UAK participation in Arctic Cruise with Kronprins Haakon in August 2024

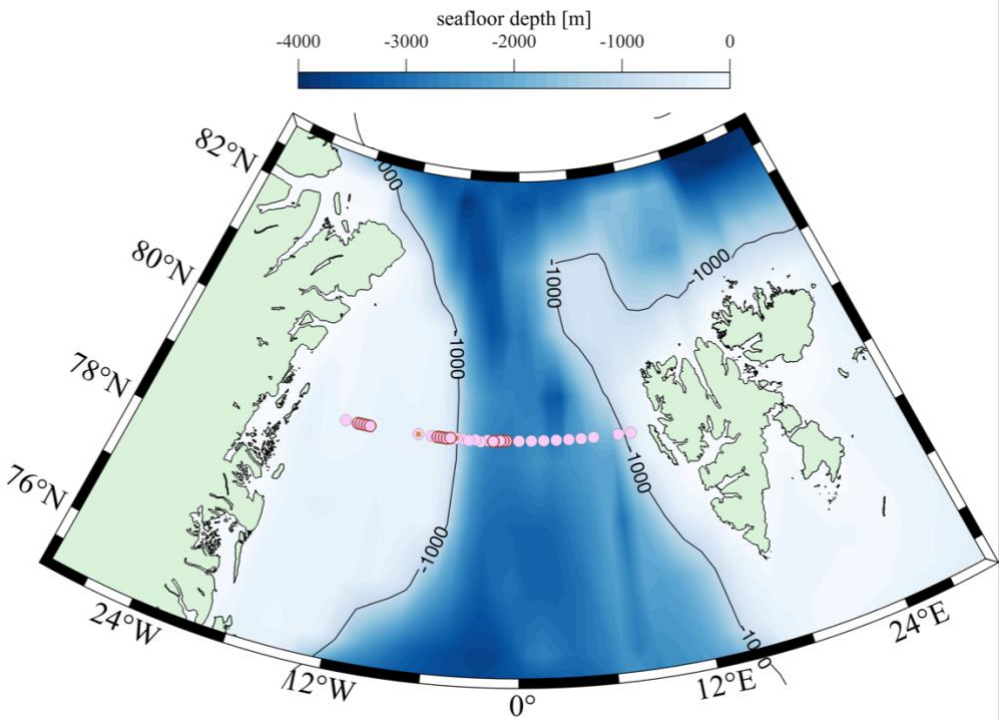
The Optics group also sent one instructor (Daniel Koestner) and one master's student (Ole Høydal) on the Fram Strait 2024 cruise (13–28 August) led by the Norwegian Polar Institute. This cruise is part of a long term (~30 year) monitoring program along the Fram Strait and typically includes the deployment and retrieval of moorings, and sea ice stations. This is a dynamic and hydrographically interesting region where the eastern portion includes warm atlantic water feeding into the Arctic Ocean and the western portion contains south-flowing cold polar water.

R/V Kronprins Haakon docked in Longyearbyen. Photo by Olaf Schneider, Norwegian Polar Institute

The UiB Marine Optics group involvement related to the development and application of tools to study organic carbon production and export through analysis of particle concentration, composition, and size distribution. Besides the training and collection of data for Master's Student Ole Høydal, we had three main objectives:

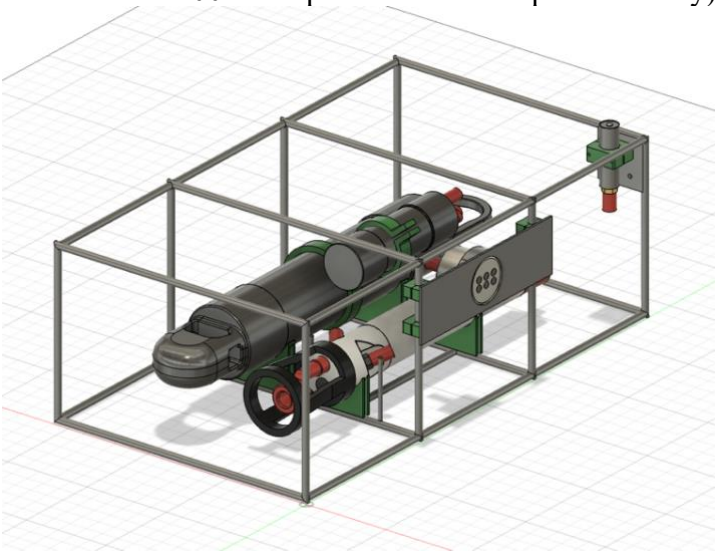
1. Measure optical properties
    a. Spectral absorption (water samples)
    b. Backscattering (700 nm; in situ)
    c. Attenuation and forward scattering (660 nm; in situ)
    d. Photosynthetically Active Radiation (in situ)
2. Measure particulate properties
    a. Mass concentration of Particulate Organic Carbon (POC; water samples)
    b. Mass concentration of Suspended Particulate Matter (water samples)
    c. Mass concentration of Chlorophyll-a (water samples)
    d. Phytoplankton and non-phytoplankton absorption (water samples)
3. To build and validate inverse-optical algorithms aimed at estimating biogeochemically relevant parameters from optical measurements
    a. POC
    b. Particle Size Metrics
    c. Phytoplankton vs. non-phytoplankton content

