

THE INTERNATIONAL OCEAN CARBON COORDINATION PROJECT (IOCCP)

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

Project Coordinator: Maria Hood, Intergovernmental Oceanographic Commission - UNESCO

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Report from the International Repeat Hydrography and Carbon Workshop

JAMSTEC, the IOCCP, and CLIVAR co-hosted an International Repeat Hydrography and Carbon Workshop on November 14-16, at Shonan Village, Japan. This workshop brought together 49 scientists from 11 countries with expertise in carbon, hydrography, tracers, prognostic modelling, data assimilation, the Argo profiling float program, and data and information managers. The goals of the workshop were to assess current ship-based hydrography programs and whether these activities are sufficient to meet science objectives of research programs, and to develop plans for a robust mechanism to compile information and data from ship-based hydrography. After a session of science talks focused on what we have learned about physical oceanography and ocean carbon from post-WOCE hydrographic activities, participants were asked to address two broad categories of questions: "Is the current design of the hydrographic program appropriate to meet science goals?", and "What are the best approaches for compilation, synthesis, and interpretation of international data sets?".

What emerged was the need for a more coordinated ship-based hydrography program that focuses not only on monitoring decadal changes but also is capable of addressing new research issues, and to set up a system of regular data synthesis and interpretation activities that are driven by science questions. The participants recognized that any synthesis mechanism that will be developed for the future must address new realities of working within the framework of a sustained observation program. Working within a program with no sunset clause, for example, will require the regular production of scientific products on a timescale that is much shorter than the traditional 10-year approach carried out through global research programs. A sustained repeat hydrography program will need to continually justify its value through publications and data products, and a mechanism for science-driven data syntheses must be developed to address these needs. Participants outlined action items to develop a small advisory group to provide guidance on the development of a more coordinated ship-based hydrography program; to establish closer links with Argo and other ocean-interior observing programs; to improve data and information coordination of existing systems; and to establish synthesis activities around science questions, beginning with the North Atlantic.

Further Reading: International Repeat Hydrography and Carbon Workshop Report (pdf 1.4Mb); For background on the workshop, visit the workshop web-site.

"Friends of Oxygen on Argo" Group Established

Following the International Repeat Hydrography and Carbon Workshop, a small group (the "Friends of Oxygen on Argo", FOA) was established to develop plans and proposals for a large-scale extension of the current small-scale deployments of Argo floats instrumented with O₂ sensors. Polarographic oxygen sensors have been deployed on Argo floats since at least as early as 2002 (link to Argo homepage). Published studies (Körtzinger et al., 2004, 2005) have also demonstrated the feasibility of a new instrument technology, the optode, which takes advantage of dynamic luminescence of luminophores, which fluoresce with a dependence on the O₂ concentration. For example, two prototype oxygen optode instruments were deployed on autonomous floats in the Labrador Sea in September 2003 and data collected over the following year showed very promising results demonstrating the required accuracy and stability (Körtzinger et al., 2004). In fact, several groups have successfully deployed Argo float with both types of O₂-sensors, bringing the total number of O₂ sensors on floats to over 60. The plan is to build on these small pilot projects and scale them up to a large internationally coordinated project for the benefit of the physical and biogeochemical communities alike.

O₂ measurements are useful because surface waters equilibrate quickly with atmospheric oxygen and typically are very close to equilibrium when transported into the ocean interior. Once isolated from the atmosphere, dissolved O₂ is removed through respiration of organic matter and thus reflects the balance between ventilation rates and organic matter supply. Together with conservative tracers, oxygen has long been used as a key water mass tracer. It has also been used as a measure of biological activity and is a critical proxy for empirical fits estimating dissolved inorganic carbon (DIC) concentrations in the ocean.

Model predictions indicate that the currently observed warming of the ocean makes the ocean a source of O₂ to the atmosphere, i.e. leading to a depletion of the oxygen inventory of the ocean (Joos et al., 2003). A comparison of recent measurements of oxygen in the ocean with those from the past indeed suggest a decrease in the oceanic O₂ content, but the data are too sparse and too intermittent to draw large-scale conclusions from them. A significant loss of O₂ from the oceans would have important implications for the partitioning of ocean and terrestrial CO₂ fluxes, because this partitioning is based on measurements of the atmospheric O₂/N₂ ratios and the assumption that the net air-sea exchange flux of oxygen is negligible when averaged over a few years. A network of oxygen profiles would therefore greatly aid the quantification of the ocean O₂ source, as well as variability of the ocean circulation and biological activity.

Led by Nicolas Gruber (UCLA), FOA will produce a white paper to present the utility and practicality of adding O₂ sensors to a portion of the Argo array as a pilot project. Issues such as the number of sensors required, interpretation of the resulting data, and technical issues including the sensor design, calibration accuracy and stability, power usage, satellite communication requirements, and additional cost will be addressed. The Argo Chair and Project Coordinator welcome and support this initiative. Inquires and expression of interest should be sent to Nicolas Gruber (ngruber@igpp.ucla.edu).

Joos, F., G.-K. Plattner, T. F. Stocker, A. Körtzinger and D. Wallace (2003), Trends in marine dissolved oxygen: Implications for ocean circulation changes and the carbon budget. *EOS*, 84, 197-204.

Körtzinger, A., J. Schimanski, U. Send and D. Wallace (2004), The ocean takes a deep breath, *Science*, 306, doi: 10.1126/science.1102557.

