

K&C Project:

## Estimating Forest Height by means of Pol-InSAR techniques

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# Forest Height

**Product name:** Forest Height (Estimation by means of Pol-InSAR)

**Description:** Canopy Top Height (where such a definition makes sense ... )

**PALSAR mode:** Quad-Pol. InSAR Acquisitions. - Opt. Dual-Pol. InSAR

**Observation cycles:** Any Possible !!!

## Production schedule (estimated):

1. Analysis of data quality / Data processing ( Ongoing ...)
2. Inversion methodology development ( Ongoing ...);
3. Application and validation on selected sites ( Autumn 2007);

## Estimated date of delivery:

➤ First ¼ of 2008

# Forest Height

## Project objective(s):

- Evaluation of the potential of (ALOS/PaISAR) Pol-InSAR techniques to provide forest height estimates.

## Open questions to be answered with ALOS/PaISAR:

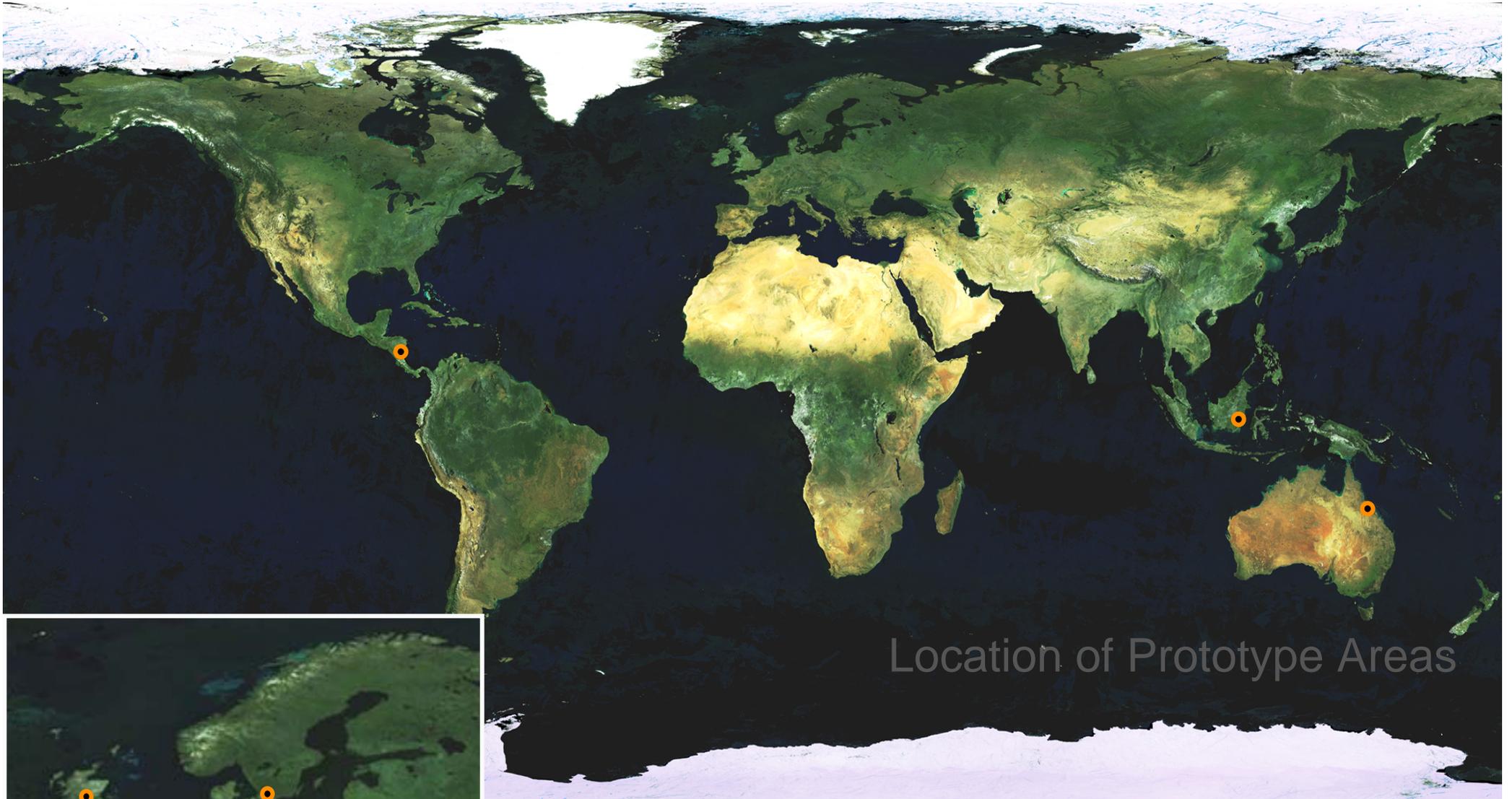
- Does L-band “see” the ground in tropical forests ?
- What is the impact of temporal decorrelation (46 days cycle) on parameter estimation ?
- What is the performance of inversion techniques over different forests environments and conditions (global view) ?
- Is ALOS/PaISAR capable for “global scale” forest height / biomass mapping ?
- Is a L-band sensor capable for global scale forest height / biomass mapping ?

## Project milestone(s):

- Inversion methodology development - based on airborne data - optimised with respect to the actual ALOS/PaISAR acquisition-scenario / operation.
- ALOS/PaISAR data inversion and validation of the obtained forest height estimates over a limited number of selected test-sites.
- Inversion methodology development adapted to the dual-pol single-/dual-baseline ALOS/PaISAR global coverage acquisition scenario

# Forest Height

- Prototype Areas: Limited Number of Selected Test Sites worldwide.  
A (prioritised) list of test sites has been proposed to / accepted by JAXA.  
7 Test Sites: (3 Tropical / 1 Boreal / 3 Temperate);
- Corresponding observation plan polygon(s): C2, C3, B3, D3, D4, D5, G1, G2, F3, F4, F5;
- No. PALSAR paths / coverage: One path per site / Consecutive Cycles;
- PALSAR request (Year 1-3): InSAR Quad pol (opt. InSAR Dual-pol passes)  
1 frame per Test site
- Input data: Level 1.1 Quad-pol products.
- Ancillary data requests: 3-dimensional baseline information  
x-, y-, z-coordinates (Coordinate System TbD) of the antenna locations along the orbit.

