

# Overview of Forest Service Information Needs for Emissions and Flux

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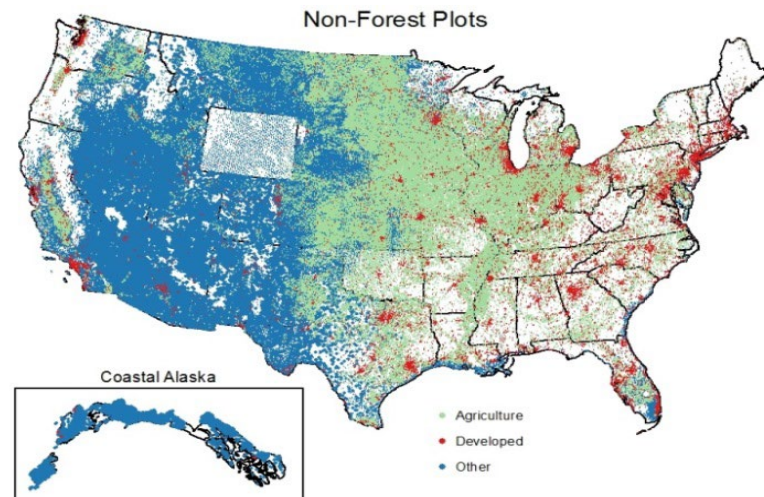
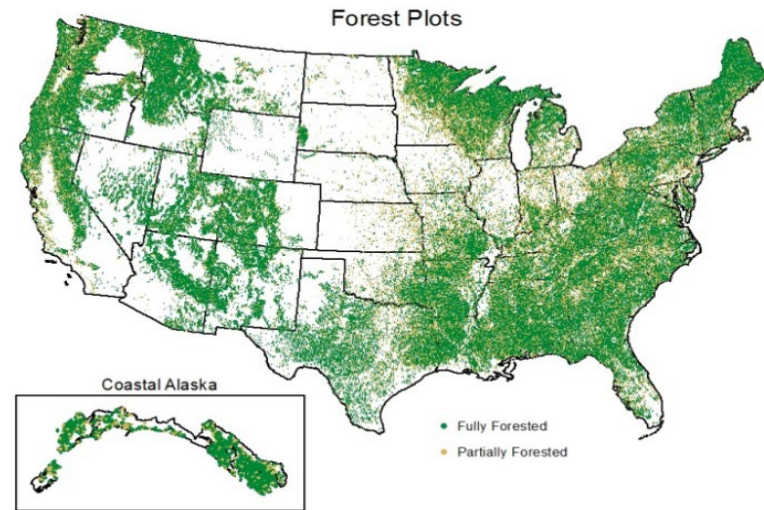
**Forest Service cooperators:** John Coulston (SRS), Sean Healey (RMRS), Andrew Gray (PNW), Chris Woodall (NRS), Charles Perry (NRS), Hans Andersen (PNW), Chris Oswalt (SRS), James Westfall (NRS), Chris Swanston (NRS), Ty Wilson (NRS), Andy Hudak (RMRS), Dave Wear (SRS), among others

**University and Agency cooperators:** Matthew Russell (UMN), Chad Babcock (UMN), Anthony D'Amato (UVM), Steve Ogle (CSU), Shawn Fraver (UMaine), Songlin Fei (PurdueU), Aaron Weiskettel (UMaine), Andy Finley (MSU), Mark Harmon (OSU), Mark Ducey (UNH), Lucas Nave (UMichigan), Sassan Saatchi (NASA), Phil Radtke (VPI), Mike Falkowski (CSU/NASA), Rodrigo Vargas (UDelaware), among others



# Forest Inventory and Analysis (FIA)

- Designed to track change over time
  - Permanent sample plots
  - Remeasurement every 5-10 years
    - ca. 15% of plots remeasured annually
- Multiple approaches for assessing disturbance (e.g., disturbance code), and ecosystem variables (e.g., mortality, removals)
- Observed land cover and land use attributes



# Mission...



...help land managers and policy makers  
evaluate existing practices and policies  
and inform future activities



