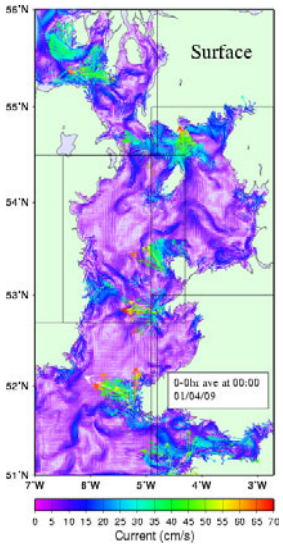
Proudman Oceanographic Laboratory

Coastal Observatory

5-year review



Coastal Observatory
Irish Sea

Proudman Oceanographic Laboratory
NATURAL ENVIRONMENT RESEARCH COUNCIL

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1. Contents.

Jonathan Sharples

2nd April 2009

2. Background.

A full description of the rationale for instigating a review of the activities of the POL Coastal Observatory is attached. The review began in July 2008 with the aim of addressing the following broad issues:

1. As the Observatory reaches its 5th anniversary, it is timely to review the scope of the work carried out in the context of the scientific objectives of the Observatory.
2. There are already some plans for expansion of the work carried out within the Observatory, but there are issues of resource availability that need to be assessed prior to such expansion. In particular, the OETG are arguably already over-stretched, and there is a long-term problem of a lack of POL scientist time available for work on the Observatory data that leads to peer-reviewed publications.
3. The Observatory was set up initially, and driven largely, through the combined efforts of Roger Proctor and John Howarth. The departure of Roger to a new job at the University of Tasmania, coupled with the semi-retirement of John Howarth, mean that the management and leadership of the Observatory need to be assessed.
4. The work carried out by the Observatory is part of POL's "National Capability" (NC), funded through NERC's NC route. We need to assess regularly that the Observatory continues to fulfil the requirements of NC. In particular the Observatory needs to underpin excellent science.
5. In addition to NC, the Observatory needs to demonstrate clearly that it contributes to NERC's "National Good". We need to assess the involvement with key stakeholders, what they currently get from the observatory, what they would like in the future, and also to watch for new stakeholders that we could benefit. There are high priority drivers for the provision of marine data from coastal and shelf seas for the UK Marine Monitoring and Assessment Strategy (UKMMAS), and providing evidence for "good environmental status" under the EU Marine Strategy.

The overall challenge for the Observatory is that in needs to fulfil 3 roles: **(1)** provide practical, high quality support for stakeholders, **(2)** provide a sound, reliable, sustainable framework of oceanographic observations as context for UK coastal/shelf sea research,

and **(3)** carry out roles (1) and (2) within a structure that has clear scientific rationale and goals.

The review was carried out by two working groups. Working group 1 (Science drivers and OETG[1] support) focused on the overarching science of the observatory and on the sustainability of support provided for the rest of the UK research community (roles (2) and (3) above). Working group 2 (Stakeholder Dialogue) focused on existing and potential stakeholders to assess how the Observatory is currently used and how it might serve future stakeholder requirements (i.e. role (1) above).

Below are the summary reports provided by the 2 working groups.

3. Working Group 1: Science Drivers and OETG Support.

3.1 Overall Scientific Context.

The original Observatory scientific objective was stated as:

> *To understand, through effective continuous measurement and modelling, a coastal sea's response to natural and anthropogenic forcing and demonstrate the value of an integrated approach to marine environmental management.*

In assessing the scientific rationale behind the Observatory it was felt that this contains both a science framework (understanding natural and anthropogenic forcing) and a broad operational/management aspiration. The latter does not fit well within the context of POL's research remit nor with the concept of providing a framework for excellent science under National Capability. While proving the concept of an integrated approach to marine environmental management is relevant through our links to key stakeholders (particularly Cefas, the EA and Defra), it is not a scientific driver of our Observatory activity. Instead we suggest the following over-arching science objective for the Observatory:

> *To monitor and understand the impacts of natural and anthropogenic forcing of a shelf sea, and to provide a framework for research into the functioning of a shelf sea in a changing climate.*

[1] Ocean Engineering and Technology Group

In assessing how the present Observatory operation is able to address this objective, there are two important considerations.

First, the extent of the original Coastal Observatory (primarily within Liverpool Bay) limits the possibilities for the Observatory results to be relevant on a broader national or international stage. Liverpool Bay has a distinct “ROFI” (Region of Freshwater Influence) behaviour that is not common in other coastal seas (there are other examples, such as the Rhine outflow region, the large estuaries along the North American east coast). While internationally-relevant process studies can still be carried out within Liverpool Bay (e.g. on sediment transport, sediments and optics, wave-current interactions), a broader reach of the scientific context requires (a) a larger, better defined area such as the Irish Sea, and (b) a greater range of physical environments, such as permanently-mixed and seasonally thermally stratified shelf waters. This would allow questions of much broader scope to be addressed; e.g. what are the key processes controlling carbon cycling and fluxes in a shelf sea, how are nutrients supplied to and utilised within a shelf sea, how will a shelf sea change as our climate warms? Options for such expansion will be addressed in section 3.4.

Second, the modelling component has made rather slow progress. A pre-operational system was set up that successfully incorporated three POLCOMS domains (Atlantic Margin Model (~12km), Medium Resolution Continental Shelf (~7km) and Irish Sea(~1.8km)). This automatically acquired forcing data from the UK Met Office, ran the models on a daily basis and displayed output on a set of web pages. As a technical exercise this was a success, but it failed to fulfil its potential in a number of important respects: (1) the modelling element did not engage with the scientific motivation of the coastal observatory particularly well; (2) it never fulfilled our aspirations to have a multi disciplinary system; and (3) the work was generally ‘bogged-down’ in the technical difficulties in keeping a system running operationally. For example it was (and remains) very vulnerable to any gaps in our data feeds. The modelling component always suffered from the over-commitment of Roger Proctor’s time. Following Roger’s departure, and combined with the need to recruit a band 6 modeller to the Observatory, modelling activity almost ground to a halt. This is now being addressed (see section 3.6).

3.2 Suitability of the Existing Observations.

The existing Observatory set-up was assessed for its suitability in tracking the fundamental dynamics of Liverpool Bay. The infrastructure has some notable successes:

- The collaboration with Cefas at site A provides a comprehensive set of physical and biochemical data from long-term moorings within the immediate output of the Mersey.
- The HF radar provides excellent coverage of tidal and residual surface flows and waves in the vicinity of the Mersey mouth, with a time series that probably represents one of the key, high-quality datasets produced by the Observatory. This is a dataset that should be producing scientific publications.
- Remote sensing (via the link to NEODAAS at PML) and the ferrybox data are vital in the larger context of the whole Irish Sea.

The following points for changes/improvements are noted:

- Mooring site B is not in a suitable position. It's position was chosen to allow direct calculation of the horizontal temperature and salinity gradients (with site A) through Liverpool Bay, but also needed to take into account mooring survival within busy shipping lanes. It's present position does not provide adequate data. A shift northward is recommended, away from the North Wales coastal influence and into a region more broadly representative of Liverpool Bay.
- The CTD grid only reaches west as far as Great Orme. Ideally this should be extended beyond 4°W so that it reaches into the permanently-mixed region.
- The CTD grid needs to be augmented with more near-coast data.
- While a 3rd mooring site has been planned, and has strong scientific merit in expanding the range of the Observatory, there are significant resource issues that need to be considered (see 3.3).
- More attention needs to be applied to instrument calibration and data quality; poor quality data is worthless in both the scientific and stakeholder/policy arenas. Several data types have been identified that fail to reach acceptable standards of documented data quality and calibration procedures. Any observational system must be able to demonstrate stringent quality control procedures so that data can be held up with confidence, for instance in peer-reviewed scientific literature or when presented to stakeholders for management purposes. This problem is largely the result of limited scientific resource being applied to Observatory data;

documented procedures combined with an increase in the use of the data for science (which naturally spotlights data quality) are required. There has also been a tendency to prioritise keeping instruments in the water to maintain timeseries rather than accepting gaps in a timeseries as a necessary compromise for achieving dependable data.

