Report of the Section on *Carbon and Climate*

The meeting of the Section on *Carbon and Climate* (S-CC) was held from 14:00–18:00 on October 13, 2013 at the PICES Annual Meeting in Nanaimo, BC, Canada. Dr. James Christian acted as meeting Chair. Seven members were present, representing Canada, China, Japan and Korea (*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

Membership rotation was discussed for the U.S. and Japanese delegations. The U.S. delegation was not present. Areas of expertise considered a priority for FUTURE objectives include ocean acidification and coastal oceans / marginal seas. It was noted that expertise in these areas has already been enhanced with addition of members Drs. Minhan Dai (China), Burke Hales (U.S.), Dong-Jin Kang (Korea), and Jeong Hee Shim (Korea) over last few years.

AGENDA ITEM 2
S-CC achievements in the past 12 months

PACIFICA data synthesis

The PACIFICA data product was published May 2013 (http://pacifica.pices.jp/, http://cdiac.ornl.gov/oceans/PACIFICA/). Some errors were found after publication (NODC ship codes); there is a log of these on JODC but not necessarily on CDIAC. Planned tasks that were not completed were the second level quality control (2QC) of CFC and pH data, 2QC of the A-line time series data (which generally lack deeper data that are the basis for the crossover analysis method), and integration of the HOT time series data.

It was noted that GLODAP-2 may proceed with funding from European sources. Nicolas Gruber (ETH, Switzerland) has submitted an abstract to Ocean Sciences 2014 on this effort.

There was some discussion of extension of this process into the marginal seas. It was suggested that SOCAT data (which already include marginal seas) could be used as a point of reference (ground truth to surface instead of deep). Some marginal seas have stable deep composition; others do not. There are also legal issues of operating in some countries' exclusive economic zones that may affect our ability to include such data in a public domain data product.

It was agreed to abandon a planned special issue centred around analyses of PACIFICA data (see S-CC Annual Report for 2012), due to lack of author response. Publications describing the construction of the data product will nonetheless be completed.

AGENDA ITEM 3
Reports of collaborating organizations and agencies

Reports were given on several international programs relevant to the mandate of S-CC, including SOCAT (Suzuki), SOLAS/IMBER (Miller, Dai), IOCCP (Ishii), CLIVAR/GO-SHIP (Murata, Ishii), NPOCE (Dai) and AMAP (R. MacDonald).

Dr. Toru Suzuki (Japan) gave a presentation on Volunteer Observing Ship (VOS) programs. Basic pCO_2 observations by two VOSs in the Pacific are supported by the regular funding from NIES (National Institute for Environmental Studies, Japan). The NIES VOS program has also collected nutrient data since 1999. There has been discussion on the establishment of a Pacific network for surface nutrient sampling/data exchange/database preparation; S-CC supports such an initiative but its exact shape is not

yet known. SOCAT is also discussing inclusion of surface nutrient data within their database, and collaboration between SOCAT and the Pacific network is anticipated. Other new or expected developments include addition of Research Ships of Opportunity (*e.g*., Japan Fisheries Research Agency) and continuous underway measurement of nitrate using sensors. A poster on surface nutrient synthesis was presented (Yasunaka *et al*., "*Monthly maps of sea surface nutrients in the North Pacific: Basin-wide distribution and seasonal to interannual variations*") in Topic Session S6 on "*Recent trends and future projections of North Pacific climate and ecosystems*".

SOLAS held a Summer School August 23–September 2, 2013 in Xiamen, China. This was the first time a SOLAS Summer School was held in a PICES member country (and the first outside of Europe). PICES supported travel for 3 students: one each from Japan, Russia and the U.S.; 36% of the students came from PICES member countries. There was further discussion on the renewal of SOLAS under the FutureEarth umbrella. A workshop has been proposed for PICES-2014 to solicit community input (*S-CC Endnote 3*).

Dr. Masao Ishii (Japan) (with input from Dr. Akihiko Murata who was not present) reviewed plans for CLIVAR/GO-SHIP cruises over the next few years. JAMSTEC will occupy P1 in July–August 2014, with occupation of Ocean Station Papa and crossovers with P02 and P16N, which American cruises will likely occupy in 2013 and 2014. JMA has just completed P3, and plans to occupy P10 in 2014. There was some discussion of the process for incorporating these data into the expected updated GLODAP data set.

