Soil Moisture and Path Loss Signal in Agricultural Soil with Remote Sensing

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Abstract

Using remote sensing to measure soil moisture can estimate how much water content the soil has. This can predict the weather forecast, erosion, runoff potential and crop yield forecasting. The project was done in a test box which was filled with agricultural soil. It was found that the higher the target water content the faster the path loss occurs. This suggests that stronger sensors should be tested to observe path loss in high water content soil.

Introduction

- Soil moisture is the amount of water contained in the soil
- A saturated soil is when the water content is at its maximum capacity, and if more water enters the soil it can collapse or turn into mud
- Water content of a soil (whether it is saturated or dry) is very important for agricultural purposes, floods, erosion, water quality and weather forecasting
- Soil moisture is part of the Earth system and it can dominate through evaporation from land (Seneviratne et al., 2010), primarily of the plants transpiration and land energy fluxes (Koster et al., 2004)
- Soil moisture can be measured with remote sensing, using antennas and satellites
- Remote sensing can measure soil moisture with electromagnetic spectrum and it has two methods: passive and active microwave remote sensing
- Microwave methods used to quantify soil moisture measure the contrast in dielectric properties of the dry soil and the water
- For passive microwave, a radiometer measures the strength of emissions from the land surface (Engman, 1991)
- Remote sensing is an excellent and helpful way to measure and estimates soil moisture but it has a lot of challenges and limitations (Seneviratne et al., 2010)
- Some of the factors that affect soil moisture measurements are soil texture, vegetation, land roughness, depth of measurement and instrument limitations with frequency of occurrence angle (Engman, 1991)
- The objective of this project is to measure the frequency of four different antennas for agricultural soil water content with increase in targets of 3%
- The agricultural soil comes from the Agricultural Farm of University of Vermont.

Materials/Methods

Fig. 1 Shows 4.8 GHz, 2.56 GHz FDR, 2.4 GHz and 1.2 GHz antennas.

Fig. 2 Represents the amplifier and the vectors network analyzers.

Laboratory measurements:
For each layer:
- Take a small sample of the soil before weigh-in
- Weigh the soil before placing in the box
- Level the soil in each layer
- Measure the soil moisture of each layer using antennas

Samples:
- The samples are from each layer of every water content target of the agricultural soil
- We considered the following water content target for the agricultural soil: 0, 3, 6, 9, 12, 15, 18, and 21%
- Determined the average of the water content of each target soil

