THE INTERNATIONAL OCEAN CARBON COORDINATION PROJECT (IOCCP)

A joint project of SCOR and IOC and an affiliate program of the Global Carbon Project.

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NEWSLETTER No. 13, August 2006

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Report summary from the Initial North Atlantic Synthesis meeting, Iceland

Twenty-three participants from 9 countries with expertise ranging from hydrography, physical oceanography, surface pCO2, ocean tracers (CFCs, O2), numerical modelling and data management met in Iceland with the assistance of Jon Olafsson of the Institute for Marine Research to present and discuss the logistics of preparing for a synthesis of carbon and carbon related data collected in the Atlantic Ocean. The meeting was cosponsored by CarboOcean and IOCCP. The key objective was to fulfil commitments to the EU CarboOcean work-package 'Quantification of decadal to centennial large scale Atlantic and Southern Ocean carbon inventory changes'. The goals of this meeting were to identify existing datasets, to document the plans and interests of individual research groups, to establish collaborations between groups based around key scientific questions, to discuss common methodologies, and to plan for a North Atlantic synthesis using multi-disciplinary approaches.

The meeting began with presentations of the key scientific questions, beginning with the hosts Jon Olafsson and Thorarinn Arnason who presented results of the Icelandic CO2 research program in the Irminger and Iceland Seas. Following that, status reports and 'learning experiences' from previous synthesis efforts were presented. The meeting then moved to the main focus, to establish working groups that will conduct the synthesis.

Key to the planning of syntheses is to learn from previous efforts. The experiences from prior projects GLODAP and CARINA were presented, with particular stress on the importance of meta-data and consistency of data reporting (including units and accuracy estimates). A critical need for increased international attention to nutrient data quality was identified in order to improve analyses of the ocean's changing CO2 levels. It was suggested that in the future cruise tracks should be planned such that common profiles are collected at intersections with other tracks (both past and planned). It was also noted that a bibliography of CARINA research papers is now available online on the CarboOceans website.

To prepare for the synthesis, several issues were identified as the key scientific questions to be addressed, including:

- anthropogenic carbon inventories and inventory changes
- lateral transports of carbon
- Cant method comparisons
- changes in pH and the saturation states of carbonate minerals
- changes in O2 content

The scientific interests were similar among participants, but tended to break down along geographical regions, and so three working groups were created:

Southern (South of 16°N, with emphasis on the Southern Ocean)

Northern (North of 60°N)

Middle (North Atlantic Sub-polar and sub-tropical gyres).

It became evident that the South Atlantic (north of the Southern Ocean) was largely devoid of recent data (i.e. post-WOCE) and therefore of scientific investigation and synthesis plans. A small group was tasked with attempting to rectify this unsatisfactory situation.

Each working group set about identifying the datasets currently available, and those that would become available in the near future. Individuals were nominated within each group to be responsible for data quality assessment of each variable (discrete pCO2, Talk, pH, Nutrients, DOC, O2, T&S, Oxygen and Carbon isotopes, CFCs). The working groups will meet again in early 2007 to report on progress.

In addition to formation of working groups and identification of responsibilities and scientific interests, it was agreed to make public the historical collection of carbon data that has been assembled by the previous CARINA project. Potential users of these data should be aware that there remain some problems with some of the data and that the quality assessment activities of the regional working groups will recommend adjustments to these data in order to assemble an internally-consistent data set.

The full report from the meeting will be made available on the CarboOcean data portal (http://www.carboocean.org/) in the near future.

Map of carbon time series sites now available

Working with Alex Kozyr at CDIAC, the IOCCP has produced a map of the time series sites that are currently measuring surface and sub-surface CO2, as well as some proposed sites (click here for the map). The map is not yet complete, and PIs with time series sites are requested to review the this map and inform the IOCCP if they would like to have their stations included on he maps and tables (email Roger Dargaville). A version of the map with only the currently operating stations is available on the CDIAC web site with clickable links to available data.

IOCCP and OceanSITES are collaborating to find the best way to collate and present the information regarding the time series sites, and any comments on the map or tables and the information supplied will be gratefully accepted.

Report from the OCCC Ocean Carbon Workshop, July 10-13 Woods Hole
Contributed by Scott C. Doney and David M. Glover

The recently formed U.S. Ocean Carbon and Biogeochemistry (OCB) program held its inaugural science workshop in July, 2006 in Woods Hole, MA, USA. The scientific focus of the OCB is ocean biogeochemistry, especially on the ocean's role as a component of the global Earth system. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the U.S. research community and with international partners. Important OCB-related activities currently include: the Ocean Carbon and Climate Change (OCCC) and the North American Carbon Program (NACP); U.S. contributions to IMBER, SOLAS, CARBOOCEAN; and numerous U.S. single-investigator and medium-size research projects funded by NASA, NOAA, and NSF.

The objectives of the OCB summer 2006 workshop were to highlight recent scientific findings in ocean biogeochemistry and related ecological and physical research, foster improved communication among existing ocean biogeochemistry observing programs and process studies, and discuss applications of emerging observational technologies in marine biogeochemistry. About 80 U.S. and international scientists participated in the four-day meeting, which was supported by the U.S. National Science Foundation (NSF). Electronic versions of the full agenda, poster abstracts, and many of the plenary talks and discussion sessions are available through the workshop web page (http://ocb.whoi.edu/workshops.html).

The meeting was organized around several major science themes:

- atmosphere-ocean CO2 exchange;
- marine ecosystem-biogeochemical dynamics;
- ocean carbon cycle and climate.

