# Biological influences on mixed-layer dynamics and global ocean circulation, OGCM/OCMIP-Caldeira, 2001 (U.S. JGOFS Synthesis & Modeling Phase project results)

**Website**: https://www.bco-dmo.org/dataset/3186
**Data Type**: model results
**Version**: 11 October 2001
**Version Date**: 2001-10-11

**Project**
» U.S. JGOFS Synthesis and Modeling (SMP)

**Program**
» U.S. Joint Global Ocean Flux Study (U.S. JGOFS)

| Contributors | Affiliation | Role |
|---|---|---|
| Caldeira, Kenneth | Lawrence Livermore National Laboratory | Co-Principal Investigator |
| Chandler, Cynthia L. | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |

## Table of Contents


- Dataset Description
- Parameters
- Deployments
- Project Information
- Program Information
- Funding


## Dataset Description

It is well known that (1) plankton dynamics are affected by solar radiation and mixed-layer dynamics, (2) plankton dynamics affect water transparency and solar extinction, and (3) solar extinction affects mixed-layer dynamics. We propose to test the hypotheses that:

1. Solar extinction in the water column is an important factor affecting absorption of excess CO2 in the global ocean.
2. Feedbacks involving marine biology, turbidity, solar-extinction, and mixed-layer dynamics, significantly affect oceanic carbon fluxes and air-sea gas exchange, both in the steady state and in response to climate change.

We will investigate the effect of these factors on CO2 fluxes in the global ocean by performing a suite of ocean general circulation (and one-dimensional) model simulations (some driven with satellite color data, others using a simple trophic-level model), and evaluating these GCM simulations by comparing model results with observations collected at the JGOFS times series sites and process study areas (and other available observations). Our general circulation and carbon-cycle models already exist and run on massively parallel machines; the proposed study involves a modest amount of new model development. This development will focus on estimating export production using satellite-based methods of estimating primary production (e.g., Behrenfeld and Falkowski, 1997; Longhurst et al., 1995).

The proposed study supports NASA and JGOFS objectives by using remote sensing, and in situ data from JGOFS, to study the impact on carbon dioxide fluxes of feedbacks involving primary production, transparency, and upper ocean dynamics. This study will emphasize satellite ocean color scanner imagery as a principal data source, although satellite derived fields such as wind speeds and irradiances will also be used in this study to drive the ocean model. In situ data collected as part of JGOFS and other programs will be essential to determining appropriate model parameter values and in evaluating model results. Conversely, the model results should help in understanding the dynamics observed at the U.S. JGOFS process study and time-series stations.

By the end of our study, it will be clear if, how, and why subsurface penetration of solar radiation is an

important factor affecting global and regional scale air-sea CO2 fluxes and ocean carbon transport.

[ table of contents | back to top ]

## Parameters

*Parameters for this dataset have not yet been identified*

[ table of contents | back to top ]

## Deployments

**USJGOFS_SMP**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/57953 |
| **Platform** | Institution laboratories |
| **Report** | http://usjgofs.whoi.edu/mzweb/smp/smpimp.htm |
| **Start Date** | 1998-01-01 |
| **End Date** | 2005-10-01 |
| **Description** | Text from the U.S. JGOFS Implementation Plan for Synthesis and Modeling The Role of Oceanic Processes in the Global Carbon Cycle [Full text at: http://usjgofs.whoi.edu/mzweb/smp/smpimp.htm] The central objective of the U.S. JGOFS Synthesis and Modeling Project (SMP) is to synthesize knowledge gained from U.S. JGOFS and related studies into a set of models that reflect our current understanding of the ocean carbon cycle and its associated uncertainties. Emphasis will be given to processes that control partitioning of carbon among oceanic reservoirs and the implications of this partitioning for exchange between the ocean and atmosphere. To this end, the following specific SMP goals were adopted. To synthesize our knowledge of inorganic and organic carbon fluxes and inventories, both natural and anthropogenic. To identify and quantify the principal processes that control the partitioning of carbon among oceanic reservoirs and between the ocean and atmosphere on local and regional scales, with a view towards synthesis and prediction on a global scale. To determine the mechanisms responsible for spatial and temporal variability in biogeochemical processes that control partitioning of carbon among oceanic reservoirs and between the ocean and atmosphere. To assess and implement strategies for scaling data and models to seasonal, annual, and interannual time scales and to regional and global spatial scales. To improve our ability to monitor and predict the role of oceanic processes in determining current and future partitionings of carbon between the ocean and atmosphere, and to evaluate uncertainties and identify gaps in our knowledge of these processes. These goals will be addressed by three major program elements: Global and regional mass balances: synthesis of improved estimates of natural and anthropogenic carbon inventories and of fluxes of carbon and related biologically active chemical substances. Mechanistic controls of local carbon balances: identification and modeling of the principal processes that control within-ocean and ocean-atmosphere partitioning of carbon and related biologically active chemical substances, with a view towards developing regional and global syntheses and models. Extrapolation, monitoring, and prediction: development and application of methods that will allow knowledge gained on small spatial and temporal scales to be scaled to seasonal, annual, and interannual time scales and to regional and global spatial scales; and development and application of methods that will improve our ability to monitor and predict the role of oceanic processes in determining the partitioning of carbon between the ocean and atmosphere and the resulting feedback to the climate system. Implicit in this effort is the quantitative evaluation and estimation of associated uncertainties, as well as the identification of gaps in our knowledge that may significantly compromise monitoring and prediction of carbon partitioning. |

