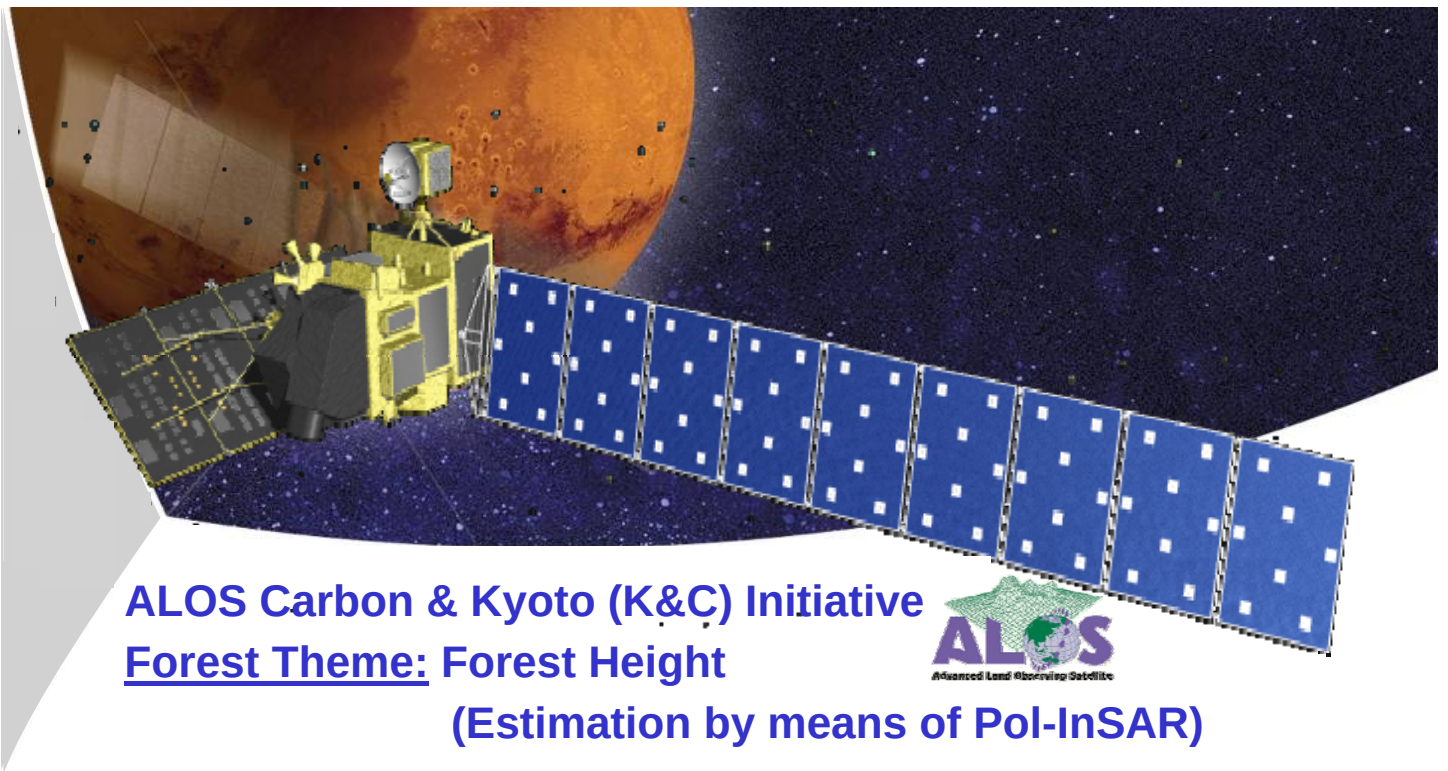




*German Aerospace Center (DLR)
 Microwaves and Radar Institute (DLR-HR)*



Microwaves and Radar Institute / Pol - InSAR Research Group



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):

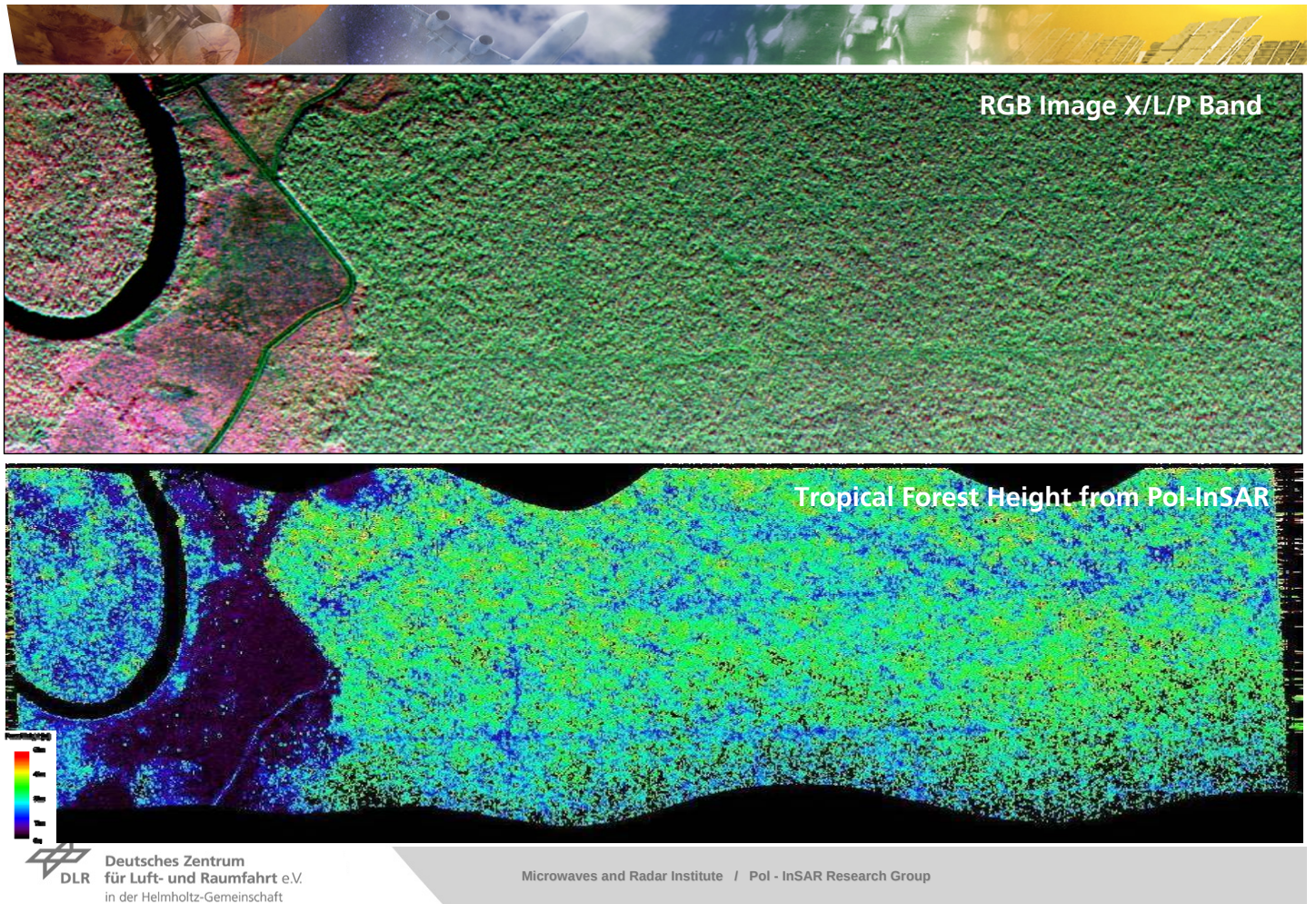
- | | |
|---|-----------------|
| 1. Analysis of data quality / Data processing | (Ongoing ...) |
| 2. Inversion methodology development | (Ongoing ...); |
| 3. Application and validation on selected sites | (Autumn 2007); |

Estimated date of delivery:

- First ¼ of 2008



Microwaves and Radar Institute / Pol - InSAR Research Group



Forest Height

Project objective(s):

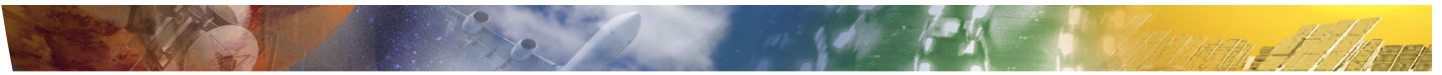
- Evaluation of the potential of (ALOS/PalSAR) Pol-InSAR techniques to provide forest height estimates.

Open questions to be answered with ALOS/PalSAR:

- 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/PalSAR capable for “global scale” forest height / biomass mapping ?
- Is a L-band sensor capable for global scale forest height / biomass mapping ?

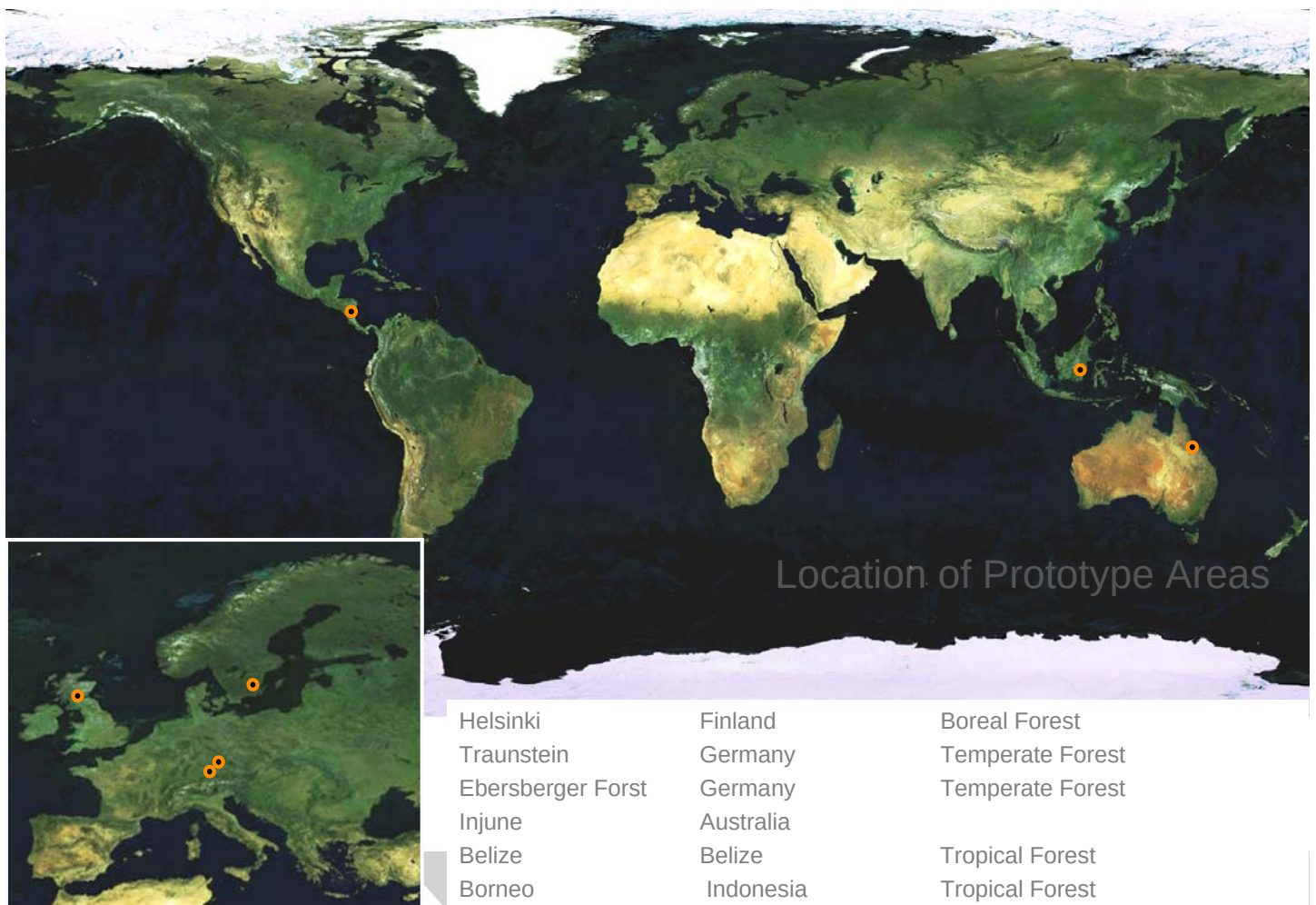
Project milestone(s):

- Inversion methodology development - based on airborne data - optimised with respect to the actual ALOS/PalSAR acquisition-scenario / operation.
- ALOS/PalSAR 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/PalSAR 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.