3.3 Pressures on OETG and Scientists.

Prior to the review it had become clear that pressures on OETG staff were reaching the stage when POL would not be able to support both Observatory activities and other POL research cruise requirements. Plans for a 3rd mooring site and additional ferryboxes, as well as additional instrumentation such as the Glider and the turbulence profiler, would push this situation well beyond breaking point.

Two possible routes towards reducing OETG effort were investigated:

- Reduce the number of Observatory survey cruises from the present 9 per year to 6 per year. This was discounted primarily because of servicing requirements on the mooring instruments. Accurate salinity data, and stable data from any optically-based instrument (e.g. chlorophyll fluorescence, optical backscatter) requires frequent instrument servicing. Reducing to 6 survey/servicing cruises would threaten the quality of the collaborative work carried out by Cefas.
- Reduce OETG involvement on the Observatory cruises. A route to this has been identified based on mobilising Observatory cruises from Birkenhead rather than Menai Bridge. Considerable travel time and vehicle rental is saved, and vessel loading is not restricted by tides or a narrow walkway as at Menai Bridge. It is likely that OETG staff on a cruise can be reduced by at least 1 (from 3) as instrument set-ups and mooring construction can be carried out on the dock prior to vessel sailing. There are additional costs associated with this, mainly fuel and use of the lock; approximately £2,500 per cruise.

Scientific resources are presently targeted mainly at management and logistics support for the Observatory data, with considerable effort required to run cruises, collect data, and maintain the Observatory web pages (including the real-time data streams). More effort is needed for science question-driven activities that critically assess and use Observatory data to lead to peer-reviewed scientific publications. With the reduction in

scientific resource by 1.5 staff (Roger Proctor and half of John Howarth) this does require recruiting new staff. There are two recommendations:

- Recruit a band 6 scientist to share some of the responsibilities for running the Observatory, and to drive question-driven science. Jo Hopkins started at POL in September 2008, bringing new skills in remote sensing to POL. She is currently augmenting the Observatory's remote sensing components within the context of tracking frontogenesis in Liverpool Bay, and will be taking on responsibility for quality control of ferrybox data.
- A shift in how POL as a whole views work within the Observatory. There is a tendency to compartmentalise staff which can limit the use of both Observatory data and of the Observatory as a context for other process-based questions. We need to encourage people to view themselves as oceanographers working within POL; some staff have responsibilities for Observatory activities, but they should still have a view of science that encompasses all that POL has to offer. The Observatory needs to be seen as a tool available to all POL staff.

Further recommendations relevant to both OETG and Science staff are:

- The 3rd mooring site should not go ahead unless we can collaborate beyond POL with a group capable of maintaining the mooring. POL is in a position to supply instrumentation for a mooring, but cannot commit effort to maintain and service the mooring (see 3.4).
- Maintain 2 ferryboxes (Liverpool-Dublin and Liverpool-Belfast) rather than the planned 3. OETG have also taken on 1 new staff which will release some of the ferrybox servicing from Chris Balfour.
- Better planning of new instrument purchases (capital) is required, with a clear scientific rationale and a clear understanding of where the support for the instrument will come from. One very useful route to supporting new measurements is through our links with the Department of Earth and Ocean Science. Dissolved inorganic nutrients and dissolved oxygen have become key parameters for the Observatory as a direct response to stakeholder needs. A POL-purchased nutrient auto-analyser is now being run by Dr. Claire Mahaffey at the University of Liverpool, aiding both the Observatory and Dr. Mahaffey's own research (which includes joint Liverpool-POL PhD students). This successful model is planned to be repeated with a precision system for dissolved oxygen

- Maintaining any timeseries, and in particular running real-time data streams, is time consuming, both for OETG and for science staff. Observed parameters and the need for real-time data need to be prioritised, and not maintained if there is no scientific, research/development or stakeholder requirement.

3.4 Options for Expansion.

The overarching scientific driver for the Observatory requires expansion of Observatory operations to cover at least the whole Irish Sea, and arguably in the future to cover the Celtic Sea. This would seem incompatible with the efforts, described above, to reduce demands on OETG staff and to rationalise science staff effort to allow more work on peer-reviewed outputs.

Expansion of observatory work can, however, be carried out once it is recognised that there are several potential partners in other institutes who are already carrying out such work in the Irish and Celtic Seas. A broader view including all of the observatory activity around the UK indicates that there exists the potential for a UK-wide monitoring network. No single institute has the resources to enable observatory work on such a scale, but together the combined activity is well placed to justify strongly observatories as National Capability and to demonstrate the key role to be played in management of the whole UK marine environment.

We are now working towards developing a co-ordination of the complimentary activities being carried out by other within the Irish and Celtic Seas, which we see as one stage in a larger co-ordination across the UK. Jonathan Sharples and Andrew Willmott visited Richard Gowen at the Agri-Food and Biosciences Institute (AFBINI), Belfast. There is very clear mutual interest in connecting our observatory work to form a larger Irish Sea capability. In particular, Richard Gowen already has a long-term mooring within the western Irish Sea which was one of the sites being considered for POL's 3rd mooring site. There is great potential for a significant collaboration. In addition, a DEFRA-funded workshop, hosted by Cefas Lowestoft (Dave Mills) is planned for March 18th – 20th. This will include Cefas, POL, AFBINI, PML, and the Irish Marine Institute, with a stated aim of achieving something concrete towards wider collaboration of existing observatory work.

Update: As this review report was being finalised the workshop hosted by Cefas took place, 18-20 March 2009. Jonathan Sharples was the POL representative. The following points are noted:

- The workshop was attended by representatives from Cefas, POL, AFBINI, PML, SAHFOS, NOCS, and the Irish Marine Institute, with a supportive message and material from SAMS.
- The initial focus of the workshop was on the new Cefas Smartbuoy, funded by Defra, for deployment in the Celtic Sea by AFBINI. All participants provided background to their institutes Observatory and research interests in the Irish Sea / Celtic Sea region.
- Cefas and the Irish Marine Institute are now collaborating, with Cefas providing basic surface water instrumentation for deployment on the Marine Institute's ODAS meteorological/wave buoys.
- All participants were keen to develop a more connected Observatory encompassing all the individual activities. An umbrella Observatory, the "Western Shelf Observatory", will be set up.
- The first stage of the Western Shelf Observatory is to develop a web portal that describes the Observatory and participants and provides links to the individual "sub-observatory" web sites already run by the participants. Richard Gowen took on the task of using AFBINI resources to take this forward.
- It is planned to have a viable Western Shelf Observatory network running in about 6 months, with a suitable launch event used to publicise this new scope for UK marine monitoring and science.
- A parallel was drawn with the European Marine Ecosystem Observatory (EMECO: http://www.emecogroup.org/). EMECO is a partnership between the Observatory activities of nations bordering the North Sea. One important strength is that the group activities are targeted towards producing types and formats of information suitable to address the management and policy requirements of the key stakeholders (Defra in the UK case).
- There was some discussion on labeling the Western Shelf Observatory as a part of EMECO. POL argued against this. Cefas (the driving organization behind EMECO) has very clear responsibilities towards one main stakeholder (Defra) which has to a large degree defined the character of EMECO. POL suggested that a true UK-wide monitoring network should be reaching a diverse range of stakeholders and research needs (e.g. see evidence presented in section 4). While EMECO is providing important examples of how to design outputs suitable

to stakeholder requirements, it represents a subset of the total stakeholder activity that the POL Observatory has and that the Western Shelf Observatory has the potential to deliver. We should certainly collaborate with EMECO where relevant.

