North American Carbon Program and Soil Science Opportunities

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There are many programs at different stages and scales on either carbon or climate change

To mention a few that I know of:

- GCP: Sub-projects in different regions of the globe: North America, Pacific, Asia, Europe, Eurasia,…
  - Earth System Science Partnership (ESSP)
  - Recently adopted global bioenergy as new activity under the ESSP project
- Inter-American Institute for Climate Change Research
  - Periodic calls for proposals, synthesis projects, collaborations with 4 or more countries

- CarboEurope
- Canadian Carbon Program (CCP)
- Mexican Carbon Program (MCP)
- US North American Carbon Program (NACP)
- These three are collaborating to develop a tri-lateral plan and projects under the CA-MX-US CarboNA (formerly JNACP)
- …

- All are broad in scope and scale, but understanding “below ground processes” and measuring and mapping soil carbon stocks is increasingly being recognized as a need.
- Soil carbon is the largest terrestrial stock, considered more or less stable in US and Canada, decreasing in much of the tropics and subtropics due to forest clearing, fire, land use change

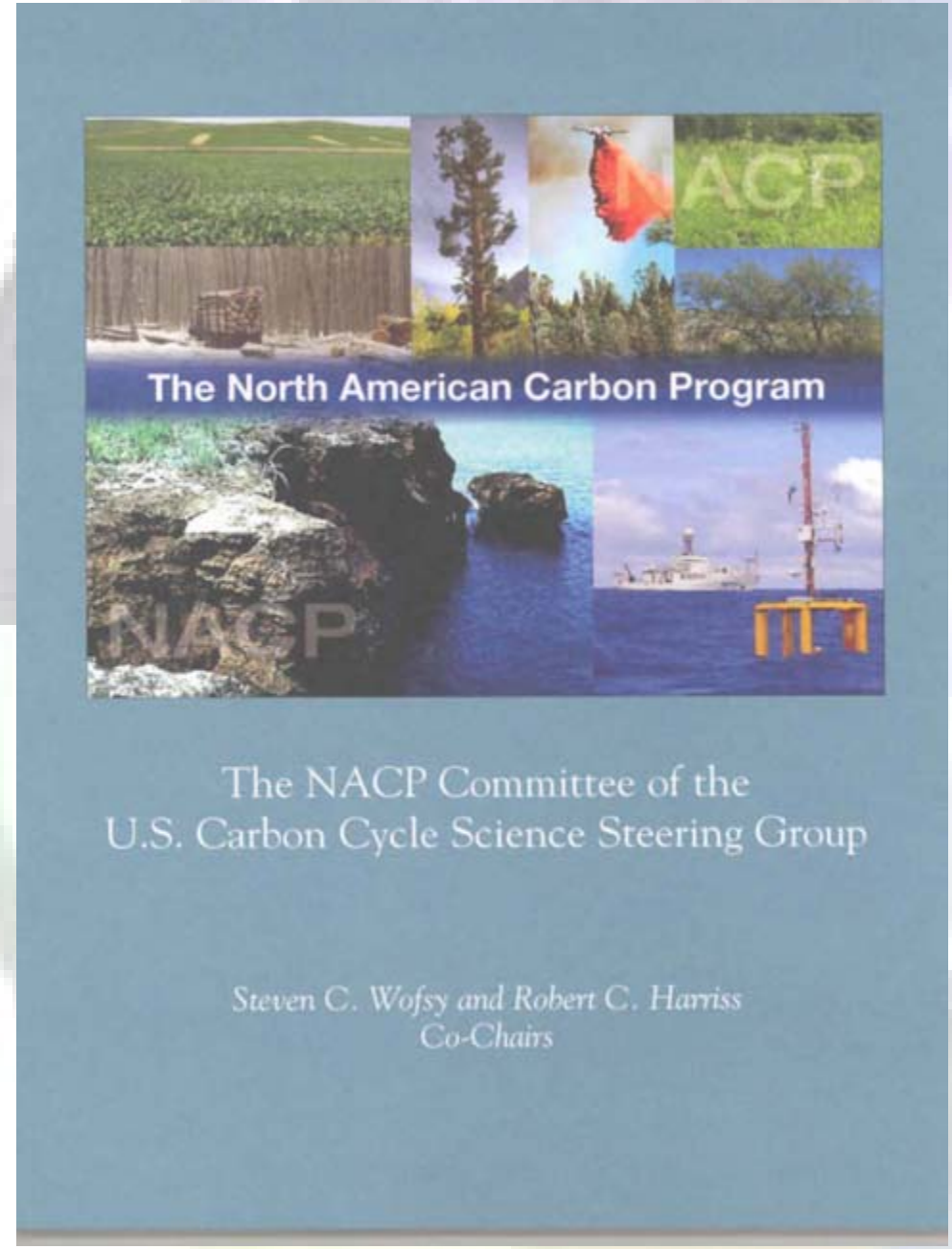
North American Carbon Program

Continental Carbon Budgets, Dynamics, Processes, and Management

The central objective of the NACP:
To measure and understand the sources and sinks of Carbon Dioxide, Methane, and Carbon Monoxide in North America and in adjacent ocean regions.

NACP is a program developed for the Carbon Cycle Interagency Working Group of the US Climate Change Science Program and is supported by the ten government agencies below:

http://www.nacarbon.org/nacp/index.html



NACP Science Plan

- Published 2002
- Prepared by CC Science Steering Group, chaired by Steven Wofsey and Robert Harris
- Describes science questions, goals and a framework for the NACP

NACP Goals

- Develop quantitative scientific knowledge, robust observations, and models to determine the emissions and uptake of CO_2, CH_4, and CO, changes in carbon stocks, and the factors regulating these processes
- Develop the scientific basis to implement full carbon accounting on regional and continental scales.
- Support long-term quantitative measurements of fluxes, sources and sinks of atmospheric CO_2 and CH_4, and develop forecasts for future trends

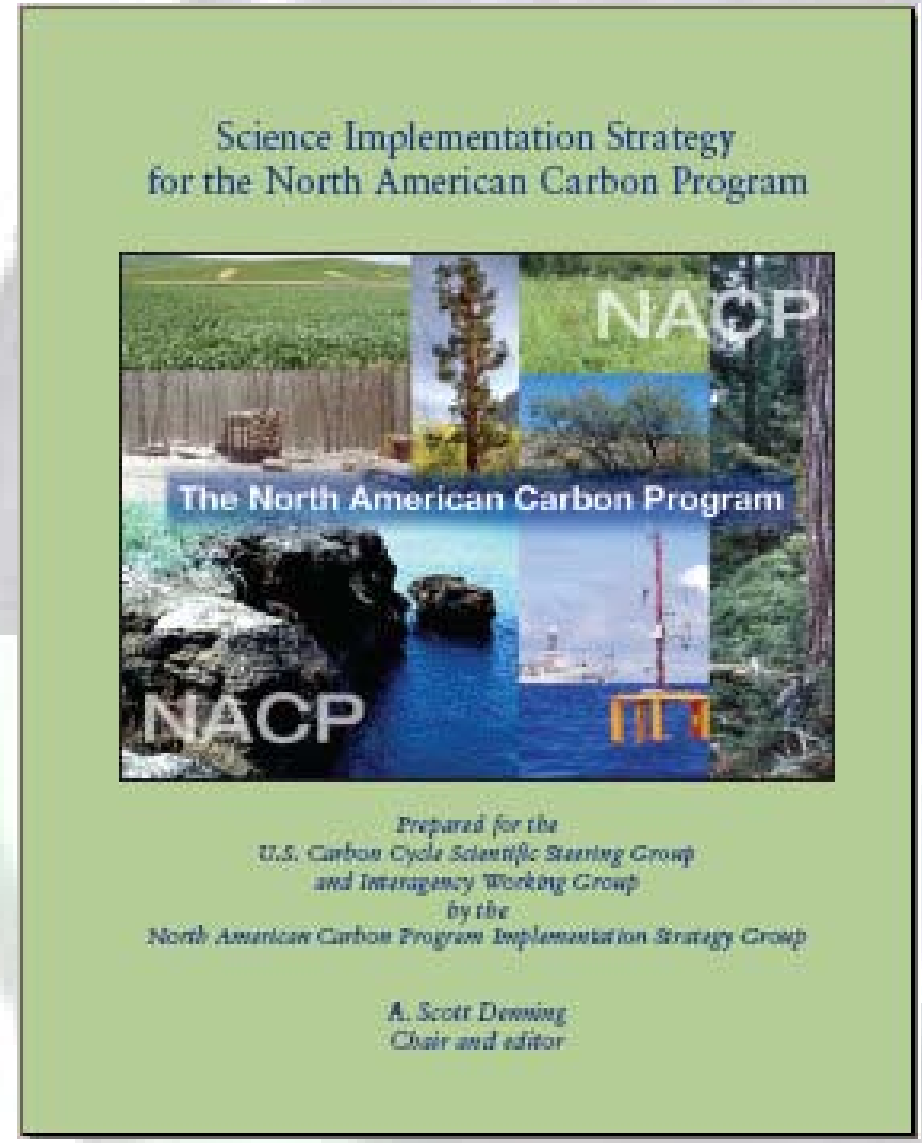
NACP Science Questions

1. What is the carbon balance of North America and adjacent oceans? What are the geographic patterns of fluxes of CO_2, CH_4, and CO and how is the balance changing over time? (diagnosis)

2. What processes control the sources and sinks of CO_2, CH_4, and CO, and how do the controls change over time? (processes)

