

Small-Scale Gradients in Big Rivers: Implications for a Research Platform in the Elbe

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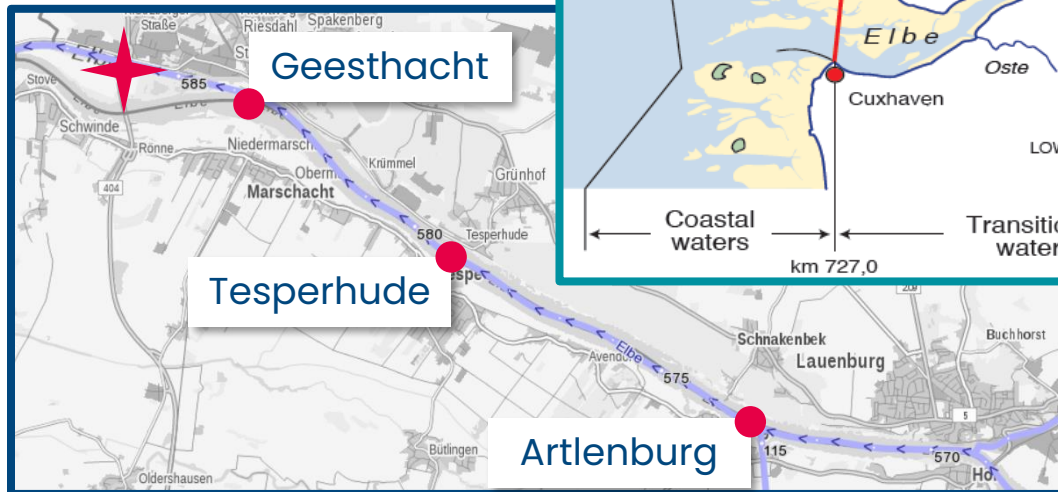


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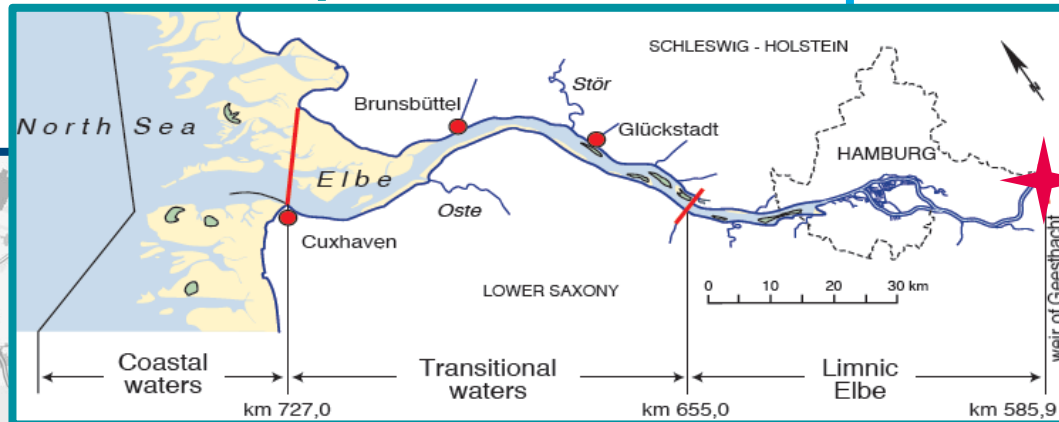
Introduction

Estuaries ultimately determine matter fluxes from land to sea. To quantify the riverine input, a floating **research platform** will be set up in **Tesperhude** at the Elbe about eight kilometres **upstream of the weir in Geesthacht** separating the Elbe river and its estuary. We investigated small-scale dynamics of selected parameters to optimise the ultimate position of the research platform.

