Intergovernmental Oceanographic Commission
Training Course Reports

20

IOC Training Course for the Global Sea Level Observing System (GLOSS) directed to the African and South American Portuguese and Spanish-Speaking Countries

Instituto Oceanográfico da Universidade de São Paulo
São Paulo, Brazil, 1-19 February 1993

UNESCO

IOC Training Course Reports

No.	Title	Language versions
1.	IOC Indian Ocean Region Training Course in Petroleum Monitoring Perth, 18 February-1 March 1980	English
2.	IOC Regional Training Course for Marine Science, Technicians Cape Ferguson, Queensland, 1-28 June 1980	English
3.	ROPME-IOC-UNEP Training Workshop on Oceanographic Sampling Analysis, Data handling and Care of Equipment, Doha, Qatar, 3-15 December 1983	English
4.	Stage COI d'initiation à la gestion et au traitement de l'information scientifique et technique pour l'océanologie, Brest, France, 28 novembre - 9 décembre 1983	French
5.	Curso mixto COI-OMM de formación sobre el Sistema Global Integrado de Servicios Oceánicos (SGISO), Buenos Aires, Argentina, 15-26 de octubre de 1984	Spanish
6.	UNESCO-IOC-NBO Training Course on Tidal Observations and Data Processing Tianjin, China, 27 August - 22 September 1984	English
7.	Stage COI sur la connaissance et la gestion de la zone côtière et du proche plateau continental Talence, France, 18 septembre - 4 octobre 1984	French
8.	IOC Regional Training Course on Marine Living Resources in the Western Indian Ocean Mombasa, Kenya, 27 August - 22 September 1984	English
9.	IOC-UNESCO Summer School on Oceanographic Data, Collection and Management Erdemli, Icel, Turkey, 21 September - 3 October 1987	English
10.	IOC-UNESCO Regional Training Workshop on Ocean Engineering and its Interface with Ocean Sciences in the Indian Ocean Region, Madras, India, 17 March - 5 April 1986	English
11.	IOC-UNESCO Training Course on the Use of Microcomputers for Oceanographic Data Management Bangkok, Thailand, 165 January - 3 February 1989	English
12.	IOC Advanced Training Course on Continental Shelf Structures Sediments and Mineral Resources Quezon City, Philippines, 2-13 October 1989	English
13.	IOC/IODE Training Course on GF3 Data Formatting System Obninsk, USSR, 14-24 May 1990	English
14.	IOC Training Course on Microcomputers and Management of Marine Data in Oceanographic Data Centres of Spanish-speaking Countries, Bogotá, Colombia, 21-30 October 1991	English Spanish
15.	IOC Advanced Training Course on Nearshore Sedimentation and the Evolution of Coastal Environments, Kuala Lumpur, Malaysia, 17-29 February 1992	English
16.	First IOC Training Course on the Applications of Satellite Remote Sensing to Marine Studies Caracas, Venezuela, 24-28 September 1990	English
17.	IOC-KMFRI-RECOSCIX (WIO) Regional Training Course on Microcomputer-based Marine Library Information Management, Mombasa, Kenya, 10-21 August 1992	English
18.	ROPME-IOC Regional Training Course on Management of Marine Data and Information on Microcomputers for the ROPME Region, Kuwait, 18-28 October 1992	English
19.	IOC-SOA Training Workshop on Environmental Effects on Benthic Communities Xiamen, China, 19-23 October 1992	English
20.	IOC Training Course for the Global Sea Level Observing System (GLOSS) directed to the African and South American Portuguese and Spanish-Speaking Countries São Paulo, Brazil, 1-19 February 1993	English

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1. INTRODUCTION

The Global Sea Level Observing System (GLOSS) course was held at the Instituto Oceanográfico da Universidade de São Paulo from 1 to 19 February 1993.

The course was welcomed by the Intergovernmental Oceanographic Commission (IOC) at the Sixteenth Session of the IOC Assembly, Paris, France in 1991, but it had to wait until 1993 to become a reality, due to the lack of funds, which involved IOC, during the period. The Diretoria de Hidrografia e Navegação (DHN) of the Brazilian Navy, the GLOSS co-ordinators in Brazil, were firmly involved with the idea of the course and supported strongly all the actions necessary for it to be given at the Instituto Oceanográfico da Universidade de São Paulo (IOUSP).

The original idea was that the course should have to follow the steps of courses given at the Proudman Oceanographic Laboratory (POL), Bidston, UK, but it evolved to its present form, by considering the variety of cultural aspects and histories of the potential participants. The course was then directed to the Portuguese and Spanish speaking countries of South America and Africa and to only a few participants, the funds of IOC allowed for, and only to persons actively engaged with the GLOSS programme in their countries.

The countries of Argentina, Chile and Uruguay from South America and Angola, Moçambique and São Tomé and Principe from Africa were invited by IOC and sent participants to the course. The Brazilian Institutions Instituto Brasileiro de Geografia e Estatística (IBGE) and Universidade do Rio Grande (FURG), also involved with GLOSS, were invited by DHN and sent their representatives.

