The Global Carbon Project:

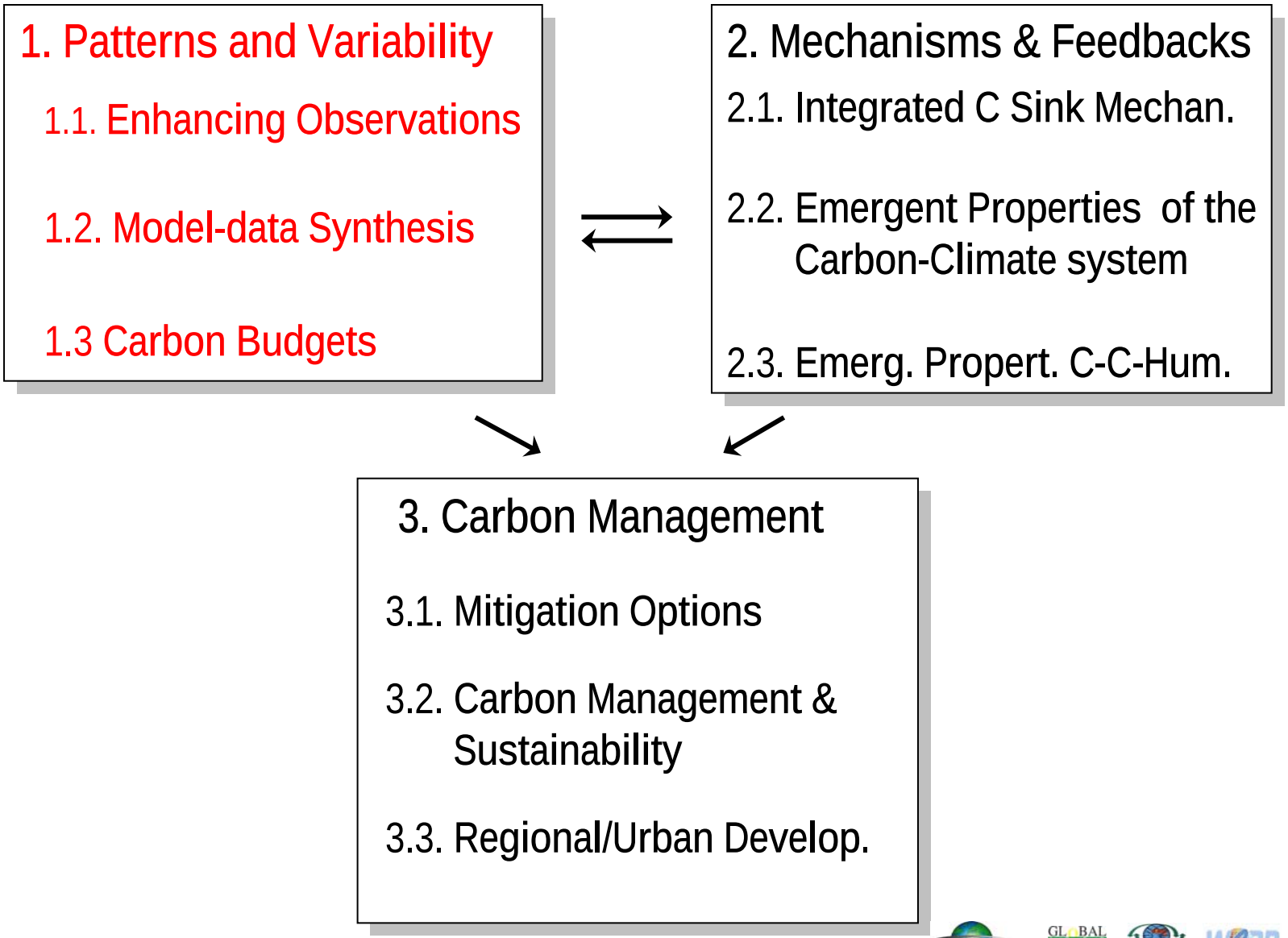
Integrating Humans, Climate, and the Natural World

Progress Report
2004-2005

Outline

- Theme 1 Activity
- Theme 2 Activity
- Theme 3 Activity
- Links to Sponsor Programs
- Meetings
- Publications
- Communication
- Support

GCP Science Framework



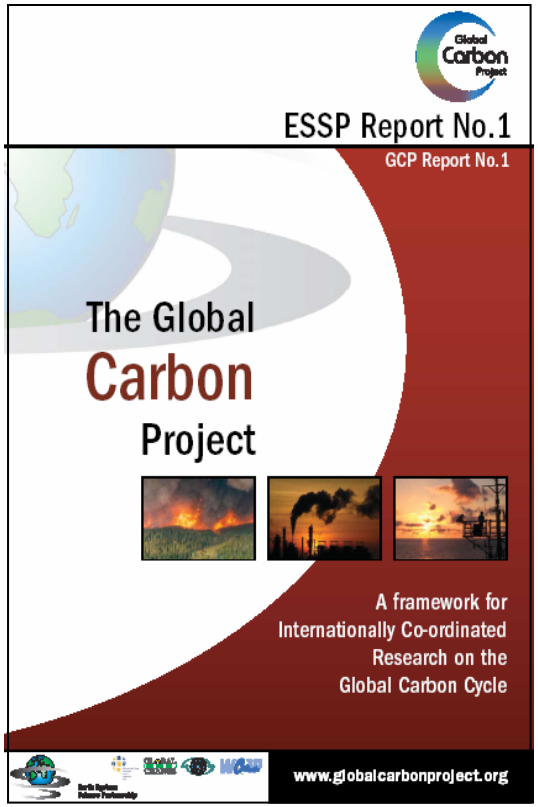
Global Carbon Project

Earth System Science Partnership

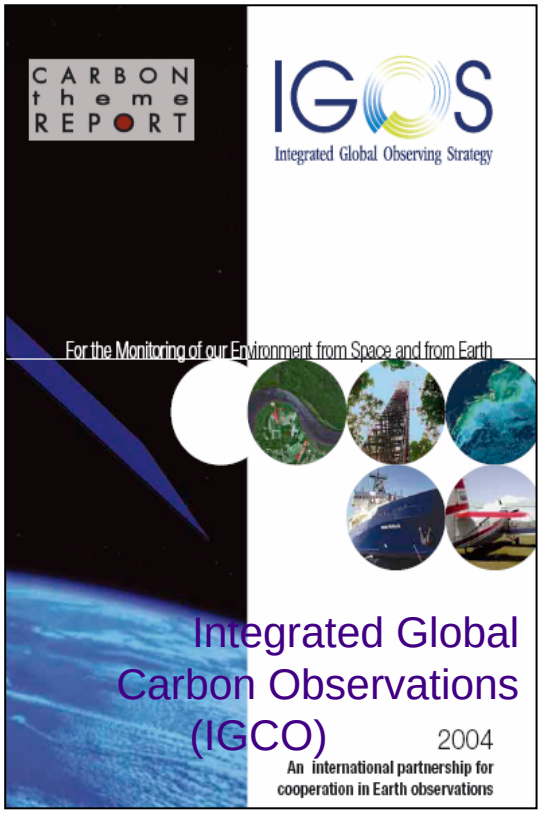
GLOBAL CHANGE IHDP WCRP

A joined front on Global C Research and Observations

Research



Observations



and GTOS (TCO) within

- Joint Development of the Implementation Plan
- Carbon from Space Wk June 2005 w/ESA/IGBP
- GLOBCARBON ESA (burned area and LAI)

Carbon from Space

6-8 June 2005, Esri Frascati, Italy

ESA, IGCO, GCP Symposium

(with help from IGBP and CarboEurope)

Specific objectives:

1. to provide an overview of current space-based systems for measuring CO_2, CH_4, CO;
2. to foster and coordinate the development of new sensors and programmes;
3. to foster and coordinate globally integrated programs for validating space-based concentration measurements with in situ observations;
4. to further the development of techniques for assimilating space-based measurements into models

Challenges to the GCP:

1. Coordinated Enhanced Observation Period - a two year period of observations (space based and others) of many aspects of the carbon cycle lead by IGCO, IGACO/GAW and GCP. To coincide with OCO/GOSAT launches in 2008.
2. Open offer from 2008 to GCP/IGCO to develop global data sets of critical need through ESA Data User Element (1m Euro). Need to specify what and define requirement (users).

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International Ocean Carbon Coordination Panel (IOCCP)

A communication and coordination service for the international ocean carbon community

- 2nd IOCCP Workshop: Ocean Surface pCO_2, Data Integration, and Database Development, Tsukuba, Japan (NIES). Produced international agreements on recommended format for pCO_2 metadata and data file reporting from underway systems, and a set of recommended practices for data exchange and data integration.
- Carbon representatives on CLIVAR (Repeated Sections) Basin Panels
- 2nd international stakeholders' meetings with national, regional, and global programs to coordinate activities and plans (CLIVAR, GCP, SOLAS, IMBER, LOICZ, PICES, CarboOceans, US OCCC, NASA Ocean Colour program, OOPC, GOOS)
- The "Ocean Carbon Directory" - a communication and coordination web-portal service (www.ioccp.org)
- New Terms of Reference for a broader mandate (ocean carbon cycle, not just CO_2), and Scientific Steering Group (Chair: Chris Sabine)

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Multiple Constraints Data Assimilation for Carbon Cycle

Intercomparison of Optimization Techniques for Parameter Estimation [OptIC: Optimization Intercomparison]

Models:

