K&C Phase 4 – Status report

Forest Aboveground Biomass Mapping in Mexico using SAR, optical and airborne LiDAR data

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[3]NASA Goddard SFC
[4]University of Maryland

Science Team meeting #23
Tokyo, Japan, January 16-20, 2017

Study area

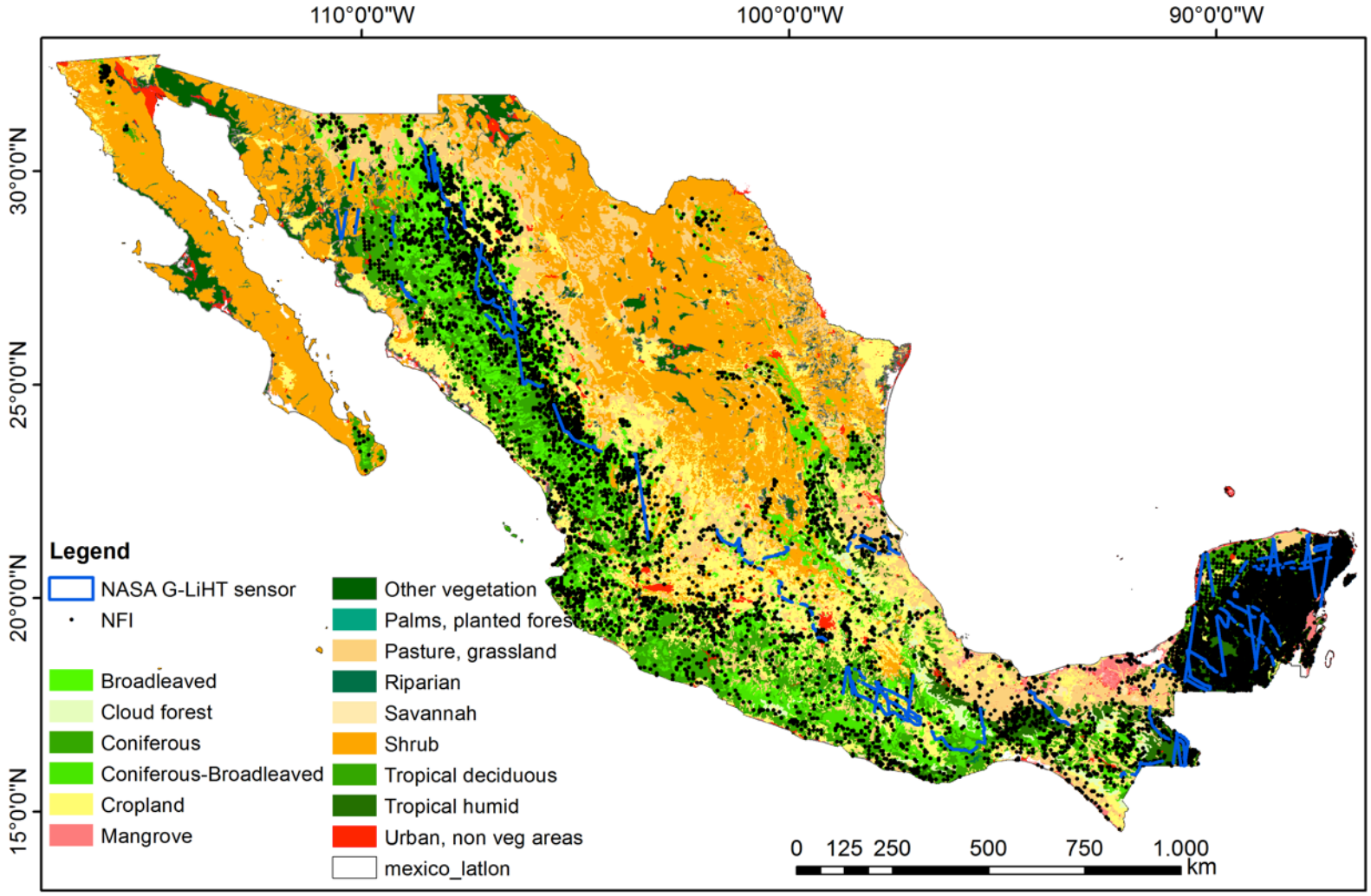


Fig. 1: CCI Land cover

Study area

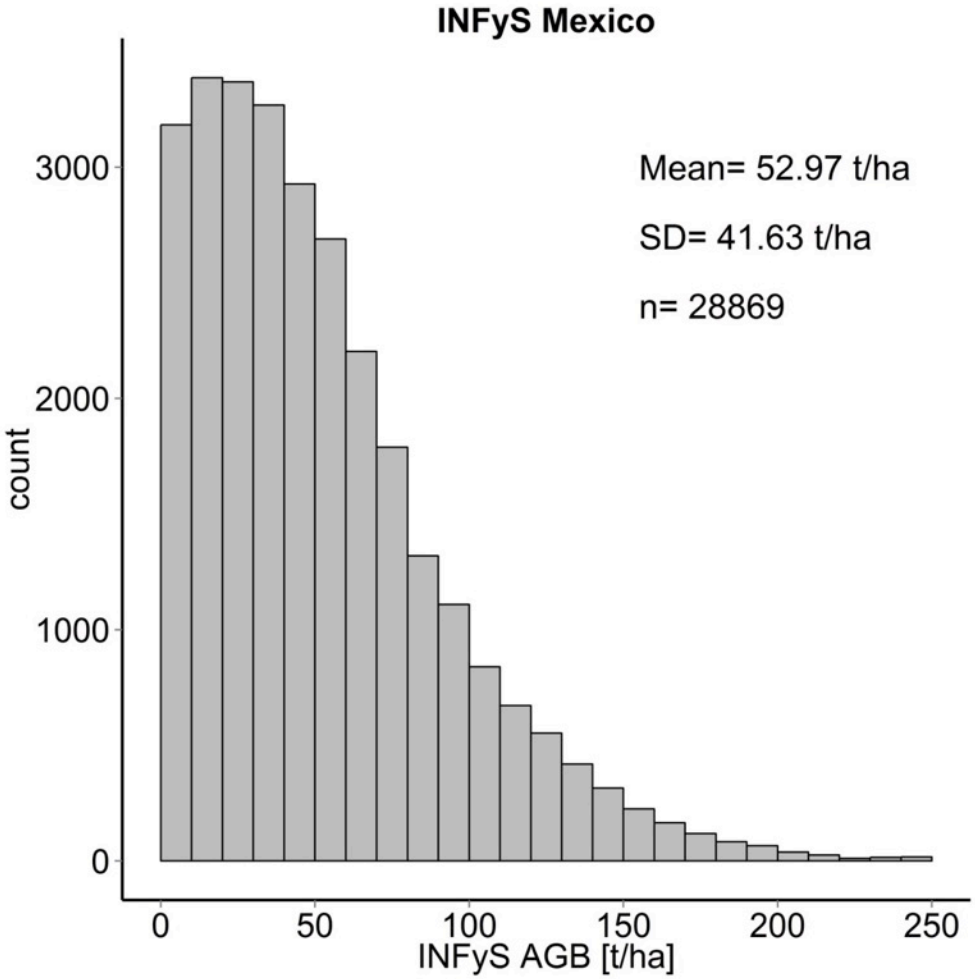


Fig. 2: AGB distribution in Mexico (National Forest Inventory (INFyS) data 2004-2012)

Data / Methods

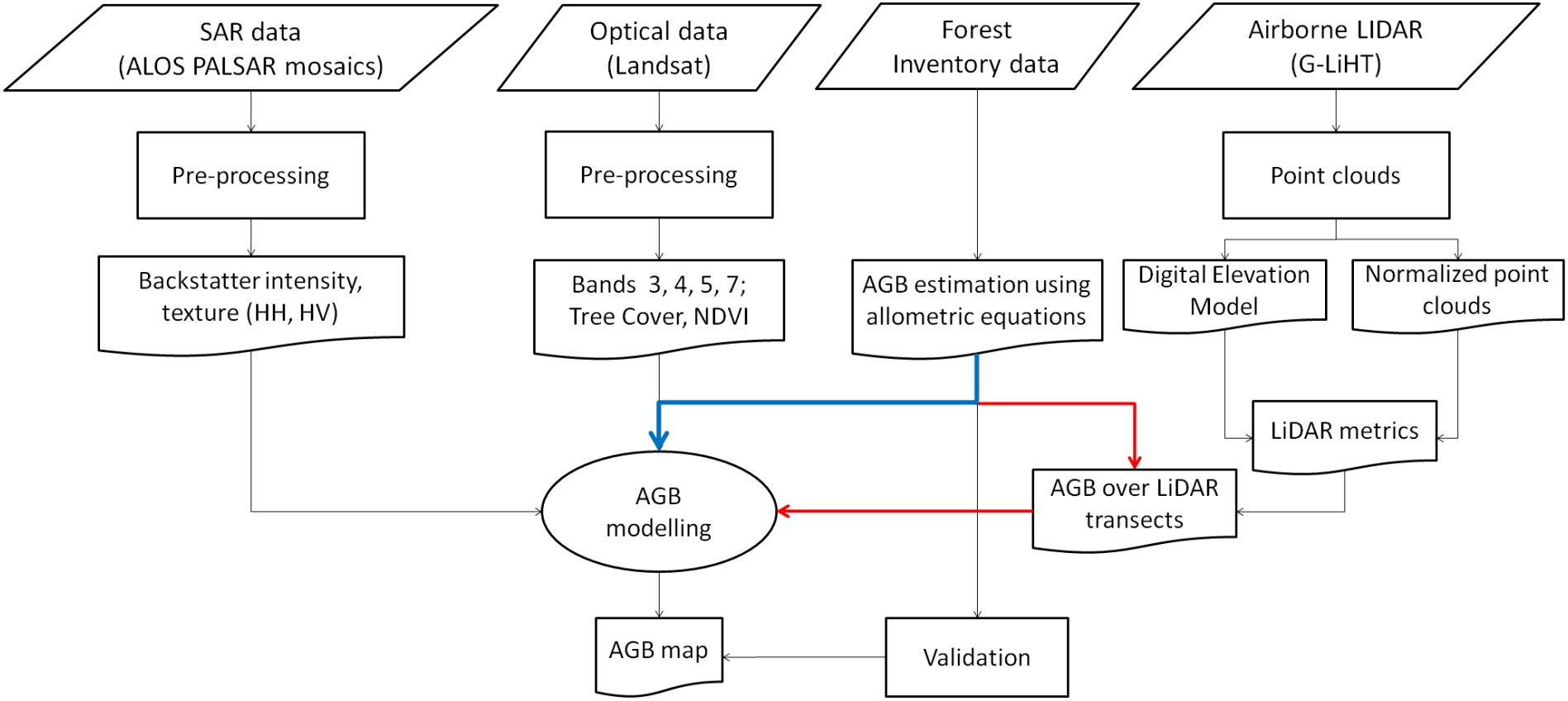
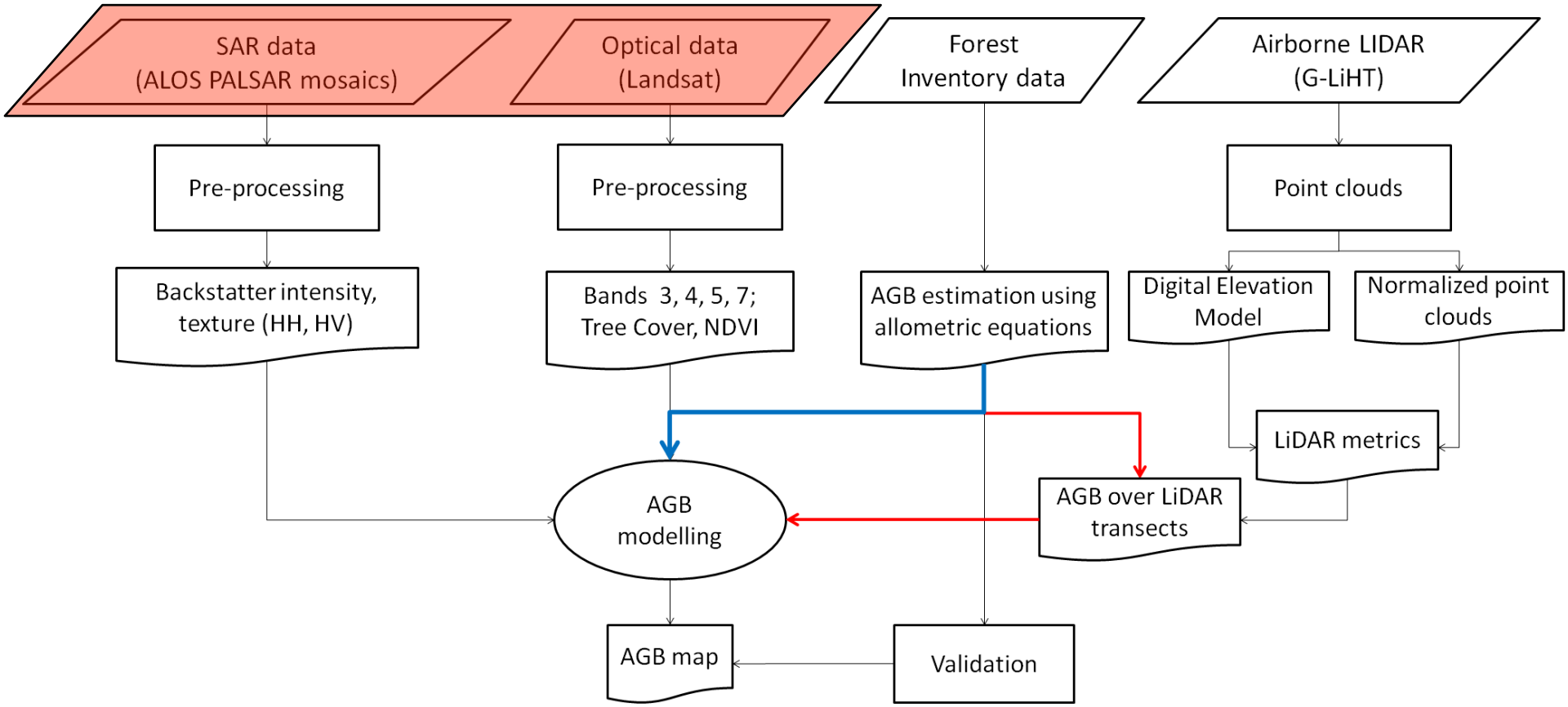


