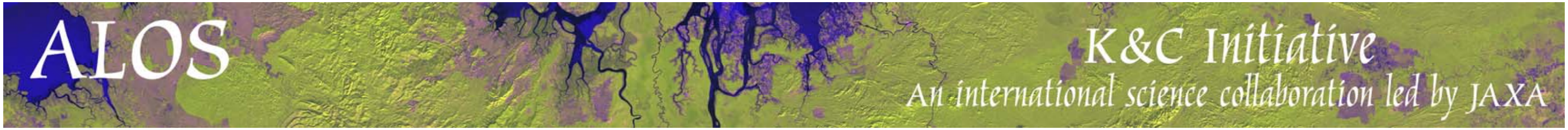
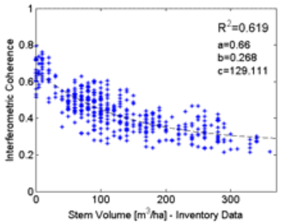



# Multi-Seasonal ALOS PALSAR Interferometric Coherence for Forestry Applications in the Boreal Zone

## Methodology of Investigation – Overview

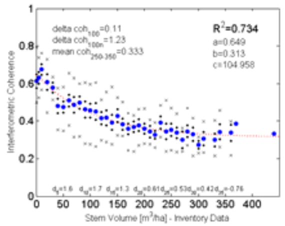
1. Generation of subsets from original frames covering forest inventory data
2. Computation of mean coherence per forest stand – new entity: forest stand
3. Computation of various statistical parameters
4. Fit of empirical exponential model (compare Askne & Santoro, 2005)
5. Creation of plots: stem volume vs. coherence
6. Check of perpendicular baseline → rejection of coherence data with baseline > ½ of critical baseline
7. Check of weather conditions

$$\gamma_{vol} = ae^{\frac{-vol}{c}} + b\left(1-e^{\frac{-vol}{c}}\right)$$




## Methodology of Investigation – Computation of various statistical parameters

1. Mean coherence per scene
2. Mean coherence for stem volume 250-350 m³/ha (mean $coh_{250\text{-}350}$)
3. $R^2$ for all considered forest stands
4. $R^2$ for mean values of 10 m³/ha stem volume classes
5. Difference of mean coherence for stem volume 0-50 m³/ha and 200-250 m³/ha related to change of 100 m³/ha (delta $coh_{100}$)
6. As (5), normalised by standard deviation of coherence (delta $coh_{100n}$)
7. As (6), stepwise for 50 m³/ha classes ($d_x$)
8. Stem volume, where saturation occurs




## Conclusions – 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

Computation of coherence based on FBS (winter) and FBD (summer) images is technically feasible but not very useful; it might be used to support forest cover mapping

## Conclusions – Summer Coherence Images

Generally high overall coherence for short temporal baselines if both images are acquired at midsummer → High coherence also for high stem volume classes – even greater than in winter!

Weak to no correlation with forest stem volume – spread of coherence measures per stem volume class is much higher than in winter

Decorrelation increases with increasing temporal baseline, decorrelation is higher at high forest biomass areas

Correlation with stem volume can increase with temporal baseline (also matter of environmental conditions)

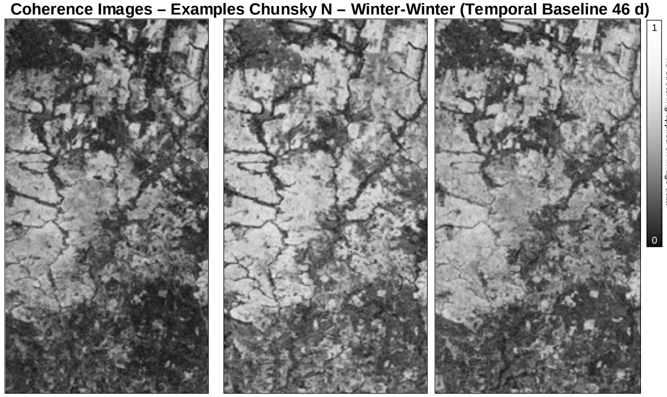
Intra- and inter-annual summer coherence can contain helpful information

Decorrelation appears at patches with (presumably) temporal soil moisture variations (e.g. headwaters, bogs, floodplains)

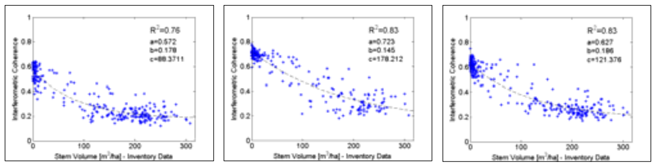
Serious decorrelation, if one of the images is out of season (midsummer)

Summer coherence is much less suited for forest stem volume estimation than winter coherence

