

Estuary bathymetry from Sentinel 3 satellite altimetry.

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Newport, UK, is situated on the River Usk right by the Severn Estuary, which is upstream of the larger Bristol Channel.

The region is dominated by a huge tidal range all the way up to 14 m. Figure 1 below shows an aerial photo of the city with the large Newport docks in the foreground constructed with locks to maintain water inside the docks during low tides.



Figure 1- Aerial photo of the Newport Docks (Credit: southwalesports.co.uk)

The Copernicus Sentinel-3B satellite has a track (number 265) that passes right over Newport. Onboard the Sentinel-3B is the SRAL radar altimeter which measures the height of the surface below the satellite with a very high precision.

With its height measurements of the water surface, the satellite acts like a tide gauge, measuring the water level in the estuary. The difference is that a tide gauge measures sea level every minute, whereas the satellite only flies over the same area every 27 days.

However, the satellite measures surface elevation below the satellite along the entire track crossing the Severn. Using a novel way of processing the satellite data using Fully Focused SAR scientists at DTU Space have been able to determine the height at a resolution of up to 50 centimeters along the track for all overflights from the past two years. Sometimes the satellite passed the Severn during high tide, and sometimes during low tides.

Figure 2 shows the exact location of the tracks (left) and their corresponding height profiles across the Severn (right). The map shows that the satellite drifts up to 1 km in orbit which means that we have been able to recover the heights across the entire swatch as the satellite passes Newport.

Some of the measured height profiles are nearly horizontal across the stretch. These are the profiles taken at high tides where the satellite measured the height of the water surface. The profiles taken at low tides have much more height variation and these are also more interesting. From north to south they map the elevation of the countryside and the city. Between 51.54 and 51.55, some profiles even capture the height of the Nash countryside.

Going into the estuary, the results are particularly interesting as it seems like the satellite can map the bathymetry of the estuary when it passes at low tide. This is traditionally difficult to map as the estuary bottom is very soft, making it difficult to obtain in-situ observations, and causing the measurements from costly campaigns to become outdated very quickly, as the sediments are moved around the estuary by the strong currents. Continuous height measurements of the Severn seabed from satellite altimetry would therefore be of great value and a much-needed addition to the available bathymetric data.

