Next Generation of Remote Sensing Data:

Contributions to global carbon cycle

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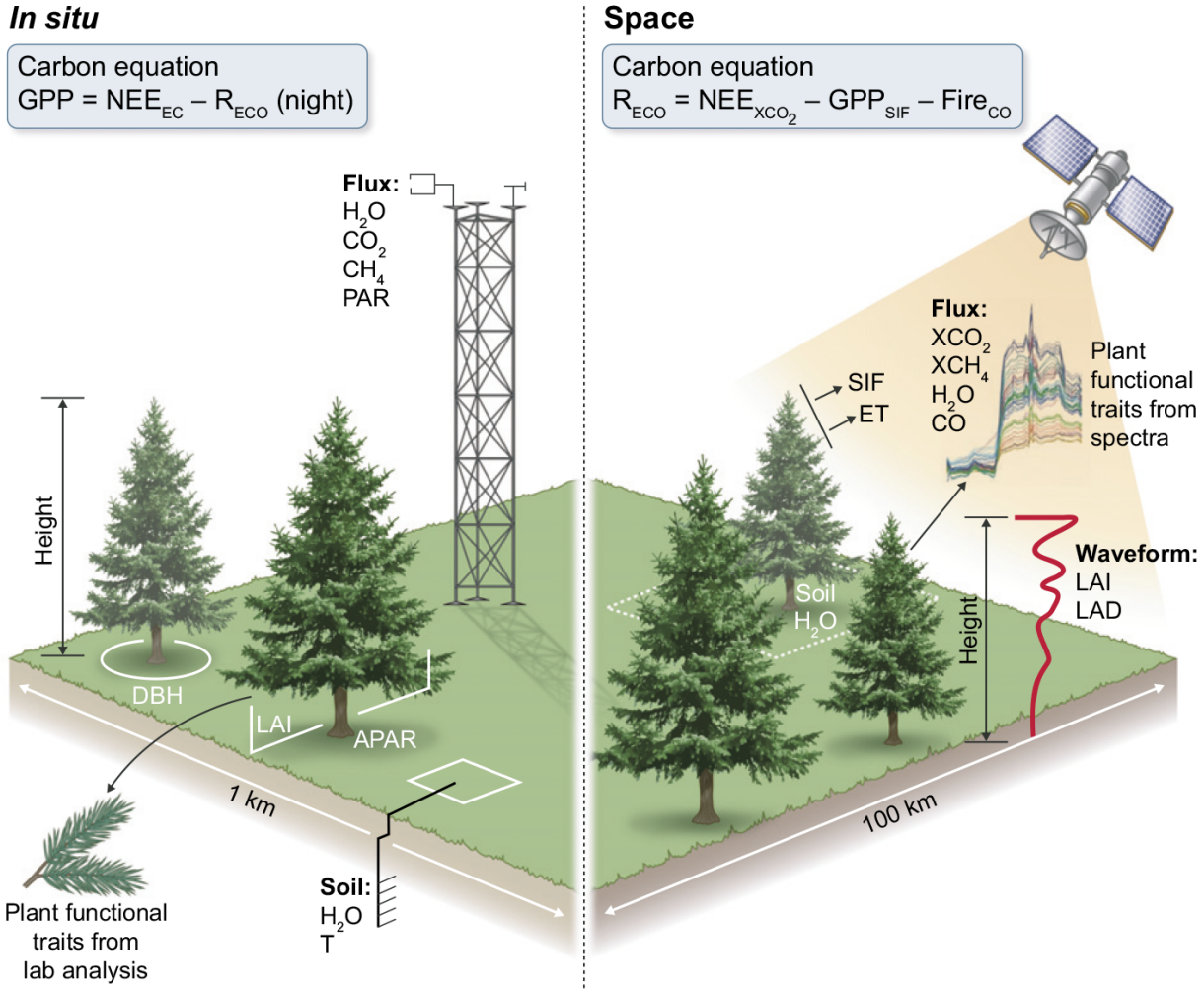
Aspen Global Change Institute
April 13-15, 2021

Observation of Terrestrial Carbon Fluxes

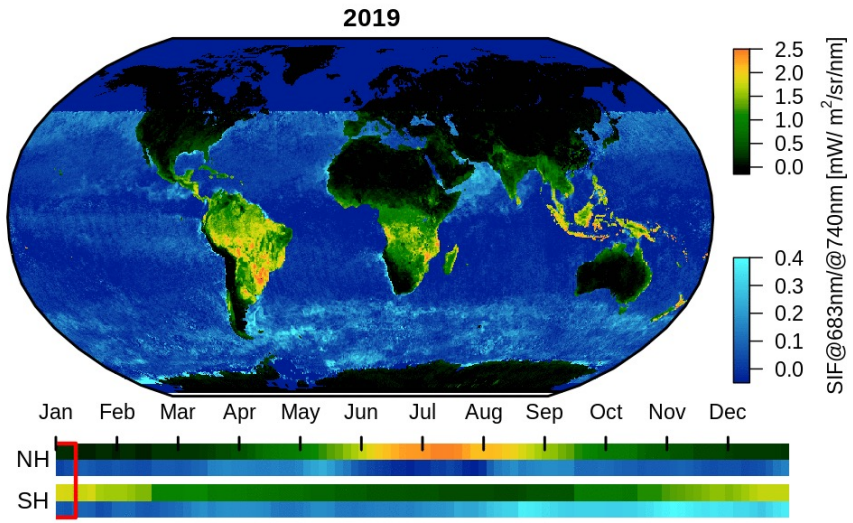


New observations from spacecrafts in orbit and upcoming mission allow an estimation of gross carbon fluxes, photosynthesis, biomass burning, evapotranspiration and live biomass, to create virtual eddy covariance sites in the sky.

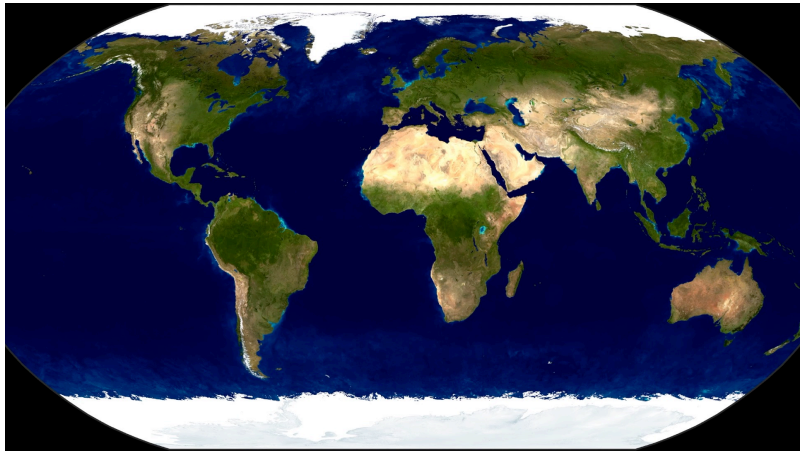
- What is the primary productivity of the globe and how is it controlled? (OCO2/3, TROPOMI)
- How much carbon does the biosphere store and how could it change? (GEDI, NISAR, BIOMASS)
- How does direct human exploitation of the biosphere affect productivity and carbon storage? (Sentinel, Landsat, FLEX)
- What is the biological diversity of the world and how does it affect the function and stability of ecosystems? (HISUI, SBG)

Schimel et al., 2020

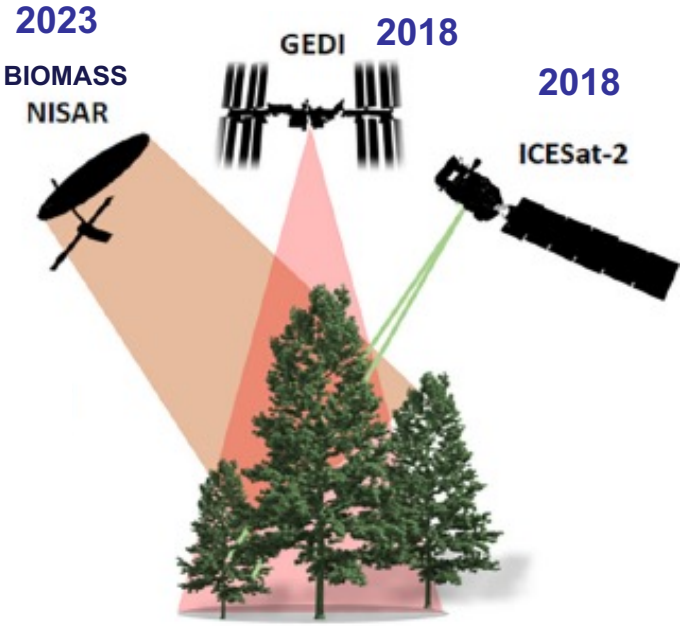
New Observations of Carbon Stocks and Dynamics

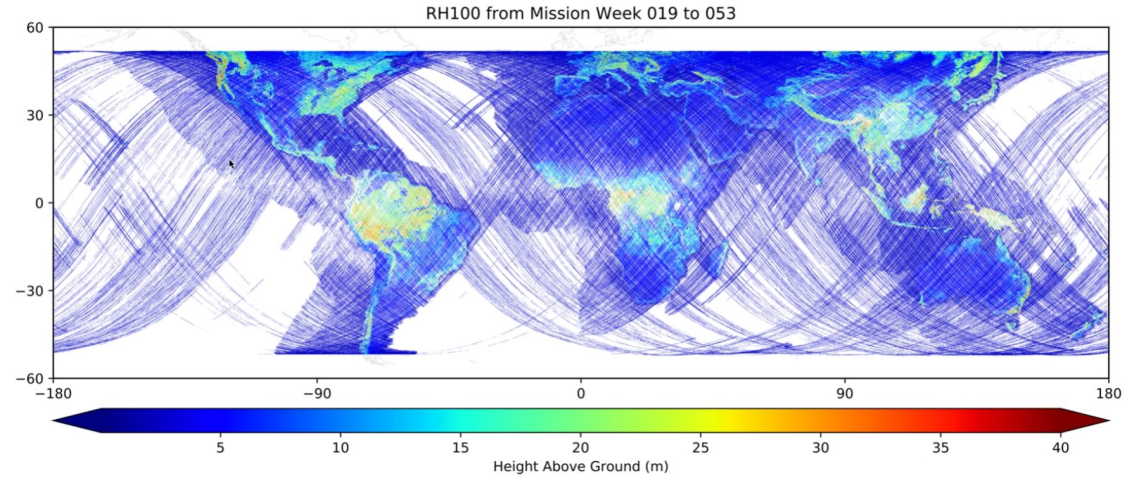


History or Evolution of SIF Measurement
Koehler et al (TROPOMI)

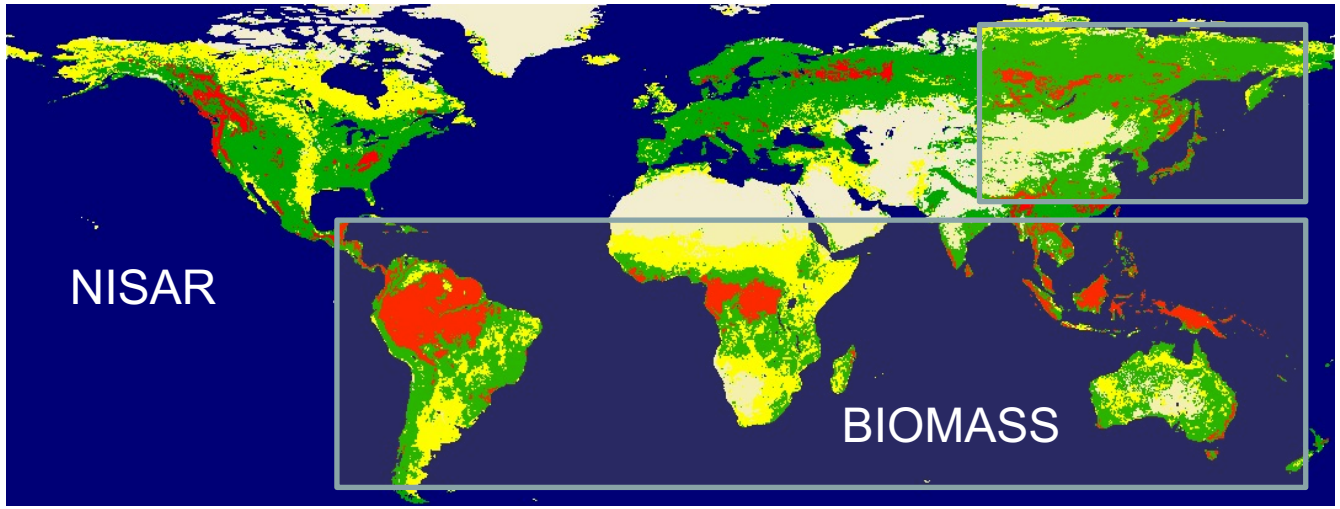


"Bowman et al. 2017: CMS-Flux, courtesy Eastham (MIT)"

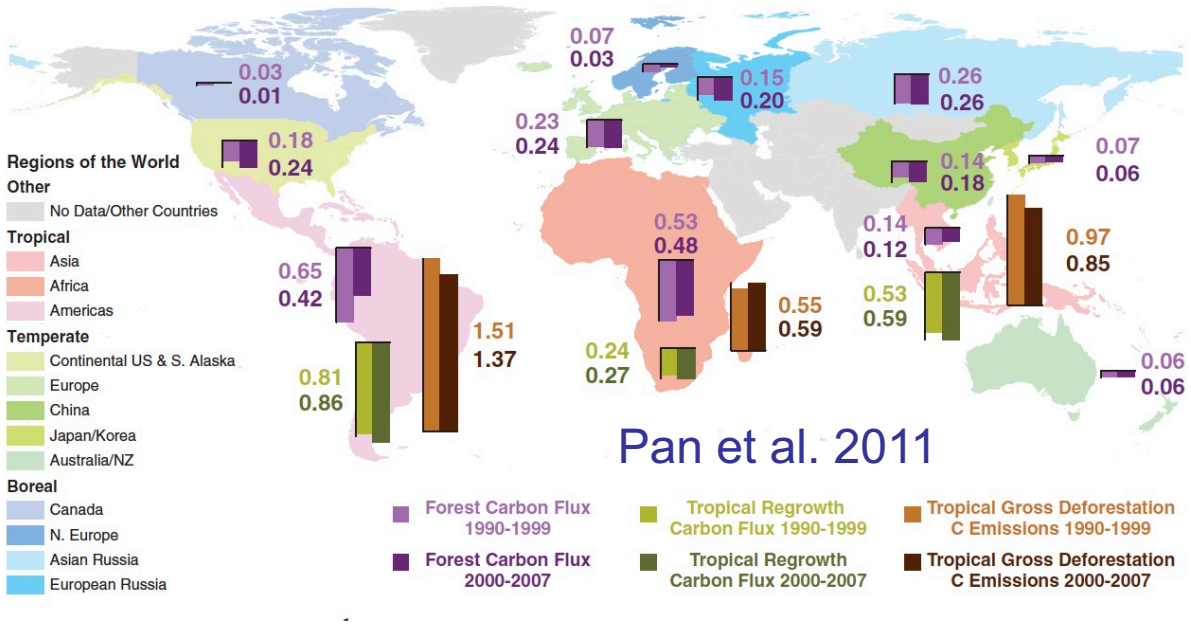




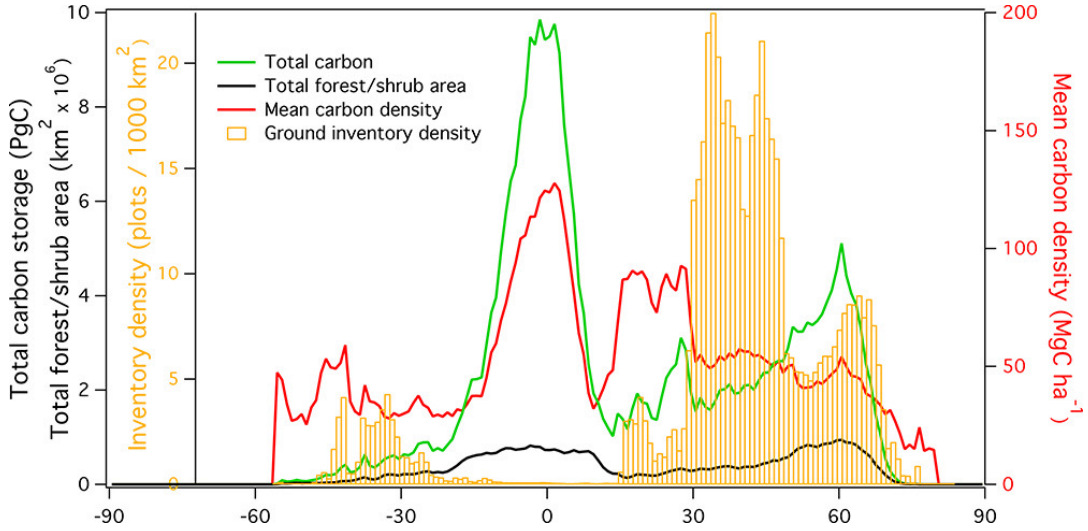
GEDI Data 2019-2020

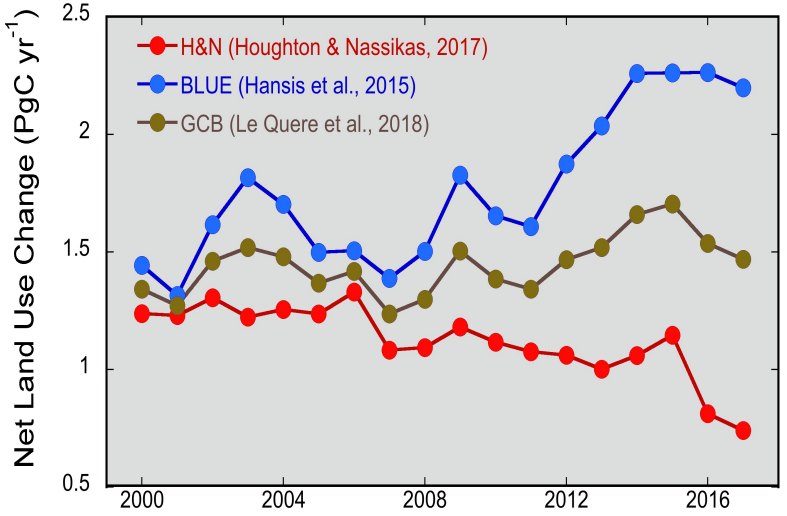


aboveground live biomass carbon stocks & changes



Pan et al. 2011





- Forest Inventory data are not systematic and synchronous globally
- Forest definition and carbon reporting varies at national scales (trees outside forest definition are ignored)
- Emissions are not calculated systematically everywhere
- Removals do not include dynamics of land use change (secondary forests in tropics)

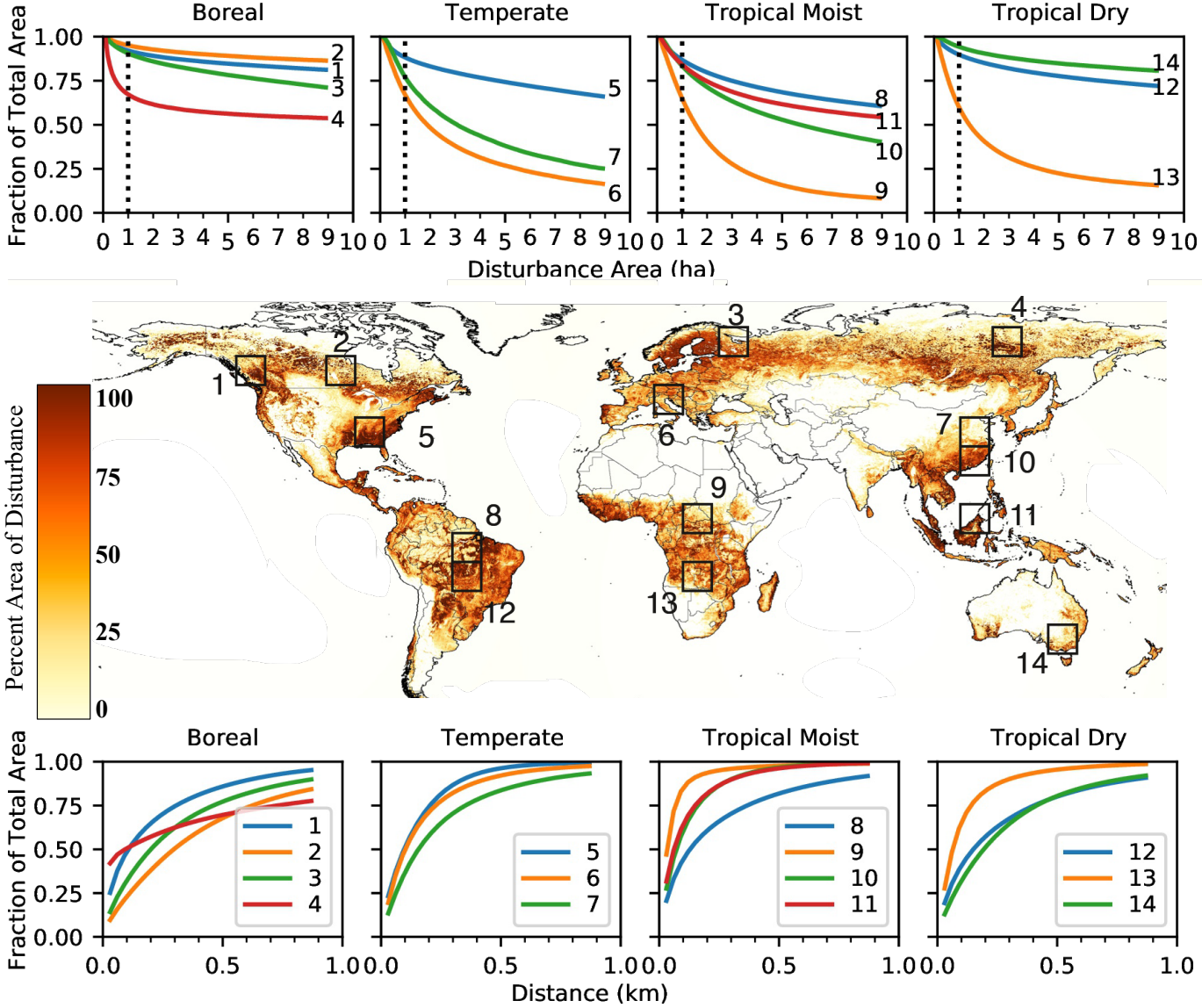
Carbon Emissions and Removals from Deforestation, Degradation, Regeneration

deforestation **degradation** **Regeneration**

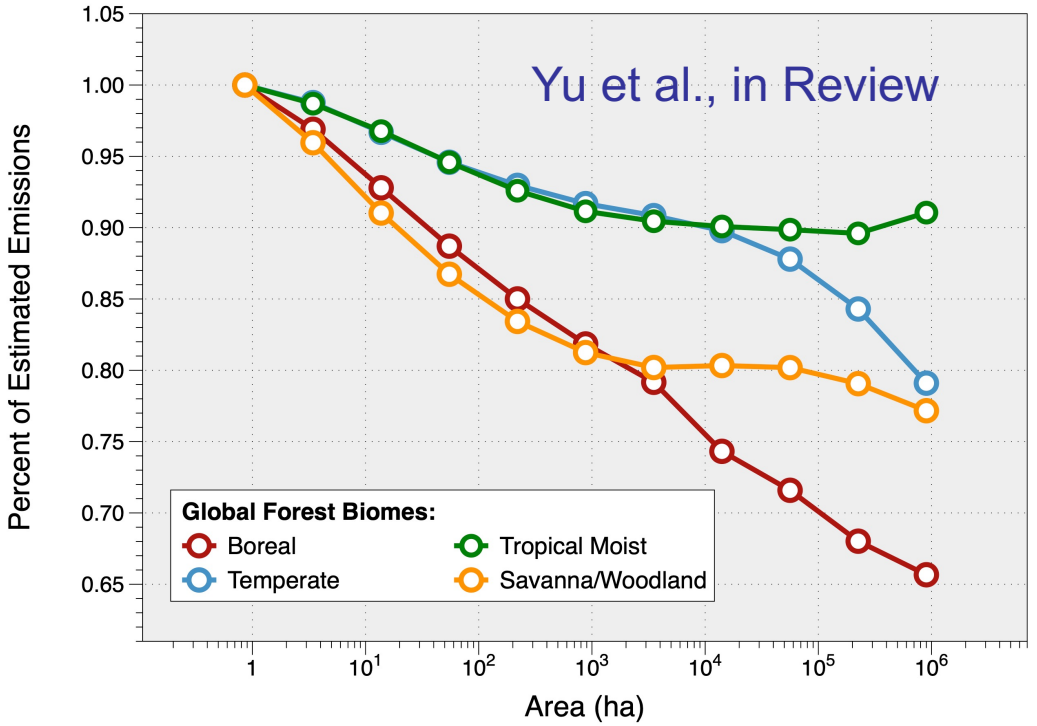
$$\Delta C = \sum \Delta A \cdot B \cdot E_{def} + \sum A \cdot \Delta B \cdot E_{\deg} + \sum A \cdot \Delta B \cdot R_{reg}$$

where A is the area of forest type, with biomass B, emission efficiency factor E, and removal efficiency R

Live Aboveground Biomass Must be Mapped

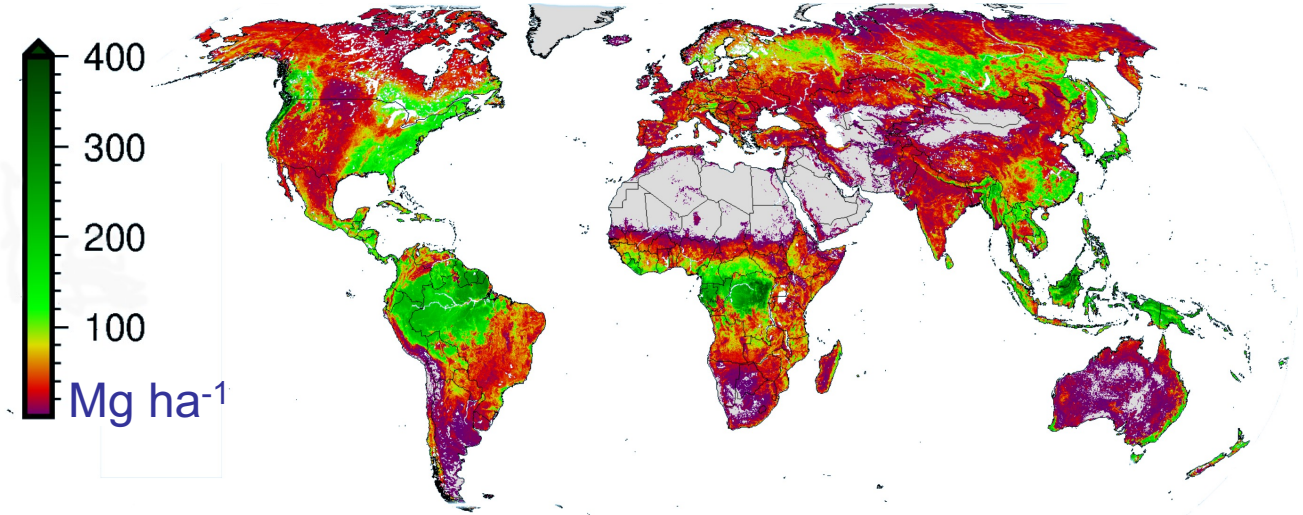


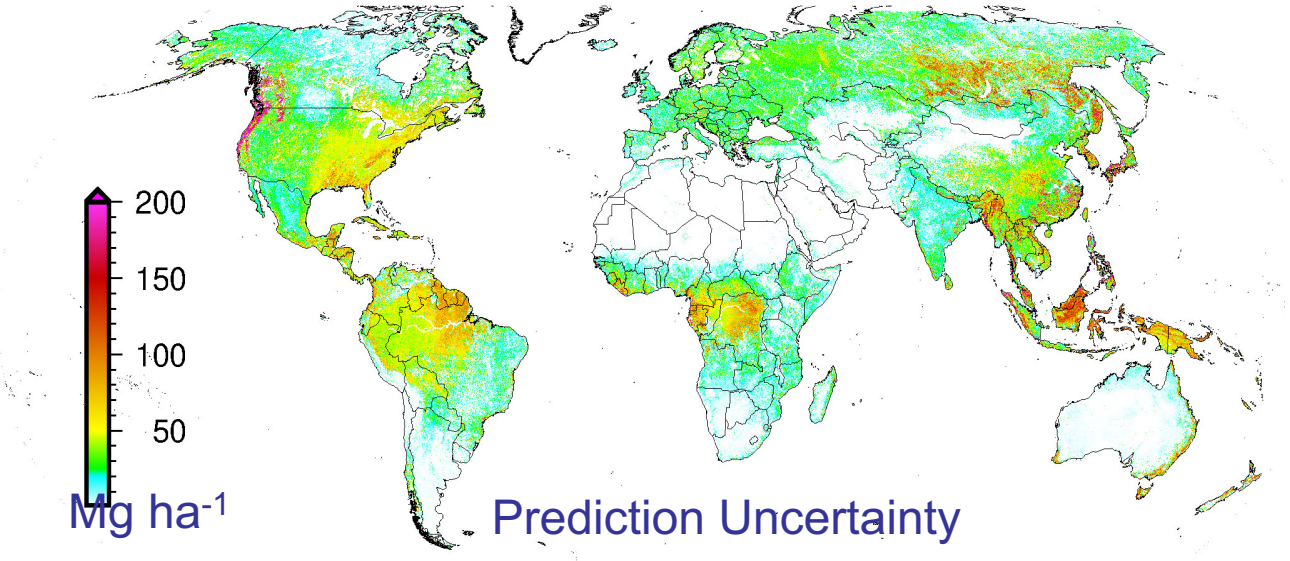
Systematic Error in estimating emissions from forest disturbance

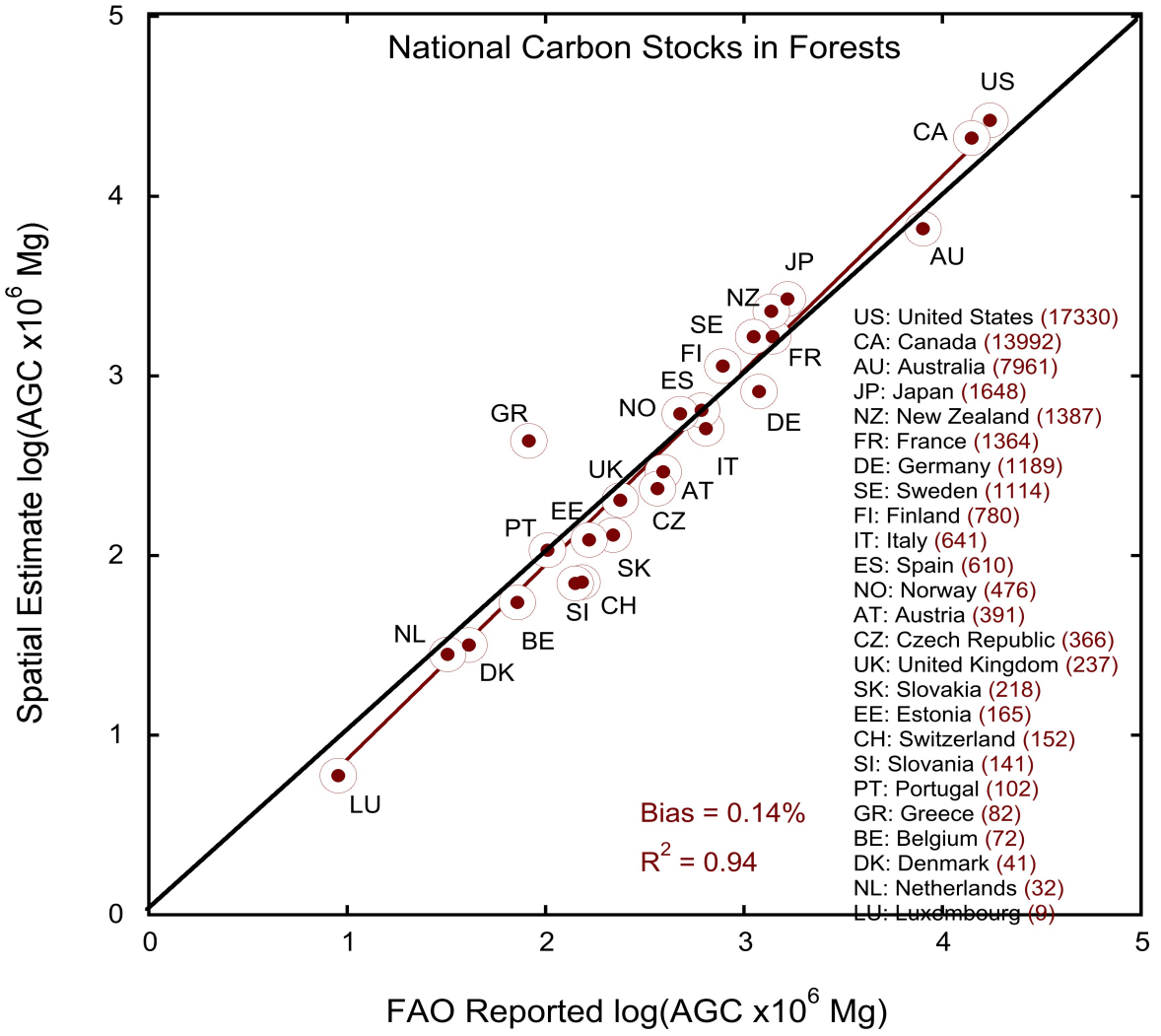


Optimum spatial scale for mapping biomass < 1-ha

Existing 1-ha biomass maps have large uncertainty

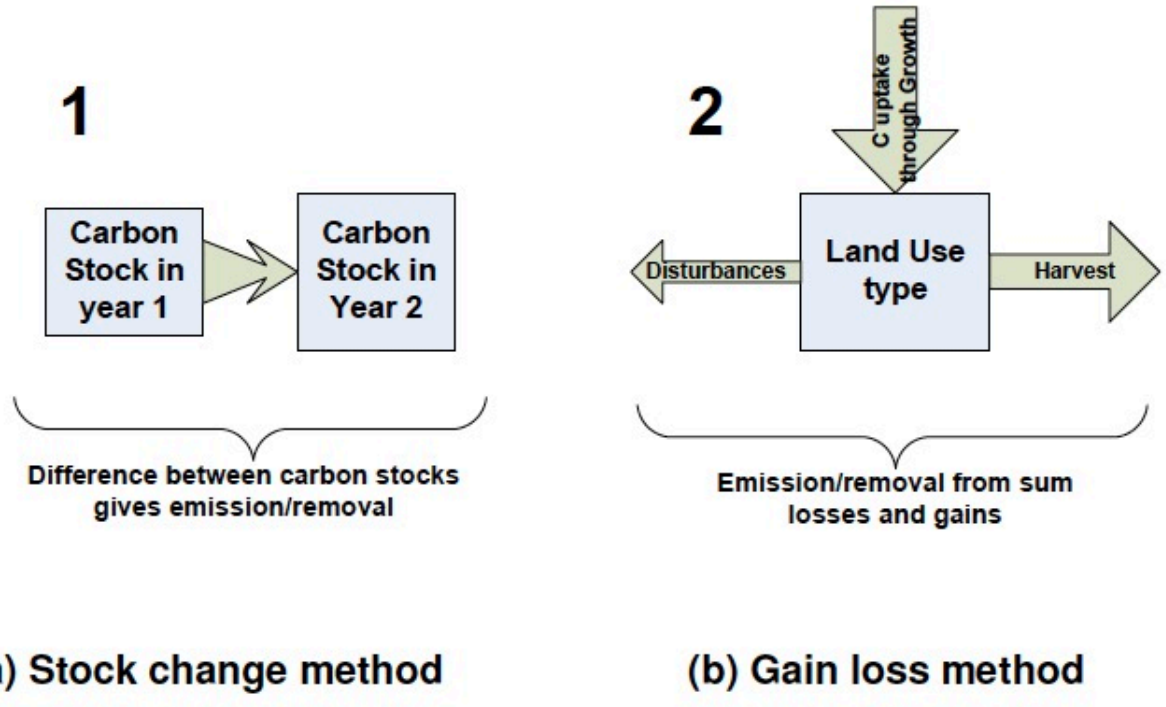




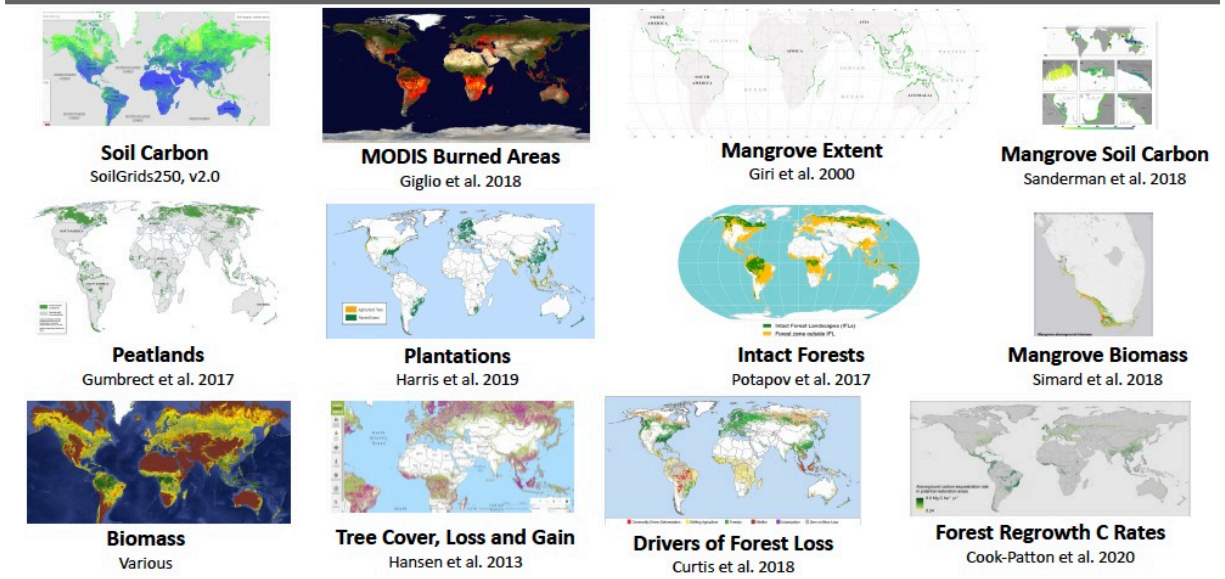


Making Bottom-up Estimates Spatial

IPCC Guidelines



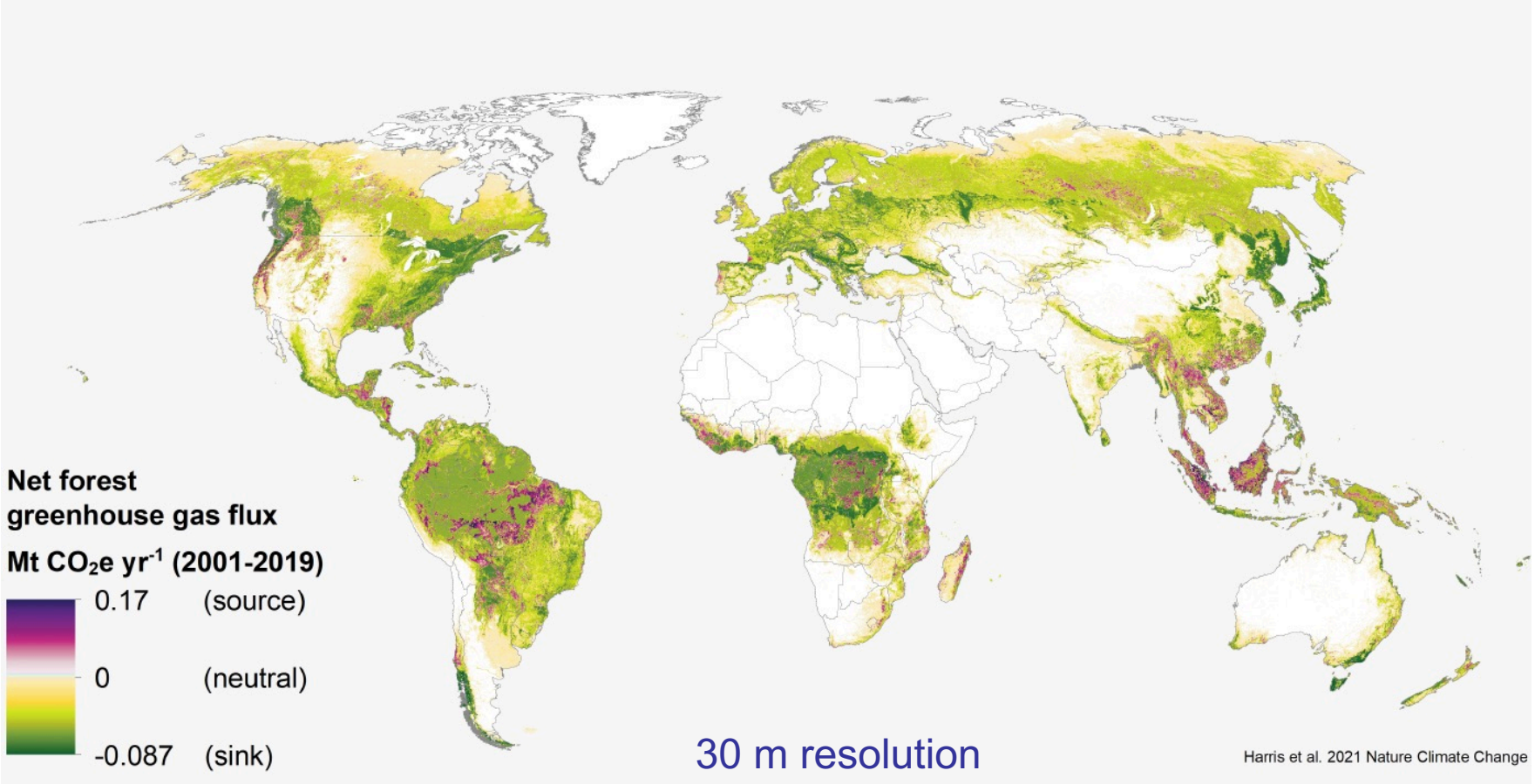
Combine data sources in inventory framework

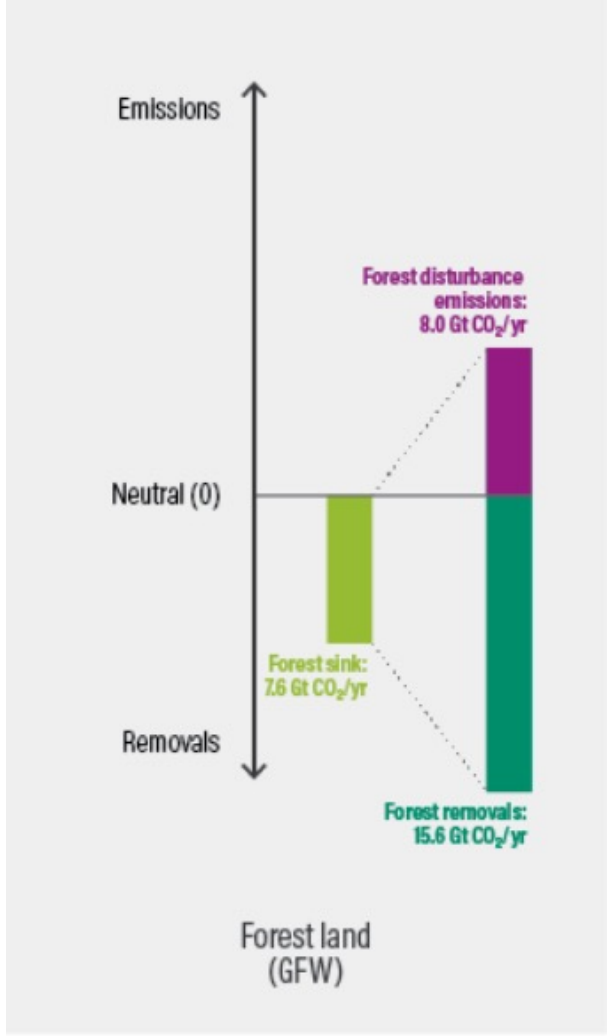


RS Based Observations and Spatial Data

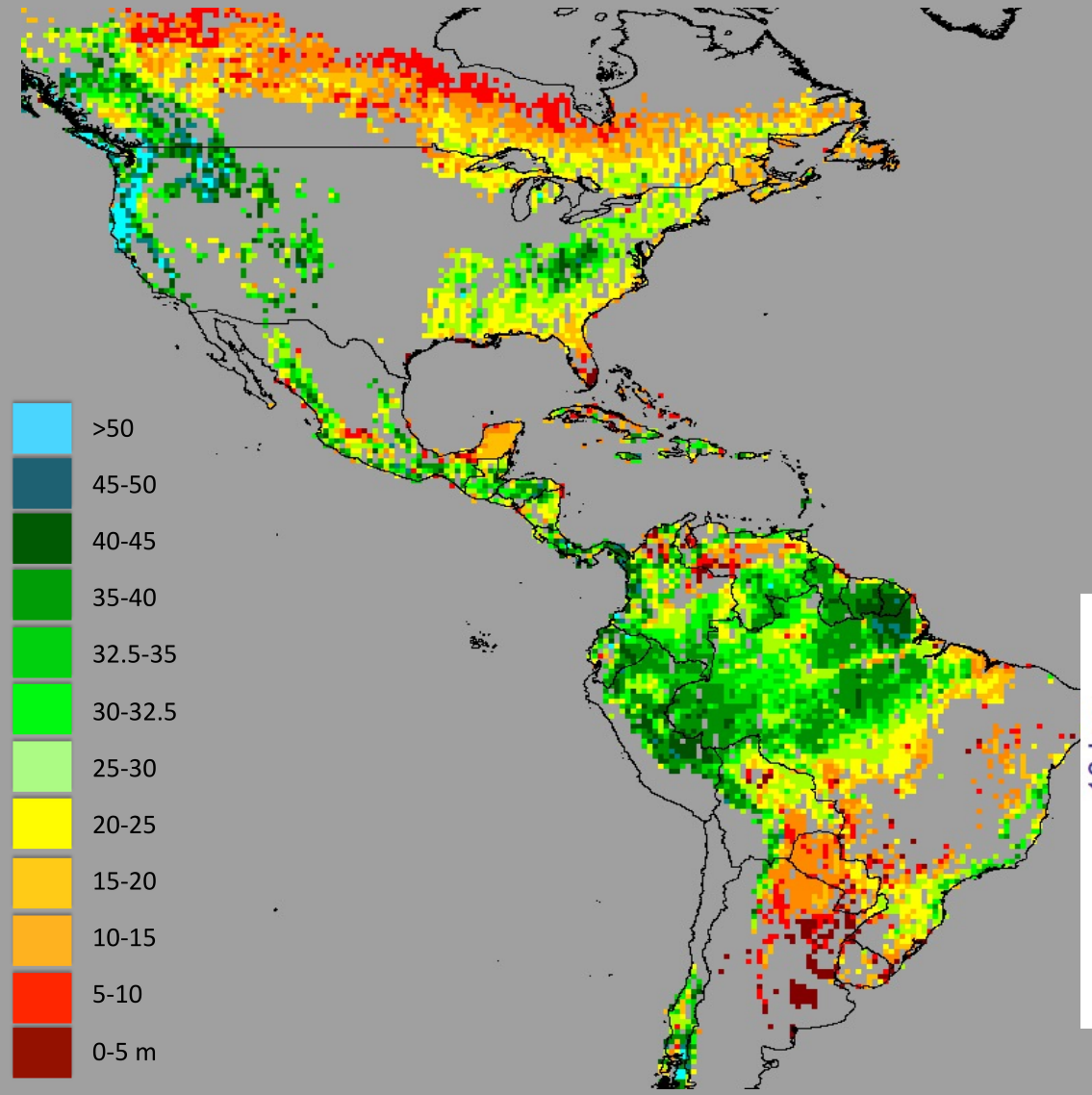
Gain-Loss Approach (2000-2019)

Harris et al., 2021

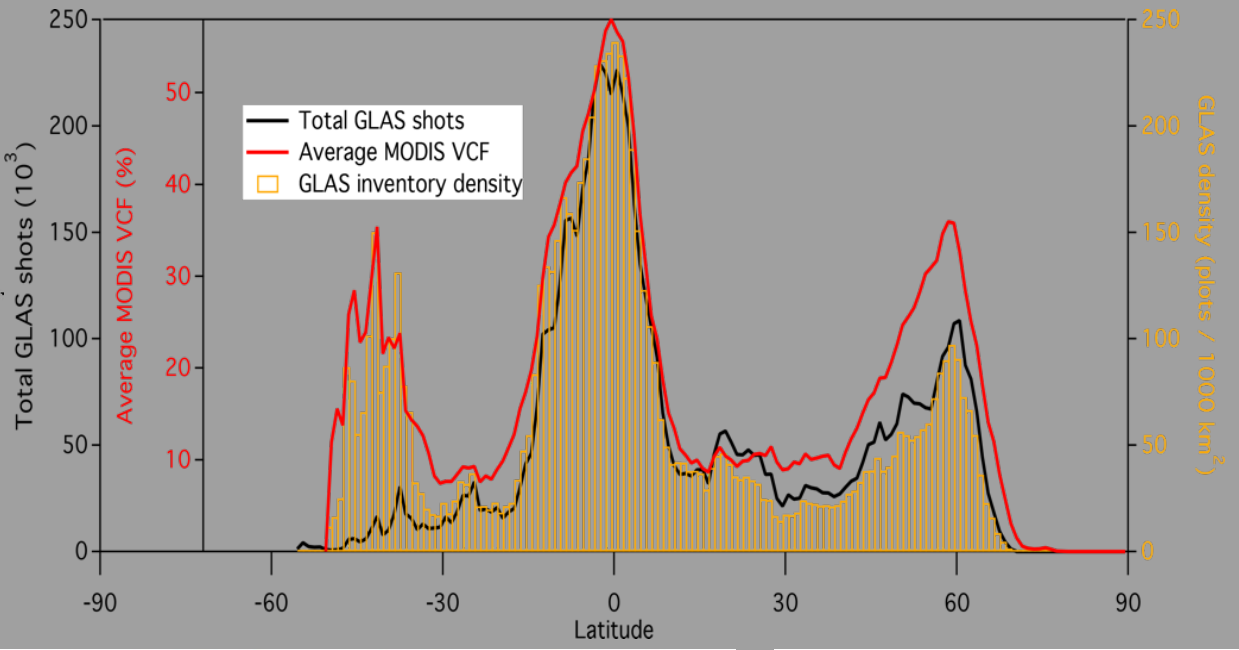


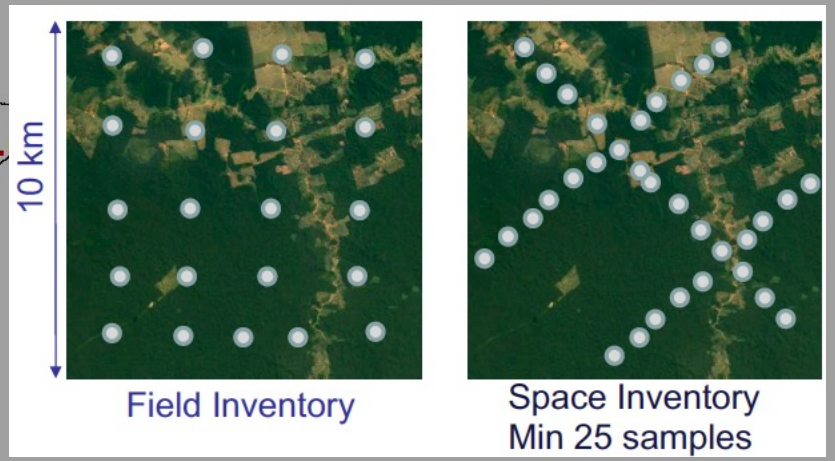


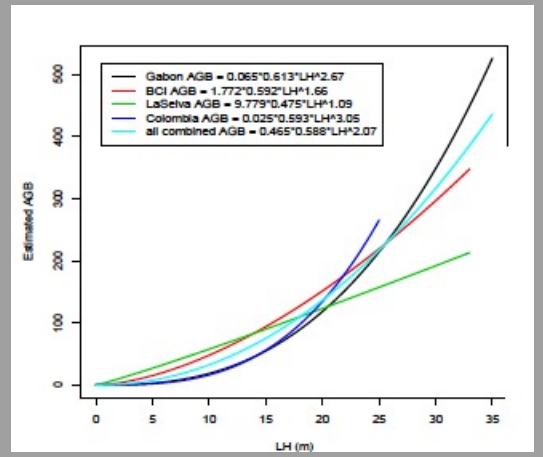
Forest Inventory from Space



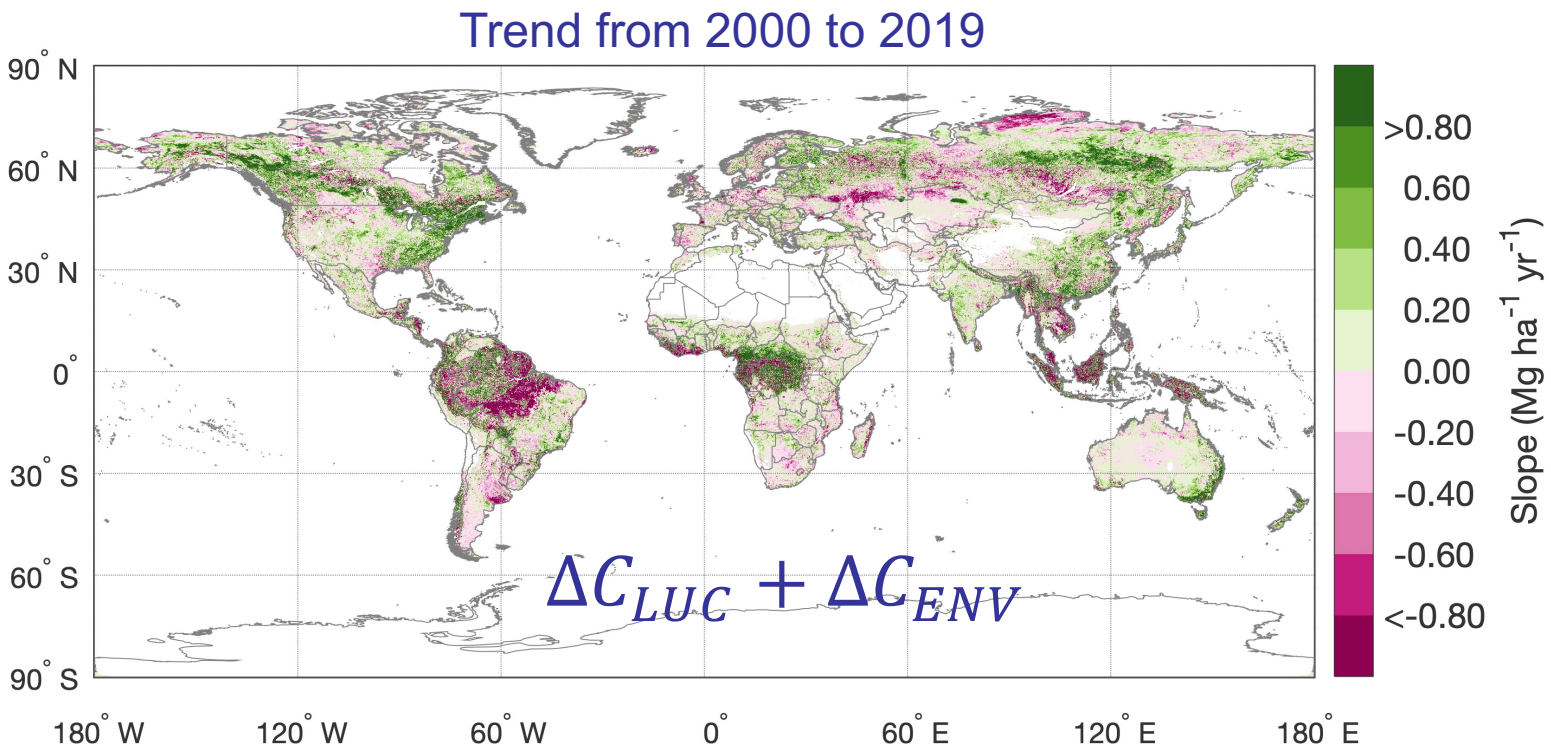
ICESAT-GLAS Height

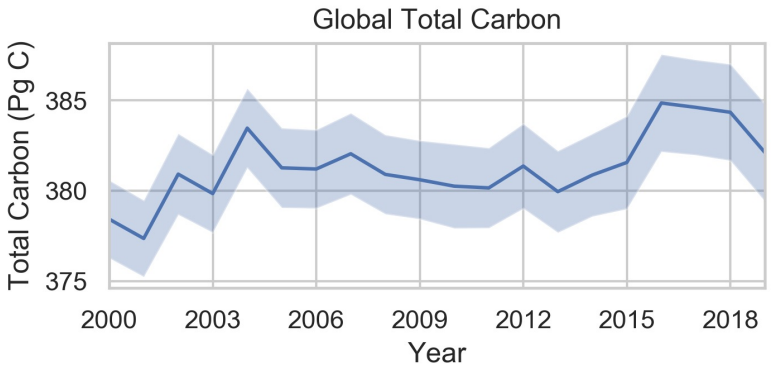




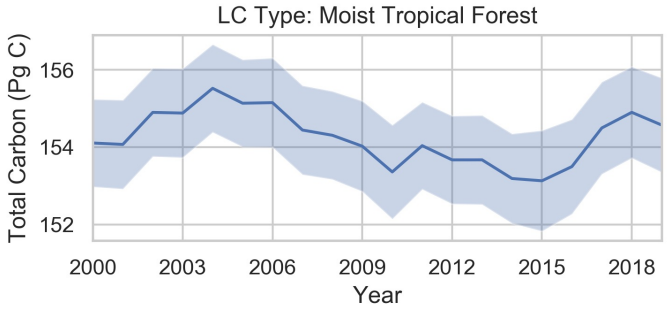


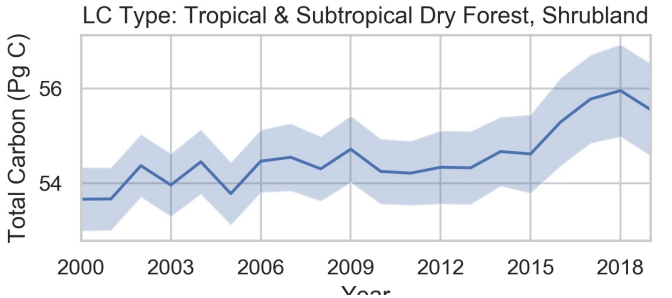
Where are gains and losses?

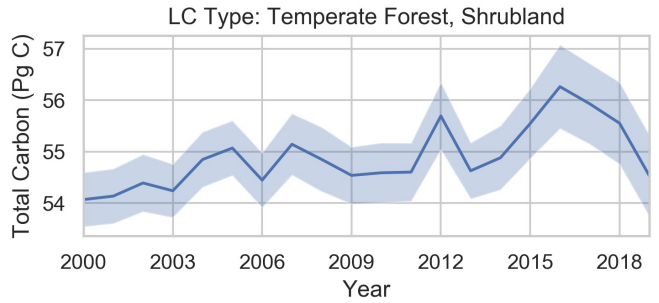


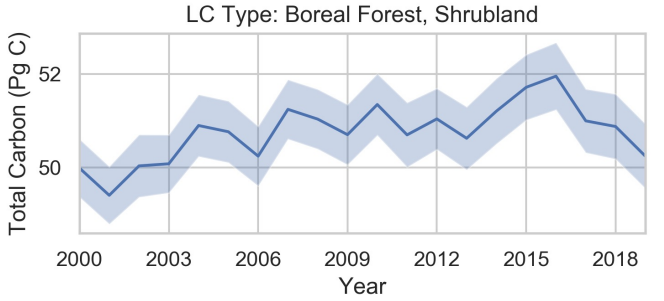


Xu et al., in Review

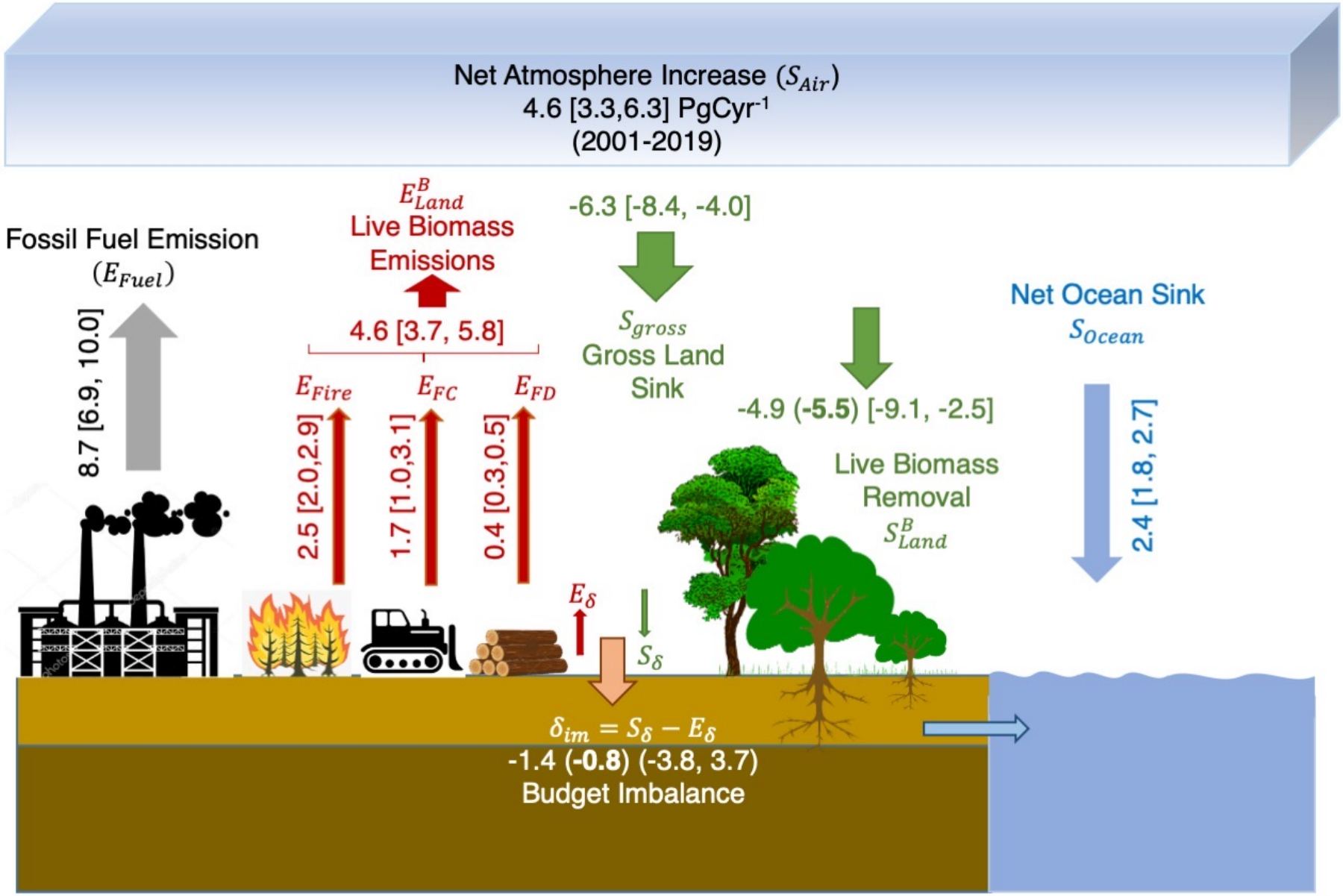








Live Biomass stock Changes Dominates Carbon Fluxes



AMAZON RIVER BASIN

Sink

Net flux : **-0.10**
Emissions : **1.1**
Removals : **-1.2**

CONGO RIVER BASIN

Gain-Loss (Harris et al., 2021)

Sink

Net flux : **-0.61**
Emissions : **0.53**
Removals : **-1.1**

SOUTHEAST ASIA

Source

Includes soil

Net flux : **0.49**
Emissions : **1.6**
Removals : **-1.1**

Stock-Change (Xu et al., 2021)

Neutral to Sink

Net flux : **-0.03(-0.38)**
Emissions : **1.54**
Removals : **-1.57(-1.95)**

Sink

Net flux : **-0.09(-0.43)**
Emissions : **0.9**
Removals : **-1.0 (-1.43)**

Source to Sink

Net flux : **0.1(-0.29)**
Emissions : **1.33**
Removals : **-1.23 (-1.62)**

Summary

Uncertainty: Uncertainty in live biomass stocks and changes remains a problem that can be resolved with NG observations

Live biomass fluxes: Live Biomass stock changes explains more than 70-80% of global terrestrial sinks and sources & other pools remain important

Regional Importance: Tropical forests dominate the sinks and sources of carbon in magnitude but remain a net neutral flux to small sink in this century

IAV of Atmospheric CO_2 growth: Tropical forest carbon stock changes from post-disturbance recovery control IAV of atmospheric CO_2