

Template for Annual SCOR Working Group Reports to SCOR

1. Name of group

Working Group 152, Measuring Essential Climate Variables in Sea Ice (ECV-Ice)

2. Activities since previous report to SCOR (e.g., virtual or in-person meetings, email discussions, special sessions). Limit 1000 words

In-person meeting

#1: Discussion meeting for air-ice CO₂ flux compilation, 24 July 2020 at Best Western hotel in Bremerhaven, Germany. Present: D. Nomura, B. Delille.

#2: Discussion meeting for sea ice storage for sea ice tank experiment at University of East Anglia, UK, 31 July 2020 at Best Western hotel in Bremerhaven, Germany. Present: D. Nomura, B. Delille.

#3: Discussion meeting for comparison of CO₂ flux measurements by chamber and eddy covariance method for MOSAiC data, 29 Sep. 2020 at R/V Polarstern during MOSAiC leg. 5. Present: D. Nomura, B. Blomquist, H. Angot, K. Posman.

#4: Discussion meeting for air-ice CO₂ flux compilation, 14 Oct. 2020 at Havenhostel in Bremerhaven, Germany. Present: D. Nomura, B. Delille.

#5: Discussion meeting for comparison of CO₂ flux measurements by chamber and eddy covariance method at Saroma-ko Lagoon, 10 Mar. 2021 at Neipal Kitami, Japan. Present: D. Nomura, H. Ikawa, Y. Kondo, T. Noshiro, N. Kanna, M. Tozawa.

Inter-comparison Experiment

#1: Sea ice inter-comparison experiment for CO₂ flux in the central Arctic during MOSAiC leg. 5, Aug.-Sep. 2020. Present: D. Nomura, B. Blomquist, H. Angot, K. Posman.

#2: Sea ice inter-comparison experiment for CO₂ flux in Saroma-ko Lagoon, Hokkaido Japan, Feb.-Mar. 2021. Present: D. Nomura, H. Ikawa, Y. Kondo, T. Noshiro, N. Kanna, M. Tozawa.

Virtual meeting

#1: Online discussion meeting for primary production compilation, 6 March 2020. Present: F. Fripiat, K. Campbell.

#2: ECV-Ice annual meeting, 24 Aug. 2020. Present: F. Fripiat, B. Else, and full and associate member.

#3: Online discussion meeting for primary production compilation, 16 Oct. 2020. Present: F. Fripiat, K. Campbell.

#4: Online discussion meeting for primary production compilation, 27 Nov. 2020. Present: F. Fripiat, K. Campbell.

#5: Online discussion meeting for primary production compilation, 12 Feb. 2021. Present: F. Fripiat, K. Campbell.

#5: Online discussion meeting for particulate organic matter compilation, 15 Apr. 2021. Present: F. Fripiat, F. Deman, H. Flores, S. Moreau.

Email discussions

#1: Planning meeting for intercomparison experiment in 2022 (late April-middle of May) at The Canadian High Arctic Research Station (CHARS), Cambridge Bay, Canada at 19 Sep. 2020. Email member: D. Nomura, F. Fripiat, B. Else.

#2: Data discussion for Gases in sea ice and sea ice-air gas flux: Roland Von Glasgow Air-Sea-Ice Chamber (University of East Anglia), January 2020. Email member: D. Nomura, B. Delille, O. Crabeck.

3. Documents published since previous report to SCOR (e.g., peer-reviewed journal articles, reports, Web pages) and should be limited to publications that resulted directly from WG activities and which acknowledge SCOR support

Peer-reviewed journal articles

#1: Nomura D, Wongpan P, Toyota T, Tanikawa T, Kawaguchi Y, Ono T, Ishino T, Tozawa M, Tamura T. P, Yabe I. S, Son E. Y, Vivier F, Lourenco A, Lebrun M, Nosaka Y, Hirawake T, Ooki A, Aoki S, Else B, Fripiat F, Inoue J, Vancoppenolle M. Saroma-ko Lagoon Observations for sea ice Physico-chemistry and Ecosystems 2019 (SLOPE2019). Bulletin of Glaciological Research, 38, 1-12, doi:10.5331/bgr.19R02, 2020.

Web page

Updated by Daiki Nomura (<https://sites.google.com/view/ecv-ice/>).

4. Progress toward achieving group's terms of reference. List each term of reference separately and describe progress on each one. Limit 1000 words

This working group gathers international experts on chemical and biological measurements in sea ice to design and coordinate required inter-comparison experiments. The group is synthesizing the results of past experiments, identifying what types of new experiments are needed, and supporting the community in executing those experiments.

