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Multi-system, multi-signal GNSS-reflectometry for sea level observations

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Information on sea level and its changes are important in connection to global change processes. For centuries sea level has been observed with coastal tide gauges and since some decades with satellite altimetry. Furthermore, during recent years also the application of GNSS-reflectometry for sea level observations has been developed. Various methods exist, using ground-based, airborne and space-borne systems, and using different analysis methods. We present results from a dedicated GNSS-based tide gauge installed at the Onsala Space Observatory at the Swedish west coast. This installation consists of two sets of commercially-off-the-shelf GNSS equipment, including geodetic-type choke-ring antennae and geodetic-type receivers. The two antennae are mounted on a beam extending in southward direction over the coastline. The antennae are aligned along the local vertical with one antenna facing toward zenith direction and the other facing toward nadir. The zenith-looking antenna is Right-Hand-Circular-Polarised (RHCP) while the nadir-looking antenna is Left-Hand-Circular-Polarised (LHCP). The zenith-looking antenna receives predominantly the direct RHCP satellite signals, while the nadir-looking antenna receives predominantly signals that are reflected off the sea surface and thus have changed polarisation to LHCP in the reflection process. The GNSS-receivers are connected to one antenna each and individually record multi-frequency signals of several GNSS. The recorded data can be analysed in different ways to derive information on the sea level and its variation. For example, data from both receivers can be analysed together applying geodetic-type phase-delay analysis with a single-difference and/or double-difference strategy. These analysis methods determine the baseline between the two antennae, which is proportional to the height of the installation above the sea surface. Another analysis method exploits the multipath oscillations in the recorded Signal-to-Noise Ratio (SNR) data observed with the zenith-looking antenna/receiver to determine the distance between the sea surface and the antenna. The different approaches have advantages and disadvantages, and they can be combined with standard positioning of the zenith-looking antenna to give absolute sea level information. In the presentation we describe the installation, the analysis methods and present the corresponding results. The focus is in particular on GPS and GLONASS observations in both L-band frequency bands, and the result obtained are from the different analysis approaches are compared with independently derived sea level observations from a co-located traditional tide gauge. Our results show that GPS and GLONASS phase-delay analysis method using signals in the L1 and L2 frequency bands gives a root-mean-square (RMS) agreement on the order of 3-4 cm when compared to independently observed sea level data. The corresponding results derived from the SNR-analysis method are worse by a factor of about 1.5 and 3 for the L1 and L2 frequency bands, respectively. However, the SNR-method appears to have advantages in conditions of high sea surface roughness.

References:

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