Surface roughness parameter uncertainties on radar based soil moisture retrievals

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A. Introduction

Surface roughness variations are often assumed to be negligible for the retrieval of sol moisture. Although previous investigations have suggested that this assumption is reasonable for natural vegetation covers (i.e. Moran et al. 2002), in-situ measurements over plowed agricultural fields (i.e. Callens et al. 2006) have shown that the soil surface roughness can change considerably due to weathering induced by rain.

Research Objectives:

1. To evaluate the impact of surface roughness changes for the soil moisture retrieval accuracy. throughout a (corn) growing season
2. To investigate the impact of the selected parameterization on soil moisture retrieval accuracy.

B. Field campaign

The OPE[3] campaign was a soil moisture focused active/passive microwave remote sensing campaign that took place in 2002.

Passive microwave:

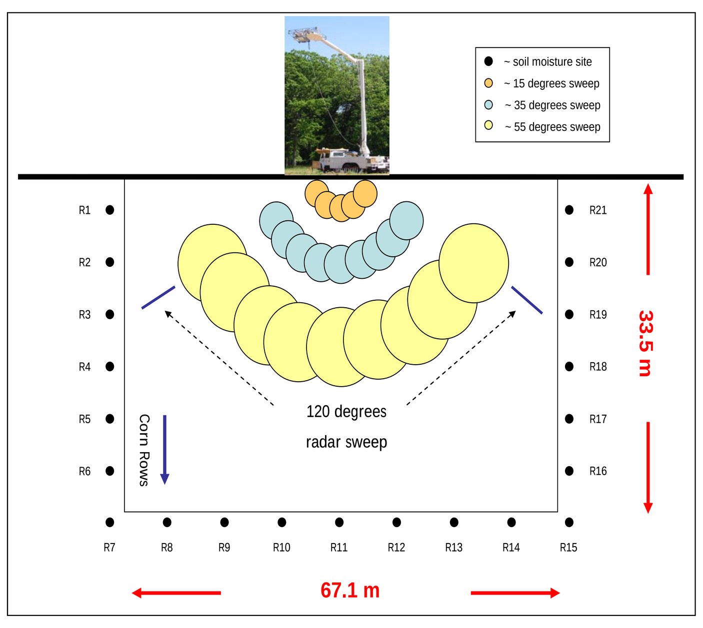
Dual-polarized L- (1.4 GHz) band radiometer (called: LRAD) designed to measure brightness temperatures from preset angular positions and at fixed time intervals.

Active microwave:

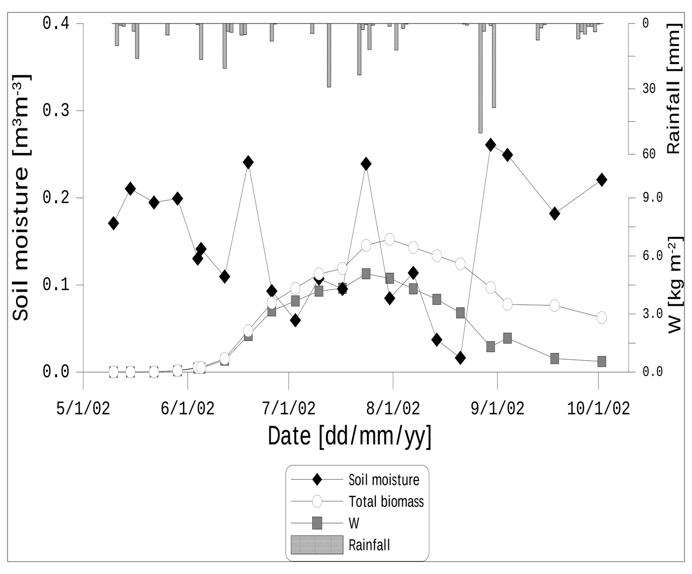
NASA-George Washington University truck mounted scatterometer was deployed to measure C- (4.75 GHz) and L- (1.6 GHz) band backscattering (now called ComRad).

