

OUR FJORD FUTURES

Sustainable Norwegian Fjords in the Anthropocene



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Background and motivation

Fjords are morphological features created by receding glaciers. They are an inseparable part of the Norwegian coastal landscape, and of many other countries. As coastal features, fjords are part of the land-ocean continuum, mediating transfers between the two realms. Fjords play multiple roles in the natural and human landscapes: archives of past land and ocean changes; fish nursery grounds; supports of local economic activities and leisurely places. Looking to the future, my research asks: what will possible climate futures mean for fjords? As a SEAS Fellow, I care about sustainable oceans. Humans play a decisive role in the health of ecosystems worldwide. In fjords and elsewhere, imprints of human action are already being observed. An effective, knowledge-based, ocean governance is needed to protect the oceans from harmful anthropogenic impacts. I also contribute to that by advocating for vigorous ocean science diplomacy.

Research description

To keep fjords sustainable, we need to understand how anthropogenic threats will affect them. One of the major problems they face is low aquatic oxygen levels and my research intends to study the effects of the natural and anthropogenic factors on fjord aquatic oxygen levels and understand the mechanisms of fjord oxygen level variations and what future climate scenarios will mean to fjord oxygen levels. As part of my ocean science diplomacy advocacy, I research how science is interwoven in international ocean governance.

Main research questions

- What is driving the observed oxygen changes in fjord basins?
- What is the impact of anthropogenic factors on these changes?
- How will climate change affect the oxygen levels in fjords?
- How can we make science relevant to international ocean governance?

Marine sustainability

My fjord research will help to better prepare the actions needed to sustainably manage the Norwegian fjords during the Anthropocene. My work in ocean science diplomacy is aimed at strengthening the role of knowledge in global ocean governance.

Aims (and/or milestones)

- Gather data on fjord oxygen levels and hydrographic and biogeochemical variables
- Develop models of fjord dynamics that account for anthropogenic factors and estimate trends of fjord oxygen levels due to climate and societal changes
- Develop a consistent and effective ocean science diplomacy apparatus

Activities

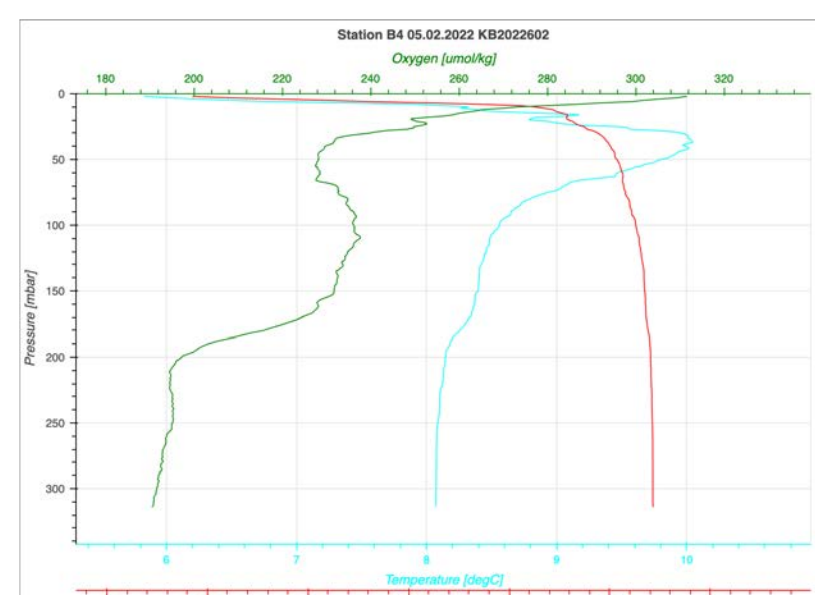
Fjord water properties sampling



Water sample collection for glider data validation in November 2023.

