From Astronomy to Oceanography –
a brief history of Bidston Observatory

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Bidston Observatory has a remarkable history. It was built 134 years ago to replace and carry on the work of the Port of Liverpool Observatory. Since then it has pursued scientific knowledge in many fields and has changed its function several times in response to the national need. Several anniversaries of these changes fall in 1999, so it is timely to record briefly the events, the people and their work which have contributed to this exceptional heritage.

Bidston Hill is the northernmost point of the sandstone ridge that forms the backbone of the Wirral Peninsula which lies between the Dee and Mersey estuaries opposite Liverpool. From the top on a clear day there are splendid views of Liverpool Bay, the mountains of North Wales as far as Snowdonia, and even the Lake District.

Being such a prominent feature, Bidston Hill has been a focus for human activity for many centuries. It bears rock carvings of a horse, a Sun goddess and a cat-faced Moon goddess all of which date back to Norse settlement 1000 years ago. There are the remains of a cock-fighting pit, a windmill, and the post holes which used to bear the flag masts used in an ingenious semaphore telegraph system that brought messages in minutes from Anglesey to shipping owners in Liverpool. This existed for several decades before it was superseded by the electric telegraph. However the most prominent feature is the cluster of three buildings which presently house the Proudman Oceanographic Laboratory. The oldest of the three buildings, constructed in 1866 is Bidston Observatory itself, a large square building faced with the very sandstone quarried for its foundations. It is topped by two prominent white domes which can be seen over a wide area. The next oldest building is a lighthouse (replacing an earlier lighthouse of 1771), with a lantern topped by a green conical roof and some associated keeper's cottages which were built in 1873. Almost exactly a century later, in 1975, these were joined by the large square white Joseph Proudman Building which, with its many small windows like so many portholes, resembles a beached ocean liner straddling the hill top.

The first Liverpool Observatory, 1843–1866

In the early 19th century it was a necessity for every major port to have an observatory to ascertain the longitude of the port and to keep accurate time. In 1834 a Lieut. Jones, RN recommended the establishment of an astronomical observatory to the Liverpool Town Council. They deliberated the question but postponed any decision. Over the next few years the Council was bombarded with a series of similar recommendations from the British Association for the Advancement of Science, William Lassell, a local astronomer who though strictly an amateur was pre-eminent in British astronomical circles, and also the Liverpool Literary and Philosophical Society. In addition Captain (later Admiral) Denham FRS, the Port Hydrographer, published 'proposals for a better port' which became the basis for the Mersey Conservancy Act of 1842, which stressed the need for an astronomical and meteorological observatory and a permanent tide gauge. Although a special committee was set up, no action was taken until 1839 when permission was granted to erect an observatory and dwelling

house at Waterloo Dock in Liverpool. Funding out of dock dues was obtained by the 1841 Liverpool Dock Act and in 1843 Mr John Hartnup, Assistant Secretary to the Royal Astronomical Society was appointed as Director. Systematic observations then began in 1845.

Apart from obtaining and preserving Greenwich time and securing the longitude of Liverpool, a further duty was to test chronometers so that in the words of the British Association, 'a captain when he sails may receive his chronometer sure both of its error and its rate'. As part of these duties, the Observatory took part in a series of chronometer exchanges to determine the longitude difference between Greenwich and Valentia in Ireland and subsequently between Greenwich and the Harvard College Observatory in the USA. A 'time ball'* was also fitted to the Observatory and meteorological observations were started to provide local forecasts for shipping. In 1857 the Mersey Docks and Harbour Board took over the running of the Observatory.

The move to Bidston 1866

In 1864, extension of the Waterloo Dock required the removal of the Observatory. Bidston Hill, which had been in the service of the port through its telegraph system, was selected for the site of the new Observatory and the land was purchased from the local landowner, Mr Vyner. Having acquired this site, the Docks and Harbour Board, spared no expense in construction of the new Observatory. Built from stone excavated at the site, it covers an area of about 500 square yards. Above ground it has two storeys over which are the two domes as well as a meteorological hut. Below ground there are cellars 12 feet deep and below these another cellar 24 feet deep which has a very steady temperature, nowadays used for gravity measurements. There are many notable architectural details – for example the decorative carved arches flanking the entrance corridor are supposedly represent the mathematical function known as a cycloid.

Observations began in 1867. As the new building was now about three miles from the river the time ball was replaced by the remote electrical firing of a cannon, a veteran of the Crimean and earlier wars, situated in Birkenhead Docks. The work continued as before. Two large warm air chambers were set up for the rating of chronometers capable of holding one hundred instruments each. Astronomical observations continued, with a transit telescope in the east dome and a massively-mounted 9-inch refracting telescope in the west dome.

In 1885, after 40 years as Director, John Hartnup retired and was succeeded by his son, John Hartnup Jr. The young John Hartnup continued much of the work of his father and wrote many papers on chronometrical management but tragically on 21 April 1892 he was killed by falling from the roof of the Observatory, where he had mounted to make meteorological observations.

He was succeeded by another astronomer, Mr William Plummer who recognised the value of the meteorological work and oversaw an increase in its importance. Perhaps ironically, William Plummer was also forced to oversee a decline in astronomical work as the increasing use of photographic methods in astronomy implied that a considerable expenditure would be required to renovate and modernise the astronomical equipment. However, a new activity commenced in 1897 with the installation in the cellars of a seismograph. This was the first of a series of seismographs of different designs that followed. In 1910, observations were made using instruments designed by Sir George Darwin, Sir Horace Darwin and others to determine the yielding of the land to the load of tidal water, now called the 'ocean loading effect'.

The Liverpool Tidal Institute 1919

In 1919 an important step took place with the establishment of the University of Liverpool Tidal Institute, located in Liverpool, with Professor Joseph Proudman as Director and Dr Arthur Doodson as Secretary. Although a separate body, separately governed and funded, there was a very early association with Bidston Observatory. It was intended as a research institution with both theoretical and practical aspects of tidal dynamics as topics of study. In 1923, one major achievement was the award by Cambridge University of the Adams Prize to Joseph Proudman for an 'Essay on the Tides'. The effects of this were far-reaching, one result being to convince the Hydrographic Department that accurate cotidal charts could be drawn for the North Sea. The association between the Institute and Bidston gradually strengthened, with William Plummer joining the governing board of the Institute. Significantly a tide-predicting machine was installed at Bidston at the end of 1924. Tide-predicting machines are devices that can be 'programmed' with the harmonic tidal constants for a particular port and then proceed to provide predictions or hindcasts for any desired date. As they required very high precision engineering, very few were in existence and several foreign governments asked the Institute to supervise the construction of machines for their own use.

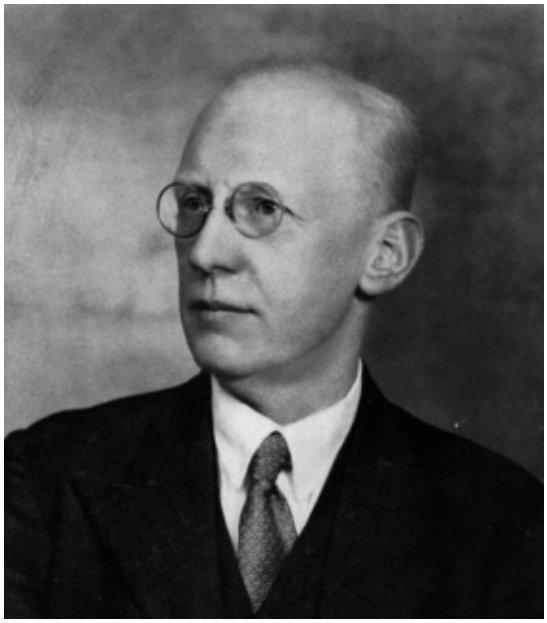
* A 'time ball' was a sphere which could move up and down a mast. Each day, the ball was raised and then abruptly dropped at a specific time, usually 1 p.m., so that shipping, etc., within sight could obtain the correct time.

The Liverpool Observatory and Tidal Institute, 1929

In 1928, William Plummer died and this may have been the catalyst for the amalgamation of the Observatory and Tidal Institute, which took place on the 1 January 1929. This was a pivotal moment as the next decade brought a considerable increase in oceanographic research to Bidston. With Joseph Proudman as Director and Arthur Doodson as Associate Director, the Liverpool Observatory and Tidal Institute developed new methods for the analysis of tides and their prediction, and a second tide-predicting machine was acquired. This second machine meant that Bidston had the only two machines in the entire British Empire, apart from perhaps an old one in India. Bidston rapidly acquired a world-wide reputation for the analysis and prediction of tides and was soon providing predictions for many British territories overseas as well as foreign countries. It has been estimated that from 1924 up to the 1950s the Institute was responsible for predicting tides for two-thirds of the world. The provision of tidal predictions was a valuable source of funding.

Apart from the prediction of tides at particular ports, interest now extended to offshore tidal elevations and currents and also the idea of drawing cotidal charts showing the distribution of the tide throughout areas such as the North Sea. Apart from theoretical studies in several pioneering papers by Joseph Proudman, this also led to actual oceanographic observation. In association with the University of Liverpool Department of Oceanography, and with grants from the Royal Society, instruments were purchased or developed. In particular mention must be made of the Favé offshore tide gauge and a current meter developed by Doodson. These were deployed on four expeditions south of the Isle of Man. An additional interest was the effect of meteorological forcing on the tides. This had become particularly important following disastrous flooding in the Thames estuary in 1928.

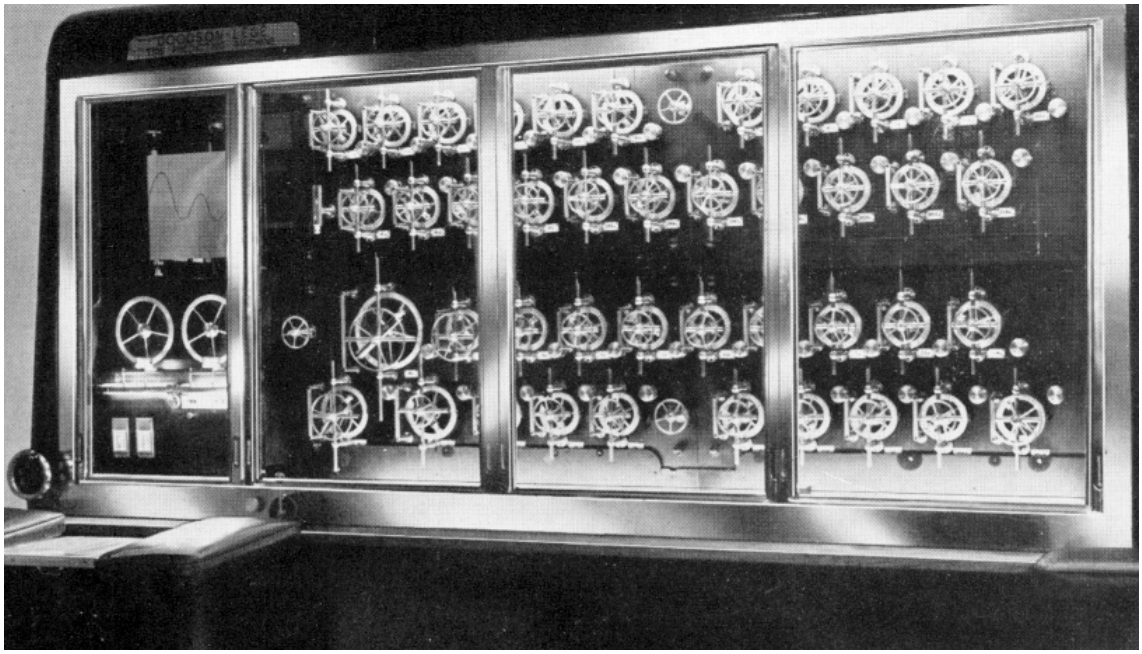
Naturally the expertise built up at Bidston became invaluable during the Second World War. It was vital to be able to predict tides for the many theatres of war, such as Burma and the D-Day landings. One of the tide-predicting machines was placed in a separate semi-underground room in the observatory grounds. Indeed the door to this room suffered blast damage from a bomb and the Observatory building itself lost a hundred panes of glass as well as suffering damage to doors, interior walls and ceilings in six different incidents. Remains of some of the necessary building reinforcements can still be seen. The scientific work itself was speeded up so that predictions were advanced by a year and they were photographically recorded against loss – a wise precaution as some were lost at sea. The staff at this time were mostly female 'computors' and some volunteered for war service. However various authorites such as the Ministry of Labour recognised the national importance of their work, so most were allowed to remain in post. Nevertheless, a few others such as the 'junior male assistant', Mr Jack Rossiter were called to active service.



