

7-17-2006

# Collaborative Research: Biogeochemical Modeling of Carbon Partitioning in the Pacific: the Role of Si and Fe in Regulating Production by Siliceous and Calcifying Phytoplankton

Fei Chai

*Principal Investigator; University of Maine, Orono, fchai@maine.edu*

Follow this and additional works at: [https://digitalcommons.library.umaine.edu/orsp\\_reports](https://digitalcommons.library.umaine.edu/orsp_reports)



Part of the [Oceanography Commons](#)

---

## Recommended Citation

Chai, Fei, "Collaborative Research: Biogeochemical Modeling of Carbon Partitioning in the Pacific: the Role of Si and Fe in Regulating Production by Siliceous and Calcifying Phytoplankton" (2006). *University of Maine Office of Research and Sponsored Programs: Grant Reports*. 207.

[https://digitalcommons.library.umaine.edu/orsp\\_reports/207](https://digitalcommons.library.umaine.edu/orsp_reports/207)

This Open-Access Report is brought to you for free and open access by DigitalCommons@UMaine. It has been accepted for inclusion in University of Maine Office of Research and Sponsored Programs: Grant Reports by an authorized administrator of DigitalCommons@UMaine. For more information, please contact [um.library.technical.services@maine.edu](mailto:um.library.technical.services@maine.edu).

**Final Report for Period:** 04/2002 - 03/2006**Submitted on:** 07/17/2006**Principal Investigator:** Chai, Fei .**Award ID:** 0137272**Organization:** University of Maine**Title:**

Collaborative Research: Biogeochemical Modeling of Carbon Partitioning in the Pacific: the Role of Si and Fe in Regulating Production by Siliceous and Calcifying Phytoplankton

**Project Participants****Senior Personnel****Name:** Chai, Fei**Worked for more than 160 Hours:** Yes**Contribution to Project:****Post-doc****Graduate Student****Undergraduate Student****Technician, Programmer****Other Participant****Research Experience for Undergraduates****Organizational Partners**

Duke University Marine Laboratory

San Francisco State University

University of Miami Rosenstiel School of Marine&amp;Atmospheric Sci

**Other Collaborators or Contacts****Activities and Findings****Research and Education Activities:**

This project incorporated the silicate pump hypothesis and Fe limitation into an ecosystem model to simulate air-sea CO<sub>2</sub> fluxes in the Pacific Ocean. A 1-D version of this model was constructed for the equatorial Pacific that was based upon the US JGOFS EqPac field program. The tested 1-D model then was embedded into a 3-D ocean circulation model for the Pacific Ocean. The 1-D model can be run and manipulated through a website with different parameters (<http://rocky.umeoce.maine.edu/1deco-new/run-model/>), and the 3-D model results can be accessed with the Live Access Server (LAS) (<http://>

rocky.umeoce.maine.edu/las-public/). Both 1-D and 3-D ecosystem models were used to test ideas about silicate and iron regulation on phytoplankton productivity for various regions in the Pacific Ocean, as well as the ecosystem response to interannual and decadal climate variability in the Pacific. This project provided partial salary support and/or research opportunities for 3 graduate students, 3 post-docs and several undergraduates. To date, there are more than 10 publications and 20 presentations have been made.

### **Findings:**

The major findings from above listed activities are: 1) silicate regulates diatoms productivity in the equatorial Pacific; 2) iron also modifies diatom growth rate in the equatorial Pacific; 3) tropical instability waves, El Nino and Pacific decadal oscillation alter silicate and iron supply to the upper ocean, therefore, the diatom productivity and Si export are highly related to physical processes in the equatorial Pacific; 4) Carbon cycle is tightly linked with diatom productivity and physical processes in the equatorial Pacific; air-sea CO<sub>2</sub> flux is mainly controlled by physical processes ranging from tropical instability waves, seasonal cycle, to El Nino and PDO time scale.

### **Training and Development:**

There were two postdocs involved in this research project. They have learned ecosystem model development, biogeochemical and physical dynamics in the equatorial Pacific. There are no teaching activities related to this project.

### **Outreach Activities:**

We have put 1D ecosystem model online, which allows public to access the website and run the ecosystem model and obtain results. We hosted a workshop to present some modeling materials to a group of middle and high school teachers. During the workshop, I showed the teachers how to access to the online 1D ecosystem model and conduct experiments. I also developed an ecosystem model with Excel, which most middle and high school students can do with some help from their teachers.

