ALOS

K&C Initiative
An international science collaboration led by JAXA

K&C Phase 3 – Brief project essentials

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

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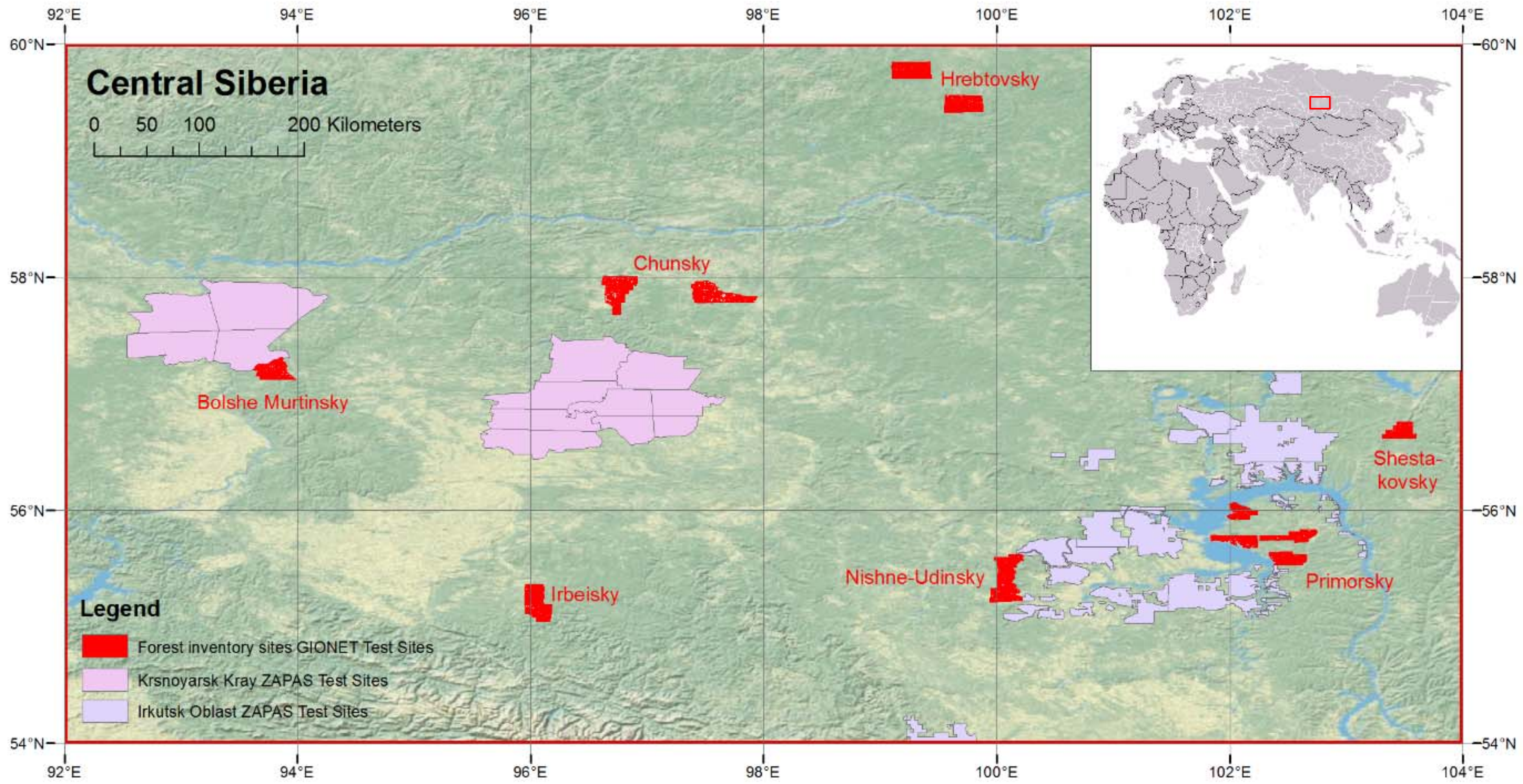
seit 1548

Science Team meeting #18 – Phase 3
JAXA RESTEC HQ, Kamiya-cho/Tokyo, Nov. 07-09, 2012

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
Shesta-kovsky
Nishne-Udinsky
Primorsky
Irbeisky
Legend
Forest inventory sites GIONET Test Sites
Krsnoyarsk Kray ZAPAS Test Sites
Irkutsk Oblast ZAPAS Test Sites

Support to JAXA's global forest mapping effort

Ground truth data

- Sites in Central Siberia
- Growing stock volume from 1995
- Several tens of forest stands per sample site
- Raster Data, 12.5 m x 12.5 m

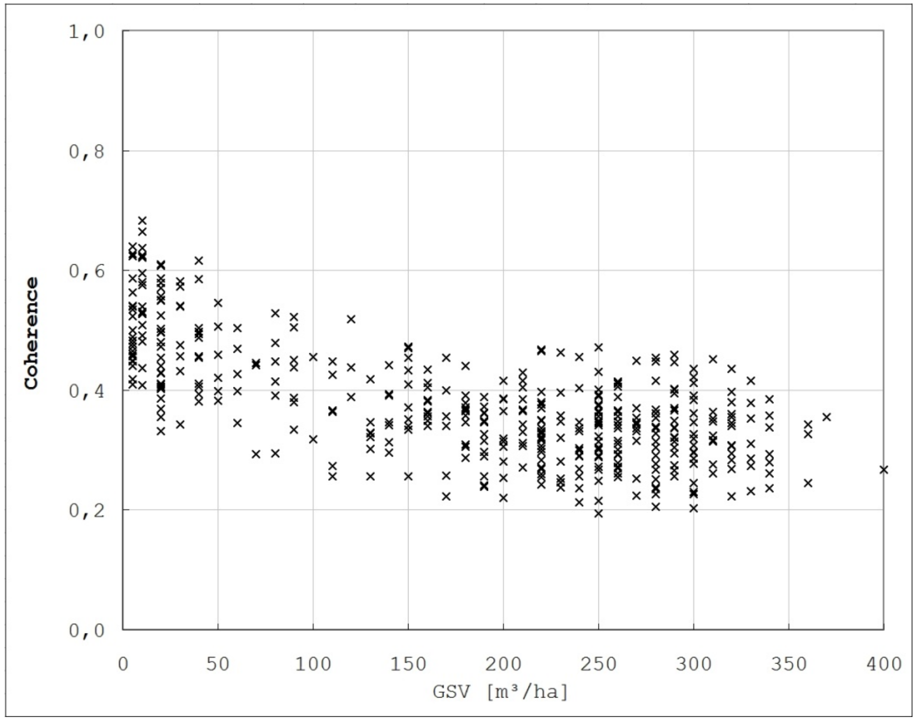
Deliverables

- MS 1: Forest biomass retrieval using POLSAR data
- MS 2: Forest biomass retrieval using INSAR coherence and backscatter
- MS 3: Forest biomass retrieval using multitemporal ScanSAR data
- MS 4: Forest cover and forest cover change mapping

