

Report of the Section on *Carbon and Climate*

The meeting of the Section on *Carbon and Climate* (S-CC) was held from 09:00-12:30 on October 18, 2014 at the PICES Annual Meeting in Yeosu, Korea. Dr. James Christian acted as meeting Chair. Eight members were present, representing Canada, Japan, Korea, and the United States (*S-CC Endnote 1*). Some minor amendments were made to the meeting agenda (*S-CC Endnote 2*) which was then adopted unanimously.

AGENDA ITEM 1

Membership

The meeting commenced with a brief tribute to former Co-Chair, Prof. Toshiro Saino, who died in early 2014. Dr. Tsuneo Ono, who was not present, has agreed to take over as Co-Chair. The membership unanimously approved his selection, and recommended his appointment.

Additional membership expansion was discussed for the U.S. and Chinese delegations. Dr. Simone Alin (U.S.) and Dr. Zhongyong Gao (China) have been suggested as additional members. Both agreed to become members and S-CC recommends their appointment by their national delegations.

AGENDA ITEM 2

Reports of collaborating organizations and agencies

Reports were given on several national and international programs relevant to the mandate of S-CC, including SOLAS (Miller), CLIVAR/GO-SHIP (Murata), BEPSII (Miller), and IOCCP (Telszewski). IOCCP Project Director, Dr. Maciej Telszewski, was present as an observer and gave the IOCCP report. Dr. Richard Feely (U.S.) gave an update on U.S. ocean acidification programs. Dr. Murata gave a brief report on the new SCOR working group “Towards comparability of global oceanic nutrient data”.

SOLAS has published a book synthesizing its first 10 years (open access at link.springer.com/book/10.1007/978-3-642-25643-1) and is preparing a renewal proposal for the second 10 years. A workshop was held the day prior to the S-CC meeting to solicit community input on the renewal of SOLAS under the FutureEarth umbrella. Dr. Lisa Miller gave a brief report on this workshop and on the progress of the renewal proposal. A key issue appears to be observations under extreme sea states, which are undersampled due to logistical and technological limitations. A SOLAS Open Science Conference will be held September 7–11, 2015 in Kiel, Germany.

Dr. Akihiko Murata gave an update on repeat hydrography activities. JAMSTEC revisited the P01 line in summer 2014, occupying 121 CTD stations including Ocean Station PAPA. Bottom water warming as observed by Fukasawa *et al.* (2004, doi:10.1038/nature02337) is continuing, with a rate of 1.1 mK/decade estimated for 2007–2014. Planned JAMSTEC cruises for 2015–2017 include I10, P17E, and P18S. JMA occupied P10 in 2014 and will do P04W in 2015. JAMSTEC will hold a workshop on November 6–7 to plan for large-scale research cruises using its vessels to be conducted between April 2016 and March 2019. This workshop will be open to both Japanese and overseas investigators (the deadline to apply to attend had already passed at the time of the S-CC meeting). Japanese, U.S., and Australian investigators are planning a major campaign in the Indian Ocean and adjacent regions of the Southern Ocean for 2018.

Dr. Murata also gave a brief report on the new SCOR working group “Towards comparability of global oceanic nutrient data” that has been approved for 2015–2017 (chaired by M. Aoyama and M. Woodward). Dr. Murata and Dr. Alexander Kozyr (U.S.) are associate members of the working group. S-CC recommends that one or both of them be designated as PICES representatives to the group. It was suggested that S-CC could play a role in cataloguing the available products to be used as reference materials. In a related activity, JAMSTEC and IOCCP will be coordinating an intercalibration exercise to be conducted late 2014/early 2015. The final list of participants will be announced and test samples shipped in mid-December 2014.

Dr. Miller gave an update on BEPSII (SCOR Working Group on Biogeochemical Exchange Processes at the Sea-Ice Interfaces). The group has published an overview paper on biogeochemical processes (Vancoppenolle *et*

al., 2013, 10.1016/j.quascirev.2013.04.011) and has submitted one on methodological approaches (Miller *et al.*, submitted to *Elementa*). Two field experiments are planned for Saroma-Ko, Japan (biogeochemistry and gas fluxes) and Tvarminne, Finland (biological production).

