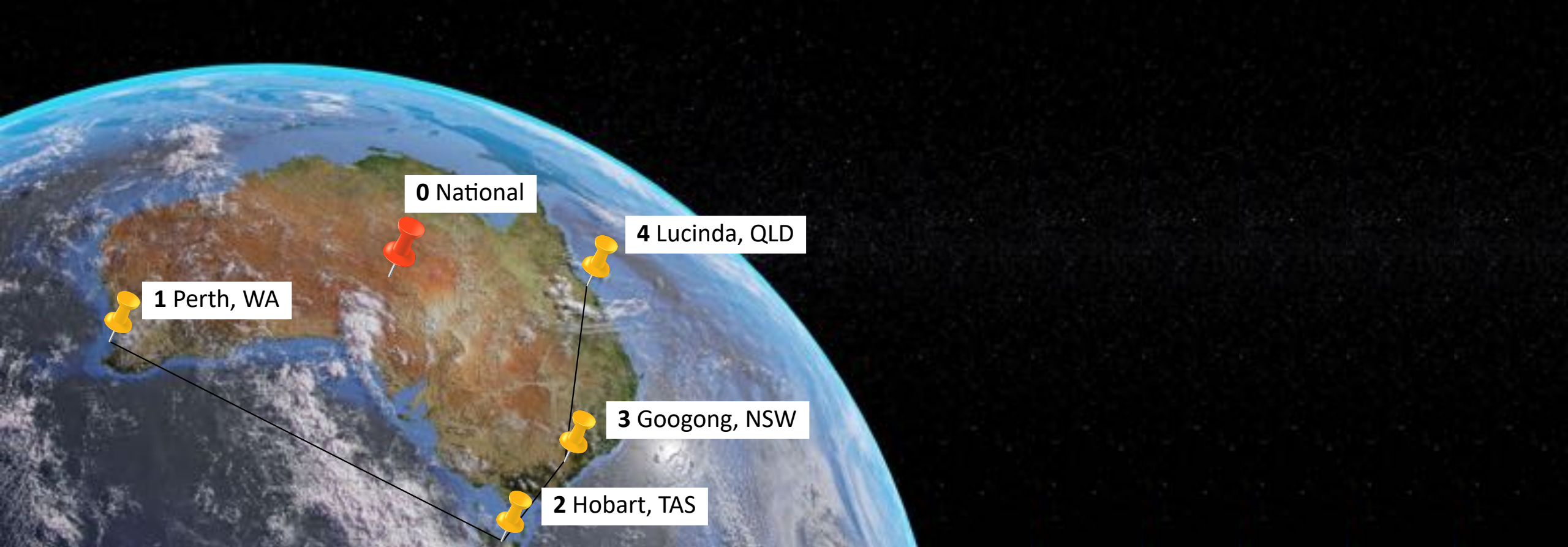




Australian Ocean Colour – Key Activities & Infrastructure

A brief update

Thomas Schroeder, David Antoine, Janet Anstee, David Blondeau-Patissier, Gemma Kerssik, Michael Hope and Tim Malthus

International Ocean Colour Science Meeting, 1-4 Dec 2023, Darmstadt, Germany



Copernicus Australasia Regional Data Hub

Distributing and promoting data from the *Sentinel* missions, supporting:

- **Government** information requirements
- **Enhanced** access to satellite Earth Observation data
- **Collaboration** between Australia, Europe, Southeast Asia and South Pacific region

www.copernicus.gov.au



Collaborative Partnership



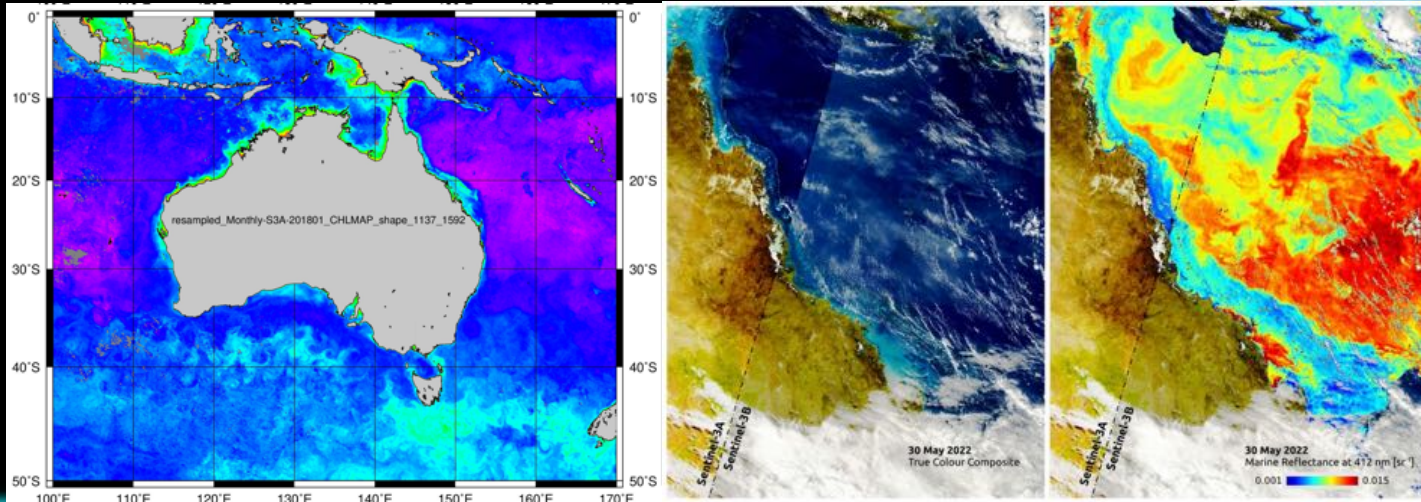
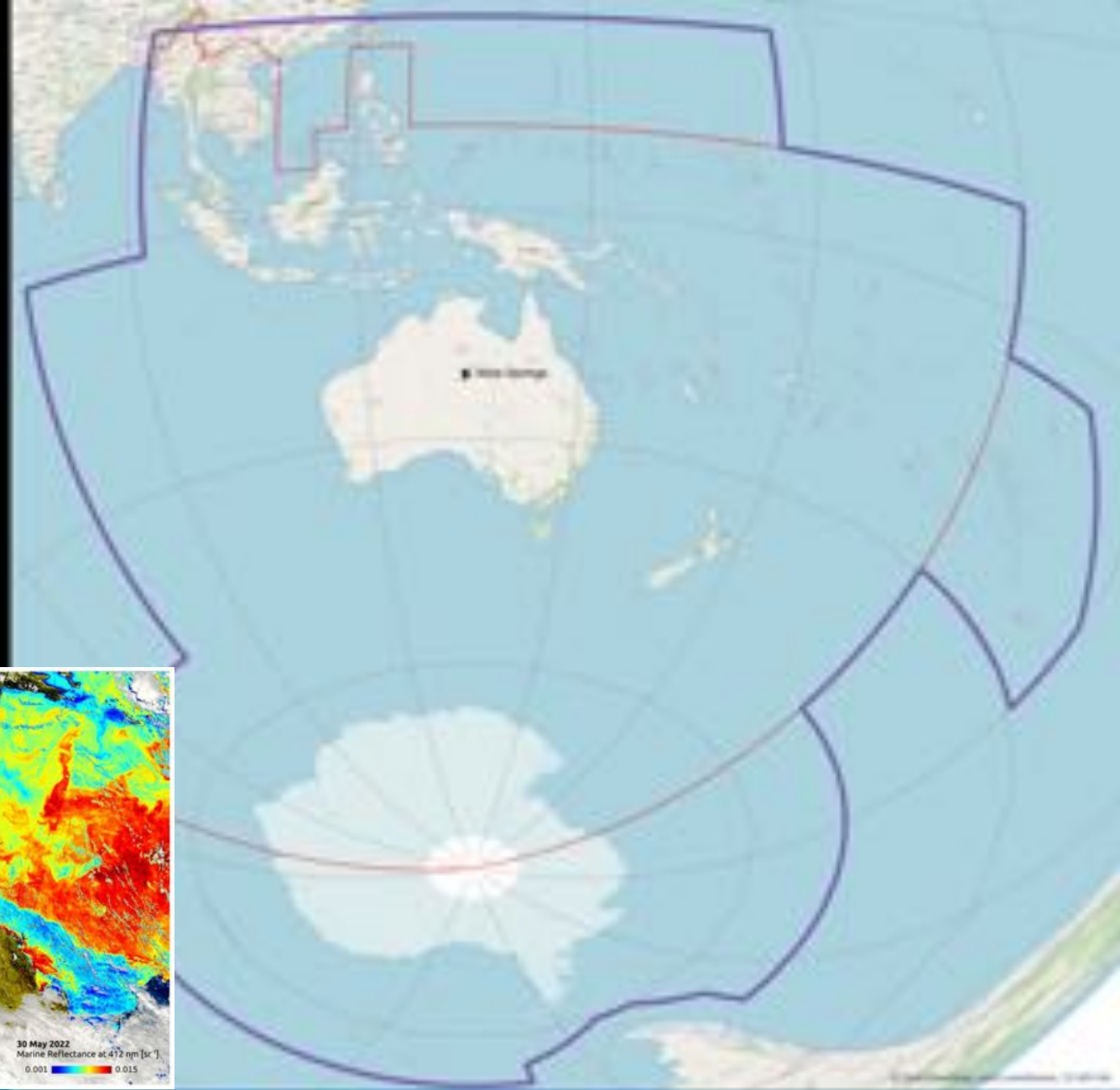
Supported by



