Mapping soils in arid regions with Sentinel-1

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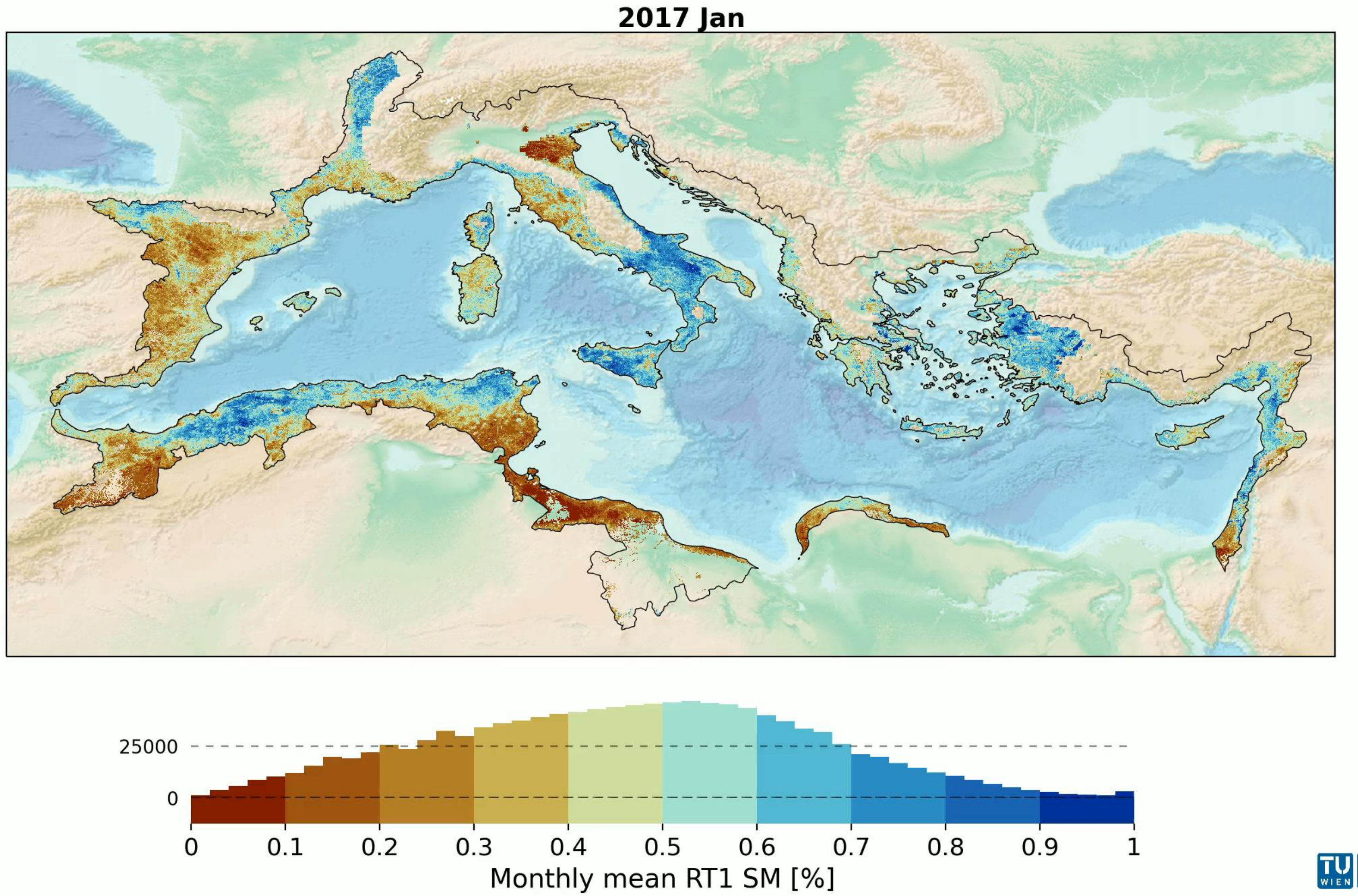
ESA Symposium on Earth Observation for Soil Protection and Restoration

