

www.csiro.au

Past, current and planned activities in Ocean Colour Cal/Val in Australia

Vittorio Brando
Environmental Earth Observation Group
CSIRO Land & Water, Australia

 **IMOS** Integrated **Marine Observing** System

Lucinda Jetty Coastal Observatory (LJCO)

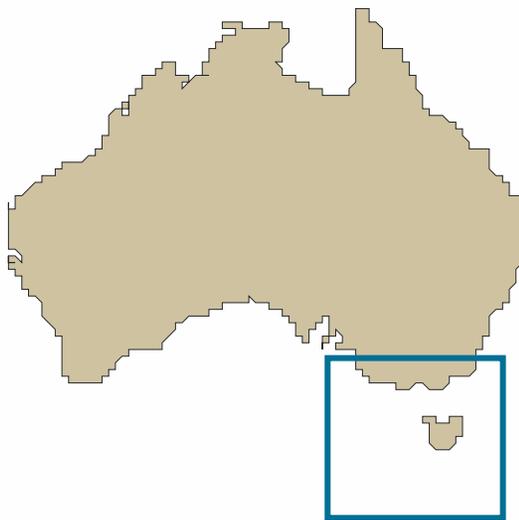


Outline of the talk

- **Past activities**
 - Regional validation studies
- **Current and planned activities within IMOS**
 - Establish a bio-optical data base of Australian Waters
 - Biogeochemical sampling and bio-optical measurements at 8 National Reference Stations
 - Radiometers mounted on ships of opportunity
 - Lucinda Jetty Coastal Observatory

Regional validation studies

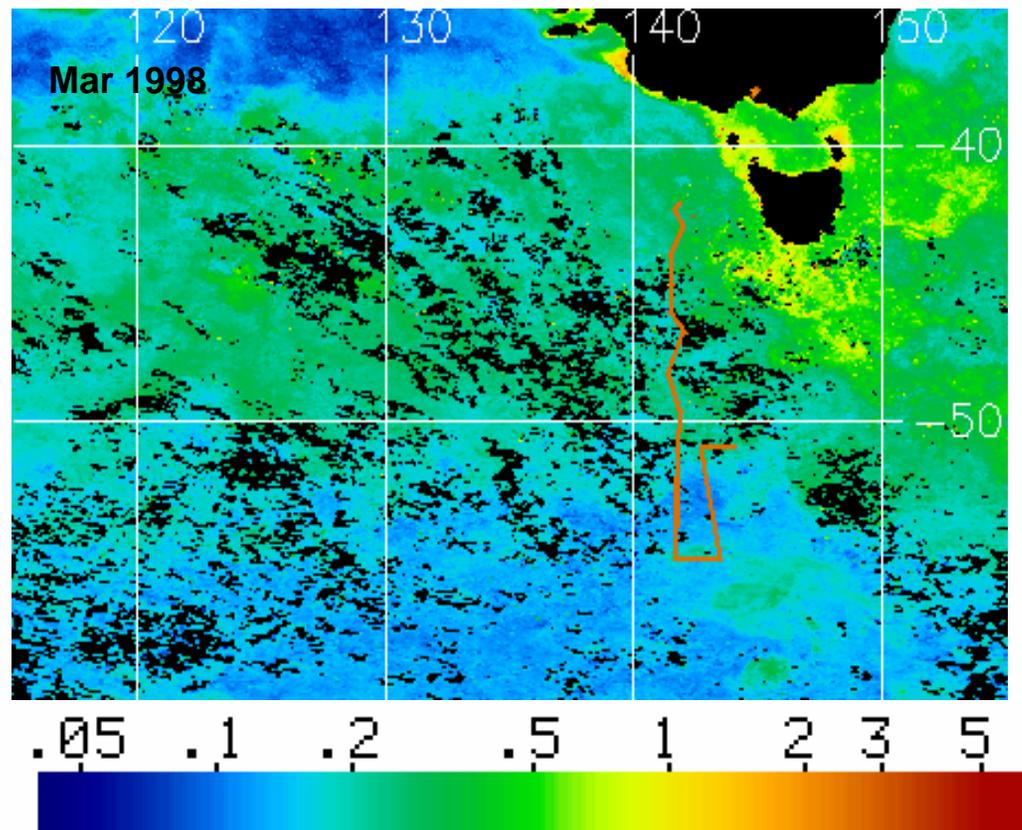
- Validation of SeaWiFS in the Austral region of the Southern Ocean.



March 1998

Clementson et al. 2001

JGR, 106, 31611-31625.

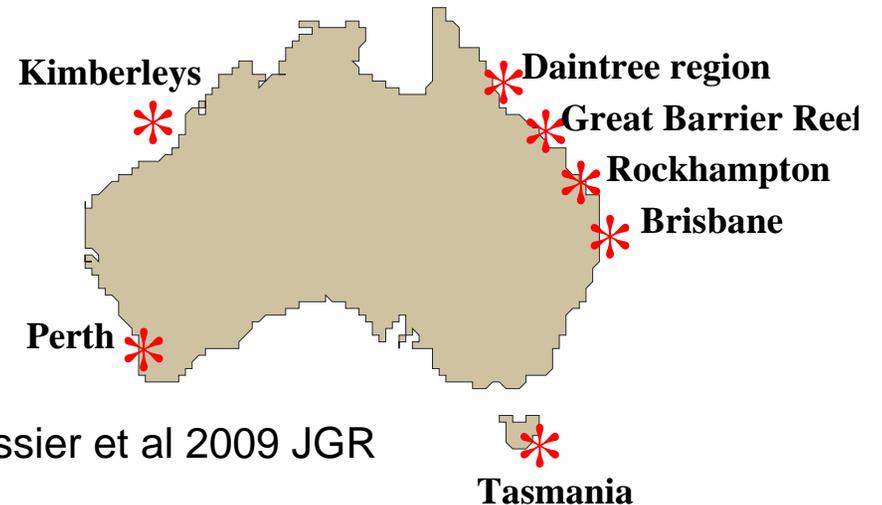


Regional validation studies

Bio-optical characterization of mostly coastal waters

- ~300 stations (2002-to date)
- Samples collected for HPLC chl a, TSM, a_{PHY} , a_{CDOM} , a_{NAP}
- AC9 & HS6 profiles
- Radiometry