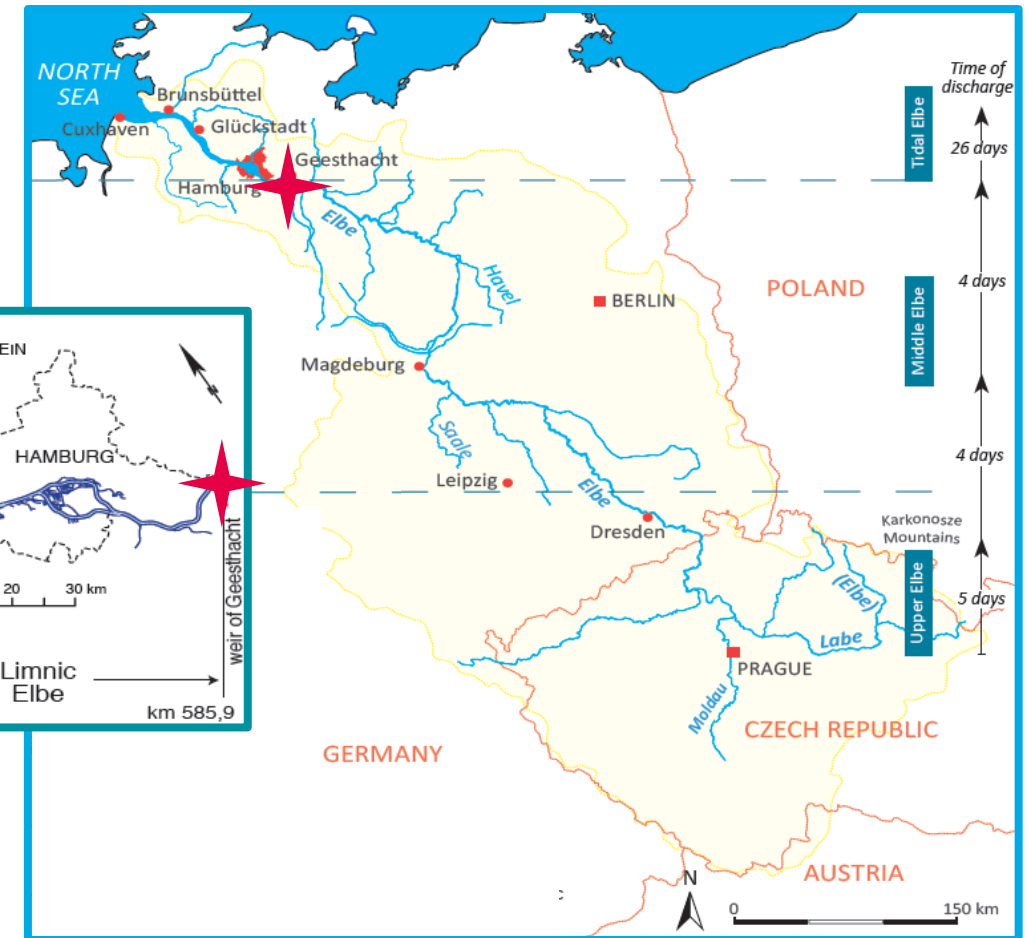
Study Area



Elbe Estuary



Elbe River



Middle & Right: http://www.tide-project.eu/downloads/0_Elbe_Factsheet.pdf

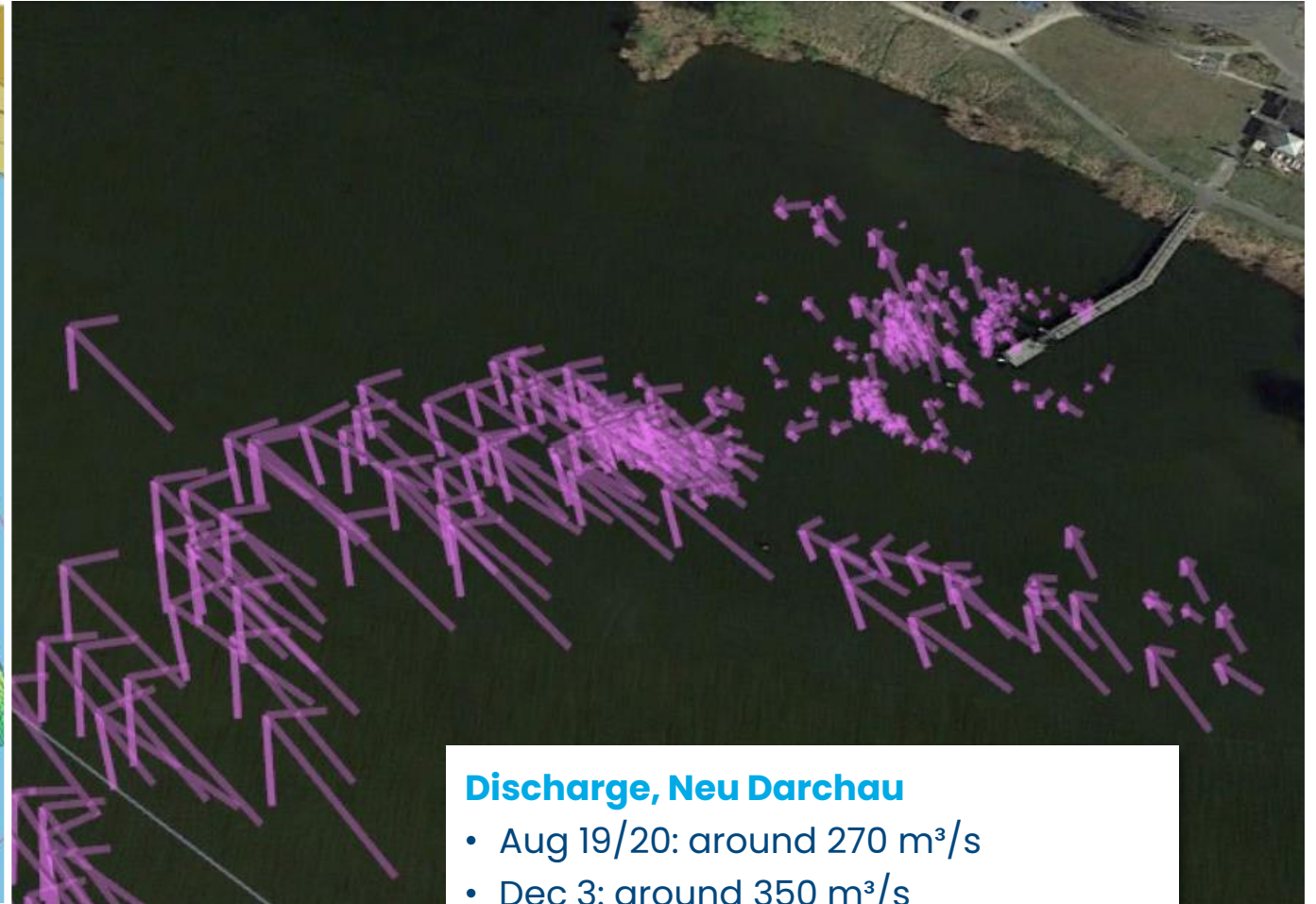
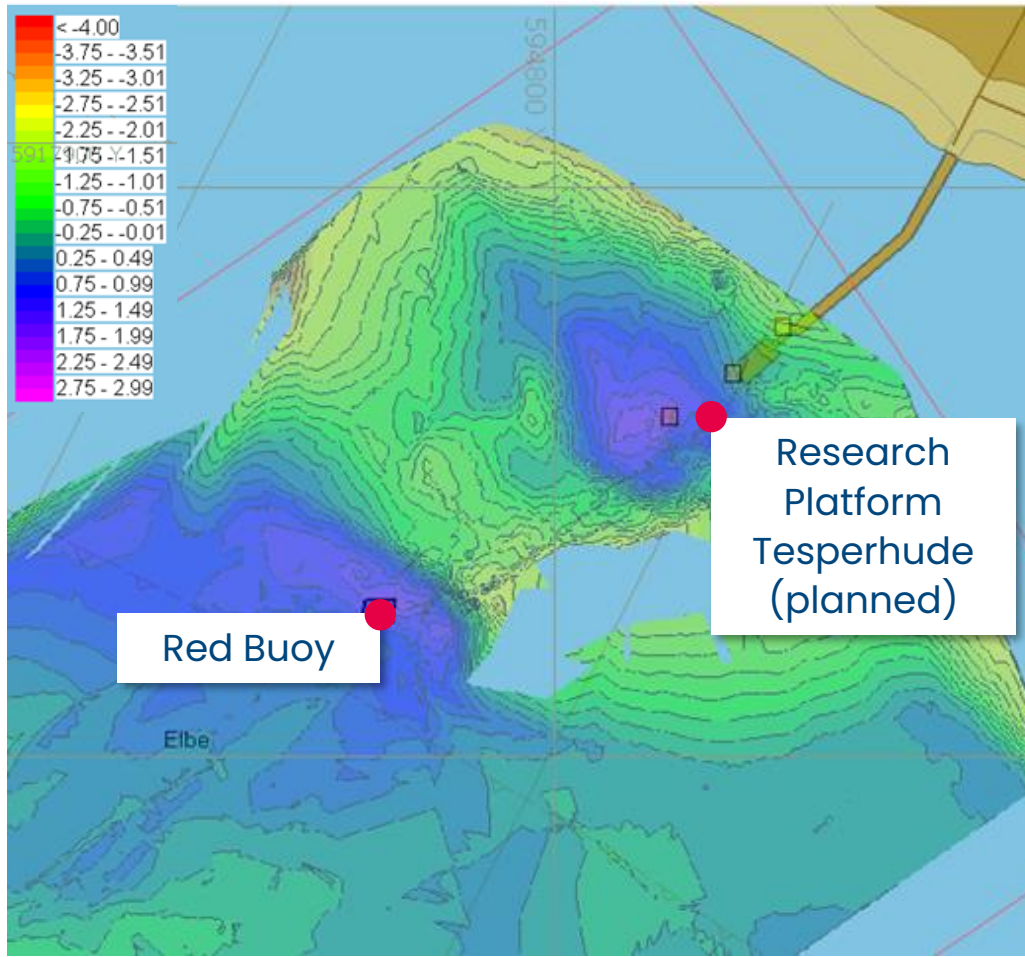
Methods

- 2 ship-based campaigns on Aug 19/20 and Dec 3, 2020
- equipped with ADCP (currents) and FerryBox incl. various sensors (for temperature, chlorophyll, turbidity, CDOM, pH, dissolved oxygen) from 1 m water depth
- cross profiles in Artlenburg (Elbe-km 584), Tesperhude (Elbe-km 579) and Geesthacht (Elbe-km 574): left and right (as far as 2 m water depth in Aug), as well as middle of fairway (same locations in Dec), from 1 m water depth
- longitudinal profiles from Geesthacht to Tesperhude (in Dec) and to Artlenburg (in Aug) in the middle of the fairway from 1 m water depth
- several vertical profiles on selected locations (not shown here)
- in total, around 50 water samples along cross, longitudinal and vertical profiles for analysis of nutrients, suspended matter, C/N, chlorophyll, alkalinity and metal ions in the lab
- sampling with Van Dorn water sampler and from FerryBox



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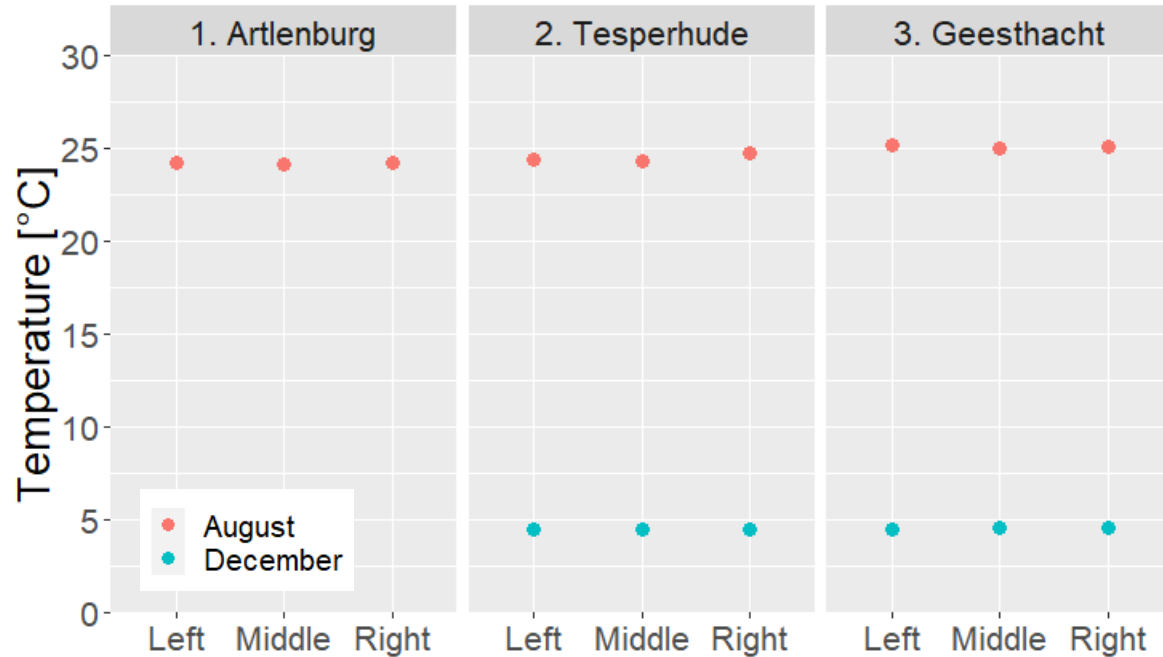
Echosoundings & Currents, Tesperhude



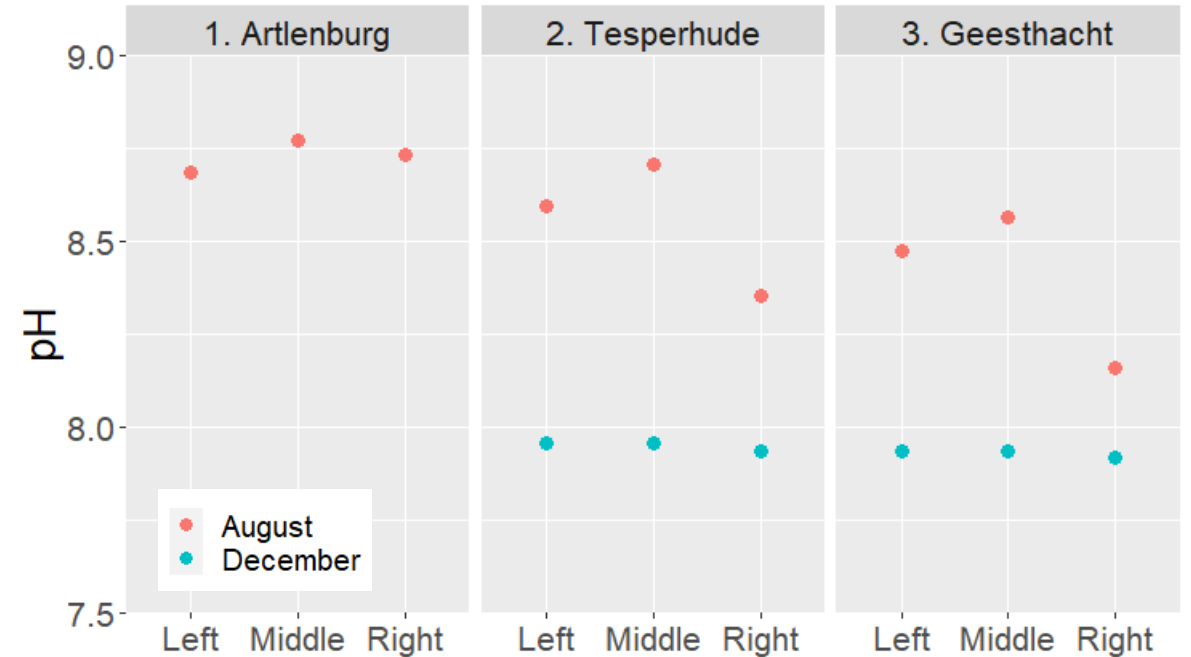
Discharge, Neu Darchau

- Aug 19/20: around 270 m³/s
- Dec 3: around 350 m³/s
- average 2015–2020: around 465 m³/s

Temperature & pH

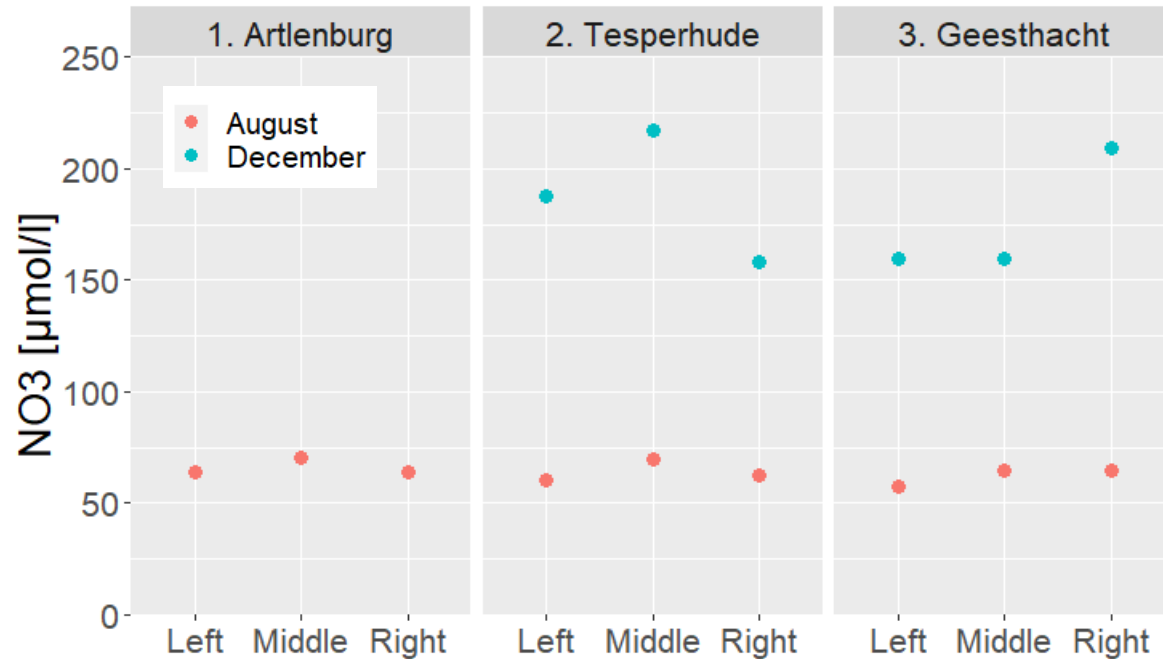


Research Platform
Tesperhude
(planned)

