Report of the Section on *Carbon and Climate*

A virtual meeting of the Section on *Carbon and Climate* (S-CC) was held from 18:00–20:00 on October 1, 2020 (US/Canada Pacific time) during PICES-2020. Drs. Alex Kozyr and Tsuneo Ono acted as meeting chairs. Eighteen members were present, representing Canada, China Japan, Korea, and the US (*S-CC Endnote 1*). Prior to this web meeting, pre-discussion occurred from September 1 by e-mail. The meeting agenda was reviewed and accepted (*S-CC Endnote 2*).

AGENDA ITEM 2
Reports of 2019–2020 S-CC activities

Tsuneo Ono gave a brief report on planned and ongoing activities regarding intercalibration of pH and pCO_2 sensors, which were outlined in the 2017 Annual Report. Attempts to obtain funding for a sensor intercomparison experiment have so far been unsuccessful. Tsuneo Ono and Shin-ichiro Nakaoka will submit a new proposal this year, and the first experiment will be conducted in 2022 if these applications are successful.

SOLAS will co-sponsor a BIO/POC Topic Session (VS5) at PICES-2020 titled "*Atmospheric nutrient deposition and microbial community responses, and predictions for the future in the North Pacific Ocean*." Kitack Lee, a member of S-CC, is a co-convener of this session. The session will be held on October 29, 18:00–21:00 (US/Canada Pacific time). Twelve oral presentations and 18 posters will be presented.

An ICES/PICES joint Topic Session titled "*Taking stock of ocean acidification research for provision of future efforts*" was planned for the ICES 2020 Annual Science Conference, but this session was postponed to 2021 due to the COVID-19 crisis.

AGENDA ITEM 3
Reports from collaborating organizations and agencies

Alex Kozyr reported recent publication of GLODAPv2.2020 and SOCATv2020 at OCADS. GLODAPv2.2020 is composed of 946 cruises covering the global ocean between 1972 and 2019, appending new data from 106 cruises to GLODAPv2.2019. Through the synthesis, the data in each cruise were subjected to primary and secondary quality control. Accuracy of synthesized data are believed to be 0.005 in salinity, 1% in oxygen, 2% in nitrate, 2% in silicate, 2% in phosphate, 4 μmol kg^{-1} in TCO2, and 4 μmol kg^{-1} in TAlk.

SOCAT version 2020 has 28.2 million quality-controlled surface ocean fCO_2 (fugacity of CO_2) observations with an estimated accuracy of better than 5 µatm and a WOCE quality flag of 2 (good) from 1957 to 2020 for the global oceans and coastal seas. In addition, 2.3 million values with an estimated accuracy of 5 to 10 μatm are available.

Shin-ichiro Nakaoka provided information on the recent progress of "Global Carbon Budget 2020". This paper has been submitted and now appears in *Earth System Science Data* (https://essd.copernicus.org/articles/12/3269/2020/).

Jim Christian introduced new R- and Python-based carbon chemistry routines. These packages are in the public domain, and are available to everyone. He offered to provide examples of the use of the /jamesorr/mocsy Python package upon request.

Wiley Evans introduced recent release of CO2sysv.3 for MATLAB (https://github.com/jonathansharp/CO2-System-Extd) and recent paper of Dillon *et al*.

(https://www.sciencedirect.com/science/article/pii/S0304420320301262) in which the extended version of the *seacarb* package to evaluate calcium uncertainty is described.

AGENDA ITEM 4
Proposals for PICES-2021 sessions and/or workshops

The ICES/PICES joint session (see Agenda Item 2), that was intended to be held at the ICES 2020 Annual Science Conference, will be tentatively held at the ICES 2021 ASC (Sept. 3–6, 2021, Copenhagen).

Richard Feely suggested that we should contact the organizing committee of the Ocean in a High CO_2 World symposium (Jean-Pierre Gattuso) so that we can avoid overlap of session dates between ICES and/or PICES and their meetings. Samantha Siedlecki will send e-mail about this to the symposium SSC.

We will request a Topic Session on ocean deoxygenation and eutrophication at the PICES 2021 Annual Meeting (*S-CC Endnote 3*). A session proposal entitled "*Connecting knowledge of ocean deoxygenation in coastal and offshore regions of the North Pacific*" was submitted to BIO and POC and was approved in each committee; a final decision will be made in the Science Board meeting that will be held October 7–9. Samantha Siedlecki expressed some reservation about ambiguous usage of the term "deoxygenation" in the session description. IPCC has defined the term "deoxygenation" as the decrease of oxygen caused by global warming, and distinguished this term from the oxygen decrease caused by eutrophication. Since our session handles both deoxygenation and eutrophication, the present usage of "deoxygenation" in the session title is unsuitable. The session description was modified by email discussion among the members, and the revised version was submitted to Science Board.

Hal Batchelder mentioned that MEQ is planning a new program on hypoxia, although the committee is planning no sessions regarding it at PICES-2021. He mentioned that S-CC should reach out to MEQ in holding this session, as our session scope is closely related to MEQ interests. Inviting some speakers from MEQ would be one practical way to achieve such a relationship.

AGENDA ITEM 5
Other 2020–2021 Section plans

The PACIFICA database was published in 2013, and the original dataset is available via two international database repositories (PACIFICA website and OCADS). However, several problems have arisen regarding its delivery. Alex Kozyr, Toru Suzuki, and Jim Christian checked existing problems and summarized then into four issues:

1. Several dead links to CDIAC are present in both PACIFICA web page and OCADS web page.
2. Some third party sites are distributing outdated and incorrect versions of PACIFICA datasets.
3. These are several inconsistencies in the contents between PACIFICA web page and OCADS web page. In particular, some of individual cruise data files in OCADS had changed from the original version while those in PACIFICA are still preserved since 2013.
4. There are several additional unofficial data products that are available on one or other of the sites. An outdated and incorrect version of one of these was removed from OCADS. S-CC members are working to resolve this issue and create up-to-date and traceable versions of these data products.

Tsuneo Ono proposed new S-CC activity on the construction of an "inventory list" of coastal monitoring stations for pH and/or oxygen in each country. This is the successor of the S-CC's latest publication "Ocean Acidification and Deoxygenation in the North Pacific Ocean" (PICES Special Publication 5) that summarized ongoing ocean acidification and deoxygenation projects in some PICES countries. The following three-step action was then proposed and agreed by the members:

1. Construct "web links" of coastal monitoring sites in each member country, both for those written in English and in each country's language.
2. For web pages written in each member country's language, add English explanation of metadata for each station (location, duration and frequency, PI, methodology, *etc*.).
3. If possible, construct list of other monitoring stations that exist but have not opened their information via webpage.

Steps (1) and (2) should be completed in each country by PICES-2021. Discussion on summarization of this information will occur at the 2021 S-CC meeting.

Tsuneo Ono will propose detailed protocols for the above actions (*e.g*., definition of "coastal area" in this activity: is it fixed by bottom depth or distance from the coast? "monitoring stations" can include moorings? *etc*.) by the end of October.

Prior to the web meeting, Masao Ishii forwarded a e-mail from Veronique Garçon, a Global Ocean Oxygen Network (GO2NE) lead, in which she encouraged participation in drafting a white paper on an oxygen data portal now in preparation/revision, and attending the virtual meeting planned for November 5 and 6 to implement a road map for the oxygen portal. Based on the above discussion, S-CC members agreed to add the following paragraph to the white paper on the oxygen data portal:

"The North Pacific Marine Science Organization (PICES) is planning to construct list of coastal oxygen monitoring stations among its member countries, and that information will help data collection of GO_2AT (Global Ocean Atlas) in the North Pacific region."

Tsuneo Ono also encouraged members to submit any input to the white paper individually by Oct.5. Several S-CC members pointed out that appropriate determination of measurement quality in oxygen data may become a big challenge in making of GO2AT, and ocean acidification community will be able to help them on this point.

S-CC Endnote 1

S-CC participation list

Members

Alexander Kozyr (USA, Co-Chair)
Tsuneo Ono (Japan, Co-Chair)
Liqi Chen (China)
James Christian (Canada)
Andrew Dickson (USA)
Wiley Evans (Canada)
Richard A. Feely (USA)
Zhongyong Gao (China)
Xianghui Guo (China)
Kitack Lee (Korea)
Shin-ichiro Nakaoka (Japan)
Jeong Hee Shim (Korea)
Samantha Siedlecki (USA)
Toru Suzuki (Japan)

Members unable to attend

China: Liyang Zhan, Yumei Zhao
Japan: Masao Ishii, Akihiko Murata
Korea: Geun-Ha Park
Russia: Andrey Andreev, Pavel Ya. Tishchenko
USA: Hernan Eduardo Garcia, Burke Hales

Observers

Simone Alin (USA)
Sonia Batten (PICES)
Harold (Hal) Batchelder (PICES)

S-CC Endnote 2

S-CC meeting agenda

1. Confirmation of member exchange and adoption of Agenda
   - Introduction of new members (Wiley Evans, Samantha Siedlecki, Geun-Ha Park, Xianghui Guo, and more)
2. Reports of 2019–2020 S-CC activities
   - Sensor inter-comparison activities (Ono)
   - SOLAS session on atmospheric nitrogen at PICES-2020 (Lee)
   - ICES/PICES joint OA session at ICES 2020 (Ono)
3. Reports from collaborating organizations and agencies
   - GLODAPv2.2020 and SOCATv2020 publications at OCADS (Kozyr)
   - New R and Python based carbon chemistry routines (Christian)
4. Discussion for proposals for PICES-2021 sessions and/or workshops
   - ICES/PICES joint OA session at ICES 2021
   - Additional session for deoxygenation at PICES-2021
5. Discussion for other 2020–2021 Section business plans
   - PACIFICA data update (Christian)
   - Development of inventory table for coastal OA monitoring sites in PICES countries (Ono)
   - Collaboration with GO2NE (Ono, Ishii)

S-CC Endnote 3

Proposal for a 1-day Topic Session on
"*Connecting knowledge of ocean deoxygenation in coastal and offshore regions of the North Pacific*"
at PICES-2021

Convenors: Tsuneo Ono (Japan), Alex Kozyr (USA), Tetjana Ross (Canada)

Ocean deoxygenation is the loss of oxygen in the ocean resulting from ocean warming, which reduces oxygen solubility and increases oxygen consumption and stratification, thereby reducing the mixing of oxygen into the ocean interior. Ocean deoxygenation exacerbates coastal hypoxia and the expansion of oxygen minimum zones globally. Hypoxia is known as a severe threat to ocean ecosystems and fisheries resources, in both offshore and coastal regions. Decreasing oxygen in seawater is caused by several processes such as increase of water temperature, changing ocean circulation and stratification, changes in production and remineralization of organic matter, and coastal eutrophication. The main cause of oxygen decline varies regionally, and sometimes multiple processes contribute. Multiple causes make it difficult to get a comprehensive understanding of ocean deoxygenation at the various scales from coastal regions to ocean basins.

PICES S-CC is planning a new program to collect an inventory of oxygen monitoring programs, as well as data and knowledge obtained from them, that are ongoing among the PICES countries. At the commencement of this program, we convene this session to gather information on ongoing ocean deoxygenation and oxygen variability studies and the resulting scientific knowledge, in both the coastal and offshore North Pacific. For this purpose, we encourage attendees to present studies of detection of deoxygenation, as well as causes of oxygen variability, at the various scales from coastal regions to ocean basins in this session. We also welcome studies of impacts of deoxygenation and hypoxia on ocean ecosystems and/or fisheries.