

CLIMATE
PROCESS
&
CHANGE

To Dianne, Mark and Kate

Climate Process & Change

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Preface

I have been sitting at my home computer for the last few months absorbed in finishing the drafts of this text. The writing has not been onerous. Outside through the open doors into my garden, I have been witnessing one of the best autumns I have experienced: clear blue skies, a light breeze and temperatures up to 23–25°C each day for weeks on end. Unfortunately, I have not been able to venture far to enjoy the weather more. The weather is overdue because southeastern Australia underwent the coldest summer in thirty-three years. It was certainly the coldest summer I have experienced. While many of the vagaries in temperature were due to the fluctuations in the state of tropical ocean temperatures in the Pacific Ocean, between the El Niño–Southern Oscillation (ENSO) and La Niña, this was not the complete picture. Neither were the abnormal temperature changes due to enhanced ‘greenhouse’ warming, as trumpeted by the media when it was too warm. Nor did they represent the demise of the Earth’s present, warm interglacial climate.

In the clear autumn sky, every time a northeast sea breeze came up, a white haze wafted across my view of the Illawarra Escarpment in the distance. When I have managed to walk along my local beach, I can trace the white haze back to an orangish smog above Sydney, 40 kilometres to the north. The haze does not officially exist. At least publicly the state Environmental Protection Agency does not seem overly concerned about it in Wollongong. The haze has existed in some form or other for the twenty-five years that I have lived in the region. Unlike most North American cities, Sydney has a limited air pollution monitoring network, and weak laws restricting industrial or vehicular emissions. The skies over Sydney can be as dirty as any seen over American cities, including Los Angeles. Between the cold summer, in a supposedly ‘greenhouse’-warming world, and the excursions of urban air pollution during a bonzer autumn, I can’t help but think that climate change is not simplistic. This text is partially my attempt to understand the climate change that the Earth

has undergone over the latter half of the twentieth century, to understand the unbearably cold winters I experienced as a teenager living in Canada, the smogs that I saw in an Arctic summer, the amazing rains and floods witnessed along the Sydney–Wollongong coast during the 1980s, and the everlasting drought that has set in over eastern Australia in the 1990s. Further, this text is an attempt to combine into one source book all the far-ranging descriptions of climate process and change that students so diligently try to seek out when writing essays, yet fail to discover, either because of their acquired bias from previous instruction, or the inadequacies of a modern, fund-strapped university library.

Unless otherwise stated, a McBryde-Thomas, flat-polar, quartic projection has been used for all world maps presented in the text. This is an equal-area, pseudocylindrical projection with pole-lines one-third as long as the equator. The central meridian lies at 0°, and degrees of longitude and latitude are plotted at 15° intervals. This map reproduces continents with a recognisable shape, and it is similar to projections such as the Mollweide, Hammer, Robinson and Hoelzel commonly used in atlases. The projection appears in many geography texts. Much of the mapped climatic data from satellite monitoring or computer simulation models, especially on the topic of anthropogenically enhanced ‘greenhouse’ warming, are biased, not because of any deficiency in the science, but because they are not plotted as equal-area projections.

Units of measurement used throughout the text follow the International System of Units. All abbreviations and conversions are based upon Rocke (1984). In order to convey viewpoints and arguments, unobstructed by copious referencing, strict adherence to formal, academic referencing has been relaxed. Usually, each section begins by listing the relevant journal articles or books that have either influenced my thinking, or are central to the topic. I apologise to anyone who feels that their crucial work has been ignored, but the

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breadth of coverage precluded a complete review of the literature on many topics. The full reference to publications can be found at the end of each chapter. Academic accreditation has been maintained only where published material is specifically referred to in a diagram or table. In addition some articles and data were acquired from the Internet. The Internet address in these cases is also referenced. Such material may not be readily sourced, due to changes in Internet addresses, or the lack of an archival tradition for this new resource medium. Where material is not available in the literature, or through these forums, it has been acknowledged at the beginning of the text.

The reporting of geological time can be confusing because of the terminology, and the fact that radiocarbon ages are younger than calendar ones by 22–27%. Unless otherwise stated all ages are reported in calendar years. Radiocarbon years are only used where dates older than 18,000 years BP have been quoted in the literature, and no correction exists to convert them to calendar years. All non-historical ages before 0 AD are referred to as years before the present (BP). The only exceptions are historical events, such as wars and epidemics,

where the term BC is used. Ages after 0 AD are simply quoted as the year, without appending 'AD.'

I have communicated over the years with most of the people at the extremes of polarised climate views. I am struck by a quote by H. Tazieff, a world renown volcanologist:

I had the surprise – oh, how pleasant – of receiving the approbation of numerous scientists, especially specialists in these matters. On the other hand, I have attracted innumerable enmities, some naive and some from certain people of doubtful honesty. But a small number of friends of quality is worth more than a bunch of fans or a bunch of foes.

TED BRYANT

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- Rocke, F.A. 1984. *Handbook of Units and Quantities*. Australian Atomic Energy Commission, Lucas Heights, 270p.
- Snyder, J.P. 1993. *Flattening the Earth*. University of Chicago Press, Chicago, 365p.

Acknowledgments

Many of the data sources and diagrams are derived from United States government publications which are not copyrighted. This book could never have been written without that policy. Individual contributors for that data are acknowledged separately in the text. Specifically, I would like to thank Dr Tom Boden of the Carbon Dioxide Information Analysis Center for making available data collated by that centre and figures appearing in Trends'93; and Dr Tom Karl of the National Climatic Data Center for Figure 1.4.

Some data, reported in Chapter 7 in the discussion of cloud, sulphates and satellite temperature measurements, are taken from anonymous articles in the *World Climate Review*, a publication of the Department of Environmental Sciences, University of Virginia, Charlottesville, USA, Dr P.J. Michaels, Chief Editor.

Other material comes from the Internet, including World Wide Web sites. The monthly sunspot numbers between 1749 and 1995 plotted in Figure 2.3 are part of a United States National Geophysical Data Center file regularly updated by the Data Support Section, Scientific Computing Division, National Center for Atmospheric Research (NCAR) at ftp://ncardata.ucar.edu/datasets/ds834.0/monthly_data. The Southern Oscillation index plotted in Figure 4.9 is partially derived from data compiled by the Joint Institute for the Study of Atmosphere and Ocean, University of Washington in Seattle at http://tao.atmos.washington.edu/pacs/additional_analyses/soi.html. The description of precipitation changes over historical timescales, specifically dealing with flooding, presented in Chapter 5, includes facts summarised on the Greenpeace web site at http://www.greenpeace.org/climate/flood_report/index.html. Milankovitch insolation values plotted in Figure 6.1 were downloaded from the NOAA web site at <ftp://ngdc1.ngdc.noaa.gov/paleo/insolation/>. The original source of data is cited in the figure caption. The Halley Bay ozone values for 1994 presented in Figure 7.16 were taken from the British Antarctic Survey ozone information web site at [http://](http://www.acd.ucar.edu/gpdf/ozone/science/bas.html)

www.acd.ucar.edu/gpdf/ozone/science/bas.html. Values are used with the permission of the British Antarctic Survey. Updated October ozone values for Halley Bay plotted in Figure 7.17 were compiled by Dr J.D. Shanklin, British Antarctic Survey and downloaded from Gregory P. Dubois-Felsmann's Internet web site at <http://www.acd.ucar.edu/gpdf/ozone/science/bas.html>. An inventory of historical values was taken from FAQ on ozone assembled by Dr Robert Parson, Department of Chemistry and Biochemistry, University of Colorado at rparson@rintintin.colorado.edu. The latter were checked for accuracy against graphs published in original sources.

Much of the material on climate impacts on health was obtained through collaborative work with Professor Christine Ewan, University of Wollongong between 1990 and 1993. Background material was compiled by John Marthick, Department of Geography, University of Wollongong, and Deanne Condon-Paoloni. John Marthick also kindly permitted Figure 8.2 to be used. Dr Paul Fraser, CSIRO Division of Atmospheric Research, Melbourne, provided valuable information on the health effects of enhanced ultraviolet radiation. Estimates of the medical cost of enhanced ultraviolet radiation in Australia presented in Table 8.3 were calculated by Professor Don Lewis, Department of Economics, University of Wollongong. Dr Keith Bentley, Environmental Health Unit, Australian Department of Community Services and Health, initiated much of the research, and facilitated funding through the National Health and Medical Research Council. Where this work is accessible to the general public, it has been referenced in the text. However the section on the health effects of ozone depletion comes from a limited-circulation report (Bryant, E., Lewis, D., Calvert, D., Ewan, C. and Fraser, P. 1992. *Estimation of the health costs, to 2030 AD, of enhanced ultraviolet radiation due to climatic change*. Final Report to the Department of Health Housing and Community Services and the Department of Arts, Sport, The Environment and

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Finally, I would like to thank many colleagues, who through difficult years, sustained my enjoyment for academia and my enthusiasm for scholarly research.