

The effect of offshore wind farms on oceans' primary production

A photograph of an offshore wind farm at sunset. The sun is low on the horizon, creating a warm orange and yellow glow. Numerous wind turbines are visible in the distance, silhouetted against the sky. In the foreground, there is a curved concrete walkway with a metal railing, overlooking the ocean.

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Intr

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<https://www>

Offshore Windfarms & Primary Production

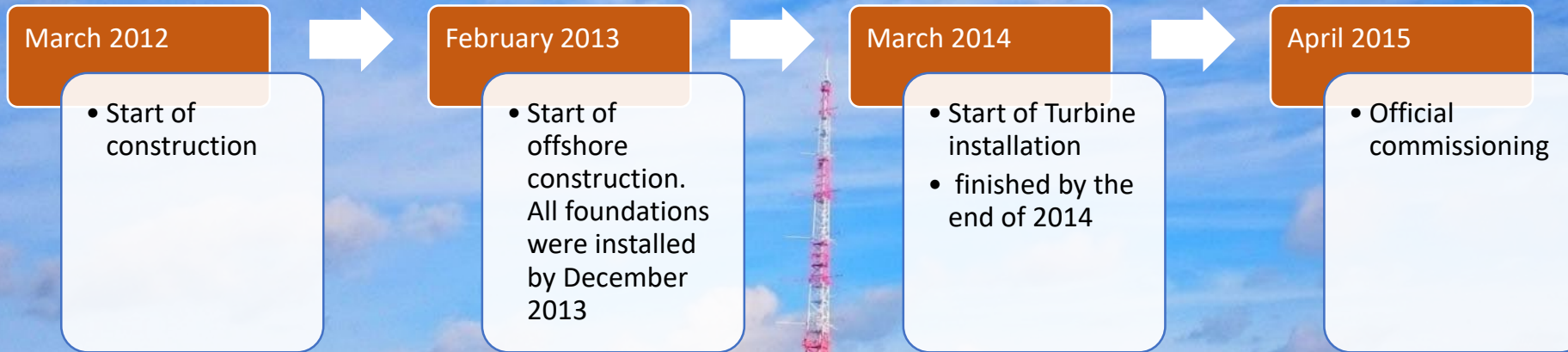
Introduction

The location of the measuring instrument

North Sea, 80 km from the shore of Sylt (55.18333° N; 7.15° E)

Ca. 23 m depth

Building process of the surrounding windfarm

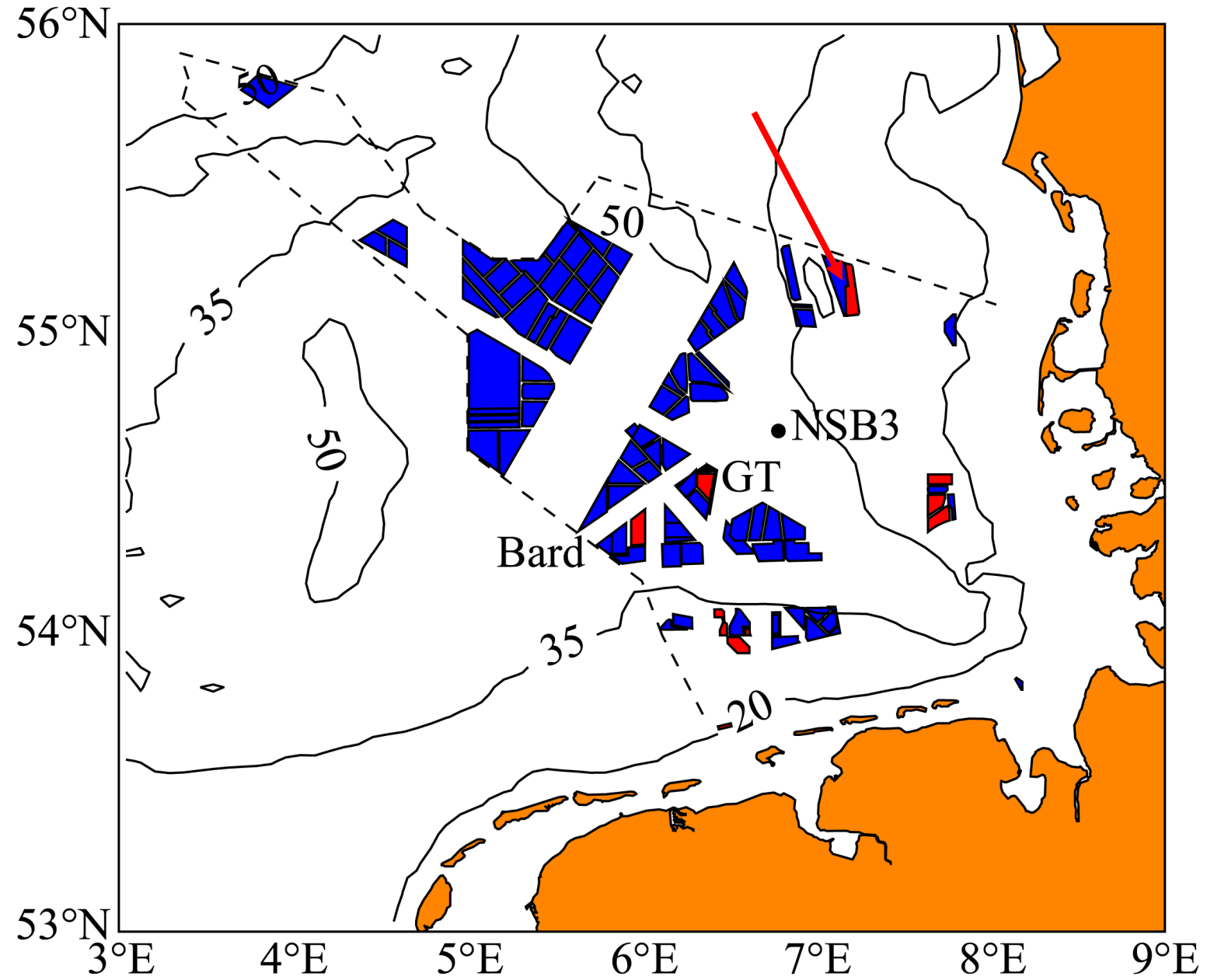


Source:
<https://www.power-technology.com/projects/dantysk-wind-farm/> ;
Bilder 26.08.2013

