UC SANTA BARBARA

THE Current

March 30, 2016
Julie Cohen

The Ocean Below

Vast and amorphous, the ocean covers more than 70 percent of the Earth's surface. It is a key player in the global carbon cycle, producing about half of the world's output of organic carbon.

Unlike terrestrial ecosystems, which can store carbon for decades, most of the organic carbon produced in the ocean is converted into CO_2 within a few days. New work by UC Santa Barbara researchers aims to facilitate a new understanding of ocean carbon transport processes, which affect climates around the world.

In a plan written for NASA, the scientists and colleagues have developed a blueprint for quantifying present conditions in the ocean's carbon cycle and developing tools to predict its future states. The EXport Processes in the Ocean from RemoTe Sensing (EXPORTS) Science Plan is described in the journal Frontiers in Marine Science and appears in its entirety online at NASA.

"Predicting how the ocean's carbon cycle changes in the future remains one of the greatest challenges in oceanography," said lead author David Siegel, director of UCSB's Earth Research Institute. "EXPORTS combines modeling, satellite data and ship and robotic field sampling to assemble a comprehensive understanding of how carbon is processed by the world's oceans. The resulting data sets will be used to determine the implications for present and future climates."

To achieve this goal, the investigators intend to quantify mechanisms of the ocean's biological pump, a major component of the carbon cycle. Its processes control the

export of carbon from the euphotic zone — the well-lit, upper ocean — to the aphotic or twilight zone, where a variable fraction of that exported organic carbon is respired back as CO_2. This process of organic carbon transport and sequestration defines the impact of the ocean ecosystem on atmospheric CO_2 levels and hence climate.

Carbon is present in the atmosphere and is stored in soils, oceans and the Earth's crust. Any movement of carbon between — or, in the case of the ocean, within — these reservoirs is called a flux. According to the researchers, quantifying this carbon flux is critical for predicting the atmosphere's response to changing climates.

EXPORTS hypothesizes that the particulars of the ocean's carbon cycle can be predicted by determining characteristics of the surface ecosystem. Proxies such as water temperature, salinity, oxygen levels and phytoplankton types, sizes and productivity can be measured and combined to create snapshots of complete states of the ocean's biological pump.

"Understanding the biological pump is critical," said Siegel, a professor in UCSB's Department of Geography. "We need to understand where carbon goes, how much of it goes into the organic matter, how that affects the air-sea exchanges of carbon dioxide and what happens to combusted fossil fuels."

Siegel's previous research estimated sinking flux, the amount of carbon that reaches ocean depths via the food web. However, scientists still seek to better understand active migration flux — formed by the daily movement of zooplankton between ocean depths and the surface — and the physical transport and utilization of dissolved organic carbon within the ocean interior. Co-author Craig Carlson, chair of the Department of Ecology, Evolution, and Marine Biology, studies the latter.

In order to improve estimates of carbon export from the euphotic zone, EXPORTS provides details for extensive fieldwork in the North Atlantic and North Pacific. The plan calls for two ships and four 30-day cruises to observe and sample myriad factors that contribute to the processes of the ocean's biological pump.

Siegel noted that once scientists are able to more accurately estimate carbon flux within the ocean, they will seek to determine how those estimates could change in the future. Creating a predictive tool that can do that is the ultimate goal of EXPORTS.

"Conducting a field program like EXPORTS will accelerate our knowledge of the role of the oceanic food web in the global carbon cycle and provide new models for

understanding contemporary and future states of the ocean’s carbon cycle and its influences on climate,” Siegel concluded. “This coordinated, process-oriented approach has the potential to foster new insights on ocean carbon cycling and will be a key step toward our understanding of the Earth as an integrated system.”

Tags
Ocean and Beaches

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.