Effects of the 2018 European heatwave and drought on coastal biogeochemistry in the German Bight

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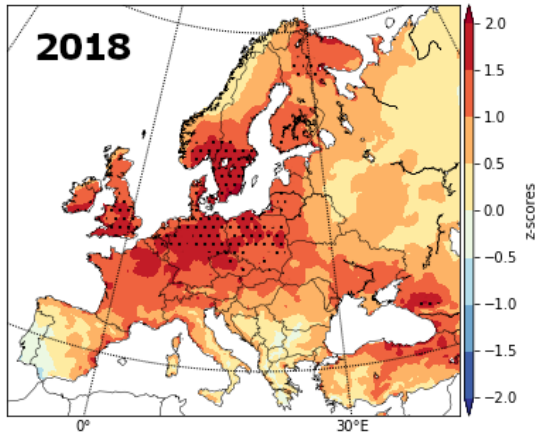
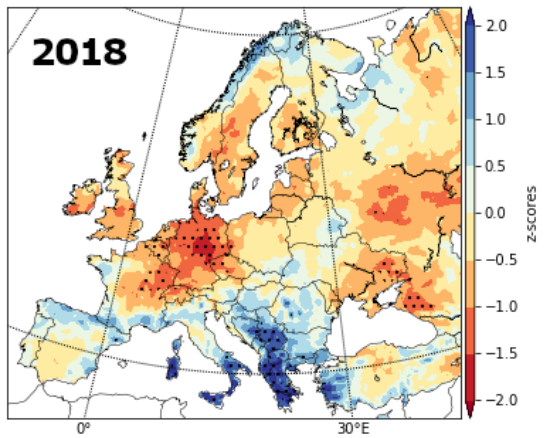
Background – the Hot Drought 2018 in Europe

Summer (JJA) meteorology and its consequences

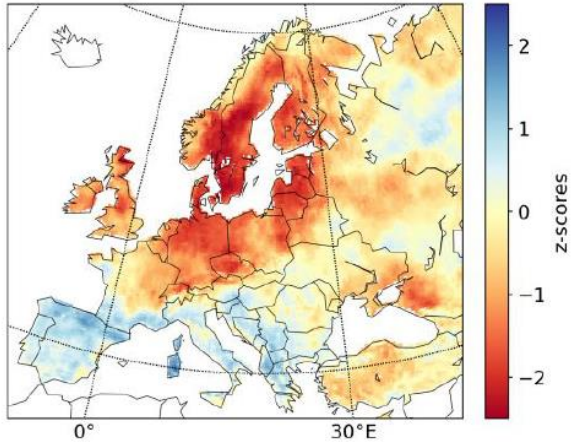
air temperature



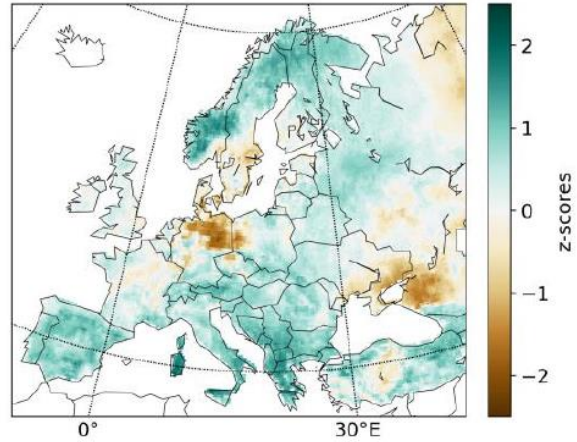
precipitation



soil moisture



above-ground C



- > 500-year record extreme summer temperature
- cold and wet winter 2017/18
  - strongest transition between a wet winter and dry summer at continental scale
  - extreme spring warming and brightening
- Record hot droughts of 2003 and 2010 were preceded by warm, dry, sunny springs

- sharp decrease in soil moisture from spring to summer
- strong reductions in vegetation productivity
  - crop losses worth €340 million in Germany
- CO_2 uptake was high in spring, but
- low in summer <u>especially in Elbe catchment</u>
  - But: No significant reduction of annual GPP

Bastos et al 2020; DOI: 10.1126/sciadv.aba2724
Wang et al. 2020; DOI: 10.1016/j.agrformet.2020.108195

