BIOSCape - Mapping of phytoplankton functional types (PFTs) from space in support of coastal resource management and decision support activities

Jinghui WU(Lead PI), Joaquim I. Goes(co-I), Helga do. R. Gomes(co-I)

Lamont Doherty Earth Observatory at Columbia University, New York, USA

Grant C. Pitcher (co-I/non-US)

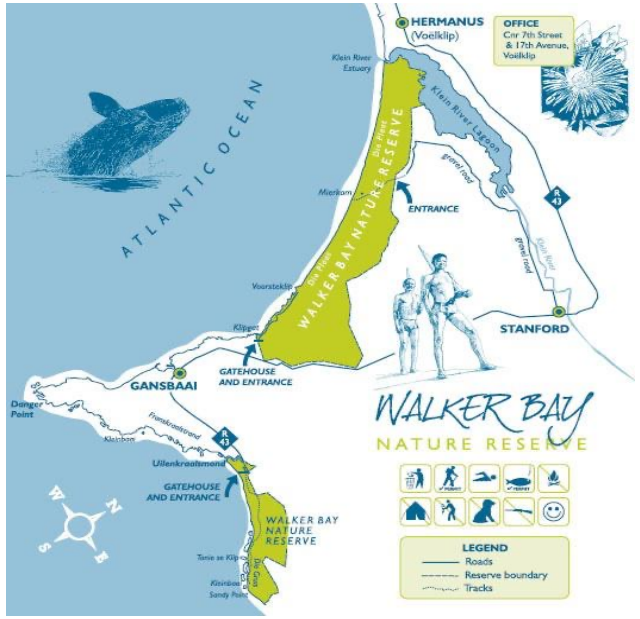
Dept. of Agriculture, Fisheries and Forestry, Cape Town, SA

Thomas G. Bornman (co-I/non-US)

Institute for Coastal and Marine Research, Nelson Mandela University, Gqeberha, SA; & South African Environmental Observation Network, Elwandle Node, Gqeberha, SA

Research Area

Walker Bay



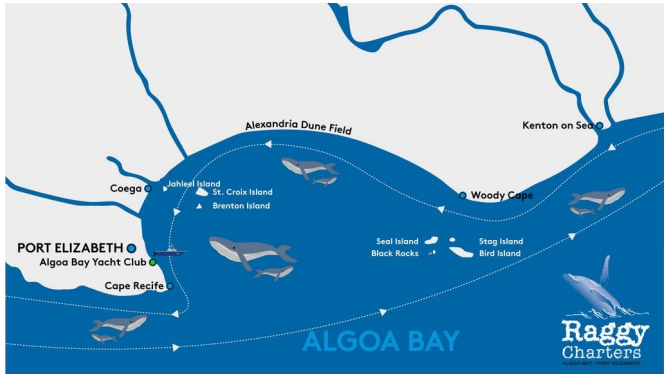
showme.co.za (Pitcher et al, 2019)

St Helena

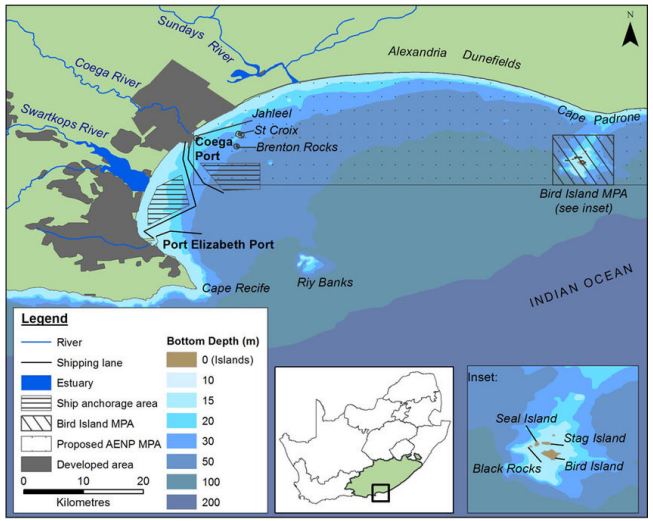
www.saintcooks.com

www.nmbt.co.za

Algoa Bay



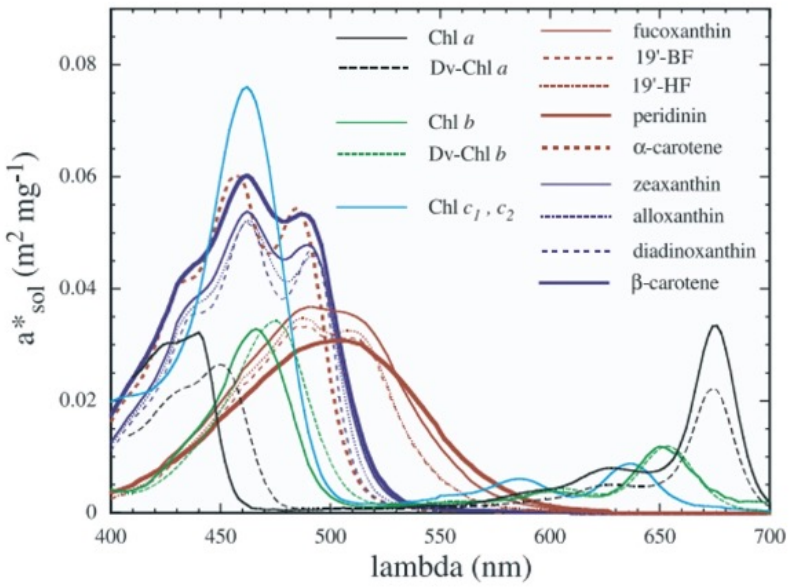
www.raggycharters.co.za



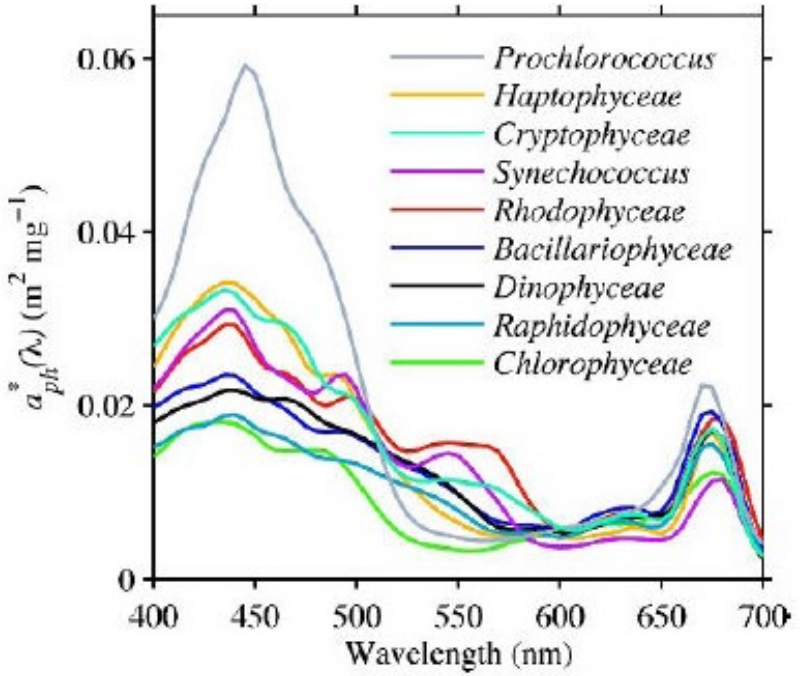
(Dorrington et al, 2018)

Goal

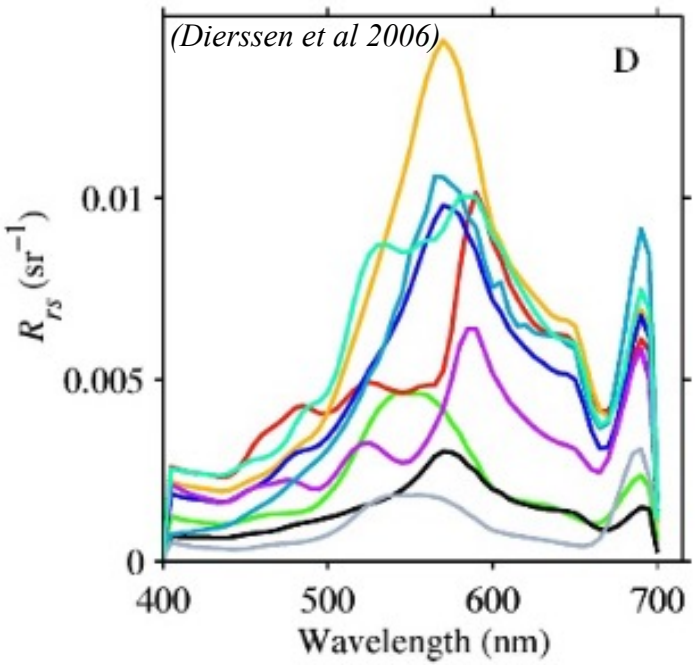
Develop a hyperspectral radiometric method to map the spatial distribution of **phytoplankton functional types (PFT)** across environmental gradients within these three ecologically distinct but socio-economically vital bays.



