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für Bildung
und Forschung

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Remote Sensing for Environmental Applications

Irena Hajnsek & Members of CT Environmental Sensing
German Aerospace Center, Microwaves and Radar Institute
ETH, Institute of Environmental Engineering

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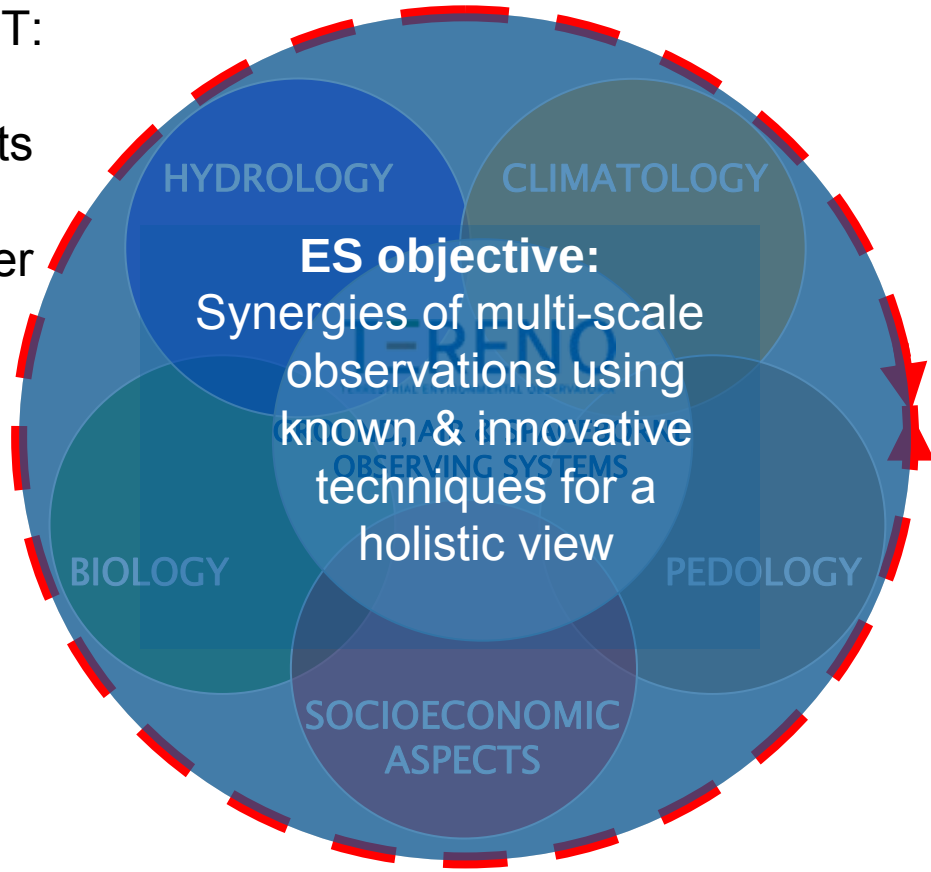
Methodological Approach of CT Environmental Sensing

The following tasks will be performed in the CT:

- Collection and coordination of requirements from different CT's
- Coordination of flights and instruments over regions of interest
- Coordination of common instrument operation over regions of interest
- Intercomparison of field instruments
- Coordination of airborne/spaceborne data acquisition with ground measurements
- Reporting on data processing status and data quality
- Exchange of inversion procedures for the environmental parameters
- Synergies between different sensors
- Collection, coordination, archiving of different types of data



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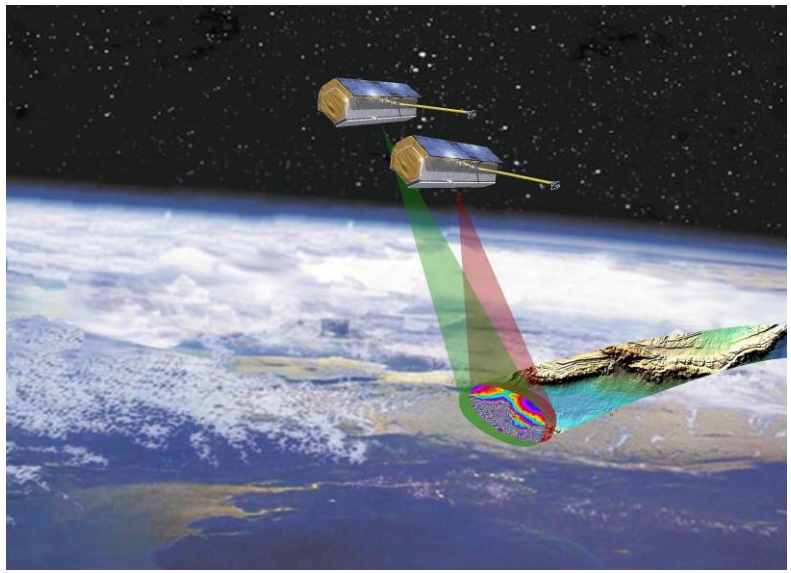
Environmental Sensing from Air and Space

Airborne measurements

- Highly flexible operation
- Coverage of dedicated areas
- Experimental configuration
- Sensor specific data formats
- Short re-visit times

Spaceborne measurements

- Highly regular observation
- Wide area coverage
- Highly operational & reliable
- Standard product delivery
- Long term observations



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Contribution & Interest from different Research Centers

