

# TOPOGRAPHY RETRIEVAL USING GNSS-R TECHNIQUES

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## 1. INTRODUCTION

Nowadays, GNSS-R techniques are being used in many remote sensing applications, as altimetry and sea state retrievals over the ocean [1-4], soil moisture retrievals over the land [5-6], and ice age or altimetry retrievals over the ice [7]. This work describes how this technique can be used to perform surface topography measurements over land.

## 2. THEORETICAL ASPECTS

The GPS Interference Pattern (IP) Technique [8] has been applied to soil moisture retrievals. Actually, since the GPS IP Technique is sensitive to phase differences, they are sensitive to topography as well. The principle is based on the idea of a mobile transmitter and a static receiver, whose positions are perfectly known. The signals sent by the transmitter, in this case a GPS satellite, are measured by a GPS receiver located at certain height over the surface whose antenna is pointing to the horizon and measures the interference between the direct and the reflected signals over the surface. A topography map can then be computed after the passage of several satellites on different orbits. The theoretical background is first described.

## 3. EXPERIMENTAL RESULTS

Secondly, the data from a field experiment carried out in Palau d'Anglesola (Lleida, Spain) [8] (fig. 1) from February to October 2008, has been used to derive the gentle topography of the field, in which a side is higher than the other so that water falls from the source point in one side to the other side where the excess water is collected.



Figure 1. The IP-GPS-R measuring at Palau d'Anglesola, Lleida (Spain).

## 4. CONCLUSIONS

The topographic results achieved will be compared to real topographic profiles of the field, extracting conclusions about the use of the Interference Pattern technique to retrieve topographic profiles. Furthermore, a study of the effect of the variables influencing the retrieval will be presented. Topographic maps will be correlated with the soil moisture maps obtained during the same field campaign [8], proving that—as expected—the lower parts corresponds to the higher soil moisture values.

## 5. REFERENCES

- [1] Font, J., G. Lagerloef, D. LeVine, A. Camps, and O.Z. Zanife, "The Determination of Surface Salinity with the European SMOS Space Mission," *IEEE Transactions on Geoscience and Remote Sensing*, vol.42, no.10, pp. 2196-2205, October 2004.
- [2] M. Martín-Neira, "A Passive Reflectometry and Interferometry System (PARIS): Application to Ocean Altimetry." *ESA Journal*, vol. 17. pp 331-355, 1993.
- [3] J.F. Marchan-Hernandez, N. Rodríguez-Álvarez, A. Camps, X. Bosch-Lluis, I. Ramos-Perez, E. Valencia, "Correction of the Sea State Impact in the L-band Brightness Temperature by Means of Delay-Doppler Maps of Global Navigation Satellite Signals Reflected over the Sea Surface," *IEEE Transactions on Geoscience and Remote Sensing*, October 2008.
- [4] M. Belmonte Rivas; M. Martin-Neira, "Coherent GPS Reflections From the Sea Surface, Coherent GPS Reflections From the Sea Surface," *IEEE Geoscience and Remote Sensing Letters*: (in press), DOI 10.1109/LGRS.2005.855617.
- [5] D. Masters , "Surface Remote Sensing Applications of GNSS Bistatic Radar: Soil Moisture and Aircraft Altimetry," *PhD dissertation*, University of Colorado, 2004.
- [6] D. Masters, V. Zavorotny, S. Katzberg and W. Emery, "GPS signal scattering from land for moisture content determination," *Proceedings of the International Geoscience and Remote Sensing Symposium 2000*, vol.7 pp. 3090-3092, Honolulu, USA.
- [7] A. Komjathy, J. Maslanik, V. Zavorotny, P. Axelrad and S. Katzberg, "Sea Ice Remote Sensing Using Surface Reflected GPS Signals," *Proceedings of the International Geoscience and Remote Sensing Symposium 2000*, Honolulu, USA.
- [8] N. Rodríguez-Álvarez, J.F. Marchán, A. Camps, E. Valencia, X. Bosch-Lluis, I. Ramos-Pérez, J.M.Nieto, "Soil Moisture Retrieval Using GNSS-R Techniques: Measurement Campaign In A Wheat Field" *International Geoscience and Remote Sensing Symposium 2008*, IGARSS 2008.