Intergovernmental Oceanographic Commission

Workshop Report No. 210

Ocean Carbon Observations from Ships of Opportunity and Repeat Hydrographic Sections

Paris, France
13–15 January 2003

IOCCP Report Number 1

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Abstract:

The SCOR-IOC Advisory Panel on Ocean CO_2 and the IGBP-IHDP-WCRP Global Carbon Project (GCP) are working together to develop a pilot project to assist in the international coordination of regional and national ocean carbon observation activities. The pilot project will develop and implement international workshops to bring the ocean community together to discuss ongoing and future carbon observations on a regular basis as needed to facilitate the coordination of national programs. The pilot project will also develop and maintain a dynamic, central Web-based source of information that will link with similar GCP sites developed for terrestrial and atmospheric carbon research activities and observations.

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1. OPENING

IOC Executive Secretary Patricio Bernal opened the meeting and welcomed the participants to the workshop. He noted that the IOC was founded by Roger Revelle and that ocean carbon has been a major part of the IOC since its inception in 1960. He gave the floor to co-chairs, Chris Sabine and Pep Canadell to present the agenda (Annex II) and introduce the goals and objectives of the workshop.

2. INTRODUCTION TO THE WORKSHOP

Over the last two centuries, human activities such as fossil fuel emissions, biomass burning, and land-use changes have profoundly impacted the global carbon cycle. Present atmospheric CO_2 levels are higher than this planet has experienced in 20 million years. Predicting the magnitude of future climate change and assessment of any proposed mitigation measures requires a thorough understanding of the carbon cycle and the potential sources and sinks for atmospheric CO_2 now and in the future.

The ocean is the largest dynamic reservoir of carbon on decadal to centennial time-scales. The sequestration of anthropogenic carbon in the ocean acts to effectively decrease the potential radiative and climate impacts of CO_2 emissions. Observational and modelling estimates suggest that the ocean is presently taking up about 30-40% of fossil fuel CO_2 emissions, but the future behaviour of the oceanic sink is uncertain, depending upon our limited understanding of the physical processes controlling present-day uptake and possible future changes in ocean circulation and marine biogeochemistry.

Three key scientific questions relevant to the ocean's role in the global carbon cycle arise from current policy-related issues:

- How large are present-day oceanic carbon sources and sinks, where do they operate, and what processes are controlling them?
- How will oceanic carbon sources and sinks behave in the future under higher atmospheric CO_2 concentrations and a possibly altered climate and ocean circulation?
- How will we assess our forecasts of future oceanic sink behaviour and thereby determine the effectiveness of any deliberate mitigation activities?

The general research framework to address these issues has been discussed within the various working groups of programmes like the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), the Intergovernmental Oceanographic Commission (IOC), and the Scientific Committee on Oceanic Research (SCOR). Based on the recommendations coming from these programs several nations are now moving ahead with plans for large-scale ocean carbon observations. Many of these national and regional projects are similar and have been designed to be complimentary to projects in other countries, but there is an immediate need for global-scale coordination of these ocean carbon observations. There is also an urgent need to critically assess the overall program of planned observations in order to ensure that the results, when combined, will indeed meet the requirements of the research community. Only through a coordinated ocean sampling programme and improved, basic scientific understanding of the ocean carbon cycle will the overall goal of skilful predictions of future atmospheric CO_2 be attained.

Recognizing the need for international coordination of ocean carbon observations, the SCOR-IOC Advisory Panel on Ocean CO_2 and the IGBP-IHDP-WCRP Global Carbon Project have initiated a collaborative Pilot Project to (1) gather information about on-going and planned ocean carbon observation activities, (2) identify gaps and duplications in ocean carbon observations, (3) produce recommendations that optimise resources and highlight potential

scientific benefits of a coordinated observation program, and (4) promote the integration of ocean carbon observations with appropriate atmospheric and/or terrestrial carbon activities. The information gathered through this collaborative process will be posted on a new Web site devoted to making the information accessible to scientists and policymakers worldwide.

The first activity of the Pilot Project is a workshop to bring together individuals from different countries who make and use ocean carbon observations, to discuss coordination of underway pCO_2 measurements and repeat hydrographic sections, and begin discussions of how these observations can contribute to ocean carbon modelling and research activities. Specifically, the workshop has the following goals:

- develop a compilation and synthesis of large-scale ocean carbon observation activities and plans,
- critically examine the scientific balance, quality and completeness of these programs with reference to research needs,
- identify the potential for international and national collaborations in observation activities to optimise use of resources,
- develop recommendations for analytical approaches, data formats, standards, data management practices, and inter-comparison exercises needed to produce high-quality integrated data sets from diverse activities.
- Evaluate priorities for technological and infrastructure advances that are required for the long-term sustainability of ocean carbon research.

3. INTERNATIONAL RESEARCH AND OBSERVATION PROGRAMS OVERVIEW

The Scientific Committee on Oceanic Research (SCOR) is an international non-profit organization formed in 1957 to identify ocean research topics that would benefit from enhanced international action; establish working groups and other subsidiary bodies—either alone or in conjunction with other organizations—for detailed examination of problems related to the marine environment and international ocean science; and work with other international organizations to develop and sustain major international ocean research programs. The Intergovernmental Oceanographic Commission (IOC) was formed in 1960 to promote international cooperation and to coordinate programmes in research, services, and capacity building, in order to learn about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States. SCOR is a body of the International Council for Science (ICSU) and IOC is a body of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

The SCOR-IOC Advisory Panel on Ocean CO_2 currently focuses on three project areas: developing strategies for and facilitating the coordination of ocean carbon observation activities; providing an international forum for discussions of the scientific aspects of ocean carbon sequestration; and (under development) strengthening linkages between the ocean carbon modelling community and observation and research activities. For details on publications and programme activities, please visit the panel's web site at: http://ioc.unesco.org/iocweb/co2panel.

Recognizing the fact that global carbon cycle research is an international multidisciplinary research topic, three global environmental change programs (IGBP, IHDP and WCRP) developed a partnership to establish the Global Carbon Project (GCP) in 2001. The GCP's mandate is to develop a research framework for the synthesis of the global carbon cycle, assist in the coordination of national programs for global-scale carbon research, and facilitate

the coupling of carbon research between the natural sciences and the social sciences. Additional information on the GCP can be found at http://www.globalcarbonproject.org.

Building upon the long-term experience of the IOC and SCOR in ocean research coordination, and the carbon focus and ties to the scientific community within IGBP, IHDP, and the WCRP, the CO_2 Panel and the GCP are working together to develop a pilot project to assist in the international coordination regional and national ocean carbon observation activities. The pilot project will develop and implement international workshops to bring the ocean community together to discuss ongoing and future carbon observations on a regular basis as needed to facilitate the coordination of national programs. The pilot project will also develop and maintain a dynamic, central Web-based source of information that will link with similar Global Carbon Project sites developed for the terrestrial and atmospheric carbon research activities and observations. This is a difficult task that will require active solicitation for updates on the latest national plans and constant vigilance to find programs that have possible conflicts or potential for better collaboration. The potential benefit to the global community is significant.

The appropriate scale for investigation of the carbon cycle is global. No single country can describe or quantify carbon cycling within its national boundaries without considering global processes occurring in the atmosphere and oceans. The vast majority of the ocean is a global commons, and its size and distant, inhospitable regions require nations to work together to develop a unified view of the ocean carbon cycle over a range of space and time scales. While we have begun to develop the capacity to monitor ocean carbon and to share this information with similar efforts in other countries, we are far from having a coordinated research or observation system, or aggregated data products on basin and global scales.

The IOC is the UN focal point for ocean science and serves as the secretariat for the global ocean observing system. The 1992 United Nations Conference on Environment and Development (UNCED) and the 2002 World Summit on Sustainable Development calls on the IOC to address critical uncertainties for the management of the marine environment and climate change: "Recognizing the important role that oceans and all seas play in attenuating potential climate change, IOC and other relevant competent United Nations bodies, with the support of countries having the resources and expertise, should carry out analysis, assessments and systematic observation of the role of oceans as a carbon sink." Also: "States should consider, *inter alia*: (b) supporting the role of the IOC in cooperation with WMO, UNEP and other international organizations in the collection, analysis and distribution of data and information from the oceans and all seas, including as appropriate, through the Global Ocean Observing System, giving special attention to the need for IOC to develop fully the strategy for providing training and technical assistance for developing countries through its Training, Education, and Mutual Assistance (TEMA) programme." The Global Climate Observing System, Global Ocean Observing System, and the World Climate Research Program are co-sponsors of the Ocean Observations Panel for Climate (OOPC), which is the primary scientific body for providing advice on requirements for sustained ocean data for climate and related physical ocean systems. Its principle partner in research is CLIVAR and its Ocean Observations Panel and Basin Panels. The Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) is the principle implementation partner of sustained ocean observation systems.

The United Nations Framework Convention on Climate Change and its Kyoto Protocol highlight the requirement for an integrated global monitoring system for CO2, and has put the responsibility for the design and implementation of such a system on the Global Climate Observing System and its ocean component, the Global Ocean Observing System. In coordination with international research programmes, the UN-sponsored global observing systems co-sponsor and implement several programmes related to ocean carbon research and observations, with a principle interest in encouraging data and information exchange,

facilitating the participation of developing country scientists in global ocean programmes, and in transitioning research -based observations to sustained networks of global observations.

