

# Light and Life in the Present and Future Ocean

## The Marine Light Climate in a Changing Ocean

I want to improve how the underwater light is observed and modelled, including under sea ice and with varying cloud cover. This I will do by using combinations of field measurements, numerical modelling and potentially satellite measurements. My main regions of interest is the Arctic Ocean, the Barents Sea and Norwegian Coastal Waters.



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### Background and motivation

I did my PhD at UiB on scattering measurements in polar waters, from turbid glacial meltwater to clear waters on the North Pole. Afterwards, I've been a researcher with the Norwegian Polar Institute with field measurements that can help us better understand the role of light in marine ecosystems in the Barents Sea. This region is warming four times as fast as the global mean and is an important for fisheries. In my SEAS project, I will continue and expand upon this work towards Norwegian coastal waters and the central Arctic.

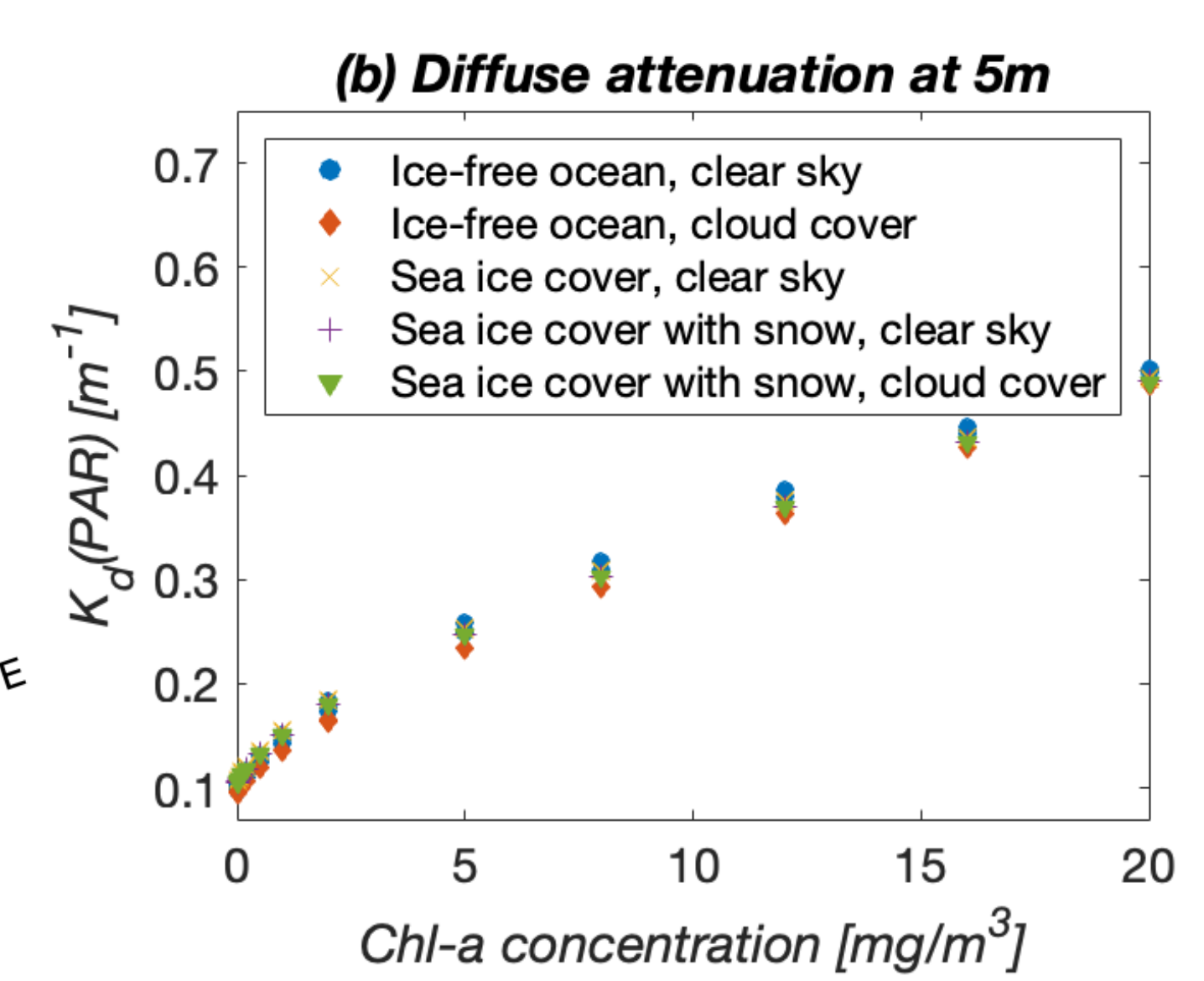
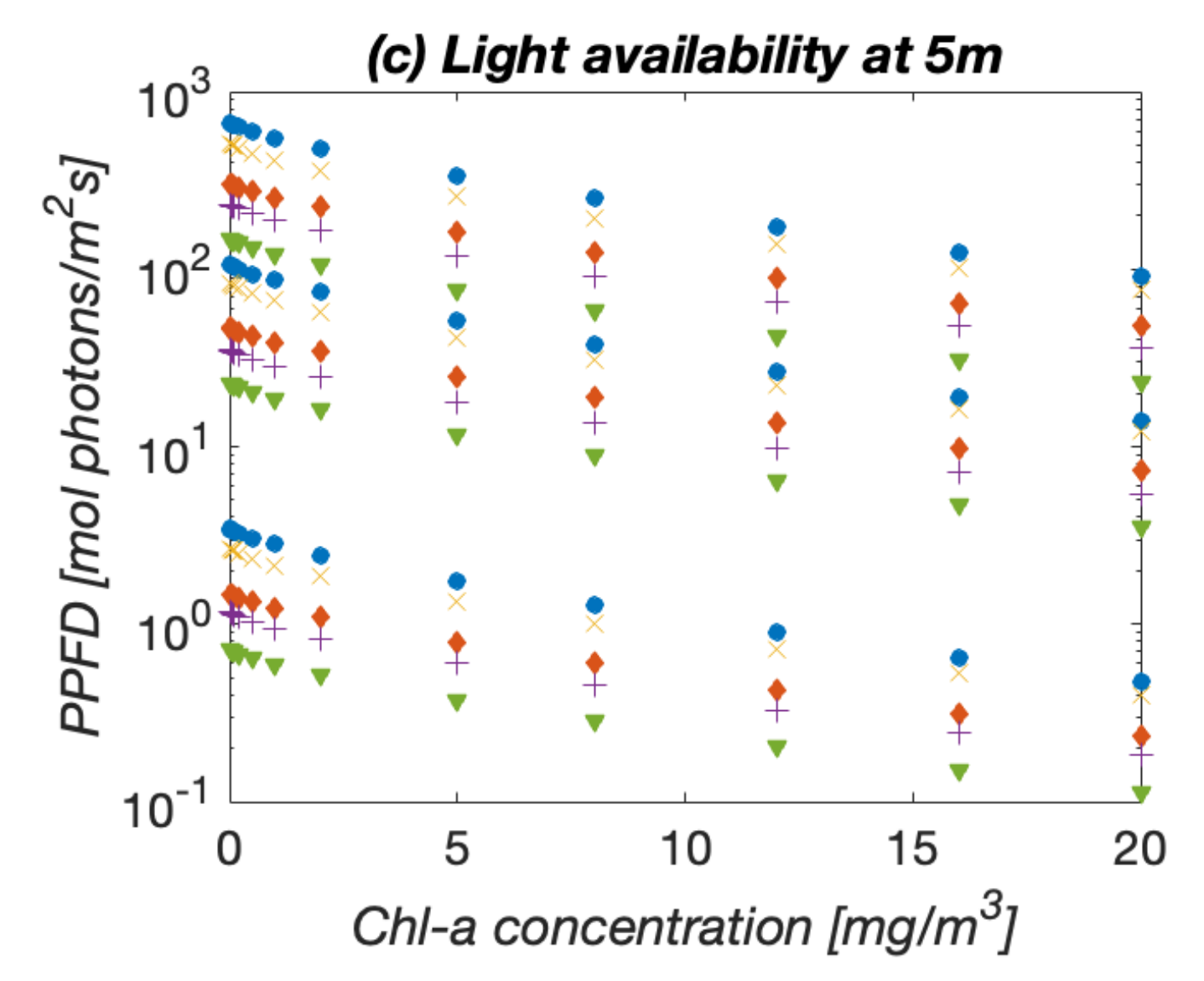
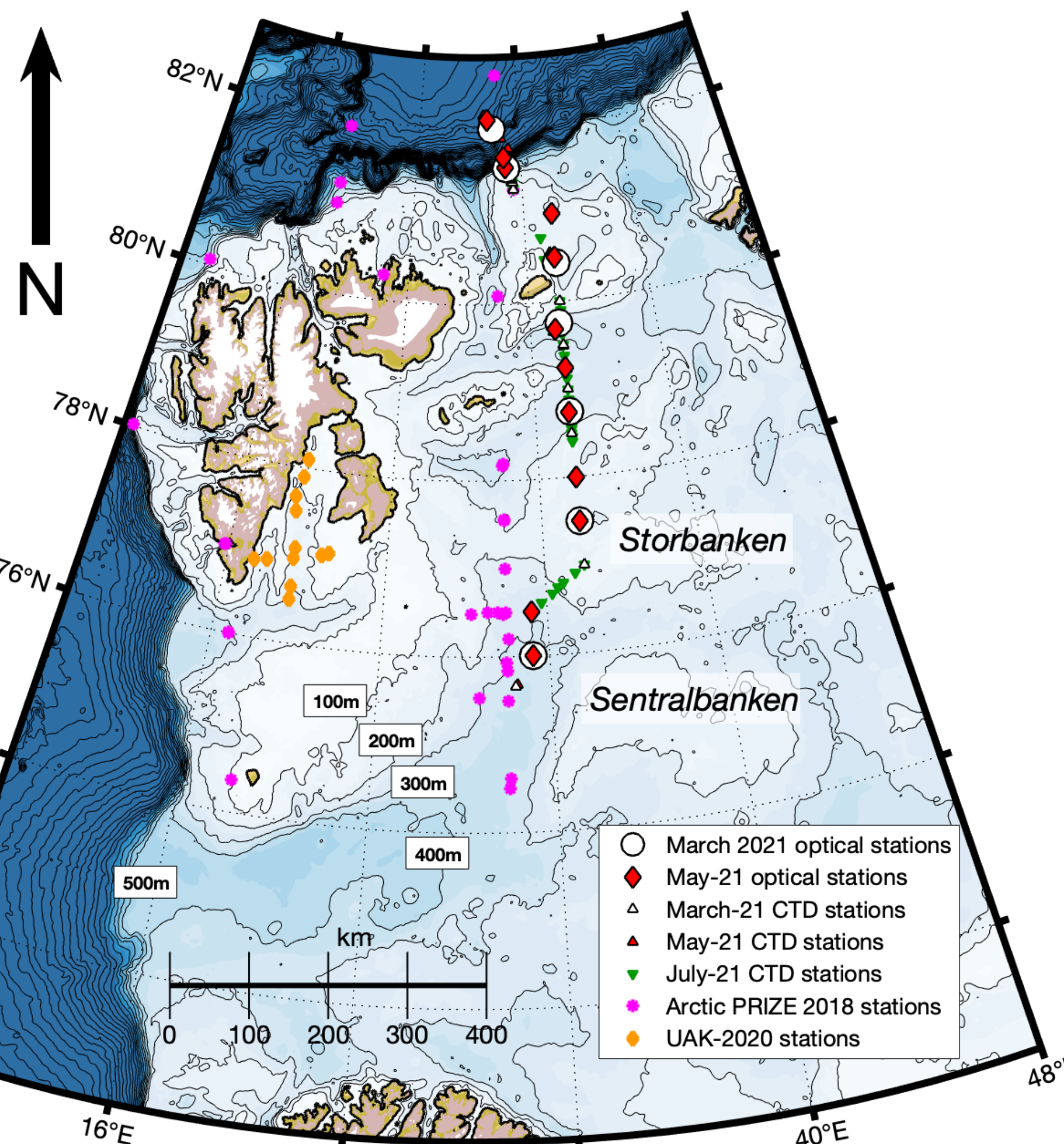


