

UC SANTA BARBARA

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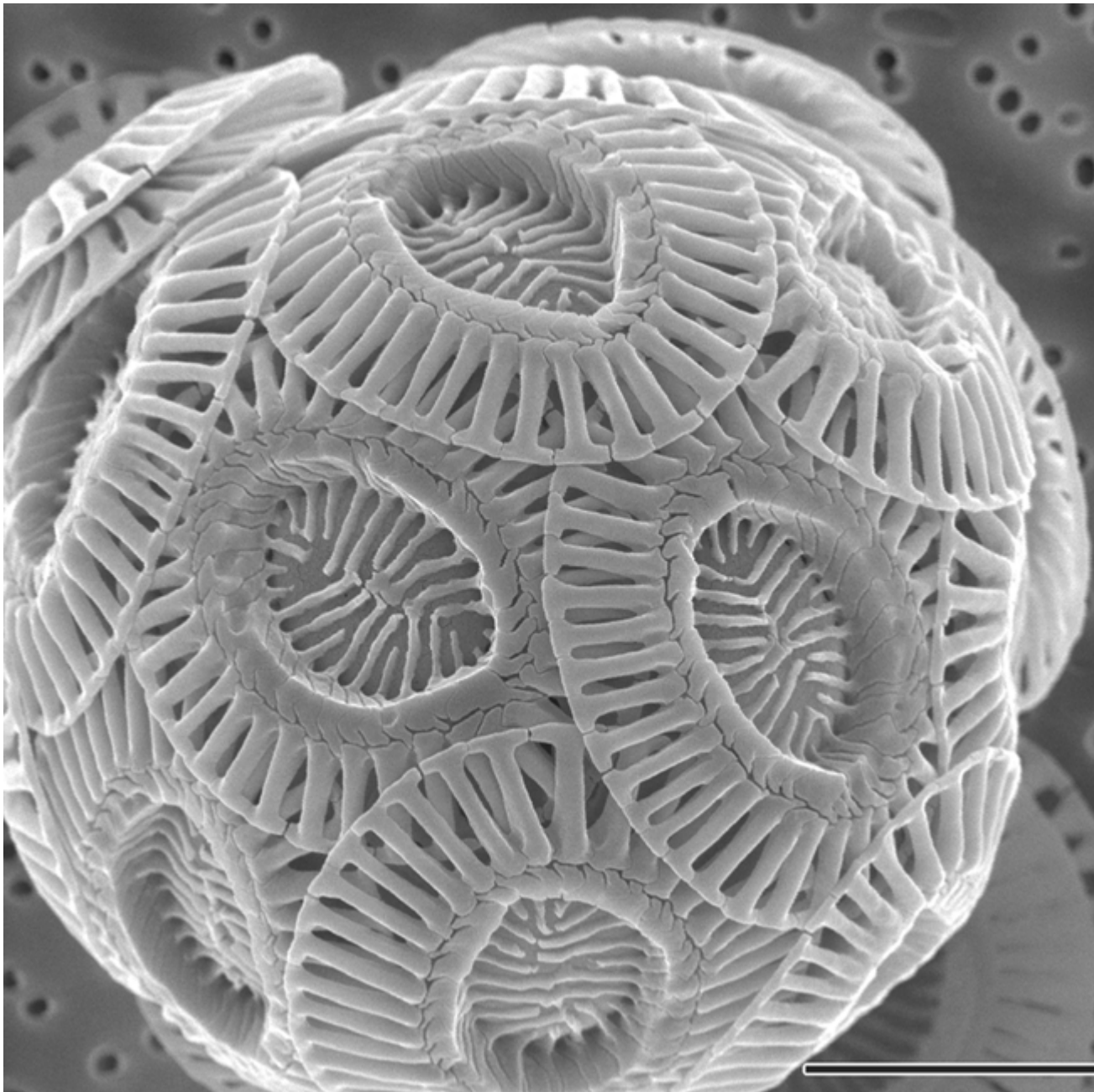
Turquoise Water Off California

It was June of 2015, and the turquoise water lapping at the shores of Santa Barbara was more reminiscent of a shallow tropical bay than of a Southern California beach. The condition puzzled scientists. What caused this unusual blue-green hue?

Four years later a group of researchers at UC Santa Barbara has sorted out the mystery. The display stemmed from an algae bloom. Their findings appear in the [Journal of Geophysical Research: Oceans](#).

“When the water off the coast of California starts to look like you’re in the Caribbean, that’s really weird,” said lead author [Paul Matson](#), a former postdoctoral scholar with [Debora Iglesias-Rodriguez](#), a professor in the ecology, evolution, and marine biology department. The similarity, however, was only superficial. Blooms like this tend to happen at higher latitudes, he noted, while the Caribbean owes its aquamarine hue to other factors.

