



Image Credit: ESA

# Evaluation of Sentinel-3 OLCI Level 2 products in Australian waters

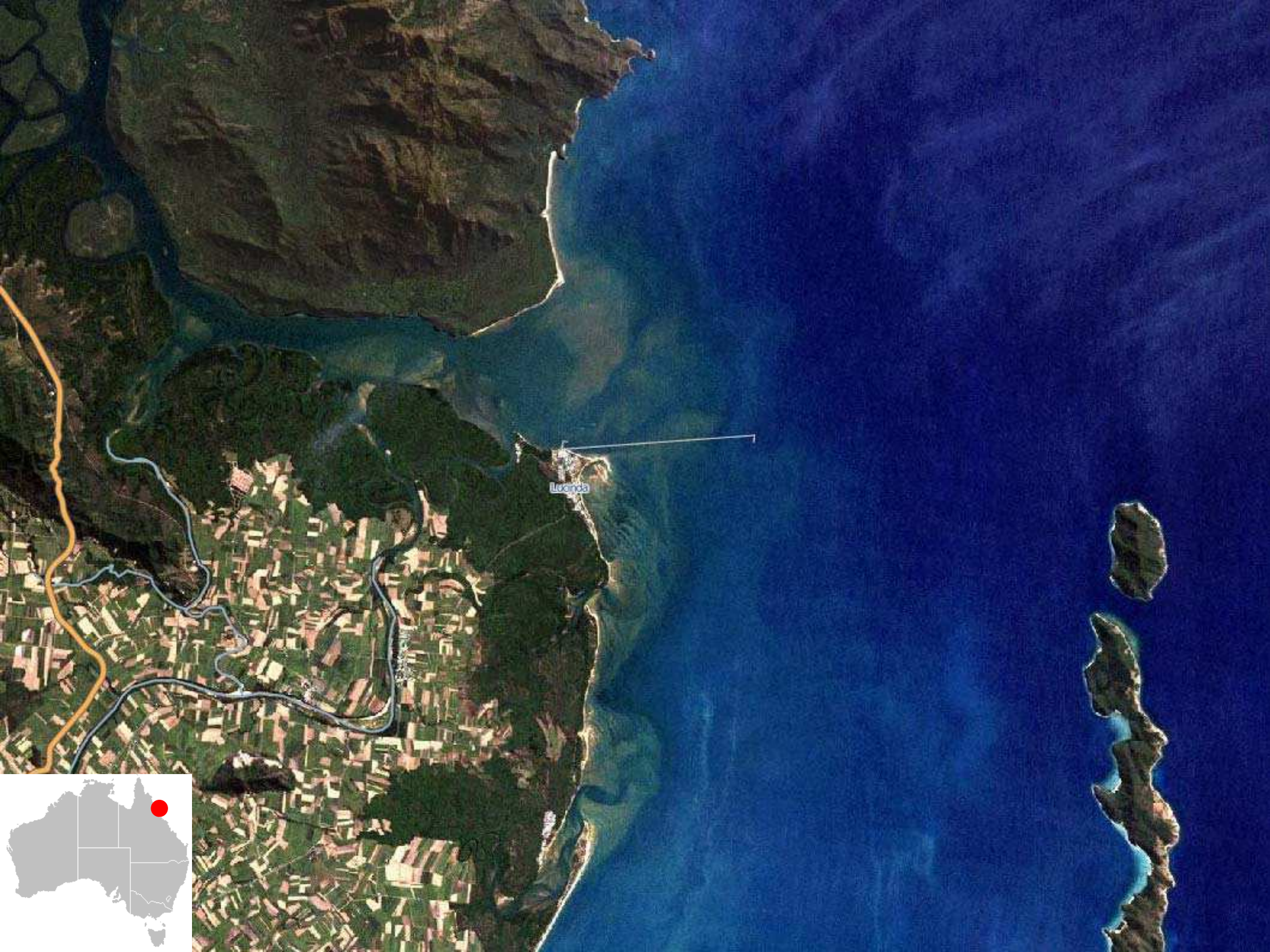
Schroeder T. on behalf of the Australian S3VT  
16 February 2017 S3VT meeting, ESA-ESRIN, Frascati, Italy

CSIRO OCEANS & ATMOSPHERE FLAGSHIP  
[www.csiro.au](http://www.csiro.au)



# This presentation

- **IMOS Lucinda Jetty Coastal Observatory**
  - Measurements, site variability
- **Radiometric match-ups “standard” and C2RCC processor**
- **Other IMOS activities to improve quality of measurements**
  - Radiometry Task Team
- **Water quality match-ups “standard” and C2RCC**
- **Some Bio-Argo results**

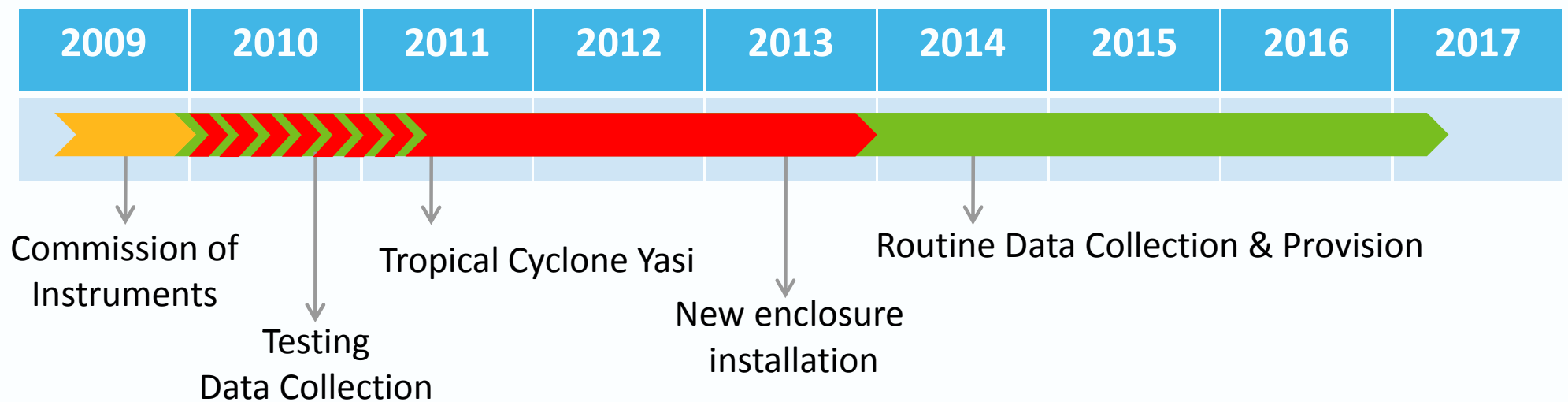


Loanda



# Lucinda Jetty Coastal Observatory (LJCO)

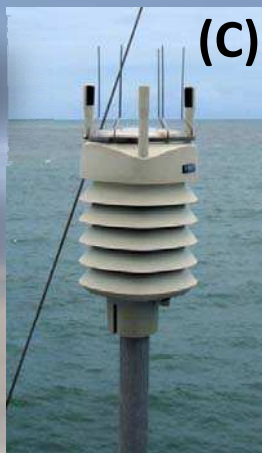
Quasi-operational data acquisition re-established in early 2014  
Continuous measurements + fortnightly water sampling



# Overview above-water measurements

## Weather Station

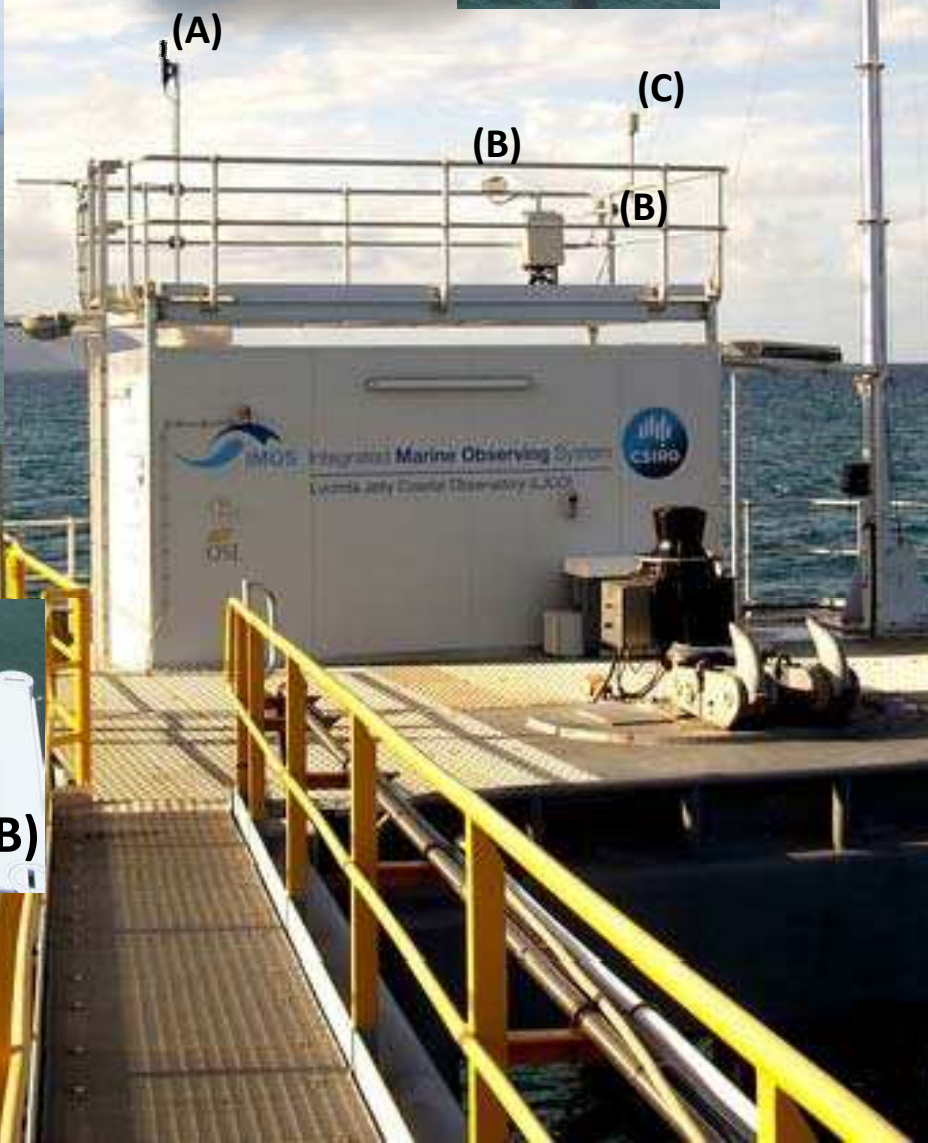
Temperature  
Pressure  
Humidity  
Dew point  
Wind speed etc



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

# Overview in-water optical measurements

## WetStar fluorometer

CDOM absorption  
Chlorophyll-a  
Uranine  
Phycoerythrin

Automatic winch controller  
keeps cage at a constant depth

ACs (80 wavelengths)  
Total absorption  
Total attenuation

## WQM

Temperature  
Salinity  
Depth  
Dissolved oxygen  
Turbidity  
Back scattering  
Chlorophyll fluorescence

## DAPCS

Network enabled  
real-time data  
logger

BB9 (9 wavelengths)  
Back-scattering

ACs switching unit  
(filtered/unfiltered)

Fortnightly servicing and water sampling  
optimized for satellite match-ups



# It's a variable coastal site

Tidal range 0.2-4 m

Water temperature 22-31°C

Salinity 27-36.5



*(Image credit D. Boadle)*

# In-situ variability key water quality parameter

Water quality sampling – 73 days (2014-2016)

Total Suspended Solids,  
Pigments,  
Spectral absorption of CDOM, Detritus,  
phytoplankton

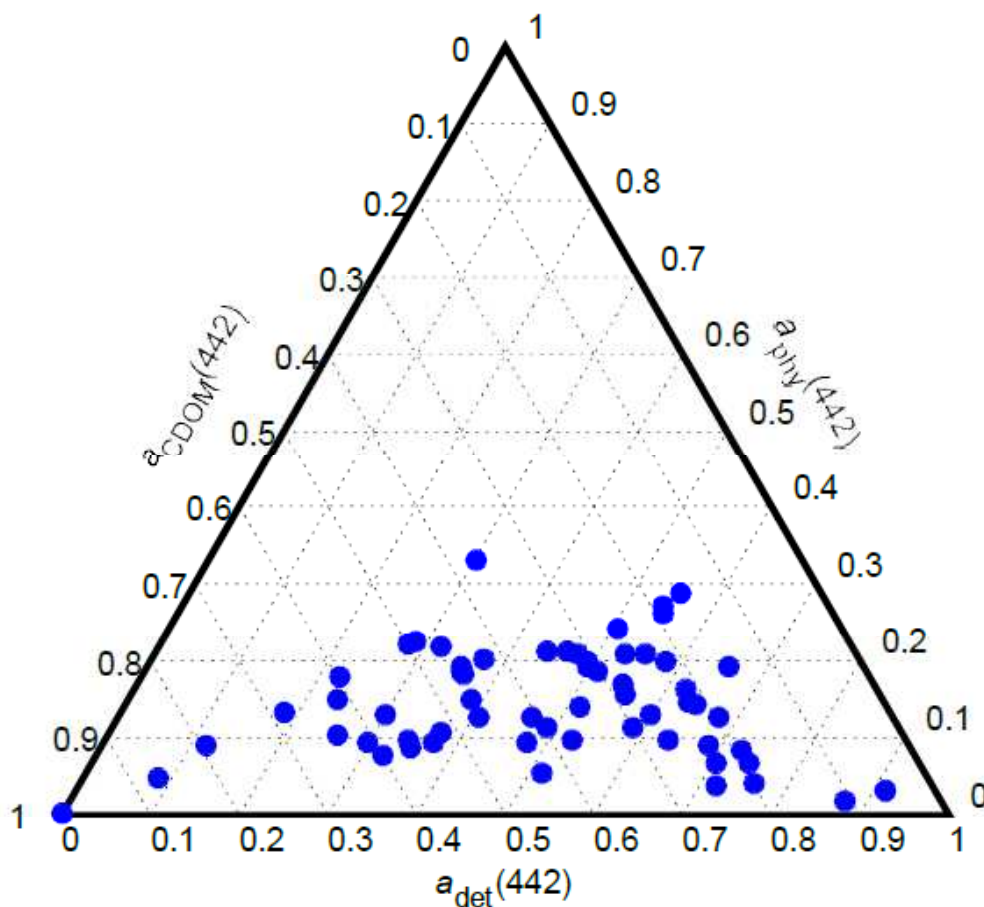
<b>TSS</b>	[1.17-35.7] g m <sup>-3</sup>
<b>Chlorophyll-a</b>	[0.22-6.35] mg m <sup>-3</sup>
<b>CDOM 443 nm</b>	[0.01-0.49] m <sup>-1</sup>

Sample collection times optimized for  
satellite match-ups

Filtration Townsville Lab

Shipment CDOM, TSS overnight Hobart,  
pigments and particulate absorption  
twice a year

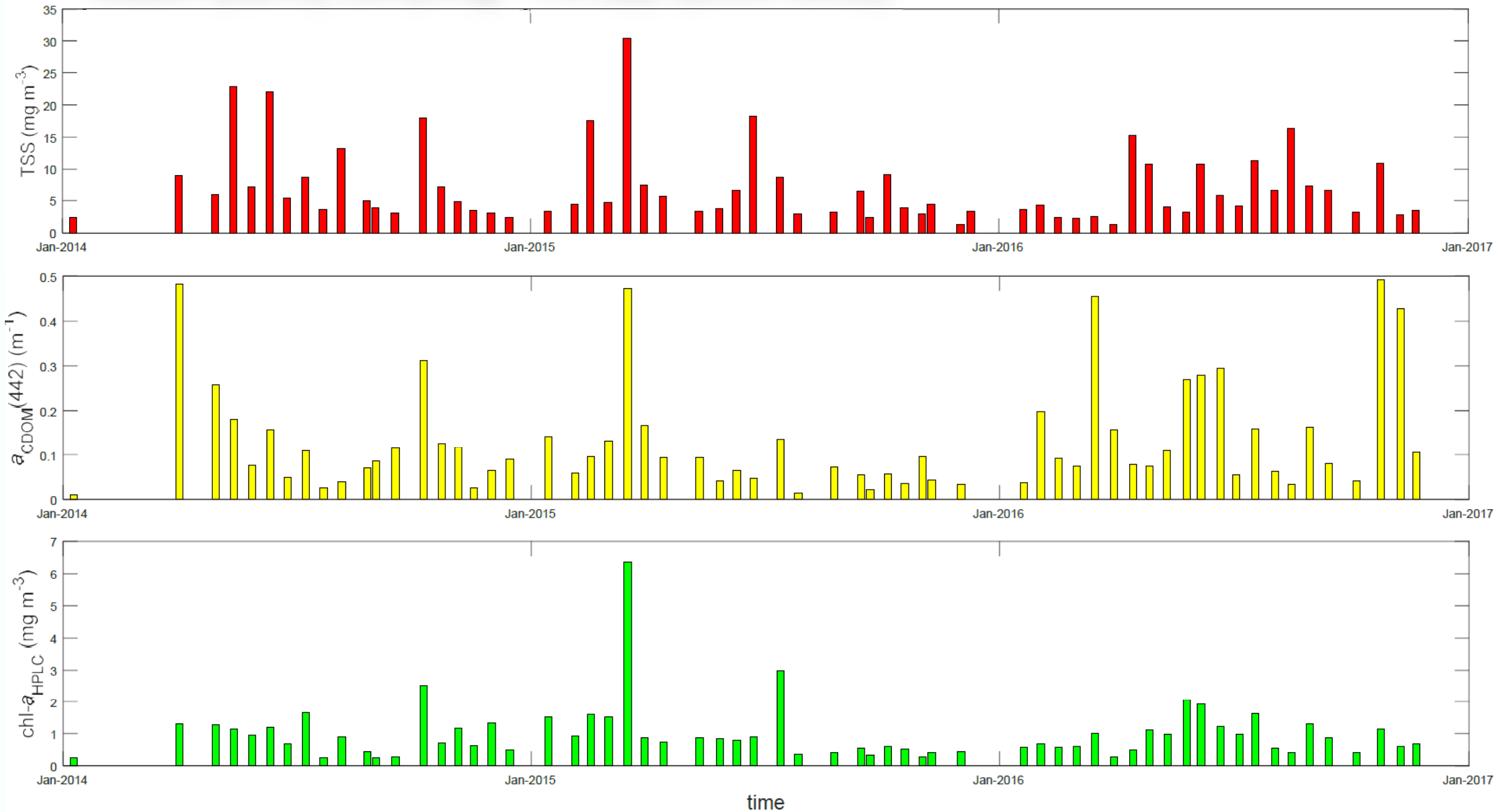
Absorption budget 442 nm





# In-situ variability key water quality parameter

## Water quality sampling – 73 days (2014-2016)



(Analysis: Baker B., Boadle D., Clementson L., Woizniak M.)

