PALSAR Intensities and Coherence for Forest Cover and Forest Change Mapping and Biomass Retrival

Christiane Schmullius, Christian Thiel, Christian Hüttich,
Martyna Stelmaszczuk, Tanvir Ahmed Chowdhury

Friedrich-Schiller-University, Jena

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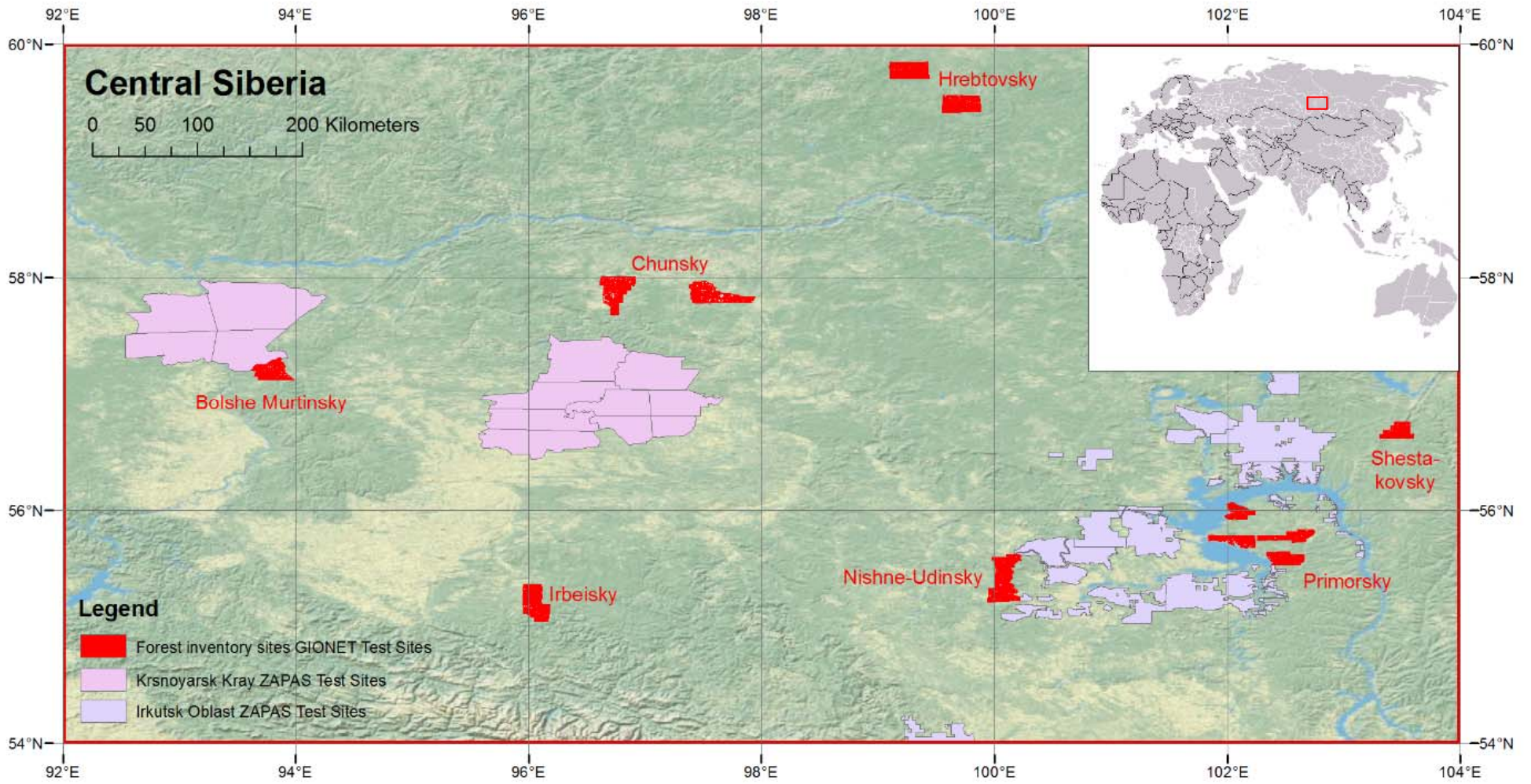
Outline

- Area of Interest
- Project objectives and schedule
- Financial support
- Support to JAXA's global forest mapping effort
- Deliverables

