The Pol-InSAR Course

…an (experimental) **SAR training course**

Course No 6: 20th of November 2023 – 09th of February 2024

Prepared by DLR-HR's Pol-InSAR Team

German Aerospace Center (DLR), Microwaves & Radar Institute (HR), Pol-InSAR Research Group

Course Organisation: ESA, DLR, EEBIOMASS

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Motivation

A rapidly growing (scientific and commercial) community with limited or no SAR background uses (or intends to use) multi-parameter SAR data:

> … a new generation of multi-parameter SAR missions with open data policy is already operational in orbit or about to be launched;
>
> … synergies between SAR and optical RS data (or products) developed in recent years confront the "optical community" with the use of multi-parameter SAR data.

The interpretation of SAR data is (compared to optical data) less intuitive, while the available literature is often “too mathematical", aiming at a more engineering oriented audience, or oversimplified.

Understanding the information content of SAR data and the basic SAR processing principles/algorithms is neither as difficult nor as complex as it might appear. Anyone willing to invest a reasonable amount of time can achieve both.

The Pol-InSAR course is an online hands-on course that aims to develop the understanding on the information content of multi-parameter SAR data and to eliminate the respect for SAR data processing in an interactive way, without assuming any prior / background knowledge.

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Course Outline: 5 SAR (2D and 3D) Techniques in 10 Units

Synthetic Aperture Radar - SAR

1. **Focusing in Range:** Spatial resolution in Range, Matched filter, 1D and 2D focusing, …
2. **Focusing in Azimuth:** Spatial resolution in Azimuth, Synthetic aperture, 1D and 2D focusing, …

SAR Polarimety - PolSAR

1. **Scatering matrix:** Polarimetric SAR, physical interpretation of scattering mechanisms, ...
2. **Covariance matrix:** Distributed scatterers, depolarization, polarimetric eigen-decomposition, …

SAR Interferometry - InSAR

1. **Interferogram formation:** Image co-registration, flat earth removal, geometric interpretation, …
2. **Interferometric coherence:** InSAR decorrelation, volume decorrelation, forest height inversion, …

Polarimetric SAR Interferometry - PolInSAR

1. **Pol-InSAR space:** Pol-InSAR observation space, interpretation and representation, …
2. **Model based Pol-InSAR inversion:** forest height inversion, dual-pol implementation, …

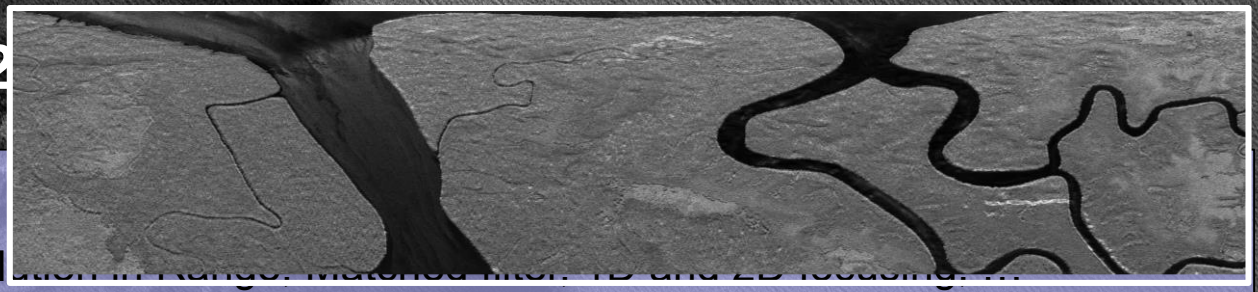
SAR Tomography - TomoSAR

1. **3D Focusing:** Vertical aperture formation, 3D resolution, 3D focusing, …
2. **3D Refelectivity:** Reconstrucion algorithms, polarimetric extension, interpretation, …

Course Outline: 5 SAR (2

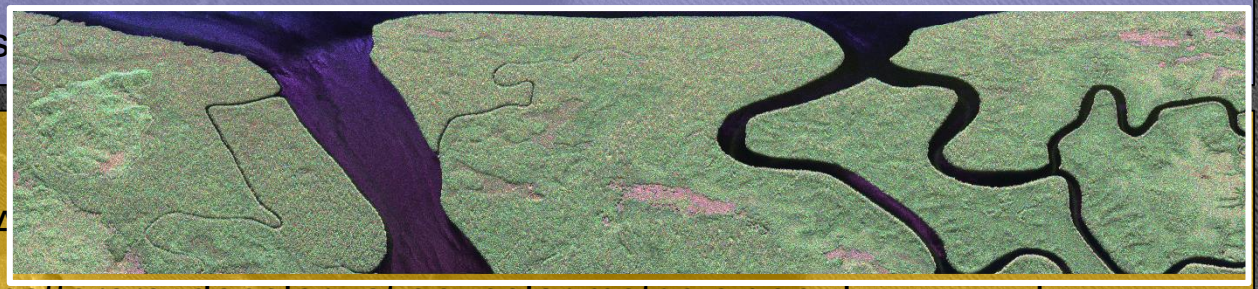
Synthetic Aperture Radar - SAR

1. **Focusing in Range:** Spatial resol
2. **Focusing in Azimuth:** Spatial res



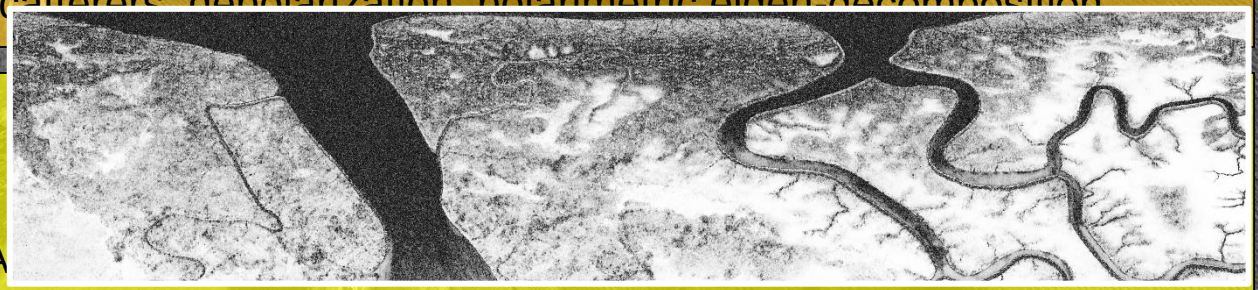
SAR Polarimety - PolSAR

1. **Scatering matrix:** Polarimetric SA
2. **Covariance matrix:** Distributed sc



