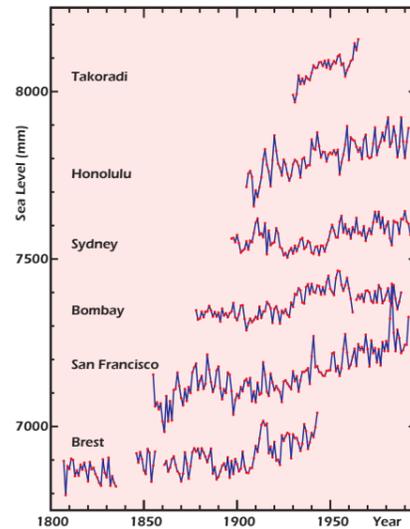


UK and worldwide sea level monitoring

In recent decades the institute has concentrated on sea level monitoring and prediction around UK coasts, and indeed on understanding sea level changes worldwide: the Permanent Service for Mean Sea Level having been established at Bidston by Proudman in 1933 and as important as ever today. Such understanding informs government departments on policies for coastal protection, and contributes to international scientific study groups such as those of the Intergovernmental Panel on Climate Change (IPCC).



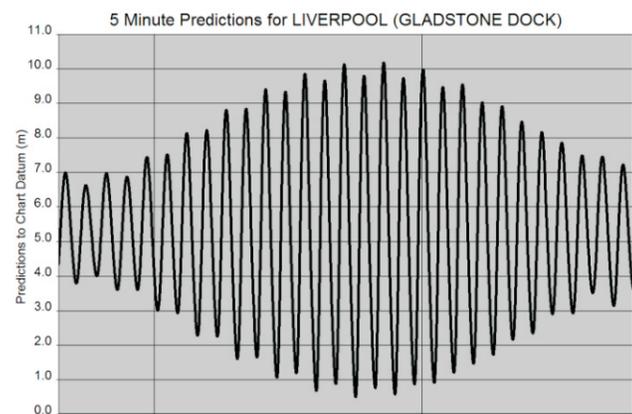
The UK National Tide Gauge Network of 44 stations.



Long sea level records from around the world from the PSMSL database indicating sea level to be rising at most locations.

Predicting tides, surges, and possible floods

Thanks to the work of Doodson and other scientists in Liverpool, the tide can be predicted at any location around the UK with several centimetre accuracy.



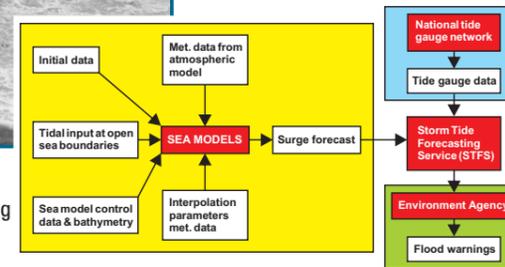
Superimposed upon the 'astronomical tide', which is caused by the gravitational attraction of the Moon and Sun, is the 'storm surge' caused by strong winds and low air pressures. The major flood at Sea Palling and other parts of the north Norfolk coast in 1953 resulted from a large storm surge occurring at high tide. This disaster led to the development of the UK National Tide Gauge Network and the UK Storm Tide Forecasting System.

POL led the development of computer models to predict UK storm surges several days ahead based on forecast weather information. Routine surge forecasts are now produced by the Met Office and result in Flood Warnings issued by the Environment Agency.



Sea Palling during the 1953 floods. Courtesy Eastern Daily Express.

How the Storm Tide Forecasting System works.



The Thames Barrier: the protection of London from large storm surges is of major importance. Its operation is controlled with the help of POL-provided surge information.

A new name – a centre of excellence

The institute was renamed the Proudman Oceanographic Laboratory in 1987, a name which survived its move from Bidston to the campus of Liverpool University in 2004. Sea Level Science now constitutes one of the three main areas of expertise of POL research, the other two closely-related fields being shelf sea science and numerical modelling of ocean processes.

Although Sea Level Science has come a long way since Horrocks' measurements at Toxteth, the scientific importance of the subject is as great as ever, and Liverpool remains one of its main worldwide centres of excellence and its 'UK home'.



Joseph Proudman Building, Liverpool – the UK home of sea level science.

