The Compact Polarimetry alternative for Soil Moisture Estimation using SMAP

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Abstract

In this paper, we investigate the potential of the compact polarimetry mode at longer wavelengths from space for soil moisture estimation using SMAP data. Compact polarimetry consists of transmitting a single polarization while receiving two polarizations. At longer wavelengths, one of the main challenges associated with compact polarimetry from space is Faraday rotation estimation and correction. In an earlier paper, we developed an estimation procedure for Faraday rotation, which relies on the scattering properties of bare surfaces. The selection of the bare surfaces can be made based on a new parameter, the conformity coefficient computed from compact polarimetry measurements. This parameter is shown to be Faraday rotation invariant. Once estimated, the Faraday rotation can be corrected over the whole image. A simple approximation to σ oHH and σ oVV based on compact polarimetry measurements over bare soil surfaces is presented, from which soil moisture can be estimated using the Dubois et al. algorithm. The results obtained using compact polarimetry are shown to be in good agreement with those obtained from the standard Dubois et al. algorithm [1] using fully polarimetric data.

The case considered so far is the ideal one, in which the surface is vegetation-free. In the case of SMAP, algorithms are under consideration that are robust in the presence of low levels of vegetation cover. Two modes of polarimetry are being considered for SMAP operation: multi-pol and compact-pol. In the multi-pol mode, h- and v-pol transmits are made at different frequencies and the reception is made at three channels (hh, hv, and vv). Therefore there will be no correlation between the co-pol signal and also among the speckle noise of the three channels. In the compact-pol mode, the HHVV correlation exceeds 90% for smooth bare surfaces [2], which applies to both the signal and the speckle. This correlation of the co-pol signal will enhance the classification capability and should improve the soil moisture retrieval. Analysis shows that perfectly correlated speckle noise between σ_{hh} and σ_{vv} improves the soil moisture retrieval error for the bare soil by a factor of ~6.

This paper continues the analysis by [2] in the following aspects. First, the comparison of the soil moisture retrieval is made between the multi-pol and compact-pol modes. Second, the retrieval is performed in the presence of vegetation. Third, the retrieval is applied to simulated $\sigma 0$ over the contiguous United States domain. We will show that the compact-pol performs better than the multi-pol retrieval when the Vegetation Water Content (VWC) is less than ~3 kg/m^2.

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References

[1] P. Dubois, J. van Zyl and T. Engman, "Measuring Soil Moisture with Imaging Radars", IEEE Trans. Geosci. Remote Sens., vol. 33, no. 4, pp. 915-926, July 1995.

[2] J.J. van Zyl and E.G. Njoku, 2003: Evaluation of Dubois *et al.* Bare Surface Radar Soil Moisture Algorithm Inversion Errors when Scaling to Lower Resolution, Private memo prepared for HYDROS Project.