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Response of reef calcification to diurnal changes in the calcium carbonate saturation state: confounding effect of light

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There is now ample experimental evidence that many calcifying organisms, including reef dwellers, and mesocosms are negatively impacted by elevated carbon dioxide. Predictions of the decline in calcification during the period 1880-2065 range from about 10 to 83%. There is, however, little field data supporting this prediction. Retrospective approaches have so far failed to provide evidence that coral calcification has declined in the past 200 years. Additionally, only few studies investigated the response of reef communities to natural changes in the carbonate chemistry. One may find this surprising as high rates of primary production, respiration and calcification in relatively shallow environments generate considerable diurnal changes in the $CaCO_3$ saturation state (ca. 2 to 5) in some reef settings. This seems ideal to investigate the response of net calcification of natural communities to changes in the carbonate chemistry under unmanipulated conditions. Until now, only two studies have used this opportunity. Both concluded that net calcification strongly depends on the saturation state and is lower at low than at high values of $CaCO_3$ saturation.

I will revisit data collected earlier on two barrier reef flats (Moorea, French Polynesia, and Yonge Reef, Great Barrier Reef). The data demonstrate large diurnal changes in net calcification which are positively correlated with $CaCO_3$ saturation, as suggested by the two studies mentioned above. However, the $CaCO_3$ saturation state co-varies with irradiance, a well known control of calcification in reef organisms. High irradiance leads to high rates of net primary production, low pCO2 and high $CaCO_3$ saturation. At night, community respiration and net calcification generate CO_2, leading to a dramatic decrease in $CaCO_3$ saturation. Disentangling the respective effects

of light and $CaCO_3$ saturation on reef calcification in the field is not straightforward. There is little doubt that the carbonate chemistry is a controlling factor but irradiance is likely the major one. I will argue that the recent studies suggesting that reef calcification strongly depends on carbonate chemistry may have overlooked the effect of irradiance.