TecVolSA: The Development of an Intelligent Sentinel-1 Data Exploitation System

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German Aerospace Center (DLR) SAR signal processing
German Aerospace Center (DLR) EO Data Science
German Research Center for Geoscience (GFZ)
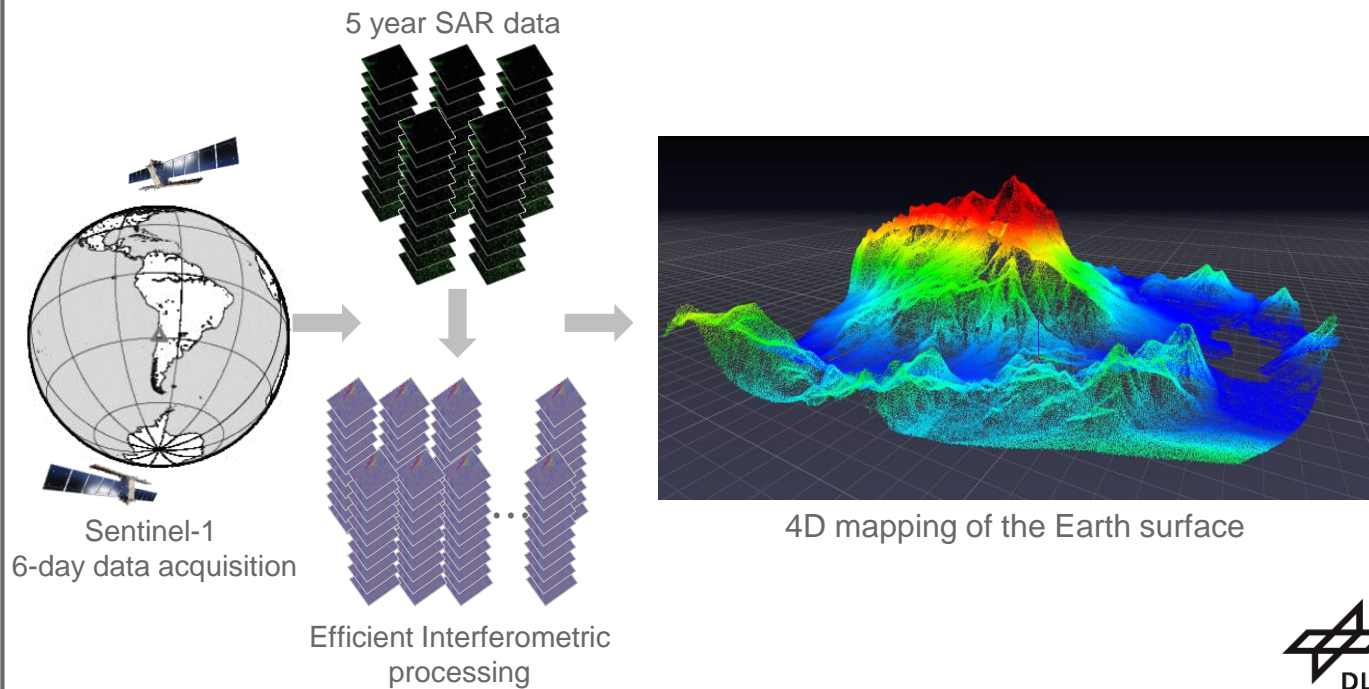Technical University of Munich (TUM)

