The role of salinity in promoting pre-spring phytoplankton patchiness

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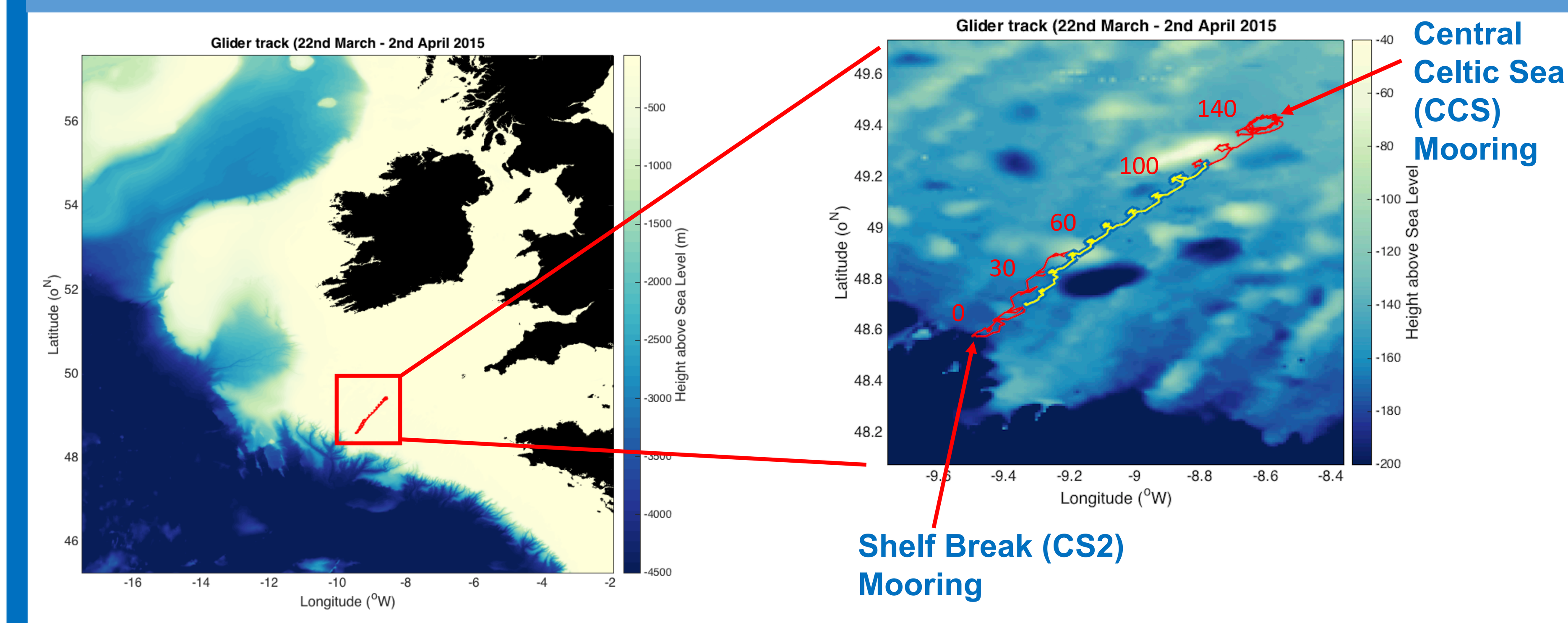
1. INTRODUCTION

Shelf seas account for up to 30% of global primary production (Wollast, 1998). As **phytoplankton** play a vital role in productivity, understanding why they occur where and when they do is essential for improving global climate change models.

As part of the **Shelf Sea Biogeochemistry** project, gliders were deployed in the Celtic Sea (FIG. 1) during late March 2015. While shelf sea stratification is usually dominated by the seasonal cycle of temperature, results show a **phytoplankton "mini-bloom" occurring between the 26th and the 29th March 2015** during sustained stratification that is mainly salinity controlled. The exact source of this fresher surface water is as yet unknown, as are the ecological implications.

