NMSC Meeting 20 July 2017 – Agenda Item 5.6

Creating a national ocean modelling system to supply defence, industry and government with accurate, detailed knowledge and predictions of ocean state

NATIONAL MARINE SCIENCE COMMITTEE

Introduction

The National Marine Science Plan sets out a very ambitious vision for a national ocean modelling system, spanning hydrodynamics, biogeochemistry, ecosystems and socioeconomics – see ATTACHMENT 1. Notwithstanding its lofty ambition, the impetus for this recommendation stems from the ocean modelling capability developed through Bluelink and eReefs, and in a number of University and State Government groups during the IMOS era. As noted on page 36 on the Plan:

> *Over the past decade, collaborations involving CSIRO, the Bureau of Meteorology, the Royal Australian Navy, universities, the Queensland Government and the Australian Institute of Marine Science have developed a suite of world-leading global and regional oceanographic models (such as Bluelink) for use in Australian waters. These have increased our ability to understand past and present ocean states and predict ocean dynamics. More recently, the establishment of regional observing systems under IMOS has helped facilitate collaborative development of hydrodynamic and biogeochemical models for Australia's continental shelf. This has involved universities, state and Commonwealth research agencies, and the Bureau of Meteorology. The eReefs modelling suite, developed for the Great Barrier Reef region through a partnership between industry, Queensland and Australian Governments, is also making advances in our ability to link terrestrial and coastal marine systems. The next step is to coalesce these developments into a national modelling approach, which would unify the national programs on baselines, experimental science and ecosystem monitoring into a coordinated, predictive and coherent whole.*

It is also important to note that the consulting industry is a significant player in this space, with Australian Government agencies responsible for search and rescue, oil spill response, and vessel management relying on model output provided by commercial enterprises e.g. RPS, OMC, DHI etc. Stronger engagement between marine science and the operational government agencies, services sector, and marine industries is being fostered through the Forum for Operational Oceanography (FOO).

For various good reasons, the modelling capability referred to in the National Marine Science Plan has been developed at global and regional scales (including a relocatable ocean model capability), but not at national scale for the Australian continental shelf. To date there has been no end user or consortium of users willing and able to invest in development of a national, shelf scale modelling capability.

Some research grade activity has been undertaken at national scale e.g.

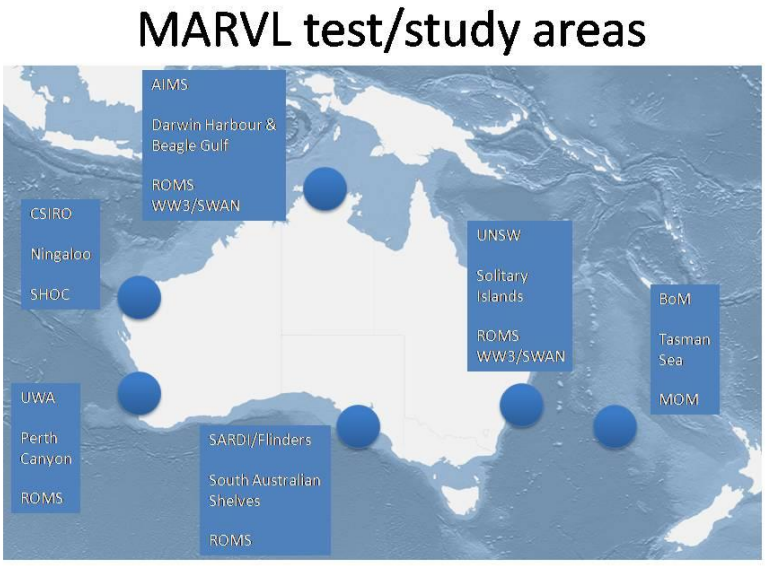
- CSIRO Ribbon Model - see http://www.emg.cmar.csiro.au/www/en/emg/projects/-Ribbon--Model.html
- UWA OzROMS – see http://coastaloceanography.org/

Background

One opportunity we have had to build towards a national ocean modelling infrastructure has been through the so-called 'eResearch' capabilities within NCRIS i.e. NeCTAR, ANDS and RDS. UTAS and CSIRO have led the development of the Marine Virtual Laboratory (MARVL), with some involvement from AIMS, UNSW, SARDI, UWA and others. The history of MARVL funding (largely from NeCTAR) is summarised below.

