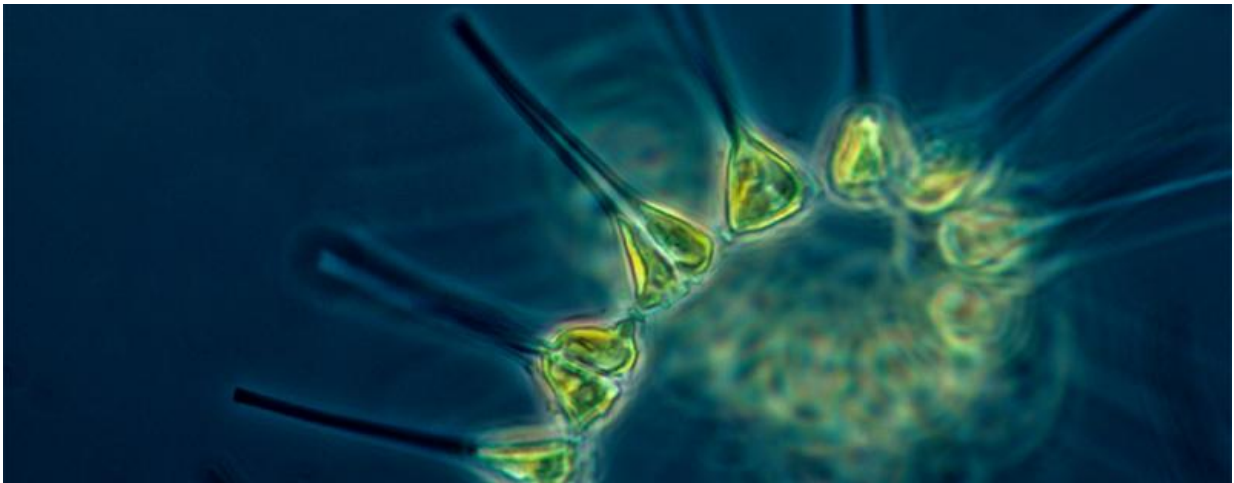


Tiny phytoplankton have big influence on climate change

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Phytoplankton, the single-celled plants that perform half of the world's photosynthetic activity, are sensitive to climate change. New research is shedding light on how their populations will rise, fall and shift as the Earth warms. Credit: NOAA

As nations across the globe negotiate how to reduce their contributions to climate change, researchers at Penn are investigating just how the coming changes will impact the planet. What's clear is that the effect extends beyond simple warming. Indeed, the very physics and chemistry of the oceans are also shifting, and are forecast to change even more in the coming decades.

These changes have implications for, among other things, the single-celled organisms that comprise the base of the ocean's [food web](#) and are responsible for half of the world's [photosynthetic activity](#): [phytoplankton](#). Not only are phytoplankton sensitive to changes in climate, they also contribute to those changes, as they can remove carbon from the atmosphere and store it deep in the ocean when they die.

A micrograph of phytoplankton. Like plants on land, phytoplankton growth is controlled by [environmental factors](#) such as light, nutrients, and temperature.

Irina Marinov, an assistant professor in the University of Pennsylvania's Department of Earth & Environmental Science in the School of Arts & Sciences, and her lab members have published two studies this fall that concern themselves with what climate models have to say about how phytoplankton and ocean ecosystems will respond to the profound changes the Earth is undergoing.

"The goal is to understand model projections of ocean ecology, productivity, and biogeochemistry for the year 2100, and check the consistency of those predictions across the current generation of climate models," says Marinov.

The latest Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), released in 2013, included 16 different models, each produced by different groups working around the globe. Marinov and colleagues, including recent graduate Shirley Leung and postdoc Anna Cabré, investigated how phytoplankton would be predicted to respond to such changing variables as [nutrients](#), light, and [ocean](#) stratification under each of the models.

Their analyses reveal complex patterns of phytoplankton response. In a paper in *Biogeosciences*, they show that, in the Southern Ocean, future

[climate change](#) will bring increases or decreases in phytoplankton abundance and production in distinct latitudinal bands—a pattern the researchers had not anticipated.

"Because with climate change you have less mixing of the water column, we thought that the phytoplankton would have more access to light and they would simply expand, but instead we saw these bands of high and low abundance," Cabré says.

Phytoplankton are very sensitive to mineral availability, including nitrate and iron, and also to light. The team found that the latitudinal bands correspond to increased iron, which increased phytoplankton productivity from 40 to 50 degrees South, decreased light driven by changes in winds and clouds, which decreased productivity from 50 to 65 degrees South; and increased light due to more sea-ice melting in the summer, which increased productivity along the Antarctic shores.

"Intriguingly, the trends in phytoplankton productivity predicted by the models are in line with what has already been observed over the past 20 or 30 years," says Marinov, "suggesting that the climate change signal might have already become apparent in parts of the Southern Ocean."

Another of the group's studies, published in *Climate Dynamics*, looked beyond the Southern Ocean to include trends in phytoplankton production across all of the Earth's biomes. They found that, while high latitudes are predicted to have increases in phytoplankton production on average, the overall global trend is toward decreased production—meaning that an important climate sink of carbon dioxide will slowly shrink.

The researchers plan to continue probing the IPCC [climate models](#), but also hope that new data will allow them to refine their predictions about the oceans' role in climate change.

"We need more observations," Cabré says. "There are a lot of new missions going to the Southern Ocean. Our analyses can help them figure out what they need to look for, and their findings will push our analyses forward."

More information: S. Leung et al. A latitudinally banded phytoplankton response to 21st century climate change in the Southern Ocean across the CMIP5 model suite, *Biogeosciences* (2015). [DOI: 10.5194/bg-12-5715-2015](https://doi.org/10.5194/bg-12-5715-2015)

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