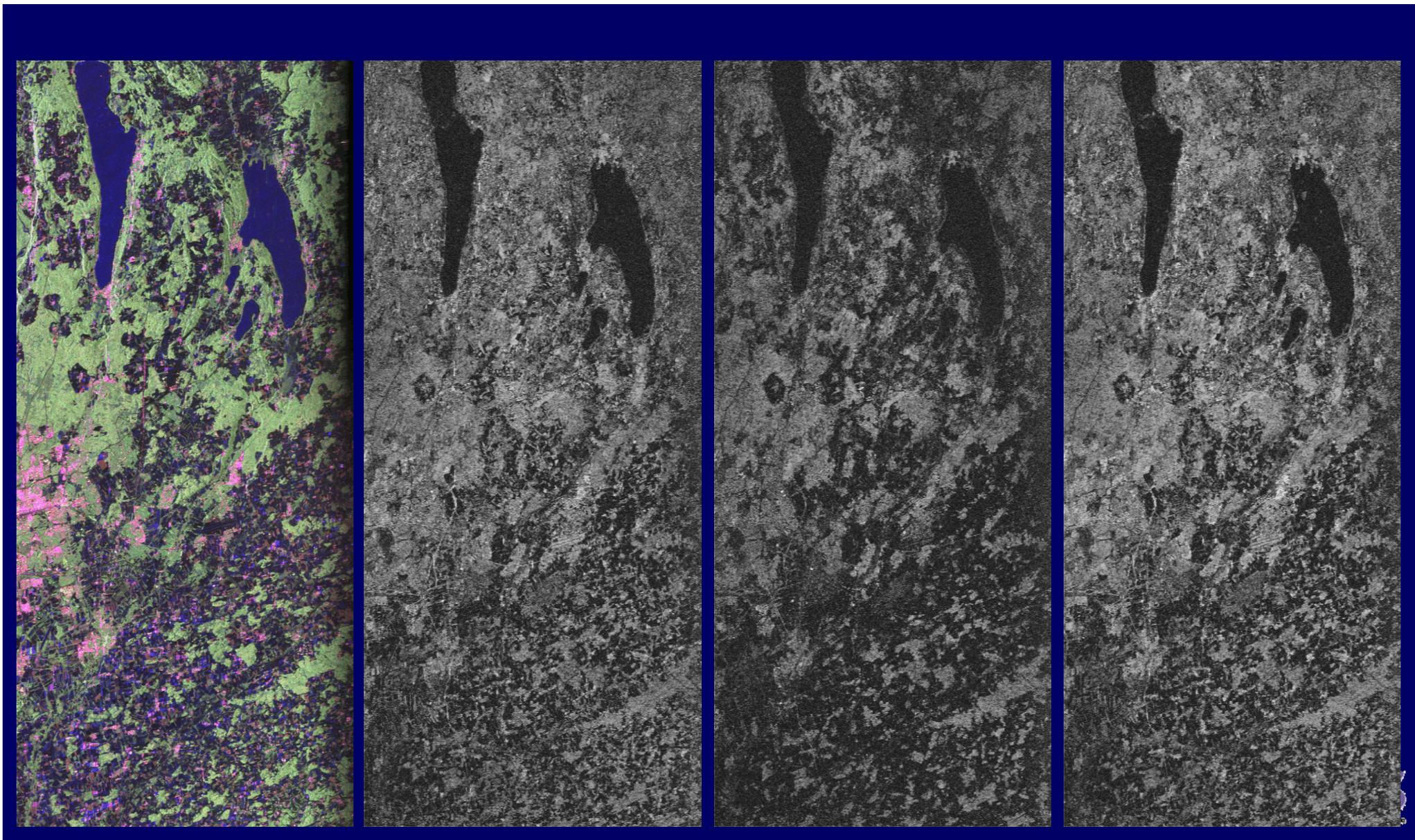


## Location of Prototype Areas

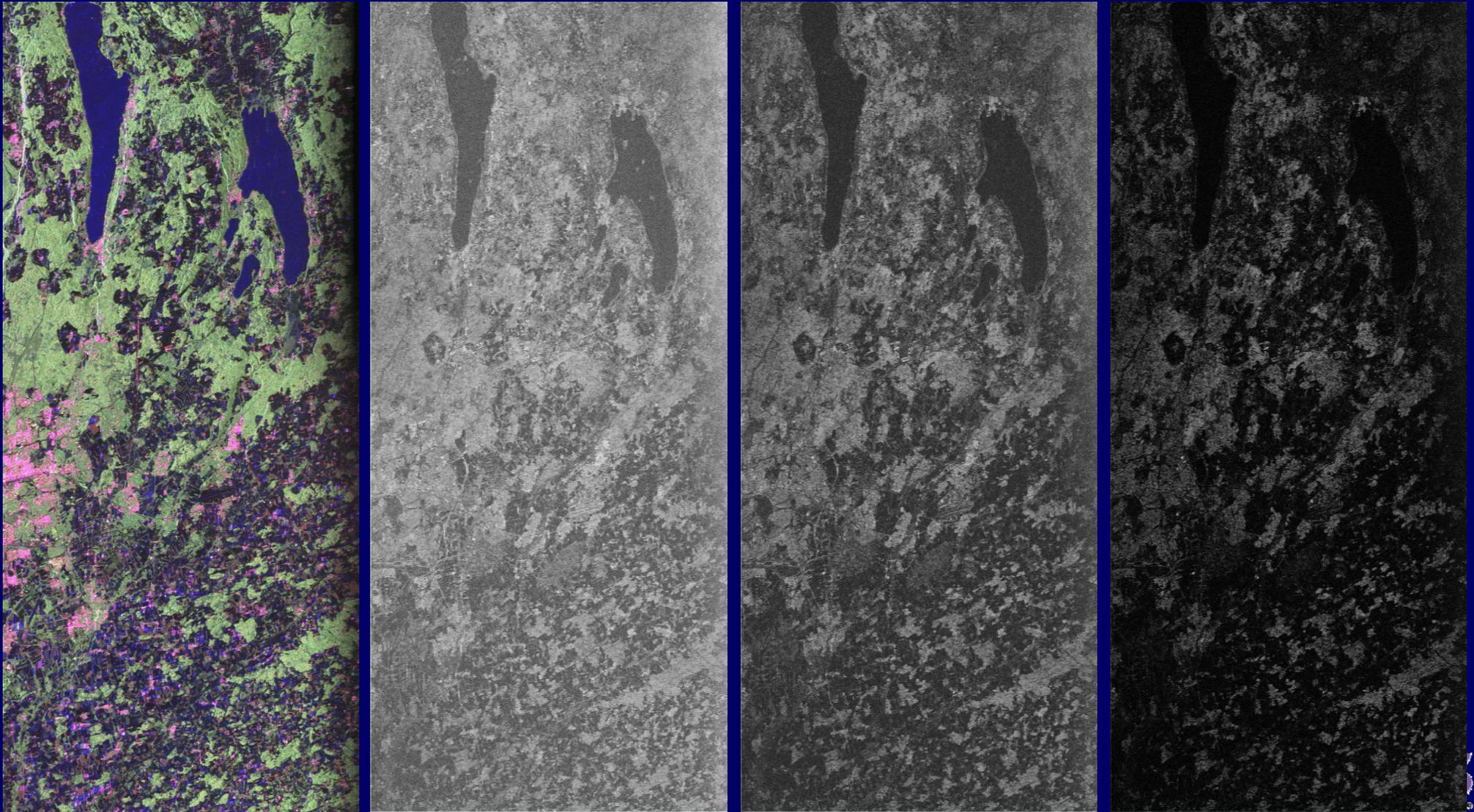


Helsinki	Finland	Boreal Forest
Traunstein	Germany	Temperate Forest
Ebersberger Forst	Germany	Temperate Forest
Injune	Australia	
Belize	Belize	Tropical Forest
Borneo	Indonesia	Tropical Forest

# ALOS-PaISAR Pol-InSAR Results

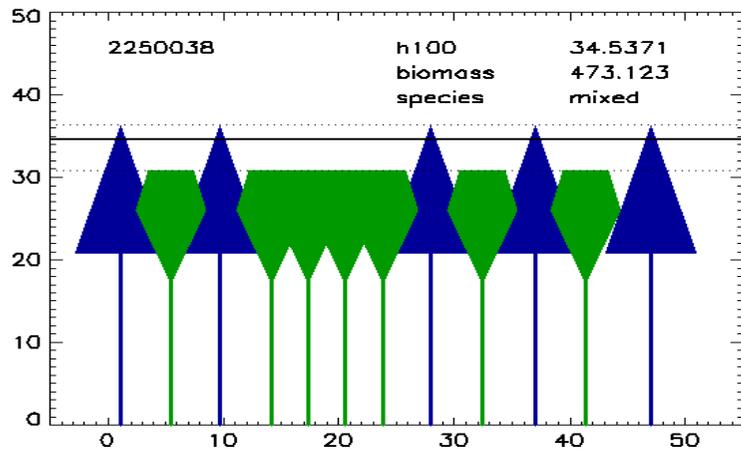
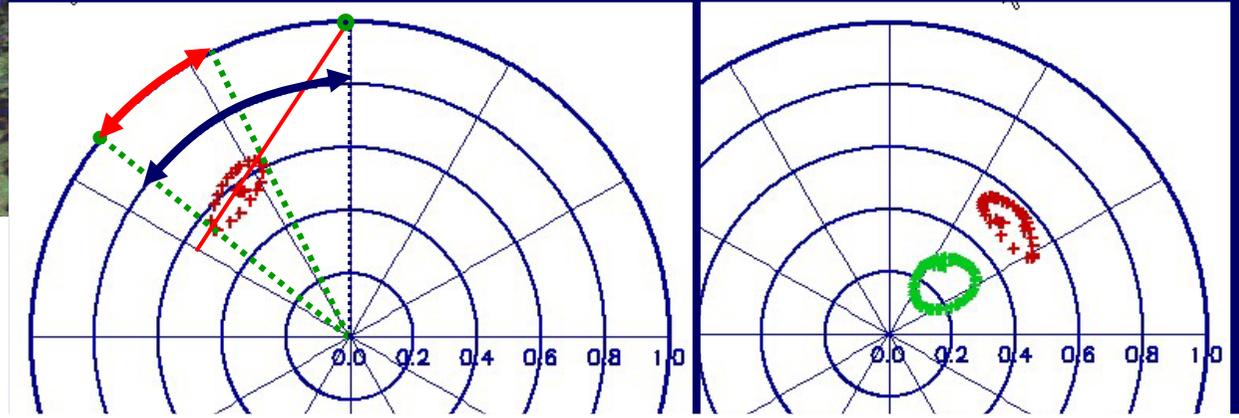
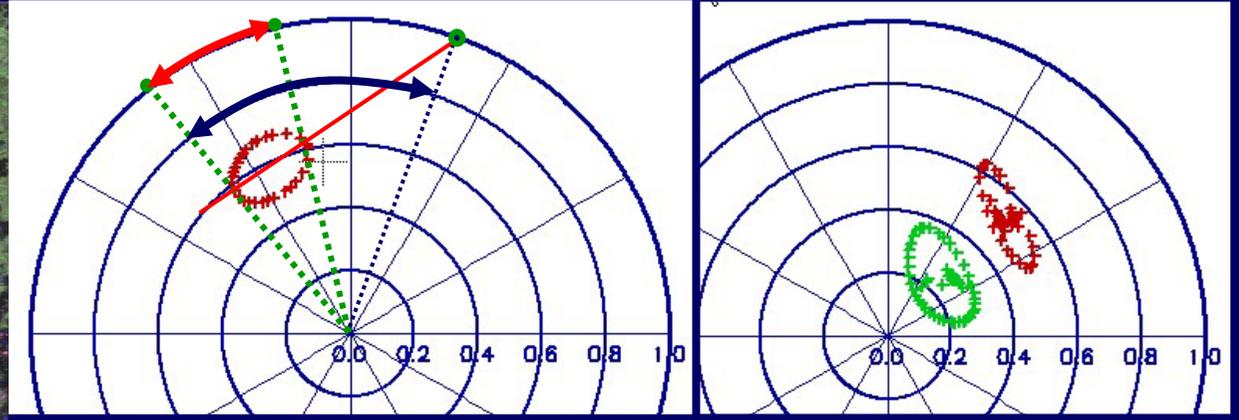
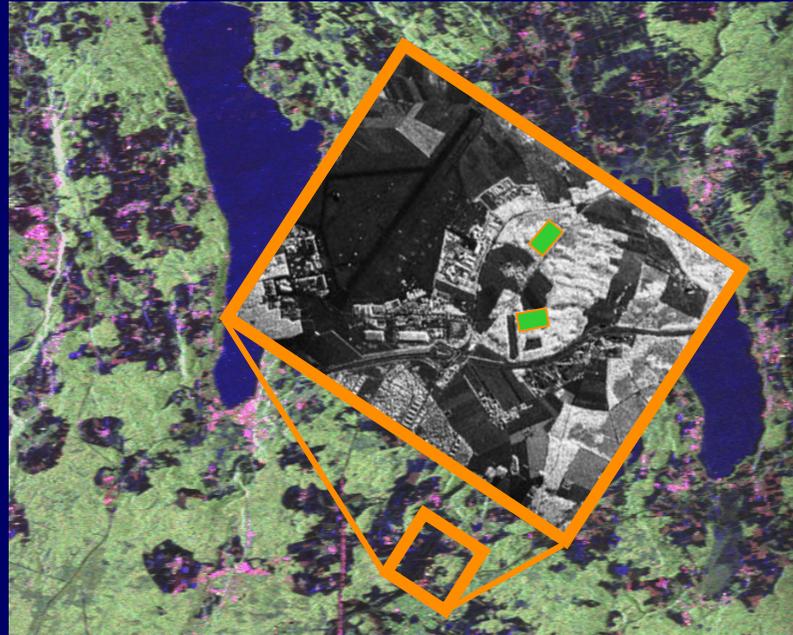