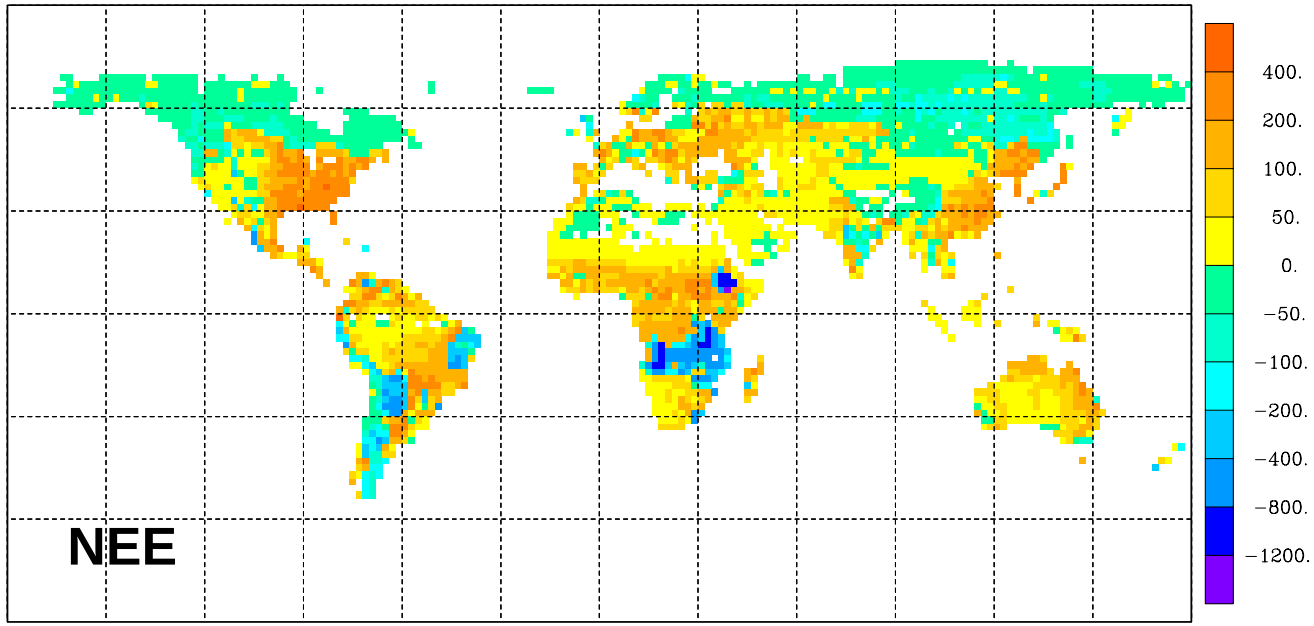
- terrestrial biosphere (BETHY)
- atmospheric transport model

Data:

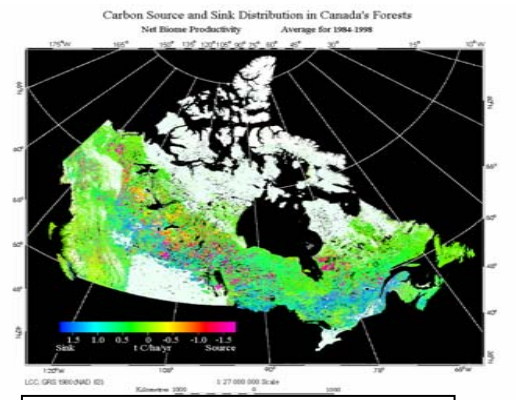
- remote sensing,
- atmospheric CO_2

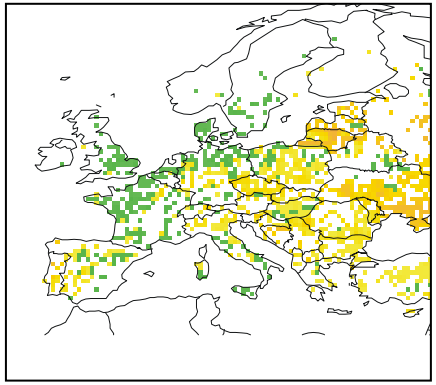
Peter Rayner
Kaminiski et al. 2002

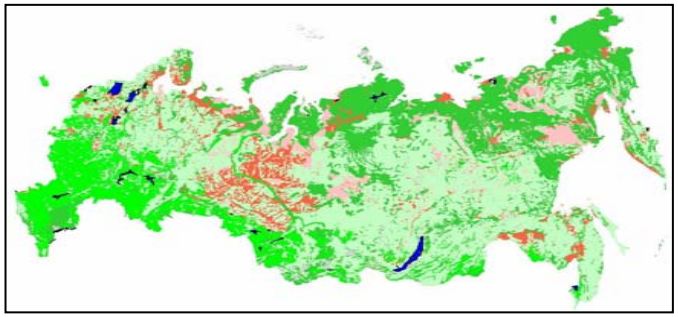
Global Net Ecosystem Exchange (gC m^{-2} y^{-1})

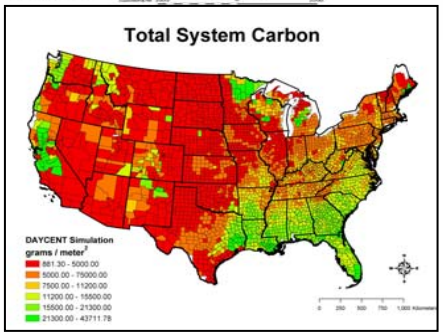


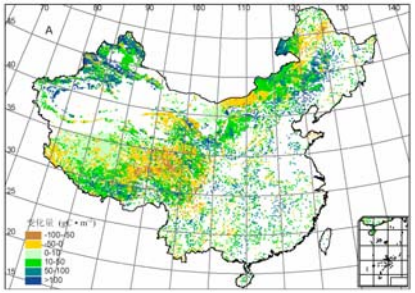
Terrestrial Carbon Budgets: From Methods to Quantities

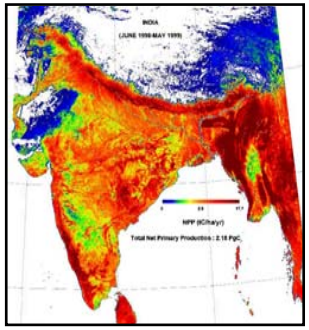


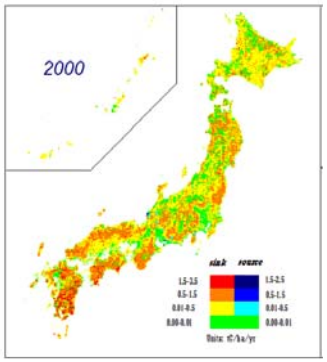


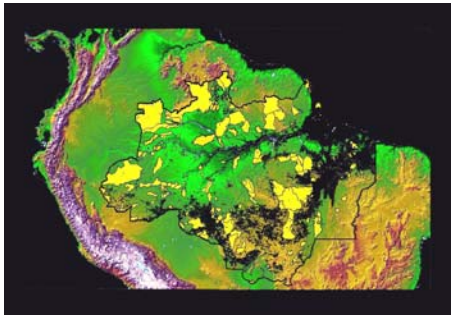




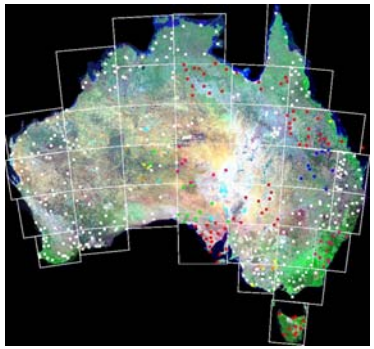








- Bottom-up constraints to the global carbon cycle.
- Harmonization of methodologies.
- Carbon management tools for informing policy development.



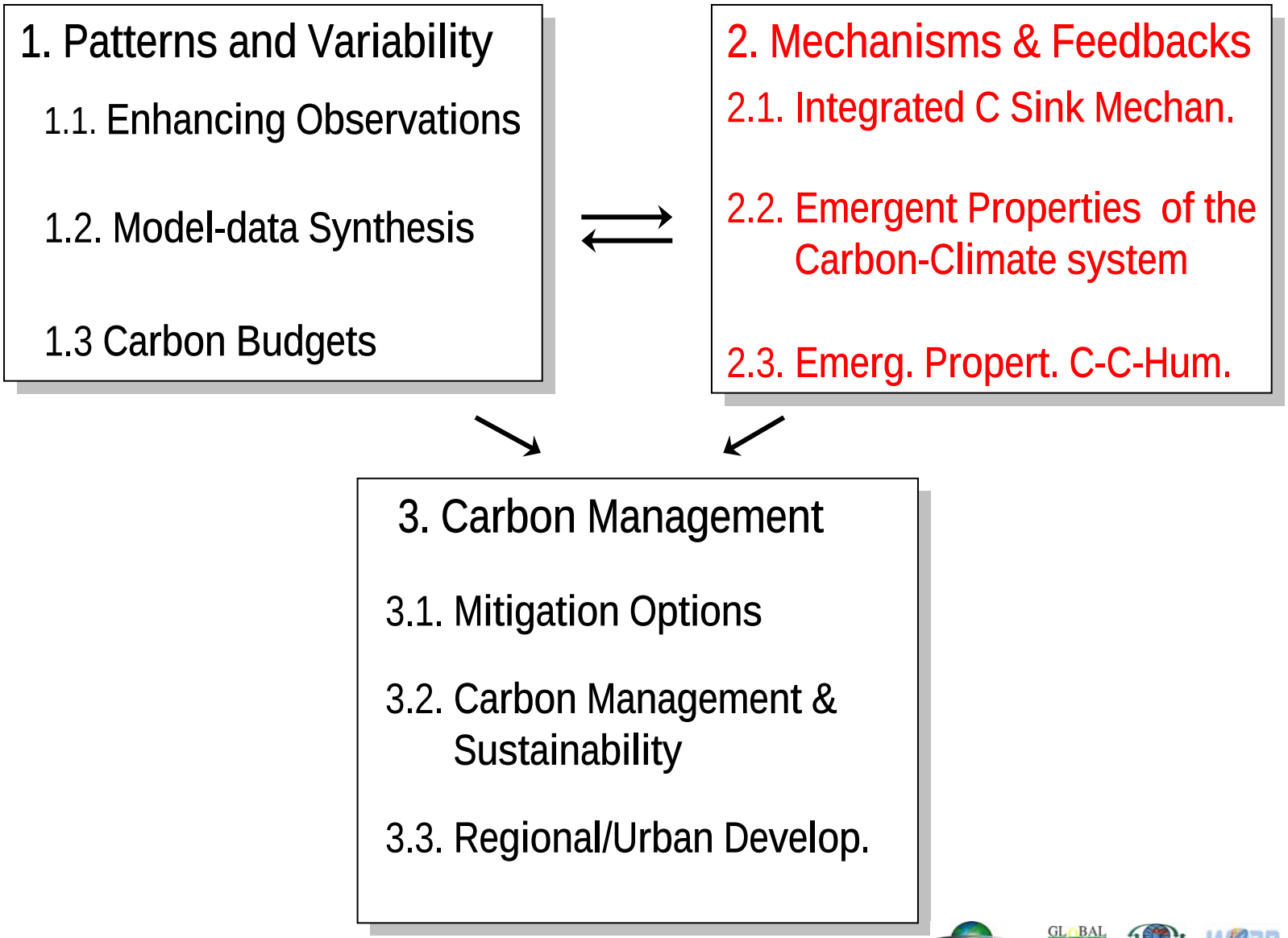
The Southeast Asia Regional Carbon and Water Project

