Pen portraits of Presidents – Prof. Henry Charnock, CBE, FRS

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Introduction

The central theme in the research career of Prof. Henry Charnock was air–sea interaction, the complex processes of turbulent momentum transfer between the atmosphere and ocean. Between the 1960s and early 1990s, he had a considerable influence on the shape and direction of United Kingdom (UK) and international marine science. A full description of his life and achievements is given by Cartwright (1999).

Early years up to the end of WWII

Henry Charnock was born on Christmas Day 1920 in Blackburn, Lancashire. His father was an engineer's clerk and his mother, Mary (MacLeod), was from Inchnadamph in the Scottish Highlands. From 1926 to 1932 he attended Audley School, and from 1932 to 1937 Queen Elizabeth's Grammar School in Blackburn. He left school aged 16 to start as a junior assistant in a chemical laboratory in Blackburn. The laboratory was part of the Ministry of Home Security's respirator factory making gas masks in case of poison gas attacks on the UK. Henry's work included the preparation of poisonous gases for testing. When the attacks did not materialise, he faced being made redundant, but intervention from his trade union, the Institution of Professional Civil Servants (IPCS), allowed him to stay on. During the five or so years he spent there, he attended evening classes at Blackburn Technical College, enabling him to complete an external London BSc in general science in 1943.

With this degree, he was likely to be conscripted to a position requiring a science background and it seemed this might be as a Royal Navy radar officer. However, following an Air Ministry interview, he trained as a meteorologist. The course enthused him about the science of the atmosphere, but wartime exigencies meant that, as soon as he had qualified as a grade 2 meteorologist in the Meteorological Office, he was seconded as an RAF Volunteer Reserve Flying Officer and spent the war at various aerodromes in the UK, and later in Iceland.

His duties were to record meteorological observations and to make weather forecasts for the units to which he was attached. This was a responsible and challenging job, given his lack of experience and the limitations of forecasting at that time. It was also probably a somewhat isolating one. However, on his posting to the RAF flying boat base on Lough Erne (RAF Castle Archdale) in Northern Ireland, Henry discovered that relations with RAF personnel improved when he began to accompany them on their sorties. This also shaped his future career, for it was during long flights at low level over the North Atlantic that his interest in oceanic weather and the interaction between atmosphere and ocean was first kindled. It was further stimulated by the dramatic natural surroundings of his final posting, to RAF Geck (Keflavik) in Iceland. Henry was in Iceland when the war ended and, impatient at the delay in getting released and never one to adhere to rules if he thought they made no sense, he hitched a lift on a trawler to Fleetwood, 30 miles from his home.

Academic and research career

By the time he was demobbed in 1946, Prof. David Brunt had offered him a place on an MSc course in the Department of Meteorology at Imperial College, London. There, he was encouraged by Asst. Prof. P. A. 'Peter' Sheppard who advised him to augment his original degree with an honours degree in physics before embarking on research. Henry did not take this advice, perhaps because in 1946 he had married Mary Dickinson, whom he had met while they were both at the Technical College in Blackburn, and he did not wish to prolong his student days. He was awarded an MSc in 1948 and initially stayed in the department as an assistant to Sheppard. In collaboration with Sheppard, he began researching the turbulent structure of winds blowing over water. The behaviour of winds over uniform land surfaces such as the wheat fields of the great plains was already quite well understood, but it had proved far harder to get to grips with the more complex situation in which the lower boundary could deform. It had never been thoroughly investigated and so he had to start from scratch.

Henry designed arrays of cup anemometers to measure wind speed at different heights above the water surface and later employed theodolite tracking of meteorological balloons for observations at greater altitudes. Together with Sheppard and another member of the department, J. R. D. Francis, he made observations of wind-drag and turbulent flow in various locations to obtain a clearer understanding of the structure of winds blowing over the sea. Their first attempt, on Lough Neagh in Northern Ireland in 1949, measured wind velocity from a moored raft and changes in water level at the shore. They discovered that these latter observations were complicated by the seiching (sloshing) of the Lough. Their next site, in the westerly winds off the Scilly Isles, also presented problems, but in 1953, they found a site in the Atlantic trade winds at Anegada, the easternmost of the British Virgin Islands (Figure 1). Both sites had the required long fetch, but the low-level wind maximum characteristic of the Trades enabled a more robust determination of the wind stress profile (Charnock *et al.*, 1956).

