

12th FerryBox Workshop
1-2 October 2024, Helsinki



SEASONAL VARIATIONS OF SURFACE PH AND PCO₂ IN THE BALTIC SEA AND THE KATTEGAT-SKAGERRAK - OBSERVATIONS FROM FERRYBOX SYSTEMS

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Anna Willstrand Wranne
– Voice of the ocean foundation (VOTO)

R/V Svea

Lenght over all 69.5 m
Breadth moulded 15.8 m
Total people: 28 persons
Crew: 9 – 15



Design and specification: 2015 – 2016
Built at Armon Shipyard, Vigo Spain 2017 – 2019
Launched: July 2018
Delivered: July 2019
First SMHI expedition: December 2019

Owner: SLU, Swedish University of
Agricultural Sciences
Management: Swedish Maritime
Administration
Main users: SLU Aqua (fish survey) and SMHI
(environmental monitoring)



R/V Svea FerryBox

SMHI

Sensors/Instruments

- Temperature, SBE45 & 38
- Salinity, SBE45
- Oxygen, Aanderaa optode
- **HydroFIA-pH, spectrophotometric pH**
- **HydroC, pCO₂**
- Chlorophyll fluor, Wetlabs
- Turbidity, Wetlabs
- Phycerythrin fluor, Turner 7F
- CDOM fluor, Trios NanoFlu
- Phycocyanin fluor, Trios NanoFlu
- IFCB, McLane
- Automated water sampling, MAXX Sampler
- 4HSampler for automatic filtration of litter, zooplankton etc...



SOOP M/V Tavastland

SMHI

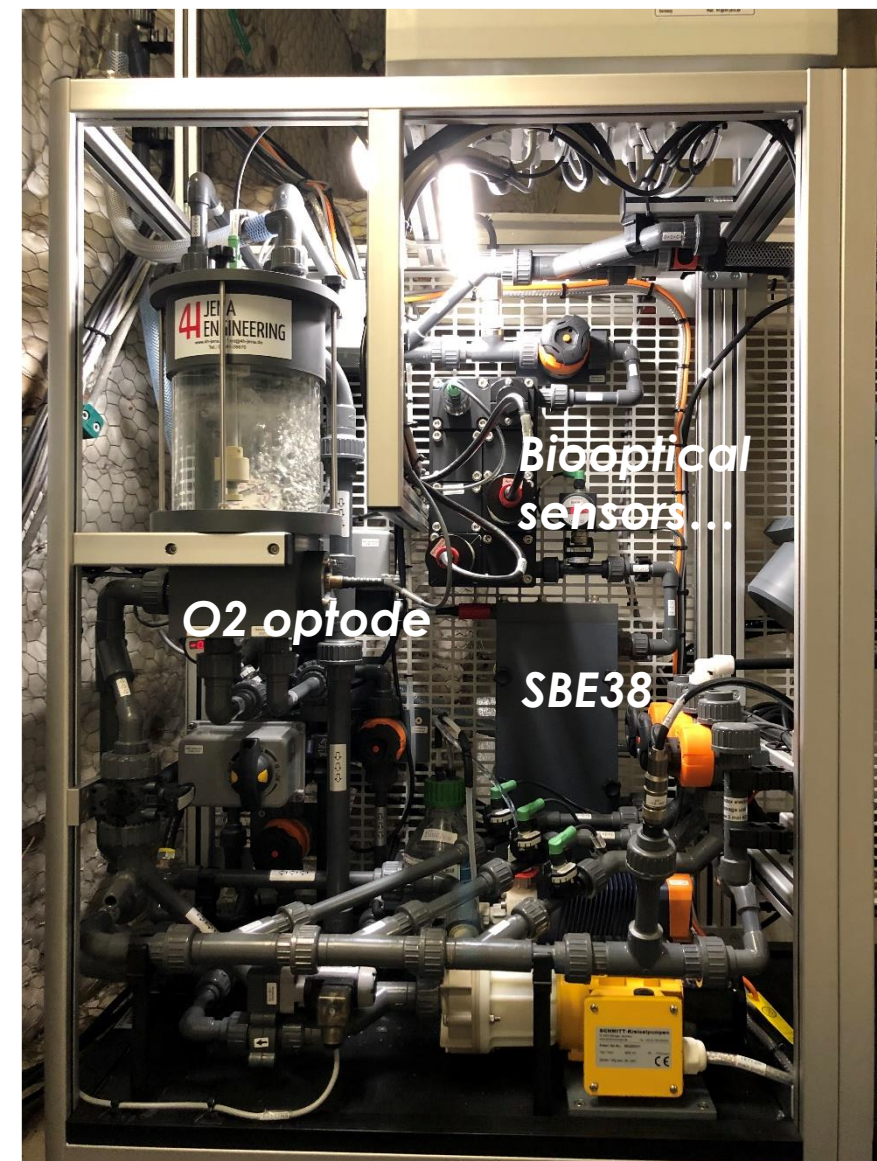
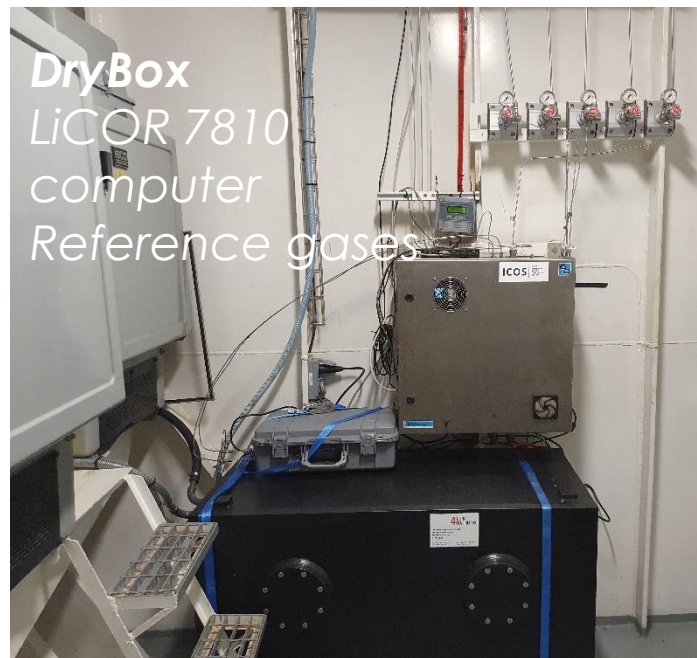
- Route (Oulu, Finland to Lübeck, Germany)
- Upgrade of pCO₂ system completed:
LiCOR 7810
- pCO₂ and CH₄
- Labelling step 2