Copernicus and EUMETSAT H SAF Soil Moisture Services

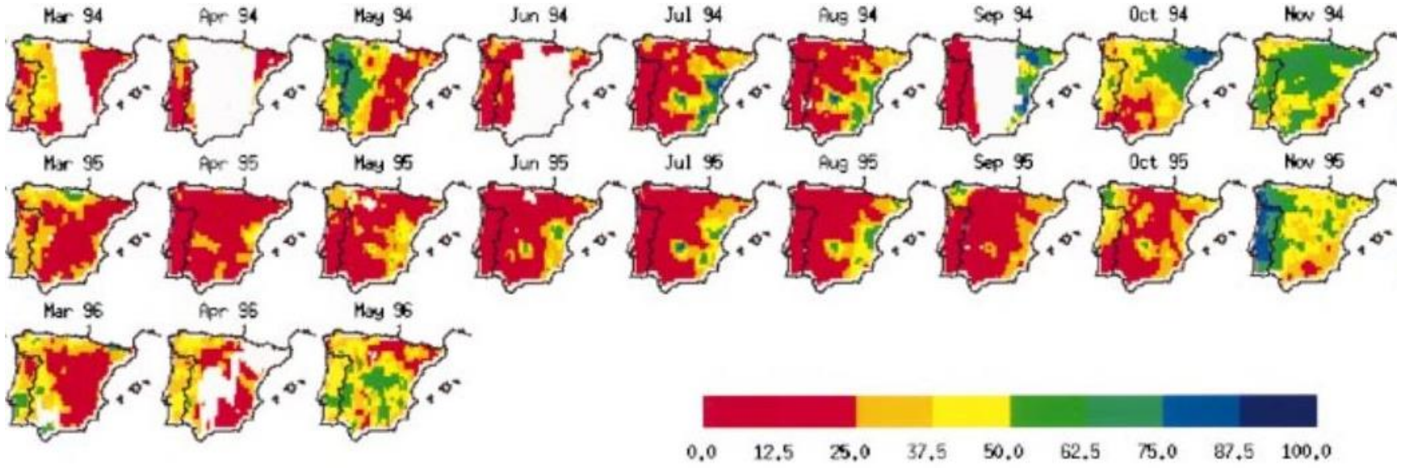
- TU Wien has developed scientific algorithms that underpin several soil moisture services
  - EUMETSAT H SAF
    - ASCAT
  - Copernicus Land Monitoring
    - Sentinel-1
    - ASCAT+Sentinel-1
  - ESA CCI and C3S
    - Active + passive microwave sensors



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

Quast et al. (2023) Soil moisture retrieval from Sentinel-1 using a first-order radiative transfer model - a case-study over the Po-Valley, Remote Sensing of Environment, 295, 113651, DOI 10.1016/j.rse.2023.113651

