Evaluation of Sentinel-3 OLCI Level 2 radiometry in Australian coastal and continental shelf waters

Jenny Lovell, on behalf of the Australian S3VT

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IMOS

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This presentation

- **Integrated Marine Observing System (IMOS) Lucinda Jetty Coastal Observatory (LJCO)**
  - Measurements, site characteristics
- **IMOS Radiometry Task**
  - Results and actions to improve data quality
- **Level 2 Radiometric Validation**
  - Lucinda Jetty Coastal Observatory, autonomous DALEC
  - Ship-based autonomous DALEC
  - Ship-based HyperOCR
- **Future Work**
  - LJCO, Bio-Argo, Southern Ocean Flux Station mooring


Sentinel-2
5 km

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)

Overview above-water measurements

Weather Station
Temperature
Pressure
Humidity
Dew point
Wind speed etc

HyperOCR
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

IMO DALEC

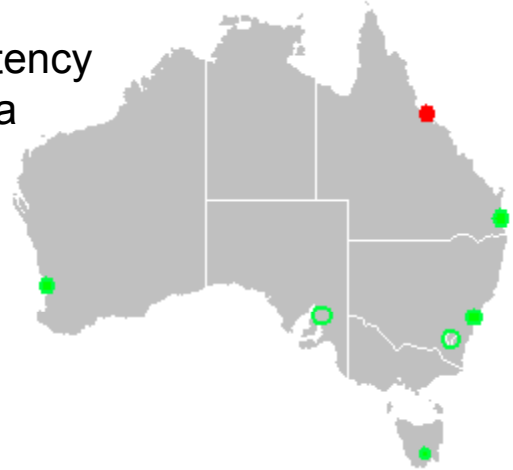
- Dynamic above water radiance and irradiance collector
- Hyperspectral: 400-1050 nm
- Autonomous operation
- 3 compact Zeiss spectroradiometers
- GPS, pitch, roll sensors
- LJCO instalment
  - May 2016 – March 2017
  - Soon to be re-installed
- Operating at 90° relative azimuth for consistency with Aeronet SeaPrism

IMOS Radiometry Task

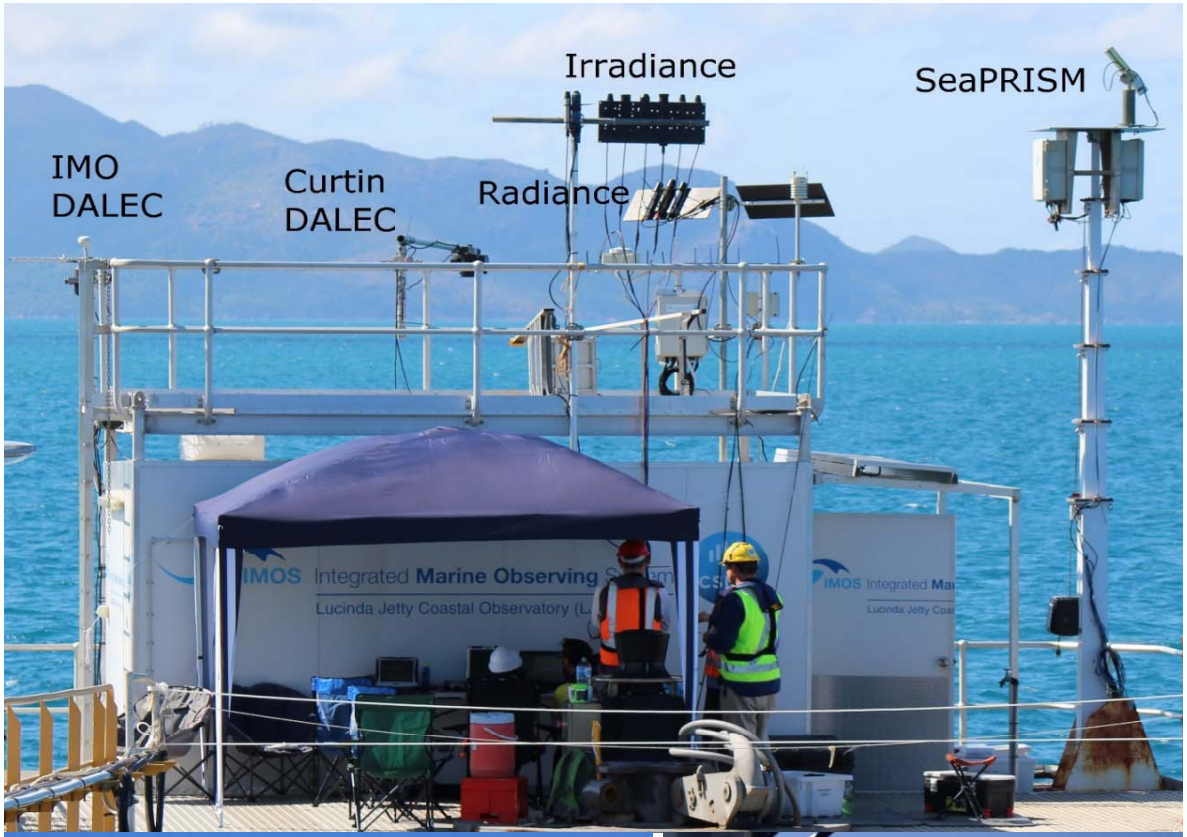
Objectives and Activities

- Participants from all Australian agencies undertaking bio-optical measurements
- Improve usability of radiometric data sets for research purposes as well as for validation of satellite ocean colour

- Evaluate consistency among existing field-platform and sea-going radiometers used in Australian bio-optical community, through dedicated laboratory and field experiments
- Propose actions to improve consistency and the way they are deployed data processing
- Develop a plan for evolution of IMOS radiometry measurements for the next decade



IMOS RTT Instrumentation, findings



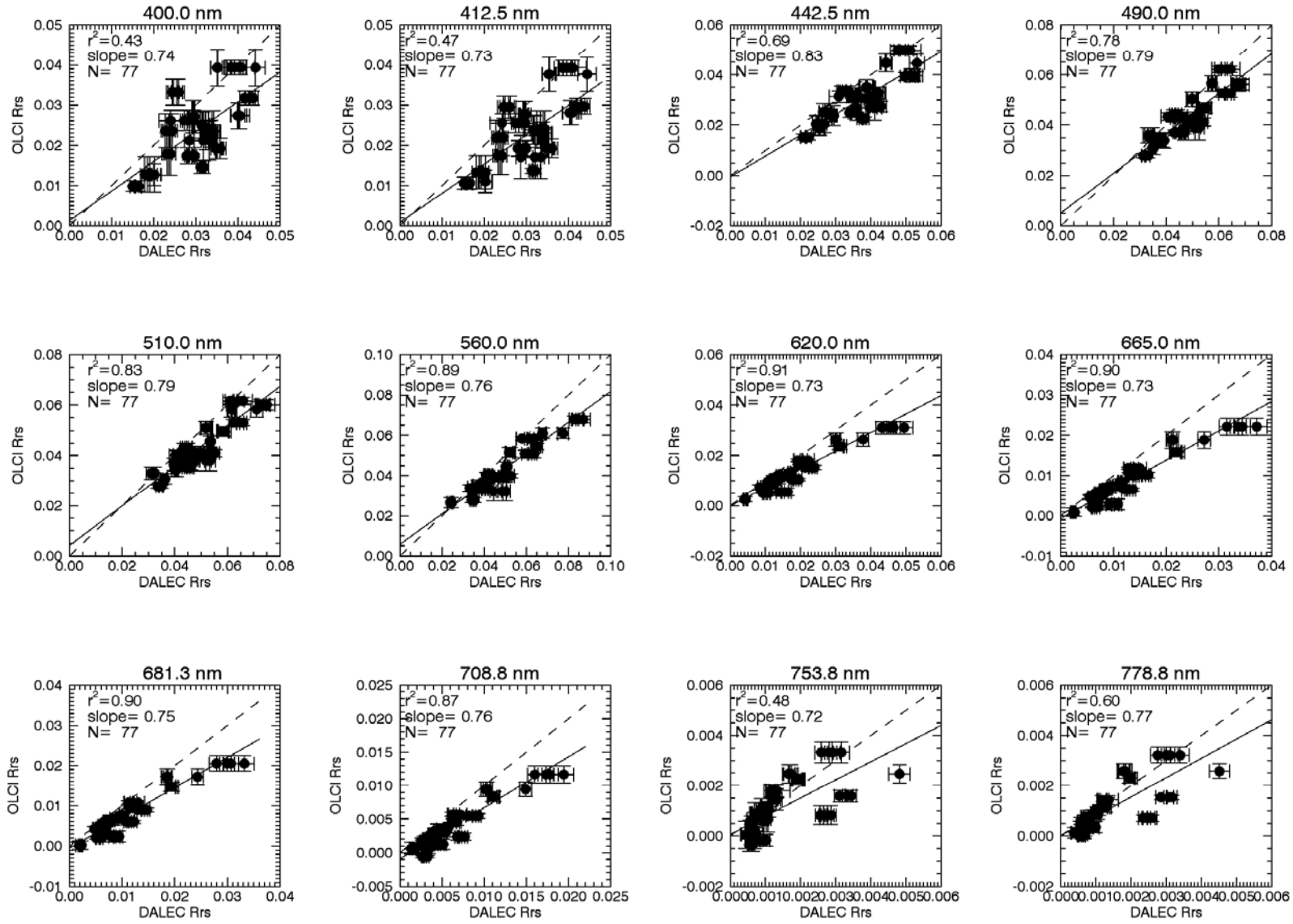
- **Community benefit**
- **Integration time matters**
  - a lot in L_{sea} measurements
- **Calibration is temperature dependent**
- Wavelength calibration should be checked
- DALEC cosine response could be improved
- **Sun zenith angle is a key parameter in QC**
- Platform effects to be investigated

Level 2 Radiometric Validation LJCO

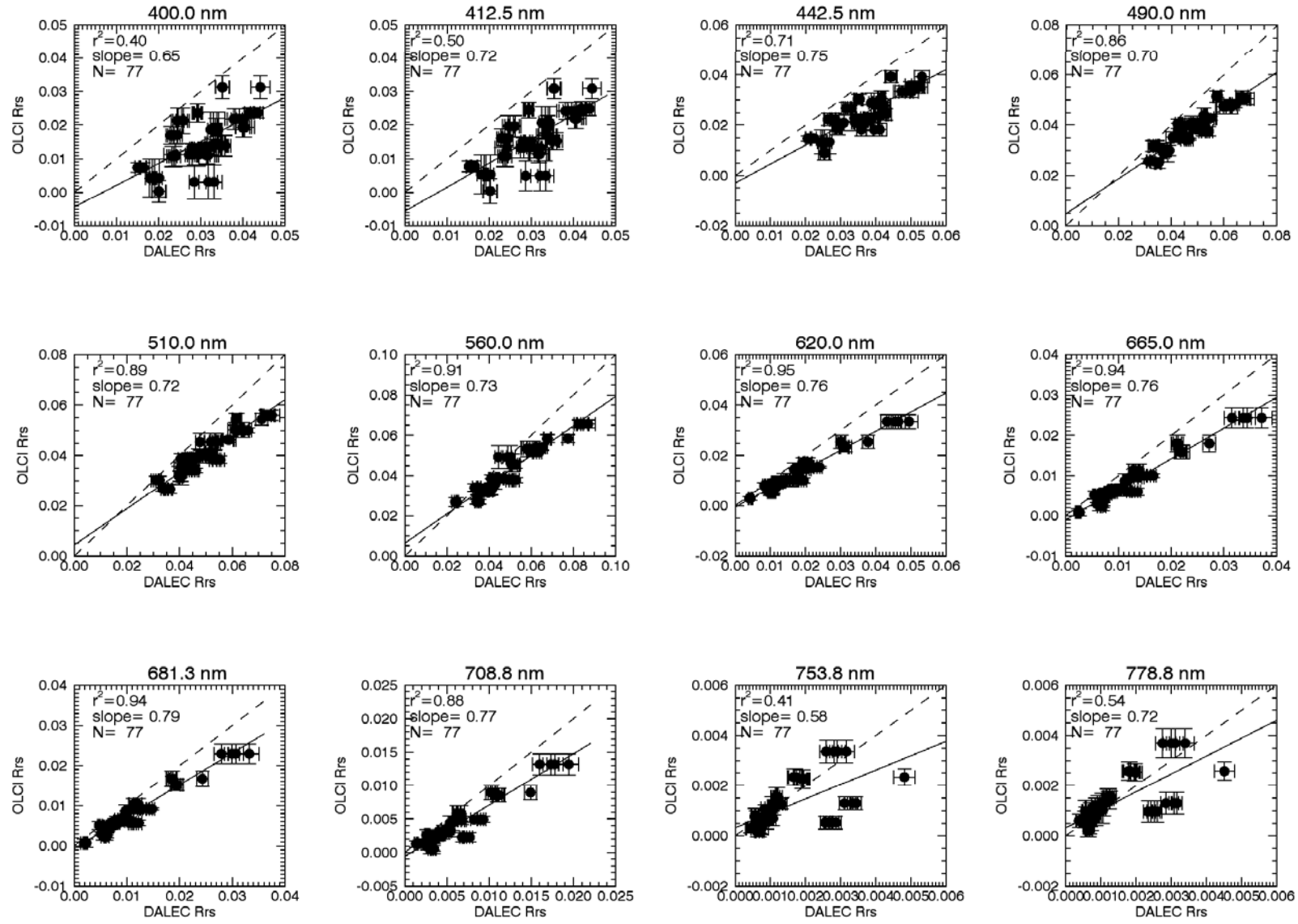
Radiometric match-ups OLCI vs DALEC

- Date range: 4 July 2016 – 20 March 2017
- OLCI flags: CLOUD, CLOUD_AMBIGUOUS, CLOUD_MARGIN, INVALID, COSMETIC, SATURATED, SUSPECT, HISOLZEN, HIGHGLINT, SNOW_ICE, LAND, INLAND_WATER
- 20 OLCI scenes provided unflagged matchups within ±30 min
- DALEC spectral range 405-1000 nm
  - (405nm used for matchup with Band 01)
- DALEC Rrs uses Mobley (2015) ρ LUT
- DALEC data averaged to 15 minute (mean, SD)
- OLCI median of 3x3 FR pixels, min 5 unflagged pixels
- Comparison with original release OLCI data and latest reprocessed data (IPF 2.23)

