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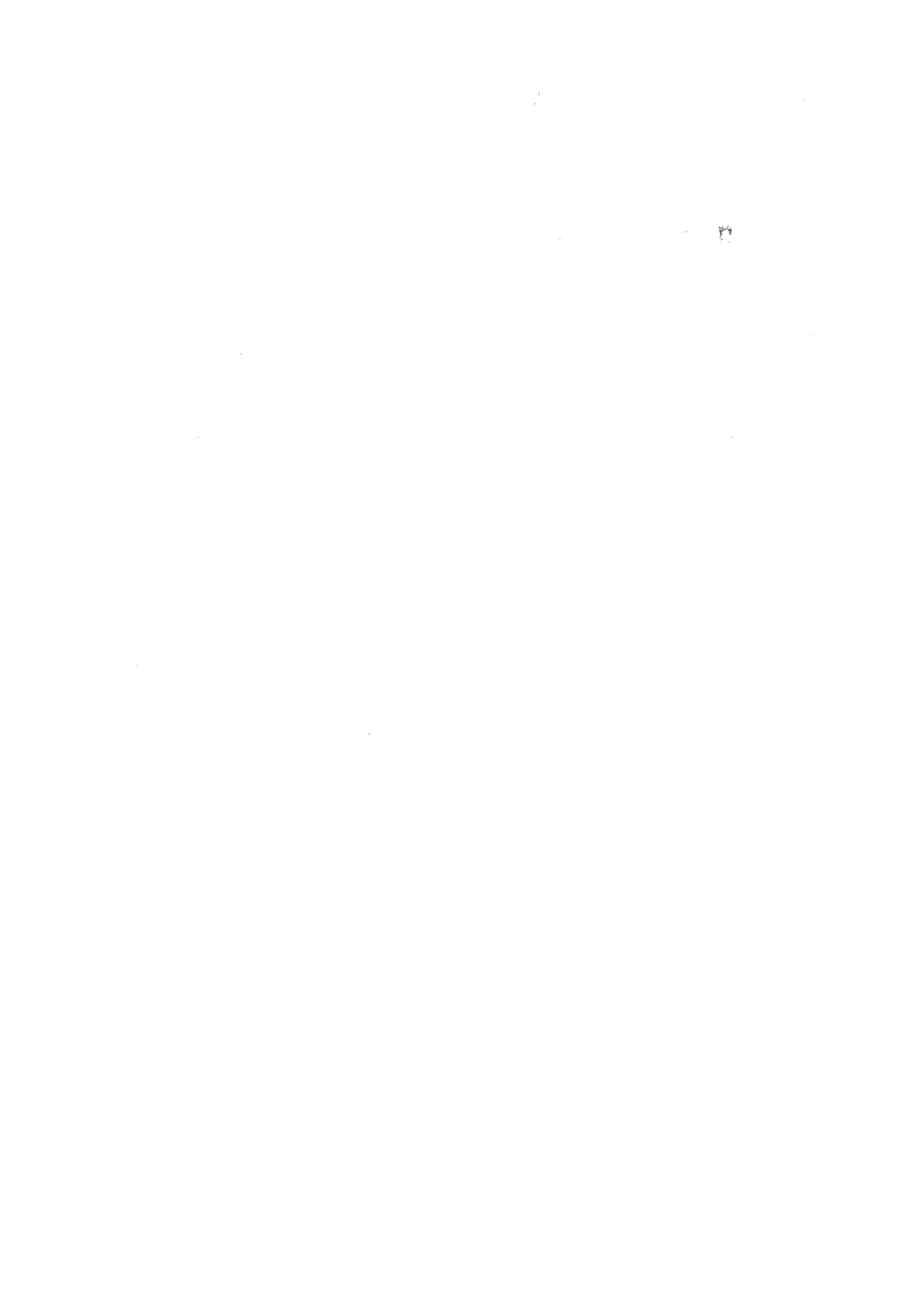
Volume 25, 1990

**IGBP Workshop 13
on**

**MATHEMATICAL AND STATISTICAL
MODELLING OF
GLOBAL CHANGE PROCESSES**

(Canberra, 23-27 April, 1990)

Edited by
Geoffrey Arthur Latham and John Ashley Taylor



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FOREWORD

In response to a request from the National Committee for the IGBP, the National Committee for Mathematics agreed to organize a Workshop on "Mathematical and Statistical Modelling of Global Change Processes". Following the well-established IGBP guidelines, the objectives for this Workshop were advertised to be:

- (a) **Identify the mathematical and statistical research which needs to be funded to support Australia's contribution to the IGBP in the next decade.**
- (b) **Stimulate interaction between the different scientific groups supporting the IGBP initiatives in Australia.**

Because of the underpinning role played by mathematics and statistics in all aspects of global change modelling, the Workshop achieved the second goal by involving scientists from a broad spectrum of the global change modelling community in Australia.

