Carbon cycling between an estuary and adjacent coastal waters

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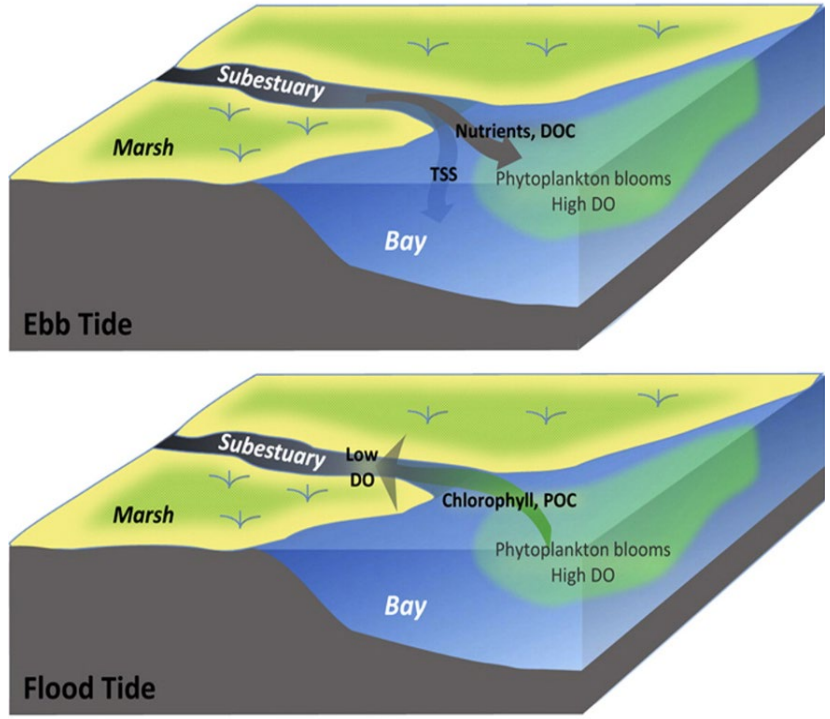
Introduction

- Estuaries are biogeochemical reactors, influencing carbon cycling, export of carbon to the ocean and global carbon budgets.
- The Elbe Estuary has undergone significant ecosystem shifts, from heavy pollution in the 1980s to a relatively recovered state at present.
- Potential ecosystem feedback mechanism in the lower and coastal estuarine region driven by tides.
- The aim is to identify how the seasonal and annual changes in DIC at the inlet of the Elbe Estuary are modulated by primary production and respiration.



Subestuary is turbid; Bay is more transparent.

Visual concept of a tidally coupled biogeochemical reactor (Voynova et al., 2013).