S3 Validation Team Meeting, 15-17 Feb 2017, Frascati, Italy



# In-situ variability atmospheric data

## AERONET-OC 2013-2016 and Weather Station Vaisala WXT520



Barometric pressure  
 Relative humidity  
 Air temperature  
 Wind speed, direction  
From pressure transducer  
 Water temperature, wave height

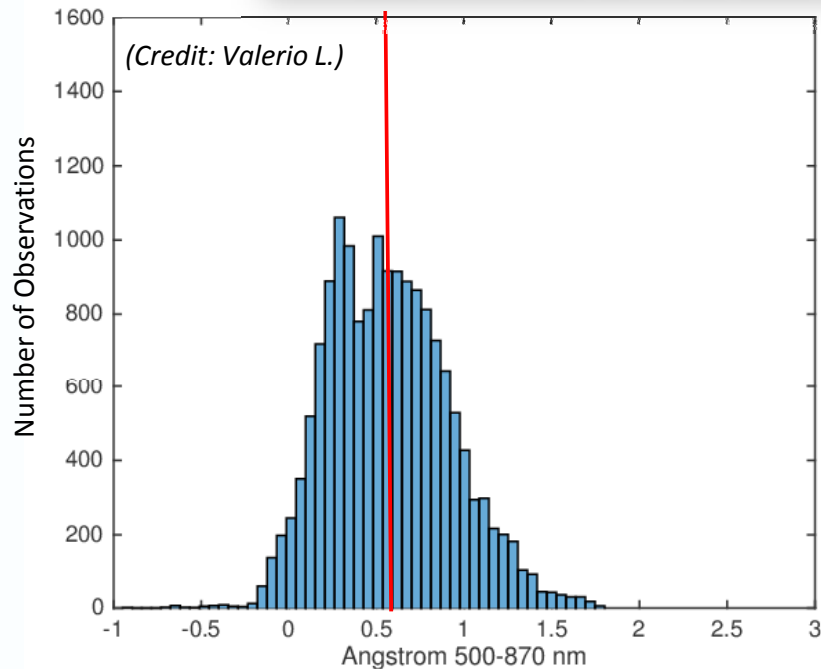


### AOT 550 nm

Median 0.067  
 Min 0.017  
 Max 0.278

### Angström 500/870 nm

Median 0.55



Maritime [%]	Continental [%]	Angström 500/870
100	0	0,211
90	10	0,313
80	20	0,415
70	30	0,517
60	40	0,619
50	50	0,721
40	60	0,823
30	70	0,924
20	80	1,026
10	90	1,128
0	100	1,230



# Level 2 validation

Focus on radiometric measurements  
Lucinda Jetty, Ship-borne



SeaPRISM AERONET-OC



DALEC



Lucinda Jetty Coastal Observatory

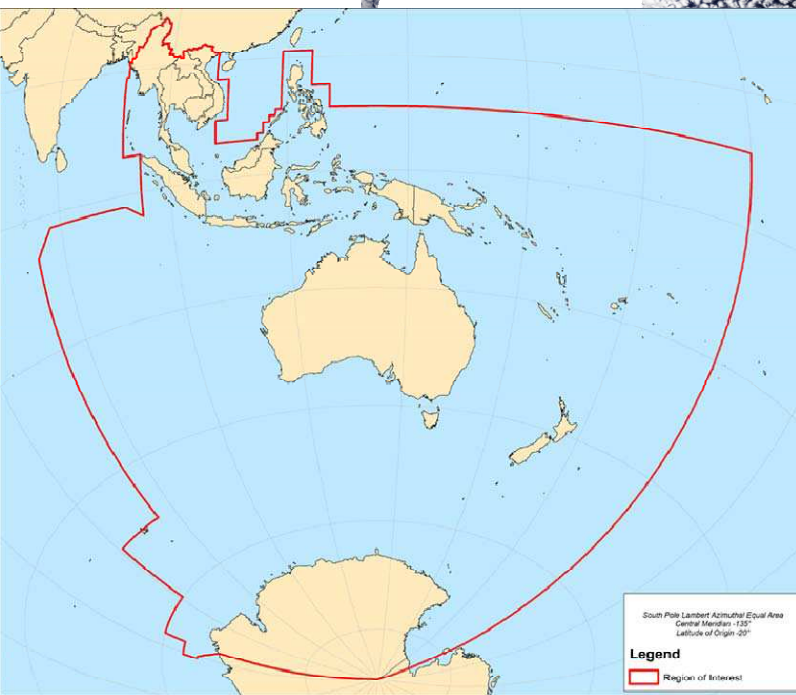
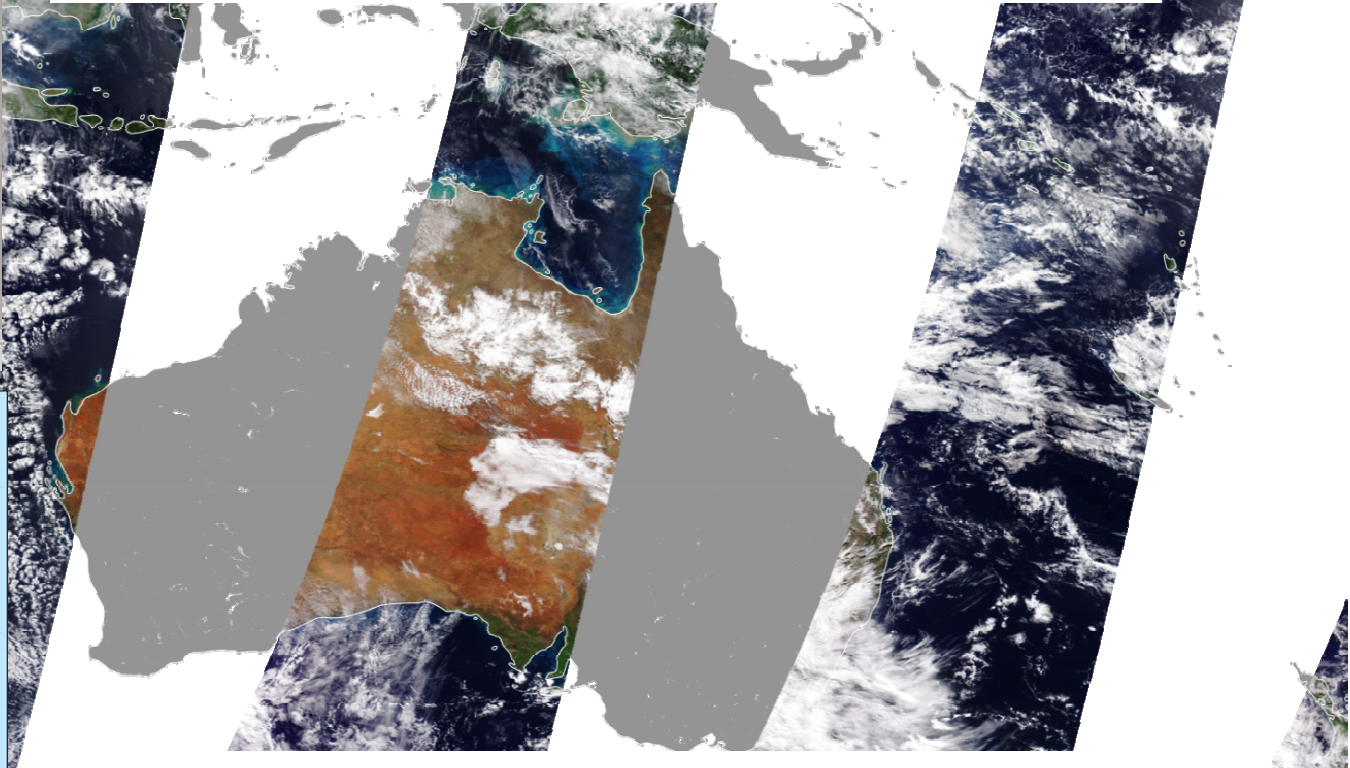


Hyper-spectral measurements (DALEC) added to Lucinda in May  
Funding secured to continue radiometric measurement under IMOS until June 2017  
Anticipated +5 years until 2022

# Sentinel-3A Data Access

## **S3VT:** EUMETSAT ODA Rolling Archive

- **OLCI** L1+L2 FR+RR Australia + LJCO subsets since 12 May 2016 Volume: 4.2 TB
- **SLSTR** L2 since 21 June 2016 Volume ~150 GB



## **Public:** EUMETCast Terrestrial on NCI

- **OLCI** L1 FR+RR Asia-Pacific since 18 Oct 2016
- **SLSTR** L1 since Asia-Pacific 16 Nov 2016

# Radiometric match-ups OLCI vs DALEC

3x3 FR, min 5 un-flagged pixels, no reprocessed data included

## Operational Processor

N=15 (8)

- 00 INVALID
  - 02 LAND
  - 03 CLOUD
  - 08 SUSPECT
  - 09 HISOLZEN
  - 10 SATURATED
  - 11 MEGLINT
  - 12 RISKGLINT
  - 13 WHITECAPS
  - 17 AC\_FAIL
- } L2 flags

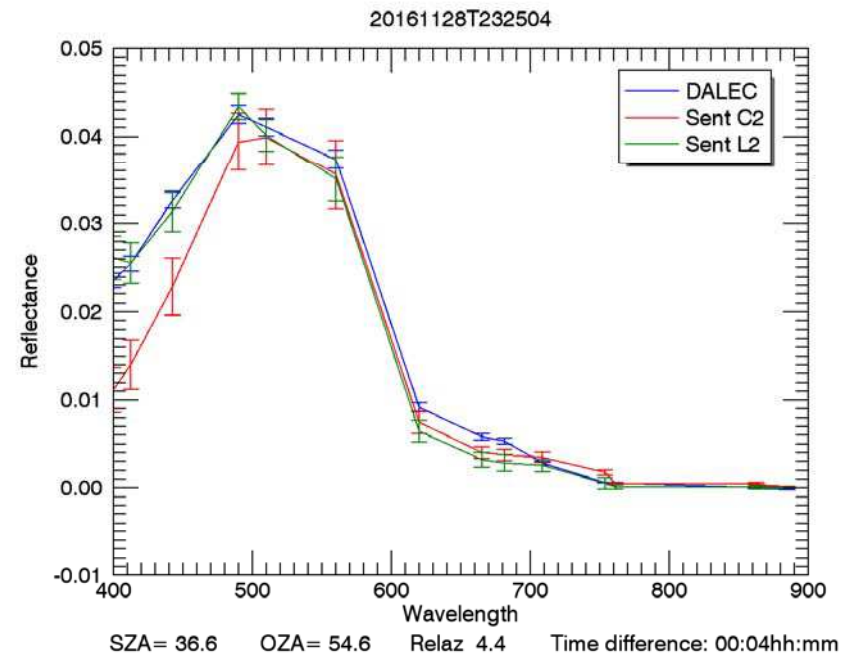
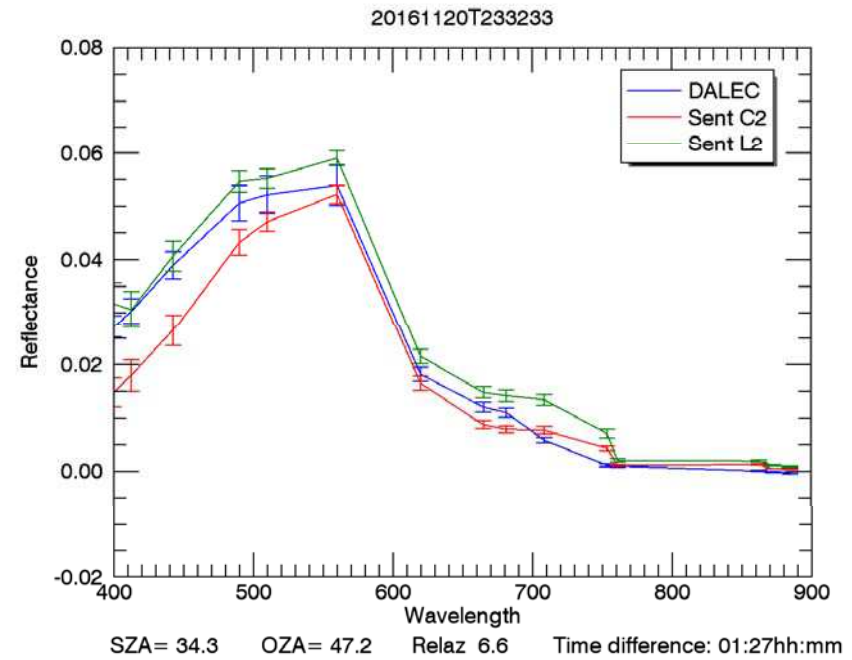
## C2CCR

N=19

- 22 SUN\_GLINT\_RISK
  - 25 INVALID
  - 26 STRAYLIGHT\_RISK
  - 30 COASTLINE
  - 31 LAND
- } L1 flags
- 
- 01 RTOSA\_OOR
  - 02 RHOW\_OOR
- } NN flags

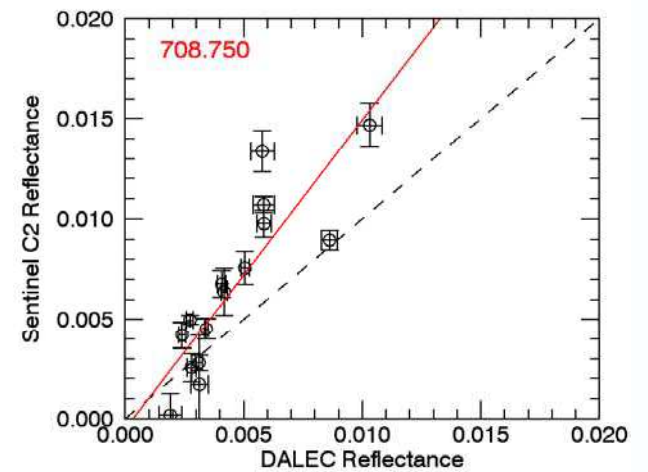
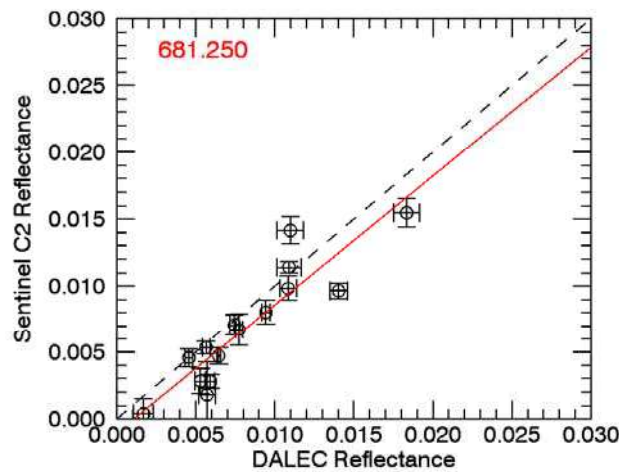
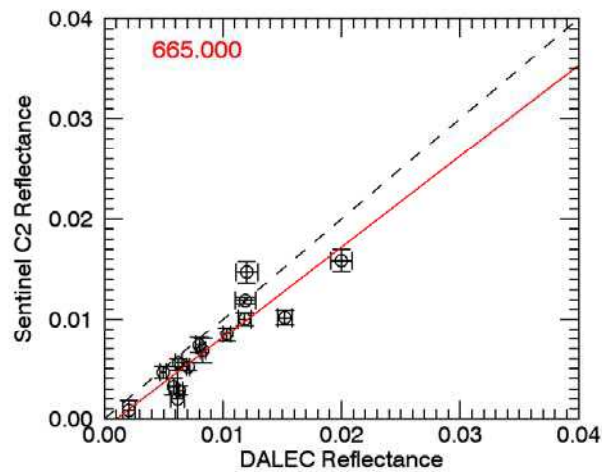
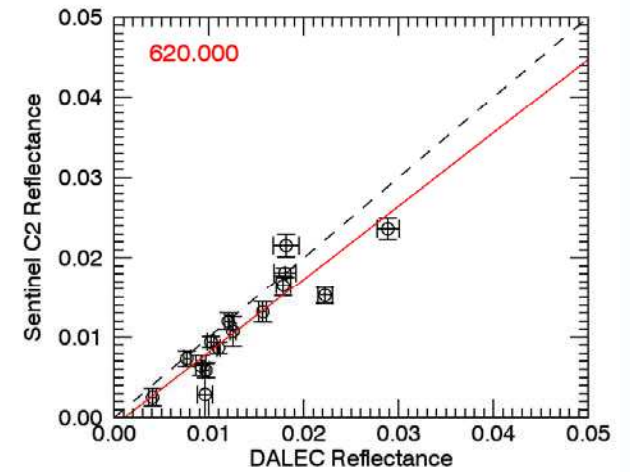
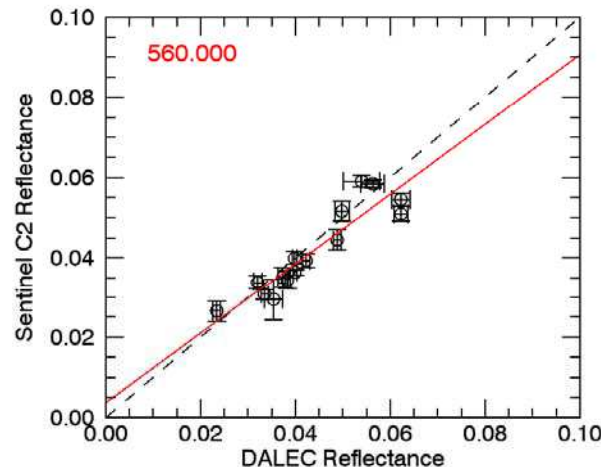
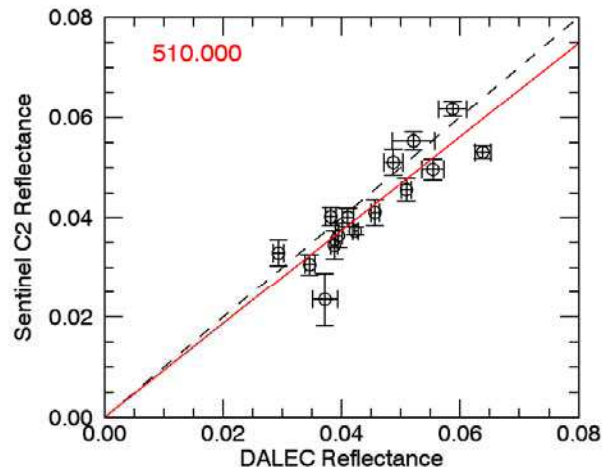
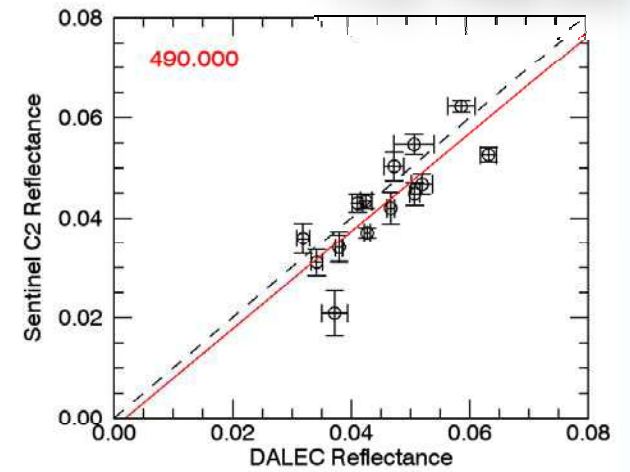
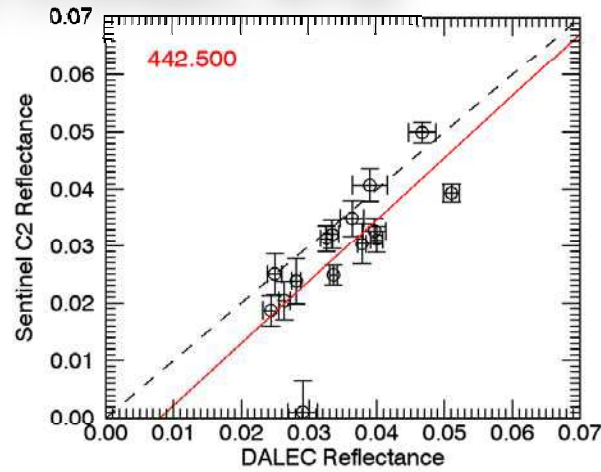
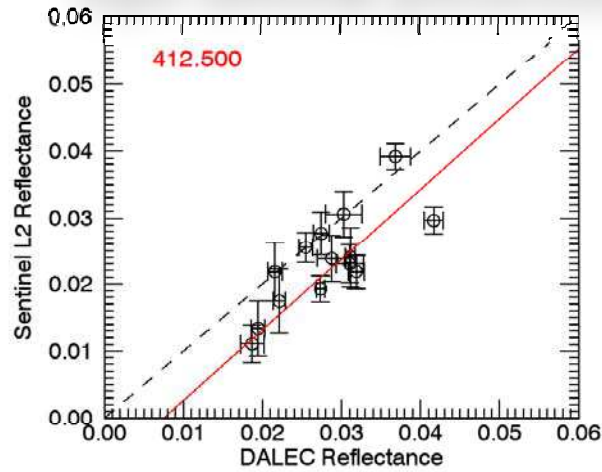
Spectral range [412.5 – 885 nm], Period 26 May – 09 Dec 2016