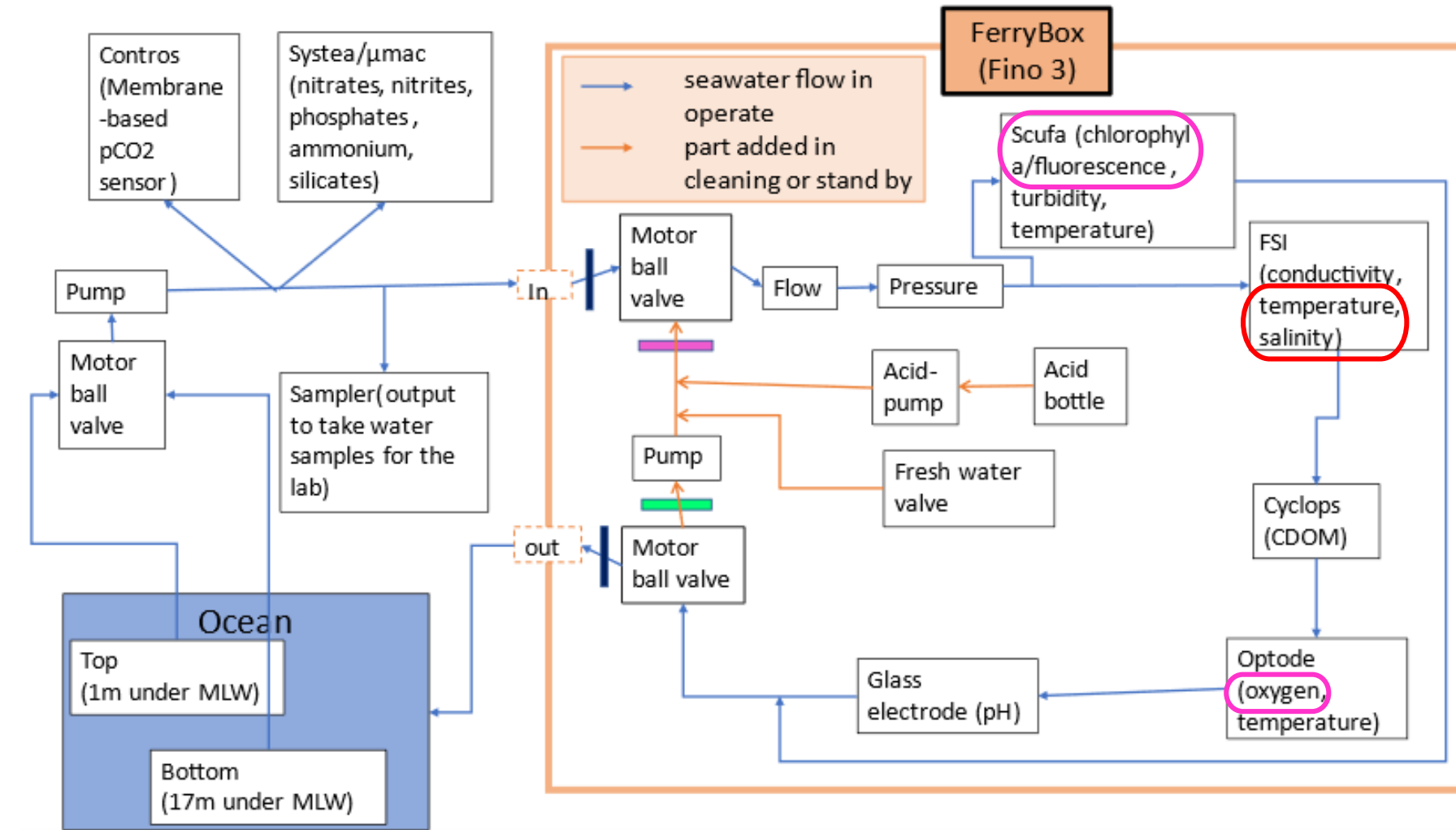
FINO3 Station with FerryBox

Is there a difference in oceans' primary production between the year 2011 without wind farm fundamentals and 2014 with windfarm fundamentals?

Location



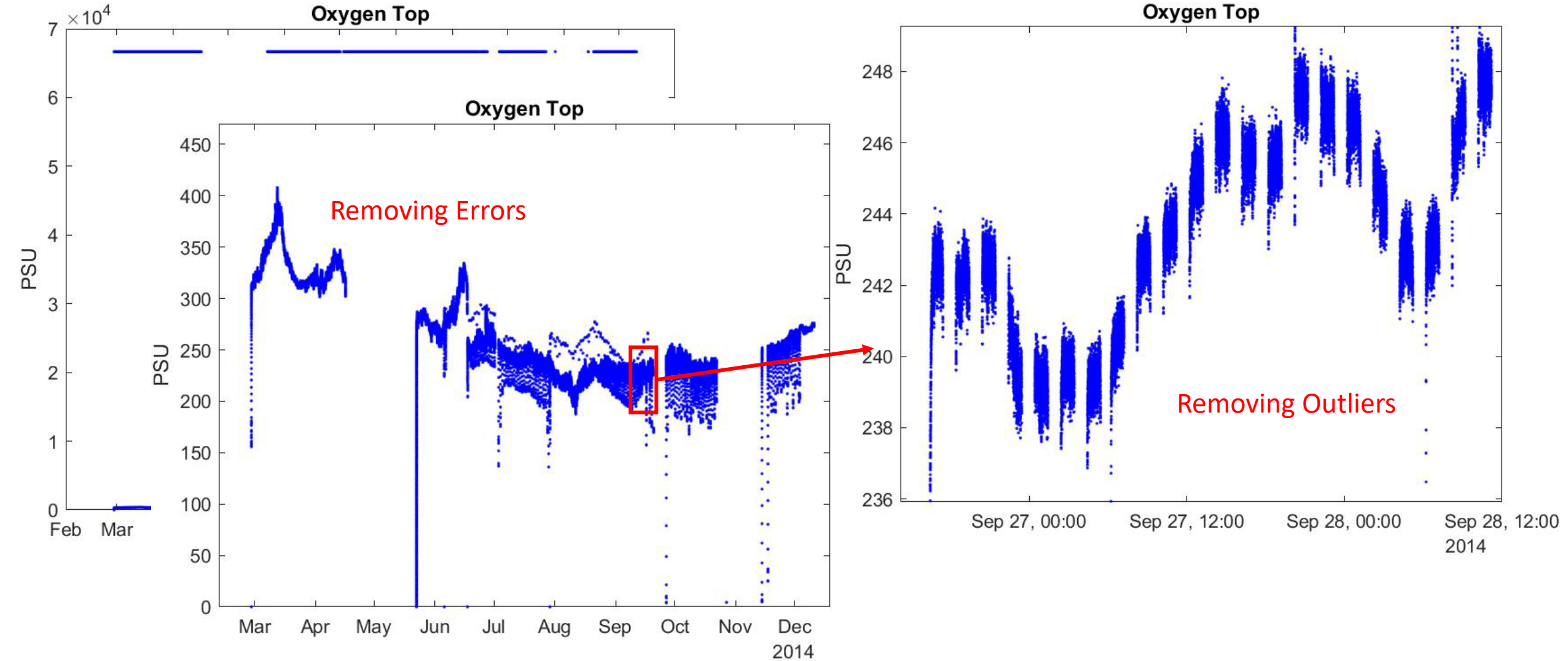
Measuring system : FerryBox on FINO3



Cycle	description
Operate cycle	The green and the purple valves are closed. The seawater is running through the blue arrows.
Standby cycle	The green valve and the black valve at 'in' are closed. The freshwater valve is open. The pump at the orange arrows is pumping freshwater through the system.
Cleaning cycle	The black valves next to the "in" and "out" are closed. The purple and the green valves are open. The acid pump is pumping acid through the system to pH of 2.