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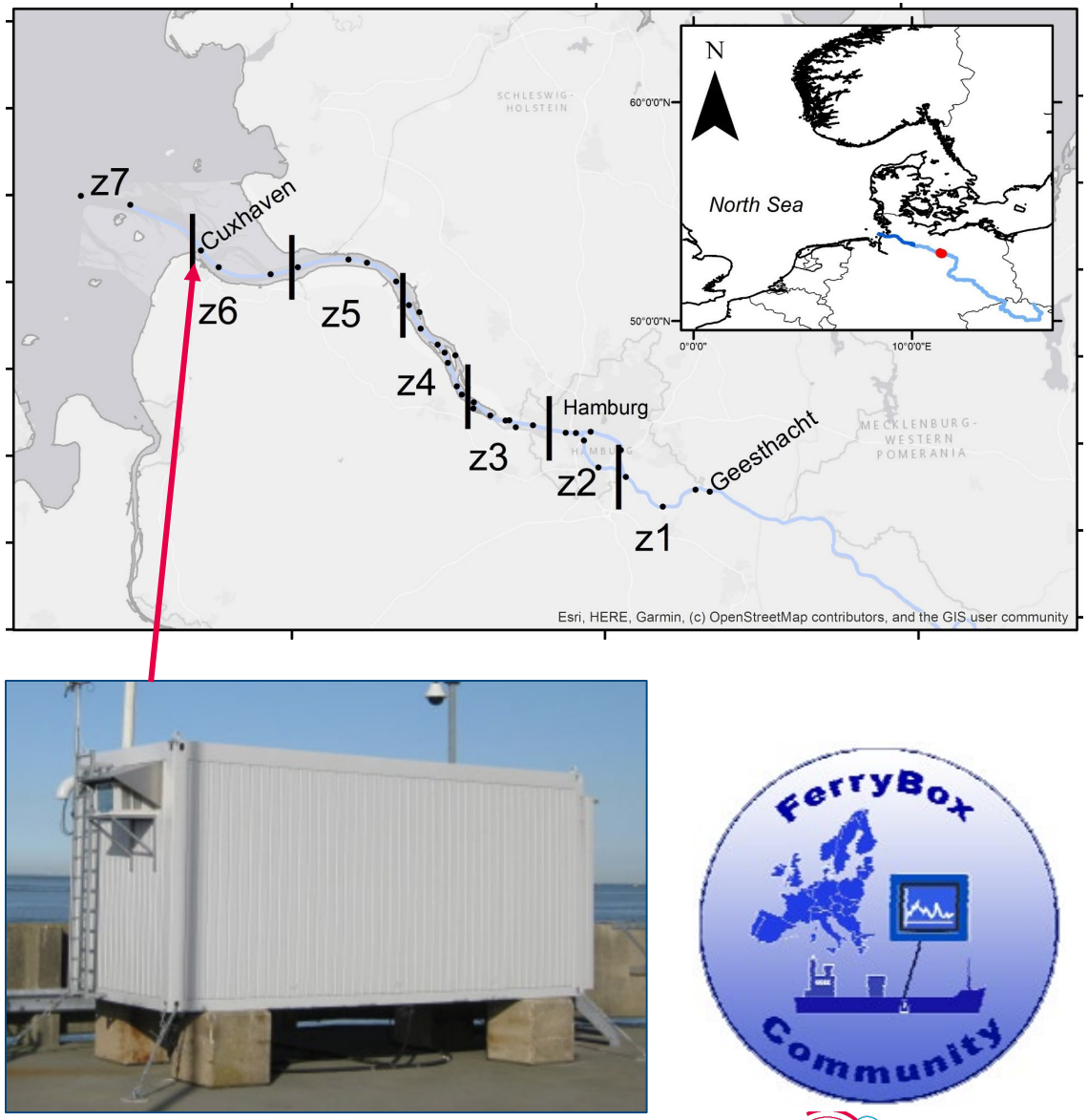
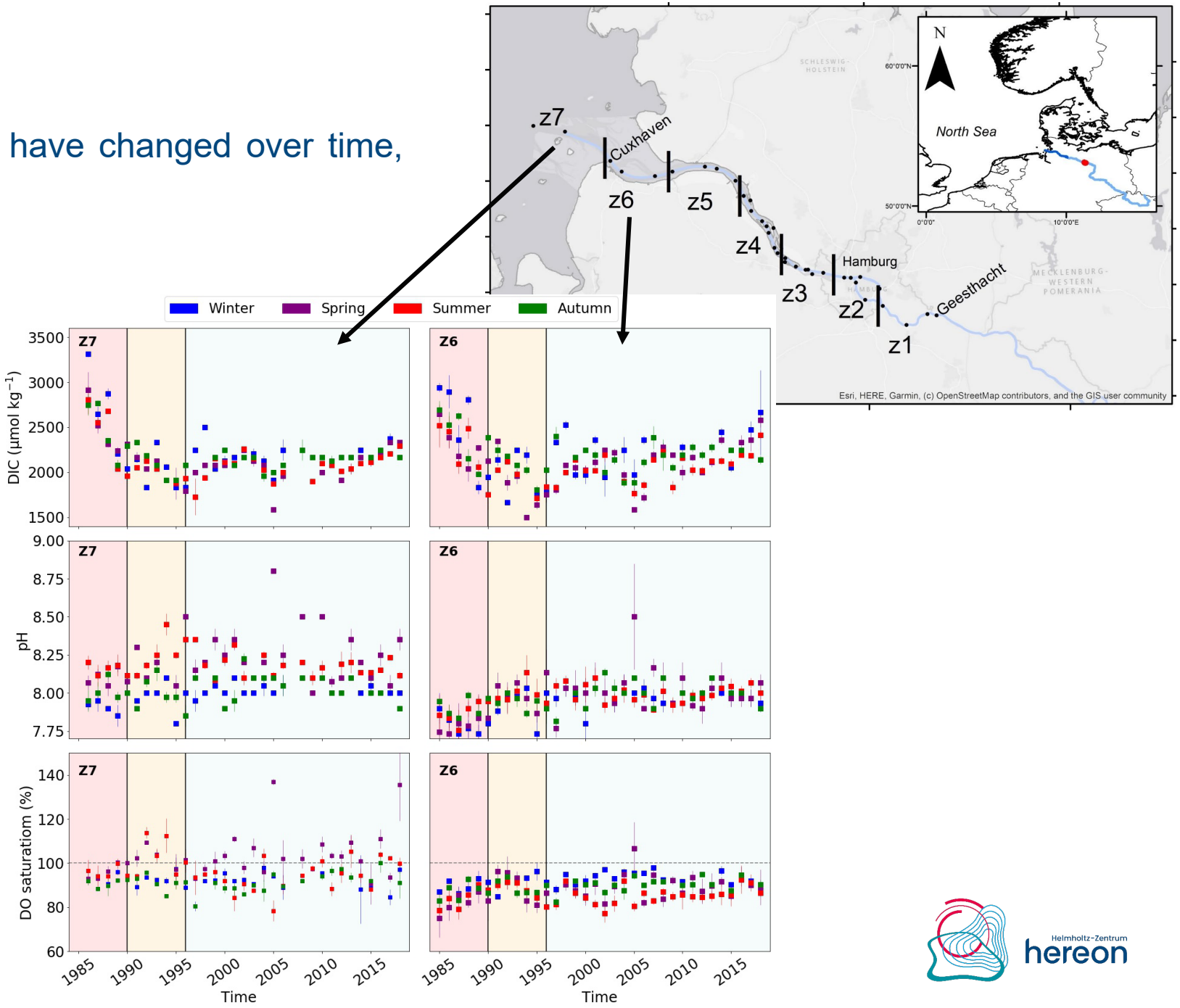
Method

- The Elbe Estuary has been monitored by the Flussgebietsgemeinschaft Elbe (FGG).
- The estuary was divided into seven zones, with focus on the lower Elbe estuary and coastal waters (zones 6-7).
- Mean seasonal DIC, pH and DO for 1985-2018.
- For last 5 years (2014-2018), salinity, temperature and dissolved oxygen (DO) was acquired from the FerryBox station in Cuxhaven
- Continuous measurements need to be corrected against discrete samples measured at HEREON.



Results

- DIC dynamics in the Elbe Estuary have changed over time, with 3 ecosystem states identified.
- Polluted (1985-1990)
- Transitional (1991-1996)
- Recovery (1997-2018)
  - Sig. increase in DIC in spring and summer over time.



Seasonal DIC, pH and DO in % saturation from 1985 to 2018 in zones 6 (Z6) and 7 (Z7).

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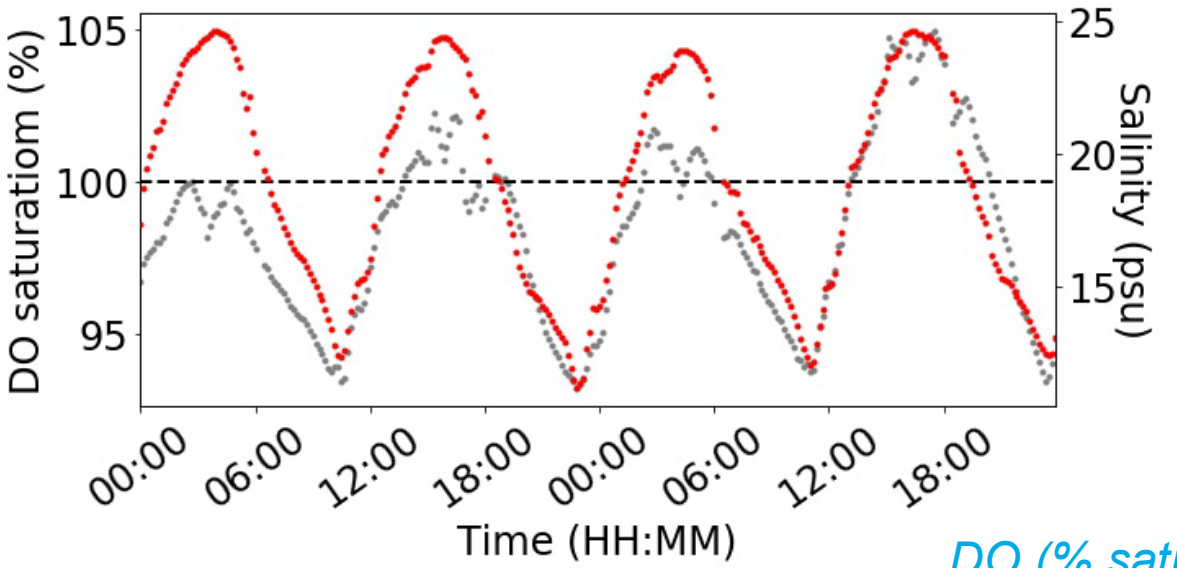
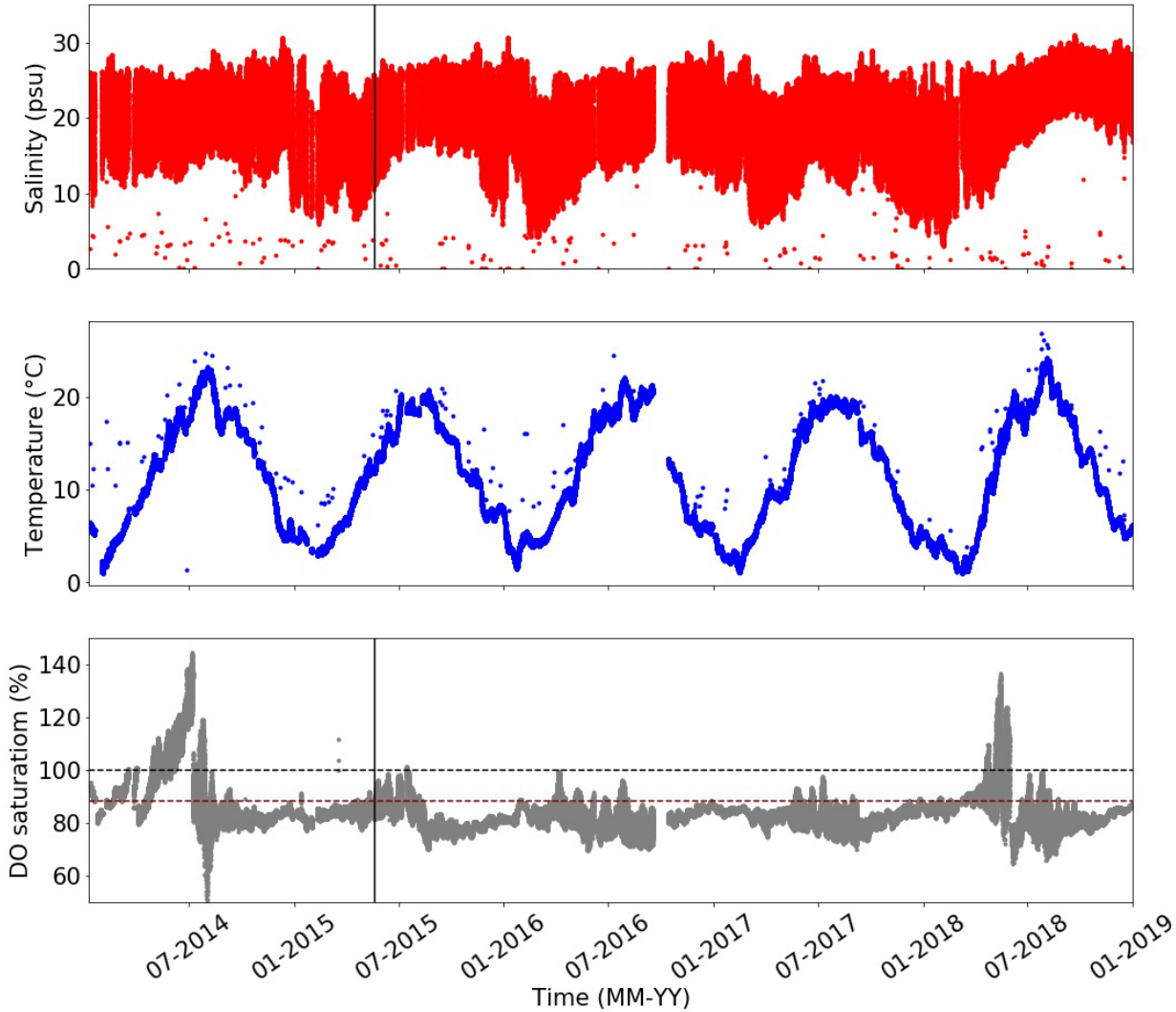
Results

- Supersaturated DO coincided with high salinity
- How is this influencing the carbon dynamics over a tidal cycle?



