Product Delivery Report for K&C Phase 2

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Science Team meeting #15
JAXA TKSC/RESTEC HQ, Tsukuba/Tokyo, January 24-28, 2011

K&C deliverables
Papers and Reports

1. Published (please provide PDF file)

- K&C Phase-1 and Phase 2 reports, contribution to K&C Booklet
- CH. THIEL, CA. THIEL & C. SCHMULLIUS (2009): Operational Large Area Forest Monitoring in Siberia Using ALOS PALSAR Summer Intensities and Winter Coherence.-In: IEEE Trans. Geoscience and Remote Sensing 47(12), pp. 3993-4000.
- CH. THIEL & C. SCHMULLIUS (2009): Examination of Multi-Seasonal ALOS PALSAR Interferometric Coherence for Forestry Applications in the Boreal Zone.-In: Proceedings of 3rd Joint PI Symposium of ALOS Data Nodes for ALOS Science Program, 09. – 13. November 2009, Kona, USA.
- THIEL, CH., M. SANTORO, O. CARTUS, CA. THIEL, T. RIEDEL & C. SCHMULLIUS (2009): Perspectives of SAR based Forest Cover, Forest Cover Change and Biomass Mapping. In: Christophe P. Vasser [Ed.], The Kyoto Protocol: Economic Assessments, Implementation Mechanisms, and Policy Implications, pp. 13-56, ISBN: 978-1-60456-983-4.
- THIEL, CA., CH. THIEL, J. REICHE, R. LEITERER & C. SCHMULLIUS (2009): Großflächige Waldüberwachung in Sibirien unter Verwendung von ALOS PALSAR Winter Kohärenzen und Sommer Intensitäten.-In: Proceedings of 29. DGPF Jahrestagung: 24.-26.03.2009, Jena, Germany.
- THIEL, C. & C. SCHMULLIUS (2010): Examination of Summer- and Winter ALOS PALSAR Interferometric Coherence and Phase in Siberia. – Proceedings of the ESA Living Planet Symposium, 28 June - 2 July 2010, Bergen, Norway.
- THIEL, C. & C. SCHMULLIUS (2010): Seasonality of ALOS PALSAR Interferometric Coherence and Interferometric Phase in central Siberia and its implication on forest parameter retrieval. - Proceedings of the International Geoscience and Remote Sensing Symposium IGARSS'10: 25-30 July 2010, Hawaii, USA.

K&C deliverables
Papers and Reports

1. Published (please provide PDF file)

2. Submitted/in preparation

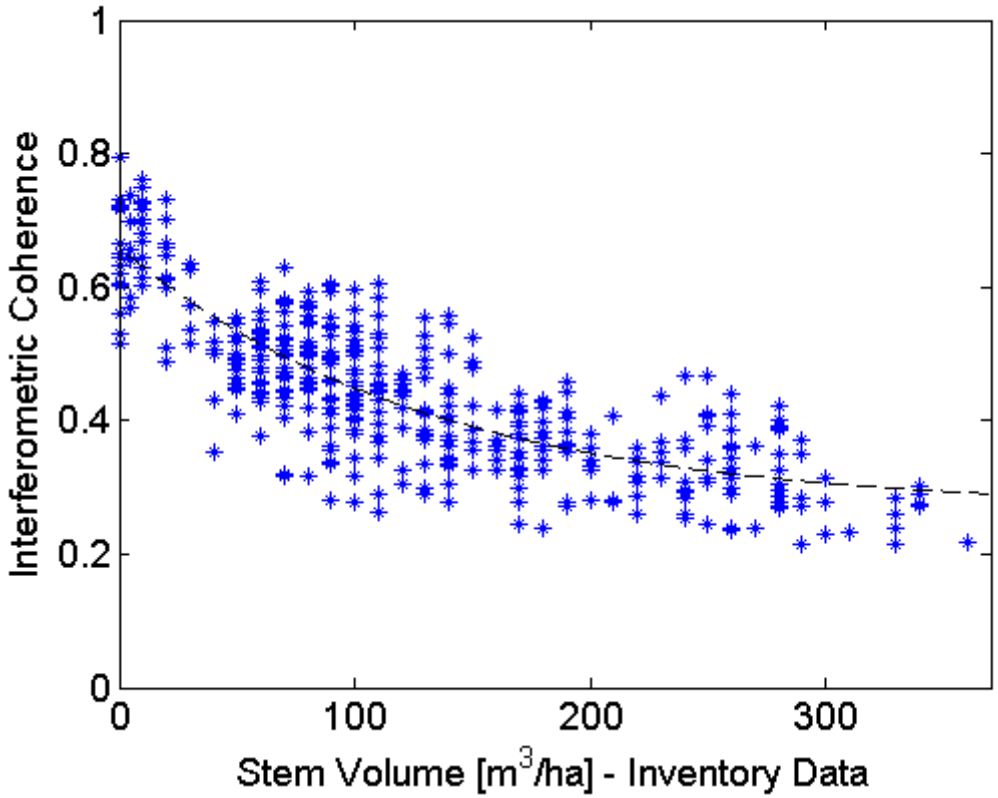
- THIEL, C. (spring 2011) et. al: Seasonality of ALOS PALSAR Interferometric Coherence and Interferometric Phase in central Siberia and its implication on forest parameter retrieval.-In: IEEE Trans. Geoscience and Remote Sensing.
- Sen4Science, ALOS Symposium 2011 etc.

K&C deliverables

- Original idea of the phase 2 proposal was to use the information contained in the winter coherence additionally to the backscatter for land cover mapping in the boreal zone. This idea was based on the very promising results of phase one.
- So far, the data base in terms of coherence data strips could not be provided. However, the whole approach is pending and might be accomplished at phase 3, at least for a smaller demonstration area.
- New overall topic: investigate use of interferometric coherence for forest biomass estimation

ALOS-PALSAR coherence for biomass estimation in the boreal zone

Background



ALOS-PALSAR coherence for biomass estimation in the boreal zone

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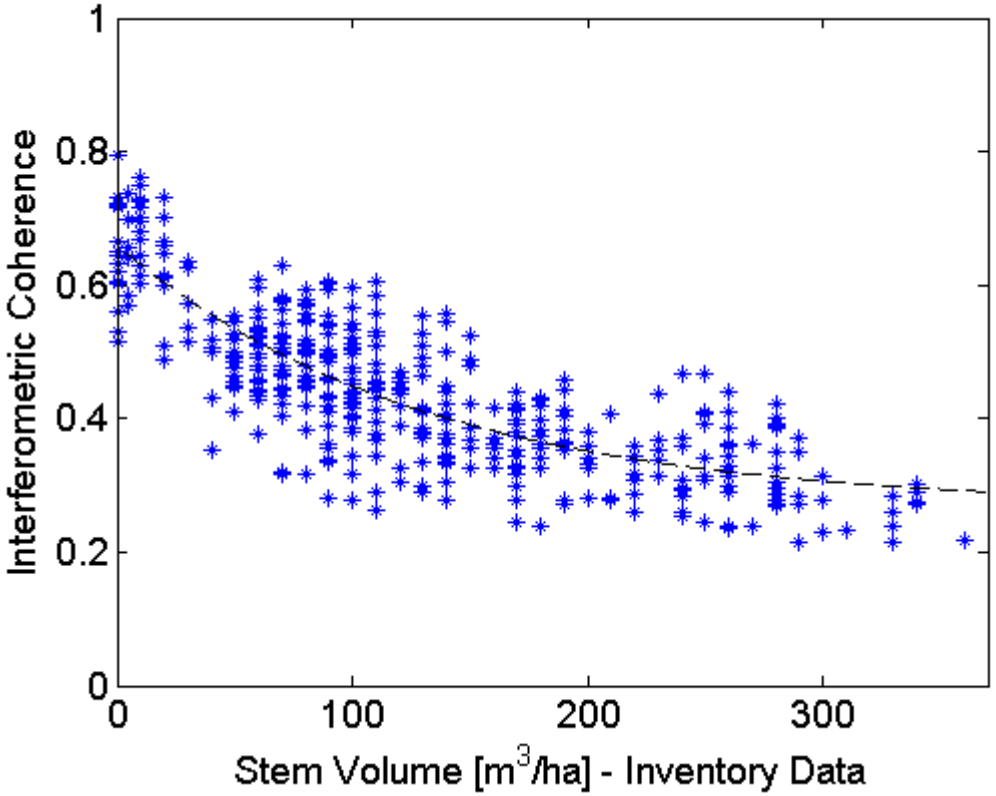


Assumption:
Decreasing coherence caused by volume decorrelation and temporal decorrelation

