Svalbard fjords as harbingers of the future Arctic: A call for interdisciplinary research on interconnected ecosystems

Kai Bischof & Geir Wing Gabrielsen
The European Arctic: The (marine) system under ONGOING change

Physico-chemical change…
Increase in temperature
Sea ice loss
Increase in precipitation
Freshwater discharge & sediment run off
More or less light?
“Atlantification”
“Acidification”
Pollutants
UV radiation

Intergovernmental Panel on Climate Change (20014)
The European Arctic: The (marine) system under ONGOING change

...and biological consequences:

Shift in distributional limits

Bloom dynamics

Change in competitive strength and community structure

Change in trophic interactions

Smothering of hard bottom communities

Bioinvasions
Kongsfjord - Svalbard

A harbinger of the changing Arctic?
Distribution of temperature at 100 dbar in summers 2002-2009

Waldek Walczowski, IOPAS

Slide provided by Haakon Hop
Mooring temperatures in Kongsfjorden, 2002-2016

Kongsfjorden Mean Temperature 2002-16

Kongsfjorden Seasonal Mean Temperatures

Summer [JASO]

Winter [JFMA]

Provided by Finlo Cottier, SAMS, UK
A harbinger of the changing Arctic?

-> How to compare?

-> What's the reference?
Available tools for/at Kongsfjorden

Transects & Moorings

- 1996 – 2000
- 197 samples
- 5 – 380 m
- muds, sands, gravels, rocky shelves, kelp forests
- different sampling methods

Machine Database at NPI

Results
- Zooplankton abundance (ind m⁻³)
- Phytoplankton abundance (cells l⁻¹)
- Chlorophyll a & phaeopigments
- Nutrient
- Lipid classes, Fatty acid and fatty alcohol (%)

To be included
- Stable isotope
- Link the Marine database to exotox & CTD database

Underwater Observatory

Main components of the AWIPEV Fjord-Observatory
- Underwater set-up at AWIPEV
  - Fully equipped ferry
  - Underwater set-up unit
- Fully equipped ferry
- Underwater set-up unit
- Fully equipped ferry
- Underwater set-up unit

Kongsfjord food web model

Duarte et al. (in press)
Water temperatures - Nyålesund/Svalbard - 78°09' N, 9°11' E

Focus on specific dates or values by horizontal or vertical left-click dragging a zoom window. Double-click for focus reset.

- Project description
- Cooperation partners
- AWIPEV research station

Related data:
- Current and tide data
- pCO2, TA and pH data
- Hydrographical data (T,S,O2 etc.)
- PAR data (In preparation)

Air temperature close to container

Value: sbe38_657:temperature
The variable "sbe38_657:temperature" is measured by a temperature probe (SBE38, Company SeaBird) located in 11m water depth (+/- tide) at the base.

Value: ctd_181:temperature & ctd_181:pressure (lower graph)
The variable "ctd_181:temperature" is measured by a combined conductivity - temperature - density probe (CTD200, Company Sea&Sun) which is profiling between 11m (+/- tide) and the surface. The probe is located close to the

Value: adcp_23789:temperature
The variable "adcp_23789:temperature" is measured by an acoustic current profiler probe (ADCP XW1200, Company Teledyne) located in 13m

Value: fb_731101:sbe45_0403:temperature
The variable "fb_731101:sbe45_0403:temperature" is measured by a land based FerryBox system (Sensor SBE45, ADM) setting its
Interaction between projects, nations, flagships

⇒ Foster collaborative, interdisciplinary, projects integrating the expertise from the *other flagships*!
Project group Solar UV-radiation
Measuring stratospheric ozone depletion over the Arctic

Monitoring atmospheric UV-radiation
Assessing UV-effects on Arctic seaweeds

-Atmosphere, Cryosphere -> Biology!

-Feedback from Biology to Atmosphere & Cryosphere?

