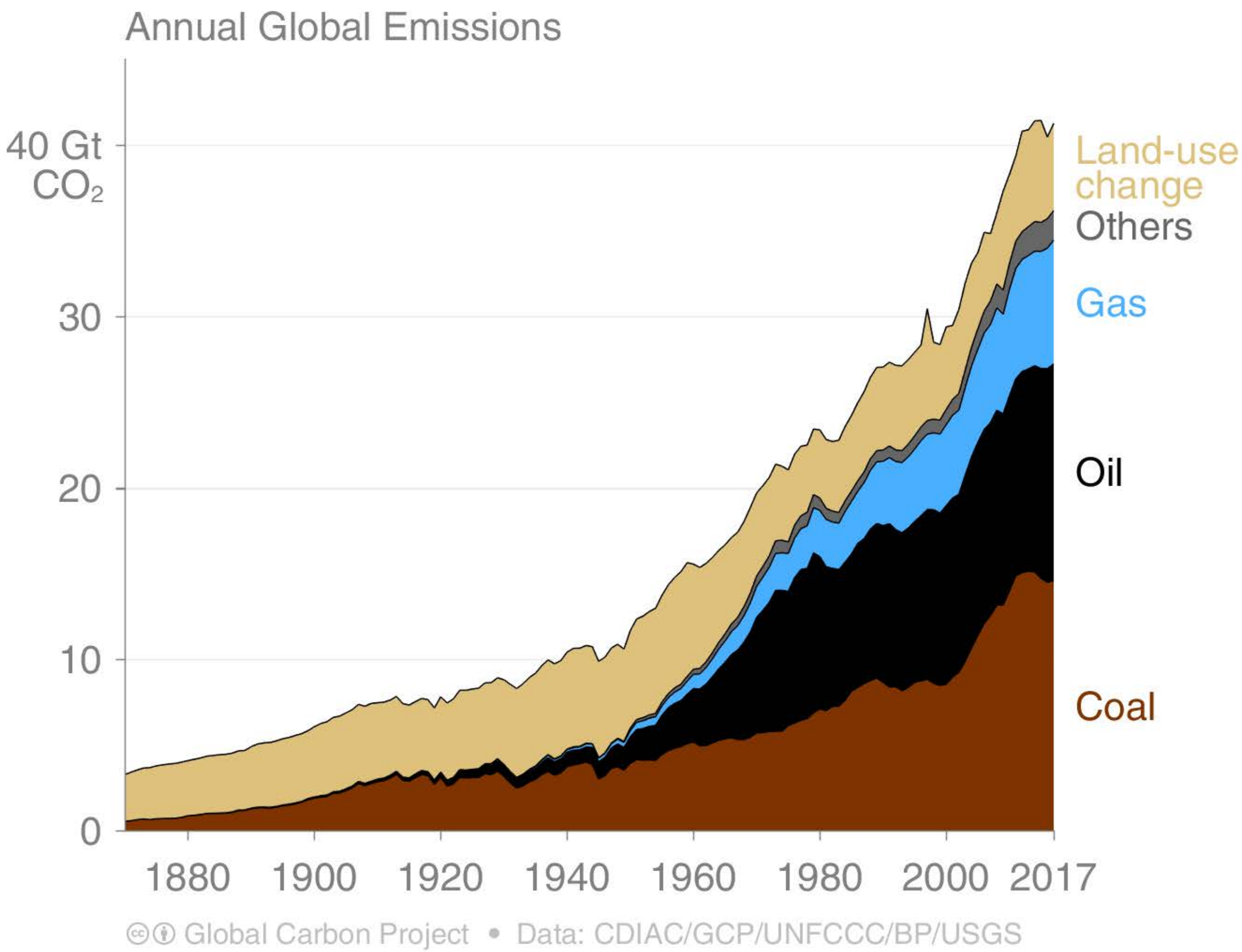
Budget Imbalance:
(the difference between estimated sources & sinks)

5%
1.9 $GtCO_2$/yr

Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2018; Global Carbon Budget 2018

# Total global emissions by source

Land-use change was the dominant source of annual $CO_2$ emissions until around 1950.
Fossil $CO_2$ emissions now dominate global changes.

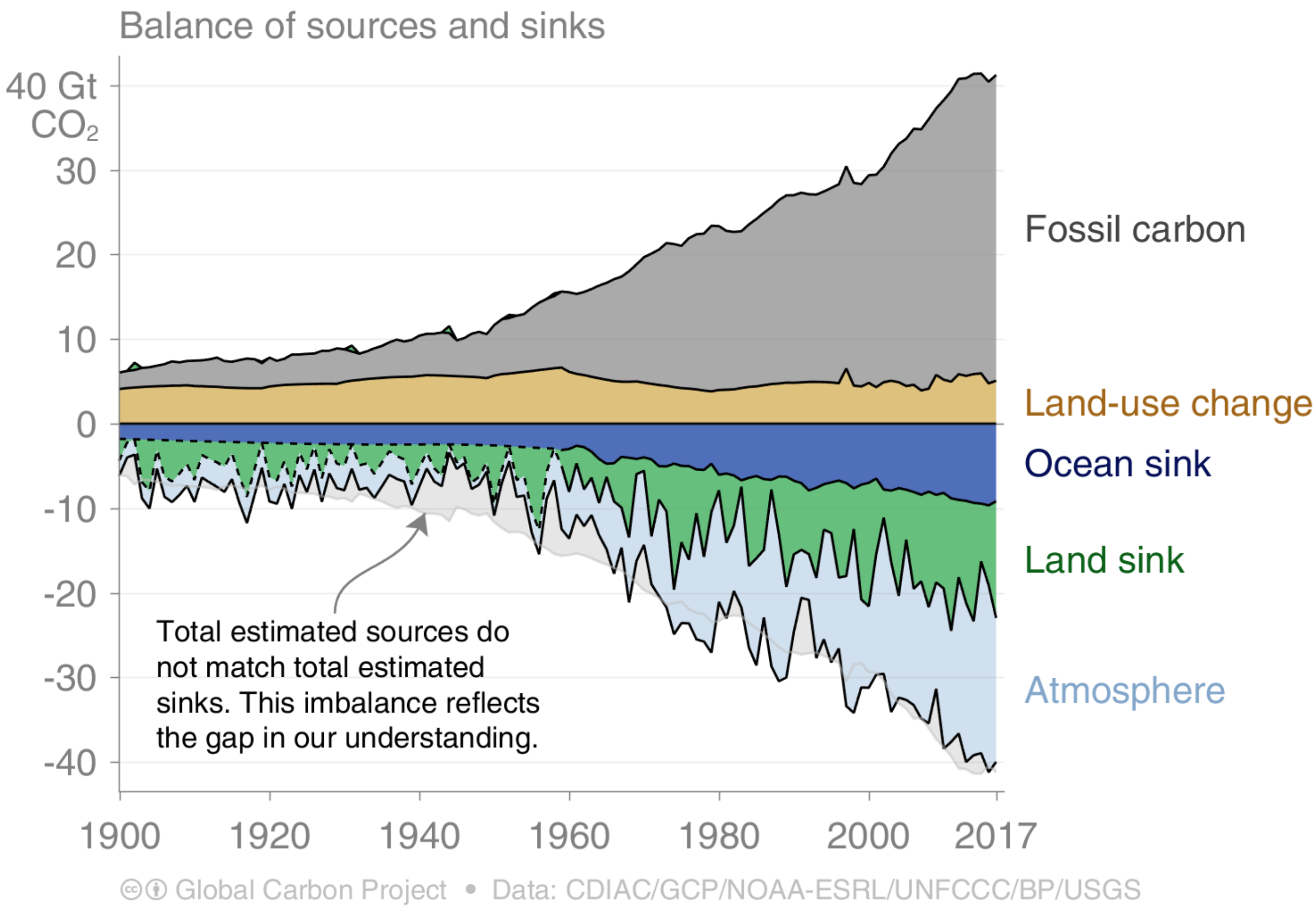



Others: Emissions from cement production and gas flaring

Source: CDIAC; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2018; Global Carbon Budget 2018