# AC\_FAIL flag seems to reject good quality spectra



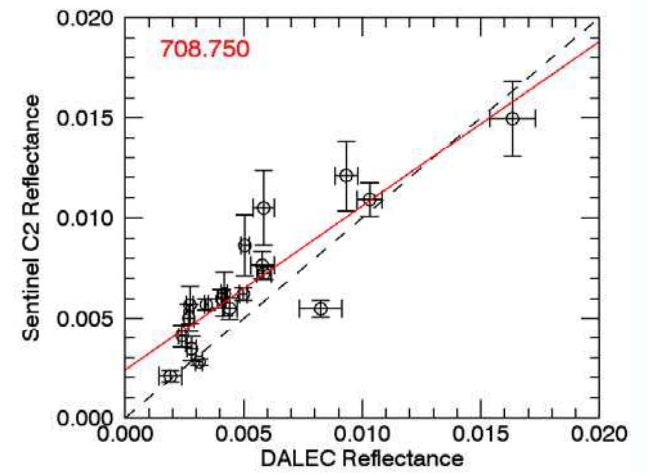
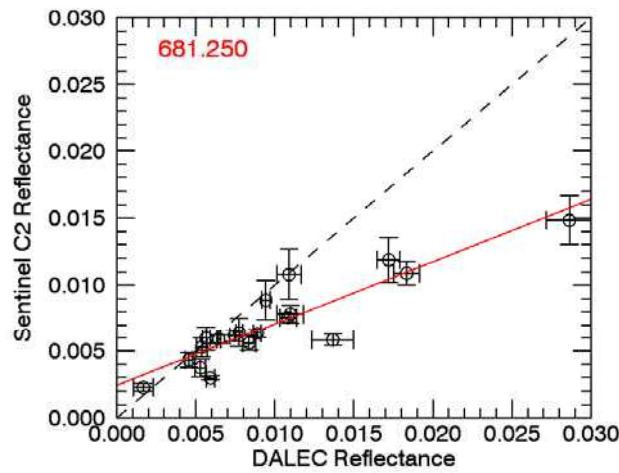
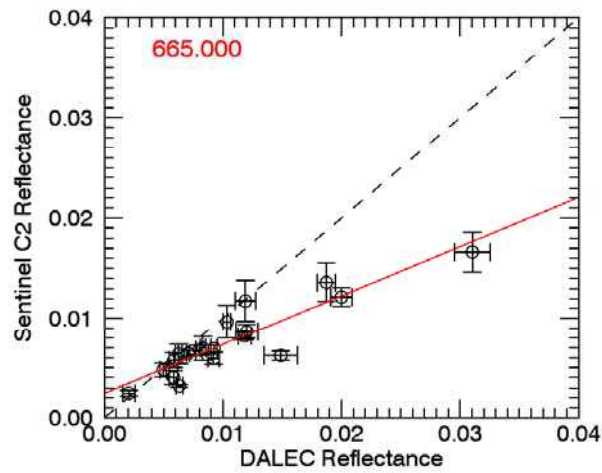
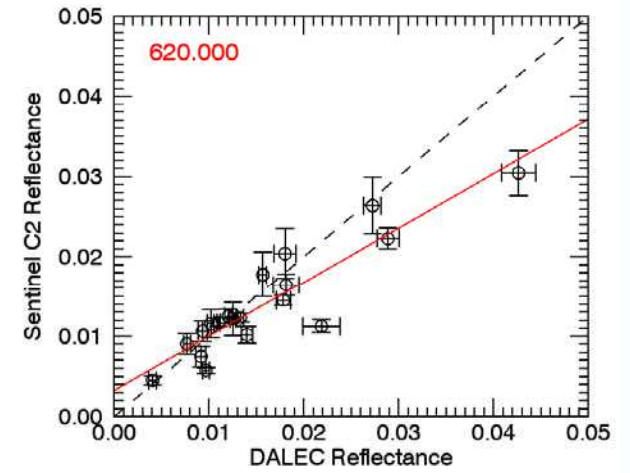
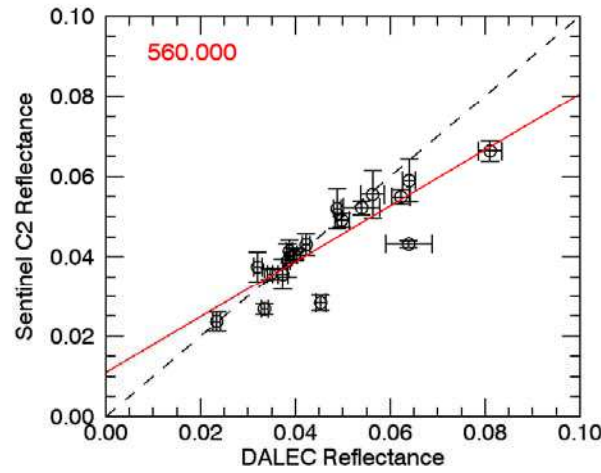
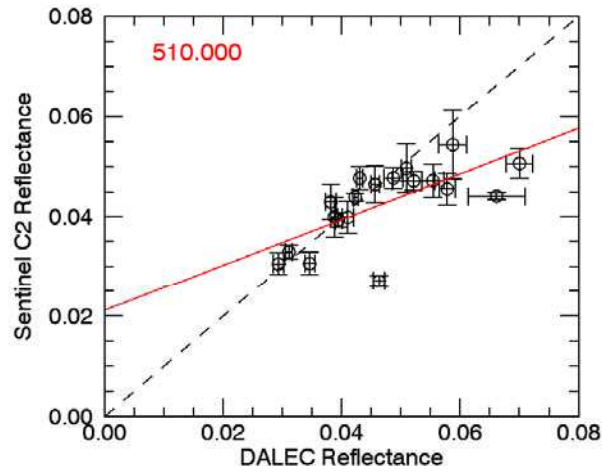
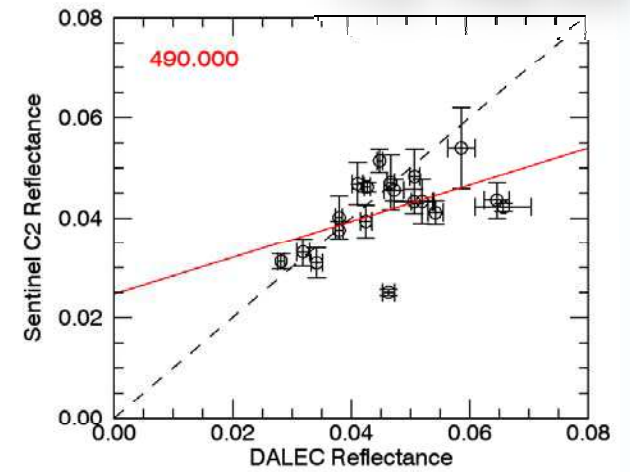
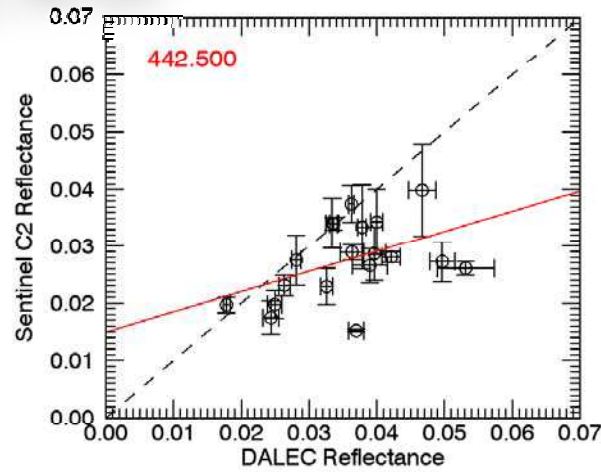
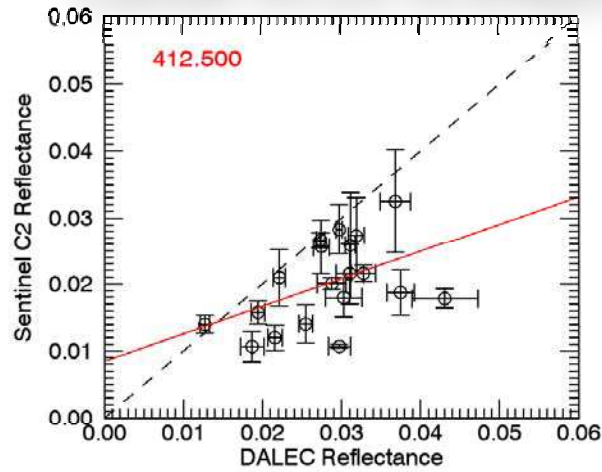
# Operational processor vs DALEC, N=15

412-708 nm



# C2CCR v0.15 vs DALEC, N=19

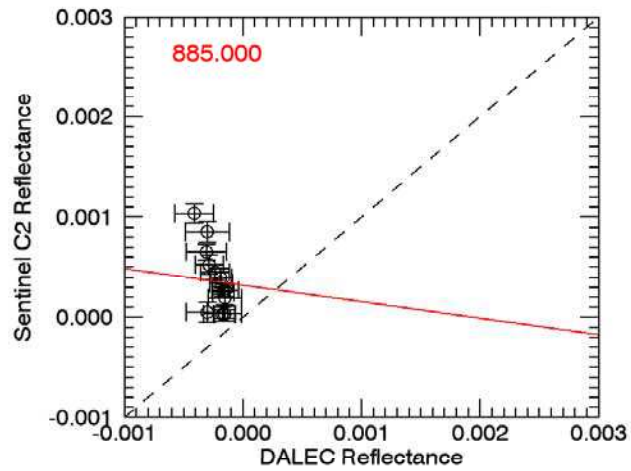
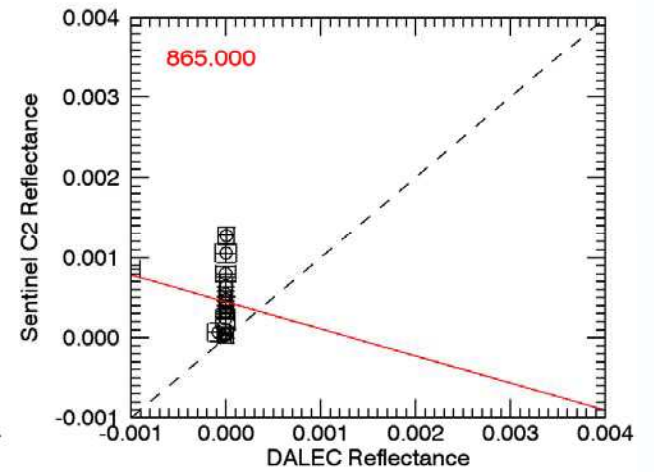
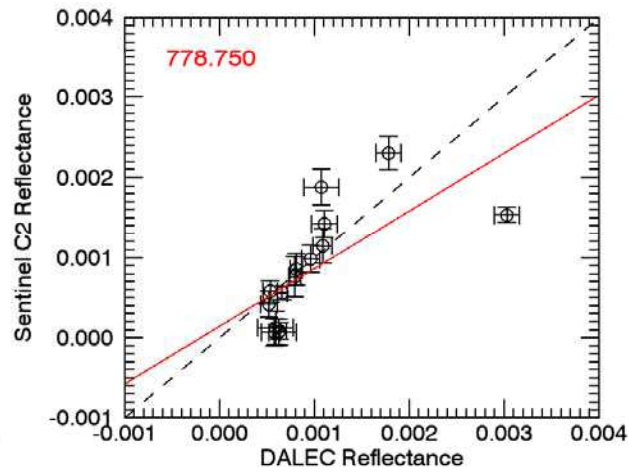
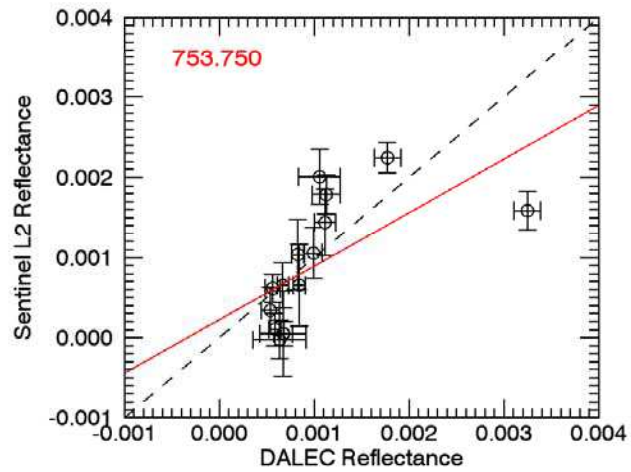
412-708 nm





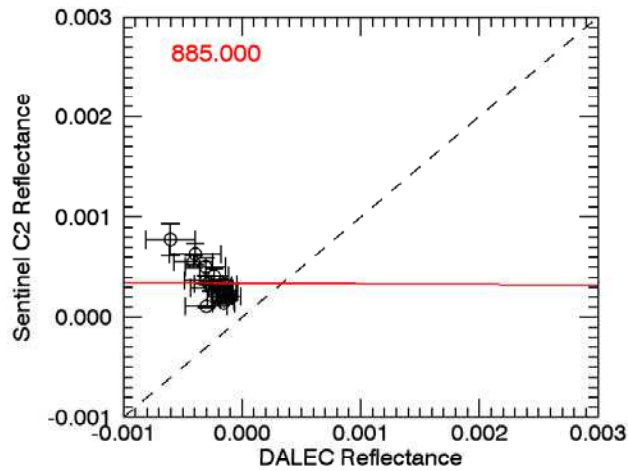
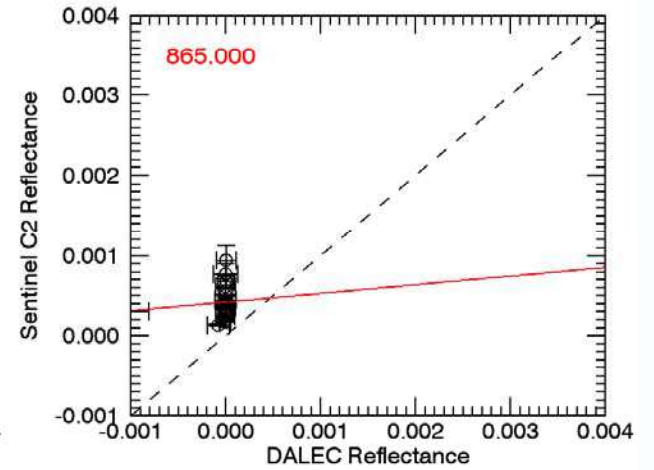
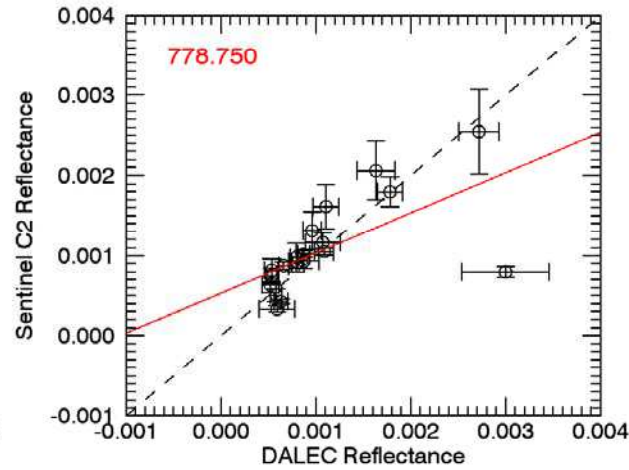
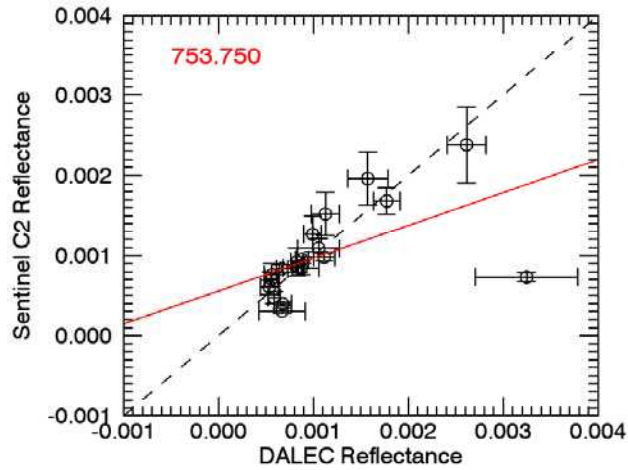
# Operational processor vs DALEC, N=15

