A New U.S. Carbon Cycle Science Plan

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CCS WG Co-Leads

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Working Group Membership

Rob Jackson – Co-lead (Duke U.)	Lisa Dilling (U. Colorado)	Brian O'Neill (NCAR)
Gregg Marland – Co-lead (ORNL)	Andy Jacobson (NOAA / U. Colorado)	Steve Pacala (Princeton)
Anna Michalak – Co-lead (U. Michigan)	Matthew Kahn (UCLA)	Jim Randerson (UC Irvine)
Chris Sabine – Co-lead (PMEL)	Steve Lohrenz (U. Mississippi)	Steve Running (U. Montana)
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Deborah Bronk (Col. of William & Mary)	Galen McKinley (U. Wisconsin)	Pieter Tans (NOAA-ESRL)
Ken Davis (Penn State)	Charles Miller (JPL)	Peter Thornton (ORNL)
Ruth DeFries (Columbia U.)	Berrien Moore (Climate Central)	Steve Wofsy (Harvard)
Scott Denning (Colorado State U.)	Dennis Ojima (Heinz Center)	Ning Zeng (U. Maryland)

Timeline to Date

- June/July 2008: Co-leads of CCS WG appointed
- September/October 2008: Members of CCS WG appointed
- November 2008: First meeting of CCS WG
- January 2009: CCS WG Meeting Report accepted for publication in EOS
- February 2009: NACP Investigators' Meeting and second meeting of CCS WG
- March 2009: Scoping paper describing main thrusts of revised plan completed (available online)
- June 1-2 2009: Third meeting of CCS WG
- Summer 2009: Blog and email account for feedback launched
- November 2009: Summary of recommendations for revised plan completed (available online)
- December 2009: Writing of full CCS Plan begins

Comments / Updates: http://www.carboncyclescience.gov/carbonplanning.php

Outreach Meetings, Conferences, Workshops

Organization	Location	Date	Scope
1st CCS WG Meeting	Washington, DC	2008 Nov 17-18	Workshop
16th CCSSG Meeting	Washington, DC	2008 Dec 9-10	Report / presentation
NACP All Investigators' Meeting	San Diego, CA	2009 Feb 17-20	CCS WG meeting, plenary pres., breakout session
AGU Toronto Meeting	Toronto, Canada	2009 May 24-27	Presentation
2nd CCS WG Meeting	Washington, DC	2009 June 1-2	Workshop
17th CCSSG Meeting	Washington, DC	2009 June 3-4	Report / presentation
ESSP GCP SSC Meeting	Beijing, China	2009 June 23-25	Report / presentation
Ocean Carbon Biogeochemistry Workshop	WHOI	2009 July 20-23	Presentations and panel
94th Ecological Society of America Meeting	Albuquerque, NM	2009 Aug 2-7	Presentation
8th International Carbon Dioxide Conference	Jena, Germany	2009 Sept 13-19	Abstract and poster
OceanObs09	Venice-Lido, Italy	2099 Sept 21-25	Presentation / poster
AmeriFlux Meeting	Washington, DC	2009 Sept 21-23	Presentation
NACP SSG Meeting	Washington, DC	2009 Sept 30	Presentation
39th NRC Committee on the Human Dimensions of Global Change Meeting	Washington, DC.	2009 Nov 19-20	Presentation
18th CCSSG Meeting	Washington, DC	2009 Dec 3-4	Report/presentation
AGU Fall Meeting	San Francisco, CA	2009 Dec 14-18	Townhall meeting
Human Dimensions workshop	Washington, DC	2010 Mar 12-13	Workshop

Overall Directions

- Many research priorities identified in the 1999 Plan remain important
- However, new priorities for carbon cycle research are also needed, including:
  1. Effects of human activities on carbon cycling,
  2. Vulnerability and resilience of ecosystems to changes in carbon cycling and associated changes in climate
  3. Efficacy and environmental consequences of carbon management policies, strategies, and technologies
- Additional emphasis is also needed to:
  - Evaluate uncertainties in our understanding of the global carbon cycle
  - Coordinate researchers across scientific disciplines

3 Fundamental Science Questions

1) How do natural processes and human actions affect the carbon cycle, on land, in the atmosphere, and in the oceans?

