Carbon in Seas
From first assessments via variability and vulnerability to manageability
Perspectives for the Institute of Carbon Cycles (KC)

Helmuth Thomas
Helmholtz-Zentrum Hereon, Geesthacht

Helmholtz-Zentrum hereon

Outline

- *Scientific challenges*
- *Understanding from 1st Assessments (short)*
- *Understanding Variability*
- *Vulnerability and Manageability*

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Two (of more) Takeaways from the 2022 IPCC Climate Change Mitigation Report

1. Global GHG emissions have continued to rise, but in pathways that limit warming to 1.5°C, they peak before 2025.

2. ...

3. ...

4. ...

5. Limiting global temperature rise to 1.5 degrees C will be impossible without carbon removal.

6. ...

Not in the report but in the news on 10.05.2022: **We will hit the 1.5°C bar with 50% probability before 2025 (WMO)**.

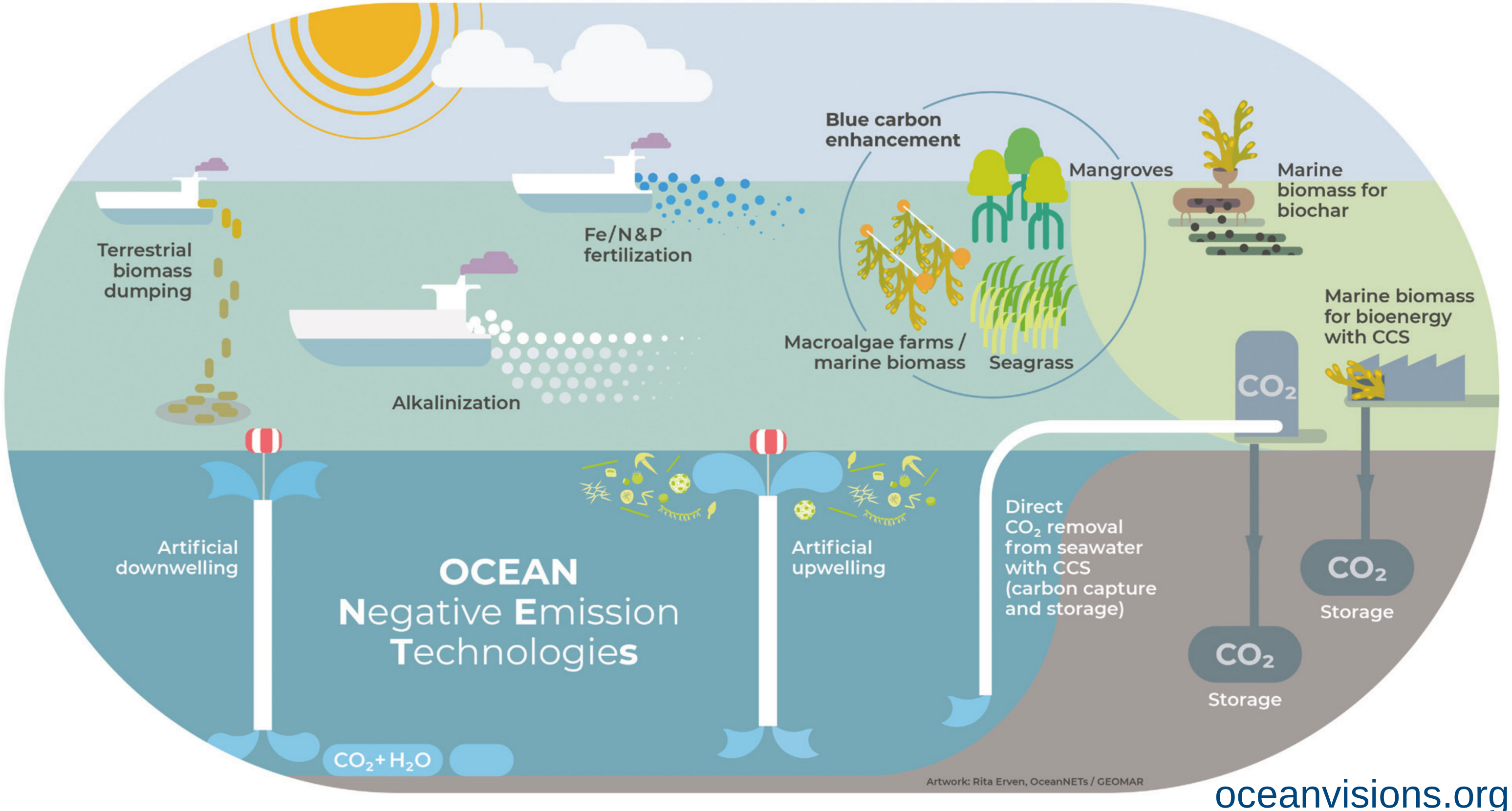
By Clea Schumer, Sophie Boehm, Taryn Fransen, Karl Hausker and Carrie Dellesky, https://www.wri.org/insights/ipcc-report-2022-mitigation-climate-change?utm_medium=email&utm_source=climatedigest&utm_campaign=climatedigestmar22