The IOCCP will facilitate the development of a coordinated, international network of ocean carbon research and observations to allow nations to plan jointly their regional observation activities and to promote the active sharing of data and creation of combined data products. While most ocean carbon observations are research-based, many observation platforms could transition to more sustained monitoring activities within the framework of existing ocean monitoring programmes. The OOPC is proposing a proof-of-concept pilot project to incorporate a small number of sustained ocean carbon and related measurements into the existing observing system, with near-real time data transmission and an open data exchange practice: near-surface ocean carbon measurements into the Ship of Opportunity Program (http://www.brest.ird.fr/soopip/); time series measurements into the OOPC-POGO-CLIVAR Global Eulerian Observatories Pilot Project; and ocean carbon and tracers into the CLIVAR repeat hydrographic sections. Many of these activities are already being planned and implemented, although not in a sustained mode or a coordinated manner with agreed data sharing, data quality, or data transmission protocols. The OOPC will work closely with the IOCCP to develop the strategy and requirements for this pilot activity, with an initial strategy to be developed in 2004.

4. OVERVIEW TALKS

4.1 GLOBAL-SCALE CARBON RESEARCH OVERVIEW

This presentation was given by Scott Doney (Woods Hole Oceanographic Institution, USA). The presentation is available on-line at:
http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.2 OBSERVATIONAL STRATEGY: REPEAT SECTIONS

This presentation was given by Douglas Wallace (IFM-GEOMAR, Germany). The presentation is available on-line at:
http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.3 OBSERVATIONAL STRATEGY: NEAR-SURFACE CO_2

This presentation was given by Yukihiro Nojiri (National Institute for Environmental Studies, Japan). The presentation is available on-line at:
http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.4 SPATIAL AND TEMPORAL VARIABILITY OF AIR-SEA CO_2 FLUXES – ISSUES FOR A GLOBAL OBSERVING NETWORK

This presentation was given by Colm Sweeney (Princeton University, USA). The presentation is available on-line at:
http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.5 SPATIAL AND TEMPORAL VARIABILITY OF CO_2 INVENTORIES – ISSUES FOR A GLOBAL OBSERVING NETWORK

This presentation was given by Richard Feely (NOAA, PMEL, USA). The presentation is available on-line at: http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.6 WHAT ATMOSPHERIC AND OCEAN INVERSIONS TELL US ABOUT OBSERVING CARBON CYCLE CHANGES IN THE OCEAN

This presentation was given by Andy Jacobson (Princeton University, USA). The presentation is available on-line at: http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.7 THE ROLE OF AUTOMATED SYSTEMS IN AN OCEAN OBSERVING NETWORK

This presentation was given by Tommy Dickey (University of California Santa Barbara, USA). The presentation is available on-line at: http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.8 THE ROLE OF REMOTE SENSING IN EVALUATING THE GLOBAL CARBON CYCLE

This presentation was given by Jacqueline Boutin (LODYC, Université Pierre et Marie Curie, France). The presentation is available on-line at: http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.9 MOVING TOWARDS AN OPERATIONAL OCEAN CARBON OBSERVATION SYSTEM FOR DATA ASSIMILATION AND MODELING

This presentation was given by Annand Gnanadesikan (Princeton University, USA). The presentation is available on-line at: http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.10 AUTOMATED CO_2 SYSTEMS FOR AN OCEAN OBSERVING NETWORK

This presentation was given by Liliane Merlivat (LODYC, Université Pierre et Marie Curie, France). The presentation is available on-line at: http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

4.11 THE ROLE OF COASTAL SEAS / MARGINS IN THE GLOBAL CARBON CYCLE AND THE IMPORTANCE OF INTERACTING WITH TERRESTRIAL AND ATMOSPHERIC COMMUNITIES

This presentation was given by Helmuth Thomas (Dalhousie University, Canada). The presentation is available on-line at: http://ioc3.unesco.org/ioccp/IOCCPWS1/WSIndex.htm#Science.

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5. WORKING GROUP 1: REPEAT HYDROGRAPHIC SECTIONS

Session 1: Presentations, Information Gathering, Analysis, and Recommendations; Bronte Tilbrook and Alex Kozyr.

Background:
The principle aim of deep ocean repeat sections is to build, maintain and utilize an observing system capable of:

- Detecting ocean climate change
- Constraining ocean inventories of carbon, heat, and freshwater - improve global budgets
- Improving our understanding of ocean carbon cycle and physics - improve models
- Compare and test model veracity/predictions

The purpose of carbon work on repeat hydrographic sections: Carbon inventories and change – meridional sections and wandering lines useful.

- Quantifying carbon transports and improving links between carbon cycle and the overturning circulation require zonal, meridional and choke point sections.

National reports :
Information sheets and presentations were provided by Australia, Canada, France, Germany, Japan, Netherlands, Norway, Spain, Sweden, UK, and USA.

Analysis of gaps and duplications:
The North Atlantic and North Pacific have the best coverage.
There are several possible duplications: P2 (Japan/USA)? and parts I9N, I5E (Aust/USA)

Potential Gaps:

- Equatorial Pacific and Atlantic – although this is not considered major problem.
- Southern Ocean:
  - sections need to be joined
  - AAIW and SAMW critical pathways for controlling current and future carbon uptake (meridional sections separated by 80 degrees longitude).
- Bering Sea and other regions may require a few stations
- SE Pacific may need more sampling to cover AAIW formation regionWOCE era lines with carbon missing (eg. South Atlantic)

Recommendation:
Revisit section information including gaps in WOCE sections. Identify if other sections are proposed by CLIVAR and if carbon measurements are possible.

Parameters measured:

- Two inorganic carbon parameters (TCO_2 and Alkalinity), possibly three
- Some gaps in measurements like CFC's and other tracers that need to considered, perhaps through international collaborations.
- DOC?

Methods and Quality Control:
Need to invest in measuring TCO_2 and alkalinity better.

- faster and more accurate measurements
- uniform guidelines for measurement procedures and reporting of CRM analyses
- uniform instrumentation, and control and at-sea data management software. Single-Operator Multiparameter Metabolic Analyzer (SOMMA) and alkalinity system age
- more complete descriptions how data are modified post-cruise

The need for a 3rd carbonate system parameter (discrete pCO_2 or pH) was discussed, but improvements in measurements are required first.

Recommendation:
Revise DOE handbook with input from international community (CO_2 panel and IOC?). To be discussed by other section working group.

Data Management:
Is there going to be an international policy for data management and release?

- US: hydrographic data is released in 5 weeks; carbon data in 6 months.
- EU: Data released and available only after program completed (up to 3 yrs).

The Carbon Dioxide Information and Analysis Center (CDIAC) and Global Hydrographic Data Office (formerly the WOCE Hydrographic Program Office) are important for managing section data. There are also groups in other countries. See CDIAC repeat section data management plan and GHDO documents.

Recommendation:
Need to identify an international group to establish a unified data release and management policy. CO_2 panel or subset people from meeting (Follow up by IOC?).

Session 2: Developing a coordinated Network; Andrew Dickson and Nick Bates

Need for high-quality measurements:
Concern about data quality has been expressed for a long time (e.g. National Research Council (NRC). 1971. Marine Chemistry: A Report of the Marine Chemistry Panel of the Committee on Oceanography. Washington, D.C. National Academy Press.) The rapid advance of marine science involves the participation of more and more people who are making more and more measurements. This situation requires the development of better methods for managing the increased quantity and the quality of the data. For the former—the recording, storage, and digesting of the data—computer techniques are available and are becoming more common. Quality control, however, needs more attention. For example, it has been reported that much of the chemical data produced by the International Indian Ocean Expedition is unusable because of doubts about its accuracy. Such reports are a perennial source of confusion in marine chemistry. Better calibration, universal standards, and inter-laboratory comparison are essential if we are to continue our present field methods, in which independent investigators make measurements that are presumably comparable.

Quality = “fitness for purpose”:

- Scientific usefulness of measurements
- Uncertainty of measurements
- Cost of measurements

Resulting data need to be widely available.

Start-to-finish quality planning, including:

Instrument design:

- Analytical quality control
- Data handling
- Accuracy / Precision
- Reliability
- Ease of use

- Sample analysis rate
- Size
- Cost

Quality Control:
The goal of quality control is to ensure that data generated are of known accuracy to some stated, quantitative, degree of probability. Sequence of activities for analytical quality control:

(1) Establish working group
(2) Define required precision and accuracy
(3) Choose analytical method
(4) Ensure unambiguous description of method
(5) Estimate within laboratory precision
(6) Ensure accuracy of calibration procedures
(7) Set up quality control charts
(8) Check between-laboratory bias

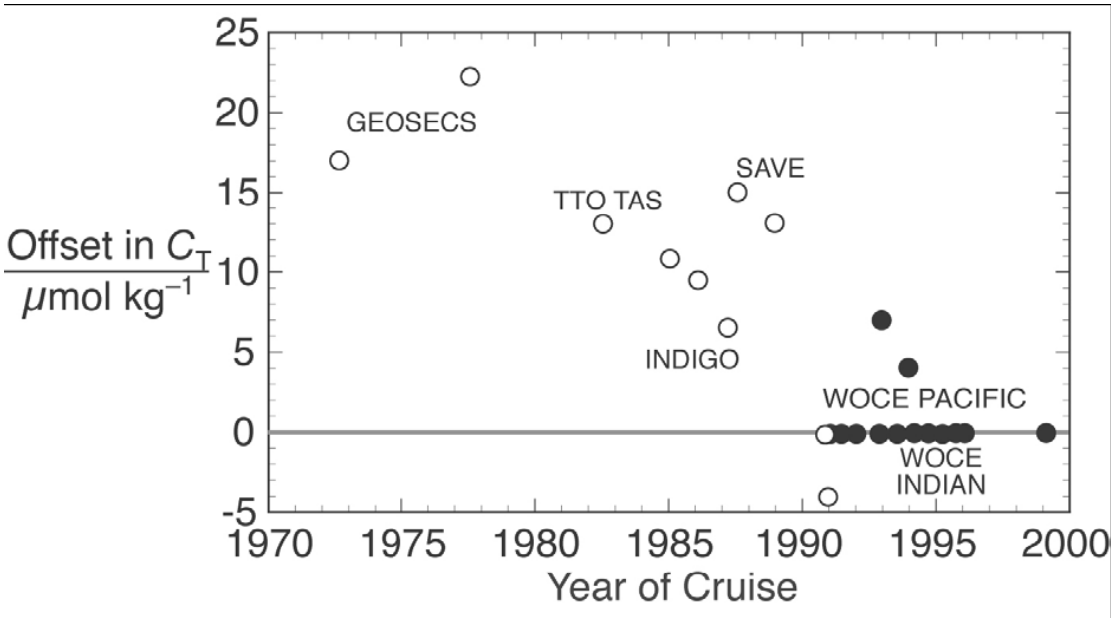
Data handling / distribution:
Improved shipboard handling of measurement data:

- Post-cruise data quality assessment (and adjustment?)
- Data available publicly (in standardized format?) (with standardized metadata?)
- Data archival and long-term distribution

Reference Materials:
RMs have had a substantial effect on C_T quality:

- Clear real-time indication of ship-board analytical problems
- Direct measure of reproducibility
- Traceability of measurements to common reference basis (if necessary can adjust calibration)
- Data quality clear from post-cruise data synthesis (cross-over analyses, etc.)

