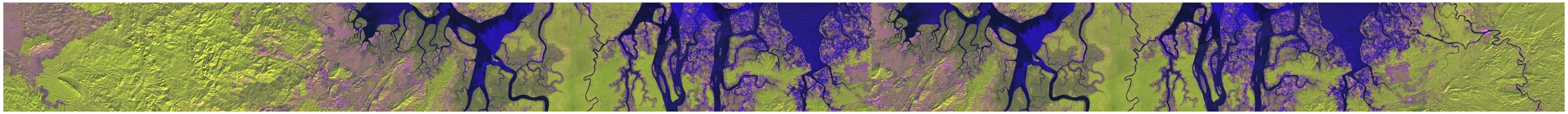

Mapping forest disturbance gradients with fused SAR & optical imagery

APPLIED GEOSOLUTIONS, LLC

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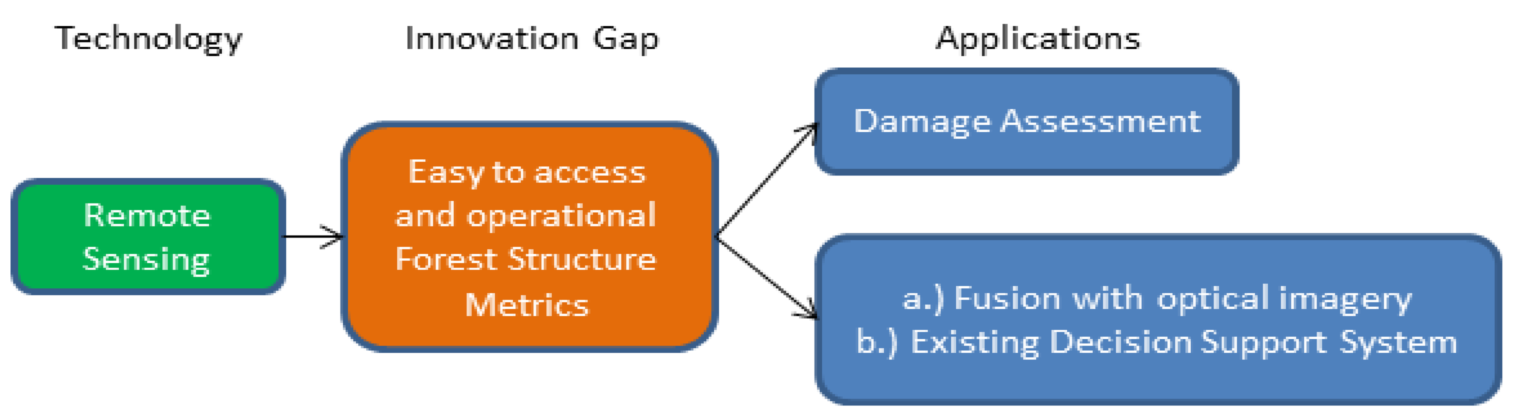
Introduction

Disturbance from natural and anthropogenic processes is a frequent occurrence in northeastern forest ecosystems. Timely and accurate assessment of disturbance events is critical for land managers to respond effectively and appropriately. In addition, assessing the severity of disturbance is useful for broad-scale management and understanding impacts on ecosystem functioning. Fusion of satellite remote sensing tools such as Phased Array Synthetic Aperture Radar (PALSAR) and Landsat hold the potential to operationally identify disturbances and quantify impacts on vegetative structural attributes. In this project a gradient of disturbance case study events is being assessed across northern New England using multiplatform remote sensing in an operational context.

Objectives

- Evaluate the ability of fused SAR-optical imagery to characterize ranging disturbance events (*e.g.*, tornado, insect infestation, wind, harvest)
- Map case study disturbance events using fused remote sensing obs
- Develop image processing algorithms that could be used in an operational context
- Assess changes or compare to reference sites using metrics of structural attributes across strategic case study events and northeast region
- Work with stakeholders and end users to integrate disturbance mapping with decision making
- Lay the foundation for operational monitoring tool for northeast, USA