753-885 nm



# C2RCC v0.15 vs DALEC, N=19

# 753-885 nm



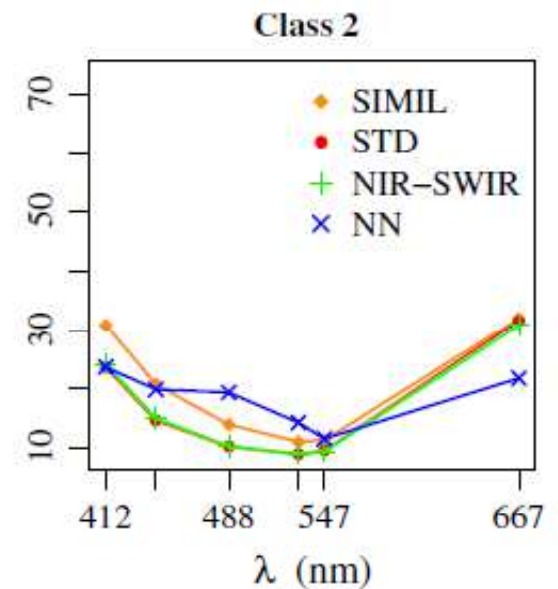
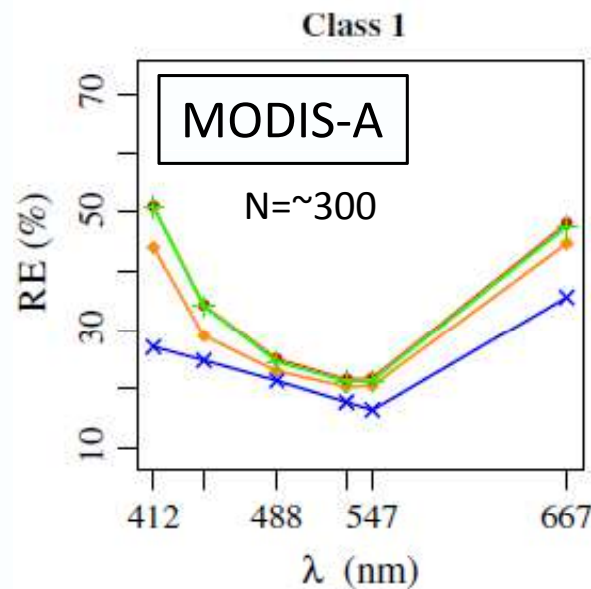
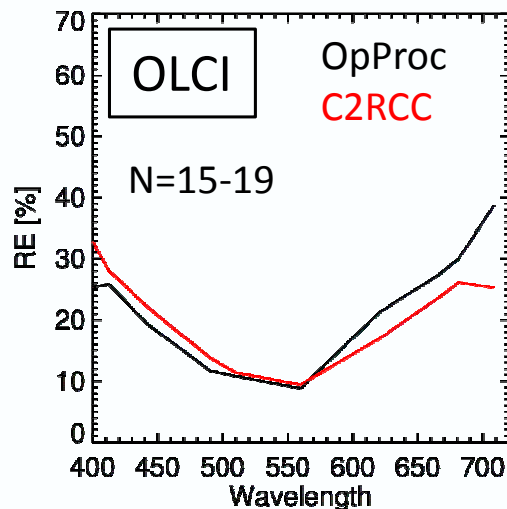
# Radiometric match-ups OLCI vs DALEC

Operational Processor (N=15)

OLCI	DALEC	R2	MAPE	RMSE	BIAS
400.00	405.00	0.372	25.4	0.0100	-0.0039
412.50	412.50	0.413	25.8	0.0108	-0.0064
442.50	442.50	0.560	19.3	0.0099	-0.0058
490.00	490.00	0.690	11.7	0.0068	-0.0028
510.00	510.00	0.757	10.8	0.0062	-0.0029
560.00	560.00	0.851	8.8	0.0051	-0.0020
620.00	620.00	0.827	21.2	0.0037	-0.0022
665.00	665.00	0.822	27.2	0.0028	-0.0018
681.25	681.25	0.920	30.0	0.0027	-0.0017
708.75	708.75	0.942	38.7	0.0018	-0.0013
753.75	753.75	0.668	48.7	0.0007	-0.0001
778.75	761.25	0.720	39.1	0.0006	-0.0001

C2RCC v0.15 Processor (N=19)

OLCI	DALEC	R2	MAPE	RMSE	BIAS
400.00	405.00	0.210	32.8	0.0115	-0.0088
412.50	412.50	0.217	28.0	0.0113	-0.0082
442.50	442.50	0.215	22.1	0.0122	-0.0082
490.00	490.00	0.253	13.8	0.0106	-0.0046
510.00	510.00	0.463	11.4	0.0100	-0.0044
560.00	560.00	0.747	9.4	0.0081	-0.0032
620.00	620.00	0.822	16.9	0.0047	-0.0019
665.00	665.00	0.813	23.5	0.0050	-0.0030
681.25	681.25	0.814	26.1	0.0048	-0.0030
708.75	708.75	0.786	25.3	0.0025	-0.0015
753.75	753.75	0.307	22.7	0.0007	-0.0001
778.75	778.75	0.394	26.2	0.0006	0.0000

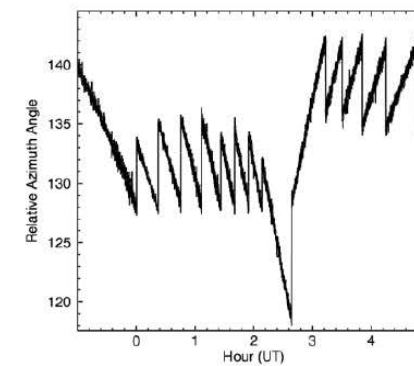
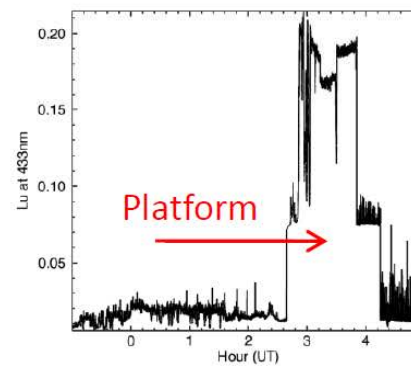
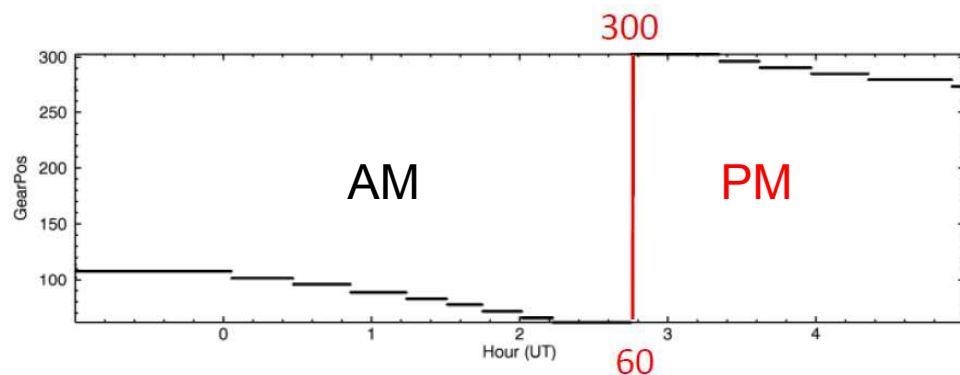
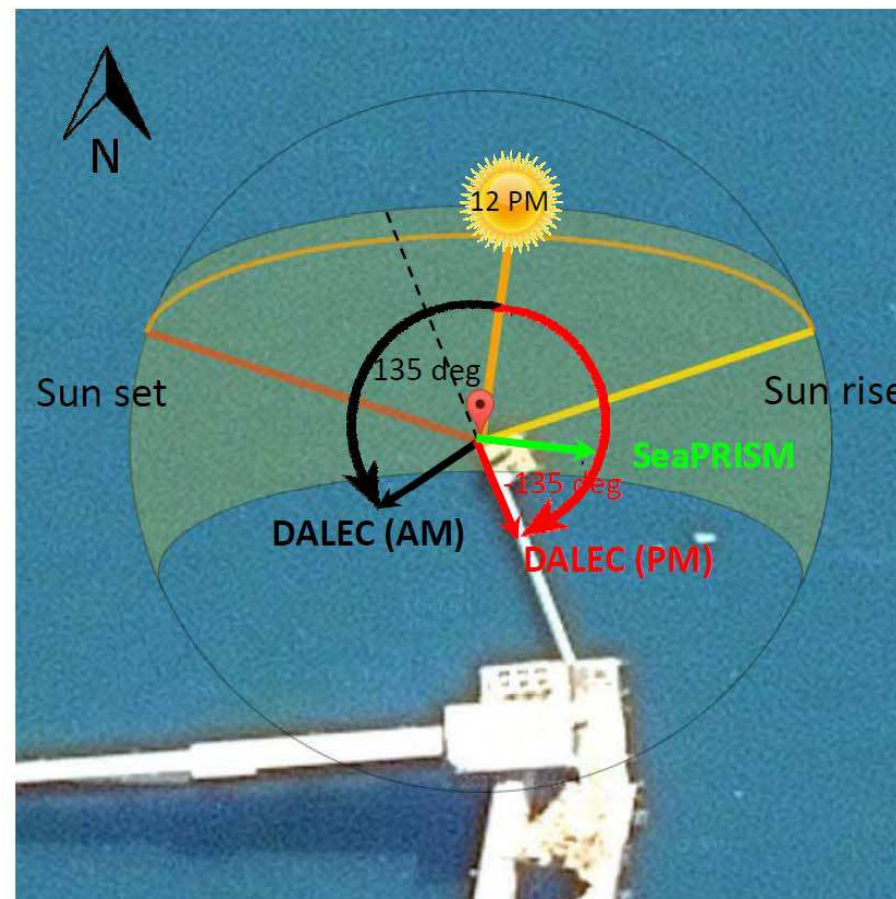
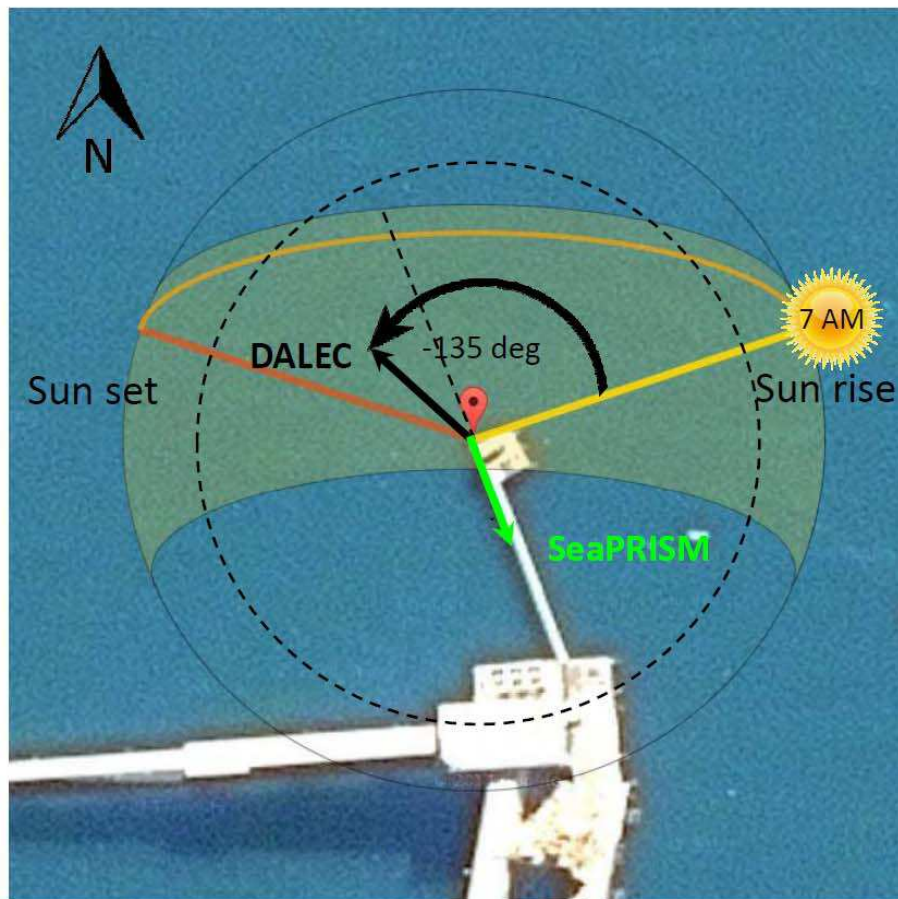


To be done: Use AERONET-OC SeaPRISM ...

(Goyens et al. RSE 2013)

# Why no SeaPRISM match-ups for OLCCI?

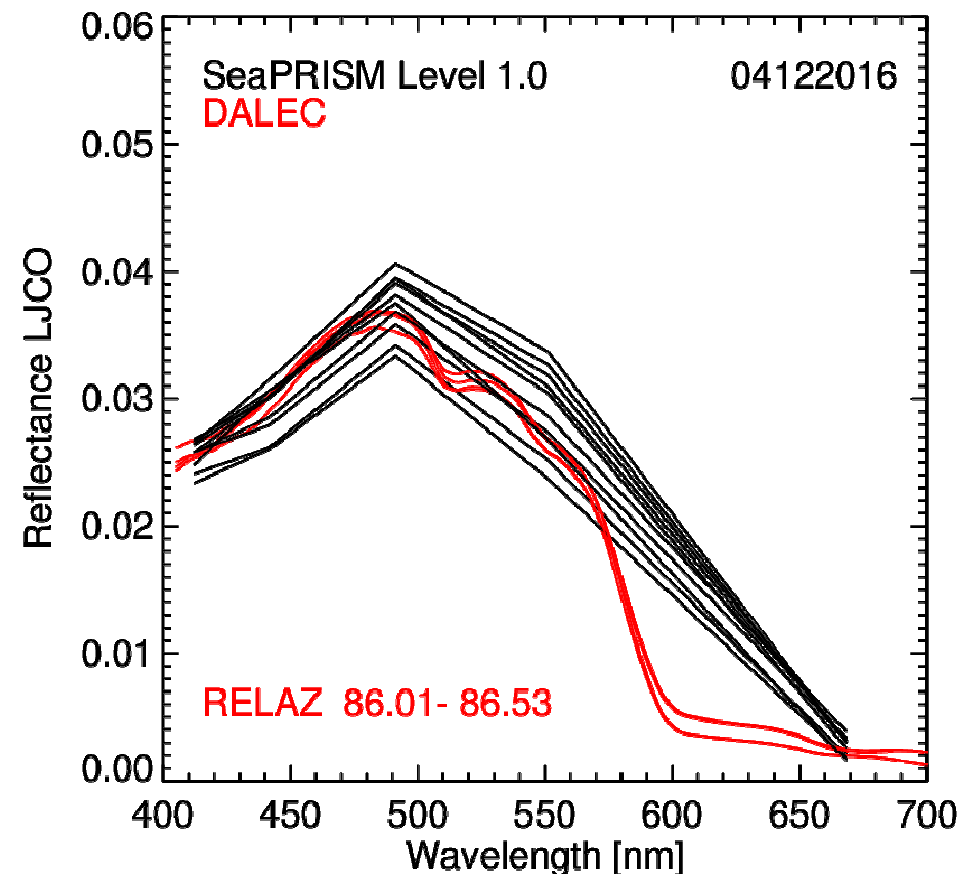
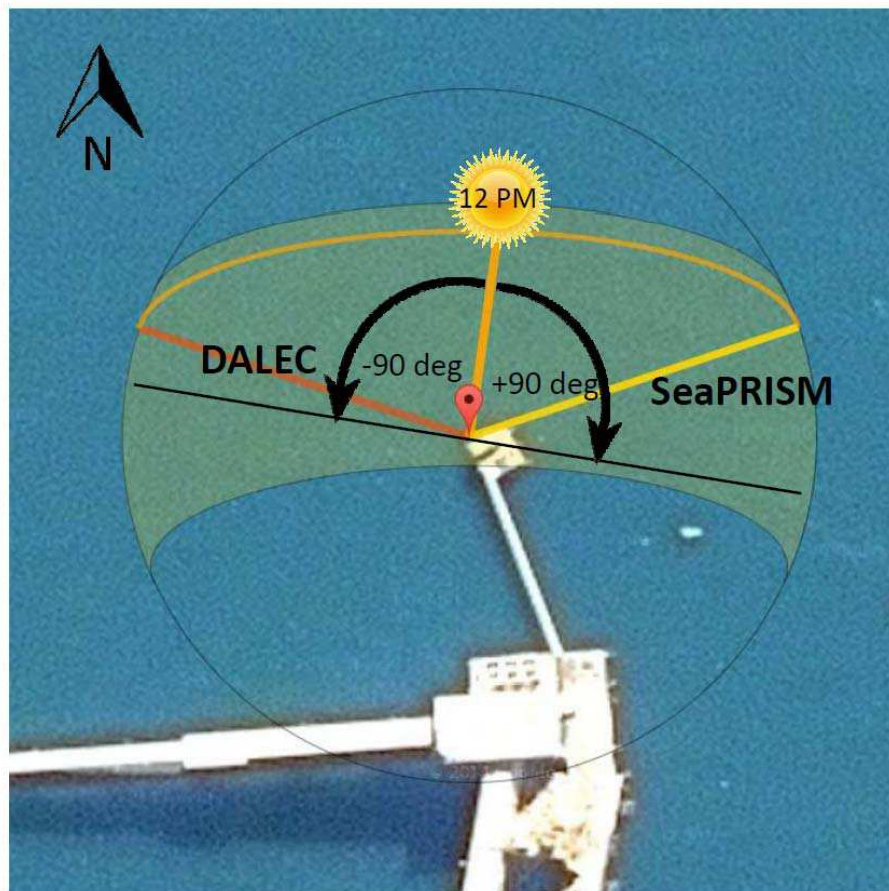
Observing and site geometry limitations – JRC data QA/QC



# Aligning observing geometries

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

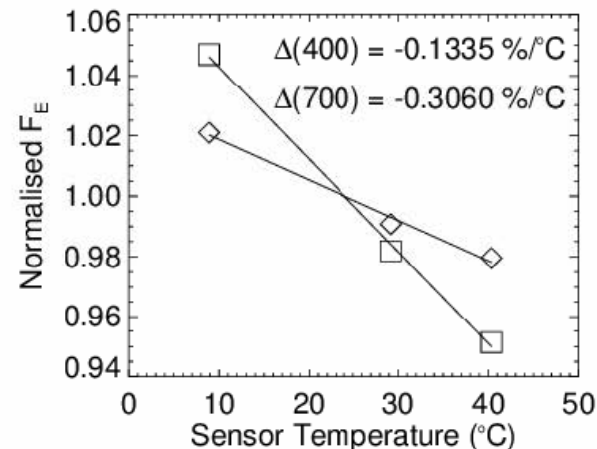
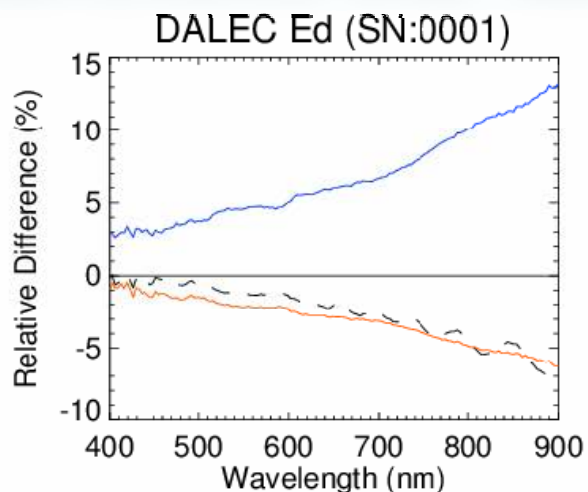
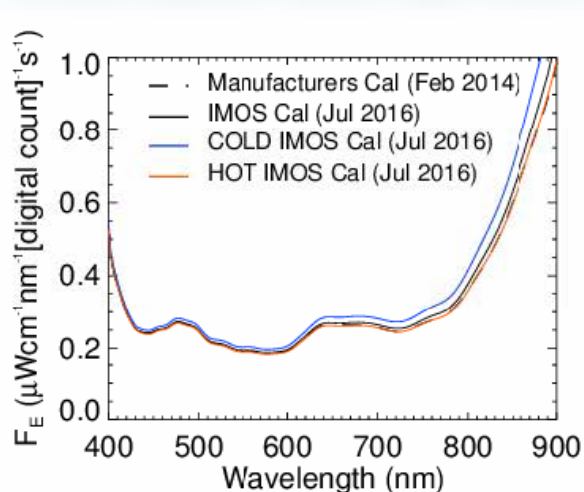
Example 4 Dec 2016