# Annual reporting responsibilities

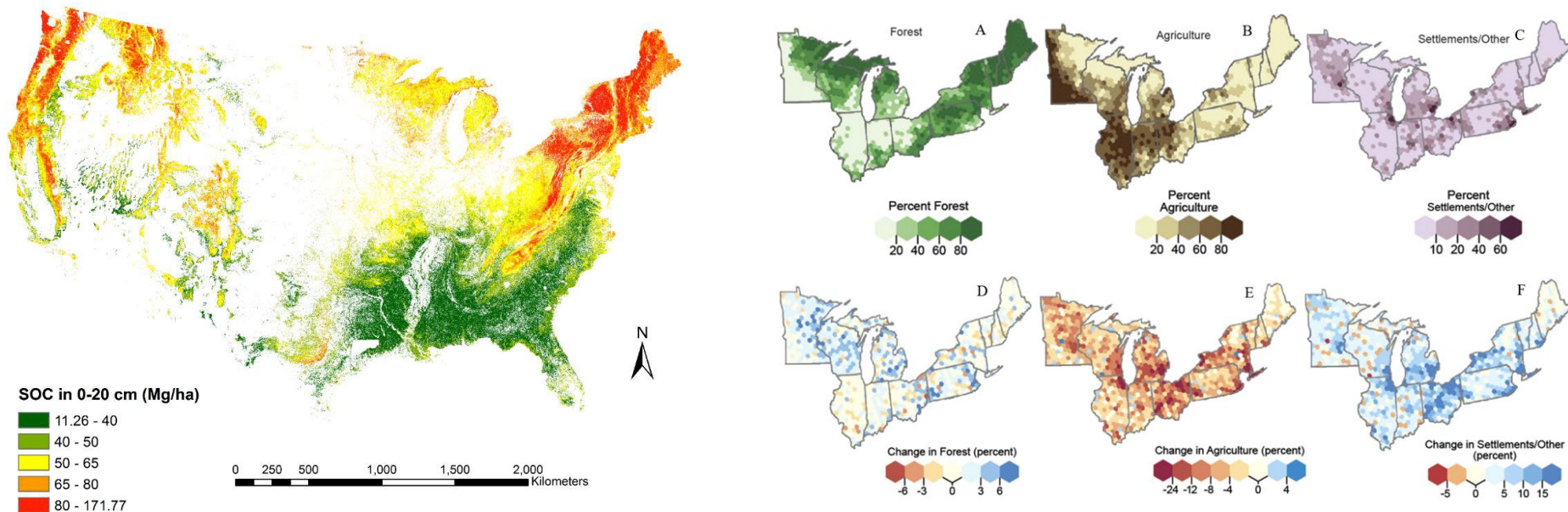
- Forest Land Remaining Forest Land
  - Forest ecosystem carbon
  - Forest fire emissions
  - Emissions from DOS and N additions to soils
- Land Converted to Forest Land
  - Forest ecosystem carbon
  - Emissions from drained organic soils
- Forest Land Converted to Land
  - Cropland, Grasslands, Settlement, Wetland, Other Land
- Woodlands in the Grassland category
- Harvested Wood Products
- Urban trees in Settlements

# Select efforts and contributions

- Ongoing R&D on carbon pool science, land use conversion dynamics, and integration of emerging data and technologies
- 2<sup>nd</sup> State of the Carbon Cycle Report – Forests
- 4<sup>th</sup> National Climate Assessment – LULC and Forests
- National Soil Assessment – Soil Carbon and IMA
- RPA Update – C and biomass
- State summaries in the Northern Region (24 states)
- State- and sub-state-level GHG estimation and reporting
- 2019 IPCC Refinement

# Current work and data used

- New C pool methods (e.g., understory, dead wood, belowground)
- Refinements to C stock changes associated with land use conversion
- Continued development of new approaches to provide more resolved estimates for the NIR and other efforts
- Attribution of changes in C stocks to activities and disturbance