# Global carbon budget

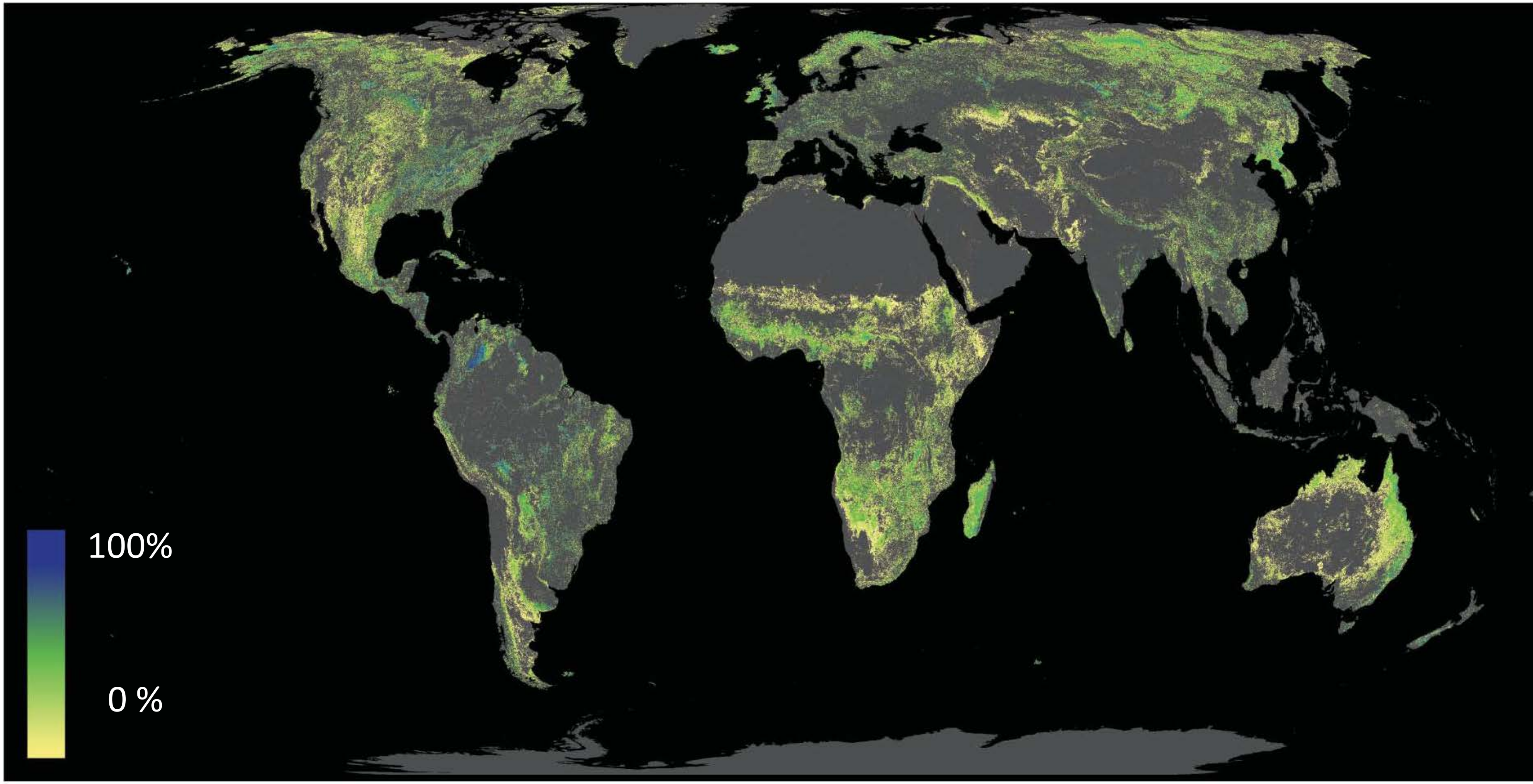
Carbon emissions are partitioned among the atmosphere and carbon sinks on land and in the ocean
The "imbalance" between total emissions and total sinks reflects the gap in our understanding




Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Joos et al 2013; Khatiwala et al. 2013; DeVries 2014; Le Quéré et al 2018; Global Carbon Budget 2018

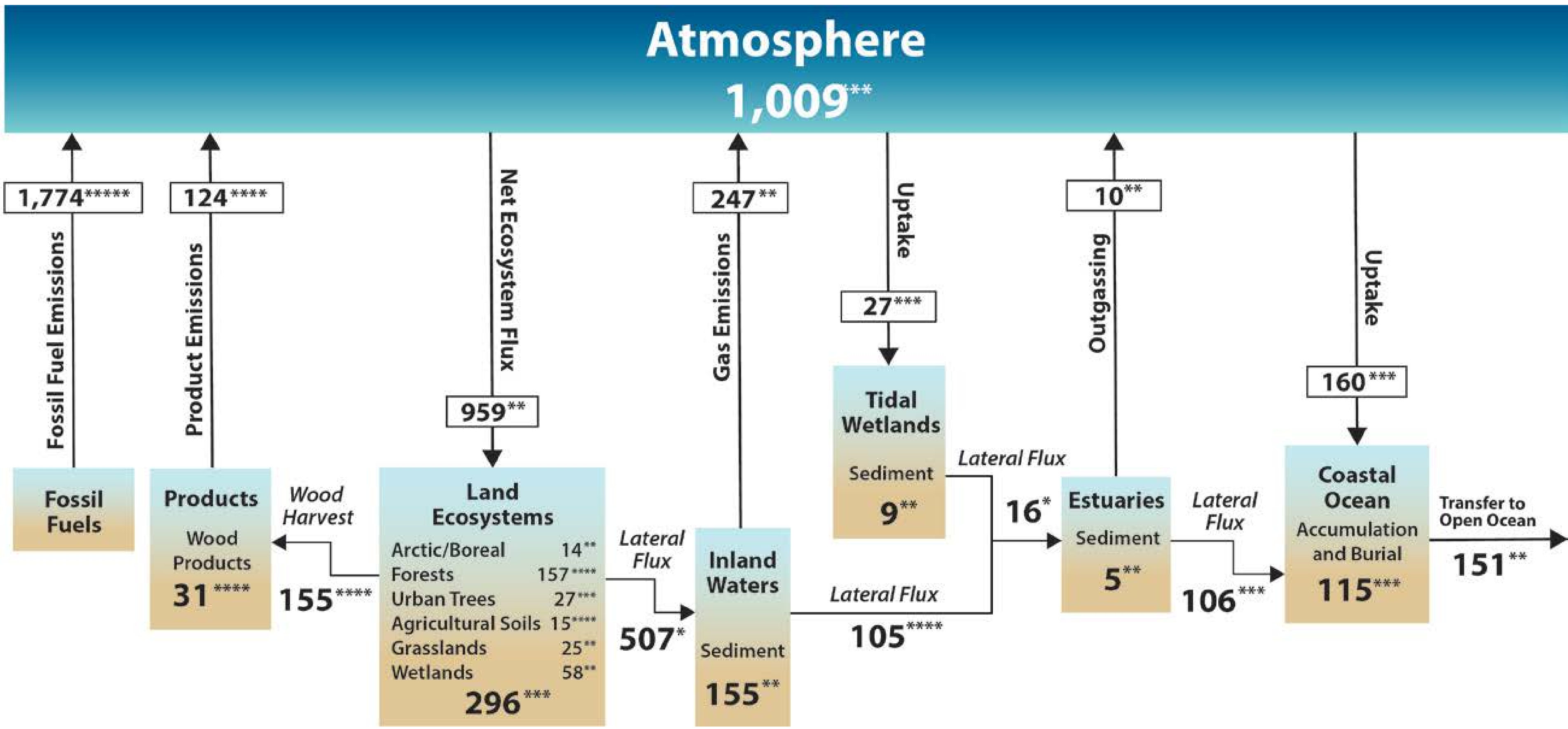
# Potential reforestation areas

“there is room for an extra 0.9 billion hectares of canopy cover, which could store 205 gigatonnes of carbon in areas that would naturally support woodlands and forests”




