Multi-sensor generation of a global biomass dataset

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Background

- Necessity of quantifying biomass at global scale for various reasons
- Ideal: high-res (< 50 m) and high accuracy (< 20% error) → reality is different and often the message is „give us anything“
- There is a bunch of regional/continental biomass datasets with different accuracies at decametric to kilometric resolution
- Global scale products of biomass are poor
- Efforts to derive a consistent global biomass dataset ongoing

Question: could currently available regional/continental scale datasets of biomass be merged to contribute to a global dataset?

Overview of talk

This talk aims at presenting one current effort to derive a global biomass dataset merging regional/continental datasets based on remote sensing

-Baccini pan-tropical AGB (Lidar / MODIS)

-Saatchi pan-tropical AGB (Lidar/MODIS)

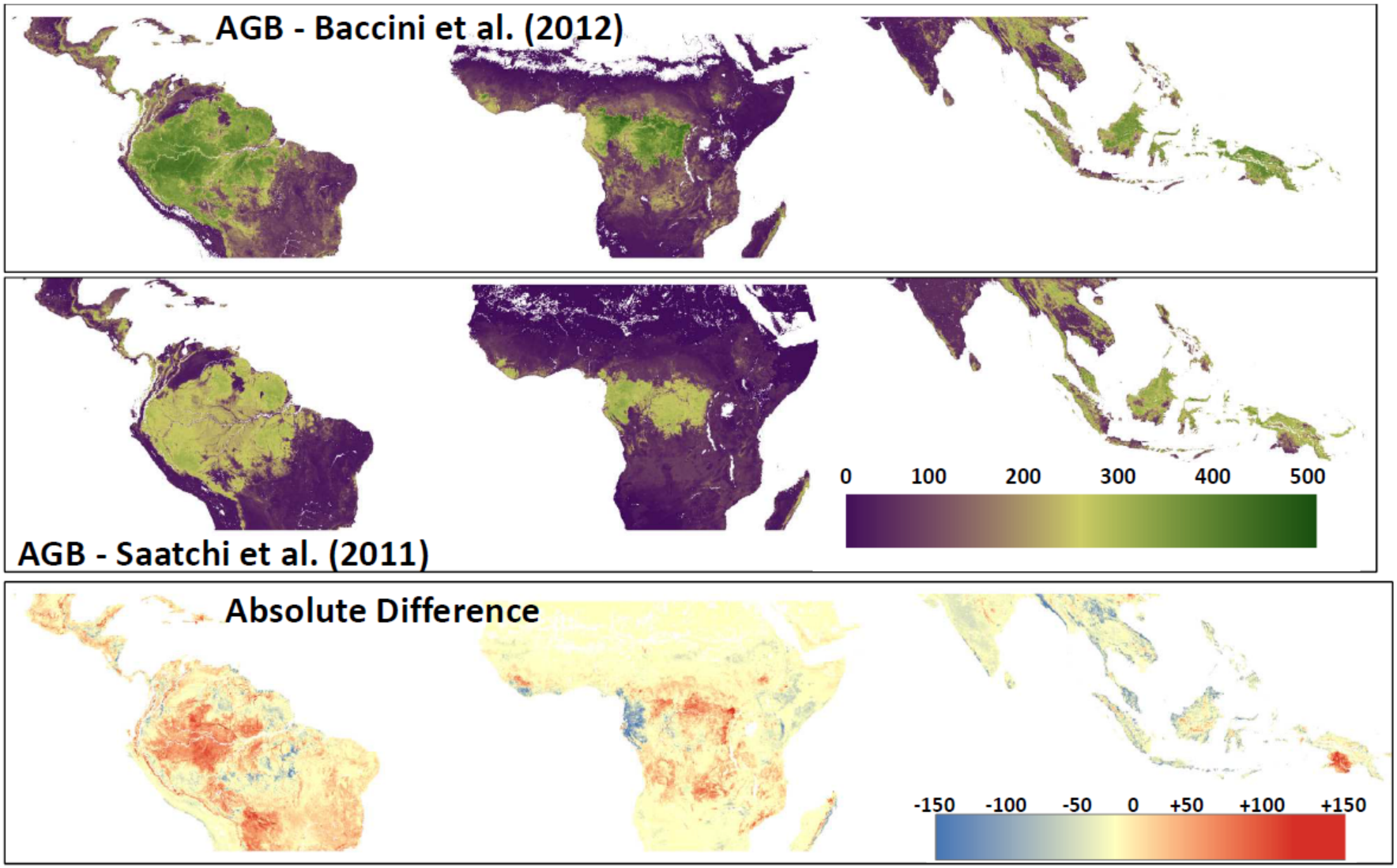
-Santoro pan-boreal AGB (C-band ASAR) … currently extending

- Other datasets in areas of gaps (e.g., Gibbs)

For areas with multiiple datasets, a merging strategy is appled. Merging is supported by regional datasets of AGB (plot data, EO raster datasets)

NOTE: none of the remote sensing data used links directly with biomass. The integrated biomass will therefore reflect flaws of individual datasets but hopefully to a more limited extent. We move from „give us anyything“ to „give us something that is consistent and makes sense“.

