Prospectus for Synthesis and Assessment Product 2.2

North American Carbon Budget and Implications for the Global Carbon Cycle
[also known as the *Prototype State of the Carbon Cycle Report (SOCCR) focused on North America*]

Lead Agency: DOE, NASA, NOAA
Supporting Agencies: USDA, USGS

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1. Description of Topic, Audience, Intended Use, and Questions to be Addressed

1.1. Introduction

The carbon cycle chapter of the *Strategic Plan for the U.S. Climate Change Science Program* (CCSP) describes a plan to produce "…a series of increasingly comprehensive and informative reports about the status and trends of carbon emissions and sequestration," each to be called a State of the Carbon Cycle Report (SOCCR). The Carbon Cycle Interagency Working Group's (CCIWG) Terms of Reference (TOR)[1] for a first SOCCR elaborated this in June 2003, saying that what is envisioned is "…a series of reports on the state of the carbon cycle designed to provide accurate, unbiased, and policy-relevant scientific information concerning the carbon cycle to a broad range of stakeholders. The two broad objectives for a State of the Carbon Cycle Report are (1) to summarize scientific knowledge about carbon cycle properties and changes, and (2) to provide scientific information for decision support and policy formulation concerning carbon." The first SOCCR will be CCSP Synthesis and Assessment Report (SAR) 2.2.

[FOOTNOTE 1: The *Terms of Reference for a First State of the Carbon Cycle Report* can be found at <http://www.carboncyclescience.gov>. It was prepared by the CCIWG in consultation with its Science Steering Group, completed in May 2003, and posted on the web in June 2003.]

The carbon cycle chapter of the CCSP Strategic Plan describes a long-term vision to regularly produce a comprehensive report on the state of the global carbon cycle within 10 years and projects that a near-term, prototype report focused on North America can be produced within 2 years. SAR 2.2 will produce substantive information about North America's carbon budget and the role of the United States, while also serving as a prototyping activity for a future global report. Subsequent reports will expand in geographic coverage and/or in depth and breadth of analyses. They are expected to evolve based on the lessons learned in producing earlier reports.

1.2. Topic and Content

SAR 2.2 will provide a synthesis and integration of the current knowledge of the North American carbon budget and its context within the global carbon cycle. In a format useful to decisionmakers, it will (1) summarize our knowledge of carbon cycle properties and changes relevant to the contributions of and impacts upon the United States and the rest of the world, and (2) provide scientific information for U.S. decision support focused on key issues for carbon management and policy.

SAR 2.2 will address carbon emissions, natural reservoirs and sequestration, rates of transfer, the consequences of changes in carbon cycling on land and the ocean, effects of purposeful carbon management, and the socio-economic drivers and consequences of changes in the carbon cycle. It will include an analysis of North America's carbon budget that will document the state of knowledge and quantify uncertainties. This analysis will provide a baseline against which future results from the North American Carbon Program (NACP) can be compared. More specifically, SAR 2.2 will:

- Quantify current uncertainties related to the buildup of carbon dioxide and methane in the atmosphere. For example, it will provide estimates of carbon dioxide emissions from combustion of fossil fuels in North America for the periods 1990-1999 and 2000-2004.
- Discuss current best projections of the future of the North American carbon budget, including projected uncertainties in fossil fuel emissions and the impact of policy and technology scenarios on those emissions.
- Provide current best estimates, with the associated uncertainties, of the fractions of global and North American fossil-fuel carbon emissions being taken up by North America's ecosystems and adjacent oceans.
- Provide current, best available answers to specific questions about the North American carbon budget relevant to carbon management policy options. The questions will be identified through early and continuing dialogue with SAR 2.2 stakeholders. The answers will include explicit characterization of uncertainties.
- Identify where research supported by the North American Carbon Program will reduce current uncertainties in the North American carbon budget and where future enhancements of NACP research can best be applied to further reduce critical uncertainties.
- Describe and characterize the carbon cycle as an integrated interactive system, using innovative graphics to depict the carbon cycle in ways that are easily understandable.

1.3. Audience

The audience for SAR 2.2 includes scientists, decisionmakers in the public sector (Federal, State, and local governments), the private sector (carbon-related industry, including energy, transportation, agriculture, and forestry sectors; and climate policy and carbon management interest groups), and the general public. This broad audience is indicative of the diversity of stakeholder groups interested in knowledge of carbon cycling in North America and of how such knowledge might be used to influence or make decisions. Not all scientific information needs of this broad audience can be met in this first synthesis and assessment report, but the scientific information to be provided will be of interest to all. The primary users of SAR 2.2 are likely to be officials involved in formulating climate policy, individuals responsible for managing carbon in the environment, and scientists involved in assessing and/or advancing the frontier of knowledge.

1.4. Intended Use

SAR 2.2 will be used (1) as a state-of-the-art assessment of our knowledge of carbon cycle properties and changes relevant to the contributions of and impacts upon the United States and the rest of the world; (2) as a contribution to relevant national and international assessments; (3) to provide the scientific basis for decision support that will guide management and policy decisions that affect carbon fluxes, emissions, and sequestration; (4) as a means of informing policymakers and the public concerning the general state of our knowledge of the global carbon cycle with respect to the contributions of and impacts on the United States; and (5) as a statement of the carbon cycle science information needs of important stakeholder groups. For example, well-quantified regional- and continental-scale carbon source and sink estimates, error terms, and associated uncertainties will be available for use in U.S. climate policy formulation and by resource managers interested in quantifying carbon emissions reductions or carbon uptake and storage. It is expected that participating scientists will publish parallel research articles in peer-reviewed science journals. These research articles will augment SAR 2.2 as a baseline against which to compare future NACP results and as input to future Intergovernmental Panel on Climate Change (IPCC) assessments. Senior managers and the general public will use the Executive Summary of SAR 2.2 and the SOCCR (SAR 2.2) web site—created to support SAR 2.2 development—to improve their overall understanding of the U.S. role in Earth's carbon budget and to gain perspective on what is and is not known.

1.5. Questions to be Addressed

Questions to be addressed by SAR 2.2 follow:

- What is the carbon cycle and why should we care?
- How do North American carbon sources and sinks relate to the global carbon cycle?
- What are the primary carbon sources and sinks in North America, and how are they changing and why?
- What are the options and measures that could significantly affect the carbon cycle?
- How can we improve the application of scientific information to decision support for carbon management and climate decisionmaking?

These questions are starting points for producing SAR 2.2; they were developed by the proposed SAR 2.2 Coordinating Team in consultation with the Agency Executive Committee (see Sections 2 and 3) and refined at the first stakeholders workshop. The draft outline of major sections of the report (see Attachment 1) elaborates on how they will be addressed in the report.

2. Contact Information: E-Mail and Telephone for Responsible Individuals at the Lead and Supporting Agencies

As assigned by the Climate Change Science Program Interagency Committee, the lead agencies are the Department of Energy (DOE), the National Oceanographic and Atmospheric

Administration (NOAA), and the National Aeronautics and Space Administration (NASA); the responsible individuals are Dr. Roger Dahlman, Dr. David Hofmann, and Dr. Diane Wickland and Mr. Ed Sheffner, respectively. Supporting agencies are the U. S. Department of Agriculture (USDA) and U.S. Geological Survey (USGS); the responsible individuals are Dr. Marilyn Buford and Mr. Peter Murdoch, respectively.

Roger Dahlman (DOE)	Roger.Dahlman@science.doe.gov	(301) 903-4951
David Hofmann (NOAA)	David.J.Hofmann@noaa.gov	(303) 497-6966
Diane E. Wickland (NASA)	Diane.E.Wickland@nasa.gov	(202) 358-0245
Ed Sheffner (NASA)	Edwin.J.Sheffner@nasa.gov	(202) 358-0239
Marilyn Buford (USDA)	mbuford@fs.fed.us	(703) 605-5176
Peter Murdoch (USGS)	pmurdoch@usgs.gov	(518) 285-5663

This group of lead and supporting agency representatives has been designated the "Agency Executive Committee" and will be hereafter referred to as such. The Agency Executive Committee plans to work in partnership with the CCIWG to develop SAR 2.2 in a way that is compatible with the SOCCR TOR. At present, all members of the Agency Executive Committee are also active members of the CCIWG. The CCIWG has formally approved that the Agency Executive Committee will fulfill the role of the "Executive Committee" envisioned in the SOCCR TOR.

3. Lead Authors: Required Expertise of Lead Authors and Biographical Information for Proposed Lead Authors

Working in close cooperation with the Agency Executive Committee, the CCIWG received, conducted a peer review, selected, and funded a proposal from a team of scientific experts to prepare the first SOCCR (SAR 2.2). The proposal was unsolicited and was received after the CCIWG's TOR for SOCCR was made publicly available. NASA, NOAA, DOE, and the National Science Foundation (NSF) have agreed to provide the funding for SAR 2.2.

The lead authors and their roles are:

Dr. Anthony King, Oak Ridge National Laboratory	Overall Lead and Interim Lead for Scientific Content
Dr. Lisa Dilling, National Center for Atmospheric Research	Stakeholder Interaction Lead
Dr. David Fairman, Consensus Building Institute, Inc.	Stakeholder Interaction
Dr. Gregg Marland, Oak Ridge National Laboratory	Scientific Content
Dr. Adam Rose, The Pennsylvania State University	Scientific Content (Economics)
Dr. Thomas Wilbanks, Oak Ridge National Laboratory	Stakeholder Interaction

Their activities will be coordinated by:

Mr. Gregory Zimmerman, Oak Ridge National Laboratory	Project Coordinator

These individuals will be responsible for organizing and outlining SAR 2.2 and for its final content and submission to the Agency Executive Committee. They will identify chapter authors, coordinate all the inputs to SAR 2.2, and lead the overall synthesis and integration of the report. They will provide oversight and editorial review of individual chapters and will, with the chapter authors, prepare any overview chapters and the Executive Summary. In order to minimize confusion with the group of chapter authors, this group of lead authors and the Project Coordinator will hereafter be referred to as the "SAR 2.2 Coordinating Team." Their biographies are provided in Attachment 2.

The responsibility for writing each individual chapter of SAR 2.2 will be assigned to a scientist expert in the topic area of the chapter; this person will be designated the chapter author. The chapter authors will be recognized leaders in their fields, drawn from the wide and diverse scientific community of North America and the world, as well as other qualified stakeholder groups. Qualifications that will be recognized are the quality and relevance of current publications in the peer-reviewed literature pertaining to their chapter topics, past or present positions of leadership in the topic fields, and other documented experience and knowledge of high relevance. Lead chapter authors will be responsible for the review and synthesis of current knowledge and production of text. They will be responsible for recruiting well-qualified contributing authors in their areas of expertise and responsibility. Chapter authors will be responsible for assuring that science and stakeholder review comments on their chapters are reflected in the final report.

Candidate chapter authors have been contacted and have agreed to participate in the SOCCR (SAR 2.2) process:

Dr. Francisco Chavez, Monterey Bay Aquarium Research Institute
Dr. Kenneth Davis, The Pennsylvania State University
Dr. Richard Houghton, The Woods Hole Research Center
Dr. Jennifer Jenkins, University of Vermont
Dr. Stephen Pacala, Princeton University
Dr. Keith Paustian, Colorado State University
Dr. Pieter Tans, National Oceanic and Atmospheric Administration
Ms. Mieke van der Wansem, Consensus Building Institute, Inc.
Dr. Steven Wofsy, Harvard University

Their biographies are provided in Attachment 3. The SAR 2.2 Coordinating Team will discuss the draft chapter outline and candidate chapter authors in their initial consultations with science, government, private sector, and other stakeholders, and will provide opportunities for comments and additional nominations during these consultations and from the public through the CCSP and SOCCR (SAR 2.2) web posting and comment processes. Anyone interested in nominating authors to contribute to SAR 2.2 is encouraged to do so. Nominations must include contact information and a biography (or resume / curriculum vitae) for each candidate author recommended. They must be sent to Ms. Gloria Rapalee, Carbon Cycle Program Officer, at <grapalee@usgcrp.gov>.

The chapter author's assignment to lead a specific topical chapter will be determined as part of this process. Lead and contributing chapter author selections will be made to ensure a balance of scientific and technical expertise and that disparate views that have significant scientific support are represented. Final authorship decisions will be made by the SAR 2.2 Coordinating Team in consultation with the Agency Executive Committee and will be posted on the SOCCR (SAR 2.2) web site after this prospectus is approved by the CCSP Interagency Committee.

4. Stakeholder Interactions

A process for engaging important stakeholder groups and establishing an ongoing dialogue with them will be a priority activity. Stakeholder involvement is essential to ensure *transparency* – open access to information on the SAR 2.2; *feedback on relevance* – review and comment on the SAR 2.2 process and verification that information produced by the SAR 2.2 will be useful; and *credibility* – recognition by the stakeholders of the scientific validity and independence of the SAR 2.2. Neither the CCIWG nor the Agency Executive Committee believe they have the expertise or time to properly engage the most important stakeholder groups or scope the stakeholder issues to be addressed in SAR 2.2. Therefore, these activities will be the responsibility of the SAR 2.2 Coordinating Team. Their plan includes *a structured dialogue between scientists and stakeholders to identify and clarify information needs of managers and decisionmakers* as the first of two major SAR 2.2 tasks.

The process of engaging stakeholders requires first establishing a meaningful, two-way dialogue. The SAR 2.2 Coordinating Team notes in its proposal that *the initial design and context are critically important* and that *the framing process requires great care*. The SAR 2.2 Coordinating Team's plan for a structured dialogue with stakeholders involves a partnership with the Consensus Building Institute, Inc. — an organization that has broad experience working with diverse stakeholder communities in the energy and environmental sectors. A multistage process has been planned to provide access and information exchange (see Section 9 below for the proposed timeline).

Significant activities have already been conducted to seek stakeholder input and to scope the report. They were conducted as SOCCR activities, without reference to SAR 2.2. These activities were used to prepare this prospectus and its attachments. They include:

- An initial draft outline of the SOCCR (SAR 2.2) was produced by the SOCCR Coordinating Team and delivered to the Agency Executive Committee on 30 September 2004.
- A stakeholder assessment involving in-depth interviews and discussions with approximately 30 representatives of key stakeholder communities (scientists, policymakers, policy advocates, carbon-related industries) was initiated 1 October 2004. Representatives of key stakeholder constituencies were identified by taking advantage of existing stakeholder contacts, processes such as CCSP's web posting and public comment process, inputs from individuals providing information for the update to the Voluntary Greenhouse Gas Registry, CCIWG member's knowledge of key policymakers and groups, and referrals from the stakeholders contacted. Inputs were assessed in order to

narrow focus to stakeholders needs in a few key areas, and then to conduct in-depth interviews with stakeholders in those areas. This assessment resulted in a November 2004 *State of the Carbon Cycle Report Stakeholder Assessment Report*.

