

# **Ocean carbon uptake Working Group Report**

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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,  $\text{NO}_3$  vs  $\text{PO}_4$ ,  $C_{\text{antr}}$  vs  $C_{\text{respired}}$ )
- 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 C<sup>4</sup>MIP – see Arora et al., 2013, but poorly characterized regionally (Anav et al., 2013)
- Big uncertainties in decadal variability of CO<sub>2</sub> 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