Biomass of the tropics



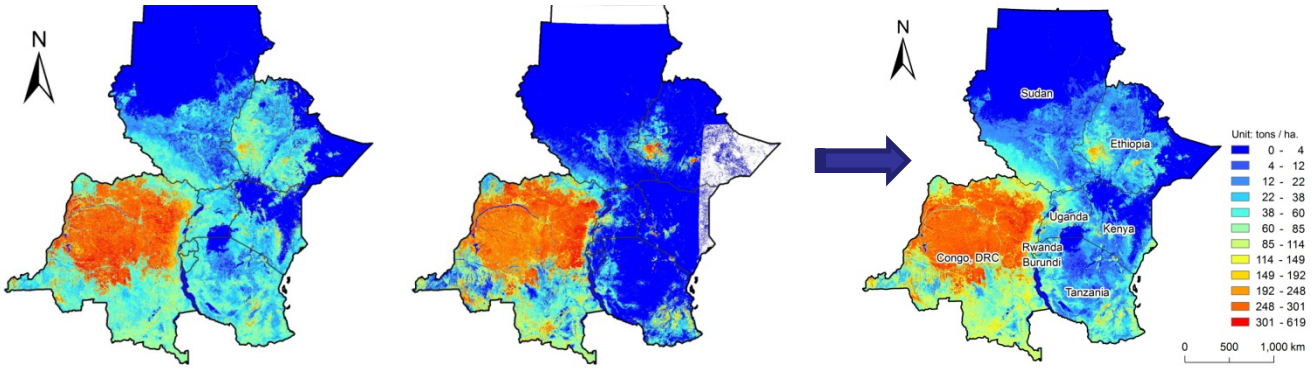
Analysis: Ed Mitchard, EU GEOCARBON

Derivation of forest AGB in the tropical region

1. Combining existing continental/global datasets (e.g. Baccini, Saatchi, Gibbs)
2. Approach: Bias removal and Weighted average by LC strata using Reference field data and local maps (Yong et al., submitted)
3. Regional “validation” using independent reference data

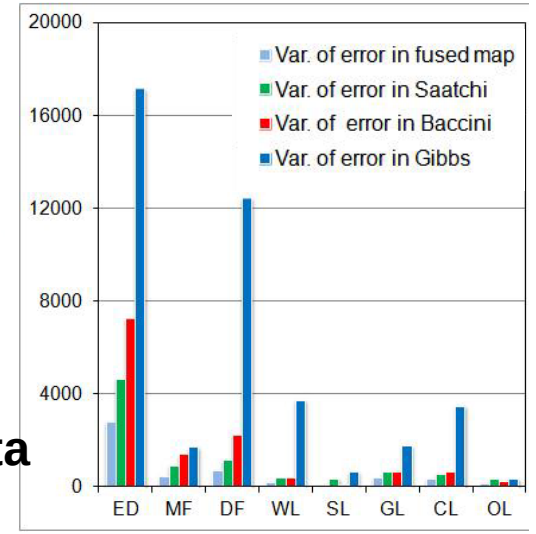
2. Calibration with high-res. biomass map $f(s) = \sum_{i=1}^{p} w_i(s) \cdot (z_i(s) - v_i(s))$

Saatchi **Baccini** **Fused map**



(Yong et al., submitted)

3. “Validation” with plot data

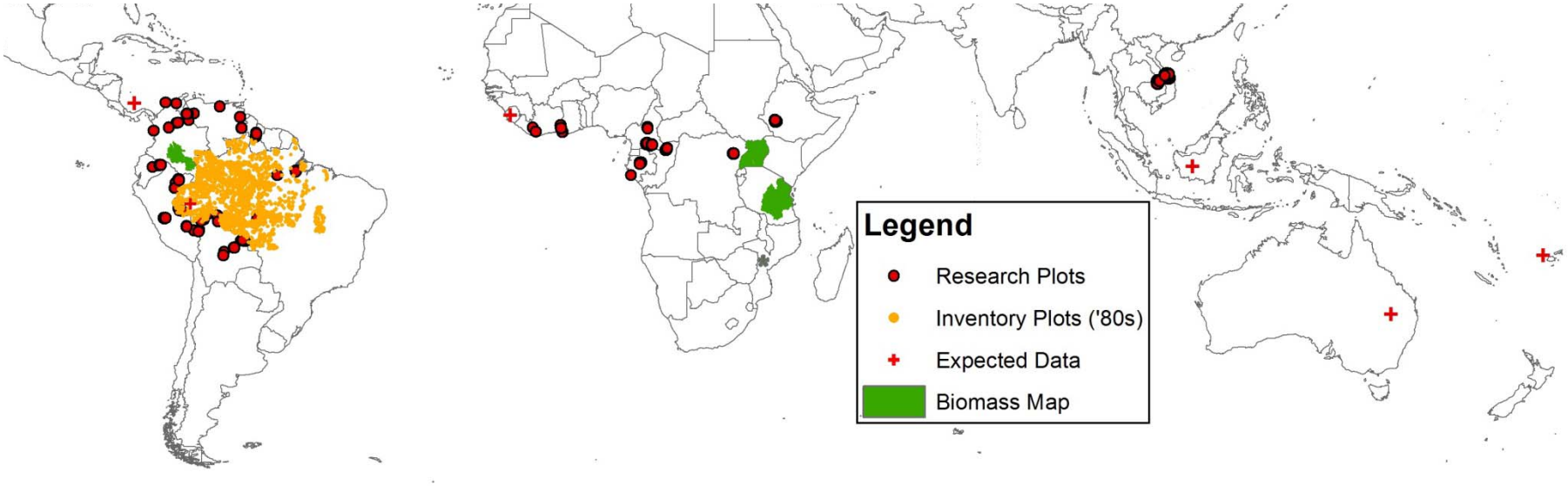


Reference dataset in the tropical region

BIOMASS MAPS		
Country	**Area (km2)**	**Year**
Vietnam	12,342	2011
Laos	5,301	2010
Ethiopia	7,192	2012
Uganda	208,065	circa-2000
Mozambique	1,160	2007
Tanzania	338,588	2009-11
Cameroon	14,196	2007
Colombia	163,330	2011
TOTAL	**750,173**	***(~1%)***

RESEARCH PLOTS		
Country	**Area (Km2)**	**Year**
Uganda	8.78	1995-2005
Uganda	0.18	2008
Vietnam	0.12	2011-2012
Vietnam	1.53	2007-2009
Ethiopia	0.11	2011-2012
Laos	0.13	2011
Amazon basin	1.29	2003 - 2011
Congo basin	0.54	2006 - 2011
TOTAL	**12.67**	

INVENTORY PLOTS		
Country	**Area (Km2)**	**Year**
Amazon basin	21.79	1980s
TOTAL	**21.79**	

