L-band Signatures Emitted from Soils with Oriented Surface Structures

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Introduction

This work deals with passive microwave measurements of soil moisture at 1.4 GHz (L-band). More precisely, we investigate the effects of straightened surface structures (such as irrigation furrows or erosion gullies) on these measurements.

Emissivities of soils with periodic surface structures differ from the emissivities of soils with the same permittivity but with specular or random rough surfaces. This has to be taken into account when interpreting passive microwave measurements such as from ESA's upcoming Soil Moisture and Ocean Salinity (SMOS) mission.

A set of experiments was carried out aiming at a better understanding of the influence of straightened surface structures on L-band signatures. Polarisation effects of diverse artificially prepared striped surface patterns were investigated. The configuration of the footprint area was varied from highly synthetic to more natural surfaces.

Set-up

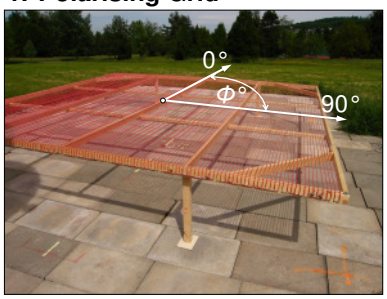
Basic set-up for all our experiments. Measurements were carried out at an observation angel of $\theta = 50°$. The elliptic area drawn on the soil box corresponds approximately to the -6 dB footprint area.

L-band Radiometer ELBARA
- $\lambda = 21$ cm ($f = 1.4$ GHz)
- two polarisations
- 12° full beam width

Auxiliary Measurements
- IR-radiometer
- TDR and temperature probes in soil box

Experiments

1. Polarising Grid



- 4 x 4 m rotating wooden frame stringed with wires
- T_B measurements at different frame orientations between 0° and 90° for different wire distances between $\lambda/10$ and λ

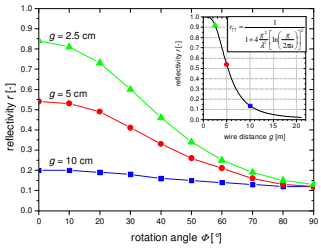
2. Rills (rill dimensions < λ)

- 3 x 4 m tiltable soil box filled with sand and rills imprinted into the surface
- T_B measurements during and after irrigating the soil box
- three surface configurations: no rills, rills ($\Phi = 0°$), rills ($\Phi = 90°$)

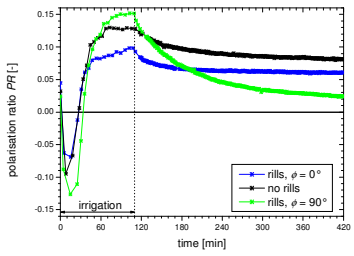
3. Rills (rill dimensions ≥ λ)

- 3 x 4 m tiltable soil box filled with sand and rills imprinted into the surface
- T_B measurements at dry and wet soil conditions
- three surface configurations: no rills, rills ($\Phi = 0°$), rills ($\Phi = 90°$)

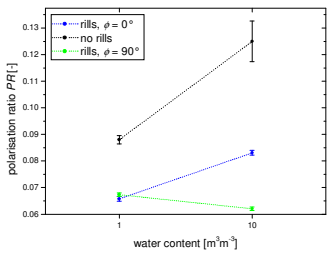
First Results



Observed reflectivities as function of rotation angle Φ for 3 wire distances g. For comparison theoretically derived values of $r_{\uparrow\uparrow}$ as function of g are shown in the small graph.



Polarisation ratios $PR = (T_B^v - T_B^h) / (T_B^v + T_B^h)$ for the 3 different surface configurations observed during and after irrigation of the soil box ($P = 7$ mm/h).



Polarisation ratios $PR = (T_B^v - T_B^h) / (T_B^v + T_B^h)$ for the 3 different surface configurations observed at dry and wet soil conditions.

Next Steps / Outlook

- implementation of a model to calculate reflectivities of periodic surfaces
- comparison of model results with the above measurements
- ELBARA measurements on a hillside displaying natural striped patterns in form of erosion gullies

Contribution to the conceptual understanding of L-band measurements (such as from SMOS) of footprints displaying features such as shown to the right.

Furrow irrigation (source: USDA ERS)

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