

Climate

Into the 21st Century



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Climate Into the 21st Century

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6 Foreword

G.O.P. Obasi
 Secretary-General
 World
 Meteorological
 Organization



Climate is one of humankind's greatest natural resources. Life itself and the existence of human beings on planet Earth depend on a favourable climate regime. People are very much affected by climate factors, including in terms of availability of food and water as well as choice of shelter and clothing. It plays an important role in our culture, health, leisure and general well-being.

More recently, we have also become more aware of the increasing interaction between society and climate, particularly the human effect on the changing climate. This interaction is among the significant considerations pertinent to the quest of nations for sustainable development.

In this regard, there has been increasing interest to have a better appreciation of what climate is, what constitutes the climate system, what progress has been made in this area and what lies ahead. It is in this light that this book, *Climate: Into the 21st Century*, was prepared. This project was undertaken by the World Meteorological Organization (WMO) in line with its long history of interest and involvement in climate issues. This goes

back to its predecessor institution, the International Meteorological Organization (IMO), which in 1929 already had a technical commission for climatology. Since its establishment in 1950, WMO has been instrumental in drawing attention to climate-related issues, particularly through its World Climate Programme.

This book highlights the enormous progress in our understanding of the climate system and also seeks to promote a better community awareness of the importance of climate in our lives. It may be recalled that substantial loss of life and property destruction in natural disasters relate to dangerous extremes of climate variability. With the recognition that the climate system is changing as a result of human activities, there is also the realization that the impacts on society may prove increasingly significant and challenging. Hence, knowledge about climate needs to be applied in an enhanced way for a safer and more productive world, for the benefit of humankind.

This book provides a perspective of the global climate system across the twentieth century; it identifies some of the major climate events and their impacts on societies. In addition, it traces the development of our capabilities to observe and monitor the climate system and outlines our understanding of the predictability of climate on timescales of months and longer. The book culminates with insights into issues for the twenty-first century, drawing heavily on the work of the WMO co-sponsored Intergovernmental Panel on Climate Change (IPCC) and its recently released Third Assessment Report.

This publication provides a readable and selective account of some of the important climatic processes, examples of the enormous impact of some climate events and the challenges that climate poses at the start of the twenty-first century. It is written for a wide audience and covers a vast spectrum of interests in climate and climate events.

The book also demonstrates the role of, and developments in, international cooperation in meteorology, especially in data collection and exchange, in research as well as in applications. The National Meteorological and Hydrological Services (NMHSs) of each country have, for a century and more, carried out the important task of observing and recording the atmospheric parameters and its associated weather. These observations were initially for immediate applications in weather forecasting and warning; now, they have resulted in an accumulated climate record, forming the backbone of our understanding of the climate system and its variability. As our understanding of the sensitivity of the climate system to human interference has grown, it is even more important that the climate observing networks are retained, and even enhanced, and that international cooperation is strengthened to better meet the challenges of climate variability and change.

In this connection, it is fitting to acknowledge the contributions of millions of dedicated professionals and volunteers who have in the past, and will continue in the twenty-first century, to record their observations of daily weather that help to build a full picture of the fascinating climate of this planet.

I take this occasion to also thank the countries, groups and individuals who have contributed to the realization of this work.

The comprehensive global perspective of this book was made possible by the contributions from the NMHSs in all regions of the world. Financial and in-kind contributions were received from several countries. Overall guidance on the structure and content has been through a Task Team of the WMO Commission for Climatology led by Ms Mary Voice of Australia. In addition, the Task Team has had the assistance of lead authors for the different sections in the formulation and review of the content. Furthermore, several eminent climatologists provided reviews of

the book at the draft layout stage, and these provided valuable guidance for its further development. This has been an undertaking fully supported by staff from the WMO Secretariat.

WMO is particularly grateful to Dr William J. Burroughs for his dedication to the challenge of compiling, selecting and editing the considerable body of scientific information, and structuring it with the accompanying graphics. His style and balance are reflected in the presentation.

It is my hope that the readers of this book will find in it a wealth of information and knowledge that will lead to a better appreciation of climate, the role it plays in our lives and the need to protect and preserve it for future generations.



(G.O.P. Obasi)
Secretary-General

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The structures of everyday life are fashioned to a surprising extent by the local climate. The climate, its seasonal patterns and the chances of extremes influence what we wear, our housing and transport, sport and recreation, what we eat and how we work. Weather and climate can even influence our emotions and moods. When we observe a clear blue morning sky, feel the gentle warmth of a rising sun, a zephyr of breeze with perhaps the scent of flowers wafting on the air – we can't help but feel a sense of peace and tranquillity. In contrast, an approaching storm with a rising wind, a swirling of dust, sand or snow and a leaden sky all evoke very different emotions. More crucially, weather and climate have the potential to enhance community wealth creation and sustainable development on a global scale, or conversely to cause severe disruption to the rhythm of life and even its destruction. It is essential then for us to understand and learn how to deal with the wide-ranging impacts that our Earth's climate is capable of delivering.