Accuracy Improvement for C_t



What was this improvement due to?

- Same general method (coulometry) used by almost all groups (after 1990).

- Availability of reference materials for C_T (after 1991).
- Similar instrumentation (SOMMA) used by many groups in the 1990s.
- Inter-laboratory comparisons and workshops
- Written standard procedure for C_T measurement (DOE, 1994).

But!

1. Coulometric method for C_T is not efficient!
2. Coulometric method for C_T is not robust!
3. Current systems are very bulky

Recommendation: What needs to be done?

1. Capacity building
2. Measurement quality control
3. Data handling
4. Improved methods
5. Better analysis systems
6. Design
7. Construction
8. Availability
9. Effective training of analysts (Including analytical quality control)
10. Enhanced data-handling system(s)
11. Measurement quality control
12. Method description and assessment
13. Reference material availability and use
14. Inter-laboratory comparisons
15. Data handling
16. Improved efficiency needed
17. Use of standard data format (including standard computer-accessible metadata)
18. Availability of well-written software to implement this data format
19. Data visualization techniques for ship-board and post-cruise data assessment
20. Clear data release mechanism needed
21. Prompt release wherever possible
22. Preparation of secondary data products

How do we move ahead? International coordination of:

- Scientific strategies
- Measurement quality control
- Data handling
- Need for good documentation and communication (web?, well-designed workshops?)

Suggested approach

- Regional scale science groups with global coordination
- International agreement on best practices
- Measurement techniques
- Quality assurance / quality control
- Data handling
- Regional and international workshops to communicate needs, improvements

PICES WG 17: Biogeochemical Data Integration and Synthesis

Develop a North Pacific database for ocean CO_2 and related parameters in association with existing data centers. Advise data centers which of the available historical data sets should be assigned a high priority for acquisition and conversion to an electronically readable form.

Prepare a written guide of best practices for oceanic CO_2 measurements and data reporting. Carry out, as needed, inter-laboratory method comparisons to assure future measurement quality. Encourage the availability of suitable reference materials. Develop a strategy to co-ordinate the planning of future North Pacific measurement programs to ensure optimal use of resources to obtain appropriate temporal and spatial coverage as well as maximum comparability with historical data. Efforts should be made to encourage timely availability of the "new" data. Organize a symposium or an annual meeting session on the impacts of climate change on the carbon cycle in the North Pacific.

The Handbook of Methods for the Analysis of the Various Parameters of the Carbon Dioxide System in Sea Water, Version 2 1994, Edited by Andrew G. Dickson and Catherine Goyet, is under revision by A. Dickson in collaboration with the Japanese Ocean Industry Association (JOIA). The new version of the handbook will be used as basis for PICES WG-17 "Best Practices" guide.

Recommendation: Role for International Ocean Carbon Coordination Project

- Identify and coordinate regional scale science groups
- Support international group to agree on and document best practices for:
    1. Measurement techniques
    2. Quality assurance / quality control
    3. Data handling
- Sponsor training workshops

Session 3: Working Group 1 Summary

Goals of International Ocean Carbon Coordination Project:

- Develop a compilation and synthesis of large-scale ocean carbon observation activities and plans.

- Critically examine the scientific balance, quality and completeness of these programs with reference to research needs.
- Identify the potential for international and national collaborations in observation activities to optimize the use of resources.
- Develop recommendations for analytical approaches, data formats, standards, data management practices, and inter-comparison exercises needed to produce high-quality integrated data sets from diverse activities.
- Evaluate priorities for technological and infrastructure advances that are required for the long-term sustainability of ocean carbon research.

Scientific Approach:

- Goals of repeat hydrographic sections - Quantify changes in storage and transport of heat, fresh water, carbon dioxide, tracers, and related parameters relative to the WOCE/JGOFS era (1990s).
- Strategy
    - Sustained sampling on decadal time scales.
    - Emphasis on high-quality measurements.
    - Integrated program wherein the sum of the whole is more significant than sum of individual parts.
    - Data to be made available to the whole scientific community as soon as is practical.

Scientific issues:
What measurement suite is essential?

- Hydrographic (T, S, O_2, nutrients)
- Tracers (halocarbons, $^3H/^3He$, …)
- Carbon (C_T, A_T, DOC, $\delta^{13}C$, $\Delta^{14}C$)
- Other measurements?
- Need a strategy to deal with inadequate measurement capability
- Collaborative cruises?
- Capacity building efforts?
- Repeat cruise?
- CLIVAR coordination needed to address this.

Data Quality = "fitness for purpose":

- Scientific usefulness of measurements
- Uncertainty of measurements
- Cost of measurements
- Resulting data need to be widely available
- Initial emphases
    1. Analytical quality control
    2. Reference materials
    3. Written procedures
    4. Method assessments by formal inter-laboratory comparisons
    5. Training workshops and effective training of analysts, including analytical quality control
    6. Best practices for data handling/reporting
    7. Propose standard data format (including standard computer-accessible metadata)
    8. Make available well-written software to implement this data format
    9. Capacity building
    10. New or improved analytical techniques
    11. Automated analysis systems
    12. Enhanced data-handling system(s)

Role for International Ocean Carbon Coordination Project:

- Identify and coordinate regional scale science groups
- Ensure direct links to CLIVAR planning activities
- Organize international group to agree on and document current best practices for:
    - Measurement techniques
    - Quality assurance / quality control
    - Data handling / data reporting
- Help to organize training workshops and inter-laboratory comparisons (with regional groups)
- Encourage rapid data availability (less than or equal to 2 years at first) to whole scientific community
- Improvements in measurements and data handling
- Data citation policy in consultation with journals

6. WORKING GROUP 2: NEAR-SURFACE CO_2 OBSERVATIONS

Session 1: Presentations, Information Gathering, Analysis, and Recommendations; Truls Johannessen and Kitack Lee

National reports:
Information sheets and presentations were provided by:

- Canada (Wong)
- EU-CAVASSOO-project (Lefevré)
- Germany (Wallace)
- France (Dandonneau and Metzl)
- Japan (Nojiri)
- India (Kumar)
- Korea (Lee)
- Norway (Johannessen)
- The Netherlands and Norway joint plans (deBaar and Johannessen)
- Spain (Rios)
- UK (Lefevré)
- US programs (Wanninkhof , Feely, Sweeney)

Other presentations:

- The intercalibration exercise in Japan March 2003 (Nojiri)
- New promising approaches for direct flux measurements (McGillis)
- The IOC-WMO JCOMM VOS / SOOP program (Manabe)

Analysis of gaps and duplications:
Inventory of programs operational or planned to begin in next 2 years:

- Atlantic = 13 (1 Southern Ocean / Atlantic Sector)
- Pacific = 9 (1 Southern Ocean/ Pacific Sector)
- Indian = 2 + coastal section (1 Southern Ocean / Indian Sector)

No duplications; Large gaps in the Southern Hemisphere

Recommendations for improved coordination, optimal measurements and coverage

Optimal measurements:

- Technology development needed to more fully automate the systems. Other carbonate system variables desirable – DIC, Alkalinity, high-quality SST and SSS data, carbon isotopes, mixed layer depth, chlorophyll, and oxygen.

Optimal coverage:

- What is the objective of VOS for pCO_2 ? There are two main objectives, each requiring a different measurement strategy. If the measurements are to be used for boundary conditions for inverse models, then the priority is on wide data coverage; If the measurements are to be used to constrain sinks, then the priority is on high-quality measurements with enough VOS coverage to adequately resolved the sections.
- How to develop an observation strategy / priorities ? The underway network is at a very immature stage. Although coordination efforts are underway, the current approach is that “we’ll take what we can get.”

<u>Session II. Developing a Coordinated Netwrok; Nicolas Metzl and Christoph Heinze</u>

Will the network outlined in Session I accomplish its scientific goals ?

Anthropogenic Carbon Inventory:

- Quantification of air sea disequilibrium.
- Definition of preformed TCO_2 values.

Magnitude and Delta of CO2 fluxes:

- Measurements are valid at local scale.
- Appropriate extrapolation to regional scale needed (remote sensing, modelling).

- Possible bias through ship routing on most economic routes.
- Ambient information to evaluate SOOP data in context of deliniating biogeochemical provinces.
- Seasonality problem (representativeness for winter situation at high latitudes).
- Smoothing of temporal maxima/minima due to undersampling.
- Climatologies are available but original data are critical for local and regional scale modeling and comparison

Global scale:

- Gaps in southern hemisphere.
- High – priority VOS lines are New Zealand - Chile, Europe-Australia, Japan-S.America.
- Polar regions - highly variable - additional time series measurements needed.
- Should take air (flask) measurements on cruises to connect ocean to lower atmosphere and for system checks.