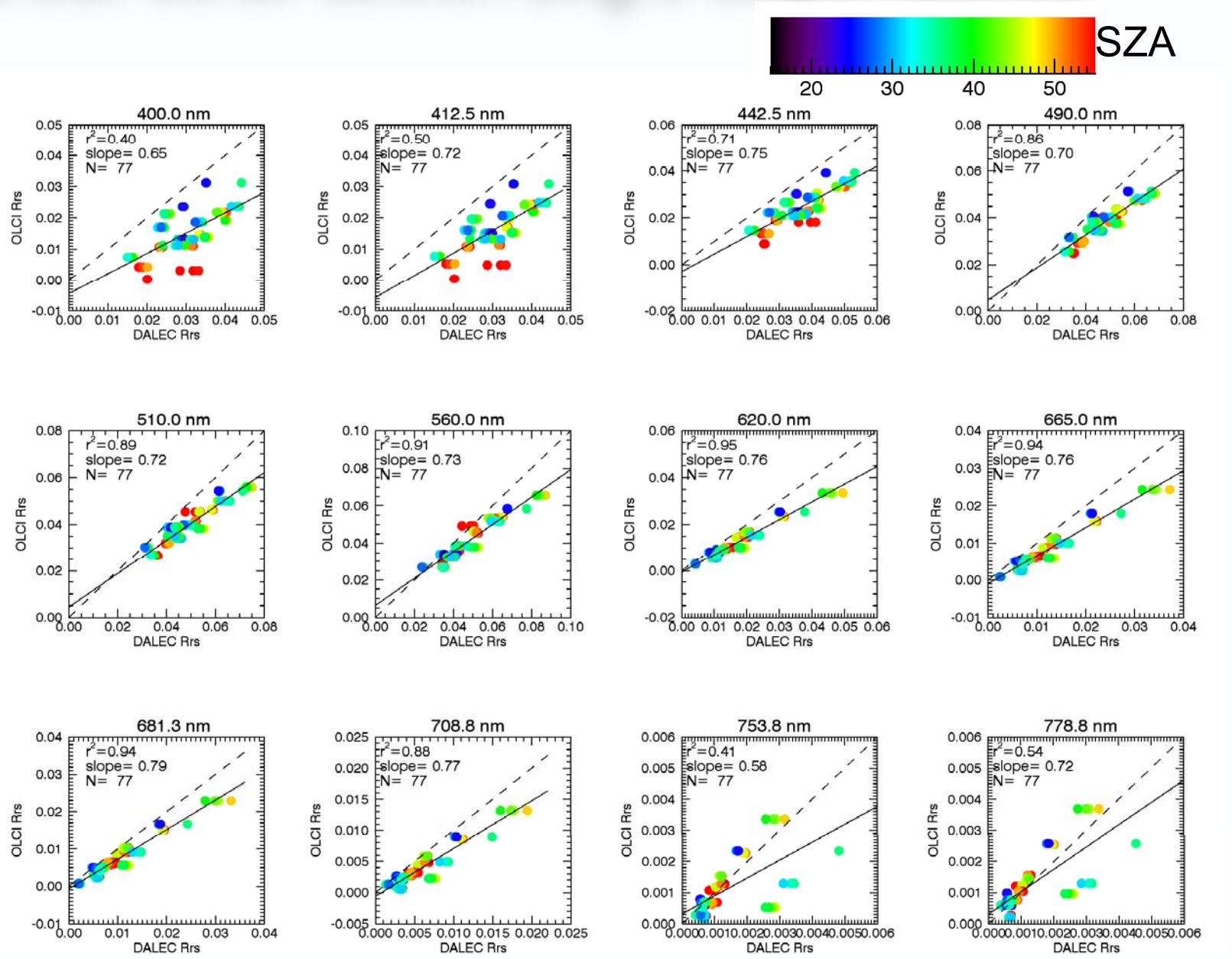
OLCI original data release vs DALEC N=77, 400-778.8 nm



OLCI IPF2.23 data vs DALEC N=77, 400-778.8 nm

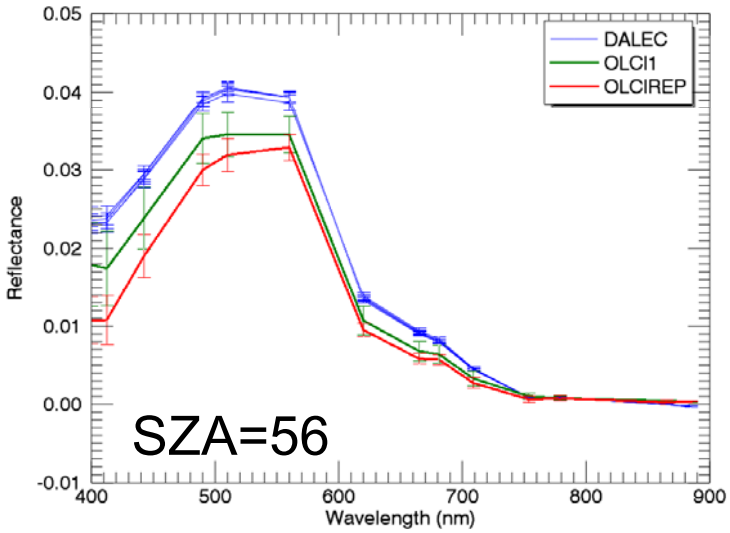


No clear Solar zenith angle dependence



Spectra OLCI vs DALEC

20160707T2358



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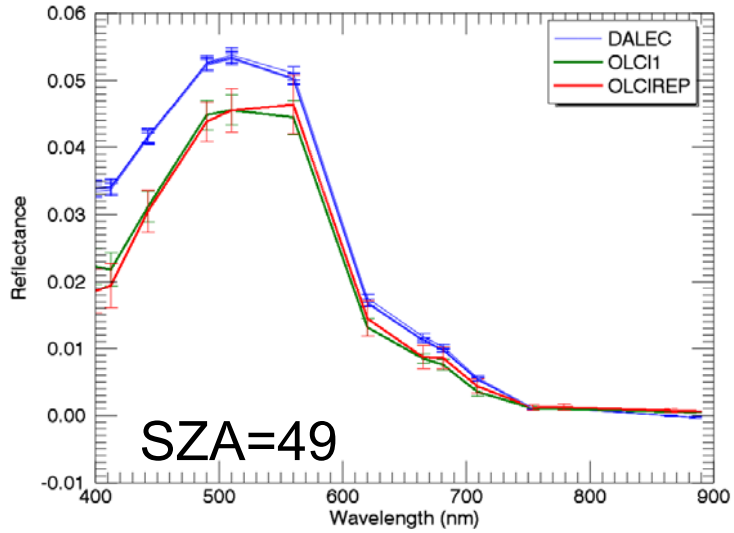

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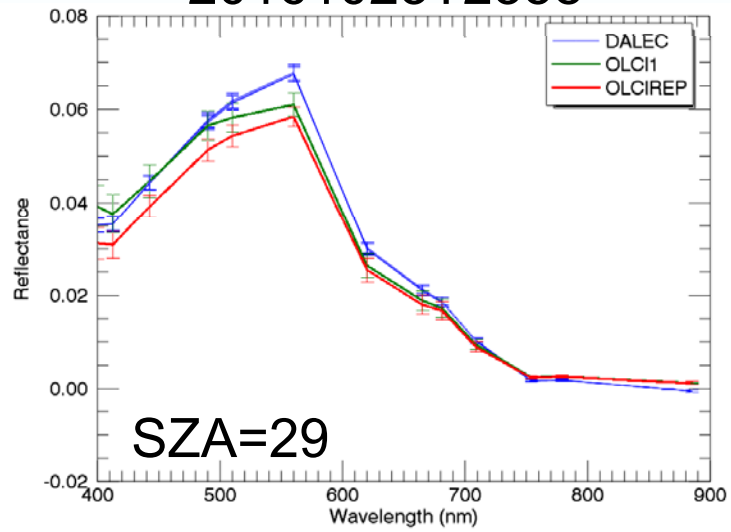

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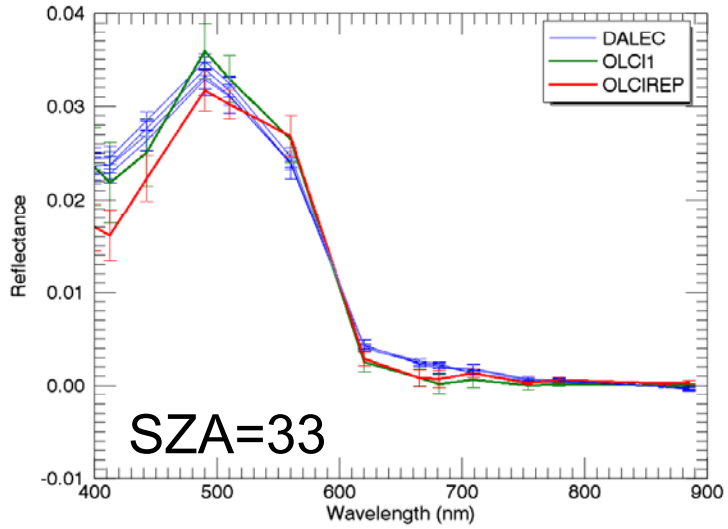
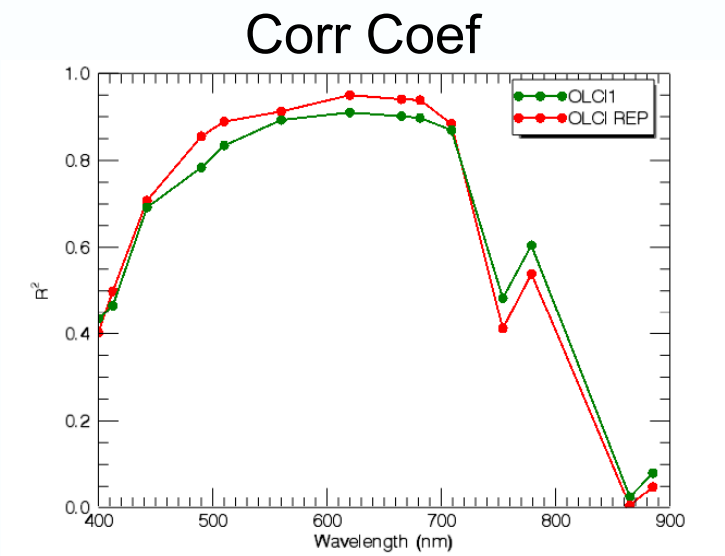
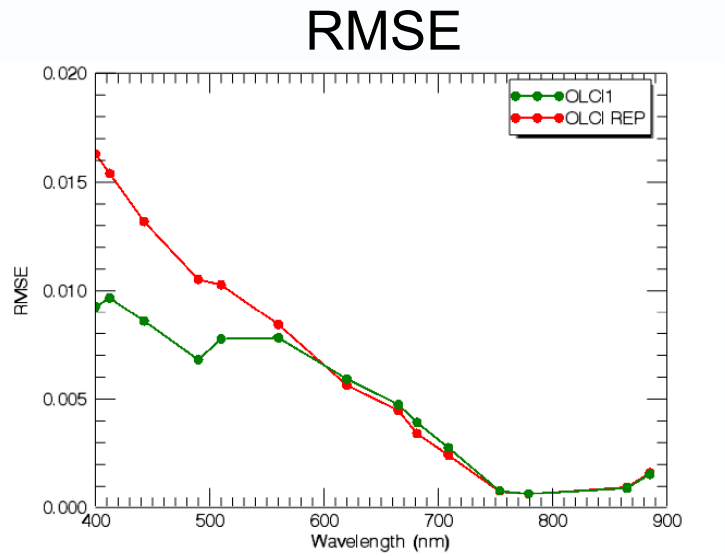
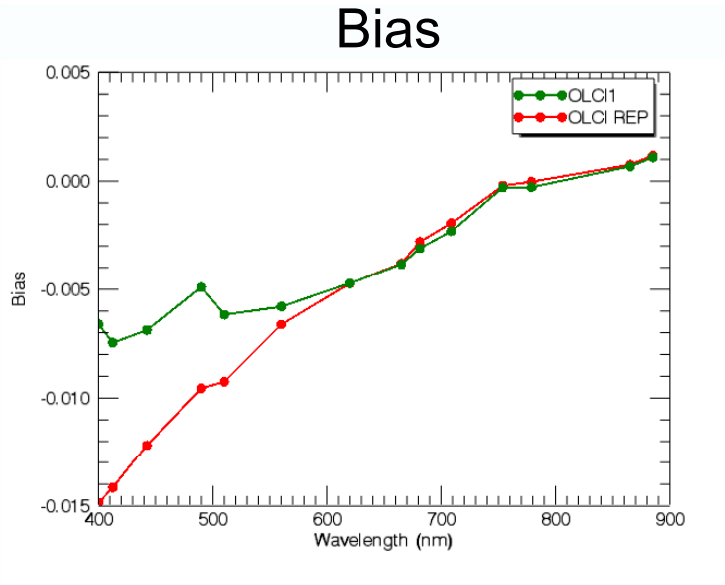
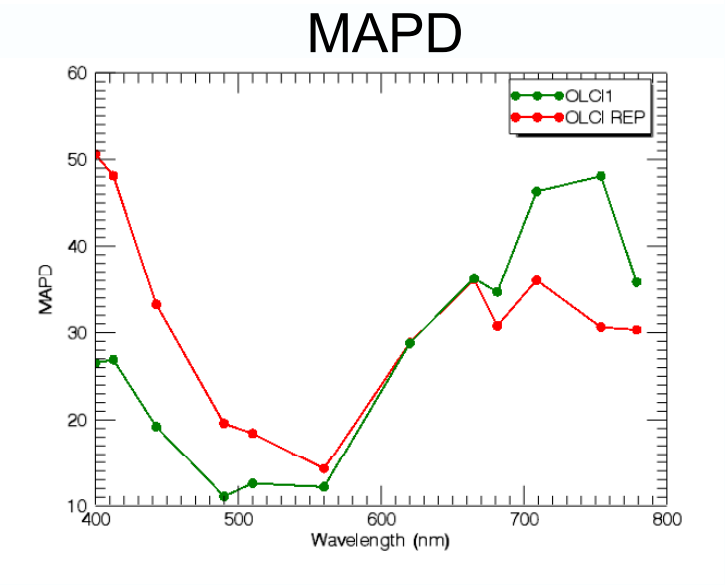


