

LTER



Climate Variability and Ecosystem Response at Long-Term Ecological Research Sites

EDITED BY
David Greenland
Douglas G. Goodin
Raymond C. Smith

LONG-TERM ECOLOGICAL RESEARCH NETWORK SERIES
LTER Publications Committee

Climate Variability and Ecosystem Response at Long-Term
Ecological Research Sites

Edited by
David Greenland, Douglas G. Goodin,
and Raymond C. Smith

Grassland Dynamics: Long-Term Ecological Research
In Tallgrass Prairie

Edited by
Alan K. Knapp, John M. Briggs,
David C. Hartnett, and Scott L. Collins

Standard Soil Methods for Long-Term Ecological Research

Edited by
G. Philip Robertson, David C. Coleman,
Caroline S. Bledsoe, and Phillip Sollins

Structure and Function of an Alpine Ecosystem:

Niwot Ridge, Colorado

Edited by
William D. Bowman and Timothy R. Seastedt

CLIMATE VARIABILITY AND ECOSYSTEM RESPONSE AT LONG-TERM ECOLOGICAL RESEARCH SITES

Edited by

David Greenland

Douglas G. Goodin

Raymond C. Smith



OXFORD
UNIVERSITY PRESS

2003

OXFORD
UNIVERSITY PRESS

Oxford New York
Auckland Bangkok Buenos Aires Cape Town Chennai
Dar es Salaam Delhi Hong Kong Istanbul Karachi Kolkata
Kuala Lumpur Madrid Melbourne Mexico City Mumbai Nairobi
São Paulo Shanghai Taipei Tokyo Toronto

Copyright © 2003 by Oxford University Press, Inc.

Published by Oxford University Press, Inc.
198 Madison Avenue, New York, New York 10016

www.oup.com

Oxford is a registered trademark of Oxford University Press

All rights reserved. No part of this publication may be reproduced,
stored in a retrieval system, or transmitted, in any form or by any means,
electronic, mechanical, photocopying, recording, or otherwise,
without the prior permission of Oxford University Press.

Library of Congress Cataloging-in-Publication Data
Climate variability and ecosystem response at long-term ecological research sites /
edited by David Greenland, Douglas G. Goodin, Raymond C. Smith.
p. cm. — (Long-Term Ecological Research Network series)
Includes bibliographical references.
ISBN 0-19-515059-7
I. Bioclimatology. 2. Ecology—Research. 3. Climatic changes.
I. Greenland, David, 1940– II. Goodin, Douglas G. (Douglas Gard)
III. Smith, R. C. (Raymond Calvin), 1934– IV. Series.
QH543 .C578 2003
577.2'2—dc21 2002033393

9 8 7 6 5 4 3 2 1

Printed in the United States of America
on recycled, acid-free paper

Preface

Global climate change is a central issue facing the world today. The topic has received intense national and international attention as exemplified by the continuing series of books produced by the Intergovernmental Panel on Climate Change. The issue of potential global warming is constantly addressed by the popular news media. Long-Term Ecological Research (LTER) sites can provide unique perspectives on this topic because of their large legacy of past ecosystem research and observations and their ability to act as a network and provide intersite comparisons. Furthermore, well over half the LTER sites have a climate investigation component as one of their main working hypotheses, and all the sites study the interaction of climate and ecosystems to some degree. The question-oriented organization adopted in this volume and some of the results described in it will provide an important stimulus to future research on the topic.

Climate variability and ecosystem response has been one of the ongoing areas of interest in the LTER since the inception of the program in 1980. The theme has been part of the fifth core area of research in the LTER program, namely, the study of patterns and frequency of disturbances, and the theme also has relevance to several of the other core areas of research. Climate Variability and Ecosystem Response was the title of a workshop held in 1988 that gave rise to a monograph written by the LTER Climate Committee in 1990 (Greenland and Swift 1990, 1991). A second monograph entitled "El Niño and Long-Term Ecological Research Sites" (Greenland 1994) arose out of another workshop held at the 1993 LTER All Scientists Meeting at Estes Park, Colorado. Climate Variability and Ecosystem Response was again the title of the Fall 1997 Long-Term Ecological Research (LTER) Coordinating Meeting in Santa Barbara. Some of the abstracts from the papers at this meeting will be posted at the LTER Climate Committee web site <http://>

intranet.lternet.edu/committees/climate/. Ongoing interest in this topic led to the planning of three workshops on the same topic for the August 2000 All Scientists Meeting LTER at Snowbird, Utah. The Snowbird workshops dealt with the overall theme as it applied to the quintennial, decadal, and century to millennial timescales. A series of questions were employed to focus the presentations and discussion on the topic. Material from these meetings and workshops together with selected additional material form the basis of the content of this book.

