K&C Phase 4 – Status report

PALSAR-1/2 Data for Vegetation Cover and Biomass Mapping in Various Climates

Stelmaszczuk-Gorska, M., Urbazaev, M. Thiel, C.,
Schmullius, C.,
Friedrich-Schiller-University Jena

Science Team meeting #22
Tokyo, Japan, February 16-18, 2016

Project outline and objectives

- **Topic 1**
  - Investigation of the potential of ALOS-2 PALSAR-2 backscatter data for AGB retrieval
- **Topic 2**
  - Development of a robust methodology for AGB estimation (comparison of MaxEnt and Random Forest)
  - AGB retrieval using ALOS PALSAR backscatter and coherence data
- **Topic 3**
  - Improving aboveground biomass estimation in southern Mexico using multi-temporal ALOS PALSAR data and MODIS NDVI time series

- Areas of interest – Central Siberia, Mexico, South Africa, Germany

PALSAR-1/2 Data for Vegetation Cover and Biomass Mapping in Various Climates

Topic 1

Investigation of the potential of ALOS-2 PALSAR-2 backscatter data
AGB retrieval using ALOS-2 PALSAR-2, RADARSAT-2 backscatter data

Stelmaszczuk-Gorska, M., Thiel, C., Schmullius, C.,
Friedrich-Schiller-University Jena

Science Team meeting #22
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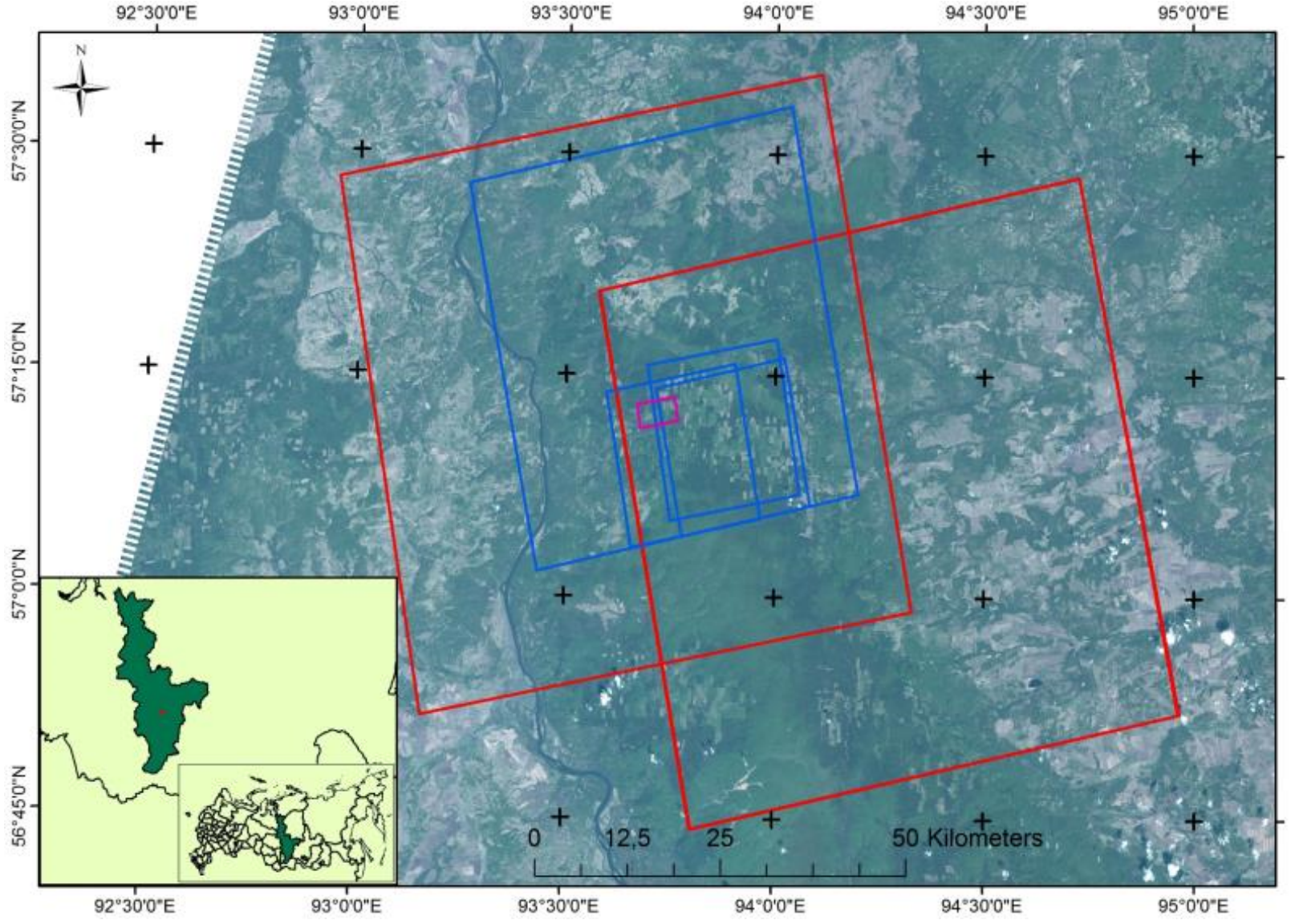
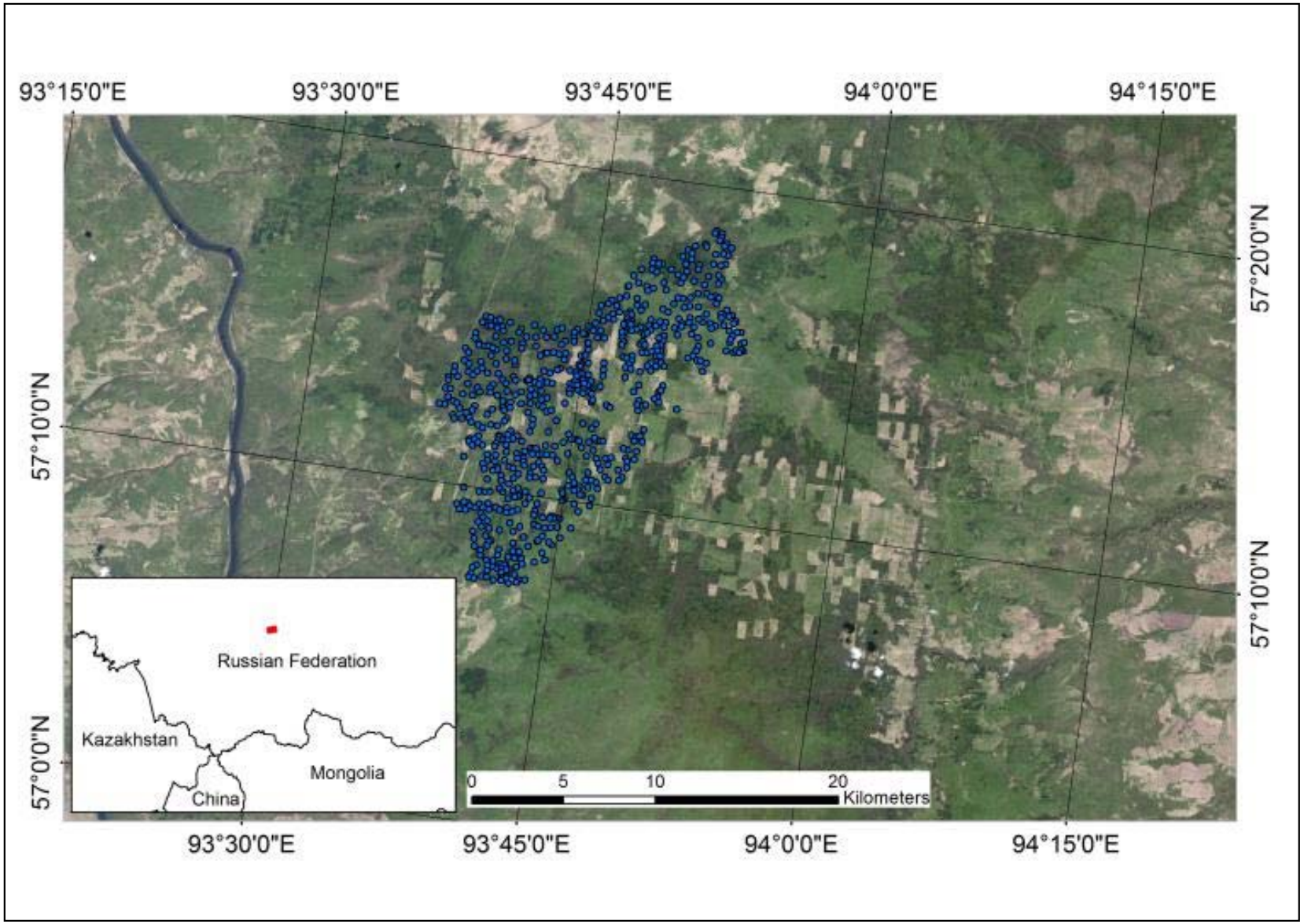
Area of interest – Central Siberia





