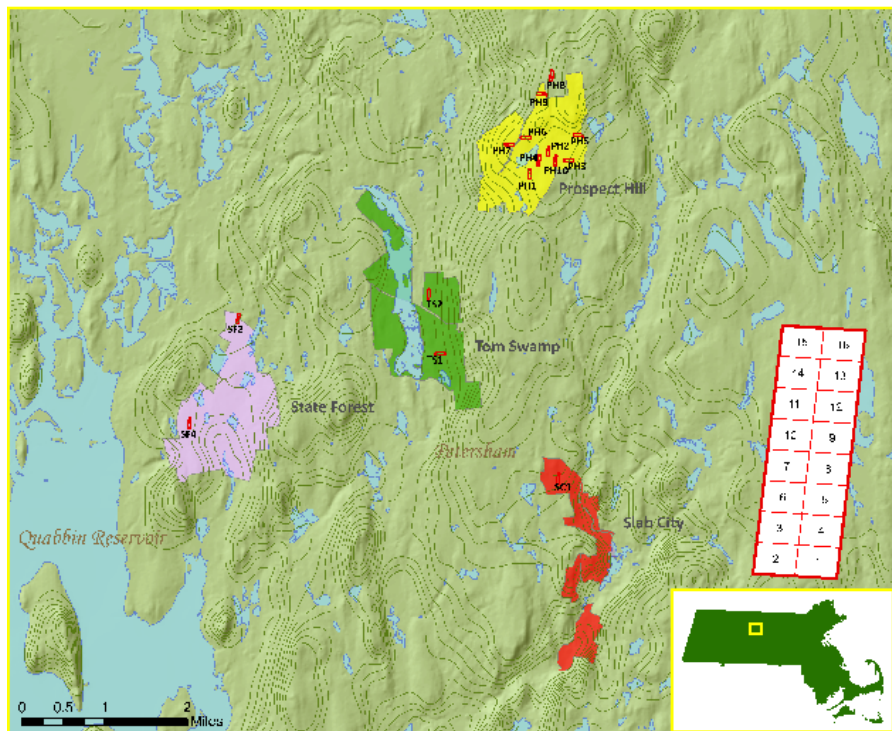


Analyzing the relationship between radar backscatter and forest biomass through UAVSAR observations

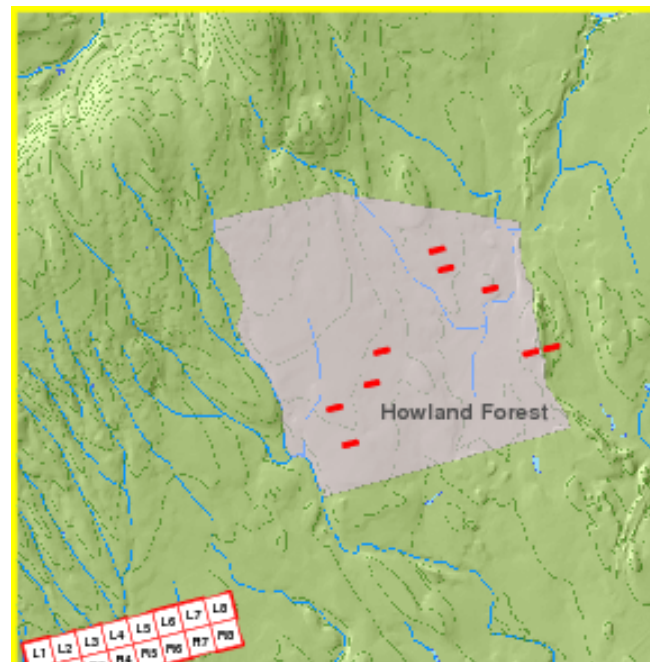
Razi Ahmed

Paul Siqueira, Scott Hensley

Jet Propulsion Laboratory,
California Institute of Technology

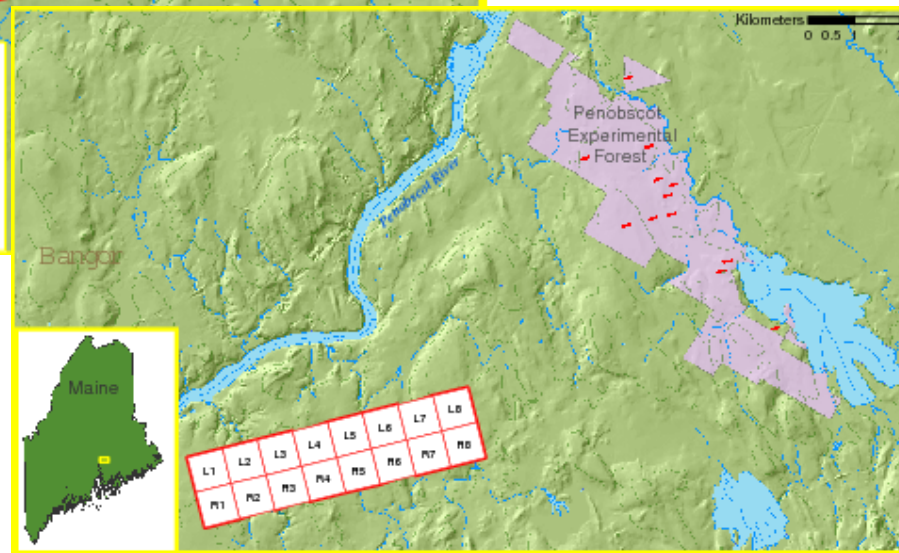


Harvard forest

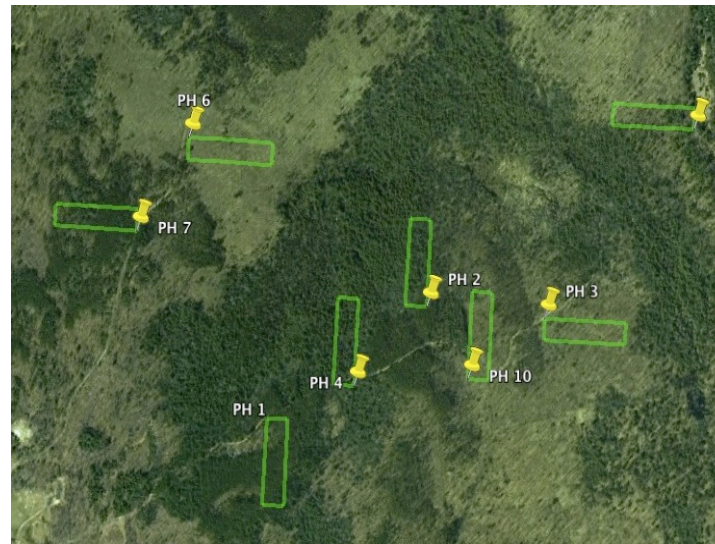
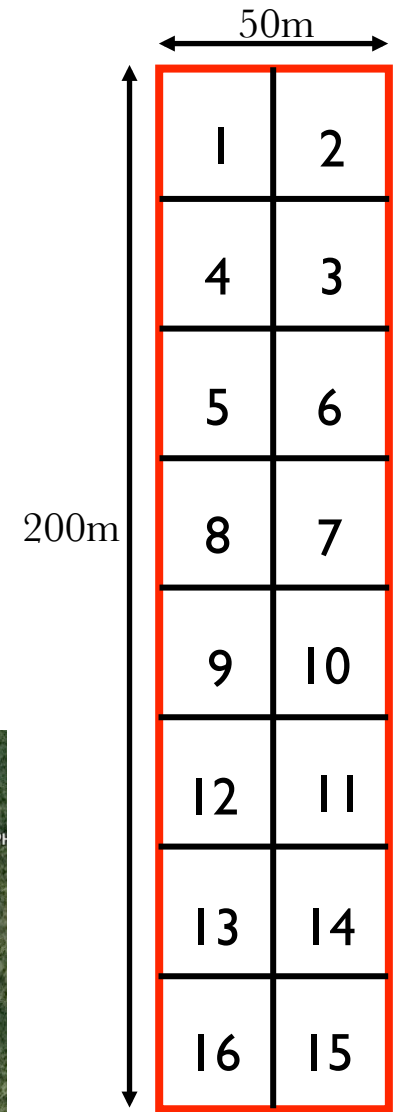