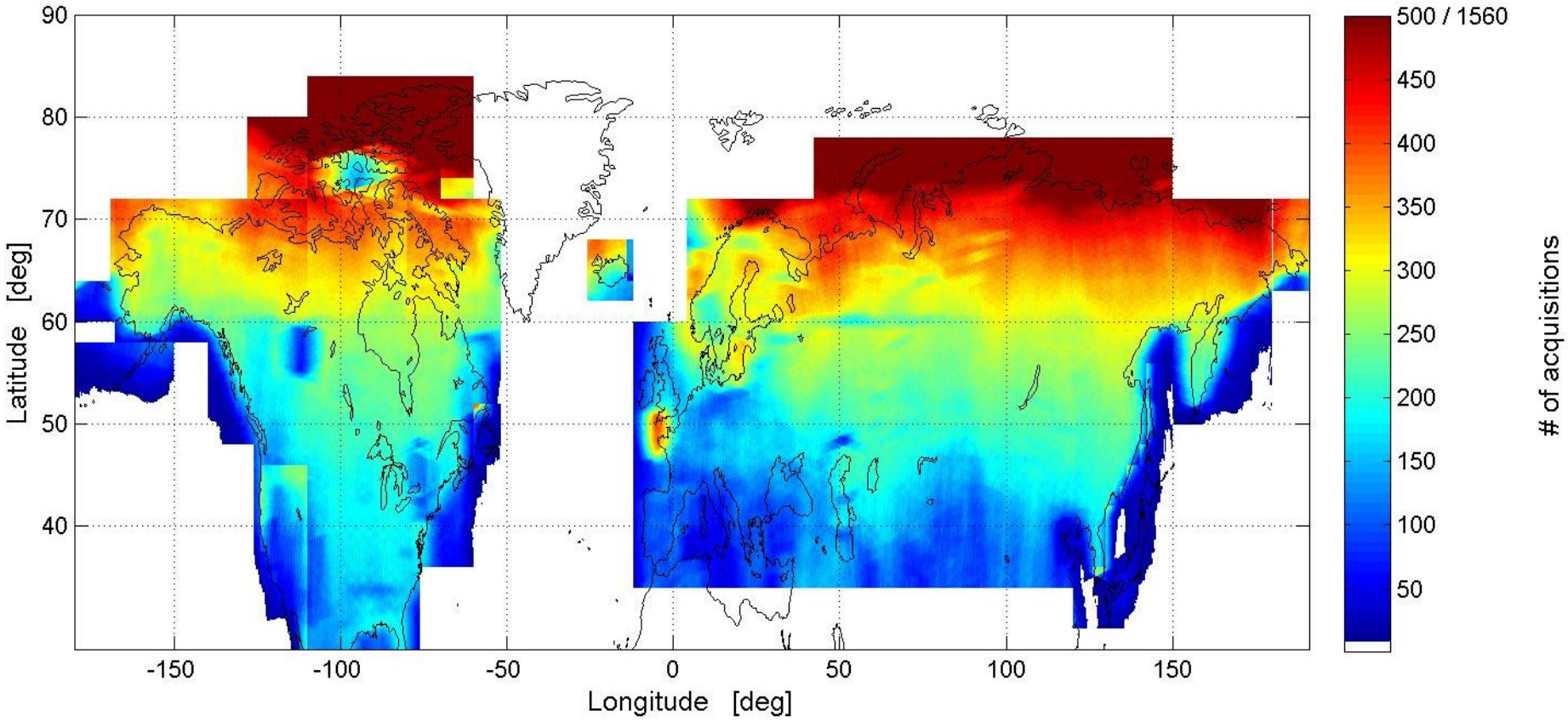


V. Avitabile, Wagenngen University (status as of March 2013)

Pan-boreal mapping of forest AGB

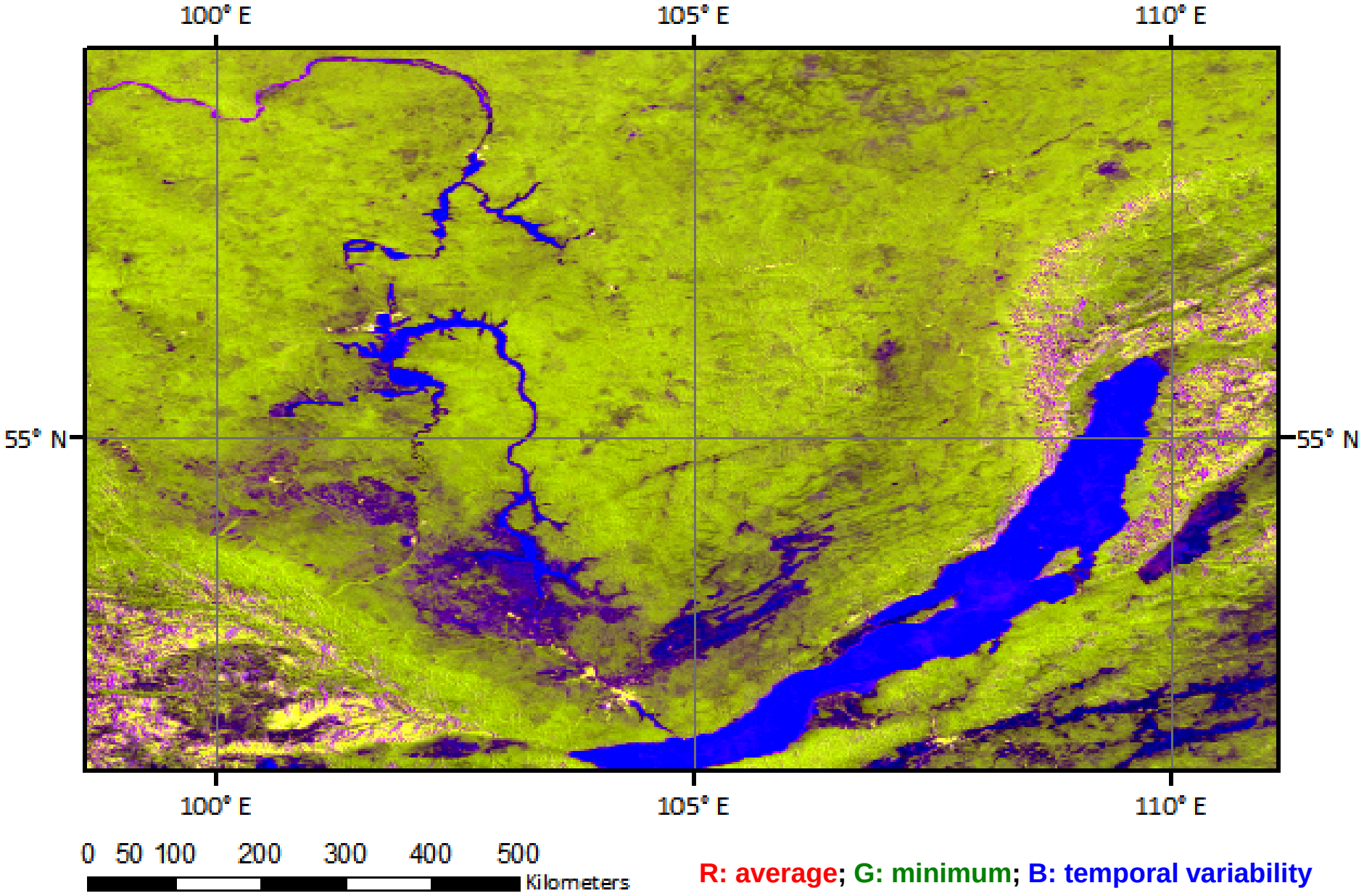
- Hyper-temporal time series of radar backscatter from Envisat ASAR ScanSAR above 30 deg N latitude
    - North America
    - Eurasia
    - Mongolia, northeast China, Korea and Japan
- Time span of SAR dataset: October 2009 – February 2011
    - For Japan no data before March 2011 → time series March 2011/2012
    - Extended time line for California, Aleutian Islands, St. Pierre et Miquelon
- Envisat ASAR ScanSAR data (Wide Swath and Global Monitoring Modes)
- All data processed to 1 km pixel size and geocoded to 0.01 degree pixel size
- Map projection: geographic coordinates