CDOM = coloured dissolved organic matter
MLW = medium low water

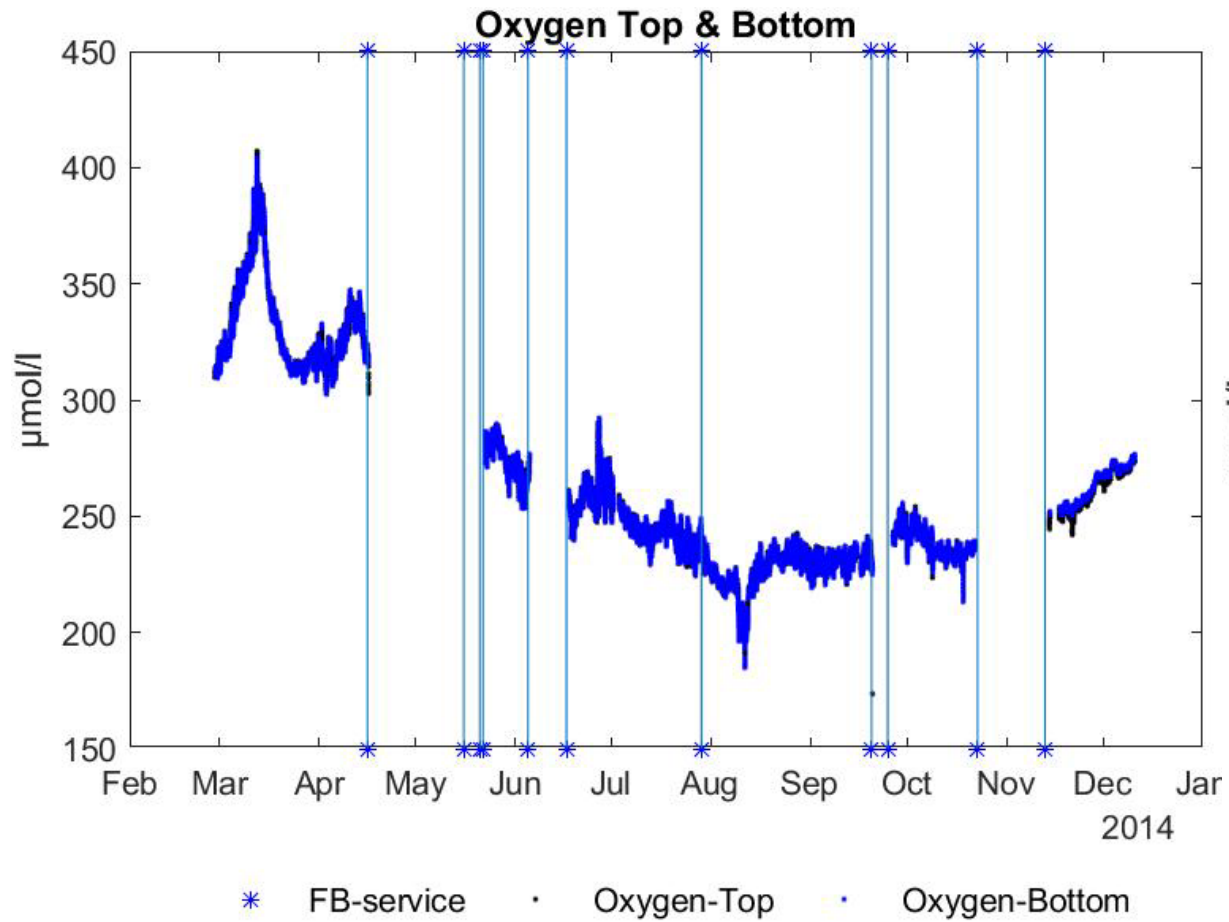
Method: Errors & Outlier



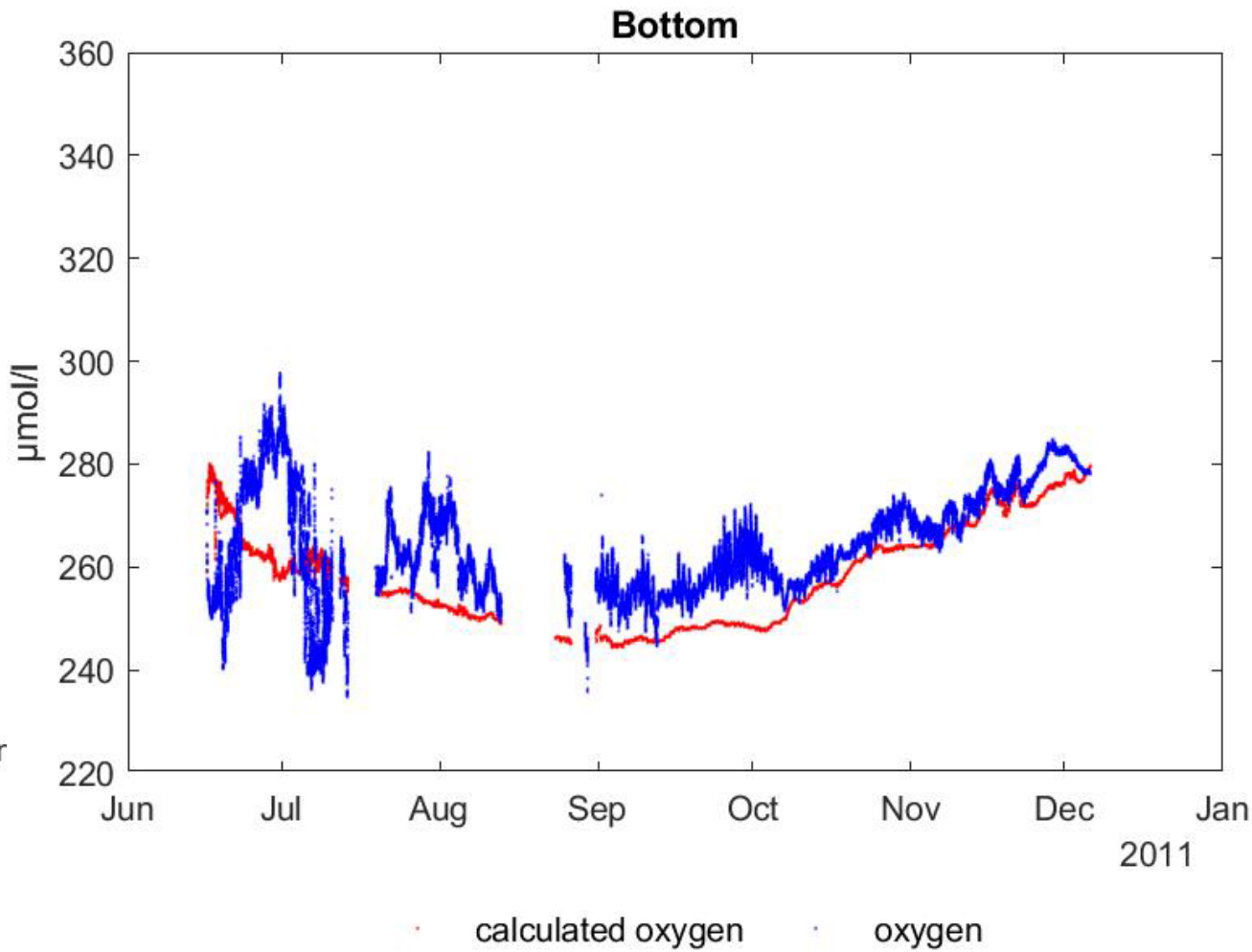
Methods: Questionable Data

