New RV Belgica

Specific call for research proposals 2021

CANOE

Climate chANge impacts on carbon cycling and fOod wEbs in Arctic fjords

DURATION
15/12/2021 - 15/03/2026

BUDGET
€ 997 645

PROJECT DESCRIPTION

Fjords around Greenland are of regional and global importance. They harbour highly productive and diverse food webs, which support rich fishing grounds and fuel carbon burial hotspots. Especially fjords with glaciers terminating in the sea (marine terminating glaciers, MTG) are highly productive due to glacier-induced upwelling. Fjords fed by rivers which derive from land-terminating glaciers (LTG) are much less productive. Through the accelerated melting of the Greenland Ice Sheet, global warming will lead to the retreat of glaciers, turning MTGs into LTGs. At present, there is no knowledge on changes in carbon transfer within food webs as a consequence of the shift of MTG to LTG, nor is the further impact on the carbon sink function known. Consequently, the impacts of further warming on the provisioning of ecosystem services by Arctic fjords (e.g. fisheries, carbon sink) remains unknown. Therefore, with this project we aim to investigate to what extent a shift from marine-terminating to land-terminating glaciers in Arctic fjords leads to lower primary productivity, lower mineralisation rates and higher carbon burial, and by that supports a less rich and diverse food web.

The CANOE project consortium will make use of the new *RV Belgica*'s advanced facilities to investigate how climate change will affect the carbon dynamics (production, mineralisation, transfer in food web and burial) in Arctic marine ecosystems. As climate change will lead to a shift from MTG to LTG, we focus on selected MTG and LTG-dominated fjord systems in SW Greenland and consider an inshore - offshore gradient in these fjords.

The research objectives of CANOE align with four scientific work packages (WP1-4), complemented by three supporting WPs on data management (WP5), coordination (WP 6) and outreach (WP7). The first three scientific WPs consist of a field work and a modelling component; the fourth WP is entirely model-based. With this approach, we strive for tight integration of the consortium research groups in order to optimally realize the multidisciplinary nature of the project.

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WP1 covers our first objective by characterizing the fjords physically by means of temperature and salinity measurements, and compiling discharge data combined with hydrodynamical modelling. A combination of literature and novel data will be used to constrain a 2D hydrodynamical model of the investigated fjords using the regional ocean modelling system (ROMS). In a second WP, we will quantify and increase our understanding of carbon cycling in the pelagic (production, respiration, grazing and export rates) and benthic environment (mineralization and burial rates) by applying a novel cross-disciplinary approach in tracking organic carbon from the sea surface to the sediment. The high resolution of the benthic mineralization rates (on the scale of different electron acceptors) allows to calibrate a dynamic early diagenetic model, enabling an accurate estimation of key parameters that control carbon cycling and burial in the studied fjords. In a third WP, we will assess the structure of food webs, investigate their resilience, and quantify major energy pathways within and between pelagic and benthic components. We will use stable isotope data across habitats (pelagic AND benthic) and across levels of organisation (from microbes and plankton to fish), and analyse the data using emerging Bayesian approaches, ultimately supporting a data-driven Linear Inverse Model of carbon flows through the entire food web of contrasting fjord systems. In a fourth WP, the 2D hydrodynamic model will be coupled with a biogeochemical module that builds on the already existing biogeochemical module of ROMS and the numerically efficient benthic diagenetic model 'OMEN-SED'. The biogeochemical model will include a basic, but complete carbon cycle (e.g. primary productivity, different pathways of water-column and benthic mineralisation), and will be validated using benthic and pelagic observations from WP2.

By means of the field-calibrated hydrodynamical model, we will scale up our findings to the whole fjord scale, run future climate scenarios and evaluate the significance of the shift from MTG to LTG-fjords on carbon dynamics, including effects on sequestration and trophic levels of commercial or conservation interest.

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LINKS

https://www.researchgate.net/project/CANOE-Climate-chANge-impacts-on-carbon-cycling-and-fOod-wEbs-in-Arctic-Fjords

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