Archive 2014 onwards provides:

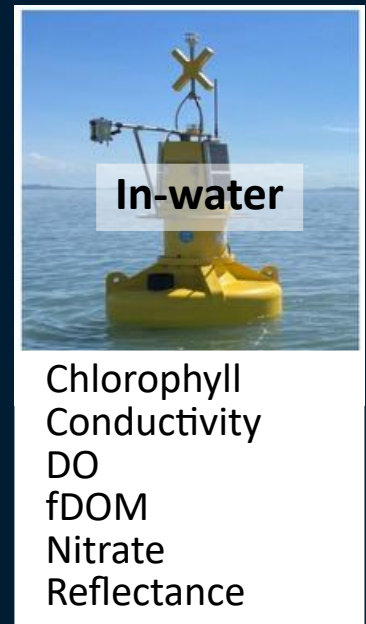
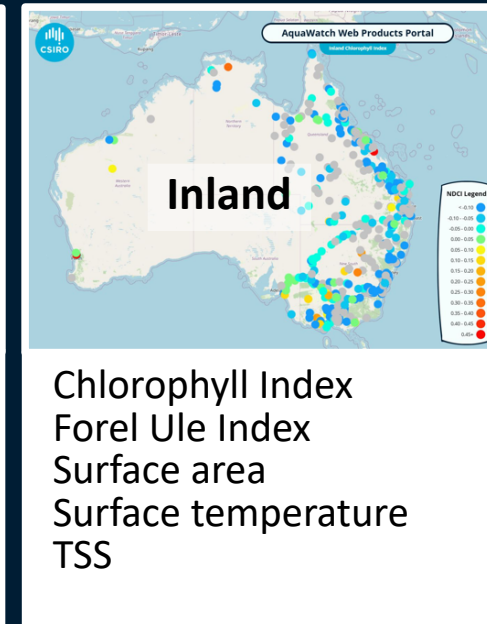
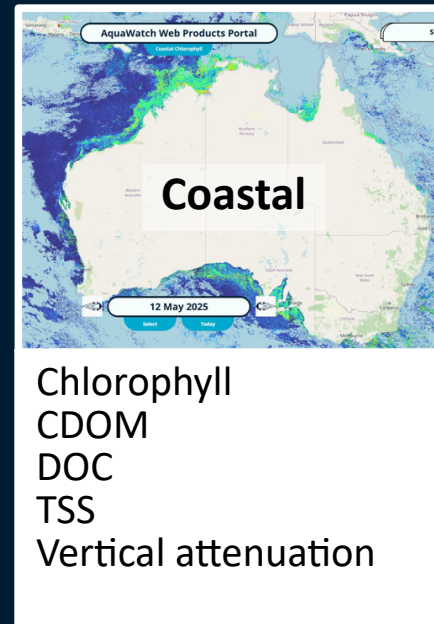
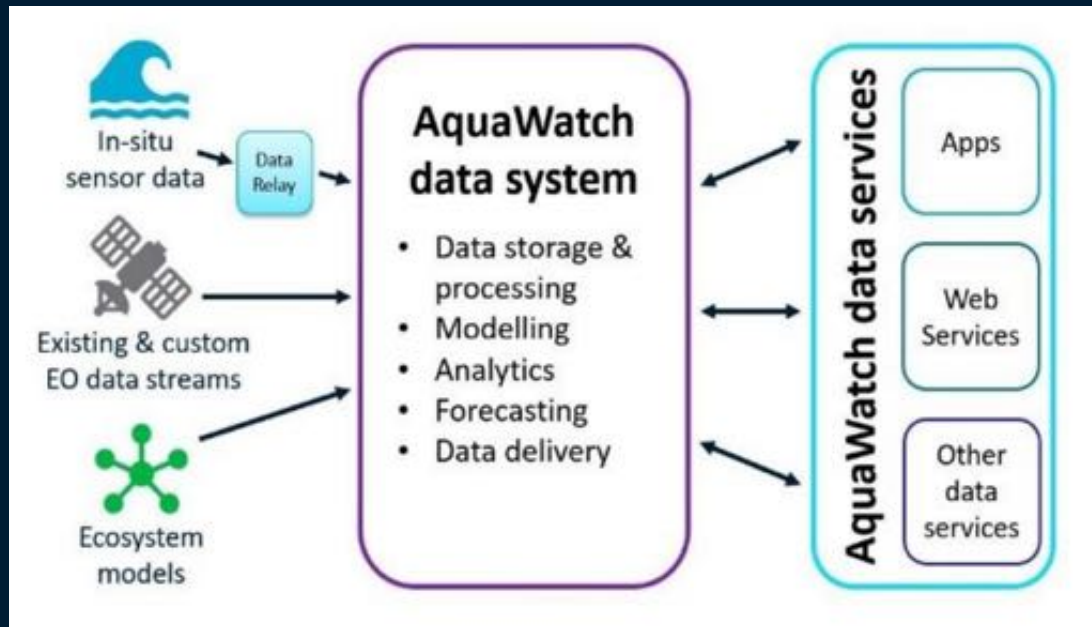
- Sentinel-1 – C-SAR (GRD, SLC, OCN)
- Sentinel-2 – MSI (L1C, L2A)
- **Sentinel-3 – OLCI, SLSTR, Synergy, SRAL**
- Sentinel-5P

Supporting a wide range of national projects:
IMOS, eReefs, AquaWatch ...



AquaWatch Australia – Cont. developing a comprehensive monitoring system

Integrated water quality monitoring network that combines satellite observations with in-situ sensors