Fig. 3: Flowchart

Data / Methods



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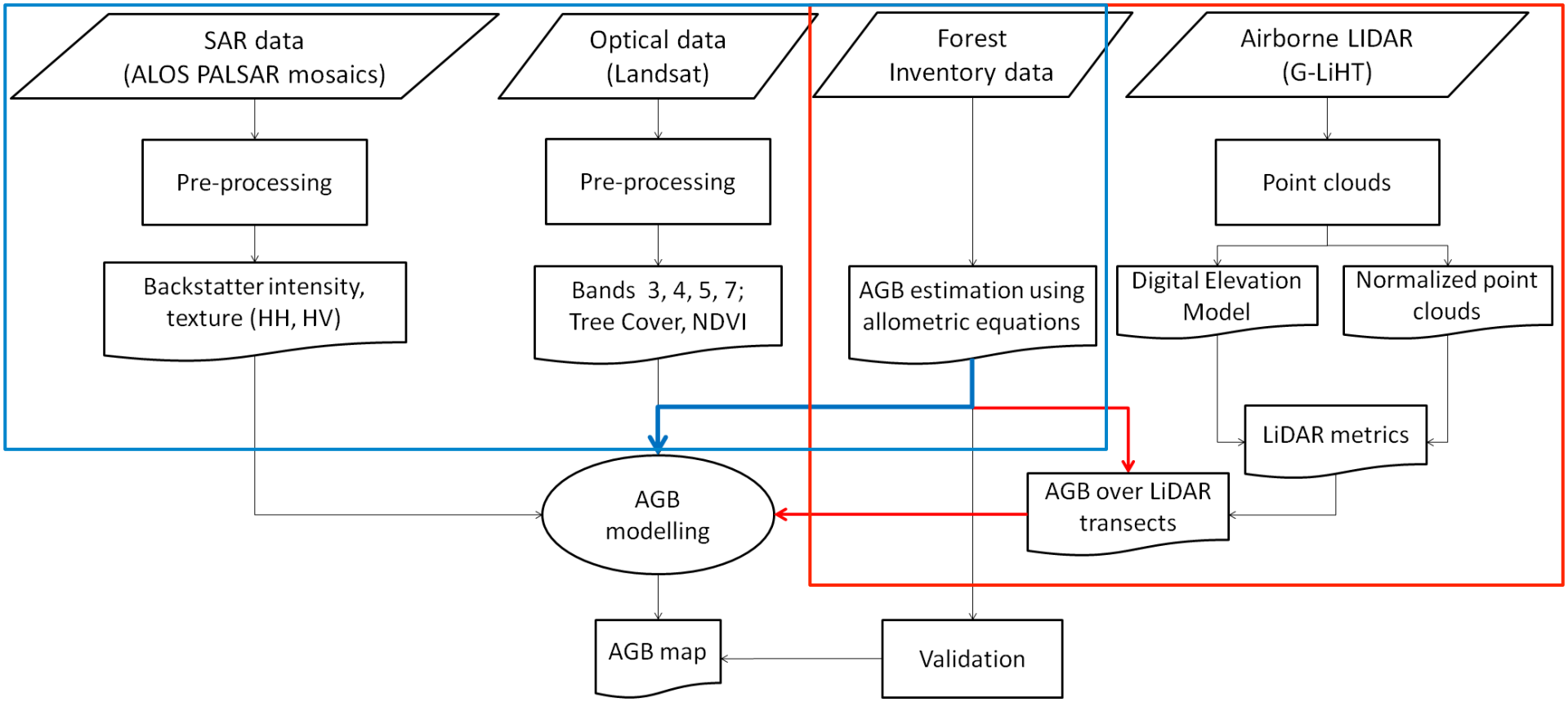
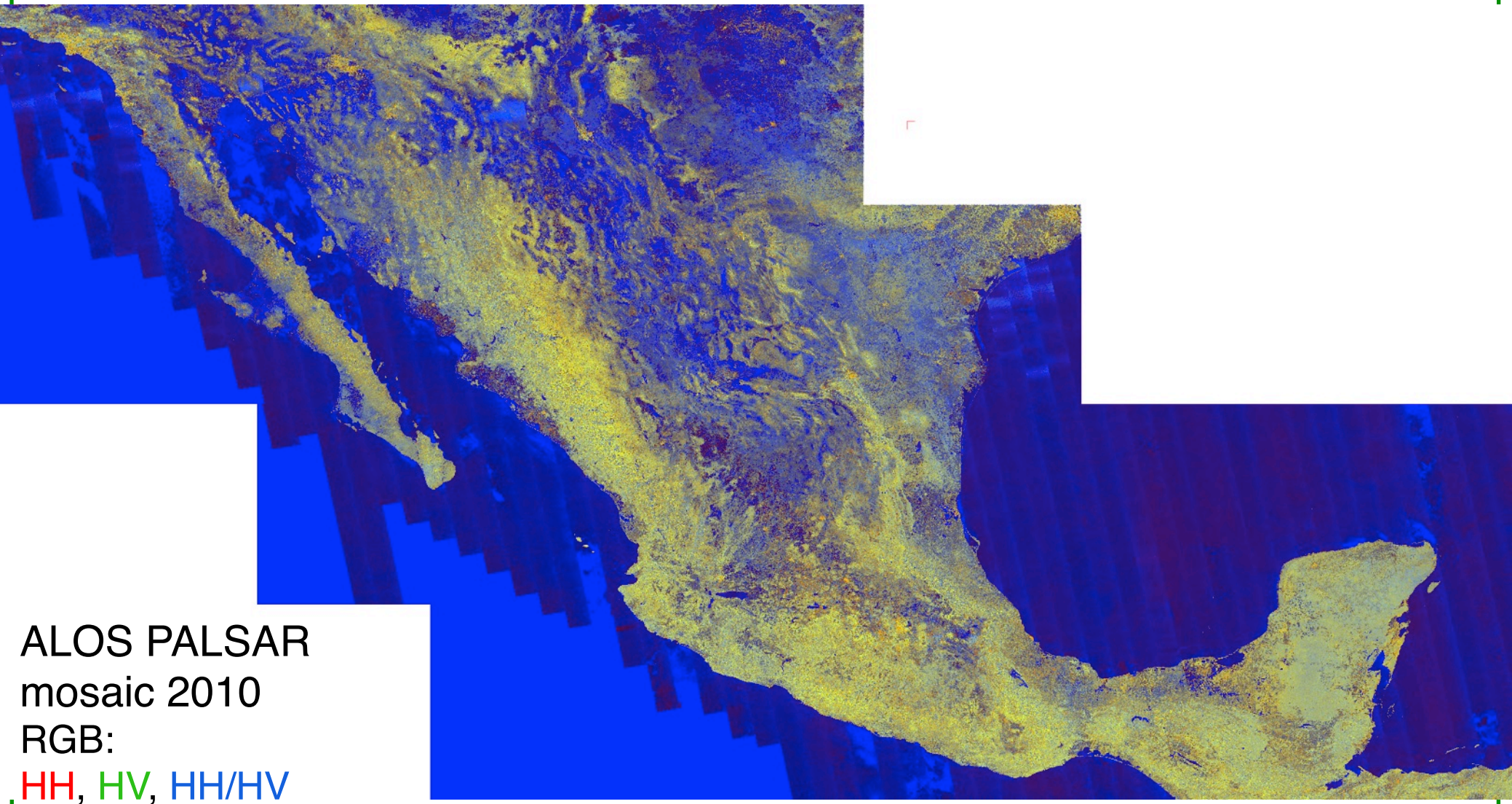