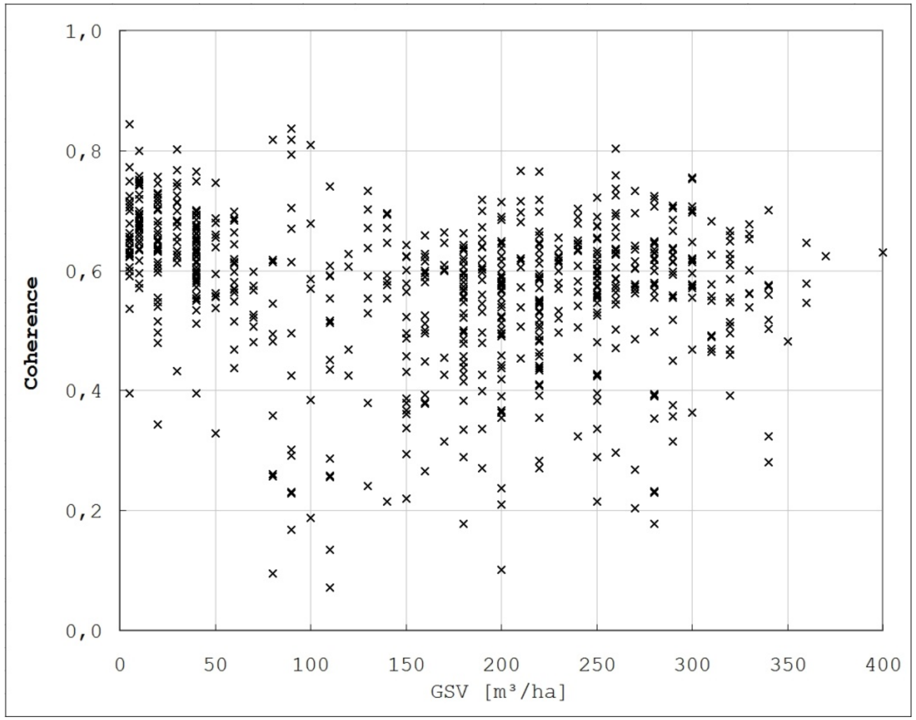
Progress on MS 2: Forest biomass retrieval using INSAR coherence and backscatter

Impact of Tree Species on PALSAR INSAR Coherence over Siberian Forest at frozen and unfrozen Conditions

Motivation



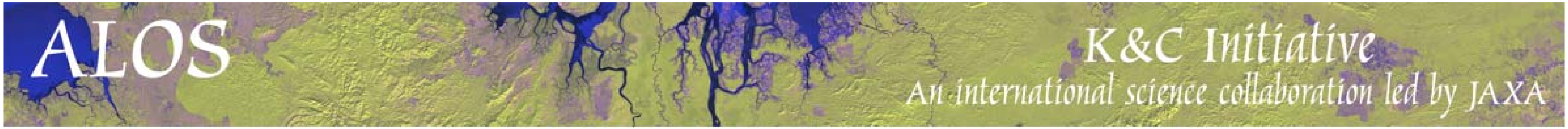
Frozen conditions



Unfrozen conditions

Magnitude of interferometric coherence vs. GSV for the site Primorsky East

What causes the spread at unfrozen conditions? Do tree species play a role?



SAR data set

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***

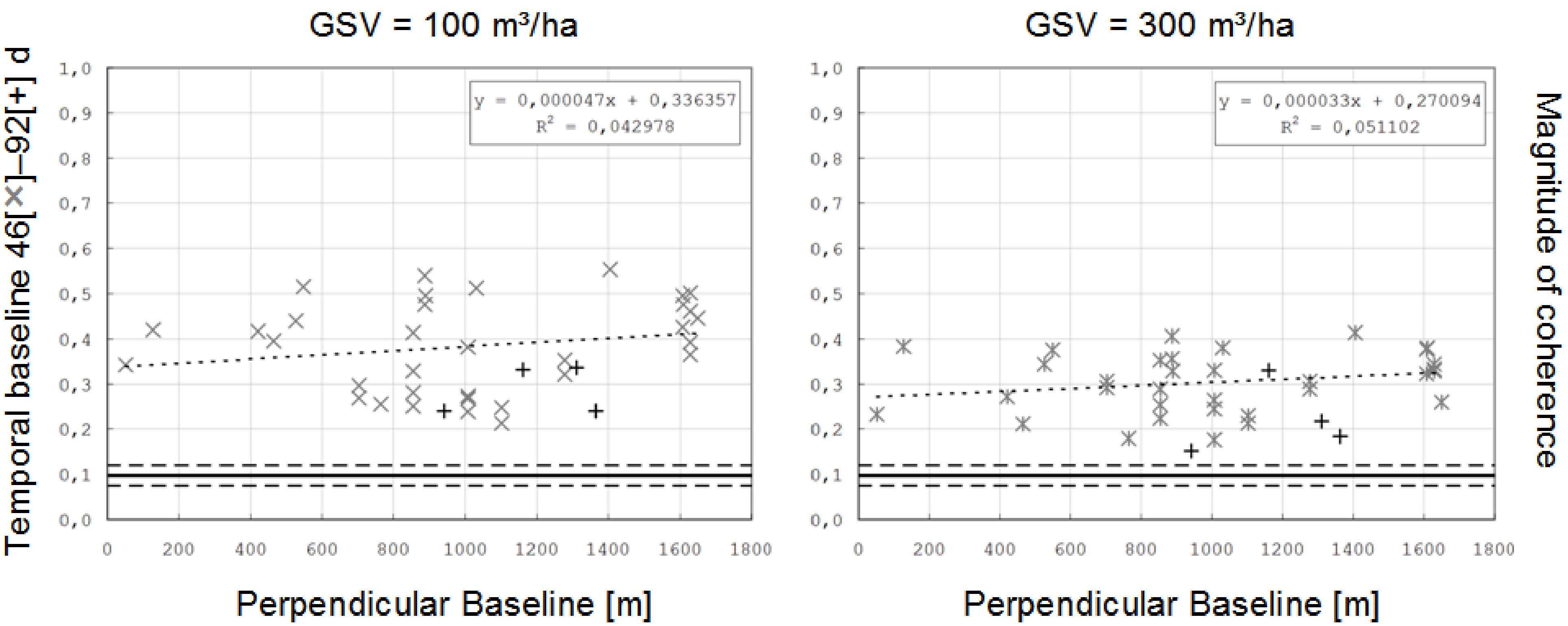
- PALSAR L-band (1,27 GHz) data
- 87 acquisitions, mode: FBS ***FBD***
- FBS: HH (28 MHz), FBD; HH/HV (14 MHz)
- Off-nadir angle 34,3˚