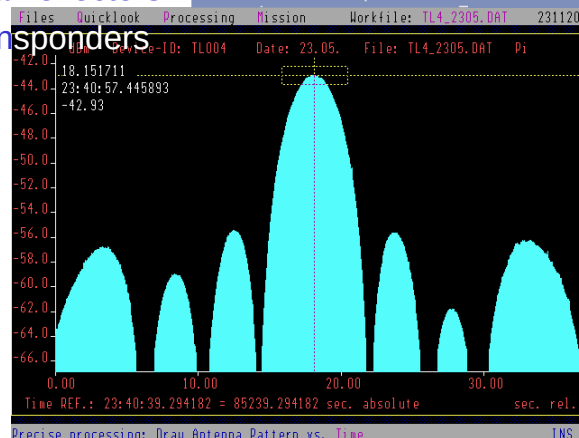


CAL-VAL CAMPAIGN

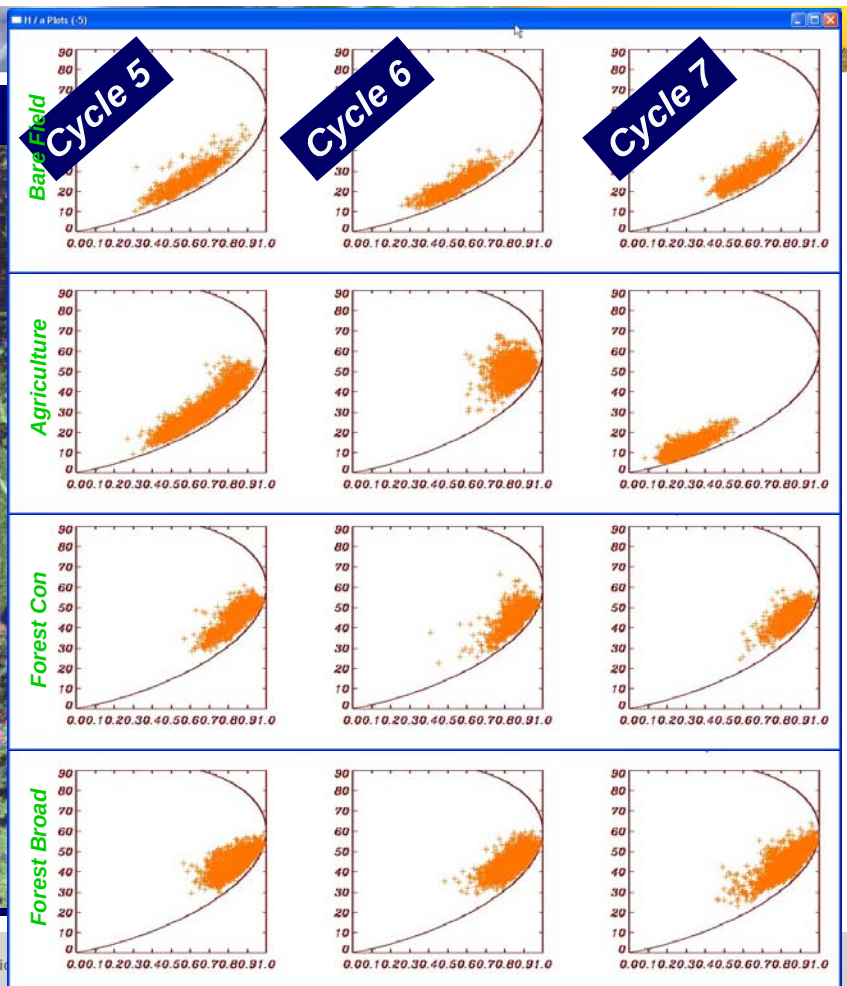
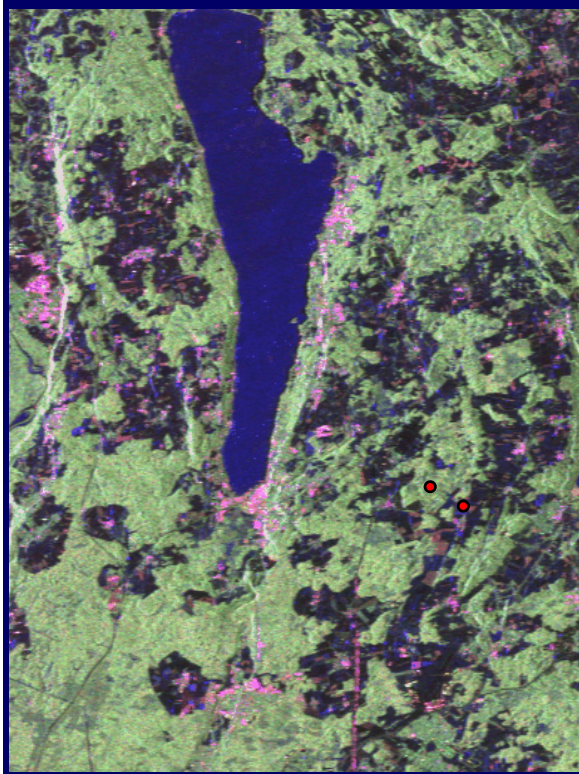
- Two Test Sites: **Oberpfaffenhofen & Traunstein**
- May until November 2006
- Total of **40(!)** acquisitions

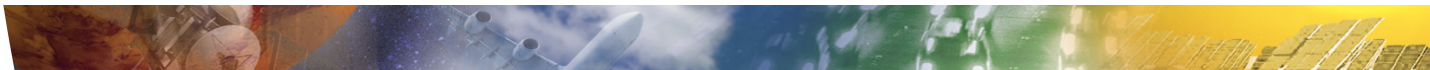
Deployed Reference targets:

- 6 x 3m trihedral reflectors
- 2 x 1.5m trihedral reflectors
- 2 x 1m dihedral reflectors
- 2 x L-band transponders

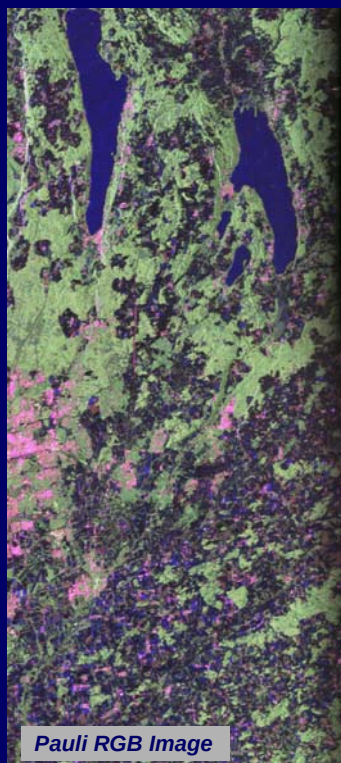


ALOS-PaISAR PoISAR Results

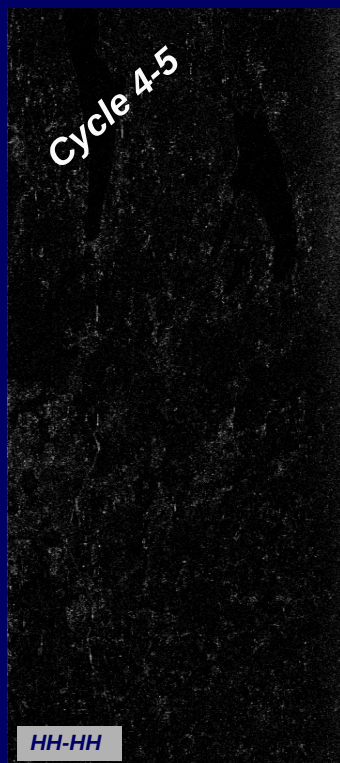




ALOS-PaISAR First InSAR Results

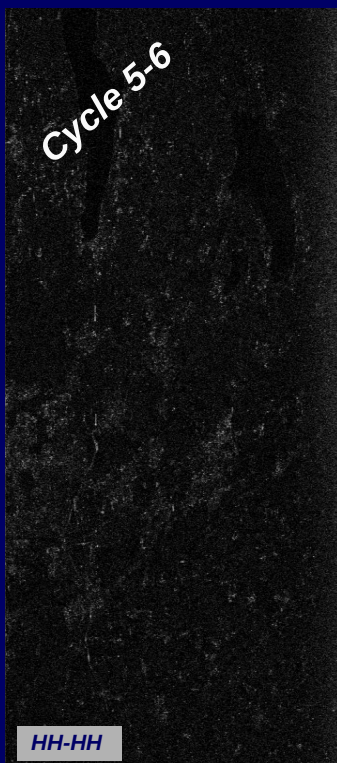


Pauli RGB Image



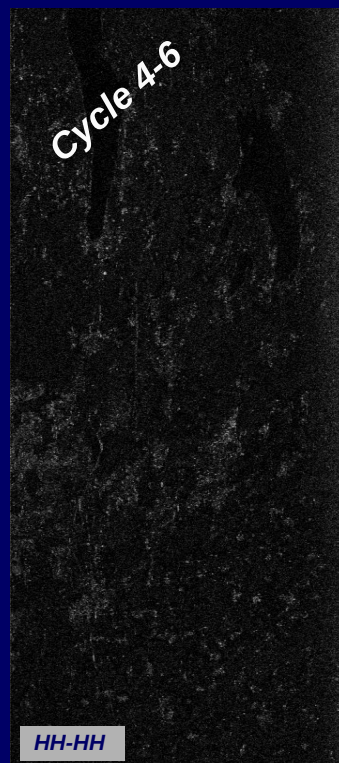
Cycle 4-5

HH-HH



Cycle 5-6

HH-HH



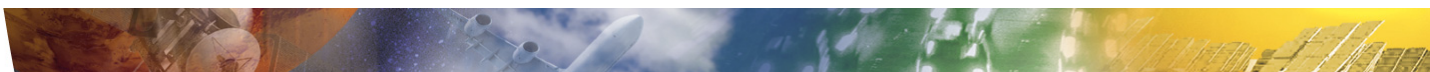
Cycle 4-6

HH-HH

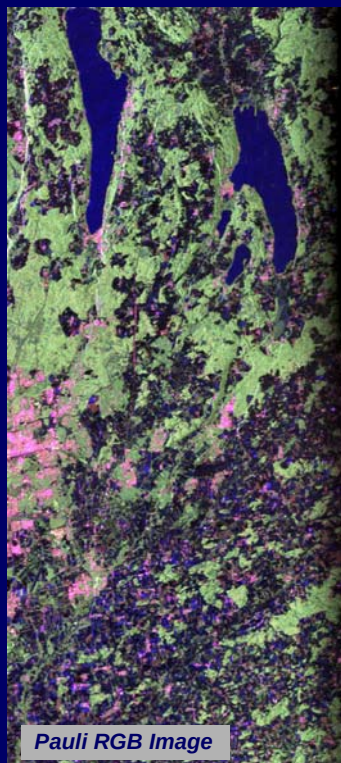


Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

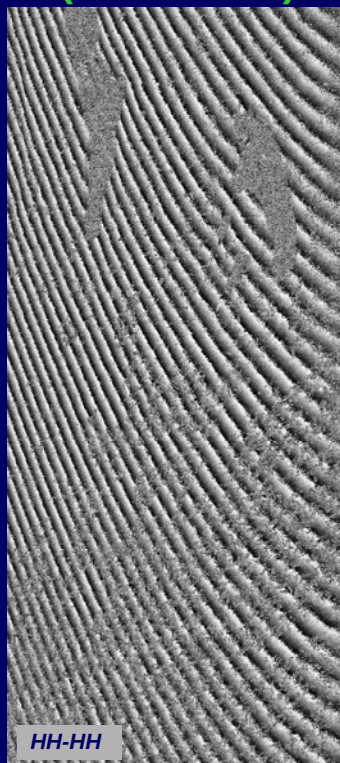
Microwaves and Radar Institute / Pol - InSAR Research Group



ALOS-PaISAR First (successful) InSAR Results



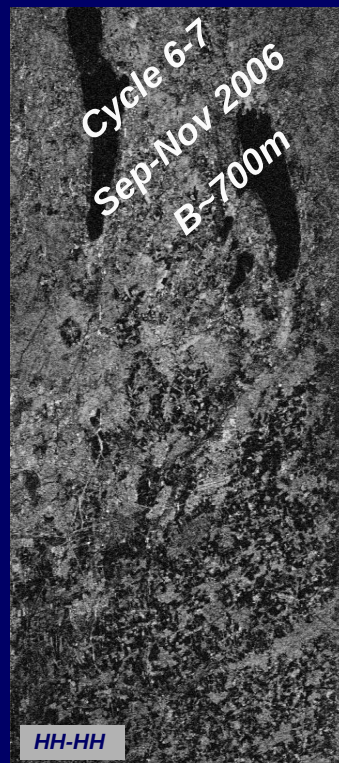
Pauli RGB Image



HH-HH



HH-HH



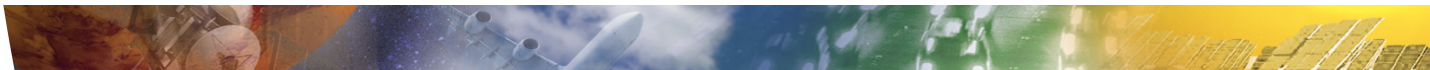
Cycle 6-7
Sep-Nov 2006
B-700m

HH-HH

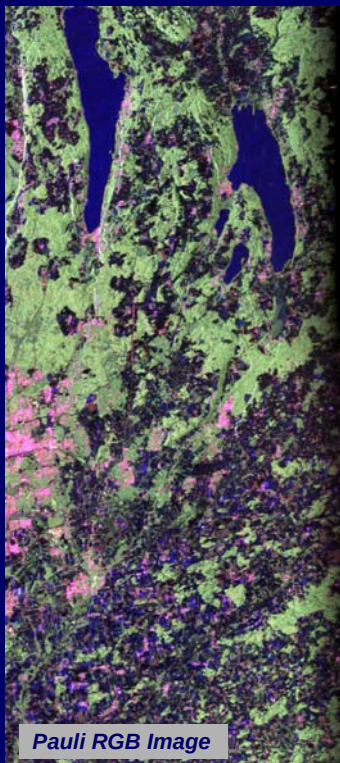


Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

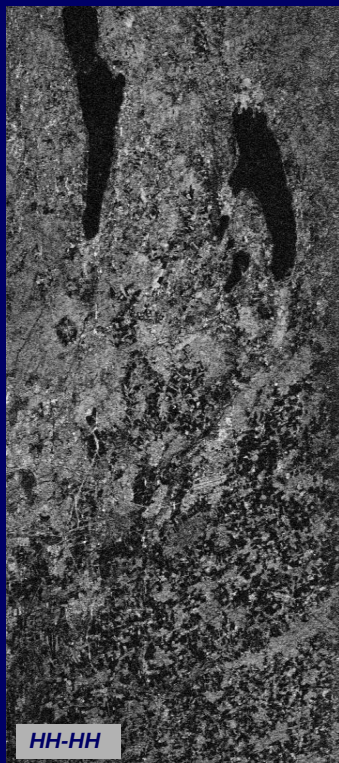
Microwaves and Radar Institute / Pol - InSAR Research Group



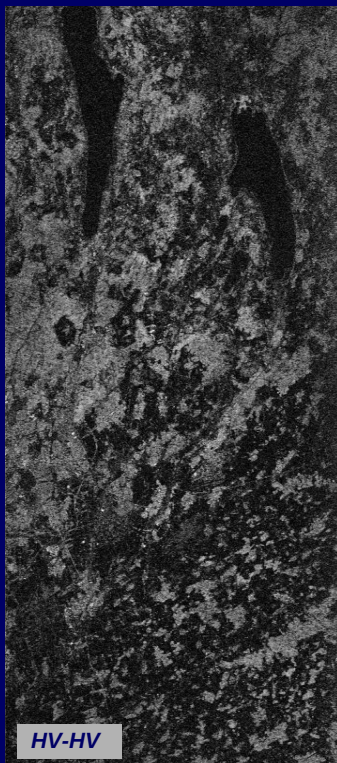
ALOS-PaISAR First Pol-InSAR Results



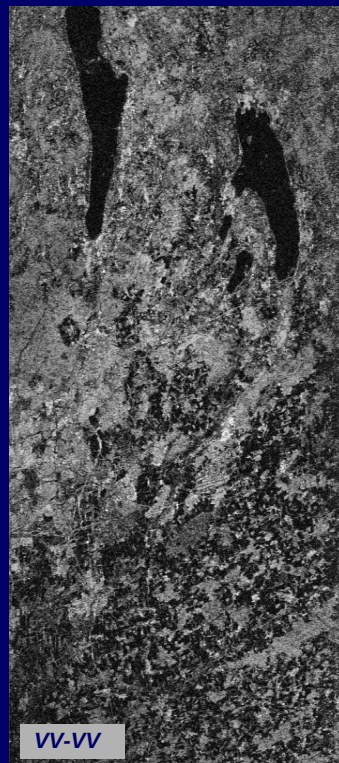
Pauli RGB Image



HH-HH



HV-HV

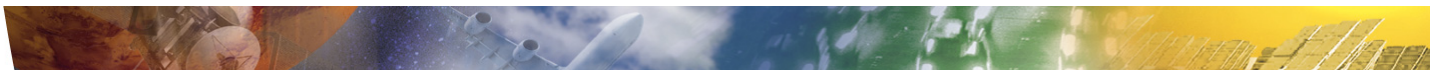


VV-VV

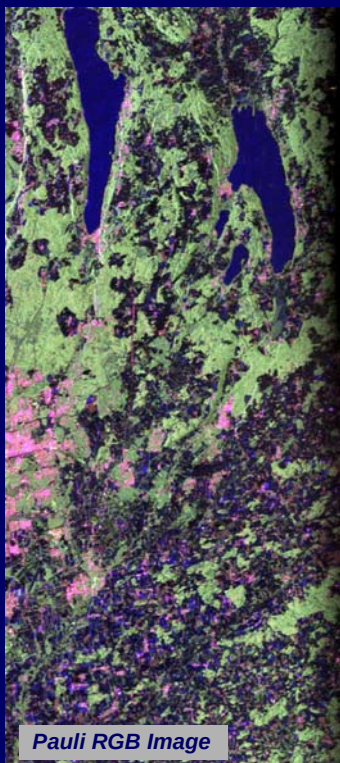


Deutsches Zentrum
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in der Helmholtz-Gemeinschaft

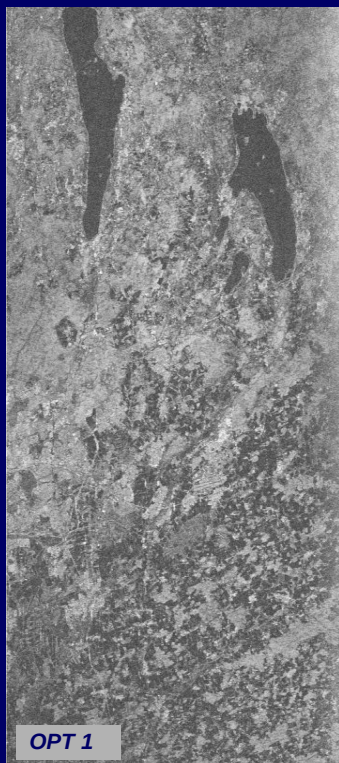
Microwaves and Radar Institute / Pol - InSAR Research Group



