Remote Sensing as a Bridge to Operational Forest Carbon Monitoring in Interior Alaska

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Participants

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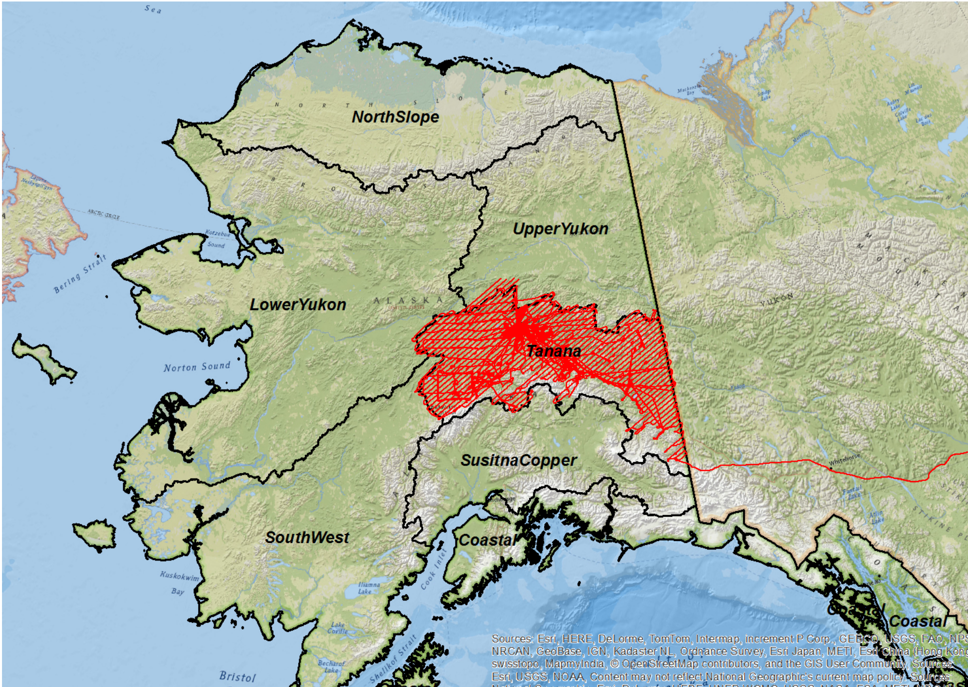
Goals and Motivation

Goal:

Design and implement an operational forest inventory in interior Alaska by extending a sparse network of field plots with G-LiHT multi-sensor data

Motivation:

- $> 450,000$ km^2 of forest land in interior Alaska (15% of US total) are not included in the USFS FIA program
- G-LiHT system uses well-calibrated, commercial instruments
- Builds on NASA-funded studies throughout North America, and leverages a new 10-year, $25M USFS FIA plan for AK
- MRV prototype for remote areas of the world where field data is sparse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LowerYukon
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SusitnaCopper
SouthWest
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ALASKA
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Kotzebue Sound
Kuskokwim Bay
Iliamna Lake
Cook Inlet
Shelikof Strait
Bristol
ARCTIC CIRCLE
YUKON
Whitehorse
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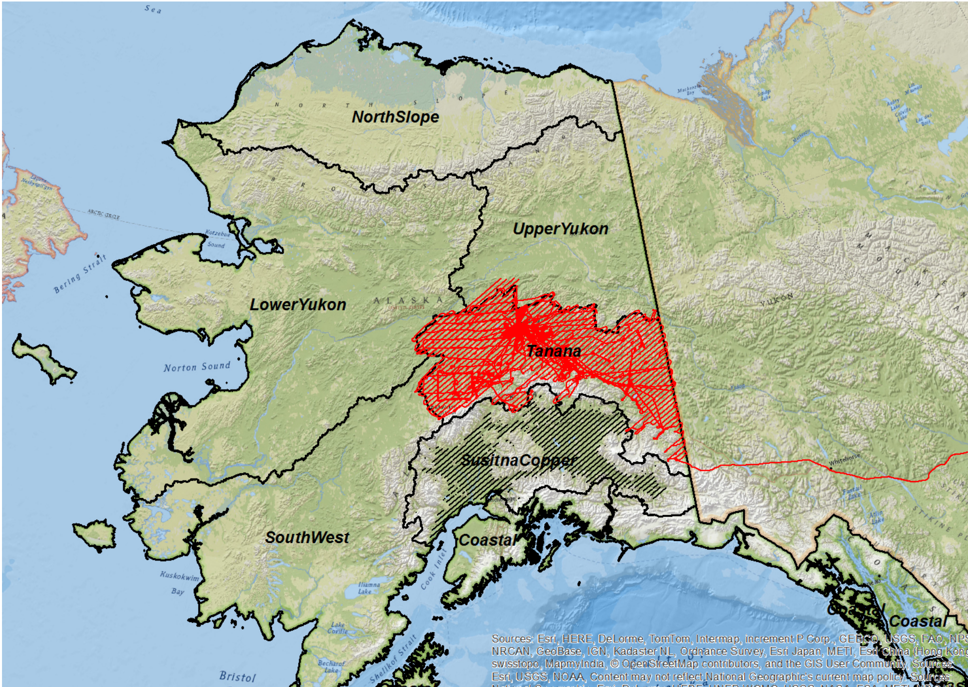
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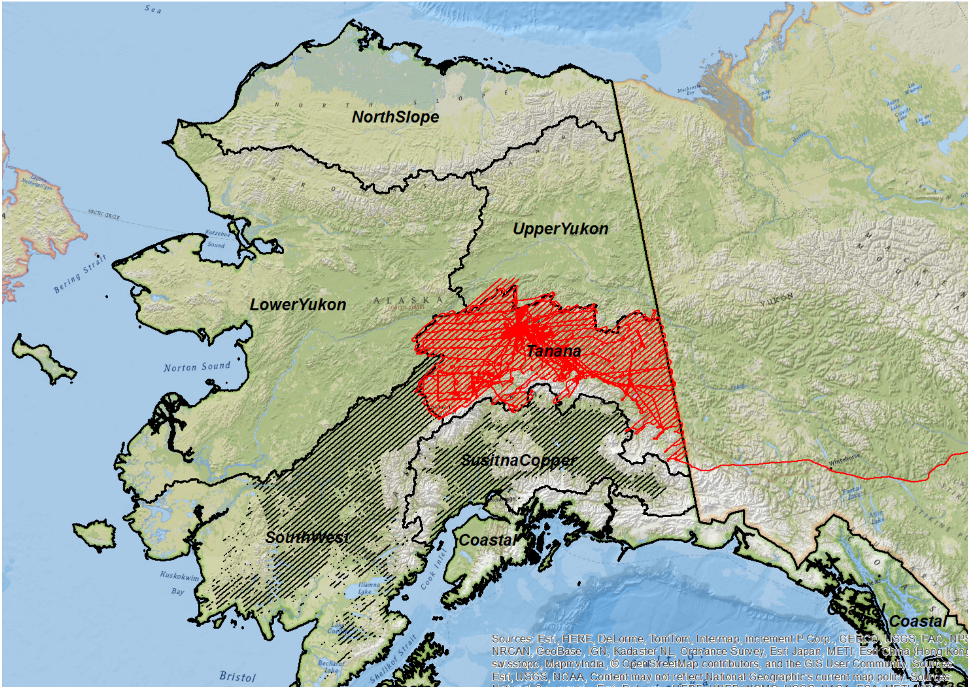
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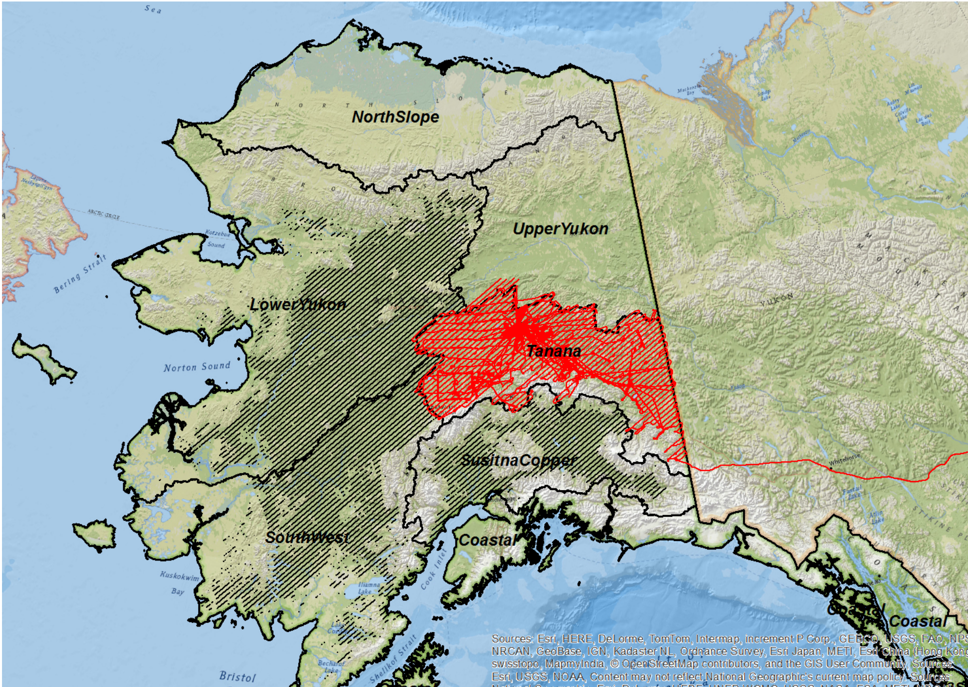
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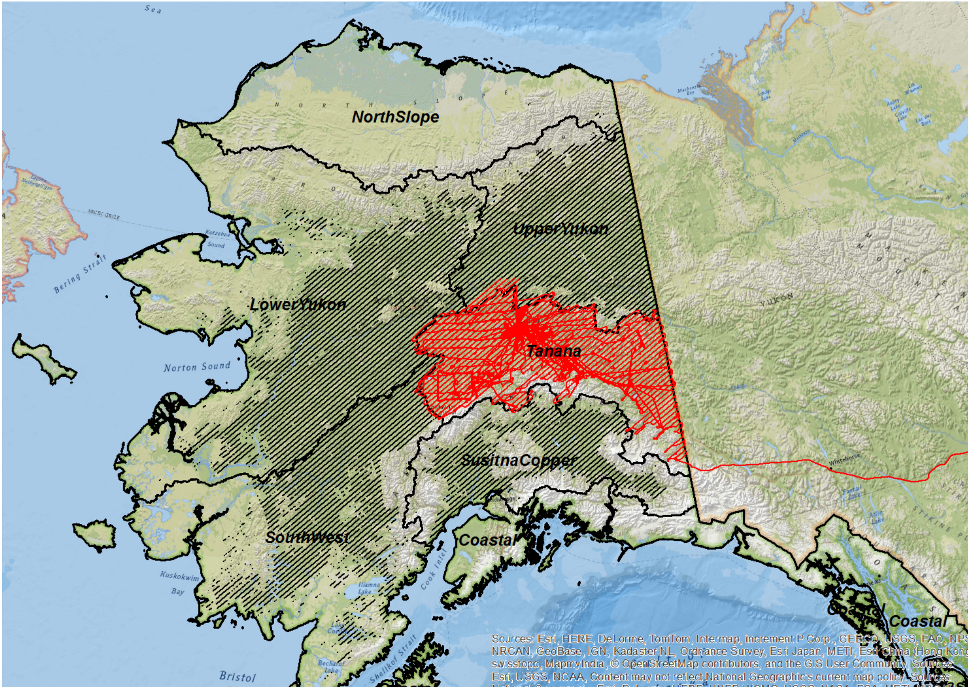
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Tanana Pilot Project

