RECCAP
REgional Carbon Cycle Assessment and Processes

Version: 6 October 2010

With updates and additions
Galen McKinley
OCB 2011
Scope

- To establish the **mean carbon balance of large regions of the globe** at the scale of continents and large ocean basins, including their component fluxes (1990-2009).

- To do it by **comparing and reconciling** multiple bottom-up estimates with the results of regional top-down atmospheric inversions, with **attribution** to main flux components.

- To evaluate the **regional ‘hot-spots’ of interannual variability and possibly the trends** and underlying processes over the past two (or more) decades by combining available long-term observations and modeling.
Why RECCAP?

• To provide **higher spatial resolution of the global carbon balance** with the aim to improve attribution to processes and hot-spots regions essential to understand the future evolution of carbon-climate feedbacks.

• To address a growing demand for a capacity to **Measure, Report, and Verify (MRV)** the evolution of regional fluxes and the outcomes of climate mitigation policies.

• To develop the **technical capacity** in regions with regional carbon balances of global significance but with little or no technical capabilities.

• To respond to the Group on Earth Observations (EOS) in establishing a **global carbon observatory** to track the evolution of natural and anthropogenic carbon sources and sinks.
RECCAP Final Products (by mid-2012)

• 28 peer-reviewed publications
  – Stage 1 (submit late 2011)
    • Regional syntheses for land and ocean regions (10 land, 4 ocean)
    • Global assessment of key processes (8)
  – Stage 2 (submit mid-2012)
    • Syntheses of Syntheses (6)

• Archive of global and regional models and data products
RECCAP Principle
Multiple Constraints to Understand One Carbon Budget

Top-down
Atmospheric CO$_2$ Inversion Models + ghg observations

Bottom-up
Land, Ocean models + Observations (in situ + remote sensing)

Regional Carbon Balance
Components of Regional Synthesis

Tier 1

Global Products

Regional fluxes
Atmospheric CO₂
Inversion Models
TransCom
(Low resolution)

Regional Carbon Balance

Regional cuts from global land & ocean models
(Low resolution)

+ Regional cuts from global data products

Tier 1 model outputs are coordinated by RECCAP
# Tier 1 Global Products for Regional Syntheses

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<tr>
<th>Product</th>
<th>Specifications</th>
<th>Coordinator</th>
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<tr>
<td><strong>Atmospheric CO₂ inversions</strong></td>
<td>TransCom (11 models), 1° x 1° grid, regional integrated fluxes according to RECCAP mask. To 2008</td>
<td>Kevin Gurney, Rachel Law, Philippe Peylin</td>
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<td><strong>Ocean forward biogeochemical models</strong></td>
<td>Nine global models at 1° x 1° for all major flux components.</td>
<td>Corinne Le Quere</td>
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<td><strong>Ocean inversion</strong></td>
<td>1 model.</td>
<td>Niki Gruber</td>
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<td><strong>pCO₂ flux Climatology</strong></td>
<td>Takahashi et al. 2009</td>
<td>Taro Takahashi</td>
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<td><strong>Terrestrial biogeochemical models and NEP-flux model</strong></td>
<td>Five Dynamic Global Vegetation Models, gridded output for all major flux components. To 2009. GPP and NEP from eddy flux data-driven model</td>
<td>Stephen Sitch, Pierre Friedlingstein, Markus Reichstein</td>
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<tr>
<td><strong>Fire emissions</strong></td>
<td>0.5° x 0.5°, monthly, burned area and fire emissions (C, CO₂, CO, CH₄, NOx, N₂O, BC others) 1997-2009.</td>
<td>Guido van Werf</td>
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</table>
Components of Regional Synthesis

Tier 1
Global Products

- Regional fluxes
  - Atmospheric CO$_2$
  - Inversion Models
    - TransCom (Low resolution)
    - + Global Obs. Network

Tier 2
Regional-Specific Products

- Regional application
  - Atmospheric CO$_2$
  - Inversions Model
    - (High resolution)
    - + Regional ghg obs.