3. Are there potential surprises (could sources increase, could sinks disappear? (prediction)

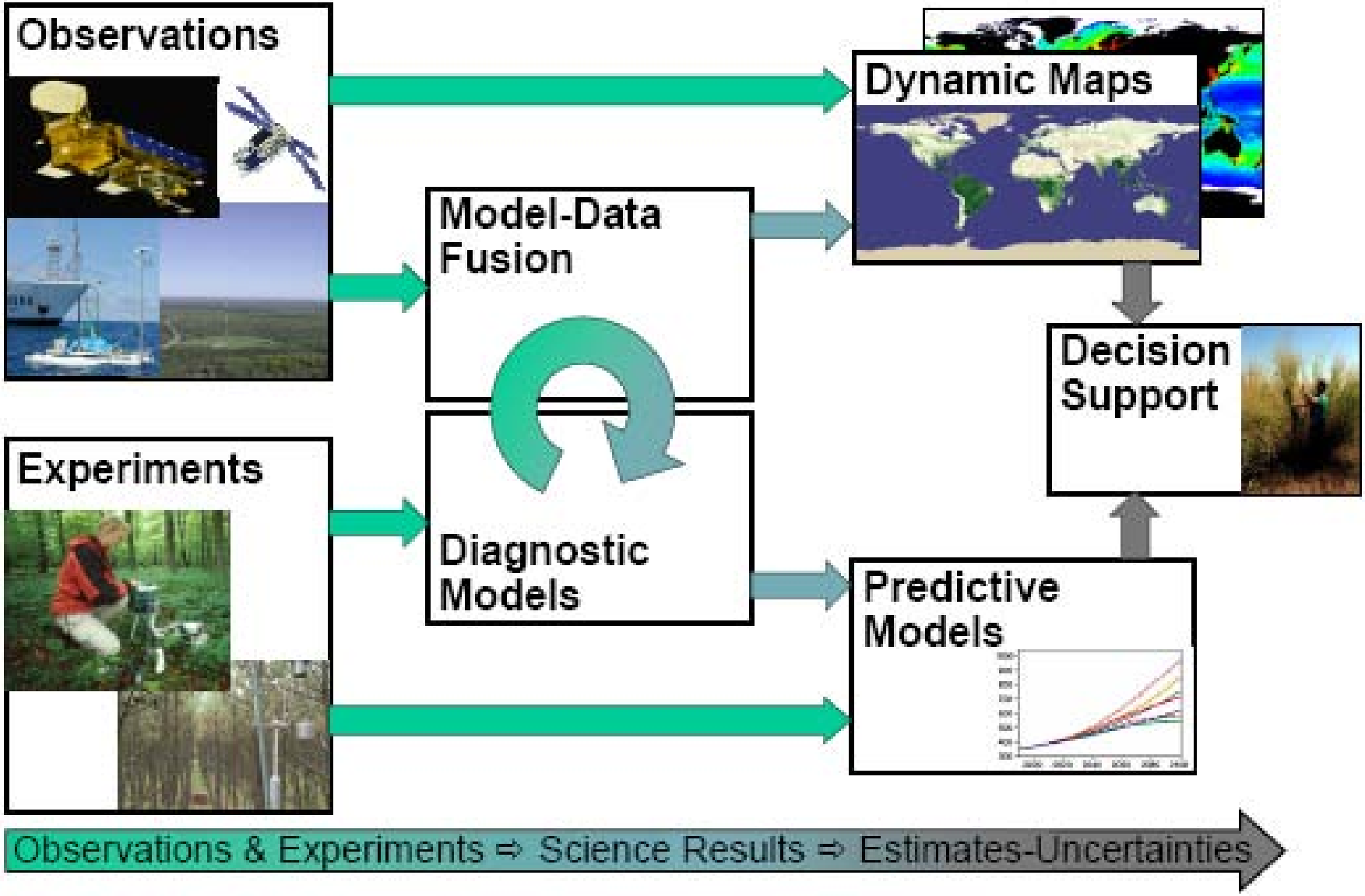
4. How can we enhance and manage long-lived carbon sinks (sequestration) and provide resources to support decision makers? (decision support)



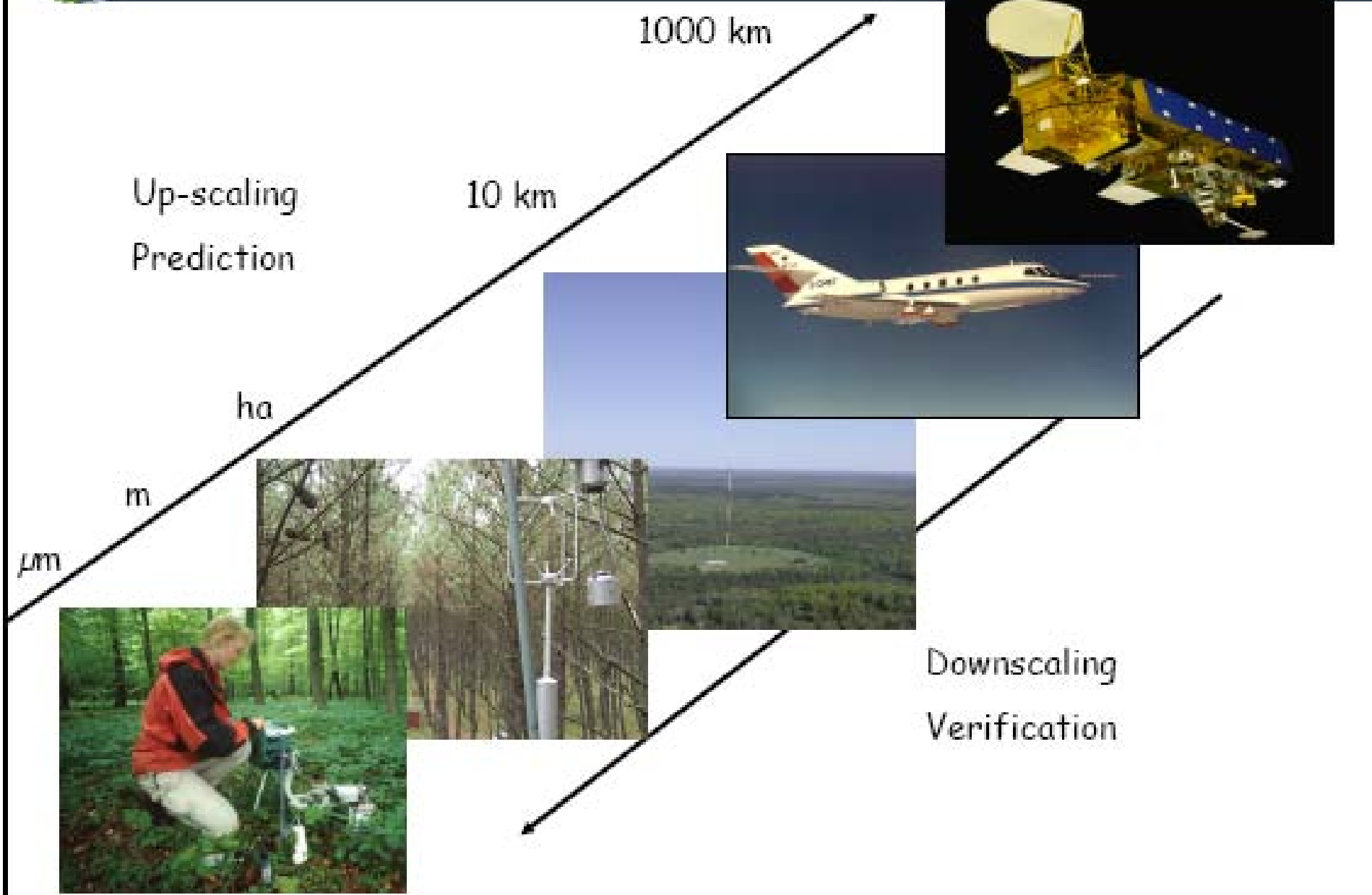
- Published in 2005, contains the overall strategy for synthesis and integration
- Phasing of NACP research
  - Processes/attribution
  - Predition
  - Decision support
- Data and information management
- Prepared by NACP SSG, Scott Denning, Chair

Note: For the latest report on the State of the North American Carbon Cycle see http://www.climatescience.gov/Library/sap/sap2-2/default.htm

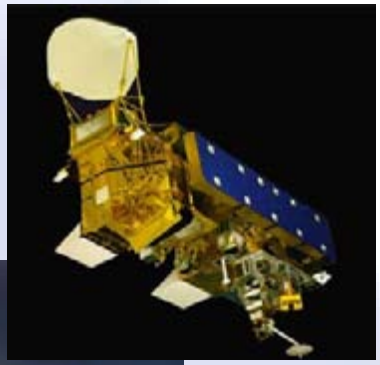
U.S. NACP Approach

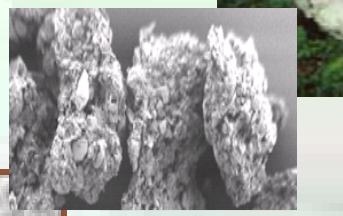


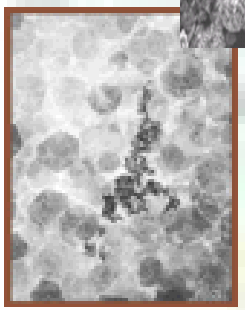
Multiple-Scale Observations and Experiments

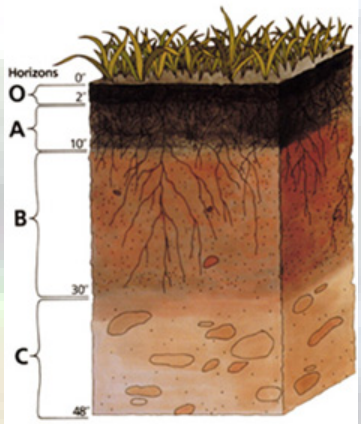


Many scientists fail to appreciate the potential of the depth of the soil (including submerged soils) nor the importance of the details of soil processes









