

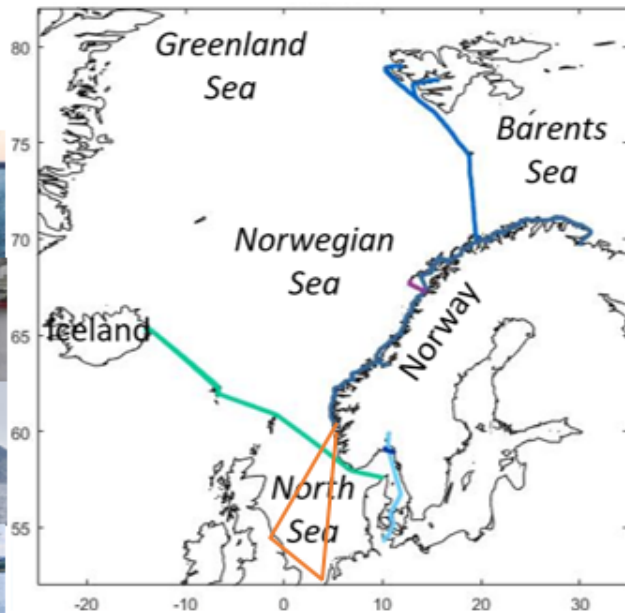
Variation in organic carbon along Norwegian coastline based on FerryBox monitoring

11th FerryBox Workshop 28-29 September 2022 Helmholtz-Zentrum Hereon
Geesthacht, GERMANY

Helene Frigstad, Therese Harvey, Louise Valestrand,
Caroline Mengeot, Amanda Poste, Elizaveta Protsenko,
Kai Sørensen, Pierre Jaccard, Andrew King



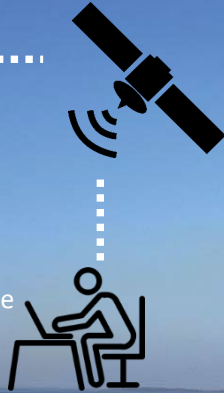
NorSOOP: Norwegian Ships of Opportunity Program



- NIVA (lead), HI, Akvaplan-niva, Met NO
- NFR INFRASTRUKTUR (2018-2023; 26.5 mNOK)
- Cruise ships, container ships, ferries equipped with scientific equipment
- Four existing lines will be upgraded
- Three new FerryBox lines will be established (Denmark-Faroe-Iceland, Lofoten Islands, and North Sea)
- Cutting edge marine and atmospheric sensors and samplers will be developed
- Marine instruments will cover biological, chemical, and physical variables, including ocean acidification variables

NorSOOP: Norwegian Ships of Opportunity program for marine and atmospheric research

Remote sensing validation



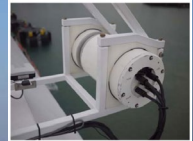
Satellite communication
(for data transfer and remote control)



Meteorological station



Light and reflectance sensors

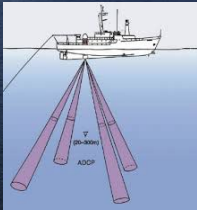


Downward-looking sensors
(sea surface skin temp, LIDAR, etc.)



FerryBox (essential ocean variables + others)

