MISTRALE: OPERATIONAL SOIL MOISTURE MONITORING SERVICE BASED ON GNSS SIGNALS

Antonio Mollfulleda[1], Francisco Martín[1], José Darrozes[2], Olivier Desenfans[3], César Roda[3], Laura Van de Vyvere[3]

[1]Starlab Limited, Building R103 Room 1-11, Harwell Campus, Didcot OX11 0QX, Antonio.mollfulleda@starlab-int.com, Francisco.martin@starlba-int.com.

[2]GET, 14, avenue Édouard Belin, 31400 Toulouse, jose.darrozes@get.obs-mip.fr

[3]M3 systems, Chermin du Stocquoy 1, 1300 Wavre, Belgium, desenfans@m3systems.eu, rodaneve@m3systems.eu, vandevyvere@m3systems.eu.

SUMMARY

MISTRALE project (**M**onitoring so**I**l moi**S**ture and wa**T**e**R**) is envisaged to provide RPAS-based soil moisture maps at high spatial resolution. MISTRALE is based on the so-called GNSS-R technique, where the GNSS signals scattered-off from the surface are used to infer the soil moisture. In this work, it is proposed to combine GNSS signals with data provided by a geodetic GPS receiver, and a VIS/IR sensor.

ABSTRACT

MISTRALE's concept consists on embed a GNSS-R sensor on a 'Remotely Piloted Aircraft System' (RPAS) platform (i.e. a fixed-wing airborne vehicle weighting less than 20 kg), which allows payloads of about 5 kg, with a 10-hour fly autonomy (i.e. 1000 km range). The GNSS-R sensor has been designed for the on-board real-time processing of the received GNSS signals (both direct and reflected), generating the so-called cross-correlations products on-real time, as Level L1 data. In the frame of MISTRALE project a service chain has been developed to upload the L1 data and process the data, jointly with the geodetic information to extract the L2 product. High soil moisture maps (10x10 meters), will be achieve flying at100m, with a speed of 20 m/s, and with a 50% overlap between consecutive tracks.

Flights conducted over France from 2015, were used to prove the feasibility of MISTRALE's concept. In those flights, the GNSS-R acquisitions were combined with the ones provided by a geodetic GPS receivers. Additional campaigns carried out along 2017 also use VIS/NIR and a thermal sensor (in addition to the GNSS-R receiver and the geodetic receiver), to provide more robust results improving the spatial resolution.

The GNSS-R sensor compares the received direct signal against the one reflected from the surface, providing the apparent reflectivity of the surface under observation. The apparent reflectivity is related to the dielectric properties of the soil, and thus to the soil moisture (because of the strong dependency of the dielectric constant with soil moisture at L-band).

The geodetic GPS receiver extracts the soil moisture content from the raw SNR data collected. SNR is related to the addition of the direct and reflected GNSS signals in the receiving antenna. Initially, SNR is mainly driven by the direct signal. However, the reflected signal noise, modifies the SNR, producing temporal fluctuations, with an amplitude A, and phase ∅, that can be correlated to the soil moisture.

The VIS/NIR sensor is used to derive the NDVI, which provides an initial estimation of the vegetation, and thus allows to account its impact in the apparent reflectivity (that is attenuated by the vegetation). The surface temperature is used to improve the dielectric constant computation, which along with the soil moisture also depends on the soil composition, and on the soil temperature. In addition, the VIS/NIR information and the thermal information are combined to estimate the soil moisture based on the relationship between the land surface energy fluxes and the surface soil moisture.

Main results, and technical aspects related with the experimental campaigns will be presented at the conference.