Biomass Products & Lessons Learned

- Examined several candidate approaches to estimate total aboveground biomass uncertainty with strip sampled lidar data via simulation. (Babcock et al., in prep).

Simulation Study		
	95% Coverage Percentage	Empirical Bias
Design-Based	**94.5% (92.0%, 95.8%)**	0.03 (-1.64, 1.69)
Two-Stage Model-Assisted	**95.0% (93.5%, 96.3%)**	0.04 (-0.75, 0.83)
Frequentist Model-Based	85.1% (82.7%, 87.3%)	0.03 (-1.64, 1.69)
Frequentist Block Kriging	92.3% (90.5%, 93.9%)	0.03 (-1.64, 1.69)
Bayesian Spatial Model-Based	**94.3% (92.7%, 95.7%)**	0.03 (-1.64, 1.70)

Intervals in parentheses represent 95% Monte Carlo error based on 1 000 simulated samples

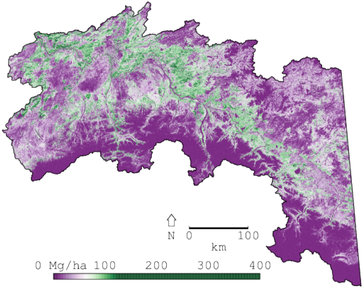
- Model-Assisted and Coregionalization Model-Based approaches yielded similar estimates of total biomass as USFS FIA Design-Based estimation procedures, but with lower uncertainty at Tetlin National Wildlife Refuge (Babcock et al., in prep).

Tetlin National Wildlife Refuge			
	Total (Tg)	**Standard Error**	**95% CI**
Design-Based	8.97	2.12 (23.6%)	(4.81, 13.13)
Two-Stage Model-Assisted	7.97	1.59 (19.9%)	(4.85, 11.09)
Coregionalization Model-Based	9.08	0.95 (10.4%)	(7.22, 10.94)

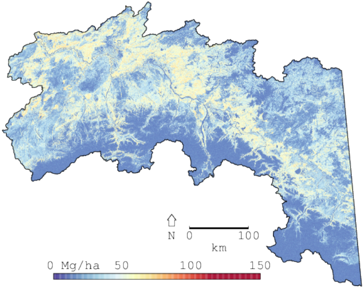
Tanana Pilot Project

Biomass Products & Lessons Learned

- Nearest Neighbor Gaussian Process (NNGP) priors provide the means to estimate complex, hierarchically structured spatial models, e.g., the coregionalization model, over extents as large as the Tanana Inventory Unit at fine spatial resolution with associated uncertainty. Maps such as these provide insight into local variability in forest carbon stocks.



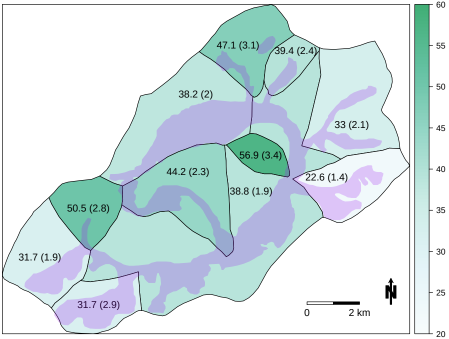
Above Ground Biomass Density

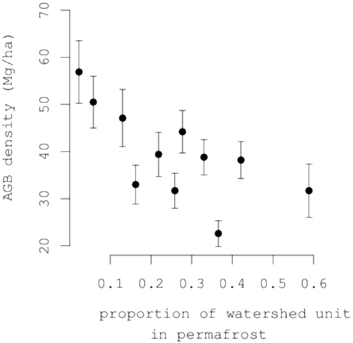


Standard Error

Tanana Pilot Project

Biomass Products & Lessons Learned



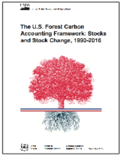


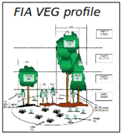
Susitna-Copper

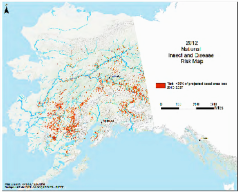
New Opportunities & Challenges

1.) Transitioning from pilot to operational status supports national objectives for MRV of US forest carbon stocks and National Greenhouse Gas Inventory reporting of emissions from the forest sector (Woodall et al., 2015)

2.) Woody shrubs not included in USFS inventory estimates, but represent a large biomass component that is likely increasing in response to climate warming. G-LiHT data and FIA VEG profiles will be used with newly acquired shrub allometries (Schulz et al.) to identify and estimate shrub biomass and augment carbon stock estimates







Susitna-Copper

New Opportunities & Challenges

3.) Most forests in interior Alaska are unmanaged and highly susceptible to disturbances such as fire, insects and disease, especially in warmer and drier climate. We will work with local Forest Health Protection scientists to map mortality from insect and disease outbreaks and estimate standing dead forest carbon using field and airborne observations