

K&C Phase 3 – Brief project essentials

Synergetic use of ALOS PALSAR data for forest biomass retrieval and wetland classification

Dr. Josef Kelldorfer

The Woods Hole Research Center

Team:

Dr. Oliver Cartus, Dr. Wayne Walker

Science Team meeting #18 –JAXA TKSC/RESTEC HQ, Tokyo,
November 7-9 2012

Project area(s)

- **Central Chile**
 - ⇒ **Industrial Scale Plantation Forest**
 - i Radiata Pine
 - i Eucalyptus
- **North Eastern United States**
 - ⇒ **Region of the Regional Greenhouse Gas Initiative (RGGI)**
 - ⇒ **Expanded to Southern Commercial Forest Lands**
- **Napo River Basin / Madre de Dios Studies**
 - ⇒ **Studies on Floodplain Classification**
 - ⇒ **Project area for shipping lock construction**
- **Congo River Basin**
 - ⇒ **Studies on DOC / Land Use change connections**

Project objectives and schedule

- BIOMASS/Carbon Studies on Forests
 - Improvement in the determination of aboveground C stock with ALOS/ALOS-2 PALSAR/PALSAR-2 time series data.
 - Study the effects of “radar phenology” (variations in backscatter and coherence changes under varying environmental conditions (moisture/temperature) and how those changes can be mined for the improvement of empirical retrieval algorithms
- WETLAND/FLOODPLAIN Studies
 - Asses the improved mapping of wetlands and floodplains through L-band radar time series
 - Improve flood cycle mapping
 - Improve models linking land-cover change with DOC transport mechanisms and methane fluxes

Project objectives and schedule

Region	Activities	04/2011 – 03/2012	04/2012 – 03/2013	04/2013 – 03/2014	04/2014 – 03/2015
Chile	SFP-Lidar based GSV/CH map production	D1.1 (due 31.3.2012)			
	Synergy ALOS intensity – Lidar for GSV/HT retrieval		D2.1 (due 31.3.2013)		
	Synergy ALOS intensity/repeat- pass coherence – Lidar for GSV/HT retrieval			D3 (due 31.3.2014)	
Vermont, USA	SFP-Lidar based GSV/CH map production	D1.2 (due 31.3.2012)			
	Synergy ALOS intensity – Lidar for GSV/HT retrieval		D2.2 (due 31.3.2013)		
Napo River / Madre de Dios Congo Basin	Biomass retrieval			D4 (due 31.3.2014)	
	Wetland classification				D5 & D6 (due 31.3.2015)

Support to JAXA's global forest mapping effort

Regional results from the project activities will be available to validate JAXA's Maps

Several reference data can be readily shared

Chile: Lidar-based maps of Growing Stock Volume

NE USA: Biomass map and change data sets from the version 2 of the National Biomass and Carbon Data set

Napo: validated maps of floodplains, collected reference points from project in 2013

Deliverables

Describe the planned output of your project.

- Biomass maps for
 - ⇒ Chlie Test Site
 - ⇒ North-Eastern US
 - ⇒ Napo/Madre de Dios River Basin
 - ⇒ Parts of the Congo Basin
- Floodplain maps for Madre de Dios, Napo, and Congo River Basin

.

Aboveground Woody Biomass and Carbon Stock of the Conterminous United States

RMSE at Various Scales	
FIA Plot	55 Mg/ha
EMAP Hex	19 Mg/ha
County	14 Mg/ha
State	12 Mg/ha

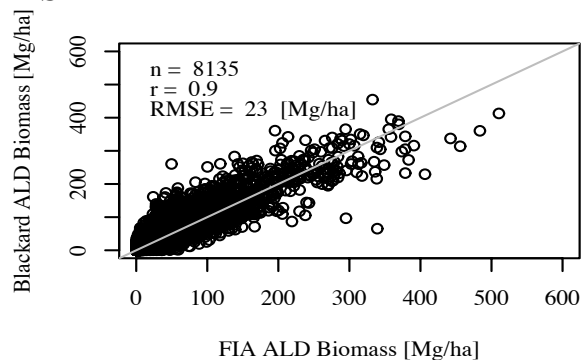
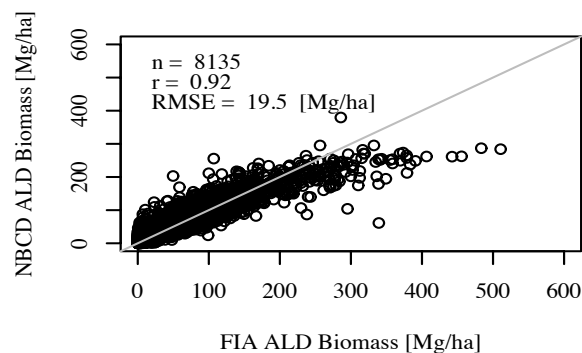
Biomass Mapping from
RS Data Fusion (InSAR/
Optical with
Forest Inventory (FIA)
Data

Kellndorfer et al., 2011

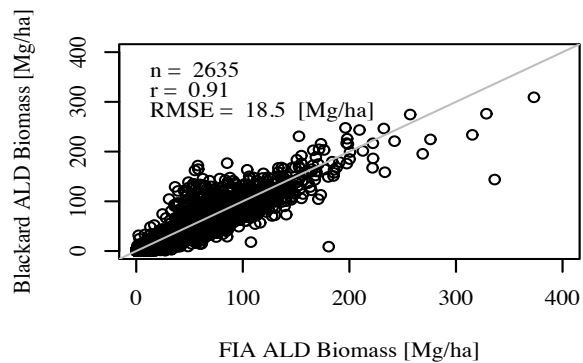
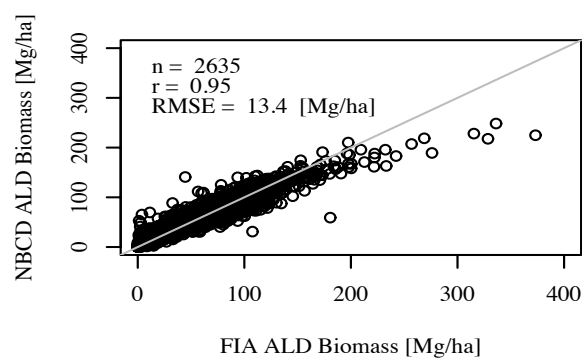