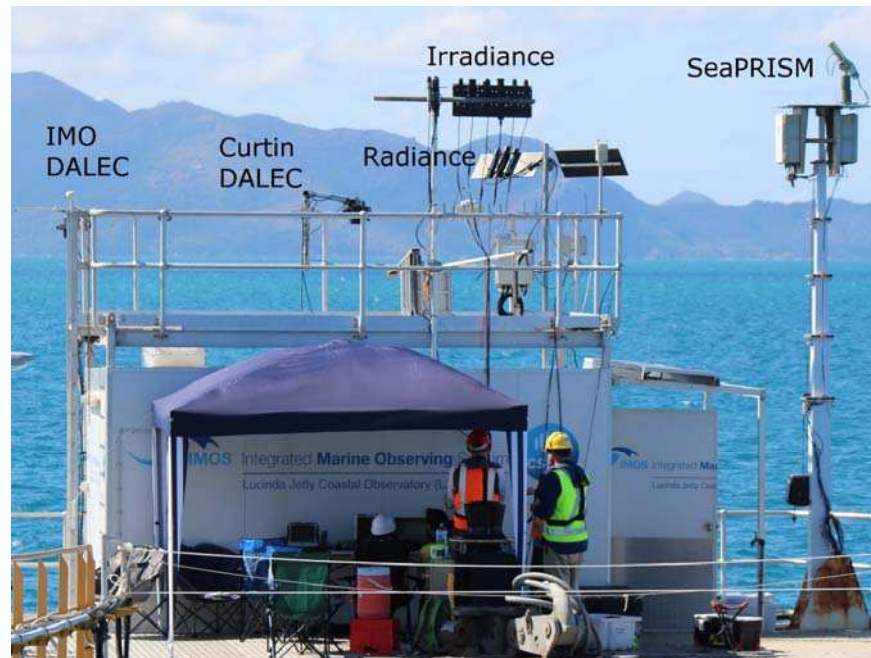
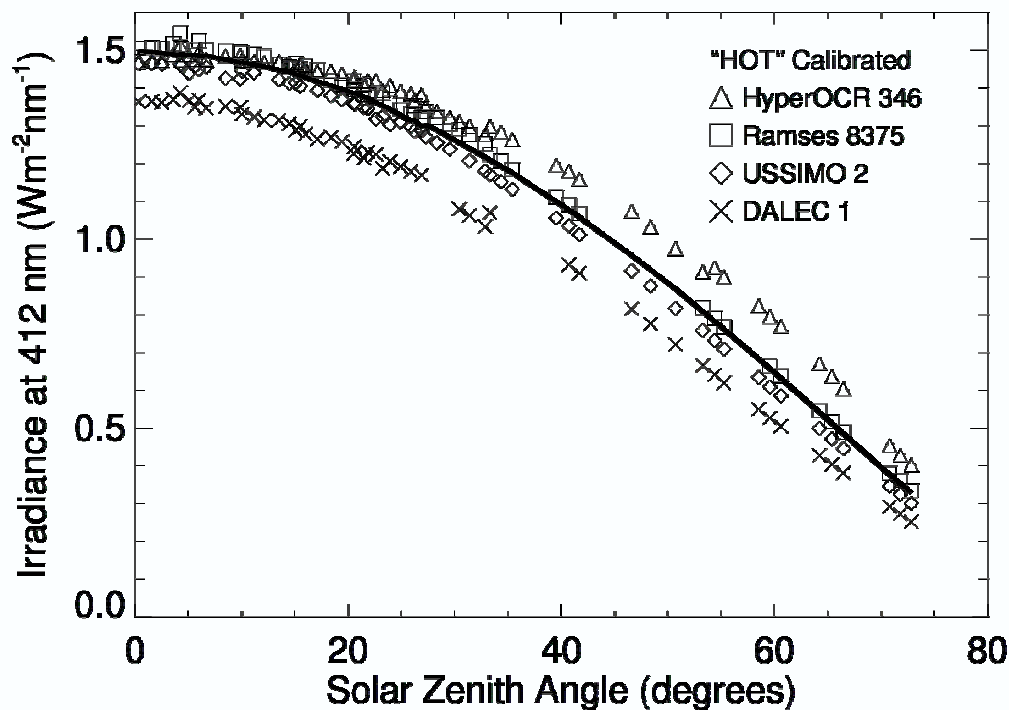
- DALEC and SeaPRISM radiometry now in good agreement
- More detailed quantitative analysis under RTT based on Level 2 data (not available yet)
- Working with In-situ Marine Optics on improving DALEC stability and remote operations
- DALEC required to capture AM satellite passes (Sentinel-3A)

# Improving consistency of radiometric measurements

IMOS Radiometry Task Team (Antoine, Schroeder et al.) – FRM4SOC presentation next week



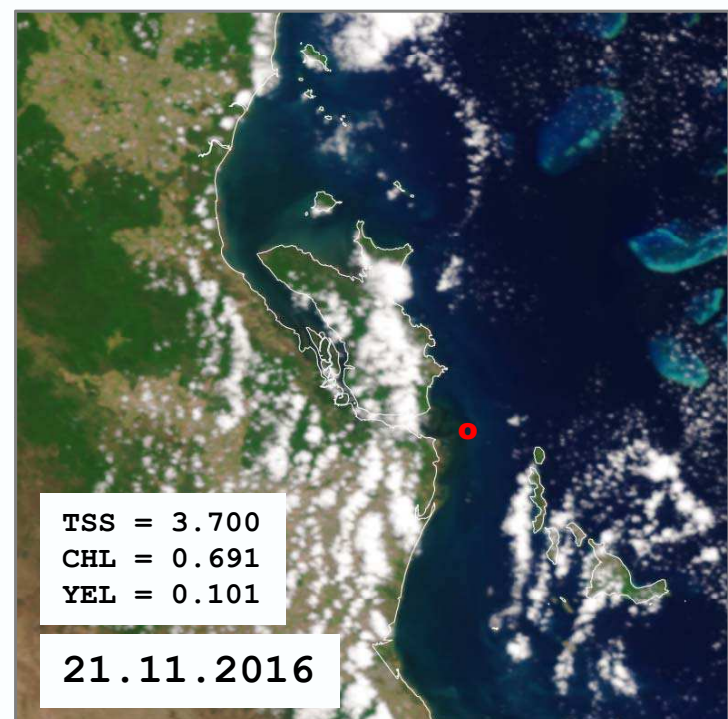
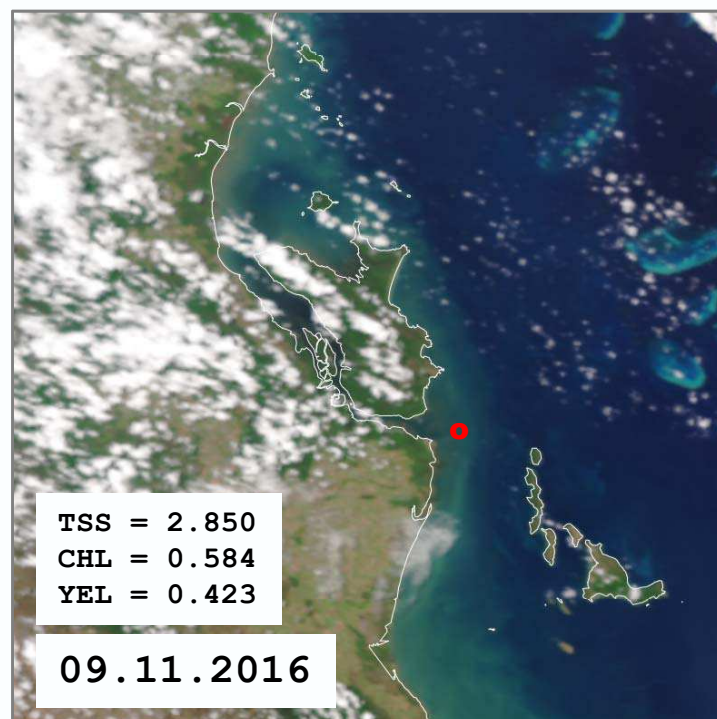
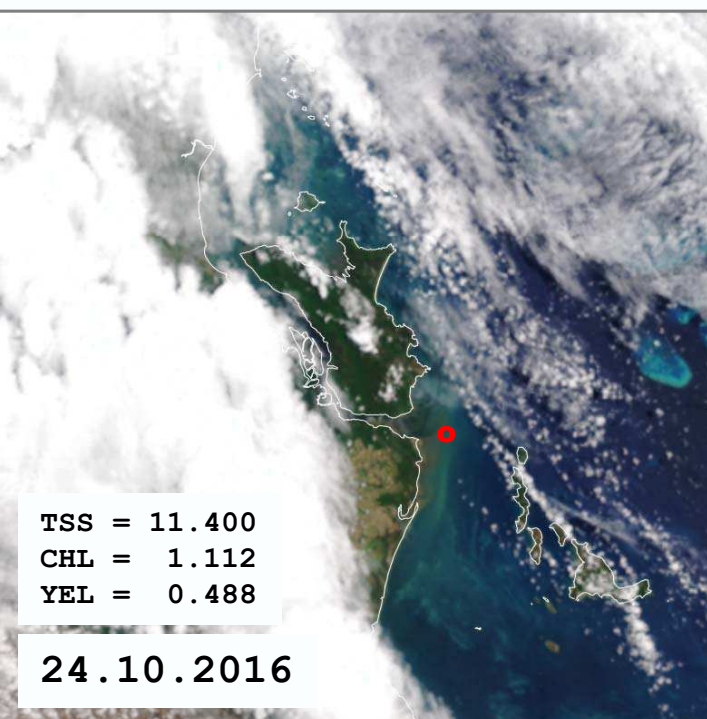
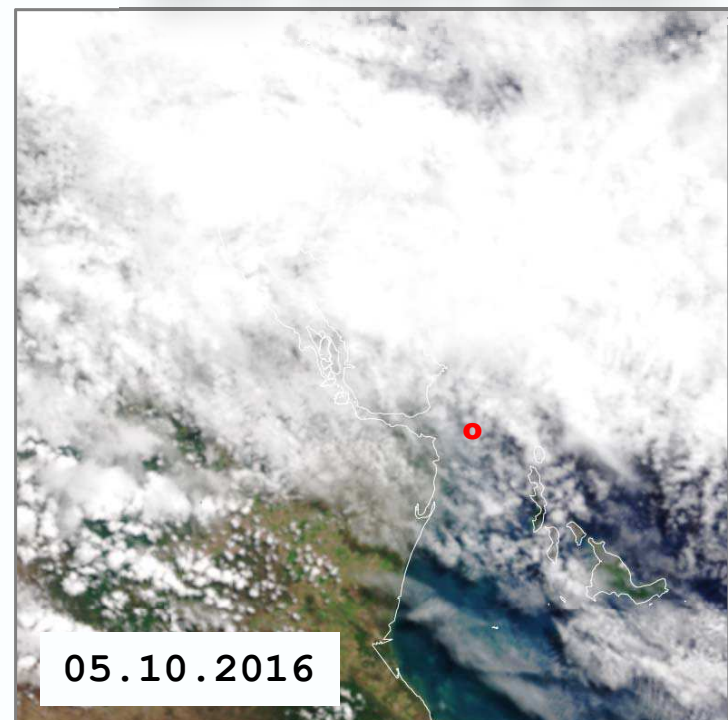
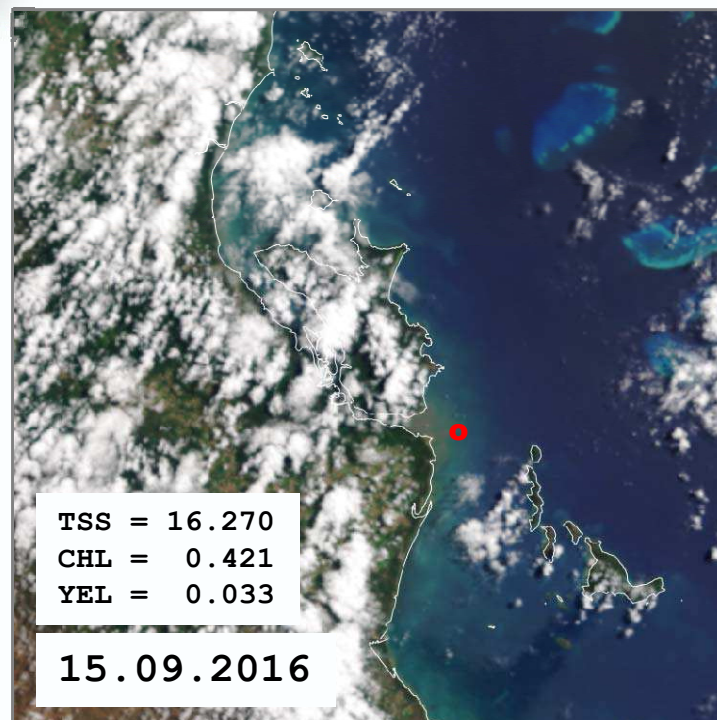
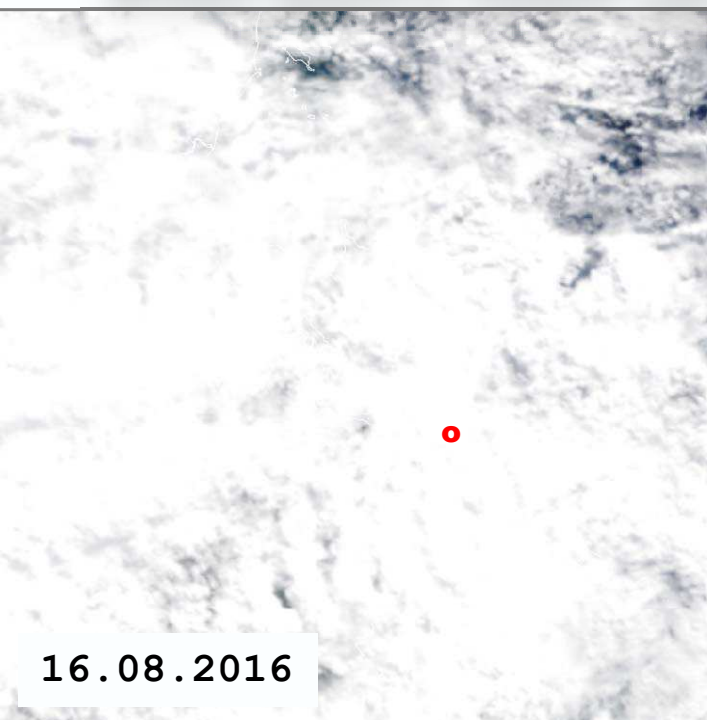
Spectral approach for temperature correction of cal. coeff. should be investigated



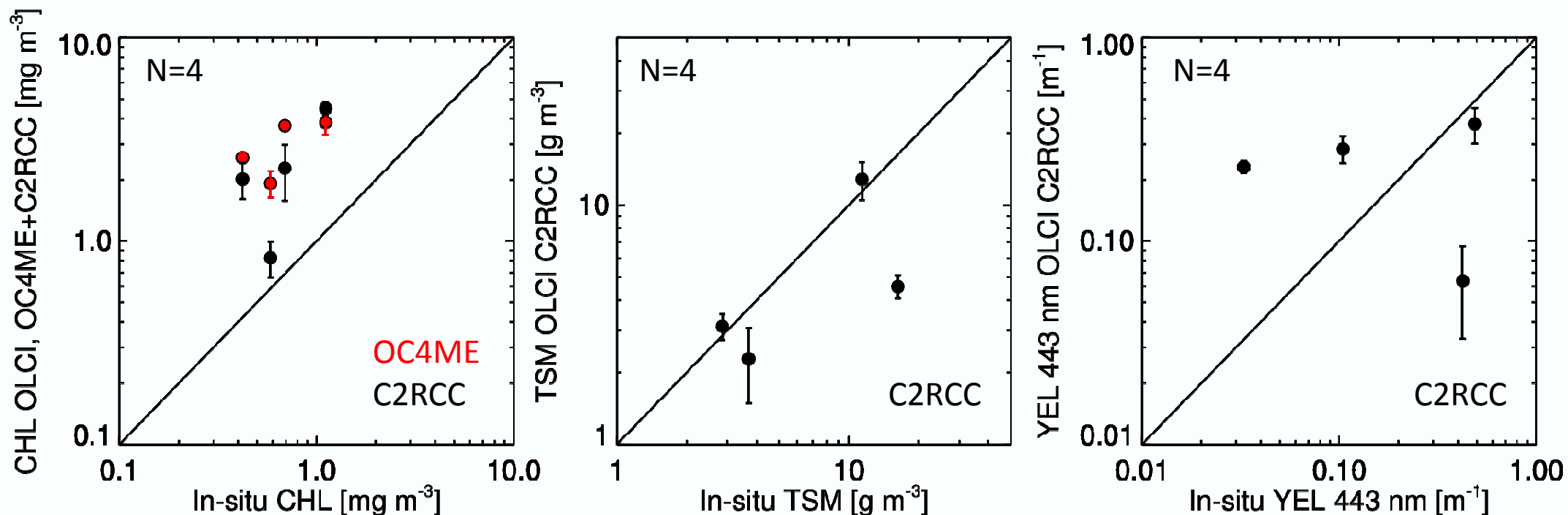
(Analysis: Slivkoff M., Klonowski W.)