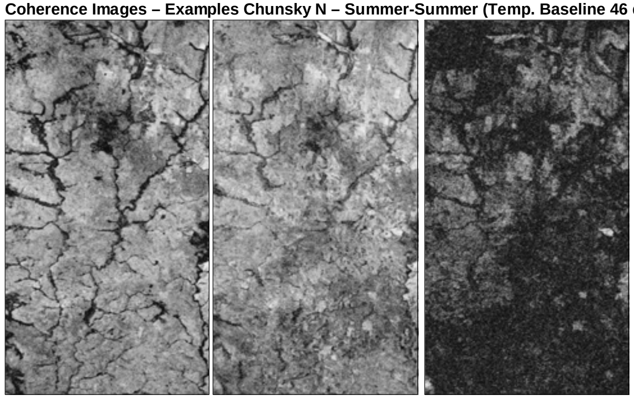
## Coherence Images – Examples Chunsky N – Winter-Winter (Temporal Baseline 46 d)



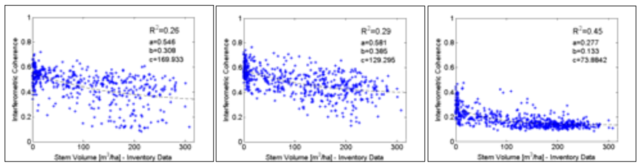

05nov07_21dec07 | 21dec07_05feb08 | 05feb08_22mar08

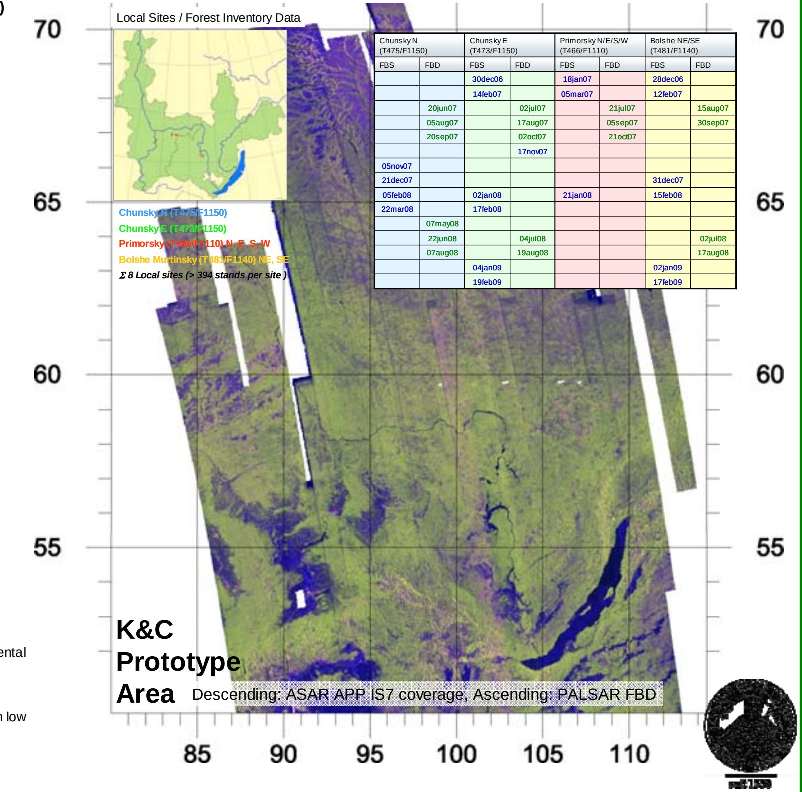



## Coherence Images – Examples Chunsky N – Summer-Summer (Temp. Baseline 46 d)



20jun07_05aug07 | 05aug07_20sep07 | 22jun08_07aug08




| Chunsky N (T475/F1150) | | Chunsky E (T473/F1150) | | Primorsky N/E/S/W (T466/F1110) | | Bolshe NE/SE (T481/F1140) | |
|---|---|---|---|---|---|---|---|
| FBS | FBD | FBS | FBD | FBS | FBD | FBS | FBD |
| | | 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 | | 04jul08 | | | | 02jul08 |
| | 07aug08 | | 19aug08 | | | | 17aug08 |
| | | 04jan09 | | | | 02jan09 | |
| | | 19feb09 | | | | 17feb09 | |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## Conclusions – Discussion

In summer obviously overall temporal decorrelation is not larger than in winter (consecutive cycle coherence). This surprisingly seems to apply also to high stem volume classes.

In winter, decorrelation of high stem volume areas is interpreted as effect of volumetric decorrelation, temporal decorrelation is assumed to have minor effect (extremely stable environmental conditions).

The decrease of penetration depth into the canopy of incoming SAR signals in summer could result in reduced volumetric decorrelation (raised and narrower scattering centre).

Evidence of this assumption could be seen in the remarkable examples (increasing coherence with increasing stem volume): → (potential) change in soil moisture in particular impacts areas with low stem volume.

In summer larger spread of coherence due to effect of various tree geometries (type etc.)? Do in winter all tree types have the same impact on coherence?