- A web site for SOCCR (<http://www.ucar.edu/soccr>) was developed and put online in October 2004 with information on progress and planning for the SOCCR. A listserve mailing list was established to distribute electronic information about SOCCR and contains over 300 individuals.
- A First Stakeholders Workshop for the SOCCR was held at the Key Bridge Marriott hotel in Arlington, Virginia, 15-16 November 2004. Twenty-seven participants from industry, academia, environmental interest organizations, scientists/researchers, and decisionmakers from the Federal government attended the workshop. A primary objective of this First Stakeholders Workshop was to seek input on how well the 30 September 2004 draft outline addressed scientific, policy, business, and other interests and concerns. The workshop resulted in the creation of a revised outline responsive to the interests and needs of the stakeholders. The workshop also identified additional opportunities for future stakeholder involvement throughout the development of the SOCCR report.
- The draft outline produced at the First Stakeholder Workshop (Attachment 1) was posted on the SOCCR web site on 19 November 2004 for a public comment period of 30 days ending 19 December 2004. Notice of the availability of the SOCCR outline for comment was e-mailed to all interviewees, workshop participants, candidate chapter authors, and individuals on the SOCCR listserve shortly after posting on the web. A number of comments have been received through the automated web site to date. The comment period will be extended to coincide with that for this prospectus and all comments received will be considered according to the *Guidelines for Producing Synthesis and Assessment Reports*.
- A "sounding board" composed of individuals of widely recognized expertise and stature in carbon cycle research has been established to provide input to the SOCCR Coordinating Team primarily on scientific/technical issues in preparing the report.
- A Town Hall meeting on the SOCCR (*The State of the Carbon Cycle Report (SOCCR): Integrating Scientific Synthesis and Assessment with Stakeholders Interests and Issues)* was held 16 December 2004, as part of the 2004 AGU Fall Meeting in San Francisco, California.

Two additional stakeholders workshops will be conducted to foster communication, establish interactions among stakeholders and SAR 2.2 authors, and develop inputs to shape the content of SAR 2.2. Throughout the development of SAR 2.2, inputs from the stakeholders will be communicated to the SAR 2.2 chapter authors so that the report can be revised and refined. The SAR 2.2 Coordinating Team is planning to take advantage of CCSP's posting and review process to both identify stakeholders and capture additional inputs from them. Stakeholder inputs that cannot be incorporated into SAR 2.2 will be captured and summarized so they can be used to inform future *State of the Carbon Cycle Reports*.

5. Drafting Process (Including Materials to be Used in Preparing the Product)

The SAR 2.2 Coordinating Team will discuss the draft chapter outline in their initial consultations with science, government, private sector, and other stakeholders, and will provide opportunities for comments and additional nominations during these consultations and from the public through the CCSP and SOCCR (SAR 2.2) web posting and comment processes. The SAR 2.2 Coordinating Team will be responsible for developing a detailed outline of the SAR 2.2 and making final decisions, in consultation with the Agency Executive Committee, about the scope and full content of the report. The SAR 2.2 Coordinating Team will be responsible for ensuring the report is well integrated, balanced, and responsive. The SAR 2.2 Coordinating Team plans to achieve the scientific synthesis through compilation and analysis of the relevant scientific literature and available databases. Since SAR 2.2 will be completed during the initial stages of NACP, much of the information for SAR 2.2 will, by necessity, be derived from publications of many independent investigations and may consider portions of North America or may subset North America from larger geographical analyses. Many decisions will be required about how to handle disparate information. A workshop involving the chapter authors will be held to set standards for kinds of information and procedures for handling them.

Many data sets required for SAR 2.2 are already available at data archives such as the NOAA Climate Monitoring Diagnostics Laboratory (CMDL), the DOE Carbon Dioxide Information Analysis Center (CDIAC), and the NASA Distributed Active Archive Centers (DAACs). However, some of the scientific questions raised by SAR 2.2 will require further data compilation, synthesis, and integration efforts. The SAR 2.2 Coordinating Team will compile a central tabulation of referenced and supporting data, including links to available data, documentation, and contact information for data that are not easily accessible. The use of unpublished data will be discouraged for SAR 2.2. If any such data should be proposed for use, approval will be sought consistent with the *Guidelines for Producing CCSP Synthesis and Assessment Products*. The SAR 2.2 will also require tabulation of data that are not purely numerical. As described above, the effective coordination of the SAR 2.2 will depend on a systematic and regularly updated tabulation of the activities of ongoing related programs, with contact information and links to relevant web sites. The proper documentation of in-text citations will require compilation of a substantial web-accessible bibliographic database.

All authors will be provided with information quality guidelines as specified in the *Guidelines for Producing CCSP Synthesis and Assessment Products*, which will include compliance with the overall Office of Management and Budget (OMB) guidelines: *OMB Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies*. The authors of SAR 2.2 will be expected to emphasize the quantification of errors and confidence levels, characterization of uncertainties, and transparency of original data and model sources. SAR 2.2 will provide a clear discussion of uncertainties and how uncertainties may be reduced, preferably through a section of each chapter in which measurements, model results, or combinations of data and models occur. Numerical values will be accompanied by measures of uncertainty (e.g., ± x units or percent). Where the uncertainty cannot be quantified, an explanation or justification will be given. Statements that are vague will be avoided. All data used in SAR 2.2 (or linked by a SAR 2.2-related website) will be clearly documented, including data source and other information needed to evaluate information.

To ensure consistency and thoroughness in the treatment of uncertainties across all chapters of SAR 2.2, the SAR 2.2 Coordinating Team will maintain regular oversight of overall data and information quality as presented in workshops and in draft text. Statistical methods will be checked, and derived estimates will be traced to original measurements and model output. The SAR 2.2 Coordinating Team will engage the services of a mathematical and statistical analysis firm to support this effort.

6. Review

The Agency Executive Committee will ensure that SAR 2.2 is reviewed at all stages as specified in the *Guidelines for Producing CCSP Synthesis and Assessment Products,* that comments and other feedback are provided to the SAR 2.2 Coordinating Team for response, and that responses are documented.

6.1. During Drafting Period

The SAR 2.2 Coordinating team plans to post on the SOCCR (SAR 2.2) web site the list of candidate authors and all drafts of the outline, chapters, and complete report, with a mechanism for providing comments through the web site. The SAR 2.2 Coordinating Team will also establish a process and standards for ongoing information quality review.

6.2. Expert Review of First Draft

The Agency Executive Committee will select expert peer reviewers to conduct a formal, external peer review of the first draft, drawing from the national and international communities of scientific and technical experts and following the highest standards of rigor in peer review. NSF's peer review procedures and conflict-of-interest rules will be applied in the identification of expert peer reviewers. Expert peer reviewers will be deemed qualified through their record of scholarly publication in the topic areas of SAR 2.2 and/or comparable experience and accomplishment that are well-documented. The Agency Executive Committee will draw from all CCIWG agencies' lists of qualified peer reviewers and will solicit suggestions for peer reviewers from the scientific community and other stakeholders through the CCSP and SAR 2.2 web posting and comment processes. Anyone interested in recommending expert peer reviewers for this process is encouraged to do so. Recommendations of expert peer reviewers must include contact information and a biography (or resume / curriculum vitae) for each person recommended. They must be sent to Ms. Gloria Rapalee, Carbon Cycle Program Officer, at <grapalee@usgcrp.gov>. Reviewer selections will be made to ensure a balance of scientific and technical expertise and that disparate views that have significant scientific support are considered appropriately.

The expert peer review will be conducted by requesting electronic mail-in evaluations from no fewer than 15 scientific/technical experts. These reviews, as submitted, will be made available to

the SAR 2.2 Coordinating Team. In addition, the Agency Executive Committee will provide their integrated assessment of the reviews and guidance concerning what type of response seems to be warranted. The Agency Executive Committee does not plan to convene a peer review panel, but reserves the right to do so (by either calling a meeting or holding a teleconference) if conflicting comments or detailed technical considerations need to be resolved prior to providing feedback to the SAR 2.2 Coordinating Team. All review comments submitted during the expert review will be made publicly available without attribution to the reviewer.

6.3. Review Dates

The expert peer review will be conducted during a 1-month period to start in January 2006, and end by mid-February 2006. The public comment period will begin in late April 2006.

7. Related Activities, Including Other National and International Assessment Processes

As a near-term product, SAR 2.2 will utilize, to the maximum extent possible, the information available from existing data, programs, and related activities in the United States and internationally. SAR 2.2 will be coordinated with related work in a way that does not duplicate previous and ongoing assessments. Coordination with the NACP will be necessary to ensure that the most current information is available to scientists and stakeholders contributing to SAR 2.2 and so that NACP benefits from the scientific baseline and assessment of stakeholder needs for scientific information that SAR 2.2 will establish. SAR 2.2 will be both informed by and used as an input to relevant national and international assessments.

A particular concern is the development of partnerships with international groups whose interests overlap those of SAR 2.2. Although SAR 2.2 will be a U.S. product, the information in SAR 2.2 must reflect international scientific understanding. It is imperative that SAR 2.2 be coordinated with ongoing international efforts to avoid duplication of effort, to maximize effectiveness, and to ensure that the most up-to-date integrated science is presented in a global context. The SAR 2.2 Coordinating Team will ensure that relevant international scientific bodies are informed of the intent and progress of the SAR 2.2 and will seek to harmonize its efforts with ongoing relevant work of such bodies.

The SAR 2.2 Coordinating Team will establish informal communications with the IPCC, the Global Carbon Project (GCP), and national programs in Canada and Mexico. The schedule for the next IPCC assessment report (May 2005 for material in draft form, and December 2005 for the material to have been published) is such that the results of SAR 2.2 will not be available in time to be incorporated. However, informal communications between the two activities and their lead authors will ensure that the most up-to-date and reliable information and analyses that are available can inform both activities.

The Agency Executive Committee and the CCIWG will support the SAR 2.2 Coordinating Team in engaging scientists from other nations in preparing and reviewing the scientific and technical content of SAR 2.2.

8. Communications: Proposed Method of Publication and Dissemination of the Product

Production and distribution of the final SAR 2.2 will be arranged by the Agency Executive Committee, in consultation with the CCIWG and CCSP Interagency Committee. Financial support will come from the Federal government agencies of the CCIWG and the U.S. CCSP. SAR 2.2 will be printed and hardcopies will be made available through the CCSP Office; it will also be made available electronically on both the CCSP and SOCCR (SAR 2.2) web sites.

An interactive, high-quality web site has been developed for SOCCR (SAR 2.2) and will be used to make SAR 2.2 and a wide variety of information about it available to all stakeholders and the general public. The web site will serve multiple functions: complementing the printed version of the SAR 2.2, allowing worldwide access to the SAR 2.2 from any internet location; expanding the SAR 2.2 content in a fashion that will be especially useful to the research community by allowing users to click on links for further information, references, notes, etc. under specific sections of the text; linking to U.S. agency and international carbon cycle science and management websites—providing a web portal to highlight all of the existing, ongoing work; and providing an interactive way for users to comment on their experience of the SAR 2.2 and how it might be made more useful in the future.

Opportunities for offering information to the SAR 2.2 Coordinating Team will be broadly disseminated in scientific and other public venues. The SAR 2.2 Coordinating Team, chapter authors, and other participants in SAR 2.2 will be encouraged to publicize the SAR 2.2 process widely. The purposes are to disseminate information about the process and to persuade key stakeholders to participate and use the SAR 2.2 product as an aid to management and decisionmaking. A package of material will be created for all those involved in the SAR 2.2 to use as they travel in their ongoing professional work. The SOCCR (SAR 2.2) web site will be publicized at scientific meetings, to agency representatives, and at other appropriate venues (e.g., carbon sequestration meetings). The web site will explain the process of the SAR 2.2, and list information as it is approved for release. There will be an opportunity for comments to be logged on that site, and records will be kept of all comments as well as the responses to those comments.

9. Proposed Timeline

SAR 2.2 will be completed within 24 months of when work on the first SOCCR was initiated. An aggressive schedule for development and review has been established:

Activity	Months From Start	Estimated Completion Date
Start work	0	1 September 2004
Submit draft outline to Agency Executive Committee	1	1 October 2004
Identify and initiate consultations with stakeholders	1.5	16 October 2004
First Stakeholders Meeting	2.5	15 November 2004
Establish SOCCR web site	2.5	15 November 2004
CCSP posts prospectus for public review	4.5	January 2005
Public review period for prospectus ends	5.5	February 2005
CCSP posts revised, final prospectus	6	late-February 2005
First Chapter Authors Workshop	7	late-March 2005
Second Stakeholders Meeting	11.5	mid-August 2005
Second Chapter Authors Workshop	11.5	mid-August 2005
Chapter Authors' materials/manuscripts completed	13.5	mid-October 2005
Submit Draft SAR 2.2 to Agency Executive Committee	16	late December 2005
Complete expert peer review of Draft SAR 2.2	17.5	mid-February 2006
Deliver revised SAR 2.2 to Agency Executive Comm.	20	late April 2006
Post Revised SAR 2.2 for public review and comment	20	late April 2006
Third Stakeholders Meeting	21	late May 2006
Public review and comment period closes	21.5	mid-June 2006
Complete and deliver SAR 2.2 to CCSP	24	late August 2006
CCSP and NSTC review completed	25	October 2006

Meeting this schedule depends on the approval of this prospectus by late February 2005 so that commitments for the participation of chapter authors can be executed. Any delays in that approval or the time needed for the agency-controlled review processes in this schedule will, of necessity, result in commensurate slippages in this schedule.

List of Attachments

1. Draft Outline
2. Biographies of SOCCR Coordinating Team (i.e., SAR 2.2 "Lead Authors")
3. Biographies of Candidate SAR 2.2 Chapter Authors

Attachment 1. Draft Outline for State of the Carbon Cycle Report - North America

Executive Summary

I. Introduction: What is the carbon cycle and why should we care?

PART I: The Carbon Cycle in North America

II. How do North American carbon sources and sinks relate to the global carbon cycle?

A. Brief overview of the natural carbon cycle and how the carbon budget is defined
B. Fossil fuel emissions
C. Accumulation of carbon in the atmosphere
D. Vegetation, soils, and land use
E. Oceans and continental margins
F. Quantitative integrated historical and current North American carbon budget in a global context

III. What are the primary carbon sources and sinks in North America, how are they changing and why?

A. Introduction and overview
B. Summary of carbon budget components for North America [synthesis linked to information in depth in Part II]
   1. Brief overview of the natural carbon cycle and how the carbon budget is defined for North America
   2. Fossil fuel emissions
   3. Terrestrial vegetation, soils and land use
   4. Aquatic carbon and land-ocean interface
   5. Coastal margins and margin-deep ocean interface
C. Knowns and uncertainties
D. Summary: State of the North American carbon budget
   1. Quantify current carbon balance of North American land and coastal margins with respect to atmospheric carbon concentrations
   2. Place current balance into historical and future perspective
   3. Potential changes in carbon sources and sinks due to factors other than carbon management

IV. What are the options and measures that could significantly affect the carbon cycle?

A. Expectations for CO_2 and CH_4 concentrations in the atmosphere with current trajectories, by e.g. 2050 (review of best-developed scenarios, including discussion of global warming potentials)
B. Options and measures (national, state, local, enterprise-level) that can reduce sources, potential reduction in atmospheric concentrations, and potential cost per unit of reduced concentrations or GWP
C. Options and measures that can enhance sinks (national, state, local, enterprise-level), potential impact and potential cost per unit impact, by sector (agriculture, forestry, other land use, injection technologies)

D. Integrated comparison of sink reduction and source enhancement options, with table/chart: potential for atmospheric concentration reductions, costs per unit reduction and possible synergies and substitution effects across options
E. Implementation issues:

V. How can we improve the application of scientific information to decision support for carbon management and climate decision-making?

PART II – The Systems and Activities that Control the Carbon Budget in North America

VI. Emissions from consuming fossil fuels and producing concrete

VII. Agriculture

VIII. Forests
A. Boreal
B. Temperate
C. Tropical

IX. Grass and Rangelands

X. Boreal Tundra and Peatlands (Canada and Alaska)

XI. Wetlands

XII. Other land categories: Shrub lands, Arid lands, Urban ecosystems

XIII. Aquatic carbon, coastal management, ocean basins

Attachment 2. Biographies of SOCCR Coordinating Team (i.e., SAR 2.2 "Lead Authors")

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Education

1978	B.S.	Zoology, Arkansas State University
1981	M.S.	Biology, Arkansas State University
1986	Ph.D.	Ecology, University of Tennessee, Knoxville

Research interests

Terrestrial ecosystems as part of the global Earth system, ecosystem and land-surface processes at landscape, regional, and global scales, climate-ecosystem feedbacks, carbon and water cycle modeling, land-use change, spatially structured population dynamics and modeling, theory of scale and system organization in ecology, model sensitivity and uncertainty analysis, model evaluation.

Employment History

1992-present	Research Staff Member, Environmental Sciences Division, Oak Ridge National Laboratory
1987-1992	Research Associate, Environmental Sciences Division, Oak Ridge National Laboratory

Selected Publications

Amthor, J.S., J. M. Chen, J.S. Clein, S.E. Frolking, M.L. Goulden, R.F. Grant, J.S.Kimball, A.W. King, A.D. McGuire, N.T. Nikolov, C.S. Potter, S. Wang and S.C. Wofsy. 2001. Boreal forest CO_2 and evapotranspiration predicted by nine ecosystem process models: inter-model comparisons and relationships to field measurements. Journal of Geophysical Research 106:33,623-33,648.

Potter, C.S., S. Wang, N.T. Nikolov, A.D. McGuire, J. Liu, A.W. King, J.S. Kimball, R.F. Grant, S.E. Frolking, J. Clein, J.M.Chen and J.S. Amthor. 2001. Comparison of boreal ecosystem model sensitivity to variability in climate and forest site parameters. Journal of Geophysical Research 106:33,671-33,688.

King, A.W., W.M. Post and S.D. Wullschleger. 1997. The potential response of terrestrial carbon storage to changes in climate and atmospheric CO_2. Climatic Change 35:199-227.

King, A.W., W.R. Emanuel, S.D. Wullschleger and W.M. Post. 1995. In search of the missing carbon sink: a model of terrestrial biospheric response to land-use change and atmospheric CO_2. Tellus 47B:501-519.

King, A.W., R.V. O'Neill and D.L. DeAngelis. 1989. Using ecosystem models to predict regional CO_2 exchange between the atmosphere and the terrestrial biosphere. Global Biogeochemical Cycles 3:337-361.

Jager, H.I., T.L. Ashwood, B.L. Jackson and A.W. King. 2000. Spatial uncertainty analysis of ecological models. Proceedings of the 4th International Conference on Integrating GIS and Environmental Modeling (GIS/EM4): Problems, Prospects, and Research Needs. Banff, Alberta, Canada, September 2-8, 2000.

Jager, H.I., W.W. Hargrove, C.C. Brandt, A.W. King, R.J. Olson, J.M.O. Scurlock and K.A. Rose. 2000. Constructive contrasts between modeled and measured climate responses over a regional scale. Ecosystems 3:396-411.

Post, W.M., A. King and S.D. Wullschleger. 1997. Historical variations in terrestrial biospheric carbon storage. Global Biogeochemical Cycles 11:99-109.

King, A.W., W.R. Emanuel and W.M. Post. 1992. Projecting future concentrations of atmospheric CO_2 with global carbon cycle models: simulating historical changes in atmospheric CO_2. Environmental Management 16:91-108.

Post, W.M., T.-H. Peng, W.R. Emanuel, A.W. King, V.H. Dale and D.L. DeAngelis. 1990. The global carbon cycle. American Scientist 78:310-326.

LISA DILLING
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National Center for Atmospheric Research
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EDUCATION

1997 Ph.D. University of California, Santa Barbara, CA Biological Sciences
1989 B.A. Harvard University, Cambridge, MA Biology, *magna cum laude*

EXPERIENCE

2003-present	Project Scientist II, Environmental and Societal Impacts Group, National Center for Atmospheric Research, Boulder CO
2002-2003	Visiting Scientist, Environmental and Societal Impacts Group, National Center for Atmospheric Research, Boulder CO
1999-2002	Co-Chair, Carbon Cycle Interagency Working Group, U.S. Global Change Research Program
1998-2002	Program Manager, Carbon Cycle Program, Office of Global Programs, National Oceanic and Atmospheric Administration, Silver Spring, MD.

1997-1998	Associate Program Manager for Ocean-Atmosphere Carbon Exchange Study and Atlantic Climate Change Program, Office of Global Programs, National Oceanic and Atmospheric Administration (through UCAR), Silver Spring, MD.
1996-1997	National Sea Grant Fellow, International Development, Office of Global Programs, National Oceanic and Atmospheric Administration, Silver Spring, MD
1990-1995	Teaching and Graduate Research Assistant, Department of Biological Sciences, University of California, Santa Barbara, CA
1989-1990	Technical Communications Specialist, Eastern Research Group, Inc., Arlington, MA

AWARDS

NOAA Cash Award, 1998, 1999, 2000, 2001
Dean John A. Knauss Marine Policy Fellowship, 1995
National Science Foundation Graduate Fellowship, 1991-1993

PUBLICATIONS

Dilling L, Doney S, Edmonds J, Gurney KR, Harriss R, Schimel D, Stephens B, and Stokes G. 2003. The role of carbon cycle observations and knowledge in carbon management. Annual Review of Environment and Resources 28:521-58.

Dilling L and MA Brzezinski. 2004. Quantifying marine snow as a food choice for zooplankton using stable silicon isotope tracers. In press, Journal of Plankton Research.

Dilling L and AL Alldredge. 2000. Fragmentation of marine snow by swimming macrozooplankton: A new process impacting carbon cycling in the sea. Deep Sea Res. I 47:1227-1245.

Dilling L, J Wilson, D Steinberg, and AL Alldredge. 1998. Feeding by the euphausiid Euphausia pacifica and the copepod Calanus pacificus on marine snow. Mar. Ecol. Prog. Ser. 170: 189-201.

Dilling L. Consumption and Fragmentation of Marine Snow by Euphausiids and Copepods. PhD Dissertation.

Dilling L. and AL Alldredge. 1993. Can chaetognath fecal pellets contribute to carbon flux? Mar. Ecol. Prog. Ser. 92:51-58.

SELECTED INVITED PRESENTATIONS
[excluding multiple NOAA and National program presentations]

Co-Chair, Session: Human Interactions and the Carbon Cycle in North America, AGU Fall 2003
Co-Chair, Session: State of the Science: The Role of the Carbon Cycle in the Earth System. Winter AMS meeting, Long Beach, CA 2003
"The U.S. Carbon Cycle Program: Building an Integrated Program" University of Maryland, College Park MD 2002
"Building an Integrated Carbon Cycle Program" Old Dominion University, Norfolk VA 2002
"Ocean Sciences at NOAA since September 11th" AGU/Ocean Sciences Meeting 2002
Co-Chair, Special Session on Oceans, Carbon Cycle and Societal Interactions, Winter American Meteorological Society Meeting, Albuquerque NM 2001

PROFESSIONAL MEMBERSHIPS

American Geophysical Union
American Meteorological Society

COLLABORATORS

Alldredge, A (University of California, Santa Barbara), Betsill, M (Colorado State University), Brzezinski, M (UC Santa Barbara), Conant, R (CSU/NREL), Cullen, H (NCAR/The Weather Channel), Doney, S (Woods Hole Oceanographic Institution), Edmonds Jae (Pacific Northwest National Laboratories, Joint Global Change Research Institute at the University of Maryland), Gurney KR. (CSU), Harriss R (NCAR), Morss, R (NCAR), Moser, S (NCAR), Pielke, Jr., R (CU), Pulwarty, R (NOAA/CIRES/CU), Sarewitz, D (CSPO), Schimel, D (NCAR), Stephens, B (NCAR), Stokes, G (Pacific Northwest National Laboratories, Joint Global Change Research Institute at the University of Maryland), Sundquist, E (USGS), Trtanj, J (NOAA/OGP)

Doctoral Thesis Advisor: Alice Alldredge, University of California, Santa Barbara

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DAVID M. FAIRMAN
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Professional Experience

Feb.1997-present **Consensus Building Institute** Cambridge, MA
Vice President (7/99-present)
Senior Associate (2/97-6/99)

Facilitator, trainer, researcher and manager for non-profit dispute resolution consulting firm. Facilitate negotiations among government, business and civil society stakeholders on economic and social development, environmental protection and natural resource use. Design and teach training courses on negotiation, mediation and consensus-building for public, non-profit and private organizations. Recent and current project conveners include World Bank, Asian Development Bank, U.S. Agency for International Development, U.S. Dept. of Housing and Urban Development, Florida Dept. of Environmental Protection, Council of State Governments, American Cancer Society, United Way of America, Harvard University.

Feb.2000-present **MIT-Harvard Public Disputes Program** Cambridge, MA
Associate Director

Initiate and direct research projects on application of dispute resolution/consensus building principles and strategies to public policy arenas. Develop strategies and materials for teaching negotiation and dispute resolution skills in secondary, university and professional education settings.

1991-1996 **Private practice** Cambridge, MA
Conflict Resolution Consultant
Designed and taught executive training courses on strategies for using negotiation and consensus building to integrate environmental, social and economic objectives in national and international policy-making. Analyzed and recommended strategies for policy integration at the national and international level. Clients included Netherlands Ministry of Housing, Spatial Planning and Environment; UN Commission on Sustainable Development, UN Development Program; U.S. Agency for International Development.

1989-1991 **Endispute, Inc.** Cambridge, MA
Public Policy Mediator
Assessed public policy conflicts at national, state, and local levels; developed and implemented consensus-building and conflict resolution strategies. Managed stakeholder consultation on siting process for low-level radioactive waste facility. Taught negotiation and conflict management skills to public officials. Clients included American Energy Assurance Council; Maine Low-level Radioactive Waste Authority; Massachusetts Dept. of Industrial Accidents; U.S. Army Corps of Engineers.

1989 **Somerville Community Development Corporation** Somerville, MA
Landlord-Tenant Mediator and Counselor

1987-1988 **Harvard College** South Asia *Sheldon Fellow*

Education

1998 ***Massachusetts Institute of Technology*** *Cambridge, MA*
Ph.D., Political Science. Dissertation examined negotiation strategies of advocates for natural resource policy reform in developing countries, based on extensive field research on forest policy reform in Philippines and Thailand.

1987 ***Harvard University*** *Cambridge, MA*
Bachelor of Arts, summa cum laude in History and Literature.
Awards: Phi Beta Kappa, Sheldon Fellowship for postgraduate study, E.C. Cumming Prize for outstanding thesis, History and Literature Prize for academic achievement, Adams House Arms Citation for contributions to residential community.

Professional Affiliations

Alliance for International Conflict Prevention and Resolution. *Board member. Chairman, Education and Outreach Committee.*
U.S. Environmental Protection Agency: *Senior Mediator, ADR Roster*
U.S. Institute for Environmental Conflict Resolution: *Senior Mediator, Roster of Conflict Resolution Professionals.*
Lincoln Institute of Land Policy: *Faculty Associate*
Association for Conflict Resolution*: Practitioner Member*
Council on Foreign Relations*: Term Member*

SELECTED ASSESSMENT AND FACILITATION PROJECTS

(References available on request)

Asian Development Bank, Chasma Right Bank Irrigation Project Social Assessment. *2001-02. Senior advisor for assessment of unresolved social issues relating to major irrigation project in Pakistan. Developed assessment strategy with CBI field consultant (Prof. Adil Najam); reviewed and edited draft assessment report; advised on agenda and work plan for consultative workshop; provided continuous oversight and advice to CBI field consultant.*

National Public Housing Assessment Policy Dialogue. *2001-02. Lead facilitator for national policy dialogue convened by U.S. Department of Housing and Urban Development (HUD) on public housing assessment. Issues included legal basis for assessment, assessment criteria and methods, and use of assessment results. In parallel, facilitated meeting of public housing industry organizations to develop industry proposals on assessment. Participants include HUD Deputy Assistant Secretaries and staff, four national housing industry associations, three residents' associations, and technical analysts from National Academy of Public Administration. Dialogue is ongoing, pending submission of industry proposals.*

National Energy Policy Initiative. *2001-02. Project manager and co-lead facilitator for convening and facilitating a national energy issues assessment and an expert workshop, in conjunction with the Rocky Mountain Institute. Assessment gathered and synthesized views of 75 leading energy policy stakeholders from business, government, advocacy and academic institutions. Workshop involved twenty-two of the country's leading energy policy experts in joint drafting process. Facilitated drafting process to produce 25-page consensus report and recommendations to inform current Congressional and Administration development of national energy policy. Gave Congressional testimony and participated in Congressional briefing and media outreach on the report.*

Florida Department of Environmental Protection Phosphorus Rule Development. *2001. Co-lead facilitator for rule development process to resolve 12-year controversy over management of phosphorus run-off from agricultural lands into Everglades Protection Area. Issues include maximum permissible phosphorus concentration, compliance test procedures, and permitting/enforcement action to be taken in event of non-compliance. Participants included Federal EPA and National Parks Service, State DEP, regional Water Management District, agricultural producer groups, regulated municipalities regional, state and national environmental groups, and scientific researchers. Process narrowed range of disagreement on scientific and technical issues.*

PAVE PAWS Upgrade Issues Assessment. *2000. Lead assessor of potential for dialogue and consensus building to resolve conflict over health and safety risks of military radar installation at the Massachusetts Military Reservation; conducted 40 stakeholder interviews, prepared assessment, facilitated public meeting and development of*

recommendations for further action. Process led to commitment by public agencies to joint health effects study.

World Bank Forest Policy Evaluation Workshop. *1999-2000. Advised on development of agenda, participation guidelines and ground rules; co-led facilitation of 2-day workshop event; and drafted post-workshop report for global workshop to review World Bank's Evaluation of its forest policy. Issues included balance among environmental, economic and social goals in current policy, and impacts of policy implementation in over 100 countries worldwide. Participants included World Bank staff, donor and borrower governments, forest conservation advocacy groups, commercial timber companies and forest researchers. Participants reached consensus on numerous strengths and weaknesses of Evaluation report, and on recommendations for further action by the World Bank and other forest policy stakeholders.*

SELECTED REPORTS AND PUBLICATIONS

Reframing the Forest: The Politics of Tropical Forest Policy Reform. Washington, D.C.: Resources for the Future Press, forthcoming 2003.

"Integrating Conflict Resolution into the High School Curriculum: The Example of Workable Peace." Co-author with Stacie Nicole Smith. In N. Noddings, ed., Educating for Global Citizenship: Challenges and Opportunities. *New York: Teachers College Press, 2003*.

"Fulfilling the Promise of Environmental Conflict Resolution." Co-author with Lisa Bingham, Dan Fiorino, and Rosemary O'Leary." In L. Bingham and R. O'Leary, eds., Evaluating Environmental and Public Policy Dispute Resolution Programs. Washington, D.C.: Resources for the Future Press, forthcoming 2003.

Consensus Building and Conflict Resolution Toolkit for National Standard Setting Processes. (IKEA-WWF Cooperation for Forest Stewardship, 2002. Available at http://www.piec.org/pathfinder/pages/instruments.html.

National Energy Policy Initiative: Expert Group Report. Snowmass, CO: Rocky Mountain Institute, March 2002.Available at www.nepinitiative.org.

Juan F. Consent Decree Issues Assessment. Confidential report to the Connecticut Department of Children and Families, Juan F. Next Friends (child welfare plaintiffs) and the Office of the Court-Appointed Monitor. January 2001.

Convening Report for Proposed PAVE PAWS Stakeholder Working Group. Cambridge, MA: Consensus Building Institute, March 2000.

"Producing Consensus." Co-author with Sarah McKearnan. In *The Consensus Building Handbook*, L.Susskind et al., eds. Thousand Oaks, CA: Sage Publications, 1999.

Reforming Natural Resource Policies in Developing Countries: The Politics of Forest Policy Reform in the Philippines, Thailand and Costa Rica, 1980-1996. Cambridge, MA: MIT Department of Political Science (dissertation), 1998.

Alternative Dispute Resolution Practitioners Guide. Co-author with Scott Brown and Christine Cervenak. Washington, D.C.: United States Agency for International Development, 1997.

"The Global Environment Facility: Haunted by the Shadow of the Future," In Robert Keohane and Marc Levy, eds., *Institutions for Environmental Aid: Pitfalls and Promise*. Cambridge, MA: MIT Press, 1996.

"Old Fads, New Lessons: Learning from Economic Development Assistance." Co-author with Michael Ross. In Robert Keohane and Marc Levy, eds., *Institutions for Environmental Aid: Pitfalls and Promise*. Cambridge, MA: MIT Press, 1996.

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Education

1964	B.S.	Virginia Polytechnic Institute, Blacksburg, VA
1964-1966		Washington University, St. Louis, MO
1972	Ph.D.	University of Minnesota, Minneapolis, MN

Employment History

2000-present	Distinguished Scientist, Oak Ridge National Laboratory
1987-2000	Senior Staff Scientist, Oak Ridge National Laboratory
1975-1987	Staff Scientist, Institute for Energy Analysis, Oak Ridge Associated Universities
1970-1975	Assistant Professor of Geology, Indiana State University

Professional Service/Activities

Committee on Global Change Research - National Research Council
Lead author - IPCC (Intergovernmental Panel on Climate Change): Special Report on Carbon Capture and Storage
Lead author - IPCC: Third Assessment Report, Land-use Change and Forestry
Lead author - IPCC: Special Report on Land Use, Land-Use Change and Forestry
Lead author - IPCC: Second Assessment Report, Energy Primer

Publications

Marland, G., A Brenkert and J. Olivier. 1999. CO_2 from fossil fuel burning: a comparison of ORNL and EDGAR estimates of national emissions. Environmental Science and Policy 2:265-273.
Marland, G. and B. Schlamadinger. 1999. The Kyoto Protocol could make a difference for optimal forest-based CO_2 mitigation strategy: some results from GORCAM. Environmental Science and Policy 2:111-124.
Schlamadinger B. and G. Marland. 1999. Net effect of forest harvest on CO_2 emissions to the atmosphere: a sensitivity analysis on the influence of time. Tellus 51B:314-325.

Andres, R.J., D.J. Fielding, G. Marland, T.A. Boden and N. Kumar. 1999. Carbon dioxide emissions from fossil-fuel use, 1751-1950. Tellus 51B:759-765.

Sampson, R.N., R.J. Scholes, et al. 2000. Additional human-induced activities – Article 3.4, In Land use, land-use change, and forestry, A special report of the Intergovernmental Panel on Climate Change, R.T. Watson, I.R. Noble, B. Bolin, N.H. Ravindranath, D.J. Verardo and D.J. Dokken (eds.), Cambridge University Press, UK, pp. 181-281.

Marland, G., B. Schlamadinger and R. Matthews. 2000. "Kyoto Forests" and a broader perspective on management. Science 290:1895-1896.

Kheshgi, H., R. Prince and G. Marland. 2000. The potential of biomass fuels in the context of global climate change: focus on transportation fuels. Annual reviews of Energy and Environment 25:1999-2444.

Marland, G., K. Fruit and R. Sedjo. 2001. Accounting for sequestered carbon: the question of permanence. Environmental Science and Policy 4:259-268.

Marland, G., T.O. West and J. Fenderson. 2001. Carbon emitted, carbon saved; CDIAC Communications Newsletter, Issue no. 28, Carbon Dioxide Information Analysis Center, Oak ridge National Laboratory, Oak Ridge, TN.

Marland, G., B.A. McCarl and U. Schneider. 2001. Soil carbon: policy and economics. Climatic Change 51:101-117.

West, T.O. and G. Marland. 2002. A synthesis of carbon sequestration, carbon emissions, and net carbon flux in agriculture: comparing tillage practices in the United States. Agricultural Ecosystems and Environment 91:217-232.

West, T.O. and G. Marland. 2002. Net carbon flux from agricultural ecosystems: methodology for full carbon cycle analyses. Environmental Pollution 116:439-444.

Marland, G. and T. Boden. 2002. The increasing concentration of atmospheric CO_2: how much, when, and why? In Proceedings of the International seminar on nuclear war and planetary emergencies 26th session, R. Ragaini (ed.), 19-24 August, 2001, Erice, Italy, World Scientific Publishing Co., River Edge, New Jersey, USA, pp. 283-295.

Pielke, R.A. Sr., G. Marland, R.A. Betts, T.N. Chase, J.L. Eastman, J.O. Niles, D.S. Niyogi and S.W. Running. 2002. The influence of land-use change and landscape dynamics on the climate system - relevance to climate change policy beyond the radioactive effect of greenhouse gases. Philosophical Transactions of the Royal Society of London A. 360:1705-1719.

Schlamadinger, B., L. Aukland, S. Berg, D. Bradley, L. Ciccarese, V. Dameron, A. Faaij, M. Jackson, G. Marland and R. Sikkema. 2002. Forest-based carbon mitigation projects; options for carbon accounting and for dealing with non-permanence, United Nations Framework Convention on Climate Change, FCCC/WEB/2002/12,4 Sept.2002, http://unfccc.int/resources/webdocs/2002/12.pdf.

Marland, E. and G. Marland. 2003. The treatment of long-lived, carbon-containing products in inventories of carbon dioxide emissions to the atmosphere. Environmental Science and Policy 6:139-152.

Huston, M.A. and G. Marland. 2003. Carbon management and biodiversity. J. of Environmental Management 67:77-86.

Marland, G., R.A. Pielke Sr., M. Apps, R. Avissar, R.A. Betts, K.J. Davis, P.C. Frumhoff, S.T. Jackson, L. Joyce, P. Kauppi, J. Katzenberger, K.G. MacDicken, R. Neilson, J.O. Niles, D.D.S. Niyogi, R.J. Norby, N. Pena, N. Sampson and Y. Xue. 2003. The climatic impacts of

land surface change and carbon management, and the implications for climate-change mitigation policy. Climate Policy 3:149-157.
Marland, G., T.O. West, B. Schlamadinger and L. Canella. 2003. Managing soil organic carbon in agriculture: the net effect on greenhouse gas emissions. Tellus 55B:613-621.
West, T.O. and G. Marland. 2003. Net carbon flux from agriculture: carbon emissions, carbon sequestration, crop yield, and land-use change. Biogeochemistry 63:73-82.
Marland, G., C.T. Garten Jr., W.M. Post and T.O. West. 2003. CSiTE studies on carbon sequestration in soils. Energy – The International Journal (in press).
Sedjo, R.A. and G. Marland. 2003. Inter-trading permanent emissions credits and rented temporary carbon emissions offsets: some issues and alternatives. Climate Policy (in press).
West, T.O., G. Marland, W.M. Post, A.W. King, A.K. Jain and K. Andrasko. 2003. Carbon management response curves: estimates of temporal carbon dynamics. Environmental Management (in press).
Marland, G., D. Archer, G. Benford, M. Ishikawa, F.B. Metting, F.M. Orr Jr. and T. Volk. 2003. Biological Options toward stabilization of greenhouse gas concentrations in the Earth's atmosphere. Aspen Global Change Institute (in press).

ADAM ZACHARY ROSE
The Pennsylvania State University
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EDUCATION

Ph.D. (Economics)	Cornell University	1974
M.A. (Economics)	Cornell University	1972
B.A. (Economics)	University of Utah	1970

RESEARCH AND TEACHING FIELDS

Environmental & Resource Economics	Natural & Man-Made Hazards
Energy Economics	Economic Development
Regional & Urban Economics	Applied General Equilibrium Analysis

EMPLOYMENT HISTORY

Professor, Department of Geography, The Pennsylvania State University	2002-
Professor, Department of Energy, Environmental, and Mineral Economics, The Pennsylvania State University (Department Head, 1988-02)	1988-02
Professor, Department of Mineral Resource Economics, West Virginia University (Department Chairman, 1986-88)	1984-88

Associate Professor, Department of Mineral Resource Economics, West Virginia University (Department Chairman, 1981-83)	1981-84
Faculty Associate, Regional Research Institute, West Virginia University	1981-88
Assistant Professor, Department of Economics, University of California, Riverside	1977-81
Lecturer, Department of Economics, University of California, Riverside	1975-77
Senior Council Economist, New York State Council of Economic Advisers	1974-75

RECENT VISITING POSITIONS

Visiting Fellow, East-West Center	2004
Resident Visitor, Resources for the Future	2001

RECENT ADVISORY POSITIONS

U.S. EPA Advisory Panel on the Second Generation Climate Policy Model	2004
Chair, NSF Site Review Team, Center for Decision-Making under Uncertainty	2004
National Academy of Sciences, Panel on Economic Benefits of Improved Seismic Monitoring	2003-
Consortium for Atlantic Regional Assessment of Climate Change, Advisory Council	2003-
NSF/Earthquake Engineering Research Institute, Panel on Research Opportunities for Earthquake Engineering	2001-03
Pennsylvania Consortium for Interdisciplinary Environmental Policy, Committee on Climate Change and Energy (Chair, 2001-03)	2001-
Multidisciplinary Center for Earthquake Engineering Research, Research Committee	2001
Editorial Board, *Energy Policy*	2000-
Editorial Board, *Pacific and Asian Journal of Energy*	1995-
Editorial Board, *Resource and Energy Economics*	1993-

SELECTED PUBLICATIONS

Recent Refereed Journal Articles

"Modeling Regional Economic Resilience to Disasters: A Computable General Equilibrium Analysis of Water Service Disruptions," Journal of Regional Science, forthcoming (with S. Liao).

"Reducing the Conflict Between Climate Policy and Energy Policy in the U.S.: The Important Role of the States," Energy Policy, forthcoming (with T. Peterson).

"Incentive-Based Approaches to Greenhouse Gas Mitigation in Pennsylvania: Protecting the Environment and Promoting Fiscal Reform," Widener Law Journal, forthcoming (with R. McKinstry and C. Ripp).

"A Greenhouse Gas Emissions Inventory for Pennsylvania," Journal of the Air and Waste Management Association, forthcoming (with B. Yarnal and others).

"Global Climate Change and the Value of Solar Energy in the U.S. Agriculture," Land Economics, forthcoming (with R. Kamat and J. Shortle).

"Defining and Measuring Economic Resilience to Disasters," Disaster Prevention and Management, Vol. 13, No. 4, 2004, pp. 307-14.
"Interregional Burden-Sharing of Greenhouse Gas Mitigation in the United States," Mitigation and Adaptation Strategies for Global Change, Vol. 9, No. 3, 2004, pp. 477-500 (with Z. Zhang).
"Greenhouse Gas Mitigation Action Planning," Penn State Environmental Law Review, Vol. 12, No. 1, 2003, pp. 153-71.
"A Dynamic Analysis of the Marketable Permits Approach to Global Warming Policy: A Comparison of Spatial and Temporal Flexibility," Journal of Environmental Economics and Management, Vol. 44, No. 1, 2002, pp. 45-69 (with B. K. Stevens).
"Business Interruption Losses from Natural Hazards: Conceptual and Methodological Issues in the Case of the Northridge Earthquake," Environmental Hazards: Human and Policy Dimensions, Vol. 4, No. 2, 2002, pp. 1-14 (with D. Lim).
"Greenhouse Gas Reduction in the U.S.: Identifying Winners and Losers in an Expanded Permit Trading System," Energy Journal, Vol. 23, No. 1, 2002, pp. 1-18 (with G. Oladosu).
"An Economic Analysis of Flexible Permit Trading in the Kyoto Protocol," International Environmental Agreements, Vol. 1, No. 2, 2001, pp. 219-42 (with B. K. Stevens).
"Characterizing Economic Impacts and Responses to Climate Change," Global and Planetary Change, Vol. 25, No. 2, 2000, pp. 67-81 (with J. Shortle and others).

Recent Research Reports

Greenhouse Gas Emissions Inventory for Pennsylvania, Report to the Pennsylvania Department of Environmental Protection, Center for Integrated Regional Assessment, The Pennsylvania State University, 2003 (with B. Yarnal and others).
User Costs in Seismic Risk Management for Urban Infrastructure Systems, Report to the National Science Foundation, Department of Geography, University of Washington, 2002 (with S. Chang and others).
Chad-Cameroon Development Project: Economic Impact Assessment of Cameroon, Report to the World Bank for ExxonMobil, URS Corporation, Houston, TX, 2002 (with F. Bayne).
Mid-Atlantic Regional Assessment (MARA): The Impacts of Climate Change, Report to the U.S. Environmental Protection Agency, The Pennsylvania State University, 2000 (with A. Fisher and others).

Recent Contributions to Public Documents

National Research Council. 2005. Economic Benefits of Improved Seismic Monitoring, Washington, DC: National Academy Press, 2004 (with other members of a National Academy of Sciences Panel).
European Union. 2003. "Understanding Sources of Resiliency to Natural Hazards," in A. van der Veen et al. (eds.) Proceedings of the Joint NEDEIS and University of Twente Workshop: In Search of a Common Methodology for Damage Estimation, Bruxelles: Office for Official Publications of the European Communities, 2003, pp. 137-50 (with S. Liao).
National Institute of Building Sciences/Federal Emergency Management Agency, "Indirect Economic Losses," Flood Loss Estimation Methodology, Washington, DC, 2003 (with H. Cochrane and S. Chang).

Earthquake Engineering Research Institute, Securing Society Against Catastrophic Loss: A Research and Technology Transfer Plan, Report to the National Science Foundation, Oakland, CA, 2002 (with other members of an Expert Review Panel).

PROFESSIONAL PRESENTATIONS (Selected)

Conferences of Professional Organizations

American Economic Association Meetings: 1986, 1987
American Association for the Advancement of Science Meetings: 1991, 1992, 1994
American Society of Civil Engineers
    Structural Engineers Joint World Congress: 1998
    U.S. Conference on Lifeline Earthquake Engineering: 1999
Association of American Geographers Meetings: 2003, 2004
Association of Environmental and Resource Economists
    European Meetings: 1992, 1993, 1996, 1997, 2000, 2001, 2003, 2004
    World Congress: 1998
International Association for Energy Economics
    International Meetings: 1999, 2001, 2002
    North American Meetings: 2000
International Society for Ecological Economics Biennial Meetings: 1996, 1998
Regional Science Association
    European Meetings: 1994
    North American Meetings: 1990, 1992, 1994-97, 1999, 2001-03
    Pacific Meetings: 1995
Western Economic Association, 1980, 1994, 1999

PROFESSIONAL RESEARCH ACTIVITIES (Recent and Current)

Major Grant and Contract Research

– Principal Investigator and Project Director, Pennsylvania Department of Environmental Protection contract – Economic Impact Modeling of Pennsylvania's Indigenous Resources, 2004-.
– Track A Team Leader, National Institute of Building Sciences/Federal Emergency Management contract – Independent Study to Assess Future Savings from Hazard Mitigation Activities (requested by U.S. Congress), 2003-04 (consultant to Applied Technology Council).
– Principal Investigator and Project Director, National Science Foundation grant (through the Multidisciplinary Center for Earthquake Engineering Research) – Modeling Regional Economic Losses from Earthquakes: LA Lifeline Study, 2003-04.
– Co-Principal Investigator and Project Leader, Pennsylvania Department of Environmental Protection contract – Pennsylvania Greenhouse Gas Emissions Inventory, 2001-03.
– Co-Principal Investigator, U.S. Department of Energy NIGEC contract – Climate Change and Policy Impacts on the Southeastern U.S. Economy, 2000-01 (subcontractor through University of Alabama; renewed Phase 2, 2001-02).

Consultantships

- DHS Center for Risk and Economic Analysis of Terrorism Events – Analyzing Threats to the Economy through Computable General Equilibrium Analysis, 2004-.
- U.S. Department of Defense – Independent Review Panel on Economic Impact Analysis Methodology for the Base Realignment and Closure 2005 Process (through Booz Allen Hamilton), 2004.
- U.S. Department of Homeland Security – Development of a Framework to Estimate the Economic Impacts of Terrorist Attacks (subcontractor to ABS Consulting), 2004.
- ICF Consulting, Inc. – Upgrading the Outer Continental Shelf Economic Impact Models for the Gulf of Mexico and the Alaska OCS, 2003-.
- Center for Energy and Economic Development – Economic Impact of Wind-Generated Electricity Displacement of Coal, 2003.

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Education

1960	B.A.	Trinity University
1967	M.A.	Syracuse University
1969	Ph.D.	Syracuse University

Research Interests

Realizing sustainable development.
Relationships between society and technology.
Responses to concerns about global environmental change.
Energy and environmental policy analysis, including technology assessment; regional assessment; environmental, social, and economic impact assessment; R&D policy.
Institution-building, especially for R&D activities and for energy and environmental policymaking and decisionmaking.
Geographic scale as an issue in sustainability science, including roles of cross-scale interactions.
Regional development, particularly problems of developing regions and cross-cultural comparisons of determinants.

Employment History

1987-present	Corporate Research Fellow and Leader, Global Change and Developing Country Programs, Oak Ridge National Laboratory
1998-present	Associate, Belfer Center for Science and International Affairs, Harvard University

200-2002	Acting Co-Director, Oak Ridge Center for Advanced Studies
1983-present	Adjunct Professor of Geography, University of Tennessee
1980-1987	Associate Director and Head of Programs and Planning, Energy Division, Oak Ridge National Laboratory
1980-1981	Acting Director, Energy Division, Oak Ridge National Laboratory
1977-1980	Senior Planner, Energy Division, Oak Ridge National Laboratory
1974-1977	Research Fellow, Science and Public Policy Program, The University of Oklahoma
1973-1977	Associate Professor and Chair, Department of Geography, The University of Oklahoma
1973	Research Director, Syracuse-Yugoslav Project on Environmental Policy and Planning, Ljubljana, Yugoslavia
1971-1972	Executive Director, Urban Transportation Institute, Syracuse University
1969-1973	Assistant Professor of Geography, Syracuse University
1969	Lecturer in Geography, Syracuse University

Professional Service/Activities

Member - Science Steering Group, U.S. Carbon Cycle Program
Co-author - scaling chapter of conceptual framework report, Millennium Ecosystem Assessment, UN Environment Programme et al.
Member - IPCC Working Group II (Impacts, Adaptation, and Vulnerabilities), Third Assessment Report; lead author of chapter 7 (human settlements, energy, and industry) and of the synthesis report and summary for policymakers
Member - Advisory Committee, Human-Environmental Research Observatories, NSF-supported national program led by the Pennsylvania State University
Coordinator - Inter-regional Forum, U.S. National Assessment of Vulnerabilities to Climate Variability and Change
Member - Board on Earth Sciences and Resources, National Academy of Sciences/National Research Council
Member - Committee on Human Dimensions of Global Change, National Academy of Sciences/National Research Council
Member - Panel on Public Participation in Environmental Assessment and Decision Making, National Academy of Sciences/National Research Council

Publications

Wilbanks, T.J. 1002. Geography and Technology, in Technology and Geography: A Social History, S. Brunn, S. Cutter, J. Harrington (eds.), Dordrecht: Kluwer.
Wilbanks, T.J., et al. 2003. Possible Responses to Global Climate Change: Integrating Mitigation and Adaptation. Environment 45(5):28-38.
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Wilbanks, T.J., and W.C. Clark, et al. 2000. Assessing Vulnerability to Global Environmental Risks, Discussion Paper 2000-12, Environment and Natural Resources Program, Kennedy School of Government, Harvard University.

Wilbanks, T.J., A. Wolfe, and N. Kerchner. 2001. Public Involvement on a Regional Scale. Environmental Assessment Review 21:431-448.

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Wilbanks, T.J., et al. 1989. Decision Making, in Energy Technology R&D: What Could Make a Difference?, W. Fulkerson et al. (eds.), ORNL-6541, Vol. 2, Oak Ridge National Laboratory, pp. 123-37.

Wilbanks, T.J. 1988. Impacts of Energy Development and Use, 1888-2088, in Earth '88: Changing Geographic Perspectives, National Geographic Society, Washington, pp. 96-114.

Wilbanks, T.J. 1985. Geography and National Policy, Annals, Association of American Geographers, LXXV, pp. 4-10.

Wilbanks, T.J., and R. Lee. 1985. Policy Analysis in Theory and Practice, in Large-Scale Energy Projects: Assessment of Regional Consequences, T.R. Lakshmanan and B. Johansson (eds.), North-Holland, Amsterdam 273-303.

Wilbanks, T.J., and E. Aronson, et al. 1984. Energy Use: The Human Dimension, W.H. Freeman, San Francisco.

Wilbanks, T.J. 1982. Is Comprehensive Analysis of Critical Interactions Possible?, in Energy, Economics, and the Environment, G. Daneke (ed.), D.C. Heath, Lexington, MA, pp. 91-110.

Wilbanks, T.J. 1980. Location and Well-being, Harper and Row, New York, 462 pp.

Wilbanks, T.J., and D.E. Kash, et al. 1976. Our Energy Future: The Role of Research, Development, and Demonstration in Reaching a National Consensus on Energy Supply, University of Oklahoma Press, Norman, 482 pp.

Wilbanks, T.J., and D.E. Kash, et al.. 1974. A Methodology and Documentation for Consistent Analysis of Energy Alternatives, Science and Public Policy Program, University of Oklahoma, Norman, Vol 4., 1400 pp.

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Education

1977 M.S. Mechanical Engineering, University of Tennessee, Knoxville
1975 B.S. Mechanical Engineering, University of Tennessee, Knoxville

Employment History

1977-present Research Staff Member, Oak Ridge National Laboratory

Publications

Zimmerman, G.P. 2001. Project leader for U.S. Nuclear Regulatory Commission, Final Environmental Impact Statement for the Construction and Operation of an Independent Spent Fuel Storage Installation on the Reservation of the Skull Valley Band of Goshute Indians and the Related Transportation Facility in Tooele County, Utah (Volumes 1 and 2), NUREG-1714, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards,Washington, D.C., December 2001.

Berry, J.B., C.J. Coomer, R.C. DeVault, M.R. Hilliard, P.J. Hughes, M.P. Ternes and G.P. Zimmerman. 2000. Case Studies in Sustaining DoD Readiness, 26th Environmental Symposium and Exhibition, March 27 to 30, 2000, Long Beach, Calif.; National Defense Industrial Association, Arlington, Va., Report No. P00-106353.

G. Ostrouchov, G.P. Zimmerman, J.J. Beauchamp, V.V. Fedorov and D.J. Downing. 1999. Evaluation of Statistical Methodologies Used in U.S. Army Ordnance and Explosives Work, ORNL/TM-13588, Oak Ridge National Laboratory, Oak Ridge, Tenn., September 1999.

Zimmerman, G.P. 1996. Technical Core Team Leader for U.S. Department of Energy, Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste, DOE/ID-10521 (Vols. 1, 2, and 3) and SAND96-0721 (Vols. 1, 2, and 3), prepared by Sandia National Laboratories, Albuquerque, New Mexico, March 1996.

J.D. Tauxe, D.W. Lee, J.C. Wang and G.P. Zimmerman. 1995. A Comparative Subsurface Transport Analysis for Radioactive Waste Disposal at Various DOE Sites, P95-79881, Proceedings of the 1995 Fall Meeting of the American Geophysical Union, San Francisco, Calif., December 11-15, 1995.

G.P. Zimmerman. 1994. Coal Technology Characterization and Discharges, Appendix A in Estimating Externalities of Coal Fuel Cycles; Report Number 3 on the External Costs and Benefits of Fuel Cycles: A Study by the U.S. Department of Energy and the Commission of the European Communities, prepared by the Oak Ridge National Laboratory and Resources for the Future; McGraw-Hill, September 1994.

Attachment 3. Biographies of Candidate SAR 2.2 Chapter Authors

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Education

1987 Ph.D. Botany, Duke University
1977 B.S. Oceanography, Humboldt State University

Research Interests

Biology and chemistry of the ocean in relation to natural climate variability and global change. Global carbon cycle. Instrumentation and systems for long-term ocean observing. Satellite remote sensing.

Employment History

2000-present	Senior Scientist , MBARI
2000-present	Faculty (courtesy), Stanford University
1996-2000	Associate Scientist (III), MBARI
1992-1996	Associate Scientist (II), MBARI
1990-present	Research Associate, University of California, Santa Cruz
1987-1992	Assistant Scientist, MBARI

Professional Service/Activities

Member - JGOFS time series oversight committee
Reviewer - Chilean Oceanographic Program, Peruvian Fisheries Program
NSF Alan Waterman award committee
NSF Advisory Committee for the Geoscience Directorate
Board of Directors - Center for Integrated Marine Technologies
Science Team - Global Eulerian Observations

Publications

Barber, R.T. and F.P. Chavez. 1983. Biological consequences of El Ni□o. Science 222:1203-1210.
Chavez, F.P., R.T. Barber and H. Soldi S. 1984. Propagated temperature changes during onset and recovery of the 1982-83 El Ni□o. Nature 309:47-49.
Barber, R.T. and F.P. Chavez. 1986. Ocean variability in relation to living resources during the 1982-83 El Ni□o. Nature 319:279-285.

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Martin, J.H. et al. 1994. Testing the iron hypothesis in ecosystems of the equatorial Pacific Ocean. Nature 371:123-129.

Paytan, A., M. Kastner and F.P. Chavez. 1996. Glacial to interglacial fluctuations in productivity in the Equatorial Pacific as indicated by marine barite. Science 274:1355-1377.