Number of backscatter observations



Number of SAR backscatter observations in Envisat ASAR ScanSAR time series

SAR multi-temporal RGB



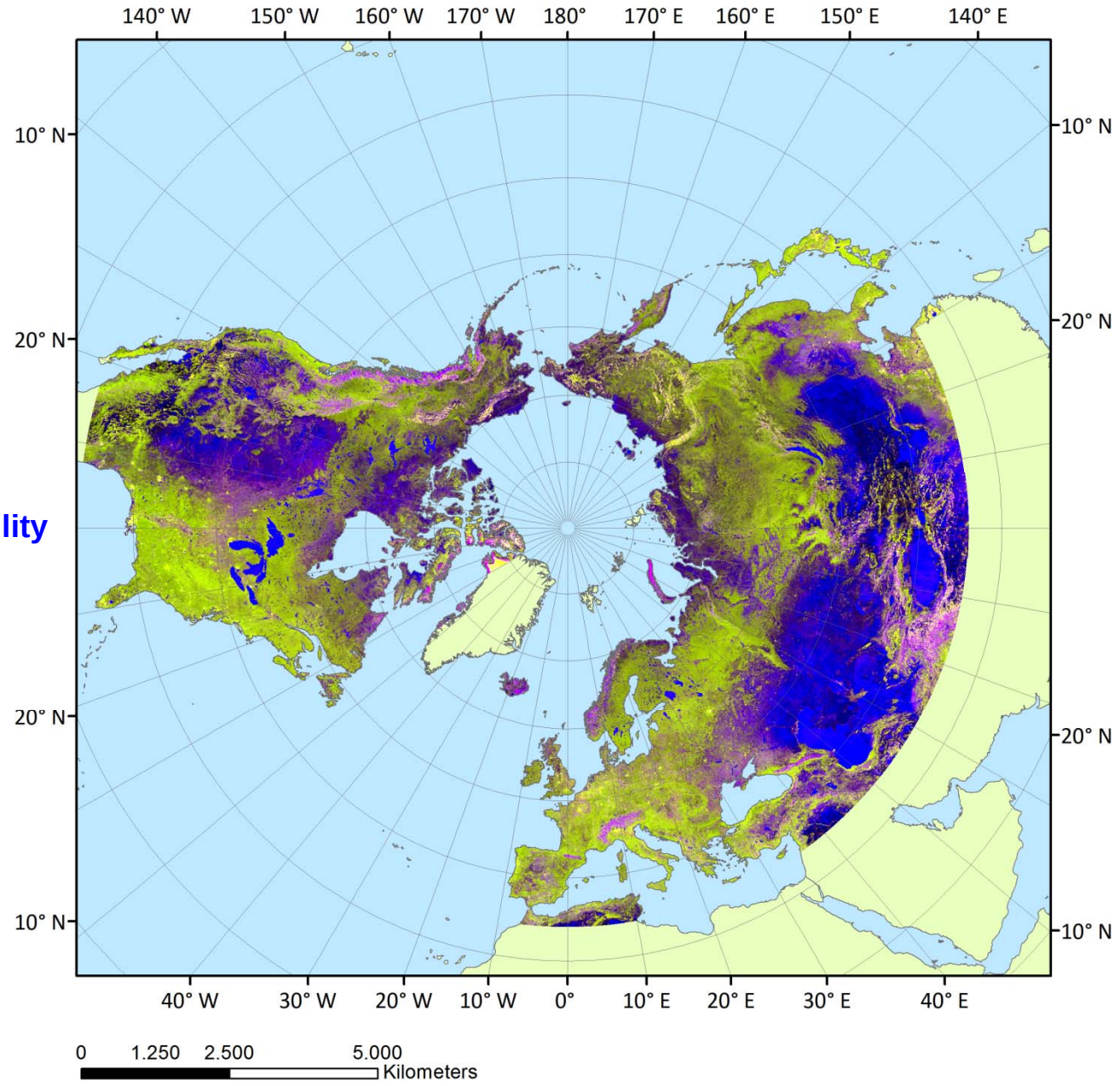
R: average; G: minimum; B: temporal variability