Fig. 3: Flowchart

ALOS

K&C Initiative

An international science collaboration led by JAXA

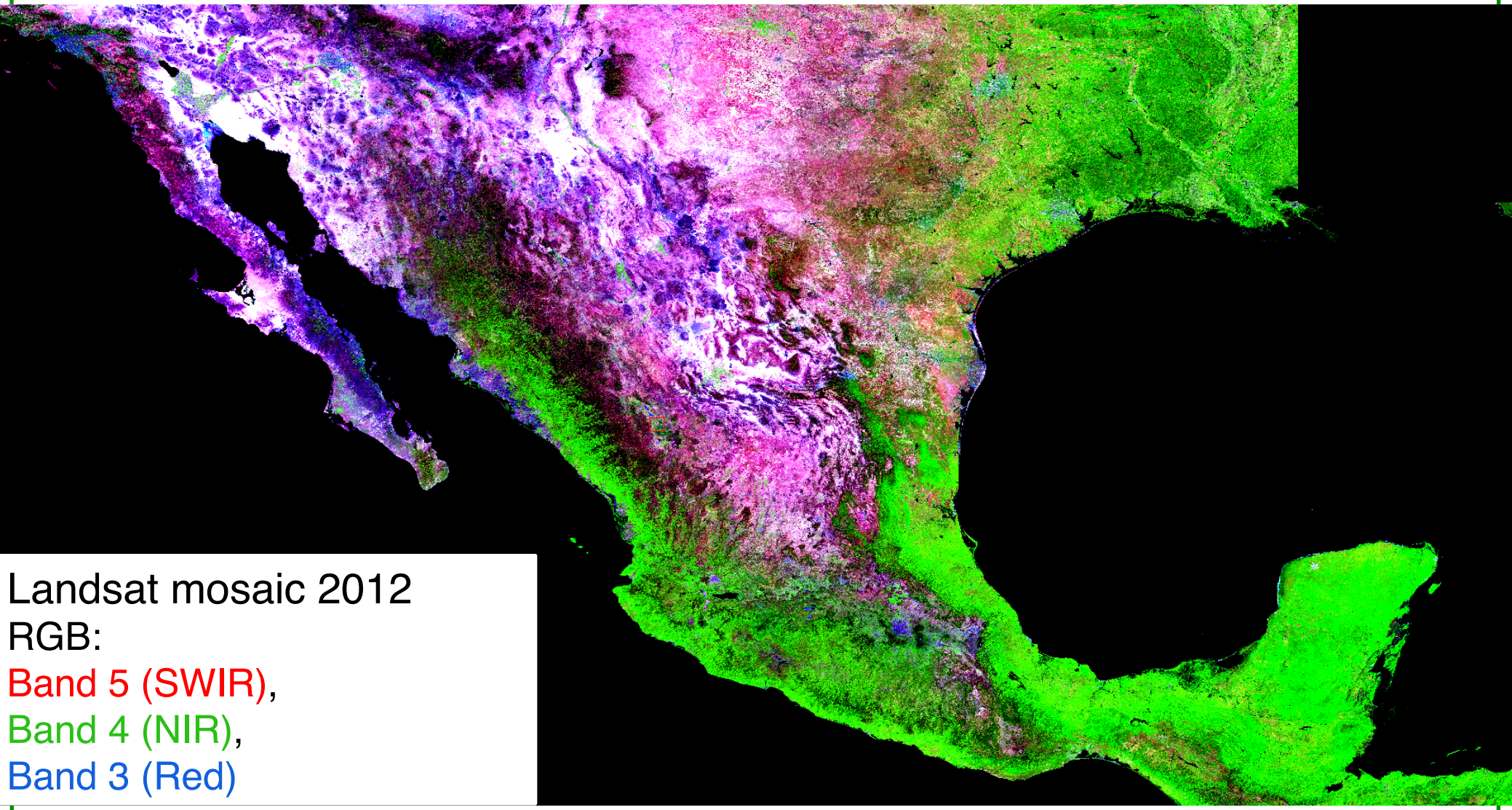


ALOS PALSAR
mosaic 2010
RGB:
HH, HV, HH/HV

ALOS

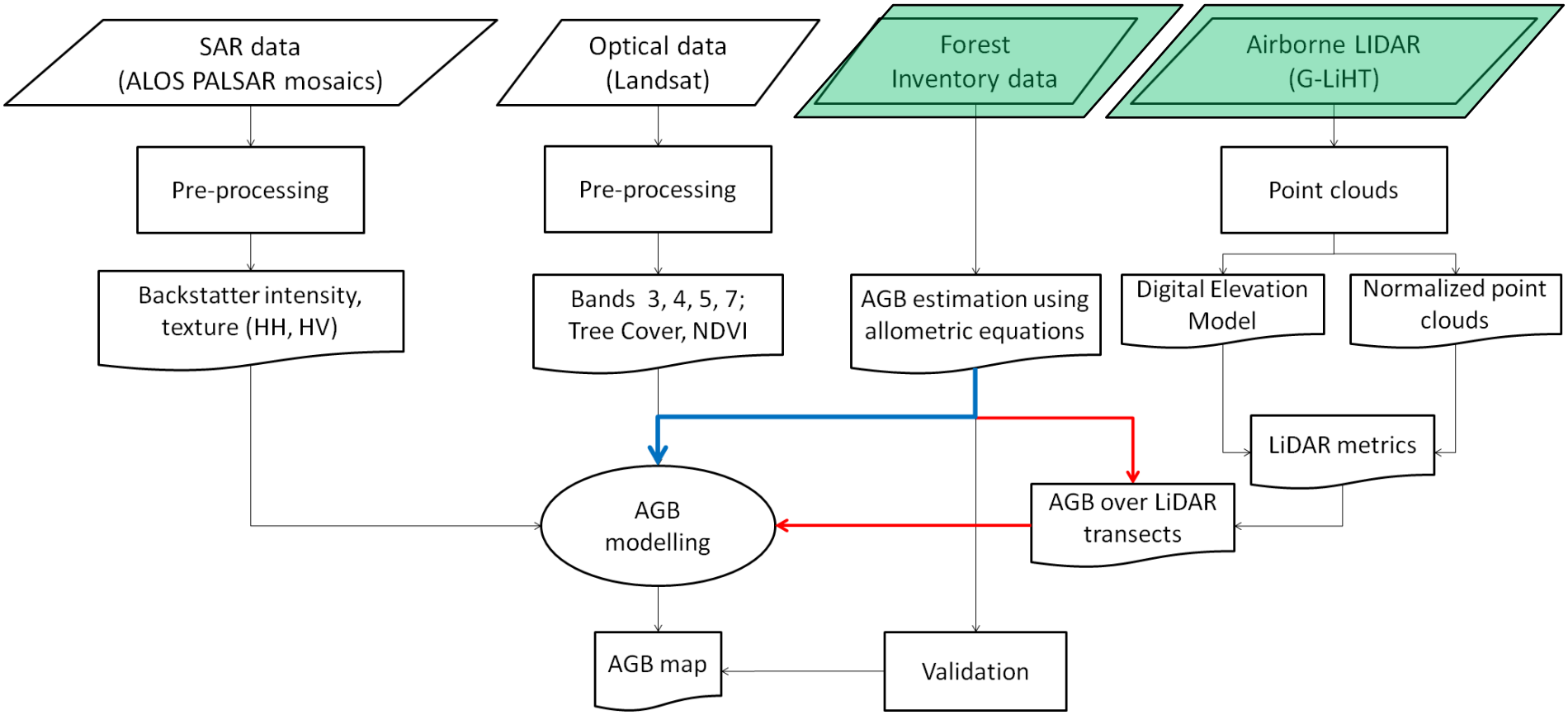
K&C Initiative

An international science collaboration led by JAXA



Landsat mosaic 2012
RGB:
Band 5 (SWIR),
Band 4 (NIR),
Band 3 (Red)

Data / Methods



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Study area

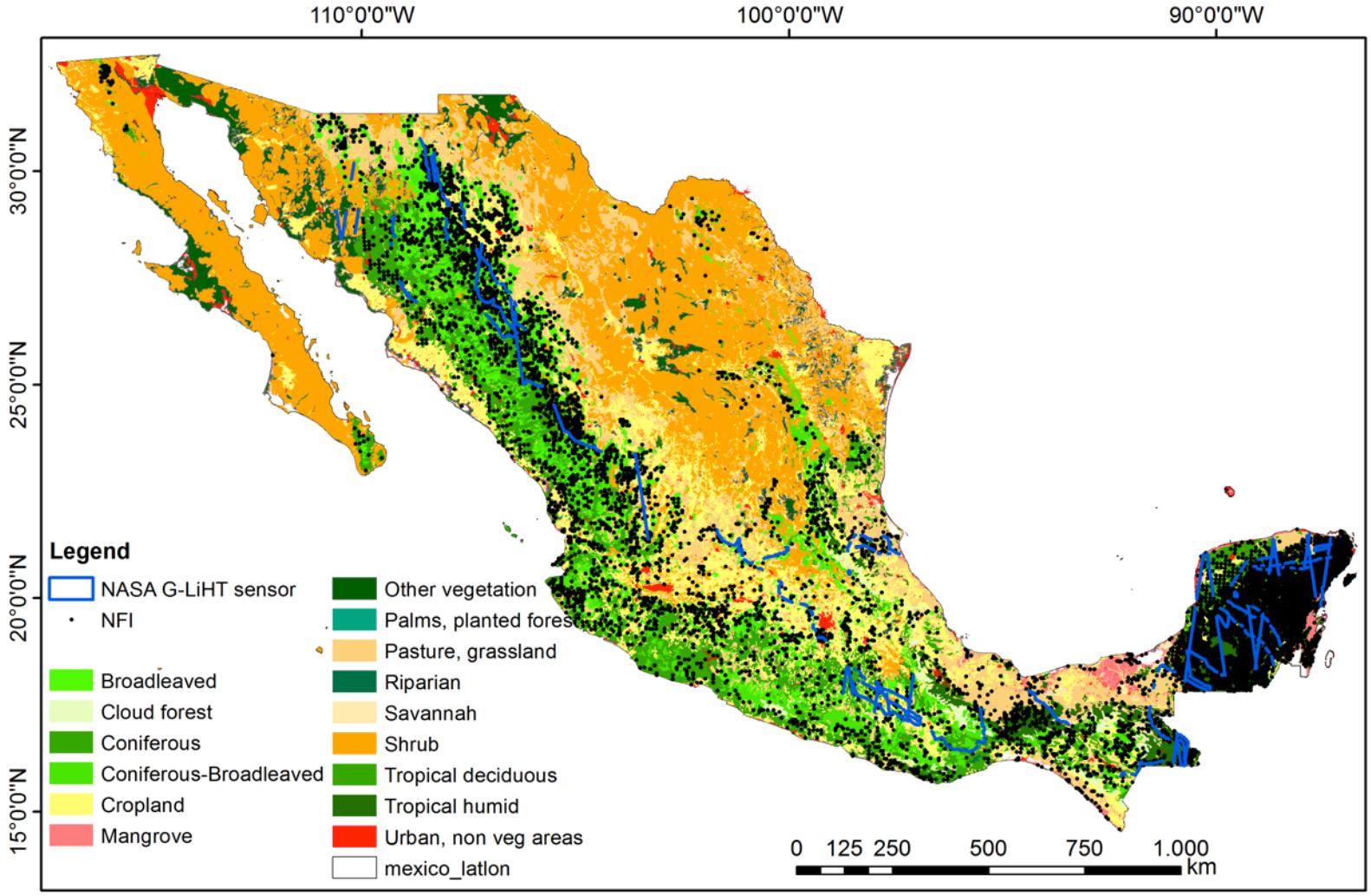
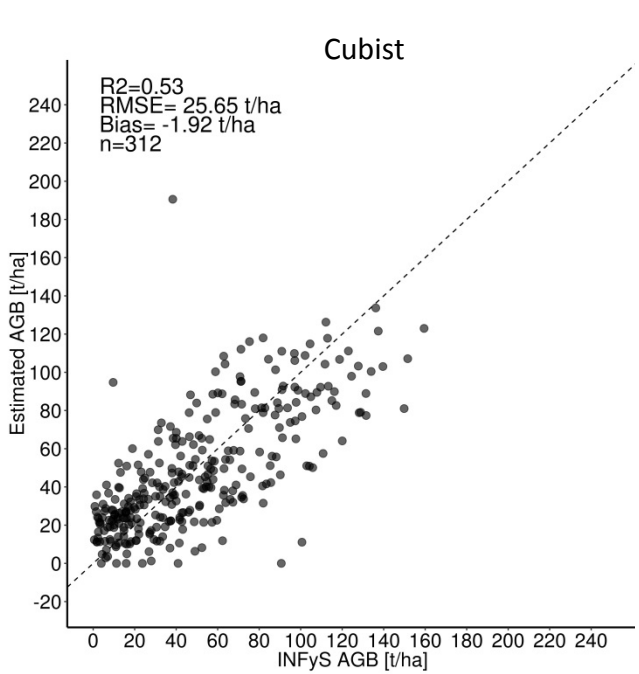
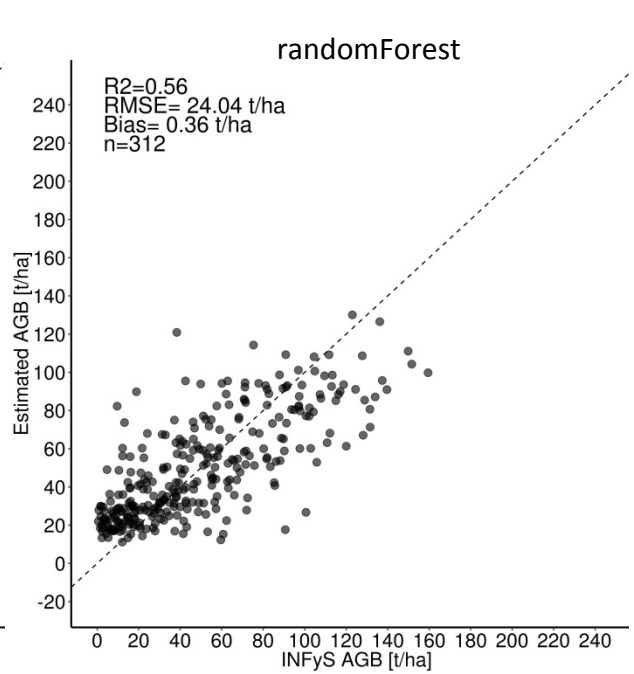


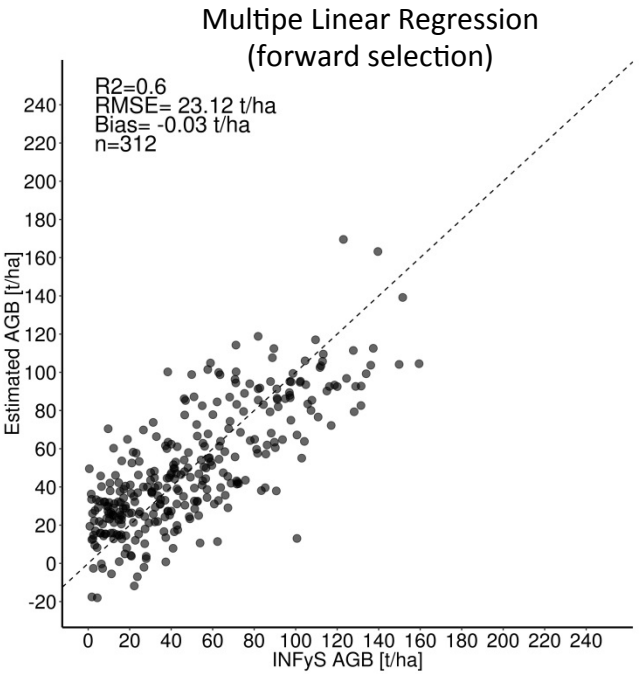
Fig. 1: CCI Land cover

Results A: AGB based on LiDAR metrics

AGB modeling for **LiDAR transects** using ***different regression models (k-fold CV)***
response variable: field-estimated AGB
spatial predictors: LiDAR metrics