  - MS 1: Forest biomass retrival using POLSAR data

Area of Interest

- Central Siberia: 92˚- 104˚E & 54˚- 60˚N
- Special focus on:
  - Several forest inventory sites
  - Krasnoyarsky Kray, Irkutsk Oblast


Central Siberia
0 50 100 200 Kilometers
92°E
94°E
96°E
98°E
100°E
102°E
104°E
60°N
58°N
56°N
54°N
Hrebtovsky
Chunsky
Bolshe Murtinsky
Irbeisky
Nishne-Udinsky
Primorsky
Shesta-kovsky
Legend
Forest inventory sites GIONET Test Sites
Krsnoyarsk Kray ZAPAS Test Sites
Irkutsk Oblast ZAPAS Test Sites

Project objectives and schedule

- To implement and develop three different approaches of forest biomass retrieval based on ALOS PALSAR:
  - multitemporal ScanSAR data
  - polarimetric data
  - coherence – GSV and backscatter – GSV relationships

ALOS

K&C Initiative

An international science collaboration led by JAXA

Kazachinskoe Region
Krasnoyarsk Kray, Siberia

ALOS PALSAR FBS-HH

interfer. coherence (28dec06 - 12feb07)

High : 0,947293

Low : 0

N

0 2 4 8 km

Project objectives and schedule

Relation to the K&C thematic drivers

Forest and biomass is clearly linked to the "3C" thematic drivers: international **Conventions**, **Carbon cycle science**, **environmental Conservation**, namely:

- biomass is identified by the UNFCCC as an **ECV**
- to improve methods for measuring global biomass within UNFCCC **REDD** mechanism
- to monitor carbon emissions due to **deforestation and forest degradation**.

Project objectives and schedule

Project milestones

- MS 1: **Forest biomass** retrieval using **POLSAR** data – 31.03.2012
- MS 2: **Forest biomass** retrieval using **INSAR** coherence and backscatter – 31.03.2013
- MS 3: **Forest biomass** retrieval using multi-temporal **ScanSAR** data – 31.03.2014
- MS 4: Forest cover and **forest cover change** mapping – 31.03.2014

Financial support

- To achive the objectives following financial support is used:
  - ZAPAS project - EU-Russia Space Dialogue (EU FP7)
  - GIONET project - Marie Curie Programme, Initial Training Networks (EU FP7)
  - PARAPOL project - German Research Foundation (DFG)

ZAPÁS

Programmatic Context

FP7 Cooperation Work Programme "Space"

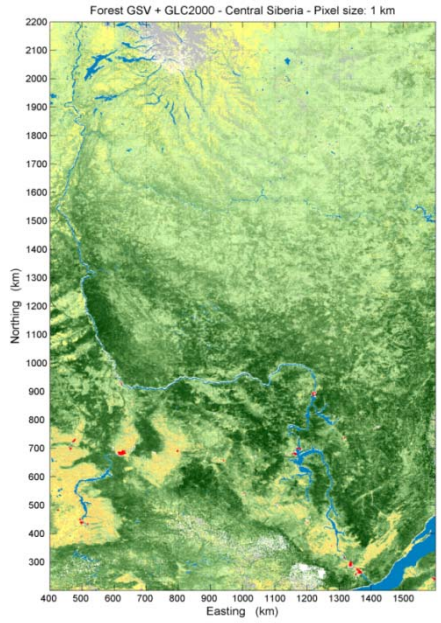
- Activity: 9.3 Cross-cutting activities
  Area 9.3.2: International Cooperation
  SPA.2010.3.2-01 EU-Russia Cooperation in GMES

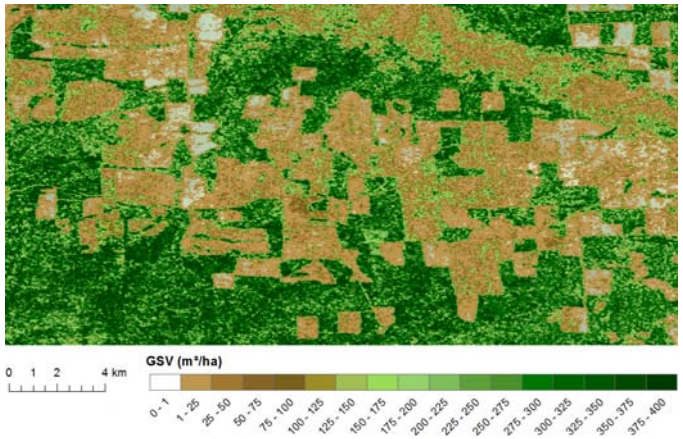
- Continuation of **EC- and GMES-cooperation** activities with Russia
- Joint and synergistic exploration of EO data provided by **ESA** and **ROSCOSMOS**
- Exchange of methodological know-how in processing Earth Observation data