PI (Country)	2005- Projects
Edvin Aldrian (Indonesia)	The Brantas Catchment Water and Carbon Cycle
Lee Choon Weng (Malaysia)	The Carbon Flux Through Bacteria in Coastal Waters East of Peninsular Malaysia
David Higit and Xixi Lu (Singapore)	Human Impacts on Water, Carbon and Sediment Fluxes in the Southeast Asian Region: Modeling and Field Approaches
Anond Snidvongs and Jeffrey Richey (Thailand)	Future Trajectories in the Delivery of Water and Carbon Across the Landscapes of Southeast Asia to the South China Sea
Penjai Sompongchaiyakul (Thailand)	Carbon, Nutirents and Water Fluxes of the Tapi River and Songkhla Lake Watersheds
C.T.A. Chen and C.R. Wu (Taiwan)	Carbon cycles in the fluvial and oceanic systems of Southeast Asia (CASA)
S.L. Wang (Taiwan)	Air-Sea CO_2 flux study in the shelf of the northern S China Sea

Global Carbon Project

Earth System Science Partnership

GCP Science Framework



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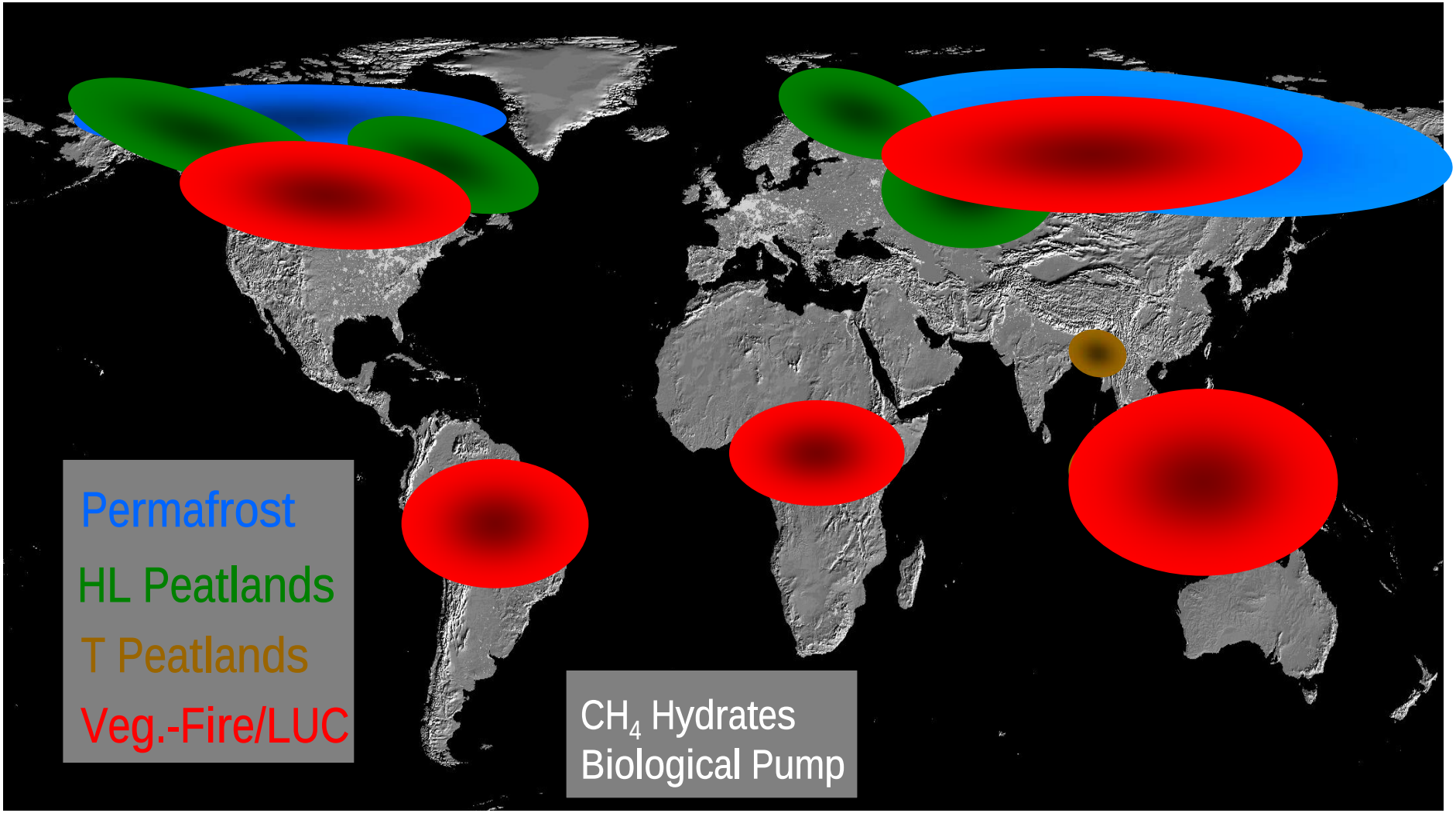
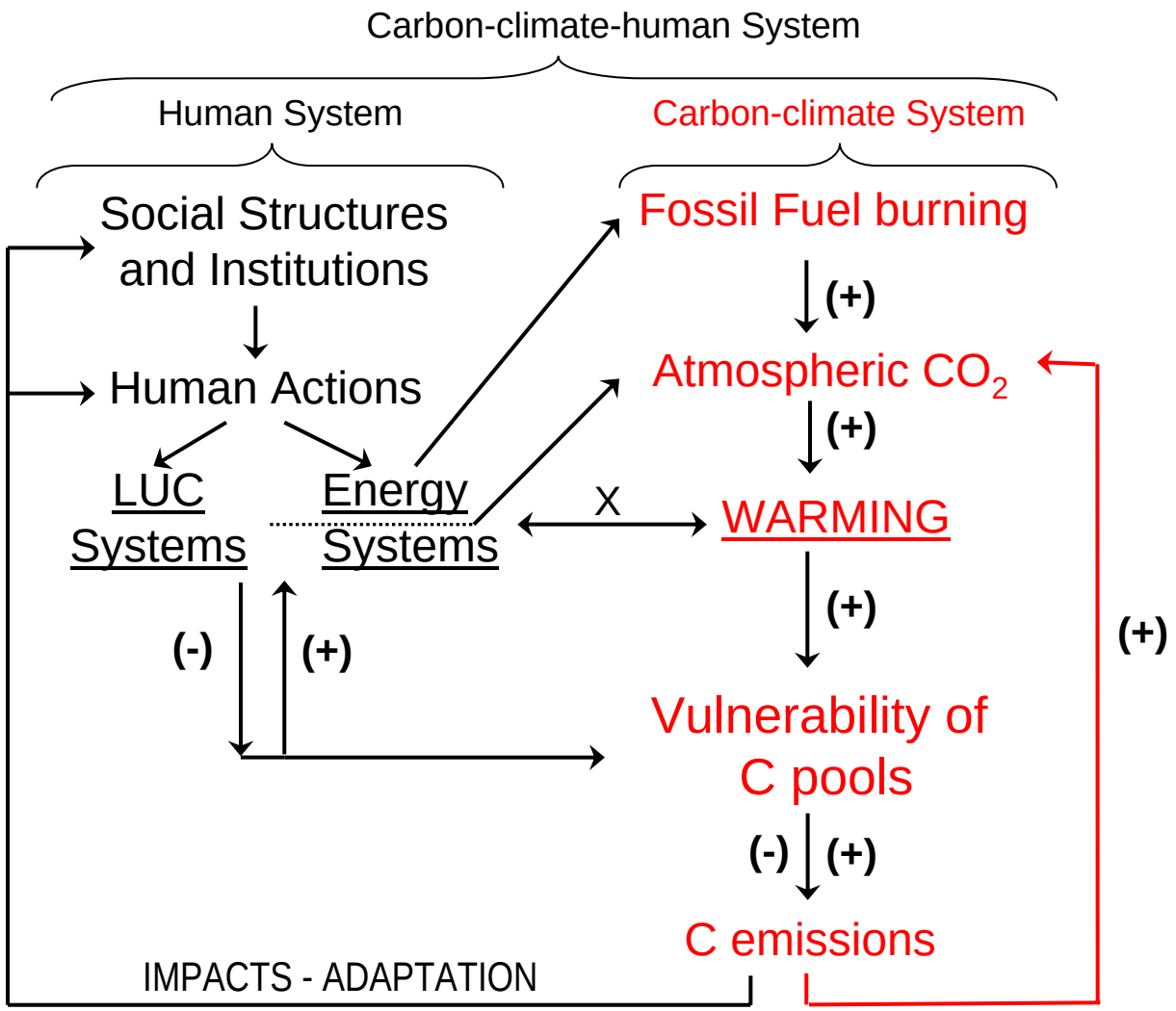
Vulnerabilities of Carbon Pools in the 21st Century

