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UC Santa Barbara leads $9 million research project on ocean cycles

The ocean is a vast and complex web of intertwined systems. Chemistry, currents, temperature and nutrients all ebb and flow, each feeding back into the others.

A multinational research team, led by UC Santa Barbara's Tim DeVries and Ralph Keeling from Scripps Institution of Oceanography at UC San Diego, aims to investigate the ocean's carbon, oxygen and heat cycles. The project, which spans 11 institutions, has received $9.5 million from the nonprofit Schmidt Sciences to fund research over the next five years. It is one of five selected by Schmidt Science and the Schmidt Ocean Institute to join the philanthropy's Ocean Biogeochemistry Virtual Institute (OBVI).

"Many processes affect all three of these cycles: carbon, heat and oxygen," said DeVries, a professor in the Geography Department. "Studying them together will help us to understand all these processes better."

This project has an ambitious scope, and the team hopes to answer a number of questions over the next few years. They aim to quantify how much carbon dioxide enters and exits the ocean, whether this rate is changing over time, and if so why. They also want to characterize trends in dissolved oxygen and the processes that govern them. They have similar questions for heat transfer and ocean temperature. Finally, the $9.5 million question is how climate change affects all these processes.

“We started out with about four of five of us, and the group gradually grew as our project got more ambitious,” DeVries said. “We tried to target the best senior researchers in the world for each facet of our project, which made our team quite international.”

The scope naturally clusters into four main areas, each with its own group and team leader. DeVries will lead the large-scale modeling, while Laure Resplandy (at Princeton University) spearheads multi-scale modeling and machine learning. The group working with ocean observational data will rally around Seth Bushinsky at the University of Hawaii at Manoa. Finally, Keeling will lead the group analyzing atmospheric observations.

Rounding out the team are Pedram Hassanzadeh at University of Chicago, Heather Graven at Imperial College London, Casper Labuschagne at the South African Weather Service, Peter Landschuetzer at Flanders Marine Institute, Francois Primeau at University of California Irvine, Christian Roedenbeck at the Max Planck Institute for Biogeochemistry, and Laure Zanna at New York University.

The project is about two-thirds modeling and one-third observation. The modeling teams will try to integrate insights from simulations at different scales using new machine learning techniques. Meanwhile, the observational teams will measure atmospheric carbon and oxygen in the Southern Hemisphere and scour existing datasets of ocean carbon, oxygen and heat to develop compilations to train the models.

“I’m thrilled to be part of this exciting project,” Keeling said. “As an atmospheric scientist, I'm especially excited to be working with oceanographers to build tools that allow atmospheric measurements to be integrated with ocean measurements for studying changes in the oceans.”

Although climate change is often framed in terms of the atmosphere, the ocean takes up more than 95% of the excess heat due to greenhouse gas emissions. It also absorbs about 30% of the carbon dioxide emitted by human activity. “Without the ocean, global warming would have caused the atmosphere to heat up by much more than it already has,” DeVries explained.

Changing seawater temperature and chemistry cut broadly across many aspects of the marine environment. Ocean acidification hinders animals' ability to form carbonate shells and skeletons. Lower oxygen levels can impact marine life across the board. Heat can kill certain organisms outright, and cause others to change their behaviors and shift their ranges.

These cycles also influence each other in complex ways. For instance, a warmer ocean cannot hold as much oxygen or CO_2. And if ocean circulation slows down, it will probably reduce how much heat the ocean takes up. Both of these could diminish how much oxygen makes it to the ocean's depths.

Sussing out the interplay between the ocean's carbon, oxygen and heat cycles is crucial for predicting how our world will change in the coming years. "This project will produce an unprecedented level of understanding of the physical and biogeochemical processes affecting these interlinked cycles" DeVries said.

Tags
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Ocean and Beaches

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draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.