

BCLME Project EV/PROVARE/06/01

**Development of Satellite Remote Sensing Products
for Operational Application**

Report 1

July 2006

Project Inception Report

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Executive Summary

Currently there is no well developed and integrated information infrastructure for marine ecosystem management in southern Africa, although appropriate initiatives are being taken towards such a goal through the Benguela and Agulhas LME programmes. Satellite remote sensing (RS) forms an important aspect of such an information system, but the knowledge and expertise in marine remote sensing in southern Africa has become somewhat fragmented with several initiatives and efforts being implemented independently, leading to a degree of duplication of effort.

This project aims to utilise BCLME funds to provide the remote sensing component of a pre-operational marine observation system. It will achieve this by securing, developing and integrating existing regional capacity in the marine remote sensing field. The project serves to support the transition between the current Marine Remote Sensing Unit (MRSU) based at the University of Cape Town (UCT) and the proposed multi-stakeholder regional Marine Remote Sensing Centre, and provide pre-operational marine remote sensing products in this transition phase.

This report will focus on detailing the activities and methods used to produce deliverables within the first six and ½ month period of the project, scheduled to run from July 2006 to January 2007. These deliverables include:

- Trial remote sensing product website offering available near real-time and archived imagery, and prototype tools for image analysis.
- RS training workshop and report - the workshop is to promote the use of a trial RS server website amongst user groups and encourage feedback.
- Progress Report 1.
- Updated web site offering broader range of imagery, updated analysis tools and satellite validation data

In addition the project will closely collaborate with the concurrently running BCLME Environmental Early Warning System (EEWS) and State of the Ecosystem Information System (SEIS) projects to ensure a coherent approach toward RS products amongst the three projects, and to ensure maximum potential take-up of TS products by the EEWS and SEIS projects.

1. Deliverables: July 2006 to January 2007

1.1 Trial Remote Sensing Server - July 2006

The trial RS server is the core deliverable of the first phase of the project. The server, the prototype of which was developed under funding from the African Coelacanth Ecosystem Programme and is running at the University of Cape Town, will initially focus on Moderate Resolution Imaging Spectrometer (MODIS) 1 km resolution standard ocean colour geophysical and SST products. Chl a and SST binary data and imagery are available for seven regions: Angola; Namibia; South African west, south and east coasts; Delagoa Bight; and Madagascar. Near real-time and archived data are available as daily images, anomalies, weighted averages and pentads (five day averages). The site provides the ability to search and download archived data, and provides a prototype visualization and analysis tool, allowing image manipulation, animations and Hofmüller plots amongst others. Examples of site content are shown in figures 1 and 2.

Data from the trial server will initially be restricted to standard NASA products, downloaded from the Goddard Space Flight Centre ftp site. These are intended as “quick-look” near-real time operational products. Data processed with locally optimized routines will be made available on the server through the course of the project (see section 1.3.2).