[ table of contents | back to top ]

## Project Information

**U.S. JGOFS Synthesis and Modeling (SMP)**

**Website**: http://usjgofs.whoi.edu/mzweb/syn-mod.htm

**Coverage**: global oceans

There were no cruises associated directly with the US JGOFS SMP. The SMP deployment refers to the project being deployed.

## INTRODUCTION

The Joint Global Ocean Flux Study (JGOFS) was an international scientific program devoted to the study of the ocean biogeochemistry of carbon and related elements and the linkages of the ocean with the global carbon cycle. The U.S. JGOFS program involved a decade long, intensive field effort that included: two on-going time-series stations off Hawaii and Bermuda; a series of process studies in the North Atlantic, Equatorial Pacific, Arabian Sea, and Southern Ocean; and a Global Ocean $CO_2$ Survey in conjunction with the World Ocean Circulation Experiment (WOCE). The resulting ocean biogeochemical data sets, together with satellite ocean color data from the NASA Sea-viewing Wide Field-of-view Sensor (SeaWiFS), formed a unique, long-term resource for the ocean community. With the completion of the field phase in the late 1990s, the U.S. JGOFS initiated a final Synthesis and Modeling Project (SMP), to build on and integrate these data sets in order to address the key scientific themes of JGOFS:

- determine the processes controlling the oceanic carbon cycle and ocean-atmosphere carbon fluxes
- develop improved capabilities for predicting future changes.

Specifically, the central objective of the SMP was to synthesize knowledge gained from U.S. JGOFS and related studies into a set of models to reflect the current understanding of the ocean carbon cycle and its associated uncertainties (U.S. JGOFS, 1997). The SMP was tasked to address not only the processes that control carbon partitioning among oceanic reservoirs, but also the implications for ocean/atmosphere carbon exchange. Both data synthesis and modeling proposals were encouraged with an emphasis on coordinated interaction between the two. The major elements of the program included:

- Individual PI level projects
- Topical Working Groups
- Project management team (two co-coordinators and a project scientist)
- Data management (both distributed and centralized)
- Community activities (PI meetings, mini-workshops, special issues etc.).

The SMP became a full fledged program with the funding of the first SMP awards in early 1998. Funding for SMP grants was provided by the National Science Foundation (NSF), the National Aeronautical and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and Department of Energy (DOE).

## PROGRAM SCOPE

Specific projects within the SMP fell into two broad categories: data synthesis and extrapolation, and modeling. There was considerable (and necessary) overlap between the two, and the overview of the projects provided below is certainly a simplification of the collective efforts of the individual researchers (details on individual SMP grants can be found at http://usjgofs.whoi.edu/mzweb/syn-mod.htm). The scope and balance of the SMP was based on geographic region of study and investigation of biogeochemical processes.