The cruise was a great success, with 43 casts performed with the optical instrument pacakge and over 150 filters collected for particulate analysis. This dataset will serve as the basis for Ole's master's thesis project while also preparing Ole for any future work in the Arctic.



Map of stations where 43 optical casts were performed. Locations where mesoscale experiments of high-resolution sampling are marked with red outlines and orange squares denote moorings with optical sensors.

In preparation for this research cruise, Ole designed, troubleshooted, improved, and built an instrument cage to contain and safely deploy necessary optical instruments up to 500 m depth. The optical package consisted of an RBR Concerto CTD.PAR.Tridente (temeprature, salinity, depth, photosythentically available radiation, backscattering at 700 nm and ~120º, and chlorophyll-a and DOM fluoresence) and a LISST-200X (near-forward scattering with 36 detectors ~0.04–12º and narrow beam transmission at 660 nm). Sensors were placed appropriately in cage so that down and upcasts would be free from obstruction (i.e., Tridente was facing outwards and LISST-200X sample volume was open vertically).



Rendering of optical instrument cage designed by Ole.

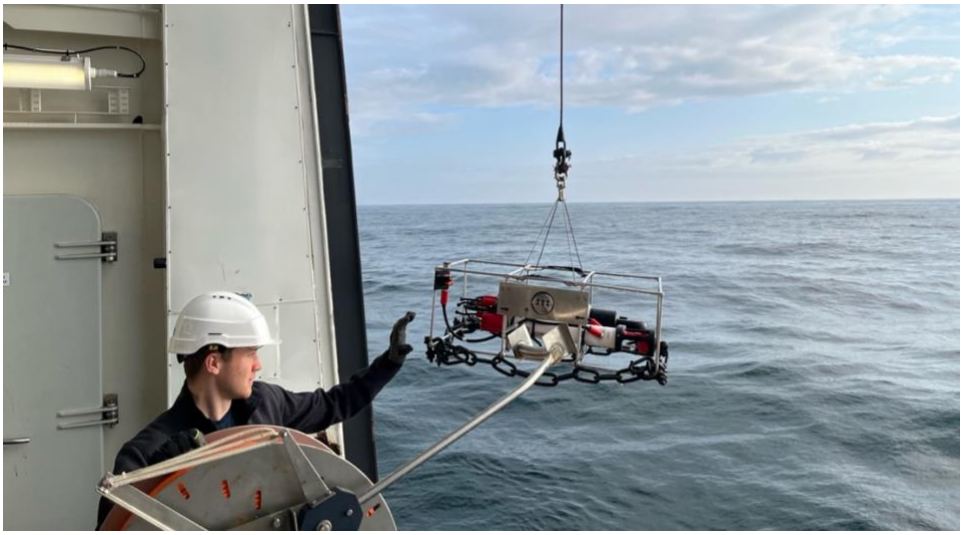
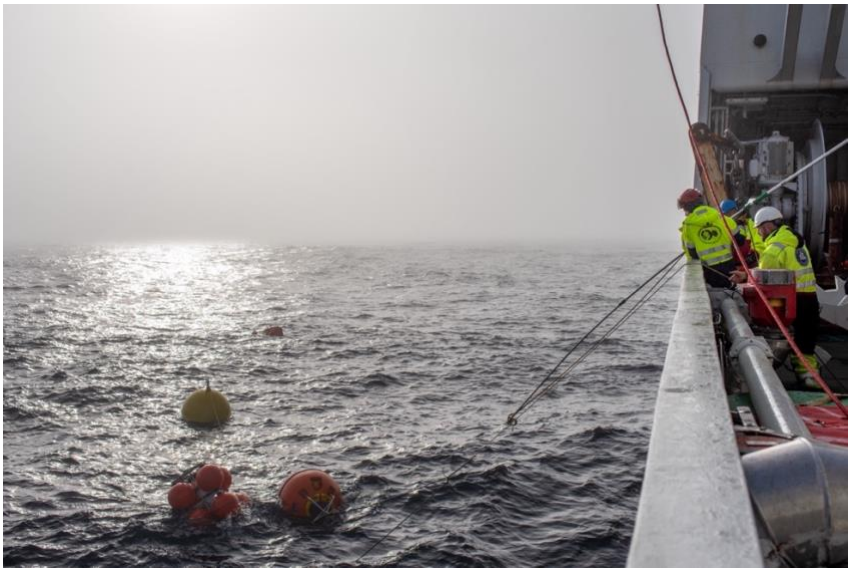