Coale, K.H et al. 1996. A massive phytoplankton bloom induced by an ecosystem-scale iron fertilization experiment in the equatorial Pacific Ocean. Nature 383:495-501.

Johnson, K.S., F.P. Chavez and G.E. Friederich. 1999. Continental shelf sediment as a primary source of iron for coastal phytoplankton. Nature 398:697-700.

Chavez, F.P., P.G. Strutton, G.E. Friederich, R.A. Feely, G.A. Feldman, D. Foley and M.J. McPhaden. 1999. Biological and chemical response of the equatorial Pacific Ocean to the 1997-1998 El Ni□o. Science 286:2126-2131.

Chavez, F.P., J.P. Ryan, S. Lluch-Cota and M. □iquen C. 2003. From anchovies to sardines and back-Multidecadal change in the Pacific Ocean. Science 299:217-221.

Chavez, F.P. and J.R. Toggweiler. 1995. Physical estimates of global new production: the upwelling contribution, In Upwelling in the Ocean: Modern Processes and Ancient Records, Summerhayes, C.P., Emeis, K.C., Angel, M.V., Smith, R.L., and Zeitzschel, B., (eds.), p. 313-320, J. Wiley & Sons, Chichester.

Chavez, F.P., J.T. Pennington, R. Herlien, H. Jannasch, G. Thurmond and G.E. Friederich. 1997. Moorings and drifters for real-time interdisciplinary oceanography. Journal of Atmospheric and Oceanic Technology 14:1199-1211.

Chavez, F.P. and C. Collins, eds. 1998. Studies of the California Current System, Deep-Sea Research II, Volume 45.

Olivieri, R.O. and F.P. Chavez. 2000. A model of plankton dynamics for the coastal upwelling system of Monterey Bay, California. Deep-Sea Research II 47:1077-1105.

Pennington, J.T. and F.P. Chavez. 2000. Seasonal fluctuations of temperature, salinity, nitrate, chlorophyll and primary production at station H3/M1 over 1989-1996 in Monterey Bay, California. Deep-Sea Research II 47:947-973.

Chavez, F.P. and C. Collins,eds. 2000. Studies of the California Current System Part 2, Deep-Sea Research II 47:5-6.

Johnson, K.S., F.P. Chavez, V.A. Elrod, S.E. Fitzwater, J.T. Pennington, K.R. Buck and P.M. Walz. 2001. The annual cycle of iron and the biological response in central California coastal waters. Geophysical Research Letters 28:1247-1250.

Johnson, K.S., C.K. Paull, J.P. Barry and F.P. Chavez. 2001. A decadal record of underflows from a coastal river into the deep sea. Geology 29:1019-1022.

Friederich, G., P. Walz, M. Burczynski and F.P. Chavez. 2002. Inorganic Carbon in the Central California Upwelling System During the 1997-1999 El Ni□o -La Nina Event. Progress in Oceanography 54:185-204.

Chavez, F.P, C.A. Collins, A. Huyer and D. Mackas (eds). 2002. El Ni□o along the west coast of North America. Progress in Oceanography 54:1-6.

Collins, C.A. J.T. Pennington, C.G. Castro, T.A. Rago and F.P. Chavez. 2003. The California Current system off Monterey, California: Physical and biological coupling. Deep-Sea Research II. doi:10.1016/S0967-0645(03)00134-6

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Education

1987	A.B.	Physics, Princeton University, Physics
1992	Ph.D.	Astrophysical, Planetary and Atmospheric Sciences, University of Colorado
1993-1994	Postdoc	Trace gas micrometeorology, National Center for Atmospheric Research

Employment History

2000-present	Associate Professor, Dept of Meteorology, The Pennsylvania State University
	Assistant Professor, Department of Soil, Water, and Climate, U. of Minnesota.
Fall 1996	Guest Scientist, Institute for Atmospheric Physics, German Aerospace Research Establishment (DLR).
1995-1996	Research Associate, University of Colorado, Cooperative Institute for Research in Environmental Sciences
1995-1996	Visiting Scientist, Mesoscale and Microscale Meteorology Division, National Center for Atmospheric Research
1993-1994	Postdoctoral Fellow, NCAR, Advanced Studies Program.
1989-1992	NASA Graduate Student Researchers Program Fellow, APAS Department, University of Colorado.
1989-1992	Graduate Research Assistant, Advanced Studies Program, NCAR.

Professional Service/Activities

Chair - Boundary Layers and Turbulence Committee, American Meteorological Society
Lead instructor - new interdisciplinary graduate course in the global carbon cycle, spring of 2002. PI of proposed IGERT on carbon cycle science and management.
Director - Penn State EMS Environment Institute Center for Advanced Carbon Research and Education (ACRE)
Principal organizer - the Chequamegon Ecosystem-Atmosphere Study (ChEAS), a multiple investigator study of forest-atmosphere CO_2 and H_2O cycling.
Participant - Annual AmeriFlux meeting and periodic Fluxnet meetings, member of the AmeriFlux Scientific steering group.

Publications

Bolstad, P.V., K.J. Davis, J. Martin, B.D. Cook and W. Wang. Component and whole-system respiration fluxes in northern hardwood forests. Tree Physiology (in press).

Davis, K.J., P.S. Bakwin, B.W. Berger, C. Yi, C. Zhao, R.M. Teclaw and J.G. Isebrands, 2003. The annual cycle of CO_2 and H_2O exchange over a northern mixed forest as observed from a very tall tower. Global Change Biology 9:1278-1293.

Baker, I., A.S. Denning, N. Hanan, L. Prihodko, M. Uliasz, P.-L. Vidale, K.J. Davis and P.S. Bakwin. 2003. Simulated and observed fluxes of sensible and latent heat and CO_2 at the WLEF-TV tower using SiB2.5. Global Change Biology 9:1262-1277.

Marland G., R.A. Betts, K.J. Davis, P.C. Frumhoff, S.T. Jackson, L.A. Joyce, P. Kauppi, J. Katzenberger, K.G. MacDicken, R.P. Neilson, J.O. Niles, D.d.S. Niyogi, R.J. Norby, N. Pena, N. Sampson, Y. Xue, R.A. Pielke Sr., M. Apps and R. Avissar. 2003. The climatic impacts of land surface change and carbon management, and the implications for climate-change mitigation policy. Climate Policy 3:149-157.

Berger, B.W., K.J. Davis, P.S. Bakwin, C. Yi and C. Zhao. 2001. Long-term carbon dioxide fluxes from a very tall tower in a northern forest: Flux measurement methodology. J. Atmos. Oceanic Tech. 18:529-542.

Denning, A.S., M. Nicholls, L. Prihodko, I. Baker, P.-L. Vidale, K.J. Davis and P.S. Bakwin. 2003. Simulated and observed variations in atmospheric CO_2 over a Wisconsin forest. Global Change Biology 9:1241-1250.

Werner, C., K J. Davis, P.S. Bakwin, C. Yi, D. Hurst and L. Lock. 2003. Interannual variability of methane exchange over a temperate-boreal lowland and wetland forest. Global Change Biology 9:1251-1261.

MacKay, D.S., D.E. Ahl, B.E. Ewers, S.T. Gower, S.N. Burrows, S. Samanta and K.J. Davis. 2002. Effects of aggregated classifications of forest composition on estimates of evapotranspiration in a northern Wisconsin forest. Global Change Biology 8:1253-1266.

Davis, K.J., N. Gamage, C. Hagelberg, D.H. Lenschow, C. Kiemle and P.P. Sullivan. 2000. An objective method for determining atmospheric structure from airborne lidar observations. J. Atmos. Oceanic Tech. 17:1455-1468.

Kuck, L.R., T. Smith, B.B. Balsley, D. Helmig, T.J. Conway, P.P. Tans, K.J. Davis, M. Jensen, J.A. Bognar, R. Vazquez Arrieta, R. Rodriquez and J.W. Birks. 2000. Measurements of landscape-scale fluxes of carbon dioxide in the Peruvian Amazon by vertical profiling through the convective boundary layer. J. Geophys. Res. 105:22,137-22,146.

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Woods Hole, Massachusetts 02543
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Education

1965 B.A. Biology, Hamilton College
1979 Ph.D. Ecology, S.U.N.Y., Stony Brook

Research Interests

Employment History

1989-present	Senior Scientist, Woods Hole Research Center, Woods Hole, Massachusetts
1993-1994	Visiting Senior Scientist, Office of Mission to Planet Earth, NASA, Wash., D.C.
1987-1989	Associate Scientist, Woods Hole Research Center, Woods Hole, MA
1984-1987	Associate Scientist., Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA
1975-1984	Res. Assoc., Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA
1967-1974	Research Associate, Biology Department, Brookhaven National. Lab., Upton, NY

Professional Service/Activities

Marquis Who's Who in America
Honorary Doctorate from the Faculty of Forest Science, University of Munich
Associate Editor, *Environmental Reviews*
National Technical Advisory Committee for NIGEC
Landsat Pathfinder Science Working Group
Member - Ecological Society of America
Member - American Geophysical Union
Member - Sigma Xi

Publications

Houghton, R.A. 1999. The annual net flux of carbon to the atmosphere from changes in land use 1850-1990. Tellus 51B:298-313.

Houghton, R.A., J.L. Hackler and K.T. Lawrence. 1999. The U.S. carbon budget: contributions from land-use change. Science 285:574-578.

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Noble, I., M. Apps, R. Houghton, D. Lashof, W. Makundi, D. Murdiyarso, B. Murray, W. Sombroek and R. Valentini. 2000. Implications of different definitions and generic issues. Pages 53-126 in: R.T. Watson, I.R. Noble, B. Bolin, N.H. Ravindranath, D.J. Verardo and D.J. Dokken (editors). Land Use, Land-Use Change, and Forestry. A Special Report of the IPCC. Cambridge University Press, New York.

Houghton, R.A. and J.L. Hackler. 2001. Carbon Flux to the Atmosphere from Land-Use Changes: 1850 to 1990. ORNL/CDIAC-131, NDP-050/R1. Carbon Dioxide Information Analysis Center, U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A.

Pacala, S.W., G.C. Hurtt, D. Baker, P. Peylin, R.A. Houghton, R.A. Birdsey, L. Heath, E.T. Sundquist, R.F. Stallard, P. Ciais, P. Moorcroft, J.P. Caspersen, E. Shevliakova, B. Moore, G. Kohlmaier, E. Holland, M. Gloor, M.E. Harmon, S.-M. Fan, J.L. Sarmiento, C.L. Goodale, D. Schimel and C.B. Field. 2001. Consistent land- and atmosphere-based U.S. carbon sink estimates. Science 292:2316-2320.

Schimel, D.S., J.I. House, K.A. Hibbard, P. Bousquet, P. Ciais, P. Peylin, B.H. Braswell, M.J. Apps, D. Baker, A. Bondeau, J. Canadell, G. Churkina, W. Cramer, A.S. Denning, C.B. Field, P. Friedlingstein, C. Goodale, M. Heimann, R.A. Houghton, J.M. Melillo, B. Moore III, D. Murdiyarso, I. Noble, S.W. Pacala, I.C. Prentice, M.R. Raupach, P.J. Rayner, R.J. Scholes, W.L. Steffen and C. Wirth. 2001. Recent patterns and mechanisms of carbon exchange by terrestrial ecosystems. Nature 414:169-172.

DeFries, R.S., R.A. Houghton, M.C. Hansen, C.B. Field, D. Skole and J. Townshend. 2002. Carbon emissions from tropical deforestation and regrowth based on satellite observations for the 1980s and 90s. Proceedings of the National Academy of Sciences 99:14256-14261.

Goodale, C.L., M.J. Apps, R.A. Birdsey, C.B. Field, L.S. Heath, R.A. Houghton, J.C. Jenkins, G. H. Kohlmaier, W. Kurz, S. Liu, G.-J. Nabuurs, S. Nilsson and A.Z. Shvidenko. 2002. Forest carbon sinks in the northern hemisphere. Ecological Applications 12:891-899.

Houghton, R.A. 2002. Magnitude, distribution and causes of terrestrial carbon sinks and some implications for policy. Climate Policy 2:71-88.

Hurtt, G.C., S.W. Pacala, P.R. Moorcroft, J. Caspersen, E. Shevliakova, R.A. Houghton and B. Moore III. 2002. Projecting the future of the U.S. carbon sink. Proceedings of the National Academy of Sciences 99:1389-1394.

Houghton, R.A. 2003. Revised estimates of the annual net flux of carbon to the atmosphere from changes in land use and land management 1850-2000. Tellus 55B:378-390.

Houghton, R.A. 2003. Why are estimates of the terrestrial carbon balance so different? Global Change Biology 9:500-509.

Houghton, R.A. and J.L. Hackler. 2003. Sources and sinks of carbon from land-use change in China. Global Biogeochemical Cycles 17(*2*):1034.

House, J.I., I.C. Prentice, N. Ramankutty, R.A. Houghton and M. Heimann. 2003. Reconciling apparent inconsistencies in estimates of terrestrial CO_2 sources and sinks. Tellus 55B:345-363.

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Education

1991	B.A.	Biology, Dartmouth College
1995	M.F.S.	Forest Science, Yale University
1998	Ph.D.	Ecosystem Ecology, University of New Hampshire

Employment History

2002-present	Visiting Assistant Professor, Gund Institute for Ecological Economics, University of Vermont Rubenstein School of Environment and Natural Resources, Burlington, VT.
1998-2002	Research Forester, USDA Forest Service Northeastern Research Station Northern Global Change Program and Forest Inventory and Analysis

Professional Service/Activities

Delegate - National Academy of Sciences Workshop on Direct and Indirect Human Contributions to Terrestrial Greenhouse Gas Fluxes
U.S. Technical Expert - IPCC Working Group on Methodologies to Factor Out Direct Human-Induced Changes in Carbon Stocks and Greenhouse Gas Emissions by Sources and Removal by Sinks
Member - NCEAS Working Groups: Carbon Balance of North America and Eurasia; Development of a Consistent Global NPP database
Participant - Cary Conference IX: Understanding Ecosystems: The Role of Quantitative Models in Observation, Synthesis, and Prediction
Journal reviews - Canadian Journal of Forest Research, Climatic Change, Computers in Science and Agriculture, Ecological Applications, Ecosystems, Environmental Pollution, Forest Science, Global Change Biology, Journal of Biogeography, Mitigation and Adaptation Strategies for Global Change
Grant reviews - EPA STAR Fellowship Panel, NSF Long-term Research in Environmental Biology (LTREB) (2002), NSF Ecosystems, NASA New Investigator Program

Publications

Jenkins, J.C., D.C. Chojnacky, L.S. Heath and R.A. Birdsey. 2003. National-scale biomass estimators for United States tree species. Forest Science 49(1):12-35.