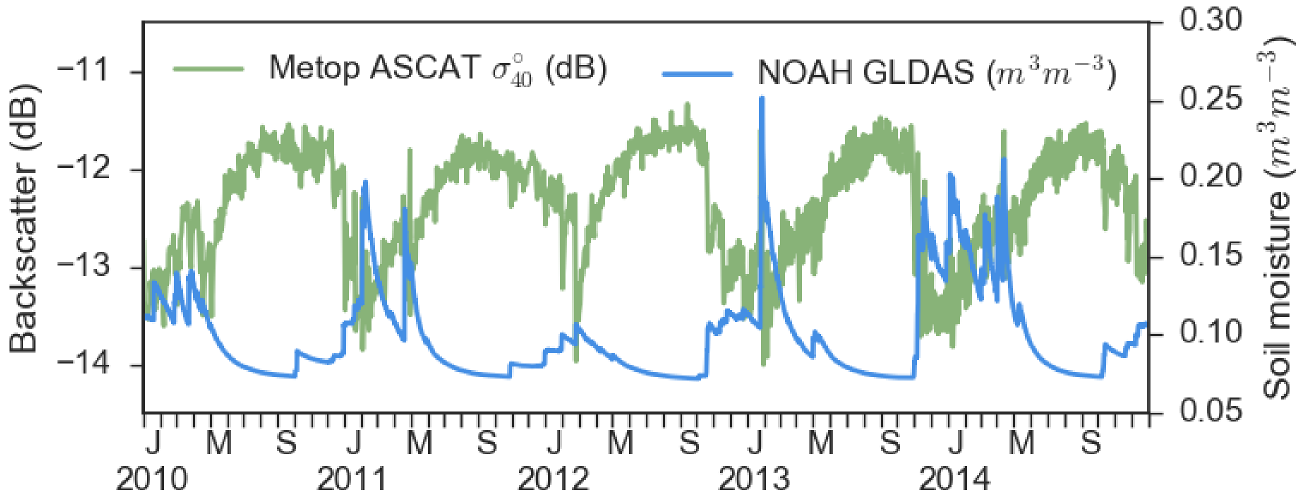
Subsurface Scattering Signals Disturb Soil Moisture Retrievals



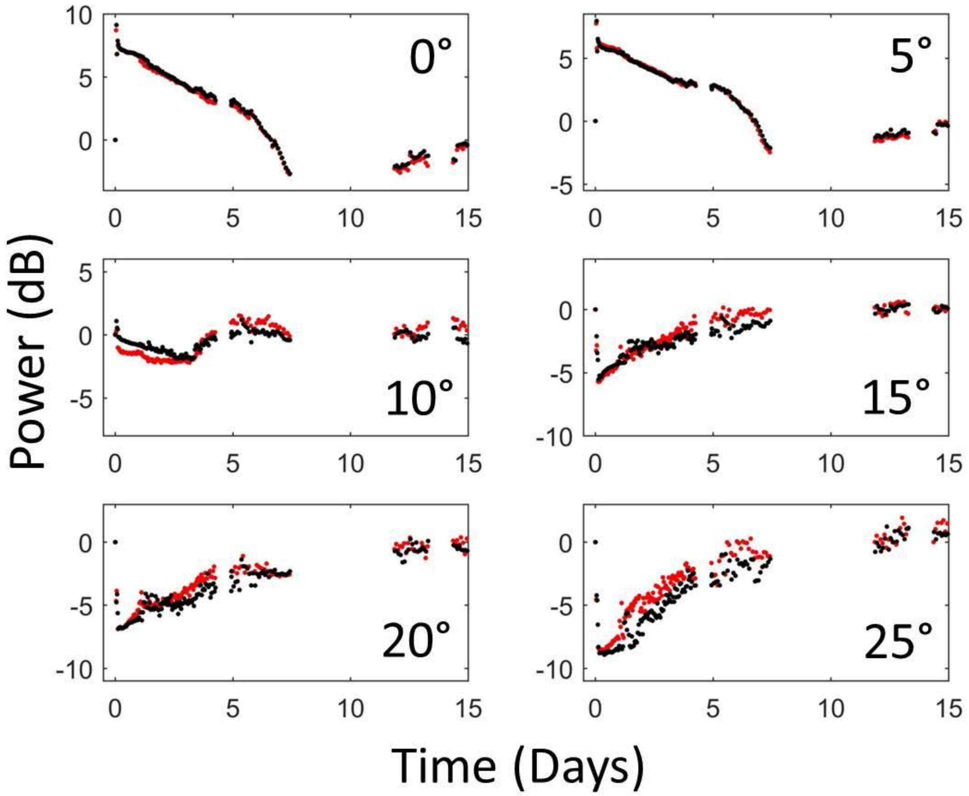
Monthly soil moisture maps of the Iberian Peninsula from years 1994-1996

