Seasonal carbonate chemistry variability in marine surface waters of the US Pacific Northwest

Fingerprinting ocean acidification (OA) in US West Coast waters is extremely challenging due to the large magnitude of natural carbonate chemistry variations common to these regions. Additionally, quantifying a change requires information about the initial conditions, which is not readily available in most coastal systems. In an effort to address this issue, we have collated high-quality publicly available data to characterize the modern seasonal carbonate chemistry variability in marine surface waters of the US Pacific Northwest. Underway ship data from version 4 of the Surface Ocean CO_2 Atlas, discrete observations from various sampling platforms, and sustained measurements from regional moorings were incorporated to provide ~ 100000 inorganic carbon observations from which modern seasonal cycles were estimated. Underway ship and discrete observations were merged and gridded to a 0.1° × 0.1° scale. Eight unique regions were identified and seasonal cycles from grid cells within each region were averaged. Data from nine surface moorings were also compiled and used to develop robust estimates of mean seasonal cycles for comparison with the eight regions. This manuscript describes our methodology and the resulting mean seasonal cycles for multiple OA metrics in an effort to provide a large-scale environmental context for ongoing research, adaptation, and management efforts throughout the US Pacific Northwest. Major findings include the identification of unique chemical characteristics across the study domain. There is a clear increase in the ratio of dissolved inorganic carbon (DIC) to total alkalinity (TA) and in the seasonal cycle amplitude of carbonate system parameters when moving from the open ocean North Pacific into the Salish Sea. Due to the logarithmic nature of the pH scale ($pH = -\log_{10}[H^+]$, where $[H^+]$ is the hydrogen ion concentration), lower annual mean pH values (associated with elevated DIC : TA ratios) coupled with larger magnitude seasonal pH cycles results in seasonal $[H^+]$ ranges that are ~ 27 times larger in Hood Canal than in the neighboring North Pacific open ocean. Organisms living in the Salish Sea are thus exposed to much larger seasonal acidity changes than those living in nearby open ocean waters. Additionally, our findings suggest that lower buffering capacities in the Salish Sea make these waters less efficient at absorbing anthropogenic carbon than open ocean waters at the same latitude.

Fassbender A. J., Alin S. R., Feely R. A., Sutton A. J., Newton J. A., Krembs C., Bos J., Keyzers M., Devol A., Ruef W. & Pelletier G., 2018. Seasonal carbonate chemistry variability in marine surface waters of the US Pacific Northwest. *Earth System Science Data* 10 (3): 1367-1401. Article.

Interactive effects of temperature, CO2 and nitrogen source on a coastal California diatom assemblage

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Abstract

Diatoms are often considered to be a single functional group, yet there is a great deal of morphological, genetic and ecological diversity within the class. How these differences will translate into species-specific responses to rapid changes in the ocean environment resulting from climate change and eutrophication is currently poorly understood. We investigated the response of a natural diatom-dominated assemblage in coastal California waters to interactions between the variables nitrogen source (nitrate and urea), temperature (19 and 23°C) and CO2 (380 and 800 ppm) in a factorial experimental matrix using continuous culture (ecostat) methods. The community included diatoms of the cosmopolitan genera Pseudo-nitzschia and Chaetoceros, as well as Leptocylindrus and Cylindrotheca. Our results demonstrate strong interactive effects of these variables on community composition; notably, nitrogen source alone and nitrogen and CO2 together had a much greater influence on diatom community structure at 23°C compared with 19°C. In addition, warming and acidification interactions significantly increased cellular quotas of the neurotoxin domoic acid produced by Pseudo-nitzschia multiseries. In general, the effects observed for the factors tested differed significantly between the various diatom genera in this assemblage, suggesting potentially divergent responses of some of these ecologically and biogeochemically important phytoplankton taxa to interactions between globalscale and local-scale anthropogenic stressors in a changing ocean.