Jenkins, J.C., D.C. Chojnacky, L.S. Heath and R.A. Birdsey. 2003. A comprehensive database of biomass equations for North American tree species. USDA Forest Service General Technical Report NE- XXX (in review).

Pan, Y., J. Hom,, J.C. Jenkins and R.a. Birdsey. 2003. Importance of foliar nitrogen concentration to predict forest productivity spatially across the Mid-Atlantic region. Forest Science (in press).

Smith, J, L.S. Heath and J.C. Jenkins. 2003. Forest volume-to-biomass models and estimates of mass for live and standing dead trees of US forests. Newtown Square, PA, USDA Forest Service General Technical Report NE-298. 57 p.

Jenkins, J.C. and R. Riemann. 2003. What does nonforest land contribute to the global C balance? Proceedings, Third Annual FIA Science Symposium, Traverse City, MI, Oct. 14-16, 2001 (in press).

Goodale, C.L., M.J. Apps, R.A. Birdsey, C.B. Field, L.S. Heath, R.A. Houghton, J.C. Jenkins, G.H. Kohlmaier, W. Kurz, S. Liu, G-J Nabuurs, S. Nillson and A. Shvidenko. 2002. Forest carbon sinks in the northern hemisphere. Ecological Applications 12:891-899.

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Nemani, R.R., M.A.White, K. Nishida, S. Reddy, J.C. Jenkins and S.W. Running. 2002. Recent trends in hydrologic balance have enhanced the terrestrial carbon sink in the United States. Geophysical Research Letters 2002GL014867.

Jenkins, J.C., D.W. Kicklighter and J.D. Aber. 2000. Predicting the regional impacts of increased CO_2 and climate change on forest productivity. Pp. 383-423 In Responses of Northern U.S. Forests to Environmental Change, R.A. Birdsey, R.H. Mickler and J. Hom (eds). Springer-Verlag, New York.

Jenkins, J.C., D.W. Kicklighter, S.V. Ollinger, J.D. Aber, J.D. and J.M. Melillo. 1999. Sources of variability at a regional scale: A comparison using PnET-II and TEM 4.0 in northeastern U.S. forests. Ecosystems 2:555-570.

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Education

B.A. 1978 Dartmouth College
Ph.D. 1982 Stanford University

Research Interests

Plant Ecology
Global Interactions of the Biosphere, Atmosphere and Hydrosphere
Mathematical Modeling
Community Ecology

Employment History

2000-present	Co-Director, The Carbon Mitigation Initiative, Princeton University
1995-present	Co-Director, NOAA Carbon Modeling Center, Princeton University
1994-present	Associated Faculty, Princeton Environmental Institute, Princeton University
1993-present	Director of Graduate Studies, Department of Ecology and Evolutionary Biology, Princeton University
1992-present	Professor, Department of Ecology and Evolutionary Biology, Princeton University
1987-1992	Associate Professor, Department of Ecology and Evolutionary Biology, The University Connecticut
1982-1987	Assistant Professor, Ecology Section, Biological Sciences Group, The University of Connecticut
1979-1981	Teaching Assistant, Stanford University
1978	Teaching Assistant, Dartmouth College
1975-1978	Research Assistant, Dartmouth College

Professional Service/Activities

Associate Editor - The American Naturalist
Associate Editor - Theoretical Population Biology
Editorial Board - Ecological Applications
Editorial Board - Global Change Biology

Publications

Kinzig, A.P. S.W. Pacala and G.D. Tilman. 2002. The Functional Consequences of Biodiversity: Experimental Progress and Theoretical Extensions. Princeton University Press, Princeton, NJ.

Hurtt, G.C., S.W. Pacala, P.R. Moorcroft, J. Caspersen, E. Shevliakova, R.A. Houghton and B. Moore III. 2002. Projecting the Future of the U.S. Carbon Sink. Proceedings of the National Academy of Sciences. 99(3):1389-1394.

Schimel, D.S., J.I. House, K.A. Hibbard, P. Bousquet, P. Ciais, P. Peylin, B.H. Braswell, M.J. Apps, D. Baker, A. Bondeau, J. Canadell, G. Churkina, W. Cramer, A.S. Denning, C.B. Field, P. Friedlingstein, C. Goodale, M. Heimann, R.A. Houghton, J.M. Melillo, B. Moore III, D. Murdiyarso, I. Noble, S.W. Pacala, I.C. Prentice, M.R. Raupach, P.J. Rayner, R.J. Scholes, W.L. Steffen and C. Wirth. 2001. Recent patterns and mechanisms of carbon exchange by terrestrial ecosystems. Nature 414:169-172.

Wilson, H.B., M.J. Keeling and S.W. Pacala. 2001. Deterministic limits to stochastic, spatial models of natural enemies. American Naturalist 159:57-80.

Moorcroft, P.R., G.C. Hurtt and S.W. Pacala. 2001. A Method for Scaling Vegetation Dynamics: the Ecosystem Demography Model (ED). Ecological Monographs 71(4):557-586.

Rees, M., R. Condit, M. Crawley, S.W. Pacala and D. Tilman. 2001. Vegetation Dynamics (9315). Science 293(5530):650-655.

Pacala S.W., Hurtt G.C., Moorcroft P.R. and Caspersen J.P. 2001. Carbon storage in the US caused by land use change. Pp. 145-172. In The Present and Future of Modeling Global Environmental Change, Terra Scientific Publishing. Toyko, Japan.

Pacala, S.W., G.C. Hurtt, R.A. Houghton, R.A. Birdsey, L. Heath, E.T. Sundquist, R.F. Stallard, D. Baker, P. Peylin, P. Moorcroft, J. Caspersen, E. Shevliakova, M.E. Harmon, S.-M. Fan, J.L. Sarmiento, C. Goodale, C.B. Field, M. Gloor and D. Schimel. 2001. Consistent Land- and Atmosphere-Based U.S. Carbon Sink Estimates. Science 292(5525):2316-2320.

Lewis, M.A. and S. Pacala. 2000. Modeling and analysis of stochastic invasion processes. Journal of Mathematical Biology 41:387-429.

Keeling, M.J., H.B. Wilson and S.W. Pacala. 2000. Re-interpreting Space, Time-lags, and Functional Responses to Ecological Models. Science 290:1758-1761.

Caspersen, J.P., S.W. Pacala, J.C. Jenkins, G.C. Hurtt, P.R. Moorcroft and R.A. Birdsey. 2000. Contributions of land-use history to carbon accumulation in US forests. Science 290:1148-1151.

Gloor, M., S.-M. Fan, S.W. Pacala and J.L. Sarmiento. 2000. Optimal sampling of the atmosphere for purpose of inverse modelling - a model study. Global Biogeochem. Cycles 14(1):407-428.

Hurtt, G.C., P.R. Moorcroft, S.W. Pacala and S. Levin. 1998. Terrestrial Models and Global Change: Challenges for the Future. Global Change Biology 4(5):581-590.

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Education

1977 B.Sc. Forest Biology, Colorado State University, Fort Collins
1980 M.Sc. Forest Ecology, Colorado State University, Fort Collins
1987 Ph.D. Systems Ecology/Agroecology, Swedish University of Agricultural Sciences, Uppsala

Research Interests

Soil carbon sequestration in grasslands; mechanisms of soil carbon storage; modeling the carbon cycle in managed ecosystems.

Employment History

2001-present Professor, Department of Soil and Crop Sciences, Colorado State University
1996-present Senior Research Scientist, Natural Resource Ecology Lab, Colorado State University
1993-1995 Research Scientist, Natural Resource Ecology Lab, Colorado State University
1991-1993 Research Assistant Professor, W.K. Kellogg Biological Station, Michigan State University
1989-1990 Research Associate, W.K. Kellogg Biological Station, Michigan State University
1987-1989 Research Scientist, Dept. of Ecology and Environmental Research, Swedish University of Agricultural Sciences

Professional Service/Activities

Executive Committee – Consortium for Agricultural Mitigation of Greenhouse Gases (CASMGS)
Coordinating Lead Author – IPCC Good Practice Guidelines for Land Use, Land Use Change and Forestry, National Inventory Guidelines
Lead Author - IPCC Special Report on a "Land use, Land use Change and Forestry" Review Team - New Zealand National Carbon Inventory System
Co-chair for CAST Taskforce on climate change impacts and greenhouse gas mitigation in US agriculture.
Planning Committee member - Terrestrial Ecosystems Research Facilities, Dept. of Energy
Steering Committee member - International Geosphere Biosphere Program/Global Change in Terrestrial Ecosystems, Focus 3, Soil Organic Matter
Steering Committee member - U.S. Climate Change National Assessment, Agricultural Sector Team
Task Force member - DOE National Taskforce to develop a Carbon Sequestration Roadmap

Co-chair - IPCC Working Group on Methodologies for Country Inventories of Greenhouse Gases: CO_2 Emissions from Soils

Publications

Paustian, K., E.T. Elliott, G.A. Peterson and K. Killian. 1996. Modelling climate, CO_2 and management impacts on soil carbon in semi-arid agroecosystems. Plant and Soil 187:351-365.

Paustian, K., O. Andren, H. Janzen, R. Lal, P. Smith, G. Tian, H. Tiessen, M. van Noordwijk and P. Woomer. 1997. Agricultural soil as a C sink to offset CO_2 emissions. Soil Use and Management 13:230-244.

Paustian, K., C.V. Cole, D. Sauerbeck and N. Sampson. 1998. CO_2 mitigation by agriculture: An overview. Climatic Change 40:135-162.

Paustian, K., E.T. Elliott, J. Six and H.W. Hunt. 2000. Management options for reducing CO_2 emissions from agricultural soils. Biogeochemistry 48:147-163.

Collins, H.P., E.T. Elliott, K. Paustian, L.G. Bundy, W.A. Dick, D.R. Huggins, A.J.M. Smucker and E.A. Paul. 2000. Soil carbon pools and fluxes in long-term Corn Belt agroecosystems. Soil Biol. Biochem. 32:157-168.

Paustian, K., E.T. Elliott, K. Killian, J. Cipra, G. Bluhm and J.L. Smith. 2001. Modeling and regional assessment of soil carbon: A case study of the Conservation Reserve Program. In: R. Lal and K. McSweeney (eds) Soil Management for Enhancing Carbon Sequestration. Pp. 207-225. SSSA Special Publ., Madison, WI.

Conant, R.T., K. Paustian and E.T. Elliott. 2001. Grassland management and conversion into grassland: Effects on soil carbon. Ecological Application 11:343-355.

Eve, M.D., M. Sperow, K. Paustian and R.F. Follett. 2002. National-scale estimation of changes in soil carbon stocks on agricultural lands. Environmental Pollution 116: 431-438.

Conant, R.T. and K. Paustian 2002. Potential soil carbon sequestration in overgrazed grassland ecosystems. Global Biogeochemical Cycles 16:90_1-90_9.

Eve, M.D., M. Sperow, K. Howerton, K. Paustian and R.F. Follett. 2002. Predicted impact of management changes on soil carbon stocks for each cropland region of the conterminous U.S. Journal of Soil and Water Conservation 57:196-204.

Antle, J.M., S.M. Capalbo, S. Mooney, E. Elliott and K. Paustian. 2002. Economic Analysis of Agricultural Soil Carbon Sequestration: An Integrated Assessment Approach. Journal of Agricultural and Resource Economics 26:344-367.

Antle, J.M., S.M. Capalbo, S. Mooney, E.T. Elliott and K. H. Paustian. 2002. A comparative examination of the efficiency of sequestering carbon in U.S. agricultural soils. American Journal of Alternative Agriculture 17:109-115.

Reilly, J., F. Tubiello, B. McCarl, D. Abler, R. Darwin, K. Fuglie, S. Hollinger C. Izaurralde, S. Jagtap, J. Jones, L. Mearns, D. Ojima, E. Paul, K. Paustian, S. Riha, N. Rosenberg, C. Rosenzweig. 2003. U.S. Agriculture and Climate Change: New Results. Climatic Change 57:43-69.

Sperow, M., M.D. Eve and K. Paustian. 2003. Potential soil C sequestration on U.S. agricultural soils. Climatic Change 57:319-339.

DeGryze, S., J. Six, K. Paustian, S.J. Morris, E.A. Paul and R. Merckx. 2003. Soil organic carbon pool changes following land use conversions. Global Change Biology (in press).

Ogle, S.M., R.T. Conant and K. Paustian. 2003. Deriving grassland management factors for a carbon accounting method developed by the Intergovernmental Panel on Climate Change. Environ. Management (in press).
Conant, R.T. and K. Paustian. 2003. Grassland management activity data: current sources and future needs. Environ. Management (in press).
Paustian, K. and B. Babcock (eds). 2003. Climate Change and Greenhouse Gas Mitigation: Challenges and Opportunities for Agriculture. Council on Agricultural Sciences and Technology (CAST). (In press).

P. Tans
Environmental Research Laboratories
Climate Monitoring and Diagnostics Laboratory (CMDL)
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Education:	Doctorandus, Theoretical Physics (1973) (cum laude).
	PhD, Experimental Physics (1978), Rijksuniversiteit Groningen. Thesis adviser: Prof. W.G. Mook. Thesis title: "^{13}C and ^{14}C in Tree Rings and the Atmospheric CO_2 Increase"
Employment:	
8/78-7/79	Postdoc, Scripps Inst. Oceanography, La Jolla, CA, with C.D. Keeling.
8/79-3/85	Staff scientist, Astrophysics Group, Lawrence Berkeley Laboratory, Berkeley.
4/85-2/90	Research Associate, CIRES, University of Colorado, Boulder.
3/90-12/96	Supervisory Physicist, Climate Monitoring and Diagnostics Laboratory, National Oceanic and Atmospheric Administration, Boulder.
12/96-	Chief Scientist, Climate Monitoring and Diagnostics Laboratory.
Past research:	Magnetic impurities in an electron lattice gas; One-dimensional radiative climate model; High precision ^{14}C counting; Stable isotopes in tree rings; Radioisotope detection with a cyclotron; Development of Raman scattering method to detect minute changes in the ratio of atmospheric O_2 to N_2.
Present:	Biogeochemical cycles; Global climate change; Stable isotope applications; Atmospheric chemistry and transport; Inverse models; Air-sea exchange of gases; Development of new generation of accurate and robust gas analyzers
7/92-8/00	Professor Adjoint, Department of Chemistry & Biochemistry, University of Colorado at Boulder.
92-93	Committee on Oceanic Carbon, Ocean Studies Board, NRC
95-97	Dec-Cen Panel, Board on Atmospheric Sciences and Climate, NRC
5/97-	CIRES fellow
98-99	Working Group drafting a multi-agency U.S. Carbon Cycle Science Plan
96-	Associate Editor, Journal of Climate

97- Editorial Advisory Board, Tellus B

10/95- Corresponding member, Royal Dutch Academy of Sciences
8/00 Gold Medal, Department of Commerce
6/02- ISI Highly Cited (248 most cited authors in the geosciences 1981-1999)
1/04- Fellow, American Geophysical Union

Other interests and activities:
Sustainability of the earth's resources
Sailboat racing (former world & Dutch national champion)

Courses taught: Physical Chemistry 1 & 2, Environmental Chemistry

Patents: Fiber-optic beam splitter
Infrared viewing of subcutaneous vascular structures

Research Support: NOAA Oceanic and Atmospheric Research, NOAA Climate Observations and Services Program, NASA LBA-ECO.