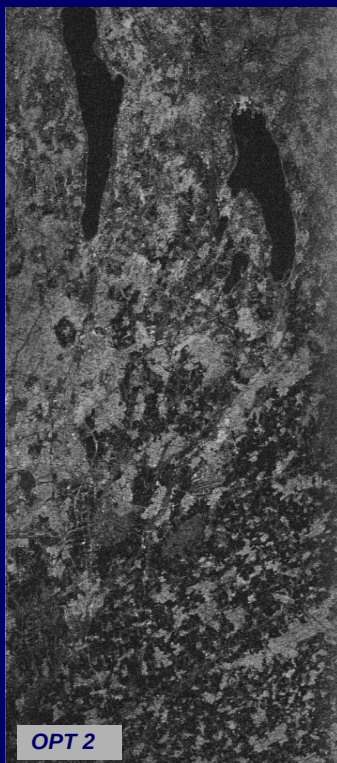
ALOS-PaISAR First Pol-InSAR Results



Pauli RGB Image



OPT 1



OPT 2

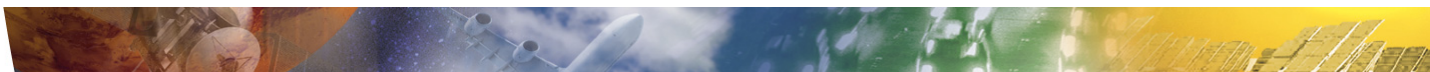


OPT 3

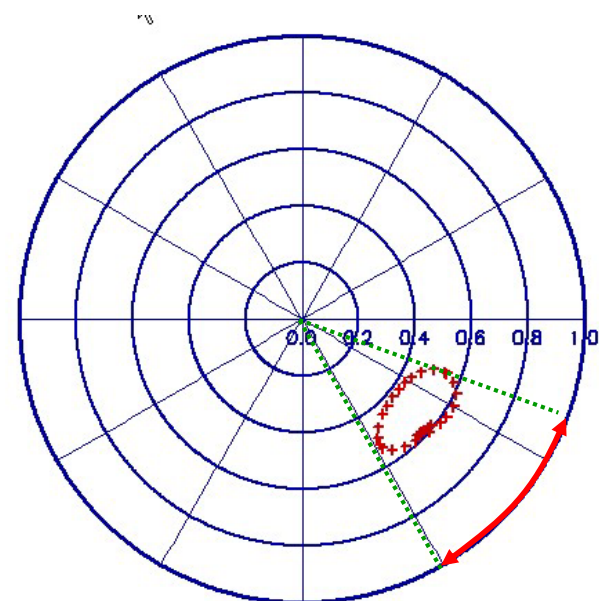
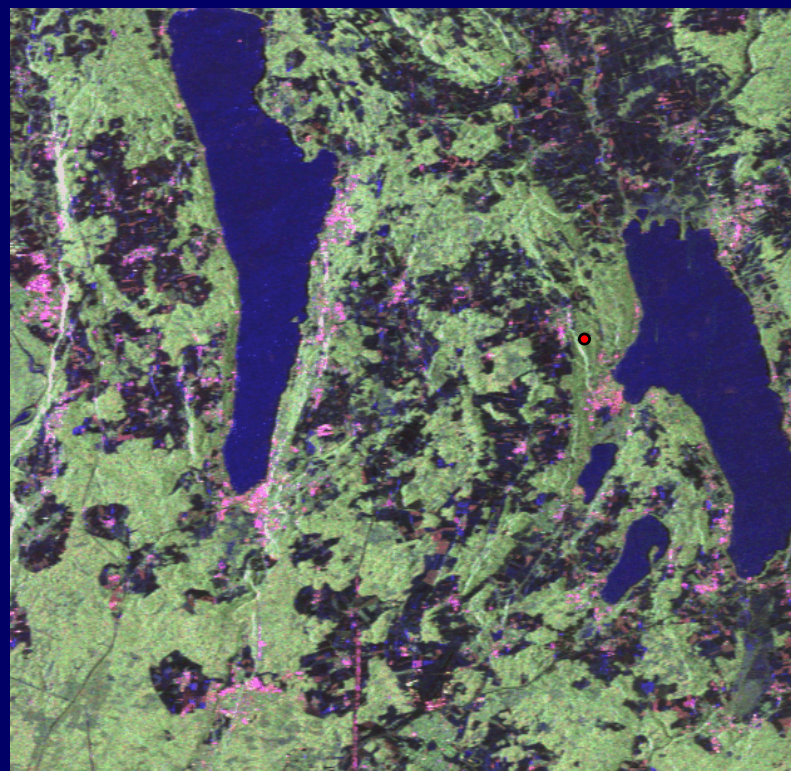


Deutsches Zentrum
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in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group



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



esa

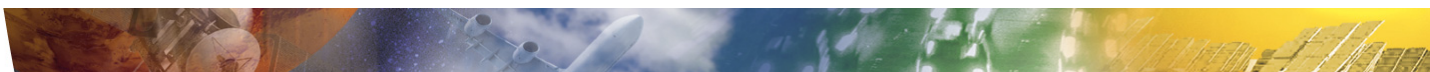


ALOS
Advanced Land Observing Satellite

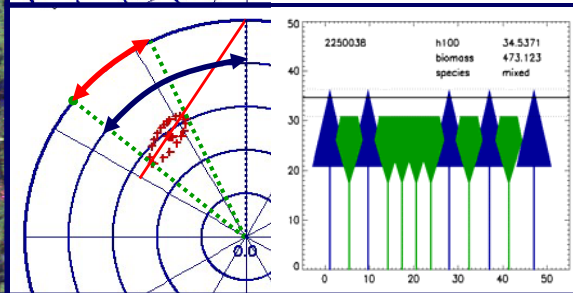
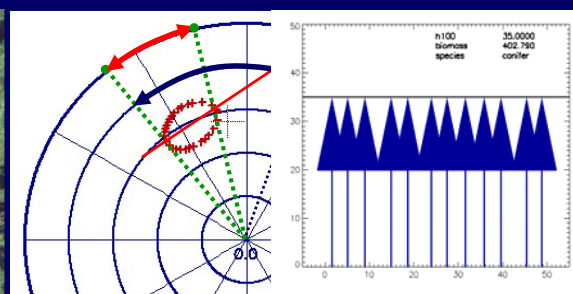
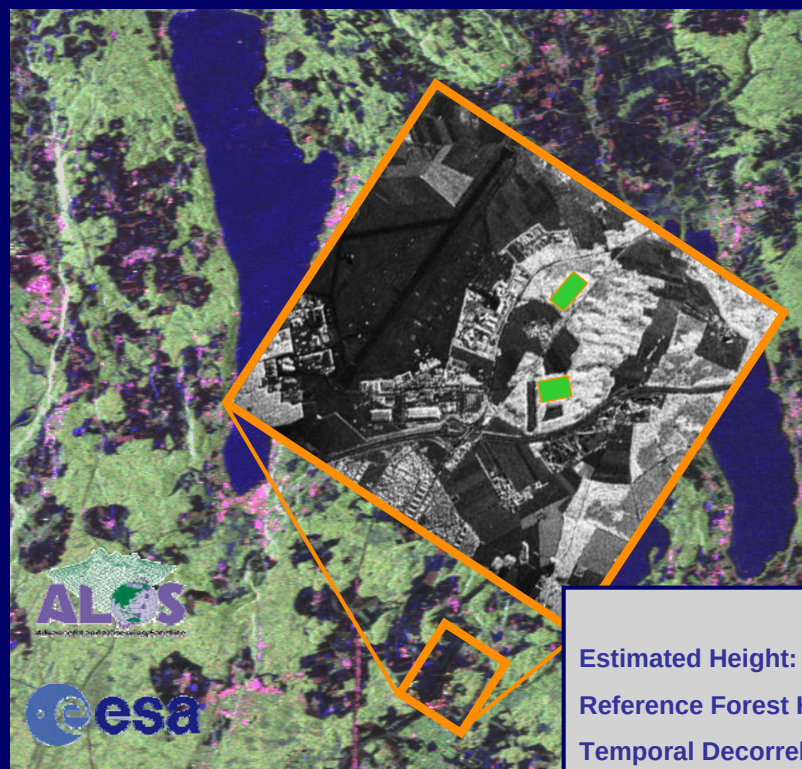


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in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group



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



Stand 1

Stand 2

Estimated Height:

~34m

~37m

Reference Forest Height:

~20-25m

~20-25m

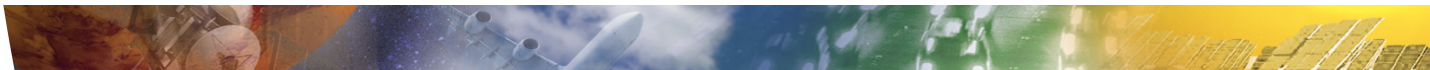
Temporal Decorrelation:

~0.65-0.75



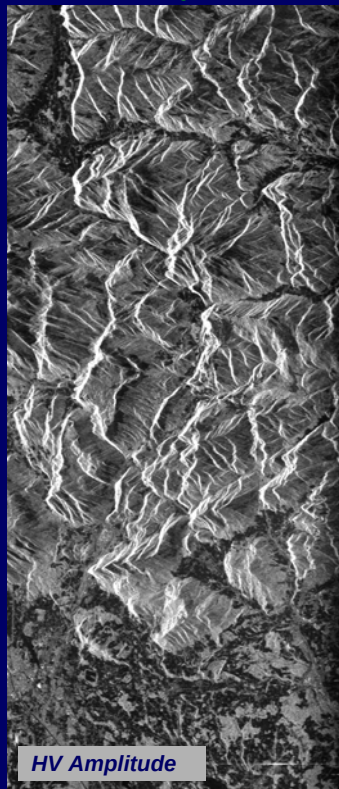
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group