Recommendations: Outfitting polar research / supply ships more regularly (also ice breakers, Coast guard ships).

Marine ecosystems responses:

- Plankton measurements in international waters feasible and still running on some VOS lines (e.g. Skogafoss). (Continuous plankton recorder not feasible.)

Understand factors controlling C uptake:

- Seasonal/interannual CO2 uptake variability (combination with hydrographic and biogeochemical measurements as well as modelling).
- Combination with XBT lines.
- Variables: Regional alkalinity/SSS – derive DIC out of this, nutrients, O_2.
- ADCP on selected VOS for determination also of mixed layer depth, very useful in N.Atl.

How can the temporal / spatial resolution of the global network be improved ?

Other Platforms:

- Time series: Include CO_2.

- Drifters: Surface ARGO (also O_2), air values would be very uselful !!!
- Repeat hydrography:
  - Very important for time dependent DIC.
  - Harmonisation with XBT lines.
  - Preconditioning for spring blooms.
  - Possible link: VOS lines at same line as repeat hydrography ?
- Models as ”platforms” for optimal mapping, interpolation.
  - o Pre-cruise operational ”measurement” by model. Optimisation of sampling strategies.
- Satellites (multiple variables data sets).
- Huge platforms for S.O.

Recommendation: Equip as many as possible repeat hydrography lines with underway pCO2 measurements. Equip all research vessels with complete underway systems. Semi-automatic systems needed. Concise guidelines for operation of systems and recommendation on instrument design. Calibration issue.

Data Set Compilation:

- Synoptic use of data sets (from research / data management point of view): CDIAC, WDC-MARE, CARINA, PICNIC, T. Takahashi.
- North America – Europe link CDIAC / WDC-MARE plus link to Japanese and further communities.
- "Model for data base" from atmospheric community for e.g. ozone data available.
- Updatable and correctable data format.
- Attempts to harmonise data exchange on WMO-based guidelines failed so far due to lack of common goals, P.I. reluctance, and individual country policies.
- Common scientific goal might facilitate common data base creation.

Requirements for resolution and accuracy:

- Precision: 2 microatm for water, 0.1 microatm for air. Goal 1 microatm for water.
- Removal of bias/systematic errors if reason for bias can be identified. Comparison of air values with the global flask network product or in situ flask measurements is a way of checking possible detector / standard bias.
- Need quality and operational control over SSS and SST (interaction with JCOMM and physical oceanographers needed).

Recommendation: Regular intercomparison exercises (e.g. every 2 years) in controlled and controllable environments (e.g. indoor seawater pool - Japan).

Question about data release policy:

- The goal is to harmonize / handle pCO2 data in the same way as other data.
- Data released too rapidly may lead to deterioration of data quality.
- Problem of duplicate or multiple data set releases.
- Need clear guidelines on data reduction, error estimation and means to exclude and clearly flag datasets that do not meet requirements.

Recommendations on CO2 data exchange: maximum 2 years release time.

Co-ordination Issues:

Data Centers and Formats: One single data center feasible ? (Long-term)

- Merging of "ad hoc" compilations using existing data base infrastructure. (Short-term and long-term)
- Agreements needed for format and data submission. CO_2 panel has already made recommendations: Group performing measurements, date, position, atm. pressure, SST, Teq, SSS; xCO_2 air and water, fCO_2 air and fCO_2 water, ΔPir, ΔPeq , intake depth.
- Need for thorough and uniform meta data.
- Thorough data documentation is also needed on the methods used.
- One catalogue site is needed with documentation where data are located.
- Find suitable interface between data centers.
- Quality data check is needed and must be documented by the data center.
- Needs for metadata catalogues or metadata about metadata catalogues.
- Community must formulate feasible methods and make recommendations.

Territorial water difficulties:
Currently, vessels are not permitted to make measurements of surface water pCO_2 within the 200 mile limit of foreign nations unless scientific clearance has been obtained. This process is long, and often the commercial shipping routes change before permission has been granted.

Recommendation: the IOC investigate the possibility of an exemption of the 200 mile limit law for non-invasive sampling from VOS ships.

Working Group II Summary:

Status of SOOP for Carbon :
Presently under development and continued development and field testing will improve reliability of these systems. Incorporating an air channel on autonomous instruments is beneficial for quality checks.

Existing databases:
CDIAC, PICNIC/PICES, CARINA, CAVASSOO (database contains presently all available historical data and presently produced data in the Atlantic sector), Takahashi climatology, and databases maintained of data holdings of individual investigators.
There is a need for regional data centers, and more importantly, for cooperation and coordination between these centers to provide coverage for ocean basin regions (e.g. both US data centers and EU data centers will have an interest in the North Atlantic. Rather than duplicating efforts, such centers should coordinate their services.)

- EU- cover the region, Europe including Africa
- US- North and South America
- Japan- all countries in Asia
- Would Australia and New Zealand join PICNIC?

Recommendations:

- Data release 1 year after download of data. Not more then two submissions would be requested.
- Establish regional projects to facilitate global integration (e.g. CARINA (Atlantic), PICNIC (North Pacific / Japan), Southern hemisphere?, Indian Ocean ?).
- Promote submission of data to one of the three regional centers (CDIAC, WDC-MARE, Japan PICNIC).
- Funds should be made available to reprocess and release historical pCO_2 data for the scientific community.
- Present and future data need to be sent to one of the above-mentioned data centres as soon as possible after collection, with 1 year as the upper limit. This will allow carbon budget estimates at annual to interannual scales.
- Make existing sensors reliable; develop “new” and validate SOOP-system sensors; encourage autonomous pCO_2 sensors on drifters, platforms, and buoys.
- Request IOC to resolve this issue of accessibility of 200 nautical miles.
- Promote intercomparisons of pCO_2 systems on a regular basis.
- Ensure collaboration with JCOMM and its Ship Observations Team (SOT)
- Establish a CO_2 flux measurement program. Encourage direct observations of CO_2 flux on appropriate ships and the development of systems on drifters and buoys.
- Refine the understanding of the link between surface water pCO_2 and atmosphere-ocean CO_2 flux.; recommend process studies and satellite remote-sensing validation studies for CO_2 flux.

7. WORKSHOP SUMMARY AND REVIEW OF SCHEDULED ACTIONS

Objectives for the International Ocean Carbon Coordination Project (A Joint Pilot Project of the SCOR-IOC Advisory Panel on Ocean CO2 and the Global Carbon Project)

1. Develop a compilation and synthesis of large-scale ocean carbon observation activities and plans.
2. Promote the full integration of large-scale carbon studies into the planning activities of international research programs (e.g., CLIVAR, OCEANS, SOLAS)
3. Identify and coordinate regional-scale science groups (e.g., PICES WG17, CARINA) to critically examine the scientific balance, quality and completeness of these programs with reference to global-scale research needs. Promote the establishment of other regional groups as needed.
4. Organize international groups to promote acceptance of:
   - Standardized Measurement techniques (e.g. through the publication of a best practices handbook);
   - Improved accessibility to international carbon data sets (e.g. Promote more uniform data handling/reporting, encourage submission of data to one of three regional data centers within 2 years or less of data collection, investigate data citation issues);
   - Internationally recognized QA/QC procedures (e.g. promoting the use of CRMs, helping to organize training workshops and inter-laboratory comparison exercises)

Specific Action Items from this Workshop:

The IOCCP should develop a web site to disseminate information on national plans for largescale carbon observations and progress on objectives listed above. **Action 1:** Hood, Sabine, Wallace, Canadell, Foster, and Hill to develop site through IOC and GCP in collaboration with CLIVAR.

The IOCCP should serve as a focal point for communication between the carbon community and CLIVAR to identify key areas of common interest and promote a stronger collaboration in developing a measurement strategy for carbon and tracers on repeat hydrographic sections. **Action 2:** Hood, Tilbrook, Sabine, and Feely to develop a statement to the CLIVAR community about the need for tracer measurements on specific repeat sections, promote the appointment of carbon representatives to the CLIVAR regional panels, and establish a closer dialogue with CLIVAR planning of repeat section work in each basin.

The IOCCP should establish formal links with PICES WG17 and CARINA to encourage these regional programs to evaluate the scientific balance, quality and completeness of the large-scale carbon programs with reference to global-scale research needs and facilitate the organization of training workshops and inter-laboratory comparisons to improve data quality. **Action 3:** Hood, Sabine, Dickson, Mintrop to establish mechanism for IOCCP to provide global coordination to regional groups.

The IOCCP should facilitate closer links (possibly through interdisciplinary workshops) between the ocean and atmospheric carbon observation communities and the modelling community. **Action 4**: Hood, Canadell, Feely, Gnanadesikan, and Heinze to document on-going ocean carbon modelling projects and groups, and begin a dialogue with appropriate key scientists to outline the needs for a workshop.

The IOCCP should promote the public release of large-scale carbon data sets within 2 years of cruise completion and encourage submission of international repeat hydrographic section data with carbon measurements to CDIAC and to GHDO**. Action 5**: Kozyr, Swift, and Hill to provide a plan for coordinated data submission of carbon and tracer data on CLIVAR repeat hydrographic sections.

The IOCCP should facilitate the revision and expansion of the DOE CO_2 Methods Handbook (lead by A. Dickson) and promote it as a manual of best practices to be followed by those participating in the large-scale carbon observation network. **Action 6:** Hood and Dickson to develop a plan to finalize the revision, possible translation into other languages, and to promote and distribute the handbook.

The IOCCP should work with appropriate organizations and scientific groups to develop a policy for the proper citation of large-scale data sets. **Action 7:** Hood, Sabine, Feely, and Wallace to encourage data centers to clearly indicate appropriate reference/acknowledgement for data being downloaded and to contact the American Geophysical Union, the European Geophysical Union, and other appropriate groups to initiate discussions on policies for acknowledging the use of large-scale data sets in peer-reviewed articles.

The IOCCP should coordinate and promote the compilation and public release of historical pCO2 data sets. **Action 8:** Dickson, Kozyr, and Heinze to develop a brief position paper outlining this high priority for the community and a plan for coordination between on-going efforts at CDIAC, WDC-MARE / ORFOIS, and other programs.

The IOCCP should address the problem of excessive delays in obtaining permission from governments to make pCO2 measurements on ships of opportunity in territorial waters. **Action 9:** Hood, Manabe, Tilbrook, Zika, Feely, and Nojiri to document particular problems faced with the current system and work with the IOC-WMO JCOMM Ship Observations Team to find the best way forward.

The IOCCP should support and promote certified reference material programs, including the development of appropriate standard gases for ocean carbon work. **Action 10**: Hood, Dickson, and Nojiri to work with the atmospheric community (Roger Francey) to develop a round-robin intercomparison test for ocean carbon gases.

Priorities for Future Workshops:

1. pCO2 inter-laboratory comparison study - March 10-14, 2003, Japan (Nojiri through PICES WG17)
2. Data exchange and formats - workshop should be held in close collaboration with data centers and analysis projects; suggested end 2003 / early 2004 (Nojiri).
3. Ocean carbon modelling and new observation system planning (Gnanadesikan).
4. Ensure increased representation of the ocean community in the International CO2 Conference, and encourage the ocean community to participate in this integrated workshop. (Wallace to contact Tans).
5. Publish the Methods Handbook and then hold a training workshop with the manual to train new / young scientists.

Web-site Features:

The central means of communication between the IOCCP between sessions / workshops will be the IOCCP Web site. The participants suggested that the site include:

1. Information about current and on-going repeat sections, underway measurement programs, and time series stations, including interactive maps and tables of information;

2. Information/recommendations for coordination of activities, upcoming workshops or meetings, position statements on best practices for large-scale ocean carbon observations;
3. Information about current ocean carbon modelling and relevant atmospheric projects and groups;
4. Contact lists / email lists for international colleagues;
5. A news bulletin, with notices and abstracts of news items sent to the community via email with links back to full articles on the web site.

Resources and Project Feasibility Issues:

The Participants noted that, given the number of different organizations to be contacted, coordinated with, and linked to, an international coordination project must have one central focal point. It was remarked that the roles for this coordination project outlined here are not new – they have been discussed for 20 years or more. The Participants stressed that the reason these coordination activities have never been accomplished is because there has never been a central focal point or sufficient secretariat support to adequately establish such a program.

The Participants also stressed that because there is interest and pressure to develop an ocean carbon observing capability and research strategy for ocean carbon assessment and projection, the ocean carbon community must have its own international coordination program rather than trying to coordinate its activities via individual scientists participating in interdisciplinary programs.

The Participants strongly urged the IOC, SCOR, and the GCP to undertake seriously this initiative to develop an international ocean carbon coordination project, taking into account previous failures at similar attempts, and further urged that these sponsor organizations recognize and support the critical need for adequate secretariat support for such an endeavour. The Participants noted with appreciation the value of the close association with the IOC, particularly in matters of developing and gaining international acceptance of standards, the development of international data exchange agreements, and issues of conducting marine scientific research in territorial waters.

ANNEX I

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ANNEX II

AGENDA

Monday, January 13 Room 13, -2 Level, Miollis Annex, UNESCO
Morning Session

0900 Opening Address - Dr. Patricio Bernal, Executive Secretary, IOC-UNESCO

0915 Welcome and Announcements - Maria Hood and Ed Urban

0920 Introduction to the OCCP and Workshop Overview - Pep Canadell and Maria Hood

0930 Global-Scale Carbon Research Overview – Scott Doney

1030 *coffee*

1100 Observational Strategy: Repeat Sections – Doug Wallace

1130 Observational Strategy: Near-surface CO_2 – Yukihiro Nojiri

1200 International Research and Observation Programs Overview: IGBP – Wendy Broadgate; SCOR – Ed Urban; CLIVAR – Howard Cattle and Katy Hill; GOOS and JCOMM – Maria Hood

1240 *Lunch*

Afternoon Sessions

1400 Instructions to the Working Groups – Chris Sabine

1415 *Room 13*
WORKING GROUP I: Repeat Hydrographic Sections Discussion Leader: Bronte Tilbrook; Rapporteur: Alex Kozyr

1415 *Room 14*
WORKING GROUP II: Near-surface CO_2 Observations
Discussion Leader: Truls Johannessen; Rapporteur: Kitack Lee

1530 *coffee*

1600 Working Groups Resume

1830 Reception at UNESCO Fontenoy 7th Floor Restaurant

Tuesday, January 14 Room 13, -2 Level, Miollis Annex, UNESCO
Morning Session

0900 Review of Schedule and Announcements – Chris Sabine

0910 Presentation from WG I – Alex Kozyr

0920 Discussion of WG I Results – Bronte Tilbrook

0935 Presentation from WG II – Kitack Lee

0945 Discussion of WG II Results – Truls Johannessen

1000 Spatial and Temporal Variability of Air-Sea CO_2 Fluxes – Issues for a Global Observing Network – Colm Sweeny

1030 Spatial and Temporal Variability of CO2 Inventories – Issues for a Global Observing Network – Dick Feely

1100 *coffee*

1130 What Atmospheric and Ocean Inversions Tell Us About Observing Carbon Cycle Changes in the Ocean – Andy Jacobson

1200 The Role of Automated Systems in an Ocean Observing Network – Tommy Dickey

1220 Discussion

1230 *Lunch*

Afternoon Sessions

1400 Instructions to Working Groups – Chris Sabine

1415 *Room 13*
Working Group I: Repeat Hydrographic Sections
Discussion Leader: Andrew Dickson; Rapporteur: Nick Bates
1415 *Room 14*
Working Group II: Near-surface CO_2 Observations
Discussion Leader: Nicolas Metzl; Rapporteur: Christoph Heinze

1530 *coffee*

1600 Working Groups Resume

1800 Sessions End.

Wednesday, January 15 Room 13, -2 Level, Miollis Annex, UNESCO
Morning Session

0900 Review of Schedule and Announcements – Chris Sabine

0910 Presentation from WG I – Alex Kozyr and Nick Bates

0925 Discussion of WG I Results – Bronte Tilbrook and Andrew Dickson

0950 Presentation from WG II – Kitack Lee and Christoph Heinze

1005 Discussion of WG II Results – Truls Johannessen and Nicolas Metzl

1030 The Role of Remote Sensing in Evaluating the Global Carbon Cycle – Jacqueline Boutin
1100 coffee

1130 Moving Towards an Operational Ocean Carbon Observations System for Data Assimilation and Modelling – Anand Gnanadesikan

1150 Automated CO_2 Systems for an Ocean Observing Network – Liliane Merlivat

1210 The Role of Coastal Seas / Margins in the Global Carbon Cycle and the Importance of Interacting with Terrestrial and Atmospheric Communities – Helmut Thomas

1230 Lunch

Afternoon Session

1400 Open Discussion: Chris Sabine

- Summary of Key Points for the Report
- Outline a Plan for Publishing Summaries in Scientific Periodicals in the US, EU, Asia, …

1530 coffee

1600 Open Discussion: Maria Hood and Pep Canadell

- The OCCP Project – community needs, project goals, web features
- Identification of focal points for programs and national / regional activities; discussion of focal point responsibilities
- The need for future workshops – potential topics, goals, and dates.

1800 Close of Workshop.

IOC Workshop Reports

The Scientific Workshops of the Intergovernmental Oceanographic Commission are sometimes jointly sponsored with other intergovernmental or non-governmental bodies. In most cases, IOC assures responsibility for printing, and copies may be requested from:

Intergovernmental Oceanographic Commission – UNESCO
1, rue Miollis, 75732 Paris Cedex 15, France

