Current Australia's Ocean Colour Radiometry Cal/val activities

David Antoine, Curtin University

Thomas Schroeder, CSIRO O&A

Curtin University

CSIRO

Composite image (March 2017) of the phytoplankton biomass around Australia, from observations of the ESA Sentinel3 "OLCI" sensor. RSSRG algorithms applied on 6 10^8 pixels using Pawsey computing resources and the Australia "Copernicus data Hub"

Currently two major “spots”

CSIRO O&A, Brisbane, Canberra, Hobart

(Schroeder, Lovell, King, Cherukuru et al.)

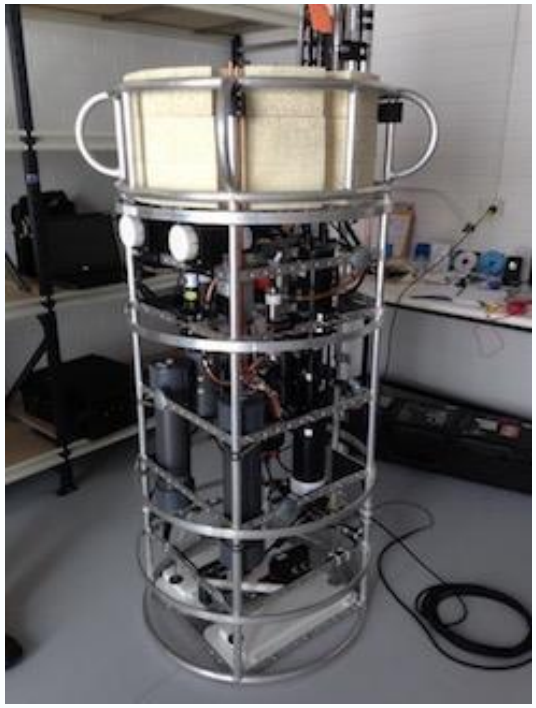
- Have developed and manage the “Lucinda Jetty Coastal Observatory”
- Run underway above-surface radiometry measurements on a vessel from AIMS
- Participate to research voyages
- Generate matchups from the above data collection efforts
- Manage the IMOS satellite ocean colour facility
- Participate to international cal/val groups (e.g., S3VT)

Curtin University, Western Australia

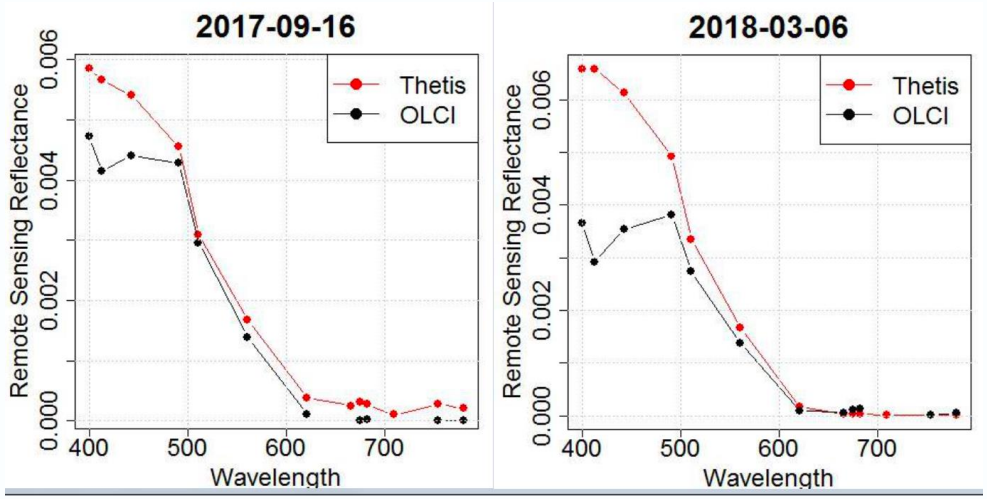
Remote Sensing & Satellite Research Group (RSSRG)

- Have started deployments off Perth of a profiling mooring (prefiguration of a “blue water” cal/val site?)
- Generate matchups from the profiler data
- Participate to research voyages (southern ocean, Indian ocean)
- Contribute to the IMOS satellite ocean colour facility
- Participate to international cal/val groups (e.g., S3VT)

In-situ profiling mooring for ocean colour cal/val



Deployment of the WETLabs Thetis moored profiler near Rottnest Island, off the coast of Perth, Australia.



System provides real-time data of optical properties, environmental parameters and phytoplankton characteristics via a 3G Telemetry system each time it completes a profile of the water column (60 m bottom depth).

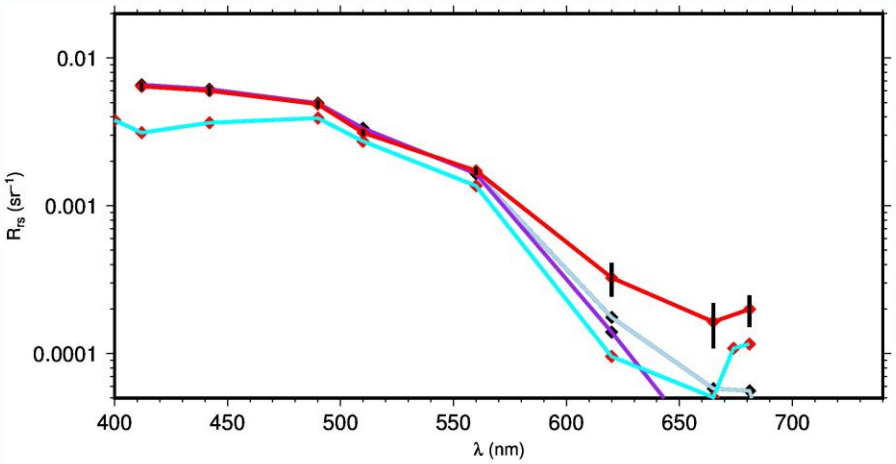
Match-ups between Thetis Satlantic OCR Radiometers and Sentinel3–OLCI instrument by Intern student Jorrit Scholze.

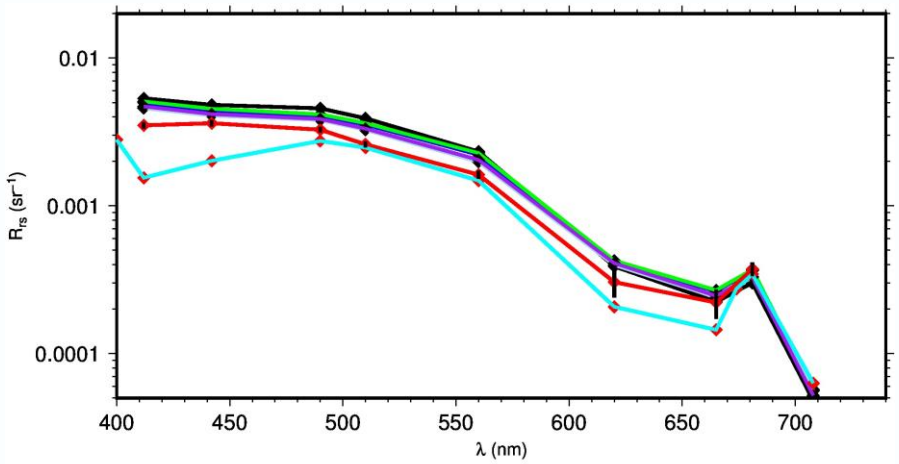
Curtin University

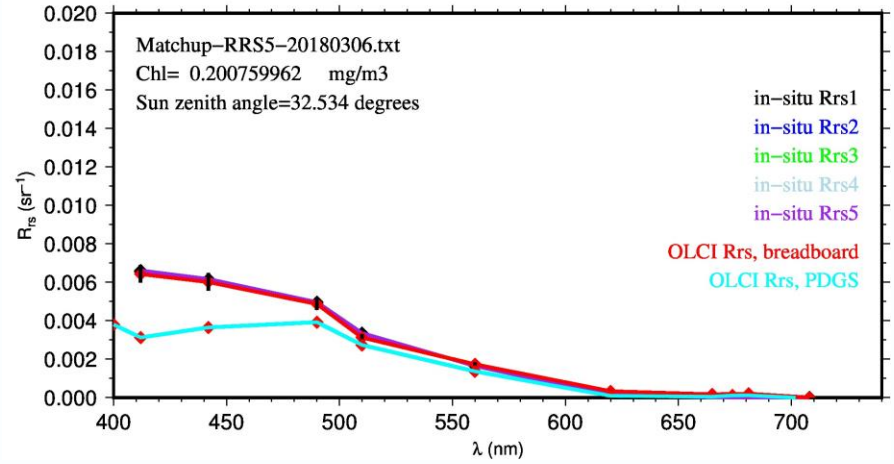
Australian Government
Australian Research Council