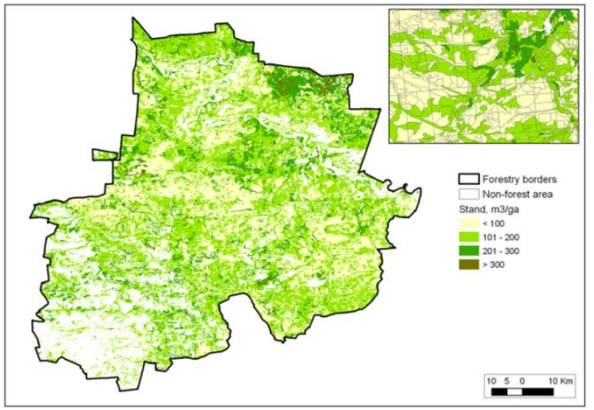
- **Overcome uncertainties in Carbon Accounting based on:**

ZAPÁS

- In-Situ and multi-scale Earth observation synergies
- Combining regional land cover mapping and biomass products







GIONET

- GIONET stands for GMES Initial Operations – Network for Earth Observation Research Training
- The aim of the project is to provide skilled personnel for the GMES land monitoring and emergency information services.
- Period of the project: 2011-2014
- 7 full network and 4 associated partners
- 14 Early Stage Researchers from 12 countries
- 14 doctoral topics

GIONET MARIE CURIE ACTIONS
University of Leicester
ASTRIUM AN EADS COMPANY
DLR
IGiK
MAGYAR TUDOMÁNYOS AKADÉMIA BALATONI LIMNOLÓGIAI KUTATÓINTÉZET
GAMMA REMOTE SENSING

GiNet @

- PhD research topic and focus: *Forest Biomass mapping using SAR techniques*

The estimation of forest biomass still meets problems related mainly to saturation.

How to overcome this problem:

- use SAR data time series
- use the combination of INSAR coherence and backscatter intensity information.

- Supervisor: Prof. Ch. Schmullius; Co-supervisor Dr. Ch. Thiel
- Data: ALOS - PALSAR

PARAPOL

- Retrieval of forest parameters from polarimetric SAR (synthetic aperture radar) data
- Financed by German Research Foundation (DFG)
- Data: ALOS - PALSAR

Dornburger Strasse 159
Dornburger Strasse 159

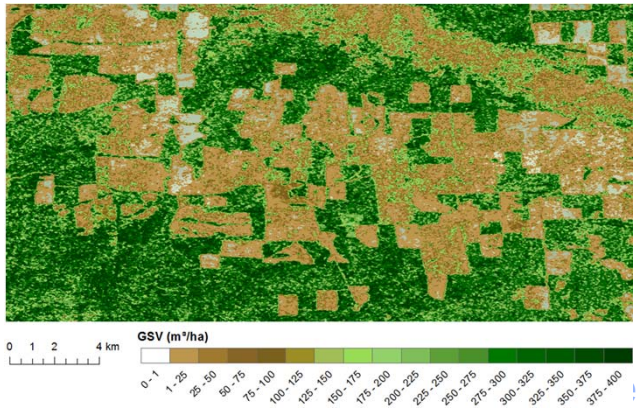
Support to JAXA's global forest mapping effort

