



International  
Science Council

SCAR Sub-Group

SG / SC

Person Responsible:

BEPSII

LS

Jacqueline  
Stefels

## XXXVII SCAR Delegates Meeting

India, September 2022

# Biogeochemical Exchange Processes at Sea-Ice Interfaces

## BEPSII – Expert Group

### 2020-22 Report

#### Summary

In 2018, BEPSII became an Expert Group under the Life Sciences. BEPSII is also endorsed by SOLAS (the Surface Ocean-Lower Atmosphere Study), CliC (Climate and Cryosphere) and receives funding from these programs and occasionally also from IASC (International Arctic Science Committee), in addition to from SCAR.

Due to the pandemic all meetings in the current reporting period were held online. As a result, there were no meeting costs and it was decided to use the funds to increase the support of young scientists through the organization of a new ECS exchange program between BEPSII-affiliated labs and through the organization of a BEPSII sea-ice field school, which took place from 14-23 May 2022 at the Canadian High Arctic Research Station (CHARS), Cambridge Bay, Canada.

Further ongoing activities within BEPSII are:

- data collations of specific variables (DIC & TA, nutrients, POC/N, DOC/N) from historic sea-ice expeditions from around Antarctica, with the aim to validate sea-ice biogeochemistry models and to estimate the distribution of these key biogeochemical properties in both Antarctic and Arctic sea ice;
- production of community-based position analyses and policy documents on sea-ice associated (eco)systems with an emphasis on the impact of biogeochemical processes; and
- collaboration with other sea-ice associated science communities, through new project and networking proposals (e.g., the new Clce2Clouds SCOR working group).

#### Report Author(s)

Jacqueline Stefels, the Netherlands; Jeff Bowman, USA

#### Summary of activities from 2020-22

Highlights:

- Following detailed evaluations, data collations, observation and model studies, BEPSII applied its collective expertise to compile several policy relevant community science papers, two of which were published in 2020. In 2021, a synthesis of climate change impacts on sea-ice ecosystems and associated ecosystem services was published in *Elementa: Science of the Anthropocene* (Steiner et al. 2021). The main outcomes of the three publications have been compiled into a **policy brief**, which has been circulated widely and received significant international attention including at the COP26 Cryosphere Pavilion. (see below for references)

- The 2021 **synthesis of the sea-ice ecosystem and associated ecosystem services** highlights that: 1. The sea-ice ecosystem supports all four ecosystem service categories; 2. sea-ice ecosystems meet the criteria for ecologically or biologically significant marine areas (EBSAs); 3. global emissions driving climate change are directly linked to the demise of sea-ice ecosystems and its ecosystem services; and 4. the sea-ice ecosystem deserves specific attention in the evaluation of marine protected area planning. The ongoing changes in the polar regions have extreme impacts on sea-ice ecosystems and associated ecosystem services. While the response of sea-ice associated primary production to environmental change is regionally variable, the effect on ice-associated mammals and birds are predominantly negative, subsequently impacting human harvesting and cultural services in both polar regions. Conservation can help protect some species and functions. However, the key mitigation measure is a reduction in carbon emissions.
- A **joint BEPSII-CATCH (Cryosphere and Atmospheric Chemistry) SCOR working group** was launched in November 2021 (SCOR-WG 163: *Clce2Clouds: Coupling of ocean-ice-atmosphere processes: from sea-Ice biogeochemistry to aerosols and Clouds*). The new WG aims to better link the communities and help improve understanding and model parameterizations of biogeochemical processes in sea-ice regions, which may impact the local and global climate and are insufficiently represented in current earth system models.
- In February/March 2021, a small sea ice **inter-comparison experiment** for CO<sub>2</sub> flux took place in Saroma-ko Lagoon, Hokkaido Japan. Nomura et al. compared the CO<sub>2</sub> flux data measured by the different type of chambers. In addition, equipment such as air–sea ice CO<sub>2</sub>/CH<sub>4</sub> flux chambers and an eddy covariance system, a trace metal analyzer, and a pump and sampler for environmental DNA were tested.
- A major field inter-comparison experiment was conducted in May 2022 at CHARS, Cambridge Bay, Canada. This experiment lasted 6 weeks and included more than 15 scientists and examined methods for measuring gas fluxes, gas concentrations, primary production, and biomass. This experiment was the last intercomparison experiment carried out by the ECV-Ice SCOR working group.
- The May 2022 inter-comparison experiment was associated with the **BEPSII field school**, to efficiently make use of scientists/teachers available for both activities. The field school was extremely successful. Although we got the green light only 3 months before the event, over 100 students and Early Career Researchers (ECRs) applied for the 30 places available.
- Both in 2020 and 2021, the **annual BEPSII meetings** were held online. Various discussion sessions, science presentations and specific ECR sessions were organized in an around-the-world set-up. These were well received, but there was also a general feeling that an in-person meeting every now and then is needed to stimulate creativity and collaboration. It was decided for the future to try to organize in-person meetings every second year in association with a relevant science meeting and use the funds for an ECR exchange program in alternate years.
- In 2020, a new BEPSII Special Feature of *Elementa Science of the Anthropocene* was opened: Insights into Biogeochemical Exchange Processes at Sea Ice Interfaces (BEPSII-2). Currently 8 papers have been published within this feature.

#### Summary Budget 2021 to 2024

	2021	2022	2023	2024
	Spent	Allocated	Request	Request
(US\$)	\$ 2000	\$ 10 771	\$ 4000	\$ 4000

## Progress to date

### Sub-group Outcomes Summary

Sub-group	Activity/Outcome/Benefit/Achievement
BEPSII	As an outcome of a 3-day side meeting of the POLAR2018 conference, the BEPSII community published a paper describing a policy-oriented position analysis on the future of Arctic sea-ice biogeochemistry and ice-associated ecosystems (Lannuzel et al. 2020, <i>Nature Climate Change</i> )
BEPSII	Publication of a commentary from the BEPSII community on Implications of Sea-Ice Management for Arctic Biogeochemistry (Miller et al. 2020, <i>EOS</i> )
BEPSII	Publication of a synthesis paper on the role of sea ice in supporting ecosystems and ecosystem services (N. Steiner et al. 2021, <i>Elementa Science of the Anthropocene</i> )
BEPSII	Launch of a new special issue in the journal <i>Elementa - Science of the Anthropocene: 2020-2022</i> . So far with 8 published papers. ( <a href="https://online.ucpress.edu/elementa/collection/8273/Special-Feature-Insights-into-Biogeochemical">https://online.ucpress.edu/elementa/collection/8273/Special-Feature-Insights-into-Biogeochemical</a> )
BEPSII	In 2021, a <i>Policy Brief</i> was distributed through our sponsor networks and at the COP26 Cryosphere Pavilion.
BEPSII	Many BEPSII members participated in the year-round Arctic sea-ice expedition MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate as part of the BGC Team; <a href="https://mosaic-expedition.org/expedition/">https://mosaic-expedition.org/expedition/</a> ). Oct. 2019 – Oct. 2020
BEPSII	February/March 2021, a sea-ice inter-comparison experiment for CO <sub>2</sub> flux measurements, Saroma-ko Lagoon, Hokkaido Japan. (Nomura et al. 2022, <i>Bulletin of Glaciological Research</i> )
BEPSII	A joint method inter-comparison experiment in Cambridge Bay, Canada, May 2022 (B. Else and ECV-Ice SCOR working group)
BEPSII	A BEPSII field school for early career scientists in Cambridge Bay, Canada, May 2022 (L. Tedesco et al.)
BEPSII	Initiation of a joint BEPSII-CATCH (Cryosphere and Atmospheric Chemistry) SCOR working group aiming to improve our understanding and model parameterizations of biogeochemical processes in ocean - sea-ice - atmosphere systems. Nov. 2021
BEPSII	24-28 August 2020 around-the-world online annual meeting + ECS meeting on 21 August. Approx. 65 subscribers
BEPSII	23-27 August 2021 around-the-world online annual meeting + ECS meeting on 20 August. Approx. 85 subscribers

### Sub-group Cash Flow

(Since previous report to Delegates in 2020)

Sub-group	Allocation	Amount spent		
		2020	2021	2022
BEPSII	\$ 4000	-	\$ 2000	\$ 10 771*

\* Due to a very generous re-allocation of unspent funds within the LS-SG community, we were able to use these funds for the organisation of the BEPSII field school, in May 2022.

## Future plans

### Planned activities in 2022 to 2024

Sub-group	Planned activity
BEPSII	An updated synthesis on the sea-ice carbon pump (BEPSII carbon cycle experts, led by Sebastien Moreau (Norway), in preparation)
BEPSII	Data collation and synthesis on nutrients in landfast Antarctic sea ice has been initiated by Sian Henley (UK)
BEPSII	Data collation & synthesis on POC/DOC/PON/DON in Antarctic sea ice and Chlorophyll-a in Arctic sea ice has been delayed, but is still in the pipeline
BEPSII	A policy-oriented position analysis “Antarctic sea-ice change: Biogeochemical and Ecological Consequences” (Klaus Meiners et al. Australia)
BEPSII	Publication of a review “Polar Seas and Sea Ice” as a contribution towards a SOLAS – special issue in <i>Elementa: Science of the Anthropocene</i> . (Else, Lannuzel, Willis et al.)
BEPSII	Production of a Special Collection “Antarctica and the Southern Ocean” in <i>Frontiers for Young Minds</i> . Lead by BEPSII ECR member Pat Wongpan (Australia) and Letizia Tedesco (Finland)
BEPSII	Preparing for a joint BEPSII-CATCH field campaign in the Antarctic to assess biogeochemical exchange processes between ocean, sea ice and the atmosphere. Collaborative effort within the new Clce2Clouds working group.
BEPSII	Coordinating an Ice Algae Model Intercomparison Project Phase 2 (IAMIP2) by Hakase Hayashida (Japan)
BEPSII	Special session on emerging technologies for sea-ice biogeochemical measurements and monitoring at the 2023 International Glaciological Society Symposium on Sea Ice, Bremerhaven, Germany, June 4-9.

### Planned use of funds for 2022 to 2024

Year (YYYY)	Purpose/Activity	Amount (in USD)	Contact Name	Contact Email
2023	In-person annual meeting in San Diego, CA, USA	\$ 4000	Jeff Bowman	jsbowman@ucsd.edu
2024	ECR exchange program	\$ 4000	Jacqueline Stefels	j.stefels@rug.nl
<b>Total</b>		\$ 8000		

### Any additional detail on funds usage and desired results/outcomes

2023: The in-person meeting is associated with the Gordon Research Conference on Polar Marine Science.

2024: Every second year, the annual meeting will be online, so that funds can be spent on an exchange program for ECRs, between BEPSII-associated labs. The 2 ECRs on the BEPSII Steering Committee will lead the award process.

**Percentage of the budget to be used for support of early-career researchers**

2022: 100%

2023: ~50%

2024: 100%

**Percentage of the budget to be used for support of scientists from countries with developing Antarctic programmes**

2022: ~5%

2023: ~10%

2024: ~20%

## Membership

### Leadership

Role	First Name	Last Name	Affiliation	Country	Primary Language	Email	Date Started
Co-chair	Jacqueline	Stefels	University of Groningen	Netherlands	Dutch	<a href="mailto:j.stefels@rug.nl">j.stefels@rug.nl</a>	Sept. 2016
Co-chair	Jeff	Bowman	Scripps Institute of Oceanography	USA	English	<a href="mailto:jsbowman@ucsd.edu">jsbowman@ucsd.edu</a>	Sept. 2016
ASPeCT liason	Klaus	Meiners	Australian Antarctic Division	Australia	German	<a href="mailto:Klaus.Meiners@aad.gov.au">Klaus.Meiners@aad.gov.au</a>	Sept. 2016
member	Maria	van Leeuwe	University of Groningen	Netherlands	Dutch	<a href="mailto:m.a.van.leeuwe@rug.nl">m.a.van.leeuwe@rug.nl</a>	Sept. 2016

(Please identify early-career researchers with \* in first column)

**Other members** (These members are BEPSII steering committee members, together with two of the SCAR EG members. In addition, there are ~200 people on the mailing list)

First Name	Last Name	Affiliation	Country	Primary Language	Email
Nadja	Steiner	Fisheries & Oceans Canada	Canada	German	<a href="mailto:Nadja.Steiner@ec.gc.ca">Nadja.Steiner@ec.gc.ca</a>
Martin	Vancoppenolle	LOCEAN – UPMC, Paris	France	French	<a href="mailto:martin.vancoppenolle@locean-ipsl.upmc.fr">martin.vancoppenolle@locean-ipsl.upmc.fr</a>
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Pat *	Wongpan	University of Tasmania	Australia	Korean	<a href="mailto:pat.wongpan@utas.edu.au">pat.wongpan@utas.edu.au</a>

(Please identify early-career researchers with \* in first column)

## Additional information (optional)

### Notable Papers

#### Selected top publications:

1. D. Lannuzel, L. Tedesco, M. van Leeuwe, K. Campbell, H. Flores, B. Delille, L. Miller, J. Stefels, P. Assmy, J. Bowman, K. Brown, G. Castellani, M. Chierici, O. Crabeck, E. Damm, B. Else, A. Fransson, F. Fripiat, N.-X. Geilfus, C. Jacques, E. Jones, H. Kaartokallio, M. Kotovitch, K. Meiners, S. Moreau, D. Nomura, I. Peeken, J.-M. Rintala, N. Steiner, J.-L. Tison, M. Vancoppenolle, F. Van der Linden, M. Vichi, P. Wongpan (2020) The future of Arctic sea-ice biogeochemistry and ice-associated ecosystems. *Nature Climate change* <https://doi.org/10.1038/s41558-020-00940-4>

This paper is the outcome of a 3-day side meeting of the POLAR2018 conference and describes BEPSII's community view on the future of Arctic sea-ice biogeochemistry and ice-associated ecosystems.

2. L. Miller, F. Fripiat, S. Moreau, D. Nomura, J. Stefels, N. Steiner, L. Tedesco, M. Vancoppenolle (2020) Implications of sea ice management on Arctic sea ice biogeochemistry. *EOS*, 101, <https://doi.org/10.1029/2020EO149927>.

This work provides a commentary from the BEPSII community on Implications of Sea-Ice Management and geo-engineering for Arctic biogeochemistry.

3. NS Steiner, J Bowman, K Campbell, M Chierici, E Eronen-Rasimus, et al. (2021) Climate change impacts on sea-ice ecosystems and associated ecosystem services, *Elem Sci Anth* 9 (1), <https://doi.org/10.1525/elementa.2021.00007>

This paper is a synthesis on the role of sea ice in supporting ecosystems and ecosystem services in both polar regions.

4. Steiner, N., Stefels, J., Bowman, J. S., Castellani, G., Crabeck, O., Delille, B., Else, B., Flores, H., Fripiat, F., Lannuzel, D., Meiners, K., Miller, L., Moreau, S., Nomura, D., Tedesco, L., & Vancoppenolle, M. (2021). **BEPSII Arctic Policy Brief**. <https://doi.org/10.5281/zenodo.5595254>

This Policy Brief was drafted by the BEPSII SSC to summarise the main outcome of the above mentioned papers and was used as input for COP26.

5. O. Crabeck, K. Campbell, S. Moreau, M. Thomas. 2021. The movement of CO<sub>2</sub> through the frozen world of sea ice. 2021. *Frontiers for Young Minds*. 9:516072. doi: 10.3389/frym.2020.516072

This is an outreach publication for kids.

**Direct support from outside organisations received for your activities**

Organisation	Support in 2020	Support in 2021	Support in 2022
SOLAS		€ 2000	\$ 5,000
CLiC		CHF 3000	CHF 6,000
IASC			€ 8,500
SCOR (ECVice)			€ 8,000
NSF-OPP			\$ 11,944

**Major collaborations your group has with other SCAR groups and with organisations/groups beyond SCAR**

**Within SCAR**

1. ASPeCT

**Outside SCAR**

1. SOLAS
2. CLiC
3. IASC
4. SCOR
5. CATCH
6. SOOS

**Outreach, communication and capacity-building activities**

Contributions to *Frontiers for Young Minds* (publication in 2021 and plans for a collection of ~15 papers; see above), to engage kids in the wonders and importance of polar science in general and sea ice as a habitat and as a key player in climate control in particular.

**Communication & Outreach:**

*Social media:*

- BEPSII mailinglist: [bepsii@lists.scar.org](mailto:bepsii@lists.scar.org) at <http://lists.scar.org/mailman/listinfo/bepsii>
- BEPSII website: [www.BEPSII.org](http://www.BEPSII.org) (links from the SCAR website refer to this site)
- BEPSII Twitter profile: @BEPSII\_seaice

*Policy Brief* published in 2021 (see scientific highlights, above)

Our ECRs are involved in the production of a Special Feature on Antarctic research in *Frontiers for Young Minds*.

**Capacity building activities:**

- BEPSII field school in May 2022 (see above)
- Since 2020, 2 early career researchers have joined the steering committee, as a means to ensure succession planning and integrate ideas from the next generation of polar leaders. After their terms on the SSC, we hope they will continue to engage in the scientific foci of BEPSII, including new leadership roles. The ECR assignments are for two years and are selected by evaluation of applications to the SCC following a public call. At the end of 2021, two new ECR steering committee members were appointed.



### Contributions to equality, diversity, and inclusion (EDI)

In 2021, members of the BEPSII Steering committee represented 10 countries, with a 50/50 women/men balance. The steering committee has included 2 early career researchers since 2020.

With this diverse leadership team, the BEPSII community aims to express inclusiveness and openness to the global research community. Inclusion of researchers in developing countries who have an interest in polar and sea-ice research is problematic, which is at least partly due to the fact that relatively few developing countries have a strong polar research program. Researchers from South Africa are well embedded in BEPSII, and through the new SCOR working group Clce2Clouds, scientists from India and Chile are now also involved.

### SCAR fellowship reviewers

First Name	Last Name	Email	Principal Expertise
Maria	Van Leeuwe	<a href="mailto:m.a.van.leeuwe@rug.nl">m.a.van.leeuwe@rug.nl</a>	Phytoplankton ecophysiology