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Sea level measurements from inverse modelling of GNSS SNR data - initial results

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The idea that sea level measurements could be done passively using available GNSS signals was proposed already over two decades ago. Since then several methods of using GNSS signals for measuring sea level have been proposed, using various degrees of specialized equipment. We present a new method to retrieve sea level from GNSS SNR data that relies upon inverse modelling of the detrended SNR data from a single off-the-shelf geodetic GNSS receiver. This method can simultaneously use SNR data from both GPS and GLONASS, and both L1 and L2 frequencies, in order to improve the performance with respect to prior studies. Results from the GNSS-R installation at the Onsala Space Observatory are presented and the retrieved sea level results are compared with data collected by a co-located pressure mareograph. The new method is found to give an RMS error of 1.8 cm. The results are also compared against previous implementations of GNSS tide gauges and found to have lower RMS than both the earlier SNR algorithm and also the dual receiver, phase delay method. This shows that inverse modelling for sea level retrieval has a potential to increase the precision of GNSS-R tide gauges, without the need for specialized equipment. Furthermore, since the method is based on SNR analysis, it can continue to operate during high winds and large sea roughness, in which the dual-receiver phase delay algorithm fails since the receiver connected to the nadir looking antenna does not succeed to lock on the satellites signals. This leads to a more stable and reliable operation. The ability to simultaneously use SNR data from different GNSS systems is also seen as a factor to increase the performance, further reducing the RMS. Therefore, in the future it is of interest to add further GNSS systems, such as Galileo and BeiDou.