No.	Title	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia (Report of the IDOE Workshop on); Bangkok, Thailand, 24-29 September 1973 UNDP (CCOP),	E (out of stock)
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974 (UNESCO Technical Paper in Marine Sciences, No. 20).	E (out of stock) S (out of stock)
3	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean; Monte Carlo, 9-14 September 1974.	E,F E (out of stock)
4	Report of the Workshop on the Phenomenon known as 'El Niño'; Guayaquil, Ecuador, 4-12 December 1974.	E (out of stock) S (out of stock)
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources; Kingston, Jamaica, 17-22 February 1975	E (out of stock) S
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Suva, Fiji, 1-6 September 1975.	E
7	Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/ EAC; Nairobi, Kenya, 25 March-2 April 1976.	E, F,S, R
8	Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters; Penang, 7-13 April 1976	E (out of stock)
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience; Mauritius 9-13 August 1976.	E, F, S, R
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring; Monaco, 14-18 June 1976	E, F E (out of stock) R
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976.	E, S (out of stock)
11 Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976	E (out of stock), S
12	Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects; Fort-de-France, Martinique, 28 November-2 December 1977.	E, F, S
13	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area; Port of Spain, Trinidad, 16-18 January 1978.	E, S
14	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas; Abidjan, Côte d'Ivoire, 2-9 May 1978	E, F
15	CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-East Pacific; Santiago de Chile, 6-10 November 1978.	E (out of stock)
16	Workshop on the Western Pacific, Tokyo, 19-20 February 1979.	E, F, R
17	Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS); Moscow, 9-11 April 1979.	E
17 suppl.	Papers submitted to the Joint IOC/WMO Seminar on Oceano-graphic Products and the IGOSS Data Processing and Services System; Moscow, 2-6 April 1979.	E
18	IOC/UNESCO Workshop on Syllabus for Training Marine Technicians; Miami, U.S.A., 22-26 May 1978 (UNESCO reports in marine sciences, No. 4 published by the Division of Marine Sciences, UNESCO).	E (out of stock), F, S (out of tock), R
19	IOC Workshop on Marine Science Syllabus for Secondary Schools; Llantwit Major, Wales, U.K., 5-9 June 1978 (UNESCO reports in marine sciences, No. 5, published by the Division of Marine Sciences, UNESCO).	E (out of stock), S, R, Ar
20	Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources; Bandung, Indonesia, 17-21 October 1978	E
21	Second IDOE Symposium on Turbulence in the Ocean; Liège, Belgium, 7-18 May 1979.	E, F, S, R
22	Third IOC/WMO Workshop on Marine Pollution Monitoring; New Delhi, 11-15 February 1980.	E, F, S, R
23	WESTPAC Workshop on the Marine Geology and Geophysics of the North-West Pacific; Tokyo, 27-31 March 1980.	E, R
24	WESTPAC Workshop on Coastal Transport of Pollutants; Tokyo, Japan, 27-31 March 1980.	E (out of stock)
25	Workshop on the Inter-calibration of Sampling Procedures of the IOC/ WMO UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open-Ocean Waters; Bermuda, 11-26 January 1980.	E (Superseded by IOC Technical Series No.22)
26	IOC Workshop on Coastal Area Management in the Caribbean Region; Mexico City, 24 September- 5 October 1979.	E, S
27	CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Nouméa, New Caledonia, 9-15 October 1980.	E
28	FAO/IOC Workshop on the effects of environmental variation on the survival of larval pelagic fishes. Lima, 20 April-5 May 1980.	E
29	WESTPAC Workshop on Marine Biological Methodology; Tokyo, 9-14 February 1981.	E
30	International Workshop on Marine Pollution in the South-West Atlantic; Montevideo, 10-14 November 1980.	E (out of stock) S
31	Third International Workshop on Marine Geoscience; Heidelberg, 19-24 July 1982.	E, F, S
32	UNU/IOC/UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the context of the New Ocean Regime; Paris, France, 27 September-1 October 1982.	E, F, S
32 Suppl.	Papers submitted to the UNU/IOC/ UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the Context of the New Ocean Regime; Paris, France, 27 September-1 October 1982.	E
33	Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (OSLR); Halifax, 26-30 September 1963.	E
34	IOC Workshop on Regional Co-operation in Marine Science in the Central Eastern Atlantic (Western Africa); Tenerife, 12-17 December 1963.	E, F, S
35	CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific; Suva, Fiji, 3-7 October 1983.	E
36	IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, Portugal, 28 May-2 June 1984.	E
36 Suppl.	Papers submitted to the IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, 28 May-2 June 1984	E
37	IOC/UNESCO Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs; Colombo, 8-13 July 1985.	E
38	IOC/ROPME/UNEP Symposium on Fate and Fluxes of Oil Pollutants in the Kuwait Action Plan Region; Basrah, Iraq, 8-12 January 1984.	E
39	CCOP (SOPAC)-IOC-IFREMER-ORSTOM Workshop on the Uses of Submersibles and Remotely Operated Vehicles in the South Pacific; Suva, Fiji, 24-29 September 1985.	E
40	IOC Workshop on the Technical Aspects of Tsunami Analysis, Prediction and Communications; Sidney, B.C., Canada, 29-31 July 1985.	E
40 Suppl.	First International Tsunami Workshop on Tsunami Analysis, Prediction and Communications, Submitted Papers; Sidney, B.C., Canada, 29 July-1 August 1985.	E
41	First Workshop of Participants in the Joint FAO/IOC/WHO/IAEA/UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region (WACAF/2); Dakar, Senegal, 28 October- 1 November 1985.	E
43	IOC Workshop on the Results of MEDALPEX and Future Oceano-graphic Programmes in the Western Mediterranean; Venice, Italy, 23-25 October 1985.	E
44	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E (out of stock) S
44 Suppl.	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities, Submitted Papers; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E
45	IOCARIBE Workshop on Physical Oceanography and Climate; Cartagena, Colombia, 19-22 August 1986.	E
46	Reunión de Trabajo para Desarrollo del Programa "Ciencia Oceánica en Relación a los Recursos No Vivos en la Región del Atlántico Sud-occidental"; Porto Alegre, Brasil, 7-11 de abril de 1986.	S
47	IOC Symposium on Marine Science in the Western Pacific: The Indo-Pacific Convergence; Townsville, 1-6 December 1966	E
48	IOCARIBE Mini-Symposium for the Regional Development of the IOC-UN (OETB) Programme on 'Ocean Science in Relation to Non-Living Resources (OSNLR)'; Havana, Cuba, 4-7 December 1986.	E, S
49	AGU-IOC-WMO-CPPS Chapman Conference: An International Symposium on 'El Niño'; Guayaquil, Ecuador, 27-31 October 1986.	E
50	CCALR-IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill (organized in collaboration with SCAR and SCOR); Paris, France, 2-6 June 1987.	E
51	CCOP/SOPAC-IOC Workshop on Coastal Processes in the South Pacific Island Nations; Lae, Papua-New Guinea, 1-8 October 1987.	E
52	SCOR-IOC-UNESCO Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects upon Living Resources and the Atmosphere; Paris, France, 6-10 May 1985.	E
53	IOC Workshop on the Biological Effects of Pollutants; Oslo, 11-29 August 1986.	E
54	Workshop on Sea-Level Measurements in Hostile Conditions; Bidston, UK, 28-31 March 1988.	E
55	IBCCA Workshop on Data Sources and Compilation, Boulder, Colorado, 18-19 July 1988.	E
56	IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Cleveland, Australia, 24-30 July 1988.	E
57	IOC Workshop on International Co-operation in the Study of Red Tides and Ocean Blooms; Takamatsu, Japan, 16-17 November 1987.	E
58	International Workshop on the Technical Aspects of the Tsunami Warning System; Novosibirsk, USSR, 4-5 August 1989.	E
58 Suppl.	Second International Workshop on the Technical Aspects of Tsunami Warning Systems, Tsunami Analysis, Preparedness,	E