2. COURSE PROGRAMME

The course programme (Annex I) was prepared, with the valuable collaboration of Bidston scientists and the IOC personnel, in the years of 1991 and 1992, as well as, the assistance of the GLOSS people of the Diretoria de Hidrografia e Navegação, by Prof. Titular A.R. de Mesquita from the Instituto Oceanográfico da Universidade de São Paulo. The establishment of the contents of the course and the level of its lectures were largely based on the academic experience and the level of responsibility of the participants at their national institutions.

The programme was organized with the aim of establishing a common knowledge regarding the sea level collection, interpretation and uses, among the participants, by means of theoretical lectures, given by experienced scientists, and by working the basic ideas with the aid of microcomputers, through practical exercises with sea level data.

The practical exercises with microcomputers emphasized the use of the FORTRAN computer language. The participants were encouraged to develop their routines, adequate to their needs, to solve their problems with the work on tides and sea level.

The visit to the Base Norte Research Station of Ubatuba was planned to show, in front of an equipment in operation, the necessary cares and attentions with the choice of the site for the gauge installation, with the maintenance, with the operation of tide gauge for long term continuous observation, including tests of operation, leveling and the establishment of bench marks.

The seminars were planned to know and discuss the problems about sea level measurements of each participant. To allow the presentation of their national network of tide gauges, the tide gauges in use, the needs for development, as well as to give the participants an opportunity to change experiences in measuring the sea level.

2.1 OPENING CEREMONY

Monday morning - 1 February 1993 - 9h to 12h

The participants were welcomed in an "Overture ceremony" by the Director of the Instituto Oceanográfico da Universidade de São Paulo, Prof. Titular Luiz Roberto Tommasi, by Dr. David Pugh, Chairman of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), by Mrs. Maria Helena Severo de Souza, representing the Diretoria de Hidrografia e Navegação, the Brazilian GLOSS representatives and by Prof. Titular Afranio Rubens de Mesquita, Co-ordinator of the GLOSS course at the Instituto Oceanográfico da Universidade de São Paulo.

Professor Tommasi also made a brief description of the Institute's activities and distributed to the participants copies of the booklet (written in portuguese language) with the "Plano Diretor das Pesquisas do Instituto Oceanográfico da Universidade de São Paulo", said that the Institute is very much honored to host the Course for GLOSS and wished to all participants the best of success in their activities.

Dr. Pugh welcomed the participants to the Workshop on behalf of the Secretary and Chairman of the IOC. He said that GLOSS, which had formally started in 1985, was concerned with measurements, with scientific analysis and with the application of sea level data, but first it was necessary to have good data. This Workshop, following another similar one in Tokyo in November 1991, would include discussions about the measurement programmes in the countries of the participants. It was very important to hold this Workshop for Portuguese and Spanish speaking countries in South America. Those countries represented at the Workshop had the responsibility for more than 10% of the gauges included in the primary GLOSS network. In particular he thanked the Diretoria de Hidrografia e Navegação da Marinha do Brasil and the Instituto Oceanográfico da Universidade de São Paulo for their encouragement and for hosting the meeting.

Mrs. Severo de Souza welcomed the participants as the Brazilian Navy's Diretoria de Hidrografia e Navegação GLOSS representative. She expressed her satisfaction for the outcome of a process, which started in 1991, at various meetings of the IOC, where the course for Portuguese and Spanish GLOSS specialists were recognized as necessary and approved by IOC and that, due the shortage of funds, it was postponed. She reminded the name of Admiral Luis Felipe da Costa Fernandes, former Director of DHN, who encouraged all the actions with IOC, necessary for the course to be held at the University of São Paulo and wished all participants a rewarding course activity.

Prof. de Mesquita welcomed the participants and summarized the activities of the starting course, pointing out that the lectures were planned after a careful examination of the curricula vitae of the participants to insure a greater profitability of the subjects to be treated. He said this was possible thanks to the prompt reaction, to IOC invitations, of the governmental authorities of the countries of Angola, Argentina, Chile, Mozambique, São Tomé and Principe and Uruguay, who timely nominated their representation to the course. He also thanked the authorities of the Brazilian Institutions: Diretoria de Hidrografia e Navegação, Instituto Brasileiro de Geografia e Estatística and from Departamento de Fisica da Universidade do Rio Grande, for indicating their participants. He expressed his wishes that the course will start, among the participants, the kind of relationship, which make things to progress, through the establishment of organizational links, between the participants and between their National Institutions, links that will elect the activities of GLOSS as extremely important and that will remain active in the years to come. He informed that the Instituto de Estudos Avançados of the University of São Paulo (IEAUSP), along this line of thought, has put the Course for GLOSS among its events of the year, which is an auspicious fact, which will register the Course for GLOSS in the history of the University of São Paulo.