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Approach

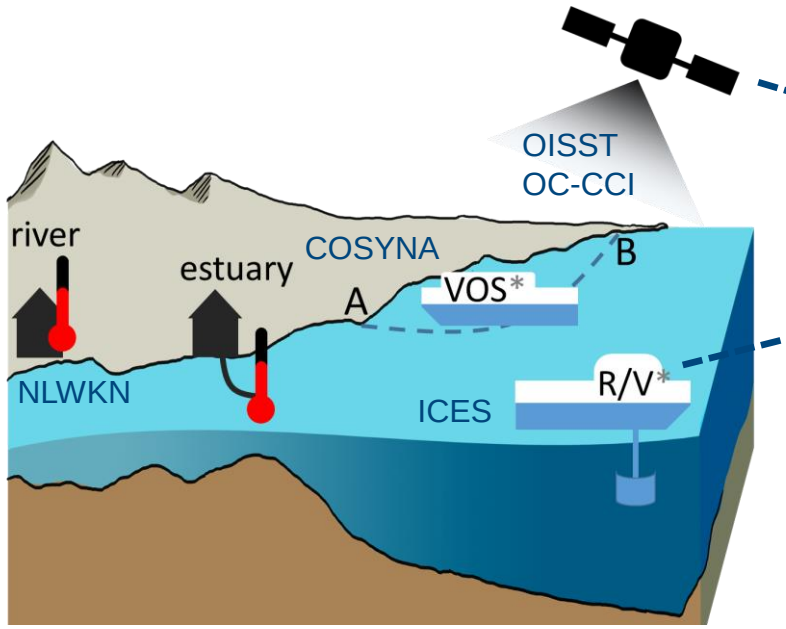
compile and analyze open data from various sources

Research questions

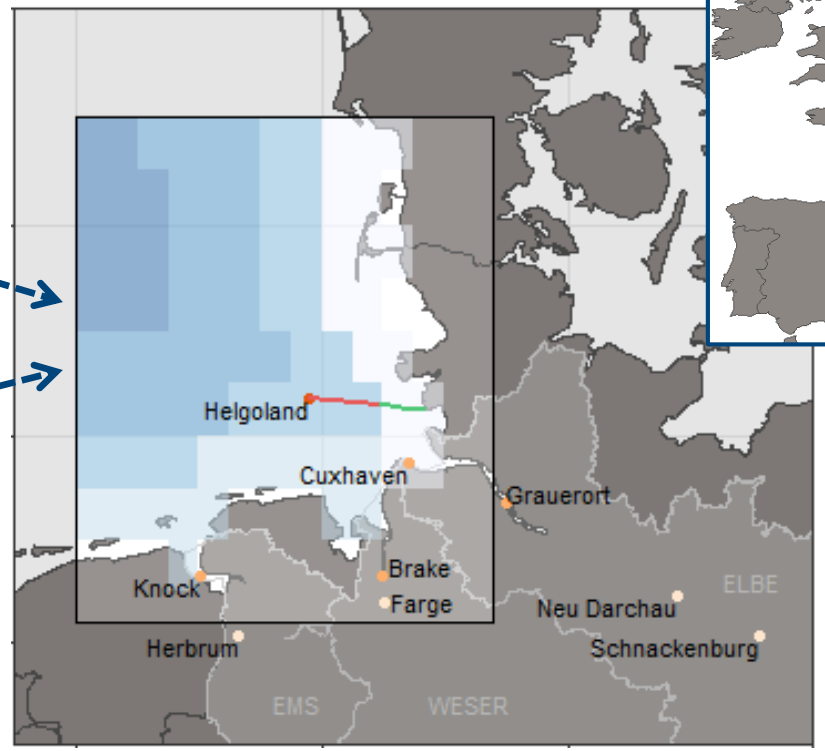
Q1: Is the heatwave reflected in surface water temperature?

Q2: How does the drought affect river (nutrient) flux and coastal loading?

