

The Course

...an (experimental) SAR training course

Prepared by DLR-HR's Pol-InSAR Team

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



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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 Polarimetry - PolSAR

1. **Scattering 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 Refeectivity:** Reconstrucion algorithms, polarimetric extension, interpretation, ...

Course Outline: 5 SAR (2

Synthetic Aperture Radar - SAR

1. Focusing in Range (1D and 2D)
2. Focusing in Azimuth (1D and 2D)

SAR Polarimetry - PolSAR

1. Scattering matrix: Polarimetric SAR
2. Covariance matrix: Distributed scatterers

SAR Interferometry - InSAR

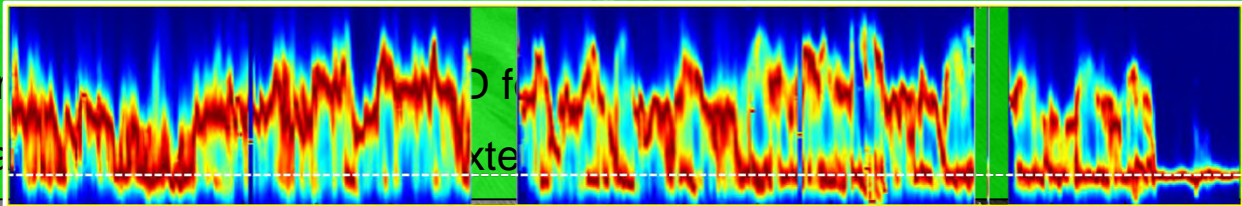
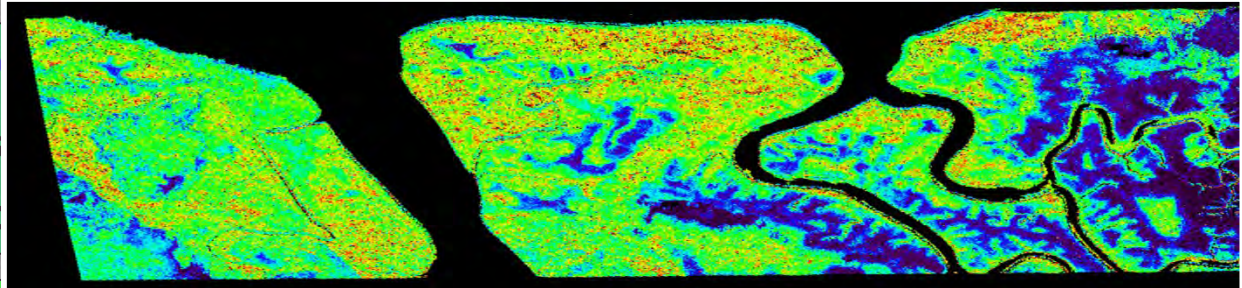
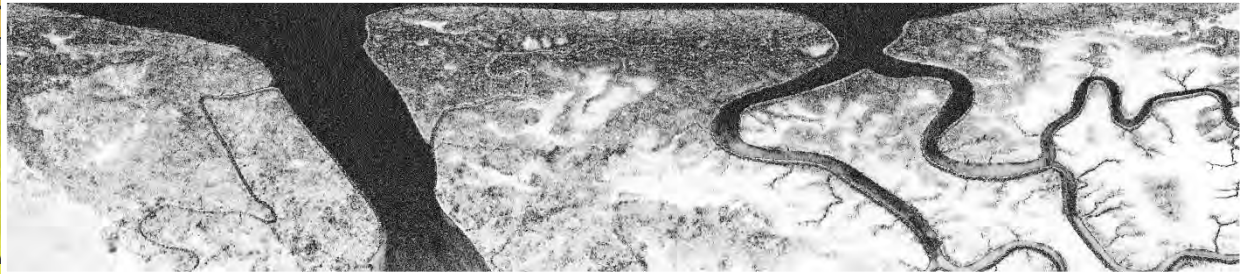
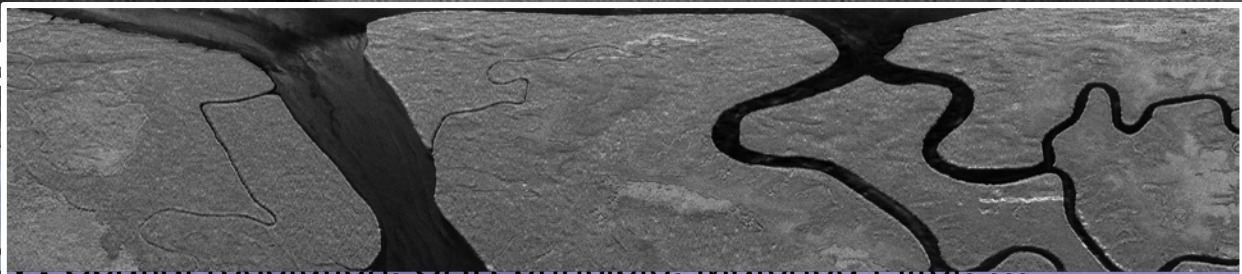
1. Interferogram formation: Image
2. Interferometric coherence: InSAR

Polarimetric SAR Interferometry - Pol-InSAR

1. Pol-InSAR space: Pol-InSAR observations
2. Model based Pol-InSAR inversion

SAR Tomography - TomoSAR

1. 3D Focusing: Vertical aperture for 3D focusing
2. 3D Refeectivity: Reconstruction of 3D reflectivity



Each Unit (in 3 Sessions) a Week !

Mon

Theoretical Background (~60min) + 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 (~60min)

Sat

Sun

ESA's Mission Algorithm and Analysis Platform

The course is hosted by ESA's Mission Algorithm and Analysis Platform (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

<https://liferay.val.esa-maap.org/>



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Overview of Eclipse Che - JupyterLab Resources

Main user interface: JupyterLab



Main programming language: Python



Additional support for: R and Julia



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



Resources per user:



RAM: 10GB



Storage: 30 GB



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Course Timeline

Synthetic Aperture Radar - SAR

- | | |
|------------------------|---------------------|
| 1. Focusing in Range | Week 18 02.05-06.05 |
| 2. Focusing in Azimuth | Week 19 09.05-13.05 |

SAR Polarimetry - PolSAR

- | | |
|-------------------------------------|---------------------|
| 1. Scattering matrix interpretation | Week 20 16.05-20.05 |
| 2. Covariance matrix interpretation | Week 21 13.05-27.05 |

SAR Interferometry - InSAR

- | | |
|------------------------------|---------------------|
| 1. Interferogram formation | Week 22 31.05-03.06 |
| 2. Interferometric Coherence | Week 23 06.06-10.06 |

Polarimetric SAR Interferometry - PolInSAR

- | | |
|------------------------------------|---------------------|
| 1. Pol-InSAR space | Week 24 13.06-17.06 |
| 2. Model based Pol-InSAR inversion | Week 25 20.06-24.06 |

SAR Tomography - TomoSAR

- | | |
|--------------------|---------------------|
| 1. 3D Focusing | Week 26 27.06-01.07 |
| 2. 3D Reflectivity | Week 27 04.07-08.07 |

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