

# The Carbon Cycle



Edited by

T.M.L. Wigley and D. S. Schimel

Reducing carbon dioxide (CO<sub>2</sub>) emissions is imperative to stabilizing our future climate. Our ability to reduce these emissions, combined with an understanding of how much fossil fuel-derived CO<sub>2</sub> the oceans and plants can absorb, is central to mitigating climate change.

In *The Carbon Cycle*, leading scientists examine how atmospheric carbon dioxide concentrations have changed in the past and how this may affect the concentrations in the future. They look at the carbon budget and the “missing sink” for carbon dioxide. They offer approaches to modeling the carbon cycle, providing mathematical tools for predicting future levels of carbon dioxide.

This comprehensive text incorporates findings from the recent IPCC reports. New insights, and a convergence of ideas and views across several disciplines, make this book an important contribution to the global change literature. It is an invaluable resource for students and researchers working in the field.

# The Carbon Cycle

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# Preface

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Since 1988, the Office for Interdisciplinary Earth Studies of the University Corporation for Atmospheric Research (UCAR) has run a series of annual Global Change Institutes (GCIs) on a range of topics under the broad theme of global environmental change. Participants in each GCI have come from a wide range of disciplines, including those peripheral to the main topic, in order to stimulate discussion and to ensure a multidisciplinary perspective. All GCIs have been highly successful and have led to important and useful proceedings volumes.

The sixth annual Global Change Institute was held over July 18–30, 1993, in Snowmass, Colorado. The topic of the institute was the carbon cycle. As a unique feature, the GCI focused on the practical problems of projecting future concentration changes for given emissions, estimating emissions for prescribed concentration profiles, and assessing the uncertainties in these calculations. Much of the discussion still involved processes, but the viewpoint fostered was as much that of the user of carbon cycle model output as of the “pure” scientist. Over the past decade, there has been a trend toward applied or socially relevant science. With the concern over future climatic change resulting from increasing greenhouse gas concentrations, and with the central role that CO<sub>2</sub> plays in this problem, there is no area of science in which cognizance of the social and policy implications is more important than in carbon cycle research.

In spite of this, the carbon cycle community had not made a coordinated effort prior to the GCI to address the issue of future concentration and emissions changes and their uncertain-

ties. The primary aim of the 1993 GCI was to take a step toward providing realistic information on these problems. The goal was not to produce quantitative answers, since we did not (and still do not, in some cases) even know the right questions to ask. Carbon cycle modeling is somewhat behind climate modeling in this regard – in 1993 there had been no comprehensive intermodel comparisons and few attempts to assess and prioritize the sources of uncertainty. The 1993 GCI provided a forum to discuss these and related issues.

The institute followed its successful format of previous years, holding an initial plenary session during which about 50% of the participants made formal presentations. This was followed by separate working group sessions, a “regrouping” plenary to ensure interaction between the working groups, a breakup into working groups again, and a final plenary.

As the GCI took place prior to the 1994 and 1995 Intergovernmental Panel on Climate Change (IPCC) reports, the working groups provided a forum for the world’s leading carbon cycle experts to examine three crucial topics in the IPCC context: the missing carbon sink (how big is it, how can it be explained, and how important is it?); past CO<sub>2</sub> variations (what is the past record, how can it be explained, and how important is it in estimating future changes?); and modeling strategies (what tools are available, what are their respective merits and weaknesses, and how are they best employed to predict future changes?). The ideas emanating from the GCI discussions and working groups provided the foundation for the carbon cycle chapters in the 1994 and 1995 IPCC reports on the carbon cycle, excerpts from which are reproduced in this book (see Chapter 2).



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We are proud to give credit to John A. Eddy as the originator of the Global Change Institutes. Additional thanks are due to the many individuals who gave a special impetus to this project: GCI co-directors Tom Wigley, Robert Watson, and Ulrich Siegenthaler; series co-editors Carol Rasmussen and Tom Wigley; and the members of the GCI's Organizing Committee: William R. Emanuel, Inez Fung, Michael B. McElroy, Berrien Moore III, David S. Schimel, and William H. Schlesinger. Most important, we thank the Office for Interdisciplinary

Earth Studies (OIES) staff, whose organizational, logistical, and on-site support made this institute a success: Lisa Butler, Diane Ehret, Stacy Long, and Paula Robinson. Special thanks are due to Diane Ehret, Lisa Butler, and Christina Tidd for their work in managing the production of this book.

Finally, we are indebted to all who came to Snowmass, especially to the rapporteurs for spending countless hours pulling together the material for the working group summaries, which fed directly into the 1994 and 1995 IPCC reports, and to the moderators of the various sessions for guiding the discussions toward the purposes assigned. In addition, we wish to thank the scientists who have taken time to review the manuscripts contained in this volume. The scientific worth of this volume is founded equally on their efforts and the papers they reviewed.



# Contributors to the 1993 Global Change Institute

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Below are the names and affiliations of the contributors to this book and the participants in the Office for Interdisciplinary Earth Studies (OIES) 1993 Global Change Institute. Each person on this list provided valuable input to this volume either through a specific chapter or by participating in discussions at the Global Change Institute. The editors would like to extend their sincere thanks to these people.

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