DO (% saturation) plus average offset (11.6%) and salinity in 21.05.15 - 22.05.15



DO (% saturation), salinity and water temperature 2014-2018 from the Ferrybox at Cuxhaven. In DO, 100% (black dashed line) and 100% minus average offset (11.6%) between continuous DO and laboratory DO (red dashed line). In salinity and DO vertical lines are 21.05.2015 -22.05.2015

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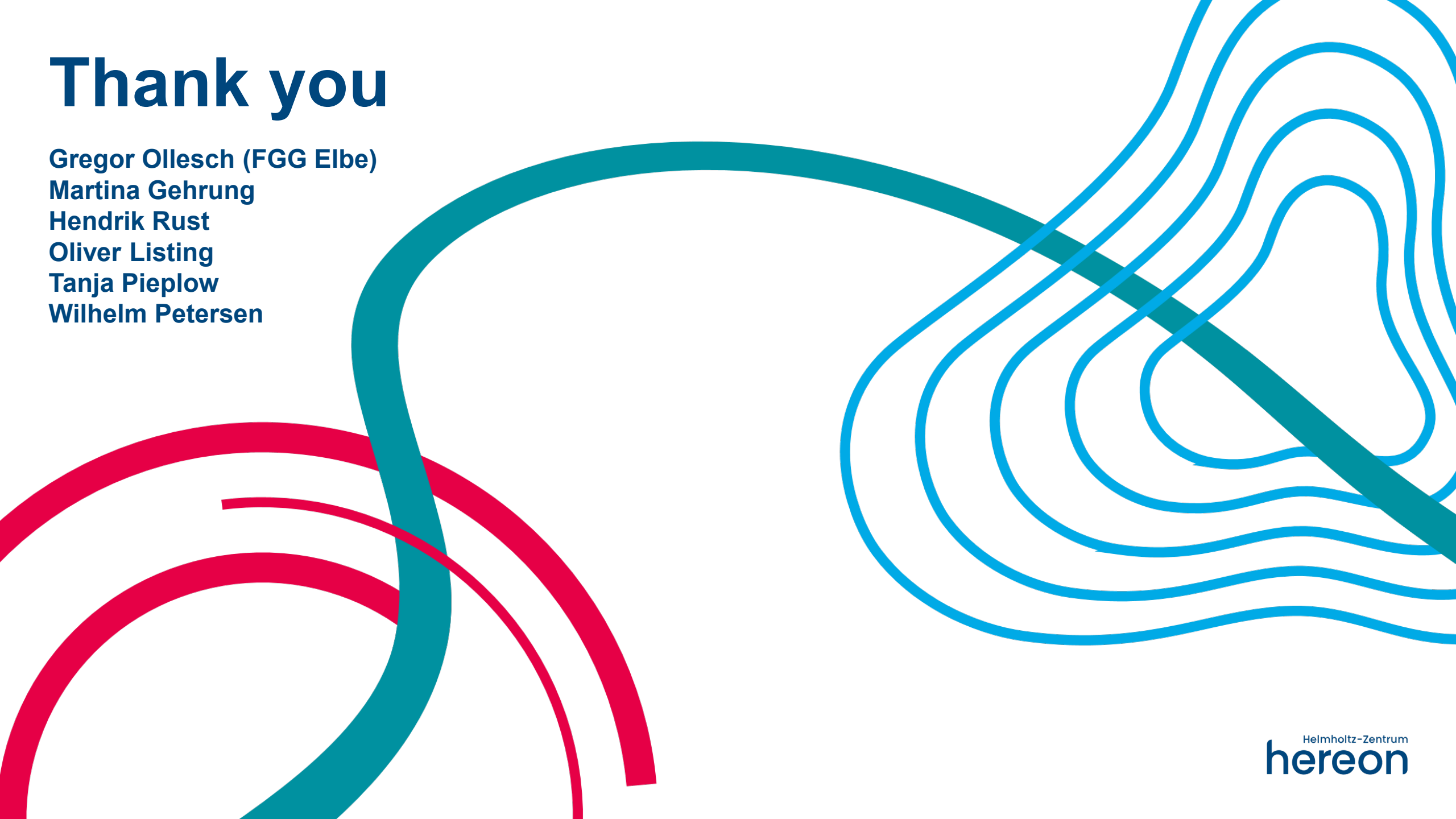
Future Work

- Quantify DO changes over a tidal cycle, i.e. daily and monthly variability.
- Conduct time-series analysis to determine the influence of respiration/primary production on changes in DIC
- Incorporate the influence of nutrient loads on primary production
- Identify the influence of carbon processing in the nearshore regions on carbon budgets.

Thank you

Gregor Ollesch (FGG Elbe)
Martina Gehrung
Hendrik Rust
Oliver Listing
Tanja Pieplow
Wilhelm Petersen