2.1.1 Inaugural Lecture - Sea Level: Change and Challenge. Dr. David Pugh

In the sequence of the programme the Inaugural Lecture of the course was given by

Dr. David Pugh with title "Mean Sea Level: Change and Challenge". He stressed the importance of the international initiatives towards the monitoring of the ocean such as the Global Ocean Observing System (GOOS) and the Global Sea Level Observing System (GLOSS), and recalled that the countries participating in the course are responsible, within the GLOSS for about 10% of the measurements from all sea level data of the GLOSS network. He mentioned the aspects related to the consequences of the predicted sea level increase as due to the "Greenhouse Effect" and the perspectives, which are open to the sea level observation related to new technologies, such as the Global Positioning System (GPS) and the Satellite Altimetry.

2.1.2 Visit to the Department of Physical Oceanography

Following the programme the participants were invited to visit the laboratories of the Department of Physical Oceanography. They were guided by the Head of the Department Prof. Titular Rolf Roland Weber.

After the visit there was a lunch at the Faculty Club with all participants of the course.

Monday afternoon - 1 February 1993 - 14h to 17h30

Free afternoon.

2.2 LECTURES

2.2.1 Oceanic Waves: Fundamentals. Prof. Titular Afranio R. de Mesquita

Tuesday morning - 2 February 1993 - 9h to 12h

The lecture dealt with the fundamentals of oceanic waves. It started with a broad view of wave oceanic phenomena going from capillary waves to the planetary waves, ending with the tidal wave, the longest wave of all. The period, amplitude, the wave length and the phase. Fundamentals of complex numbers. The formula of Euler and its representation in complex numbers. The complex amplitude of an harmonic function. The analytic forms of the progressive and the stationary waves. The characteristics of the capillary waves, the gravity waves, tsunamis, the inertial waves, and the internal waves were examined, stopping for a closer analysis, on results of the tidal wave numerical models, for the entire world of Hendershot, Zahel, Schwiderski and, from satellite altimetry measurements, on the charts of Cartwright and Ray, all of which will require good GLOSS data to be improved.

Tuesday afternoon - 2 February 1993 - 14h to 17h30

Practical: Introduction to microcomputers. A questionnaire was passed, to be filled by the participants, to access their knowledge of microcomputers. Knowledge of XT 8086, AT 80286, AT 80386 and AT 80486, IBM PC microcomputers and their uses in the course.

2.2.2 The Tidal Phenomenon: Basic Notions. Dr. A.S. Franco

Wednesday morning - 3 February 1993 - 9h to 12h

The phenomenon of tides was described. The formation of bulges. The declination effect. The semidiurnal inequality. Conjunctions of the Earth, Sun and Moon system. Definition of the orbital planes of Sun, Moon and the equatorial plane. Intersection of the orbital planes with the equatorial plane. Orbital periods. Characteristics of the oceanic tides. Amplitude and phase. Diurnal and semidiurnal tides. Non linear tides. Shelf water tides. Phase lag. Tide predictive machine. Numerical predictions.

Wednesday afternoon - 3 February 1993 - 14h to 17h30

Practical: Introduction to microcomputers. Uses of statistical packages. Make of simple algorithms for reading, calculating averages and writing results of sea level data. Uses of the IMSL/PC Library (International Mathematical Statistical Libraries) in calculating Fourier Transforms.

2.2.3 The Tide Generating Potential. Dr. D. Pugh

Thursday morning - 4 February 1993 - 9h to 12h

The lecture dealt with the gravitational potential, the tide generating potential. The development of the tide generating potential in series of polynomials of Legendre. The equilibrium tide. Analysis and prediction of tides based in the development of the tide generating potential. Uses of the tide generating potential in the Response Method. Spectrum of the equilibrium tide. Ratio of predicted amplitudes of tide and the observed tide. Phase lags of predicted and observed tides.

Thursday afternoon - 4 February 1993 - 14h to 17h30

Practical: Seminars of the participants - see section 3.

2.2.4 The Principal Tidal Levels. Dr. D. Pugh

Friday morning - 5 February 1993 - 9h to 12h

The mean sea level as a function of time. Secular changes. Global changes (eustatic). Vertical movements of Earth (epirogenetic). Ocean currents and the sea level. Variations of water density and the sea level. The atmospheric pressure and the sea level. Daily sea level. Monthly sea level. Mean tidal level and the influences of shallow water tides. Sea level space variability. Chart datum. The definition of the geoid. Satellite altimetry. Greenhouse effect and the sea level.

Friday afternoon - 5 February 1993 - 14h to 17h30

Practical: Seminars of the participants - see section 3.

2.2.5 Field Trip to the Base Norte Research Station I

Monday morning - 8 February 1993 - 9h to 13h

During the morning a bus trip took all participants to the research station, Base Norte, of the Instituto Oceanográfico da Universidade de São Paulo and it lasted from 9 to 13h. The course activities started at 15h with a guided visit to the tide gauge installations and to the site of the meteorological station of Base Norte.

