Section on Carbon and Climate: Terms of Reference

(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 coordination of ocean carbon studies, such as the International Ocean Carbon Coordination Project (IOCCP), CLIVAR/CO2 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.

(4) Identify gaps in our knowledge, and make prioritized recommendations for future research. Periodically review the status of the methodology of CO2 measurements including the preparation of standards and reference materials, and advise on intercalibration and quality control procedures;

(5) Identify suitable data sets on the oceanic CO2 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 symposiums, workshops, or annual meeting sessions on the carbon cycle, ocean acidification, and climate studies in the North Pacific.

CC-S contributions to FUTURE

CC-S contributions to FUTURE will focus on three central themes:

- **productivity**
- **hypoxia**
- **ocean acidification**

CC-S contributions to FUTURE (cont.)

Ocean acidification is an emerging issue in oceanography internationally that is particularly relevant to the North Pacific. The original CC-S TOR were revised in 2007 to take account of this emerging reality.

CC-S members envision that FUTURE will address both feedbacks of CO_2-induced acidification on future ocean CO_2 uptake and acidification impacts on the broader ecosystem.

Productivity and hypoxia are cross-cutting issues in North Pacific Ocean biogeochemistry that address a broad spectrum of issues relating ocean circulation and biogeochemical cycles to ecosystem structure and function.

These issues relate to traditional CC-S concerns such as ocean CO_2 uptake (most closely aligned with COVE) as well as issues such as anoxia impacts on shelf benthic fisheries (AICE).

Status, Outlooks, Forecasts, Engagement

- What is the present distribution of dissolved oxygen and the depth of the suboxic zones? What is the distribution of dissolved CO_2, total alkalinity, carbonate ion, and pH, and the depth of the aragonite and calcite saturation depths?
- What are the best climate indices in a changing world? What are useful indices of biogeochemical variability?
- What are the important pathways of supply of oxygen, carbon and nutrients to the North Pacific thermocline?
- What are the major groups of phytoplankton and zooplankton that determine oceanic primary production? What are the limiting nutrients for oceanic primary production?

Status, Outlooks, Forecasts, Engagement

- What biogeochemical properties of marine ecosystems increase or decrease ecosystem vulnerability to environmental change? How does ocean biogeochemistry interact with other human factors such as eutrophication to impact coastal ecosystems?

- How will anthropogenic CO_2 affect ocean chemistry and how do these changes impact ecosystems? What are the mechanisms of ocean acidification impacts on ecosystems?

- How will the chemical composition of waters upwelled onto continental shelves change (e.g., will suboxic zones expand)? Will physical processes that transport suboxic waters onto the shelves change? How will hypoxia interact with changing coastal ocean productivity and local human impacts?

Status, Outlooks, Forecasts, Engagement

- **CC-S members have been engaged for many years in addressing Objective 1 ("Understanding Critical Processes") in the FUTURE Implementation Plan. The emergence of ocean acidification as a central impact of anthropogenic CO_2 underscores that biogeochemical processes are critical for understanding ocean biology, and interdisciplinary studies with strong participation from biogeochemists are needed to address emerging issues like hypoxia.**

- **With respect to Objective 2 ("Status Reports, Outlooks, Forecasts, and Engagement"), we are still in the process of learning what this means (as is everyone else).**

- **The PACIFICA data base will contain an unprecedented amount of temporal information, by comparison with earlier efforts such as GLODAP and CARINA. This will create opportunities for interdisciplinary studies of future ocean change in the context of past variability and change.**

CC-S objectives for 2010-2015

- complete and publish scientific analyses arising from PACIFICA data synthesis (as noted above these contain temporal information not available in earlier synthesis projects)
- proceed with data synthesis and intercalibration efforts for marginal seas (East/Japan Sea, South China Sea, East China Sea, Sea of Okhotsk, Bering Sea) and scientific analyses of these data
- conduct analyses of the SOCAT pCO_2 data base for the North Pacific region and coordinate synthesis and archiving of pCO_2 data from ongoing programs in PICES member countries
- document and archive historical pH data and conduct retrospective analyses of ocean acidification
- coordinate and encourage research into ocean acidification and its biological impacts