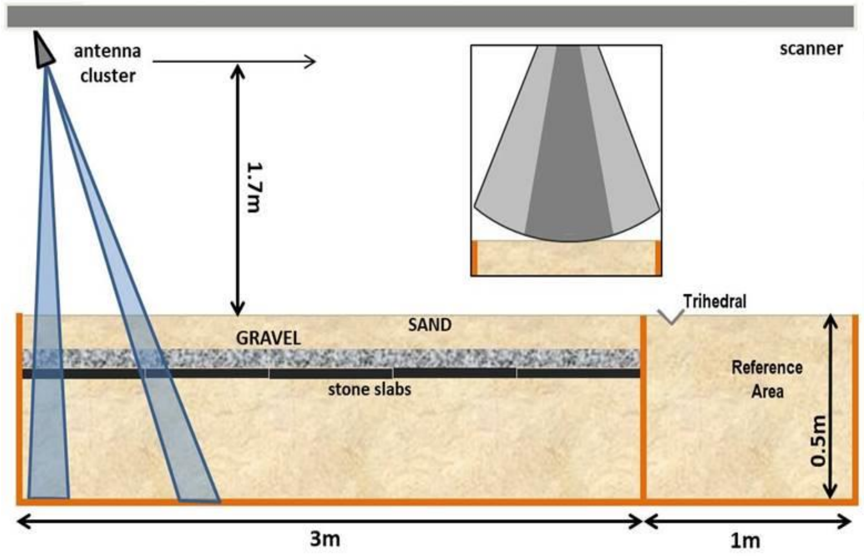
Wagner et al. (1999) A study of vegetation cover effects on ERS Scatterometer data, IEEE Trans. Geosci. Remote Sensing, 37(2), 938-948.

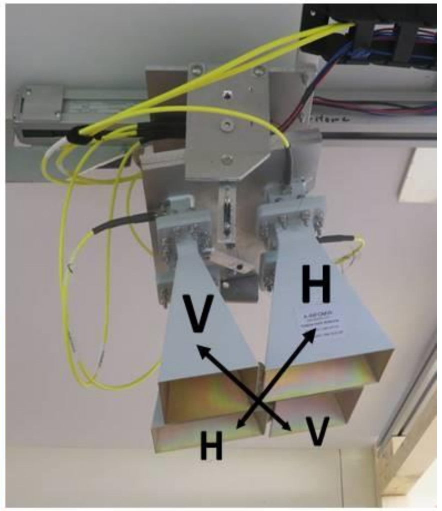
ASCAT backscatter and GLDAS soil moisture over point in Saudi Arabia

