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SNR-based GNSS multipath reflectometry for soil moisture retrieval –Demonstration and assessment in three continents and over multiple years

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Global navigation satellite system multipath reflectometry (GNSS-MR) has emerged based on the exploitation of signals of opportunity at L-band. GNSS-MR benefits from the short-delay near-grazing incidence multipath that is within the modulation code length. The simultaneous reception of the direct and coherently reflected signals causes constructive and destructive interference fringes as the reflection geometry changes. Oscillations in signal-to-noise ratio (SNR) data have been used in GNSS-MR to estimate near-surface soil moisture. The phase of the interference fringes is related to the GNSS antenna patterns, surface roughness, and Fresnel reflection coefficients. As the soil moisture content is a function of soil permittivity, its variations affect the modulation frequency of the SNR oscillations. In this contribution, a physically-based forward and statistically-rigorous inverse model is used to model coupled surface/antenna properties on SNR phase shift retrievals. The forward/inverse modeling of SNR-based GNSS-MR is then used to assess the accuracy and precision of different GNSS soil moisture retrieval methods for multiple years at three sites: in Luxembourg, in South Africa, and in the U.S. Both GPS and GLONASS SNR were processed. Finally, a new method is developed to retrieve SNR phase shift and phase chirp for soil moisture applications. Results indicate that the new algorithm can successfully retrieve near-surface soil moisture with correlation around 0.9 and an RMS error of less than 0.04 cm3/cm3.