Some Key Facts Impacting SAR data

- Very pronounced seasonality – long freezing periods during winter
- During freezing, environmental conditions are very stable:
  - No soil moisture changes, no growth etc.
  - Very low temporal decorrelation at open areas (even for large temporal baselines)
- During freezing, backscatter from forest reduced
- Frozen trees → deeper penetration
- Coherence acquired during freezing correlates with forest biomass

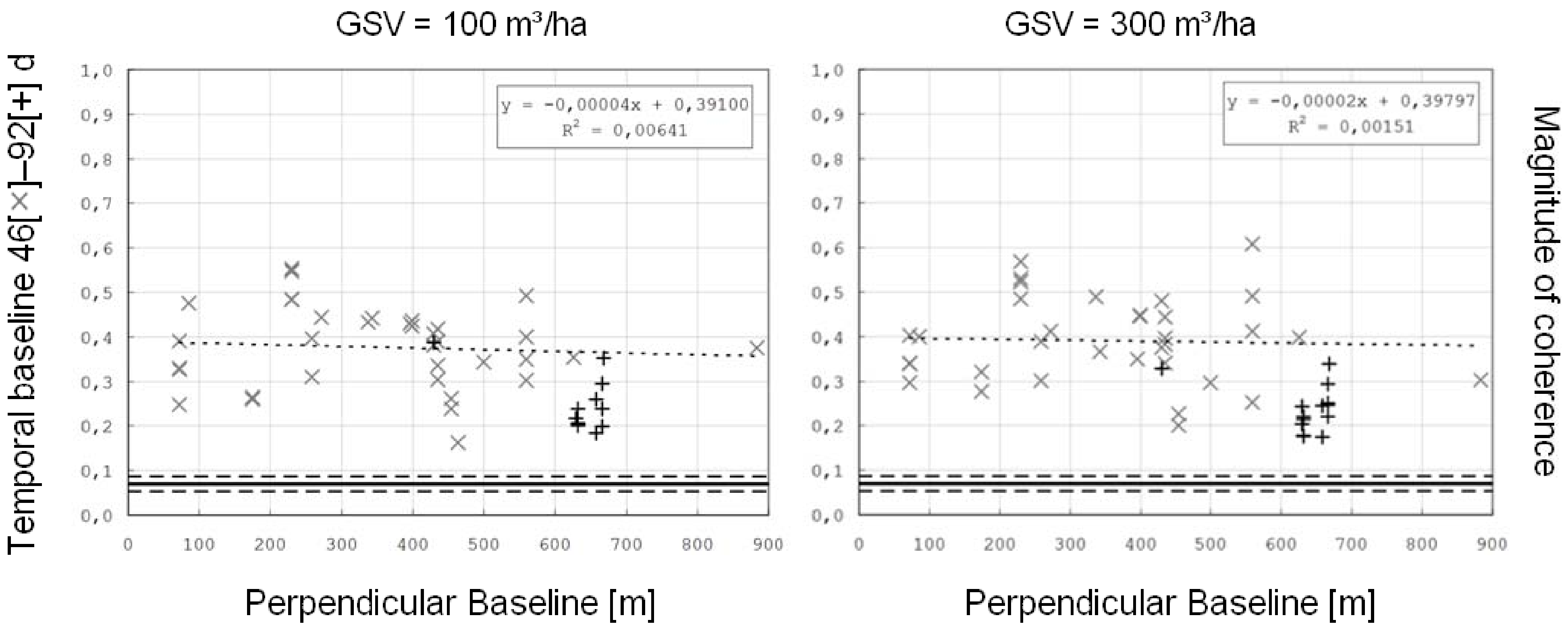
Impact of Perpendicular Baseline

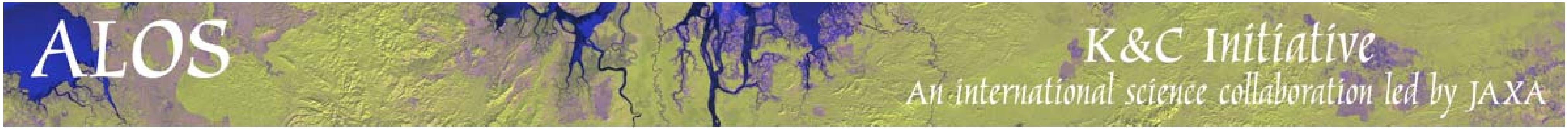
Frozen conditions (winter period)



