Soil moisture monitoring over wetland areas using GNSS signals

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For many scientists, climate warming induces an increases in evaporation and precipitation leading to an acceleration of the water cycle. Soil moisture is a key parameter to study the water cycle variations. At global scale it controls the exchange of water and heat between the land surface and the atmosphere through plant evapotranspiration. At local/regional scale is also a relevant parameter. Well knowledge of the soil moisture is of paramount importance for ecological processes, agriculture applications even more considering that is expected an increase of a 45% in the water demands. Therefore, its knowledge will be essential to optimize the use of the fresh water, which in turn will allow to distribute it better, and to improve the quantity and quality of the crop production. In addition, soil moisture, can be useful to predict when excess rainfall can cause water logging and/or flooding instead, it also useful to prevent droughts.

Missions like SMOS (radiometer at L-Band) from ESA, or SMAP (radiometer and radar at L-Band) from NASA, are dedicated missions focused on the retrieval of the soil moisture. Unfortunately, the current spatial resolution offered for that missions (40 and 10 kms respectively) are more suitable for global applications, than for local applications.

Recently the GNSS-R signals have been used for monitoring soil moisture. As other remote sensing techniques (e.g. radiometry), GNSS-R is based on the variability of the soil's dielectric properties with the ground water content. Therefore, the GNSS reflected signals will present changes as a function of the soil moisture. In the same way, flooded areas can also be detected, measuring in this case 100 percent of water saturation content (very high values of reflectivity). An example of the sensitivity of the GNSS-R signals to soil parameters, can be found in [1], where significant variations in the measured reflection coefficients were related to different soil moisture content, and vegetation conditions. Results obtained on [1] (Leimon project), were confirmed on the GRASS project, were several experimental campaigns were carried out over an agricultural area in the vicinity of Florence.

In this work is proposed to integrate a GNSS-R sensor on a dedicated RPAS platform. One of the main advantages of this technique with respect others techniques (e.g L-band radars), is that it is cheaper and lighter, allowing to embend it onboard of a RPAS, which is of high interest for agriculture applications and river management (flooded area mapping), since it is very flexible and require fewer energetic resources compared with other techniques.

During summer 2015, two experimental campaigns (Mistrale Project) have been carried out to validate the data processing concept. In those campaigns a complete GNSS-R sensor was

installed on an ultralight aircraft, allowing gathering polarimetric GNSS-R data. The flights were done in France over the Camargue area (flooded areas, marshlands and water salinity changes), and Pech Rouge area (agricultural plots). In addition, in-situ measurements using SNR analysis [2] have been acquired as ancillary information, serving as a ground truth.

The estimated reflection coefficients acquired during the flights, have been computed and geo-referenced on ground, showing that the reflection coefficients are sensible to terrain changes. Main results obtained during these experiments, will be presented during the conference.

Keywords: Agriculture, Floods, Soil moisture, Biomass

Satellites: Future Missions.

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