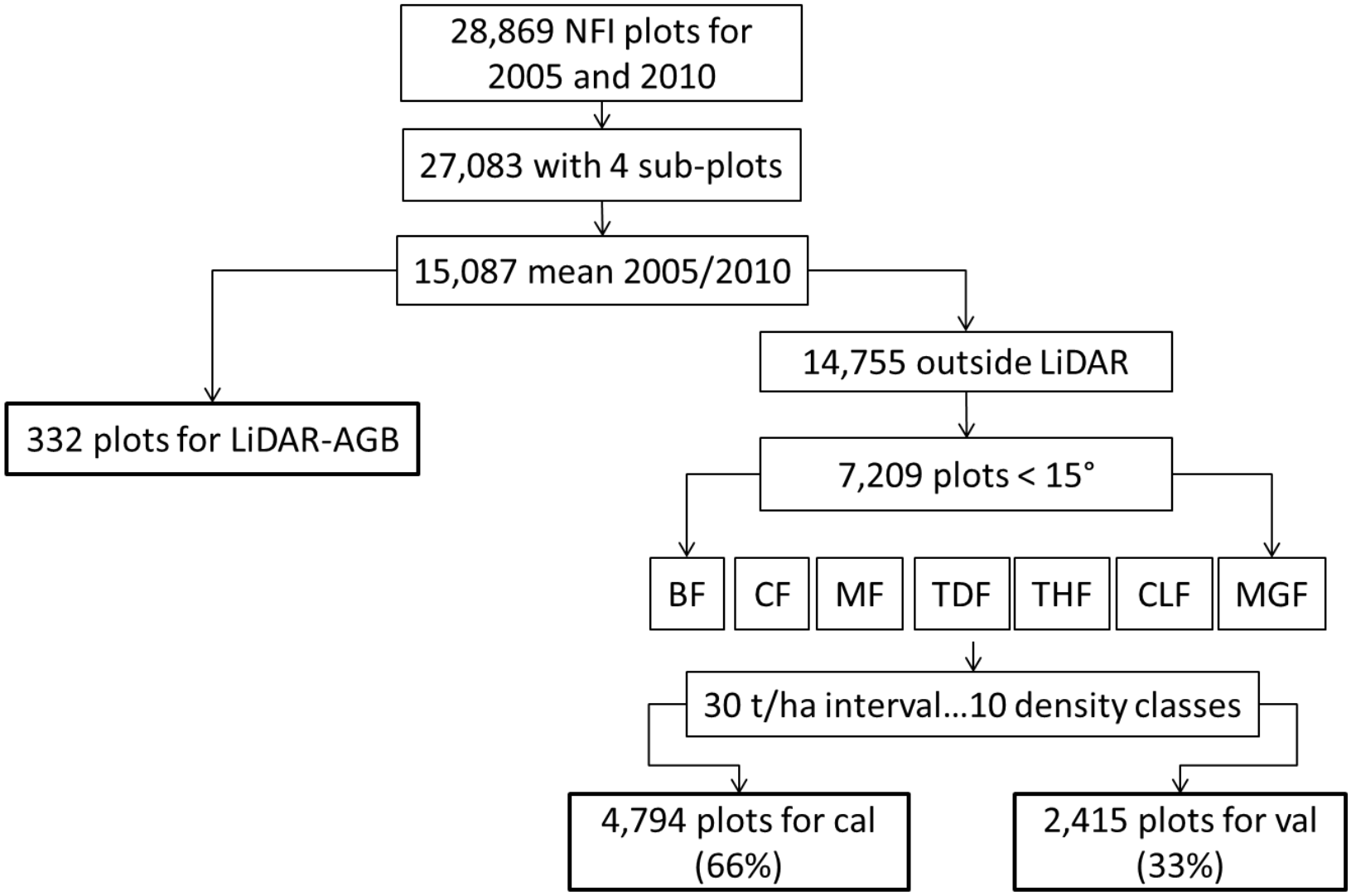






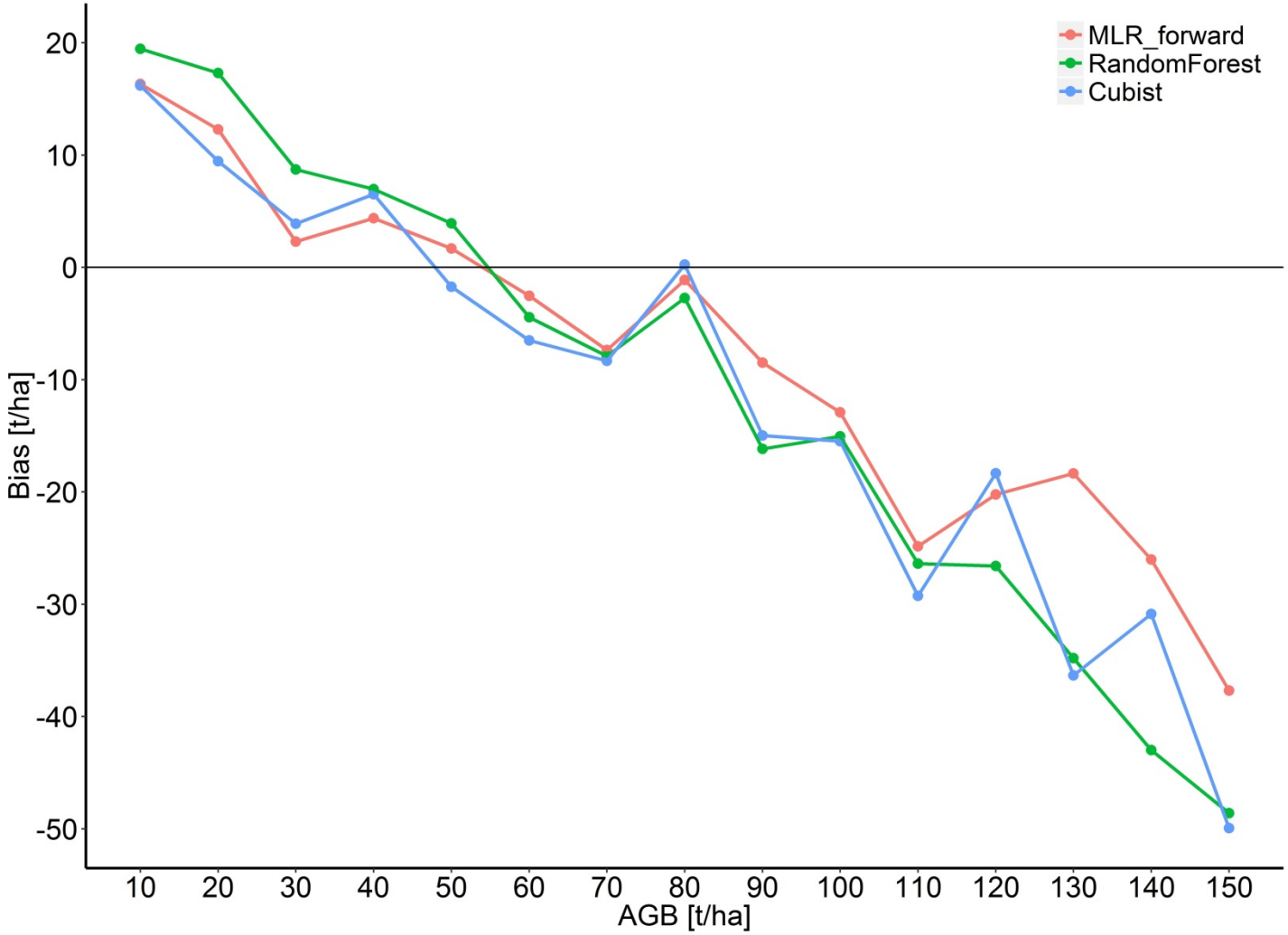
	R2	Mean R2	RMSE (t/ha)	Mean RMSE (t/ha)
Cubist	0.27-0.66	0.54	18.71-33.4	25.42
RandomForest	0.29-0.76	0.58	17.2-30.5	23.69
Multiple Linear Regression	0.5-0.78	0.61	20.43-26.46	23.04

Data / Methods



Results A: AGB based on LiDAR metrics

Bias at different AGB ranges



AGB versus PALSAR

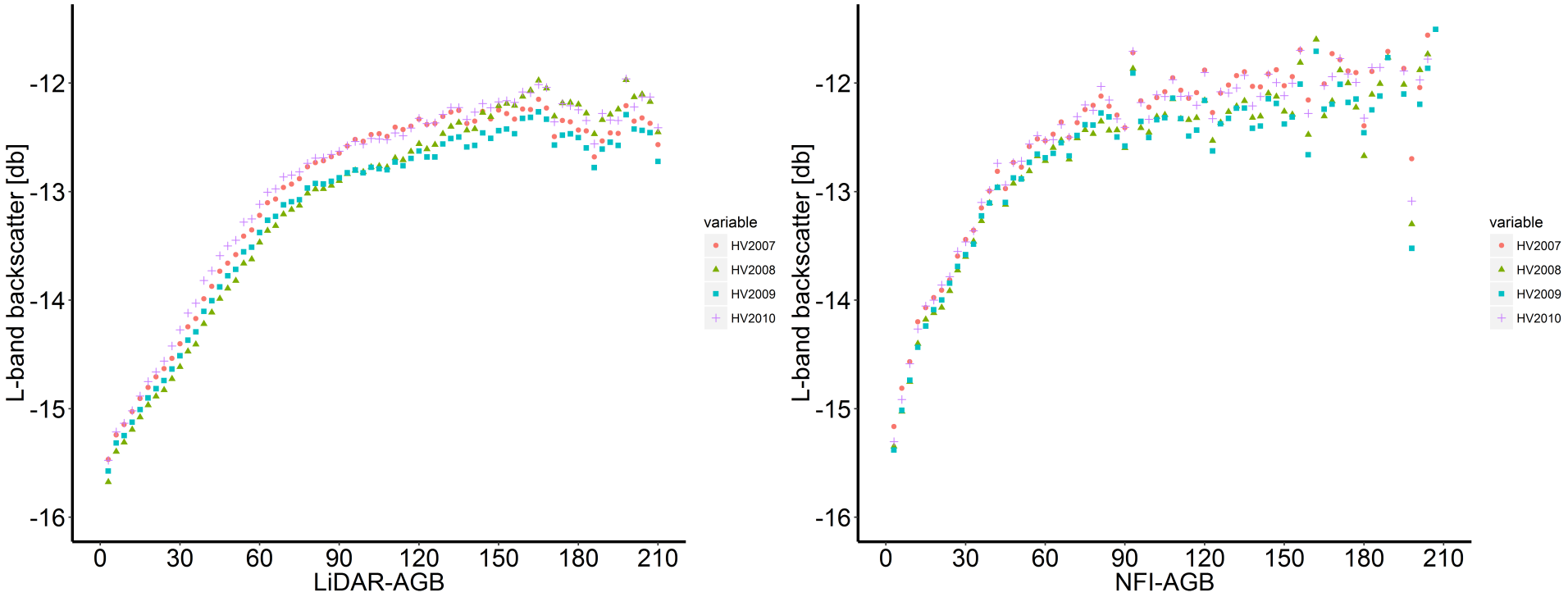


Fig.: Bin-averaged (3 t/ha bin) **HV** backscatter against LiDAR-based AGB (left) and NFI-based AGB (right)

AGB versus PALSAR

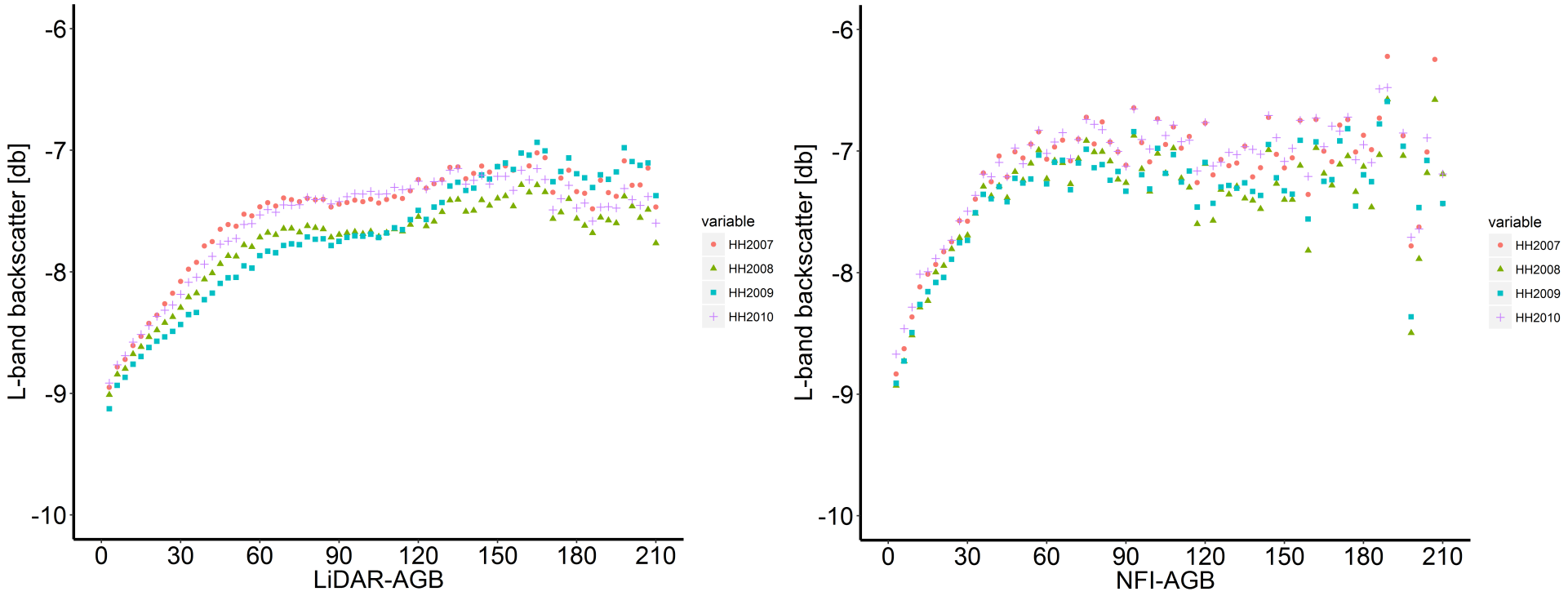


Fig.: Bin-averaged (3 t/ha bin) **HH** backscatter against LiDAR-based AGB (left) and NFI-based AGB (right)