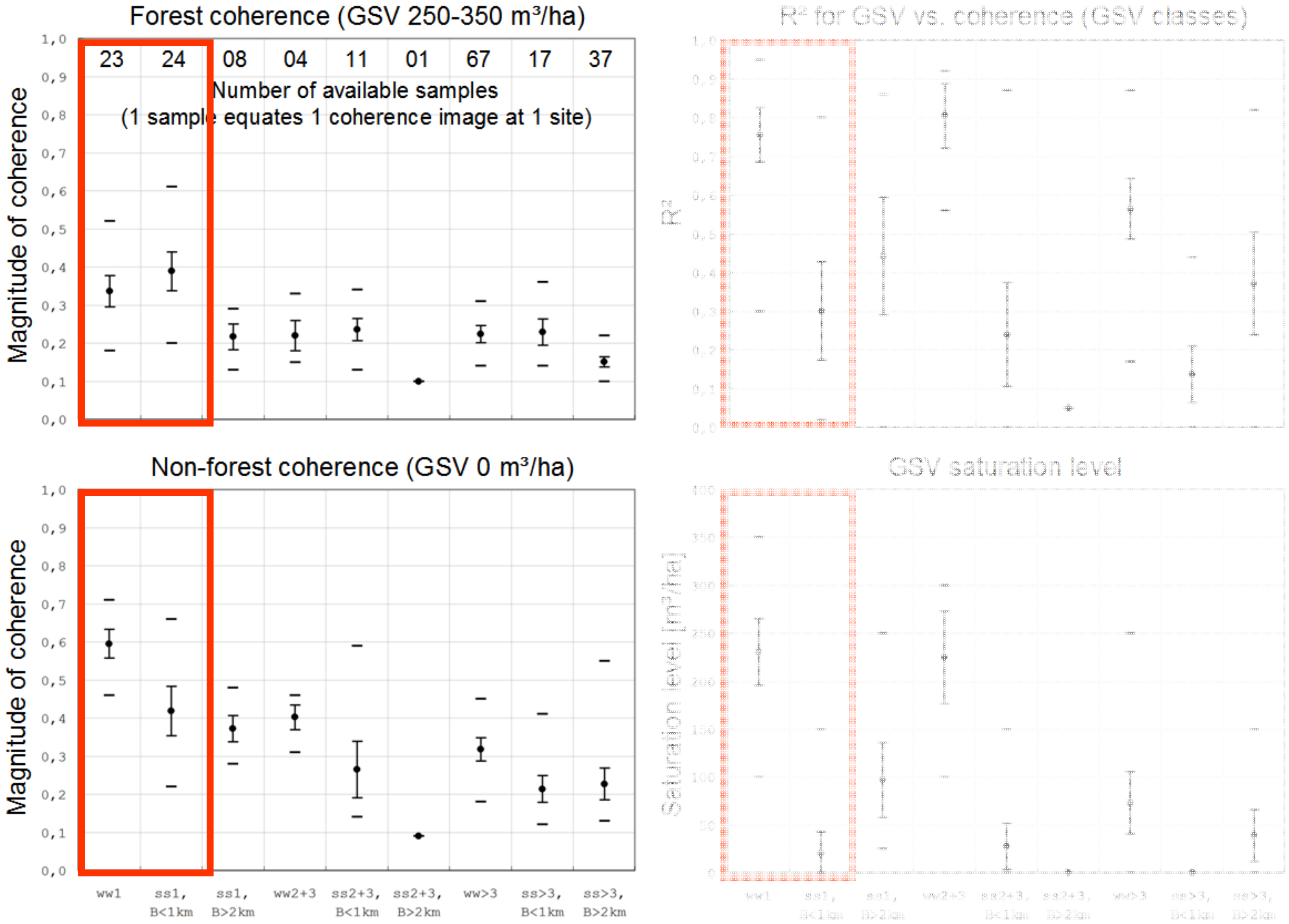
Impact of Perpendicular Baseline

Unfrozen conditions (summer period)

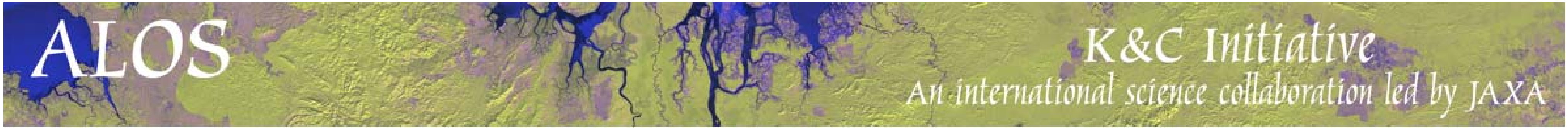




Summary of all observations



• = average; I = standard deviation; – = minimum/maximum; w = winter; s = summer; 1,2,3 = Δ cycle