Oxygen correction

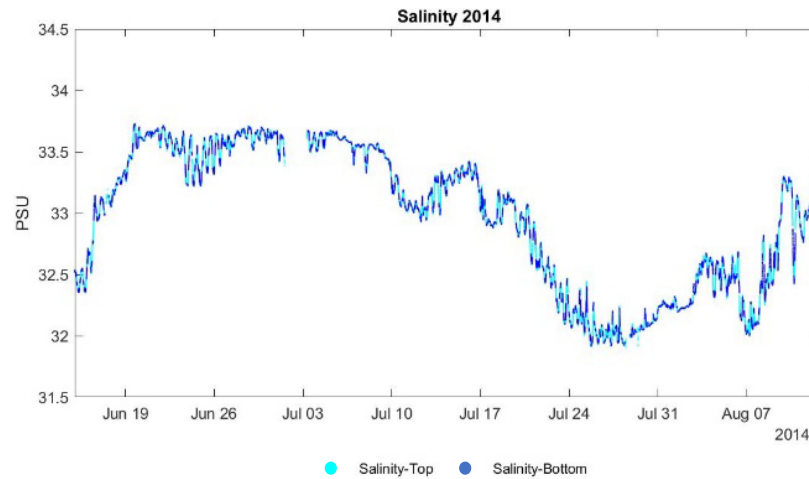
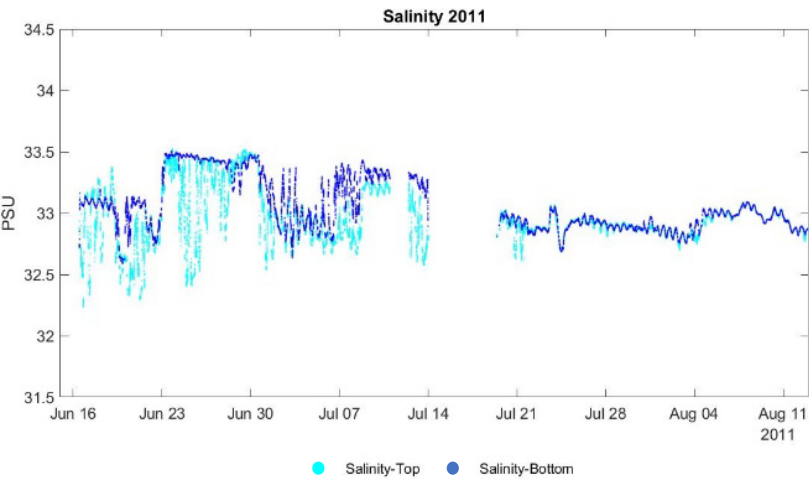
2014



2011

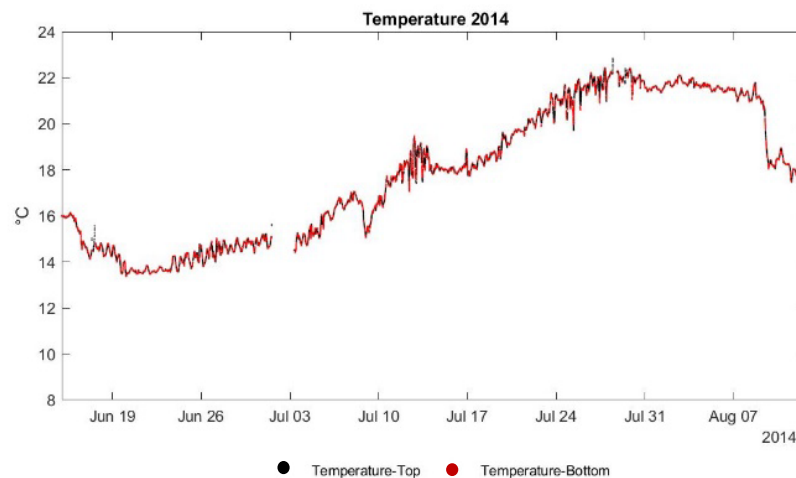
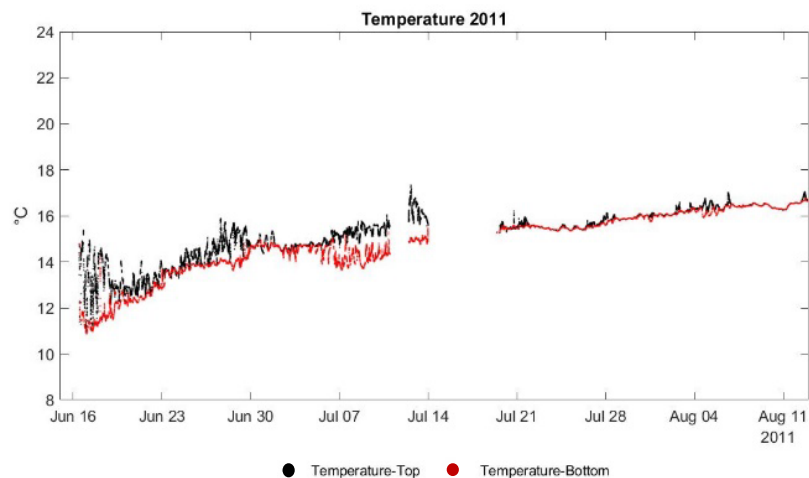


