



## **Remote monitoring of ocean heights in coastal areas by ground-based observations of reflected GPS signals**

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Recent studies have shown that ground-based GPS receivers offer the potential to monitor ocean heights in coastal areas by observing GPS signals reflected from the water surface. Results from a GPS reflectometry experiment with the OpenGPS receiver are presented, conducted in September 2004 on Rügen Island (Germany) at the shore of the Baltic Sea.

The OpenGPS receiver with a single patch antenna was positioned at the Königsstuhl location (13.66°E, 54.57°N) about 120 m above the water level. The 12 channel L1 frequency receiver was modified to allow for openloop tracking of reflected signals. The receiver uses up to 8 channels in order to track direct GPS signals to acquire time, position and navigation data. Additionally, the receiver can record up to 4 different reflected GPS signals simultaneously, depending on the constellation of the satellites and the fixed receiver.

The observed reflected GPS signals show amplitude variations induced by interference between the coherently reflected GPS signal and a correlator generated model signal, which is phaselocked to the direct signal and shifted by the expected delay in time. The delay estimate is calculated from the geometry of receiver and observed satellite position. The relative altimetric height variation of the ocean surface is derived from the amplitude variations of the reflected signal components.

During the experiment the ocean surface could be successfully monitored and relative height changes with amplitudes of about 20 cm could be observed with an accuracy within cm range. Reflections could be observed down to elevation angles of about 1 degree and distances of several km from the receiver.