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Sea level estimate from multi-frequency signal-to-noise ratio data collected by a single geodetic receiver

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GNSS-Reflectometry (GNSS-R) altimetry has demonstrated a strong potential for sea level monitoring.
Interference Pattern Technique (IPT) based on the analysis of the Signal-to-Noise Ratio (SNR) estimated by a GNSS receiver, presents the main advantage of being applicable everywhere by using a single geodetic antenna and receiver, transforming them to real tide gauges. Such a technique has already been tested in various configurations of acquisition of surface-reflected GNSS signals with an accuracy of a few centimeters. Nevertheless, the classical SNR analysis method for estimating the reflecting surface-antenna height is limited by an approximation: the vertical velocity of the reflecting surface must be negligible. Authors present a significant improvement of the SNR technique to solve this problem and broaden the scope of SNR-based tide monitoring. The performances achieved on the different GNSS frequency band (L1, L2 and L5) are analyzed.

The method is based on a Least-Mean Square Resolution Method (LSM), combining simultaneous measurements from different GNSS constellations (GPS, GLONASS), which permits to take the dynamic of the surface into account. It was validated in situ [1], with an antenna placed at 60 meters above the Atlantic Ocean surface with variations reaching ± 3 meters, and amplitude rate of the semi-diurnal tide up to 0.5 mm/s. Over the three months of SNR records on L1 frequency band for sea level determination, we found linear correlations of 0.94 by comparing with a classical tide gauge record. Our SNR-based time series was also compared to a tide theoretical model and amplitudes and phases of the main astronomical periods (6-, 12- and 24-h) were perfectly well detected. Waves and swell are also likely to be detected.
If the validity of our method is already well-established with L1 band [1], the aim of our current study is to analyze the results obtained with the other GNSS frequency band: L2 and L5. L1 band seems to provide the best sea level estimation, but the combination of SNR data from each frequency increases the number of observables and thus the quality of the final estimation.

[1] N. Roussel, G. Ramillien, F. Frappart, J. Darrozes, A. Gay, R. Biancale, N. Striebig, V. Hanquiez, X. Bertin, D. Allain : “Sea level monitoring and sea state estimate using a single geodetic receiver”, Remote Sensing of Environment 171 (2015) 261-277.