

Ocean carbon uptake Working Group Report

Annalisa Bracco

School of Earth and Atmospheric Sciences
GaTech

Curtis Deutsch

School of Oceanography
Un. Washington

With contributions from all members of the WG

U.S. CLIVAR 2013 Summit
9 July 2013

US CLIVAR – OCB

Ocean carbon uptake WG

- Formed in March 2012
- Co-chairs:
 - Annalisa Bracco, EAS, GaTech
 - Curtis Deutsch, School of Oceanography, University of Washington
 - Taka Ito, EAS, GaTech

Members of the WG :

- ◆ Scott Doney, WHOI
- ◆ John Dunne, NOAA/GFDL
- ◆ Marcus Jochum, NCAR
- ◆ Matt Long, NCAR
- ◆ Nicole Lovenduski, U. Colorado
- ◆ Galen McKinley, U. Wisconsin
- ◆ Ralph Milliff, Colorado Res. Associates
- ◆ Shang-Ping Xie, U. Hawaii/IPRC

International Contributing Members

- Jamie Palter, McGill University
- (Damon Matthews, Concordia University)

Goals:

- Define common physical and biogeochemical metric to guide the model-model and model-data comparison.
- Coordinate the evaluation of CMIP5 experiments in different regions (spatial pattern characterization)
- Organize the 2013 ASP Summer Colloquium and Research workshop to explore key uncertainties in the understanding and model representation of the global carbon cycle

Problems:

Logistical:

- Ensembles including direct representation of carbon cycling are smaller than initially planned and were released late
- Lack of uniformity in quantities made available by different modeling groups (wind stress vs wind speed, NO_3 vs PO_4 , C_{antr} vs C_{respired})
- Changes in deep C storage not documented by most models
- Funding..

Main scientific issues

In the projections (IPCC report, Chapter 6):

- Carbon – climate feedback estimates are (relatively) well constrained globally – better than in C⁴MIP – see Arora et al., 2013, but poorly characterized regionally (Anav et al., 2013)
- Big uncertainties in decadal variability of CO₂ ocean uptake
- Divergent long-term trends

Ocean specific issues I

Key metrics for testing model biases:

- Ocean carbon uptake (Integrated global ocean carbon uptake is underestimated by all models but GFDL-ES2M, where correct answer is likely achieved by wrong mechanism as too weak SAMW/AAIW ventilation- J. Dunne)
- Anthropogenic carbon inventory
- Ocean heat uptake
- Mixed-layer depth (not available for all models!!)
- Mode water formation

Ocean specific issues II

Key physical processes controlling ocean carbon uptake:

- Precipitation i.e. salinity changes (wet-gets-wetter; important for tropics)
- WES feedback for SST changes
- Changes in subduction and mode water formation
- Shoaling of mixed-layer depth (MLD in CMIP5 analyzed for SO – Sallee et al., 2013, but not globally)
- Weakening of trade winds (problems in detecting/assessing trends in historical data-sets)

Near term scientific objectives

- Investigate changes in biological C storage in the deep ocean usually not documented by models. AOU can be used as proxy and 4-5 centers provide it
- Mixed-layer depth analysis (building upon Xie' investigation of SST, winds, evaporation and precipitation changes) – easier to get larger number of models
- MiniMIP-type investigation looking at few divergent models to (try to) attribute trends to physical process representations

Longer term scientific objectives

- Quantifying impact of N Atlantic and Southern Ocean overturning circulation representation on modeled C storage
- Quantifying impact of representation of formation and subduction of subtropical mode waters on modeled C storage
- Investigate existence of predictors of MLD biases in models

July-August activities

2013 NCAR ASP Summer Colloquium and Researcher Workshop

July 29 – August 16, 2013

Carbon-climate connections in the Earth system

Effort lead by:

Matt Long and Quinn Thomas (NCAR)

Naomi Levine (USC)

Curtis Deutsch (UCLA)

Galen McKinley (U. Wisconsin)

Annalisa Bracco (GaTech)

Student Colloquium

- ~ 25 graduate students and ~17 lecturers from both ocean and land carbon communities (50/50)
- Centered around physical/biological/chemical mechanisms regulating carbon cycling and their representation in models
- Lectures and hands-on tutorials
- Student projects to examine CMIP5 outputs (to be presented at AGU fall meeting)

Researcher workshop
Key uncertainties in the global carbon cycle
August 6-10

Sponsored by OCB, US-CLIVAR,
CCIWG via USDA

Designed to bring together terrestrial and ocean carbon cycle scientists (approx. 60 scientists plus students)

Goals:

- explore key uncertainties the global carbon cycle
- build a dialogue crossing disciplinary boundaries to address common challenges.

Series of hour-long invited talks and 40 min contributed with ample time for discussions alternating ocean and land contributions + poster presentations

Invited speakers include: V. Arora, N. Zeng, P. Ciais, T. Ito, W. P. Wang, C. Deutsch, A. Burd, S. Frey, R. Fisher, T. Lenton, J. Chambers, N. Lovenduski, J. Hicke, T. Anderson, K. Ogle, G. McKinley

Sessions on: State of the carbon cycle, Nutrient cycling control, Role of individual, Role of physical climate variability, Data to constrain carbon cycle feedbacks

Planned Outcomes

- White paper synthesizing understanding of carbon cycling and status of carbon cycling modeling
- Meeting Summary for BAMS
- Posters from student projects for fall AGU meeting