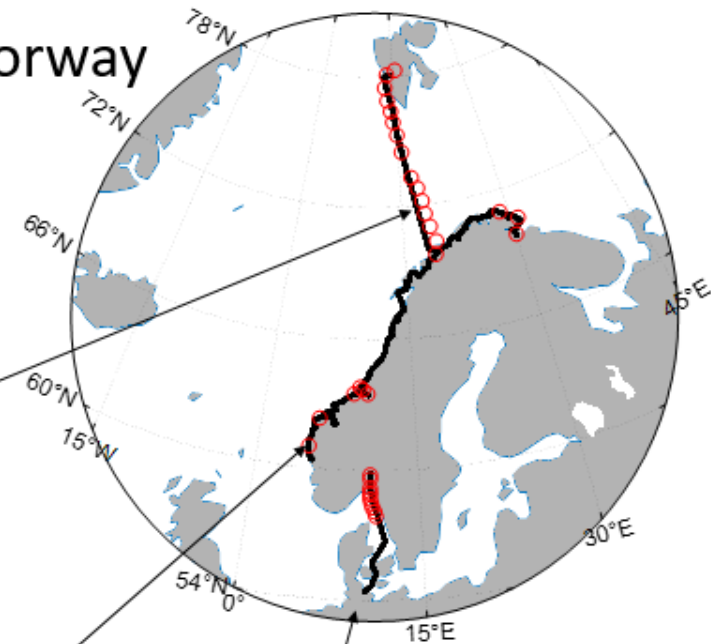
Towed or hull-mounted instruments
(continuous plankton recorder, current meters)



- Ocean observations that range from ocean salinity and temperature to microplastics and pollutants
- Presently five operational “FerryBoxes” on cruise and container ships
- Covering almost all of coastal Norway, parts of the Arctic Ocean and North Atlantic Ocean
- New and novel equipment being installed and developed through various related NFR and H2020 projects

National monitoring using FerryBox in Norway

- Ecosystem monitoring of Norwegian coastal waters (ØKOKYST) for Water Framework Directive
 - Underway measurements and discrete samples for water quality on MS Trollfjord, Color Fantasy, and Norbjørn
- Ocean acidification monitoring
 - Underway measurements (pCO_2 , pH) and discrete samples (DIC, Alk) on MS Color Fantasy and Norbjørn