2: Scientific challenges and perspectives

KC's future challenges:
Can we deliberately manage C-reservoirs in the coastal zone?

- Are the coastal zones able to supply this required negative emissions?
- Which deliberate approaches might appear worth considering?
- How to verify and attribute deliberate measures?
- What are the transport pathways and ultimate sinks?
- Are there collateral benefits/caveats (price tag)?
- How does coastal engineering affect the environment, and how does the environment affect coastal engineering?

Some proposed ideas



oceanvisions.org

Negative emissions in the marine realm

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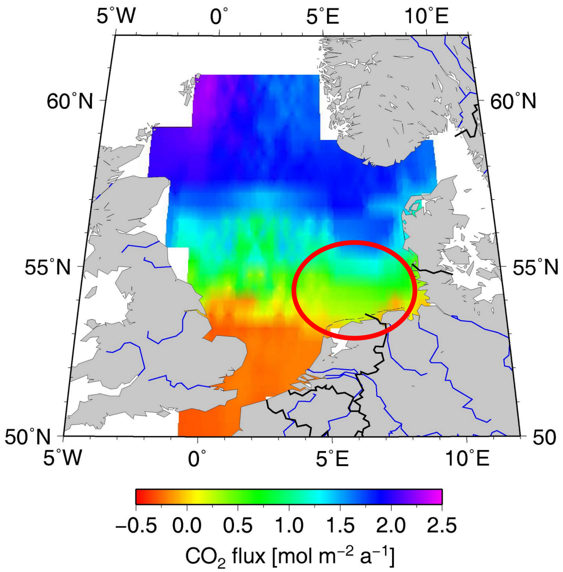
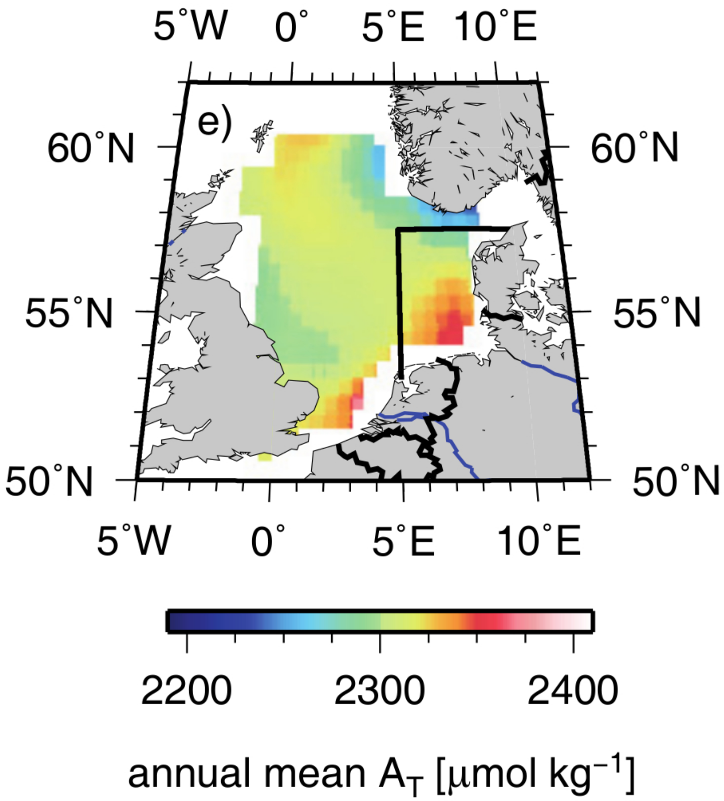
Understanding from 1st Assessments – the role of alkalinity





