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GLONASS-R: Direct correlation GNSS reflectometry by means of software defined radio

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Global Navigation Satellite System (GNSS) applications usually process the received satellite signals to determine position, velocity or time of the receiver, derive information about the atmosphere or ionosphere or serve other geodetic/geophysical purposes. However, the information from reflected signals can become a valuable data source, from which (geo-) physical properties can be deduced. This approach, called GNSS-Reflectometry (GNSS-R), can be used to develop instruments that act as an altimeter when arrival times of direct and reflected signals are compared. Current GNSS-R systems usually normally rely on signals from the Global Positioning Service (GPS) and provide and altimetric accuracy of a few centimeters. Hobiger et al. (2014) have demonstrated that the usage of the Russian GLONASS system, which has not been considered so far, has the potential to simplify the processing scheme and allows direct correlation of direct and reflected signals like a bi-static radar. Such a GLONASS-based GNSS-R system was developed and deployed for test purposes at the Onsala Space Observatory, Sweden. Over a period of two weeks in October 2013, sea-level monitoring and measurements with the newly developed GLONASS-based GNSS-R system were carried out, in parallel to measurements with the conventional GPS-based GNSS-R installation at Onsala. In addition, data from tide gauge measurements were available for comparison. It could be shown that precision and accuracy of the GLONASS-based GNSS-R system is comparable to conventional GPS-based GNSS-R solutions. In the recent months, the GLONASS-R concept has been improved further and expensive hardware front-ends were replaced with software-defined radio equipment and off-the-shelf PCs. These modifications did not only reduce the cost of a GLONASS-R system, but also widened the possibilities that come with the concept of software defined radio. Thus, beside delay-based sea-level observations it is now possible to utilize the same equipment and mount it on an airborne platform in order to provide Delay-Doppler maps (DDM) which serve as input for a variety of ocean sciences applications, including sea surface roughness, salinity, and wind parameters.