A new service providing water level data using GNSS sensors Andy Matthews, Simon Williams, Liz Bradshaw National Oceanography Centre, Liverpool, United Kingdom. antt@noc.ac.uk

Recent studies have demonstrated the utility of ground based GNSS Interferometric Reflectometry (GNSS-IR) for the observation of sea level. GNSS (Global Navigation Satellite Systems, such as GPS, GLONASS, Galileo and BeiDou) receivers suffer from multipath, but if the physical and geometric effects multipath has on the measured signals are understood then this knowledge can be used to measure other environmental parameters such as the sea surface reflection. Here were present a new international archive to preserve and deliver GNSS-IR data and to integrate these data with existing sea level observing networks. We also present our a new installation at Sheerness, UK: the first site in the world that produces data near real time data from GNSS-IR and a conventional tide gauge.





Tide gauge data can be difficult to interpret without information about the vertical motion of the coastline measured. For this reason, it is common practice to install a GNSS receiver at or near a tide gauge. For data measured using GNSS-IR this is

GNSS-IR Site Map





not an issue: the primary data from the receiver can place the instrument in a well-defined reference frame.

Development of a GNSS-IR data centre

Our initial funding has allowed us to provide data processed from about 250 sites. At each site, we provide calculated sea levels, along with information about which satellite constellation and frequency were used to calculate each value. We also provide metadata from the site, some example plots, and links to nearby tide gauges and information on the sites of other data providers.

In the longer term, we aim to automate the process of updating data, and to work towards a data service that implements FAIR principles (Findable, Accessible, Interoperable and Resuable) by developing a metadata model populated using controlled vocabularies, and delivering data through an ERDDAP server. We will also work with GNSS data repositories to develop suitable universally unique site



Examples of monthly GNSS-IR derived mean sea level (orange) compared to tide gauge (blue), offset for clarity. In some cases this has helped identify issues in the existing tide gauge data.

Good site - reflectometry works well and data is available Decommissioned - reflectometry works well, data is available, but site is no longer operating Questionable - reflectometry works sometimes or the signal is very weak probably due to location Bad - no data available at the site, either due to positioning of the sensor, lack of signal to noise ratio data, or data sampling is inadequate for the height of the sensor

A map of the Fresnel zones (reflecting region) used for the site at Noumea, New Caledonia



Data Availability





Sheerness Tide Gauge and GNSS-IR Gauge



Sheerness in the southeast of England has tide gauge records extending back to at least 1832. In September 2021 we installed a new state-ofthe-art system and upgraded and repositioned the GNSS antenna so that it could be used for GNSS-IR.

Data are downloaded every 15 minutes and the last hour is used to produce 15 minute sea level averages. The results are produced in near-real time: the world's first system to be run in a continuous operational mode.

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The graph here shows tidal residuals from the tide gauge (blue) and the GNSS-IR measurements (orange dots). The RMS standard error is just over 3cm.

We have recently completed the installation of a similar system on the Birkenhead side of the River Mersey opposite Liverpool, in the northwest of England.



https://psmsl.org/data/gnssir

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