**Bastin et al. 2019 Science**

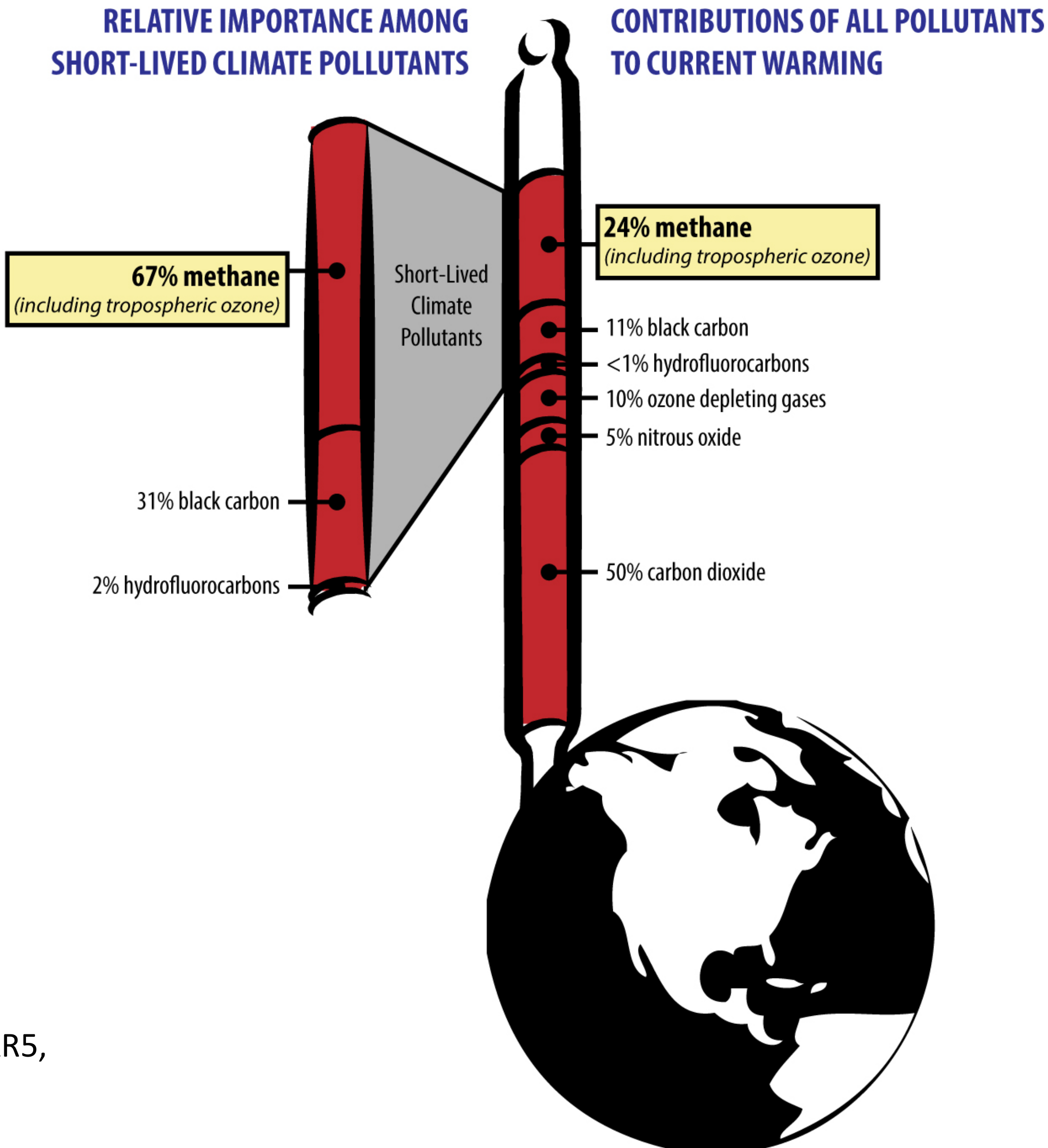
# Major Components of the North American Carbon Cycle.




Boxes represent stock changes – arrows fluxes teragrams of carbon (Tg C) per year.