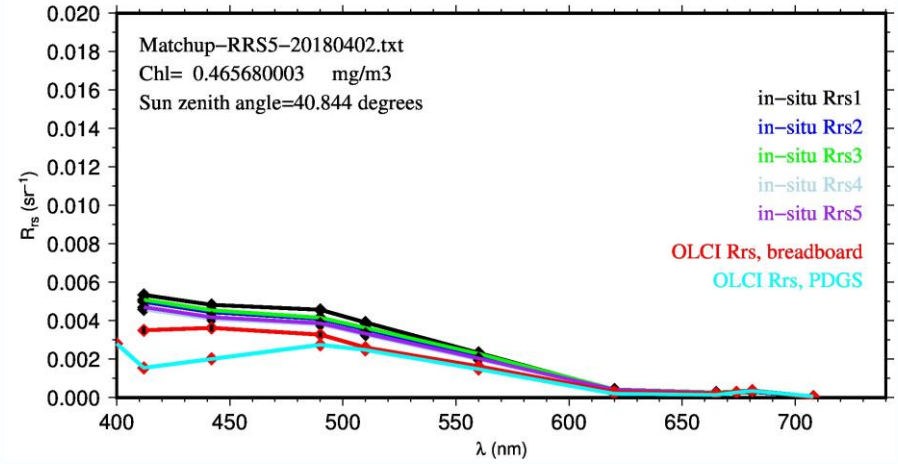
IMOS

S3A/OLCI matchups
IPF processing *vs*. in-house "Breadboard prototype"









Something looks wrong with the ground segment processing

“A coupled bio-physical, ecosystem-scale, examination of Australia’s International Indian Ocean Expedition line”

Lead PI: Lynnath Beckley, Murdoch University, Perth, WA

Co-I David Antoine, Curtin University, Perth, WA, for the bio-optics, ocean color and productivity / export part:

32 days in **May-June 2019**, 94m **R/V Investigator** (http://www.mnf.csiro.au)

- 30 Science berths, **10** for the optics /ocean color etc..

- 20 16-hour stations

Conditions: from oligo- to meso-trophic

Part of the **“2nd International Indian Ocean Expedition” (IIOE-2)**

IOC/UNESCO, IOGOOS, SCOR, SIBER (and many others) joint activity

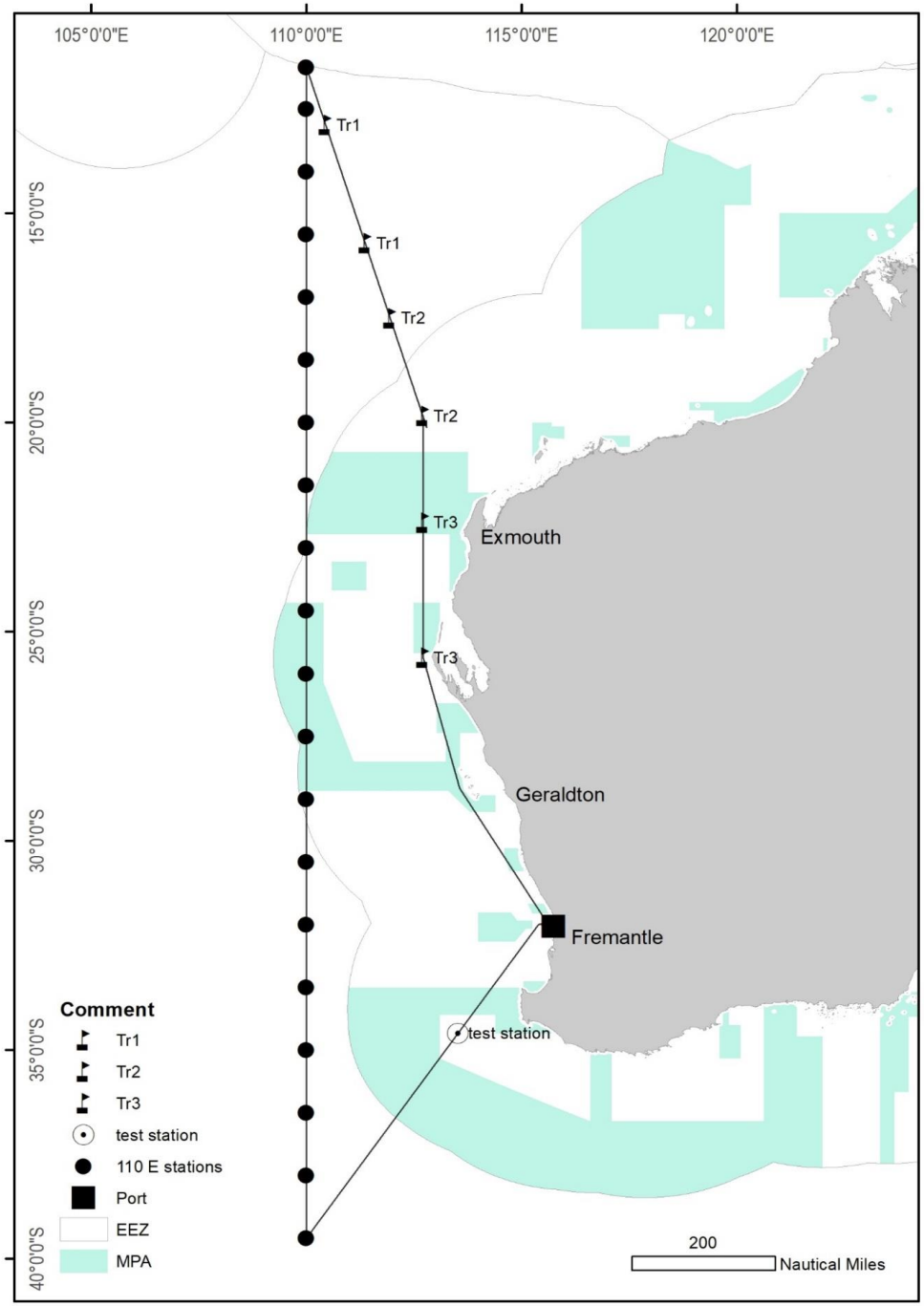
http://www.iioe-2.incois.gov.in/IIOE-2/EP06.jsp

IIOE-2 2nd International Indian Ocean Expedition 2015-2020

Curtin University

Murdoch University

Supported by: esa



Voyage plan

Instruments to be deployed for radiometry:

- *In-situ Marine Optics* (IMO, Perth) ***DALEC*** sensor, 350-800nm, resolution 3nm (above-water radiometry configuration)
- Biospherical ***C-OPS*** in-water profiling radiometer, 18 wavelengths (320, 340, 380, 395, 412, 443, 465, 490, 510, 532, 555, 565, 589, 625, 665, 683, 710 and 780 nm) in "free-fall" mode in the water column
- Satlantic ***HyperPRO*** profiling radiometer (350-800nm, resolution 3nm)
- Radiance cameras (CIMEL/LOV prototype)

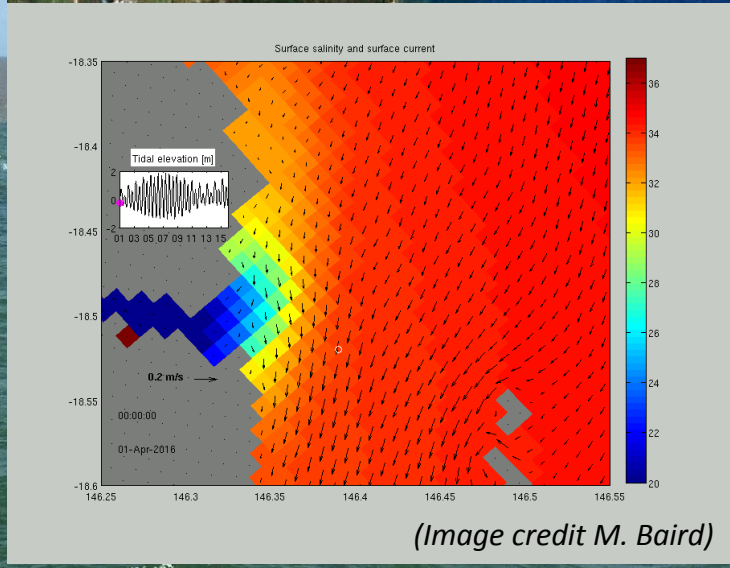
Plus:

- IOP package (absorption, backscattering)
- Phytoplankton pigments
- …..

