



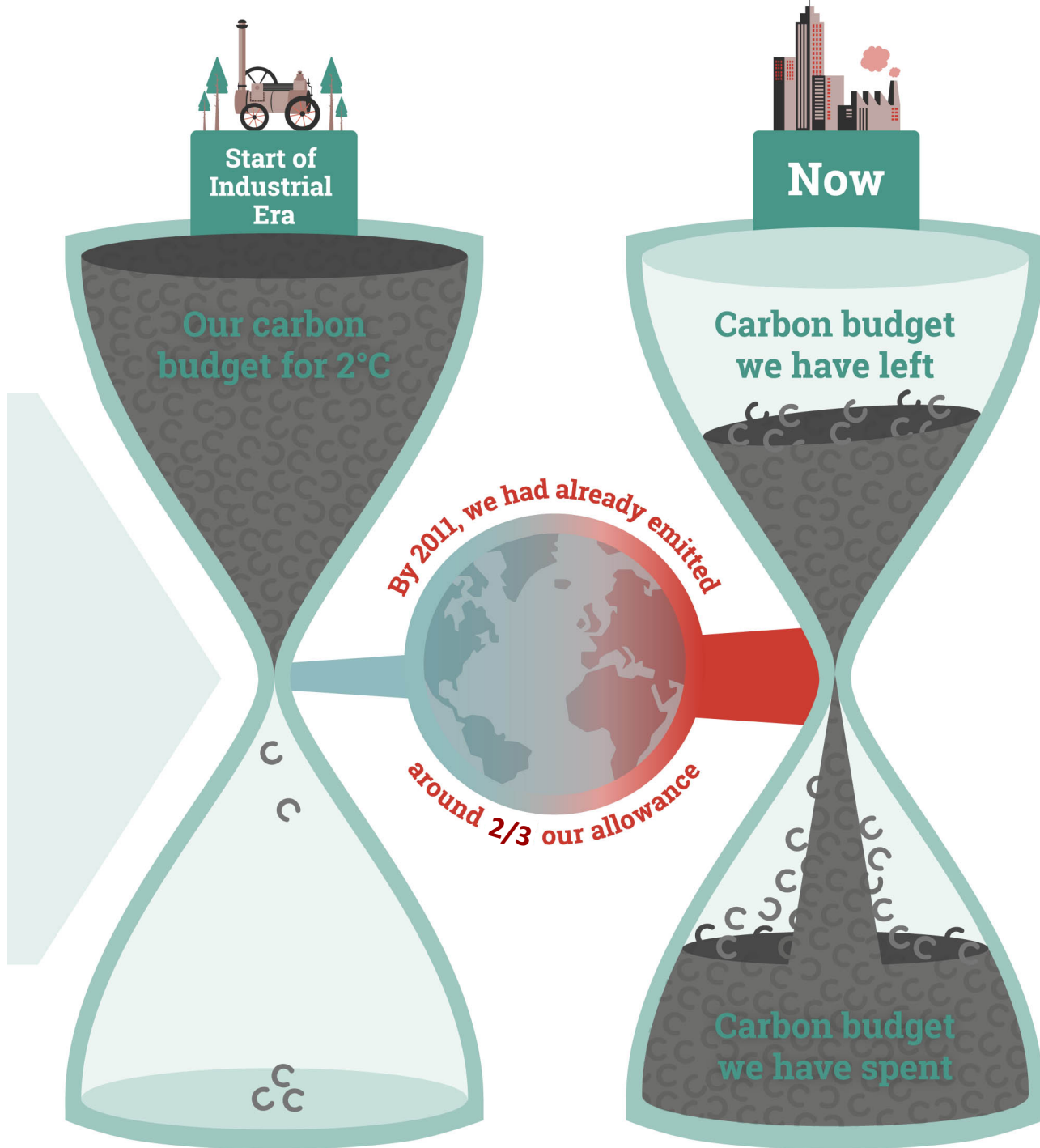
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Rightsizing expectations for carbon dioxide removal towards ambitious climate goals