Oubelkheir et al 2006 JGR, Blondeau- Patissier et al 2009 JGR



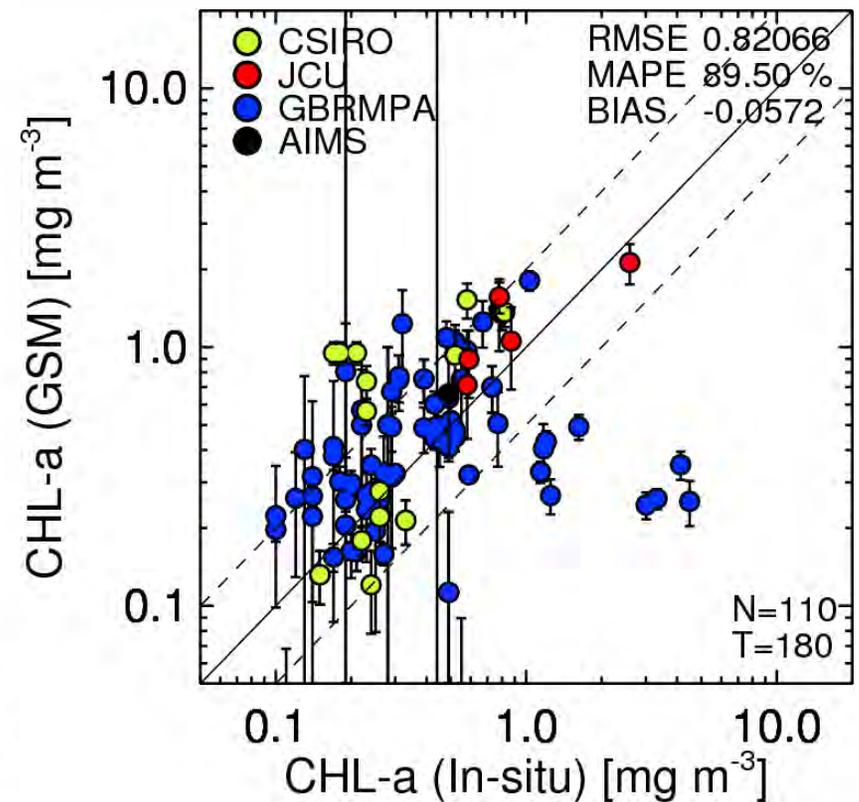
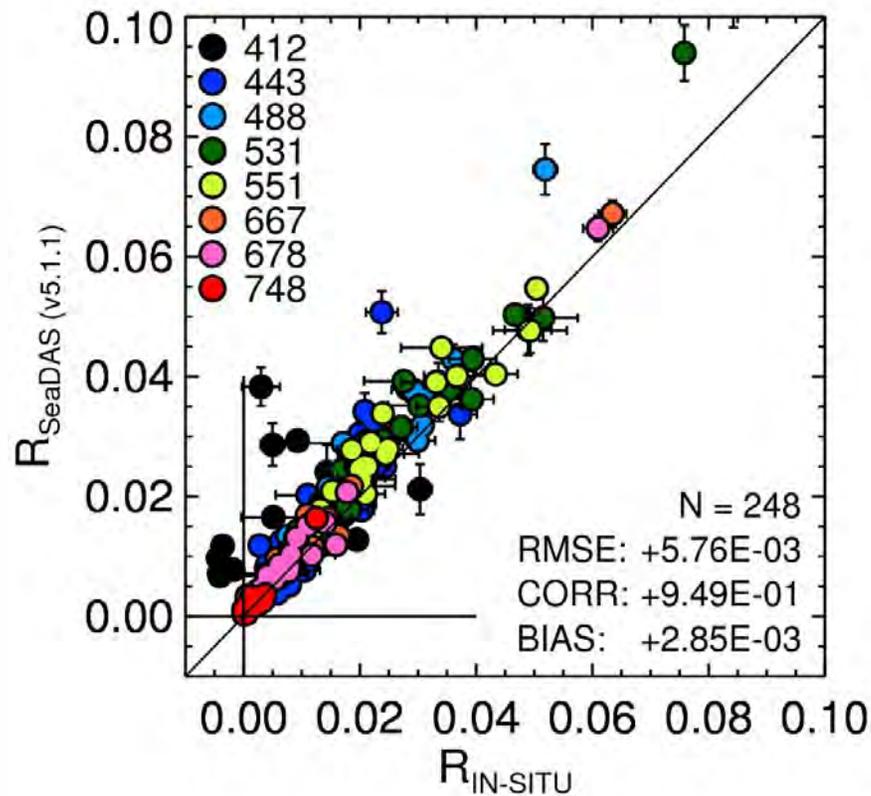
MERIS Validation Project – Project AO595

- CSIRO Land and Water
- CSIRO Marine and Atmospheric Research
- University of Queensland
- Curtin University

Data delivered to ESA CoastColour project

Regional validation studies

- Validation of MODIS products for Great Barrier Reef Waters



Schroeder et al 2008, OOXIX

Current and planned activities within IMOS

- **Establish a bio-optical data base of Australian Waters**
- **Biogeochemical sampling and bio-optical measurements at 8 National Reference Stations**
- **Radiometers mounted on ships of opportunity**
- **Lucinda Jetty Coastal Observatory**

These activities are funded up to July 2013 by Australia's Integrated Marine Observing System

IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative.

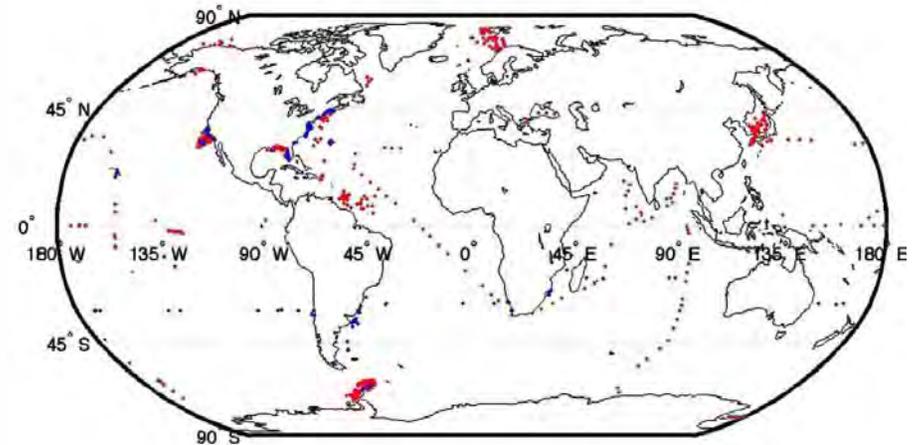
Ship-mounted radiometers

- In order to extend the footprint of the Calibration and Validation activities of remotely-sensed satellite ocean colour products carried out at LJCO, two spectroradiometers will be installed on ships of opportunity to acquire continuous measurements of the water leaving radiance in the Australian sector of the Indian, Pacific and Southern Oceans.
- Given the need for daily maintenance activities and troubleshooting for the radiometers, these instruments will be installed on board of research vessels (Aurora Australis, Solander, Southern Surveyor and/or the new MNF vessel).
- **Currently in the instrument selection and setup phase.**

Establish bio-optical data base of Australian Waters

- The database will contain:
 - bio-optical data (i.e. HPLC, Chlorophyll by spectrophotometric methods, full spectral absorptions, TSS)
 - and in situ optical data (Vertical attenuation, water leaving radiance, reflectances, Atmospheric Optical Depth, spectral and single channel absorption and backscattering)collected by the Australian Community since 1997.

- The **bio-optical data base** will underpin the assessment of ocean colour products in the Australian region
- The **bio-optical data base** will be contributed to international space agencies

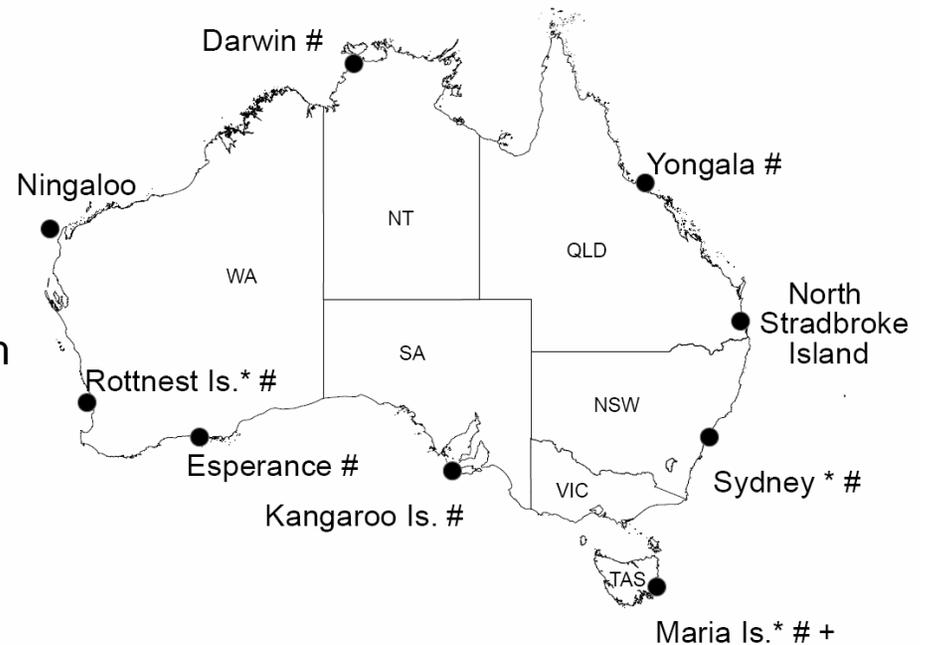


Currently in data inventory phase.

