BCLME Project EV/HAB/02/05

Development of an Operational Capacity for Real-time Observations and Forecasting of Harmful Algal Blooms in the Benguela Current Large Marine Ecosystem Region: Regional Demonstration of Namaqua Shelf Bio-optical Mooring.

Report 7

June 2006

Regional Mooring Demonstration

Department of Oceanography

University of Cape Town

Introduction

Amongst the original deliverables of project EV/HAB/02/05 was a regional mooring demonstration workshop at NatMirc, Namibia. This workshop structure was changed to an intensive hands-on demonstration at the Namaqua mooring site, originally scheduled for March/April 2005 (see EV/HAB/02/05 Interim Report 5). The SAMSS conference, the seasonal nature of the Namaqua mooring, and some subsequent uncertainties about the proposed nature of the demonstration caused additional delays in the demonstration, which took place from the 16th to 18th May 2006, as detailed in this report.

Rationale

The two moorings designed and deployed by the project gathered eight months of multi-sensor data on the southern Namaqua shelf, from March to June 2004 and February to July 2005. A further five months of data have been collected in 2005/2006 under the auspices of the DST Frontier program. The buoy and mooring design has shown itself as stable from a systems perspective, has good hydro-mechanical performance, and offers high quality biological and physical data. Data products from the mooring, in conjunction with satellite data from the MERIS sensor, have been used for the detection and monitoring of several bloom events in real-time. Mooring deployment and operation has been extremely valuable in better understanding the technical, logistical and conceptual requirements for the operational use of lightweight buoy systems, and an extensive set of recommendations for operational mooring have been presented.

One of the central aims of the original BCLME project was the development of locally evolved low-cost mooring technologies and systems, and of a regional expertise in mooring design, deployment and maintenance. The mooring demonstration was central to these aims and sought to achieve the following:

- Exposure of Angolan, Namibian and South African scientists to mooring operations in the field, allowing them to gain a greater appreciation of the work needed to operate and maintain such moorings.
- Presentation of sensor selection, buoy and mooring design, and mooring maintenance and operation to facilitate planning and deployment of any potential further moorings in both the northern and southern Benguela
- Detailed discussion of the potential advantage of further moorings in the northern and southern Benguela, including selection of core measurement parameters and appropriate sensors, site-specific mooring requirements, budgeting and funding.

The mooring demonstration was timed to coincide with a routine UCT/M&CM mooring servicing operation, thereby allowing observers access to the mooring at sea and the ability to view all stages of servicing.

Attendees

Mooring Operations Group: Stewart Bernard (UCT), Alex Fawcett (UCT), Lionel Delaney (UCT), Andre du Randt (M&CM)

BCLME Observers: Deon Louw (NatMirc, Namibia), Quilanda Fidel (INIP, Angola), Isabel Rangel (INIP, Angola)

Additional Observers: Christo Whittle and Tarron Lamont (Marine Remote Sensing Unit, UCT)

Photographs of various attendees taking part in demonstration activities can be seen in Figures 1,2, and 3.

Programme

The mooring demonstration was structured with three main components:

- Demonstration and description of the mooring at sea, recovery and cleaning of the principal scientific buoy.
- Detailed description and discussion of the scientific buoy and payload
- Presentation and discussion of mooring & buoy design, mooring requirements & logistical needs, and mooring observation programs.

15th May 2006	Arrival of Angolan & Namibian observers in Cape Town
16th May 2006	Arrival of observers in Lamberts Bay
	Demonstration of mooring at sea
	Recovery of principal scientific buoy & marker buoy
17th May 2006	Demonstration of principal scientific buoy
	Group presentation and discussion
18th May 2006	Return of observers & mooring team to Cape Town
19th May 2006	Return of Angolan & Namibian observers from Cape Town

An outline of the mooring presentation made on 17th May can be seen in Appendix 1.

Results and Summary

Feedback from the observers on the workshop was very positive, and there is now considerable interest in starting low cost mooring programmes in both Namibia and Angola. Observers in particular stated the usefulness of detailed discussion on site specific mooring configurations, uses and field operation of various sensor types, and the various logistical demands of operating a coastal mooring system.