Monday afternoon - 8 February 1993 - 15h to 19h

At 16h started a discussion group on the IOC publication - Manual de Medição e Interpretação do Nivel do Mar, guided by the MSc. Carlos Augusto de Sampaio França. There were discussions on different types of tide gauges, different types of sensors, tide records, archives of tidal data, transmission of data, site for a tide gauge installation, types of cares during the installation, leveling, tidal staff, leveling and operation of the tide gauges, tests of operation, calibration points.

2.2.6 Field Trip to the Base Norte Research Station II

Tuesday morning/afternoon - 9 February 1993 - 9h to 14h

Leveling exercises of the tide gauge relative to bench marks were made. The exercises were guided by the topographer Oswaldo Yoshioka and the use of the leveling equipment made

available by the University of São Paulo.

The group for discussion was guided by Dr. Eduardo Marone who examined the questions about reducing the sea level data from records. The errors caused by the tide gauge. Errors due to the recording device. Errors due to the archiving system. Errors due to the recording pen. Digitization errors. Errors due to the clock device. Errors due to the floating device. Errors due to the sediments in the well. Phenomenon of alliasing. Datum.

Tuesday afternoon - 9 February 1993 - 16h

Return trip to São Paulo city.

2.2.7 Fourier and Spectral Analyses: Fundamentals. Prof. Tit. Afranio R. de Mesquita

Wednesday morning - 10 February 1993 - 9h to 12h

The series of annual rainfall of the city of Fortaleza, State of Ceara, Brazil and its periodogramme; the series of annual sea level of the city of San Francisco, USA and its periodogramme were described and compared, as motivating examples. Periodicity analysis in the time domain. The Fourier integral. The Fourier transform. The inverse Fourier transform. Determination of the coefficients of the Fourier series. Calculus of the coefficients of Fourier at harmonic frequencies. Deterministic and random processes. Realizations of random processes. Stationary random processes. Mean and variance. Autocovariance and autocorrelation functions. Spectral density function. Relation between the autocorrelation function and spectral density function. Periodicity tests. Confidence intervals. Spectrum of sea level data of the city of Cananéia, State of São Paulo, Brazil; the interval of confidence accepted spectral peaks, also found in the periodogramme of rainfall of Fortaleza and the one of the sea level data of San Francisco, as an example of uses of the Fourier and Spectral Analyses.

Wednesday afternoon - 10 February 1993 - 14h to 17h30

Practical: Series generation by using the PC-MATLAB (Matrix Laboratory) package. Calculating Fourier transforms by MATLAB.

2.2.8 The GLOSS Programme of Global Observations: TOGA. Mr. Patrick Caldwell

Thursday morning - 11 February 1993 - 9h to 12h

The TOGA sea level stations. Sea level stations of the Indo-Pacific. Data flow to the TOGA data bank. Configuration of the sea level stations in the Indo-Pacific network. The encoder. The telemetry system. Solar cells. Data loggers and the Personal Computers. Float tide gauges. The tidal staff. Switches for calibration. Remote data transmission. Data reduction. Diagrammes for tide gauge calibration. The tidal spectra. Residual between real data and predicted tidal data. Checking data by correlation with nearby tidal stations.

Thursday afternoon - 11 February 1993 - 14h to 17h30

Practical: Presentation of the computer programmes of TOGA Sea Level Centre. Explanation of their uses. Application of the programmes to real sea level data.

2.2.9 TOGA Sea Level Centre - Data Quality Control. Mr. Patrick Caldwell

Friday morning - 12 February 1993 - 9h to 12h

The Foreman method of tidal analysis. Plotting the results. Analysis of the results. Prediction of tidal data. Calculation of the residual. Correction of the spikes. Correction of leveling errors. Correction of timing errors.

Friday afternoon - 12 February 1993 - 14h to 17h30

Practical: Presentation of the computer programmes of TOGA Sea Level Centre. Explanation of their uses. Application of the programmes to real sea level data.

2.2.10 The Harmonic Method of Tidal Analysis: Fundamentals. Dr. A.S. Franco

Monday morning - 15 February 1993 - 9h to 12h

Tidal analysis by the Harmonic Method. The Fast Fourier Transform (FFT) in tidal analysis. Tidal analysis in microcomputers. Refined tidal analysis. The harmonic test of Karunaratne. Filters in tidal analysis. The S242425 filter. The daily sea level. The monthly sea level. The annual sea level. Tidal constants. Prediction of tides.

Monday afternoon - 15 February 1993 - 14h to 17h30

Practical: Practical exercises with the Harmonic Method of tidal analysis. Tidal analysis of real data. Karunaratne test of errors in tidal series. Godin's filter S24S24S25 in real data.

2.2.11 Seminar/Workshop Discussion

Tuesday morning - 16 February 1993 - 9h to 12h

Seminar/Workshop Discussion - see section 3.

Tuesday afternoon - 16 February 1993 - 14h to 17h30

Practical: Elaboration of the "workshop" reports by the participants.