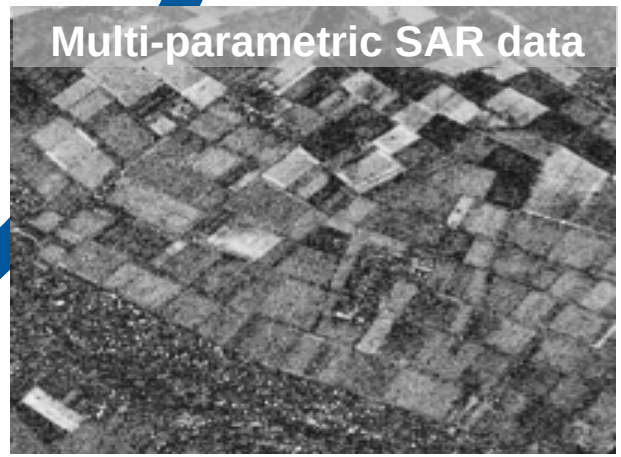
Research Institution	Optic	SAR	Radiometry
German Aerospace Center Microwaves and Radar Inst.; Earth Observation Center	Hyperspectral Sensors	F-SAR TerraSAR-X TanDEM-X	---
UFZ Helmholtz Center for Environmental Research	Hyperspectral Sensors	---	---
Forschungszentrum Jülich GmbH Agrosphere Institute (IBG 3)	---	---	PLMR/PLMR2 EMIRAD-2 HUT-2D (ELBARA)
Karlsruhe Institute of Technology	Thermal Infrared Camera	---	---
Helmholtz Center Potsdam - German Research Center for Geociences	Hyperspectral Sensors	---	---

DLR (HR) - Soil Moisture from SAR

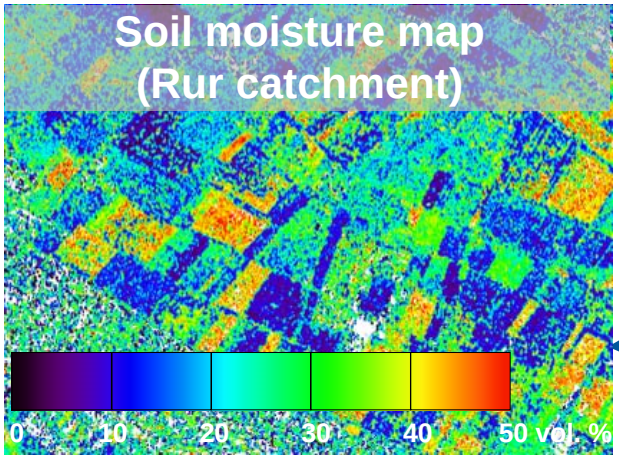
Derivation of soil moisture from multi-parametric SAR data:

- SAR data acquisition
  (campaign planning, campaign execution)
- SAR data processing
  (transcription, processing, flight reconstruction)
- Physical parameter estimation (model application, multi-parametric SAR data inversion, geocoding)

SAR data processing



Modelling & Inversion



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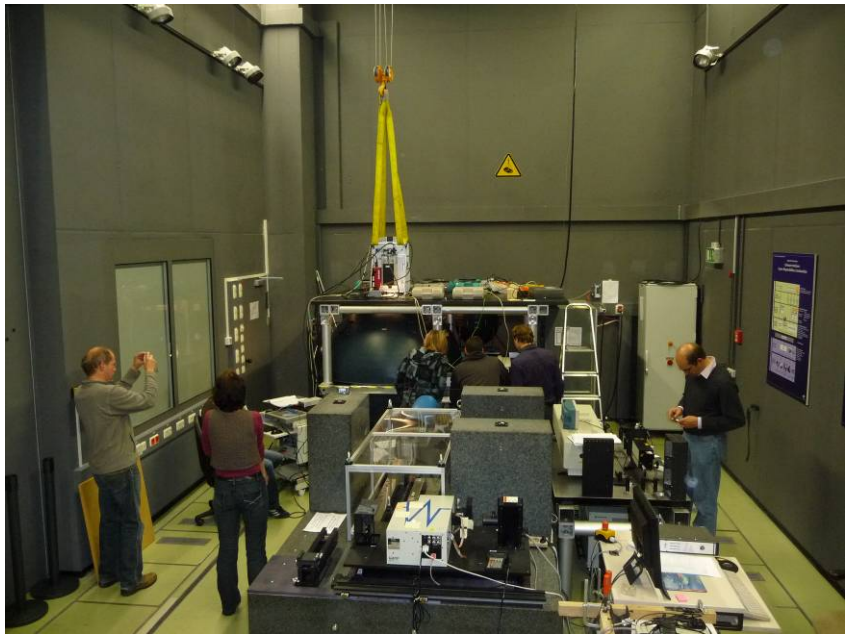
DLR (EOC) - Intercomparison of Field Instruments

- Access to optical lab infrastructure (*CHB, Calibration Home Base*) at DLR Oberpfaffenhofen
- Scientific support: Instrument characterisation, calibration (models, procedures, measurement techniques,data evaluation/interpretation)

Recent activity:

Intercomparison campaign,2.-5.11.2010

- Sensors: 8 field spectrometers
- TERENO Partners: GFZ, UFZ, FZJ, DLR
- Radiometric & spectral characterisation, performance comparison