M/V Tavastland FerryBox

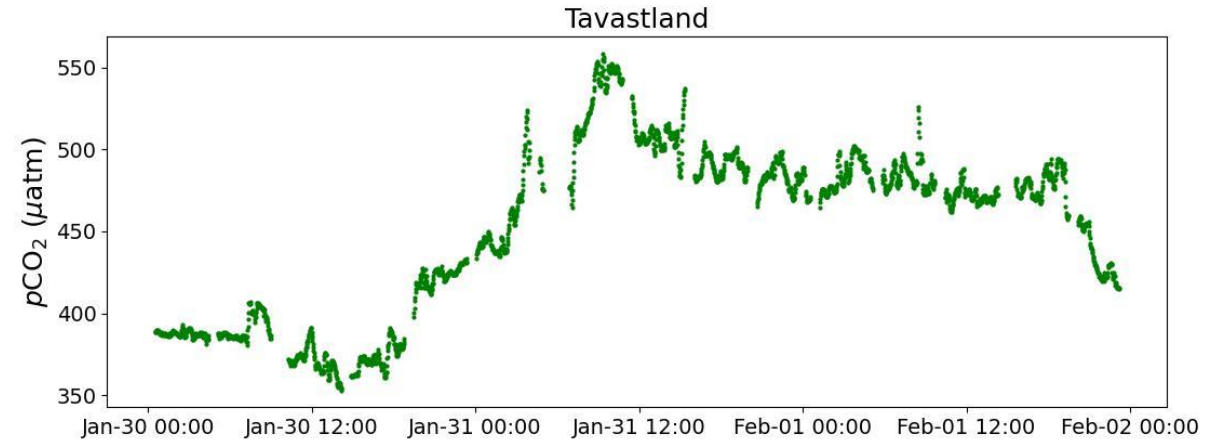
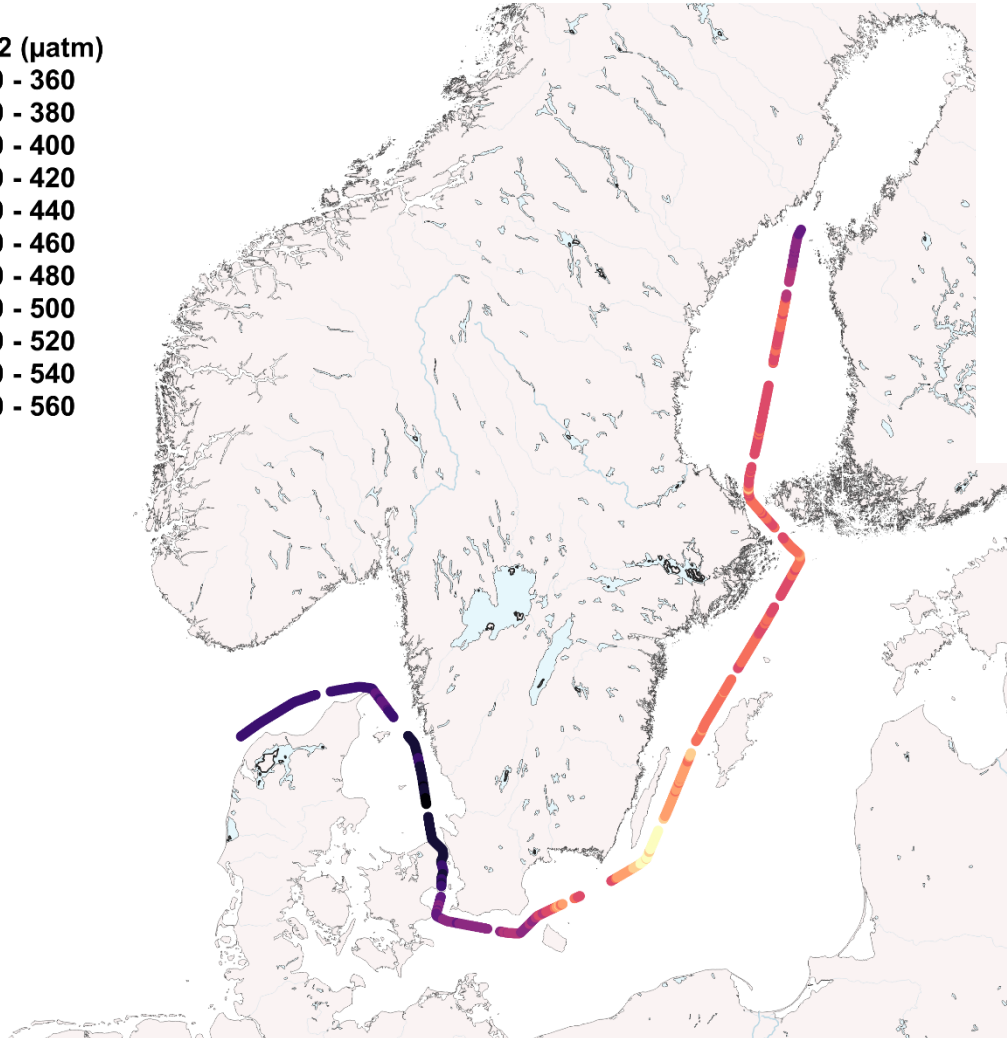
- pCO₂ General Oceanics
- ... and more