SAR multi-temporal RGB

R: average

G: minimum

B: temporal variability

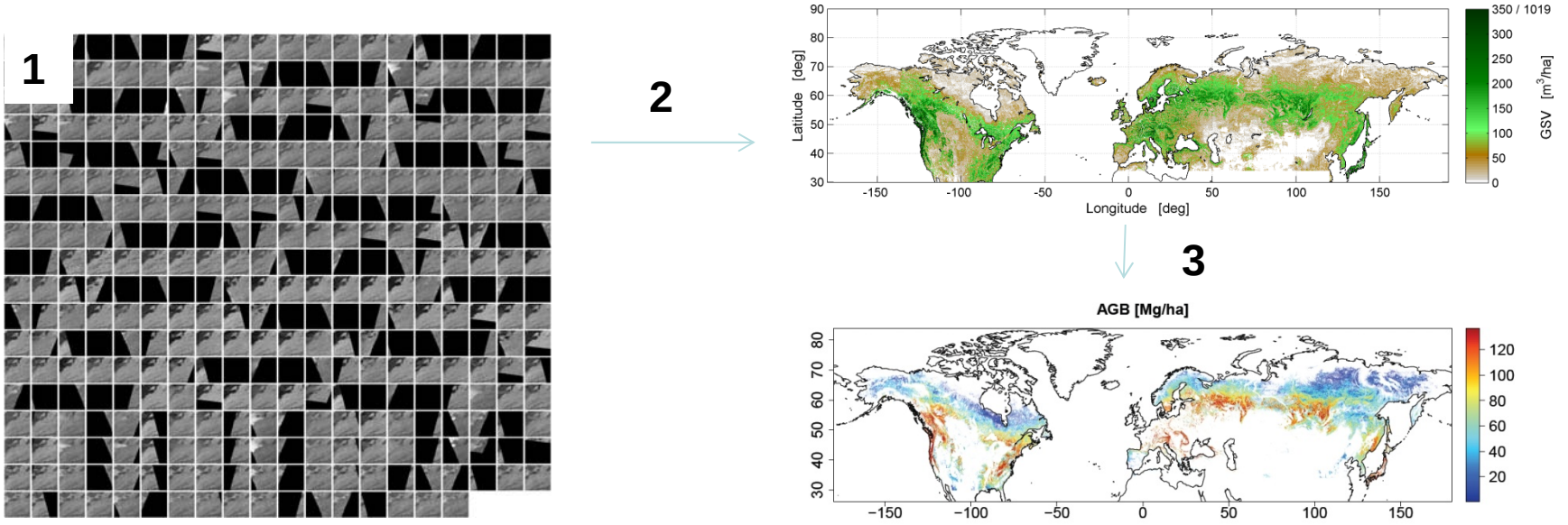


Derivation of AGB in boreal and temperate forest

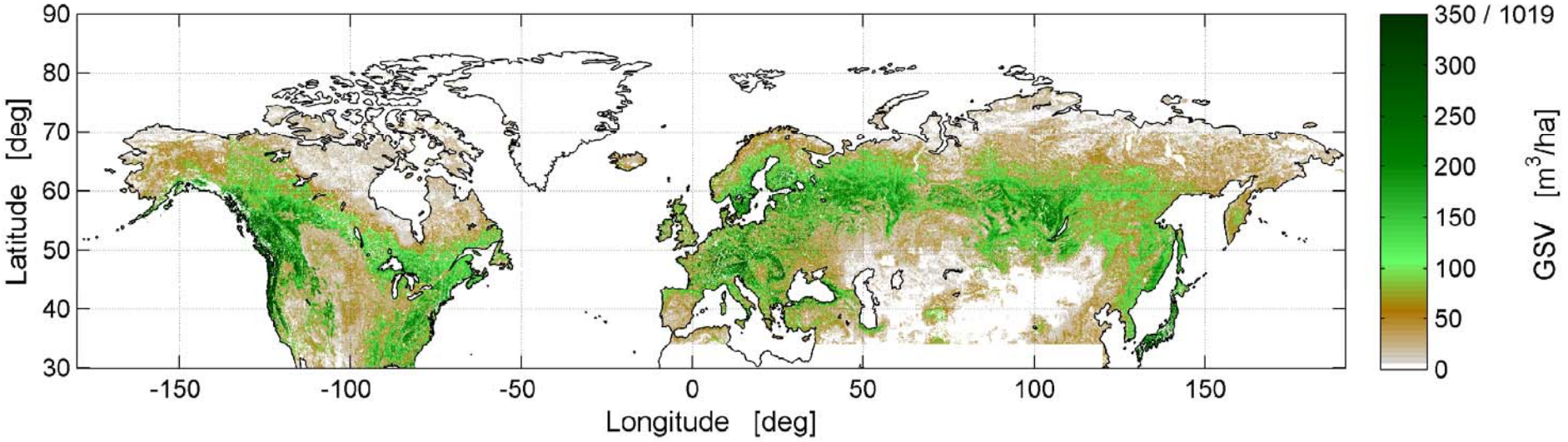
1. Single input dataset: multiple images of spaceborne Envisat ASAR (C-band), 1 km resolution, year 2010

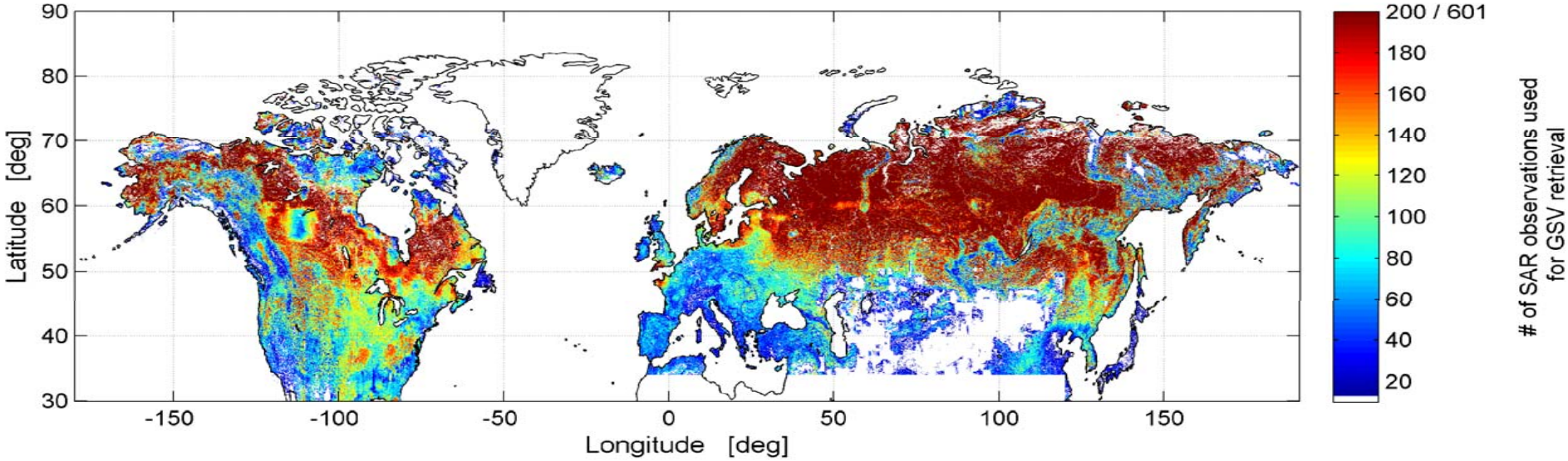
2. Model-based estimation of forest growing stock volume (GSV, m3/ha) from ASAR data (Santoro et al., 2011)