Some characteristics:
Frequency: C- (4.75 GHz) and L- (1.4 GHz) band
Polarization: quad (HH, HV, VV and VH)
View angles: 15º, 35º, 55º
Accuracy: < 1.0 dB

•Radar operations were weekly
•Measurements were collected at four times (8h, 10h, 12h, 14h) of the day
•During each run 60 independent samples were collected within a 120º sweep



Land Surface conditions



C. Research method

1. Correction of the backscatter measurements for the corn effects using the method described in Joseph et al. (RSE 2010 and TGRS 2008).

→ **Bare soil backscatter coefficient**

2. Retrieve soil moisture using the Integral Equation Method (IEM, Fung et al. 1992) surface scattering model.

How to obtain the surface roughness parameters ??

IEM surface roughness parameters include:

- RMS height (s)
- Autocorrelation length (*l*)
- Autocorrelation length function (ACF)

Roughness estimation:

- In-situ measurements (see above)
- Calibration via minimizing difference measured and simulated/measured
  - Backscatter: Start growth cycle
  - Soil moisture: Entire growth cycle

Surface roughness parameterization is obtained through calibration by minimizing the difference between measured and,

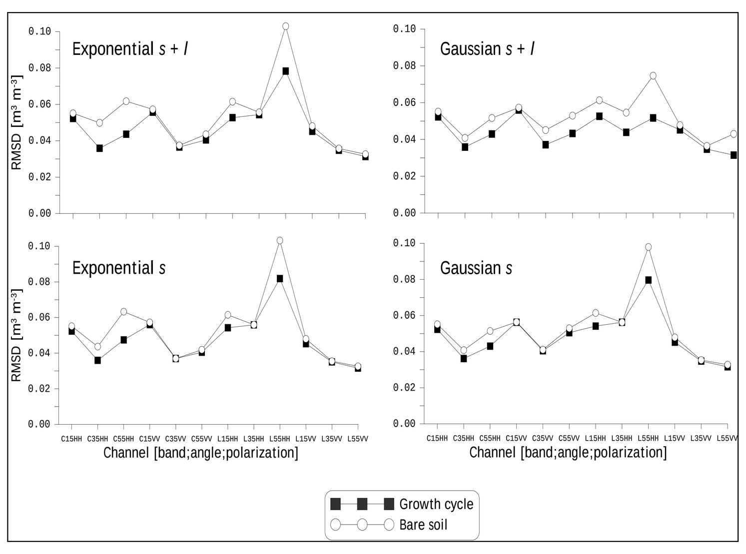
- Simulated backscatter at the start of the growing season (bare soil)
- Retrieved soil moisture for the entire growth cycle (growth cycle)

In addition, four parameterization types are selected for the calibration:

Parameterization	*s*	*l*	*ACF*
1	optimize	optimize	Exponential
2	optimize	Fixed	Exponential
3	optimize	optimize	Gaussian
4	optimize	Fixed	Gaussian