### Synthesis and Modeling Projects

The U.S. JGOFS SMP continued through the 2003-2004 time frame. As the program matured and specific initial projects were completed, the foci for the program was refined to emphasize both emerging new scientific directions and remaining unfinished elements of the original implementation plan. The SMP together with the U.S. JGOFS Steering Committee periodically assessed the program with regard to future priorities. During the active research phase, these are some of the topics identified as filling critical gaps for SMP science:

1. synthesis of primary production, new production and export production (both particulate and dissolved)
2. the mechanisms and rates of mid to deep water particle flux and remineralization as well as sediment

diagenesis
3. controls and distributions of calcium carbonate and silica production, transport and remineralization
4. biogeochemical effects of trace metal cycling
5. spatial and temporal extrapolation of biogeochemical flux estimates (e.g. export production) from local to basin and global scales
6. development, evaluation and incorporation of mechanistically based, biological models for global carbon cycle simulations
7. synthesis and modeling studies of the Arabian Sea, Southern Ocean, North Atlantic, ocean margins (with respect to the role of each in basin to global-scale carbon cycle), and the set of U.S. and international time-series stations data.

At the local to regional scale, a series of data synthesis and food web modeling investigations explored aspects of euphotic zone production, recycling, export, transport and remineralization, and sediment cycling using the JGOFS process and time-series data base and related data sets. Individual projects concentrated, for example, on subsets of the overall JGOFS data (e.g. bacteria, mesozooplankton, HPLC pigments). Related projects focused on the distribution and dynamics of planktonic functional groups (e.g. $N_2$ fixers, diatoms, calcifiers). The eventual aim of many of these food web related studies was to extrapolate the findings to basin and global scale and/or to develop improved process-based parameterizations that could be incorporated into regional and global models.

One or more regional ecosystem modeling studies were undertaken for each of the following U.S. process/time-series study locations: Equatorial Pacific and Atlantic, Arabian Sea, Ross Sea, Bermuda, and North Atlantic. Additionally, there were four projects which concentrated on data synthesis and/or modeling for various continental margins: NW Atlantic margin, southern Caribbean, Cariaco Basin, and several coastal upwelling regions. The regional synthesis and modeling studies as well as some of the food web projects relied heavily on satellite data. Many SMP projects utilized satellite data, in particular SeaWiFS ocean color, as an integral part of both model evaluation and time/space extrapolation.

On the global perspective, over a dozen synthesis groups worked on the JGOFS/WOCE global $CO_2$ survey data with good coverage for all of the carbon related parameters (DIC, alkalinity, $^{13}C$, $^{14}C$, nutrients, oxygen, $pCO_2$, etc.). A coordinated global biogeochemical modeling effort was initiated as part of the international Ocean Carbon Model Intercomparison Project (OCMIP, http://www.ipsl.jussieu.fr/OCMIP/). As the name implies, this was an observation-based evaluation of some thirteen global ocean biogeochemical models of the natural and anthropogenic inorganic carbon system, biogeochemical fields (nutrients, oxygen), and related passive chemical tracers (e.g. CFCs, $^{14}C$, $^{3}He$).

**Links to Related Programs Subsequent to US JGOFS SMP:**

Ocean Carbon & Biogeochemistry (OCB)
North American Carbon Program (NACP) Coastal Synthesis

[ table of contents | back to top ]

---

## Program Information

**U.S. Joint Global Ocean Flux Study (U.S. JGOFS)**

**Website**: http://usjgofs.whoi.edu/

**Coverage**: Global

The United States Joint Global Ocean Flux Study was a national component of international JGOFS and an integral part of global climate change research.

The U.S. launched the Joint Global Ocean Flux Study (JGOFS) in the late 1980s to study the ocean carbon cycle. An ambitious goal was set to understand the controls on the concentrations and fluxes of carbon and

associated nutrients in the ocean. A new field of ocean biogeochemistry emerged with an emphasis on quality measurements of carbon system parameters and interdisciplinary field studies of the biological, chemical and physical process which control the ocean carbon cycle. As we studied ocean biogeochemistry, we learned that our simple views of carbon uptake and transport were severely limited, and a new "wave" of ocean science was born. U.S. JGOFS has been supported primarily by the U.S. National Science Foundation in collaboration with the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the Department of Energy and the Office of Naval Research. U.S. JGOFS, ended in 2005 with the conclusion of the Synthesis and Modeling Project (SMP).

[ table of contents | back to top ]

## Funding


| Funding Source | Award |
|---|---|
| National Aeronautics & Space Administration (NASA) | unknown SMP NASA |


[ table of contents | back to top ]