IMPACT OF RECEIVER'S FREQUENCY RESPONSE IN GNSS REFLECTOMETERS

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Global Navigation Satellite System's (GNSS) opportunity signals reflected over the surface of the Earth can be used for altimetry [1, 2] or sea state determination [3-8], among several other applications. GPS signals scattered over the surface of the Earth have already been collected from space [9, 10] showing the potential of this technique. However, the signal-to-noise ratio (SNR) of the scattered GPS signal is so poor, that it requires a coherent integration (typically 1 ms for the coarse/acquisition or C/A code to avoid the phase reversal of the navigation bit), followed by a large number of incoherent integrations (on the order of 200-1000 for space-borne applications over the ocean).

So far, this integration relies on the cross-correlation of the received signal with a local replica of the transmitted signal, shifted in frequency (Δf_d) and in delay (τ). However, since the restricted codes of the transmitted signals are not available and they will probably not, it is not possible to achieve the full potential (bandwidth) of these signals. In order to overcome this problem, a solution was devised in [11] that consists of cross-correlating the direct and reflected signals among them. However, to improve the SNR high gain antennas are required and they must be steerable so as to point to the direct satellite and to the specular reflection point.

Either if the GNSS-reflectometer topology is based on the cross-correlation with a local replica of the transmitted signal as in [1,12], or it is based on the cross-correlation of the direct and reflected signals as in [11], an active array is needed at least for the down-looking antenna.

Differences between the receivers' frequency responses, including the complex weights that are assigned to each receiver to steer the beam in a given direction, impact the overall frequency response, and how it may distort the ideal observables, that would be measured by a reflectometer with just two elementary isotropic antennas. These observables can be either the waveform (cross-correlation vs. τ, at $\Delta f_d = 0$), or the full Delay Doppler Map or DDM (cross-correlation vs. τ, at a number of Δf_d 's around the maximum of the DDM) [13].

This work will present the analytical computation of the GNSS reflectometer observables in the above conditions and will compare them to the ideal ones, so as to be able to properly specify the receivers' frequency response.

Examples will be provided showing the distorsion of the observables and the receiver specifications to satisfy the accuracy requirements both for altimetric measurements and sea state determination.

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