3. Conversion of GSV to AGB (Mg/ha) (Thurner et al., submitted)



Pan-boreal GSV





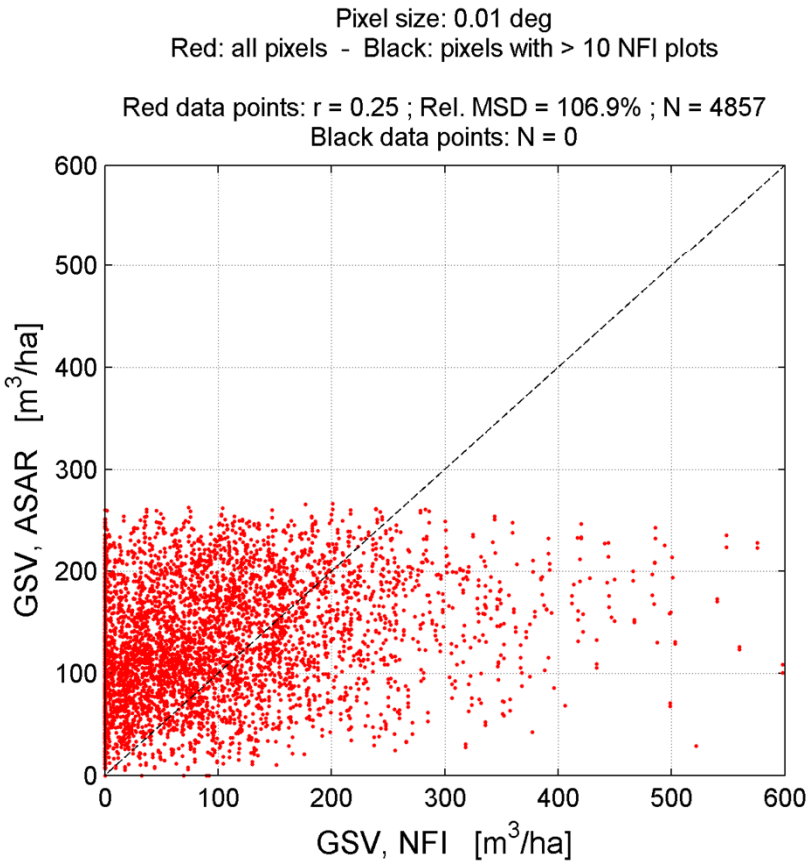
Verification and validation approach

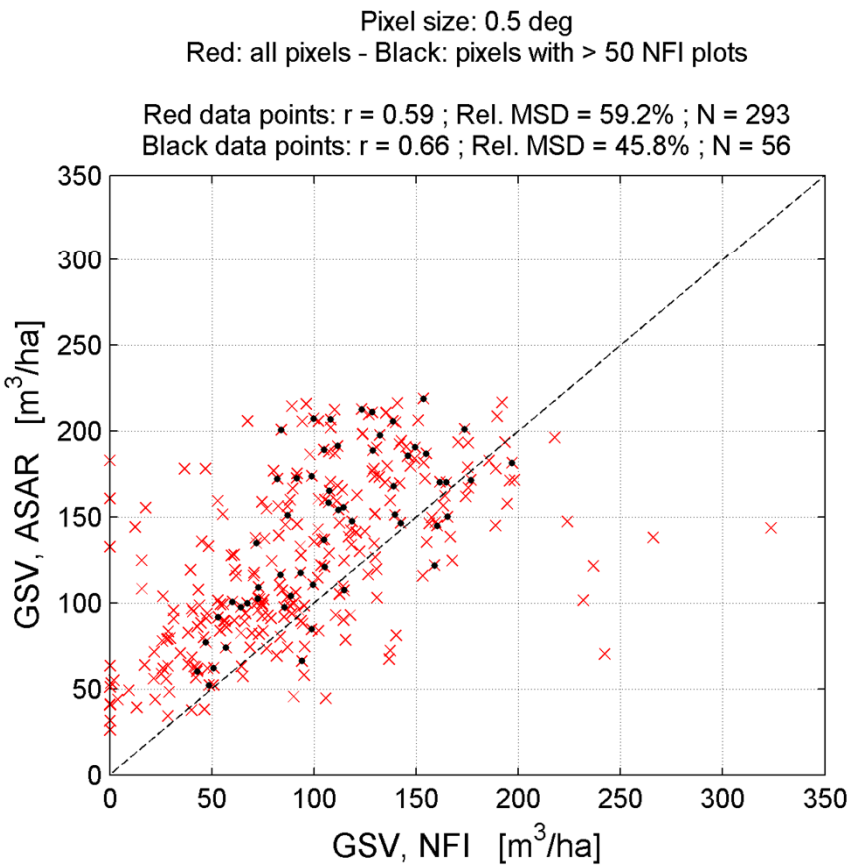
- Validation of GSV consisted of a comparison with respect to in situ measurements. Two aspects are crucial for the assessment
    - Comparable scales
    - Coverage
- Large-scale datasets of 1-km measurements of GSV practically do not exist. Either one combines plots or aggregates polygons → how representative is the aggregate for a 1-km pixel? → issue of forest cover fraction
- Aggregating both datasets makes the GSV therein represented more comparable → validation more sound but only at county/country level then.