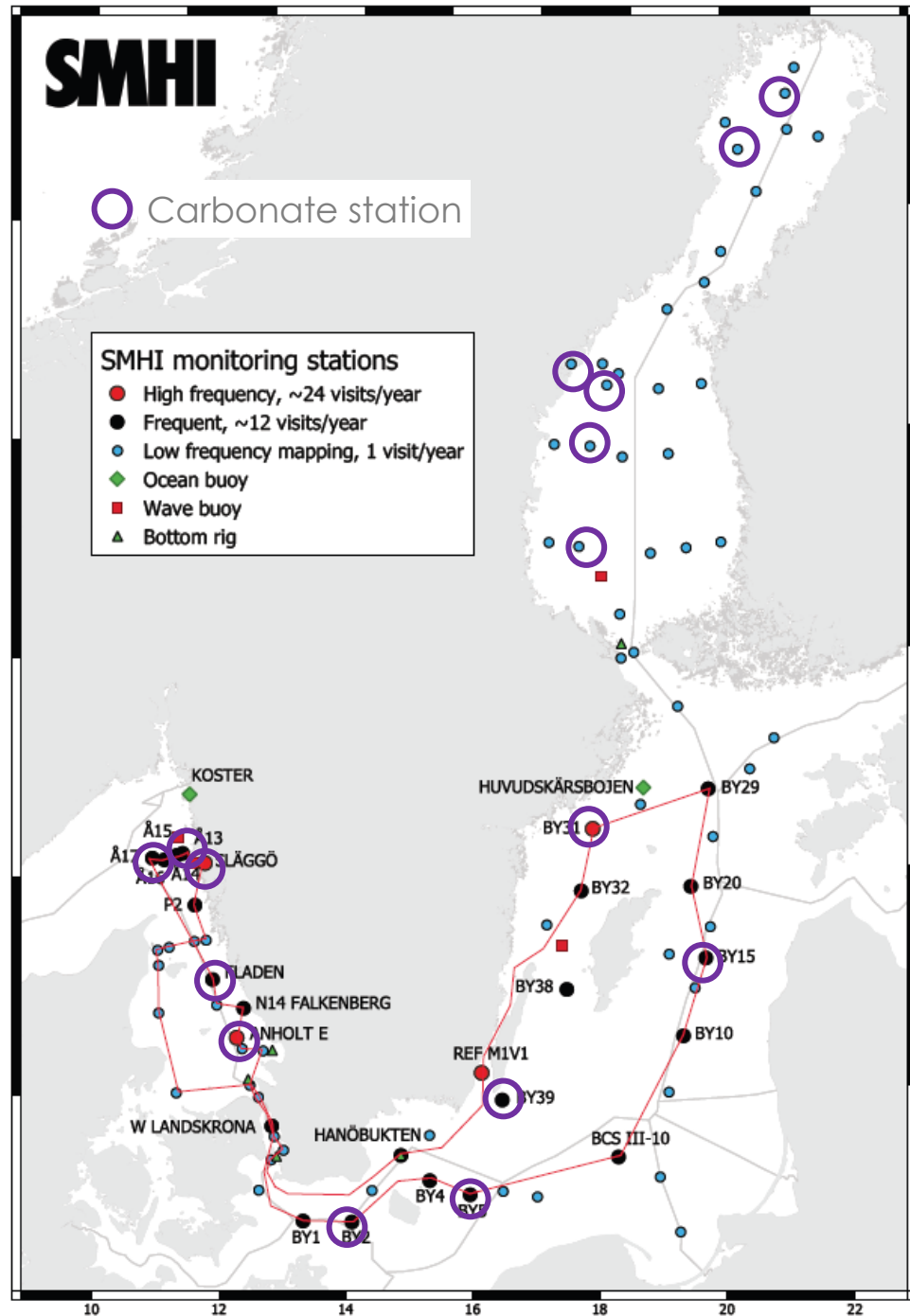


Example data from M/V Tavastland

pCO₂ (µatm)

- 350 - 360
- 360 - 380
- 380 - 400
- 400 - 420
- 420 - 440
- 440 - 460
- 460 - 480
- 480 - 500
- 500 - 520
- 520 - 540
- 540 - 560



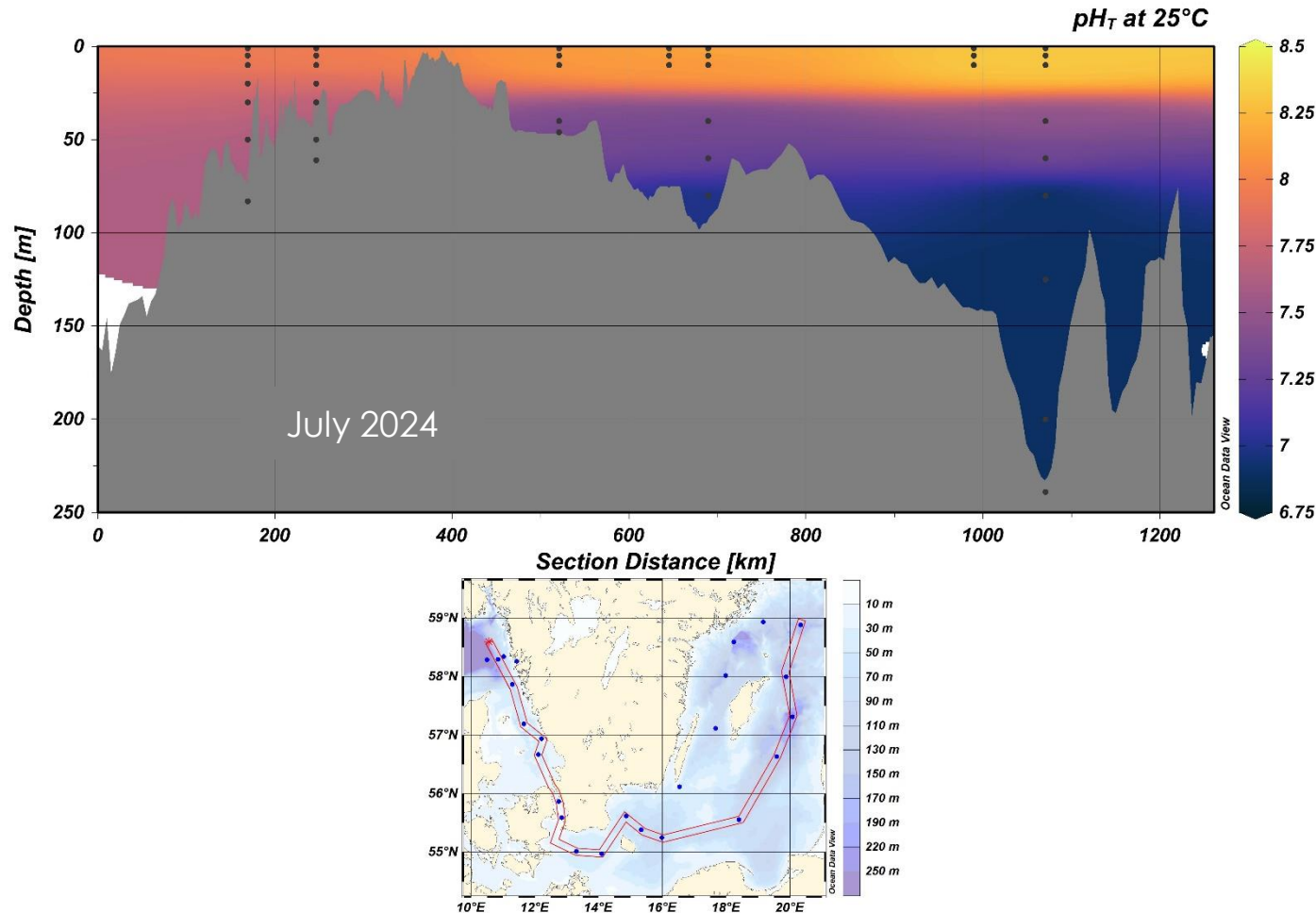


Monitoring program

News and Improvements:

- Increased number of stations for carbonate parameters
all basins represented
- New method implemented:
spectrophotometric pH (pH-T)
- Underway measurements of pH-T and pCO₂ (and other param) between stations using FerryBox
- Underway vertical profiles of temp, salinity and oxygen using Moving Vessel Profiler (MVP)

Example of pHT from discrete water samples



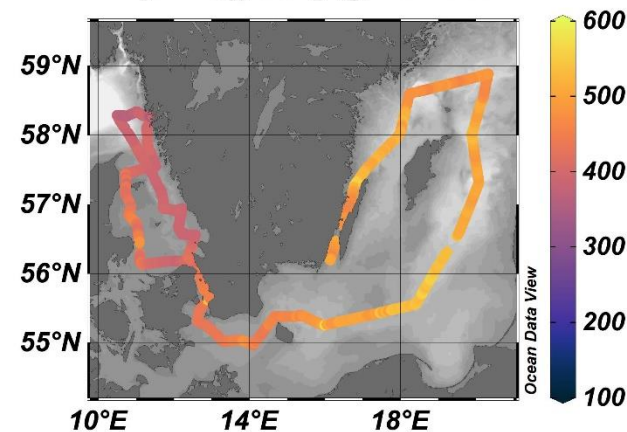
- pH in the Baltic Sea show large variations – both vertical and lateral
- Primary production – higher pH in the surface water
- Anoxic deep waters rich in decay products – lowers pH
- Extreme pH variability – challenges regarding methodologies
- Variations with depth will not be seen with FerryBox...