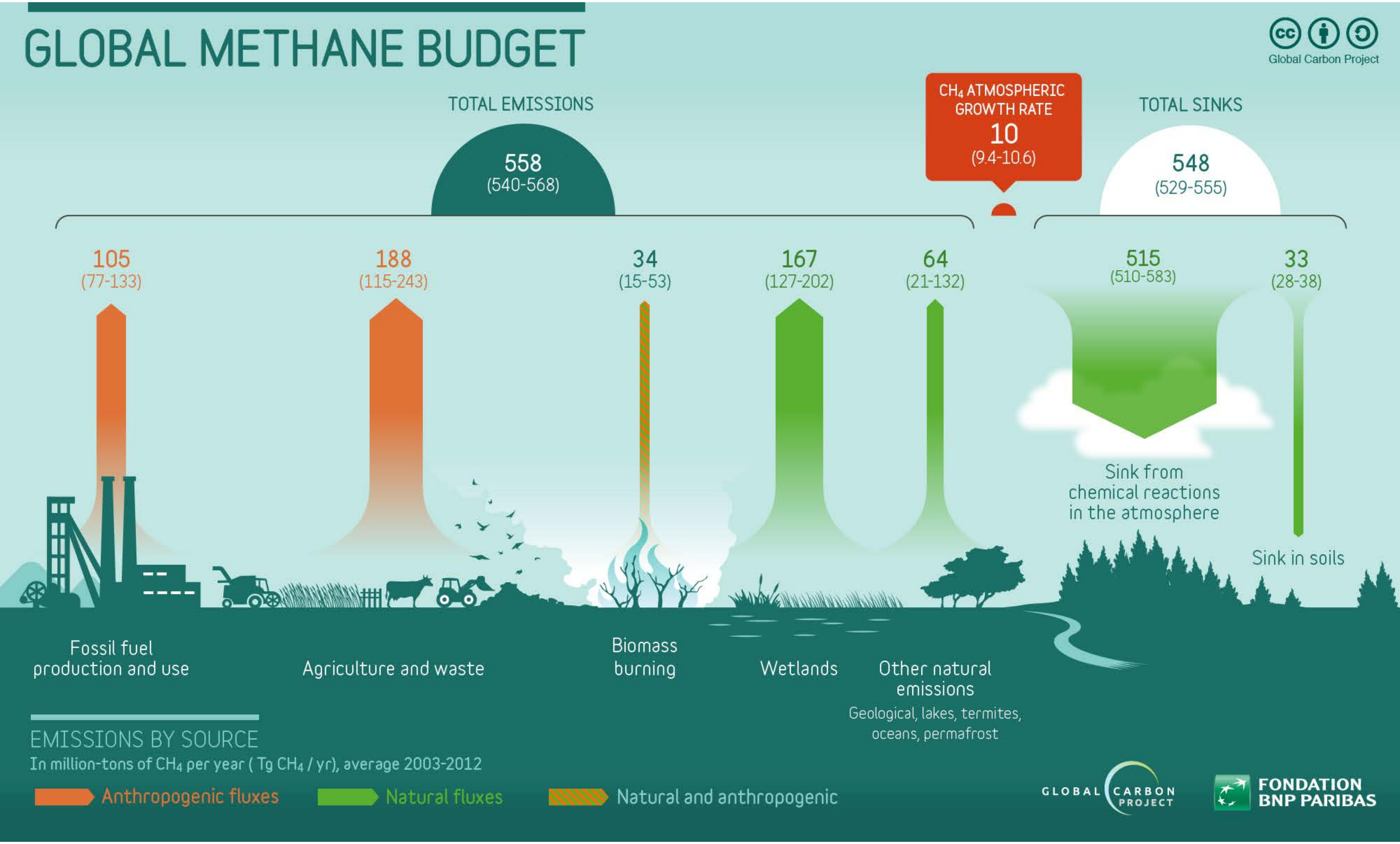
From SOCCR2

# Anthropogenic $CH_4$ causes >25% of today's radiative forcing




Adapted from IPCC AR5, Table 8.SM.6

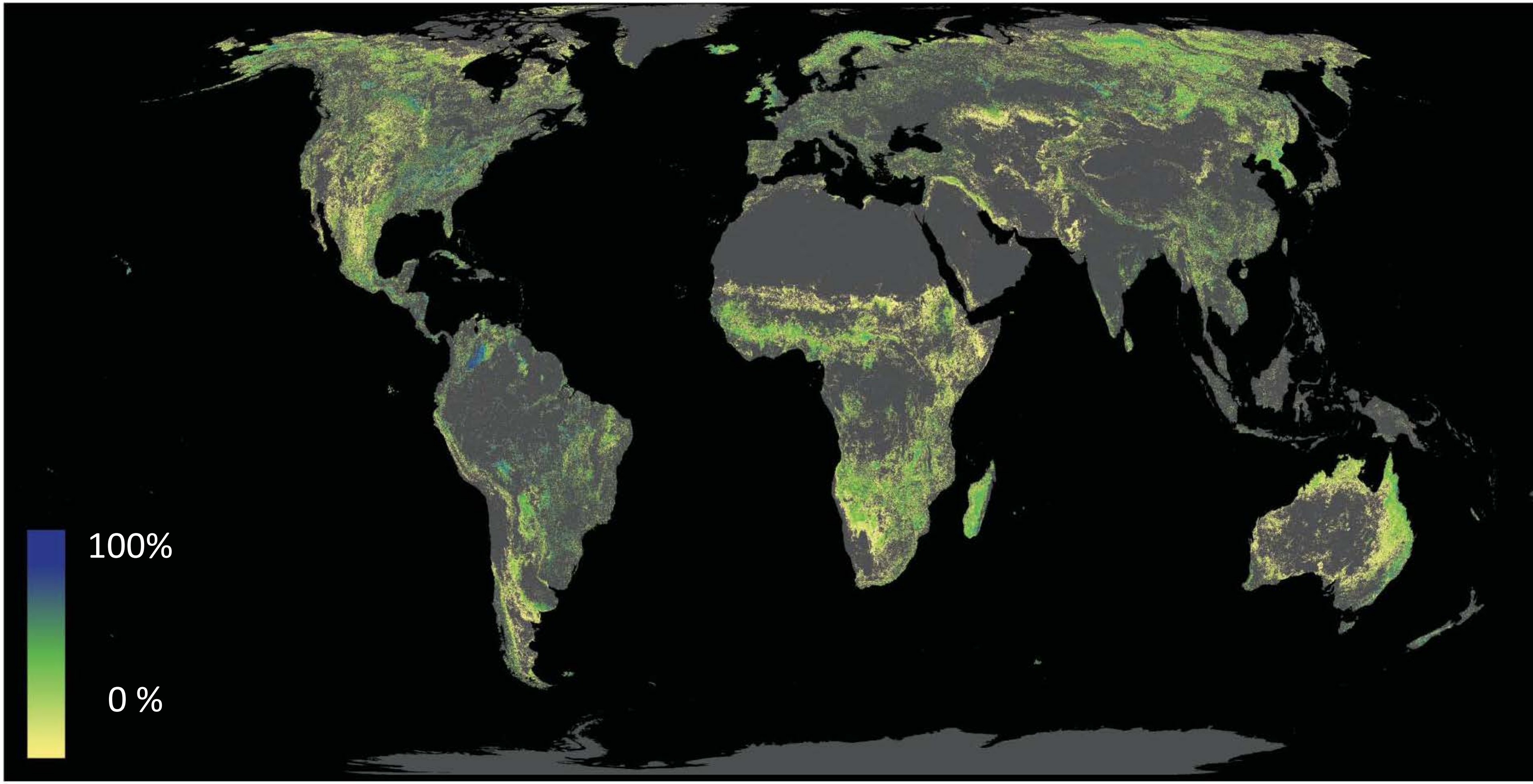
# Global Methane Budget 2003-2012



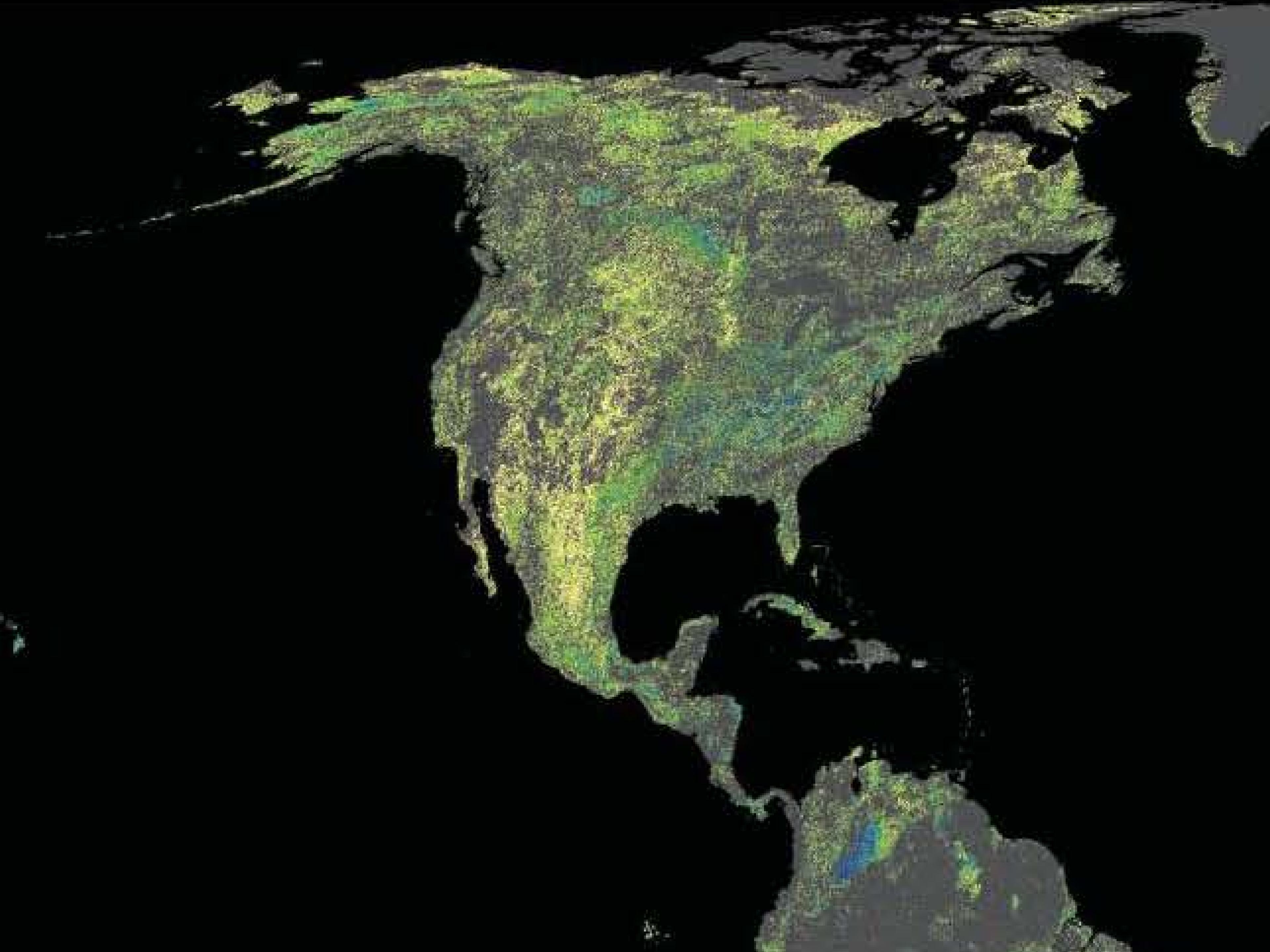

http://www.globalcarbonatlas.org

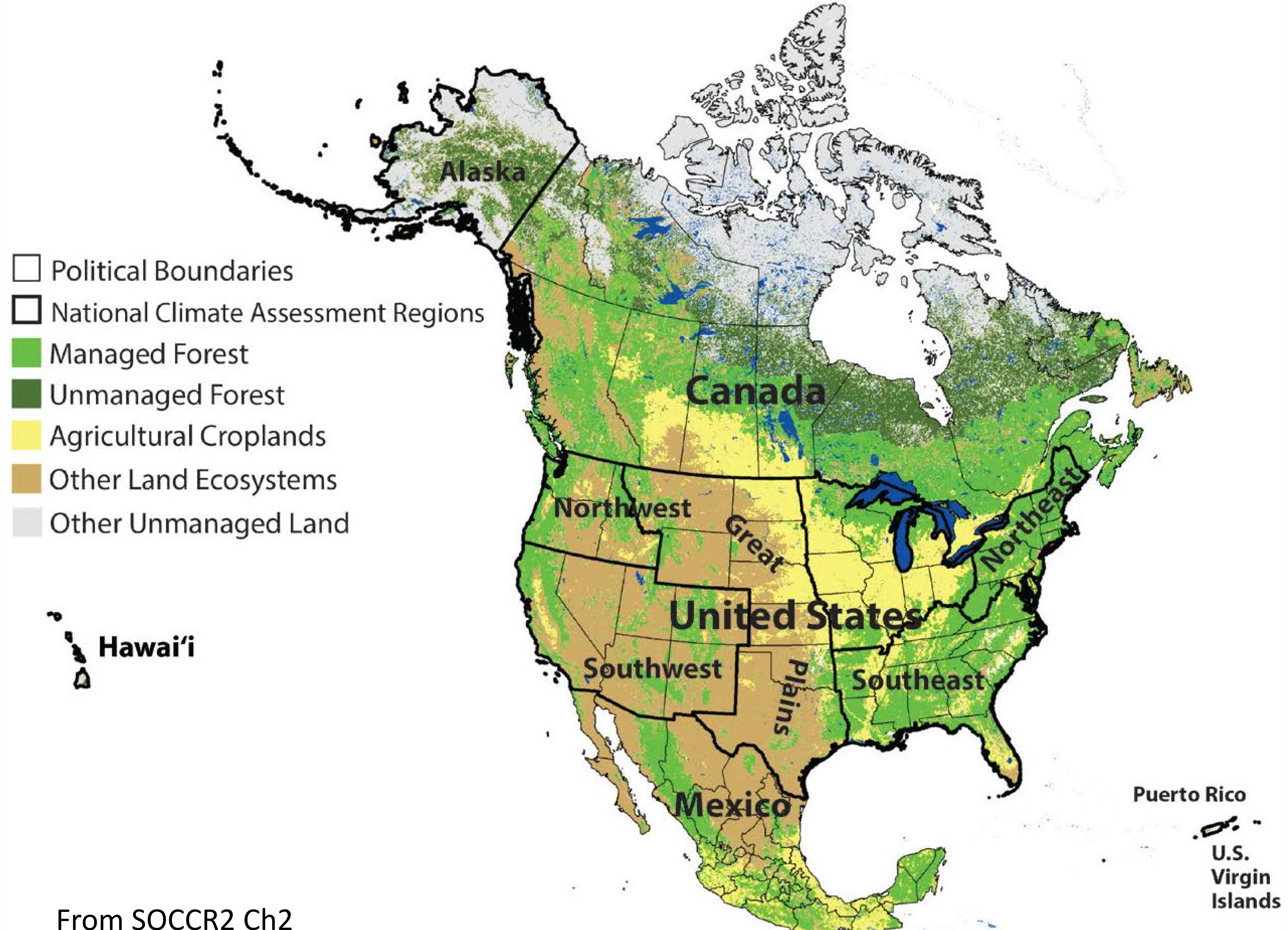
# Potential reforestation areas

"there is room for an extra 0.9 billion hectares of canopy cover, which could store 205 gigatonnes of carbon in areas that would naturally support woodlands and forests"

