

GNSS Meteorology and Soil Moisture Determination

Reflected GNSS signals, also called multipath, are unwanted effect for GNSS positioning. But these signals provide opportunities to estimate properties of the reflective surfaces. For ground-based GNSS stations these surfaces can be buildings, soils or water in rivers, lakes or seas. This research is focused on the surface properties of soils and open ground. Thus the reflected signals carry information about soil moisture, as well as about the water content in vegetation.

Of the shelf GNSS receivers produce RINEX files, where not only the time from the satellite to the receiver is recorded, but also the signal-to-noise ratio, or SNR. Several different effects are contained within the SNR data. If plotted against elevation angle, SNR presents the power of the GNSS signal, received at the station against elevation as a second order polynomial with maximum at the closest angles to zenith. At the lowest angles an interference pattern can be observed between the direct and reflected signals. These are caused by the change in superposition, in which at some angles the signals cancel themselves, while at others they amplify. From the phase changes of these interference patterns in time, the surface properties, such as soil moisture and vegetation can be retrieved.

This method was proposed in 2008 (Larson et al. 2008) and since than it has been used for monitoring of some more than 100 GNSS permanent stations in the US. This technique is now for the first time being applied in Germany in several experimental stations. Station Marquardt was specifically set for soil moisture measurements with various techniques. Thus the GNSS results are verified in a controlled environment with Time Domain Reflectometry (TDR) and sporadic Gravimetric measurements.

References:

Larson, Kristine M., et al. "Use of GPS receivers as a soil moisture network for water cycle studies." *Geophysical Research Letters* 35.24 (2008).