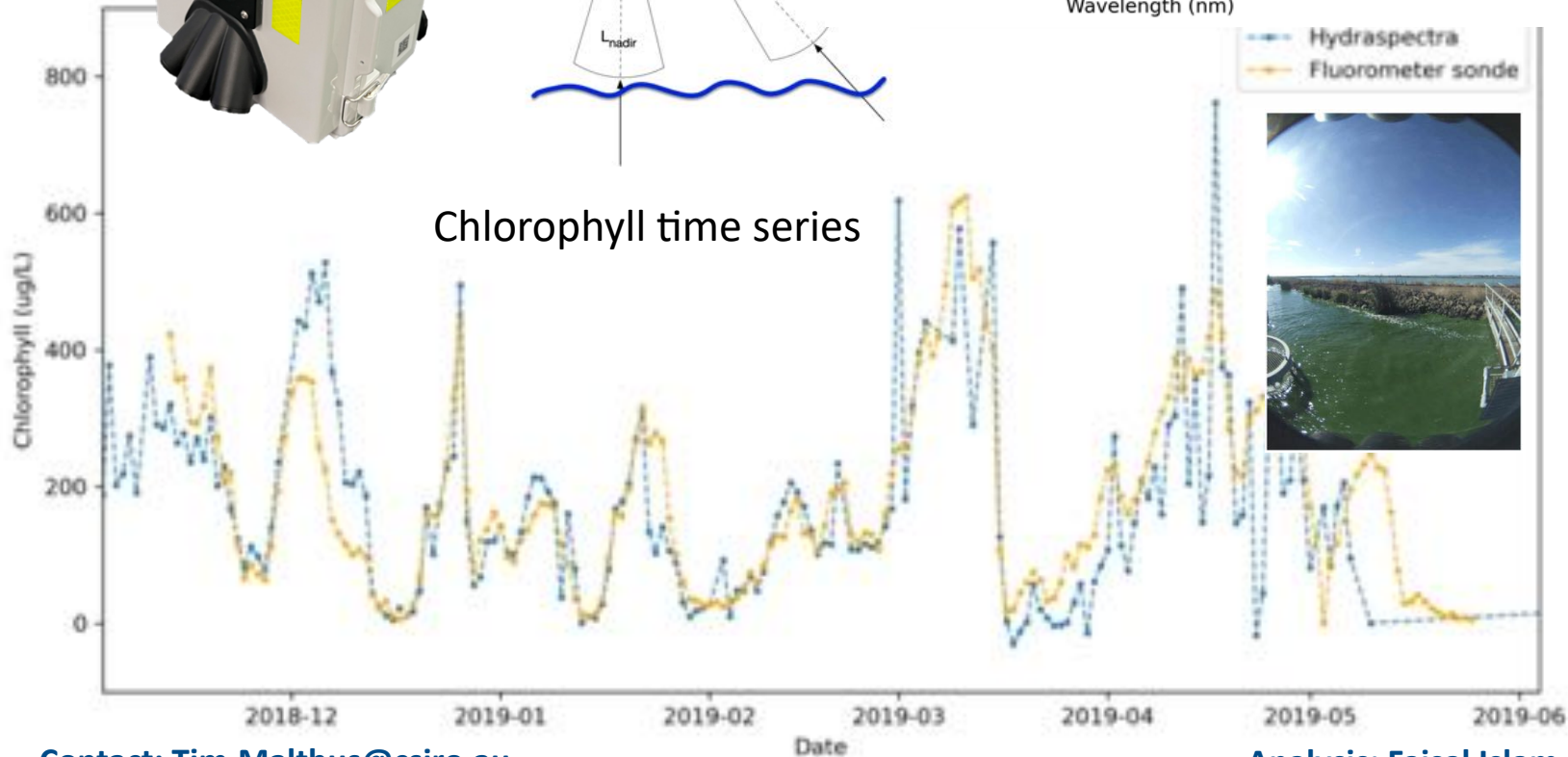
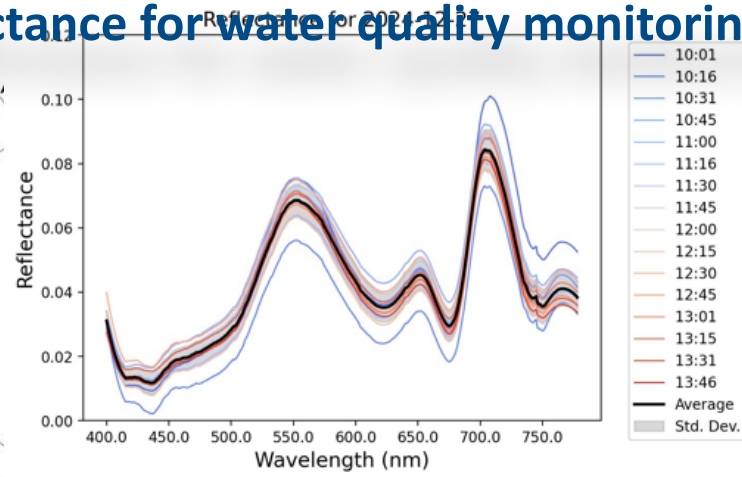
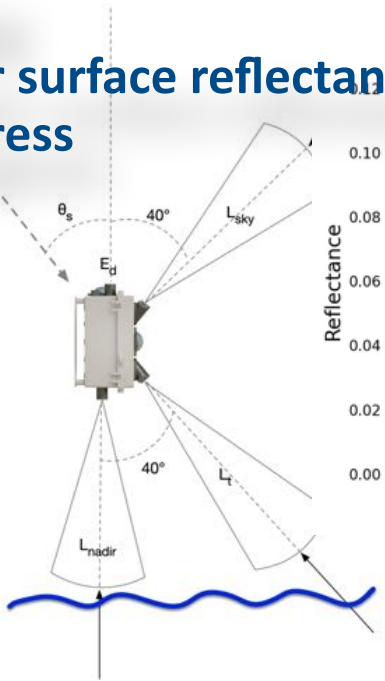
- Earth Observation satellite data: Sentinel 1/2/3, Landsat 5/7/8/9, VIIRS 19/20/21, MODIS Ocean, Hyperspectral (future)
- Ground based in situ sensor networks: Eagle.io, Senaps, HydroVu Sofar, HydraSpectra, SORAD
- Scalable cloud computing to continental scale
- AI and Machine Learning support
- Flexible integrated data analytics platform for exploratory data analysis
- Production grade automation

Coastal, Inland and In-water Monitoring Network
Six national pilot sites – mature prototypes
Sites aim to be operational by end of 2026
Potential national scale-up
Hand-over to operational partner
Ongoing improvements



HydraSpectra

Low-cost above water surface reflectance for water quality monitoring
Development in progress



Lucinda



AAOT

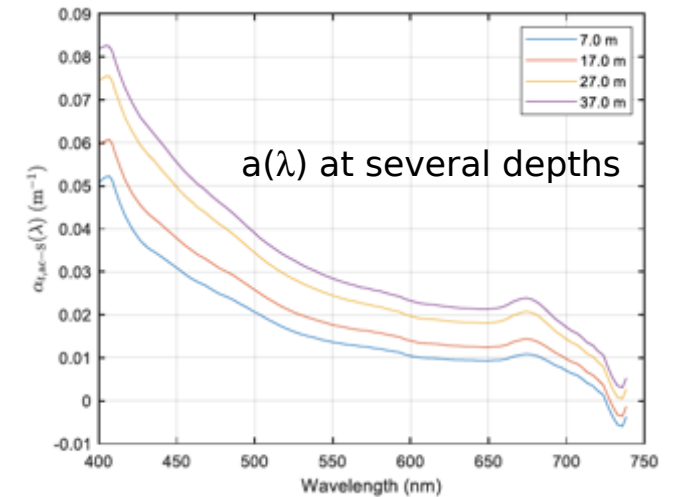
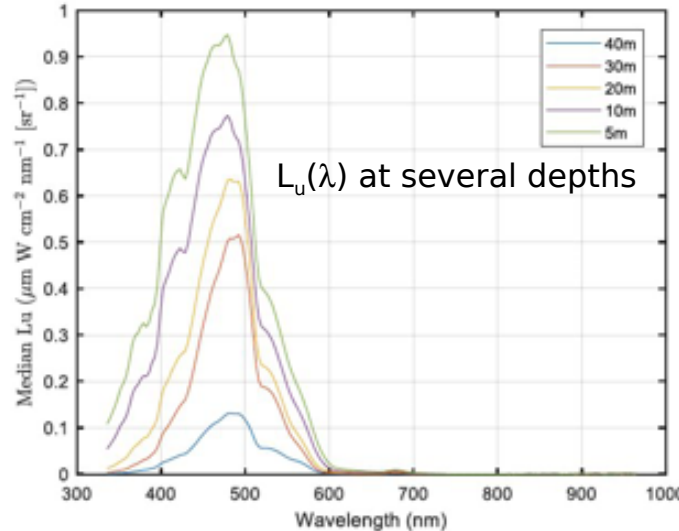
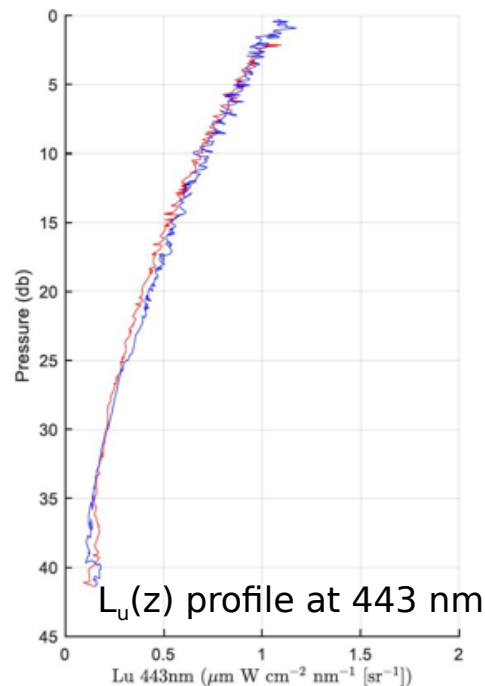
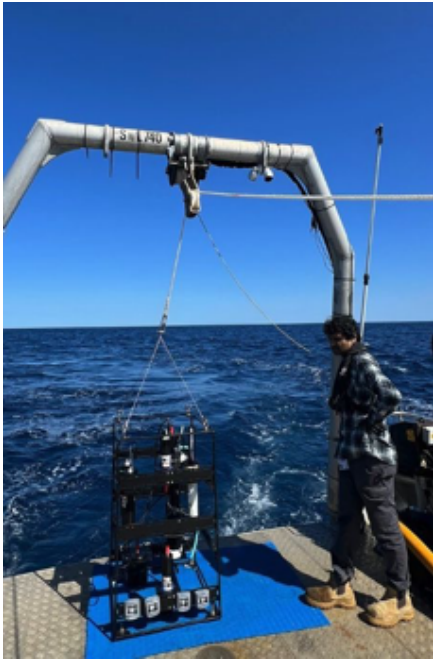
Monthly bio-optical sampling off Rottnest Island