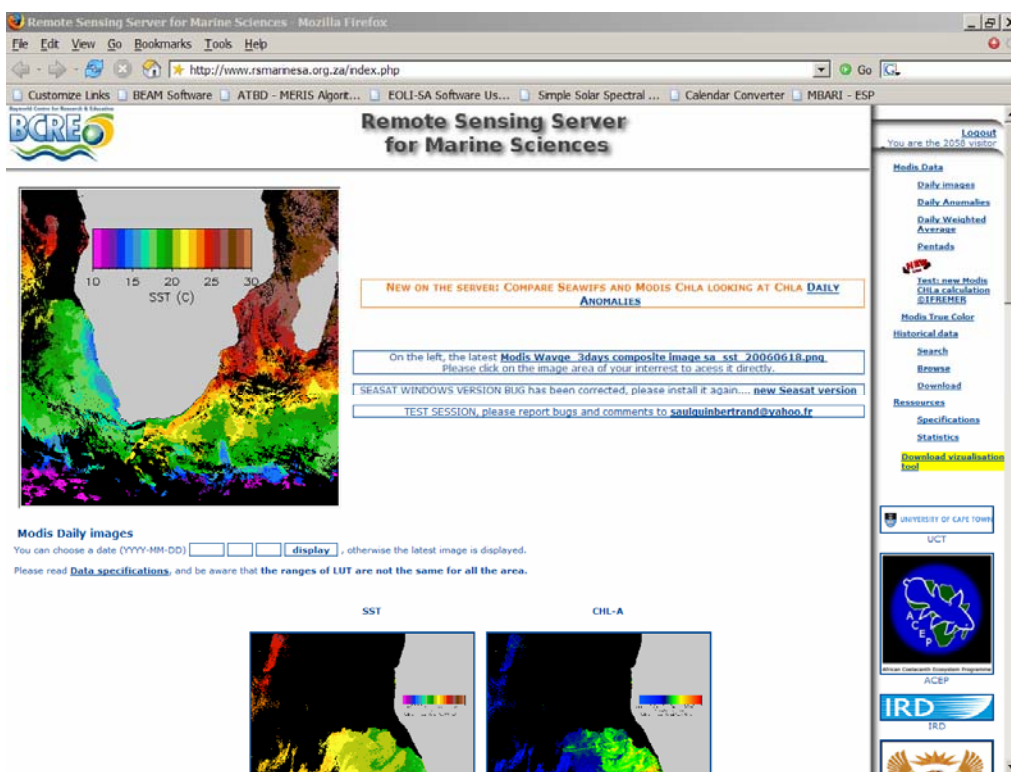


Figure 1. Screenshot of the RS server homepage whilst under development.

1.2 RS Server Workshop & Report - July 2006

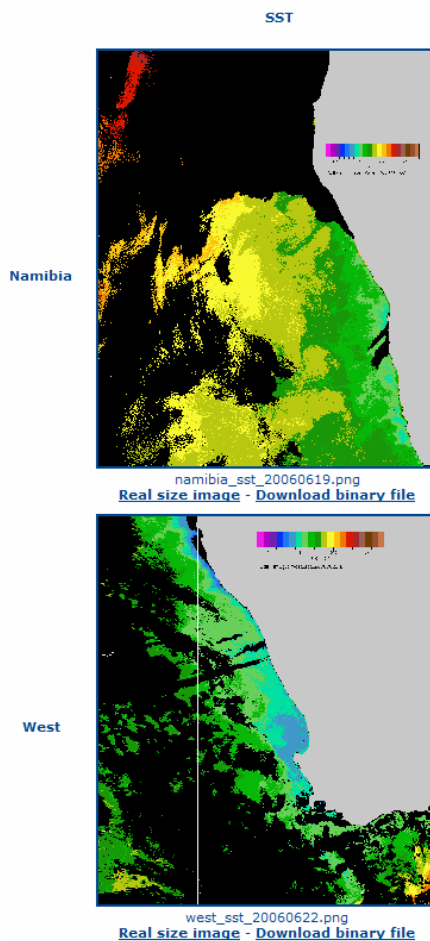


Figure 2. Sample SST images for two of the seven server areas

server) will also be demonstrated, as it is likely that these sites will be merged in the course of the project.

The workshop is intended to notify stakeholders of the availability of the server, demonstrate server usage, and identify core server users. It is currently scheduled for 6th July at UCT Oceanography Department. The workshop will be advertised through Sancor, remote sensing mailing lists and any other media deemed necessary. Specific invitations will be issued and travel funding will be made available to the Namibian and Angolan representatives identified in the project contract document. The workshop agenda will include the following

- Introduction to the project and description of it's aims
- Introduction to the RS server web site and tutorial on usage of the web site and visualisation/analysis tools.
- Identification of core stakeholders main RS requirements
- Inviting and addressing user feedback

The last point is of particular importance to the project, as user feedback during the project duration is expected to play a major role in determining the direction of server devolvement. Local RS web sites also currently providing near real-time data (in addition to the

1.3 Progress Report 1 - January 2007

A brief description of the work that will be undertaken under the three sub-projects during the first six and ½ months of the project is outlined below.

1.3.1 Ocean Colour Validation

Ocean colour remote sensing in the Benguela is made complex by both high biomass waters and highly variable atmospheric conditions associated with a long semi-desert coastline. Validation is required for effective use of ocean colour products: both radiometric validation i.e. of the satellite received signal and assessment of the atmospheric correction, and geophysical validation i.e.

assessment of algorithm efficacy. The southern Benguela Namaqua mooring is maintained as a collaborative validation facility by UCT and Marine and Coastal Management, offering automated sampling suitable for radiometric validation. Validation of algorithms and geophysical products requires *in situ* sampling, and this will be conducted during buoy servicing and dedicated scientific field experiments. An example of the complexities of ocean colour use in the Benguela can be seen in Figure 3, showing radiometric validation match-ups between the Namaqua mooring and the MODIS sensor. The figure shows the often poor match between measured *in situ* reflectance and MODIS reflectance, illustrating the often poor performance of the MODIS atmospheric correction.