No.	Title	Languages
	Observation and Instrumentation. Submitted Papers; Novosibirsk, USSR, 4-5 August 1989.	
59	IOC-UNEP Regional Workshop to Review Priorities for Marine Pollution Monitoring Research, Control and Abatement in the Wider Caribbean; San José, Costa Rica, 24-30 August 1989.	E, F, S
60	IOC Workshop to Define IOCARIBE-TRODERP proposals; Caracas, Venezuela, 12-16 September 1989.	E
61	Second IOC Workshop on the Biological Effects of Pollutants; Bermuda, 10 September- 2 October 1988.	E
62	Second Workshop of Participants in the Joint FAO-IOC-WHO-IAEA-UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region; Accra, Ghana, 13-17 June 1988.	E
63	IOC/WESTPAC Workshop on Co-operative Study of the Continental Shelf Circulation in the Western Pacific; Bangkok, Thailand, 31 October-3 November 1989.	E
64	Second IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Phuket, Thailand, 25-31 September 1989.	E
65	Second IOC Workshop on Sardine/Anchovy Recruitment Project (SARP) in the Southwest Atlantic; Montevideo, Uruguay, 21-23 August 1989.	E
66	IOC ad hoc Expert Consultation on Sardine/ Anchovy Recruitment Programme; La Jolla, California, U.S.A., 1989	E
67	Interdisciplinary Seminar on Research Problems in the IOCARIBE Region; Caracas, Venezuela, 28 November- 1 December 1989.	E (out of stock)
68	International Workshop on Marine Acoustics; Beijing, China, 26-30 March 1990.	E
69	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Leningrad, USSR, 28-31 May 1990.	E
69 Suppl.	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Submitted Papers; Leningrad, USSR, 28-31 May 1990.	E
70	IOC-SAREC-UNEP-FAO-IAEA-WHO Workshop on Regional Aspects of Marine Pollution; Mauritius, 29 October - 9 November 1990.	E
71	IOC-FAO Workshop on the Identification of Penaeid Prawn Larvae and Postlarvae; Cleveland, Australia, 23-28 September 1990.	E
72	IOC/WESTPAC Scientific Steering Group Meeting on Co-Operative Study of the Continental Shelf Circulation in the Western Pacific; Kuala Lumpur; Malaysia, 9-11 October 1990.	E
73	Expert Consultation for the IOC Programme on Coastal Ocean Advanced Science and Technology Study; Liège, Belgium, 11-13 May 1991.	E
74	IOC-UNEP Review Meeting on Oceanographic Processes of Transport and Distribution of Pollutants in the Sea; Zagreb, Yugoslavia, 15-18 May 1989.	E
75	IOC-SCOR Workshop on Global Ocean Ecosystem Dynamics; Solomons, Maryland, U.S.A., 29 April-2 May 1991.	E
76	IOC/WESTPAC Scientific Symposium on Marine Science and Management of Marine Areas of the Western Pacific; Penang, Malaysia, 2-6 December 1991.	E
77	IOC-SAREC-KMFRI Regional Workshop on Causes and Consequences of Sea-Level Changes on the Western Indian Ocean Coasts and Islands; Mombasa, Kenya, 24-28 June 1991.	E
78	IOC-CEC-ICES-WMO-ICSU Ocean Climate Data Workshop Goddard Space Flight Center; Greenbelt, Maryland, U.S.A., 18-21 February 1992.	E
79	IOC/WESTPAC Workshop on River Inputs of Nutrients to the Marine Environment in the WESTPAC Region; Penang, Malaysia, 26-29 November 1991.	E
80	IOC-SCOR Workshop on Programme Development for Harmful Algae Blooms; Newport, U.S.A. 2-3 November 1991.	E
81	Joint IAPSO-IOC Workshop on Sea Level Measurements and Quality Control; Paris, France, 12-13 October 1992.	E
82	BORDOMER 92: International Convention on Rational Use of Coastal Zones. A Preparatory Meeting for the Organization of an International Conference on Coastal Change; Bordeaux, France, 30 September-2 October 1992.	E
83	IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 12-13 October 1992.	E
84	Workshop on Atlantic Ocean Climate Variability; Moscow, Russian Federation, 13-17 July 1992	E
85	IOC Workshop on Coastal Oceanography in Relation to Integrated Coastal Zone Management; Kona, Hawaii, 1-5 June 1992.	E
86	International Workshop on the Black Sea; Varna, Bulgaria, 30 September – 4 October 1991	E
87	Taller de trabajo sobre efectos biológicos del fenómeno «El Niño» en ecosistemas costeros del Pacífico Sudeste; Santa Cruz, Galápagos, Ecuador, 5-14 de octubre de 1989.	S only (summary in E, F, S)
88	IOC-CEC-ICSU-ICES Regional Workshop for Member States of Eastern and Northern Europe (GODAR Project); Obninsk, Russia, 17-20 May 1993.	E
89	IOC-ICSEM Workshop on Ocean Sciences in Non-Living Resources; Perpignan, France, 15-20 October 1990.	E
90	IOC Seminar on Integrated Coastal Management; New Orleans, U.S.A., 17-18 July 1993.	E
91	Hydroblack'91 CTD Intercalibration Workshop; Woods Hole, U.S.A., 1-10 December 1991.	E
92	Réunion de travail IOCEA-OSNLR sur le Projet « Budgets sédimentaires le long de la côte occidentale d'Afrique » Abidjan, côte d'Ivoire, 26-28 juin 1991.	E
93	IOC-UNEP Workshop on Impacts of Sea-Level Rise due to Global Warming. Dhaka, Bangladesh, 16-19 November 1992.	E
94	BMTC-IOC-POLARMAR International Workshop on Training Requirements in the Field of Eutrophication in Semi-enclosed Seas and Harmful Algal Blooms, Bremerhaven, Germany, 29 September-3 October 1992.	E
95	SAREC-IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 23-25 November 1993.	E
96	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Zanzibar, United Republic of Tanzania, 17-21 January 1994.	E
96 Suppl.	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers 1. Coastal Erosion; Zanzibar, United Republic of Tanzania 17-21 January 1994.	E
96 Suppl	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers 2. Sea Level; Zanzibar, United Republic of Tanzania 17-21 January 1994.	E
97	IOC Workshop on Small Island Oceanography in Relation to Sustainable Economic Development and Coastal Area Management of Small Island Development States; Fort-de-France, Martinique, 8-10 November, 1993.	E
98	CoMSBlack '92A Physical and Chemical Intercalibration Workshop; Erdemli, Turkey, 15-29 January 1993.	E
99	IOC-SAREC Field Study Exercise on Nutrients in Tropical Marine Waters; Mombasa, Kenya, 5-15 April 1994.	E
100	IOC-SOA-NOAA Regional Workshop for Member States of the Western Pacific - GODAR-II (Global Oceanographic Data Archeology and Rescue Project); Tianjin, China, 8-11 March 1994.	E
101	IOC Regional Science Planning Workshop on Harmful Algal Blooms; Montevideo, Uruguay, 15-17 June 1994.	E
102	First IOC Workshop on Coastal Ocean Advanced Science and Technology Study (COASTS); Liège, Belgium, 5-9 May 1994.	E
103	IOC Workshop on GIS Applications in the Coastal Zone Management of Small Island Developing States; Barbados, 20-22 April 1994.	E
104	Workshop on Integrated Coastal Management; Dartmouth, Canada, 19-20 September 1994.	E
105	BORDOMER 95: Conference on Coastal Change; Bordeaux, France, 6-10 February 1995.	E
105 Suppl.	Conference on Coastal Change: Proceedings; Bordeaux, France, 6-10 February 1995	E
106	IOC/WESTPAC Workshop on the Paleographic Map; Bali, Indonesia, 20-21 October 1994.	E
107	IOC-ICSU-NIO-NOAA Regional Workshop for Member States of the Indian Ocean - GODAR-III; Dona Paula, Goa, India, 6-9 December 1994.	E
108	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Paris, France, 9-12 May 1995.	E
108 Suppl.	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Submitted Papers; Paris, France, 9-12 May 1995.	E
109	First IOC-UNEP CEPPOL Symposium; San José, Costa Rica, 14-15 April 1993.	E
110	IOC-ICSU-CEC regional Workshop for Member States of the Mediterranean - GODAR-IV (Global Oceanographic Data Archeology and Rescue Project) Foundation for International Studies, University of Malta, Valletta, Malta, 25-28 April 1995.	E
111	Chapman Conference on the Circulation of the Intra-Americas Sea; La Parguera, Puerto Rico, 22-26 January 1995.	E
112	IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials (GESREM) Workshop; Miami, U.S.A., 7-8 December 1993.	E
113	IOC Regional Workshop on Marine Debris and Waste Management in the Gulf of Guinea; Lagos, Nigeria, 14-16 December 1994.	E
114	International Workshop on Integrated Coastal Zone Management (ICZM) Karachi, Pakistan; 10-14 October 1994.	E
115	IOC/GLOSS-IAPSO Workshop on Sea Level Variability and Southern Ocean Dynamics; Bordeaux, France, 31 January 1995	E
116	IOC/WESTPAC International Scientific Symposium on Sustainability of Marine Environment: Review of the WESTPAC Programme, with Particular Reference to ICAM, Bali, Indonesia, 22-26 November 1994.	E
117	Joint IOC-CIDA-Sida (SAREC) Workshop on the Benefits of Improved Relationships between International Development Agencies, the IOC and other Multilateral Inter-governmental Organizations in the Delivery of Ocean, Marine Affairs and Fisheries Programmes; Sidney B.C., Canada, 26-28 September 1995.	E
118	IOC-UNEP-NOAA-Sea Grant Fourth Caribbean Marine Debris Workshop; La Romana, Santo Domingo, 21-24 August 1995.	E
119	IOC Workshop on Ocean Colour Data Requirements and Utilization; Sydney B.C., Canada, 21-22 September 1995.	E
120	International Training Workshop on Integrated Coastal Management; Tampa, Florida, U.S.A., 15-17 July 1995.	E
121	Atelier régional IOC-CERESCOR sur la gestion intégrée des zones littorales (ICAM), Conakry, Guinée, 18–22 décembre 1995	F
122	IOC-EU-BSH-NOAA-(WDC-A) International Workshop on Oceanographic Biological and Chemical Data Management, Hamburg, Germany, 20-23 May 1996	E
123	Second IOC Regional Science Planning Workshop on Harmful Algal Blooms in South America; Mar del Plata, Argentina, 30 October–1 November 1995.	E, S
124	GLOBEC-IOC-SAHFOS-MBA Workshop on the Analysis of Time Series with Particular Reference to the Continuous Plankton Recorder Survey; Plymouth, U.K.,4-7 May 1993.	E
125	Atelier sous-régional de la COI sur les ressources marines vivantes du Golfe de Guinée ; Cotonou, Bénin, 1-4 juillet 1996.	E