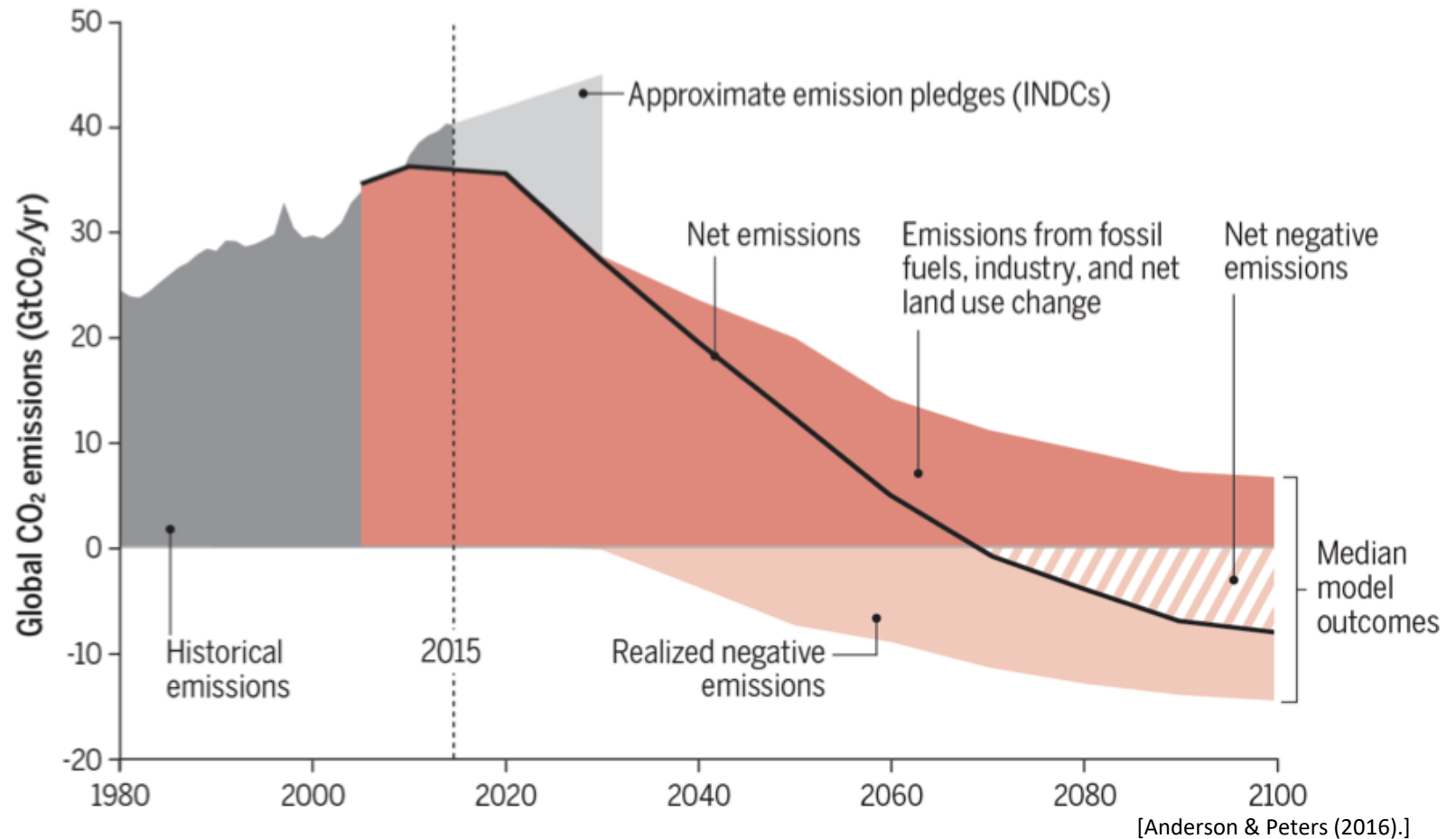
Katharine J. Mach

Department of Earth System Science

Carbon Budget



Rightsizing Expectations for Carbon Dioxide Removal



Baik et al. *PNAS* (2018).
Field & Mach *Science* (2017).
Sanchez et al. *PNAS* (2018).
Turner et al. *Nature Sustainability* (in press).
Turner et al. *Climatic Change* (2018).

Rightsizing Carbon Dioxide Removal Expectations

A sampling of CDR technologies

Comparative features of three widely discussed, potentially large-scale strategies for carbon dioxide removal (2, 7).

	FOREST AND SOIL STEWARDSHIP	BECCS	DIRECT AIR CAPTURE
Level of engineering complexity	Low	Medium	High
Environmental cobenefits	High	Low	Low
Land area required for large-scale deployment	High	High	Low
Risk of later carbon dioxide release	High	Low	Low
Energy status	~Neutral	Production	Consumption

