Project information

Project title
ECOAN WP1-OA2 Ocean Acidification and biogeochemical drivers OADRIVER
Year
2015
Project leader
Agneta Fransson (NPI) and Melissa Chierici (IMR)
Participants

Mats Granskog (NPI)

Helene Hodal lødemel (IMR)

Collaborators:

Eva Falck (UNIS)

Daiki Nomura (Hokkaido University, Japan)

Ellen Damm (AWI, Germany)

Gernot Nehrke (AWI), Gerhard Dieckman (AWI)

Flagship
Ocean Acidification
Funding Source

Fram Centre (KLD), NFD, in kind from NPI and IMR

Summary of Results

Large emphasis in 2015 has been the N-ICE 2015 expedition with sample collection and analyses covering winter to spring data of sea ice and under-ice water. We also continued to write and publish results from previous years (2012-2013) of studies in the Tempelfjorden (Figure 1) and to a smaller extent field work in April. A one-day field study for complementary measurements of physical and chemical parameters was conducted in Tempelfjorden in April 2015 All the water samples were analysed for dissolved inorganic carbon (DIC), total alkalinity (A_T), phosphate, silicate, nitrate, and stable isotopic ratio of oxygen.

In 2015, we published the findings that the two contrasting years in atmospheric and fjord

hydrographical conditions resulted in large interannual differences in in the water column under the sea ice. Preliminary results also showed variability in all parameters between the two years in winter in sea ice as an effect of biological processes, glacial melt water and Atlantic water during the contrasting years and sea-ice conditions. Influence of glacial water was observed in the underlying water at stations near the glacier, affecting pH and aragonite saturation.

Unique sea ice and under-ice water data was obtained during the drift expedition N-ICE 2015 (January to June) for seasonal studies (winter-to-spring) of the carbonate system, CO2 gas fluxes, ocean acidification state and the driving biogeochemical processes

For the Management

Glaciers have the potential to contribute with alkalinity thereby mitigating for part of the OA decrease due to freshening.

- Sea ice contributes to alkalinity during melting in spring, hence partly mitigates OA and increases the potential for more ocean uptake of atmospheric CO_2

- OA studies in Svalbard fjords in collaboration with Monitoring of Svalbard and Jan Mayen-MOSJ project (NPI), shows large variability of pH and OA state in the fjord-water column. Necessary to continue to fill in data gaps to increase knowledge on biological and chemical coupling for calcifiers in the fjord.
- Sampling of Limacina helicina and studies of shell thickness and isotopic ratio shows variability. Mechanism behind not certain.
- Competence and expertise for sea ice chemistry studies has advanced rapidly at Fram centre. Contribute with knowledge transfer to other science fields.

All projects produce data necessary for data bases, models and validations.

Published Results/Planned Publications

Peer-viewed publications in 2015

Fransson A., M. Chierici, H. Findlay, H. Hop, S. Kristiansen, A. Wold. Seasonal of change ocean acidification state in Kongsfjorden, with implications for calcifying organisms. Submitted, 2015.

Fransson A, M Chierici, P Dodd, M Granskog, C Stedmon, E Hansen. Feedbacks of freshwater and primary production on the carbonate system, air-sea CO_2 fluxes and ocean acidification state in the Nioghalvfjerdsfjorden and Djimphna Sound, NE Greenland. Submitted.

Fransson A. M. Chierici, D. Nomura, M. A. Granskog, S. Kristiansen, T. Martma, G. Nehrke. Effect of glacial drainage water on the CO_2 system and ocean acidification state in an Arctic tidewater-glacier fjord during two contrasting years. Journal of Geophysical Research: Oceans DOI 10.1002/2014JC01032.

Fransson, A., M. Chierici., K. Abrahamsson., M. Andersson., A. Granfors., K. Gårdfeldt., A. Torstensson., A. Wulff. 2015. Development of the CO2 system in young and new sea ice and CO2-gas exchange at the ice-air interface through brine transport and frost flowers in Kongsfjorden, Svalbard. Annals of Glaciology 56(69), 245-257, doi:10.3189/2015AoG69A563

Miller L.A., (Fransson A.) et al. 2015 Methods for biogeochemical studies of sea ice: The state of the art, caveats, and recommendations. Elementa Special Feature Biogeochemical Exchange Processes at

Sea Ice Interfaces (BEPSII), 2015.

Related papers (supported partly by FRAM):

Torstensson, A., J. Dinasquet, M. Chierici, A. Fransson, L. Riemann, A. Wulff. 2015. Physicochemical control of bacterial and protest community composition and diversity in Antarctic sea ice, Environmental Microbiology, DOI: 10.1111/1462-2920.12865

Planned publications/in preparation:

Fransson A. M. Chierici, D. Nomura, M. A. Granskog, S. Kristiansen, T. Martma, G. Nehrke. Variability of sea-ice CO_2 system and influence of glacial water and ikaite formation in a Spitsbergen fjord (Tempelfjorden) - two contrasting years. To be submitted in 2015.

Fransson A. et al., Seasonal impact of sea-ice processes on calcium carbonate saturation in the East Greenland Current. In prep.

Fransson A. et al., Export of sea-ice inorganic carbon from Arctic Ocean: implication for ocean acidification. In prep.

Communicated Results

Conferences/workshops 2015:

Gordon Research Conference GRC Polar Marine Sciences, Il Ciocco, Italy (posters: Tempelfjorden + 79N fjord/Djimphna), 24 March 2015,

FRAM Science Days, 10-11 th Nov 2015 FRAM Science Days (main organizer + contribute 2 poster presentations)

OA flagship workshop on Calanus and socioeconomic modeling, November 2015 at NORUT.

N-ICE mini works shops at NPI every week, Sept to Dec 2015. Presentation (Fransson) of gases and carbonate system.

N-ICE Data and publication workshop, 17-19 November 2015, Malangen, Norway.

Norske havforskermøte, October 2015, Bodø, Norway (2 poster presentations)

Conference abstracts 2015:

Fransson A, Chierici M, Nomura D, Granskog MA, Kristiansen S, Martma T, Nehrke G. Effect of glacial

drainage water on the CO_2 system and ocean acidification state in an Arctic tidewater-glacier fjord during two contrasting years. Abstract for poster presentation at GRC conference, Italy, March, 2015

Fransson A, Chierici M, Nomura D, Granskog MA, Kristiansen S, Martma T, Nehrke G. Effect of glacial drainage water on the CO_2 system and ocean acidification state in an Arctic tidewater-glacier fjord during two contrasting years. Abstract for poster presentation at FRAM Science days, Tromsø, November 2015

Fransson A, Chierici M, Nomura D, Granskog MA, Kristiansen S, Martma T, Nehrke G. Effect of glacial drainage water on the CO_2 system and ocean acidification state in an Arctic tidewater-glacier fjord during two contrasting years. Abstract for poster presentation at IGS Ocean-Ice sheet Interaction, Cambridge, UK, August 2015

Fransson A, Chierici M, Dodd P, Granskog MA, Stedmon C, Hansen E. Feedbacks of glacial water and primary production on the carbonate system and ocean acidification state in the Djimphna Sound fjord system, NE Greenland. Abstract for poster presentation at IGS Ocean-Ice sheet Interaction, Cambridge, UK, August 2015

Fransson A, Chierici M, Dodd P, Granskog MA, Stedmon C, Hansen E. Feedbacks of glacial water and primary production on the carbonate system and ocean acidification state in the Djimphna Sound fjord system, NE Greenland. Abstract for poster presentation at FRAM Science days, Tromsø, November 2015

Fransson A, Chierici M, Dodd P, Granskog MA, Stedmon C, Hansen E. Feedbacks of glacial water and primary production on the carbonate system and ocean acidification state in the Djimphna Sound fjord system, NE Greenland. Abstract for poster presentation at Norske Havforskermøte, October 2015

Nomura D, B. Delille, G.S. Dieckmann, M.A. Granskog, J.-L. Tison, K.M. Meiners, A. Fransson, K.I. Ohshima, T. Tamura. Mid-winter surveys of sea ice biogeochemistry in polar oceans. Abstract for Goldschmidt Conference, Prague, August 2015

Interdisciplinary Cooperation

The project has had great benefit of the large collaboration between the natural science disciplines. In particular, inter-disciplinary cooperation between chemical and physical oceanographers and biologists in the Svalbard fjord studies and the N-ICE 2015 expedition offers a wide range of knowledge and contribution to the project. Only positive aspects.

For all studies (including Fram Strait expedition and N-ICE), we collaborated with biologists regarding nutrient availability. For the fjord studies of the sea ice, we also collaborated with biologists from University of Gothenburg regarding bacterial and sea-ice algae activity in sea ice and underlying water. Only positive aspects.

N-ICE work was performed in collaboration with biologists and ice-physics specialists. Only positive aspects.

Collaborations on the sea-ice CO_2 system study with Japanese scientists at Hokkaido University.

Extended collaboration with AWI for methane studies in sea ice and crystal content in sea ice.

Budget in accordance to results

Yes. The project funding has been fundamental to implement this project. It supports the hiring of A. Fransson (project PI), and supports the high costs associated with Arctic field work and extensive sample analysis required in the work, in particular obtained from N-ICE winter-to-spring study.

For the Svalbard fjord study, funding was used to support one field activities in April, which could not have been performed without the funding. It also supported sampling and analysis of several chemical and physical parameters which are used as tracers for water mass composition.

Field work, travel costs for personal and instrumentation

Field equipment (partly)

Reagents and devices (electrodes, pipettes etc.)

Certified Reference Material, chemicals, sampling bottles, and transportation of equipment.

Although the project relies on IMR and NPI research platforms such as ships and laboratories and in-kind contribution, the project could not have been performed without the funding.

Could results from the project be subject for any commercial utilization

No

Conclusions

- Two contrasting winters with different sea-ice conditions resulted in lower aragonite saturation in winter 2012 compared to in winter 2013

- Sea ice contributes to alkalinity during melting in spring due to dissolution of ikaite crystals in the ice, hence partly mitigating OA and increasing the potential for more ocean uptake of atmospheric CO_2

- Increased freshwater leads to decreasing $CaCO_3$ saturation (Ω). However, glacial drainage water added carbonitic crystals of dolomite and calcite, with the capacity to partly mitigate against part of the decrease in Ω and OAstate.
- Tempelfjorden acted as a net annual CO_2 sink for atmospheric CO_2.