Data / Methods

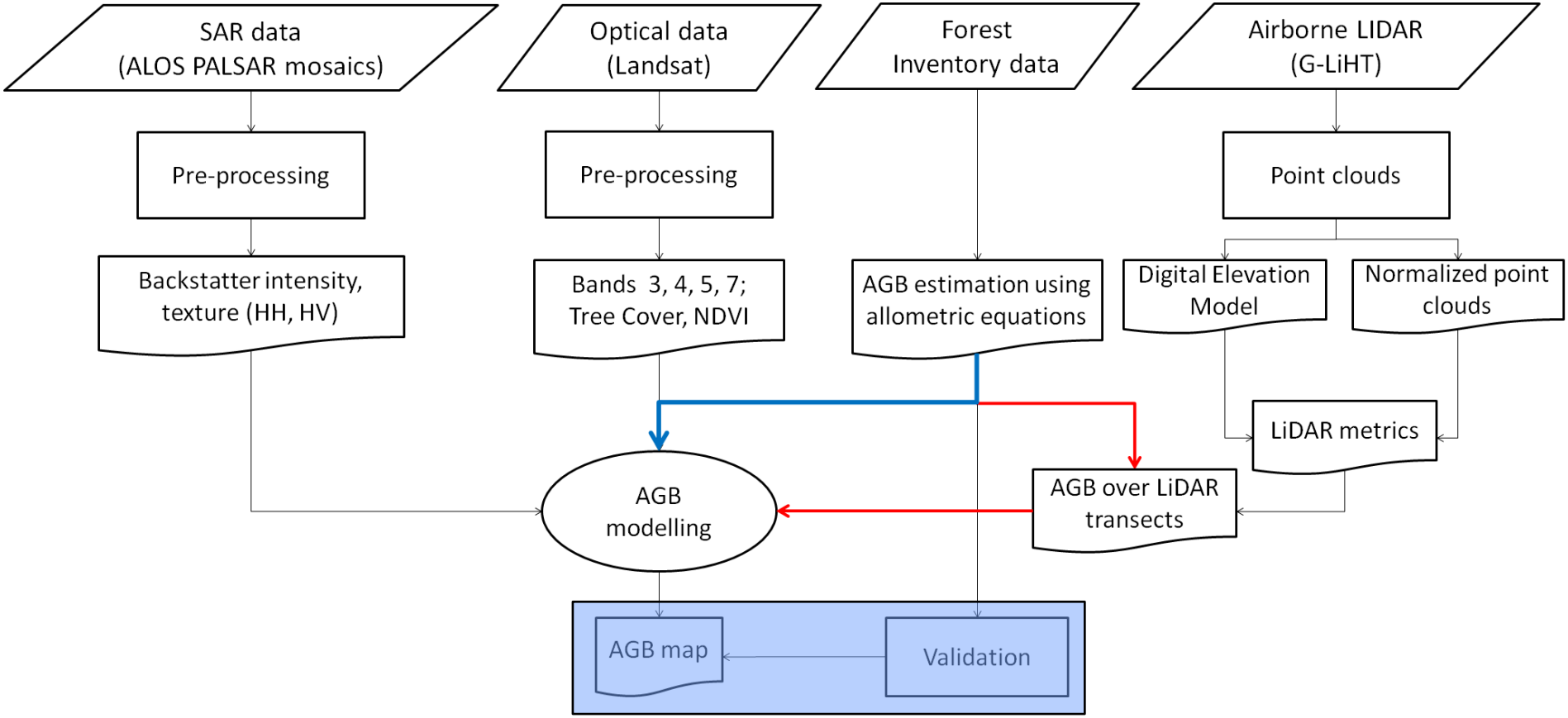


Fig. 3: Flowchart

Data / Methods

Wall-to-wall AGB estimation using PALSAR and Landsat data

Response variable: 1) NFI-based AGB; 2) LiDAR-based AGB

Predicting variables:

- PALSAR backscatter 2007-2010 (dual pol) (JAXA global mosaics)
- Backscatter texture metrics (homogeneity, variance, entropy)
- Landsat mosaic 2012 (Band 3 (red), 4 (NIR), 5 (SWIR), 7 (SWIR), NDVI)
- Landsat tree cover 2010
- SRTM DEM
- SRTM DEM Slope

Spatial resolution: 100 m (1ha)

Models: Cubist (cran.r-project.org), RandomForest, MLR

Validation: 30% of NFI data

Data / Methods

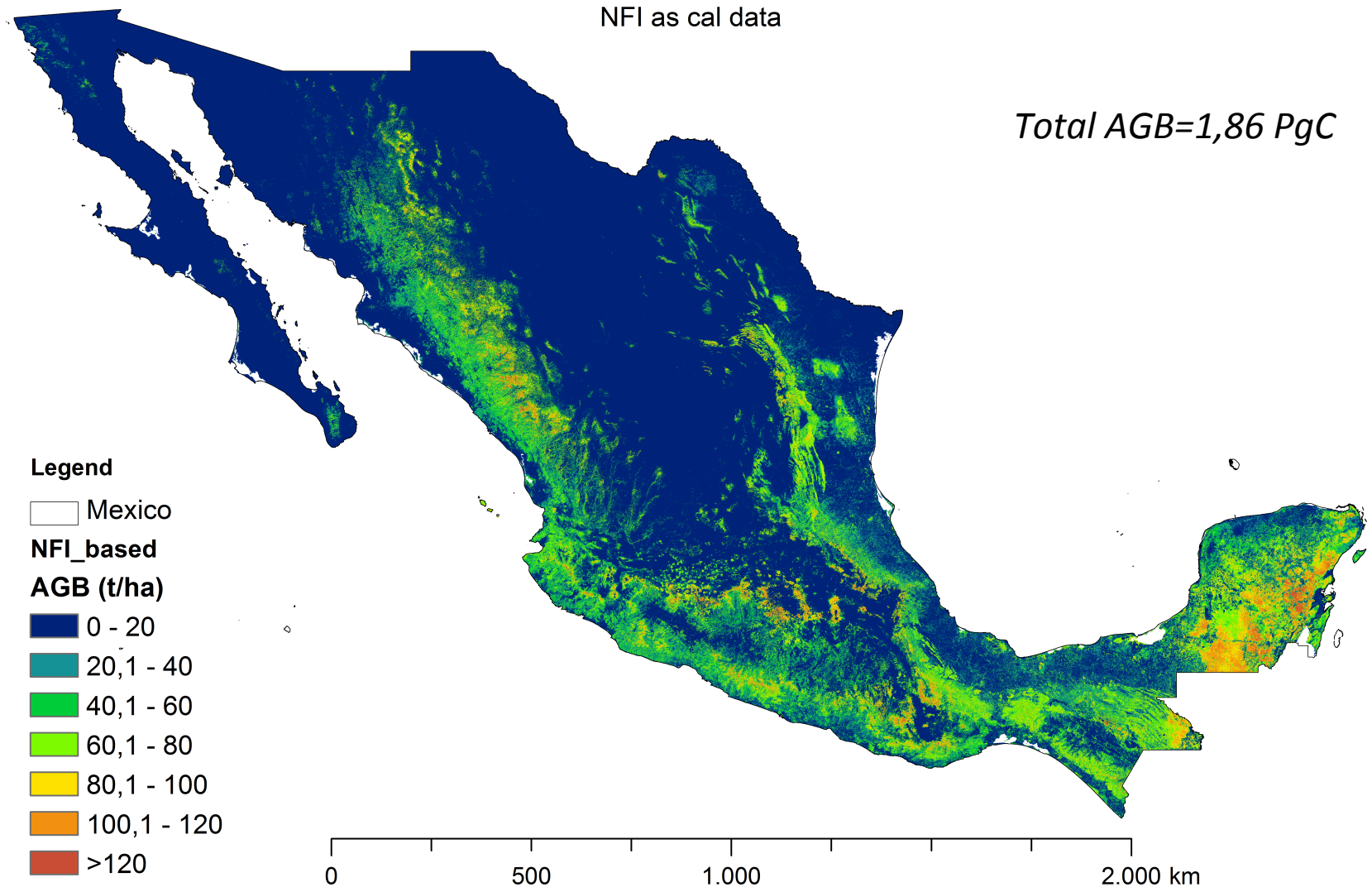
Two AGB modeling scenarios:

- AGB modeling based on **NFI data** (4,794 NFI plots)
- AGB modeling based on **LiDAR**-AGB (312 LiDAR covered NFI plots) *(347,979 LiDAR samples)*

