Modeling Forest Productivity Across a Heterogeneous Landscape: A Comparison of Satellite, Geospatial, and Climate Predictors

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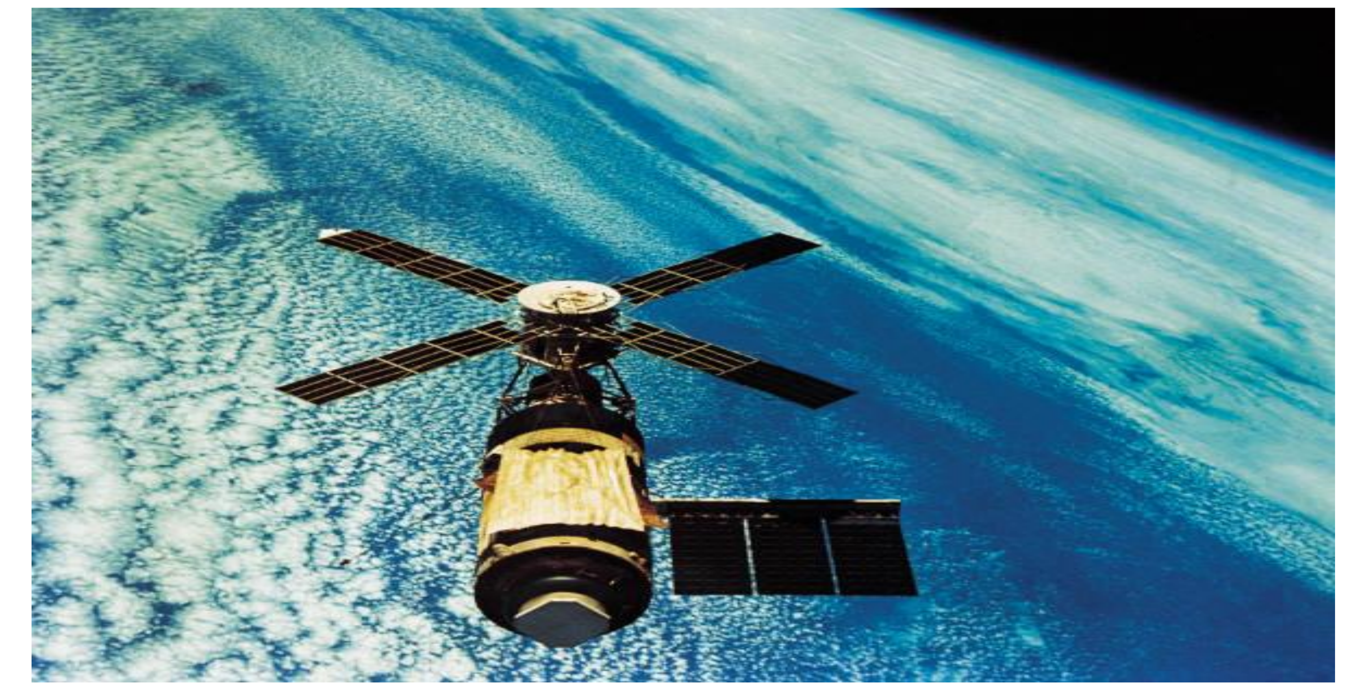
Remote sensing can provide a relatively low-cost and low-impact approach to large scale assessment of forest condition and productivity over time. However, the connection between canopy spectral signatures and scalable field metrics is not well understood. To explore this relationship, we compared annual basal area increment (BAI) throughout northern Vermont and New Hampshire to a suite of vegetation indices, ancillary spatial data sets and climate variables. Our specific research questions include:

- How well can we model forest productivity across a heterogeneous landscape using remote sensing metrics?
- How much do predictions improve if we include ancillary environmental variables as covariates?
- How sensitive is the model to repeated measures?



Model Inputs:

- **Response Variable:** Yearly Basal Area Increment measurements between 2001 and 2012 were measured for 1322 tree cores across 105 plots
- **Independent Predictor Variables**: For each core sample, 108 variables from different geospatial datasets were recorded which include: remote sensing variables like MODIS NDWI (min, max, mean),ancillary data such as disturbance, and PRISM climate data like temperature(min, max, mean).

Model Calibration and Assessment:

- Because of the large number of possible predictor variables a backwards stepwise regression with a p-value threshold of 0.01 was used to identify a subset of key spatial data sets for forest productivity modeling.
- Compare these results to a mixed effects model with Site ID nested in year as a random effect to determine the impact of autocorrelation across yearly metrics on model accuracy and stability.
- Repeat these models with the addition of ancillary and environmental variables

Preliminary Results:

- Remote Sensing metrics alone can NOT be used to model productivity across a heterogeneous landscape
- The addition of ancillary environmental variables improves predictions significantly, and the addition of climate variables increases accuracy further.
- There was no significant difference in models developed, their accuracy or significance between the stepwise and mixed effects approaches.

	Stepwise			Mixed Model		
Approach	**RS Only**	**RS + Site**	**RS + Site + Climate**	**RS Only**	**RS + Site**	**RS + Site + Climate**
r^2	0.006	0.14	0.269	0.01	0.14	0.269
r^2 Adjusted	0.006	0.134	0.25	0.009	0.139	0.268
RMSE	6.5	6.06	5.64	0.654	6.05	5.58
press RMSE	6.42	6.09	5.75	0.655	6.06	5.59
AIC	8704	8528	8367	9525	8528	8360
BIC	8720	8580	8551	9547	8584	8549
Durban Watson Autocorrelation	0.8	0.77	0.73	0.04	0.77	0.74
DW significance	<0.0001	<0.0001	<0.0001	<.0435	<0.0001	<0.0001
Variable Count	1	8	33	2	9	34

Conclusions:

- Landscape scale assessments of forest productivity must include ancillary environmental and climate variables
- Repeated yearly metrics do not limit model power or configuration, such that this is a viable analytical approach to modeling dendrochronological data.
- This information will be used to investigate spatial and temporal patterns in forest productivity across the northeast.