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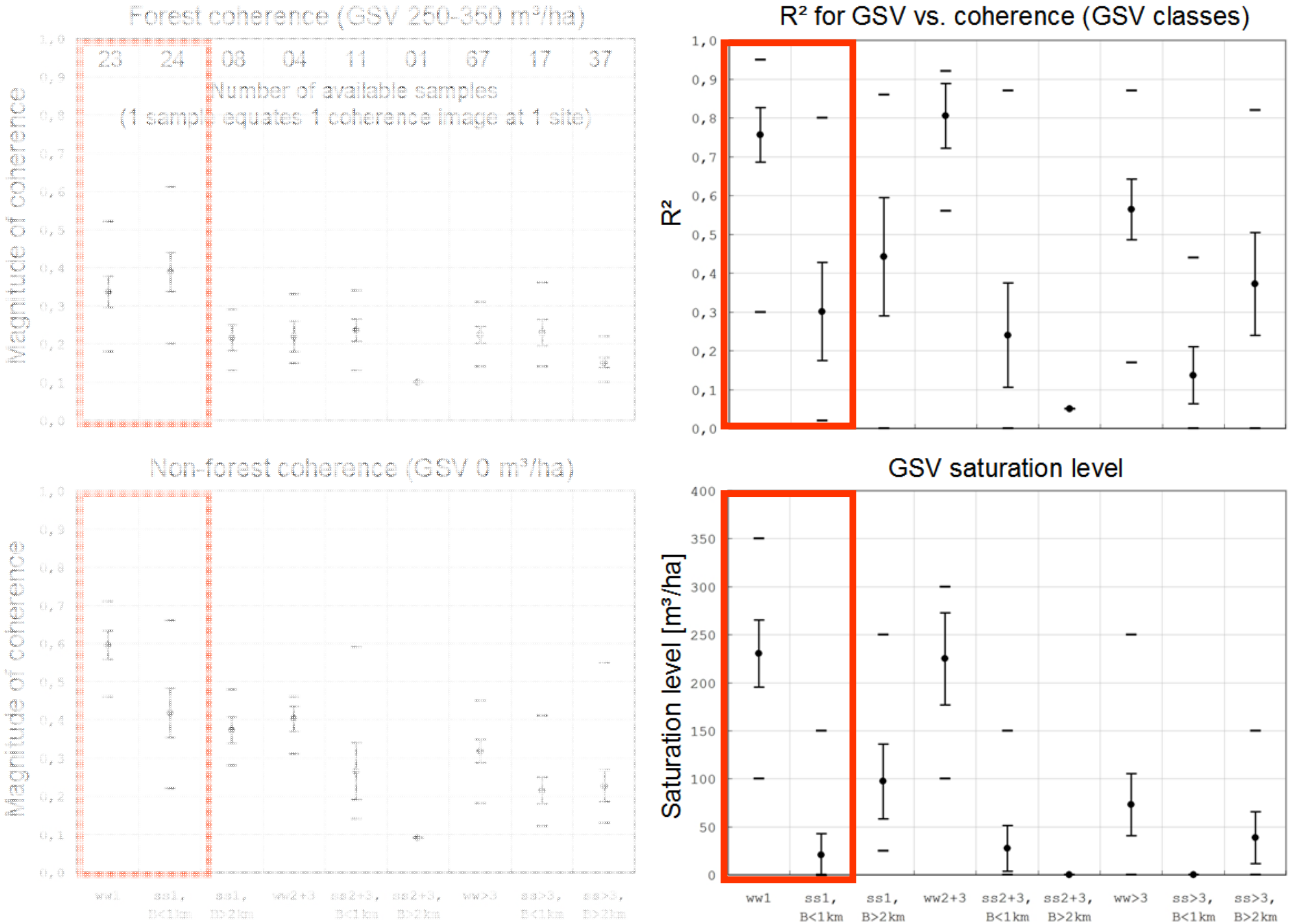

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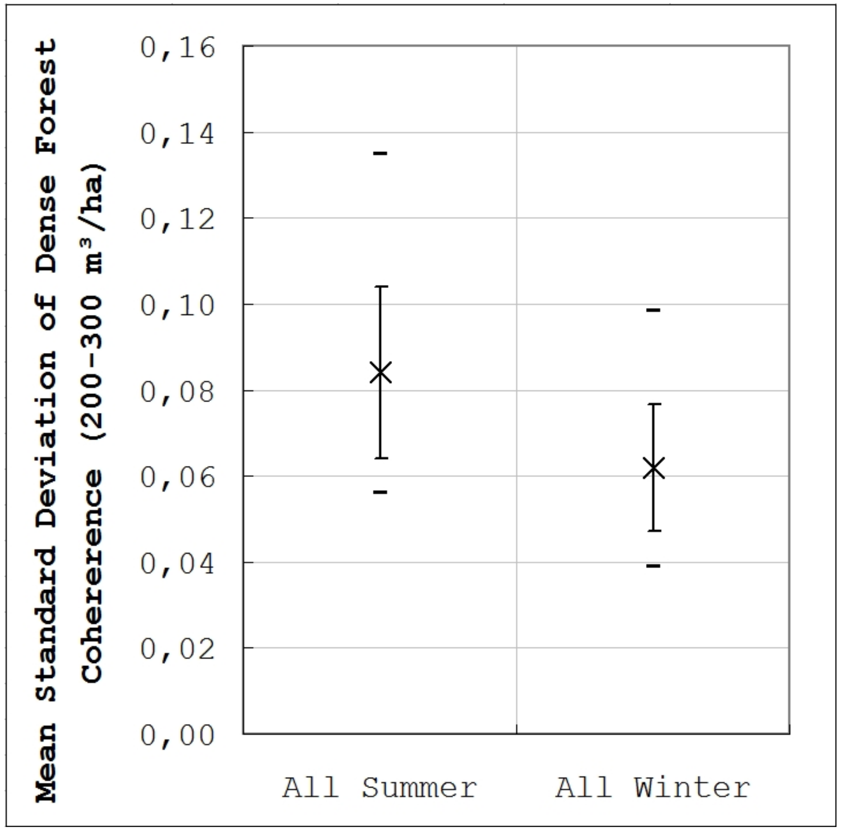
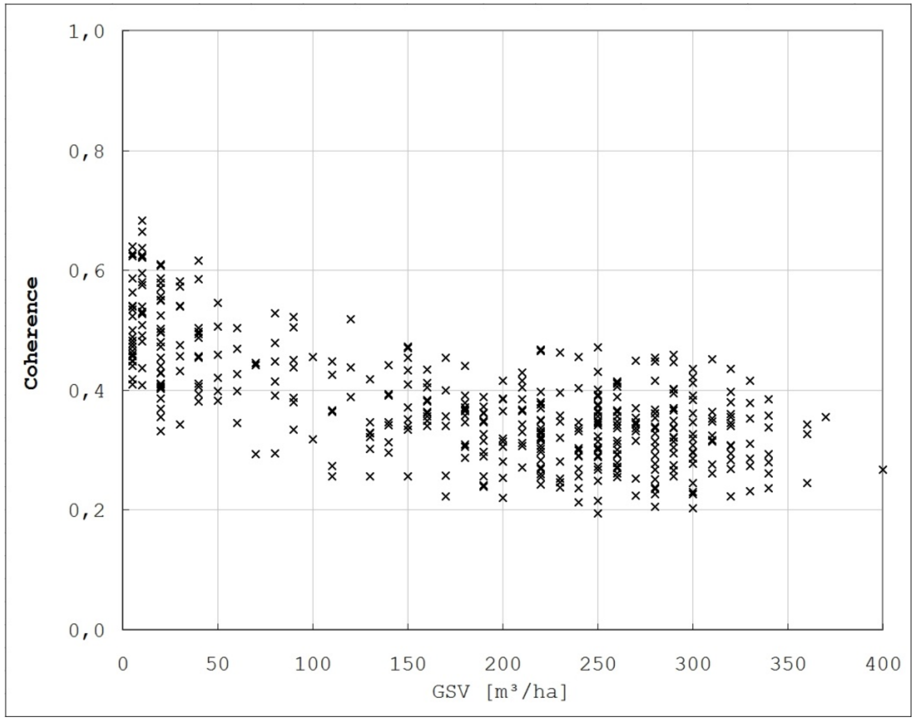


Standard deviation of coherence magnitude for dense forest – all sites.