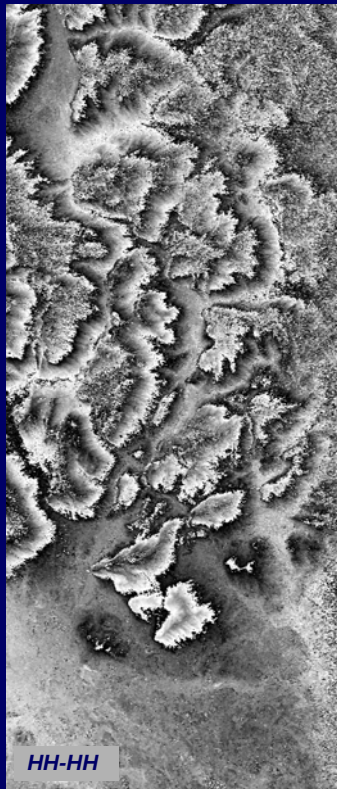


ALOS-PaISAR: Quad-Pol @ 23.5° / Scene ID: ALPSRP035642650-ALPSRP042352650

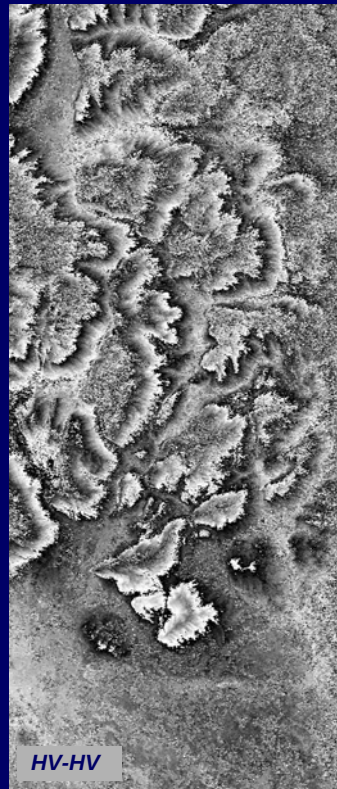
Test Site: Traunstein, Germany



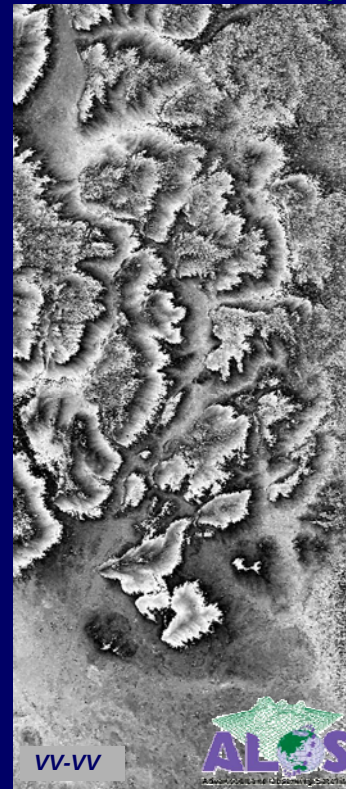
HV Amplitude



HH-HH



HV-HV

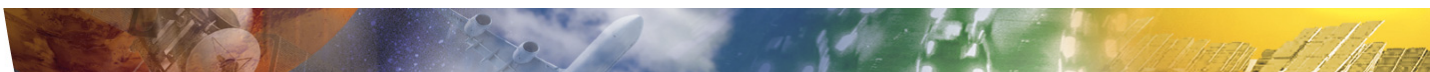


VV-VV



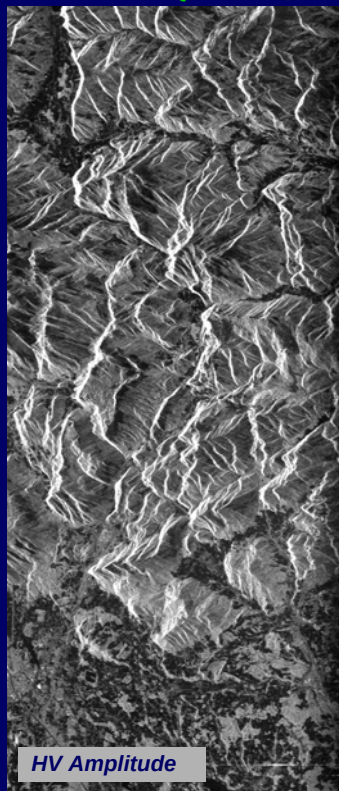
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
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Microwaves and Radar Institute / Pol - InSAR Research Group

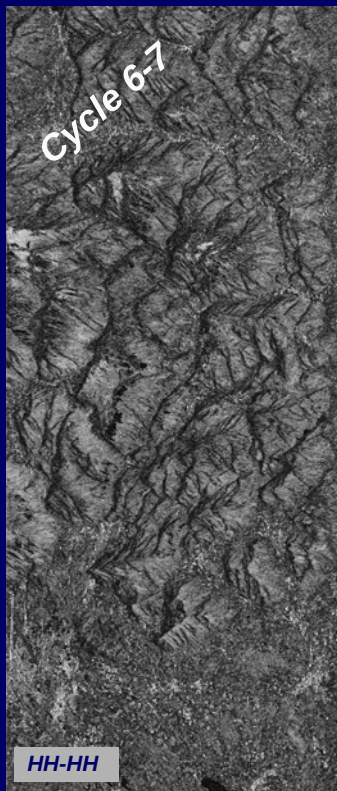


ALOS-PaISAR: Quad-Pol @ 23.5° / Scene ID: ALPSRP035642650-ALPSRP042352650

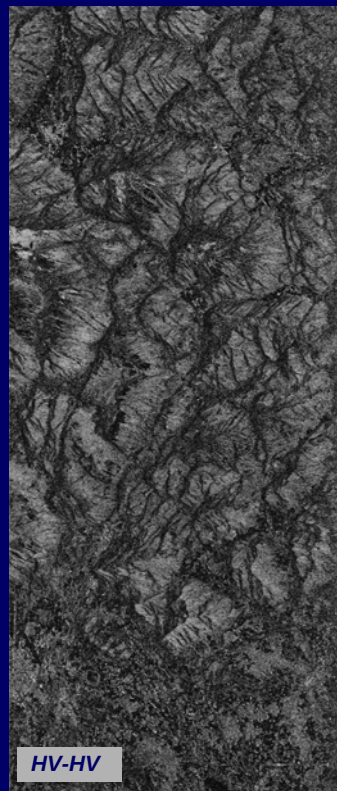
Test Site: Traunstein, Germany



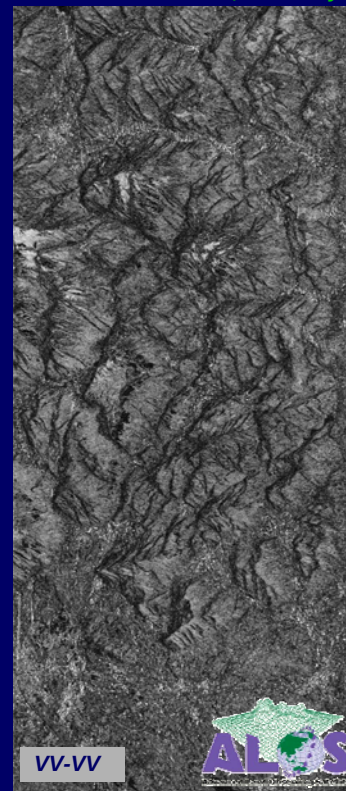
HV Amplitude



HH-HH



HV-HV

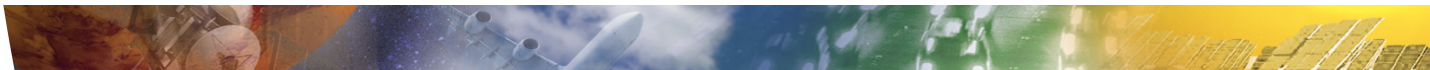


VV-VV



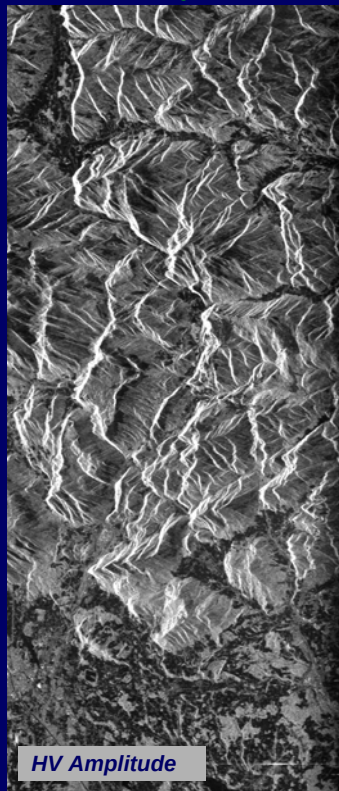
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

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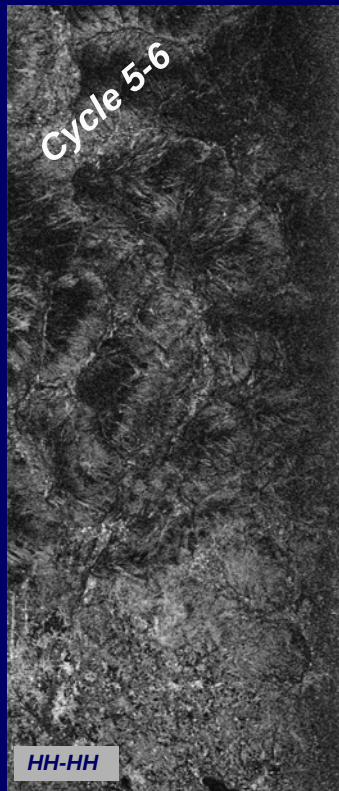


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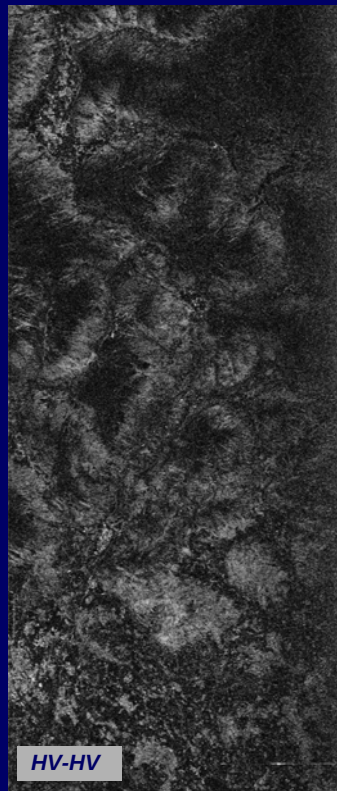
Test Site: Traunstein, Germany



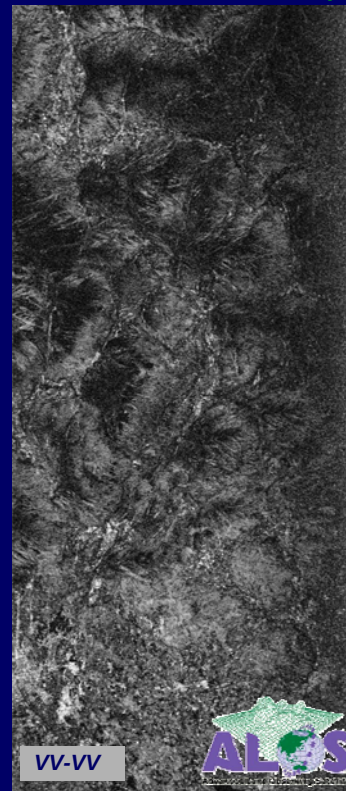
HV Amplitude



HH-HH



HV-HV

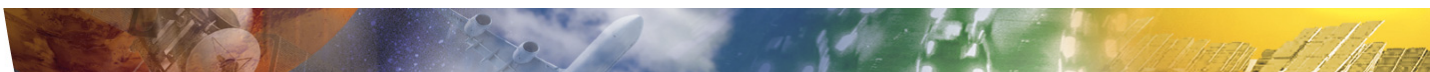


VV-VV



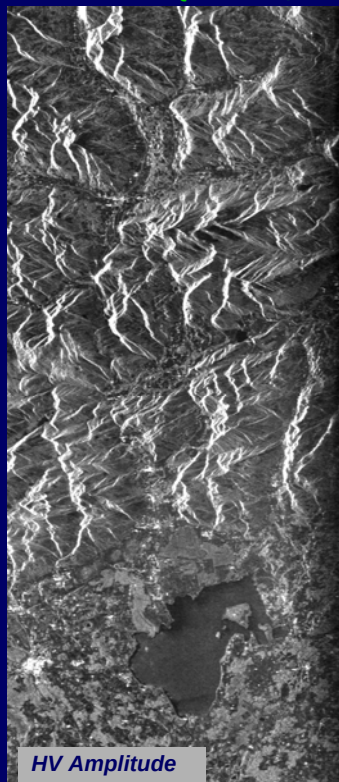
Deutsches Zentrum
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in der Helmholtz-Gemeinschaft

