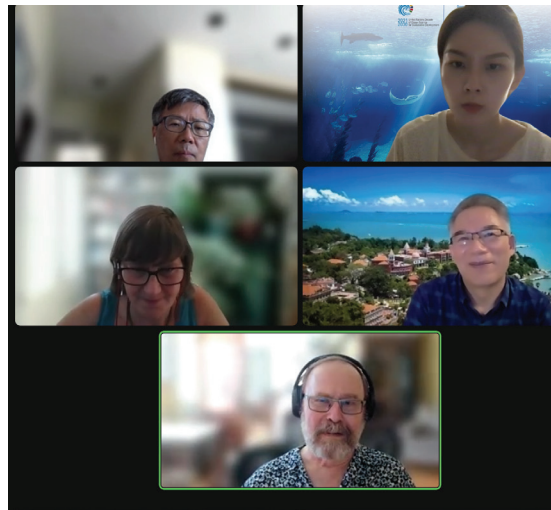
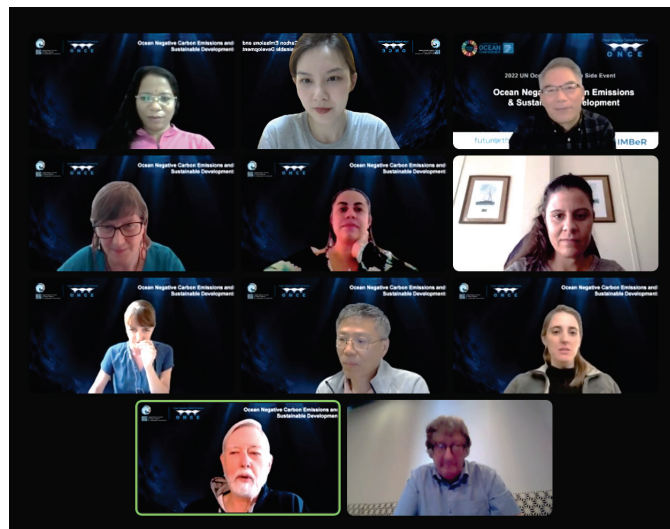


2022 Report of Working Group 46: Joint PICES/ICES Working Group on *Ocean Negative Carbon Emissions*

Working Group 46, a joint PICES/ICES Working Group on *Ocean Negative Carbon Emissions* (ONCE), was established with all members being officially assigned on April, 6, 2021. Due to COVID-19, four meetings were convened virtually, including one meeting to plan a side event at the UN Ocean Conference (Nianzhi Jiao, Carol Robinson, and scientists in related fields), a side event at the UN Ocean Conference, one meeting of the WG Co-Chairs and one 2022 annual business meeting.

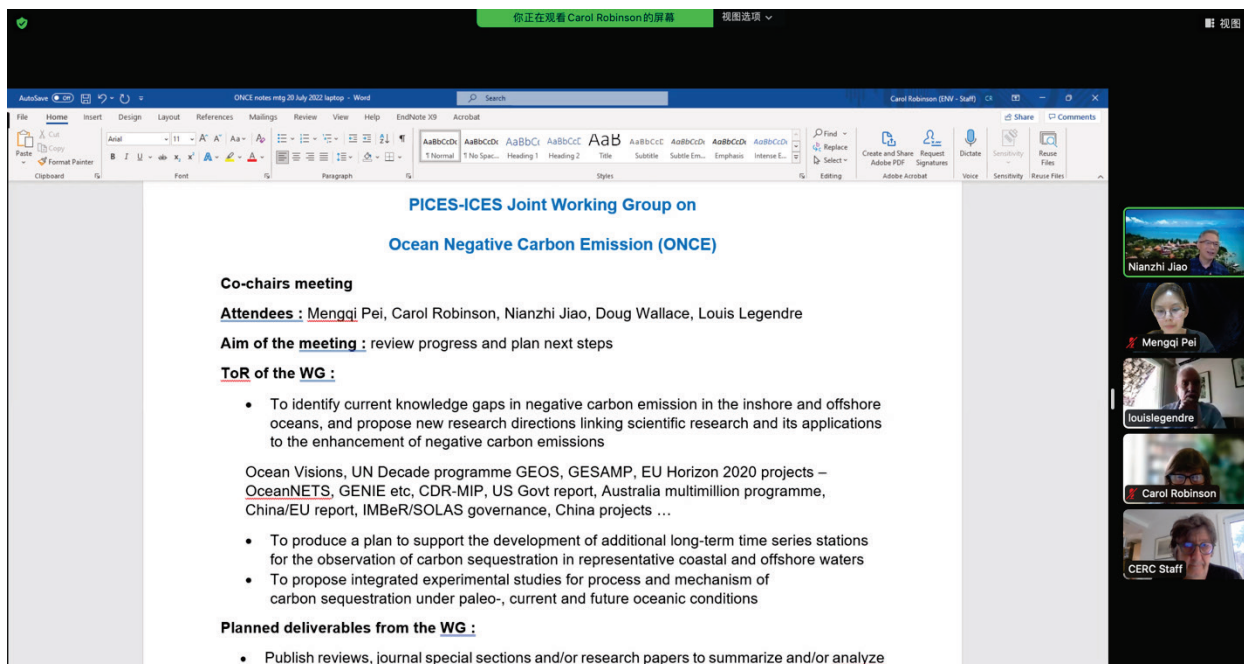


Meeting on June 24, 2022 to plan a session at the UN Ocean Conference.



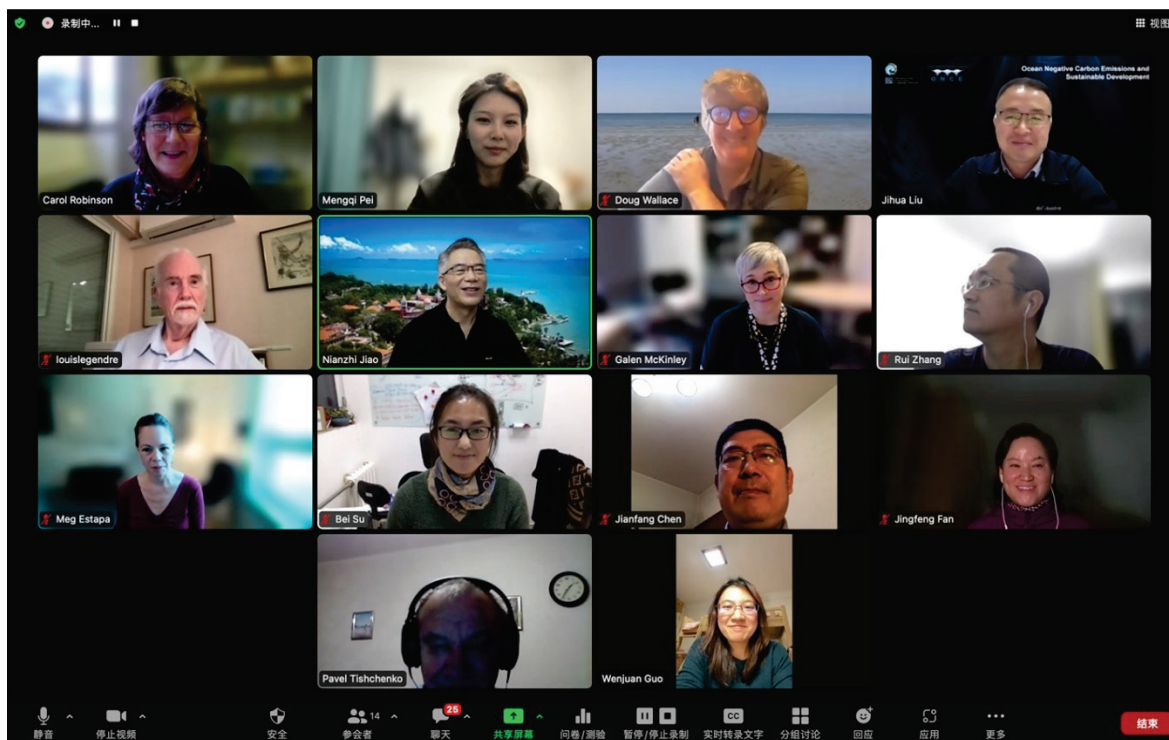
Session at the UN Ocean Conference on June 28, 2022.

A meeting of the Working Group (WG 46) Co-Chairs was held virtually on July 20, 2022. Several proposed WG actions for the next 15 months were combined into a newsletter and sent to all WG members.



Co-Chair meeting on July 20, 2022.

The 2022 annual meeting was held virtually on November 7, 2022. Twelve members plus 2 guest participants were in attendance (*WG 46 Endnote 1*). During the meeting, the past activities and meetings of the WG were reviewed, updates on the progress made towards achieving the Terms of Reference (ToRs) and further steps for the WG were discussed. The agenda for the meeting is given in *WG 46 Endnote 2*.



WG 46 annual meeting participants (pictured only) on November 7, 2022.

AGENDA ITEM 2

Review 2022 activities and actions towards achieving Terms of Reference**1. UN Ocean Decade Programme Global ONCE**

- Objectives of Global ONCE, some of which are an extension of those of WG 46:
 - 1) Develop an international network of field stations and research facilities;
 - 2) Develop an evaluation framework;
 - 3) Develop capacity and ocean literacy and
 - 4) Facilitate equitable policy and governance.
- Date of approval: June 8, 2022
- Please visit <https://www.oceandecade.org/actions/global-ocean-negative-carbon-emission/> for detailed information.
- The objective of WG 46 to propose an international program on ocean negative carbon emissions has been achieved.

2. UN Ocean Conference side event

- The aim of the side event was to discuss how ocean carbon storage and negative emission technologies contribute to the UN Sustainable Development Goals, to stimulate discussion and to encourage people to get involved in Global ONCE.
- Date: 30 June 2022
- Please visit <https://www.global-once.org/#!/detail?title=Activities&name=Conference&code=Conference> for detailed information.

3. ONCE – progress in China

- Five Missions of ONCE in China, funded by MOST (Ministry of Science and Technology of China):
 - 1) Developing innovative research

Scientific Goal: Use a combination of BCP (Biological Carbon Pump)-CCP (Carbonate Counter Pump)-MCP (Microbial Carbon Pump) to achieve synergistic carbon storage.
 - 2) Construction of ONCE research platforms (RPs)

RP1: Marine Environmental Chamber System;

RP2: Intelligent Simulation System of Marine Platform;

RP3: Oceanic Residence Research Platform;

RP4: Seabed Scientific Observation Network;

RP5: Marine Ranching Facilities.
 - 3) Demos in the field for ONCE approaches

Demo 1: Land-Ocean Integrated Eco-engineering;

Demo 2: Seaweed Farming Environment–Artificial Upwelling;

Demo 3: Ocean Alkalinity Enhancement–Wastewater Treatment Plants.
 - 4) International communications
 - 5) Science popularization: ONCE Virtual Lab for Earth System Science

4. Talks at PICES-2022, Busan, Korea

- Prof. Nianzhi Jiao and Dr. Rui Zhang presented at the POC and BIO meetings *via Zoom* and requested the establishment a new working group to continue the activities after the term of WG46.

5. Report to ICES 2022 [to be submitted end 2022], completed ToR

- Dr. Jihua Liu prepared a draft of the 2022 Interim Working Group e-evaluation for WG members to edit and update progress made.

6. Review actions towards achieving ToR

Planned deliverables WG 46 include:

- 1) Research papers, journal special issues or sections and reviews of the science related to ocean based negative carbon emission approaches;
- 2) A proposal for future research directions in ocean based negative carbon emissions;
- 3) An outreach product for the general public; and
- 4) A final report for ICES and PICES summarizing the results of the Working Group.

AGENDA ITEM 3

Working Group activities in 2023

- Co-Chairs and WG members will be able to attend at least one face-to-face meeting in 2023, which will be updated in the coming months and discussed at the Co-Chairs' meeting in the early 2023.
- ICES ASC (September 11–15, 2023), PICES-2023 (1 day)
- **Seaweed aquaculture joint paper.** This is a proposed contribution to the WG's ToR, which is about integrated studies for ocean carbon negative emissions.
- **Time series monitoring paper.** An essential and critical outcome of the WG is that TT2 proposed to produce paper on the development of a global network of stations dedicated to ocean negative carbon emissions, considering what should be there and building on examples if there are any.

AGENDA ITEM 4

Update on WG 46 ocean negative carbon emissions research and publications

Four papers have been published so far, based on the discussion among WG 46 members in 2022:

- Cai, W. J., and Jiao, N. (2022). [Wastewater alkalinity addition as a novel approach for ocean negative carbon emissions](#). *The Innovation*, 3(4), 100272.
- Wang, Y., Lu, Y., Liu, J., and Zhang, C. (2022). [Advocating eco-engineering approach for ocean carbon negative emission](#). *Bulletin of Chinese Academy of Sciences (Chinese Version)*, 36(3), 279–287.
- Wallace, D. (2022). [Consider the Ocean: Climate change's invisible solution](#).
- Liu, J., Robinson, C., Wallace, D., Legendre, L., & Jiao, N. (2022). [Ocean negative carbon emissions: A new UN Decade program](#). *The Innovation*, 3(5), 100302.
- Zhang, C., Shi, T., Liu, J., He, Z., Thomas, H., Dong, H., Rinkevich, B., Wang, Y., Hyun, J.H., Weinbauer, M., López-Abbate, C., Tu, Q., Xie, S., Yamashita, Y., Tishchenko, P., Chen, Q., Zhang, R., and Jiao, N. (2022). [Eco-engineering approaches for ocean negative carbon emission](#). *Science Bulletin*, 67(24), 2564–2573.

WG 46 Endnote 1

WG 46 participation list

Members

Nianzhi Jiao (China, Co-Chair/PICES)
Douglas W. Wallace (Canada, Co-Chair/PICES)
Carol Robinson (UK, Co-Chair/ICES)
Louis Legendre (France, Co-Chair/ICES)
Jianfang Chen (China)
Jingfeng Fan (China)
Jihua Liu (China)
Rui Zhang (China)
Phil Renforth (ICES, UK)
Pavel Ya. Tishchenko (Russia)
Galen McKinley (USA)
Bei Su (ICES, China)
Phil Renforth (ICES, UK)
Meg Estapa (ICES, USA)

Members unable to attend

Canada: Debby Ianson, Curtis Suttle
China: Shucheng Xie
Japan: Youhei Yamashita
Korea: Jung-Ho Hyun
USA: Lihini Aluwihare

Observers

Wenjuan Guo (China)
Mengqi Pei (China)

WG 46 Endnote 2

WG 46 annual meeting agenda

1. Welcome and introduction (Carol Robinson)
2. ONCE working group 2022 activities towards achieving ToR (Louis Legendre)
3. International activities [since 2022] related to ONCE (Doug Wallace)
4. Future planning for ONCE Working Group activities in 2023 (Carol Robinson)
5. Review actions: Priority actions for WG to achieve ToR