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## Single-frequency GNSS-IR for estimating snowpack height with consumer grade receivers and antennas

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Ground and space based GNSS-IR (Interferometric Reflectometry) has been used in the last 20 years for characterizing the Earth Surface, together with other remote sensing techniques. Among the physical quantities which can be monitored using these techniques, the characterization of the snow cover is of particular interest since it is an important source of freshwater. The increase of the global temperature due to anthropogenic climate changes is threatening the seasonal recharging, and for this reason monitoring the snow cover is crucial. Ground based GNSS-IR can be used for obtaining information on the height of the snowpack, with a precision of 0.04 m by using geodetic-grade GNSS instruments (such those involved in Continuously Operating Reference Stations - CORS). In the present study, the sensitivity of the retrieval of the snowpack height from data acquired with low cost non-geodetic grade instruments with the GNSS-IR technique is evaluated. The analysis is applied to a flat alpine area in the Lavarone plateau in the Province of Trento, Italy (1400 m above sea level), where GNSS field campaigns were carried out in 2018, 2019 for short time periods (90, 120 minutes) due to constraints of the study area. Single-frequency GPS observations were collected with u-blox M8T GNSS receivers and patch u-blox and Tallysman antennas. Leica antenna and receiver were also used for collecting GPS data in double frequency, in order to acquire reference data with geodetic grade instruments. Given the characteristics of the area, it is possible to consider that GPS signals reflect with specular reflection, and thus modelling the Signal to Noise Ratio (SNR) as a function of the distance between the reflecting snow surface above solid ground and the antenna. Multipath frequency associated with snowpack height is retrieved by applying the Lomb Scargle Periodogram on SNR data. The results show that, by applying GNSS-IR technique to data acquired with low-cost receivers and antennas, it is possible to retrieve the height of the snow pack with a standard deviation of about 0.05 m. This demonstrates the feasibility of GNSS-IR also with non-geodetic grade instruments.