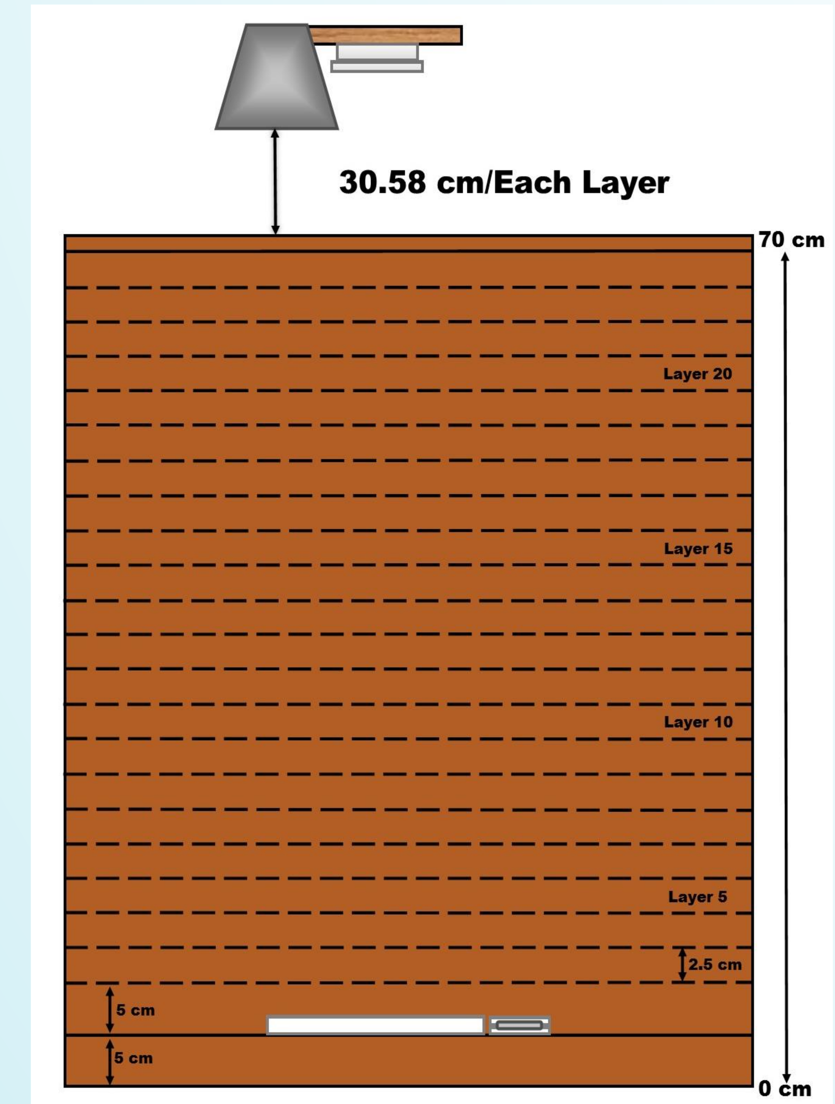

Fig. 3 Represents the test box filled with agricultural soil and the antennas buried at the second layer.

