BEST-BSIERP
Bering Sea PROJECT
UNDERSTANDING ECOSYSTEM PROCESSES IN THE BERING SEA 2007–2013

Steps Toward Predicting the Future of the Bering Sea Fish Catch

HOW COMPUTER MODELS HELP FISHERMEN FIND THE "COLD POOL" ... AND DINNER

With the Bering Sea bringing in over 50% of the US fish catch, there are some obvious advantages to fishermen, fish resource managers, and markets if we can predict, even just by some months, which fish stocks will do well. One clue to this is to understand the creation and fate of the eastern Bering Sea "cold pool," a region on the Bering Sea shelf about the size of California below 2°C (~36°F). This "cold pool" (which changes through the year and from year to year) is important for crab and bottom-fish distributions. For example, it acts as a barrier to northward migration of some types of fish, e.g., walleye pollock, one of the largest and most valuable fisheries in the world. Can we predict how this cold pool will change and where it will be found? We found that, using a good computer simulation, to some extent, we can.

How We Did It

We used a state-of-the-art computer model focused on simulating the ocean and sea ice of the Bering Sea. To enable it to be near real-time, this BESTMAS (Bering Ecosystem STudy ice–ocean Modeling and Assimilation System) model is driven by atmospheric forcings from the weather forecasting models of the National Centers for Environmental Prediction (NCEP) and the National Center for Atmospheric Research (NCAR).

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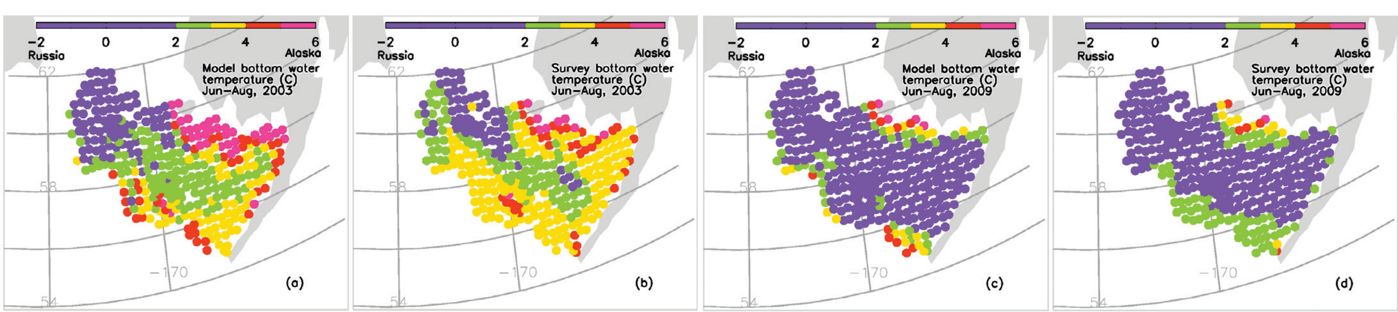
The Big Picture

Although the Bering Sea is small compared to the world ocean, it is still too big to measure all of it at one time, other than by satellites (which can only measure the surface). Thus, to study the whole system, we created a virtual reality, a computer model of the system from the seafloor to the sea ice surface. This virtual reality is based on our understanding of the physics, chemistry and biology of the real world and (crucially) is tested against measurements we can make. Researchers, managers and fishermen can then use this model as a tool for understanding, as a framework for their measurements, and (given enough model skill) as a predictor of the system and where, for example, to find the cold pool ... and hence dinner.

Fig. 1



Eastern Bering Sea shelf bottom water temperatures (°C) from ship-based surveys (right column) and corresponding BESTMAS model results (left column) for 2003 (a warm year, upper panels) and 2009 (a cold year, lower panels). The cold pool is marked by purple color. This figure shows that BESTMAS is able to capture reasonably well the spatial patterns of observed spring-summer bottom layer temperature fields and the distribution and extent of the cold pool (purple region) for both cold and warm years.

THE IMPACT OF CHANGES IN SEA ICE ON THE PHYSICAL FORCINGS OF THE EASTERN BERING ECOSYSTEM - RETROSPECTIVE INVESTIGATION AND FUTURE PROJECTION
A component of the BEST-BSIERP Bering Sea Project, funded by the National Science Foundation and the North Pacific Research Board with in-kind support from participants.

This model runs on a computer cluster (connected computers that work together) at the University of Washington, where simulating one year of the Bering Sea ice-ocean system takes about four hours of computer time. We found the model's sea ice—one of the drivers of the cold pool formation—matched well with data from satellites. Moreover, we found that the extent and location of the cold pool in the model agreed well with ship data from the region, in the years where ship data was available (Figure 1).