LJCO is variable coastal site

Tidal range 0.2-4 m
Water temperature 22-31°C
Salinity 27-36.5

TSS	**1.17-35.7 g m^{-3}**
CDOM	**0.22-6.35 mg m^{-3}**
Chl-a	**0.01-0.49 m^{-1}**



(Image credit M. Baird)

(Image credit D. Boadle)

S3VT-OC

Radiometric measurements
Lucinda Jetty & Ship-borne

Contact: Thomas.Schroeder@csiro.au

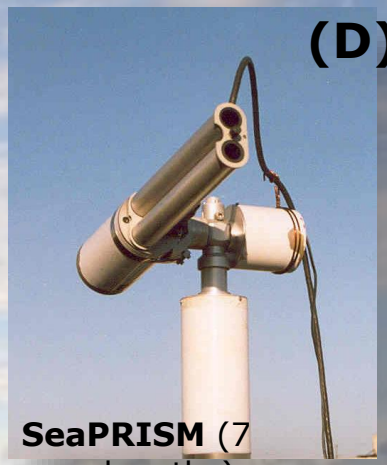
Hyper-spectral measurements (DALEC) added to Lucinda (ad-hoc deployments)

Update on quality assessment of operational and C2RCC processors to be presented at March 2018 S3VT meeting in Darmstadt

IMOS inter-comparison task helped to quantify instrument uncertainties

Overview above-water measurements

Weather Station
Temperature
Pressure
Humidity
Dew point
Wind speed
etc



Satlantic
Spectral irradiance

Webcams
Sky and Sea

SeaPRISM (7 wavelengths)
Water-leaving radiance
Aerosol optical thickness
Aerosol absorption
Aerosol size distribution
Refractive index
Single scattering albedo
Phasefunction
Water vapor
Spectral flux
Radiative forcing

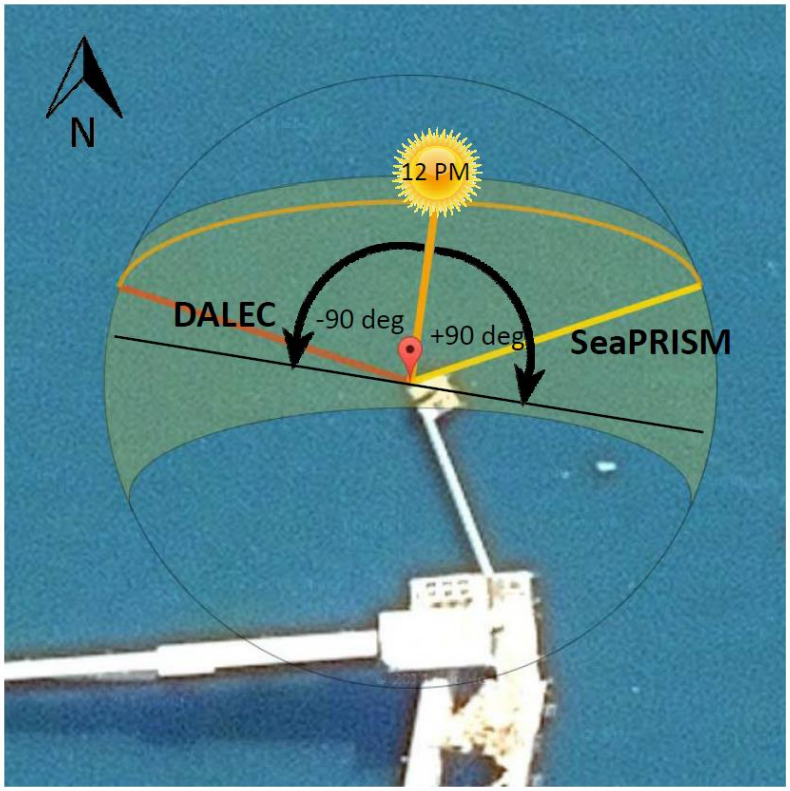
Contact: Thomas.Schroeder@csiro.au

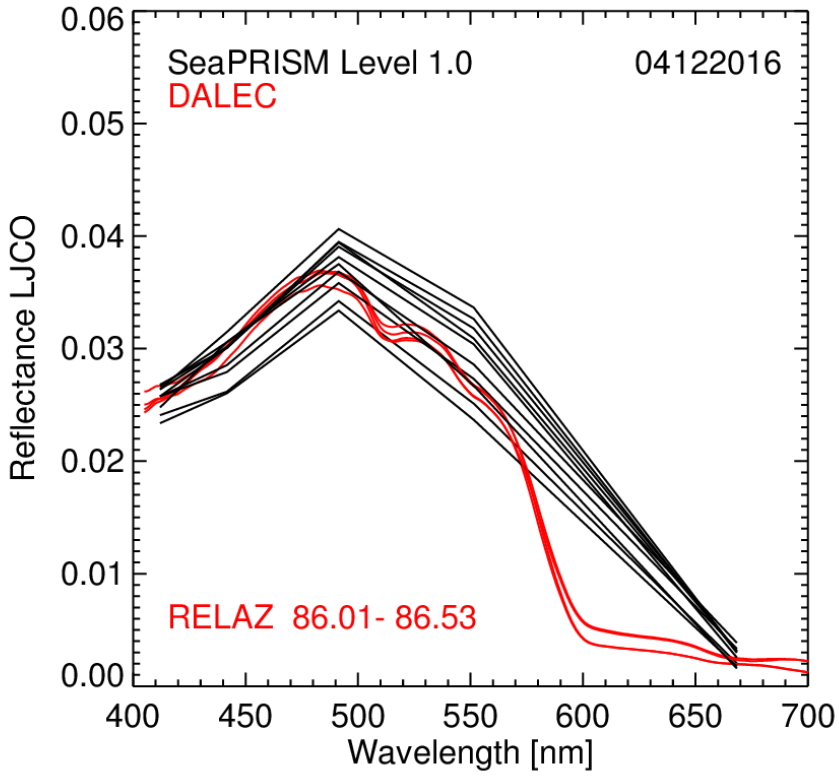
Aligning observing geometries

Data quality improved - DALEC and SeaPRISM now 90° with respect to the Sun

Example 4 Dec 2016

Contact: Thomas.Schroeder@csiro.au





- DALEC and SeaPRISM radiometry now in good agreement
- More detailed quantitative analysis under RTT based on Level 2 data
- Working with In-situ Marine Optics on improving DALEC stability and remote operations
- DALEC required to capture AM satellite passes (Sentinel-3A)

IMOS Ocean Colour Validation

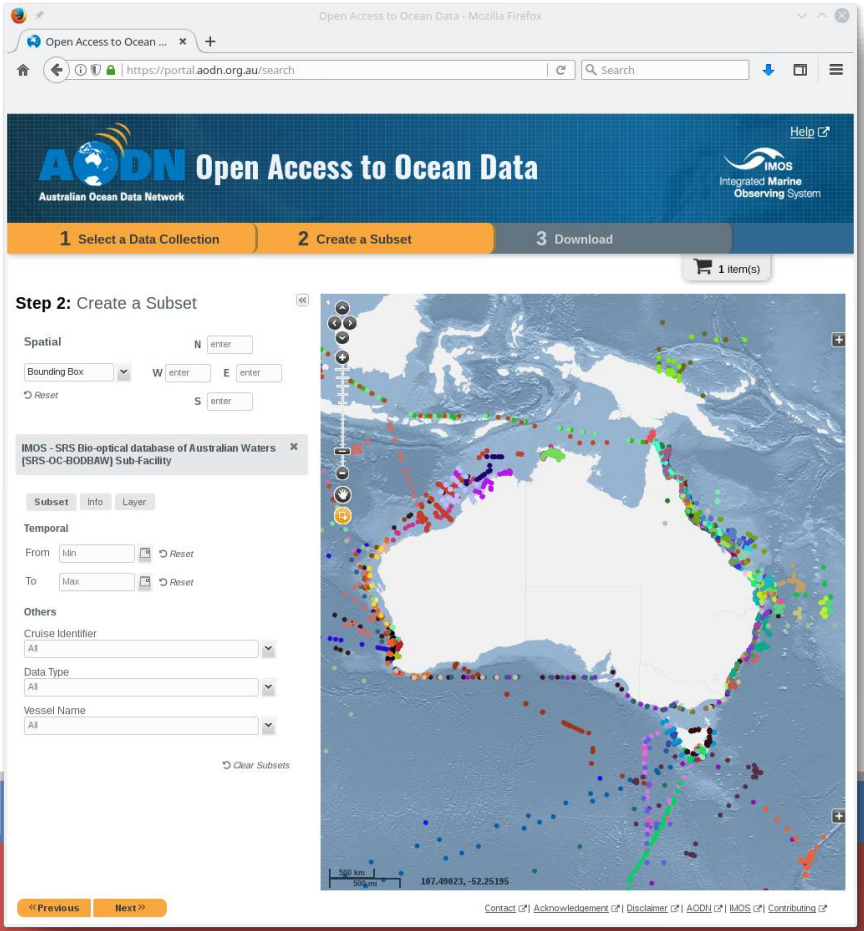
Contact: Thomas.Schroeder@csiro.au

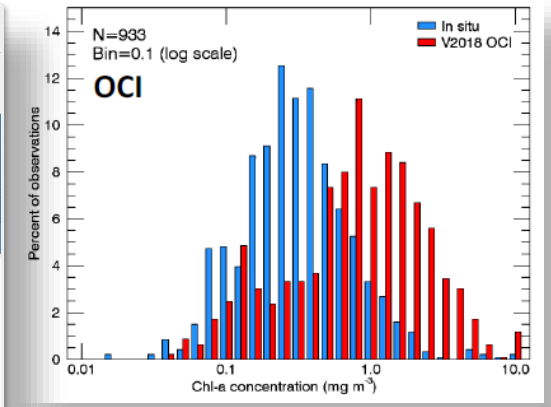
Sub-facility generates daily Level-3 (gridded) ocean colour products from MODIS-Aqua and VIIRS

