IMOS National Working Group on Bio-optical Instrumentation and Observing

Terms of Reference

During its first meeting on 23-24 March 2010, the IMOS Bio-optics Working Group (WG) discussed the Terms of Reference (ToR) for its operations during Jan 2010 to July 2012. The five identified ToR are listed here, and are followed by a more detailed explanation of each, including associated tasks.

1) Develop an integrated and scientifically robust strategy for the calibration, validation and interpretation of single-waveband fluorescence, absorption and scattering data, as collected by a number of IMOS facilities

2) Review and advise on priorities for incorporating more advanced bio-optical instrumentation within IMOS facilities

3) Facilitate and improve links from bio-optical data streams to biogeochemical models

4) Advance integration of in situ bio-optical observations and satellite remote sensing, including strategies for the development of inter-calibration protocols and exercises

5) Work towards building a national bio-optical Community of Practice

1a. Develop an integrated and scientifically robust strategy for the calibration, validation and interpretation of single-waveband fluorescence, absorption and scattering data, as collected by a number of IMOS facilities.

IMOS currently supports approximately 60 sensors that collect fluorescence and scattering data on numerous platforms, including gliders, moorings, ships of opportunity and autonomous vehicles. Currently there is no unified approach to the calibration, validation and interpretation of data from these universally deployed sensors, yet there is general agreement that this would reduce the uncertainty in data streams, improve comparability across platforms and ecosystems, and therefore greatly improve utility for data users.

Calibration. It is well recognised that such sensors require calibration before deployment, but there are a number of challenges in doing this operationally:

- Absolute calibration is expensive, requiring shipment of instruments overseas and is probably only realistic once a year;
- Furthermore, for some instruments, there is a lack of understanding or disagreement with how the default factory settings are derived;
- Sensors may diverge from the factory calibration settings during shipment and deployment, so there is a need to check instrument performance more regularly, including intercalibration between sensors.

The WG will address these issues by recommending strategies for bio-optical sensor calibration across IMOS facilities, including inter-calibration and inter-comparison exercises.

Validation. Multiple dissolved, colloidal and particulate constituents of seawater contribute to fluorescence, absorption and backscatter signals, so there is a need to validate what bio-optical sensors are actually measuring. Differences in water mass properties at the regional scale make a major contribution to this variability—i.e. there are inherent differences in bio-optical signals across Australian coastal waters that cannot be removed through sensor calibration.

The WG will address this issue by recommending protocols for comparison with physical sampling and laboratory measurements, as well as the collection of ancillary data to help interpret fluorescence, absorption and scattering data.

Interpretation. The WG recognise there is a general lack of understanding about what bio-optical data is, what contributes to its variability and what it can be used for.

To increase the community's understanding of bio-optical data being collected within IMOS, the WG will compile a list of sensors and their specifications (e.g. excitation and emission wavelengths, optical geometry, etc.), and how they are being deployed across nodes and facilities. It will also prepare, using relevant reviews from the literature where possible, background documents about fundamentals of marine bio-optics, including describing what happens in the measurement of chl-a and CDOM fluorescence as well as backscatter, where the sources of variability are and a strategy for reducing their errors.

1b. Develop an integrated and scientifically robust strategy for the calibration, validation and interpretation of multi-spectral fluorescence, absorption and beam attenuation data, as currently collected by the Lucinda Jetty Coastal Observatory.

Multi-spectral and hyperspectral sensors offer more information, but the challenges of calibration, validation and interpretation are commensurately greater than single-wavelength sensors.

2. Review and advise on priorities for incorporating more advanced bio-optical instrumentation within IMOS facilities

Several IMOS facilities (e.g. ANFOG, SOOP and AUV) are purchasing additional bio-optical instrumentation in the first half of 2010 and are seeking input from the WG about the types of sensors, their suitability for deployment on particular platforms, and appropriate deployment locations. Furthermore, IMOS partners and operators are purchasing platforms onto which additional and potentially more advanced bio-optical instrumentation could be deployed.

