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[*For Internal Expert/Peer Review*]

The First State of the Carbon Cycle Report (*SOCCR*): The North American Carbon Budget and Implications for the Global Carbon Cycle

U.S. Climate Change Science Program

Synthesis and Assessment Product 2.2

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[Note: The organization of this publication is subject to change]

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PREFACE

A primary objective of the U.S. Climate Change Science Program (CCSP) is to provide the best possible scientific information to support public discussion, as well as government and private sector decision-making, on key climate-related issues. To help meet this objective, the CCSP has identified an initial set of 21 synthesis and assessment products that address its highest priority research, observation, and decision-support needs.

This CCSP Report, which is one of the 21 products, provides 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 decision makers, it (1) summarizes our knowledge of carbon cycle properties and changes relevant to the contributions of and impacts[1] 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. Consequently, this Report promises to be of significant value to decision-makers, and to the expert scientific and stakeholder communities. For example, we expect this Report to be a major contributor to the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (due to be published in 2007).

This Report—Synthesis and Assessment Product (SAP) 2.2—addresses 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; effects of agriculture, forestry, and natural resource management on the carbon cycle; and the socio-economic drivers and consequences of changes in the carbon cycle. It covers North America's land, atmosphere, inland waters, and adjacent oceans, where "North America" is defined as Canada, the United States of America, and Mexico. The Report includes an analysis of North America's carbon budget that documents the state of knowledge and quantifies the best estimates (i.e., consensus, accepted, official) and uncertainties. This analysis provides a baseline against which future results from the North American Carbon Program (NACP) can be compared. SAP 2.2 will be coordinated with other CCSP synthesis and assessment products as appropriate, especially SAP 2.1 (*Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations and Review of Integrated Scenario Development and Application*) and SAP 3.1 (*Climate Models: An Assessment of Strengths and Limitations for User Applications*).

[1]The term "impacts" as used in this Report refers to specific effects of changes in the carbon cycle, such as acidification of the ocean, the effect of increased CO_2 on plant growth and survival, and changes in concentrations of carbon in the atmosphere. The term is not used as a shortened version of "climate impacts," as was adopted for the *Strategic Plan for the U.S.Climate Change Science Program*.

The focus of this Report follows the Prospectus developed by the Climate Change Science Program and posted on its website at www.climatescience.gov. More specifically, SAP 2.2 attempts to:

- Quantify current information on sources and sinks and associated uncertainties related to the buildup of carbon dioxide (CO_2) and methane (CH_4) in the atmosphere. For example, it provides the best available estimates of the contribution of carbon dioxide emissions from combustion of fossil fuels in North America to changes in global atmospheric concentrations of carbon dioxide for recent decades. Discussion of future changes in fossil fuel emissions are limited to existing scenarios because scenarios are the central element of the work being done under SAP 2.1.
- Discuss and assess current accepted projections of the future of the North American carbon budget, including uncertainties in projected fossil fuel emissions and the impact of policy and technology scenarios on those emissions.
- Provide current 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 key questions were identified through early and continuing dialogue with SAP 2.2 stakeholders. The answers include explicit characterization of uncertainties.
- Identify where NACP-supported research 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.

The audience for SAP 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), the international community, 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 the scientific information needs of this broad audience can be met in this first synthesis and assessment product, but the scientific information provided herein is designed to be understandable by all. The primary users of SAP 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.

It is envisioned that SAP 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 carbon-specific impacts upon the United States in the context of 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. This Report is also intended for senior managers and members of the general public who desire 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.

The questions addressed by this Report include:

- 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 direct, non-climatic effects of increasing atmospheric carbon dioxide or other changes in the carbon cycle on the land and oceans of North America?
- What are the options and measures implemented in North America that could significantly affect the North American and global carbon cycles (e.g., North American sinks and global atmospheric concentrations of carbon dioxide)?
- How can we improve the application of scientific information to decision support for carbon management and climate decision making?

These questions provide the basis for the five chapters in Part I of this Synthesis and Assessment Report. Part II of the Report focuses on the human-system components of the North American carbon cycle, and discusses the carbon "sources and sinks" aspects of (a) energy extraction and conversion,

(b) the transportation sector, (c) industry and waste management, and (d) the buildings sector. Part III provides information about land and water systems, including human settlements, and their roles in the carbon cycle.

[NOTE TO REVIEWERS: The following items will also be included in the PREFACE, but have not yet been developed.]

- Structure and organization of this report; How to read this report
- Definition of basic terms, acronyms, units, etc.
- Treatment of carbon vs CO_2 vs CO_2 equivalents
- Treatment of CH_4
- Treatment of greenhouse gases
- Conventions for sources and sinks (i.e., positive and negative numbers)