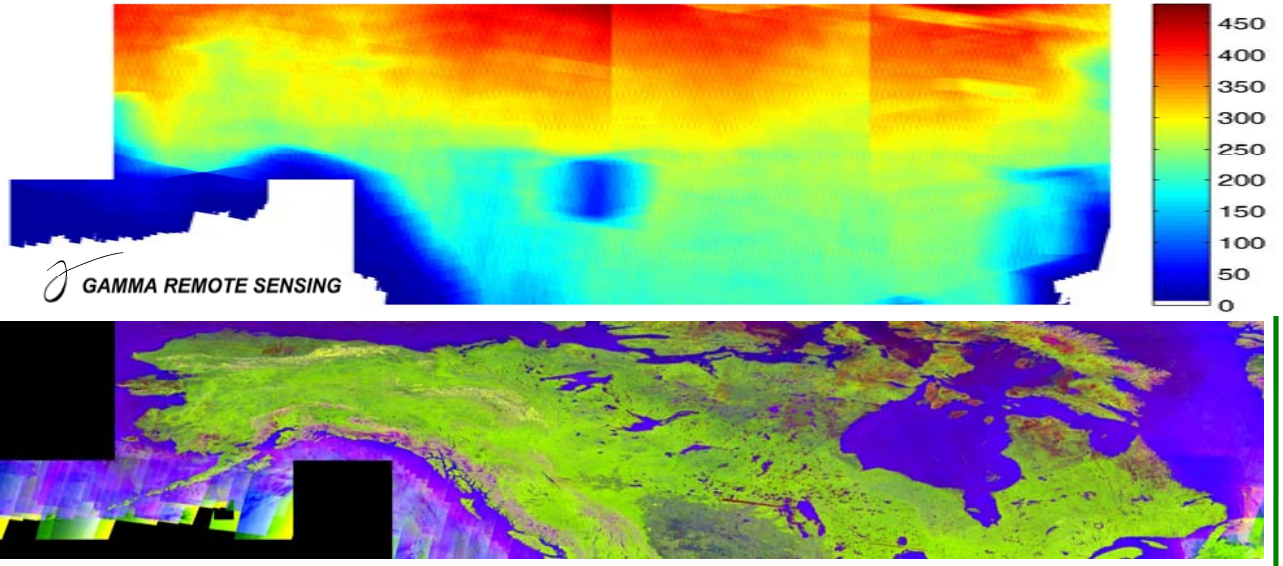
Support to JAXA by delivering following methodology and products:

1. forest cover and forest cover change mapping.
2. biomass retrieval based on three different approaches: multi-temporal ScanSAR data, polarimetric data, INSAR winter coherence and backscatter from summer.

… to pan-boreal applications

local…

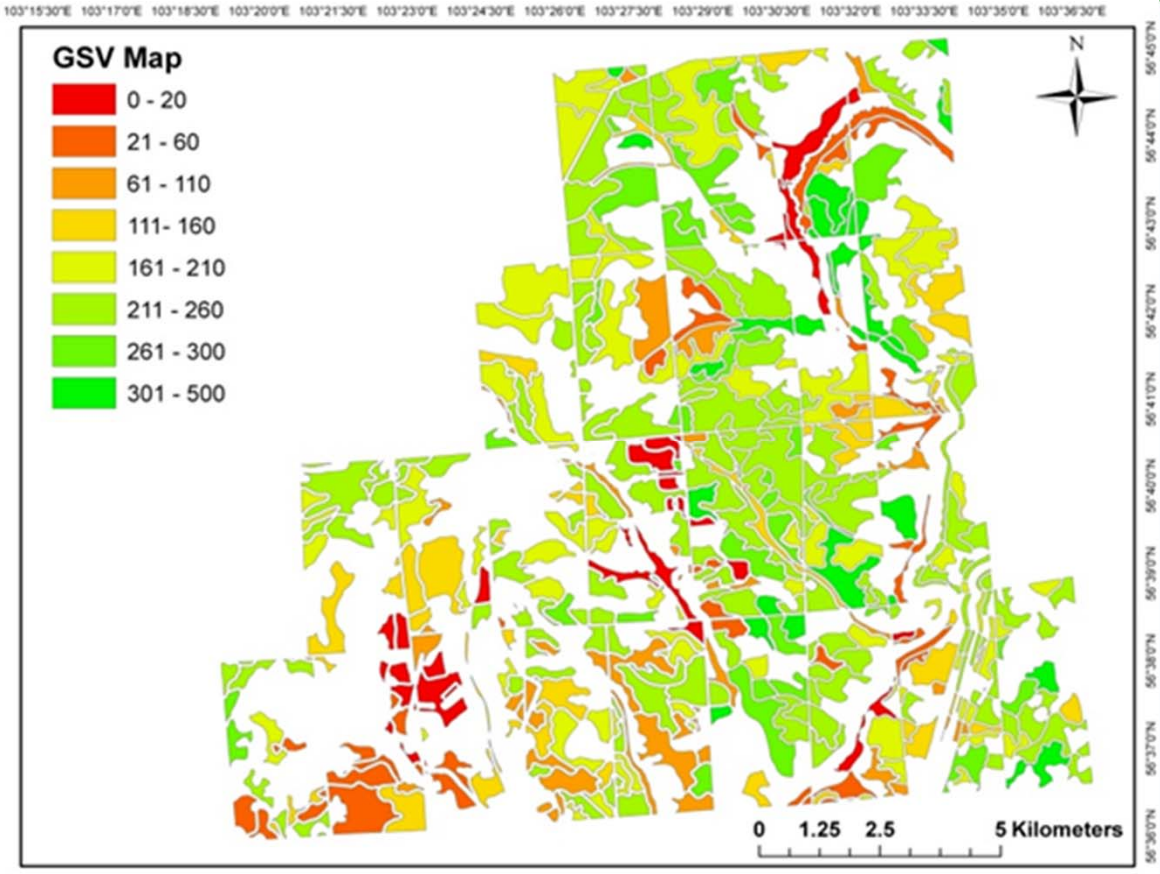




Support to JAXA's global forest mapping effort

Ground truth data

- Sites in Central Siberia
- Growing stock volume from 1995, updated in 1998
- Restrictions: do not impart, do not publish the data

