Project information

Project title
Establishing the current status of ocean acidification in the Norwegian Arctic - OA state
Year
2012/2013
Project leader
Agneta Fransson, NPI and Kai Sørensen, NIVA
Participants

Project leaders:

- Agneta Fransson (NPI) and Kai Sørensen (NIVA)

Participants:

- Melissa Chierici (IMR), Are Olsen (IMR)
- Mats Granskog (NPI), Edmond Hansen (NPI), Arild Sundfjord (NPI), Vladimir Pavlov (NPI)
- Evgeniy Yakushev (NIVA) and Richard Bellerby (NIVA)

Flagship

Ocean acidification, Theme: Understanding the physical and chemical mechanisms controlling ocean acidification in Arctic waters - past, present and future

Collaboration with the flagship “Sea-Ice in the Arctic Ocean, technology and agreements” for the ICE and NPI Fram Strait and A-TWAIN expeditions.

Funding Source
Fram Centre, in kind
Summary of Results

- First investigation of CO2 system and OA state in 79°N fjord area (79N –fjord is one area with large glacier melt-water outflow from the Greenland Ice Sheet)
- **Found layer with low pH/low CaCO3 saturation (high CO2)** coinciding with high organic matter content and high brine fraction

→ hypothesis: high CO2 due to a combination of bacteria respiration and transport of surface CO2 to deeper layer via brine (sea-ice formation) transport.

- Large and successful sampling campaign in several parts of the Arctic, resulting in a unique data set covering ocean acidification data, and tracers for studies on the effect of freshwater on OA state. Planned start of time series in Arctic for OA studies during Fram Strait annual cruises and along A-TWAIN mooring section if continued.
- First seasonal data set in the Fram Strait from autonomous water samplers and new deployment of two samplers at 5°W.
- New deployment of two automated water samplers for weekly samples in the East Greenland Current at approximately 5°W, 79°N.

Published Results/Planned Publications

Peer-viewed publication

- Yakushev E. , and K. Sørensen. On seasonal changes of the carbonate system in the Barents Sea: observation and modeling, Marine biology research, 2012

Publications (reports)

- Chierici, M., K. Sørensen., T. Johannessen., K.Y. Børsheim., A.Olsen., E. Yakushev., A. Omar., S. Lauvset., T.A. Blakseth. 2012. Tillførselprogrammet 2011, Overvåking av havsforsuring av norske farvann, Rapport, Klif, TA2936 2012.

Book Chapter:

- Papakyriakou, Carnat, Chierici, Delille, Else, Fransson et al., 2012. Air-sea CO2 exchange and carbon source/sink dynamics in the Southeast Beaufort Sea, In: ” On the Edge”, Editor: D. Barber, Univ of Manitoba Press, Winnipeg, Canada

Conference/workshop proceedings: Five international conferences

- Participation at the Third International Symposium on the Ocean in a High CO2 World, Monterey, USA, 24-27 September

2012. www.highco2-iii.org

Contributed with a total number of three poster and one oral presentations supported by the Fram Centre (incentive funding):

Abstracts (e.g.):

- Author/presenter: Knut Yngve Børsheim, IMR Title: Growth and composition of phytoplankton cultivated at constant pH in present and future pCO2 scenarios Session/Date/Time/Type: Impacts of ocean acidification on food webs and fisheries, 26 September, 17:00, oral presentation

Biological experiments for the investigation of ocean acidification effects meet with the challenge of keeping carbonate chemistry in growth media under strict control. All living organisms are either net producers or consumers of CO2, and media for microorganisms are usually heavily buffered to avoid major pH changes. This strategy is not recommended when the purpose of the experiment is to simulate natural carbonate chemistry in future scenarios with elevated pCO2 levels. We have designed a facility where future pCO2 scenarios are produced and controlled in large tanks that serve to feed experimental aquaria for various types of marine plankton organisms.

The investigation presented here has incorporated phytoplankton cultures into this facility. The cultures are enclosed in dialysis tubes, which conveniently serve to keep the microalgae confined while also allows the carbonate chemistry to continually equilibrate with the large volume of strictly controlled seawater circulating in the system. The half life of the [H+] in the dialyzed cultures were approximately 17 minutes, sufficient to keep the pH in the enclosure essentially constant. The effects of four regimes from of pCO2 from 380 ppm to 1000 ppm on the chemical composition and growth of the cultures were investigated. A further refinement of the experimental set up will involve feeding of zooplankton with phytoplankton cultures reared at future pCO2 scenarios.

- Authors/presenter: Agneta Fransson, M. Chierici , L.A. Miller, G. Carnat, E. Shadwick, H. Thomas, T.N. Papkyriakou. Title: Effect of sea ice and brine rejection on the CaCO3 saturation state in the Amundsen Gulf, Arctic Ocean.

Session/Date/Time/Type: “Biogeochemical consequences of ocean acidification and feedbacks to the Earth system”, poster presentation was posted two days and presented 24th and 25th September 2012 between 17:30 to 19:30.