Dr. Ishii also gave an update on IOCCP activities. The latest activities include organizing an international time-series methods workshop jointly with U.S. research project OCB (Ocean Carbon and Biogeochemistry; (http://www.whoi.edu/website/TS-workshop/), contributing toward developing the Global Ocean Acidification Observing Network (http://www.pmel.noaa.gov/co2/GOA_ON/2013/), and having the first technical workshop for the GOOS Biogeochemistry Panel to nominate Essential Ocean Variables (http://www.ioccp.org/slides/45-slide-3). Several countries have new initiatives in terms of ocean observatories. China plans to deploy a cabled observatory in 2015. Supporting the activities of SOCAT and GLODAP-2, information exchange on surface and interior ocean observations and instruments, and data and information management are also continuing activities of IOCCP.

Prof. Minhan Dai (China) gave a brief presentation on NPOCE (Northwest Pacific Ocean Circulation and Climate Experiment), an international program with participants from (at least) China, the U.S. and Australia. The goals of NPOCE are to improve the understanding of northwest Pacific ocean circulation, and its role in warm pool maintenance, low-frequency variability, modulation of ENSO, the East Asian Monsoon variability, and tropical cyclones. Prof. Dai heads the biogeochemistry working group and is soliciting others to join this group.

Dr. Robie MacDonald (Canada) gave a presentation on the Arctic Monitoring and Assessment Program, which recently completed its Arctic Ocean Acidification Assessment. AMAP was tasked by the Arctic Council to evaluate the status of Arctic ocean acidification and its implications for future ecosystem impacts. Three PICES member countries are members of the Arctic Council, and the other three are observers. The recently completed assessment report is available at http://www.amap.no/documents/doc/amap-assessment-2013-arctic-ocean-acidification/881.

AGENDA ITEM 4
Future goals and objectives

PACIFICA publications

It was decided that a special issue on PACIFICA scientific analyses would not proceed (Dr. Lisa Miller had volunteered to act as a Guest Editor at the previous Annual Meeting in Hiroshima) due to lack of author interest. Several publications on the PACIFICA data products and methodology will nonetheless be completed. Drs. Christian, Ishii, and Suzuki will take primary responsibility for these.

Topic sessions for 2014

Topic Session S4 convened by Drs. Dai, Sophia Johannessen, and Dong-Jin Kang, entitled "*The changing carbon cycle of North Pacific continental shelves and marginal seas*" was very well subscribed, indicating substantial interest in this topic. Several S-CC members are involved in several workshop and topic session proposals, including a workshop for PICES-2014 (*S-CC Endnote 3*).

Integration with FUTURE

Plans for the coming years and integration of S-CC into FUTURE were discussed at length. (S-CC submitted a report for another 3-year extension for review by the BIO and POC parent committees for (*S-CC Endnote 4*)). Suggested activities include using SOCAT data to link the coastal and open ocean, and to extend the PACIFICA methodology into marginal seas where the assumption of constant deep water composition is not warranted, documenting procedures for second-level quality control (2QC) for the coastal ocean and marginal seas, doing a focused AMAP-type assessment on a specific target region that would be chosen to be of broad interest among scientists and policymakers from PICES countries, and a general synthesis of the state of knowledge of oxygen minimum zones and deoxygenation in the North Pacific. Membership renewal was discussed with respect to future activities, but as noted above the addition of Drs. Dai, Hales, Kang and Shim has already added substantial new expertise in the targeted areas. FUTURE related data products or syntheses will be developed over the next few years in consultation with the FUTURE APs and other expert groups.

S-CC Endnote 1

S-CC participation list

Members	Observers
James Christian (Canada, Co-Chair)	Robie MacDonald (Canada)
Minhan Dai (China)	Toshiya Nakano (Japan)
Masao Ishii (Japan)	Boram Sim (Korea)
Dong-Jin Kang (Korea)	
Lisa Miller (Canada)	
Jeong Hee Shim (Korea)	
Toru Suzuki (Japan)	

S-CC Endnote 2

S-CC meeting agenda

1. Opening (Christian, Saino)
   - Review and adopt agenda
   - Membership: Saino, Watanabe to rotate off?
2. S-CC achievements in the past 12 months
   - PACIFICA Data Synthesis (Ishii, Suzuki)
3. Information Exchange
   - SOCAT (Suzuki)
   - SOLAS-IMBER (Miller, Dai)
   - CLIVAR/GO-SHIP (Murata)
   - IOCCP (Ishii)
   - AMAP (R. MacDonald)
   - Future goals and objectives: refocus section objectives around ocean acidification and its impacts? Integration with FUTURE
   - PACIFICA Publications
   - Topic sessions for 2014