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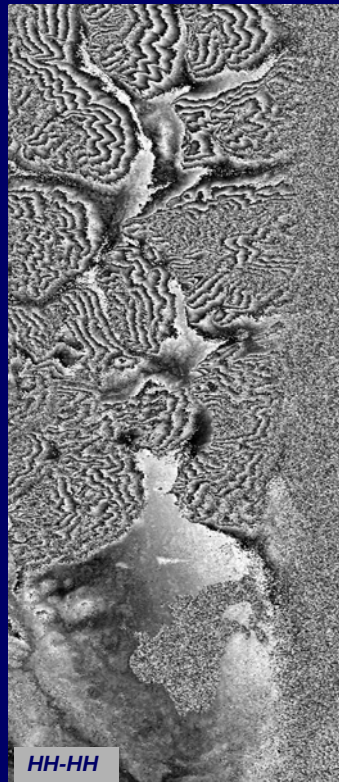


ALOS-PaISAR: Quad-Pol @ 23.5° / Scene ID: ALPSRP049062650-ALPSRP055772650

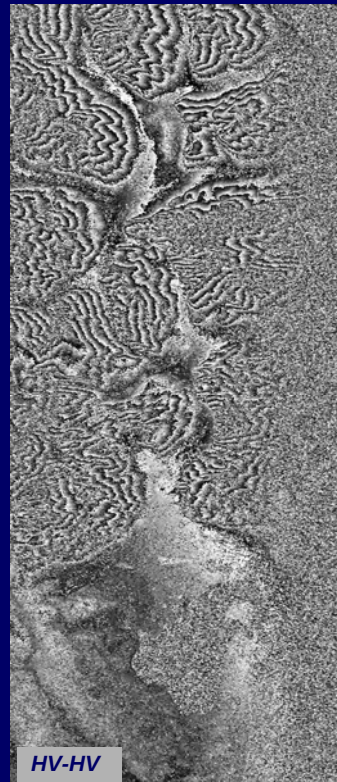
Test Site: Traunstein, Germany



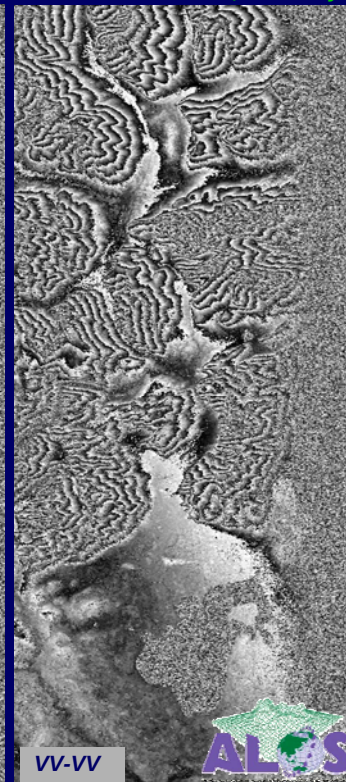
HV Amplitude



HH-HH



HV-HV

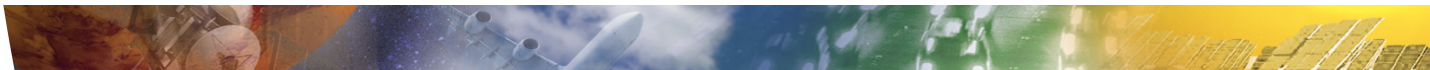


VV-VV



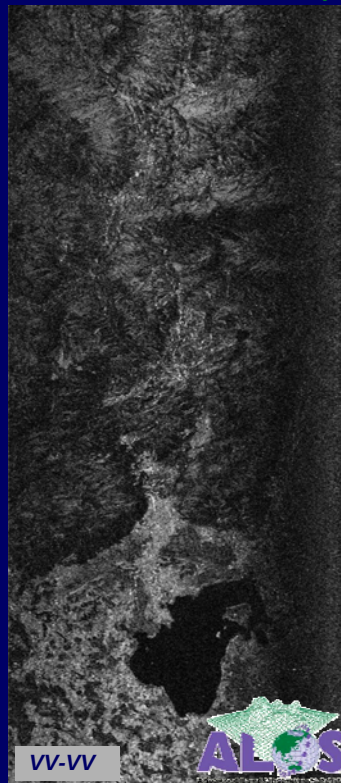
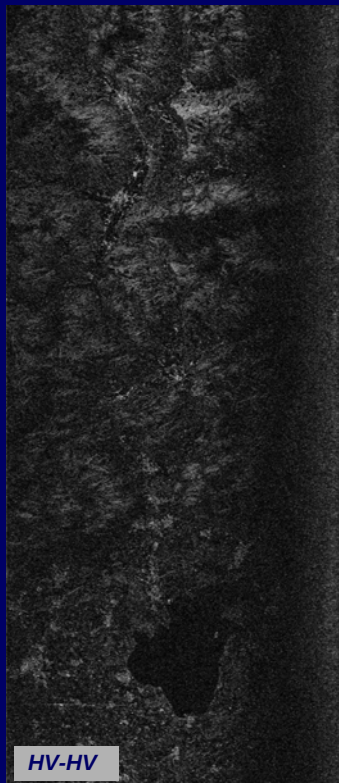
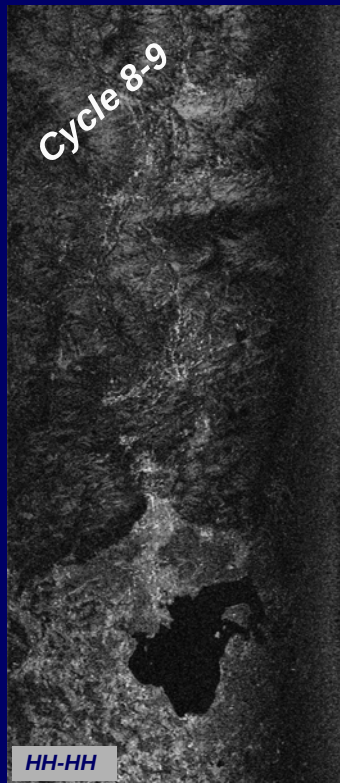
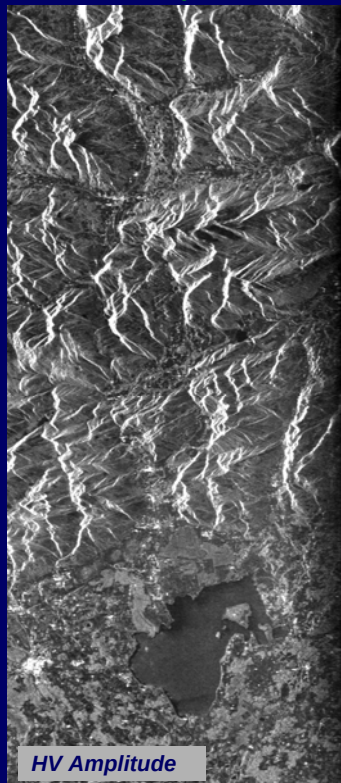
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group



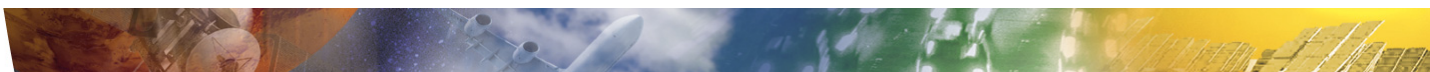
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Test Site: Traunstein, Germany



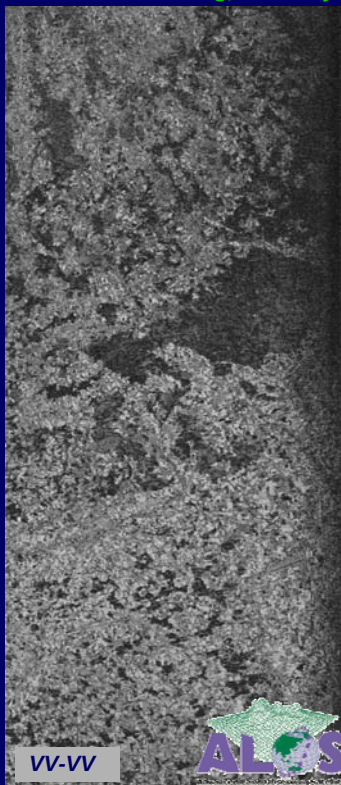
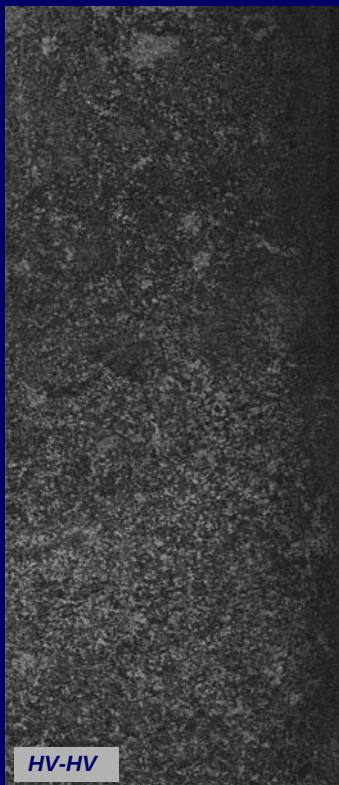
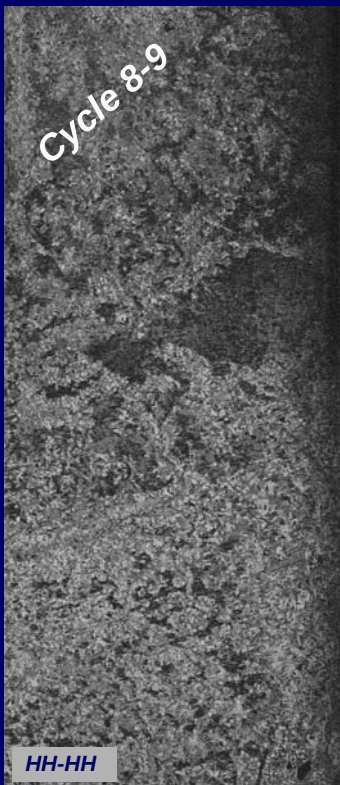
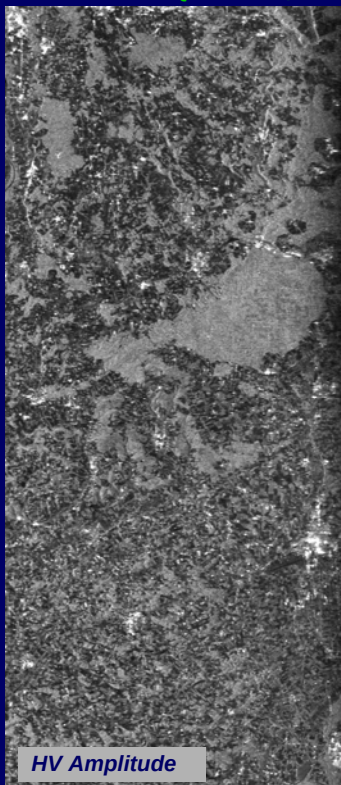
Deutsches Zentrum
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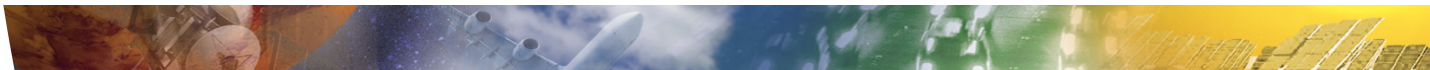
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Test Site: Ebersberg, Germany