Carbon-Climate Feedbacks Hot Spots



Vulnerabilities of the Carbon-Climate-Human system



Vulnerabilities of the Permafrost-Carbon-Climate System

Distribution of Permafrost and C stocks

- Spatial distribution and southern boundary dynamics

Carbon Processes

- Biogeochemical modeling of C dynamics in thawing permafrost

Climate Impacts (100 years timeframe)

- Off-line calculations and Coupled Earth System modeling

Global Carbon Project
Climate and Cryosphere
International Permafrost Ass.
Others (C^4MIP)

2 workshops (2005 and 2006) – Overall assessment, National Center for Ecological Analysis and Synthesis (NCEAS) – FUNDED, Field and Canadell

1 workshop - Below-ground carbon pools in permafrost regions, European Science Foundation (ESF) – FUNDED, Kuhry

1 workshop (2007) – ICSU. Contribution to IPY-2007/08 – SUBMITTED, Canadell (IGBP_WCRP)

PEACE –
PErmafrost And Carbon
Emissions (IPY 2007-08)

- CAPP
Belowground CArbon Pools
in Permafrost Regions

Vulnerabilities of Peatlands-Carbon-Climate System

Tropical Peatlands

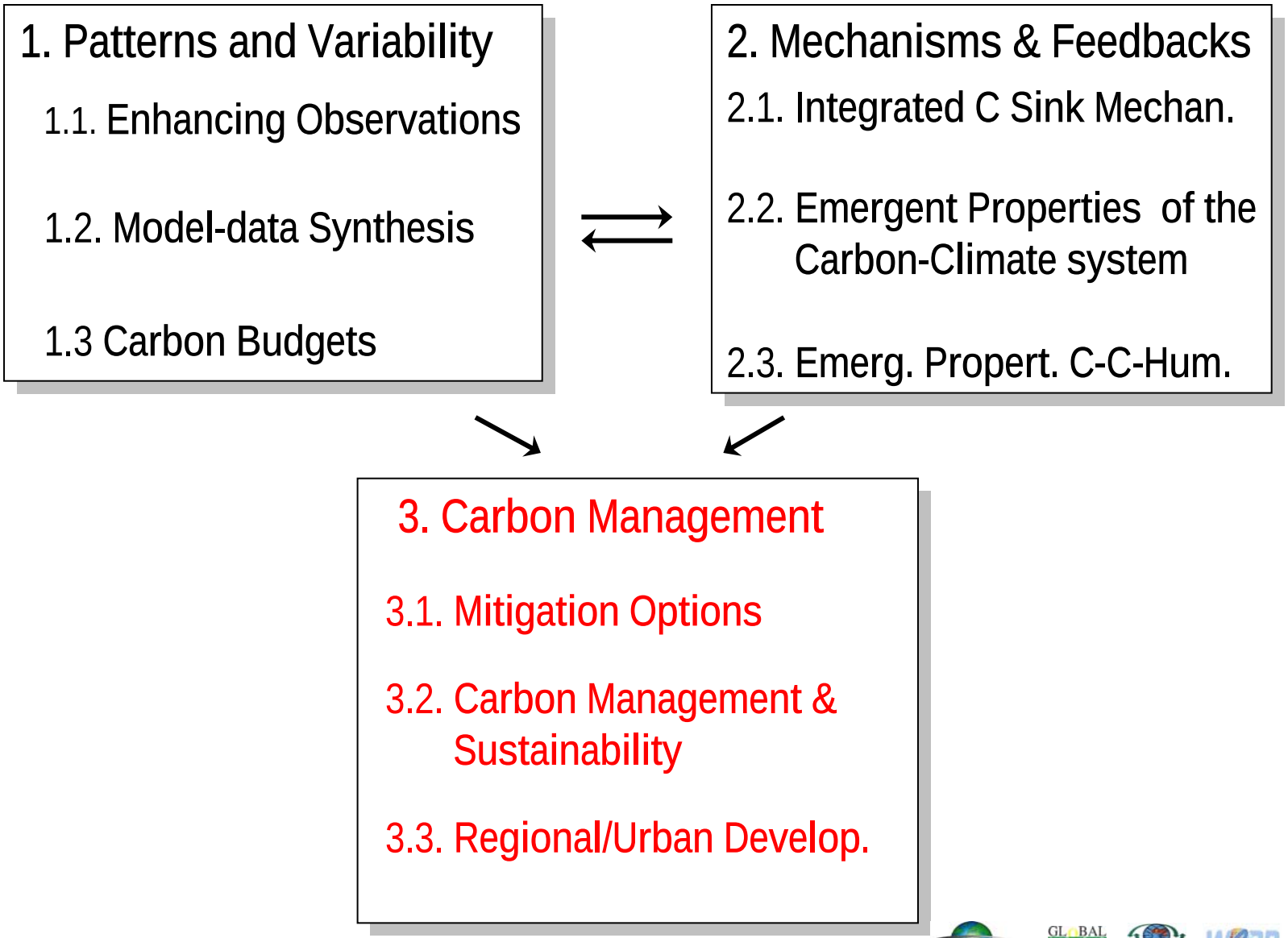
- Asia Pacific –
  Tropical Peatland Synthesis:
  - Carbon stocks
  - Drivers of change
  - Biogeochemical modeling
  - Input into GCMs

APN FUNDED (2 workshops, 2005-06)
Parish & Canadell

- Tropical forests and climate change adaptation: criteria and indicators for adaptive management for reduced vulnerability and long-term sustainability

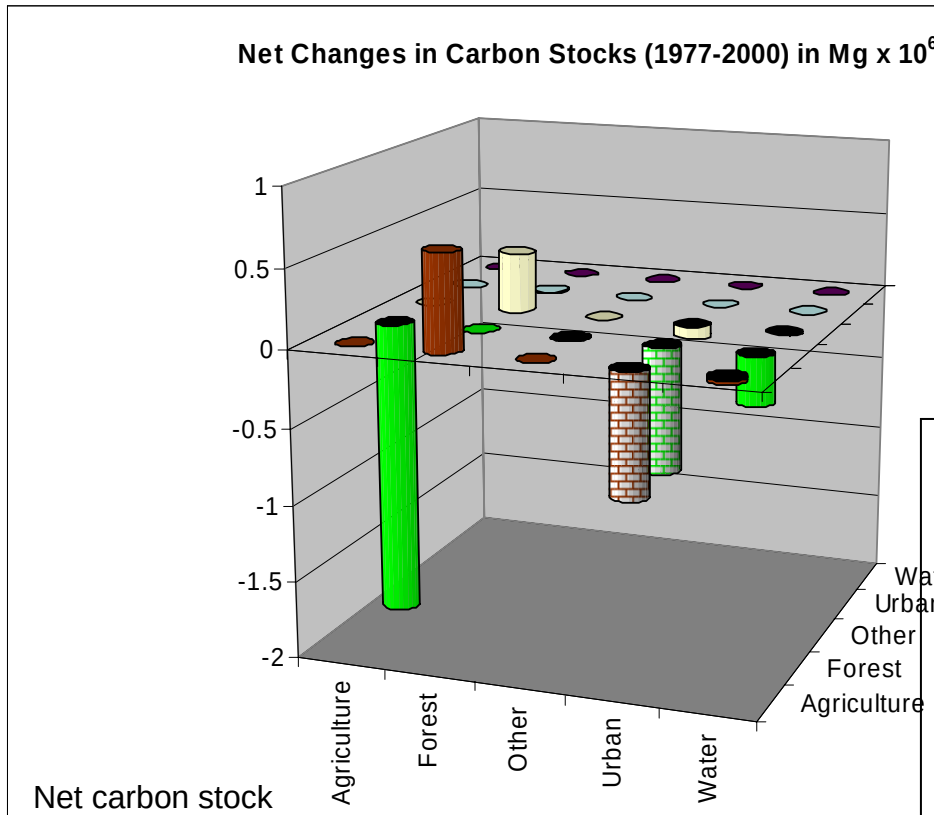
EU-FUNDED (2005-2008)
CIFOR, Indonesia, Murdiyarso et al.