Multi-Scale ALDB Comparison FIA/NBCD/Blackard

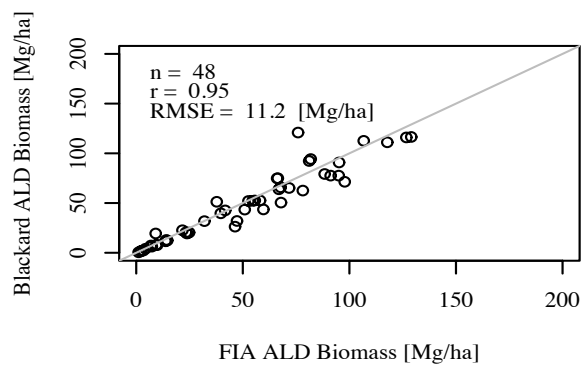
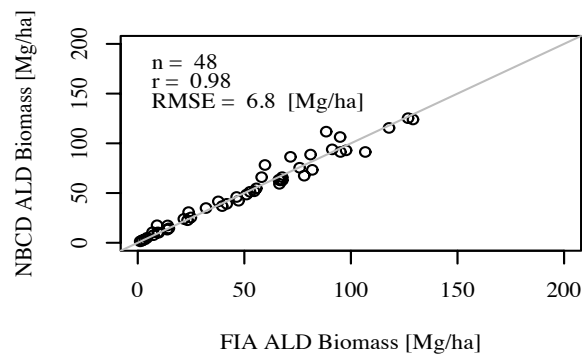
Hexagon Scale