In each theme, a series of plenary talks was given synthesizing both field-based and modeling results and in particular emphasizing new findings and unresolved science issues. Here we present a selection of some of the more noteworthy material:

> New independent estimates of Southern Ocean air-sea CO2 fluxes based on an expanded synthesis of surface pCO2 data and numerical inversions of ocean carbon interior data show relatively small mean net uptake, much lower than previous observational and model calculations;
>
> Model simulations suggest substantial interannual variability in Southern Ocean air-sea CO2 fluxes associated with the Southern Annular Mode, highlighting the need for more high latitude ocean biogeochemical observations and time-series;
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> Better instrumentation (e.g., Lagrangian floating sediment traps) and focused process studies are beginning to shed light on biogeochemical transport and remineralization in the mesopelagic region just below the base of the euphotic zone. Organic matter remineralization length scales appear to differ considerably from a subtropical and subpolar site, perhaps linked to temperature;
>
> Innovative stochastic modeling approaches are being developed to explore competitive exclusion and phytoplankton niches in 3-D models. These techniques offer an objective approach for assessing the required complexity of ecological/geochemical functional group models;

Physical observational and numerical studies illustrate the significant variability on horizontal distances smaller than those associated with mesoscale eddies (~100-300 km). The effect of the resulting large submesocale vertical velocity variations and lateral stirring on large-scale nutrient fluxes and biological rates and patterns need to be better characterized;

Detection and attribution of the long-term temporal trends in ocean biogeochemistry associated with anthropogenic carbon uptake and climate change are substantially hampered by sub-annual to interannual variability. Studies are underway to assess the skill of various numerical, modeling and remote sensing techniques to address these problems;

Dramatic and rapid advances are occurring in marine microbial genomics. For example, new findings suggest a much greater prokaryotic and eukaryotic diversity than previously thought. New conceptual models and methods are need to bridge between the emerging wealth of genomic data and more traditional ecological and biogeochemical approaches;

Exciting new capabilities were demonstrated using in situ chemical and biooptical sensors on autonomous platforms (profiling floats, moorings, and gliders). These observing technologies will be central to addressing biogeochemical science questions in the upcoming U.S. NSF-funded ORION initiative;

A synthesis of paleoceanographic data was presented in support of a new conceptual model to explain the 80-100 ppm drawdown in atmospheric CO2 from interglacial to glacial periods. The hypothesis involves a long intermediate glacial period where atmospheric CO2 was only about 40 ppm lower than pre-industrial levels caused be changes in ocean physics and temperature and a full glacial state driven by changes in the ocean alkalinity inventory;

A new interpretation was presented to explain the diurnal variations in in situ variable fluorescence data from pump/probe instruments. This may provide useful measures of nitrogen and iron stress on phytoplankton physiology and has important implications for traditional ocean color remote sensing.

Special discussion sessions were also held on future research opportunities related to:

- ocean acidification (see also a new report Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers Report: A Guide for Future Research; http://www.isse.ucar.edu/florida/);
- the Southern Ocean Gas Exchange Experiment (Gas-Ex III; http://duck-rabbit.ldeo.columbia.edu/so_gasex/);
- other Southern Ocean physical and biogeochemical field campaigns (DIMES, ACE/CSIRO)
- the EU CARBOOCEAN project (http://www.carboocean.org)
- the Hawaii Ocean Time-Series (HOT; http://hahana.soest.hawaii.edu/hot/hot.html); and
- the Ocean Research Interactive Observatory Networks (ORION; www.orionprogram.org/).

Another Ocean Carbon and Biogeochemistry science workshop will be held in the summer of 2007, the exact dates and location to be announced via email and on the OCB website (http://ocb.whoi.edu).

Ocean carbon and the International Polar Year web site

As the International Polar Year approaches, there is a need to compile information about on-going and planned ocean carbon research in the polar areas. Building on information collected during the November International Repeat Hydrography and Carbon workshop, the regular inventories of the IOCCP, and compiled information from SOLAS and IMBER, we have developed an initial compilation of on-going or planned field programs for the Arctic and Antarctic regions. Many of these projects are not affiliated with or funded by the International Polar Year program, and many are multi-disciplinary programs that deal with a broad range of issues. In partnership with the research programs, the IOCCP will continue to develop this compilation and create a web-site database for this information. For more information, please visit http://www.ioc.unesco.org/ioccp/IPY_carbon.htm

Report release: 'Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers'

Extract from the executive summary: A variety of evidence indicates that [due to ocean uptake of anthropogenic CO2] calcification rates will decrease, and carbonate dissolution rates increase, as CaCO3 saturation state decreases. This evidence comes from principles of thermodynamics, the geologic record, and the evolutionary pathways of CaCO3 secreting organisms. Further evidence, from controlled experiments of biocalcification under increased CO2 conditions, confirms that calcification rates of many organisms decrease with decreasing CaCO3 saturation state. Extrapolation of these results to the real world suggests that calcification rates will decrease up to 60% within the 21st century. We know that such extrapolations are oversimplified and do not fully consider other environmental and biological effects (e.g., rising water temperature, biological adaptation); nor do they address effects on organism fitness, community structure, and ecosystem functioning. Any of these factors could increase or decrease the laboratory-based estimates, but it is certain that net production of CaCO3 will decrease in the future.

Download the full report at: http://www.ucar.edu/communications/Final_acidification.pdf (pdf, 9.4Mb).