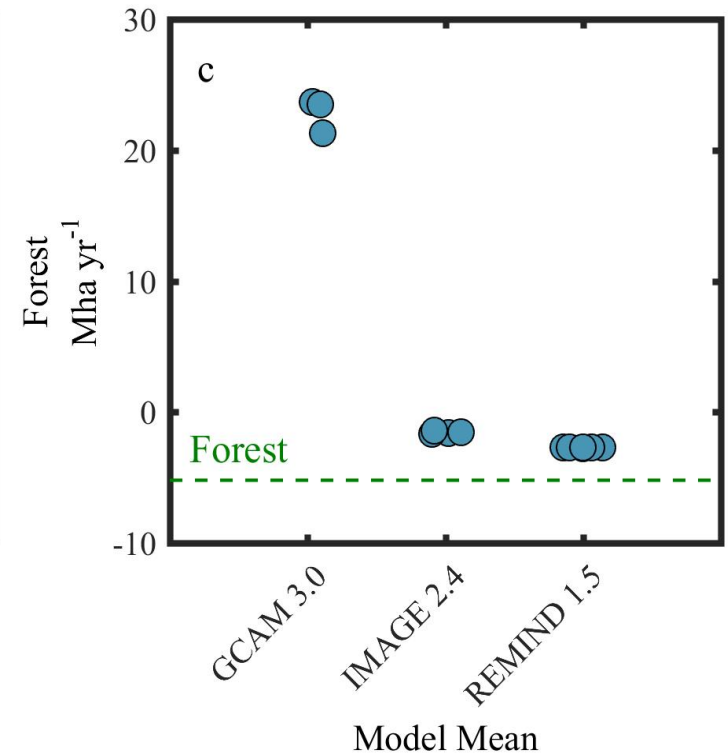
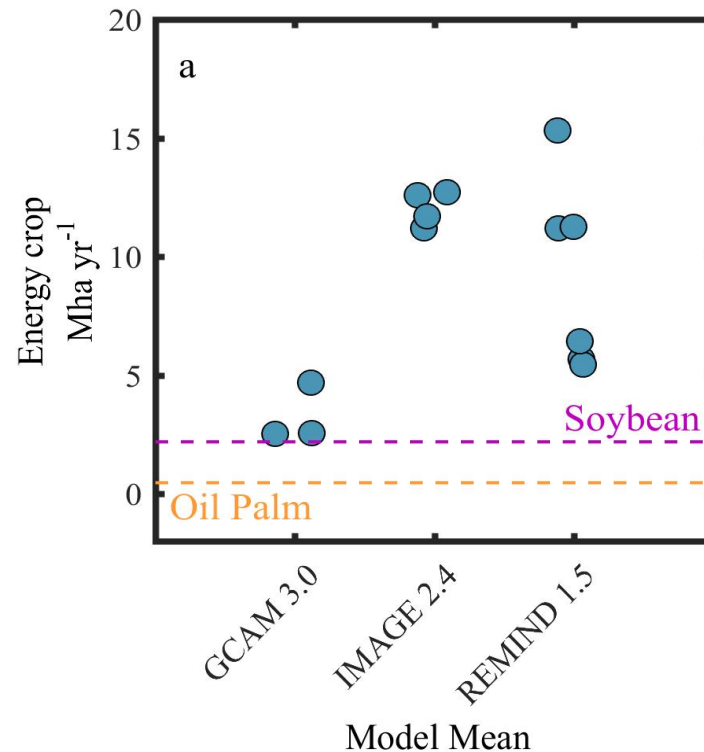
Rightsizing Carbon Dioxide Removal Expectations

- Feasible at scale? Game changing?
- Limits to deployment? (Land, water, reservoirs, energy)
- Does overshoot limit impacts? Why 2100?
- Can-kicking ethics?
 - shifting responsibility vs preserving flexibility
- What problem are we trying to solve?

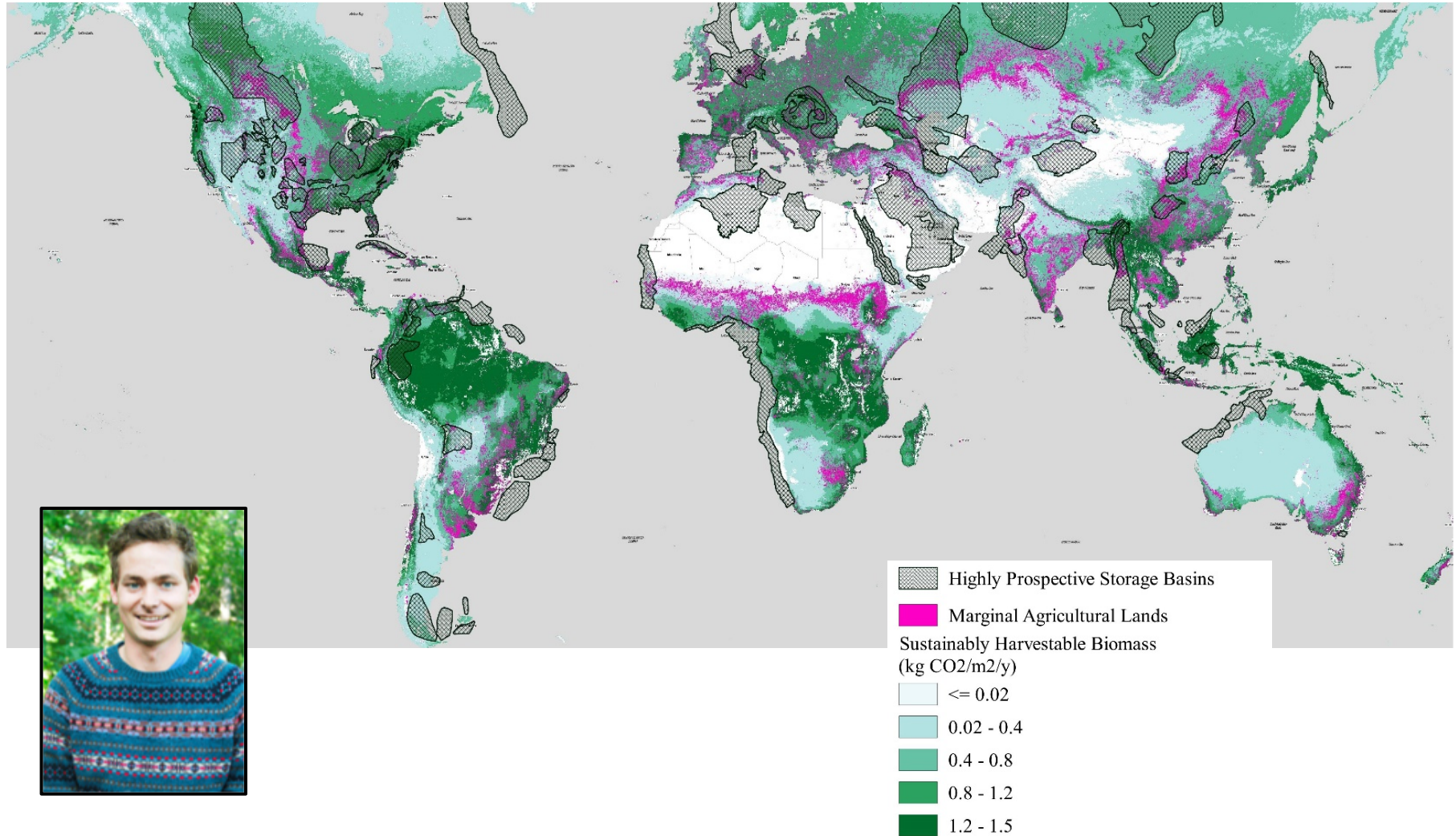
Understanding Rates of Land-Use Transformation