Q3: What are the compound effects on coastal biogeochemistry and productivity?



summarised into zones



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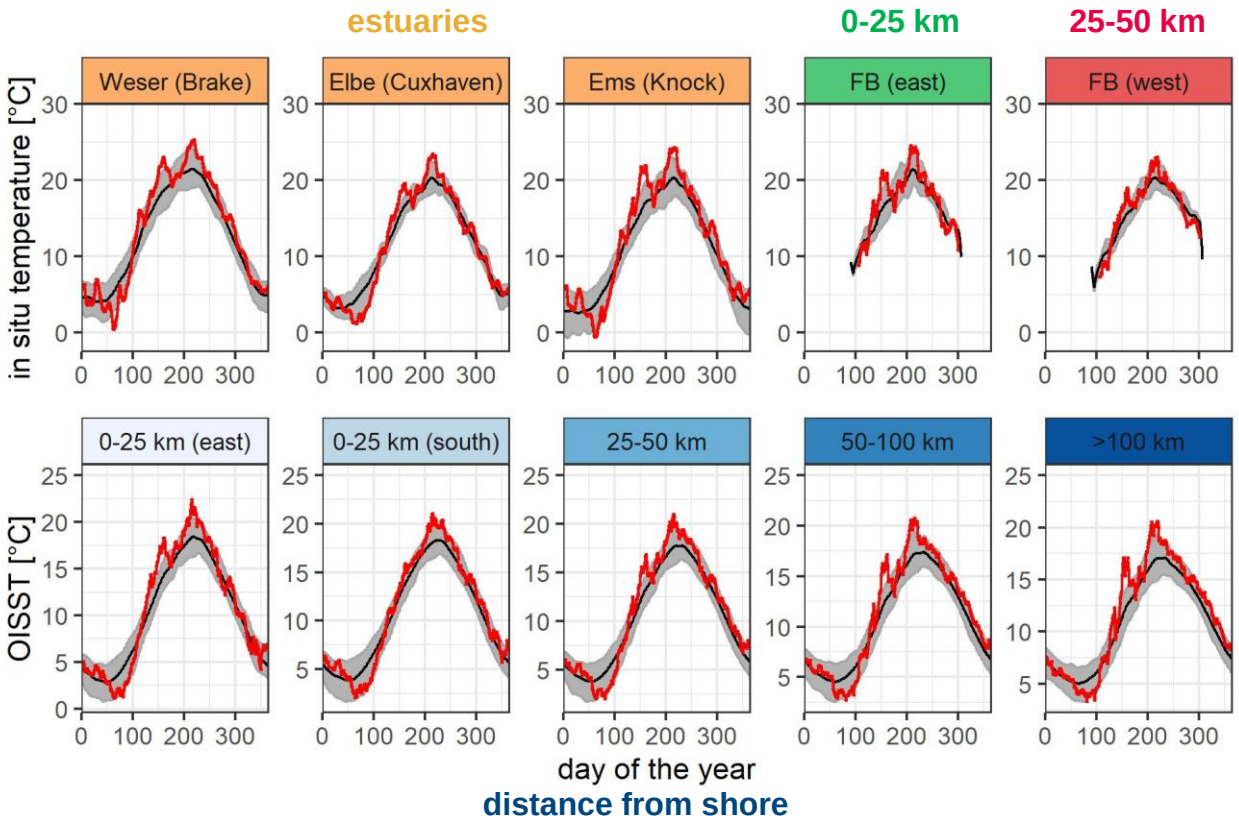
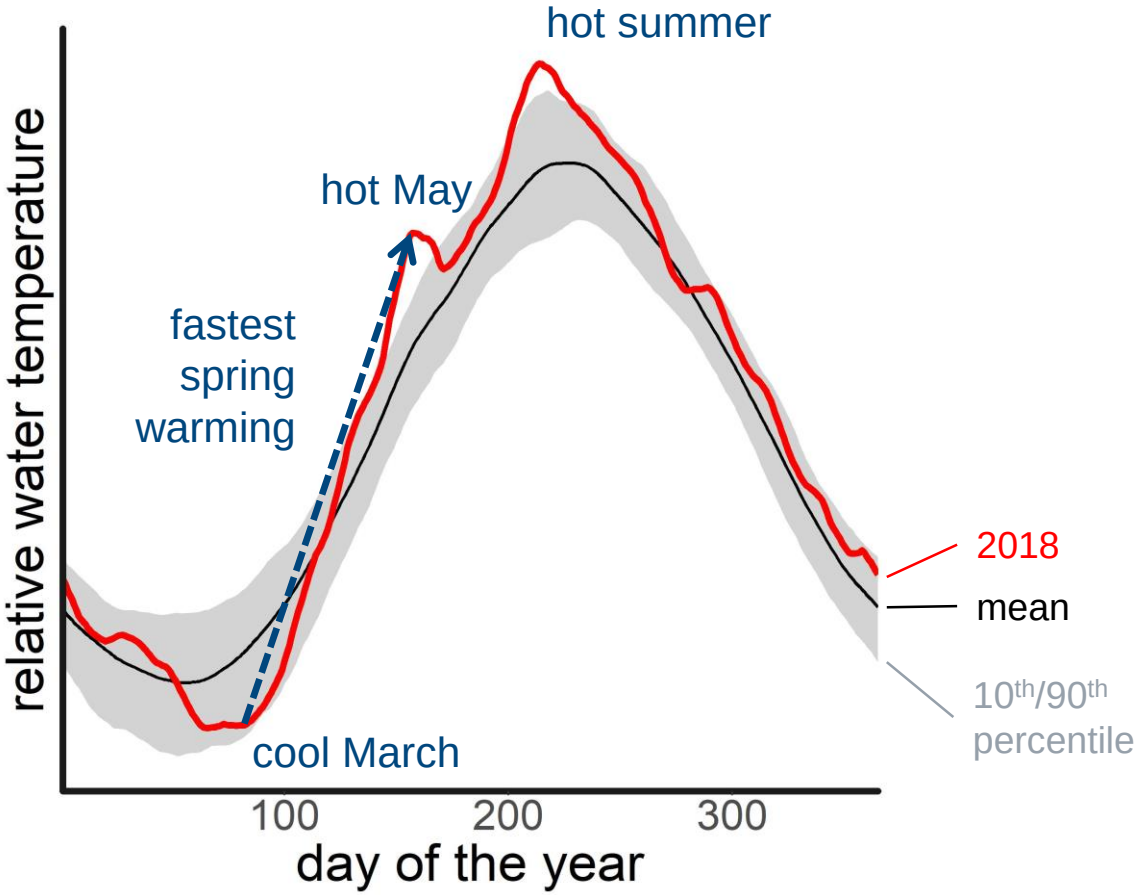
Results
unusual surface water temperature in 2018





