Mapping soils in arid regions with Sentinel-1

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Copernicus and EUMETSAT H SAF Soil Moisture Services

- TU Wien has developed scientific algorithms that underpin several soil moisture services
  - EUMETSAT H SAF
    - ASCAT
  - Copernicus Land Monitoring
    - Sentinel-1
    - ASCAT+Sentinel-1
  - ESA CCI and C3S
    - Active + passive microwave sensors

Next generation Sentinel-1 soil moisture product developed within ESA DTE Hydrology project

Subsurface Scattering Signals Disturb Soil Moisture Retrievals

Monthly soil moisture maps of the Iberian Peninsula from years 1994-1996


ASCAT backscatter and GLDAS soil moisture over point in Saudi Arabia
High-resolution C-band Tomographic Profiling Experiments

Experiment: The co-polar VV (black) and HH (red) backscatter drying curves for incidence angles 0°, 5°, 10°, 15°, 20°, 25°. All curves are shown over a 14 dB power range. The first data point - corresponding to dry soil before the addition of water - was set to 0 dB in each plot. The next four points correspond to the successive addition of 1mm depths of water.

Subsurface Scattering Model

\[ \sigma_{soil}^0 = \sigma_{top}^0 + \Gamma_{soil}^2 \sigma_{sub}^0 \]

Attema & Ulaby (1978)

\[ \sigma_{soil}^0 = \alpha e^{\beta \theta} + \psi e^{-\xi \theta} \]

Mapping of Subsurface Scatterers with ASCAT and Sentinel-1

Wagner et al. (2024) Mapping subsurface scatterers from SAR backscatter time series, 15th EUSAR Conference, Munich, 23-26 April 2024, in press.
Field Visit to Fossil Rock near Dubai

- Sentinel-1 false colour composite
  - Blue = VV
  - Green = VH
  - Red = Subsurface scattering
Key Messages

- SAR data are yet underutilised in soil mapping efforts

- SAR backscatter intensity images reflect a combination of factors
  - Surface roughness, vegetation biomass, built-up areas

- **New method available that allows mapping subsurface soil properties**
  - Shallow bedrock, stones, distinct boundary layers, etc.
  - Combination of C-, L- and P-band SAR would allow to probe different depths