MS Norbjørn



MS Trollfjord

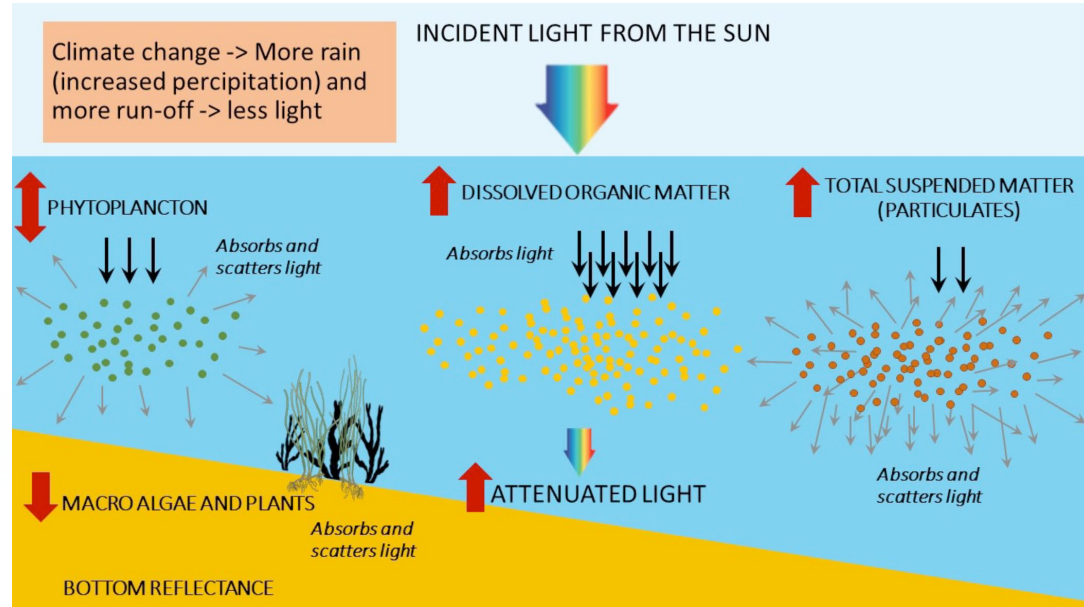


MS Color Fantasy



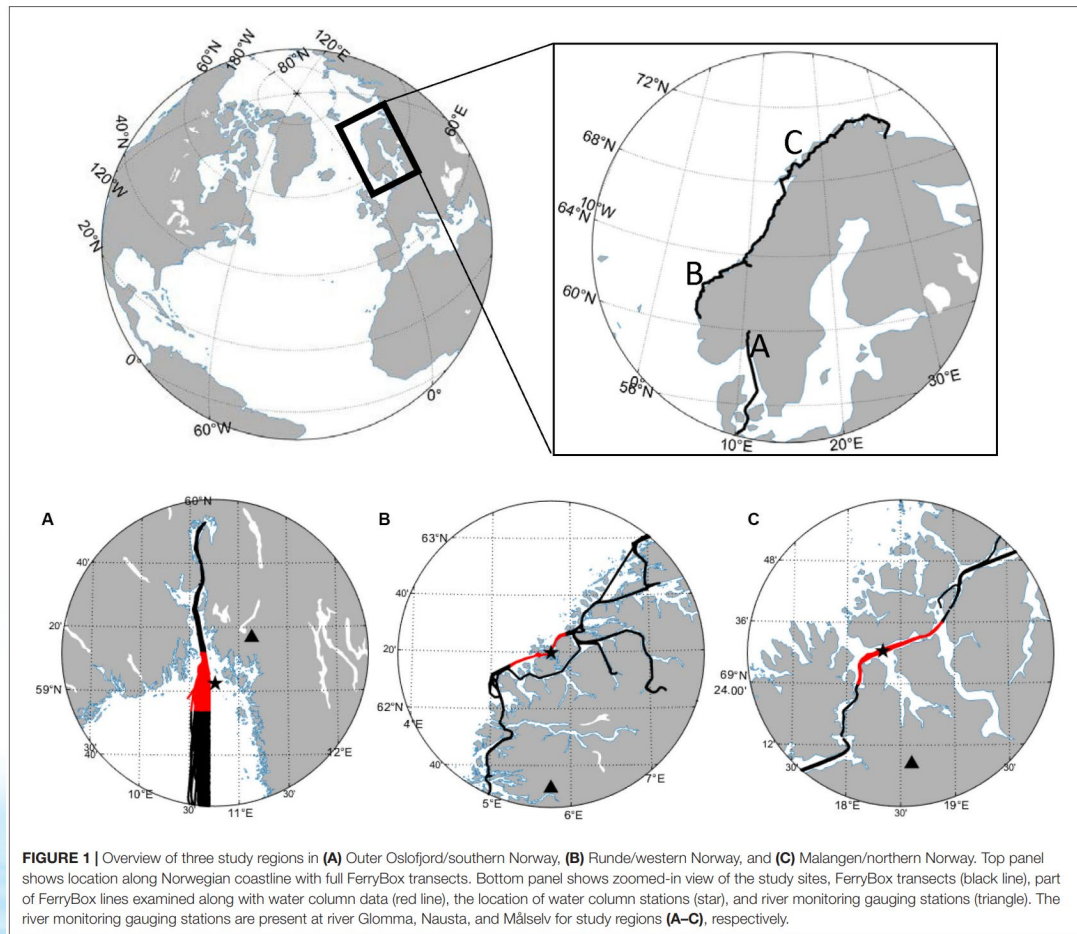
Understanding drivers and impacts of «Coastal darkening»

- Long-term increase in light attenuation of coastal waters
- Largely driven by increased riverine inputs of organic carbon
- Need to increase our understanding of coastal organic carbon dynamics and potential impacts



Frigstad, H. Harvey T, Deininger A and Poste A (2020) Increased light attenuation in Norwegian coastal waters - A literature review. Report for Norwegian Environment Agency M-1808.