Knowledge for Tomorrow

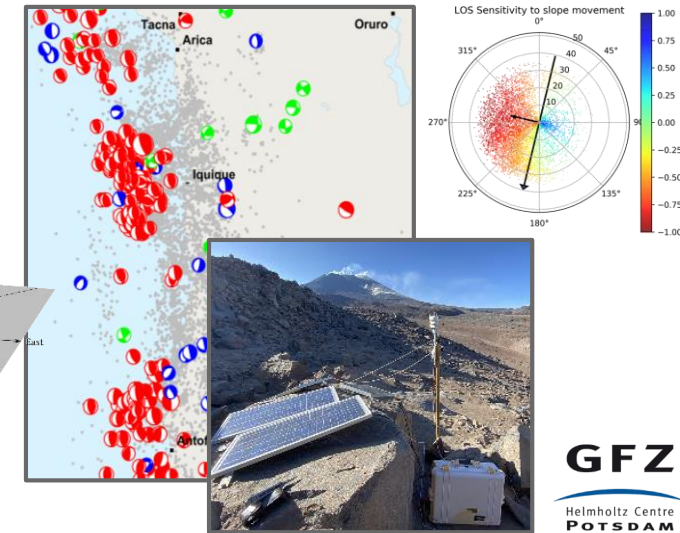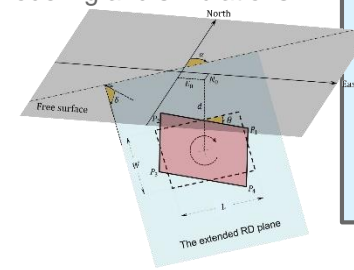# TecVolSA: monitoring Tectonics and Volcanoes of South America

SAR Signal Processing
4D mapping of the Earth surface from Sentinel-1

5 year SAR data

Sentinel-1
6-day data acquisition

Efficient Interferometric processing

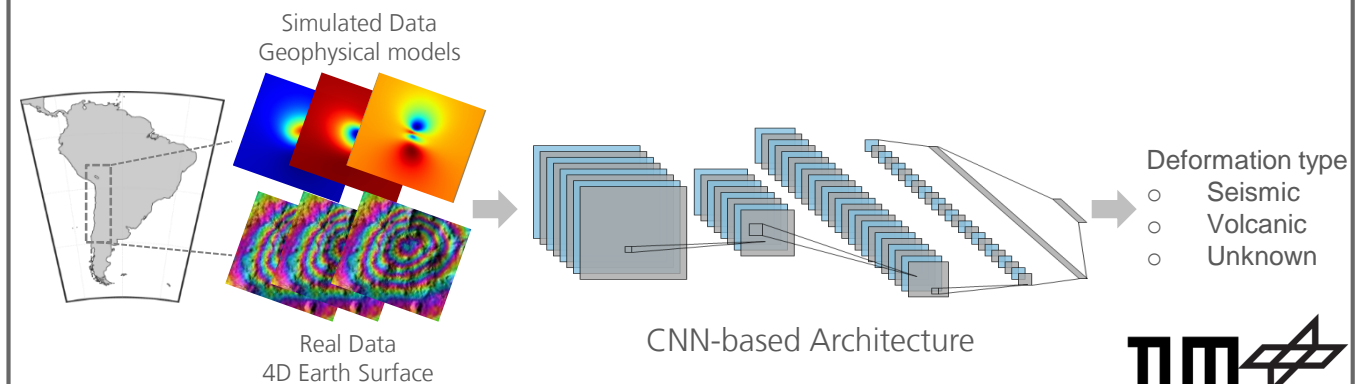4D mapping of the Earth surface

Research Center for Geosciences
Geophysical expertise

- Physical signal interpretation
- Field campaign
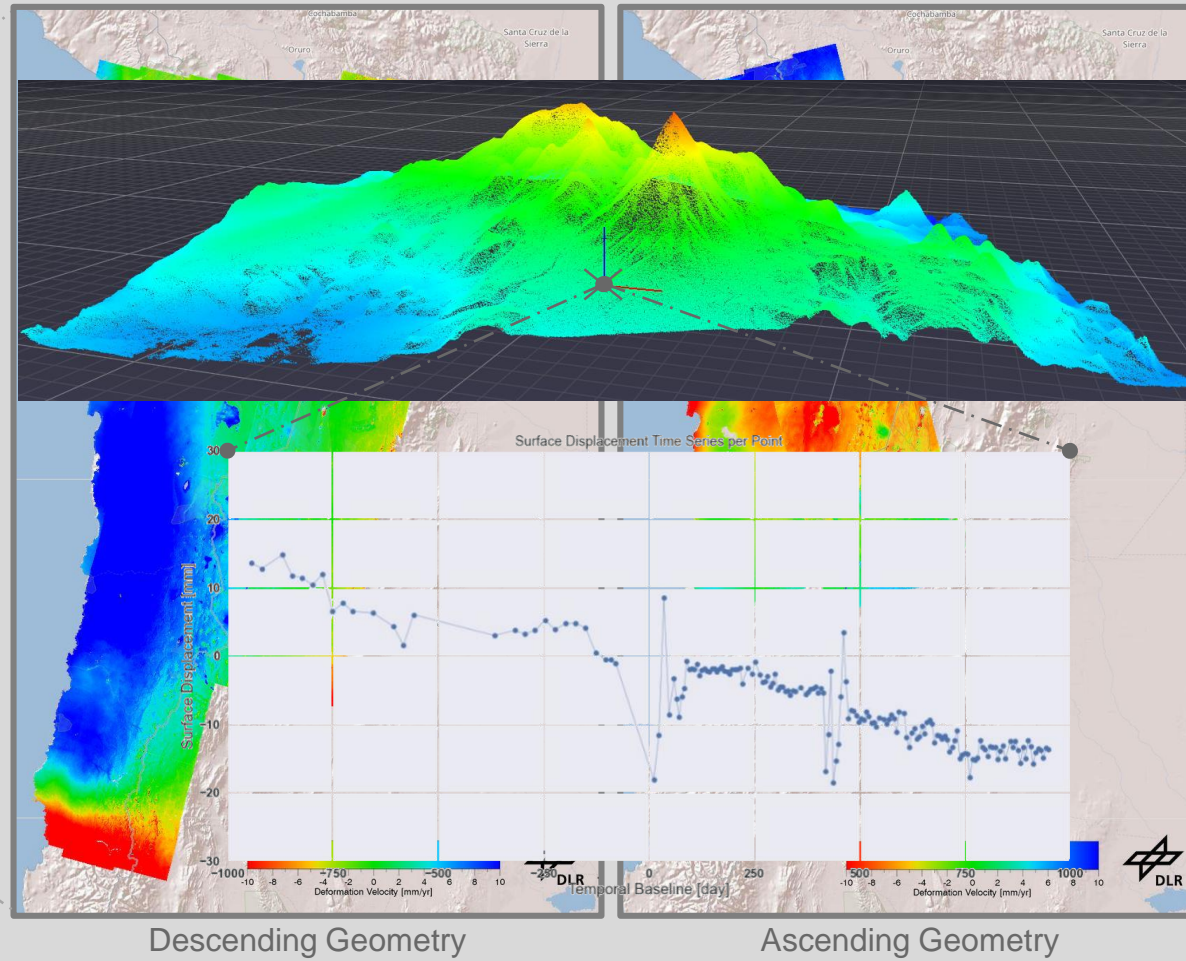- In situ measurements
- Geophysical modeling and simulations

LOS Sensitivity to slope movement

EO Data Science
Artificial Intelligence: Efficient information extraction from the 4D data

