North Pacific Research Board Semiannual Progress Reports

Project # 607

Title: Modeling study on the response of lower trophic level production to climate

Principal Investigator(s): (Include name, affiliation and email address)

Meibing Jin, IARC/University of Alaska Fairbanks, Email: mjin@iarc.uaf.edu
Clara, J. Deal, IARC/ University of Alaska Fairbanks, Email: deal@iarc.uaf.edu
Jia Wang, IARC/ University of Alaska Fairbanks, Email: jwang@iarc.uaf.edu

Contract Period and Amount of Funding:
June 1, 2006 to May 30 2008, $149,547
Report Period: July 16, 2006 to January 15, 2007
Report Date: January 12, 2007
Lead Author of Report: Meibing Jin

Project Summary:
The most prominent climate trends resulting from global climate warming in the southeastern Bering Sea, reduced sea ice cover and rising seawater temperature, have profound impacts on lower trophic level production and fishery production. Some explanatory hypotheses relating sea ice variability to marine ecosystems have been proposed, such as the Oscillating Control Hypothesis (OCH, Hunt et al. 2002), but have not been studied through a coupled ice-ocean ecosystem model yet. This study aims to establish a coupled ice-ocean ecosystem model including both pelagic and sea ice habitats, based on the existing pelagic ecosystem model (Jin et al. 2006b) for the Bering Sea and the ice-ocean ecosystem model (Jin et al. 2006a) for offshore Barrow. We will conduct sensitivity studies of the impact of physical and biological process variations on primary production, nutrient cycling, phytoplankton species composition, and carbon export to benthos. We will provide recommendations on how, when and which observations should be made to ensure effective improvement in understanding of the Bering Sea ecosystem. Historical observations from the NOAA mooring site M2 are being used to construct a multi-year (1958-2005) model run. The long time series of biogeochemical model results will be used to elucidate the lower trophic level productivity response to climate changes.

Progress Summary:

During the second half year of 2006, we established the coupled ice-ocean ecosystem model for the Bering Sea. The model includes both pelagic and sea ice habitats, based on the existing pelagic ecosystem model (Jin et al. 2006a) for the Bering Sea and the ice-ocean ecosystem model (Jin et al. 2006b) for offshore Barrow.

A multi-year (1995-2000) model run has been performed to test the Oscillating Control Hypothesis (OCH, Hunt et al., 2002). forced by SSMI sea ice concentration, NCEP

meteorological data and sea surface temperature and salinity from NOAA/PMEL moor 2. Our model successfully reproduced the observed ice-associated blooms in 1997 and 1999 at the NOAA/PMEL mooring M2. The model results suggest that the ice-associated blooms were seeded by sea ice algae released from melting sea ice. For an ice-associated bloom to grow and reach the typical magnitude of phytoplankton bloom in the region, ice melting-resulted low-salinity stratification must not be followed by strong wind that could breakup the stratification. The ice-associated blooms had little impacts on the annual primary production, but had significant impacts in terms of shifting phytoplankton species, and the timing and magnitude of the bloom. These changes, superimposed on a gradual ecosystem shift attributed by global warming, can dramatically alter the Bering Sea ecosystem. Based on the above, the following manuscript was written and accepted with minor revision:

Jin, M., C. Deal, J. Wang, V. Alexander, R. Gradinger, S. Saitoh, T. Iida, Z. Wan, and P. Stabeno 2007. **Ice-associated phytoplankton blooms in the southeastern Bering Sea**. *Geophysical Research Letter*, accepted.

We attended the SOLAS-sponsored CODiM workshop (Comparison of Oceanic Dimethylsulfide Models) which allow us to participate in this important international activity to our ecosystem model inter-comparison in three important regions of the world ocean that has long time series of observations. The comparison allows us to learn different ecosystem model skills which are very helpful to the project. PI thanks for NPRB's travel support to the meeting. An abstract on CODIM for the IMBER/SOLAS special session was submitted at the next EGU meeting in Vienna this April and a joint manuscript by the meeting participant will be written. Title is: A first appraisal of ocean DMS models and prospects for their use in climate models.

For the purpose of outreach and education, a DOE/EPSCoR (U.S. Department of Energy's Experimental Program to Stimulate Competitive Research) high school student worked with PI on data and image processing and web display of research results during summer 2006. This activity has been reported in our last semi-annual report and it lasts into this period. The full description can be accessed as below:
http://denali.frontier.iarc.uaf.edu:8080/~mbj/student2006/

A recent Research Highlight on the IARC Homepage, "Dimethylsulfide (DMS): A Natural Link Between Marine Biology and Climate" http://www.iarc.uaf.edu/ presents our work developing and utilizing ecosystem models to provide quantitative assessments of the predicted impacts of climate warming in the Arctic. This summary was written for the public by Co-PI Clara Deal and posted on September 14, 2006. It exemplifies how we build upon our ecosystem model in the Bering Sea to also model biogeochemical cycling of major nutrient elements.

Updates of our project web site:
http://www.frontier.iarc.uaf.edu/nprb2006/