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Seaglider observations of summertime upwelling in the North Atlantic

Christopher W Brown

Overview

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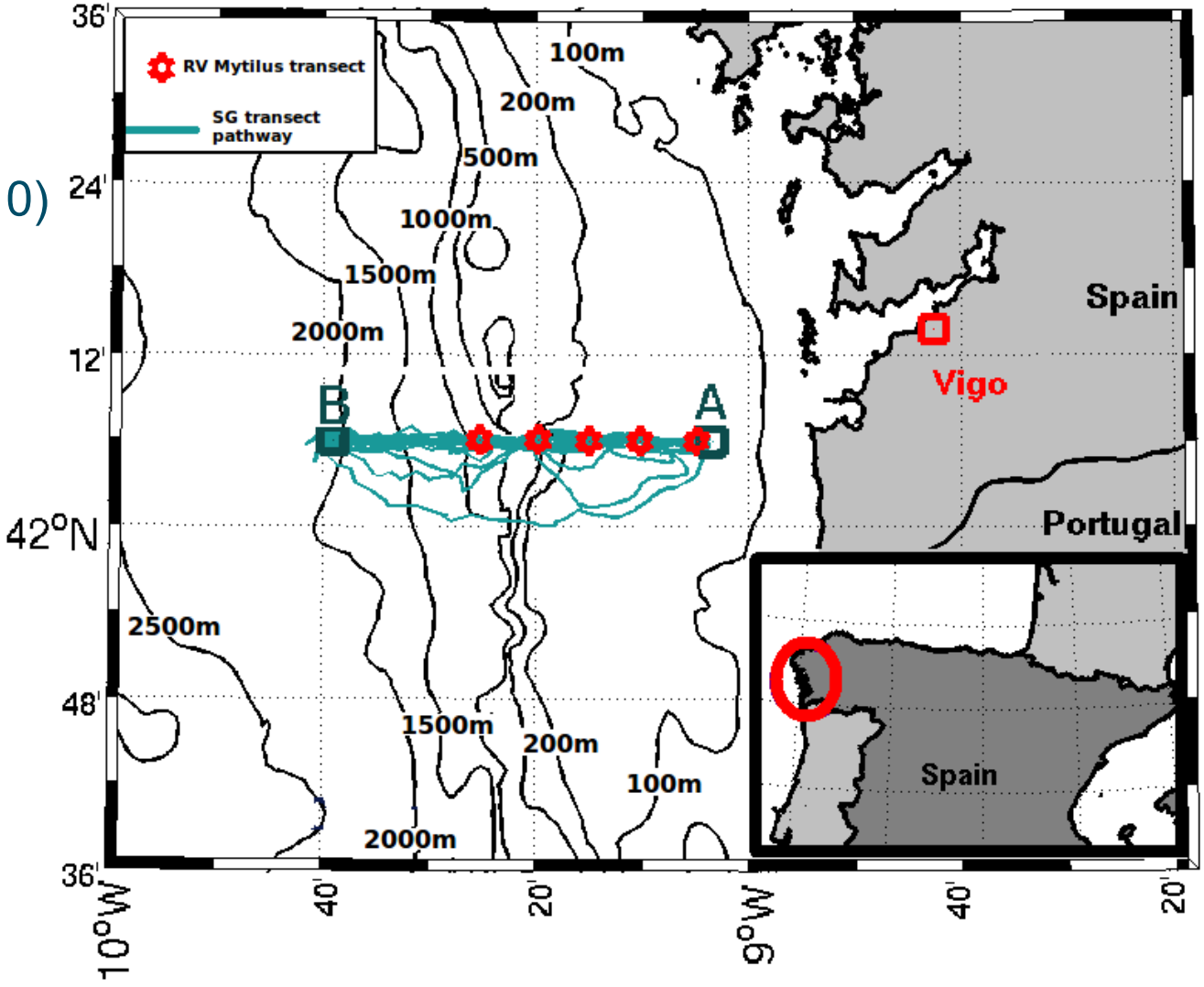
- Summer season (June to September ‘10)
- Iberian Upwelling
- 113 days
- 1611 dives