Dr. Feely (U.S.) gave a brief presentation on U.S. ocean acidification activities. The U.S. appears to have the most extensive program to date of any PICES member country. Nine agencies are involved; NOAA is lead agency. The U.S. Strategic Plan For Federal Research on OA states that U.S. research will include, among other elements: (1) Improving existing technology; (2) Research on adaptive capacity, multiple stressors, carbon cycling effects, feedbacks, and bio-indices; (3) Predictive ocean carbon cycle models linked to biological impacts; (4) Data QA/QC. The U.S. monitoring network includes more than 20 sites to date, about half coastal and half oceanic, and contains Repeat Hydrography cruises and volunteer observing ships as well as moorings and ship-based time series. Laboratories have been outfitted at the Alaska Fisheries Science Center to conduct research on biotic impacts. Most NOAA impacts research to date has been done in the lab and there has been some difficulty getting funding for larger-scale mesocosm experiments.

Dr. Telszewski (IOCCP) gave a brief overview of IOCCP activities. IOCCP thematic groups include Underway $p\text{CO}_2$ Observations, Surface CO_2 Data, Ocean Interior Observations, Ocean Interior Data, Time Series Networks, Instruments and Sensors, Data Management, Nutrients, Framework for Ocean Observations, and Ocean Acidification. S-CC members are theme leaders on two of these, Ocean Interior Observations (Ishii) and Ocean Acidification (Feely). The goals of the Framework for Ocean Observations are to:

- Guide the observing community in a common language and in accordance with a consistent set of requirements, observing technologies and data streams to sustain and expand the capabilities of the ocean observing system;
- Promote collaborative alignment of existing – largely independent – groups, communities, and networks; build on existing structures as much as possible to take lessons learned from successes of different observing elements (best practices);
- Support self-funding and self-managing elements;
- Deliver a fit-for-purpose coastal and open ocean integrated observing system driven by requirements and focused around Essential Ocean Variables assessed for their readiness.

The first workshop to define Biogeochemical Essential Ocean Variables was held in November 2013 in Townsville, Australia. A town hall meeting was held at Ocean Sciences 2014 in Honolulu, with more than 100 attendees. For those unable to attend, a Webinar can be viewed at www.ioccp.org/foo, and the process is still open to community input.

A summer school on biogeochemical sensors will be held in Sweden in June 2015. S-CC will make a request to its parent committees to support travel for one early career scientist from a PICES member country to attend.

AGENDA ITEM 3

Future goals and objectives

Topic Session for 2015

A topic session on development of ocean acidification observing systems for the 2015 Annual Meeting (S-CC Endnote 3) was proposed by S-CC member, Prof. Liqi Chen (China). The original proposed title was “*Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific Oceans*”. At the S-CC meeting, members suggested that the session description be edited to provide more of a Pacific focus, and that additional S-CC members be recruited as co-convenors. Prof. Chen subsequently agreed to this and the revised proposal entitled “*Ocean Acidification Observation Networks for the North Pacific and adjacent areas of the Arctic Ocean*” was presented to the parent committees at their meetings on October 22. Individual members will be encouraged to contribute presentations to this session which will form a basis for synthesis of individual member countries’ activities.

Develop a basin-wide acidification assessment

It was proposed that S-CC lead the development of a basin-wide acidification assessment (Outlook) to which each individual member country will be expected to contribute results or syntheses. S-CC will propose to convene a

workshop at the 2016 Annual Meeting to examine successes/failures of this process and advise on processes for conducting such assessments/Outlooks. It was suggested that the S-CC meeting at the 2015 Annual Meeting be a full day, so that half a day could be devoted to a review of the first year's activities towards this goal and planning for Year 2. This request was made to the parent committees at their meetings on October 22.