2.2.12 The Response Method of Tidal Analysis: Fundamentals. Dr. J.M. Vassie

Wednesday morning - 17 February 1993 - 9h to 12h

UK tide gauge network. Tides. Storm Surge. Numerical Model of the continental shelf. Bottom pressure gauge: MARK I, MARK IV. The Response Method of tidal analysis applied to short period data. Tidal potential as time series. Response of a physical system: admittance. Tidal potential expanded in spherical harmonics. Radiational tide. Nonlinear tides. Prediction through the Response Method.

Wednesday afternoon - 17 February 1993 - 14h to 17h30

Practical: Practical exercises of the Response Method. Demonstration of the computer Response Method programmes. Generation of the ephemeris of the Sun and the Moon (MONSUN). Generation of the tidal potential and response analysis (POTC). Response analysis between two nearby tidal stations (ARBT).

2.2.13 Extreme Sea Levels. Dr. J.M. Vassie

Thursday morning - 18 February 1993 - 9h to 12h

Coastal defence to Storm Surges. Off-shore oil rigs defence. Prediction of extreme sea levels. Traditional methods. Joint probability method. Application of models. Revised joint probability method. New approaches: spatial coherence.

Thursday afternoon - 18 February 1993 - 14h to 17h30

Practical: Exercises on prediction of extreme sea levels. Demonstration of programmes

for calculating extreme sea levels. Computer programmes for calculation of the joint probability.

2.2.14 Satellite Altimetry. Dr. J.M. Vassie

Friday morning - 19 February 1993 - 9h to 12h

Altimetric satellites: SEASAT, GEOSAT, ERS-1, TOPEX/POSEIDON. Orbits. Altitude sensors. The altimetric measurement: geocentric, co-ordinates, geoid, propagation corrections. Objectives: ocean circulation, ocean-atmosphere interactions, heat transport in the oceans, global oceanic tides, marine gravity field. Open sea measurements of the sea level. Comparison between altimetric and "*in situ*" sea levels.

Friday afternoon - 19 February 1993 - 14h to 16h

Practical: Presentation of altimetric data of the GEOSAT satellite.

2.3 PRACTICAL

All lectures were followed by computer practical exercises, guided by Dr. Eduardo Marone and Mr. Carlos A. de S. França.

3. SEMINARS OF THE PARTICIPANTS

3.1 Mrs. Monica M.E. Fiore - Argentina

The description of operational tide gauges of Argentina in a total of 10 permanent stations were given. The equipment presently in use at Argentina tidal stations is of the floating type, the pressure type of gauge (AANDERAA) and the Next Generation Water Level Measurement System (NGWLMS). Among them 5 stations are in the GLOSS network; 4 are operational and 1 in process of being installed in Antarctica.

3.2 Mr. Ernesto Agustin Forbes - Uruguay

The network of Uruguayan tide gauges is all of the floating type of gauges. Four stations are operational but only one is a GLOSS gauge. There is one more tide station planned for the Antarctica.

3.3 Cmd. Juan J. Fierro Contreras - Chile

The network of Chile has 16 permanent tidal stations, being 9 of them belonging also to the GLOSS network. The network operates float type of gauges, bubbles tide gauges and acoustic tide gauges. They are producing tidal data of good quality and long time series.

3.4 Mr. Jafar Ruby - Moçambique

Mozambique operates on tide gauges of the float type. There is one station which belongs to the GLOSS network that has problems with its site of installation. There are being installed presently, three permanent tidal stations, one of them belongs to the GLOSS network. Funding difficulties are presently delaying the activities.

3.5 Mr. Manuel Teixeira - São Tomé e Príncipe

In São Tomé e Príncipe there are no equipment for measuring tides installed. The unique tidal station, which is mentioned in the GLOSS publications, is no longer operational. Being at the equator, in the Atlantic, the island is of interest for studies on equatorial circulation. São Tomé e Príncipe needs international assistance for restarting sea level measurements.

3.6 Mr. Mauricio M. Mata - Brasil/FURG

The Fundação Universidade do Rio Grande is an institution in the southern coast of Brazil, which takes measurements of tides in the lagunar region of Lagoa dos Patos, in the State of Rio Grande do Sul. They measure tides with the objective of developing a circulation numerical model for that lagoon. They also have plans for installing and operate a tide gauge station in the coast of the Brazilian State of Rio Grande do Sul.

3.7 Mr. Roberto T. Luz, Miss Valéria M. Guimarães and Mr. Victor M. da Matta - Brasil/IBGE

The geodetic work in Brazil is made by the Instituto Brasileiro de Geografia e Estatística (IBGE). They are presently reexamining the chosen site of the city of Imbituba, BR, as the national reference datum. They are also installing a permanent tidal station in Rio de Janeiro in the beach of Copacabana. They are connecting all the Brazilian GLOSS stations to a common datum.