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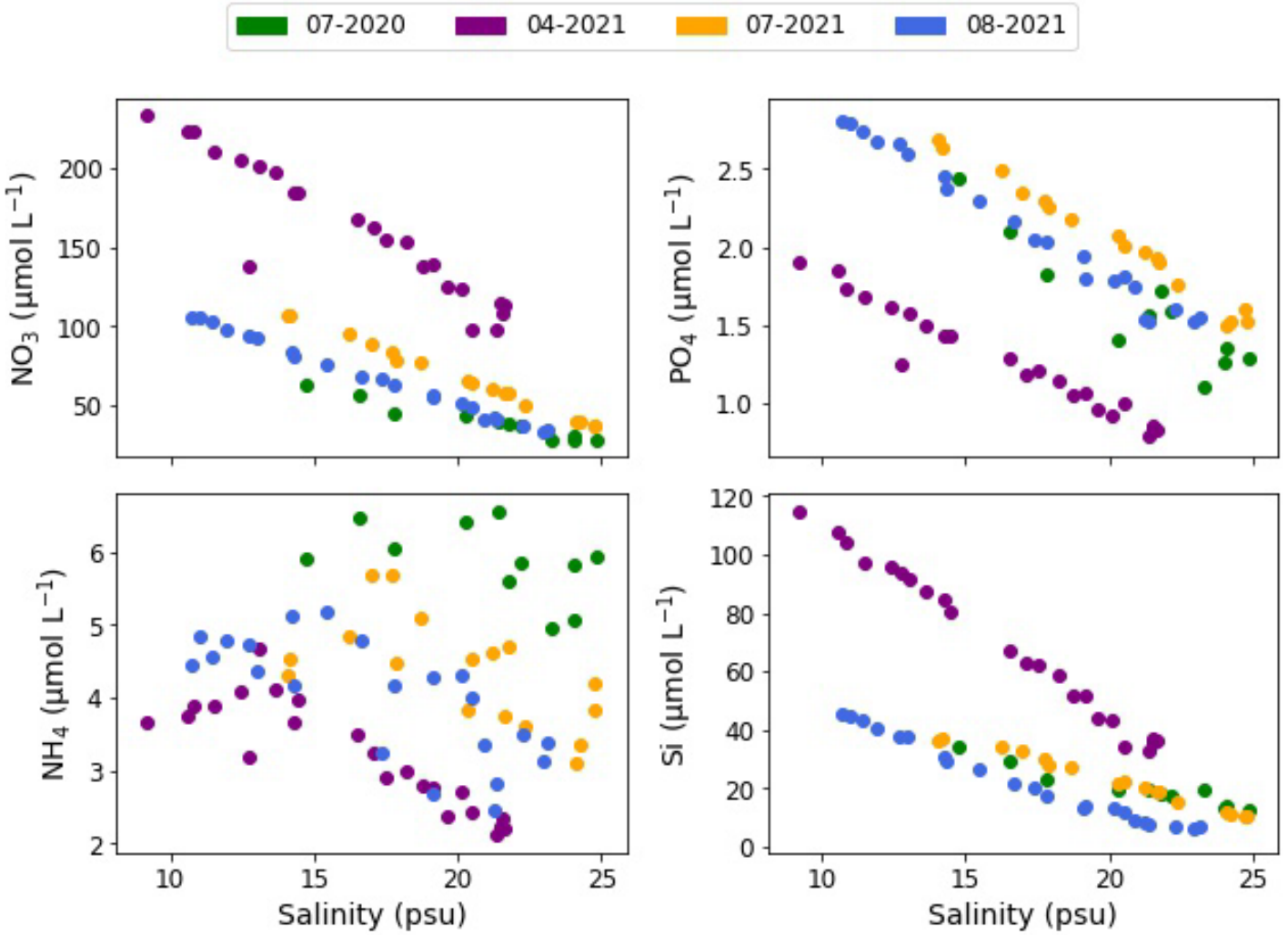
- NO3, PO4 and Si negatively correlated with salinity
- Nutrient loading likely fueling primary production



Nutrients versus salinity

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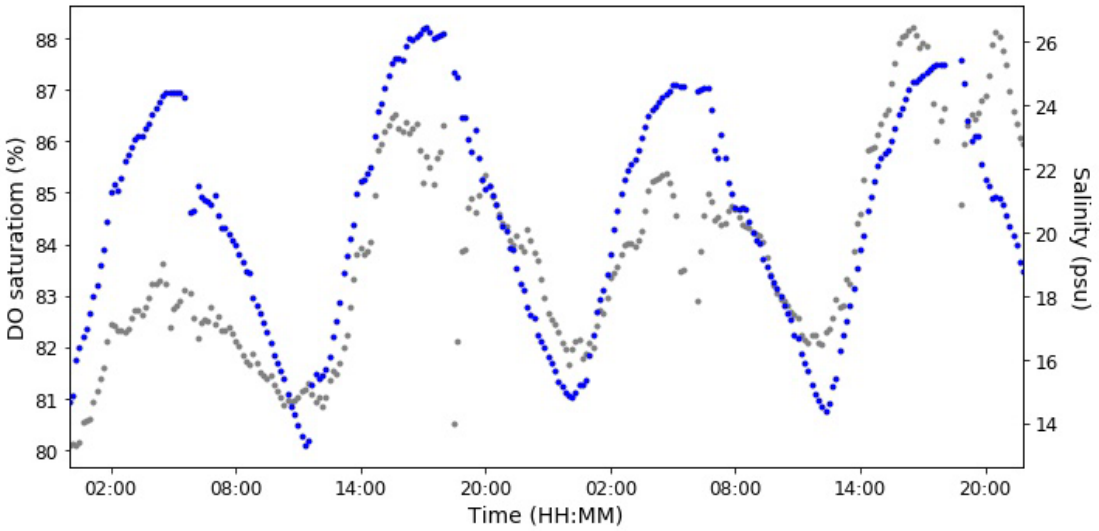
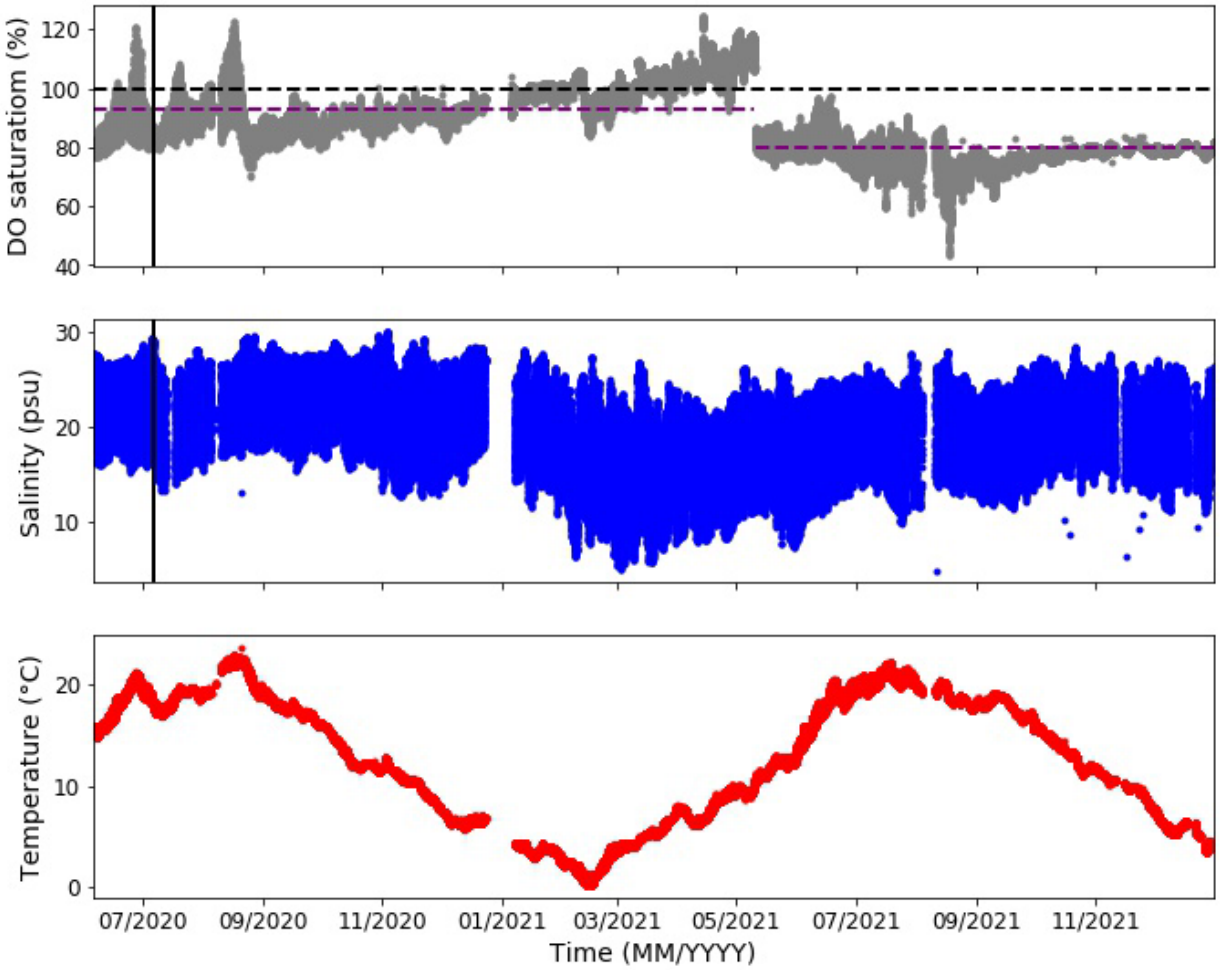
SOM

