

Project information

Keywords

Fjord oceanography; numerical modelling; sediment flux; carbonate system; pelagic-benthic coupling; integrated ecosystem study

Project title

Impact of massive Winter Herring Abundances on the KaLdfjorden Environment (WHALE)

Year

2018

Project leader

Angelika Renner

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)

Kaldfjorden, Troms, approx. 69.8°N, 18.7°E

Participants

Jon Albretsen, Lars Asplin, Martin Biuw, Melissa Chierici, Elizabeth Jones, Anna Nikolopoulos, Jofrid Skarðhamar (IMR), Ole Anders Nøst, Paul Renaud, Qin Zhou (Apn), Marit Reigstad, Ingrid Wiedmann, Emma Persson, Johanna Petersen (UiT), Zoe Walker (UW/UiT) Evgeny Yakushev (NIVA)

Flagship

Fjord and Coast

Funding Source

Fjord and Coast flagship

Summary of Results

WHALE investigates the physical, chemical and biogeochemical environment of Kaldfjorden. The fjord has recently experienced massive winter herring abundances and high numbers of whales with large effects on the local fisheries, aquaculture industry and tourism. Close collaboration with two other Fram Centre Fjord and Coast projects (weShare, PI M. Biuw; EFFECTS, PI P. Renaud) and the RCN project JellyFarm (PI P. Renaud) provides an integrated investigation into the physical-biological-human coupling in this fjord where baseline data are lacking, making impact assessments of extreme events such as the herring invasions difficult.

In this second project year, we concluded the field work successfully: Monthly hydrographic surveys and water sampling were finished in early September 2018; monthly short-term sediment trap deployments were conducted until May 2018 and thus covered a longer period than originally planned; the long-term moorings deployed by JellyFarm with WHALE ADCPs were recovered successfully in July. Highlights of the field season include an extensive sampling opportunity covering the inflow fjords during the BIO-2516/BIO-3504 teaching cruise in April, and bringing RV Kronprins Haakon into Kaldfjorden to conduct the July water sampling. Laboratory analyses are largely finalised, with only few samples still to be processed. Processing and analyses of field data are ongoing.

The two numerical models NorFjords and FVCOM were set up and model runs are ongoing, covering the WHALE sampling period and earlier seasons that are of interest for the sister projects weShare and EFFECTS. Analysis of model output has started.

Preliminary results of the hydrographic data and water samples show large seasonality in both physical and chemical conditions in the fjord (Figure 1). Comparison with data from the 2016-2017 season also suggest interannual variability. Meteorological conditions have a large influence on temperature and salinity, both through local and regional forcing. Wind conditions offshore can promote inflow of coastal waters at the surface or at depth, or enhance mixing locally. Biological activity clearly impacts nutrient distribution and carbonate chemistry on a seasonal cycle.

