

Report of the Section on *Carbon and Climate*

The meeting of the Section on *Carbon and Climate* (S-CC) was held from 09:00-18:00 on October 15, 2011 in Khabarovsk, Russia. Drs. James Christian (Canada) and Toshiro Saino (Japan) acted as meeting chairs. Eight members were present, representing all PICES member countries (*S-CC Endnote 1*). Some minor amendments were made to the meeting agenda (*S-CC Endnote 2*) which was then adopted unanimously.

AGENDA ITEM 2

Membership

Since the PICES 2010 Annual Meeting, two additional members were appointed to S-CC, Dr. Dong-Jin Kang of KORDI, representing Korea, and Dr. Burke Hales (OSU), representing the United States. Drs. Kyung-Ryul Kim (Korea) and Steve Emerson (USA) have stepped down. An additional *ex-officio* member has been proposed, representing SOLAS (Dr. Yukihiro Nojiri), but has not yet been appointed. Drs. Kang and Hales attended the meeting and introduced themselves to the membership (Dr. Hales could not attend in person but was present via VOIP connection).

AGENDA ITEM 3

S-CC achievements in the past 12 months

Five year report to parent committees

Following the S-CC meeting at PICES-2010, a report was made to the parent committees (BIO and POC) on achievements during the first 5 years and plans for the next 5. This report was well received by the parent committees and was published in the 2010 Annual Report. A brief review of this report was given for the membership, and further discussion of future plans and goals was undertaken in the afternoon.

PACIFICA Carbon Data Synthesis

A brief review of the status of PACIFICA was given. The data analysis and adjustment phase is winding down with the key data products expected to be opened in a beta version by the end of 2011. Some key participants, such as Drs. Masao Ishii and Tsuneo Ono, were not present so some key decisions had to be deferred and will be proposed to the full membership via email. The adjustment table is online and all PACIFICA participants can propose alterations to the adjustment values in this table. All participants will be encouraged to propose any remaining changes by a date yet to be fixed but not later than February 2012.

Publication of Korean and Chinese versions of the Guide to Best Practices for Ocean CO₂ Measurements

The Best Practices Guide (see the 2007 Annual Report) has now been published in both Korean and Chinese languages. The Korean version is available online at CDIAC. The Chinese version is not but we will endeavour to have it there soon. Both are available in hardcopy. The Korean translation was carried out by Drs. Tongsup Lee, Dong-Jin Kang, Junghee Shim and Jae-Yeon Kim and is published by KORDI. Five hundred hardcopies were printed. The Chinese translation was carried out by Drs. Liqi Chen and Zhongyong Gao and is published by the Ocean Press of China (oceanpress.com.cn). The Korean version includes corrections specified in the Errata to the English original to YYYY-MM-DD. This date needs to be published on CDIAC.

AGENDA ITEM 4

Reports of collaborating organizations and agencies

Reports were given on several international programs relevant to the mandate of S-CC including GLODAP (Kozyr), SOCAT (Kozyr), SOLAS (Dai), IOCCP (Kozyr), and CLIVAR/GO-SHIP (Murata). Dr. Tischenko (Russia) gave a brief report on recent S-CC related activities at the V.I. Il'ichev Pacific Oceanological Institute (POI), the main Russian oceanographic institute on the Pacific Coast.

GLODAP is planning a GLODAP v.2 dataset which will include PACIFICA, CARINA and other new datasets published since the release of original GLODAP database.

The SOCAT database has just been opened to the public as Version 1.5. Versions 1.0–1.4 were open only to SOCAT investigators. There are cruise data and gridded data viewers, both LAS based. Dr. Reiner Schlitzer (AWI, Germany) has created an ODV version. Dr. Hales commented that it is important to make sure links to the original data are maintained, and to avoid artificial redundancy (*e.g.*, if someone posts $f\text{CO}_2$ data that are calculated from $p\text{CO}_2$ data already in the dataset). Dr. Alex Kozyr gave some examples of how Digital Object Identifiers (doi) are used to uniquely identify datasets and to give data originators a traceable reference they can list on their own CVs and activity reports, which provides an additional incentive to share data. Dr. Christian commented that in PACIFICA all data are identified by EXPCODE, which is a unique identifier to an individual cruise.

