

Earth System Feedbacks: Vulnerability of the Carbon Cycle to Drought and Fire

Canberra, Australia

5-8 June 2006

8-9 June 2006 –Follow Up National Meeting

Organized by:

Global Carbon Project

ARC Network for Earth System Science

CSIRO Marine and Atmospheric Research

Australian Climate Change Science Program

Australian Academy of Science

Analysis, Integration and Modeling of the Earth System

European Space Agency

Background

Over the last century we have seen major modifications of the water cycle including the distribution, variability and trends of rainfall, runoff, and evaporation. Such changes are thought to result to some degree from increasing emissions of human-driven greenhouse gases (GHG), and consequently, expected to become even larger during the course of this century as GHG emissions increase.

Global Climate Models predict major changes of the water cycle over the next 100 years including the increase of *i*) global precipitation, *ii*) water stress in some regions, and *iii*) inter-annual variability and extreme events (eg, droughts, floods).

Changes in water cycle variables such as precipitation, runoff, streamflow, soil moisture, and atmospheric vapor pressure impact carbon stocks and fluxes (e.g., soil and ecosystem respiration, production) and disturbance events such as fire frequency and intensity. Fully coupled carbon-climate models suggest that biogeochemical and vegetation structure changes can be forced by drought and fire, thereby altering carbon exchange by terrestrial ecosystems. Robust simulations under projected climate change using such models remains a challenge.

In fact, recent climate trends and higher intra- and inter-annual variability may have increased the amplitude of the seasonal cycle of CO₂, however, it is not clear if or how these changes will lead to increased or decreased carbon storage. Initial results are suggesting a diminished strength of the terrestrial net carbon sink.

Scope

The first part of the workshop (International, days 1-4) will explore interactions between energy, water and carbon in the earth system caused by drought and variability of the water cycle and its effects on carbon exchange, ecosystem respiration, and on disturbance frequency and emissions. This will be achieved through four themes (below).

The second part of the workshop (National, days 4-5) will address Australia's national research priorities in the area of terrestrial coupled carbon and water cycle research. Participants from the Australian community are strongly encouraged to attend along with invited international participants. Two activities will provide the focus to address this (see below).

The time dimensions of interest include the recent past, current, and future changes and impacts, globally, and in drought-prone regions. Paleo aspects will also be considered.

Changes in the water cycle include:

- Short-term variability and extremes (seasonal)
- Long-term variability (annual)
- Trends (decadal)
- Thresholds

Terrestrial carbon processes are:

- Changes in vegetation structure
- Carbon exchange (Gross Primary Productivity, NPP, NEP, NEE)
- Ecosystem respiration
- Disturbances, e.g., fire.

Workshop Themes

Workshop Part I (International, days 1-4)

Theme 1: Observations of Climate Change, Variability and the Carbon Cycle

- Ground and remotely sensed observations of precipitation and temperature anomalies and trends, including soil moisture, run-off, streamflow and others.
- Atmospheric observations of CO₂ growth anomalies.
- Satellite observations of vegetation state and change.
- Ground observations of changes in carbon stocks and fluxes due to changes in climate variability and drought (eddy covariance, forest inventories, soil carbon, crop production, statistics on fire frequency and area burned, measurements of carbon emissions from fires, others).

Theme 2: Processes and Controls of Coupled Carbon-Water Cycles

- What processes are driving the net carbon balance in drought cycles and increased climate variability (GPP, R_e, oxidation)?
- Disturbances (e.g., fire, insect damage)
- Water use efficiency under elevated CO₂
- Field experiments on carbon-water interactions (e.g., water exclusion experiments, FACE water treatments, transects across systems of changing water availability)

Theme 3: Modeling Present and Future Interactions of Carbon and Hydrological Cycles

- What is the evidence of past and current trends in the hydrologic cycle?
- What are the future projections for climate change and variability?
- What are the current and future requirements of observations needed to address altered water cycle and carbon-water interactions?
- How do models implement disturbance and recovery at multiple scales?
- How do models handle critical uptake and emission processes, particularly emissions from fires and ecosystem respiration?
- What do models tell us about the key vulnerabilities in the carbon-water system and are there thresholds?
- Major families of models including:
 - Coupled carbon-climate GCMs (C⁴MIP family)
 - Dynamic Global Vegetation Models (DGVMs)
 - Data Assimilation and model-data fusion approaches.