Results

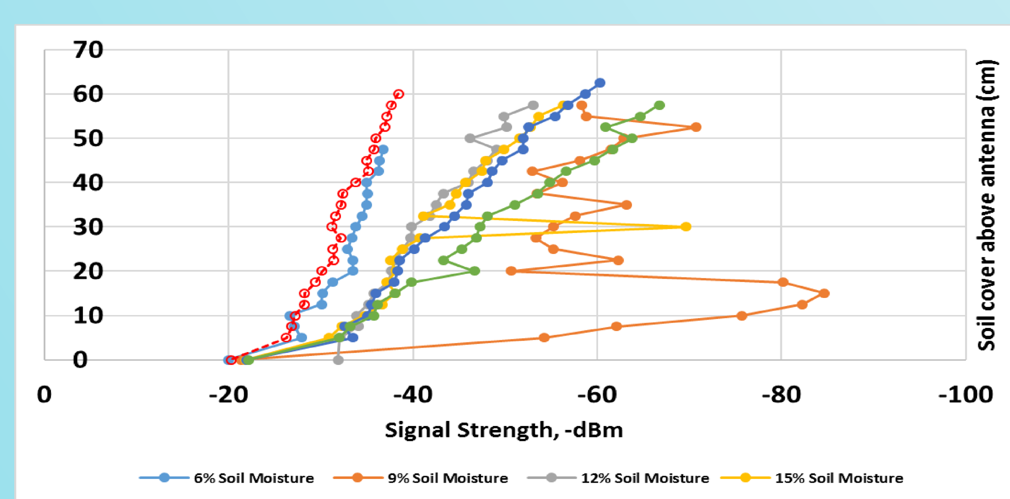

Fig. 4 Antenna 1.2 GHz signal in the agricultural soil

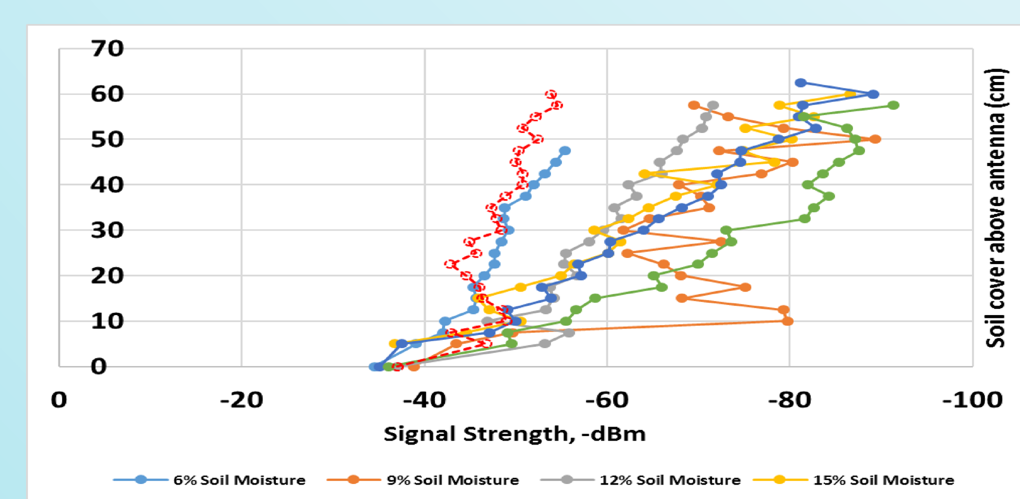

Fig. 5 Antenna 2.4 GHz signal in the agricultural soil

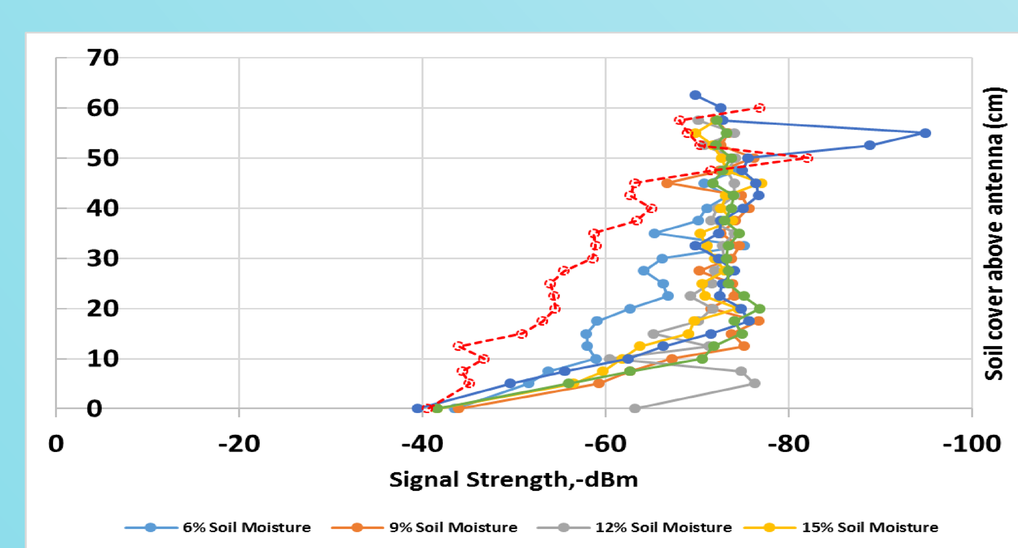

Fig. 6 Antenna 4.8 GHz signal in the agricultural soil

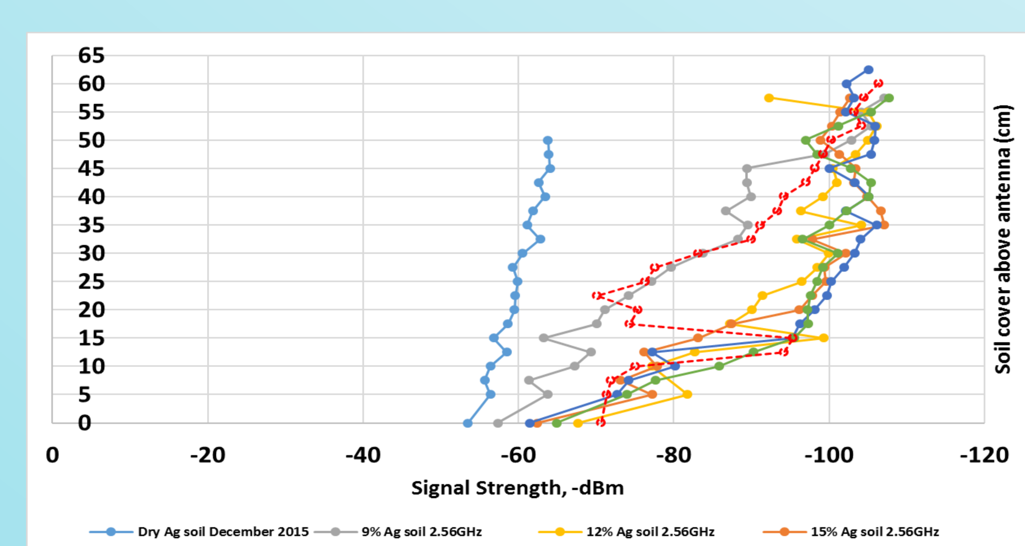

Fig. 7 Antenna 2.56 FDR signal in agricultural soil

Discussion/Conclusion

- The results of this study demonstrate that the higher the target water content the faster the path loss occurs
- The 1.2 GHz antenna signal in almost all targets is constant except the 9% target in which there is a difference between signals
- The 2.4 GHz antenna signal is constant in all targets. It can be noticed that the Dry Soil has a stronger signal than the 21% target
- The 4.8 GHz antenna, all targets are consistent of each other except for the Dry Soil which has a stronger signal
- Comparing the 2.56 FDR antenna signal from December 2015 and the summer of 2016 shows that they are neither similar nor consistent
- As the soil moisture increases, the dielectric constant can increase to a value of 20, or greater (Schmugge, 1983)
- This project helps to reduce erosion and predicts soil moisture in agricultural environment

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(MSFC) Marshall Space Flight Center. http://weather.msfc.nasa.gov/landprocess/. Accesed on July 22, 2016
(SMAP) Soil Moisture Active Passive http://smap.jpl.nasa.gov/mission/why-it-matters/. Accessed on July 22, 2016

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