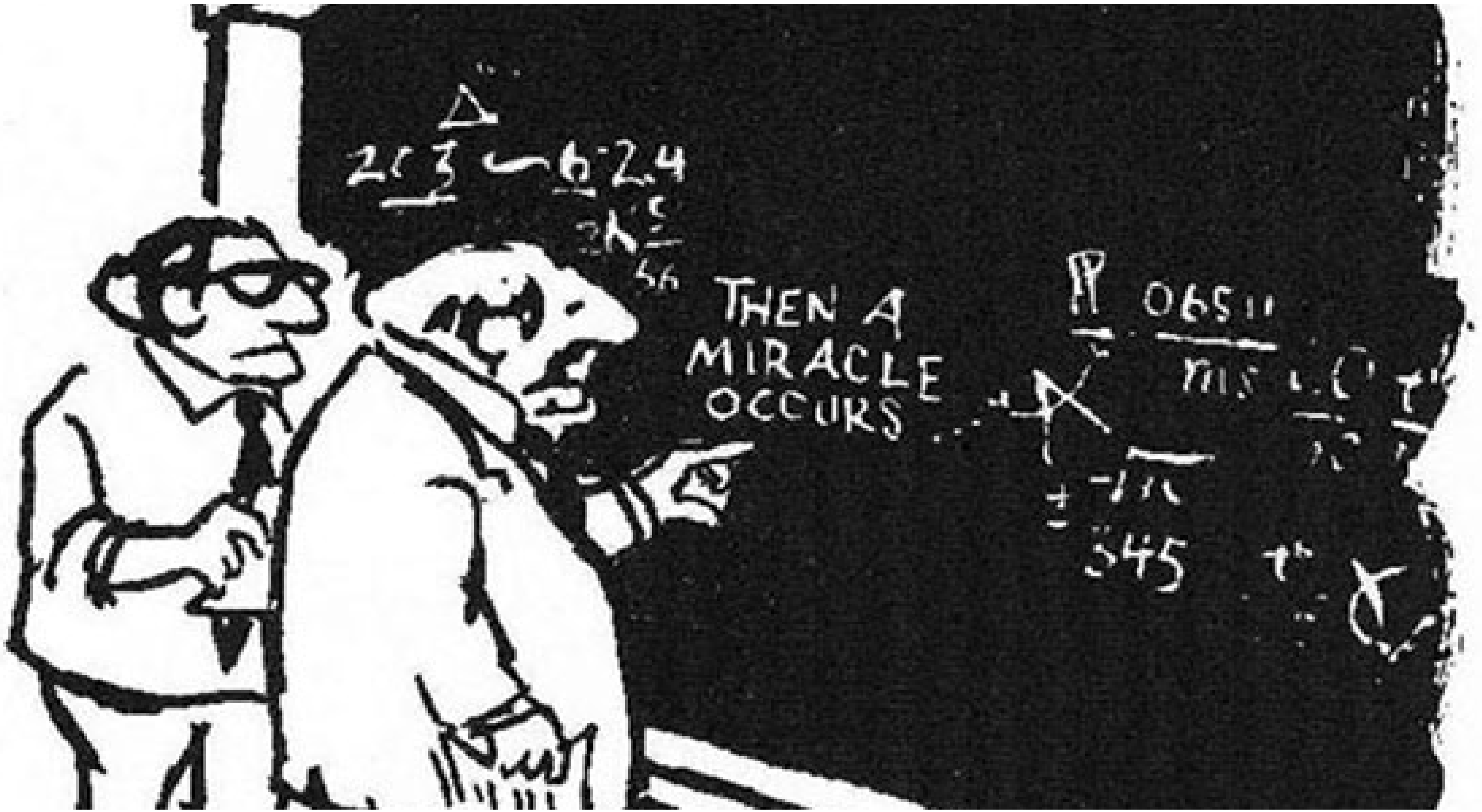



**Bastin et al. 2019 Science**






From SOCCR2 Ch2




I think you should be more explicit here in step two

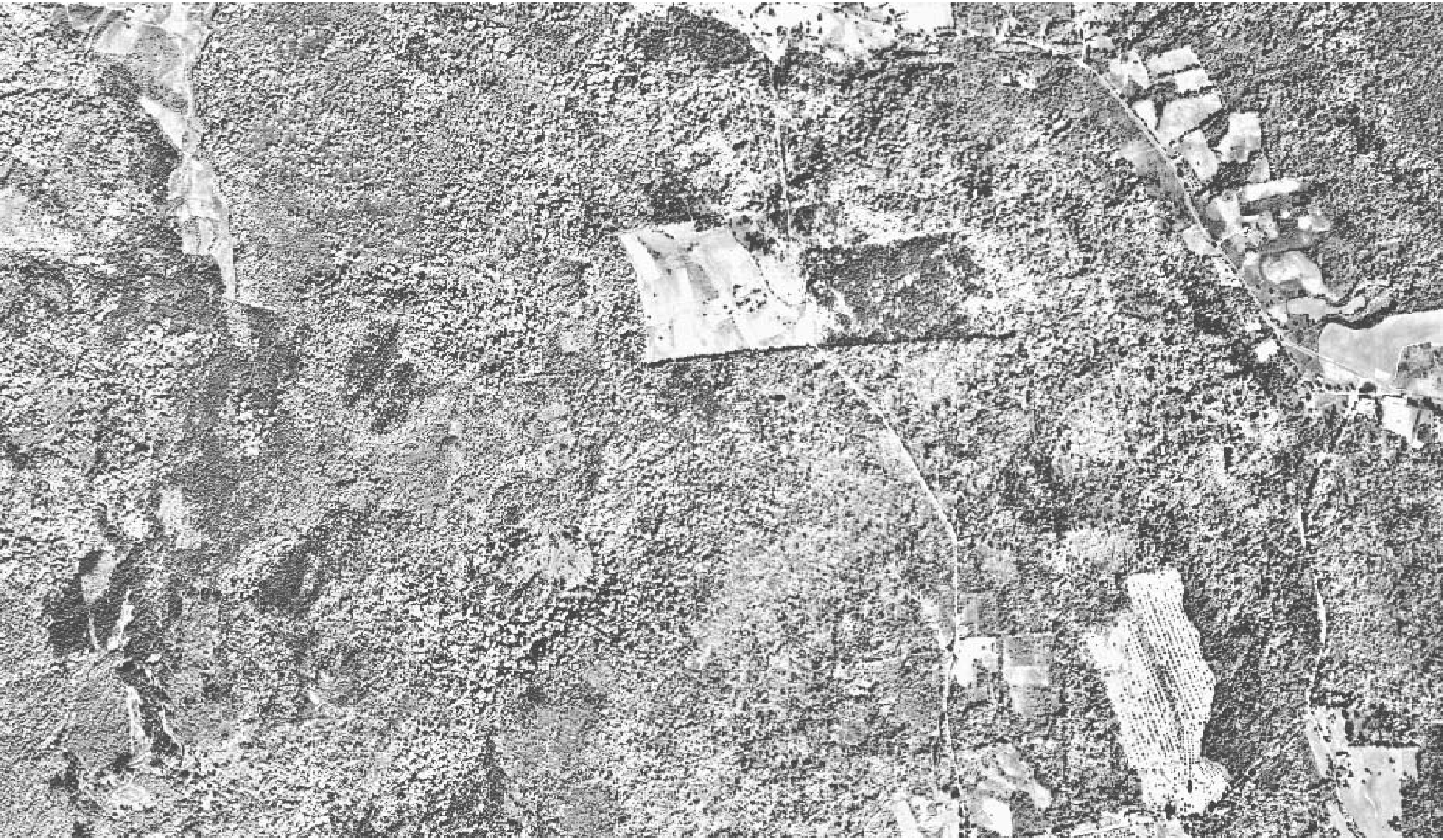
# Key issues that need to be addressed

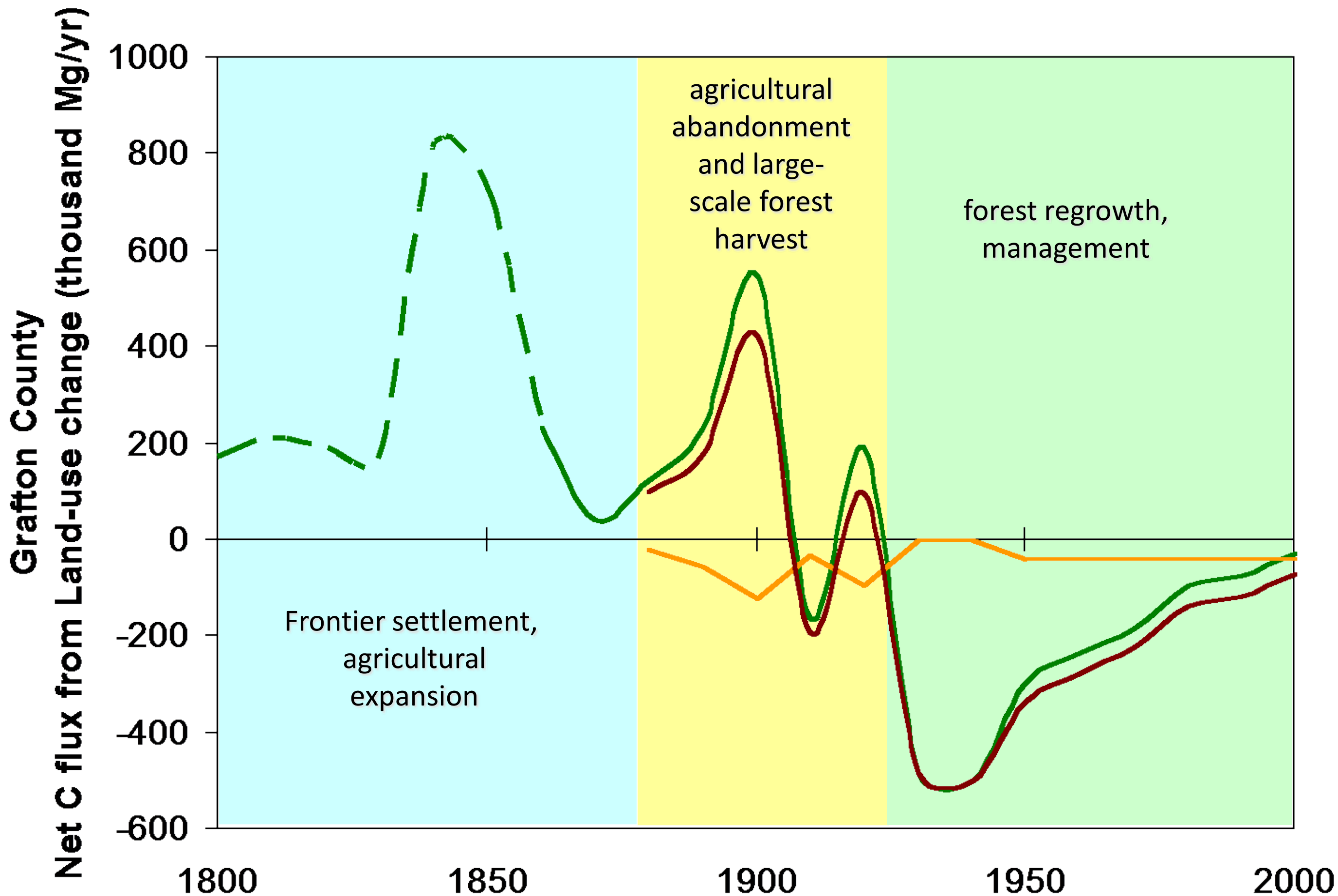
- **Baseline/Counter Factual** has an enormous influence on the benefits you calculate

- **Time** matters in figuring out the implications

- **Spatial Scale** – stand, woodshed, region, globe

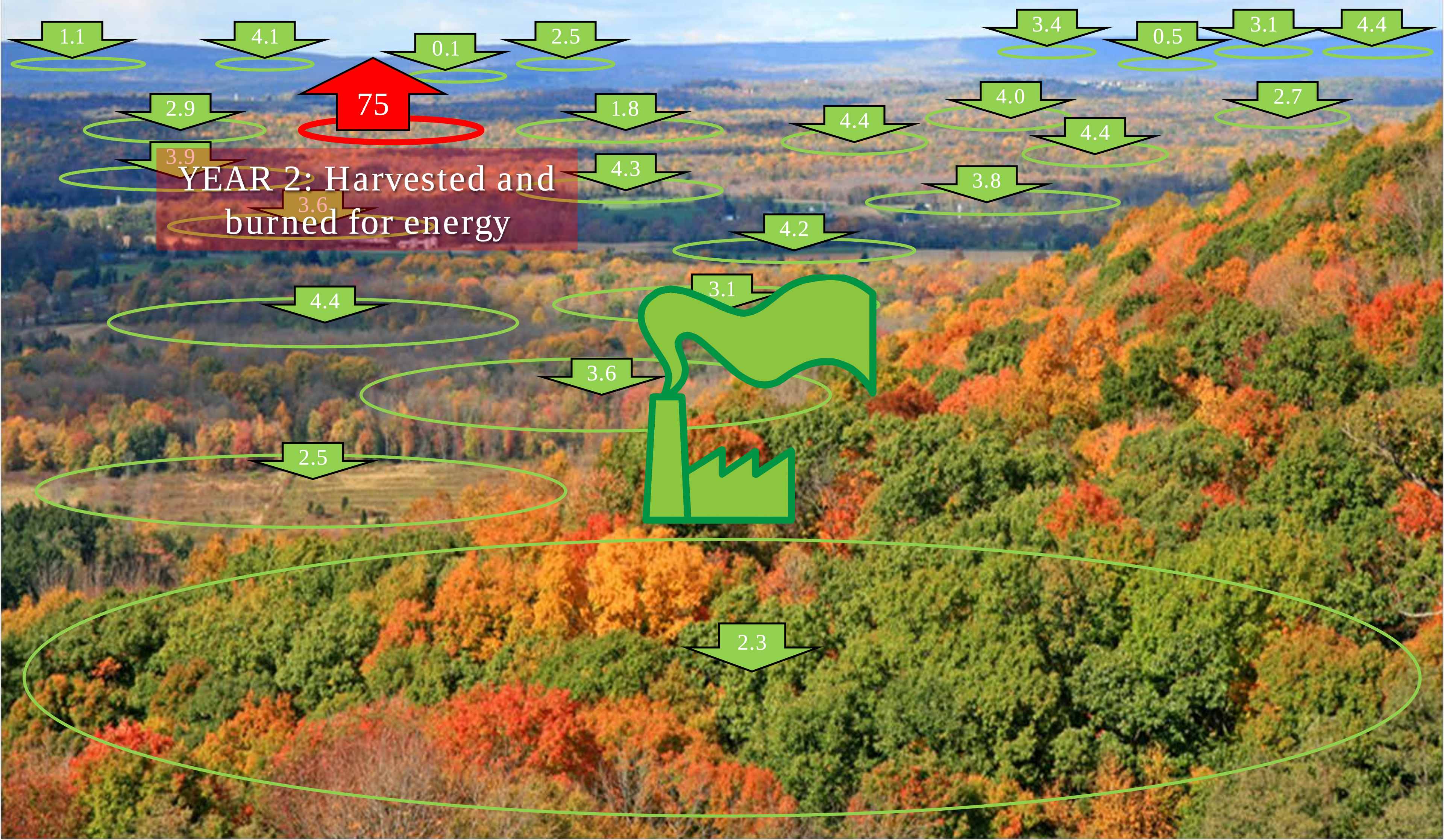
# Historic aerial photography - Bald Mountain, 1942