Influence of Riverine Input on Norwegian Coastal Systems



Frigstad H, Kaste Ø, Deininger A, Kvalsund K, Christensen G, Bellerby RGJ, Sørensen K, Norli M and King AL (2020)

Influence of Riverine Input on Norwegian Coastal Systems. *Front. Mar. Sci.* 7:332. doi: 10.3389/fmars.2020.00332

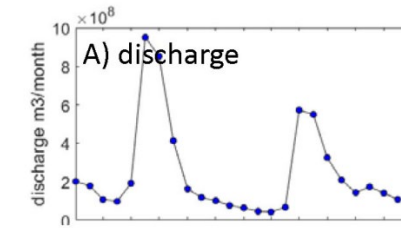
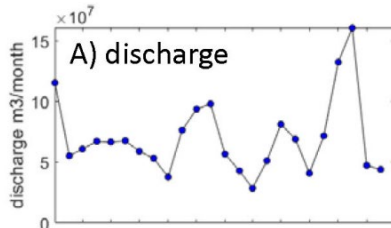
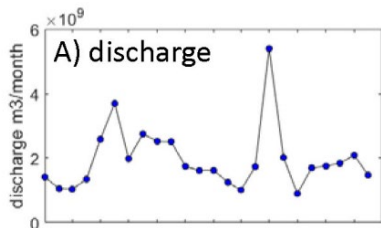
Impacts of freshwater inputs

A: Southern Norway / Oslofjord

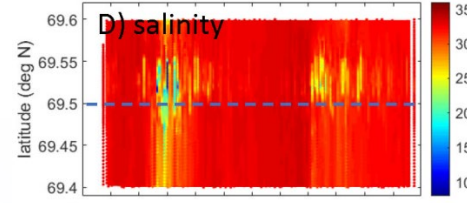
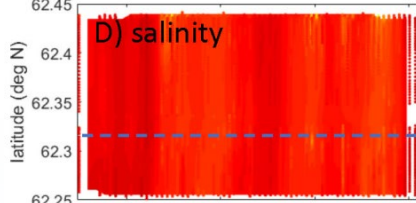
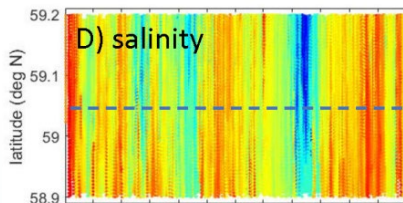
B: Western Norway / Runde

C: Northern Norway / Malangen

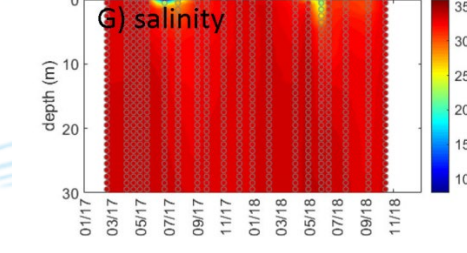
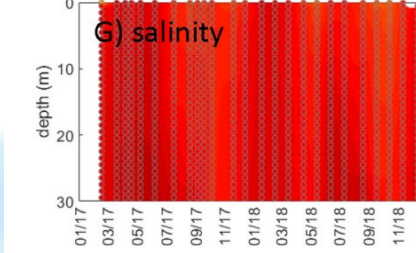
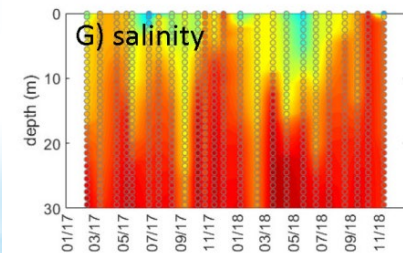
River station