IMOS National reference station



Shallow-water (60 m) profiling for hyperspectral radiometry (IMO USSIMO sensors), hyperspectral absorption/attenuation (Seabird/WETLabs AC-S), multispectral backscattering and Chl fluorescence (IMO SC6), plus T/S (Seabird SBE49)
Plus sampling for CDOM absorption

Started March 2024



Objectives: bio-optical variability, satellite matchups, phytoplankton community composition (in combination with pigments and genomics)



National Aeronautics and
Space Administration



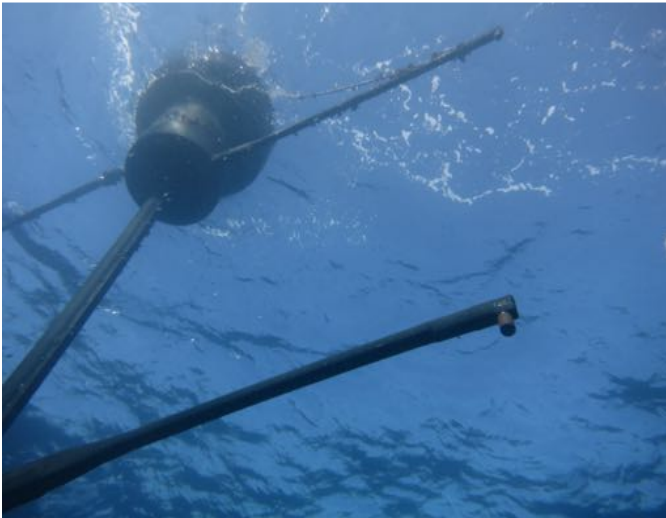
UNIVERSITY
OF MIAMI

SJSU

NIST



Poster 128 – Session 3 on Wednesday

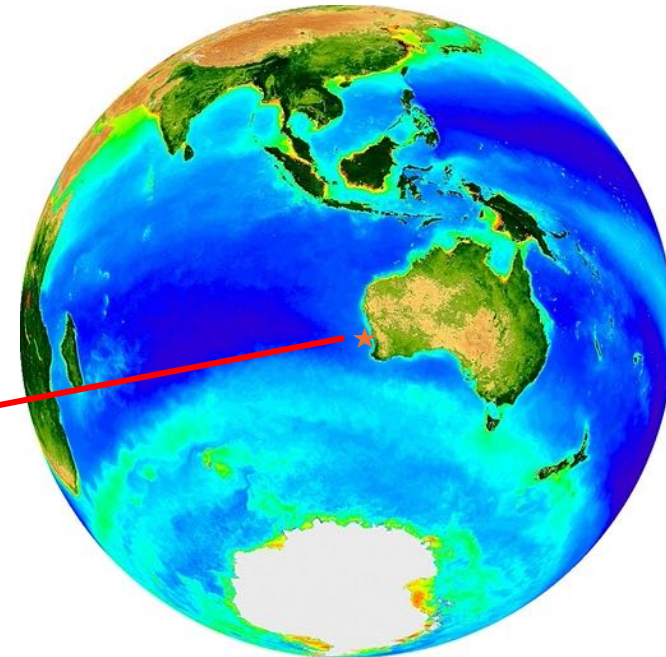
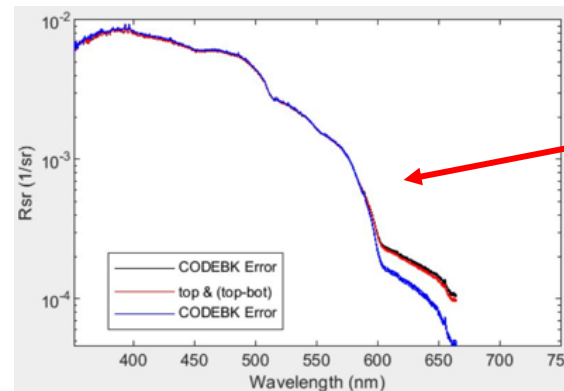


Marine Optical Network (MarONet)

Curtin University's RSSRG hosts the "Marine Optical Network" (**MarONet**), deployed 45 km off Perth, in deep clear waters. This unique equipment is the new generation "system vicarious calibration" (SVC) buoy for the NASA PACE mission



Operating since September 2024



Curtin University

Remote Sensing and Satellite Research Group (<https://research.curtin.edu.au/remotesensing/>)
david.antoine@curtin.edu.au

Bringing together the bio-optics and phytoplankton photo-physiology communities *in the context of PACE*

5-day workshop including:

- Invited talks
- Contributed talks and posters
- Extended discussion time

Potential deliverables:

- A review paper (current knowledge and future actions)
- An action plan – with a dedicated web page to link international bio-optical sampling across the S. Ocean, with both the PACE mission and the new hyperspectral radiance sensors on robotic floats
- Future similar meetings or dedicated conference sessions

Organising Committee

David Antoine (Curtin Uni), Philip Boyd (Uni Tasmania), Christina Schallenberg (CSIRO), Robert Strzepek (Uni Tasmania)

<https://antarctic.org.au/southern-ocean-bio-optics-workshop/>

Remote Sensing and Satellite Research Group (<https://research.curtin.edu.au/remotesensing/>)
david.antoine@curtin.edu.au



Southern Ocean Bio-optics Workshop

Reconciling bio-optics,
photophysiology and floristics
in the PACE era

10-14 November 2025

Institute for Marine and Antarctic Studies
University of Tasmania, Hobart Australia

PLENARY SPEAKERS

Mike Behrenfeld (OSU, USA)
Heidi Dierssen (UCorn, USA)
Jay Mace (JoU, USA)
Nina Schuback (Switzerland)
Charlie Stock (NOAA, USA)
Robert Strzepek (UTAS, Australia)
Julia Uitz (LOV, France)

SPONSORS



Darkwater Inland Observatory Network (DION)

Googong Dam, NSW, Australia



- **Operational since Sept 2024**
High-CDOM, low TSS, narrow freshwater site
- Built to meet FRM standards through traceable calibrations and uncertainty budgets
- Provides QA-assured data for global cal/val efforts, enhancing satellite water-quality products
- High-temporal database linking lab, in-situ, and satellite observations for improved modelling and forecasting
- Future-proofed platform with capacity for additional instrumentation



CSIRO | DION Project Team | Janet Anstee, Gemma Kerrisk, Darius Culvenor*, David Benn, James Taylor, Albertina Diaz

*Environmental Sensing Systems



DION



Stage 1

1

Platform deployment and development 2023-24

- Mooring & pontoon installation
- Electronics & power system setup
- Sensor integration & data logging
- Sample collection & routine maintenance
- Live monitoring via Grafana dashboard

Stage 2

2

Data processing automation 2025

- DION2 HyperCP conversion
- HyperCP automation with Argo
- Thermal radiometer integration
- Metadata alignment with QA/QC
- Water-quality sensor integration
- Workflow for AquaWatch Data Portal
- Platform and method documentation