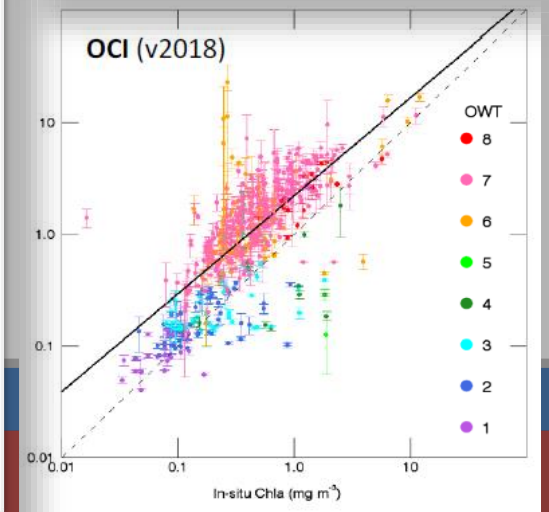
Product validation using IMOS Bio-optical Database – freely available via AODN

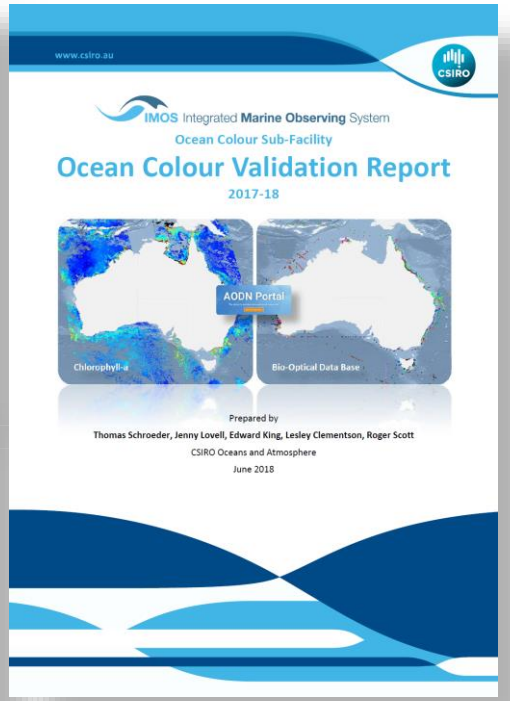
Match-up are separated into Optical Water Types (Moore et al. 2009)