Winter

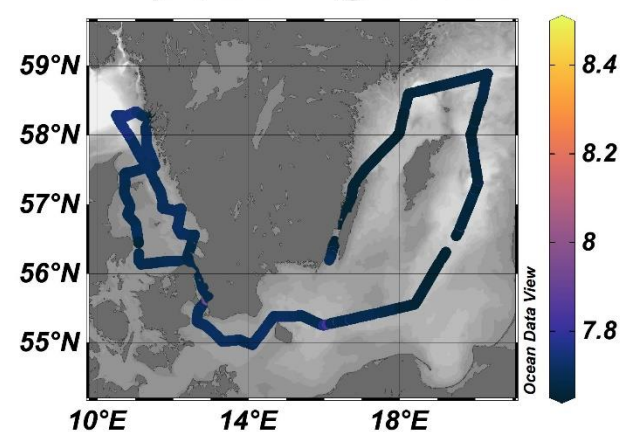
The high pCO₂ concurs with
low pH

Surf water pCO₂ > atm pCO₂
- Source to atm

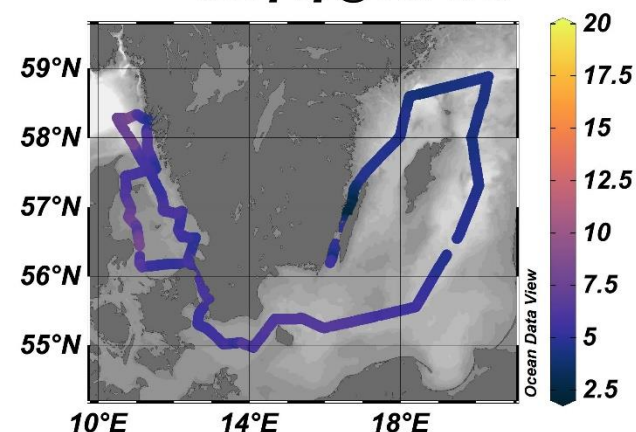
pCO₂ [μatm] @ 4 m=first



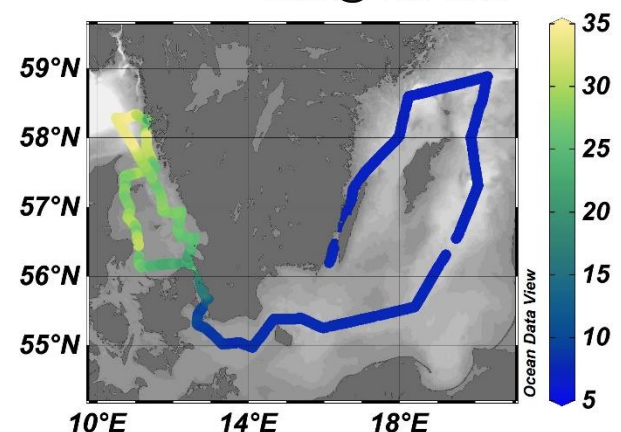
pH_T at 25°C @ 4 m=first



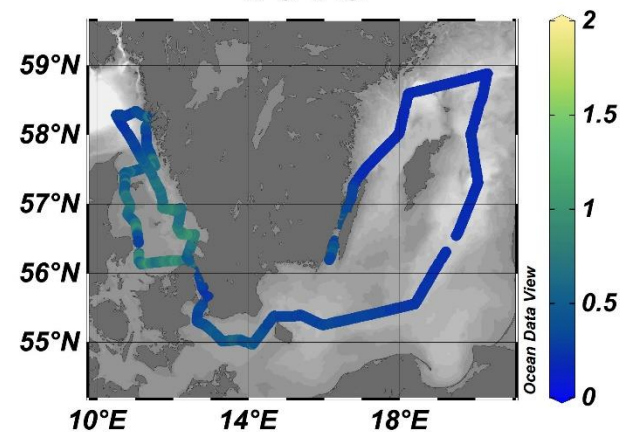
SST [°C] @ 4 m=first



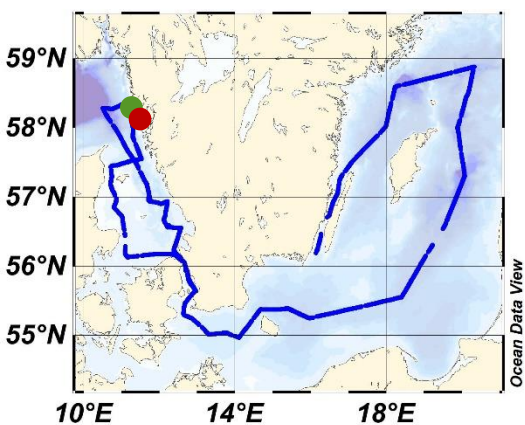
SSS @ 4 m=first



CHLa [μg/l] @ 4 m=first



FerryBox data from
Svea January 2023



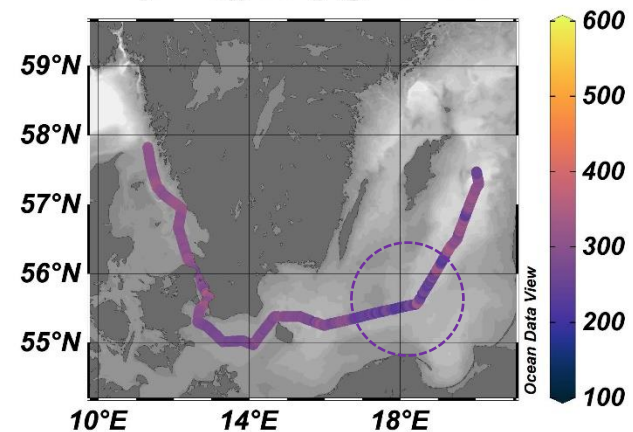
Spring

pCO₂ decreases

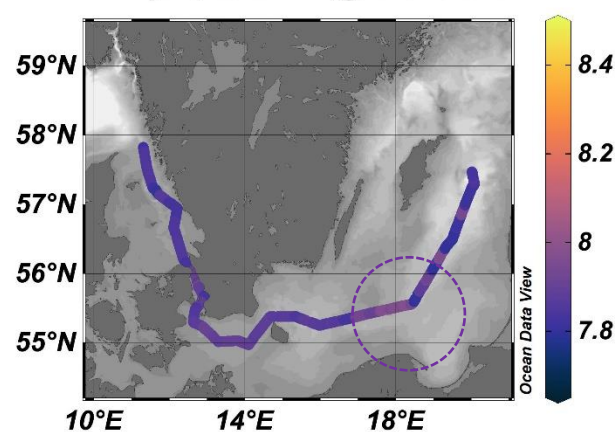
pH increase due to
consumption of CO₂ in primary
production