# Water quality match-ups

LJCO 18.5197 E 146.3858 S



Local dates UTC+10, YEL= CDOM absorption at 443 nm

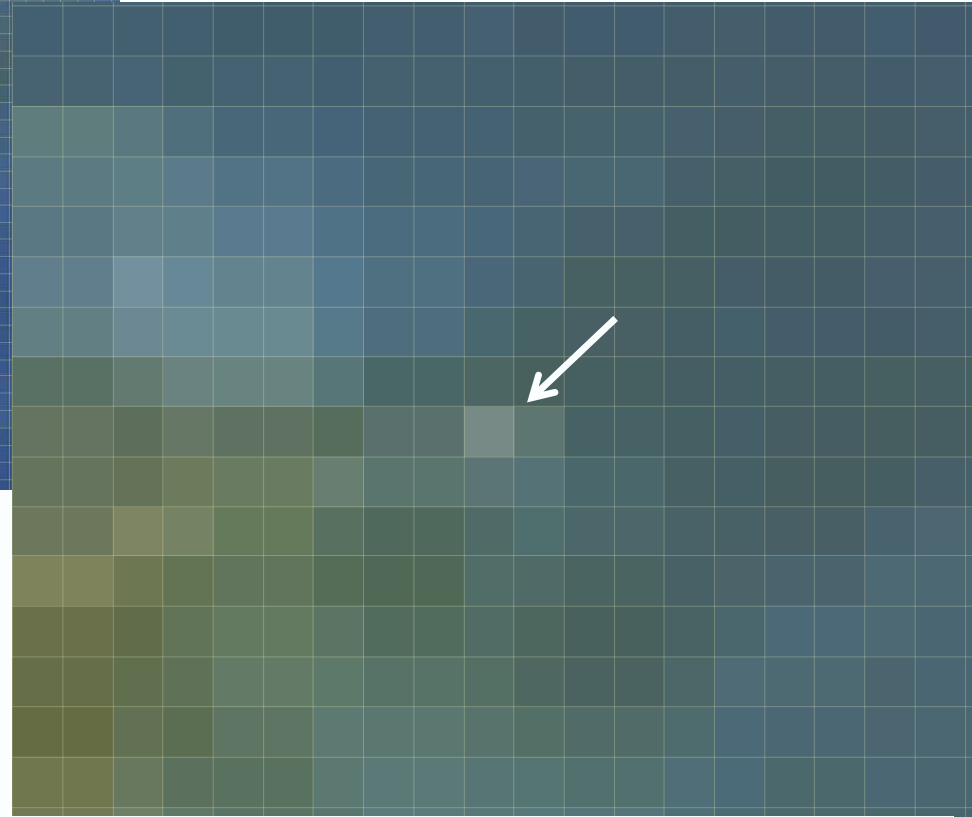
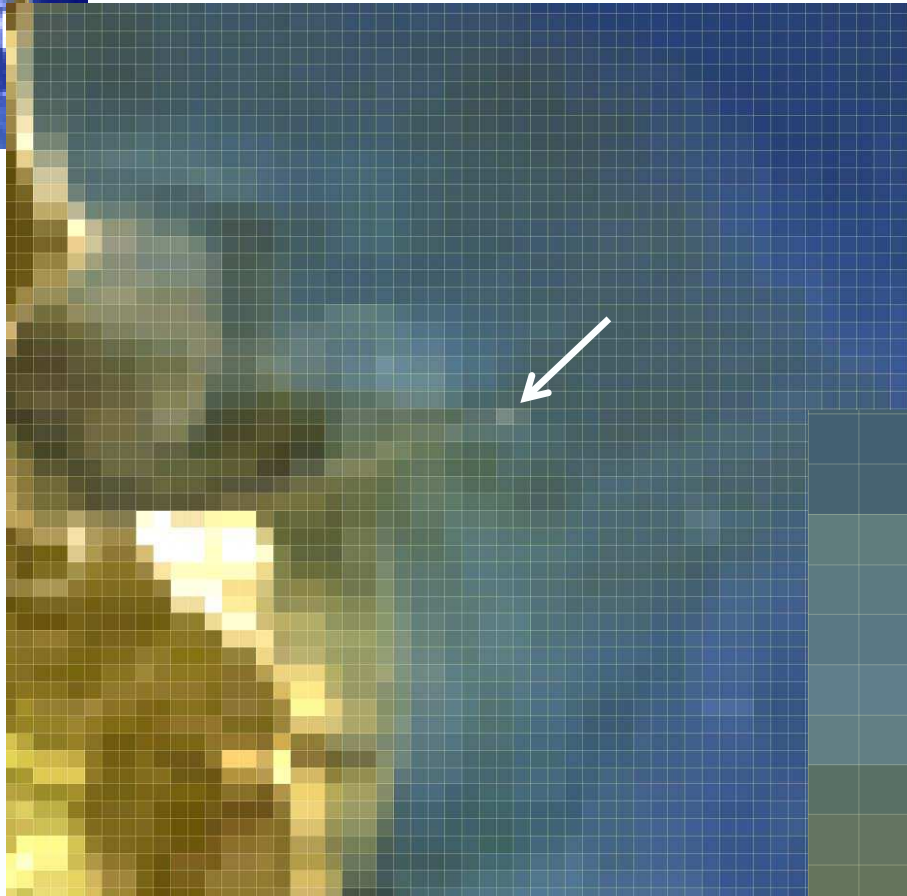
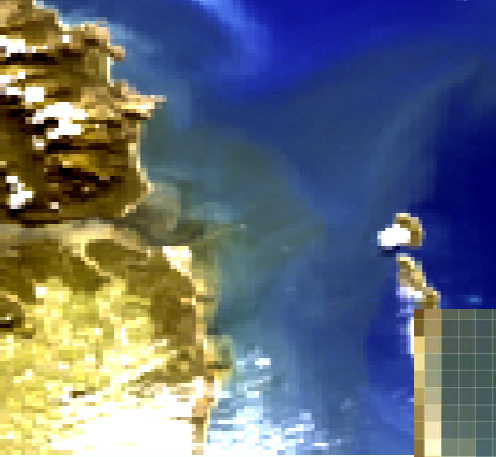


More comprehensive picture once integrated into Mermaid and combined with analysis from other sites



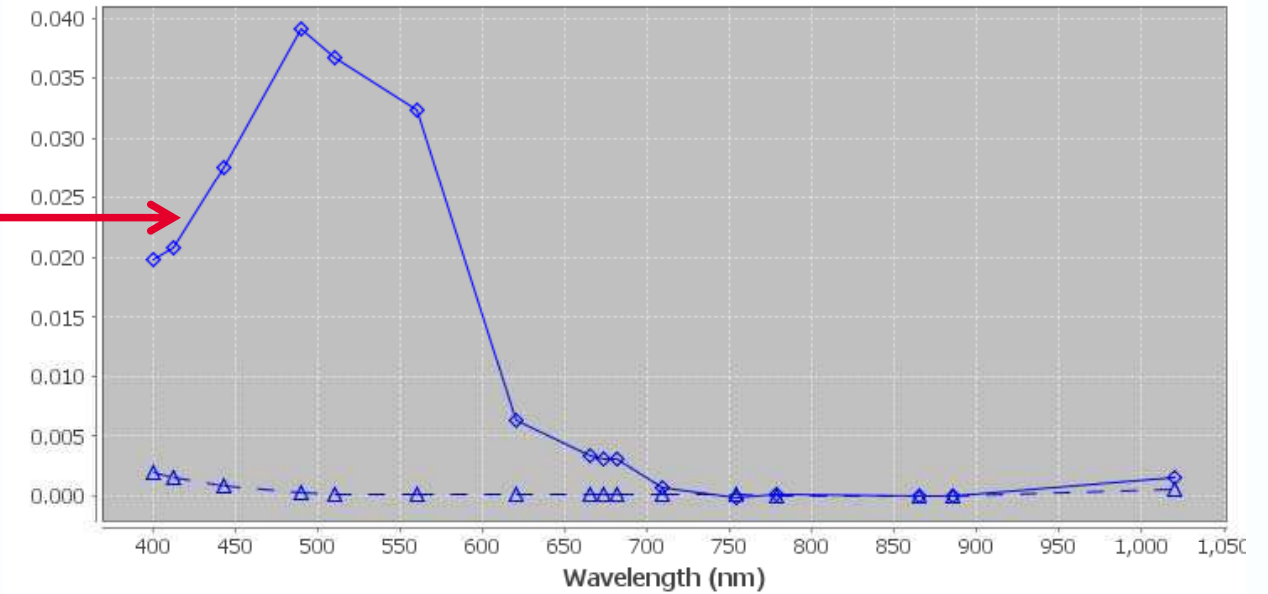
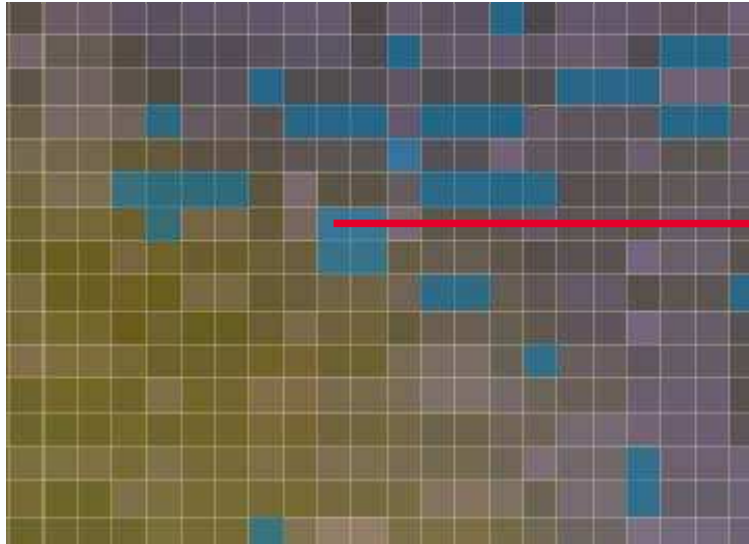
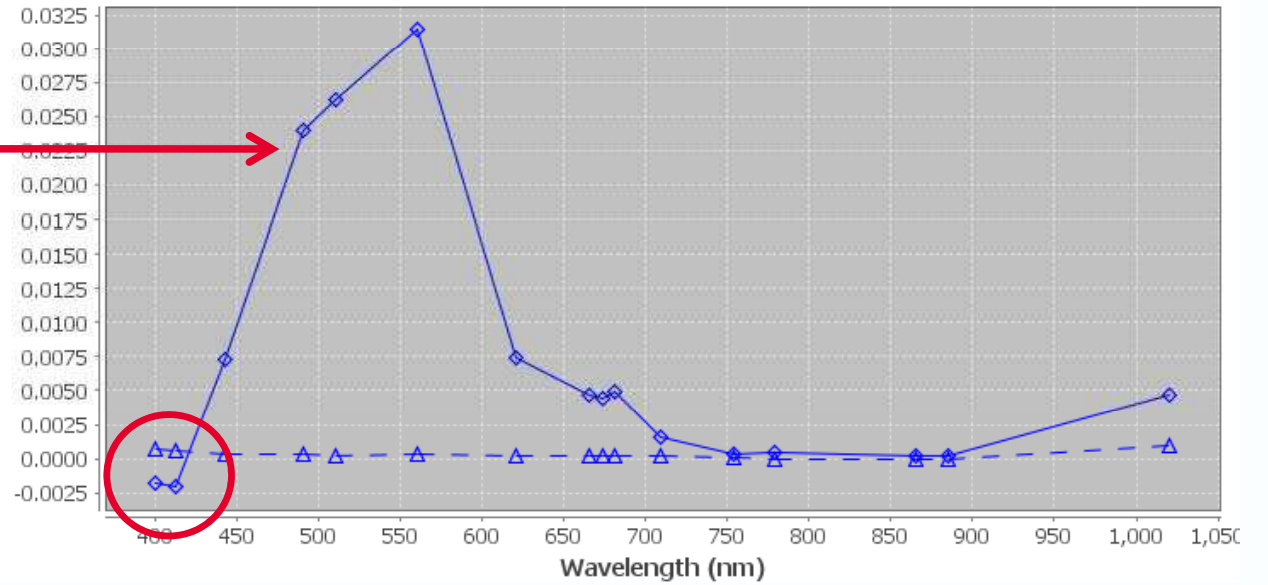
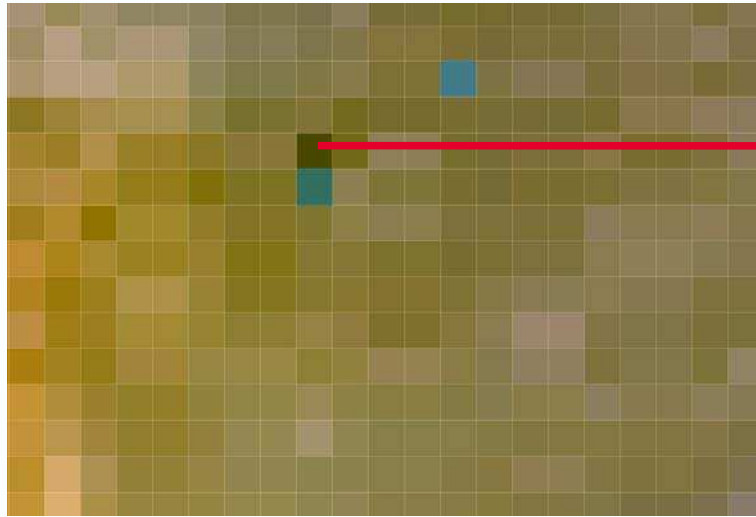
# Site can be seen in the OLCI FR data

Sometimes - Example : 23.07.2016



# RWNEG\_O1 flagging issue

Example LICO : 23.07.2016 (light blue mask)



# Bio-Argo Validation

East Coast of Australia, August 2016 – January 2017

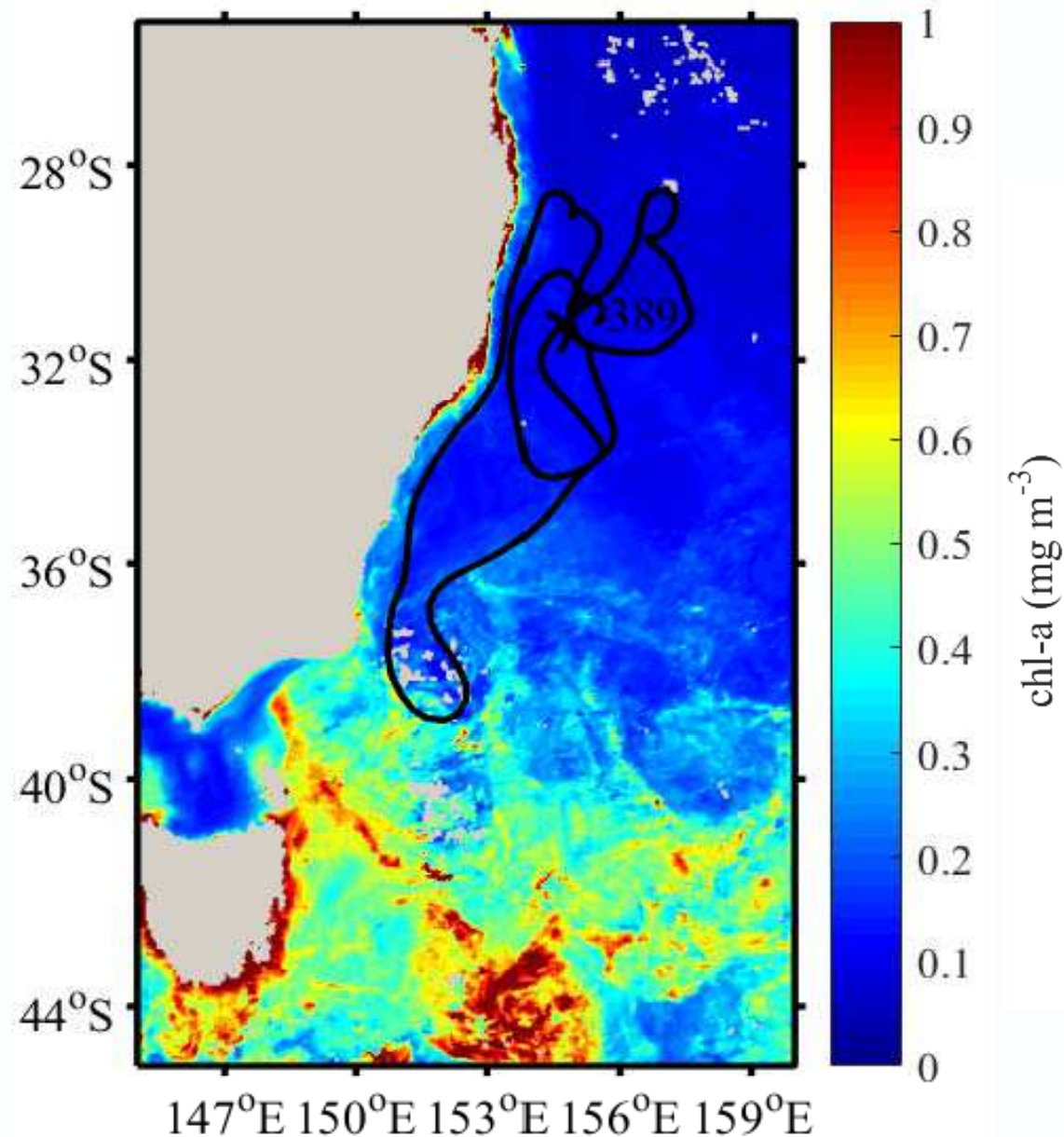


MCOMS

- Chl F1
- CD F1
- BB

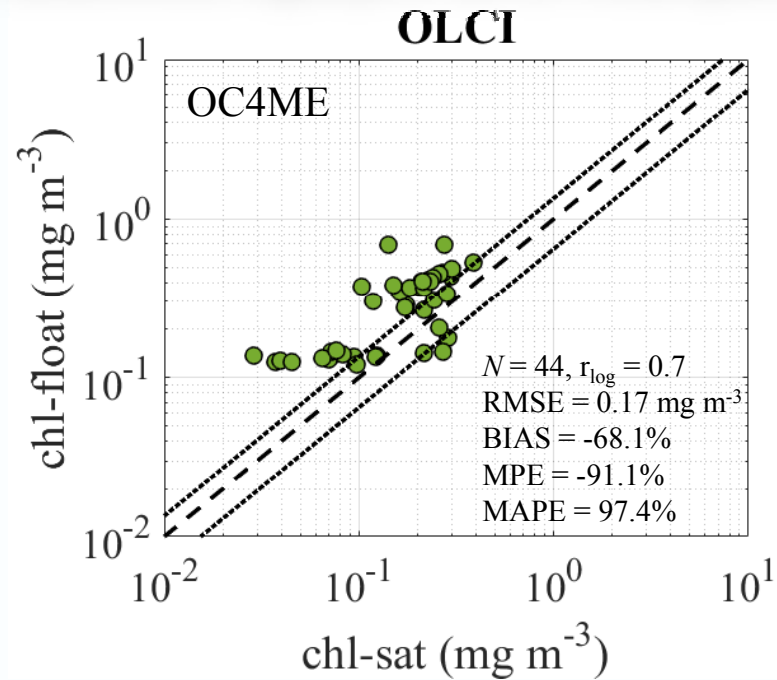
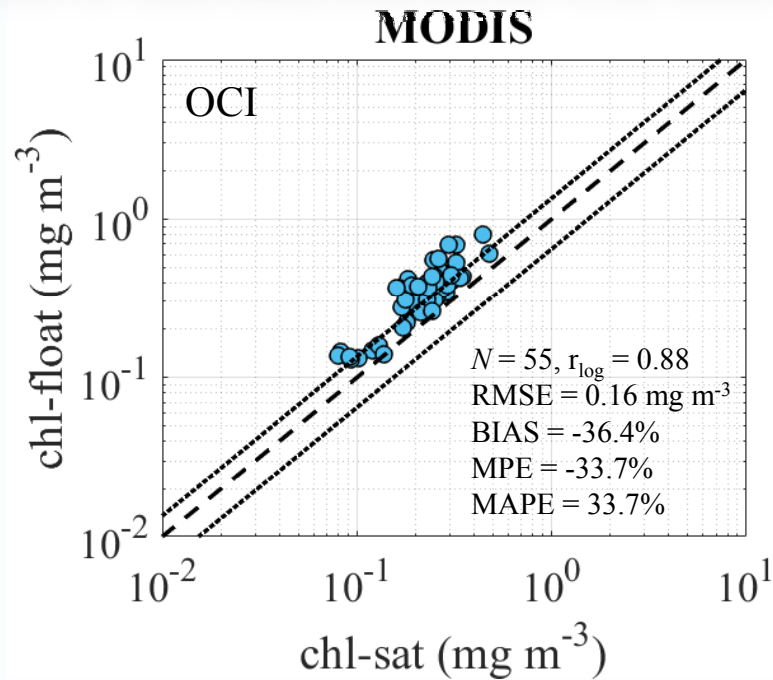
OCR504I/R