Thomas et al., 2004, 2009

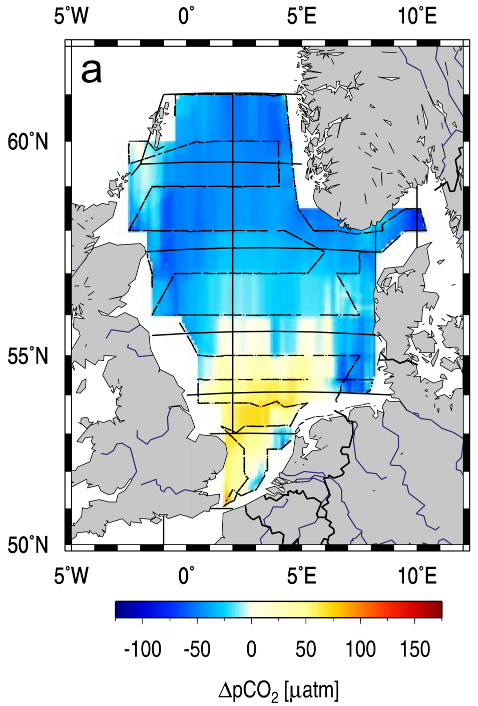
Why does the pCO_2 remain low in the southern Bight?

- Lateral and vertical sources into shallow North Sea appear to contribute approx. equally to A_T inputs.
  (Burt, Thomas et al., 2014, 2016)
- Anaerobic control
- See also Voynova et al., 2019, L&O, ferrybox paper

The metabolic switch: O_2

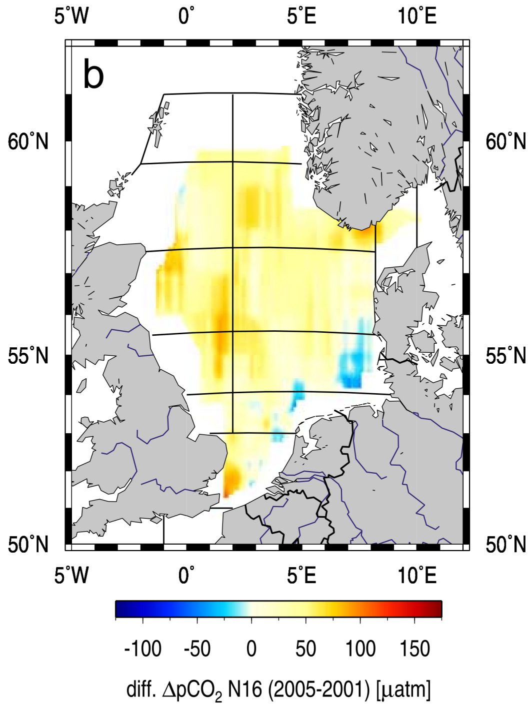
Understanding Variability - local/regional control