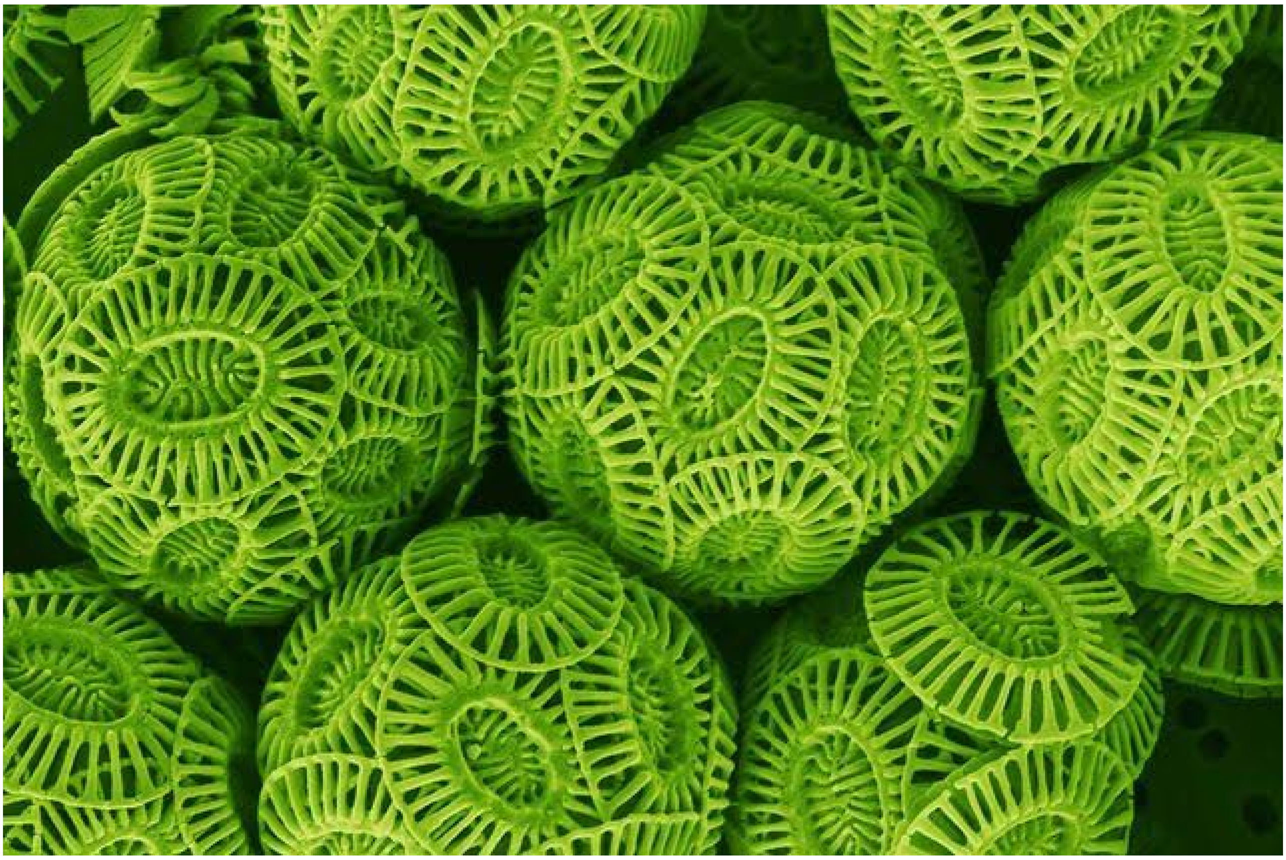
Paper

www.c-can.info/reference/Tattersetal2018JPR.pdf

UCLA research shows how carbon-filled oceans affect a tiny but important organism

Single-celled coastal coccolithophores appear resilient to high levels of carbon dioxide

David ColganAugust 03, 2018



Coccolithophores, shown here under magnification, are food sources for small fish and zooplankton, and they also remove huge amounts of carbon from the ocean. — hhmi.org

They’re impossible to see with the naked eye. They’re difficult to pronounce.

But coccolithophores, a single-celled plankton, have an outsized effect on oceans due to their sheer quantity — their blooms are visible from space — and because of the fundamental role they play in food chains and the carbon cycle. Small fish and zooplankton feast on them, and they remove huge amounts of carbon from the ocean.

A quarter of the carbon dioxide humans put into the atmosphere ends up in oceans, where it reacts chemically and makes the water more acidic. This disrupts a variety of marine life, inhibiting some species — including corals, clams and other mollusks — from forming shells and skeletons. So as the threat of ocean acidification, which has emerged as a companion to climate change, looms large, scientists have become concerned that increasing acidification will jeopardize the health of these crucial carbon-absorbing creatures and add another lifeform to the list of species threatened by pollution.

But research published in Nature Communications uncovered good news for coastal varieties of the plankton — those changes in ocean chemistry don’t appear to bother them.

