

# THE IOCCP CONVEYOR



## THE INTERNATIONAL OCEAN CARBON COORDINATION PROJECT

*A joint project of Scientific Committee on Oceanic Research and  
Intergovernmental Oceanographic Commission of UNESCO and an affiliate  
program of the Global Carbon Project.*

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## SOCAT public release in September

The Surface Ocean CO<sub>2</sub> Atlas (SOCAT) is a global compilation of underway surface water fCO<sub>2</sub> (fugacity of CO<sub>2</sub>) data with 6.3 million measurements from 1767 cruises run between 1968 and 2008 by more than 10 countries. SOCAT brings together, in a common format, all publicly available surface water data from the global oceans, including the Arctic, and the coastal seas. All data are evaluated for data quality using methods that are transparent and fully documented (<http://www.socat.info/>). The details of the data analysis and preparation will be described in technical articles that will be submitted shortly (Pfeil et al., in preparation; Sabine et al., in preparation). The first public release of SOCAT (version 1.4) will be on 14 September 2011.

Two SOCAT products will be made publicly available: 1) A global surface ocean fCO<sub>2</sub> data set with second level quality control; 2) A global gridded product of monthly surface water fCO<sub>2</sub> means, with no temporal or spatial interpolation (i.e. bin averages). A Live Access Server (<http://ferret.pmel.noaa.gov/LAS>) will allow exploration and downloading of the data and gridded products from the web.

SOCAT will be released on 14 September as part of ‘The Ocean Carbon

Cycle at a Time of Change: Synthesis and Vulnerabilities’ workshop (see article on page 8), where the researchers that helped produce the CO<sub>2</sub> Atlas will present some of the initial science coming from the product. There is also a special session at the Ocean Sciences meeting on 20-24 February 2012 devoted to SOCAT science titled: ‘The Changing Ocean Carbon Cycle: Data Synthesis, Analyses and Modeling’.

Research using SOCAT will highlight the response of surface water fCO<sub>2</sub> and the oceanic CO<sub>2</sub> sink to increasing levels of atmospheric CO<sub>2</sub> in a changing climate. The SOCAT data set will be an important building block for future global carbon research.

Future updates to SOCAT are envisaged, but only if sustained funding can be secured to augment the initial funding now available. Colleagues are strongly encouraged to use the Atlas and to submit their quality controlled surface water fCO<sub>2</sub> data for inclusion in future SOCAT releases. We simply ask that you acknowledge the SOCAT project and let us know if you publish a manuscript based on the Atlas. We also welcome your ideas on future SOCAT.

Enjoy SOCAT,

*Dorothee Bakker, Benjamin Pfeil, Are Olsen, Chris Sabine, Nicolas Metzl, Steve Hankin, Heather Koyuk, Jeremy Malczyk, Alex Kozyr, Maciej Telszewski and all SOCAT contributors.*

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## LDEO Database V2010 is now available at CDIAC

The 2010 version of the LDEO Database is now available from CDIAC: [http://cdiac.ornl.gov/oceans/LDEO Underway Database/](http://cdiac.ornl.gov/oceans/LDEO_Underway_Database/). Approximately 5.2 million measurements of surface water partial pressure of CO<sub>2</sub> obtained over the global oceans during 1957-2010 are listed in the Lamont-Doherty Earth Observatory (LDEO) database, which includes open ocean and coastal water measurements.

The data assembled include only those measured by equilibrator-CO<sub>2</sub> analyzer systems and have been quality-controlled based on the stability of the system performance, the reliability of calibrations for CO<sub>2</sub> analysis, and the internal consistency of data. To allow re-examination of the data in the future, a number of measured parameters relevant to pCO<sub>2</sub> measurements are listed.

The overall uncertainty for the pCO<sub>2</sub> values listed is estimated to be +/- 2.5 µatm on the average. For simplicity and for ease of reference, this version is referred to as V2010, meaning that data collected through 31 December 2010 has been included. The database will be updated annually. In this update, 21 new cruise/ship files are added to the previous version V2009.

The data presented in this database include the analyses of partial pressure of CO<sub>2</sub> (pCO<sub>2</sub>), sea surface temperature (SST), sea surface salinity (SSS), pressure and temperature of the equilibration, and barometric pressure in the outside air from the ship's observation system.

A minor equilibration temperature problem has been corrected in the R/V Laurence M. Gould data for 2010.