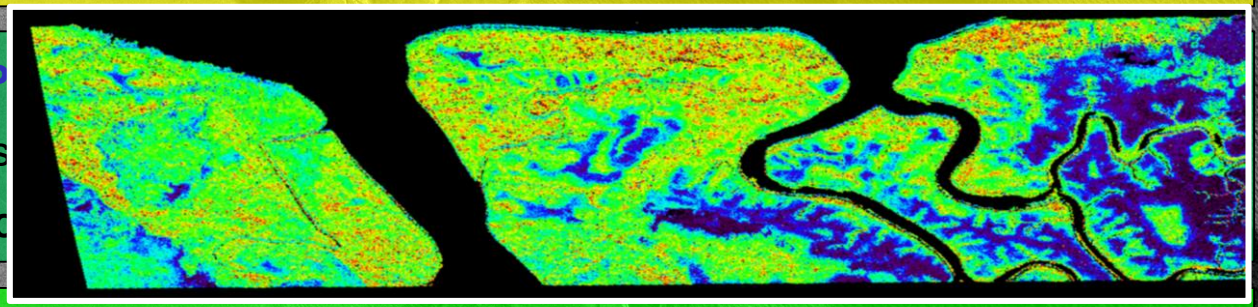
SAR Interferometry - InSAR

1. **Interferogram formation:** Image
2. **Interferometric coherence:** InSA



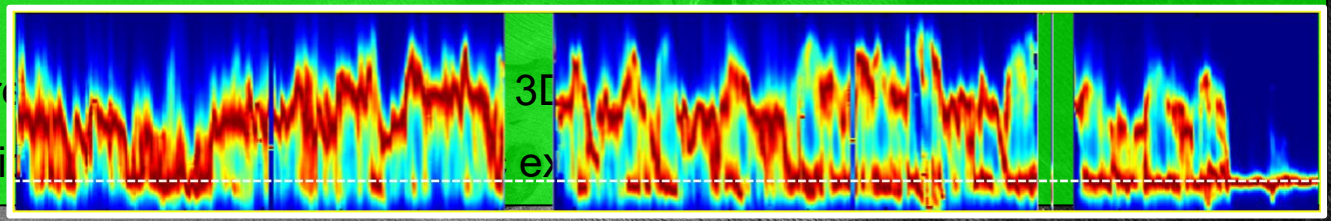
Polarimetric SAR Interferometry - P

1. **Pol-InSAR space:** Pol-InSAR obs
2. **Model based Pol-InSAR inversio**



SAR Tomography - TomoSAR

1. **3D Focusing:** Vertical apertur
2. **3D Refelectivity:** Reconstruci



Each Unit (in 3 Sessions) a Week !

Mon	**Theoretical Background (~60min) + Break + Introduction of Exercise(s) (~60min)**
Tue	
Wed	**Check Point: Discussion of problems & results, questions & answers (~60min)**
Thu	
Fri	**Closing Session: Discussion of results, questions & answers (~60-90min)**
Sat	
Sun	

In total 40 Course Hours + Time for the implementation of the course exercises !!!

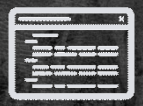
The course is based on Zoom Sessions and the exercises are performed on ESA‘s MAAP

ESA‘s Mission Algorithm and Analysis Plattform (MAAP)

The course is hosted by ESA‘s Mission Algorithm and Analysis Plattform (MAAP) that is a virtual open and collaborative environment that:

Enables researchers to easily discover, process, visualize and analyze large volumes of data.

Provides tools and infrastructures to bring data into the same coordinate reference frame to enable comparison, analysis and evaluation.



Provides a version-controlled science algorithm development environment that supports tools, co-located data, and processing resources.

Addresses intellectual property and sharing issues related to collaborative algorithm development and sharing of data and algorithms.

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Overview of Eclipse Che - JupyterLab Resources on the MAAP

Main user interface: JupyterLab

Main programming language: Python

Additional support for: R and Julia

Main packages: NumPy, SciPy, GDAL, Scikit-Learn, Dask, Xarray

Available resources per user:

RAM: 10GB

Storage: 30 GB

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Proposed Course Timeline

Synthetic Apperture Radar - SAR

1. Focusing in Range — Week 47 20.11-24.11
2. Focusing in Azimuth — Week 48 27.11-01.12

SAR Polarimety - PolSAR

1. Scatering matrix interpretation — Week 49 04.12-08.12
2. Covariance matrix interpretation — Week 50 11.12-15.12

SAR Interferometry - InSAR

1. Interferogram formation — Week 51 18.12-22.12
2. Interferometric Coherence — Week 02 08.01-12.01

Polarimetric SAR Interferometry - PolInSAR

1. Pol-InSAR space — Week 03 15.01-19.01
2. Model based Pol-InSAR inversion — Week 04 22.01-26.01

SAR Tomography - TomoSAR

1. 3D Focusing — Week 05 29.01-02.02
2. 3D Reflectivity — Week 06 05.02-09.02

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