Körtzinger, A., J. Schimanski and U. Send (2005). High Quality Oxygen Measurements from Profiling Floats: A Promising New Technique, *J. of Atmos. and Oceanic Tech.*, 22, doi: 10.1175/JTECH1701.1

Roger Dargaville Joins the IOCCP Project Office

Following the agreements between the IOCCP sponsors, SCOR and IOC, to make the IOCCP a standing project with a broadened mandate, NSF has funded a second project coordinator to work with Maria Hood on the coordination of the project. Roger Dargaville commenced the post at the start of January 2006, and will focus on issues regarding surface pCO₂ and repeat hydrography as well as running the IOCCP web portal and newsletters.

Roger hails from Australia, and his expertise lies in the modelling of atmospheric transport of CO₂, and deducing CO₂ fluxes (both oceanic and terrestrial) by inverse methods. He has also studied physical chemistry and physical oceanography. Many years ago Roger assisted Bronte Tilbrook on two WOCE Southern Ocean cruises aboard the *Aurora Australis*, and worked as a postdoc with Scott Doney at NCAR before moving to France 3 years ago. The past 12 months he worked with Philippe Ciais and Berrien Moore (co-chairs) as the coordinator of the Carbon theme of the Integrated Global Observing Strategy (IGOS), where Maria Hood and Scott Doney provided the bulk of the input on ocean carbon observations. Plans are afoot to create an office at UNESCO to coordinate the implementation of the Carbon Theme Implementation Plan. Roger is looking forward to getting to know the ocean carbon community, and working towards an integrated observation and research network. He can be contacted by email on r.dargaville@unesco.org and by phone on +33 1 45 68 39 86.

Ocean Carbon Community Invited to Advise ESA GlobColour Project

Sick of permanently switching from SeaWiFS to MERIS or MODIS ocean color products to validate your favorite ocean carbon model? GlobCOLOUR, a 3-year project funded by the European Space Agency, will provide you, in 2008, with a single coherent 10-year archive of global chlorophyll concentrations that merges data from all sensors.

The GlobColour project aims to develop and demonstrate an EO-based service supporting global ocean carbon-cycle research. An understanding of the cycling of carbon by the ocean biosphere is critical for developing scientifically based response to the sequestration of anthropogenic carbon emissions. ESA has one mission aboard ENVISAT: the Medium Resolution Imaging Spectrometer Instrument (MERIS), NASA has three missions in orbit to assess ocean biological processes by measuring the colour of the sea, the Sea-viewing Wide Field of view Sensor (SeaWiFS) and two flight models of the Moderate Imaging Spectrometer (MODIS) on the Terra and Aqua Earth Observing System (EOS) missions and CNES has now launched a new POLDER on board Parasol. In the coming years, the VIIRS, on the NPOESS Preparatory Project (NPP) will be deployed while ESA will deploy the Sentinel GMES-1 mission. In addition to ESA and NASA, several international space agencies have planned and deployed satellite ocean colour missions. As of today, there are 12 moderate resolution ocean colour imagers in orbit (www.ioccg.org/sensors/500m.html) although many of these are pilot missions and do not produce research quality data. Clearly, there are many ocean colour data products for researchers, educators, students and policy makers to choose from.

These ocean colour missions have been developed to answer many of the most basic questions of how the ocean biosphere operates. Is the amount of vegetal biomass in the ocean increasing or decreasing in time? What is the role of climate change on the ocean biosphere? How do anthropogenic processes (in particular increasing atmospheric CO₂) influence the ocean biosphere and can these changes be detected? It seems obvious that better ocean colour data products will come from the merging of different data sets:

1. Different satellites following specific orbits observe clouds in different times and locations. Hence, one would expect coverage to improve by merging data sets (e.g., Gregg and Woodward, 1998);
2. The precision of merged data products will also increase simply due to the small sample statistics (once inter-satellite calibration issues are resolved).

The differences and similarities of the spectral observations can be taken advantage of in the merging process leading to improved accuracy and measurable uncertainties (e.g., Siegel, 1998; Maritorena et al. 2002). Finally, the merging process must be well justified and documented so all users understand its implications. The latter points to the importance of unified climate data records of ocean colour products with measured and documented uncertainties where the merging process is transparent for all users.

The project will provide scientists with a long time-series of consistently calibrated global ocean colour information, according to requirements specified by the global ocean colour user community, as represented by the user group. GLOBCOLOUR will also put in place the capacity to continue the ocean colour service in the future. The IOCCP, working with the International Ocean-Colour Coordinating Group, will serve as links between the ocean carbon community and this project, to provide input into the development of the data products to ensure they are useful for the ocean carbon community. The IOCCP focal point for this activity is Cyril Moulin. Please contact Cyril (cyril.moulin@cea.fr) for details, questions or suggestions about GlobCOLOUR products.

For more information: visit the GlobColour web-site at <http://www.globcolour.info/>

SCAR-SCOR Southern Ocean Expert Group Report Available

The Scientific Committee on Antarctic Research (SCAR) and SCOR sponsor a joint Oceanography Expert Group. The group met in October and the report from their meeting is now available. Many global research projects are mentioned in the report, which provides recommendations about Southern Ocean research and observations. The Expert Group's Web site can be found at: <http://www.clivar.org/organization/southern/expertgroup/index.htm>.