The compilation of work such as this is the result of a very large amount of time, energy, and resources provided by numerous people and organizations. We thank all those who helped run the various workshops over the years and all those who contributed papers and presentations to them. We especially thank the successive leaders of the LTER program, former leader Dr. Jerry Franklin, University of Washington, and current leader Dr. Jim Gosz (Chair) and Dr. Bob Waide (Executive Director), both of the University of New Mexico, for their ongoing support. Dr. David Coleman, University of Georgia, chair of the LTER Publications Committee, Mr. Kirk Jensen, Executive Editor, and Mr. Keith Faivre, Production Editor, Oxford University Press, have also been extremely supportive. The copyeditor at Oxford University Press made major improvements to the text. We also thank Dr. Andrew Fountain, Portland State University, Dr. Berry Lyons, Ohio State University, and Dr. Glen Juday, University of Alaska, who were earlier coeditors of the project. All of these people are noteworthy for extremely selfless action, and they continue the long tradition in the LTER program of putting the good of the program before the interests of individuals. We also thank the National Science Foundation Division of Environmental Biology, Long-Term Programs for funding to all parts of the LTER Program and especially the Network Office, which supported several of the meetings that culminated in this book. Any opinions, findings, conclusions, and recommendations expressed in the material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

We would also like to acknowledge the following institutions and journals for permission to reproduce some previously published material: *BioScience*, *Physical Geography*, and *Geografiska Annaler Series A*.

Several of the chapters in this book went through multiple internal review processes—especially those chapters with multiple authors. At least one person has reviewed all of the chapters in this book. Five outside reviewers reviewed the overall outline of the book. The concluding materials were kindly and constructively reviewed by Dr. Bruce Hayden of the University of Virginia. Specifically, he is responsible for suggesting that future attention be given to the problem of detecting the climate signal in ecosystem dynamics. Other persons who provided help for reviews include Dr. John A. Harrington, Jr., Dr. Peter Lamb, Dr. Nathan Mantua, Dr. Charles W. Martin, Dr. Aaron Moody, Dr. Timothy R. Seastedt, and Dr. Marilyn Walker. We thank them for their help, and we apologize to anyone we may have inadvertently omitted.

References

- Greenland, D., editor. 1994. *El Niño and Long-Term Ecological Research Sites*. Publication No. 18. LTER Network Office: University of Washington, Seattle, WA. 57 pp.
- Greenland D., and L. W. Swift, Jr. 1990. *Climate Variability and Ecosystem Response*. USDA Forest Service. Southeastern Forest Experimental Station. General Technical Report SE-65. 90 pp.
- Greenland D., and L. W. Swift, Jr. 1991. Climate Variability and Ecosystem Response: Opportunities for the LTER Network. *Bulletin of the Ecological Society of America* 72(2):118–126.

Contents

Contributors xiii

Abbreviations xvii

- 1 An Introduction to Climate Variability and Ecosystem Response 3**
David Greenland, Douglas G. Goodin, and Raymond C. Smith

I Short-Term Climate Events

Introductory Overview 23
David Greenland

- 2 Hurricane Impacts in New England and Puerto Rico 25**
Emery R. Boose

- 3 Drought Impacts on Tree Growth and Mortality of Southern
Appalachian Forests 43**
Brian D. Kloeppel, Barton D. Clinton, James M. Vose,
and Aaron R. Cooper

- 4 Climate Variability in the North Central Region: Characterizing
Drought Severity Patterns 56**
Stuart H. Gage

V Climate Variability and Ecosystem Response at Selected LTER Sites at Multiple Timescales

Introductory Overview 391

David Greenland and Douglas G. Goodin

19 Climate Variability and Ecosystem Response at the H. J. Andrews Long-Term Ecological Research Site 393

David Greenland, Frederick Bierlmaier, Mark Harmon, Julia Jones, Arthur McKee, Joseph Means, Frederick J. Swanson, and Cathy Whitlock

20 Climate Variability in Tallgrass Prairie at Multiple Timescales: Konza Prairie Biological Station 411

Douglas G. Goodin, Philip A. Fay, and Maurice J. McHugh

21 Climate Variability and Ecosystem Response—Synthesis 425

David Greenland, Douglas G. Goodin, Raymond C. Smith, and Frederick J. Swanson

Index 451

Contributors

Full contact information of LTER members may be obtained from the LTER Network web site personnel directory at <http://lternet.edu/people/>.

Valerie Barber
Bonanza Creek LTER
University of Alaska

Julio L. Betancourt
Sevilleta LTER
USGS Tucson

Neil Bettez
Arctic LTER Site
Woods Hole Oceanographic Institution

Fred Bierlmaier
H. J. Andrews LTER
USDA Forest Service

Emery R. Boose
Harvard Forest LTER
Harvard University

Anthony J. Brazel
Central Arizona Phoenix LTER
Arizona State University

Barton D. Clinton
Coweeta LTER
USDA Forest Service

Aaron R. Cooper
Coweeta LTER
North Carolina State University

Linda A. Deegan
Arctic LTER Site
Woods Hole Oceanographic Institution

Peter T. Doran
McMurdo LTER
University of Illinois at Chicago

Andrew W. Ellis
Central Arizona Phoenix LTER
Arizona State University

Scott Elias
Niwot Ridge LTER
University of Colorado