Absorption of individual Pigments



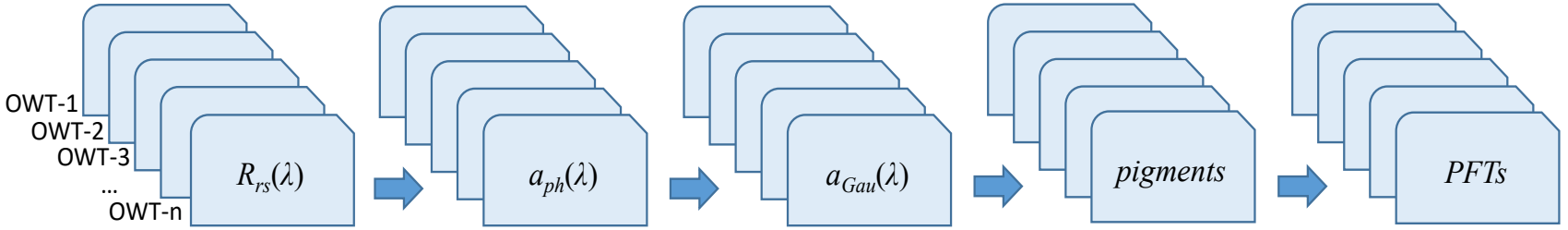
Aph of PFTs



Remote sensing reflectance (Rrs)

Method

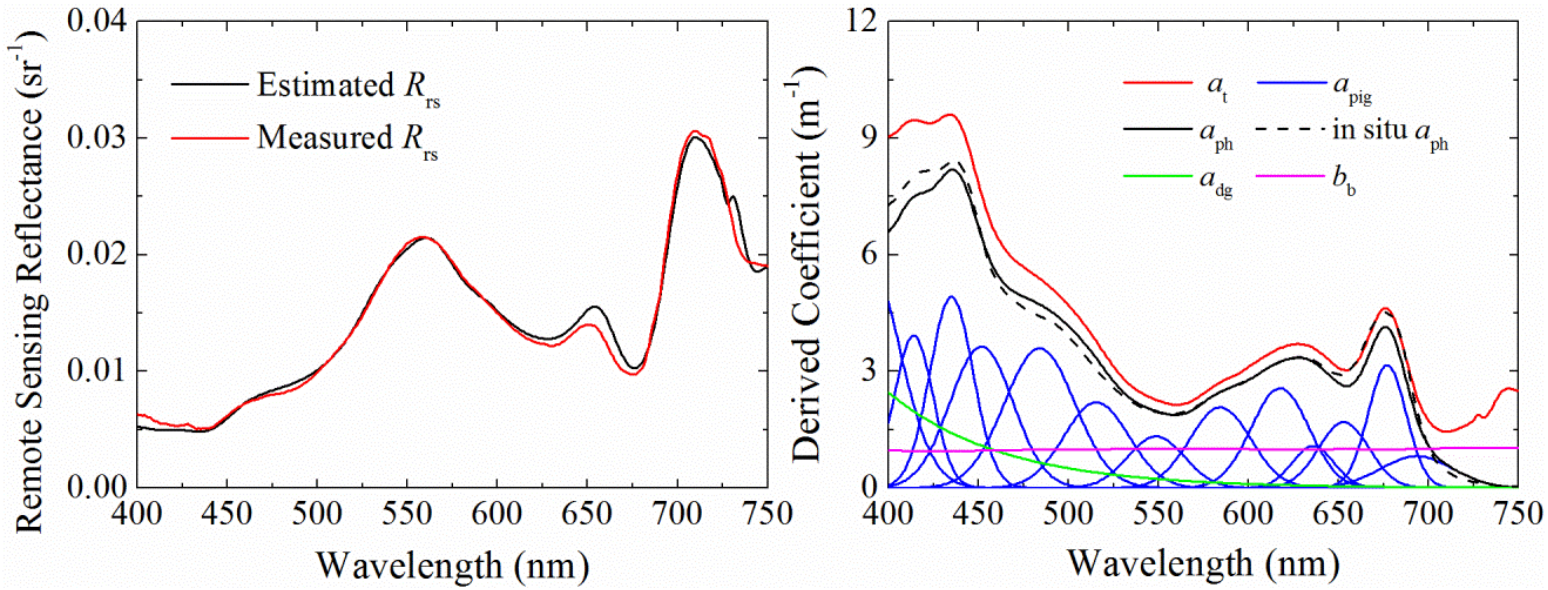
Multi-pigment inversion model (MuPI)



$$R_{rs}(\lambda) = f\left(\frac{b_b}{a_t + b_b}\right) = f\left(\frac{b_{bw} + 0.01\left(c_s - a_{ph}(\lambda)\right)}{\sum_{i=1}^{n} a_{gaus}(\lambda_i)\exp\left[-0.5\left(\frac{\lambda - \lambda_i}{\sigma_i}\right)^2\right] + a_{dg}(\lambda_0)\exp\left(-S(\lambda - \lambda_0)\right) + a_w + b_{bw} + 0.01\left(c_s - a_{ph}(\lambda)\right)}\right)$$

Where

- a_{gaus} and s(λ) are the peak magnitude and width of the i^{th} Gaussian Curve
- $a_{dg}(\lambda)$ is absorption coefficient of detritus and colored dissolved organic matter
- a_w (λ) is the absorption coefficient of seawater
- c_s is the beam attenuation coefficient
-



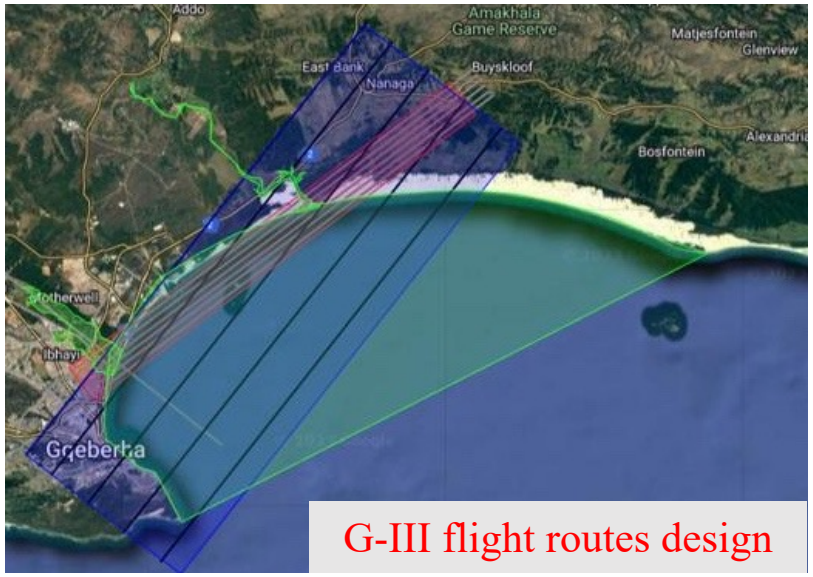
(Wang et al. 2016; Wang, Lee & Mouw, 2017)

Data Collection (NASA BIOSCape Oct 13rd- Nov 19th 2023)

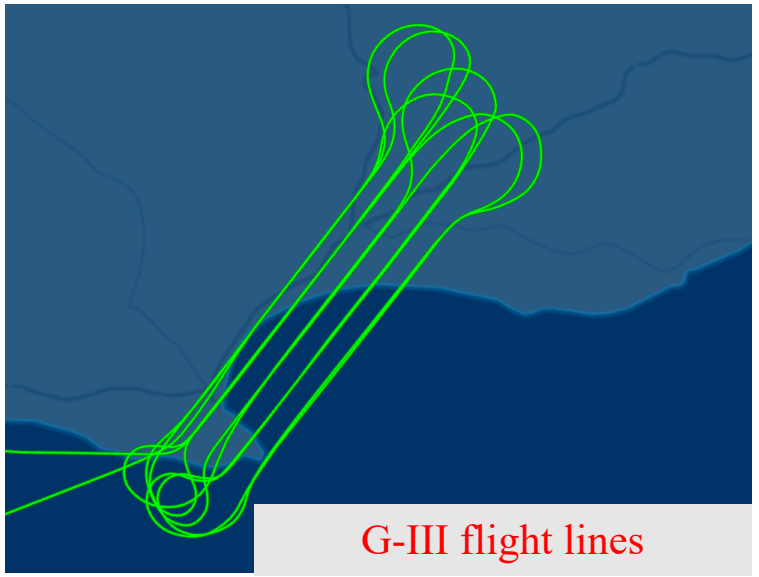
- **Algoa Bay**
  - - Oct 25th
  - - Oct 26th
- **St Helena Bay**
  - - Oct 30th
  - - Oct 31st
- **Walker Bay**
  - - Nov 08th
  - - Nov 09th
- **False Bay**
  - - Nov 12nd

Type	Property and/or description	Methods or instruments	Sampling mode
AOPs	R_{rs} : remote sensing reflectance	SVC Hri (Spectra Vista Corp)	On station at surface
	Ed(z) and Lu(z) : vertical profiles of irradiance and radiance	HyperPro II (Satlantic)	On station depth profile
IOPs	a : total absorption coefficient	ac-s (WET Labs)	Depth Profile/Underway
	c : total beam attenuation coefficient; b_p (=c-a -b_w): particle scattering	ac-s (WET Labs)	Depth Profile/Underway
	b_{bp} : particle backscattering coefficient	BB9 (WET Labs)	Depth Profile/Underway
	a_p , a_{ph} : of particles and phytoplankton,	Filter-pad & spectrophotometer (Shimadzu)	Discrete depth
	a_g : CDOM absorption coefficient	Spectrophotometer (Aqualog)	Discrete depth
Bio-optical	PFTs and PSCs	PFT-Imaging Microscopy (Nikon), FlowCAM (Fluid Imaging), PFT - Algal Online Analyzer (BBE), ALFA (Wetlabs), e-DNA (qPCR, Biomeme "Franklin")	Discrete depth/Underway
	Concentration of CHL and other pigments	Fluorometry (Turner Designs), HPLC (NASA), ALFA (Wetlabs),	Discrete depth/Underway/Profile
	PSCs and/or PSD	FlowCAM	Discrete depth/Underway
	CDOM concentrations and slopes	Spectrophotometer	Discrete depth
Bydrography Currents, Nutrient, Carbonate Chemistry	Temperature, Salinity, Oxygen, pH profiles, Curents, pCO_2, inorganic nutrients,	CTD, pH and DO Sensors (profiles, ADCP, Nutrients (discrete), pCO2 and pH underway,	Discrete depth/Underway/Flowthrough

Algoa Bay 2023-10-25 (flight)

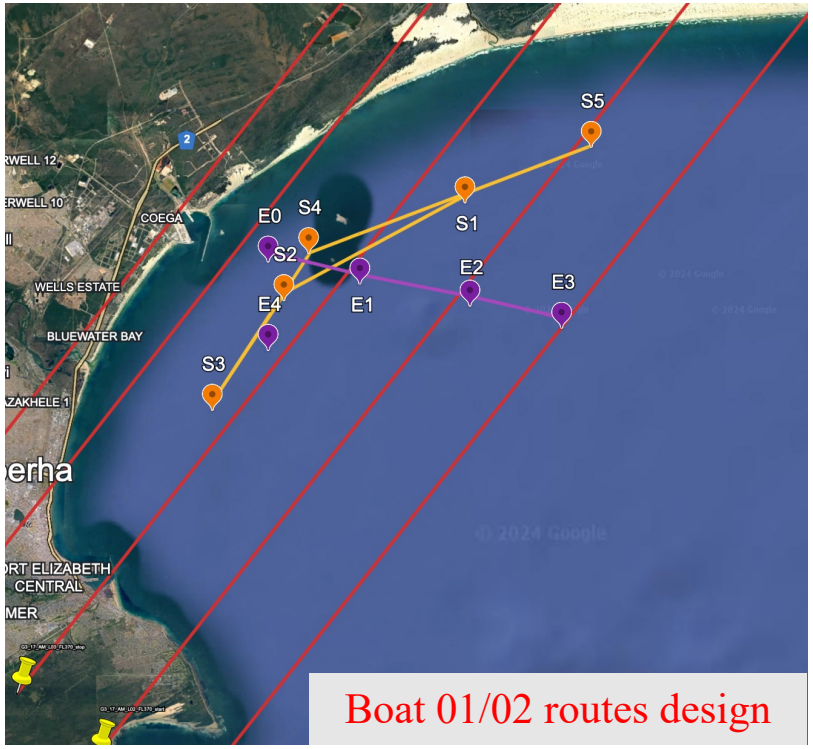


G-III flight routes design



G-III flight lines

Got you, G-III!



Boat 01/02 routes design

Algoa_Bay_NASA_G-III_First line_Picture

Algoa Bay
2023-10-25
(boat 1)

Optical
AOPs

Boat from SAEON

Handhold SVC (above water Rrs)

SBA (on water Rrs)

CTD (T,S,P)

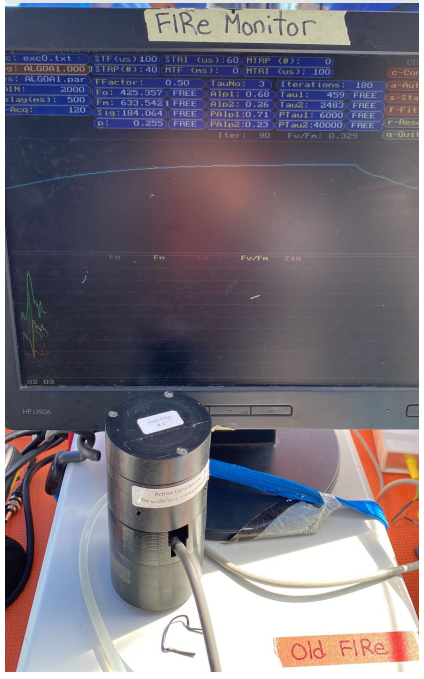
Gybe (Underway Rrs)

Algoa Bay
2023-10-25
(boat 1)

Biological

ALFA (Phytoplankton)

FiRe (Fv/Fm)



FlowCAM (Fluid Imaging for PFTs)

PP incubation

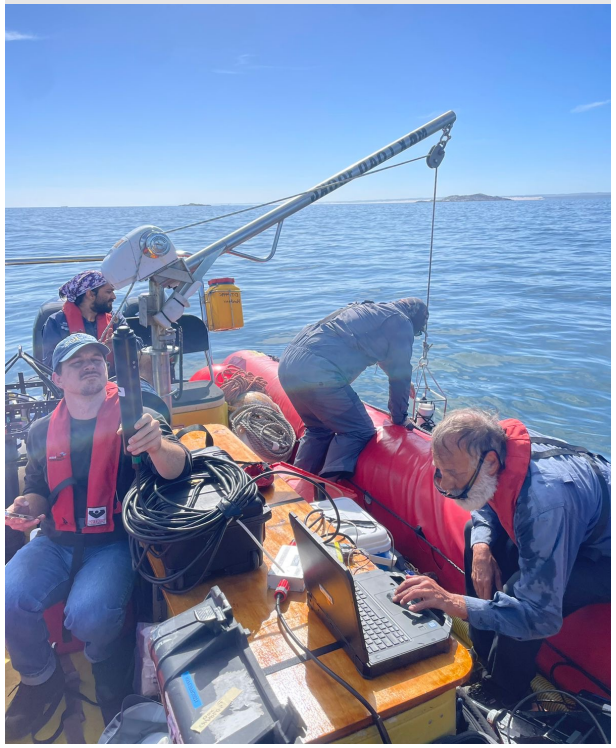
Zooplankton

Algoa Bay
2023-10-25
(boat 2)

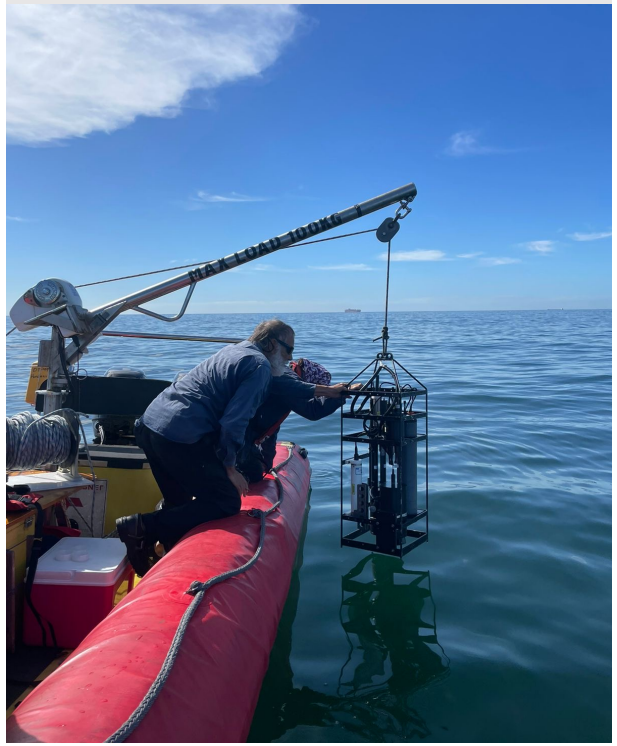
Optical
AOPs & IOPs

Handhold SVC (above water Rrs)

HyperPro (Profile Rrs)

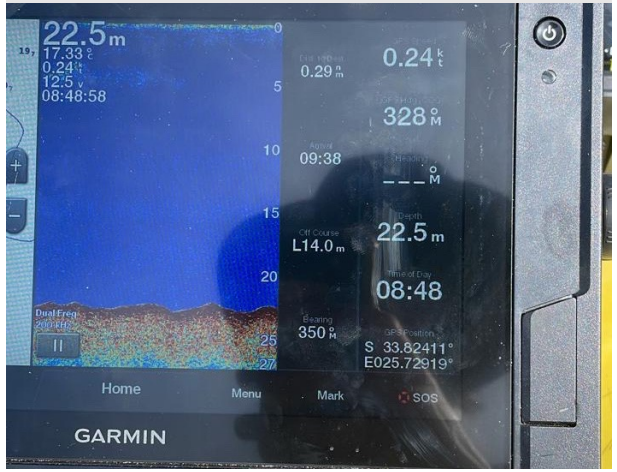


IOPs (ac-s, bb9, CTD)



Profiler Boat 2

Hydrography



Algoa Bay
2023-10-25
(laboratory work)

Bio-optical

Water Samples

Filter-pad (CHL, HPLC, aph, PC/PE, SPM)

DOC & CDOM

Algae cultivation

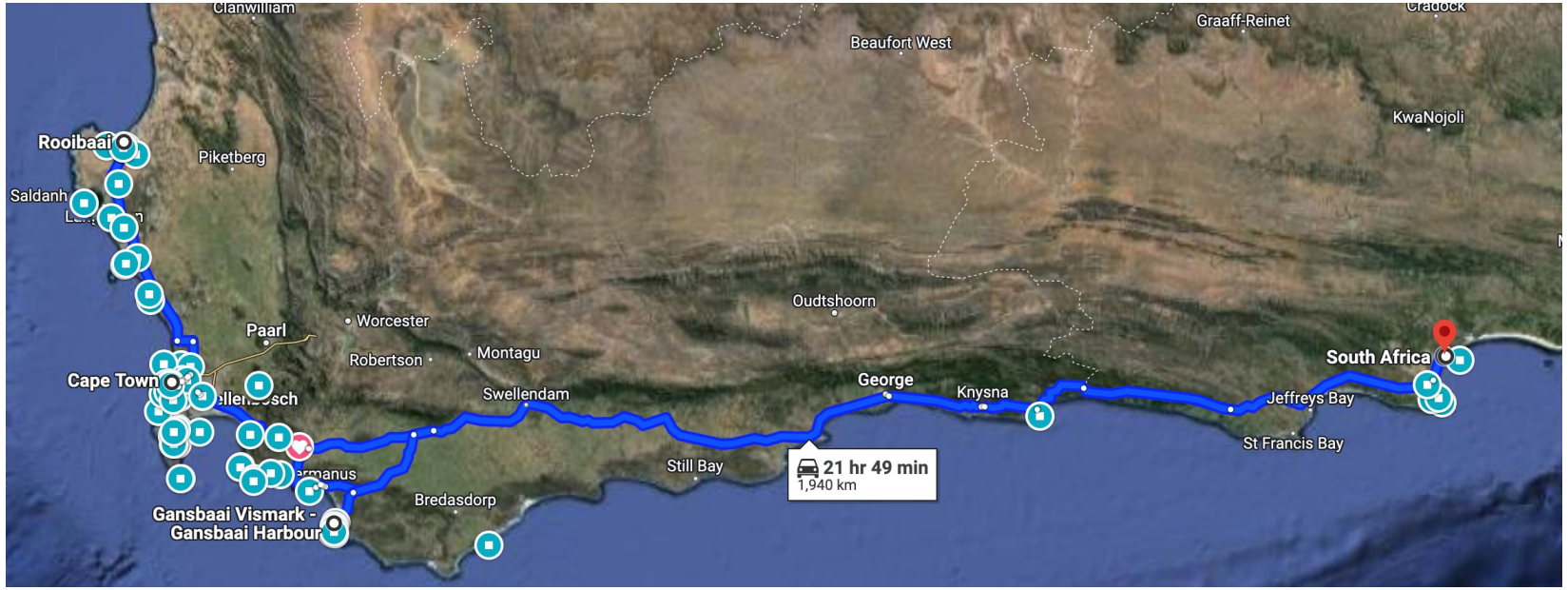
Nutrient

Imaging Microscopy (PFTs)

Per-work / logistical challenges

2000km, > 20 boxes, one gear

- Port Of Coega , Harbour, Coega, (
- Cape Town, South Africa
- Rooibaai, Laaiplek, Bergrivier, 73(
- Cape Town, South Africa
- Gansbaai Vismark - Gansbaai Ha
- Coega, Gqeberha, 6100, South Af



Per-work / logistical challenges

Algoa Bay

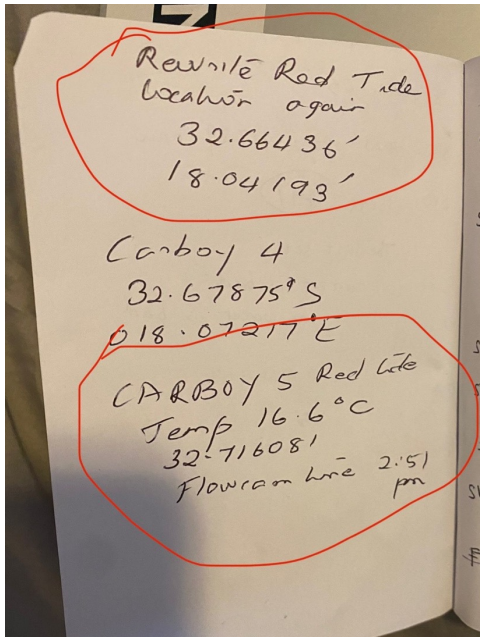
St. Helena Bay

Walker Bay

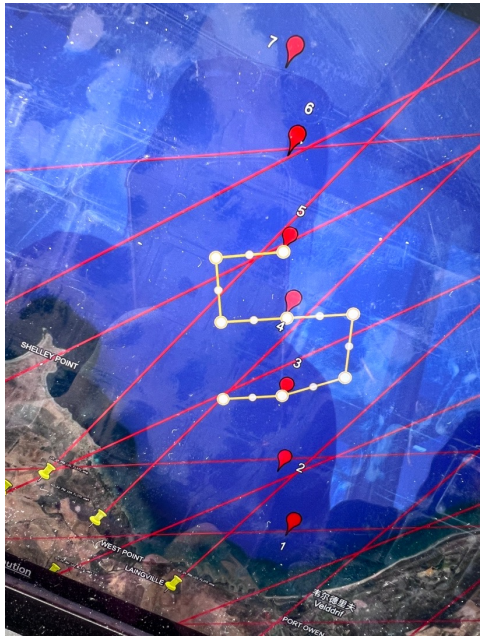
False Bay

2023-10-27
To
2023-10-30

Chasing Red Tide



First day of St. Helena Bay 2023-10-30th

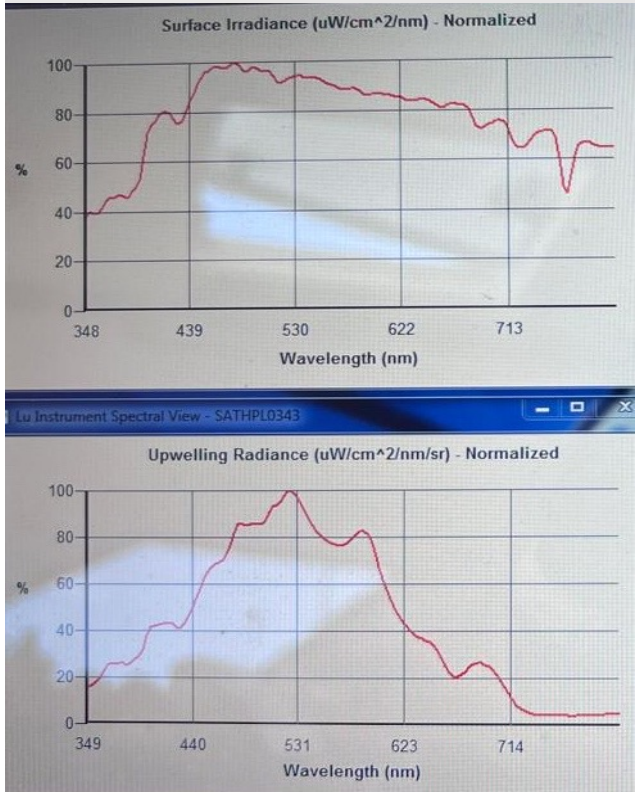


St. Helena Bay
2023-10-31
(boat 1 & 2)

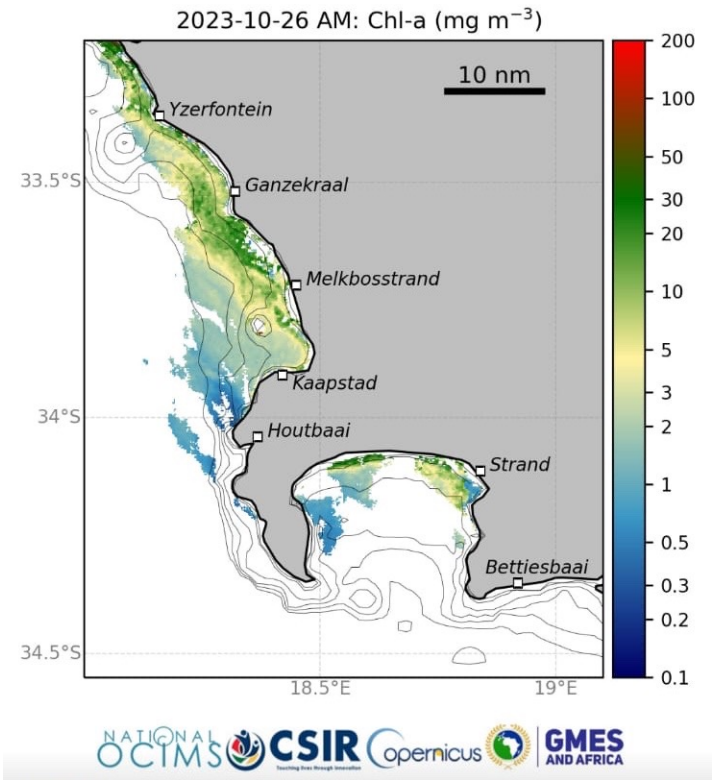
Red Tide

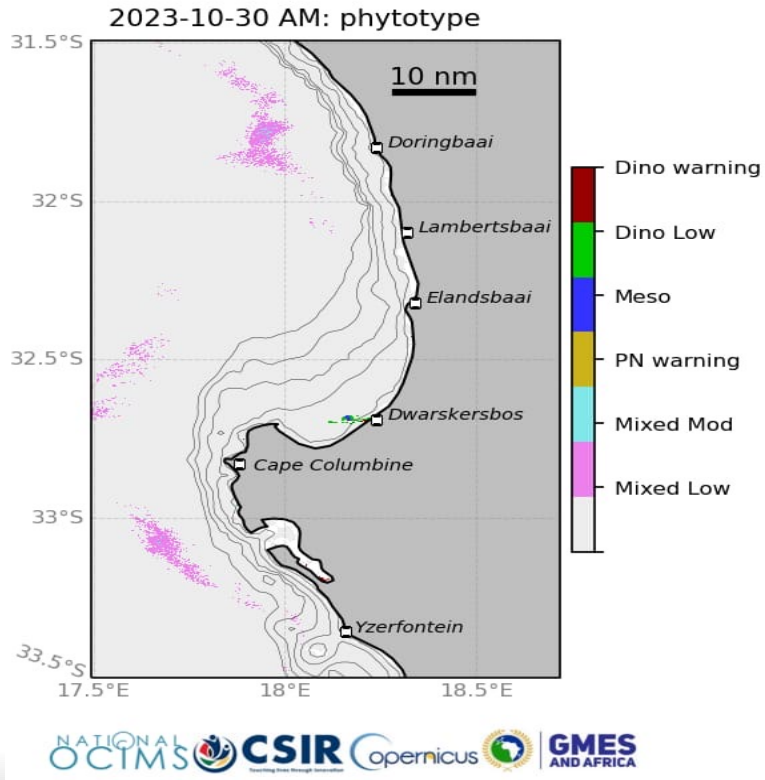
St. Helena Bay
2023-10-31
(Red Tide)

SBA (Huge Algaes in red bands)

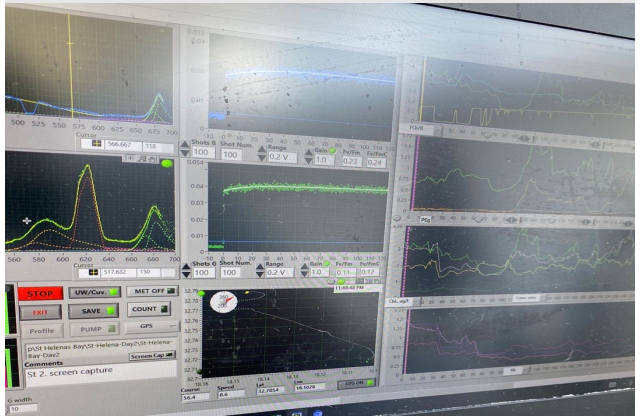


Local Report





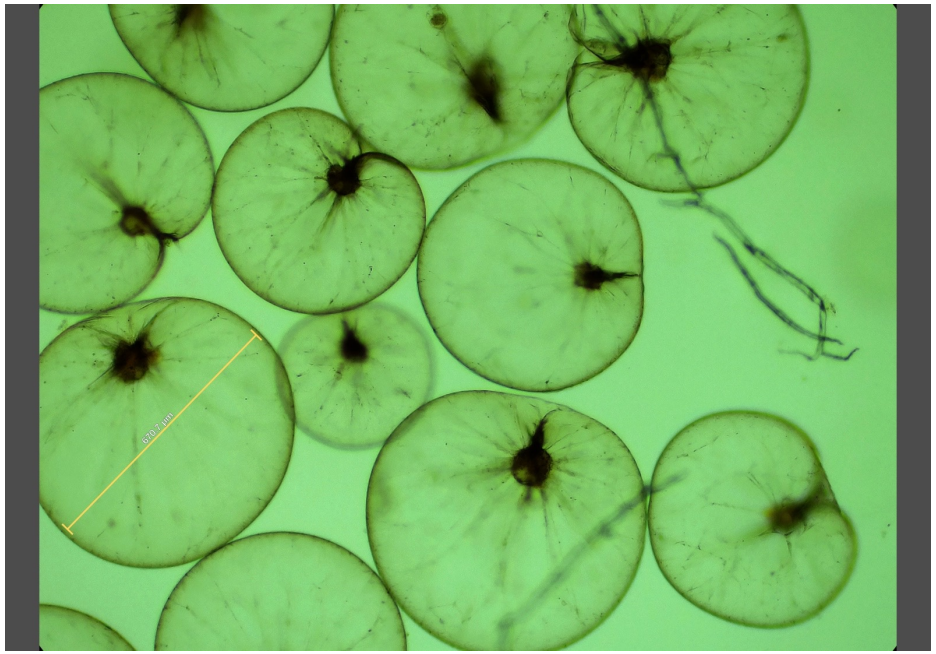
ALFA (shows bloom)

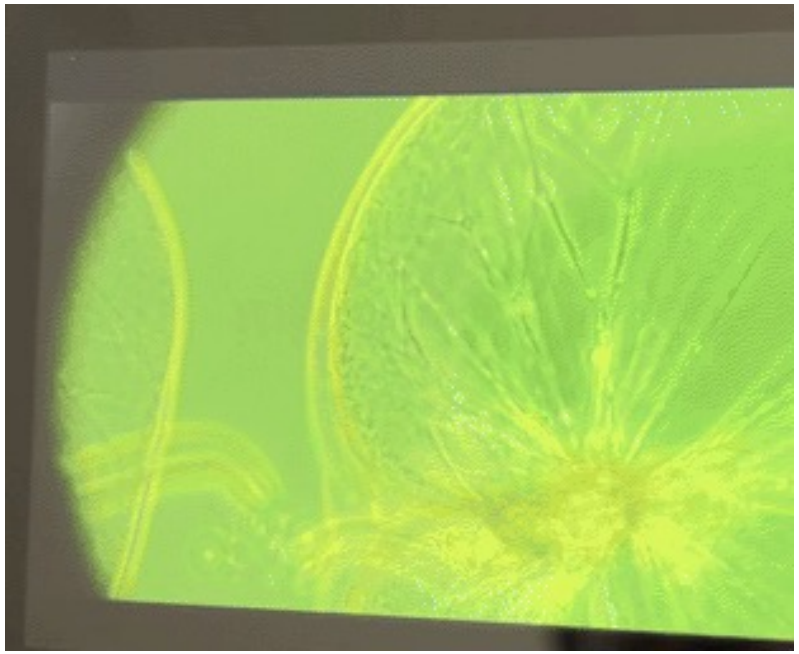


FlowCAM (Red Noctiluca)

Noctiluca scintillans (dinoflagellate) --bioluminescence

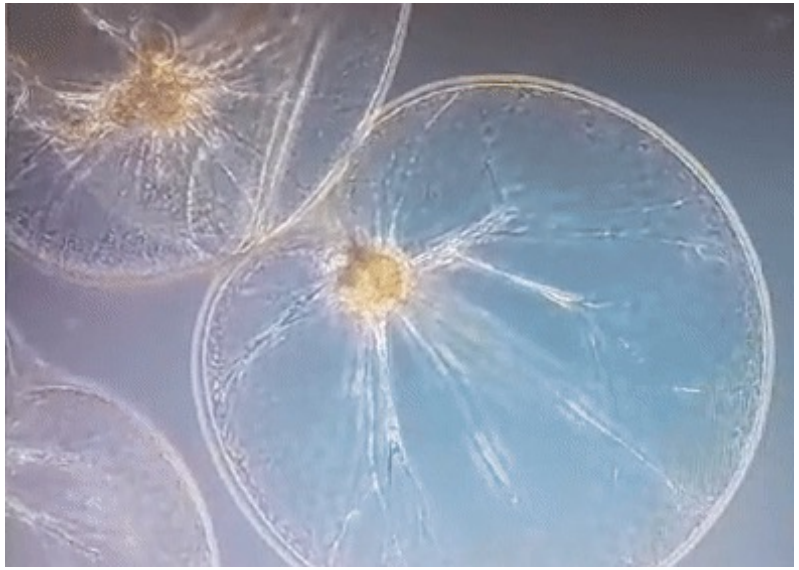
Marine biological diversity





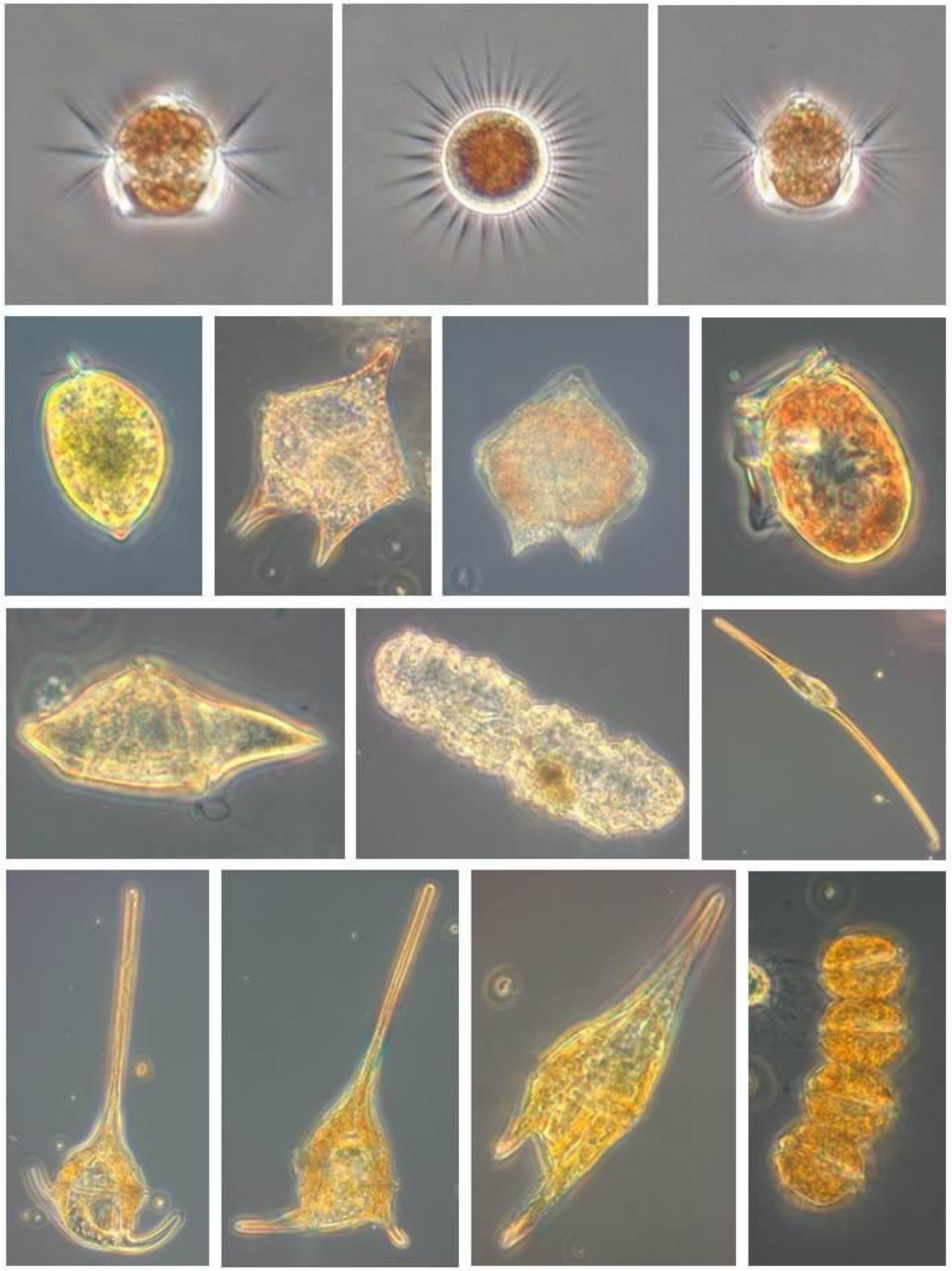
Aequorea crystal jellyfish with amphipods

Pink Meanie Jellyfish (Drymonema larsoni)

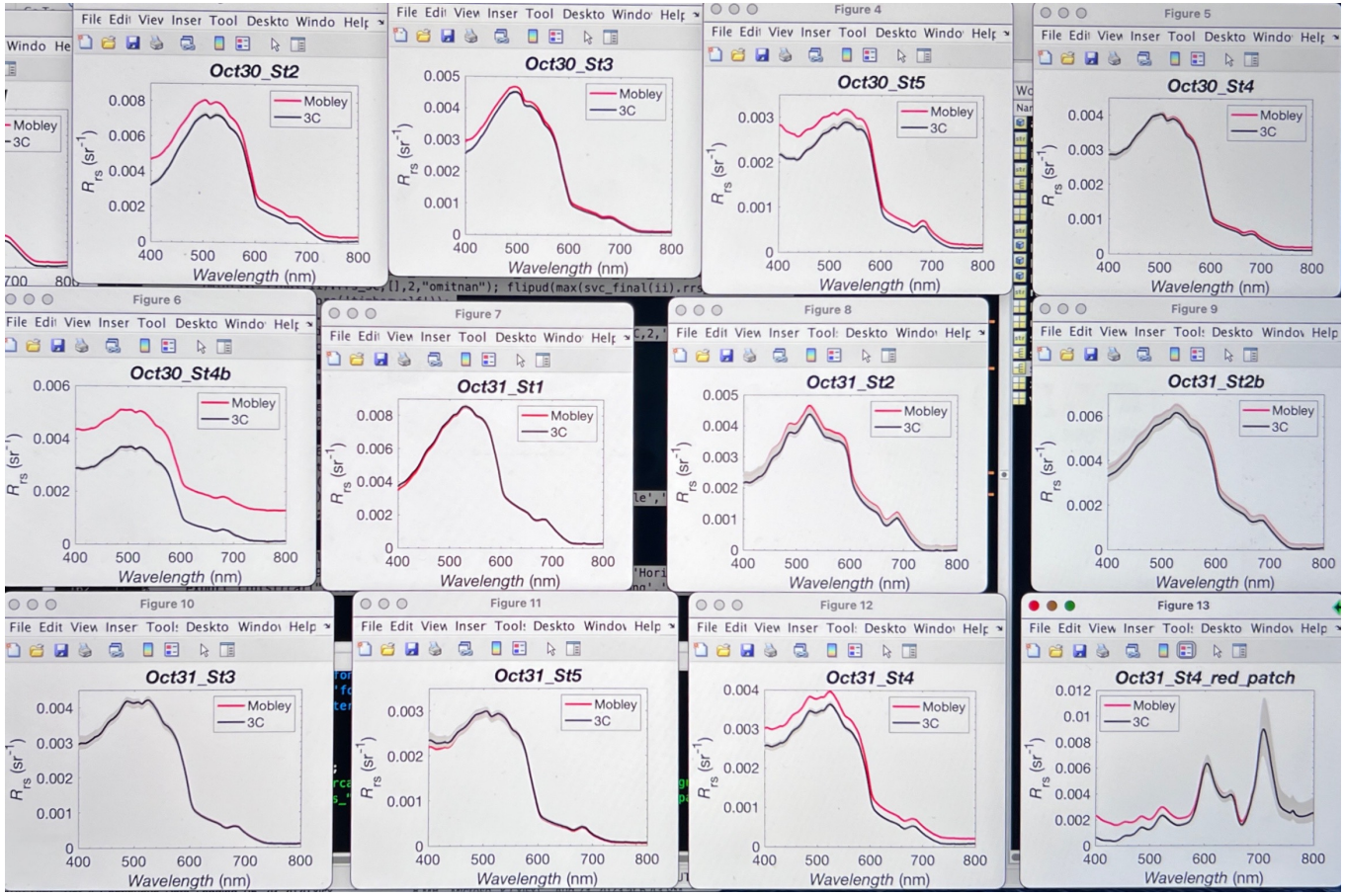


Diatom Plate (Algoa Bay)

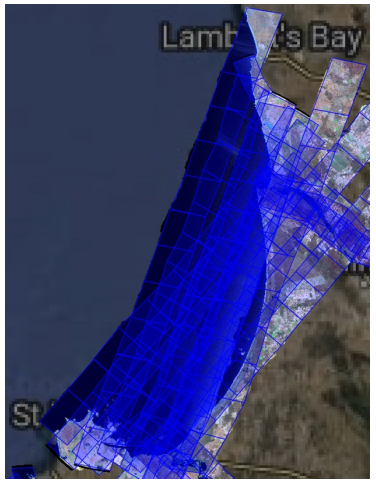
Plankton (St Helena Bay)