Data

Remote Sensing Platforms

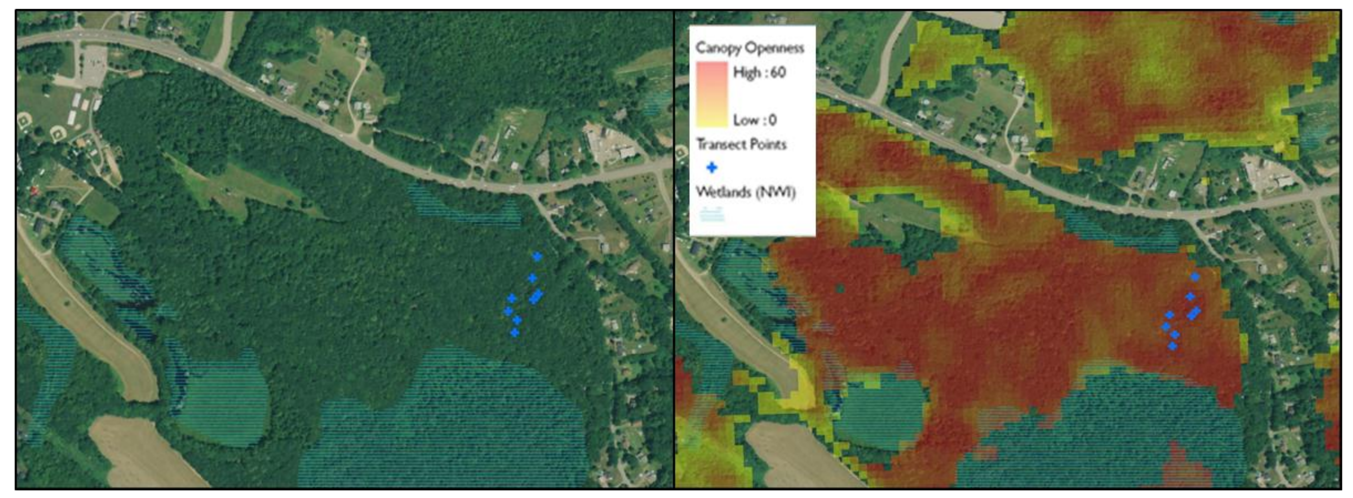
- ALOS-1 PALSAR fine-beam single (hh), dual (hh:hv), and quad polarimetric (hh:hv:vh:vv) (Single Look Complex L1.1, 6.25m – 24m)
- ALOS-1 ScanSAR WideBeam-1 (hh: orthorecitified & slant range) (~75m)
- Landsat 5 TM & 7 ETM+ (T1 & G1) (30m)
- ICESat GLAS LiDAR (75m- scattered footprints)
- NAIP digital photos (1m, visible range)

Field data collection

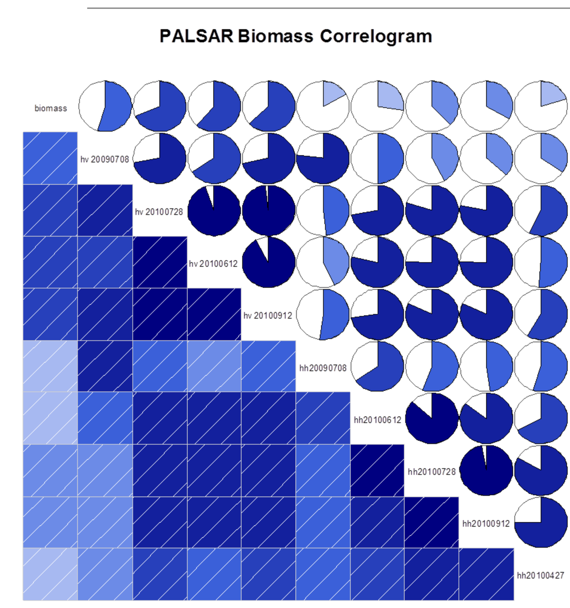
- Year 1 n=32, central NH and southern ME
- Year 2, northern NH &central ME, higher elevations
- Metrics quantify overstory, understory, biomass, canopy structure, downed dead wood, tree height, structure
- Scaled protocol developed to link from field plot to patch to landscape

Summary Methods & Results

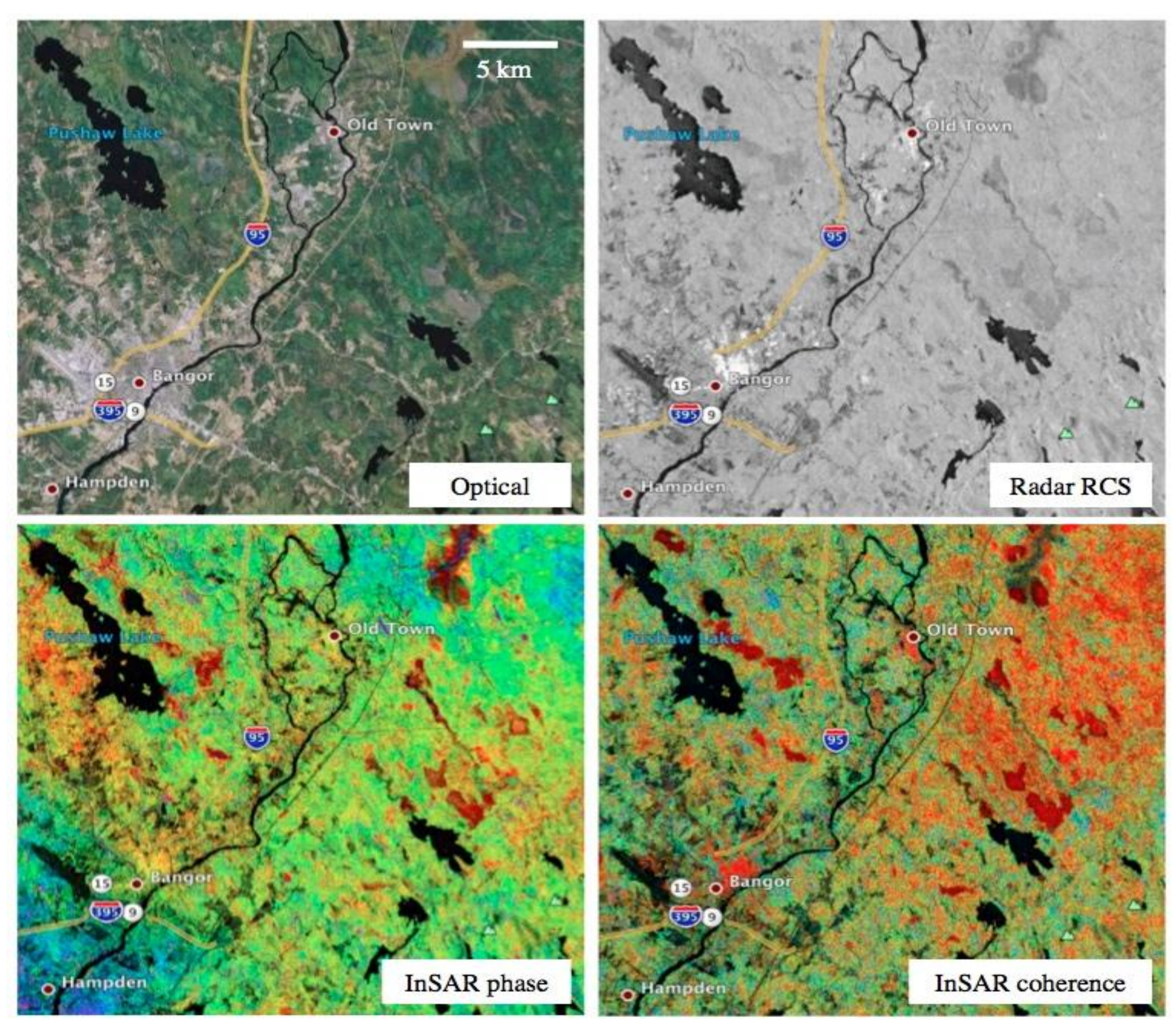
- Pre-processing implemented operational routines (TOA, sigma, gamma)
- Techniques executed include image differencing, band ratios and decomposition, InSAR, data fusion using randomForest, regression models, & neural network routines



Example canopy openness map using TM2 & PALSAR HV regression (R^2=0.68)



- Correlogram of fine-beam dual pol (γ) with corresponding site level biomass
- Moderate strength relationships for HV (9/12/2010) having the strongest (R^2:0.5)
- Multiple linear regression models using FBD raised the R^2 to 0.65



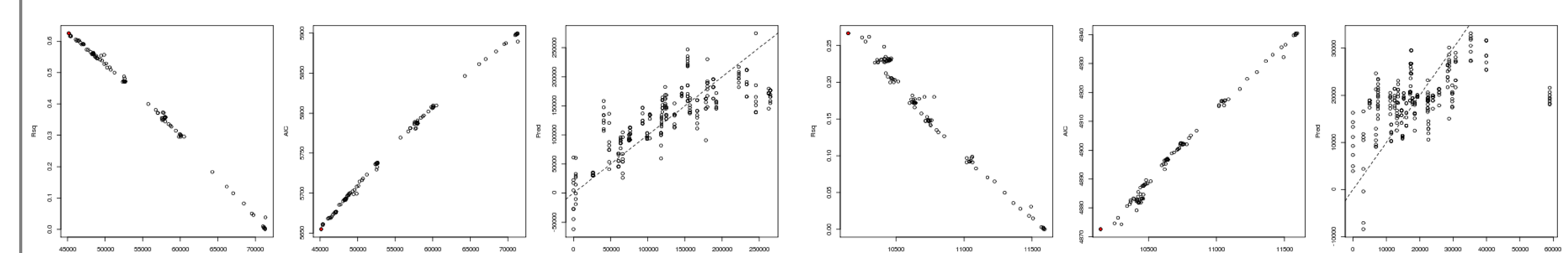
GoogleEarth outside Bangor, the radar backscatter power, the InSAR phase (related to the topography) and the InSAR coherence (related to the tree height). Clearly seen is water, less clear in the optical imagery, are clearcut and swamp regions (red in the coherence image).

Summary Results

Left table: Summary "generic" model results using PALSAR & Landsat; Right table shows "date-dependent" model results ("generic[a]" vs "date-dependent[b]")

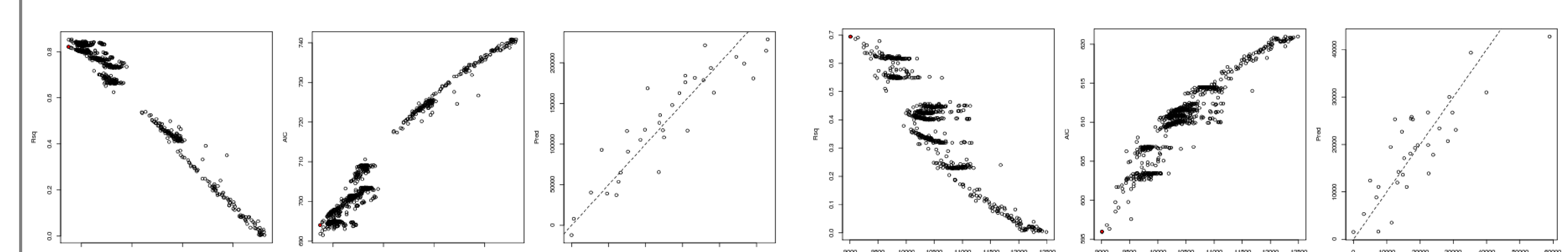
Dependent Var.	N Indep. Vars	Rel. Err.	Rsq.
Basal Area per ha	6	0.44	0.67
Trees per ha	6	0.55	0.48
Volume (m^3/ha)	7	0.45	0.65
Biomass (Mg/ha)	8	0.48	0.63
Crown Area (m^2/ha)	8	0.62	0.27

Indep. Var. Name	N Indep. Vars	Rel. Err.	Rsq.	AIC
Avg_BA	8	0.36	0.88	112.2
Avg_TPH	9	0.35	0.89	351.8
Volume_Site	9	0.44	0.87	262.2
Biomass_Site	7	0.43	0.82	695.0
Crown_Area_Site	9	0.62	0.69	596.0



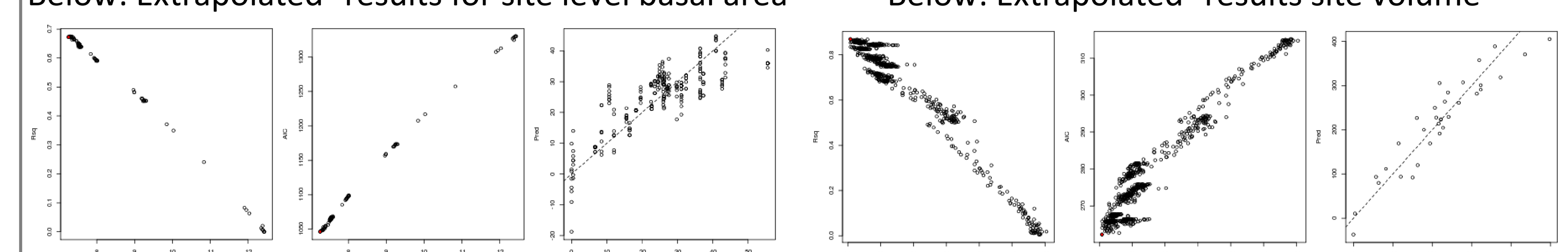
Above: Generic[a] cross fitting Biomass @ site level
Below: Extrapolated[b] results for Biomass

Generic[a] cross fitting Crown Area @ site level
Below: Extrapolated[b] results for Crown Area



Below: Extrapolated[b] results for site level basal area

Below: Extrapolated[b] results site volume



Preliminary Conclusions & Next Steps

- PALSAR & Landsat fusion better than either platform alone
- Crown area metrics remain challenging for "generic" models
- Temporal decorrelation remains an obstacle for automated InSAR routine
- Integrating Year 2 field data into modeling to broaden inference space
- InSAR, PLR, and LiDAR inputs planned for future improvement
- Applying over case studies to map disturbance and assess damage
- Open up web-GIS to share with public via website
- Developing blueprint for large-scale MRV tool with partners

Thanks to our funding sources!
Interested in partnering on a case study?

JAXA Japan Aerospace Exploration Agency — NASA — NSRC Northeastern States Research Cooperative