Q1: Yes, the heatwave caused record spring warming from cool March to hot summer.

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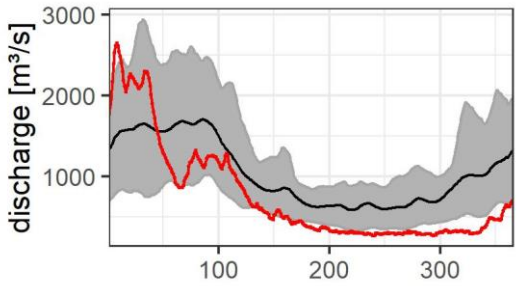
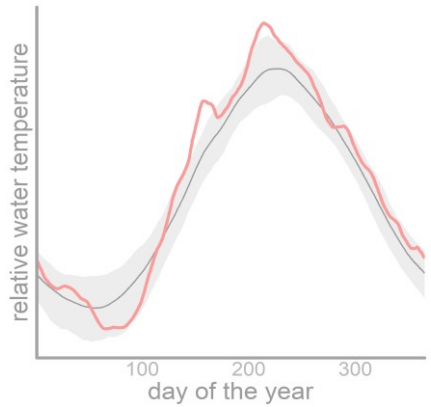
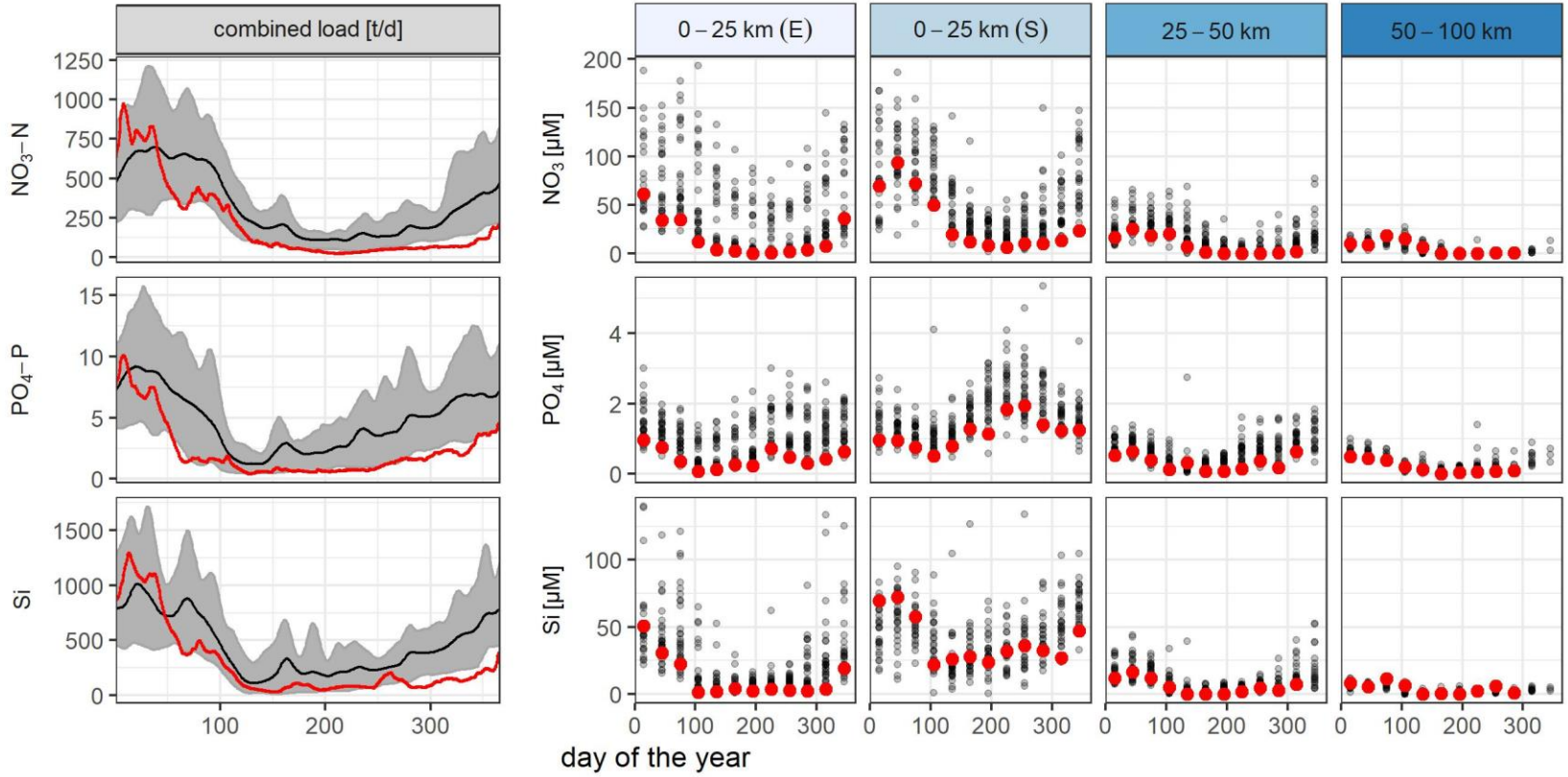
Results

low discharge and nutrient loads from rivers (Elbe+Weser+Ems)







Values are low even against a long-term decreasing trend!

Q2: The drought caused low discharge and nutrient loading, resulting in low nutrient concentrations in the GB.

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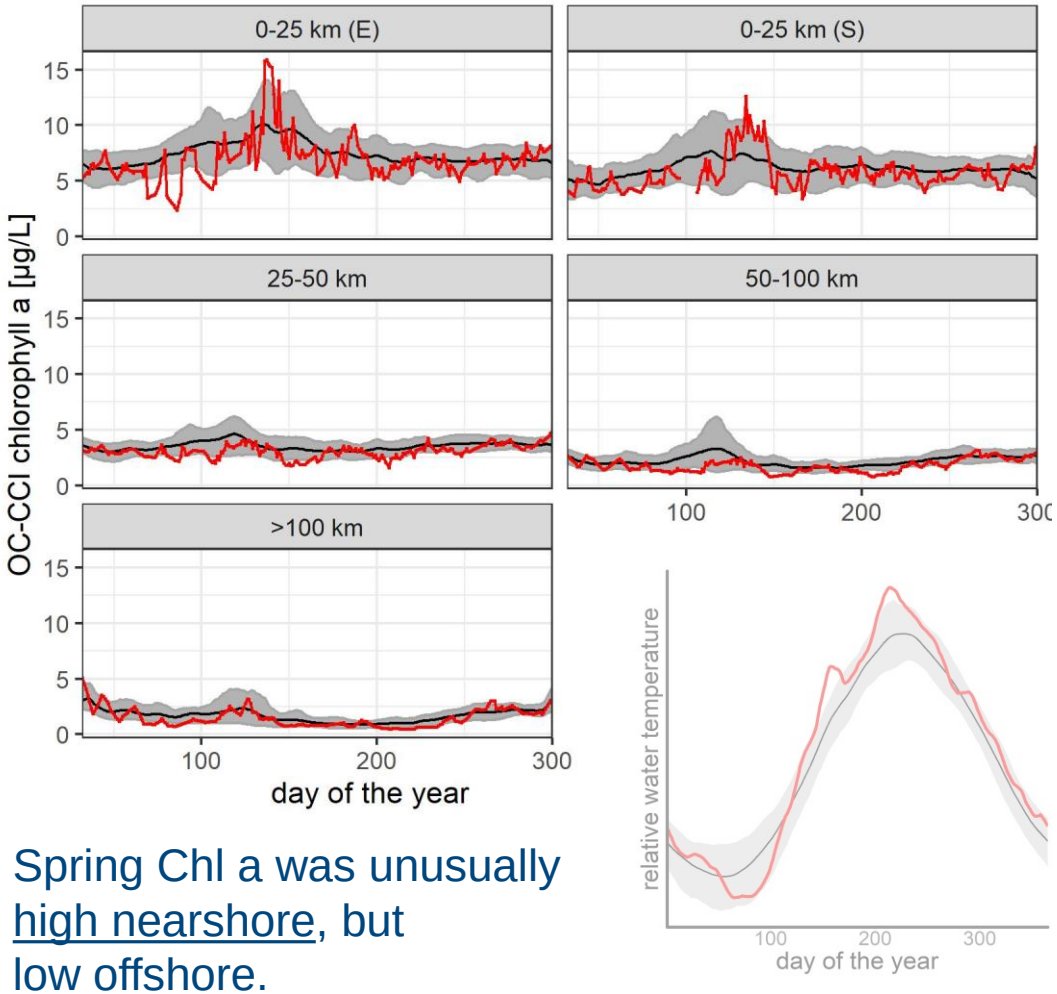
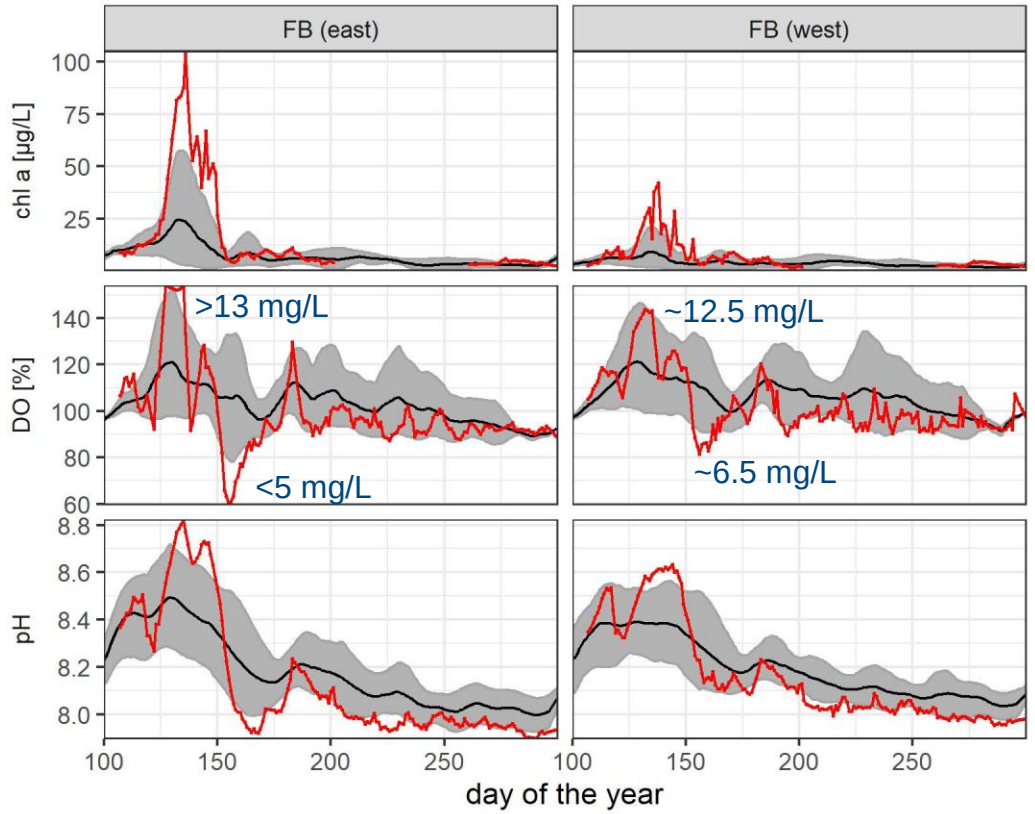
Results

spring peaks in chlorophyll a, dissolved oxygen and pH



Spring Chl a was unusually high nearshore, but low offshore.