FerryBox



Water column station



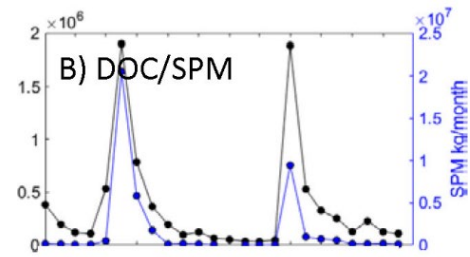
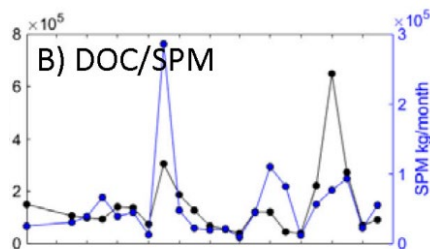
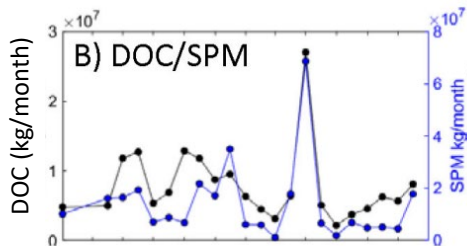
Impacts of terrestrial carbon inputs

A: Southern Norway / Oslofjord

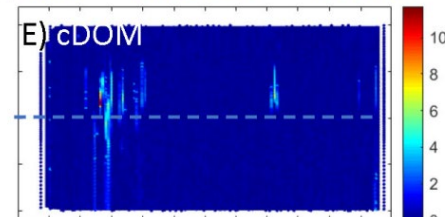
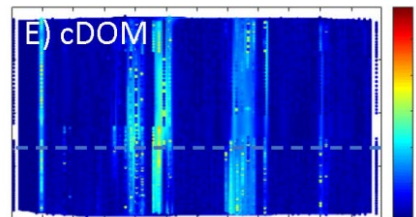
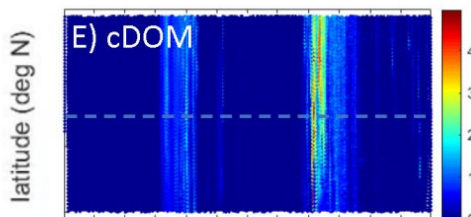
B: Western Norway / Runde

C: Northern Norway / Malangen

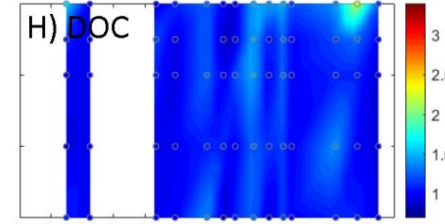
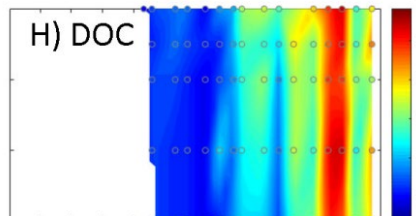
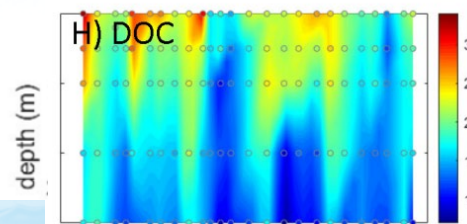
River station
fluxes