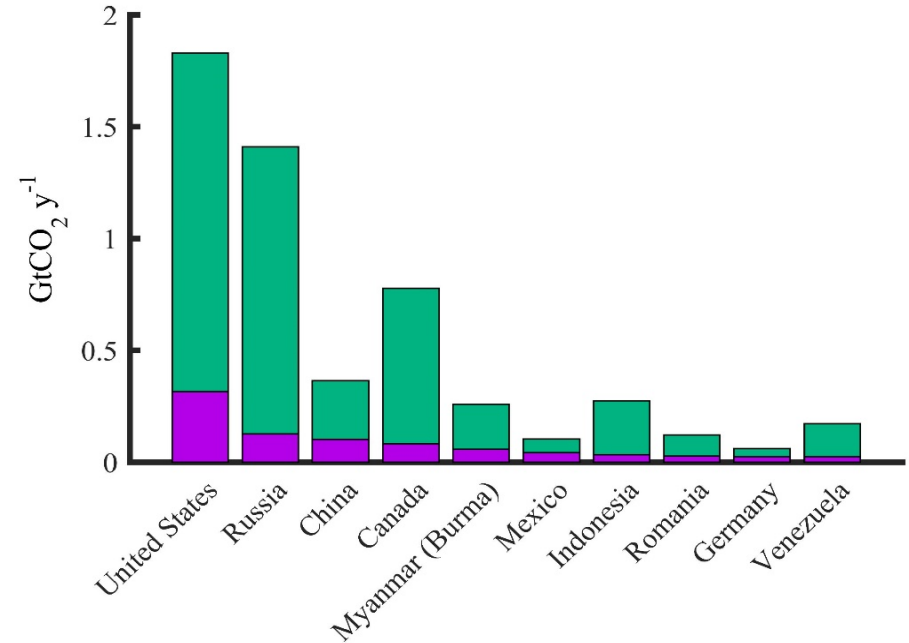
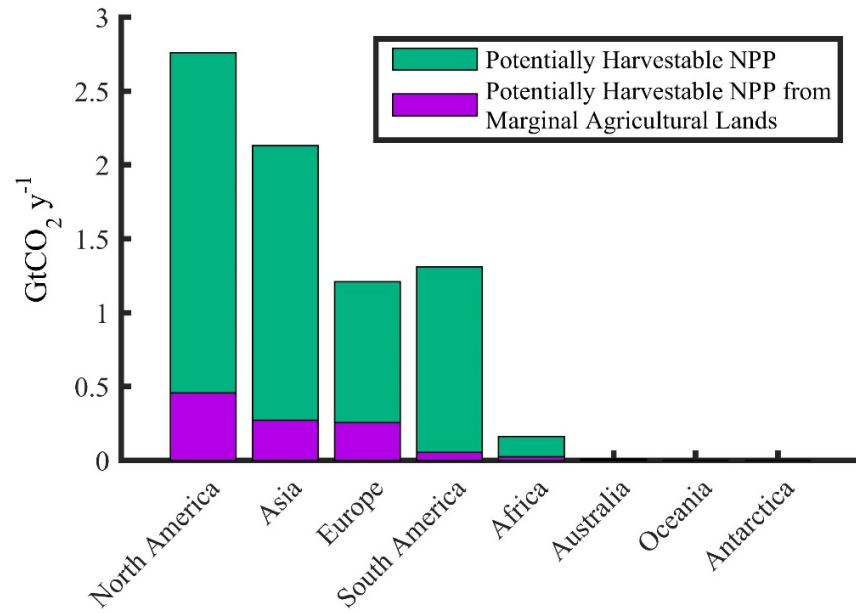
Understanding Rates of Land-Use Transformation



