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Hydrology and Earth System Sciences Discussions

Interactive comment on "Relating surface backscatter response from TRMM Precipitation Radar to soil moisture: results over a semi-arid region" *by* H. Stephen et al.

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We have added Fig. 3 to further elaborate the relationships between Ku-band backscatter soil moisture and vegetation density. Similar to the Fig. 2, this figure shows the sensitivity of backscatter and its incidence angle response to soil moisture for three difference vegetation covers. Following text has been added to clarify the reviewers comment. **In order to further clarify the role of soil moisture in the σ° θ-response, Fig. 3 shows the σ° vs. θ plots and line fits for three soil moisture values over the three vegetation cover types. It is evident that the increase in soil moisture**

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Interactive Discussion

Discussion Paper

increases the backscatter and slope of the incidence angle response. This effect is more pronounced in the areas with low vegetation.

We use Least Squares Solution to estimate the values of the model parameters. Using several measurements, the model in its matrix form is inverted to compute a vector containing the values of the model parameters. The model inversion depends upon the availability of sufficient well spread and model-representative data. In our case, we find the model to be quiet well posed for most of the area. The description of the approach is further elaborated on page 11.

We have provided a brief comparison of our method with the temporal change detection approaches of Wagner et al., 1999 and Kim and van Zyl, 2009. **Wagner (1999) approach relates C-band low resolution backscatter (ERS scatterometer) to 40° incidence angle which in turn is linearly related to soil moisture, whereas we include the incidence angle dependence into the model. Kim and van Zyl (2009) have proposed a similar model of backscatter and soil moisture where copolarized backscatter (in dB) from L-band radar is linearly related to the volumetric soil moisture. In their model, the dependence on incidence angle is explicitly incorporated through a term that relates it to the surface roughness characteristics, whereas in our model the dependence on incidence angle is incorporated in the model empirically.**

We have added a paragraph describing the weaknesses and strengths of the proposed model, i.e., **The method has limited utility in areas that lack soil moisture data for calibration. Moreover, the calibration of the model is grid-point specific and thus for spatial mapping requires spatial maps of soil moisture from hydrological modeling. Nevertheless, the model has established the ability of TRMM Ku-band data over arid-regions for soil moisture retrieval.**

A discussion on the advantage of using TRMM Ku-band data is also added. **TRMM Ku-band data provides an opportunity to study backscatter relationship to soil**

moisture at moderate spatial resolution and low to moderate vegetation cover. TRMM has been observing tropical regions for a decade and can contribute in the understanding of global hydrology by providing moderate resolution soil moisture maps of the arid regions.

As mentioned in response to the second comment, the model inversion is performed using Least Squares Solution. In this method, known soil moisture data during a year is used to calibrate the model. The calibrated model is used to estimate soil moisture during the following year(s). Sufficient calibration data was available that kept the parameter estimation well-posed. We have added further details of the model parameter estimation in the text on page 11.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 6425, 2009.

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Interactive Comment

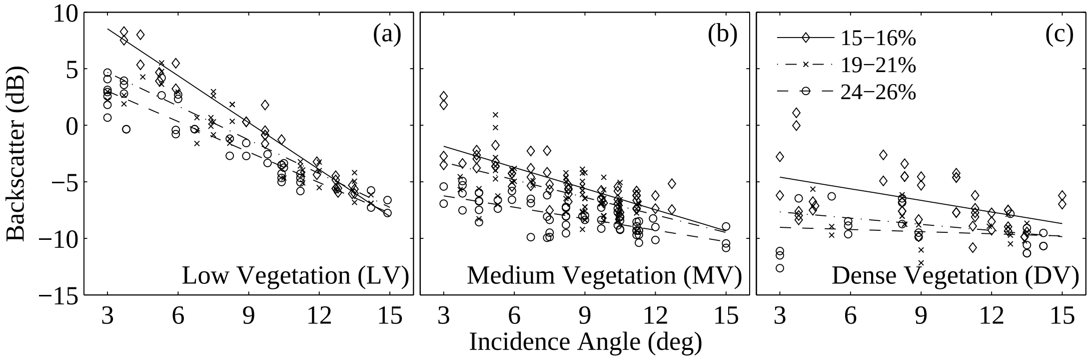

Fig. 1. Backscatter incidence angle dependence for three soil moisture ranges (15-16%, 19-21%, and 24-26%) and vegetation covers, i.e., (a) LV, (b) MV, and (c) DV.