County Scale

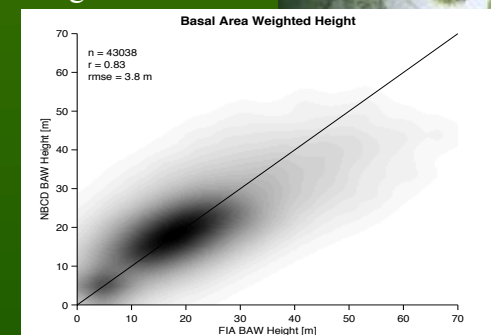


State Scale

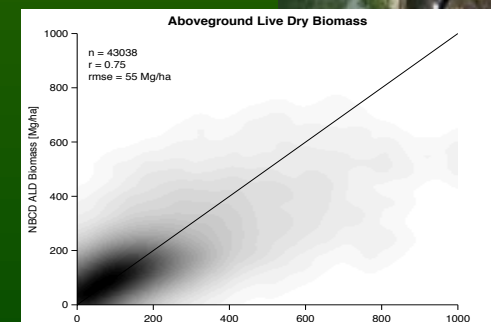


Pixel Scale

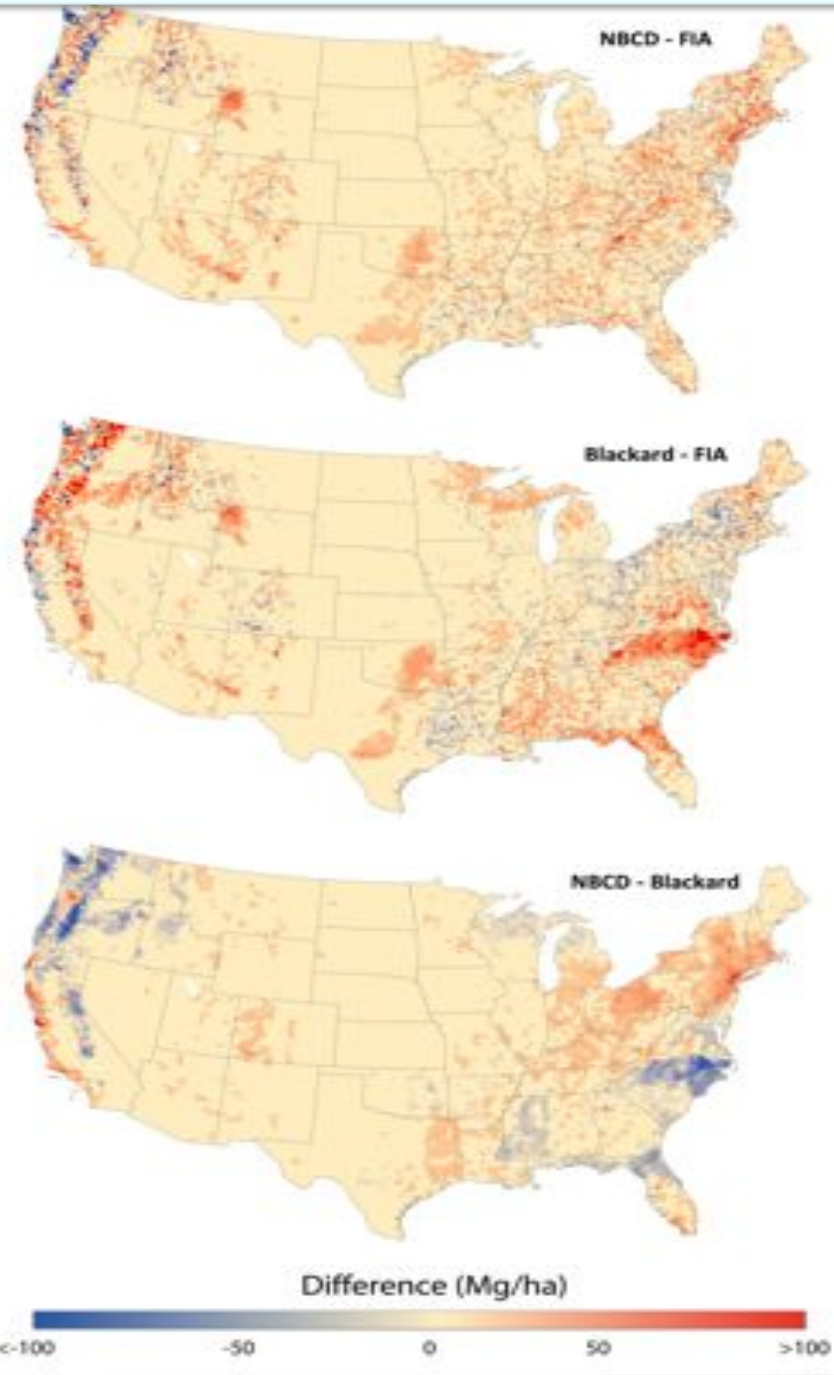
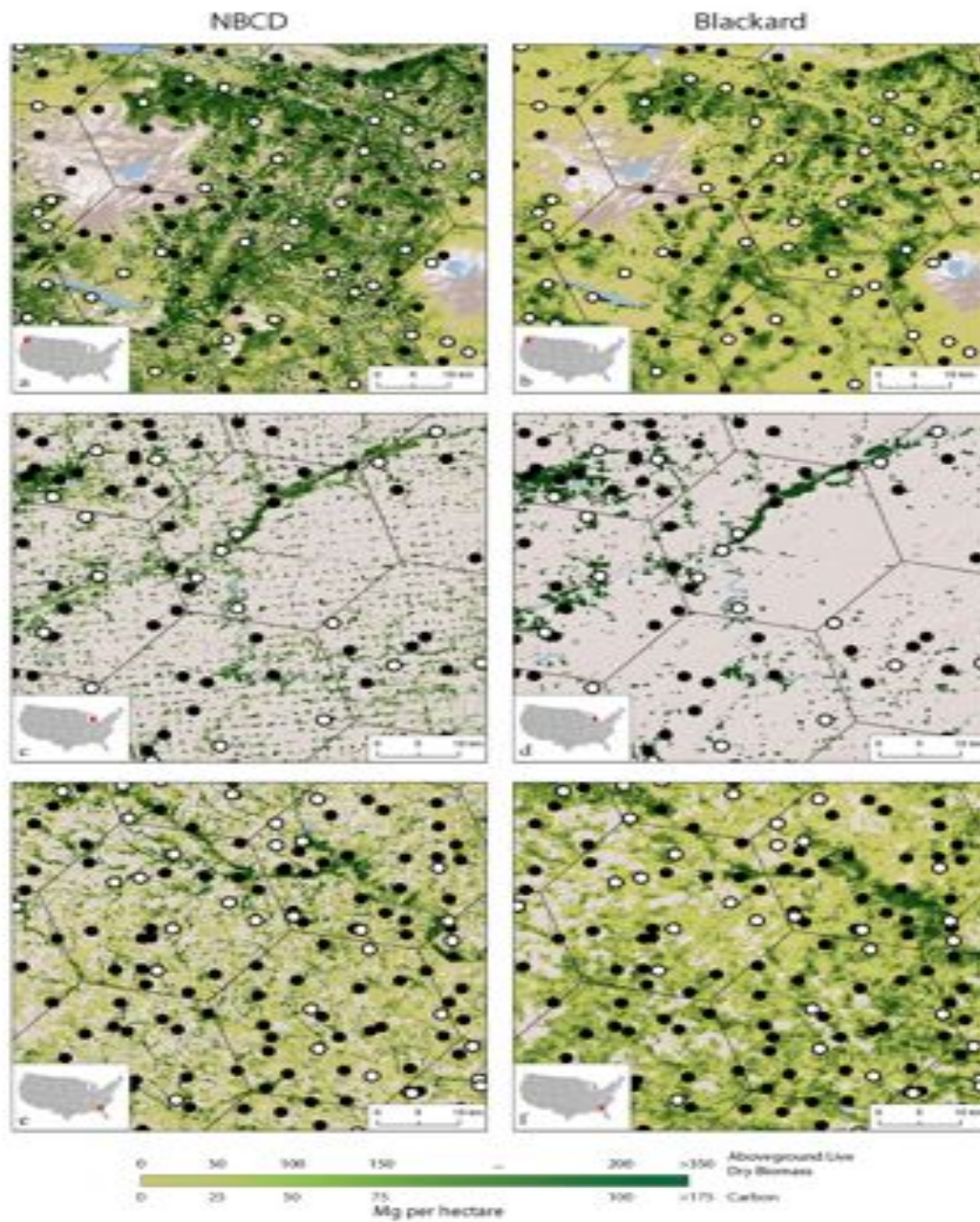
Height