Statistics OLCI vs DALEC





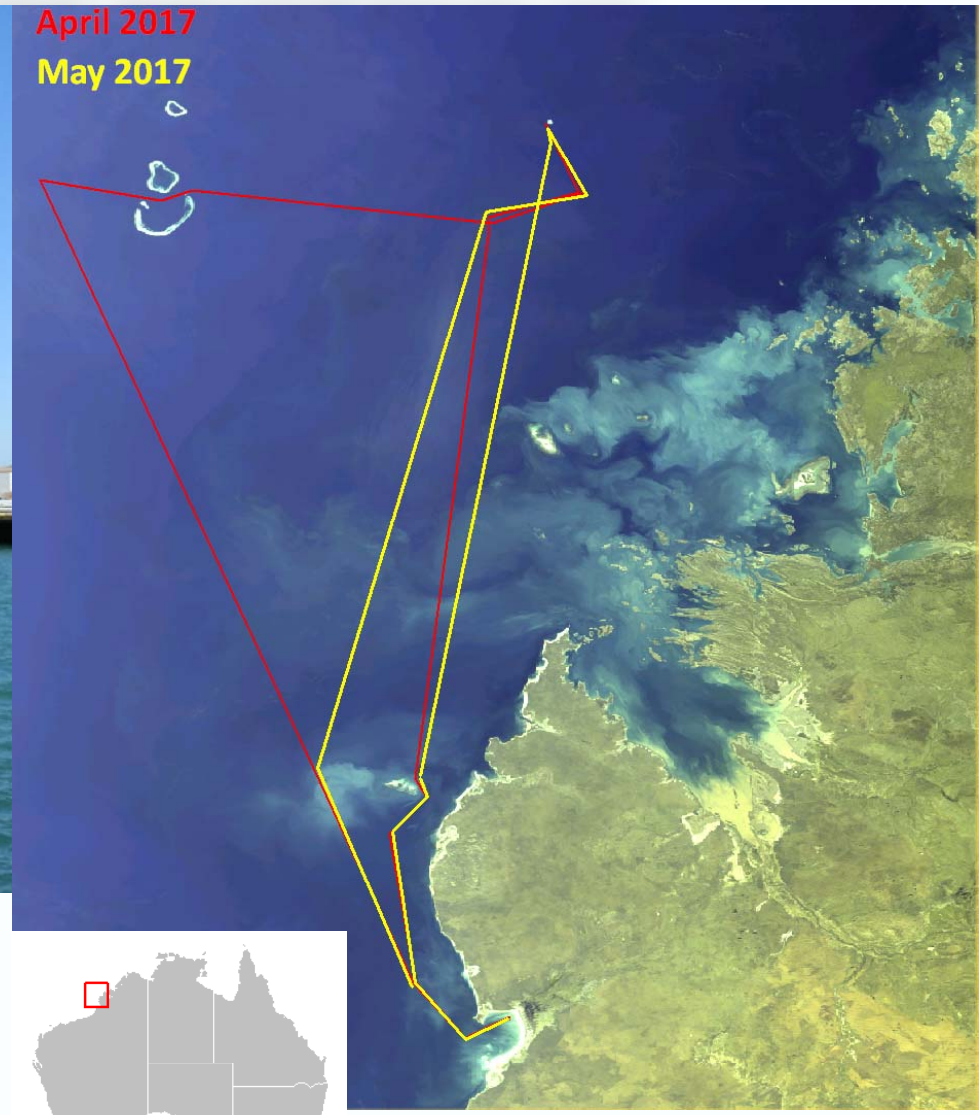




Level 2 Radiometric Validation Ship – NW Shelf, DALEC

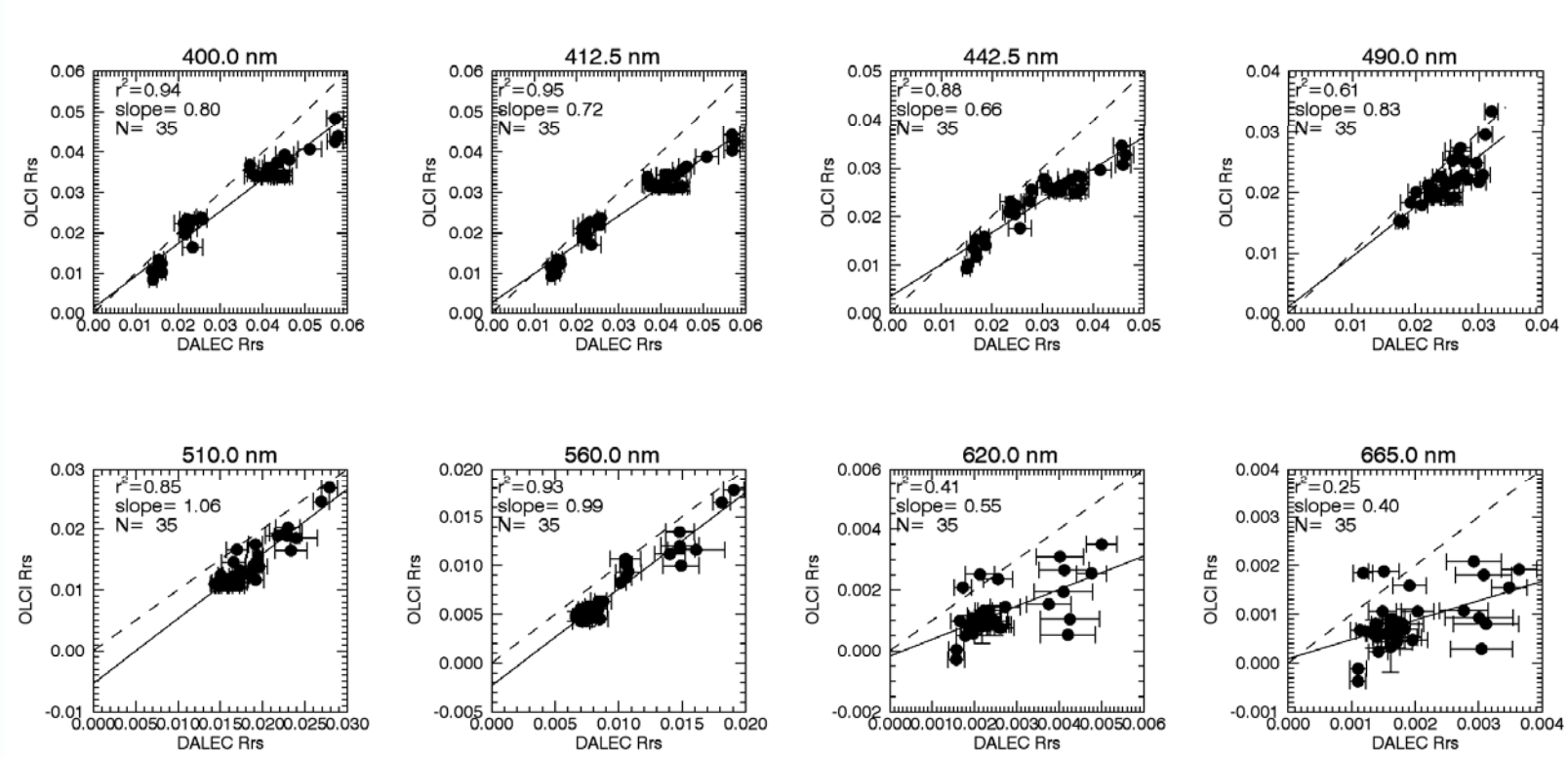
DALEC on RV Solander

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

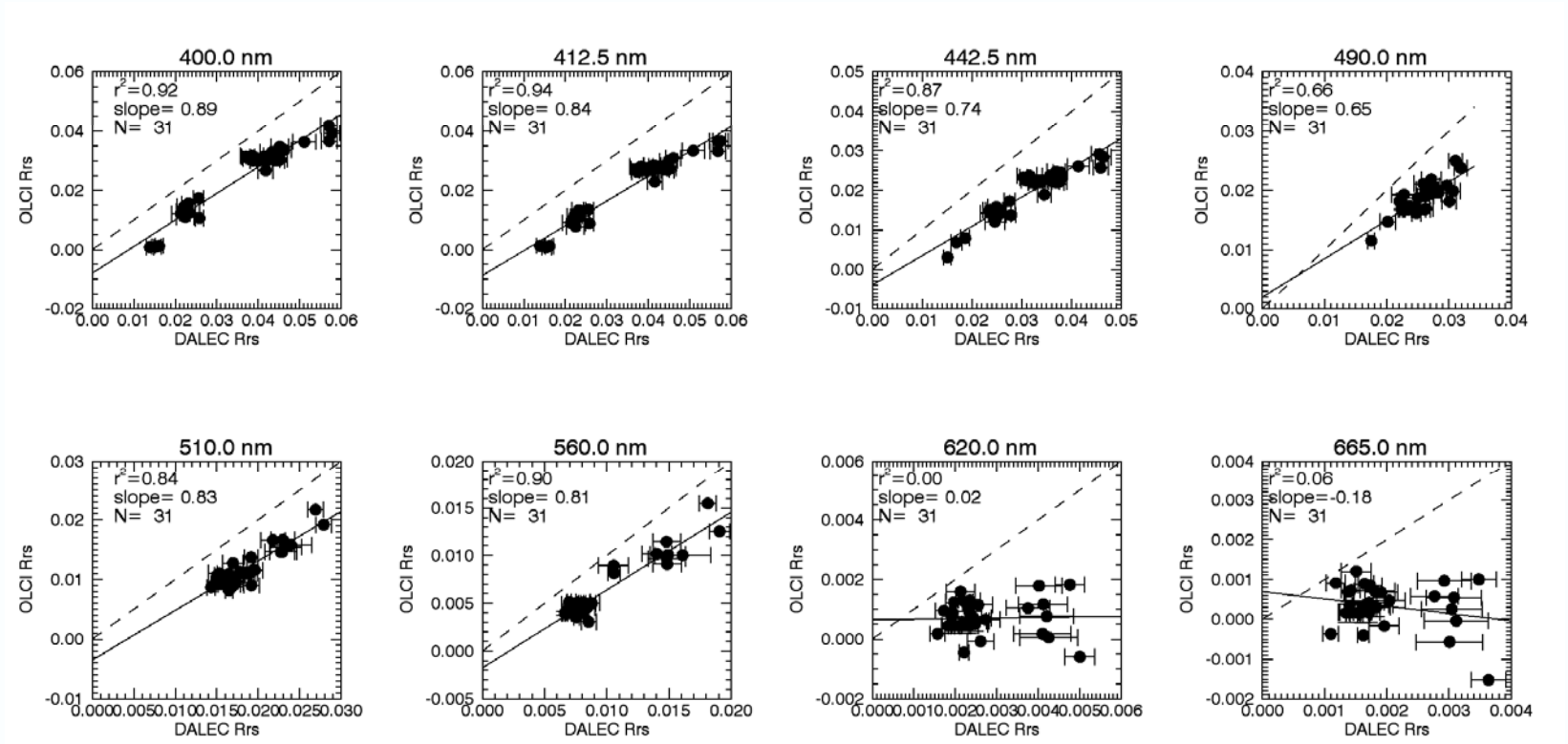


- Continental shelf
- 5 OLCI scenes, 3x3 median
- DALEC R_{rs} 15 min mean
- Matchups ±1 hr