The first objective represented the goal of the talks, discussions and deliberations of the Workshop.

To ensure that all issues were adequately discussed, the Workshop was organized as a study group activity. On the Monday, invited speakers identified the modelling issues which appeared to require further mathematical and statistical research. In subsequent days, informally constituted study groups (with the assistance of previously appointed moderators) examined the extent to which current mathematical and statistical knowledge could answer the issues raised, and thereby focus on the type of work requiring further research.

In order to maximize the opportunity which the Workshop gave for interaction between mathematicians, statisticians, modellers and field scientists, a One-Day Seminar on "Current Australian Contributions to the Modelling of Global Change" was convened by Drs Geoff Latham (Centre for Mathematical Analysis, ANU) and John Taylor (Centre for Resouce and Enviromental Studies, ANU) on the Tuesday. In addition, the study group deliberations of Wednesday, Thursday and Friday were complemented by a series of invited talks which focussed on important related issues such as chemical and dynamical aspects of stratospheric ozone depletion, terrestrial biota, and ice sheets.

At the end of the Workshop, there was unanimous agreement that enhanced understanding of global change processes depended crucially on the construction and study of generic models of the various aspects of global change. For example, the construction of generic models to study the sources for instability in climate and weather patterns; to investigate the role of sea surface temperature in coupling the oceanic and atmospheric circulations; to simulate in real time various climatic scenarios; etc.

In addition, the need for enhanced mathematical and statistical research on the following topics was identified:

(i) All aspects associated with the various indirect measurement (inverse) problems which are connected with global change modelling. For example, the determination of CO₂ sources from the world wide observation of CO₂ concentrations; the assessment of oceanic circulation on the basis of satellite observation of sea surface characteristics; the analysis and interpretation of ocean tracer studies; etc.

(ii) The use of simple models, which account for physically important phenomena, to delineate the essential characteristics of more complex models. For example, the effect of continental geometry and topography on climate and weather patterns.

(iii) The matching of processes involving different scales such as the biosphere with the atmosphere, and the oceans with the atmosphere.

(iv) The construction and analysis of methods for the prediction of extremes of climate and weather, and of the impacts of pollutants.

There was also general agreement that the future success of IGBP endeavours depended heavily on improved communication between the different scientific groups involved. The fact that these groups were located in different places geographically within different institutions with competing priorities was seen as an impediment to improving contact, discussion, coordination, etc. All attending acknowledged that the Workshop reinforced the fact that mathematics was the common bridge across which the different IGBP scientific groups communicated professionally. As a result, it was agreed that mathematics and mathematicians had a greater role to play in stimulating and fostering the mentioned communication.

Copies of the official IGBP Workshop 13 Report, which includes details of the full program etc, can be obtained from Ms Faye Harris, IGBP Officer, Australian Academy of Science, GPO Box 783, Canberra, ACT 2601.

Robert S. Anderssen,
Chair, National Committee for Mathematics,
June, 1990

PREFACE

As part of the special year in Applications and Numerical Solution of Partial Differential Equations, the Centre for Mathematical Analysis at the Australian National University hosted the International Geosphere–Biosphere Program (IGBP) Workshop 13 on Mathematical and Statistical Modelling of Global Change Processes. This workshop, sponsored jointly by the National Committees for the IGBP and Mathematics and the Centre for Mathematical Analysis, was one in a series of workshops with the aim of providing informed guidance for Government policy makers to assist in deciding which IGBP related mathematical research activities should be supported over the next decade. These activities would constitute part of Australia’s contribution to the IGBP research.