“We found that they were very resilient to high levels of carbon dioxide,” said Robert Eagle, author of the paper and UCLA assistant professor who works at the intersection of biology, oceanography and climate science. Eagle is part of growing contingent of scientists investigating coccolithophores because of the role they play in the carbon cycle and ecosystems. “In some cases, you find the plankton do much better. They grow faster.”

To test the resilience of the coccolithophores, scientists took live samples and put them in tanks of ocean water. They added extra carbon dioxide to the water — levels matching projections of how much could be in the ocean by the middle or end of the century. The plankton appeared to be utilizing the extra carbon dioxide in the water to grow.

Bloom of coccolithophores visible from space.

The findings stand in contrast to what was found in previous studies on open ocean species of coccolithophores, some of which were negatively affected by ocean acidification. Eagle suggested coastal species may be hardier because they’ve had to evolve to a variable environment, living in places where water acidity changes because of upwelling, ocean currents and other natural phenomena.

He cautioned against too much optimism with the findings, however.

“The fact that some things are negatively impacted and others aren’t isn’t necessarily a good thing,” Eagle said. “It’s still going to drive a huge ecosystem shift in the ocean.”

Because of their place at the bottom of food chains, Eagle said, major shifts in the numbers and location of coccolithophores would likely affect creatures higher up — all the way to apex predators — which all depend on the single-celled creatures, directly or indirectly, for sustenance.

Since coccolithophores are “carbon fixers” that take carbon dioxide out of the environment, some scientists and engineers proposed using them as a solution to global emissions and climate change, Eagle said. But that idea met with skepticism. As anyone who has ever owned a salt-water aquarium knows, oceans are complicated systems. Numerous other variables including temperature, currents, salinity, pollution and overfishing all affect marine life and ecosystems. Scaling up an operation that would use coccolithophores to make a global impact would present not just technological hurdles, but could negatively impact oceans in ways that are hard to predict.

Learning more about the organisms is vitally important to understanding the interplay of climate change and oceans, said Yi-Wei Liu, the paper’s lead author. There are still a lot of unknowns, though more researchers are paying closer attention these days.

“Coccolithophores account for half of the calcium carbonate creation in the ocean,” Liu said. “They could potentially sequester carbon from the atmosphere down to the ocean and then sediments.”

“And we can use them to reconstruct paleoclimates,” she added. Finding out how coccolithophores reacted to changes in prehistoric climates could give scientists better vision of what may happen as our contemporary climate changes in decades and centuries to come.

Original post: http://newsroom.ucla.edu/

Can seagrass help fight ocean acidification?

Of course, the only way to truly fight ocean acidification reducing emissions

Seagrass off the coast of California’s Channel Islands. *Credit: Photographer: Claire Fackler, CINMS, NOAA.*

Seagrass meadows could play a limited, localized role in alleviating ocean acidification in coastal ecosystems, according to new work led by Carnegie’s David Koweek and including Carnegie’s Ken Caldeira and published in *Ecological Applications*.

When coal, oil, or gas is burned, the resulting carbon dioxide is released into the atmosphere where it is the driving force behind global climate change. But this atmospheric carbon dioxide is also absorbed into the ocean where chemical reactions with the seawater produce carbonic acid, which is corrosive to marine life, particularly to organisms like mussels and oysters that construct their shells and exoskeletons out of calcium carbonate.

Seagrasses provide an important source of food and shelter for marine animals, help fight erosion of the sediments that form the sea bed, and filter bacterial pathogens from the water. They also take up carbon dioxide as part of their daytime photosynthetic activity.

Research has already demonstrated that the estuaries and bays of California’s coastline are experiencing ocean acidification. So, the team set out to test the theory that carbon dioxide uptake by seagrass meadows could buffer the pH of the ocean water in their immediate surroundings and help to fight off the effects of acidification in the short term.

They combined data from seagrass meadows in Tomales Bay, an inlet of the Pacific Ocean in California’s Marin County, with sophisticated modeling tools that accounted for a variety of factors including, the amount of seagrass within the meadow, seasonal variation in photosynthetic activity and nighttime respiration, water depth, and tidal currents.

“Local stakeholders, such as California’s shellfish industry, want to know whether seagrass meadows may help to counteract ocean acidification,” Koweek said. “Our results suggest that seagrass meadows along the California coast will likely offer only limited ability to counteract ocean acidification over long periods of time.”

On average, the computer simulations predicted that the seagrass meadows would turn back the clock on ocean acidification a few decades, a small offset to the more than

150 years of acidification — a process that is now happening more quickly than ever with increasing fossil fuel emissions.

