Glimpses of the bio-optical variability in coastal waters of Western Australia from a "Thetis" profiler moored off Perth.

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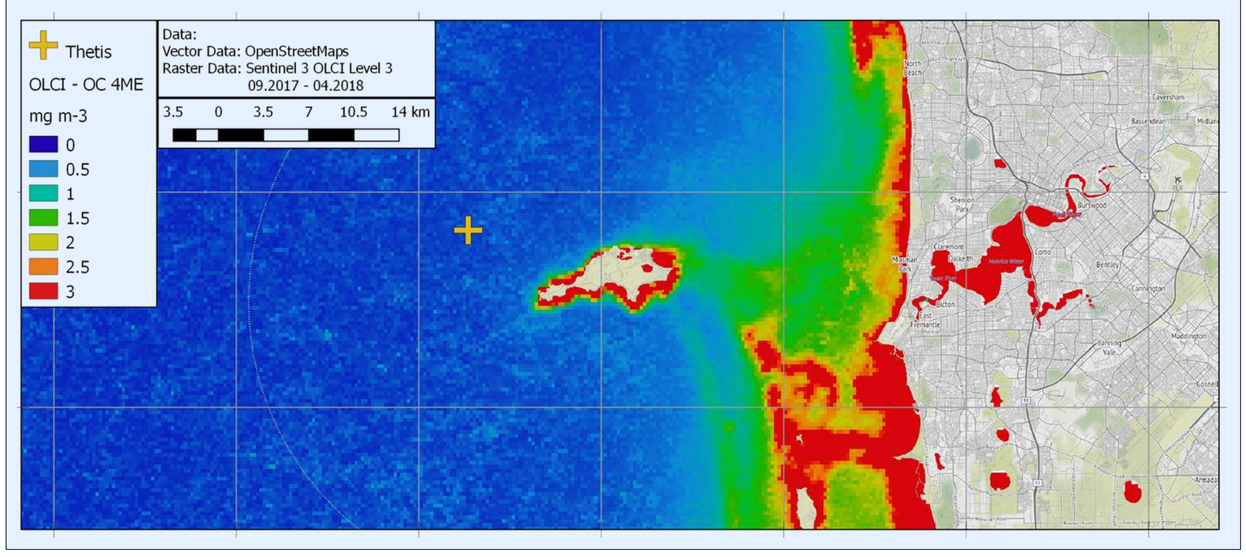
A WET Labs “Thetis” moored profiler was deployed off Perth, Western Australia, in an effort to start characterizing the bio-optical variability in coastal waters (depth ~60m) influenced by the Eastern Indian Ocean environment. Objectives also include evaluating the diel variability in bio-optical and other properties in view of determining ecosystem productivity, and delivering reflectance matchups for current ocean colour remote sensing satellite missions (in particular the Copernicus Sentinels). Measured parameters include temperature and salinity, dissolved oxygen, chlorophyll and CDOM fluorescence and optical particle backscattering (at 470, 532 and 700 nm), total hyperspectral attenuation and absorption, upwelling radiance at nadir and downward irradiance. Data were first collected in October and November 2017, with 0-50m profiles at dawn, midday and dusk. Additional data started to be collected from mid February 2018, with only one profile at 11am each day. Water optical properties are as expected for an oligo- to mesotrophic environment, where surface chlorophyll concentrations are minimum in summer (November) of about 0.1 mg m-3, and increase up to about 0.5 mg m-3 when fall begins in April. Higher concentrations, up to about 1 mg m-3 are observed at depths around 30-40m. Preliminary results indicate that bio-optical relationships would conform to average models. Reflectance matchups show some underestimation of the reflectance in the blue by the Sentinel3A/OLCI sensor.