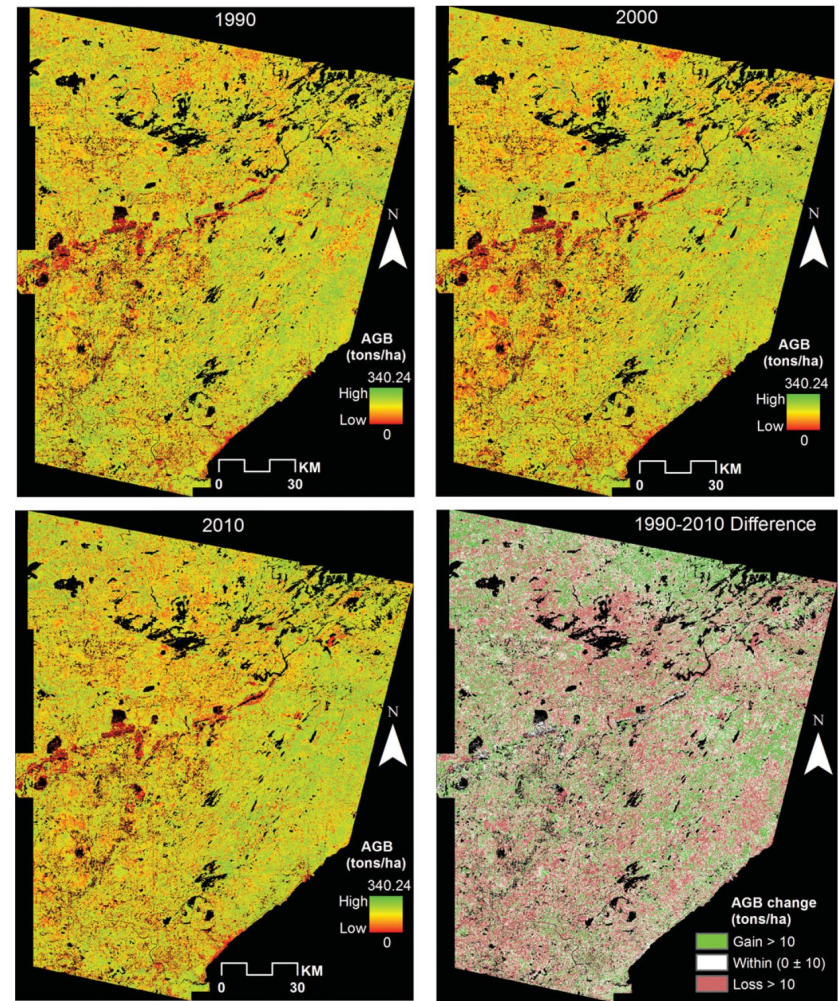
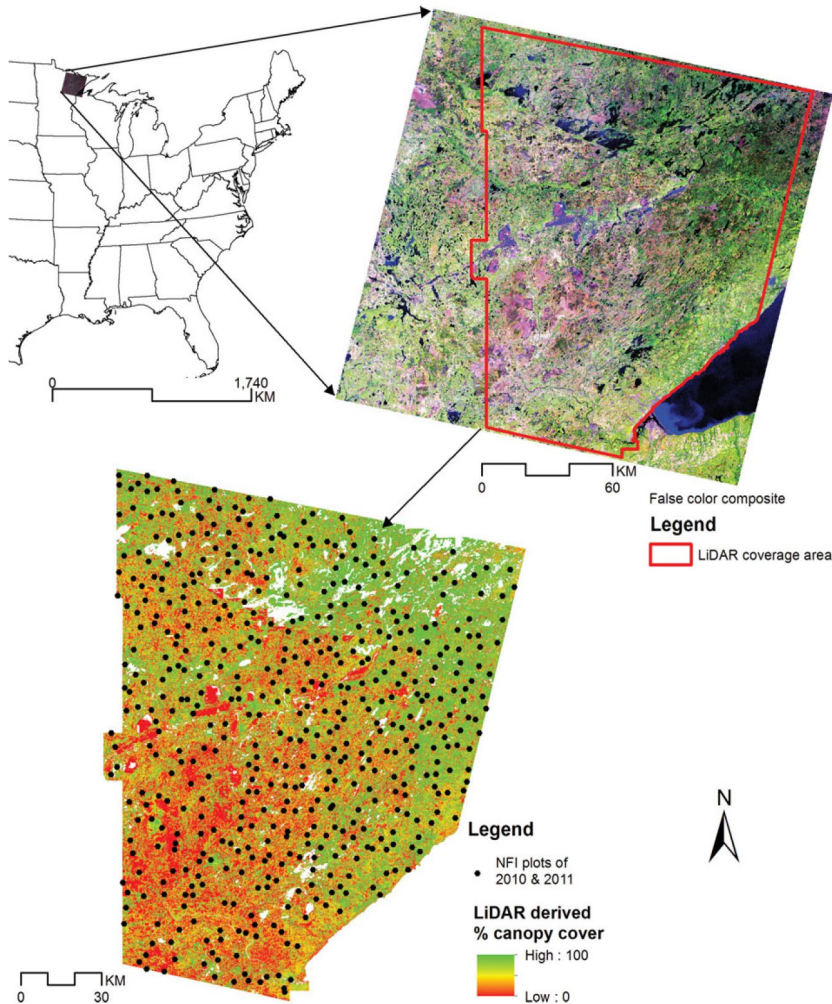


