

# Breaking waves propel ancient molecules into the air

October 24 2019

---



Steven Beaupré at sea with the generator used to study how aerosol production carries ancient organic matter from the ocean to the atmosphere. Credit: Stony Brook University

A discovery that helps explain how organic matter produced by life thousands of years ago is ultimately removed from the sea has been published in *Science Advances* by Steven Beaupré of Stony Brook University's School of Marine and Atmospheric Sciences (SoMAS) and a national team of scientists.

When waves crash in the [ocean](#), they inject tiny particles into the air (called aerosols) that carry [organic molecules](#) more than 5,000 years old, the study finds.

Decades of measurements have revealed that nearly all of the [organic matter](#) dissolved in the oceans is surprisingly old—up to several thousand years. But scientists do not completely understand how this ancient organic matter is eventually destroyed. Beaupré and colleagues performed experiments to show that some of this ancient organic matter can be removed from seawater when wave-generated [air bubbles](#) burst on the [ocean surface](#) and inject aerosols into the atmosphere. By directly measuring the radiocarbon ( $^{14}\text{C}$ ) ages of the aerosols, they estimate that somewhere between 19 and 40 percent of the [aerosol](#) organic matter is at least 5,000 years old.

Prior experiments by Beaupré 's colleagues David Kieber (SUNY ESF) and Bill Keene (University of Virginia) suggested that old organic [molecules](#) might leave the ocean as stowaways aboard these [tiny particles](#)

"Our new study shows that a significant proportion of that organic matter is indeed quite old, and that the formation of aerosols by breaking waves could be a significant removal pathway for the old carbon found in the sea," says Beaupré, lead author and assistant professor.

This pool of ancient organic matter is massive, holding about as many carbon atoms in the ocean as there are in all of the vegetation on land or

in all of the carbon dioxide (CO<sub>2</sub>) in the atmosphere. It is primarily created by photosynthesis and therefore represents a long-term storage reservoir for atmospheric CO<sub>2</sub>, which is a potent greenhouse gas. Therefore, it is important to understand what processes ultimately break down these ancient molecules into something that can be used again by nature.

Once in the atmosphere, these aerosolized molecules are likely to be broken down by sunlight into CO<sub>2</sub> and other molecules that are more palatable to marine life. Accordingly, emphasizes Beaupré, this finding has implications for both oceanic and atmospheric biogeochemistry, as well as the global carbon cycle and climate.

Beaupré also says the results were somewhat surprising because it is generally believed that only the youngest organic molecules are likely to be injected into the atmosphere by breaking waves. This is because the ancient molecules should have degraded to less reactive forms during their prolonged exposure to the environment.

"Despite the effects of aging for thousands of years, our results suggest that even some of the oldest molecules in the sea can compete with the youngest to grab hold of rising bubbles and rocket into the sky," he says.

The research team used a special aerosol generator to study this process during a month-long cruise to the North Atlantic Ocean. The device produced aerosols by closely mimicking the bubbles plumes created by breaking waves, as described in a companion paper also published online and co-authored by Beaupré in the *Journal of Geophysical Research-Atmospheres*.

They measured the [chemical composition](#) and radiocarbon ages of seawater flowing through the generator and of the aerosols that it produced. Combined with measurements of the particle sizes, they

concluded that the aerosolized organic matter could survive for about a week in the atmosphere, where it could be carried inland by winds, chemically degraded, and/or redeposited in the ocean.

While future research will address the rate at which ancient organic matter is spewed from ocean by breaking waves, the research team will also investigate other ways in which marine organic matter is removed from the sea.

**More information:** Amanda A. Frossard et al. Marine Aerosol Production via Detrainment of Bubble Plumes Generated in Natural Seawater With a Forced-Air Venturi, *Journal of Geophysical Research: Atmospheres* (2019). [DOI: 10.1029/2019JD030299](https://doi.org/10.1029/2019JD030299)

Steven R. Beaupré et al. Oceanic efflux of ancient marine dissolved organic carbon in primary marine aerosol, *Science Advances* (2019). [DOI: 10.1126/sciadv.aax6535](https://doi.org/10.1126/sciadv.aax6535)

Provided by Stony Brook University

Citation: Breaking waves propel ancient molecules into the air (2019, October 24) retrieved 19 April 2024 from <https://phys.org/news/2019-10-propel-ancient-molecules-air.html>

<p>This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.</p>
--