FIG. 1: (Below) Bathymetry of the NW European shelf, including track of the glider between the CCS and CS2 moorings. The yellow track indicates sustained stratification, while the red numbers represent approximate distances from CS2 (in km)

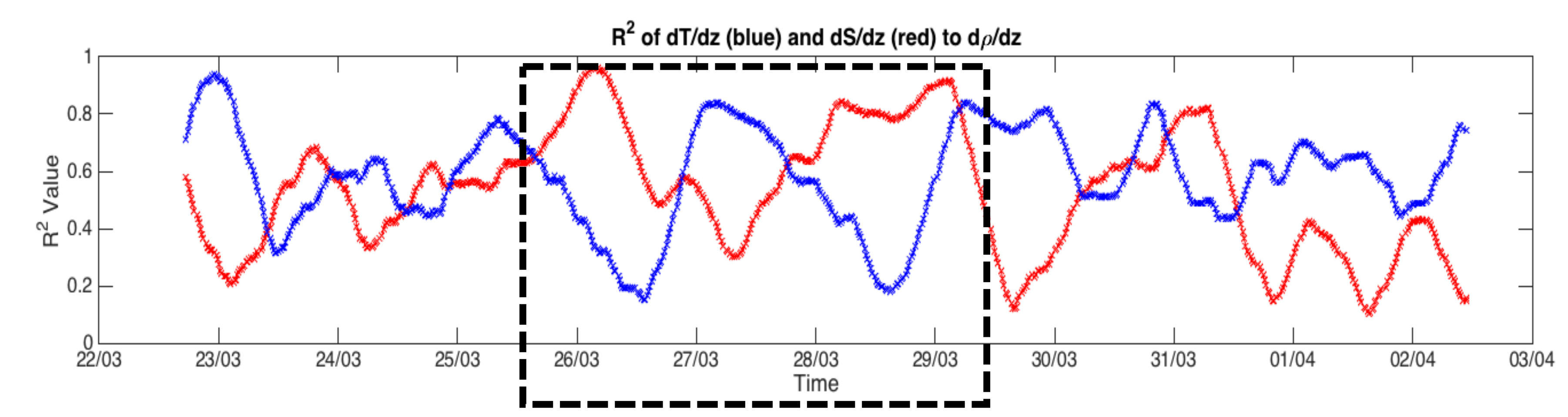


2. TEMPERATURE OR SALINITY?

Analysis of the potential density reveals an area of sustained stratification that coincides with a phytoplankton mini-bloom, **but what caused this area of stratification highlighted in FIG. 2 and FIG. 3?**

Correlative analysis (R^2) reveals an observed switch between dominant temperature (T) and salinity (S) controls on stratification. For the period of sustained stratification (as seen by the black box in FIG. 2) the majority of the variance is caused by changes in S: differences between R^2 values exceed 0.6 (e.g. 28th March).

FIG. 2: (Below) R^2 values of temperature (blue) and salinity (red) with respect to potential density, with the black box indicating the time of sustained stratification. Note that temperature is non-conservative.