surf water pCO₂ < atm pCO₂
- Sink for atm

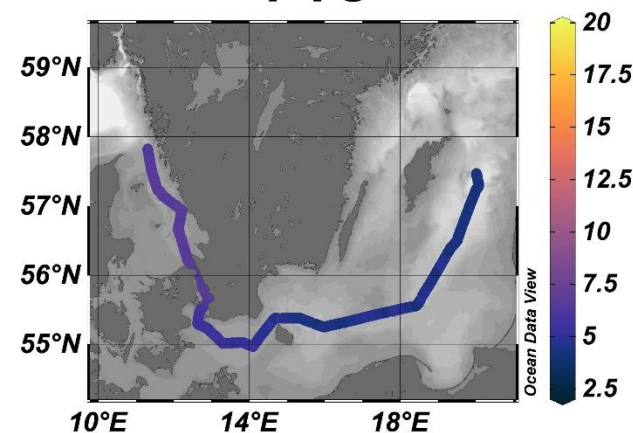
pCO₂ [μatm] @ 4 m=first



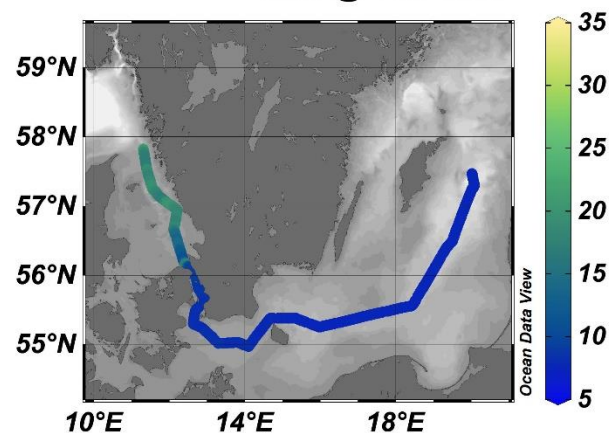
pH_T at 25°C @ 4 m=first



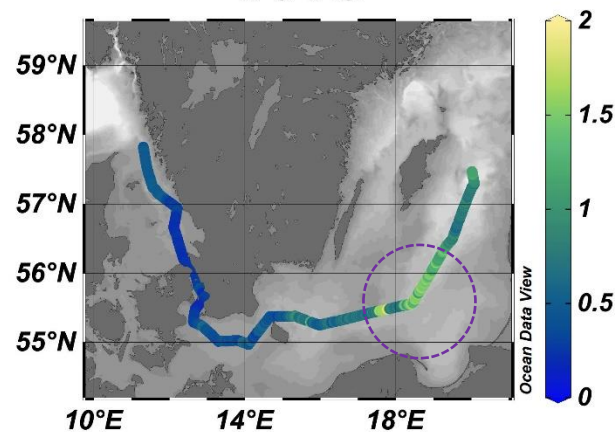
SST [°C] @ 4 m=first



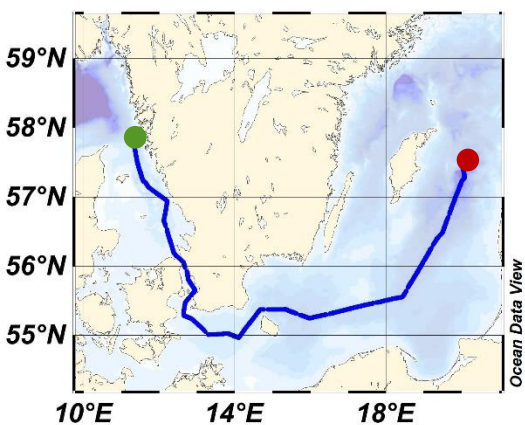
SSS @ 4 m=first



CHLa [μg/l] @ 4 m=first



FerryBox data from
Svea April 2023



Summer

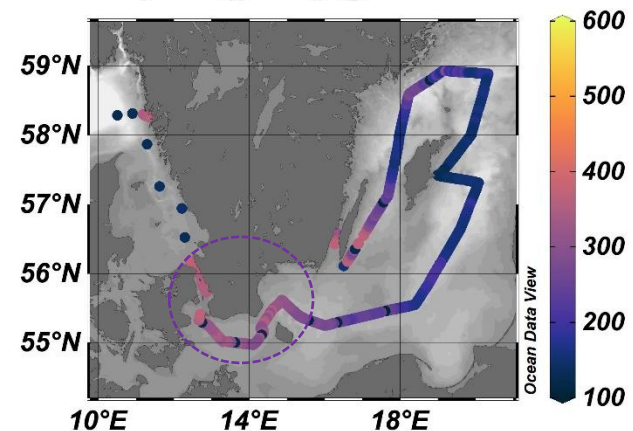
Some regions have replenished some of the CO₂

- source of CO₂ to the atm

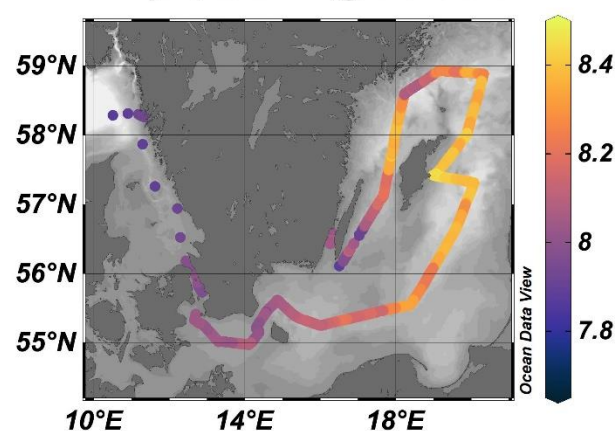
Late blooms still affecting some regions,

