# GOPINA – Seaglider observations in the Galician upwelling

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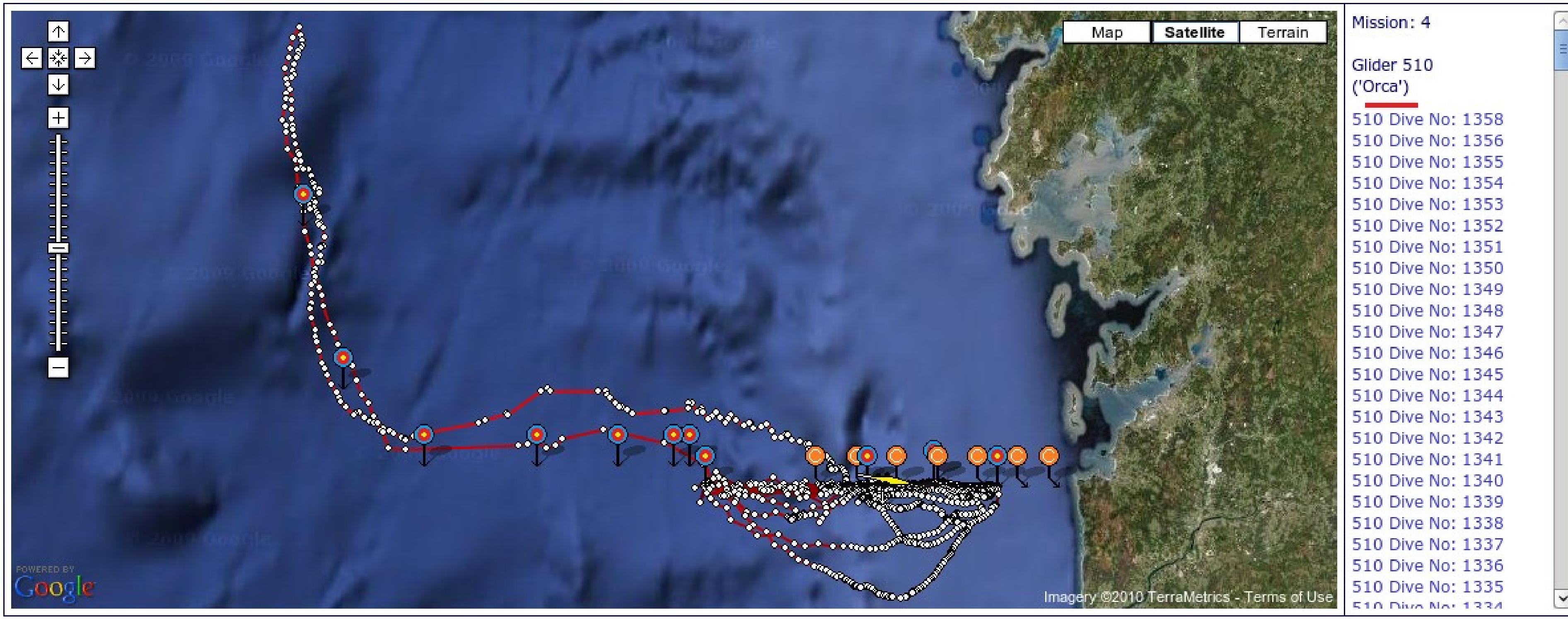
# http://ueaglider.uea.ac.uk

UEA
University of East Anglia



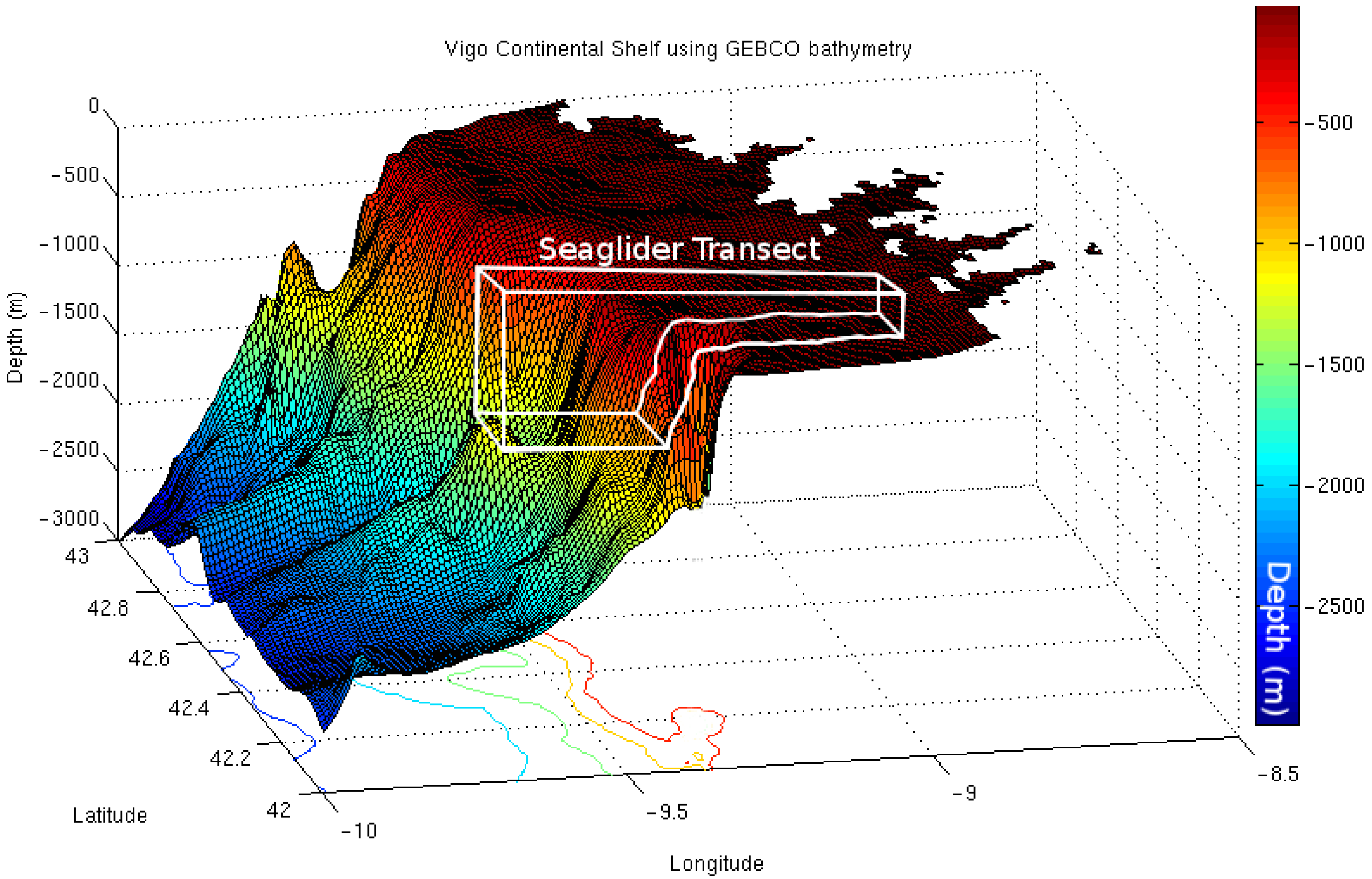
# GOPINA mission statistics

University of East Anglia

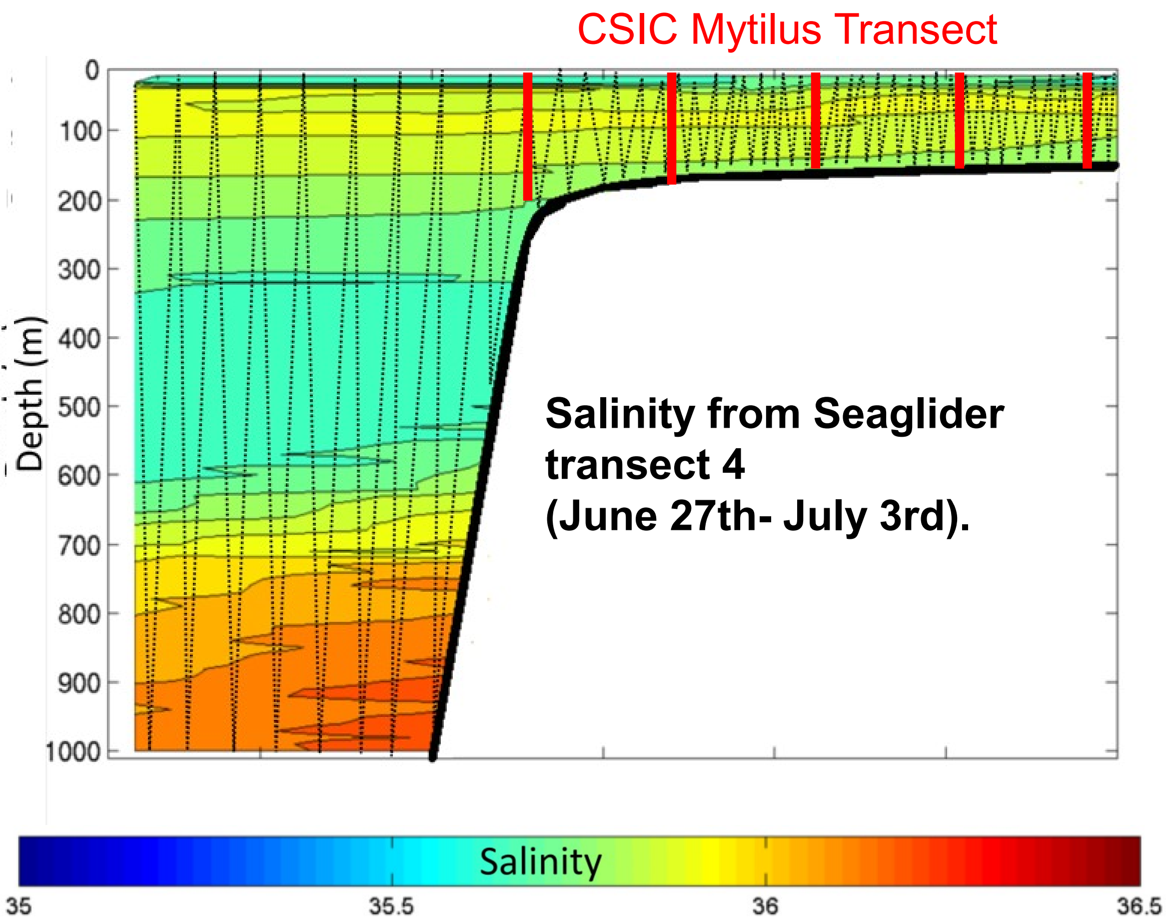
- 1 June – 21 September 2010
- 113 days at sea
- 1611 dives
- 1346 dives with data
- 18 transects, 16 in first two months
- horizontal distance: 1600 km
- vertical distance: ≈1000 km
- battery use: 24 V – 148 Ah / 145-150 Ah (engine)
  10 V – 89 Ah / 95-100 Ah (electronics)

# The North Atlantic at 42º N, 9º W

- Majority of mission spent <200m



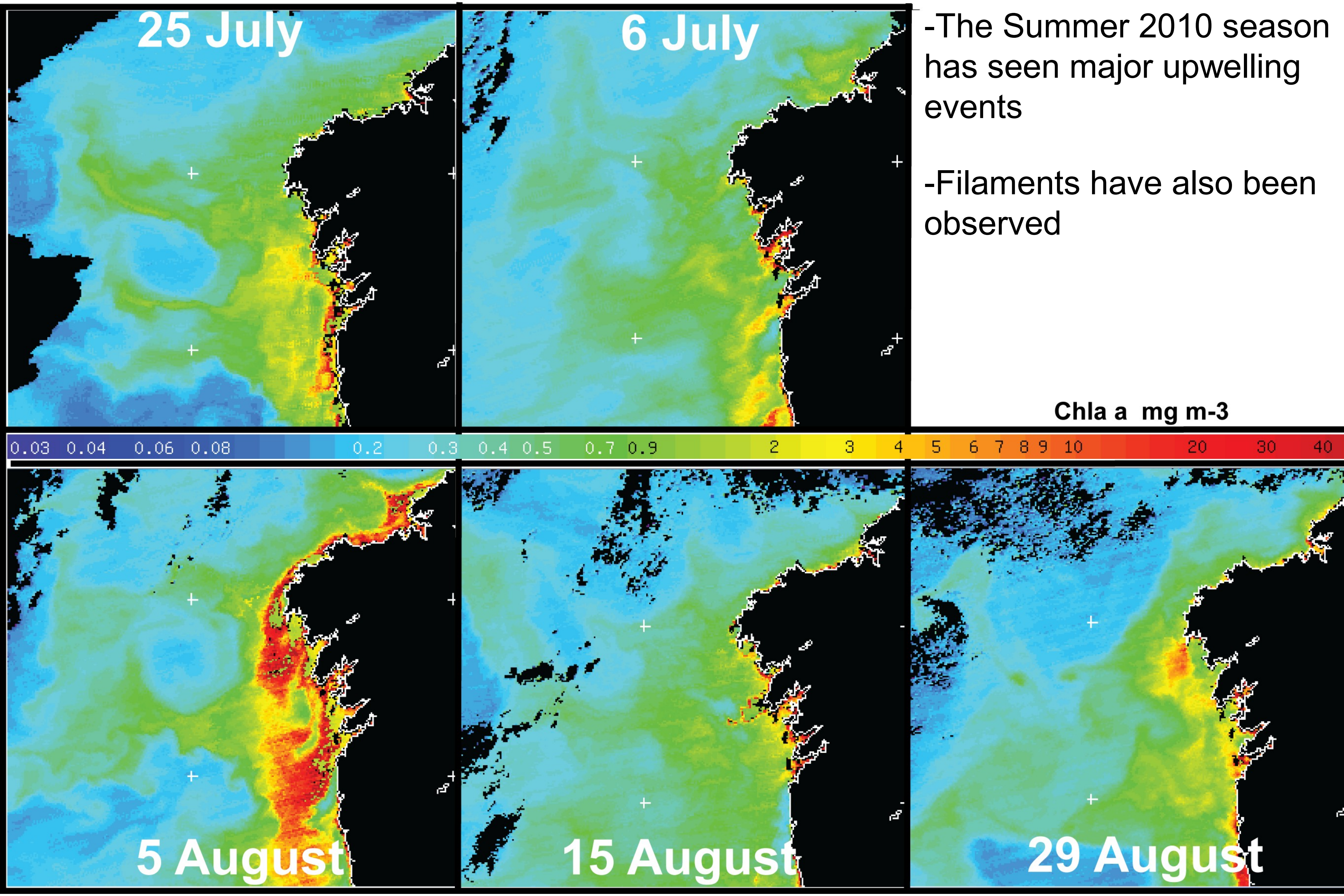
# Seaglider transect




**A brief overview of the region**

1. Strong seasonal northerly winds form, increasing the velocity of the Portugal current
2. Ekman transport leads to upwelling
3. Intermediate water masses are advected towards the surface, promoting the fertilization of the photic zone
4. Chlorophyll a and dissolved oxygen concentrations increase between 0 and 60m

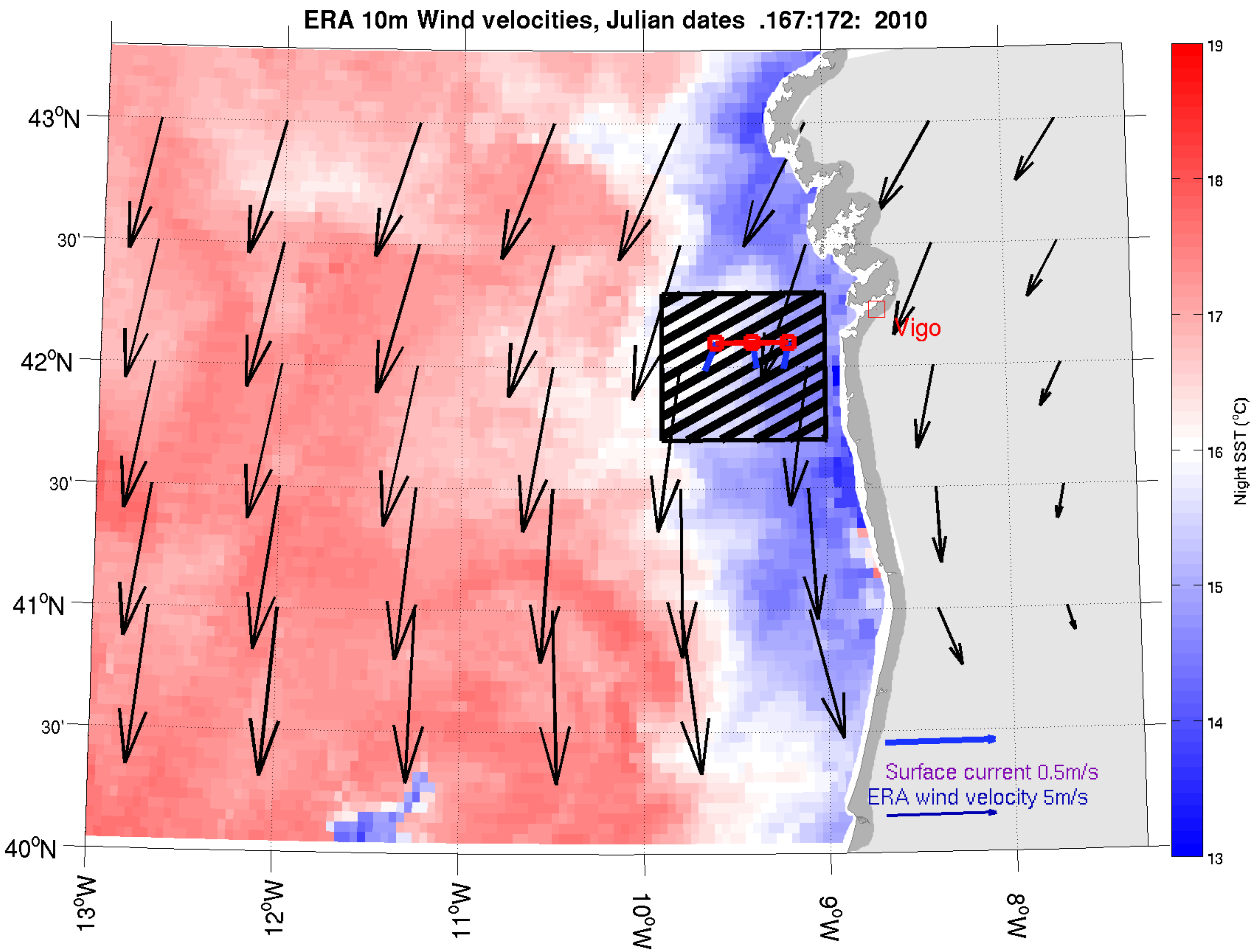
# Observations of upwelling




-The Summer 2010 season has seen major upwelling events

-Filaments have also been observed

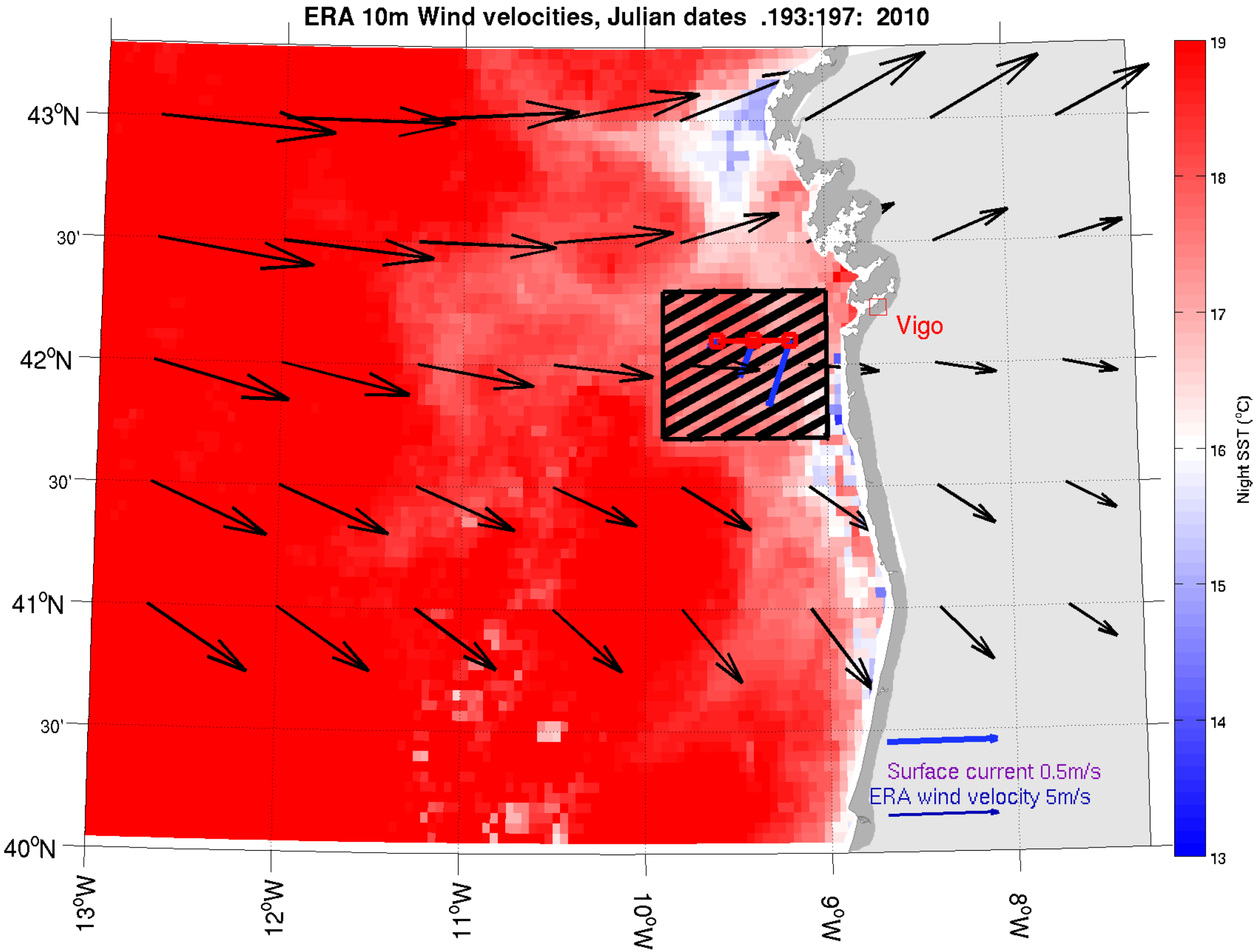
# I. ERA winds/ Surface Drift/ MODIS




Seaglider takes two GPS coordinates at surface

During steady northerly winds- surface currents flow to the SW at velocities between 12-32cm/s

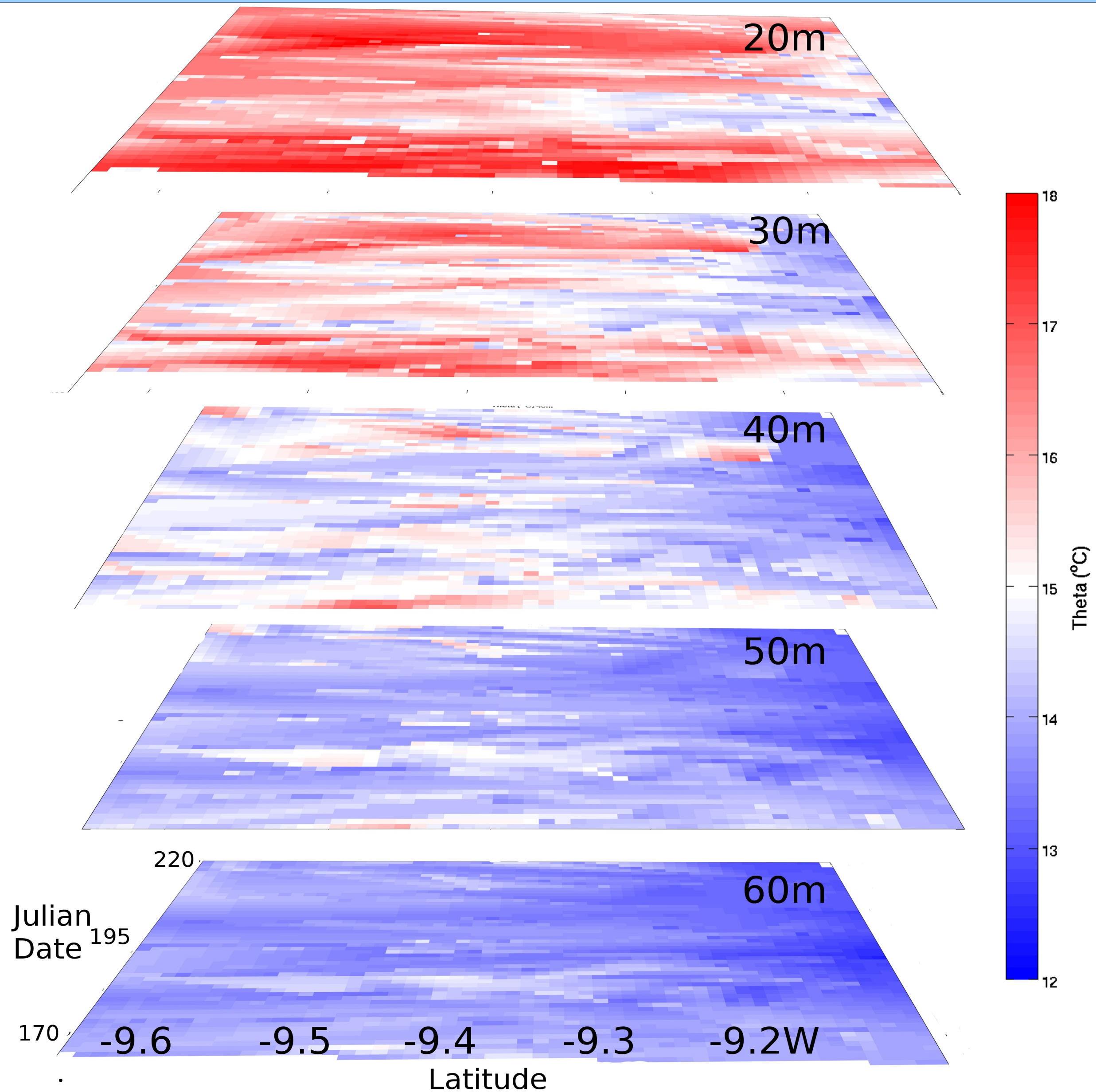
# ERA winds/ Surface Drift/ MODIS




- -Onshore winds bring a reduction in upwelling

- - Surface drift velocities eventually slow. However there is lots of inertia in the system