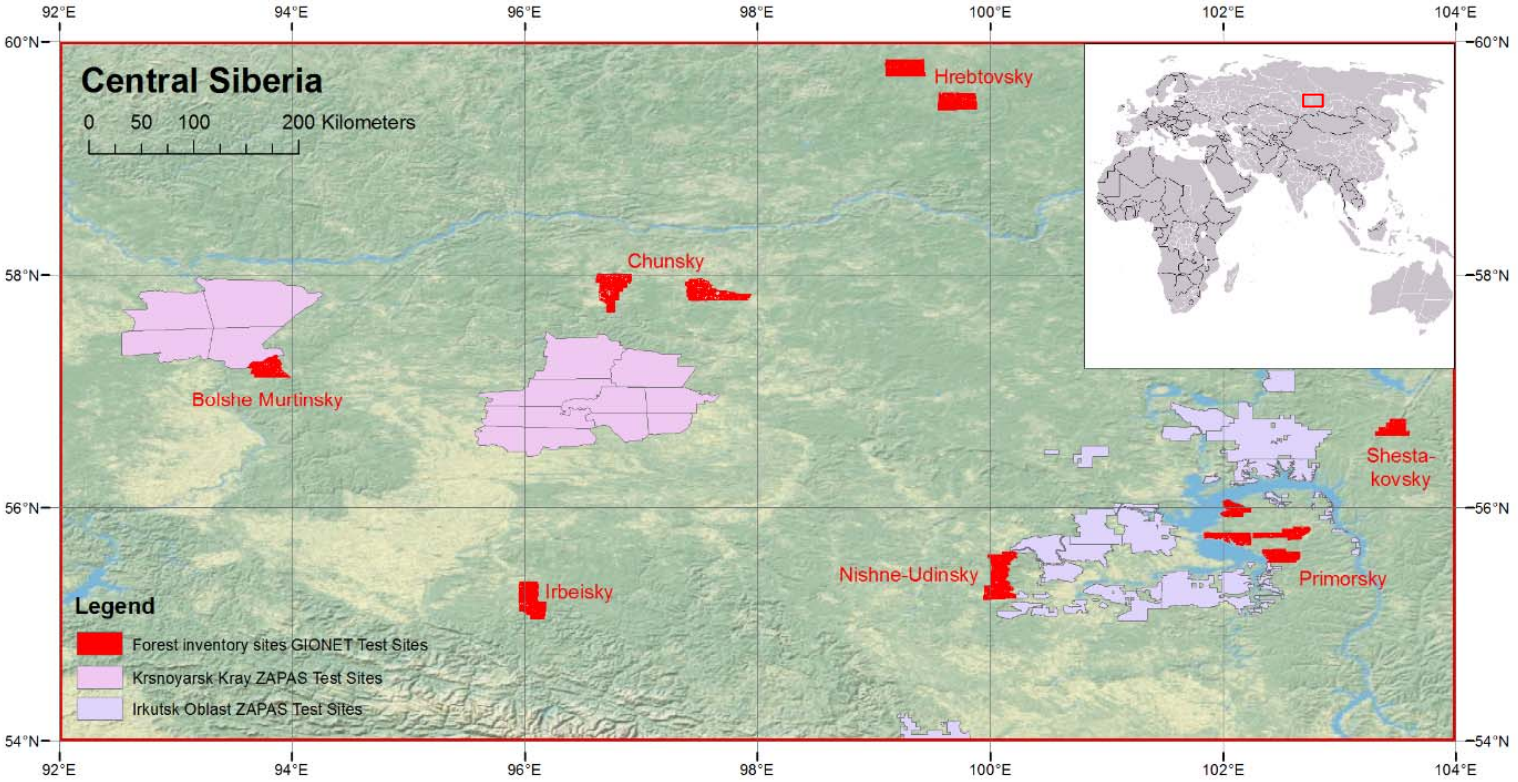


Deliverables

- D 1: Methods on forest biomass retrieval using **POLSAR** data
- D 2: Methods on forest biomass retrieval using **INSAR** coherence and backscatter
- D 3: Methods on forest biomass retrieval using multi-temporal **ScanSAR** data
- D 4: Methods on **forest cover and forest cover** change mapping

MS 1: Forest biomass retrieval using POLSAR data

- Results of the **PARAPOL** project



MS 1: Forest biomass retrieval using POLSAR data

Test Sites	HV	HH/HV	VV/HV	HHVV coherence	Entropy	Alpha	Freeman Vol	VanZyl Vol	Yamaguchi Vol	Ground/ Volume
Shestakovsky-N	0.75	0.46	0.54	-0.82	0.76	0.76	0.71	0.72	0.72	-0.75
Primorsky-E	0.65	0.29	0.46	-0.59	0.60	0.58	0.61	0.61	0.63	-0.59
Primorsky-W	0.65	0.08	0.05	-0.23	0.25	0.19	0.63	0.64	0.64	-0.24
Chunsky-E	0.81	0.63	0.65	-0.78	0.73	0.76	0.82	0.82	0.82	-0.74
Chunsky-N	0.73	0.60	0.68	-0.72	0.69	0.70	0.75	0.76	0.76	-0.66
Chunsky-S	0.54	0.11	0.12	-0.41	0.38	0.32	0.49	0.50	0.50	-0.35
Chunsky-W	0.51	0.40	0.45	-0.54	0.51	0.52	0.50	0.50	0.51	-0.48
Bolshe-NE	0.86	-0.12	-0.23	-0.72	0.63	0.59	0.85	0.85	0.84	-0.62
Bolshe-SE	0.70	0.30	0.30	-0.68	0.57	0.53	0.67	0.68	0.68	-0.57
Bolshe-NW	0.82	0.21	0.59	-0.80	0.69	0.72	0.75	0.77	0.79	-0.75
Bolshe-SW	0.59	0.07	0.23	-0.48	0.37	0.39	0.50	0.53	0.54	-0.44

Linear Pearson correlation coefficients for growing stock volume against SAR parameters

MS 1: Forest biomass retrieval using POLSAR data

RVOG-POLSAR model

The water cloud model*

Ground-to-volume ratio:

$$\mu_{max} = \frac{\sigma_s}{\sigma_v} \frac{e^{-\beta v}}{1 - e^{-\beta v}} \qquad R = \frac{\sigma_s}{\sigma_v}$$

