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GNSS-R for detection of soil moisture and effective height changes using SNR phase unwrapping method: study case of Dahra (Senegal)

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Around 70 percent of worldwide freshwater is used by by anthropogenic activities (e.g. agriculture, agrifood industry). In these circumstances, water demand is expected to tremendously increase in the next decades. In an effort to optimize water resource management, it is crucial to improve soil moisture situation awareness. Records from classical humidity probes are punctual and are not representative, at a local scale, of the soil moisture of an entire parcel, this was less true on a broader, more global scale. With the remote sensing advent, soil moisture is systematically monitored at the global scale but at the expense of the temporal and/or spatial resolution. Even with the SMOS satellite mission, the repetitiveness of the measurements is three days, which is not sufficient to monitor diurnal variations. Recent studies suggested to take advantage of continuously emitted waves by the GNSS constellations, to retrieve soil moisture. This opportunistic remote sensing technique, known as GNSS reflectometry (GNSS-R), consists in comparing the interference of reflected waves by the ground and those which come directly from satellites. It offers a wide range of applications in Earth sciences and particularly in soil moisture monitoring, have shown their efficiency on soil with high clay content. It namely presents the advantage of sensing a whole surface around the antenna. Our study are focused on a study case located near Dahra (Kolda region, Senegal). This zone shows very substantial differences compared to the usual sites: less rainfall with few hundred millimeters during the rainfall season (June-October), huge temperature (20°-45°C) conducive to a strong evaporation during dry season and soils having a high sand content. We demonstrate that, in this case, L wave penetrate deep into the ground during dry period and strongly reduce the interest of GNSS-R moisture measurements. But, thankfully, using phase unwrapping method, it is possible to retrieve a correct and efficient measurement of the soil moisture and obtain a very good temporal monitoring for a spatial resolution directly correlated to the antenna height.