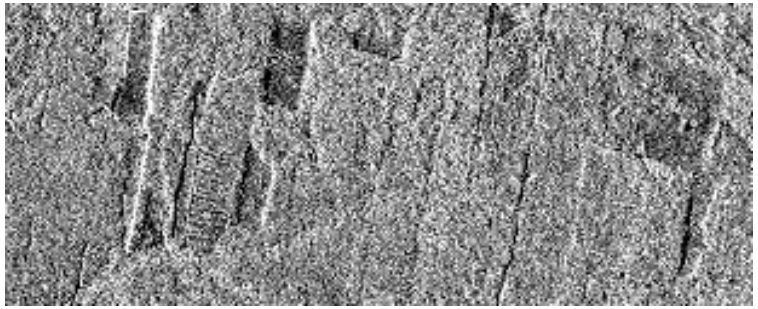
Krasnoyarskiy Kray

ALOS

K&C Initiative

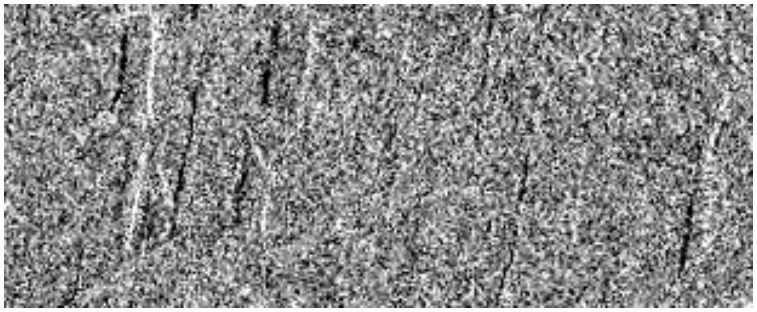
An international science collaboration led by JAXA

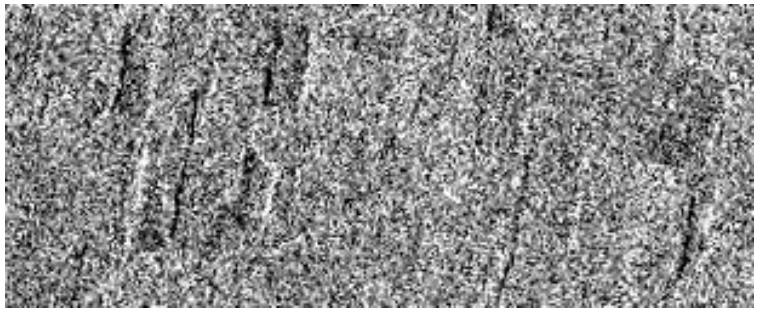
TSX, 2014/07/08 Staring Spotlight
Inc. angle: 30.5˚ Res: 0.9x0.17 m



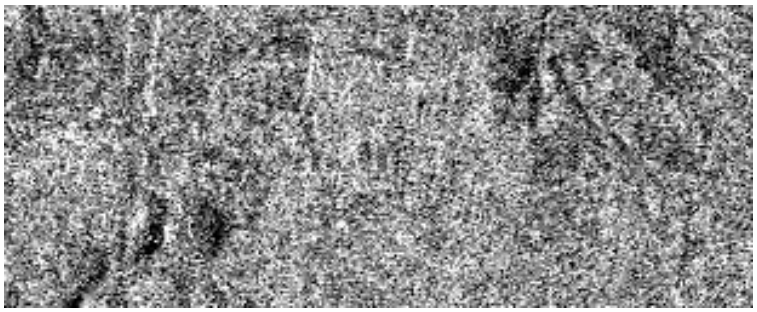
RSAT-2, 2014/08/05
Ultrafine
Inc. angle: 35.4˚
Res: 2.3x2.1 m

RapidEye, 2012/06/11





RSAT-2, 2014/07/19 HH & HV
Fine
Inc. angle: 32˚
Res: 8.9x4.8 m



PSAR-2, 2014/09/26 HH & HV
Fine
Inc. angle: 31.5˚
Res: 8.2x3.2 m

SAR data

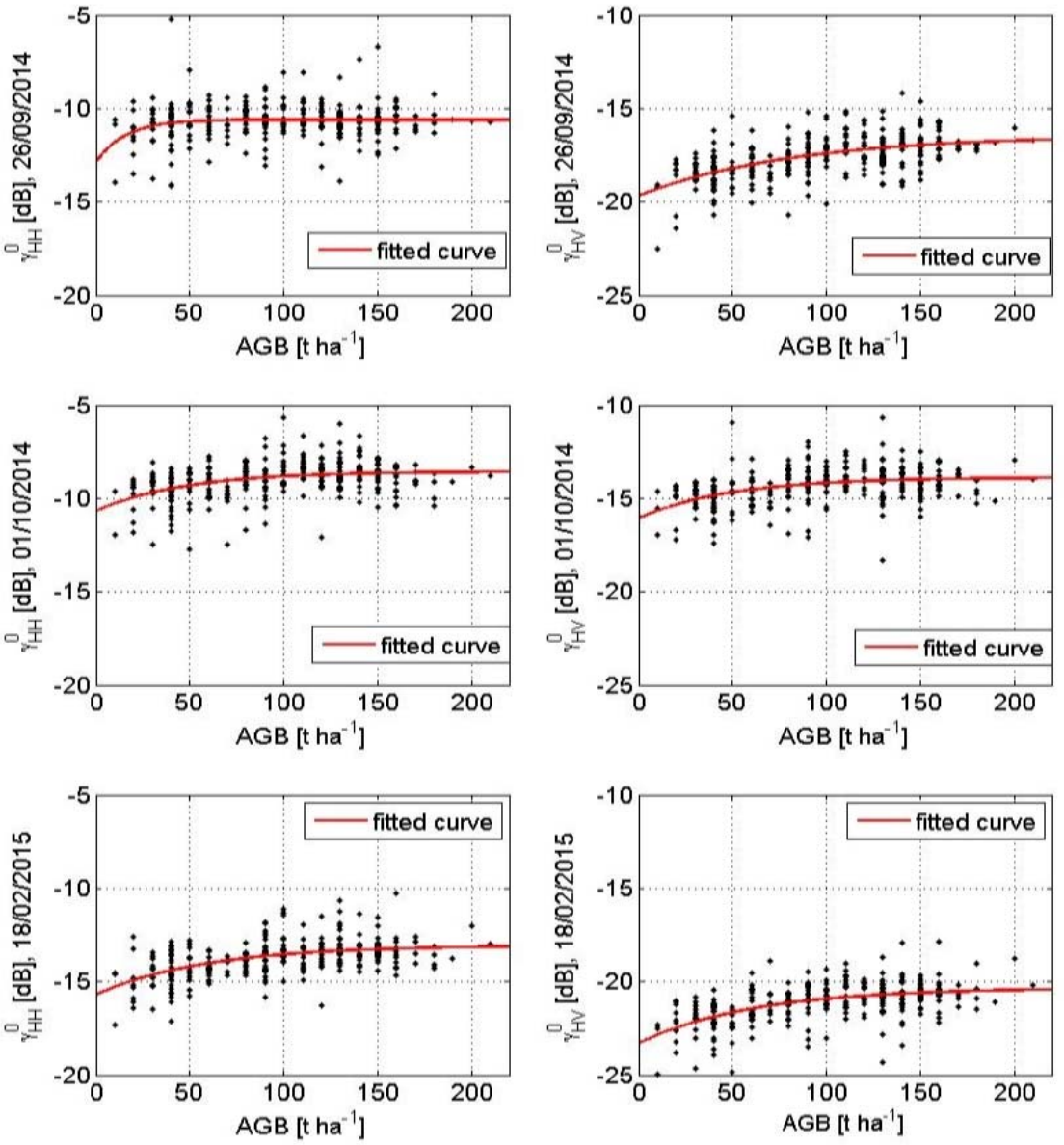
- ✓ C- and L-band, Single Look Complex (SLC)
- ✓ Data source: RADARSAT2 – SOAR2 © ESA, ALOS-2 data provided within Kyoto&Carbon Initiative © JAXA/METI