ALOS

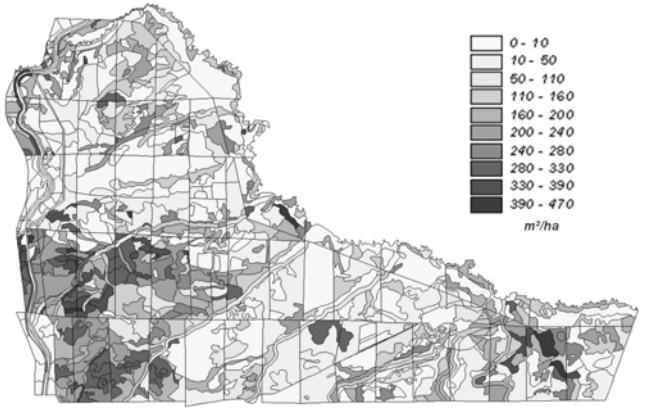
K&C Initiative

An international science collaboration led by JAXA

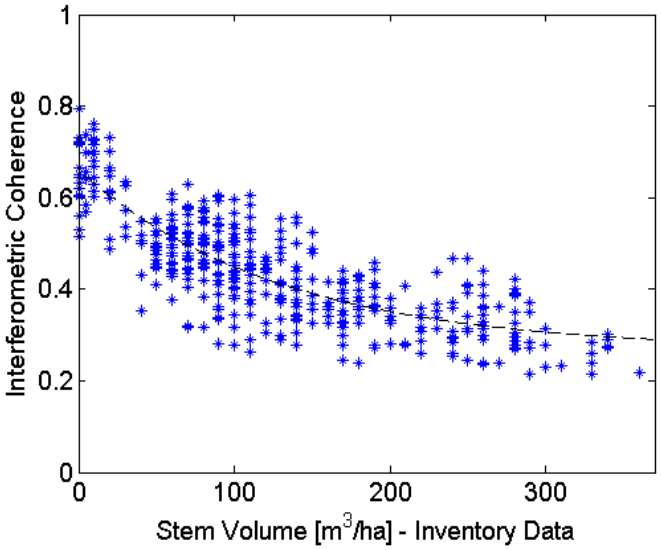
Chunsky N	Chunsky E	Primorsky	Bolshe
T475/F1150	T473/F1150	T466/F1110	T481/F1140
(Track/Frame)	30dec06	18jan07	28dec06
	14feb07	05mar07	12feb07
20jun07	***02jul07***	***21jul07***	***15aug07***
05aug07	***17aug07***	***05sep07***	***30sep07***
20sep07	***02oct07***	***21oct07***	
	17nov07		
05nov07			
21dec07			31dec07
05feb08	02jan08	21jan08	15feb08
22mar08	17feb08		
07may08			
22jun08			
07aug08	***04jul08***		***02jul08***
	19aug08		***17aug08***
	04jan09		02jan09
	19feb09		17feb09

Shestakovsky	Nizhne-Udinsky	Irbeisky	Hrebtovsky
T0463/F1130	T0471/F1100	T0478/F1100	T0468/F1190
13jan07	11jan07		06jan07
28feb07	26feb07		21feb07
16jul07	***14jul07***		***09jul07***
31aug07		***10aug07***	***24aug07***
16oct07	***14oct07***		***09oct07***
16jan08		**10nov07**	09jan08
02mar08	29feb08	26dec07	24feb08
17apr08		10feb08	***11jul08***
18jul08	***16jul08***	***27jun08***	***26aug08***
02sep08	***31aug08***	***12aug08***	
18jan09	16jan09	28dec08	11jan09
05mar09	03mar09	12feb09	26feb09
21jul09		***30jun09***	***14jul09***
05sep09		***15aug09***	***29aug09***
21oct09		***30sep09***	***14oct09***

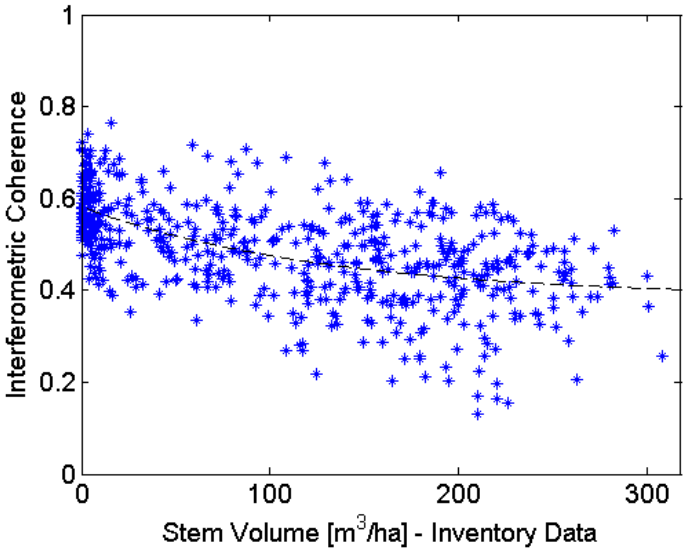
Data



Winter vs. Summer coherence



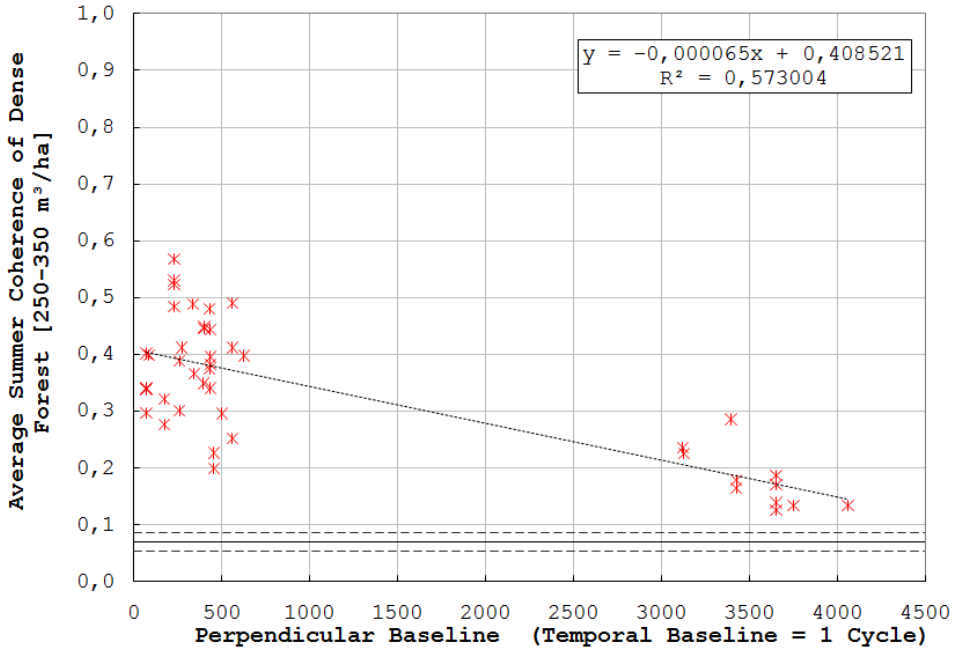
Winter coherence (46 days)



Summer coherence (46 days)

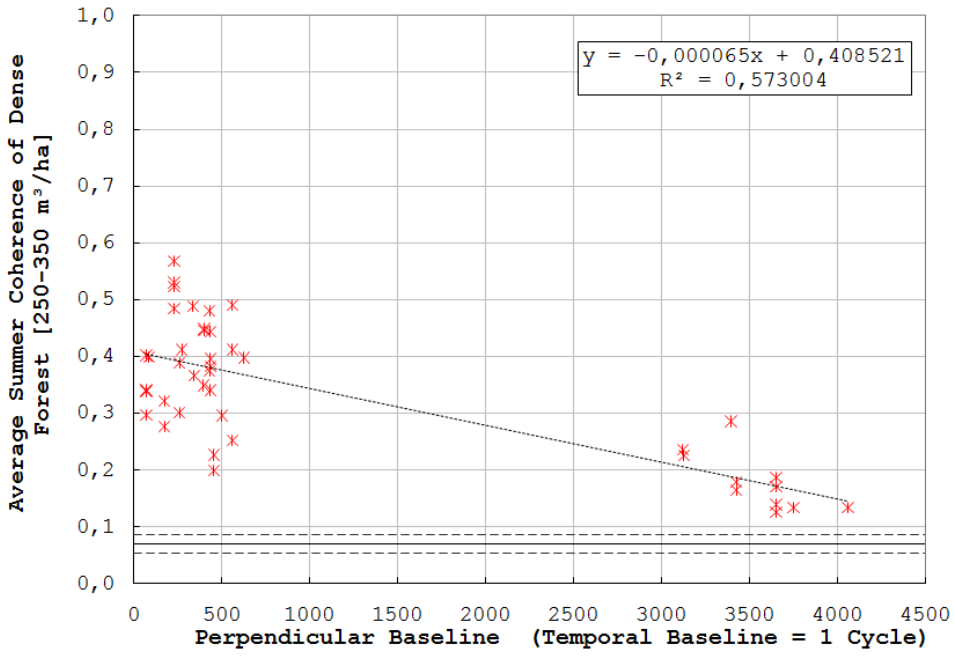
This behavior was found for all sites. Dependency of perpendicular baseline?