Results: Stratification



Difference between top and bottom
(bottom - top)

salinity	2011	2014
mean	0,035	0,000
std	0,124	0,010

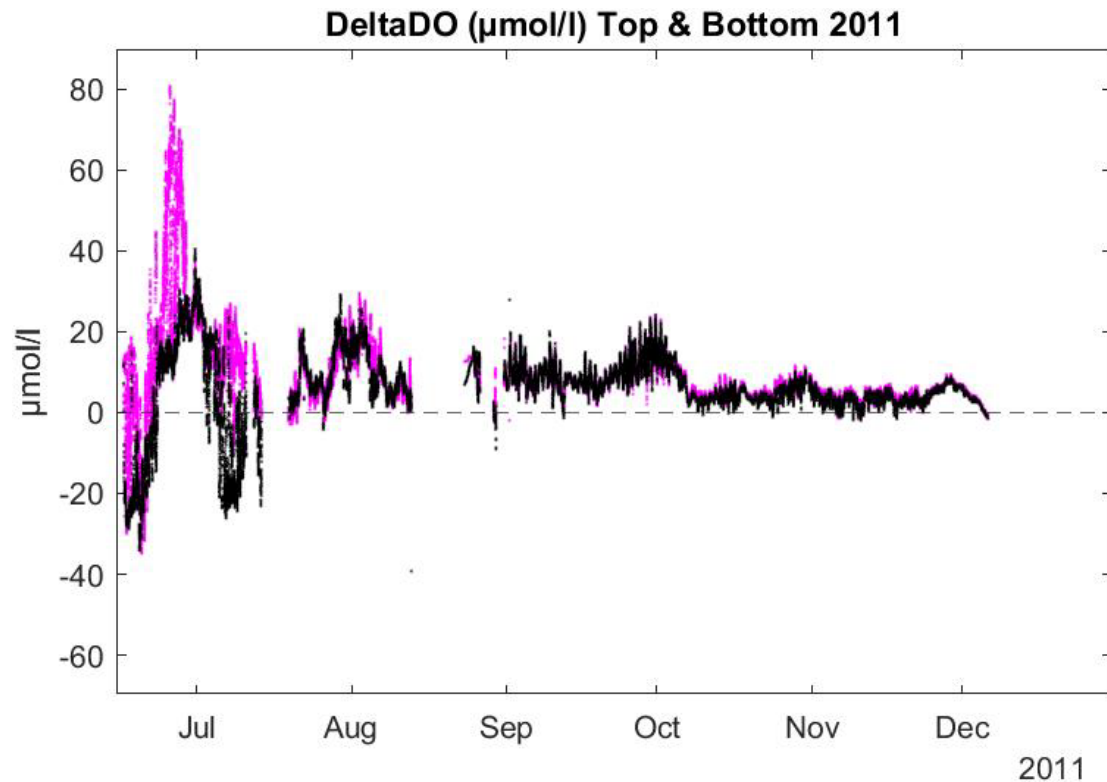


temperature	2011	2014
mean	-0,116	0,001
std	0,402	0,032

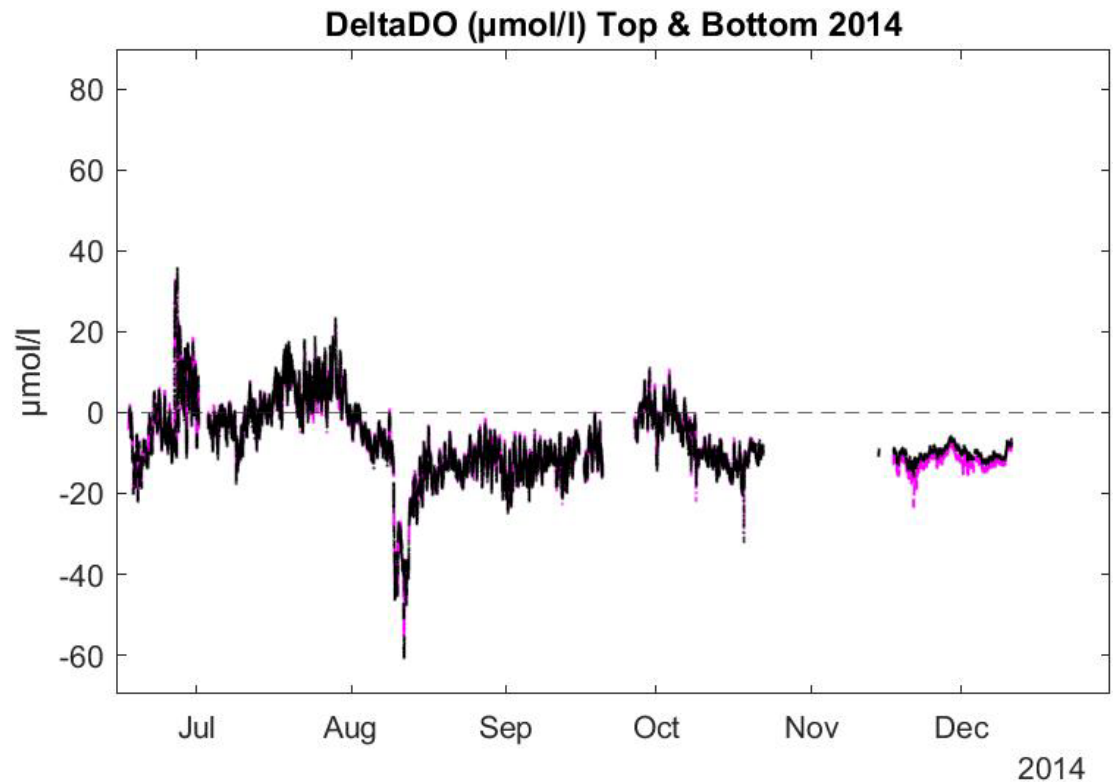
→ There is a difference in stratification between 2011 and 2014

Does this effect the primary production?