Hierarchical Measurements Over Land

Continental "wall-to-wall" by remote sensing

- 80 projects involving satellite and aircraft remote sensing
- NASA supports 65

Extensive inventories (FIA and NRI)

- More than 170,000 sites at 5-10 yr intervals
- Improved sampling for carbon

Intermediate intensity with systematic sampling

- Pilot Forest Service projects
- Potential NEON contributions
- Requires substantial additional funding

Very intensive process investigations

- ~100 AmeriFlux, Agriflux, LTER, and similar sites

Needs/Questions related to soil mineral-organic matter interactions

- Estimates have put the carbon contained in soils at 2/3 to ¾ of the terrestrial carbon stocks
  - How much? Why and how is it being sequestered?
  - Dynamics/processes that control flux from soils--what is the relative importance of chemical and biochemical processes, mineralogy, soil physics, coupled processes?
  - How will changing inputs, land use, temperature, CO_2 affect these dynamics
  - One key to science question 3 (surprises) may be coupling processes—soil processes←→plant responses←→ microbial processes←→ atmospheric processes←→climate/weather←→land management←→soil processes…

- Assumptions in terms of relative carbon storage and potential for storage may not be right according to recent evidence:
  - No till may increase C storage, may decrease it (priming?), or may just change the depth distribution
  - Wetlands and rice paddies may be sources or may be sinks for CH_4, CO_2, N_2O
  - Increased litter deposits may “prime” the forest soil system and increase CO_2 flux out of the soil
  - Increased C inputs from roots may prime the decomposition of old soil organic matter (CO2 fertilization→increased SOM decomposition→N and P fertilization→ What will the final C balance be? Will it reach a new equilibrium at higher or lower SOM?
  - Does nitrogen play a key role in sequestering carbon by enhancing retention by mineral surfaces?

NACP Intensive Campaigns

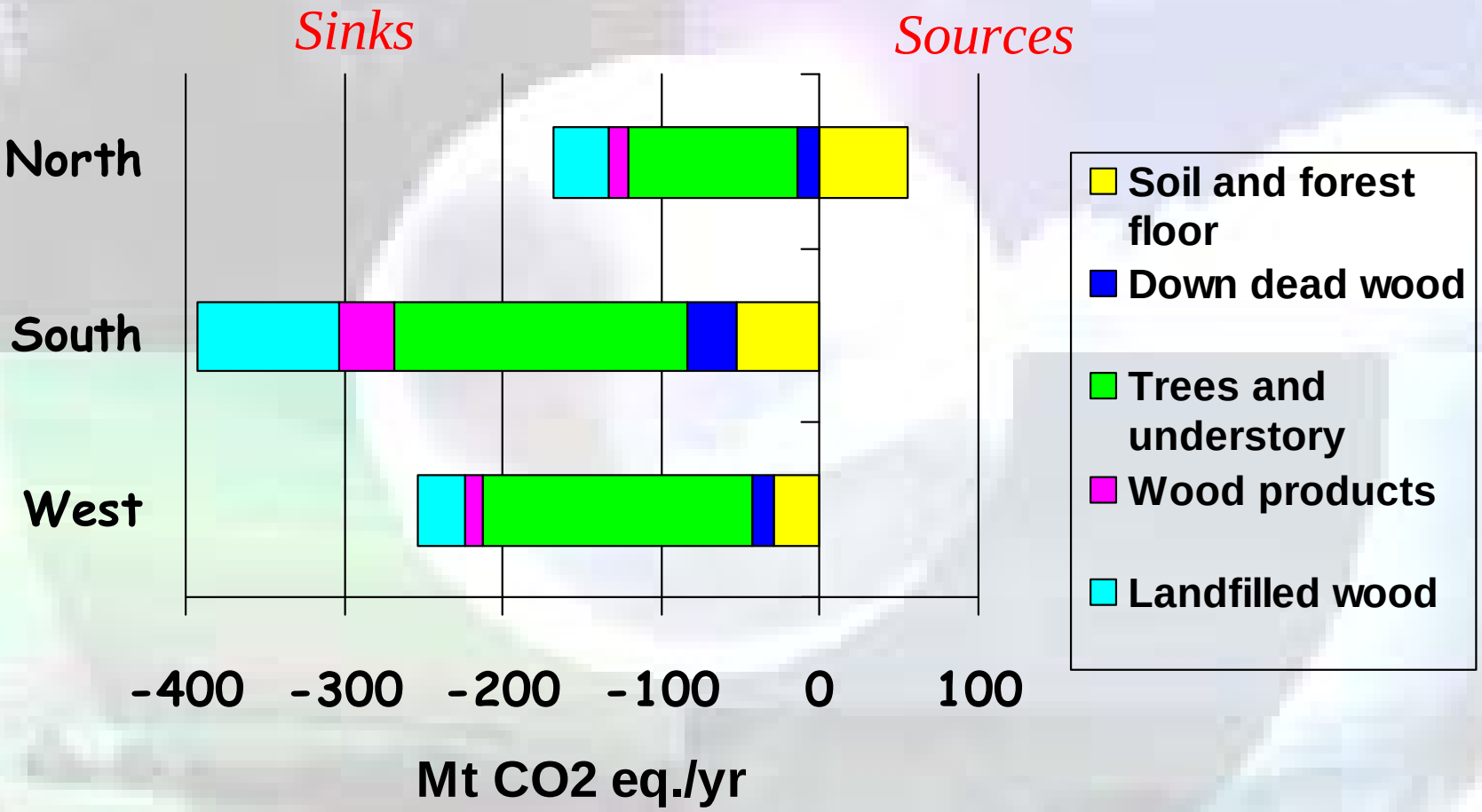
- The North American Carbon Program (NACP) conducts intensive experimental and field campaigns to:
  - Address specific science issues, questions and hypotheses;
  - Reduce specific, major uncertainties;
  - Develop and test methods and models;
  - Calibrate and validate remote sensing observations relevant to NACP objectives; and
  - Produce critical data or analyses.
- NACP intensive campaigns may focus on a specific region or regions within North America.

- But the NACP is not a collection of intensive campaigns.

Program Elements: Question 1
Diagnosis of Current Carbon Budgets

- **A hierarchical approach for large-scale, distributed terrestrial measurements**
- **Substantially improved fossil fuel emissions inventories with high resolution downscaling in time and space, and methods for evaluating these inventories using atmospheric measurements**
- **Hydrologic transfers of carbon over land, and sequestration in sediments**
- **Ocean measurements and modeling, both in the coastal zone and the open ocean, in coordination with the OCCC**
- **An atmospheric observing system consisting of ground stations, aircraft and measurements from towers**
- **Spatially-distributed modeling of carbon cycle processes**
- **Model-data fusion and data assimilation to produce optimal estimates of spatial and temporal variations that are consistent with observations and process understanding**
- **Interdisciplinary intensive field campaigns designed to evaluate major components of the model-data fusion framework**

Net US Forest Contribution to CO_2 Emissions and Sinks, 2001



Courtesy of Linda Heath, USFS

“Operational” Atmospheric Budgets

Global Monitoring Division

http://chinook.cmdl.noaa.gov/ccgg/carbontracker/index.php

Earth System Research Laboratory
Global Monitoring Division

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Data

CarbonTracker

- Home
- Introduction
- Latest Results
  - Carbon Weather
  - Flux Maps
  - Flux Time Series
  - Product Evaluation
- Description
- Documentation
- Summary

Data

- Observations
  - Download
  - IADV
- Model

Participation

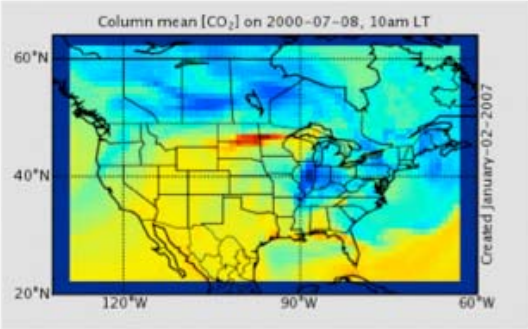
- Contact
- Membership

Resources

- Site Map
- FAQ
- Glossary
- Performance Goals

CarbonTracker

CarbonTracker is a tool designed to keep track of time dependent emissions and uptake of atmospheric carbon dioxide (CO_2), both natural and manmade. CarbonTracker is global, but the emphasis is on North America because that is where we currently have the most data. We expect to update this product once a year, with results through the end of the previous year. The atmospheric CO_2 data is still very sparse, and we invite additional organizations to join and make this an evolving community project by bringing in new data and model improvements. [read more]



Plumes of Carbon Dioxide move with the weather

Products >> CarbonTracker

U.S. Department of Commerce | National Oceanic and Atmospheric Administration
Earth System Research Laboratory | Global Monitoring Division
http://chinook.cmdl.noaa.gov/ccgg/carbontracker/index.php

