Temporal Stability of Surface Roughness Effects on Radar Based Soil Moisture Retrieval During the Corn Growth Cycle

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Abstract

A representative soil surface roughness parameterization needed for the retrieval of soil moisture from active microwave satellite observation is difficult to obtain through either in-situ measurements or remote sensing-based inversion techniques. Typically, for the retrieval of soil moisture, temporal variations in surface roughness are assumed to be negligible. Although previous investigations have suggested that this assumption might be reasonable for natural vegetation covers (Moran et al. 2002, Thoma et al. 2006), in-situ measurements over plowed agricultural fields (Callens et al. 2006) have shown that the soil surface roughness can change considerably over time. This paper reports on the temporal stability of surface roughness effects on radar observations and soil moisture retrieved from these radar observations collected once a week during a corn growth cycle (May 10th – October 2nd, 2002). The data set employed was collected during the Optimizing Production Inputs for Economic and Environmental Enhancement (OPE^3) field campaign covering this 2002 corn growth cycle and consists of dual-polarized (HH and VV) L-band (1.6 GHz) acquired at view angles of 15, 35, and 55 degrees. Cross-polarized L band radar data were also collected as part of this experiment, but are not used in the analysis reported on here.

After accounting for vegetation effects on radar observations, time-invariant optimum roughness parameters were determined using the Integral Equation Method (IEM) and radar observations acquired over bare soil and cropped conditions (the complete radar data set includes entire corn growth cycle). The optimum roughness parameters, soil moisture retrieval uncertainty, temporal distribution of retrieval errors and its relationship with the weather conditions (e.g. rainfall and wind speed) have been analyzed. It is shown that over the corn growth cycle, temporal roughness variations due to weathering by rain are responsible for almost 50% of soil moisture retrieval uncertainty depending on the sensing configuration. The effects of surface roughness variations are found to be smallest for observations acquired at a view angle of 55 degrees and HH polarization. A

possible explanation for this result is that at 55 degrees and HH polarization the effect of vertical surface height changes on the observed radar response are limited because the microwaves travel parallel to the incident plane and as a result will not interact directly with vertically oriented soil structures.

References:

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KEYWORDS: soil moisture, retrieval algorithms, radar, surface roughness