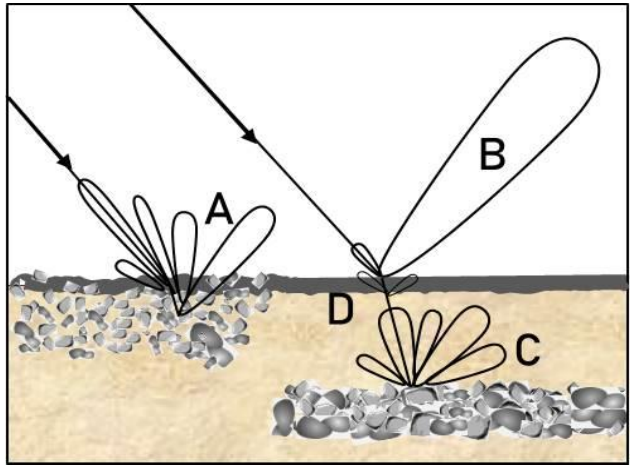


High-resolution C-band Tomographic Profiling Experiments





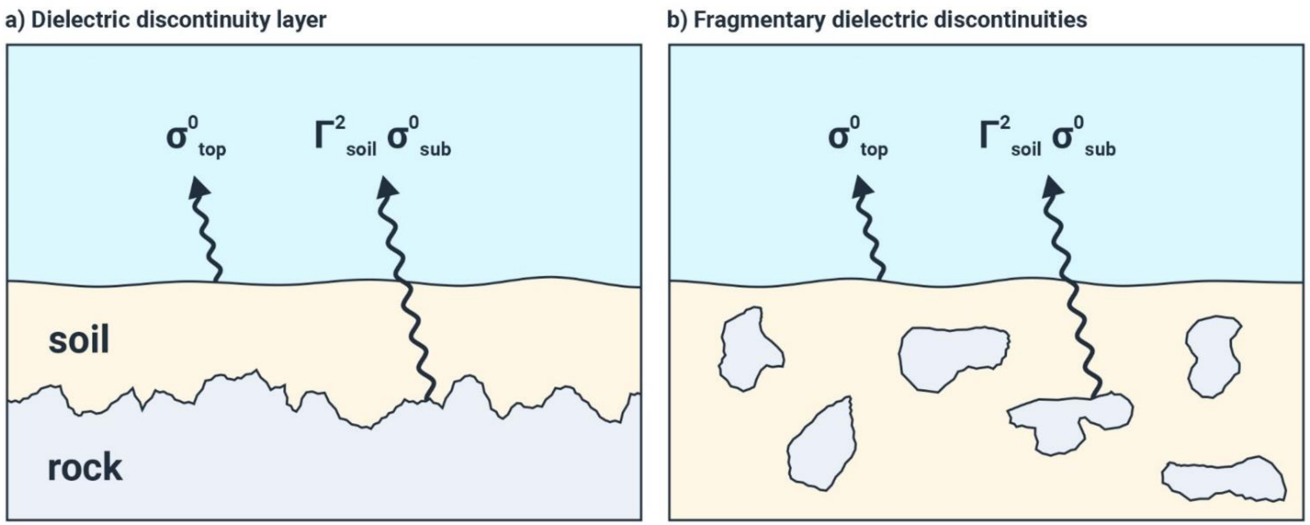




Experiment: The co-polar VV (black) and HH (red) backscatter drying curves for incidence angles 0°, 5°, 10°, 15°, 20°, 25°. All curves are shown over a 14 dB power range. The first data point - corresponding to dry soil before the addition of water - was set to 0 dB in each plot. The next four points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

Morrison, K., W. Wagner (2020) Explaining anomalies in SAR and scatterometer soil moisture retrievals from dry soils with sub-surface scattering, IEEE Transactions on Geoscience and Remote Sensing, 58(3), 2190-2197

