Report of the Section on *Carbon and Climate*

The meeting of the Section on Carbon and Climate (S-CC) was held from 09:00-17:00 on September 23, 2017 at PICES-2017 in Vladivostok, Russia. Drs. James Christian and Tsuneo Ono acted as meeting Chairs. Six members were present, representing Canada, China, Japan, and Russia (***S-CC Endnote 1***). The meeting agenda (***S-CC Endnote 2***) was adopted unanimously.

AGENDA ITEM 2
Acidification/deoxygenation synthesis

A great deal of progress has been made on the acidification/deoxygenation synthesis report, but parts are still missing and completion is behind schedule. The East Asian Marginal Seas, the Bering Sea, and the California Current are considered regions of concern, as little or nothing has been produced to date for chapters focused on these regions. Most of the members with regionally focused expertise were present (Andreev, Tishchenko – Japan/East Sea, Gao – Bering Sea) and agreed to complete drafts of these chapters in the coming months. Dr. Christian will contact North American colleagues regarding the California Current. A chapter on the Japan coastal area has been completed and other national delegations are invited to produce similar chapters for their own coastal waters. A deadline of November 30, 2017 was agreed upon for completion of initial drafts.

Request to parent committees, BIO and POC, for funding for design work (see the 2016 Annual Report) was denied by Governing Council. Dr. Christian has obtained some funds for this purpose from Canadian sources, but it is not clear that this is a sufficient. A renewed request for PICES support will be discussed with the parent committees.

AGENDA ITEM 3
Sensor intercomparison activity

Dr. Ono gave a brief report on planned and ongoing activities regarding intercalibration of pH and pCO_2 sensors. Several groups from Japan participated in the Wendy Schmidt Ocean Health XPRIZE competition at Monterey, California (the group from JAMSTEC and Kimoto Electric came third). Dr. Ono is of the opinion that the XPRIZE approach is quite engineering focused, and emphasizes precision at the expense of accuracy. Dr. Christian remarked that in conversations with Dr. Lisa Miller (Canada member not present) and others, it appears that the most limiting factor in establishing sensor accuracy and reliability is sea-truth data, without which no improvement in precision can make the data useful.

Drs. Ono and Shin-ichiro Nakaoka will apply for funding from Japanese agencies for an inter-comparison experiment tentatively scheduled for October–November 2019 (one week). Funds are expected to be on the order of US$100K, including travel and shipping costs for international participants. The experiment will be held at the Japan Fisheries Research Agency Miyako Lab (~500 km north of Tokyo). This facility provides a 500 ton tank filled with fresh, temperature-controlled sea water, with good technical support. The Hasaki lab used for some previous experiments is considered unsuitable because it must use aged seawater.

Ocean Networks Canada plans to host a workshop on the state of the art in sensor technology within the current fiscal year (ends March 31, 2018). Dr. Christian will be coordinating this activity along with Dr. Akash Sastri from ONC (BIO, AP-NPCOOS) and will be sending out invitations soon. Mr. Tsunoda from the

Sasakawa Peace Foundation attended the meeting as an observer and suggested that the foundation would be open to funding participation of some Japanese scientists in this workshop.

AGENDA ITEM 4
Russia plans for Sea of Okhotsk campaign

Dr. Pavel Tishchenko gave a brief presentation on plans for the reoccupation of WOCE P01W Line across the Sea of Ohkhotsk. Russian scientists from the Pacific Oceanological Institute (POI) plan to occupy P01W in summer 2018 aboard the R/V *Akademik Oparin*. This will be the first full occupation of this line since 1993. This will be a GEOTRACES cruise and all data will go to the GEOTRACES data system. Tentative cruise dates are August 15–September 19, 2018. POI will measure alkalinity and pH. Japanese scientists will measure ^{13}C and ^{14}C of DIC (PI is Jing Zhang, Toyama University).

