Australian and Indian Bio-optical profiling float activities in the Indian Ocean

Nick Hardman-Mountford, Tom Trull, Jim Greenwood, Francois Dufois, Dirk Slawinski (CSIRO)

Muthalagu Ravichandran, Satya Prakash, Uday Bhaskar (ESSO-INCOIS)

Helen Phillips, Peter Strutton (U. Tasmania)

CSIRO OCEANS & ATMOSPHERE FLAGSHIP
www.csiro.au

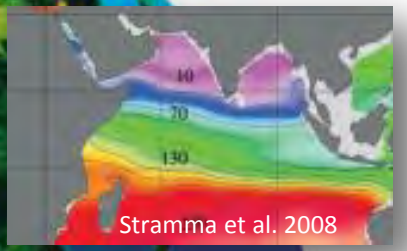
UTAS

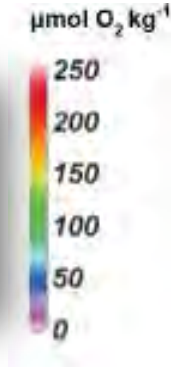
ACE CRC
ANTARCTIC CLIMATE & ECOSYSTEMS
COOPERATIVE RESEARCH CENTRE

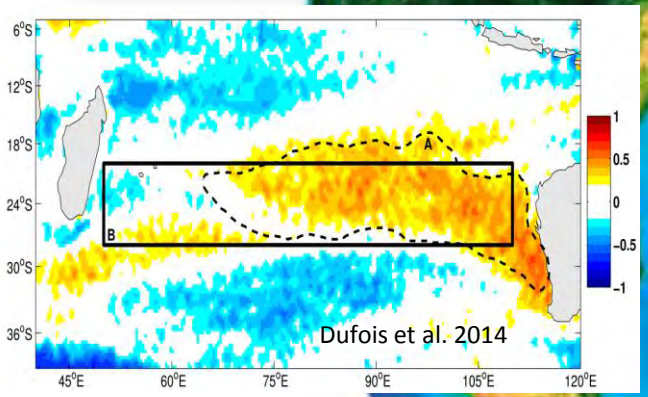
INCOIS

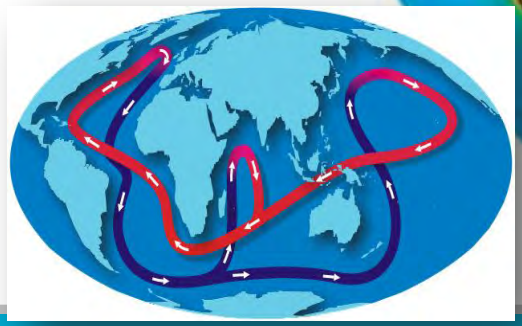
CSIRO

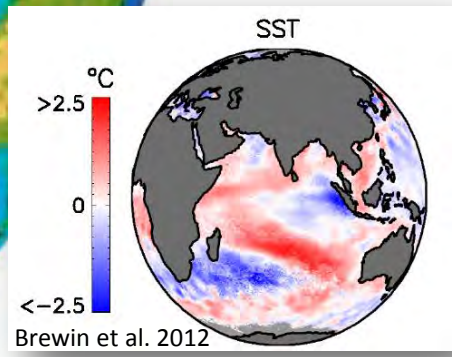
Indian Ocean biogeochemistry









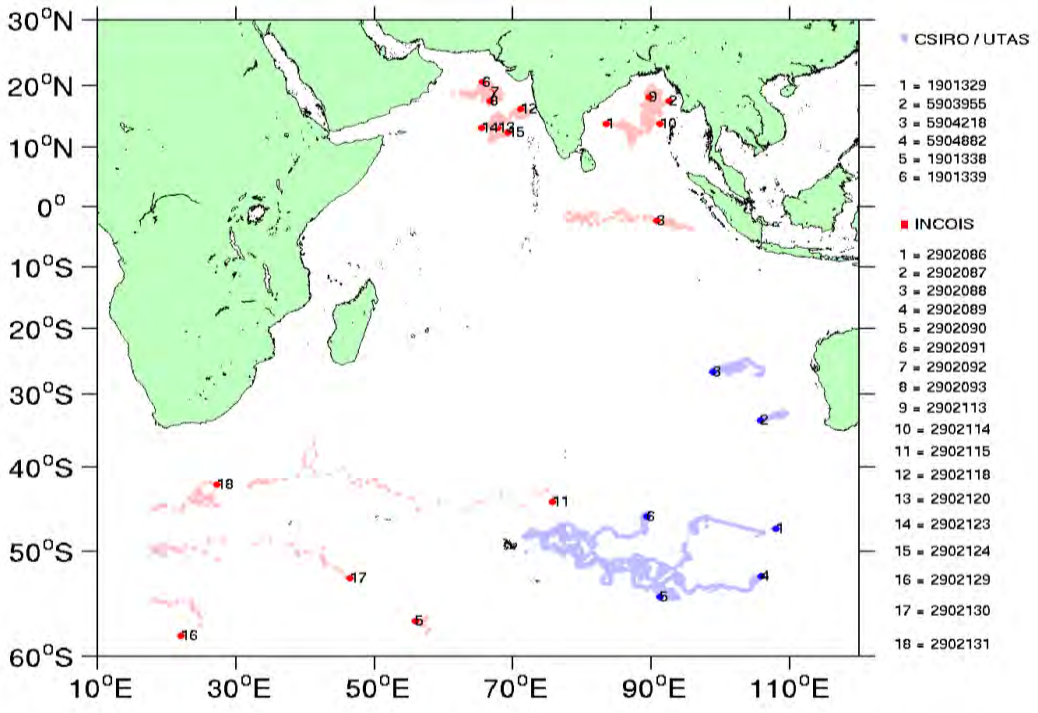


NASA: SeaWiFS

Australia-India Joint Indian Ocean Bio-Argo Project

"Characterising the changing Indian Ocean's biogeochemistry and ecology using revolutionary new robotic tools"

- Collaboration between CSIRO (Australia), CSIR-NIO and ESSO-INCOIS (India) and IOC (UNESCO)



Objectives:

- Coordinated bio-float deployments (2014-16)
- Joint protocol development for deployments and data (with international Bio-Argo community)
- Facilitate wider collaboration towards Indian Ocean Bio-Argo network

Sensors on floats

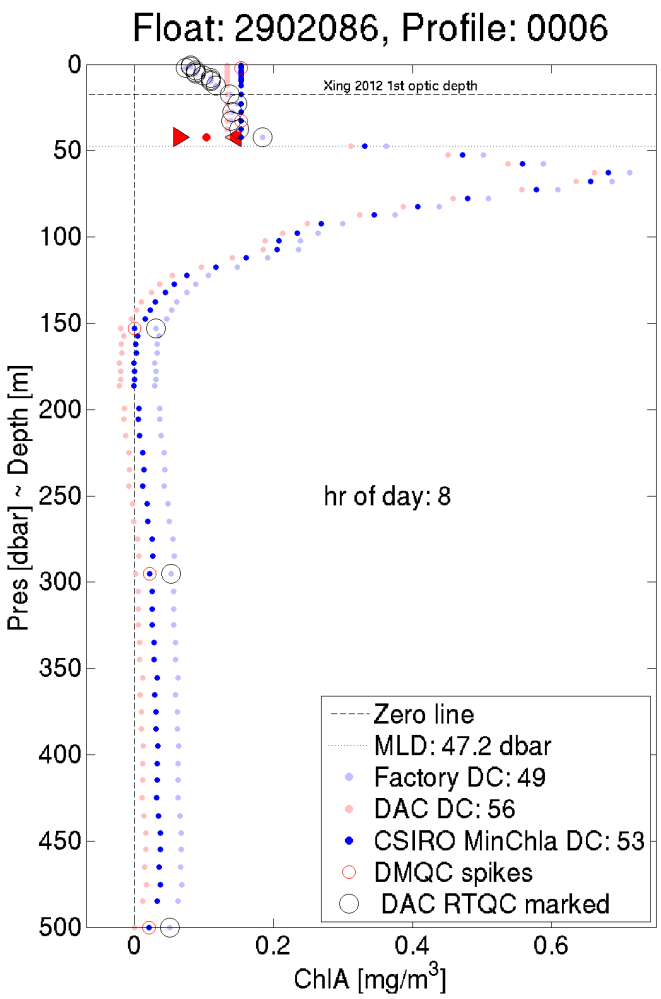
For the next round of deployments, integrated optical sensors on Seabird Navis / Teledyne APEX include:

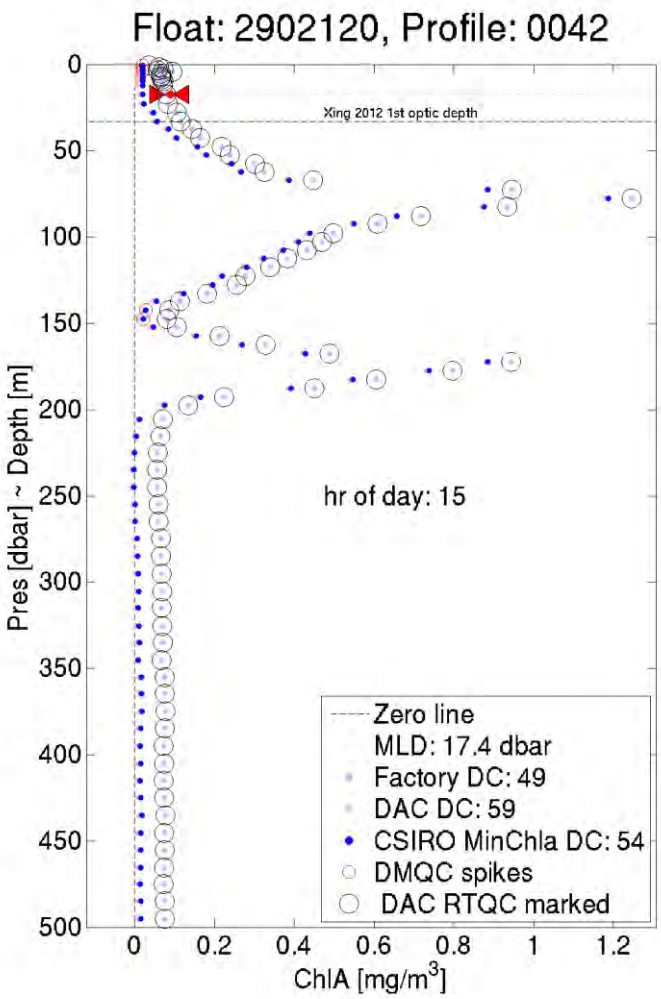
- Seabird SBE63 optode dissolved oxygen
- Wetlabs MCOMS (F_{chl}, $F_{cdom}/b_b(532)$, $b_b(700)$)
- MBARI/Seabird pH

Bolt-on optical sensors include:

- Wetlabs C-Rover 2000 transmissometer
- Wetlabs eco-bb3 (b_b @ 470, 532, 700 nm)
- Satlantic Deep SUNA (UV nitrate)
- Satlantic OCR 504 E_d & L_u (412, 443, 490, 555) or Ed only (380, 412, 443, PAR)
- Aanderaa optode dissolved oxygen

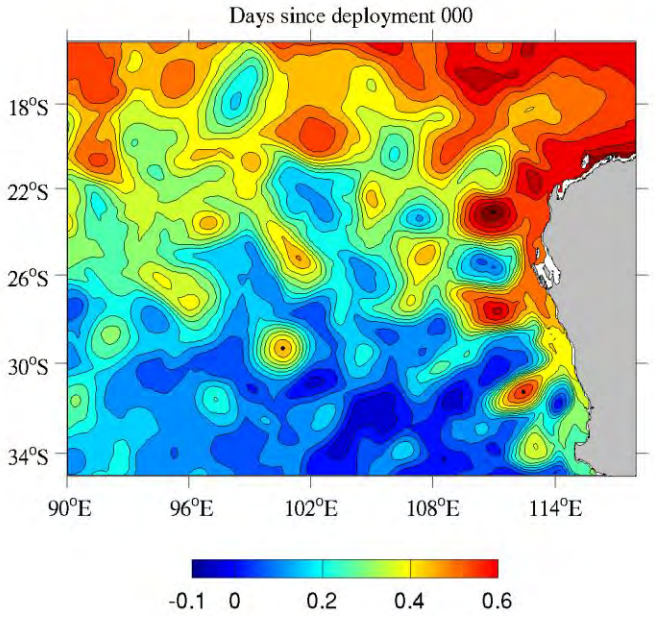
Quality Control considerations





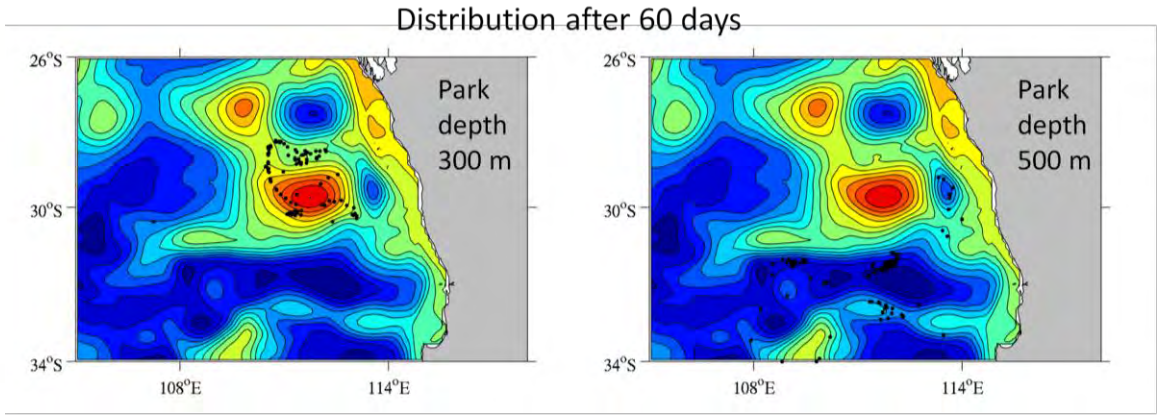
- Pre-deployment 'standards':
  - Parallel profiles
  - Fl caps
  - Lab inter-calibration
- Quenching depth vs. MLD
- Comparability of sensors: MCOMS vs. Eco b_b
- Non-zero dark counts
- Ocean colour match-ups

Deployment design: modelling float retention

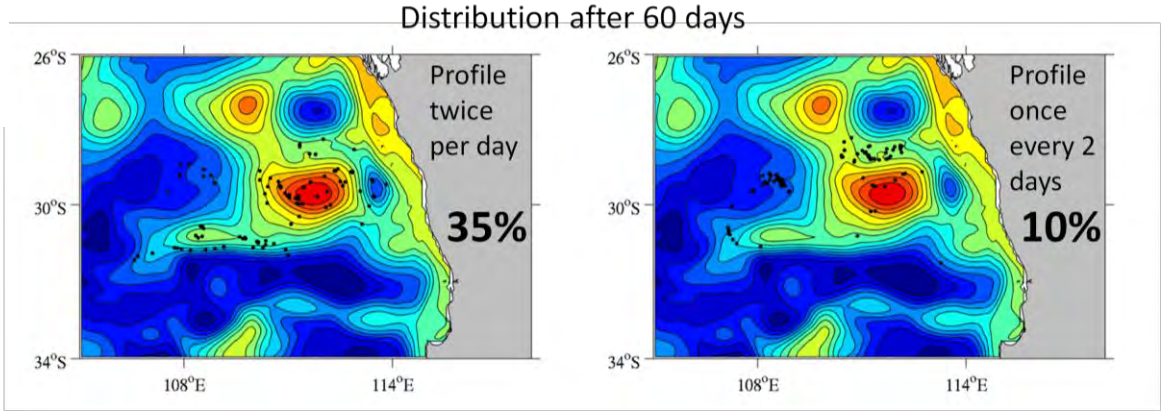


Mature eddies retain floats longer

Shallower park depths give better retention



More frequent profiling gives better retention

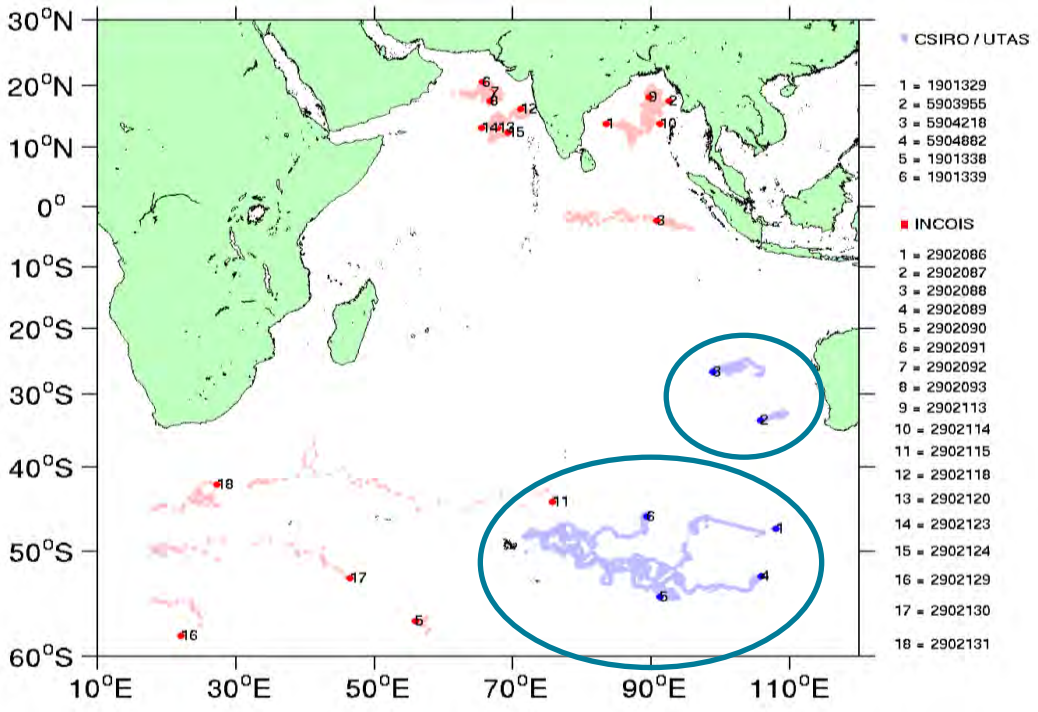


Greenwood, H-M, Dufois et al. (in prep).

Australia-India Joint Indian Ocean Bio-Argo Project

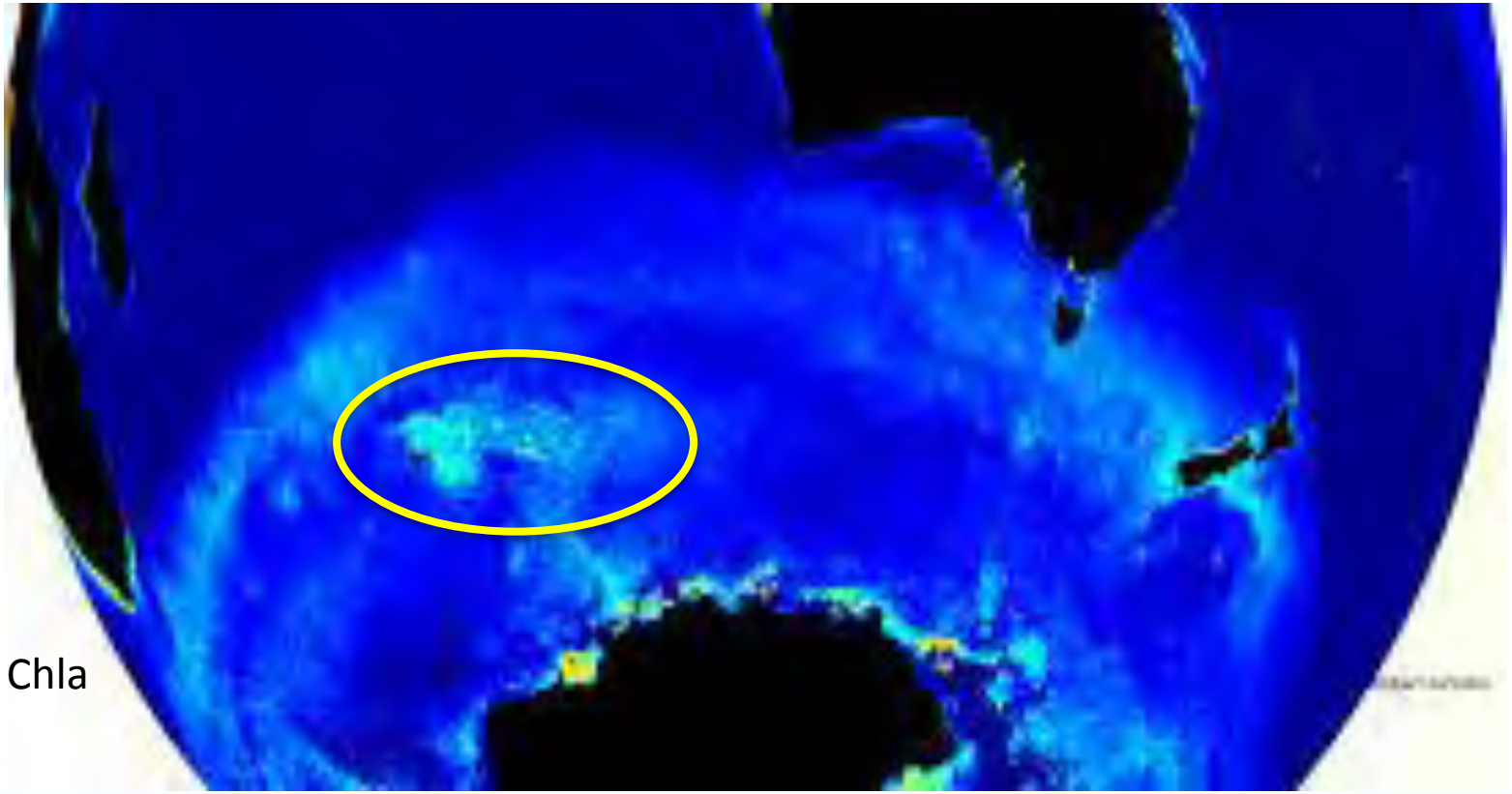
"Characterising the changing Indian Ocean's biogeochemistry and ecology using revolutionary new robotic tools"

- Collaboration between CSIRO (Australia), CSIR-NIO and ESSO-INCOIS (India) and IOC (UNESCO)



Objectives:

- Coordinated bio-float deployments (2014-16)
- Joint protocol development for deployments and data (with international Bio-Argo community)
- Facilitate wider collaboration towards Indian Ocean Bio-Argo network



Satellite Chla

Autonomous profiling float observations of the high biomass plume downstream of the Kerguelen plateau in the Southern Ocean

Melanie Grenier, Alice Della Penna, and Tom Trull

Published in Biogeosciences, 2015

An Australian Government Initiative

ANTARCTIC CLIMATE & ECOSYSTEMS COOPERATIVE RESEARCH CENTRE

4 Bio-profilers (1 in 2011, 3 in 2014)

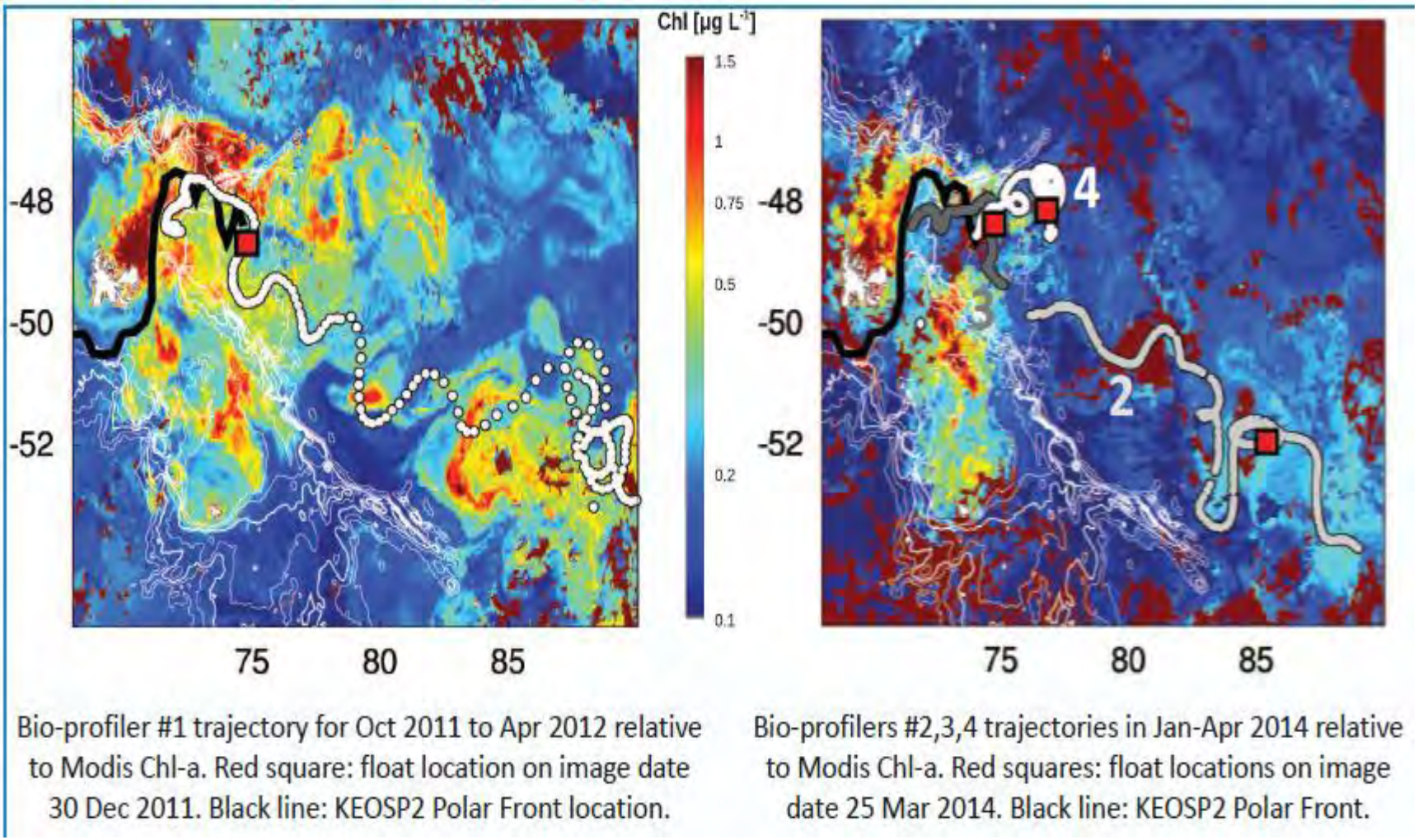
Teledyne-Webb
APF9I APEX floats

Specialized sensors
T, S, O_2
470/695 nm chlorophyll fluorescence
700 nm particle backscatter

Specialized mission swapping:
shallow profiles from 300 m to surface
4-5 times per day
single deep profile to 2000 m
every 3 days

Grenier, Della Penna, Trull (2015) BG

Good sampling of plume

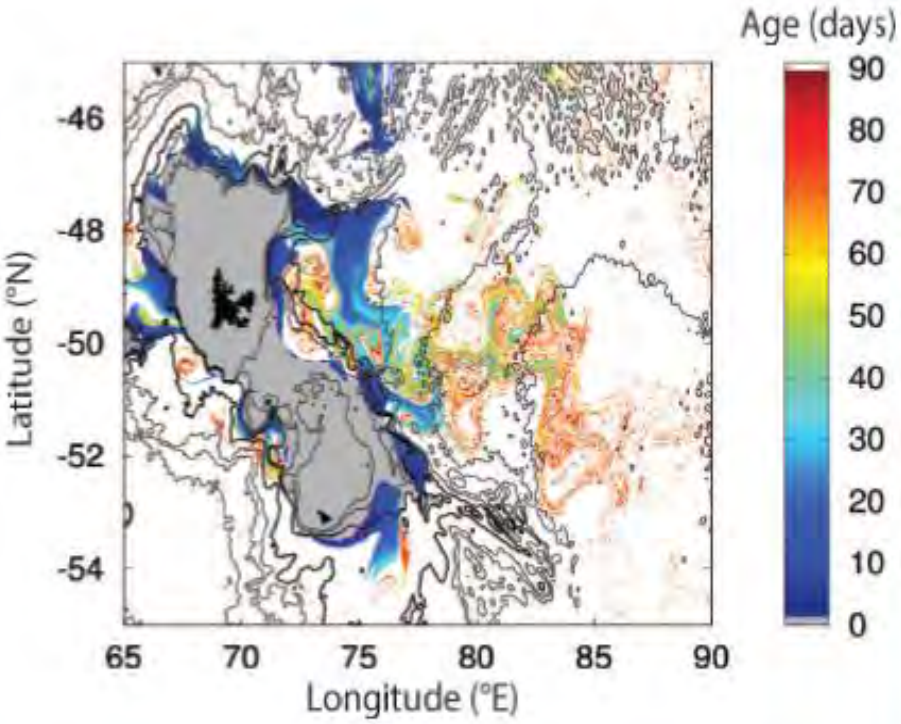


Bio-profiler #1 trajectory for Oct 2011 to Apr 2012 relative to Modis Chl-a. Red square: float location on image date 30 Dec 2011. Black line: KEOSP2 Polar Front location.

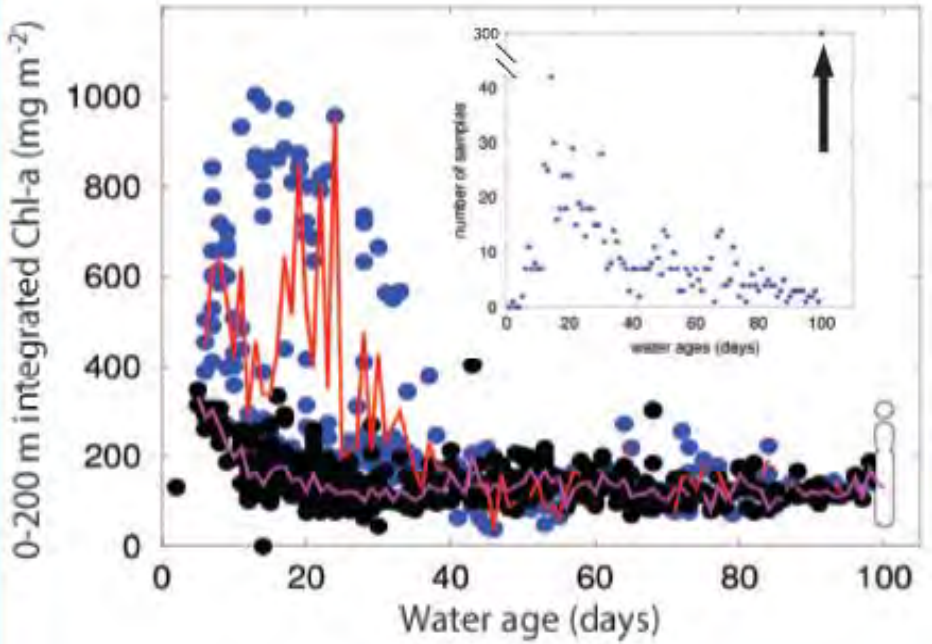
Bio-profilers #2,3,4 trajectories in Jan-Apr 2014 relative to Modis Chl-a. Red squares: float locations on image date 25 Mar 2014. Black line: KEOSP2 Polar Front.

Grenier, Della Penna, Trull (2015) BG

Time from plateau controls biomass



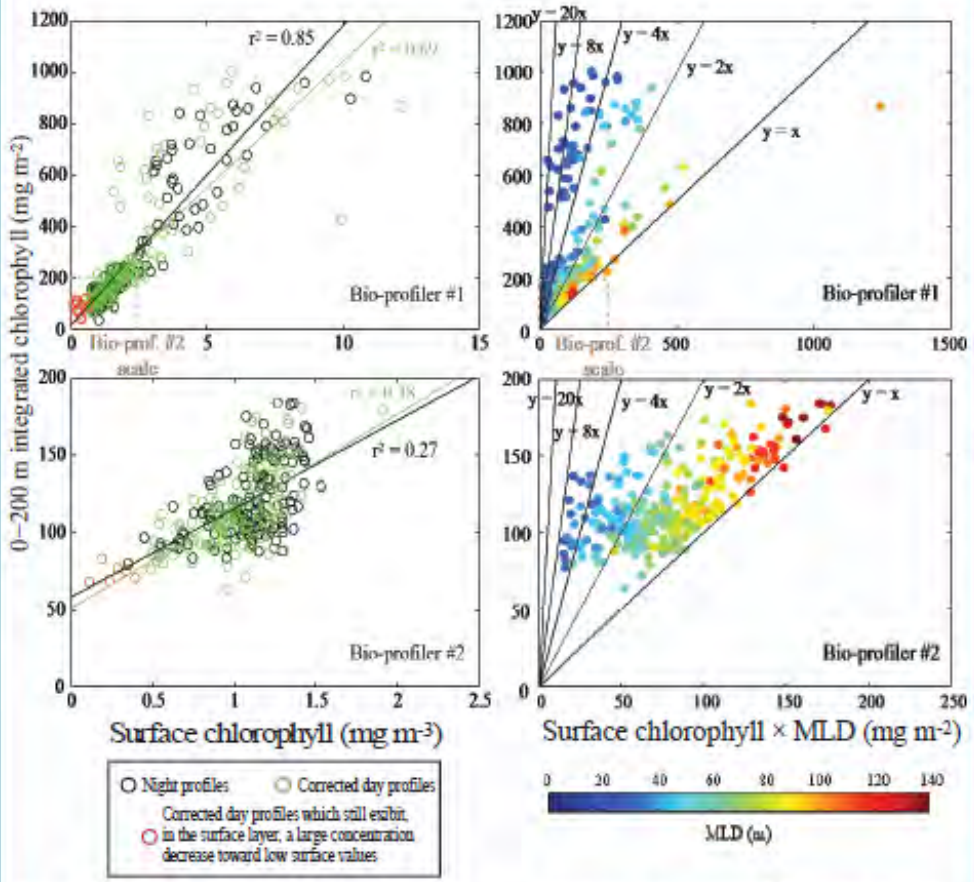
Water parcel ages since leaving the Kerguelen Plateau, from altimetric geostrophic back-trajectories (redrawn from d'Ovidio et al., 2015).



Decrease of water column Chl-a inventories with water parcel ages. Light blue: bio-profiler #1; dark blue: bio-profilers #2,3,4; lines: medians; inset: sampling statistics.

Grenier, Della Penna, Trull (2015) BG

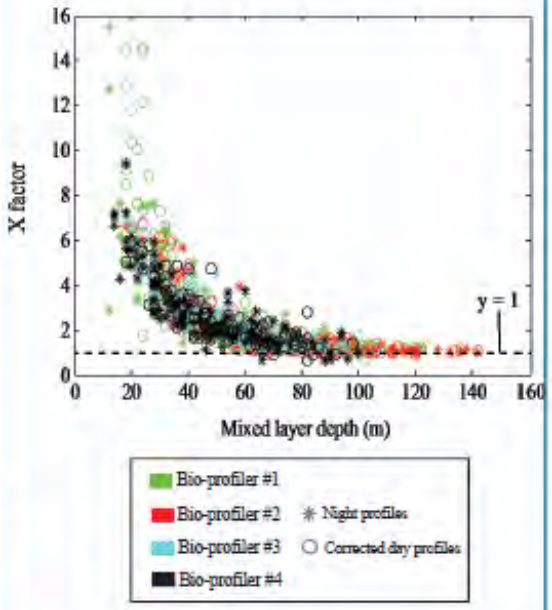
Surface (*"satellite"*) vs. column (bioprofiler) Chl-a



Best (Bio-profiler #1) and worst (Bio-profiler #2) correlations between surface and total column inventory chlorophyll suggests biases up to ~ 2-fold.

Using physical Mixed Layer Depth as an estimate of Chl-a vertical extent strongly underestimates the water column inventories – up to 20-fold.

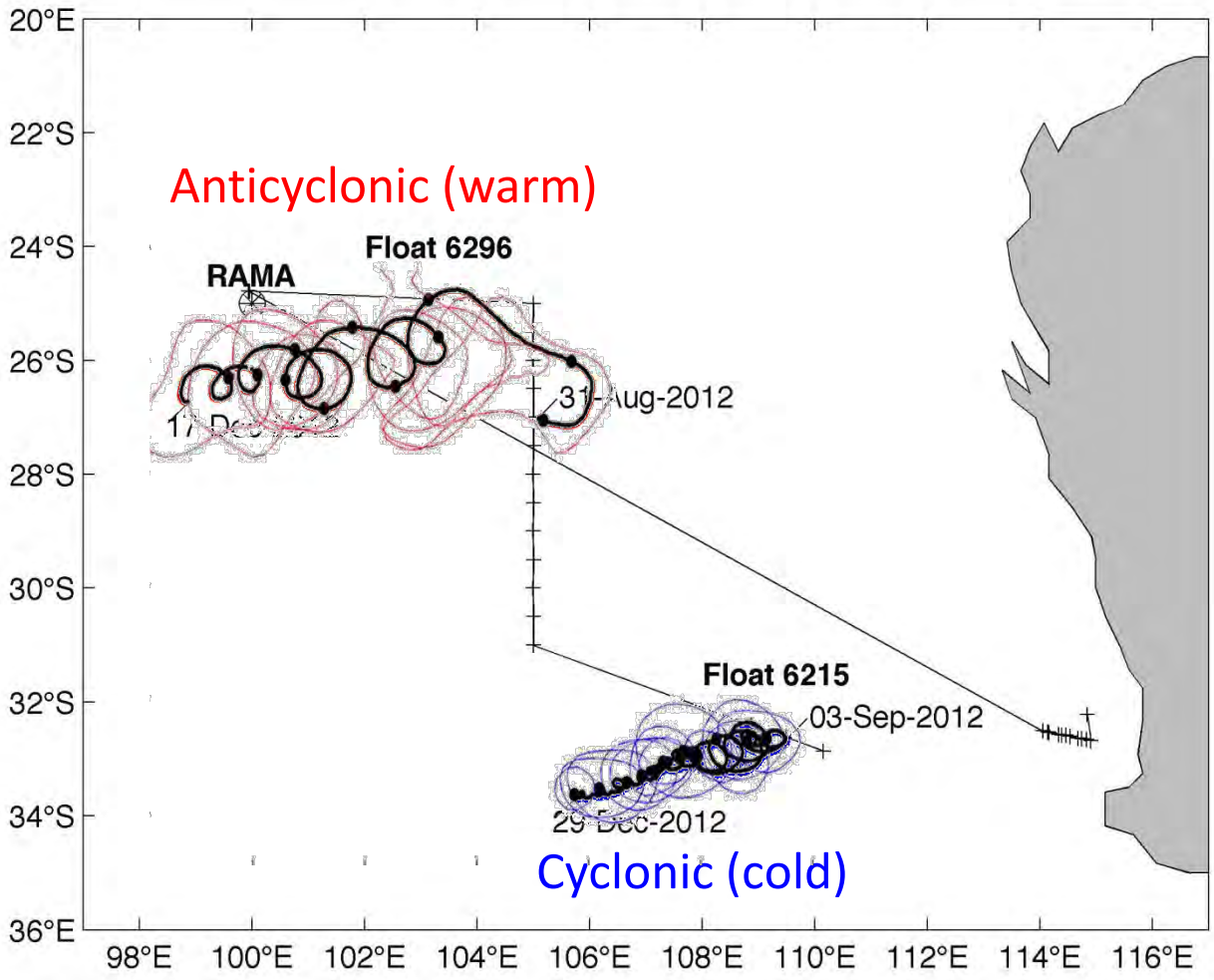
$$\text{X-factor} = \frac{\text{Integrated Chl-a}}{\text{surface Chla x MLD}}$$



The underestimation of inventories from surface Chl-a x physical mixed layer depths is worst in summer, in response to shoaling mixed layers. This emphasizes the importance of system history.

Grenier, Della Penna, Trull (2015) BG

Deployments in Eddies: Lagrangian floats?



Consistent sea surface height (SSH) contours plotted every 10 days to show that the float trajectory matches the movement of the eddy

Pump, Phillips, Strutton, Trull (in prep.)

UTAS

CSIRO

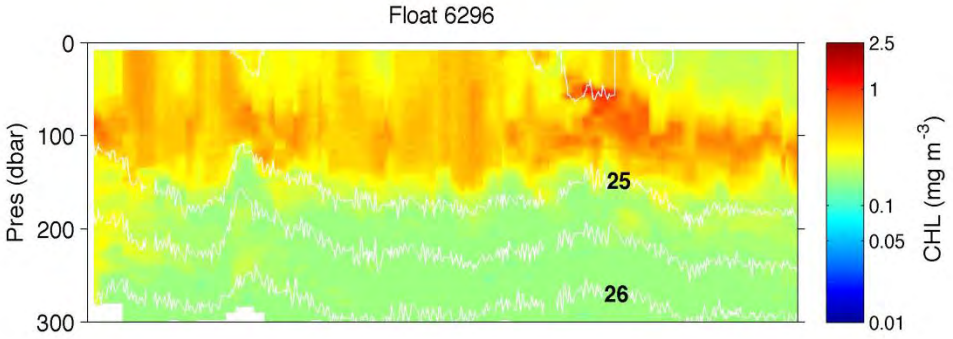
Seasonal adjustment of eddy phytoplankton

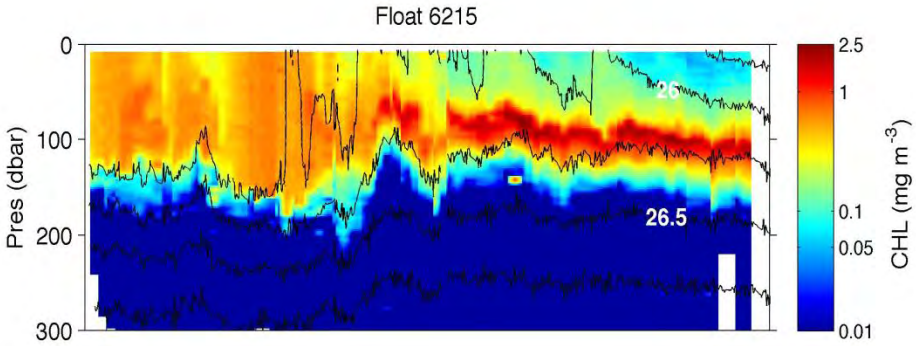
Anticyclonic

Note: bad backscatter data after 14th Nov

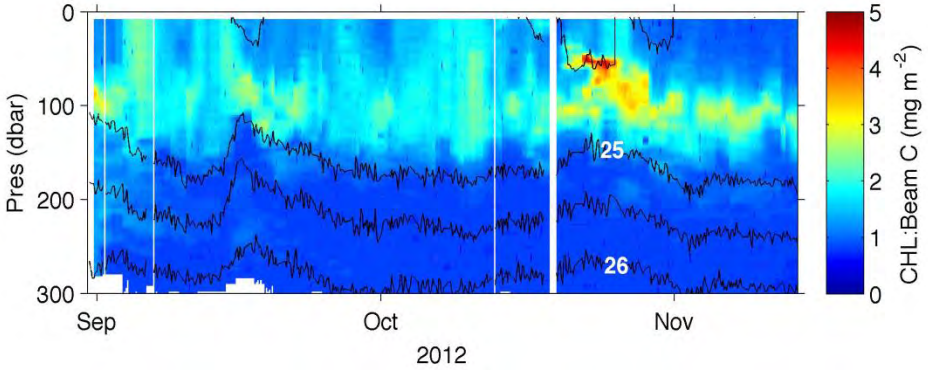
Cyclonic

Note: no biological data after 26th Nov

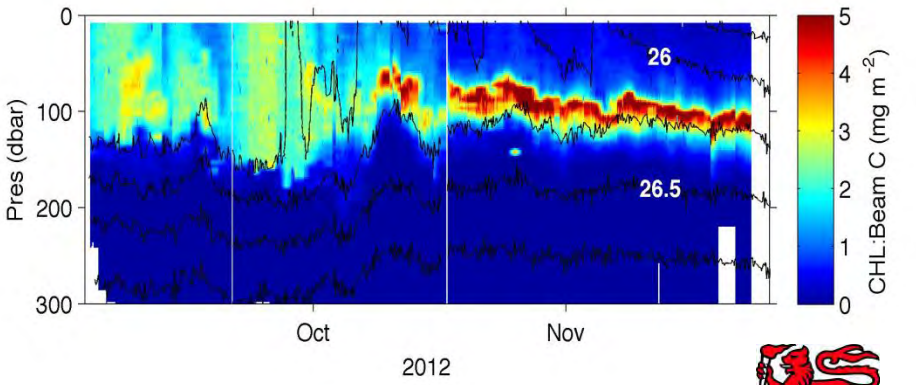




- More chlorophyll per cell in late October.



- More chlorophyll per cell from mid- October



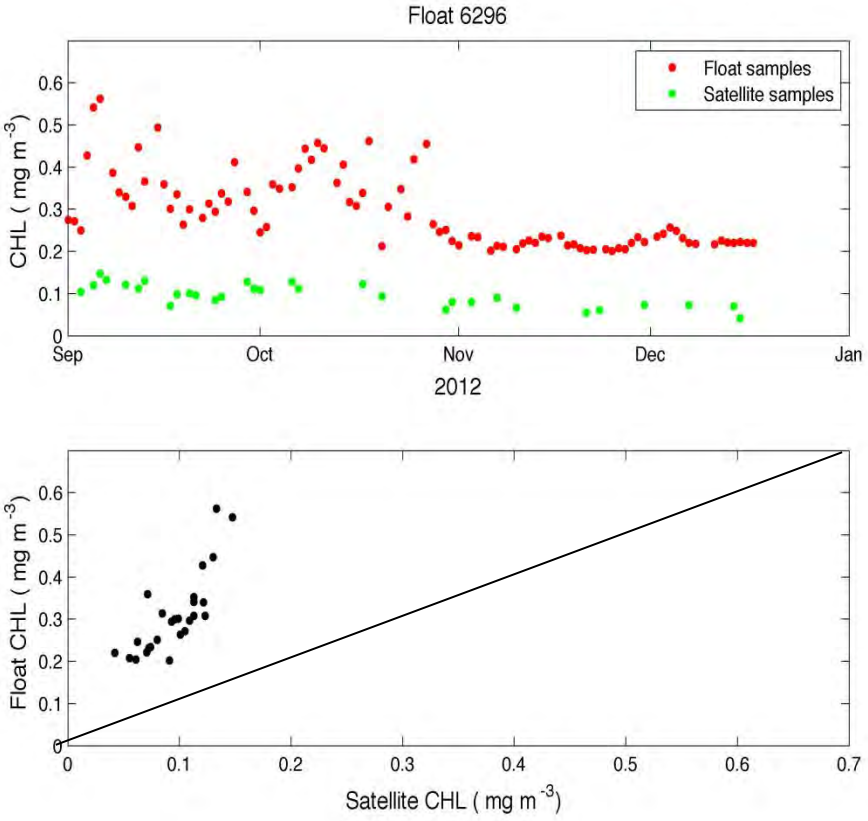
Pump, Phillips, Strutton, Trull (in prep.)

UTAS

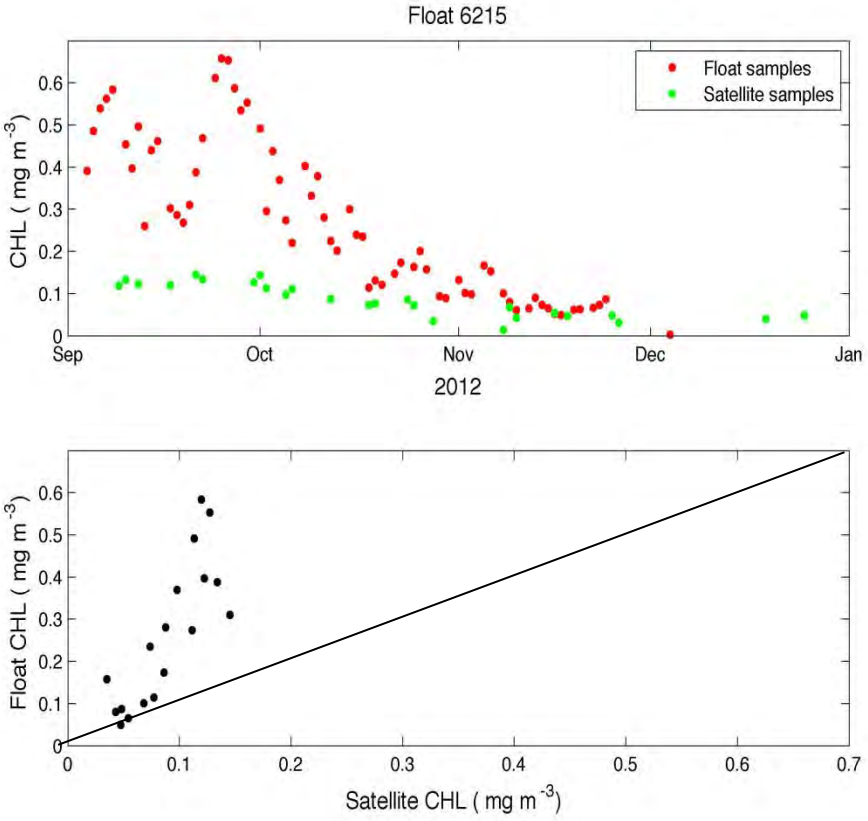
CSIRO

Satellite CHL data vs Float CHL data in top 20m

Anticyclonic



Cyclonic



Pump, Phillips, Strutton, Trull (in prep.)

Questions?

NICK.HARDMAN-MOUNTFORD@CSIRO.AU
www.csiro.au