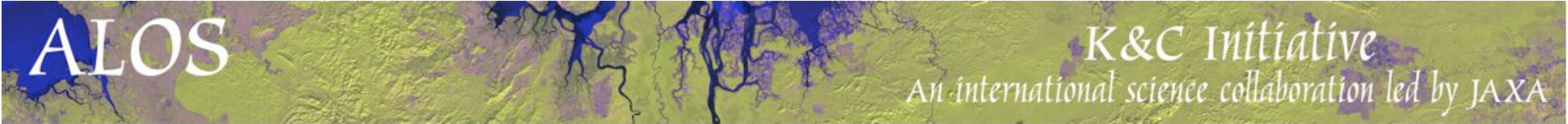


Biomass



COMPARISON of Maps at Hexagon Scale





ALOS

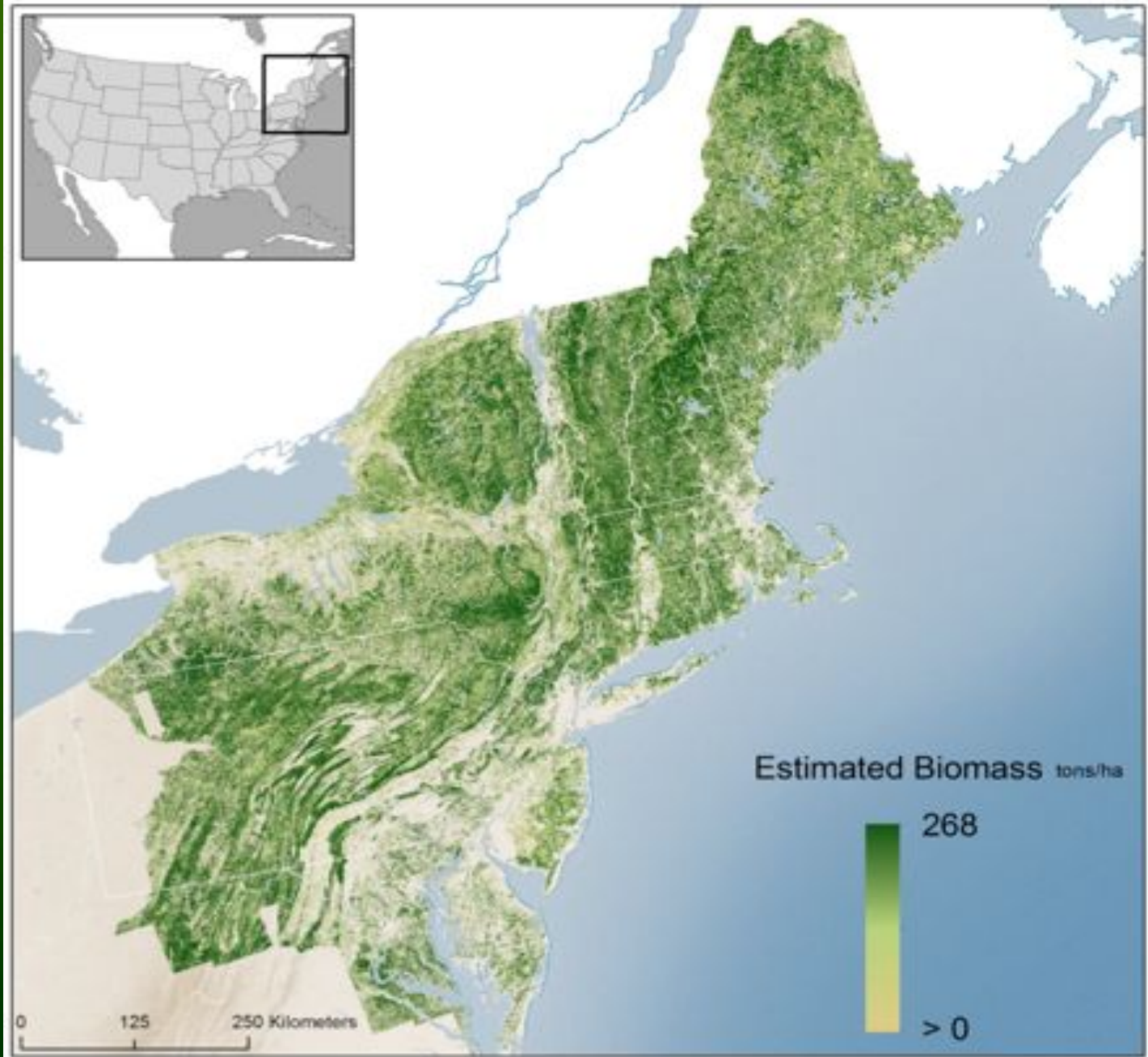
K&C Initiative
An international science collaboration led by JAXA