3.8 Ltn. Ana C. da Paula and MSc. Geraldo N. da Silva - Brasil/DHN

The Diretoria de Hidrografia e Navegação of the Brazilian Navy is the Brazilian co-ordinator for GLOSS. They operate 24 tidal stations, 9 of them belonging to the GLOSS network. They use mostly the float type of tide gauge and pressure tide gauges. The DHN is also the National Data Bank of oceanographic data.

3.9 Mr. Kivuna Nkiamby - Angola

There are no tide gauges in operation in Angola. The tide stations mentioned in the GLOSS publications were inactive. There is a project for equipment acquisition and the installation of permanent tidal stations. There is, however, the need for international financial assistance for the job.

4. SEMINARS/WORKSHOP DISCUSSION

Discussions. during the seminars indicated that the African participants are in the need of help from IOC through its appropriate channels and from the GLOSS programme in order to install tide gauges and actively produce sea level data of good quality.

The programmes of data collection of countries such as Argentina and Chile were the most advanced ones relative to the other participants and were considered as good examples, where the international collaboration of sea level programmes as the TOGA and the NOAA, both from USA, is fruitful.

As suggested by Dr. Pugh the participants accepted the idea of organizing the contents of the presentation given by the participants, as the results of a Workshop and to consult IOC about publishing it.

Also suggested by Dr. Pugh, it was accepted the idea of having a newsletter to keep the GLOSS Spanish and Portuguese communities informed about the improvements with the GLOSS tide gauges network and results of data analyses. The participants agreed that it should have biannual issues and that its editorial board should be initially constituted by Prof. de Mesquita, Dr. Marone and Mr. França, who would care for the three languages. It will accept articles for publication: Portuguese, Spanish and English. After two years a new board of editors will be elected. The name of the newsletter most accepted was: "Afro-America GLOSS Newsletter" with underwritings in the three languages saying: of the Portuguese and Spanish speaking communities.

5. RECOMMENDATIONS

The participants from their experiences and after having followed the GLOSS course, decided to raise a set of items, which form the recommendations below:

Considering: that the Course for GLOSS has formed a group of specialists devoted to the data collecting activities and in order to further these actions, it is necessary to organize periodical meetings of the GLOSS Portuguese and Spanish speaking community;

that the Chilean GLOSS stations do not cover adequately the great variety of tides along the coast of Chile, it is necessary to make the stations of GLOSS more close to each other geographically;

that one of the GLOSS stations of the Mozambiquean coast is not in an adequate site for operation and that there is the need for a better distribution of the positions of the tide stations, which are now being planned for installation, it is necessary the reallocation of the GLOSS sea level stations in Mozambique;

that São Tomé e Príncipe has a complete lack of known tide gauges installed, it is necessary to assure the means, at IOC level, in order to promote an adequate aid, aiming at recovering all the existing previous information on tides and tide gauges of ST&P and provide the required means for installation of permanent gauges in the islands;

that Angola has a complete lack of known tide gauges installed, it is necessary to assure the means, at IOC level, in order to promote an adequate aid, aiming at recovering all the existing previous information on tides and tide gauges in Angola and provide the required means for installation of permanent gauges along the Angolan coast;

that the "Manual de Medição e Interpretação do Nivel do Mar" is a valuable document for the GLOSS specialists and in order to make it continually useful, it is necessary its revision so that to include, for example, the description and uses of the modern tide gauges, which are now available;

that planimetry and altimetry are a basic knowledge, in order to make the reference of the GLOSS sea level heights to the land, it is necessary the inter-linking of all national altimetric and planimetric networks of each continent;

that communication is an important item to assure the unity of the present group of specialists, it is necessary that the facilities of electronic mail to be made to the reach of all GLOSS participants;

that the example of the sea level data bank of TOGA at Hawaii is a great success, it is desirable that Regional Sea Level Data Banks to be created, so that to allow that regional sea level data to be looked after, in an easier way, with much greater facility for data exchange;

that the activities now proposed will require the continuous endogenous knowledge of the people regionally involved, active in data collection and research, it is necessary the organization of an update File containing their names and addresses, etc.;

that information about gauges and results of data analysis are relevant items to be circulated among the GLOSS Spanish and Portuguese participants, it is necessary the constitution and publication of a "newsletter";

that information given by the participants during the seminars of this course are original and relevant material to the GLOSS programme, it is necessary that the contents of the seminars should be published as a "workshop" results.

ANNEX I

COURSE PROGRAMME

IOC Training Course for the Global Sea Level Observing System (GLOSS) directed to the African and American Portuguese and Spanish Speaking Countries, Sao Paulo, Brazil, 1-19 February 1993

PROGRAMME AND TIMETABLE

Course on "Observation and Analysis of Sea Level Data"

1st Week

MORNING (9h-12h)	AFTERNOON (14h-17h)
Monday 1 February 1993	
Opening Lecture (9h-10h30) Sea Level: Change and Challenge Dr. D.T. Pugh	Lunch: Faculty Club (US $5)
visit the IOUSP (11h-17h)	Free afternoon
Tuesday 2 February 1993	
Oceanic Waves: Fundamentals Prof. Tit. A.R. de Mesquita	Introduction to microcomputers Use of statistical packages
Wednesday 3 February 1993	
Tide Generating Potential Dr. D.T. Pugh	Seminars of the participants
Friday 5 February 1993	
The Principal Tidal Levels Dr. D.T. Pugh	Seminars of the participants

2nd Week

Monday 8 February 1993	
Visiting the North Tidal Station of IOUSP: bus trip to the town of UBATURA	Tide gauge demonstration and other installations, practical exercises, etc.
Tuesday 9 February 1993	
Complementary Tidal Measurements	General discussion on GLOSS Return trip to Sao Paulo city

MORNING (9h-12h)	AFTERNOON (14h-17h)
Wednesday 10 February 1993	
Fourier and Spectral Analysis: Fundamentals Prof. A.R. de Mesquita	Statistical Computer Software Package
Thursday 11 February 1993	
The GLOSS Programme of Global Observations: TOGA Mr. Patrick Caldwell	TOGA Sea Level Centre Software
Friday 12 February 1993	
TOGA Sea Level Centre - Data Quality Control Mr. Patrick Caldwell	TOGA Sea Level Centre Software
3rd Week	
Monday 15 February 1993	
The Harmonic Method of Tidal Analysis: Fundamentals Dr. A.S. Franco	Computer Practice
Tuesday 16 February 1993	
Seminar/Workshop Discussion	Computer Practice
Wednesday 17 February 1993	
The Response Method of Tidal Analysis: Fundamentals Dr. J.M. Vassie	Response Method Computer Demonstration
Thursday 18 February 1993	
Extreme Sea Levels Dr. J.M. Vassie	Extreme Sea Levels Demonstration
Friday 19 February 1993	
Satellite Altimetry Dr. J.M. Vassie	Closure

The afternoon practicals were guided by Dr. E. Marone and Mr. Carlos A. de S. França.

ANNEX II

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ANNEX III

LIST OF COURSE MATERIALS AND INFORMATION DOCUMENTS

The following documents were distributed by the lecturers, listed below, to the participants, as handouts of lecture notes, manuals, scientific paper etc., during the course of the Global Sea Level Observing System (GLOSS), held at the Instituto Oceanográfico da Universidade de São Paulo, Brazil, from 1 to 19 February 1993.

1. Dr. David Pugh

Lectures Notes: 1. Tidal analysis and prediction. 2. Tidal dynamics. 3. Shallow water dynamics. 4. Mean sea level. IOS Deacon Laboratory. UK.

Manuals: Manual de medição e interpretação do nível do mar. 1985. UNESCO-Comissão Oceanográfica Intergovernamental. Série Manuais e Guias. (14): 1-82.

Scientific papers: Sea Level: Change and Challenge. 1990. Nature and Resources, 26(4): 36-46.

Leaflets: GLOSS Station Handbook. Intergovernmental Oceanographic Commission. Proudman Oceanographic Laboratory. UK.

Global Sea Level Observing System (GLOSS). Intergovernmental Oceanographic Commission - UNESCO. Paris, France.

Global Ocean Observing System (GOOS). Intergovernmental Oceanographic Commission - UNESCO. Paris, France.

2. MSc. Carlos A. de S. França

Lecture Notes: Practical exercises. 1. Introdução aos microcomputadores. 2. Introdução a pacotes estatísticos. 3. Introdução a medidas altimétricas de satélite. Instituto Oceanográfico da Universidade de São Paulo.

3. Dr. E. Marone

Lecture Notes: Practical exercises. 1. Questionário para avaliação do conhecimento dos participantes no uso de microcomputadores. 2. Exercícios de microcomputador utilizando o programa PC-MATLAB. Laboratório de Física Marinha. Centro de Estudos do Mar, UFPR.

4. Dr. A.S. Franco

Lecture Notes: 1. Apuntes curso de Mareas 1991 - ITBA. 2. Variações do nível do mar.

Manuals: Marés: Programas par previsão e análise.

Scientific papers: Comparative accuracy of Fourier tidal analysis employing different time spans with reference to a Doodson analysis. 1972, The Second International Ocean Development Conference, Keidanren Kaikan, Tokyo. 189-210.

5. Prof. Dr. A.R. de Mesquita

Lecture Notes: 1. Ondas Oceânicas: Fundamentos. 2. Análise de Fourier e Espectral: Fundamentos. Instituto Oceanográfico da Universidade de São Paulo.

Scientific papers: Circulation and evidences of shelf break upwelling, Brazil near Lat. 26°07S; Long. 47°39W. 1989. Relat. Cruzeiros, ser. "N/Oc. Prof. W. Besnard". Instituto Oceanográfico da Universidade de São Paulo. (8): 1-27.

Tabuas das Mares de Ubatuba e Cananéia para os anos de 1992 e 1993. 1991. Relat. int. Instituto Oceanográfico da Universidade de São Paulo. (31): 1-20.