Find out more

Those interested in this subject will find more information in the following:

POL website www.pol.ac.uk

Bidston Observatory: The Place and the People (Paperback) by Joyce Scoffield.

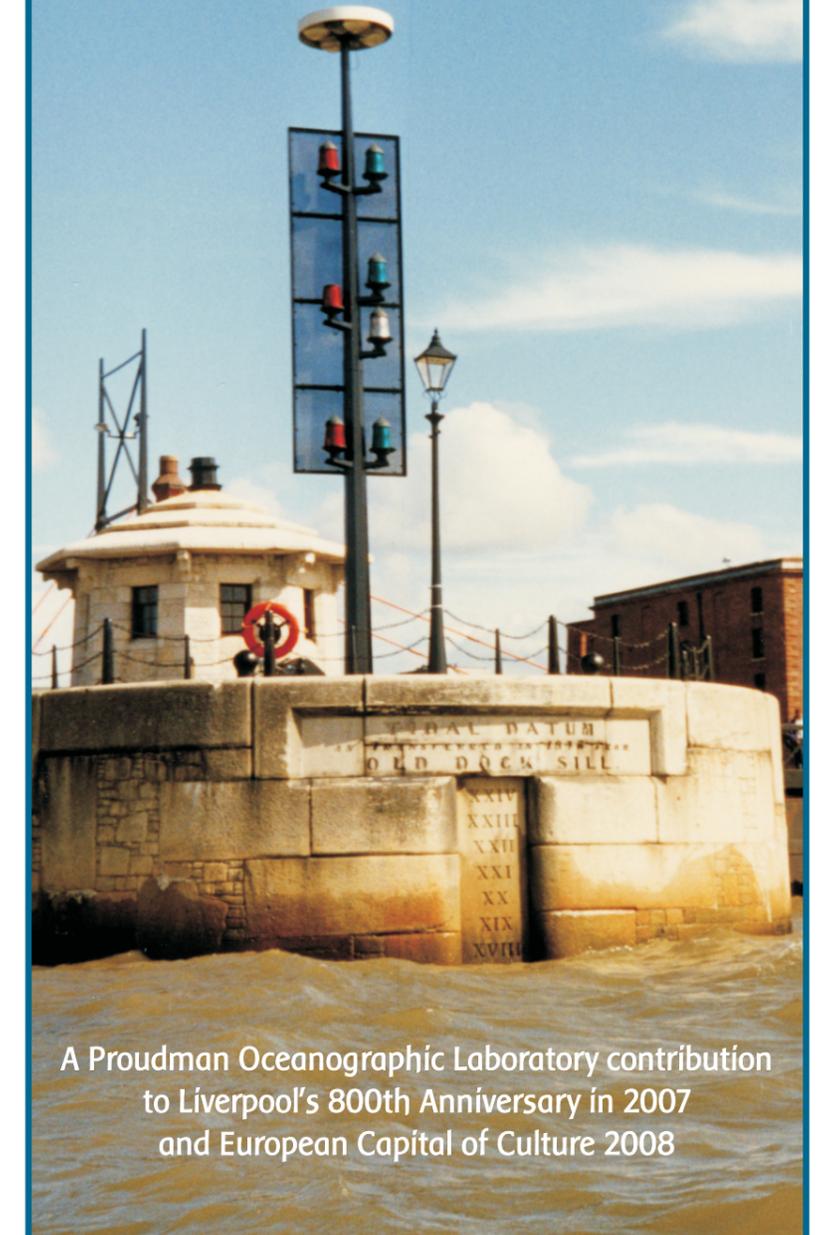
D.E. Cartwright, Tides – a scientific history, (Cambridge, 1999).

Pugh, D.T. 2004. Changing sea levels. Effects of tides, weather and climate.

Cambridge: Cambridge University Press, 280pp.