First Results

J. Kelndorfer et al., 2012

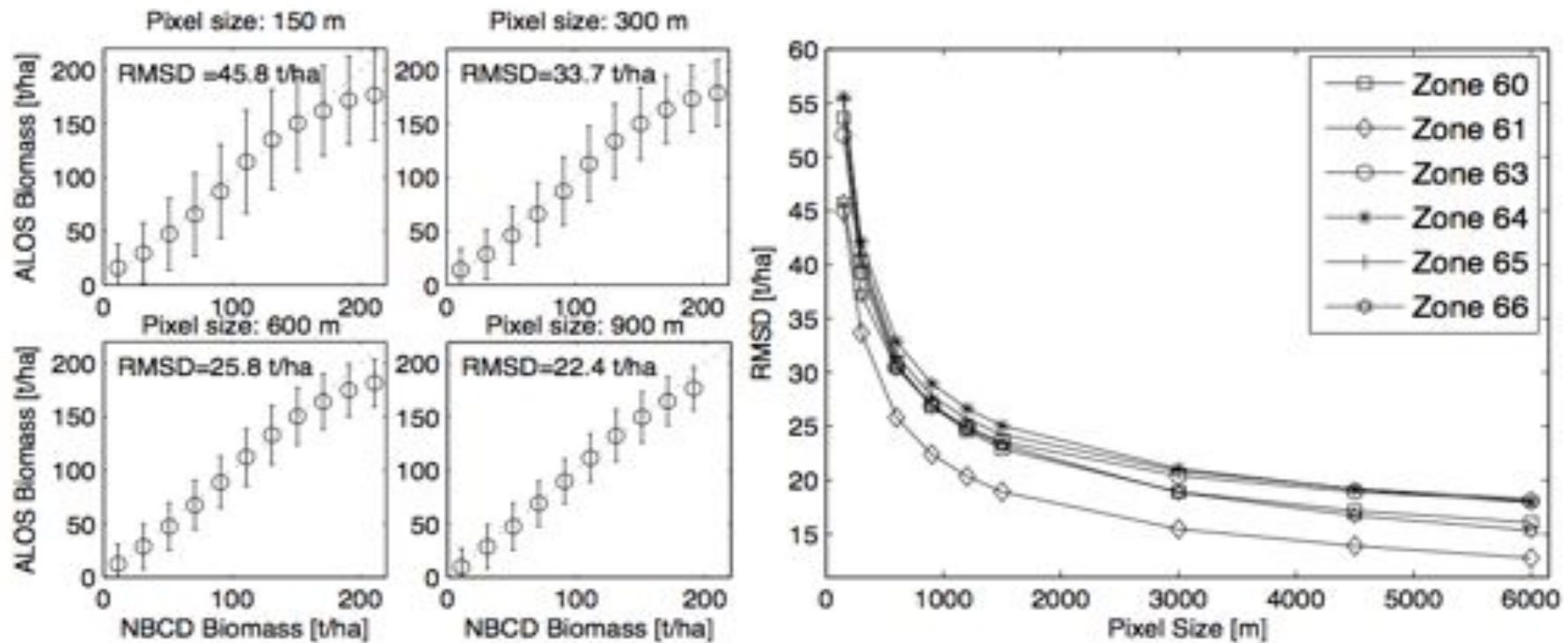
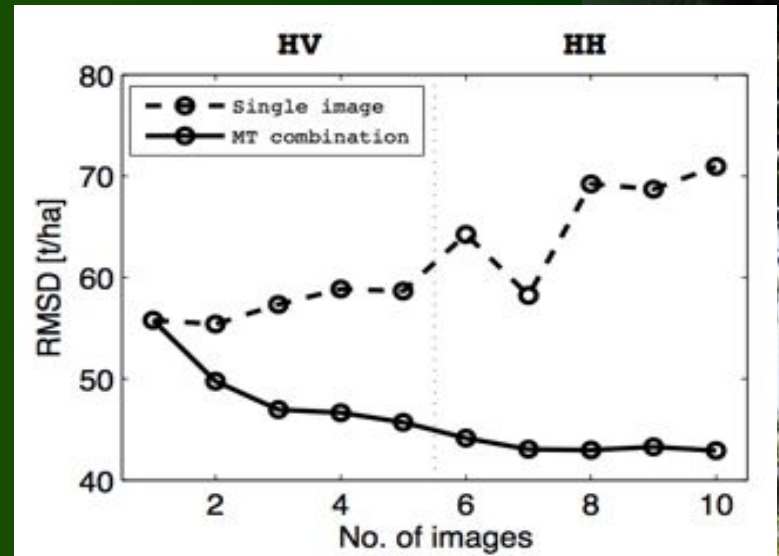
NE USA Biomass Mapping with ALOS/ PALSAR (644 multi- temporal Dual-pol scenes)

150 m pixel
aggregation



Effect of Multi-Temporal Retrieval

Effect of Scaling



Test of ALS/PALSAR/Landsat fusion at three ~100 km² large test sites

Spatial Predictors:

2x FBD HH/HV intensity

2-3x FBS HH intensity

All FBD-FBD/FBS-FBS/FBD-FBS coherences with temporal baselines ≤ 92 days (up to five images)

Landsat ETM+

Segmented Canopy Height Model (eCognition segmentation)

Response variables:

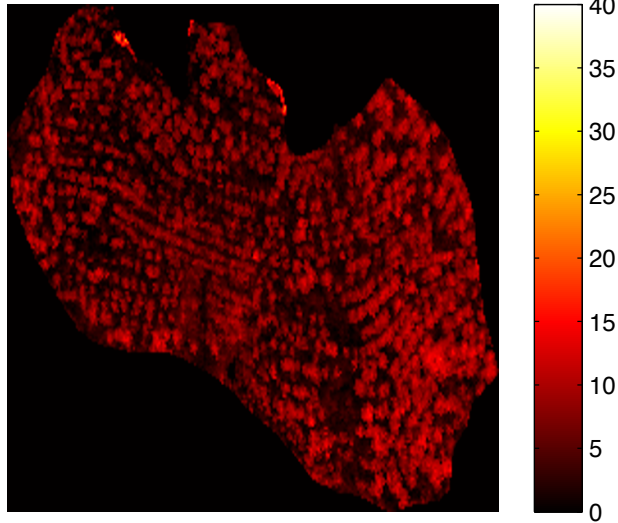
ALS based estimates of GSV
and Height for segments

Cartus, O.; Kelldorfer, J.; Rombach, M.; Walker, W. Mapping Canopy Height and Growing Stock Volume Using Airborne Lidar, ALOS PALSAR and Landsat ETM+. *Remote Sens.* **2012**, 4, 3320-3345.