Early Activity	2011-12	$698K
Stage 2	2012-14	$1.399M
Stage 3	2014-15	$223K
Stage 4	2015-16	$225K
Stage 5	2016-17	$177K

The vision for MARVL is very exciting and good progress was made during Stage 2 when there was sufficient time and resources available to engage a broad range of users and use cases – see below:



However relatively small levels of funding contracted on an annual basis has made it difficult to maintain the momentum over the last few years. With NeCTAR, ANDS and RDS being 'aligned' during 2017-18 and evolved into a single entity from 2018-19 onwards, there may be an opportunity to regain momentum and for MARVL to gain broad acceptance as an essential component of a national ocean modelling infrastructure. See further comments below.

Within the IMOS community, it was proposed (in February 2014, pre-NMSP) that a logical next step would be to produce an Australian National Shelf Reanalysis (ANSR), capitalising on the vastly increased level of shelf observations available from the first decade of IMOS and the greatly enhanced shelf modelling capability in IMOS Nodes through CSIRO, BOM, AIMS, UNSW, SARDI, UWA and others.

ANSR was scoped in May 2015 (again, pre-NMSP). It was estimated to cost $1M pa for five years plus co-investment (50:50). However it is yet to be implemented due to lack of funding, and reservations within the marine science community about the relative benefits of global, regional and national modelling approaches.

In the absence of ANSR, the Bluelink system continues to be used for shelf applications that it is not designed to support. Many marine industries are affected by ocean dynamics not represented by the global (10km resolution) Bluelink system. So the need for ANSR has not gone away.

A national shelf reanalysis system requires:

1. a national, numerical ocean model
2. forcing data for the model (open boundary conditions, river flows, bathymetry, meteorology)
3. a data assimilation system, and
4. an observational data base.

Products to be generated from a national shelf reanalysis system would include:

- a versioned ANSR observation database which is accessible nationally
- a high-resolution observation based shelf climatology derived from the database
- a non-assimilating control run of the national model with evaluation metrics reported, and
- a completed ~20 year reanalysis including comprehensive community validation and published documented.

Through MARVL we have been able to put some of the building blocks for ANSR in place. Specifically, access to open source ocean models, some forcing data, and an observational database.

With respect to a national model, MARVL has a good grid generator that exports to various model configurations including MOM and ROMS, thus it would be possible to generate the grid in MARVL. However a national model used to produce a national shelf reanalysis needs to be data assimilating, and this capability does not currently exist (though could be established with further effort).

Current Status

A summary of ocean models being run on an operational or routine (vs experimental) basis is as follows:

Models	Domain	Data assimil-ation	Re-analysis	Output available
Bluelink (suite)	Global Relocatable	Yes, BODAS	Yes, BRAN	http://dapds00.nci.org.au/thredds/catalog/gb6/OFAM3/catalog.html http://dapds00.nci.org.au/thredds/catalog/gb6/BRAN/catalog.html
eReefs (suite)	Regional, GBR	No, but could be	No	http://dapds00.nci.org.au/thredds/catalogs/fx3/catalog.html
SETAS, STORM	Regional, Tasmania	No	No	http://data1.tpac.org.au/thredds/catalog/tascem/catalog.html
Moreton Bay, Gladstone Harbour	Regional, Queens-land	No	No	http://acef.tern.org.au/thredds/catalog.html
OzROMS	National	No	No	http://130.95.29.56:8080/thredds/catalog.html
SAROM	Regional, GAB/Gulfs	Yes	No	Not public at this stage
Darwin Harbour	Regional, NT	No	No	Not public at this stage

N.B. Apologies for any errors or omissions in the above, which will be corrected if advised.

Beyond Bluelink at 0.1^0 (~10km) resolution, there is no national, shelf scale, data assimilating model being run on a routine basis at the moment. OZROMS is a national model but it is not data assimilating. Data assimilation is now beginning to happen routinely in some regions (e.g. SA) but not at national scale.

A recent, informal review of the ANSR scoping documentation suggests that taking subsequent developments and current capabilities into account, the effort required to produce a national shelf reanalysis could be more like 3 FTE pa for three years i.e. much less than estimated in 2015.

With respect to further funding for MARVL, we have been in discussion with NeCTAR/ANDS/RDS in the context of their aligned planning for 2017-18. 'Marine' is one of their priority research domains and there is an opportunity attract investment from their Data-enhanced Virtual Laboratory program. The level of funds being talked about (up to $500K) is insufficient to deliver a national shelf reanalysis product as it is only for one year, and no forward commitment can be given on behalf of the single entity that will come into being in 2018-19. However great progress could be made on the observational database and the forcing data required for a shelf reanalysis. It would be novel to include both hydrodynamic and biogeochemical data, and the availability of a much improved observational database and forcing data delivered through MARVL would have wide uptake and use regardless of whether or not a shelf reanalysis is able to be funded. UTAS intends to facilitate a discussion with the relevant partners about this with the intention of submitting a proposal for marine 'Data-enhanced Virtual Laboratory' funding in 2017-18.