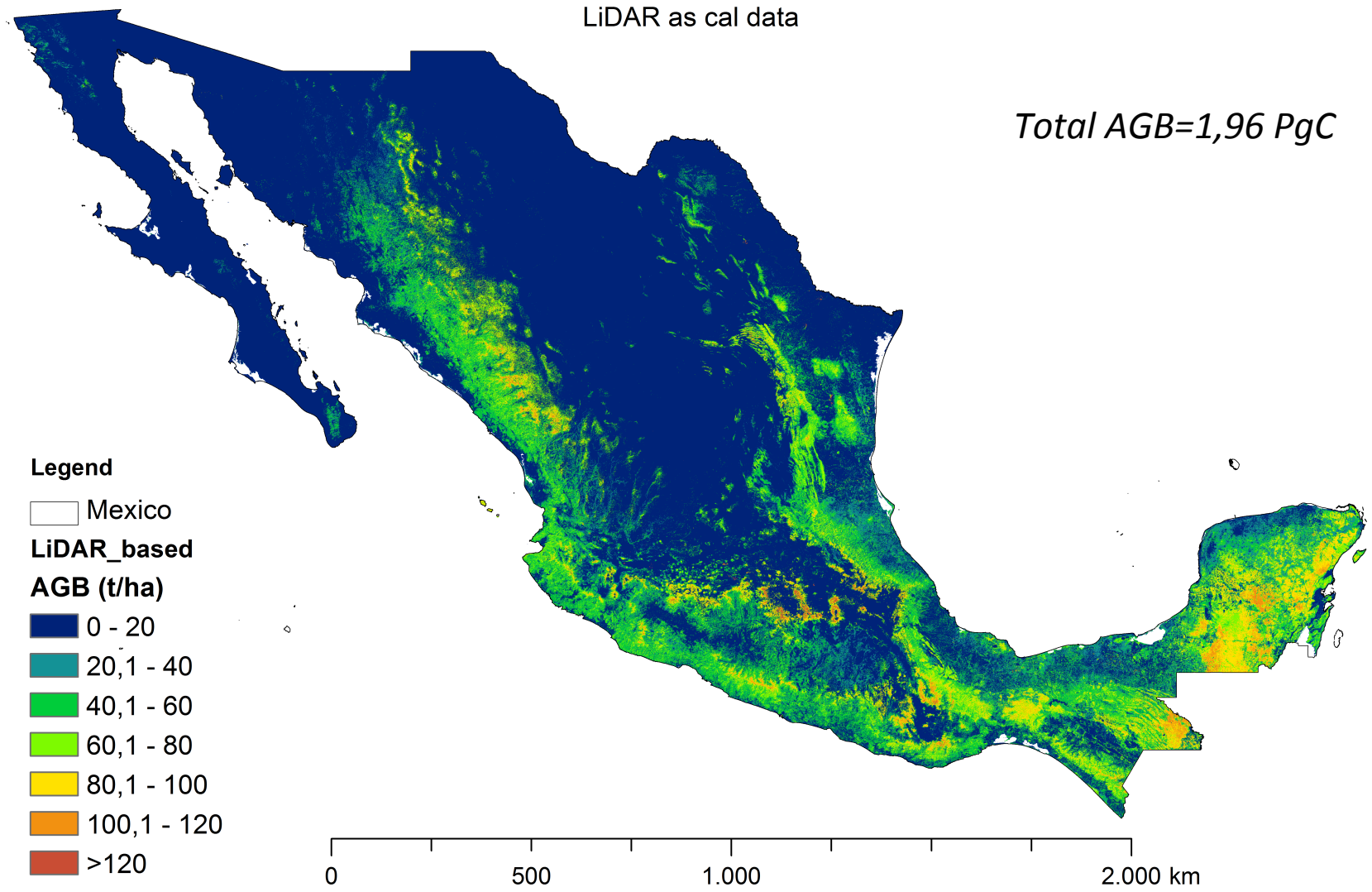
Validation with 2,415 NFI plots

IMPRS gBGC

Results B: Wall2Wall AGB Mexico

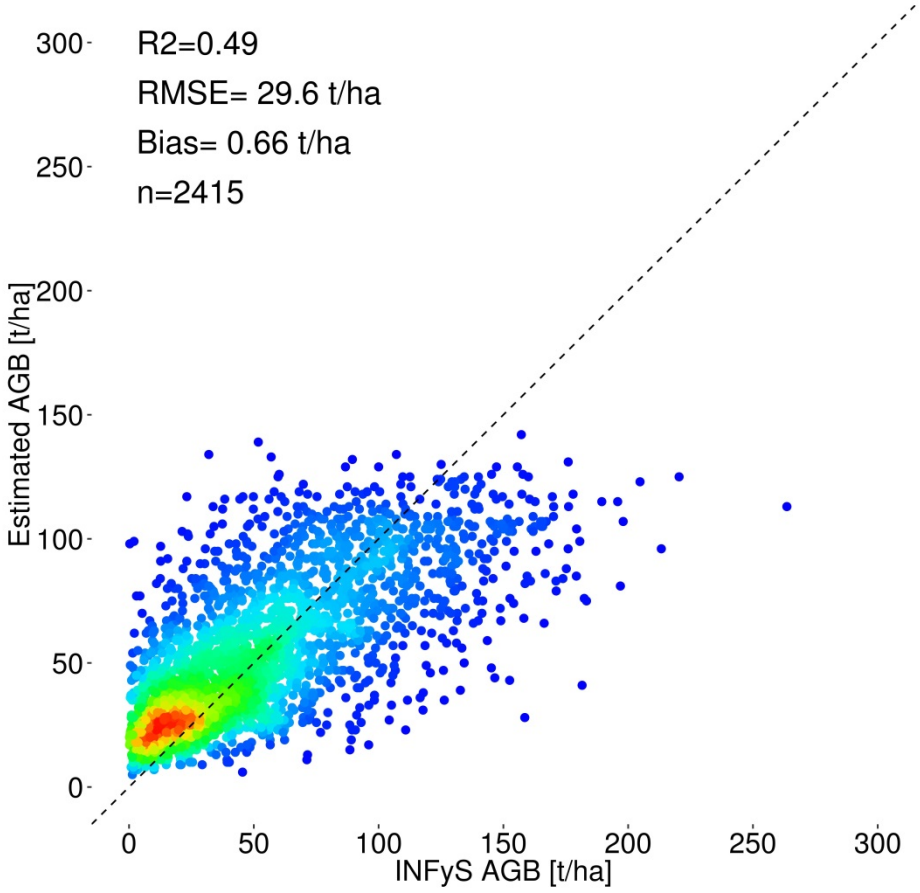


Results B: Wall2Wall AGB Mexico

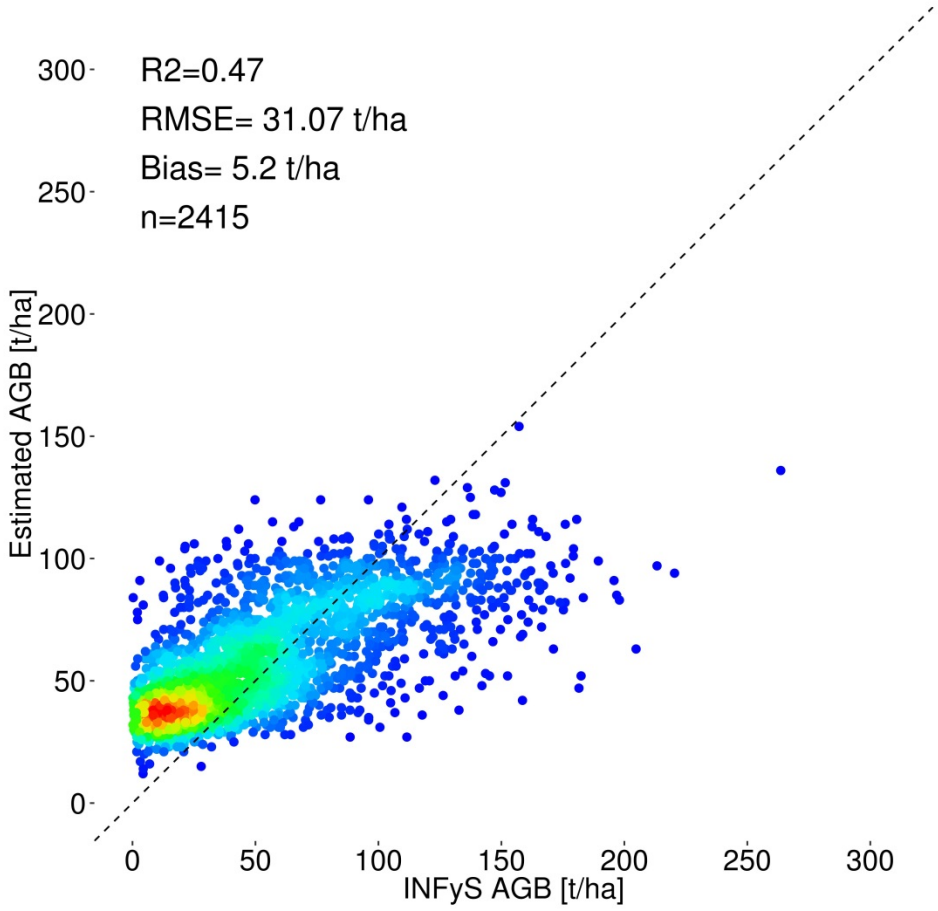


Results B: Wall2Wall AGB Mexico

NFI as cal data



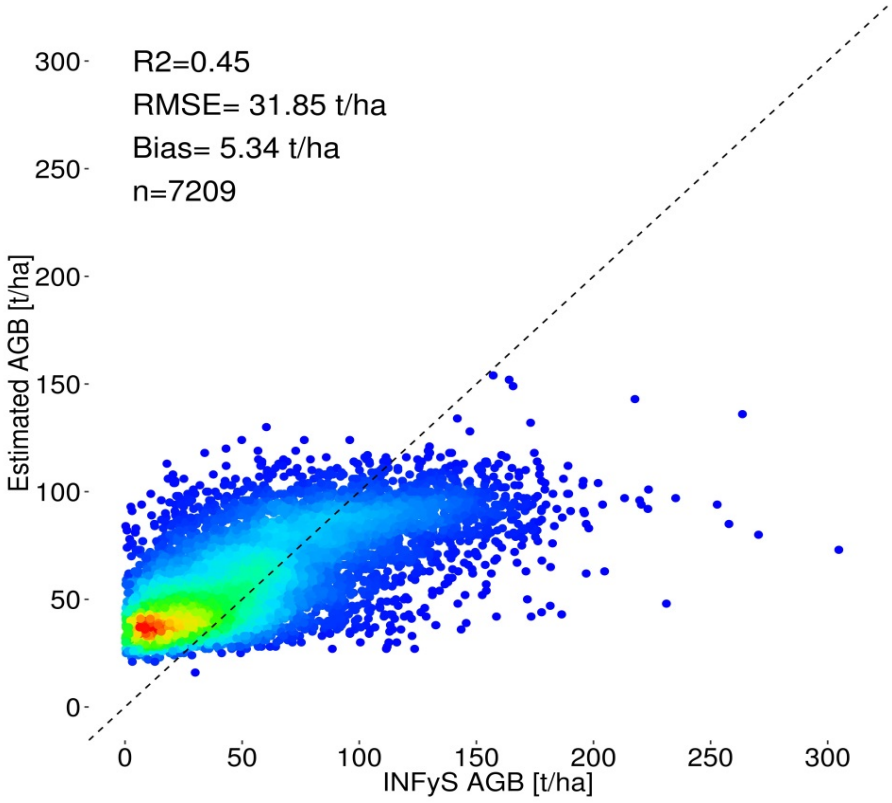
LiDAR as cal data



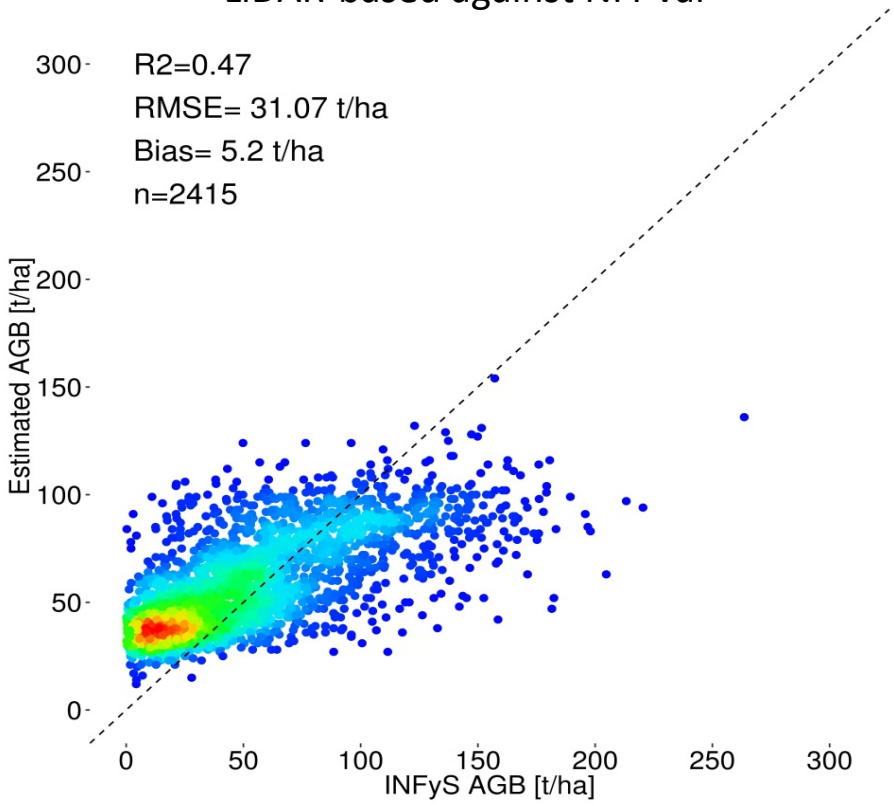
Results B: Wall2Wall AGB Mexico

Validation results of the **AGB map based on LiDAR data** (RandomForest)

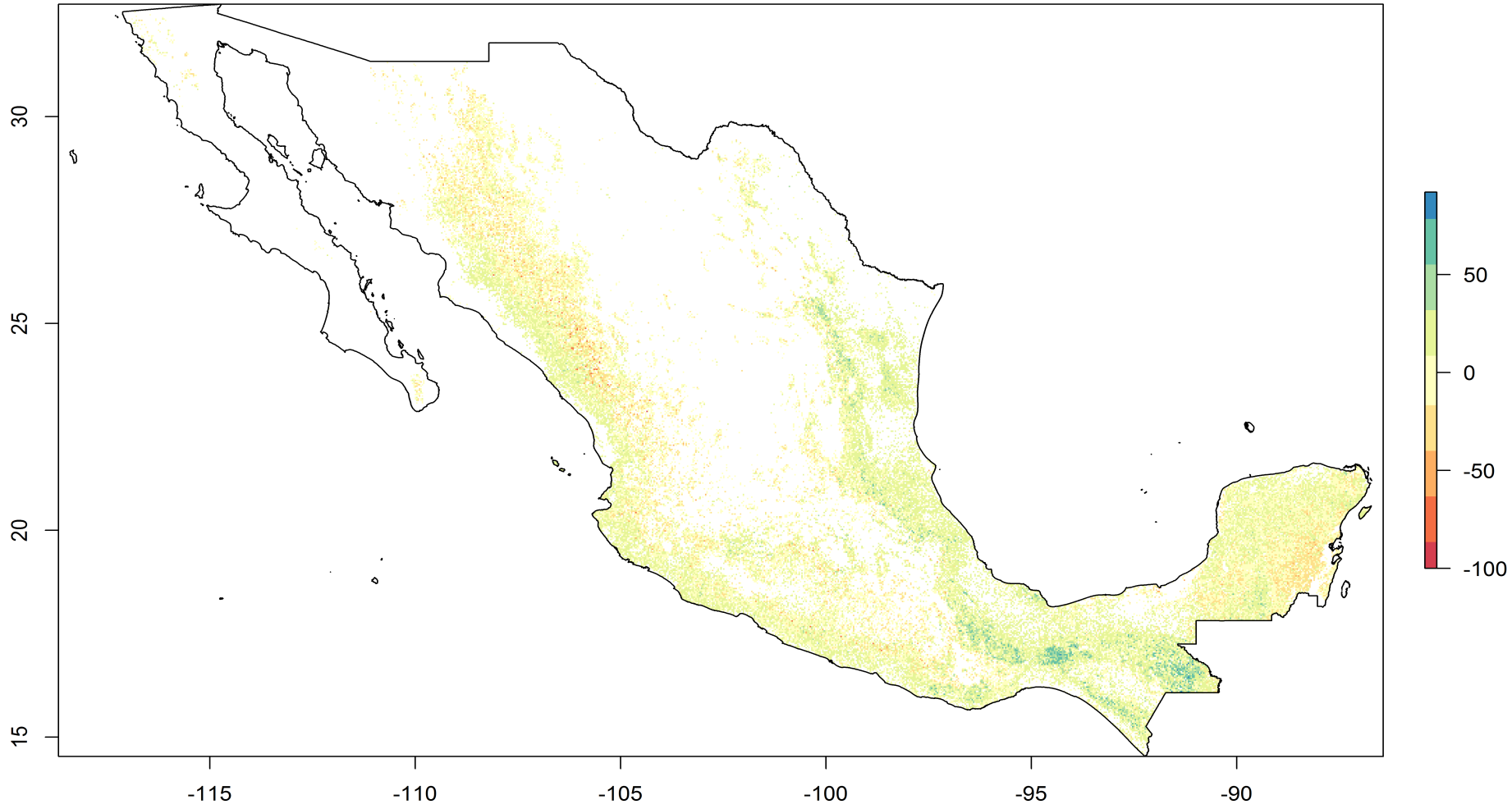
LiDAR-based against all NFI (outside LiDAR areas)

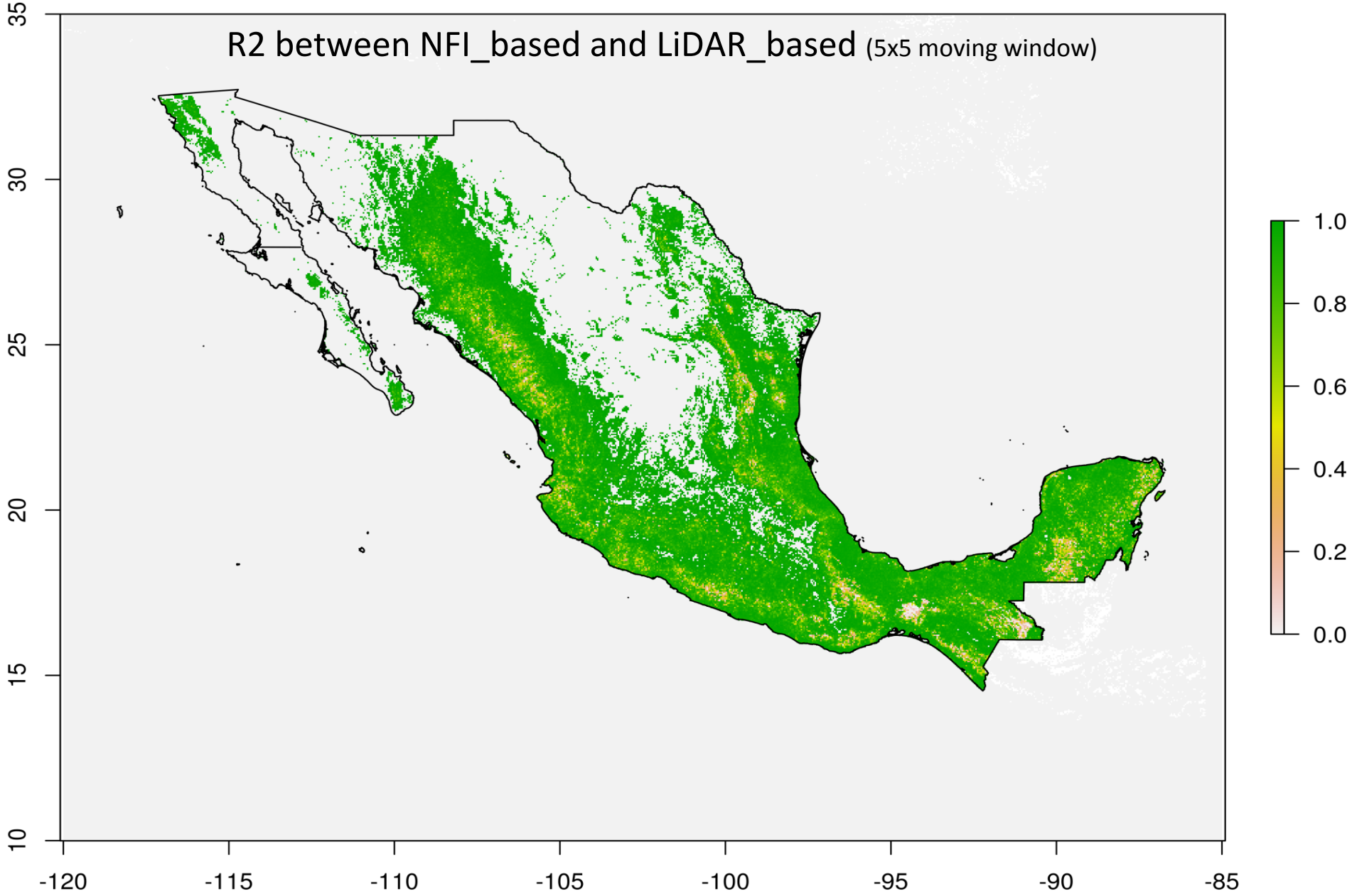


LiDAR-based against NFI-val



LiDAR-AGB minus NFI-AGB

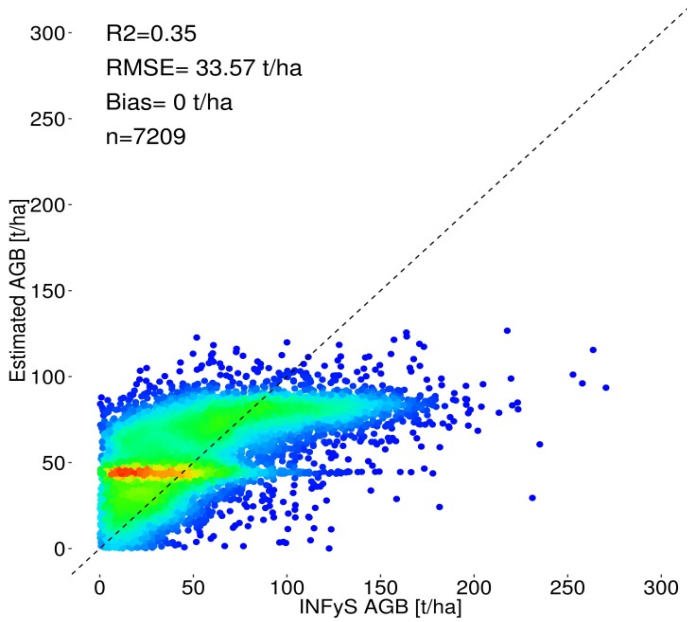



R2 between NFI_based and LiDAR_based (5x5 moving window)
35
30
25
20
15
10
-120
-115
-110
-105
-100
-95
-90
-85
1.0
0.8
0.6
0.4
0.2
0.0

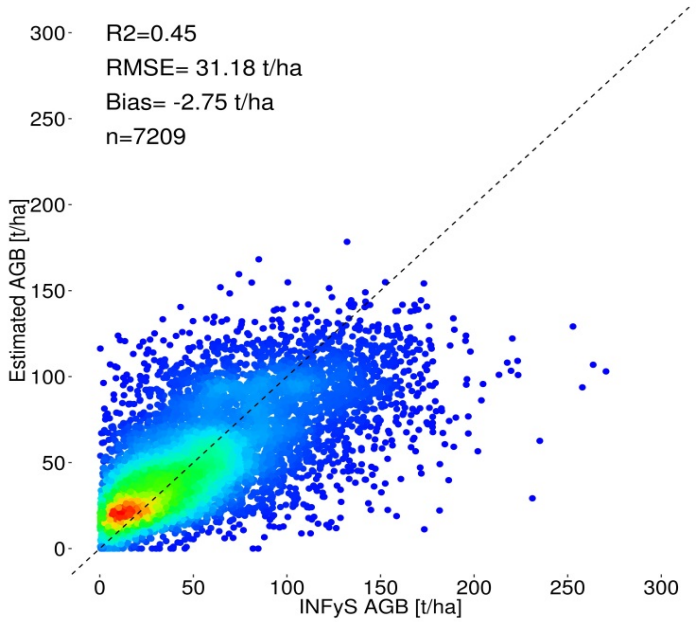
Results B: Wall2Wall AGB Mexico

Impact of modelling approach on AGB estimation

Stepwise linear regression



Cubist



Random Forests

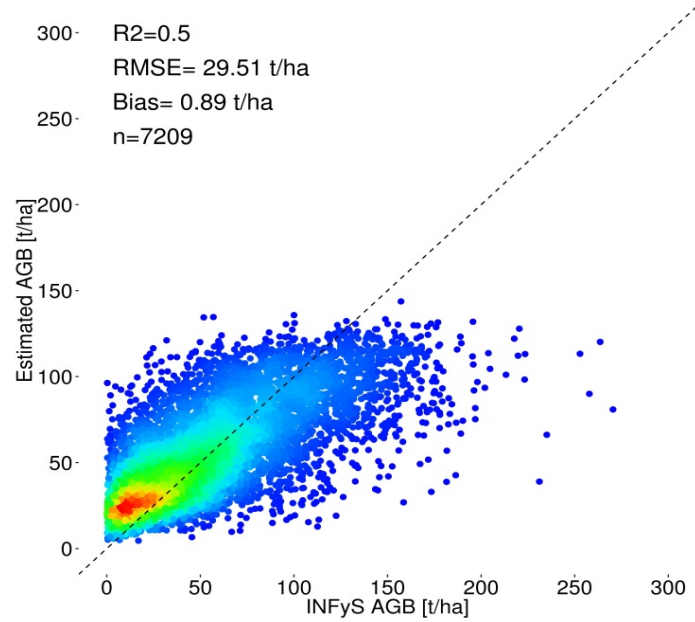
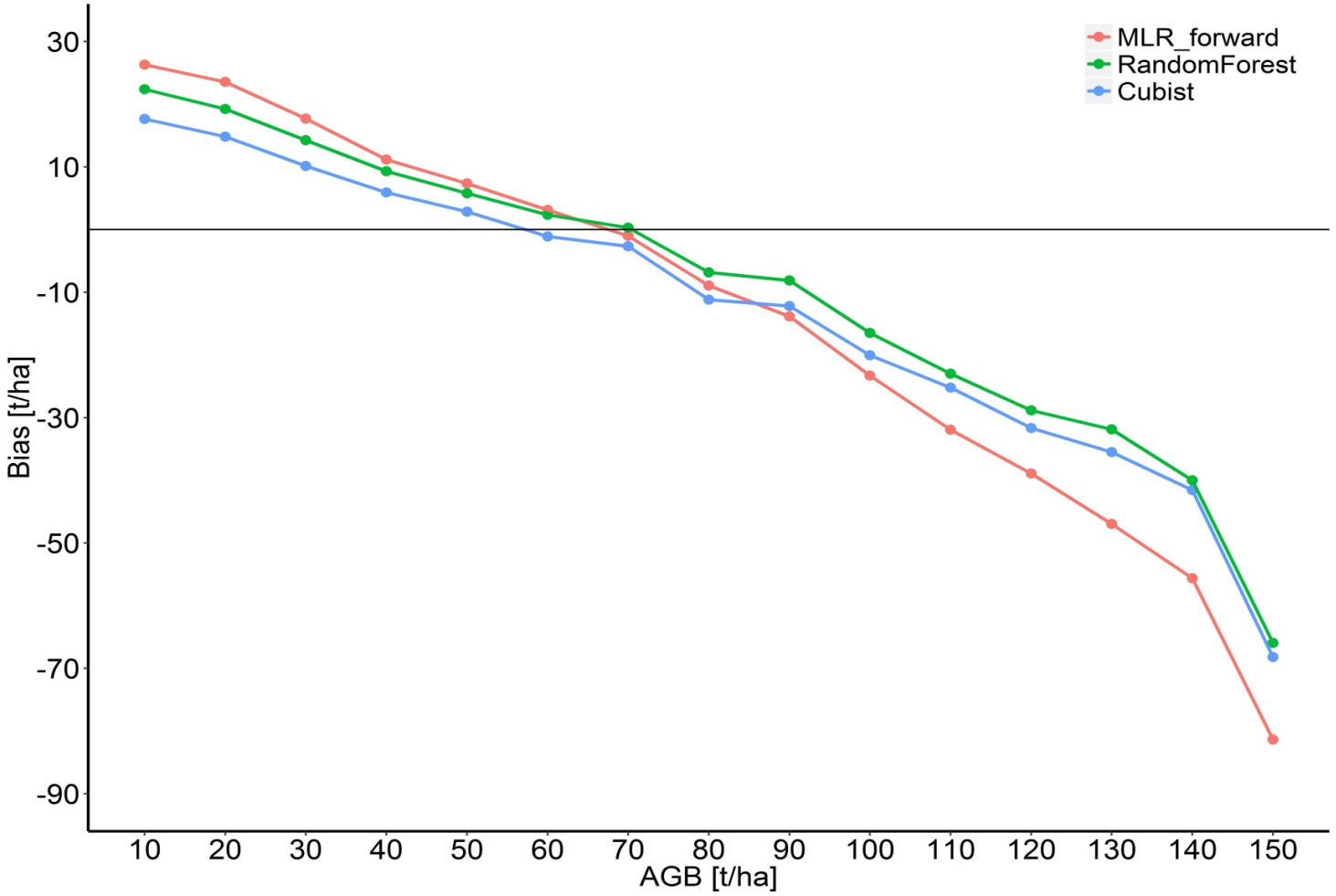