GCP Science Framework

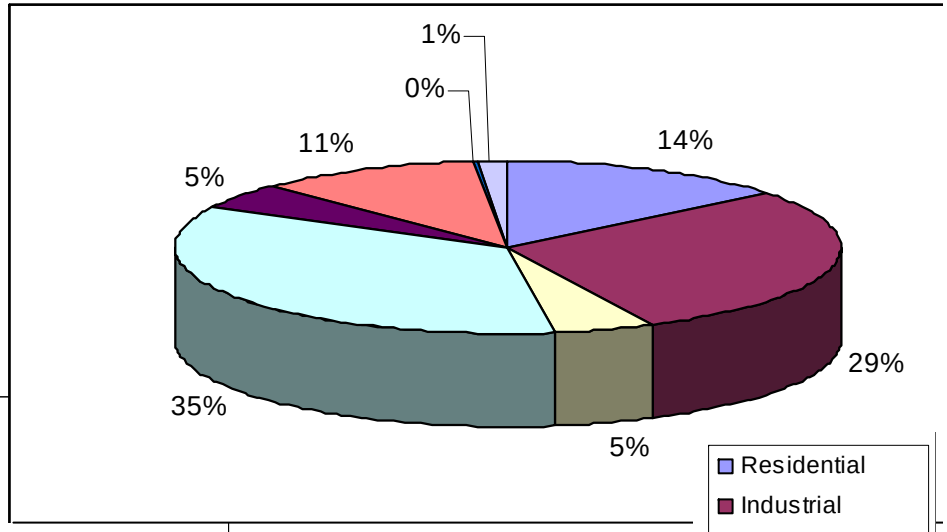


Decarbonization Pathways in Urban Development

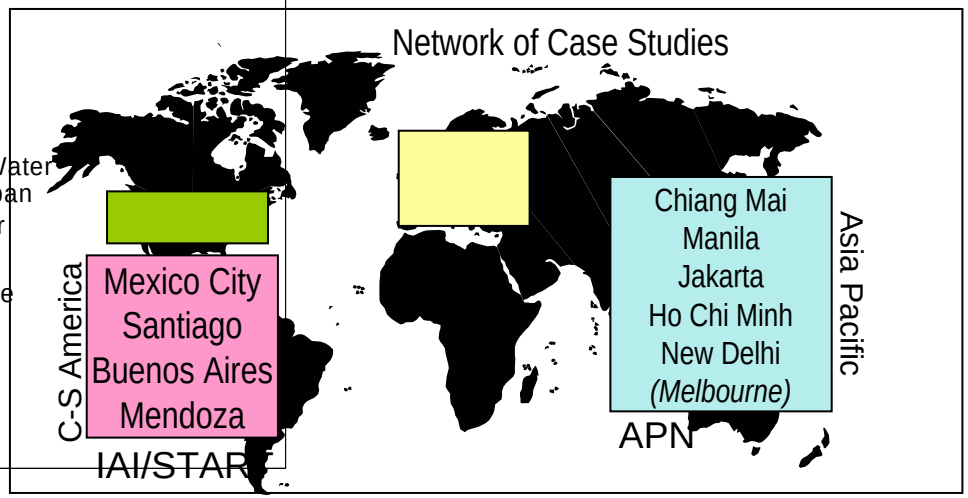
Impacts of urbanization on carbon stocks in Chiang Mai (Thailand)



Net carbon stock changes with land-use 1977-2000



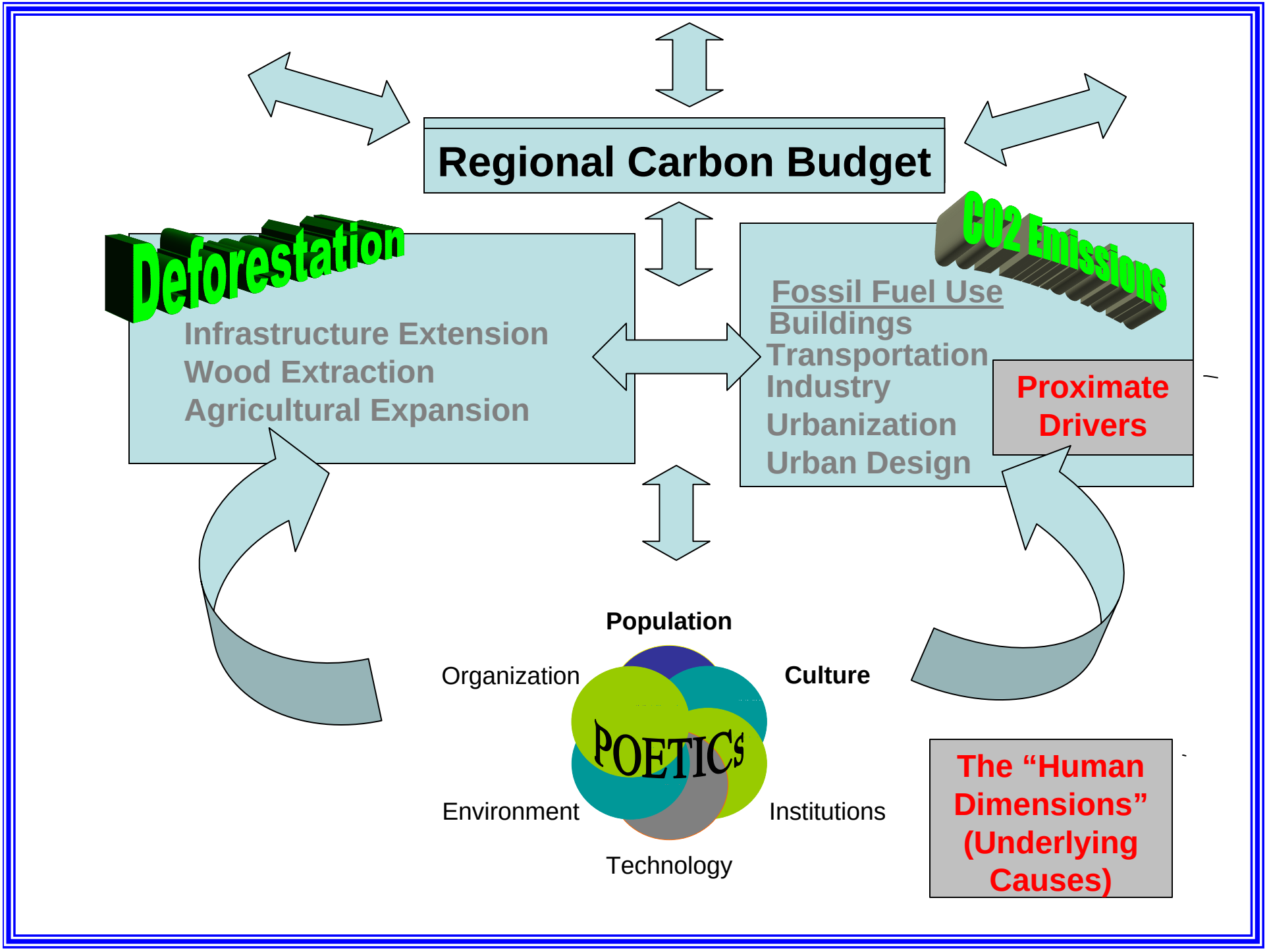
CO_2 emissions by different sectors in Mexico City



Theme 3
Global Logic, Regional Application

- **Social <u>System</u> Drivers: P-O-E-T-I-Cs**

- **Tools**
  - **Case Studies using multiple methodologies**
  - **Meta-analyses based on QCA**
  - **Social Network Analyses**
  - **Relational Databases**


Regional Carbon Budget
Deforestation
Infrastructure Extension
Wood Extraction
Agricultural Expansion
CO2 Emissions
Fossil Fuel Use
Buildings
Transportation
Industry
Urbanization
Urban Design
Proximate Drivers
Population
Organization
Culture
POETICS
Environment
Institutions
Technology
The "Human Dimensions" (Underlying Causes)

GCP Initiative for Theme 3:
Urban and Regional Carbon Management

Understanding and quantifying

1. **Direct carbon emissions of urban areas and regions**

2. **Embedded-carbon consequences of consumption patterns of urban areas and regions**

3. **Drivers of "1" and "2" abin terms of systemic configurations of P-O-E-T-I-Cs**

   Population **Organization**
   Environment **Technology**
   Institutions **Culture**

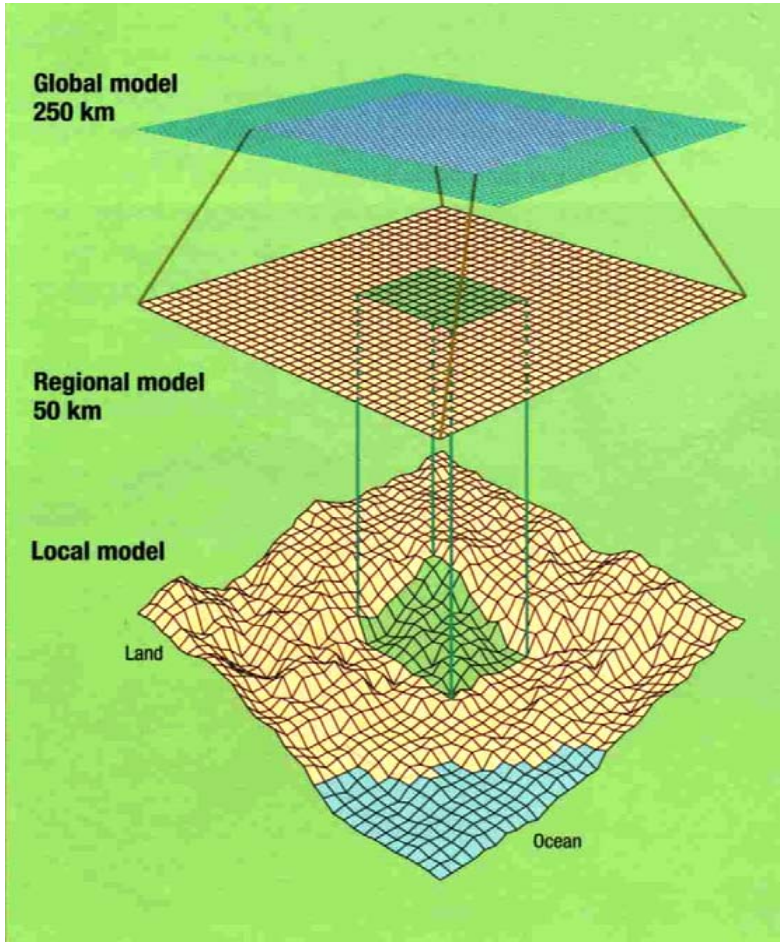
Characterizing, Identifying, Developing

4. **Development pathways by which "1", "2," & "3" evolve**

5. **Key opportunities, threshold points and barriers for altering development pathways to be synergistic with local concerns through multi-level governance.**

6. **Decision support systems for carbon management in urban areas and regions.**