## **Journal Publications**

McKinley, G.A., T. Takahashi, E. Buitenhuis, F. Chai, J. R. Christian, S. C. Doney, M.-S. Jiang, C. Le Quere, I. Lima, K. Lindsay, J.K. Moore, R. Murtugudde, L. Shi, P. Wetzel, "North Pacific carbon cycle response to climate variability on seasonal to decadal timescales", *Journal of Geophysical Research*, p. C07S06, vol. 111, (2006). Published

Fujii, M., Y. Yamanaka, Y. Nojiri, M.J. Kishi, and F. Chai, "Comparison of seasonal characteristics in biogeochemistry among the subarctic North Pacific stations described with a NEMURO-based marine ecosystem model", *Ecological Modeling*, p. , vol. , (2006). Accepted

Jiang, M-S and F. Chai, "Physical and biological controls on the latitudinal asymmetry of surface nutrients and pCO<sub>2</sub> in the central and eastern equatorial Pacific.", *Journal of Geophysical Research*, p. C06007, vol. 110, (2005). Published

Fujii, M. and F. Chai, "Effects of biogenic silica dissolution on silicon cycling and export production", *Geophys. Res. Lett.*, p. L05617, vol. 32, (2005). Published

Fujii, M., N. Yoshie, Y. Yamanaka, and F. Chai, "Simulated biogeochemical responses to iron enrichments in three high nutrient, low chlorophyll (HNLC) regions", *Progress in Oceanography*, p. 307, vol. 64, (2005). Published

Jiang, M-S and F. Chai, "Iron and silicate regulation on new and export production in the equatorial Pacific: A physical-biological model study.", *Geophys. Res. Lett.*, p. L07307, vol. 31, (2004). Published

Dugdale, R.C., M. Lyle, F.P. Wilkerson, F. Chai, R.T. Barber, T-H Peng, and A.G. Wischmeyer, "The Influence of Equatorial Diatom

Processes on Si Deposition and Atmospheric CO<sub>2</sub> Cycles at Glacial/Interglacial Time Scales", *Paleoceanography*, p. PA3011, vol. 19, (2004). Published

Chai, F., M. Jiang, R.T. Barber, R.C. Dugdale, and Y. Chao, "Interdecadal Variation of the Transition Zone Chlorophyll Front, A Physical-Biological Model Simulation between 1960 and 1990.", *Journal of Oceanography*, p. 461, vol. 59, (2003). Published

Jiang, M-S, F. Chai, R.T. Barber, R.C. Dugdale, F. Wilkerson, and T-H Peng, "A nitrate and silicate budget in the Equatorial Pacific Ocean: A coupled biological-physical model study", *Deep Sea Res. II.*, p. 2971, vol. 50, (2003). Published

Chai, F., R. C. Dugdale, T-H Peng, F. P. Wilkerson, and R. T. Barber, "One Dimensional Ecosystem Model of the Equatorial Pacific Upwelling System, Part I: Model Development and Silicon and Nitrogen Cycle", *Deep-Sea Res. II.*, p. 2713, vol. 49, (2002). Published

Dugdale, R.C., R. T. Barber, F. Chai, T.H. Peng, and F.P. Wilkerson, "One Dimensional Ecosystem Model of the Equatorial Pacific Upwelling System, Part II: Sensitivity Analysis and Comparison with JGOFS EqPac Data", *Deep-Sea Res. II.*, p. 2746, vol. 49, (2002). Published

### **Books or Other One-time Publications**

#### **Web/Internet Site**

#### **Other Specific Products**

#### **Contributions**

##### **Contributions within Discipline:**

The research activities and publications resulted from this project have advanced our understanding on physical and biological regulations on air-sea CO<sub>2</sub> flux in the equatorial Pacific. The modeling results and observational data showed clear silicate and iron co-limitation on diatom growth, therefore direct impacts on carbon cycle in the region.

##### **Contributions to Other Disciplines:**

The modeling project also advanced our numerical modeling techniques by conducting many ecosystem model simulations on several supercomputers.

##### **Contributions to Human Resource Development:**

The project trained two postdocs by developing and conducting model simulations. The project also involved in two graduate students indirectly, which they have used the models for other modeling projects.

##### **Contributions to Resources for Research and Education:**

##### **Contributions Beyond Science and Engineering:**

#### **Categories for which nothing is reported:**

Any Book

Any Web/Internet Site

Any Product

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering