

JACQUES C. J. NIHOUL
(EDITOR)



Modelling of Marine Systems



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Edited by

JACQUES C.J. NIHOUL

*Mathematical Institute
University of Liège
Liège, Belgium*



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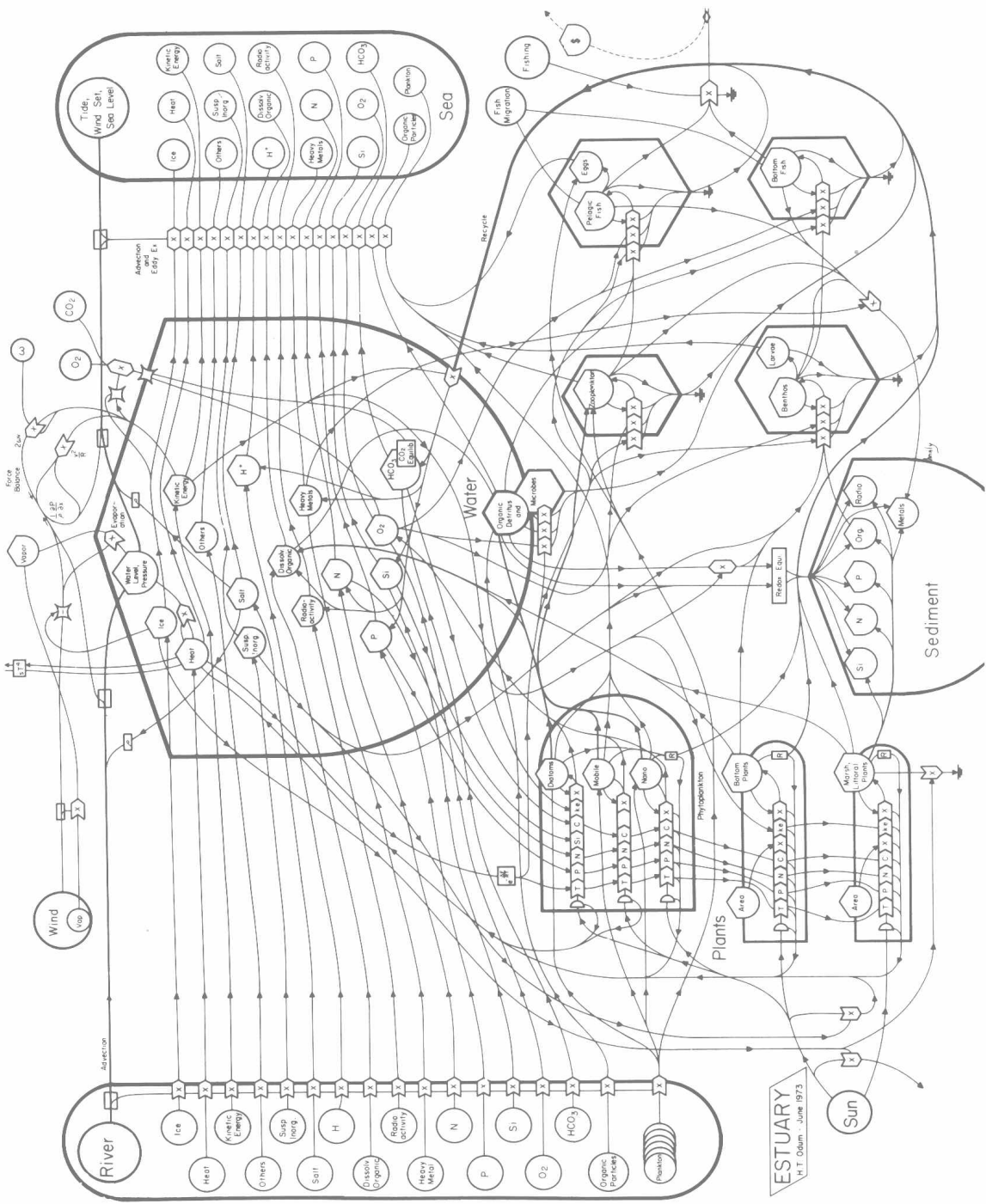
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Model for an estuarine system translated into energy circuit language.

PREFACE

The present book emerged from the Conference on Modelling of Marine Systems held in Ofir (Portugal) in June 1973. The conference was organized under the auspices of the NATO Science Committee as part of its continuing effort to promote the useful progress of science through international cooperation.

The Science Committee Conferences are deliberately designed and structured to focus expert attention on what is not known, rather than what is known. The participants are carefully selected to bring together a variety of complementary viewpoints. Through intensive group discussion, they seek to reach agreement on conclusions and recommendations for future research which will be of value to the scientific community.

The attractiveness of this format was confirmed in the present case. Some twenty-eight papers, often specially written reviews, were contributed by the participants for advance circulation, to outline the state-of-the-art in the areas of physical, chemical and biological modelling, and to focus attention on key problems. The availability of this background material precluded the need for lengthy introductory presentations and permitted rapid initiation of interdisciplinary discussions. All participants gave generously and enthusiastically of their expertise and effort during the week of the meeting, and we extend to them our deep gratitude.

We are pleased to have this opportunity to record our special thanks to Prof. Jacques C.J. Nihoul for his diligent efforts as Chairman of the meeting, to his colleagues on the Organizing Committee — Prof. I. Elskens, Prof. D. Garfinkel, Prof. E.D. Goldberg, Dr. R.F. Henry, Prof. J. Pinto Peixoto, Dr. J.H. Steele, Prof. J.W. Stewart — for their wise guidance, and to the leaders and rapporteurs of the Working Groups, as listed, for their indispensable dedication.

We also wish to record our appreciation to the U.S. Office of Naval Research, whose provision of travel support contributed significantly to the success of the meeting.

EUGENE G. KOVACH

Deputy Assistant Secretary General
for Scientific Affairs

FOREWORD

Mathematical models of marine systems have been extensively developed in the recent years. These models were either research models, aiming at a better understanding of the systems' dynamics, or management models designed to assist the administration of water resources and the fight against pollution. At first, the models concentrated on physical, chemical or biological processes according to their particular concerns. Then, the increased threat on the environment requiring a more thorough understanding of ecosystems, the models were extended, in an effort to overlap the frontiers between the disciplines and include imperatives from other fields. Exhaustive multidisciplinary models were conceived which were sometimes praised sometimes criticized for their ambition.

The prodigious development of numerical techniques and computing facilities, recently, supported the idea that such ambitious models were not unrealistic and could provide a convenient framework for the rational assemblage of the so far dispersed partial models.

The time had come for scientists of different fields or different concerns to compare their different approaches to modelling and set up a common language, promoting interdisciplinary research and combined action.

Although rapid progress in modelling of marine systems was evident, it was also obvious that significant developments within any speciality had not always been recognized for their pertinence to the others. The separate evolutions of the different types of models had furthermore concealed many problems which were progressively exposed as the more exhaustive interdisciplinary models stumbled over them.

The desirability of bringing together specialists from all fields of marine modelling became apparent to many within the scientific community. The members of the Organizing Committee were all fully aware of this necessity and they proposed therefore to hold a conference with the intention of assembling a group of active scientists from different countries, to foster a mutually beneficial exchange of information. Such communication, attempting to assort different points of view, was expected to disclose interdisciplinary problems and interdisciplinary solutions unperceived so far and to identify simultaneously subjects for further research and new paths to further achievement.

To enhance the degree of interaction — after an indispensable plenary introduction to acquaint all participants with the semantics and present status of research within the different fields — small working groups were formed to discuss specialized topics chosen for their ability to provoke a maximum overlap between the different approaches. To prepare and nourish the discussions, all participants were asked to submit in advance a paper (original contribution, review or recently published work) and the selected papers assembled in a pre-Conference volume were made available to everyone before the Conference.

After the Conference, it was recommended that a book be written.

The intention of this book is not the publication of the Conference's proceedings or the reproduction of the informal pre-Conference volume, many papers of which were in the process of being published in specialized journals or were in a preliminary form suitable only to workshop's discussion. The purpose of the book is, beside the diffusion of the conclusions and recommendations of the working group, — providing guide-lines for further theoretical, experimental and applied work —, the survey, through specially commissioned papers, of the state-of-the-art in interdisciplinary modelling of marine systems. The invited papers contributing to this survey are based on the most recent publications and in particular on the content of the pre-Conference volume which had stimulated the discussions. Due reference to the participants' work is given in the text and a detailed list of addresses is included to enable the reader to get directly in touch with any specialist he may wish to consult.