Clearly, the vigorous greenhouse debate of the past two decades about the possible extent and likely consequences of global warming indicates that in spite of modern technology and know-how, we still have a long way to go in climate-proofing our societies and ourselves. Even more significantly, we are being told that it is our own actions which are introducing new uncertainties into how the global climate machine is working. At the same time, a fear of future climate change from the greenhouse effect or other causes, accompanied by a lack of knowledge and understanding of the climate variations that our parents and grandparents have lived through, is not the best foundation for good community planning.

Thus, we on the Task Team believed there was an important story to tell. In putting this story together, we remain convinced that to cope better with the climate of the future a greater awareness is needed of what has happened to our climate during the 20th century and even further back through time. Armed with this knowledge

and understanding, communities that already know how to manage season-to-season and year-to-year climate variability will more easily learn how to cope with climate change.

From this background grew the seed of the idea for this book. The seed germinated during discussions among colleagues of the Commission for Climatology of the World Meteorological Organization (WMO). It was the international perspective of these discussions and the need for international cooperation that brought a proposal to produce this book to the attention of the Twelfth Congress of WMO. Congress enthusiastically endorsed the plan and an international Task Team was formed to guide the project through to completion.

The challenge was to cover a century of climate with both geographic and temporal balance, recognizing at the same time that even one hundred years of climate is but a snapshot of what has been experienced by the planet over thousands and millions of years. During the 20th century the population of the planet approximately quadrupled with much of the expansion being increasingly concentrated in the larger cities of the world. These facts alone distort our perspective on what have been the most significant weather and climate events of the past one hundred years or so. They also help to explain why an extreme weather event may have a greater impact today than an event of similar severity occurring decades ago. Another factor distorting our view of the past is that there is progressively less information available about climate events as we go back in time. Other factors inhibiting a comprehensive coverage include the varying degree of record keeping that often depended on local needs, as well as historically limited communications between peoples speaking different languages. We are therefore especially grateful to those contributors who have supplied materials translated into the working language of the project. As a result of these and many other factors, there was the risk that a book of this nature could give a deceptive impression of trends

in the occurrence and severity of extreme events. Cognizant of this challenge, the Task Team has done its best to delve into those archives that extend back to the beginnings of meteorology as a modern science along with its sister disciplines of hydrology and oceanography, and to early studies of weather and climate phenomena. In doing so, we hope that we can bring to the reader a clearer view of how the Earth's climate has varied in the past and a better perspective on the extreme events that continue to dominate our perceptions of the turbulent natural environment in which we live. Notwithstanding our best efforts, it is inevitable that the distant past and some geographic areas are under-represented within this book.

The book has five sections beginning with a broad accessible synopsis of what has been happening in the climate system over a century and more. Section 2 on the climate system includes a survey of a number of major weather and climate events of the past interspersed with somewhat more challenging topics on the sciences that underpin our knowledge of climate. Section 3 describes the many influences and impacts of a varying climate and is followed by a section analysing in more detail how they affect the Earth and its peoples. The final two sections review the contribution of science and technology to understanding the climate of the 20th century, and the prospects for applying that knowledge and the accompanying experiences for the benefit of society in the 21st century. Each section comprises a number of two-page spreads that cover particular topics relevant to the section, and it is the intention that each spread or in some cases a group of spreads is complete in itself, without the need to cross-reference to other parts of the book. Nonetheless, since the Earth is for the most part a closed system, with the energy coming in from the Sun balanced by that radiated back to space, everything is ultimately connected. Hence we see topics such as El Niño, monsoons, floods, droughts and so on cropping up in many contexts. We trust that the reader will make

good use of the index in order to gain a fuller appreciation of the complexities behind both the causes and the effects of these weather and climatic phenomena.

The Task Team would like to thank the many contributors and reviewers who have helped to shape this book. We especially acknowledge the assistance and guidance of the section leaders who formulated the intent of each section and scrutinized the integrity of each two-page spread as it emerged from the efforts of many expert views and opinions: Neville Nicholls, Section 1; Ann Henderson-Sellers, Section 2; Michael Glantz, Section 3; Reid Basher and Hiroki Kondo, Section 4; and Richard Moss and Stephen Schneider, Section 5.

We, the people who made this project happen, have had one eye on surveying the past century and one eye on the future in offering you this book. It contains, we believe, a collective and faithful perspective of the Member countries of the World Meteorological Organization on many important climate issues.