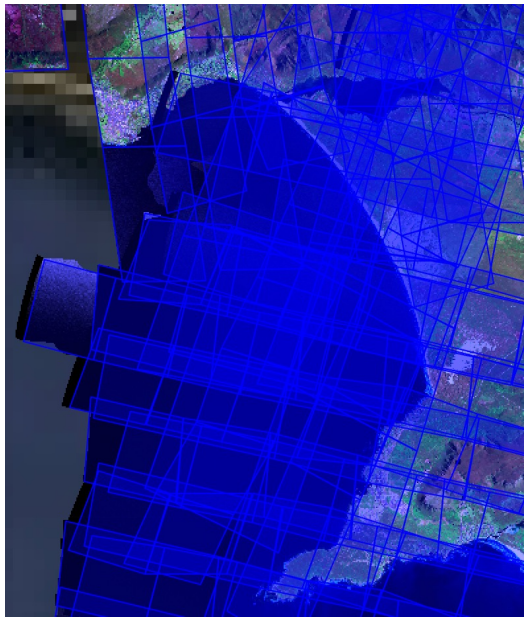


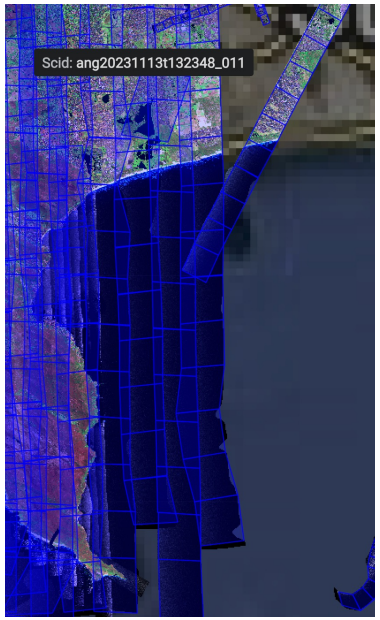
SVC Rrs



BioSCape AVIRIS-NG Data

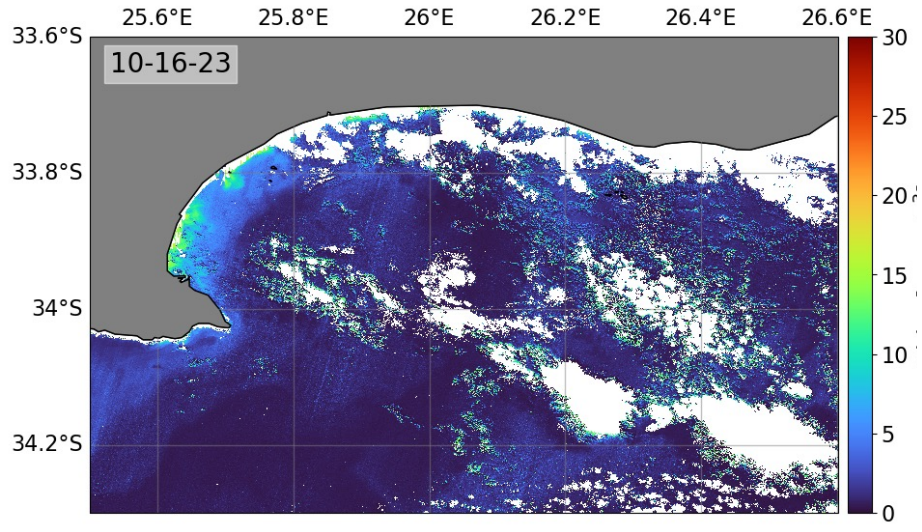


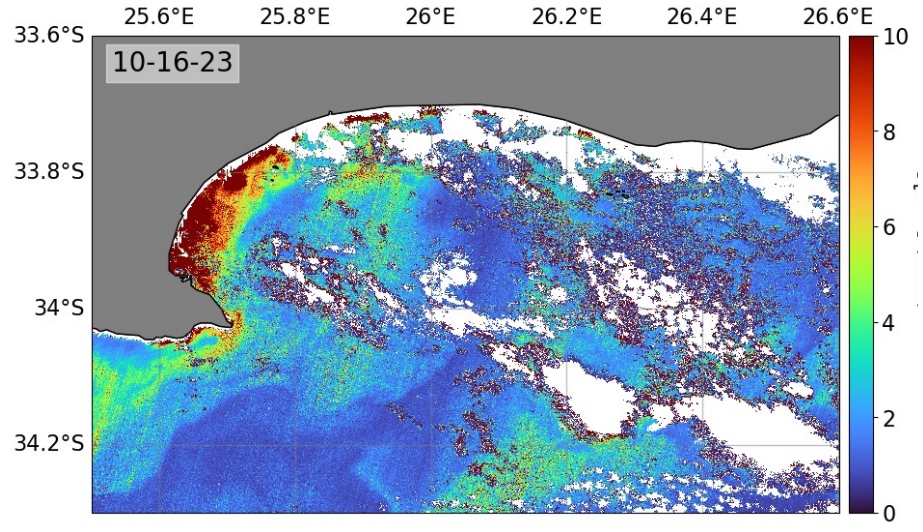




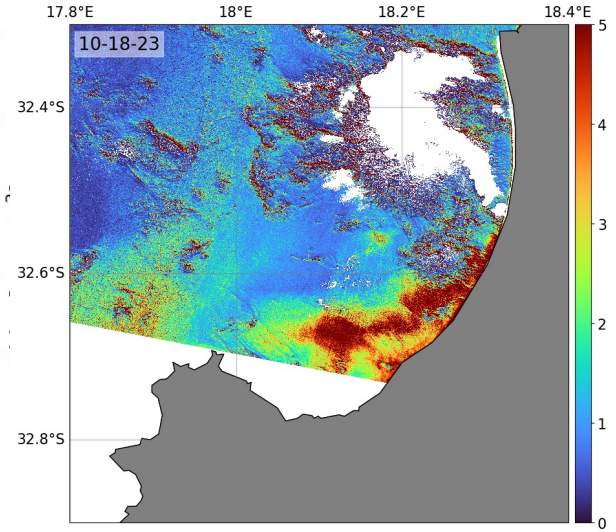
L8 OLI

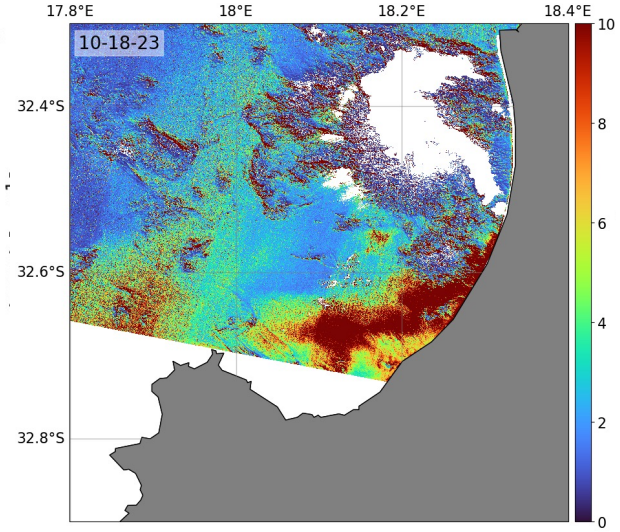
Algoa Bay



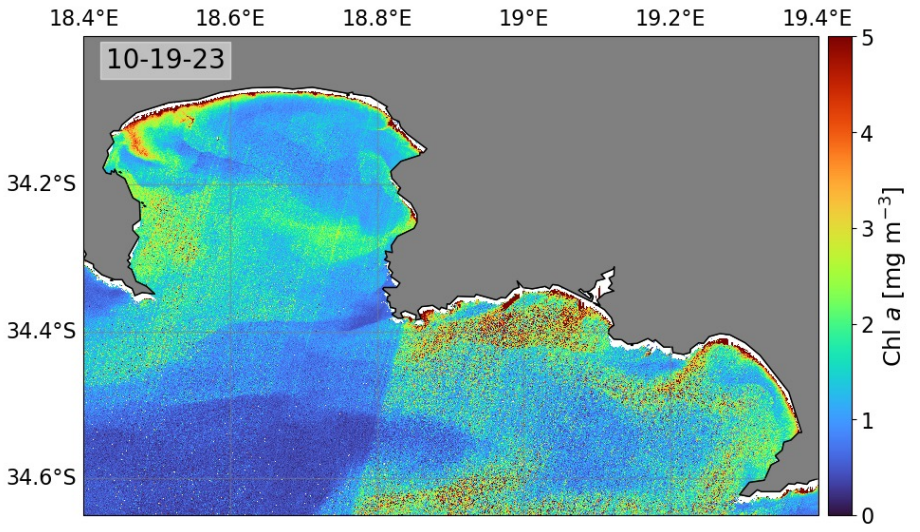