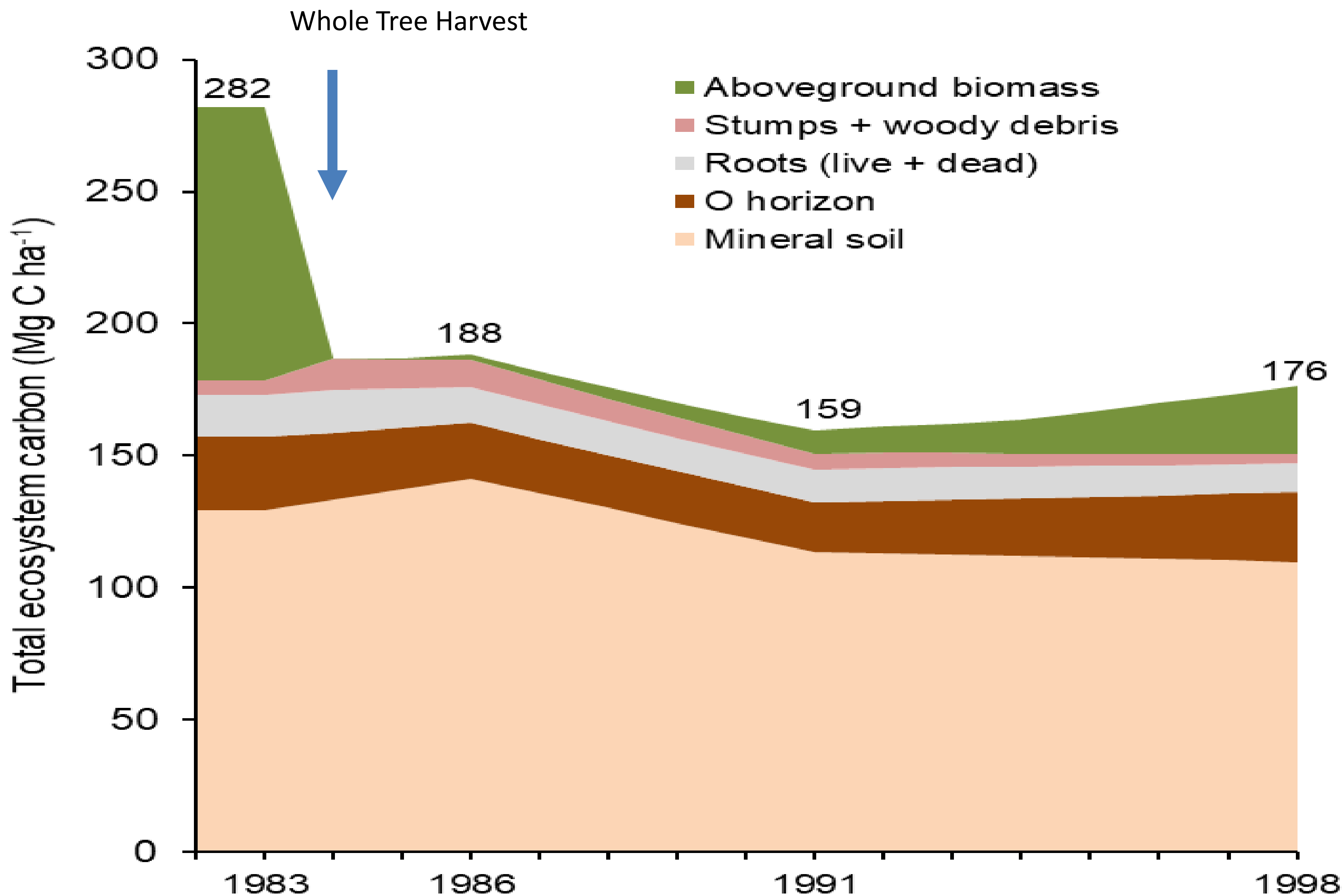



Grafton County, NH is 4,000 km$^2$

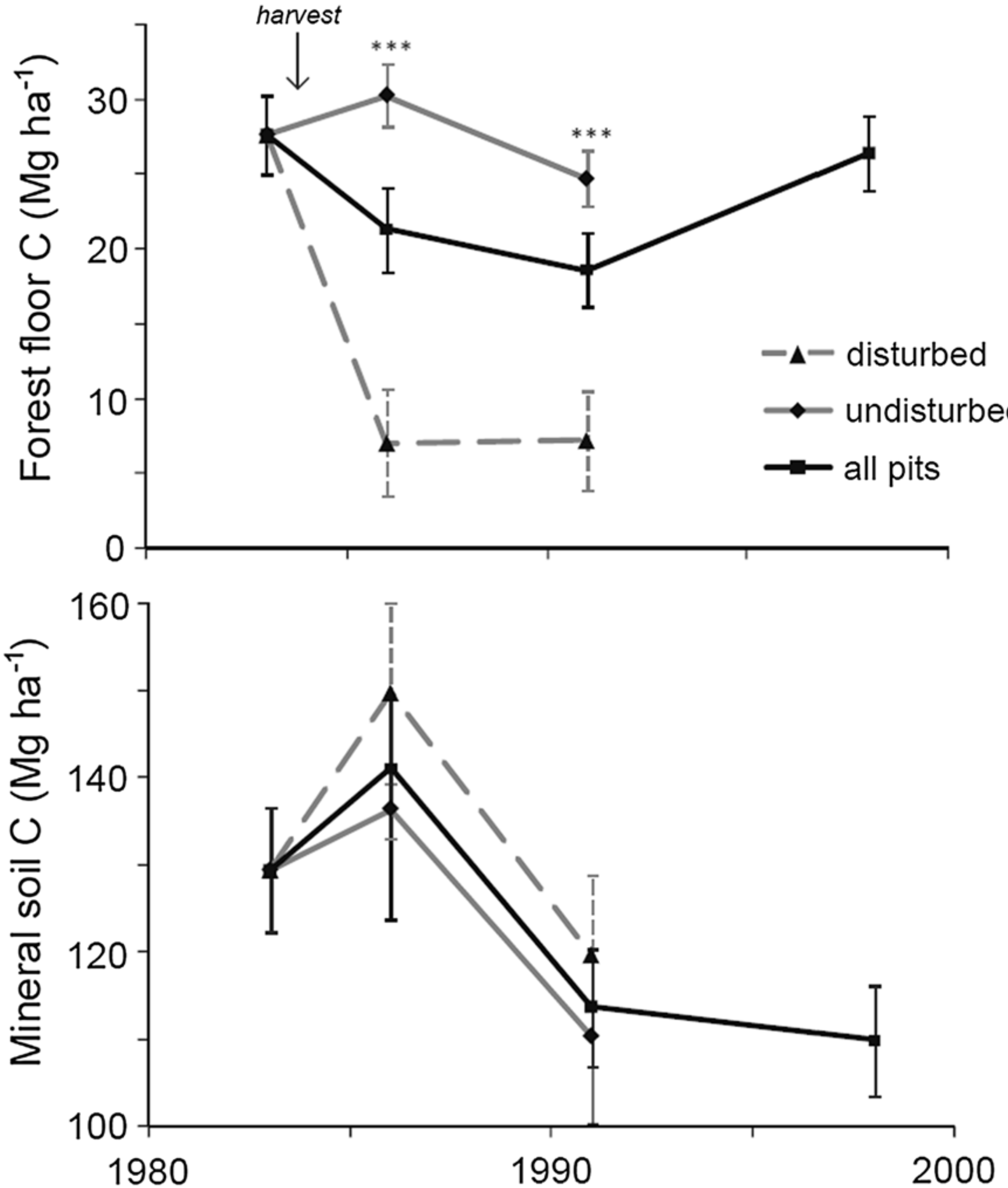
# Forest regrowth equal harvest at the end of the first rotation – how you account for the baseline is critical