# ALOS-PaISAR Pol-InSAR Results



# Forest Height

ALOS-PaISAR: Quad-Pol. / Scene ID: ALPSRP029662630-ALPSRP036372630



	Stand 1	Stand 2
Estimated Height:	~27m	~29m
Reference Forest Height:	~20-25m	~20-25m
Temporal Decorrelation:	~0.65-0.75 / ~0.3-0.35	

Cycle 15-16

HH-HH

AVG:  $\gamma_{\text{Temporal}}=0.4$

HV-HV

AVG:  $\gamma_{\text{Temporal}}=0.3$

VV-VV

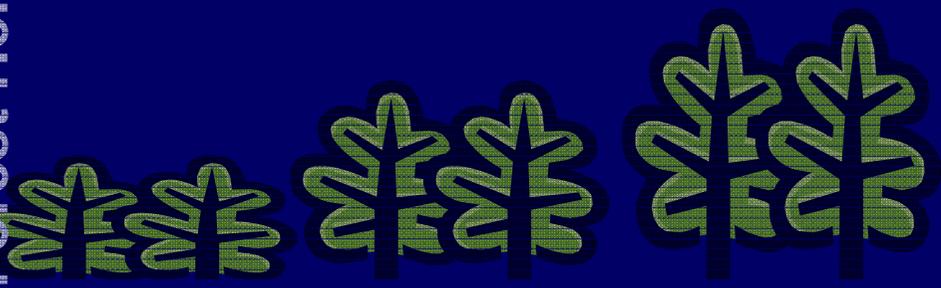
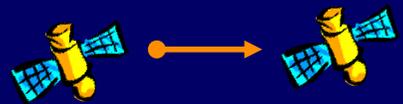
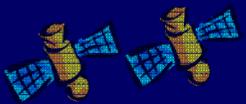
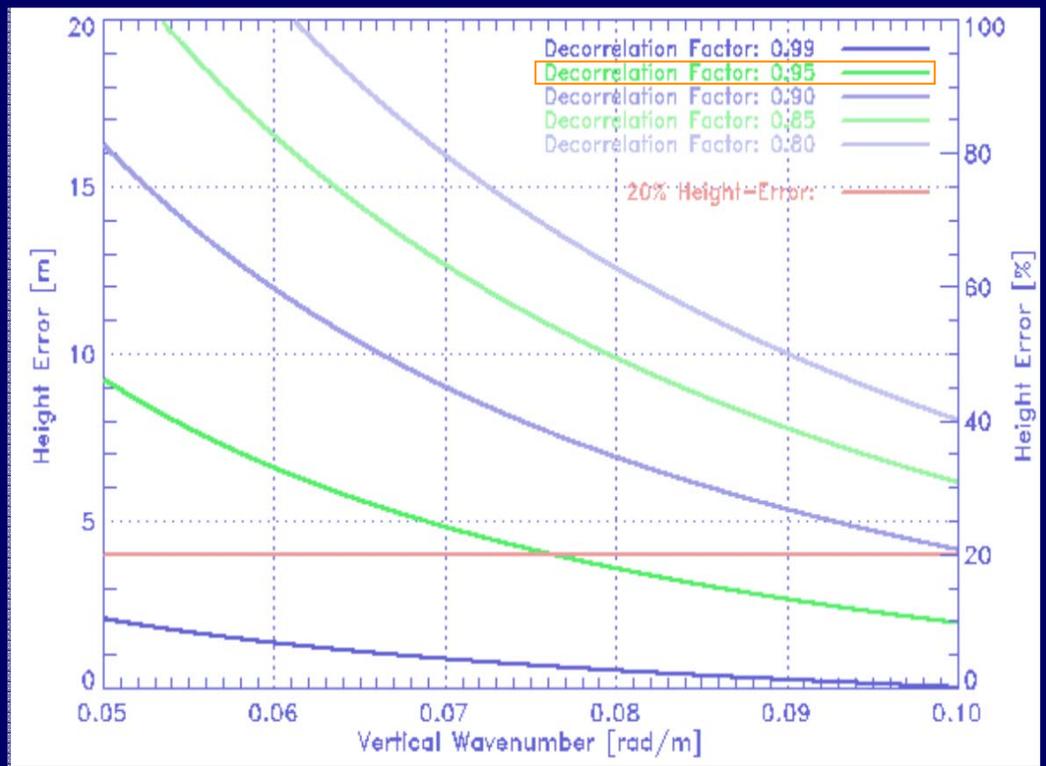
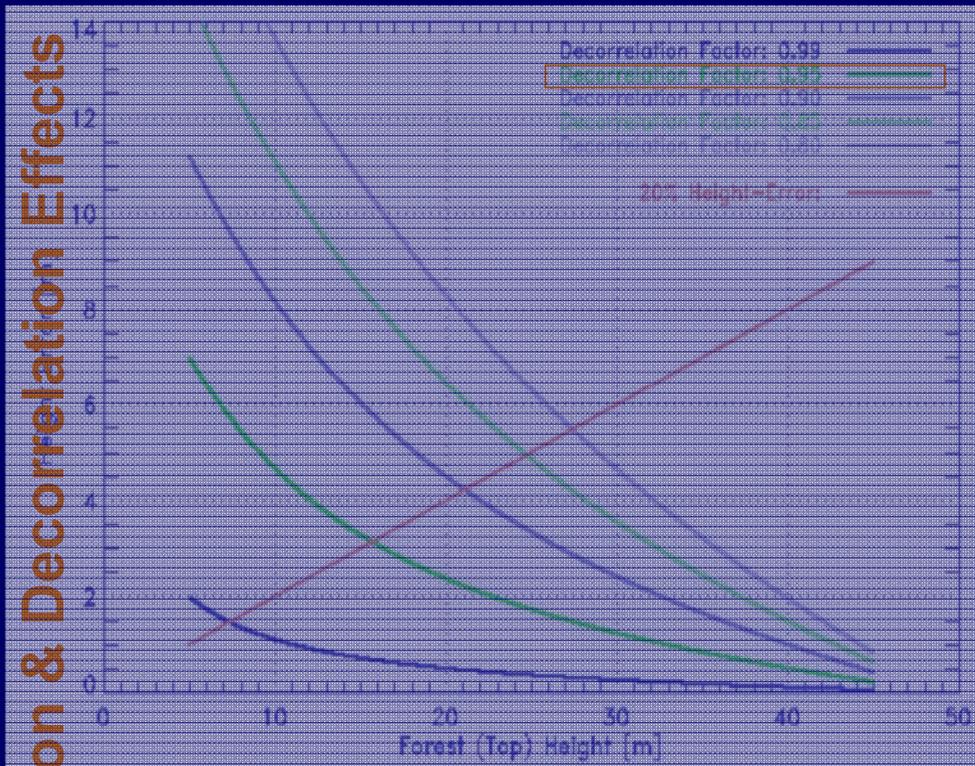
AVG:  $\gamma_{\text{Temporal}}=0.4$



## Conclusions after looking on 6 Test sites & 70 Pol-InSAR Scenes:

- + ALOS PaISAR Quad-Pol Quality is excellent and within the Specs.
- The 46 days temporal baseline provided limits quantitative forest Pol-InSAR applications.
- Spatial baselines are sub-optimal for quantitative forest Pol-InSAR applications.
- The acquisition of multiple baselines is limited by the actual observation scenario.
- + Demonstration of dual-baseline Pol-InSAR height inversion possible on a stand basis.

# Forest Height Estimation & Decorrelation Effects

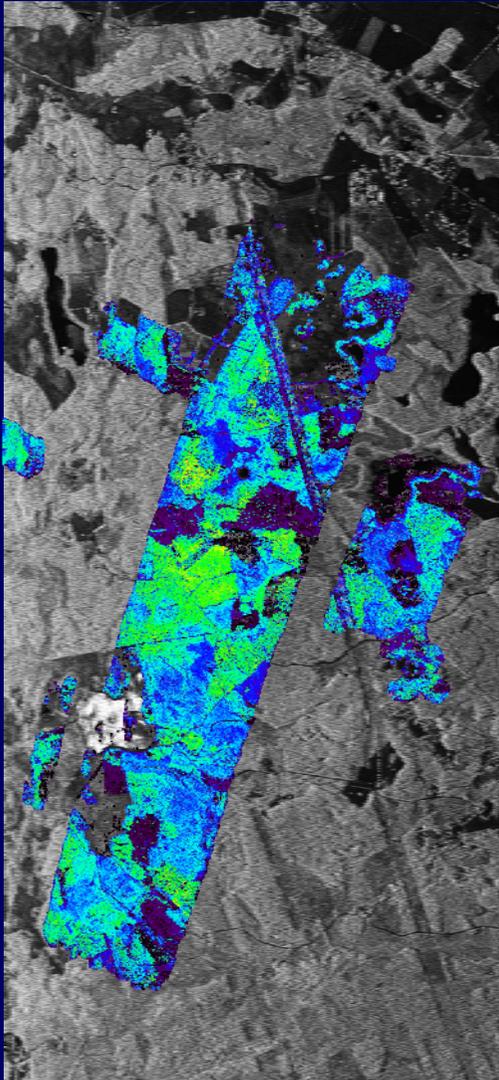


## BIOSAR: Remningstorp Test Site

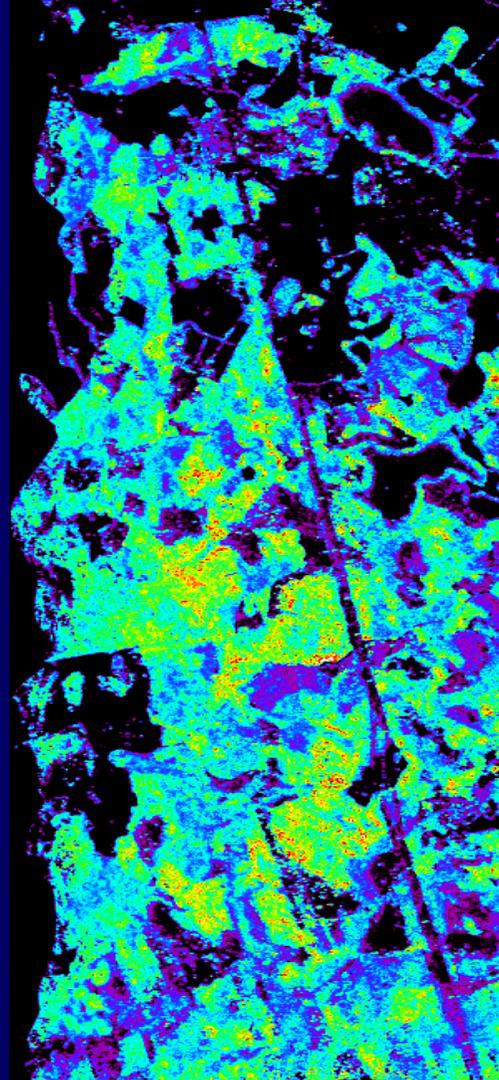
- **Forest Heights: up to 25 -30m**
- **Predominantly Spruce but also Pine and Mixed stands.**
- **Homogenous and Managed.**
- **Biomass Level: up to 300t/ha**
- **Flat Topography**