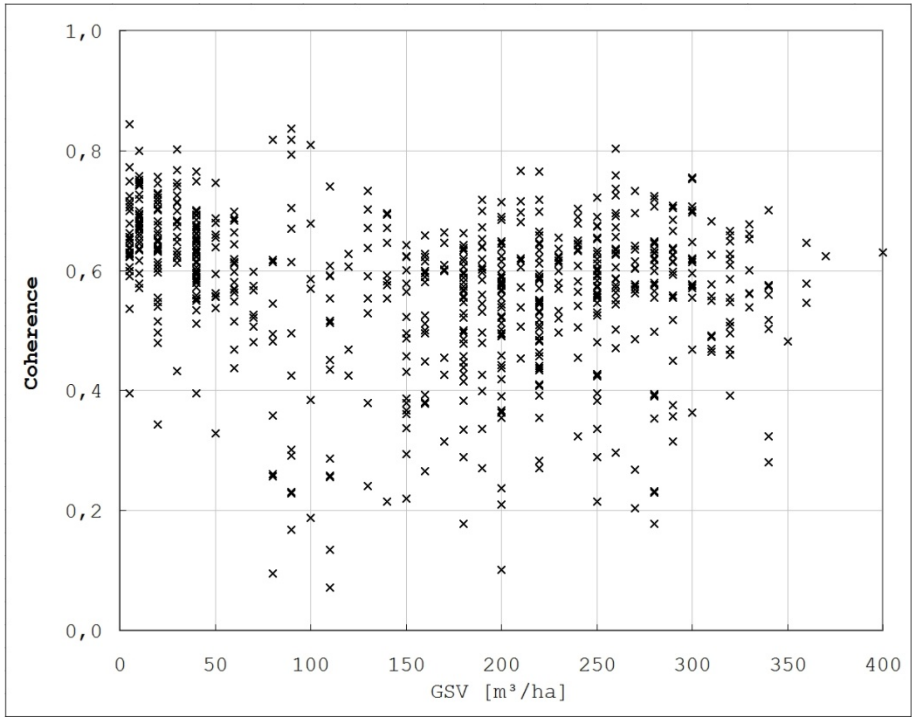
Investigation of Impact of Species on Coherence

- Only image pairs from consecutive cycles were employed
- The perpendicular baseline varied between 50 m and 700 m for FBD data and between 50 m and 1,700 m for FBS data (38 interferograms)
- All analyses were conducted on forest stand level
- Stand selection: dominating tree species covers at least 80%, GSV = 200-300 m^3/ha
- 4,500 forest samples (one sample = one forest stand covered by one interferogram)