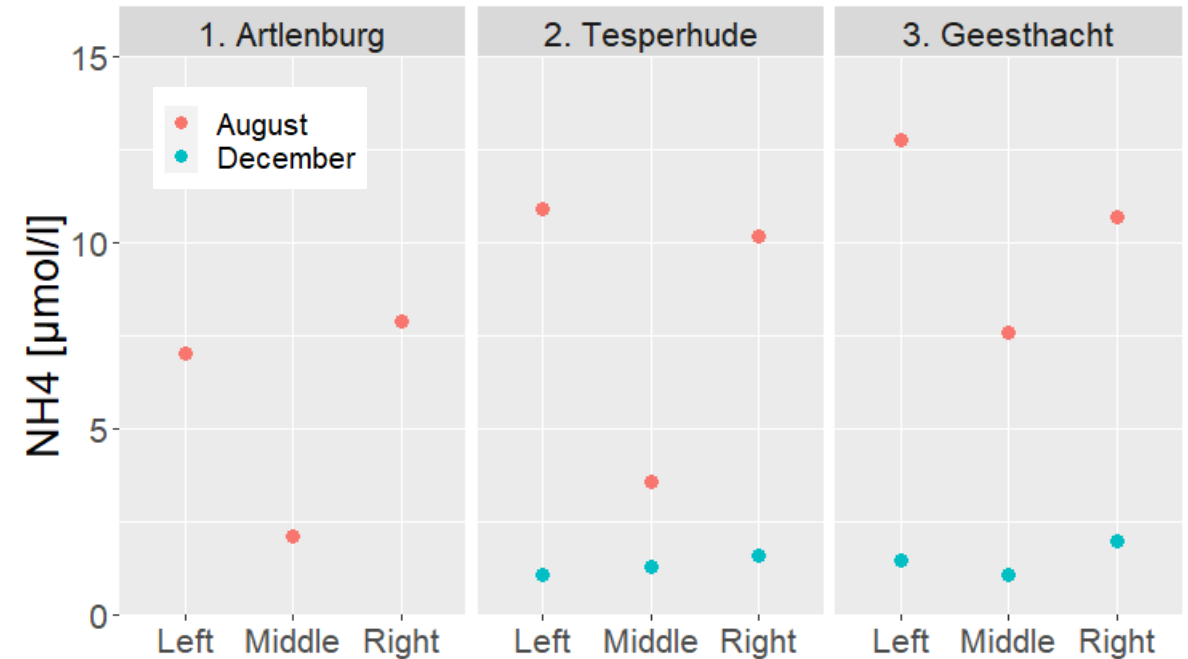


pH is lower at the sides in August,
no differences in December

Nitrate & Ammonium

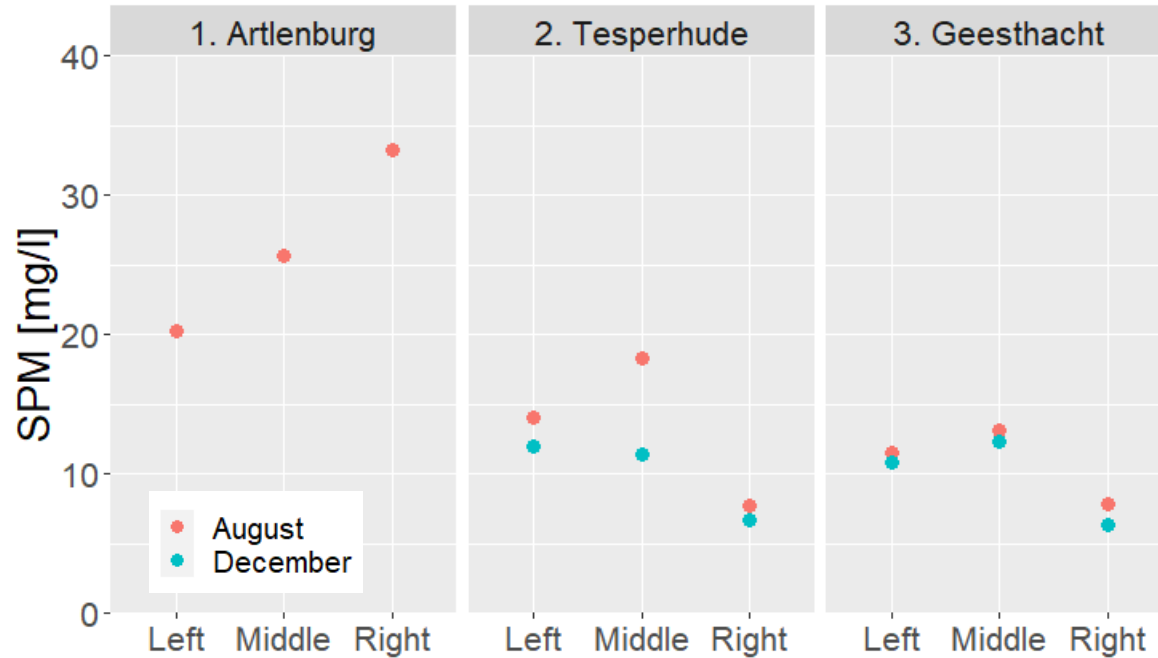


NO₃ is lower at the sides in August
and around Tesperhude in December

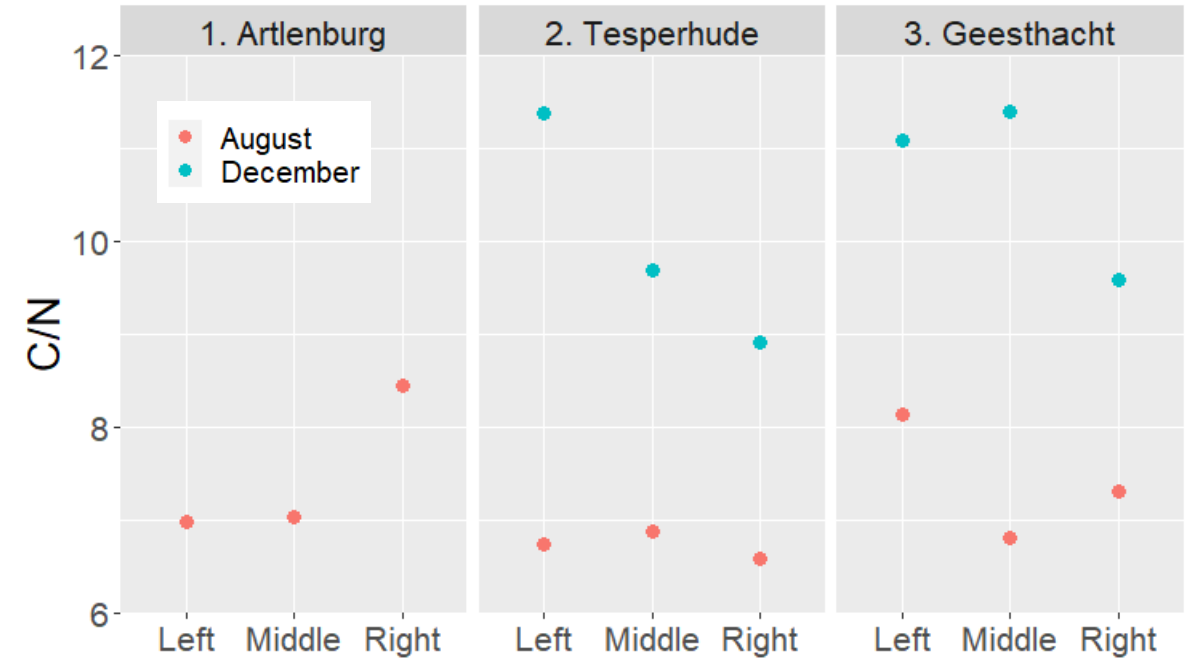


NH₄ is higher at the sides in August,