2) How do policy and management decisions affect the levels of atmospheric carbon dioxide and methane?

3) How are ecosystems, species, and resources impacted by increasing greenhouse gas concentrations, the associated changes in climate, and carbon management decisions?

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Goals for the Carbon Cycle Science Program

Six proposed goals provide concrete milestones for carbon cycle science for the upcoming decade.

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Goal 1

- Provide clear and timely explanation of past and current variations observed in atmospheric CO_2 and CH_4 - and the uncertainties surrounding them. (Q1, Q2)
- *To address this goal, we need to develop the capability to estimate variability in carbon sources and sinks, as well as the processes controlling that variability. This goal also provides a link to the human dimensions of the carbon cycle, because understanding the economic and policy links to anthropogenic emissions and sequestration efforts is essential for understanding variations in atmospheric CO_2 and CH_4.*

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Goal 2

- Understand and quantify the socio-economic drivers of carbon emissions, and develop transparent methods to monitor and verify those emissions (Q1, Q2).
- *This goal seeks to understand the fundamental human processes that drive carbon emissions. It also provides a framework for developing quantitative tools for verifying the magnitude of emissions and determining the effects of mitigation and sequestration activities using "bottom up" and "top down" approaches. The developed approaches must be transparent and relevant to policy-makers.*

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Goal 3

- Determine and evaluate the carbon stocks and flows that are most vulnerable to climate change and land–use change, emphasizing potential positive feedbacks to sources or sinks that make climate stabilization more critical or more difficult. (Q1, Q2, Q3)
- *All carbon reservoirs and carbon processes are not equally vulnerable to change, resilient to stress, responsive to management, and susceptible to unintended consequences of management decisions. We need to be able to identify the signs of change, the symptoms of trouble, and the opportunities for managing the natural and anthropogenic components of the global carbon cycle.*

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Goal 4

- Predict how ecosystems, biodiversity, and natural resources will change under different CO_2 and climate change scenarios. (Q3)
- *Even in the absence of climate change, rising atmospheric CO_2 alters ecological factors such as the chemistry of surface waters and the biodiversity of terrestrial ecosystems. For instance, changes in water chemistry have been shown to have important but still poorly understood consequences for coral reefs and other marine organisms with carbonate shells. This goal assesses the impacts of increased atmospheric CO_2 on ecosystem form and function.*

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Goal 5

- Determine the likelihood of success and the potential for unintended consequences of carbon-management pathways that might be undertaken to achieve a low carbon future. (Q1, Q2, Q3)
- *The global carbon cycle is complex and closely linked to the energy, water, and nutrient cycles on Earth as well as to demographic and economic systems globally. Ethical and equity issues are central to what actions might be taken, who takes them, and what consequences result. This goal aims to understand interlinked natural and managed systems well enough for individuals, corporations, and governments to be able to make rational and well-informed decisions on how to best reduce their environmental footprint.*

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Goal 6

- Address decision-maker needs for current and future carbon-cycle information and provide data and projections that are relevant, credible, and legitimate for their decisions. (Q1, Q2, Q3)
- *Useful science involves both asking the right questions and making the results available in a useful way. A goal of carbon cycle research is to interact with decision makers in an on-going dialogue so that socially relevant questions are addressed and that research results are accessible where and when needed. Decision makers need sound understanding of what is happening now and sound projections of what can be expected in the future. We also recognize for the importance of curiosity-driven research that anticipates the needs and basic understanding behind questions not yet asked by decision makers.*

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An Over-riding Consideration

- Establish baseline data sets and monitoring systems for key carbon system variables and develop new long-term records to detect change.
- *In support of all of the other goals, we need an optimally designed and integrated long-term monitoring system of essential atmospheric, oceanic, biologic, demographic, and socioeconomic data to establish baselines, evaluate change, understand processes, and monitor mitigation actions. With this goal comes a commitment to data management and rapid data access.*

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Elements

Four proposed elements that feed into all of the goals. Rather than developing a laundry list of relevant projects, they have been grouped into four categories.