Figure: Maps of sampling locations and preliminary modelling results

### The role of light in the ocean and marine sustainability

Light is crucial for marine ecosystems. Marine photosynthesis contribute to more than half the global oxygen production. Most fish find food with visual search and can be out-competed by tactile predators such as jellyfish in low-light environments.

Sea ice retreat. Increases in run-off from land. Variability in cloud cover. Many factors are changing the marine light in the polar ocean and in coastal areas, yet we know little about its full impact in the upcoming decades, and the consequences on the marine ecosystem and consequently fisheries. Will there be sustainable fisheries in the northern Barents Sea, or will the fish stock decrease or move more eastwards?

### Main questions

- What is the role of phytoplankton and run-off in the underwater light climate, compared to sea ice and cloud cover?
- Can simple sensors be used to estimate light extinction?
- What is the present seasonal variability in the underwater light environment in the Arctic Ocean?

### Highlighted results and activities

#### Publications:

- Sandven, H., Hamre, B., Petit, T., Röttgers, R., Liu, H., & Granskog, M. A. (2023). Seasonality and drivers of water column optical properties on the northwestern Barents Sea shelf. *Progress in Oceanography*, 103076.
- Koenig, Z., Muilwijk, M., Sandven, H., Lundesgaard, Ø., Assmy, P., Lind, S., ... & Granskog, M. A. (under revisions). From Winter to Late Summer in the Northwestern Barents Sea Shelf: Impacts of Seasonal Progression of Sea Ice and Upper Ocean on Nutrient and Phytoplankton Dynamics. *Progress in Oceanography*.
- Ugulen, H. S., Koestner, D., Sandven, H., Hamre, B., Kristoffersen, A. S., & Saetre, C. (2023). Neural network approach for correction of multiple scattering errors in the LISST-VSF instrument. *Optics Express*, 31(20), 32737-32751.

#### Posters:

- Optical observations and parametrizations of Svalbard coastal waters and the adjacent Barents Sea (2023). Svalbard Science Conference 2023, Oslo, Norway.

#### Other activities:

- Start of research stay in Glasgow in September 2023.

### Aims and milestones

- Research stay Glasgow 2023-2025
- Cruises northwest Svalbard 2024 and 2026
- Publish Arctic Ocean data sets from 2022 and 2018
- Create bio-optical algorithm to estimate light availability in the central Arctic Ocean
- Improve cloud and sea-ice component in light availability model "HEIMDALL" and possibly other biogeochemical models
- Use a neural network approach to estimate changes in light availability in Norwegian coastal waters
- Foster new collaborations and develop proposals for future research projects

### Supervisory team

Internal supervisor: Børge Hamre, UiB  
Department of Physics and Technology  
External supervisor: David McKee, University of Strathclyde

Internal co-supervisor: Camilla Sætre, UiB  
Department of Physics and Technology

UiB co-supervisor: Anders Opdal,  
Department of Biology

Mentor: Anders Tengberg, Xylem Aanderaa

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