Simulated Data
Geophysical models

Real Data
4D Earth Surface

CNN-based Architecture

Deformation type
- Seismic
- Volcanic
- Unknown

Earth Surface Displacement Retrieval

5 Year SAR Data
Sentinel-1 A/B
2014 − 2019
Central Volcanic Zone of the Andes

H. Volcanoes
P. Volcanoes

Descending Geometry

Ascending Geometry

Retrieved Data Products

Surface displacement velocity maps:
    precision*: 1 mm/yr at large scale

4D point clouds:
    temporal evolution of the Earth surface
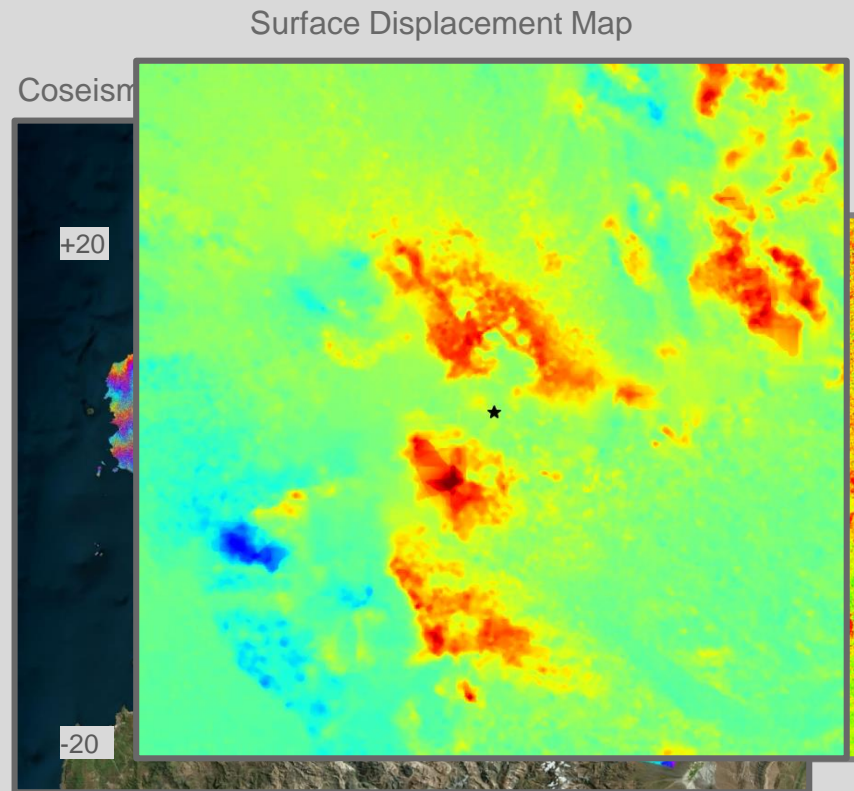
*Algorithms to ensure high-precision:
Ansari et. al. "Study of Systematic Bias in Measuring Deformation with SAR Interferometry", IEEE-TGRS 2020
Parizzi et. al. "Validation of InSAR Large Scale Deformation Measurements Performance: the Impact of Model-Based Tropospheric Delay Corrections", submitted to IEEE-TGRS
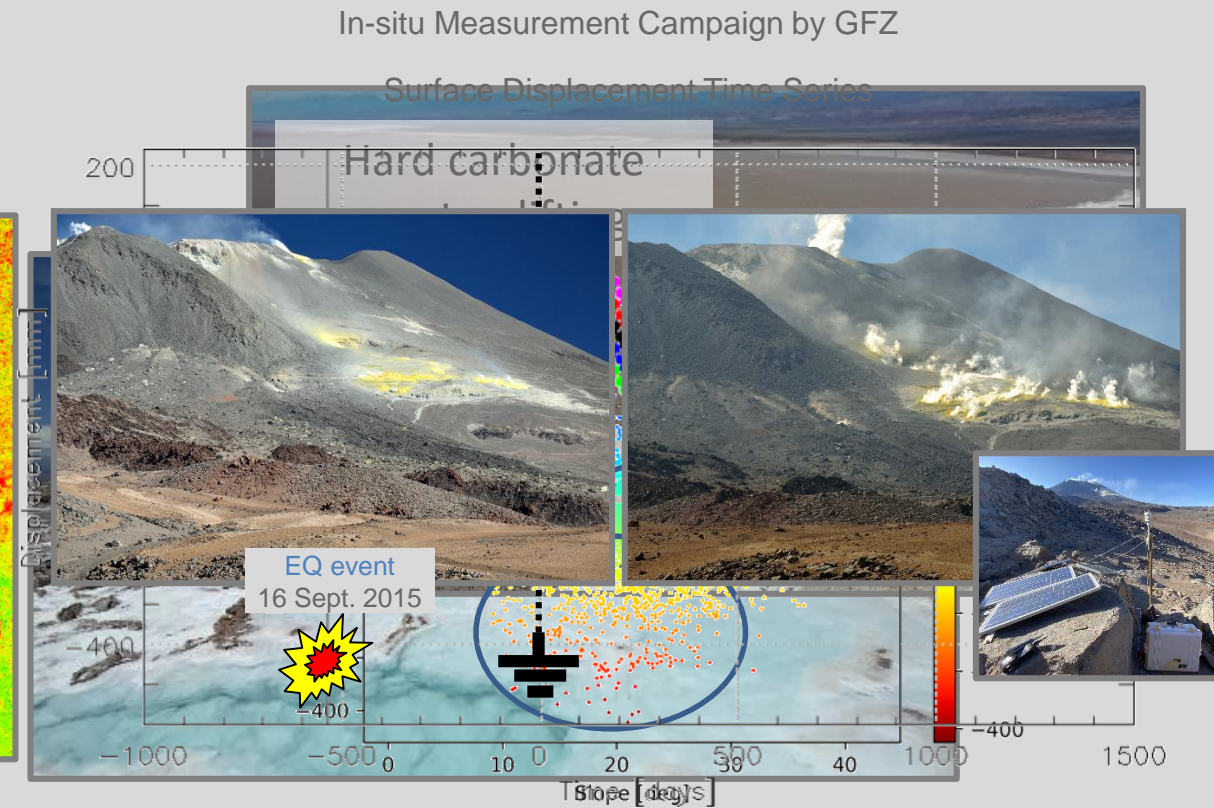
Investigation of Various Signal Sources