Annual validation reports

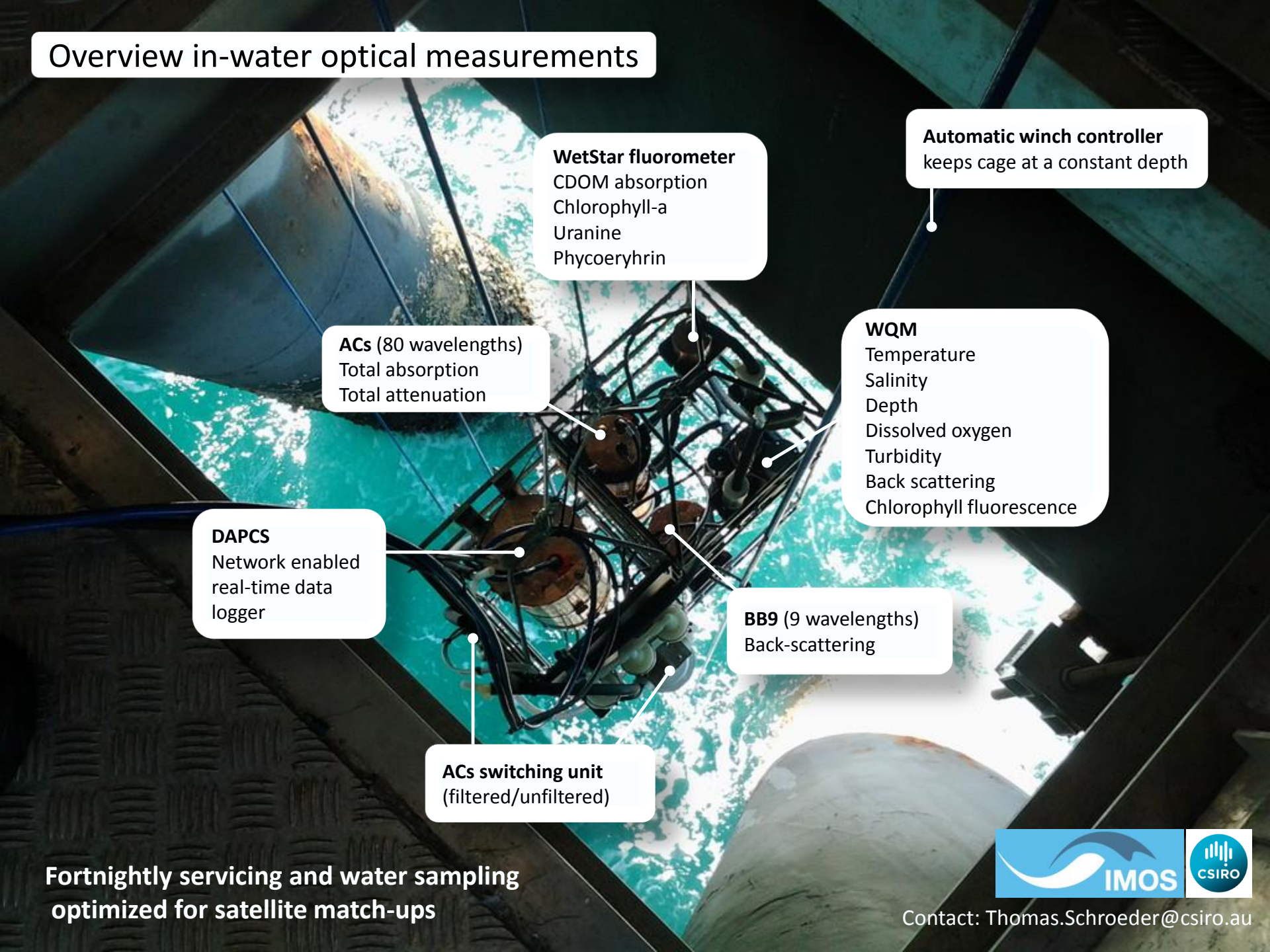








Overview in-water optical measurements

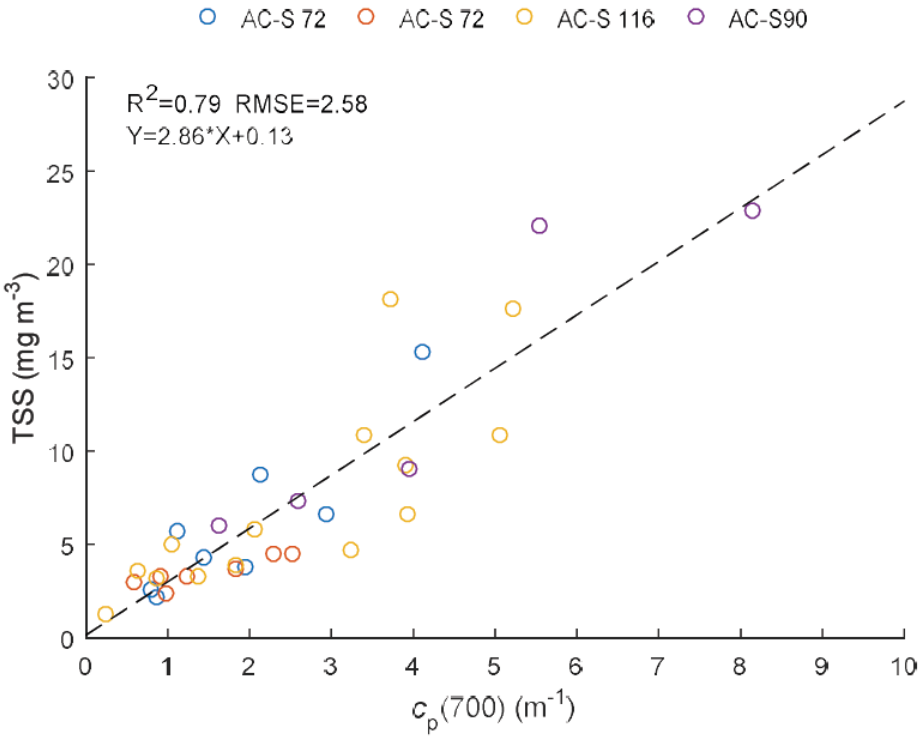


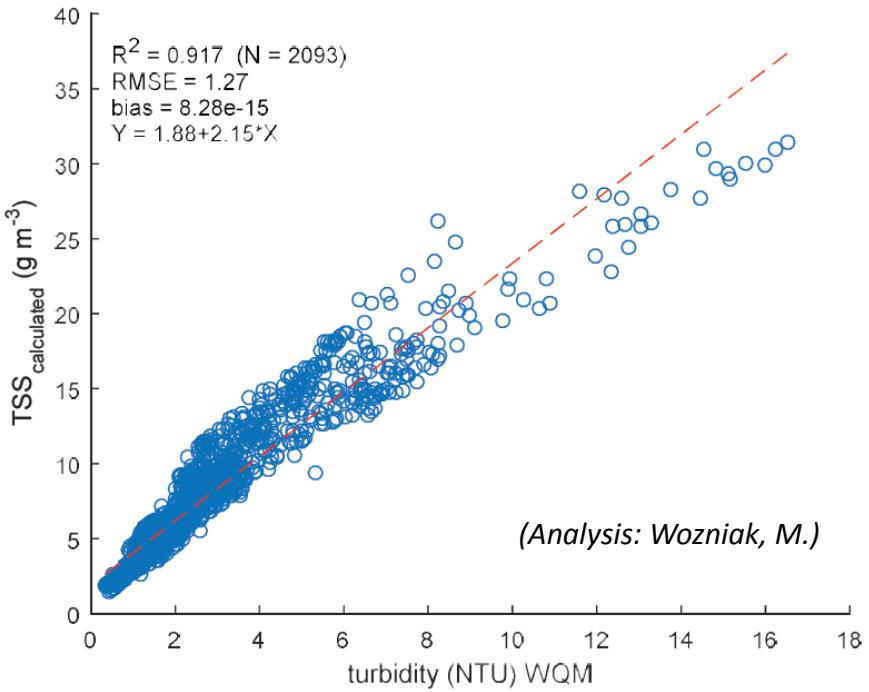
Fortnightly servicing and water sampling optimized for satellite match-ups

Contact: Thomas.Schroeder@csiro.au

Lucinda Jetty – bio-optical relationships

Proxies to derive continuous concentration time series





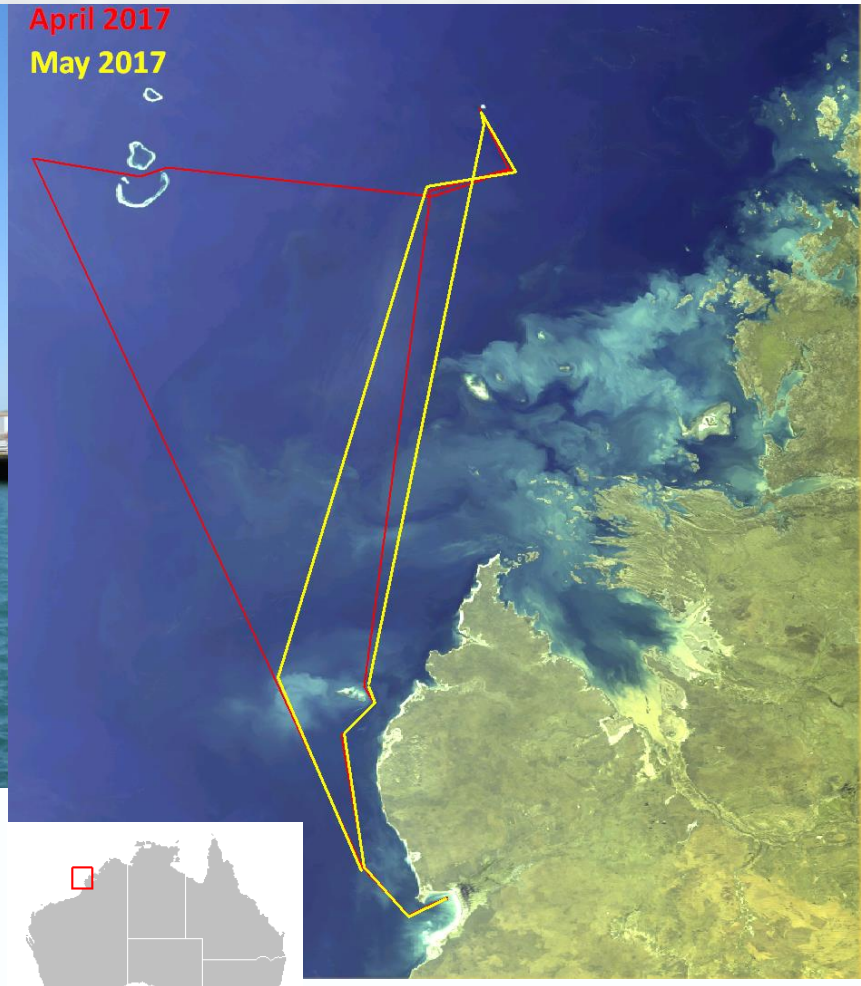
Relationship between attenuation (AC-s) and lab TSS used to calculate TSS from WQM

In addition regression of AC-s absorption at 678 nm vs HPLC chlorophyll.

Relationships will be used to derive a **continuous time water quality series** of TSS and chlorophyll-a from in-water optical AC-s and WQM measurements.

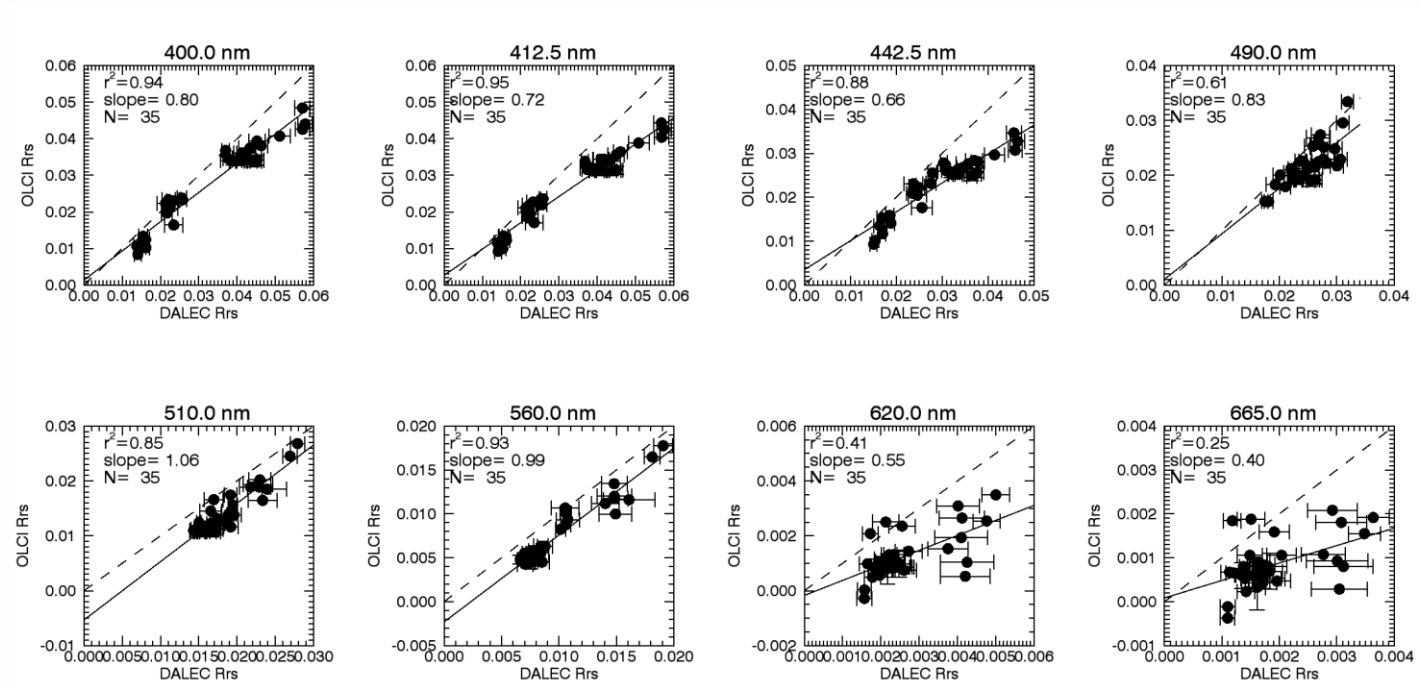
DALEC on RV Solander

Operated by Australian Institute of Marine Science, DALEC deployed ~60 days per year