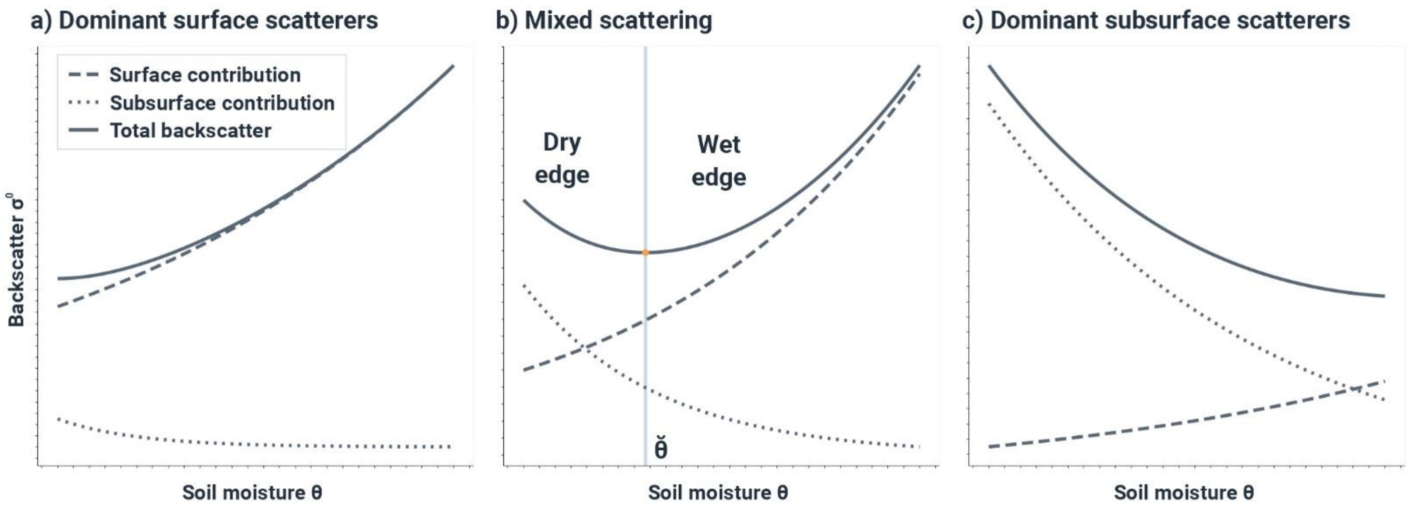
Subsurface Scattering Model



$$\sigma^0_{soil} = \sigma^0_{top} + \Gamma^2_{soil}\sigma^0_{sub}$$

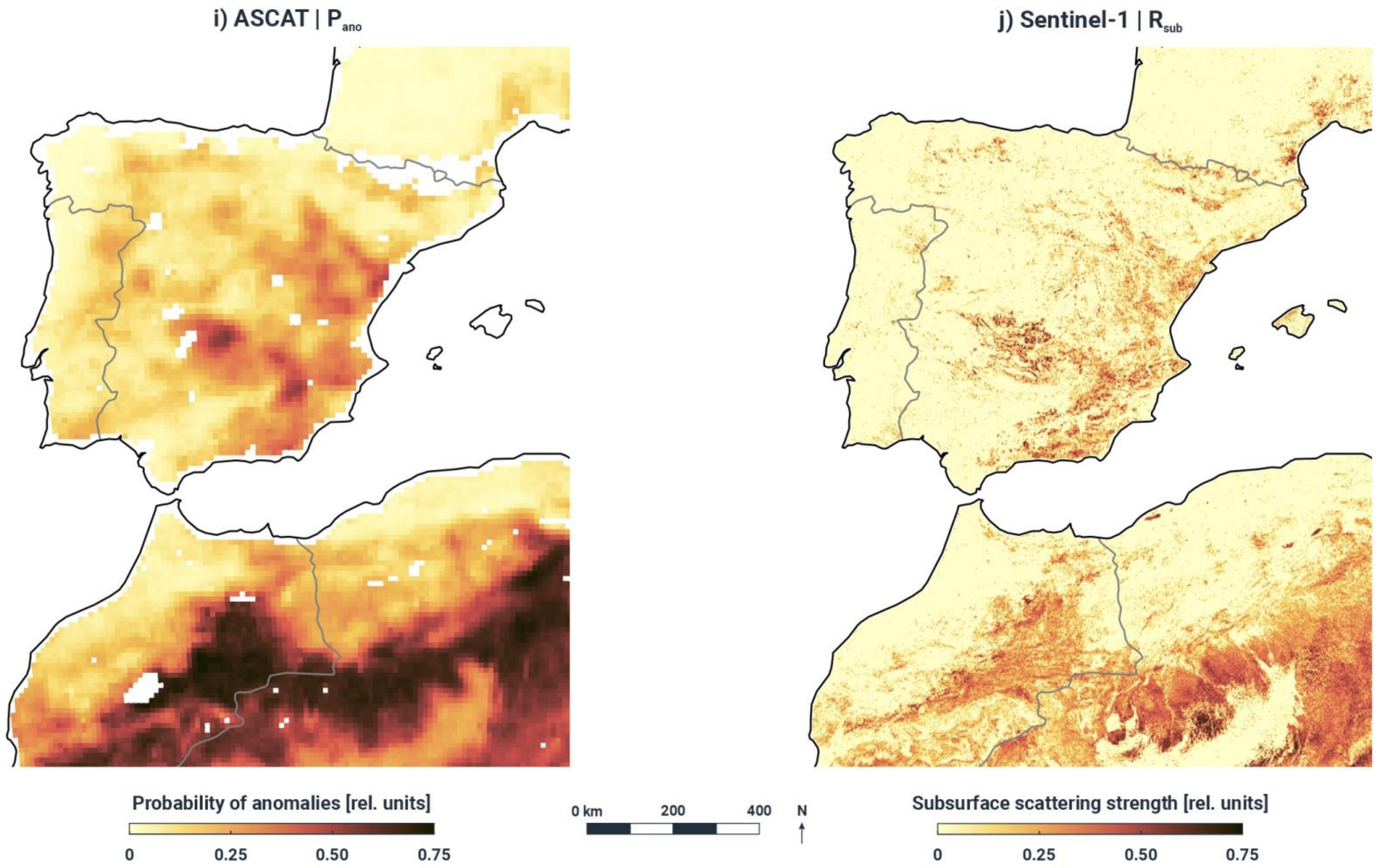
Attema & Ulaby (1978)