Stage 3

3

Product verification and model development 2026

- Platform & data verification experiments
- Water-quality sensor QA/QC
- Bio-optical library compilation
- Thermal radiometer uncertainty testing
- AquaWatch Dashboard implementation
- Data QA/QC documentation

Stage 4

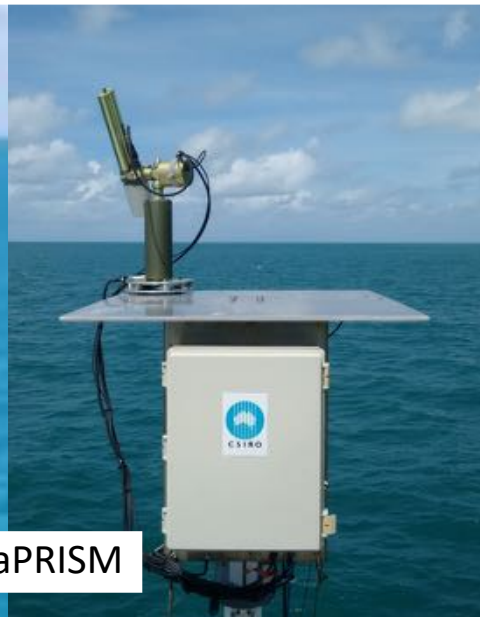
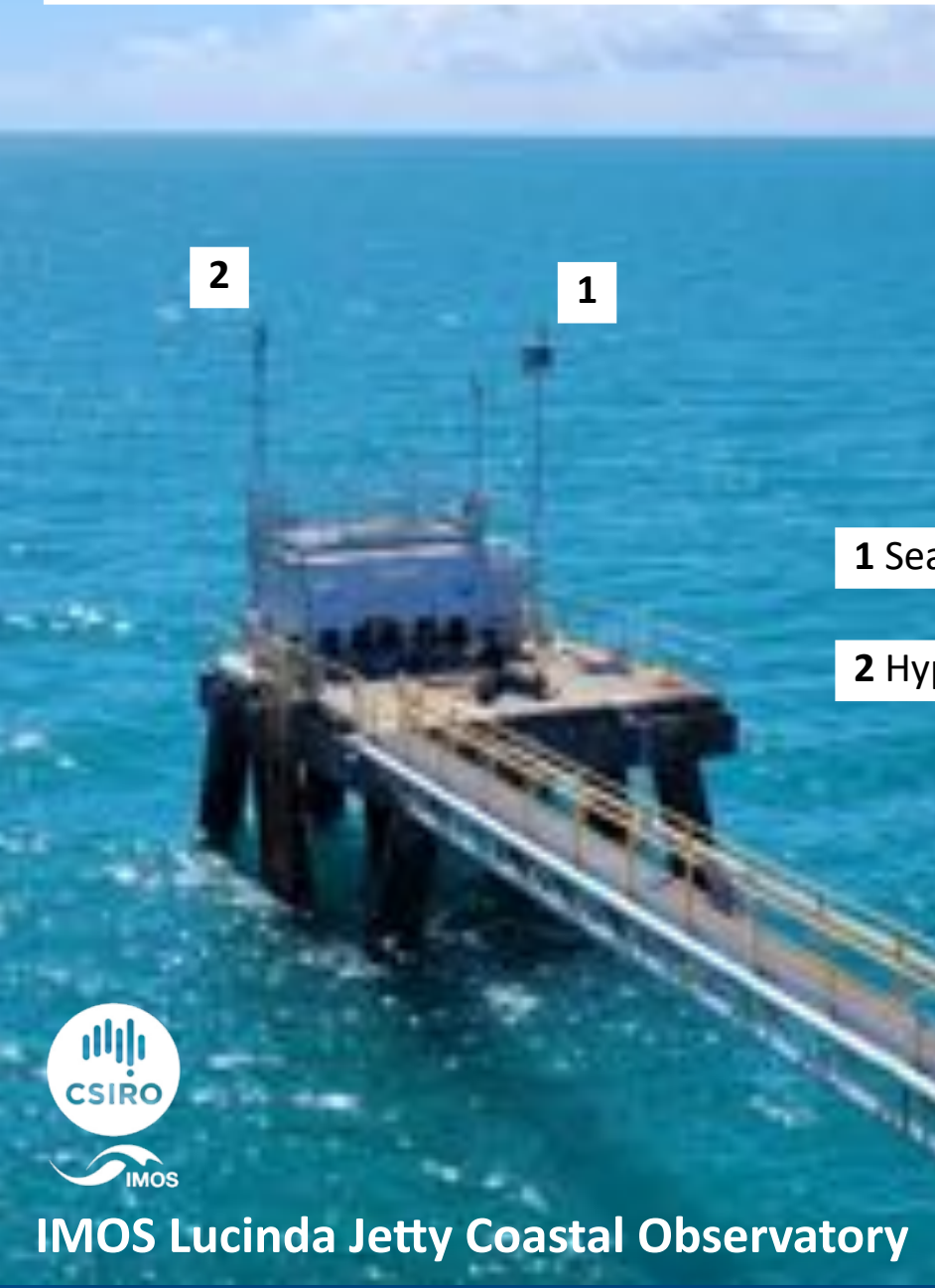
4

Expanded sensor integration and Cal/Val product verification 2027+

- New sensor integrations
- Enhanced QA flagging (eg cloud detection)
- Upgraded data processing automation
- Ongoing site & platform maintenance
- Continuous cross comparisons and platform verification
- Satellite + AtCor product validation



Hyper-spectral vs multi-spectral radiometry – consistency checks



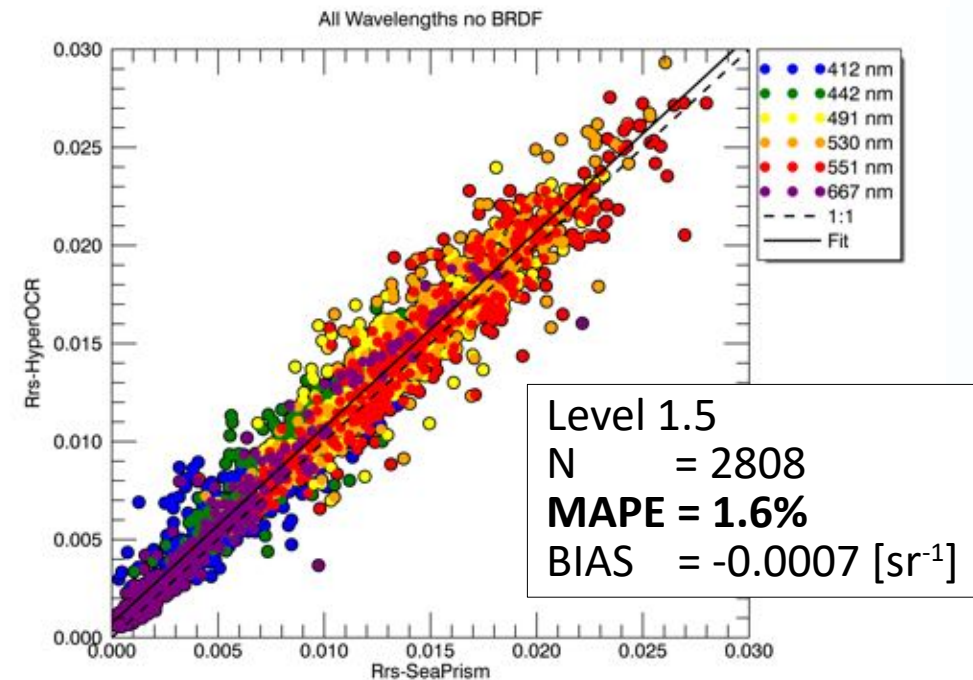
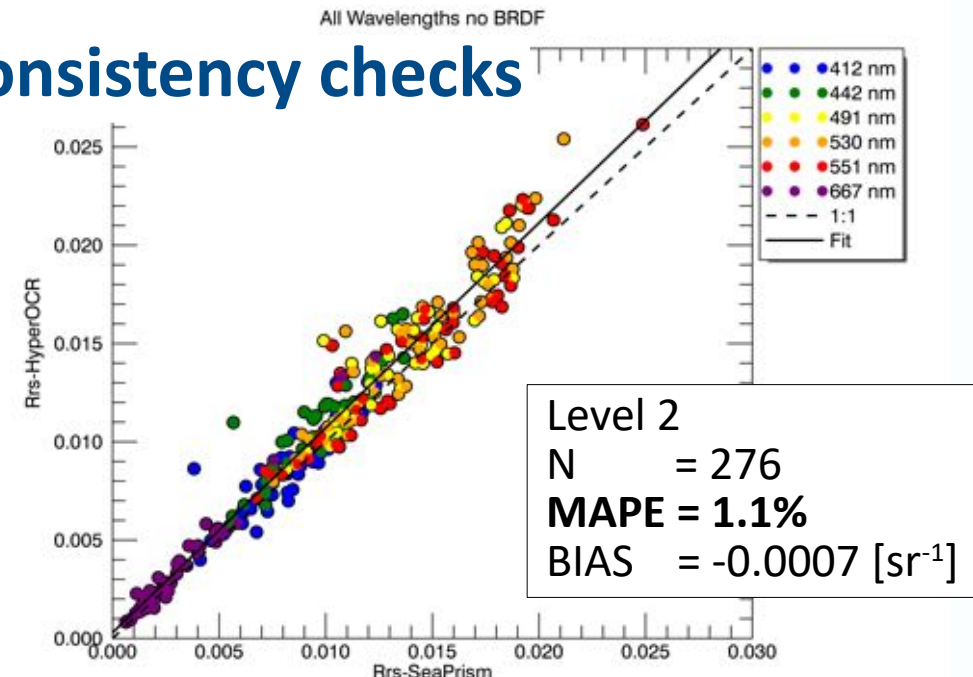
1 SeaPRISM