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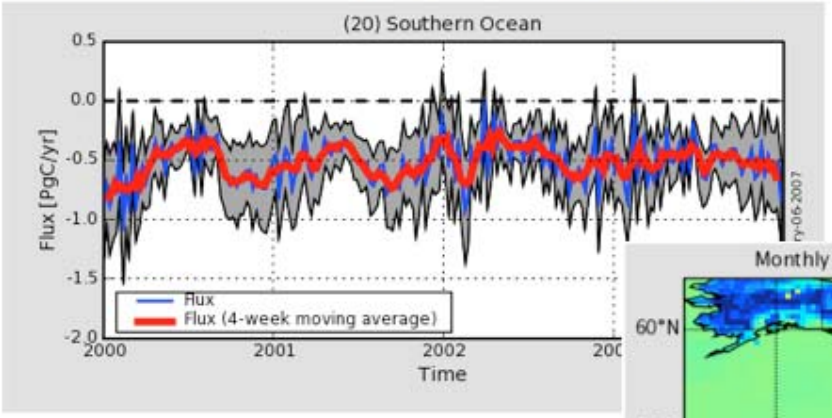
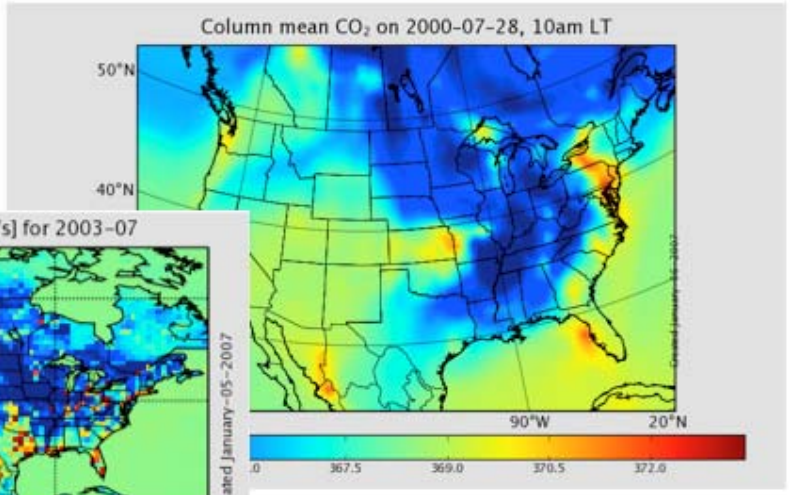
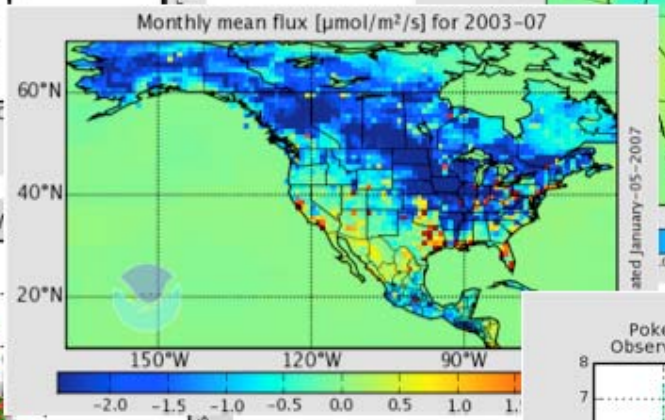
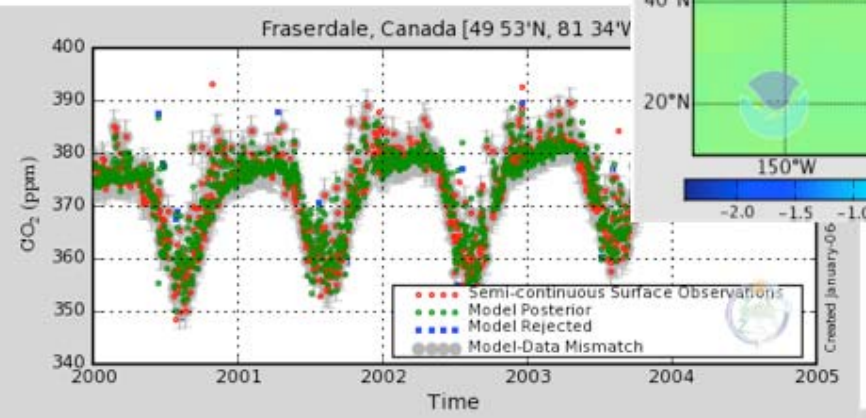
Courtesy Wouter Peters, NOAA ESRL

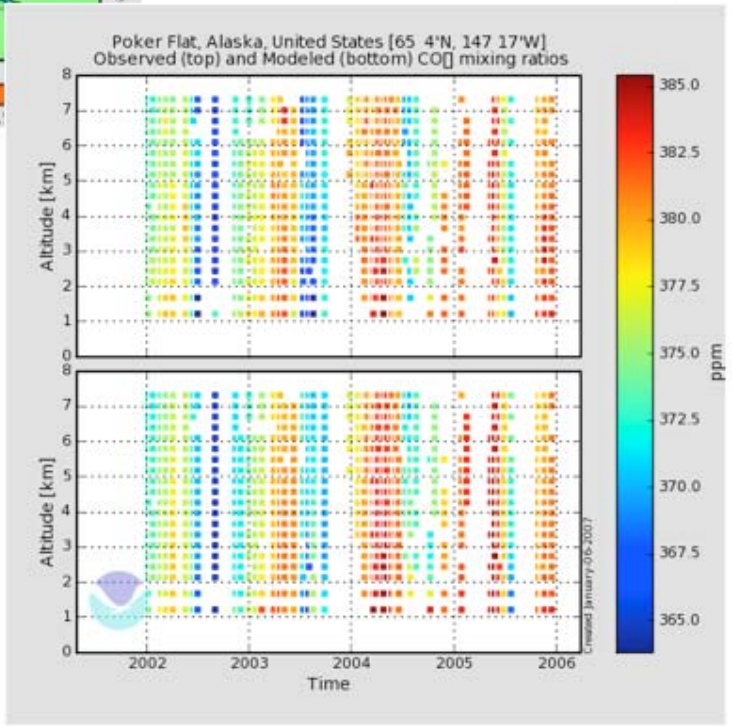
CarbonTracker: Examples

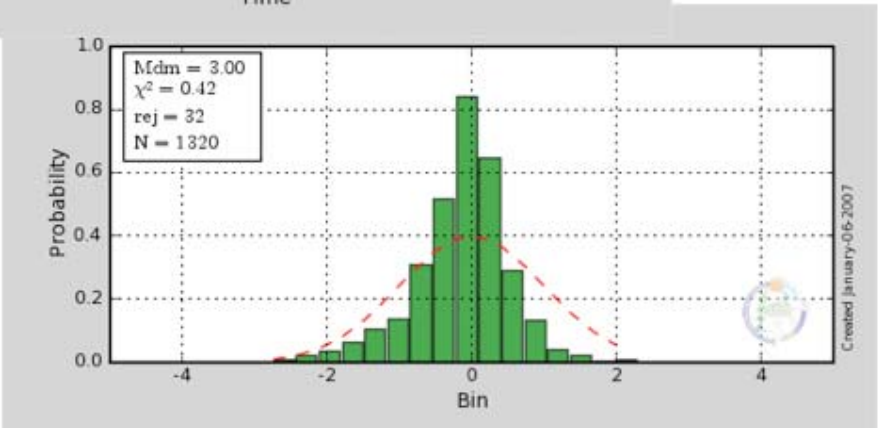












Research Elements: Question 2
Processes Controlling Carbon Budgets

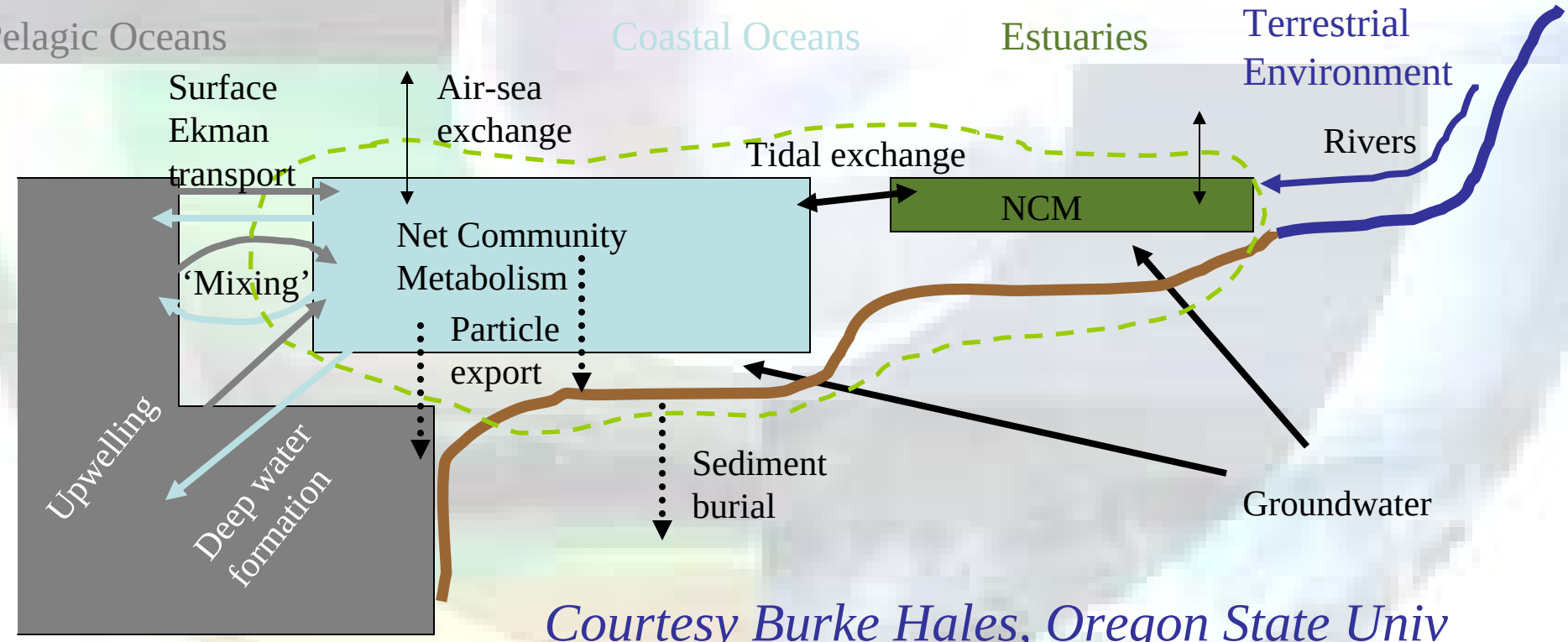
- Carbon consequences of terrestrial ecosystems to changes in atmospheric CO_2, tropospheric ozone, nitrogen deposition, and climate
- Responses of terrestrial ecosystems to changes in disturbance regimes, forest management, and land use
- Responses of terrestrial ecosystems to agricultural and range management
- The impacts of lateral flows of carbon in surface water from land to fresh water and to coastal ocean environments
- Estuarine biogeochemical transformations;
- Coastal marine ecology and sedimentation;
- Air-sea exchange and marine carbon transport; and
- Human institutions and economics
- Urban & suburban land management

Ocean margins are the ‘bridge’ between terrestrial landscapes and the pelagic environment where:

Terrestrial carbon is delivered, deposited, decomposed,

Most organic carbon input to ocean interior occurs,

Autotrophic/heterotrophic balance of the pelagic ocean is determined.



Courtesy Burke Hales, Oregon State Univ

Mid-Continent Intensive

Overall Objective:

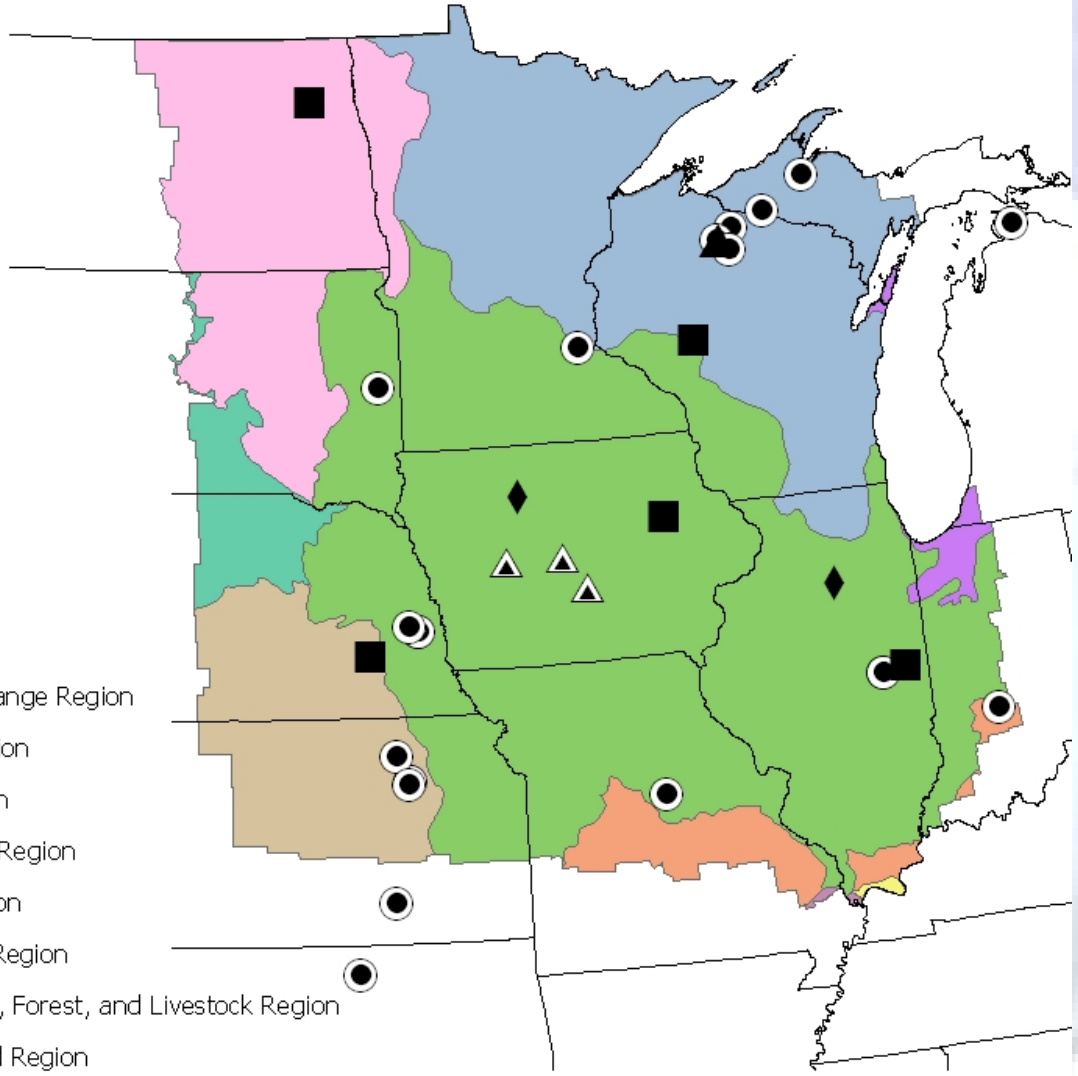
- test “top down” atmospheric budget and “bottom-up” ecosystem model based inventories for determining regional carbon fluxes on hourly to annual time scales.

Specific Objectives:

- Evaluate discrepancies between top down and bottom up approaches and diagnose problems
- Incrementally improve estimates for both approaches through mutual “learning”
- Work towards an optimization of field and atmospheric sampling schemes
- Provide mechanistic explanations for net flux patterns across seasonal to annual time spans
- Provide guidance to future intensives

Mid-Continent Intensive Campaign Study Region

Tall Tower and Eddy Covariance Flux Tower Locations



Generalized Experimental Design

- ***Step 1: Develop "Top-Down" Atmospheric Budgets and "Bottom-Up" Inventories to estimate CO_2 and CH_4 Fluxes.***
- ***Step 2. Compare Results from Approaches and Make Iterative Improvements.***
- ***Step 3: Determine Sources and Sinks of CO_2 and CH_4 fluxes during MCI.***
- ***Step 4: Evaluate the Influence of Future Policy-Based Scenarios on CO_2 and CH_4 fluxes.***

Program Elements: Question 3
Predictive Modeling

- Transfer of synthesized information from process studies into prognostic carbon-cycle models
- Retrospective analyses to evaluate the spatial and temporal dynamics of disturbance regimes simulated by prognostic models
- Evaluation of predictions of interannual variations with predictive models against continued monitoring using observational networks and diagnostic model-data fusion systems
- Development of scenarios of future changes in driving variables of prognostic models
- Application and comparison of prognostic models to evaluate the sensitivity of carbon storage into the future
- Incorporation of prognostic models into coupled models of the climate system

Program Elements: Question 4
Decision Support

- North American contribution to the State of the Carbon Cycle Report (SOCCR)
- Analysis of the longevity of sinks
- Assessment of sequestration options given best scientific evaluation of present and future behavior of carbon cycling
- Provide scientific understanding to inform management of the carbon cycle given improved understanding, diagnosis, and prediction
- Early detection of carbon cycle risks and vulnerabilities
- Scenario development for simulation of future climate

Opportunities

- If you have a project/idea that could contribute to the NACP, you could become part of the program and increase opportunity to interact with other carbon cycle scientists in an interdisciplinary way
- CSREES, NASA, NSF, NOAA, EPA, DOE all are likely to have solicitations relating to NACP
- Joint NASA-DOE-CSREES solicitation 3 years ago—due for likely second round
- International Canada-Mexico-US CarboNA is just getting started—do you have an ongoing North American international collaborative research project?

CarboNA

An international collaboration between Canada, Mexico, and the United States for carbon cycle science research throughout North America and adjacent coastal waters.

GOAL

To understand the temporal and regional distribution and magnitudes of carbon pools and greenhouse gas fluxes throughout North America, and how these affect and are affected by disturbances, human behavior, and climate and related changes, in order to predict future climate change and evaluate carbon related mitigation strategies and new technologies.

May 24–27, 2009
AGU: The Meeting of the Americas, 2009 Joint Assembly
Toronto, Ontario, Canada Special Session: CarboNA: Continental Carbon Cycle Studies in North America (B06)

October 7–9, 2009 Mexican Carbon Program Meeting
Ensenada, Baja California, Mexico

Relevant Experiments

- **Field/Plot Scale Investigations**
  - Long-term agricultural experiments and forest inventory plots
  - Flux Tower Networks (Ameriflux, USDA Sites)
  - Support bottom-up modeling
- **Mini-Intensives**
  - Bondville Study, SMEX05 Study
  - Provide high resolution data on fluxes and associated environmental variables
- **MC Region Wide Studies**
  - CMDL Tall Tower Network
  - Regional scale bottom-up modeling
  - Core Applications
- **Continental to Global Scale Applications**
  - Setting boundary conditions and gap filling
- **Fluxnet-Canada→ Canadian Carbon Program**

- Currently US moving toward more international, more global modeling
- NACP→CA-MX-US CarboNA
- Moving towards Western Hemisphere - IAI interest in expanding to South America
- Strong interest in Amazon—potentially large source or sink
- Strong emphasis on polar regions (melting permafrost, methane hydrates) and tropical regions (Rapid land use/land cover changes)