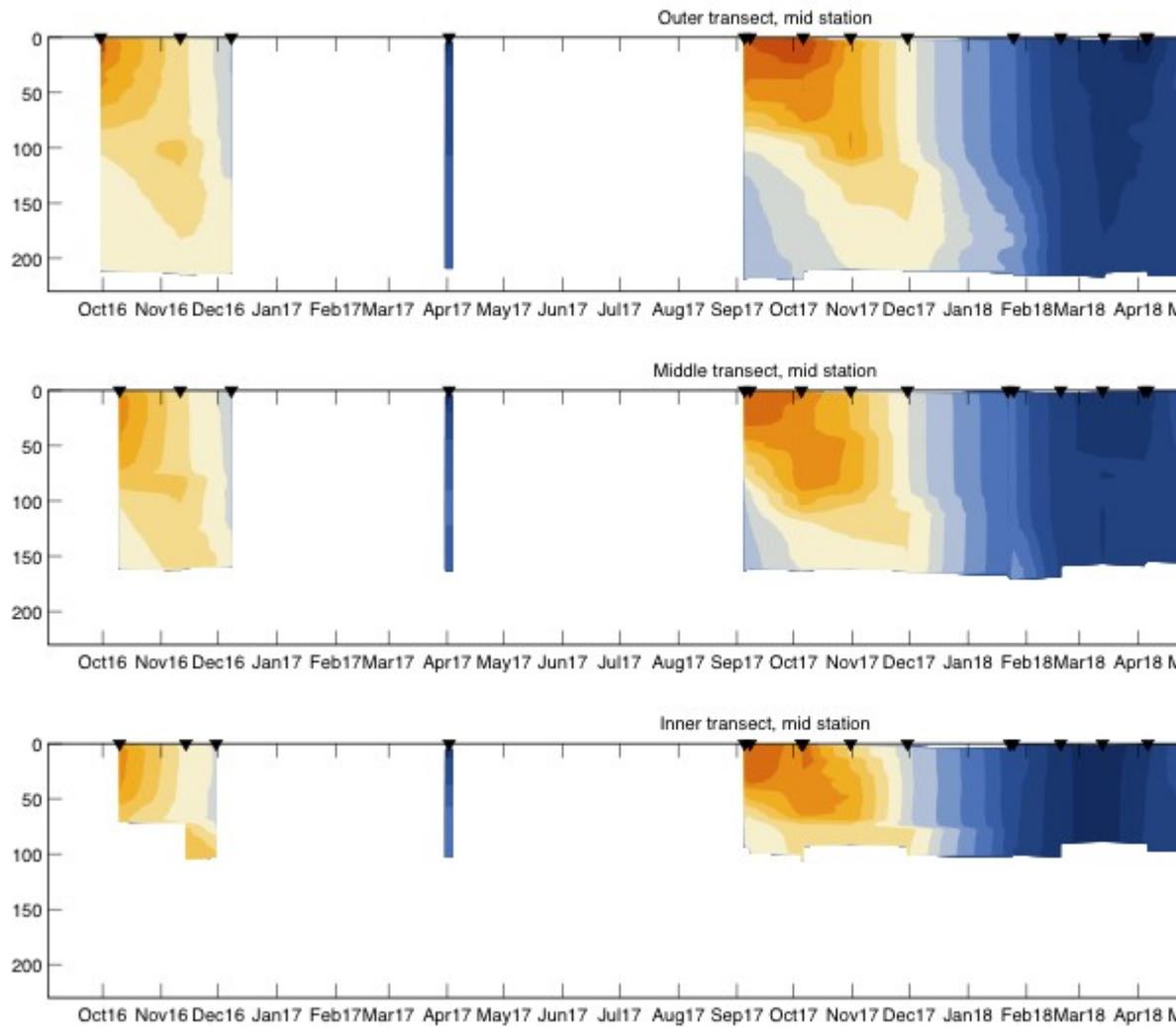


Figure 1: Temperature on three stations in Kaldfjorden. Top: outermost station between Rekvik and Røsnes. Middle: station west of Fiskøya. Bottom station east of Kræmarvik. Black triangles denote days of sampling.

Short-term sediment trap deployments were combined with zooplankton sampling to investigate pelagic-benthic coupling and potential drivers of variability through winter and spring (Figure 2). Zoe Walker submitted and successfully defended her Master thesis on the topic (Walker, 2018). Emma Persson used the sediment traps for an investigation into sampling methods for Chl a flux, which as published in her BSc thesis (Persson, 2018). Flux data derived from the short-term sediment traps will be combined with the results from the long-term traps in EFFECT/JellyFarm, and will feed into the biogeochemical model BROM.

