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 meetings

#1: ECV-Ice final annual meeting at Scripps Institute of Oceanography, La Jolla, California, USA, 13 March 2023. Present: F. Fripiat, B. Else, D. Nomura and full and associate member.

#2: In-person discussion at Scripps Institute of Oceanography, La Jolla, California, USA, 12 March 2023 for ECV-Ice 2023 planning. Present: F. Fripiat, B. Else, D. Nomura and full and associate member.

#3: In-person discussion at the Canadian High Arctic Research Station (CHARS), Canada, 12 May 2023 for results from sea ice inter-comparison experiment for CO_2 flux in Cambridge Bay 2022. Present: B. Else, D. Nomura.

Virtual meeting

#1: Online discussion meeting (12 Dec. 2022) for the CO_2 flux chamber compilation. Present: D. Nomura, B. Delille, O. Crabeck.

#2: Online discussion meeting (24 April. 2023) to discuss the results for the intercalibration of primary production at Cambridge Bay. Present: C. Campbell, F. Fripiat, O. Crabeck.

#3. Online discussion meeting (2 May. 2023) to discuss results of tests studying suitability of ice melt procedures for greenhouse gases. Present: B. Else, 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: Lebrun, M., Vancoppenolle, M., Madec, G., Babin, M., Becu G., Lourenco, A., Nomura, D., Vivier, F., Delille, B. (2023). Light under Arctic sea ice in observations and Earth System Models. Journal of Geophysical Research-Oceans, 128, 3, https://doi.org/10.1029/2021JC018161.

#2: Else, B. G. T., Cranch, A., Sims, R. P., Jones, S., Dalman, L. A., Mundy, C. J., Segal, R. A., Scharien, R. K., and Guha, T. (2022). Variability in sea ice carbonate chemistry: a case study comparing the importance of ikaite precipitation, bottom-ice algae, and currents across an invisible polynya. The Cryosphere, 16, 3685–3701, https://doi.org/10.5194/tc-16-3685-2022.

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 CO_2 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 (^{13}C, O_2, ^{14}C), 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, O. Crabeck 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, Lebrun et al., 2023) 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 CO_2 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 CO_2 flux on sea ice (very small magnitude of CO_2 flux), we have examined the drying air experiments in the National Agriculture and Food Research Organization, Tsukuba, Japan. We prepared two CO_2/H_2O analyzers (enclosed, LI-7200) and compared with/without air drying systems (Drierite, Magnesium perchlorate, Perma pure dryer) for CO_2 signals to calculate the CO_2 flux. The experiment was successful and a peer reviewed paper (Noshiro et al., in revision, Journal of Agricultural Meteorology) will be published. This EC system was used for inter-comparison experiment in the Cambridge Bay, Canada, 2022 to compare with the other EC system and enclosure CO_2 chamber system for air-sea ice CO_2 flux.

#6: Sea ice inter-comparison experiment for CO_2 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 CO_2 flux. The experiment was successful and a peer reviewed paper (Nomura et al., 2022) was published.

#7 Primary Production and Gas Fluxes: The Canadian High Arctic Research Station (CHARS), Cambridge Bay, Canada 2022

Participants: B. Else (lead), D. Nomura, B. Delille, K. Campbell, S. Muller, O. Crabeck, K. Simpson, T. Noshiro, M. Tozawa, N. Kanna.

Summary: An intercalibration experiments (more than one month) was carried out at Cambridge Bay (Canada) in May 2022 to evaluate the different methodologies for assessing air-ice CO_2 flux and primary production in sea ice. The experiment was successful.

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 CH_4 and 4% for N_2O. The reproducibility of our measurements was over 20% for CH_4 and just under 10% for N_2O. 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 have started 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

We will create a guide of best practices for biological and biogeochemical studies in the sea-ice environment based on the intercomparison experiments.

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

None

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

Working Group 152, ECV-Ice will be finished in this year. We would like to express heartfelt thanks to SCOR for support to ECV-Ice.

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.