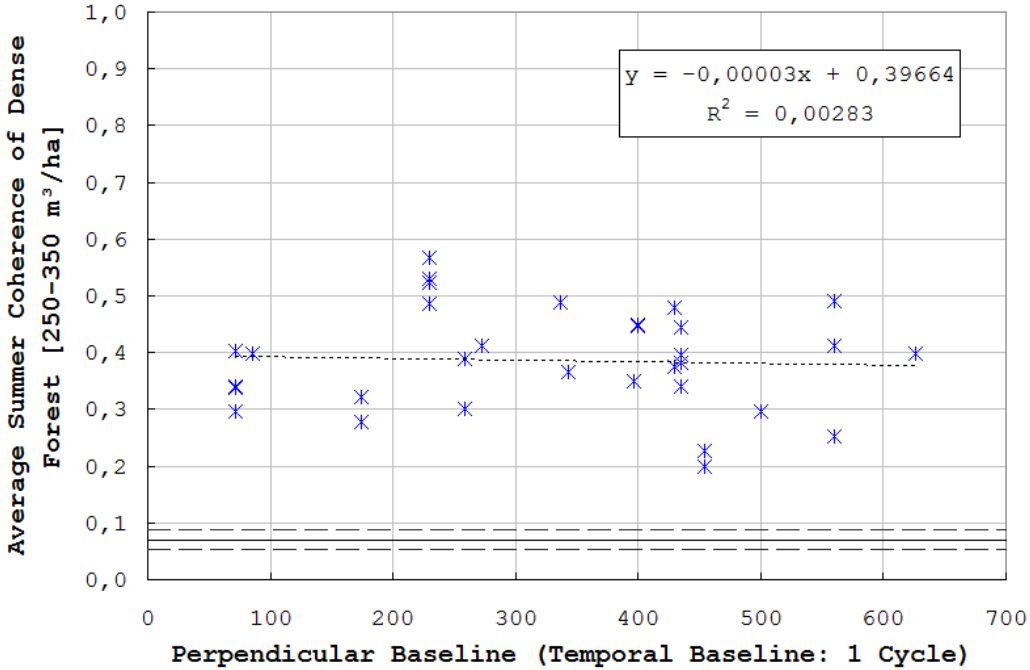
Forest coherence versus perpendicular baselines: summer



Horizontal lines denote coherence (and its standard deviation) for decorrelated data

Forest coherence versus perpendicular baselines: summer





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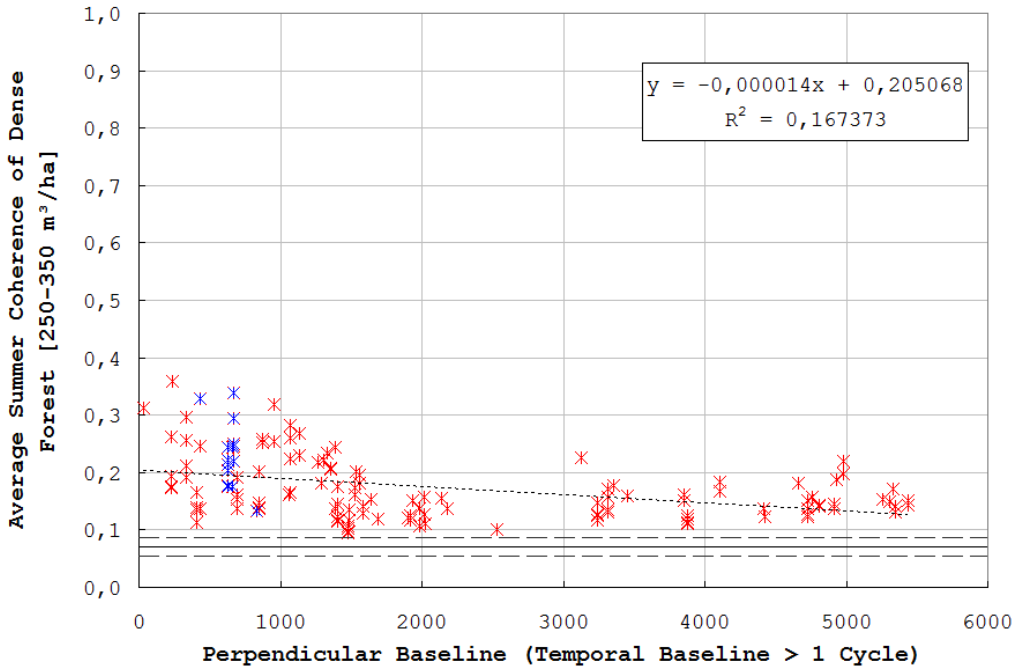

Temporal baseline = 92 days (blue) and > 92 days (red), all perpendicular baselines

Forest coherence versus perpendicular baselines: winter

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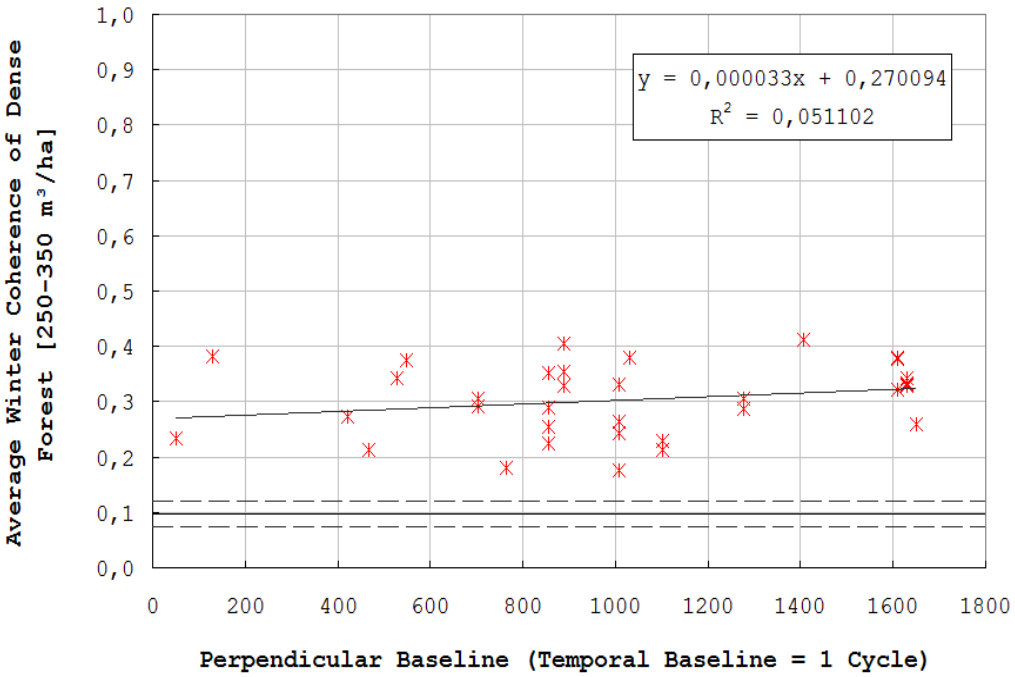

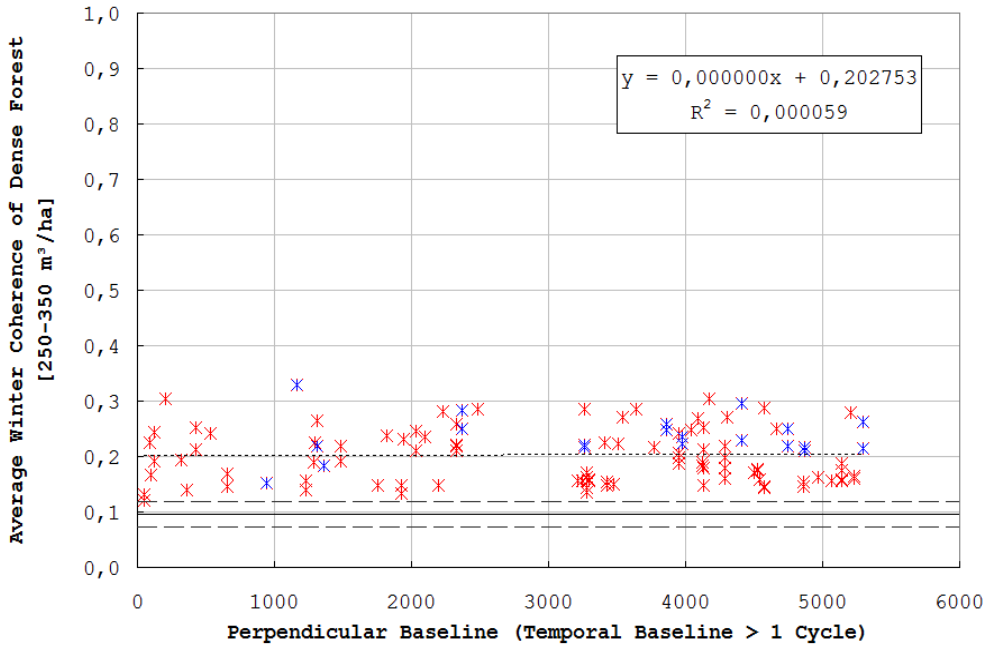

Temporal baseline = 92 days (blue) and > 92 days (red), all perpendicular baselines

Is volume decorrelation occurring?

