Monthly Oceanic Upper Layer Nutrient Climatologies, 1999 (U.S. JGOFS Synthesis & Modeling Phase project results)

Website: https://www.bco-dmo.org/dataset/3205
Version: 15 October 1999
Version Date: 1999-10-15

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

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

Contributors	Affiliation	Role
Louanchi, Ferial	Pennsylvania State University (PSU)	Co-Principal Investigator
Najjar, Raymond	Pennsylvania State University (PSU)	Co-Principal Investigator, Contact
Chandler, Cynthia L.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

Oceanic Upper Layer Nutrient Climatologies (nitrate, phosphate, silicate) on 2° grid

Description copied from: SMP site

OpenDAP access: data access via OpenDAP

Introduction The phosphate, nitrate and silicate data used to produce the monthly climatologies were taken from the World Ocean Atlas 1998 (Conkright et al., 1998), produced by the Ocean Climate Laboratory at the National Oceanographic Data Center (NODC). The number of available profiles varies from one parameter to another: 318,800 for phosphate, 200,651 for silicate and 73,471 for nitrate. This means that the accuracy of the monthly maps will be different from one nutrient to another. The procedure of producing monthly climatologies of nutrients is very similar to that used by Najjar and Keeling (1997) to produce a monthly climatology of the oxygen anomaly. The main difference is that nutrient-temperature relationships are used to filter and extrapolate the nutrient data.

Relationship between nutrients and temperature Good relationships between nutrients and temperature were found in the surface ocean by Kamykowski and Zentara (1985, 1986), Takahashi et al. (1993), and many others. We explored nutrient-temperature relationships for the NODC data sets for the upper 500 m of the ocean to see if they could be used for filtering and extrapolation of the nutrient data. We found that nutrient-temperature relationships varied spatially, so we partitioned the ocean into eight regions. For each region, we defined parabolic least-squares fits for temperature below 25°C, and linear fits for temperature between 25° and 30°C. We assumed that for temperature greater than 30°C, nutrient concentrations were zero. The eight regions used were: North Pacific (15N - 60N), North Atlantic including Arctic ocean (north of 15N), Tropical Pacific, Tropical Atlantic, (15N - 15S for both of them), Tropical Indian, (North of 15S), South Pacific, South Atlantic and South Indian (south of 15S). We found that segregation of the data as a function of time and depth did not noticeably improve the regressions. r^2 values varied from 0.50

to 0.85. The best fits were obtained for the high Southern latitudes and the North Pacific.

Filtering the data We took advantage of the extensive quality control procedures performed by Conkright et al. (1998) and used only those data that passed all of their tests. This left us with 287,554 phosphate profiles, 171,141 silicate profiles and 66446 nitrate profiles. We still found, however, that many outliers remained in the data, so we conducted additional filtering using the nutrient-temperature relationships described above. We simply deleted all nutrient data that were more than a defined deviation from the least squares fit for each region. The deviations were a function of temperature; as we didn't want to smooth the seasonal signal of the nutrients, we took larger intervals of tolerance (two to three standard deviationa) for cold waters (where the seasonal signal is strong) and moderate intervals (about one standard deviation) for warm waters.

Vertical interpolation We vertically interpolated the data to the top 14 NODC standard levels (0, 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400 and 500 m) using the monotonic scheme of Steffen (1990), as described in Najjar and Keeling (1997). In some cases interpolation could not be performed because of poor vertical resolution of the measurements. The final number of profiles of nutrients used for the mapping were:

> PO4: 183,451 profiles (discarded 42% of the initial profiles)
> NO3: 48,254 profiles (discarded 34%)
> SiO2: 121,124 profiles (discarded 40%)

Most of the discarded profiles (approx. 2/3 of the profiles used) failed in the vertical interpolation processing. That means that the profiles discarded contain 2 or less data. The other profiles were presumably not representative of open ocean conditions (near-shore, coastal profiles ...).

Binning the data on the equal-area grid The equal-area grid described in Najjar and Keeling (1997) was used for the horizontal spacing of the nutrient maps. The grid is 2 degrees in latitude and variable in longitude (2 degrees at the equator to 120 degrees at the poles). For each depth level an average was computed for each grid point containing an observation. We did this for each month, and then we also used these binned data to create three- and five-month moving averages. For example, for January, we have one binned field representing data in January, a second representing data from December to February, and a third representing data from November to March.

Horizontal interpolating and smoothing To fill in undefined values of the five month moving average maps, the nutrient-temperature relationships described above and the temperature climatology of Levitus and Boyer (1994a) were used. Following Najjar and Keeling (1997), distance weighted averaging with a 1000 km Cressman function was used to smooth the monthly binned fields. Where data density allowed it, the map obtained was filled with the three-month moving averages or preferably one-month averages. The Cressman function was used to smooth the fields once more. A final test on the maps was used to calculate the difference between regression-data blend fields and regression-only fields. A new interval of tolerance was defined as a function of latitude. Where this interval was not respected, the data from the blended fields was replaced by the regression estimate. A final smoothing was done by using the Cressman function.

Transferring the data from the equal area grid to a regular 2X2 degree grid A simple scheme of zonal linear interpolation was taken. The resulting monthly 3D fields between 0 and 75 m are available.

References

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Parameters

Parameters for this dataset have not yet been identified

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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.

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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

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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).

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