3.5 Present University Research Attached to the Observatory.

The following are significant projects currently run collaboratively between POL and Liverpool University:

- Claire Mahaffey (Department of Earth and Ocean Science): Nutrient concentration in Liverpool bay. Samples collected at surface and bottom during each CTD. Analysed using POL purchased instrument. Contribution towards Clare Davies (Department of Earth and Ocean Science) PhD (Jonathan Sharples is a co-supervisor).
- Claire Mahaffey (Department of Earth and Ocean Science): SOFI studentship, *'How does pulsed stratification alter coastal primary and secondary production? A case study in Liverpool Bay'* Anouska Bailey started September 2008, Jonathan Sharples is a co-supervisor.
- Stan van den Berg/Conrad Chapman/Pascal Salaun (Department of Earth and Ocean Science): Investigating trace metals concentration in Liverpool Bay. Includes development of new instrumentation, proposed CASE studentship bid.
- Chris Frid (School of Biological Sciences): annual benthic survey.
- Andy Plater (Geography): Sediment survey, grab samples taken at each CTD station to produce a long term record of sediment composition in Liverpool Bay
- Jennifer Edwards (School of Biological Sciences): deterioration studies for Molecular Microbial Ecology Group.
- Colin Jago, Bangor university: suspended sediments in coastal and shelf seas.
- Elena Stoica (School of Biological Sciences): Marie Curie Intra-European Research Fellow. Investigating ammonia-oxidizing microorganisms, FP7 EU Research project ERAMMON.
- Lucy Abram (Department of Earth and ocean Science): PhD student (George Wolff, Chris Frid, Jonathan Sharples supervisors) studying ecosystem functioning in the Eastern/Central Irish Sea, starts April 2009.

Collaborative research with other University and Centre partners:

- Tom Rippeth (Bangor) investigation of '*The fate of freshwater in tidally stirred shelf seas*'. PDRA at UWB and PhD student Eleanor Howlett baed at POL (co-supervisor John Howarth). Further collaboration within this project includes 1-D modelling by Hans Burchard (Warnemunde, Germany).
- PML (Nick Hardman-Mountford)/Bangor University (Gay Mitchelson-Jacob). Emmer Litt CASIX PhD project and the CARBON-OPS NERC KT Project: Temporal variability of C02 flux estimates in contrasting shelf sea regimes, involves PhD (Emmer Litt, PML/UWB) project.
- NOCS: David Hydes, Defra contract on a study to define the present state of UK waters with respect to potential changes in the degree of acidification (pH), combining collection of new data over two years, review of pre-existing information and numerical analysis. (Data collection within the Irish Sea/Liverpool Bay will started on the October 2008 cruise). Other areas will be covered by PML, FRS Aberdeen, NOCS and UEA.
- Suzanna Ilic (Lancaster University): Observatory data for coastal erosion work, and incolved in MICORE and COFEE projects.
- Sheffield University: PhD student (Lucy Wyatt and John Howarth supervisors) working on the HF radar.
- In addition web statistics are taken on research users who are not necessarily involved with cruises. There are 550 active users who have downloaded data in the last 6 months. Users describing themselves as *research users* at registration make up 30%.

All the above collaborations are ongoing. Most requests for space on Observatory cruises are made informally, and space has usually been found. Likewise, any requests for additional data to be collected during surveys have generally been met. Observatory cruises have now reached the stage where there is barely enough time to carry out sample processing between survey stations; a typical Observatory survey is now collecting as much data as it is possible to collect. While this represents considerable added value to the money that POL invests in time on the RV *Prince Madog,* the success of the surveys in attracting other participants means that a more measured approach is now needed to assess both the success of existing collaborations and the

merits of new suggestions. A system similar to that run by NEODAAS (PML's remote sensing service) may be a useful model. New applications include a project description and details on data and/or berth requirements. Existing collaborations, particularly those where Observatory staff collect the samples and send them off to the collaborator, need to be assessed regularly, probably annually, to make sure they are still active.

One suggestion made by this review was to free up some cruise time partially to release pressure on OETG staff (see section 3.3) and also to provide more flexibility in allowing other researchers access to vessel time without being unduly constrained by a pre-determined Observatory cruise plan. While significant reductions in the number of survey/servicing cruises has been found to be impractical, the timetabling of Observatory cruises is now being made more flexible so that our collaborators can have more input to when/where the ship should go. The cruise planning for 2009 is testing this approach by timetabling cruises both in terms of survey/servicing requirements and to address particular science-driven issues on biological responses to cycles in physical stability (the PhD research of Anouska Bailey, University of Liverpool). Additional cruise time has also been made available via our interactions with Bangor University, and by utilising the *Prince Madog* within the Eastern Irish Sea for other POL process-focused research.

3.6 Observatory Modelling Strategy.

An important component of the original rationale for the Observatory was to provide a link between real- or near-real time observations and POL's expertise in numerical modelling in coastal and shelf seas. This link between observations and modelling was to occur on 3 levels.

1. Observations would provide details on particular processes suitable for rigorous testing of model capability.
2. Model failings would allow identification of processes either poorly parameterised, or not included, within the models and so lead to model improvements and targeting of observational effort.
3. Numerical modelling can be used to demonstrate the potential for regular forecasts of physical and biochemical conditions within the Irish Sea. POL has neither the resource nor remit to allow us to operate operational modelling, but we can develop the necessary models and show the strengths of an operational capacity through, for instance, well-defined case studies and scenario tests.

Longer-term predictions (e.g. several years – the next century) do, however, fit within the scientific scope of POL's work and the Observatory's scientific objective.

Following recent appointments the modelling group is now moving the Observatory modelling forward again. One new post (Claire O'Neill) was specifically targeted towards Observatory modelling. Jeff Polton also plays an important role in investigating physical processes in the Irish Sea through a combined model –observation approach. A new modelling strategy now needs to be formulated for the coastal observatory, particularly addressing the questions: (1) What are the time scales (both forecast and hindcast) our stakeholders are interested in and that relate to our key scientific questions? (2) What are the modelling approaches that are needed to answer these needs and questions (some will be tried and tested some more radical)? (3) What level of "pre-operational" capacity can we realistically expect to develop and support? We need then to design an approach that is appropriate to the scientific and stakeholder needs, and is synergistic with the operational agencies (particularly NCOF and the Met Office).

3.7 Scientific Outputs.

Prior to the Observatory review there was a perception that the number of scientific outputs, particularly peer-reviewed papers, was lower than we might expect a substantial area of National Capability to be delivering. During the review it was discovered that the situation was not as bad as originally thought, and a detailed list of Observatory outputs is now being maintained on the web pages:

http://cobs.pol.ac.uk/cobsadmin/outputs.html

However, there are 2 issues that the review raises:

1. A number of peer-reviewed publications that utilised the Observatory had not made it clear within the acknowledgements that Observatory data and/or vessel time had been used. There is a need to encourage a more rigorous approach of collaborators and POL scientists to acknowledging Observatory resources when they have been used. It is noted that other major components of National Capability (e.g. NEODAAS at PML) make such acknowledgement a clear condition for the use of their data; these

acknowledgements are then an integral part of the regular collections of evidence used to justify further support.

2. A moderate rate of publications in the first 5 years of the Observatory can be justified due to the time required to set up Observatory data streams, ensure good quality control, and to collect data series of sufficient length to address the original Observatory rationale. As the Observatory passes through its 6th year we should expect an increasing rate of publications; it is vital that science staff effort is available for this.

