GNSS-R altimetry using a Geostationary Satellite

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The GNSS reflectometry (GNSS-R) uses GNSS signals reflected at the sea surface, which are usually eliminated as the multipath error. The reflected GNSS path received at an antenna is always longer than the direct path, so that the height of the antenna from the sea surface is geometrically determined from the excess path length. The excess path length can be either directly determined by measuring the temporal delay of the reflected signals, or indirectly estimated from interferometric cyclic modulations of the received power (often referred as signal-to-noise ratio; SNR) induced by phase differences between the direct and reflected GNSS signals. In the latter method, as the elevation angle of an earth orbiting GNSS satellite changes in time, the geometric reflection point on the sea surface temporally displaces, which results in interferometric changes of the path length during a period while the satellite is in sight. Meanwhile, for a geostationary satellite in BeiDou constellations that are always in sight, the path length changes not by the movement of the satellite but the elevation of the reflection surface, *i.e.* the sea level rise. In this study, we used the three-month time series (2016/09-11) of the 1Hz SNR of the geostationary BeiDou #02 satellite observed by a GNSS-R system deployed to the Shirahama Oceanographic Observatory Tower owned by Kyoto University (33deg, 42’ 32’’ N, 135deg, 19’ 58’’ E) at the height of ~20m. The geostationary GNSS-R altimetry observed significant flood tides when the wind speed is stably low; the 0.6m sea level rise was successfully determined by the SNR interferometry with 0.05m rms difference. However, significant interferometric SNR changes by tides were not recorded at high or low tides since at least 0.25m sea level change is required for the interferometry cycle. Consequently, the cyclic periods of the geostationary GNSS-R altimetry for tides become long (1-4 hours for 0.25m change in Shirahama), the interferometric variations were usually contaminated by SNR changes induced by the other factors such as winds. On the contrary, faster sea level changes by wave motions could be recognized by the geostationary GNSS-R altimetry, although the temporal sampling intervals of the present data were not adequate.

Keywords: GNSS-R , altimetry, BeiDou geostationary GNSS satellite