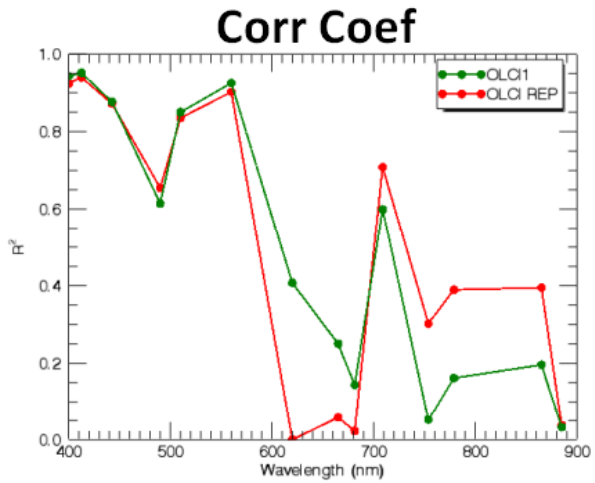
OLCI original data release vs DALEC N=35, 400-665 nm

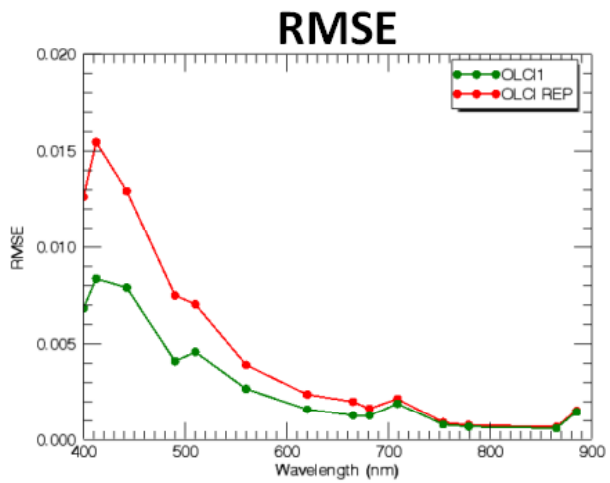


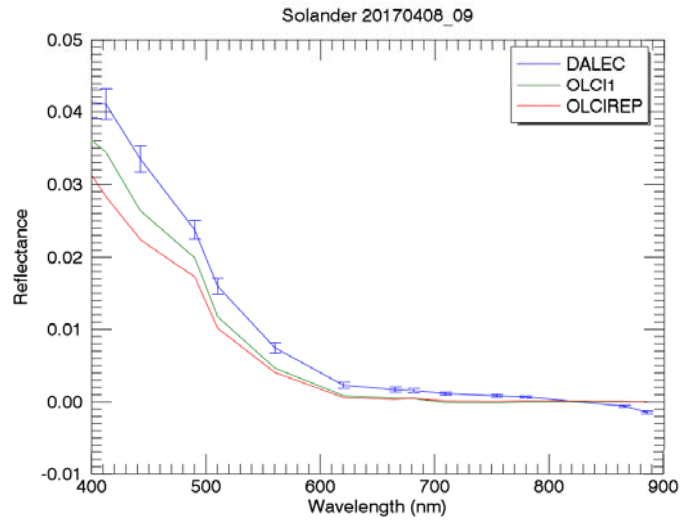
OLCI IPF2.23 data vs DALEC N=31, 400-665 nm

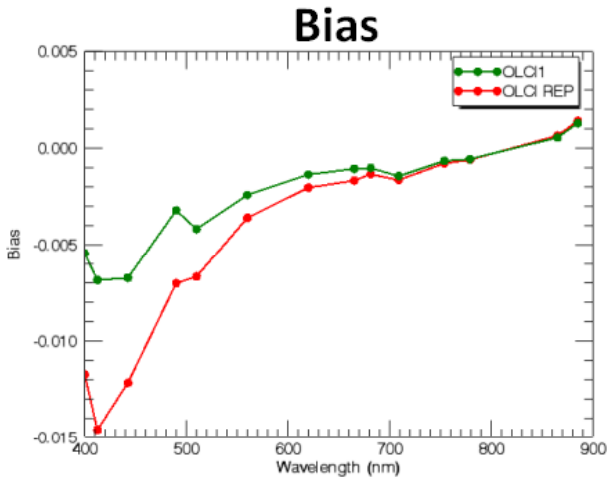


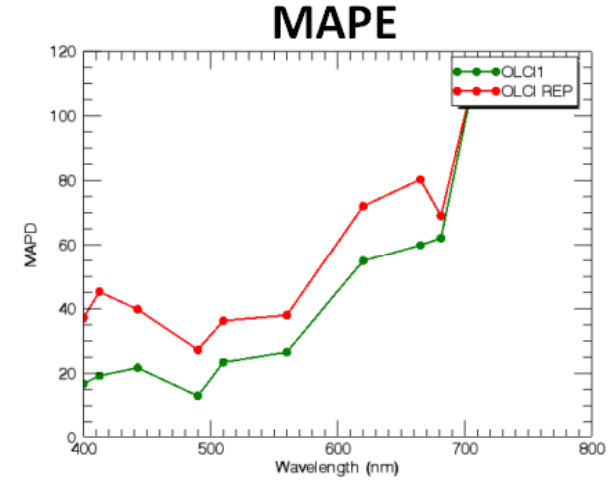
Spectra and Statistics OLCI vs Ship-based DALEC

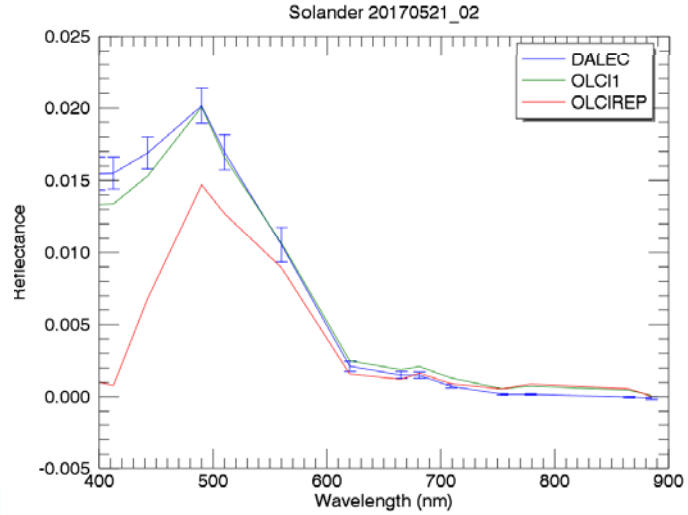










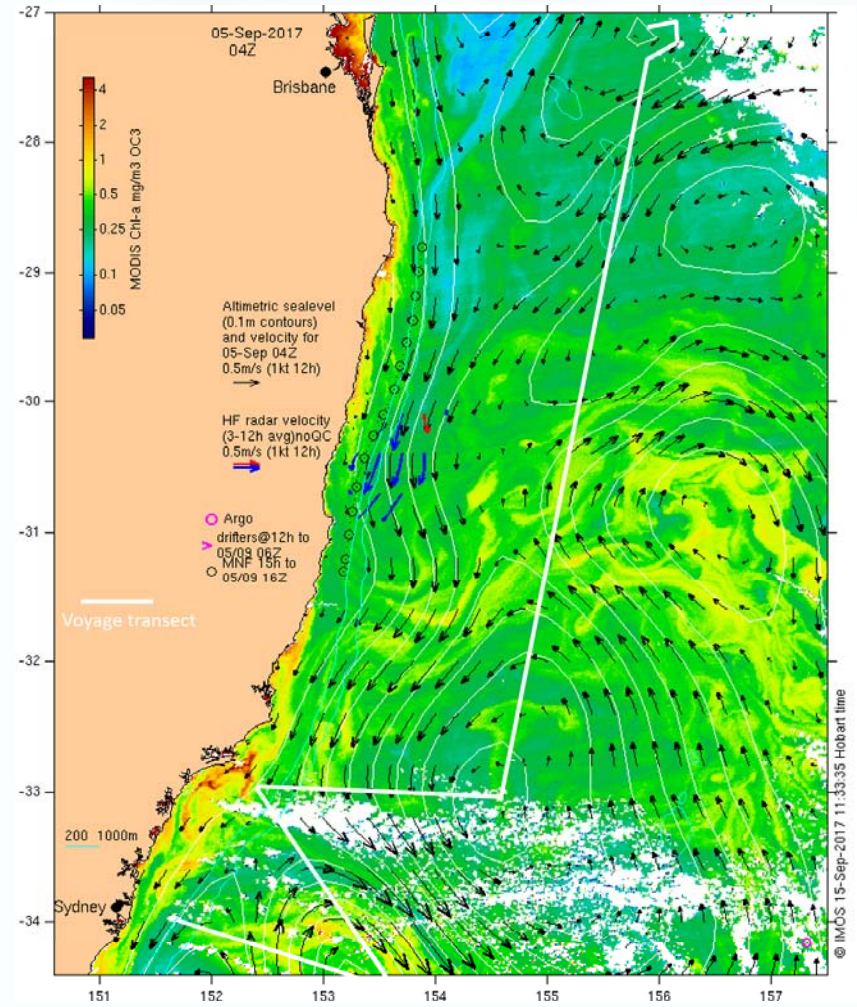


Summary table
Level 2 Radiance Regression Slope vs DALEC

Wavelength	LJCO OLCI1	LJCO OLCIRep	Ship OLCI1	Ship OLCIRep
412.5	0.73	0.72	0.72	**0.84**
442.5	**0.83**	0.75	0.66	**0.74**
490	**0.79**	0.70	**0.83**	0.65
560	**0.76**	0.73	**0.99**	0.81
620	0.73	0.76	0.55	0.02
681.3	0.75	**0.79**	0.32	-0.10
708.8	0.76	0.77	-1.38	-1.95

Level 2 Radiometric Validation Ship – East Australia, HyperOCR

Validation voyage off east coast of Australia
September 2017 – RV Investigator



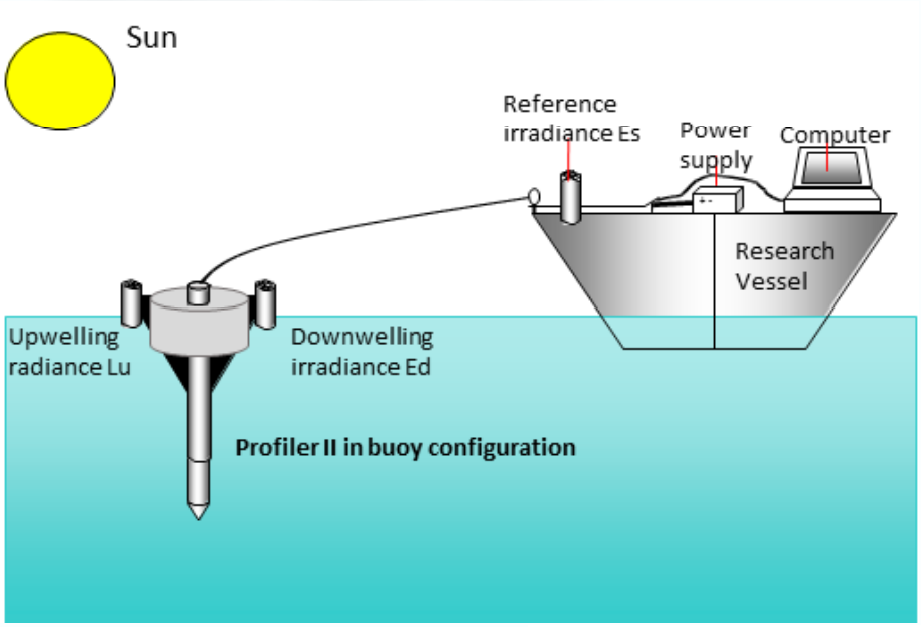
Range of bio-optical data from the surface

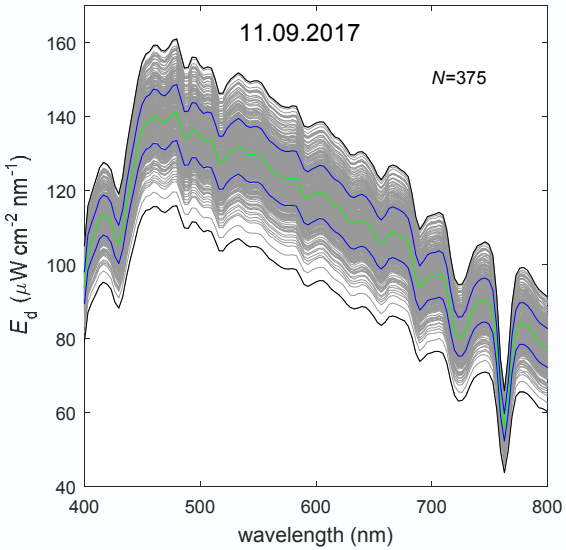
	min	mean	std	max
Chl-*a* HPLC (mg m^{-3})	**0.19**	**0.51**	**0.46**	**1.76**
TSS gravimetric (g m^{-3})	**0.15**	**0.27** (34% inorganic, 66% organic)	**0.09**	**0.48**
$a_{CDOM}(443)$ spectroscopy (m^{-1})	**0.002**	**0.011**	**0.009**	**0.033**
$a_{ph}(443)$ spectroscopy (m^{-1})	**0.013**	**0.025**	**0.014**	**0.064**
$a_{NAP}(443)$ spectroscopy (m^{-1})	**0.003**	**0.004**	**0.002**	**0.007**

