Demonstrating the Potential of ALOS PALSAR Backscatter and INSAR Coherence for Forest Growing Stock Volume Estimation in Central Siberia

seit 1558

Christian J. Thiel & Christiane Schmullius

http://www.eo.uni-jena.de

Introduction

SUMMARY OF RESULTS

- Coherence at frozen conditions offers the largest potential for *GSV* estimation: Saturation at 230 m³/ha, R^2 between coherence and *GSV* is 0.58 (Comparable to ERS-1/2 Tandem)
- Backscatter: Saturation at 75-100 m³/ha, R^2 backscatter vs. *GSV* 0.42 (HH) - 0.48 (HV)
- Combination of backscatter and coherence led to improvement of *GSV* estimation, in particular exclusion of areas with contradictory *GSV* (coherence vs. backscatter) helpful
- Potential of ALOS PALSAR to map the *GSV* of the Siberian forest with a precision close to the accuracy of the conventional forest inventory data (relative RMSE approx. 25%)
- Data availability Siberia: In average 4 coherence images (Bt 46 days) acquired at frozen conditions and 6 FBD backscatter images acquired at unfrozen conditions

STUDY AREA

Central Siberia: Middle Siberian Plateau in the southern part of the territory is characterised by hills up to 1,700 m. Northern part is flat with elevations up to 500 m. Boreal forests.

FOREST INVETORY DATA

Ministerial forest inventory data: Many parameters, including the average GSV per forest stand.

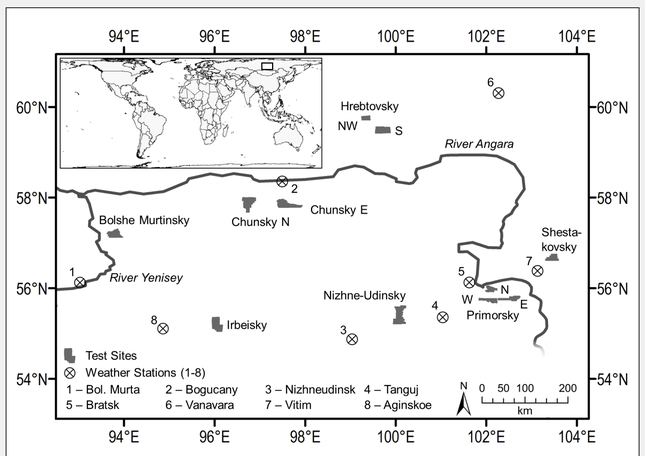
METEOROLOGICAL DATA

Typical weather conditions observed: Temperatures far below freezing point during winter and above 0°C during summer. Only little precipitation.

Data & Methods

Location	Chunsky N	Chunsky E	Primorsky	Bolshe	Shesta.	Nizhne	Irbeisky	Hrebt.
2006	—	30 Dec	—	28 Dec	—	—	—	—
2007	***20 Jun***	14 Feb	18 Jan	12 Feb	13 Jan	11 Jan	***10 Aug***	6 Jan
	5 Aug	***2 Jul***	5 Mar	***15 Aug***	28 Feb	26 Feb	**10 Nov**	21 Feb
	20 Sep	***17 Aug***	***21 Jul***	***30 Sep***	***16 Jul***	***14 Jul***	26 Dec	***9 Jul***
	5 Nov	***2 Oct***	***5 Sep***	31 Dec	***31 Aug***	***14 Oct***	—	***24 Aug***
	21 Dec	**17 Nov**	***21 Oct***	—	***16 Oct***	—	—	***9 Oct***
2008	5 Feb	2 Jan	21 Jan	15 Feb	16 Jan	29 Feb	10 Feb	9 Jan
	22 Mar	17 Feb	—	***2 Jul***	2 Mar	***16 Jul***	***27 Jun***	24 Feb
	7 May	***4 Jul***	—	***17 Aug***	***17 Apr***	***31 Aug***	***12 Aug***	***11 Jul***
	22 Jun	***19 Aug***	—	—	***18 Jul***	—	28 Dec	***26 Aug***
	7 Aug	—	—	—	***2 Sep***	—	—	—
2009	—	4 Jan	—	2 Jan	18 Jan	16 Jan	12 Feb	11 Jan
	—	19 Feb	—	17 Feb	5 Mar	3 Mar	***30 Jun***	26 Feb
	—	—	—	—	***21 Jul***	—	***15 Aug***	***14 Jul***
	—	—	—	—	***5 Sep***	—	***30 Sep***	***29 Aug***
	—	—	—	—	***21 Oct***	—	—	***14 Oct***

PALSAR data: *Italics: unfrozen*; **Bold: FBD** (Fine Beam Dual); Other: FBS (Fine Beam Single) & frozen