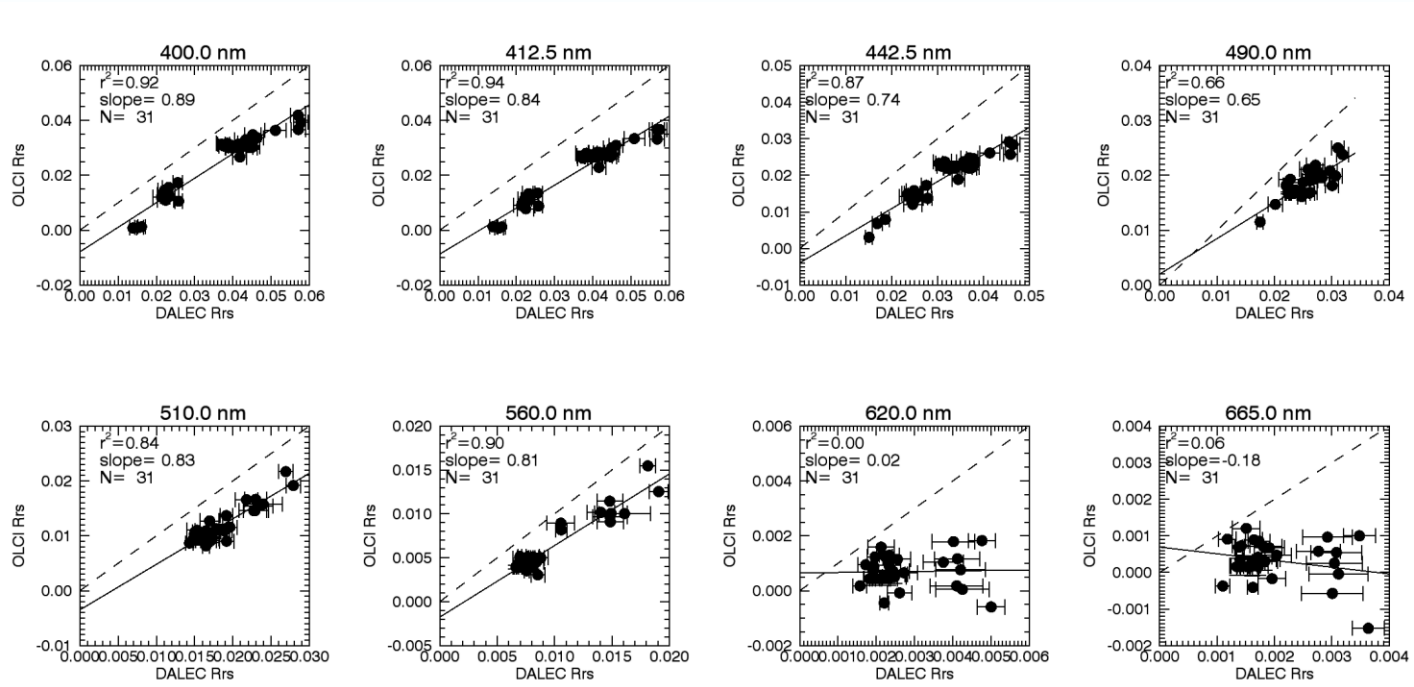


- Continental shelf
- 5 OLCI scenes, 3x3 median
- DALEC R_{rs} 15 min mean
- Matchups ±1 hr

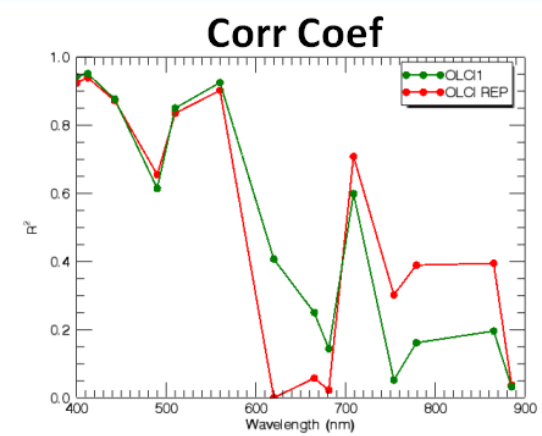
OLCI original data release vs DALEC N=35, 400-665 nm

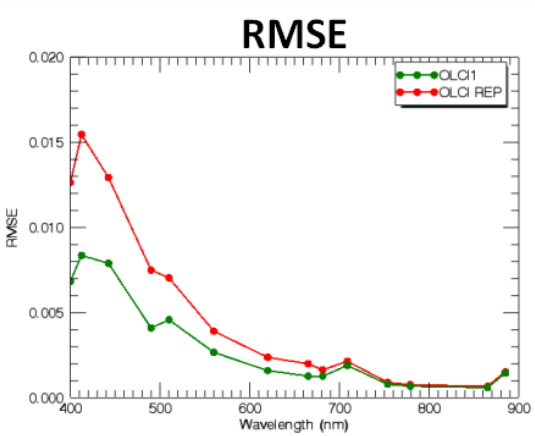


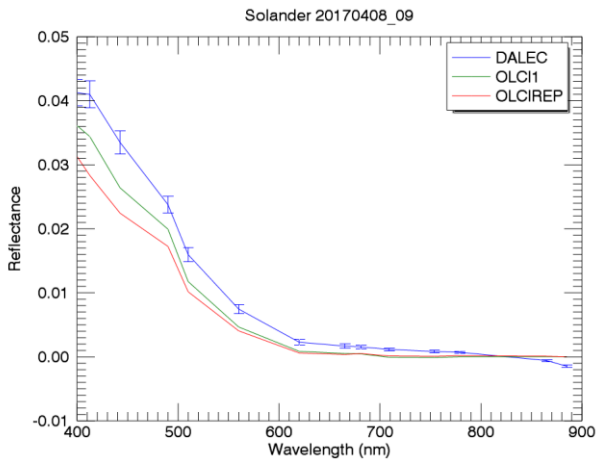
OLCI IPF2.23 data vs DALEC
N=31, 400-665 nm

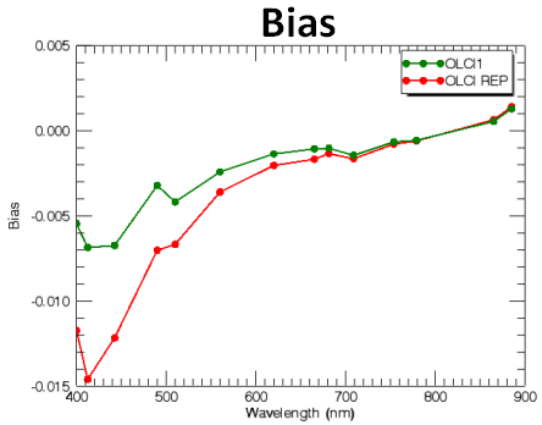


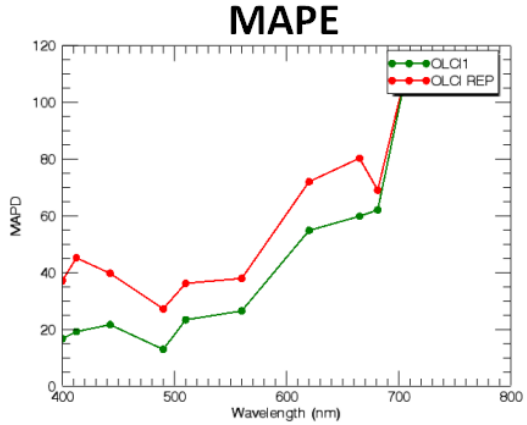
Spectra and Statistics OLCI vs Ship-based DALEC

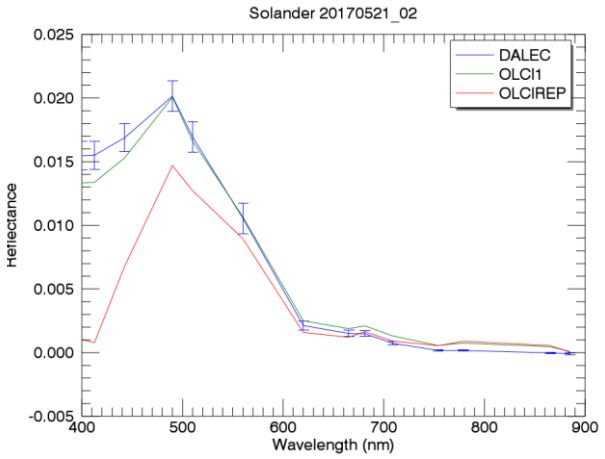












(Analysis: Lovell, J.)