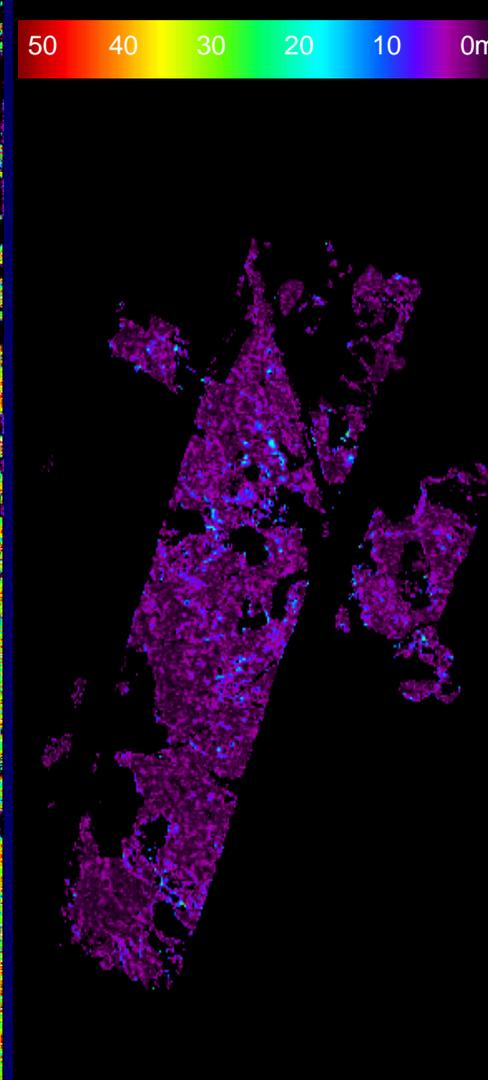
# Remningstorp Test Site: Multi-baseline Forest Height - L-Band



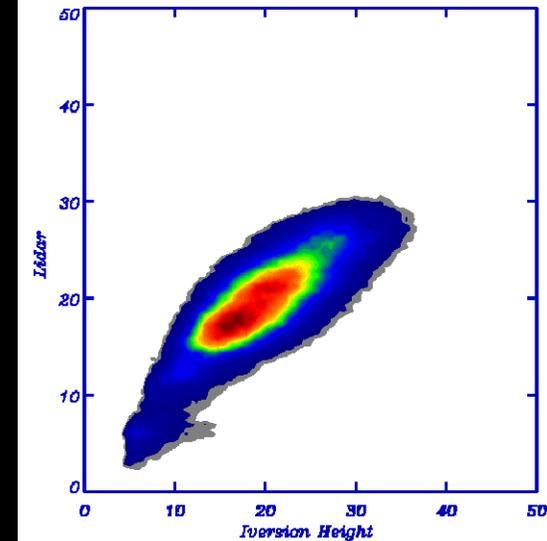
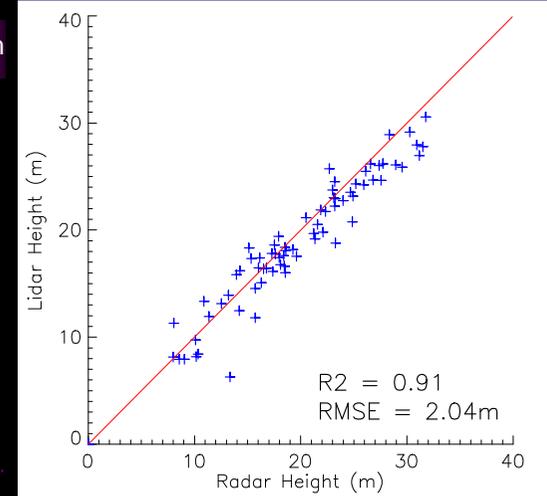
Amplitude Image HH



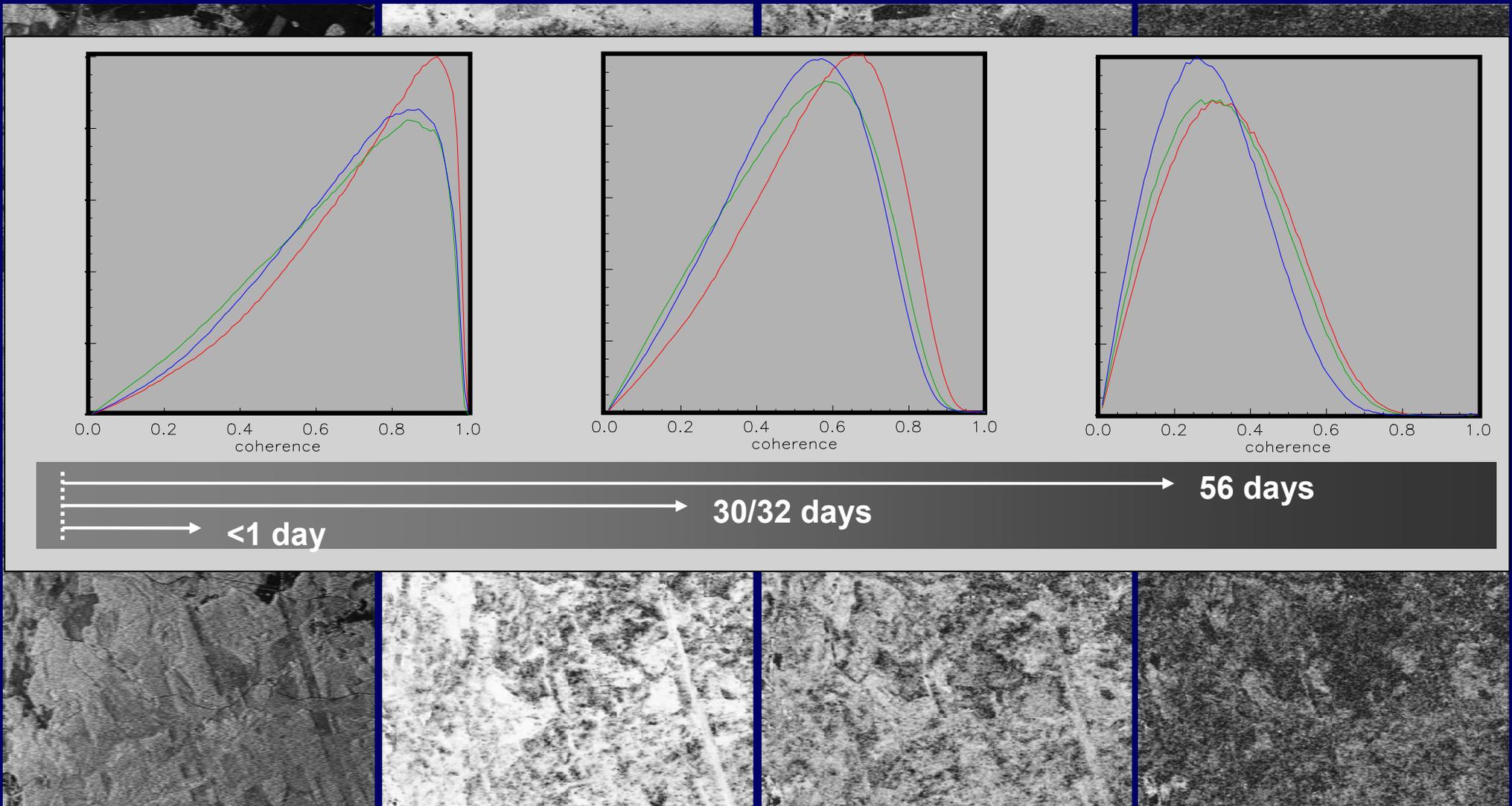
Radar derived H100



Difference [m]