- Verification of GSV consists of inter-comparison with respect to EO raster datasets of AGB

Validation / verification of GSV

Scales matter

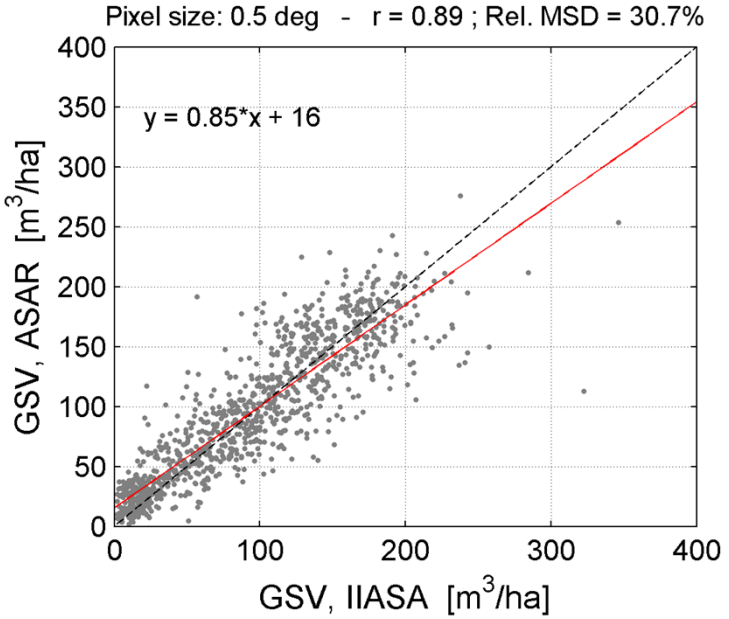




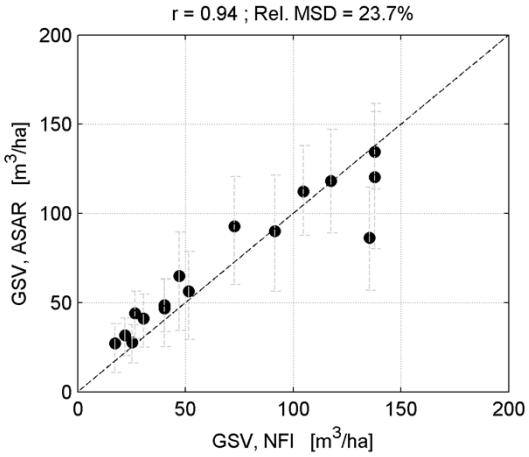
ASAR vs. NFI Sweden forest plots (courtesy of J. Fransson and, J. Fridman)

Validation / verification of GSV

At coarse resolution, strong agreement (error: 20-30 %)



1



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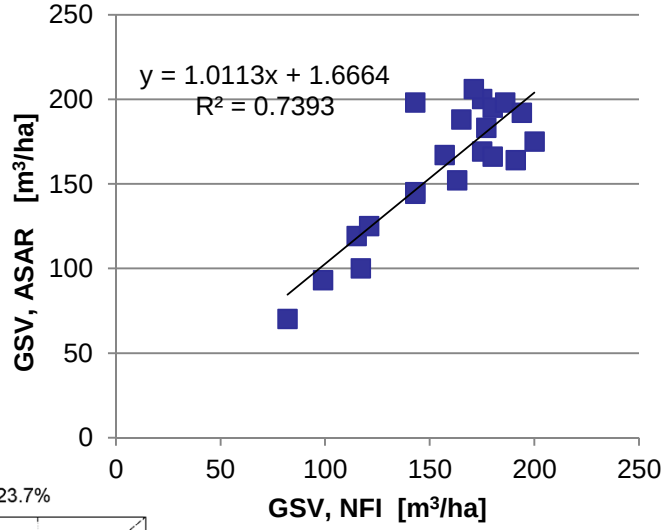

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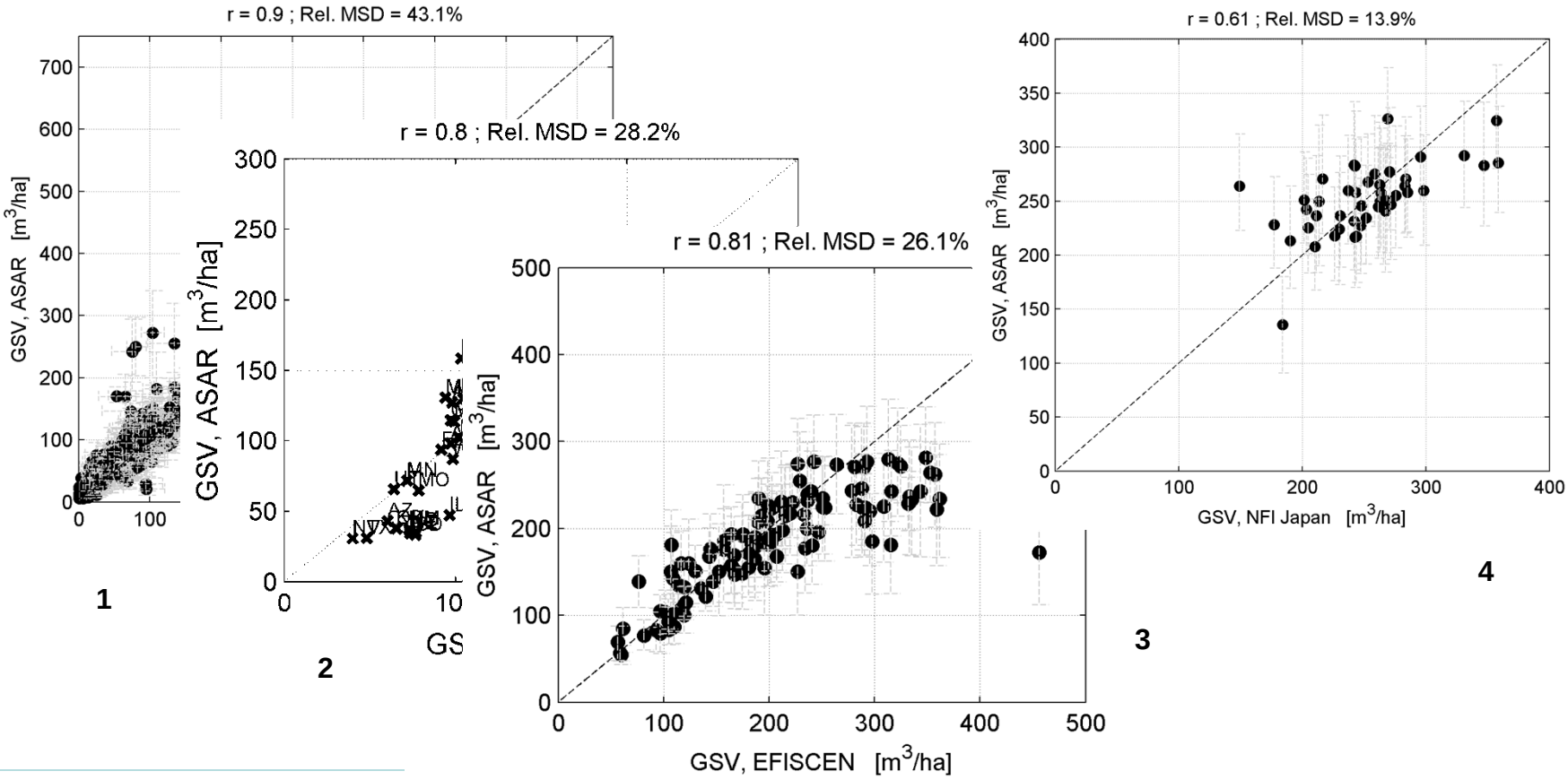
1 GSV, IIASA = raster EO dataset of Russia (Schepaschenko et al., 2011)