Results: Primary Production



● deltaDO-Top ● deltaDO-Bottom - - - - data1



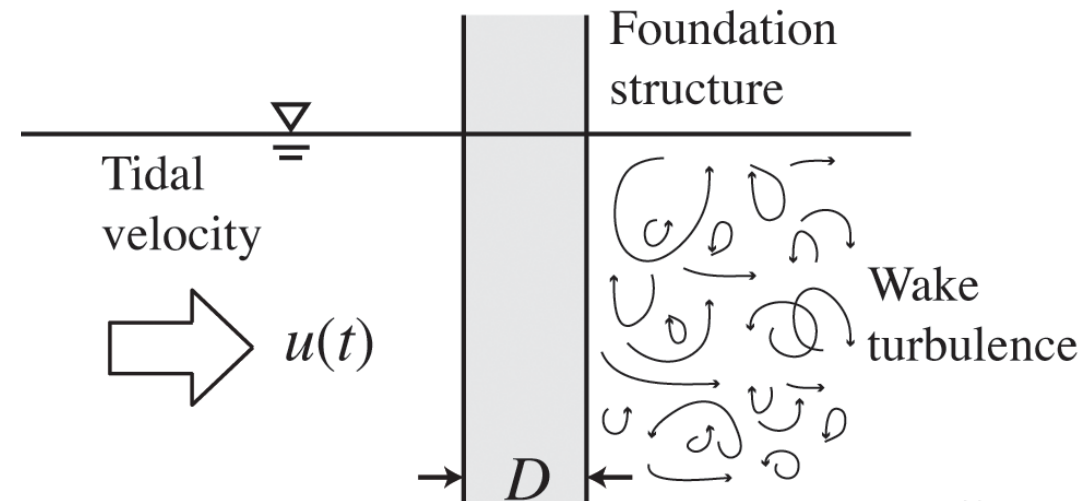
● deltaDO-Top ● deltaDO-Bottom - - - - data1

Values > 0 = more than expected oxygen
Values < 0 = less than expected oxygen

DO = dissolved oxygen

Results: Summary

- Stratification in summer 2011, before the wind farm was built, but no stratification in 2014, after the wind farm was built. Whether this is caused by a natural variability or by the windfarms is uncertain.



- Different oxygen levels were measured in the top and bottom layers in 2011.

What to do next:

- Calculating the total amount of produced oxygen
 - Respiration
 - Water column (Stratification)
 - Air sea exchange
 - Waves
 - Sediment water exchange
- Looking into papers about:
 - The effect of windfarms on oceans dynamics
 - The natural stratification occurrence at FINO3

A photograph of an offshore wind farm at sunset. The sun is low on the horizon, casting a warm orange glow over the sea and sky. Numerous wind turbines are visible in the distance, stretching across the horizon. In the foreground, a helipad with green and yellow markings is visible, along with a metal railing. The overall scene is serene and captures the beauty of renewable energy infrastructure.

Thank you for listening!
Questions?

Method: Calculation Expected Oxygen

Formel: $\ln (C_{s(\mu\text{mol/l})}) = I + J/T + K/T^2 + L/T^3 + M/T^4 - S \times (N + P/T + Q/T^2)$

T = Temperature in Kelvin

S = Salinity

Constants:

$$I = -135,90205$$

$$J = +1,575701 \times 10^5$$

$$K = -6,642308 \times 10^7$$

$$L = +1,243800 \times 10^{10}$$

$$M = -8,621949 \times 10^{11}$$

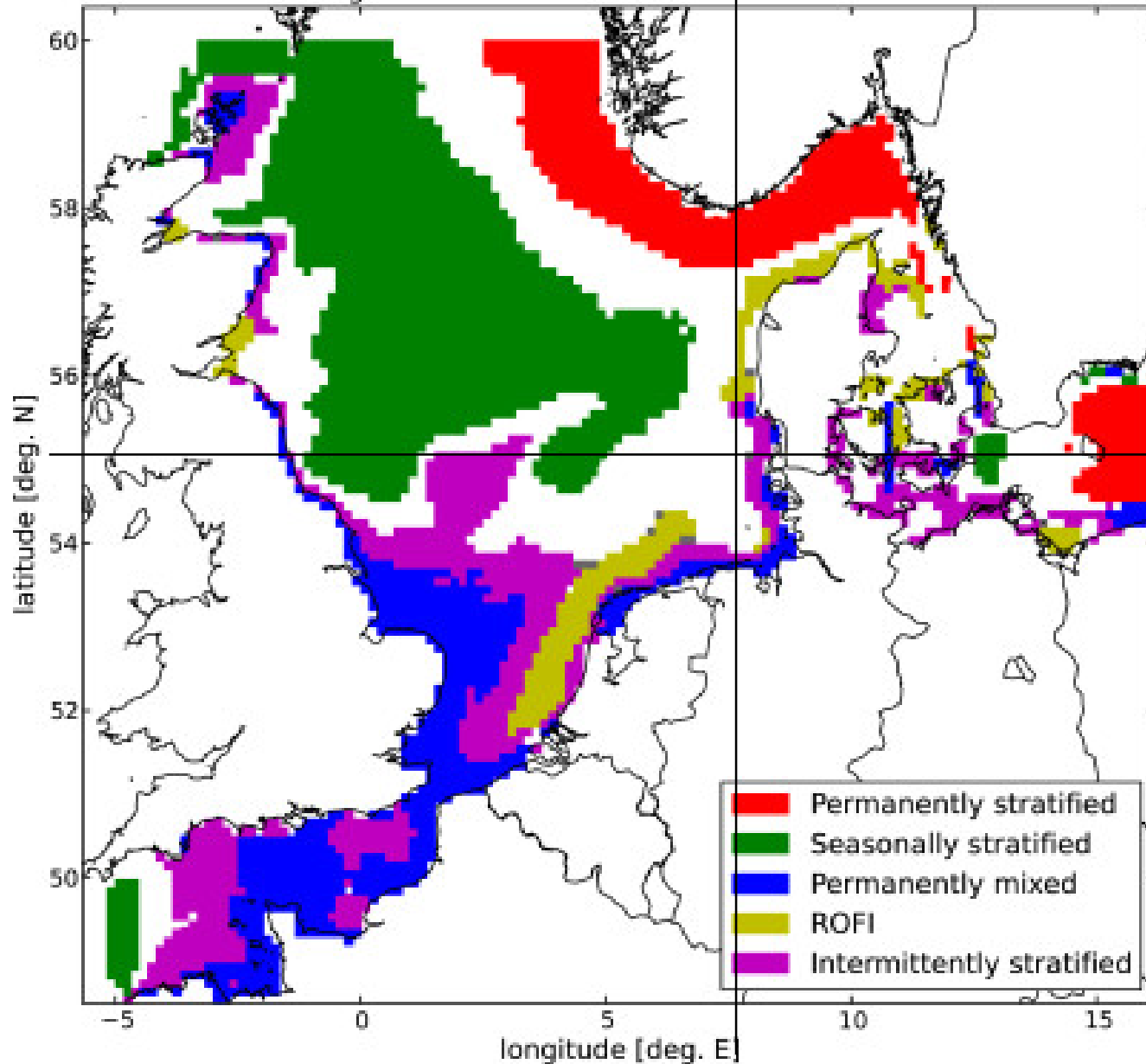
$$N = +0,017674$$

$$P = -10,754$$

$$Q = +2140,7$$

Helcom Combine (o.a.): Manual for Marine Monitoring in the COMBINE Programme of HELCOM, Part B, General guidelines on quality assurance for monitoring in the Baltic Sea, Annex B-8, Technical note on the determination of hydrographic parameters, Appendix 3, Recommended equations for the calculation of solubility and saturation of dissolved oxygen in sea water.