S-CC Endnote 3

Proposal for a ½-day POC Workshop on "*SOLAS into the future: Designing the next phase of the Surface Ocean-Lower Atmosphere Study within the context of the Future Earth program*" at PICES-2014

Co-sponsor: SOLAS

Duration: 0.5-day
Convenors: Lisa Miller (Canada), Minhan Dai (Canada), Yukihiro Nojiri (Japan)

For more than a decade, the Surface Ocean-Lower Atmosphere Study (SOLAS) has fostered cutting-edge research in air-sea interactions, facilitating communication, coordinating and directing research, and advocating for new projects. The SOLAS program has facilitated major advances, changing fundamental understanding in a number of subjects, including the significance of ocean acidification, the roles of DMS and marine organic matter in atmospheric chemistry, and the importance of sea-ice biogeochemistry in controlling air-sea exchange. At the same time, the significance of earth system science to society has become increasingly apparent, and FutureEarth is replacing the International Geosphere-Biosphere Programme as a major SOLAS sponsor. Within this context, SOLAS is plotting a new course for the next 10 years. This discussion session is one of a number at various conferences that is soliciting community input into the future of SOLAS. In particular, we are asking the question: In a world where Earth system science is coming under increasing political and public scrutiny, what is and should be the contribution of SOLAS science to society? Ideas and conclusions from this and other, similar workshops will be incorporated into the new SOLAS science plan.

S-CC Endnote 4

Report of the Section on *Carbon and Climate* for 2010–2013

The Section on *Carbon and Climate* (S-CC) was created in the fall of 2005 at the PICES Annual Meeting in Vladivostok, Russia, following discussions to the effect that a more permanent body was needed to carry on the work of the disbanded Working Groups 13 (on *Carbon Dioxide in the North Pacific*) and 17 (on *Biogeochemical Data Integration and Synthesis*). At the 2010 Annual Meeting the Section was reauthorized for a further five years. Subsequent changes to the Rules of Procedure (Rule of Procedure 13(iii)(d)) reduced the reauthorization period to three years.

The S-CC has two parent committees, POC and BIO. Drs. James Christian (Canada) and Toshiro Saino (Japan) have chaired the Section since its inception.

Membership

S-CC has members from all PICES member countries, in addition to an *ex-officio* member representing IGBP (Prof. C.T.A. Chen). Current membership is 22; national complements range from 2 to 6 (see Annex 1).

S-CC achievements in the past 3 years

Topic Sessions at PICES Annual Meetings

At the 2012 Annual Meeting in Hiroshima, Japan, POC and TCODE co-sponsored a topic session called "*Changing ocean biogeochemistry and its ecosystem impacts*" (co-sponsored by ICES, IMBER and SOLAS). S-CC members Drs. Masao Ishii (Japan) and Chen (*ex-officio*) were convenors and S-CC member Dr. Akihiko Murata (Japan) was an invited speaker.

At the 2013 Annual Meeting in Nanaimo, Canada, POC sponsored a topic session called "*The changing carbon cycle of North Pacific continental shelves and marginal seas*" (co-sponsored by SOLAS). S-CC members Drs. Minhan Dai (China), Sophia Johannessen (Canada), and Dong-Jin Kang (Korea) were the convenors.

Both sessions drew large audiences and large numbers of presenters. This attests to widespread interest in carbon biogeochemistry at PICES Annual Meetings and the need for the continued presence of a formal body dedicated to these topic areas.

PACIFICA data synthesis

The most significant undertaking of S-CC is the data synthesis project known as PACIFICA (PACIFic ocean Interior Carbon) database. PACIFICA has collected biogeochemical data (DIC, TA, nutrients, oxygen, salinity) from more than 200 cruises in the Pacific and has implemented a set of algorithms for cross-over analysis that permits the construction of a basin-wide, consistently calibrated data set. The PACIFICA algorithms were adapted from CARINA and implemented by Dr. Toru Suzuki (Japan). The data product was published in early 2013 as NDP-092 (http://cdiac.ornl.gov/oceans/PACIFICA/ndp092.html).

Contribution to RECCAP

The REgional Carbon Cycle Assessment and Processes (RECCAP) project is an international effort to develop a global carbon budget, synthesizing ocean, terrestrial, and atmospheric carbon studies. S-CC members Masao Ishii and Richard Feely are leading the ocean carbon synthesis effort for the Pacific (http://www.globalcarbonproject.org/reccap/syntheses.htm). PACIFICA data played an important role in the Pacific ocean synthesis.