2 HyperOCR

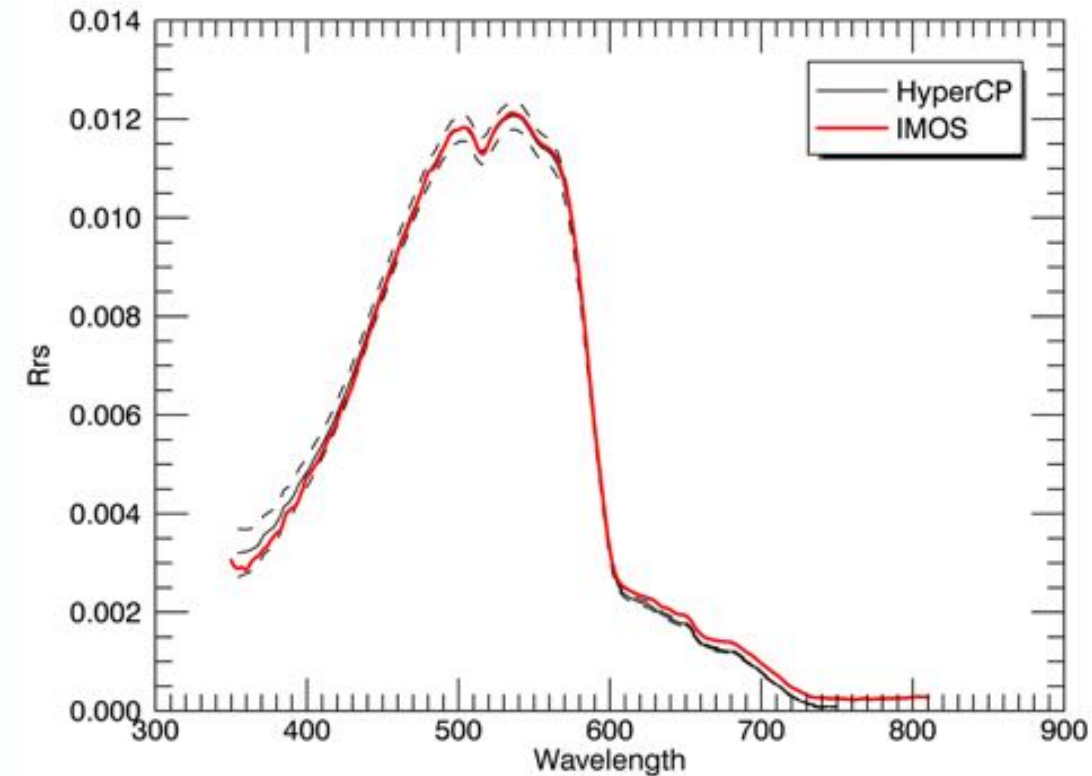
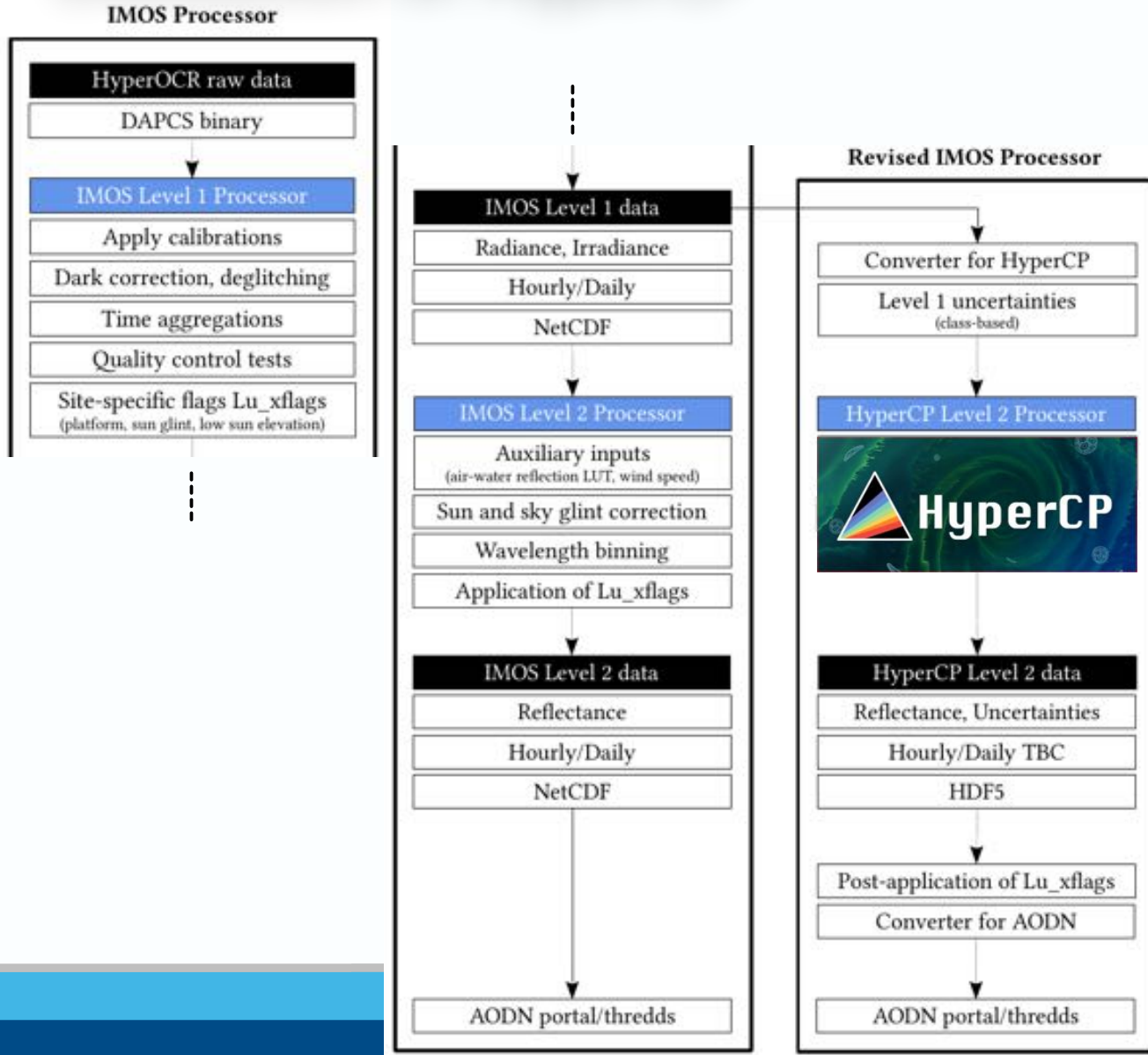