SOLAS has national programs in 26 countries and SSC members from 12. It has just published its Mid-Term Development Strategy and elected new chairs: Eric Saltzmann (USA) and Veronique Garcon (France). It will host an Open Science Conference May 7–10, 2012 in the U.S. and a Summer School in Xiamen, China (tentatively August 22–September 4, 2013). This will be the first SOLAS Summer School held in a PICES country. SOLAS and IMBER also have a new joint Working Group on Ocean Acidification (launched September 2009).

IOCCP met in Paris in September. Discussion was mostly on SOCAT, future data submission, and the next release of the SOCAT dataset. Dr. Kozyr made presentations on the new data that are available at CDIAC, PACIFICA and GLODAP v.2 at this meeting.

CLIVAR ends in 2012, and GO-SHIP becomes the main international program for ship-based hydrographic observations. A map on the CDIAC web site (<http://cdiac.ornl.gov/oceans/RepeatSections/>) shows all past CLIVAR cruises as well as forthcoming GO-SHIP cruises. The Japan Repeat Hydrography implementation group met at JMA on February 17, 2011. This group includes many PACIFICA investigators and S-CC members (*e.g.*, Drs. Akihiko Murata, Masao Ishii, Takeshi Kawano, Michio Aoyama). A planned cruise will begin in the Indian Ocean and sail to the Pacific occupying the P10 line. There are also plans to reoccupy P1, and occupy a new P10N line, in 2014. Dr. Christian commented that previous occupations of P1 have passed near Line P but not close enough to have crossovers with most Line P cruises with the PACIFICA crossover radius of 250 km, and it will help future data synthesis efforts if longline cruises passing near to time series locations make an effort to occupy the key time series stations. Japan GEOTRACES and SOLAS/IMBER cruises are also planned which will provide useful data, and occupy lines that may be included in future data products like GLODAP v.2.

Dr. Tischenko described some key POI projects during 2007–2011, including monitoring climate change in the Japan/East Sea, Peter the Great Bay and the Primorye shelf area (9 cruises total). These cruises measured oxygen, nutrients, pH, alkalinity, and humic substances. The methods used for pH and alkalinity differ from the current international standard methods, but analysis of certified reference materials for alkalinity show differences from the standard values usually $< 1 \mu\text{mol/kg}$ (the PACIFICA threshold for adjustment is $6 \mu\text{mol/kg}$). These cruises also measured underway temperature, salinity, and $p\text{CO}_2$. Joint cruises have been held with Korean scientists under East-U. In August 2007 severe hypoxia was observed in Amursky Bay (down to $4 \mu\text{mol/kg}$). Russian scientists also participated in a Japanese GEOTRACES cruise in the Japan/East Sea.

AGENDA ITEM 5

Report on Paris workshop: Surface/Interior Carbon Synthesis

A joint SOLAS/IMBER/IOCCP Surface/Interior Carbon Synthesis meeting was held from September 14–16, 2011 in Paris, France. S-CC members Ishii, Murata, Suzuki (Japan), Feely, Sabine, and Kozyr (USA) attended. Drs. Feely and Ishii chaired the Pacific Basin breakout group. Topics of discussion included verifying the reality of surface $p\text{CO}_2$ trends. The PACIFICA data product will play a key role in answering this question. Future observing needs were also discussed, and it was suggested that full seasonal coverage and improved South Pacific coverage are needed, along with additional parameters such as O_2/Ar and $^{16}/^{17}/^{18}\text{O}$ to constrain NCP and NPP. It was also suggested that sampling requirements for new sensors (*e.g.*, onboard Argo floats) can be identified using models.

AGENDA ITEM 6

Completion of PACIFICA

The finalization of the PACIFICA data product was discussed at length and it is planned to open a beta version within the next 3 months. Because several key participants were not present, an exact target date was not decided upon, but will be at the very latest February 2012. Dr. Christian gave a brief presentation on the revised Line P data set and methods for integrating time series data, which were not considered in the CARINA protocols from which the PACIFICA protocols were adapted. A scientific publication describing these methods is in preparation, and the highlights were presented. It was suggested that A-line data be excluded from PACIFICA due to lack of data below 1500 m which PACIFICA protocols specify as the minimum depth for crossover analysis; a final decision will be made in consultation with A-line PI Dr. Ono.