# Remningstorp Test Site: Temporal Decorrelation: L-band



HV Amplitude Image

<1day

30days

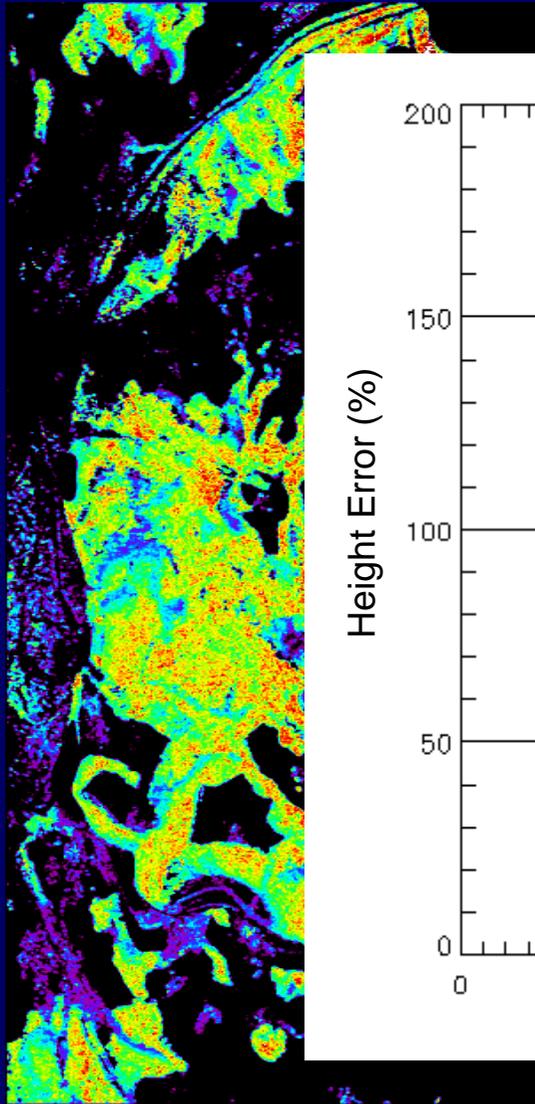
56days



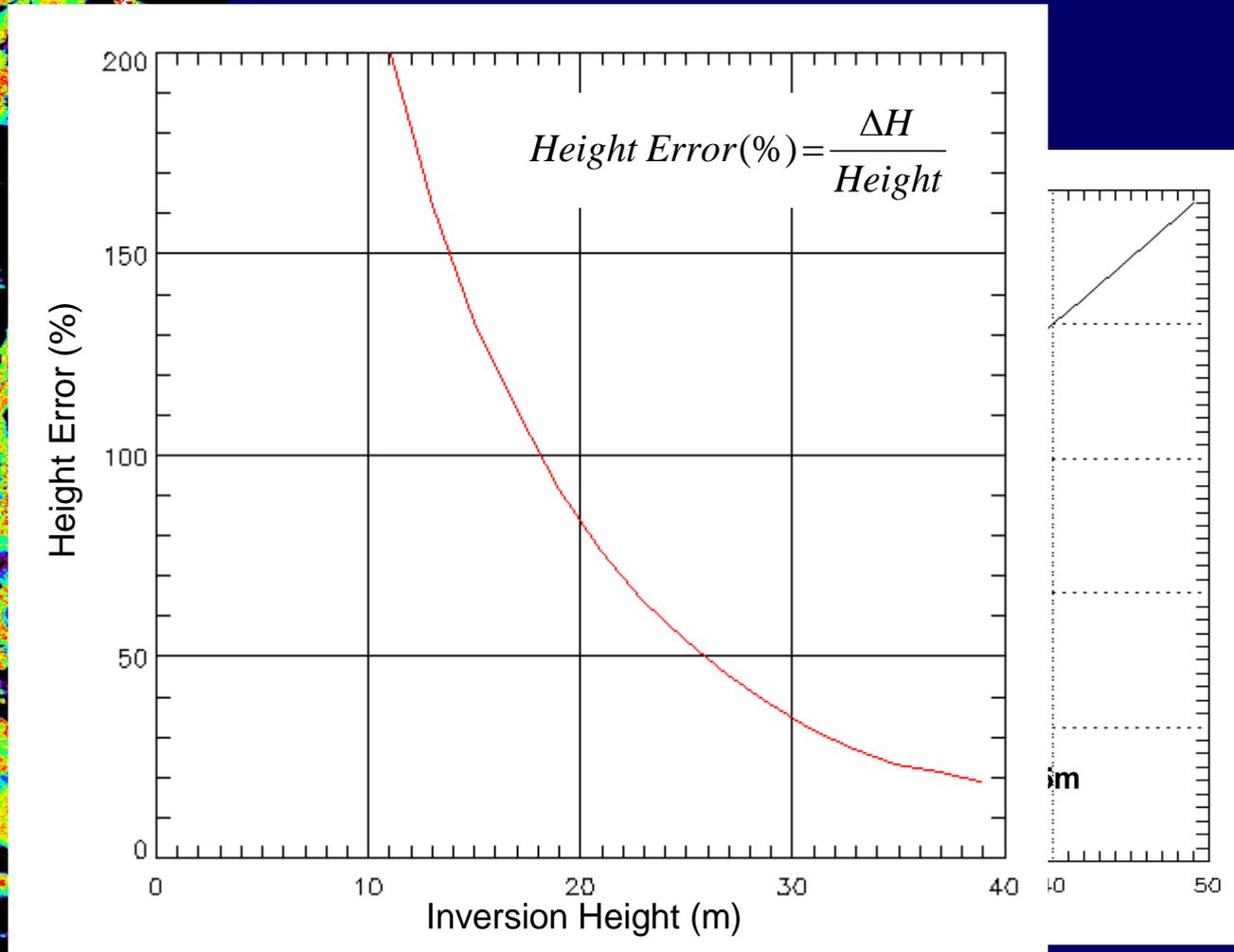
# Traunstein Test Site

Campaign	TreeSAR 2003	TempoSAR 2008
Test site	Traunstein (Germany)	
Forest type	Temperate	
Frequency	L-band	
Topography	Moderate slopes	
Height	25 ~ 30m	
Species	N. Spruce, E. Beech, White Fir	
Biomass	40 ~ 450 t/ha	
Baselines	0, 5, 10 m	-15,-5, 0, 5, 10 m
Acquisition Dates	11 Oct. 2003	7 June 2008
	26 Oct. 2003	8 June 2008
		10 June 2008
		12 June 2008
		19 June 2008
		20 June 2008

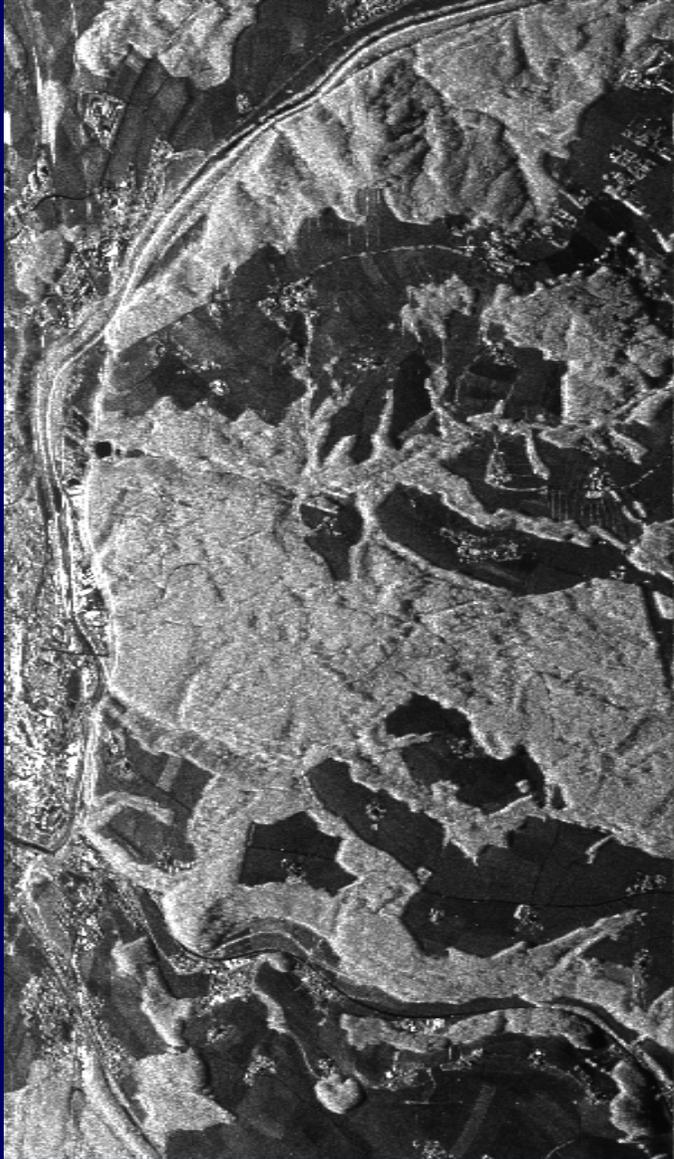
# Traunstein Test Site: TreeSAR 2003 Campaign



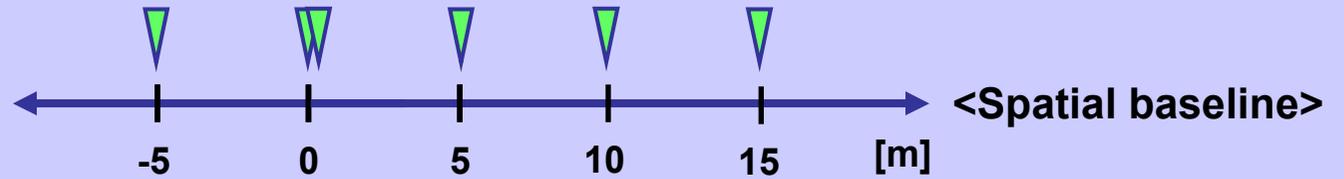
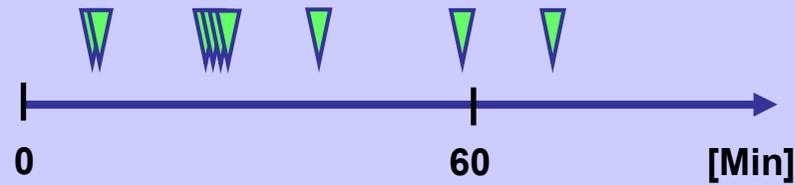
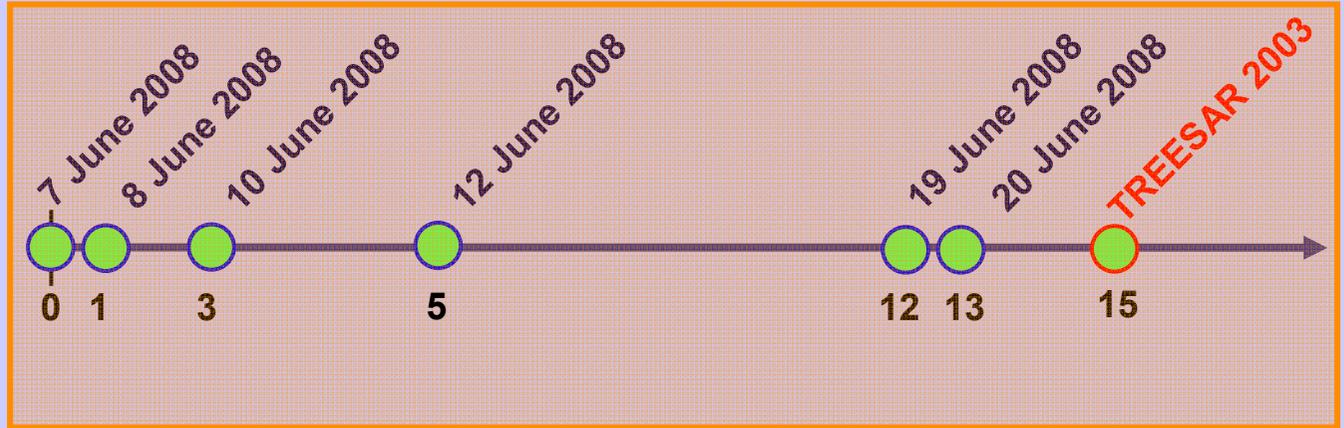
F-Height  $\Delta T=0$ days