Summary of coherence behavior (averaged over 10 sites)

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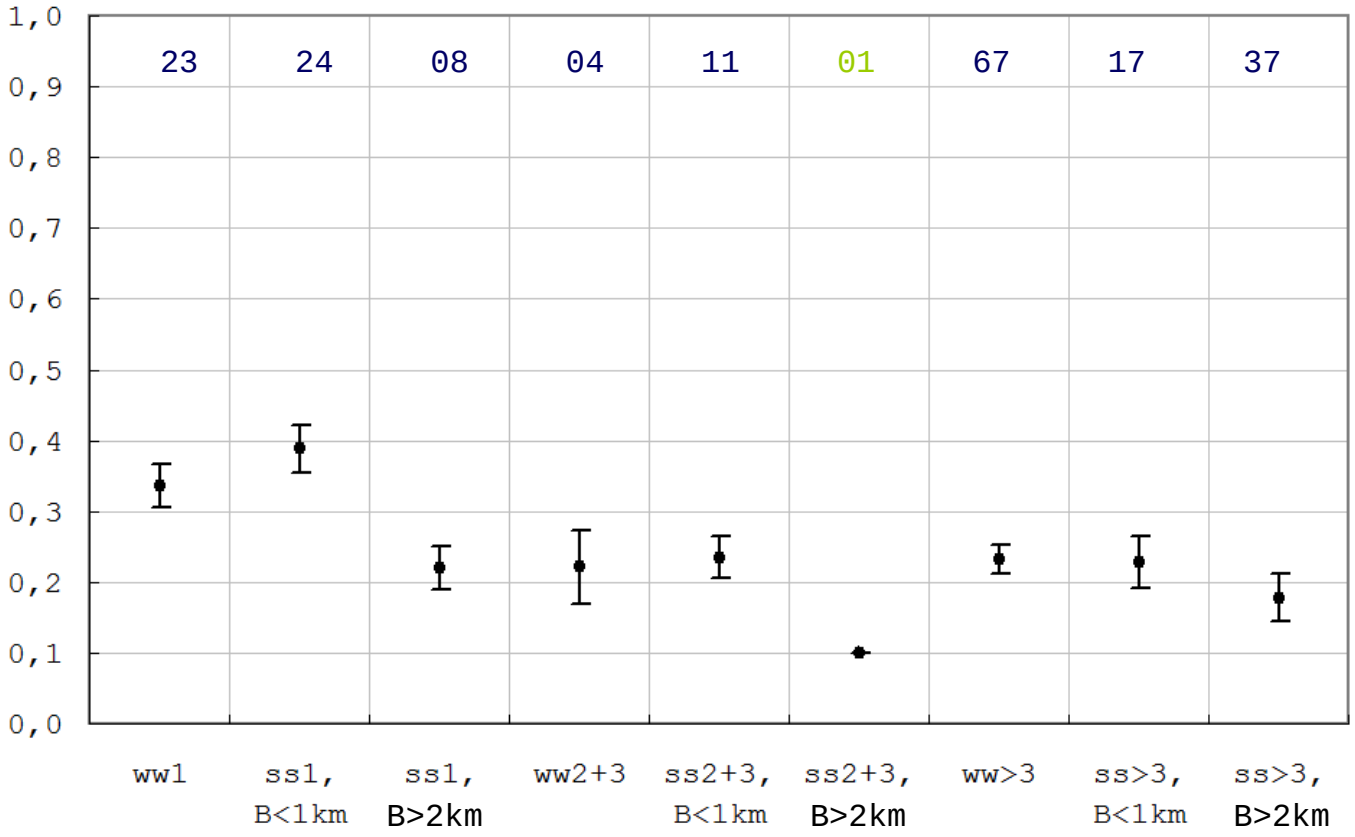
Average coherence for stem volume 250-350 m³/ha