Impact of Species: Results



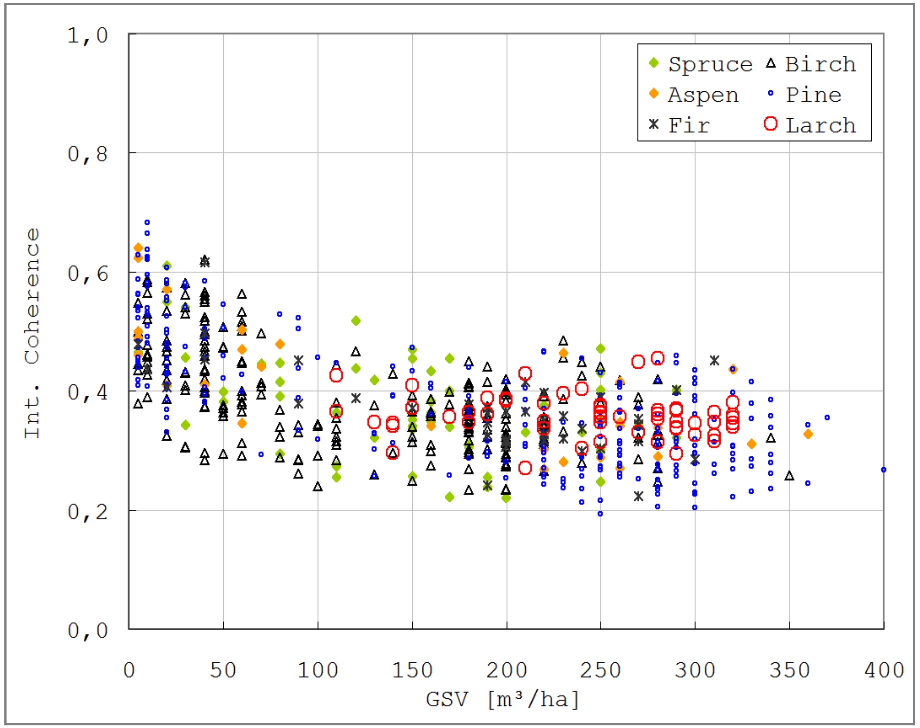
Frozen conditions



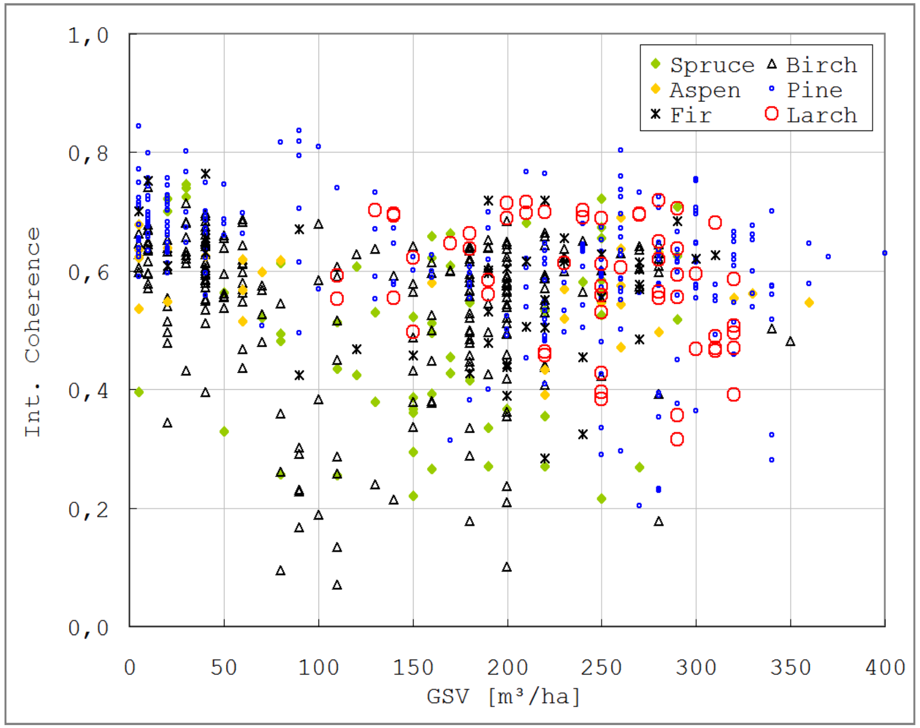
Unfrozen conditions

Magnitude of interferometric coherence vs. GSV for the site Primorsky East

Impact of Species: Results



Frozen conditions



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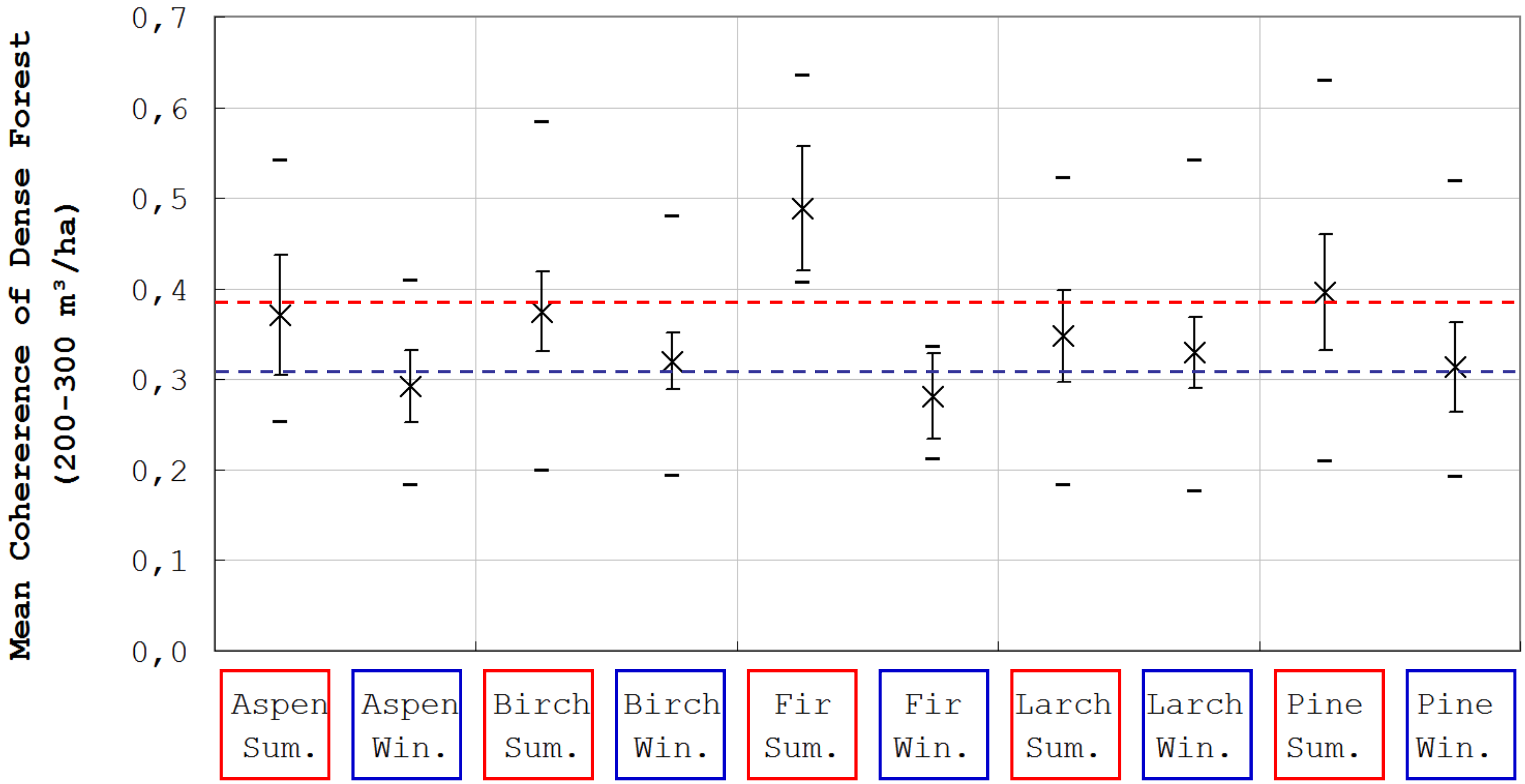
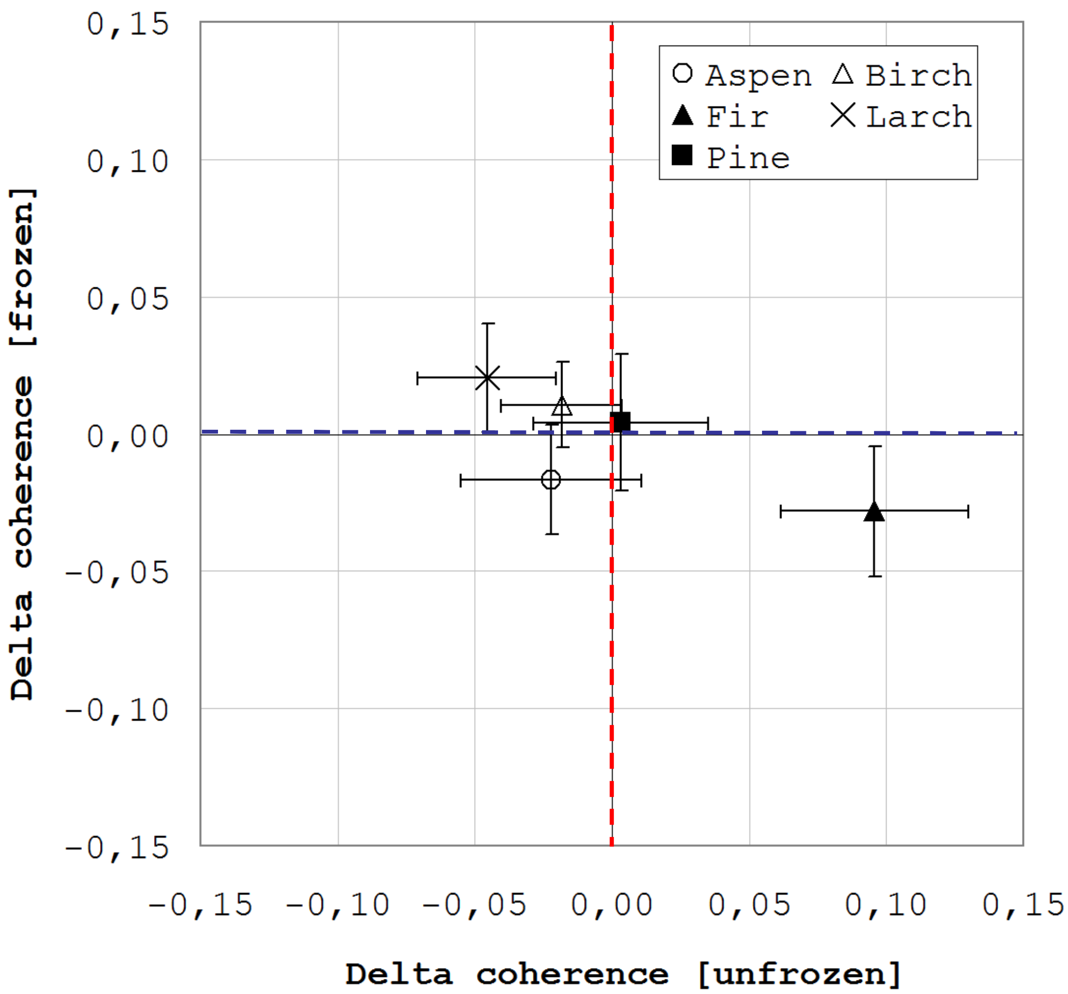