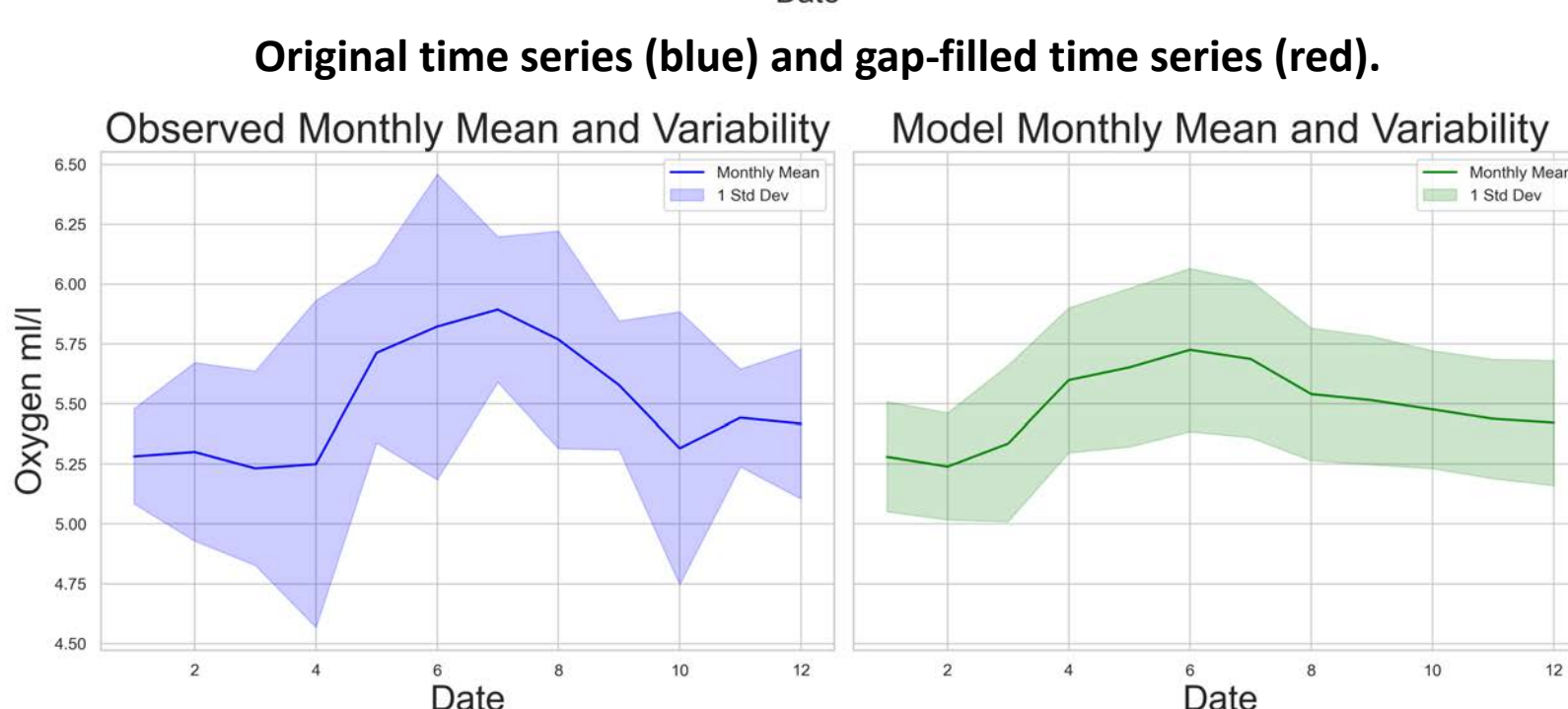
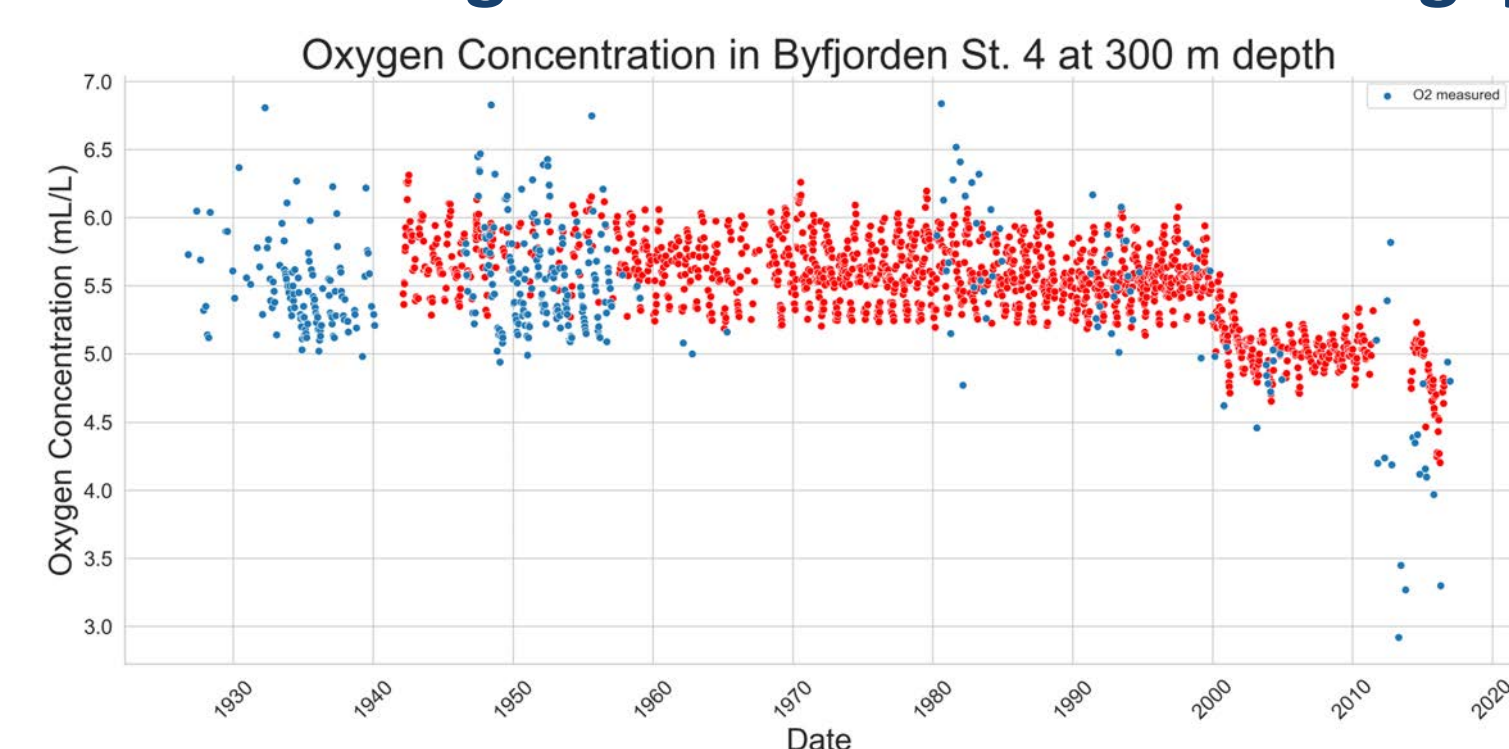