The Lough Neagh work was a joint venture between Imperial College and the newly established National Institute of Oceanography (NIO) whose director, George Deacon, came to see the work. Since Deacon was keen to have all aspects of marine research represented in NIO, he suggested that Henry might like to work there. Later that year, Henry joined the Institute's marine physics group as a Senior Scientific Officer in the Royal Naval Scientific Service.

By the time the Anegada work was published, his career had opened out considerably as new opportunities and interests presented themselves. Most of his NIO colleagues had been in the Admiralty's Oceanographic Research Unit (Group W) (Figure 2), which had been set up in 1944 to study ocean waves. In their new guise, they continued to occupy their former premises at the Admiralty Research Laboratory at Teddington until a suitable site could be found to unite all the staff of the new institute, including biologists from the Natural History Museum. This was not until 1953 when NIO acquired an ex-Admiralty building at Wormley in Surrey. Throughout this period, Henry continued to work closely with his former colleagues at Imperial College. First, he completed some work on atmospheric diffusion, using Kolmogoroff's recent ideas on locally isotropic turbulence. This brought him into

Figure 1. Henry Charnock (centre facing camera) carrying out early fieldwork. Sheppard is on the far left. Though the metadata suggest this may have been at the Anegada site, the clothing was probably more appropriate for Lough Neagh (Archives, National Oceanography Centre Southampton).

contact with G. K. Batchelor (FRS, 1957) and in turn with T. H. (Tom) Ellison, an independent researcher who lived on the Isle of Man and who was to become a lifelong friend and collaborator. He obtained permission to use one of the reservoirs near Staines and set up a recording station there to make small-scale measurements of wind and waves without the complications found at Lough Neagh. He later recalled the bizarre scenario of his colleagues using watering cans to 'water' the reservoir surface with various liquids in an attempt to change the surface tension.

The resulting research note (Charnock, 1955) was the original definition of the 'Charnock constant' describing the aerodynamic roughness length over a water surface. Henry preferred to call this the 'Charnock-Ellison formula' to acknowledge Ellison's contribution. (In the 1970s, Charnock and Ellison were both involved with an Isle of Man company 'Air-Sea and Financial Studies Limited', which organised a NATO Advanced Study Institute on Air-Sea Interaction on the island in 1970, and also, no doubt to Henry's amusement, offered advice on the tax advantages of 'expressing a wish to be buried on the Isle of Man'!)