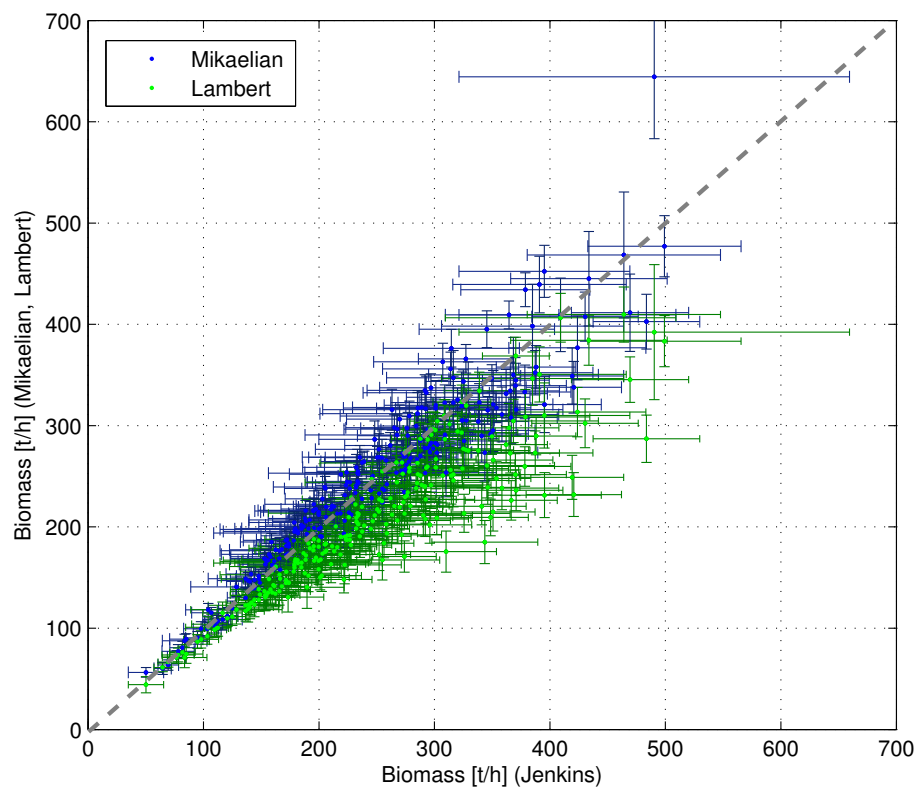
Howland Forest

Howland Forest
(Penobscott)

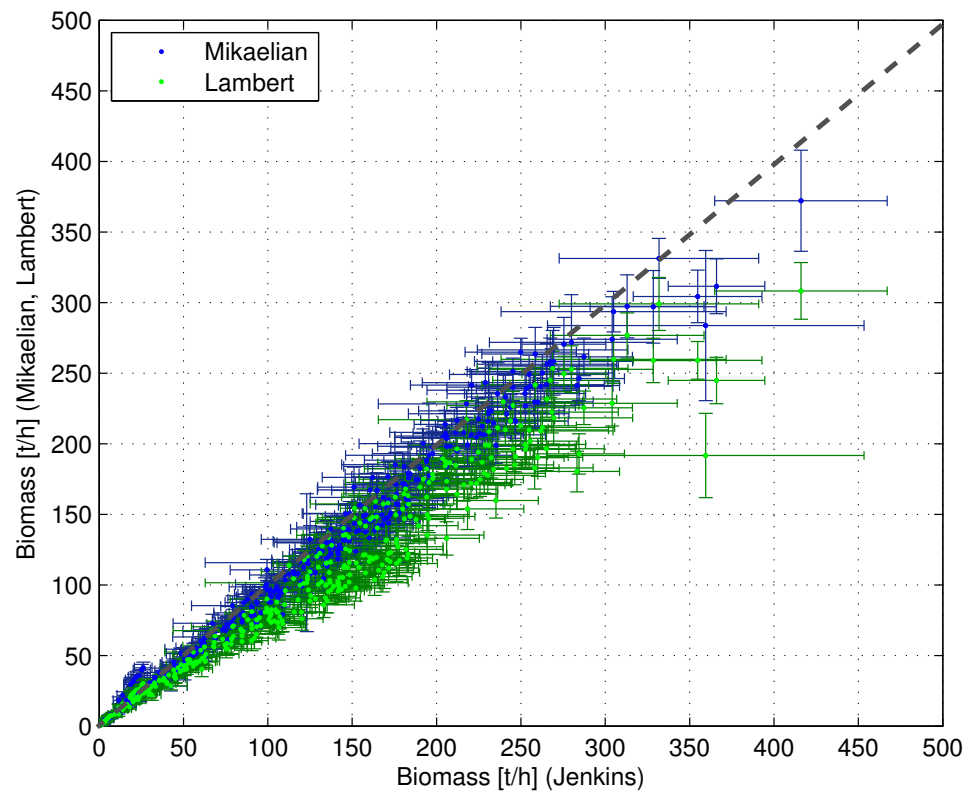


- Species, diameters, condition (live/dead) for every tree above 10cm in diameter per subplot
- Harvard Forest
 - 1200 Hectares of mixed forest
 - 15 1-**hectares** plots (240 **subplots**)
 - Dominant Species
 - Red Oak, Red Maple, White Pine, Eastern Hemlock
- Howland Forest
 - 500 Hectares of mixed forest
 - 23 1-**hectares** plots (368 **subplots**)
 - Dominant Species
 - Spruce, Fir, Hemlock, Pines and Maples