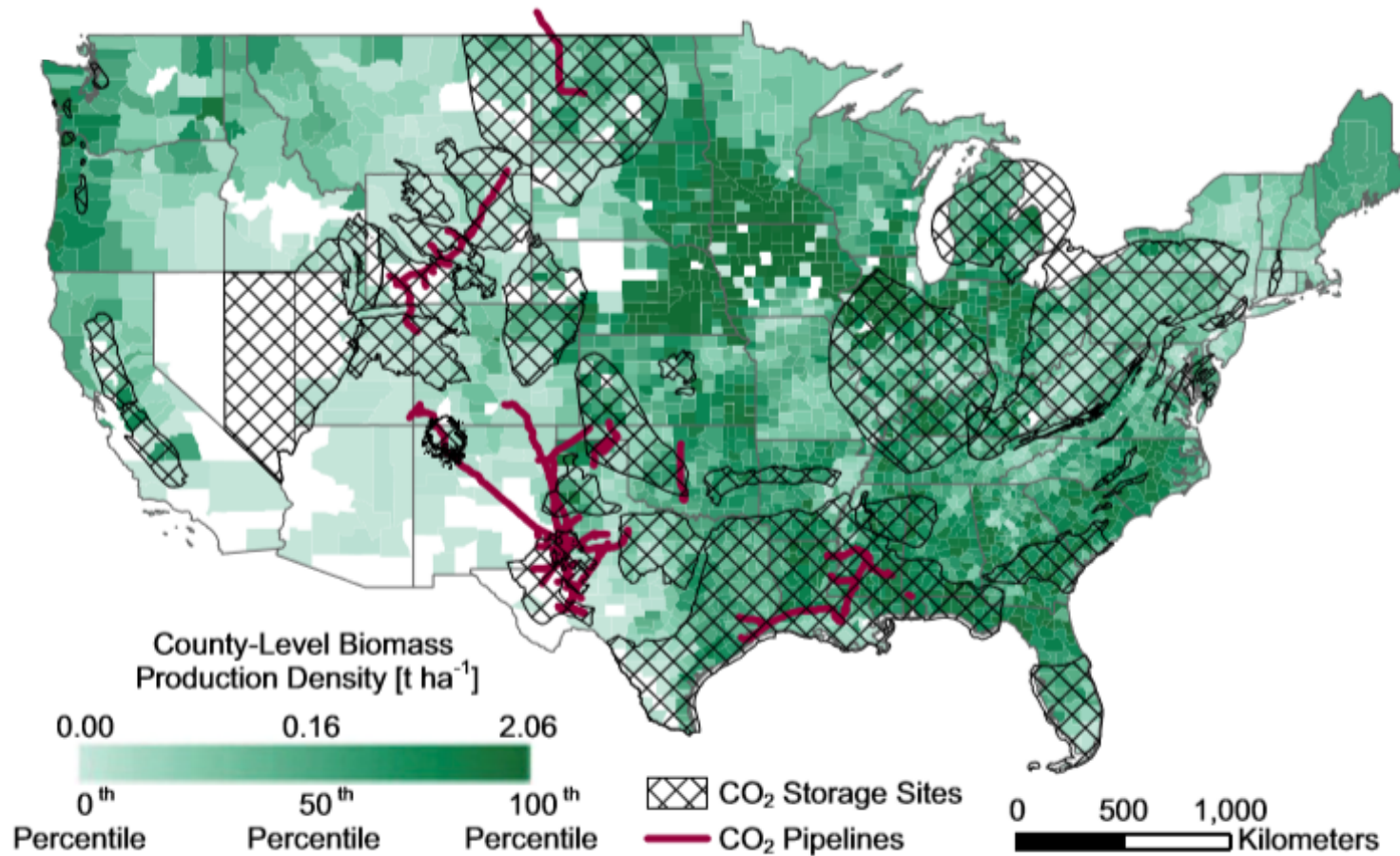
Global Overlap of Bioenergy and Carbon Sequestration Potential