	RADARSAT-2	**PALSAR-2**
Acquisition date	25/06/2014 – 02/10/2014	26/09/2014 – 18/02/2015
Local acquisition time	~19:30	~01:00
Number of data layers	7	6
Polarization	Single and dual HH, HV	Dual HH, HV
Incidence angle	32 – 44°	31 – 36°
Multilooking factor	5 x 5 (Ultrafine); 2 x 5 (Fine)	2 x 4-5
Ground resolution	~ 10 m; ~ 15-20 m	~ 15 m

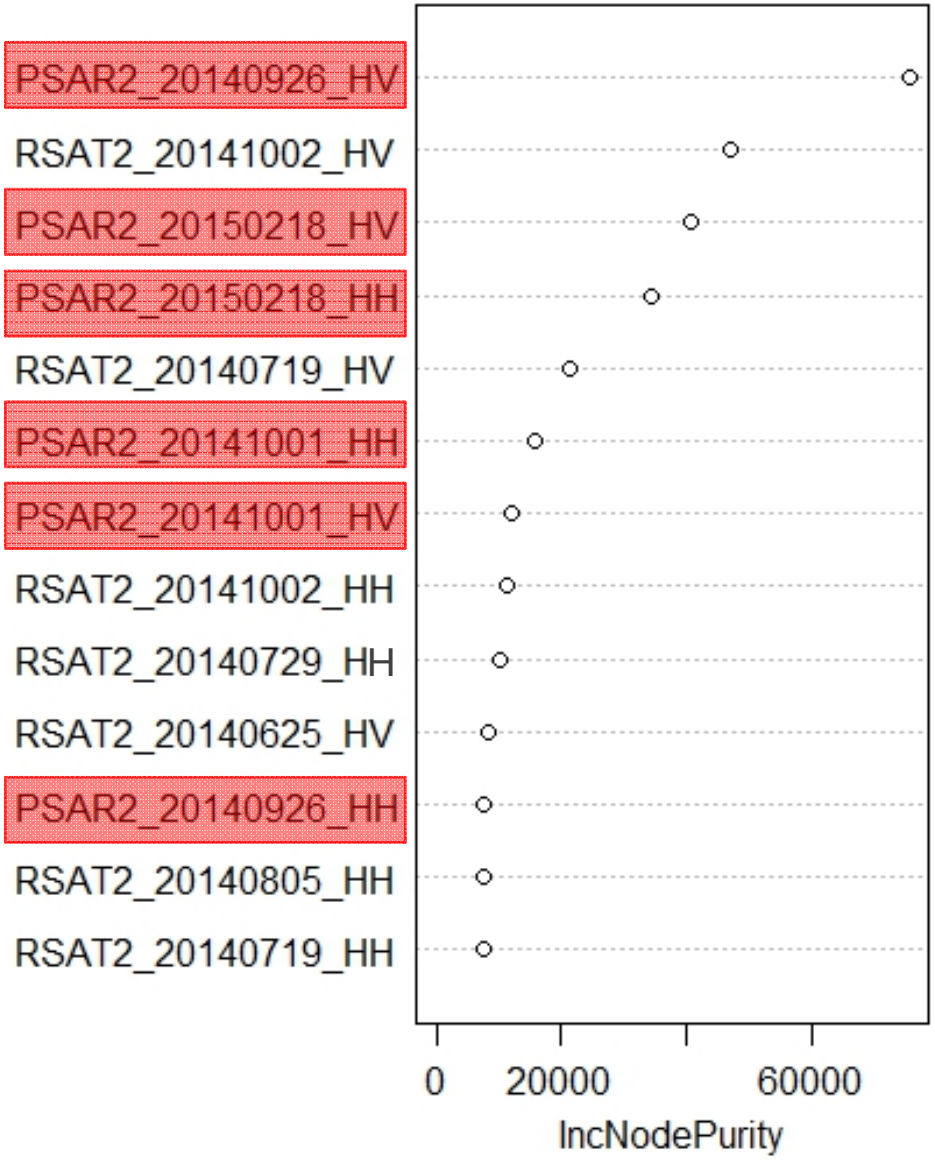
PALSAR-2:

Date/Polarisation/(min/max/mean)

26/09/2014 HH	-14	-5	-11
26/09/2014 HV	-22.5	-14	-18
01/10/2014 HH	-13	-4.5	-9
01/10/2014 HV	-18	-11	-14
18/02/2015 HH	**-17**	**-10**	**-14**
18/02/2015 HV	**-25**	**-18**	**-21**



Random forest predictor importance ranking

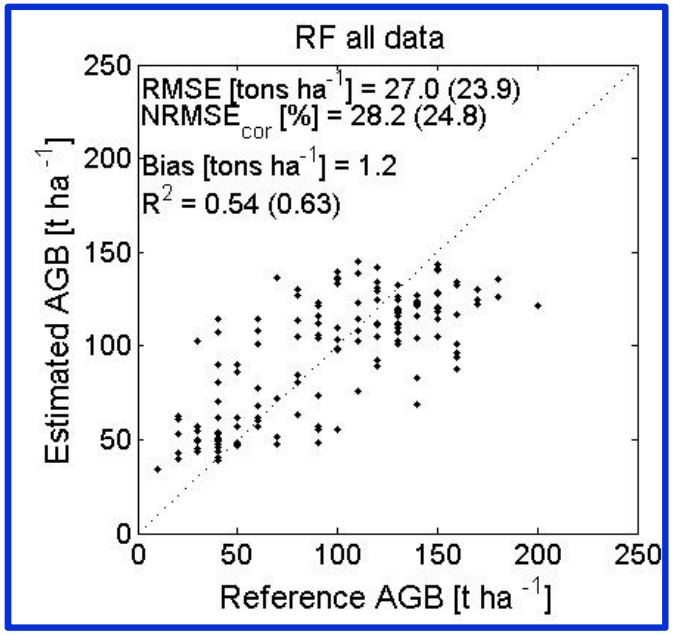


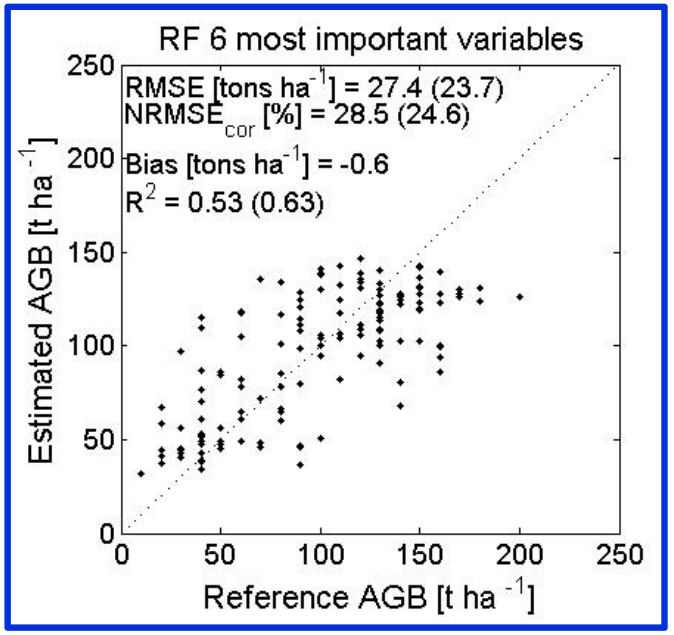
Model validation

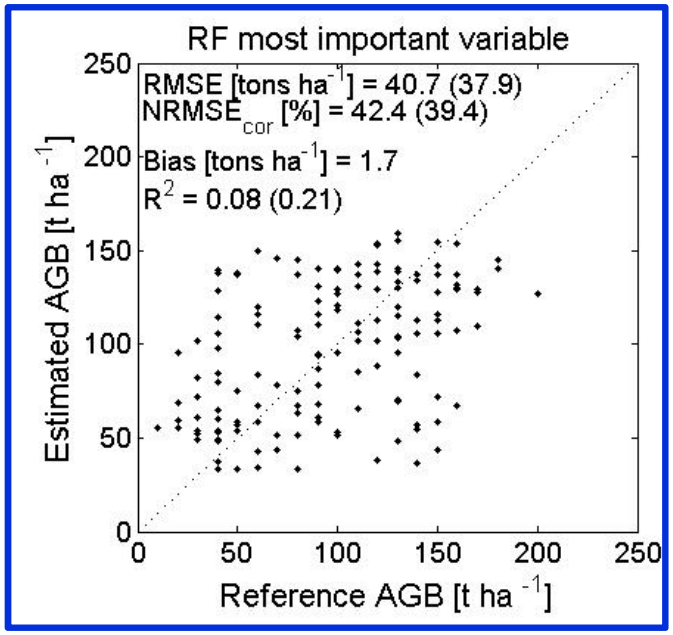
All data used:
RMSE [t ha^{-1}] = 27.0
NRMSE$_{cor}$: 28.2%