Water samples from Cruise KB2022614, with varying levels of dissolved oxygen, increasing from left to right. May 2022



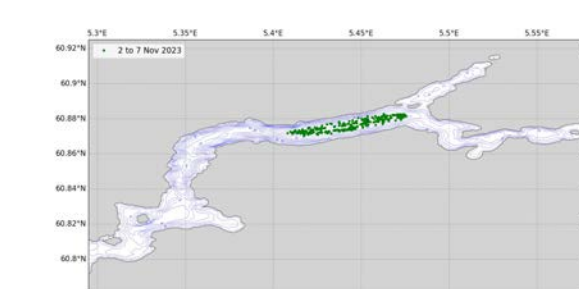
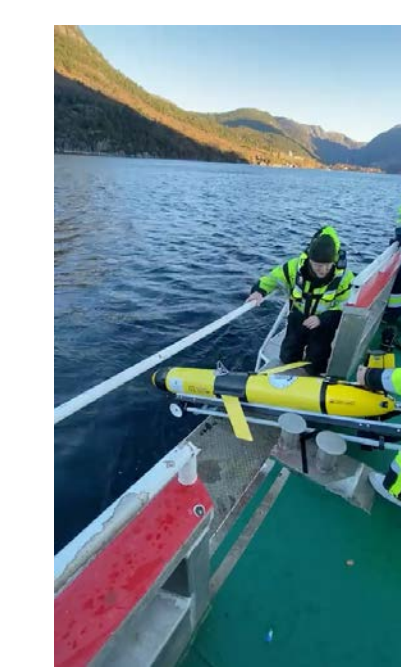
Oxygen and hydrographic profiles measured at Station 4 in Byfjorden. Cruise KB2022602.