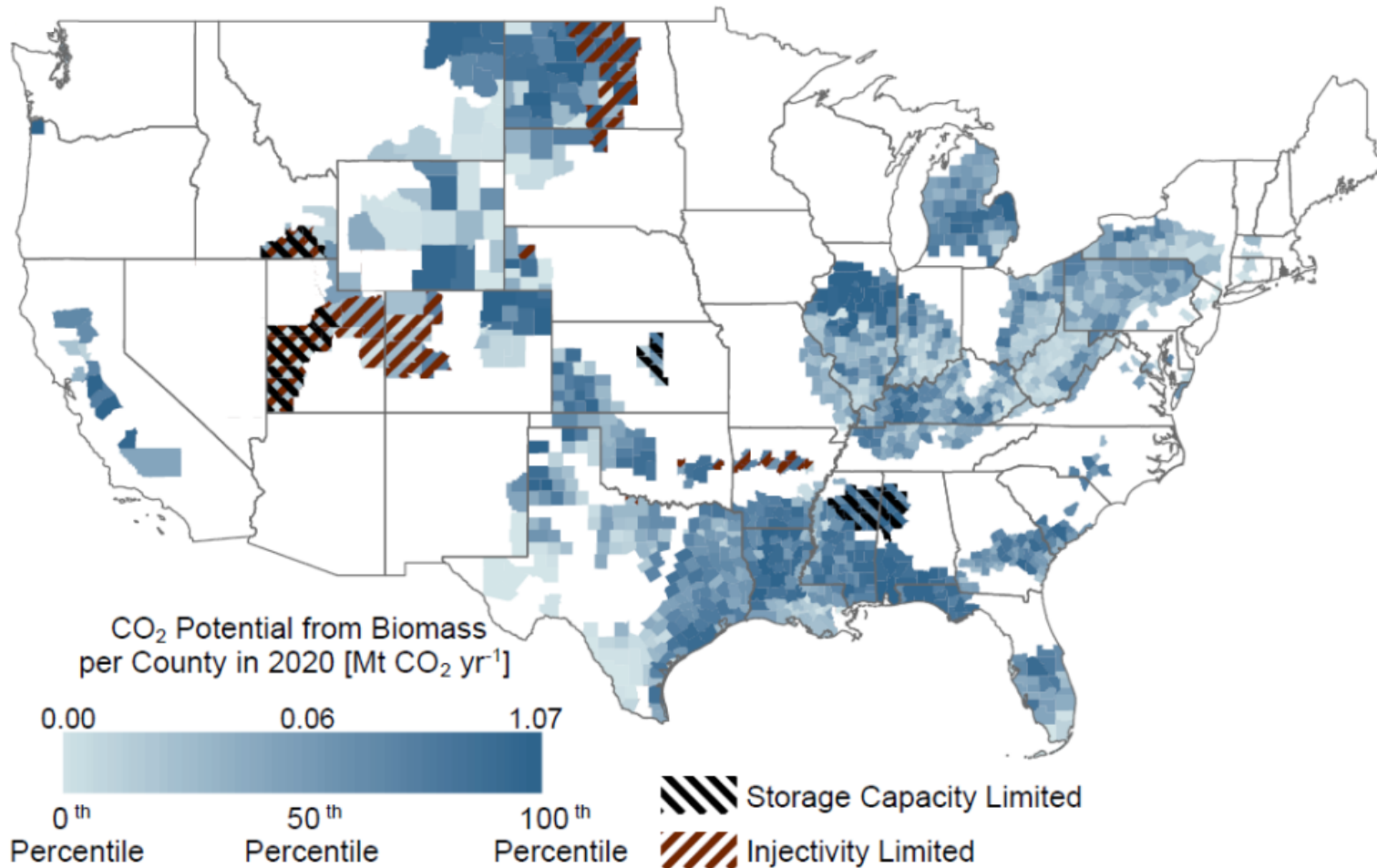
Global Overlap of Bioenergy and Carbon Sequestration Potential