# Observations of upwelling

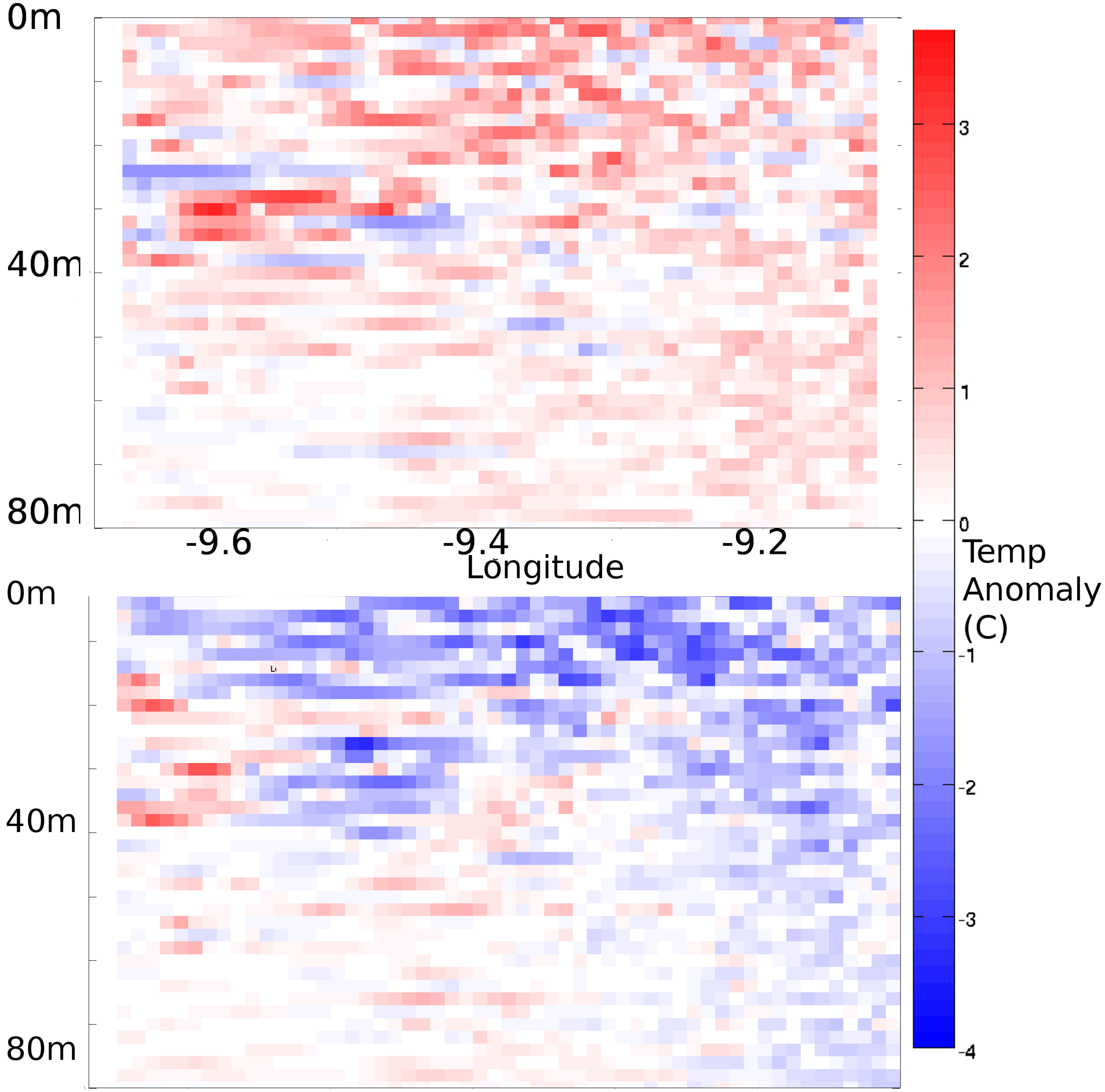



-Hovmöller plot of temperature at 20, 30, 40 ,50 and 60 m depths

- Strong upwelling at 9.1 to 9.3º W

-Transport of water masses offshore at <40 m

# Temperature anomalies & upwelling

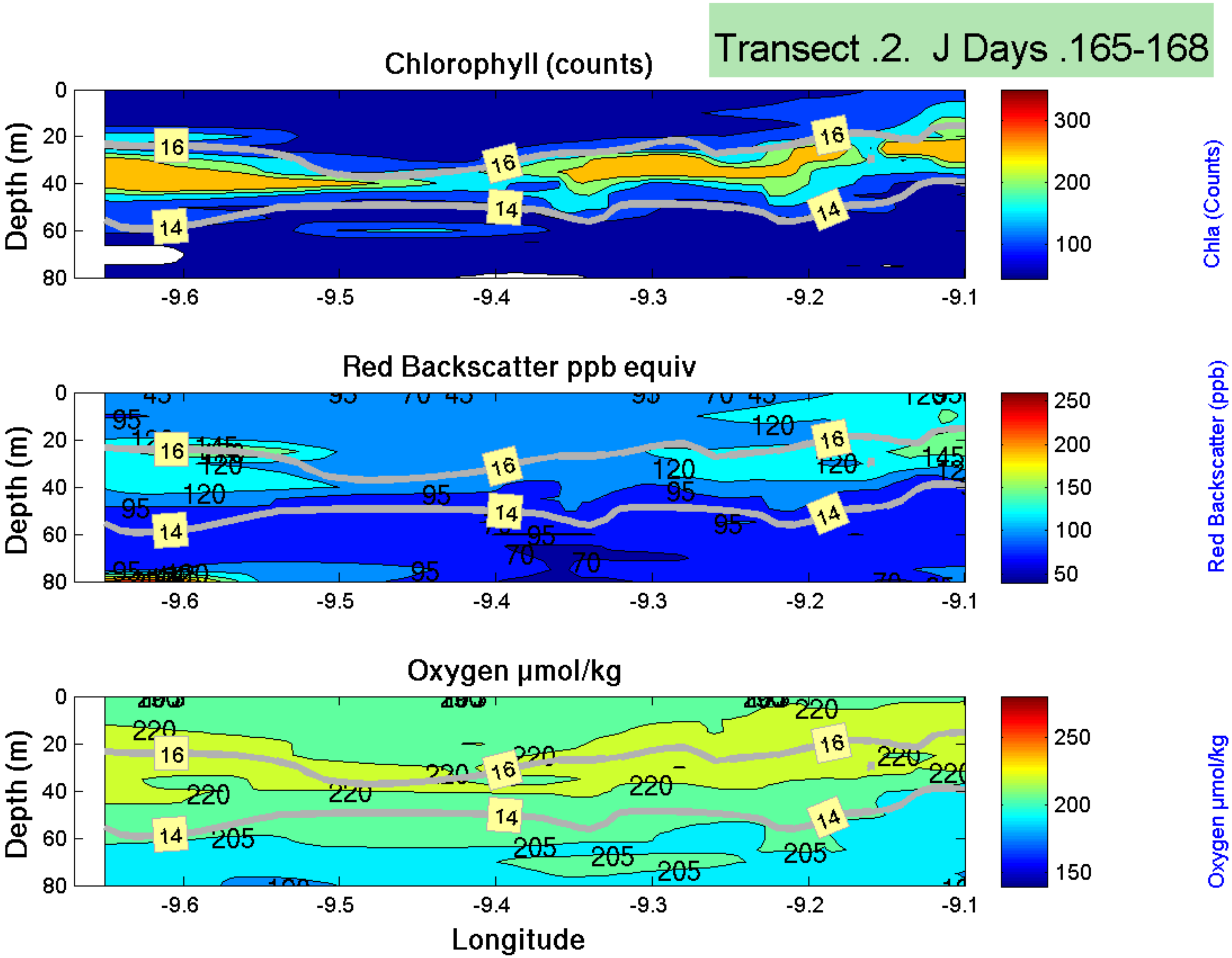



Examples of the two summertime regimes observed with theta anomalies

**Upwelling**
Transect 3 (lower figure) - Strong upwelling of Atlantic intermediate water from 9.2º W to 9.1 ºW.

**Stable**
Transect 12 (upper figure) Stratified water column, warming from the surface down.

# II. Biology in a stable water column

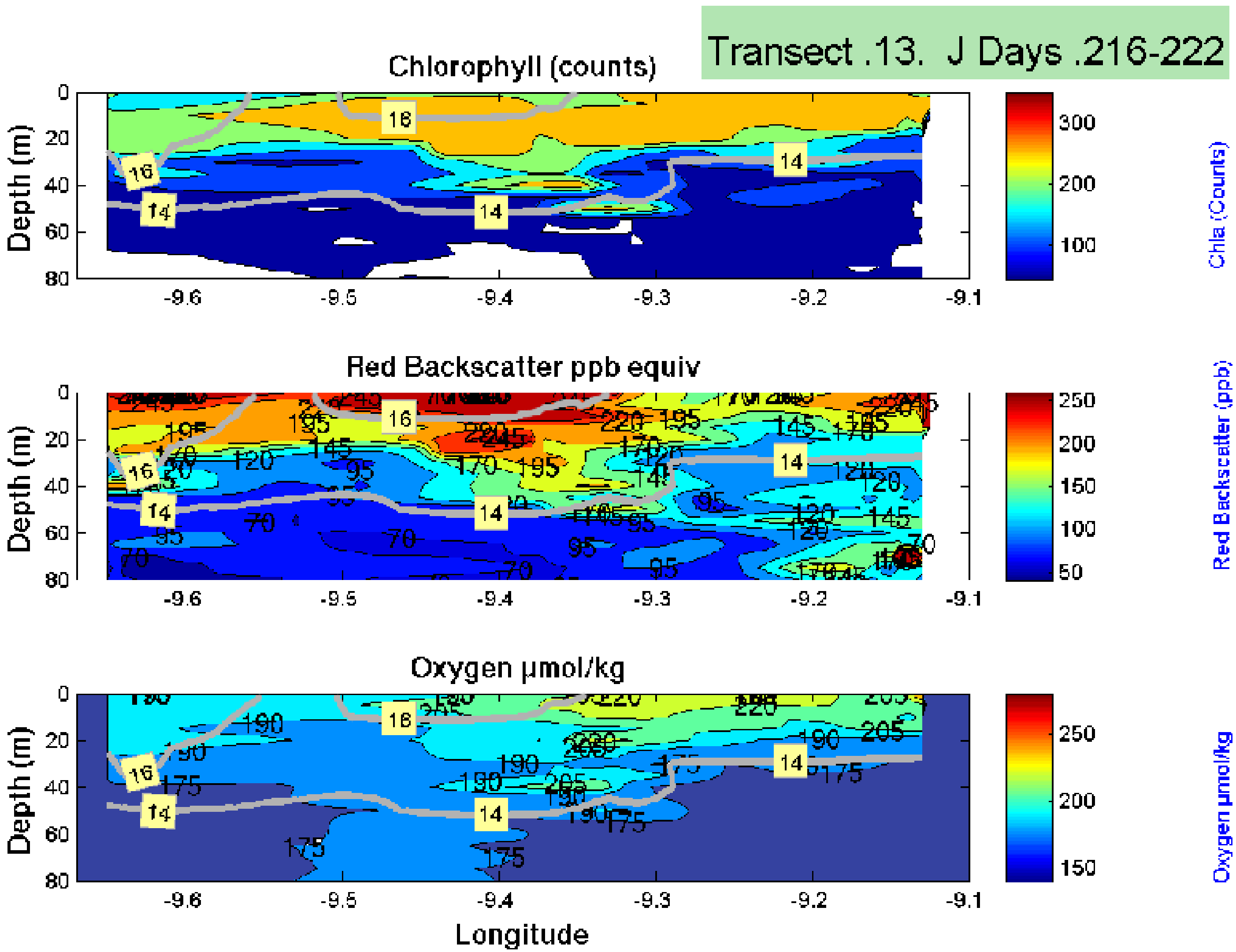



- Deep Chlorophyll Maxima forms at a greater depth

- Isotherms are deeper and more equal across the transect

- Red backscatter is low in top 100 m

# Biology during upwelling

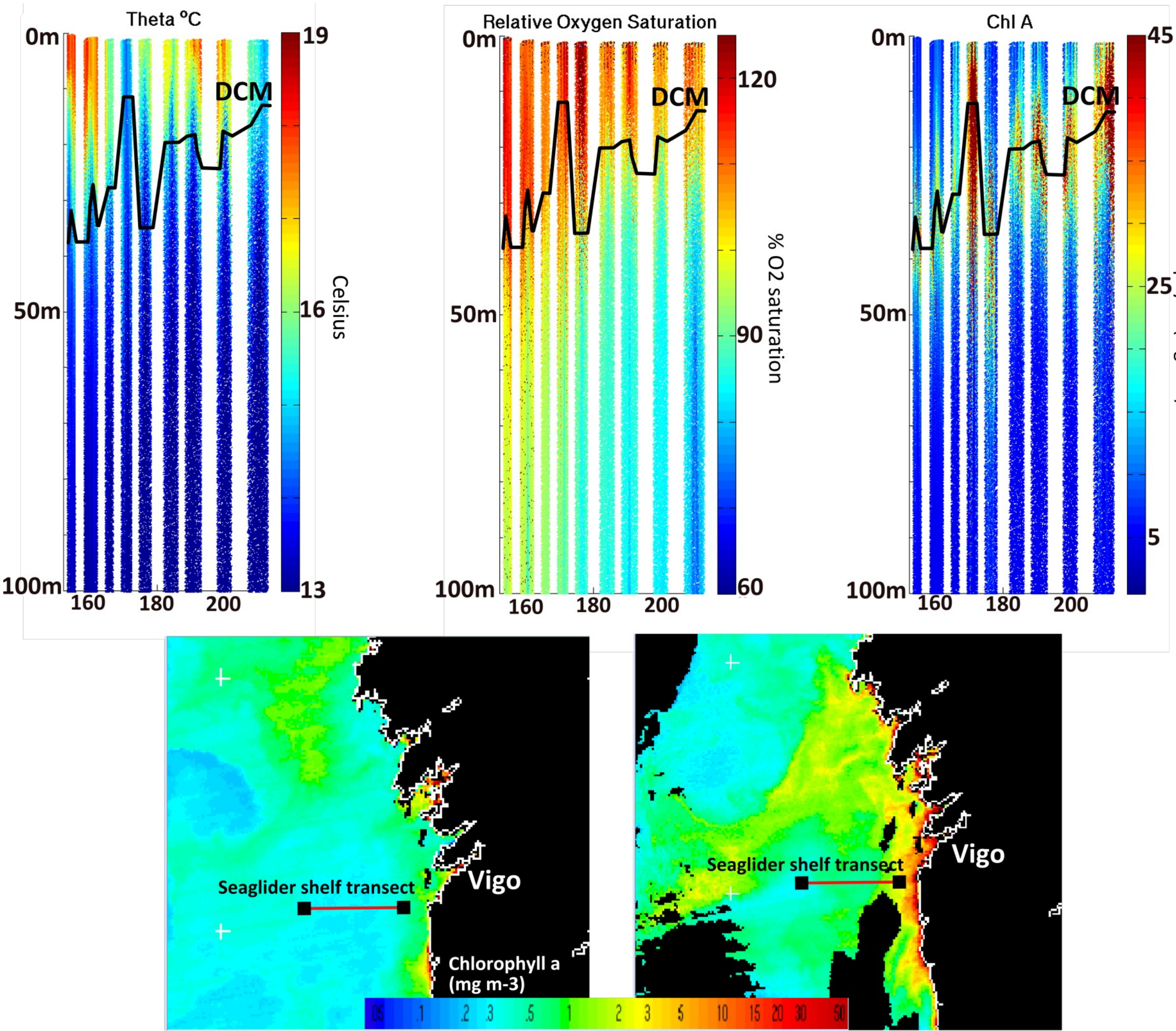



- Deep Chlorophyll Maxima forms 10-15m shallower than before

- Isotherms are skewed by upwelling

- Red backscatter spikes in regions with high Chl A

# Tracking DCM through both regimes

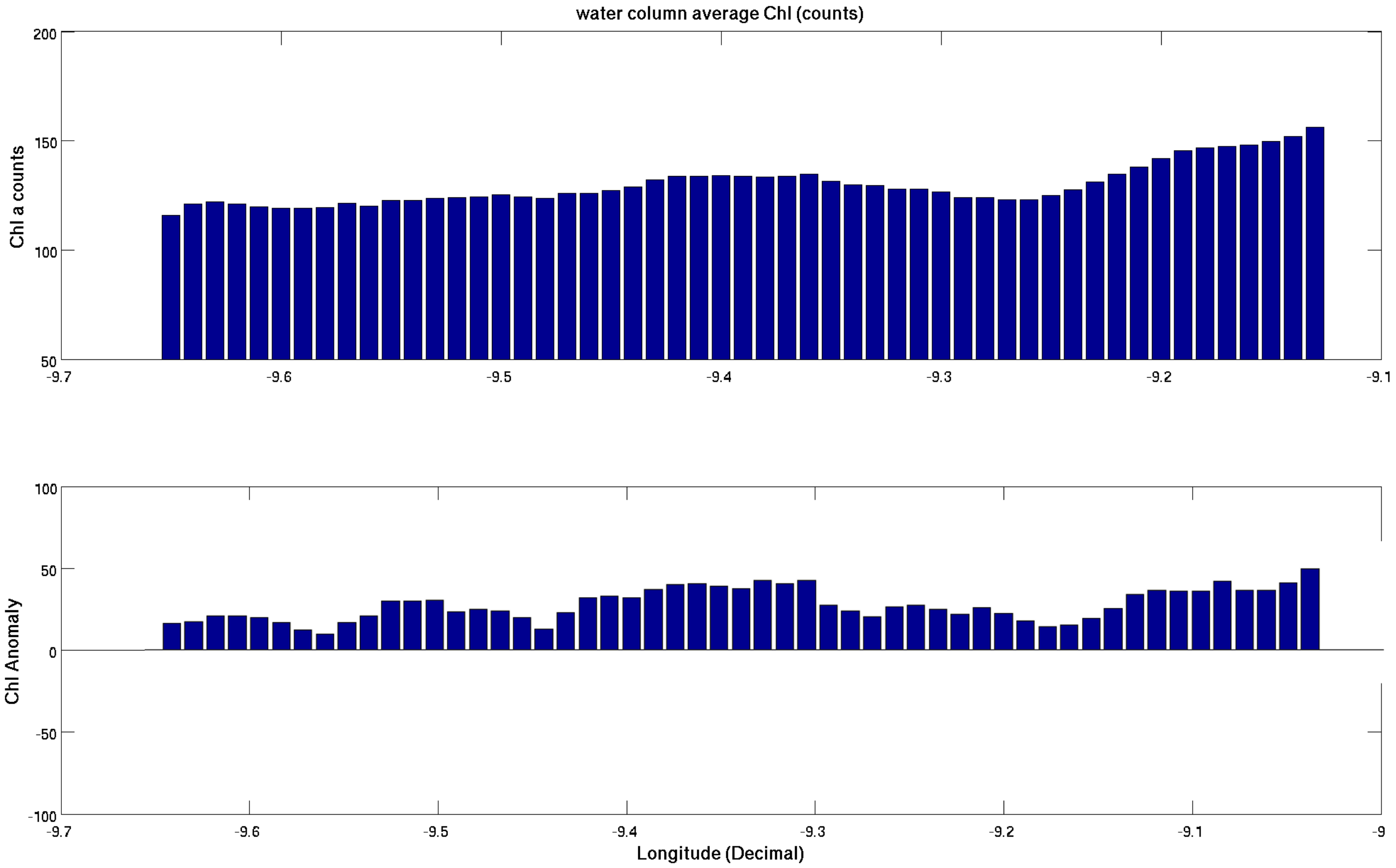



-Shelf data only

-Strong association between Chl a, temp & $O_2$

-Deep Chlorophyll Maximum (DCM) shifted towards surface with upwelling

# Productivity under the two regimes

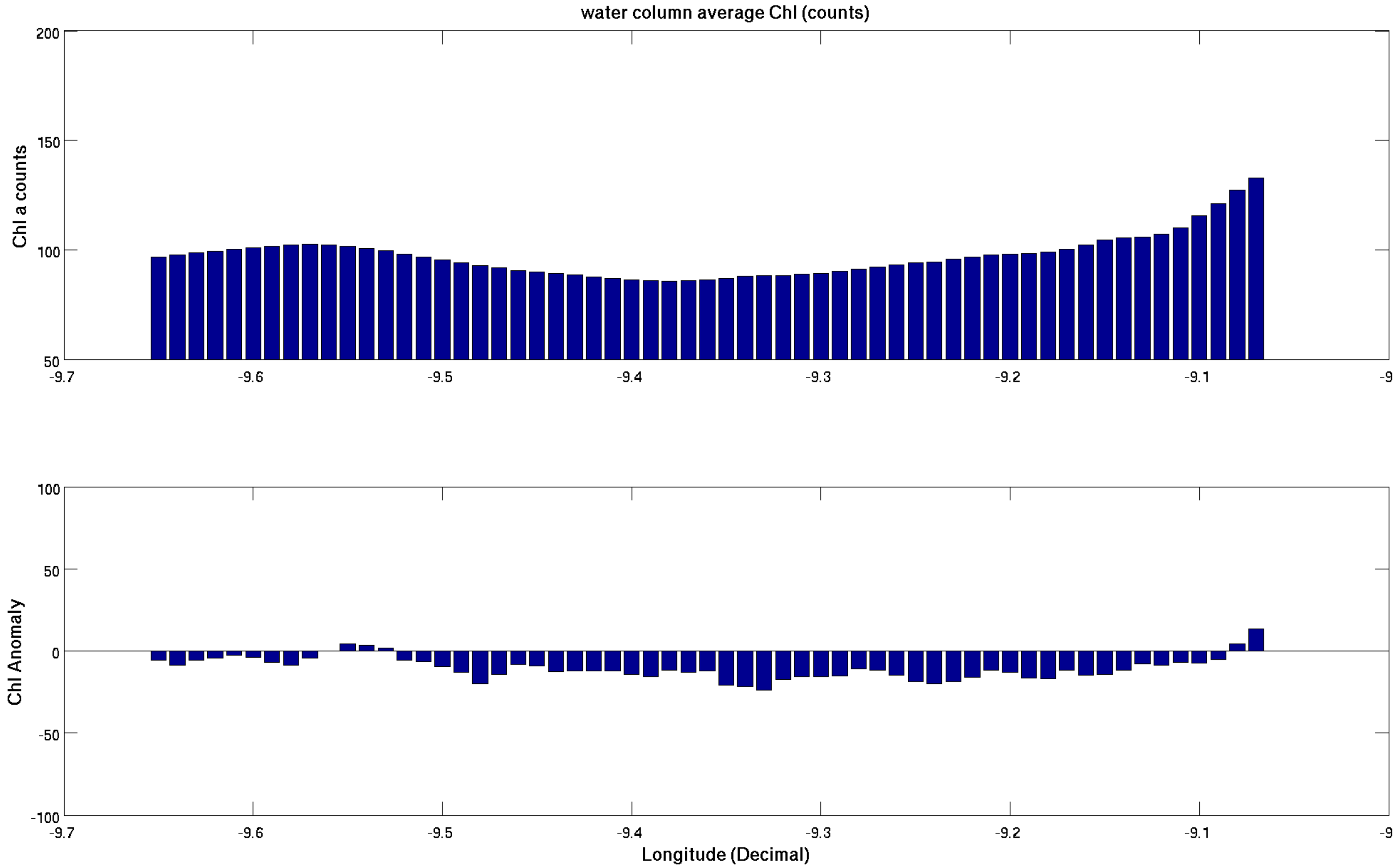



**Upwelling regime**

-Higher concentrations of Chl a are found further east

- More productive over majority of transect.

# Productivity under the two regimes




**Stable regime**

-Lower productivity on average over majority of transect

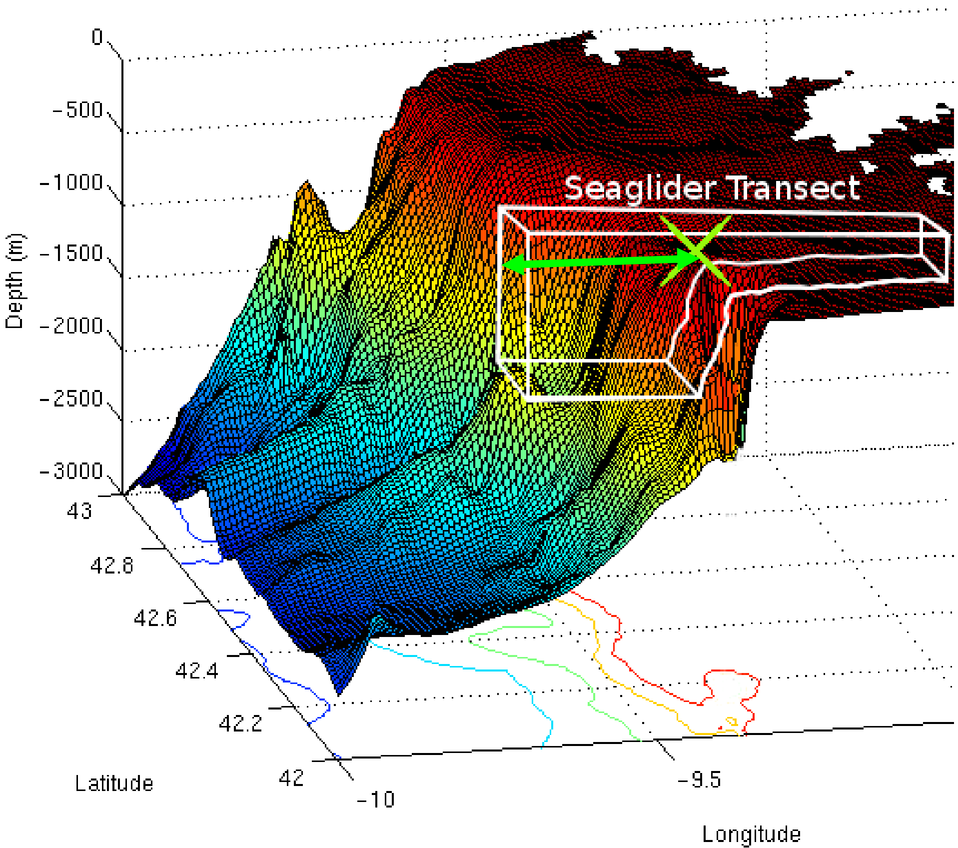
# West of 9.3 ºW – Region of homogeneity

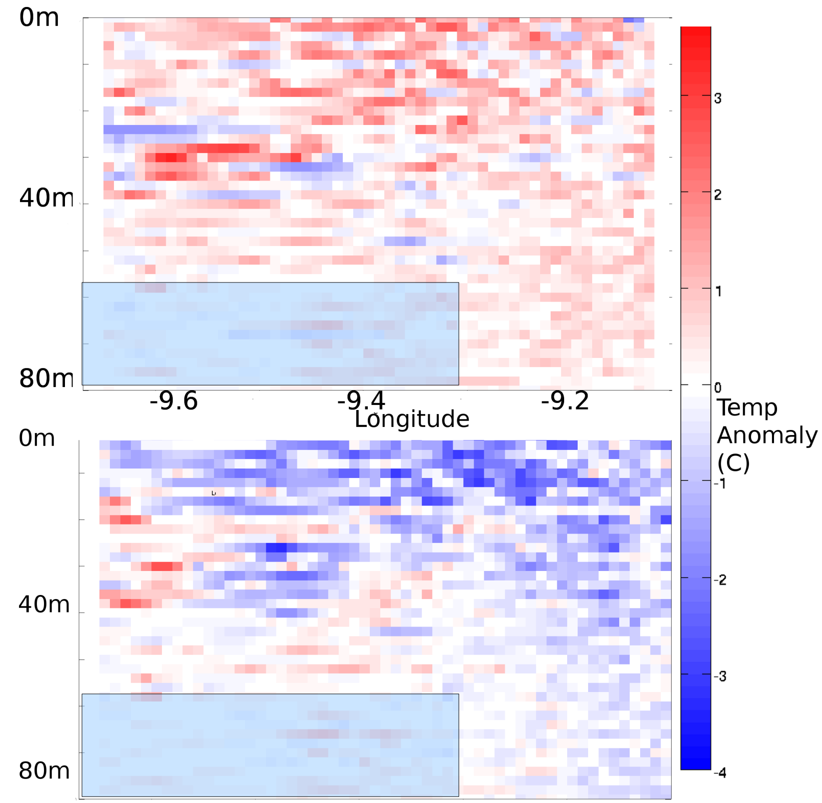
Water column between the shelf and 60 m depth has lower variability compared to rest of transect