4. Working Group 2: Stakeholder Input.

4.1 An Observatory as a Management Tool.

The second objective of the original Observatory rationale dealt with demonstrating the potential use of observatories for the effective management of coastal seas and resources:

> *To provide the science that will underpin an ecosystem based approach to marine management and integrated coastal zone management.*

Over the 6 years of operation the Observatory web pages have attracted a large, consistent group of stakeholders who re-visit the site regularly. This involvement of so many different groups is a great strength of the Observatory. Based on the wide range of stakeholders that actively use the Observatory web pages the original objective is too narrow. Also, in the context of demonstrating the Observatory's role as a contributor to "National Good" the somewhat aspirational objective does not characterise the Observatory's strengths as well as the real day-to-day connections with stakeholders. A more suitable objective is:

> *To provide customised scientific information targeted to the requirements of a range of stakeholders, and to foster recognition of the roles that sustained coastal/shelf sea monitoring and modelling can play in the management of the marine environment.*

In order to develop this focus, running parallel with the scientific aims, the Observatory has developed a strong Steering Group with a large non-research stakeholder contingent, ranging from local groups (e.g. Sefton Council, the Mersey Harbour Authority) to national agencies (e.g. Cefas, the Environment Agency). A full list of the current Steering Group is included in Appendix 2.

The Observatory review used both the Steering Group and the larger group of stakeholders known through their interactions with the observatory web pages to collate information on the types of stakeholders that current use Observatory data and on the particular types of data that are most used.

4.2 Registered Users of Observatory Data.

Anyone requiring data from the observatory needs to register their interest on the Observatory website (which is free), and then they have access to the majority of Observatory data. An assessment of the current users of the Observatory website yielded the following breakdown of user groups ("active" here means that the user has downloaded data within the past 12 months):

- Government (64 Total, 45 Active)
- Research (248 Total, 175 Active)
- Commercial (68 Total, 48 Active)
- Educational (116 Total, 88 Active)
- General interest (368 Total, 162 Active)

The total number of registered users is 940, with 560 being active.

4.3 Stakeholder Groups.

The review noted 4 main groups of stakeholders:

1. Major stakeholders:

    Environment Agency
    Sefton Council/Coastal Engineering UK Ltd. (Representing Cell 11, Coastal Defence)
    Met Office
    Natural England
    Cefas
    Mersey Docks and Harbour Company
    Isle of Man Government
    Local emergency services
    Lancaster University (representing university interests)

Most of the major stakeholders are represented on the Observatory Steering Group.

2. University researchers involved with our Survey cruises.
   See section 3.5.
3. Users registered for data via website (research, commercial, education & general interest).
   Assessed using a web survey.
4. General internet usage (views of all open information, not registered to download data).
   This usage was assessed through analysis of internet log files.

4.4 Observatory Data Use by Stakeholder Groups.

The major stakeholders use various sources of Observatory data (Appendix 3). The most important data are observations of waves provided by the WaveNet buoy, and also the HF and X-band radars. Primarily this is monitored in the context of coastal defences. The Environment Agency also uses Observatory data (particularly water quality) to augment their own coastal surveys (between the coast and the closest inshore survey position visited by the RV *Prince Madog* during Observatory cruises).

A list of the replies received from registered users (data via the website) is included in Appendix 4. This is an edited list of replies received from research and commercial users, and so is somewhat patchy in the detail (e.g. who is using the data, which data, and what for). However, the Observatory data are clearly being used for research purposes ranging from undergraduate dissertations and essays to NERC responsive-mode projects. Commercial work ranges through a broad range of government and non-government projects. Not surprisingly, much of the commercial work is focused on the development of wind farms in the region. Also, while the list in Appendix 4 reflects data usage from a wide range of groups, the main data types used is quite limited. Most of the data used are meteorological, waves, and sea level, with the broader oceanographic data being utilised far less often. This is particularly the case for the commercial users.

In addition to research and commercial use, the web survey received a considerable number of replies from schools and colleges (about 100 replies), and from the general

public (>300 replies). Again, the majority of users require meteorological and tidal height data. These replies have not been included in this report, but are available on request.

4.5 Future Plans for Stakeholder Engagement.

Current Priority Data.

Based on the replies from both major and other stakeholders, there is a clear need to maintain, possibly extend, the Observatory meteorological data and wave data. This data needs to be seen as having a high priority. This knowledge should inform (though not necessarily completely determine) our discussions on new instrumentation and priorities in real-time data transfers.

Expansion of the Observatory.

The original drive to expand Observatory scope from Liverpool Bay to the Irish and Celtic Seas was driven primarily from a science/research perspective. However, we also note that such expansion as planned under the Western Shelf Observatory partnership is far better suited to the data needs of groups such as Defra and the Marine Management Organisation.

Two-way Observatory-Stakeholder Communication.

The first five years of the Observatory concentrated on developing a suite of instrumentation and data types based on initial discussions with major stakeholders. This review, in particular as it was discussed at Steering Group meetings, has highlighted a need to better develop a more responsive dialogue between the major stakeholders and the Observatory scientists and engineers. Towards this we suggest that the Steering Group identifies 1 or 2 key questions to be addressed through a more targeted workshop each year. For instance, two issues were raised during the review of stakeholder use of data. First, many groups are keen to see additional sites supplying real-time wave information. This requirement could inform discussions on the instrumentation at the 2nd mooring site, and on the possible replacement for the HF radar beyond 2012. Second, local stakeholder groups are interested in using the numerical modelling within the observatory to carry out “what-if” scenarios, for instance of contaminant dispersal, search-and-rescue exercises, or major storm events. Both of these would form ideal topics for dedicated workshops.

Encourage greater data type exploitation.

We have noted that the main data types used by most stakeholders are the meteorological, wave, and sea level streams. Other oceanographic variables are used by University researchers, and also by 2 of the major stakeholders (the EA and Cefas). There is potential for encouraging other stakeholders (particularly local councils, as well as the public and schools) to investigate what they may be able to extract from the oceanographic variables. This would require more effort on web-based products using our data, rather than providing raw data for download from the web. There is current ongoing discussion amongst the Oceans2025 Sustained Observations groups addressing this issue.

5. Summary of Recommendations.

5.1 Expand the scientific scope of the observatory to encompass the whole Irish Sea and into the Celtic Sea. This is being done by collaborating with other partners (notably AFBINI, Cefas, the Environment Agency, and the Irish Marine Institute, PML and SAMS), i.e. expansion via better linking existing data streams, rather than by expanding POL's own observing activities.

5.2 Extend the science activity of the Observatory by increasing science staff time available for analysis and publication. This includes 2 new Observatory-linked posts recently made.

5.3 Develop a more rigorous approach to getting Observatory activities acknowledged in peer-reviewed papers that use them.

5.4 Develop more rigorous quality-control of data streams. This has largely been achieved by augmenting the instrument pool to a level where 1 set of instruments can be away being calibrated, while the other is deployed. The quality control of individual data streams / instruments needs to be assigned to individuals within the Observatory.

5.5 Clarify roles and responsibilities within the management of the Observatory. On the management level we require (1) effective scientific leadership, (2) fieldwork co-ordination, (3) budget setting, (4) stakeholder engagement and

involvement, (5) co-ordination of science collaborations, and (6) co-ordination of a modelling strategy. A key role carried out by Roger Proctor was developing the EU and broader international links of the Observatory. With Roger's departure this currently represents a significant gap in Observatory activity.

5.6 Provide a well-documented "business case" and project plan for any new major instrumentation, taking into account (1) the science that the instrumentation allows us to address, (2) the availability of the necessary scientific and OETG support, and (3) the link to stakeholder data requirements.

5.7 Set up a system to manage and document scientific collaborations, regularly assess effectiveness and data use, and determine possibilities for new collaborations.

5.8 Continuously assess the workloads of science and OETG staff. In particular:

- 5.8.1 Cancel plans for a "3rd mooring" and instead make a collaborative link with Richard Gowen (AFBI) and his long-term mooring in the western Irish Sea.
- 5.8.2 Maintain 2 ferry boxes (Liverpool-Dublin and Liverpool-Belfast) only.
- 5.8.3 Shift cruise mobilisation to Birkenhead.
- 5.8.4 Assess requirements for real-time data streams.