## New (Thermodynamic) Equation of Seawater - TEOS-10

The Intergovernmental Oceanographic Commission (IOC), with the endorsement of the Scientific Committee on Oceanic Research (SCOR) and the International Association for the Physical Sciences of the Oceans (IAPSO), has adopted the International Thermodynamic Equation Of Seawater - 2010 (TEOS-10) as the official description of seawater and ice properties in marine science. All oceanographers are now urged to use the new TEOS-10 algorithms and variables to report their work.

Notable differences of TEOS-10 compared with the previous description (EOS-80) are:

1. Absolute Salinity S<sub>A</sub> is used to describe the salinity of seawater. S<sub>A</sub>

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incorporates the spatially varying composition of seawater.

2. Conservative Temperature to replace potential temperature.
3. TEOS-10 thermodynamic quantities are totally consistent with each other.

While Absolute Salinity is the TEOS-10 salinity variable for research purposes and for publications, the salinity that is reported to national databases remain Practical Salinity as determined on the Practical Salinity Scale of 1978. Version 3.0 of the GSW Oceanographic Toolbox was released on 15th May 2011 and is available for download. The GSW toolbox has undergone extensive improvements since the release of version 2.0 in October 2010, and it also contains several new functions. The major improvements are :

1. An improved routine to calculate Absolute Salinity which takes into account ocean dilution and evaporation;
2. Many of the functions in the GSW Toolbox are based on the 48-term computationally efficient expression for density. The use of this equation ensures consistency between the different branches of oceanography, namely observational, theoretical oceanography and ocean modelling;
3. Freezing temperature and latent heats of melting and evaporation, and

4. Minor bug fixes.

The whole oceanographic community is urged to upgrade their TEOS-10 software to version 3.0. Note that no significant changes of the code apart from minor bug fixes are planned.

The TEOS-10 web site ([www.TEOS-10.org](http://www.TEOS-10.org)) provides numerous background documents including a brief introduction to TEOS-10, "Getting started with TEOS-10 and the Gibbs Seawater (GSW) Oceanographic Toolbox", TEOS-10 lecture slides, TEOS-10 Manual and more.

*Trevor McDougall and Paul Barker (on behalf of SCOR/IAPSO Working Group 127)*

## **First National Meeting for U.S. Ocean Acidification Researchers**

A milestone was reached this spring toward building a strong ocean acidification (OA) research community in the U.S., when the first workshop for U.S. OA researchers was held on 22-24 March 2011, at the Woods Hole Oceanographic Institution.

Over the past few years, several U.S. agencies have dedicated funding for ocean acidification research, although a U.S. national OA program to coordinate research, education, policy, and outreach is still being developed. This meeting was designed to

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help begin to coordinate the rapidly growing U.S. OA research community, which now includes hundreds of researchers from an expanding range of disciplines. Not only is building a strong U.S. OA research community an essential piece of the U.S. national OA program, but it is also crucial to organize it in ways that maximize coordination with established OA research programs in other nations (EPOCA, BIOACID, UKOARP, etc.).

The meeting was organized and hosted by the Ocean Carbon and Biogeochemistry Program (OCB) and coordinated by OCB's Ocean Acidification subcommittee (OCB-OA), and was financially supported by the NSF, NOAA, USGS, EPA, and the Naval Postgraduate School. Meeting organizers worked with program managers from these agencies and NASA to invite representatives from all their funded OA research projects. The 112 meeting attendees included ecologists, paleoceanographers, instrumentation specialists, chemists, biologists of all types, socioeconomists, modelers, and communications specialists.

The goals for this workshop included: networking OA researchers to strengthen existing collaborations or develop new ones, minimizing unnecessary duplication of effort, building capacity by entraining new specialists and agency representatives, and identifying short- and long-term research

goals. During the meeting, OCB-OA also hoped to promote effective data management, to improve communication with the public about OA, and to determine how OCB could best facilitate OA science.

Attendees also began to identify potential collaborative OA research activities for the next five years. Highlights include:

- Holding an interdisciplinary WOCE-like experiment
- Assessing OA's effects relative to other influences
- Comparing sensitivity across systems using biological approaches like comparative phylogeography and biodiversity surveys
- Quantifying fluxes and variability in particulate pools
- Assembling a comprehensive global monitoring system
- Bringing in social scientists and humanists
- Developing cheap, user-friendly biological sensors
- Determining the consequences of large pH change on the carbonate system

The OCB-OA Subcommittee is exploring ways to facilitate many of these multi-investigator activities, and hopes that this will be the first of many productive

meetings for OA investigators in the United States.