During the Circumpolar Flaw Lead System study, in the southern Beaufort Sea and Amundsen Gulf from November 2007 to May 2008, we sampled sea ice of various thicknesses, brine and under-ice water (UIW) to follow the seasonal evolution and rejection of total inorganic carbon (CT), total alkalinity (AT) and salinity with brines. Most of the changes in sea ice CT concentration were explained by brine rejection. This resulted in increased CT, salinity, and density in the under-lying water. The difference between measured CT increase in UIW and than what was lost from the ice due to brine rejection was attributed to CaCO3 particles trapped in the ice and/or CO2 outgassing from the ice, or primary production. The AT:CT ratio and carbonate ion concentrations were at a minima in the ice-water interface during March, which is consistent with CaCO3 precipitation in the ice. It is evident from our study that the sea-ice dynamics influence the variability of calcium-carbonate saturation.

Manuscript in preparation

- Chierici, M., A. Fransson, M. Granskog, P. Dodd, E. Hansen. The ocean acidification state in a Greenland fjord at 79°N influenced by glacier meltwater. In preparation.
- Fransson A., Chierici, M., Granskog, P. Dodd, C. Stedmon, E. Hansen. Influence of freshwater Arctic Ocean outflow for the ocean acidification state. In preparation.
- Dodd P., E. Hansen, M. Granskog, A. Fransson, M. Chierici, C. Stedmon, Precipitation in the Arctic Ocean outflow quantified with concurrent δ18O and AT measurements. In preparation.
- Chierici et al. Variability of CO2 flux, carbon transport and ocean acidification state in Fram Strait Polar waters.

Communicated Results

In review board for the AMAP report for Arctic Ocean Acidification (www.amap.no) and contributed with data and expertise (M. Chierici , A. Fransson, M. Granskog)

Workshops

- International workshop to develop an Ocean Acidification Observing Network of ship surveys, moorings, floats and gliders, Univ. of Washington, Seattle, USA 26-28 June, 2012. (M. Chierici, invited for expertise). www.noaa.pmel.gov/co2/OA2012Workshop
- Participated in delegation for Norway-Japan Business and technology Forum, Tokyo, Japan, 2 November 2012. M Chierici oral presentation. injapan.no/bizdelegation-day2/agenda/#f-track
- Ocean Acidification seminar day 30th Nov, 2012, SMHI/Univ of Gothenburg, Sweden. (A. Fransson invited presentation, M. Chierici invited)
- Workshop on Arctic freshwater in Lerici, Italy, Oct. 2012 (presentation by Granskog et al.)
- The Third International Symposium on the Ocean in a High CO2 World, Monterey, USA, 24-27 September 2012. www.highco2-iii.org

OA Flagship meetings

- OAstate: Status report and presentation (Chierici et al.) at two OA Flagship meetings in April and September 2012.

Public presentations

- Vaardal-Lunde,J., Chierici, M., and A. Fransson: “Lance in Fram Strait 2012”movie for public use to enhance awareness of the procedure in the field to sample and investigate for several scientific issues such as: ocean acidification, sea-ice physics and chemistry, and methodology. In December 2012 placed at: www.framshorts.com and www.imr.no
- Chronicle in Fram Forum magazine ”Ocean acidification in high-latitude oceans – Does the Arctic turn acid? – Towards understanding ocean acidification in the Arctic ”submit in 2012
- Data base: Provide data for the data bases SOCAT, GLODAP and MOSJ

Interdisciplinary Cooperation

The inter-disciplinary cooperation between chemical and physical oceanographers offers a wide range of knowledge and contribution to the project, especially regarding the study of the water masses and Arctic outflow in Fram Strait**.** The carbonate system and ocean acidification part are added from 2011. Only positive aspects. Unique possibility to understand the underlying mechanisms if this work can continue.

Disciplines involved in the project:

- Physical oceanography (water column studies such as stratification, water mass)
- Chemical oceanography (carbonate system and OA state in water column)

We have collaboration with biological oceanographers for nutrients availability in the water column and as tracers.

Budget in accordance to results

The project funding has been fundamental to implement this project. It supports the hiring of A. Fransson (project post doc and PI), and supports the high costs associated with Arctic field work and extensive sample analysis required in the work. It has also supported to acquire state-of-the-art instrument that are needed for measurements outside the time in the field. However, the funds have to be supplemented by significant external and in-kind contributions (IMR, NPI, NIVA) for successfulness.

Fram Centre funding boosted joint effort to establish time serie section north of Svalbard with other Flagship and between institutes/universities.

Fram Centre funds have supported:

- Salary to A. Fransson (Project post doc – 7 months)
- Purchase of autonomous water sampler (mainly 2011 funds)
- Purchase of pCO2 sensor (SICCA+OAstate, 2012)
- Field work and travel
- Chemical analyses
- Field equipment (partly)
- Supported attendance to conference and workshops

Could results from the project be subject for any commercial utilization

No

Conclusions

a) Continuation of the inter-annual study of the physical and chemical properties of water masses, and outflow of Arctic water in the Fram Strait. Add chemical sensors on the moorings in future (Fram Strait (NPI) and A-TWAIN). Need to link our work with research done in the Canadian Archipelago, the other important gateway for exchange. Collaboration initiated 2012.

b) New chemical sensors such as CO2 sensors to put on moorings are needed to obtain information on the seasonal variability of the carbonate system and ocean acidification.