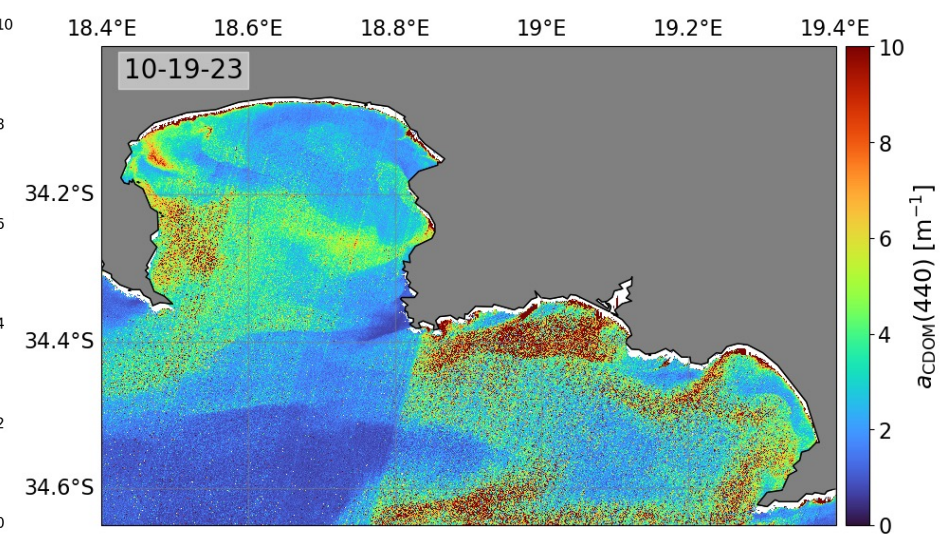
St. Helena Bay





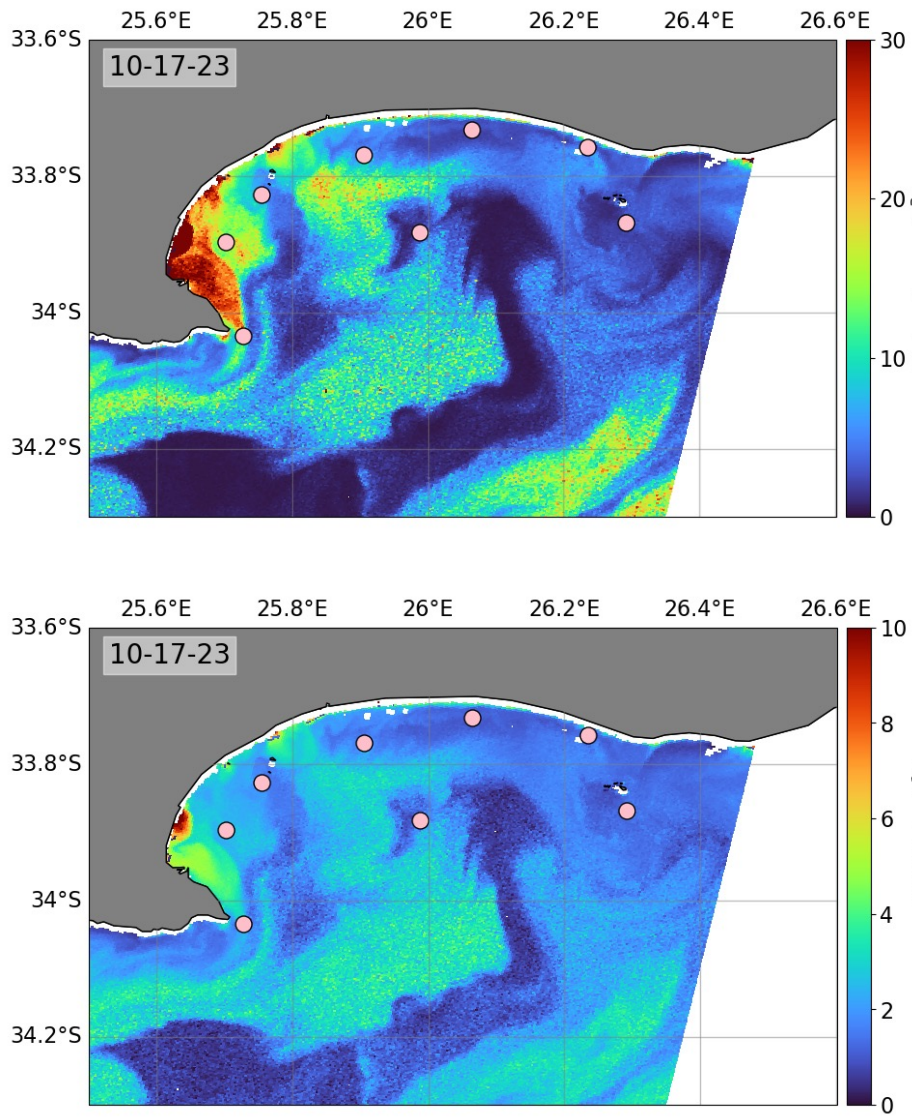
Walker & False Bay



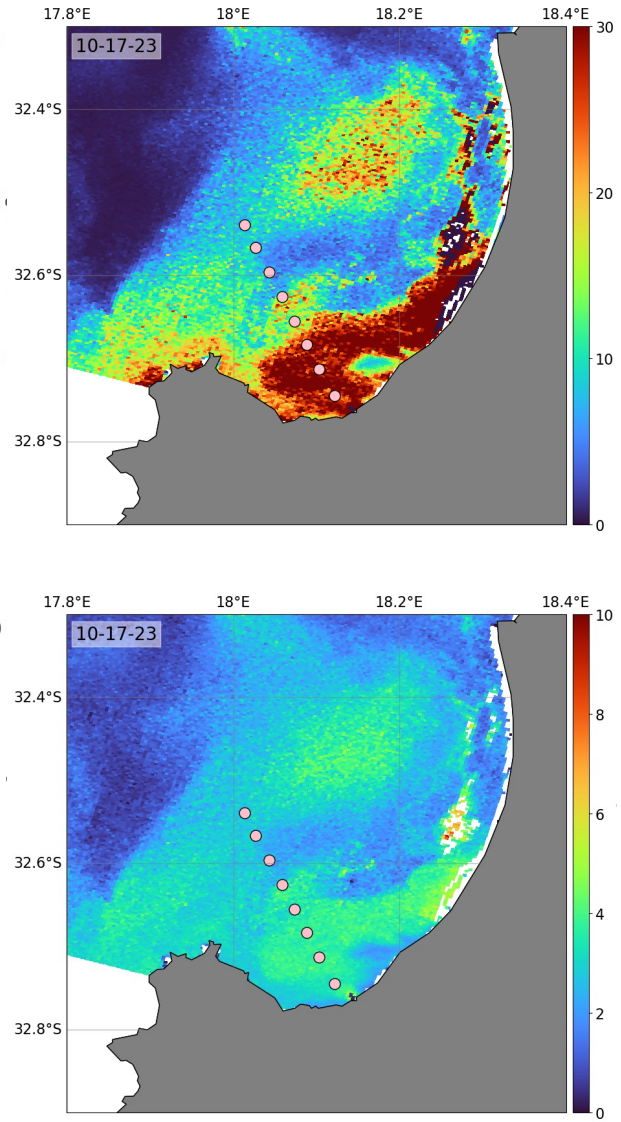


S3 OLCI

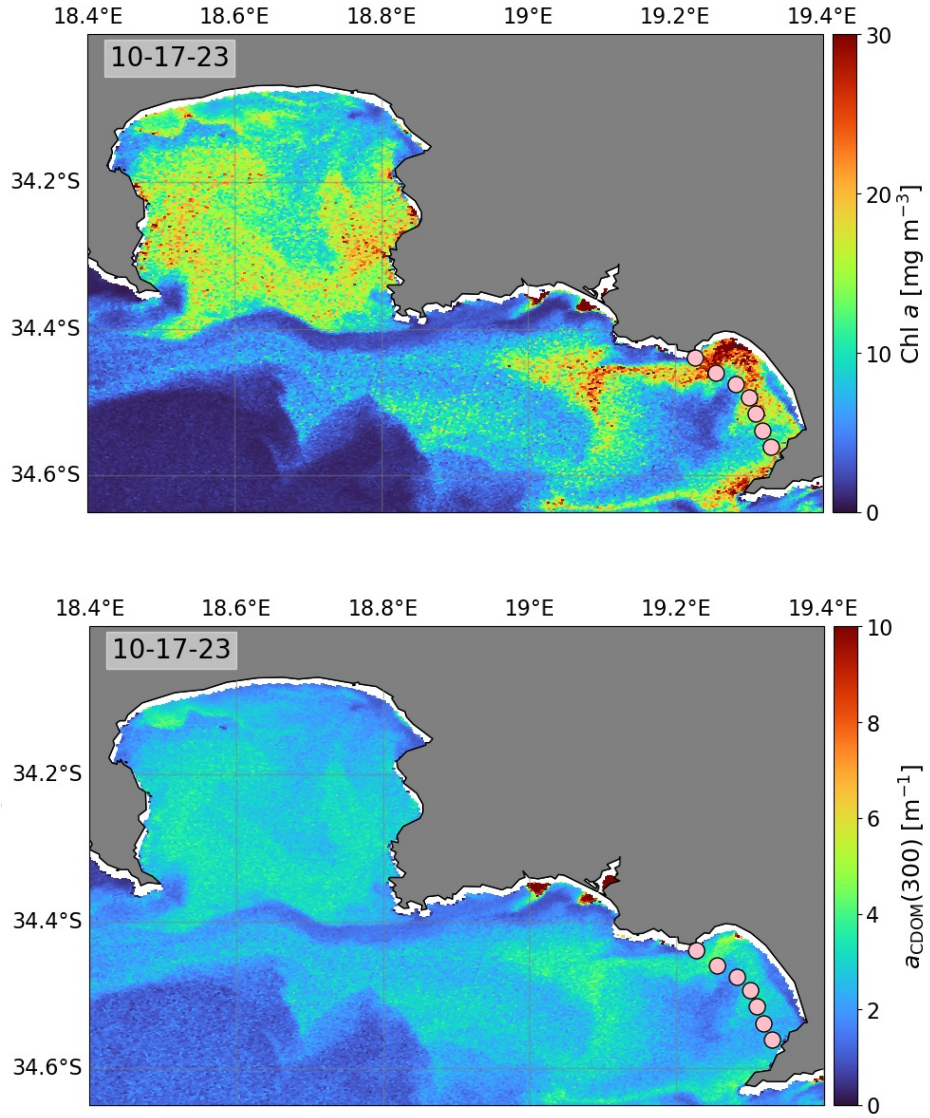
Algoa Bay



St. Helena Bay



Walker & False Bay




algae


ROCKPOOL
MAIN ROAD · CAPE TOWN

Thank you~