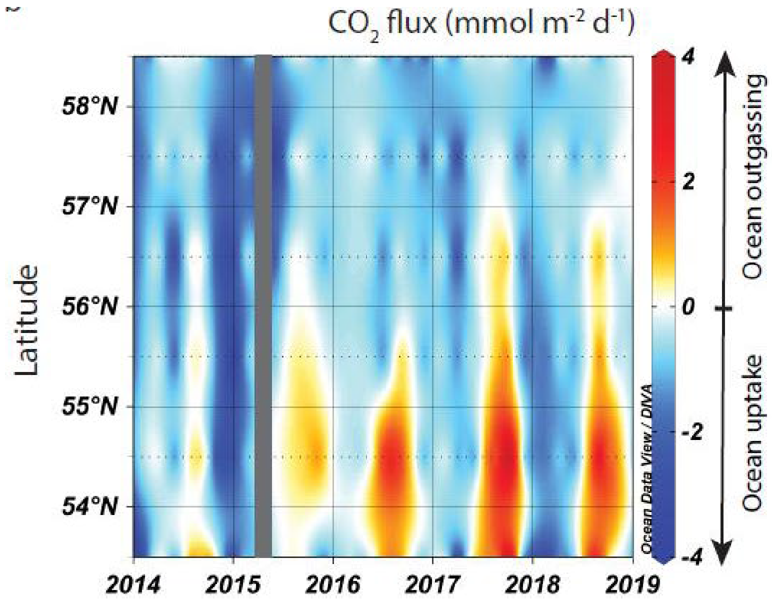
ΔpCO_2 in 2001



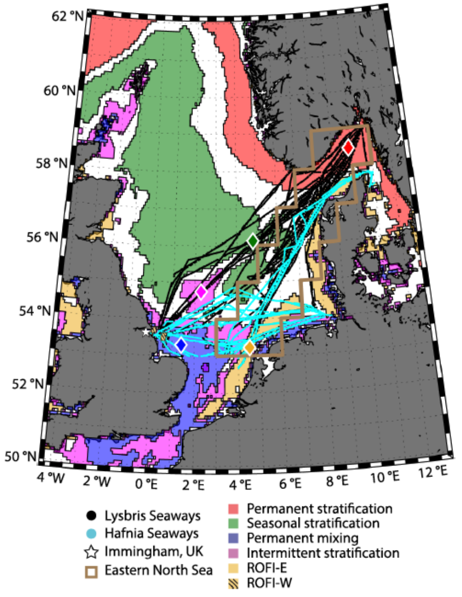
Thomas et al., 2007

Changes in ΔpCO_2 2005-2001