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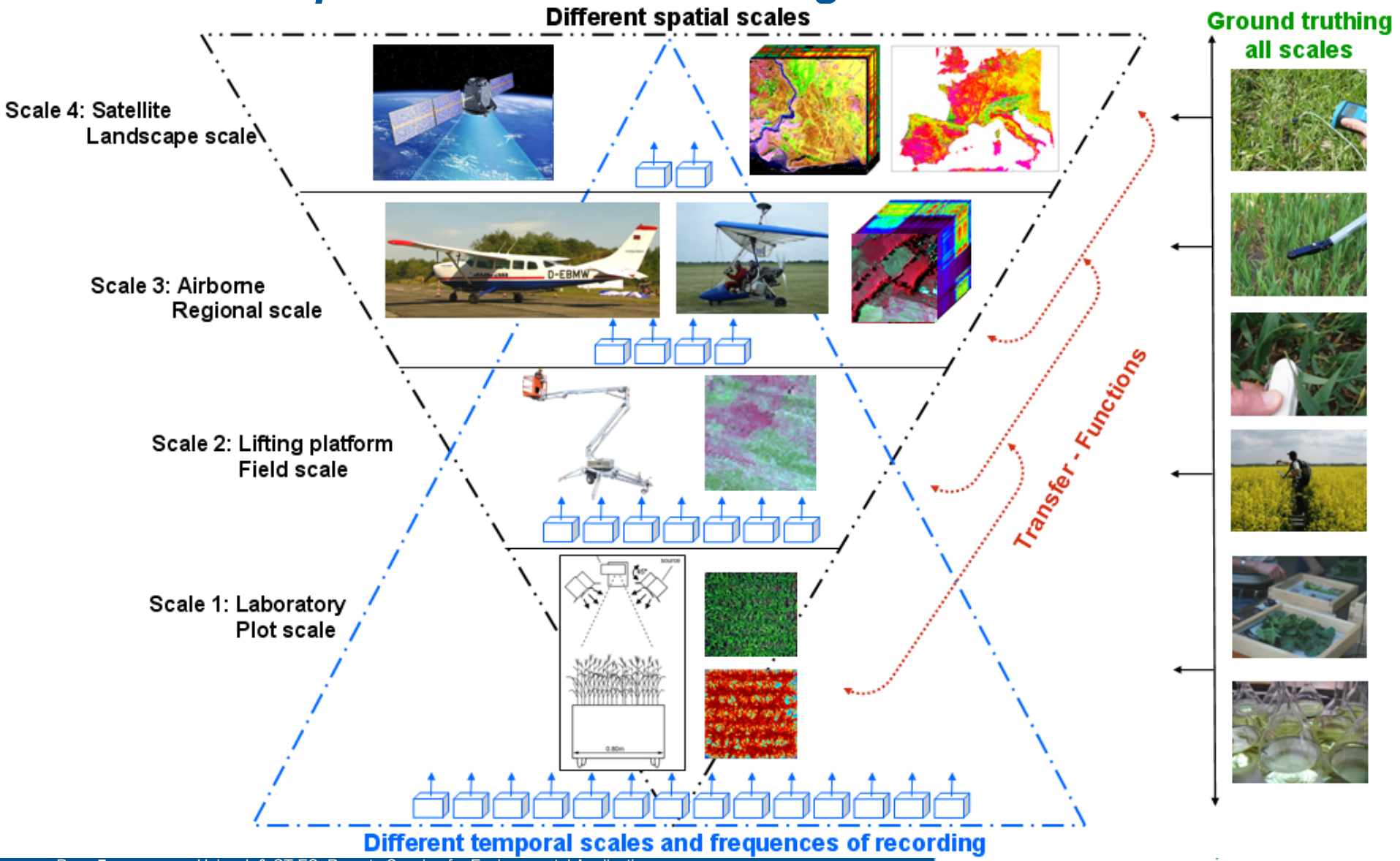
UFZ - Scale-Specific Remote Sensing



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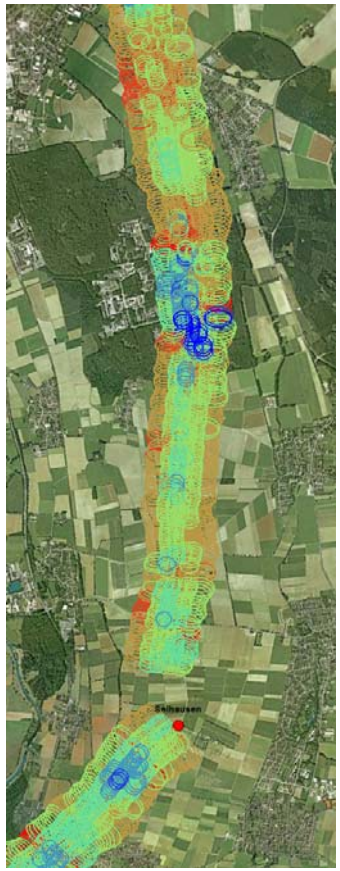
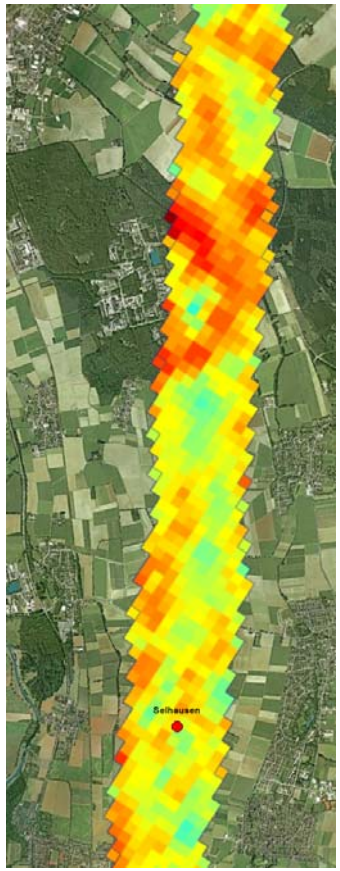
FZJ - Airborne Microwave Sensor Recordings