Additional publications

Contributors to Topic Session S4 (“*The changing carbon cycle of North Pacific continental shelves and marginal seas*”) at PICES-2013 are encouraged to contribute to a special issue of Continental Shelf Research “Marginal seas in a changing world: New findings from marine environmental and biogeochemical studies” being edited by S-CC member, Prof. Arthur Chen (IGBP). The convenors of the session (Drs. Minhan Dai, Sophia Johannessen, and Dong-Jin Kang) will contact presenters.

Dr. Christian will contribute a chapter to the final report of Working Group 29 on CMIP5 model data available for regional downscaling activities including carbon fields, oxygen, and nutrients.

Dr. Kitack Lee has a paper in review documenting trends in total nitrogen in northwest Pacific waters that made extensive use of PACIFICA data. It was suggested that PACIFICA needs to have a strategy for making sure that secondary data products from publications like this get into the public domain. Dr. Christian will begin to compile a list of publications using PACIFICA data.

Integration with FUTURE

For several years Section members have been discussing integration of S-CC into FUTURE, but receiving little guidance from the FUTURE Advisory Panels about exactly what to do in this respect. The Outlook discussed above constitutes a proactive approach that meets the needs of the Advisory Panels and other related expert groups as outlined in the Implementation Plan.

S-CC Endnote 1

S-CC participation list

Members

James Christian (Canada, Co-Chair)
Richard Feely (USA)
Dong-Jin Kang (Korea)
Kitack Lee (Korea)
Lisa Miller (Canada)
Akihiko Murata (Japan)
Jeong Hee Shim (Korea)
Toru Suzuki (Japan)

Observers

Shin-ichiro Nakaoka (Japan)
Yukihiro Nojiri (Japan)
Maciej Telszewski (IOCCP)

S-CC Endnote 2

S-CC meeting agenda

1. Opening (Christian)
 - Review and adopt agenda
 - Tribute to Toshi Saino
 - Discussion of membership and new co-chair
2. Information Exchange
 - SOLAS, BEPSII (Miller)
 - CLIVAR/GO-SHIP (Murata)
 - US Ocean Acidification Programs (Feely)
 - Update on IOCCP activities and Framework for Ocean Observing (Telszewski)

3. Future goals and objectives: refocus section objectives around ocean
 - acidification and its impacts; integration with FUTURE
 - Workshops / Topic Sessions for 2015
 - Publications

S-CC Endnote 3

Proposal for a 1-day POC/BIO/MONITOR/TCODE Topic Session on *Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific oceans at PICES-2015*

Convenors: Li-Qi Chen, (China), Fei Chai (USA)

Suggested Invited Speaker: Richard A. Feely (USA)

Potential Co-sponsors: AMAP-AOA, GOA-ON

Ocean acidification (OA) in the 21st century has reached levels not seen for 55 million years. The average surface pH of the world ocean has decreased by 0.1 since the industrial revolution and is projected to decrease 0.3 to 0.4 pH by the end of this century, an up to 2.5 times increase in ocean acidity. Due to its cold water temperature, low alkalinity and rapid loss of sea-ice, the subarctic Pacific Ocean and adjacent Arctic Ocean have absorbed large amounts of atmospheric CO₂ and have changed the CaCO₃ system so that aragonite unsaturated states have appeared or will appear soon on a large scale. OA in the subarctic Pacific Ocean will greatly change the marine chemical environment with far-reaching effect on marine ecosystems. This session will include a review of observations and research on OA and will consider the potential for development of an OA observation network. Main discussion issues are 1) advances in investigations and research in OA in the North Pacific and adjacent areas of the Arctic Ocean, 2) the role of the North Pacific and the Pacific Arctic regions in GOA-ON (Global Ocean Acidification Observation Networks) and AMAP-AOA (Arctic Monitoring and Assessment Program-Arctic Ocean Acidification) and 3) the exchange of data and involvement of early career scientists interested in OA.