Surface Displacement Map

Coseism

In-situ Measurement Campaign by GFZ

Surface Displacement Time Series

Hard carbonate

EQ event
16 Sept. 2015

Andes - Lastarria Volcano
Volcanic deformation
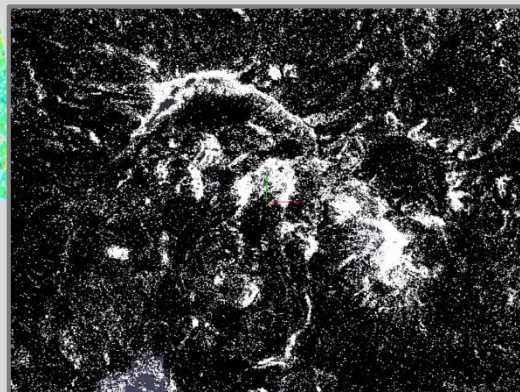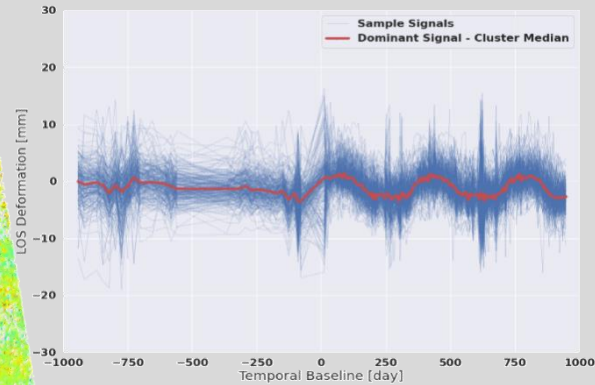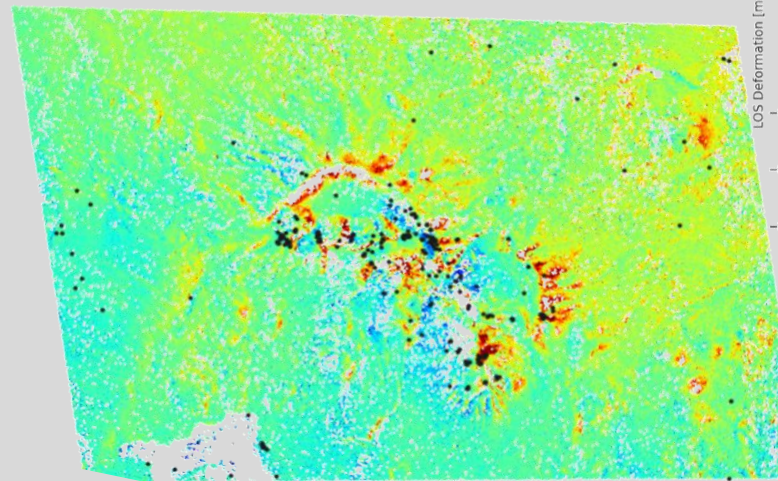
Chile - Atacama Salt Pane
Lithium mining activities