However, there were small time windows where their models show that seagrass meadows were able to offer much greater buffering. These occurred during periods when low tides occurred during the daytime when photosynthesis occurs. Koweek and Caldeira say that these offer important opportunities.

This level of buffering could make an impact in aquaculture endeavors or even in natural shellfish communities where marine organisms are able to align their calcification activity with the seagrass buffering periods.

“We are starting to understand that some marine organisms, such as blue mussels, are actually able to shift the time of day in which they do most of their calcification. If other organisms are able to do the same, then even brief windows of significant ocean acidification buffering by seagrass meadows may bring substantial benefits to the organisms that live in them,” Koweek said.

Koweek and Caldeira are grounded in their optimism for solutions to stop ocean acidification around the world.

“Of course, the only way to truly fight ocean acidification is to rapidly and permanently reduce the rate at which we are spewing carbon dioxide emissions into the sky,” Caldeira noted.

“However,” added Koweek, “seagrass meadows are a critical part of California’s coastline. Although our results indicate that seagrass meadows along the California coast are not likely to offer long-term buffering to fight ocean acidification, their enduring role as habitat for marine organisms, protectors against sea level rise, and magnets of biodiversity should be more than enough reason to restore and protect these iconic ecosystems.”

Original post: https://www.sciencedaily.com/releases/2018/07/180731141632.htm

Source: Carnegie Institution for Science

Summary: Seagrass meadows could play a limited, localized role in alleviating ocean acidification in coastal ecosystems, according to new work.

News OSU study: size key to ocean acidification response

Calliarthron_tuberculosum, a type of coralline algae in the Pacific Northwest (Photo: Allison Barner/OSU)

CORVALLIS, Ore. – New findings from a former Oregon State University researcher suggests size is the main factor that predicts how calcifying organisms will respond to ocean acidification.

The findings shed key light on which information is most important for projecting the effects of ocean acidification, a byproduct of rising carbon dioxide levels in the atmosphere.

Previously, many different drivers had been proposed to predict how different species will respond to ocean acidification, including evolutionary relatedness, habitat, and morphology.

But a study of five species of coralline algae found that these factors play far less role in physiological performance in the face of sinking pH levels than the organism's size.

"Decades of research have shown that calcifying species are negatively affected by ocean acidification," said the study's corresponding author, Allison Barner, who did the research while completing her Ph.D. in integrative biology at Oregon State University. "But even closely related species can have different responses to acidification and not much was known about the drivers that shape this variation."

About 30 percent of the carbon dioxide in the air ends up in the sea, where it causes a reduction in carbonate ions – a key building block for a variety of calcifying organisms, including not only the algae in the study, but also animals like mussels, sea stars, oysters and corals.

Barner and colleagues in the OSU College of Science tested multiple hypotheses for predicting how the five species of turf-forming algae, native to the Pacific Northwest coast, would perform physiologically in acidified conditions.

In addition to running experiments that simulated future ocean acidification conditions, Barner and colleagues measured a suite of properties for each species, including its habitat distribution along the Oregon coastline and its size, surface area and shape.

“All of the species had declining calcification with short-term increases in acidification,” said Barner, now a postdoctoral scholar at the University of California, Berkeley. “And the findings supported the hypothesis that organismal size is the best predictor of an individual’s physiological performance under acidified conditions. Importantly, we can rule out the scenario that each species might have a different response to ocean acidification.”

By understanding the factors that control species response, Barner says, scientists may be able to better predict how groups of organisms might respond to ocean acidification and other climate change factors, beyond one species at a time.

The species studied were Corallina officinalis, Corallina vancouveriensis, Calliarthron tuberculosum, Bossiella orbiginiana and Bossiella plumosa.

“Coralline algae are among the most vulnerable calcifying species to an acidifying ocean,” Barner said. “The ecological consequences of coralline algae decline are likely to be high, as they play key roles in many marine ecosystems.”

Previous experiments from the same researchers found that in Oregon, coralline algae act as a “nursery” for other species, providing habitat for a diverse assemblage of animals and seaweeds.

Findings from the most recent research were published Wednesday in [Global Change Biology](#).

The U.S. Environmental Protection Agency, the National Science Foundation, the David and Lucille Packard Foundation, the OSU Hatfield Marine Science Center Marnie Markham Research Grant, the Kingfisher Foundation, the Wayne and Gladys Valley

Foundation, and the OSU Integrative Biology Research Fund supported this study.

KTVZ.COM, 26 July 2018. [Article].