- DO to be corrected against laboratory winkler DO.
- High DO coincided with high salinity
- Is nutrient loading fueling metabolism?



DO (% saturation) and salinity in 10.07.20 – 11.07.20



DO (% saturation), salinity and water temperature 2020-2021 from the Ferrybox at Cuxhaven. In DO, 100% (black dashed line) and 100% minus average offset (7% & 18%) between continuous DO for two optodes and laboratory DO (purple dashed line). In salinity and DO vertical lines are 10.07.20 – 11.07.20

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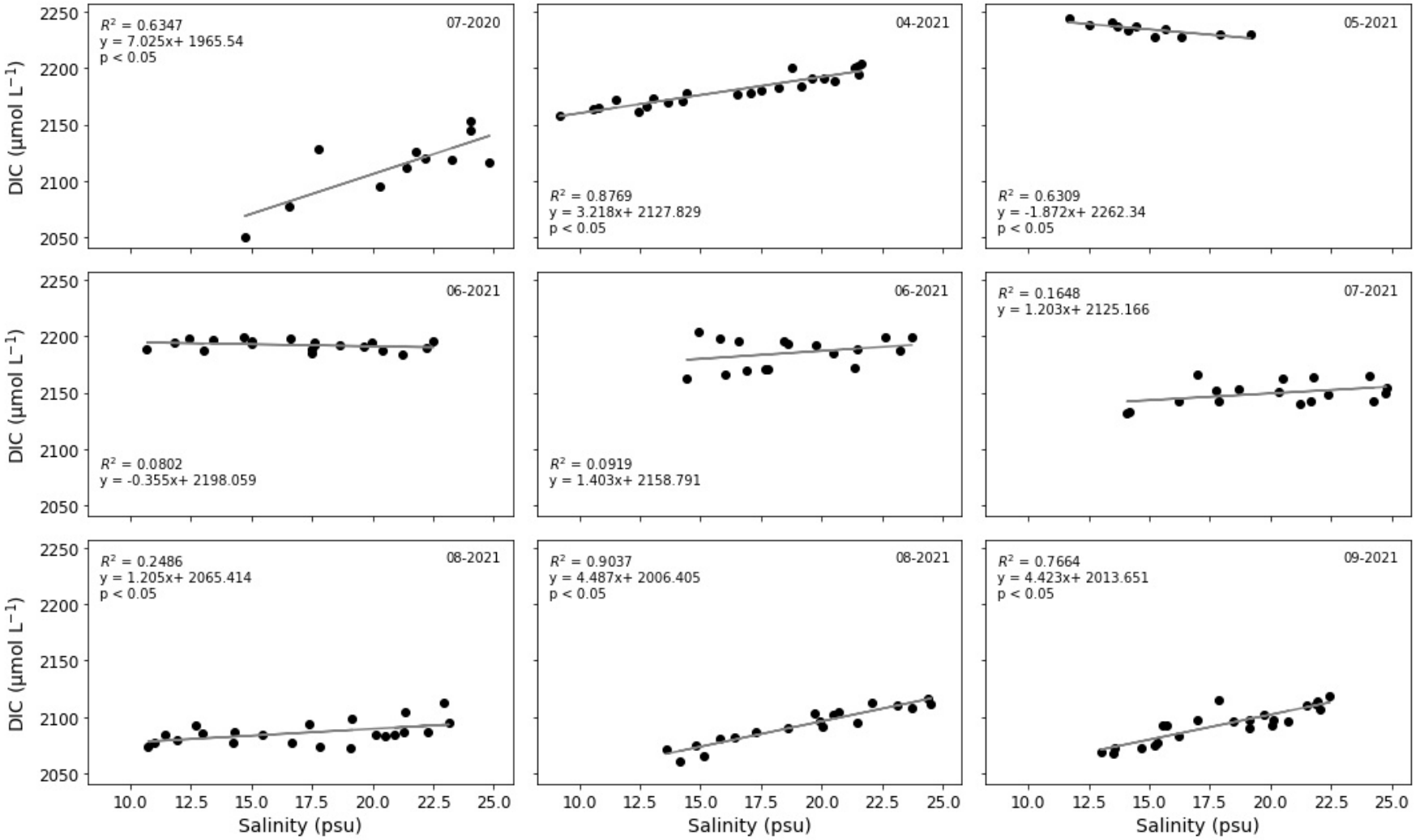
SOM