Fig.: Predicted AGB against **NFI-based AGB**
using stepwise linear regression (left), Cubist (middle) and Random Forests (right)
k-fold cross-validation (*k*=10)

	R2	Mean R2	RMSE (t/ha)	Mean RMSE (t/ha)
Cubist	0.38-0.48	0.45	29.18-33.98	31.14
RandomForest	0.44-0.56	0.5	26.47-32.84	29.45
Multiple Linear Regression	0.31-0.39	0.35	32.01-38.81	33.51

Results B: Wall2Wall AGB Mexico

Impact of modelling approach on AGB estimation



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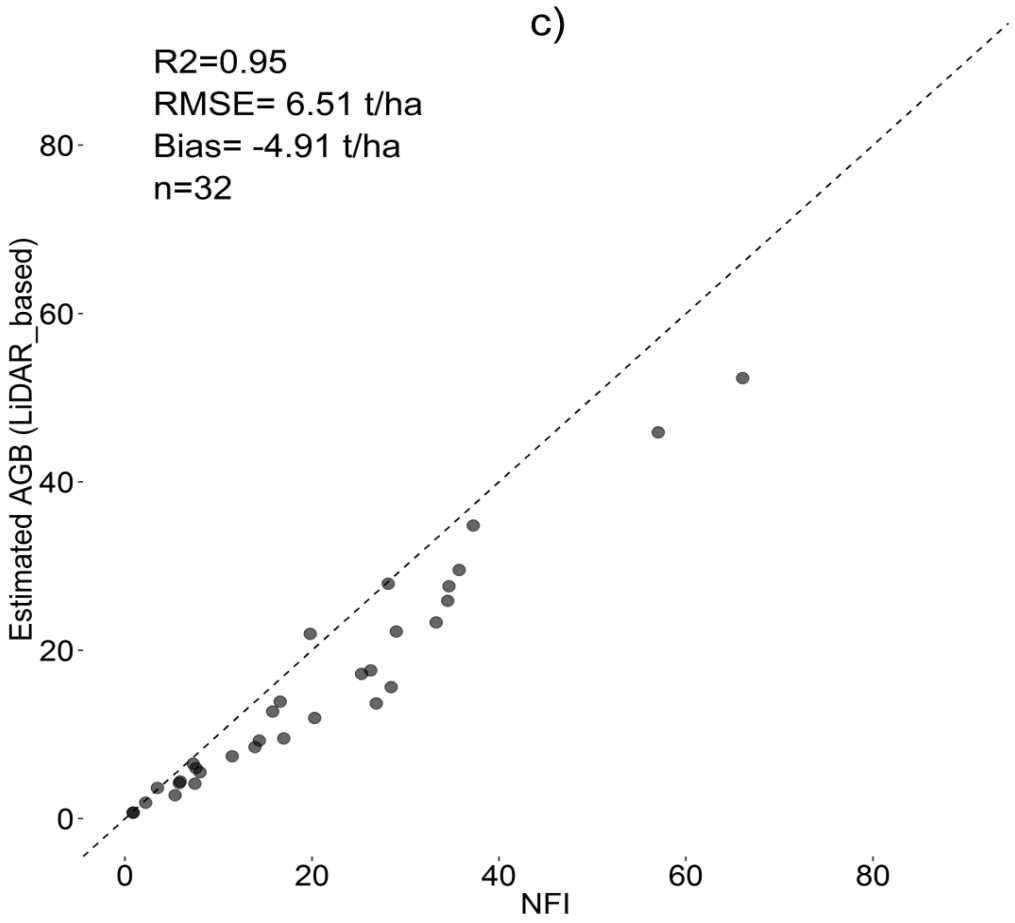

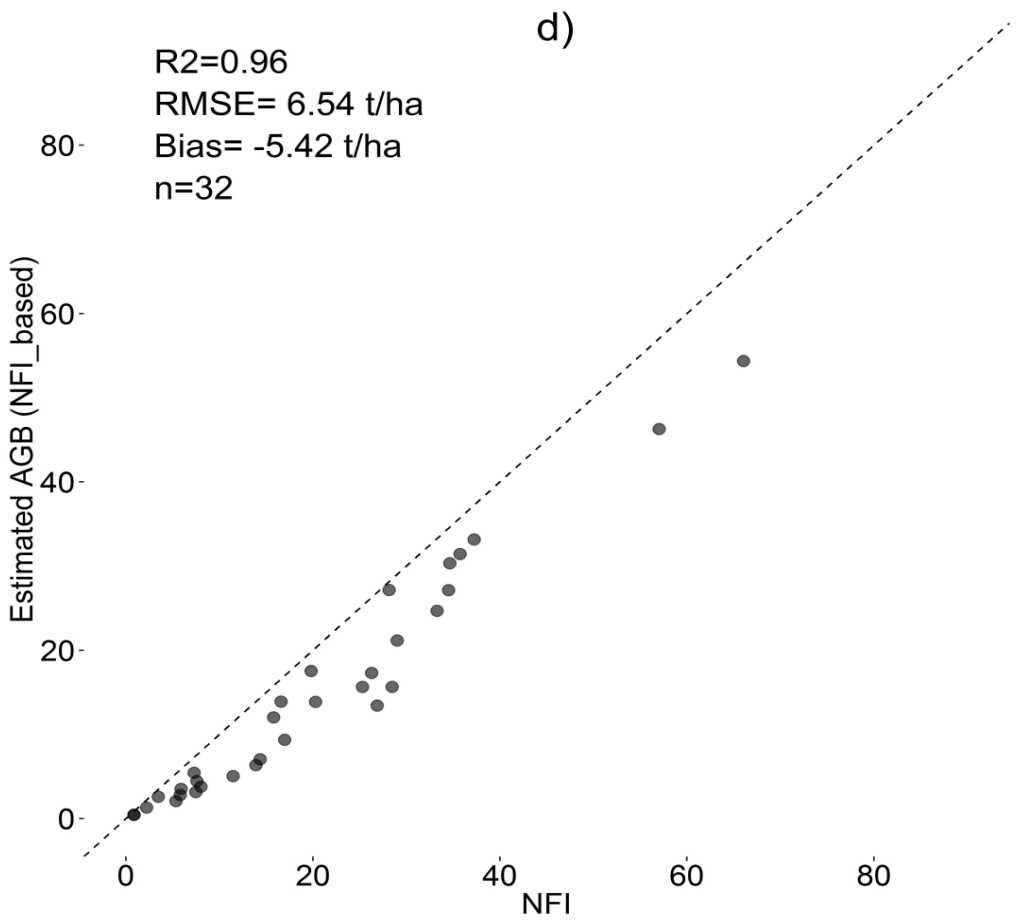

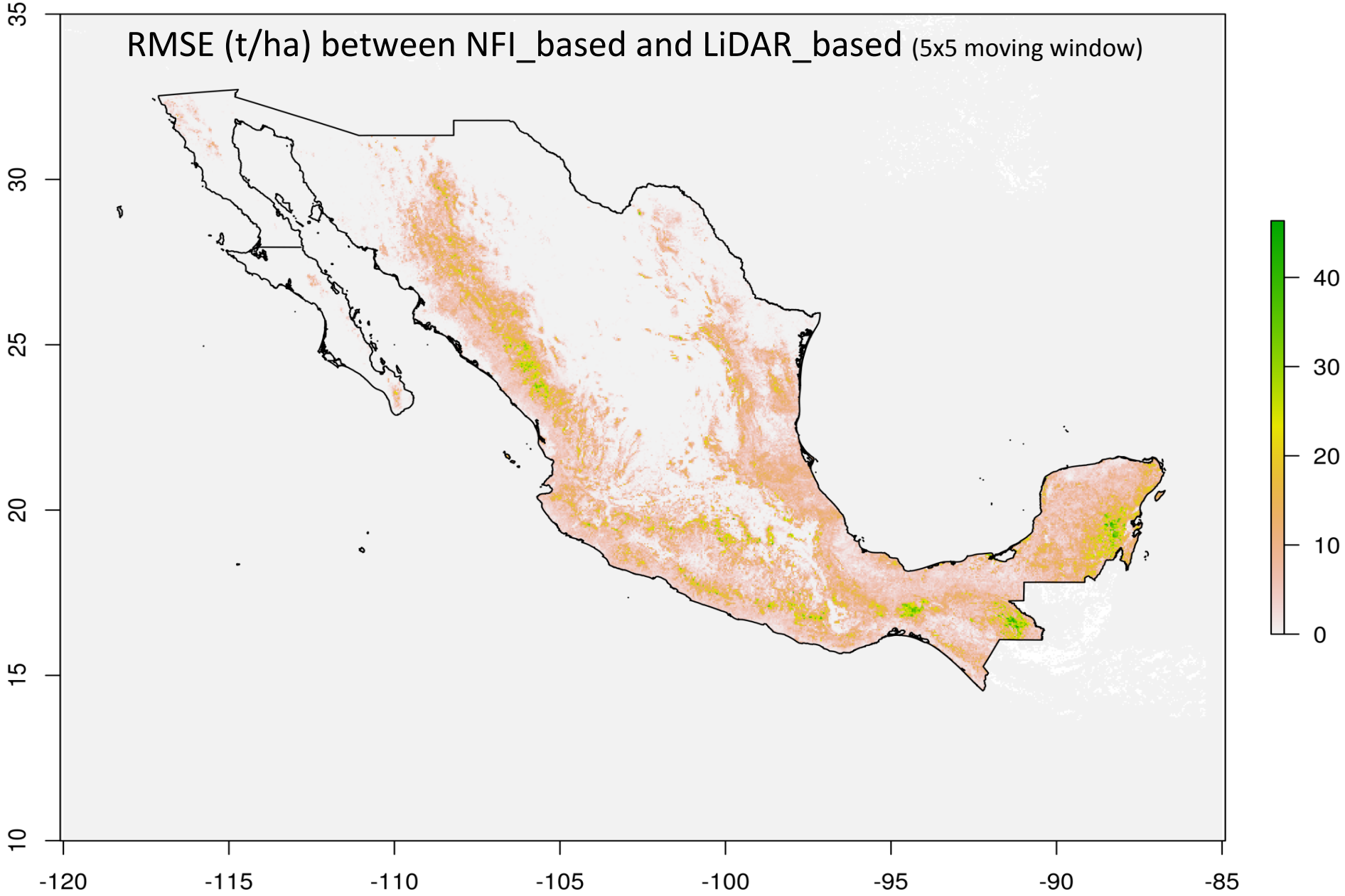
RMSE (t/ha) between NFI_based and LiDAR_based (5x5 moving window)
35
30
25
20
15
10
-120
-115
-110
-105
-100
-95
-90
-85
40
30
20
10
0

Results and significant findings thus far

- Similar goodness-of-fit statistics of NFI and LIDAR based results
  - Accurate estimates at hexagon and state scales (both approaches) compared to the NFI data
  - Spatial discrepancies at pixel level
- Different spatial patterns in particular in regions with high AGB (Lancadon and Chimalapas forests, Yucatan peninsula)
- A stratified NFI sampling with bigger plot size (~1ha) over LiDAR transects should result in higher accuracies

Deliverables – Papers and reports

1. Published (please provide PDF file)

Urbazaev, M., Thiel, C., Migliavacca, M., Reichstein, M., Rodriguez-Veiga, P., Schmullius, C. (2016). Improved Multi-Sensor Satellite-Based Aboveground Biomass Estimation by Selecting Temporally Stable Forest Inventory Plots Using NDVI Time Series. ***Forests***, 7(8), 169. doi:10.3390/f7080169

Urbazaev, M., Thiel, C., Migliavacca, M., Reichstein, M., Cook, B., Dubayah, R. & C. Schmullius (2016): Forest Aboveground Biomass Mapping in Mexico using SAR, Optical and Airborne LiDAR Data. 67th International Astronautical Congress, 26-30 September 2016, Guadalajara, Mexico. **Proceedings Paper IAC2016.**

2. Submitted/in preparation

- *Journal Paper (Remote Sensing Letters, expected publication date: 2017)*

Urbazaev, M., Thiel, C., Migliavacca, M., Reichstein, M., Cook, B., Dubayah, R. & C. Schmullius (**in preparation**): A comparative analysis of NFI-based and LiDAR-based forest aboveground biomass maps in Mexico. **Carbon Balance and Management**.