$$V = \frac{1}{\beta} \ln\left(1 + \frac{R}{\mu_{max}}\right)$$

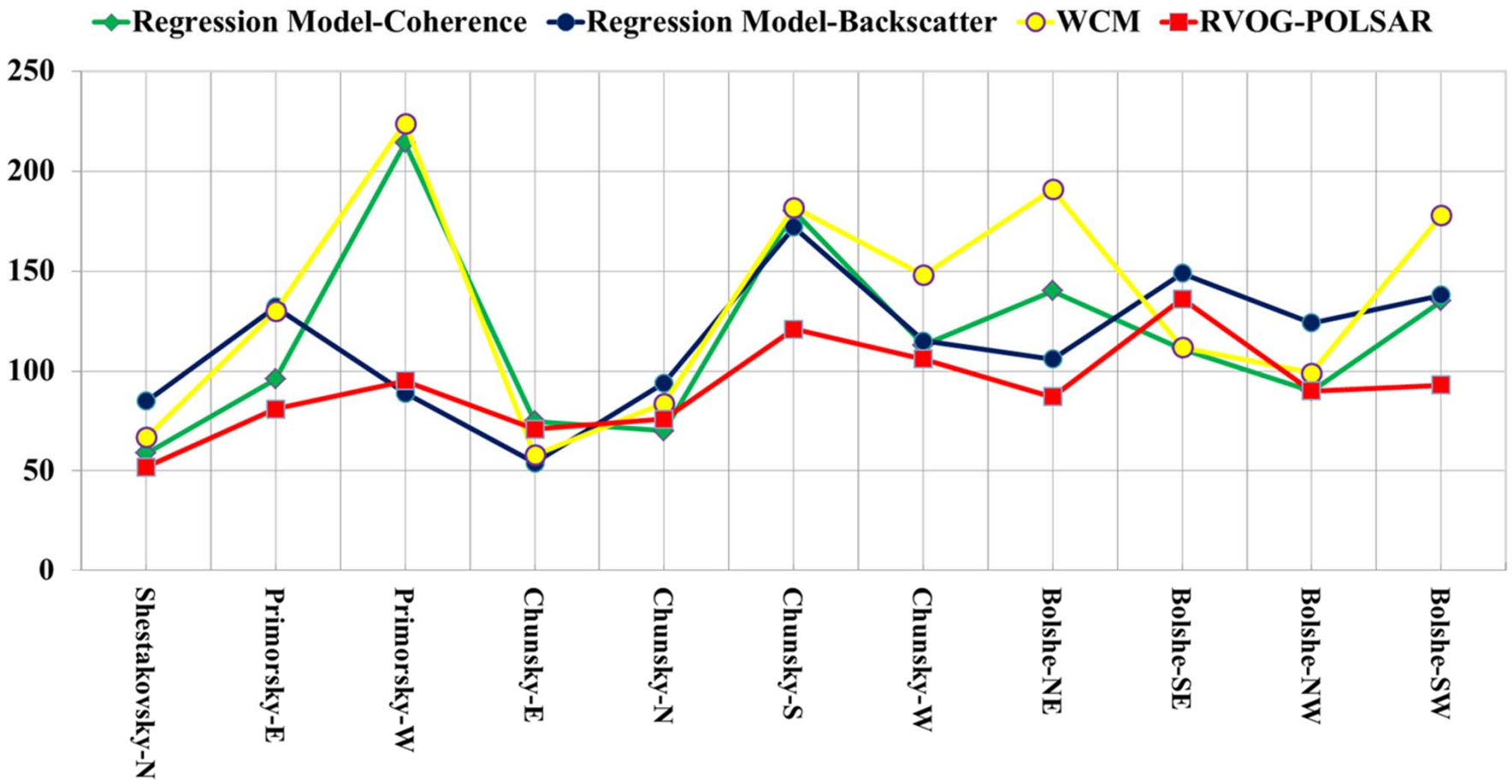
We can use polarimetry orthogonality to isolate volume+surface terms:

two model parameters R and ß to be set...2 ways to solve this:

1. Use regression against sites of known biomass.
2. Fix ß and estimate R from the data itself (forest/non-forest mask).

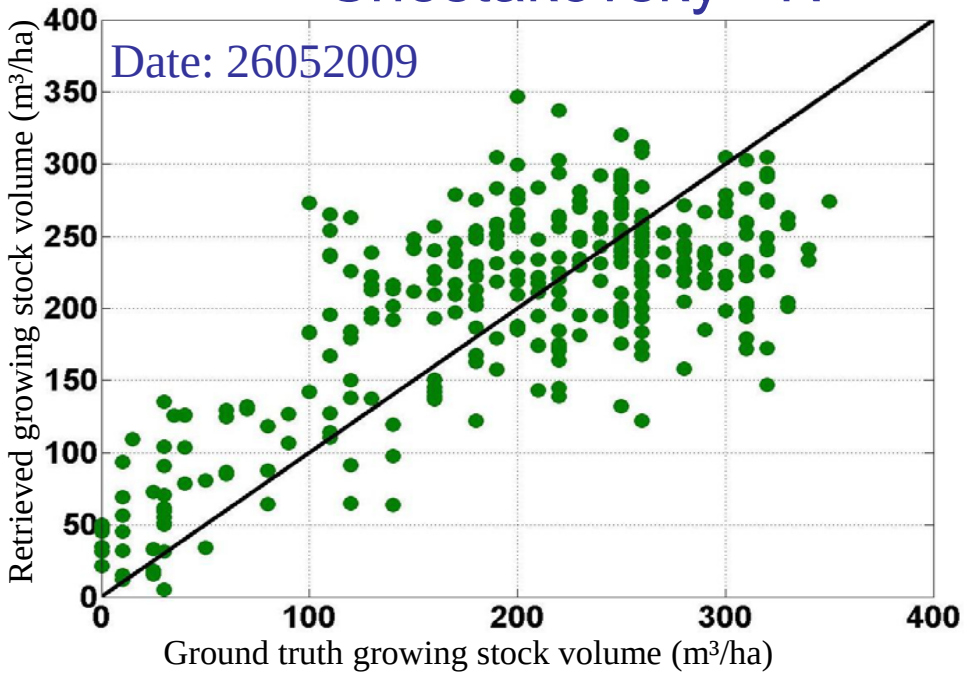
*ASKNE, J., M. SANTORO, G. SMITH & J.E.S. FRANSSON (2003): Multi-temporal repeat pass SAR interferometry of boreal forests. – *IEEE Transactions on Geoscience and Remote Sensing 41*, 7, 1540-1550.

MS 1: Forest biomass retrieval using POLSAR data



MS 1: Forest biomass retrieval using POLSAR data

Shestakovsky - N



Best results for RVOG-POLSAR :

RMSE = 52 m³/ha

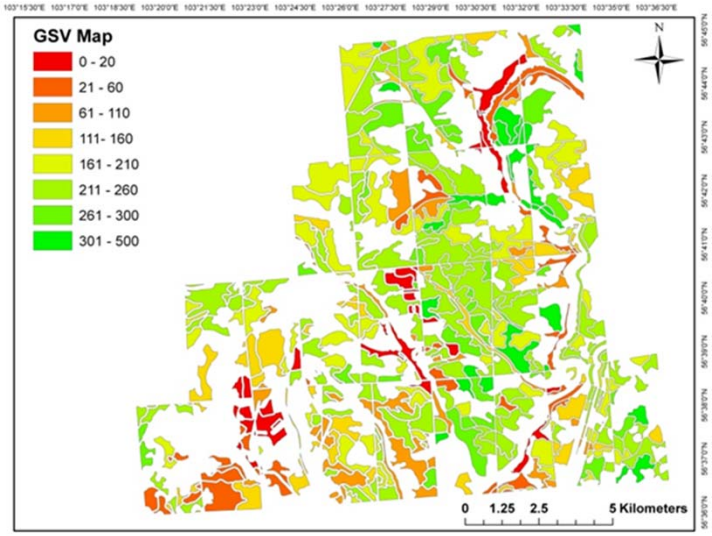
Relative RMSE = 26%

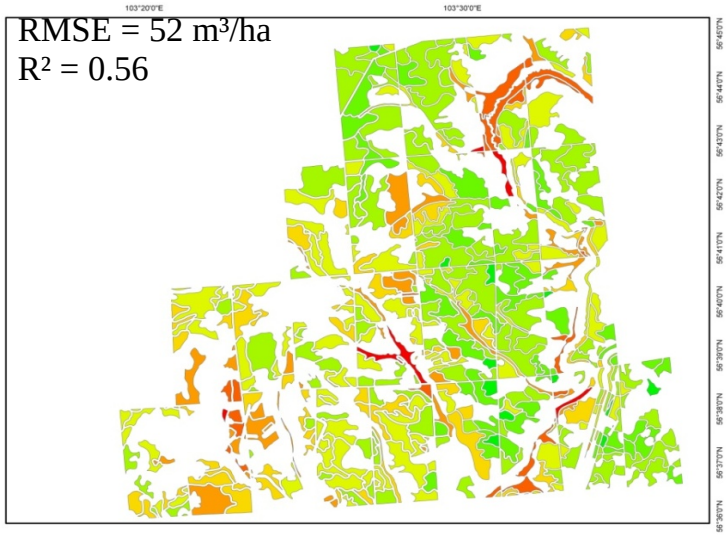
$R^2 = 0.56$

MS 1: Forest biomass retrieval using POLSAR data

Shestakovsky-N

Forest Inventory





RVOG-POLSAR

Acknowledgements

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Thank you


Thank you for your attention!
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