5.9 Develop flexibility in cruise timing. While servicing of the moorings takes precedence in order to maintain data quality, we should also allow scientific considerations to play a role in cruise planning so that the Observatory both addresses immediate scientific questions as well as maintains the longer-term quality-controlled data. The cruise programme in 2009 is a first attempt at this, providing a platform for the work of 4 PhD students (3 Liverpool University, 1 Plymouth University) within the Observatory framework.

5.10 Following the appointment of a science/modelling post, document a new Observatory modelling strategy. [This is an urgent requirement and should be completed by the end of May 2009].

5.11 Use the Observatory Steering Group to develop stakeholder-relevant uses of Observatory data:

5.11.1 Hold workshops with the Steering Group (plus others) to investigate emerging coastal management questions (e.g. using models to test “what-if?” scenarios).

5.11.2 Develop Observatory “high-level” outputs targeted to stakeholder questions (e.g. annual “state of the Irish Sea” summaries, maps/timeseries of relevant variables with interpretations) rather than solely focusing on making raw data available.

5.11.3 Regularly assess data use by stakeholders, investigate possibilities for extension of key data types, and encourage take-up of other data streams.

Appendix 1.

Review of the Liverpool Bay Coastal Observatory (31st March 2008)

Discussion Document

Participants: John Huthnance, Jonathan Sharples, Roger proctor and Andrew Willmott

Introduction

This review was triggered firstly by the announcement that Roger Proctor will take a 3-year leave of absence from POL from 1st. July 2008. He will however be spending a total of 6 weeks per annum in Europe and the UK serving on committees such as EuroGOOS and overseeing the development of the POL observatory (we will need to find a substitute Theme 10 leader and to make sure that other committees that Roger sits on have stand-ins as needed). Over the last 3 years there has also been concern that the Liverpool Bay Observatory has been creating an unsustainable high demand on the OETG. With plans to extend the geographical extent of the observatory to the entire Irish Sea, albeit with regional partners, it is clear that the manpower resources do not exist at POL to realise this goal without significant re-structuring of the operation. Thirdly, POL invests more funding in the observatory than in any other of its projects, and the scientific outputs must be commensurate with this investment, which arguably they have not been.

This review is also taking place against the background of the launch of the new NERC strategy *Next Generation Science for Planet Earth.* The strategy contains two new NERC funding streams, National Capability (NC) and Research Programmes (RP), in addition to the long running Responsive Mode (RM) funding. NC will mainly reside in the NERC Research Centres (RCs) and embraces the facilities required to carry out world-leading environmental research such as long-term monitoring, the running of ships and aircraft, data centres and support of a critical mass of modellers developing community models. The transition to NC, RP and RM funding streams will begin 1st. April 2009 and will take place over 5 years. POL, together with the other three NERC RCs, is currently partitioning its core funding from NERC into NC and RP funding.

The funding invested into the coastal observatory will be classified as NC and POL is obligated to demonstrate to the NERC that the wider UK environmental science community requires this facility. We expect the UKMMAS run by *Defra* will look to the observatory for data to demonstrate that the Irish Sea is healthy, clean and biologically diverse. *Defra* is also taking the lead in bringing a draft Marine Bill to Parliament, hopefully in April 2008. At the heart of the bill is the creation of the Marine Management Organisation (MMO), a one-stop shop charged with licensing UK coastal waters for a wide variety of uses such as exploitation of sands, gravels and hydrocarbons, the creation of offshore wind farms and wave/tidal energy schemes to the designation of marine conservation areas. The MMO will be looking to existing programmes and organisations that collect a variety of data sets from the UK coastal seas to provide them with the data required to discharge its duties. Clearly, the POL observatory has the potential to contribute a wealth of Irish Sea data to the MMO. It is incumbent on us to enter a dialogue with the MMO about the types of data they require for the Irish Sea because we may be able to accommodate their requirements within our scientific programme. Clearly, the operation of our observatory is strengthened if we are serving

the requirements of a major stakeholder such as the MMO and from the point of the NERC we would be seen as operating a facility for the *National Good*.

At the European level the EU Marine Directive, the EU BWD and the EU WWD will demand that the UK and Irish Governments manage the Irish Sea in a sustainable way and this will require a variety of data to demonstrate compliance. Thus, the data from the observatory is meeting a *National Good* requirement. In planning the establishment of an Irish Sea Observatory we must learn lessons from the Baltic Sea programme where the countries bordering this sea are collaborating on an interdisciplinary scientific project studying the impact of climate change on the sea.

Over the 5 years the observatory has been running a valuable data base has been established showing how the dynamics of the Eastern Irish Sea vary from year to year, which is certainly important for climate studies. Confronting POLCOMS with high resolution spatial and temporal data, much of it returned to the laboratory in real-time, has revealed the strengths and weaknesses of predictive capability of this shelf sea circulation model. Without doubt this is an effective way of developing numerical ocean circulation models such as POLCOMS. However, it is less clear that the observatory will elicit overwhelming support from the marine community based in the HEI sector. The involvement of scientists from the HEI sector in the design and operation of the observatory has had some success (particularly within the University of Liverpool), but needs to be substantially increased. Scientists from this sector have not been knocking on our door with requests to use the observatory infrastructure to address key scientific hypotheses or questions and we must confront this issue in a re-structuring plan.

The Challenge
It is clear from the above discussion that re-structuring of the observatory must put the operation on a sustainable trajectory and one that will receive support from all quarters of the UK environmental science community. Further, the observatory must enable marine scientists to address a major scientific challenge. It is also must raise its profile with potential stakeholders such as local authorities in the NW and the insurance industry. We need to demonstrate the worth of having such a facility to major stakeholders, such as *Defra*, to the extent that they see a benefit in taking on some responsibility for funding. Lastly, the range of outputs from the observatory must increase, particularly publications in refereed ISI journals.

Overarching scientific challenge for the observatory
How will the Irish Sea respond physically and biologically over the next 20 years to climate change?

Re-structuring proposal
The major change proposed is to reduce the maintenance cruises from nine to six and to invite scientists based in institutions bordering the Irish Sea to openly bid for the Prince Madog time that will be released. In making these changes we will ensure that the *Cefas* smart buoy will continue to be maintained. By opening up three cruises to the wider marine community we immediately obtain some degree of buy in outside POL and *Cefas*. We hope that the scientists that successfully bid for the Prince Madog sea time will work in partnership with scientists at POL and *Cefas*. The time could be used either added on to Cobs survey cruises, or as separate stand-alone cruises (including using the time for a single, longer cruise). This should release some of the effort currently demanded of OETG.

How will we release sea time on the Prince Madog? We propose to carry out the CTD survey grid four times per year, rather than the current nine. The extra 2 cruises (bringing the total to 6) will cover the need in summer to service moorings more regularly. The feasibility of this change to the numbers of dedicated survey/servicing cruises needs to be explored further in the context of, in particular, the *Cefas* instrumentation. The grid would be surveyed seasonally and by doing this we will be able to release ship time for others to use. At this point it is worth mentioning that the current survey grid is not ideal if we are to collect data that will enable us to address the overarching scientific question posed above. Ideally, we would like the grid to extend westward of Anglesey into the mixed water of the Irish Sea. This may be achievable by reducing the spatial density of the current grid and adding nodes further west. Can we demonstrate that the high resolution grid we currently maintain has provided data that has been critical to understanding a dynamical or biogeochemical problem in the Eastern Irish Sea? We need to be pragmatic about the questions we want different components of the observatory to address and the scientific/technical effort we have available.

Scientifically, there are overwhelming arguments for developing an operational oceanography system in the entire Irish Sea. Indeed, a clear goal of the Coastal Observatory is to demonstrate the value of having a UK-wide monitoring network using UK-wide resources and building on the pilot scheme we have developed. One of the challenges to achieving the next step to the Irish Sea Observatory is how to collect data from a much larger domain given the limited resources at POL's disposal. POL will be shortly taking delivery of two gliders that will allow coast-to-coast vertical sections to be carried out across the Irish Sea. POL also runs a ferry box operation on the service that runs between Liverpool and Dublin/Belfast. Both these instrument platforms provide data from coast-to-coast. The maintenance of the ferry instruments is very time consuming; there is a case for re-visiting the parameters deemed needed for measurement balanced against the time required for instrument servicing/calibration and the desirability of the data type (e.g. based on information from data assimilation work with the models).

From the point of view of carrying out budgets for the entire Irish Sea it would be highly desirable to obtain ferry box data from the ferries operating between Fishguard - Rosslare and Stranraer - Belfast, the southern and northern boundaries of the domain respectively. POL is not in a position to be able to support ferry box operations on these routes and would be looking to partners to do this.

Remote sensing data provides invaluable synoptic coverage of the Irish Sea, weather permitting. POL must ensure we receive all the relevant data sets of this type. The laboratory may have to enter into partnerships with other regional institutions to acquire all the data. This is an aspect of the present Cobs that is working well already.

We propose to re-visit the positioning of the 2nd mooring site. Currently it does not fulfil the main scientific criterion of allowing direct calculation of horizontal gradients as it is positioned too close to the North Wales coast (where the isopycnals have turned following the coastline. However, while pushing the mooring further north into a region will better capture the intra-tidal and spring-neap variability of the larger Liverpool Bay region, there are mooring protection/vulnerability issues to consider. The 3rd site (presently suggested to be in the stratified western Irish Sea) cannot be set-up without the involvement of a partner who could take on the bulk of the servicing effort (with us

providing the mooring hardware); the additional shiptime and OETG effort is beyond what we can reasonably expect to do.

During Roger's secondment to Australia how can we best support the observatory? We need to make sure that critical Observatory work currently carried out by Roger is covered, but we can also think creatively of what new opportunities we can develop. Two possibilities immediately come to mind. We could appoint the inaugural Research Fellow in the Liverpool Centre for Marine and Climate Research with the brief to use the data sets and modelling system to conduct research on dynamics and biogeochemistry of the Irish Sea. This 3-year fellowship would be targeted at high-flyers, scientists who expect to publish several refereed papers during their tenure and then move onward and upward in their scientific career. An annual research support grant could be linked with this fellowship further enhancing the attractiveness of the post, potentially including some guaranteed ship time on the *Prince Madog* if the successful applicant aims to work with observational data. This Fellowship would increase the scientific output of the Coastal Observatory, and be an important high-profile position for Cobs and the Climate Research Centre.

Another possibility is to offer a scientist based at *Defra* or *Cefas* an opportunity to spend one year based at POL developing closer links between our operational oceanography system and a major end user. Establishing closer links with a Government Department/ Agency will hopefully ensure that re-structuring plans will take into account the likely requirements for "evidence based policy". On the other hand, this option is less likely to dramatically increase the number of refereed journal publications. If this option is not feasible it is still imperative that we work other avenues to improving our *Defra* and *Cefas* links.

All of these activities/changes need to be carried out in the context of the existing Cobs steering group and other interested (and potentially interested) stakeholders. As a part of the review we will require a detailed survey of stakeholder views and needs (particularly timely given the establishment of Cobs over the past 5 years).

Summary

1. Decrease the spatial resolution of the survey grid and extend the new grid further west. The precise grid design is to be established as soon as possible.
2. Survey the re-designed grid seasonally (i.e. four times per year).
3. Review the location of the second mooring site, with a view to it northward to better capture the spring-neap and intra-tidal variability of the wider Liverpool Bay region.
4. Maintain all the *in-situ* observing systems (e.g. moorings and survey grid), including the deployment and recovery of the *Cefas* smart buoy, using six cruises per year.
5. Invite scientists based in NW England, N Wales, Eire and Northern Ireland to bid in open competition for the remaining ship time, equivalent to 7 or 8 days per year, to work on Irish Sea research, hopefully in collaboration with scientists at POL.
6. Appoint a Research Fellow in the Liverpool Centre for marine and Climate Research for 3-years to work on the physics and biogeochemistry of the Irish Sea. The precise research field would be proposed by the applicants and would form part of the search criteria. The successful applicant will be expected to

produce high-quality published research outputs and to use the post as a springboard to permanent position.

7. Explore the possibility of a scientist being seconded from *Defra* or *Cefas* for one year, based at POL, with the remit to develop close and enduring links between the Observatory and their home institution.
8. Engage with a wide range of stakeholders with a vested interest in the Irish Sea to make the Irish Sea observatory a reality. The Welsh Assembly may well be interested in supporting this initiative and discussions with Professor Steve Hawkins at Bangor will help clarify the picture. From the point of view of carrying out any type of budget for the Irish Sea it is vital to have ferry box data across the extreme northern and southern boundaries of the domain, and the Observatory Steering Group are invited to consider how this might be achieved. What is clear is that POL does not have the resources to instrument these ferries.

Andrew J Willmott

Appendix 2.

Members of the Observatory Steering group.

Andrew Wither (Chair)	Environment Agency
Phil Knight (Secretary)	Proudman Oceanographic Laboratory
Rosa Barciela	Met Office
Andy Bradbury	Channel Coastal Observatory, National Oceanography Centre, Southampton
Capt. Steve Gallimore	Marine operations manager, The Mersey Docks and Harbour Company
Ian Holden	Hydrographic manager, The Mersey Docks and Harbour Company
John Howarth	Proudman Oceanographic Laboratory
Suzana Ilic	Lancaster University, Department of Geography
Chris Lumb	Joint Nature Conservation Committee
Graham Lymbery	Project leader, Coastal Defence Technical Services, Sefton Council
Robin McCandliss	British Oceanographic Data Centre
Steve Malcolm	CEFAS Lowestoft Laboratory
David Mills	CEFAS Lowestoft Laboratory
Matthew Palmer	Proudman Oceanographic Laboratory
Richard Park	Scottish Environmental Protection Agency
Theresa Shammon	Marine Science Government Laboratory (Isle of Man Government)
Jonathan Sharples	Proudman Oceanographic Laboratory
Alan Williams	Coastal Engineering UK Ltd.
Andrew Willmott	Proudman Oceanographic Laboratory

Appendix 3.

Registered Users of Observatory Data – Major Stakeholder Data Use.

Environment Agency.

1. Compare with our EA water quality data.
2. Qualitative verification of STFS (Storm Tide Forecasting Service) wind and wave forecasts in Liverpool Bay area.
3. Regulatory information.
4. Periodic review of the Irish Sea as required by the UWWT Directive. Data will not be used in isolation, but considered in combination with data sets owned by the Environment Agency and other organizations.

Cefas

1. Links between WaveNet and the Liverpool Bay Observatory.
2. Check Licor data on the SmartBuoy against solar radiation.
3. Use the data together with data from the CEFAS SmartBuoy for research and model comparisons.
4. Derive primary productivity estimates from optode oxygen readings.
5. Use data in a discussion regarding benthic fauna sampled from the historic sewage sludge disposal site.
6. Temperature data is used to calculate plaice egg development rates.

Met Office

1. Compare data with NCOF (National Centre for ocean Forecasting) models
2. Identify strongest winds in 2006 in the Irish Sea, to extreme-test the met office wave model.
3. Model validation.

Countryside Council for Wales.

1. Assessing potential use of Observatory data in a predictive habitat model.

Local government

1. Weather data for energy usage calculations in Liverpool.
2. Monitor Weather conditions for use on site work etc.
3. Research into local coastal processes.
4. Oceanographic context for hydrographic surveying.
5. Monitor weather and wave conditions at HIlbre Island and matching up with predicted data to assess storm warnings.
6. Monitoring the Conwy coastal zone.
7. For use as background information when analysing accretion/erosion patterns.
8. General wind data for Halton Borough Council.
9. Calculate rainfall volumes for waste management.
10. Beach surveying using the Hilbre webcam difference between wet and dry days.
11. Compare cooling system performance with external temperatures.
12. Validation of insurance claim regarding storm damage (Conwy).
13. Scotland/Galway: Determine climatic conditions for Luce Bay.
14. Sefton Council: Investigate stormy years.