Contribution to SOCAT

Surface Ocean CO_2 ATlas (SOCAT) is "a collection of underway ocean CO_2 observations quality controlled by the science community" (http://www.socat.info/about.html). Eight S-CC members contributed to SOCAT as data contributors and/or participants in data quality control and the development of the data product (L. Chen, R. Feely, B. Hales, A. Kozyr, A. Murata, T. Ono, C. Sabine, T. Suzuki, http://www.socat.info/credits.html). (Dr. Sabine resigned from S-CC in early 2013 due to new responsibilities as Director of NOAA-PMEL.)

Scientific publications

Annex 2 provides a list of sample publications for the years 2011–2013, emphasizing those that involve multiple S-CC members from different PICES member countries (and a few that include multiple S-CC members within the same country but from different institutions). There are numerous additional publications not listed here that represent, for example, member collaborations with members of other PICES expert groups or with nonmember scientists in other PICES member countries. There are several additional publications that represent work conducted during this period but were not accepted in final form by 2013.

Participation in international symposia

At the second symposium on "*Effects of climate change on the world's oceans*" (co-sponsored by PICES, ICES, and IOC) in Yeosu, Korea in May 2012, S-CC Co-Chair Dr. James Christian (Canada) was on the Scientific Steering Committee and co-chaired a theme session, "*Changes in the ocean carbon cycle*" with S-CC member Prof. Kitack Lee (Korea). S-CC member Dr. Masao Ishii (Japan) was an invited speaker. The third symposium on "*The ocean in a high-CO_2 world*" was held in September 2012 in Monterey, California. S-CC member Dr. Richard Feely (USA) was on the International Steering Committee. S-CC members Drs. Andrew Dickson, Hernan Garcia, Masao Ishii, Akihiko Murata, Jeong Hee Shim, and Toru Suzuki attended. Dr. James Christian (Canada) was an invited plenary speaker at the second ESSAS Open Science Meeting in Seattle, Washington (co-sponsored by PICES, ICES, IMBER, and GOOS).

Future plans

The FUTURE Science Plan notes that "natural and anthropogenic pressures are causing the oceans to acidify, while pollution, extirpations, invasive species, anoxia, habitat loss, and exploitation affect the coastal zones", and suggests that "Region-specific assessments of topical issues (*e.g.*, harmful algal blooms, eutrophication, native and alien species range changes, anoxia, and ocean acidification)" will be one of the key "anticipated benefits and products" of FUTURE. It is clear that ocean acidification, deoxygenation and productivity will be key issues for FUTURE and for Pacific Ocean science over the

next 5–10 years. In PICES, much of the scientific expertise on these issues – particularly acidification – resides within S-CC. S-CC anticipates a shift in focus from carbon biogeochemistry toward biological impacts of ocean acidification; the Terms of Reference have already been revised (2008) to reflect this (see Annex 3). S-CC gives a presentation on S-CC activities and potential areas of cooperation at the FUTURE and AP-COVE meetings at each PICES Annual Meeting. At S-CC meetings at recent Annual Meetings, we have discussed potential data syntheses and data products to be developed in cooperation with the FUTURE APs and other related expert groups.

Overall objectives for 2013–2016

1) Complete publication of scientific analyses arising from PACIFICA data synthesis.
2) Develop data syntheses or products related to ocean acidification and deoxygenation and their biological and ecosystem impacts in support of FUTURE objectives, in consultation with FUTURE APs and other expert groups.
3) Develop strategy for assessment of the carbon cycle in coastal oceans and marginal seas of the North Pacific (data syntheses, data products, documentation of methods), in consultation with FUTURE APs and other expert groups.

Annex 1: S-CC members

Canada: Dr. James Christian (Co-Chair); Dr. Sophia Johannessen; Dr. Lisa Miller

China: Prof. Liqi Chen; Prof. Minhan Dai

Japan: Dr. Masao Ishii; Dr. Akihiko Murata; Dr. Tsuneo Ono; Dr. Toshiro Saino (Co-Chair); Dr. Toru Suzuki; Prof. Yutaka Watanabe

Korea: Dr. Dong-Jin Kang; Prof. Kitack Lee; Dr. Jeong Hee Shim

Russia: Dr. Andrey Andreev; Dr. Pavel Tishchenko

United States: Prof. Andrew Dickson; Dr. Richard Feely; Dr. Hernan Garcia; Prof. Burke Hales; Dr. Alexander Kozyr

ex-officio: Prof. Chen-Tung Arthur Chen

Annex 2: Sample S-CC Publications

(S-CC authors in bold)

Alin, S., R. **Feely**, A. **Dickson**, J. Hernandez-Ayon, L. Juranek, M. Ohman, and R. Goericke (2012), Robust empirical relationships for estimating the carbonate system in the southern California Current System and application to CalCOFI hydrographic cruise data (2005-2011), *Journal of Geophysical Research-Oceans, 117*, doi:10.1029/2011JC007511.