Interim synthesis products/projects Current

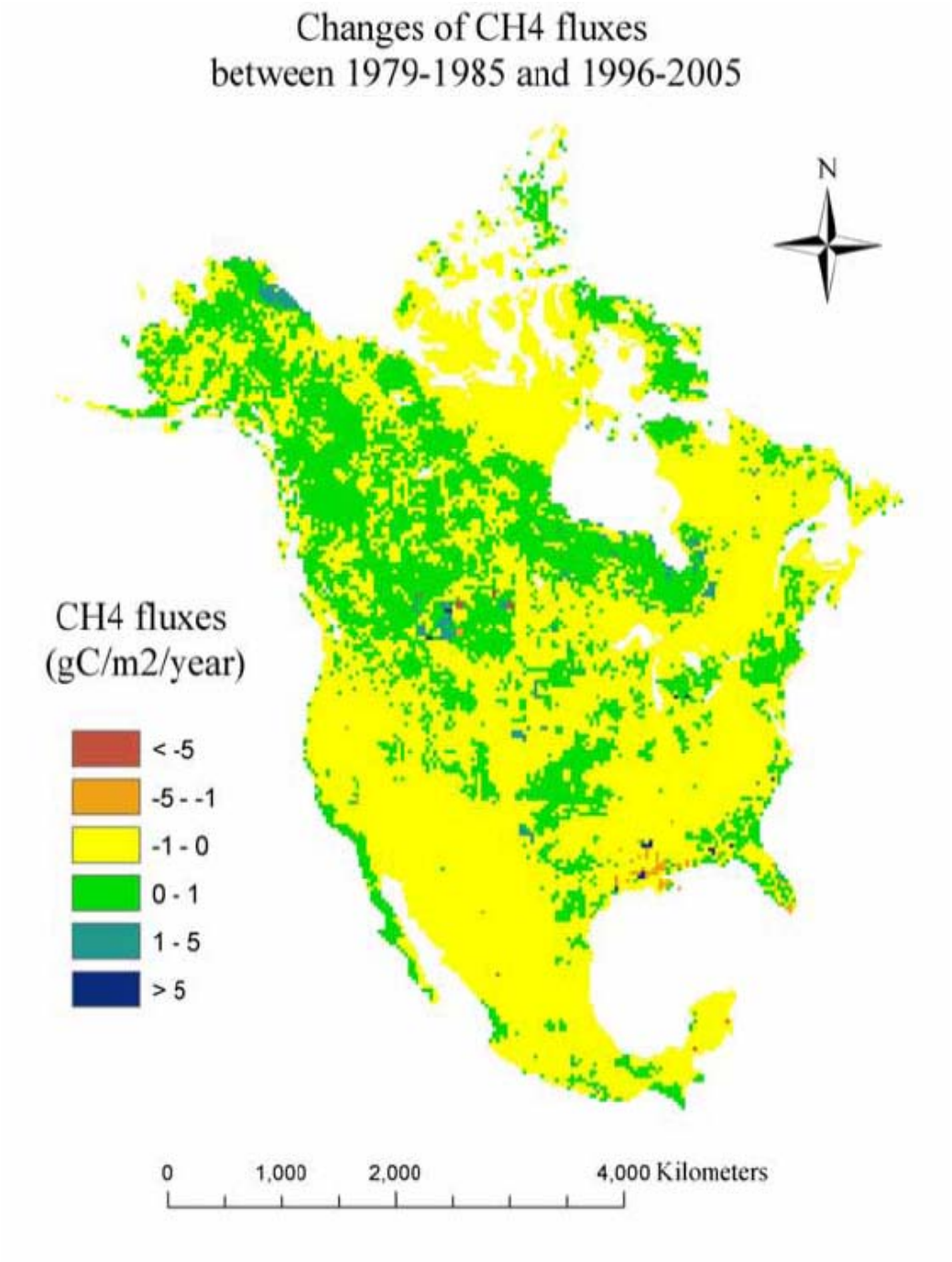
- Site-level synthesis of modeled and measured carbon, water, and energy fluxes across North America: Evaluation of model and measurement uncertainty
  - a detailed evaluation of modeled and observed carbon stocks and fluxes across a wide range of North American vegetation types and climate zones, focusing explicitly on the problem of uncertainty estimation in both observations and model results.

Interim synthesis products/projects Current

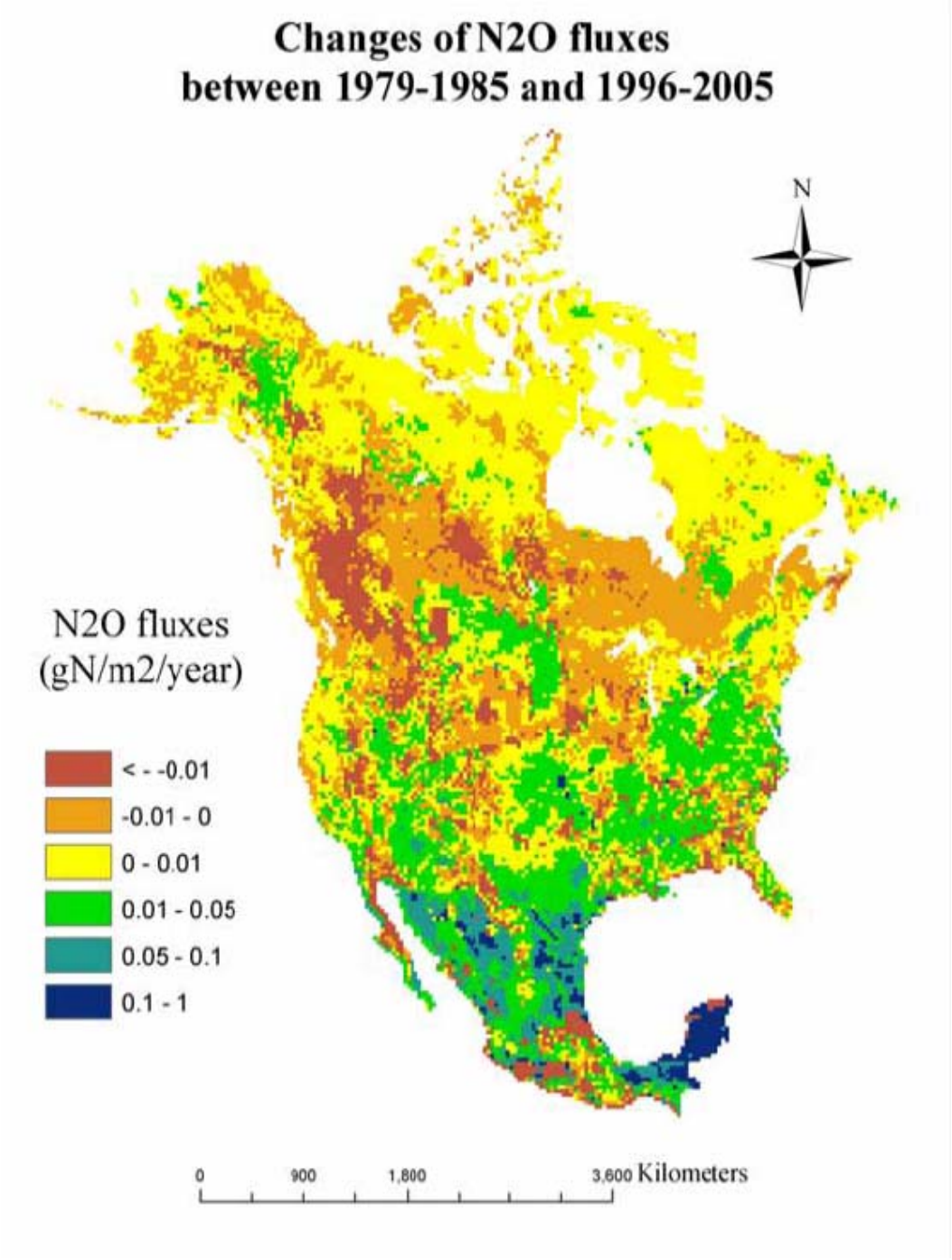
- Regional to Continental Upscaling of AmeriFlux (eddy flux) Data for Carbon Cycle Studies
  - review the different approaches for the upscaling of eddy flux data (e.g., machine learning methods, light use efficiency models, empirical carbon models, and process-based biogeochemical models)
  - Quantification of carbon flux uncertainties and implications for attribution and prediction of regional to continental scale fluxes.
  - Eveluate the strengths, weaknesses, and problems of the upscaling of AmeriFlux data in carbon cycling studies in comparison to alternative approaches (e.g., atmospheric inverse models, inventory approaches, model simulations).

Interim synthesis products/projects Current

- Mid-Continent Intensive
  - Comparison of inventory-based CO2 budget and atmospheric inversions
- Non-CO2/Greenhouse Gases
  - Spatial and Temporal Distributions of Sources for non-CO2 Greenhouse Gases (CH4, CO, N2O, SF6, PFCs,…)in North America
  - Regional N2O and CH4 study
  - Multiple simultaneous species, model—data fusion emissions and inventories
  - Special data project: Footprint files and driver data



S. Wofsy, E. Kort, A. Dayalu, Harvard University



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Interim synthesis products/projects Proposed

- Disturbance effects comparisons
  - Fire
  - Insects
  - Wind
  - Drought
  - Floods

National Soil Carbon Network

Provide a *community* voice to:

- Coordinate soil carbon observation, archiving, experimentation, and modeling.
- Understand the relationship between soil carbon and ecosystem services.
- Forecast soil carbon vulnerability under changing climate, land use, and other disturbance.
- Contribute to organizing and communicating this information for land managers, modelers, and policy makers.

Rational and Mission

Rationale:

- No single agency or institution is able to provide the level of information and data about soil carbon stocks, turnover, and vulnerability necessary to fully integrate soil processes and feedbacks into our models of the carbon cycle.

- Greater collaboration, synthesis, and shared effort is required to meet the challenge. The network is a grass roots effort to make it happen.

Mission:

- Improve the understanding of carbon dynamics in soils across the United States — including the spatial and temporal distribution and stability of carbon forms — through a national soil carbon network.