Emergency services

1. Check local Met data before flying the local Police Helicopter from RAF Woodvale
2. Energy management within the NHS (weather station data).
3. Weather data used to assist with preparation of Fire reports.
4. Comparing levels of rainfall against incidence of grass fires.
5. Lifeboat stations use met station, web camera and radar.

Health & Safety Executive

1. Require temperatures for the Liverpool area to help with an incident investigation.

2. Data needed in connection with accident investigation work where wind etc is a factor.
3. Investigation of wind speeds and the use of tower cranes.

International Government & Agencies

1. France (Pierre-yves Valantin, Ministère de l Écologie, de l Energie, du Développement durable et de l Aménagement du territoire): We are studying if a webcam monitoring can identify coastal and shoreline evolution
2. Australia (Kate Roberts, Integrated Marine Observing Systems, University of Tasmania): Review format and delivery, to identify best strategy for us to deliver our data from BlueNet and eMII.

Appendix 4.

Other Research Uses of Observatory Data.
The list below is based on replies received to a survey of web users of Observatory data.

Research – National.

1. University of Wales (School of Ocean Sciences): Investigate further the tidal straining process.
2. Edge Hill: Use as background information during PhD research in geomorphology & sediment dynamics on the north Sefton coast.
3. University College London: Use it as an example in an essay for an MSc course.
4. We are doing a world-wide search for anyone that has witnessed a particularly intense or extensive bloom (>15mg Chlor/m3) any time during the period March 1, 2002 to present.
5. I am undertaking a Phd and hope to use the data to develop a statistical air pollution model.
6. University of Liverpool: Research relating to driving rain index for architectural project.
7. University of Liverpool: I am investing the possible effect that external conditions (temp,rainfall, etc) may have on an industrial process close to Liverpool airport.
8. University of Leeds: The data will be used for my Solar Hydrogen Project The average Solarity will calculate the average power output of a solar panel through out the year.
9. Liverpool John Moores University: Calculate to see if there has been an increase in sea level.
10. Liverpool University: I am researching storm typicality, erosion risk and flood risk for my masters.
11. University of Stirling: I want to obtain wind speed and wave direction for the moored buoy outside the Ribble Estuary, to identify links with wave action and sediment transport within the estuary.
12. University of Wales: Compare to data from Menai Strait to see if similar signal patterns appear.
13. University of Birmingham: I am determining when the first light from the eastern horizon can be seen (dawn). I am hoping that some of your time lapse pictures will help me.
14. University of Liverpool: Compare with PEML long-term data sets.
15. University of Wales: Compare with other data collected in Liverpool Bay
16. Liverpool University: I run the met office weather station at UoL Ness Gardens , and am interested in comparisons.
17. University of Wales: Obtain horizontal density gradients in Liverpool Bay area as background to suspended sediment dynamics research.
18. University of Leeds: Data will be used for both undergraduate and postgraduate teaching and research.
19. Liverpool John Moores University: Historical analysis to estimate trends and frequencies of specific events.
20. Liverpool John Moores University: Compare with my manual data done on West Kirby beach.
21. As an Architecture student De Montfort Uni. to incorporate different environmental design strategies into my project.
22. University of Liverpool: Correlation with weathering tests on material.
23. University of Liverpool: Link to ecological information.
24. Queens University Belfast: Use the data in PhD studies in subtidal benthic habitat predictive modelling.
25. University of Liverpool: To research local weather trends (temperature and humidity) to help us manage animal environments at the Leahurst Veterinary Field Station.
26. Lancaster University: Use for dissertation purposes.
27. Liverpool University: Use of basic CTD data to aid ecological research project based at Hilbre Island.
28. Birkbeck University of London: Predict the movement of drifters in the bay.
29. University of Swansea: Working on Jellyfish abundances, in particular in the Irish Sea on NERC studentship # NERC/S/A/2006/14076. Ideally I would link current velocity and direction predictions/data with known Jellyfish abundances and movements.
30. Use in reports for my degree course in Coastal Conservation and Marine Biology.

31. University of Southampton: I intend to use them for my PhD, were I am looking at optical properties in case II waters.
32. Use of wind speed data as probabilistic data source for calculating overhead line swing angle.
33. University of Liverpool: Investigating direction of prevailing wind.
34. Review the data to try and gain ideas for a geography dissertation on the coastal areas of the Wirral Peninsular.
35. University of Liverpool: Support data for PhD student.
36. University of Liverpool: Tackle the effect of rainfall on the chemistry change on the surface water.
37. University of Sheffield: Tidal and current analysis.
38. University College London: Use wave data to make sure the inputs for a wave model of Liverpool Bay are realistic.
39. Liverpool John Moores University: Research for university architecture project.
40. University of Wales: Relate Irish Sea scallop recruitment to climate variables.
41. Lancaster University: Possibly for use in Ph.D. research into scour around offshore wind turbines.
42. University of Wales: Used to study spatial and temporal variation of suspended sediments in the Irish Sea.
43. I am working on renewable energy potential estimation in Liverpool with the objective of optimising a low energy house design.
44. University of Wales: Chlorophyll concentrations in Liverpool Bay as baseline for chlorophyll coming into Menai Strait during our research, summers 2004 and 2005.
45. I intend to use wave data in a numerical model to determine the effect that the building of the Mersey training channels has had upon wave climate within the Mersey Estuary.
46. University of East Anglia: I want to look at the underway data for the Prince Madog to identify when there were gales/storms in the Irish Sea.
47. Manchester Met Uni: Use it to understand water quality data sampled from the two streams within the area of Bromborough in September 2005. This research is for my 3rd yr.
48. University of Wales: I intend to use the data in a report for my degree in geological oceanography at University of Wales, Bangor.
49. Liverpool University: Compare temperature, salinity, density and nutrient fields to decipher seasonality.
50. Strathclyde University: Input into hydrodynamic models.
51. Determine the long-term wind direction of Merseyside to support research associated with air transport of pollutant (MSc Thesis).
52. University of Liverpool: I'm working on the Irish Sea microbiology. I need data to have an overview of environmental parameters of my sampling sites.
53. University of Bristol: Comparing temperature with moth catches in the area for study under supervision from the University of Bristol.
54. Oxford University: mathematics of random data.
55. University of Edinburgh: Data will be used for a Matching study at the University of Edinburgh.
56. University of Southampton: Calculate ETo using FAO Penman-Monteith.
57. University of Manchester: I am a PhD student from the University of Manchester. I wish to find out the composition of seawater in order to carry out research in succinic acid production using seawater from the Liverpool Bay.
58. University of Wales: Compare rainfall data in Liverpool Bay to estimates of CDOM in order to find a seasonal link. Part of NERC funded PhD at Bangor University.
59. University of Liverpool: I intend to use the data for flooding model for MREs at Liverpool University.
60. University of Liverpool: Correlate the data of POL with trace metals and metalloids analysis carried out in our laboratory from Liverpool Bay samples. This will help to get a better understanding of the biogeochemical cycling of these metals.
61. University of Strathclyde: Provide contextual information for interpreting remote sensing images.

62. University of Ulster: Wave sizes in Ireland for energy assignment for masters in renewable energy.
63. Liverpool University: Use to provide a climatic background for observations of suspended sediment loads in Liverpool Bay.