Joseph Proudman, first Director of the amalgamated Observatory and Tidal Institute

This was also a period of close cooperation with the Admiralty Hydrographic Department. One of the fruits of this collaboration was the *Admiralty Manual of Tides* written jointly by Arthur Doodson and Commander H. Warburg and published in 1941. This cooperation continues up to the present in the annual *Admiralty Tide Tables*. In 1946, Joseph Proudman retired as Director and was succeeded by Doodson.

Arthur Doodson, Proudman's Associate Director and successor



The 1949 Doodson-Légé tide-predicting machine

The tide-prediction service expanded and was augmented by the construction of a large 42-constituent Doodson-Légé tide predicting machine in 1949 (see above).

In 1953 there was a catastrophic storm surge in the southern North Sea, with the loss of about 2000 lives in the Netherlands and along the east coast of England, and damage running into many millions of pounds. That disaster provided a new impetus for research in the meteorological perturbation of tides and this became a dominant area of study at Bidston. Interest in long-term sea-level change had been a by-product of the tidal work, and led in 1933 to the establishment of the Committee on Mean Sea Level and its Variations, of the International Association of Physical Oceanography (the predecessor of the International Association for the Physical Sciences of the Ocean) under Proudman's direction. After the International Geophysical Year of 1956–1957 the Committee was renamed the Permanent Service for Mean Sea Level (PSMSL) of the International Union of Geodesy and Geophysics (IUGG), with Doodson as chairman and Rossiter as Secretary. This event was marked by a large International Symposium held in Liverpool in 1959. Over the next decade Rossiter carried out a major reorganisation of the PSMSL, and today's service is essentially a modern computerised version. Investigations into Earth tides also continued with instruments situated in the cellars. In 1960, Arthur Doodson retired and was succeeded by Jack Rossiter, who simultaneously obtained the degree of DSc.

The University Of Liverpool Tidal Institute and Observatory, 1961

The increasing interest in oceanographic research was recognised in 1961 when Bidston became a full department of the Faculty of Science of Liverpool University. Various services still continued, such as meteorological observations and the firing of the one o'clock gun (replaced by a Hotchkiss naval gun in 1946). However, this move was important because being a university department underpinned the expansion in oceanographic research. There was a gradual transition from tide-prediction machines to computers.

It was during this period in 1962 that Mr Norman S. Heaps joined the staff. It looked as if the relatively new field of computer-based numerical modelling might be a key to understanding meteorological influences on water level additional to the tides. Norman Heap's work culminated (in 1978) in what was perhaps the world's first operational storm-surge prediction scheme based on a numerical model. Having access to the University computers was a vital facility for the development of modelling techniques. Modelling also commenced in studies for tidal barriers and in particular a proposed storm surge barrier for the Thames. At the same, time interests continued to expand in other fields. In 1968 Earth tide measurements were moved to a disused mine in North Wales to provide a quieter background.

The Institute of Coastal Oceanography and Tides, 1969

With the Natural Environment Research Council taking over responsibility for a large part of the oceanographic research in the UK, Bidston Observatory changed its name yet again and joined the Natural Environment Research Council on the 1 April 1969. This was a time of great change. The telescopes were removed from the domes and sent to the Liverpool Museum, and the

one o'clock gun was fired for the last time on 18 July 1969. Even the domes changed colour from white to black! There followed a very rapid increase in staff from 26 to 66, requiring the use of temporary accommodation at Moreton about three miles distant. The first computer at Bidston, an IBM 1130 was installed in the basement of the Observatory. With a connection to an IBM 360 at the London Data Centre this allowed a great expansion in the modelling of coastal and shelf seas by Norman Heaps and others. Sadly, in 1972 Rossiter died suddenly and Mr Geoffrey W. Lennon took over as acting Director.