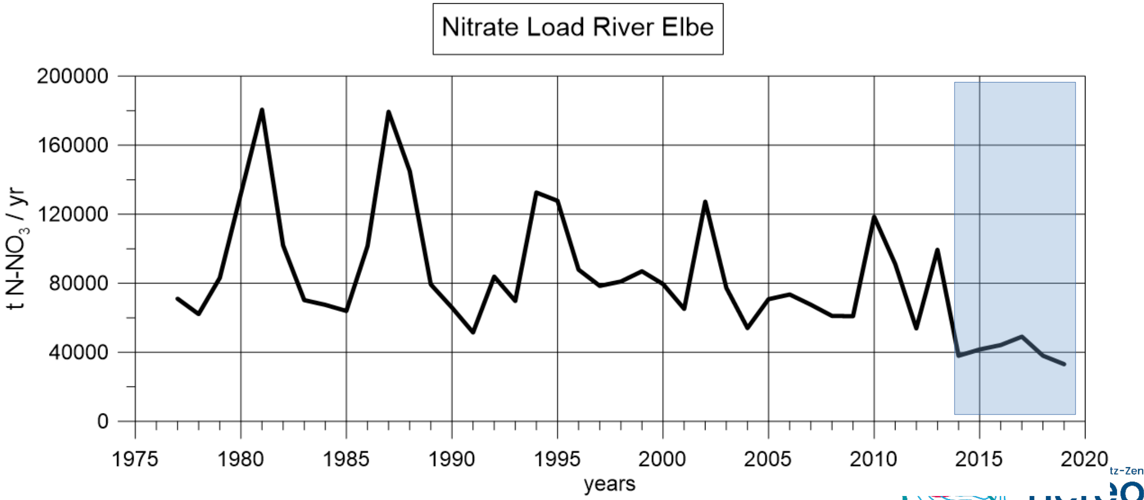




2014 2019



Macovei et al., 2021



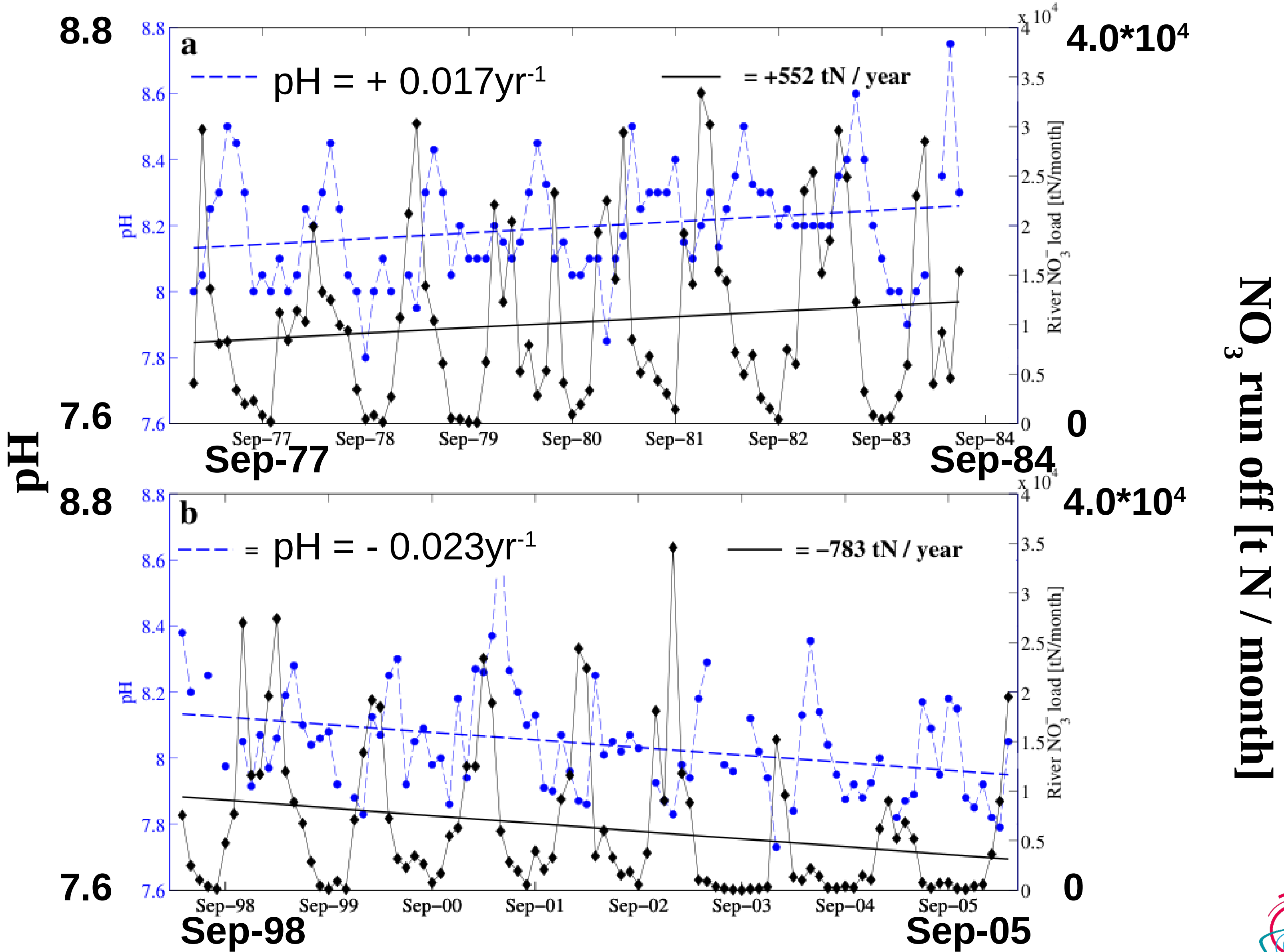
Declining CO_2 uptake? Trend or Variability?