The workshop was also extremely useful to the project, in that it exposed the project team to the needs and requirements of the Namibian and Angolan

groups. Anticipating such needs is very useful with regard to future evolution of low-cost locally evolved mooring systems. In addition, the involvement of the Marine Remote Sensing Unit from UCT was very positive, as the mooring is considered the primary validation site for local ocean colour product. Exposure of MRSU personnel to the practical aspects of the validation site is of particular relevance to BCLME project EV/PROVARE/06/01 “Development of Satellite Remote Sensing Products”

Recommendations

The final project report of BCLME Project EV/HAB/02/05 recommended the most effective means of operating multiple moorings in the South African context was formation of a coalition of personnel, with a communal vested interest in mooring maintenance and appropriate expertise and access to required resources. Given the continued regional interest in providing more mooring facilities for a variety of regional stakeholders it is suggested that a regional Oceanographic Mooring Working Group be formed. In addition to an end user stimulated need for evolving local mooring systems, there is also considerable government interest in realizing large scale plans for autonomous ocean observation, specifically through the South African Department of Science and Technology. GEOSS, SAEON, and other long term broad reaching international and national programmes all have a keen interest in facilitating autonomous ocean observation, and a Mooring Working Group would be well placed to potentially take advantage of this current climate of enthusiasm. The working group would ideally represent a wide variety of interest groups: scientific (both scientists and programmes), management, commercial, government and funding organizations.

Figure 1. Demonstration of the mooring and servicing at sea, using the M&CM rigid inflatable boat *Zygo-B*.

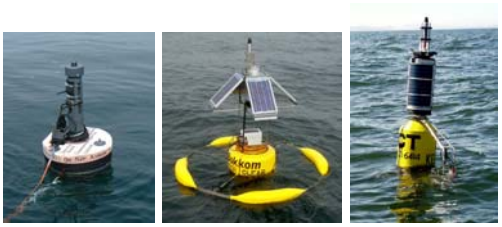
Figure 2. Observers taking part in high pressure cleaning of the scientific buoy ashore in Lambert's Bay. A) Deon Louw (NatMirc), B) Tarron Lamont (UCT), and C) Isabel Rangel (INIP).

Figure 3. Mooring demonstration and discussion, ashore in Lambert's Bay.

Appendix 1: Outline of Mooring Demonstration Presentation

Slide 1&2

DEMONSTRATION OF THE SOUTHERN BENGUELA MULTI-SENSOR HARMFUL ALGAL BLOOM MOORING



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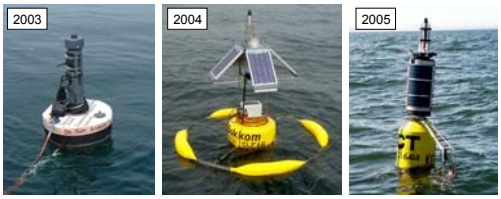
Key Mooring Considerations

- Identification of key oceanographic parameters – biological, physical and chemical - and operational and/or research needs e.g. real time data, measurement frequency, deployment length.
- Identification of affordable low-power sensors capable of autonomous measurement.
- Buoy and mooring design – robust, lightweight bus with good seakeeping abilities and capacity to mount required sensors appropriately. Appreciation of bio-fouling effects on mooring performance.
- Servicing needs and capability – mooring servicing extremely important, particularly for biological sensors and/or lightweight moorings.

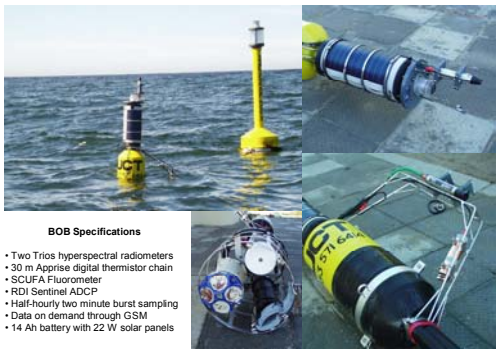
Slide 3&4

Evolution of a Real-Time Multi-Sensor Mooring

- Robust, cost-effective system developed locally providing real-time data for HAB monitoring
- Hyperspectral ocean colour sensors to provide real-time detection of algal assemblage change
- Temperature and current sensors to provide data on water column structure and transport
- High frequency Eulerian data provide both research and operational data
- Easily serviceable from small boat
- Use proven technology and sensors that can be calibrated in field
- Self-sufficient power system powering instruments and providing back-up power
- Mooring configuration should minimise shading of radiometers



Current Real-Time Multi-Sensor Mooring: BOB

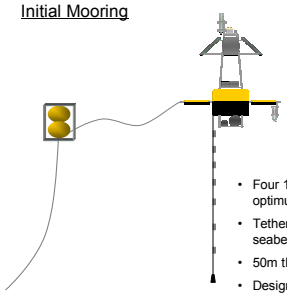


BOB Specifications

- Two Trios hyperspectral radiometers
- 30 m Apprise digital thermistor chain
- SCUFA Fluorometer
- RDI Sentinel ADCP
- Half-hourly two minute burst sampling
- Data on demand through GSM
- 14 Ah battery with 22 W solar panels