6 most important variables:
RMSE [t ha^{-1}] = 27.4
NRMSE$_{cor}$: 28.5%

PALSAR-2 data:
RMSE [t ha^{-1}] = 40.7
NRMSE$_{cor}$: 42.4%







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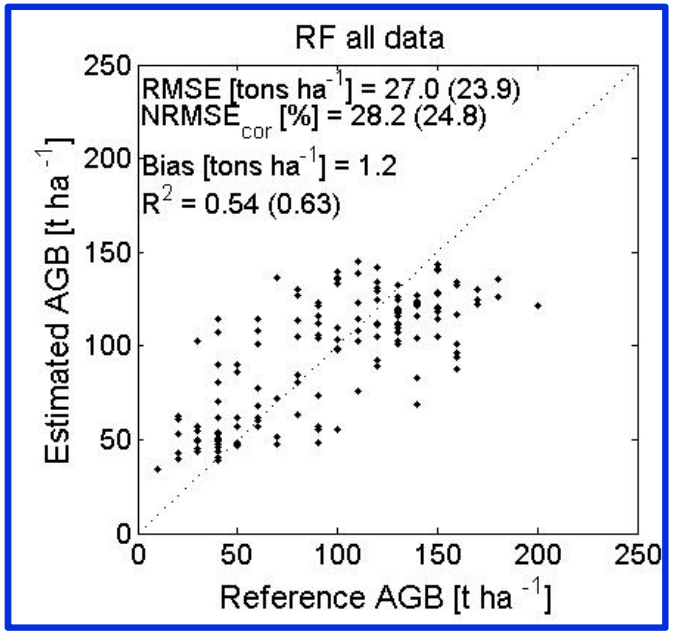
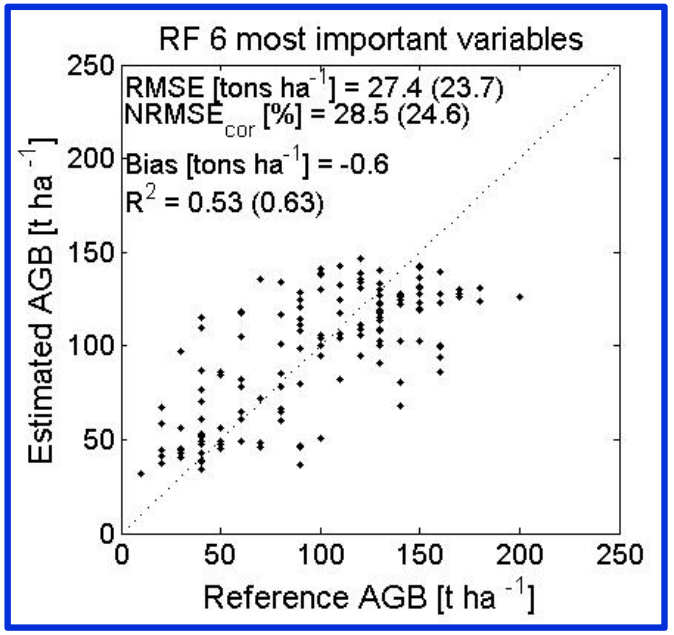
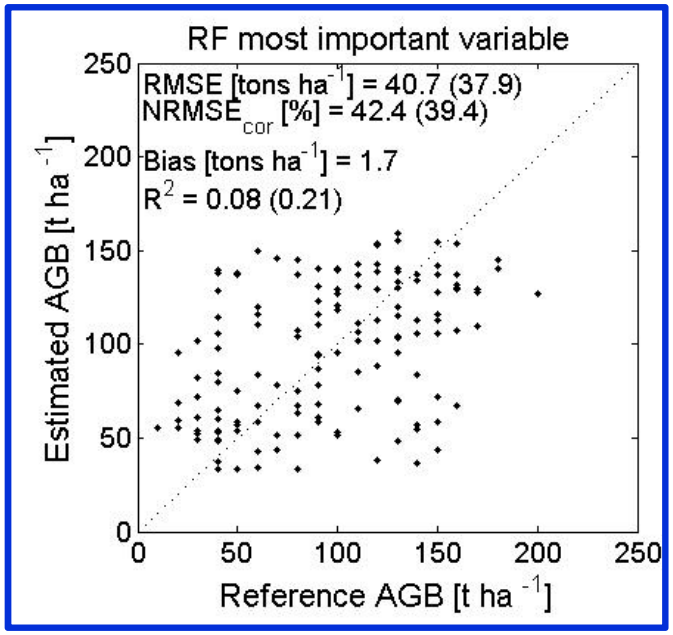
RMSE [t ha^{-1}] = 27.4
NRMSE$_{cor}$: 28.5%

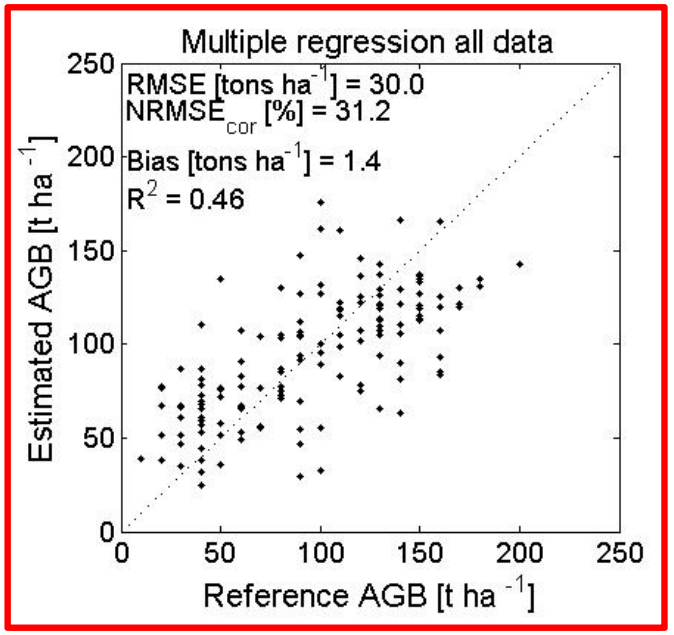
PALSAR-2 data:
RMSE [t ha^{-1}] = 40.7
NRMSE$_{cor}$: 42.4%

All data (Multiple regression):
RMSE [t ha^{-1}] = 30.0
NRMSE$_{cor}$: 31.2%









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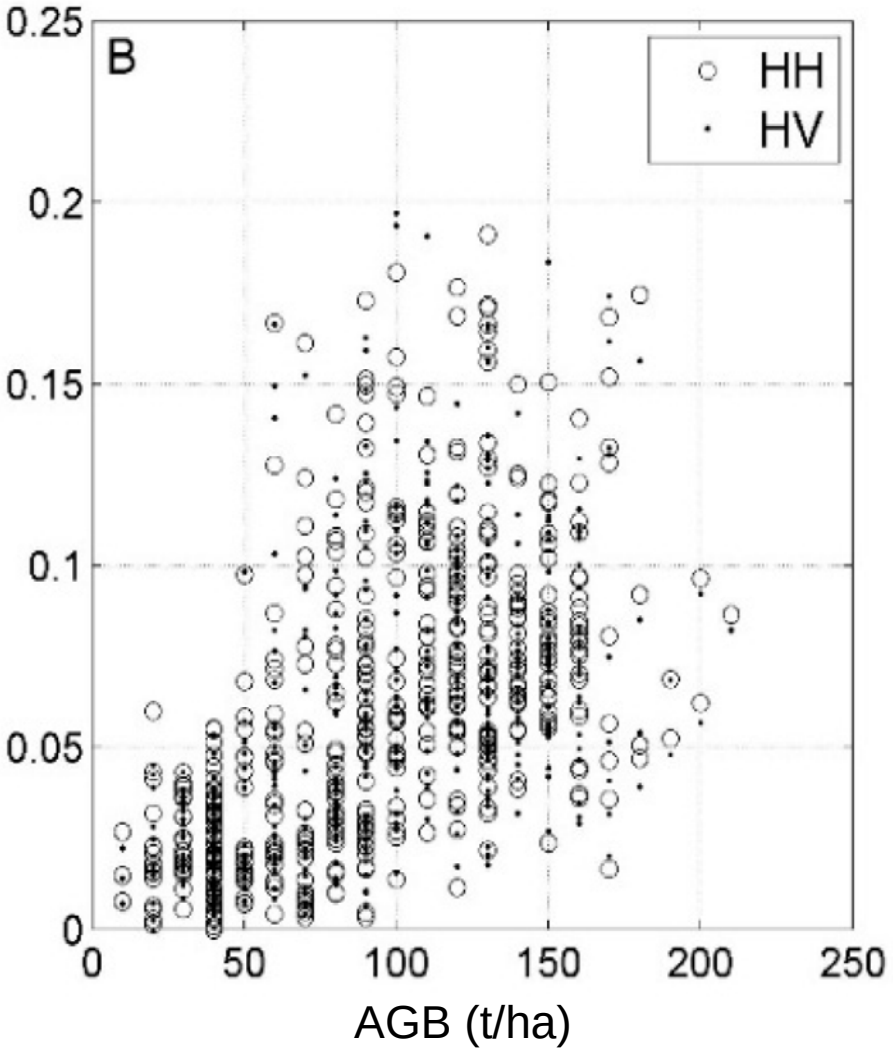
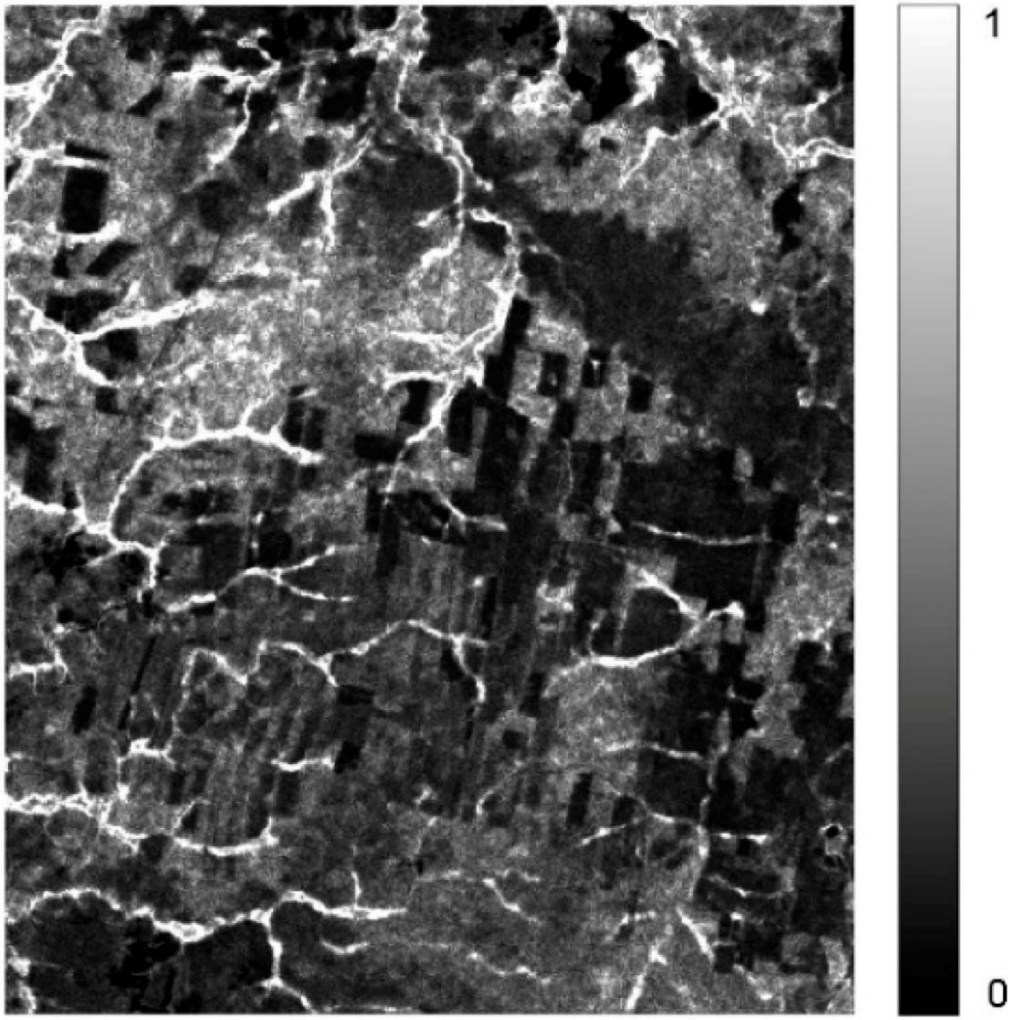
Backscatter-Coherence Ratios