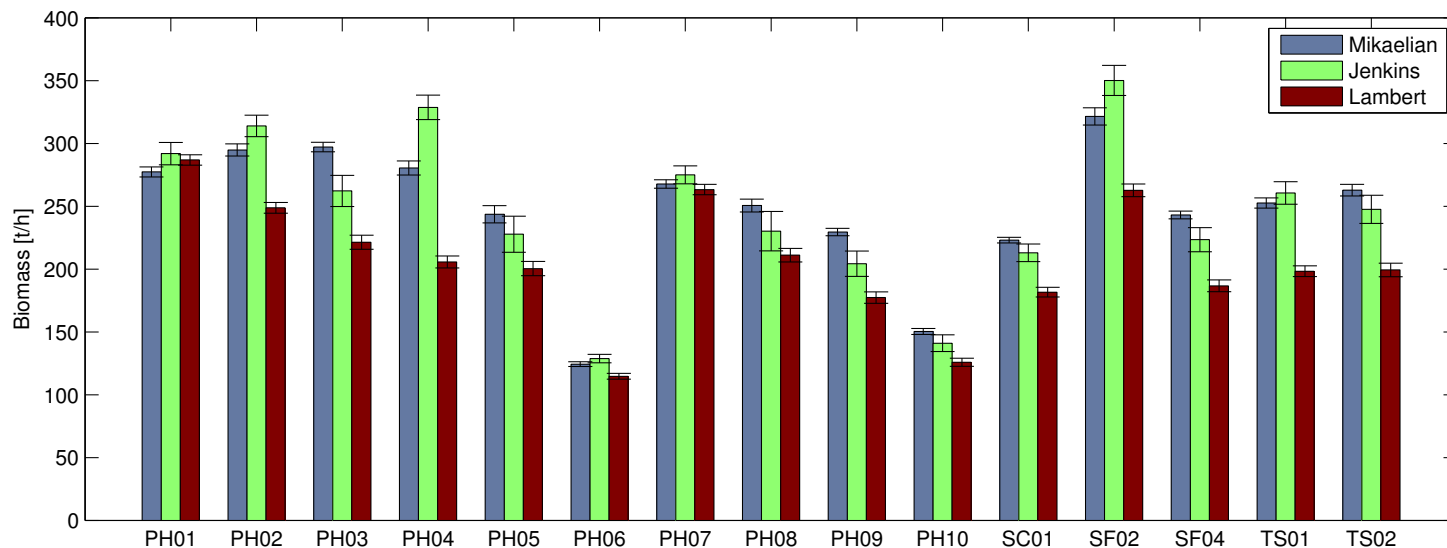


Harvard forest

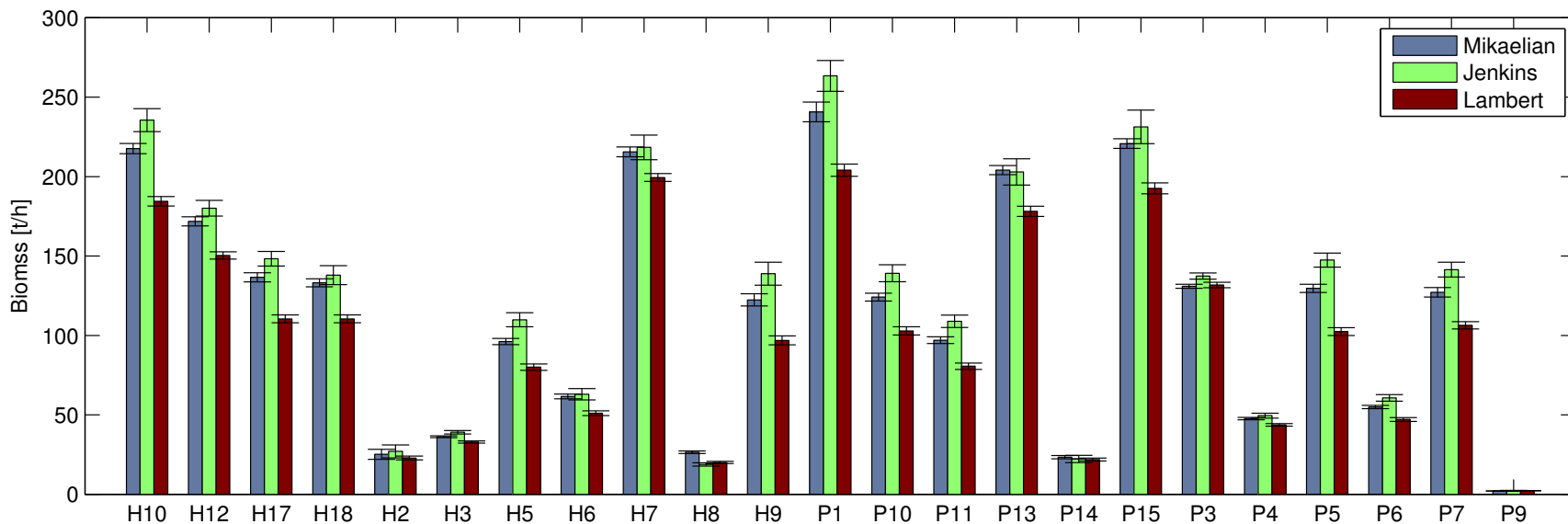


Howland Forest

Harvard Forest



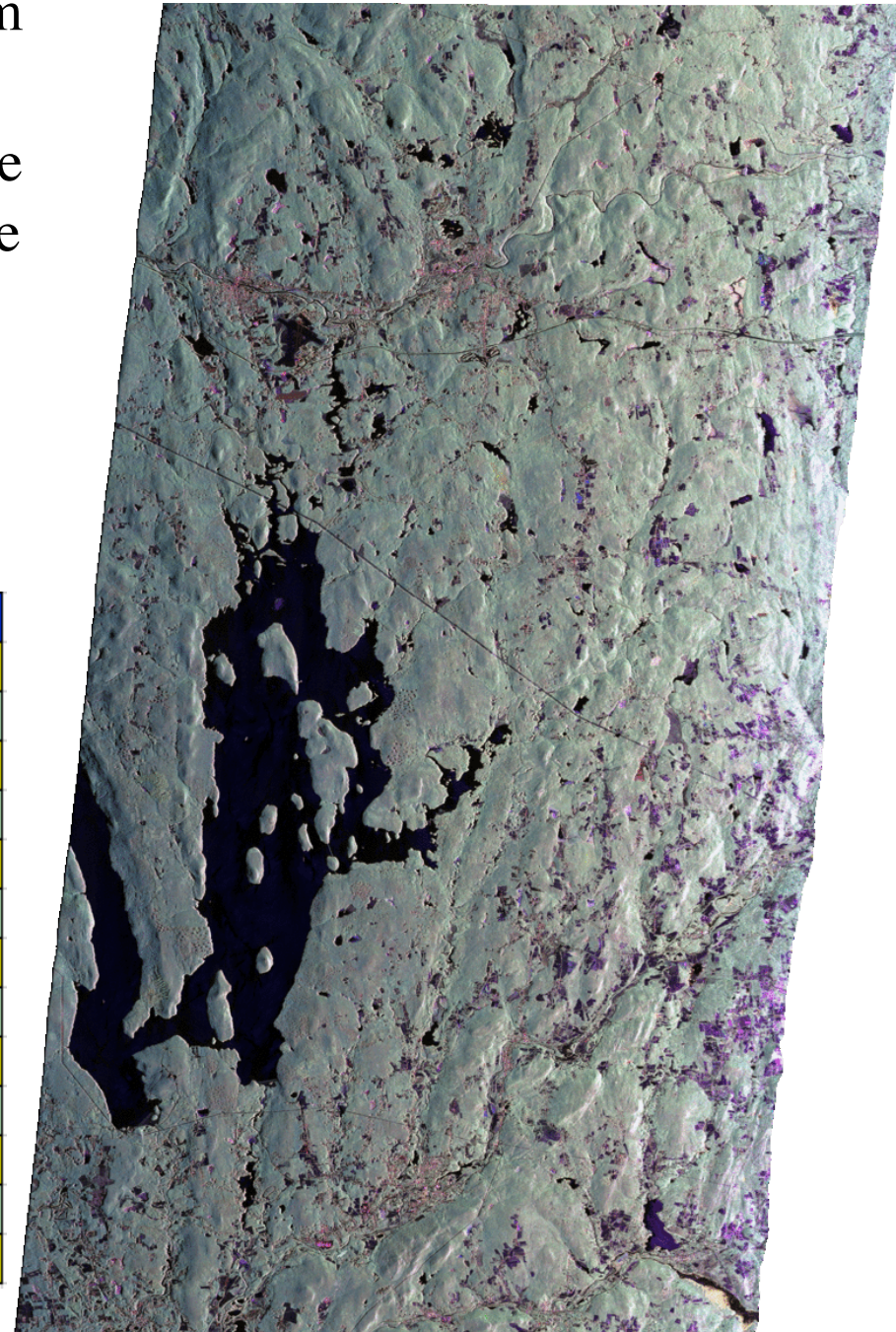
Howland Forest

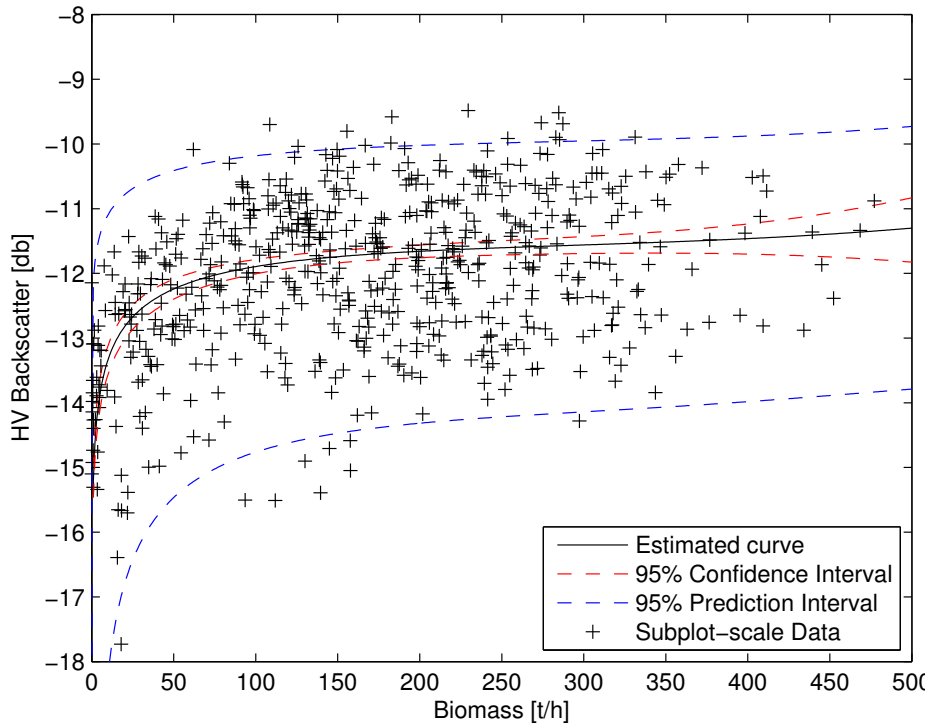


- UAVSAR data was collected on dates from August 6-17, 2009.
- Similar lines were collected over the Howland/Penobscott Forests during the same time frame (August 5-14, 2009).