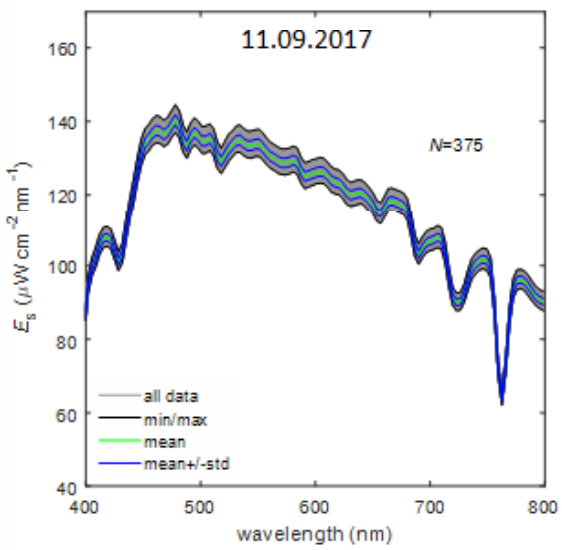
Soja-Woźniak et al., *in prep.*

Radiometric Measurements

Satlantic Hyper Pro II

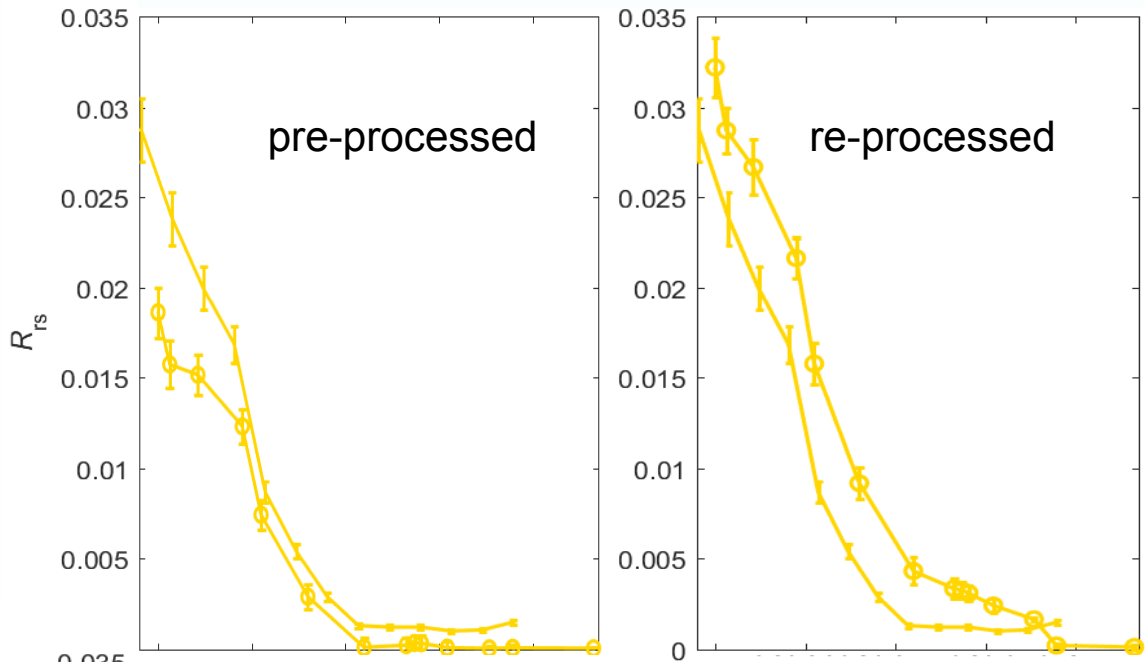






- Surface deployment :
  - for 10min
  - sunny side
  - ~25 m off the vessel
  - 'on deck' pressure tare equal to atmospheric pressure (~10.1 m)
- Reference irradiance E_s on the 2nd deck of the vessel

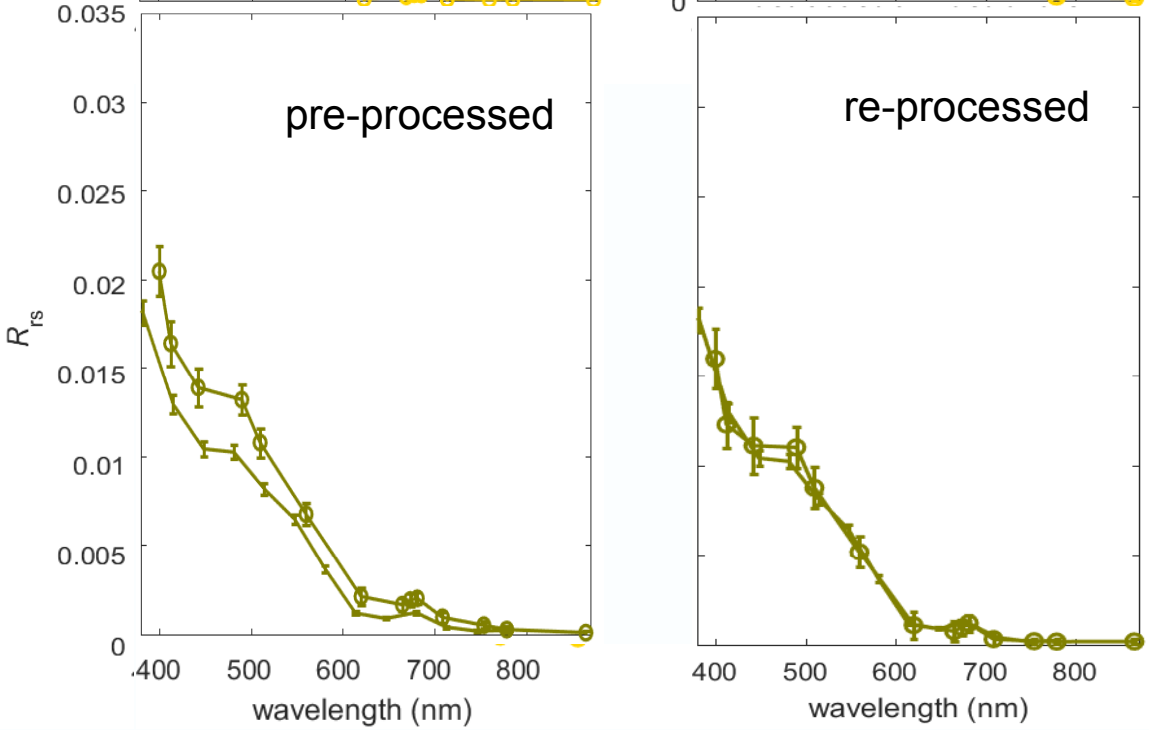
Soja-Woźniak et al., *in prep.*



2017 09 15 OLCI FR (mean of 3x3)
2017 09 13 *in situ* CTD #29

	in situ	OLCI
Chl-*a* =	0.22 mg m^{-3}	0.26 mg m^{-3}
a_{CDM} =	0.0031 m^{-1}	0.017 m^{-1}
TSS =	0.23 g m^{-3}	0.31 g m^{-3}

East coast of Australia
Anticyclonic eddies



2017 09 11 OLCI FR (mean of 3x3)
2017 09 12 *in situ* CTD #27

	in situ	OLCI
Chl-*a* =	1.8 mg m^{-3}	0.44 mg m^{-3}
a_{CDM} =	0.018 m^{-1}	0.022 m^{-1}
TSS =	0.48 g m^{-3}	0.44 g m^{-3}

East coast of Australia
Cyclonic eddies

Soja-Woźniak et al., *in prep.*

Future Work

- Continuation of Lucinda Jetty Coastal Observatory
  - Above-water and in-water measurements – **http://coast-rs-1.it.csiro.au/**
  - Water sampling approx. every 2 weeks **timed to coincide with OLCI**
- Maintenance of IMOS Bio-optical Database
- Deployment of autonomous DALEC on RV 60 days per year
- **ANN atmospheric correction applied to L1B OLCI data**
- Deployment of 3 BGC argo floats near but north of the Southern Ocean Flux Station (SOFS) moorings : 46.7° S, 141 °E
  - E_d and L_u sensors (412, 443, 490, 555 nm)
  - transmissometer, chl-*a* and CDOM fluorescence
  - backscattering (470, 532, 700 nm)

SOFS-7 Air-Sea Flux Mooring Optics www.imos.org.au

On tower:

Short and long wave radiation

Licor PAR

ISMO MS9 wiped

Ed:(410,440,490,510,550,636,660,685,710)

Just below surface:

Wetlabs FLNTUS: F-Chl, Bb(700)

ISMO MS9 wiped Lu (same bands as Ed)

At 30 m:

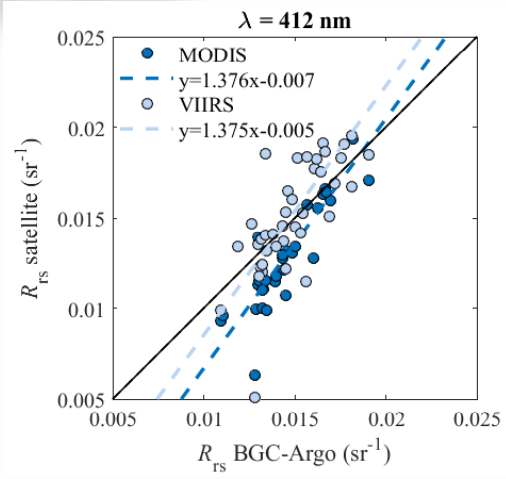
Wetlabs wiped PAR

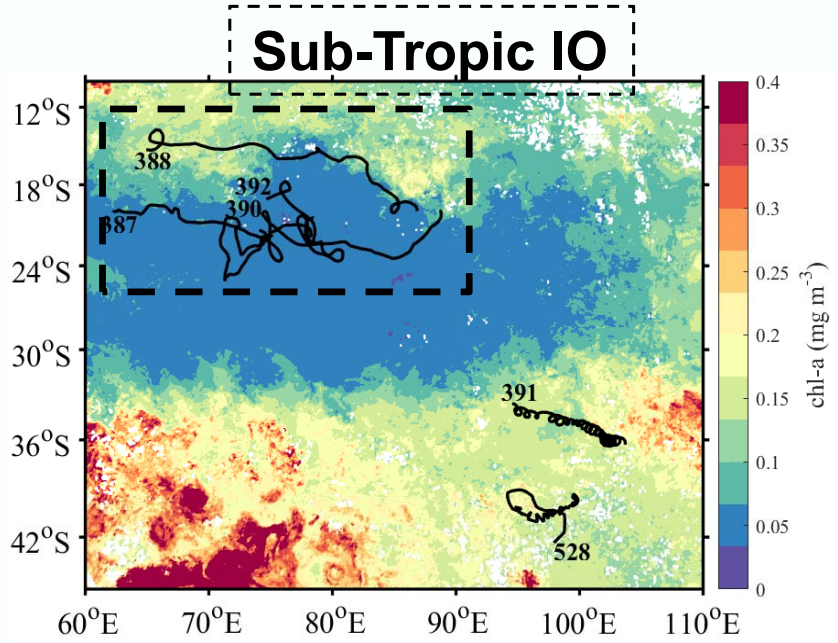
ISMO MS9 wiped Ed (as above)

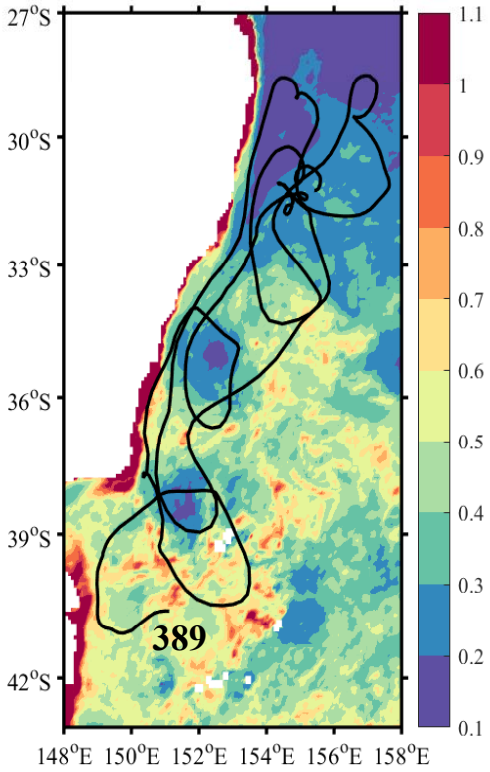
Wetlabs FLNTUS (as above)

