Soil Moisture Retrieval using Indigenously Developed NavIC-GPS-SBAS Receiver: Initial Results

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Soil Moisture is very important parameter to study water and carbon cycles. Many earth observation satellite missions tried to estimate soil moisture using sensor data. However, *in-situ* measurements are essential to validate the measurements provided by satellite sensors. Global network of GNSS receivers can provide this *in-situ* dataset for validation of sensor data. GNSS satellites operate at the L-band microwave frequency between 1.2 to 1.6 GHz for constellations such as GPS [2]. NavIC is newly established regional constellation of 3 Geostationary (GEO) and 4 Geosynchronous (GSO) navigation satellites providing the data at L5 (1176.45 MGz) and S bands (2492.028 MHz). The present work reports the very first attempt of utilising indigenously developed NavIC-GPS-SBAS (NGS) user receiver to retrieve soil moisture. Surface soil moisture was retrieved based on multipath phase, directly affecting SNR measurements of the GNSS user receiver. As NavIC is operating with GEO and GSO satellites 24-hour data is available to provide continuous *in-situ* measurements for soil moisture.

Multipath reflections from the surface, results in the oscillating SNR at relatively low elevation angles below 30^o. SNR observations between 15^o to 27^o and between 5^o to 26^o elevation angles were selected for retrieval of soil moisture using NavIC L5 and GPS L1 signals; respectively; in the present study. Low-Order polynomial fitting approach was used to estimate multipath SNR from the composite (direct + reflected) SNR as measured by the NGS receiver. Least-Squares technique was developed to estimate multipath amplitude and multipath phase which were affected by the reflections due to surface soil moisture. The rate of change of multipath phase (Ψ) is directly proportional to rate of change of elevation angle (θ) and antenna height (h) above the surface. The estimated rate of change of multipath phase using developed technique was validated with theoretically calculated rate of change of multipath phase as given by equation (1) [1]. Significant correlation was observed between estimated and theoretically calculated rate of change of multipath phase.

$$\frac{d\Psi}{dt} = \frac{2\pi}{\lambda} 2h \cos\theta \frac{d\theta}{dt} \qquad (1)$$

In-situ observations for volumetric soil moisture (VSM) were collected at Space Applications Centre (SAC), Ahmedabad using soil moisture probe. Estimated multipath phase was linearly related with *in-situ* VSM. R^2 of 0.84 and 0.98 were observed between *in-situ* VSM and estimated multipath phase using NavIC L5 and GPS L1 signals; respectively. Thus, scaled soil wetness index was used to estimate volumetric soil moisture ($m^3.m^{-3}$) (figure 1) as a function of multipath phase [2].

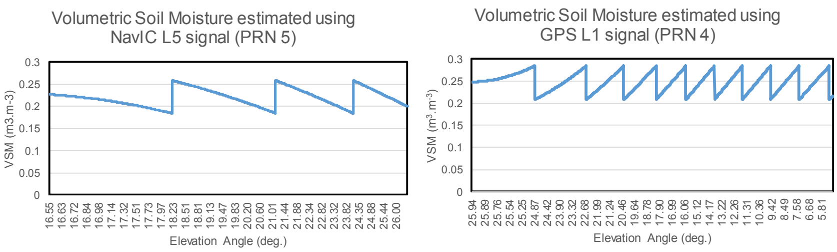

Figure 1: VSM estimated using NavIC L5 and GPS L1 signals

The present study, thus has set up the platform for using NavIC signals for retrieval of surface soil moisture. The study can be further extended for different kinds of soil-surfaces. The results of the present study are thus encouraging for various reflectometry applications using newly established NavIC signals.

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