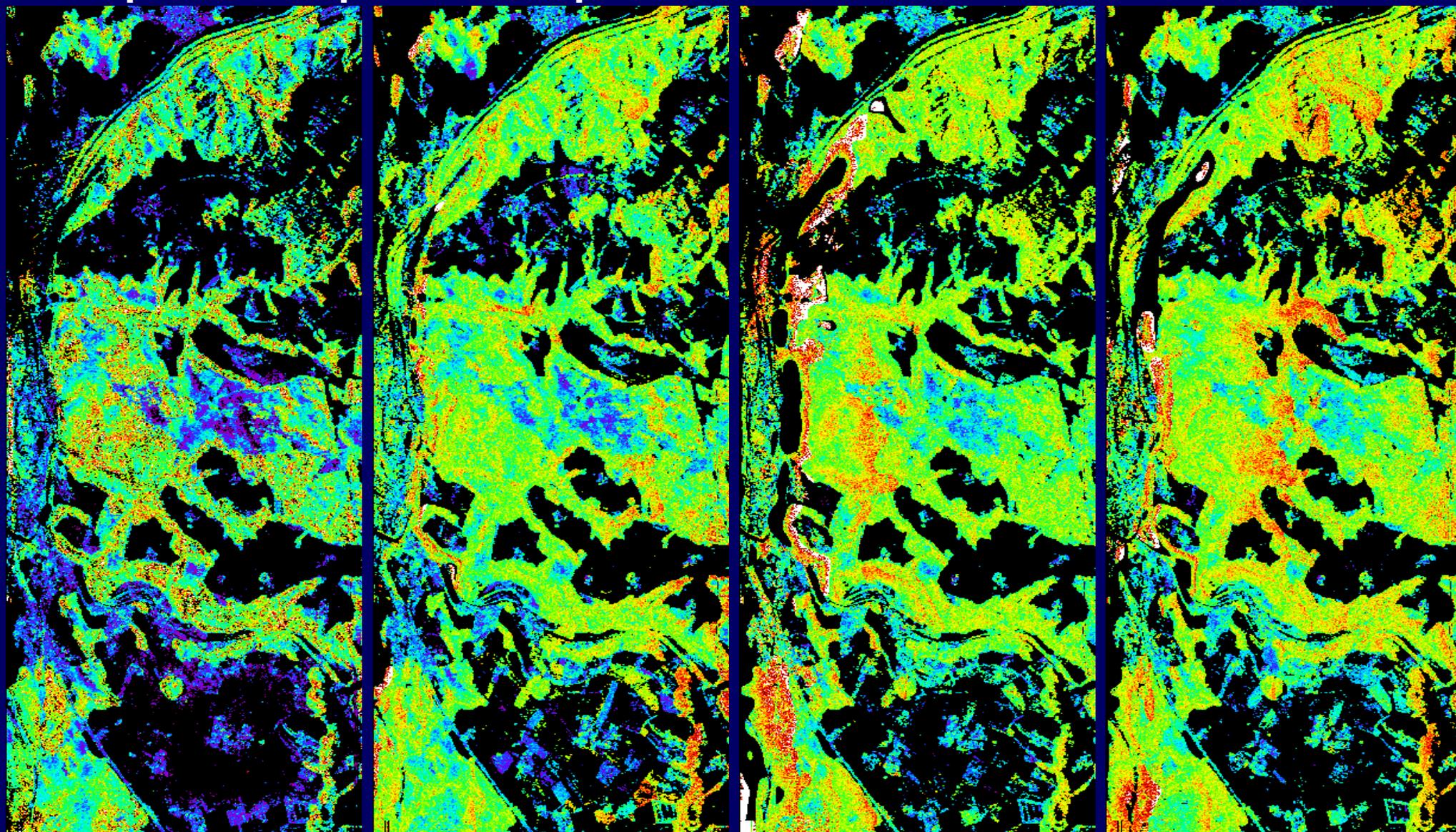
# Test Site: Traunstein



## TEMPOSAR 2008



# TempoSAR: Impact of Temporal Decorrelation



$\Delta T=0$ day

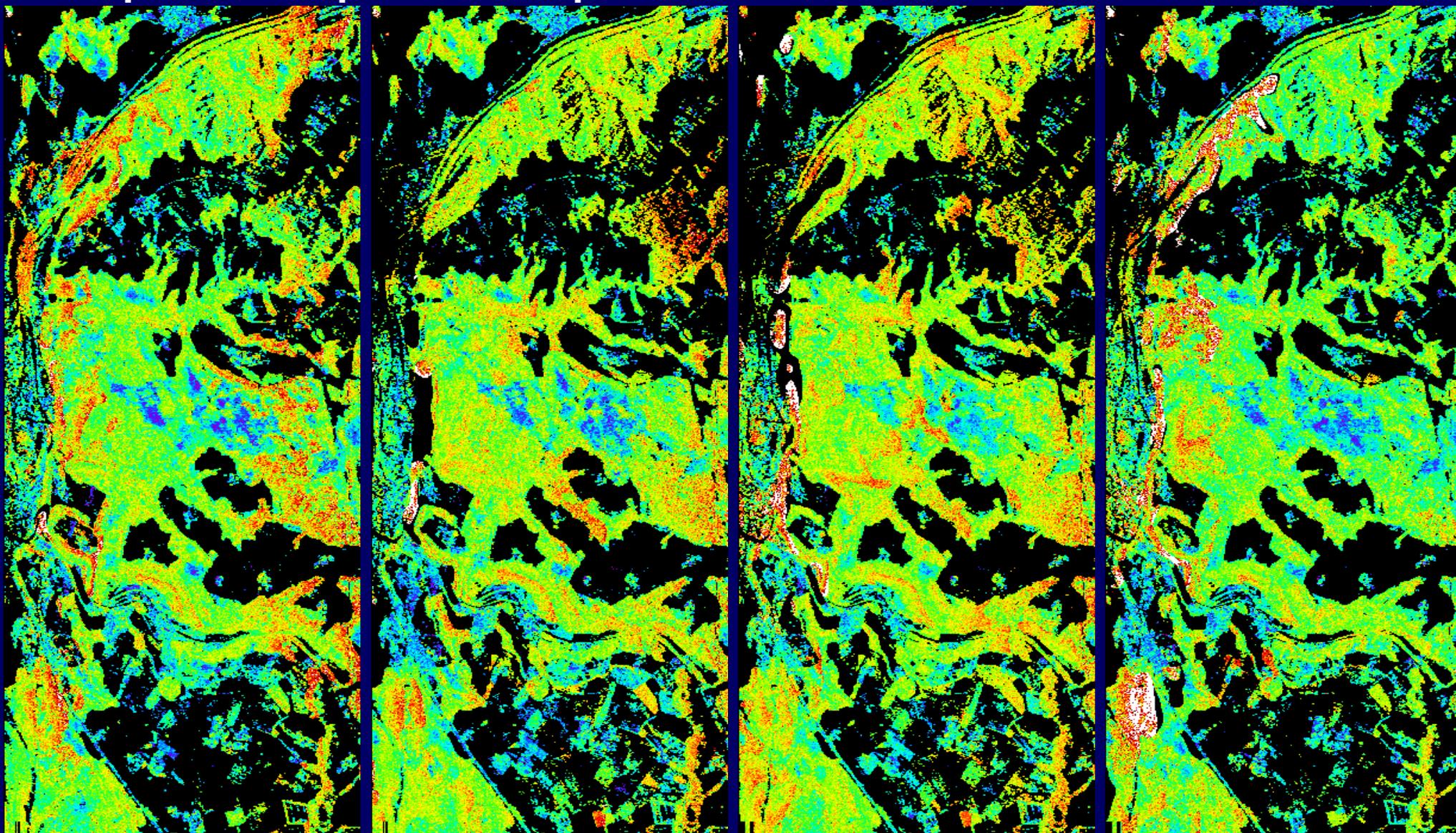
$\Delta T=1$ day

$\Delta T=2$ day

$\Delta T=3$ day



# TempoSAR: Impact of Temporal Decorrelation



$\Delta T=5\text{day}$

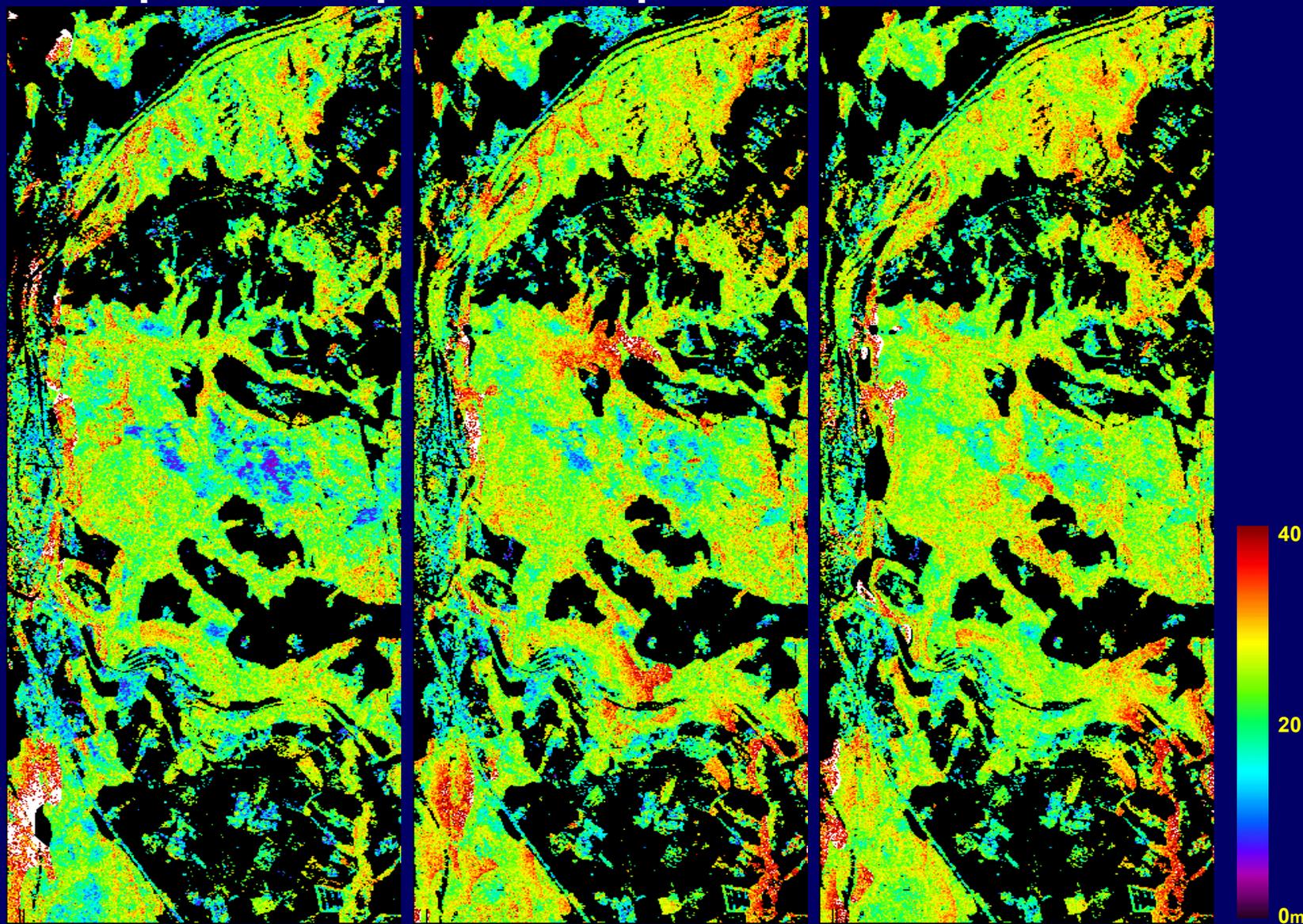
$\Delta T=7\text{day}$