The Institute of Oceanographic Sciences (Bidston), 1973

Once again the death of the Director seemed to be the catalyst for change, as in 1973 the Institute of Oceanographic Sciences (IOS) was formed by initially combining Bidston with the National Institute of Oceanography (Wormley, Surrey), the Unit of Coastal Sedimentation (Taunton, Somerset) and some of the Research Vessel Services (Barry, South Wales). In 1975 staff occupied the new Joseph Proudman building. With the expansion in the numbers of staff, there were great advances in the type of work being carried out at Bidston. A much larger Honeywell 66/20 computer was installed which, after several upgrades, in effect became the main NERC computer. The Marine Information and Advisory Service (MIAS) came into existence, the forerunner of the British Oceanographic Data Centre (BODC) which is the national data centre based at Bidston.

Instrumentation and technical support services expanded greatly and existing fields of study such as sea-level change, Earth tides and numerical modelling were strengthened. With hindsight, this was a period which laid the groundwork for much that was achieved in succeeding years. For example, there was a demonstration of how a model scheme could be used successfully to estimate the distribution of radioactive caesium emitted from the nuclear reprocessing plant in Cumbria. In 1978, based on the work by Norman Heaps and Roger Flather, the east coast storm-surge forecasting scheme went into operation at the Meteorological Office. This model has been continually upgraded. The tides were not ignored, however, as the renowned tidal theoretician, Dr David Cartwright, was appointed Assistant Director in overall charge of Bidston. He expanded tidal and sea-level research into the new fields of bottom pressure recorder measurements and satellite radar altimetry. It was also during this period that Bidston became the centre for a unified 'A Class' national tide-gauge network. Inevitably, with time there was internal reorganisation within IOS which resulted in the closure of the Taunton laboratory and the move of some members of staff, which brought sedimentary studies to Bidston. In 1986 Norman Heaps died after a long illness. He is honoured by a memorial prize awarded for the best paper by a young researcher at each UK Oceanography conference.

The Proudman Oceanographic Laboratory photographed from the air in 1986, when the domes (lower right) were still painted black

The Proudman Oceanographic Laboratory (POL), 1987

After the retirement of David Cartwright, the Directorship was taken up briefly by Dr Keith Dyer who moved from IOS (Taunton).There was brief period of reorganisation, following which Bidston attained a period of autonomy within NERC and a new Director – Dr Brian McCartney – was appointed. It was at this time that the laboratory was given its present name in honour of Joseph Proudman. The following decade built on the experience of earlier years but new key activities commenced. During 1987–1992, POL was the host laboratory for the North Sea Project the first large 'community research project' involving many other UK institutes and university research departments. One main aspect of this project was that this established strong links with researchers in fields other than the physical sciences. This continued with increasing participation in many other collaborative projects in the UK and elsewhere, especially under the auspices of the European Union.

There were continuing advances in many kinds of instrumentation, for example the use of radar to measure surface currents and waves, the use of ADCPs in many observational programmes, the development of the sea bed STABLE and MYRTLE platforms, the latter achieving a four-year deep ocean record from the sea-bed in the Drake Passage. Tidal measurements were made at stations such as Tristan da Cunha and Signy in Antarctica. There were a number of observational and modelling efforts examining processes along the UK Shelf edge, which now included microplankton distribution as well as the usual physical variables. By now, shelf-sea models were addressing various time- and space-scales, three-dimensional baroclinic systems, temperature and salinity, and different turbulence and advection schemes, as well as ocean-shelf coupling. Sedimentary and biological processes were also included. The national need was also recognised when models were set up, in collaboration with other laboratories, to look at the major oil spill during the Gulf War as well as those from several tanker groundings. Models were even used as part of the Olympic Yachting effort. In Earth tides, the measurements became increasingly part of international collaboration across Europe as well in China. In addition, instruments were deployed near a pumped water storage scheme in North Wales to detect possible variation in the universal constant of Gravitation.

Table 1 *Important Bidston anniversaries falling in 1999*

160th	Permission granted to construct an Observatory at Waterloo Dock (1839)
80th	Establishment of the Liverpool Tidal Institute with Proudman as Director (1919)
70th	Amalgamation of the Tidal Institute with Bidston Observatory (1929)
50th	Construction of the 42-constituent Doodson-Légé tide-predicting machine (1949)
40th	Symposium marking the setting up of the Permanent Service for Mean Sea-Level (1959)
30th	The tidal institute enters the Natural Environment Research Council (1969)

This increasing collaboration with other institutes resulted in the recognition of common interests with two other major UK Laboratories, which led to the incorporation of POL within the Centre for Coastal and Marine Sciences (CCMS).