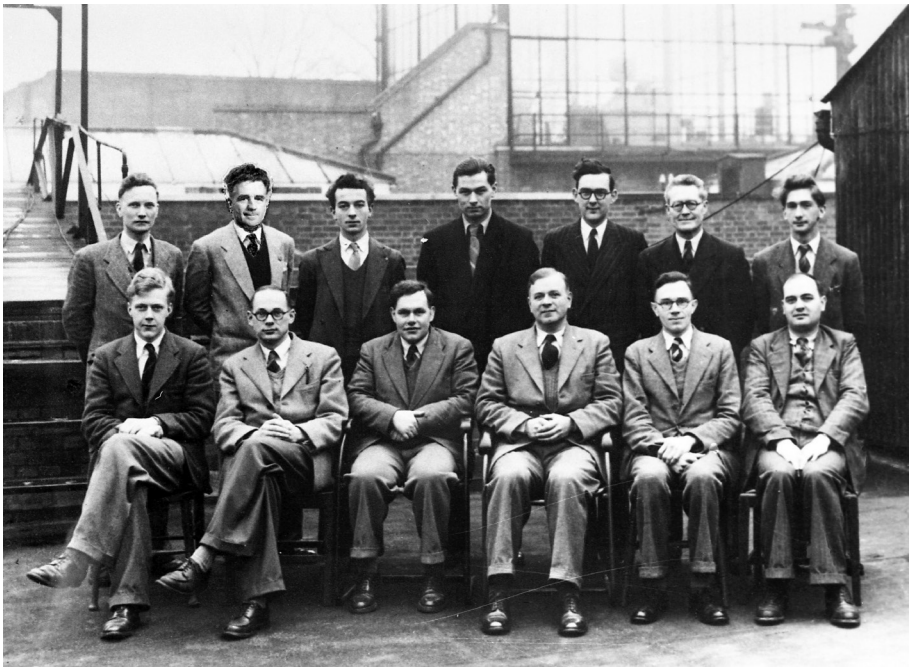

Figure 2. Group W shortly before the move from ARL Teddington to Wormley. Front row: James Crease far left, Henry Charnock and George Deacon third and fourth from left (see Laughton et al., 2010 for all names) (Archives, National Oceanography Centre Southampton).

The subject of air–sea interaction that he had chosen was an extremely complex one and did not yield rapid and dramatic advances of the kind being made in some other branches of marine physics, in particular revealing the internal circulation of the ocean. Indeed, it would take decades of research before the understanding of air–sea interaction was sufficiently well developed for its role in the physics and biogeochemistry of global weather and climate to be appreciated. Doubts and difficulties must have plagued its pioneers and may have been partly responsible for frequent about-turns in Henry's career.

The NIO was at that time a stimulating environment and many of his colleagues would go on to have distinguished research careers encouraged by the considerable freedom given to them under Deacon's leadership and backed by expert engineering and electronics support (Laughton *et al.*, 2010). NIO had developed a close relationship with Woods Hole Oceanographic Institution (WHOI) in the US where Henry Stommel was a driving force. Henry Charnock's links with WHOI lasted throughout his life.

Henry's interest in air–sea interaction continued, but he also took part in pioneering work on deep ocean currents and, in 1953 and 1954, worked with the Royal Navy investigating the structure of the thermocline off Malta and whether it was perturbed by the passage of a submarine and if the wake produced a surface thermal signature. The results were classified and unpublished. Henry's later explanation – given with a deadpan expression – was that neither he nor his colleague, James Crease, could distinguish between the latter's handwritten headings of 'stern' and 'stem' (the bow) of the submarine rendering the results useless. Crease remembered Henry as equally at ease with ranks from Admiral to stoker. Robinson (2018) notes that Deacon used the submarine work in the Mediterranean as an example of the value of an 'arms length' NIO to the Admiralty and hence NIO's need for its own home.

Though many of his ex-Group W colleagues worked at the Wormley laboratory throughout their careers, Henry was less settled. In 1958, he took a readership

at Imperial College yet remained there for only a year. A NATO research centre was being established at La Spezia in Italy and the Admiralty asked Deacon to find a physicist to head a group. Henry returned to NIO and was given a 3-year secondment to what is now the NATO Undersea Research Centre. There he gathered an international team of geophysicists and physical oceanographers to develop the understanding of the underwater environment needed for undersea warfare.

The time at La Spezia gave Henry good international contacts, strengthened his interest in the Mediterranean and developed his individual style of leadership and management. A memoir by his La Spezia colleague Tom Allan, (Allan, 2008), gives insights to this style. Henry found it bizarre that there were so many memos from the American administration. He therefore devised his own filing system – a length of stout plastic-covered wire with a knot at one end. Every memo was impaled on the wire and if someone enquired about a memo Henry, having established the date, would mutter that it must be 'about 3 inches down' and would emerge triumphant clutching the memo. When Henry left the Centre, he was presented with his filing system which by then could hardly be lifted.