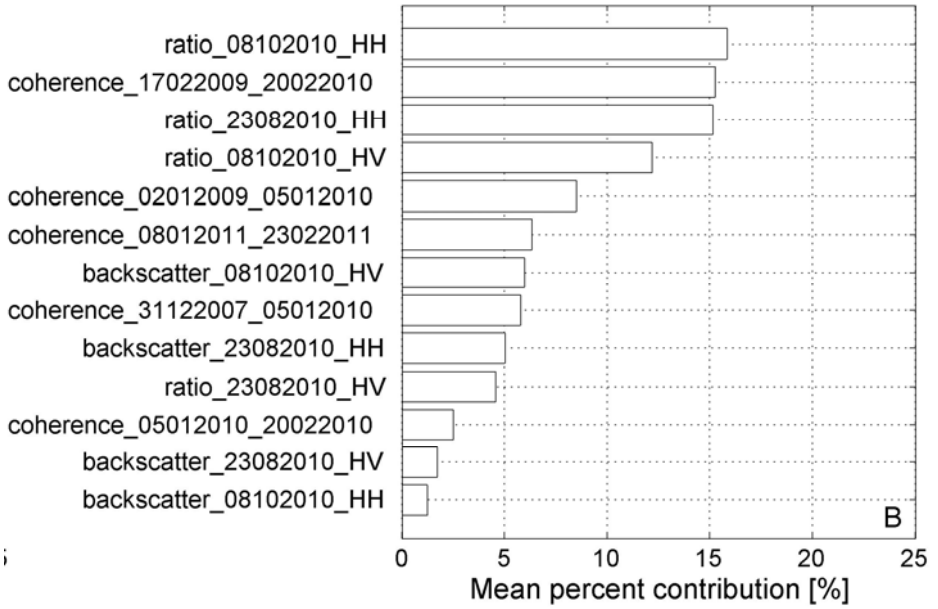
2010_08_23 / coh 2010_01_05 + 46 days



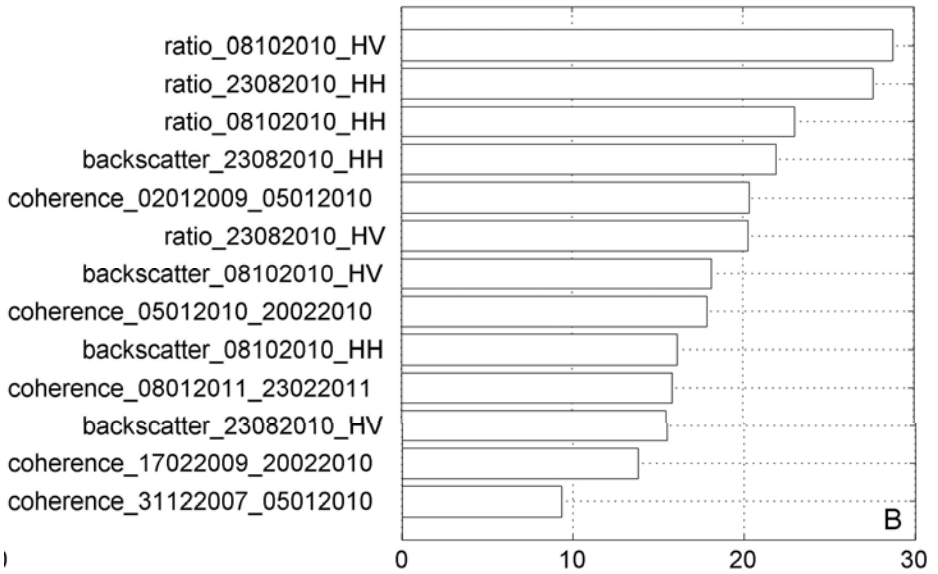


Variables contributions

MaxEnt



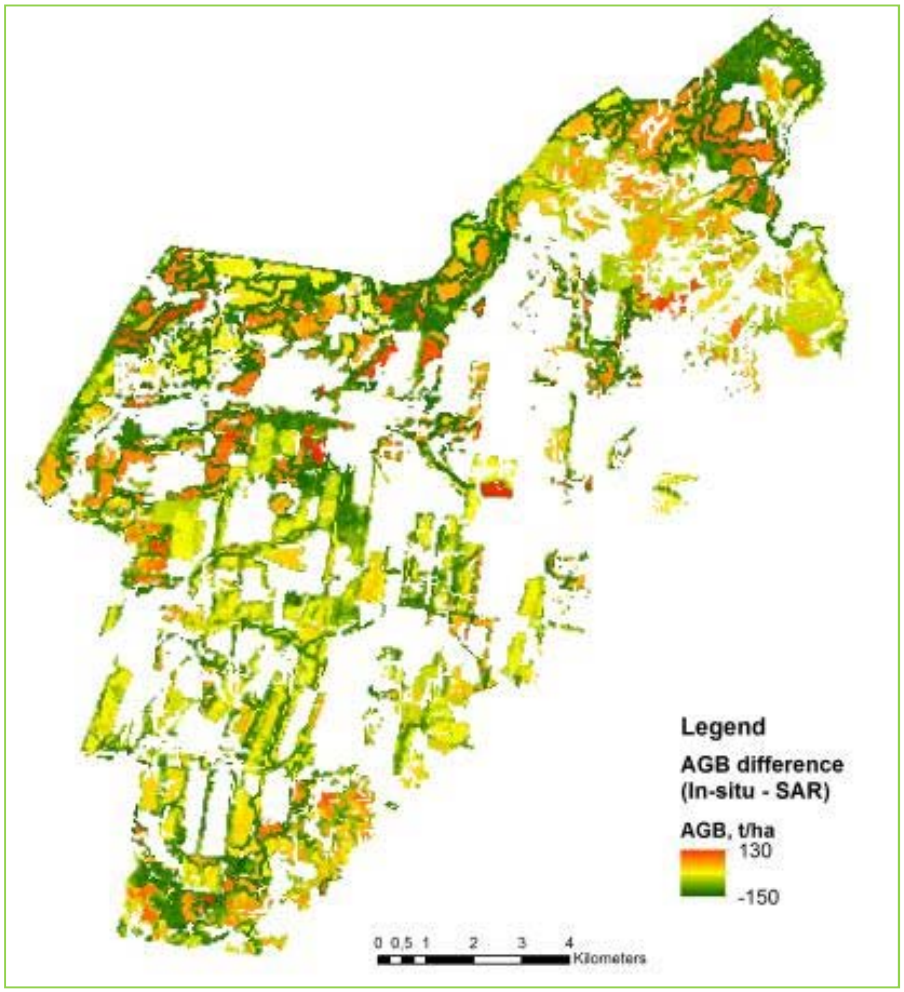
Random Forest



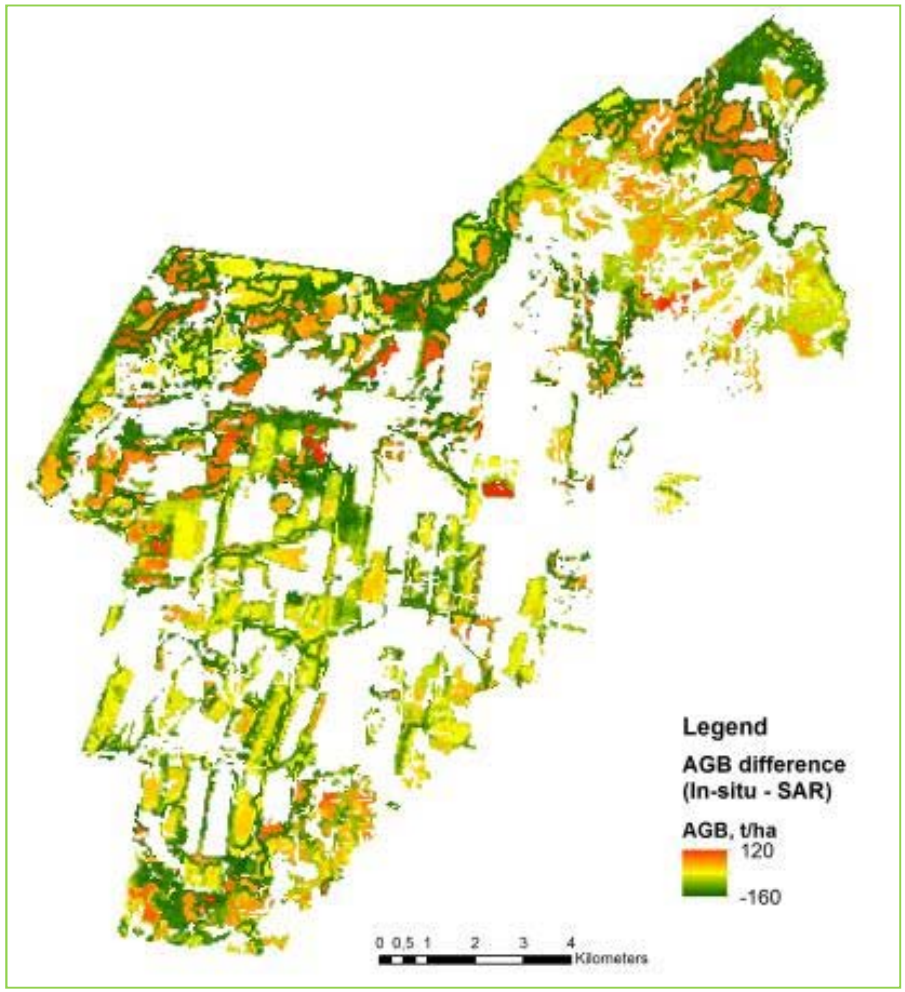
Validation of AGB retrieval results

Model	$RMSE_{cor}$ [t ha^{-1}]	$rRMSE_{cor}$ [%]	Bias [t ha^{-1}]
MaxEnt	Training/Validation		
	28.7/35.8	29.6/38.8	6.9/4.3
Random Forest			
	21.3/35.0	22.0/36.9	0.9/4.5

AGB difference maps between updated forest inventory (*in situ*) and SAR-derived AGB



MaxEnt



Random Forest

Topic 3: Improving aboveground biomass estimation in southern Mexico using multi-temporal ALOS PALSAR data and MODIS NDVI time series

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[2]Max-Planck-Institute for Biogeochemistry Jena

Friedrich-Schiller-Universität Jena
seit 1558

Max Planck Institute for Biogeochemistry

Science Team meeting #22 – Phase 4 Result Presentations
Kyoto Research Park, Kyoto, Japan