- sink of CO₂ for the atm

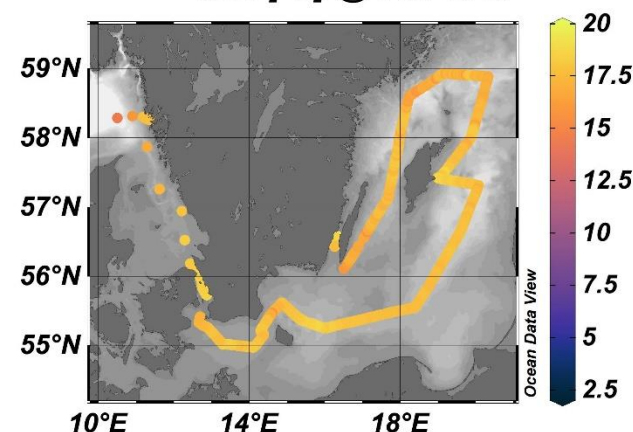
pCO₂ [μatm] @ 4 m=first



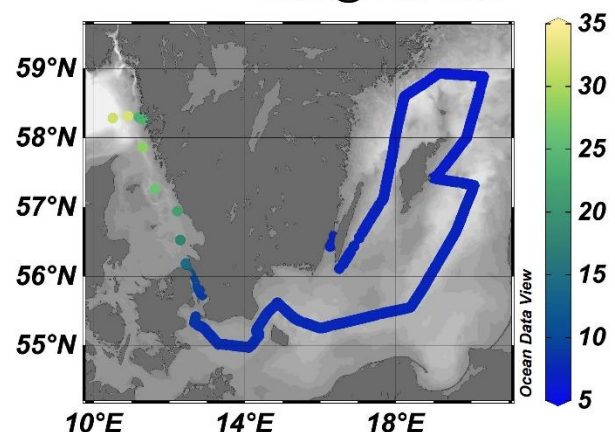
pH_T at 25°C @ 4 m=first



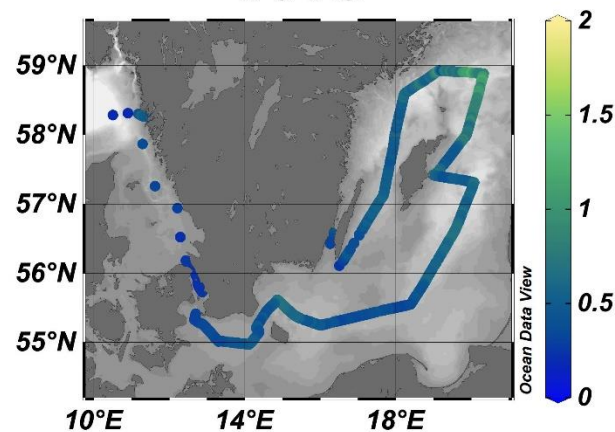
SST [°C] @ 4 m=first



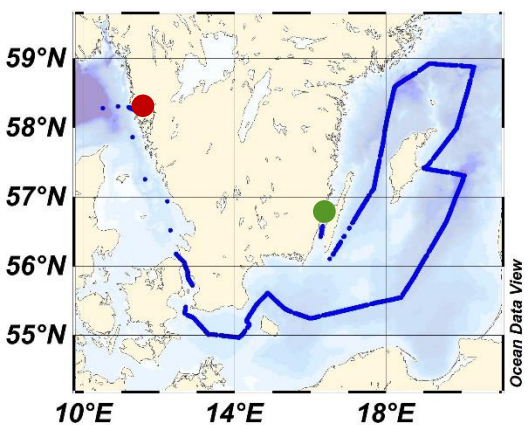
SSS @ 4 m=first



CHLa [μg/l] @ 4 m=first



FerryBox data from Svea July 2023



Autumn

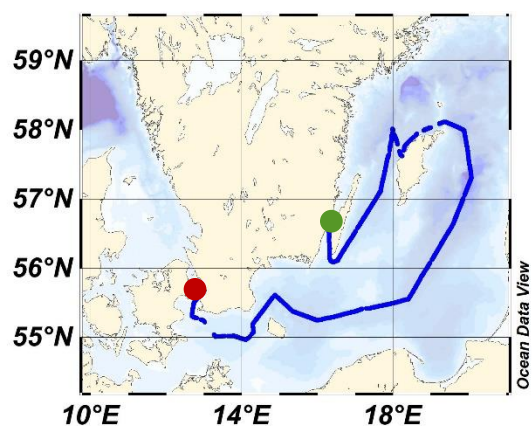
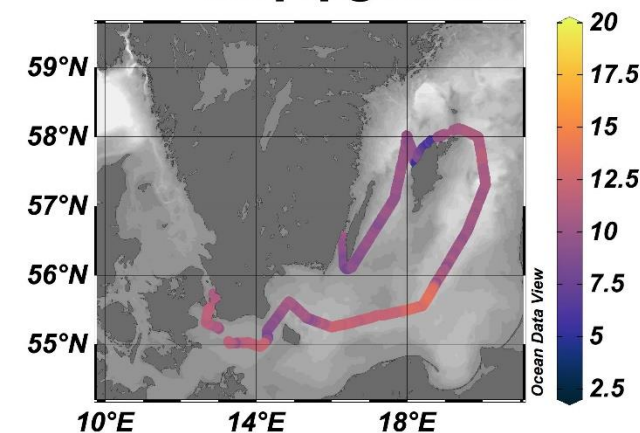
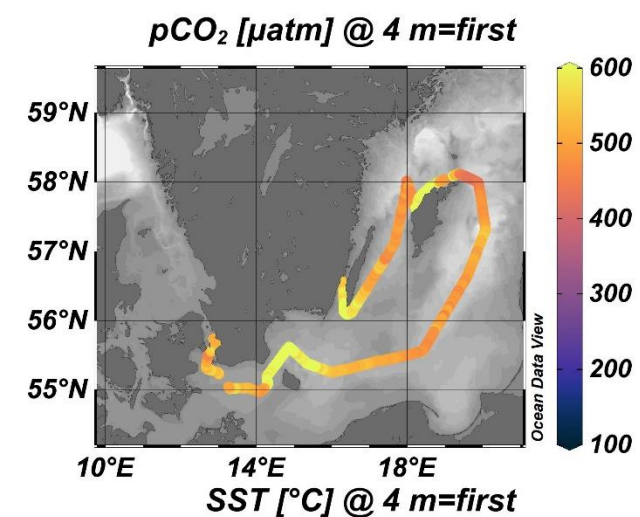
Increase in pCO₂

Decrease in pH

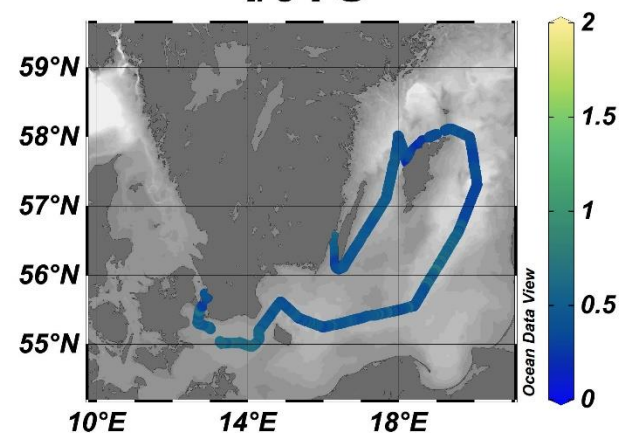
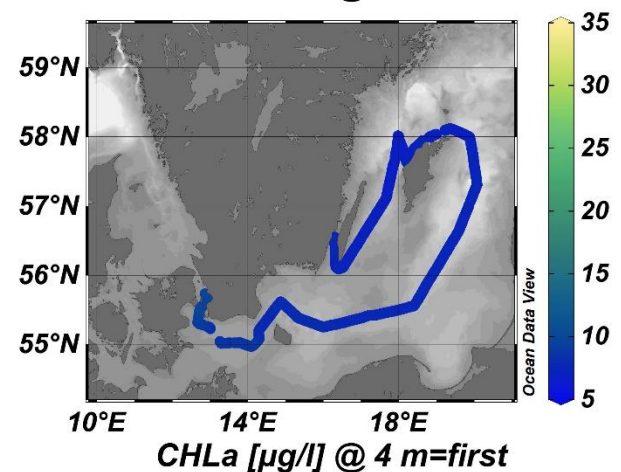
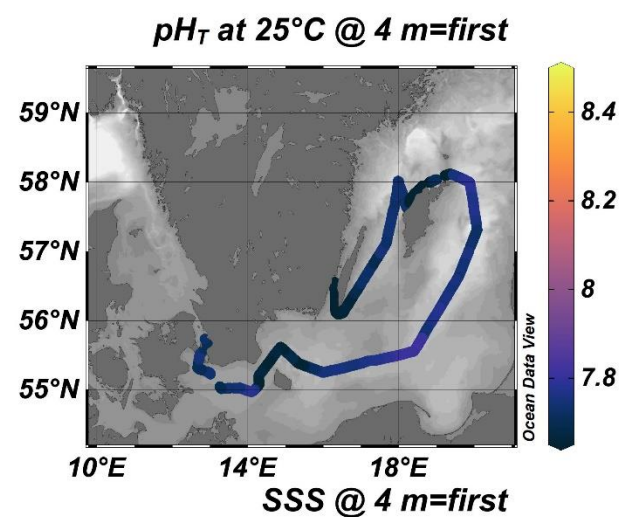
Surf water pCO₂ > atm pCO₂
- source to the atm

Highest observed pCO₂
(600 μ atm) for the year.

