Focus

Taking the pulse of Australia's oceans

The rapid advance of remote sensing technology is now allowing the collection of continuous ocean data on an unprecedented scale. The national Integrated Marine Observing System (IMOS) program uses a wealth of distributed marine devices, services and expertise, within a world class marine monitoring framework designed to detect changes in ecosystems and deliver data through one system to many potential users. **James Porteous** spent time on a rolling sea with participating scientists.

Aboard the Marine National Facility vessel, *Southern Surveyor*, about a day's lumpy sailing from Hobart, Dr Tim Lynch from CSIRO is clad in blue overalls and hunched over a hunk of metal that resembles a cross between a piece of precision military hardware and a small satellite.

It is perverse to hear that something so shiny and expensive-looking is about to go over the side, for three months, but the ocean recorder in front of me is destined for a deep-sea task about 5 nautical miles off nearby Maria Island. Attached near the top of a 90-metre-long mooring line and beneath a series of floats, it will conduct trial recording of the sea's temperature, chemical make-up and plankton density as part of the state-of-the-art Integrated Marine Observing System (IMOS).

Launched in 2006 under the National Collaborative Research Infrastructure Strategy (NCRIS), IMOS is a five-year, $92 million collaborative program, designed by the marine science community, to collect and provide data for research into emerging critical marine issues, including the effects of climate change and the sustainability of our ecosystems.

Now hitting stride, it involves the latest remote sensing technology and data information services distributed around key points of Australia's ocean territory, making IMOS world-class infrastructure. Ten reporting Facilities deliver time series data streams for marine research, industry and management processes.

Over thirty institutions are involved nationally, representing most of the universities and organisations working in ocean and marine research. IMOS is heavily linked internationally too, across programs and agencies that are integrating the data into better-than-ever pictures of the Earth's ocean dynamics.

An overview of the Nodes and Facilities that make up IMOS. Louise Bell, CSIRO

Of particular focus is observing the open ocean and its interactions with the Continental Shelf. It is here that the program's sensitive instruments, such as the mooring recorder being dropped over the side of our research support ship by Dr Lynch, are tracking changes in the ocean currents which drive marine ecosystems and the weather around Australia.

For example, based on 60 years of preceding data diligently recorded at Maria Island, the waters off Tasmania's east coast have been gradually getting warmer and saltier, suggesting that the East Australia Current is moving further south. It is important that researchers are able to continue to record the long-term data and expand the features monitored to see how this may influence biodiversity, and alter the management of fisheries, marine resources and conservation. Maria Island's station has therefore been enhanced under IMOS as one of eight national reference stations.

Professor Gary Meyers is Director of IMOS, based in the operational hub at Hobart's University of Tasmania. It is from here that deployment of the program's high-tech equipment and assembly of data from the 11 dispersed

Facilities are coordinated. Professor Meyers, internationally respected for his broad background in ocean monitoring research, is excited about the progress of IMOS and the tremendous benefits and opportunities is it bringing. He should be; he was instrumental in the program's establishment after pushing for a comprehensive capability like this for over 20 years.

'It's fantastic – the advance of computing technology, in the last five years particularly, has brought sensor and remote data transmission technology within affordable reach, meaning we can now deploy these very sensitive small instruments into networks to cover both remote and near-shore areas and report back to us via satellite,' he says.

'Perhaps most exciting of all though, for me, is that we are collecting very large amounts of data from the oceans, virtually in real time, and after getting it into common formats with computing, can share it around or combine useful data streams.

'This is very powerful. It means we can write papers straight away without having to wait months or years for data, and modellers can now feed the data directly into their programs to calculate immediate results, whereas once models could only use "old" data that was recorded sometime earlier in order to paint their pictures,' he says.

'We have much more manipulable data, and researchers no longer need deep computer savvy to work with it. When we now need to understand fast changes in global environments, the implications of all this are obvious.'

Marine Scientist Dr Tim Lynch with his deep-sea recorder set to be deployed off Maria Island as part of the Australian National Mooring Network under IMOS. James Porteous, CSIRO

Professor Meyers is particularly inspired by the ability of IMOS data to now be flowed into other programs for 'cross research' efforts. For example, ocean observations can be linked to other data being collected about changes on the mainland under the broader NCRIS program, or fed directly into international marine research community efforts, such as the Global Ocean Observing System (GOOS), or the BlueLINK data assimilation system which uses thousands of Argo robotic reporting floats around the world to give a best estimate of the weekly state of the oceans.

Simon Allen from CSIRO Marine and Atmospheric Research is Technical Director at IMOS in Hobart, overseeing deployment operations as well as the eMarine Information Infrastructure (eMII). The eMII is responsible for coordinating the delivery, hosting, management, distribution and archiving of data streams being contributed by Facilities operators. With a background in the oil and gas industry Mr Allen agrees the opportunities ahead are quite outstanding – he's just trying to get the separate institutional teams working at each Facility to submit their data according to schedule!

'The funding behind IMOS provides great support to ocean monitoring – it communalises the technical and delivery work, which is normally conducted by individual efforts that have a lot at stake financially. That also tends to restrict sharing of results,' he points out.

'Ultimately we need a high quality systematic set of observations to provide an initial baseline of conditions in Australian waters from which change can be observed, monitored and eventually understood. IMOS does not fulfil this requirement entirely, but it is a significant step in the right direction.'

'Putting the data collected through

IMOS Nodes provide the scientific rationale

There are five Science Nodes, responsible for identifying the scientific objectives, assessing progress and promoting use of IMOS data. The Bluewater and Climate Node addresses the open, bluewater oceans around Australia, providing data streams that support research on the role of the oceans in the climate system.

Four Coastal Nodes in Queensland, New South Wales, South Australia and Western Australia address regional issues including change in the major boundary currents and their impacts on shelf ecosystems and biodiversity.

1. **Bluewater and Climate** supports research into climate change and its impacts on all timescales, by focusing on the physical and dynamical state of the ocean. Biogeo-chemical observations will play a role.
2. **GBROOS** Great Barrier Reef Ocean Observation System – understanding the physical environment which governs the GBR region, and how it is changing.
3. **NSW IMOS** New South Wales IMOS – focusing on the East Australia Current, and its impact on shelf ecosystems.
4. **SAIMOS** Southern Australia IMOS – explores the nature and dynamics of ecosystems in the region of Kangaroo Island–Eyre Peninsula and the Bonney Coast.
5. **WAIMOS** Western Australia IMOS – focusing on the Leeuwin Current and its impact on shelf ecosystems.

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IMOS into the scientific commons allows the entire scientific community access, meaning local process studies can be more conclusive and, for international scientists, it makes working on Australian questions highly attractive,' Mr Allen says.

'Our National Reference stations are now collecting biological data – such as plankton counts – as well as physical and chemical recordings, together. So we can record changes across all areas.'

Meanwhile, the next phases of IMOS are underway. Professor Meyers says 10 data Facilities are in place now with good progress in all of them. The deployment of Australia's commitment of 50 Argo robotic floats per year is on track, more national moorings are being dropped on the Continental Shelf and Continental Slope, and underwater gliders have increased their technical capability. In eastern Australia, two plankton recorders will be towed, voluntarily, by merchant ships that want to be part of the IMOS effort.

Professor Meyers says, however, that capacity for ocean monitoring still needs to be significantly increased across Australia's vast territories. He sees the investment as undeniably worthwhile. Ocean analyses and forecasts not only contribute to research, but also increasingly to offshore industry – such as fisheries and oil and gas exploration, as well as navigation, tracking oil drift, search and rescue, ocean races and military applications.

The Marine National Facility arrives into Sydney after a three-day Bass Strait crossing from Hobart to deploy an IMOS mooring at Maria Island and record sea bed mapping. James Porteous, CSIRO

'A 2006 report for the Australian Academy of Technical Sciences and Engineering[1] found that only taking into account the value to oil and gas, fishing, and search and rescue, the return on investment was in the order of 20 to 1. And that was conservative,' he highlights.

'As for the environmental value?' he asks pointedly. 'Well, we can't really place a value on it at present can we? But we need it. It's priceless.'

1 Australian Academy of Technological Sciences and Engineering and the Western Australian Global Ocean Observing System Inc (2006) 'Economics of Australia's sustained ocean observation system, benefits and rationale for public funding.'

More information:
IMOS overview, www.imos.org.au

IMOS Facilities

The IMOS program's broad coverage of Australia's ocean territories involves 11 operational components:

1. **Argo Australia** – a fleet of ~200 profiling floats observing ocean physics to 2000 m, part of a larger global program (www.argo.int)
2. **Enhancement of Measurements on Ships of Opportunity** – a set of observing systems for physical, chemical and biological oceanography on volunteer observing ships.
3. **Southern Ocean Time Series** – a set of moored biogeochemical and ocean weather instruments in the Sub Antarctic Zone.
4. **Australian National Facility for Gliders** – a multisensor system similar to an Argo float, which can traverse as well as profile, and is operated from a land base.

Dr Lindsay Macdonald from CSIRO Marine and Atmospheric Research in Hobart with an IMOS underwater glider. CSIRO

5. **Australian National Autonomous Underwater Vehicle (AUV) Facility** – used for high resolution surveys of benthic habitats.
6. **Australian National Mooring Network** – a network of national reference stations, plus regional mooring arrays on shelves and slopes.
7. **Australian Coastal Ocean Radar Network** – for high resolution mapping of coastal currents.
8. **Australian Acoustic Tagging and Monitoring System** – curtains of receivers to monitor movements of tagged marine animals.
9. **Facility for Automated Intelligent Monitoring of Marine Systems** – a communications system on The Great Barrier Reef, facilitating the delivery of data from sensors to the scientists in real time.
10. **eMarine Information Infrastructure (eMII)** – responsible for hosting, managing, distributing and archiving IMOS data.
11. **Enhancing Access to Australian Ocean Remote Sensing Data** – to make satellite products to support research in Australia's regional waters.