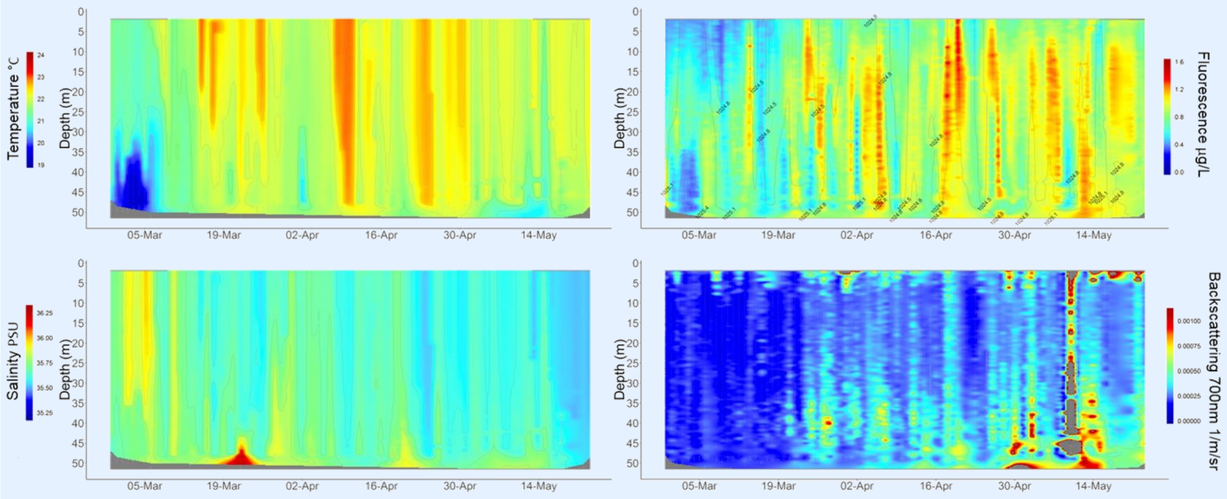
Geographical Location

The “Thetis” is a positively buoyant profiling instrument frame that has an on-board winch and 3G telemetry system. The Thetis is deployed between Rottnest Island and the Rottenest Island canyon in approximately 60m of water and collects data during the ascent.

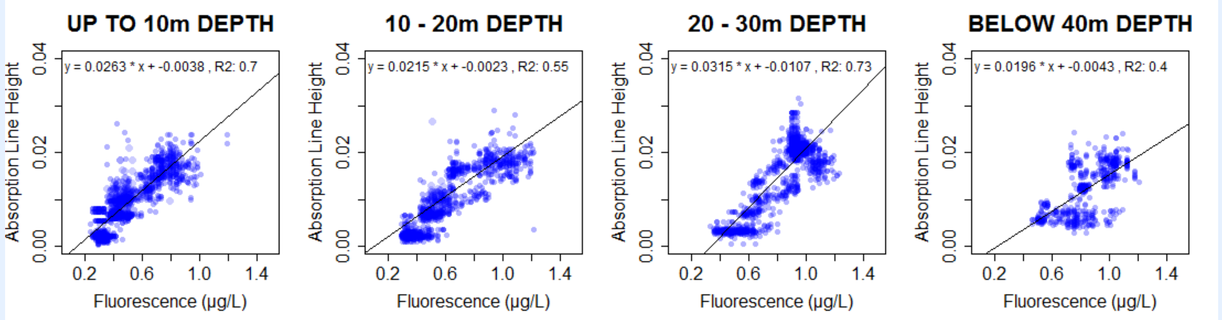


Measurement Results

Measured profiles were filtered for corrupt data and evaluated over time and depth. The daily profiles for 2018 of the ECO Triplet Fluorometer show an increase from February to May. Single periods feature a striking high level of chlorophyll for all depths. Especially in march a low chlorophyll content below 30m and in mid April a high chlorophyll content can be depicted. Increases or decreases in temperature may explain the peaks or lows in chlorophyll. Generally the temporal patterns in particulate backscattering coefficient at 700 nm were similar to chlorophyll, however the depth-specific relationships within each profile demonstrated considerable variability.



A second estimate of chlorophyll was derived using the Absorption Line Height (ALH) calculated from the WET Labs AC-S spectrophotometer using bands centred at 651 nm, 677 nm and 700 nm. The result were compared to the measured fluorescence from the ECO Triplet Fluorometer. AC-S Profiles from 2017 were neglected due to rusting flow tube collars. For all depths, a linear relationship can be assumed. The AHL determination is effective in removing the contributions to absorption by coloured dissolved organic matter and non-algal particles. Furthermore the AHL is not sensitive to incident irradiance, in particular non-photochemical quenching. At all depths above 40m, the ALH is significantly and positively related to the ECO measured fluorescence. Below 40m depth a deviation for a low AHL occurs.