The 3-year secondment stretched to almost six and Henry returned to NIO in 1964. The Institute had changed. It had a newly built research ship, *RRS Discovery*, but ties to the Admiralty, through the National Oceanographic Council, had weakened and so had Deacon's autonomy. Moves were being made towards NIO becoming a component of the Natural Environment Research Council (NERC) in 1965. Henry was then local chairman of the IPCS and expended considerable effort securing suitable terms for the NIO staff as they faced transfer from the Civil Service proper to NERC, a fringe body.

Between Wormley and Southampton

Perhaps, with these changes in mind, and having played a leading role at La Spezia, Henry moved again in 1966, to take up the newly created chair of physical oceanography at the University of Southampton. There, though he had a certain degree of freedom, he lacked the technological and logistical backing that he had enjoyed at NIO and La Spezia. He was, however, instrumental in giving a new direction to the department's academic courses.

The department had a much more coastal focus than he was used to and, in an effort to introduce a deep-water element, the department mounted a multi-disciplinary cruise aboard the *RRS John Murray* (a small, converted trawler) to the Tyrrhenian Sea in the summer of 1969. Henry was Chief Scientist. A NERC Research Vessel Unit had taken over the running of the research ships and provided a staff member to help run the cruise. It was certainly not a great success, and the cruise report shows clearly Henry's irritation about poor preparation and communication and defective equipment.

At the time that Henry joined, the Southampton University Department of Oceanography (SUDO), did not award undergraduate degrees, but in the 1970/1971 academic year, it offered physics undergraduates a course, 'Physics of the Earth and its Environment'. This included a module on Physics of the Atmosphere and Ocean taught by Henry. However, Henry provided minimal supervision for his research students being often away from the Department. He was already busy negotiating significant resources for the Joint Air-Sea Interaction (JASIN) experiment. Originally suggested by Charnock and Ellison at the 1967 Global Atmospheric Research Programme (GARP) Stockholm Conference as a UK contribution, Henry had negotiated sponsorship by the Royal Society. The first JASIN cruise in 1970 included a trial of a new radio-navigation-based balloon tracking system, which Henry had identified as a replacement for the pilot balloons used in his earlier experiments.

When Deacon (knighted 1971) retired from the Directorship of NIO in 1971, NERC sought his successor, but it was for a position very different from that held by Deacon. NERC was to bring three laboratories under a single administration. These were the NIO, the Institute of Coastal Oceanography and Tides at Bidston on the Wirral and the Unit of Coastal Sedimentation located alongside the Admiralty Hydrographic Department in Taunton. They would form the Institute of Oceanographic Sciences (IOS). Henry returned to Wormley as Director, assisted by Tony Rees, a geophysicist who he had recruited to Southampton and by Assistant Directors at Bidston and Taunton. The amalgamation was not achieved without feathers being ruffled and some staff resignations. One battle that Henry fought and won was that NERC had wanted to transfer the NIO marine biology group to Plymouth where there was another strong biology group. Henry succeeded in retaining the Wormley laboratory's multi-disciplinarity.

The funding and scientific environments were undergoing substantial changes too. Micro-electronics allowed sustained monitoring of the oceans to be contemplated and previously intractable problems to be addressed. The 1971 Rothschild report meant that laboratories such as IOS were expected to undertake commissioned research that addressed the priorities of Government Departments and were funded by them. This presented a challenge for the IOS Director to accommodate these changes while retaining the Institute's portfolio of curiosity-driven research.

In arguments with NERC and in Whitehall, Henry represented the IOS well and Tony Rees commented that '*He was able to argue his case, often to a potentially hostile audience, good humouredly and so cogently and in such reasonable sounding terms that he usually came out a winner. He won a lot because he was usually right*'.

Two areas of commissioned research are noteworthy. The largest, and that which had the biggest impact on IOS, was research into the feasibility of disposing high-level radioactive waste on or under the deep-sea floor. The second was to provide the environmental information to allow safe oil and gas field development in deep water north and west of the UK. The former involved all of IOS's disciplines and resulted in substantial recruitment, and the latter involved mostly physics but established long-term monitoring sites using moored instruments.