- Website: www.soilcarb.net

Some NRI funding results

- **Stephen Ogle with co investigators K. Pautian, F.J. Breidt, and R.T. Conant of Colorado State University Addressing the uncertainties of carbon fluxes from agricultural lands in the Mid-West and working with NRCS, have developed sampling and analysis protocols for soil carbon.**

- **The second phase of this project, to develop decision support tools for land owners and carbon aggregators, has just begun and will be funded by NASA.**

- **Refinement of the carbon flux models, by combining vegetation models and soil process models, and including C4 crops such as corn, has increased confidence in modeling carbon stock changes using the integrated CASA-Century model.**

- **Dr. Thomas Kolb with co-investigators Montes-Helu, M.C., S. Dore, B. Sullivan, S. Hart, J. Kaye, W. Winslow, G. Koch, B. Hungate of Northern Arizona University**

- **Investigating CO2 and methane fluxes from ponderosa pine forests in the West and the effects of forest management and increasing wildfires.**

- **Effects of prescribed burning and thinning on bark beetle attack, tree mortality, and tree pest resistance, providing forest managers with science-based information for deciding on management strategies to optimize forest growth and carbon sequestration, and reduce risk of stand-replacing fires.**

- **Showed that intense, stand-replacing fires, which are increasing with recent warmer temperatures and longer growing seasons, change these forest carbon sinks into carbon sources for over 10 years after the fire.**

DIRT project

- **Network of sites in eastern and western forests plus a site in Eastern Europe to study forest litter and soil carbon and nitrogen cycling.**
- **A major finding was that increased carbon inputs as litter or roots, via management or through increased atmospheric CO2, can have a priming effect on soil carbon decomposition, releasing greater amounts of CO2 than is fixed through photosynthesis or added via management practices.**
- **Key role of nitrogen in controlling these processes.**
- **This priming effect and the result that old growth forests can continue to be carbon sinks, has lead to a rethinking of models and estimates for the impact of climate change and increasing CO2.**
- **Findings have been instrumental in convincing the IPCC working groups to include nitrogen as a factor in modeling the effects of increasing CO2 on ecosystems and their feedback to the atmosphere and climate change.**

Some soil C projects from NRI/AFRI

- ***ABIOTIC AND BIOTIC CONTROLS ON PRIMING OF SLOW-CYCLING SOIL ORGANIC MATTER POOLS*** **Meier, C. L.; Neff, J. C. UNIVERSITY OF COLORADO**
- **RHIZOSPHERE PRIMING EFFECTS ON SOIL N AVAILABILITY: THE ROLE OF ROOT EXUDATES IN COUPLING ECOSYSTEM C AND N CYCLES UNDER ELEVATED CO2 Phillips, R. P. INDIANA UNIVERSITY**
-
- **MOLECULAR SCALE STUDY OF ORGANIC MATTER AND PHOSPHORUS INTERACTIONS WITH SURFACES: ULTRAHIGH RESOLUTION MASS SPECTROMETRY & FTIR APPROACHES Ohno, T. UNIVERSITY OF MAINE**
- **MOLECULAR SOIL CARBON DYNAMICS FOLLOWING NITROGEN ENRICHMENT: LINKS TO MICROSITES, ENZYMES, AND ECOSYSTEMS Grandy, A. S. MICHIGAN STATE UNIV**
- **BRIDGING SCALES FROM NANO- TO MICRO-SCALE SPATIAL DISTRIBUTION OF ORGANIC MATTER IN MINERAL ASSEMBLAGES USING SYNCHROTRON-BASED FTIR AND NEXAFS SPECTROMICROSCOPY Lehmann, J. CORNELL UNIVERSITY**
- **SOIL ORGANIC CARBON RESPONSE TO LONG-TERM GRADUAL CARBON DIOXIDE ENRICHMENT Loecke, T. D. INST OF ECOSYSTEM STUDIES**
- **MICROBIAL AND BIOGEOCHEMICAL MECHANISMS OF ALTERED DECOMPOSITION AND N MINERALIZATION IN A RANGELAND ECOSYSTEM EXPOSED TO GLOBAL CHANGE Pendall, E. G. UNIVERSITY OF WYOMING**
- **FUNCTIONAL CONSTRAINTS IN MICROSCALE CARBON AND NITROGEN CYCLING BY BIOLOGICAL SOIL CRUSTS Garcia-Pichel, F. ARIZONA STATE UNIVERSITY**

- **PEDOGENIC AND CLIMATIC THRESHOLDS IN CARBON STABILIZATION Kramer, M. G. UNIVERSITY OF CALIFORNIA SANTA CRUZ**
- **RAPID ASSESSMENT AND TRAJECTORY MODELING OF SOIL CARBON ACROSS A SOUTHEASTERN LANDSCAPE Grunwald, S. UNIVERSITY OF FLORIDA**
- **SOIL ECOSYSTEM CHANGES IN C AND N BUDGETS INDUCED BY A SHIFT TO BIOFUELS PRODUCTION Pierce, F. J. WASHINGTON STATE UNIVERSITY**
- **KEY ROLE OF NITROGENOUS COMPOUNDS IN SOIL ORGANIC MATTERS STABILIZATION VIA INTERACTIONS WITH MINERAL SURFACES Sollins, P. OREGON STATE UNIVERSITY**
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- **BLACK CARBON STOCKS IN SOIL OF THE UNITED STATES Lehmann, J. CORNELL UNIVERSITY**
- **CO2 FLUXES BETWEEN AGRICULTURAL LANDS AND THE ATMOSPHERE: TOWARDS MORE COMPLETE ACCTG BY INTEGRATING REMOTE SENSING WITH SIMULATION MODELING Ogle, S. M. COLORADO STATE UNIVERSITY**
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- **FUNCTIONAL CONSTRAINTS IN MICROSCALE CARBON AND NITROGEN CYCLING BY BIOLOGICAL SOIL CRUSTS Garcia-Pichel, F. ARIZONA STATE UNIVERSITY**
- **PEDOGENIC AND CLIMATIC THRESHOLDS IN CARBON STABILIZATION Kramer, M. G. UNIVERSITY OF CALIFORNIA SANTA CRUZ**

- **SOIL ECOSYSTEM CHANGES IN C AND N BUDGETS INDUCED BY A SHIFT TO BIOFUELS PRODUCTION Pierce, F. J. WASHINGTON STATE UNIVERSITY**
- **RAPID ASSESSMENT AND TRAJECTORY MODELING OF SOIL CARBON ACROSS A SOUTHEASTERN LANDSCAPE Grunwald, S. UNIVERSITY OF FLORIDA**
- **RECALCITRANT SOIL ORGANIC MATTER IN AGRICULTURAL LANDSCAPES Thompson, M. IOWA STATE UNIVERSITY**
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- **MICROBIAL CARBON AND NITROGEN CYCLE PROCESS RESPONSE TO CALCIUM ADDITIONS IN A NORTHERN HARDWOOD FOREST ECOSYSTEM Groffman, P. M. INST OF ECOSYSTEM STUDIES**
- **INTERACTING MICROBIAL X CHEMCIAL X NITROGEN CONTROLS ON LITTER-TO-HUMUS TRANSFORMATION Moorhead, D. L. UNIVERSITY OF TOLEDO**
- **KEY ROLE OF NITROGENOUS COMPOUNDS IN SOIL ORGANIC MATTERS STABILIZATION VIA INTERACTIONS WITH MINERAL SURFACES Sollins, P. OREGON STATE UNIVERSITY**
- **BLACK CARBON STOCKS IN SOIL OF THE UNITED STATES Lehmann, J. CORNELL UNIVERSITY**
- **CO2 FLUXES BETWEEN AGRICULTURAL LANDS AND THE ATMOSPHERE: TOWARDS MORE COMPLETE ACCTG BY INTEGRATING REMOTE SENSING WITH SIMULATION MODELING Ogle, S. M. COLORADO STATE UNIVERSITY**

Update

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Food, Conservation and Energy Act of 2008 (Farm Bill)

- **Creation of National Institute of Food and Agriculture (NIFA)**
  - By Oct. 1, 2009
  - Letter from Under Secretary REE: http://www.csrees.usda.gov/newsroom/pdfs/Scientists_Educators_Stakeholders_Letter.pdf
  - NIFA Guiding principles: http://www.csrees.usda.gov/newsroom/pdfs/NIFA_Guidelines.pdf

Food, Conservation and Energy Act of 2008 (Farm Bill)

- **Creation of National Institute of Food and Agriculture (NIFA)**
  - Federal Register notice solicited stakeholder input
  - Internal coordinating committee and subcommittees have been formed
  - Director will be politically appointed to a 6-year term (current acting: Colien Hefferan)
  - New Chief Scientist will be the appointed Undersecretary for REE or her/his designee (current acting Katherine Smith, current nominee Rajiv J. Shah, M.D. Director, Agricultural Development Global Development Program http://www.gatesfoundation.org/leadership/Pages/rajiv-shah.aspx)

Food, Conservation and Energy Act of 2008 (Farm Bill)

Creation of Agriculture and Food Research Initiative (AFRI) – encompasses programs from NRI and IFAFS

- **Full RFA with application instructions released March: http://www.csrees.usda.gov/funding/rfas/pdfs/09_afri.pdf**
- **New Indirect costs limit: 22% of total costs or 28.205% of direct costs or direct cost basis.**
- **At least 30% of funds must be to Integrated programs**
- **Exactly 40% of remaining must be applied, 60% basic research**
- **Includes research only, education only, extension only**
- **Soil program includes research only, education only, and REENet**
- **New proof of concept Long Term Agricultural Project- focus on carbon**

Food, Conservation and Energy Act of 2008 (Farm Bill)