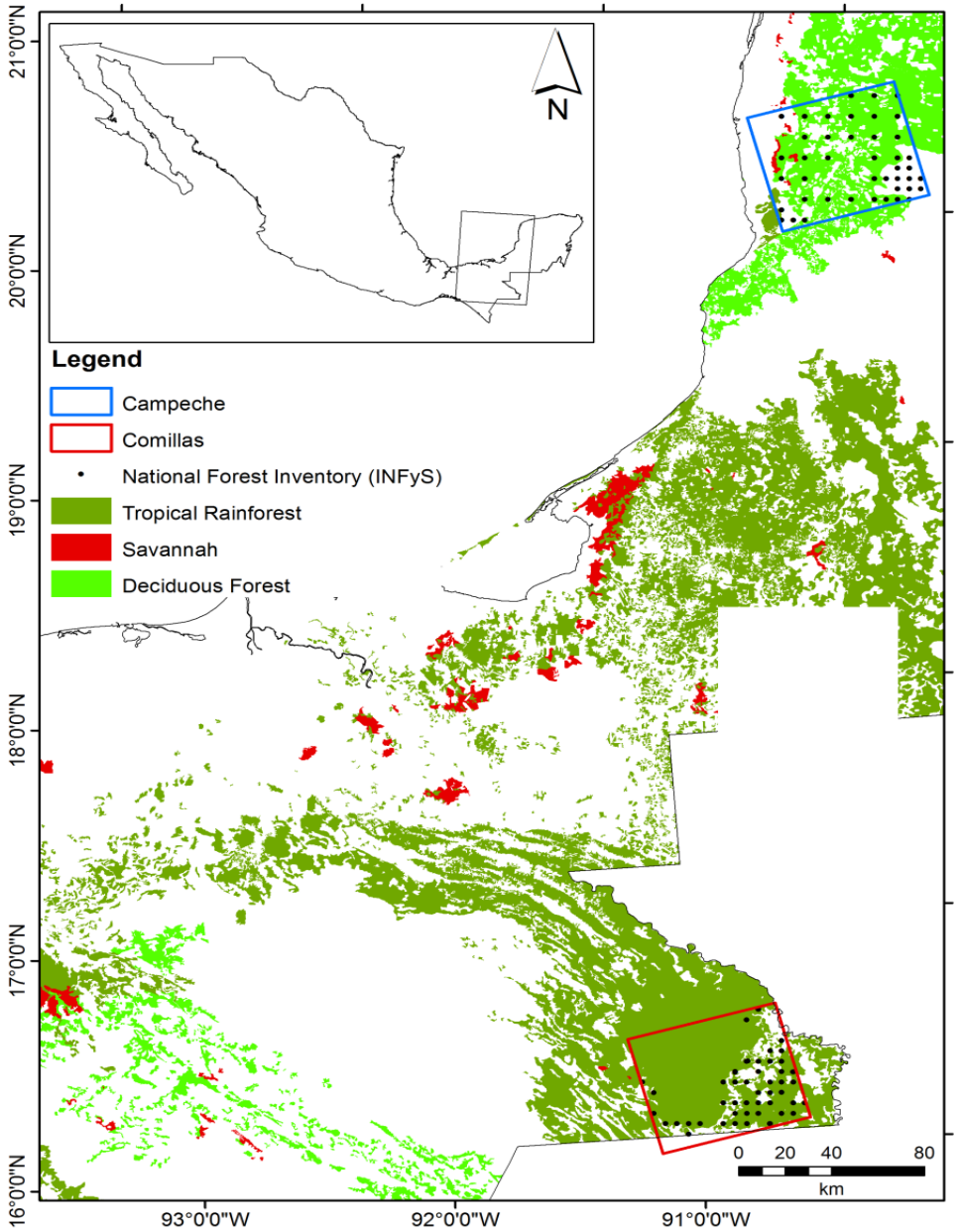


Fig.1: Study areas overlaid on INEGI land cover map

Testsite 1, tropical dry forest (TDF):
Comillas de Marques
(Elevation: 280.9 ± 195.9 m; slope: 5.5 ± 6.4 degree;
MAT: 24° C; MAP: 2500 mm)

Testsite 2, tropical humid forest (THF):
Campeche
(Elevation: 37.2 ± 36.8 m; slope: 1.5 ± 1.8 degree;
MAT: 26° C; MAP: 1000 mm)

Remote sensing data

1. Multi-temporal ALOS PALSAR L-band data in FBS (single polarization) and FBD (dual polarization) modes (acq. date between 2007-2010)

   Testsite 1 TDF:
   8 FBS and 5 FBD scenes (18 backscatter intensities, 7 interferometric coherences)

   Testsite 2 THF:
   12 FBS and 9 FBD scenes (30 backscatter intensities, 14 interferometric coherences)

2. ALOS PALSAR mosaics for 2007-2010

3. Landsat VCF Tree Cover for 2005

4. SRTM Digital Elevation Model (1 arcsec.)

In-situ data

National Forest and Soil Inventory of Mexico (span. acronym INFyS)
INFyS data for 2005, 2010

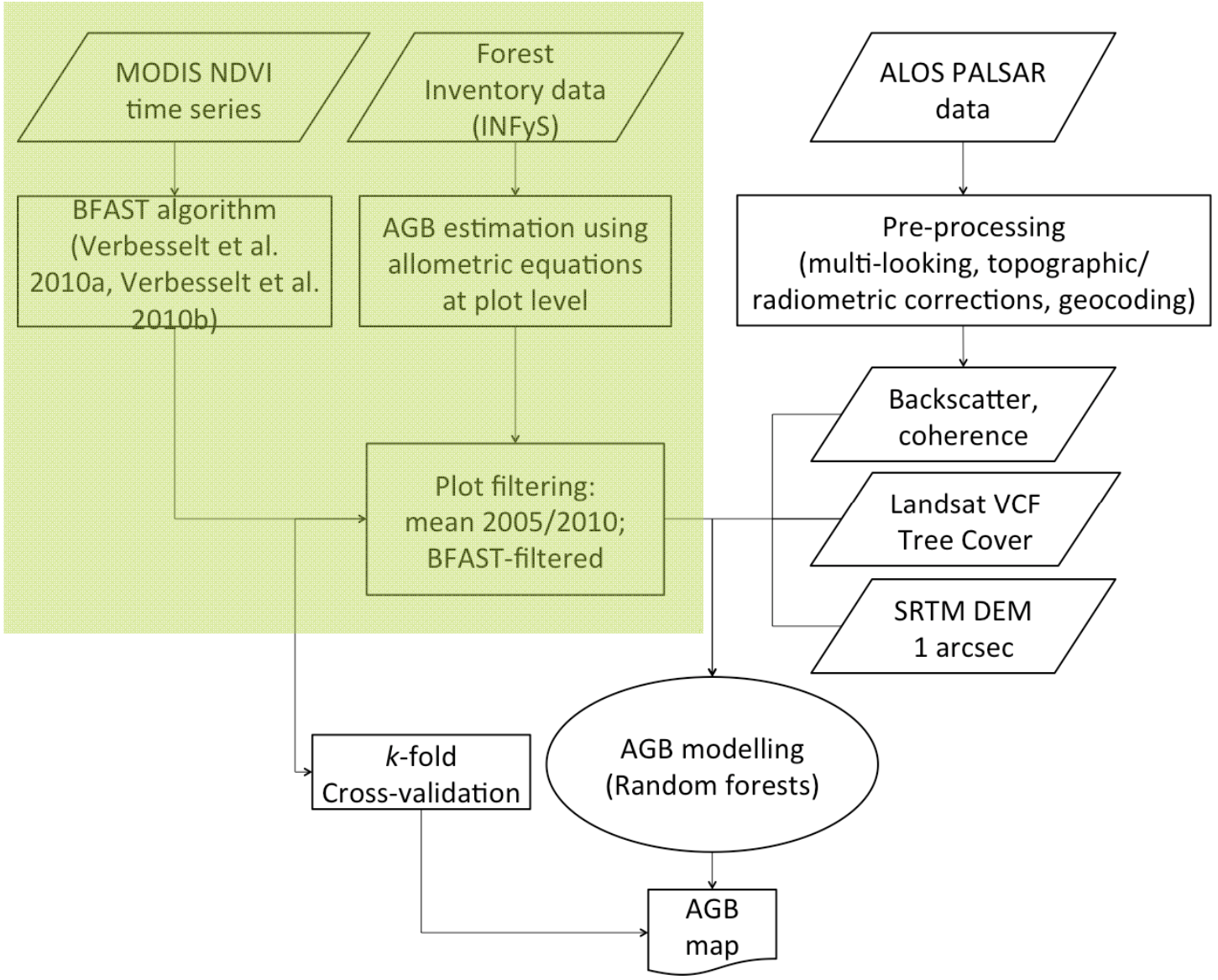
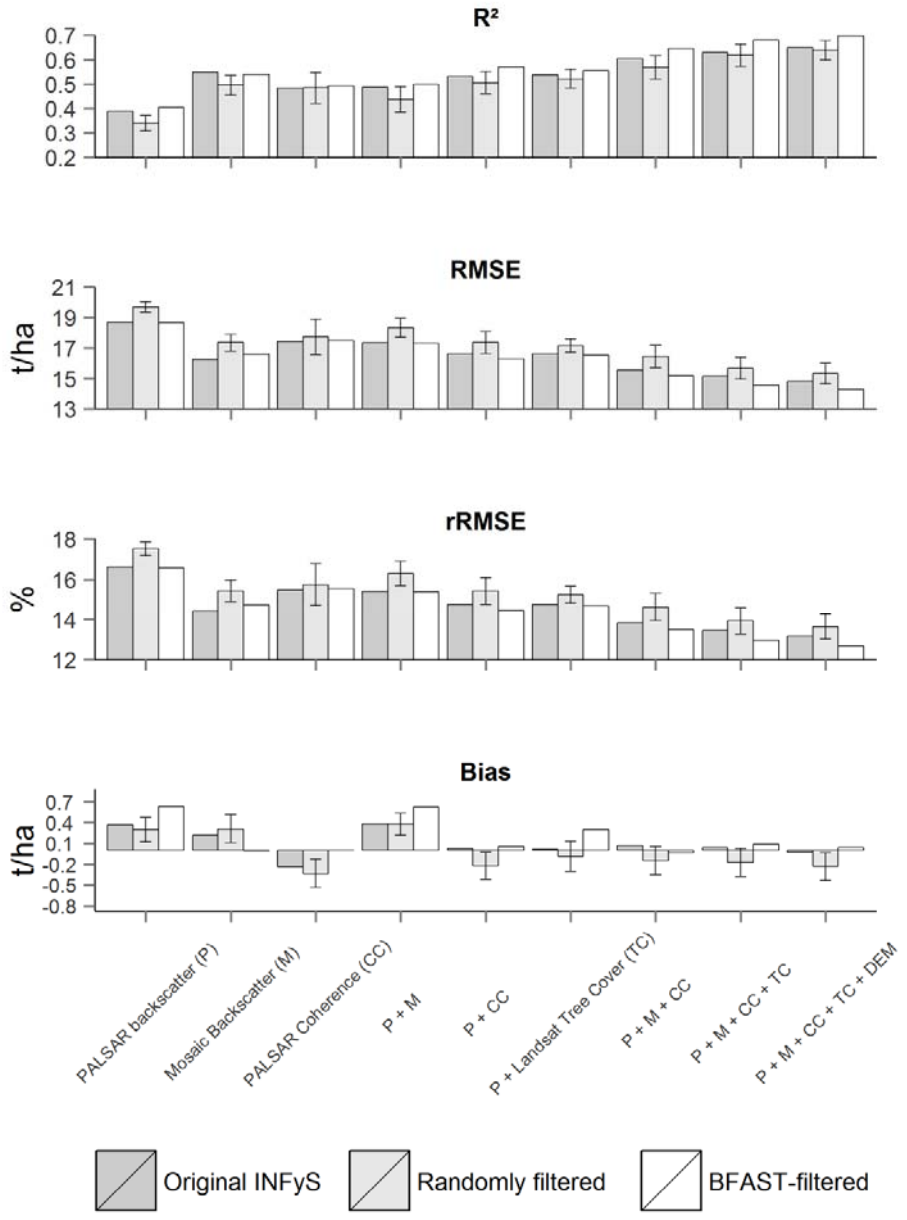
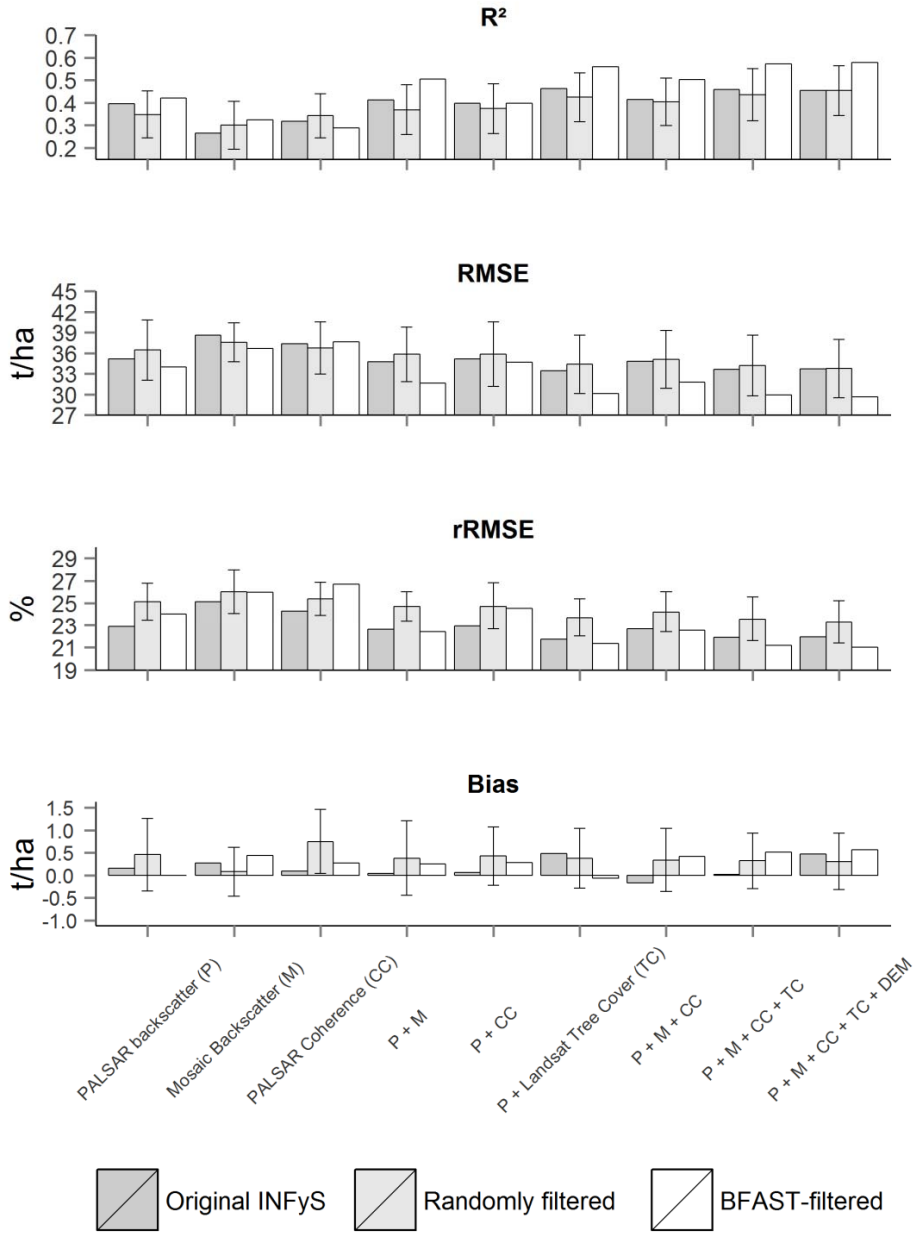