Theme 4: Vulnerability and Ecosystem Services of Carbon-Water Cycles

- What are ecosystem services associated with the coupled carbon-water cycles?

- How does extratropical wildfire affect ecosystem services?
- How does tropical wildfire affect ecosystem services?
- How do climate change and water resources and water resource management interact?
- What are vulnerability and sustainability issues of the carbon-water cycles?
- Case study: How do climate and management interact in rangelands?
- Case study: How do climate and management interact in forested ecosystems?
- Case study: A historical and archeological perspective on management and climate interactions

Workshop Part II (National, days 4-5)

Activity 1: Interactive coupling of the carbon cycle to the physical climate system (future)

We will advance a strategy to further develop a fully integrated carbon/land surface model (CABLE) for stand alone use and coupling to ACCESS, including an Australian capacity in a Dynamic Global Vegetation Model. Specifically:

Activity 2: Blueprint for Australian Terrestrial Carbon Cycle Research

We will address the major issues in the Blueprint for Australian Terrestrial Carbon Cycle Research in order to define how the ARC NESS and CSIRO and other institutions can contribute to the plan and how we may develop funding opportunities. Specifically we will address:

1. Patterns of sources and sinks of carbon across Australia
2. Vulnerability of terrestrial carbon sinks into the future
3. Interactive coupling of the carbon cycle to the physical climate system (current)

Workshop Structure

Workshop Part I (days 1-4)

Plenary talks with ample time for questions and discussions at the end of each theme

Discussion on products and drafting synthesis paper

The workshop will finish at 1:00 pm on Thursday 8 June. For those people who are not participating for the rest of the national workshop we will organize a short excursion in the afternoon.

Workshop Part II (days 4-5)

On day 4 (Thursday 8) in the morning, Part I and Part II of the workshops are the same.

The meeting will finish at 3:00 pm on Friday 9 June.

Part I and II

Poster Session: Participants who will not give an oral presentation are encouraged to bring a poster.

Publications

During the meeting will explore the possibility to publish a journal special issue with a combination of invited talks and synthesis papers resulting from the discussions in the workshop. We are exploring several possibilities including EGU and AGU journals and the possibility of fast publication in one of their open access web journals. Other alternatives include Global Change Biology and other suggestions from participants.

A synthesis publication for Science or Nature will be considered too.

Part II. A synthesis paper will be organized with the outcomes of the discussions.

Participating Organizations and Sponsors

International

- Global Carbon Project (GCP of the Earth System Science Partnership: IGBP, WCRP, IHDP, Diversitas)
- Analysis, Integration and Modeling of the Earth System (AIMES of the International Geosphere-Biosphere Program, IGBP)
- Global Land Project (GLP of IGBP and IHDP)
- European Space Agency (ESF)

National

- ARC Network for Earth System Science (ARC-NESS)
- Australian Greenhouse Office-Australian Climate Change Science Program (AGO-ACCSP)
- CSIRO Marine and Atmospheric Research (CMAR)
- Australian Academy of Science

Scientific Committee

Mike Raupach and Pep Canadell (GCP-CSIRO); Jason Beringer and Andy Pitman (ARC-NESS); Dave Schimel and Kathy Hibbard (AIMES).

Local Host

Global Carbon Project – International Project Office in Canberra
CSIRO – Marine and Atmospheric Research

Conference Venue

The Shine Dome at the Australian National Academy of Science, Canberra, Australia

<http://www.science.org.au/>

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