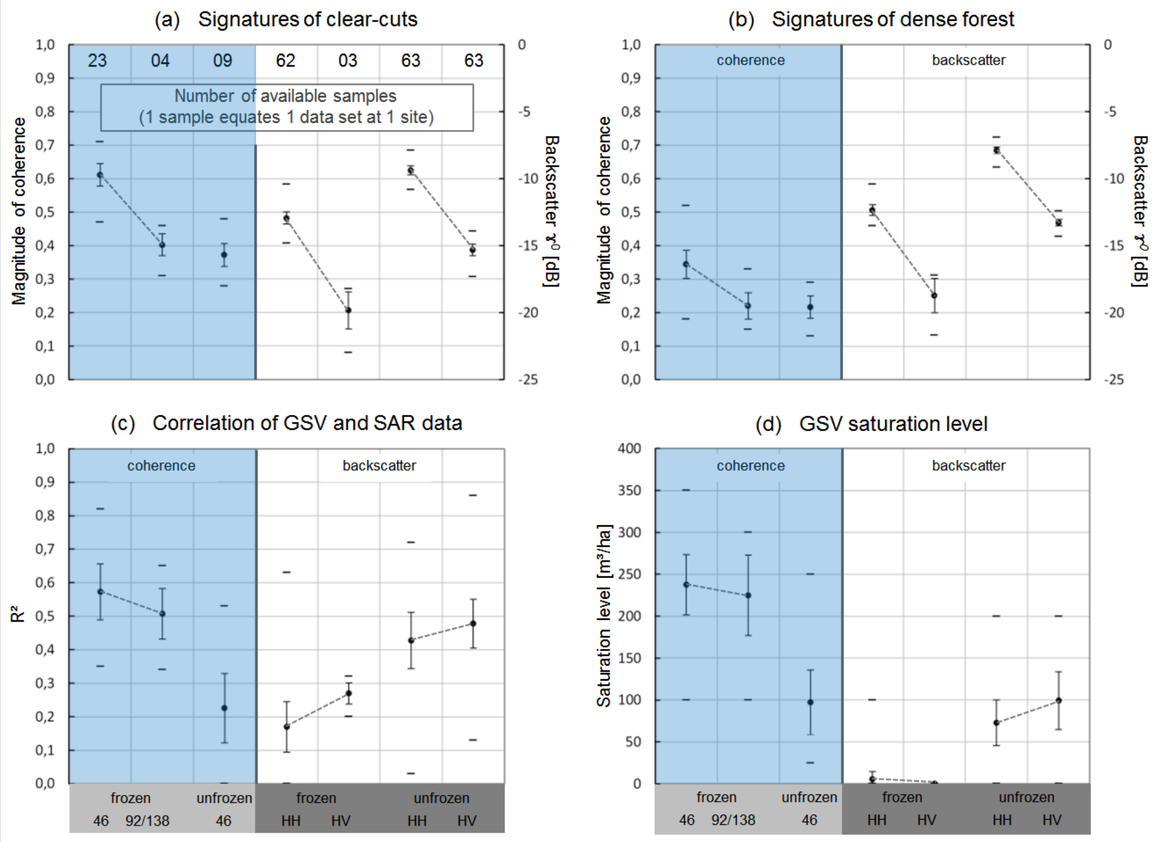
Each site > 330 stands, mean GSV 185 m³ ha^{-1} (excl. clear-cuts)

DELINEATION OF GSV MAPS

1. Random training data selection (20% of inventory data)
2. Training of empirical exponential model
3. Pixel based model inversion
4. Averaging intermediate *GSV* maps resulting in one backscatter based and in one coherence based *GSV* map
5. Merging coherence and backscatter based *GSV* map
6. Elimination of pixels with a GSV difference > 100 m³/ha
7. Setting all negative *GSV* values to zero
8. Assessing accuracy using remaining 80% of inventory data