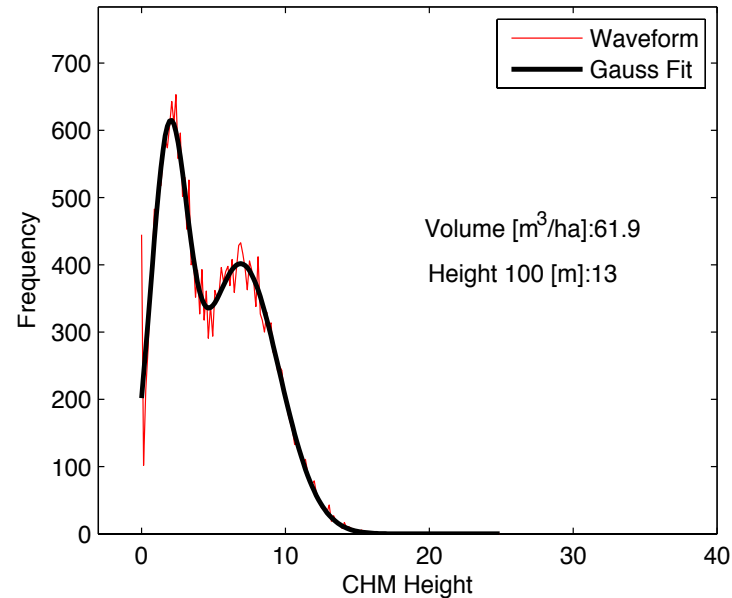


Extraction of ALS canopy structure indices for inventory stands

CHM



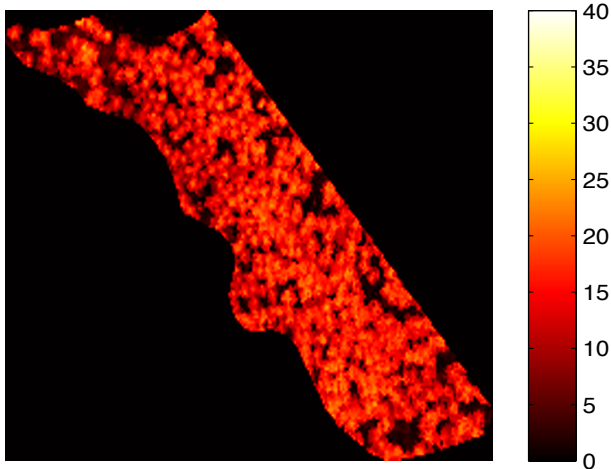
No. Gaussians:2



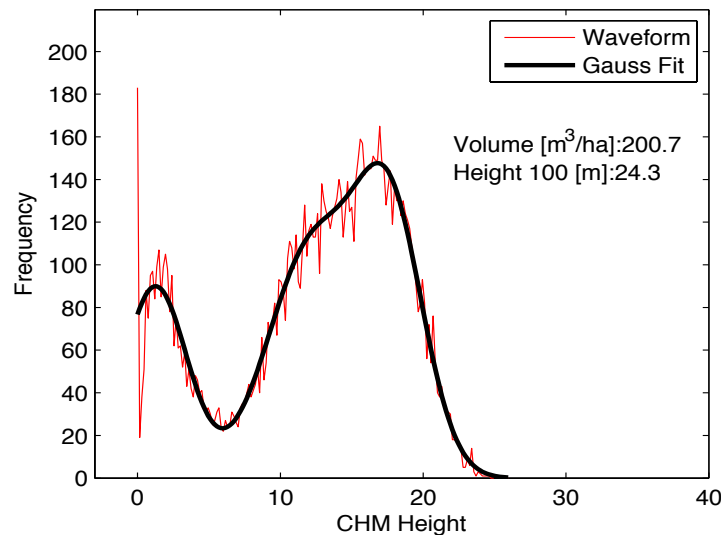
Extracted indices:

- Relative Heights 10-100% distribution)
- Canopy Cover (CD)
- Kurtosis/Skewness
- Mean/CV
- Number of Gaussians

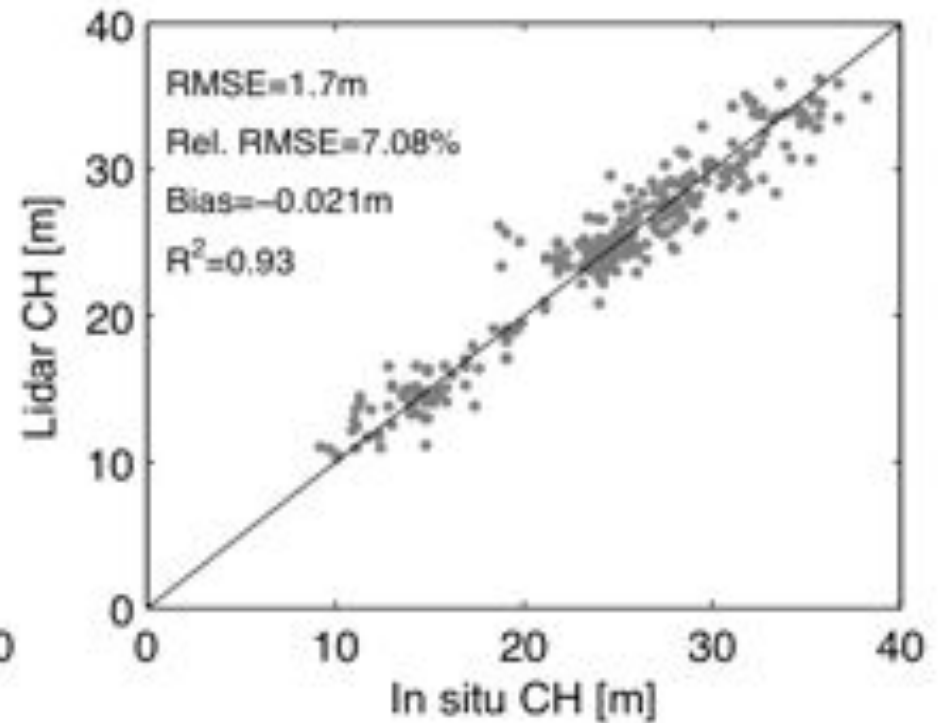
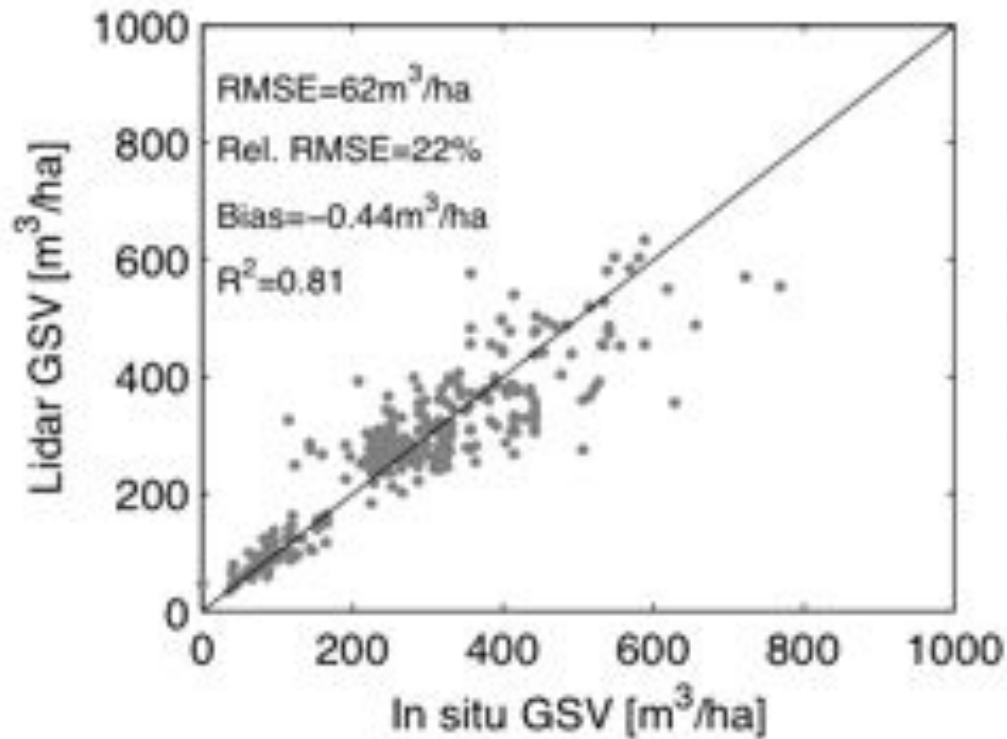
CHM



No. Gaussians:3

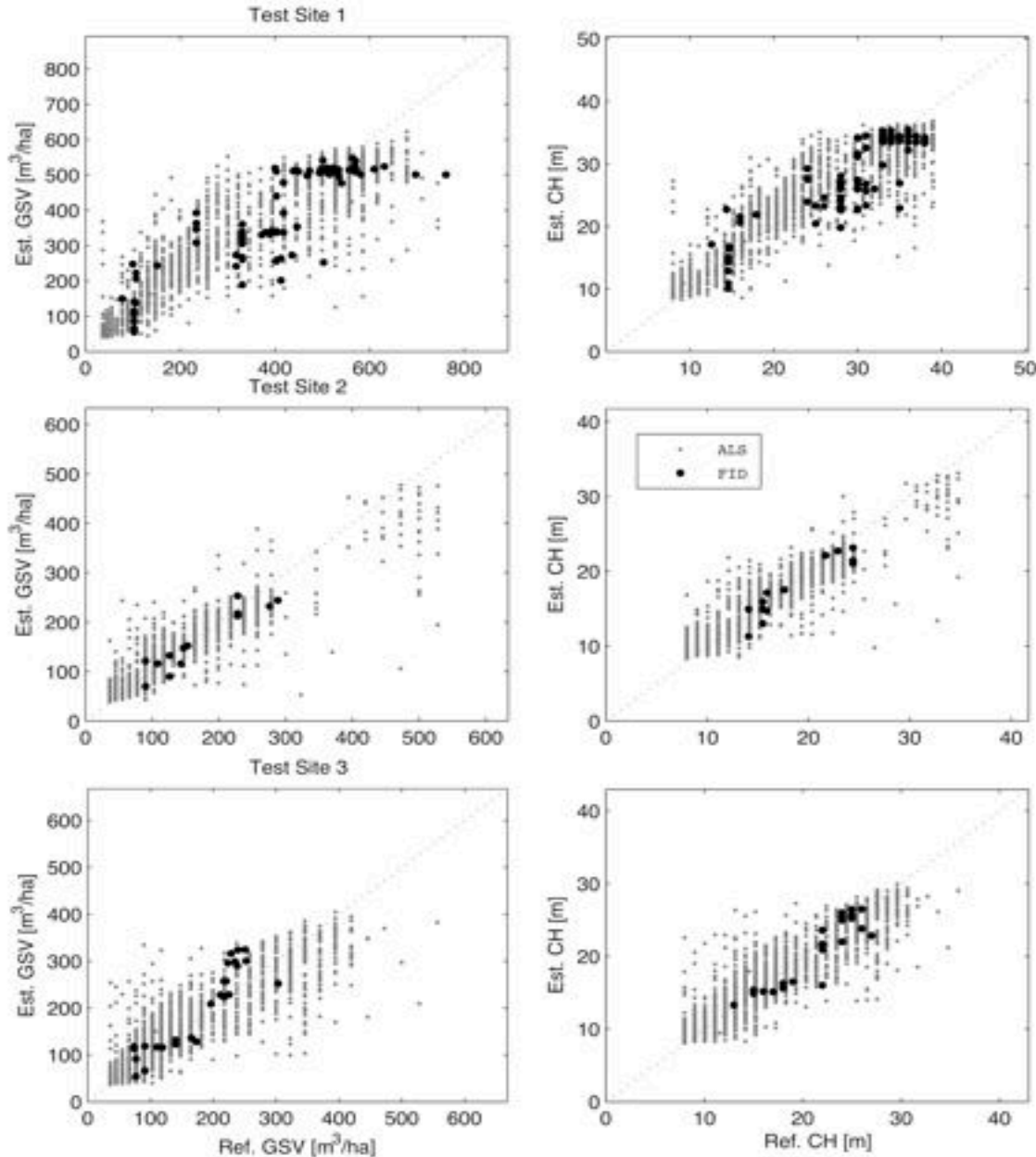


Stand-level Retrieval with ALS



Out-of-bag retrieval results for ~300 inventory stands

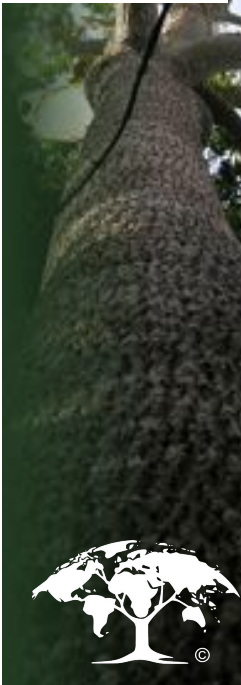
Accuracy of Retrieval with PALSAR/Landsat



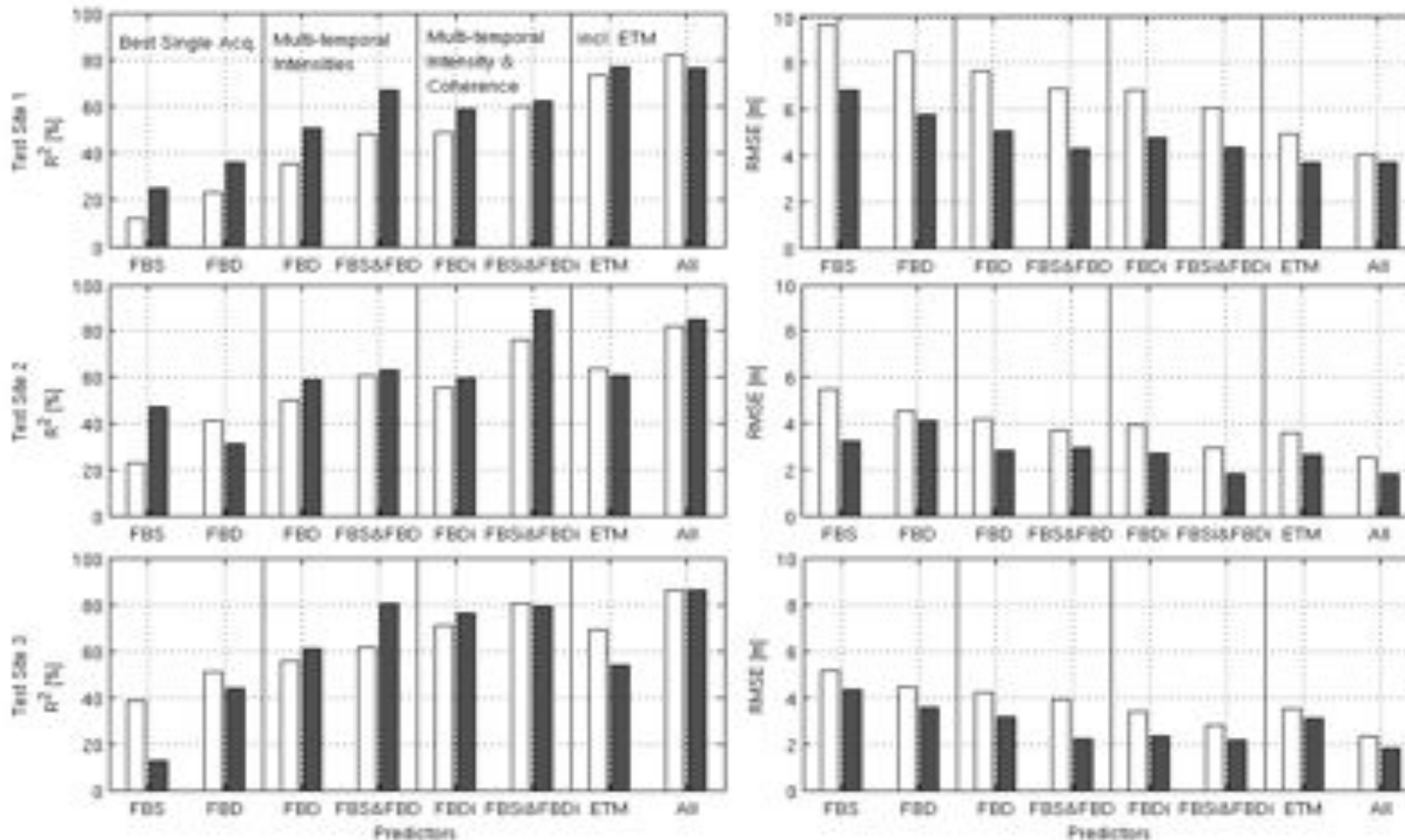
Test Site	Retrieval error	ALS		FID	
		GSV	CH	GSV	CH
1	RMSE	89.6	4.1	87.2	3.72
	RMSEr	28.3	16.5	22.6	12.9
	R²	0.79	0.82	0.72	0.76
	Bias	0.06	0.01	-15.0	-0.93
2	RMSE	43.9	2.53	25.8	1.80
	RMSEr	28.5	15.0	15.0	9.7
	R²	0.81	0.82	0.87	0.86
	Bias	0.37	0.1	-9.4	-1.0
3	RMSE	42.6	2.5	43.8	1.8
	RMSEr	29.6	15.6	25.5	8.5
	R²	0.83	0.83	0.87	0.86
	Bias	-0.1	0.01	20	-0.51

GSV and CH estimates compared to:

- 1) ALS based GSV and CH estimates for segments derived from the CHM (grey dots)
- 2) an independent set of inventory CH and GSV measurements (black dots).



Performance of Stand-level Height Retrieval With Increasing Number of Predictors (100 km² Test Sites)



White: Comparison of PALSAR/Landsat OOB predictions and ALS based estimates

Grey: Comparison of PALSAR/Landsat predictions and *in situ* data

Test Site 1: highest average and maximum CH/GSV → ETM outperforms PALSAR