No.	Title	Languages
126	IOC-UNEP-PERSGA-ACOPS-IUCN Workshop on Oceanographic Input to Integrated Coastal Zone Management in the Red Sea and Gulf of Aden. Jeddah, Saudi Arabia, 8 October 1995.	E
127	IOC Regional Workshop for Member States of the Caribbean and South America GODAR-V (Global Oceanographic Data Archeology and Rescue Project); Cartagena de Indias, Colombia, 8-11 October 1996.	E
128	Atelier IOC-Banque Mondiale-Sida/SAREC-ONE sur la Gestion Intégrée des Zones Côtières ; Nosy Bé, Madagascar, 14-18 octobre 1996.	E
129	Gas and Fluids in Marine Sediments, Amsterdam, the Netherlands; 27-29 January 1997.	E
130	Atelier régional de la COI sur l'océanographie côtière et la gestion de la zone côtière ;Moroni, RFI des Comores, 16-19 décembre 1996.	E
131	GOOS Coastal Module Planning Workshop; Miami, USA, 24-28 February 1997	E
132	Third IOC-FANSA Workshop; Punta-Arenas, Chile, 28-30 July 1997	S/E
133	Joint IOC-CIESM Training Workshop on Sea-level Observations and Analysis for the Countries of the Mediterranean and Black Seas; Birkenhead, U.K., 16-27 June 1997.	E
134	IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping (Holocene Optimum); Shanghai, China, 27-29 May 1997.	E
135	Regional Workshop on Integrated Coastal Zone Management; Chabahar, Iran; February 1996.	E
136	IOC Regional Workshop for Member States of Western Africa (GODAR-VI); Accra, Ghana, 22-25 April 1997.	E
137	GOOS Planning Workshop for Living Marine Resources, Dartmouth, USA; 1-5 March 1996.	E
138	Gestión de Sistemas Oceanográficos del Pacífico Oriental; Concepción, Chile, 9-16 de abril de 1996.	S
139	Sistemas Oceanográficos del Atlántico Sudoccidental, Taller, TEMA;Furg, Rio Grande, Brasil, 3-11 de noviembre de 1997	S
140	IOC Workshop on GOOS Capacity Building for the Mediterranean Region; Valletta, Malta, 26-29 November 1997.	E
141	IOC/WESTPAC Workshop on Co-operative Study in the Gulf of Thailand: A Science Plan; Bangkok, Thailand, 25-28 February 1997.	E
142	Pelagic Biogeography ICoPB II. Proceedings of the 2nd International Conference. Final Report of SCOR/IOC Working Group 93; Noordwijkerhout, The Netherlands, 9-14 July 1995.	E
143	Geosphere-biosphere coupling: Carbonate Mud Mounds and Cold Water Reefs; Gent, Belgium, 7–11 February 1998.	E
144	IOC-SOPAC Workshop Report on Pacific Regional Global Ocean Observing Systems; Suva, Fiji, 13-17 February 1998.	E
145	IOC-Black Sea Regional Committee Workshop: 'Black Sea Fluxes' Istanbul, Turkey, 10-12 June 1997.	E
146	Taller Internacional sobre Formacíon de Capacidades para el Manejo de las Costas y los Oéanos en le Gran Caribe, La Habana, – Cuba, 7–10 de Julio de 1998 / International Workshop on Management Capacity-Building for Coasts and Oceans in the Wider Caribbean, Havana, Cuba, 7–10 July 1998	S/E
147	IOC-SOA International Training Workshop on the Intregration of Marine Sciences into the Process of Integrated Coastal Management, Dalian, China, 19-24 May 1997.	E
148	IOC/WESTPAC International Scientific Symposium – Role of Ocean Sciences for Sustainable Development Okinawa, Japan, 2-7 February 1998.	E
149	Workshops on Marine Debris & Waste Management in the Gulf of Guinea, 1995-97.	E
150	First IOCARIBE-ANCA Workshop Havana, Cuba, 29 June-1 July 1998.	E
151	Taller Pluridisciplinario TEMA sobre Redes del Gran Caribe en Gestión Integrada de Áreas Costeras Cartagena de Indias, Colombia, 7-12 de septiembre de 1998.	S
152	Workshop on Data for Sustainable Integrated Coastal Management (SICOM) Maputo, Mozambique, 18-22 July 1998	E
153	IOC/WESTPAC-Sida (SAREC) Workshop on Atmospheric Inputs of Pollutants to the Marine Environment Qingdao, China, 24-26 June 1998	E
154	IOC-Sida-Flanders-SFRI Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA project) Capetown, South Africa, 30 November-11 December 1998.	E
155	Science of the Mediterranean Sea and its applications UNESCO, Paris 29-31 July 1997	E
156	IOC-LUC-KMFRI Workshop on RECOSCIX-WIO in the Year 2000 and Beyond, Mombasa, Kenya, 12-16 April 1999	E
157	'98 IOC-KMI International Workshop on Integrated Coastal Management (ICM), Seoul, Republic of Korea 16-18 April 1998	E
158	The IOCARIBE Users and the Global Ocean Observing System (GOOS) Capacity Building Workshop, San José, Costa Rica, 22-24 April 1999	E
159	Oceanic Fronts and Related Phenomena (Konstantin Fedorov Memorial Symposium) – Proceedings, Pushkin, Russian Federation, 18-22 May 1998	E
160	Under preparation	
161	Under preparation	
162	Workshop report on the Transports and Linkages of the Intra-americas Sea (IAS), Cozumel, Mexico, 1-5 November 1997	E
163	Under preparation	
164	IOC-Sida-Flanders-MCM Third Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA Project), Cape Town, South Africa, 29 November – 11 December 1999	E
165	An African Conference on Sustainable Integrated Management; Proceedings of the Workshops. An Integrated Approach, (PACSICOM), Maputo, Mozambique, 18 –25 July 1998	E, F
166	IOC-SOA International Workshop on Coastal Megacities: Challenges of Growing Urbanization of the World's Coastal Areas; Hangzhou, P.R. China, 27 –30 September 1999	E
167	IOC-Flanders First ODINAFRICA-II Planning Workshop, Dakar, Senegal, 2-4 May 2000	E
168	Geological Processes on European Continental Margins; International Conference and Eight Post-cruise Meeting of the Training-Through-Research Programme, Granada, Spain, 31 January – 3 February 2000	E
169	International Conference on the International Oceanographic Data & Information Exchange in the Western Pacific (IODE-WESTPAC) 1999, ICIWP '99, Langkawi, Malaysia, 1-4 November 1999	***under preparation***
170	IOCARIBE-GODAR-I Cartagenas, Colombia, February 2000	***under preparation***
171	Ocean Circulation Science derived from the Atlantic, Indian and Arctic Sea Level Networks, Toulouse, France, 10-11 May 1999	E
172	(*Under preparation*)	
173	The Benefits of the Implementation of the GOOS in the Mediterranean Region, Rabat, Morocco, 1-3 November 1999	E, F
174	IOC-SOPAC Regional Workshop on Coastal Global Ocean Observing System (GOOS) for the Pacific Region, Apia, Samoa, 16-17 August 2000	E
175	Geological Processes on Deep-water European Margins, Moscow-Mozhenka, 28 Jan.-2 Feb. 2001	E
176	MedGLOSS Workshop and Coordination Meeting for the Pilot Monitoring Network System of Systematic Sea Level Measurements in the Mediterranean and Black Seas, Haifa, Israel, 15-17 May 2000	E
177	*(Under preparation)*	
178	*(Under preparation)*	
179	*(Under preparation)*	
180	Abstracts of Presentations at Workshops during the 7th session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, USA, 23-27 April 2001	E
181	*(Under preparation)*	
182	*(Under preparation)*	
183	Geosphere/Biosphere/Hydrosphere Coupling Process, Fluid Escape Structures and Tectonics at Continental Margins and Ocean Ridges, International Conference & Tenth Post-cruise Meeting of the Training-through-Research Programme, Aveiro, Portugal, 30 January-2 February 2002	E
184	*(Under preparation)*	
185	*(Under preparation)*	
186	*(Under preparation)*	
186	*(Under preparation)*	
187	Geological and Biological Processes at deep-sea European Margins and Oceanic Basins, Bologna, Italy, 2–6 February 2003	E
188	Proceedings of 'The Ocean Colour Data' Symposium, Brussels, Belgium, 25-27 November 2002	E
189	Workshop for the Formulation of a Draft Project on Integrated Coastal Management (ICM) in Latin America and the Caribbean (LAC), Cartagena, Colombia, 23–25 October 2003	E F ***(electronic copy only)***
	Taller de Formulación de un Anteproyecto de Manejo Costero Integrado (MCI) en América Latina y el Caribe (ALC), Cartagena, Colombia, 23–25 de Octubre de 2003	
190	First ODINCARSA Planning Workshop for Caribbean Islands, Christchurch, Barbados, 15–18 December 2003	E ***(electronic copy only)***
191	North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes — International Conference and Twelfth Post-cruise Meeting of the Training-through-research Programme, Copenhagen, Denmark, 29–31 January 2004	E
192	Regional Workshop on Coral Reefs Monitoring and Management in the ROPME Sea Area, Iran I.R., 14–17 December 2003	E ***(under preparation)***
193	Workshop on New Technical Developments in Sea and Land Level Observing Systems, Paris, France, 14–16 October 2003	E ***(electronic copy only)*** ***(under preparation)***
194	IOC/ROPME Planning Meeting for the Ocean Data and Information Network for the Central Indian Ocean Region	
195	Workshop on Indicators of Stress in the Marine Benthos, Torregrande-Oristano, Italy, 8–9 October 2004	E
196	International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework, Paris, France, 3–8 March 2005	E
197	Geosphere-Biosphere Coupling Processes: The TTR Interdisciplinary Approach Towards Studies of the European and North African Margins; International Conference and Post-cruise Meeting of the Training-Through-Research Programme, Morocco, 2-5 February 2005	E
198	Second International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean, Grand Baie, Mauritius, 14–16 April 2005	E
199	International Conference for the Establishment of a Tsunami and Coastal Hazards Warning System for the Caribbean and Adjacent Regions, Mexico, 1–3 June 2005	E
200	Lagoons and Coastal Wetlands in the Global Change Context: Impacts and Management Issues — Proceedings of the International Conference, Venice, 26–28 April 2004 (*ICAM Dossier N° 3*)	E
201	Geological processes on deep-water European margins - International Conference and 15th Anniversary Post-cruise Meeting of the Training-Through-Research Programme, Moscow/Zvenigorod, Russian Federation, 29 January–4 February 2006	E
202	Proceedings of 'Ocean Biodiversity Informatics': an international conference on marine biodiversity data management Hamburg, Germany, 29 November–1 December 2004	E
203	IOC-Flanders Planning Workshop for the formulation of a regional Pilot Project on Integrated Coastal Area Management in Latin America, Cartagena de Indias, Colombia, 16–18 January 2007	*E* ***(electronic copy only)***
204	Geo-marine Research along European Continental Margins, International Conference and Post-cruise Meeting of the Training-through-research Programme, Bremen, Germany, 29 January–1 February 2007	E
205	IODE/ICAM Workshop on the development of the Caribbean marine atlas (CMA), United Nations House, Bridgetown, Barbados, 8–10 October 2007	E ***(electronic copy only)***
206	IODE/JCOMM Forum on Oceanographic Data Management and Exchange Standards, Ostend, Belgium, 21–25 January 2008	*(Under preparation)*
207	SCOR/IODE Workshop on Data Publishing, Ostend, Belgium, 17–18 June 2008	*(Under preparation)*
208	JCOMM Technical Workshop on Wave Measurements from Buoys, New York, USA, 2–3 October 2008 (IOC-WMO publication)	*(Under preparation)*

No.	Title	Languages
209	Collaboration between IOC and OBIS towards the Long-term Management Archival and Accessibility of Ocean Biogeographic Data, Ostend, Belgium, 24–26 November 2008	*(Under preparation)*
210	Ocean Carbon Observations from Ships of Opportunity and Repeat Hydrographic Sections (IOCCP Reports, 1), Paris, France, 13–15 January 2003	E ***(electronic copy only)***