2 GSV, NFI = provincial GSV from 3rd forest inventory of Spain

3. GSV, NFI = county-wise GSV, Sweden official statistics (SLU, 2012)

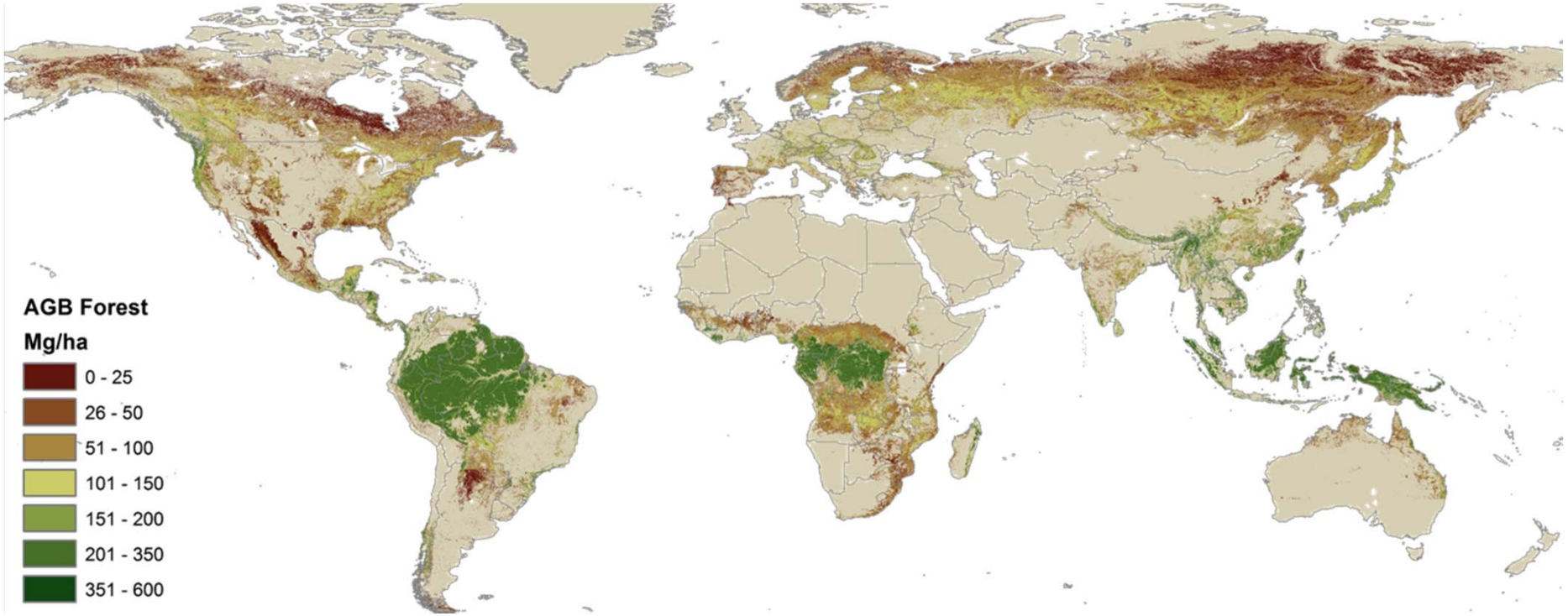
Validation / verification of GSV

Rather consistent tendency of saturation at ~ 300 m³/ha



1. GSV EOSD Canada (Hall et al., 2010) (EOSD data provided by R. Hall) @ 2 deg
2. GSV FIA (US Forest Inventory and Analysis) @ statel level (FIA data available at FIADB)
3. GSV EFISCEN inventory database of Europe,(*Schelhaas, M.J. et al., 2006)* @ provincial level
4. GSV NFI Japan @ prefecture level (data provided by F. Kitahara, Forestry and Forest Products Research)

Prototype global AGB (forest areas only)



Availability of data products

- SAR Products and GSV estimates shall be publically available at the end of the BIOMASARproject (end of April) at http://www.biomasar.org

- Availability of AGB and C stocks to be defined

-Global AGB map available publically at the end of GEO-CARBON project (fall 2014)

-Support to validate the global AGB data product very welcome!