Term of reference (TR) #1: Publish synthetic reviews compiled from measurements demonstrating large, unresolved discrepancies.

We compiled published and unpublished datasets (raw data, methodologies and associated protocols for data correction, instruments, and sampling design) on sea ice-air CO₂ flux and *in situ* primary production from the sea-ice research communities.

(1) Published and unpublished datasets, using various methodologies, have been collated for primary production both in the Arctic and Antarctic sea ice: incubations (¹³C, O₂, ¹⁴C), under-ice microelectrode, and biomass accumulation rates (F. Fripiat, C. J. Mundy, F. Deman, and K. Campbell). The different methods will be compared, and a mechanistic understanding of the observed

discrepancies will be elaborated. Together, this dataset represents the largest compilation of primary production rates so far in sea ice.

(2) Published and unpublished datasets have been collated to compare gas flux measurements over sea ice using chamber techniques (D. Nomura, B. Else, F. Fripiat et al.).

TR #2: Design and coordinate intercalibration experiments to evaluate different methods for key parameters.

Completed Inter-comparison Experiments:

#1: The effect of melting treatments on the assessment of biomass and nutrients in sea ice: Saroma-ko Lagoon, Hokkaido, Japan, March 2016

Participant: D. Nomura, F. Deman, H. Hattori, F. Fripiat

Summary: The impact of melting temperature and buffer addition to avoid osmotic shock was tested on ice sampled in Saroma-ko Lagoon on the northeastern coast of Hokkaido, Japan. The experiment was successful and a peer reviewed paper (Roukaerts et al., 2019) was published.

#2: Primary production measurement: Saroma-Ko Lagoon, March 2018

Participants: D. Nomura, K. Yoshida, E. Cimoli, M. Kiuchi, K. Suzuki, D. Yan, N. Kanna, Y. Kawaguchi, B. Butterworth, B. Delille, K. Campbell, F. Deman, R. Shibusawa, T. Hirawake.

Summary: An intercalibration experiment (one week; Lead: D. Nomura) was carried out at Saroma-ko lagoon (Japan) in March 2018 to evaluate different methodologies assessing sea-ice primary production. The interpretation of the dataset is still currently ongoing.

#3: Sea ice light measurement: Saroma-Ko Lagoon, February 2019

Participants: D. Nomura, P. Wongpan, T. Toyota, T. Tanikawa, Y. Kawaguchi, T. Ono, T. Ishino, M. Tozawa, T. P. Tamura, I. Yabe, E. Y. Son, F. Vivier, A. Lourenco, M. Lebrun, Y. Nosaka, and M. Vancoppenolle.

Summary: An intercalibration experiment (one week; Lead: D. Nomura) was carried out at Saroma-ko lagoon (Japan) in February 2019 to evaluate different methodologies (sensors) assessing sea-ice over/under ice light measurement. The experiment was successful and a peer reviewed paper (Nomura et al., 2020) was published.

#4: Gases in sea ice and sea ice-air gas flux: Roland Von Glasgow Air-Sea-Ice Chamber (University of East Anglia), January 2020

Participants: B. Delille, D. Nomura, A. K. Simpson, O. Crabeck

Summary: Sea ice freezing experiments were carried out at Roland von Glasgow air-sea-ice chamber (University of East Anglia) for the sea ice storage inter-comparison experiments. We obtained warm and cold sea ice and stored them in the different kinds of bags over different time periods to inter-compare the storage of sea ice samples.

#5: Eddy covariance (EC) drying air comparison for air-sea ice CO₂ flux measurement: Tsukuba, Japan, February 2020

Participant: Daiki Nomura, Hiroki Ikawa, Keisuke Ono, Fumiyoshi Kondo

Summary: In order to check the moisture effect on the EC CO₂ flux on sea ice (very small magnitude of CO₂ flux), we have examined the drying air experiments in the National Agriculture and Food Research Organization, Tsukuba, Japan. We prepared two CO₂/H₂O analyzers (enclosed, LI-7200) and compared with/without air drying systems (Drierite, Magnesium perchlorate, Perma pure dryer) for CO₂ signals to calculate the CO₂ flux. This EC system will be used for inter-comparison experiment in the Cambridge Bay, Canada, 2021 to compare with the other EC system and enclosure CO₂ chamber system for air-sea ice CO₂ flux.

#6: Sea ice inter-comparison experiment for CO₂ flux in Saroma-ko Lagoon, Hokkaido Japan 2021

Participants: D. Nomura, H. Ikawa, Y. Kondo, T. Noshiro, N. Kanna. M. Tozawa.

Summary: An intercalibration experiment (two weeks; Lead: D. Nomura) was carried out at Saroma-ko lagoon (Japan) in February and March 2021 to evaluate different methodologies (sensors) assessing air-ice CO₂ flux. The experiment was successful.

Planned Intercalibration Experiments:

Primary Production and Gas Fluxes: The Canadian High Arctic Research Station (CHARS), Cambridge Bay, Canada

Participants: Brent Else (lead), F. Fripiat (co-lead), D. Nomura (co-lead), Bowman, C.J. Mundy, N. Kanna, B. Delille, L. Tedesco, N. Geilfus, N. Steiner, L.A. Miller, O. Crabeck etc.

Summary: We will attempt to do this experiment in 2022 (late April-middle of May), in order to target the sea-ice algal bloom in an ascending phase. During the Canada-Japan workshop 2019 at CHARS (July 2019), we discussed (science, logistics, funding) the possibility to perform a large-scale intercalibration experiment in Cambridge Bay. At the ECV-Ice annual meeting (August 2020) and email, we also discussed with ECV-Ice and BEPSII members.

TR #3: Design inter-comparison studies to facilitate validation and adoption of new technologies for assessing the complexity and heterogeneity of sea ice at various spatial and temporal scales.

We have tried to merge as much as possible the inter-comparison experiments (Roland Von Glasgow Air-Sea-Ice Chamber in University of East Anglia, Saroma sea ice work 2021) with emerging technologies. Preliminary results: regarding gas measurement, we obtained analytical precision of 15% for CH₄ and 4% for N₂O. The reproducibility of our measurements was over 20% for CH₄ and just under 10% for N₂O. We believe that spatial variability linked to sea ice microstructure induced these larger errors in our sampling. Regarding storage, the storage of the samples at -25C during several months has no impact on the parameters analyzed and ikaite precipitation.

TR #4: Create a guide of best practices for biological and biogeochemical studies in the sea-ice environment.

Based on the information available at this time, we will start to create a guide of best practices hosted on the ECV-Ice website as a living document. The first entry will be the Miller et al. (2015) methodological review from SCOR WG 140, and the results of additional methods evaluations and intercalibrations will be added, as they become available.

5. WG activities planned for the coming year. Limit 500 words

Virtual meetings: Expect to meet 2-3 times to discuss updates and working plans for the different TR. F. Fripiat, B. Else, and D. Nomura and other members. 2-3 meetings expected to discuss about each data collation related to TR1 (primary production and sea ice-air CO₂ exchange).

In-person meeting: We planned May 2021, ECV-Ice annual meeting with BEPSII during Gordon Research Conference (GRC), Polar Marine Science, USA. However, due to Covid-19, GRC was cancelled. Alternatively, we will discuss as virtual meeting at summer 2021 for review progress on the Terms of reference (present the data-collations (TR2), pursue the elaboration of intercalibration experiments (TR #1 and #3)), including reviewing results of Saroma sea ice work 2021.

Inter-calibration experiment: We will attempt to do this experiment in 2022 (late April-middle of May) at The Canadian High Arctic Research Station (CHARS), Cambridge Bay, Canada in order to target the sea-ice algal bloom in an ascending phase. Expected participants: Brent Else (lead), F. Fripiat (co-lead), D. Nomura (co-lead), Bowman, C.J. Mundy, N. Kanna, B. Delille, L. Tedesco, N. Geilfus, N. Steiner, L.A. Miller, O. Crabeck etc.

6. Is the group having difficulties expected in achieving terms of reference or meeting original time schedule? If so, why, and what is being done to address the difficulties Limit 200 words

We are planning to do the inter-comparison experiment in the Cambridge Bay, Canada for long time. However, due to corona, we cannot do, so far. We would like to do in next year (2022) as ECV-Ice activity.

7. Any special comments or requests to SCOR. Limit 100 words.

Inter comparison experiment in the Cambridge Bay will our final ECV-Ice activity. Therefore, until finish this inter comparison experiment in the Cambridge Bay, we would like to keep our SCOR working group (we will not request the money for this experiment).

Additional information can be submitted and will be included in the background book for the SCOR meeting at the discretion of the SCOR Executive Committee Reporter for the WG and the SCOR Secretariat.

Nothing.