Slide 5&6

Initial Mooring

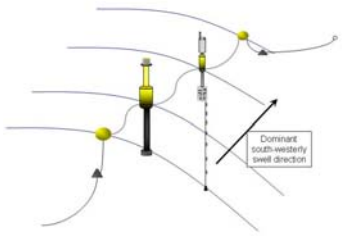


- Four 10W solar panels mounted at 45° for optimum power generation
- Tethered to main mooring anchored to seabed
- 50m thermistor chain
- Designed to minimise shading of optical sensors
- ADCP mounted on main mooring in logging mode

- Deployed from February to June 2004. Detected a number of bloom events during three month period
- Shape difficult to deploy and recover from small boat
- Thermistor chain became entangled around main mooring line and pulled off buoy
- Tethering to single point puts stress on frame
- Surface following buoy leads to high tilt/ roll values and stress on tether

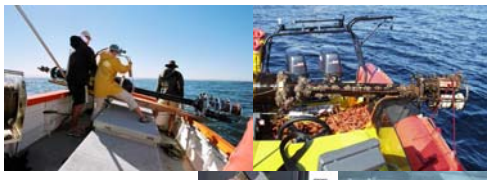
Slide 7&8

Second Mooring



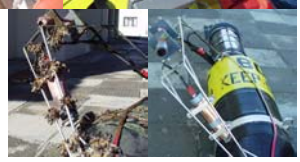
- Dual anchor tight line mooring aligned into dominant south-westerly swell
- Thermistor chain kept at a distance from mooring lines
- Pencil buoy design hangs from surface and changes position in water column as swell passes – more stable platform for data collection and less stress on structure

Current Real-Time Multi-Sensor Mooring: Servicing



Servicing and Bio-Fouling

- Scientific buoy serviced on a monthly basis
- Optical sensors wrapped in copper to prevent fouling on windows
- Fouling also a problem for the main mooring which requires servicing on a six-monthly basis

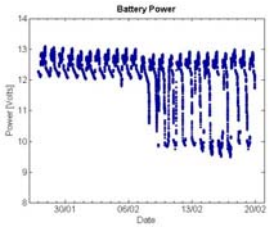


Adequate resources and logistical considerations for servicing are critically important

Slide 9&10

Data Collection

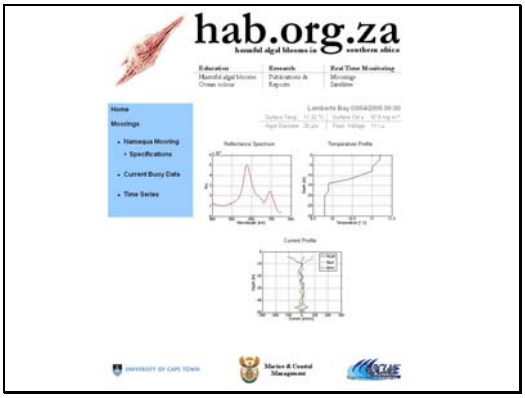
- Trade-off - ideally collect data as frequently as possible but need to consider balance between time scales to be measured and implications for power and storage
- Particular problem in bloom situation due to patchiness
- Data collected from instruments for two minutes every half an hour and stored on internal Compact Flash card
- Radiometer data only collected between 8am and 5pm
- Half hourly acquisition - system uses around 2Ah per day
- Buoy powered by combination of solar panels and 10Ah battery pack



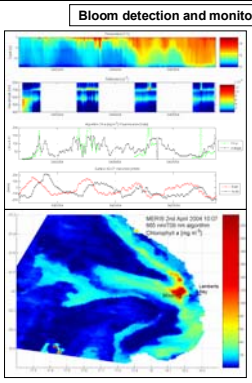
Data Storage and Transmission

- Buoy generates large amount of data ~1.5MB day
- All data stored on buoy – twice daily dial into buoy and download most recent acquisition via GSM modem.
- Data transmission rate around 14kbps – too expensive and time consuming to download all data via GSM
- Data processed and uploaded to website
- Website shows current snapshot of data, weekly time series, satellite data and background information on harmful algal blooms
- All data downloaded monthly during servicing