- Ed x 4
- Lu x 4



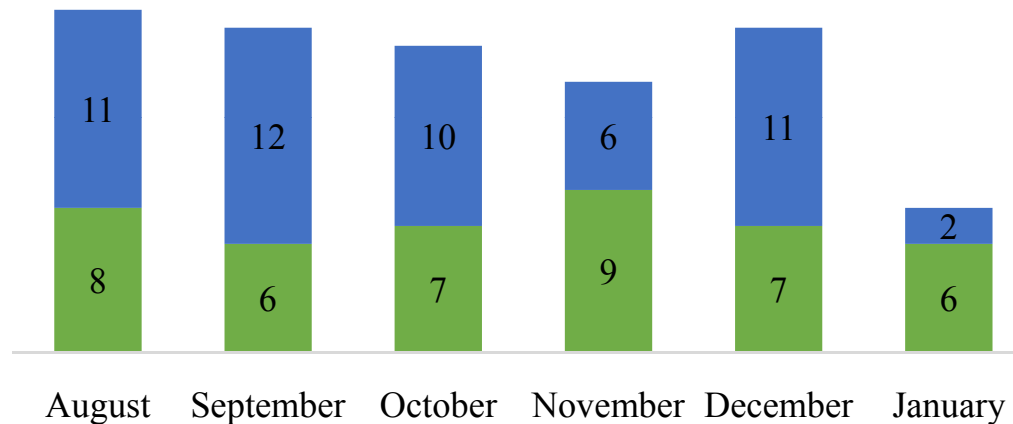
# Bio-Argo Validation

East Coast of Australia, ship-borne HPLC used for calibration, night profiles to avoid quenching



## Bio-Argo vs OLCI in Western Pacific

■ Bio-Argo matchups ■ NaN (clouds, sun glint)



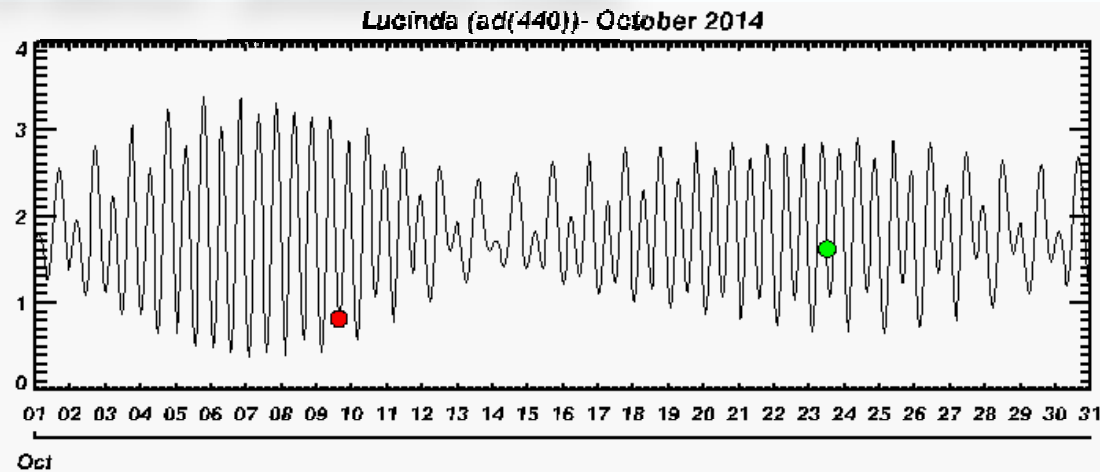
# Acknowledgements (in alphabetical order)

David Antoine  
Vittorio Brando  
Brett Baker  
David Blondeau-Patissier  
David Boadle  
Susan Campbell  
Lesley Clementson  
Nick Hardman Mountford  
Edward King  
Wojciech Klonowski  
Jenny Lovell  
Ross Mitchell  
Yi Qin  
Matthew Slivkoff  
Larissa Valerio  
Monika Woizniak  
Bozena Wojtasiewicz

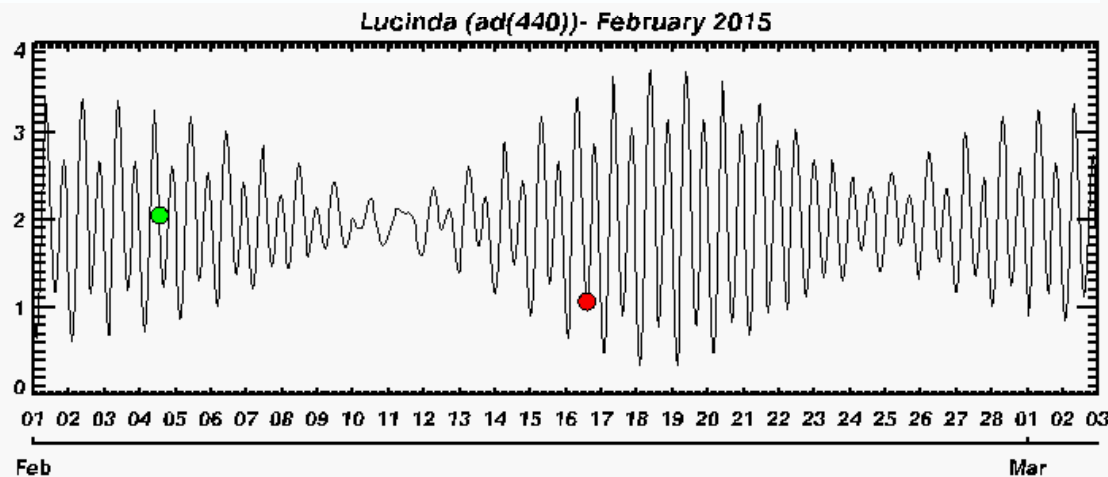
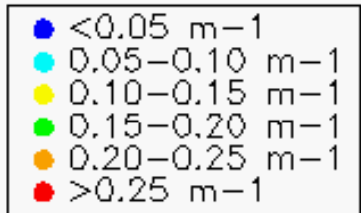
# Extras

# Tidal impact on discrete measurements

Example absorption of detritus – preliminary results




2014



2015

# How to get the data?

In progress



About Browse Order

WQM

- CHLF
- PRES\_REL**
- TURB
- TEMP
- PSAL
- DOX1\_2

555 12

September 2016

Mon	Tue	Wed	Thu	Fri	Sat	Sun
			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		

About Browse Order

Instrument

- ACS
- BB9
- WQM
- HyperOCR
- EcoTriplet

Frequency

- Hourly
- Daily

Date Range

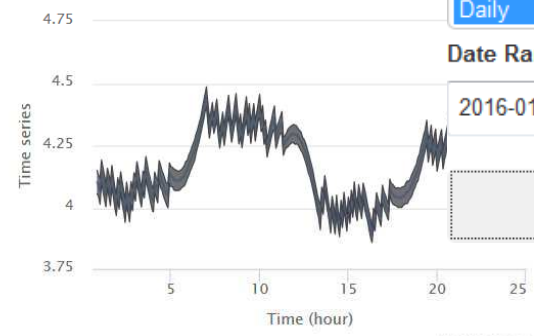
2016-01-01 2016-12-31

Select

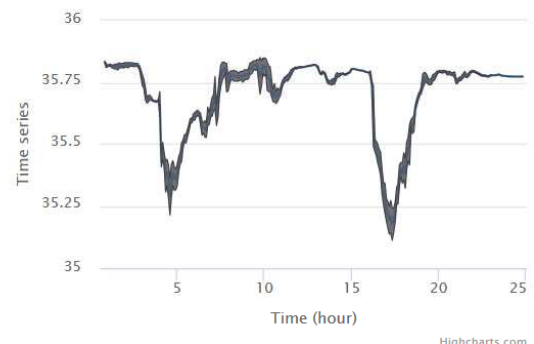
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Plots Selected variables

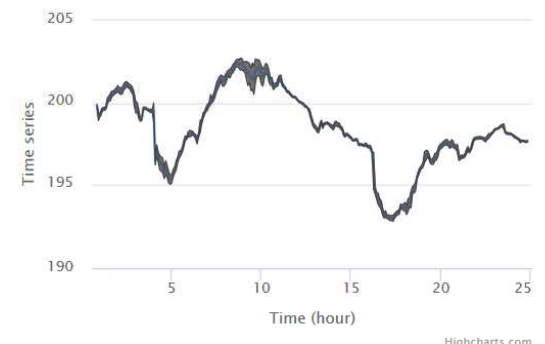
PRES\_REL: Time series



PSAL: Time series



DOX1\_2: Time series



(Analysis: Qin Y.)  
S3 Validation Team Meeting, 15-17 Feb 2017, Frascati, Italy







# FUB-(CSIRO) Processor

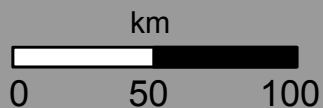
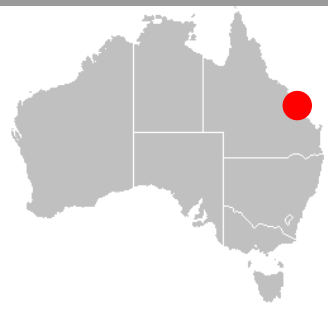
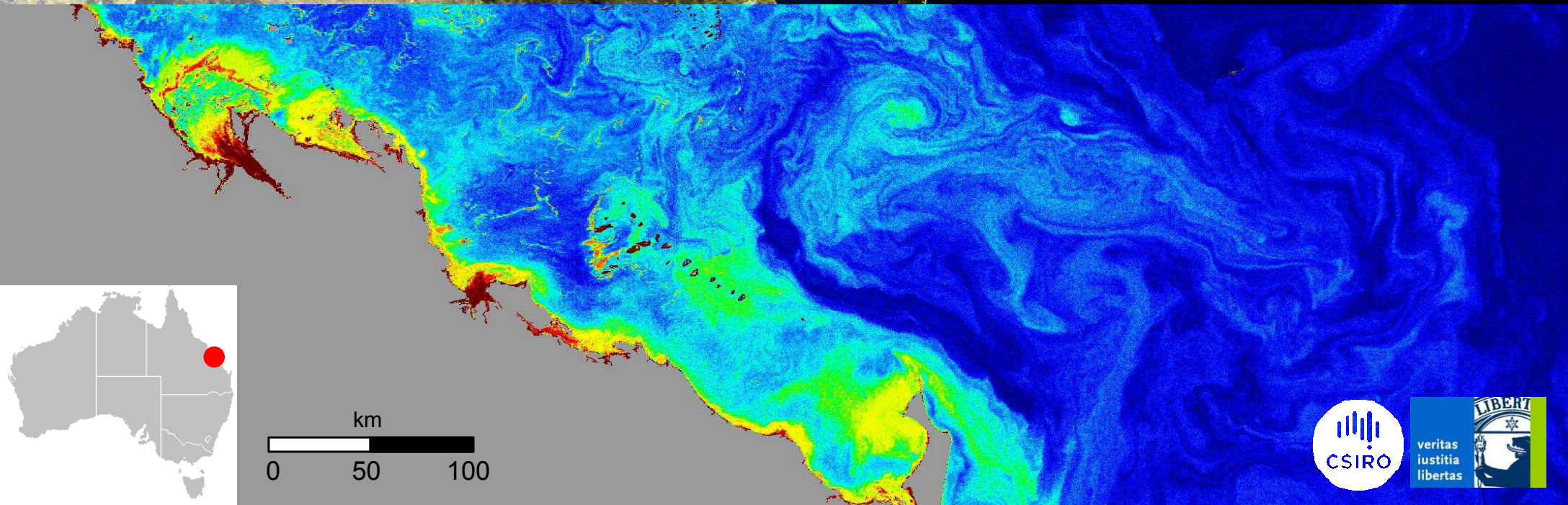
## Chlorophyll-a Great Barrier Reef



S3A\_OL\_1\_EFR\_\_\_\_20160608T231306\_20160608T231357\_20160609T015217\_0050\_005\_101\_3420\_MAR\_O\_NR\_001  
Level 1b NRT ANN input constant wind speed 3 ms<sup>-1</sup>  
IPF-OL-1-EO version 05.03.12