$\Delta T=8\text{day}$

$\Delta T=9\text{day}$



# TempoSAR: Impact of Temporal Decorrelation



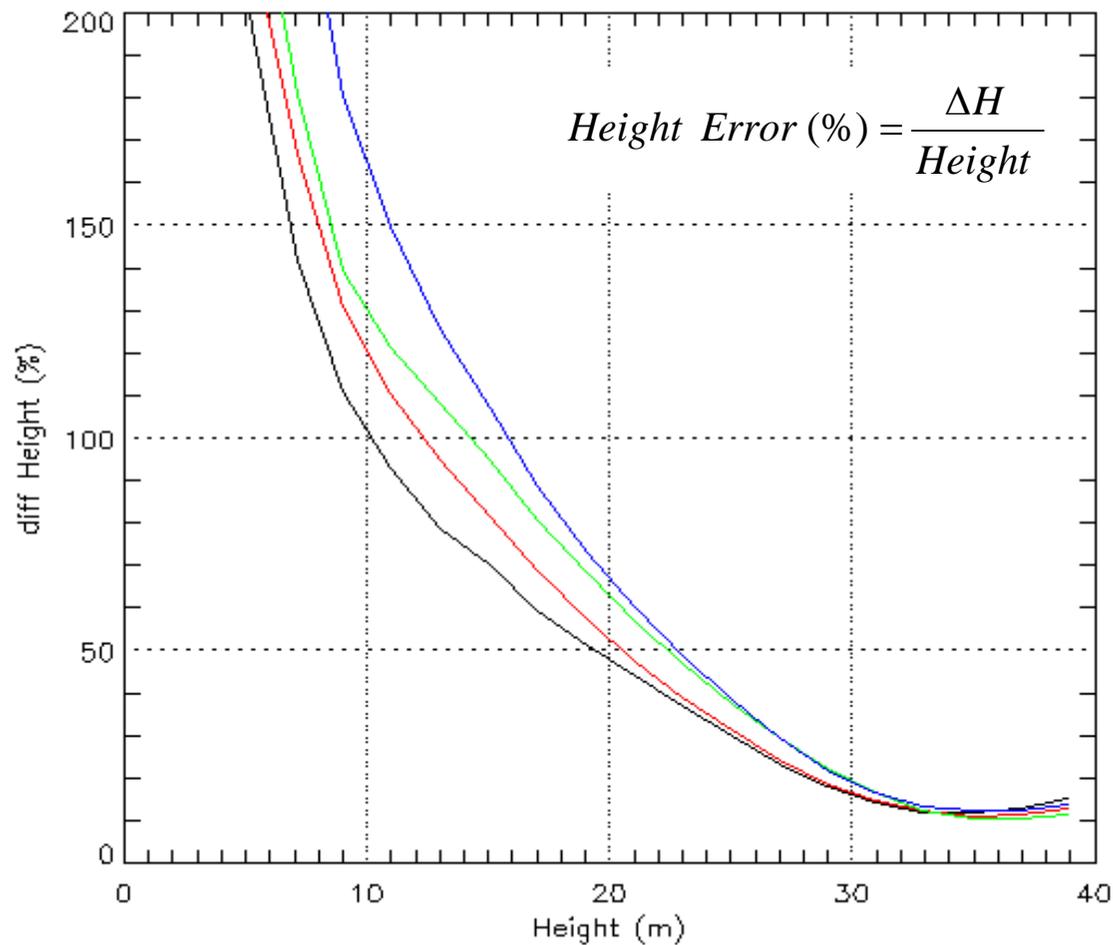
$\Delta T=10\text{day}$

$\Delta T=12\text{day}$

$\Delta T=13\text{day}$



# TempoSAR: Impact of Temporal Decorrelation

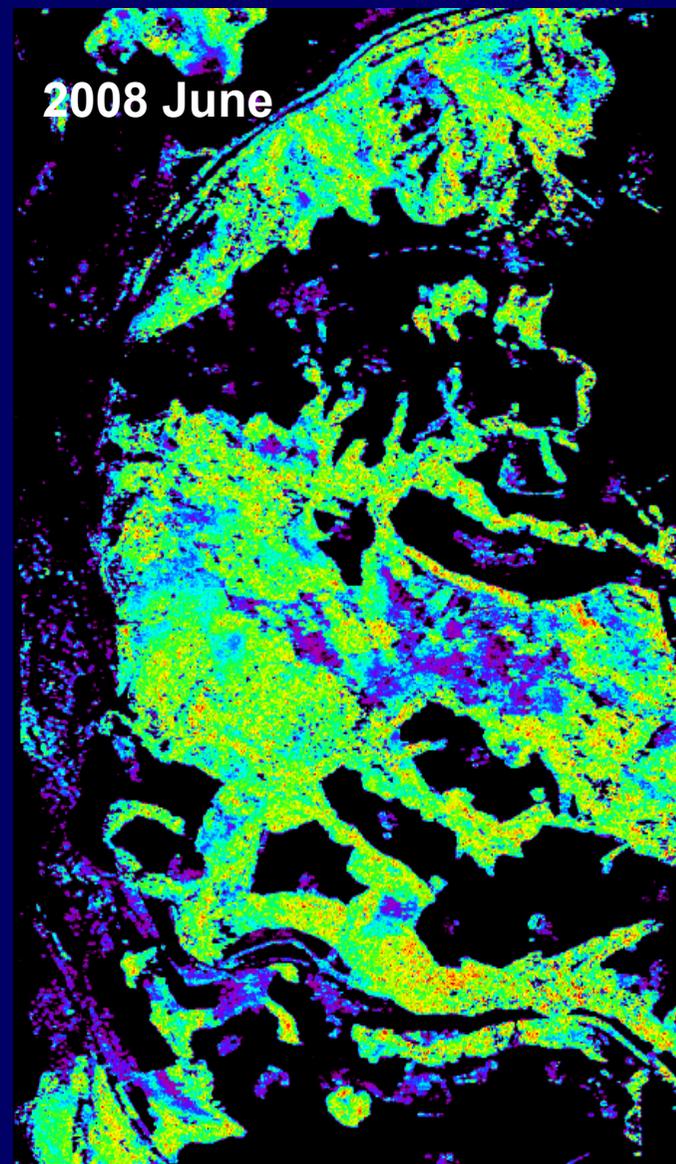
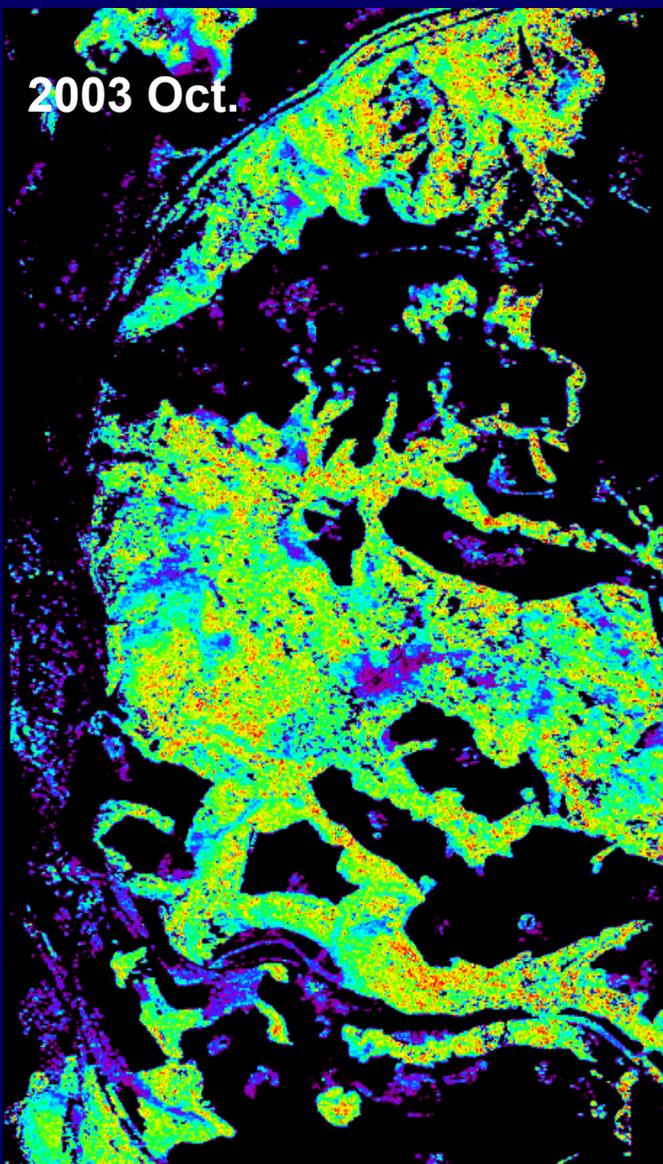
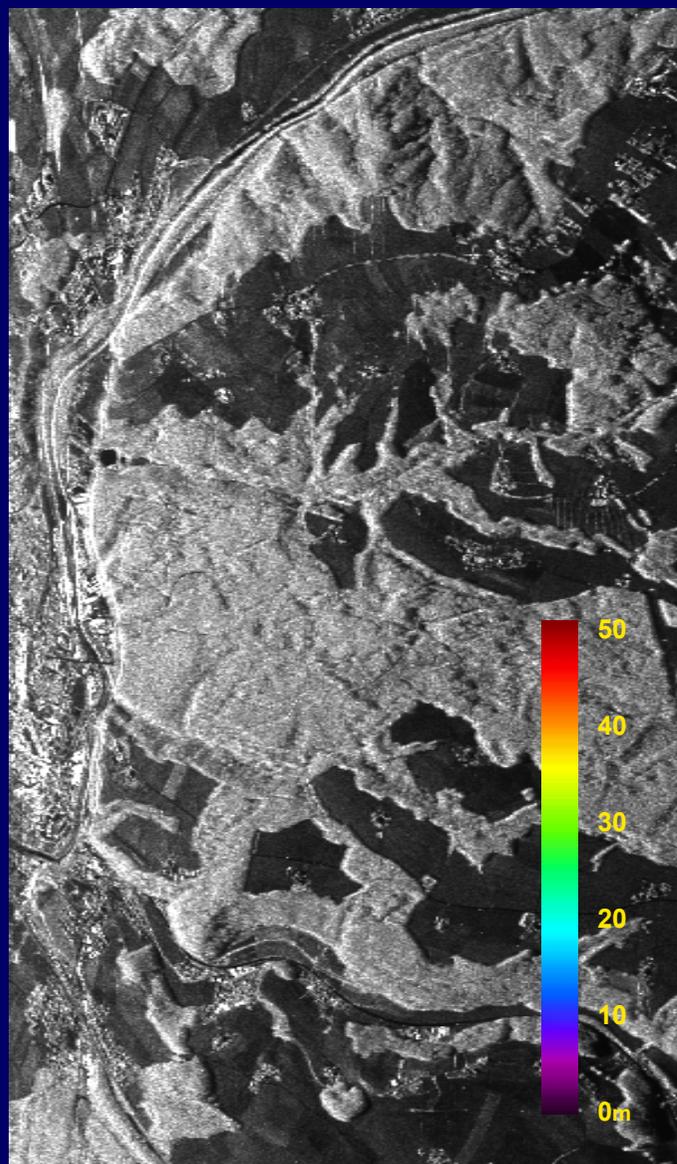