Dados Climatológicos de Cananéia e Ubatuba (Estado de São Paulo). Bolm climatol. Instituto Oceanográfico, São Paulo, (6): 1-21.

Leaflets: Centro de Calibração Oceanográfica (L.V. Nonato). Instituto Oceanográfico da Universidade de São Paulo.

6. Mr. Patrick Caldwell

Leaflets: Tropical Ocean Atmospheric Programme (TOGA). The International TOGA Project Office. World Meteorological Organization. Geneva, Switzerland.

Topex/Poseidon, A United States/France Mission. Lecture Notes: Processamento e Controle de Qualidade de Dados do Nivel do Mar pelo "TOGA Sea Level Centre". Joint Archives for the Sea Level of the National Oceanographic Data Centre. University of Hawaii, Honolulu, Hawaii, USA.

Scientific papers: In the pursuit of high-quality sea level data. 1991. IEEE Ocean Proceedings. 2: 669-675. University of Hawaii, Honolulu, Hawaii, USA.

Building an archive of tropical sea level data. 1992. Earth System Monitor. 3(2): 4-6. NOAA OA124. Seattle, WA, USA.

TOGA Sea Level Centre: Data from the Atlantic Ocean. 1992. Joint Institute for Marine and Atmospheric Research. University of Hawaii. Data report (10): 1-28. University of Hawaii, Honolulu, Hawaii, USA.

7. Dr. J.M. Vassie

Lecture Notes: 1. The Response Method of Tidal Analysis. 2. Estimation of Extreme Sea Levels. Proudman Oceanographic Laboratory. UK.

Scientific papers: Recent improvements in the joint probability method for estimating extreme sea levels (with Tawn), 1991. In: Parker, B.B., ed. Tidal Hydrodynamics. New York, John Willey. p. 813-828.

U.K. altimeter studies of temporal variations in the sea surface topography: past, present and future. (P. Woodworth). 1991. Int. J. Remote Sensing, 12(8): 1639-1647.

Observations of the Mf Ocean tide from GEOSAT altimetry. (Cartwright and Ray). 1990. Geophys. res. Letters, 17(5): 619-622.

ANNEX IV

COURSE CERTIFICATE

UNIVERSIDADE DE SÃO PAULO
INSTITUTO OCEANOGRÁFICO

COMISSÃO OCEANOGRÁFICA
INTERGOVERNAMENTAL

PROGRAMA GLOSS

Certificamos que o *Lic. Marco Antonio Corrêia* colaborou, como monitor no *"Curso de Observação e Análise do Nível do Mar do GLOSS"*, ministrado neste Instituto no período de 1 de fevereiro a 20 de fevereiro de 1993, sob responsabilidade do Prof. Dr. Afranio Rubens de Mesquita do Departamento de Oceanografia Física, com um total de 180 horas/aula.

Instituto Oceanográfico da Universidade de São Paulo, aos 20 de fevereiro de 1993.

Prof. Dr. Afranio Rubens de Mesquita
Professor Responsável

Prof. Dr. Luiz Roberto Tommasi
Diretor

ANNEX V

LIST OF ACRONYMS

DHN	Diretoria de Hidrografia e Navegação
ERS-1	European Remote Satellite No. 1
FFT	Fast Fourier Transform
FURG	Fundação Universidade do Rio Grande
GEOSAT	Geodetic Satellite
GLOSS	Global Sea Level Observing System
GOOS	Global Ocean Observing System
GPS	Global Positioning System
IBGE	Instituto Brasileiro de Geografia e Estatística
IEAUSP	Instituto de Estudos Avançados da Universidade de São Paulo
IIP	Instituto de Investigação Pesqueira
IMSL	International Mathematical and Statistical Libraries
INAHINA	Instituto Nacional de Hidrografia e Navegação
IOC	Intergovernmental Oceanographic Commission
IOS	Institute of Oceanographic Sciences
IOUSP	Instituto Oceanográfico da Universidade de São Paulo
NGWLMS	Next Generation Water Level Measurement System
NOAA	National Oceanic and Atmospheric Administration
PC-MATLAB	Personal Computer Matrix Laboratory
POL	Proudman Oceanographic Laboratory
PSMSL	Permanent Service for Mean Sea Level
SEASAT	Sea Satellite
SHN	Servicio de Hidrografia Naval
SHOA	Servicio Hidrográfico y Oceanográfico de la Armada
SOHMA	Servicio de Oceanografia, Hidrografia y Meteorologia de la Armada
ST&P	São Tomé e Principe
TOGA	Tropical Ocean and Global Atmosphere
TSLC	TOGA Sea Level Centre
UFPR	Universidade Federal do Paraná
UH	University of Hawaii
UNESCO	United Nations Educational, Scientific and Cultural Organization
UK	United Kingdom
USA	United States of America
USP	Universidade de São Paulo
VLBI	Very Long Baseline Interferometry