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Preindustrial to Modern Decadal Variability in Coral Reef pH

C. Pelejero (1,4), E. Calvo (1), M. T. McCulloch (1), J. F. Marshall (1), M. K. Gagan (1), J. M. Lough (2) and B. N. Opdyke (3)

(1) Research School of Earth Sciences, The Australian National University, Canberra, Australia, (2) Australian Institute of Marine Science, Townsville, Australia, (3) Earth and Marine Sciences, The Australian National University, Canberra, Australia, (4) Now at Institut de Ciències del Mar, CMIMA-CSIC, Barcelona, Catalonia, Spain. (pelejero@cmima.csic.es / Fax: +34 93-2309555 / Phone: +34 93-2309523 Ext: 1143)

Since the beginning of the industrial revolution, burning of fossil fuels has increased the CO_2 content of the atmosphere from $\sim$280 to over 370 p.p.m.v., a level unprecedented in the last 420 kyr. Predictions indicate that this release of anthropogenic CO_2 could lead to a reduction in surface ocean pH of nearly 0.8 units by 2300 AD, which is unprecedented in the last 300 million years. This acidification will have adverse consequences for marine biota, including calcareous plankton and coral reef communities. However, the fate of individual species will depend on their past acclimatisation and ability to adapt, and will remain unknown until the preindustrial range of surface ocean pH is quantified. In the present study, we use the isotopic composition of boron in a massive Porites coral from Flinders Reef (17.5ºS, 148.3ºE), western Coral Sea, to reconstruct reef-water pH since $\sim$1700 AD. We find surprisingly large variations in pH ($\sim$0.3 units) in 55-yr cycles that are well correlated with the Interdecadal Pacific Oscillation (IPO). Reductions in western Pacific trade-wind velocity, sea level, and ventilation of reef waters may explain seawater pH reductions during positive phases of the IPO. Our results indicate that Flinders Reef corals survived large 'natural' swings in pH that were larger than the shift brought about, so far, by the build-up of atmopsheric CO_2. This study also suggests that the effects of the progressive acidification of the oceans in coral reefs will likely be very different from site to site. Reefs like Flinders, where ventilation of waters play an important role, will be specifically threatened at times when ocean currents are weakest.