An increasingly global perspective

In 1960, TIROS-1 – the first earth observing satellite – was launched, which revealed the Earth's weather systems, though in a very crude manner. Its images and those of its successors, together with the 'blue marble' image of Earth from the 1968 Apollo 8 mission and the first computer models of a coupled ocean/atmosphere system (Manabe and Bryan, 1969), drew attention to the global ocean and its key role in climate.

Henry presided over the International Union of Geodesy and Geophysics (IUGG) from 1971 to 1975. His role as President arguably stimulated IOS to become involved in important international experiments. The GARP Atlantic Tropical Experiment (GATE) in June–September 1974 made observations in the inter-tropical convergence zone off West Africa. Steve Thorpe (RMetS President, 1990–1992) was Chief Scientist on *RRS Discovery* measuring currents and thermal structure in the upper ocean using a variety of instruments including a Canadian towed undulating vehicle known as Batfish.

This, relatively modest IOS contribution to GARP contrasted markedly with the main JASIN experiment in July–September 1978 in the Rockall area. Co-ordinated by the UK with Henry as the project Director, JASIN involved 50 teams of investigators from 9 countries, 14 ships and 3 aircraft as well as 32 moored observatories, some of which were commissioned by the Department of Energy (Pollard, 1978; Pollard *et al.*, 1983). The upper ocean was surveyed by Seasoar, IOS's much improved derivative from Batfish.

JASIN was the last of a series of multi-ship air–sea interaction experiments conducted by various countries during the 1970s. Its heritage could be traced to Henry's earlier experiments. Interpretation of the JASIN data was, however, hampered by the horizontal variability in both the atmosphere and the ocean at the chosen mid-latitude site. Such an experiment if conducted today would be in a much better defined oceanographic and meteorological context. It is probably fair to say that the main results, published in the Proceedings of the Royal Society, would not alone have justified the resources deployed.

Fortuitously however, JASIN coincided with the brief (100 days) operating life of SEASAT, the first satellite with a specific ocean focus. The satellite's premature failure was before the planned ground-truth experiments had been performed. Thus, the JASIN observations became an invaluable source of high-quality ground-truth for the evaluation of the scatterometer measuring the wind field and the radar altimeter measuring both waves and sea-surface height variations. This information would influence future research missions such as the European ERS-1 and 2 and the French/US TOPEX/POSEIDON as well as their operational successors. A couple of years before SEASAT, Henry had recruited his former La Spezia colleague, Tom Allan, to develop satellite remote sensing at IOS. Henry's foresight enabled the institute to play a pioneering role in ocean remote sensing.

Henry was elected to Fellowship of the Royal Society in 1976. The citation, mentioning his scientific contributions to oceanography and meteorology, noted that he had '*been active in promoting co-operative and interdisciplinary work in the earth sciences*'. The Royal Society Biographical Memoir (Cartwright, 1999) includes a full list of Henry's publications and awards.

By 1978, he was 2 years short of NERC's mandatory retirement age of 60 and he moved back to the Department in Southampton. He was succeeded as IOS Director by Anthony (A. S.) Laughton (knighted 1987). In Southampton, he replaced Prof. John Woods who had been appointed to a chair of physical oceanography in Kiel, Germany. (Woods was another alumnus of Imperial College who had also worked extensively on the thermal structure of the upper ocean and with focus on the Mediterranean.)

Shaping science

Following his IUGG presidency and his Royal Society Fellowship, in 1980 Henry was elected to the 2-year Presidency of the Scientific Committee for Oceanic Research (SCOR). SCOR was, and remains, the international body that represents all disciplines of marine science. From 1982 to 1984, he was also deputy Vice Chancellor of Southampton University.