only small differences in December

Suspended Particulate Matter & Carbon-to-Nitrogen Ratio

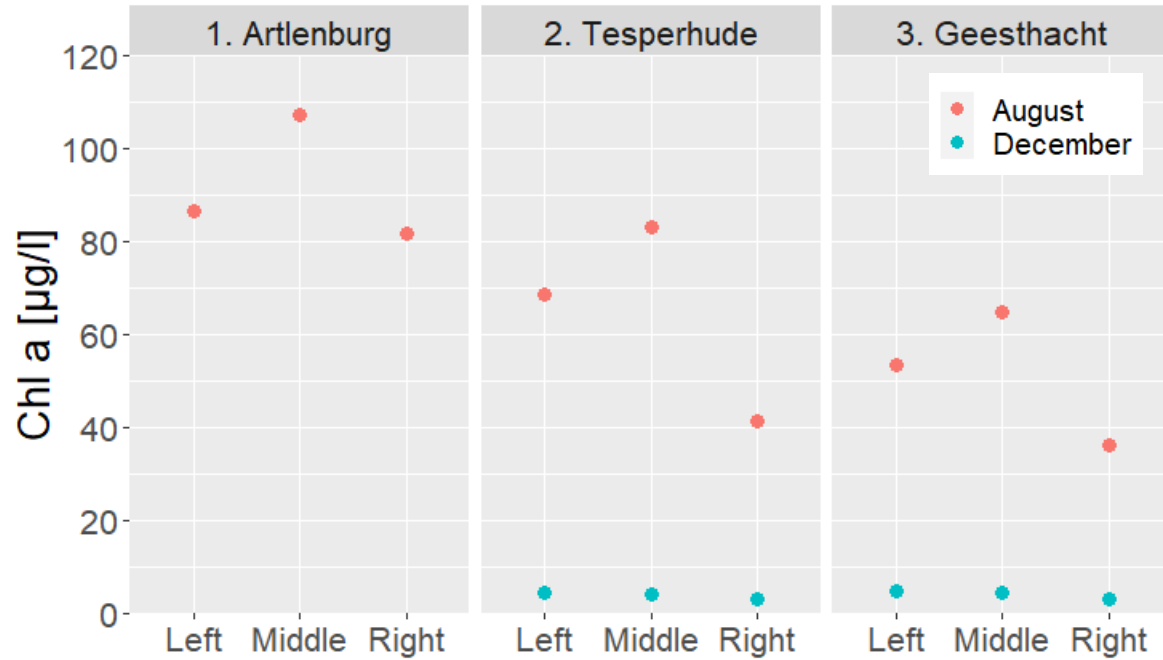


SPM is lower at the sides
in August and December

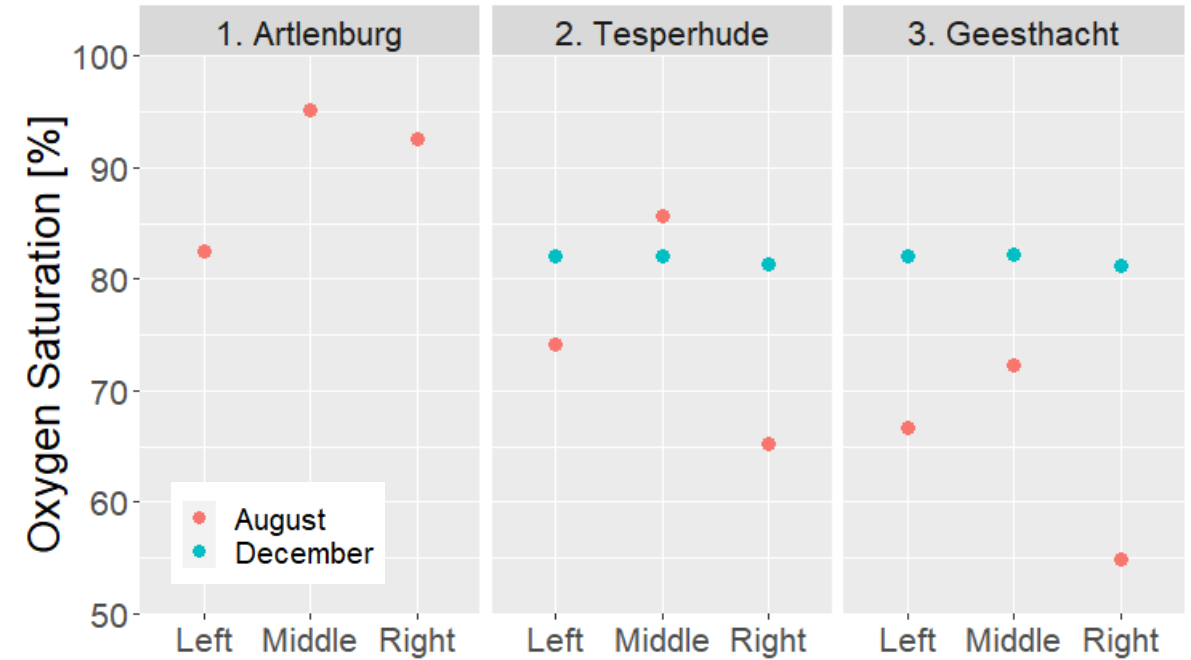


C/N is lower at the sides in Tesperhude
but higher at the sides in Geesthacht in August,
and reversed in Geesthacht in December