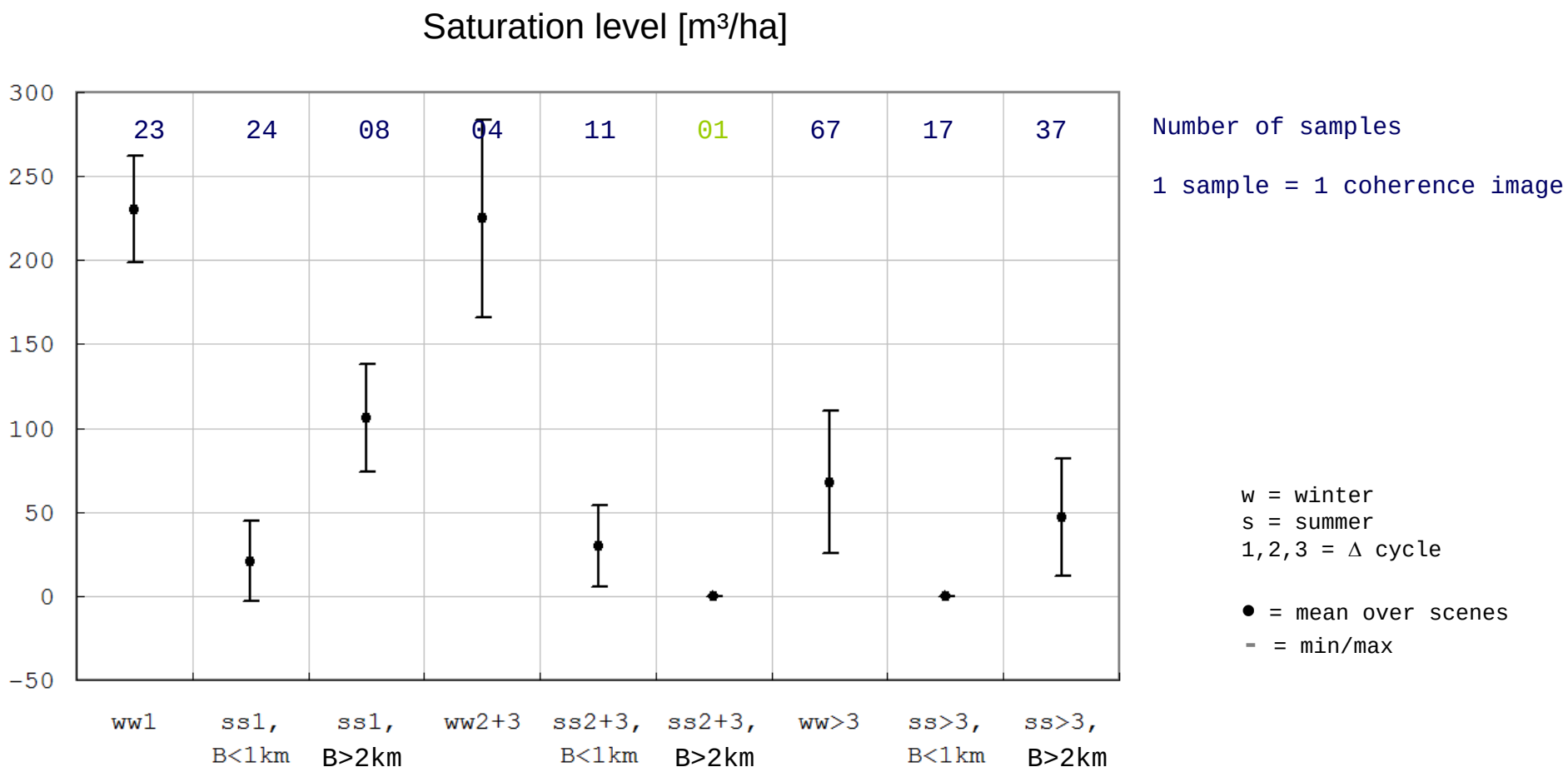
Number of samples

1 sample = 1 coherence image

w = winter
s = summer
1,2,3 = Δ cycle

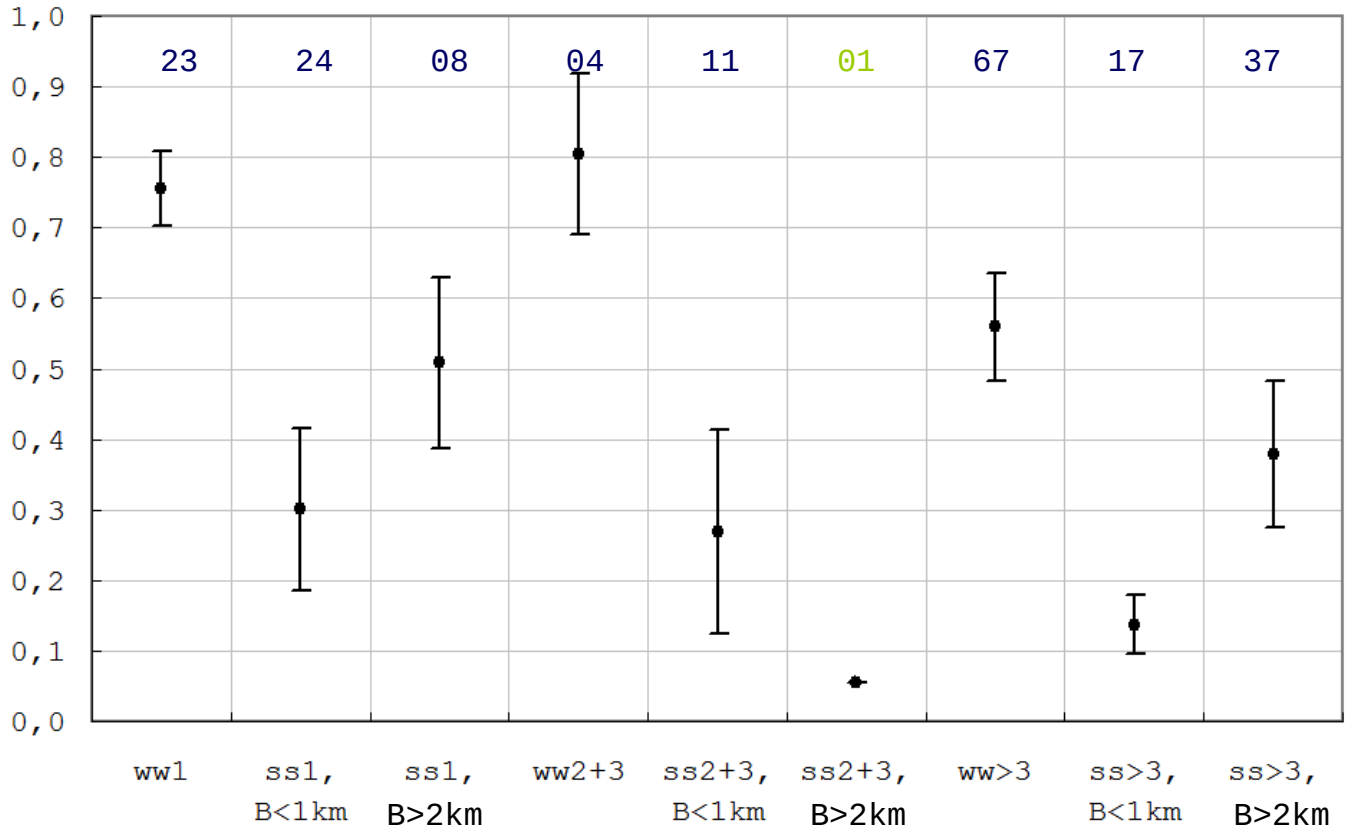
● = mean over scenes
- = min/max

Summary of coherence behavior (averaged over 10 sites)



Summary of coherence behavior (averaged over 10 sites)

R² stem volume vs. coherence (@ 10 m³/ha biomass class level)



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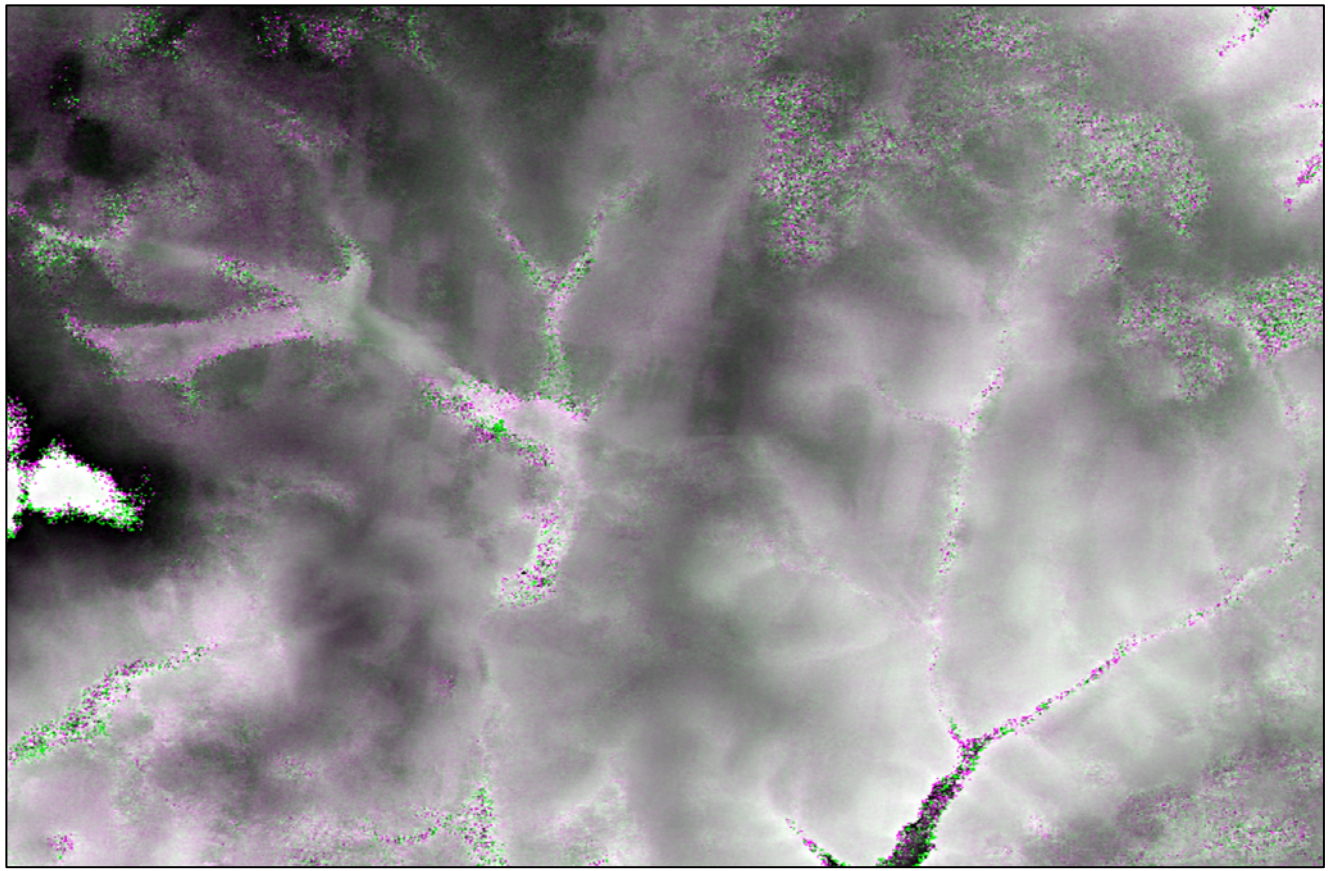
Investigation of interferometric phase

Clear-cuts visible at shaded relief based on SRTM elevation data (Chunsky N)

Investigation of interferometric phase

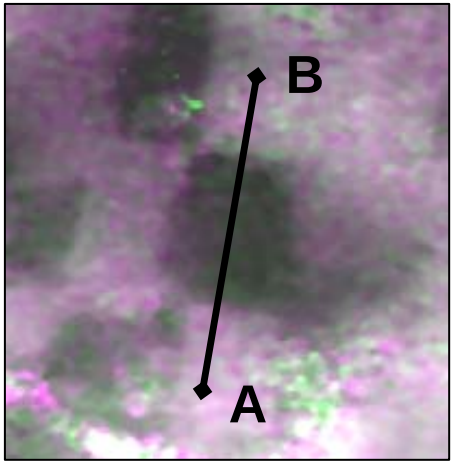
Clarification of “high summer coherence phenomenon” → Investigation of interferometric phase (comparison of winter against summer phase centre)