- **AFRI programs include:**
  - **Enhancing Ecosystem Services from Agricultural Lands: Management, Quantification, and Developing Decision Support Tools : Joint with EPA-STAR, rfa to be released early February 09, application deadline tbd http://es.epa.gov/ncer/rfa/**
    - **Specific stressors included: Climate Change, Soil and Land Degradation, Water Availability, reactive nitrogen, invasive species**
  - **Sustainable Agroecosystems Science Long-Term Agroecosystem Program: Proof of Concept: applications due 3/2/09**
  - **Rapid Response Food and Agricultural Science for Emergency Issues: LOI required, no deadline; submit any time from rfa release till 7/30/09**

Food, Conservation and Energy Act of 2008 (Farm Bill)

Other funding opportunities:

- **Specialty Crops Research Initiative: http://www.csrees.usda.gov/fo/specialtycropresearchinitiative.cfm**
- **Beginning Farmer and Rancher Development Program: http://www.csrees.usda.gov/business/reporting/stakeholder/bfrdp.html**
- **Smith-Lever 3(d) Extension Integrated Pest Management Competitive Grants Program: http://www.csrees.usda.gov/business/reporting/stakeholder/eipm_stakeholder.html**

Food, Conservation and Energy Act of 2008 (Farm Bill)

Other funding opportunities:

- **Biomass Research and Development Initiative-to be released soon, joint with DOE**
- **Hispanic-Serving Agricultural Colleges and Universities programs: http://www.csrees.usda.gov/business/reporting/stakeholder/hsacu.html**
- **Integrated Research, Education, and Extension Competitive Grants Program: National Integrated Water Quality Program** expected release May 09

FY2009: Program Areas and Investment – Competitive Programs

- National Research Initiative……..$201 M
- Organic agriculture research and extension.$18M
- Graduate Fellowships ……..$3.9M
- Biomass Research & Development……$20M
- Biotechnology Risk Assessment……$3.0 M
- SBIR……$20.4 M
- Section 406……$42 M
- Specialty Crop Research Initiative……$50M

NRI Annual Report, FY 2007

- On the web at: http://www.csrees.usda.gov/funding/nri/pdfs/2007_ann_report.pdf
- 2008 will be the final NRI Annual Report and will include some “Best of the NRI” highlights-out soon

CSREES Competitive Funding Opportunities Workshop

General workshops held in the fall:

- Covers all programs
- Useful for new faculty
- November 10-11, 2009, Kansas City, MO; Embassy Suites Kansas City International Airport
- November 18-19, 2009, Washington, D.C.; Marriott Crystal Gateway
- See: http://www.csrees.usda.gov/business/training/cpworkshops.html

Integrated Programs workshop

- Held March 9-10, 2010 at Las Vegas site TBD
- see: http://www.unce.unr.edu/adhoc/grantsworkshop/

Canada, Mexico, and the United States have mutual interests in improving the scientific understanding of carbon cycle science to address issues including, but not restricted to, the following:

- The temporal and regional distributions and magnitudes of carbon sources, sinks and greenhouse gas fluxes;
- Understanding how climate change, natural disturbance, and socioeconomic and institutional drivers affect the pools and fluxes of the carbon cycle, and ultimately the concentrations of CO2, CO, CH4 and N2O in the atmosphere;
- The complex interrelationships between the carbon cycle and the climate system in order to account for past variability in atmospheric CO2 and to predict future climate and carbon cycle fluxes;
- Developing management strategies and new technologies to reduce greenhouse gas emissions and/or enhance carbon stocks;
- Evaluating environmental, economic and social costs and benefits of potential management strategies, new technologies and their implementation.

To address these scientific questions, an optimal research strategy would include, but not be limited to:

- Integrating studies of carbon stock changes and flux measurements associated with various ecosystems, management strategies, and new technologies with studies of atmospheric composition and remote sensing at regional and continental scales;
- Belowground carbon stocks and fluxes and measurement technologies, including the problem of scale, especially how to scale-up from point measurements;
- Focusing on a continental scale in an attempt to account for all major sources and sinks of CO2, CH4, and N2O, terrestrial and oceanic;
- Securing consistent, high-quality regional and continental data sets to permit the scientific community to conduct rigorous analyses of carbon dynamics at larger spatial scales;
- Develop our understanding of the key factors controlling biospheric sources and sinks for CO2, CH4, and N2O to predict the dynamic changes in the future sources and sinks of greenhouse gases under a variety of scenarios;
- Understanding how different mixes of related causes and underlying drivers interact to produce emissions trajectories by the three countries and their regions;
- Evaluating cost-effective management strategies and new technologies to reduce biospheric emissions or enhance carbon sinks, including the exploration of both social, economic and institutional constraints and opportunities
- Identifying social and economic constraints and needs for capacity building to attack the problems of how to reduce emissions

We agree to work together on carbon cycle research by:

- Establishing a **Government Coordination Working Group** on carbon cycle research that is co-chaired by a representative selected from each country.
- Establishing a joint **Science Steering Committee** for joint research on carbon cycle science for the North American continent and adjacent ocean basins to provide guidance and advice on research priorities and activities within joint and complementary research initiatives;
- Organizing a joint workshop to identify priority areas for cooperative research activities and research areas where we have common interests and complementary expertise;
- Identifying the scope of disciplines and research expertise needed to address common research questions and ensuring that the major organizations within each country are given an opportunity to participate**;**
- Identifying existing research groups and projects within each and between countries and encouraging better scientific integration among them including standardized measurement protocols and sharing of research data and results;
- Developing international projects that could form the focus for new initiatives that could be considered for cooperative funding by appropriate agencies in the respective countries;
- Exploring the opportunity to make this research an important element in cooperative agreements between countries (e.g., a Bilateral Agreement on Climate Change), thereby raising its profile and recognizing the importance of this research at high levels within each country.

Types of activities

- **Type 1**: Activities in this tier could be built upon existing activities within one or several countries. These activities could be complementary to existing or planned initiatives but with some coordination between partners conducting or similar work, become included within the activities under the Joint NACP. These activities would require minimal time or new resources in order to be refocused for inclusion within the Joint NACP (i.e. “cheap and easy”).

- **Type 2**: Types of activities in this tier would be either an augmentation of Tier 1 activities or new initiatives developed or planned within the context of the Joint NACP.

- **Type 3**: Activities in this tier would be new activities that are larger in scope than the first two tiers. These projects would be highly collaborative, require new funding sources, and may require bi or trilateral coordination under the Joint NACP.

Near-Term Type 1 Activities Identified in January meeting

- Coastal oceans
- Existing atmospheric data sharing enabling top-down modeling and analysis activities.
- Flux measurement comparisons
- High-latitude field work (summer 2007)
- Human dimensions initiated broadly within carbon cycle research activities.
- Canadian near-term/mid-term/long-term opportunities for collaboration include:
  - Atmospheric measurements
  - Fossil fuel emissions
  - Sub-arctic (long term)
  - Biomass burning

Longer-Term Type 3 Activities Identified in January meeting

- Scenarios with scaling for decision support.
- Type 3 activities building upon Type 1 and Type 2 activities may be more compelling for funding.
- Socio-economic analysis of economic development in different countries influences on carbon stocks and fluxes.
- Gulf of Mexico land-coastal-gulf study
- Arctic to tropics Landsat scale map of disturbance and land-use change.
- Arctic land-oceans-atmosphere study to investigate influences of human activities and climate change.
  - Local drivers, including socio-economic, ecological
- CONAFOR and Canadian Forest Services agreement to look at Canadian carbon budget model testing

- **Arkebauer, Timothy Controls on Soil Surface CO2, N2O and CH4 Fluxes, Ecosystem Respiration and Global Warming Potentials in Great Plains Agricultural Ecosystems DOE**
- **Balser, Teri Evaluating changes in soil carbon cycling in reed canary grass invaded soils subject to elevated atmospheric CO2 and increased soil nitrogen DOE**
- **Billings, Sharon Linking microbial activity and soil organic matter transformations in forest soils under elevated CO2 DOE**
- **Brouder, Sylvie Ecological services of agro-biofuels: productivity, soil C storage, and air and water quality USDA CSREES**
- **Classen, Aimee; Norby, Richard (Rich)Community and ecosystem response to global change: interactive effects of atmospheric carbon dioxide, surface temperatures, and soil moisture DOE**
- **Davidson, Eric Decadal-Scale Measurements of Decadal-Cycling Forest Soil Carbon DOE**
- **Filley, Timothy Investigating the soil-earthworm-litter system controls on the stabilization of soil organic matter in deciduous forests NSF**

- **Jastrow, Julie Soil Carbon Responses to Elevated Atmospheric CO2 DOE**
- **Kasischke, Eric Wildfire consumption of ground-layer organic matter in North American boreal forests and peatlands: implications for atmospheric trace gas emissions and long-term soil carbon storage NASA**
- **Lajtha, Kate Detrital controls on SOM dynamics in an old growth Douglas fir soil NSF, USDA CSREES**
- **Law, Beverly (Bev)The effects of disturbance and climate on carbon storage and the exchanges of CO2, water vapor and energy exchange of evergreen coniferous forests in the Pacific Northwest: integration of eddy flux, plant and soil measurements at a cluster of supersites DOE**
- **Lehmann, Johannes Black carbon stocks in soil of the United States USDA CSREES**
- **Loecke, TerrenceSoil organic carbon response to long-term gradual carbon dioxide enrichment USDA CSREES**
- **Melillo, Jerry Soil Warming and Carbon-Cycle Feedbacks to the Climate System DOE**
- **Pierce, Francis (Fran)Soil ecosystem changes in c and n budgets induced by a shift to biofuels production USDA CSREES**
- **Ping, Chien-Lu Black spruce forest soils in boreal regions of Alaska: their characterization, organic carbon pool, and relationship to forest management USDA CSREES**