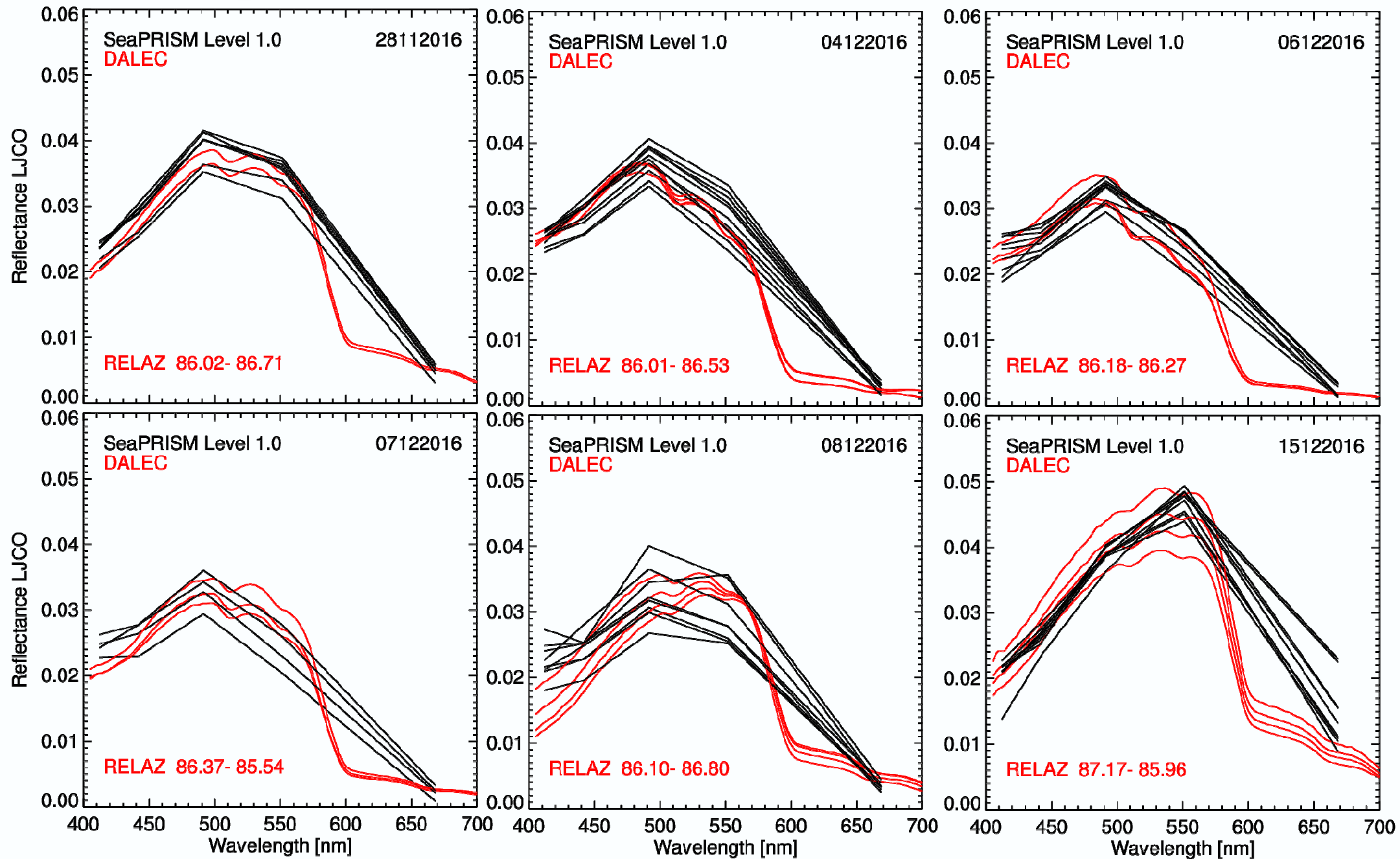


8 June 2016



# Inter-comparison SeaPRISM and DALEC

Preliminary based on AERONET-OC Level 1.0

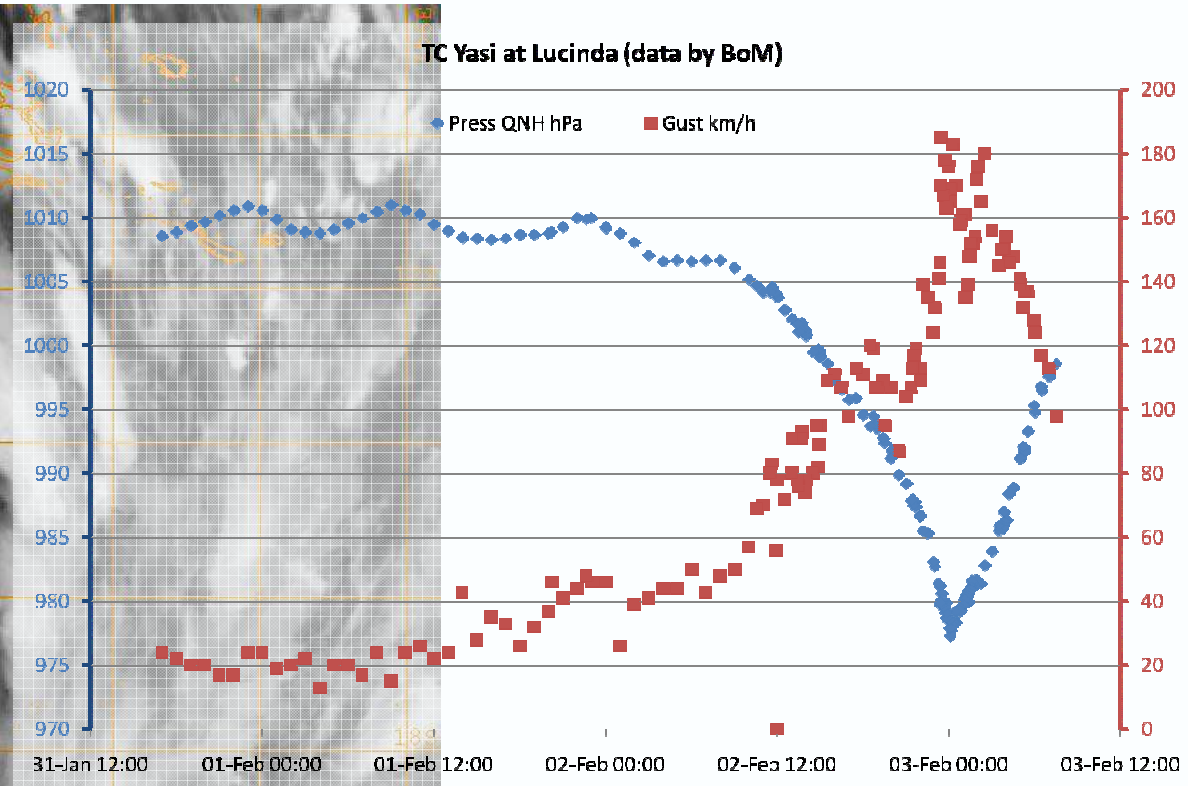
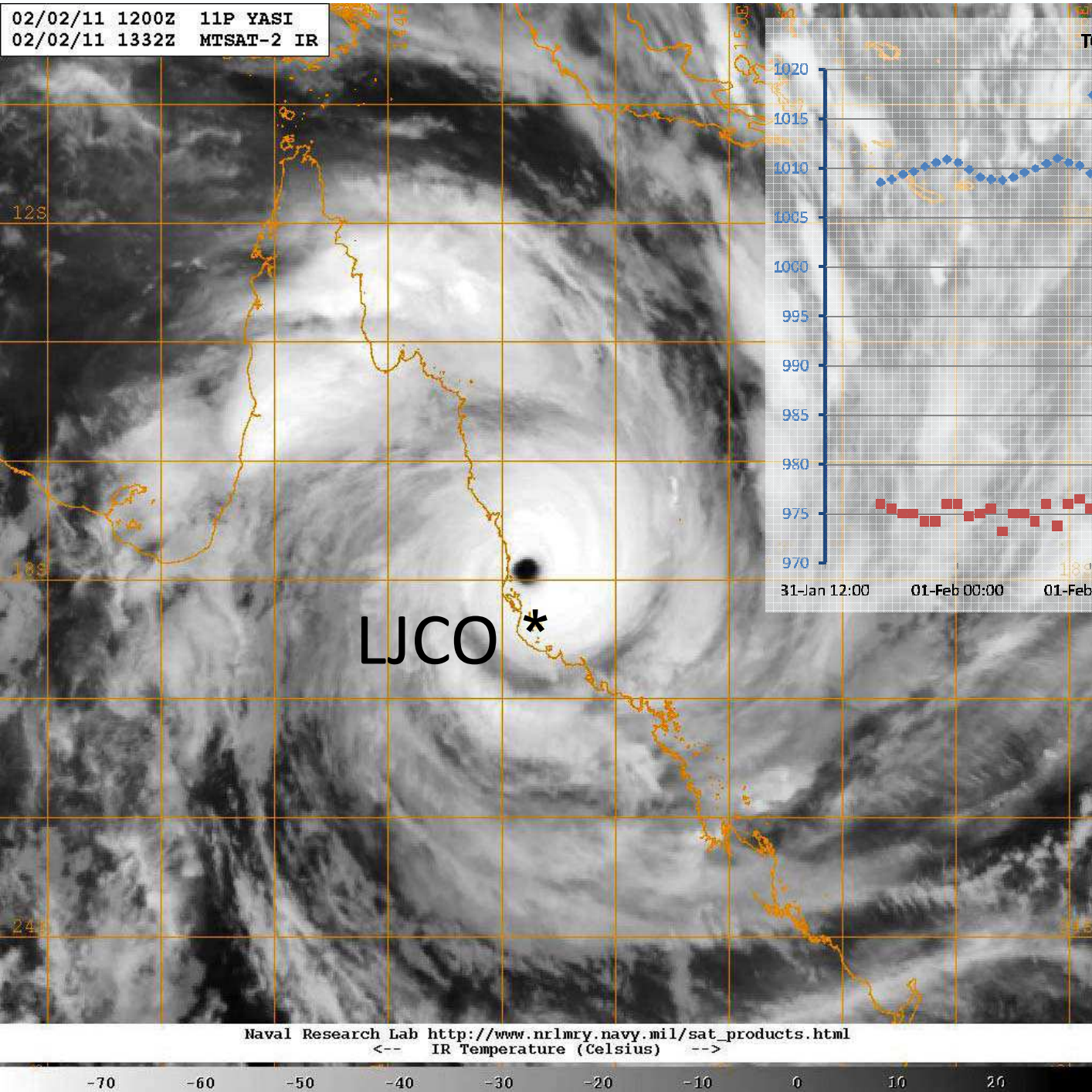




02/09/2014 10:56

# Severe Tropical Cyclone Yasi (Category 5)

## 2-3 February 2011





IMOS Integrated Marine Observing System  
Lyndon Jolly Centre Observatory (LJCO)



3 weeks of deployment ...



# Inter-dependent processing flow

WQM → ACs → BB9

Temperature  
Salinity

Absorption



# AERONET AEROSOL ROBOTIC NETWORK

- + AEROSOL OPTICAL DEPTH
- + AEROSOL INVERSIONS
- + SOLAR FLUX
- + OCEAN COLOR
- + MARITIME AEROSOL

- + Home
- Ocean Color**
- + AEROSOL/FLUX NETWORKS
- + CAMPAIGNS
- + COLLABORATORS
- DATA
- + LOGISTICS
- + NASA PROJECTS
- + OPERATIONS
- + PUBLICATIONS
- + SITE INFORMATION
- + STAFF
- + SYSTEM DESCRIPTION

- AERONET DATA ACCESS**
- DATA SYNERGY TOOL**
- + Data Display
- AEROSOL OPTICAL DEPTH**
- + Data Display
- + Download Tool
- + Download All Sites
- + Climatology Tables
- + Climatology Maps
- + V2 L2 Data Availability
- AEROSOL INVERSIONS**
- + Data Display
- + Download Tool
- + Download All Sites
- SOLAR FLUX**
- + Data Display
- OCEAN COLOR**
- + Data Display
- CLOUD MODE**
- + Data Display


- AERONET Site Lists**
- + Text Format
- + Google Earth Format
- + All Lists

**AERONET-Ocean Color (OC) Data Display Interface**

**DISCLAIMER** AERONET-OC Level 1.0. Real Time Data.  
The following AERONET data are unscreened and may not have final calibration applied

**DATA USAGE** Due to the research and development phase characterizing AERONET Ocean Color, use of these data requires offering co-authorship to the Principal Investigator.

**Lucinda**



The principal investigator(s) of the 'Lucinda' site:  
**Thomas Schroeder**  
If you intend to use the following data please contact principal investigator:  
e-mail: [Thomas.Schroeder@csiro.au](mailto:Thomas.Schroeder@csiro.au)

Return to the World Map

**Choose Display Options:**  
AERONET-OC Data Type:  Lwn (with f/Q correction)  Level 1.0  Level 1.5  
Data Format:  All points  Daily averages

**SELECT CHARTS FOR LARGER IMAGES**

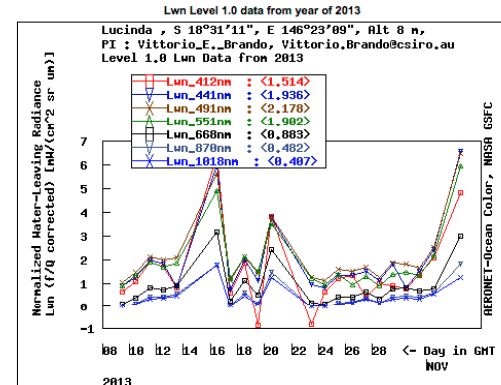
Choose year: 2009 2010 2013  
Choose month of 2013: OCT NOV

**Data Display Controls**

Related Product Availability for Lucinda (select each day below):  
 • Show Back Trajectory Analyses - Availability - Disclaimer  
 • MPLNET Images - Availability - More Information  
 • Show TERRA-MODIS | AQUA-MODIS Rapid Response Imag  
 • GIOVANNI AQUA-MODIS 9km Ocean Images GIOVANNI Se  
 Not Available

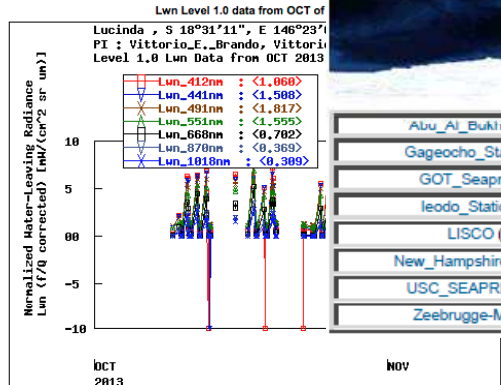
Choose day of OCT 2013

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
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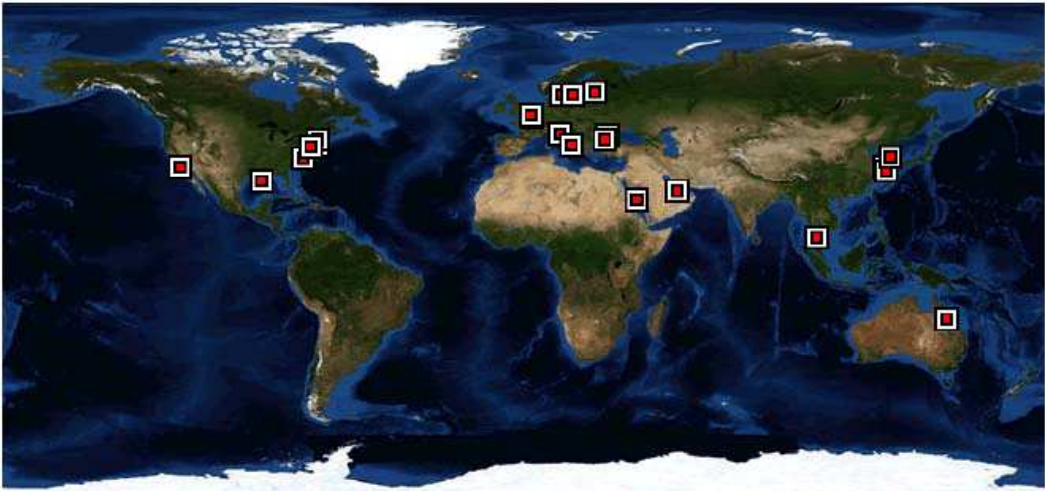
**AERONET-OC DOWNLOAD**

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



**AERONET-OC DOWNLOAD**

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



Abu_Ai_Bukhurosh (25N,53E)	Bari_Waterfront (41N,10E)	GOVE_SEAPRISM (30N,75W)
Gagecho_Station (33N,124E)	Galata_Platform (43N,28E)	Glonia (44N,29E)
GOT_SeaprisM (8N,101E)	Gustav_Dalen_Tower (58N,17E)	Helsinki_Lighthouse (59N,24E)
Ieodo_Station (32N,125E)	KAUST_Campus (22N,39E)	KIOST-Ansan (37N,126E)
LISCO (40N,73W)	Lucinda (18S,146E)	MVCO (41N,70W)
New_Hampshire_Univ (43N,70W)	Palgrunden (58N,13E)	Thornton_C-power (51N,2E)
USC_SEAPRISM (33N,118W)	Venise (45N,12E)	WaveCIS_Site_CSI_8 (28N,90W)
Zeebrugge-MOW1 (51N,3E)		

# SeaPRISM data Online at NASA Aeronet-OC

[http://aeronet.gsfc.nasa.gov/new\\_web/ocean\\_color.html](http://aeronet.gsfc.nasa.gov/new_web/ocean_color.html)

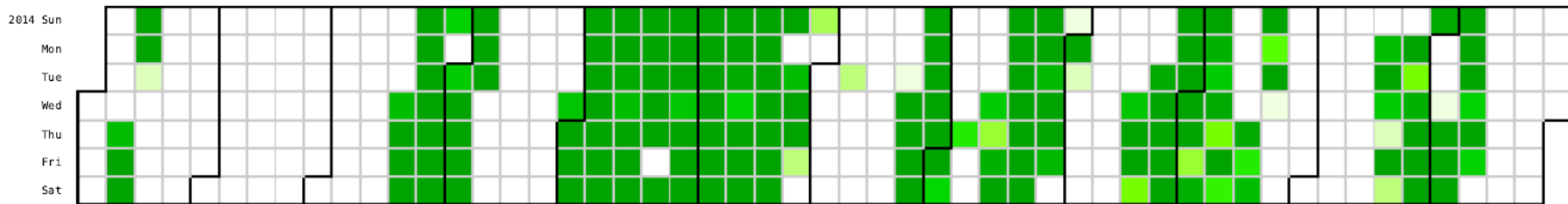




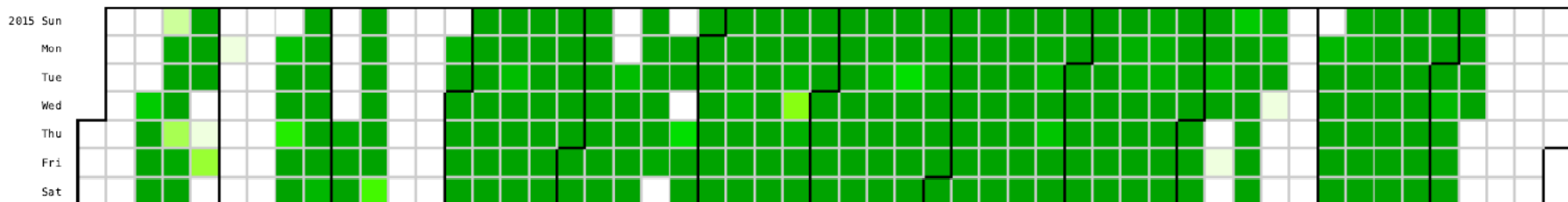
# Data Availability Example WQM 2014 – 2016

WQM

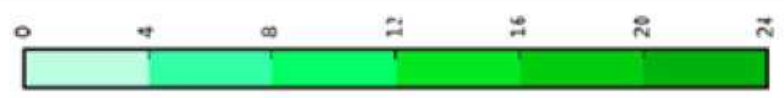
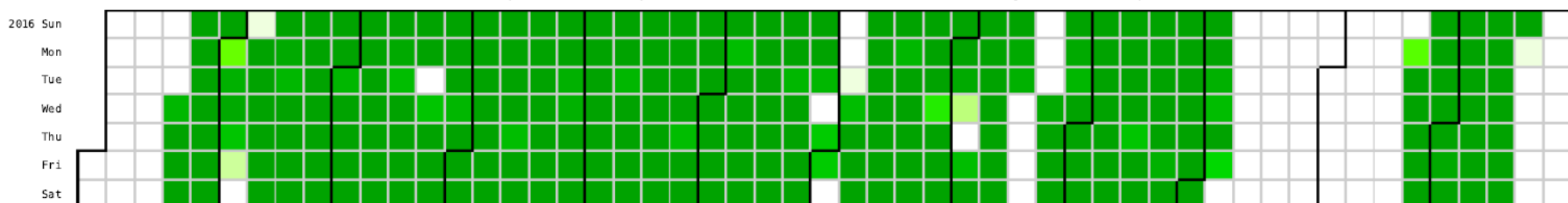
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

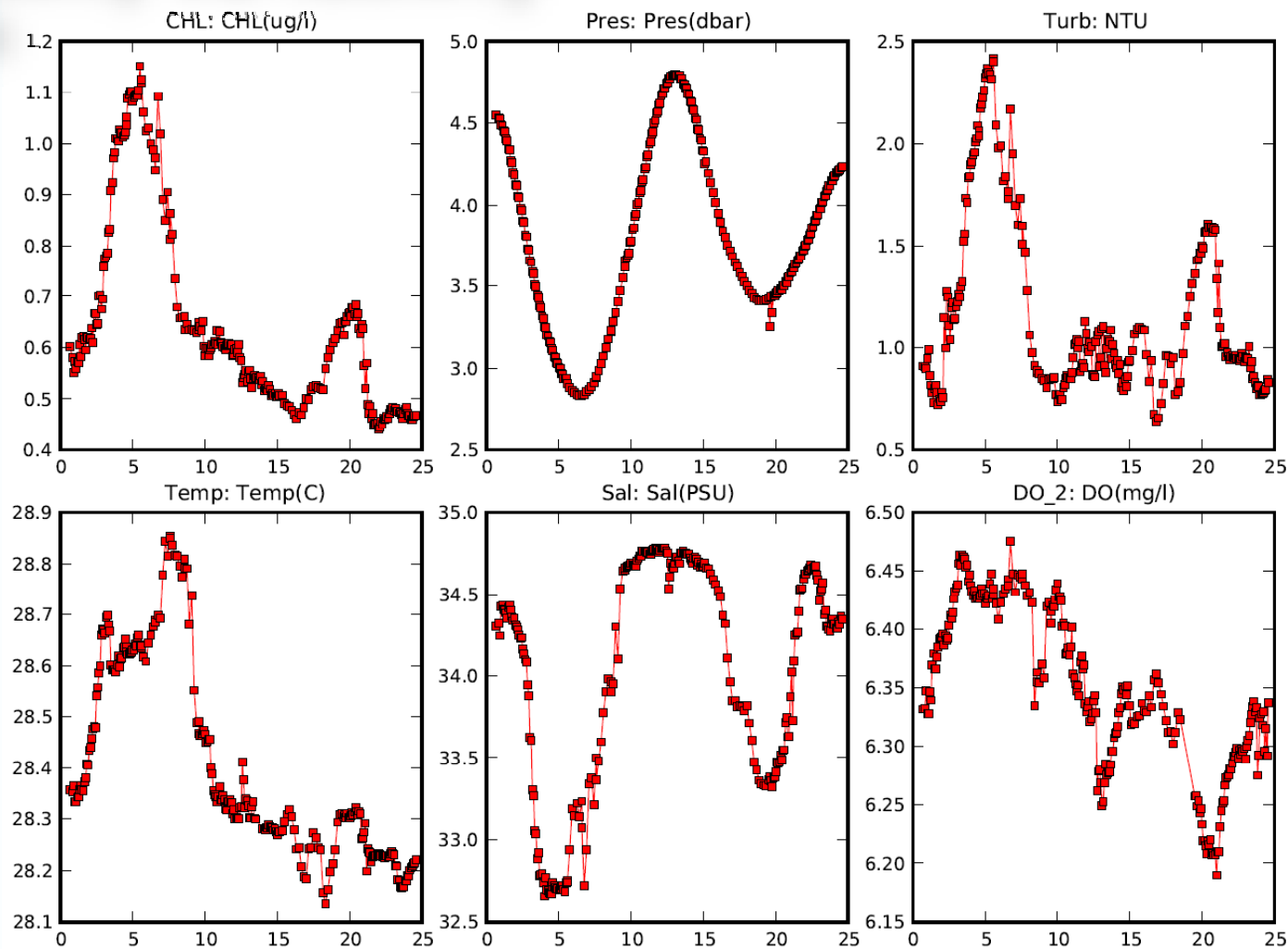


Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



# WQM daily variability

1 April 2014



QA/QC-ing & NetCDF conversion not through IMOS toolbox – python scripting Linux  
All DAPCS data back-processed to 2009