Both in the North Sea and the North Atlantic?

Trend or variability?

Vulnerability and Manageability

<u>One example:</u>
Eutrophication and CO_2/pH conditions

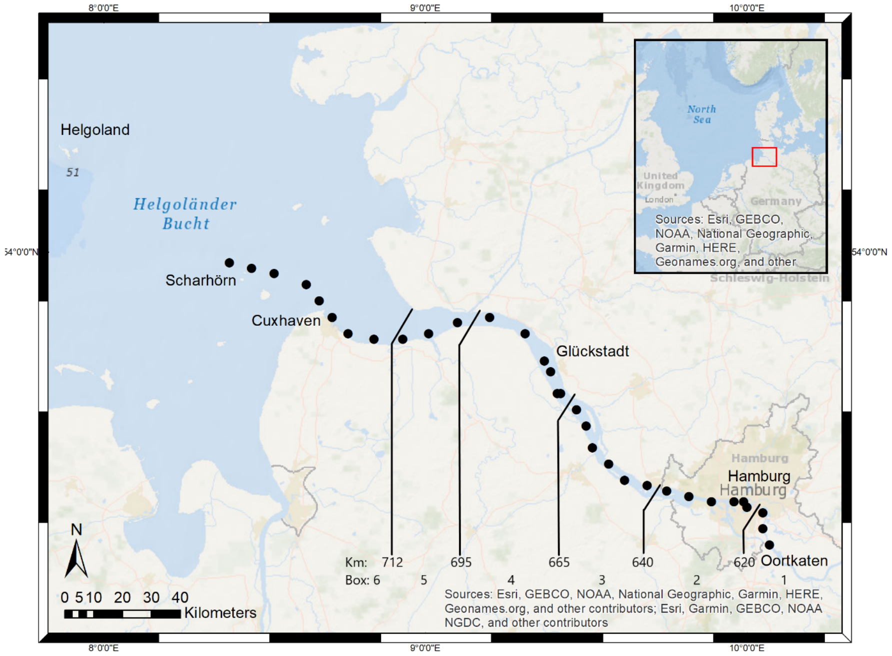


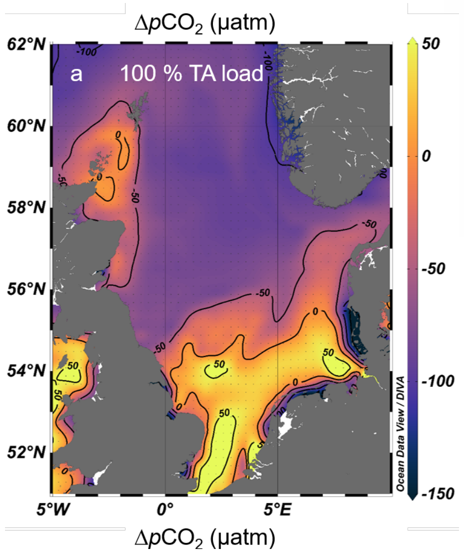
<u>For comparison:</u>
Open ocean pH *<u>decreases</u>* approx. 0.001-0.003 yr^{-1}