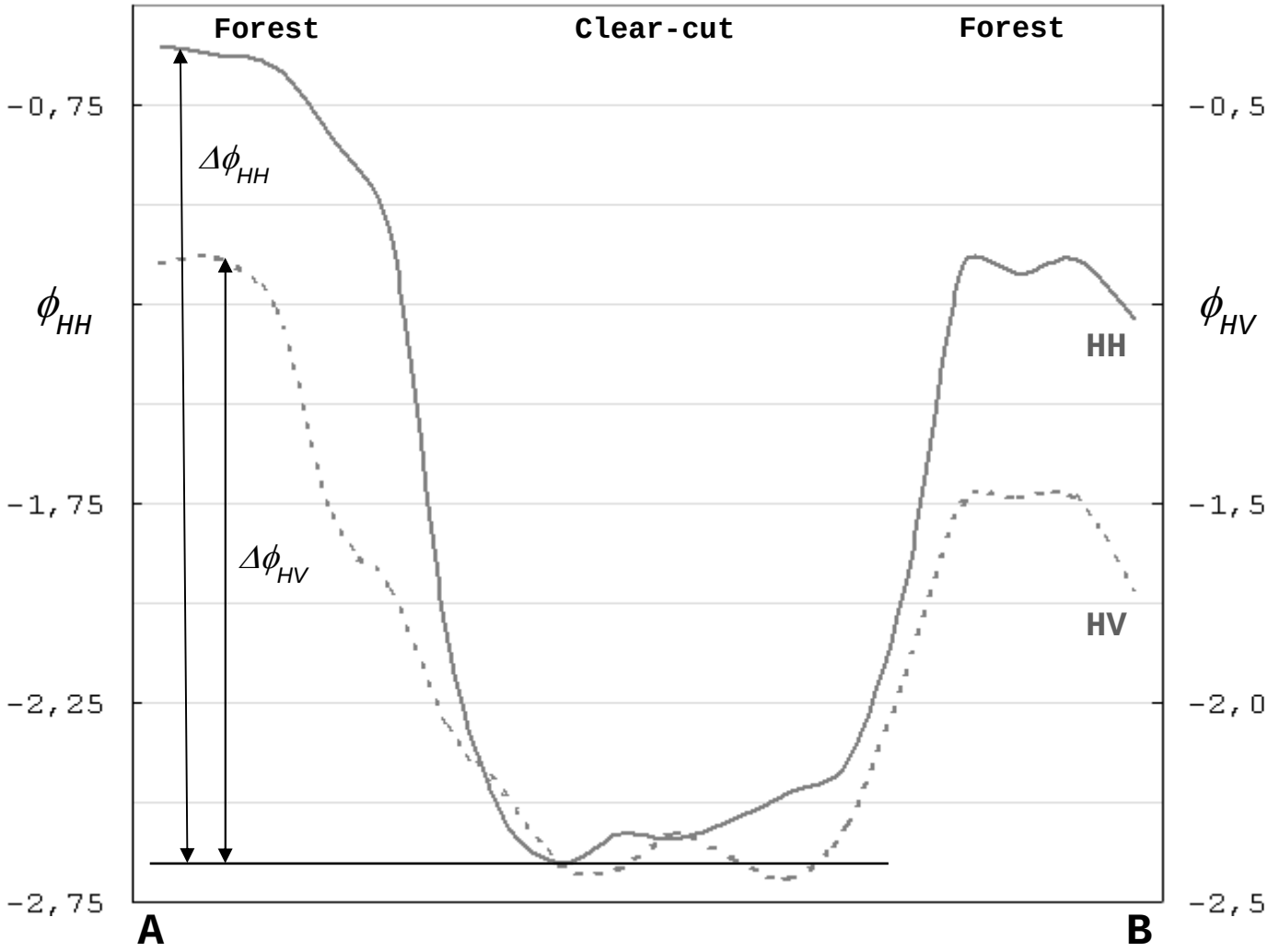
Summer INSAR Phase

$$RGB = \phi_{HH}\phi_{HV}\phi_{HH}$$

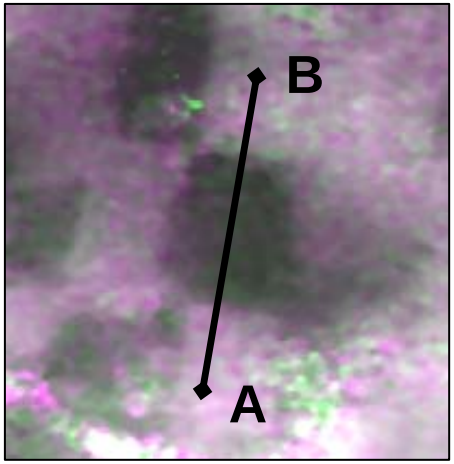
Investigation of interferometric phase



$RGB = \phi_{HH}\phi_{HV}\phi_{HH}$



Investigation of interferometric phase



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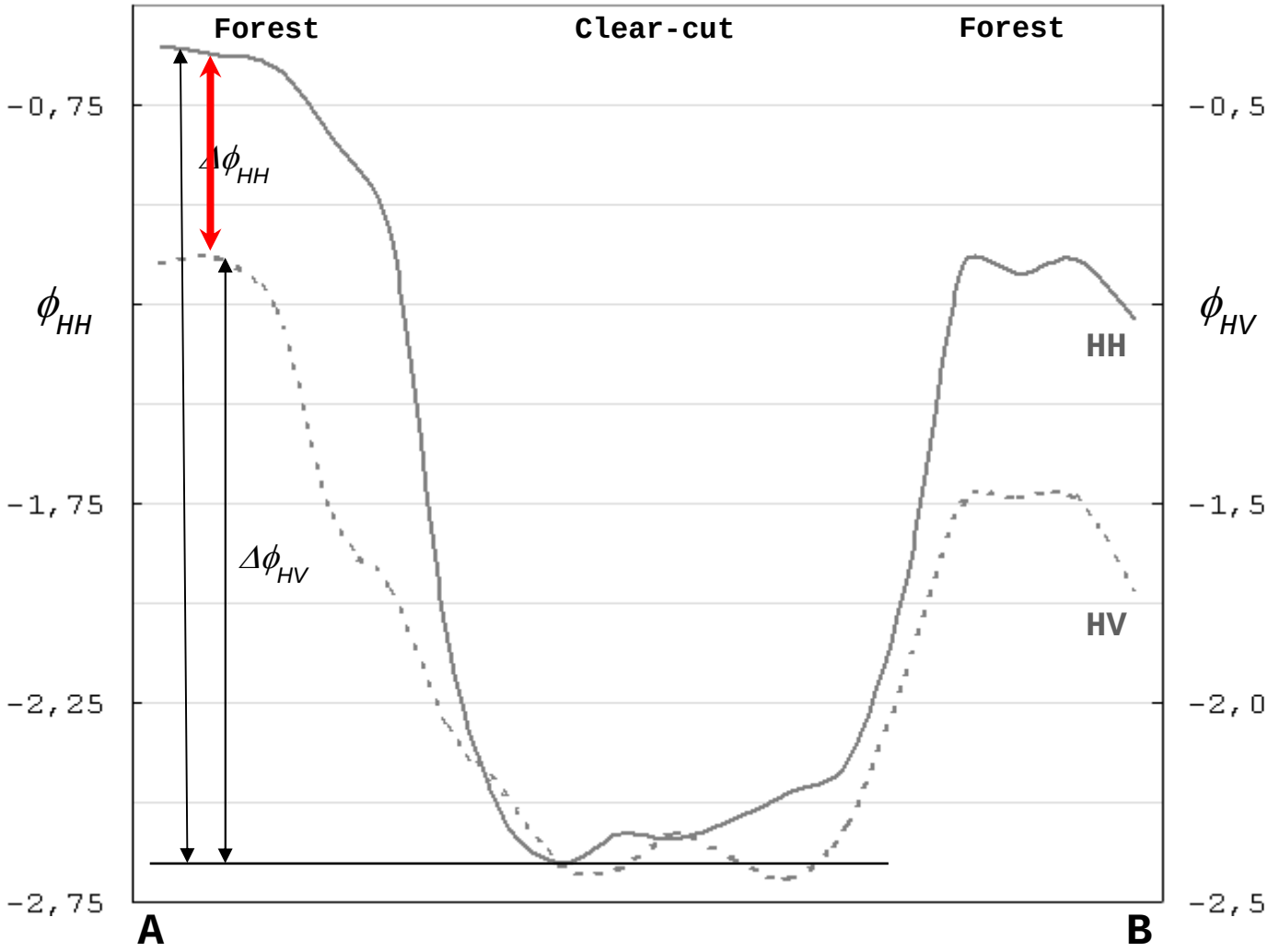