The meeting agenda, presentations, and videos of plenary sessions, along with breakout reports and links to supplementary materials, as well as the full meeting report are available on the meeting website (<http://www.whoi.edu/workshops/OAPI2011/>)

## **The Mediterranean Sea in need of a GO-SHIP-like program**

The Mediterranean Sea strongly affects the climate of the surrounding lands. To define its impact and interaction with atmospheric forcing, basin-wide repeat surveys of this sea are of primary importance. In this context the Mediterranean Science Commission (CIESM) invited 17 international scientists, all experts of the region, to a brainstorming Workshop in Supetar, on the island of Brac, Croatia, 11-14 May 2011, where they designed a Med SHIP program, and planed repeat basin-wide hydrographic surveys for climatic studies in the Mediterranean Sea.

Studying the Mediterranean general circulation and its interannual and decadal variability is essential to gain insight into the global climate impact at the regional and global scales. In order to document the changes in the basin hydrology and

biogeochemistry, many technological and innovative tools are available to scientists and at work in various national/regional programs: CTDs and different types of sensors deployed during oceanographic campaigns, gliders, floats, moorings, satellites, etc. What's missing is a single international platform that would, as in the case of GO-SHIP (<http://www.go-ship.org/>), enable the integration of data obtained by different measurement techniques and distinct national/international campaigns. There is also a need to exchange, on a permanent basis, information on planned national cruises in order to avoid duplications and to develop scientific syntheses and interpretation of hydrographic data, in partnership with global research programs.

To monitor variability in space and time, the design of continuous coordinated repeat basin-wide hydrographic surveys in place for at least next 10 years was discussed during the workshop with strong recommendations that a future Med SHIP program should *inter alia* optimize national ship time resources, enable merging and interpreting collected data at international level, define priorities in training, capacity building with a particular focus on developing countries so as to enhance cooperation and facilitate the exchange and sharing of data between northern and southern countries.



To implement a GO-SHIP-like program in the region, some recommendations were adopted that take into account the specificity of the Mediterranean. To obtain a synoptic view of Mediterranean hydrology, different surveys need to be carried out, including:

- High-frequency lines (3 years), generally North-South lines and low-frequency lines (6 years) along an East-West hydrographic transect along the longitudinal axis of the Mediterranean;
- High frequency surveys using different platforms (ships and gliders mostly) at sub-basin and mesoscale in order to follow the variability of structures/processes that are influencing the basin scale circulation. To document and understand the water property distributions, their changes, and drivers including physical and biogeochemical properties, the survey shall consider relevant key areas.

The coordination of the Med SHIP program will be carried out by the Task Force and the Scientific Committee, both tentatively formed at the workshop.

## The IOCCP Surface Ocean CO<sub>2</sub> Data-to-Flux Workshop

In 2010 a series of community and plenary white papers (CWP) were published as part of the OceanObs'09 proceedings which set out decadal challenges to the surface ocean CO<sub>2</sub> flux community as well as identifying technical obstacles towards achieving them.

Perhaps one of the biggest challenges is the reduction of the global flux uncertainty to a level that is necessary and meaningful to resolve interannual trends. Presently, this is considered to be in the 10 – 15% range. While this has been achieved on the basis of SOOP observations in some regions such as the North Atlantic, it is clear that the same approach is not feasible in the Southern Ocean south of 30°S where seasonal biases are an additional challenge.

This workshop (12-13 September 2011, UNESCO Headquarters, Paris) will use the CWP from the Surface Ocean Observation community together with other topic specific CWPs as a starting point to assemble issues and invited participants from all the communities (observational, modelling, sensor development, platform development and operations and data management) that have a strong contribution to make in enabling the decadal goals to be achieved in a realistic way. The workshop will run as a mix

of plenaries and theme-focused discussion groups. This workshop will have a technical focus and complement the following SOLAS/IMBER/IOCCP science meeting.

## **The Ocean Carbon Cycle At A Time Of Change Science Meeting**

The ocean carbon cycle is changing at a rate whose magnitude and pattern we are only beginning to document, quantify, and understand. The uptake of anthropogenic CO<sub>2</sub> from the atmosphere, climate fluctuations as well as long-term trends in ocean circulation and biology have led already to substantial changes in the ocean carbon cycle, with potentially larger changes looming ahead. In the last decade, substantial efforts have been undertaken to measure these changes, and a number of projects are underway to synthesize them and to put them into the context of climate variability and change.