The group reports and the commissioned papers have tried to be accessible to readers of all backgrounds and all disciplines in marine modelling. The intention was more to inform as accurately and clearly as possible specialists of other fields of important developments in one's own domain than to provide fellow scientists with advanced reviews. If mathematical equations have been mentioned in Part I for the sake of assorting the notations between specialists, they are, in most cases, not essential to the general philosophy of the text, which means to be understood without going into the details of them.

The purpose of the present book is thus to assemble the elements of a first manual on modelling of marine systems.

Such a manual could only emerge with the right degree of simplicity and sophistication from such an enthusiastic mixing of active scientists from related but not identical disciplines and concerns.

It is a pleasure, as the Chairman of the Organizing Scientific Committee, to thank all the persons who made that meeting possible; to the Nato Scientific Committee for its generous support, to Dr. Kovach and Miss Austin for their gentle efficiency, to Prof. Peixoto, Prof. Juerra and Dr. Meira for their noteworthy hospitality, to the members of the Organizing Committee for

their dedicated work in preparing and animating the Conference, to all participants finally for their valuable and enthusiastic contributions.

JACQUES C.J. NIHOUL

Chairman of the
Organizing Scientific Committee
December 1973

LIST OF PARTICIPANTS

Mr. Y.A. ADAM
Institut de Mathématique
Université de Liège
Av. des Tilleuls 15
4000 Liège (Belgium)

Dr. N.R. ANDERSEN
Ocean Science and Technology Division
(Code 480)
Office of Naval Research
800 N. Quincy Street
Arlington, Va. 22217 (U.S.A.)

Mr. W. BAYENS
Analytische Scheikunde
Vrije Universiteit Brussel
A. Buyllaan 105
1050 Brussels (Belgium)

Dr. M. BERNHARD
Laboratorio per lo Studio della
Contaminazione Radioattiva del Mare
C.N.E.N. — EURATOM
I-19030 Fiascherino
La Spezia (Italy)

Dr. SANDRA L. BUCKINGHAM
Institute of Resource Ecology
University of British Columbia
Vancouver 8, B.C. (Canada)

Dr. J.D. BURTON
Department of Oceanography
The University
Southampton, SO9 5NH (Great Britain)

Dr. D.H. CUSHING
Fisheries Laboratory
Ministry of Agriculture, Fisheries and Food
Lowestoft, Suffolk (Great Britain)

Prof. Dr. L. DE CONINCK
Rijksuniversiteit Gent
Ledeganckstraat 35
9000 Ghent (Belgium)

Prof. Dr. A. DISTÈCHE
Institut E. Van Beneden
Section: Océanologie
Université de Liège
Quai Van Beneden 22
4000 Liège (Belgium)

Dr. D.M. DI TORO
Environmental Engineering Program
Manhattan College
Bronx, N.Y. 10471 (U.S.A.)

Dr. J. DUGAN
Code 8301
Ocean Sciences Division
Naval Research Laboratory
Washington, D.C. 2P375 (U.S.A.)

Prof. Dr. R. DUGDALE
Dept. of Oceanography
University of Washington
Seattle, Wash. 98105 (U.S.A.)

Prof. Dr. I. ELSKENS
Analytische Scheikunde
Vrije Universiteit Brussel
A. Buyllaan 105
1050 Brussels (Belgium)

Dr. E.J. FEE
Freshwater Institute
501 University Crescent
Winnipeg, Man. (Canada)

Dr. H.G. GADE
Geophysics Institute
University of Bergen
Allegat 70
5000 Bergen (Norway)

Prof. Dr. D. GARFINKEL
Moore School of Electrical Engineering
University of Pennsylvania
Philadelphia, Pa. 19174 (U.S.A.)

Prof. Dr. E.D. GOLDBERG
Scripps Institution of Oceanography
La Jolla, Calif. 92037 (U.S.A.)

Dr. N.S. HEAPS
Institute of Coastal Oceanography and
Tides
Bidston Observatory
Birkenhead, Cheshire L43 7RA
(Great Britain)

Dr. R.F. HENRY
Department of the Environment
Pacific Region
Marine Sciences Directorate
512 Federal Building
Victoria, B.C. (Canada)

Dr. T.S. HOPKINS
Institute of Oceanographic and Fishing
Research (IOKAE)
Aghios Kosmas
Ellinikon (Greece)

Dr. J.L. HYACINTHE
C.N.E.X.O.
2^eN Plouzane
B.P. 337
Brest (France)

Dr. B-O. JANSSON
Asko Laboratory
c/o Department of Zoology
University of Stockholm
P.O. Box 6801
11386 Stockholm (Sweden)

Dr. B.H. KETCHUM
Associate Director
Woods Hole Oceanographic Institution
Woods Hole, Mass. 02543 (U.S.A.)

Prof. Dr. W. KRAUSS
Institut für Meereskunde an der
Universität Kiel
Düsternbrooker Weg 20
23 Kiel (Germany)

Dr. P. LEBLOND
Institute of Oceanology
University of British Columbia
Vancouver 8, B.C. (Canada)

Dr. J.J. LEENDERTSE
RAND Corporation
1700 Main Street
Santa Monica, Calif. 90406 (U.S.A.)

Dr. P.S. LISS
School of Environmental Sciences
University of East Anglia
Norwich, NOR 88C (Great Britain)

Dr. I.N. McCAVE
School of Environmental Sciences
University of East Anglia
Norwich, NOR 88C (Great Britain)

Dr. J.C. MACKINNON
Department of Biology
Dalhousie University
Halifax, N.S. (Canada)

Dr. K.H. MANN
Department of Biology
Dalhousie University
Halifax, N.S. (Canada)

Prof. Dr. R. MARGALEF
Instituto de Investigaciones Pesqueras
Paseo Nacional s/n
Barcelona 3 (Spain)

Dr. D.W. MENZEL
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, Ga. 31406 (U.S.A.)

Mr. J-P. MOMMAERTS
Dienst Ekologie en Systematiek
Vrije Universiteit Brussel
A. Buyllaan 105
1050 Brussels (Belgium)

Prof. Dr. C. MORELLI
Presidente
Osservatorio Sperimentale di Geofisica
34123 Trieste (Italy)

Dr. C.H. MORTIMER
Center for Great Lakes Studies
University of Wisconsin—Milwaukee
Milwaukee, Wisc. 53201 (U.S.A.)

Dr. K. MOUNTFORD
Benedict Estuarine Laboratory
Academy of Natural Sciences of
Philadelphia
Benedict, Md. 20612 (U.S.A.)

Dr. T.S. MURTY
Marine Sciences Directorate
615 Booth Street
Ottawa, Ont. (Canada)

Prof. Dr. J.C.J. NIHOUL, Chairman
Belgian National Program on the
Environment
Ministry for Science Policy, Belgium
Institut de Mathématique
Université de Liège
Av. des Tilleuls 15
4000 Liège (Belgium)

Prof. Dr. J.J. O'BRIEN
Department of Meteorology
Florida State University
Tallahassee, Fla. 32306 (U.S.A.)

Prof. Dr. H.T. ODUM
Department of Environmental Engineering
University of Florida
Gainesville, Fla. 32601 (U.S.A.)

Mr. J.P. O'KANE
Department of Civil Engineering
University College
Upper Merrion Street
Dublin 2 (Ireland)

Dr. R.T. PAINE
Department of Zoology
University of Washington
Seattle, Wash. 98105 (U.S.A.)

Prof. Dr. T.R. PARSONS
Institute of Oceanography
University of British Columbia
Vancouver, B.C. (Canada)

Mr. G. PICHOT
Institut de Mathématique
Université de Liège
Av. des Tilleuls 15
4000 Liège (Belgium)

Prof. Dr. J. PINTO PEIXOTO
Institute of Geophysics
University of Lisbon
Lisbon (Portugal)

Dr. A. PIRO
Laboratorio per lo Studio della
Contaminazione Radioattiva del Mare
C.N.E.N. — EURATOM
I-19030 Fiascherino
La Spezia (Italy)

Dr. T. PLATT
Marine Ecology Laboratory
Bedford Institute of Oceanography
Dartmouth, N.S. (Canada)

Prof. Dr. Ph. POLK
Fakulteit der Wetenschappen
Dienst Ekologie en Systematiek
Vrije Universiteit Brussel
A. Buyllaan 105
1050 Brussels (Belgium)

Dr. H. POSTMA
Netherlands Institute for Sea Research
Postbus 59
Horntje, Texel (The Netherlands)

Dr. G. RADACH
Sonderforschungsbereich 94
Meeresforschung Hamburg
Universität Hamburg
Heimhuderstrasse 71
2 Hamburg 13 (Germany)

Dr. E.D. SCHNEIDER
National Marine Water Quality Laboratory
U.S. Environmental Protection Agency
P.O. Box 277
West Kingston, R.I. 02892 (U.S.A.)