Results

EXPERIMENTAL DATA – SUMMARY



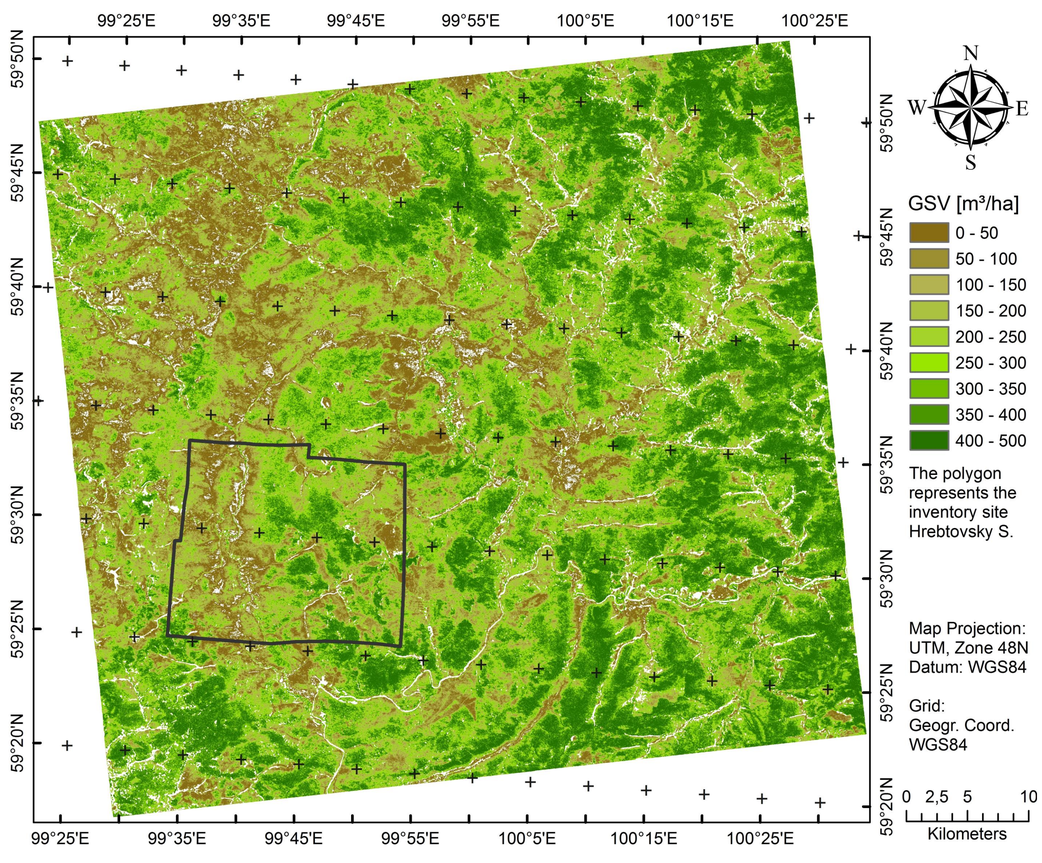
• = average; I = standard deviation; ¯ = minimum/maximum; 46, 92,138 = temporal baseline [d]

ACCURACY OF GSV MAPS DEPENDING ON USED DATA

	Chunsky E	Chunsky N	Shesta	Hrebt S	Nishni
R^2 coh + int	**0.79**	**0.79**	**0.54**	**0.57**	**0.83**
R^2 coh	0.80	0.78	0.37	0.55	0.82
R^2 int	0.67	0.70	0.56	0.50	0.82
RMSE [m³/ha] coh + int	**56.6**	**41.2**	**50.4**	**57.4**	**48.9**
RMSE [m³/ha] coh	56.4	42.4	52.7	61.9	50.7
RMSE [m³/ha] int	71.1	50.3	56.2	59.1	56.1

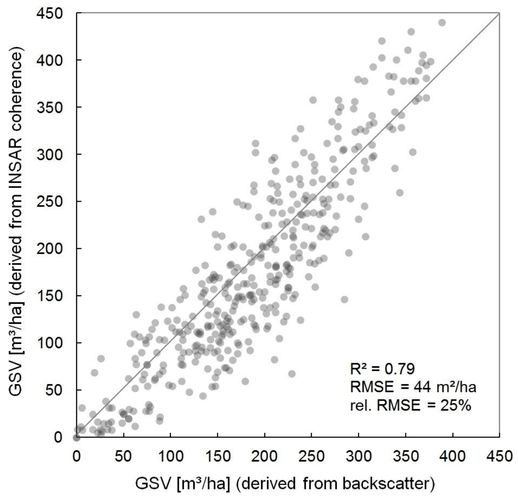
Corrected relative RMSE approximately 25% for all sites

PALSAR BASED GSV MAP EXAMPLE (HREBTOVSKY)

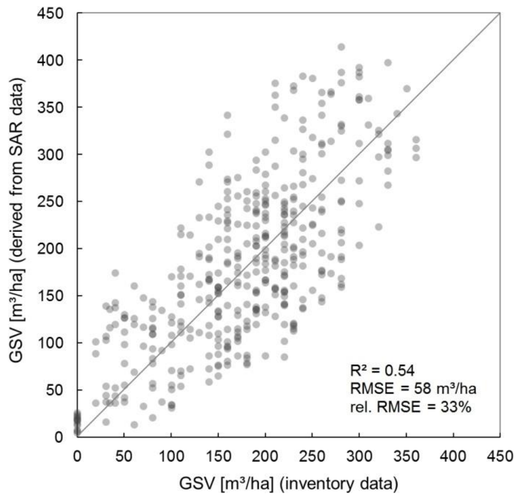


FOREST STAND LEVEL BASED COMPARISON OF GSV (HREBTOVSKY)

Backscatter based vs. coherence based GSV map



SAR based vs. inventory GSV



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.

Contact

Friedrich-Schiller-University Jena, Department of Earth Observation
Grietgasse 6, 07743 Jena, Germany
Christian.Thiel@uni-jena.de, +49 3641 94 88 75
C.Schmullius@uni-jena.de