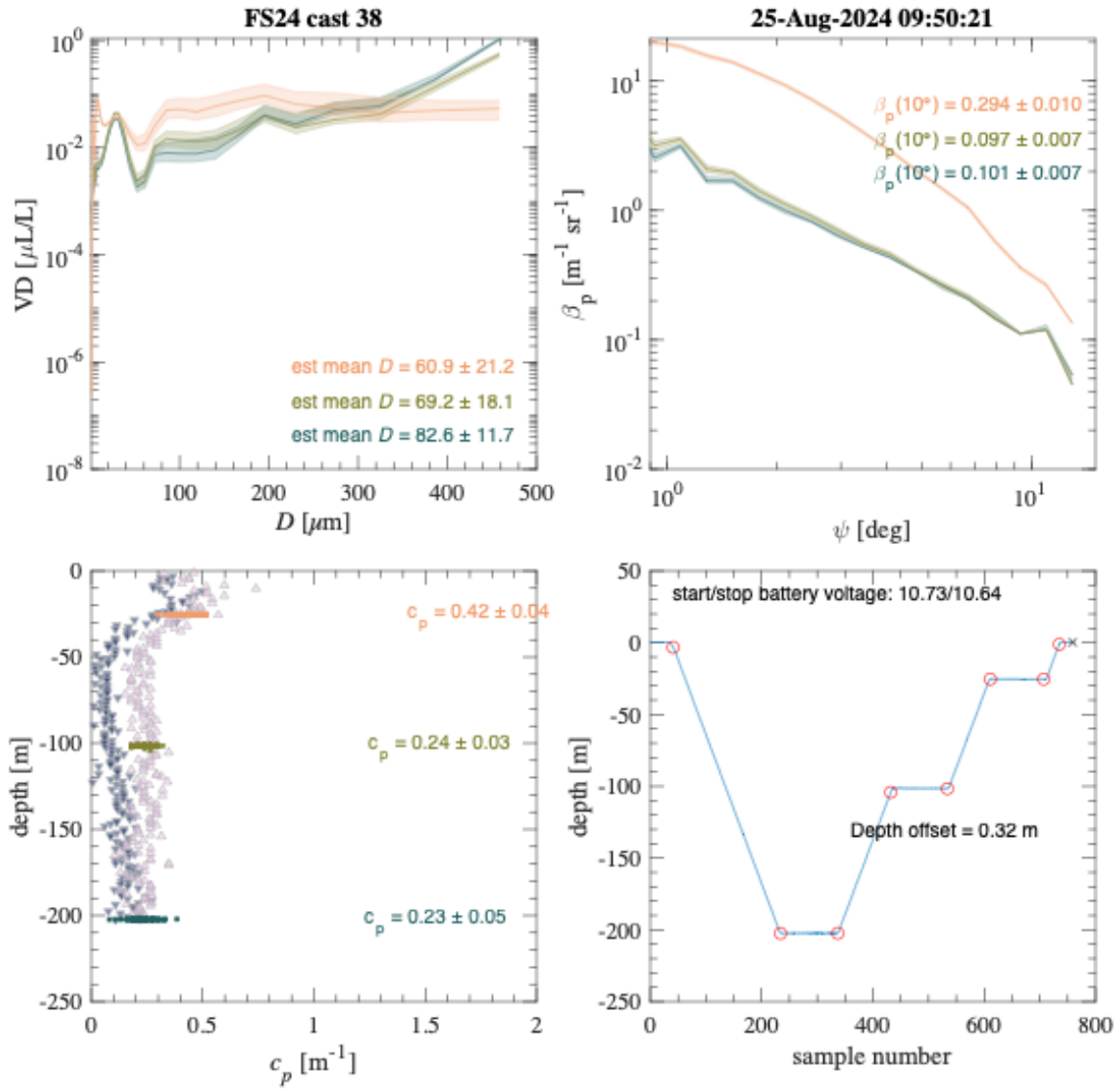
Photo of Ole deploying the custom-build optical cage off the R/V Kronprins Haakon.

Filtration set-up to collect material for particulate anlayses. Photos by Olaf Schneider, Norwegian Polar Institute



Deployment of a mooring with specialized optical sensors. Targeted optical casts were performed to support validation of mooring data at two mooring locations at 5 and 8 ºW. Photo by Olaf Schneider, Norwegian Polar Institute

Ole learned a lot about practicalities of collecting, processing, and visualizing oceanographic data. We planned and implemented an appropriate sampling program given time constraints. A standard profile was 0.3 m/s down and up to 200 m with 5-minute parking at 200, 100, and 25 m on the upcast at whole degrees which fit within the ship's operating schedule.