Bio-optics at 9 National Reference Stations

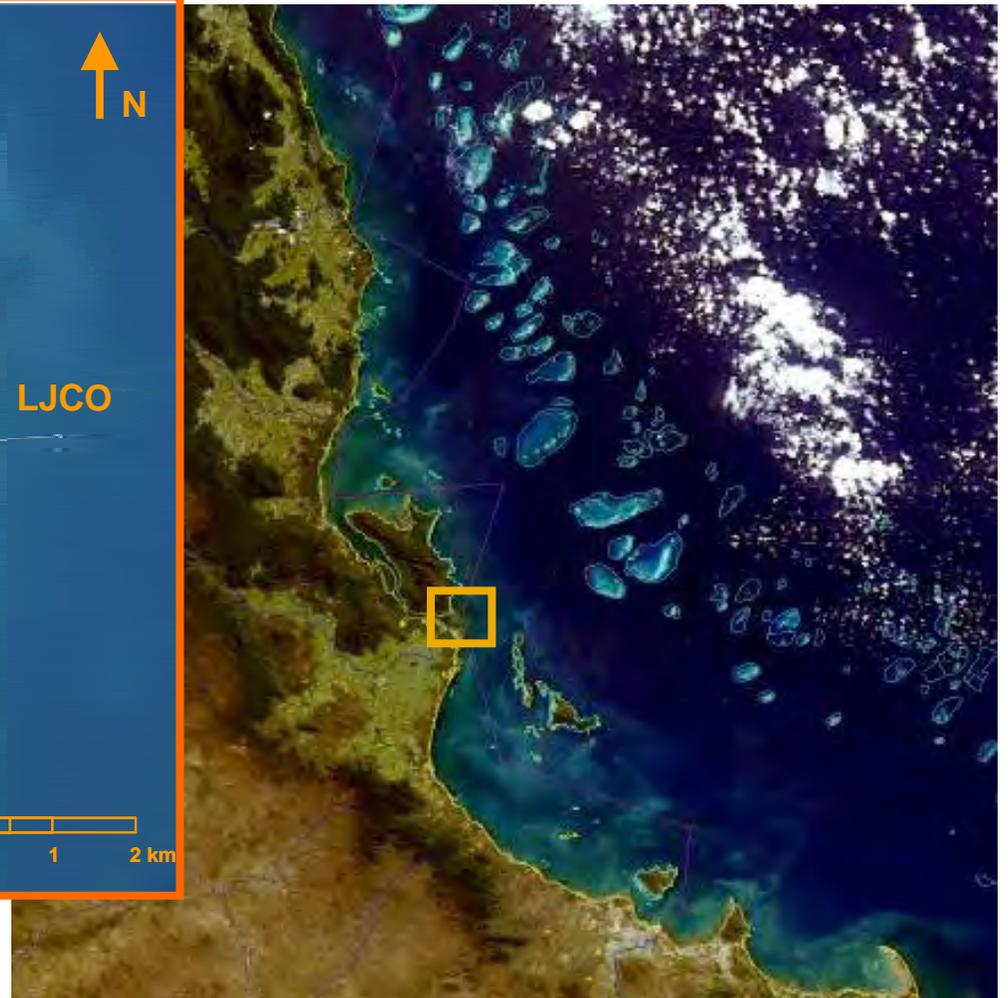
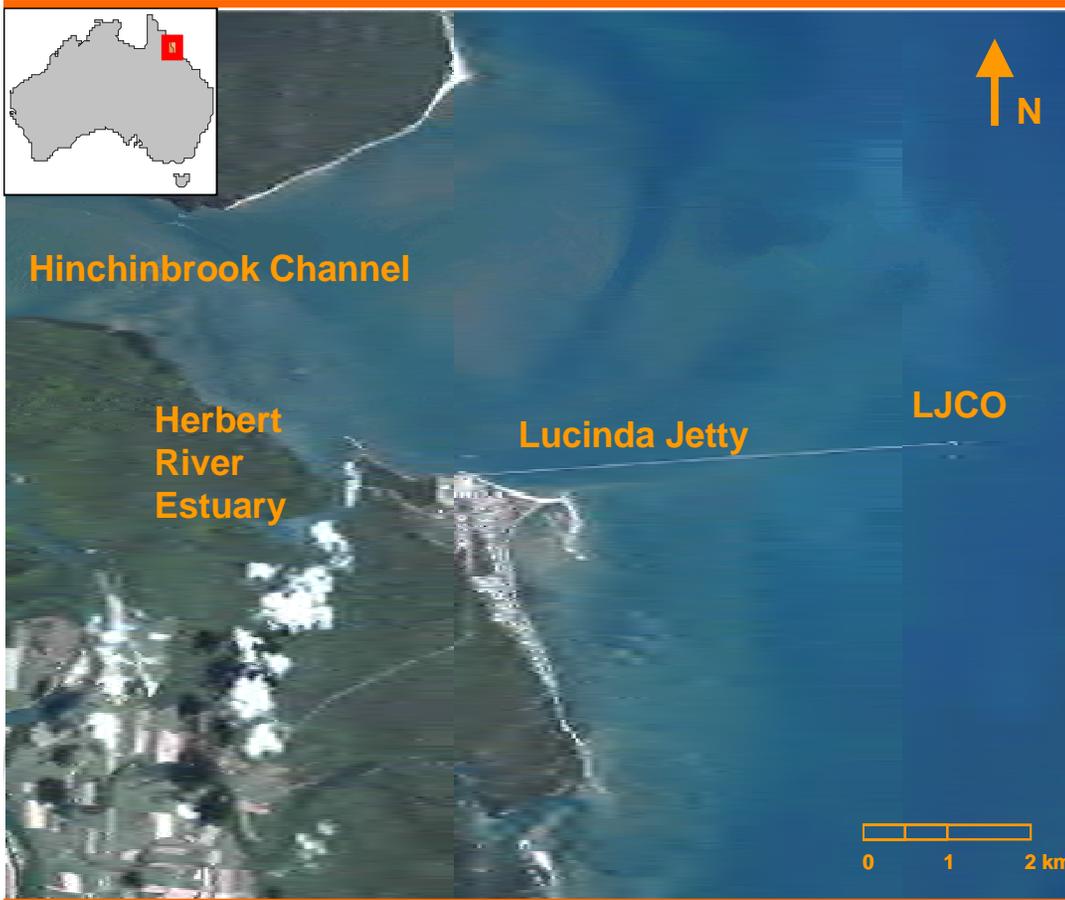
- **Bio-optical instrumentation and monthly sampling at 9 moorings to provide sustained observation of key bio-optical variables for Australia's shelves:**

- WQMs
 - Chlorophyll-a fluorescence
 - Backscattering at 700 nm
- EcoTriplets
 - CDOM fluorescence
 - Backscattering at 440 and 550nm
- Monthly sampling for :
 - phytoplankton pigments by HPLC
 - total suspended solids (organic and mineral fractions)
 - Nutrients
 - TOC, DOC and POC

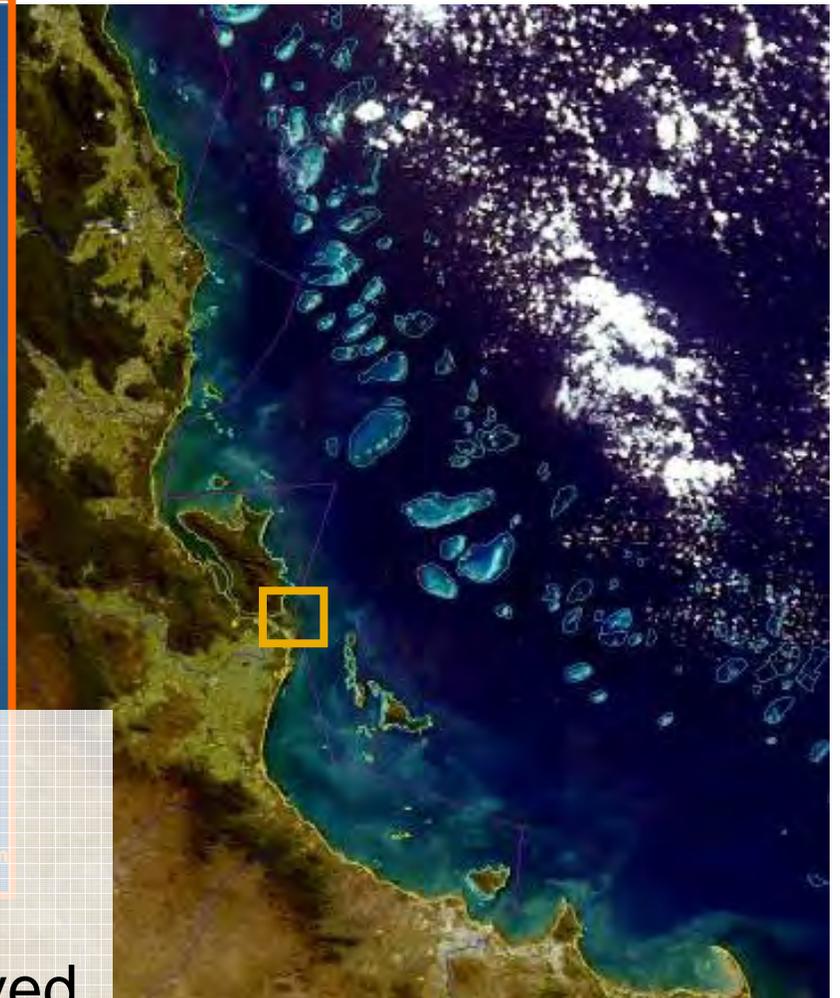
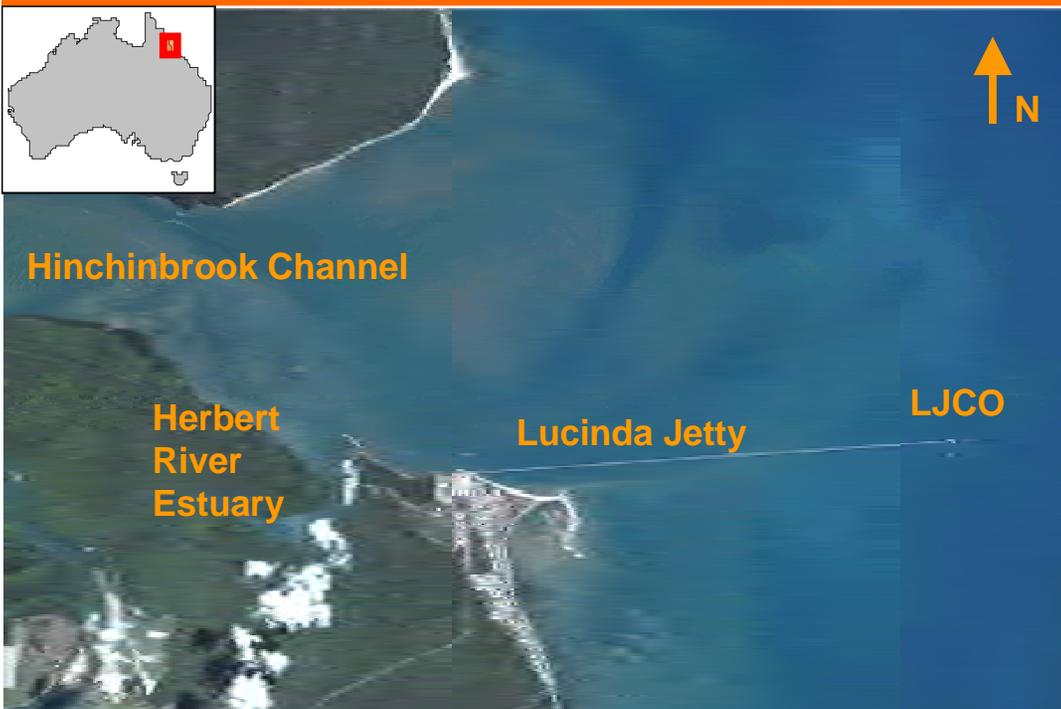


- **WQMs and sampling active since 2009**

The Lucinda Jetty Coastal Observatory



The Lucinda Jetty Coastal Observatory



The location of the LJCO is ideal to monitor and characterize the optical properties in a coastal system where the sources of particulate and dissolved matter substantially vary during the tidal and seasonal cycles.

The Lucinda Jetty Coastal Observatory

- The 5.76km long the Lucinda Jetty provides an ideal platform for the long term deployment of instrumentation.
- Access to the end of the jetty is possible by vehicle enabling the retrieval and servicing of instruments.
- Access by vehicle, the power supply and platform stability overcome most of the limitations which make collecting continuous high quality optical data difficult with traditional moorings or ship-based methods.