AGENDA ITEM 7

Intercomparison experiments

A new carbon parameters intercomparison experiment is currently being planned by S-CC member Dr. Andrew Dickson (USA), and all members were encouraged to participate.

Dr. Murata gave a brief presentation on a planned nutrient intercomparison experiment to be carried out in early 2012. The core parameters will be nitrate, nitrite, phosphate and silicate concentrations, with ammonium and dissolved organic carbon, nitrogen and phosphorus as optional parameters. The method of preservation is to be heat-sterilization followed by sealing in polypropylene bottles, which has been quite successful in the past. The participant list will be finalized in December 2011, samples will be sent out mid January 2012 and results will be reported by end of April 2012. A preliminary report will be released June 2012. This experiment will be followed up with onboard intercomparison experiments planned for 2013 and/or 2015 on the Australian and Japanese research vessels *Investigator* and *Mirai*, respectively.

AGENDA ITEM 8

Topic sessions for PICES-2012

A topic session was proposed by S-CC to the BIO and POC Committees for PICES-2012 in Hiroshima, Japan, on the topic of “*Anthropogenic CO₂ trends and their impacts on marine ecosystems in the North Pacific and its marginal seas*” (S-CC Endnote 3). An additional session has been proposed by TCODE for POC and BIO co-sponsorship, on the topic of “*Trends in hypoxia and ecosystem impacts in the North Pacific*”. S-CC members support the endorsement of this proposal by the parent committees, but it was suggested that the title could be revised to replace the term “hypoxia” with “declining oxygen concentrations”. It was suggested that the S-CC proposed topic session could be revised to include O₂ as well as CO₂ and so broadened to merge the proposed TCODE session into that session, if the one is approved and the other declined. Subsequent to the Annual Meeting it was agreed that the proposed topic sessions would be merged. The revised topic session description is included as S-CC Endnote 4.

AGENDA ITEM 9

Participation in international conferences

Several major international symposia are planned for 2012: Second International Symposium on “*Effects of climate change on the world’s oceans*” in Yeosu, Korea (May 15–19, 2012) and the Third International Symposium on “*The ocean in a high CO₂ world*” in Monterey, California (September 24–27, 2012). The first is PICES co-sponsored and S-CC members are well represented. Previously S-CC had planned to organize a topic session, but the conference organizing structure precluded this. Nonetheless, S-CC members are organizing the carbon biogeochemistry session (“*Changes in the marine carbon cycle*”, S10). The second symposium has less S-CC representation. However, S-CC member, Dr. Richard Feely (USA), is on the SSC. Members were encouraged to submit abstracts to both symposia.

AGENDA ITEM 10

Four-year plan and integration with FUTURE

Plans for the next 4 years and integration of S-CC into FUTURE were discussed at length. Science Board Chair, Dr. Sinjae Yoo, gave a brief presentation on the structure, goals and objectives of FUTURE, and its new and planned experts groups. It was decided that the principal role of S-CC is to provide data and expertise to the various expert groups whose primary goals include understanding the impacts of biogeochemical phenomena like ocean acidification and deoxygenation, but lack specific expertise in biogeochemistry. Specific strategies for offering these groups Status reports, Outlooks and Forecasts were discussed. This is also discussed at length in the 5-year report included in the 2010 PICES Annual Report (see http://www.pices.int/publications/annual_reports/Ann_Rpt_10/2010%20CC-S.pdf). It was also recommended that PICES co-sponsor training initiatives like the 2013 SOLAS Summer School in Xiamen and the 2012 $p\text{CO}_2$ intercomparison experiment, and provide some funding for early career scientists from PICES member countries to attend.

It was also discussed that within the next 2–3 years plans should be initiated for some sort of “final product” to be created that would summarize the work of S-CC at the completion of 10 years of its existence.

S-CC Endnote 1

S-CC participation list

Members

James Christian (Canada, Co-Chairman)
Minhan Dai (China)
Burke Hales (USA)
Dong-Jin Kang (Korea)
Alex Kozyr (USA)
Akihiko Murata (Japan)
Toshiro Saino (Japan, Co-Chairman)
Toru Suzuki (Japan)
Pavel Tischenko (Russia)

Observers

Taekeun Rho (Korea)
Mitsuo Uematsu (Japan)
Sinjae Yoo (Science Board Chairman)

S-CC Endnote 2

S-CC meeting agenda

1. Opening (Christian, Saino)
Review and adopt agenda
2. Membership
3. S-CC achievements in the past 12 months
5-year report to parent committees (Christian, Saino)
PACIFICA Data Synthesis (Christian, Suzuki)
Publication of Korean version of Best Practices Guide (Kang)
4. Information exchange
SOCAT (Kozyr)
SOLAS-IMBER (Dai)
IOCCP/GCP/GLODAP2 (Kozyr)
CLIVAR/GO-SHIP (Murata, Kozyr)
POI activities (Tischenko)
5. Report on Paris workshop: Surface/Interior Carbon Synthesis (Murata)
Future goals and objectives
6. Completion of PACIFICA
7. Intercomparison experiments: nutrients, carbon
8. Topic sessions for PICES-2012
9. Participation in international conferences in Yeosu and Monterey
10. Four-year road map and integration with FUTURE

S-CC Endnote 3**Originally proposed topic session for PICES-2012**

Title: *Anthropogenic CO₂ trends and their impacts on marine ecosystems in the North Pacific and its marginal seas*

Duration: 1 day

Sponsoring Committees: POC, BIO

Anthropogenic CO₂ has been accumulating in the upper ocean for the past two centuries, and is beginning impact ecosystems in ways that will likely become more profound and ubiquitous in the coming decades. The North Pacific is a key area of concern because of naturally shallow carbonate saturation horizons and relatively low buffering capacity. Anthropogenic CO₂ alters the oceanic carbonate system, the main chemical equilibrium that gives seawater its buffering capacity. The added carbon drives down the pH and reduces the saturation state of carbonate minerals like calcite and aragonite in a process known as “ocean acidification”. Anthropogenic changes are not only seen in the open ocean, but can be even more significant in coastal regions and marginal seas. Anthropogenic CO₂ affects calcifying organisms, but its biological impacts are not limited to these organisms and are felt across ecosystems. We invite papers on the changing distribution of anthropogenic CO₂ in the upper ocean, its impacts on organisms and ecosystem function, and emergent impacts on biogeochemical cycles related to the interaction of ocean acidification with climate change and other anthropogenic impacts.

Scientists willing to serve as PICES convenors: Masao Ishii (Japan), Lisa Miller (Canada)

S-CC Endnote 4**Revised topic session proposal for PICES-2012**

Title: *Changing ocean biogeochemistry and its ecosystem impacts*

Duration: 1 day

Sponsoring Committees: POC, BIO

Ocean biogeochemistry is undergoing rapid and growing anthropogenic change. A significant fraction of anthropogenic CO₂ is taken up by the ocean, which drives down pH and reduces the saturation state of carbonate minerals like calcite and aragonite, a process known as “ocean acidification”. Dissolved oxygen concentrations in the subsurface ocean will also likely decline over the coming century with a warmer and more stratified upper ocean and reduced ventilation of the deep ocean. Declining oxygen levels have now been reported from mid-ocean depths in the tropical oceans and across the North Pacific. Both processes are of particular concern in the North Pacific, where the water is naturally ‘old’ and has shallow calcium carbonate saturation horizons, relatively low buffering capacity, and extensive oxygen minimum zones. It is anticipated that these anthropogenic influences on the global ocean will increase in coming decades as atmospheric CO₂ levels and global temperatures continue to rise. We invite papers on the changing biogeochemistry of the global ocean, its impacts on organisms and ecosystem function, and emergent impacts on biogeochemical cycles related to the interaction of ocean acidification and declining oxygen with climate change and other anthropogenic impacts.

PICES convenors: Tony Koslow (USA), Arthur Chen (IGBP), Lisa Miller (Canada), Steven Bograd (USA)

Potential invited speakers: Brad Seibel (USA); Frank Whitney (Canada); Tsuneo Ono (Japan), Y.W. Watanabe (Japan)