The WG will therefore:

Make recommendations regarding the configuration and deployment of ECO-puck triplet sensors at a subset of NRS sites.

Make recommendations regarding priorities for new bio-optical sensors within ANFOG, SOOP, and AUV facilities.

Draft a set of recommendations / strategy for gathering proof of concept data for promising instrument and platform combinations.

Contribute knowledge on initiatives outside of IMOS that would be relevant for sensor testing (e.g. CSIRO glider purchase).

Generate a list of sensors (bottom up approach) with a matrix of considerations (e.g. cost, maintenance, deployment specifications, calibration, products they yield, utility for different IMOS facilities and data users, etc.) to assist in identifying and guiding priorities for investing in bio-optical instrumentation.

Frame a set of key research questions (top down approach) involving bio-optical data and then reference back to the necessary bio-optical (and other) data streams required to answer the questions

3. Facilitate and improve links from bio-optical data streams to biogeochemical models

IMOS is a distributed network of sensors collecting in situ data over multiple spatial and temporal scales. Given that there are mechanistic links between light absorption, fluorescence and biological productivity, and that a key strategic priority for IMOS is to increase the useability of data, there is increasing recognition that bio-optical data should be better linked to models. The models referred to here are biogeochemical models or inverse models for satellite data.

In this context, the WG aims to:

Articulate links between in situ bio-optical data and model inputs and outputs to develop more direct modelling approaches relevant to the question being asked and reduce additional calculations that introduce errors in derived parameters.

Define sources of uncertainty in bio-optical data and how to understand the error structures in the observations as well as derived parameters.

Determine how a gridded product for various bio-optical parameters could be produced.

4. Advance integration of in situ bio-optical observations and satellite remote sensing, including strategies for the development of inter-calibration protocols and exercises

Satellite data are currently available to the oceanographic community, but their utility in Australian coastal waters is restricted by large errors in estimates of ocean colour and other parameters. This is partly because global products are developed from a match-up database skewed towards the North Atlantic, but could also be because the inherent optical properties of water masses in Australia are different to other regions. There is a clear need to assess the potential differences in optical properties of Australian coastal waters with other locations, and to develop regional products that have greater accuracy.

To this end, there are a number of developing initiatives the WG support, but will not undertake, which will contribute to the integration of in situ bio-optical data with satellite data to improve utility of remotely sensed products.

i. Collation of existing bio-optical data from Australian waters into a centralised database. It is envisaged that a subset of this data will be of suitable quality to meet match up data requirements used to develop global products;

ii. Agreement between IMOS and the Marine National Facility for any bio-optical data collected on board the national research vessel to automatically be incorporated into the centralised database.
iii. Assessment of the accuracy of satellite products in the Southern Ocean, so that a research strategy for this priority region can be articulated.

The WG will also:

Recommend ways on re-designing approaches for delivering SRS products using in situ bio-optical data; e.g. short-circuiting computations that introduce large errors

Provide a clear statement about what the SRS group is currently delivering, including what the constraints and opportunities it has for developing new or improved products

Assist in identifying/developing SRS products that maximize utility for diverse user groups

5. Work towards building a national bio-optical Community of Practice

IMOS have supported the WG until 2012 to focus on a specific set of tasks (as outlined in these Terms of Reference), with a view to improving the utility and uptake of bio-optical and SRS data. Over the longer term, it is envisaged that the community will be self-sustaining.

With the longer-term view in mind, the WG will:

Build and maintain a WG website (under IMOS) as a portal for delivering information to the community, to gather input into WG activities and priorities, and assist in developing a community dialog. One specific activity is to provide on-line tutorials and relevant literature citations about bio-optical instruments, data, and applications.

Identify links with relevant international and national programs.

Engage with broader community through AMSA/other national conferences, and hold 3 community-based workshops between 2010 and 2012.