Chlorophyll & Oxygen

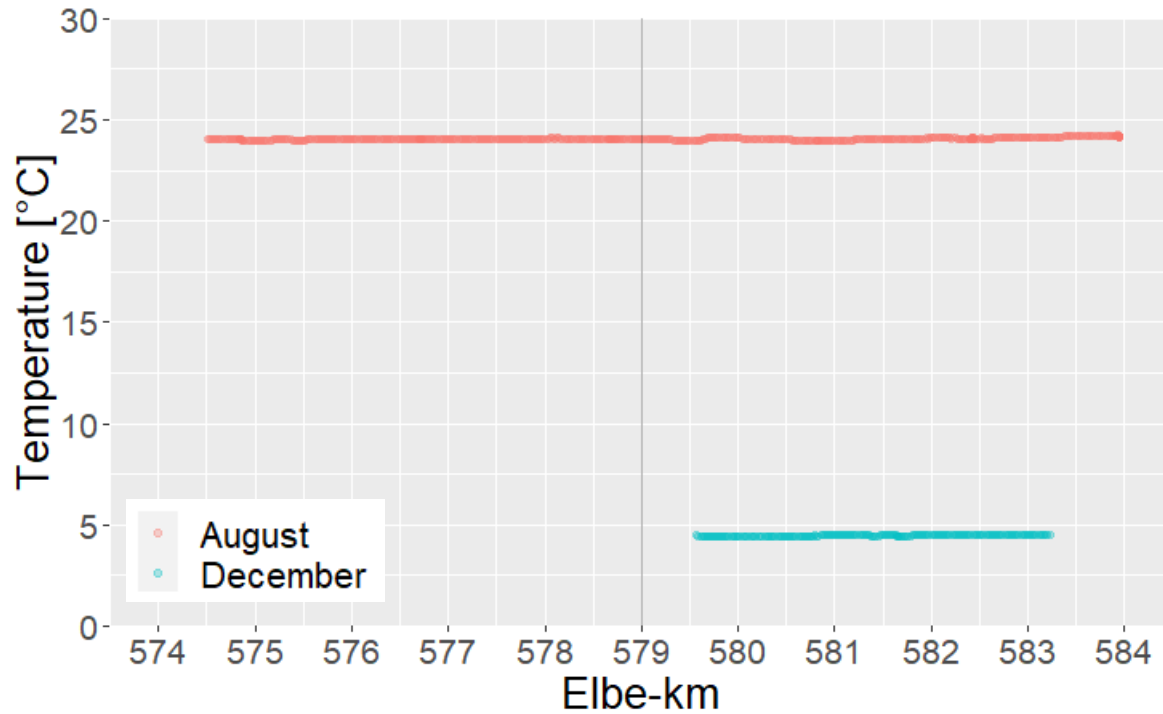


Chlorophyll is lower at the sides in August,
no differences in December



Oxygen is lower at the sides in August,
no differences in December

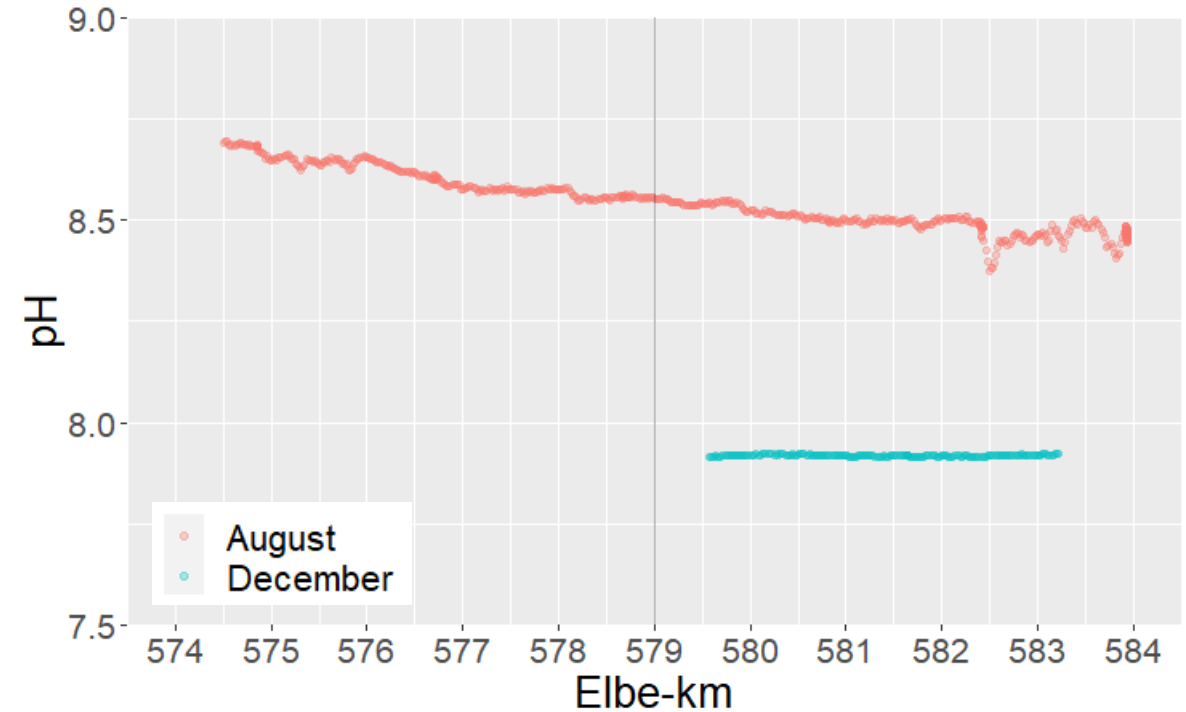
Temperature & pH



↑
Artlenburg

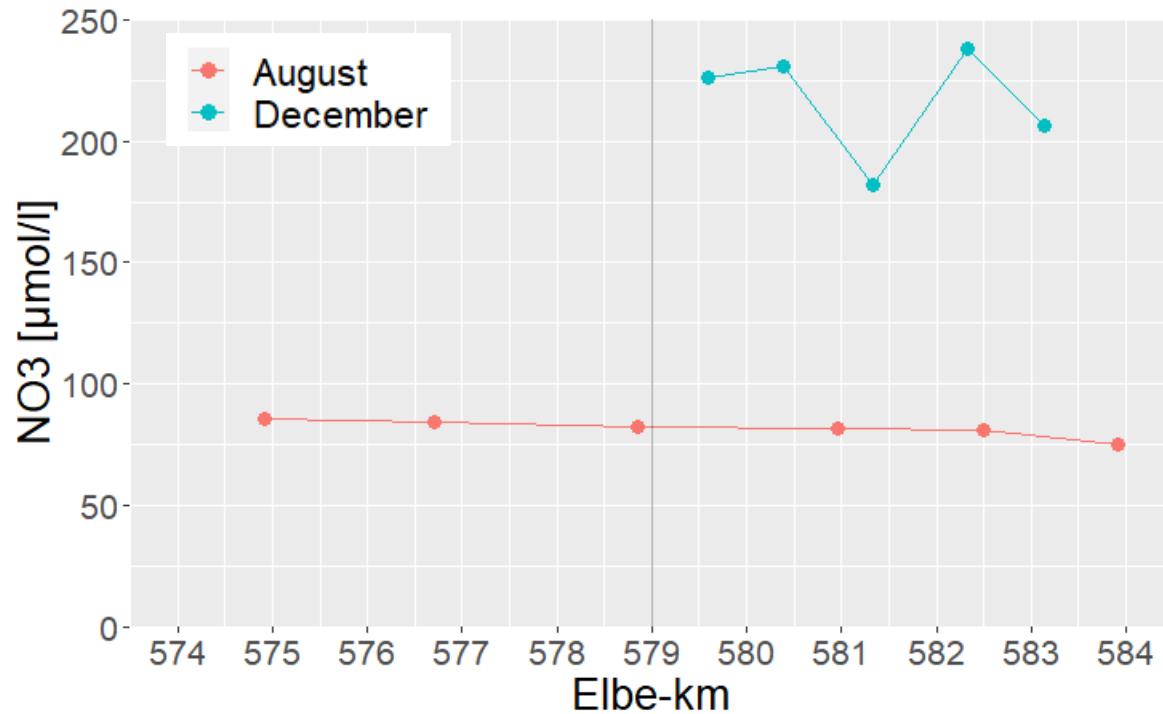
↑
Tesperhude

↑
Geesthacht

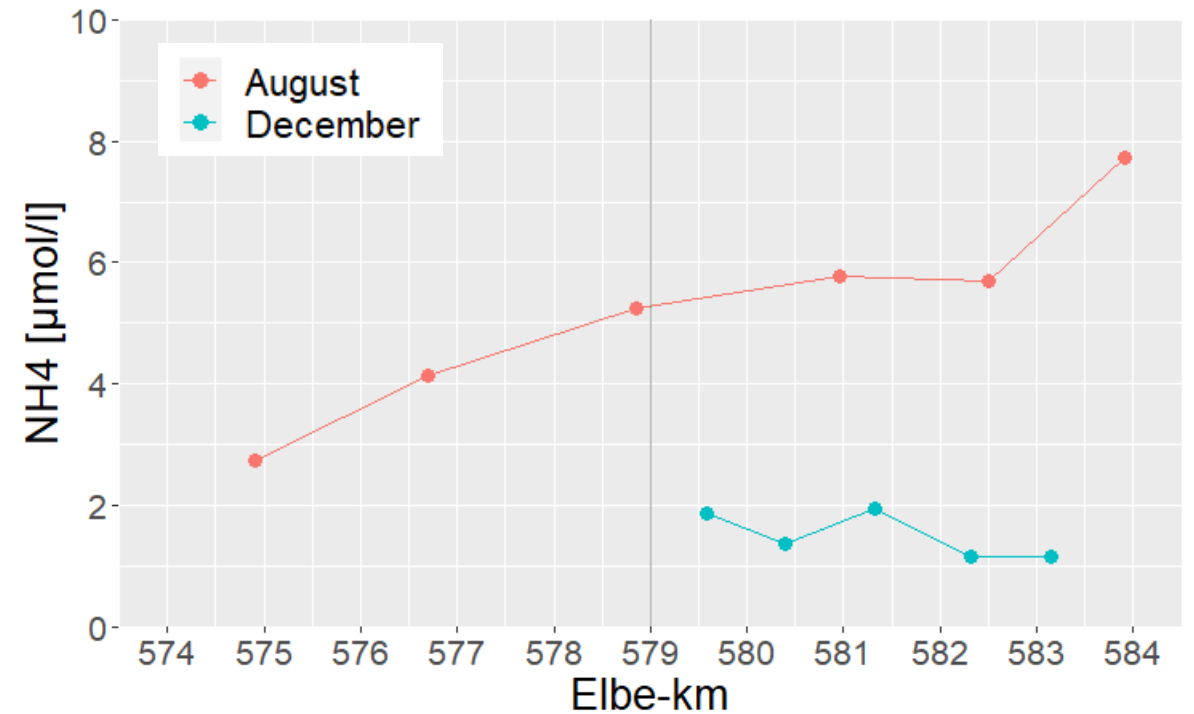


pH is decreasing in August,
no changes in December

Nitrate & Ammonium

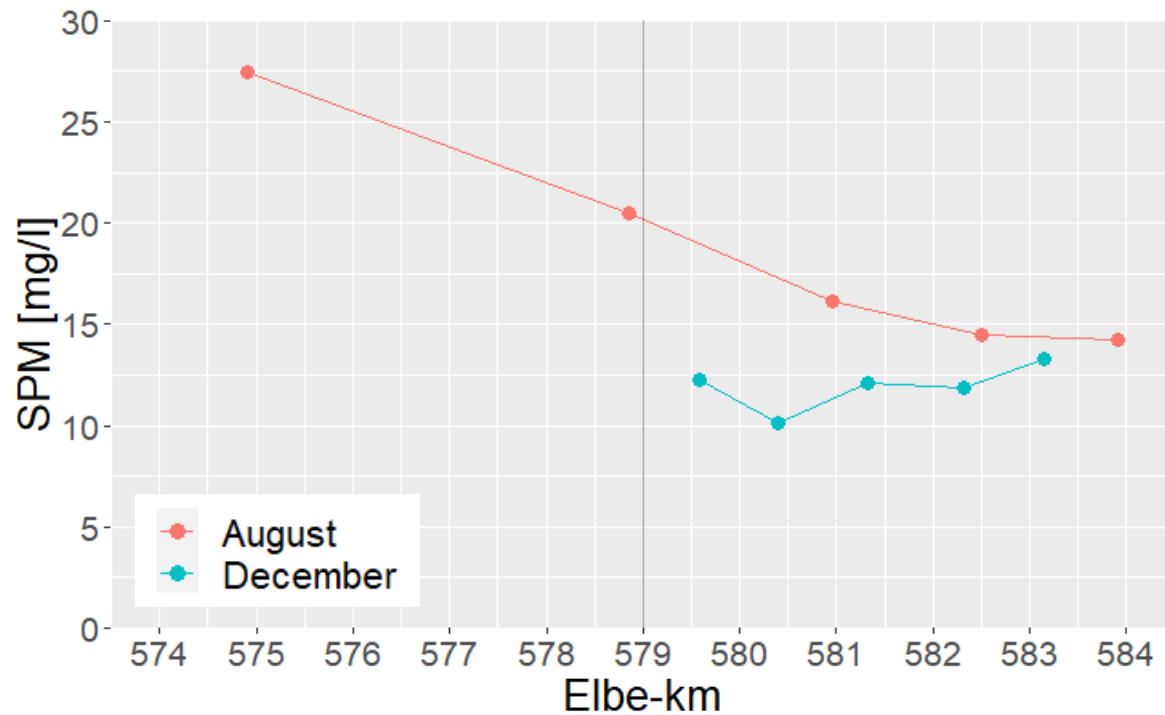


NO_3 is slightly decreasing in August,
no clear change in December

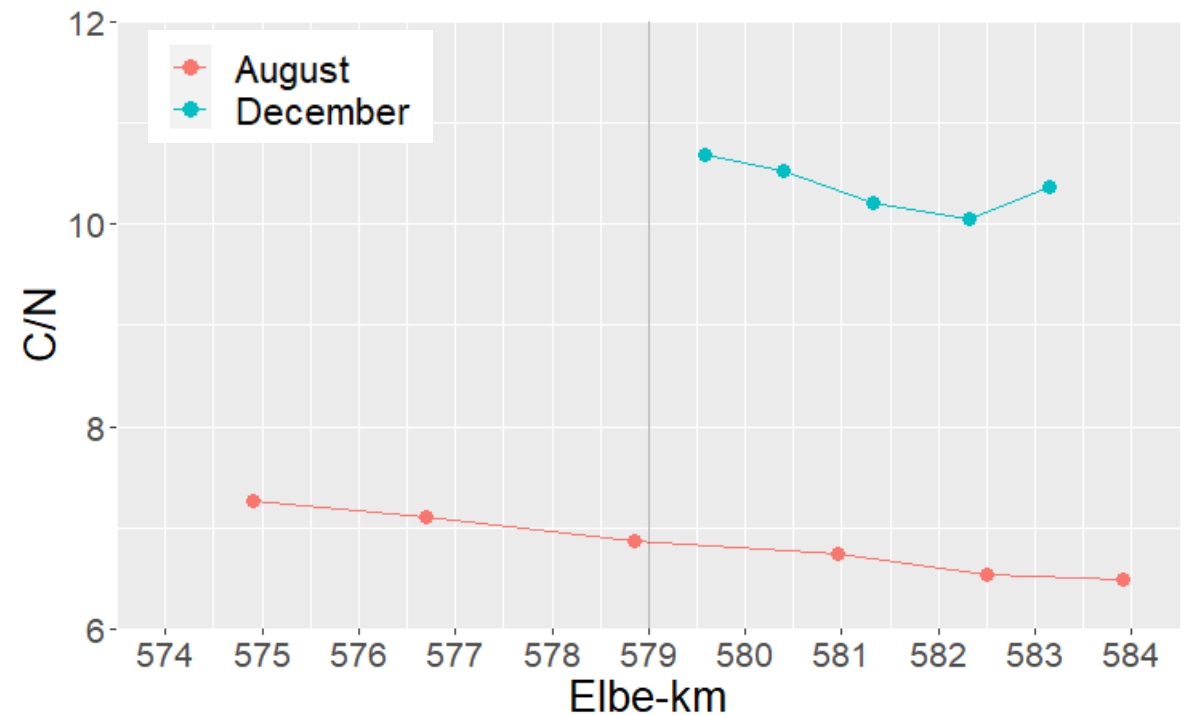


NH_4 is increasing in August,
slightly decreasing in December

Suspended Particulate Matter & Carbon-to-Nitrogen Ratio

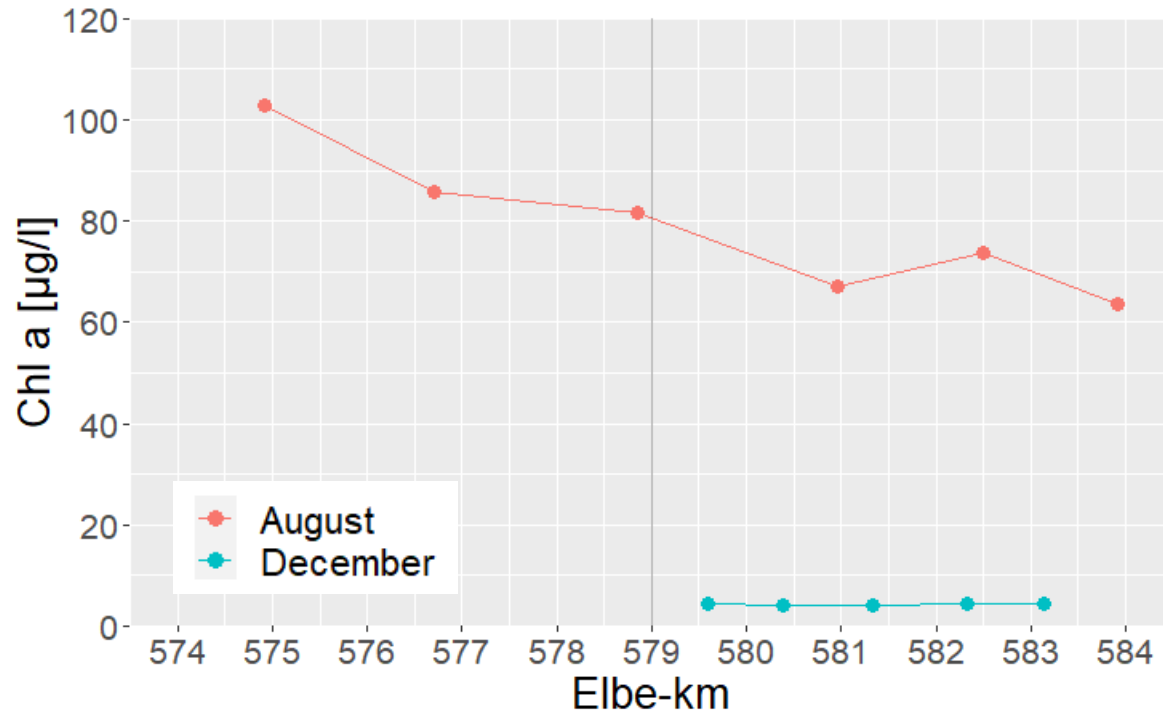


SPM is decreasing in August,
slightly increasing in December

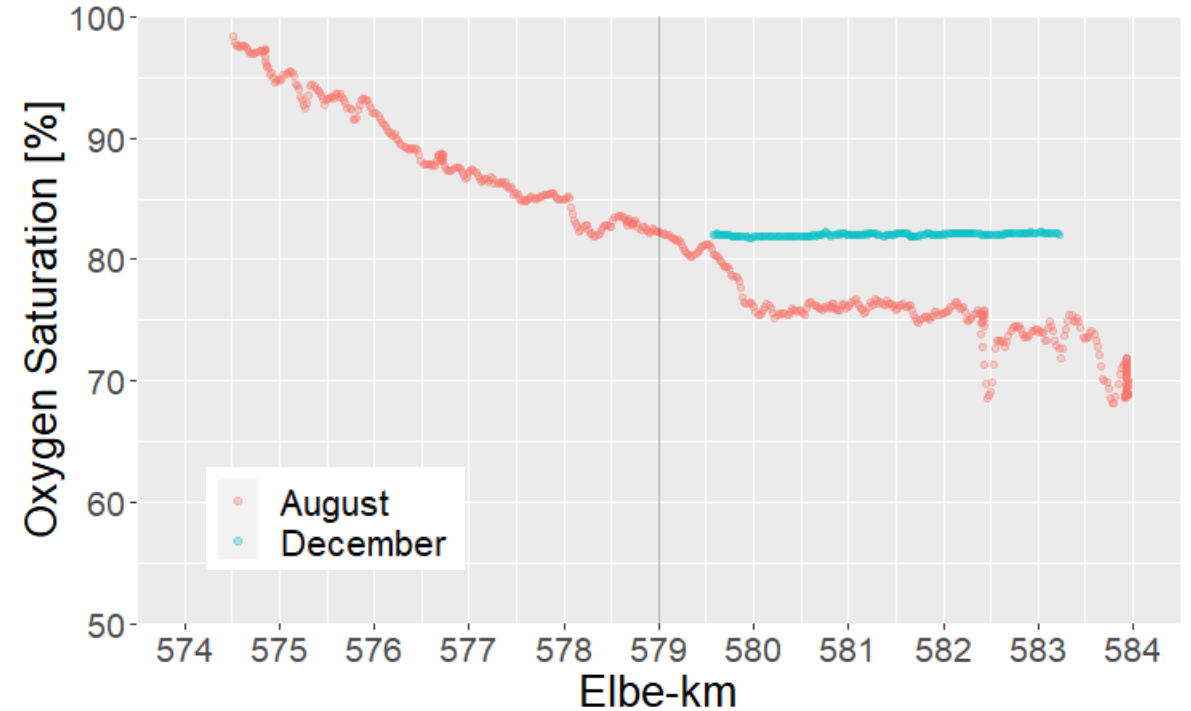


C/N is decreasing in August and
slightly decreasing in December

Chlorophyll & Oxygen



Chlorophyll is decreasing in August,
no differences in December



Oxygen is decreasing in August,
no differences in December

Conclusions

There are differences between river middle and the sides for some parameters in August and December:

- higher sedimentation at the sides → sink for suspended matter (Aug/Dec) and chlorophyll (Aug)
- higher remineralisation at the sides → source for most nutrients (Aug/Dec) and sink for oxygen (Aug)
- maybe denitrification at the sides → sink for nitrate (Aug/Dec)

