URSI AP-RASC 2019, New Delhi, India; 09 - 15 March 2019

Evaluation of the Penetration Depth of L- and S-Band (NISAR mission) Microwave SAR Signals into Ground

Abhilash Singh*(1), Ganesh Kumar Meena(1), Shashi Kumar(2), and Kumar Gaurav(1)
(1) Indian Institute of Science Education and Research, Bhopal, India
(2) Indian Institute of Remote Sensing, ISRO, Dehradun, India

Microwave remote sensing has emerged as an efficient tool for the estimation of soil moisture due to its higher sensitivity to the dielectric properties of soil. Synthetic Aperture Radar (SAR) sensors have been used to estimate soil moisture at large scale. The penetration depth of microwave signals into the ground soil vary significantly with the available moisture content. It has been found that the longer wavelengths have a higher capability to penetrate soil, however, their penetration capability decreases with increasing dielectric behaviour of the soil. Moisture content in the soil increases the dielectric behaviour of soil.

Here we study the effect of soil texture, incidence angle and soil moisture content on the penetration depth of microwave pulses into ground. In doing so, we have compared the penetration depth of SAR signals in soil using the Dobson empirical [1], Dobson semi-empirical [2] and Hallikainen empirical model [3] over samples collected at three different locations in Bhopal, Madhya Pradesh, India. We observed all these models results into different penetration depth for the same set of soil parameters at same frequency. Further, we explored the potential of the proposed L- and S-band sensor of the upcoming NISAR mission for the estimation penetration depth in soil at different incident angles. According to the NISAR mission science user handbook, the frequency used for L- and S-band SAR systems are 1.25 GHz and 3.22 GHz respectively with variation in the incident angle of 33^0 to 47^0 respectively [4].

We observed the penetration depth of microwave signals into the ground decreases as moisture content in the soil sample, incident angle and frequency of SAR sensors increases. The maximum penetration depth is observed at nadir. The decrease in the soil penetration depth is significant for the first 10% increase in Volumetric Water Content (VWC). However, any further increase in moisture content has a reduced effect on soil penetration depth. The penetration depth is more in L-band SAR signal as compared with the S-band SAR signal. Finally, we conclude that the Dobson empirical model results into higher penetration depth whereas Dobson semi-empirical model into the lowest penetration depth.

References

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