Mean coherence over dense forest separated by tree species at frozen and unfrozen conditions – all sites.

Impact of Species: Results Summary



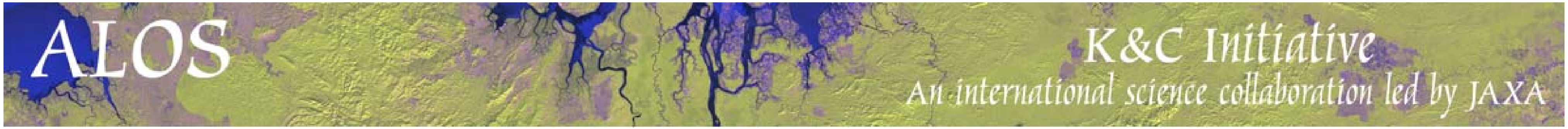
Deviation of tree species specific magnitude of coherence from average – all sites.

Interpretation and Discussion

- In general, differing tree species can be accompanied by specific forest structure and environmental conditions (undergrowth, water consumption, interception, wind prone etc.) → differing **temporal decorrelation**
- Geometric properties of trees (crown shape, alignment of tree components) and forest structure affect attenuation and the distribution of the major scatterers → differing **volumetric decorrelation**

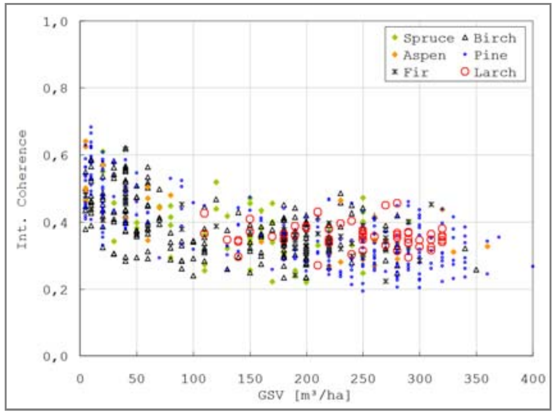
Interpretation and Discussion

- In general, differing tree species can be accompanied by specific forest structure and environmental conditions (undergrowth, water consumption, interception, wind prone etc.) → differing **temporal decorrelation**
- Geometric properties of trees (crown shape, alignment of tree components) and forest structure affect attenuation and the distribution of the major scatterers → differing **volumetric decorrelation**
- Spatiotemporal variability of environmental conditions during the growing season (precipitation, soil moisture change, growth etc.) result in increased spread (inter and intra species)
- At frozen and calm conditions, tree species specific temporal decorrelation is minor, and…
- …geometric properties are of decreased importance, as the amount of scattering within the canopy is also decreased

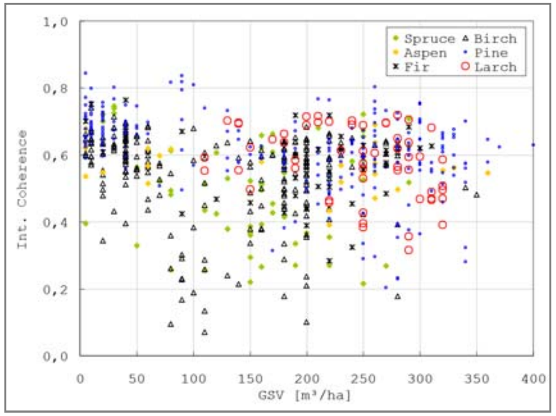


Summary and Conclusions

- Very low impact of tree species on coherence at frozen conditions
- At unfrozen conditions the impact is increased (in particular for fir and larch)
- At unfrozen conditions increased intra-species variance of coherence – most likely caused by spatiotemporal variable environmental conditions



Frozen conditions



Unfrozen conditions