In particular, the SOLAS-IMBER carbon working groups jointly with IOCCP and other international organizations (e.g. PICES, EU FP7) have initiated and supported a number of analysis and synthesis activities such as SOCAT, CARINA and PACIFICA, with the goal to arrive at (i) homogeneous and quality controlled data sets and (ii)

regional to global assessments of the changing ocean carbon cycle.

This meeting (14-16 September 2011, UNESCO Headquarters) aims to bring together the scientists working on these synthesis projects, but is open to all other scientists who are interested in developing an integrated view of how the ocean carbon cycle has changed in the recent decades. Of interest are data syntheses, analyses and modeling studies focusing on air-sea CO<sub>2</sub> fluxes, changes in ocean surface and interior carbon properties, and how the changes in these realms are connected to each other.

This meeting will provide critical inputs to further development of the ocean carbon observing systems, and to the next (5<sup>th</sup>) assessment report of the Intergovernmental Panel on Climate Change (IPCC AR5). It will also form the basis of a number of planned synthesis papers. The meeting consists of plenary talks, poster session, and meetings of individual working groups.



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## “Carbon in a Changing World” Conference

The conference on "Carbon in a changing world", organized by the EU Coordination Action Carbon Observing System (COCOS) and the Food and Agriculture Organization of the United Nations (FAO), will be held in Rome, 24-26 October 2011.

The conference has the aims to:

- present the latest scientific developments in understanding of the global carbon cycle
- present an overview of the building and implementation of the Global Carbon Observing System for land, oceans and the atmosphere
- identify progress and gaps in obtaining politically meaningful estimates of regional carbon budgets on land and ocean

**Registration is open** at <http://dwms.fao.org/geo-carbon/>. One can register either as an auditor or presenting author with a choice of poster and oral presentation in the relevant session. Further information, including logistic details, is available at the same website.

## Third Symposium on the Ocean in a High-CO<sub>2</sub> World

The Scientific Committee on Oceanic Research, the International Geosphere-Biosphere Programme and the Intergovernmental Oceanographic Commission of UNESCO announce the Third Symposium on the Ocean in a High-CO<sub>2</sub> World, 24-27 September 2012, Monterey, California, USA.

Key dates:

- Abstract submission opens **15 September 2011**
- Abstract submission deadline **1 April 2012**
- Early registration deadline (reduced fee) **15 June 2012**

**Limited travel support is available for early-career and developing country scientists.** Travel grants and networking/mentoring activities will be announced on the Symposium's website.

Abstracts may be submitted for any of these 16 topics:

- Changes in ocean carbonate chemistry since the Industrial Revolution (Keynote speaker: Richard Zeebe, United States)

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- Rates of change of ocean acidification: Insights from the paleorecord (Keynote speaker: Daniela Schmidt, United Kingdom)
- Interactions of ocean acidification with physical climate change (Keynote speaker: Laurent Bopp, France)
- Responses of marine organisms and ecosystems to multiple environmental stressors: ocean acidification, hypoxia, temperature, UV, etc. (Keynote speaker: Hans-Otto Poertner, Germany)
- Acclimation and adaption to ocean acidification: Genomics, physiology, and behavior (Keynote speaker: Gretchen Hofmann, United States)
- Ecosystem change and resilience in response to ocean acidification (Keynote speaker: Steve Widdicombe, United Kingdom)
- Biogeochemical consequences of ocean acidification and feedbacks to the Earth system (Keynote speaker: Richard Matear, Australia)
- Understanding the economics of ocean acidification (Keynote speaker: Luke Brander, Hong Kong, China)
- Policy and governance in the context of ocean acidification: Implications, solutions, and barriers (Keynote speaker: Victor Galaz, Sweden)
- Impacts of ocean acidification on food webs and fisheries (Keynote speaker: Beth Fulton, Australia)
- Detection and attribution of ocean acidification changes
- Effects of ocean acidification on nutrient and metal speciation
- New developments in measuring and observing ocean acidification and its effects
- Regional impacts of ocean acidification
- Effects of ocean acidification on calcifying organisms
- New concerns in ocean acidification research

For more information please consult the Symposium website: [www.highco2-iii.org/](http://www.highco2-iii.org/)

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To subscribe to the IOCCP mailing list and receive regular updates and announcements, send an email to [sympa@sympa.iode.org](mailto:sympa@sympa.iode.org) with “subscribe ioccp” in the header body.

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