-Terrestrial <-> Marine Ecosystems
Physiological and fitness consequences of emerging contaminants exposure in arctic seabirds (2016-2019)

O Chastel, P Blévin, F Angelier, S Tartu, A Goutte, C Parenteau, P Bustamante, D Costantini, D Herzke, B Moe, C Bech, JO Bustnes, GW Gabrielsen
PCBs exposure increases stress hormone secretion

POPs exposure disrupts coloration

Mercury suppresses reproduction

HCB exposure decreases adult survival

IPEV project ORNITHO-ENDOCRINO: Endocrine and fitness consequences of mercury and legacy POPs exposure
Diet studies of kittiwakes in Kongsfjorden

Vihtakari et al. Scientific Report (under revision)
Climate warming:

Rain-on-snow events!

Food access

Alternative food?

Some new trophic systems establishing?
Ashild Önvik Pedersen (Norsk Polarinstittutt): Adaptations of diet - Reindeer grazing on seaweed and kelp

Example from 2010:

- 98% of the study area covered with ground ice
- 13% of the population used the shore area
- Most reindeer were young (new recruits)
Diet studies

Using isotopes ($\delta^{13}C$ and $\delta^{15}N$) from red blood cells and plasma it has been shown that polar bears from the North-West part of Svalbard feed more from the terrestrial ecosystem when compared to polar bears from South-East part and Nordaustlandet (feed mainly on marine food).
Polar bears from the North-West part of Svalbard are in poorer body condition when compared to the other areas.

Bourgeon et al. 2017. Env Res
Interaction between projects, nations, flagships

⇒ Foster collaborative, interdisciplinary, projects integrating the expertise from the other nations
Temperature effects on energy metabolism in Arctic copepods

- What conditions do organisms already experience (temperature, salinity, pH...)?
- What is the natural variability, not just the average state?
- How do organisms respond to changes in these stressors?

Collaborations

- Helen Findlay (PML, UK)
- Piero Calosi (UQAR, Canada)
- Peter Thor, Haakon Hop (NPI)
- Carbonate chemistry: Agneta Fransson (Norwegian Polar Institute, Norway) & Melissa Chierici (Institute of Marine Research, Norway)
1. Distribution and fate of inorganic and organic Hg in Kongsfjorden

2. Non-target monitoring of emerging organic pollutants

PI : Kitae Kim, KOPRI

In cooperation with NPI

Diclofenac

Ephedrine

Galaxolidone

Diethyl toluamide
Ongoing research

Korea-Norway Joint cruises to Svalbard fjords 2017 and 2018

Objectives:
- Sedimentary processes
- Glacier dynamics
- Sea-ice proxy IP_{25}
- Pore water microbiology

Seung-Ill Nam (KOPRI)
Ongoing research

Functional diversity of heterotrophic bacteria in the water column and sediments of Kongsfjorden
A.A. Mohamed Hatha, A.V. Saramma
Dept. of Marine Biology, Microbiology and Biochemistry, Cochin University of Science and Technology, India

- Functional diversity of the bacterial community along the depth gradient and sediment of Kongsfjorden

- Extracellular enzymes and functional gene diversity with reference to those involved in the carbon cycle
Ongoing research

Seasonal fluctuation in the marine environment of Kongsfjorden

- Hydrology & chemistry
- (Microbial) Biodiversity and community structure
- Organic pollutants

Shunan Cao
Polar Research Institute of China
Kongsfjorden as harbinger of the future Arctic: knowns, unknowns and research priorities

Kai Bischof*1, Peter Convey2, Pedro Duarte3, Jean-Pierre Gattuso4,5, Maria Granberg6, Haakon Hop3,7, Clara Hoppe8, Carlos Jimenez9, Leonid Lisitsyn10, Brezo Martínez11, Michael Y. Roleda12, Peter Thor3, Jozef Wiktor13, Geir Wing Gabrielsen3,14

Refer to strategy paper when applying for funding

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The Ecosystem of Kongsfjorden, Svalbard
Hop H, Wiencke C (eds.)
Hypotheses