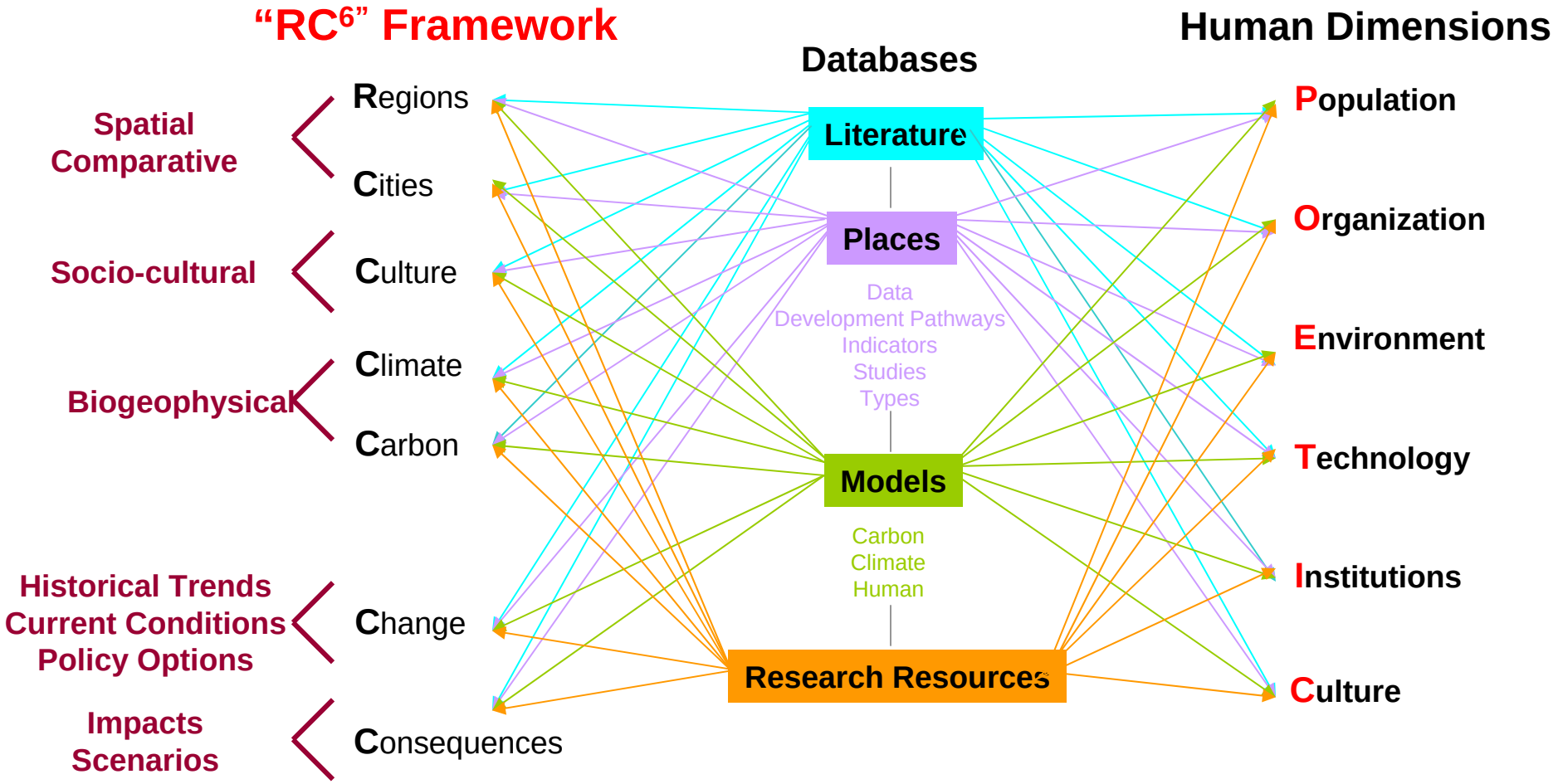
Social Networks & Urban/Regional Carbon Management



1. **Power to Change & Power to Resist**
2. **Missing or Weak Clusters in Policy-Making or Implementation**
3. **Shared Values for Building Consensus**
4. **Creating Knowledge-Sharing Action Clusters**
5. **Knitting Networks for Action**
6. **Stakeholder Networks, Worldview, Commitment to Decarbonized Future**
7. **Time & Place Stamps in Network Data**
8. **Computational Laboratories**

National Institute for Environmental Studies
Tsukuba, Japan
April 5-7, 2005

A comparative and historical approach to urban, regional and global carbon footprints, their determinants, trajectories and management opportunities

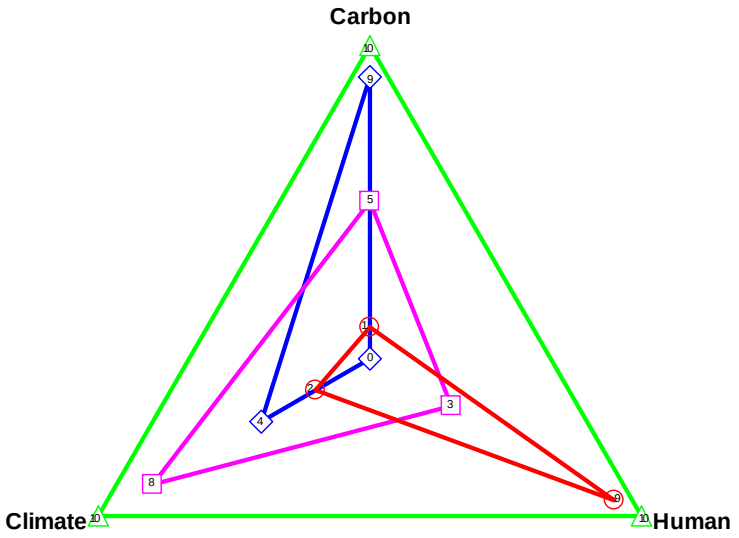


NIES, Tsukuba

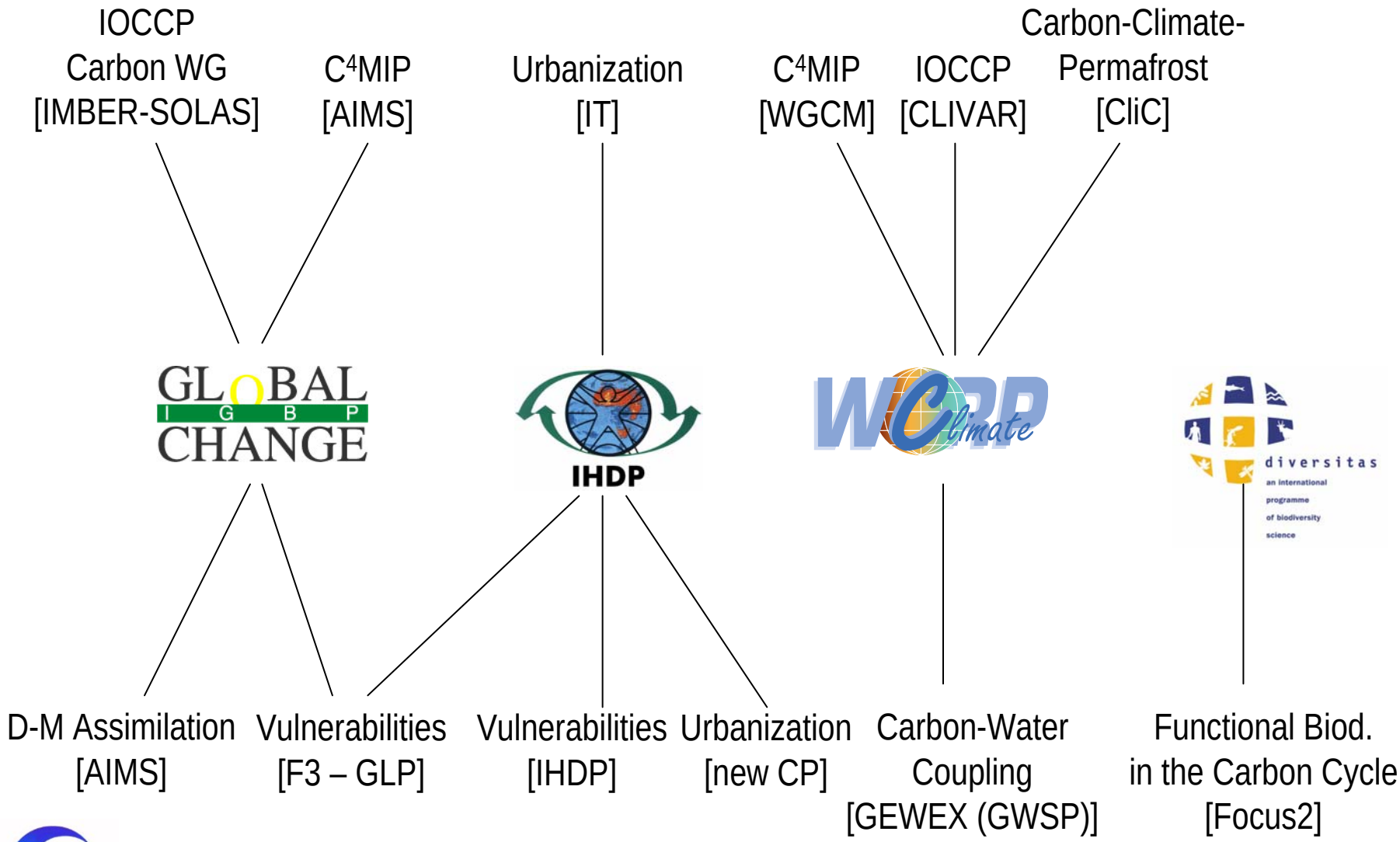
Coupled (Envir-Human) Models Taxonomy

1. Identify and Assemble Models for Analysis (200)
2. Characterization
3. Focus on Inclusion across Human, Carbon, and Climate Dimensions of the Global Carbon Cycle
4. Inclusion Report with Graphic Portrait
5. Validation Survey to Model Creators
6. Report to the Scientific Community