IMOS Integrated Marine Observing System

Western Australian Integrated Marine Observing System (WAIMOS)

IMOS "Radiometry Task Team"

David Antoine, Curtin University,
Thomas Schroeder, CSIRO O&A flagship,

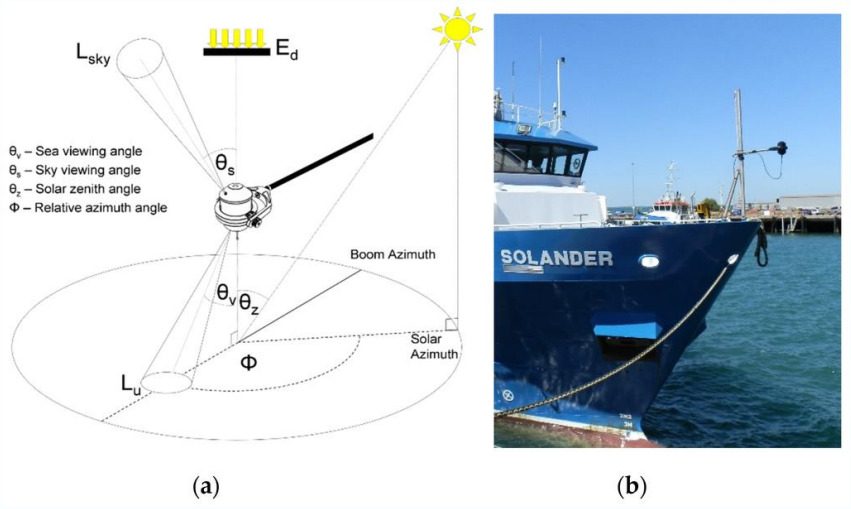
and the task team members, by alphabetic order:

Elizabeth Botha (CSIRO), **Nagur Cherukuru** (CSIRO), **Arnold Dekker** (CSIRO), **Martina Doblin** (UTS), **Peter Fearns** (Curtin), **Nick Hardman-Mountford** (CSIRO), **Rob Johnson** (BoM), **Edward King** (CSIRO), **Wojciech Klonowski** (IMO), **Jenny Lovell** (CSIRO), **Tim Malthus** (CSIRO), **Ross Mitchell** (CSIRO), **Matt Slivkoff** (Curtin), **Peter Thompson** (CSIRO), **Paul Van Ruth** (SARDI)

Curtin University · CSIRO · UTS University of Technology Sydney · Australian Government Bureau of Meteorology · IMO · SARDI South Australian Research and Development Institute

What the Australian community does?

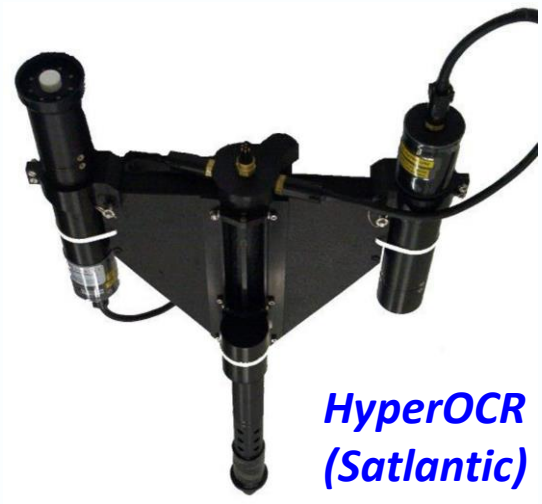
DALEC (IMO)



Brando et al., Remote Sens. **2016**, *8*(2), 150; doi:10.3390/rs8020150

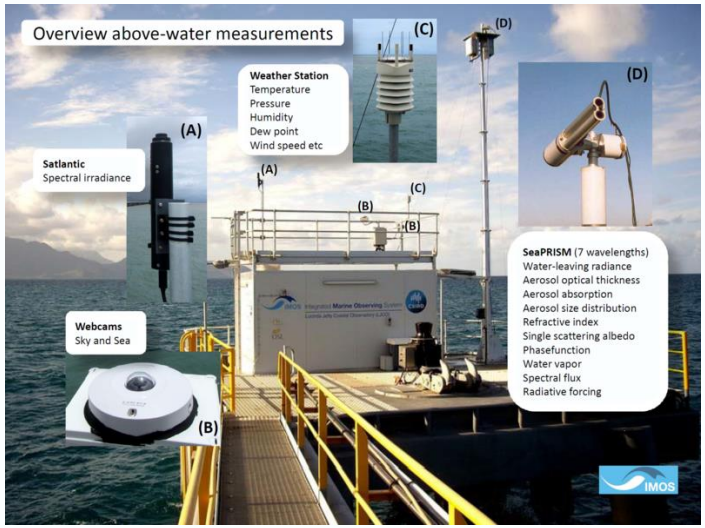
RAMSES (Trios)

http://www.iopan.gda.pl/RSL/equipment.html

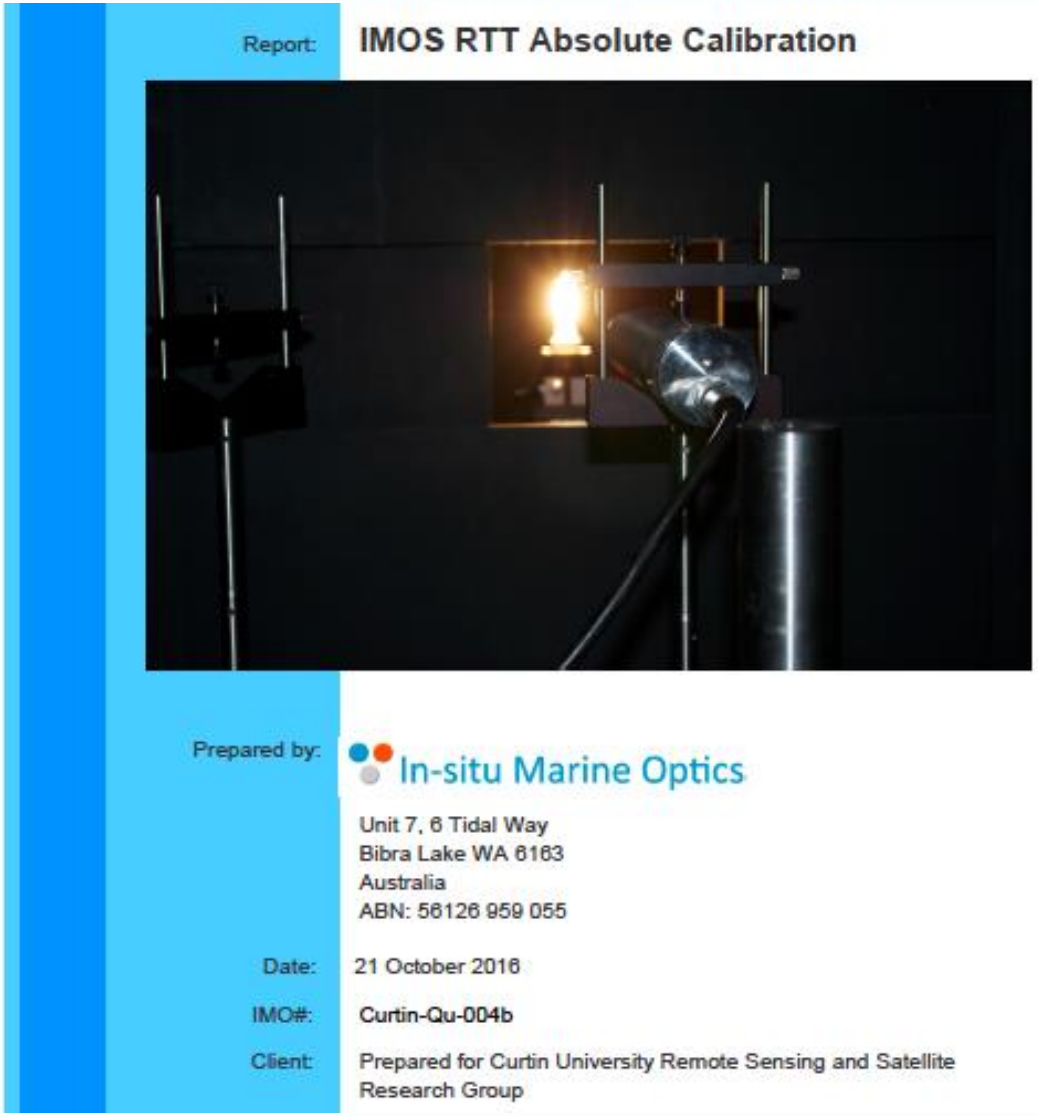


HyperOCR (Satlantic)

SeaPRISM (CIMEL)