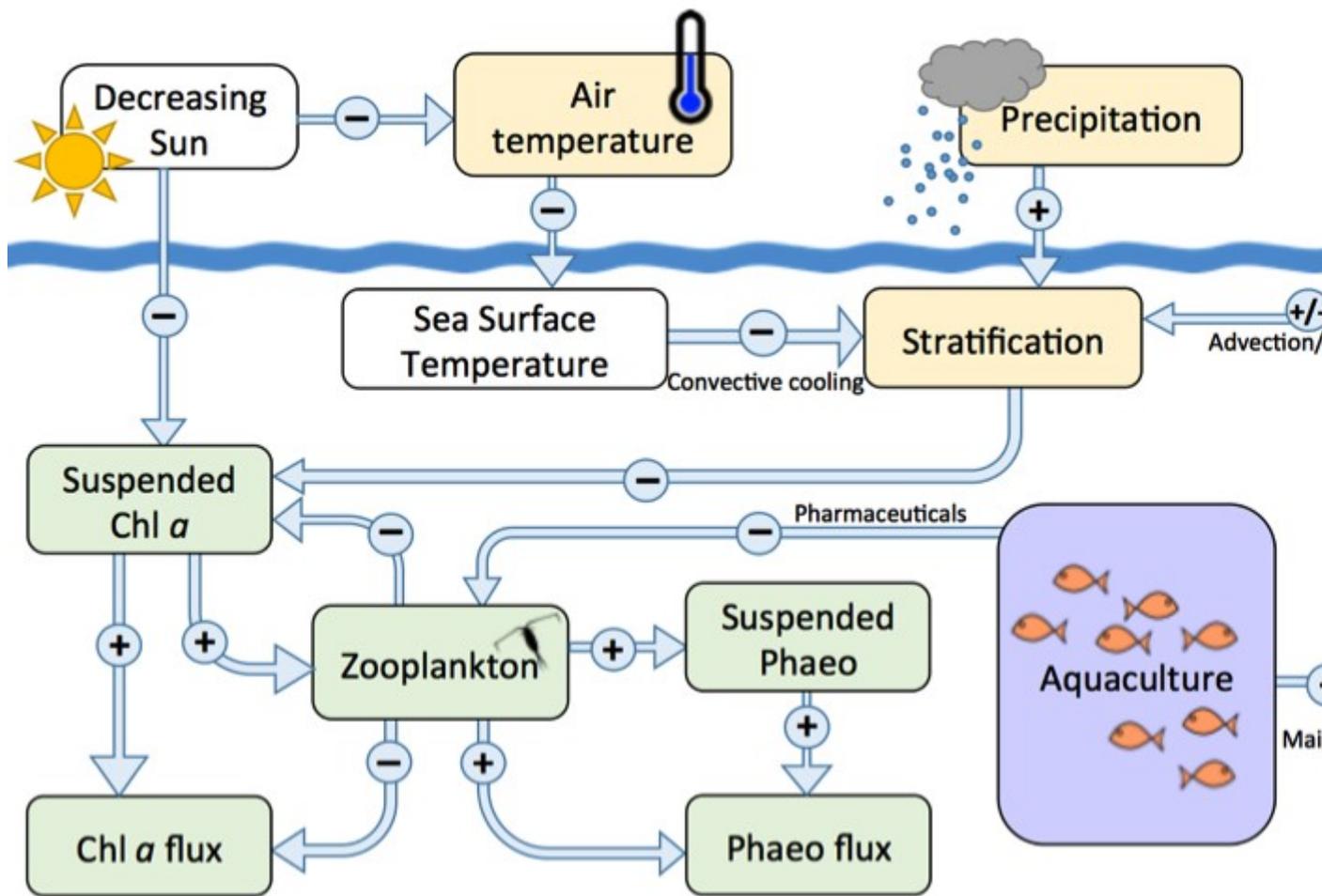


Figure 2: Observed pattern of seasonal transition from late autumn to winter in Kaldfjorden. +/- indicate the direction of the cascading consequences of the decreasing incoming solar radiation (Walker, 2018).

The numerical models NorFjords and FVCOM provide very high resolution simulations of currents and hydrography in Kaldfjorden (Figure 3). Initial results suggest a more dynamic environment than expected with small scale eddy features and high variable circulation patterns. CTD data from the monthly surveys and ADCP data from the long-term moorings will provide validation data, and will in turn be supplemented for an assessment of the spatial and temporal variability and exchange rates in the fjord.