Deployed Instruments

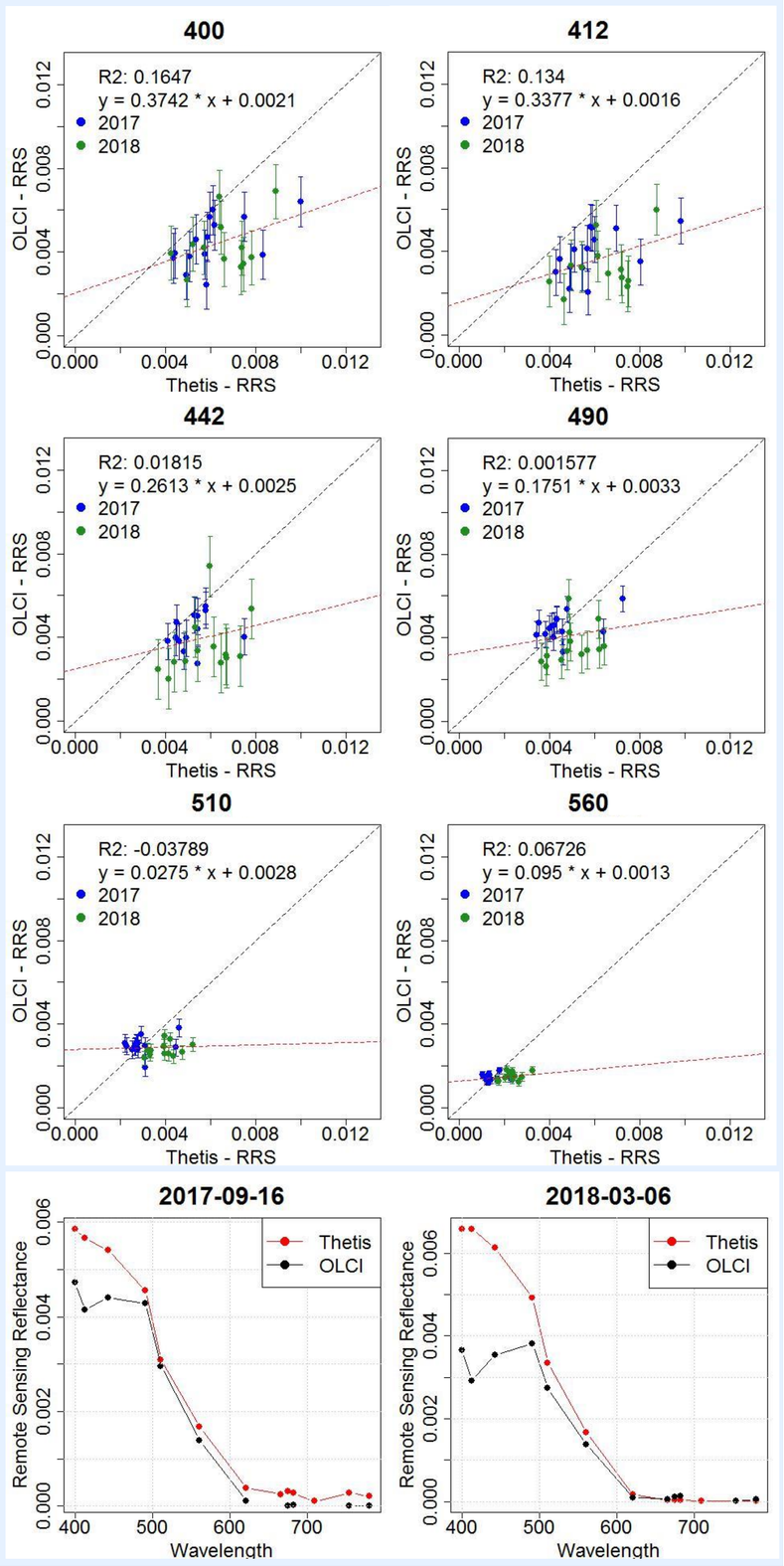
The Thetis is equipped with a unique physical and optical sensor payload, including:

- Seabird Conductivity, Temperature, and Pressure Sensor (SBE 49 FastCAT)
- 2x WET Labs ECO Triplet BB2FLs
  - Backscattering measurements at 470nm, 532nm and 700nm
  - 370nm/460nm (CDOM)
  - 470nm/695nm (Chlorophyll)
- WET Labs AC-S hyperspectral reflective tube spectrophotometer
  - a and c at 400-730nm (~4nm intervals)
- 2 x Satlantic HyperOCR (Ed, Lu) for profiling radiometry
- Seabird Dissolved Oxygen SBE43

Remote Sensing Reflectance Analysis

Remote sensing reflectance (R_{RS}) from the “Thetis” Satlantic HyperOCR sensors was estimated using different exponential extrapolation methods for downwelling irradiance. Firstly above-water irradiance data was used during Thetis surfacing events.
Secondly, both surface and subsurface data was included in the extrapolation model fit. ESA Sentinel 3 OLCI reflectances from pre-processed maritime Level 2 products were extracted and compared to temporal matching Thetis R_{RS} . Wavelength dependent scatterplots including both years are illustrated. All scatterplots show a underestimation of R_{RS} in the OLCI products. The bands at 400 and 412 particularly outline this effect. At 442 and 490 nm significant underestimations by the OLCI is evident during 2018. As expected no trend was evident in the match ups at 510.

A recurring pattern in the blue the OLCI spectra was observed as shown by the two sample dates here. An unusual inflection is evident in the blue bands around 412 nm, and was more prominent in matchups from 2018. The cause of the inflection remains undetermined.



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