IMOS Lucinda Jetty Coastal Observatory

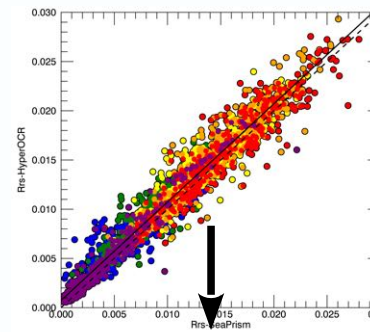


Evaluation of HyperCP

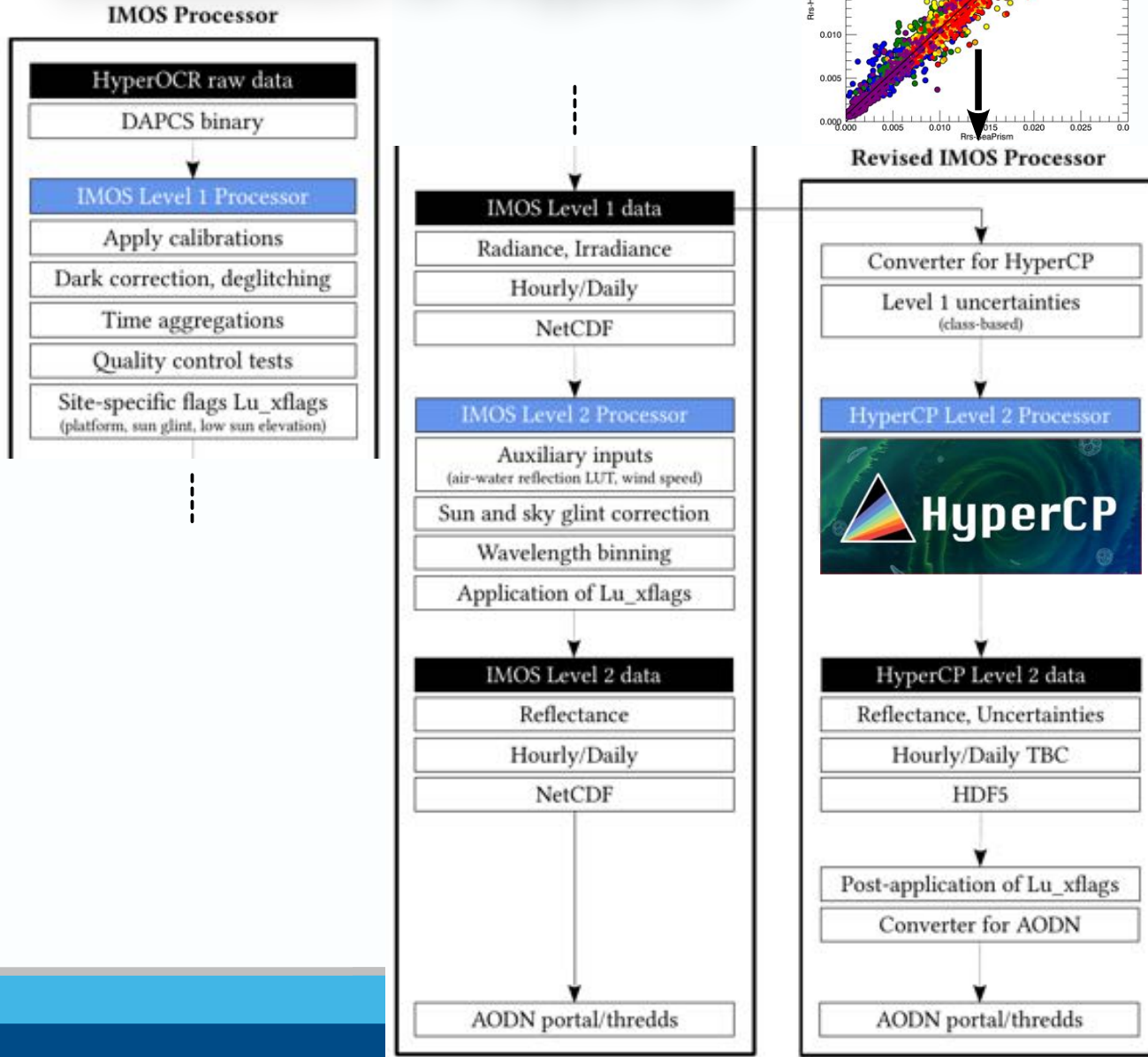
- **Objective:** Utilize and evaluate HyperCP uncertainty framework
- IMOS in-house developed processor uses different data format and site-specific Level 1 flagging
- **Converter** for IMOS L1 to HyperCP implemented



Evaluation of HyperCP



- **Objective:** Utilize and evaluate HyperCP uncertainty framework
- IMOS in-house developed processor uses different data format and site-specific Level 1 flagging
- Converter for IMOS L1 to HyperCP implemented
- SeaPRISM-HyperOCR reference data set will be used to **systematically evaluate consistency** of HyperCP processing
- If in good agreement possible operational implementation
- Advantage uncertainties added and data **sharing with EUMETSAT OCDB**
- Still requires Level 2 converter to deliver to IMOS Australian Ocean Data Network Portal
- How to evaluate consistency of uncertainties?
→ **HYPSTAR radiometer**



Upgrades 2026

HYPSTAR-SR hyper-spectral radiometer funded by ESA
Replacement of Cimel/SeaPRISM with T-model

(Artist impression)