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E1: Global & Regional Observational Networks

- Earth observing satellites for carbon and related parameters.
- Integrated tower and aircraft sampling of atmospheric carbon and related species.
- Coordinated global ocean carbon and ocean acidification observing networks.
- Global networks of terrestrial inventories and fluxes, including soils.
- Monitoring and assessment of human systems, including mitigation and adaptation strategies and associated impacts.

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E2: Global, Regional, Urban, & Ecosystem Scale Process Studies of System Dynamics & Function

- Intensive studies to understand physical and socioeconomic processes responsible for controlling carbon emissions, uptake, and storage as well as how they might change in the future.
- Manipulative laboratory and field studies to elucidate the response of representative land and marine ecosystems to climate and biogeochemical change.

E3: Data Assimilation, Modeling, Prediction, Synthesis, and Uncertainty Quantification

- Coupled physical and socio-economic components of existing climate system and assessment models to produce first-generation integrated Earth System models.
- Synthesis of observations, experimental results, and models to reduce uncertainty in model predictions and to increase model skill.
- Data assimilation methods for optimally integrating atmospheric observations, including land, ocean, and fossil fuel fluxes, and coupling those observations with atmospheric transport models to quantify and reduce uncertainty in carbon cycle estimates.

E4: Communication and Dissemination

- Regular, two-way communication with the decision-making community and the general public, including seeking out critical public information needs.
- Tools to translate results from synthesis and prediction into quantitative, understandable products for policy and management professionals.
- Approaches for communicating the level of certainty that scientists have in various components of the carbon budget to managers, decision-makers, and the general public
- Evaluation of the implications of uncertainty in present-day knowledge and in future carbon cycle projections for managers, decision-makers, and the general public.
- Regional analyses to determine how management options are being evaluated and how the carbon science community can help inform that process

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Review Process – Proposed

- August 23-24: Workshop for CCS WG to review Plan
- October 1: Plan submitted for "broad brush" review by CCIWG and CCSSG
- November 1: Plan available for review by:
  - CCS WG members
  - CCSSG (full review)
  - CCIWG (full review)
  - External experts (U.S. and international), with reviews posted online
  - Open online review
- January 1: Review deadline
- January 1 – March 1: Final iterative revisions and input
- March 1: Plan completed

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Priorities / Budget

- We are in the process of discussing priorities from among the goals and elements identified in the plan
  - High level priorities
  - Element-level priorities

- We would like to receive:
  - Thoughts on the scope of the budget
  - Thoughts on making the priorities compatible with agencies' focus areas (i.e. feasibility)

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1999 U.S. CCS Plan Goals

1. Quantify and understand the Northern Hemisphere terrestrial carbon sink
2. Quantify and understand the uptake of anthropogenic CO_2 in the ocean
3. Determine the impacts of past and current land use on the carbon budget
4. Provide greatly improved projections of future atmospheric concentrations of CO_2
5. Develop the scientific basis for societal decisions about management of CO_2 and the carbon cycle

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Primary Program Elements

	Program Elements			
Goals	Sustained observations	Process studies and experiments	Modeling, prediction, synthesis	Communication dissemination
Explain observed variations	X	X	X	X
Quantify anthropogenic emissions	X	X	X	X
Evaluate vulnerable stocks and flows	X	X	X	X
Ecosystem impacts	X	X	X	X
Evaluate carbon management options	X	X	X	X
Decision support and information management	X	X	X	X