Research – International

1. In Ifremer, we are developing operational oceanography systems. The coastal observatory experiment is a good example.
2. Mid Sweden University: Compare nutrient levels in the Irish Sea and the Baltic.
3. BRGM France: Validation of hydrodynamics models.
4. National Institute of Oceanography, India: Coastal modelling.
5. Department of Fisheries, University of Las Palmas, Gran Canaria: To check programs (software) for ocean currents analysis.
6. Evolutionary Biology Centre, Uppsala University, Sweden: Used in planning for future field work.
7. Chalmers University, Sweden: The data will be used to verify the wind, ocean waves and currents retrieval algorithms that are supposed to be developed within the framework of an EU-funded project (http://www.sectronic.eu/).
8. NASA: Ground truth for remote sensing algorithm.
9. University of Jyvaskyla, Finland: I'll include some indication of production to my MSc thesis study on porpoises around Pembrokeshire islands.
10. National Academy of Sciences of Ukraine: Exchange of knowledge, possible cooperation on study of marine coastal ecosystems.
11. University of Tokyo, Institute of Marine: Comparing with my result of CTD observation in Menai Strait.

Commercial – Government projects.

1. Observe correlation of open water temperature trends with dock water temperature trends for use in MoD safety studies.
2. View records to gauge road conditions on a given day.
3. Flood risk study for North West Environment Agency.
4. The tidal data are going to be part of the database the Environment Agency has commissioned us to undertake for the project: North Wales Tidal Flood Mapping-Data Collection and initial site analysis.
5. Compile data for UKMMAS protocols manual.
6. Wave monitoring.
7. Apply to safety of navigation issues and risk assessment reviews.

Commercial – general.

1. Check wind speed against incidents of damage to buildings.
2. Investigate the effects of prolonged weather exposure on our products.
3. Use in Acoustic model.
4. Unilever research in to link between dry skin & the weather.
5. Vauxhall: Comparing Weather Data with Paint Process Defects.
6. Unilever: The data is used to assist the analysis of data generated in human clinical studies - weather data has a profound effect on the human body.
7. Improve the knowledge of the Dee Conservancy Authority.
8. View format of data. I am currently engaged in an MRes research project to develop a website for the Liverpool Bay Coastal Group to display their data.
9. Offshore wind farm coastal process study.
10. For use within my extended essay on the evidence for long shore drift and management of an oil spill on the North Wales coast.
11. Check for offshore to near shore runs with SWAN. Validating data.
12. Analysis to see what annual time-lapse photography of coast might look like for possible project on BBC series on coasts.
13. Include it into a level one report on weather soils and vegetation

14. Wind-driven rain calculations on buildings.
15. Shell: For calibration of barometric pressure.
16. Phoenix Chemicals: Compare weather data against our plant performance.
17. Compare it with the temperature of underground storage tanks. This may improve leak detection.
18. Offshore wind resource assessment using Synthetic Aperture Radar.
19. Investigate possibility of setting up tidal station at Garston.
20. Preliminary look at Irish sea conditions for the purposes of siting marine turbines.
21. Estimate the temperature of the sea bed between 1 and 3 metres beneath the surface.
22. Ongoing research into sediment transport and geomorphologic change in the Mersey Estuary.
23. Defra funded academic research in to wave scour.
24. Examine impact of abstraction of freshwater from the River Lune on water quality in Morecambe Bay.
25. Investigation in dynamic behaviour of RoRo vessels in heavy weather.
26. Halcrow: Oceanographic modelling.
27. Understand local weather conditions for building and turbine design.
28. Royalhaskoning: Consulting engineer working on Seaforth Triangle.
29. Establishment of hydrographic data for off shore wind farms.
30. Planning offshore wind farm.
31. Regularly undertake marine biological surveys in the Irish Sea. Would be useful to know real time information before commencing survey.
32. To enable us to plan diving trips using all the information that may be of use in making our trips as safe as possible. Thank you for providing such a useful source of information.
33. MDHC: Monitor pilot boarding station.
34. Reference data or tender documents for new fenders on the 12 Quays Ro Ro Berth.
35. Rwenpower: cross correlate with available wave data.
36. We are trying to get an idea of the current in the bay of Liverpool since we are preparing a tender for the wind turbine foundations at Burbo.
37. Use it for vessel movements and to establish no of days we can work out at the new Gwyn-ty-Mor windfarm.
38. Abpmer: Offshore wind farm model calibration.
39. Possible use of data as input parameters for modelling work.
40. Bv: Assess historic trends.
41. Niras: Statistical analyst.
42. Cmaxsltd: for EIAs etc if appropriate; probably mainly just by refering to the existence of the web site and suggesting to s that they might wish to use it.
43. Helzel: Check RADAR data.
44. Oakham: Correction of emission monitoring pressures.
45. Evc-int: Compare with local measurements at Runcorn.
46. Aeat: Wind energy analysis.
47. Nwtrading: Shipping.
48. Paragon-sci: Monitoring of barometric pressure.
49. Abpmer: I am gathering all meteocean data that exist in the Liverpool bay for wind farm studies.
50. Study predicted sea conditions in order to asses whether or not to sail with passengers (anglers)
51. Axa-insurance: Validation of insurance claim.
52. Evaluate prospects for suspended offshore mussel cultivation.
53. I am developing software for the analysis and prediction of tidal currents. Your data sets will be used to verify my methods.
54. Seatec-services: Offshore Marine Engineering project.
55. Power.alstom: Consider weather the winter of 2005-2006 was better or worse than normal.
56. Offleyinsurance: Record for clients.
57. Metoc: Assessment of seawater temperature climatology for offshore development.
58. To obtain a wind speed to allow installation of panels on tower west Liverpool.

59. uk.enritec: Sizing of cooling towers.
60. Eon-uk: Assess sensitivity of filtration dust loading to wind speed and direction
61. Abpmer: Windfarm - evidence in preparation of a bid. use in design data if successful.
62. Power.alstom: Evidence in preparation of a bid. use in design data if successful.
63. Royalhaskoning: Reports and design.
64. Fugro: Assist in project Planning of Inshore Survey Operations on Burbo Bank Windfarm.
65. fabermaunsell.com: To relate dimensional data to temperature change.
66. coast2coast.org.uk: To check on the weather conditions. Marine electrics company.
67. royalhaskoning.com: Haskoning UK are conducting an extreme low tide assesment for Mersey Docks and Harbour Company, investigating the conditions surrounding the failure of the Mersey Ferries landing stage in March 2006.
68. novartis.com : Used as baseline data for HVAC study.
69. hdrinc: General research of surrounding environment.
70. ceanteam.net: Company is installing an intercoonector cable between UK and Ireland and need to know oceanographic conditions.
71. arup.com: Understand wave conditions at Castletown in the Isle of Man, to make some preliminary assessments about the feasibility of a marina.
72. abpmer.co.uk: Model calibration and environmental understanding.
73. eogresources.com: Use data to assess metocean conditions for drilling rig emplacement in Liverpool Bay.
74. rwenpower.com: Initial concept marine design.
75. amec.com: Determining tidal patterns in order to enable appropriate borehole level monitoring.
76. rpsgroup.com: Research for a Renewable Energy Strategy for Welsh Assembly.
77. fabermaunsell.com: I need to use the data as downstream boundary of river Birket fluvial model.
78. warrant-group.com: Use in Statement of Facts for a commercial vessel.
79. mottmac.com: The data may be analysed and the results of this analysis will be incorporated into reports if relevant.
80. john-doyle.co.uk: Establish norm for previous years.
81. esgl.co.uk: Check tidal observations taken from the Dee estuary.
82. abpmer.co.uk: calibration of wave model.
83. As the Marine Manager for Tranmere and Stanlow monitor conditions offshore and relate them to ship delays / change of pilot boarding area etc.
84. WET Labs is generally interested in ocean monitoring and specifically in developing instrumentation for long term deployments. I'll be monitoring the data more for curiosity than anything in particular.
85. globecommltd@aol.com : monitor Orbcomm's performance.