Fig. 2: Flow chart of the data processing and analysis steps

Testsite 1
(deciduous / tropical dry forest)



Testsite 2
(tropical humid forest)



Comparison to other studies

	Data	Method	Mapping unit	R^2	RMSE	Bias
Cartus et al. 2014	Multi-temp PALSAR, PALSAR texture, Landsat VCF, SRTM DEM	rForest	30 m (segmentation)	**0.52**	**29.37 t/ha**	**1.62 t/ha**
Rodriguez-Veiga et al. (in review)	MODIS products, PALSAR mosaics, SRTM DEM	MaxEnt	250 m	**-**	**36.1 t/ha**	**-3.6 t/ha**
TDF_mean	Multi-temp PALSAR, PALSAR mosaics, PALSAR coherence, Landsat VCF, SRTM DEM	rForest	50 m	0.65	14.82 t/ha	-0.03 t/ha
TDF_bfast				0.70	14.26 t/ha	0.04 t/ha
THF_mean				0.45	33.7 t/ha	0.47 t/ha
THF_bfast				0.62	29.6 t/ha	0.56 t/ha
Two sites_mean				**0.52**	**24.26 t/ha**	**0.25 t/ha**
Two sites_bfast				**0.66**	**21.93 t/ha**	**0.3 t/ha**

Results and significant findings

- Improved AGB estimations using BFAST-algortihm based on NDVI time series over two tropical sites in Mexico
- Improved AGB estimations using additional layers (PALSAR coherence, Landsat tree cover, SRTM DEM)

Deliverables – Papers and reports

1. Published

C. THIEL & C. SCHMULLIUS (2016): The potential of ALOS PALSAR backscatter and InSAR coherence for forest growing stock volume estimation in Central Siberia images.-In: Remote Sensing of Environment 173, pp. 258-273.

M. URBAZAEV, C. THIEL, R. MATHIEU, L. NAIDOO, S. R. LEVICK, I.P.J. SMIT, G.P. ASNER, C. SCHMULLIUS (2015): Assessment of the mapping of fractional woody cover in southern African savannas using multi-temporal and polarimetric ALOS PALSAR L-band images.-In: Remote Sensing of Environment 166, pp. 138-153.

Urbazaev, M., Thiel, C., Migliavacca, M. & C. Schmullius (2014): Toward aboveground biomass estimation with RADAR, LiDAR and optical remote sensing data in southern Mexico. AGU Fall Meeting 2014, 15-19 December 2014, San Francisco, USA.

Stelmaszczuk-Górska, M., Thiel, C., & Schmullius, C. (2015): Radar remote sensing for aboveground biomass estimation in boreal forests. In H. Balzter (Ed.), Earth Observation for Land and Emergency Monitoring. Innovative concepts for environmental monitoring from space. Wiley, in press.

Stelmaszczuk-Górska, M., Rodriguez-Veiga, P., Ackermann, N., Thiel, C., Balzter, H., & Schmullius, C. (2015): Non-Parametric Retrieval of Aboveground Biomass in Siberian Boreal Forests with ALOS PALSAR Interferometric Coherence and Backscatter Intensity. Journal of Imaging, 2(1), 1. http://doi.org/10.3390/jimaging2010001

Stelmaszczuk-Górska, M., Thiel, C., & Schmullius, C. (2015): Retrieval of aboveground biomass using multi-frequency SAR. Abstract for ESA Living Planet Symposium, Prague, Czech Republic. 9 -12 May 2016.

2. Submitted/in preparation

Urbazaev, M., Thiel, C., Migliavacca, M., Reichstein, M., Rodriguez-Veiga, P. & C. Schmullius (**submitted**): Improving aboveground biomass estimation in southern Mexico using L-band SAR data and MODIS NDVI time series. Remote Sensing Letters

ALOS

K&C Initiative

An international science collaboration led by JAXA

Regional Sites

- Poland: temperate zone
- Sweden: boreal zone
- Indonesia / Borneo: tropical zone
- Mexico: tropical-woodland
- South Africa: savanna mosaic

+ Global Mapping