Precise ground-based GNSS-reflectometry water level measurements using multiple low-cost antennas

David Purnell, Natalya Gomez, William Minarik, and Gregory Langston
Earth and Planetary Sciences, McGill University, Montreal, Quebec, Canada (david.purnell@mail.mcgill.ca)

GNSS-Reflectometry (GNSS-R) is a promising new technique to monitor water levels due to easier and cheaper installation of instruments in remote environments compared to traditional acoustic sensors or pressure gauges. GNSS stations that have been used for reflectometry purposes thus far are designed for monitoring land motion and may cost more than 10,000 USD each. We have found that a low-cost GNSS antenna and receiver (10 USD) can be used to make equally precise water level measurements, with an RMSE of a few centimeters when compared to a collocated acoustic sensor. However, an RMSE of less than one centimeter is typical for water level sensors and this level of accuracy is desired for research purposes. Two of the dominant sources of error in GNSS-R measurements are the effects of random noise in the Signal-to-Noise Ratio (SNR) data and tropospheric delay. Modelling work suggests that these sources of error can be reduced by using multiple low-cost antennas in the same location. In light of this, we have installed an experimental setup of antennas at various locations along the Saint Lawrence River and Initial results show that multiple antennas can be used to provide more precise measurements than a single antenna. Our installations of multiple antennas are less than 5% of the cost of stations that have been used in previous GNSS-R literature. Hence this approach could be applied to install a dense network of water level sensors along rivers, lakes or coastlines at a relatively low cost. We expect that this approach could also be applied to GNSS-R soil moisture or snow depth measurements.