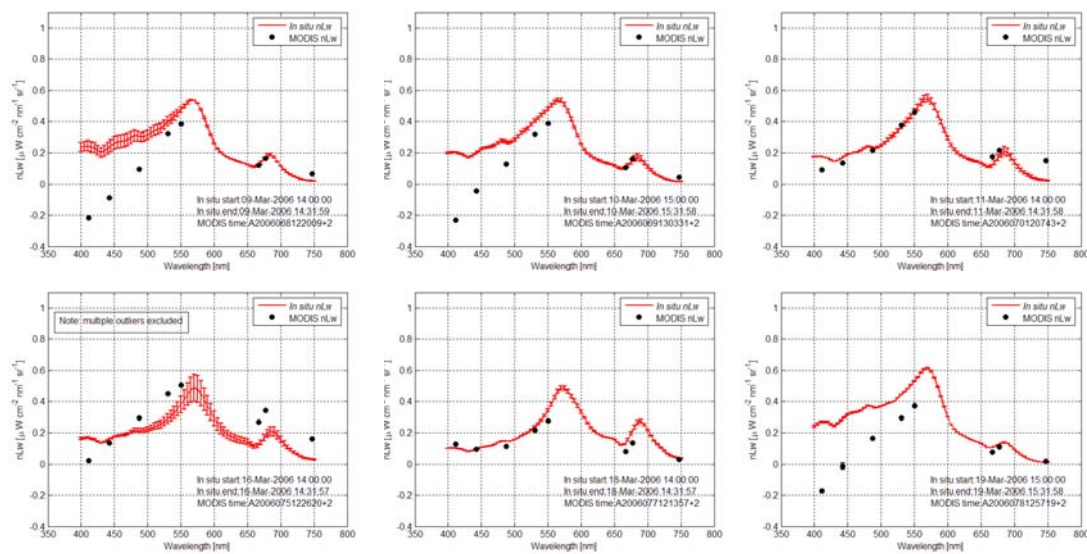


Figure 3. Comparison of sample reflectance measurements from the hyperspectral sensors on the Namaqua mooring (red lines) and the MODIS sensor (black dots) in March 2006.

The Namaqua mooring has an additional role in local implementation of the Global Earth Observation System of Systems (GEOSS) strategy calling for use of *in situ* observations in Ocean Observing Systems; as a pilot autonomous platform offering real time data suitable for integration into observation and forecasting systems. The mooring is also expected to play an important role in the forthcoming C-GOOS (Coastal component of the Global Ocean Observing System) programme, implemented under GEOSS. The integration of observational data from multiple platforms and at different scales of measurement is an important aspect of future observing systems.

The first six ½ months of the project will have two core validation aims: further acquisition of satellite validation data through the continued operation of the Namaqua mooring with co-funding from the Department of Science and Technology's Frontier programme, and the processing and analysis of validation data gathered to date. In addition to reporting to the BCLME on validation issues, the project aims to make provisional validation reports to both the National

Aeronautics and Space Administration (NASA) and the European Space Agency (ESA) – active dialogue with these agencies is critical to improving both sensor performance and securing data reception. Initial setting up & training with the Hydrolight radiative transfer model will be followed by trial validation modeling.

1.3.2 Development of Local Processing Protocols & Experimental Products

Core remote sensing products required for the region are ocean colour geophysical products and sea surface temperature (SST), derived from MODIS, MERIS, and the AVHRR series of sensors. Production of high quality data requires regionally optimized processing routines. MODIS data, for example, is routinely reprocessed several days after acquisition to incorporate corrected ephemeris and ancillary meteorological and ozone data. It is therefore likely that a two tier data system will be used for level 2 ocean colour products, giving rapidly and automatically processed “quick-look” data for near real-time operational use (such as those currently available through the RS server), and high quality optimally processed data several days after acquisition

Regionally optimised processing protocols will be evolved over the course of the project, and these data will be made available on the server as it is further developed. In addition to the generation of standard ocean colour derived geophysical products e.g. chlorophyll *a*, experimental products from new algorithms will also be developed. These will include algal size descriptors, inherent optical properties, algal fluorescence products, primary production products, descriptors of non-algal water constituents, and other water quality parameters. Sample images of various algal descriptor and other analytical products derived from the MERIS sensor are shown in figure 4.

SST data from MODIS and the NOAA Advanced Very High Resolution Radiometer (AVHRR) sensor series will be used as core products. In addition to these there is currently a trial project examining feasibility of the MeteoSat Second Generation (MSG) geo-stationary satellite, capable of producing 3 km resolution SST data at 15 minute intervals.