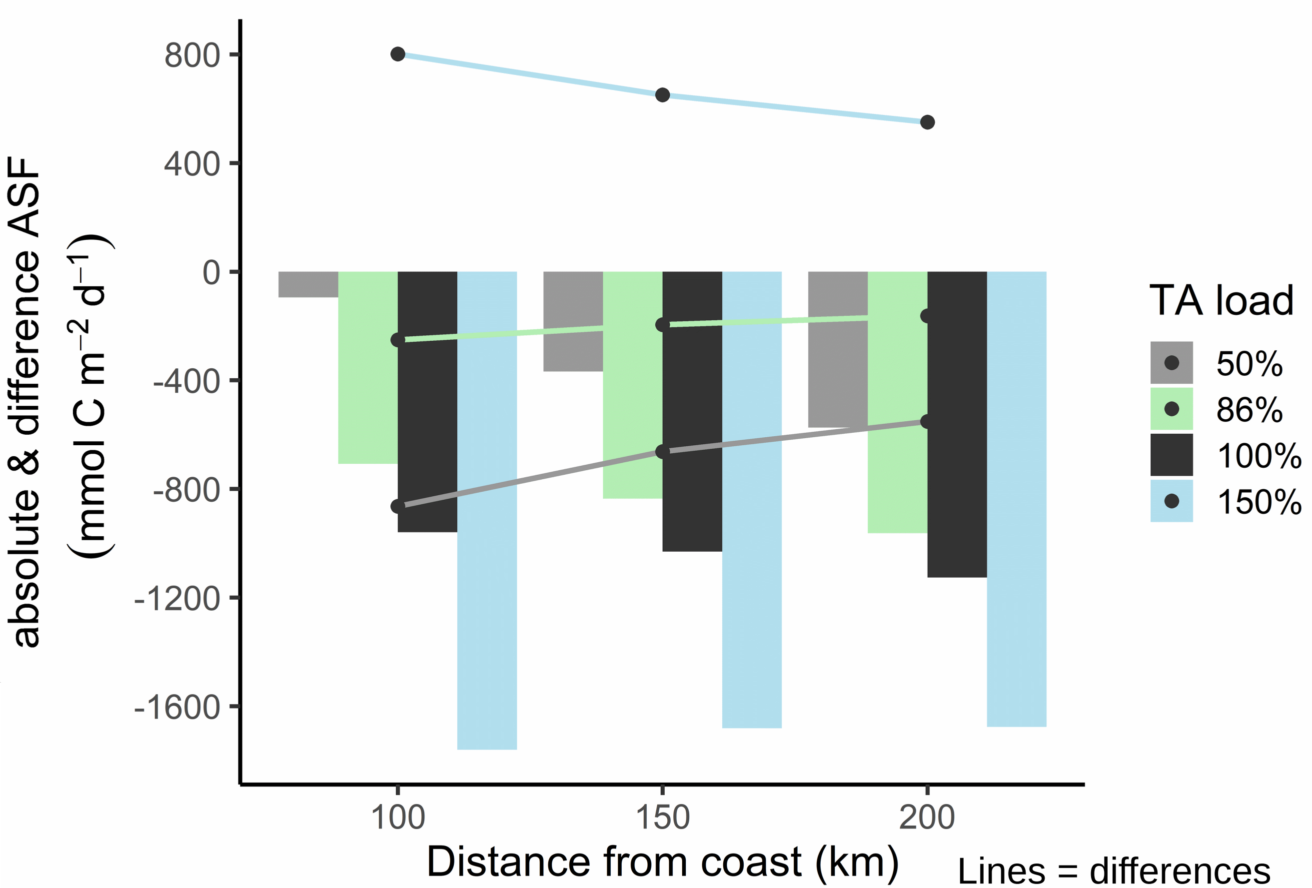
Burt , Thomas… et al., 2016, NO3 run-off: Pätsch and Lenhardt, 2011, pH after Provoost et al., 2010

Deliberate human control

Vulnerability and Manageability - alkalinity input from rivers







Lines = differences
Bars = absolute changes

M. Norbisrath, PhD thesis

Deliberate human control

Thank you very much for your attention!

Helmuth Thomas
Institute of Carbon Cycles
Max-Planck-Straße 1
21502 Geesthacht
helmuth.thomas@hereon.de

www.hereon.de