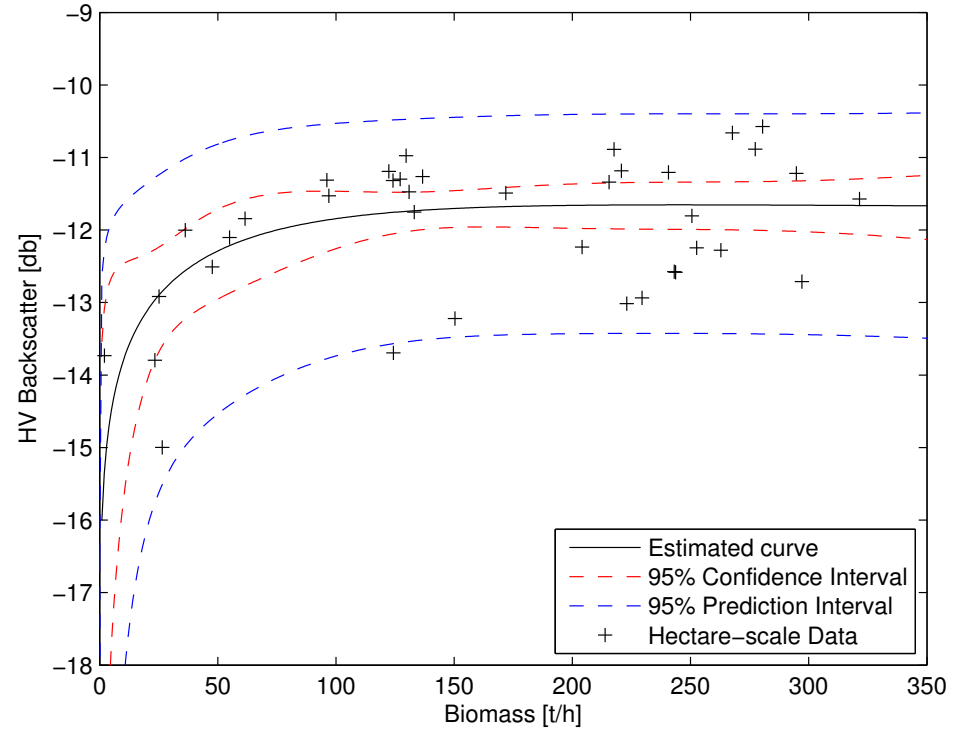
UAVSAR Image of Harvard Forest Region

Track Number	Date	Time of Day
1	August 6, 2009	13:59:57
2	August 6, 2009	14:31:27
3	August 6, 2009	15:01:56
4	August 6, 2009	15:32:54
5	August 8, 2009	15:13:26
6	August 8, 2009	15:43:51
7	August 8, 2009	16:14:49
8	August 13, 2009	19:15:09
9	August 13, 2009	19:48:39
10	August 16, 2009	13:51:11
11	August 17, 2009	14:57:43
12	August 17, 2009	13:58:03
13	August 17, 2009	13:28:53