1st activity: lab calibration/characterization



Report: **IMOS RTT Absolute Calibration**

Prepared by: In-situ Marine Optics

Unit 7, 6 Tidal Way
Bibra Lake WA 6163
Australia
ABN: 56126 959 055

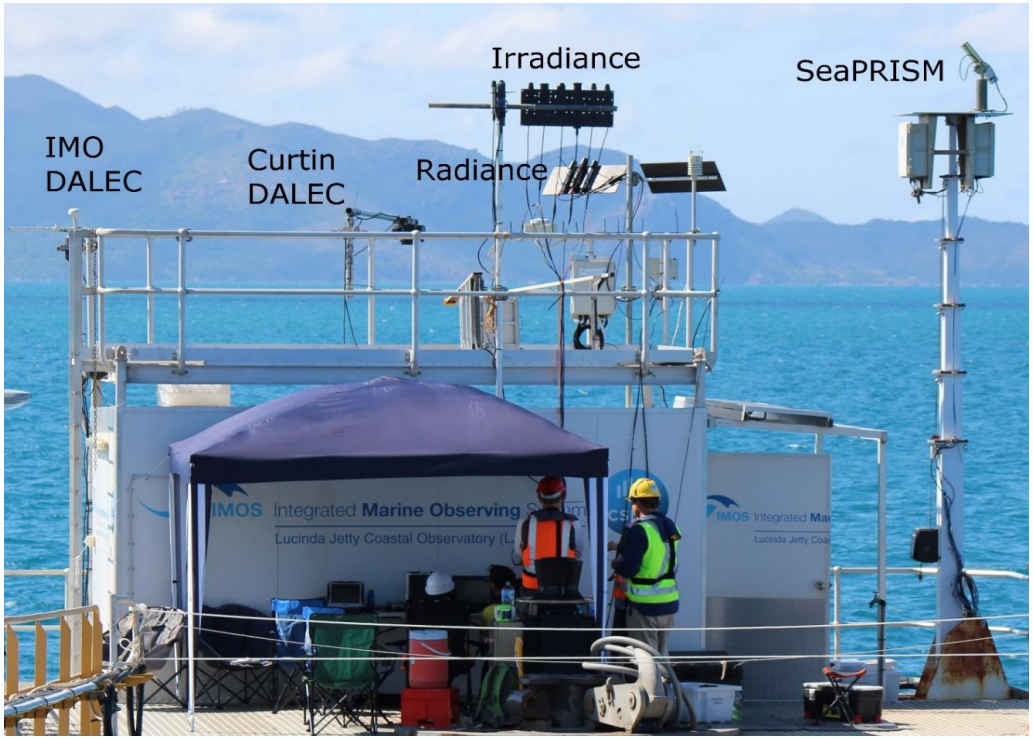
Date: 21 October 2016

IMO#: Curtin-Qu-004b

Client: Prepared for Curtin University Remote Sensing and Satellite Research Group

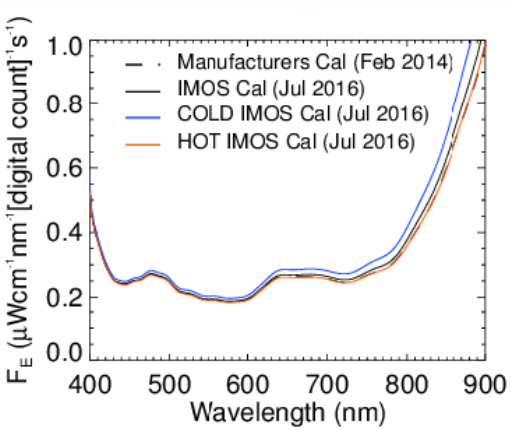
- Overall consistency of the calibration lamps
- No "out-of-range" instrument
- Temperature is to be monitored for spectrometer-based instruments
- Calibration must be done at different internal temperatures
- Manufacturer cal/charact. work insufficient
- Look at counts when using a spectrometer, and don't try to get measurements for too low/high counts
- This will be pursued with the presentation at the ESA's FRM4SOC workshop (next week), plus lamps will be part of the "LCE1" exercise as well

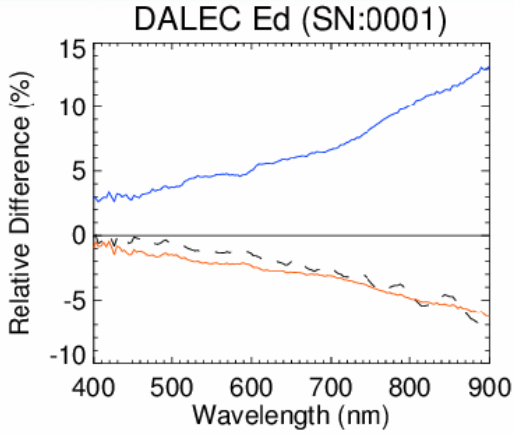
2nd activity: field inter-comparison at LJCO

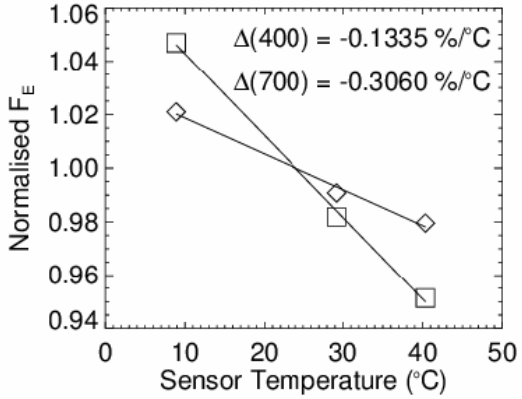


Improving consistency of radiometric measurements

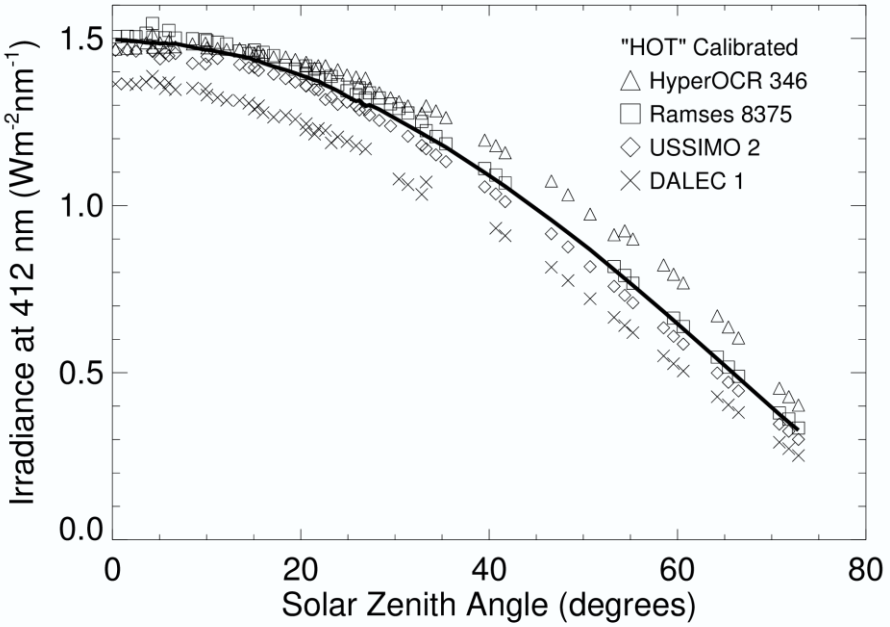
IMOS Radiometry Task Team (Antoine, Schroeder et al.)

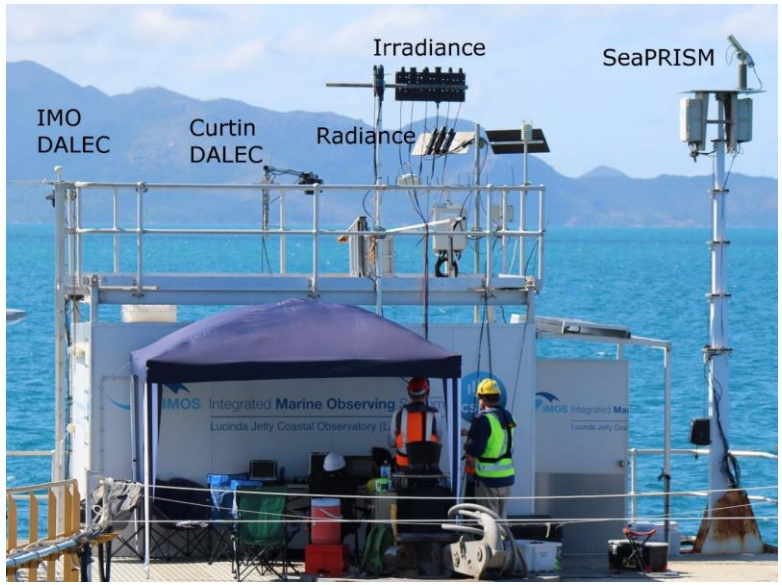






Spectral approach for temperature correction of cal. coeff. should be investigated





(Analysis: Slivkoff M., Klonowski W.)

Thanks for your attention