- DIC showed a significant positive correlation with salinity in July 2020, April 2021, August 2021 and September 2021
- How is metabolism impacting DIC dynamics?



DIC versus salinity in 2020-2021

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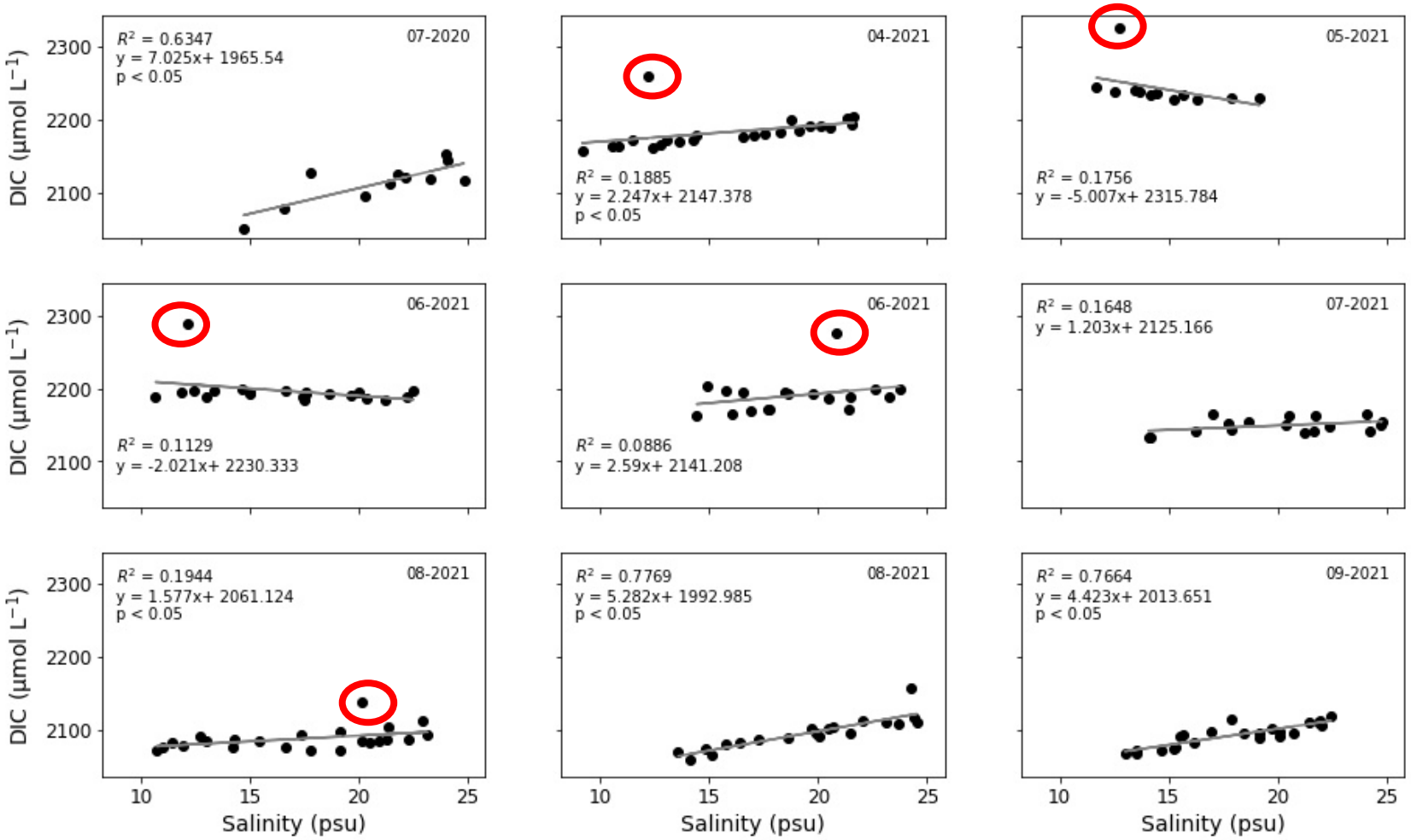
SOM

- DIC showed a significant positive correlation with salinity in July 2020, April 2021, August 2021 and September 2021
- How is metabolism impacting DIC dynamics?
- Outliers: sample 1