-Temporal decorrelation(1 day) leads to 20 -100 % overestimation.

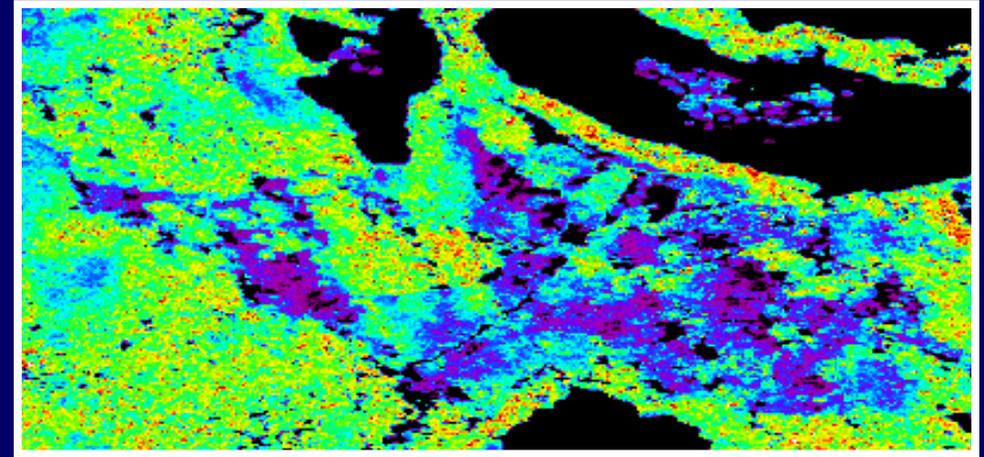
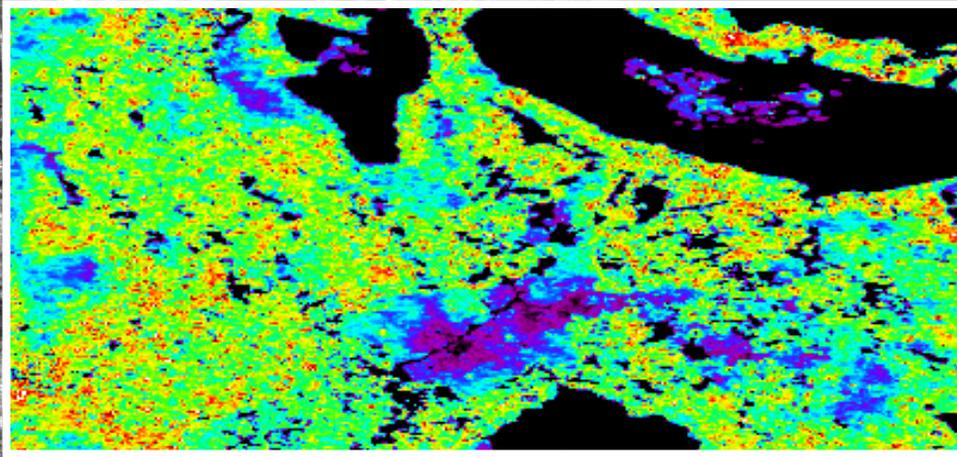
- 13 days Temporal Decorrelation
- 7 days Temporal Decorrelation
- 5 days Temporal Decorrelation
- 1 days Temporal Decorrelation



# Test Site: Traunstein

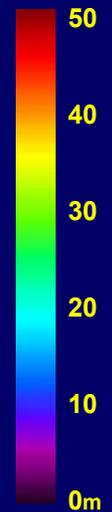
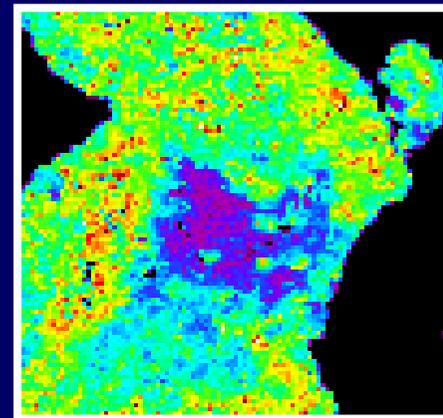
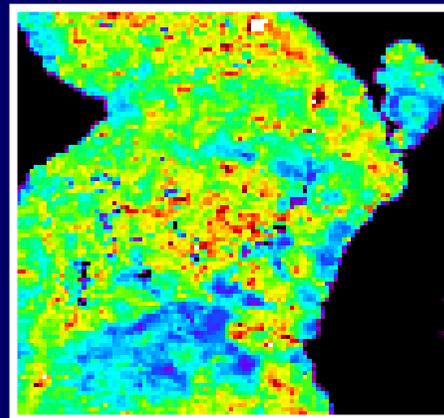
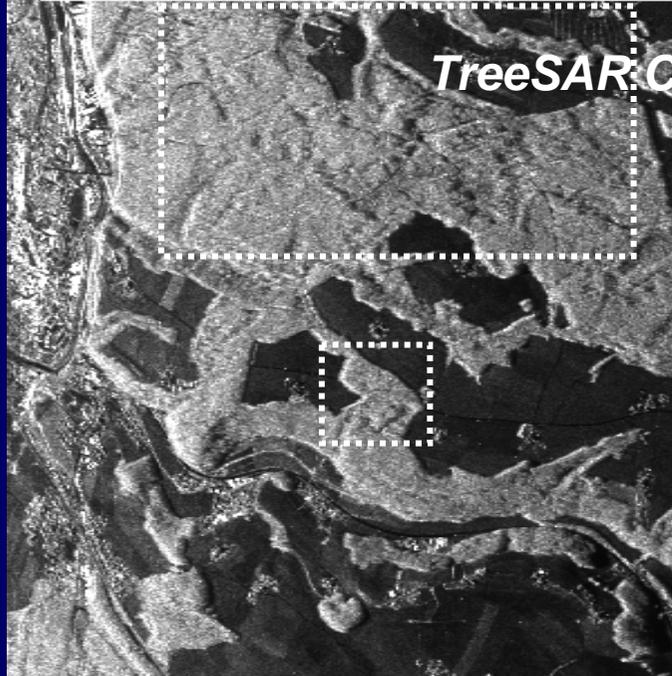


# Test Site: Traunstein



*TreeSAR Campaign 2003*

*TempoSAR Campaign 2008*



**Thank you!**



**Deutsches Zentrum  
für Luft- und Raumfahrt e.V.**  
in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group