BGC Argo Validation

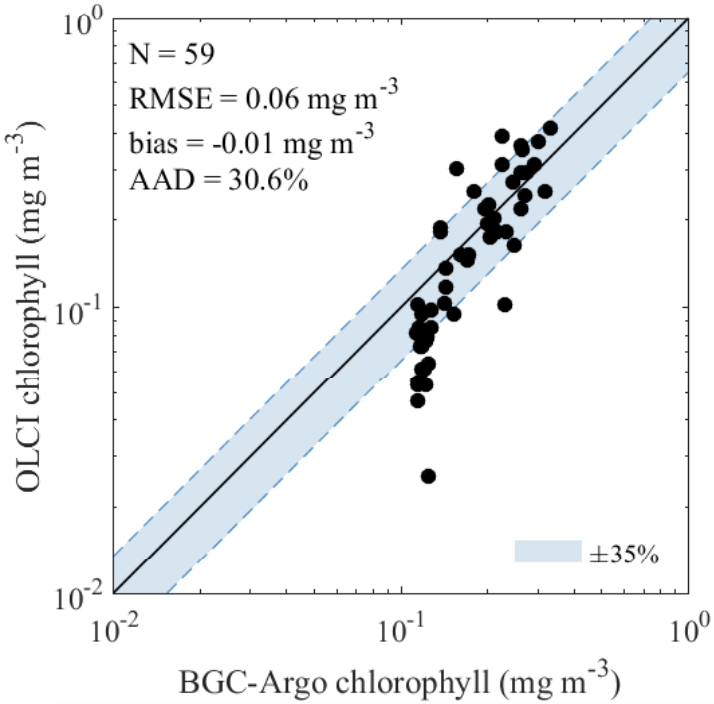
- Successful use of R_{rs} derived from BGC-Argo for validation of MODIS and VIIRS products
- *No* R_{rs} matchups with OLCI due to early float failure, but new deployments planned

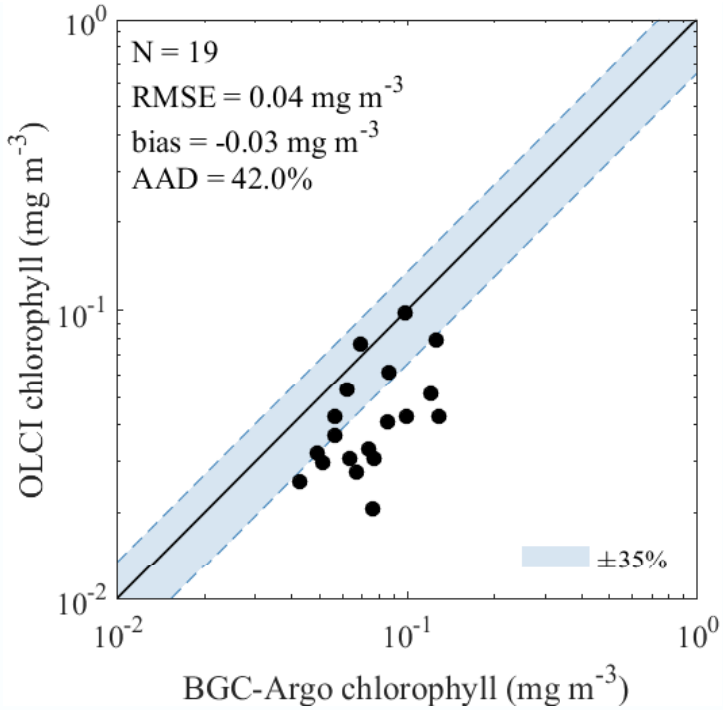






Pacific





Wojtasiewicz et al. 2018, RSE (in press)

Feedback

- **S3VT regular meetings** provide a great overview of the latest news on S-3 OLCI
  - These meetings are key for us and we thank Marc and Ewa for their organisation and delivery
  - They showcase an active community. **Thank you !!**
- **LJCO** is a challenging site for ocean colour radiometry validation but we are looking forward to showcase more research coming out of LJCO in the context of S-3 OLCI in the years to come
- **LJCO data available online** and should be contributed to ESA MERMAID DB
- At LJCO and in Northern Australian Waters the **IP2.23 data is low in the blue**
- **Change of granule size** in reprocessing complicated the matchup extraction
- The order of flags listed in SNAP and the list in attributes when exported to netCDF is different to the actual bit order of flags

Contributors (in alphabetical order)

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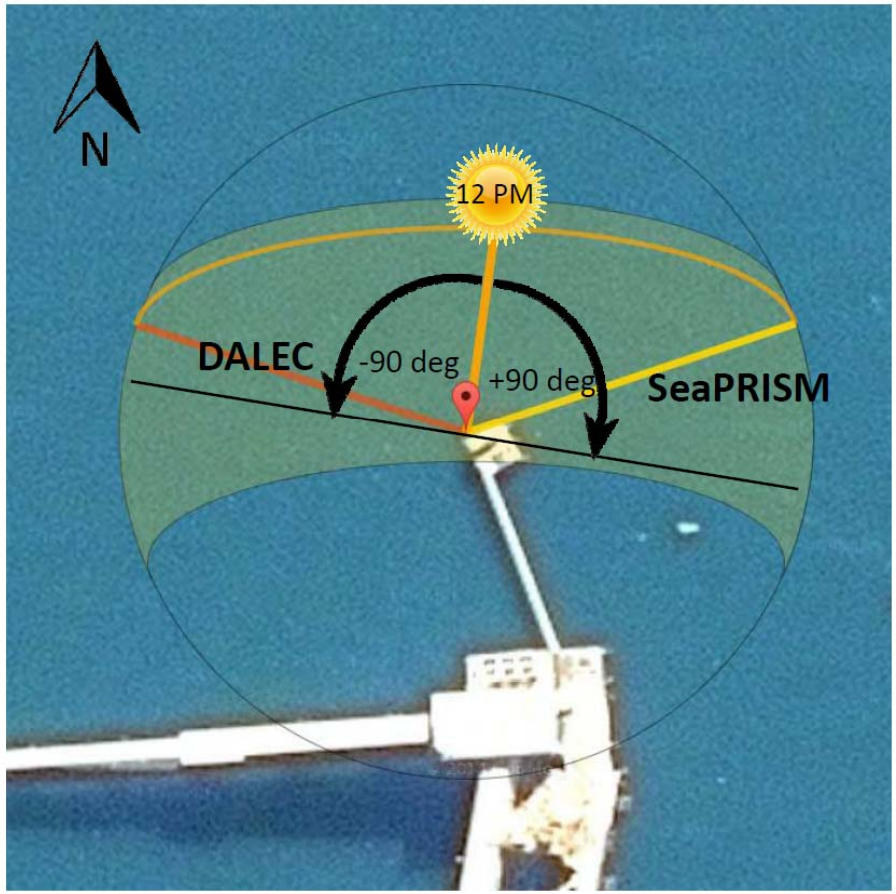
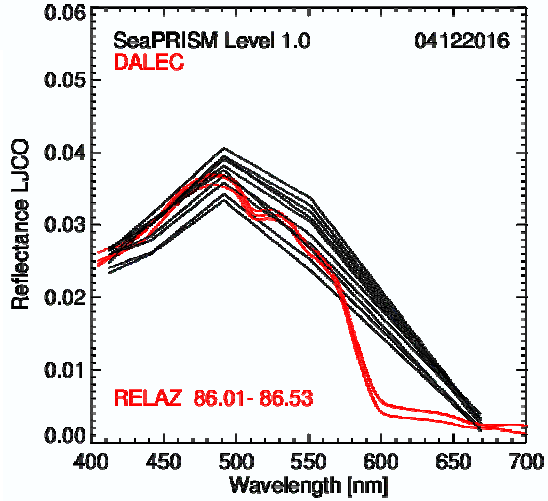
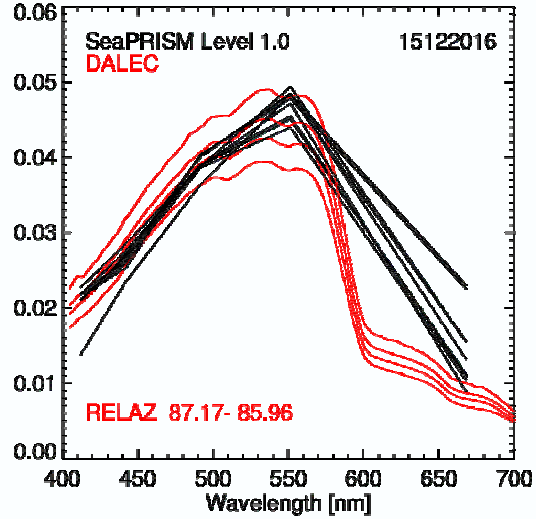
Extras

Level 2 Radiance Validation - LJCO

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



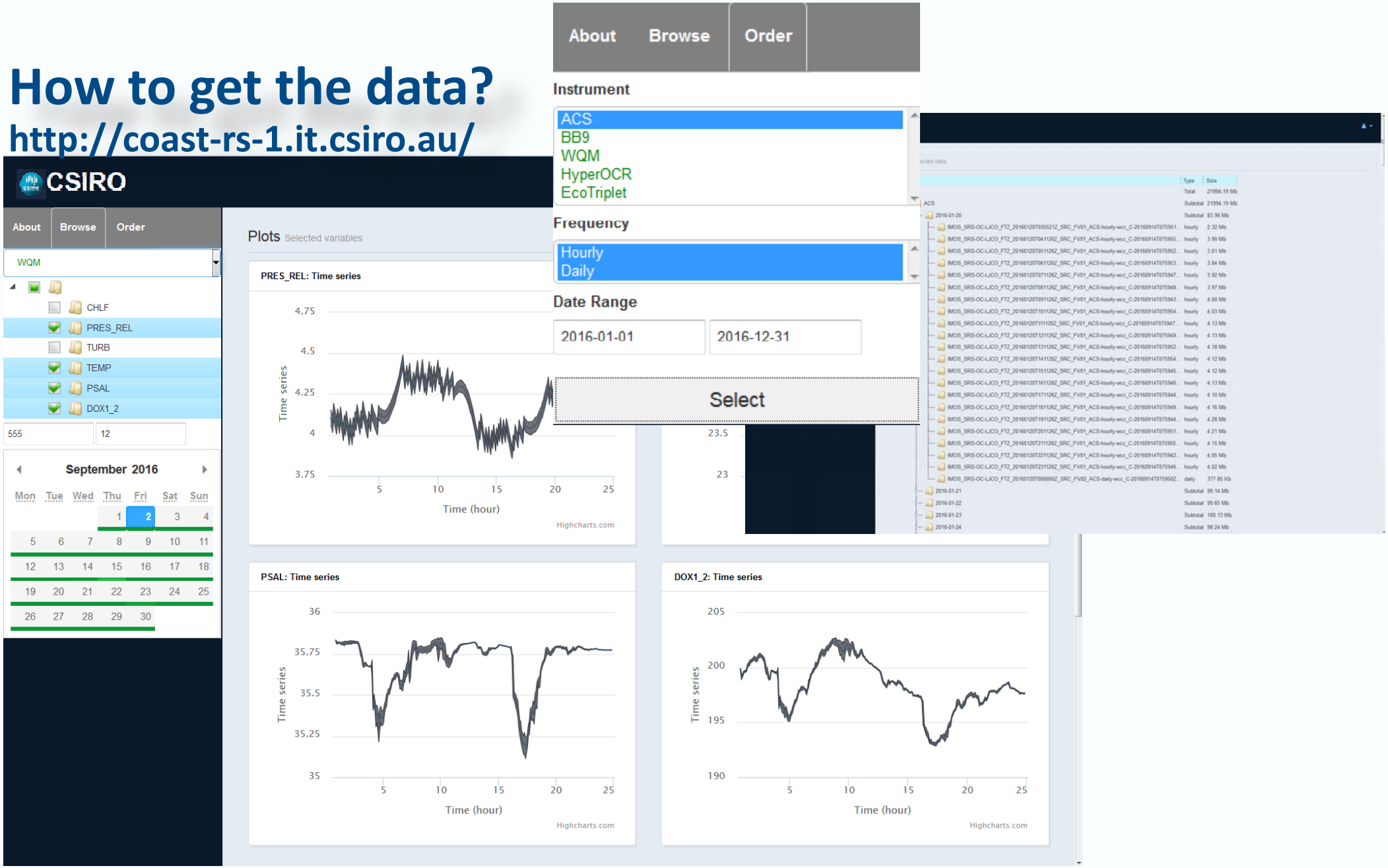




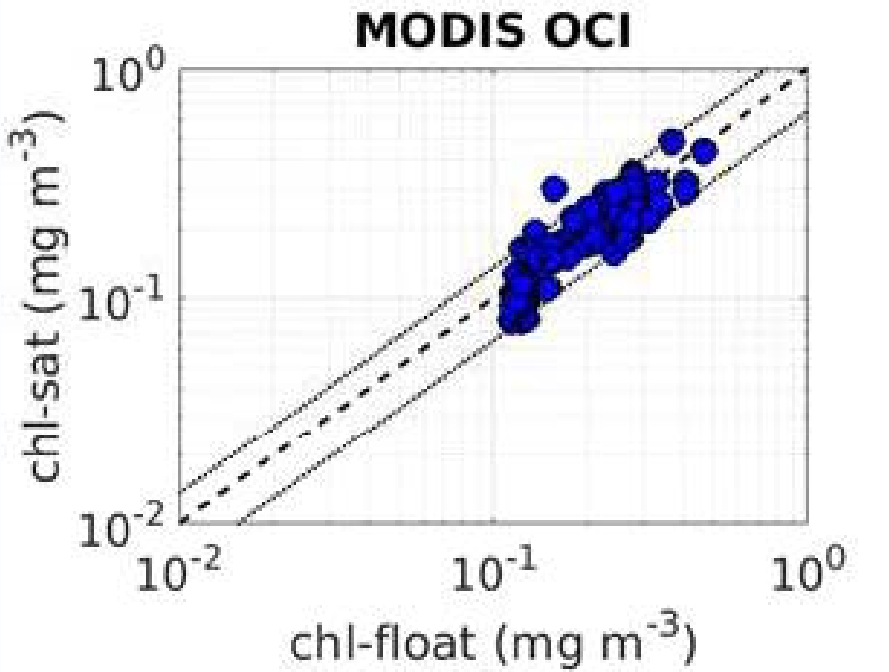
- DALEC and SeaPRISM radiometry now in good agreement
- DALEC required to capture AM satellite passes (Sentinel-3A)

