IAF EARTH OBSERVATION SYMPOSIUM (B1)
Mitigating the Climate Crisis from Space (6)

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CONCEPT, SET-UP, AND PLANNED DATA ANALYSIS OF A LOW-COST SOFTWARE DEFINED RECEIVER FOR BALLOON-BORNE GNSS RADIO OCCULTATION: ROMULUS EXPERIMENT

Abstract

The increase of anomalous and severe atmospheric phenomena due to climate change requires the improvement of atmospheric sensing techniques employed for weather forecasting and climate monitoring. Consequently, in recent years the request for daily atmospheric measurements has been widely raised. In this scenario, performing GNSS Radio Occultation (GNSS-RO) measurements from a stratospheric balloon using Software Defined Receivers (SDRs) could demonstrate a flexible and low-cost solution to this issue. The balloon-borne configuration offers the opportunity to increase the density of RO soundings in specific areas of interest, augmenting the number of daily profiles to be assimilated in Numerical Weather Prediction models and regional climatological monitoring. In addition, the choice of using SDRs allows to

store all the raw GNSS signals recorded during the flight and to process them later with different tracking algorithms. ROMULUS' goal is to test this technology with a small-scale payload designed and developed by a team of students from the S5Lab at Sapienza University of Rome. This solution could be then adapted to a CubeSat module which will be flown in Low Earth Orbit. As a matter of fact, integrating balloon-borne soundings with measurements made from constellations of nanosatellites could strongly intensify global coverage of GNSS-RO data. ROMULUS' setup features Commercial Off-The-Shelf components which will be used to equip the experiment with three software defined Radio Frequency chains, two on-board computers and a multi-frequency GNSS receiver. The experiment will acquire, down-convert and digitize signals from low elevation GNSS satellites and then compute the related GNSS observables and its positioning to obtain RO measurements. In addition to the widely used GPS signals in L1 and L2 bands, ROMULUS will also acquire and process signals from GPS in L5 band and Galileo in E5a band to assess their effectiveness for RO operations in the stratosphere. In fact, the higher power of these signals and the increased length of their Pseudo-Random Noise codes suggest a more stable and effective tracking. The project has been selected for the 14th cycle of the REXUS/BEXUS Programme and will be designed, developed, tested and flown by a student team supported by the space agencies organizing the Programme. ROMULUS will be launched on-board the BEXUS 32 stratospheric balloon in October 2022, from the Esrange Space Center in Kiruna (Sweden). This paper will deal with the ROMULUS experiment, providing a description of its concept and set-up, structure, data analysis plan and simulations and expected experimental results.