Brightness Temperatures

EMIRAD
(TU Denmark)



PLMR/PLMR2
(MU Melbourne/IBG 3)



HUT-2D
(Aalto Uni Helsinki)

E-SAR
(DLR)

IBG 3 focuses on the investigation of soil moisture patterns with passive and active L-band microwave systems

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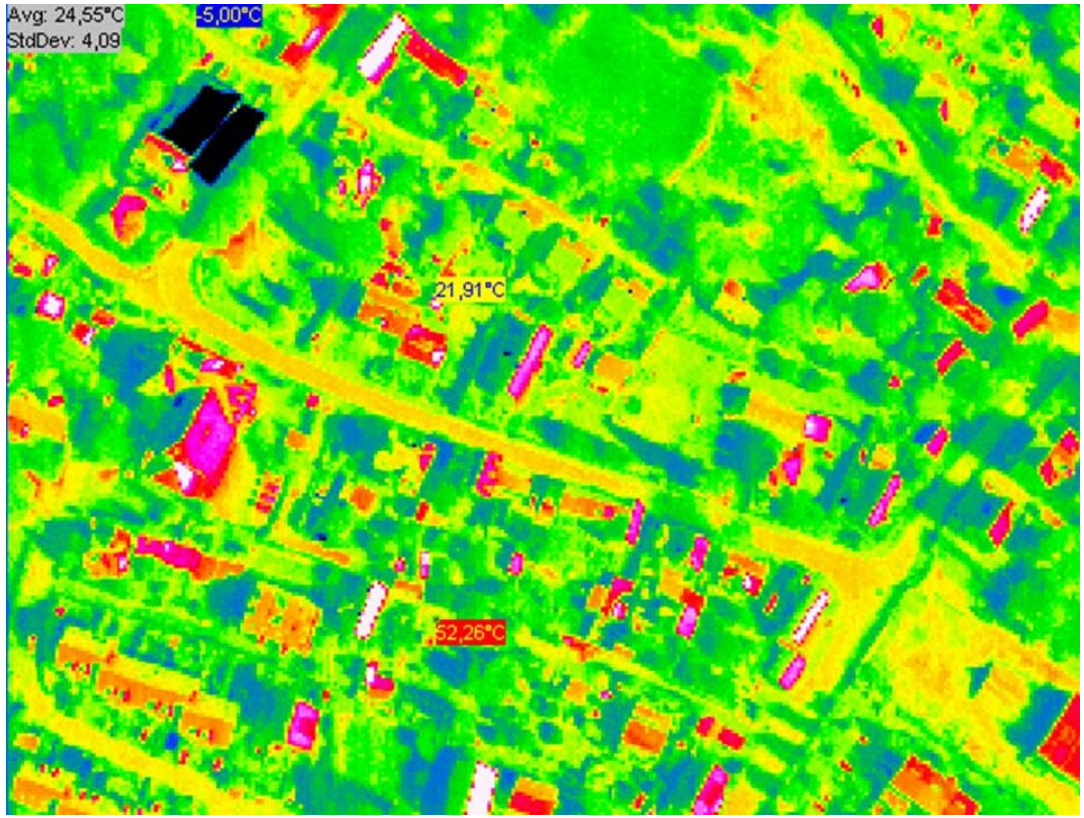
KIT – Product Derivation with Thermal Infrared

Thermal infrared imaging products

- Soil temperature impact on turbulent fluxes / boundary layer structure



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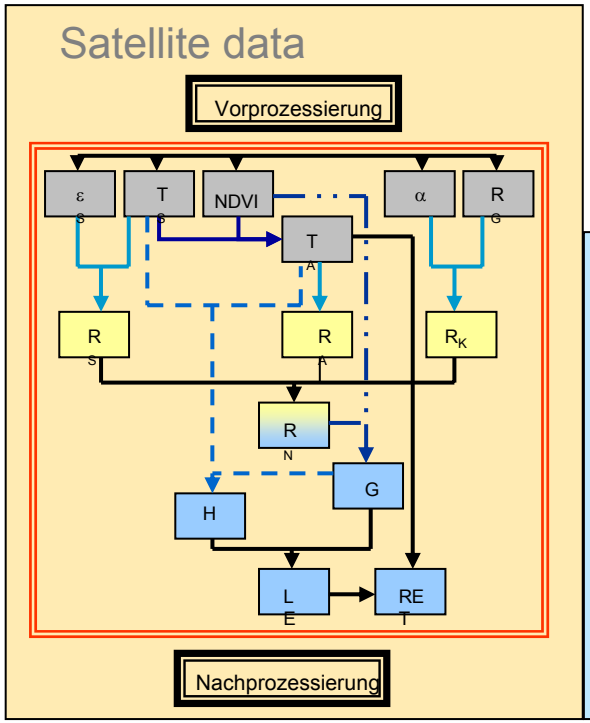
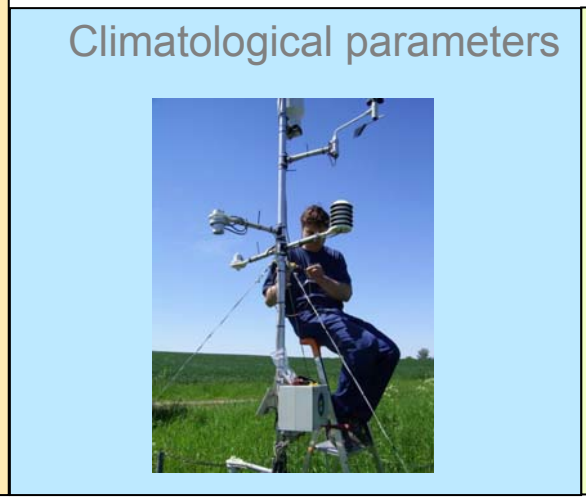
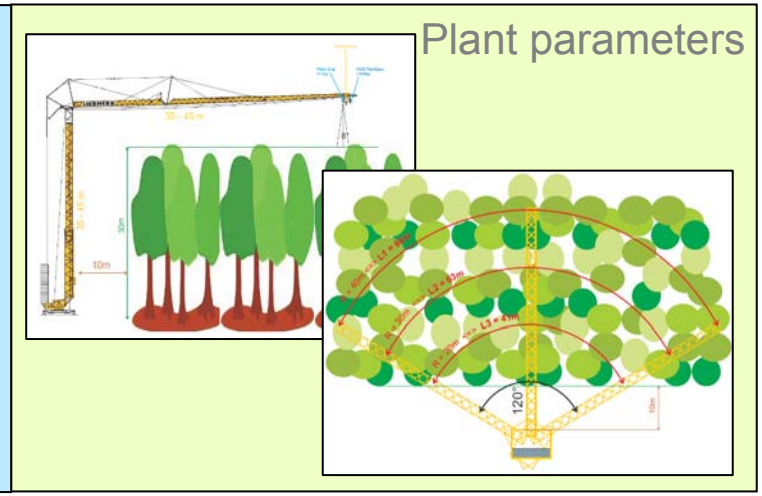
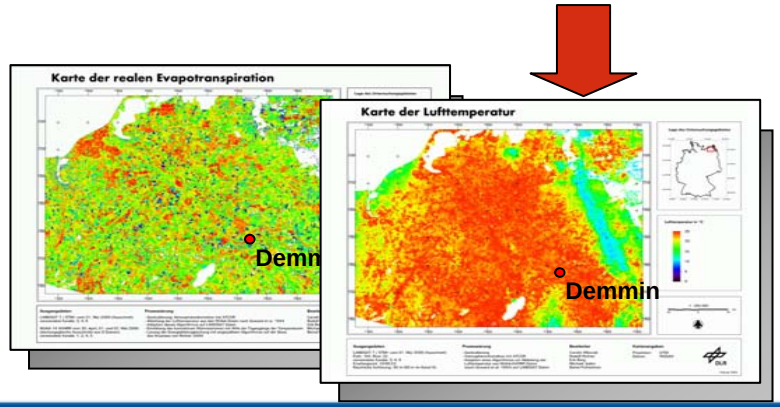
GFZ/DLR – Measurement and Processing Concept – Climate



Developing and Implementation of a operational processor for generation of remote sensing based climatologically relevant parameter maps such as air temperature and evapotranspiration for the CAL/VAL-Site DEMMIN







GFZ/DLR – Installation of a crane-/tower measurement-station for hyperspectral measurements in forests of CAL/VAL-Site DEMMIN
Intended Beginning of Operation: Spring 2011

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Requirements on Spaceborne Sensors & Products

Research Institution	Optic		SAR		Passive Radar	
	Sensor	Data Product	Sensor	Data Product	Sensor	Data Product
German Aerospace Center *Microwaves and Radar Inst.; Earth Observation Center*	EnMAP (2015)	biophysical, biochemical, geochemical variables	TerraSAR-X TanDEM-X PALSAR Tandem-L (2017)	land class map; change detection; soil moisture; DEM	---	
UFZ Helmholtz Center for Environmental Research	SPOT	land class map; vegetation cover	TerraSAR-X Envisat	land class map; …	---	
Forschungszentrum Jülich GmbH *Agrosphere Institute (IBG 3)*	ASTER SPOT (LANDSAT) Rapid Eye	land cover NDVI, DTM imperviousness	ERS-2 RADARSAT-2 ALOS, SMAP (2014)	soil moisture (roughness)	SMOS, SMAP (2014)	soil moisture
Karlsruhe Institute of Technology	---					
Helmholtz Center Potsdam - German Research Center for Geociences	EnMAP (2015) LANDSAT Rapid Eye Sentinel-2 (2012)	Hydrological, biophysical, geochemical variables, Land class map	---	---	---	

Germany's Radar Mission: TanDEM-X

TerraSAR-X add-on for Digital Elevation Measurements

DEMs	Spatial Resolution	Absolute Vertical Accuracy (90%)	Relative Vertical Accuracy (point-to-point in 1° cell, 90%
DTED-1	90m x 90m	< 30m	< 20m
DTED-2	30m x30m	< 18m	< 12m
TanDEM-X DEM	**12m x 12m**	**< 10m**	**< 2m**
HDEM	6m x6m	< 5m	< 0.8m

DLR EADS ASTRIUM infoterra GFZ POTSDAM

Launch: June, 21th 2010

16. Juli. 2010

October Revolution Island, Russia

First TanDEM-X high resolution DEM
(pursuit monostatic mode):
vertical accuracy ~ 10 cm