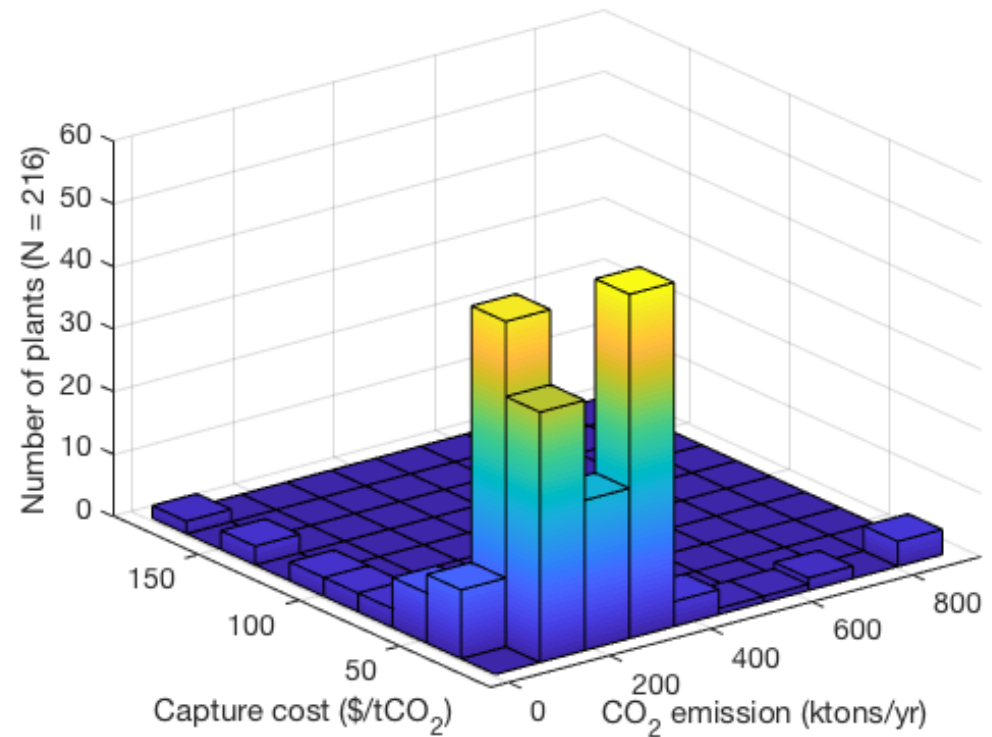
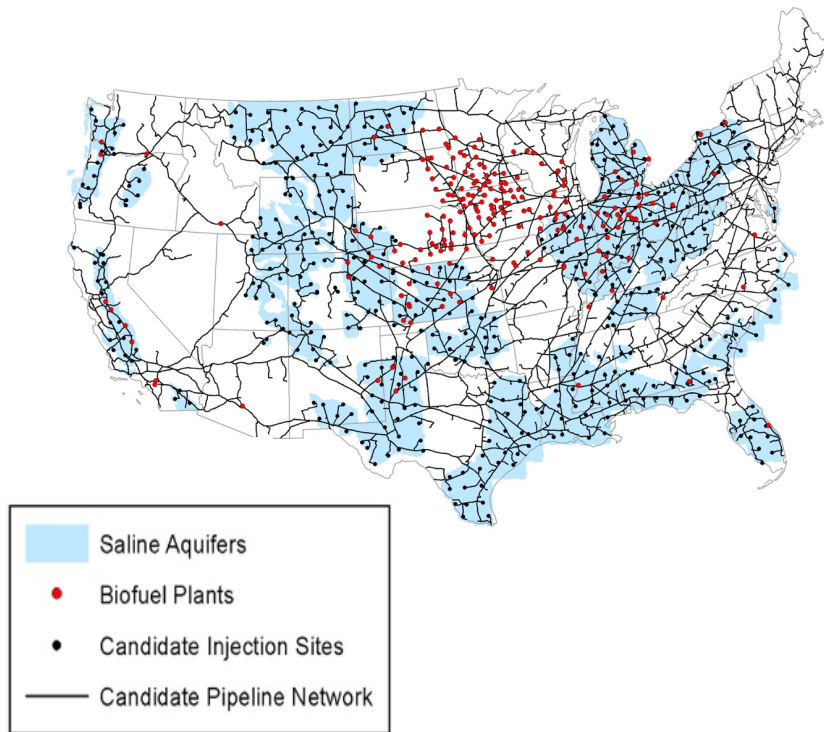
Carbon-Negative Bioenergy Potential with “Low Transport”