FerryBox



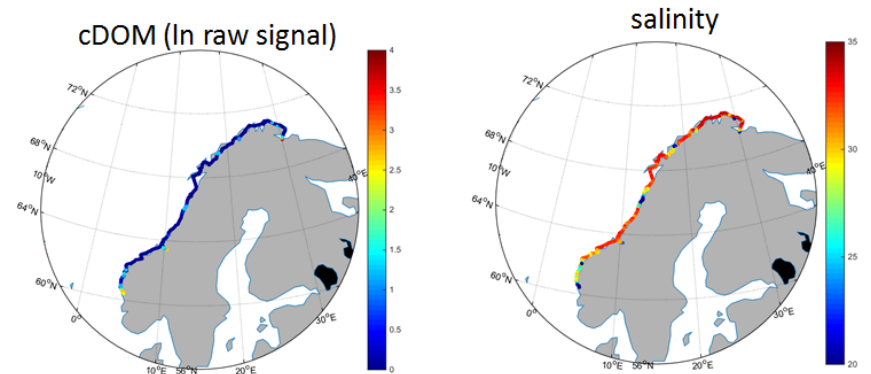
Water column
station



Ongoing studies on understanding organic carbon dynamics in Norway

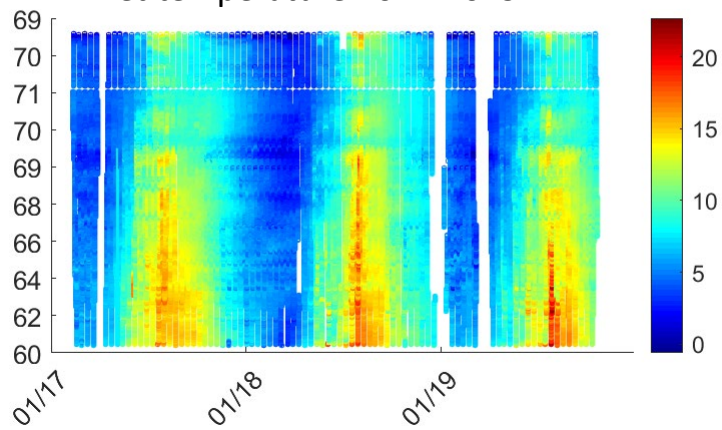
- Co-funded through NIVAs strategic initiative on «Global change on northern latitudes - NoLa»
- Main research questions:
 - ✓ What is the regional and seasonal variability in organic carbon (DOC and cDOM) along Norwegian coastline?
 - ✓ Are the observed cDOM hotspots a consistent feature both spatially and across seasonal timescales?
 - ✓ What is the relationship between variations in DOC/cDOM and other potential drivers (salinity, chl_a)?

cDOM «hotspots»