Regional Carbon Balance

- Regional cuts from global land & ocean models
  - (Low resolution)
- Regional cuts from global data products
- Regional specific Models
  - (continental, ocean basin, biome, land use change, others)
- Regional specific observations
  - (fluxes, pCO$_2$, remote sensing, forest inv., others)

Tier 1 model outputs are coordinated by RECCAP.
Land and Ocean Regional Syntheses

Land
L1 Africa
L2 Arctic tundra
L3 Australia
L4 Europe
L5 North America
L6 Russia
L7 South America
L8 East Asia
L9 Southeast Asia
L10 South Asia

Oceans (lead authors)
O2 Pacific (M. Ishii, R. Feely)
O3 Atlantic and Arctic (G. McKinley, U. Schuster)
O4 Southern Ocean (A. Lenton, B. Tilbrook)
O5 Indian (N. Metzl, V. Sharma)
Ocean Regions
Primary is 11 region (Transcom), some use of 24 for detail
N. Atlantic Subpolar Gyre

![Graphs showing data and seasonal cycle in the North Atlantic Subpolar Gyre.](image)
Notes on Ocean Coordination

- Air-sea CO$_2$ flux
  - Interior only in global chapter
- Common components
  - Long-term mean (90-09), decadal means
  - Seasonal cycle
  - Interannual variability
- If possible - trends
<table>
<thead>
<tr>
<th>Section</th>
<th>Observed</th>
<th>Ocean Inv</th>
<th>Atm Inv</th>
<th>Forward Model</th>
<th>Best estimate</th>
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In both PgC/yr and mol/m²/yr

Author’s Judgment
Global Assessments (Lead Authors)

- Global ocean surface CO$_2$ flux (R. Wanninkhof, T. Takahashi)
- Global ocean interior C storage (T. Tanhua, S. Khatiwala)
- Coastal (A. Borges)
- Rivers fluxes (P. Raymond)

- Fossil fuel emissions
- Land use change emissions
- Global atmospheric budget
- Embedded fluxes in international trade

http://www.globalcarbonproject.org/reccap/syntheses.htm
Global Syntheses of Syntheses (SoS)

Ch-S1  Comparison of top & bottom up
Ch-S2  Interannual variability
Ch-S3  Attribution to regional processes
Ch-S4  Trends
Ch-S5  Uncertainty
Ch-S6  Final recommendations
Target Deadlines

• Submission of regional and global syntheses by December 15, 2011 (Biogeosciences)

• Complete 6 SoS chapters by Spring 2012

• Deadlines for IPCC AR5 is submission by July 31, 2012; Acceptance by March 31, 2013
Atlantic / Arctic Status

U. Schuster, G. McKinley

• First Draft to co-authors (Sept 1)
  – Tier 1 plots for regions
  – Text outline

• Revised draft (Oct 15)
  – Additional flux estimates
  – Flesh out all text
  – What is the Best Estimate?

• Final submission (Dec 15)
Scientific Steering Committee

- Philippe Ciais, Chair (France)
- Pep Canadell, Coordinator (Australia)
- Han Dolman (The Netherlands)
- Niki Gruber (Switzerland)
- Kevin Gurney (USA)
- Corinne Le Quere (UK)
- Mac Post (USA)
- Mike Raupach (Australia)
- Chris Sabine (USA)
- Piao Shilong (China)
- Stephen Sitch (UK)
Partners and Sponsors

- COoordination action Carbon Observation System (COCOS), Europe
- Carbon Cycle Science Program - CCIWG, USA
- International Ocean Carbon Coordination Project (IOCCP)
- Chinese Science Academy (CAS), China
- CSIRO Marine and Atmospheric Research, Australia
- National Institute for Environmental Studies (NIES), Japan
- Carbo-Africa
- Quantifying and Understanding the Earth System (QUEST), UK
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