Cao, B., Domke, G.M., Russell, M.B. and Walters, B.F., 2019. Spatial modeling of litter and soil carbon stocks on forest land in the conterminous United States. *Science of the Total Environment*, 654, pp.94-106.

Glasby, M.J., Russell, M.B. and Domke, G.M., 2019. Analyzing the impacts of forest disturbance on individual tree diameter increment across the US Lake States. *Environmental Monitoring and Assessment*, 191(2), p.56.

Ma, W., Domke, G.M., D'Amato, A.W., Woodall, C.W., Walters, B.F. and Deo, R.K., 2018. Using matrix models to estimate aboveground forest biomass dynamics in the eastern USA through various combinations of LiDAR, Landsat, and forest inventory data. *Environmental Research Letters*, 13(12), p.125004.

# Moving from points to pixels



Deo, R.K., Russell, M.B., Domke, G.M., Woodall, C.W., Falkowski, M., Cohen, W. 2017. Using Landsat time-series and lidar to inform aboveground biomass baselines in northern Minnesota, U.S.A. *Canadian Journal of Remote Sensing*.

Deo, R.K., Russell, M.B., Domke, G.M., Andersen, H.E., Cohen, W.B., Woodall, C.W. 2017. Evaluating site-specific and generalized spatial models of aboveground forest biomass based on Landsat time-series and LiDAR strip samples in the eastern U.S.A. *Remote Sensing*. 9(6), 598.

Deo, R.K., Domke, G.M., Russell, M.B., Woodall, C.W., Andersen, H.E. 2018. Evaluating the influence of spatial resolution of Landsat predictors on the accuracy of biomass models for large-area estimation across the eastern USA. *Environmental Research Letters*.

# Example - Alaska

- Alaska is big - 28.5 Mha of managed forest land, 10% of all managed forest land in the US
- Estimated C stocks represent 17% (9853 MMT C  $\pm$  3350) of total stocks
- Flux driven, in large part, by wildfire – major differences between coastal and interior forest land
- Net sink (-4.0 MMT C) but there is substantial interannual variability
- NFI field campaigns are essential



PNW FIA Crew photo

Domke, G.M., Walters, B.F., Nowak, D.J., Smith, J.E.; Ogle, S.M., Coulston, J.W. 2019. Greenhouse Gas Emissions and Removals from Forest Land, Woodlands, and Urban Trees in the United States, 1990-2017. Resource Update FS-178. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 4 p.  
<https://doi.org/10.2737/FS-RU-178>

EPA. 2019. Inventory of U.S. Greenhouse Gas Emissions and Sinks. <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>

# **Critical data/technological challenges**

**1. Latency**

**2. Spatial extent**

**3. Attribution**

# Final thoughts



- Forest Service continues to expand role in GHG reporting
- FIA data continues to be the foundation
- Developing more spatially and temporally resolved GHG information
- Continue to improve and grow capabilities - collaboration and partnerships are essential
- Inform policy and land management practices across scales

# Thanks!

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**FIA program:** [www.fia.fs.fed.us](http://www.fia.fs.fed.us)

**FIA carbon:** <http://www.fia.fs.fed.us/forestcarbon/>