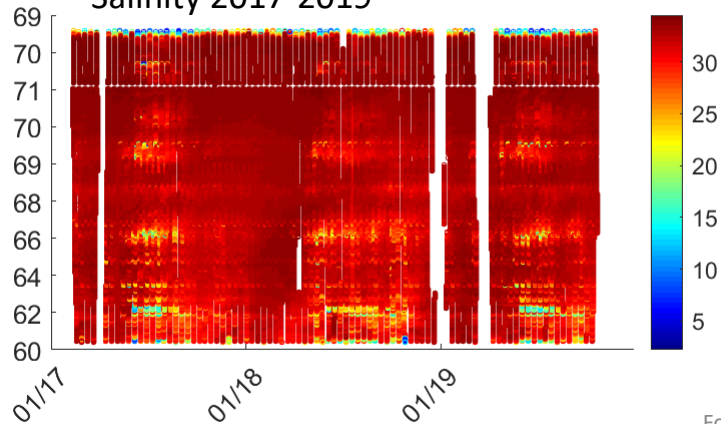


Continuous data from FerryBox transect from Bergen-Kirkenes

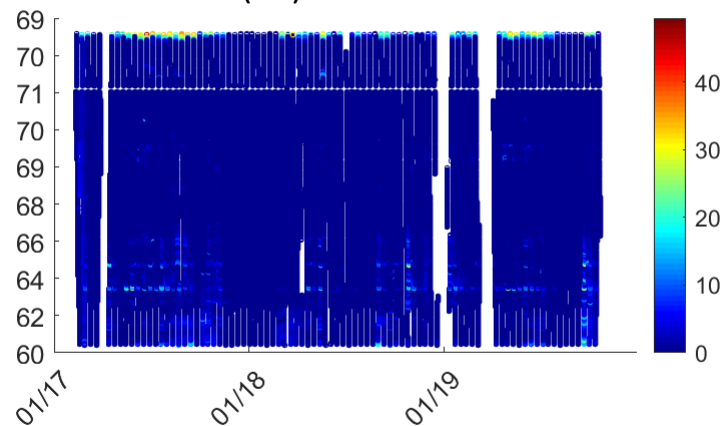
Inlet temperature 2017-2019



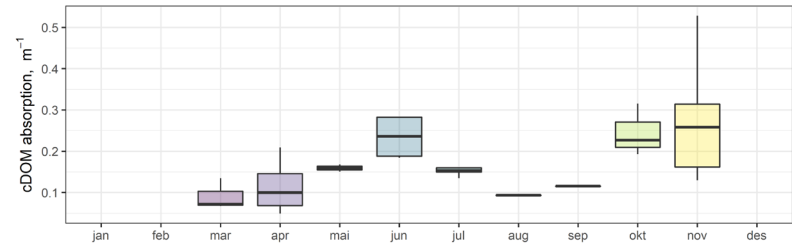
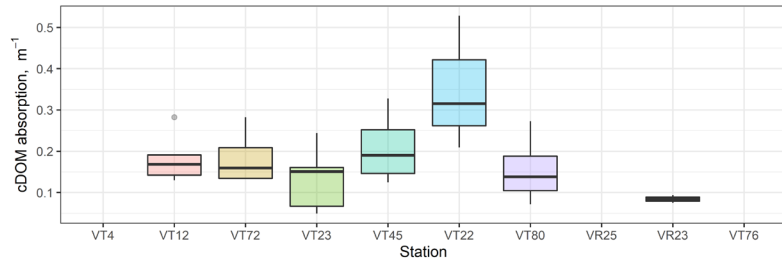
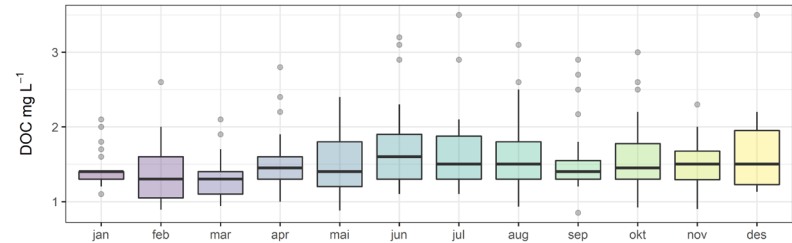
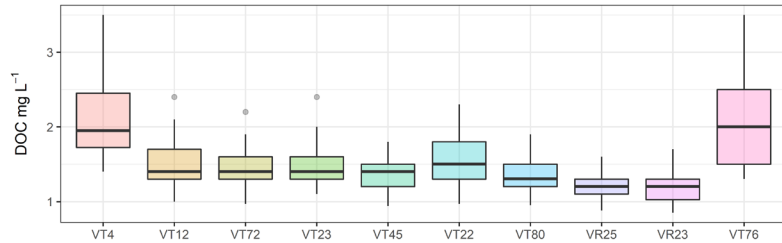
Salinity 2017-2019