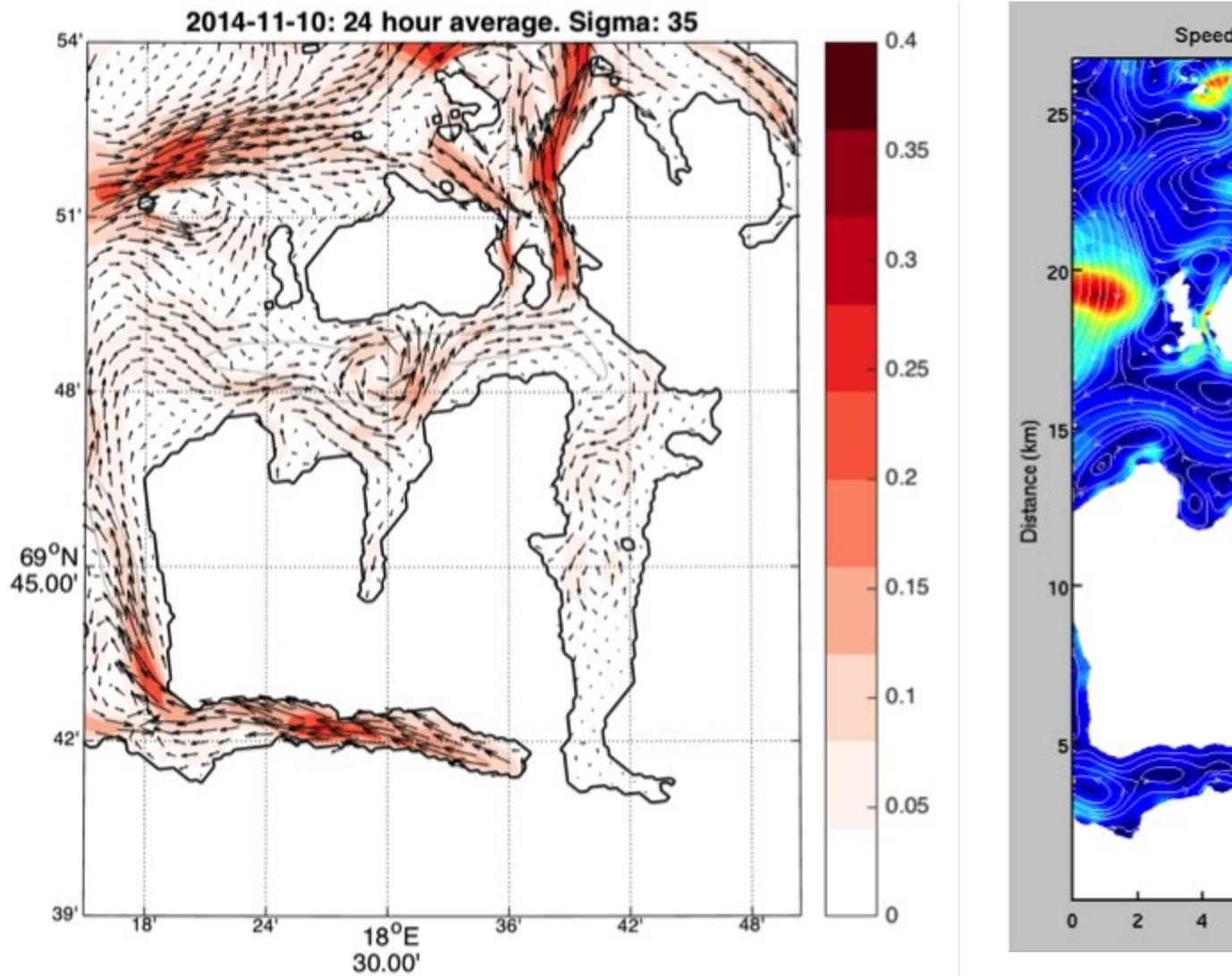


Figure 3: Left: average current field in NorFjords160 on 10.11.2014. Right: Average current in FVCOM on 30.12.2014.

Model data will support the work in EFFECTS and weShare. Integration of the different datasets in the projects is ongoing. To promote further exchange, collaboration and synthesis between the projects, a workshop supported by Fram Centre incentive funding was held in May 2018, and an overview of all datasets in the integrated Kaldfjorden study and their status was compiled. Work on a synthesis paper will start in early July 2019.

Master and PhD-students involved in the project

Emily-zoe Walker, Master of Resource Management, University of Akureyri, University Centre of the Westfjords, Isafjordur, Iceland: Pelagic-Benthic Coupling in a Northern Norwegian Fjord Over Winter: Considering Seasonality in High-Latitude Aquaculture. May 2018

BSc students:

Emma Persson, BSc, UiT: A comparison between short-term sediment traps with filtered sea water and without during two contrasting periods with respect to Chl a and phytoplankton composition. June 2018

Johanna Petersen, BSc, UiT: Working title: Seasonality of turbidity in Kaldfjorden, Troms. To be submitted December 2018.

Students in the UiT courses BIO-2516 Ocean Climate (BSc level course) and BIO-3504 Production and Growth in Polar Areas (MSc level course) collected data and conducted course projects during a teaching cruise onboard RV Helmer Hanssen in Kaldfjorden. Data, analyses and experiments were linked to WHALE sampling and results.

For the Management

Human pressure on Norwegian fjords is increasing and becoming more diverse with fishing, aquaculture, tourism and recreational activities. When these activities focus on a small area as happened in Kaldfjorden with the arrival of herring schools and whales, efficient management requires solid knowledge and understanding of the fjord ecosystem and environment. In the absence of massive herring abundances, WHALE provides insight into the physical, chemical and biogeochemical processes which will enable an assessment of potential effects of herring invasions on the fjord system.