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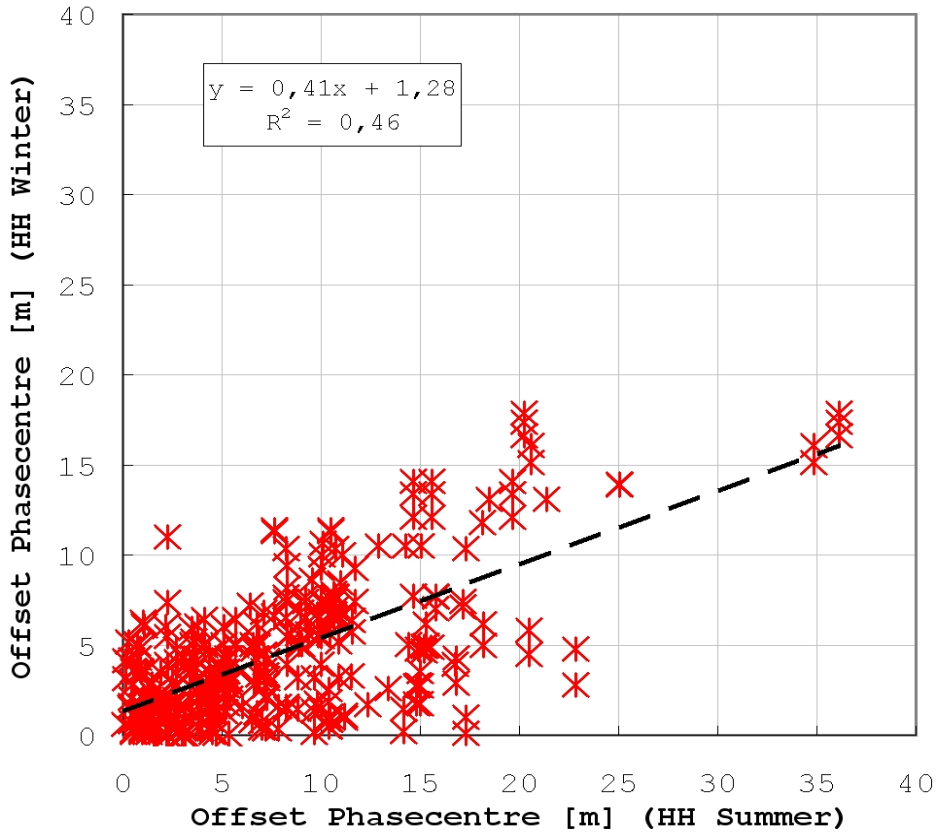
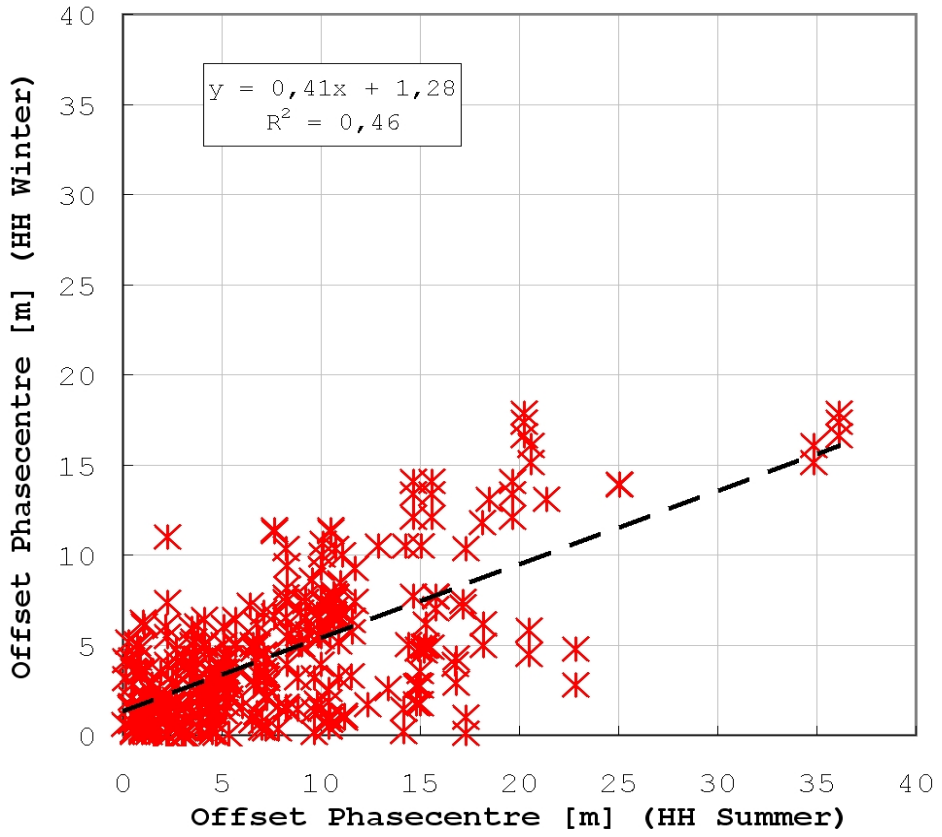
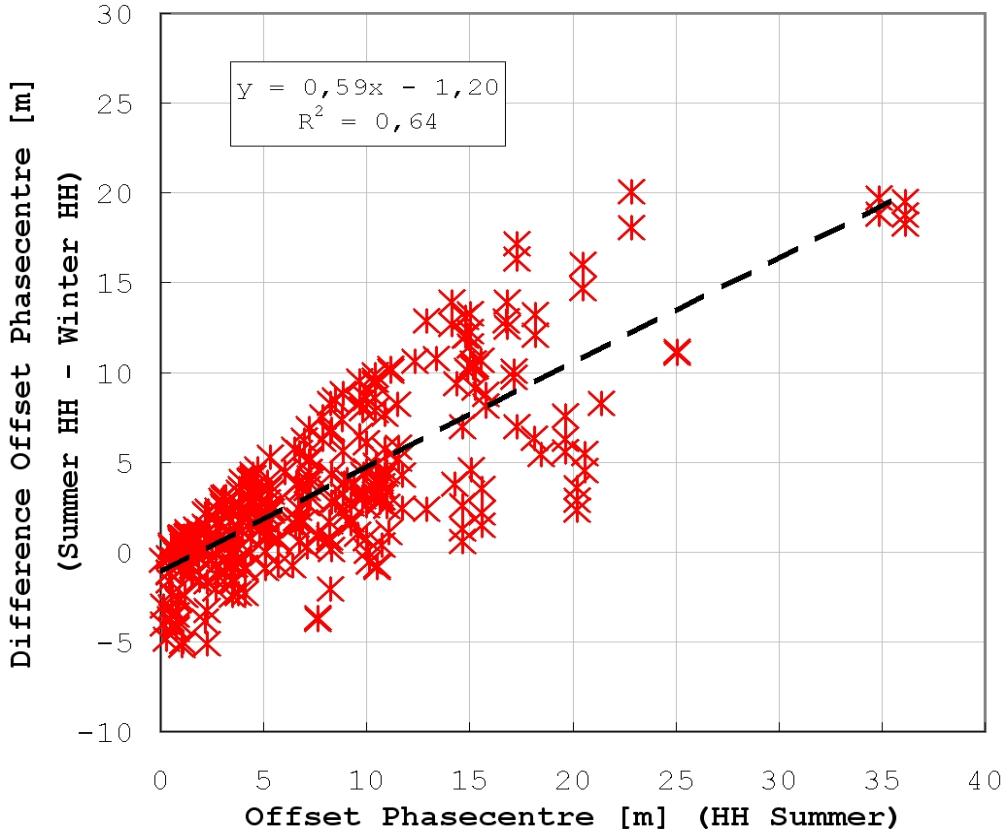


(320 entities)

- Biased by topography (this bias can unfortunately not be corrected for, as no topographic surface model is available)
- Absolute offset (difference) is unaffected
- Difference in summer is about two times larger than in winter
- Only wanes considered, were the SRTM data features greater elevation for forest as for the related clear-cut, merely positive offsets emerge

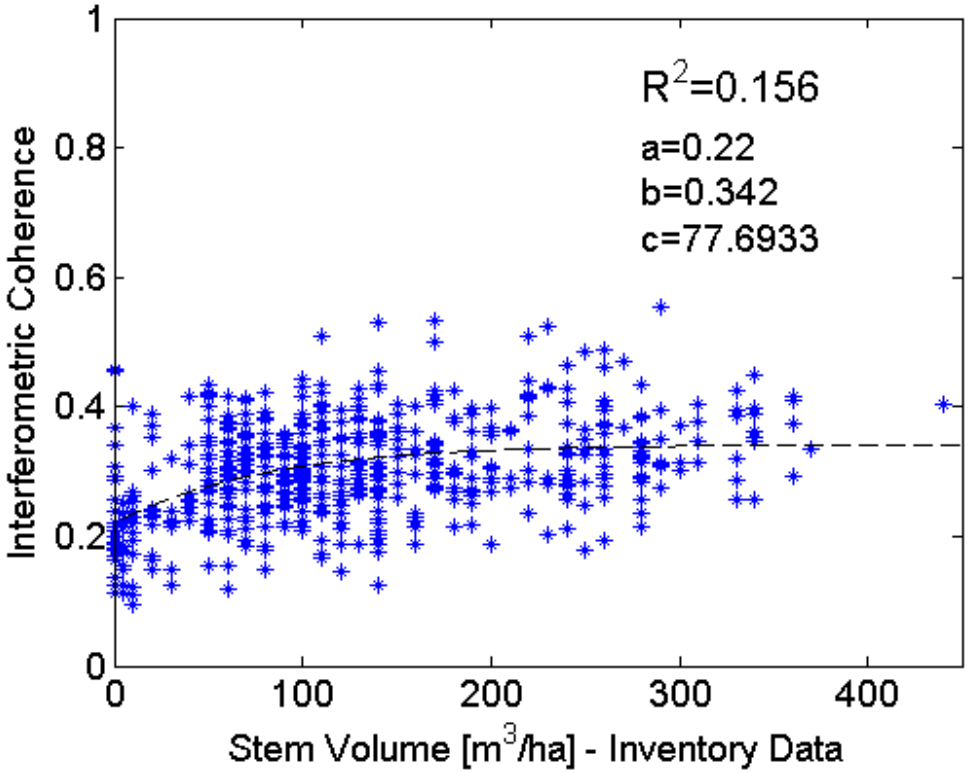
Investigation of interferometric phase





(320 entities)

Summer Coherence – Remarkable examples (summer only)



How much coherence is produced by the trees without ground interaction?