$$\sigma^0_{soil} = \alpha e^{\beta\theta} + \psi e^{-\xi\theta}$$



Wagner et al. (2022) Widespread occurrence of anomalous C-band backscatter signals in arid environments by subsurface scattering, Remote Sensing of Environment, 276, 113025, 14p.

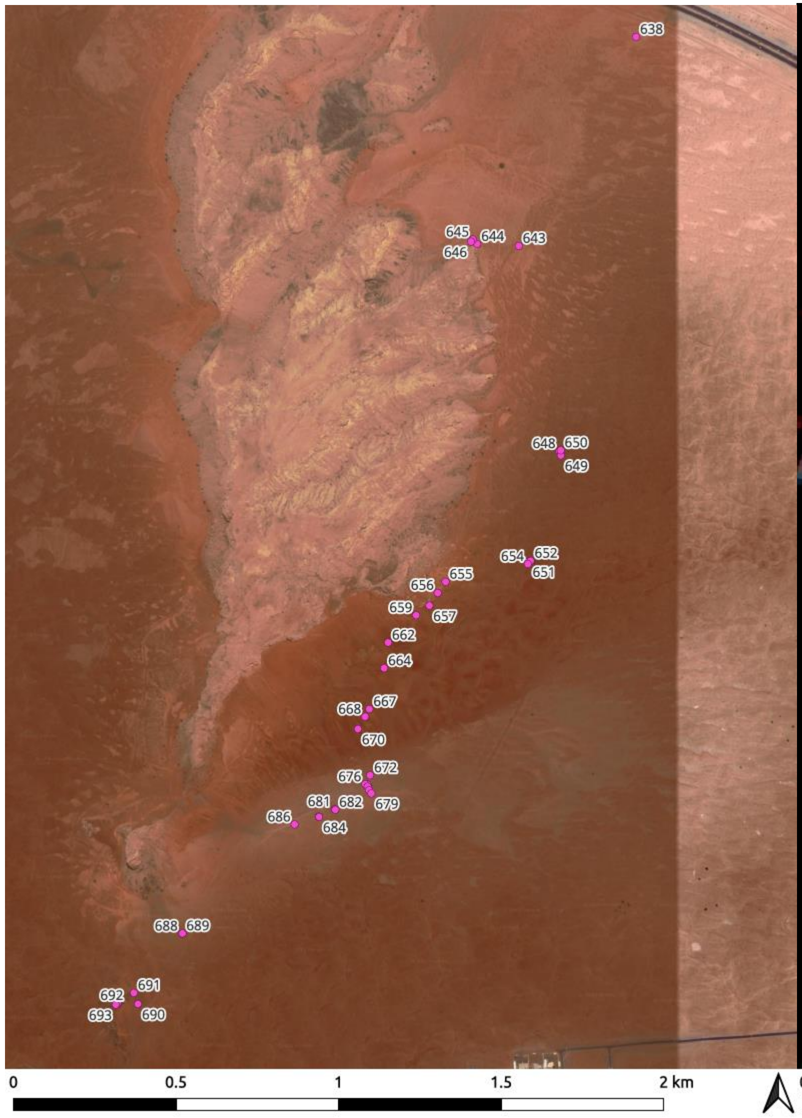
Mapping of Subsurface Scatterers with ASCAT and Sentinel-1