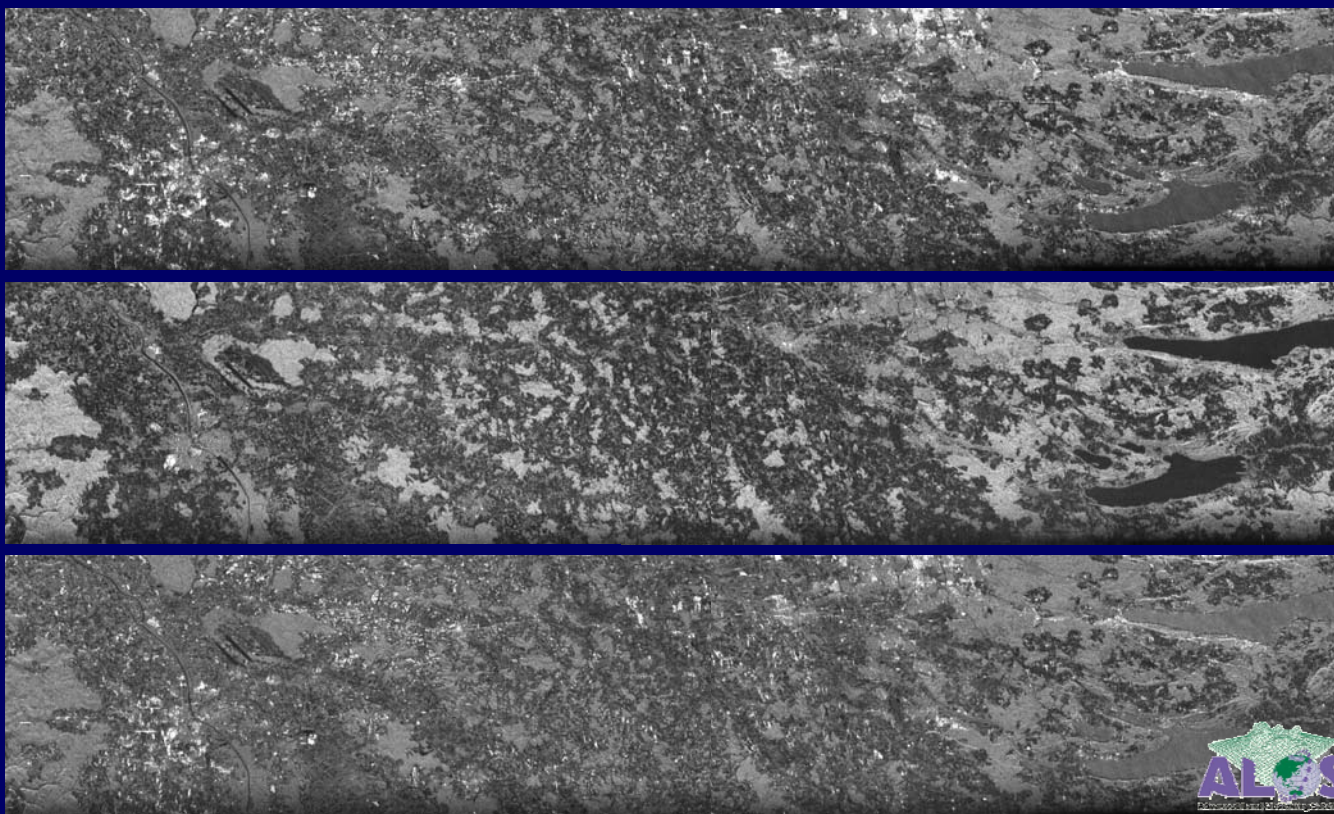
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group



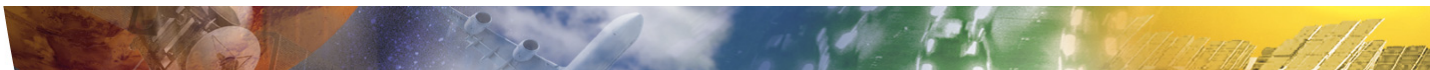
Test Site: Obbeppfaffenhofen, Germany

ALOS-PaISAR: Quad-Pol.



Deutsches Zentrum
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in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group



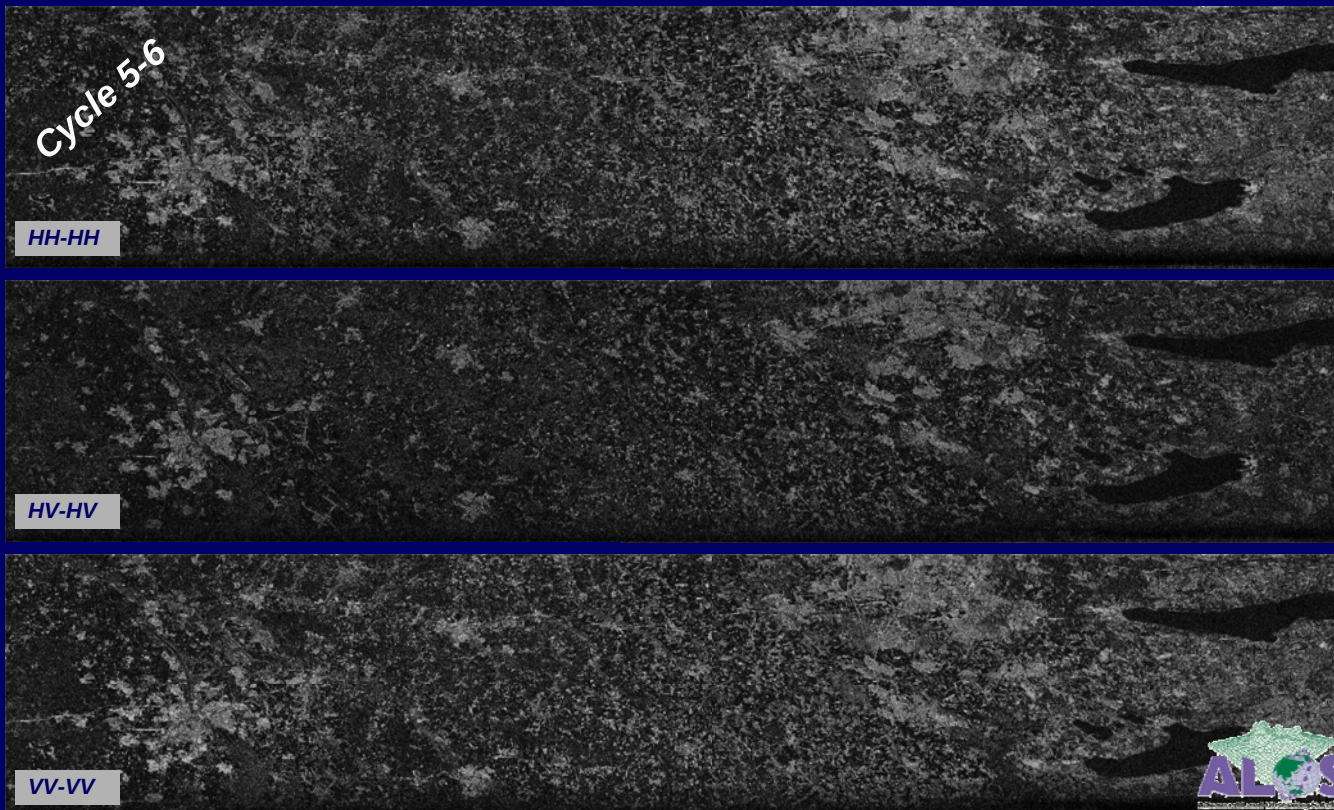
ALOS-PaISAR: Quad-Pol. / Scene ID: ALPSRP029662630-ALPSRP036372630

Cycle 5-6

HH-HH

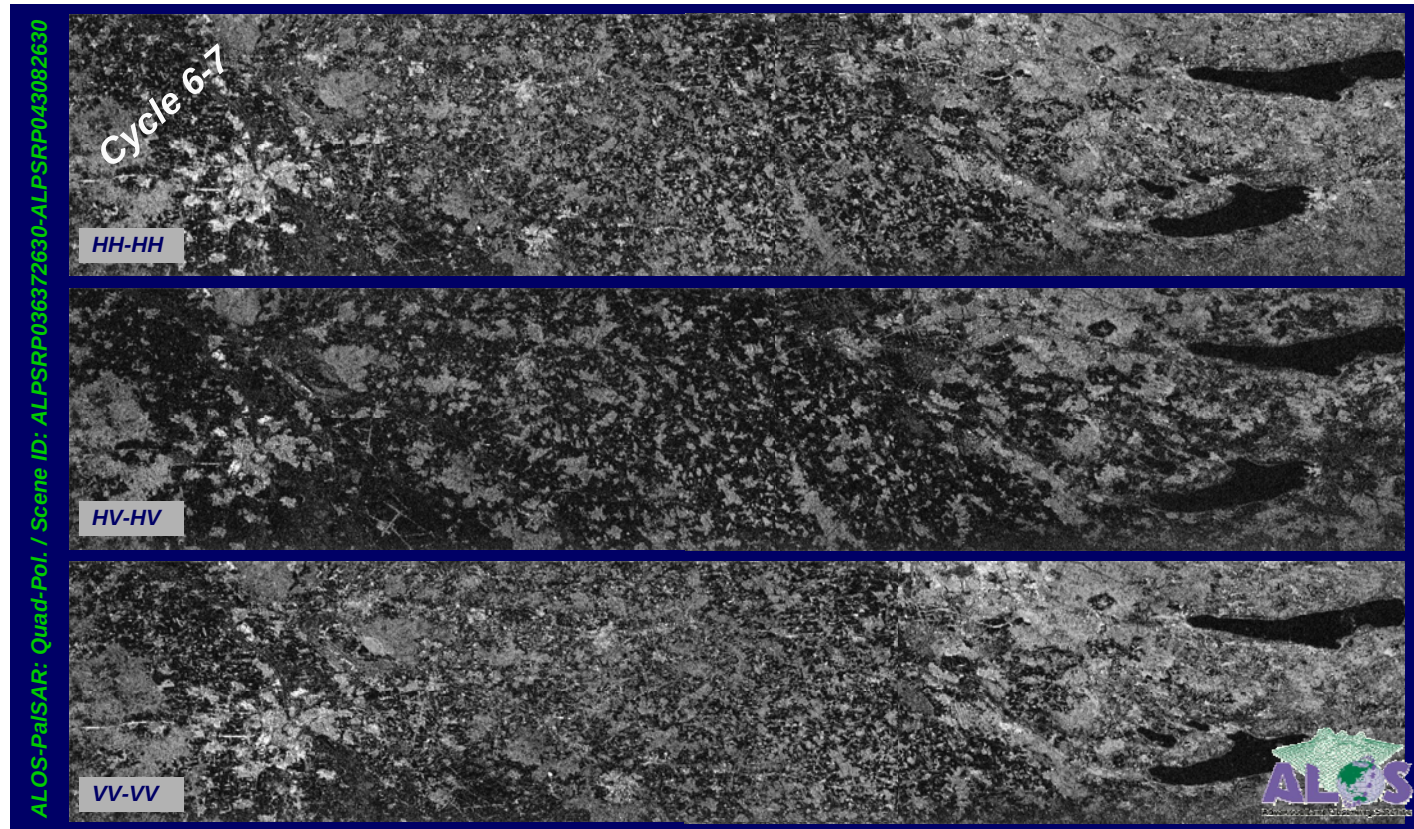
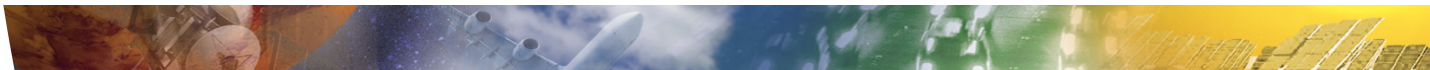
HV-HV