AGENDA ITEM 5
Reports of collaborating organizations and agencies

Dr. Nakaoka gave a brief update on SOCAT (Surface Ocean CO_2 Atlas). SOCAT v. 5 was released in July 2017. Plans for v. 6 are to include surface water chemistry (*e.g.*, DIC, nutrients) and atmospheric CO_2 concentration data, but these data will not receive any additional QA/QC. The National Institute for Environmental Studies (NIES) leads pCO_2 data QA/QC for the North Pacific. SOCAT encourages all members and their respective institutes to submit all data not yet submitted. These are mostly recent data. NIES staff led by S-CC member Nakaoka will support all such submissions with QA/QC assistance.

Several other members representing collaborating organizations were not present but sent presentations. Dr. Masao Ishii is now Co-Chair of the IOCCP along with Dr. Toste Tanhua (Germany). IOCCP now functions as the GOOS Biogeochemistry Panel. IOCCP will hold a 1-day kick-off workshop to develop a structure for a Surface Ocean Carbon Observing Network on February 11, 2018, in Portland, Oregon, USA, prior to OSM2018. A new Reference Group has been organized for regular updates to GLODAP. IOCCP has requested S-CC to endorse S-CC members Drs. Ishii, Akihiko Murata, and Toru Suzuki to become GLODAP RG members and to cooperate in regular updates of GLODAP. The membership endorsed this in principle but noted that these individuals are all from Japan and suggested that some additional members from other countries be included. A second IOCCP–JAMSTEC intercomparison exercise for seawater nutrient concentrations will begin in late 2017. Dr. Michio Aoyama (Fukushima Univ./JAMSTEC/IOCCP SSG) is an organizer of this activity, and S-CC member Murata is a collaborator. All members are invited to participate. IOCCP plans to hold another International Summer Course on best practices for selected biogeochemical sensors (oxygen, pH, pCO_2, nitrate) in Sweden in summer 2018. The OceanObs'19 conference will be held in September 2019 in Honolulu; S-CC member Dr. Minhan Dai is on the Program Committee.

CDIAC-Oceans has been incorporated into the National Centers for Environmental Information (NCEI, NOAA) as the Ocean Carbon Data System (OCADS; www.nodc.noaa.gov/ocads). S-CC member Dr. Alex Kozyr is still the main point of contact. Its role will remain hosting and providing access for ocean carbon data for the international community, similar to CDIAC-Oceans. All CDIAC-Ocean historical data as well as newly archived data are now available from the OCADS archives as the final/public data, including subsurface/bottle data from Hydrographic Repeat Sections (CLIVAR, GO-SHIP) cruises, surface/underway data from Ships of Opportunity (SOOP or VOS), Time Series and Moorings data, and Coastal Ocean Acidification data. All data are in the NCEI archival system, following NCEI data archival process rules and regulations. All OCADS Ocean carbon data are searchable through the Ocean Carbon and Acidification Data Portal

(https://www.nodc.noaa.gov/oceanacidification/stewardship/data_portal.html) or can be found using clickable maps and tables similar to those at CDIAC. Publication of data sets at NCEI is like publication of papers in a scientific journal: once published, it will always be available. Data providers can request to create a new version of the data set; both the latest version (default) and the historical versions will be accessible. The version control can also be used to archive data sets from an ongoing long-term project to a single data package. Each version will have a unique Digital Object Identifier. The metadata template is described by Jiang *et al*., 2015 (A metadata template for ocean acidification data. *Earth System Science Data* **7**: 117–125).

Dr. Lisa Miller sent a brief update on SOLAS. Dr. Miller will chair the Scientific Steering Committee starting January 2018. The Executive Director position is currently vacant and applications are being accepted through November 15, 2017. SOLAS is co-hosting (with NASA and the European Space Agency) a workshop on "*Remote sensing to study the ocean-atmosphere interface*" in March 2018, Washington, DC, USA. The long-standing SOLAS-IMBER Carbon working groups have been disbanded and are currently being reorganized. A side meeting at the 2017 International CO_2 Conference in Interlaken, Switzerland started that process, under the leadership of Prof. Nicolas Gruber (Switzerland). Dr. Nakaoka attended the meeting. SOLAS will host a Summer School in summer 2018 in Cargèse, France. PICES support is requested for travel for 1 to 3 early career scientists from PICES countries. The next SOLAS Open Science Conference will be held in Sapporo, Japan, April 21– 25, 2019.