Sensor package

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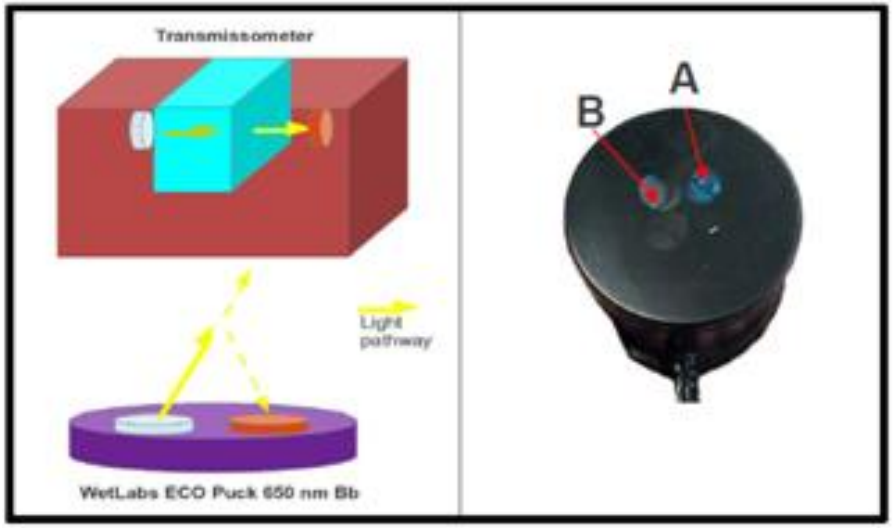
- Aanderaa 4330 F(ast foil) Optode
- Wetlabs ECO puck
- 650 nm backscatter/ Chl *a*/ CDOM



- CTD values remained good for mission
- Chl *a* was close to filtered water samples

Optode calibration

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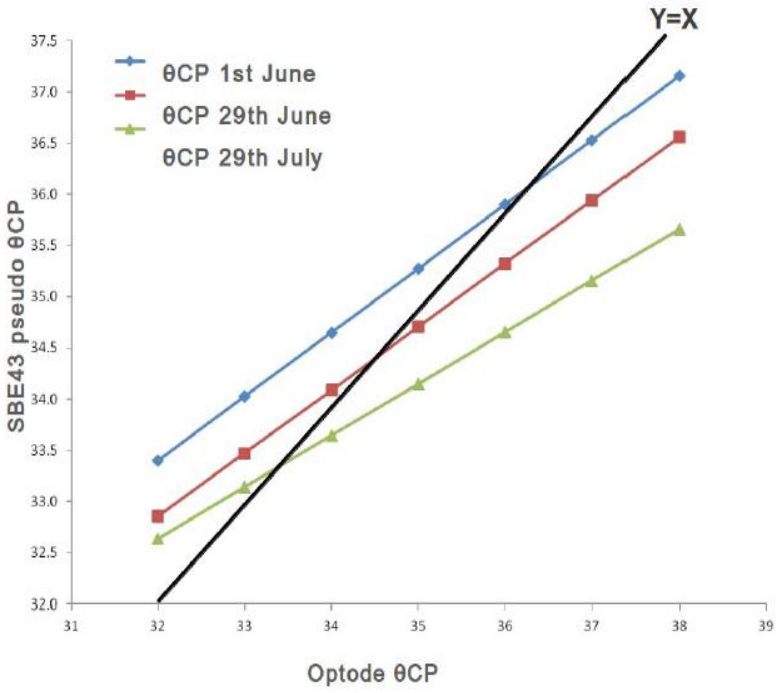
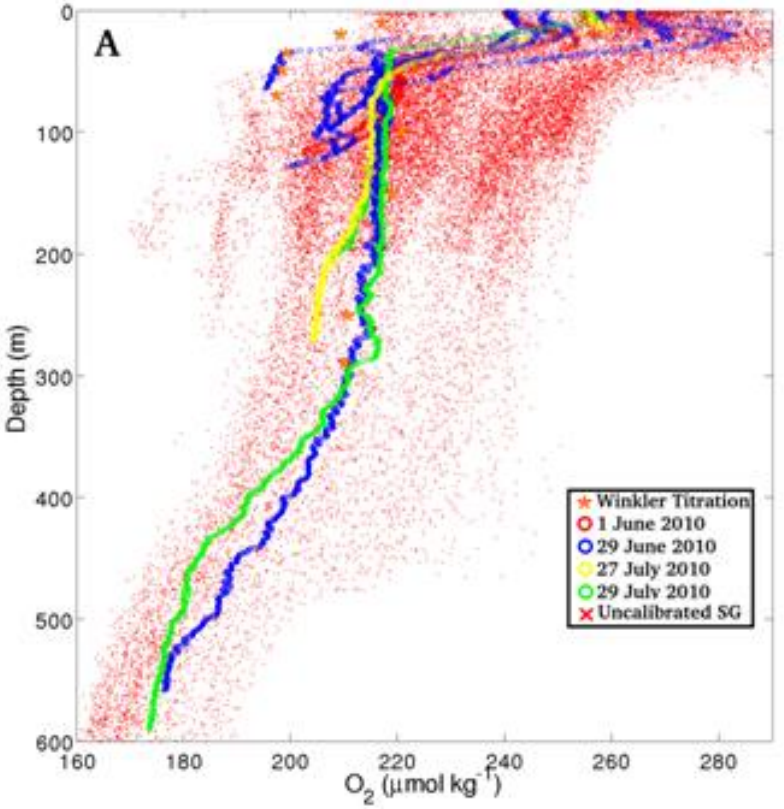
- 4 Co-located cruises transects (RV Mytilus, CSIC)
- Optode values drifted- possible foil degradation



Pre- Calibration



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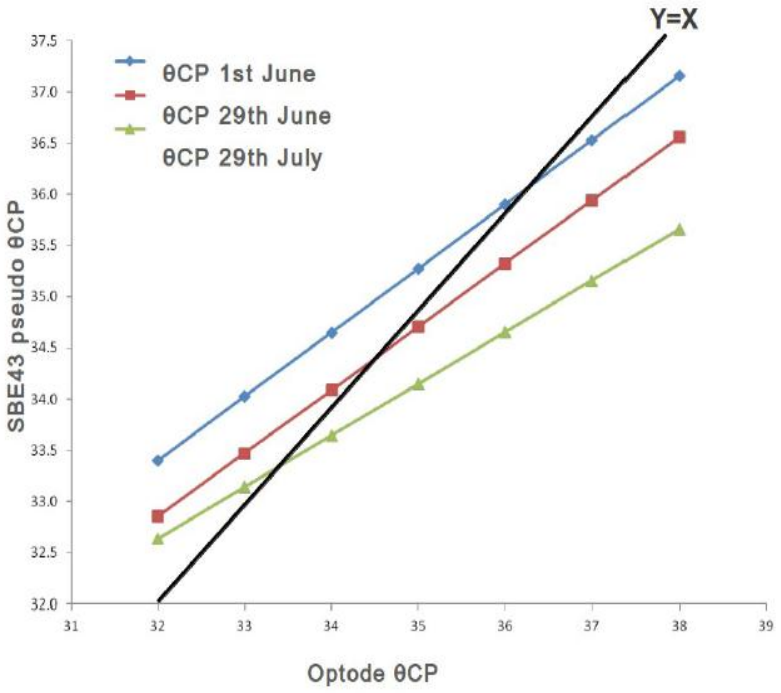
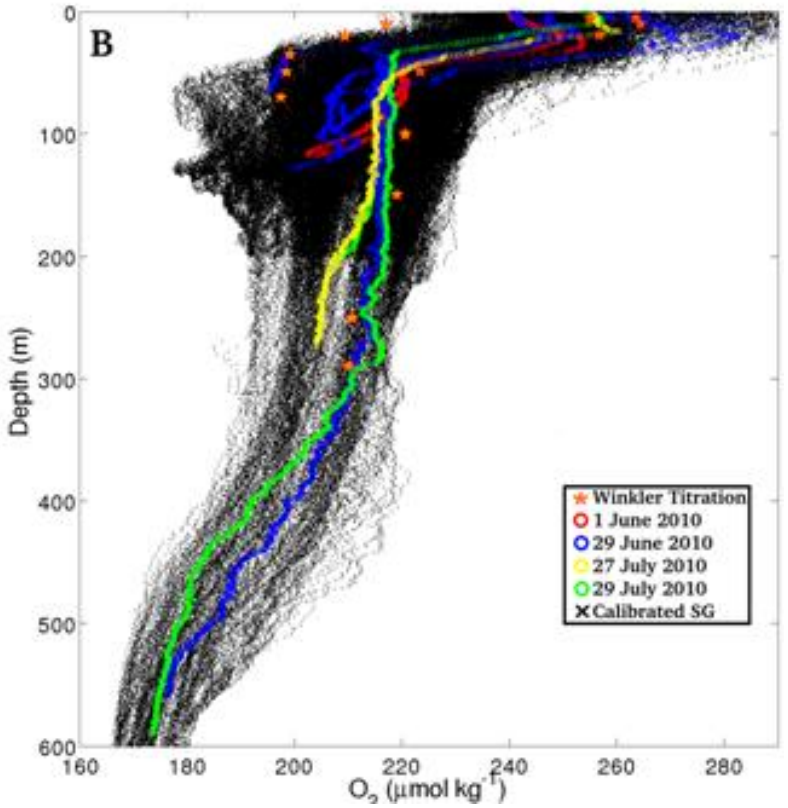


Post- Calibration



Part 2: Data

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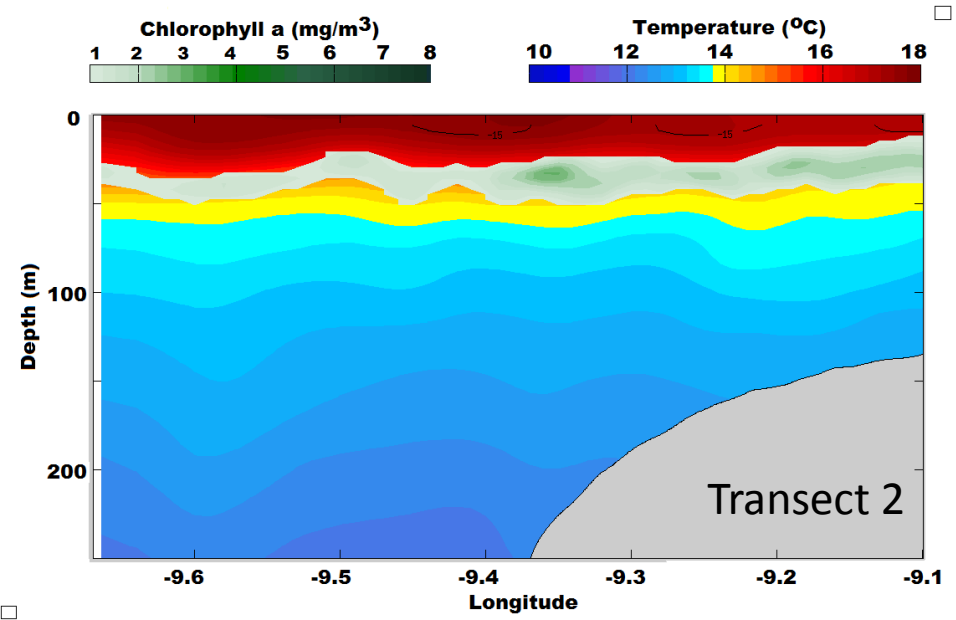
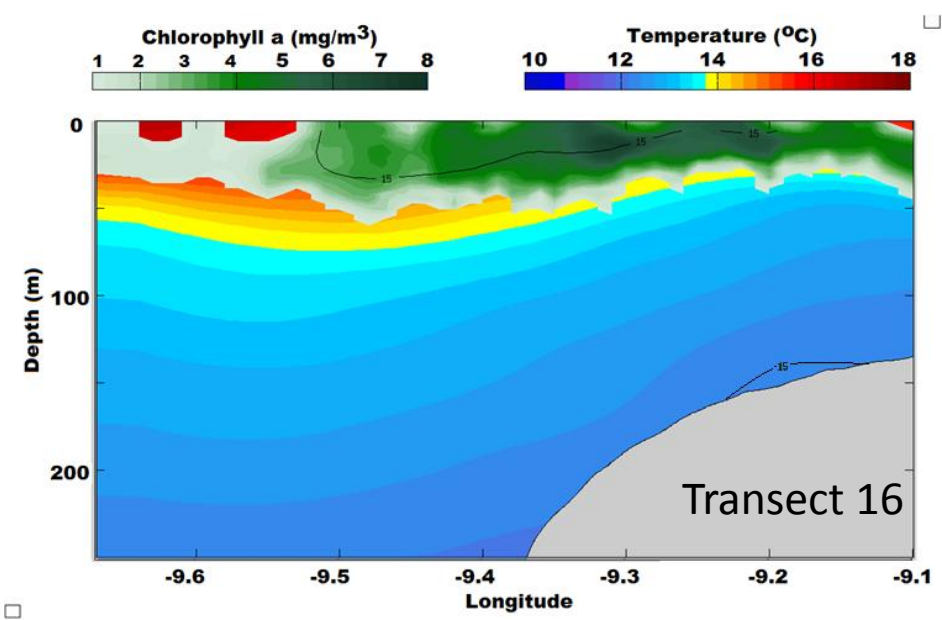
The 17 transects

- Summer season (June to September)
- Three upwelling events
- Two stratification events





Part 2: Data

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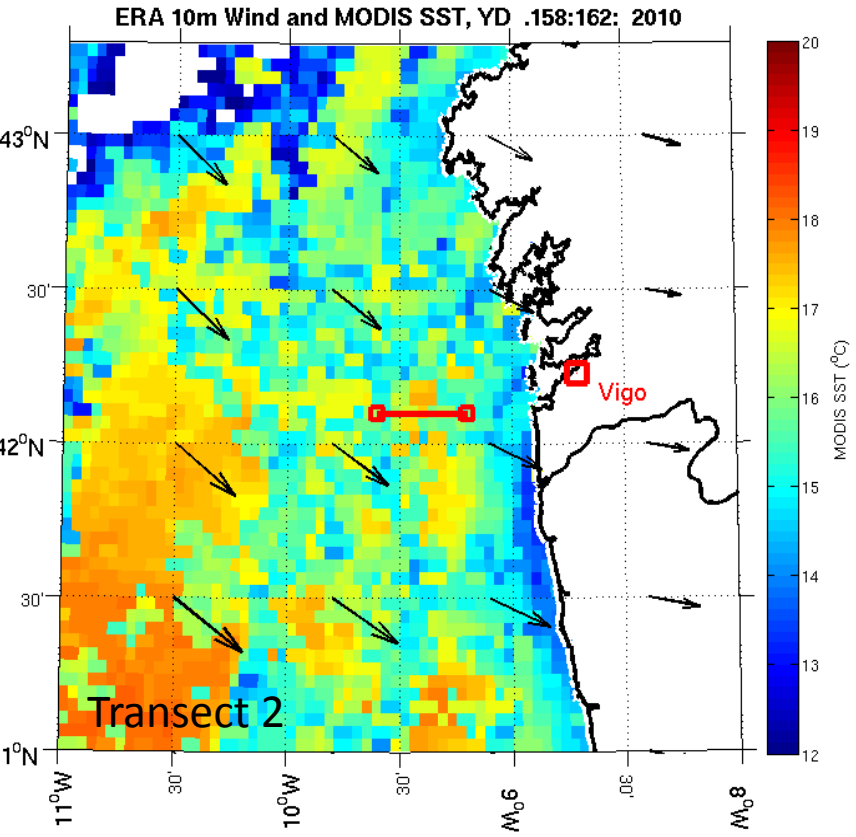
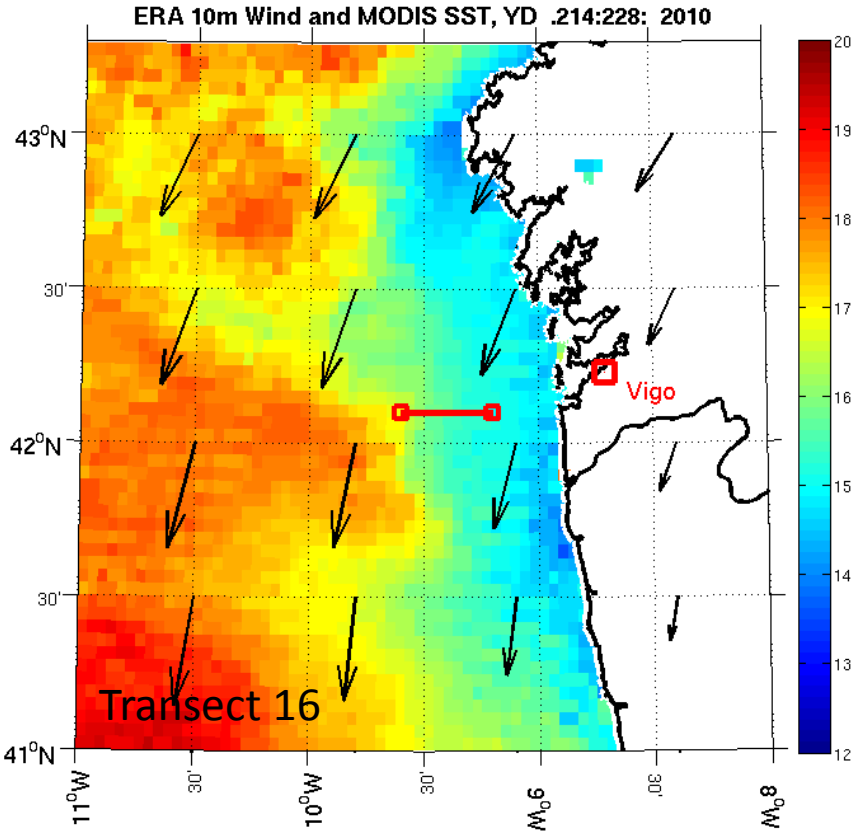
Wind & SST

- Shows the first order control wind velocity has on upwelling





Part 2: Data

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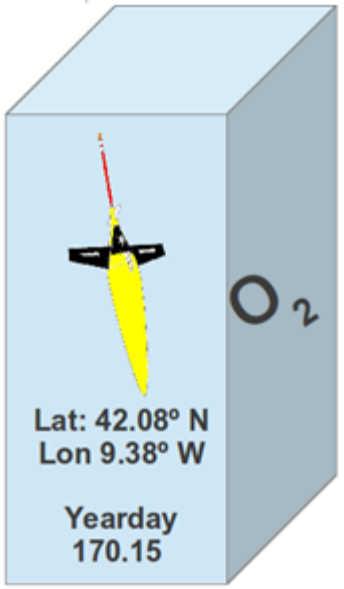
Net Community production

[PP + respiration (both auto and heterotrophic)+ decomposition]

- Aim: how much O_2 is produced/ lost per day per m^{-2} of the watercolumn

- Integrated oxygen inventory for a watercolumn
0 – 65 m

- Is region a net source
or sink of O_2



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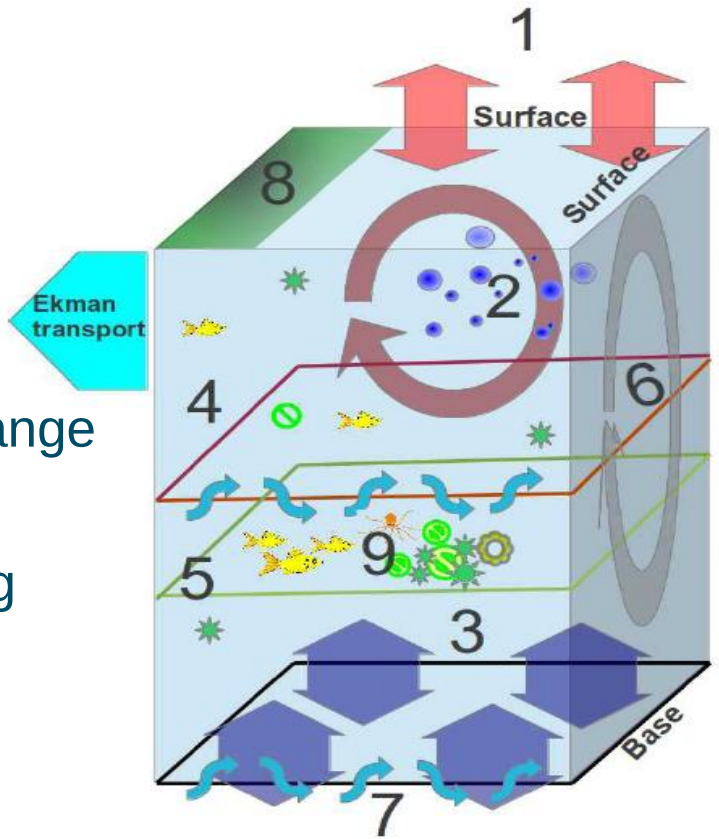
Net Community production

- Physical processes that alter the O2 water column inventory
- Air-Sea gas exchange
- Bubble- sea gas exchange
- Upwelling/ downwelling



Considerations

1. F_g [O_2]
2. F_{bubble} [O_2]
3. F_{up} [O_2]
4. Mixed layer
5. Sub Mixed layer
6. Langmuir Circulation
7. Diapycnal mixing
8. Surfactants
9. Deep chlorophyll Maxima

Calculating the fluxes

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$$I(O_2) = \int_{Z=0m}^{Zbase} C(O_2)\cdot\rho\, dZ$$

$$F_i = \frac{\Delta I(O_2)}{\Delta t} = \frac{[I(O_2)Q_{n+1}\cdot\rho Q_{n+1}] - [I(O_2)T_n\cdot\rho Q_n]}{tQ_{n+1} - tQ_n}$$

$$F_{up}[O_2] = C(O_2(UW)) - C(O_2(ML))\cdot W$$

$$F_g = \left(\left(\frac{S_{cc}}{660}\right)^{-0.5}\cdot k\right)\cdot(C(O_2(ML)) - C(O_2(Sat)))\cdot\rho$$

$$Zbub = (0.15\cdot U_{10m} - 0.55)$$

$$F_{(Bub)} = A_p\cdot\left(\frac{U_{10m}}{ms^{-1}} - 2.27\right)^3 \alpha\left(\frac{D_i}{D_0}\right)^{0.6667}\frac{(X_i P_{atm})}{RT}\left(1 + \frac{(\rho g Z_{bub})}{P_{atm}} - \frac{C_w}{C_{wi}}\right)$$

$$NCP\left(mmol\, m^{-3}\, d^{-1}\right) = F_i - \frac{(F_g + F_{Bub} + F_{up})}{d}$$

Part 2: Data

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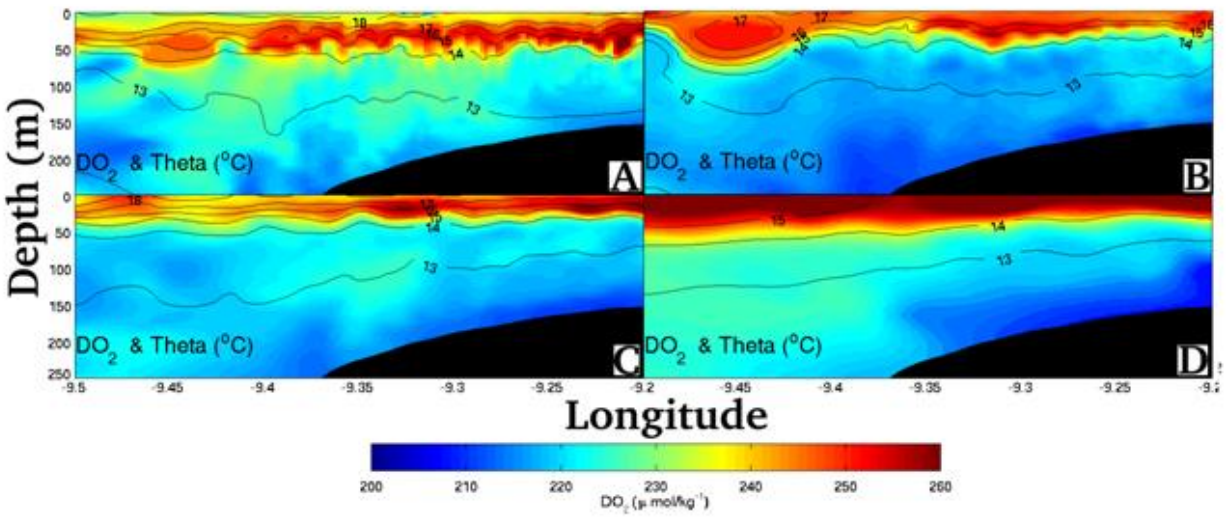
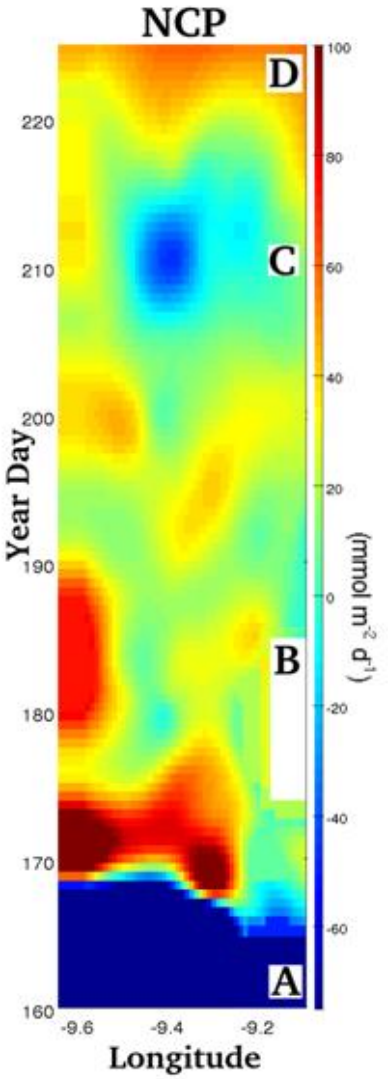
Net Autotrophy (B & D)
- 2 periods of positive NCP (total of 42 days)
-B & D feature decreased deep oxygen concentrations, and depressed isotherms highlighting the upwelling of deep water
- NCP across entire transect, not limited to the continental shelf region to the east of the transect

Net Heterotrophy (A & C)
- 2 periods of negative NCP (total of 20 days)
-Decreased surface oxygen concentrations and increased surface temperatures indicate a stable (non-upwelling) water column
-Higher oxygen concentrations in the deep (>100 m) show the mixing of near-surface oxygenated waters downwards





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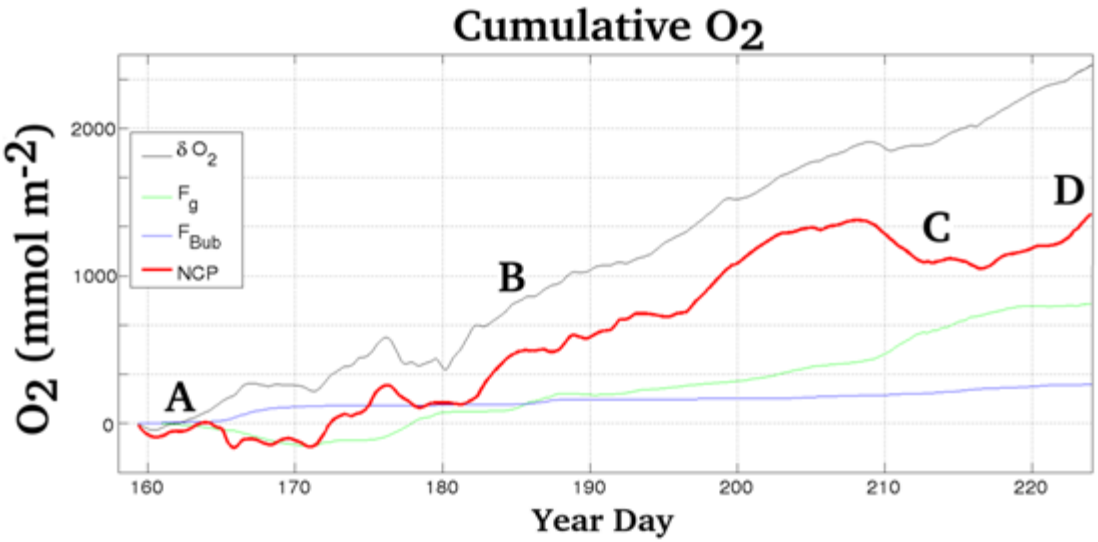