Argentina - Tebenquicho
Solifluction signal

Chile – Illapel
2015 8.3 Mw Earthquake
and aftershocks

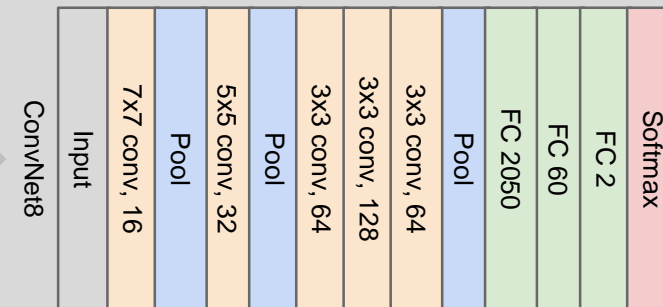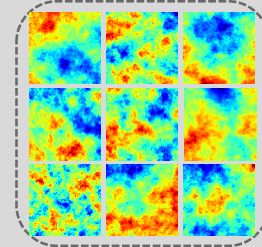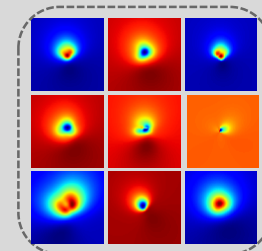# AI for efficient information extraction from Terabytes of Data

Unsupervised Machine Learning:

- Clustering similar signals
- Detection of non linear transient signals
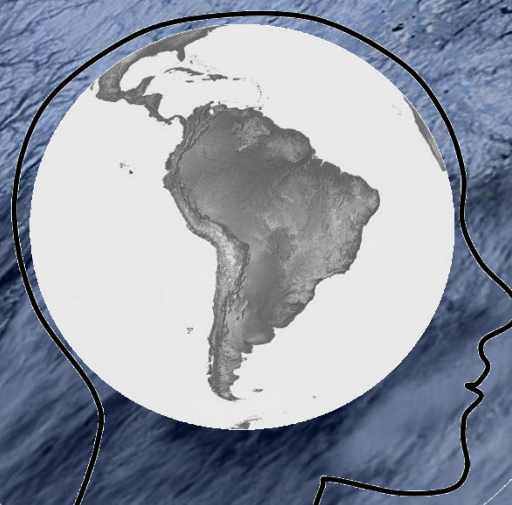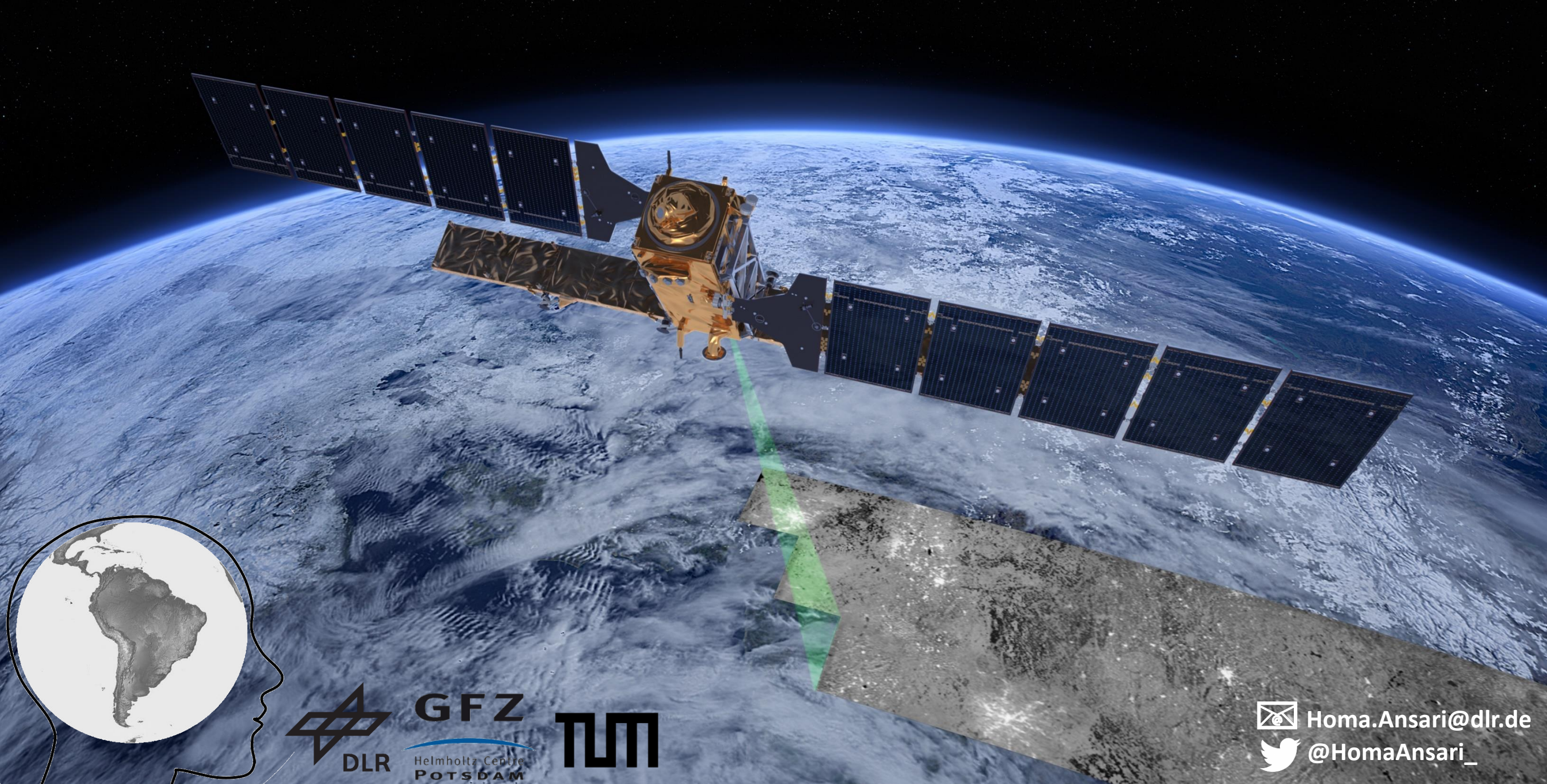- Detection of solifluction signal surrounding the volcanoes

Supervised Deep Learning:

- Training CNNs using simulated data
- Classification of deformation maps
- Anomaly detection

ConvNet8

Input | 7x7 conv, 16 | Pool | 5x5 conv, 32 | Pool | 3x3 conv, 64 | 3x3 conv, 128 | 3x3 conv, 64 | Pool | FC 2050 | FC 60 | FC 2 | Softmax

Deformation type
- Seismic
- Volcanic
- Unknown

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