AGENDA ITEM 6
Further business

Prof. Yutaka Watanabe (Japan) has rotated off and Dr. Shin-Ichiro Nakaoka has joined. Prof. Chen-Tung Arthur Chen (*ex-officio* member representing IGBP) will also rotate off (IGBP ended in 2015). S-CC will request the removal from membership of Dr. Sophia Johannessen (Canada) and the appointment of Dr. Helen Gurney-Smith.

Drs. Ono and Christian submitted a topic session proposal for PICES-2018 (***S-CC Endnote 3***). A third convener will be recruited if possible, ideally a biologist and ideally not from Canada or Japan.

S-CC Endnote 1

S-CC participation list

Members

Andrey Andreev (Russia)
James Christian (Canada, Co-Chair)
Zhongyong Gao (China)
Shin-ichiro Nakaoka (Japan)
Tsuneo Ono (Japan, Co-Chair)
Pavel Ya. Tishchenko (Russia)

Observers

Yumi Okochi (Japan)
Tomohiko Tsunoda (Japan)
Toichi Yonezawa (Japan)

Members unable to attend

Canada: Sophia Johannessen, Lisa Ann Miller
China: Liqi Chen, Minhan Dai, Liyang Zhan, Yumei Zhao
Chinese-Taipei: Chen-Tung Arthur Chen (*ex officio* representing IGBP)
Japan: Masao Ishii, Akihiko Murata, Toru Suzuki
Korea: Dong-Jin Kang, Kitack Lee, Jeong Hee Shim
USA: Richard A. Feely, Hernan Eduardo Garcia, Burke Hales, Alexander Kozyr

S-CC Endnote 2

S-CC meeting agenda

1. Opening (Christian, Ono)
   - Review and adopt agenda
2. Discussion of acidification synthesis and steps towards completion (Christian, Ono)
3. Discussion of planned sensor intercomparison activities (Ono, Nakaoka)
4. Recent biogeochemical study of Okhotsk Sea and future plan (Tishchenko)
5. Information exchange
   - SOLAS (Miller, Dai)
   - OCADS (Kozyr)
   - COMPONUT (Murata)
   - SOCAT (Nakaoka)
   - IOCCP (Ishii)
6. Further discussion of acidification synthesis and steps towards completion
7. Further discussion of Section business (membership, publications, future activies)
8. Adjourn

S-CC Endnote 3

Proposal for a Topic Session on
"*Ocean acidification and deoxygenation and their impact on ocean ecosystems: synthesis and next steps*"
At PICES-2018

Duration: 1 day

Co-Sponsor: ICES

Convenors: James Christian (Canada), Tsuneo Ono (Japan), TBD

Studies of ocean acidification (OA) are showing progress, in particular, monitoring of oceanic acidification status (pH, pCO_2 and $\Omega_{aragonite}$, $\Omega_{calcite}$) in the various PICES countries has significantly progressed in recent years. Progress has also been achieved in the field of biological OA impact. The importance of interactions with other stressors (temperature, deoxygenation, *etc*.), interspecific interaction (*e.g*., OA effects on prey species), and biological ability to adapt to OA stress, are increasingly recognized. We welcome presentations from the fields of OA monitoring and impact experiments, to construct new perspective on present OA status in the North Pacific. Presentations on future projections are also welcome. We also welcome presentations about plans for further progress in our understanding, such as continuous carbon system monitoring by new technologies, new experimental studies for OA adaptation, and field observation of biological responses to existing OA and deoxygenation events.