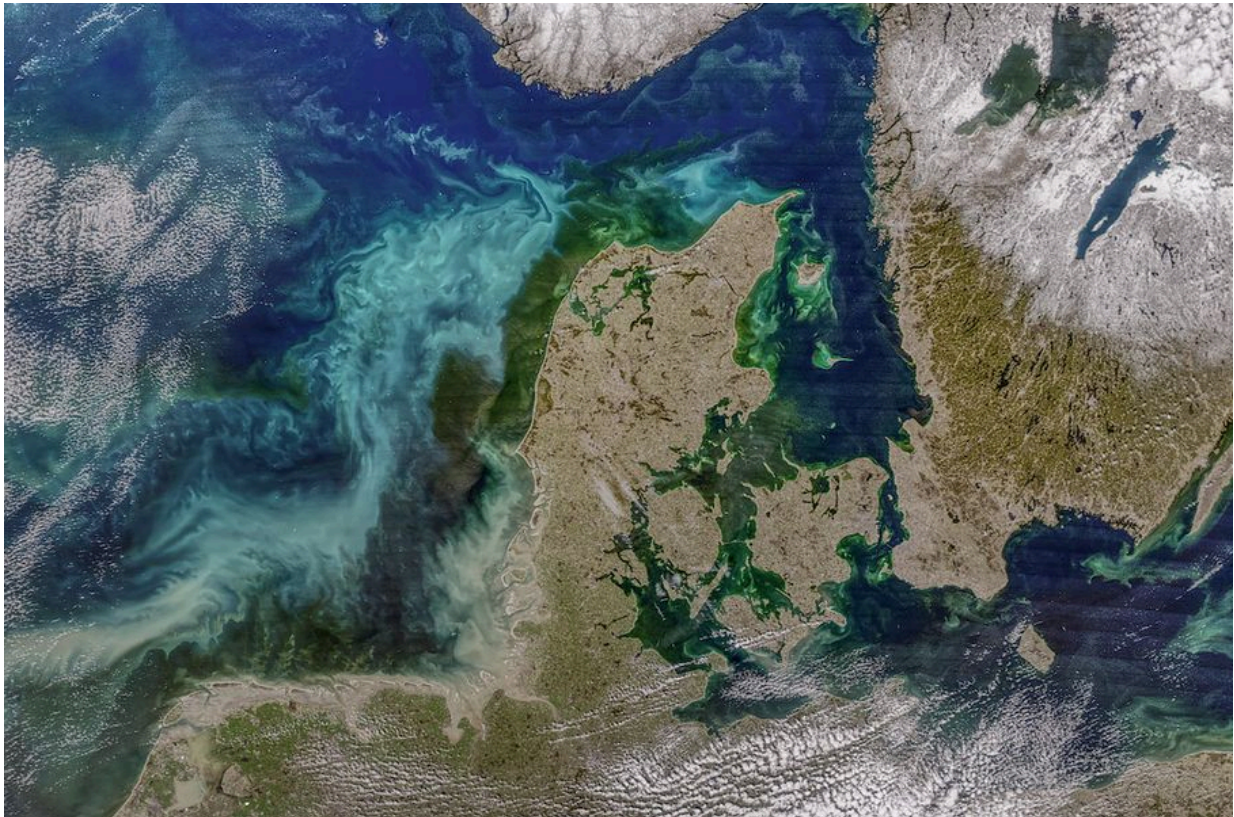


Climate change impacting ocean's color

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The ocean's color has changed significantly over the last 20 years, and the global trend is likely a consequence of human-induced climate change, scientists, including one from Oregon State University, report in a [new study](#).

In the study published in *Nature*, the team, which includes researchers from National Oceanography Center in the U.K., MIT and the University of Maine, writes that they have detected changes in ocean color over the past two decades that cannot be explained by natural, year-to-year variability alone.

These color shifts, though subtle to the human eye, have occurred over 56% of the world's oceans — an expanse that is larger than the total land area on Earth.

In particular, the researchers found that tropical ocean regions near the equator have become steadily greener over time. The shift in ocean color indicates that ecosystems within the surface ocean must also be changing, as the color of the ocean is a literal reflection of the organisms and materials in its waters.

At this point, the researchers cannot say how exactly marine ecosystems are changing to reflect the shifting color. But they are pretty sure of one thing: Human-induced climate change is likely the driver.

“This gives additional evidence of how human activities are affecting life on Earth over a huge spatial extent,” said lead author B. B. Cael of the National Oceanography Center. “It’s another way that humans are affecting the biosphere.”

The ocean’s color is a visual product of whatever lies within its upper layers. Generally, waters that are deep blue reflect very little life, whereas greener waters indicate the presence of ecosystems, and mainly phytoplankton — plant-like microbes that are abundant in the upper ocean and that contain the green pigment chlorophyll. The pigment helps plankton harvest sunlight, which they use to capture carbon dioxide from the atmosphere and convert it into sugars.

Phytoplankton are the foundation of the marine food web that sustains progressively more complex organisms, on up to krill, fish, and seabirds and marine mammals. Phytoplankton are also a powerful muscle in the ocean’s ability to capture and store carbon dioxide. Scientists are therefore keen to monitor phytoplankton across the surface oceans and to see how these essential communities might respond to climate change.

In the current study, Cael and the team, including Kelsey Bisson, an oceanographer at Oregon State, analyzed measurements of ocean color taken by the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Aqua satellite, which has been monitoring ocean color for 21 years. They used MODIS measurements in seven visible wavelengths, including the two colors researchers traditionally use to estimate chlorophyll.

“Being able to quantify detectable trends from satellites opens up many new avenues of research that are also relevant for policy changes, such as legal protection against certain activities for the high seas,” said Bisson an assistant professor (senior research) in Oregon State’s College of Agricultural Sciences. “There are some dedicated field stations in the areas identified as having a trend, which can be used in tandem with our results to uncover specifically how and why the ecosystem is changing.”

The differences in color that the satellite picks up are too subtle for human eyes to differentiate. Much of the ocean appears blue to our eye, whereas the true color may contain a mix of subtler wavelengths, from blue to green and even red.

Cael carried out a statistical analysis using all seven ocean colors measured by the satellite from 2002 to 2022 together. He first looked at how much the seven colors changed from region to region during a given year, which gave him an idea of their natural variations. He then zoomed out to see how these annual variations in ocean color changed over a longer stretch of two decades. This analysis turned up a clear trend, above the normal year-to-year variability.

To see whether this trend is related to climate change, he then looked to a model developed in 2019 by Stephanie Dutkiewicz of MIT. This model simulated the Earth’s oceans under two scenarios: one with the addition of greenhouse gases, and the other without it. The greenhouse-gas model predicted that a significant

trend should show up within 20 years and that this trend should cause changes to ocean color in about 50% of the world's surface oceans — almost exactly what Cael found in his analysis of real-world satellite data.

The study's co-authors also include Stephanie Henson of the National Oceanography Center and Emmanuel Boss of the University of Maine.

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