Next Steps

In order to push ahead in a somewhat uncertain stakeholder/partner/funding environment, a two-pronged approach is recommended:

1. Moving towards the ambitious vision for a national ocean modelling system set out in the National Marine Science Plan will require a multi-institutional consortium to come together, involving at least CSIRO, BOM, AIMS, UNSW, SARDI, UWA, and possibly others. NMSC should attempt to facilitate the establishment of this consortium.

2. In parallel, IMOS (which is a consortium including all of the abovementioned partners) will continue to take in lead in exploring options to deliver the first ever Australian National Shelf Reanalysis.

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ATTACHMENT 1 - Relevant extracts from the National Marine Science Plan

Page 8
Create a National Oceanographic Modelling System to supply defence, industry and government with accurate, detailed knowledge and predictions of ocean state.

Page 14
The next generations of models will improve estimates and management of:
• oil spill and pollutant dispersion
• dredge spoil movement
• impacts of sediments, nutrients and chemicals from agricultural run-off
• coastal fisheries and aquaculture
• ocean productivity and health.

Improved estimates of wind, current and wave fields will also benefit:
• recreational boating
• the shipping industry
• search-and-rescue operators
• the Australian Defence Force (ADF)
• the offshore engineering industry, which can reduce costs incurred by over-engineering platforms and sub-sea structures.

Page 27
National marine environment and socioeconomic modelling system

Goal: Establish a national effort in marine modelling, across the physical, biogeochemical, environmental and socioeconomic systems of both coastal and open ocean domains, which supports all users of the marine environment

Understanding and predicting the dynamics of ocean and coastal processes (such as currents, waves, nutrient cycles, productivity, water quality impacts, noise and pollution impacts) is a fundamental requirement for implementation of this Plan.

Similarly, the incorporation of social and economic elements into marine system models is also essential. Marine scientists, environmental managers, policymakers, industry and the community increasingly recognise the importance of these triple-bottomline elements for assessing impacts and informing decision-making.

We need to coalesce past efforts into a collaborative, national capability in modelling, re-analysis and forecasting for the entire Australian shelf and coast. This would benefit every marine industry sector, and provide an invaluable foundation for marine science and improved environmental management in perpetuity.

Pages 35-36
National marine modelling and forecast centre

This Plan highlights the need for a coordinated national marine environment and socioeconomic

modelling system. A National Collaborative Research Facility akin to IMOS, and dedicated to developing and using a suite of national marine system models, would provide the next important step in managing our marine estate.

Over the past decade, collaborations involving CSIRO, the Bureau of Meteorology, the Royal Australian Navy, universities, the Queensland Government and the Australian Institute of Marine Science have developed a suite of world-leading global and regional oceanographic models (such as Bluelink) for use in Australian waters. These have increased our ability to understand past and present ocean states and predict ocean dynamics. More recently, the establishment of regional observing systems under IMOS has helped facilitate collaborative development of hydrodynamic and biogeochemical models for Australia's continental shelf. This has involved universities, state and Commonwealth research agencies, and the Bureau of Meteorology. The eReefs modelling suite, developed for the Great Barrier Reef region through a partnership between industry, Queensland and Australian Governments, is also making advances in our ability to link terrestrial and coastal marine systems. The next step is to coalesce these developments into a national modelling approach, which would unify the national programs on baselines, experimental science and ecosystem monitoring into a coordinated, predictive and coherent whole.

Page 41
4. Create a National Oceanographic Modelling System to supply the accurate, detailed knowledge and predictions of ocean state that defence, industry and government need.

This modelling system would serve the broad range of Australian Government regulators and operational agencies, marine industry sectors (offshore oil and gas, shipping, fisheries, aquaculture and tourism) and public users that require accurate, detailed knowledge and predictions of ocean state, including currents, waves, temperature, salinity, pH and productivity. It would use and assimilate data collected by a sustained and expanded IMOS and our national research vessel fleet, and also draw in the significant observational data collected by industry as part of their core business. Given the scale of this challenge, and the depth of capability across academic institutions and publicly funded research agencies, we recommend that a national research focus on operational oceanography be established to ensure timely delivery of this significant national capability.