Lucinda Jetty from the water



Lucinda Jetty: Northern Dolphin

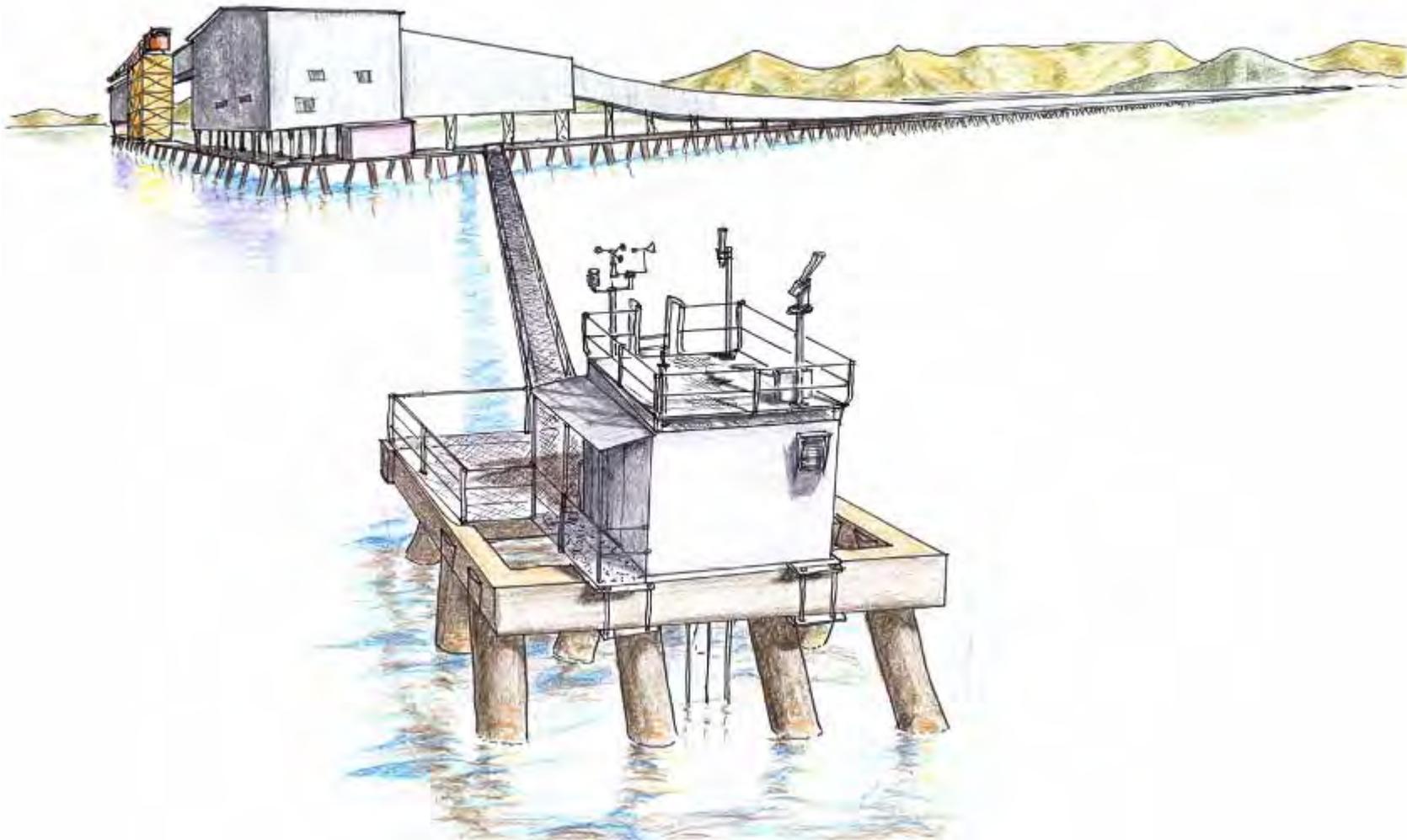


IMOS Integrated Marine Observing System

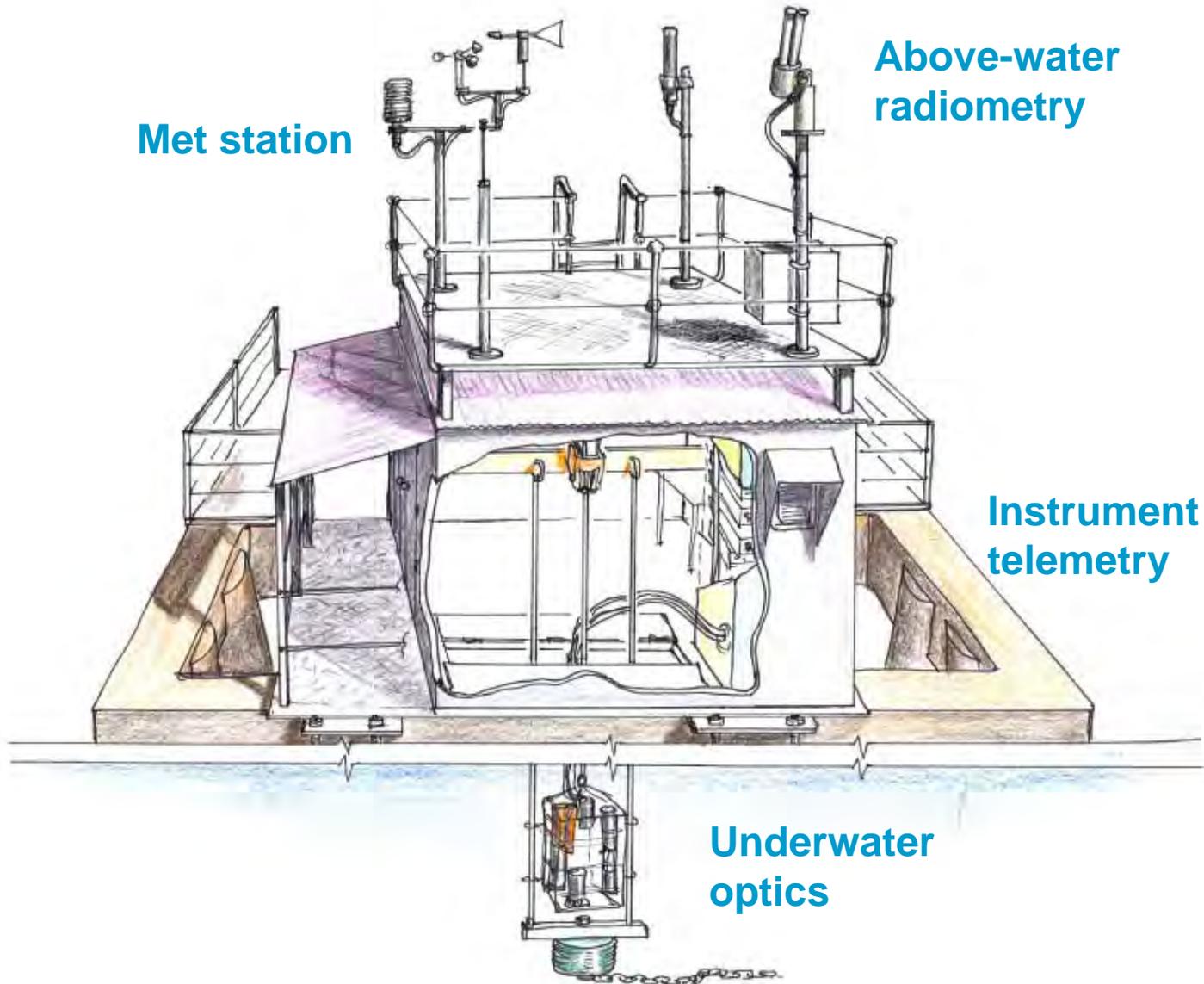
Lucinda Jetty Coastal Observatory (LJCO)