	Carbon	Human	Climate
Model A	9	0	4
Model B	5	3	8
Model C	10	10	10
Model D	1	9	2



GCP links to Projects of the Sponsor Program



Program Wide

Meetings (i): June-Dec. 2004

1. **THE NORTH PACIFIC CARBON CYCLE**
2-4 June 2004, Seattle, Washington

2. **INTERCOMPARISON OF OPTIMIZATION TECHNIQUES FOR PARAMETER ESTIMATION (Opt-IC)**
7-9 September 2004, Canberra, Australia

3. **GLOBAL WARMING, THE CARBON CYCLE, AND REGIONALISM: THE YAMAGATA-COLORADO SYMPOSIUM**
23-26 October 2004, Yamagata, Japan

4. **INTEGRATED GLOBAL CARBON OBSERVATION (IGCO) IMPLEMENTATION MEETING**
3-5 November 2004, Frascati, Italy

5. **REGIONAL CARBON BUDGETS: FROM METHDOLOGIES TO QUANTIFICATION**
15-18 November 2004, Beijing, China

Meetings (ii): 2005

6. **INTERNATIONAL OCEAN CARBON COORDINATION PROJECT (IOCCP)**
6-7 December 2004, Paris, France

7. **INTEGRATING CARBON MANAGEMENT INTO THE DEVELOPMENT STRATEGIES OF CITIES**
6-8 January 2005, Chiang Mai, Thailand

8. **A BLUEPRINT FOR A GREENHOUSE GASES MONITOR SYSTEM IN EUROPE**
4-5 April 2005, Amsterdam, The Netherlands

9. **SOCIAL NETWORK THEORY AND METHODS: APPLICATIONS FOR REGIONAL CARBON MANAGEMENT**
5-7 April 2005, Tsukuba, Japan

10. **OPTIONS FOR INCLUDING LULUCF ACTIVITIES IN A POST-2012 INTERNATIONAL CLIMATE AGREEMENT**
5-6 May 2005, Graz, Austria

Meetings (iii): 2005

11. **CARBON FROM SPACE**
6-10 June 2005, European Space Agency-ESRIN, Frascati, Italy

12. **ATMOSPHERIC TRACES TRANSPORT MODEL INTERCOMPARSION (TRANSCOM)**
13-17 June 2005, Paris, France

13. **SCIENCE-JOURNALISM PARTNERSHIP**
2-4 June 2005, Tokyo, Japan

14. **RC^6 WORKSHOP**
12-13 June 2005, Paris, France

Meetings (iv): 2005 – still to come

15. **VULNERABILITIES OF THE CARBON-CLIMATE-HUMAN SYSTEM**
15 June 2005, UNESCO, Paris, France

16. **CARBON CYCLE AND CLIMATE**
2-11 August 2005, IAMAS session, Beijing, China

17. **DIDACTIC SEMINAR ON SOCIOLOGY, GLOBAL WARMING AND THE CARBON CYCLE**
12 August 2005, ASA session, Philadelphia, USA

18. **7th INTERNATIONAL CO_2 CONFERENCE**
26-30 September 2005, Broomfield, CO, USA

19. **CARBON-HUMAN DIMENSIONS:**
OPEN MEETING OF THE HUMAN DIMENSIONS COMMUNITY
9-13 October 2005, Several sessions, Bonn, Germany

Meetings (v): 2005 - still to come

20. **GREENHOUSE 2005: ACTION ON CLIMATE CONTROL**
13-17 November, Melbourne, Australia

21. **ADVANCE TRAINING WORKSHOP ON CARBON AND WATER ISSUES IN SOUTHEAST ASIA**
15-28 November, Taiwan

22. **VULNERABILITIES OF THE PEATLAND-CARBON-CLIMATE SYSTEM**
1-4 September, October 2005, Indonesia

23. **VULNERABILITIES OF THE PERMAFROST-CARBON-CLIMATE SYSTEM**
TBA, 2005, Santa Barbara, CA, USA

Meetings (vi): 2004-2005 – Reporting/Project Meetings

24. **SCIENTIFIC STEERING GROUP MEETING OF THE CLIMATE AND CRYOSPHERE PROJECT (CliC)**
25-30 October 2004, Hobart, Australia

25. **IGBP SCIENTIFIC COMMITTEE MEETING**
19-23 February 2005, Beijing, China

26. **WCRP JOINT SCIENTIFIC COMMITTEE MEETING**
14-18 March 2005, Guayaquil, Ecuador

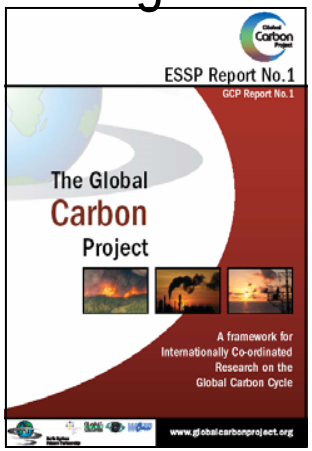
27. **IHDP SCIENTIFIC COMMITTEE MEETING**
April 2005, Bonn, Germany

28. **ESSP CHAIRS AND DIRECTORS MEETING**
20-22 May 2005, Stockholm, Sweden

29. **5th SCIENTIFIC STEERING COMMITTEE MEETING**
14-17 June 2005, Paris, France

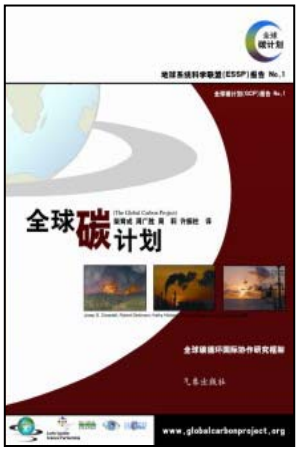
Publications (i)

English



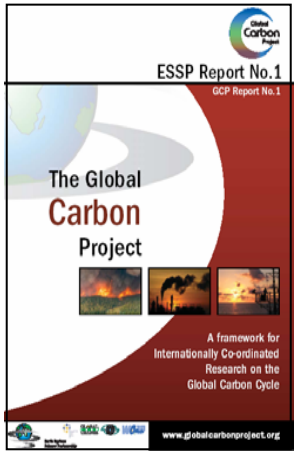
Oct. 2003

Chinese



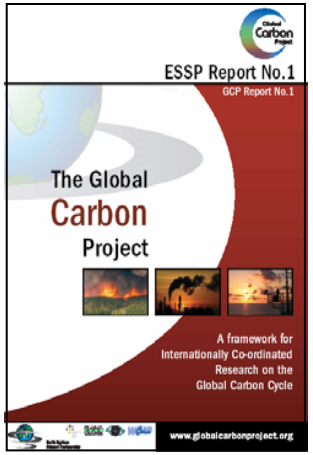
Nov. 2004

Russian



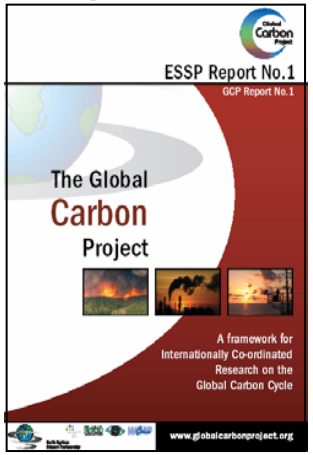
August 2005

Japanese



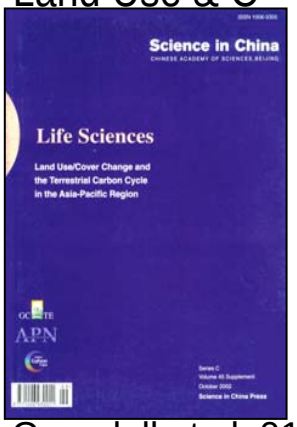
August 2005

Spanish



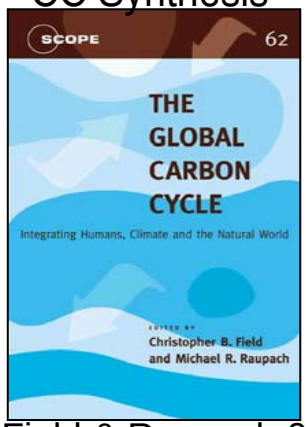
Nov. 2005

Land Use & C



Canadell et al. 01

CC Synthesis

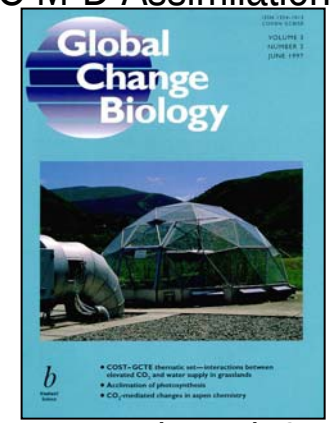


Field & Raupach 04

Terrestrial C

Canadell et al. 04

C M-D Assimilation



Raupach et al. 05

Global Carbon Project

Earth System Science Partnership

Publications (ii)

Sabine et al, 2004

Eos, Vol. 85, No. 42, 19 October 2004

scheduled as needed in conjunction with meetings and workshops for the respective satellite missions.

Follow-on Activities

The workshop provided plans and recommendations for jointly implementing satellite and ground-based measurements of salinity and soil moisture. Key actions are being taken related to ancillary data sets, future airborne and field campaigns, climate observing systems, and models that are common to the three satellite missions. Working groups were established to continue collaboration on all common science and technical issues for salinity and soil moisture measurements, and for satellite sensor calibration. The problems from radio frequency interference (RFI) in the protected microwave bands were raised in multiple sessions, and this issue must be pursued jointly by all concerned.

Participants agreed to conduct joint science meetings of all three missions on a regular basis, with the next such meeting in about 18 months. They also recognized the need for cross participation in smaller mission team meetings in the interim. Lastly, there were discussions emphasizing the unprecedented scientific opportunity provided by the overlapping of these missions with the Global Precipitation Measurement (GPM). This provides for comprehensive analyses of the ocean-land-atmosphere branches of the water cycle that are not achievable with the stand-alone missions, and will require focused global water cycle research initiatives to take full advantage of this evolving new satellite constellation.