Overall regions of dominant rho stratification in 1958-2008



All of the coloured regions accrue with a dominance above 50% of the modelled period (51 years)

ROFI = regions of fresh water influence

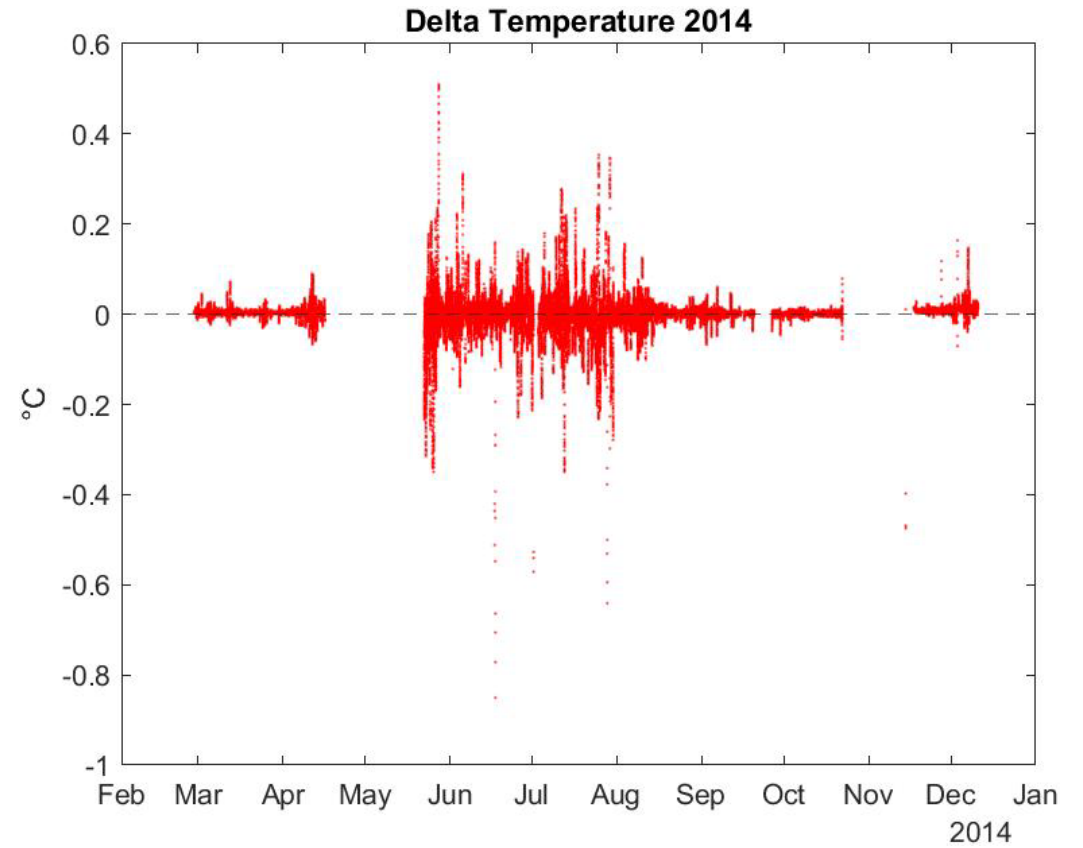
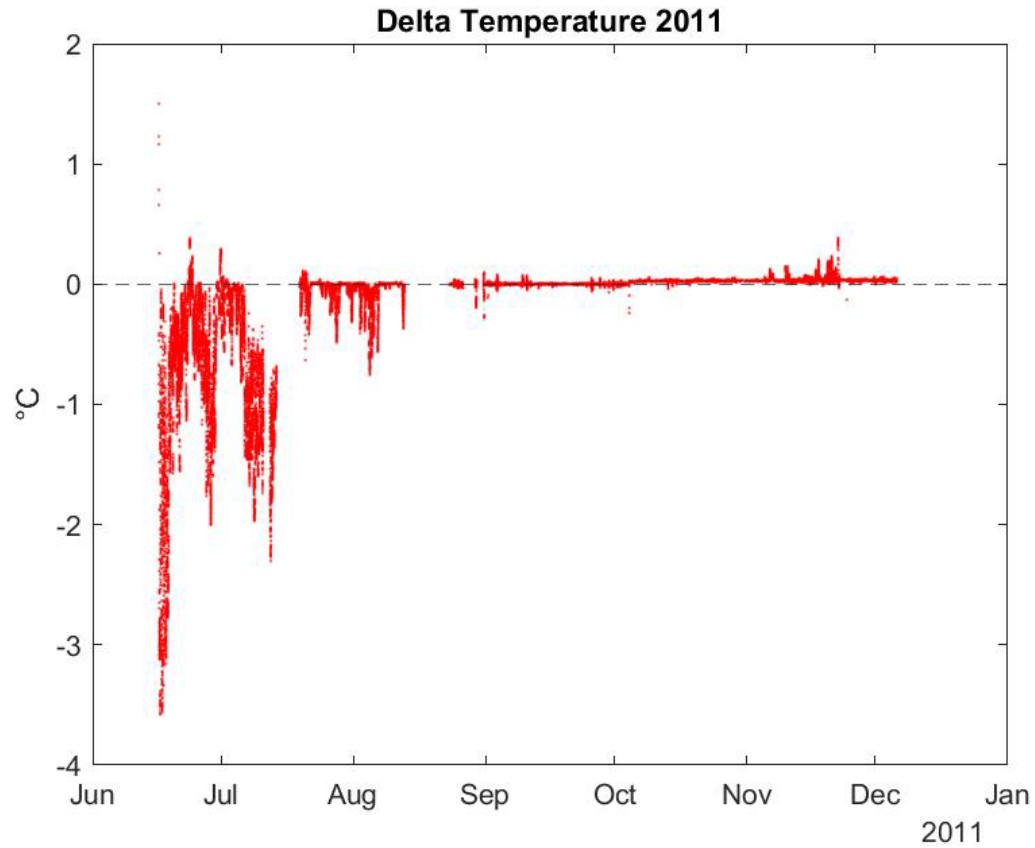
Definition white area:

These areas are characterized by a high variability. They do not reach over 50% in one of the categories.