Example data from the LISST-200X from cast 38. The bottom right shows the typical sampling program.

Due to faster transits than expected because of the very low sea ice concentrations, extra time became available to implement additional sampling. We designed three high-resolution experiments with optical sampling every 0.25º from 13–12 ºW, 6.5–5.5 ºW, and 2–1 ºW to explore interesting mesoscale features observed in CTD data of deep chlorophyll-a max. These profiles were typically 0.3 m/s down and up to 300 m with no parking. Two additional short casts with 5-minute park at approximate depth (55 m) of ECO-Triplet sensors on F13-25 (~5 ºW) and F17-20 (~8 ºW) moorings were also performed shortly after mooring deployments.

Approximately half of the casts included coincident water sampling at 25 m and 100 m for particle properties. Water samples were filtered onto 25 mm diameter glass fiber filters (Whatman Grade F; GF/F) for subsequent onshore analysis of mass concentrations of suspended particulate matter, particulate organic carbon, and chlorophyll-a (and additional

pigments with HPLC). Water samples were also collected for absorption of particulate matter retained on GF/F filters and colored dissolved organic matter (i.e. 0.2 µm filtrate) using a liquid-waveguide capillary cell system with 1 m pathlength.

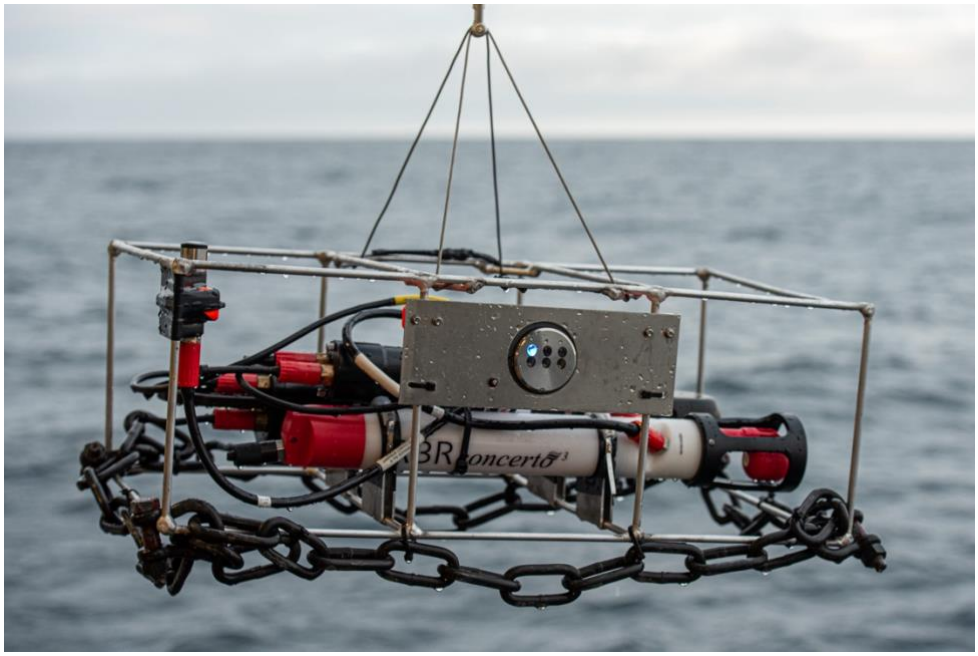


Photo of the completed instrument cage. We had to add additional chain to add weight to keep the instrument profiling vertically. We also decided to include additional tape in a few locations to keep instruments secure. Photo by Olaf Schneider, Norwegian Polar Institute

We got a brief break from optical sampling when we finally found sea ice near the coast of Greenland. However, we spent those days taking turns on polar bear watch at the bridge. Here, we each spend 45-minute shifts watching for polar bears, so that we could keep the sea ice team safe. We had two very close visitors, and nobody was harmed ☺.

Drone photo of the Kronprins Haakon during sea ice station1. Photo by Olaf Schneider, Norwegian Polar Institute

Photo by Olaf Schneider, Norwegian Polar Institute

The cruise was a massive success and Ole has more than enough data to support his master's thesis project. We built connections with researchers at the Norwegian Polar Institute while supporting an extended sampling program for their cruise. We hope to send Ole up to NPI in Tromsø during early 2025 to gain invaluable experience with processing and interpreting the physical ocean variables collceted with the boat's CTD. We also expect more future collaborations with researchers at NPI and DTU.

Ole happy the cruise is over, we can see land!

Science crew on the Fram Strait 2024 research cruise. Photo by Olaf Schneider, Norwegian Polar Institute