Hubbard Brook Experimental Forest
Watershed 5 (22 ha) - Northern Hardwood Forest

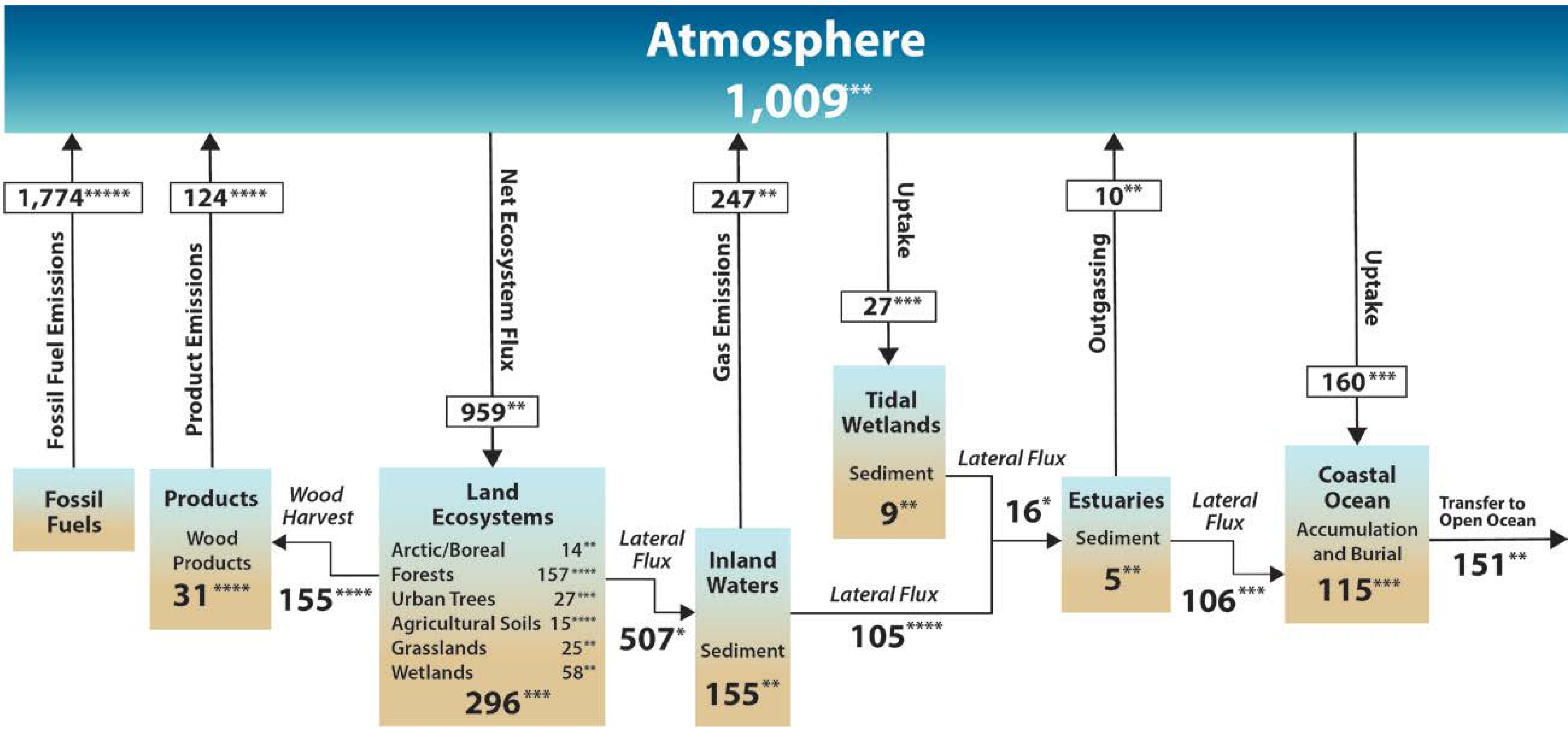



15 years post harvest ecosystem carbon is about the same as preharvest



harvest
***
***
Forest floor C (Mg ha-1)
30
20
10
0
disturbed
undisturbed
all pits
Mineral soil C (Mg ha-1)
160
140
120
100
1980
1990
2000

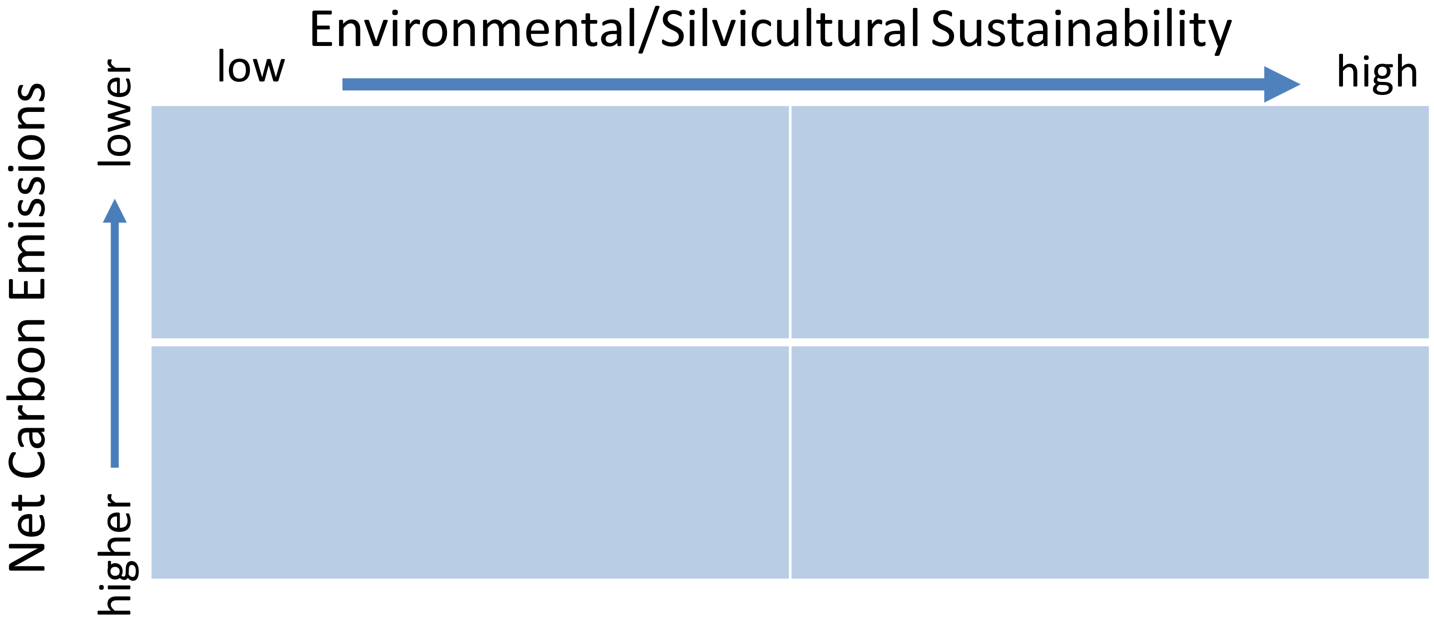
# Major Components of the North American Carbon Cycle.



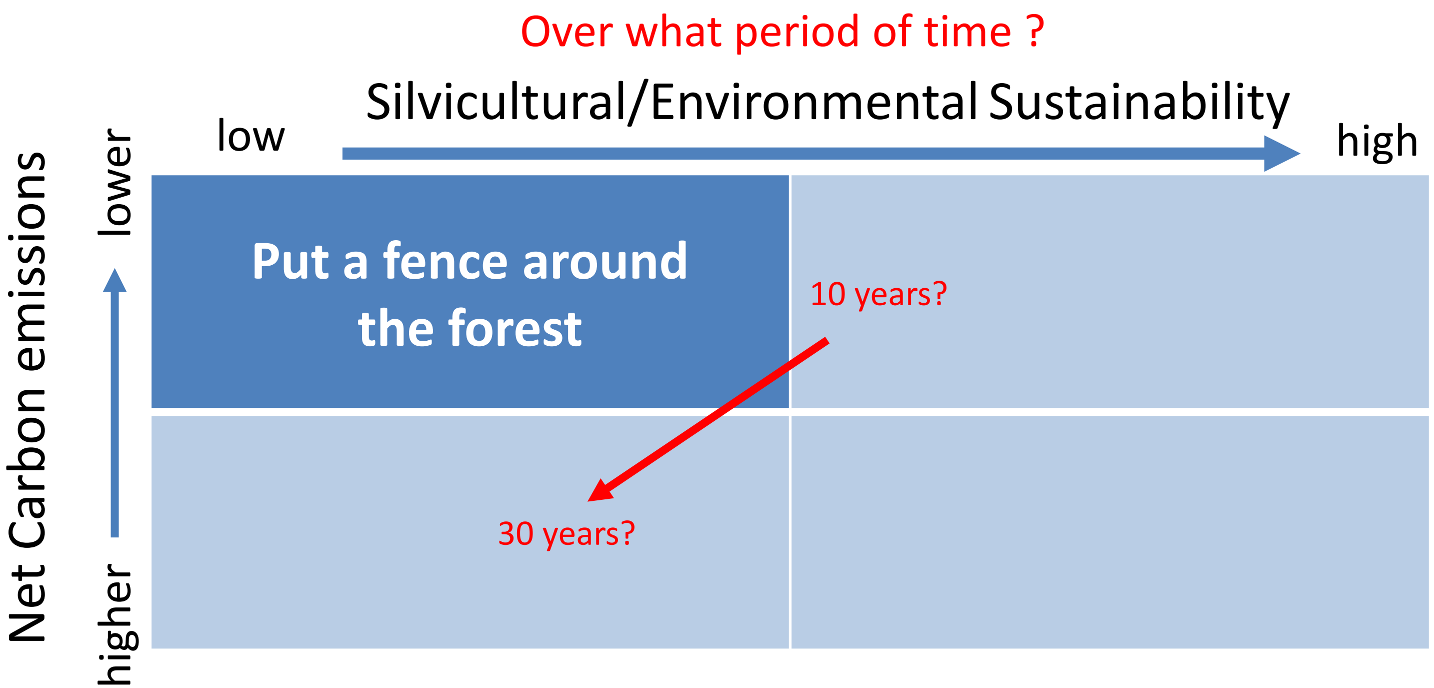

Boxes represent stock changes – arrows fluxes teragrams of carbon (Tg C) per year.

From SOCCR2

# The challenge of ensuring Bioenergy is climate beneficial



# The challenge of ensuring Bioenergy is climate beneficial



# System level impacts matter in determining the role that land use/ forests will play in deep decarbonization

- Albedo changes
- Bioenergy – net stock changes, BECCS assume bioenergy is largely carbon neutral
- Methane - net emissions/uptake
- Norms and local economics drive land use
  - Fragmentation
  - Tradition – Swiss high pastures

# Does deep decarbonization = ↓ net radiative forcing?

Does deep decarbonization = ↓ net radiative forcing?

It depends greatly –

be very careful in assuming they are equal

# Metrics Matter

$CO_2e$

# Metrics Matter

~~$CO_2e$~~

# Metrics Matter

~~$CO_2e$~~

$GWP_{20}/GWP_{100}$ [1]

[1] Ocko et al. 2017. Unmask temporal trade-offs in climate policy debates. Science 356:6337

# Metrics Matter

~~$CO_2e$~~

$GWP_{20}/GWP_{100}$ [1]

[1] Ocko et al. 2017. Unmask temporal trade-offs in climate policy debates. Science 356:6337

Pulse versus constant flow of emissions