Or contact Philip Woodworth – plw@pol.ac.uk

Liverpool Home of UK Sea Level Science



A Proudman Oceanographic Laboratory contribution to Liverpool's 800th Anniversary in 2007 and European Capital of Culture 2008



**Proudman
Oceanographic Laboratory**
NATURAL ENVIRONMENT RESEARCH COUNCIL



First tidal measurements taken at Liverpool

Our story starts with Jeremiah Horrocks (1619–1641). He was one of the great scientists of the 17th century, and a man even Isaac Newton held in high regard. He is most famous for predicting, and then observing, the transit of Venus in 1639 at Much Hoole near Preston. However, he also had a great interest in understanding ocean tides, and in particular in verifying that tidal changes were closely related to variations in the Moon's orbit. Horrocks was born and died at Toxteth. Shortly before his death, he is known to have

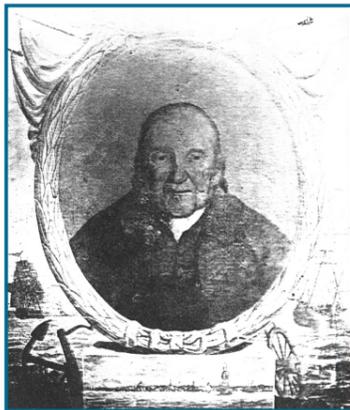


Jeremiah Horrocks watches the Transit of Venus.

made measurements of high waters (probably the times and perhaps also the heights of high tide) on the Mersey coast near his home for at least a month. Unfortunately, his tidal measurements (but not his astronomical records) were lost in the civil war or possibly in the Fire of London.

A century later – measurements resume

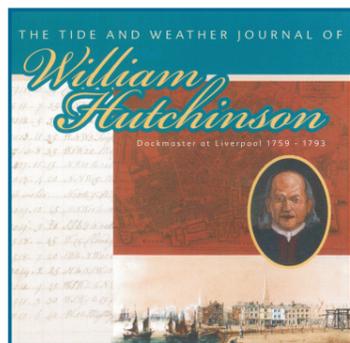
A second major figure is William Hutchinson (1716–1801) who compiled the first extended set of sea level measurements in the UK, together with a comprehensive set of meteorological information. His measurements of the heights and times of every high water during 1764–1793 at the Liverpool Old Dock not only spanned many years but were of high quality and are still being used in scientific research today.



William Hutchinson – tidal observer, author and many other talents.

William Hutchinson – mariner and privateer

Hutchinson made many important contributions to Liverpool's history. The first half of his life was spent as a mariner and privateer captain during the Seven Years War. Only in the second half did he develop into becoming a dock master, entrepreneur, inventor, author, philanthropist and, what we would nowadays call, scientific researcher. To mark Liverpool 2007 and 2008, POL together with colleagues at Brock University, Canada will

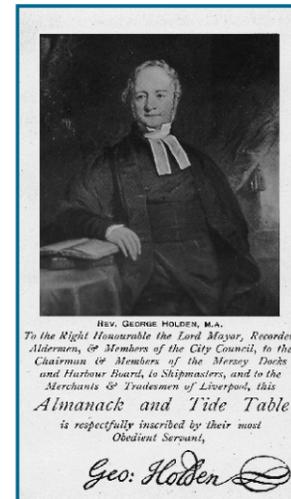
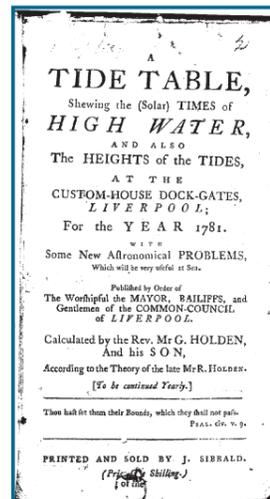


Hutchinson's tidal and meteorological data sets are available on CD.

produce a CD containing copies of all Hutchinson's tidal and meteorological data sets and background information on his life.

The first reliable tide tables

Hutchinson's measurements of the tides during 1764–1767 were used by Richard and George Holden to derive the first reliable publicly-accessible tide tables in the UK. They first appeared in 1770 and were published for over 200 years.

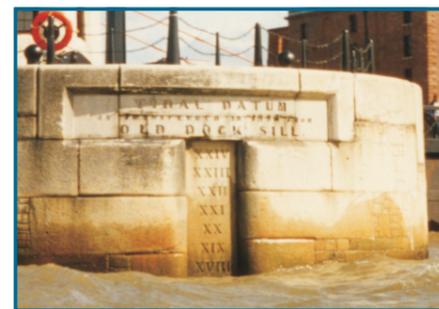


Left: The Liverpool tide tables for 1781 produced by Richard and George Holden based on earlier measurements of the tide by Hutchinson.