Machine learning model for O2 time series gap-filling

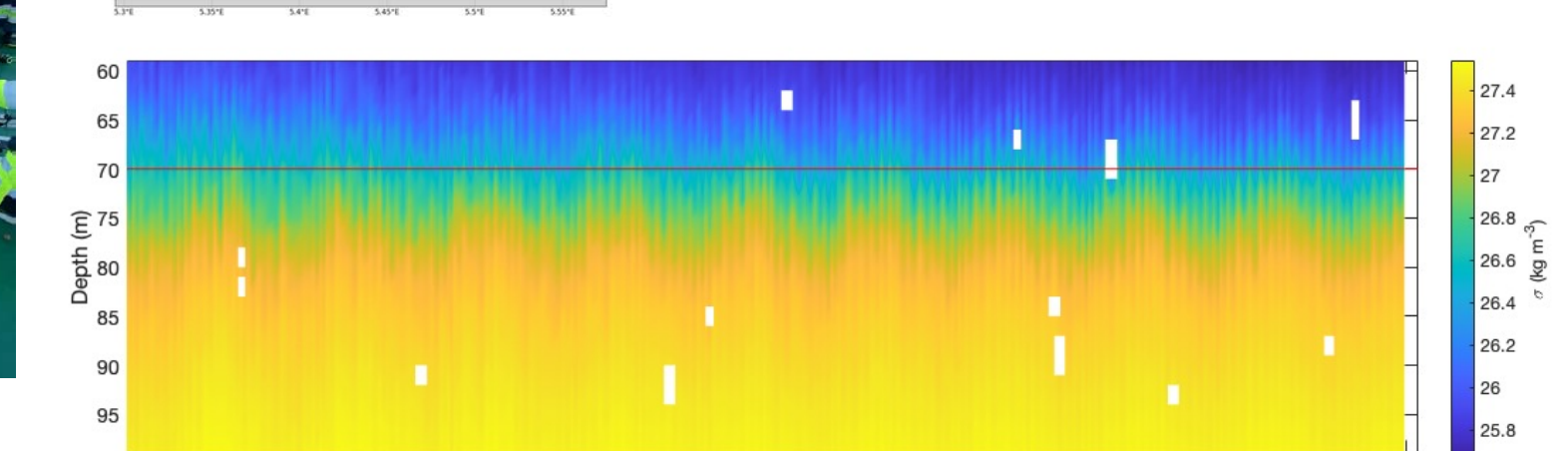


Observation-based and model deduced climatologies of O2 in Byfjorden basin.