The Centre for Coastal and Marine Sciences, Proudman Laboratory 1994–2000

In 1994 the CCMS was formed from the Plymouth Marine Laboratory, Dunstaffnage Marine Laboratory and Proudman Oceanographic Laboratory, under the overall Directorship of, at first, Dr Brian Bayne (1994–1998) and then Professor Jacqueline McGlade (1998–2000). After the retirement of Dr Brian McCartney (now Professor), Professor John Huthnance became acting Director at Bidston until the appointment of Dr Ed (A.E.) Hill, from April 1999. This also marked the start of six new core-strategic projects, linking the three CCMS laboratories.

The formation of the Centre for Coastal and Marine Sciences provided the setting for integrating the scientific effort in an interdisciplinary way, drawing on the strengths of each laboratory and affording the prospect of new opportunities for innovative research by the Centre as a whole. Even the domes are back to their original white!

Table 1 shows the various anniversaries that Bidston celebrated in 1999. To mark 70 years as an oceanographic laboratory a special conference on Irish Sea science was held. Even astronomically there was an 'anniversary' to celebrate. A feature of total solar eclipses is that they repeat under almost exactly similar conditions – called the 'Saros' – every 18 years 11.3 days. On 29 June 1927 Bidston Observatory was surrounded by 50 000 people observing the last total solar eclipse on the UK mainland. Four Saroses later we reached 11 August 1999, when a total solar eclipse corssed the UK, passing over CCMS Laboratory at Plymouth.

The Proudman Oceanographic Laboratory, 2000–

In 2000 the closure of the CCMS was announced and once again the Proudman Oceanographic Laboratory became an independent Institute under the Natural Environment Research Council. In response to the new circumstances new scientific plans were prepared drawing on the experience gained under CCMS. In a changing world Bidston

continues to be flexible in response to changing scientific challenges.

Bidston Observatory has had a remarkable history in so many ways. It has even had its 'show business' connections. The Director Jack Rossiter was brother of the comic actor Leonard Rossiter, particularly known for such television series as 'Rising Damp'. Also it must be a proud distinction, particularly for a Merseyside-based institute that it has had both Lennon and McCartney as Directors (Table 2)!

Bidston Observatory has evolved in many ways over the years in response to waxing and waning interests in various scientific fields, and has achieved great distinction in each of these. It continues to play a major role in UK Science, and on past performance will undoubtedly continue to build on its existing expertise, and will evolve to meet new challenges as required by both national and international needs.

Further Reading

'William Hutchinson – Local Hero' by Philip Woodworth (1998), *Ocean Challenge*, Vol. 8, No. 3, pp.47–51.

'Modelling the Tides for the 1988 Olympic Games' by Roger Proctor and Judith Wolf (1990) *Ocean Challenge*, Vol. 1, Spring, pp.10–14.

For more information about work undertaken at Bidston, see the Annual Reports of the Proudman Oceanographic Laboratory (or its predecessors), or see the website at: http://www.pol.ac.uk/

Table 2 *Changing names, changing Directors*

The Liverpool Observatory (after 1866 located at Bidston)
J. Hartnup 1843–1885
J. Hartnup (Jr) 1885–1892
W.E. Plummer 1892–1928

University of Liverpool Tidal Institute
Joseph Proudman 1919–1928

Liverpool Observatory and Tidal Institute
Joseph Proudman 1929–1946
Arthur (A.T.) Doodson 1946–1960

University of Liverpool Tidal Institute and Observatory
Jack (J.R.) Rossiter 1960–1969

Institute of Coastal Oceanography and Tides
Jack (J.R.) Rossiter 1969–1972
Geoffrey(G.W.) Lennon (Acting Director) 1972–1973

Institute of Oceanographic Sciences
David (D.E.) Cartwright (Assistant Director) 1973–1986
Keith (K.R.) Dyer (Acting Assistant Director) 1986
John (J.M.) Huthnance (Officer-in-Charge) 1987

Proudman Oceanographic Laboratory
(CCMS-POL, 1994-2000)
Brian (B.S.) McCartney 1987–1998
John (J.M.) Huthnance (Acting Director) 1998–1999
Ed (A.E.) Hill 1999–

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