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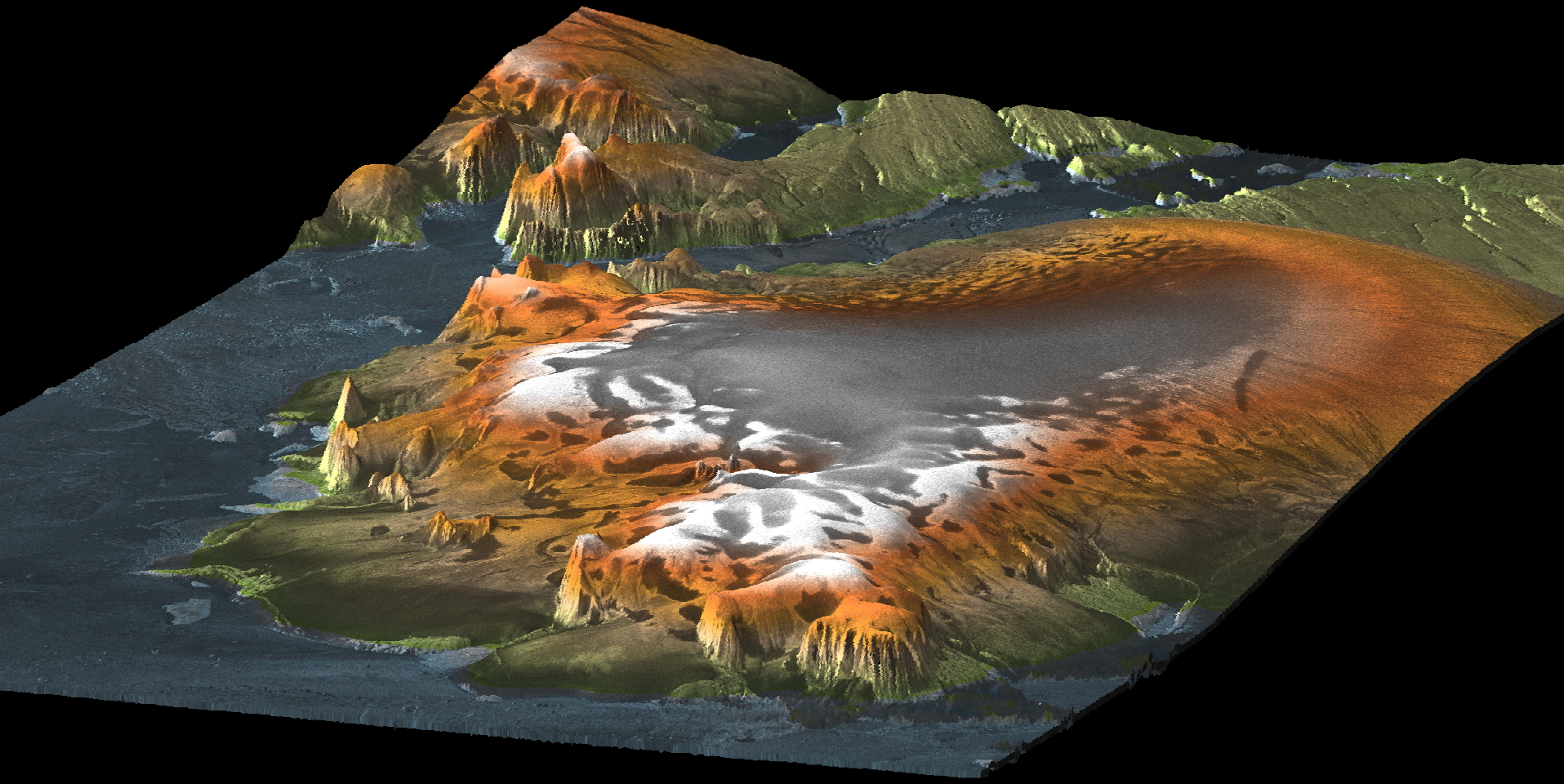
TanDEM

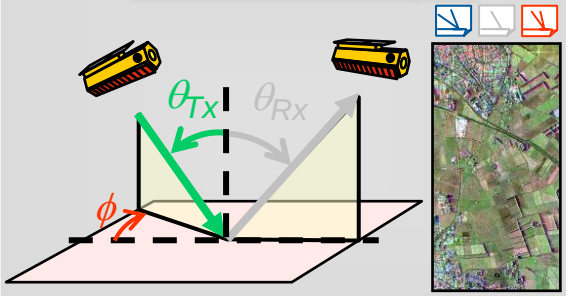
October Revolution Island Revisited

High Resolution DEMs at 79°N, 96°E

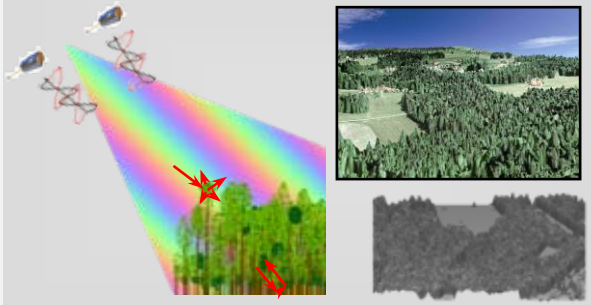


Secondary Mission Objectives: New Techniques Demonstration

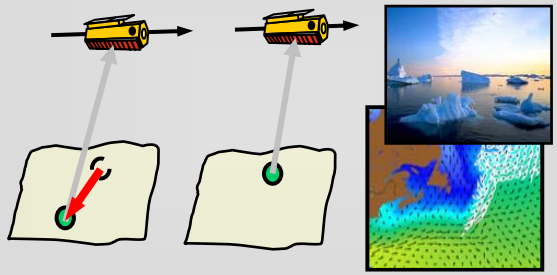
Bistatic SAR Imaging



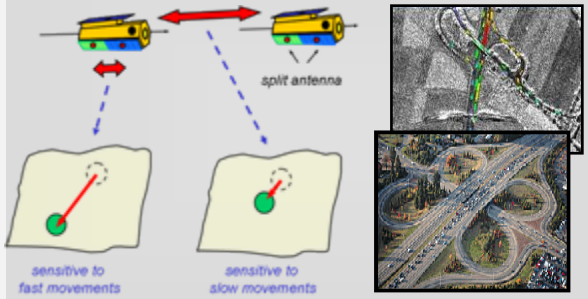
Polarimetric SAR Interferometry



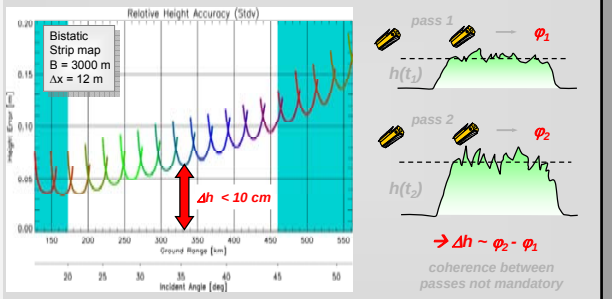
Along-Track Interferometry



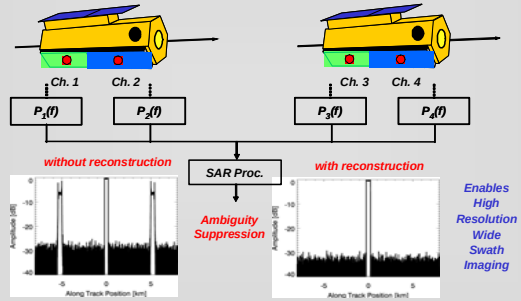
Ground Moving Target Indication



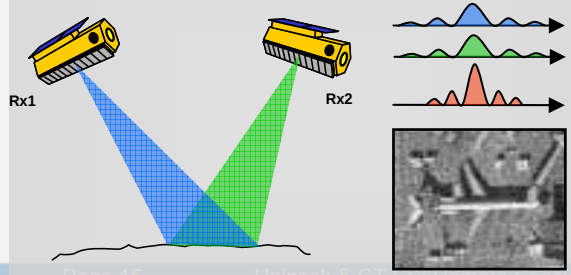
Double Differential Interferometry



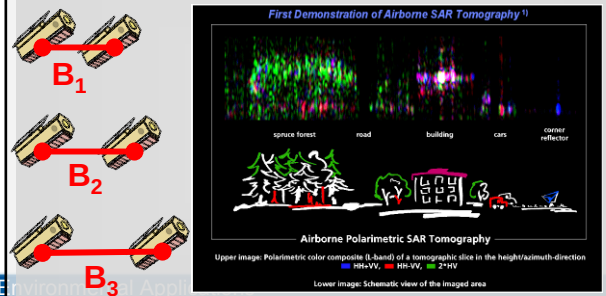
Digital Beamforming



Super Resolution



SAR Tomography



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First Pol-InSAR Data Takes

Dual-Pol HH-VV Spotlight

Test Site Location: Russia

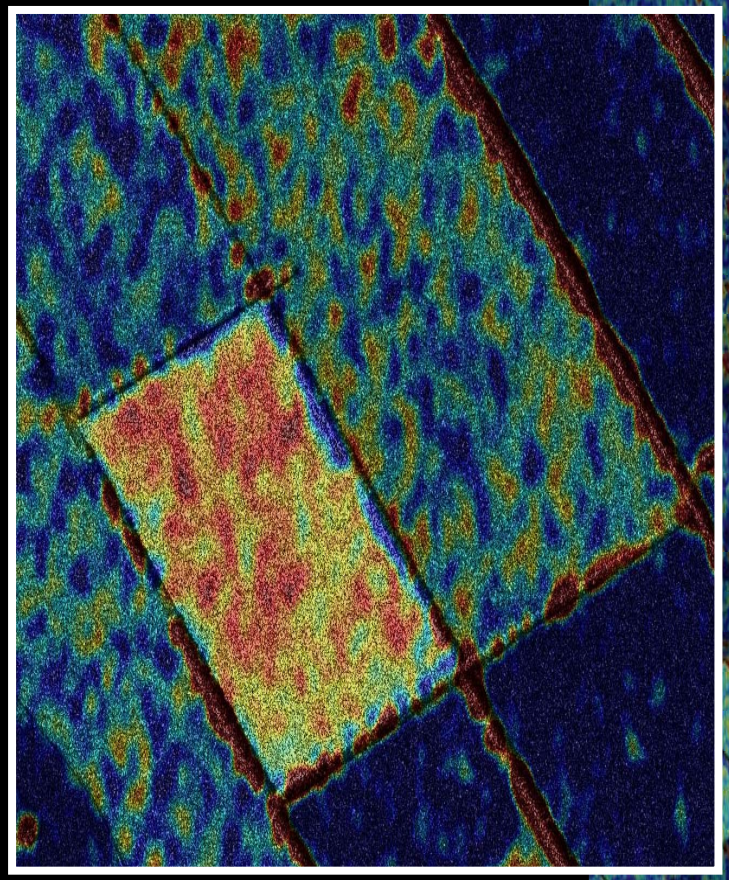
InSAR Mode: Monostatic

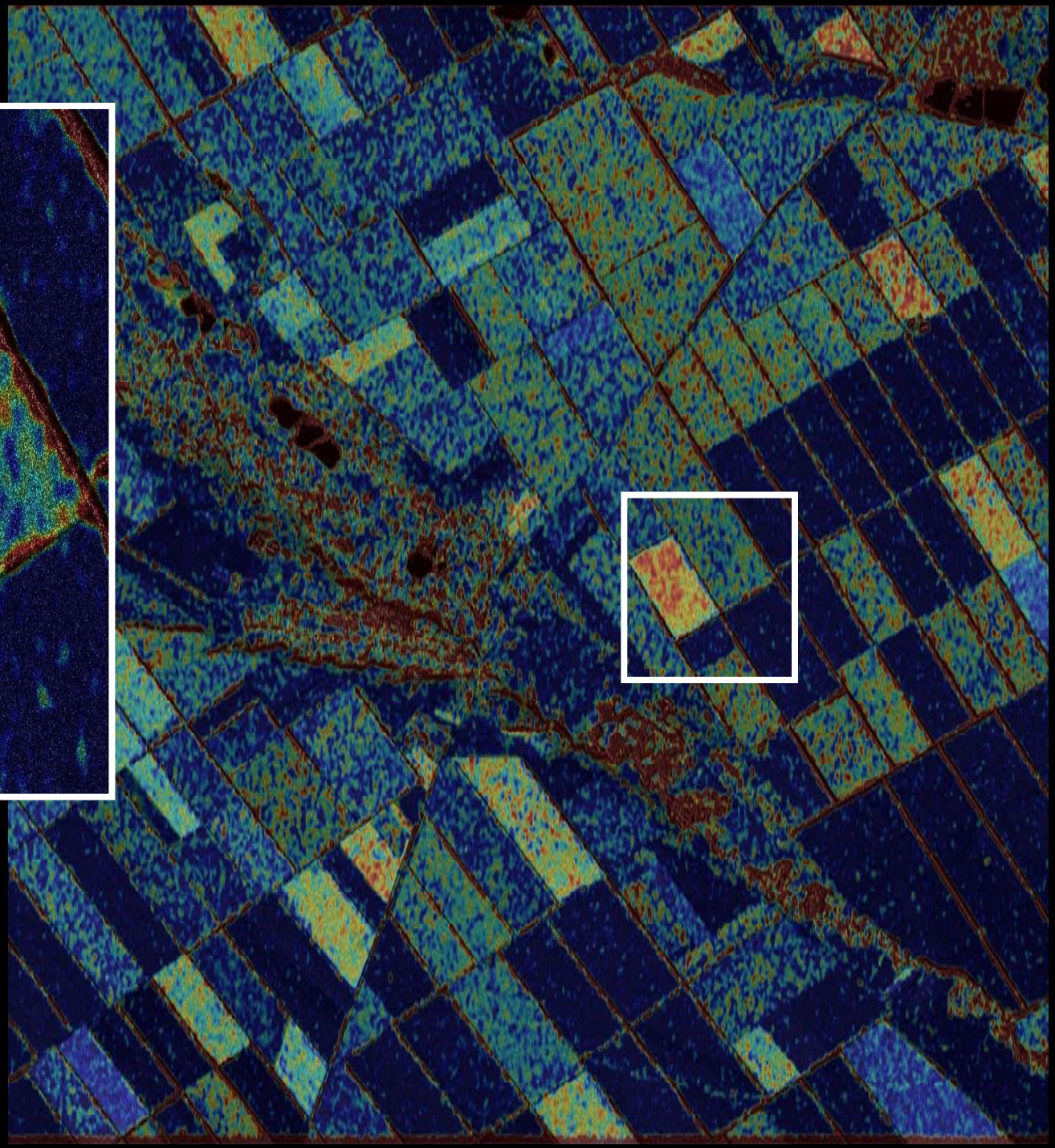
Temporal Baseline: 3sec

Spatial Baseline ($\perp$): 275m

TanDEM

Pol-InSAR





Phase difference in height [m]:

0 1 2 [m] 3

TanDEM

Tandem-L

Systematic monitoring of dynamic processes on the Earth surface

	Produkte	Auflösung	Wiederholrate
Biosphäre	Waldhöhe	20 - 50 m	alle 16 Tage bis saisonal
	Wald gebundene Biomasse		
	Vertikale Waldstruktur		
Geo-/ Lithosphäre	Plattentektonik	5 - 100 m	wöchentlich
	Vulkanismus		
	Hangrutschungen		
	Deformationen		
Kryo- & Hydrosphäre	Gletscherbewegungen	50 - 500 m	wöchentlich
	Oberflächennahe Bodenfeuchte		wöchentlich
	Änderungen des Wasserspiegels		bei Bedarf
	Schnee Wasser-Äquivalent		saisonal
	Änderungen der Eisstruktur		saisonal
	Meeresströmungen		wöchentlich
Global	Digitale Gelände- & Oberflächenmodelle	20 - 50 m	jährlich

DLR NASA

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Outlook

Discussion topic in the splinter meeting:

- Formulation and collection of requirements from the different CT‘s
- Availability of ground and air/space based instruments/sensors in 2011/2012
- Selection of test observatories for data collection
- Formulation of a rough campaign plan (ground, air, space borne)
- Assignment of contact persons for campaign organisation

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