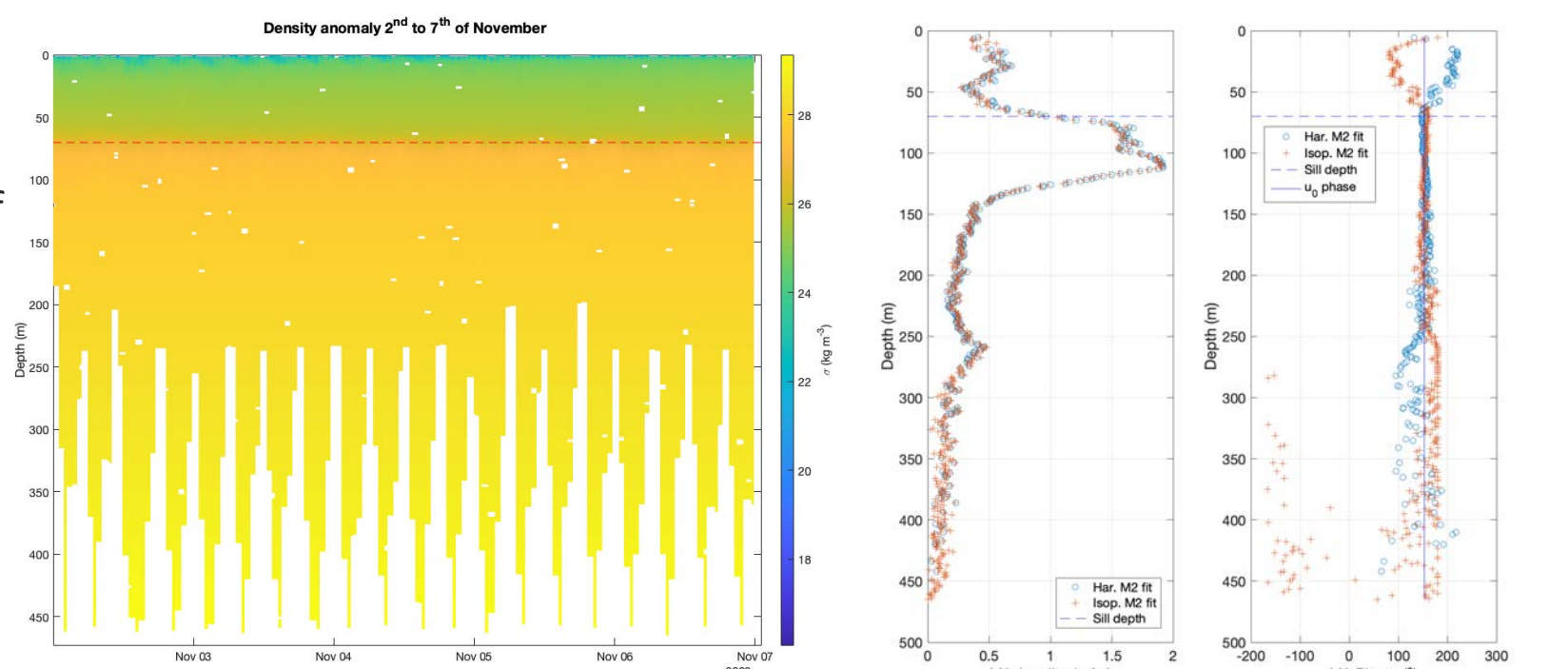
Internal tides in Masfjorden from glider observations



Internal tides
Internal tides are vertical oscillations of the water column caused by tides passing over the fjord sill.



They are responsible for vertical mixing that transports oxygen to the lower depths of the fjord basin. They also reduce the density of the fjord basin water, which facilitates basin water renewal.



Ocean Science Diplomacy

Ocean Futures 2030
I'm part of the **Ocean Futures 2030** initiative at UiB (<https://www.uib.no/en/osb>), that creates meeting points for scientists, diplomats and society at large to discuss sustainable ocean development. We have organized several events and published policy briefs regarding ocean governance.



Ocean Science Diplomacy Thematic Entry Point
The **EU Science Diplomacy Alliance's** entry point dedicated to Ocean Science Diplomacy (<https://www.uib.no/en/osb/170322/ocean-science-diplomacy---thematic-entry-point>) is managed by the OF2030 initiative. The aim of the Ocean TEP is to focus on the ocean dimension of science diplomacy to strengthen the EU's global position in ocean-related matters.

Science Diplomacy in Deep Seabed Mining
Deep seabed mining is a deeply contested activity that generates heated debates on the national and on the international level. I've been studying how the **science-diplomacy nexus** operates in deep seabed mining regulations in the seabed outside national jurisdiction, particularly in the development on regional environmental management plans.

Grants and outcomes

Grants:
BCCR Fast Track Initiative «Glider surveys of hydrography and dissolved oxygen distribution in Masfjorden» (May 2022 to November 2023) / 400k NOK / Co-Principal Investigator (Co-PI)

Research articles:
Bettencourt, J.H., Darelus, E. **Observations of Internal tides in a West Norwegian Fjord.** In preparation.
Bettencourt, J.H., et al. **Fjord futures: a conceptual exploration of future climates impacts on fjordic processes.** In preparation.
Bettencourt, J.H., 2024. **Science-Diplomacy Nexus in Deep-sea Mining: Creation of the Clarion-Clipperton Zone Regional Environmental Management Plan.** Science Diplomacy 7, 10-13.
Bettencourt, J.H., Liang, C.C.A., 2024. **Defining Strategic Environmental Goals and Objectives for the Management of Deep-sea Mining Operations in the Seabed Beyond National Jurisdiction.** JSPG 24. <https://doi.org/10.38126/JSPG240102>
Mykssvoll, M.S., Britt Sandø, A., Tjiputra, J., Samuelsen, A., Çağlar Yumruktepe, V., Li, C., Mousing, E.A., Bettencourt, J.P.H., Ottersen, G., 2023. **Key physical processes and their model representation for projecting climate impacts on subarctic Atlantic net primary production: A synthesis.** Progress in Oceanography 217, 103084. <https://doi.org/10.1016/j.pocean.2023.103084>