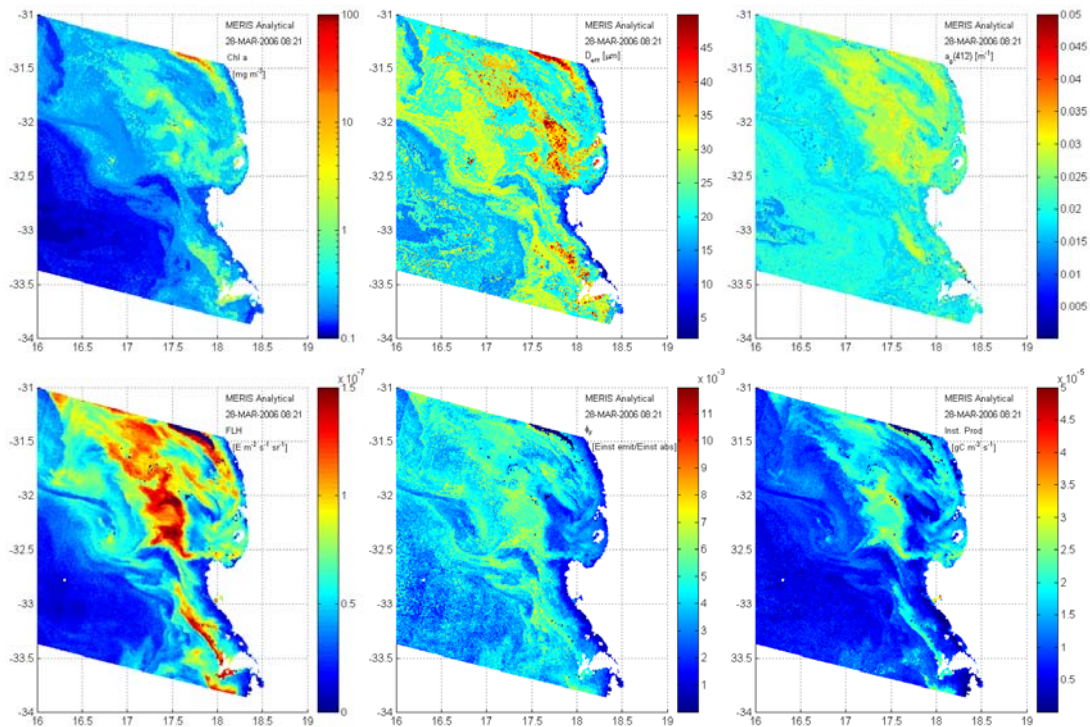


Figure 4. Demonstration of analytical algorithms products for the MERIS sensor, from 28th March 2006 in the St. Helena Bay region. Images clockwise from the top left are chlorophyll a, algal effective diameter, gelbstoff absorption, instantaneous primary production, algal fluorescence quantum yield, and fluorescence line height.

1.3.3 Server Refinement & Integration

Archiving and dissemination is a key element in developing an effective remote sensing system - dissemination of products using large volumes of data often lag far behind the collection of observations, which prevents the timely use of information. RS capacity development is thus highly dependent upon IT infrastructure, bandwidth, and archiving and dissemination systems, and it is these issues that the project will focus on.

The provision of effective diffusion tools for RS data is essential to the project. The ultimate aim of a southern African marine information structure is to provide a web portal where *in situ*, remote sensing, GIS and modeling products will be widely accessible. The project will seek to take advantage of RS server tools developed for the east coast to provide a powerful but easy-to-use means of accessing and analyzing RS data from the web portal. A high priority will be placed on developing architecture and analysis tools that allow high coherency between this project and the SEIS and EEWS projects, facilitating the ultimate integration of the three projects. The first six and ½ month project phase will

focus on two aspects of the RS server: adding regionally optimised locally processed data to the standard GSFC products currently available, and incorporating user feedback to refine server structure and product choice to best suit stakeholder needs.

1.3.4 Training

Training of personnel, capacity building and the transfer of skills and technology have all been identified as key focus areas in the development of a regional remote sensing capability. Addressing the lack of sufficient skilled personnel in both the scientific and technical domains is of considerable importance. The project aims to produce at least one skilled person, with the capability to continue working independently in their specialised field, for each of the three sub-project areas. In addition the project will ensure the involvement of at least one representative from each country in the regional partnership, with the dual aim of providing specialised training and facilitating further regional knowledge transfer. A particular focus will be placed on ensuring that regional representatives achieve a strong familiarity with the RS server, tools and data that are the main output of the project, thus ensuring the availability of regional expertise and facilitating regional take-up of the project's outputs.

The first project phase will focus on the following aspects of training:

- Familiarising Namibian and Angolan representatives with the RS server and underlying processing routines.
- Knowledge transfer of server structure and coding to allow a broad knowledge base for server refinement and maintenance
- Skills transfer with regard to the highly specialised technical skills required for the operation of autonomous moored platforms
- Set up of PhD and MSc sub-projects.

In addition, the RS server will provide data for south-east Africa, thereby promoting collaboration with the ASCLME and skills transfer on a broad regional basis e.g. the specific involvement of Mozambican scientists in the RS server workshop.

2. Collaboration with EEWS & SEIS

The products developed in this project will complement those used in the BCLME funded SEIS and EEWS projects, with a specific focus on provision of high frequency, high spatial resolution specialised products for the coastal zone. Preliminary discussions have already been made regarding common aspects of the three projects and potential cross-overs. The Statement of Work for EV/PROVARE/06/01 will be made available to the EEWS and SEIS projects, as will all further deliverables.