ALTIMETRY STUDY PERFORMED USING AN AIRBORNE GNSS-REFLECTOMETER

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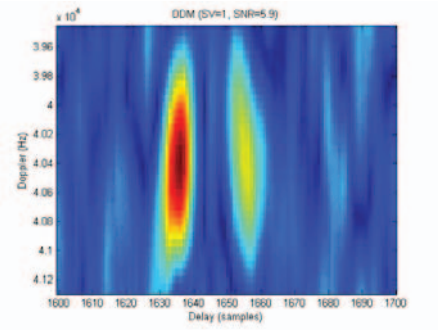
The Global Navigation Satellite Signals Reflections (GNSS-R) techniques have been widely used for remote sensing purposes retrieving geophysical parameters over different types of surfaces. Over the ocean, altimetry [1-3] or sea state [4, 5] can be retrieved. Over land, soil moisture [6-8] can be inferred and over ice, altimetry and ice age [9] are also retrieved. This paper presents the results of using GNSS-R techniques to retrieve altimetry from the measurements of an airborne reflectometer.

The first part of this work focuses on the theoretical aspects of applying GNSS-R techniques to measure simultaneously the direct and the reflected signals using a RHCP uplooking antenna and a LHCP downlooking antenna. The two signals are combined into a single one, which is correlated with a local replica of the PRN code, to compute the Delay-Doppler Map (DDM) [10]. This DDM has two peaks. In order to visualize them, the radio control aircraft must fly high enough to separate in delay samples the reflected signal from the direct signal, avoiding that the direct signal masks the less intense reflected signal.

As a test of this concept a campaign took place over Ripollet, Spain in June 2009. Figure 1 shows the field experiment performed.

(a)



(b)

Figure 1. Field experiment performed over Ripollet, Spain. (a) The reflectometer onboard a radio control aircraft taking off, and (b) sample DDM obtained processing the measurements. The sample DDM peak difference is 21 delay samples that considering the instrument sampling frequency (8183.8 KHz) corresponds to 385 m instrument height.

The retrieved height is obtained as half the difference between the two maxima in Fig. 1b expressed in meters. Using the reflectometer measurements the estimated height was 384,9 m, while the value provided by the navigation system of the aircraft was 379,1 m. The retrieval error was 5.8 m, well below the expected vertical error (1 chip = 300 m, $1\,\text{sample} = \frac{1.023\ \text{Mchips/seg}}{8.184\ \text{MHz}} = 0.125\ \text{chips} = 37.5\ \text{m}$).

The second part of this work describes the performance of the reflectometer, which is mainly composed of two antennas, one antenna for the direct signal and one antenna for the reflected signal. These two antennas are combined and measured using the SiGe GN3s sampler, developed by GNSS at the Colorado Center for Astrodynamics Research (CCAR) [11] and SiGe Semiconductor enterprise [12]. The raw GPS data is collected using an USB interface and processed using a radio front-end, which saves it into a binary file in the on-board computer.

The third part of this work will present the measurement field campaigns that will take place during the spring 2010. The measurements will be processed and all theory developed will be applied to perform the altimetry observations.

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