3. CONTROLS ON PRE-SPRING PHYTOPLANKTON PATCHES

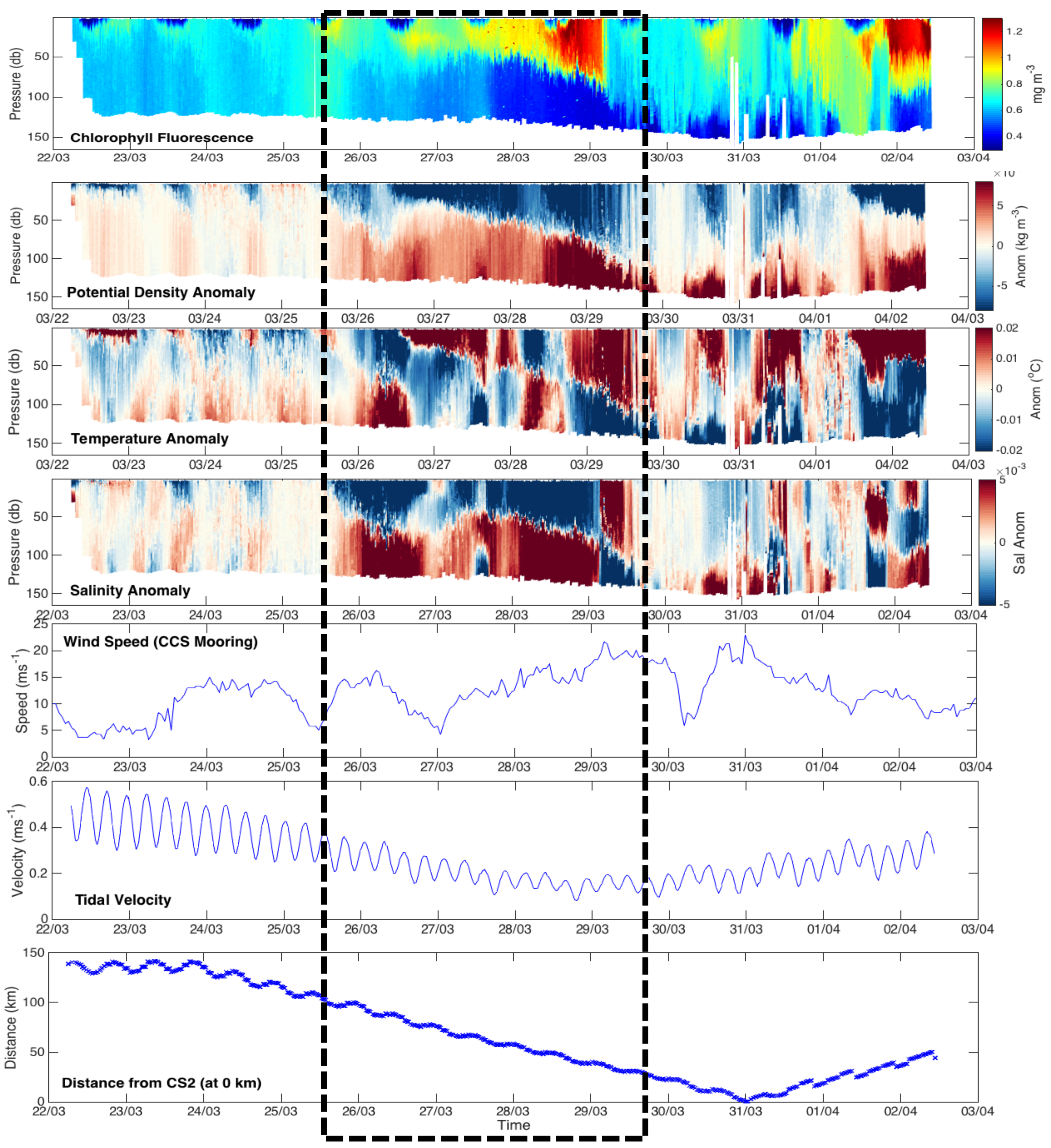


FIG. 3: (Above) Glider, meteorological (CCS Metbuoy) and modelled tidal (POLPRED) data for the 22nd March to the 2nd April. The black box indicates the region of sustained stratification.

There is a pronounced increase in chlorophyll fluorescence during the period of sustained stratification

- Despite a shallower thermal surface mixed layer (SML) on the 27th March, phytoplankton still follow the weaker, salinity-driven stratification
- A fluorescence maximum occurs on 28th March, before an abrupt end when wind speed exceeds 21.5 ms^{-1}, coinciding with the end of salinity-controls
- Chlorophyll fluorescence remains low despite thermal stratification that persists a further day
- Mixing is controlled by low tidal velocities and strong wind speeds, leading to a progressively deepening SML until a fully-mixed water column is formed late on the 29th March.

4. ECOLOGICAL IMPACTS

The relative importance and reproducibility of these transient regions of salinity stratification, and the associated phytoplankton patches, is still under investigation.

Further investigation includes:

- Size-fractionated chlorophyll data from CTD casts over the same period
- Physics-ecosystem models to test if the same biological response can be replicated under the same physical conditions discussed here

5. CONCLUSION TO DATE

Evidence suggests that salinity-controlled stratification is more important that temperature in sustaining pre-spring bloom phytoplankton patchiness…

But what are the ecological consequences of this in terms of a pre-conditioning of the spring bloom, and what are the associated impacts on higher trophic levels?

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Wollast (1998), 'Evaluation and comparison of the global carbon cycle in the coastal zone and in the open ocean', In: Brink, K.H., Robinson, A.R. (Eds.), *The Sea*, vol. 10. Wiley, New York, pp. 213–252.