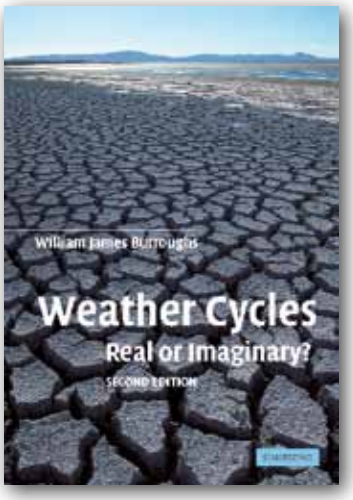
Weather Cycles

Real or Imaginary?

Written by William James Burroughs
Second Edition, Cambridge University Press, 2003, 330 pages
Hardcover: ISBN 0521820847, $100 US
Paperback: ISBN 0521528224, $50 US



REVIEWED BY MICHAEL N. EVANS

Are observed climate variations best described as cyclical, stochastic, or chaotic in nature? This is the essential question posed by W.J. Burroughs. Our confidence in climate predictions on time scales of seasons to centuries, including the global warming debate, depends on the answer. The book explores evidence and arguments for cyclical features in direct meteorological records such as temperature and precipitation, as well as indirect, or proxy, climate data derived from geological, biological, and economic data series. It then proceeds to lay out the physical and statistical mechanisms that may support the existence of these cyclicities when the observations are messy, indirect, incomplete, or simply don't span enough time.

This well-written, clearly illustrated and argued book, geared for everyone from climate-change scientist to layperson, forms a clear opinion, shot through with dry wit. With a few notable exceptions, much of the variability we see is likely stochastic or weakly chaotic, which explains our many failures to both diagnose stationary cyclicities in the climate system and use them for predictive purposes. The result has important implications for climate modelers, policy-makers, and voters. If the climate system is weakly chaotic, there may be underlying structure, albeit with limited predictability. It also means that familiar climatological patterns may be better described as regimes subject to abrupt changes in mean state and variability. The appearance of such changes may be sensitive to anthropogenic perturbations in ways we do not yet understand.

Published in 2003, the second edition is extensively revised from the 1992 edition in three important ways. First, there is an expanded introduction to statistical methods, notably wavelet analysis and singular spectrum analysis. These techniques have been more commonly applied since publication of the first edition, and are reasonably described as more applicable than classical Fourier-based analytical techniques for the study of short, noisy data sets with embedded quasiperiodicities. Statistics buffs and those who use statistics in the study of climatological and paleoclimatological data would do well to pore over the appendices before interpreting subtle signals in their own data.

Second, there is also a substantially expanded review of climate and paleoclimate data, which forms the first half of the book. This review is important, because in the last decade there has been an explosion in the amount and quality of paleoclimatic proxy climate data relevant to the question Burroughs has framed. Burroughs's expanded review is generally well done. His one omission is discussion of the development of spatiotemporal data analysis techniques for reconstruction of climate fields from networks of climatological and paleoclimatological data, which received much attention in the mid-1990s. These techniques contain the implicit ability to extract periodicities and patterns common to disparate data series through eigenanalysis-based techniques, although not without significant assumptions and uncertainties; Burroughs would be well suited to review these techniques objectively.

In his third major revision to the text, Burroughs has expanded his review of the leading hypotheses put forward to explain the observed climate variability discussed in the second half of the book. Again, Burroughs has captured much of the new interest in climate dynamics across the international scientific community. The reviewed mechanisms include internal dynamical phenomena, external (solar) forcing, stochastic with memory and resonance, and chaos. Major physical mechanisms internal to the climate system, including tides, the Quasibiennial Oscillation (QBO), the

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Madden-Julian Oscillation (MJO), the El Niño/Southern Oscillation (ENSO), the thermohaline circulation, and Earth's orbital variations are reviewed. External forcing, potentially caused by solar variability, is given an objective description. Finally, statistical explanations are explored: the possibility that it is all "noise," that it is noise with memory or nonlinear resonance, and that it is the result of low order chaos. Only a few cyclicities survive Burroughs' analysis: the annual cycle, the quasibiennial oscillation, the El Niño-Southern Oscillation (ENSO), and perhaps a bidecadal cycle.

I found only a few features of this book with which to quibble. The use of the term "weather" in the title is not quite representative of the subject matter, which is mainly concerned with climate changes on interannual and longer time scales. There are a few subtle referencing errors. Typographical errors (some new, others holdovers from the first edition) are regrettable. I found the observational summary tables (3.1, 4.2) difficult to parse and not entirely consistent with the text or my reading of the data. However, the overall point that most cycles are not well defined and appear to come and go, or shift frequencies, over the time period, remains well taken.

Most intriguing to me was Burroughs's suggestion of a chaotic framework for the observations and our predictive failures. He has produced a well-written, clearly illustrated review, which makes an important point. But Burroughs stops short of fully developing chaos as a paradigm for his review of the extant climatological and paleoclimatological data. I only hope that he has done so to whet our appetites for a companion volume exploring this hypothesis, as was done so well by Paul Ormerod (*The Death of Economics*, 1994; *Butterfly Economics*, 1998) for economic and social phenomena. In the meantime, I will recommend this book to colleagues and friends interested in the science of climate change.

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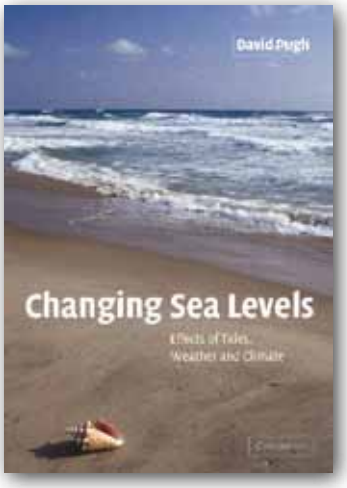
Changing Sea Levels

Effects of Tides, Weather and Climate



Written by David Pugh
Cambridge University Press
2004, 280 pages
Hardcover: ISBN 0521825326, $115 US
Paperback: ISBN 0521532183, $60 US

REVIEWED BY NICK HARVEY

Changing Sea Levels: Effects of Tides, Weather and Climate by David Pugh is a welcome addition to the literature, particularly because of the increasing debate over predictions for sea-level rise stimulated by deliberations and reports of the Intergovernmental Panel on Climate Change (IPCC). This book is aimed at undergraduate students involved in interdisciplinary studies, although it will also be very useful for a variety of professionals such as coastal planners and engineers.

The book, which arose from Pugh's earlier (1996) volume, *Tides, Surges and Mean Sea-Level,* has been written in an informative and easy-to-read style in a deliberate attempt to reduce the number of statistics presented. Additional mathematical detail is given in an appendix and on a related web site. The book is very well illustrated with clear black and white diagrams and photographs. In addition, eight of the more complex global diagrams have been reproduced in color