Peaks in FerryBox data suggest unusually strong nearshore phytoplankton growth, oxygen release and CO_2 uptake.

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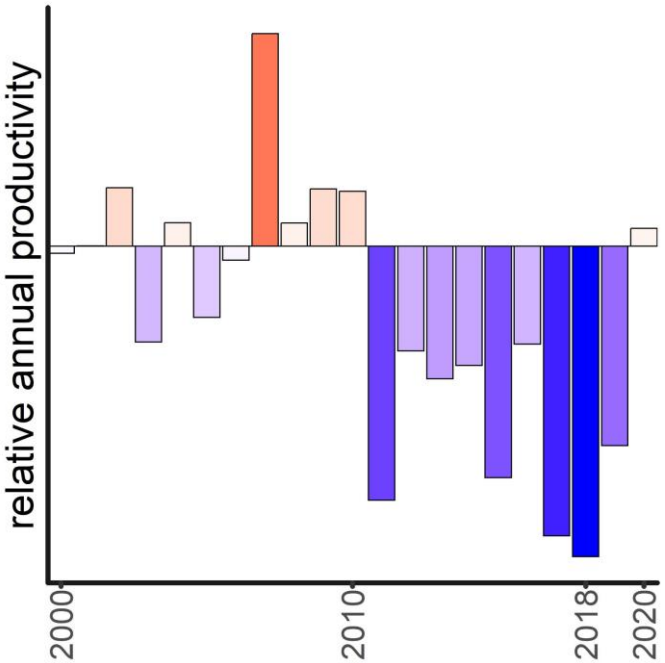
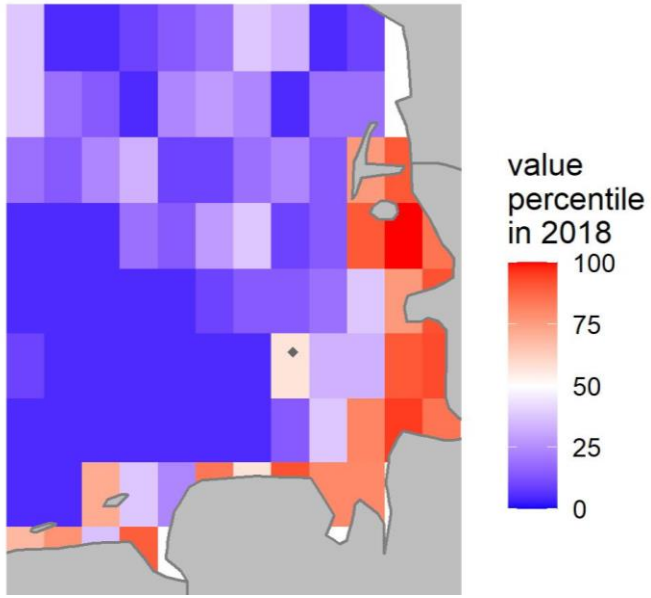
Conclusion

heat and drought have compounded impact on productivity





Annual chlorophyll a „gain“
= sum of positive day-to-day changes in OC-CCI

lowest values in drought year 2018
despite high spring nearshore values

Q3: In sping, **low discharge** caused **high residence time**, which together with **high SST** facilitated effective (winter) **nutrient utilization** and resulted in **high primary production** near the coast.

Offshore, **low nutrient loading** and coastal nutrient uptake **minimized lateral supply,** and the heatwave caused **strong stratification** that **blocked vertical supply**, causing **nutrient limitation** and **low primary production**.

Thanks for your attention

Thanks to data providers and aggregators
NLWKN http://www.wasserdaten.niedersachsen.de
ICES www.ices.dk
COSYNA https://codm.hzg.de/codm/
OC-CCI www.oceancolour.org/thredds
OISST https://coastwatch.pfeg.noaa.gov

What‘s next?

Effects of compound dry and hot extremes

- Large world river estuaries and ROFI!
- Global gridded coast approach?

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