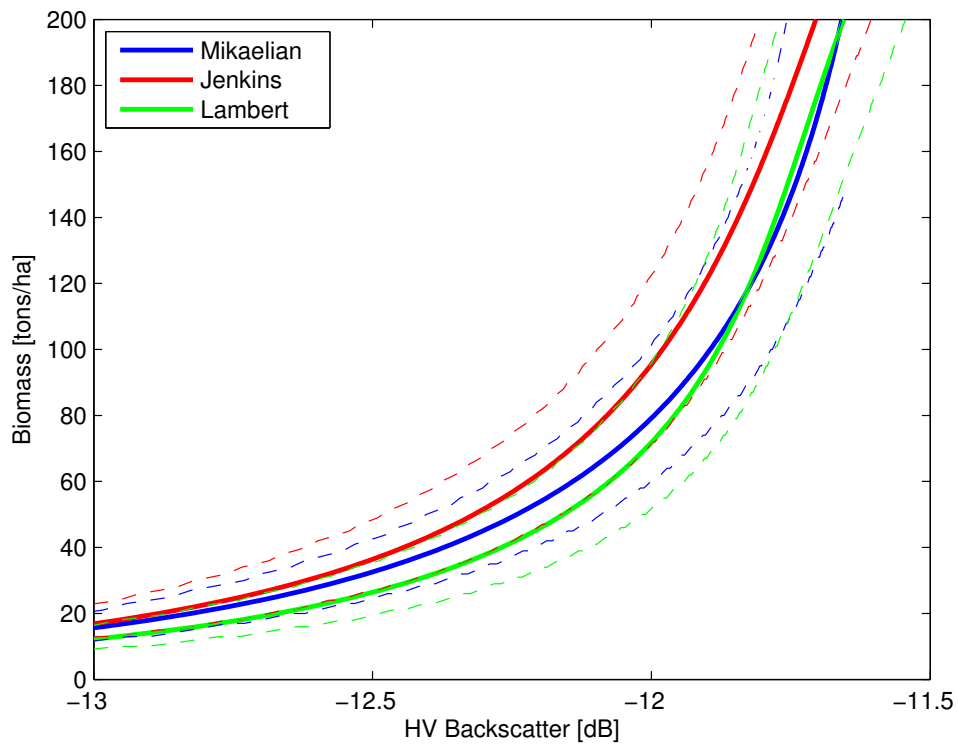


subplots

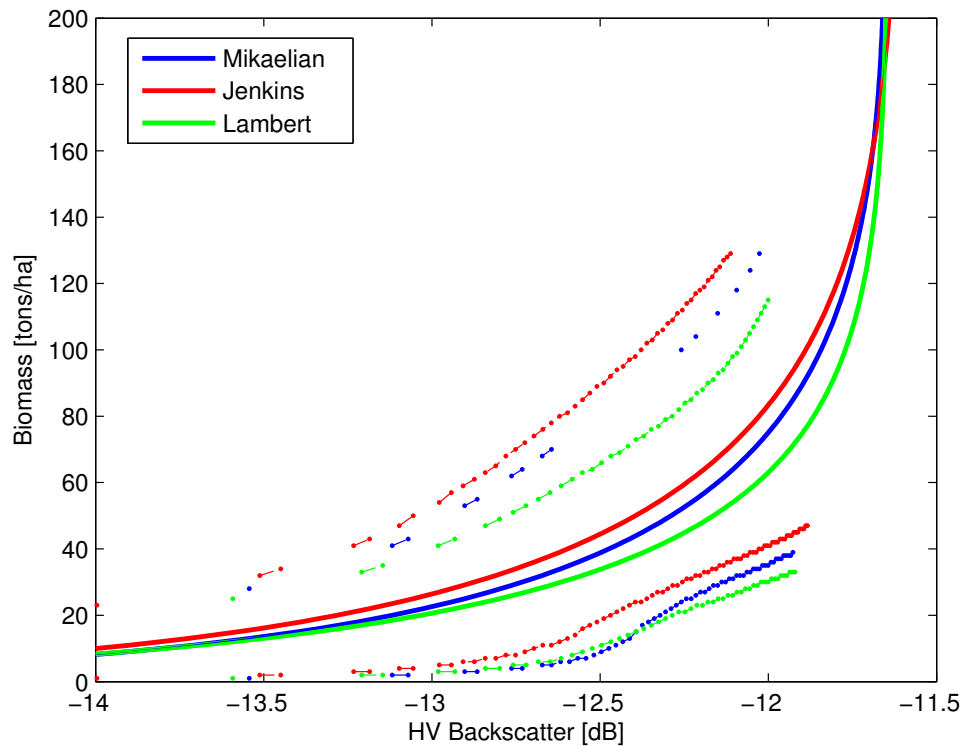


hectares

$$\sigma = \beta_0(1 - e^{-\beta_1 M}) + \beta_2 M^{0.2} e^{-\beta_1 M}$$

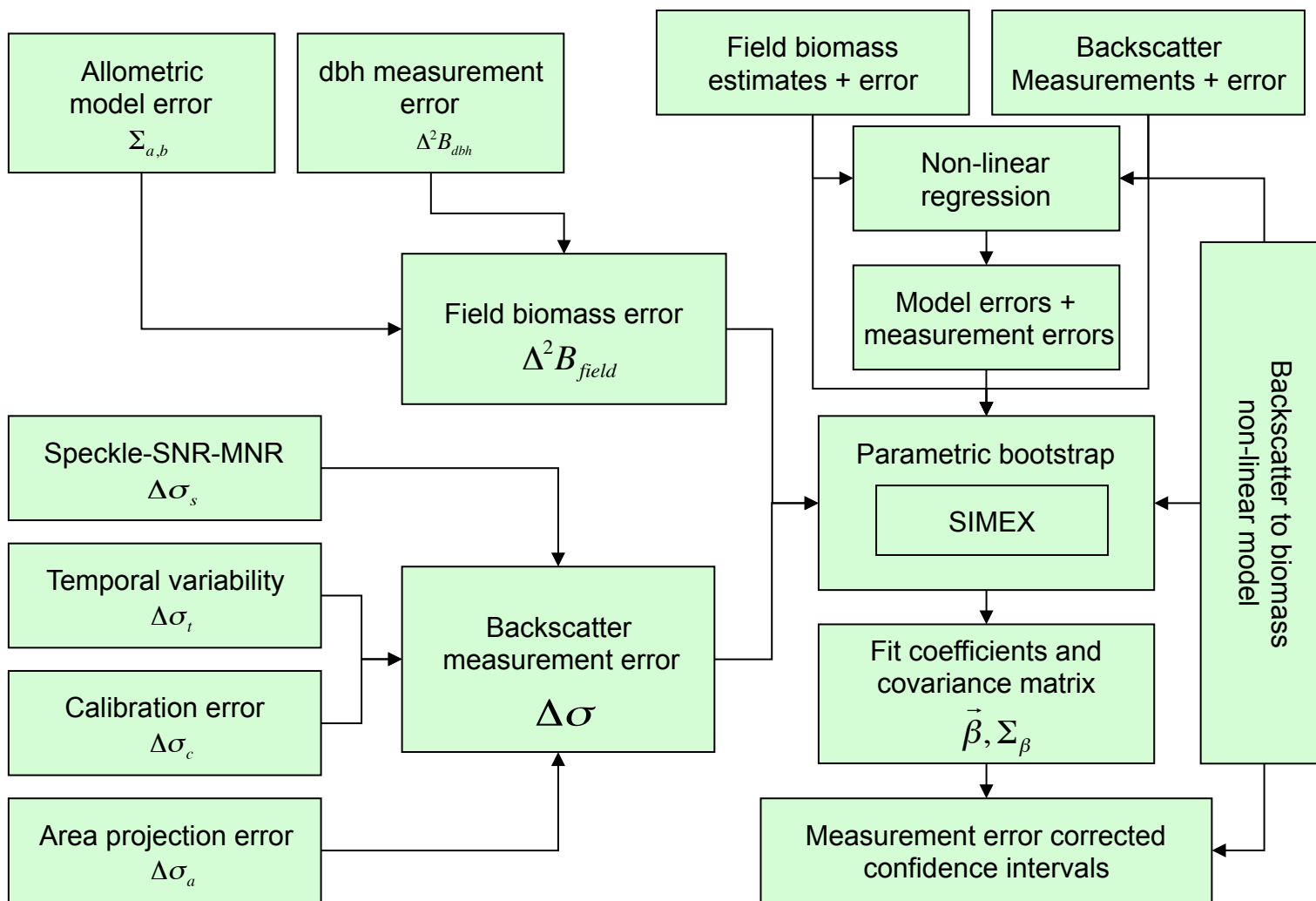


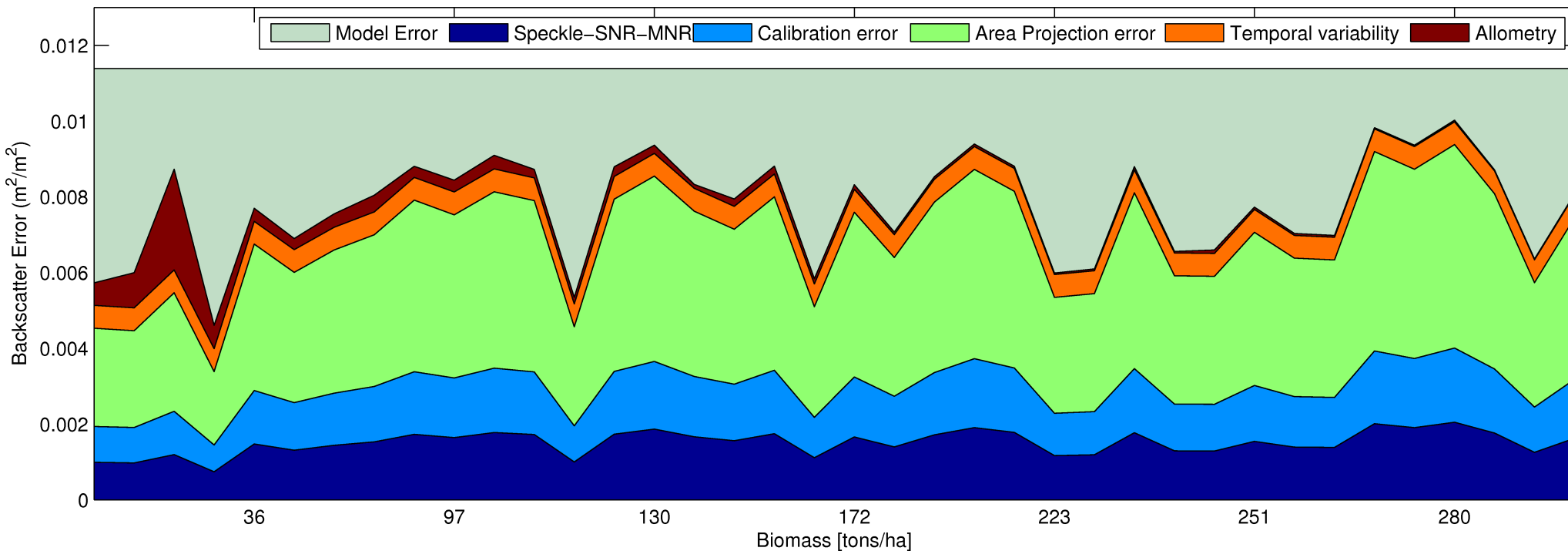
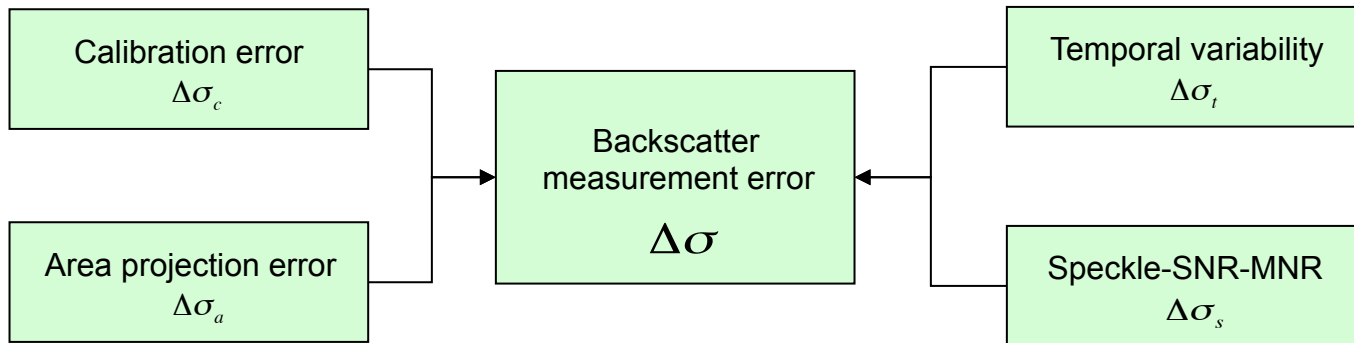
subplots