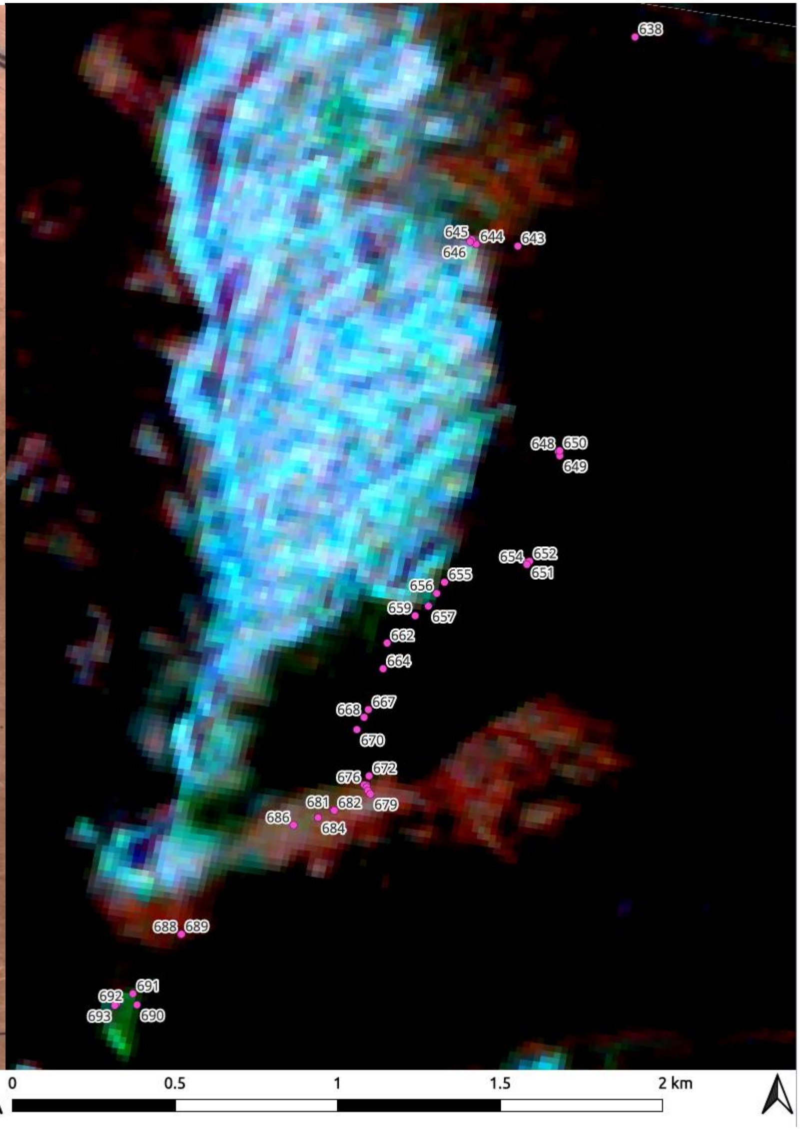


Subsurface scattering area in Morocco

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