Storm Babet?

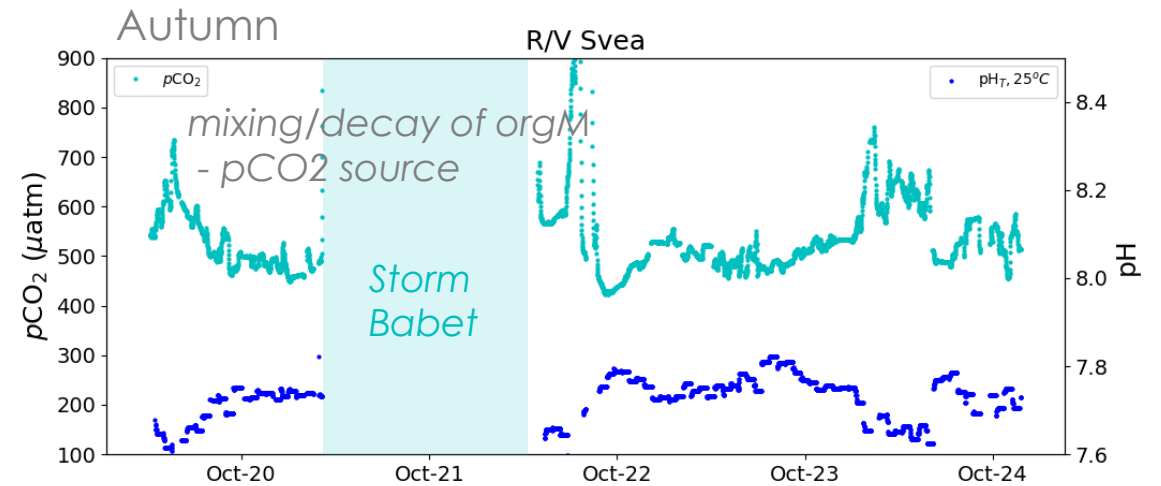
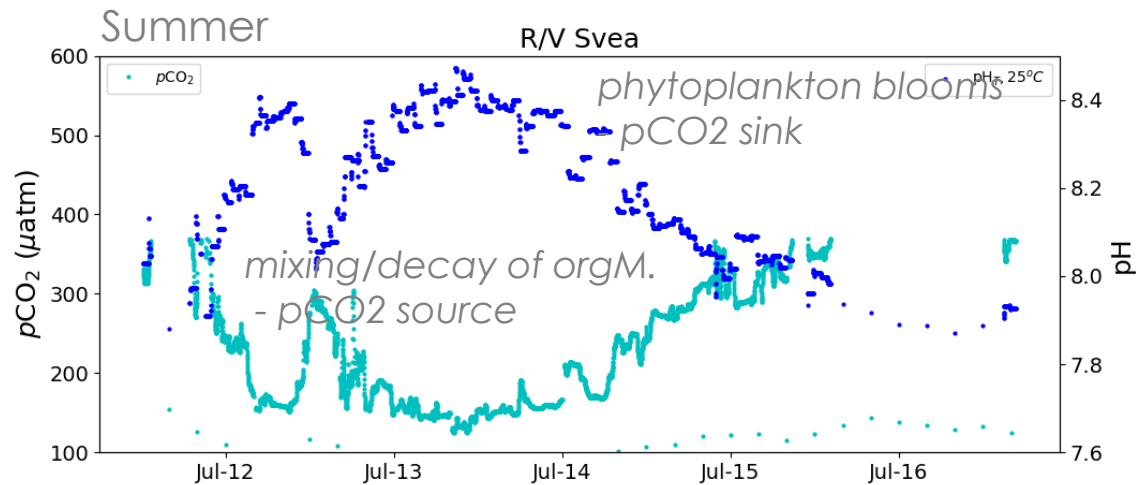
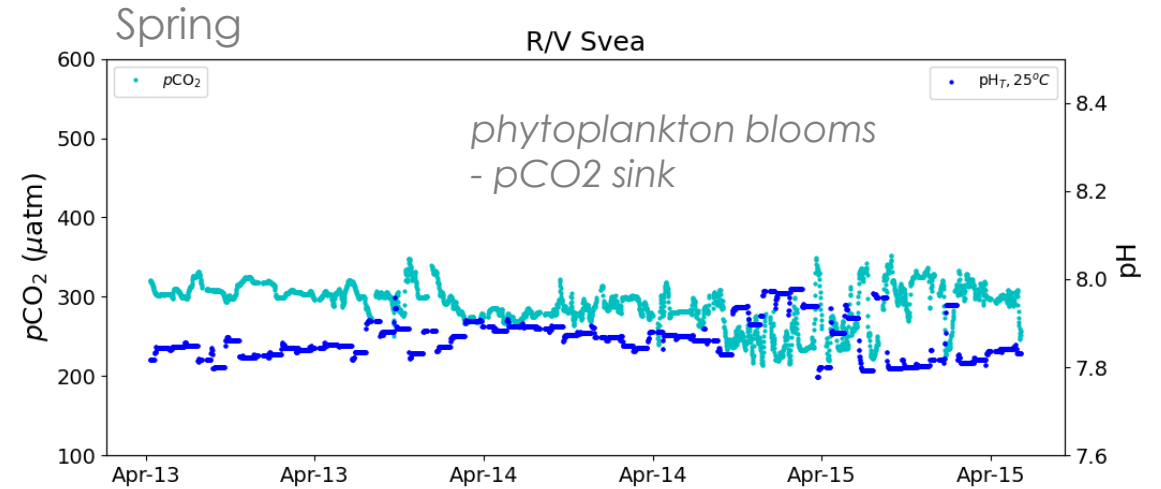
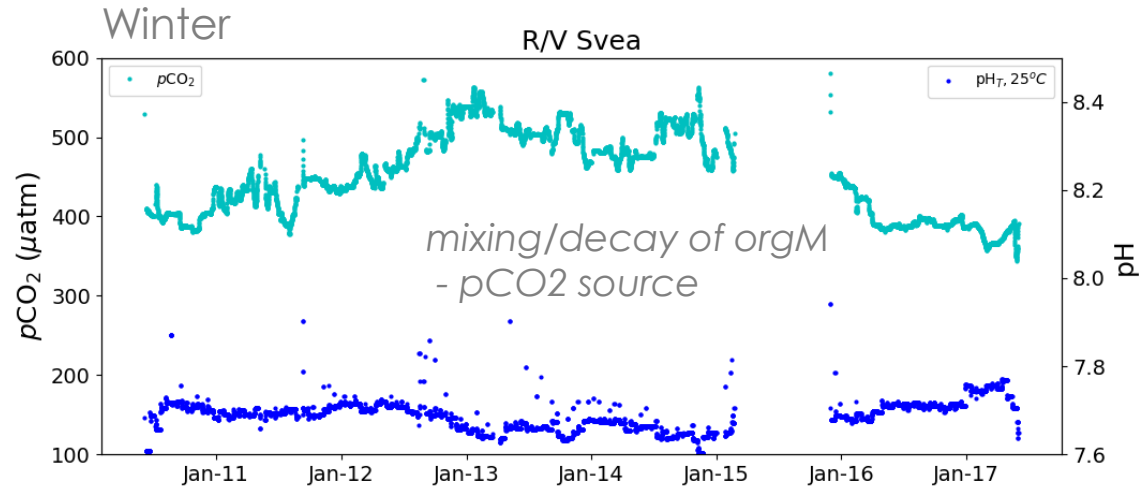