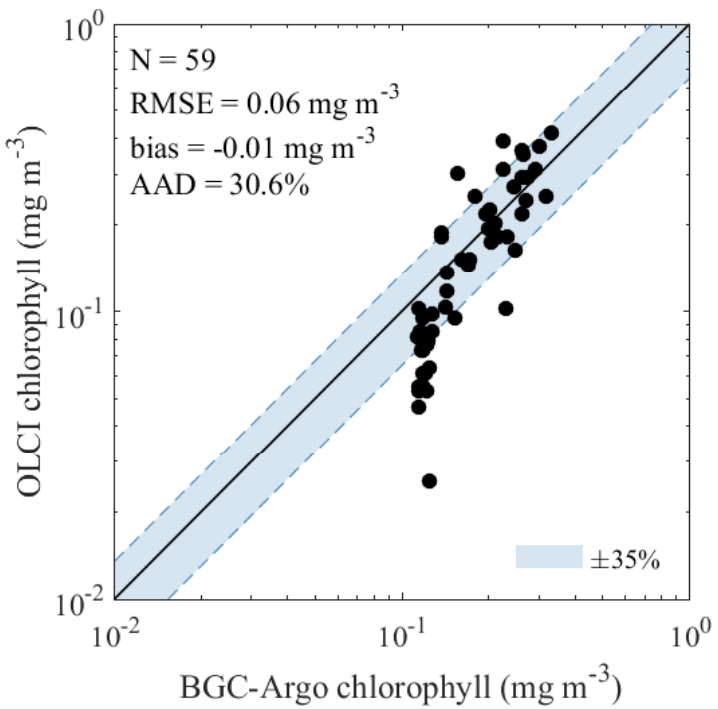
How to get the data?

http://coast-rs-1.it.csiro.au/



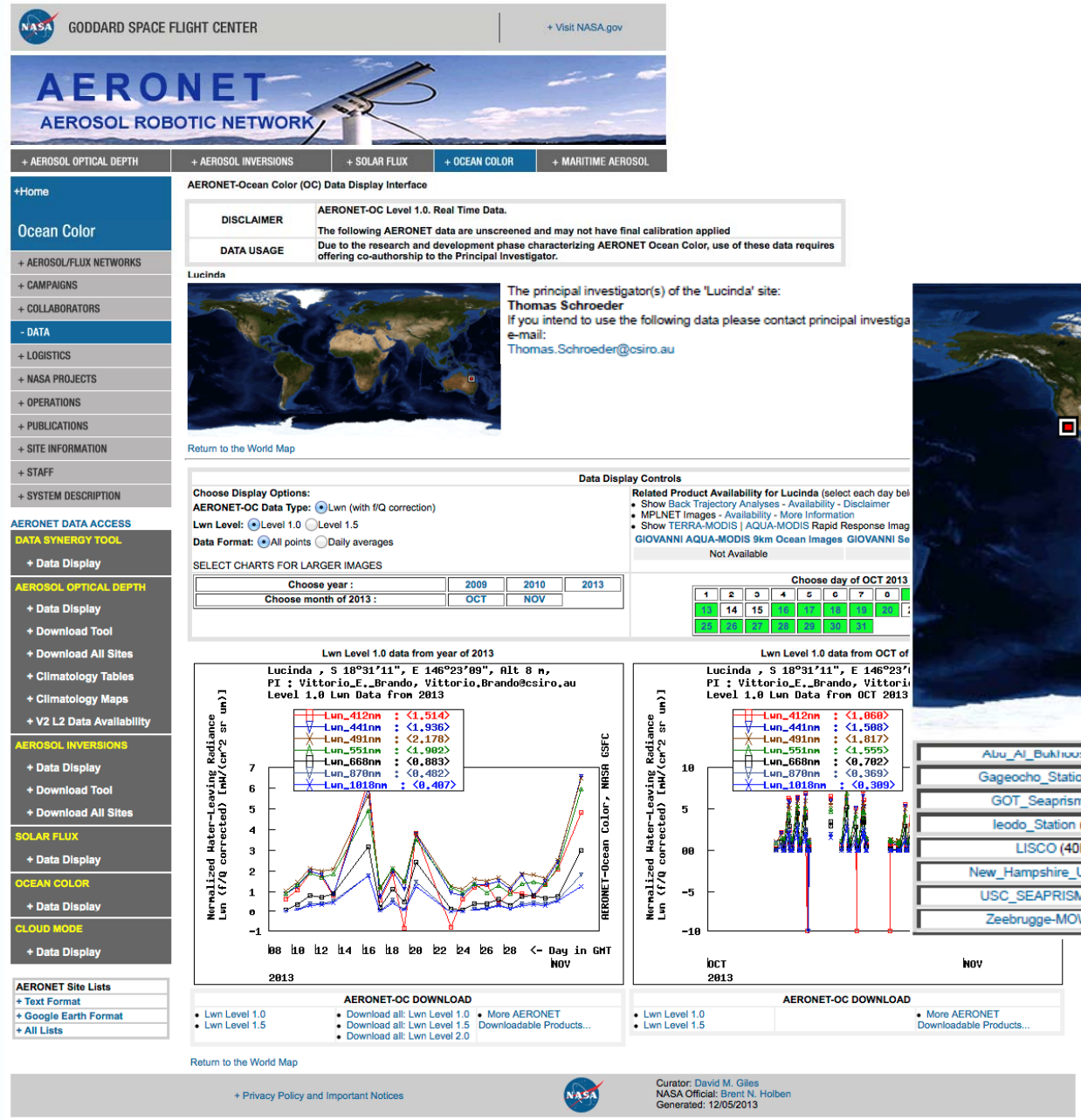
BGC argo MODIS - Pacific

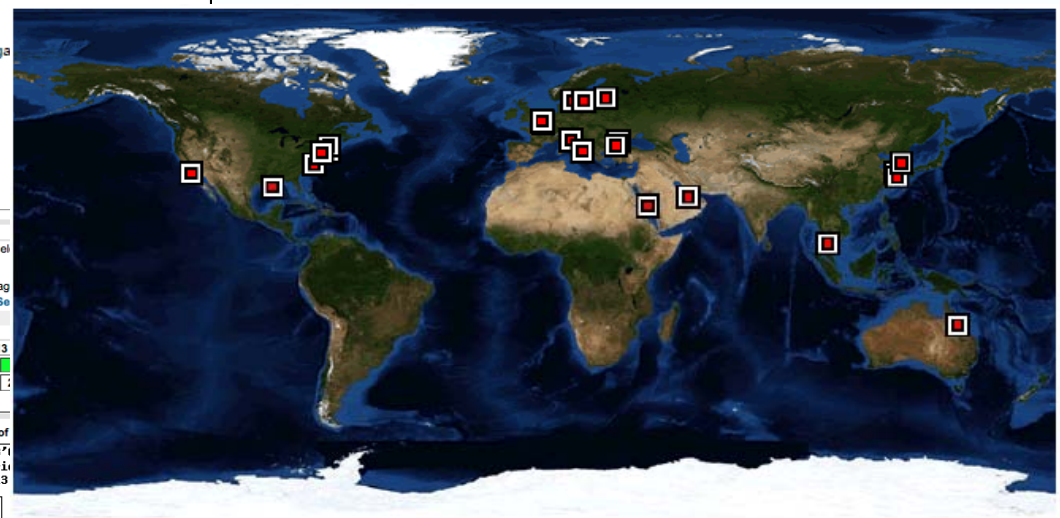




SeaPRISM data

Online at NASA Aeronet-OC



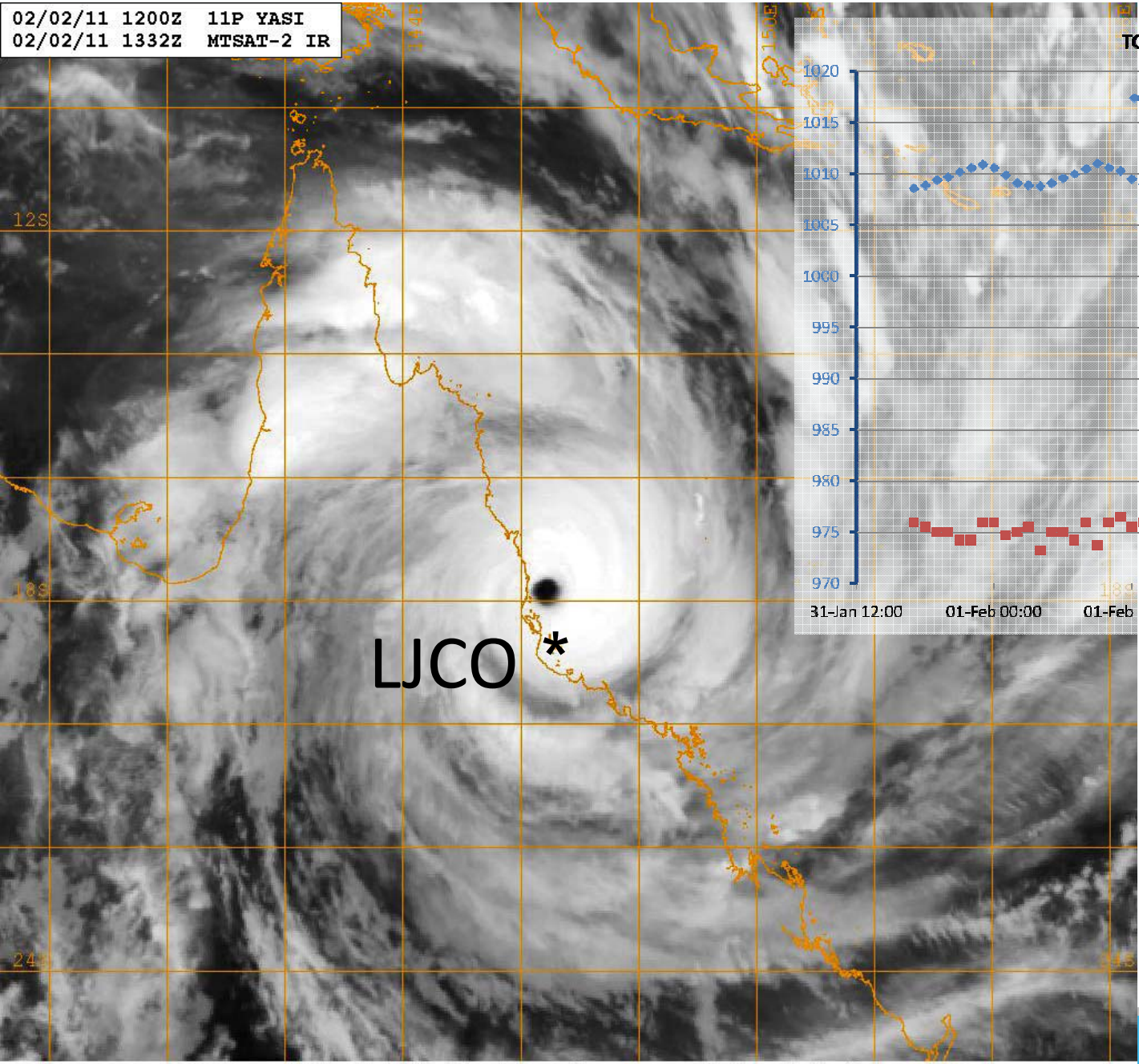


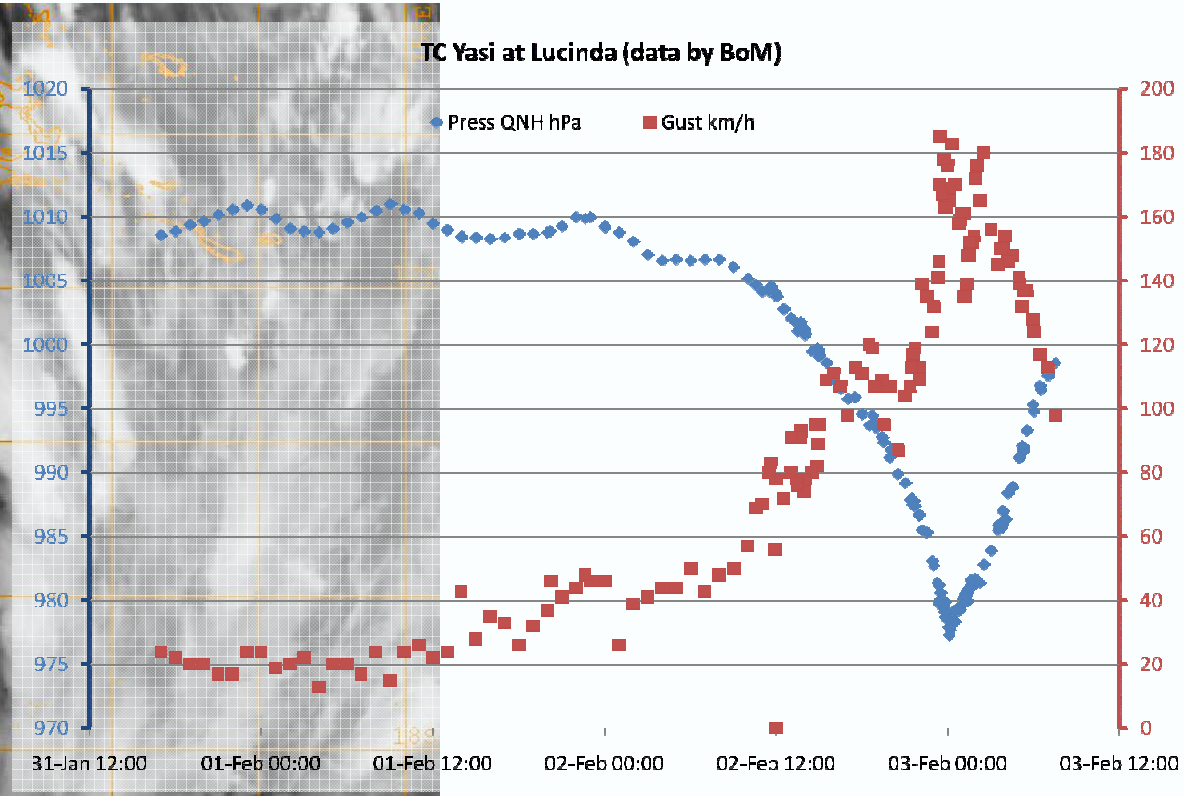
Abu_Al_Bukhoosh (25N,53E)	Bari_Waterfront (41N,16E)	COVE_SEAPRISM (36N,76W)
Gageocho_Station (33N,124E)	Galata_Platform (43N,28E)	Gloria (44N,29E)
GOT_Seaprism (9N,101E)	Gustav_Dalen_Tower (58N,17E)	Helsinki_Lighthouse (59N,24E)
Ieodo_Station (32N,125E)	KAUST_Campus (22N,39E)	KIOST_Ansan (37N,126E)
LISCO (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_6 (28N,90W)
Zeebrugge-MOW1 (51N,3E)		

http://aeronet.gsfc.nasa.gov/new_web/ocean_color.html


02/09/2014 10:56

Severe Tropical Cyclone Yasi (Category 5)
2-3 February 2011



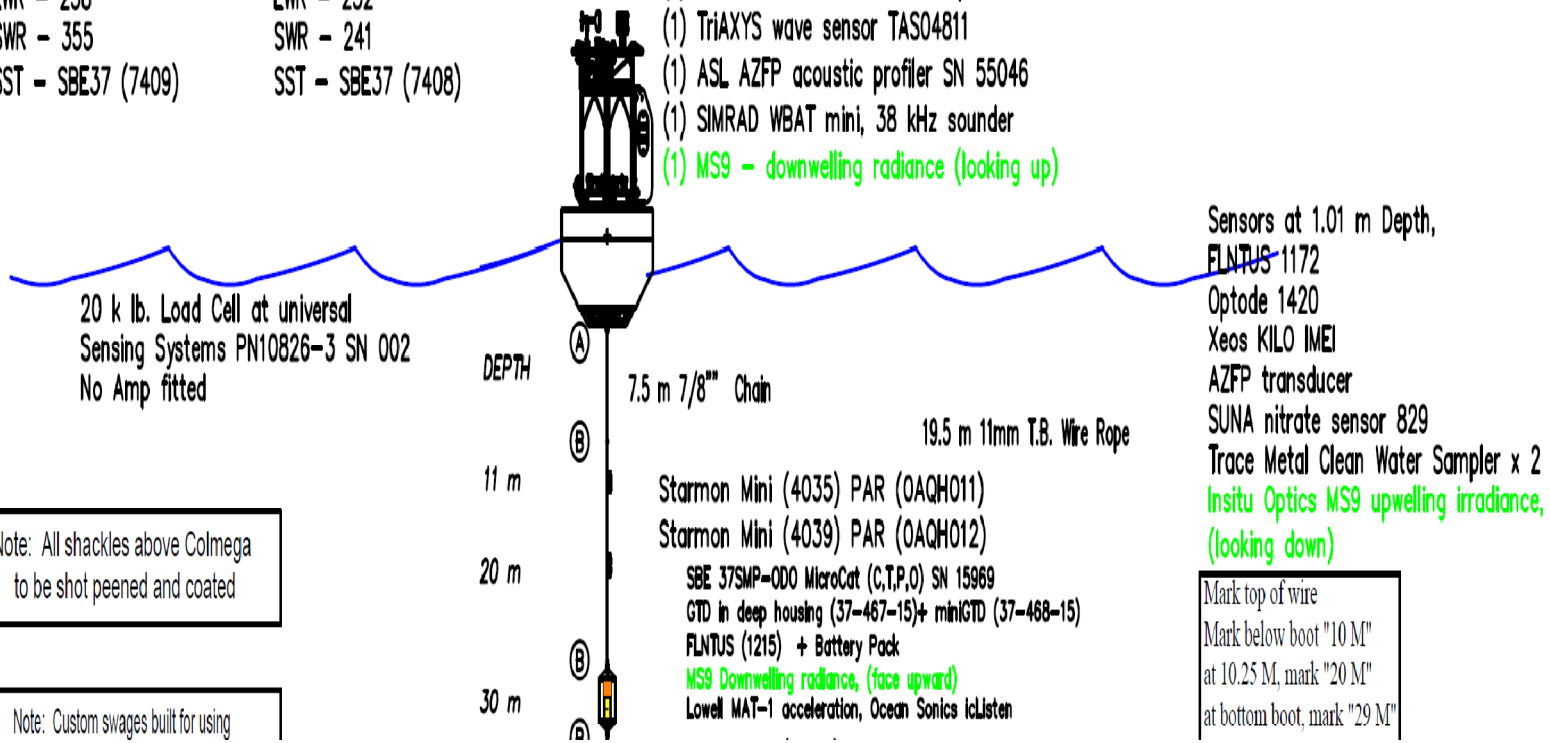


SOFS-7

2.7 m Modular Buoy with the following equipment:
(2) ASIMET with IridiumTelemetry L22 and L23
(1) Pickup Rope Launcher 27.195 MHz, Remote
(1) PMEL PCO2 System, SN=
(1) CSIRO MRU logger for (FLNTUS, Optode, LiCOR Par, loadcell, MRU) IMEI
(1) LiCOR PAR LI-1905A=
(1) NAL-Tracker IMEI 300234064802080
(2) Solar lights, Flash 6 sec, 0.5 sec On
(1) SBE39 SN 5282
(1) Trace Metal Clean Water Sampler
(1) TriAXYS wave sensor TAS04811
(1) ASL AZFP acoustic profiler SN 55046
(1) SIMRAD WBAT mini, 38 kHz sounder
(1) MS9 – downwelling radiance (looking up)

L22 IMEI 300234063587940
HRH -363
BPR - 276
PRC - 227 (CT S 9217)
SWND -
LWR - 238
SWR - 355
SST - SBE37 (7409)

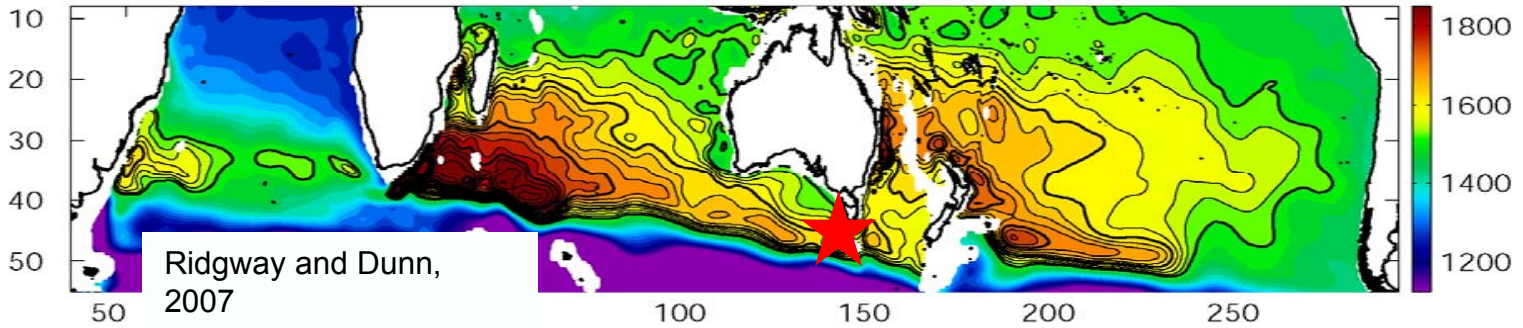
L23 IMEI 300234010551260
HRH - 255
BPR - 227
PRC - 228 (CT S)
SWND
LWR - 252
SWR - 241
SST - SBE37 (7408)



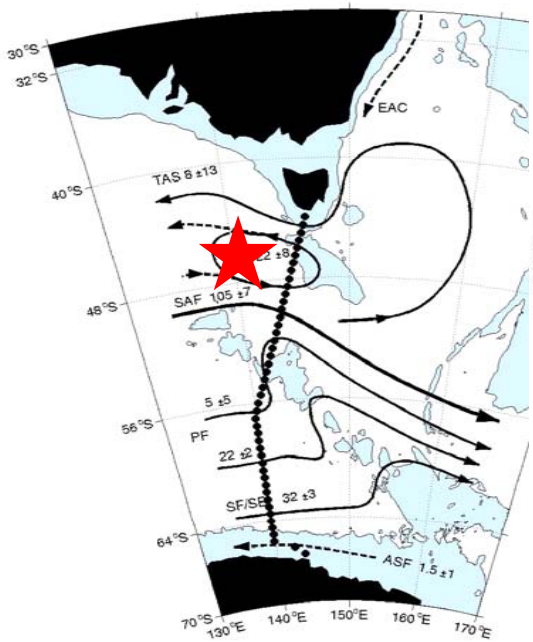
Note: All shackles above Colmega to be shot peened and coated

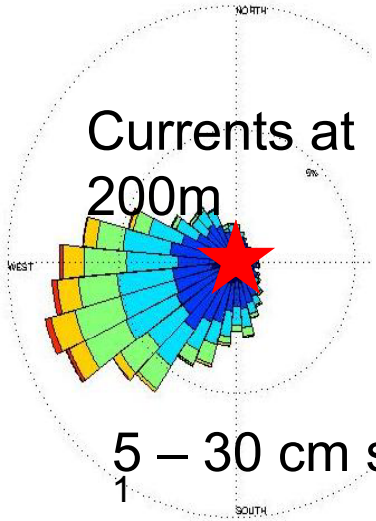
Note: Custom swages built for using

SOTS location: west flowing closer of super-gyre, upper limb of overturning circulation



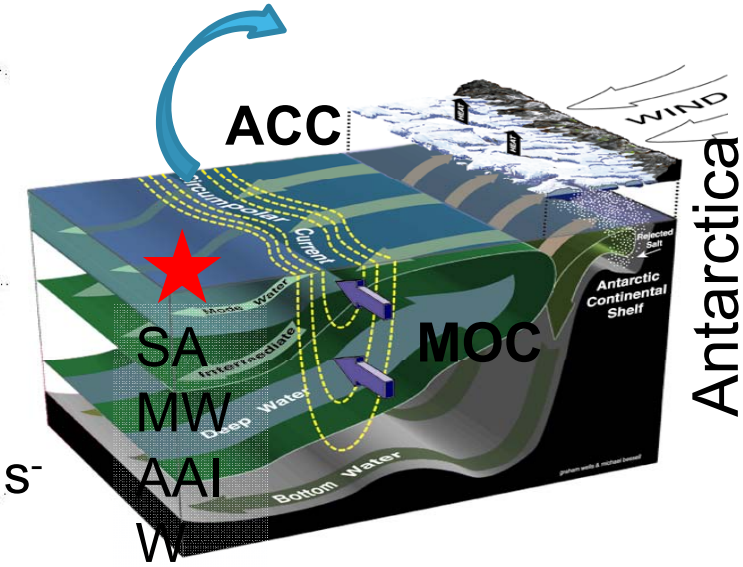
Ridgway and Dunn, 2007





Currents at 200m

5 – 30 cm s^{-1}



SA MW AAIW

MOC