E.g. location [54.5 N,7.0 E]:
12% seasonally stratified
12% ROFI
2% intermittently stratified

Sonja van Leeuwen et. al (2015)

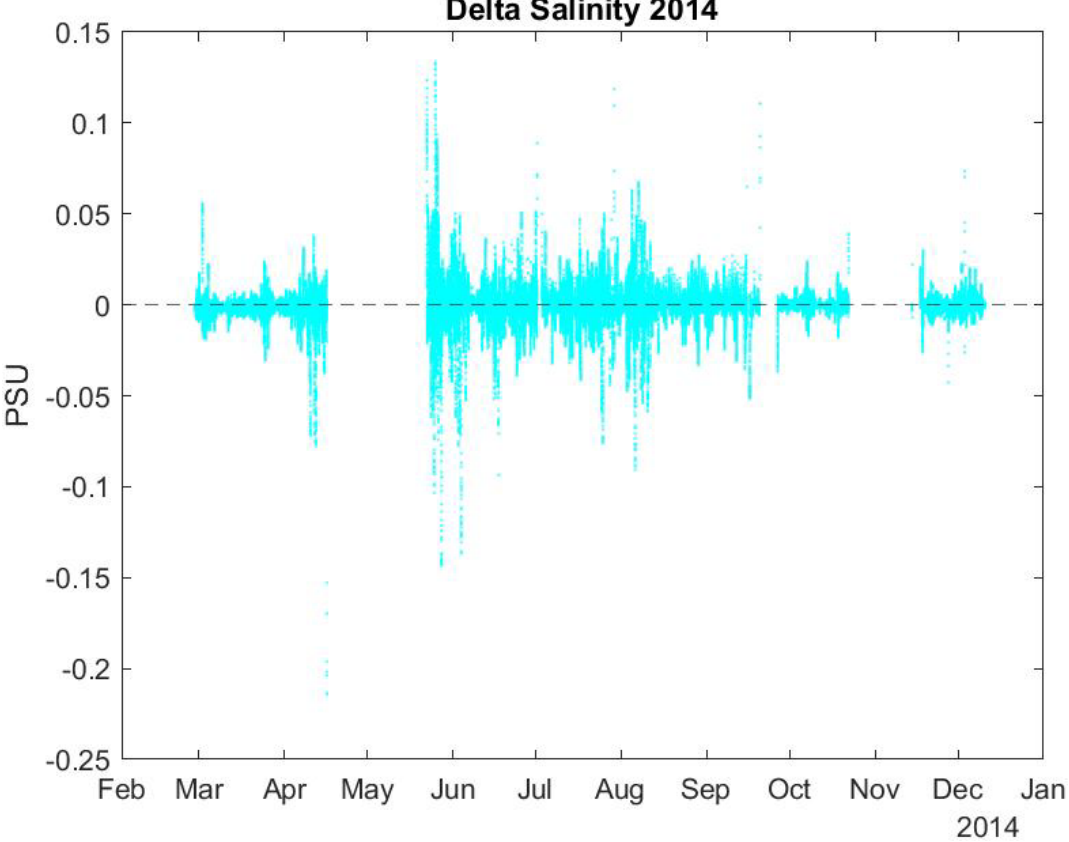
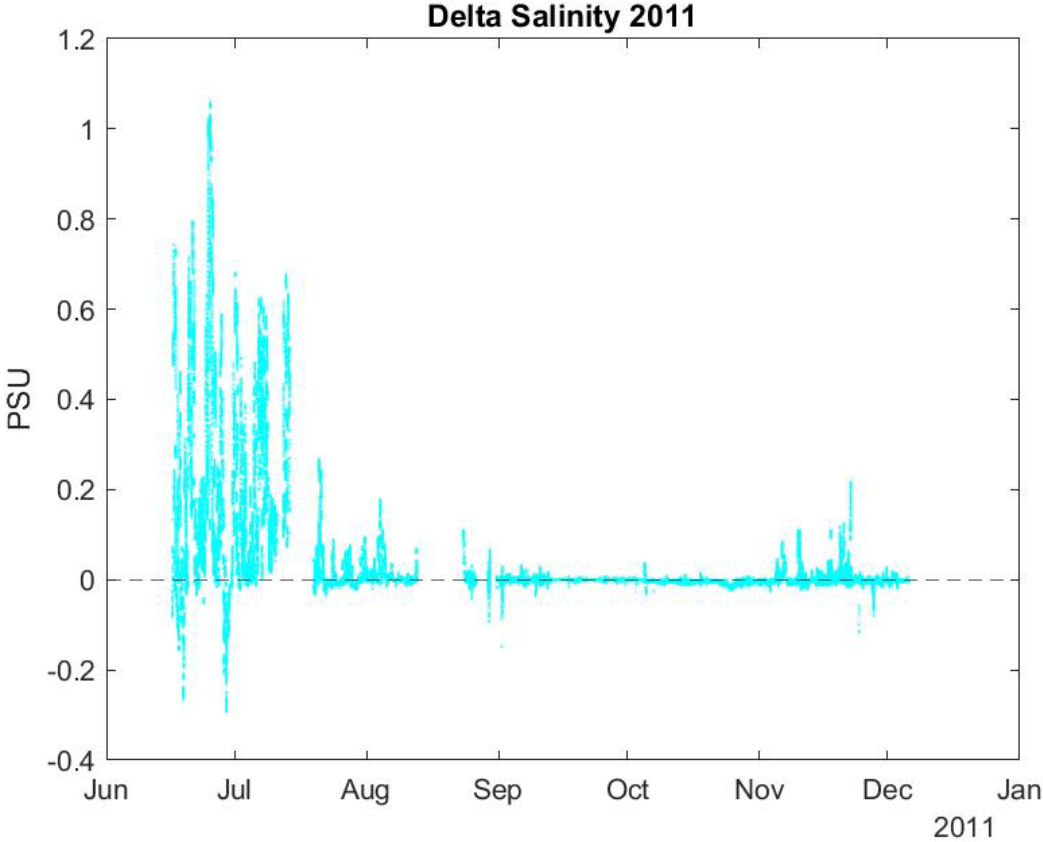
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