Satellite productivity

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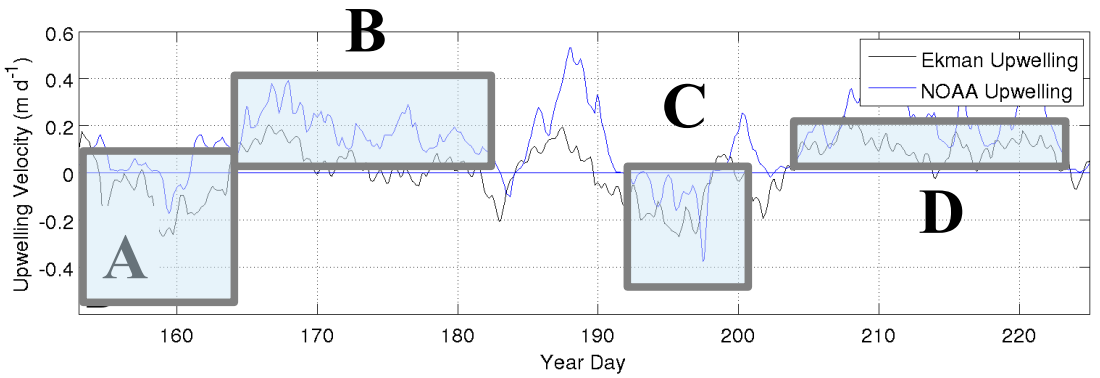
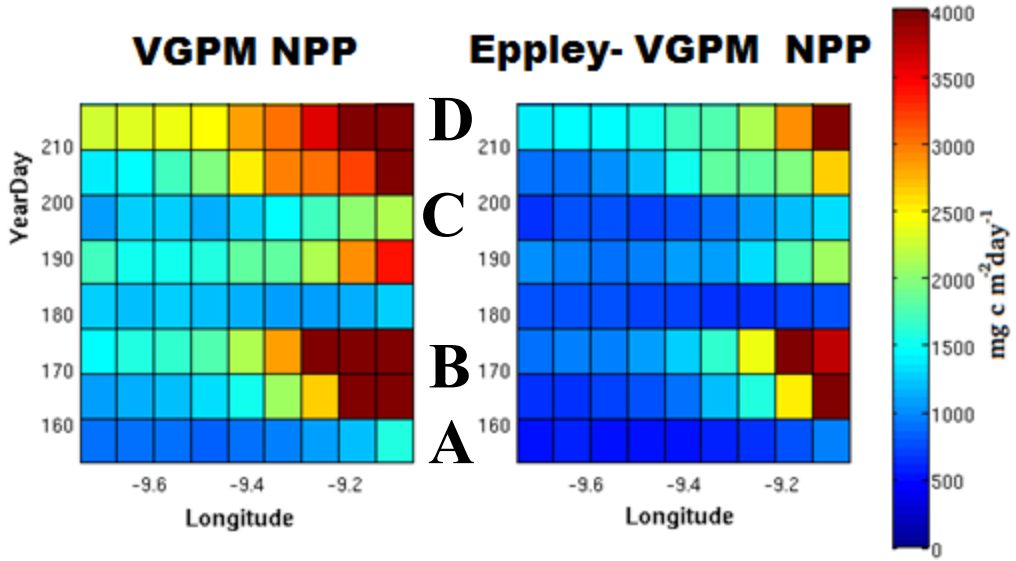
Net primary productivity from Vertically generalized productivity models (VGPM)

- Upwelling velocities from Ekman or NOAA models
- Agreement between NPP and upwelling events
- Strong east-west
- difference in NPP





Satellite productivity & SG NCP

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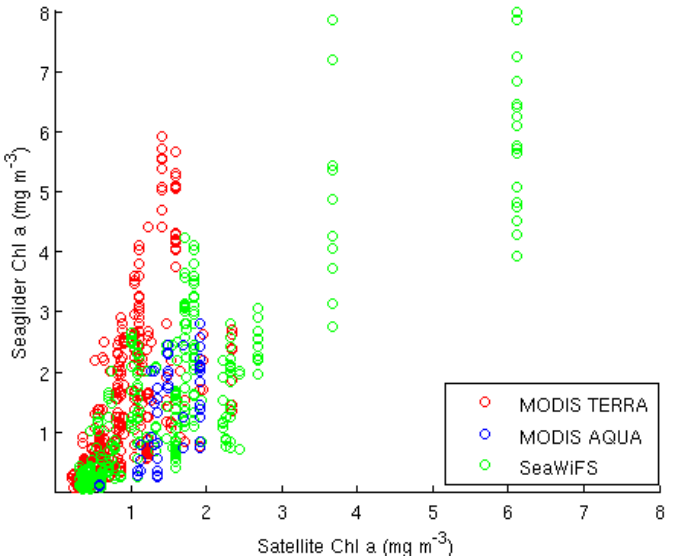
- Underestimated NPP due to MODIS measurements of near surface values
- Deeper DCM towards west of transect
- Westward advection of phytoplankton, with Ekman surface current



Conclusions

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- First Seaglider estimate of NCP
- In-situ optode calibration is vital
- Two regimes- stratified and upwelling.
- Fi > Fg > Fup > Fbub
- Region was net autotrophic- net production of 21 mmol m^{-2} d^{-1}
- Satellite NPP values identified bloom events but very different to NCP

Comparison of NPP to satellite productivity

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- Underestimated NPP due to MODIS measurements of near surface values
- Deeper DCM towards west of transect
- Intensified diapycnal mixing towards west of transect?
- Westward advection of phytoplankton, with Ekman surface current