With his experience in academia and of UK government science and his international perspective, Henry became involved in a wide range of strategic decisions relating to UK marine and environmental science and policy. In 1984, he was invited to contribute to the work of the House of Lords Select Committee examining the state of marine science and technology. Its report contained much criticism of the funding level and lack of policy in the UK compared with other countries. Eventually, a Coordination Committee chaired by Sir John Mason, FRS (RMetS President, 1968–1970), was established to develop a national strategy. One of its conclusions was that there should be stronger associations between the research institutes such those of NERC and university departments. Henry was in a unique position to highlight the synergies between Southampton University and IOS (Nash and Sherwood, 2002), and the Committee specifically recommended this union.

In the meantime, NERC appointed its own Science Directors and in 1986 John Woods assumed responsibility for Marine and Atmospheric Sciences. This was a position of considerable influence in allocating funding to laboratories, setting research priorities and directions. The strategy's implementation led to the allocation of resources supporting the UK's involvement in the World Climate Research Programme's World Ocean Circulation Experiment (WOCE). Woods had been a member of the WOCE international Scientific Steering Group from its start in 1982 until 1989 and IOS hosted the WOCE International Project Office starting in 1983. It also allowed *RRS Discovery* to be modernised to fit it for the extended WOCE missions. In 1989/1990, government funding was allocated to establish an Oceanography Centre in Southampton as a fusion of IOS, the Southampton Departments of Oceanography and Geology and the NERC Research Vessel Services. The new building in Southampton docks opened in 1995 (Figure 3). As a precursor, in 1990, NERC established the James Rennell Centre for Ocean Circulation in Southampton as the scientific focus of the UK's contribution to WOCE. It was headed by Raymond Pollard who had worked closely with Henry and with John Woods in upper ocean dynamics.

Figure 3. This portrait of Henry, painted by his wife Mary in 1998, now hangs outside the Henry Charnock lecture theatre at NOC in Southampton (Archives, National Oceanography Centre Southampton).

In retrospect

Henry was honoured with a CBE in 1992 in recognition of his work on the Royal Commission on Environmental Pollution (1985–1994) and

as Chairman of the Research Committee of the Meteorological Office. Though his scientific interests were broad, his bibliography contains a relatively modest number of original research papers. He had, however, a broad view of many areas of marine and atmospheric sciences and wrote many authoritative reviews. He was the first President of the Royal Meteorological Society who had an oceanographic as well as a meteorological background and it was during his presidency (1982–1984) that the Society's History Special Interest Group was established.

He undoubtedly influenced the evolution of the structure of marine science in the UK, one legacy of which is the NOC in Southampton. Despite his rather cavalier attitude to research students and his mischievous Machiavellian streak, he was respected for his honesty, integrity and staunch defence of just causes. By nature, he was financially frugal with public funding, a characteristic he shared with several of his early NIO colleagues. This involved the use of modest accommodation and economical transport to meetings. However, he was generous in other ways, notably hosting an open house each year for neighbours and colleagues in his and Mary's home in Witley on Boxing Day.

Away from work, Henry read extensively and listened to music – Beethoven quartets were a particular love. He disliked gardening but enjoyed walking as a recreation. He and Mary celebrated their Golden Wedding in 1996 by climbing Snowdon, and on another occasion trekked across the Grand Canyon together. His interest and involvement in science continued until he died after a short illness just short of his 77th birthday. His memorial concert in Southampton University's Turner Sims concert hall featured Beethoven quartets.

Acknowledgements

In addition to the referenced documents, this pen picture incorporates material from a manuscript by Margaret Deacon describing Charnock's early life and from an anonymous, incomplete biography found among papers in the SUDO. Inputs from Peter K. Taylor and Trevor Guymer focus on the JASIN experiment. It also draws on comments by Ian Robinson, Neil Wells and Norman Hamilton who described his influence in the University of Southampton and Howard Roe on Charnock's influence on UK Marine Science and Technology. The assistance of Harry Bryden, Kate Davis and Emma Guest, University of Southampton, is also gratefully acknowledged. It is written at the request of the RMetS History of Meteorology and Physical Oceanography Committee, of which the author is a member. Writing pen portraits of past RMetS Presidents in *Weather* is a current responsibility of the group.

Data availability statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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