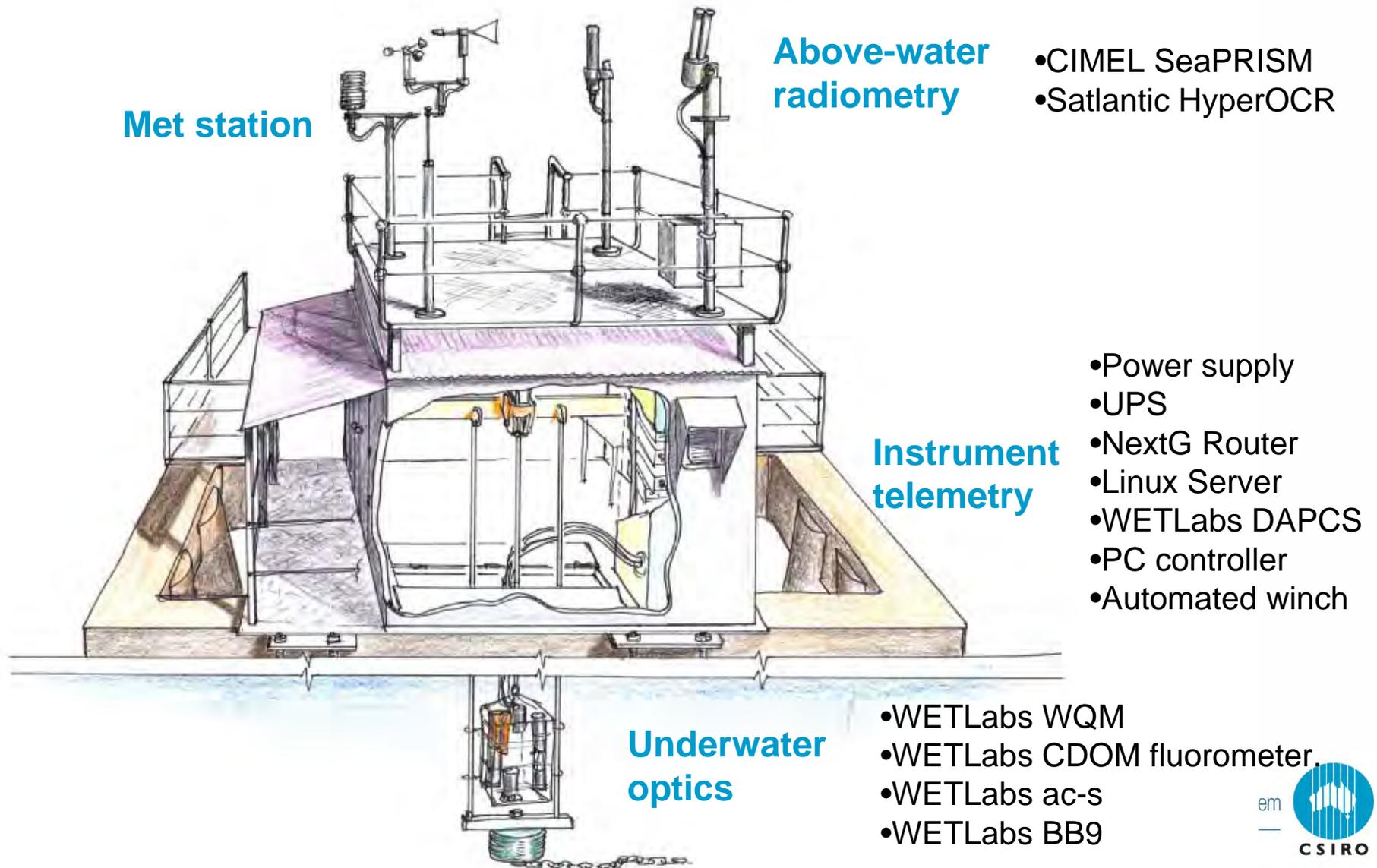
Sketch of LJCO facility



Sketch of LJCO facility



Sketch of LJCO facility



LJCO facility



LJCO facility



Instrumentation

At LJCO three main data streams are acquired:

- **apparent optical properties of the water column measured using above water radiometry,**
- **inherent optical properties of the water column measured with an in situ water optical package,**
- **ancillary information on weather and sky and sea conditions.**

Instrumentation: Above-water radiometry and aerosol characterization

CIMEL-SeaPRISM

- a CIMEL CE-318 automated sunphotometer modified to perform above-water radiometric measurements in addition to the regular atmospheric measurements defined for NASA's Aerosol Robotic Network (AERONET).
- autonomously perform multiple sky- and sea-radiance observations at programmable viewing and azimuth angles at nine centre wavelengths in the 412–1020 nm spectral range.
- SeaPRISM sea-viewing measurements are performed every 15 minutes with the objective of collecting data between 8 AM and 4 PM local time.



Instrumentation: Above-water radiometry and aerosol characterization

CIMEL-SeaPRISM

- SeaPRISM data is collected, processed following the AERONET-OC common protocols and archived at NASA.
- Derived products are accessible through a Web interface under a specified data policy.

The screenshot shows the AERONET Ocean Color (OC) Data Display Interface for the Lucinda site. The interface includes a navigation menu on the left, a main content area with a disclaimer and data usage information, a world map, and data display controls. Two line graphs show Normalized Water-Leaving Radiance (L_w) for various wavelengths (412nm, 441nm, 491nm, 555nm, 668nm, 870nm, 1028nm) for Level 1.0 data from 2009. The graphs show data points and error bars for each wavelength over the course of the day in GMT.

Disclaimer: AERONET-OC Level 1.0. Real Time Data. The following AERONET data are unscreened and may not have final calibration applied. Due to the research and development phase characterizing AERONET Ocean Color, use of these data requires offering co-authorship to the Principal Investigator.

Data Display Controls:

- Choose Display Options: AERONET-OC Data Type: L_w (with f₀ correction) Level 1.5
- Data Format: All points Daily averages
- SELECT CHARTS FOR LARGER IMAGES
- Choose year: 2009, 2010
- Choose month of 2009: DEC
- Choose day of DEC 2009: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31

Normalized Water-Leaving Radiance (L_w) (f₀ corrected) [W₀(nm² sr⁻¹ um⁻¹)]

Lucinda - 5 10°31'11" N, E 146°23'09" W, Alt 0 m, PI : Vittorio E. Brando, Vittorio.Brando@csiro.au

Level 1.0 L_w Data From 2009

L _w _412nm	<0.519>
L _w _441nm	<0.737>
L _w _491nm	<1.032>
L _w _555nm	<0.983>
L _w _668nm	<0.138>
L _w _870nm	<-0.089>
L _w _1028nm	<0.082>

Level 1.0 L_w Data from DEC of 2009

L _w _412nm	<0.519>
L _w _441nm	<0.738>
L _w _491nm	<1.035>
L _w _555nm	<0.932>
L _w _668nm	<0.129>
L _w _870nm	<-0.089>
L _w _1028nm	<-0.080>

AERONET-OC DOWNLOAD

- L_w Level 1.0
- L_w Level 1.5
- Download all: L_w Level 1.0
- Download all: L_w Level 1.5
- Download all: L_w Level 2.0
- More AERONET Downloadable Products...

AERONET-OC DOWNLOAD

- L_w Level 1.0
- L_w Level 1.5
- More AERONET Downloadable Products...

Return to the World Map

Privacy Policy and Important Notices

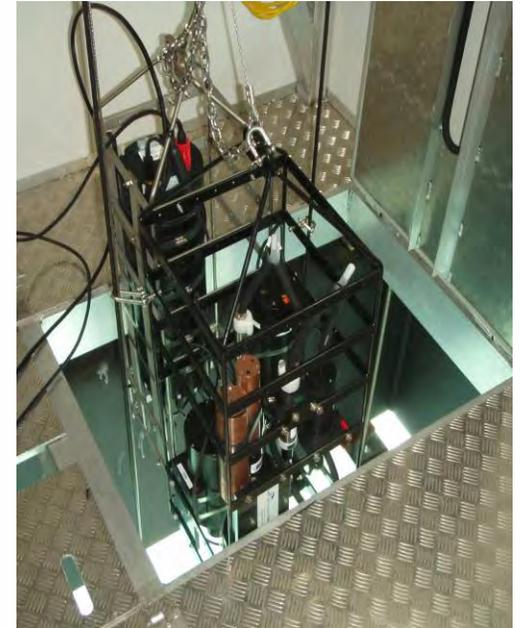
NASA

Director: David M. Giles
NASA Official: Brent N. Hobben
Generated: 03/09/2010

Instrumentation:

inherent optical properties of the water column

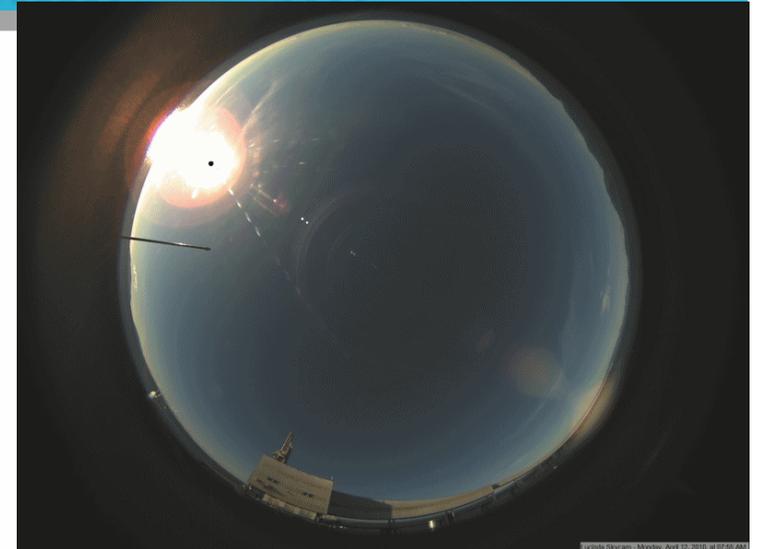
- **Optical package is deployed at the Jetty to characterize the Inherent optical properties of these waters:**
 - WET Labs WQM (integrated sensors for conductivity, temperature, pressure, dissolved oxygen, chlorophyll fluorometer, and turbidity)
 - WET Labs Wetstar chromophoric dissolved organic matter (CDOM) fluorometer.
 - One WETLabs ac-s spectral absorption meter (10-cm path length) will be used for the acquisition of in situ measures of the total and dissolved absorption and attenuation coefficients. A WETLabs BB9 will be provide measures of total backscattering coefficients.
- **Data is acquired in continuous mode at a nominal depth of ~1.5-2 m .**
- **We have two identical sets to be hot-swapped for maintenance and calibration**



Instrumentation:

ancillary information on weather and sky and sea conditions

- Weather conditions at the site are measured using a Vaisala WXT520 multi parameter instrument which measures barometric pressure, humidity, precipitation, air temperature, wind speed and direction.
- Two hemispherical cameras to capture a full sky view and a sea state information for use in post processing and interpretation of radiometric data



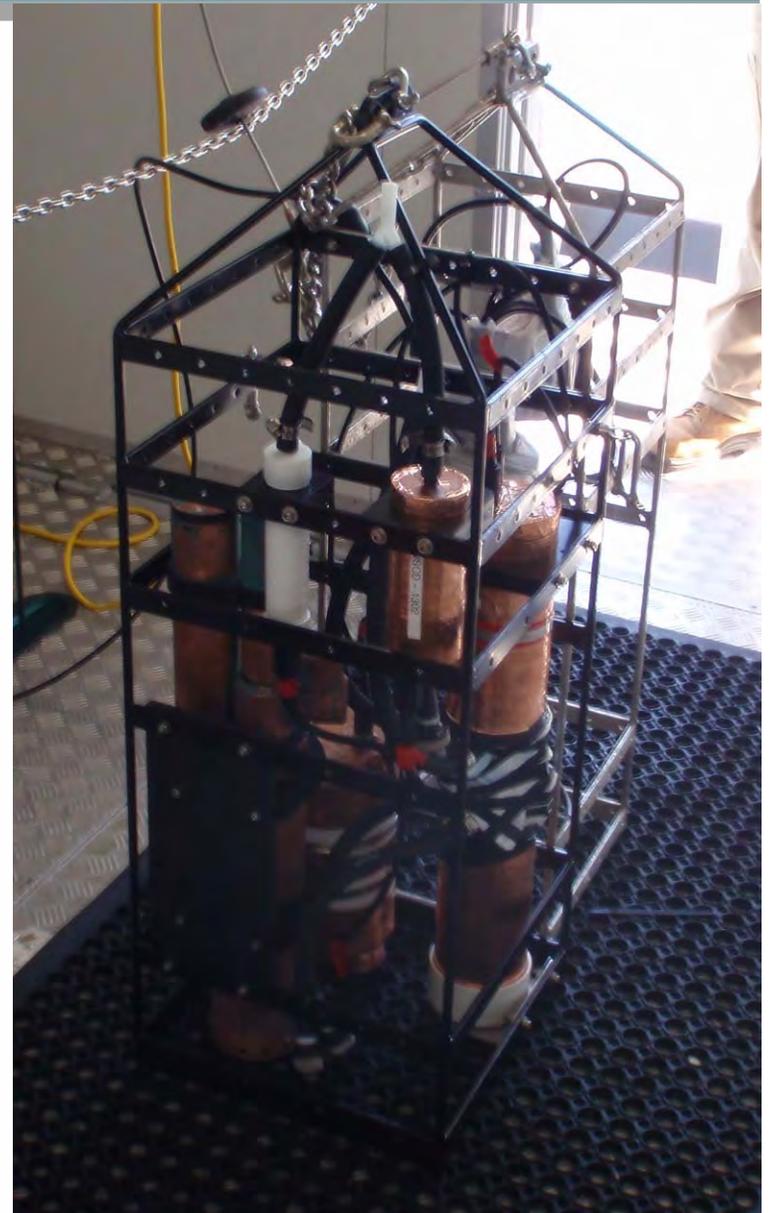
Maintenance and calibration

- **Antibiofouling system**

- Sensor systems are surrounded by copper either by copper shielding or adhesive backed copper tape
- WETLabs WQM utilizes the bio-wiper™ active cleaning and protection system

- **Servicing and calibration**

- The instruments are serviced on a fortnightly basis for cleaning of the SeaPRISM and in water optical packages.
- The SeaPRISM is calibrated by NASA following the AERONET-OC protocols prior and following each 6-12 months deployment. Only after the post deployment calibration the data will be processed to L2 and released after QA/QC..
- Following instrument changeover the *in situ* optical instruments are returned to the laboratory for cleaning, calibration and re-application of anti fouling copper coatings.
- All instruments are tested and calibrated with MilliQ water prior to each deployment.



Discrete measurements of bio-optical and biogeochemical data on 1 to 2 week basis

1. near-water surface sampling

1. Biogeochemical data (to match instrument package - performed at CMAR laboratories in Hobart, as for all IMOS reference stations):
 1. phytoplankton pigments by HPLC
 2. total suspended solids (organic and mineral fractions)
 3. Nutrients
 4. TOC, DOC and POC (TBD)
2. Spectrophotometric light absorption by :
 1. total particulate matter & phytoplankton pigments (providing non-algal particulate matter absorption)
 2. coloured dissolved organic matter.

2. Underwater light measurements:

1. Up and downwelling radiance/irradiance measurements (incl profiles for k_d) with Satlantic Hyper OCS tethered profiling system
2. LISST-100 particle sizing and refractive index

Data Acquisition and processing Controllers and telemetry

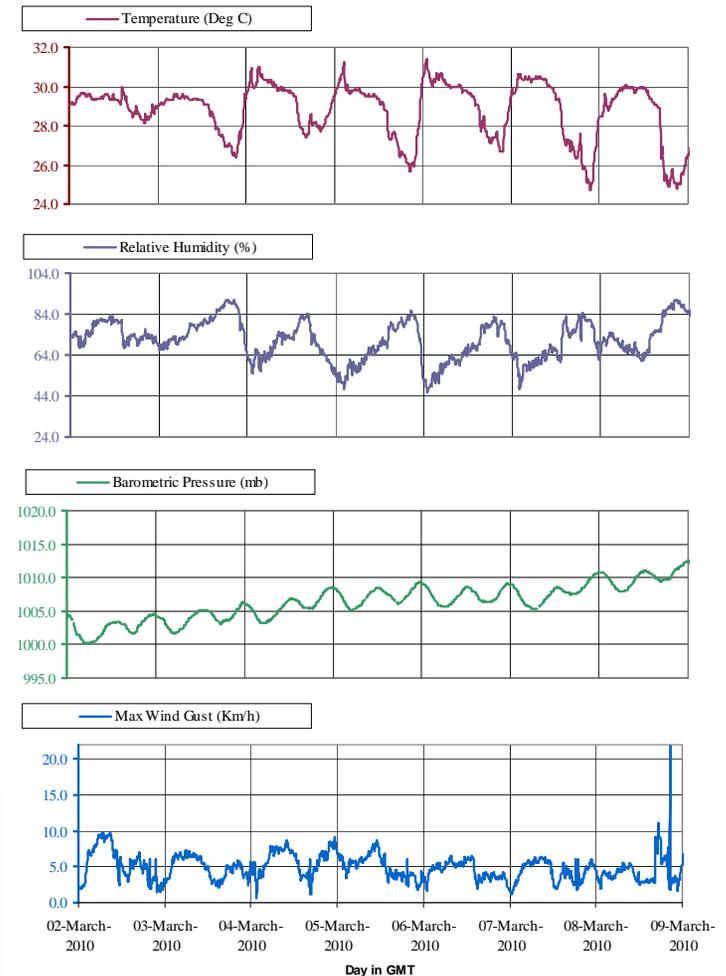
- Data from all the instruments is acquired in real time or in delayed mode using a mix of instrument controllers, loggers, a rack mounted Dell PowerEdge 2950 Linux Server and an Advantech ARK PC installed in an air-conditioned cabinet (25 C).
- Computers and communication devices are powered via a UPS.
- Remote control over circuit switching is obtained through the use of a power distribution unit allowing devices to be remotely powered on and off via an Ethernet interface.
- Network connectivity is provided thorough a broadband connection



Data Acquisition and processing

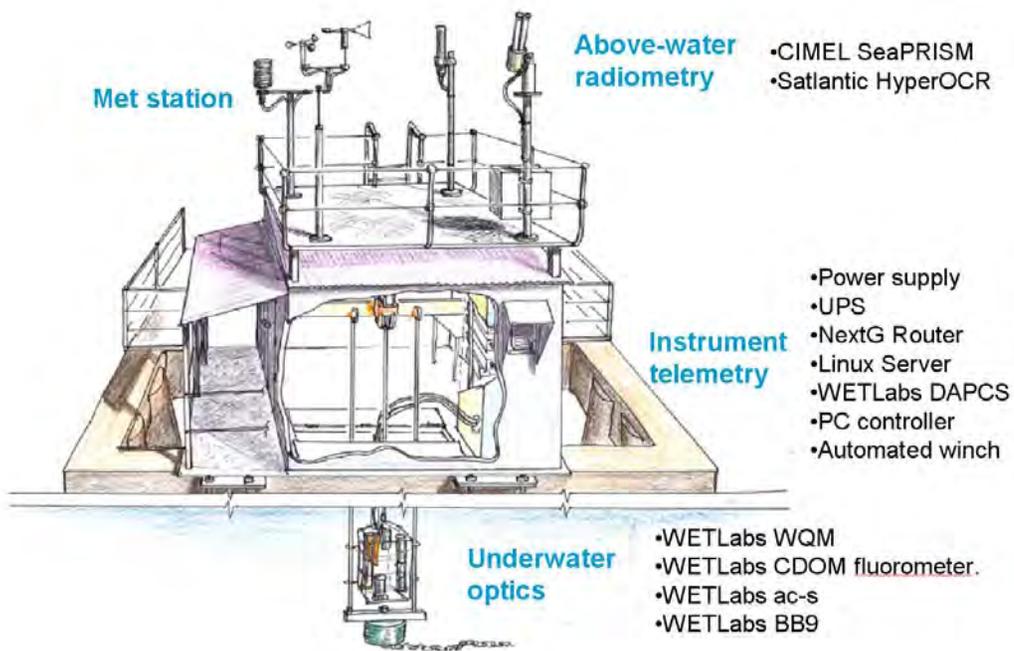
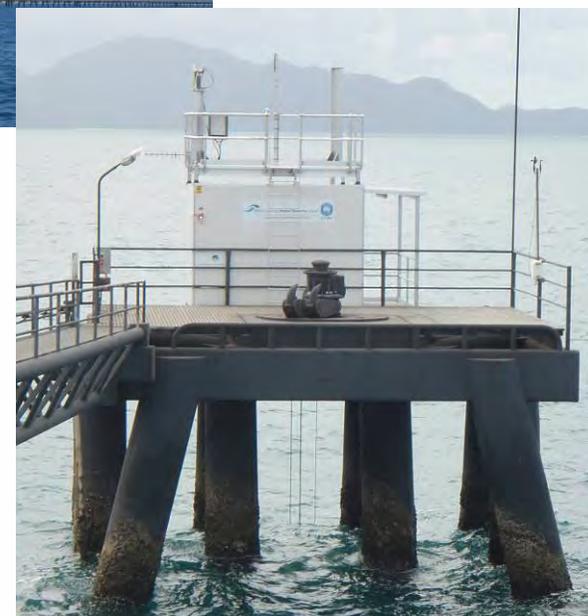
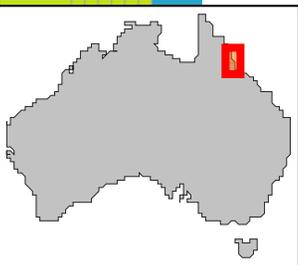
Data processing and access

- The raw data-streams for the *in situ* water optical package, the Satlantic HyperOCR and the weather data are uploaded via NextG broadband to CSIRO's data storage in Canberra.
- After pre-processing and QA/QC protocols are applied to each data stream, the near real time data will be packaged into IMOS compatible netCDF files and uploaded to eMII (the IMOS data and information facility) for archiving and distribution.
- When the provisioning phase of the data streams is completed all the data streams generated at LJCO will be made freely available according to the IMOS data policy.
- As all IMOS data, LJCO data will be accessible through the IMOS Ocean Portal [<http://imos.aodn.org.au/webportal/>].
- The SeaPRISM derived data products are accessible through the AERONET-OC web page at NASA Goddard Space Flight Center [<http://aeronet.gsfc.nasa.gov/>].



IMOS Integrated Marine Observing System

Lucinda Jetty Coastal Observatory (LJCO)
Imos.org.au/ljco.html



Thank you !



Dr Vittorio E. Brando

Research Scientist

Environmental Earth Observation Group

CSIRO Land & Water

Phone: +61 2 62465716

Email: *Vittorio.Brando@csiro.au*

 **IMOS** Integrated **Marine Observing** System

Lucinda Jetty Coastal Observatory (LJCO)