Published Results/Planned Publications

Emily-zoe Walker: Pelagic-Benthic Coupling in a Northern Norwegian Fjord Over Winter: Considering Seasonality in High-Latitude Aquaculture. Master thesis, Master of Resource Management, University of Akureyri, University Centre of the Westfjords, Iceland, May 2018

Emma Persson: A comparison between short-term sediment traps with filtered sea water and without during two contrasting periods with respect to Chl a and phytoplankton composition. Bachelor thesis, UiT- The Arctic University of Norway, June 2018

Paul Renaud et al.: Herring impacts on north Norwegian fjord ecosystems. Fram Forum, Fram Centre, Tromsø, 2018

Øyvind Leikvin: Utslippsmodellering og –vurdering, Skulsfjord, Tromsø kommune, 2015-2018. Akvaplan-niva report no. 7701-01, 34pp, 2018. (data contribution from WHALE)

E. Jones et al: The impact of seasonality on hydrography and water chemistry in a sub-Arctic fjord. To be submitted winter/spring 2019.

Z. Walker et al: Pelagic-benthic coupling in a sub-Arctic fjord from autumn to spring. To be submitted spring 2019.

A. Nikolopoulos et al: Seasonality in fjord circulation and hydrography as represented in two different numerical ocean models. Autumn 2019.

J. Petersen, Bachelor thesis, UiT-The Arctic University of Norway, to be submitted December 2018.

Communicated Results

A. Renner et al.: From water to whale: ecosystem studies in a northern Norwegian fjord. Public lecture, University Centre of the Westfjords, Isafjordur, Iceland, 23. November 2018 (talk)

Ingrid Wiedmann et al.: From water to whale: ecosystem studies in Kaldfjorden. ARCTOS colloquium, Tromsø, 12 November 2018 (talk)

Ingrid Wiedmann et al.: From water to whale: ecosystem studies in Kaldfjorden. Fjord and Coast Flagship DialogueDay, Tromsø. 16 October 2018 (talk)

Zoe Walker: Pelagic-benthic coupling over winter in a Northern Norwegian fjord. YOUMARES Conference for Young Marine Researchers, Oldenburg, Germany, 11-14 September 2018 (talk)

Kathy Dunlop: Fra vann til hval: økosystemstudier av Kaldfjorden. Framdagen, Tromsø, 22 August 2018 (talk)

Zoe Walker: What's going down in Kaldfjorden? Pelagic-benthic coupling during late autumn and winter. AkvaSem, UiT, 27. April 2018 (talk)

Kathy Dunlop, Ingrid Wiedmann, Elizabeth Jones et al.: An integrated ecosystem understanding of a northern fjord receiving massive winter herring and whale arrivals. Fjord i Nord Symposium, Tromsø, 17-18 April 2018 (talk)

Kaldfjorden workshop funded by Fram Centre Incentive Funding, collaboration between WHALE, weShare and EFFECTS (& JellyFarm). Institute of Marine Research, Fram Centre, Tromsø, 28. May 2018

Interdisciplinary Cooperation

The project is inherently interdisciplinary by including different disciplines in the natural sciences. The Master thesis by Zoe Walker investigated the implications of the observed patterns in pelagic-benthic coupling and hydrography for aquaculture in fjords. Close collaboration with the other Kaldfjorden projects extends the work with the human perspective as well insight into fish and whale dynamics in weShare, the benthic community and biogeochemical modelling in EFFECTS and JellyFarm, and a larger geographical perspective in JellyFarm.

Budget in accordance to results

yes

Could results from the project be subject for any commercial utilization

No

Conclusions

The field work was successfully concluded, and most lab work is finished. Data processing is ongoing and first result are promising. Hydrography, sediment flux, zooplankton abundance, and the carbonate system display strong seasonality; analyses now focus on the processes connecting these different components. Both numerical models have produced first model output, and while model runs are slightly delayed, they should be completed in time in 2019. Preparation of WHALE manuscripts is in progress. Data exchange with the other projects has been initiated, and a synthesis paper summarising the integrated ecosystem study is in planning. Communication with industry has been initiated through the workshop organised in May. Training of students and early career researchers continues to be a strong component in the project with new students and postdocs having joined in 2018.