-Average 70 m theta anomaly 9.4º W-9.5º W: 0.25 ºC

-Average 70 m theta anomaly 9.1º W-9.3º W: 0.45 ºC

-Average 70 m theta anomaly 9.4º W-9.6º W: 0.31 ºC

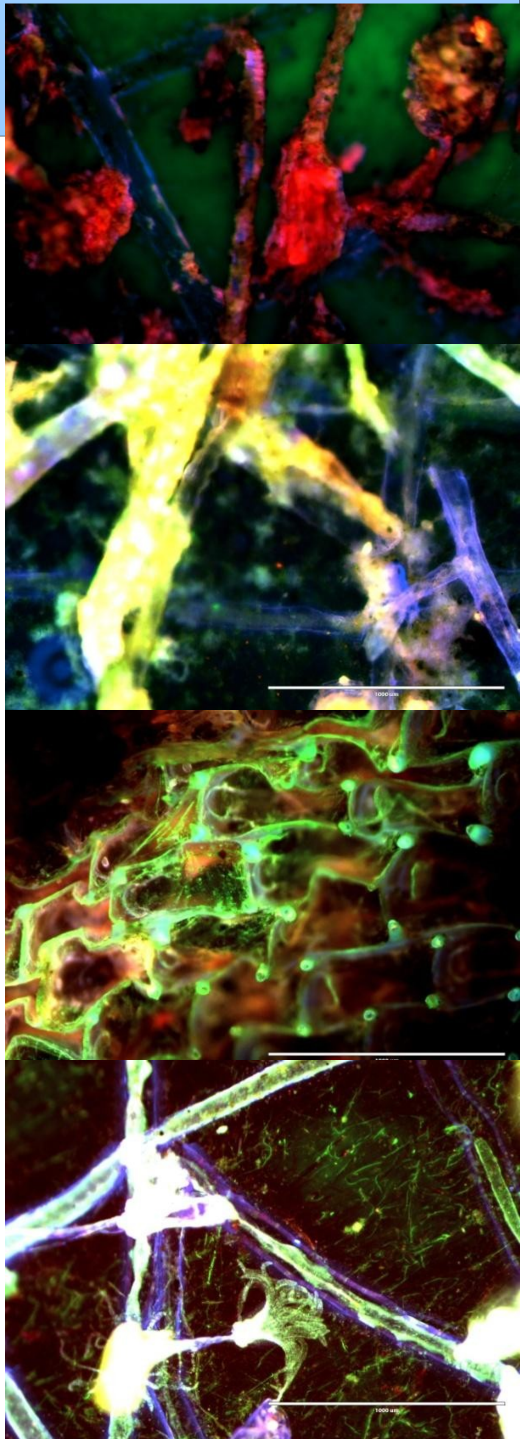


# III. Lessons learnt

Biofouling...

- Longer missions in productive regions will result in significant biofouling.
-Seaglider has no active or passive protection against biofouling
- Detrimental for both hydrodynamics and optical sensors

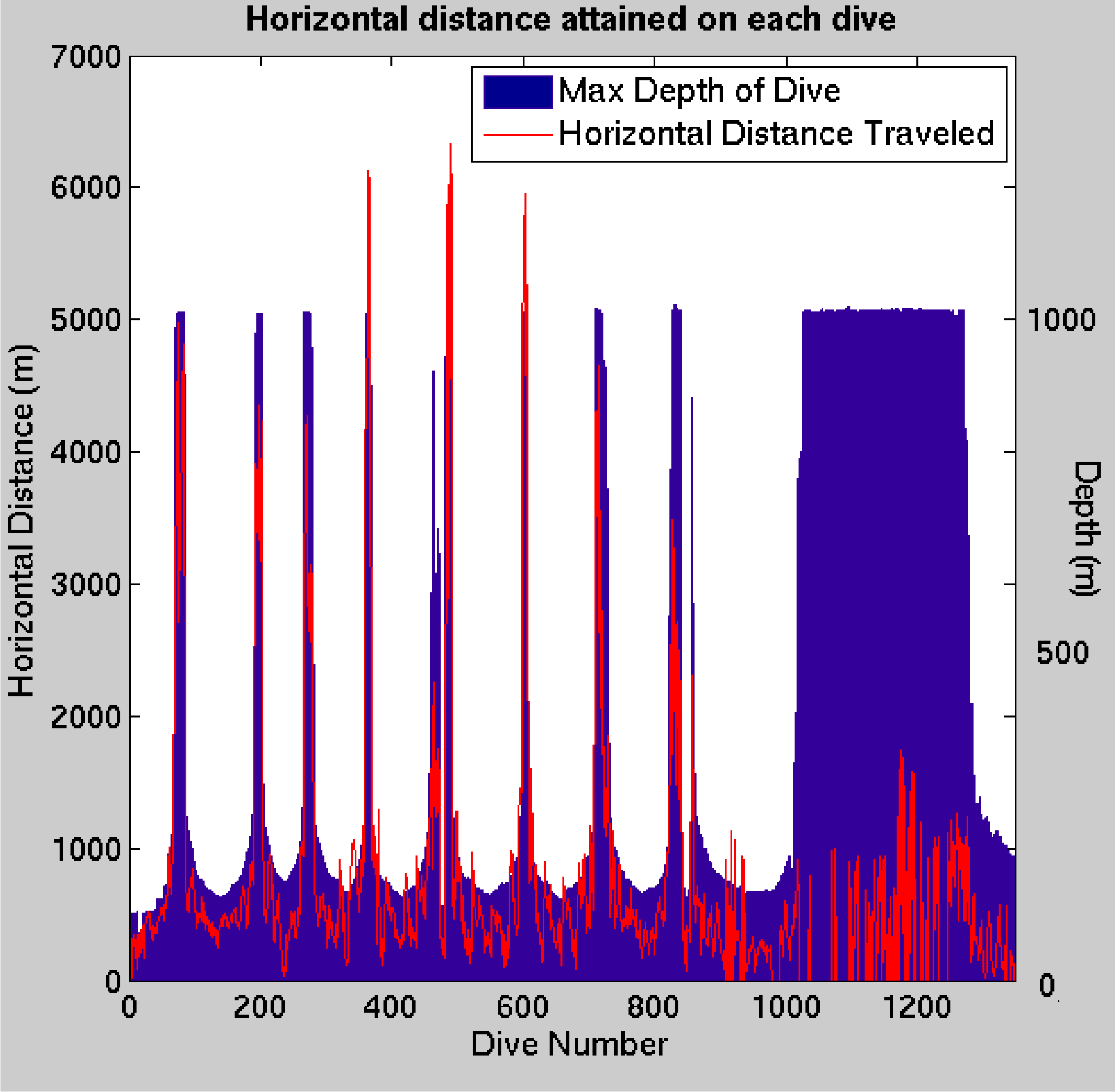


# Hydrodynamics

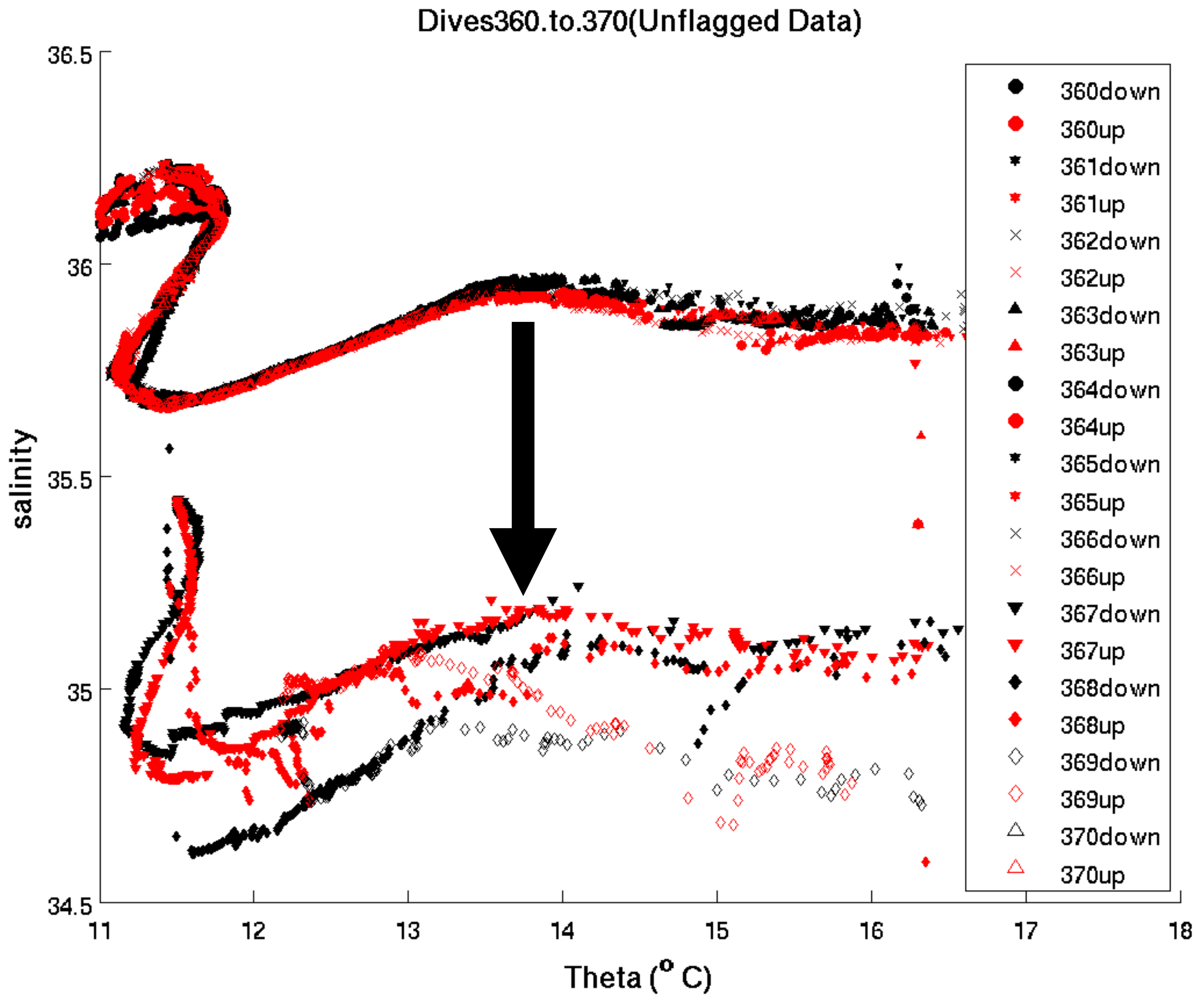
-Horizontal distances for 1000 m deep dives varied from 6.3 km at Dive 488 to 1.3 km for dives 1070-1080.

