Pacific Islands Climate Change Cooperative

Ocean acidification accelerates coral bleaching under current and future conditions

Scientists have assessed one of Hawai‘i’s most common reef corals for its response to three primary environmental stressors and confirmed that ocean acidification can accelerate bleaching and mortality and slow down recovery from stress, particularly in combination with rising temperatures and exposure to strong sunlight. Experiments described interactions between temperature, water chemistry, and radiation from the sun on growth and mortality in the reef coral species *Montipora capitata*.

Coral reefs are among the most biologically productive and diverse ecosystems in the world. Ocean acidification is one of the most ubiquitous impacts worldwide resulting from increasing CO_2 (carbon dioxide) concentrations in Earth’s atmosphere, a large portion of which dissolve in the world’s oceans.

The interaction of sun, CO_2, and temperature

Both higher temperatures and increased levels of CO_2 are known to be detrimental to corals when acting in isolation, but little is known about their combined effects, or how they interact with sunlight. Contrary to the popular image of shallow reefs thriving and sparkling under sun-drenched skies, corals can be highly sensitive to solar radiation. Bleaching is the process whereby algae that live in coral tissues die or lose the pigments necessary for photosynthesis. Intense bleaching is often a precursor of coral death because corals cannot live for long without these algae. During bleaching events, higher than normal water temperatures, low wind, lack of cloud cover and highly transparent water all contribute to extremely high levels of solar radiation. What effects do these conditions have on stressed corals?

Coral bleaching and die off accelerated

For this project, corals were grown under three levels of solar radiation (100%, 50%, 8%), two levels of CO_2 concentration (present day levels and twice present), and various regimes ranging up to the high temperatures that will occur during this century due to global warming.

Researchers found that while the degree of solar radiation is the primary driver of coral bleaching and mortality, ocean acidification can accelerate both at all temperatures. At future conditions of both high temperature and high solar radiation, initial bleaching occurs sooner when the CO_2 concentrations

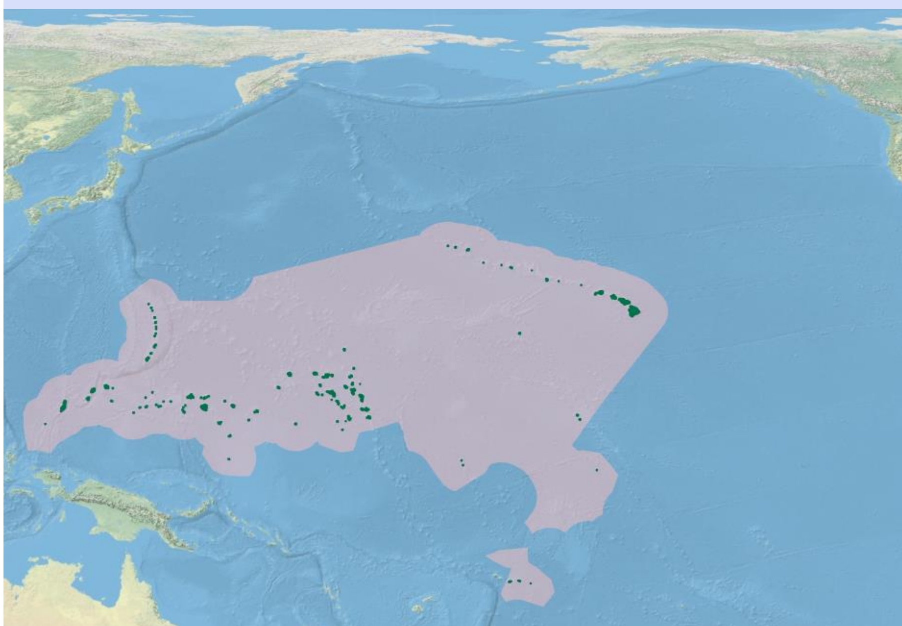
are also high (i.e., the ocean is more acidic). Growth rates of coral are also suppressed under future conditions of high temperature and ocean acidification, even without increased solar radiation. At future conditions that combine all three factors - higher temperatures, solar radiation and acidification - coral growth, mortality, bleaching response and recovery rate are all negatively affected.

Implications for management

This study, supported by the Pacific Islands Climate Change Cooperative, will allow further development of models that can evaluate and project climate change impacts on Pacific coral reef communities. Researchers observed increased recovery in corals exposed only to a single stressor in contrast to those exposed to multiple stressors. This means conservation strategies that can address even one or two of the three primary reef stressors may be significant and effective. Furthermore, deep reefs can provide refuge from heat and harsh sun while shallow reefs will likely be most immediately impacted by future climate change.

Additional benefits of this study include the training of two undergraduate students, the publishing of 15 scientific papers, and the development of a novel method for conducting studies of coral reef metabolism under realistic conditions. This new method permits long-term experiments under full sunlight with rapid sea water turnover rate. The method allows calculation of net changes in ocean chemistry throughout the daily cycle. For more information, visit the PICCC projects page: piccc.net/our-projects.

The map below depicts the PICCC geography, which includes Hawai‘i, American Sāmoa, Guam, the Northern Mariana Islands, the Marshall Islands, the Federated States of Micronesia, Palau and 4 Marine National Monuments.



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The Pacific Islands Climate Change Cooperative (PICCC) was established in 2009 to assist those who manage native species, island ecosystems, and key cultural resources in adapting their management to climate change for the continuing benefit of the people of the Pacific Islands. The PICCC provides a range of services and tools to help managers in Hawai‘i, the Mariana Islands, American Sāmoa, and other Pacific Island groups make informed decisions for conservation of natural and cultural resources including climate models at the scale of islands and archipelagos, ecological response models, and implementation and monitoring strategies for island species, resources, and communities. Our goal is to help managers reach explicit biological and cultural conservation objectives in the face of climate change and ongoing threats such as fire, land conversion, and invasive species.

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