Carbon-Negative Bioenergy Potential with “Low Transport”



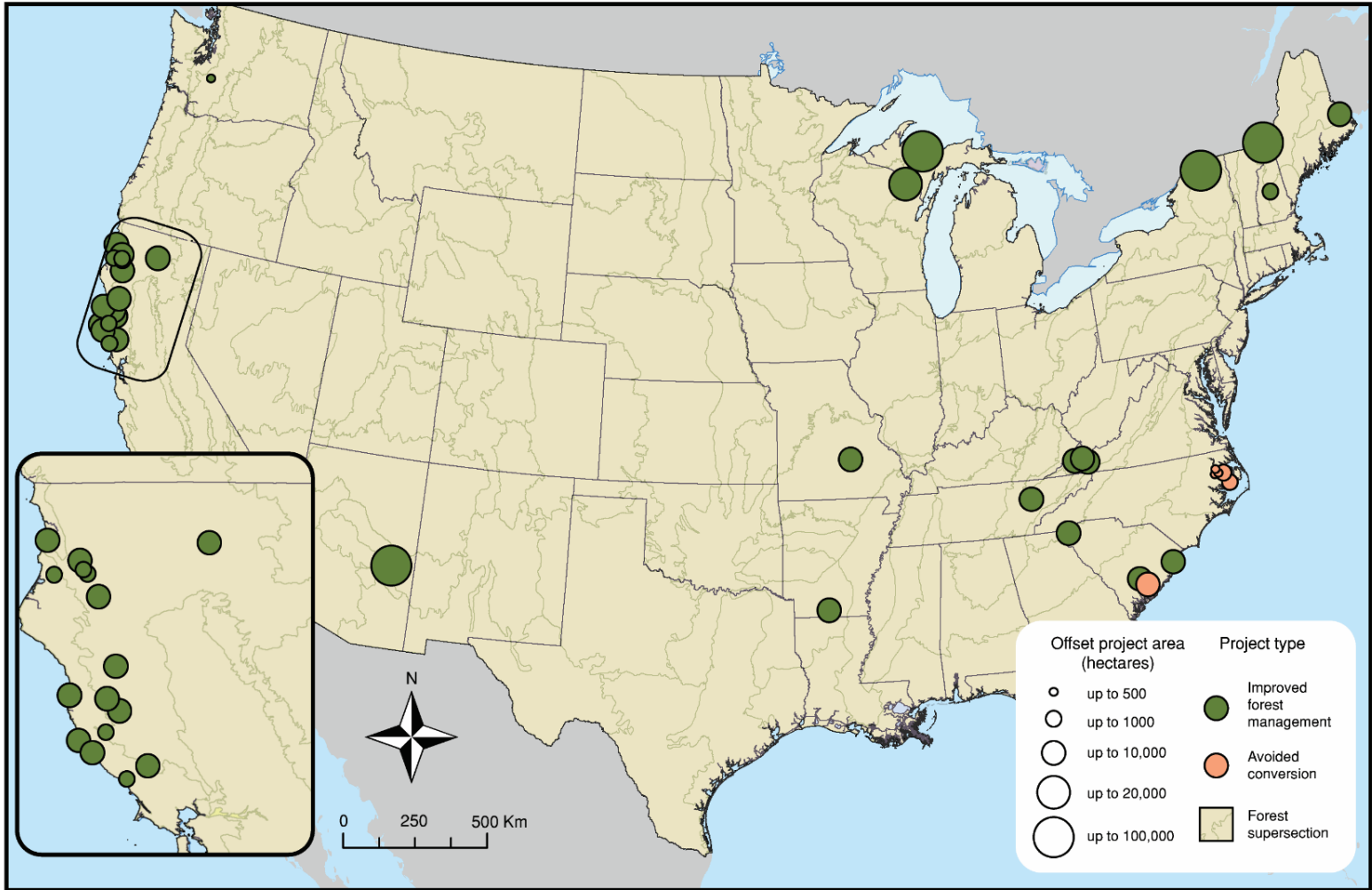
CCS at US Ethanol Biorefineries



Rightsizing Stewardship Opportunities

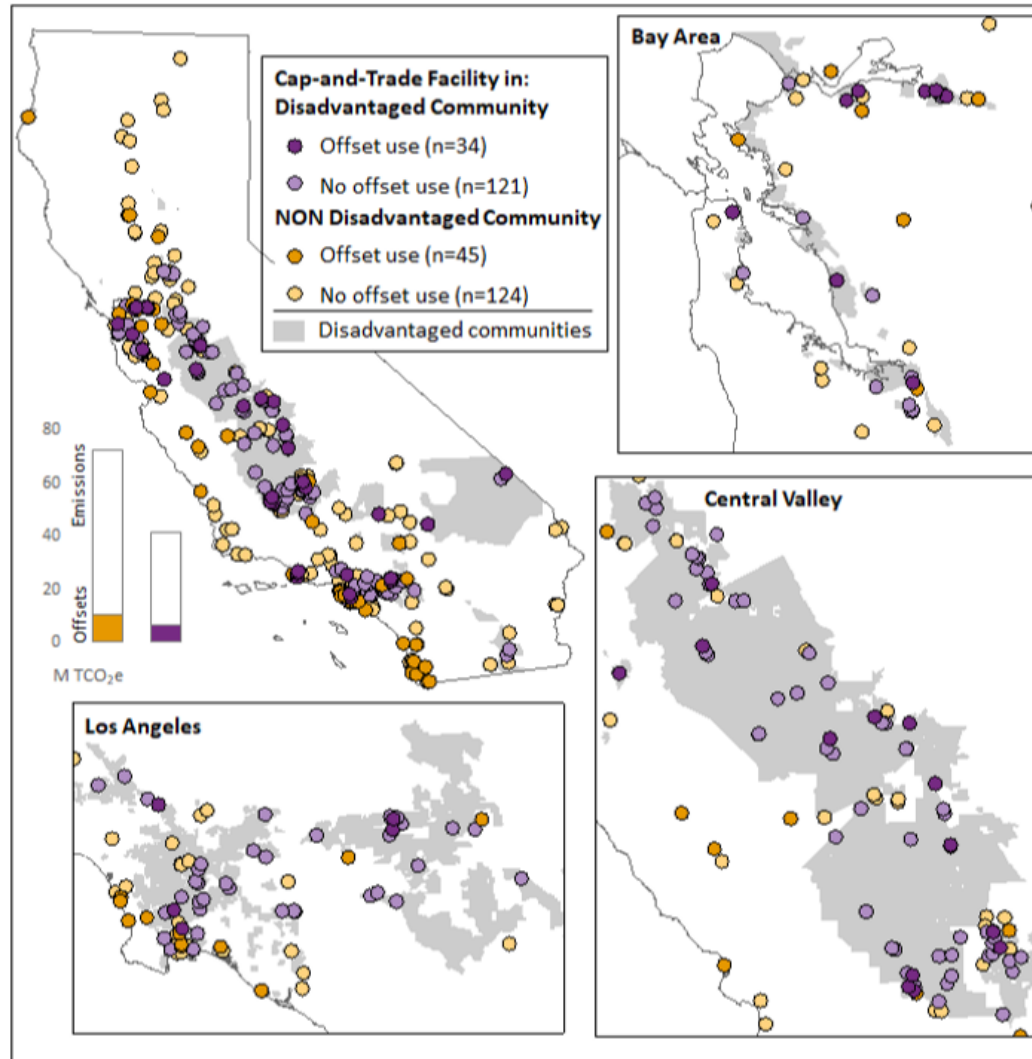


Forest Offsets Partner Mitigation & Conservation



Anderson et al. *Frontiers in Ecology and the Environment* (2017).
Anderson et al. (in review).

Forest Offsets Partner Mitigation & Conservation (Then: Environmental Justice & Air Quality Implications)



Anderson et al. *Frontiers in Ecology and the Environment* (2017).

Anderson et al. (in review).

Thanks to the team



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