Summary – Overall

- ALOS PALSAR data have high potential for forest stem volume estimation in Siberia
- Midwinter FBS coherence provides the most powerful measure
- Summer FBD coherence can provide additional information (e.g. for forest cover mapping), however, temporal baseline must be enlarged to increase temporal decorrelation → This approach is very susceptible to variable environmental conditions (weather, soil moisture)
- Computation of coherence based on FBS (winter) and FBD (summer) images is possible, but not very useful; it might be used to support forest cover mapping

- At forests scattering processes in summer and winter are entirely different → This fact must be considered when developing biomass estimation models

Summary – Scientific Issues

- In summer overall temporal decorrelation is not larger than in winter (consecutive cycle coherence)
- This applies in particular to high stem volume classes
- In winter, decorrelation of high stem volume areas is interpreted as effect of volume decorrelation, temporal decorrelation is assumed to have minor effect (extremely stable environmental conditions) → However independency of perp. baseline! Contradictionary to volume decorrelation assumption
- In summer, the decrease of penetration depth
- Remarkable examples (increasing coherence with increasing stem volume): → Changing soil moisture impacts areas with low stem volume

Summary – Scientific Issues

- For winter coherence no impact of spatial baseline evident
- One possible explanation (in accordance with all above results):
  - Frozen forest, represented by stems and canopy, is a semitransparent layer on top of the surface. This layer introduces a noise component to the coherent signal coming from the ground (point- and surface scattering)
  - Amount of noise driven by the density and the depth of this forest layer
  - Basing on this assumption the coherence modelling over forest becomes rather simple

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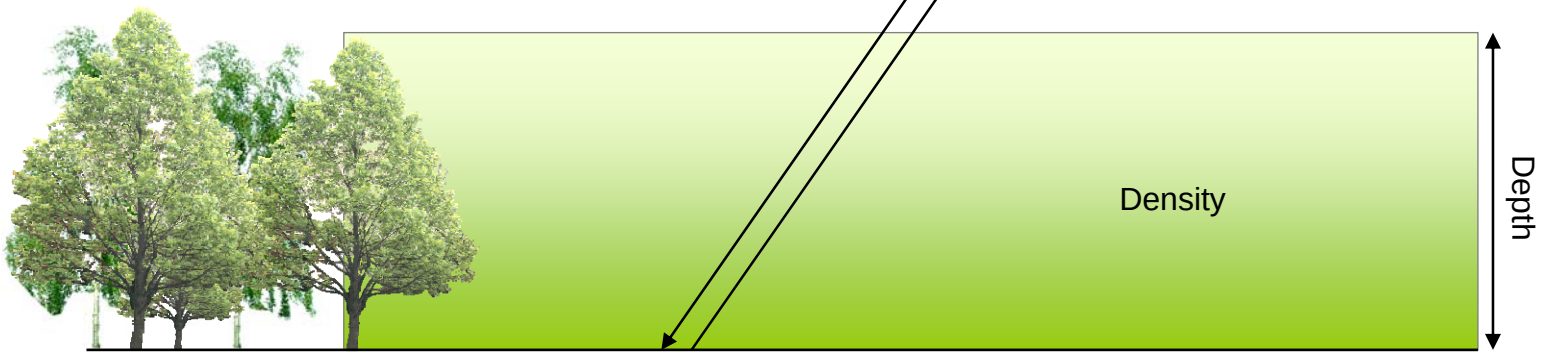
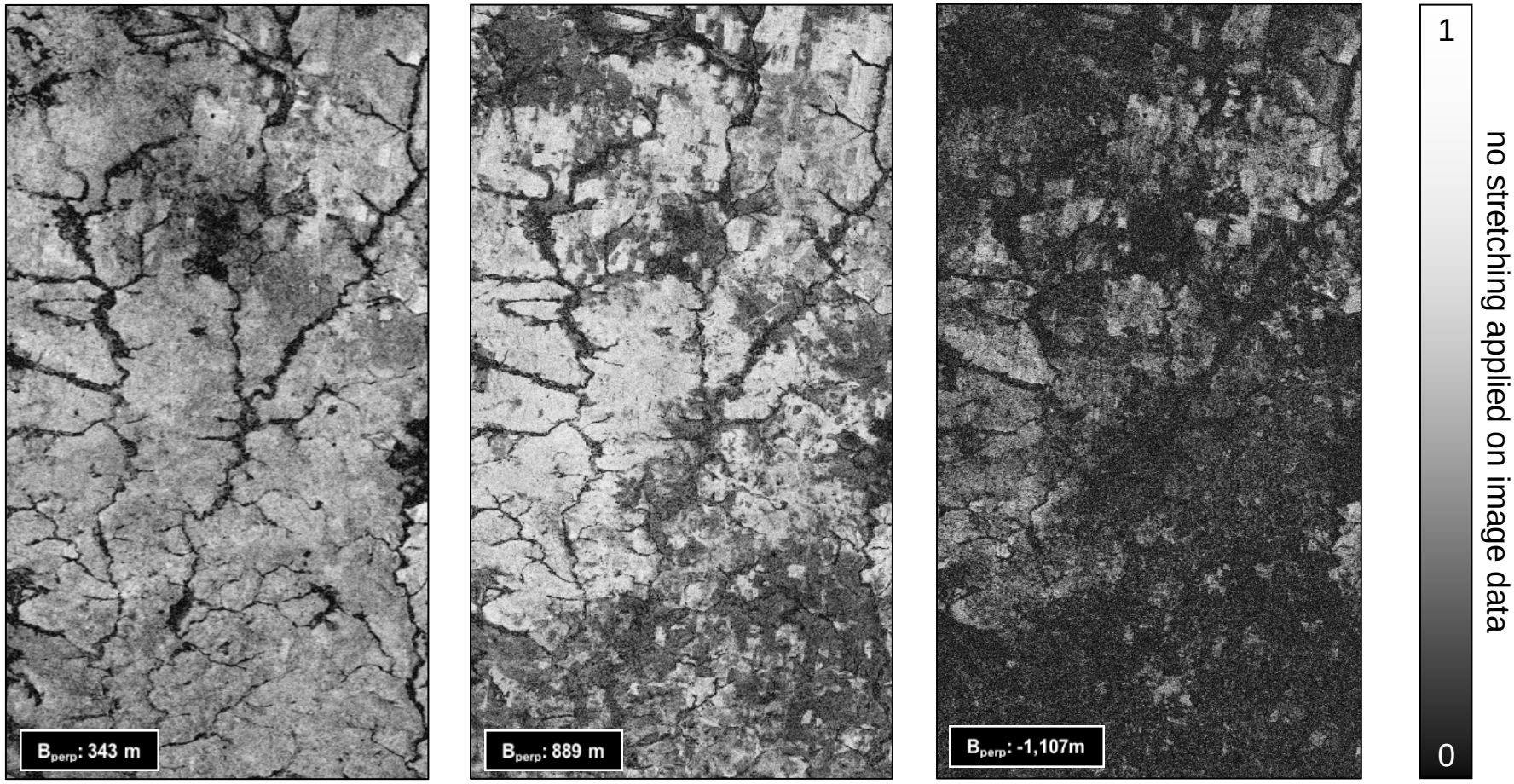
  - Basing on this assumption the coherence modelling over forest becomes rather simple

$$\gamma_{for} = \gamma_{ground} + noise$$

$$noise = density \times depth$$



Thank you!



20jun07_05aug07 21dec07_05feb08 05nov07_20jun07

Coherence Images – Examples Chunsky N (Temp. Baseline 46 d)