Use of GNSS-R for soil moisture monitoring

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Seventy percent of worldwide freshwater is used by by anthropogenic activities (e.g. agriculture, agrifood industry). In these circumstances, water demand is expected to 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 [1], the repetitivity 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 and direct waves. It is particularly suited for soil moisture monitoring, have shown their efficiency on soil with high clay content, on the Lamasquere experiment where we conduct our first study. GNSS-R presents the advantage of sensing a whole surface around the antenna ([2], [3]). Our second study are focused on Dahra area (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, Radar waves penetrate deeply into the ground during dry period and using phase unwrapping technics 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 depending on the antenna height.

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