DIC versus salinity in 2020-2021

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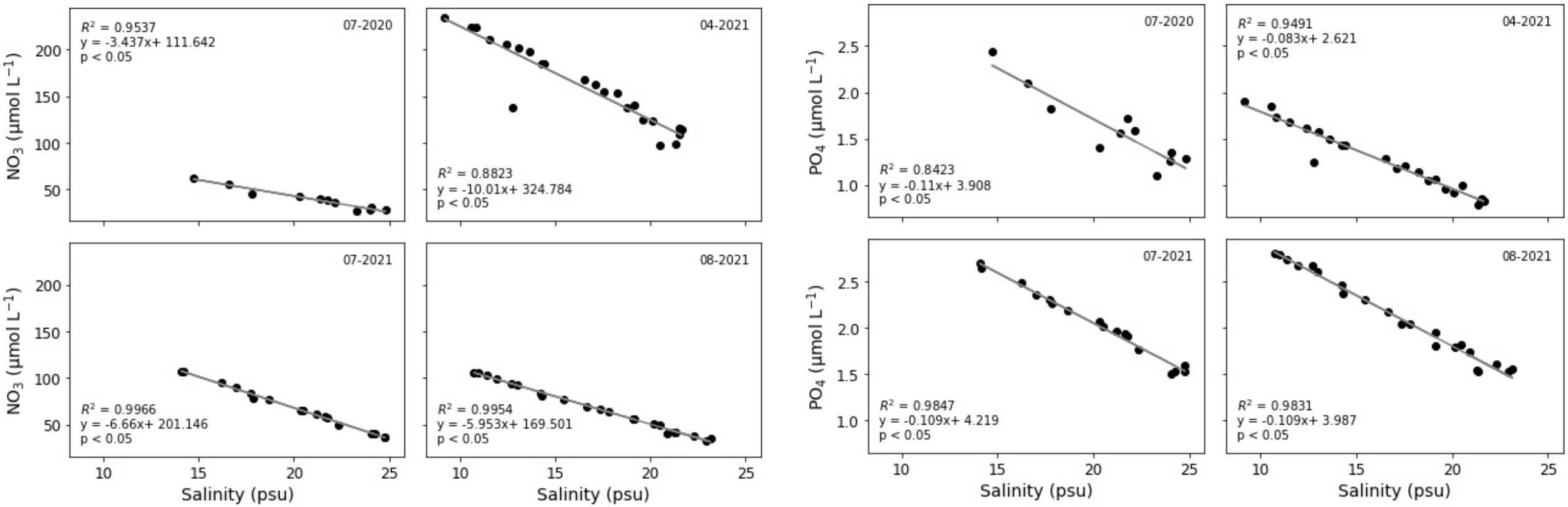

NO3 and PO4 versus salinity in 2020-2021

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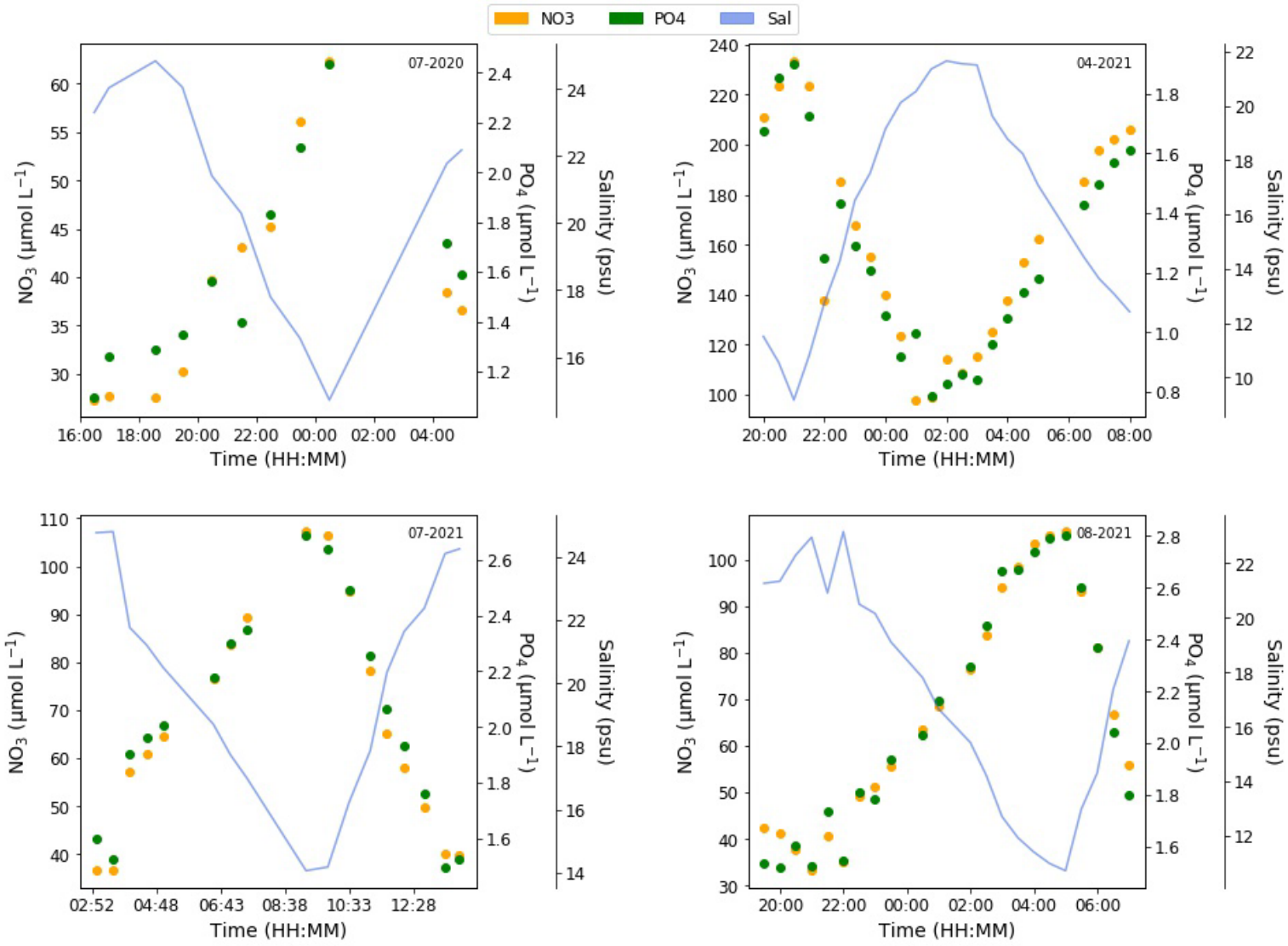

NO3, PO4 and salinity against time

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