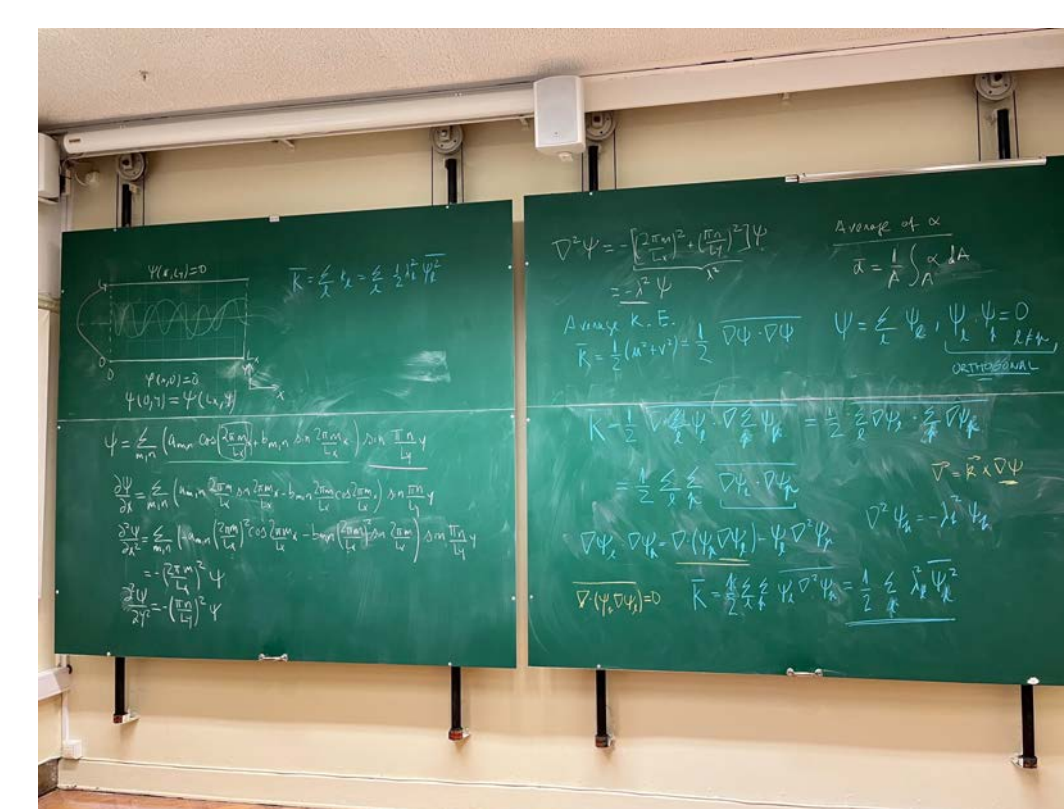
Other articles:
João H. Bettencourt. **Solaristics; or, How to get lost on our way to 2030.** October 2024. <https://seas.w.uib.no/2023/12/05/climate-cops-a-modern-day-cargo-cult/>.
Ocean Futures 2030: Science and diplomacy for ocean governance – our common ocean, OCEAN FUTURES 2030 – POLICY BRIEF #1 | MARCH 2024 (with co-authors) https://www.uib.no/sites/w3.uib.no/files/attachments/policy_brief_from_ocean_futures_2030_brussels_event_february_2024_0.pdf
João H. Bettencourt. **Climate COPs: A Modern-Day Cargo Cult?** December 2023. <https://seas.w.uib.no/2023/12/05/climate-cops-a-modern-day-cargo-cult/>.

Teaching

Courses taught:

GEOF211: Numerical modeling (Spring semester 2023)

Online textbook:



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Supervisory team

Supervisor: Prof. Elin Darelus (GFI)
Co-supervisors: Dr. Mari Mykssvoll (IMR/UiB);
Prof. Are Olsen (GFI)

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