Dr. J.H. STEELE
Marine Laboratory
Department of Agriculture and Fisheries
for Scotland
P.O. Box 101
Aberdeen, AB9 8DB (Great Britain)

Prof. Dr. R.W. STEWART
Marine Sciences Branch
Pacific Region
Department of the Environment
1230 Government Street
Victoria, B.C. (Canada)

Dr. R.E. ULANOWICZ
University of Maryland
Natural Resources Institute
Chesapeake Biological Laboratory
Box 36
Solomons, Md. 20688 (U.S.A.)

Dr. J.J. WALSH
Department of Oceanography
University of Washington
Seattle, Wash. 98195 (U.S.A.)

Dr. C.J. WALTERS
Institute of Resource Ecology
University of British Columbia
Vancouver 8, B.C. (Canada)

Prof. Dr. R. WOLLAST
Laboratoire de Chimie Industrielle
Université Libre de Bruxelles
Avenue F.D. Roosevelt 50
1050 Brussels (Belgium)

Dr. B. ZEITZSCHEL
Institut für Meereskunde an der
Universität Kiel
Düsternbrooker Weg 20
23 Kiel (Germany)

Observers

Cdt. M. RENSON
Services du Premier Ministre
Commission Interministérielle de la
Politique Scientifique
Environnement
Rue de la Science 8
1040 Brussels (Belgium)

Dr. W. ZAHLE
Institut für Meereskunde
Heimhuderstrasse 71
2 Hamburg 13 (Germany)

Dr. VICTOR TAVARES
Serviço Meteorológico Nacional
Rua Saraiva Carvalho No. 2
Lisbon (Portugal)

Dr. ARTUR PIRES
Serviço Meteorológico Nacional
Rua Saraiva Carvalho No. 2
Lisbon (Portugal)

Dra. ISABEL AMBAR
Instituto Geofísico do Infante D. Luís
Faculdade de Ciências de Lisboa
Rua da Escola Politécnica
Lisbon (Portugal)

Dr. ARMANDO FIUZA
Instituto Geofísico do Infante D. Luís
Faculdade de Ciências de Lisboa
Rua da Escola Politécnica
Lisbon (Portugal)

Dr. DANIEL RODRIGUES
Instituto Hidrográfico
Ministério da Marinha
Rua das Trinas
Lisbon (Portugal)

Cte. JOSÉ MANUEL SALDANHA
Instituto Hidrográfico
Ministério da Marinha
Rua das Trinas
Lisbon (Portugal)

Prof. Dr. MARIA HELENA GALHANO
Instituto de Zoologia Dr. Augusto Nobre
Faculdade de Ciências do Porto
Porto (Portugal)

Dr. LUIS SALDANHA
Museu Bocage — Faculdade de Ciências
Rua da Escola Politécnica
Lisbon (Portugal)

Dr. JOAQUIM AGUAS
Departamento de Higiene
Escola Superior de Medicina Veterinária
Rua de Gomes Freire
Lisbon (Portugal)

Prof. Dr. ARNALDO ROZEIRA
Faculdade de Ciências do Porto
Porto (Portugal)

Prof. Dr. JORGE VEIGA
Laboratório de Química
Universidade de Lourenço-Marques
Lourenço-Marques (Moçambique)

Dr. CARLOS PISSARRO
Centro de Biologia Aquática Tropical
Junta de Investigações do Ultramar
Rua Dr. António Cândido, 9
Lisbon (Portugal)

NATO

Dr. E.G. KOVACH
Deputy Assistant Secretary
General for Scientific Affairs,
NATO
1110 Brussels (Belgium)

Miss E.I. AUSTIN
Scientific Affairs Division
NATO
1110 Brussels (Belgium)

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PART I

CONCEPTS AND TECHNIQUES OF MARINE MODELLING