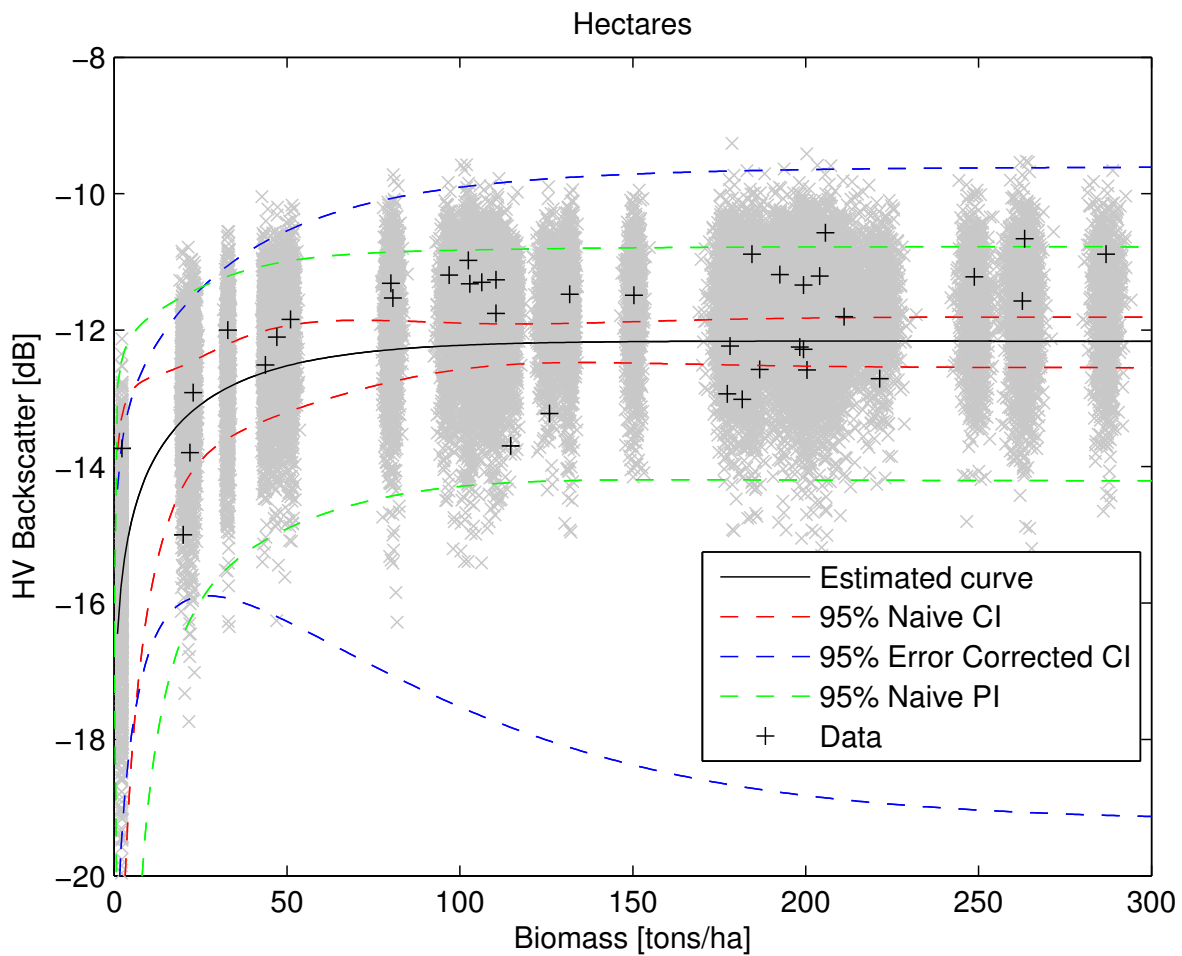


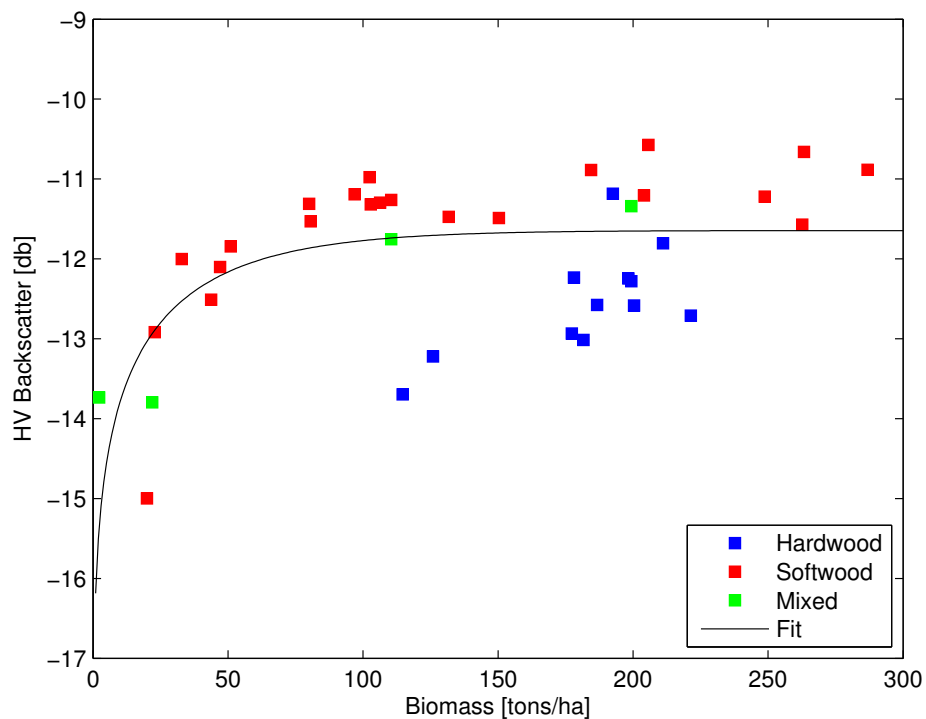
hectares

- Various types of errors in the non-linear backscatter-biomass relationship
 - Measurement errors in radar backscatter $\Delta\sigma$
 - Measurement errors in biomass $\Delta^2 B_{field}$
 - Natural uncertainty in the relationship (model error)
 - RMS residuals from the regression
 - Confidence intervals and variance of the fit coefficients $\vec{\beta}, \Sigma_{\beta}$
- How do all these errors fit together? **Non-linear two stage bootstrap**