-Warming and acidification in Arctic coastal waters will continue

-Tidewater glaciers will disappear, with consequences for seawater circulation and associated biological systems

-“Atlantification” will continue, leading to local extinction of endemic and the establishment of temperate species

Kongsfjorden as harbinger of the future Arctic? Research priorities of the Kongsfjord Ecosystem Flagship Program

Kai Bischof1, Geir Wing Gabrielsen2, Haakon Hop3, Jean-Pierre Gattuso5, on behalf of the Kongsfjord Ecosystem Flagship Program

1University of Bremen, Marine Botany & Alfred Wegener Institute, Germany, 1 kbschoef@uni-bremen.de
2Norwegian Polar Institute, Tromsø, Norway
3Grønlandske Institute, University of Copenhagen, Copenhagen, Denmark
4Sorbonne Université, UPMC Univ Paris 06, CNRS-INSU, Villefranche-sur-Mer, France

Hypotheses

- Warming and acidification in Arctic coastal waters will continue beyond the range of current natural variability.
- Tidewater glaciers will disappear, with major consequences for seawater circulation and associated biological systems.
- “Atlantification” will continue, leading to local extinction of endemic species and the establishment of temperate species in Arctic marine ecosystems.

Background

Research at the international research and monitoring facility in Ny Alesund, Svalbard, is organized in four topical research areas: Flagship programmes.

The Kongsfjord ecosystem is situated in the transition of an Arctic to Atlantic fjord system. It is, thus, regarded as particularly susceptible to the impacts of climate change. While the outer fjord is much influenced by Atlantic water advected from the west Spitsbergen Current, the inner part represents rather Arctic conditions strongly influenced by freshwater runoff from large tidal glaciers. Because of the dual Atlantic-Arctic inputs, the fjord hosts pelagic and benthic communities that comprise a mixture of boreal and Arctic flora and fauna, which varies seasonally as well as interannually. Recent hydrographic changes have resulted in a pre-mixed inflow of Atlantic water into the fjord system during winter, which may have driven the system into a “regime-shift” from a cold system (prior to 2000) to a “warm system” with winter temperatures > 0 °C and little tidalc in the fjord.

Aims

The Kongsfjord flagship thrives for increasing interdisciplinary, international cooperation. To define research priorities and perspectives the overarching hypotheses and research questions have been defined de novo.

References

Research priorities for marine biological research in Kongsfjorden have been defined in the perspective paper: Bischof K et al. (submitted) “Kongsfjorden as harbinger of the future Arctic” in essence, prehense and research priorities. In: Hop H, Wiese C (eds) Advances in Polar Ecology: Ecosystem Kongsfjord. Svalbard. Springer Publisher.

Acknowledgements

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Six workpackages

WP 1: Physical, chemical and ecological observations (F. Cottier)

WP 2: Contaminant flow and deposition (G. W. Gabrielsen)

WP 3: Land-sea-atmosphere interactions (K. Bischof)

WP 4: Seasonal control of the nutrient regime (C. Jimenez)

WP 5: Response to key environmental drivers and potential for acclimation and adaptation (J.P. Gattuso)

WP 6: Approaches in modelling the Kongsfjorden/Krossfjorden ecosystem (P. Duarte)

Aim for interdisciplinary & international cooperation projects

-> Meeting in Tromso coming up 14-16 May 2018
Side meeting

Program Thursday
09:00 – 12:00 
Room „HYDRA“ Level 2

*Kongsfjorden System in Ny-Ålesund* Chair: Prof. Kai Bischof, University of Bremen, and the Kongsfjorden System in Ny-Ålesund.

Informal discussion on research priorities and interdisciplinary research initiatives within the Kongsfjord Flagship.
Marine Research in Svalbard

Four overview talks:
Monitoring, sea-ice, heavy metals, tidewater glaciers

Specific topics:
Sediment input, Polar night, multiple stressors, contaminants, (de-)calcification....
Success!

Thanks to: