Sea level monitoring using ground-based GNSS reflectometry

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Abstract

POLENET and GNET global navigation satellite system networks are installed to study solid Earth and ice mass changes in Antarctica and Greenland, respectively. Geodetic-quality antennas are designed to boost the energy from the satellite transmitter and to suppress the reflections. But it is still possible to receive both the direct and short delayed surface reflections simultaneously. The instantaneous excess delay of the sea-surface reflections with respect to the line-of-sight propagation can be used to estimate water level with direct connection to the terrestrial reference frame. Here, SNR observations from commercial off-the-shelf systems are used to estimate sea level in Antarctica and Greenland. After correcting the retrieved reflector heights for the propagation delay of microwave signals from GNSS satellites to ground-based receiver, water levels are retrieved applying two methods. In the first method, we correct the retrieved heights for the vertical velocity to consider the dynamic state of the sea and in the second method tidal parameters are estimated that allows us to determine the vertical velocity directly. The RMSE between sea level prediction using sub-daily GNSS retrievals and tide gauge records is 1.98 cm with correlation coefficient that exceeds 0.998. The regression slope between GNSS-MR and tide gauge records does not deviate significantly from a one-to-one relationship.

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