Right: Picture taken from a 19th century edition of the Holden tables showing Rev. George Holden (grandson of the first). The signature is of the first George and was copied from earlier editions.

The first tide gauge network

During the 19th century, the Mersey Docks & Harbour Board (MDHB) established an impressive network of a dozen state-of-the-art sea level stations along the Mersey, Dee and neighbouring coasts. They were used to provide the best possible tidal information to what became one of the most important ports in the Empire, together with data for surveying and coastal engineering. The main Liverpool gauges were at George's Pier (the present-day Pier Head), then Prince's Pier (next to the ocean liner landing stage) and now



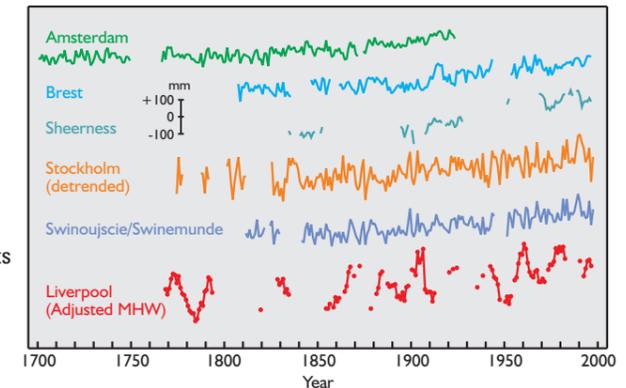
The stonework at the entrance to Canning Half Tide Dock commemorating the Old Dock Sill datum used by Hutchinson and throughout the Port of Liverpool.



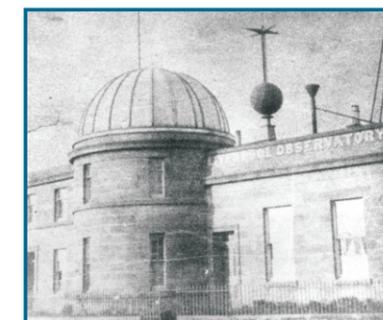
Entrance to the Old Dock at Liverpool painted by Herdman in about 1805. Hutchinson's house would on the right hand corner of the street opposite.

Gladstone Dock. Together these sites have provided data which make up the longest UK sea level record and one of the longest in the world. These data have been used to study long term changes in mean sea levels and in the sea level extreme levels which often result in flooding.

Long sea level records from NW Europe for the last three centuries indicating a gentle acceleration in sea level. The record shown for Liverpool is of Mean High Water rather than Mean Sea Level, which accounts for the quasi-18 year periodicity.



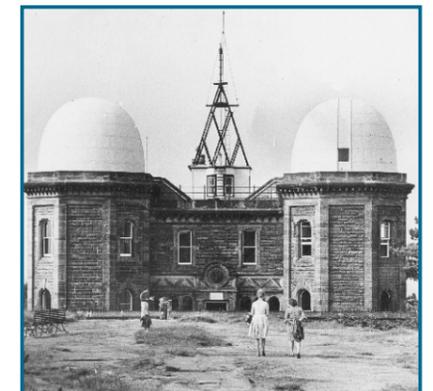
Liverpool's first observatory



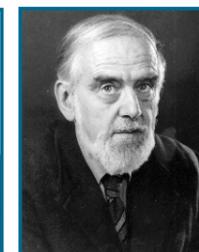
The Liverpool Observatory at Waterloo Dock.

In 1845 the MDHB established the Liverpool Observatory at Waterloo Dock, to provide all the tidal, meteorological and astronomical information required by ship owners.

The expanding port resulted in the Observatory being relocated in 1866 to Bidston Hill in the Wirral. Its work became more focused on scientific research, rather than port operations, in 1929 when the Liverpool Observatory was merged with the Liverpool University Tidal Institute. This combined institute (with a number of name changes and official owners) was to become a world-famous centre for sea level and tidal research with no less than three Fellows of the Royal Society among its Directors: Joseph Proudman, Arthur Doodson and David Cartwright.



Bidston Observatory, Birkenhead.



From the left: Joseph Proudman, Arthur Doodson and David Cartwright.