Slide 11&12



Bloom detection and monitoring on the event scale

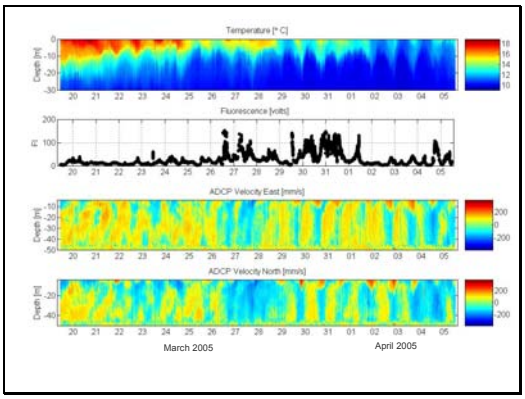


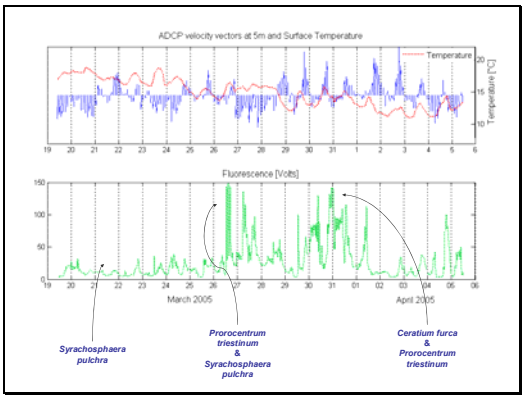
Mooring time series data and MERIS chlorophyll *a* data showing the detection and wide spatial extent of a bloom of the small dinoflagellate *Prorocentrum triestinum* from 2nd to 5th April 2004, in the Namaqua shelf region.

The bloom appears at the mooring ~ 4 hours after the satellite overpass, as warm high biomass bloom waters are advected shorewards in the easterly surface flow.

Satellite chlorophyll *a* data, derived through an experimental red band algorithm designed for high biomass application, show the widespread and complex distribution pattern of the bloom. Data such as these are likely to form the basis of a southern Benguela HAB observation system

Slide 7





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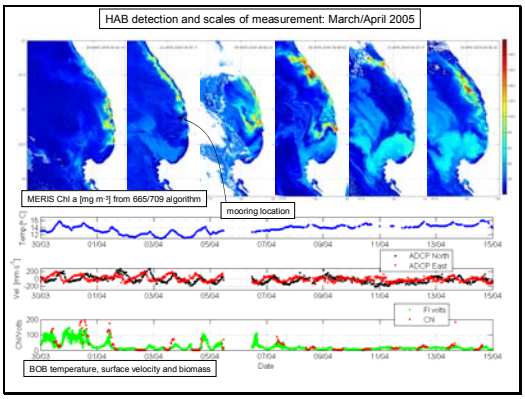

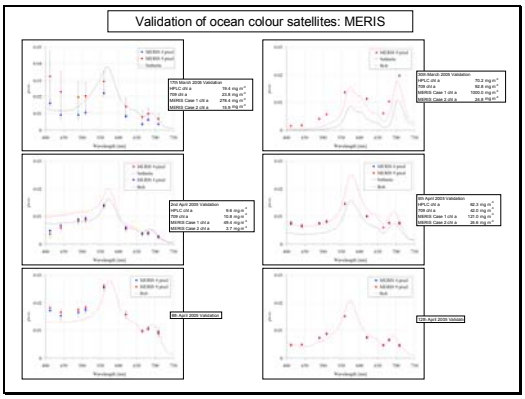

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Example of Mooring Costs

	Current	4 sensor	2 sensor
Mooring and Buoy Bus			
BOB bus:	15000	15000	15000
BOMB bus:	15000	15000	
Mooring gear:	10000	10000	2000
System & sensors			
Ocean-I	50000	35000	25000
Radiometer x 2	120000		
BB2F	40000	40000	40000
Templine	25000	25000	25000
Power, Solar etc	7000	7000	7000
Connectors etc	10000	7500	5000
ADCP	100000	100000	
Oxygen		25000	
Total Mooring Cost	392000	279500	119000

- Servicing costs are extremely important – current project spends ~ZAR 5000 p.m. on direct servicing costs
- Telemetry costs also a factor – current project spends ~ZAR 600 p.m. on GSM costs. Satellite transmission e.g. ARGOS much higher.

Summary

- Lamberts Bay mooring currently collects half hourly data providing real-time data for snapshot of current conditions and harmful algal bloom detection, high-frequency time series research data and satellite validation data
- Maintenance of mooring is time consuming and requires commitment of personnel, resources and funds
- Mooring is still in demonstration phase and will be maintained for as long as possible in its current state. Still a long way from operational and requires much greater resources and access to replacement sensors etc. to provide continuous data
- Current mooring cost ~R100 000 and is fitted with ~R450 000 sensors
  Would like to develop smaller, cheaper mooring for ~R120 000 for monitoring of temperature profile and a biological parameter (fluorescence, backscattering)