VV-VV



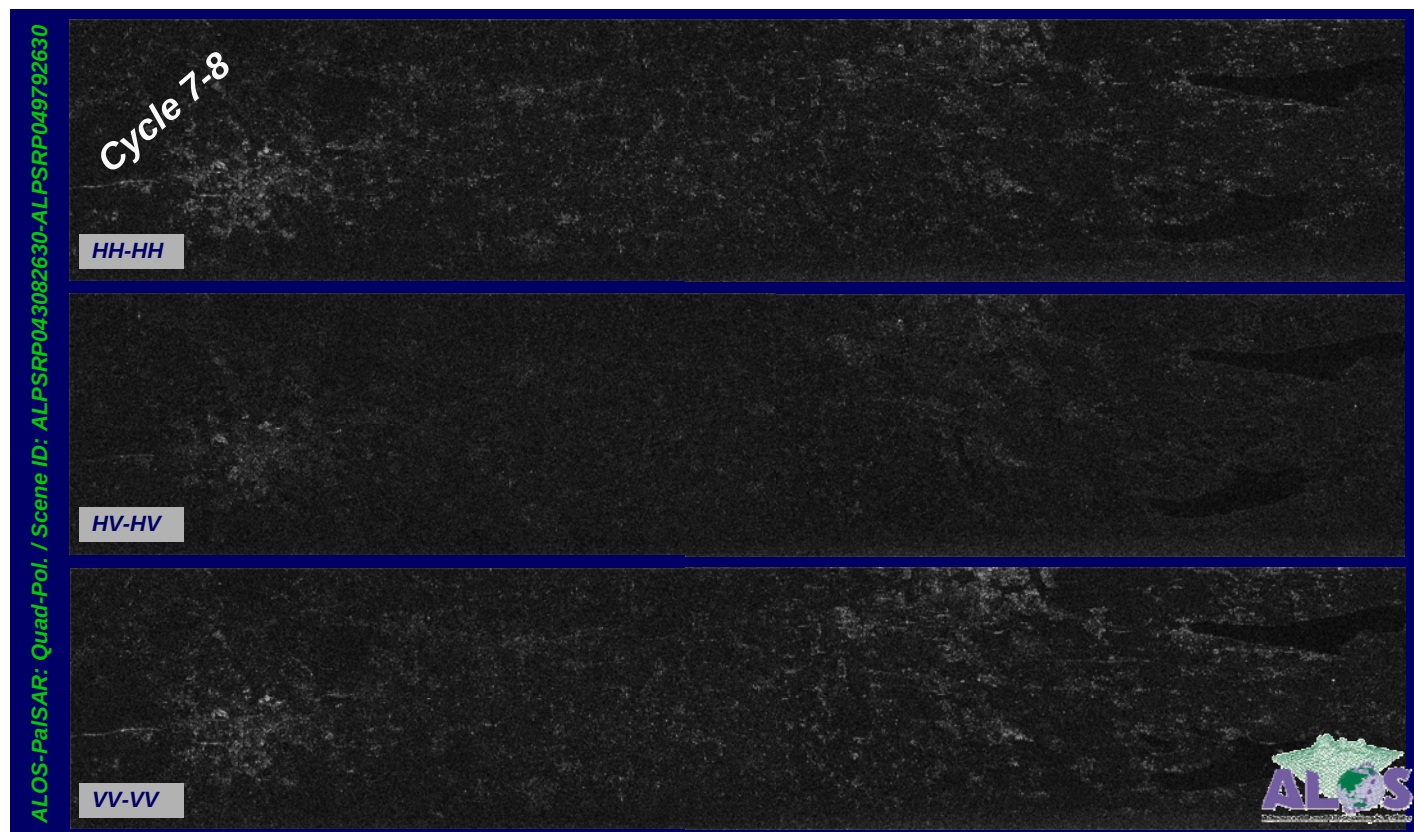
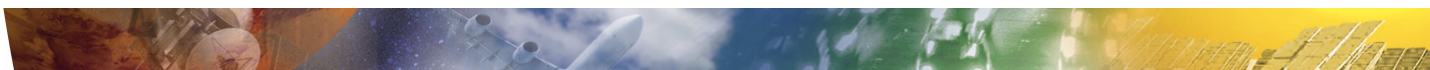
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

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Deutsches Zentrum
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in der Helmholtz-Gemeinschaft

Microwaves and Radar Institute / Pol - InSAR Research Group



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

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Cycle 8-9

HH-HH

HV-HV

VV-VV



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Coherence Calibration

$$\tilde{V}_{OBS} = \tilde{V}_{TRANS} \tilde{V}_{PROP} \tilde{V}_{SCAT}$$

$$\tilde{V}_{SCAT} = \tilde{V}_{TEMP} \tilde{V}_{BAS}$$



$$\tilde{V}_{BAS} = Y_{AZ} Y_{RG} \tilde{V}_{VOL}$$

$$\tilde{V}_{PROP} = \tilde{V}_{ATMO} \tilde{V}_{IONO}$$

$$\tilde{V}_{TRANS} = Y_{SYS} \tilde{V}_{PRO} Y_{EST}$$



$$Y_{SYS} = Y_{QUAN} Y_{AMB} \tilde{V}_{SNR}$$

$$\tilde{V}_{PRO} = \tilde{V}_{CAL} Y_{INTR} Y_{COR}$$

$$Y_{EST} = Y_{BIAS} Y_{TOPO}$$

$\tilde{V}_{TEMP}$ Temporal Decorrelation

Y_{AZ} Doppler Decorrelation (=1)

Y_{RG} Range Decorrelation (=1)

$\tilde{V}_{VOL}$ Volume Decorrelation

$\tilde{V}_{ATMO}$ Atmospheric Decorrelation

$\tilde{V}_{IONO}$ Ionospheric Decorrelation

$\tilde{V}_{SNR}$ SNR Decorrelation

$\tilde{V}_{QUAN}$ Quantisation Effects (0.99)

$\tilde{V}_{AMB}$ Ambiguities

$\tilde{V}_{CAL}$ Calibration Decorrelation

Y_{INTR} Interpolation Effects

Y_{COR} Corregistration Effects

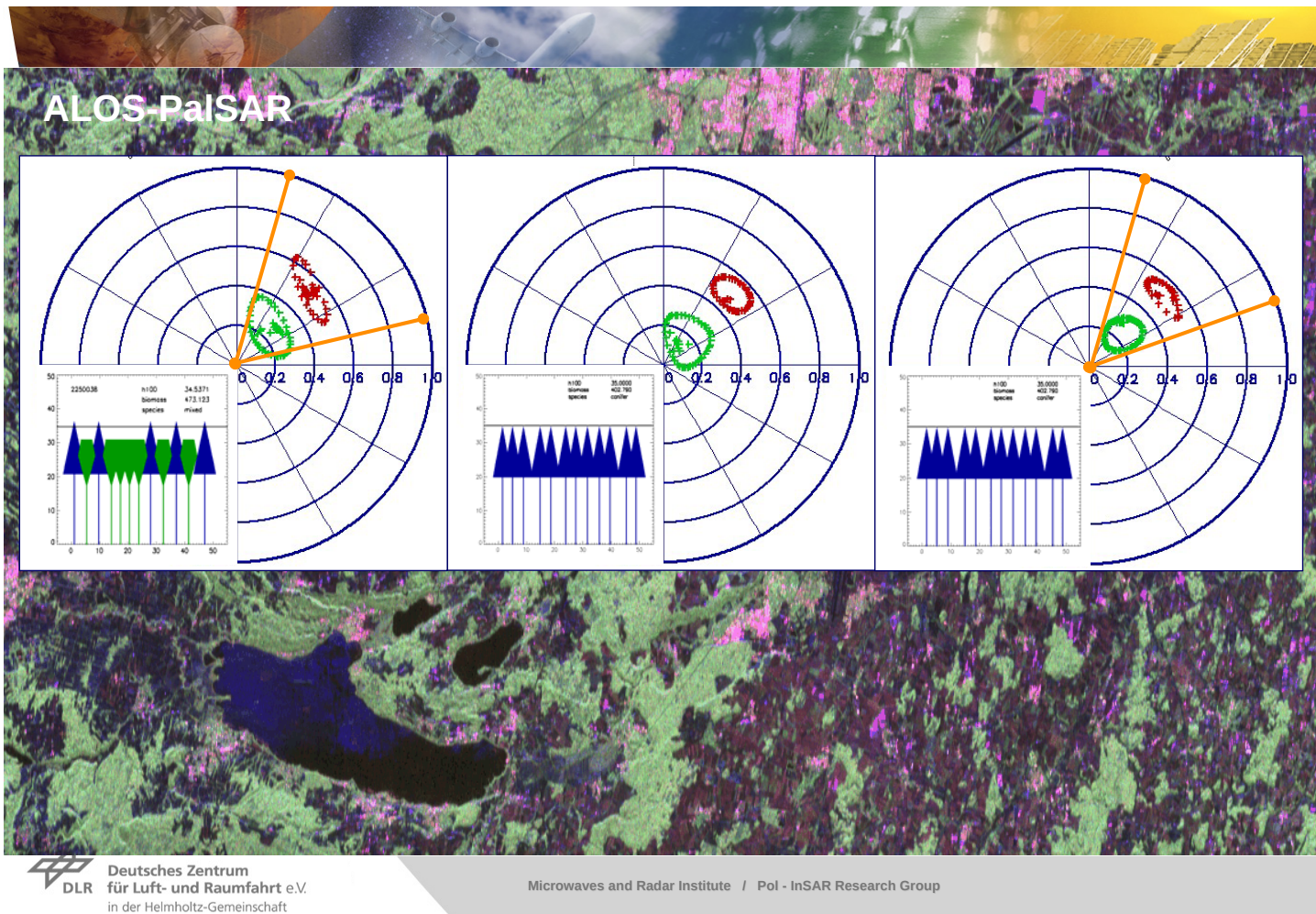
Y_{BIAS} Coh Estimation Bias (=1)

Y_{TOPO} Topography Induced Coh Bias



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ALOS Carbon & Kyoto (K&C) Initiative
Forest Theme: Forest Height
 (Estimation by means of Pol-InSAR)

ALOS
 Advanced Land Observing Satellite

German Aerospace Center (DLR)
 Microwaves and Radar Institute (DLR-HR)

DLR HR Cesa JAXA