-Daily distances covered (excluding surface drift)
Max. 24.1 km over 3.8 dives
Min. 7.5 km over 5.7 dives

-Maximum surface currents experienced in region were typically 15 cm/s, meaning progress was often slow at the end of the mission.



# CT cell operation



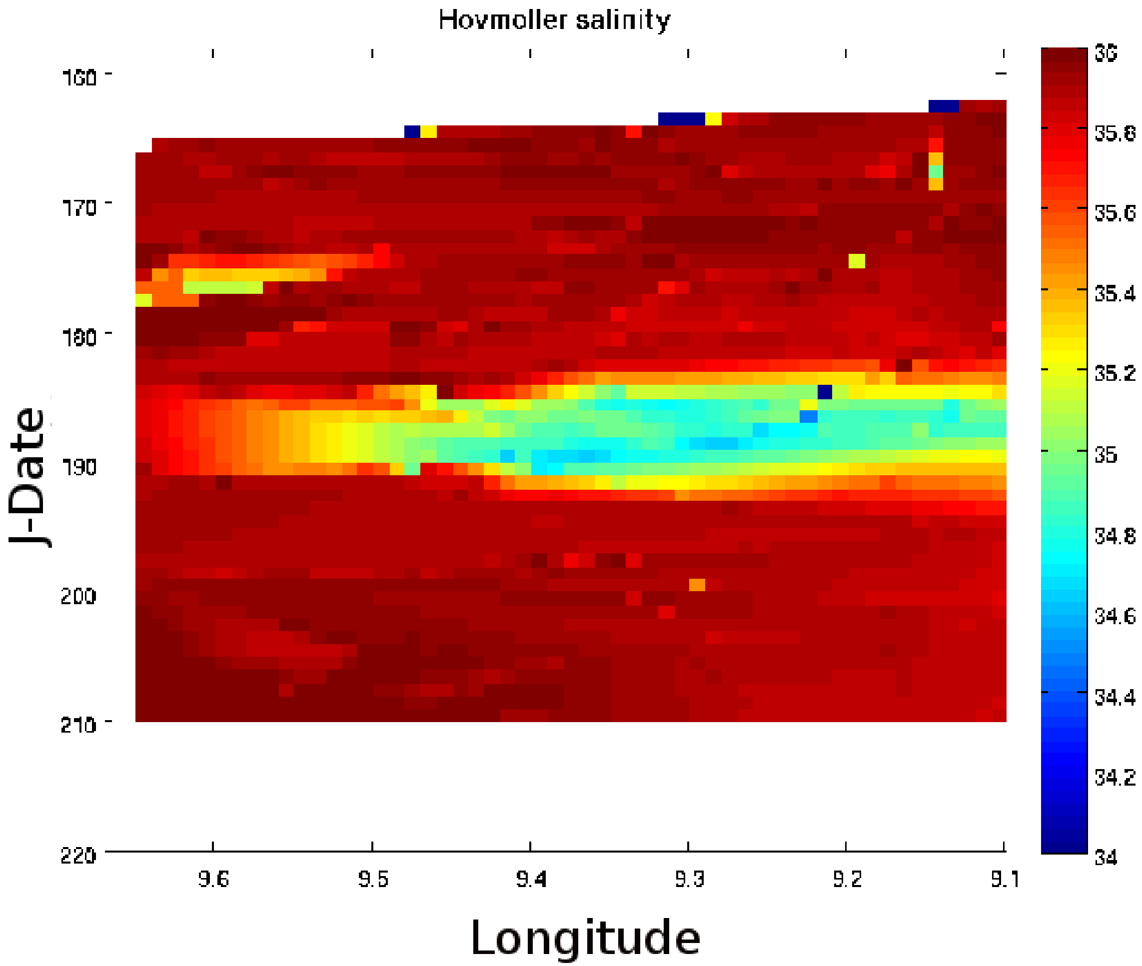

-Bottom collision occurred at dive 366

- salinity offset ≈ 1, and hugely increased standard deviation values.

-Detritus entered CT cell, altered conductivity properties.

- Solved by a series of fast dives- cleared the sediment.

# CT cell operation

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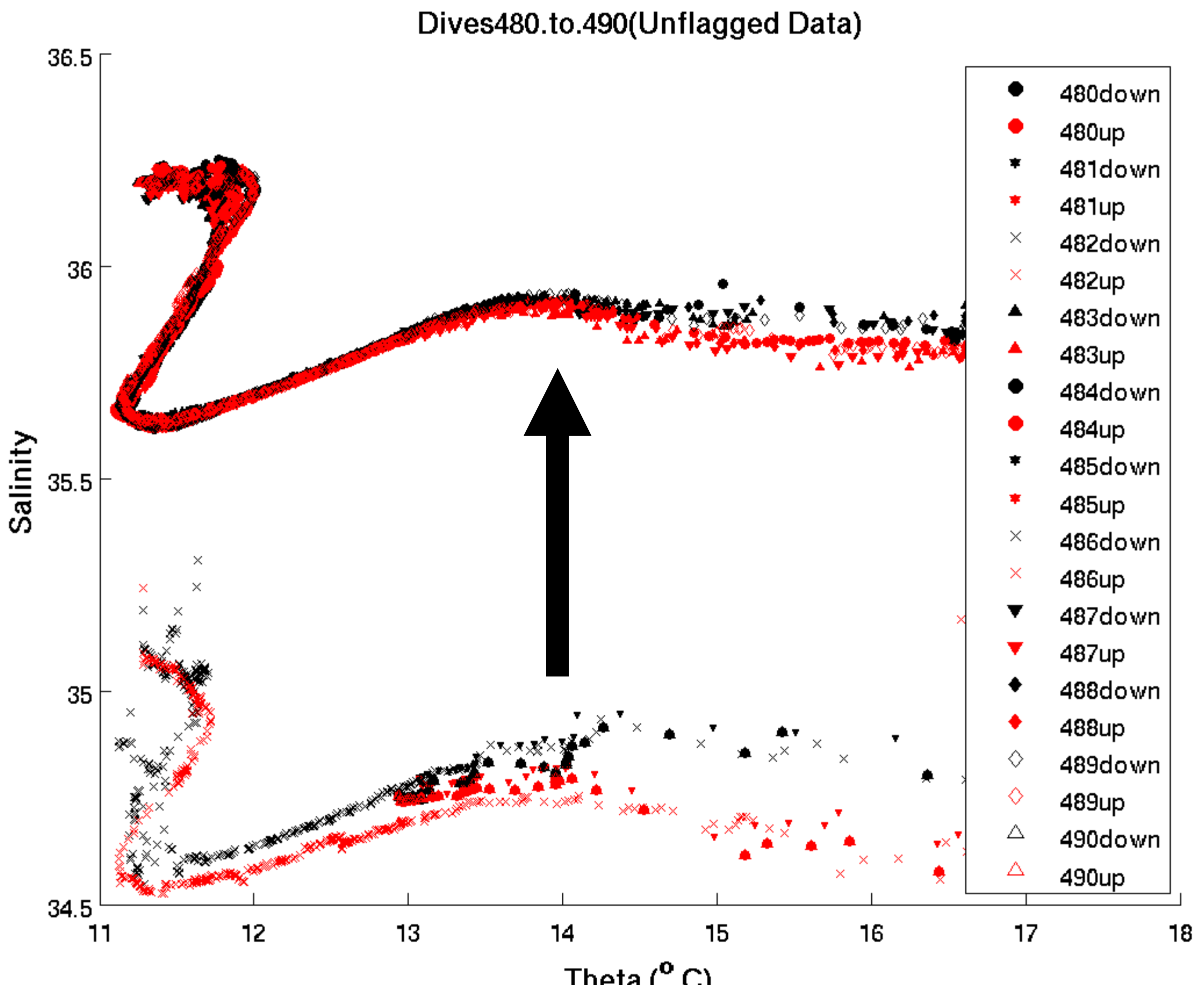


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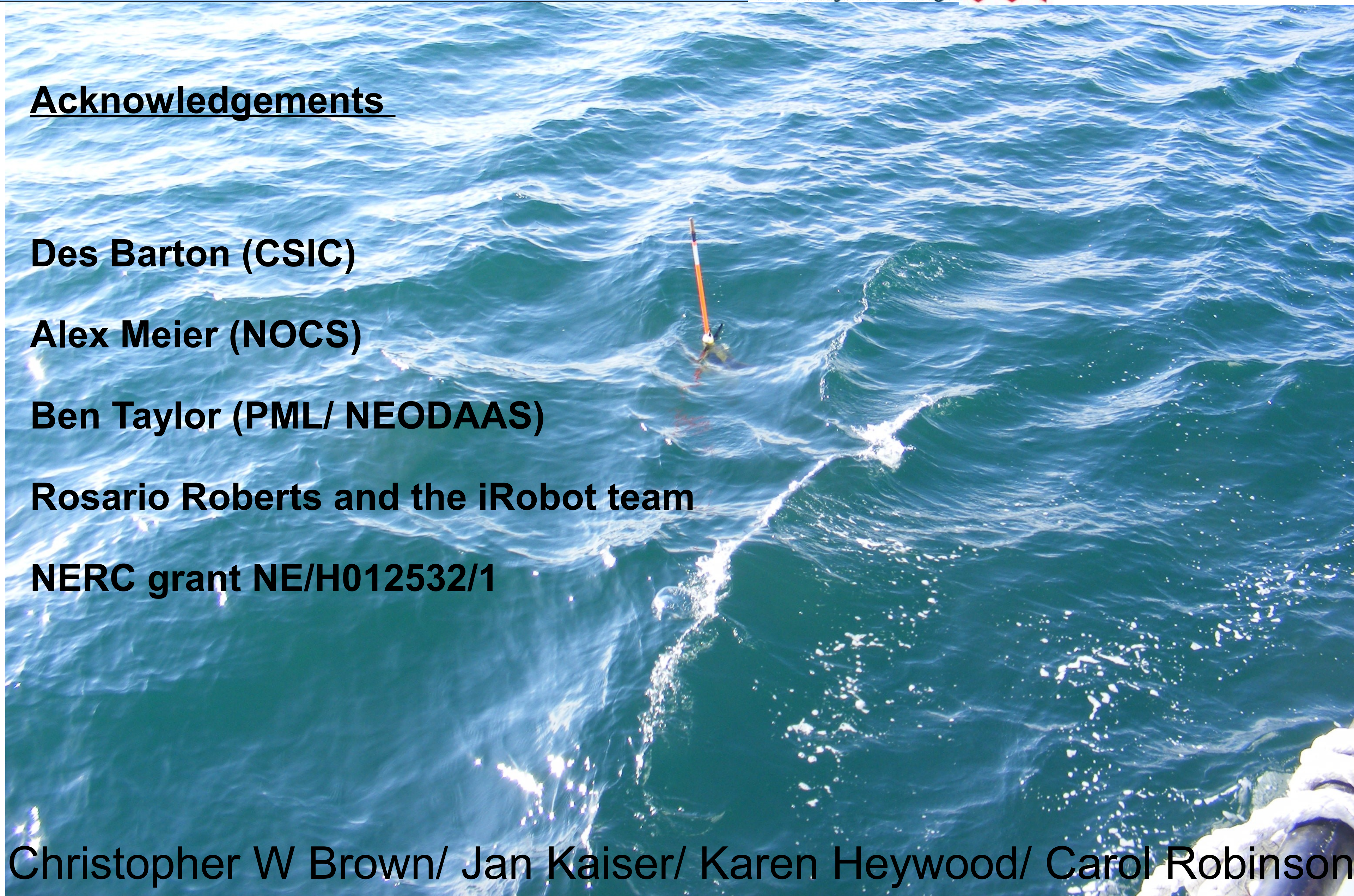
# Conclusions

- North Atlantic summer 2010 saw many large wind-driven upwelling events
- Using the Seaglider resulted in a higher resolution dataset compared to traditional methods
- The strongest upwelling occurs east of 9.3 ºW, and then propagates westwards in the top 100 m
- Surface drift remained to the South-West for the majority of the mission
- Issues such as biofouling and bottom collisions should be considerations for extended missions

# ueaglider.uea.ac.uk

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**Rosario Roberts and the iRobot team**

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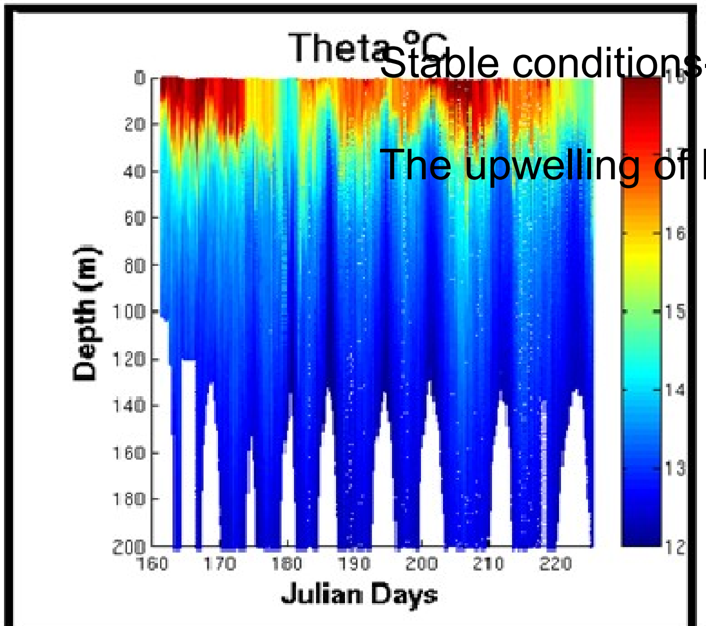
Christopher W Brown/ Jan Kaiser/ Karen Heywood/ Carol Robinson

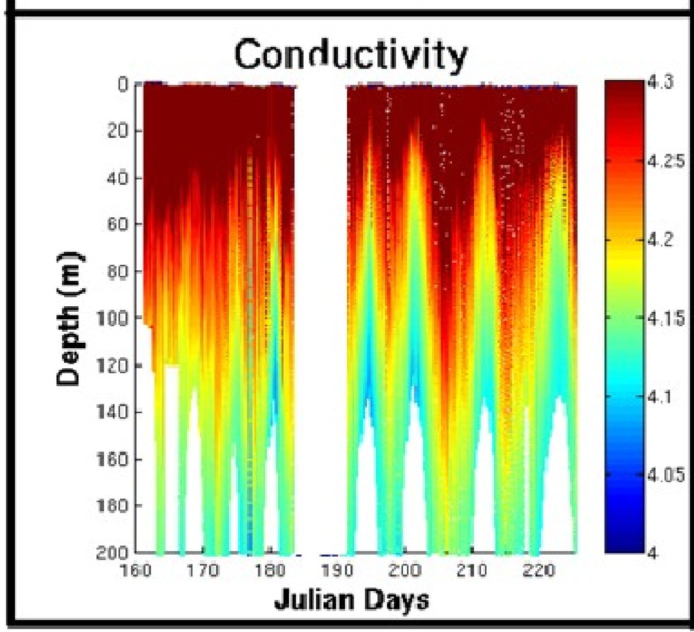
Cut out slides...

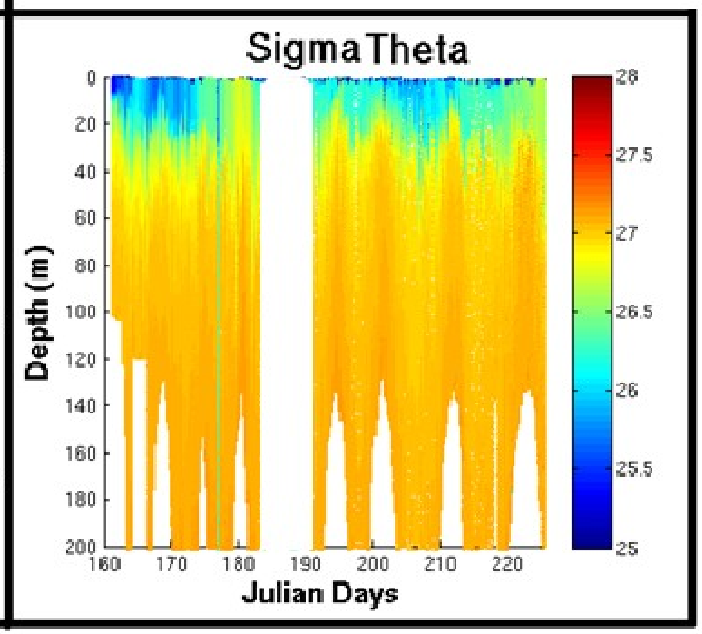
# Upwelling in the watercolumn

Stable conditions- Fresher surface waters, higher temperatures

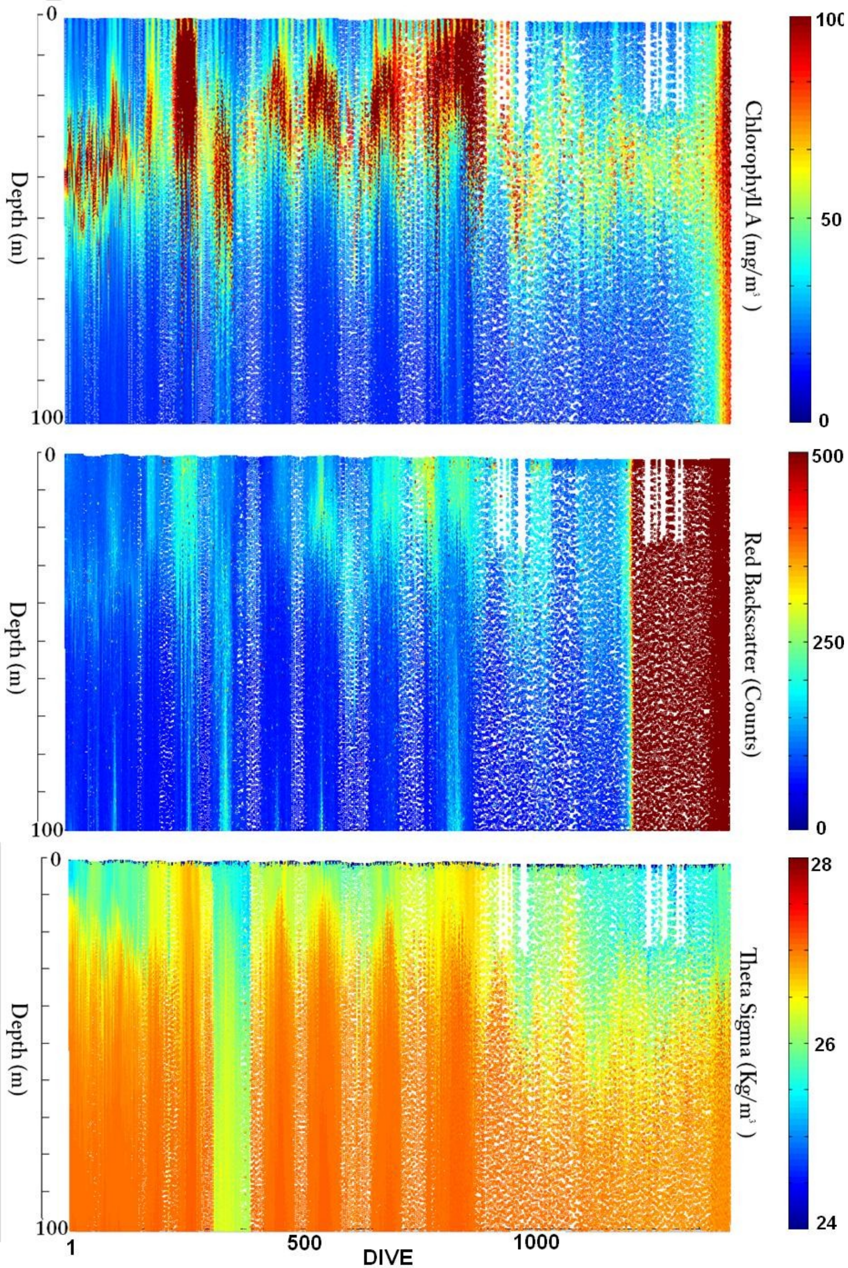
The upwelling of North Atlantic intermediate water  replaces these with colder, de



# Tracing Biofouling



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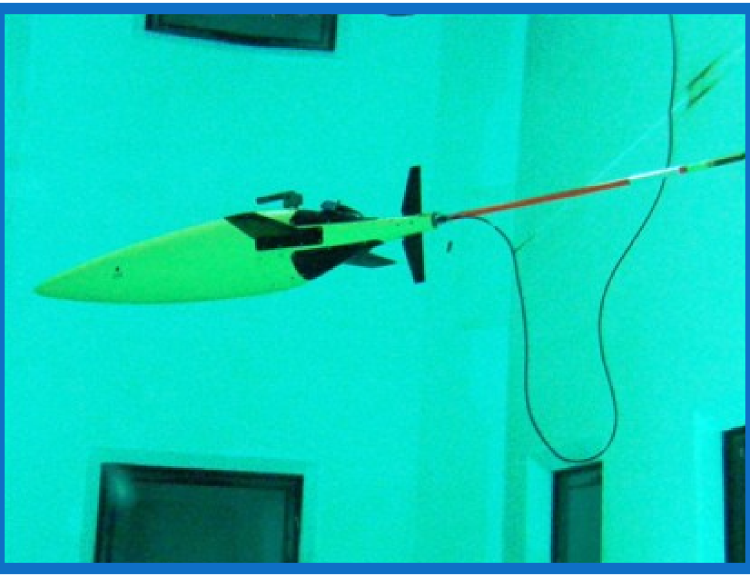
# North Atlantic Upwelling



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