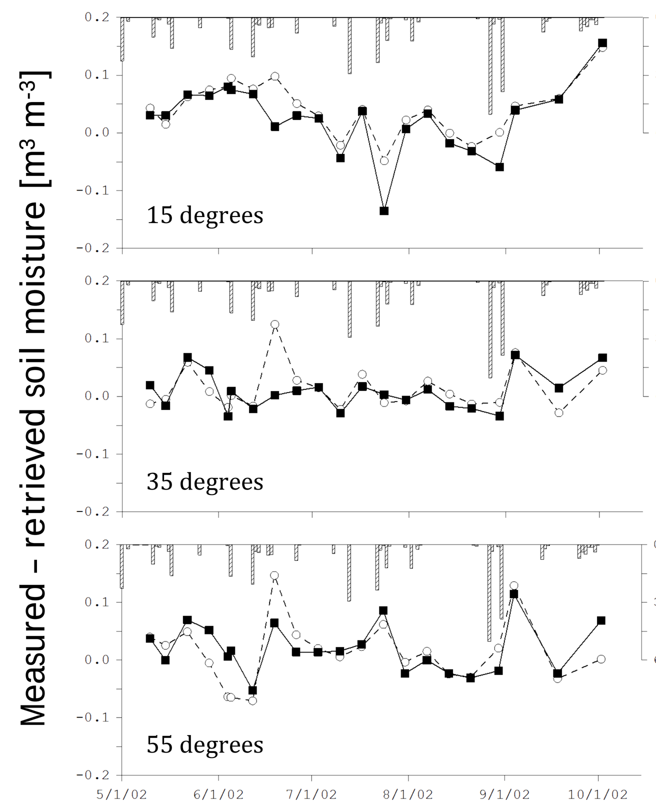
D. Results

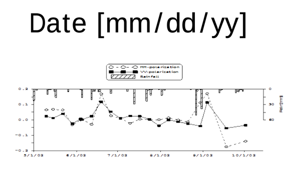
Analysis of Root Mean Squared Difference (RMSD) Measured/Retrieved Soil Moisture



In general, differences in the retrieval accuracy obtained with bare soil and growth cycle parameterizations are limited.

Analysis of derivations between daily measured and retrieval soil moisture





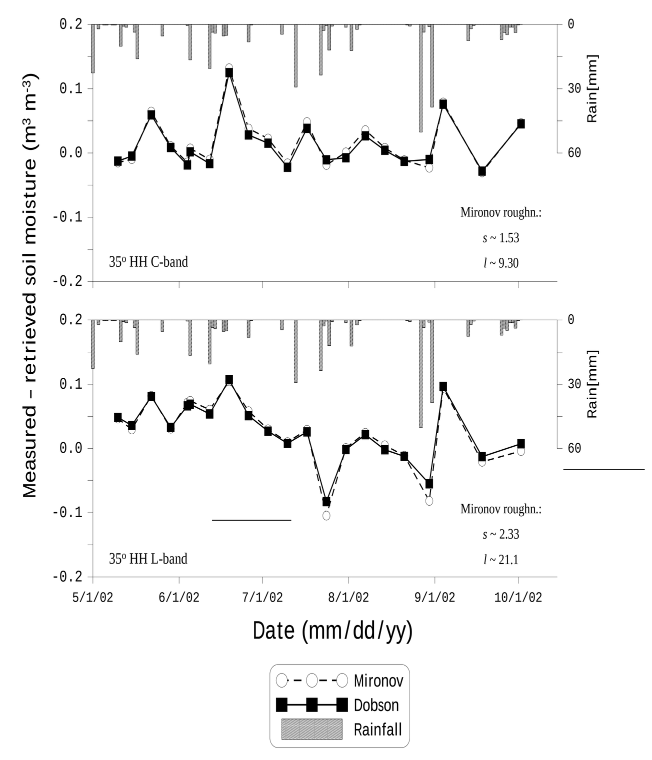
After rain events the difference between measurements and retrievals increase.

→ **Surface roughness change caused by weathering**

However, also:

- Vegetation correction approach is imperfect;
- Surface scattering component holds uncertainties (e.g. IEM model, dielectric mixing model).

Effect of the utilized mixing model



Little difference can be noted between the daily retrieval errors obtained with Mironov's and Dobson's dielectric mixing model.

E. Conclusions

•On the seasonal scale, the usage of surface roughness parameters estimated at the start of growth cycle introduces a minimal amount of uncertainty on radar-based soil moisture retrievals.
•With any type of surface roughness parameterization soil moisture can be estimated with similar levels of accuracy.
•For this field campaign, a higher soil moisture accuracy is obtained for the VV polarization than HH polarization.
•Higher soil moisture retrieval errors are noted after rain events, specifically for the HH polarization.

References:

A.K. Fung, Z. Li, K.S. Chen, (1992) "Backscattering from a randomly rough dielectric surface", *IEEE Transactions on Geoscience and Remote Sensing*, **30**, 356-369.
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