The color off the California coast that summer came from coccolithophores, a group of single-celled algae similar to diatoms. But where diatoms coat themselves in silica, coccolithophores are covered in tiny plates of calcium carbonate. They shed these plates, which scatter light as they drift in the water, imparting the ocean with a milky, turquoise hue.



E. huxleyi as seen through a scanning electron microscope.

Photo Credit: PLOS BIOLOGY (CC BY 2.5)

The specific coccolithophore species the scientists found — *Emiliana huxleyi* (affectionately called *E. hux*) — occurs everywhere, but blooms like this are rare in mid-latitude regions like the Santa Barbara Channel. So the team began to piece together what triggered the bloom.

This was an odd time for the West Coast. A large region of abnormally warm water, nicknamed “the Blob,” set into the northeast Pacific in autumn of 2013. The anomaly

persisted well into 2016 and patches periodically traveled down the California current. The ocean then transitioned from these warm water conditions into the 2015 El Niño event, which extended the unusual temperatures.

“We had this extended period of time when we had extremely warm waters. We had low nutrient availability, and just strange things were happening,” Matson said.

E. hux tend to live just offshore, and although they’re efficient when nutrients are scarce, the small algae are often outcompeted when conditions are more favorable. Before the *E. hux* bloom, the California coast saw a major bloom of the often-toxic diatom, *Pseudo-nitzschia*. When the diatoms had used up the dissolved silica, conditions became ripe for coccolithophores, which aren’t constrained by the limited silica. Fueled by the nutrients released by the decaying diatoms, the *E. hux* population exploded.

Matson first wanted to document the bloom, so he collected samples to test water chemistry, see the density of plankton, identify species, and track biomass. What’s more, the team could calculate the age of the bloom by the ratio of loose plates floating in the water to the number of actual cells. The group could also estimate how much calcium carbonate was still present in the water thanks to the efforts of graduate students Tanika Ladd and Zoë Welch.

These blooms can cover large swathes of ocean; astronauts on the International Space Station report seeing them from space. Wanting to track the extent of this particular bloom from above as it developed, Matson collaborated with UC Santa Barbara geography professor [David Siegel](#), an oceanographer who works on ocean color remote sensing via satellite images.



The *E. hux* bloom stretches from the mainland to the Channel Islands in this satellite image, one of many the researchers used in the study.

Photo Credit: PAUL MATSON

Remote-sensing images provided snapshots of the bloom, generally once per day. The gaps were filled in by geography professor [Libe Washburn](#)'s research group at the university's Marine Science Institute, which uses radar arrays to study surface currents.

The network is run by the Southern California Coastal Ocean Observing System (SCCOOS) and covers the Santa Barbara Channel. The team combined the satellite images with hourly maps of surface currents to create a simulation that connected points in one day's satellite image to those in following day's image.

This is one of the first studies to combine surface current observations and satellite images to quantify changes in an ongoing phytoplankton bloom. Field sampling confirmed the presence of *E. hux* and the loose plates floating in the water. This, in turn, validated the researchers' understanding of how the bloom developed based on the surface current and remote sensing results.

It's difficult to study the early phase of bloom formation because scientists typically detect a bloom only after it's well developed. But using surface current tracking, the team could identify areas where they suspected coccolithophores were present, but not yet at densities high enough to be seen by satellite. Matson suspected that these might be pre-bloom populations.

"That's going to be where the new bloom comes from," he said, "so we can look back and try to figure out what was going on in those areas that could have contributed to the bloom occurring."

He also pointed out that this technique will work for other types of blooms as well. "Our hope is that this approach can be used for studying other types of phytoplankton, like *Pseudo-nitzschia*, an important species of harmful algal blooms," he said. This would be a welcome tool, as tracking these blooms would help predict where there may be risks for human and animal health.

Matson also highlighted the team's good fortune regarding where the bloom occurred: at the confluence of three long-term monitoring projects. Namely, across sites within the [Santa Barbara Coastal Long Term Ecological Research project](#), within the region covered by SCCOOS's radar network, and in the study area of Siegel's Plumes and Blooms project. "It happened to occur in a place that we were actively monitoring, where we had a lot of baseline data to actually be able to pick apart a very novel event like this coccolithophore bloom," he said. "If this had happened in an area where we didn't have those resources, we would not have been able to do something this interesting."

More research stories from the Santa Barbara Channel can be found in The Current's featured compilation, [Channel for Discovery](#).

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.