Barton, A., B. **Hales**, G. Waldbusser, C. Langdon, and R. **Feely** (2012), The Pacific oyster, Crassostrea gigas, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near-term ocean acidification effects, *Limnology and Oceanography, 57*, 698–710.

Feely, R., C. **Sabine**, R. Byrne, F. Millero, A. **Dickson**, R. Wanninkhof, A. **Murata**, L. **Miller**, and D. Greeley (2012), Decadal changes in the aragonite and calcite saturation state of the Pacific Ocean, *Global Biogeochemical Cycles, 26*, doi:10.1029/2011GB004157.

Hales, B., P. Strutton, M. Saraceno, R. Letelier, T. Takahashi, R. **Feely**, C. **Sabine**, and F. Chavez (2012), Satellite-based prediction of pCO_2 in coastal waters of the eastern North Pacific, *Progress in Oceanography, 103*, 1–15.

Khatiwala, S., Tanhua, T., Mikaloff Fletcher, S., Gerber, M., Doney, S.C., Graven, H.D., Gruber, N., McKinley, G.A., **Murata**, A., Ríos, A.F. and **Sabine,** C.L. (2013), Global ocean storage of anthropogenic carbon, *Biogeosciences*, *10*, 2169–2191.

Lee, K., C. **Sabine**, T. Tanhua, T. Kim, R. **Feely**, and H. Kim (2011), Roles of marginal seas in absorbing and storing fossil fuel CO_2, *Energy & Environmental Science*, *4*, 1133–1146.

Maiti, K., K.O. Buesseler, S.M. Pike, C. Benitez-Nelson, P.H. Cai, W.F. Chen, K. Cochran, M.H. **Dai**, F. Dehairs, B. Gasser, R.P. Kelly, P. Masque, L.A. **Miller**, J.C. Miquel, S.B. Moran, P.J. Morris, F. Peine, F. Planchon, A.A. Renfro, M.R. van der Loeff, P.H. Santschi, R. Turnewitsch, J.T. Waples, and C. Xu (2012), Intercalibration studies of short-lived thorium-234 in the water column and marine particles, *Limnology and Oceanography-Methods*, *10*, 631–644.

Midorikawa, T., H. Inoue, M. **Ishii**, D. Sasano, N. Kosugi, G. Hashida, S. Nakaoka, and T. **Suzuki** (2012), Decreasing pH trend estimated from 35-year time series of carbonate parameters in the Pacific sector of the Southern Ocean in summer, *Deep-Sea Research I, 61*, 131–139.

Pfeil, B., A. Olsen, D.C.E. Bakker, S. Hankin, H. Koyuk, A. **Kozyr**, J. Malczyk, A. Manke, N. Metzl, C.L. **Sabine**, J. Akl, S.R. Alin, N. Bates, R.G.J. Bellerby, A. Borges, J. Boutin, P.J. Brown, W.-J. Cai, F.P. Chavez, A. **Chen**, C. Cosca, A.J. Fassbender, R.A. **Feely**, M. González-Dávila, C. Goyet, B. **Hales**, N. Hardman-Mountford, C. Heinze, M. Hood, M. Hoppema, C.W. Hunt, D. Hydes, M. **Ishii**, T. Johannessen, S.D. Jones, R.M. Key, A. Körtzinger, P. Landschützer, S.K. Lauvset, N. Lefèvre, A. Lenton, A. Lourantou, L. Merlivat, T. Midorikawa, L. Mintrop, C. Miyazaki, A. **Murata**, A. Nakadate, Y. Nakano, S. Nakaoka, Y. Nojiri, A.M. Omar, X.A. Padin, G.-H. Park, K. Paterson, F.F. Perez, D. Pierrot, A. Poisson, A.F. Ríos, J. Salisbury, J.M. Santana-Casiano, V.V.S.S. Sarma, R. Schlitzer, B. Schneider, U. Schuster, R. Sieger, I. Skjelvan, T. Steinhoff, T. **Suzuki**, T. Takahashi, K. Tedesco, M. Telszewski, H. Thomas, B. Tilbrook, J. Tjiputra, D. Vandemark, T. Veness, R. Wanninkhof, A.J. Watson, R. Weiss, C.S. Wong, and H. Yoshikawa-Inoue (2013), A uniform, quality controlled surface ocean CO_2 atlas (SOCAT). *Earth Syst. Sci. Data*, 5, 125–143.

Sabine, C.L., S. Hankin, H. Koyuk, D.C.E. Bakker, B. Pfeil, A. Olsen, N. Metzl, A. **Kozyr**, A. Fassbender, A. Manke, J. Malczyk, J. Akl, S.R. Alin, R.G.J. Bellerby, A. Borges, J. Boutin, P.J. Brown, W.-J. Cai, F.P. Chavez, A. **Chen**, C. Cosca, R.A. **Feely**, M. González-Dávila, C. Goyet, N. Hardman-Mountford, C. Heinze, M. Hoppema, C.W. Hunt, D. Hydes, M. **Ishii**, T. Johannessen, R.M. Key, A. Körtzinger, P. Landschützer, S.K. Lauvset, N. Lefèvre, A. Lenton, A. Lourantou, L. Merlivat, T. Midorikawa, L. Mintrop, C. Miyazaki, A. **Murata**, A. Nakadate, Y. Nakano, S. Nakaoka, Y. Nojiri, A.M. Omar, X.A. Padin, G.-H. Park, K. Paterson, F.F. Perez, D. Pierrot, A. Poisson, A.F. Ríos, J. Salisbury, J.M. Santana-Casiano, V.V.S.S. Sarma, R. Schlitzer, B. Schneider, U. Schuster, R. Sieger, I. Skjelvan, T. Steinhoff, T. **Suzuki**, T. Takahashi, K. Tedesco, M. Telszewski, H. Thomas, B. Tilbrook, D. Vandemark, T. Veness, A.J. Watson, R. Weiss, C.S. Wong, and H. Yoshikawa-Inoue (2013), Surface ocean CO_2 atlas (SOCAT) gridded data products. *Earth Syst. Sci. Data*, 5, 145–153.

Tishchenko, P., D. **Kang**, R. Chichkin, A. Lazaryuk, C. Wong, and W. Johnson (2011), Application of potentiometric method using a cell without liquid junction to underway pH measurements in surface seawater, *Deep-Sea Research Part I, 58*, 778–786.

Turk, D., C. Zappa, C. Meinen, J. **Christian**, D. Ho, A. **Dickson**, and W. McGillis (2010), Rain impacts on CO_2 exchange in the western equatorial Pacific Ocean, *Geophysical Research Letters*, *37*, doi:10.1029/2010GL045520.

Wang, D., W. Lin, X. Yang, W. Zhai, M. **Dai**, and C. **Chen** (2012), Occurrences of dissolved trace metals (Cu, Cd, and Mn) in the Pearl River Estuary (China), a large river-groundwater-estuary system, *Continental Shelf Research*, *50–51*, 54–63.

Annex 3: S-CC Terms of Reference

(bold indicates 2008 revisions)

1. Coordinate and encourage ongoing and planned national and international syntheses of carbon cycle research studies in the North Pacific and, where necessary and appropriate, for the larger Pacific basin;

2. Ensure effective two-way communication with other international scientific groups that have a responsibility for the coordination of ocean carbon studies, such as the International Ocean Carbon Coordination Project (IOCCP), CLIVAR/CO_2 Repeat Hydrography and the SOLAS/IMBER implementation group for carbon research;

3. Review the existing information on carbon cycling in the North Pacific, including anthropogenic carbon, the biological pump, impacts **of ocean acidification** on marine biota, and possible feedbacks to atmospheric greenhouse gases; identify gaps in our knowledge, and make prioritized recommendations for future research;

4. Periodically review the status of the methodology of CO_2 measurements, including the preparation of standards and reference materials, and advise on inter-calibration and quality control procedures;

5. Identify suitable data sets on the oceanic CO_2 system in the Pacific region as they become available, and recommend the mechanisms of data and information exchange;

6. Carry out and publish (in the refereed literature) basin-scale syntheses of carbon cycling in the North Pacific, including new data whenever appropriate, and encourage scientific interpretation of these evolving data sets;

7. Organize symposia, workshops, or Annual Meeting sessions on **the carbon cycle, ocean acidification**, and climate studies in the North Pacific.