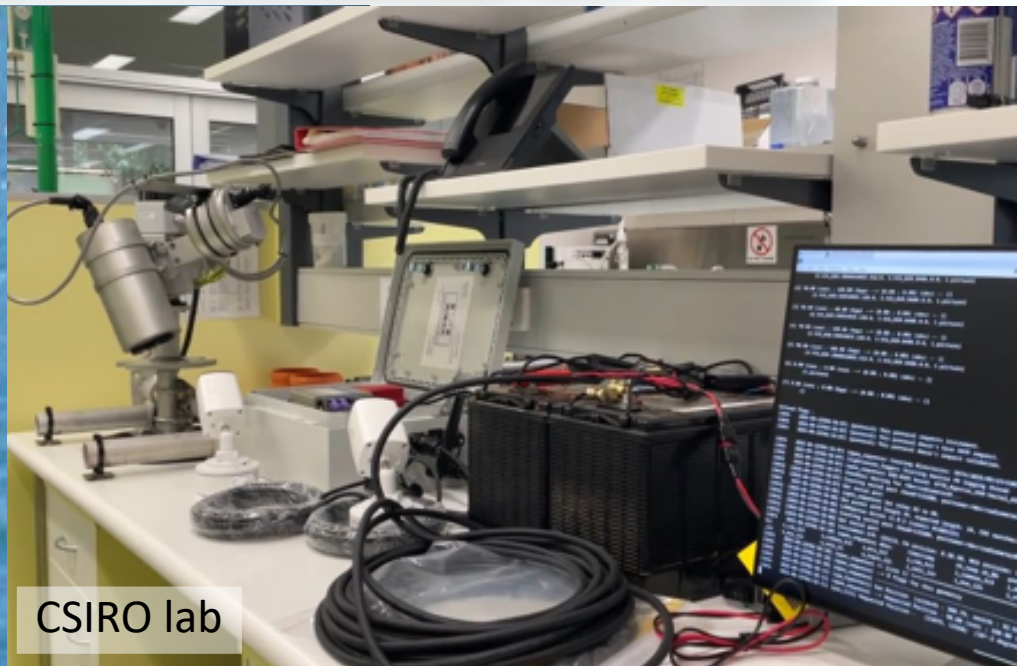
Satlantic
HyperOCR

HYPSTAR-SR

SeaPRISM



PI/Contact: Thomas.Schroeder@csiro.au



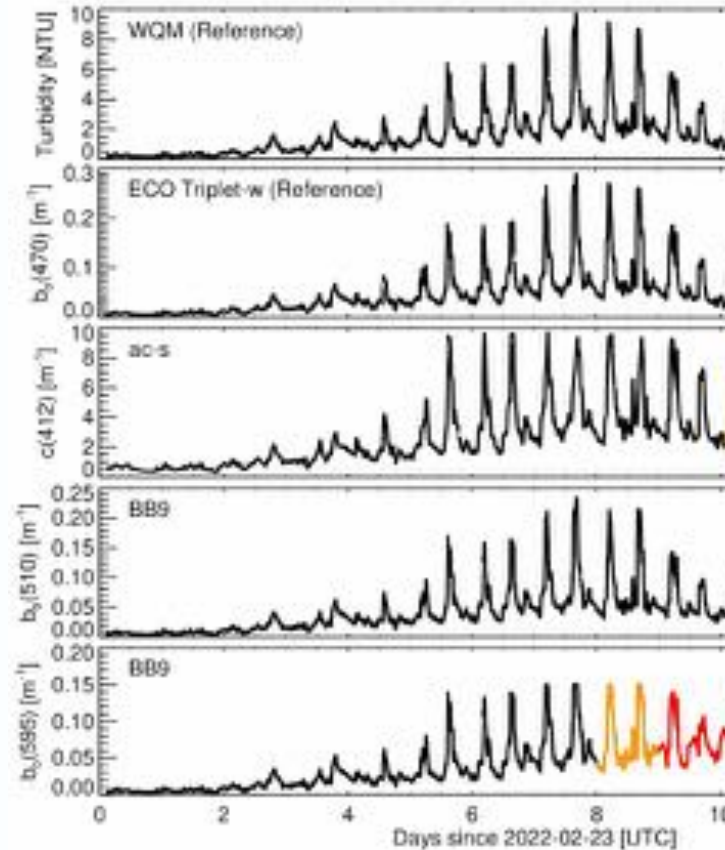
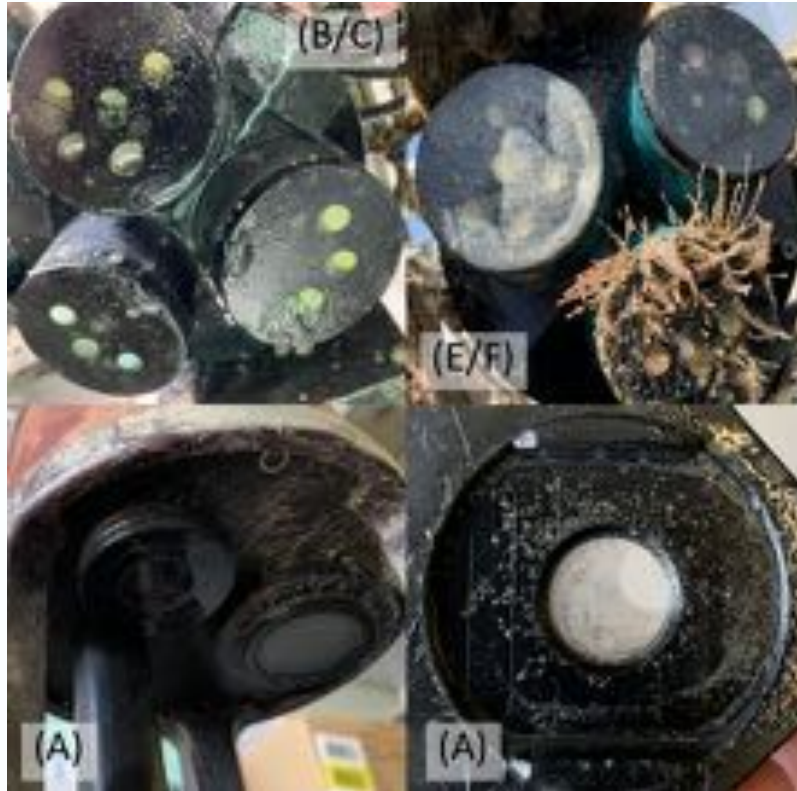
CSIRO lab



AAOT, Image credit: HYPERNETS

Bio-fouling detection of moored IOP sensors

Using copper shuttered reference instruments at LJCO



Bio-fouling detection of moored inherent optical sensors
Application at the IMOS Lucinda Jetty Coastal Observatory

Thomas Schroeder¹, Yi Qin², and Jenny Lovell³

¹ CSIRO Environment, Brisbane, QLD 4068, Australia; ² CSIRO Environment, Canberra, ACT 2601, Australia; ³ CSIRO Environment, Hobart, TAS 7502, Australia

Presented at the International Space-Colour Science (ISCS) Meeting 2025, 1-4 Dec 2025, Darmstadt, Germany

Thomas.Schroeder@csiro.au
www.csiro.au

1 Motivation Bio-fouling on optical sensors is the main limiting factor determining measurement accuracy and a significant challenge for medium-range coastal ocean deployments lasting more than two weeks. This is the case for the continuous inherent optical observations collected at the Australian Integrated Marine Observing System (IMOS) Lucinda Jetty Coastal Observatory (LJCO; <http://lucinda.csiro.au>). Regular band efforts to reduce bio-fouling using copper tubing and copper tape, data degradation due to bio-fouling can be observed frequently in the Lucinda Jetty site. As beam attenuation and absorption measurements, and the Lucinda Jetty B01 backscattering observations at the site. Maintenance at the LJCO is usually on 1-2 week intervals and photo deployment photos provide evidence of the top and extent of the bio-fouling on optical lenses and tubing. The fouling can be highly variable depending on the season, ranging from thin almost transparent biofilms to significant kelp-like growth (see conclusions). We tested different detection methods using copper diffusion reference measurements such as the Lucinda Jetty B02 Fluorescein and B02M devices that are presented in this study. The best performing detection method found at five sensor locations has been implemented for operational data analysis and engineering version v2025.0, which is available from the Australian Ocean Data Portal (<https://portal.aodn.org.au>). This data version now provides an additional bio-fouling flag for improved quality control of the IMOS-LJCO in-situ and B01 observations, ensuring high quality, consistent datasets in an operational time series.

2 Method We implemented and tested two methods for bio-fouling detection using backscattering ratios (R_{rs}) and single line series correlation (C-method). Both methods assume that bio-fouling does not occur during the first seven days of a new deployment. For the R-method to detect bio-fouling as a data, we first calculate the daily mean ratio (backscattering) R_{rs} at the difference of the observation and the absorption (or K_d) from temperature and salinity corrected as a data of 470 nm. A ratio is calculated using the daily mean B01 Fluorescein backscattering (R_{rs} at 470 nm) and 470 nm as the B01M Fluorescein (Chlorophyll) as reference. These ratios are normalized by the corresponding ratio value calculated in the first 7 days of deployment. The first 7 days of deployment are used to test for fouling of any of the B01 sensors. We first calculate the daily mean B01 backscattering divided by the daily mean of the corresponding ratio period. Empirically, we derived thresholds to identify and flag three levels of bio-fouling: B01, B02 and B03. The correlation method (C-method) is much simpler and calculates Pearson's Correlation using the ratio value properties over a 3-day moving window (Fig. 1). This method also applies empirically derived thresholds to flag three levels of bio-fouling (B01, B02 and B03).

3 Results Two cases of bio-fouling were investigated (Case 1: 2025-01-2025-02-20). Post-deployment photos confirm moderate fouling on B01 and any optical lenses and tubing. Bio-fouling of any a tube detected by C-method on day 8 and R-method on day 9, seven after the safe period. The onset of B01 fouling is detected and detected for band 1 (B01) on day 11, white band 2 (B02) and remains free of fouling until the last day of this three week deployment. Good agreement of C- and R-method detections. Case 2: 2025-02-2025-03-20. Photos confirm severe fouling on B01 lenses and optical tubing. Fouling of any a tube detected by C-method one day ahead of R-method on day 11. Both methods detected fouling of B01 band 4 (B01) only on day 5 white band 4 (B02) only remains free of fouling for the entire deployment period of two weeks, which is in agreement with the post deployment photos taken.

4 Conclusions While both detection methods generally produce very similar results, the C-method is preferred because it does not depend on the mean optical condition of the site gained and is similar to operational processing of Lucinda Jetty water optics data and provides a bio-fouling flag in water optics data data quality control.

References

1. Schroeder, T., Lovell, J., Qin, Y., & Lovell, J. (2025). Bio-fouling detection of moored inherent optical sensors. *International Space-Colour Science (ISCS) Meeting 2025*, 1-4 Dec 2025, Darmstadt, Germany.

Keywords

bio-fouling, optical sensors, backscattering ratios, absorption coefficients, correlation method, IMOS, Lucinda Jetty Coastal Observatory, water optics data, data quality control.