Selected Publications:

Francey, R. J. and P. P. Tans, Latitudinal variation in oxygen-18 of atmospheric CO_2, **Nature 327**, 495-497, 1987.

Tans, P. P., T. J. Conway, and T. Nakazawa, Latitudinal distribution of the sources and sinks of atmospheric carbon dioxide derived from surface observations and atmospheric transport model, **J. Geophys. Res. 94**, 5151-5172, 1989.

Tans, P. P., I. Y. Fung, and T. Takahashi, Observational constraints on the global atmospheric carbon dioxide budget, **Science 247**, 1431-1438, 1990.

Steele, L.P., E.J. Dlugokencky, P.M. Lang, P.P. Tans, R.C. Martin, and K.A. Masarie, Slowing down of the global accumulation of atmospheric methane during the 1980's, **Nature, 358**, 313-316, 1992.

Tans, P.P., J.A. Berry, and R.F. Keeling, Oceanic $^{13}C/^{12}C$ observations, a new window on CO_2 uptake by the oceans, **Glob. Biogeochem. Cycles, 7,** 353-368, 1993.

Novelli, P.C., K.A. Masarie, P.P. Tans, and P.M. Lang, Recent changes in atmospheric carbon monoxide, **Science, 263,** 1587-1590, 1994.

Bender, M.L., P.P. Tans, J.T. Ellis, J. Orchardo, and K. Habfast, A high precision isotope ratio mass spectrometry method for measuring the O_2/N_2 ratio of air, **Geochim. Cosmochim. Acta, 58,** 4751-4758, 1994.

Ciais, P., P.P. Tans, M. Trolier, J.W.C. White, and R.J. Francey, A large northern hemisphere terrestrial CO_2 sink indicated by the $^{13}C/^{12}C$ ratio of atmospheric CO_2, **Science, 269**, 1098-1102, 1995.

Battle, M., M. Bender, T. Sowers, P. Tans, J. Butler, J. Elkins, J. Ellis, T. Conway, N. Zhang, P. Lang, and A. Clarke, Atmospheric gas concentrations over the past century measured in air from firn at the South Pole, **Nature 383,** 231-235, 1996.

Tans, P.P., Why carbon dioxide from fossil fuel burning won't go away, in: Perspectives in Environmental Chemistry, edited by D. Macalady, Ch. 12, pp. 271-291, Oxford University Press, New York, 1998.

Tans, P.P., The CO_2 lifetime concept should be banished, **Climatic Change,** 37, 487-490, 1997.

Fan, S., M. Gloor, J. Mahlman, S. Pacala, J. Sarmiento, T. Takahashi, and P. Tans, A large terrestrial sink in North America implied by atmospheric and oceanic carbon dioxide data and models, **Science 282**, 442-446, 1998.

Bousquet, Philippe, Philippe Peylin, Philippe Ciais, Corinne le Quere, Pierre Friedlingstein, and Pieter Tans, Regional changes in carbon dioxide fluxes of land and oceans since 1980, **Science 290**, 1342-1346, 2000.

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EXPERIENCE

Consensus Building Institute (CBI), Cambridge, Massachusetts September 1998 – Present
A not-for-profit organization that provides mediation and dispute system design services to public and private clients worldwide.
Vice President for Research, Evaluation, and Special Projects and for Management.
Conduct conflict assessments and develop negotiation and consensus building training courses for public and non-profit organizations. Convene and facilitate public meetings and on-going policy dialogues. Train various audiences on facilitation and stakeholder participation approaches. Design multi-party negotiation simulations. Conduct research on and write about the use of mediation in solving land use disputes. Program Manager for CBI work in the Netherlands. Manage CBI's program development.

Consultant February 1997 – August 1998
Oxfam America, Boston, Massachusetts -.Conducted a research survey on hydrology and fish studies of the Mekong River Basin.

Consensus Building Institute (CBI), Cambridge, Massachusetts – Project Advisor.

Stonyfield Farm, Inc., Londonderry, New Hampshire - Set up a corporate Carbon Mitigation Program and wrote a brochure on how to start a Carbon Mitigation Program for other businesses.

World Resources Institute (WRI), Washington, D.C. - Wrote a technical report on participation and facilitation in the Cambodian National Environmental Action Plan (NEAP) process.

World Resources Institute (WRI), Washington, D.C. November 1990 - January 1997
An independent center for policy research and technical assistance on global environmental and development issues.
Associate and *Coordinator for Asia and the Pacific*, Center for International Development and Environment. October 1992 - January 1997
Managed the Cambodia Environmental Management Project (CEMP) and served as Environmental Policy Advisor to the Royal Government of Cambodia's Ministry of Environment -- based in Phnom Penh, Cambodia (for eight months).
Coordinated the USAID-Indonesia Environmental Assessment and Strategy.
Managed the "Strengthening Environmental Impact Assessment (EIA) Capacity in Asia" project.

Program Analyst, Center for International Development and Environment. November 1991 - September 1992

Research Assistant, Resource and Environmental Information Program. November 1990 - October 1991

United Nations Environment Programme, Bangkok, Thailand *June – August 1989*
UN agency addressing the management of global and regional environmental issues.
Intern
Researched and wrote a report on alternative policies for addressing climate change in Asia and the Pacific.

***Center for Environmental Management*, Tufts University, Medford, MA.** *July - October 1990*
Research center addressing local, national, and international environmental management issues.
Research Assistant.
Assisted in the preparation of a case study on the regional, national, and local boundaries of decision-making and implementation of global climate change responses in New England and Eastern Canada.

***International Institute for Management and Development (IMD),* Lausanne, Switzerland** *May 1986 -*
International management school with advanced programs for senior executives and an MBA program.
Public Relations Coordinator and *Editor*.

United Nations Association of Greater Boston, Boston, MA. *January - December 1985*
Association set up to create awareness of the United Nations and the issues they address.
Co-Executive Director.

EDUCATION

The Fletcher School of Law and Diplomacy, Tufts University, Medford, MA.
Master of Arts in Law and Diplomacy, *August 1990*. Masters thesis topic: Alternative Policies for Addressing Climate Change in Asia and the Pacific. Teaching Assistant for Professors William Moomaw and Rick Wetzler for a graduate and undergraduate course on Environmental Science, Spring 1990.

Boston University, Boston, MA.
Bachelor of Science in Mass Communications, *May 1985*.

PERSONAL

U.S. Permanent Resident, Dutch citizenship

Fluent in English, Dutch, and French. Reading knowledge of German, and beginning Indonesian.

Steven C. Wofsy
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Education

University of Chicago, Chicago, Illinois. B.S. (with honors) in Chemistry, 1966.
Harvard University, Cambridge, MA. M.A. in Chemistry, 1967; Ph.D. in Chemistry, 1971

Research Interests

Terrestrial carbon cycle; effects of forests on climate, and climate on forests.
Inference of large scale carbon budgets from atmospheric and land surface data
CO_2 as a tracer of atmospheric transport in the upper troposphere and stratosphere
New instrumentation for measuring atmospheric carbon cycle species (CO_2, CO, CH_4).

Professional Experience

June 1971 to September 1973. NRC Research Associate, Smithsonian Astrophysical Observatory.
September 1973 to June 1977. Division of Engineering and Applied Physics, Harvard, Lecturer and Research Fellow on Atmospheric Chemistry (Harvard DEAS).
July 1977 to June 1982. Associate Professor of Atmospheric Chemistry, (Harvard DEAS).
July, 1982 to February, 1995. Senior Research Fellow, (Harvard DEAS).
February, 1995. Gordon McKay Professor of Atmospheric and Environmental Sciences, Harvard (DEAS) and Department of Earth and Planetary Sciences (EPS).
January, 1997. Abbott Lawrence Rotch Professor of Atmospheric and Environmental Science, Harvard University DEAS and EPS.

Committees (recent)

NASA Earth System Science and Applications Advisory Committee 1995-2000; chair, 1997-1999; NASA Advisory Council, 1997-1999.

Carbon Cycle Science Plan Working Group, co-chair, 1998-1999; North American Carbon Program writing group, chair, 2001-2003.

Project or Lead Scientist for the following aircraft measurement programs

Stratospheric Photochemistry, Aerosol, and Dynamics Experiment (NASA ER-2, 1992-3)

Stratospheric Tracers of Atmospheric Transport (STRAT; NASA ER-2 platform, 1995-7)

CO_2 Boundary-layer Regional Atmospheric Study (COBRA, UND Citation 2, 1999-2000, NASA/NOAA/NSF/DoE)

CO_2 Boundary-layer Regional Atmospheric Study- North American Carbon Program, Canada-US

Preliminary Study (May - June 2003, NASA/TEP).

CO_2 Boundary-layer Regional Atmospheric Study-Maine (COBRA, U. Wyoming King Air, 2004 NSF/Biocomplexity)

Selected Recent Publications (200 total since 1970)

Andrews, A. E., K. A. Boering, S. C. Wofsy, B. C. Daube, D. B. Jones, S. Alex, M. Loewenstein, J. R. Podolske, and S. E. Strahan, Empirical age spectra for the midlatitude lower stratosphere from *in situ* observations of CO_2, *J. Geophys. Res, 106,* 10257-10274, 2001.

Barford, Carol C., Steven C. Wofsy, Michael L. Goulden, J. Wm. Munger, Elizabeth Hammond Pyle, Shawn P. Urbanski, Lucy Hutyra, Scott R. Saleska, David Fitzjarrald, Kathleen Moore, Factors controlling long and short term sequestration of atmospheric CO_2 in a mid-latitude forest, *Science 294 (5547):* 1688-1691, 2001.

Chou, Wendy W., Steven C. Wofsy, Robert C. Harriss, John C. Lin, C. Gerbig, and Glenn W. Sachse, Net fluxes of CO_2 in Amazônia derived from aircraft observations, *i. Geophys Res. 107 (D22), 4614, 10.1029/2001JD001295, 2002.*

Daube BC; Boering KA; Andrews AE; Wofsy SC**:** A high-precision fast-response airborne CO_2 analyzer for in situ sampling from the surface to the middle stratosphere. *J. Atmos. Oceanic Technol. 19*, Iss 10, pp 1532-1543, 2002.

Goldstein, A. H., S.M. Fan, M.L. Goulden, J.W. Munger, S.C. Wofsy. Biogenic Olefin Emissions from a Midlatitude Forest, *J. Geophys. Res. 101*, . 9149-9157, 1996.

Goulden, M. L., J. W. Munger, S.-M. Fan, B. C. Daube, and S. C. Wofsy, Effects of interannual climate variability on the carbon dioxide exchange of a temperate deciduous forest, *Science 271*, 1576-1578, 1996.

Goulden, M. L., J. W. Munger, S.-M. Fan, B. C. Daube, and S. C. Wofsy, Measurements of carbon storage by long-term eddy covariance, *Global Change Biology 2, 169-182,* 1996.

Gu, Lianhong, Dennis D. Baldocchi, Steven C. Wofsy, J. William Munger, Joseph J. Michalsky, Shawn P. Urbanski, Thomas A. Boden, Response of a deciduous forest to the Mt. Pinatubo eruption: Enhanced photosynthesis, *Science 299*, 2035-2038, 28 MARCH 2003.

Lin, J. C., C. Gerbig, S.C. Wofsy, A.E. Andrews, B.C. Daube, K.J. Davis, A. Grainger, The Stochastic Time-Inverted Lagrangian Transport Model (STILT): Quantitiative analysis of surface sources from atmospheric concentration data using particle ensembles in a turbulent atmosphere, *J. Geophys. Res.* 108, No. D16, 4493, *10.1029/2002JD003161, 2003.*

Lai, Chun-Ta , James R. Ehleringer , Steve Wofsy, Dave Hollinger, and P.P. Tans. Estimating photosynthetic ^{13}C discrimination in terrestrial CO_2 exchange from canopy to regional scales (accepted in *Global Biogeochemical Cycles*).

Litvak, M., S. Miller, S. Wofsy, M. Goulden, Effect of stand age on whole-ecosystem CO_2 exchange in the Canadian boreal forest. *J. Geophys.Res. Doi: 10.1029/2001/JD000854*, 2003.

Munger, J. William, Song-Miao Fan, Peter S. Bakwin, Mike L. Goulden, A. H. Goldstein, A. S. Colman, and Steven C. Wofsy, Regional budgets for Nitrogen Oxides from Continental Sources: Variations of rates for oxidation and deposition with season and distance from source regions, J. *Geophys.Res., 103*: (D7) 8355-8368, 1998

Potosnak, M. J. S. C. Wofsy, A. S. Denning, T. J. Conway, J.W. Munger, and D. H. Barnes, Influence of biotic exchange and combustion sources on atmospheric CO_2 concentrations in New England from observations at a forest flux tower. *J. Geophys. Res, 104*: 9561-9569, 1999.

Turner, David P., Shawn P. Urbanski, Dale Bremer, Steven C. Wofsy, Tilden Meyers, Stith T. Gower, Matthew Gregory A Cross-biome Comparison of Daily Light Use Efficiency for Gross Primary Production, *Global Change Biology (in press, 2003)*.

Wofsy, S. C. and R.C. Harriss, 2002: *The North American Carbon Program (NACP)*. Report of the NACP Committee of the U.S. Interagency Carbon Cycle Science Program. Washington, DC: *US Global Change Research Program*, 75pp.

Wofsy, Steven C. , Where Has All the Carbon Gone? *Science 292*: 2261-2263. (in Perspectives), 2001.