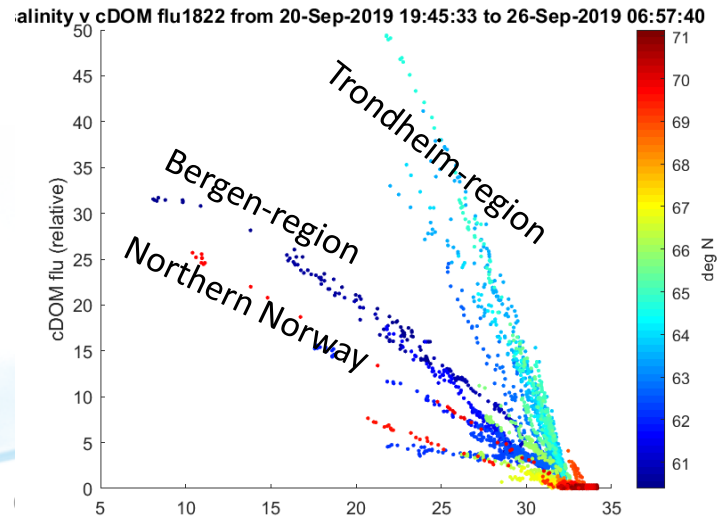
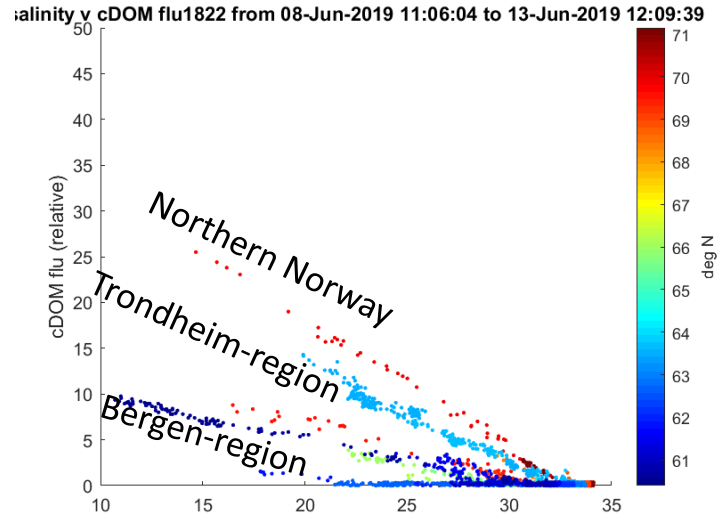
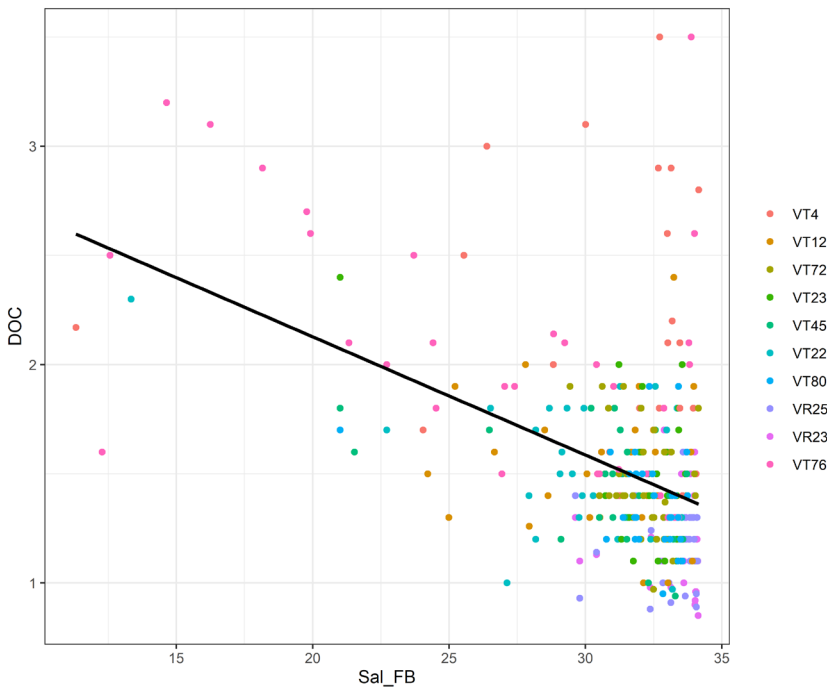
cDOM flu (rel) 2017-2019



Preliminary results: Regional and seasonal variation in DOC/cDOM



Preliminary results: DOC/cDOM vs salinity relationship



Summary and next steps

- Long-term increase in light attenuation observed for Norwegian coastal waters (coastal darkening)
- Large gradients along Norwegian coastline – in south higher and persistent impact of riverine inputs, while in north more short-lived «pulsed» impacts
- Distinct variations in DOC/cDOM between regions/stations, influenced by local riverine inputs and large-scale catchment characteristics
- Next steps include:
 - Investigating local/region specific DOC/cDOM abs vs salinity relationships and converting and validating FerryBox cDOM fluorescence sensors
 - Examining the cDOM abs metrics (e.g. SUVA 254) and slope
 - Linking with riverine station data and catchment characteristics

Thank you! Questions?