FerryBox data from
Svea October 2023



Seasonal variations in pH and pCO₂

SMHI



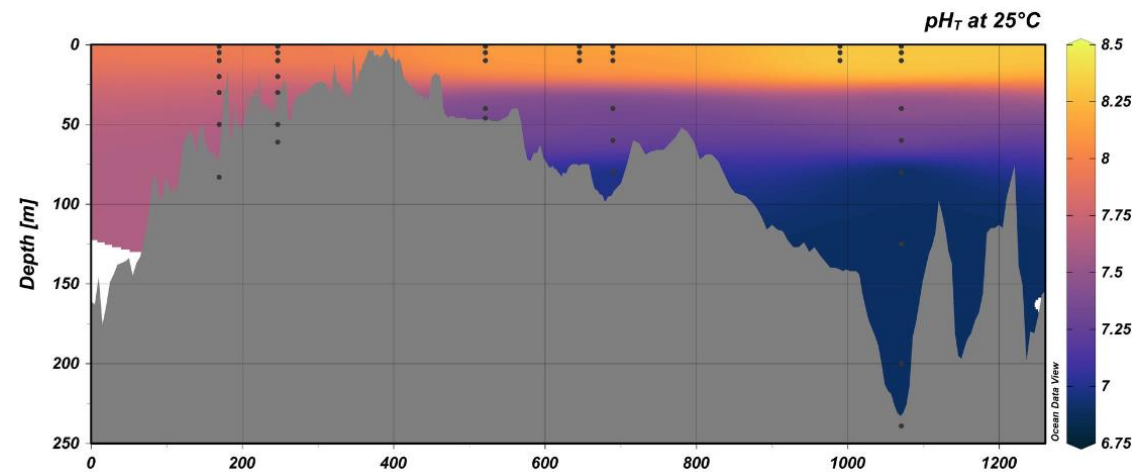
Highest pCO₂

Summary and conclusions

pH and pCO₂ in the Baltic Sea and Kategatt-Skagerrak are highly variable in both time and space. High-resolution data is needed to explore these variations.

Mixing/upwelling of deep waters have large impact on the pH and pCO₂ dynamics as seen after the storm event Babet. Importance of monitoring also deep water.

Improvements in monitoring of carbonate parameters are giving results



*Partners and
funding sources:*

FORMAS 

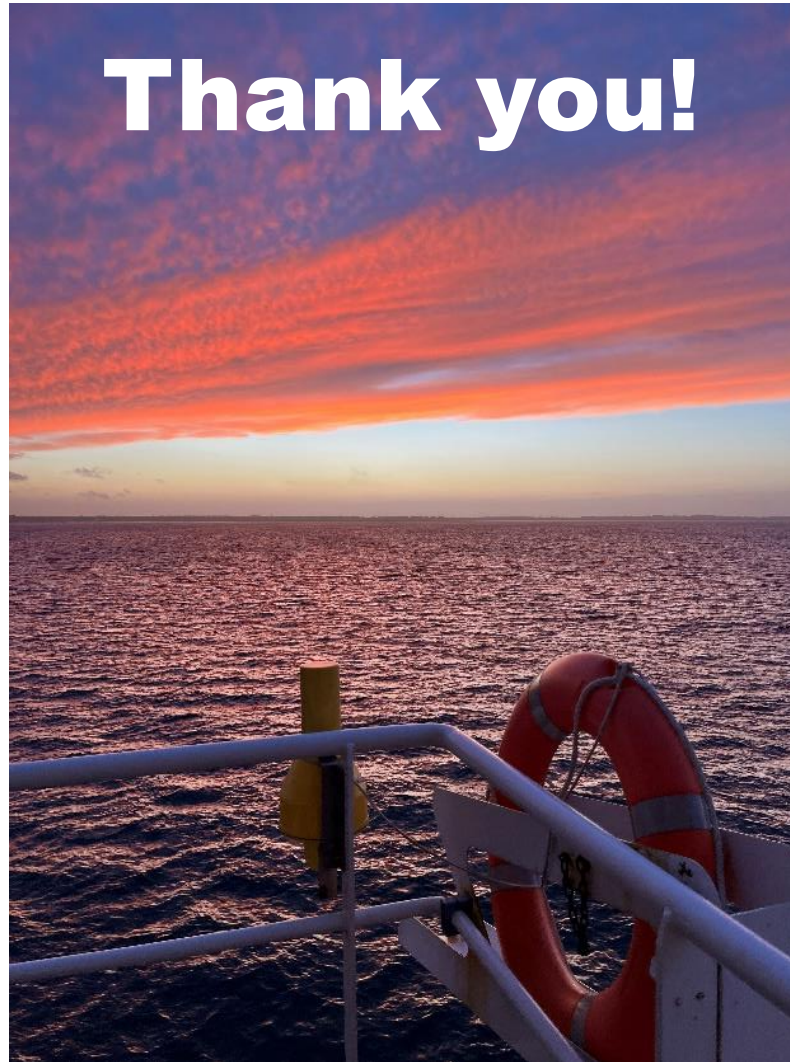
 Vetenskapsrådet

ICOS |  National
Network
Sweden

WALLENIOUS  SOL®

 JERICOS₃
SCIENCE - SERVICES - SUSTAINABILITY

Thank you!



madeleine.nilsson@smhi.se

SMHI

 Voice of the Ocean




SLU

 Copernicus
Marine Service

Swedish Agency
Marine and
Water Management

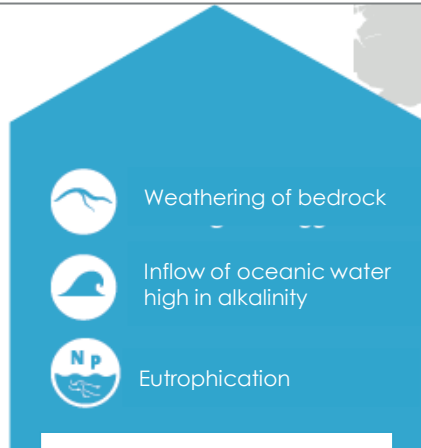
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pH variability in the Baltic Sea

Differences in salinity, catchment area and type of bedrock

Production and degradation of organic matter

eutrophication



pH +
Ocean
Acidification
decrease