There are differences along the 10 km transect from Artlenburg over Tesperhude to Geesthacht for some parameters in August:

- higher sedimentation towards Geesthacht → sink for suspended matter and chlorophyll (Aug)
- higher remineralisation towards Geesthacht → source for most nutrients and sink for oxygen (Aug)
- maybe denitrification in front of weir Geesthacht → sink for nitrate (Aug)
- no significant differences for most parameters in Dec

- there are some small-scale gradients in the cross and longitudinal profiles within the study area upstream of the weir Geesthacht, separating the river from the estuary, especially in August
- the water for the research platform will be pumped from close to the fairway
- further research is needed to quantify the role of areas outside the fairway and the role of the weir for biogeochemical cycling, especially during periods of low discharges

Outlook

The research platform consists of a ponton with a container housing diverse state-of-the-art observation systems providing continuous, high resolution and near-real-time data. These include ...

- a **FerryBox** (e.g. temperature, chlorophyll, algal classes, turbidity, CDOM, pH, dissolved oxygen),
- **fluorometer** for measuring primary productivity,
- **nutrient analysers** (ammonium, nitrate, phosphate, silicate),
- **gas analysers** (nitrous oxide, carbon dioxide, methane, radon),
- a mobile inductively coupled plasma mass spectrometer (**ICP-MS**) for analysing dissolved metal ions,
- a horizontal acoustic doppler current profiler (**ADCP**) for current measurements, as well as
- a **weather station** (e.g. wind speed and direction, air temperature, radiance, humidity, precipitation, air pressure),

- a hyperspectral **water reflectance** station for determining water constituents.

In addition, the research platform contains an automated water sampler, a continuous flow centrifuge and a sedimentation box for suspended matter collection.

The research platform, planned to be operational in autumn 2021, is also **open for users**:

- to develop and test new methods and technologies,
- to access data through the “Helmholtz Coastal Data Centre”.

In combination with data from a station in Cuxhaven, the data from the research platform in Tesperhude will allow e.g. to quantify carbon and nutrient budgets for the Elbe estuary.

More information: www.hzg.de/tesperhude

Acknowledgements

The research platform is set-up in cooperation with the Helmholtz Association initiative **MOSES ("Modular Observation Solutions for Earth Systems")**, which investigates the interactions of short-term events (e.g. hydrological extremes) and long-term trends.

Furthermore, the research platform will be incorporated in the regional case study "Elbe-North Sea Supersite" of the pan-European research infrastructure initiative **DANUBIUS-RI ("International Centre for Advanced Studies on River-Sea Systems")**, which researches land-river-sea interactions.

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