The Aquarius/SAC-D-SMOS-HYDROS Joint Science Workshop on Salinity and Soil Moisture Remote Sensing was held 20–22 April 2004, in Miami, Florida.

Understanding North Pacific Carbon Cycle Changes

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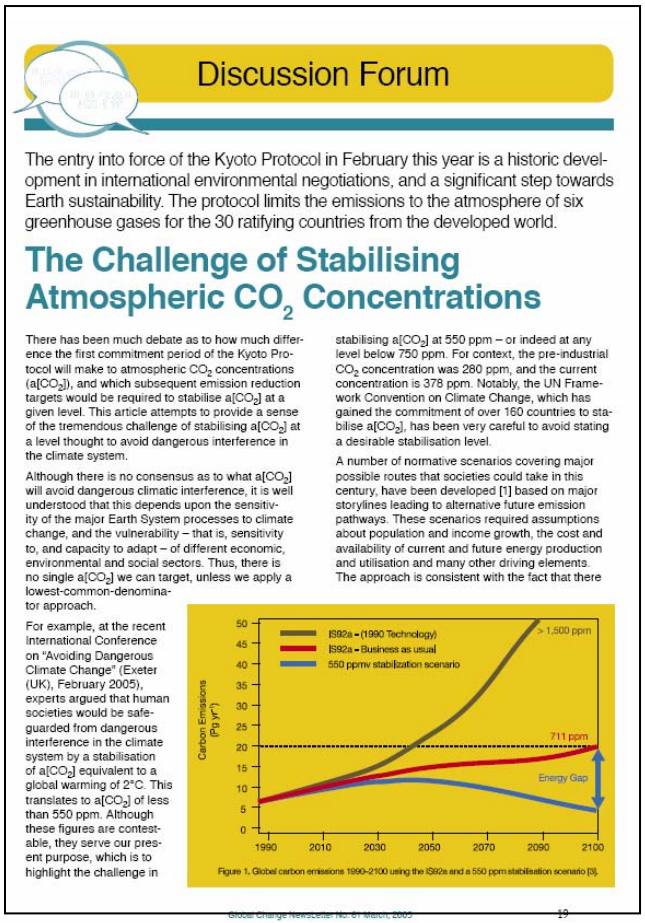
Although increasing levels of atmospheric carbon dioxide have been well documented, the response of the ocean to these changes is less understood, particularly on regional space scales. Evidence is accumulating that there is substantial variability in the cycling of carbon and related biogeochemical elements over a wide range of timescales, including interannual and decadal timescales, which have been the focus of studies aimed at identifying a climate change signal. Most of these studies, however, have been limited in time, space, or number of parameters examined, preventing a full appreciation of the scale and magnitude of the changes.

In June 2004, scientists gathered in Seattle, Washington, to synthesize individual studies of the North Pacific into a coherent picture of North Pacific carbon cycle changes, and to identify the requirements for detecting a long-term climate change signal. The workshop established variability has also been observed in North Pacific carbon measurements and other parameters.

The North Pacific Carbon Cycle Workshop was an effort to synthesize the numerous individual studies in the North Pacific. The format for this study was unique in that a strong effort was made to bring together modelers and observationalists representing different biogeochemical and physical specialties and different regional expertise, to combine their latest model runs and data in a common format determined in preparation for this meeting. The goal of this workshop was to encourage real-time exchange and development of ideas among scientists who do not regularly collaborate, but have a common interest (i.e., the North Pacific), with the objective of generating synthesis publications that draw from the unique perspective of each participant. This way, we can develop an understanding that could not be easily achieved by any individual.

New Approaches

Canadell & Raupach 2005



Discussion Forum

The entry into force of the Kyoto Protocol in February this year is a historic development in international environmental negotiations, and a significant step towards Earth sustainability. The protocol limits the emissions to the atmosphere of six greenhouse gases for the 30 ratifying countries from the developed world.

The Challenge of Stabilising Atmospheric CO_2 Concentrations

There has been much debate as to how much difference the first commitment period of the Kyoto Protocol will make to atmospheric CO_2 concentrations ($a[CO_2]$), and which subsequent emission reduction targets would be required to stabilise $a[CO_2]$ at a given level. This article attempts to provide a sense of the tremendous challenge of stabilising $a[CO_2]$ at a level thought to avoid dangerous interference in the climate system.

Although there is no consensus as to what $a[CO_2]$ will avoid dangerous climatic interference, it is well understood that this depends upon the sensitivity of the major Earth System processes to climate change, and the vulnerability – that is, sensitivity to, and capacity to adapt – of different economic, environmental and social sectors. Thus, there is no single $a[CO_2]$ we can target, unless we apply a lowest-common-denominator approach.

For example, at the recent International Conference on "Avoiding Dangerous Climate Change" (Exeter (UK), February 2005), experts argued that human societies would be safeguarded from dangerous interference in the climate system by a stabilisation of $a[CO_2]$ equivalent to a global warming of 2°C. This translates to $a[CO_2]$ of less than 550 ppm. Although these figures are contestable, they serve our present purpose, which is to highlight the challenge in stabilising $a[CO_2]$ at 550 ppm – or indeed at any level below 750 ppm. For context, the pre-industrial CO_2 concentration was 280 ppm, and the current concentration is 378 ppm. Notably, the UN Framework Convention on Climate Change, which has gained the commitment of over 160 countries to stabilise $a[CO_2]$, has been very careful to avoid stating a desirable stabilisation level.

A number of normative scenarios covering major possible routes that societies could take in this century, have been developed [1] based on major storylines leading to alternative future emission pathways. These scenarios required assumptions about population and income growth, the cost and availability of current and future energy production and utilisation and many other driving elements. The approach is consistent with the fact that there

Figure 1. Global carbon emissions 1990-2100 using the IS92a and a 550 ppm stabilisation scenario [3].

Canan 2004

Global Carbon Project:
The Tsukuba Office

IHDP Newsletter

Canadell & Canan 2005

Regional Carbon Budgets:
from methodologies
to quantification

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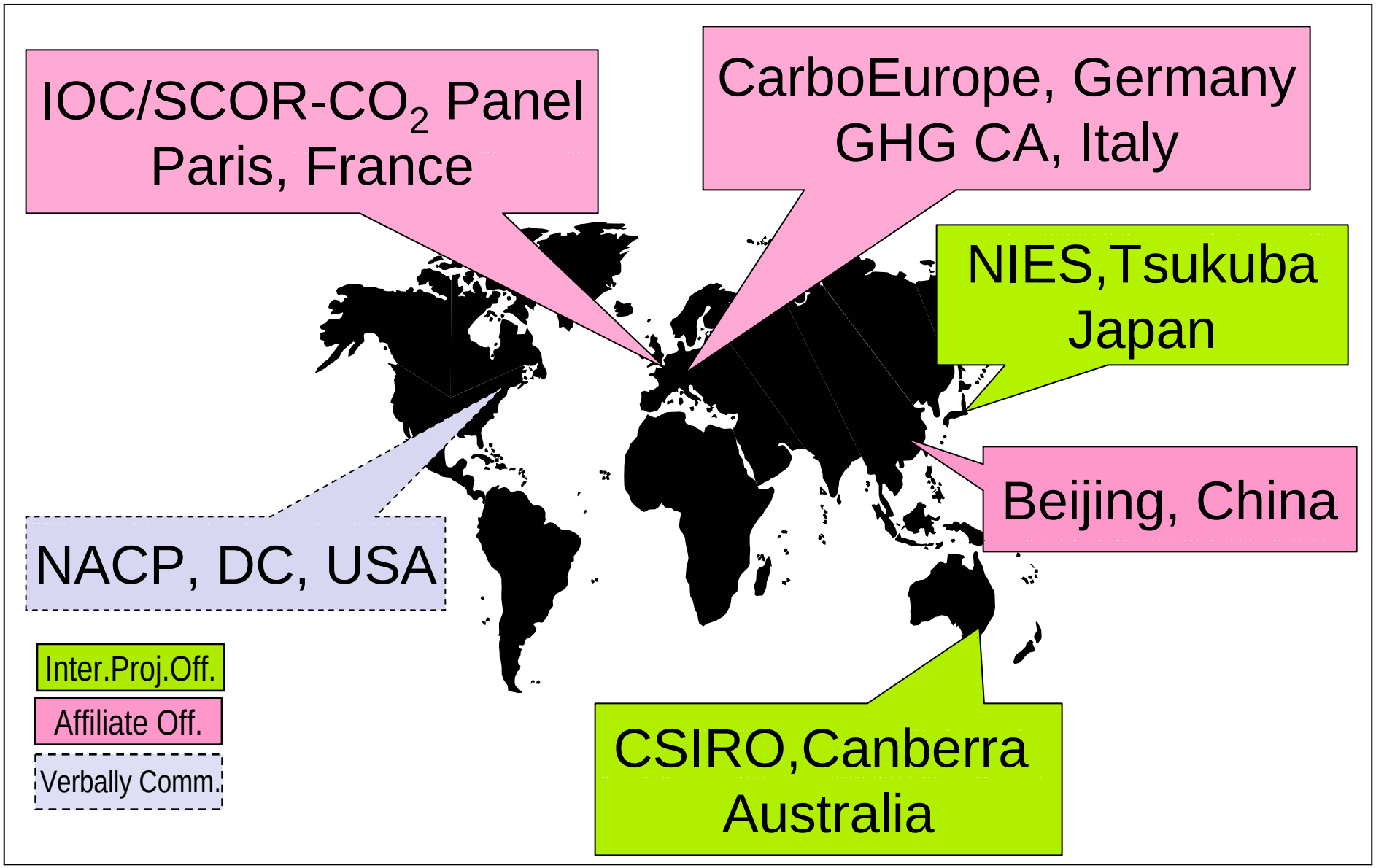

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