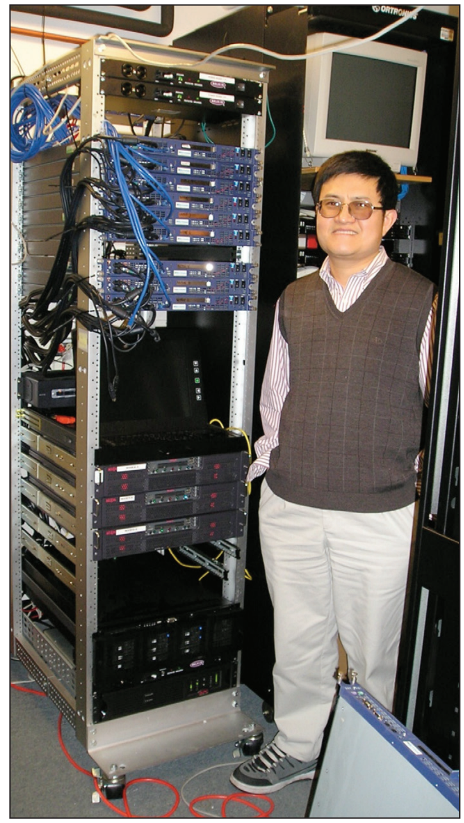
So then we can use the model to study what the cold pool looked like in years when there wasn't ship data, and, most importantly, to consider why and how the cold pool forms, and how the cold pool changes over the season. From this, we found out, for example, that the simulated field of bottom layer temperature on the Bering Sea shelf at the end of May is a good predictor of the distribution and extent of cold bottom waters throughout late spring and summer (Figure 2). Thus, we can use the model results from the end of May to predict what the spring and summer will be like some months in the future.

Why We Did It

Quantifying the cold pool is a key part of predicting the balance of fisheries in the Bering Sea. The location and duration of the cold pool changes a lot during the year and from year to year, dependent on atmosphere, ocean and sea ice conditions during the previous winter. All these preconditions interact, but a coupled ice-ocean model such as BESTMAS allows us to combine all these effects in a physically consistent manner, and make predictions of the cold pool location and extent months in advance.

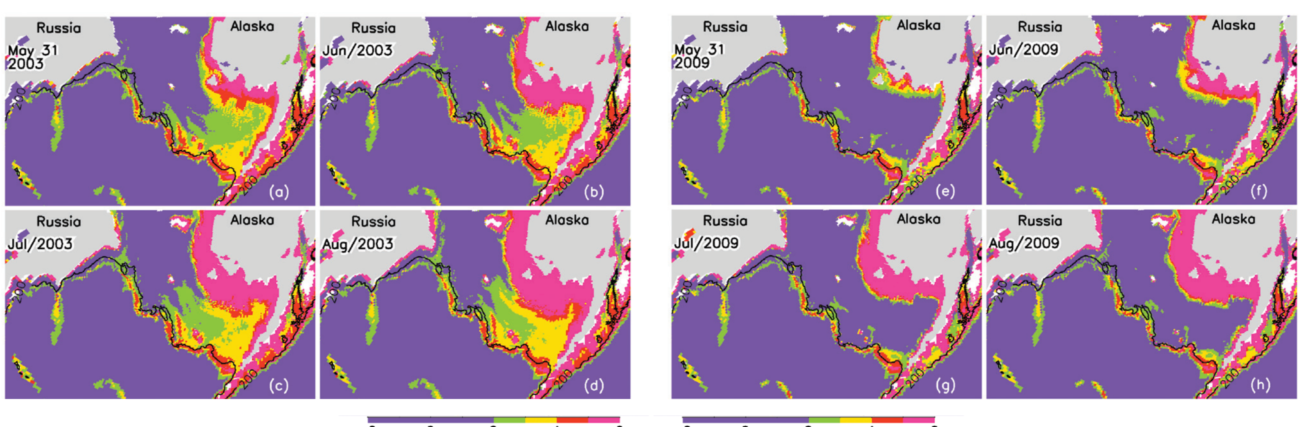
Jinlun Zhang, University of Washington
Rebecca Woodgate, University of Washington

The Bering Sea Project is a partnership between the North Pacific Research Board's Bering Sea Integrated Ecosystem Research Program and the National Science Foundation's Bering Ecosystem Study. **www.nprb.org/beringseaproject**



Armchair Oceanography. The University of Washington computer cluster MIZ (Marginal Ice Zone) used to run the BESTMAS model, alongside the creator of the BESTMAS model, Jinlun Zhang.

Fig. 2



Simulated May 31 daily mean and June, July, and August monthly mean fields of bottom water temperature (˚C) for 2003 (a warm year) and 2009 (a cold year). Black line represents the 200 m depth contour. Purple shows areas of bottom temperatures below 2˚C, representing, on the Bering Sea shelf (i.e., between the 200 m contour and Alaska), the cold pool extent. This figure shows that the simulated field of bottom layer temperature on the Bering Sea shelf on May 31 is a good predictor of the distribution and extent of the cold pool throughout late spring and summer, for both cold and warm years.