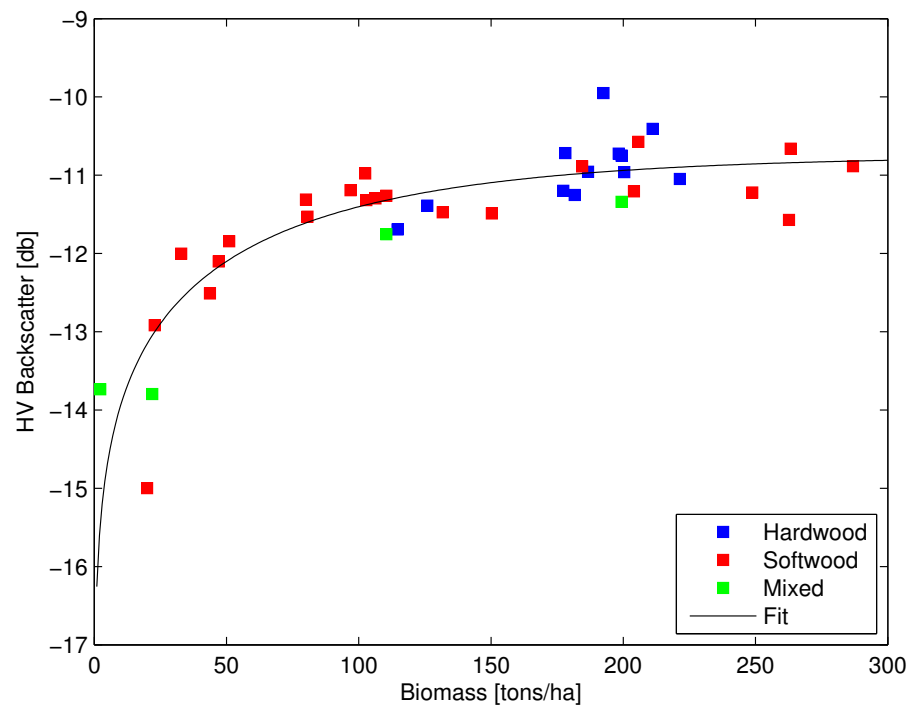




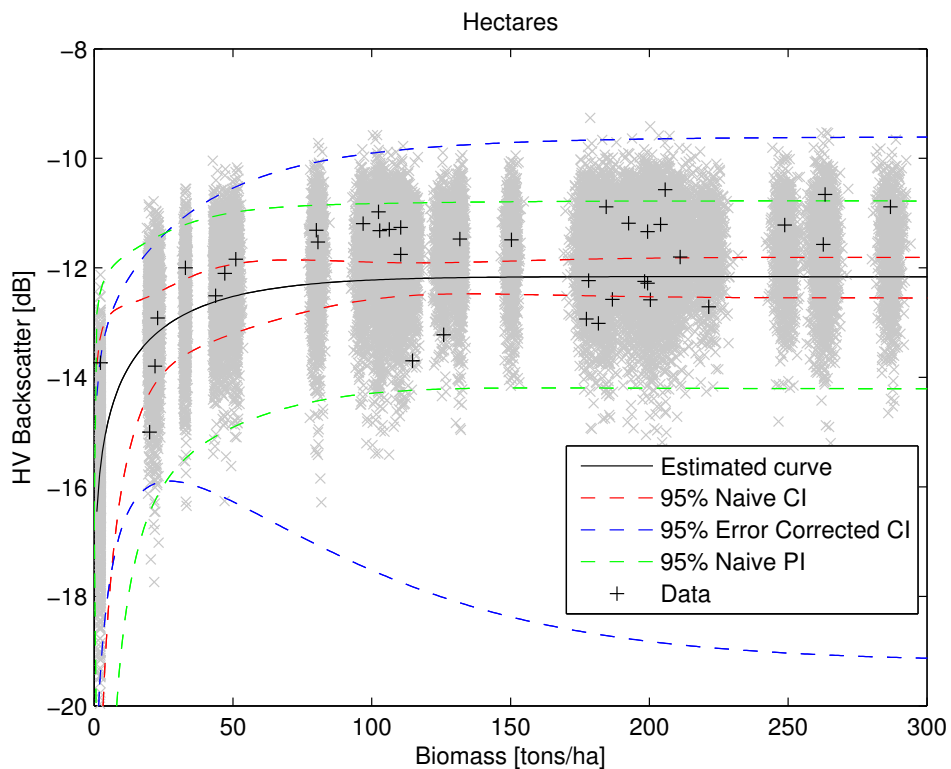




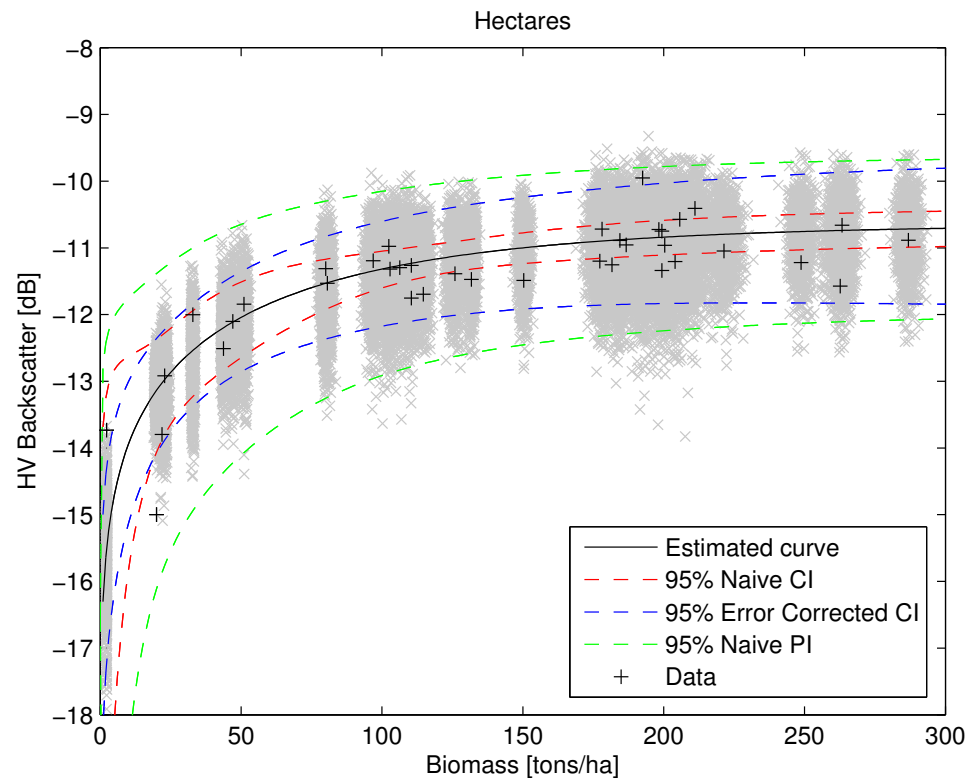
Dependence of radar backscatter on species class



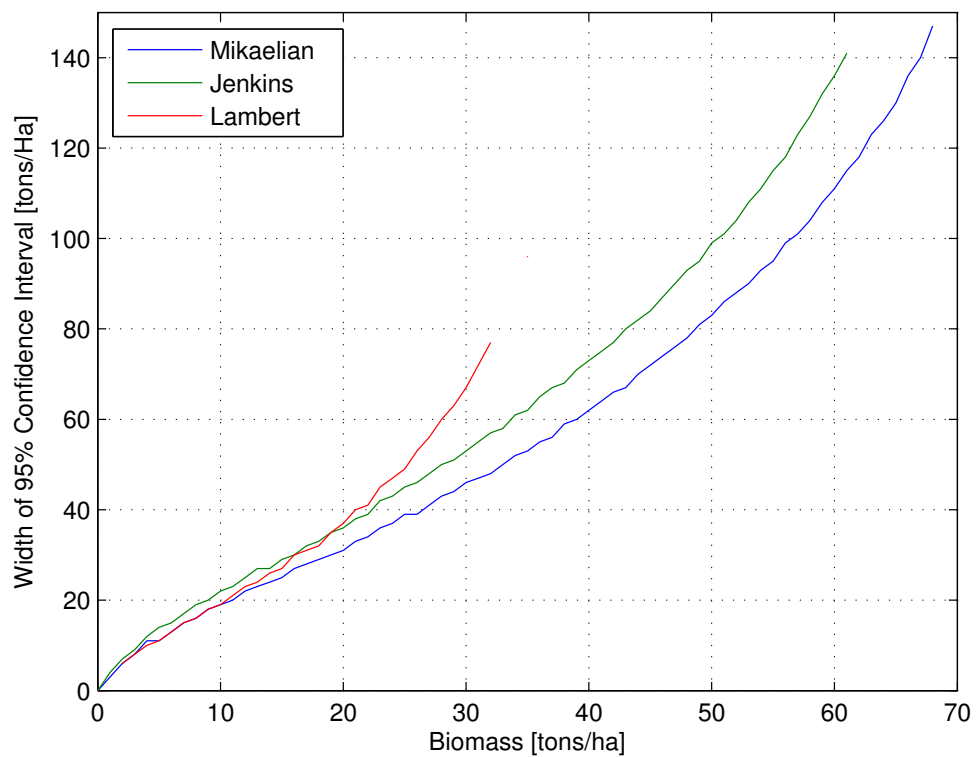
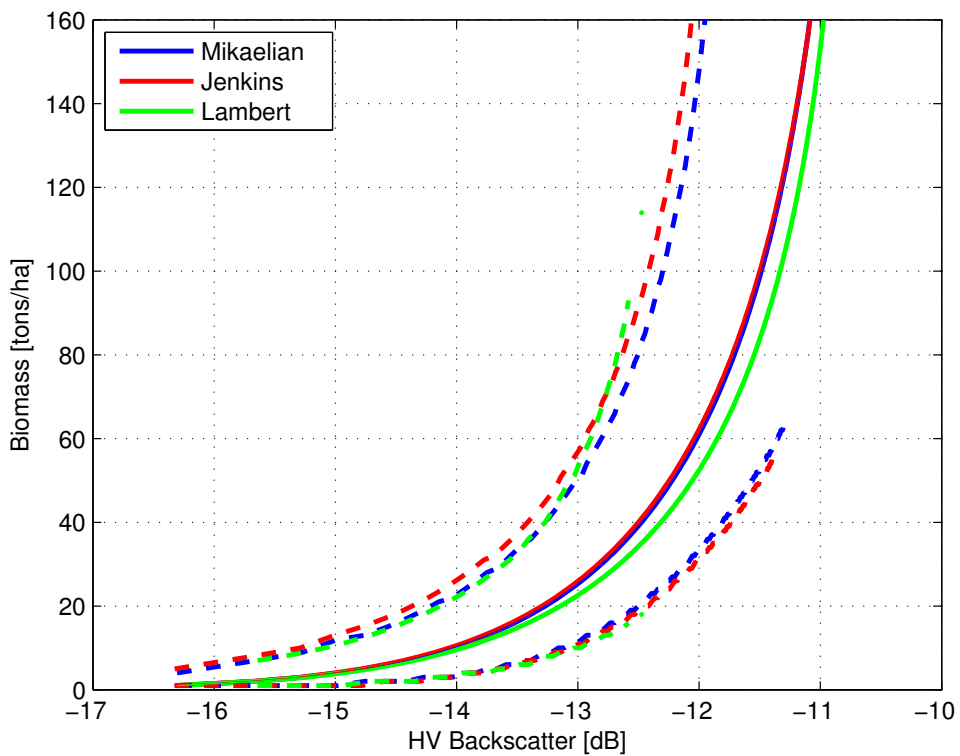
Reduced model error as the mean separation between hardwood/softwood pixels is removed

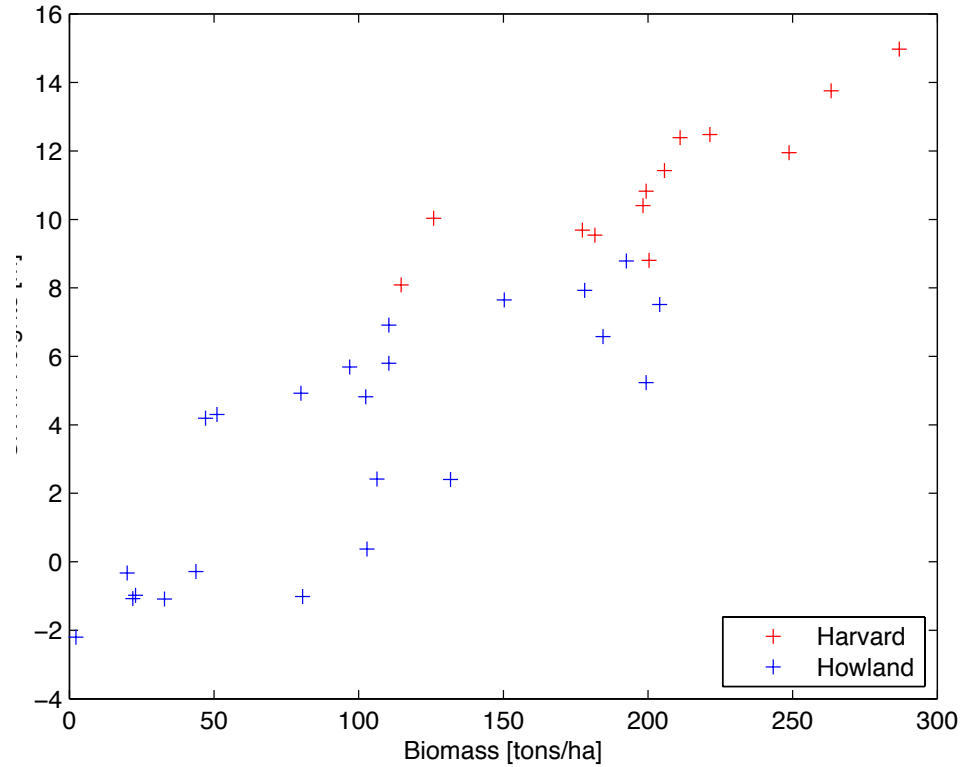
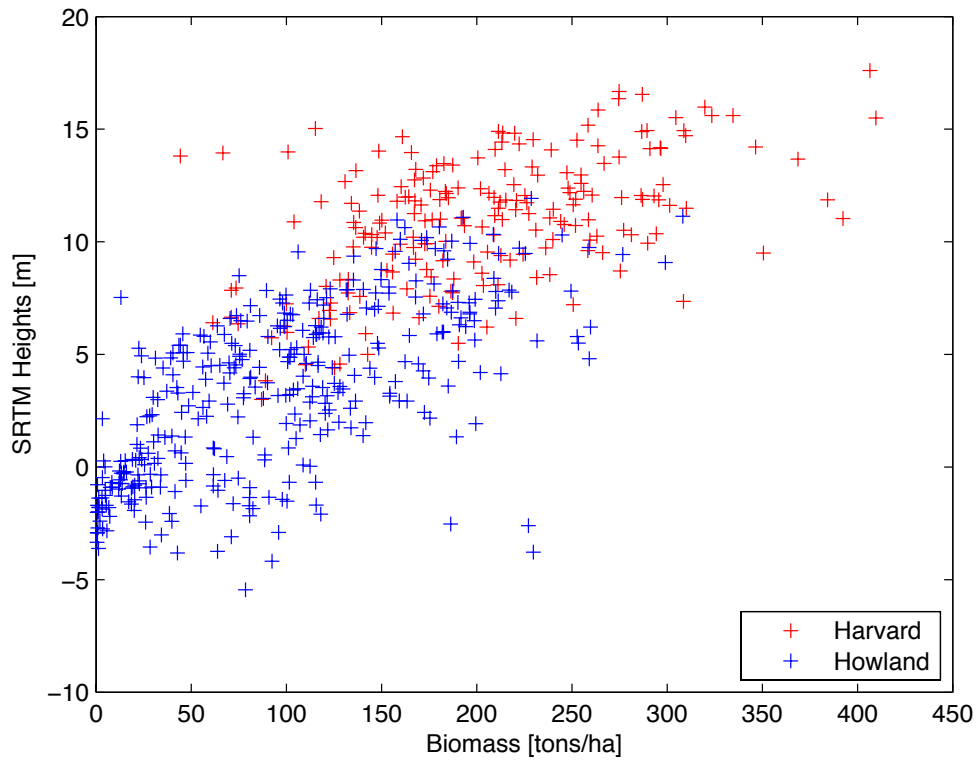


Large model error



Reduced model error





	R^2	RMSE [tons/ha]
Harvard	0.27	60.03
Howland	0.42	51.37
Combined	0.58	54.83
RH100	0.43	68.58

	R^2	RMSE [tons/ha]
Harvard	0.72	25.66
Howland	0.63	38.36
Combined	0.79	34.55
RH100	0.69	39.59