Workshop 13 focussed specifically on the mathematical and statistical aspects of the modelling of global change processes. Accordingly, the objectives of the workshop were, first, to identify those mathematical and statistical problems whose solution would significantly advance present research, and second, to stimulate interaction between different scientific groups supporting the IGBP initiatives in Australia. The Workshop was a resounding success on both these counts. Up to 60 scientists and students from various disciplines attended the one week meeting. Besides the formally presented talks, several study group sessions discussed problems of mutual interest. These included study groups on matching different scales, generic models and inverse problems. In addition, a special session on important problems associated with the global carbon budget was held. Notes from this session appear in this Proceedings. It was during these lively study group discussions that the main targets for future IGBP research were identified.

This volume is divided into two parts. Part I consists of papers presented at a seminar session aimed at describing current Australian contributions to modelling of global change. In this regard, it touches upon many aspects of Geosphere–Biosphere modelling. Part II is a collection of invited papers on selected topics of importance to global modelling.

The success of the IGBP Workshop 13 could not have been possible without the untiring work and support of many people. We wish to thank first of all, Professor Neil Trudinger, the Director of the Centre for Mathematical Analysis, for the support of the Centre, its staff and facilities. In particular the organizational skills of Marilyn Gray, and the expert preparation of these proceedings by Jill Smith and Joyce Heinz, were indispensable. Thanks also goes to Ian Enting for organizing the special session on the carbon budget. Next we would like to thank the sponsoring National Committees for the IGBP

and Mathematics as well as the Workshop 13 Organizing Committee. Finally, many thanks should go to the participants themselves who shared with each other, for a week at least, their most nagging scientific problems, so that a true picture of the needed research could emerge.

Geoff A. Latham and John A. Taylor, editors.

CONTENTS

FOREWARD	(i)
PREFACE	(iii)
PART I: CURRENT AUSTRALIAN CONTRIBUTIONS TO MODELLING OF GLOBAL CHANGE	
GLOBAL MODELLING WITHIN THE CSIRO DIVISION OF ATMOSPHERIC RESEARCH <i>B.G. Hunt</i>	1
GREENHOUSE MODELLING IN BMRC <i>M.J. Manton</i>	25
IMPACT OF REDUCED SEA ICE CONCENTRATION ON THE ANTARCTIC MASS BALANCE <i>I. Simmonds</i>	39
GREENHOUSE CLIMATE CHANGE FINGERPRINT DETECTION <i>D.J. Karoly</i>	49
MATHEMATICAL MODELLING RELATED TO THE INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME AT THE CENTRE FOR RESOURCE AND ENVIRONMENTAL STUDIES <i>J.A. Taylor, A.J. Jakeman, M.S. Common and M.F. Hutchinson</i>	61
MODELLING LAND SURFACE-ATMOSPHERE INTERACTIONS AT DIFFERENT SPATIAL SCALES <i>A.J. Pitman</i>	84
REGIONAL CLIMATE CHANGE SCENARIOS FOR AUSTRALIA <i>K.J. Hennessy</i>	113
LACUNAE IN BOUNDARY-LAYER MODELLING <i>J.J. Finnigan</i>	136
INVERTING TRACER DATA FOR THREE-DIMENSIONAL VELOCITY FIELDS WITH DYNAMICAL CONSTRAINTS <i>P.C. McIntosh</i>	174

PART II: INVITED PAPERS

TWO-DIMENSIONAL COMPUTER MODELLING OF GLOBAL TRACE GAS CHEMISTRY AND TRANSPORT <i>A.R. Curtis, R.G. Derwent, A.M. Hough and C.E. Johnson</i>	197
CARBON CYCLE MODELLING: ILLUSTRATIONS OF MODELLING PROBLEMS IN IGBP STUDIES <i>I.G. Enting</i>	212
THE ROLE OF THE TERRESTRIAL BIOTA IN THE ATMOSPHERIC CARBON BUDGET <i>R.J. Francey and I.G. Enting</i>	235
PROFESSORS AND PARLIAMENTARIANS <i>W.C. Wentworth</i>	246
GLOBAL MODELLING OF CLIMATE AND ICE SHEETS <i>W.F. Budd and P. Rayner</i>	261
LIST OF PARTICIPANTS	278

PART I

CURRENT AUSTRALIAN CONTRIBUTIONS TO
MODELLING OF GLOBAL CHANGE

